

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

DISH NETWORK CORP.; DISH NETWORK LLC; AND
DISH NETWORK SERVICE LLC,

Petitioners

v.

ENTROPIC COMMUNICATIONS, LLC

Patent Owner.

PTAB Case No. IPR 2023-00392

Patent No. 7,542,715

**DECLARATION OF DAN SCHONFELD, PH.D.
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW OF U.S.
PATENT NO. 7,542,715**

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EXHIBIT LIST

Ex.1001	U.S. Patent No. 7,542,715 (“’715 patent”)
Ex.1002	Declaration of Dr. Dan Schonfeld (“Schonfeld”) and Appendices A-C Thereto (including CV)
Ex.1003	International Publication No. WO 2002/065771 (“Fisk”)
Ex.1004	European Patent No. EP0740434B1 (“Carnero”) (Certified English Translation with Translator’s Affidavit)
Ex.1005	U.S. Patent No. 5,073,930 (“Green”)
Ex.1006	U.S. Patent Pub. No. 2002/0154055 (“Davis”)
Ex.1007	U.S. Patent No. 5,959,592 (“Petruzzelli”)
Ex.1008	U.S. Patent No. 6,134,419 (“Williams”)
Ex.1009	<i>Entropic Communications v. DirectTV, LLC</i> , Case No. 2:22-cv-07775-JWH-JEM, C.D. Cal., Plaintiff’s Claim Construction Statement, December 1, 2022
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Ex.1013	U.S. Patent No. 4,455,651 (“Baran”)
Ex.1014	Dan Logan, The Scoop on the Dish, Los Angeles Times (1996), https://www.latimes.com/archives/la-xpm-1996-09-07-hm-41715-story.html
Ex.1015	U.S. Patent No. 4,675,732 (“Oleson”)
Ex.1016	File History - U.S. Patent No. 7,130,576 File History (family member of ’715 patent) (“’576 FH”)
Ex.1017	File History - U.S. Patent No. 7,130,576 Reexamination History (family member of ’715 patent) (“’576 Reexam”)
Ex.1018	IEEE 802.11, Wikipedia (2022), https://en.wikipedia.org/wiki/IEEE_802.11

Ex.1019	Customer Experience, What is the Difference Between RG59 and RG6?, Sewell Direct (2019), https://sewelldirect.com/blogs/learning-center/what-is-the-difference-between-rg59-and-rg6
Ex.1020	Site Editor, RG6 vs RG59: Which Should You Buy?, Foshan New King Cable Industrial Co., Ltd. (2020), https://newkingcable.com/rg6-vs-rg59-which-one-to-choose.html
Ex.1021	Coaxial cable, Wikipedia (2022), https://en.wikipedia.org/wiki/Coaxial_cable
Ex.1022	Product Coaxial Cable, Caledonian (2022), https://www.caledonian-cables.co.uk/products/coaxial-cable/CT_Series/CT125.shtml
Ex.1023	Products Coaxial Cable, Addison (2022), https://www.addison-cables.com/product/coaxial%20cables/CT%20Series%20Coaxial%20Cables/CT125.htm
Ex.1024	Virtual Channel, Wikipedia (2022), https://en.wikipedia.org/wiki/Virtual_channel
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Ex.1026	U.S. Patent No. 6,493,873 (“Williams ’873”)
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Ex.1035	U.S. Patent No. 4,677,588 (“Benjamin”)
Ex.1036	U.S. Patent No. 7,123,649 (“Smith”)
Ex.1037	U.S. Patent No. 6,408,436 (“de Haas”)

I, Dan Schonfeld, Ph.D., declare as follows:

1. I have been retained as an expert consultant by DISH Network Corporation, DISH Network L.L.C., and Dish Network Service L.L.C. (“Petitioners”) in this proceeding before the United States Patent and Trademark Office (“PTO”) against Entropic Communications, LLC (“Patent Owner”) regarding U.S. Patent No. 7,542,715 (“the ’715 patent”) (Ex.1001). I have been asked to consider whether certain references disclose or suggest the features recited in claims 1-19 (“the challenged claims”) of the ’715 patent. My opinions are set forth below.

2. I am being compensated at my standard consulting rate of \$750/hour for my work in this proceeding. My compensation is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of this or any other proceeding. I have no other interest in this proceeding.

I. INTRODUCTION AND QUALIFICATIONS

3. I am an independent consultant. All my opinions stated in this Declaration are based on my own personal knowledge and professional judgment. In forming my opinions, I have relied on my knowledge and experience in designing, developing, researching, and teaching regarding multimedia communications technology and multimedia information systems referenced in this Declaration.

4. I am over 18 years of age and, if I am called upon to do so, I would be

competent to testify as to the matters set forth herein. I understand that a copy of my current curriculum vitae, which includes a more detailed summary of my education and professional and academic experience, is provided as Appendix A to this Declaration. The following provides an overview of some of my experience that is relevant to the matters set forth in this Declaration.

A. Qualifications

5. I am a Professor in the Department of Electrical and Computer Engineering at the University of Illinois at Chicago. I have been elected Fellow of the Institute of Electrical and Electronics Engineers (“IEEE”) as well as Fellow of the International Society for Optics and Photonics (“SPIE”). I have also been elected University Scholar of the University of Illinois.

6. I received my B.S. degree in Electrical Engineering and Computer Science from the University of California, Berkeley, California, and my M.S. and Ph.D. degrees in Electrical and Computer Engineering from The Johns Hopkins University, Baltimore, Maryland, in 1986, 1988 and 1990, respectively.

7. In 1990, I joined the Department of Electrical Engineering and Computer Science at the University of Illinois, Chicago, Illinois, where I am a tenured Professor in the Departments of Electrical and Computer Engineering, Computer Science, and Bioengineering. I serve as Co-Director of the Multimedia Communications Laboratory (“MCL”) and member of the Signal and Image

Research Laboratory (“SIRL”). I have also served as Director of the University-Industry Engineering Research Center (“UIERC”), also known as the Manufacturing Research Center (“MRC”), in the College of Engineering. Before I joined the University of Illinois at Chicago, I served as an instructor in the Department of Electrical and Computer Engineering at The Johns Hopkins University.

8. Over the past two decades, I have also served as a visiting professor in (a) the Advanced Analytics Institute (AAI) at the University of Technology, Sydney, Australia, (b) the Department of Information Engineering and Computer Science (“DISI”) at the University of Trento, Italy, (c) the School of Computer Engineering at the Nanyang Technological University, Singapore, and (d) the Department of Electrical Engineering—Systems at Tel-Aviv University, Israel.

9. I have previously served as Editor-in-Chief and Deputy Editor-in-Chief of the IEEE Transactions on Circuits and Systems for Video Technology. I have also previously served as Area Editor for special issues of the IEEE Signal Processing Magazine. I have also served as Associate Editor of the IEEE Transactions on Circuits and Systems for Video Technology, IEEE Transactions on Image Processing, and IEEE Transactions on Signal Processing. I have also served on the editorial board of the IEEE Signal Processing Magazine, EURASIP Journal of Image and Video Processing, Research Letters in Signal Processing, and Bentham Science

Publishers, Ltd.'s "Recent Patents on Computer Science" and "Recent Patents on Electrical Engineering" publications. I have served as guest editor of numerous special issues in various journals in the area of multimedia systems.

10. I currently serve on the Conference Board of the IEEE Signal Processing Society. I have previously served as Technical Program Chair of the IEEE International Conference on Acoustics, Speech, and Signal Processing ("ICASSP") 2018 as well as Program Chair of the IEEE Conference on Visual Communications and Image Processing ("VCIP") 2015. I have previously served as General Co-Chair of the Workshop on Big Data in 3D Computer Vision 2013 and the IEEE International Conference on Multimedia and Expo ("ICME") 2012. I have also served as Chair of the IEEE Workshop on Video Mining 2008 and the SPIE Conference on Visual Communications and Image Processing 2007. I have also served on the organizing committees of various conferences including the IEEE International Conference on Image Processing 1998, 2012, and 2020.

11. I have authored and co-authored over 200 technical papers for various journals and conferences. I was author of a book chapter, entitled: "Image and video communication networks," and later editions entitled: "Video communication networks." I was also co-author (with Carlo Giulietti and Rashid Ansari) of a paper that won the Best Paper Award at the ACM Multimedia Workshop on Advanced

Video Streaming Techniques for Peer-to-Peer Networks and Social Networking 2010. I was also coauthor (with Junlan Yang) of a paper that won the Best Student Paper Award at the IEEE International Conference on Image Processing 2007. I was also co-author (with Wei Qu) of a paper that won the Best Student Paper Award at the IEEE International Conference on Image Processing 2006. I was also co-author (with Nidhal Bouaynaya) of a paper that won the Best Student Paper Award in Visual Communications and Image Processing 2006. In addition, many of my publications relate to the broad topic of multimedia systems, which includes audio, image, and video processing. My publications in the area of multimedia systems dates back to 1988.

12. I was invited as a Plenary Speaker and Keynote Speaker to the International Conference on Intelligent Control and Information Processing (“ICICIP”) 2013 and International Conference on Brain Inspired Cognitive Systems (“BICS”) 2013, IEEE/EIT International Conference on Audio, Language, and Image Processing 2010, the IEEE International Conference on Advanced Video and Signal-Based Surveillance 2009, and the ASME International Conference on Communications, Signals and Systems 1995 and 2001.

13. I have served as Representative of Regions 1-6 (North America) on the Chapters Committee of the IEEE Signal Processing Society. I have also served as

Chairman of the IEEE Signal Processing Chicago Chapter. I have also served on the IEEE Image, Video and Multidimensional Signal Processing Technical Committee as well as the IEEE Multimedia Communications Technical Committee. I also serve on the American National Standards Institute (“ANSI”) / Underwriters Laboratory (“UL”) Standards Technical Panel (“STP”) on Multimedia Systems.

14. I have also taught various courses that relate to multimedia systems. For example, since the late 1990s, I have introduced and taught an advanced undergraduate-level / first-year graduate-level course on multimedia systems (originally called multimedia communication networks).

B. Materials Reviewed

15. The opinions contained in this Declaration are based on the documents I reviewed, my professional judgment, as well as my education, experience, and knowledge regarding multimedia communications technology and/or multimedia information systems including, for example, television signal processing and satellite communications, or a related field.

16. In forming my opinions expressed in this Declaration, I reviewed the following materials and information (and any other materials and information I reference in this Declaration):

Ex.1001	U.S. Patent No. 7,542,715 (“’715 patent”)
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Ex.1003	International Publication No. WO 2002/065771 (“Fisk”)
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Ex.1023	Products Coaxial Cable, Addison (2022), https://www.addison-cables.com/product/coaxial%20cables/CT%20Series%20Coaxial%20Cables/CT125.htm
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Ex.1036	U.S. Patent No. 7,123,649 (“Smith”)
Ex.1037	U.S. Patent No. 6,408,436 (“de Haas”)

17. My opinions contained in this Declaration are based on the documents I reviewed and considered, and my knowledge and professional judgment. My opinions have also been guided by my appreciation of how a person of ordinary skill in the art (“POSITA”) would have understood the state of the art, the prior art, and the claims and the specification of the ’715 patent at the time of the alleged invention.

18. I have been asked to initially consider that the time of the alleged invention of the ’715 patent encompasses the time frames near and including November 7, 2001. I understand the application for the ’715 patent claims priority to multiple applications, the earliest of which was filed on November 7, 2001. (Ex.1001, 2.) My opinions reflect how one of ordinary skill in the art (which I describe below) would have understood the ’715 patent, the prior art to the patent, and the state of the art at the time of the alleged invention as I was asked to consider noted above.

19. Based on my experience and expertise, it is my opinion that the prior art discloses and/or suggests all the limitations recited in challenged claims 1-19 of the ’715 patent, as I discuss in detail below.

II. GOVERNING LAW AND PERSPECTIVES APPLIED

20. I am not a lawyer and I will not provide any legal opinions. Although I am not a lawyer, I have been advised that certain legal standards are to be applied by technical experts in forming opinions regarding the meaning and validity of patent claims.

21. I understand that a patent claim is invalid if it is anticipated or obvious in view of the prior art and that a claim can be unpatentable even if all of the requirements of the claim cannot be found in a single prior-art reference. I further understand that invalidating a claim requires that the claim be anticipated or obvious from the perspective of a POSITA at the time the invention was made.

22. In forming my analysis, opinions, and conclusions expressed in this Declaration, I have applied the legal principles set forth below which were provided to me by counsel for Petitioners.

A. Types of Claims

23. I understand that there are two types of U.S. patent claims: 1) independent claims; and 2) dependent claims. I understand that independent claims only include the aspects stated in the independent claim. I further understand that dependent claims include the aspects stated in that dependent claim, and any other aspects stated in any claim from which that dependent claim depends.

B. Anticipation and Obviousness

24. I understand that a claim is not patentable if it is anticipated or obvious.

I understand that anticipation of a claim requires that every element of a claim is disclosed expressly or inherently in a single prior art reference.

25. I further understand that obviousness of a claim requires that the claim be obvious from the perspective of a person of ordinary skill in the relevant art, at the time the invention was made. I understand that the earliest patent application filing leading to the '715 patent was a U.S. provisional patent application filed on November 7, 2001, and I have assumed this is the '715 patent's alleged invention date.

26. I have therefore analyzed the unpatentability of the claims as of that day. I may refer to the relevant time period as the “2001 timeframe” in this Declaration, with the understanding that this does not include the time period on or after the filing date of the first application (*i.e.*, November 7, 2001).

27. I understand that to prove that prior art or a combination of prior art renders a patent obvious, it is necessary to:

- a) identify the particular references that, singly or in combination, make the patent obvious;
- b) specifically identify which elements of the patent claim appear in each of the asserted references; and

- c) explain why a POSITA would have combined the references, and how they would have done so, to create the inventions claimed in the patent.

28. I further understand that exemplary rationales that may support a conclusion of obviousness include:

- a) combining prior art elements according to known methods to yield predictable results;
- b) simple substitution of one known element for another to obtain predictable results;
- c) use of known technique(s) to improve similar devices (methods or products) in the same way;
- d) applying a known technique to a known device (method or product) ready for improvement to yield predictable results;
- e) “obvious to try” - choosing from a finite number of identified, predictable solutions with a reasonable expectation of success;
- f) known work in one field of endeavor may prompt variations of the work for use in either the same field or a different field based on design incentives or other market forces if the variations are predictable to a POSITA; and
- g) some teaching, suggestion, or motivation in the prior art that would have led a POSITA to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

29. In analyzing obviousness, I understand that it is important to understand

the scope of the claims, the level of skill in the relevant art, the scope and content of the prior art, the differences between the prior art and the claims, and any “secondary considerations” (described below). I also understand that if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill. Although I understand that it is not required, there may also be a specific “teaching, suggestion or motivation” to combine any first prior art reference with a second prior art reference. Such a “teaching, suggestion, or motivation” to combine the first prior art reference with the second prior art reference can be explicit or implicit, and may provide further evidence of obviousness.

30. I understand that secondary (or objective) considerations are relevant to the determination of whether a claim is obvious. Such secondary (or objective) considerations can include evidence of commercial success caused by an invention, evidence of a long-felt need that was solved by an invention, evidence that others copied an invention, or evidence that an invention achieved a surprising or unexpected result. I understand that such evidence must have a nexus, or causal relationship to the elements of a claim, to be relevant to the obviousness or non-obviousness of the claim. I am not currently aware of any such evidence for the

claims of the '715 patent and reserve my right to review and respond to such evidence if presented.

C. Claim Construction

31. I understand that, for purposes of my analysis, the terms appearing in the patent claims should be interpreted according to their “ordinary and customary meaning.” In determining the ordinary and customary meaning, the words of a claim are first given their plain meaning that those words would have had to a POSITA. I understand that the structure of the claims, the specification, and the file history also may be used to better construe a claim term. Additionally, treatises and dictionaries may be used, in limited circumstances, to determine the meaning attributed by a person of ordinary skill in the art to a claim term at the time of filing. I have followed this approach in my analysis, and for all of the claim terms considered in this Declaration, I have applied the ordinary and customary meaning of those terms.

32. I also understand that the words of the claims should be interpreted as they would have been interpreted by a POSITA at the time the alleged invention was made and not as of today. I have used the date of November 7, 2001 for reasons explained above.

III. PERSON OF ORDINARY SKILL IN THE ART

33. Based on my knowledge and experience, I understand what a person of ordinary skill in the art would have known at the time of the alleged invention. My

opinions herein are, where appropriate, based on my understandings as to a person of ordinary skill in the art at that time. In my opinion, based on the materials and information I have reviewed, and based on my experience in the technical areas relevant to the '715 patent, a person of ordinary skill in the art ("POSITA") at the time of the alleged invention of the '715 patent (*e.g.*, November 7, 2001) would have had at least: (i) a bachelor's degree in electrical engineering, computer engineering, or the equivalent, and three or more years of experience with television signal processing and satellite communications; (ii) a master's degree in electrical engineering, computer engineering, or a related field, and at least one year of experience in television signal processing and satellite communications; or (iii) a doctoral degree in electrical engineering, computer engineering, or a related field, and at least some experience in television signal processing and satellite communications. Additional education may substitute for professional experience, and significant work experience may substitute for formal education.

34. Based on my review of the '715 patent and my technical experience, it is my opinion that a person of ordinary skill in the art would have possessed knowledge of conventional satellite communications technologies and techniques, such as the structure and properties of signals transmitted by orbital satellites, including transponders, polarity, analog and digital data, etc.; satellite signal

receivers, such as satellite dishes, including components such as feedhorns; low-noise amplifiers and block-down converters (LNBs); satellite signal processing including filtering, frequency shifting/translating, and combining; signal distribution technologies and techniques, including transmission media (coaxial cable, Ethernet cable, wireless, etc.) and networking components such as switches, gateways, etc.; and set-top boxes/integrated receiver decoders. (*See generally* Ex.1001-'715 patent, 1:19-11:57.) As described in further detail below, many of these technologies and associated techniques fall generally within communications and networking concepts related to the satellite signal processing and distribution known at the relevant time.

IV. STATE OF THE ART AND APPLICANT ADMITTED PRIOR ART (AAPA)

35. The '715 patent describes and claims features relating to distributing received satellite television channels, and the use of known processes and technologies to facilitate the distribution of the television channels to a plurality of set-top boxes ("STBs")/integrated receiver decoders ("IRDs"). However, as I explain below, it is my opinion that such methods and related technologies were conventional and known to persons of ordinary skill in the art at and before November 2001.

36. Below, I present a brief overview of certain aspects of satellite signal

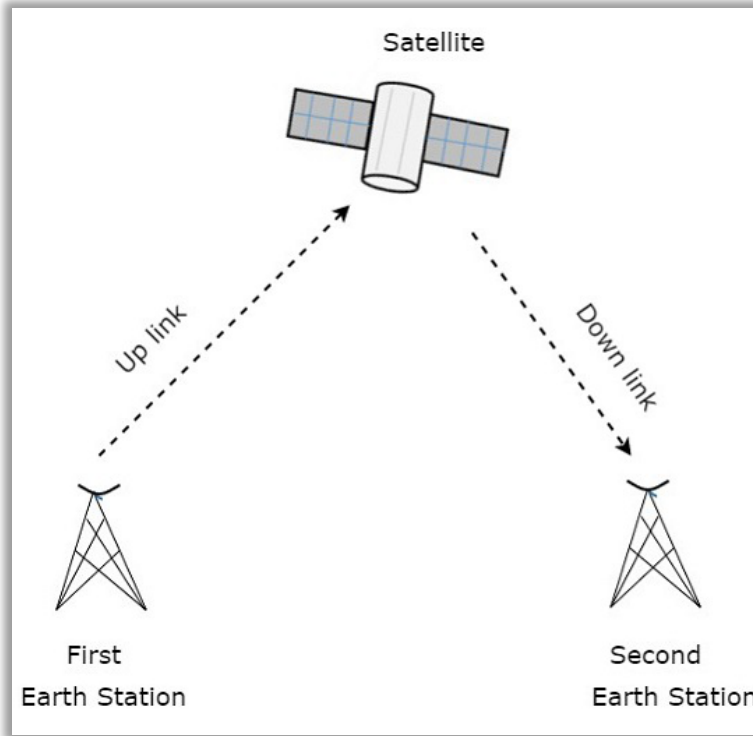
processing and distribution, and use of known components and processes, like those discussed and claimed in the '715 patent that were known to a person of ordinary skill in the art prior to and at the time of the alleged invention of the '715 patent. The features, functionalities, and concepts I describe below in this technical background section reflect the state-of-the-art knowledge that a person of ordinary skill in the art would have had prior to and at the time of the alleged invention of the '715 patent (*e.g.*, November 2001). I rely on and incorporate the following disclosures and opinions to support my opinions in this Declaration, including those opinions relating to how the prior art discloses and/or suggests the challenged claims of the '715 patent and how and why a person of ordinary skill in the art would have been motivated to consider and combine the disclosures and suggestions from one or more prior art references as I explain throughout this Declaration. The concepts below would have been within the knowledge and mindset of a person of ordinary skill in the art at the time when considering the prior art identified below, such as Applicant Admitted Prior Art ("AAPA") Petruzzelli and Williams, and other references discussed therein, including Oleson and Green.

A. Direct Broadcast Satellite Systems and Key Terminology

37. By November 2001, orbital satellites had been used for nearly forty years to communicate video, audio, and data signals. The Telstar I, launched in 1962 by Bell Labs and NASA, was the first direct-relay communications satellite, and

could communicate a single television program across the Atlantic Ocean. (*See* Ex.1012, 3.) By the mid-1980's (in the United States, at least), individual consumers were permitted by law under the 1984 Cable Communications Policy Act of 1984 to decrypt satellite signals, ushering in the era of satellite television services. The use of satellites to distribute a plurality of signals bearing televisions programs proliferated in the early to mid-1990's with the introduction of Echostar's DISH Network and Hughes Network System's DirecTV, among other direct broadcast satellite ("DBS") services. These satellite systems were designed to broadcast digital video data (*i.e.*, video data carried on high-frequency, analog RF signals) by using geostationary satellites. The digital video data is transmitted to the satellite via an uplink antenna on the ground over a band (or range) of frequencies referred to as the uplink frequencies and is retransmitted by the satellite to various antennas back on the ground (*e.g.*, a subscriber's satellite dish) at a different band of frequencies referred to as the downlink frequencies. A simple depiction of the system is shown in the figure below:¹

¹ The image was obtained from https://www.tutorialspoint.com/satellite_communication/satellite_communication_quick_guide.htm on January 6, 2023.



38. “Transponder” and “channel” are two important terms POSITAs use to describe the distribution of television data by satellites, and because these terms are often used to refer to different aspects of the distribution, I will first discuss each term and explain how I am using them in this Declaration. I also discuss the term “program” in relation to the different kinds of “channels.”

39. The original understanding of “transponder” referred to specialized hardware on a satellite that processes the signal transmitted over an uplink before responding by broadcasting the signal to subscribers. “Transponder” is a portmanteau of the words “transmit” and “respond.” Satellites have a plurality of transponders that receive, process, and broadcast a portion of an uplink signal. Thus,

“transponder” is sometimes also used to refer either to the *signal* that is the portion of the uplink received, processed, and broadcast by the transponder, or alternatively to the frequency *channel* through which the signal is communicated (more on channel in the next paragraph). When referring to the signal received by the transponder, I will use the term “transponder signal” as it is more precise than “transponder.”

40. “Channel” is also a term with multiple meanings in this art. The original understanding of “channel” referred to a defined frequency used by a particular transponder. To be clear, although a channel is often discussed with reference to a single frequency, it actually refers to a range of frequencies (*i.e.*, the frequency band) centered about the single frequency carrying the received uplink signal and the single frequency of the signal broadcasted by the transponder (*i.e.*, the “transponder channel”). However, most lay people instead think of “channel” in this context to refer to a television channel—ESPNTM, HBOTM, DisneyTM, etc.—and POSITAs will sometimes do the same. For example, when analog signals were transmitted by satellites, each transponder channel typically carried only a single analog television channel, so a given television channel (*e.g.*, channel number 38, ESPN) corresponded to a specific transponder channel (*e.g.*, the channel associated with transponder number five on a satellite having sixteen transponders). In the digital

broadcast systems that became common in the late 1990's, compressed digital signals associated with several television channels could be transmitted within a single transponder channel, creating potential confusion when the word "channel" is used, by itself. In this Declaration, I will use the terms "transponder channel" and "television channel" to distinguish these two kinds of channels.

41. I note that some of the prior art discussed herein uses the word "transponder," by itself, to refer to either the signal from a transponder or the transponder channel. (*E.g.*, Ex.1008-AAPA Williams, 1:52-54; Ex.1007-AAPA Petruzzelli, 5:1-15.). To the extent I use "transponder" in discussing or quoting that prior art, I am referring to a "transponder signal" or "transponder channel" and not the physical transponder, unless otherwise stated. This is consistent with the uses of these terms in the '715 patent. (*See, e.g.*, Ex.1001-'715 patent, 6:9-12 ("Each transponder channel may be frequency translated to the desired new carrier frequency, then filtered to produce a single transponder signal that can be combined with other similarly selected transponder channels.")).

42. Finally, "program" refers to the audio and video data associated with a single "television channel." In digital broadcast systems, "programs" are generally transmitted as MPEG-encoded video and audio. POSITAs will sometimes use the term "program multiplex" to refer to the data of a particular "transponder channel."

(*E.g.*, Ex.1008-AAPA Williams 1:52-55.) This is because the programs associated with a plurality of “television channels” are multiplexed together for transmission over a single “transponder channel.”

43. The '715 patent describes DBS satellite systems that were commonplace as of 2000, when satellites typically broadcast 16- or 32- transponder signals. (*See* Ex.1001-'715 patent, 1:21-2:49.) The total bandwidth of the RF signal broadcast by the satellite, the number of transponder signals within the broadcast signal, and the number of television channels per transponder signal were a function of both technical and regulatory concerns. Typically, within these systems, an uplink would be used to transmit to transponders on the satellite a high-frequency, analog RF signal carrying digital video data that represents multiple (*i.e.*, tens to hundreds) of streams of programming. Transponders at the satellite would then translate the programs included in the RF signal received from the uplink into one or more transponder channels for broadcast over the downlink to the requesting subscriber antennas. In 2001, a single transponder signal having a bandwidth of 36 MHz (typical, as the '715 patent admits) generally carried six or more programs in the program multiplex. (Ex.1001-'715 patent, 1:21-44; Ex.1007-AAPA Petruzzelli, 1:21-62, 2:11-21; Ex.1008-AAPA Williams, 2:11-40.)

44. As early as the 1980's, satellites were able to increase throughput by

simultaneously distributing two sets of transponder channels over the same frequency range by taking advantage of polarity multiplexing (also called polarization-division multiplexing). Polarity is a physical signal property, meaning that it differentiates two signals with otherwise identical properties. In satellite systems commonplace by the 1990's, a single satellite can emit two information signals—typically characterized as either left/right hand polarized, or vertical/horizontal polarized—over the same frequency range. (*See, e.g.,* Ex.1005-Green (1989), 1:42-68.) This enabled satellites to transmit, and satellite dish receivers to receive, twice as many transponder signals from a single satellite. The '715 patent admits that polarization-division multiplexing was known in the prior art. (*See* Ex.1001-'715 patent, 1:45-2:45.)

45. The excerpt from Figure 10 of EP 0 740 434 (“Carnero”), one of the references in Petitioner’s grounds for invalidity, visually depicts a typical satellite signal having twenty-four transponder channels (numbered 70-93), with twelve transponder channels per polarity (vertical and horizontal), all located in the X-band (between 7 and 12 GHz).

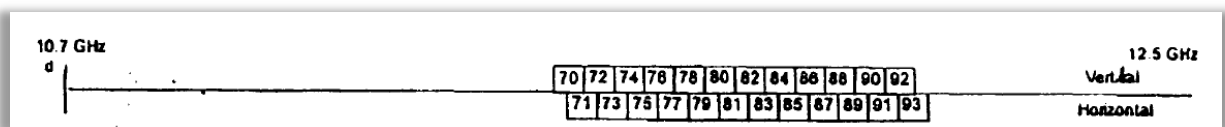


Figure 10 — Signal Received by a Left Parabolic Antenna from an Orbital Satellite.

46. Signal modulation schemes—changing the amplitude, frequency, or phase of the signal—can allow for transmission of multiple television channels over a particular frequency range, but with quality and fidelity as trade-offs. Early analog satellite television services relied on frequency modulation (FM). (*See, e.g.,* Ex.1030, 5.) Quadrature phase-shift keying (QPSK), sometimes also referred to as 4-phase-shift keying (4-PSK), was already a standard satellite modulation technique in the early 1980’s and remained a (if not the) prevailing modulation scheme for transmitting satellite television channels by November 2001. (Ex.1013-Baran, 1:31-39.) For example, the Digital Video Broadcasting–Satellite (DVB-S)—a digital video broadcasting standard for satellite communications released in 1995—used QPSK. (*See, e.g.,* Ex.1031, 1.) The main advantage of QPSK is its power efficiency, which comes at the expense of the bandwidth required. (Ex.1032, 171.) Other common modulation schemes (such as variations of quadrature amplitude modulation, QAM, used to distribute for terrestrial television signals) provide distinct advantages and disadvantages. For example, QAM typically requires less frequency bandwidth to transmit a television program relative to QPSK, but the signal will be of lower quality with a higher potential for error.

B. ODU Processing of an RF Satellite Signal

47. At the downlink, and consistent with AAPA and Background within the ’715 patent, an antenna (*i.e.*, “satellite dish”) at each subscriber location received the

high-frequency (4GHz–18GHz+) RF satellite signals transmitted by the satellite transponders. (Ex.1007-AAPA Petruzzelli, 1:21-62, 2:11-21; Ex.1008-AAPA Williams, 2:11-40.) Early dishes were very large—often three or more meters tall—but by the mid to late-1990’s, the dishes used for consumer satellite television services were around a meter tall. While dish size dropped significantly from the 1970’s through the year 2000, the core functionality remained the same.

48. A dish receiver has one or more “feedhorns”—one per transmitting satellite—that are capable of receiving satellite signals at very high frequencies: typically, in the C-band (3.7–4.2 GHz), X-band (7–12 GHz), and/or Ku-band (12-18+ GHz) ranges. (*E.g.*, Ex.1007-AAPA Petruzzelli, 1:21-37; Ex.1001-’715 patent, 1:35-40.) Figure 1 of the ’715 patent depicts what the patentee admits is prior art. The figure shows a parabolic satellite receiver 150 (“dish antenna”) having two satellite feedhorns 130.

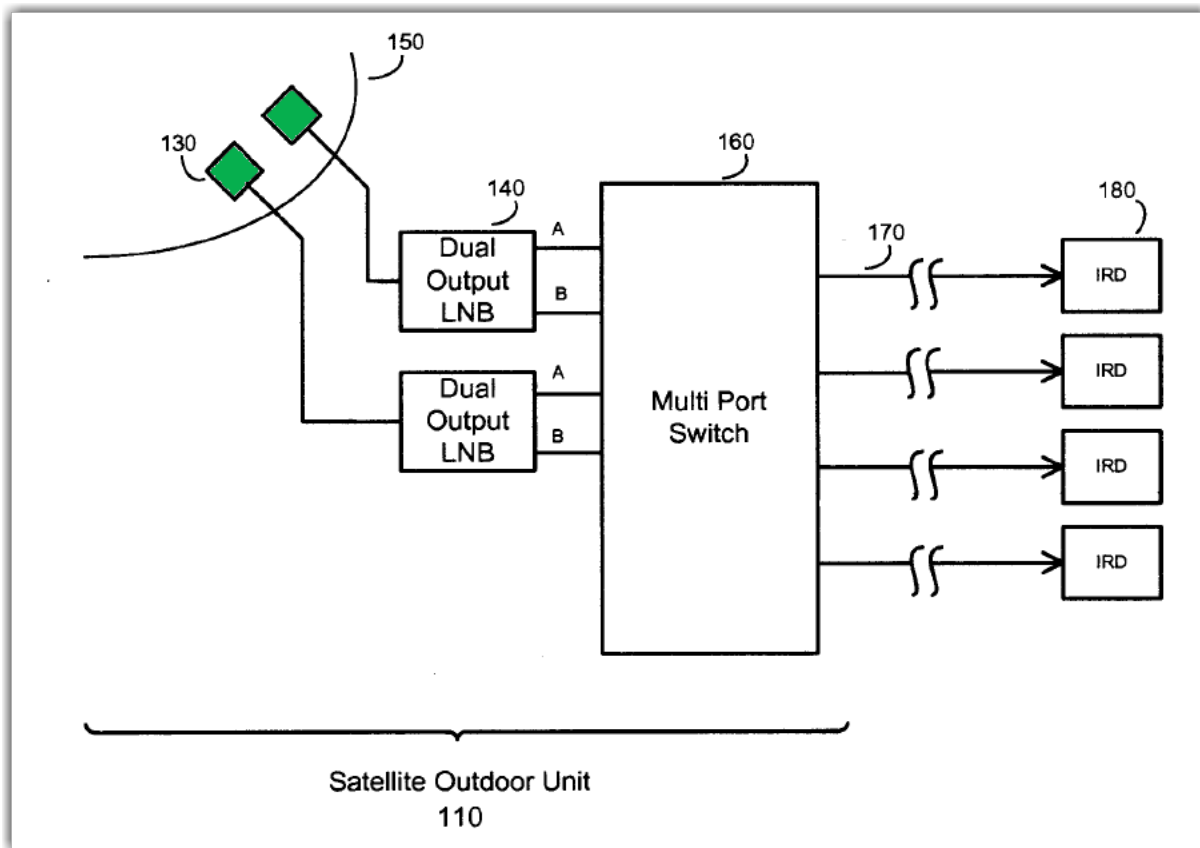


Figure 1 — Feedhorns 130, Part of Satellite Receiver 150 (AAPA).

49. While satellite signals are typically received in frequencies exceeding 10 GHz, the signals must be converted to lower frequencies, “down converted,” for local distribution. For example, coaxial cables are best suited to transmit signals three orders of magnitude smaller—approximately 2 MHz or lower (within the “intermediate frequency” range of radio frequencies). Even wireless networks (*e.g.*, Wi-Fi) typically transmitted at 2.4 GHz in November 2001. (*See* Ex.1018, 2 (discussing 802.11b standard, released in 1997).) As such, satellite receivers have long been required to down-shift the frequencies of the received signals for

distribution.

50. The well-known solution to preparing received satellite signals for terrestrial distribution is the use of low noise amplifier and block-down converters (“LNBs”). (*See, e.g.,* Ex.1005-Green, 2:26-35, 6:28-53, 9:45-50.) The low noise amplifiers boost (or “amplify”) the received signals, and the block-down converters shift the frequencies of the received signals typically into the sub-2 MHz range. Figure 1 of the ’715 patent describing the prior art shows two dual output LNBs 140, each of which receives a polarized signal from feedhorns 130, down-converts the signals into IF, and outputs a separate signal for each polarization received from the corresponding feedhorn (A and B).

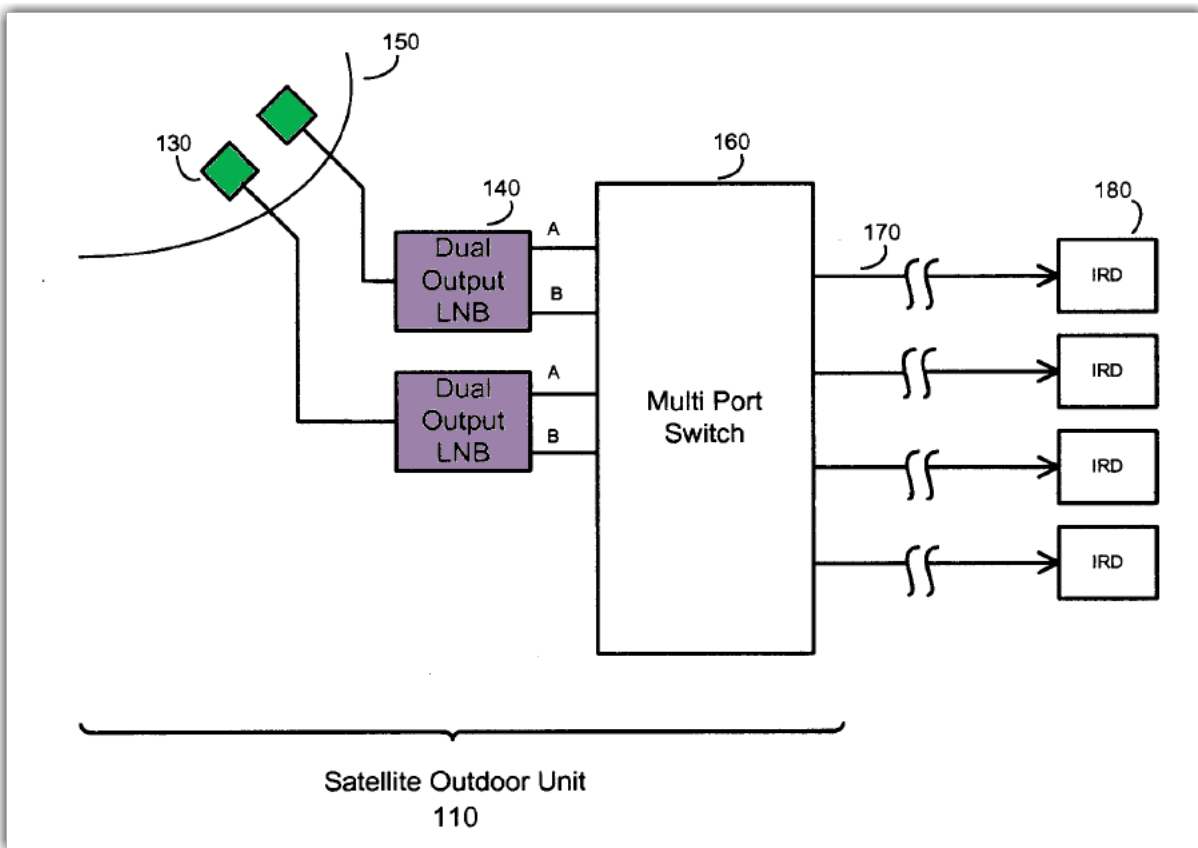


Figure 1 — Feedhorns 130 Output to Dual Output LNBs (One Per Input Signal Polarity) (AAPA).

(See also Ex.1001-'715 patent, 1:19-29, 1:44-45.) Figure 10 of Carnero provides a visual depiction of the signal at the input of an LNB (line "d"), and the resulting outputs, which contain all transponder channels from a single polarity in the IF range of 950 MHz - 2.050 MHz (lines "g" and "h", corresponding to A and B in the '715 patent, Figure 1).

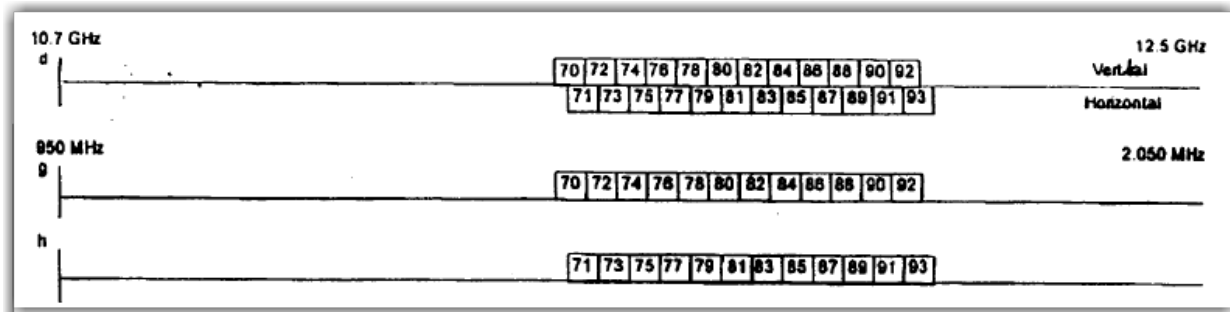


Figure 10 — Down Converters (LNBs) Select a Polarization and Down-Shift into IF.

51. The feed components are part of the outdoor unit (“ODU”) located at or near the exterior of a building or home at as subscriber location. (Ex.1001-’715 patent, 1:29-29, 1:45-2:6.) The ’715 patent discloses each of these components as part of the prior art ODUs. (Ex.1001-’715 patent, 1:21-55, Figure 1; *see also* Ex.1007-AAPA Petruzzelli, 1:21-37, 2:54-65, 4:23-45, 4:58-5:15, 5:1-15, 5:61-6:21; Ex.1008-AAPA Williams, 2:11-40.)

C. Set-Top Boxes / Integrated Receiver Decoders

52. After down-conversion, received transponder signals are suitable for distribution to integrated receiver/decoders (“IRDs”), also known as set-top boxes (“STBs”). Because the method of distribution is purportedly a source of novelty over the prior art, I discuss the STBs first.

53. The original purpose for an STB, which is still an important purpose, was to decode received television signals so the signal could be displayed on a television. For decades, televisions were designed to receive and display television

signals transmitted “over-the-air” in an analog, standard-definition signal. In the United States, the prevailing standard modulation since the 1950’s was called NTSC, an acronym for the National Televisions Standards committee. The television would include a “tuner” that could “tune” (*i.e.*, detect only) a channel at a center frequency in a received NTSC signal and display a television program in the channel. But as cable and satellite television services rose throughout the 1980’s and 90’s, alternative modulation schemes arose to meet the needs of particular distribution networks (including QAM and QPSK, discussed above). And analog signals were increasingly used to carry digital television signals that were encoded (*e.g.*, in accordance with the MPEG standard), which further reduced the bandwidth needed to transmit a given television program (which became especially important in the late 1990’s with the introduction of high-definition television—HDTV) and provided other advantages such as reliability. In order to ensure compatibility with NTSC-compliant television, a receiver decoder was used to receive a cable or satellite television signal and output an NTSC-compliant signal for display on the television.

54. When an STB receives a signal containing a program stream, the STB “tunes” to the transponder channel carrying a desired television program (*e.g.*, “ESPN2”) for processing and display. (Ex.1001-’715 patent, 1:40-44.) The STB then

performs other operations including demodulating the IF signal down to a baseband signal, decoding digital video data encoded within the RF satellite signal (including demultiplexing an MPEG stream comprising a plurality of television programs, which includes the desired program), and generating the RF output signal necessary to display content on a connected television. (Ex.1001-'715 patent, 1:40-44.)

55. Figure 1 of the '715 patent (and its related disclosure), which describe the admitted state of the art, depicts an ODU distributing down-converted IF satellite television signals to a plurality of IRDs simultaneously.

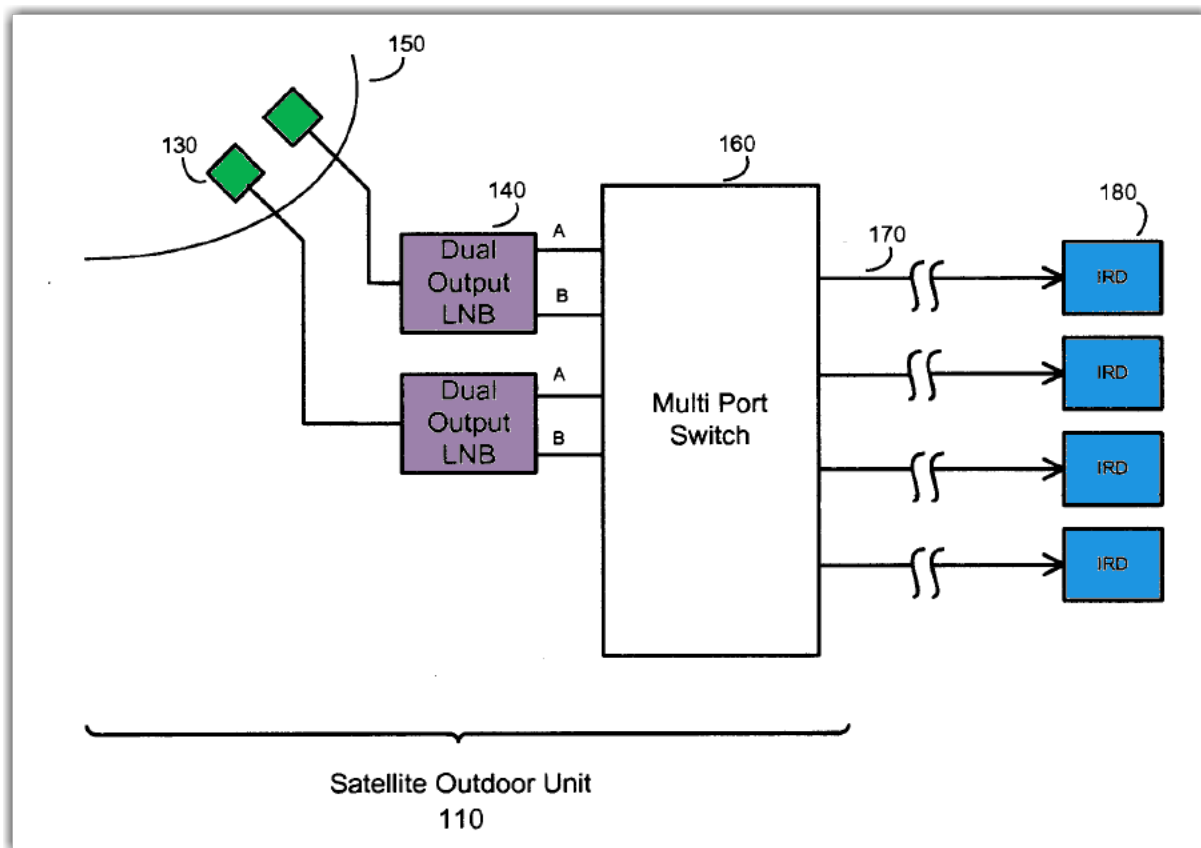


Figure 1 — Outputs of Dual-Output LNBs Distributed to a Plurality of IRDs (AAPA).

(See Ex.1001-'715 patent 1:21-2:6.) AAPA Williams also teaches IRDs performing tuning, demodulation, and decoding, as the '715 patent recognizes. (Ex.1001-'715 patent at 2:7-24, *see generally* AAPA Williams at 14:4-18:29.)

D. Signal Processing and Distribution

56. In a system where a single transponder signal is received by the satellite dish (as in the Telstar I example from the 1960's), distribution would be simple: connect the output of the LNB to an STB. If the hypothetical system involves receipt of a plurality of transponder signals in a single satellite signal (*e.g.*, the signal on either of the "A" or "B" cables in Figure 1 of the '715 patent, or lines "g" or "h" from Carnero's Figure 10), the distribution system still requires just one connection, for example, by coaxial cable, between the LNB output and an STB. But even by the 1970's, satellite systems were rarely so limited.

57. POSITAs have long been motivated to invent local satellite distribution systems that can distribute transponder signals from a plurality of received satellite signals, each comprised of dozens (if not 100+) of television channels, so that a plurality of STBs can each receive the programming desired by their operator (*i.e.*, a television viewer), in an economical, efficient, and practical manner, bearing in mind the well-known bandwidth limitations of distribution media (namely, coaxial cables). Among the motivations:

- Capability to distribute the ever-increasing number of available satellite

television programs to viewers. The 1980's saw the advent of many new "cable" channels such as HBO, TBS, CNN and Showtime, which satellite television subscribers also wanted to watch. Case in point, by the mid-1990's, the leading satellite television service providers (including DISH) simultaneously offered well over 100 television programs (*see* Ex.1014, 3);

- Providing satellite television channels from a plurality of received satellite signals to a plurality of STBs within a single home or multi-dwelling unit (such as an apartment or hotel) wherein each STB is able to receive a desired television channel without interfering with the television channels other STBs are able to receive. At least by the mid-1980's, persons inventing in the field observed that a single satellite DISH could be used to serve "hundreds and even thousands" of hotel rooms, or a multi-television home, as it was "fairly common" for homes at the time to have between four and six televisions. (Ex.1015-Oleson, 1:24-31.) POSITAs sought to invent to accommodate such use cases; and
- Optimally distributing satellite television channels in accordance with the above motivations in light of physical limitations of the distribution media and the distribution area (*i.e.*, a home or building). The typical distribution medium at the time of its invention was a coaxial cable, particularly what are known as the RG-6 or RG-59 cables, and these cables had limited available bandwidth. For example, the attenuation (signal loss) for an RG-6 and RG-59 is 4.3 and 7.0 dB per 100 ft, respectively, at 400 MHz; compared to an attenuation of 7.0 and 12.0 dB per 100 ft, respectively, at 1,000 MHz. (Ex.1019, 4-5; Ex.1020, 6-7.) As the '715 patent correctly recognizes, it would not have been possible to distribute more a few LNB output signals (*i.e.*, 24-36 transponder signals) simultaneously over a single coaxial cable. (Ex.1001-'715 patent at 1:34-47.) Davis similarly recognizes that "digital television subscription services ... can require multiple cables between the ODU and the IDU" given the volume of available channels, and additional cables may be necessary if the same subscriber utilizes other satellite communications services (*e.g.*, satellite internet). (Ex.1006-Davis, ¶¶5-6.) Thus, where a building contained multiple STBs, the cost and difficulty of running multiple coaxial cables to each STB necessitated solutions limiting the number of cables to carry video

data ultimately destined for the multiple STBs.

58. Since at least the early 1980's, POSITAs have come up with signal distribution solutions bearing in mind the above considerations. This Declaration describes three in detail: signal switching, signal stacking, and transponder selecting and stacking.

E. Signal Switching

59. The '715 patent describes what it calls a "typical[]" or "conventional" satellite distribution system which I will refer to as "signal switching." (*See* Ex.1001-'715 patent, 1:19-62, Fig. 1.) Signal switching is among the least sophisticated of the distribution methods, and was long past being the "state of the art" in November 2001, as the following sections will make clear. Thus, while not representative of the state of the art at the time of the alleged invention, I briefly describe it here because it is discussed in the '715 patent.

60. In a signal switching system, a plurality of signals are input into a switch, such as the multiport cross point switch 160 discussed in the Background of the '715 patent. In the example of Figure 1, the switch receives four input signals, each containing a plurality of transponder signals from one polarity of a received satellite signal (these are "LNB output signals"). When a television viewer desires to watch a specific television program (*e.g.*, SportsCenter on ESPN2), the STB 180 associated with the television communicates a request to be switched to the LNB

output signal having that program. The switch facilitates the selection, and the STB is supplied on its dedicated cable 170 the entire LNB output signal, which contains a plurality of transponder channels, and the STB tunes to the transponder channel bearing the desired program and performs its ordinary signal processing to output the desired program to a display (*e.g.*, television set).

61. The switch is able to provide any of the input signals to each of the STBs in the distribution system; in the example in Figure 1, to four STBs (shown as “IRD”s).

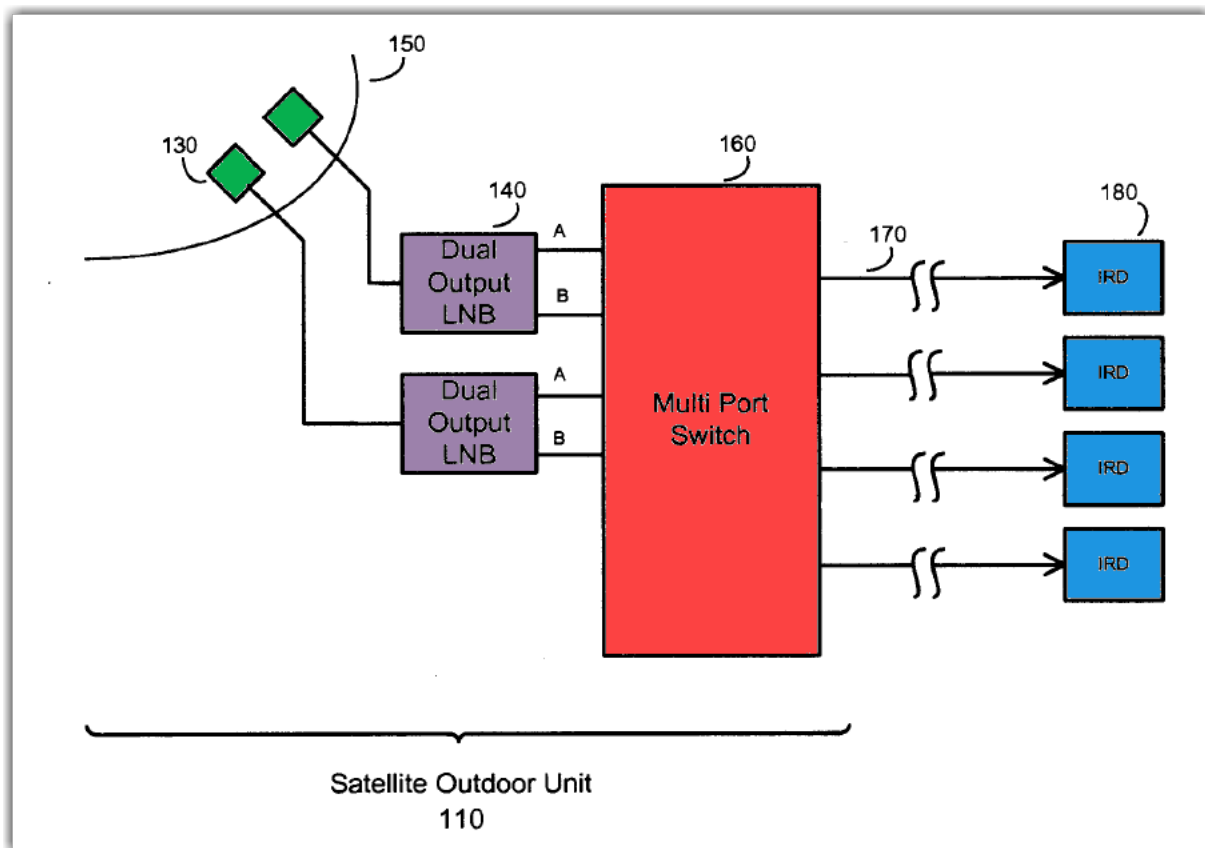


Figure 1 — Each IRD (STB) Receives One of Four LNB Output Signals (AAPA).

62. The advantage of signal switching is that each STB can be supplied with the television program desired by its user without interfering with any other STB's ability to obtain whatever program it desires. The downside, as the '715 patent recognizes, is that each STB requires a separate cable; otherwise, only television channels from a single input signal would be available for selection by all STBs, limiting user choice.

F. Signal / Band Stacking

63. One alternative to signal selection is what I will call "signal stacking" or "band stacking," which takes multiple LNB outputs and combines them for distribution as a single signal (which the '715 patent calls a "composite signal"). One example signal stacking implementation is taught in AAPA Petruzzelli. I understand that the original assignee of the patent, Echostar Engineering Corporation, was a subsidiary of Echostar Corporation which operated the DISH Network satellite television service.

64. AAPA Petruzzelli teaches that two "bands" of transponder channels can be distributed together, where a "band" refers to one set of sixteen transponder channels received on one polarization of a dual-polarized satellite signal. (*See generally* Ex.1007-AAPA Petruzzelli, 5:46-6:50.) When the LNBs down-convert the received bands of transponder channels from each polarization, each band is still shifted into the IF range, but the ranges do not overlap. (*See* Ex.1007-AAPA

Petruzzelli, 5:45-6:50.) For example, one set of sixteen transponder channels occupies a 500-MHz band between 950-1450 MHz, and another set occupies a band of the same width between 1550-2050 MHz, which leaves a 100-MHz “guard band.” (Ex.1007-AAPA Petruzzelli, 7:64-8:39.) Hardware to combine signals, such as a diplexer, combines the two bands into a single signal so they can be “transmi[tted] by a single cable.” (See Ex.1007-AAPA Petruzzelli, Abstract.)

65. Petruzzelli posits that frequencies below 950 MHz may be used to transmit terrestrial television signals (*see id.* 6:22-36), but this frequency range is equally available to transmit at least two other bands of transponder signals.

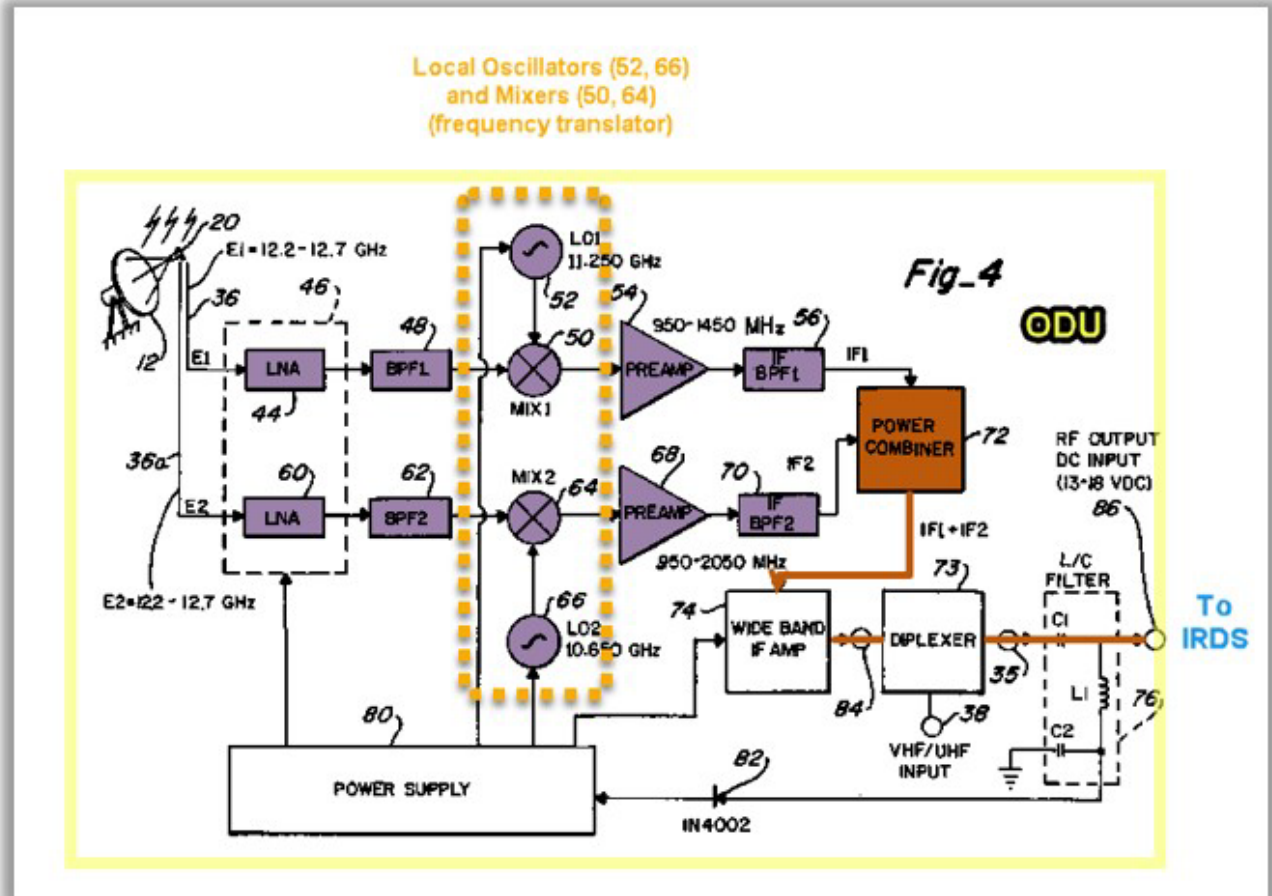


Figure 4 — AAPA Petruzzelli's Signal Distribution System.

G. Transponder Signal Selection Stacking

66. Rather than select and distribute entire blocks of transponder signals from the same received satellite signal, some persons inventing in the field instead proposed selecting individual transponder signals from various received satellite signals, and in some cases, stacking those transponder signals together to form a single signal for distribution. While the '715 patent suggests these are novel concepts, they were actually proposed as much as sixteen years earlier.

67. U.S. Patent No. 4,675,732 to Oleson was filed in 1984 and is discussed

in AAPA Petruzzelli. Oleson proposed using a small multipurpose computer programmed to manage a signal distribution matrix to distribute received satellite television channels to a plurality of TVs. Oleson uses a plurality of “channel strips” comprising variable tuner, filter and variable modulator, with each channel strip associated with a predefined output frequency. (*See* Ex.1015-Oleson, 1:14-58.) Under control of the computer, the channel strips each tune to a particular input frequency and supply it at a fixed and distinct output for distribution to a plurality of televisions. (*See* Ex.1015-Oleson, 1:14-58, 7:21-35.)

68. U.S. Patent No. 5,073,930 to Green, filed in 1989 and also discussed in AAPA Petruzzelli, similarly sought to more effectively distribute desired television programs in a multi-television environment. Green offered a two-tiered solution. First, Green proposed selecting transponder signals from various broadband LNB outputs, frequency shifting the selected transponder signals, and outputting a block of 12 transponder signals in the standard 950-1500 MHz range for distribution to receivers in the community, without demodulating the signal. (Ex.1005-Green, 9:65-10:63.) The resulting “mapped” output would appear as if the selected transponder signals originated on the same signal polarity after it was output by an LNB, as shown in Figure 2 from Green:

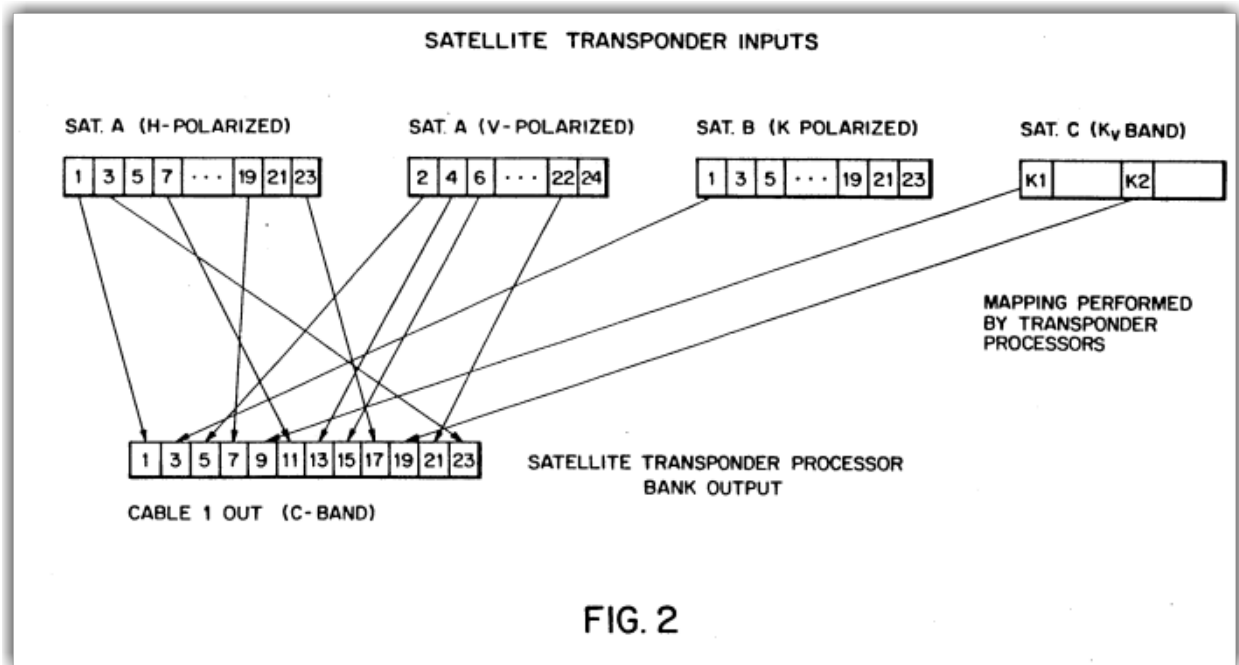


Figure 2 — Transponder Processors Perform Mapping of Transponder Signal Inputs to Bank Output.

Green surmised that this selection, extraction and combination process could be performed four separate times, resulting in four signals in the 950-1500 MHz range, each comprising 12 selected transponder signals, all provided to a central “multiplexor/selector” via a distinct distribution cable. (See Ex.1005-Green, 8:22-37, 9:65-10:63.) From here, the multiplexor/selector switches each STB to the cable containing the television channel desired by the STB. (See Ex.1005-Green, 8:22-37.)

69. Finally, AAPA Williams describes a system for transmitting a combined satellite/cable signal over a single coaxial cable. (Ex.1008-AAPA Williams, Fig. 1 (below), 9:40-67.)

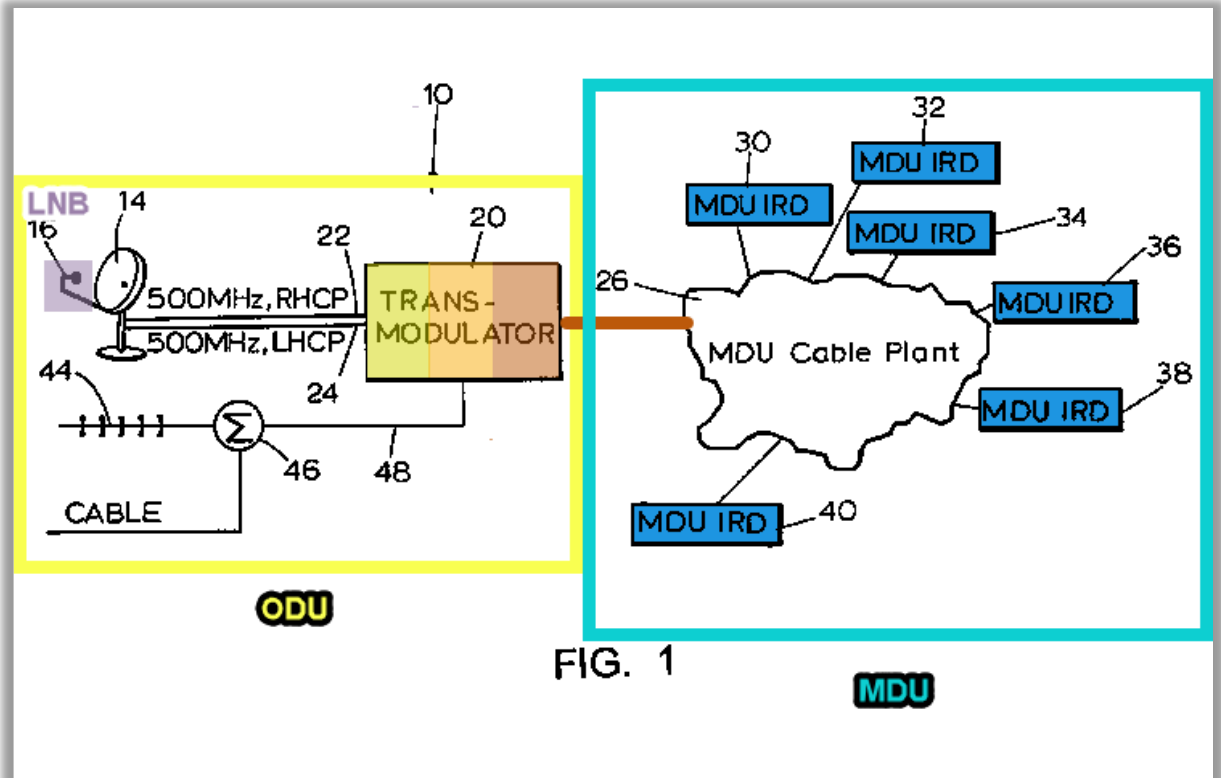


Figure 1 — AAPA Williams's Signal Distribution System.

The Williams solution teaches reducing the bandwidth necessary to transmit a narrow bandwidth RF signal (*e.g.*, a QPSK-modulated signal typical of satellite systems) into a wide bandwidth RF signal (*e.g.*, a 128-QAM signal typical of cable systems) by adjusting modulation schemes. (Ex.1008-AAPA Williams, 6:52-67.)

H. Building and Maintaining a Translation Table

70. Whenever a distribution system alters the frequency of a received transponder channel, such as in the systems of AAPA Petruzzelli, AAPA Williams, Oleson, and Green discussed above, it is necessary to maintain information that allows an STB to locate the channel at its new frequency so the STB is able to tune

to the proper frequency associated with the transponder channel. Given that there were many solutions prior to November 2001 that shift the frequency of transponder channels as a part of signal distribution, maintaining such a table was known in the art, and would not have been difficult to implement, store, and exchange.

71. For example, Green teaches that its transponder processors 112 “perform[] a selected frequency ‘mapping’ or conversion process.” (Ex.1005-Green, 10:4-12.) Selector 208 of Green contains a mapping of the original channel locations at the input of Green’s transponder processors 112 and the new channel locations on the transponder processor output. (See Ex.1005-Green, 12:57-16:2.) While not expressly disclosed in Green, the STBs receiving the distributed signals of Green would have needed this information to correctly select the cable on which a desired channel is located, and then to tune to the frequency where the channel is located. As another example, U.S. Patent No. 7,376,387 to Eck teaches utilizing the “QPSK carrier frequency” information that is included in a received digital satellite signal (which indicates the frequency at which the satellite signal is received by all customer receivers) and preparing a “frequency translation table” at the STB additionally containing the frequency at which the signal is distributed locally after frequency translation. (See, e.g., Ex.1025-Eck, 1:21-35, 1:54-64, 2:10-25.) And more generally, *virtual channel* remapping could be used to associate program

identifiers or transport stream IDs associated with a specific program with a new television channel to which it has been remapped, for example, out of a desire to make a set of related television channels, like the ESPN family of television channels, appear to be located consecutively when they are not received in that fashion. (*See generally* Ex.1024.)

I. Distribution via Gateways over Networks (including LANs)

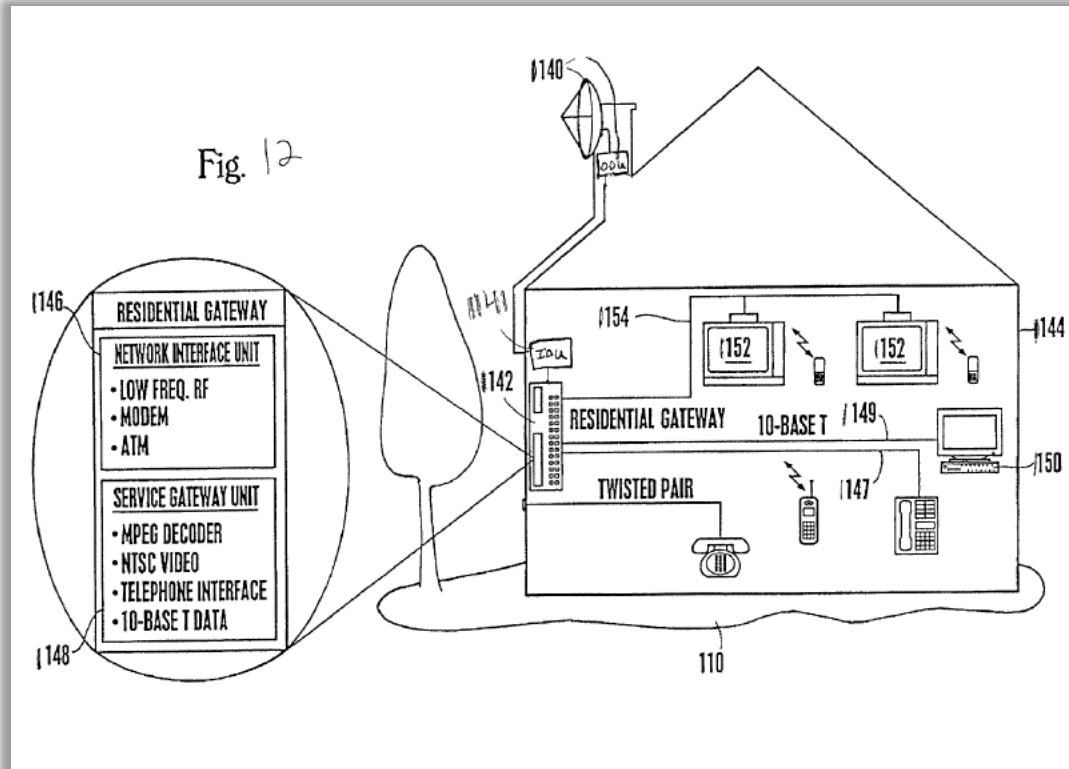
72. A “gateway” in the networking context has long referred to a device interfacing two or more networks. (*See, e.g.*, Ex.1033 at 161.) Gateways typically are located at the “edge” of one network and perform signal processing operations, particularly on received data, to facilitate distribution of that data to devices in that network (but also facilitate communications with other networks). (*See* Ex.1034-Gagliardi (1994), 1:32-42 (gateways “carry[] out protocol conversion and other connectivity functions” to “connect local area networks.”))

73. Gateways are particularly useful where the networks of interest are dissimilar; rather than change the properties of one or both networks to ensure interoperability, the gateway can work as an intermediary and each network (and devices on the network) can continue to operate as normal. For example, an IBM patent filed in 1983 (which acknowledged gateways were already prior art) proposed:

A facility called “Gateway” ... to interconnect a plurality of independently controlled communication networks so that logical units (LUs) in the networks can communicate with one another without any changes to the network. The gateway includes a programmable device or devices which establish and monitor cross network sessions and for each formatted message, on the session, the programmable device changes the contents on the request unit (RU) and/or the transmission header (TH) fields so that data is delivered to a target LU.

(Ex.1035-Benjamin, Abstract, 1:59-2:30.)

74. Gateways can also ensure that different kinds of devices in the same local area network can be provided with communications in an expected format. For example, U.S. Patent No. 7,123,649 to Smith, filed more than a year before the priority date of the '715 patent, teaches “an MPEG decoder, NTSC video interface, telephone interface, and 10-baseT data interface.” (Ex.1036-Smith, 25:29-26:5.) As depicted in Figure 12 from Smith (below), the gateway can decode MPEG video received via ODU 1140 (a satellite receiver) and distribute it to televisions in the expected NTSC format, while also interfacing with telephones and 10-Base T (Ethernet)-compatible devices such as computers and Internet-enabled phones. (*See id.*)



Other inventors in the satellite distribution and networking space similarly proposed using gateways to decode received video programs before the priority date of the '715 patent. (See, e.g., Ex.1037-de Haas, 1:11-31, 6:4-7:25; Ex.1028-Rakib, 23:54-24:48.)

J. Summary of the State of the Art

75. I have prepared the below table to summarize how various concepts relevant to the challenged claims of the '715 patent were found in the art, primarily using AAPA and the file history of a family member of the '715 patent, before the priority date of the '715 patent. The cited prior art references in the table, and the citations to specific passages and figures in each reference, are not meant to be

exhaustive, but to merely provide examples.

Concepts Relevant to Challenged Claims	Disclosure of Concept in State of Art as Shown Primarily in AAPA and Prosecution History
Receiving and down-converting broadband satellite signals at an ODU.	Ex.1001-'715 patent, 1:21-55 (Background); Ex.1007-AAPA Petruzzelli, 1:21-62, 2:11-21, 2:54-65, 4:23-45, 4:58-5:15, 5:1-15, 5:61-6:21; Ex.1008-AAPA Williams, 2:11-40; Ex.1026-Williams '873, 5:59-6:11, Fig. 4; Ex.1027-Shah, 1:64-3:6, Figs. 1, 4 (Ex.1016-'576 FH, 96); "Eutelsat Installers Guide," Figs. 8, 11 (Ex.1017-'576 Reexam, 276-77); Ex.1015-Oleson, 4:35-50.
Selecting transponder signals from broadband satellite signals based on request information.	Ex.1026-Williams '873, 3:56-4:33, 5:45-6:9, Figs. 1, 3 (Ex.1016-'576 FH, 67); "Eutelsat Installers Guide," 19, 26, Figs, 7, 11 (Ex.1017-'576 Reexam, 277-79).
Frequency translating selected transponder signals.	Ex.1007-AAPA Petruzzelli, Abstract, 5:45-6:50, 7:64-8:39; Ex.1026-Williams '873, 3:56-4:33, 6:12-21, 9:40-48, Figs. 1, 3 (Ex.1016-'576 FH, 67); Ex.1027-Shah, 2:66-3:3, 4:61-67, Figs. 1, 4 (Ex.1016-'576 FH, 96); "Eutelsat Installers Guide," 15, 19, Figs. 7, 11 (Ex.1017-'576 Reexam, 281-82); Ex.1015-Oleson, 1:14-58, 7:21-35.
Combining selected transponder signals for distribution.	Ex.1007-AAPA Petruzzelli, Abstract, 5:45-6:50, 7:64-8:39; Ex.1026-Williams '873, 3:56-4:33, 10:24-39, Figs. 1, 3 (Ex.1016-'576 FH, 67-68); Ex.1027-Shah, 3:55-4:38, Figs. 1, 4 (Ex.1016-'576 FH, 96-97); "Eutelsat Installers Guide," 15, 19, 27, Figs. 7, 11 (Ex.1017-'576 Reexam, 281-82, 284-85); Ex.1015-Oleson, 1:14-58, 7:21-35.
Distributing decoded programs via gateway over a local area network.	Ex.1036-Smith, 25:29-26:5; Ex.1037-de Haas, 1:11-31, 6:4-7:25; Ex.1028-Rakib, 23:54-24:48.

Concepts Relevant to Challenged Claims	Disclosure of Concept in State of Art as Shown Primarily in AAPA and Prosecution History
Distributing selected transponder signals in the same modulation as received in broadband satellite signals.	Ex.1007-AAPA Petruzzelli, Abstract, 5:45-6:50, 7:64-8:39; Ex.1015-Oleson, 1:14-58, 7:21-35; Ex.1026-Williams '873, 4:57-60, 7:15-23, 15:15-27; Ex.1027-Shah, 3:47-54, 4:28-38, Figs. 3, 4 (Ex.1016-'576 FH, 99); "Eutelsat Installers Guide," Fig. 7 (Ex.1017-'576 Reexam, 281-82).
Maintaining and distributing information about frequency locations for selected transponder signals.	Ex.1026-Williams '873, 10:53-11:67 (Ex.1016-'576 FH, 69); Ex.1027-Shah, 4:28-52 (Ex.1016-'576 FH, 98); "Eutelsat Installers Guide," 27 (Ex.1017-'576 Reexam, 287); Ex.1025-Eck, 1:21-35, 1:54-64, 2:10-25.

V. THE '715 PATENT

A. The Alleged Invention of the Challenged Claims

76. The '715 patent addresses an age-old problem within video distribution systems: how to efficiently deliver satellite video signals to more than one set-top box within a multiroom building such as house or hotel. A conventional satellite video distribution system including an ODU and multiple STBs is depicted below in Figure 1 of the '715 patent.

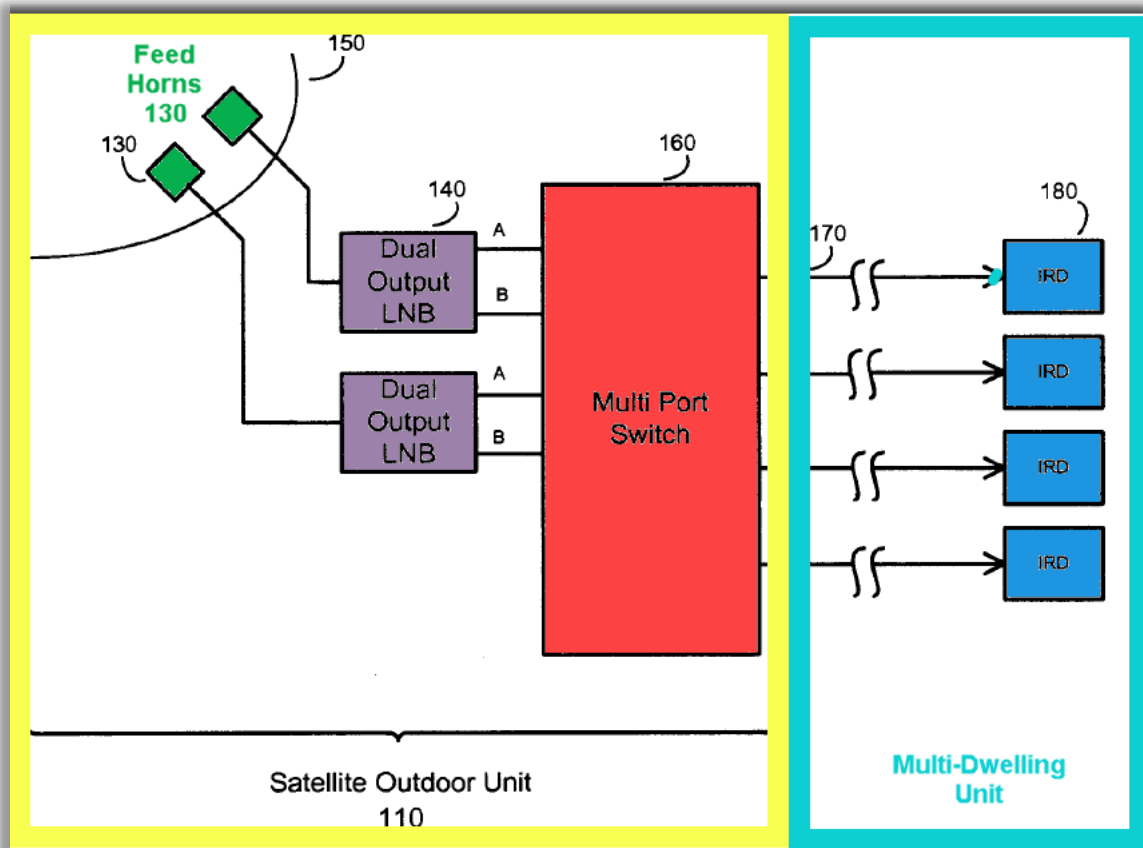


Figure 1 — Video Signal Distribution System (AAPA).

77. The '715 patent explains that “the conventional” approach, requiring separate cables between the ODU and each STB, was inconvenient when adding additional STBs to new locations within a building. (Ex.1001-'715 patent, 1:45-55.) The '715 patent’s purported solution draws on known techniques, including those summarized in the table above in Section IV.G, to transmit desired channels as a combined signal that is outputted to all STBs. Specifically, the '715 patent teaches “selecting” requested satellite signals (*e.g.*, selecting transponder signals from a broadband LNB output signal), “translating” those transponder signals to various

frequencies for transmission within an intermediate frequency (IF) signal, and “combining” the selected, translated transponder signals into a composite IF signal for output to all STBs. (Ex.1001-’715 patent, 2:53-3:2.)

78. The ’715 patent’s process for creating a “composite signal” is illustrated in Figure 5 below.

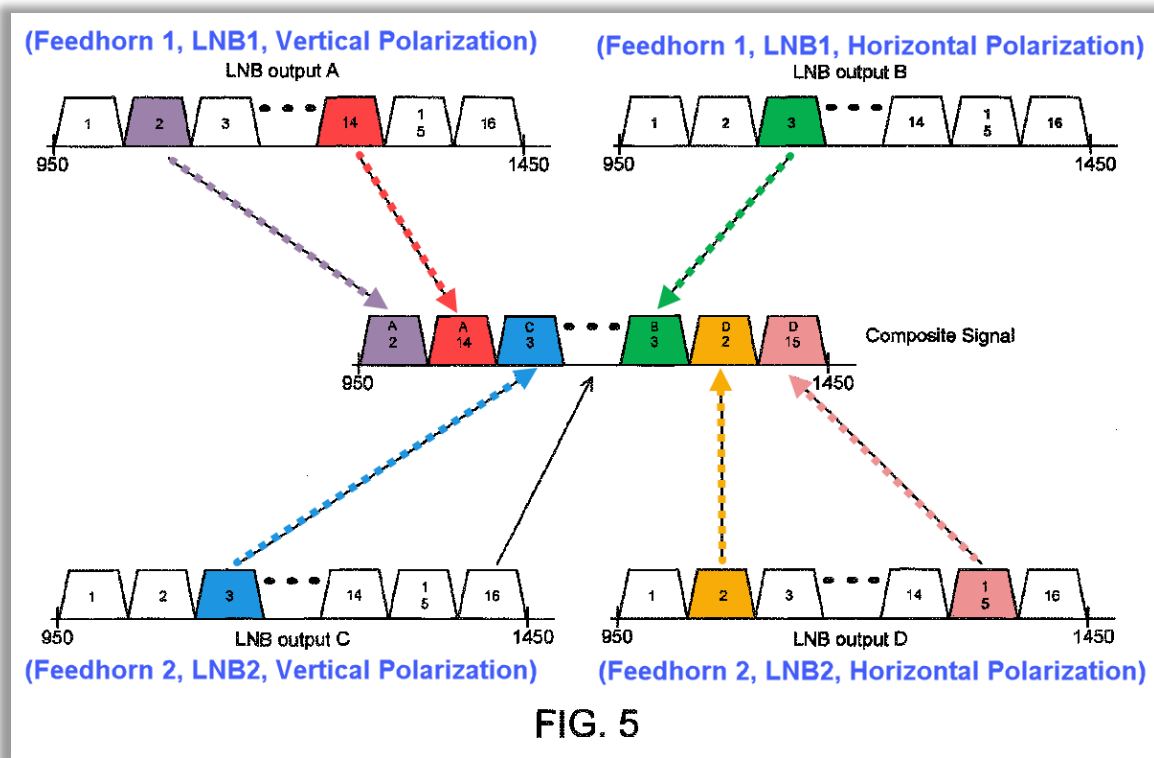


Figure 5 — The ’715 Patent’s “Composite Signal” For Transmission Over a Single Cable.

79. Here, each numbered frequency block represents a transponder channel having a transponder signal comprising one or more television channels. The transponder channels are shown grouped together into four satellite signals (*i.e.*,

broadband LNB outputs), labeled A-D, that correspond to the satellite hardware (*i.e.*, transponder) and signal polarization (*i.e.*, left- or right-polarity) of the satellite signals received by the feedhorns on the satellite antenna. Upon receiving these four satellite signals, selected transponder channels from the broadband LNB output signals are combined into a “composite” IF signal having a frequency range of 950 to 1450 MHz. (Ex.1001-’715 patent, 7:32-38.) Figure 9 depicts system components for selection, translation, and combination to create the composite IF signal.

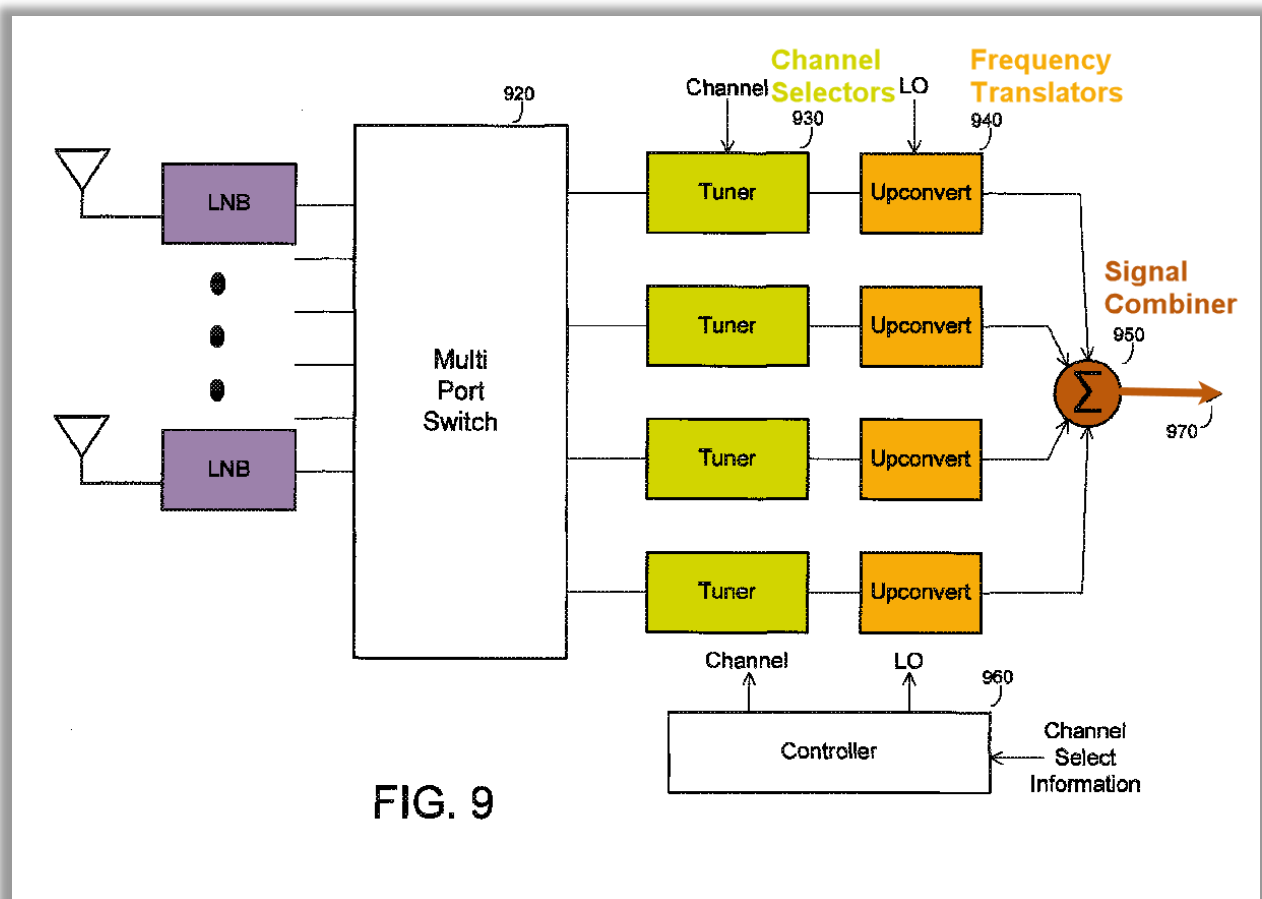


Figure 9 — Tuners and Upconverters Used to Select and Combine Channels.

80. Figure 9 illustrates that each LNB output signal carries frequencies corresponding to particular satellite transponder channels that communicate video data. Desired transponder channels are selected by tuners 930. (Ex.1001-'715 patent, 8:55-57.) The frequency range for selected satellite transponder channels is shifted by up converters 940. (Ex.1001-'715 patent, 8:55-9:14.) Finally, all transponder channels selected for distribution are combined into a composite signal for distribution over a single cable 970. (Ex.1001-'715 patent, 8:55-57.)

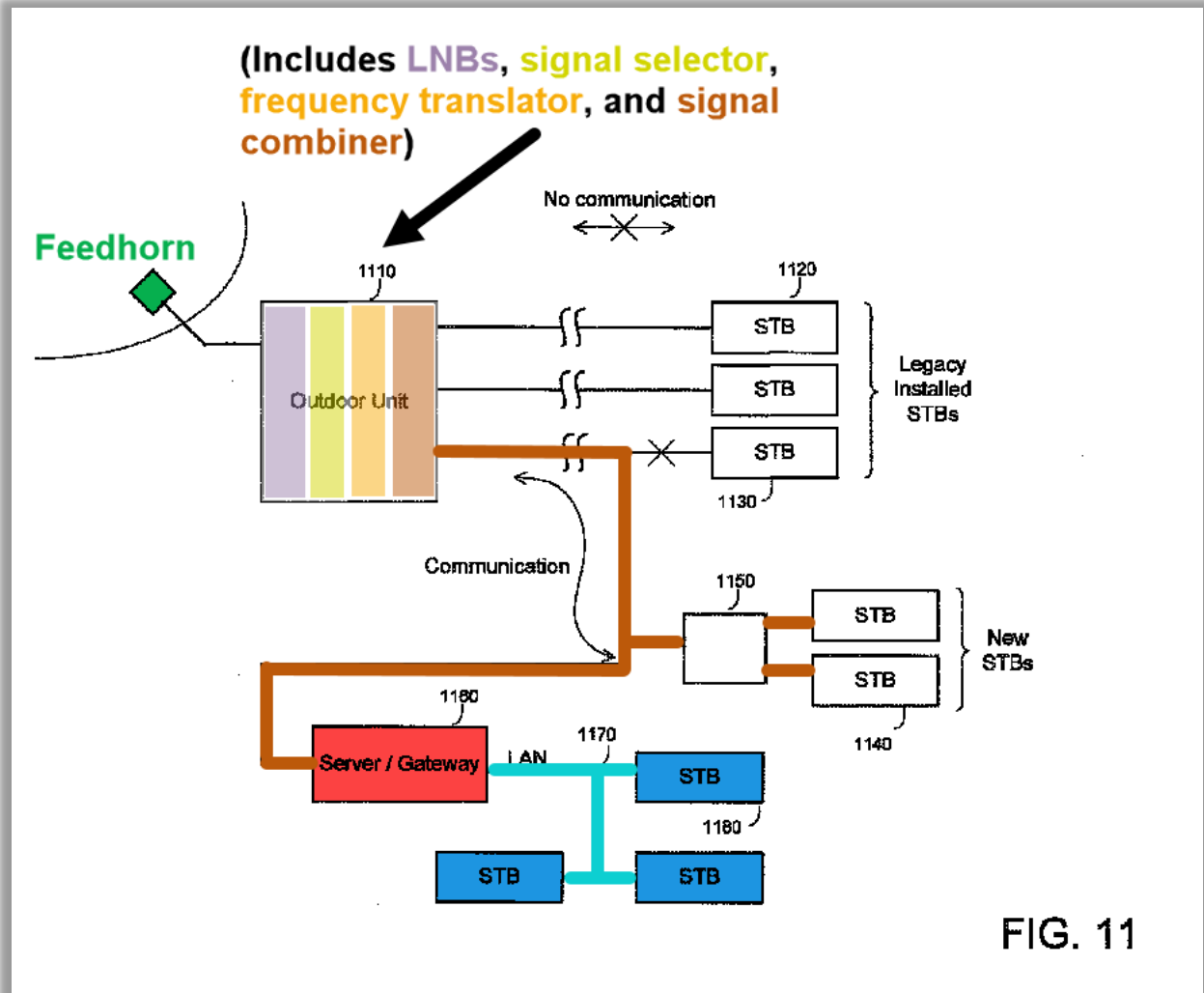


FIG. 11

Figure 11 — The '715 Patent's Signal Distribution System Using a Gateway.

81. When distributing the composite signal to the STBs, the '715 patent teaches outputting the composite signal through a gateway. (Ex.1001-'715 patent, 2:59-65.) Admittedly, the gateway "can be a simple power splitter/summer" (Ex.1001-'715 patent, 4:40-41), or more advanced and capable of both "decod[ing] specific programs," and distributing those programs over a digital local area network to the plurality of STBs, as shown in Figure 11. (Ex.1001-'715 patent, 9:44-48.)

B. Prosecution History of the '715 Patent

82. The '715 patent is a continuation of U.S. Patent No. 7,130,576 (“’576 patent”), and claims priority to several provisional applications, the earliest filed on November 7, 2001. (Ex.1001-’715 patent, Cover.) I have reviewed the prosecution history of the '715 patent, which contains no office actions, and believe it has no relevance to this proceeding. I have also reviewed the prosecution history (Ex.1016) and reexamination history (Ex.1017) for the '576 patent, a family member of the '715 patent. While this record reveals additional prior art disclosing key limitations of the challenged claims (some of which I have incorporated into my “State of the Art” section above), I do not believe it is otherwise relevant to this proceeding.

C. Assumed Priority Date of the '715 Patent

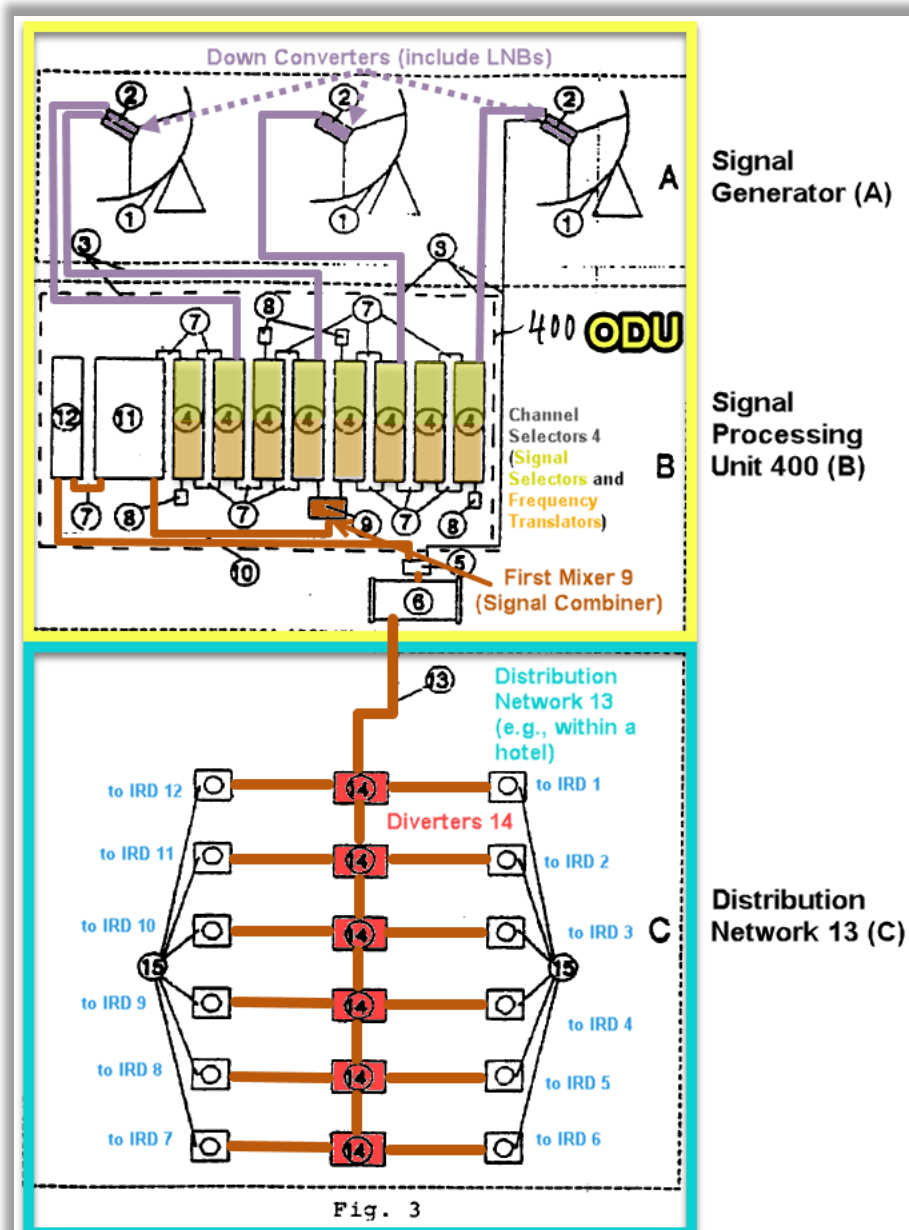
83. I have been asked to assume, for the purposes of this proceeding only, that the '715 patent’s priority date is November 7, 2001.

VI. DESCRIPTION OF THE PRIOR ART

A. Carnero

84. Carnero addresses the same problem as the '715 patent—how to send pre-selected satellite TV channels to multiple STBs in a community/multiroom environment over a single cable. However, Carnero solved the problem five years earlier. In Carnero’s system, a user is provided “with pre-definable channels, via only one distribution cable, which are individually selected from signals originating

from one antenna or from several antennas.” (Ex.1004-Carnero, 3:9-12, Abstract.)



85. Carnero's Figure 3 depicts its satellite television distribution system including signal generators (block A), signal processors (block B), and a distribution network (block C). (Ex.1004-Carnero, 4.) The signal generator includes

conventional antennas 1 and corresponding LNBs 3 while the signal processing device 400 comprises channel-specific converters 4 and mixer 5 and outputs a signal of preselected transponder channels (which Carnero refers to simply as “channels”), each 27 MHz (consistent with typical transponder channel bandwidth, as the ’715 patent recognizes at 1:45-55), over single cable 3. (Ex.1004-Carnero, 6:1-30.) Together, the signal generator and signal processor make up the ODU located on the roof of the building and the signal of preselected channels is output over signal cable 43 for access by multiple STBs in a user community (*i.e.*, hotel). (Ex.1004-Carnero, 10.)

86. Carnero describes in detail how its signal processing device 400 selects specific transponder channels from the received satellite signal to generate an output signal of user-specified transponder channels. Specifically, antennas 1 receive the signals from the satellites that are passed through LNBs 3 and translated from broadband signals into an IF band (*e.g.*, 950 MHz - 1450 MHz). (Ex.1004-Carnero, 4:30-45, Claim 1.) The IF signals are then processed by the plurality of channel-specific converters 4 that “convert a pre-definable channel in the intermediate frequency band, into another channel in the intermediate frequency band.” (Ex.1004-Carnero, 4, Abstract.) For each converter, a microprocessor “designat[es] a predeterminable input channel frequency” corresponding to a desired channel to be

distributed, and also designates “a predeterminable output channel frequency” corresponding to the frequency at which the channel will be distributed over the distribution cable. (Ex.1004-Carnero, 3:48-53.) As a result, “a channel is selected and converted from an input frequency, in the intermediate frequency range, to a predeterminable output frequency in the intermediate frequency range,” a process which does not involve remodulation of the selected transponder signals. (Ex.1004-Carnero, 5:29-41.) The outputs of the channel-specific converter are combined and distributed via a single cable.

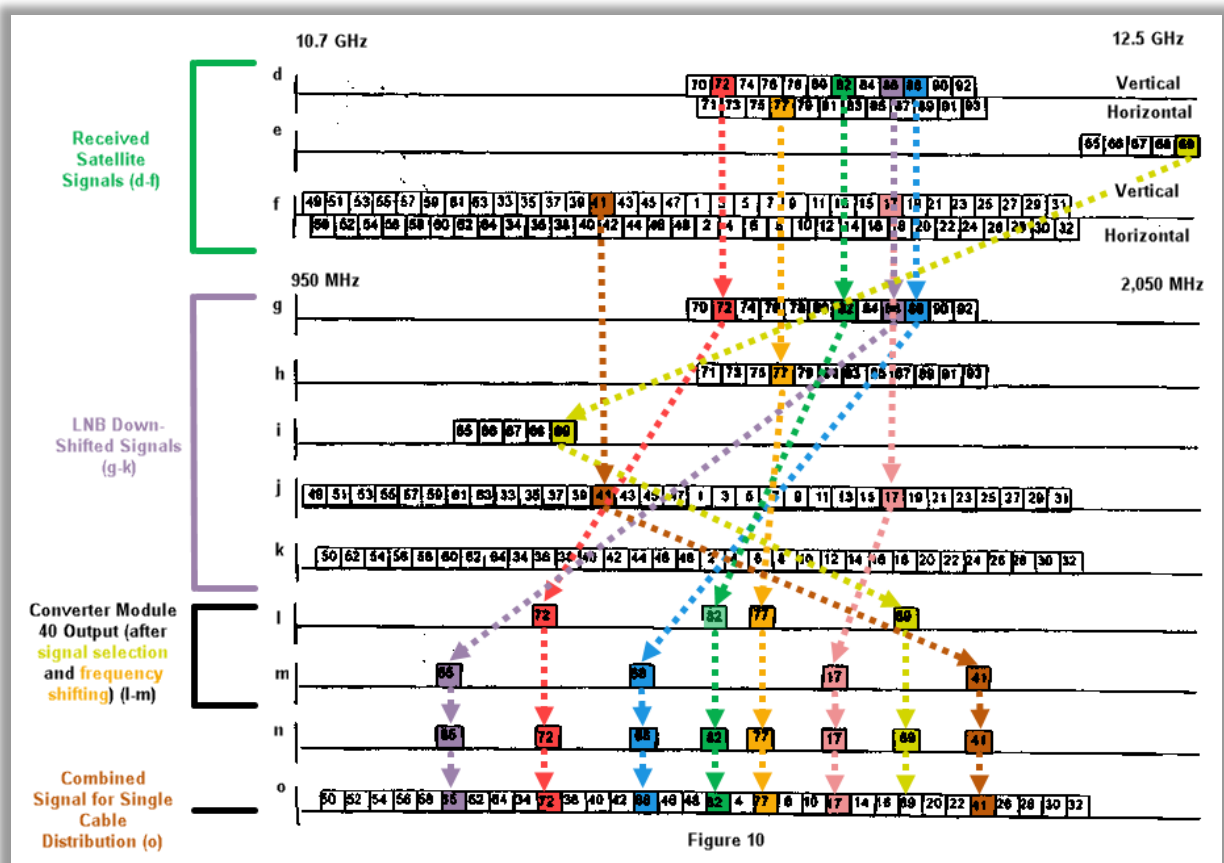


Figure 10 — Process to Create a Combined Signal for Distribution on a Single Cable.

87. Carnero's Figure 10 depicts the channel selection and combination process and is annotated to show how signal frequency channels, requested from an end user, are selected from the received satellite signals and frequency-translated to create a combined, composite signal for output over a single cable. Here, lines "d", "e", and "f" represent signals received by three different feedhorns from satellites in the frequency range of 10.7-12.5 GHz. Lines "g", "h", "i", "j", and "k" represent the respective signals shifted into the intermediate frequency range of 950 MHz-2,050 MHz. The channels selected by each of the channel-specific converter are shown isolated and frequency-shifted in lines "l" and "m", and are then shown together in line "n". Finally, those channels are combined with the entirety of the signal on line "k", where the selected and translated channels replace channels of the same frequency from line "k". The entire signal is distributed to the multiple-dwelling unit (MDU) as a combined, composite signal transmitted on a single cable. (Ex.1004-Carnero, 9:28-46.)

B. Fisk

88. Like the '715 patent, Fisk also describes a centralized server for distributing television and video signals throughout a multi-unit dwelling such as a hotel. (Ex.1003-Fisk, Cover, 2:13-23; *see also* Ex.1001-'715 patent, 9:44-48 (referring to "server/gateway 1160").) The centralized server manages distribution of the digital video signals based on requests for content from receivers located in

various rooms. (Ex.1003-Fisk, Abstract.) Fisk explicitly describes implementing its signal distribution system in a hotel setting where the server is in an equipment room and distributes the requested content to guest rooms over the hotel's network.

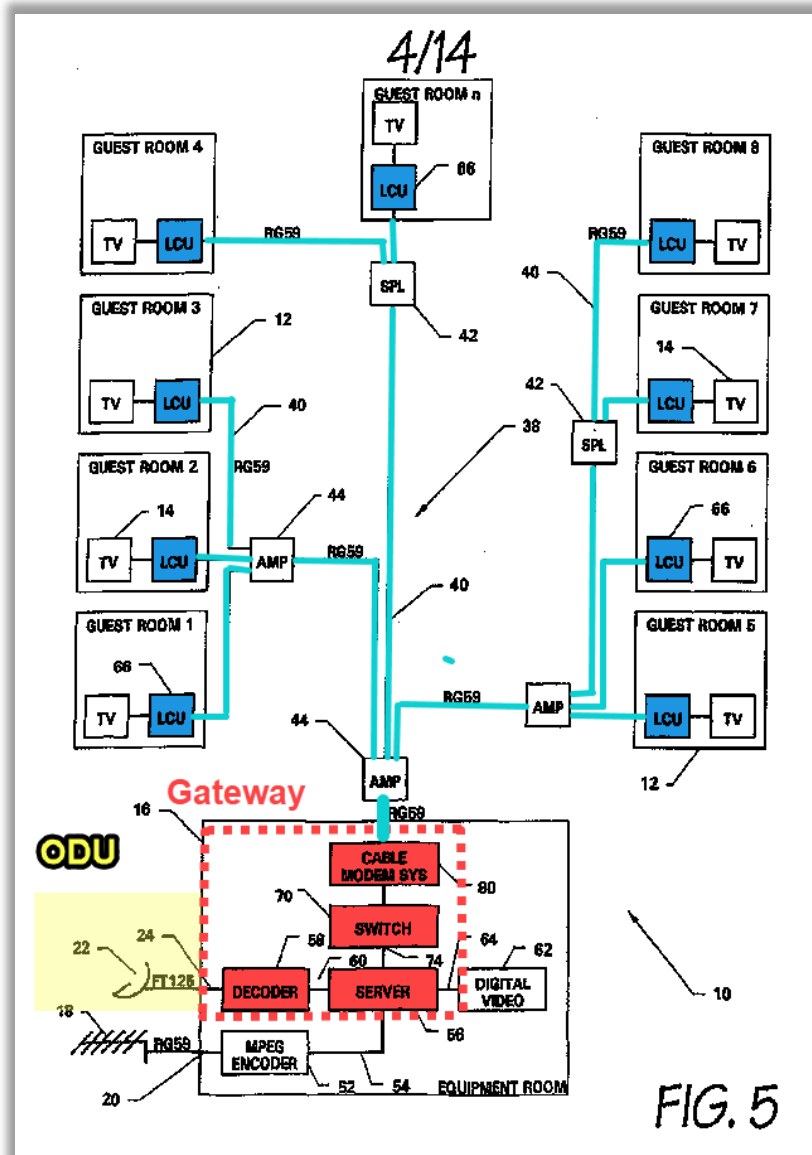


Figure 5 — Fisk's Video Distribution System with a Centralized Server.

89. Figure 5 depicts Fisk's video distribution system implemented in a hotel setting where each guestroom 12 includes a TV and local control unit (LCU)

66 serving as an *IRD/STB* in Fisk's system. Each guestroom is connected to media server 56 over network 40. Central server 56 accesses video media originating from various sources, including via satellite 22. (Ex.1003-Fisk, 12:1-9.) Decoders 58 process the received satellite signals and provide digital MPEG video streams to the server. (Ex.1003-Fisk, 22:9-22.) If the server 56 receives a television channel request from an LCU 66 in a guest room, the server transmits the digital television signal over the network. (Ex.1003-Fisk, 6:7-21.) All requested media is provided by the server to the network via a single output cable 74 for distribution to the LCUs. (Ex.1003-Fisk, Figure 4.) Fisk's server maintains a configuration manager database with information about the channels assigned to various receivers to facilitate management of the media distribution. (Ex.1003-Fisk, 40:10-19.)

C. Green

90. Green describes a system for receiving and distributing satellite transmitted television signals by selecting transponder signals from one or more satellites for distribution to a plurality of subscribers in a "community television" context (*i.e.*, within apartments, hotels, and the like). (Ex.1005-Green, Abstract, 6:18-34.) More than twelve years before the '715 patent's filing date, Green ensures that a plurality of STBs are provided with signals from various satellite receivers, over a single cable, without degrading quality.

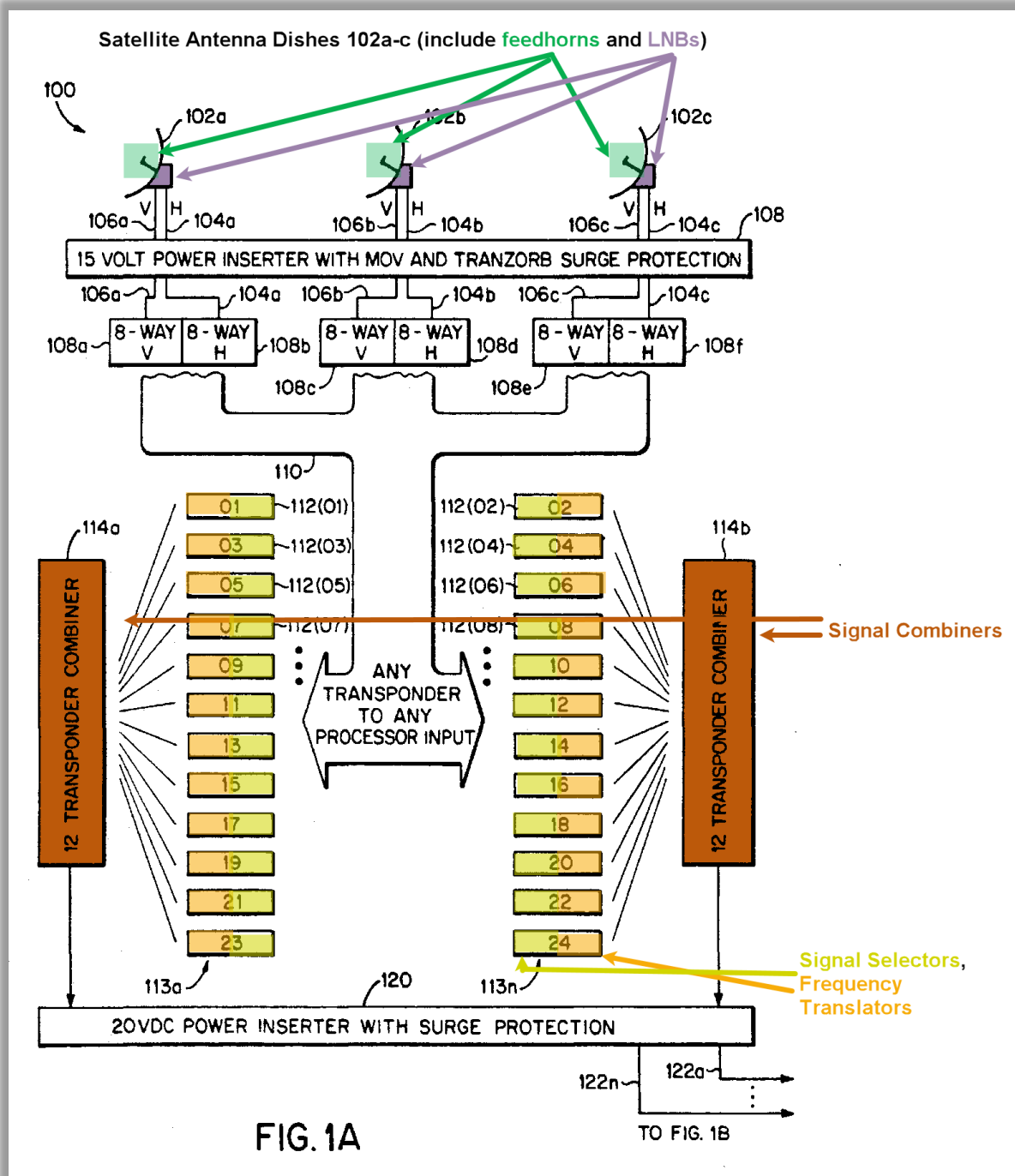


Figure 1A — Community Television Distribution System.

91. Green includes multiple dish receivers 102a-c, each containing a feedhorn and a dual-output LNB. (See Ex.1005-Green, 9:29-50.) These

“conventional” LNBs down convert each received polarized signal 104a-c (horizontal) and 106a-c (vertical) and output a block of transponder channels shifted into the 900-1500 MHz range. (Ex.1005-Green, 9:45-50.) Each transponder block is fed into an eight-way power amplifier, which outputs eight identical copies of the input to be provided to as many as eight banks 113 of transponder processors 112. (Ex.1005-Green, 9:41-64.)

92. Figure 1A depicts two banks, 113a and 113n. Each transponder processor 112 selects a single transponder channel from one of the transponder blocks and shifts the signal to a desired frequency (*i.e.*, different from the frequency used by the other processors in the block). (Ex.1005-Green, 9:65-10:19.) A 12-transponder combiner 114a combines the outputs of the processors in one block into a single combined signal, amplified by 120 and distributed to multiple subscribers via a single cable 122a. (Ex.1005-Green, 9:65-68.)

93. Green touts the benefit of providing each subscriber its desired channel on a “single individual ‘drop’ coaxial cable” 130 that is “prewired” in its residency. (Ex.1005-Green, 11:7-16.) Green further teaches using a cable selector 128 that is “remote from the actual subscriber location” but “convenient” to each drop cable 130. (Ex.1005-Green, 11:7-16.) Based upon a request from selector unit 140 associated with a TV and satellite receiver 136, one of the cables 126 carrying a

block of twelve transponder signals containing the requested television channel is selected for tuning and decoding by the satellite receiver 136. Figure 1B of Green shows the preferred embodiment of four blocks of twelve transponders transmitted over cables 126a-d.

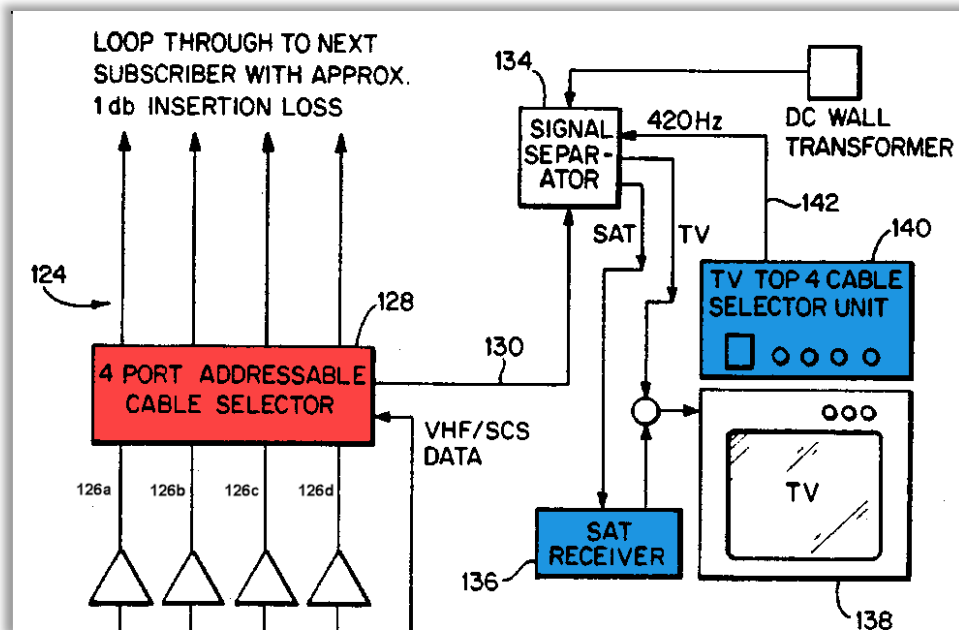


Figure 1B — Distribution Network at a Subscriber Location.

D. Davis

94. Davis describes a local area network-based satellite signal distribution system. (Ex.1006-Davis, Abstract.) Davis teaches limiting the number of cables needed to transmit satellite television signals to multiple STBs. (Ex.1006-Davis, ¶¶4-7, 10-12 (“It would be advantageous to simplify the installation of multiple IDUs at a particular site, while reducing the number of cables required for such an installation. ... Further, it would be advantageous to allow for new IDUs and/or new

services to be installed at a particular site without needing to install more cables.”).

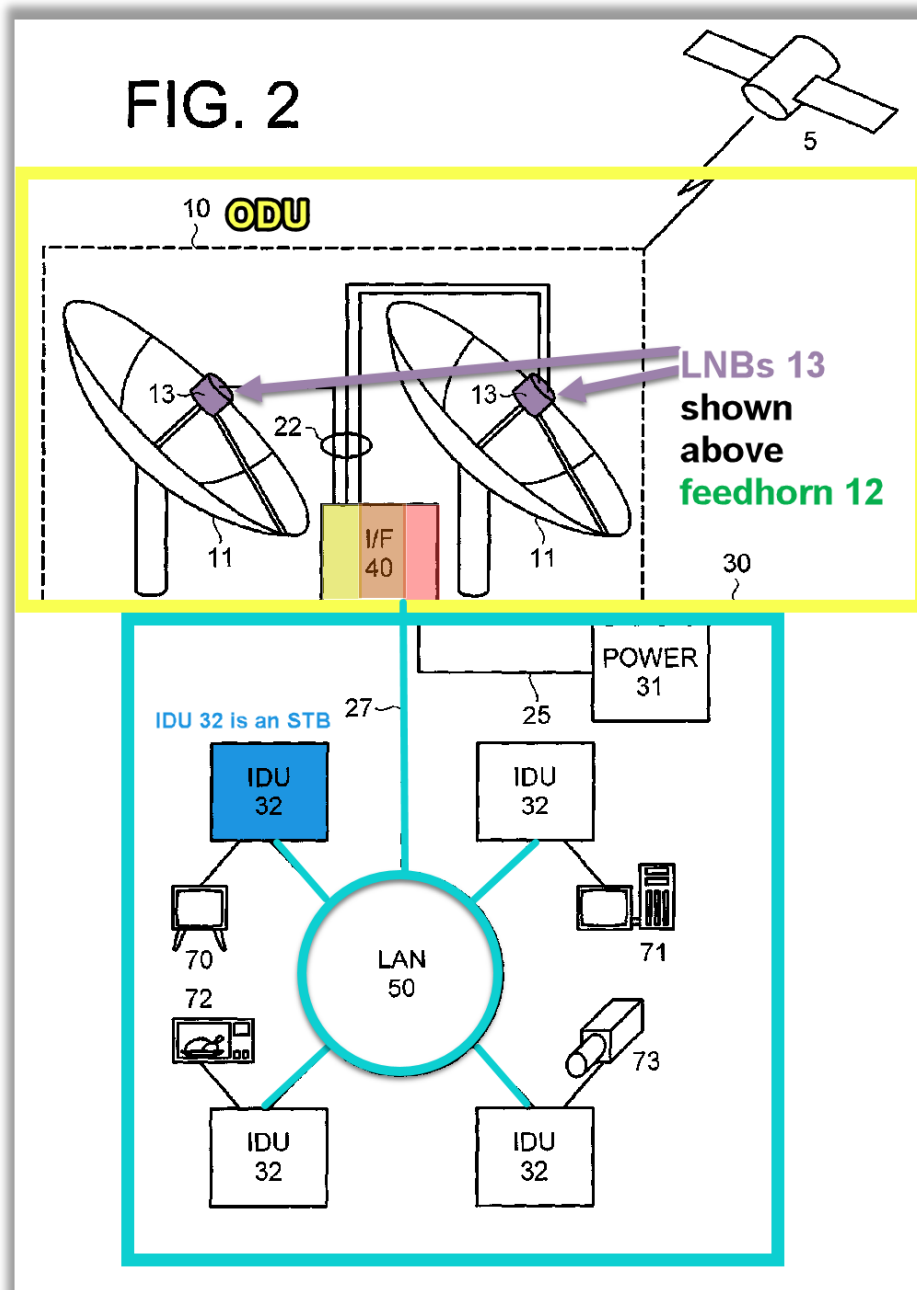


Figure 2 — Davis's Satellite Television Distribution System.

95. Davis's interface device 40 converts the IF output from LNBs 13 to digital baseband information. (Ex.1006-Davis, ¶13.) By digitizing, Davis teaches

leveraging known local area network (LAN) techniques for distributing selected signals to a plurality of indoor units 32 via point-to-point communications and the TCP/IP protocol. (Ex.1006-Davis, ¶¶13, 36, 53.) After digitizing the received LNB outputs, interface device 40 selects the received signals desired for distribution, performs other signal processing, and multiplexes the selected signals for distribution over the LAN. (Ex.1006-Davis, ¶13.)

96. I understand that for Davis to be entitled to the benefit of the April 18, 2001 filing date of U.S. Provisional Patent Application No. 10/123,383 (Ex.1029, “Davis Provis.”) under 35 U.S.C. § 119(e)(1), and thus rendering Davis prior art to the ’715 patent under at least 35 U.S.C. § 102(e), two conditions must be met. First, I understand that the Davis Provis. must provide written description support for at least one claim of Davis; that is, it must “describe the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that the inventor had possession of the claimed invention.” (*See Moba, B.V. v. Diamond Automation, Inc.*, 325 F.3d 1306, 1319, 66 USPQ2d 1429, 1438 (Fed. Cir. 2003), MPEP §2163(I).) Second, I understand that the Davis Provis. must provide written description support for the disclosure I rely upon in my opinion that Davis (in combination with other prior art) renders the ’715 patent obvious. (*Amgen Inc. v. Sanofi*, 872 F.3d 1367, 1380 (Fed. Cir. 2017); MPEP § 2136.03(III).)

97. In my opinion, the Davis Provis. meets both criteria. As I show in Appendix B to this Declaration, the Davis Provis. provides written description support for at least claim 1 of Davis. And as I show in Appendix C to this Declaration, the Davis Provis. provides written description support for the disclosures from Davis that I rely upon in forming my opinion that Davis (in combination with other prior art) renders the '715 patent obvious.

VII. PETITIONERS' GROUNDS FOR CHALLENGE

98. Independent claims 1, 9 and 13 are directed to a signal distribution system for distributing LNB output signals received from a satellite. I understand that Petitioners are challenging all 19 claims of the '715 patent. Because I understand only claims 9-12 are asserted in the Federal District Court patent infringement case filed by Patent Owner, I address grounds challenging those claims first.

A. Ground 1: Claims 9-12 are Obvious over Fisk and Carnero and in Further View of the General Knowledge of a POSITA

1. Motivation to Combine Fisk and Carnero

99. A POSITA would have been motivated to combine the teachings of Fisk and Carnero.

100. Both Fisk and Carnero are in the field of television distribution system from satellite signals to individual users and address variations of the same problem—namely, how to increase the number of desired television

channels/programs that can be transmitted to individual users. Fisk and Carnero both describe receiving, selecting, combining, and distributing satellite and cable signals. Thus, a POSITA would look to these similar and related references to efficiently distribute received satellite signals, including television channels, to a multiple users.

101. In 2001, a single satellite dish—such as Fisk’s antenna 22—received dozens of transponder signals carrying perhaps hundreds of television programs. (*See, e.g.*, Ex.1014, discussing DISH and DirecTV television offerings in 1996.) Transmitting hundreds of television programs over Fisk’s single coaxial cable (coaxial cable download 24) would be problematic because physical limitations of coaxial cables provide a relatively narrow band of frequencies over which signals can be reliably carried: in the case of Fisk’s FT125 (also known as CT125) coaxial cable download 24, approximately 3.51 and 5.18 dB per 100 ft are attenuated at 460 and 1,000 MHz, respectively. (Ex.1003-Fisk, 21:1-51; Ex.1022, 1; *see also* Ex.1023, 2.) Accordingly, a skilled artisan would have been motivated to modify Fisk to incorporate signal selectors upstream of download 24 that pass on only the user-selected signals, as Carnero teaches. Indeed, Carnero explicitly encourages using its signal selectors (“channel-specific converters”) “in cases where a single distribution cable has already been laid or in cases where the laying of a further distribution cable

would be costly or impossible.” (Ex.1004-Carnero, 3:19-21.) Fisk’s hotel fits the exact environment suggested by Carnero for implementing its signal selectors.

102. While Fisk describes receiving satellite signals for decoding and distributing to multiple receivers located in different rooms, Fisk provides minimal detail as to how satellite signals are received by the ODU prior to distribution over a LAN, other than that those signals are received in analog or digital format. (Ex.1003-Fisk, 43, 45.) If Fisk’s server 56 receives signals directly from the satellite antenna without any intermediate signal processing, that would require server compatibility with hundreds of received programs on several cables, any number of those programs may be requested by receivers (LCUs), and thus would need to be accessible to server 56 for distribution. A POSITA thus would have been motivated to ensure that the hundreds of available television channels in common satellite television services could be efficiently and economically made available to the LCUs in Fisk on demand.

103. Carnero teaches a transponder signal selection process that would ensure greater efficiency when implemented in the Fisk server. Under control of a microprocessor, Carnero’s channel-specific converters each select a desired channel via tuning and filtering, frequency shift the channel to a set output frequency, and combine the output signals over a frequency spectrum sufficient for distribution over

a single coaxial cable. A POSITA would have been motivated to employ the channel selection and combination system of Carnero to provide the input satellite signal for Fisk's signal distribution system via a server gateway. Carnero's output simplifies how Fisk receives satellite signals for distribution. Fisk's decoders need only receive a single input (the output of Carnero), and need only tune to a specific frequency for each desired program so that the program could be demultiplexed from a transponder signal for distribution to a requesting LCU, no matter the number of programs received by the satellite receiver prior to processing by Carnero's channel selector. Thus, Carnero's solutions ensure that Fisk's decoder receives desired programs in a manageable quantity while maintaining fidelity.

104. Fisk's server 56 and decoder 58 and Carnero's signal processing unit 400 have similar architecture and functionality such that a skilled artisan would know to incorporate—with a reasonable expectation of success—the signal processing head 400 to improve the functionality of Fisk. A skilled artisan would know that Carnero's signal processing head 400 has channel-specific converters 4 that are responsive to selections made by microprocessor 49, thus including a microprocessor in Fisk's server that provides transponder select information from a microprocessor in server 56 to the signal selection devices (*e.g.*, channel-specific converters) in server 56. The result of using such a microprocessor would be that

server 56 has access to all signal selection information received from all the receivers and can have complete autonomy in processing the incoming television signals. Moreover, as evidenced by the AAPA, implementing the functionality recited in the challenged claims was conventional and the fundamental desire to efficiently distribute satellite television signals to multiple receivers in a multi-unit dwelling like a hotel or apartment was well within the general knowledge of a POSITA. (*See supra*, Section IV.G; *see generally* Section IV.)

2. Independent Claim 9

9[pre] “A signal distribution system for distributing a plurality of low noise amplifier and block converter (LNB) output signals from a satellite outdoor unit (ODU) comprising:”

105. To the extent the preamble is limiting, it is separately taught by Fisk and Carnero. Fisk “relates to distribution and networking of television, video and other signals” in a multi-dwelling unit. (Ex.1003-Fisk, 1:5-12.) Fisk’s video distribution system is shown in Figure 5.

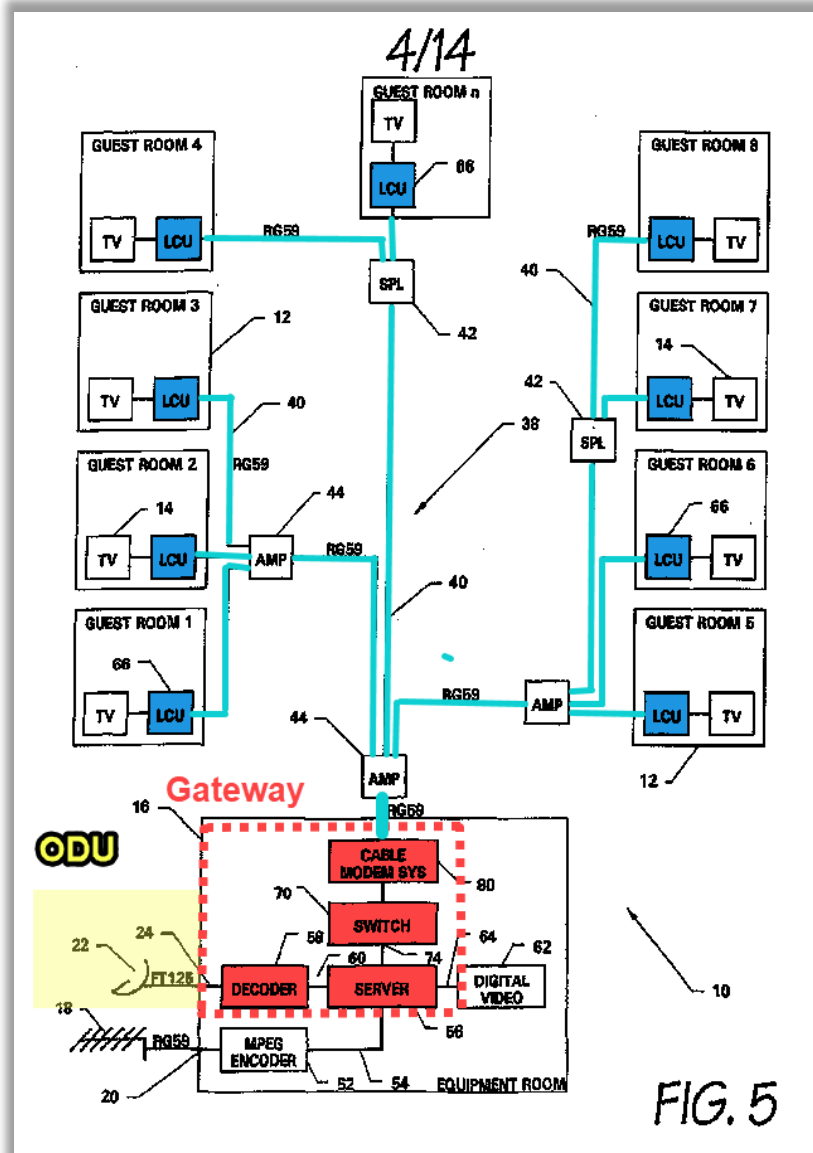


Figure 5 — Fisk's Video Distribution System.

106. A “satellite receiver” 22—also called a satellite dish—receives satellite television signals for processing and distribution. (Ex.1003-Fisk, 10:23-11:3, 21:1-5 (describing reception of digital satellite television signals).) Fisk does not delve into the details of the satellite dish 22 and processing components (that make up the *ODU*), but it was well within the general knowledge of a POSITA at the time that

analog television signals received by the satellite dish are passed through *LNBs* and then outputted at an IF suitable for distribution over coaxial cable, such as the FT125 coaxial cable 24 described in Fisk. (Ex.1003-Fisk, 21:1-9.) For instance, each of AAPA Petruzzelli, AAPA Williams, and the summary of a “conventional” system in Figure 1 all disclose LNB(s) down-shifting received satellite television signals into IF. (*E.g.*, Ex.1007-AAPA Petruzzelli, 1:21-37, Ex.1008-AAPA Williams, 2:11-21, Ex.1001-’715 patent, 1:21-44.)

107. Once Fisk’s server 56 receives the *LNB output signal*, it selects the video programs requested by the LCUs 66 in individual guest rooms, and outputs that program content together with other requested video content, including over-the-air cable and on-demand programming. (Ex.1003-Fisk, 21:1-29, 22:9-27 (“The server 56 selects which of the video streams is to be transmitted to which room 12 and places the selected video streams on the digital network 50 using UDP/IP, or TCP/IP”).) Accordingly, Fisk meets this limitation.

108. Carnero likewise discloses “a community antenna system, for distributing television signals of different channels” and describes in detail how the *LNB output signals* are processed and output. (Ex.1004-Carnero, Abstract.) Carnero’s Figure 3 depicts its “*signal distribution system.*” (Ex.1004-Carnero, 4.)

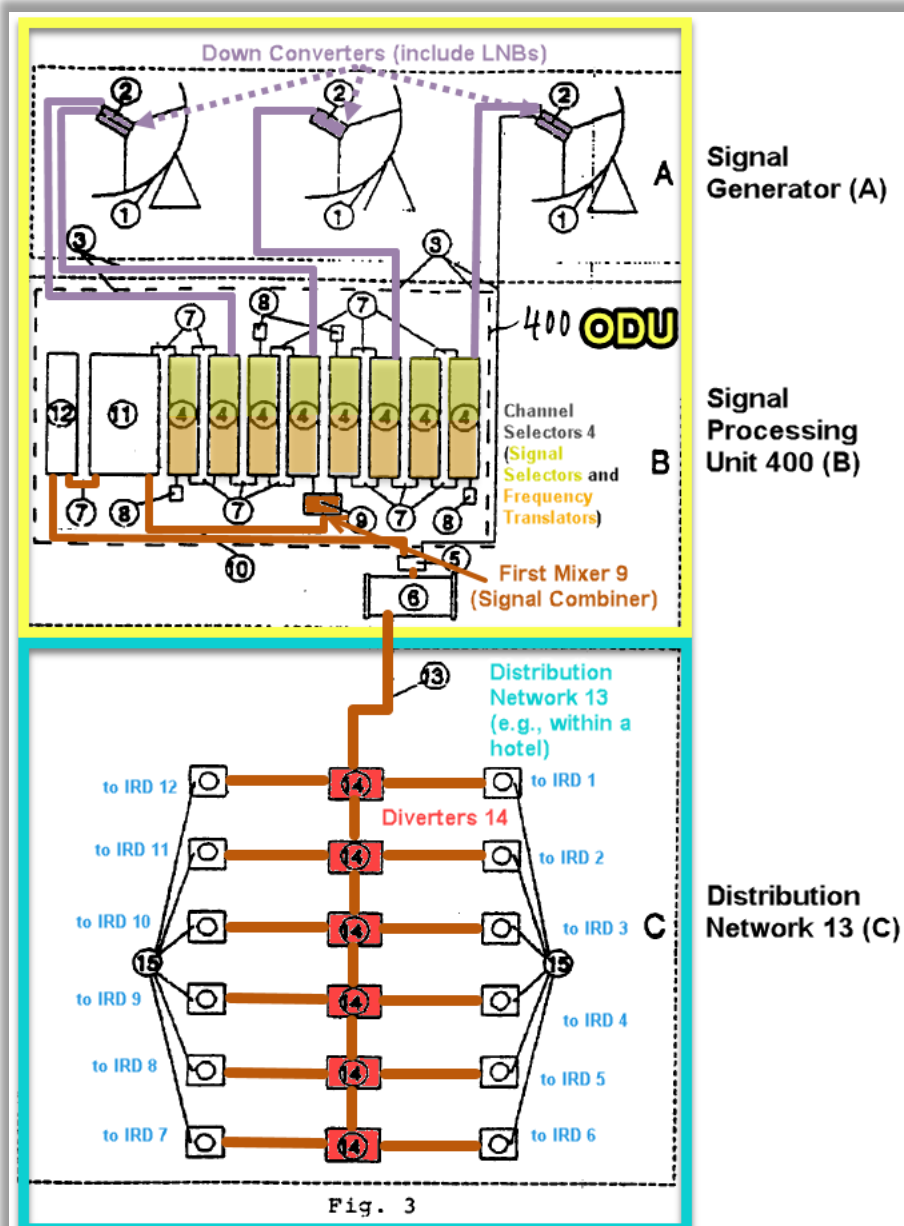


Figure 3 — Carnero's Signal Distribution System.

109. Together, Blocks A and B constitute the claimed *ODU*. Block A includes antenna 1 and multiple low-noise amplifier LNAs and low-noise block converter LNBs 2. (Ex.1004-Carnero, 4.) Signals received by antenna 1 (Block A) are processed by the LNBs “that convert the received signal, in an already known

way, from the received frequency range . . . to an intermediate frequency range.” (Ex.1004-Carnero, 4.) The IF signal output by the LNBs is the claimed *plurality of low noise amplifier and block converter (LNB) output signals*.

110. The IF signal (*LNB output signal*) is output over cable 3 to channel-specific converters 4 and mixer 5 (Block B) that select and combine pre-defined channels into a single signal for distribution via network 13 in Block C. (Ex.1004-Carnero, 4, 3:19-17 (stating “the user is provided with pre-definable channels, via only one distribution cable, which are individually selected from signals originating from one antenna or several antennas.”), claims 1-2.) Accordingly, Carnero also discloses *a signal distribution system for distributing a plurality of low noise amplifier and block converter (LNB) output signals from a satellite outdoor unit (ODU)*.

9[a] “a gateway in communication with the ODU and at least one set top box (STB);”

111. Fisk’s server 56 is included in the claimed *gateway* and acts as a mediator between the system’s antenna 22 (*ODU*) and LCUs 66 (*STBs*). As discussed above in Section IV.F, gateways were known in the art as network intermediaries, which is the role served by the server 56 of Fisk. The architecture of Fisk’s video distribution system using a gateway is illustrated in Figure 5 below.

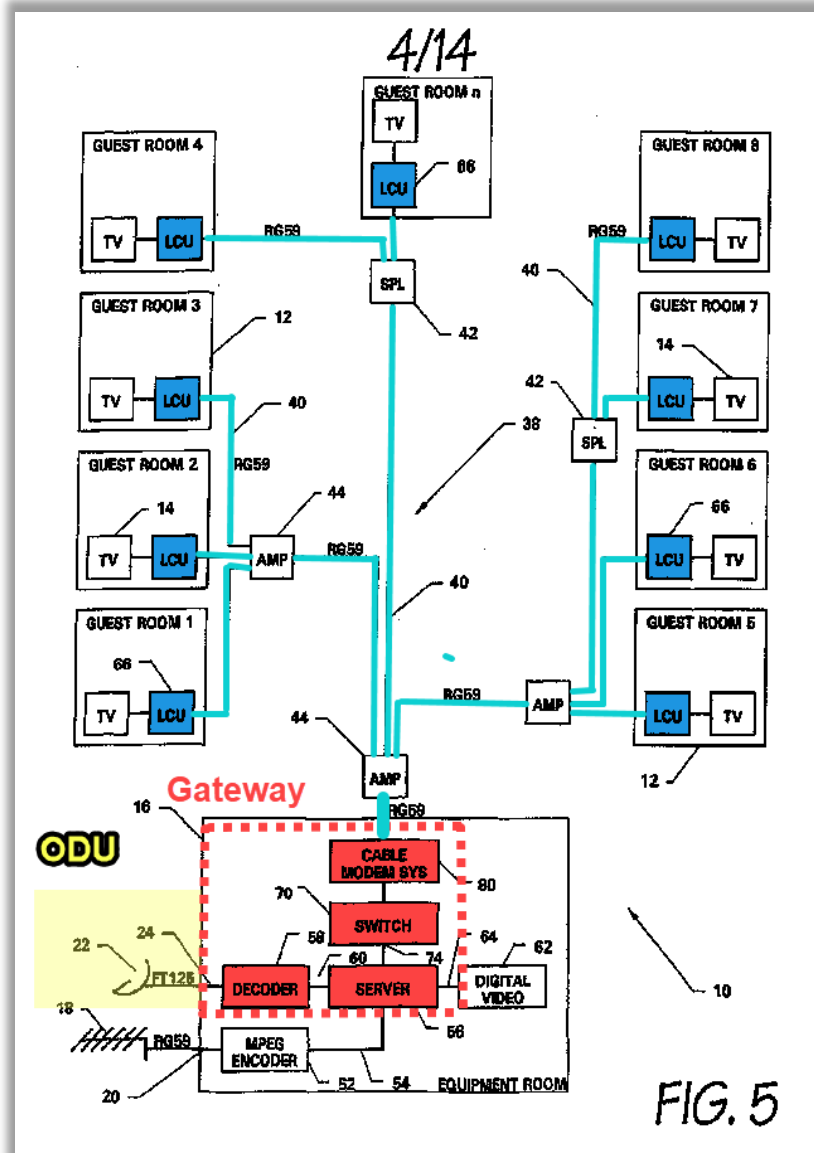


Figure 5 — Fisk’s Video Distribution System.

112. Fisk’s server 56 (part of the *gateway*) is in *communication with the ODU*. Fisk discloses that its server 56 receives “digital MPEG video streams 60 for the received satellite television programmes” from antenna 22. (Ex.1003-Fisk, 22:16-18.) As explained above, ODUs are essential components of any satellite or

cable video broadcast system. Indeed, the '715 patent admits that ODUs were well known and describes the ODU as typically including a dish antenna, down converters (LNBs), and a switch that “allows connection of the outdoor unit to more than one integrated receiver decoder (IRD) located inside a building.” (Ex.1001-'715 patent, 1:20-44; *see also* Ex.1007-AAPA Petruzzelli, 1:21-37, 2:54-65, 4:23-45, 4:58-5:15, 5:1-15, 5:61-6:21; Ex.1008-AAPA Williams, 2:11-40.) A POSITA would have understood that Fisk’s ODU is antenna 22 and its associated components including LNBs that process signals via server 56 (part of the *gateway*) for distribution to the to the receivers (LCUs), and thus are in *communication with the gateway*.

113. To the extent Patent Owner argues that “communication” requires bi-directional communication between the *ODU* and the *gateway*, a POSITA would have understood that Fisk’s server 56 would have communicated to the *ODU* to ensure, for example, that the *ODU* was only operational when the server 56 needed to distribute received satellite signals; otherwise, the *ODU* would have wasted energy amplifying and down-converting signals that were not needed. Further, it would have been obvious to a POSITA in view of Carnero that server 56 could communicate with the *ODU* to provide information to the *ODU* to facilitate channel selection by the channel-specific converters of Carnero’s *ODU*. (*See supra* ¶¶102-

04, *infra* ¶¶143-45; Ex.1004-Carnero, 3:48-54.)

114. Fisk’s server 56 (part of the *gateway*) is also in *communication with at least one STB*. Fisk teaches that server 56 receives channel request information from its LCUs. The LCU “compris[es] [1] means for enabling connection to the server by means of a network (for example, a connector, for instance a telephone or coaxial connector),” “[2] means for selecting a required one of the programmes (for example a keypad),” and “[3] means for communicating the selection to the server (for example, a transmitter).” (Ex.1003-Fisk, 4:1-11, 22:22-27.) Fisk’s server 56 ultimately distributes the selected program to the LCUs (*STBs*). (Ex.1003-Fisk, 4:1-11, 22:9-27 (“The server 56 selects which of the video streams is to be transmitted to which room 12, and places the selected video streams on the digital network 50 using UDP/IP, or TCP/IP, each addressed to the selected room 12.”).) Like the *STBs* described in the Background of the ’715 patent, Fisk’s LCUs “receive[] the video stream addressed to room 12, decode[] it, and suppl[y] the resulting analogue video and audio signals to television 14”—and are therefore the claimed *STBs*. (Ex.1003-Fisk, 22:23-25, 33:15-24 (“LCU 66 can [] utilise many of the components designed for” *STBs*) *compared with* ’715 patent, 1:32-44 (“set top boxes (*STBs*) . . . tune[] one transponder channel, demodulate[] the IF signal from the LNB down to base band, provide[] channel selection, conditional access, decode[] the digital data to

produce a video signal, and generate[] an RF output to drive a television.”.) To the extent the LCU of Fisk is not deemed to be an STB within the meaning of the claim term, it would have been obvious to modify Fisk’s system to include known STBs which were readily available (as opposed to the LCUs, which did not exist separate from the disclosure of Fisk) and compatible with the remaining signal distribution system of Fisk.

115. Thus, Fisk discloses this limitation, or it otherwise would have been obvious in view of Fisk and Carnero and the general knowledge of a POSITA.

9[b] “a signal selector that receives a plurality of broadband LNB signals comprising a plurality of transponder signals, the signal selector is responsive to transponder select information transmitted by the gateway and selects a plurality of transponder signals from at least one broadband LNB signal based on the transponder select information;”

116. Together, the combination of Fisk and Carnero renders this limitation obvious. Carnero teaches a *signal selector*. Carnero’s signal processing unit 400 is a *signal selector that receives a plurality of broadband LNB signals comprising a plurality of transponder signals*. As depicted by Carnero’s Figure 3, signal processing unit 400 receives a *plurality* of broadband LNB signals from three LNBs 2 via cables 3.

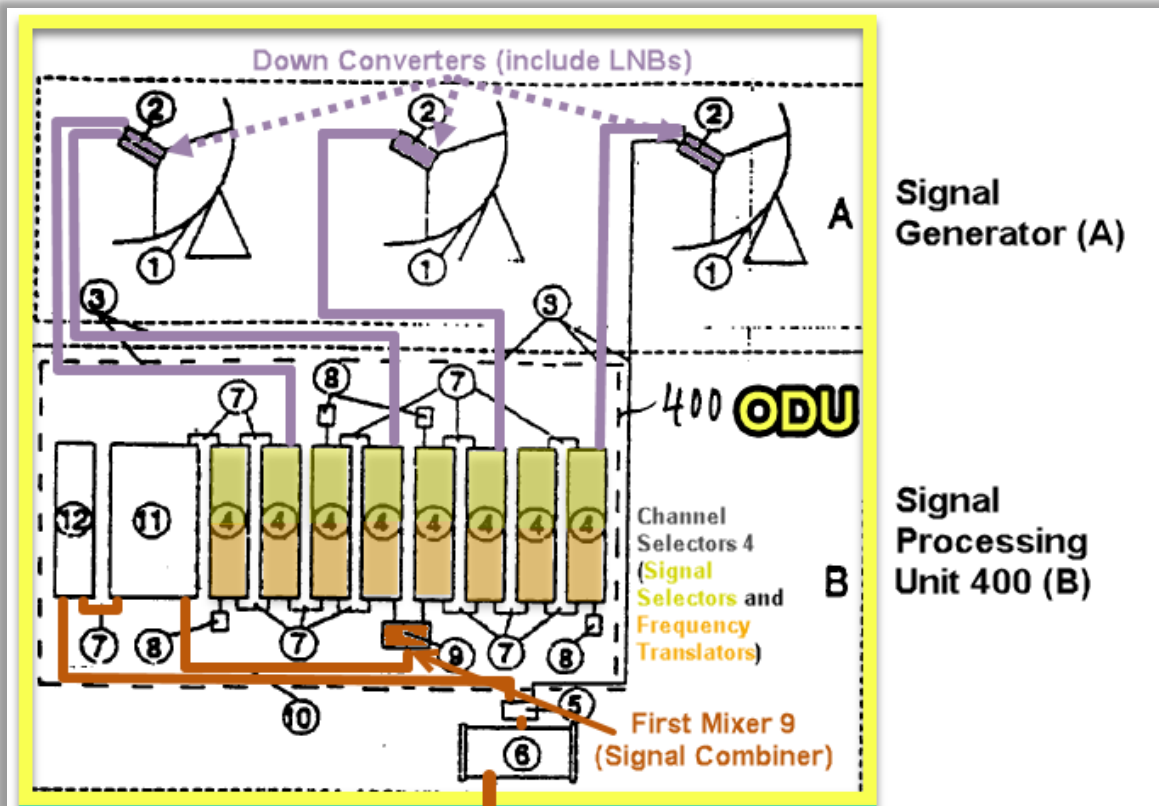


Figure 3 — LNB Outputs into Signal Processing Unit 400.

117. Specifically, Carnero describes that “each antenna 1 has one or two downconverters 2 (*LNBs*) depending on whether signals of one or two polarities are to be received per antenna.” (Ex.1004-Carnero, 4.) “The down converters 2 [*LNBs*] are each connected to a cable 3 on the output side” where “one or more cables 3, as shown in Figures 3, 4, 5, 6 and 9, run to the signal processing unit 400 having at least one channel-specific converter 4.” (Ex.1004-Carnero, 4.) The down converters (*LNB*) cause the entire received broadband signal to be shifted from an ultra-high frequency to an intermediate frequency, an example of which is shown in Figure 10, where the channels on lines “d” and “f” (in the range of 10.7-12.5 GHz) are all

translated into the intermediate signals on lines “g”-“h” and “j”-“k” in the range of 950 MHz to 2,050 MHz. (Ex.1004-Carnero, 4, Fig. 10.) Additionally, channel-specific converters 4 of the signal processing unit 400 are “connected at [their] input[s], via a cable 3, to a down converter (LNA/LNB) 2” and receive the output signal (*e.g.*, those on lines “g”-“k” of Figure 10). (Ex.1004-Carnero, 4.) Finally, these broadband LNB outputs contain a plurality of transponder signals in the channels of Carnero (the numbered boxes in Figure 10). Line “d” of Figure 10, for example, shows 12 channels on one broadband LNB output.

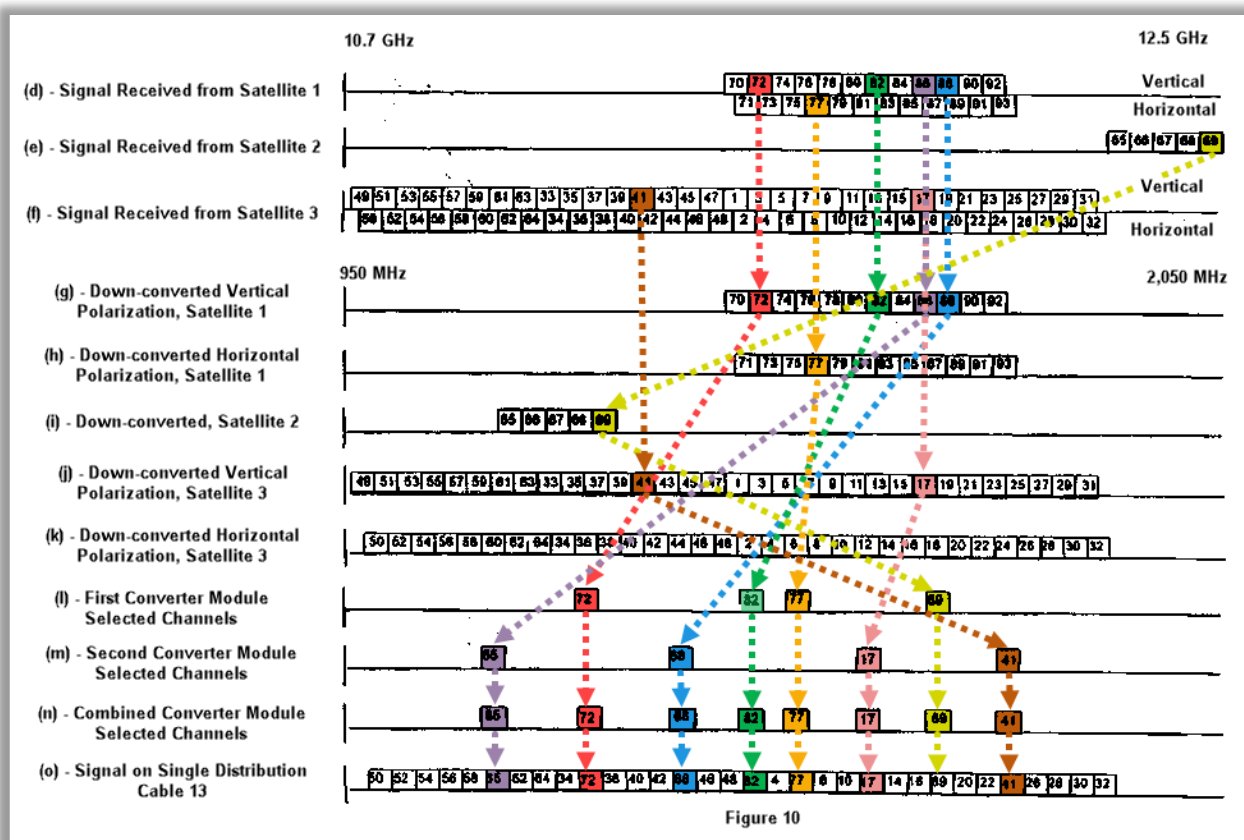


Figure 10 — Process to Create a Combined Signal from Selected Channels.

Note that while Carnero was filed in the mid-1990's during the transition from distributing analog satellite television signals to digital MPEG multiplexed signals, Carnero's *signal selector* would have been able to select transponder signals in either system. While the structure of the signal transmitted by the satellite would differ from a single analog program to a multiple digital program multiplex within a single transponder signal, the transponder signal was nonetheless an analog signal transmitted over a transponder channel, and it is this kind of analog signal that the signal processing of Carnero was designed to process.

118. Limitation 9[b] further requires that the *signal selector is responsive to transponder select information transmitted by the gateway*. The combined system of Carnero and Fisk meets this portion of limitation 9[b].

119. In Carnero, each channel-specific converter 4 of the signal processing unit 400 has an associated microprocessor that receives information from a "converter-external input device" to allow it to select a channel from the input LNB broadband signal. The input device may be "a remote-controlled transmitter" to permit transmitting transponder selection information (as opposed to direct input by, for example, a keypad). (Ex.1004-Carnero, 3:48-53, 8:23-25.) Carnero uses this input information to identify the transponder channel containing the requested television program, and thus is the claimed "transponder select information."

(Ex.1004-Carnero, 3:48-53.) However, Carnero does not specify the source of its input. In the combined system of Fisk and Carnero, the source to Carnero's input ("transponder select information") to Carnero's signal processing unit 400 is provided by Fisk's server 56 (gateway) based on requests for programs it receives from the LCUs, as discussed above in limitation 9[a] and below regarding the remainder of this limitation.

120. Lastly, limitation 9[b] requires that the signal selector *selects a plurality of transponder signals from at least one broadband LNB signal based on the transponder select information*. Fisk's server 56 receives requests from the LCUs for specific satellite television programs. In the combined system of Fisk and Carnero, the server of Fisk directs the microprocessor of Carnero to select from the received broadband LNB signals each transponder signal containing the requested television programs. This instruction allows Carnero's signal selector unit 400 to select a plurality of transponder signals having the requested television programs from at least one broadband LNB signal, thus the selection is based on the *transponder select information* provided by the server.

121. Specifically, for each satellite television program requested by an LCU, Carnero's channel-specific converters 4 will, under control of its microprocessor receive *transponder select information* from Fisk's server and select the transponder

signals for that program from the input received broadband LNB output signal. (Ex.1004-Carnero, 5:29-41 (“With each channel-specific converter 4, a channel is selected and converted from an input frequency, in the intermediate frequency range, to a predeterminable output frequency in the intermediate frequency range.”). “A bandpass filter tuned to the selected input channel frequency” and controlled by the microprocessor is used to select the channel having the transponder signal which includes the desired program. (Ex.1004-Carnero, 7:43-46.) As discussed above in paragraph 103, a skilled artisan would have been motivated to modify Fisk to incorporate signal selectors upstream of download 24 that pass on only the user-selected signals, as Carnero teaches, which provides advantages of, for example, reducing the number of channels that the server 56 and decoder 58 of Fisk need to process. And a POSITA would have had a reasonable expectation of success in so doing, as Carnero describes that the “channel-specific converters” receive input from a device “external to the converter[s].” (Ex.1004-Carnero, 3:48-54, Claims 7-8.) The data received from this input device includes data that “designate[s] a predeterminable input channel frequency,” *i.e.*, transponder select information used to select transponder signals. (Ex.1004-Carnero, 3:48-54.)

122. Accordingly, the combination of Fisk and Carnero renders limitation 9[b] obvious.

9[c] “a frequency translator coupled to the signal selector that is capable of shifting the selected transponder signals to new carrier frequencies to produce RF signals; and”

123. Carnero’s signal processing unit 400 includes a *frequency translator* as recited in limitation 9[c]. After Carnero’s channel-specific converters 4 complete channel selection via the tuned bandpass filter, the signal is further processed culminating in application of mixer 52, local oscillator 53, and filter 55. (Ex.1004-Carnero, 7:35-59.) The selected channel signal is mixed “with a signal formed by a local oscillator (OL) 53,” the local oscillator signal is controlled by the microprocessor, and then filtered so that the resulting signal “carries the signal of the frequency-converted channel.” (Ex.1004-Carnero, 7:55-59, 9:36-47 (“According to the invention, channels are provided at the output of each converter module 40,” a collection of channel-specific converters, “which have a different frequency position compared to the frequency position at the input of the modules.”))

124. A POSITA would have understood how to use a mixer, local oscillator and filter to “shift” or “translate” a transponder channel to a specific predetermined frequency as taught by Carnero and shown in Figure 10. These were routine signal processing components used for the routine task of frequency-shifting signals as discussed in, for example, AAPA Petruzzelli. (See Ex.1007-AAPA Petruzzelli at 1:21-37, 5:46-61.) Carnero’s channel-specific converters are “set to predeterminable input frequencies in the intermediate frequency range,” that is, to a frequency in the

intermediate RF range. (Ex.1004-Carnero, 7:27-30.) Indeed, selecting an output in the intermediate RF range is most desirable because that is the range best suited to communicate signals over coaxial cable, the transmission media of the output signal in Carnero and of the satellite input signal FT125 to Fisk's server. This is shown, for example, in the increasing power loss per 100 ft exhibited by the FT125 (also called CT125) at 1,000 MHz relative to 460 MHz, which would continue to worsen at higher frequencies. (*See* Ex.1022, 1; *see also* Ex.1023, 2.)

125. As discussed above in paragraph 103, a POSITA would have been motivated to maintain the frequency translators of Carnero into the combined system of Fisk and Carnero because it ensures the benefit of Carnero—"distribution of a larger number of channels" over a single distribution cable to Fisk's server—while reducing the number of channels that the server 56 and decoder 58 of Fisk need to process. (Ex.1004-Carnero, 3:3-5, 3:19-21.) Frequency translating also solves the "problem" of the server selecting for distribution transponder signals that are located at the same frequency in the broadband LNB signal (*i.e.*, that have been down-converted to the same frequency). By frequency translating so that each of the selected transponder signals is at a different center frequency, each can be provided to the server 56 over a single cable without interference from the other.

126. Carnero's Figure 10 depicts the frequency shifting process.

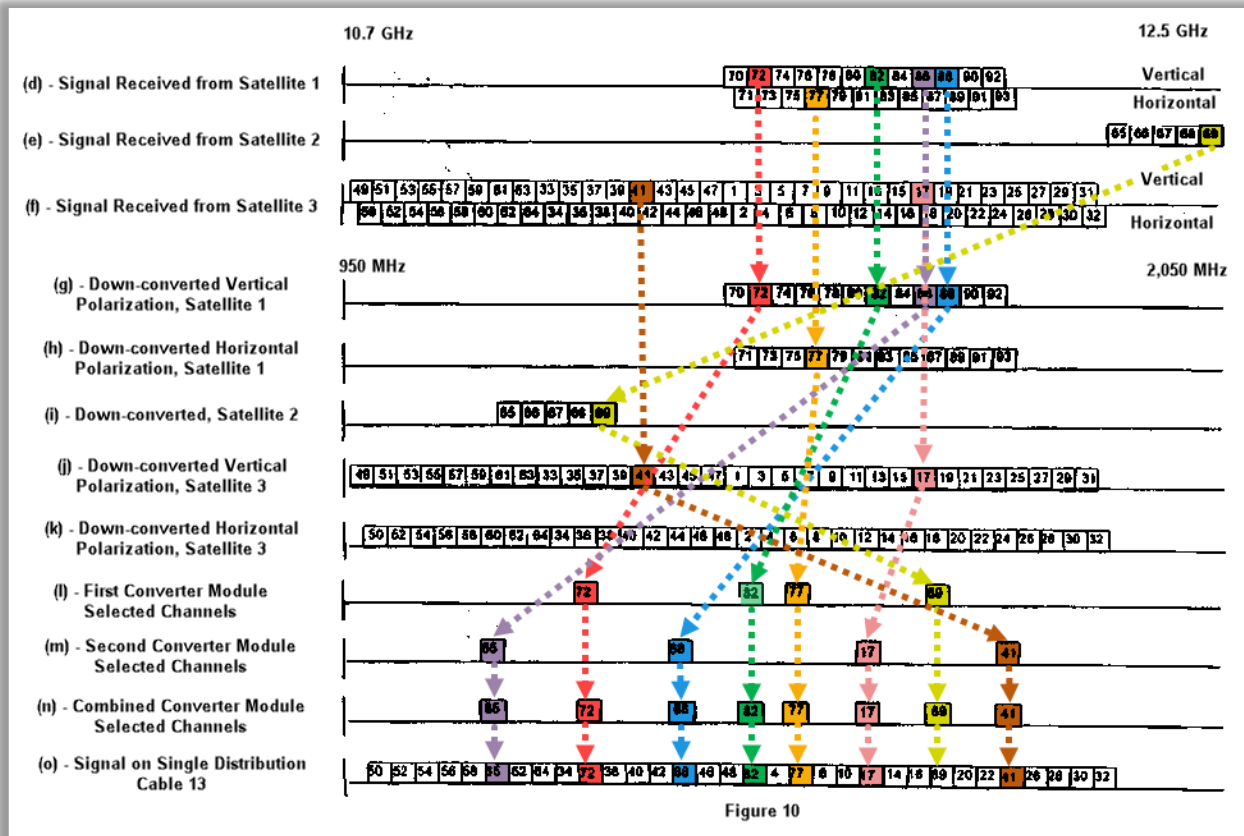


Figure 10 — Process to Create a Combined Signal from Selected, Frequency-Translated Channels.

127. Lines “g”-“k” represent the inputs of the signal processing unit 400, and line “o” represents the output. (Ex.1004-Carnero, Fig. 9, 9:21-24.) As can be seen, the output on line “o” is based on the input signal on line “k”, with certain channels replaced with channels 65, 72, 68, 82, 77, 17, 89, and 41 from other input signals (*i.e.*, originating from other polarities or satellites than the channels on line “k”). The frequencies of the replacement channels are shifted along the 950-2,050 MHz spectrum by varying degrees relative to their frequency at the input of the signal processing unit. (Ex.1004-Carnero, 9:28-47.)

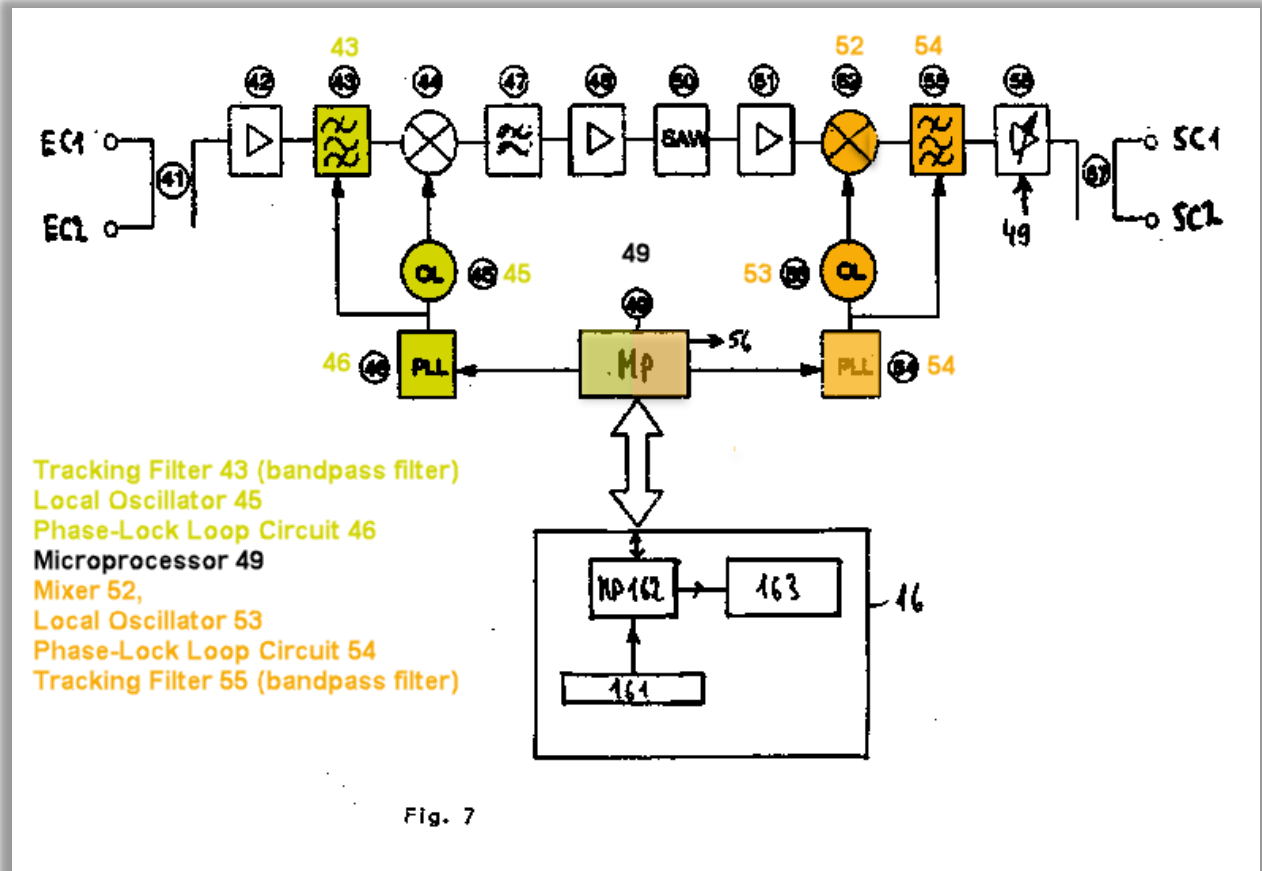


Figure 7 — In Each of Carnero’s Channel Selectors, the Frequency Translator (Orange Items) is Coupled to a Signal Selector (Yellow-Green Items).

128. In sum, Carnero teaches “a frequency translator coupled to the signal selector that is capable of shifting the selected transponder signals to new carrier frequencies to produce RF signals” as required by limitation 9[c].

9[d] “a signal combiner coupled to at least one frequency translator capable of combining at least two RF signals to produce a composite signal;”

129. Carnero discloses a *signal combiner* as recited in limitation 9[d]. Carnero teaches a variety of signal combiners, resulting in a signal sent on “a single

distribution cable 13, on which all channels, that are FM modulated, are transmitted.” (Ex.1004-Carnero, 7:20-22, Fig. 9.)

130. Carnero teaches that the outputs of a plurality of channel-specific converters are combined into a composite signal. Referring to Figure 10, lines “g”-“j” represent the input signals of four distinct converter modules, comprising a plurality of the channel-specific selectors 4. (Ex.1004-Carnero, 9:42-45.)

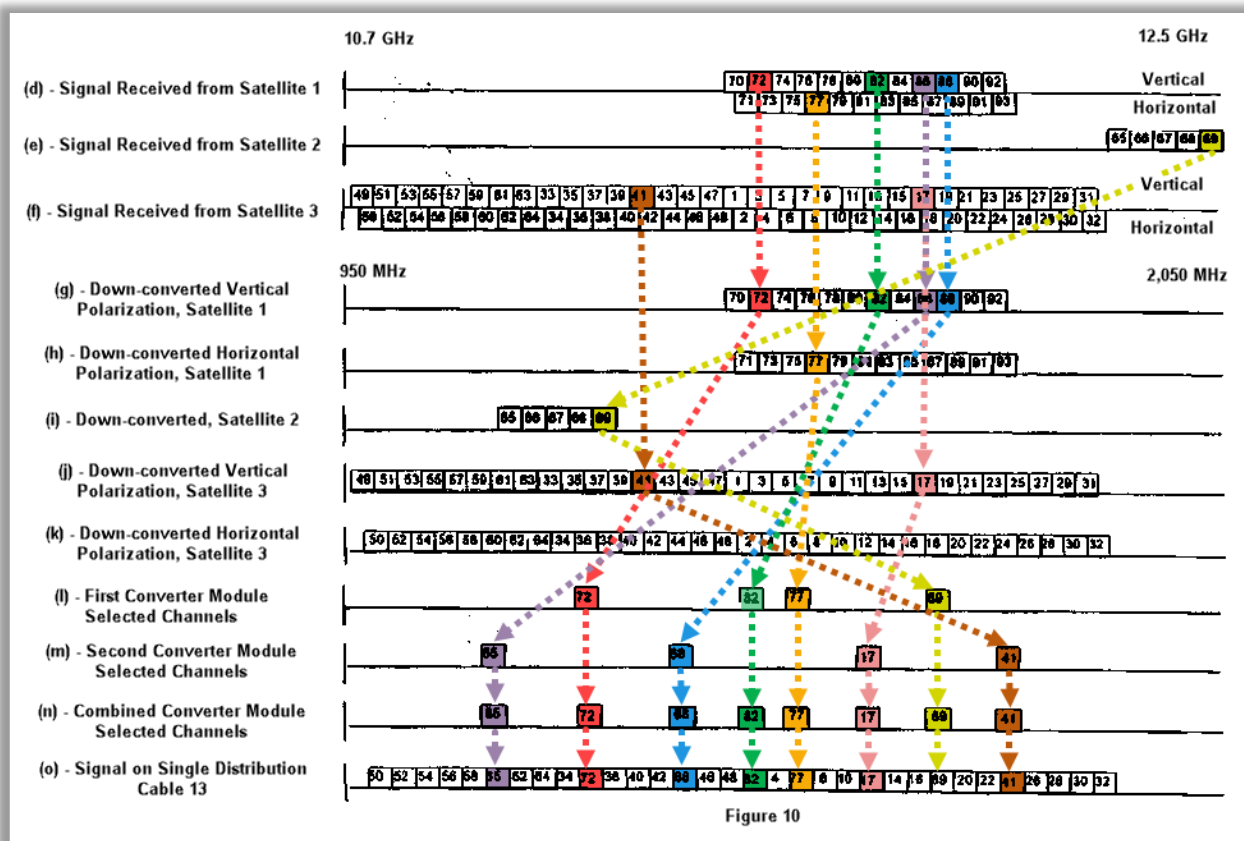


Figure 10 — Process to Create a Combined Signal from Selected, Frequency-Translated Channels.

131. A POSITA would have understood what is shown on line “l” is a composite of the output signals from the converter modules receiving lines “g” and

“h”, as the channels shown on line “l” originate from one of the line “g” or “h” signals. (Ex.1004-Carnero, Fig. 9.) Carnero teaches that the outputs of converter modules “can be linked together, for example, via a mixer.” (Ex.1004-Carnero, 3:39-42, 8:42-44 (“Two adjacent modules can be combined via a (‘first’) mixer 9.”).) This first mixer 9 is shown below coupled to the output of two channel selectors 4 in adjacent modules.

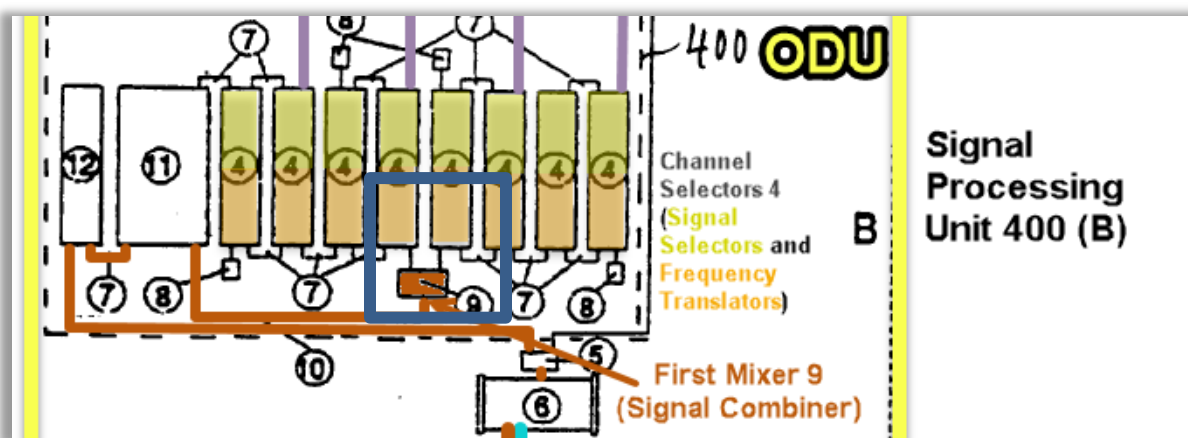


Figure 10 — Channel Selectors 4 Coupled to First Mixer 9.

132. Therefore, a POSITA would have understood Figures 9 and 10 as disclosing a signal combiner (mixer) that combines at least two RF signals, one or more from each converter module. The mixer is electrically coupled to at least one frequency translator from each of the converter modules, as the signals received at the mixer are the outputs of individual channel-specific controllers 4. Line “m” is like line “n”, except that it is the composite of the outputs of the convert modules which received as inputs lines “i” and “j”. Finally, line “n” represents a composite

signal of lines “l” and “m”, which a POSITA would have understood to have been formed by a mixer. Therefore, Carnero teaches a signal combiner as required by limitation 9[d].

9[e] “wherein the modulation of the composite signal is the same as the modulation of the broadband LNB signals and”

133. Carnero teaches that the signals distributed through the single cable 13 are—at least in part—“FM modulated” channels. (Ex.1004-Carnero, 7:20-22.) A POSITA would have understood Carnero’s reference to signals being “FM modulated” to mean that the *composite signal* uses the same modulation as the *broadband LNB signals* prior to their input into the converter modules. This is evidenced by Carnero’s distinction of two state-of-the-art systems. The first system uses “FM demodulators/AM modulators,” which are expensive and complicated to implement in large numbers, while the second system does not use FM demodulators, but instead requires multiple cables to transmit a large number of transponder signals such that in lieu of channel selection, all received programs are transmitted—numbering in the dozens or hundreds. (Ex.1004-Carnero, 2:1-43.) Carnero’s solution does not utilize demodulators yet distributes a desired subset of transponder signals on a single cable by channel selection, avoiding the problem of multiple distribution cables.

134. Further, a POSITA would have understood that none of the signal

processing taught by Carnero would involve changing the modulation of the composite signal or any component of that composite (*i.e.*, the selected channels). Carnero's "input side" (*broadband LNB signals*) and "output side" (*composite signal*) frequency range and bandwidth are unchanged, depicted graphically in Figure 10 where each of the transponder signals retains its width throughout the process of selection, frequency shifting, and combining. In addition to the lack of any teaching that the modification changes, which I would expect to see if Carnero involved remodulation, this graphical depiction is consistent with the modulation of the input and output transponder signals being the same. Accordingly, a POSITA would have understood the modulation of the composite signal is the same as the modulation of the broadband LNB signal prior to channel selection. Carnero teaches limitation 9[e].

9[f] "*wherein the composite signal is transmitted to the gateway*"

135. Here, the combination of Carnero and Fisk renders limitation 9[f] obvious. In the combined system, Carnero transmits, and the server of Fisk receives, all requested satellite transponder signals via coaxial cable FT125. The signal containing all requested satellite television channels, discussed above regarding limitations 9[d] and 9[e], is the claimed *composite signal*.

9[g] “and the gateway receives the composite signal, decodes specific programs, and distributes the programs over a digital local area network (LAN) to STBs.”

136. Fisk discloses this limitation. As discussed above, at least in limitation 9[f], Fisk’s server 56 and decoder 58 (part of the gateway) *receive* selected satellite television programs in a *composite signal* output from Carnero’s signal processing device. Decoder/descrambler 58 receives an input signal from the ODU—here, the *composite signal*. (Ex.1003-Fisk, 41:7-11, 24:16-18.) Decoder/descrambler 58 and server 56 are part of the *gateway* and may be integrated in the server 56. (Ex.1003-Fisk, 41:7-11 (“Referring also to FIGS. 19 to 23, the server may include the following components: television and radio cards 180,182,184,188 that receive analogue RF and satellite signals and convert them to digital signals in MPEG-2 format, ...”).)

137. Fisk’s decoder *decodes specific* received satellite television *programs* prior to distribution. “Decode” is a broad term that refers to various data operations. For example, an IRD—or integrated receiver *decoder*—can descramble a received signal, demodulate it, and demultiplex a transponder signal to obtain a specific video stream, for example, an MPEG video of a television program—each of these is a form of decoding in the satellite signal distribution and processing context. For example, AAPA Williams describes an IRD that “tunes to the frequency associated with a selected” signal, a “standard DVB cable decoder such as the BCM3118

decoder” by Broadcom Corp, which “demodulates the QAM transmodulated signal to produce a set of interleaved, R-S encoded data packets,” a “demultiplexer 120” which “may be any standard demultiplexer” which acts to “extract one of the five to eight A-V programs from the program multiplexed data signal,” and an “MPEG video decoder” such as those “commonly known in the art” that “operates to produce a digital video signal,” which it provides to an “NTSC encoder 125” to generate an NTSC video signal for a television set. (*See generally* Ex.1008-AAPA Williams 14:11-16:20.) Gateways were also known to perform decoding functions. (*See supra*, ¶74.)

138. The ’715 patent does not specify what kind of decoding is performed by its gateway, declaring only that it “decodes specific programs” before “distribut[ing] the program information in packetized MPEG over a digital local area network (LAN) 1170 to STBs.” (Ex.1001-’715 patent, 9:44-48.)

139. Fisk teaches that tuning, descrambling, and demultiplexing is performed by the decoder. Fisk teaches two types of hardware that a POSITA would understand to perform decoding functions. First, IRDs such as those taught in AAPA Williams and known in the art. (Ex.1003-Fisk, 11:3-5 (“The descrambling, demultiplexing and modulating may therefore be provided by a conventional set top box”), 21:5-9 (“The satellite television download 24 is connected to the input of at

least one satellite television decoder (or ‘set top box’) 26, ...”). Second, Fisk teaches the use of “satellite receiver cards,” a type of electronic device-interfacing hardware such as an electronic board inserted into a computer slot (as opposed to an STB, which is typically stand-alone) having similar decoding capabilities, including through its descrambler 230 and demultiplexer 232. (Ex.1003-Fisk, 44:10-45:1.)

140. Fisk teaches descrambling by the decoder as part of processing received satellite television signals. (Ex.1003-Fisk, 42:6-45:1.) Fisk describes demodulating received satellite signals. (Ex.1003-Fisk, 57 (“the receiving means includes a satellite receiver ... and means for demodulating the RF signal.”).) And, as the ’715 patent describes, Fisk demultiplexes to “extract[] a specific video program.” (Ex.1001-’715 patent, 9:15-18; Ex.1003-Fisk, 57 (“means for descrambling and demultiplexing the signal for at least one of the programmes ...”), 22:16-18 (“decoder/descrambler 58 [] provides digital MPEG video streams 60 for the received satellite television programmes ...”).)

141. The *digital local area network* is shown below in Figure 5 of Fisk.

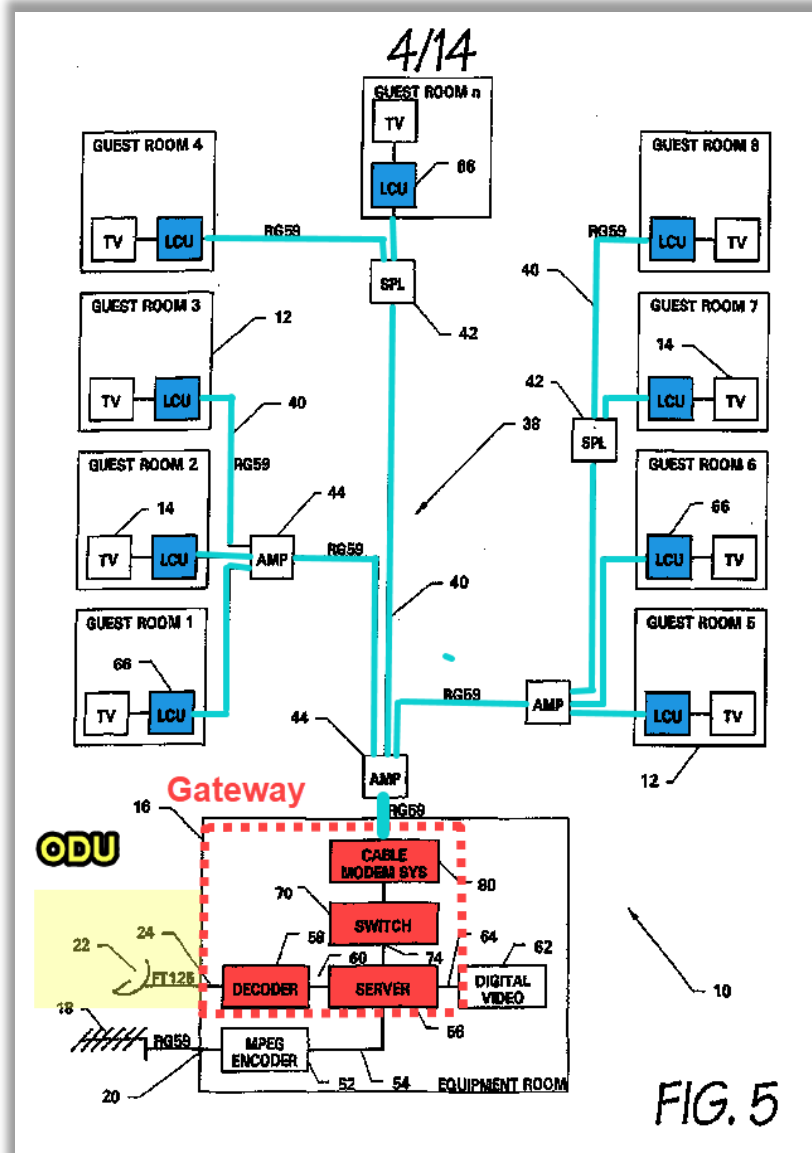


Figure 5 — Fisk’s Signal Distribution System (Digital LAN is Light Blue).

142. Consistent with the historical role of gateways in a network, the server of Fisk then distributes the specific programs over a digital local area network, for example, as shown in Figure 5. (Ex.1003-Fisk, 22:9-22; *see also supra*, ¶¶72-74.) The server “selects which of the video streams to be transmitted to which room 12, and places the selected video streams on the digital network 50 using UDP/IP, or

TCP/IP, each addressed to the selected room.” (Ex.1003-Fisk, 40:4-9 (“The UDP/IP transport protocol is used for transmitting MPEG-2 streams to the LCU 66.”).)

Accordingly, the combination of Carnero and Fisk renders claim 9 obvious.

3. Dependent Claim 10

The signal distribution system of claim 9 wherein a translation table maps original channel locations on the selector input to new channel locations on the selector output.

143. This claim is obvious in view of the combined system of Carnero and Fisk. Carnero teaches that its channel-specific converters are assigned a “predeterminable input channel frequency” corresponding to the frequency of a transponder channel of a transponder signal to be selected from the broadband LNB signal, and a “predeterminable output channel frequency” corresponding to the frequency at which Carnero’s channel-specific converters will output the selected channel. (Ex.1004-Carnero, 3:48-53.) Carnero’s channel-specific converters 4 operate under control of microprocessors 49, and information regarding the input and output frequencies is provided to the microprocessor 49 by an input unit. (Ex.1004-Carnero, 8:10-25, Claims 6-7.)

144. In the combined system of Carnero and Ex.1003-Fisk, the input unit is associated with Fisk’s server which determines, based on requests by LCUs, which channels are requested and transmits information about those channels to Carnero’s channel-specific converters. Fisk’s servers would store this information in a

management database that “holds information specific to the server 56” including “the channels that have been assigned.” (Ex.1003-Fisk, 4:10-19.)

145. In view of these teachings, it would have been obvious to a POSITA to *store a translation table mapping original channel locations on the selector input to new channel locations on the selector output*. In order for the server of Fisk to be able to assign channels received by Carnero’s ODU and transmit to the LCUs programs requested from transponder signals of particular channels, it would have been obvious to a POSITA to store information regarding the frequencies on which specific channels are being input to Carnero’s channel-specific converters on the down-converted LNB broadband signals (to ensure the converters select the correct channels), and also the corresponding frequencies on which those channels will be output to the server (so that the server can differentiate and correctly distribute programs from those channels to the correct LCUs). If such a translation table was not actively maintained and updated, Fisk’s server would not be able to distribute requested satellite television programs in accordance with the goals of Fisk. And implementing such a translation table at Fisk’s server would be simple, as there is already a database associated with the server that can store “the channels that have been assigned.” Finally, as discussed above in Section IV.E, maintaining look-up tables bearing information about where to locate television programming was known

in the art, necessary to facilitate end-user selection of programs, and would not have been difficult to implement, store, and exchange.

146. Thus, the combination of Fisk and Carnero renders claim 10 obvious.

4. Dependent Claim 11

The signal distribution system of claim 10 wherein the translation table is maintained by a controller located in the gateway and the translation table is communicated to devices in the network.

147. This claim is obvious in view of the combined system of Carnero and Fisk. As discussed in claim 10, it would have been obvious to a POSITA for Fisk's server to maintain the translation table on its configuration management database; without a table mapping input and output frequencies, the server would be unable to ensure that it correctly distributes the requested programs to the LCUs that requested those programs. And implementing the claimed translation table would have involved applying known techniques in a known way to achieve a predictable result. *See supra* claim 10.

148. Further, it would have been necessary for the table to be communicated by the server of Fisk to the ODU of Carnero so that the selected transponder signals will be transmitted by the ODU to the server at the frequencies desired by the server, and so that the server can then select transponder signals bearing the programs desired by the LCUs and provide them to the LCU at frequencies where the LCU expects to find them. It was also necessary for the table to be communicated by the

server of Fisk to the LCUs that requested particular programs so that the LCU can retrieve the transponder signals bearing the programs desired by the LCU and extract the desired program from the transponder signal. The server can select transponder signals bearing the programs desired by the LCUs and provide them to the LCU (by way of the server) at frequencies where the LCU expects to find them. Thus, the combination of Fisk and Carnero renders claim 11 obvious.

5. Dependent Claim 12

The signal distribution system of claim 10 wherein the translation table is maintained by a controller located in the ODU and the translation table is communicated to devices in the network.

149. The combination of Carnero and Fisk renders dependent claim 12 obvious. As discussed above in claim 10, maintaining a translation table would have been necessary to effectuate the signal distribution taught in Fisk. While maintaining a translation table at the server and communicating the table to the ODU and LCUs would have been obvious and leveraged existing server storage and processing (*see* claims 10-11), a POSITA would have known that an obvious alternative was for the table to be maintained by a controller located in the ODU of Carnero and communicated to the server and LCUs. Fisk's server is indifferent to the specific frequency at which it receives a particular channel, so long as the server knows the frequencies on which the channels corresponding to requested programs will be output to the server (so that the server can differentiate and correctly distribute

programs from those channels to the correct LCUs). Thus, the translation table could alternatively be maintained at the ODU and communicated to the server to facilitate program distribution. Moreover, it was also necessary for the table to be communicated by the ODU (preferably via the server of Fisk) to the LCUs that requested particular programs so that the LCU can retrieve the transponder signals bearing the programs desired by the LCU and extract the desired program from the transponder signal.

150. The decision to maintain the translation table at the ODU rather than the server of Fisk is nothing more than a design choice with limited additional cost or complexity. In scenarios where one ODU services multiple gateways (*e.g.*, in a community television system servicing a plurality of MDUs, each MDU having its own gateway), it would have been preferable to centralize the maintenance of the translation table so that each gateway could be provided with its requested transponder signals via a single output cable without the potential for conflict (which could occur if each gateway maintained the translation table for the channel(s) it needed).

151. Thus, the combination of Fisk and Carnero renders claim 12 obvious.

B. Ground 2: Claims 9-12 are Obvious over Green and Davis and in

further view of the General Knowledge of a POSITA

1. Motivation to Combine Green and Davis

152. A POSITA would have been motivated to combine the teachings of Green and Davis. Both references are in the same field of distributing satellite television channels to a plurality of receivers. (Ex.1005-Green, Abstract; Ex.1006-Davis, Abstract).) Further, both references discuss aspects of receiving, selecting, combining and distributing satellite signals. And both references sought to solve the same problem of efficiently distributing satellite signals bearing in mind that existing houses and MDUs were typically wired to receive, at most, a single cable in each room. (Ex.1005-Green, 11:7-16; Ex.1006-Davis, ¶12.) Thus, a POSITA would look to both references to more efficiently distribute received satellite signals, including television channels, to a plurality of users.

153. Green teaches selecting desired transponders and distributing them over a plurality of cables, with each cable bearing a block of 12 transponder signals. (Ex.1005-Green, 10:44-64.) Although Green ultimately provides to each dwelling only a single block of transponder signals, a plurality of cables must be used to transmit all of the transponder signal blocks to the “drop” at each dwelling. (Ex.1005-Green, 11:7-16.) Green also requires switching hardware for each dwelling to select the requested transponder signal block. A POSITA would have recognized that Green poses scalability issues where there is a desire to increase the

number of transponder signals distributed or the number of dwellings provisioned to receive the satellite signals. Davis expressly recognizes that adding cables to a building “can be quite complex, expensive and time consuming.” (Ex.1006-Davis, ¶10.)

154. Green further states that each subscriber must have “a conventional off-the-shelf satellite receiver 136” that “selects among the transponders within the block of transponder signals” and then “demodulates and otherwise converts the selected transponder signal . . . into standard NTSC amplitude modulated television signals for application to a conventional television receiver 138.” (Ex.1005-Green, 11:28-53.)

155. A skilled artisan would have looked to Davis’s interface device (*gateway*) to solve these problems. For example, Davis teaches that “multiple satellite services can be implemented in a particular site 30 without requiring multiple cables running throughout the site 30.” (Ex.1006-Davis, ¶51.) As discussed above in paragraphs 72-74, gateways were known to be useful for this purpose. In addition, the gateway enables “point-to-point communications” over a LAN, whereby the gateway “transmit[s] packets of the baseband signal directly to the IDU 32 for which the signal is intended,” obviating the need for “a processor for examining the received packet and determining whether the data in the packet is

intended for that IDU 32, or for another,” and further obviating the need for tuning functionality typically required in an STB. (Ex.1006-Davis, ¶47; *see also supra*, ¶¶53-54, 72-74.)

156. Accordingly, a skilled artisan would have been motivated to modify Green’s system to incorporate Davis’s interface device and LAN. Davis’s interface device would receive the multiplexed signals from Green’s transponder combiner 114, “convert[] [them] into a digital baseband signal,” “assemble[] the data into message packets, determine[] the destination address of each packet,” and then “transmit[] them to the LAN.” (Ex.1006-Davis, ¶¶46-47.) Moreover, as evidenced by the AAPA, implementing the functionality recited in the challenged claims was conventional and the fundamental desire to efficiently distribute satellite television signals to multiple receivers in a multi-unit dwelling like a hotel or apartment was well within the general knowledge of a POSITA. (*See supra*, Section IV.G; *see generally* Section IV.)

2. Independent Claim 9

9[pre] “A signal distribution system for distributing a plurality of low noise amplifier and block converter (LNB) output signals from a satellite outdoor unit (ODU) comprising:”

157. To the extent the preamble is limiting, it is taught by Green and Davis. As an initial matter, as discussed above in Ground 1, the prior art (including AAPA) conventional satellite distribution systems all disclose ODUs having LNBs that

down-shift received signals for distribution. (*See supra*, ¶106 (*citing* Ex.1007-AAPA Petruzzelli, 1:21-37, Ex.1008-AAPA Williams, 2:11-21, Ex.1001-'715 patent, 1:21-44.) Green includes one or more antennas 102 comprising an *outdoor unit*, each antenna including “a conventional low-noise amplifier (LNA) and block converter (LNB).” (Ex.1005-Green, 9:45-50.)

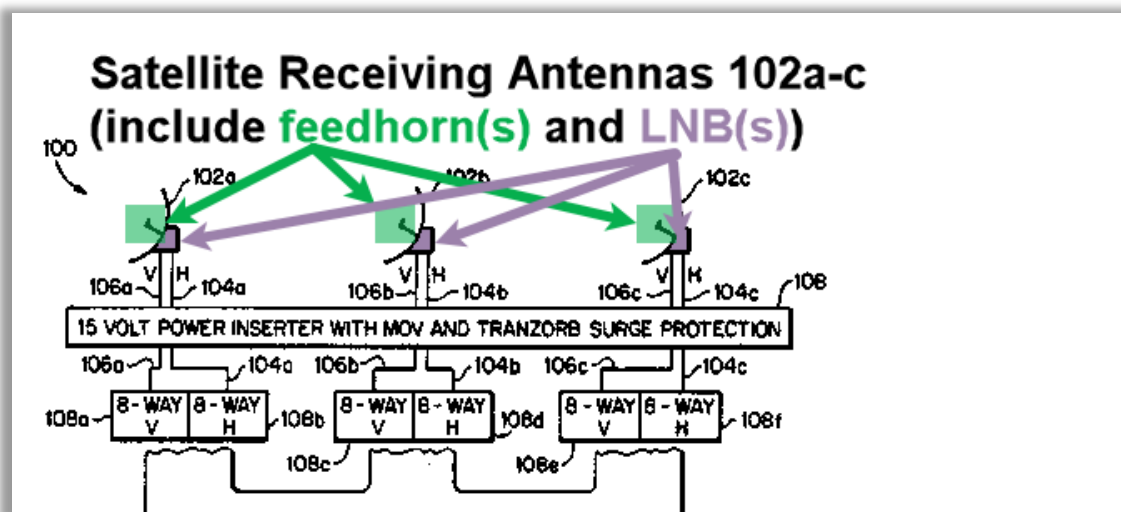


Figure 1A — Green’s Satellite Receivers 102a-c Contain LNBs.

158. “The LNB down-converts received C-band (and Ku-band) signals in a conventional manner to the range of 900-1500 MHz before applying the signals to transmission line outputs” for distribution. (Ex.1005-Green, 9:45-50.) Green’s system then distributes select *output signals* from the *LNB* throughout a multi-dwelling unit. (Ex.1005-Green, 1:7-20, 9:51-10:63.) Thus, Green discloses the preamble.

159. Davis also discloses the preamble. Davis describes a system for

“distributing satellite signals received from an outdoor unit (ODU) to a plurality of indoor units (IDUs).” (Ex.1006-Davis, Abstract.) The receivers of the Davis’s ODU include at least one LNB. (Ex.1006-Davis, ¶37.)

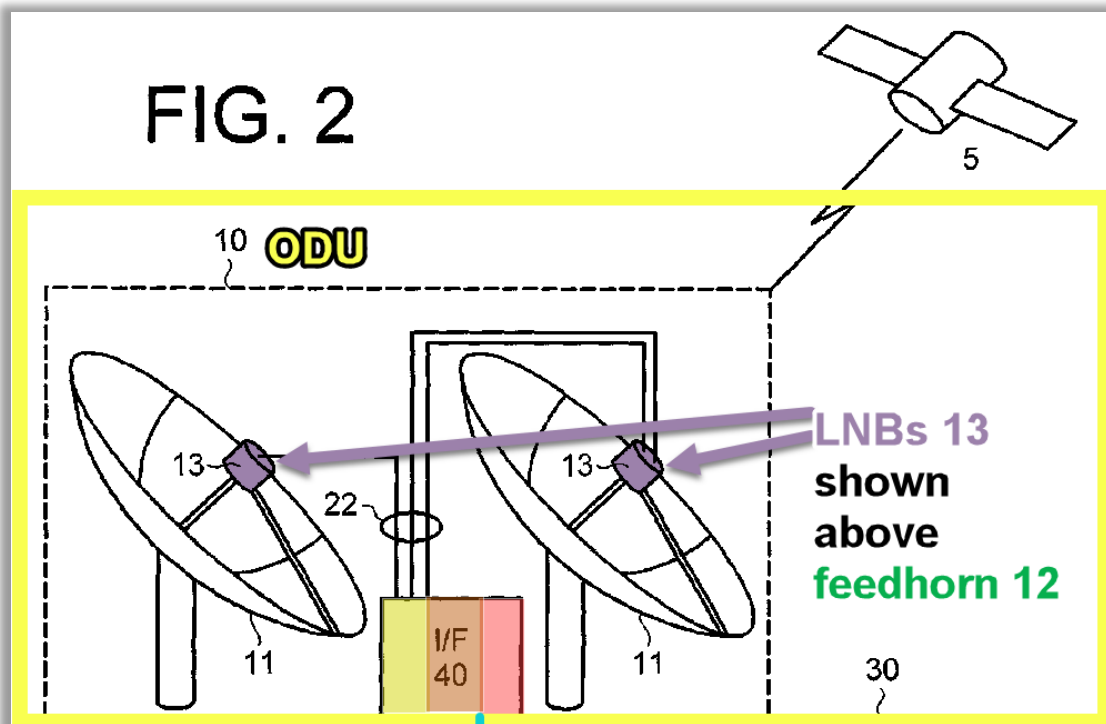


Figure 2 — Davis’s Outdoor Unit Including LNBs.

160. Interface device 40 receives the LNB output signals, processes the signals, and distributes select transponder signals to a plurality of IDUs (which may be STBs). (Ex.1006-Davis, ¶¶36, 45-47.) Specifically, the output of an LNB 13 “may be sent to a corresponding input/output port of LNB interface 41” of interface device 40. (Ex.1006-Davis, ¶45.) “The RF signal may then be sent to the received signal processing and encryption unit 44, where the signal is converted into a digital baseband signal,” among “other signal processing.” (Ex.1006-Davis, ¶45.) After

processing “the processed digital signal may then be sent to the network protocols and services processing unit 45” of the interface device 40, “which assembles the data into message packets, determines the destination address of each packet, and controls the transmission of such packets” over a LAN to IDUs (which may be STBs). (Ex.1006-Davis, ¶¶36, 45-47.)

9[a] “a gateway in communication with the ODU and at least one set top box (STB);”

161. Davis discloses this limitation. As discussed above in Section IV.G, gateways were known in the art as network intermediaries, which is the role served by the interface device of Davis. Davis teaches interface device 40 (*gateway*) “distribut[es] satellite signals received from an outdoor unit (ODU) to a plurality of indoor units (IDUs) connected to a local area network.” (Ex.1006-Davis, Abstract.) Davis’s IDUs 32 comprise “a receiver or a transceiver allowing a user to receive and/or transmit data over the satellite network,” and expressly include integrated receiver decoders (*i.e.*, STBs). (Ex.1006-Davis, ¶¶5, 36.) Interface device 40 transmits received satellite signals to the IDUs via the LAN (Ex.1006-Davis, ¶47), receives request information from the IDUs for content (Ex.1006-Davis, ¶¶55-56), and is thus *in communication with IDUs/STBs*. (Ex.1006-Davis, ¶39.) Interface device 40 receives satellite signals from the ODU 10 for communication to the IDUs (Ex.1006-Davis, ¶45) and communicates requests to the antenna 11 (Ex.1006-Davis,

¶¶55-56), and thus is in *communication with the ODU*. Figure 2 of Davis depicts the topology of an exemplary system involving an ODU, the interface device, and a plurality of IDUs.

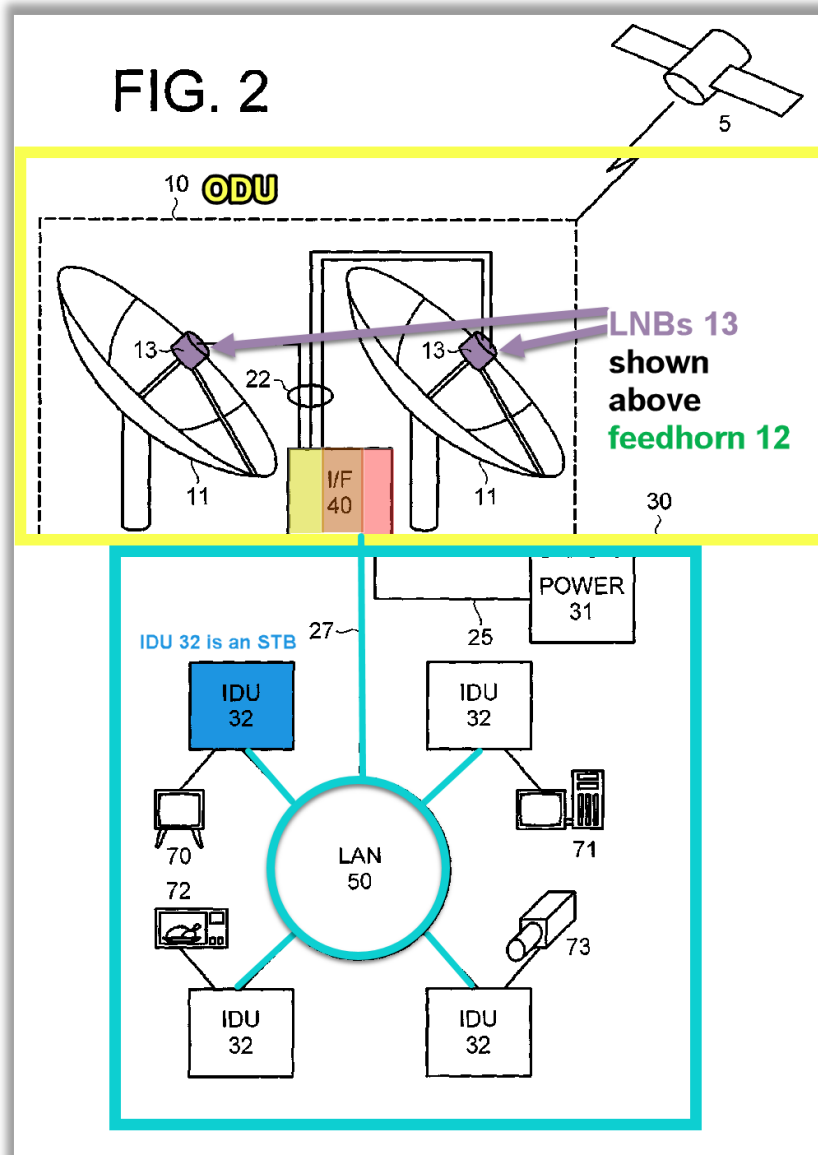


Figure 2 — Davis’s Interface Device in Communication with Receivers / IDUs.

162. Although Figure 2 includes interface device 40 within the box delineating the ODU 10, Davis makes clear the IDU may be “located inside” a

dwelling “relatively close to the ODU.” (Ex.1006-Davis, ¶75.) Thus, Davis discloses limitation 9[a].

9[b] “a signal selector that receives a plurality of broadband LNB signals comprising a plurality of transponder signals, the signal selector is responsive to transponder select information transmitted by the gateway and selects a plurality of transponder signals from at least one broadband LNB signal based on the transponder select information;”

163. The combined system of Green and Davis renders this limitation obvious.

164. Green discloses a *signal selector that receives a plurality of broadband LNB signals comprising a plurality of transponder signals*. Each LNB of Green receives a polarized signal containing a plurality of transponder signals from a satellite in the C- or Ku-bands, and down-converts the signal into the range of 900-1500 MHz. (Ex.1005-Green, 9:47-10:7.) Each polarization is output separately as a broadband signal 104 and 106, covering a broad range of frequencies, here, 600 MHz. All of the *broadband LNB signals* output are fed into each bank 113 of transponder processors 112, which are responsible for *signal selection*. (Ex.1005-Green, 9:47-10:7, 12:11-27 (“satellite transponder processor 112 in the preferred embodiment accepts as an input a block of twelve satellite transponder television signals ... as down-converted by the LNB.) And as with Carnero, Green’s *signal selector* would have been able to select transponder signals carrying a single analog

program or the digital MPEG multiplex stream that became the norm in the late 1990's. (*See supra*, ¶117.)

165. Green also discloses *selecting a plurality of transponder signals from at least one broadband LNB signal*. Each transponder processor 112 takes its received block of transponder signals in the broadband LNB signal and “produces as an output a single satellite transponder FM television signal.” (Ex.1005-Green, 12:11-27.) Figure 2A of Green depicts an exemplary transponder processor 112, which has a down-converter 200 operating under control of a micro-controller 206 to shift the broadband LNB signal so that the selected transponder signal is located at a frequency that enables the subsequent state/AGC/bandpass filter to output only that transponder signal. (Ex.1005-Green, 8:53-54, 12:11-13:2.) The selector 208 receives input (*e.g.*, from a person) indicating the transponder signal and received frequency of the selected channel to enable selection. (Ex.1005-Green, 12:11-13:2.)

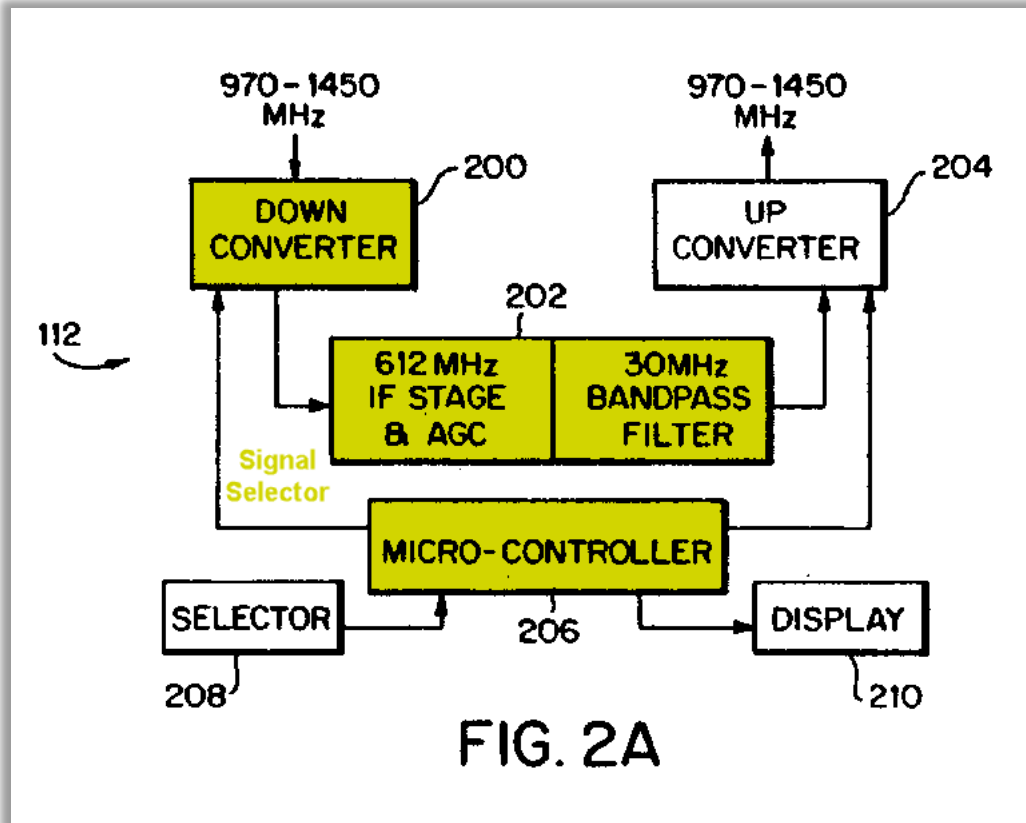


Figure 2A — A Transponder Processor from Green (highlighted elements for signal selection).

166. Any of transponder processors 112 selects a plurality of transponder signals from the various *broadband LNB signals*. (Ex.1005-Green, 2:26-35, 6:28-53.) Green's Figure 2 depicts this selection with each square on "Cable 1 Out" representing a particular transponder signal that is selected by a transponder processor.

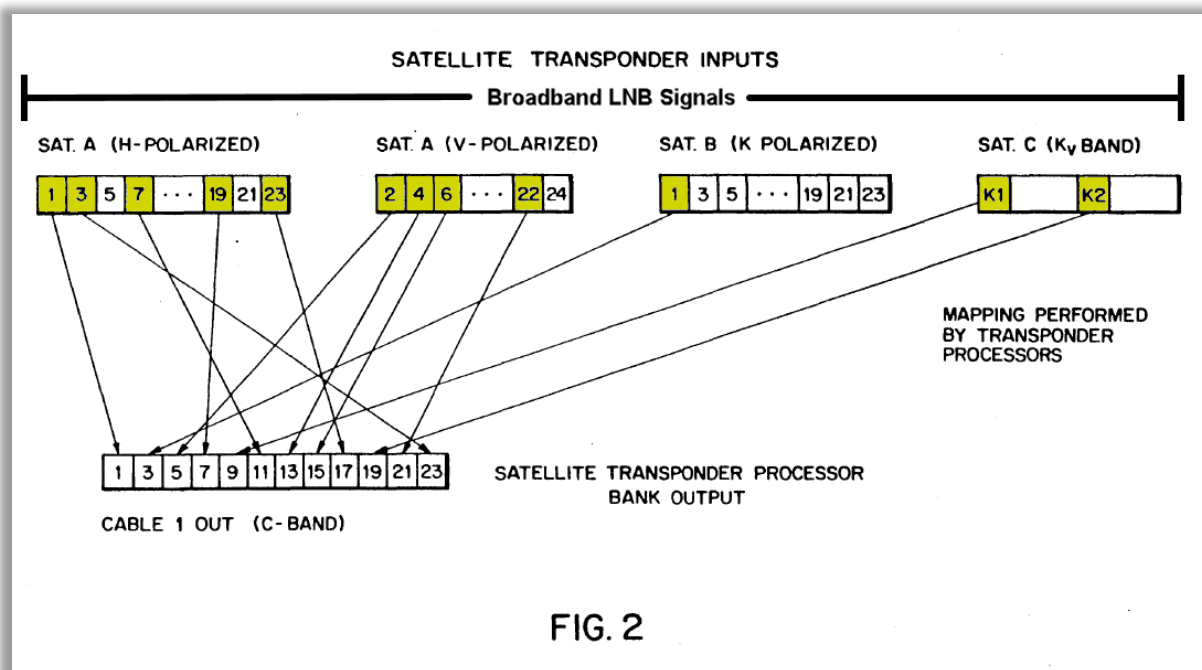


Figure 2 — Green’s Signal Selection Visualized.

167. Green does not detail why transponder processors 112 select specific transponder signals, except that it can be done by “installation and maintenance personnel” in a manner “flexible and easily customizable so that any desired satellite downlink transponder signal can be provided within any transponder frequency band at the output of the transponder combiner.” (Ex.1005-Green, 10:30-39, 12:64-13:2.) While Green discloses that a selector unit 140 associated with a given satellite receiver 136 requests a signal bearing a block of transponder signals, those requests are received locally by a cable selector 128, rather than in a gateway or ODU. (Ex.1005-Green, 11:7-16, Fig. 1B.)

168. But in the combined system of Green and Davis, it would have been

obvious to a POSITA that the signal selectors (banks 113 of transponder processors 112) *select transponder signals responsive to transponder select information* from STBs by way of interface device 40 transmitted by the gateway of Davis (interface device 40). The benefit of the transponder processors is that they provide a subset of all transponder signals for distribution to the STBs, and the most efficient implementation would select only those transponder signals bearing the desired programs, thus reducing the number of transponder signals that must be processed and transmitted. Davis teaches that IDUs (which may be STBs) can transmit requests to the ODU “over the same cable connection” as the IDU receives transponder signals. (Ex.1006-Davis, ¶55.) Accordingly, it would have been obvious, and a POSITA would have been motivated to modify Green’s transponder selectors, to utilize transponder select information, and to modify Green’s STBs to transmit requests for individual transponder signals, rather than whole blocks of transponders, as taught regarding Davis’s IDUs. Similar systems using requests from STBs to select transponder signals for distribution were known in the art (including in Fisk, Williams ’873, and “Eutelsat Installers Guide”). (*See supra* Section IV.G, ¶120.)

169. To ensure each of Green’s satellite receivers 136 (STBs) receive the television program desired by its user, the requests must be communicated to the ODU so that the ODU selects the transponder signal containing that program from

the input broadband LNB signals. The request is first provided to the interface device 40 (gateway), and then to the ODU. Davis teaches that the interface device 40 is in communication with both the ODU and the STBs (in Green, comprising a selector unit 140 and the receiver 136; in Davis, the IDUs 32) as discussed above in limitation 9[a], and in the combined system of Green and Davis, a POSITA would have been motivated to modify the ODU and STBs to communicate with the interface device regarding transponder select information.

170. Accordingly, the combination of Green and Davis renders limitation 9[b] obvious.

9[c] “a frequency translator coupled to the signal selector that is capable of shifting the selected transponder signals to new carrier frequencies to produce RF signals; and”

171. Green discloses a *frequency translator* as recited in limitation 9[c]. Each transponder processor 112 receives a plurality of LNB broadband signals in the 900-1500 MHz range and selects a transponder signal from one of the received LNB broadband signals. The transponder processor 112 “performs a selected frequency ‘mapping’ or conversion process” on a selected transponder signal “and produces a resulting frequency converted signal at its output.” (Ex.1005-Green, 10:4-12.) Green explains that “the ‘mapping’ performed by transponder processors 112 is flexible and easily customizable so that any desired satellite downlink transponder can be provided within any transponder frequency band provided” at

the output of each processor, and eventually to the transponder combiner which combines those outputs. (Ex.1005-Green, 10:34-43.) The upconverter 204 “converts the selected signal back to a signal having a center frequency within the original 950-1450 MHz—and more specifically to have a center frequency exactly matching a standard center frequency of a given desired transponder channel within that band.” (Ex.1005-Green, 12:50-56.) This conversion process is performed under the direction of the micro-controller 206. (Ex.1005-Green, 12:57-64 (“[M]icrocontroller 206 ... controls up converter 204 to convert that selected signal to any desired transponder output frequency.”))

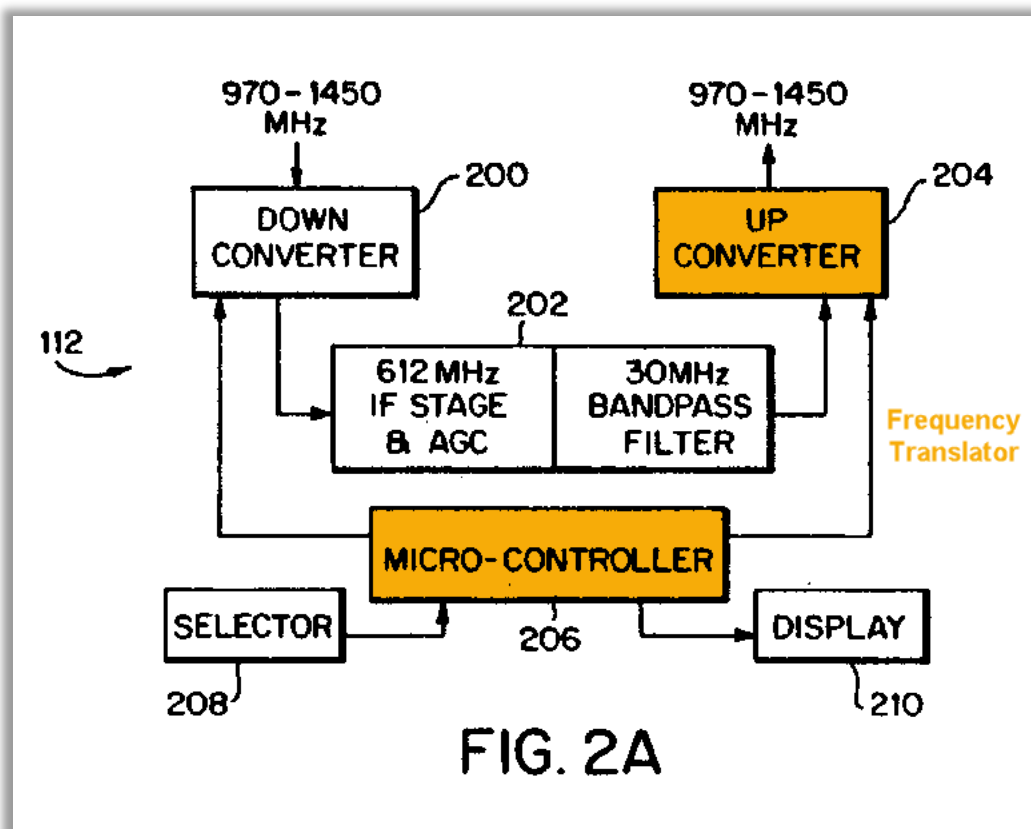


Figure 2A — Transponder Processor from Green (highlighted elements for frequency translating).

Green teaches that its *frequency translator* (including up converter 204) utilizes a mixer, local oscillator and filter, routine components for frequency-shifting signals. (See *supra*, ¶124 (citing Ex.1007-AAPA Petruzzelli at 1:21-37, 5:46-61.))

172. Accordingly, Green teaches that its “frequency mapping” may include “shifting the frequency of at least one of said received television signals from a first transponder channel within the range of 900-1500 MHz to a second transponder channel,” a *new carrier frequency*, “different from said first channel also within the range of 900-1500 MHz,” which is an *RF signal*. (Ex.1005-Green, Claim 5.) Accordingly, Green discloses limitation 9[c].

9[d] “a signal combiner coupled to at least one frequency translator capable of combining at least two RF signals to produce a composite signal;”

173. Green discloses the claimed *signal combiner*. Green teaches that the output of each transponder selector 112 (containing *frequency translators*) of a bank of transponder selectors 113 is fed into a 12-transponder combiner 114. (Ex.1005-Green, 10:12-15.) The signals provided by each transponder selector 112 *are RF signals* with different center frequencies in the 900-1500 MHz range so that, when combined by the 12 transponder combiner, they “look[]” (in terms of frequency range, format, mode and other parameters) as if [they] might have been outputted

directly by a single one of satellite antennas 102.” (Ex.1005-Green, 10:20-34.) That is, the signals are combined into a single *composite signal* in the 900-1500 MHz range, as shown by the lines emanating from the combiners 114a and 114b in Figure 1A.

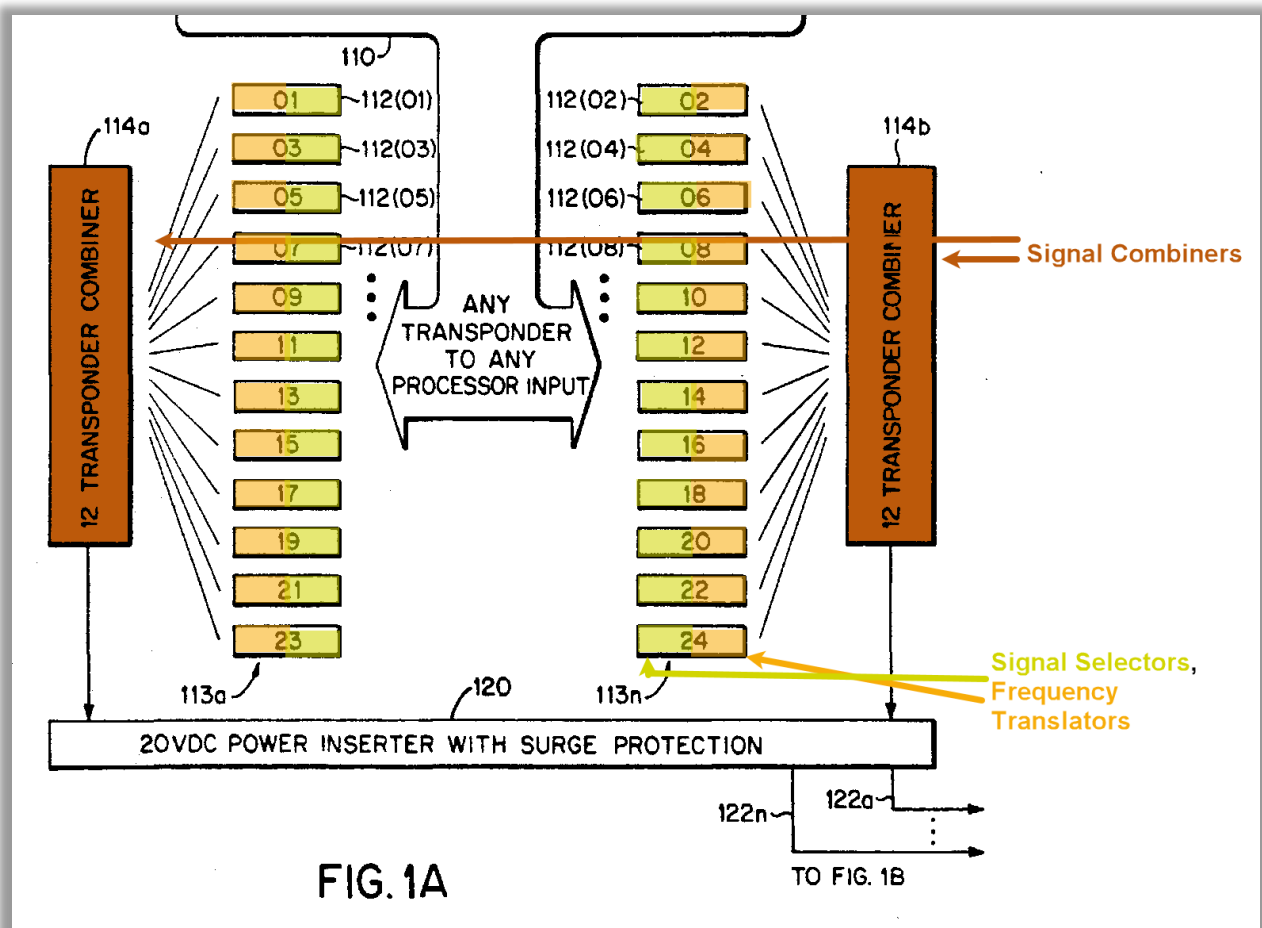


Figure 1A — Green’s Transponder Processors are Coupled to a Transponder Combiner.

174. Accordingly, Green discloses this limitation.

9[e] “wherein the modulation of the composite signal is the same as the modulation of the broadband LNB signals and”

175. Green discloses this limitation. Green teaches that in the process of altering the frequency of the selected transponder signals (*i.e.*, down-shifting and then up-shifting), it does so “without demodulating said selected signals.” (Ex.1005-Green, Claims 1-2.) A POSITA would have understood that the remaining signal processing performed by the transponder selectors 112 (downconverter, state/AGC/bandpass filter, and upconverter, *see* Figure 2A) would not impact the modulation. Green explains that the composite signal output from the 12-transponder combiner 114 is “a contiguous block of FM television signals in the range of 900-1500 MHz” such that the resulting signal “‘looks’ (in terms of frequency range, format, mode and other parameters) as if it might have been outputted directly by a single one of satellite antennas 102 on one of the horizontally polarized or vertically polarized transmission line outputs,” *i.e.*, as if outputted by an LNB. (Ex.1005-Green, 10:22-28.) Accordingly, Green discloses this limitation.

9[f] “wherein the composite signal is transmitted to the gateway”

176. The combined system of Green and Davis renders this limitation obvious. In Davis, interface device 40 receives radio frequency (RF) signals from the outputs of the relevant LNBs. (Ex.1006-Davis, ¶13.) In the combined system, interface device 40 is performing signal processing and facilitating distribution of

selected satellite signals to various STBs via a local area network as described in Davis. (Ex.1006-Davis, ¶13.) To perform signal processing and distribute the selected signals, interface device 40 receives the *composite signal* from the 12-transponder combiner 114, and thus it would need to be *transmitted* to the interface device 40 (*gateway*). Accordingly, the combined system of Green and Davis renders this limitation obvious.

9[g] “*and the gateway receives the composite signal, decodes specific programs, and distributes the programs over a digital local area network (LAN) to STBs.*”

177. The combined system of Green and Davis renders limitation 9[g] obvious.

178. As discussed above in limitation 9[f], to perform the signal processing and distribution taught in Davis, interface device 40 (*gateway*) *receives the composite signal* output by Green’s 12-transponder combiner 114. Davis’s interface device 40 performs signal processing, including decoding specific programs. As I discuss above in Ground 1 for this limitation, “decodes” broadly refers to data processing operations, including tuning, demodulating, and demultiplexing that were known in the art to be performed by STBs and/or gateways. (*See supra*, ¶137.) LNB interface 41 of the interface device 40 (*gateway*) includes “conventional [signal processing] elements, such as a tuner/demodulator pair.” (Ex.1006-Davis, ¶¶41, 45.) The tuner/demodulator pair “processes an RF input,” in the combined system, a

composite signal from the ODU, and “produces a corresponding digital output.” (Ex.1006-Davis, ¶¶41, 45.)

179. In Davis, where the interface device 40 (*gateway*) is providing received satellite signals intended for specific IDUs (see below), a POSITA would have understood the interface device will make a selection and digitization of a specific program for distribution to the IDU, here, an STB. Otherwise, the interface device would unnecessarily waste bandwidth and require additional processing downstream for tuning, demodulation, and filtering wideband LNB signals by, for example, each IDU (*i.e.*, STBs), which a POSITA would have been motivated to avoid. Here, where the received satellite signals contain digital video and audio data (*e.g.*, MPEG programs) that are carried on the analog RF signal (as was typical when Davis was filed), a POSITA would have understood that the “conventional [signal processing] elements” would have included a demultiplexer to demultiplex an MPEG stream to select a single MPEG program for distribution. AAPA Williams demonstrates, for example, that known or conventional decoding functionality may include a “standard demultiplexer” which acts on an MPEG multiplexed stream such as the selected transponder signal to “extract one of the five to eight A-V programs from the program multiplexed data signal.” (*See generally* Ex.1008-AAPA Williams 15:54-16:20.) Thus, even if Davis does not inherently teach the use of a

demultiplexer in the interface device 40, it would have been obvious to modify Davis to include demultiplexer(s) in the interface device 40 to provide only the programs requested by an STB, which would reduce bandwidth in the LAN relative to providing all MPEG programs in a transponder signal containing the requested program and reduce the computation needed for demultiplexing downstream by, for example, the IDU (*i.e.*, IRD/STB).

180. Consistent with the historical role of gateways in a network, interface device 40 *distributes the decode[d] ... programs over a digital local area network (LAN) to STBs. (See supra, ¶¶72-74.)* The decoded programs are packetized, and the network protocols and services processing unit 45 of the interface device 40 “determines the destination address of each packet[] and controls the transmission of such packets according to a set of network protocols. ... [t]he message packets are then transmitted to the LAN 50 through LAN interface 46 and LAN cable 27.” (Ex.1006-Davis, ¶¶45-46.) Transmission media for the LAN include Ethernet cables. (Ex.1006-Davis, ¶¶45-46.) The packets are distributed to IDUs 32, including STBs, which decrypt and/or descramble received signals for presentation on a television. (Ex.1006-Davis, ¶¶36, 39.) An exemplary distribution digital LAN is shown below in Figure 2, with one STB shown in blue.

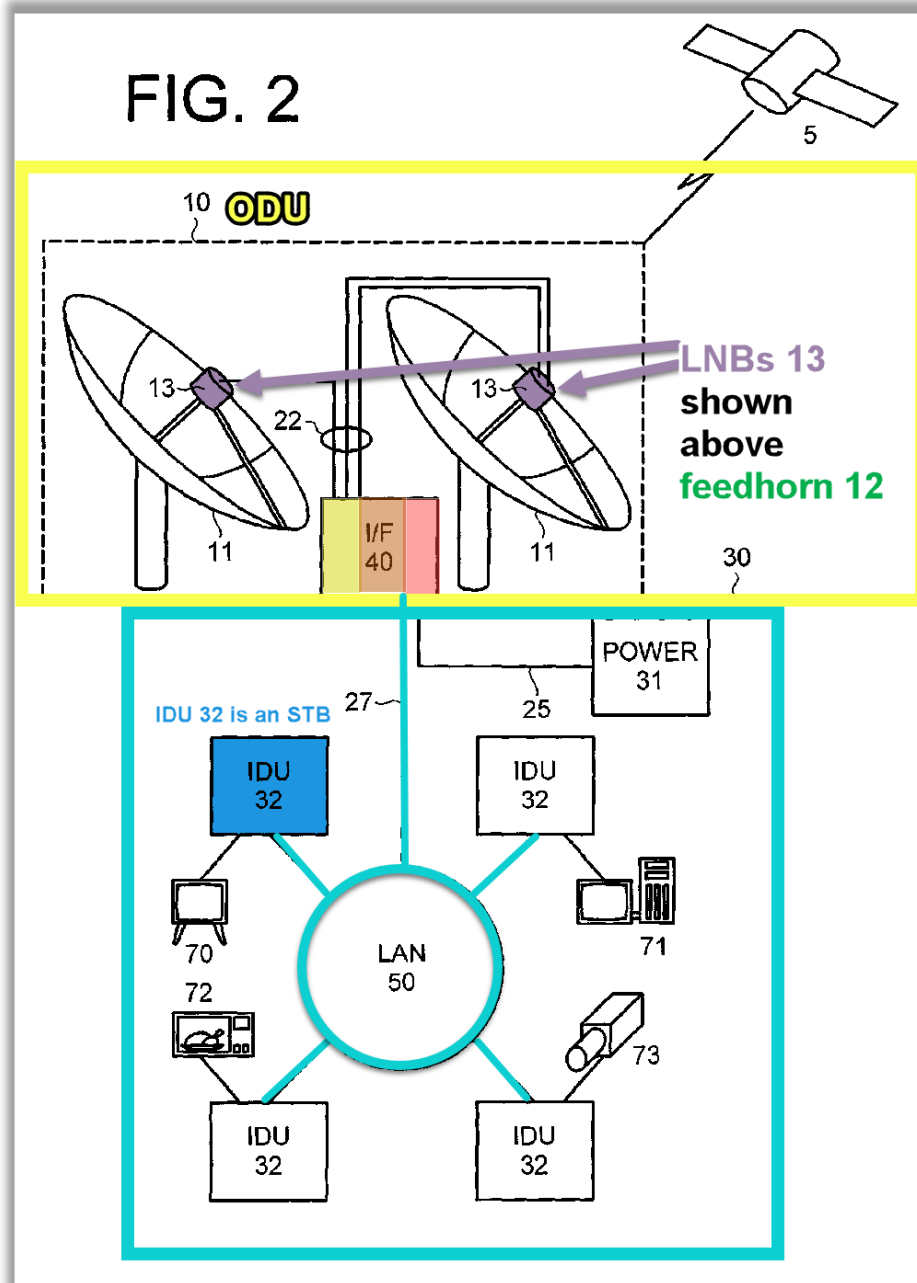


Figure 2 — Davis's Interface Device Distributes Programs Digitally via a LAN.

181. Accordingly, the combination of Green and Davis renders claim 9 obvious.

3. Dependent Claim 10

The signal distribution system of claim 9 wherein a translation table maps original channel locations on the selector input to new channel locations on the selector output.

182. This claim is taught by Green. As discussed above in limitation 9[c], the transponder processors 112 of Green “perform[] a selected frequency ‘mapping’ or conversion process.” (Ex.1005-Green, 10:4-12.) The processors use input by “installation [or] maintenance personal” to selector 208 “to select the transponder signal to be down converted by down converter 200 and the transponder frequency to which a resulting selected signal is up converted by the up-converter.” (Ex.1005-Green, 12:57-16:2.) A “display 210 indicates the conversion frequencies that have been selected.” (Ex.1005-Green, 12:57-16:2.) Thus, selector 208 contains a mapping of original channel locations at the input to the transponder processor 112 and the new channel locations on the transponder processor 112 output.

183. To the extent Patent Owner argues that a “translation table” must be in a single location, such as a single memory, rather than contained among a plurality of selectors, it would have been obvious to a POSITA to modify Green to maintain all of the selector mapping information in a single location for ease of implementation and maintenance. While Green teaches the use of switches and two-bit displays for each selector 208 (Ex.1005-Green, 15:30-17:58), Green was filed in 1989—twelve years before the priority date of the ’715 patent. In the intervening

years, advances in computer technology made significant improvements in computer display, processing, and memory technology while reducing costs. As such, by 2001, a POSITA would have been motivated to take advantage of affordable and readily-available processor and memory technology to utilize only a single processor and memory to control the plurality of transponder processors 112 (which include the selectors), especially given that the primary embodiment of Green teaches at least forty-eight separate transponder processors 112. (Ex.1005-Green, 9:65-68.) Thus, this claim is suggested by Green and the general knowledge of a skilled artisan.

184. Further, the claimed translation table would be well within the general knowledge of a POSITA in view of the combined system of Green and Davis. As discussed above in limitations 9[a], 9[b], and 9[g], the interface device 40 of Davis—the *gateway*—is responsible for receiving transponder select information from a plurality of STBs and providing the information to the ODU of Green so that the desired transponder channels with transponder signals bearing desired programs may be provided to the interface device 40 for distribution to STBs. To effectuate this system, it would have been obvious to a POSITA to maintain a translation table so that the ODU knows which transponder channels to provide and at what frequencies, the interface device knows which channels it has received for distribution and where to transmit those transponder channels, and the STBs know

how to request and extract a particular transponder channel bearing desirable programming. Finally, as discussed above in Section IV.E, maintaining look-up tables bearing information about where to locate television programming was known in the art, necessary to facilitate end-user selection of programs, and would not have been difficult to implement, store, and exchange.

185. Accordingly, claim 10 is disclosed by Green and is otherwise rendered obvious by Green in view of Davis and/or the knowledge of a POSITA.

4. Dependent Claim 11

The signal distribution system of claim 10 wherein the translation table is maintained by a controller located in the gateway and the translation table is communicated to devices in the network.

186. This claim is obvious in view of the combined system of Green and Davis. As discussed above in limitations 9[b]-9[d], the interface device 40 of Davis is used to receive transponder select information from STBs and provides this information to the ODU of Green for selection. It would have been obvious to a POSITA for the interface device 40 (*gateway*) to *maintain the translation table, i.e.*, information about the channel frequency of each transponder signal input to the transponder processors 112, so that the correct transponder signal can be selected by the transponder processors 112, and further obvious for the interface device 40 to maintain information about the channel frequency of each transponder signal output from the ODU so that the interface device 40 would know at what frequency each

requested program is located for distribution to the particular IDU that requested the program.

187. Because the interface device 40 would also need to provide the transponder select information to the transponder processors 112 of the ODU so that they could make appropriate selection, the table would therefore need to be communicated to the ODU. Moreover, as discussed above in Section IV.E, the table would also need to be transmitted to the IDUs that requested particular programs so that the IDUs can extract the requested programs from the selected transponder signals received.

188. Thus, the combination of Green and Davis renders claim 11 obvious.

5. Dependent Claim 12

The signal distribution system of claim 10 wherein the translation table is maintained by a controller located in the ODU and the translation table is communicated to devices in the network.

189. This claim is obvious in view of the combination of Green and Davis for similar reasons to those discussed above regarding the same claim in Ground 1. As discussed above in claim 10, maintaining a translation table would have been obvious, if not necessary, to effectuate the LAN distribution taught in Davis. While maintaining the transponder select information at the interface device 40 would have been obvious (see claims 10-11), a POSITA would have known that an obvious alternative was for the table to be maintained by a controller located in by the ODU

of Green.

190. The interface device 40 of Davis is indifferent to the specific frequency at which it receives a requested television program, so long as the interface device 40 knows the channel frequencies on which the transponder signals corresponding to requested programs will be output to the interface device (so that the interface device can differentiate and correctly distribute programs from those transponder signals to the correct STBs). Thus, the translation table could alternatively have been maintained by a controller at the ODU and communicated to the interface device to facilitate program distribution. Moreover, it was also necessary for the table to be communicated by the ODU (preferably via the interface device of Davis) to the STBs that requested particular programs so that the STB can retrieve the transponder signals bearing the programs desired by the STB and extract the desired program from the transponder signal.

191. The decision to maintain the translation table at the ODU rather than at the interface device of Davis was an implementation decision with limited additional cost or complexity. And in some situations, such as where one ODU was servicing multiple gateways (*e.g.*, in a community television system servicing a plurality of MDUs), it would have been preferable to centralize the maintenance of the translation table so that each gateway could be provided with its requested

transponder signals via a single output cable without the potential for conflict (which would occur if each gateway maintained the translation table for the channel(s) it needed).

192. Thus, the combination of Green and Davis renders claim 12 obvious

C. Ground 3: Claims 1-8 are Obvious over Fisk in view of the Knowledge of a Skilled Artisan

193. Unlike claim 9, claim 1 does not require frequency translation of selected transponder signals, nor compositing of selected transponder signals into a composite signal, both of which are disclosed in Carnero, but not Fisk. Claim 1 merely requires the signal selection step of claim limitation 9[b] (which Fisk performs separate from Carnero), and subsequent signal processing so that requested video programs are distributed via a digital network.

1. Independent Claim 1

1[pre] “A signal distribution system for distributing a plurality of video programs from a satellite outdoor unit (ODU) over a digital network comprising”

194. To the extent the preamble is limiting, Fisk discloses *distributing a plurality of video programs from the ODU over a digital network*. Fisk’s server 56 distributes *a plurality of video programs*, including those received via satellite dish (ODU). (Ex.1003-Fisk, 2:13-24, 10:23-11:5, 22:9-27, 40:1-3.) Fisk’s server selects the video programs requested by the LCUs 66 and outputs the programs over *digital*

network 50. (Ex.1003-Fisk, Figure 5, 21:1-29, 22:9-27.)

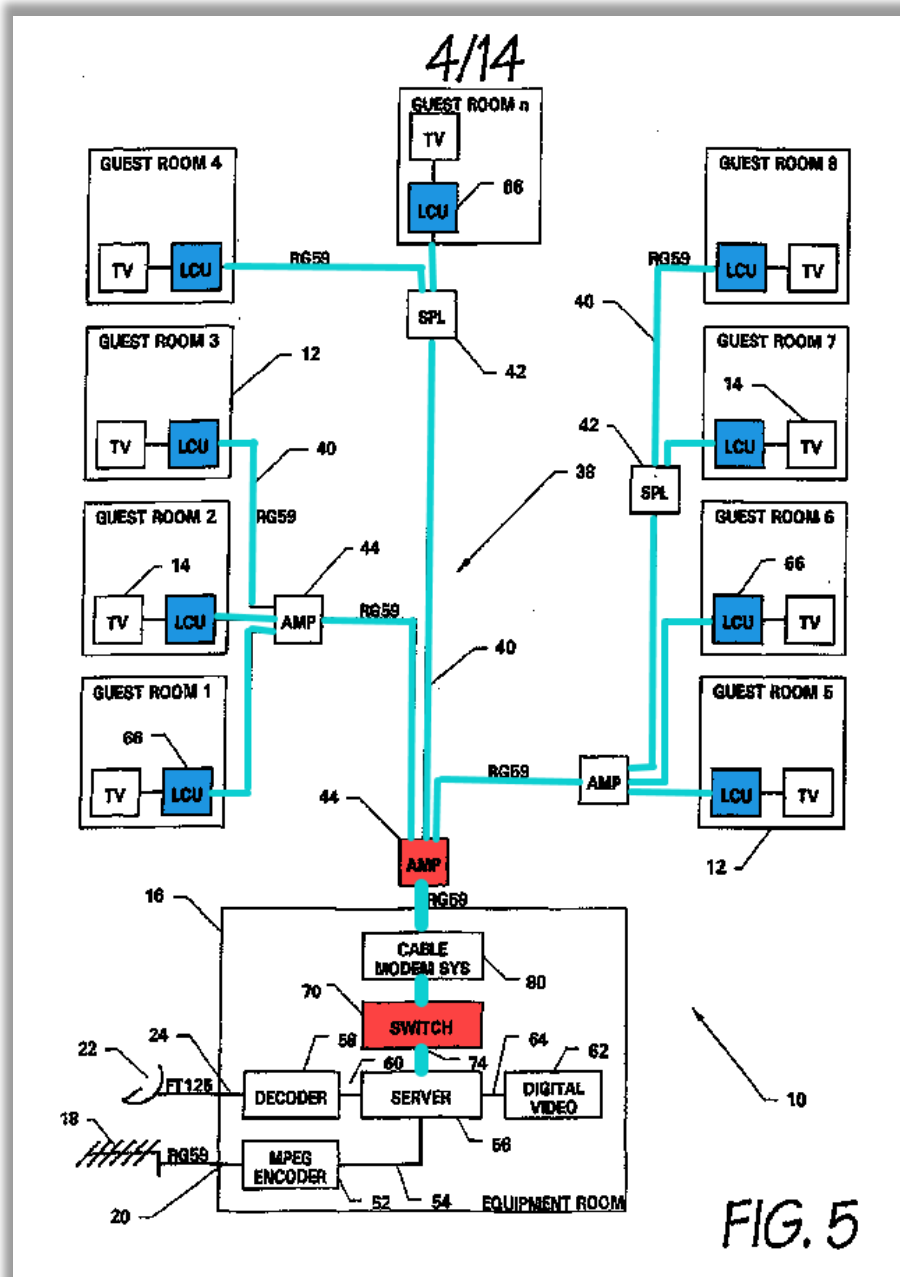


Figure 5 — Fisk's Video Distribution System.

195. Fisk's ODU is antenna 22 and associated components. An ODU was within the general knowledge of a POSITA in 2001, for example, AAPA Petruzzelli

describes a “prior art type of satellite receiving system” includes a “parabolic satellite antenna,” “feedhorn,” “low noise amplifier and ... block down converter 14, 16.” (AAPA Petruzzelli at 2:51-3:20.) And the ’715 patent admits an ODU is part of a “conventional” satellite distribution system. (Ex.1001-’715 patent, 1:21-62.) Therefore, to the extent Fisk does not expressly use the term ODU, it would have been obvious and well within the general knowledge of a POSITA.

1[a] “a signal selector that receives LNB signals comprising a plurality of transponder channels, the signal selector is responsive to transponder information transmitted over the digital network, and selects at least one transponder channel from the broadband LNB signal based on the transponder select information”

196. This limitation is obvious in view of Fisk and the knowledge of a POSITA. Fisk’s plurality of decoders/descramblers 58 receive satellite signals from satellite dish 22 via downlead 24. (Ex.1003-Fisk, 10:23-26, 21:1-5, 22:9-27.) As admitted by the ’715 patent, a POSITA would have known that received satellite signals are down-converted by an LNB and outputted and are thus the claimed *broadband LNB signals*. (Ex.1001-’715 patent, 1:21-44.) A POSITA would have also understood that the LNB signals comprise a *plurality of transponder channels*, as this is the basic structure of a satellite signal, as I discussed above in Section IV.A.

197. As discussed above in Section VII.A.2, limitation 9[g], Fisk teaches two types of hardware that are part of the decoder 58 and that a POSITA would understand perform the decoding operations of tuning, descrambling, and

demultiplexing: “conventional” IRDs and satellite receiver cards. In each case, “tuning” refers to the *selection of a transponder channel from the broadband LNB signal* that can then be descrambled and demultiplexed into MPEG programs. *See also supra*, ¶¶53-54 (discussing tuning operations of conventional STBs).

198. It would have been obvious to a POSITA that the conventional STB or satellite receiver cards of the decoder 58 would select *transponder channels based on the transponder request information* received by Fisk’s server from the LCUs. The purpose of the decoder is to provide programs to the server for distribution to the LCUs that request the programs (Ex.1003-Fisk, 22:9-27), so it need only select those transponder channels bearing the desired programs. Limitation 1[a] is obvious in view of Fisk and the knowledge of a POSITA.

1[b] “at least one transport stream demultiplexer coupled to the signal selector to extract a specific video program from the transponder channel”

199. The decoder 58 in Fisk includes a *transport stream demultiplexer*, which demultiplexes a *selected transponder channel* signal to *extract a specific video program*. After the decoder 58 tunes to a specific transponder channel (*see* 1[a]), the tuned transponder channel is then demultiplexed by demultiplexer 232 to extract a “selected channel,” which is a specific video program in digital MPEG2 format. The below table from Fisk “tracks the path of the stream sequentially through the digital satellite television card 190,” which is one kind of hardware taught by

Fisk to perform decoding functions, and shows the card includes a demultiplexer 232 which receives a “[d]igital, [m]ultiplexed, MPEG-2” signal and outputs a “[d]igital, MPEG-2” signal, *i.e.*, one that has been demultiplexed.

Digital Satellite Television Card 190			
Component	Path of Signal	Format	Notes
Satellite Receiver System	Satellite dish 22	Digital, Scrambled, Multiplexed, MPEG-2	
	Coaxial cable 24	Digital, Scrambled, Multiplexed, MPEG-2	
Satellite Receiver Card	Coaxial input port 228	Digital, Scrambled, Multiplexed, MPEG-2	
	Descrambler 230	Digital, Multiplexed, MPEG-2	
	Demultiplexer 232	Digital, MPEG-2	The selected channel is under software control
	RJ45 output port 192	Digital, MPEG-2	An IP address is assigned to the port by a DHCP client on the server 56

(Ex.1003-Fisk, 44:10-45:1, 41:7-11, 22:16-18 (“decoder/descrambler 58 [] provides digital MPEG video streams 60 for the received satellite television programmes to the server 56.”).)

200. The *demultiplexer 232* is coupled to the signal selector, as both are part of the decoder 58. Although the tuning operation is not expressly described in Fisk, a POSITA would have understood that in conventional satellite signal processing and communication systems, tuning would necessarily occur prior to the

demultiplexing by demultiplexer 232 shown in the table above. (*See, e.g.,* Ex.1008-AAPA Williams 16:28-38 (teaching the order of processing by its IRD performed by “tuner 110, decoder 112, packetizer 114, splitter 116, transport decoder 118, and demultiplexer 120.”)) Thus, a POSITA would have understood the signal selector to be coupled to the transport stream demultiplexer of Fisk’s decoder. Fisk and the general knowledge of a POSITA render limitation 1[b] obvious.

1[c] “a data combiner coupled to the transport stream demultiplexers to combine video programs and produce a multiplexed signal”

201. Fisk discloses this limitation. Fisk teaches that after the decoder 58 demultiplexes one or more programs, the server 56 (*data combiner*) “selects which of the video streams [*programs*] is to be transmitted to which room 12.” (Ex.1003-Fisk, 22:20-22.) In one embodiment, the server 56 transmits the “digital television/video signals” over a network, “the signals being multiplexed ... each on a preset channel allocated according to the device so that the device has a respective preset one of the channels,” and preferably, “the signals are” either “frequency-multiplexed and/or phase multiplexed.” (Ex.1003-Fisk, 6:25-31, 23:28-24:8 (“coaxial cable has a typical bandwidth of 460 MHz, which allows up to 76 television channels to be frequency multiplexed together and carried by the one cable network”), 27:4-7, 33:4-6.)

202. The server (*data combiner*) is coupled to the decoder 58 that contains

transport stream demultiplexers. The output of the decoder (demultiplexed video signals for selected programs) is fed to the server for multiplexing, and in some embodiments where the decoders are cards, the decoders are part of the server. (Ex.1003-Fisk, 41:6-19.) In each instance, the decoder is coupled to the data combiner of Fisk's server.

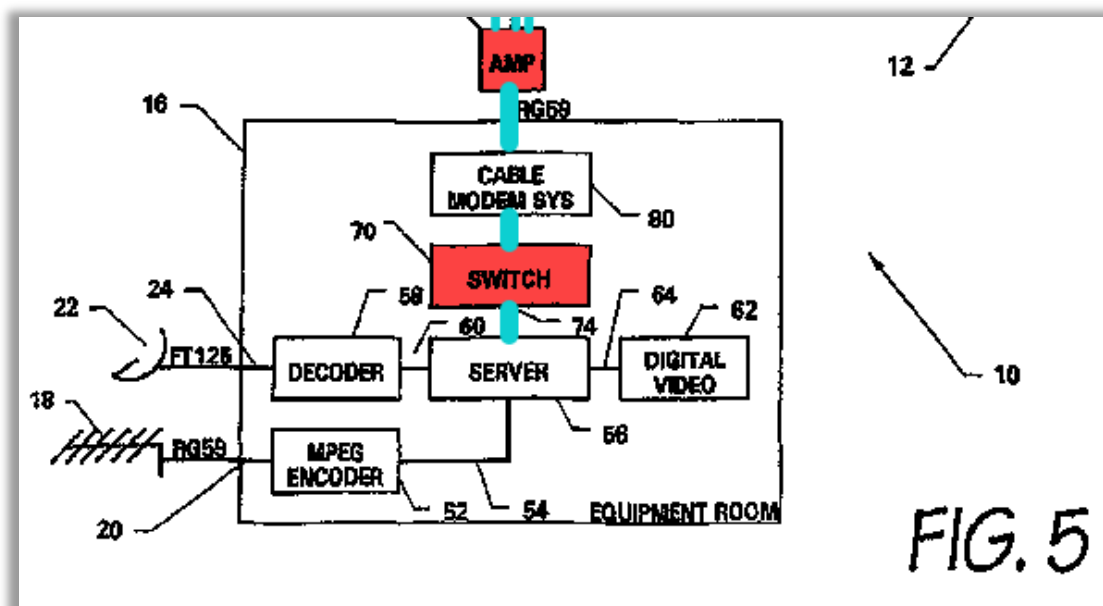


Figure 5 — Fisk's Decoder Output is Inputted to a Server for Multiplexing.

203. Fisk, accordingly, discloses this limitation.

1[d] “wherein the multiplexed signal is formatted for transmission on the digital network and the digital network connects to the ODU.”

204. See Sections VII.A.2-4, limitations 9[a] and 9[g], claims 10-12.

205. This limitation is obvious in view of Fisk. The *multiplexed signal is formatted for transmission over a digital network* at least partially provided by a

conductor, such as coaxial or Ethernet cable. (Ex.1003-Fisk, 6:25-31.) “The signals may be digital signals,” (*id.*) as in the primary embodiments, where the signals are “digital MPEG video streams” transmitted over a “digital network” to LCUs (*id.*, 22:9-27), “the signals being multiplexed ... each on a preset channel allocated according to the device so that the device has a respective preset one of the channels,” and preferably, “the signals are” either “frequency-multiplexed and/or phase multiplexed.” (Ex.1003-Fisk, 6:25-31, 23:28-24:8 (“coaxial cable has a typical bandwidth of 460 MHz, which allows up to 76 television channels to be frequency multiplexed together and carried by the one cable network”), 33:4-6.) The digital network transmitting the multiplexed signal includes the server 56 and a plurality of LCUs 66, which request programs from the server and receive selected video programs for display. (See claim limitation 9[a].) The ODU (including antenna 22) communicates with the server 52 and/or decoder 58 (*e.g.*, to provide satellite television programs), and therefore the *digital network connects to the ODU*. This limitation is accordingly disclosed by Fisk.

206. To the extent Patent Owner assumes that the digital network of Fisk is not connected to the ODU because it does not directly connect to the ODU but rather connects indirectly via the server and decoder in the equipment room, it would have been obvious to a POSITA to modify the disclosure of Fisk such that Fisk’s digital

network directly connects to the ODU by also allowing a direct link between the LCUs and ODU. Including a direct link between the ODU and LCUs would have provided additional benefits, such as permitting an uplink (*i.e.*, for sending communication messages using the satellite dish, a feature necessary for satellite Internet). And it would have been within the skill and knowledge of a POSITA to incorporate a direct link between the LCUs and the ODU. Accordingly, to the extent not disclosed by Ex.1003-Fisk, this limitation would have been obvious in view of Fisk and the general knowledge of a POSITA.

207. In conclusion, this claim is rendered obvious in view of Fisk and the knowledge of a POSITA.

2. Dependent Claim 2

The signal distribution system of claim 1 further comprising a plurality of set top boxes (STBs) connected to the digital network wherein all STBs extract channels from the multiplexed signals.

208. See Section VII.A.2, limitation 9[a].

209. This claim is obvious in view of Fisk. Fisk teaches a plurality of LCUs (receivers) 66 in a digital network with at least the server 56. (*e.g.*, Ex.1003-Fisk, 6:25-30, 22:9-27, Figs. 4-5.) As discussed in Ground 1 regarding limitation 9[a], LCUs are the claimed *STBs*, or it would have been obvious to replace Fisk's LCUs with conventional *STBs*.

210. Each LCU *receiver extracts channels from the multiplexed signal of*

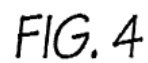
video television programs from Fisk's server. Fisk teaches that its server distributes programs in a multiplexed signal via the digital network (see limitation 1[d]) with "a preset channel allocated according to the [LCU] so that each [LCU] has a respective preset one of the channels." (Ex.1003-Fisk, 6:24-30; *see also id.*, 6:7-21.) A POSITA would have understood this to mean that each LCU is extracting the one channel associated with the LCU from the multiplexed signal to obtain a requested video program.

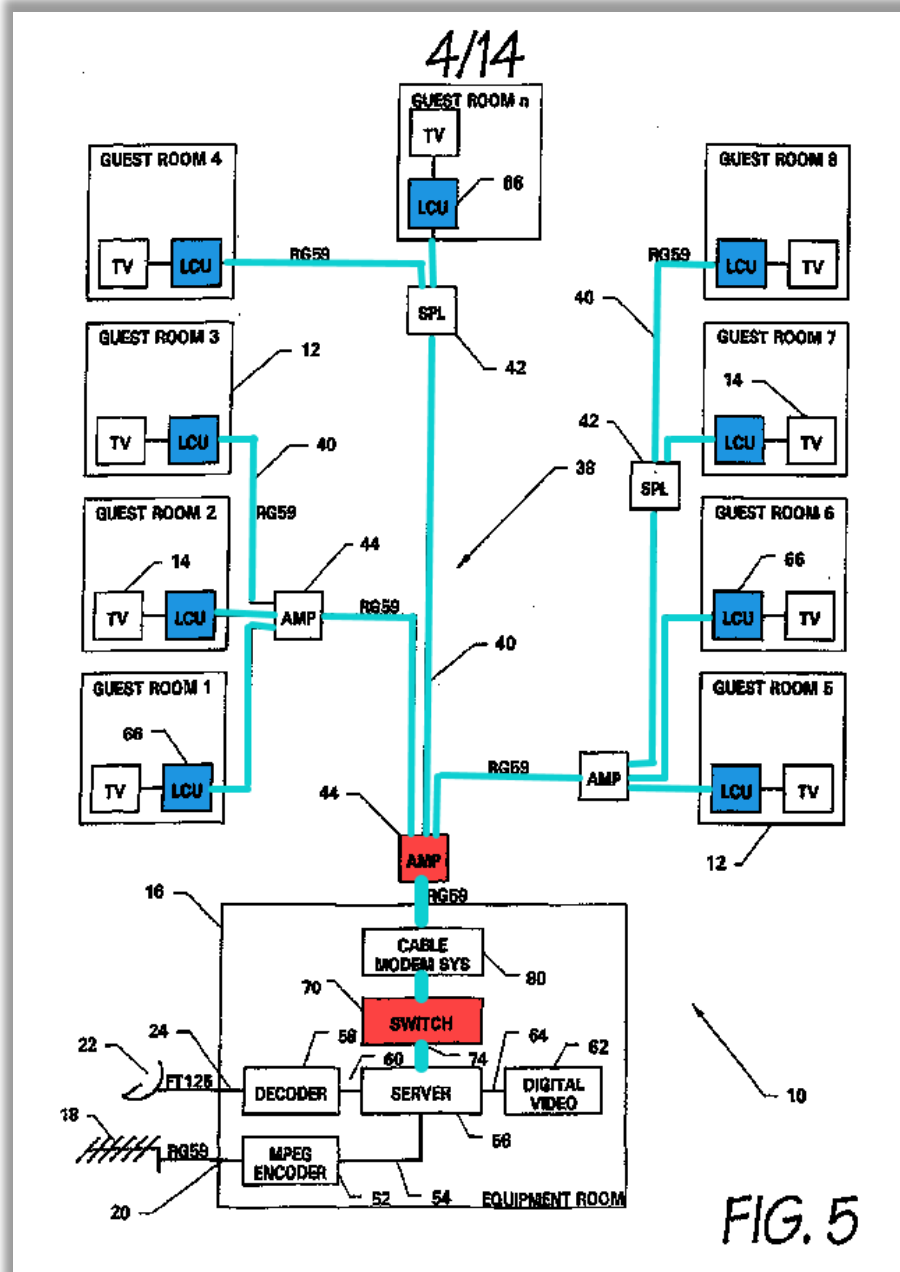
3. Dependent Claim 3

The signal distribution system of claim 1 wherein the digital network is a local area network (LAN).

211. *See* Section VII.A.2, limitation 9[g], *supra*.

212. Fisk's *digital network is a LAN* as shown in Figures 4 and 5.





Figures 4 and 5 — Fisk’s Local Area Network Connecting a Server and LCUs (Light Blue).

213. These figures respectively represent embodiments wherein the digital network is comprised of a CAT 5 (e.g., Ethernet) or coaxial cable wired connection between LCUs and the server 56. (Ex.1003-Fisk, 6:6-30, 22:9-22, 23:2-24:15.) A

POSITA would have understood that this architecture reflects a *digital local area network*: Ethernet is a *digital local area network*, and while a coaxial network could be either an analog or digital network, because Fisk teaches the coaxial cable transmits MPEG programs, a POSITA would understand that the coaxial network in Fisk is also a *digital local area network*. Accordingly, this claim is obvious in view of Fisk.

4. Dependent Claim 4

The signal distribution system of claim 3 wherein the LAN is an Ethernet LAN.

214. See claim 3, *supra*. Fisk discloses that its local area network may use Category 5 cables, which a POSITA would have understood to include Ethernet. (Ex.1003-Fisk at 2:27-3:3, 33:10-14.) Therefore, claim 4 is obvious in view of Fisk.

5. Dependent Claim 5

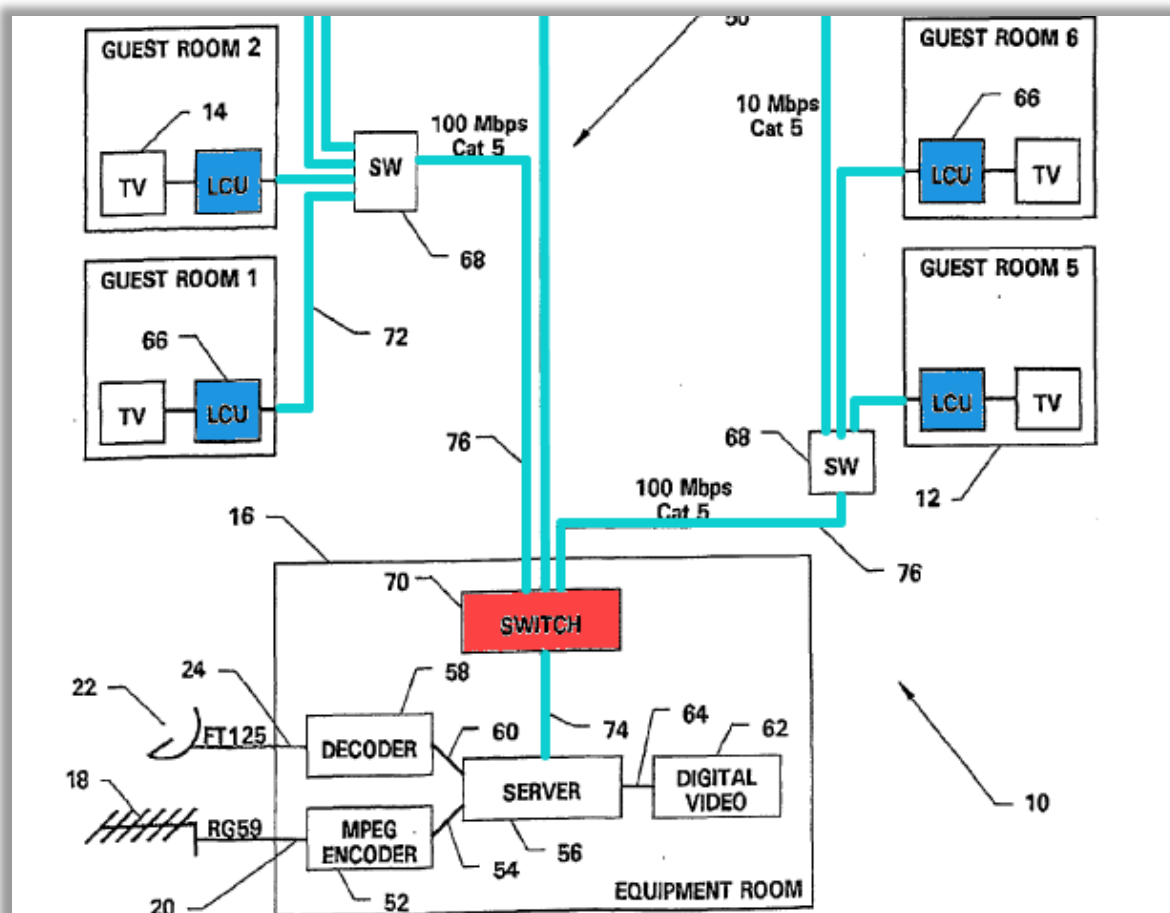
The signal distribution system of claim 3 wherein the LAN uses data packets.

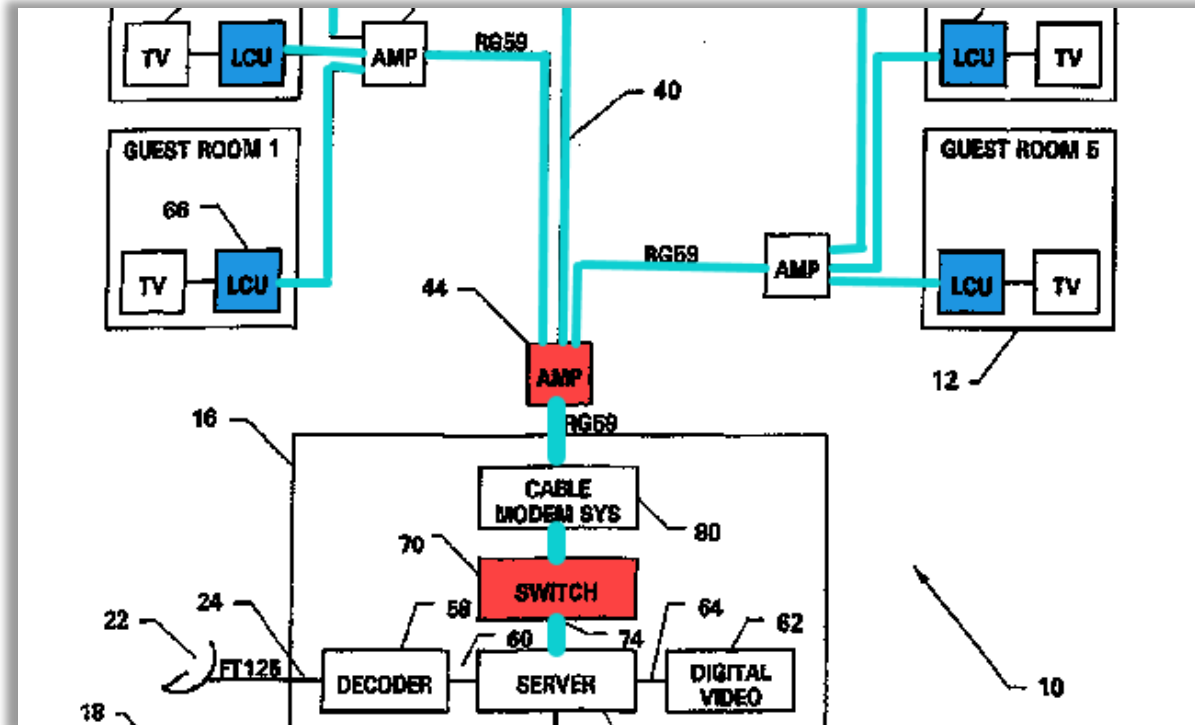
215. See claims 3 and 4, *supra*. Fisk discloses that as part of its signal processing, its server 56 “split[s]” live feeds, such as video programs, “into packets.” (Ex.1003-Fisk, 40:20-25.) Additionally, a POSITA would have understood that distributing MPEG-2 video over a digital network, such as the TCP/IP network disclosed in Fisk, would require packetizing the video. (Ex.1003-Fisk, 22:9-27.) Accordingly, this claim is obvious in view of Fisk.

6. Dependent Claim 6

The signal distribution system of claim 1 wherein transponder select information is transmitted over the digital network by a gateway.

216. See limitation 1[a]. Fisk's LCUs transmit their requests for video programs (*transponder select information*) to the server over the digital network. (Ex.1003-Fisk, 22:25-27 ("Each LCU 6 is also operable to send requests over the network 38 to the server 56, for example to change the television/video channel supplied to that LCU 66.")) Between Fisk's server 56 and the LCUs 66 is a switch 70 (*gateway*), as shown in Figures 4 and 5 below, and in Figure 5, one or more active distribution amplifiers 44. (Ex.1003-Fisk, 21:19-25, 24:2-10.)





Figures 4 and 5 — Communications Between the LCUs and a Server are Transmitted by Switch 70, Amplifier 44 (*Gateways*).

217. Unlike the gateway of claim 9, which was responsible for, among other things, decoding specific programs, the claimed gateway here *need only transmit the received transponder select information to the server*. This is consistent with the '715 patent specification, which teaches that a gateway “can be a simple power splitter/summer allowing the IRDs to connect directly to the” source of the multiplexed signal; here, the server. (See Ex.1001-'715 patent, 4:40-41.) This is exactly what a POSITA would have understood this is what active distribution amplifiers 44 do in the digital network, and the switch 70 otherwise “allow[s] the IRDs to connect directly to” the server to convey, *e.g.*, *transponder select*

information. This claim is therefore obvious in view of Fisk.

7. Dependent Claim 7

The signal distribution system of claim 1 wherein transponder select information is transmitted over a wireless link.

218. While Fisk teaches that *transponder select information* is transmitted over the existing wired coaxial or Category 5 digital network, Fisk recognizes that alternative communication channels may be used. (Ex.1003-Fisk, 33:2-4 (“It may be possible to use a hybrid solution that uses the coaxial cable as a down-link and the telephone system as the up-link.”).) Fisk suggests using alternative channels where bandwidth use on the down-link is significant (*i.e.*, due to distributing many video programs). (Ex.1003-Fisk, 33:1-2.) An obvious alternative is the use of a wireless link, such as wireless RF communication or WiFi, which was well known to a POSITA in 2001. A variety of wireless communications standards existed and were known by November 2001, including 802.11 (which became popularly known as “WiFi”) as well as various analog and digital cellular networks (*e.g.*, AMPS, Digital AMPS, GSM, cdmaOne, CDMA2000, UMTS, etc.), and other kinds of RF wireless communications. (*E.g.*, Ex.1018.) Indeed, each of AAPA Williams and Davis teach the use of wireless networks for the entire satellite signal distribution, which is far more bandwidth intensive than using wireless communications for transponder select information only, and Davis expressly discloses using its LAN (which may be

wireless) to transmit request information from IDUs (which may be IRDs) to the ODU. (Ex.1006-Davis, ¶¶36, 56 (“requests for digital content may be transmitted from an IDU 32 over the LAN 50 to interface device 40, which forwards the request to an antenna 11 for transmission to a satellite 5”), 75 (noting LAN 50 may be “wired or wireless”); Ex.1008-AAPA Williams, 3:37-42, 6:20-24 (“The transmodulator 20 may instead, or in addition, distribute the transmodulated signals over wire or any wireless communication channel (including, for example, microwave and optical systems”).) Further, during the reexamination of the ’576 patent, the parent of the ’715 patent, the examiner noted that “it would have been obvious to use” a known receiver having wireless capabilities “or other commonly available wireless technology to communicate transponder select information over a wireless link.” (Ex.1017-’576 Reexam, 301.) I agree. Further, a POSITA could have implemented a wireless link for transmitting transponder select information at limited cost and complexity, either by using STBs having wireless communications features (such as the one discussed in the ’576 reexam), or by incorporating that technology into the STB of their system (such as in the LCUs of Fisk). This claim is therefore obvious in view of Fisk and the general knowledge of a POSITA.

8. Dependent Claim 8

The signal distribution system of claim 1 further comprising a gateway connected to the digital network that receives the video program in the

multiplexed signal and distributes the video programs over a local area network (LAN) to STBs.

219. See claims 2, 6, *supra*. Fisk's switch 70 and active distribution amplifiers 44 are gateways connected to the digital network between the server 56, which formats the multiplexed signal carrying the selected video program, and the LCUs, which receive the multiplexed signal via the LAN. See limitations 1[c]-1[d], *supra*. These components receive the *video programs in the multiplexed signal* (from the server) and *distribute the signal over the digital local area network*. (Ex.1003-Fisk, 21:1-29, 28:20-29, 40:1-9.) This claim is therefore obvious in view of Fisk and the general knowledge of a POSITA.

D. Ground 4: Claims 13-19 are Obvious over Carnero in view of the Knowledge of a Skilled Artisan

1. Independent Claim 13

13[pre] - “*A signal distribution system for distributing a plurality of transponder channels to new and legacy set top boxes (STBs) comprising:*”

220. To the extent the preamble is limiting, it is obvious in view of Carnero. As discussed above in Section VIII.A.2, limitations 9[pre] and 9[a], Carnero discloses a *signal distribution system for distributing a plurality of transponder channels*. (See, e.g., Ex.1004-Carnero, Abstract (“a community antenna system, for distributing television signals of different channels”).) Carnero's Figure 3 depicts its *signal distribution system*.

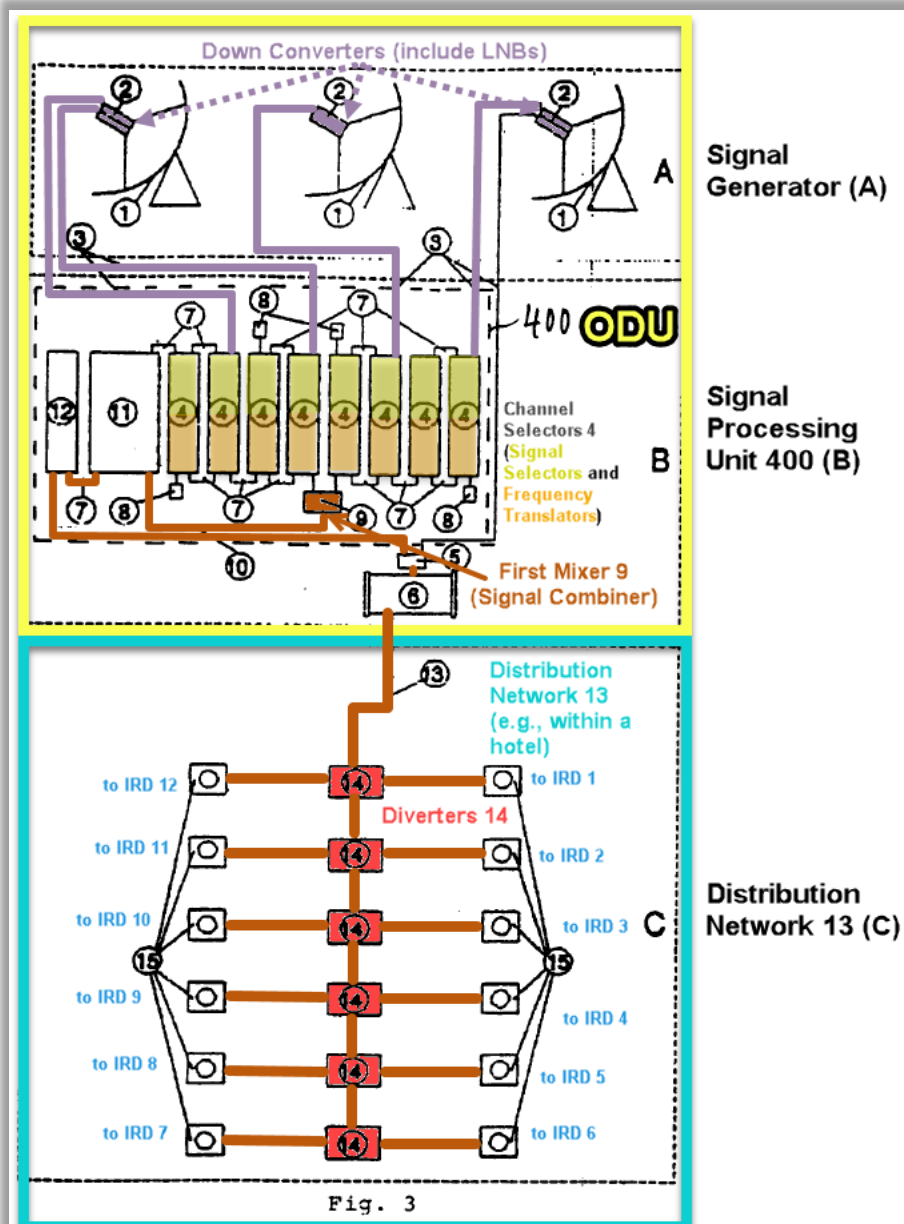


Figure 3 — Carnero's Signal Distribution System.

221. Carnero's signal distribution system *distributes a plurality of transponder channels* to user antenna outlets 15. A POSITA would have understood that an STB connects to the system at each outlet 15 to receive the distributed transponder channels: STBs or equivalent are necessary to process a received

transponder channel (or channels) to output a video signal to, for example, a television. (Ex.1001-'715 patent, 1:21-44.) The basic role and functions of an STB in the context of satellite signal distribution is taught in both AAPA Williams and in Green, the latter filed over a decade before the '715 patent's priority date. (*See, e.g.*, Ex.1005-Green, 11:28-53 (describing “conventional off-the-shelf satellite receiver 136” processing received transponder signals to output “NTSC television signals”); Ex.1008-AAPA Williams, 14:4-18:29.) And an STB compatible to receive the signal distributed by Carnero would meet the understanding of a “new” STB in the '715 patent in that the STB would need to receive a signal spanning one or more transponder channels over a broad frequency spectrum, where transponder channels may be output in a different order (*i.e.*, as a composite signal) than the order of transponder channels in the LNB output. Thus, Carnero's system teaches signal distribution to “new” STBs.

222. Carnero acknowledges the “legacy” approach but advocates for the use of its invention to obtain the advantages of its signal selection discussed in Ground 1. (Carnero, 2:30-43.) But where a POSITA had a desire (or a need) to distribute satellite signals in a community that included users with legacy equipment, it would have been obvious to a POSITA to provide legacy distribution in parallel in order to avoid obsolescence. Based on the '715 patent specification, a “legacy” STB would

be, in contrast to a “new” STB, one which is compatible to select only entire broadband LNB outputs, as distinct from individual transponder channels, and knows where to locate specific transponder channels when they are received by the “legacy” STB in the order and at frequencies that result from the LNB down-conversion. (*See, e.g.*, Ex.1001-’715 patent, 9:22-32, 1:40-62.) To be sure, such a “legacy” STB would be compatible with Carnero insofar as Carnero provides “an IF signal” that the STB can use to “tune to a single transponder channel.” (*See* Ex.1001-’715 patent, 9:26-28.) But to the extent Patent Owner argues that the “legacy” STB must also be able to (1) request broadband LNB outputs of the ODU in Carnero; and (2) correctly identify a desired transponder channel for tuning, then it would have been obvious to modify Carnero to use legacy structures (as discussed in greater detail below) so that a legacy “STB” would continue to work as intended. This could be done with limited cost or complexity: indeed, by adding Carnero’s distribution in parallel to existing infrastructure, both “new” and “legacy” devices could be served with only basic signal splitting components. Accordingly, to the extent not expressly disclosed, this limitation is obvious in view of Carnero and the general knowledge of a POSITA.

13[a] “a signal selector that receives broadband LNB signals comprising a plurality of transponder channels, the signal selector is responsive to transponder select information transmitted from at least one STB, and selects at least one transponder channel from the

broadband LNB signal based on the transponder select information and outputs a composite signal comprising selected transponder channels:”

223. This limitation is similar to limitations 9[b] and 9[d]. Thus, Section VII.A.2, limitation 9[b] demonstrates that Carnero has a *signal selector* (signal processing unit 400) *that receives broadband LNB signals comprising a plurality of transponder channels and selects at least one transponder channel from the broadband LNB signal* (by a channel-specific converter 4). And Section VII.A.2, limitation 9[d] demonstrates that Carnero *outputs a composite signal comprising selected transponder channels* (e.g., at the first mixer 9).

224. It would have been obvious to a POSITA that the signal processing unit 400 of Carnero performed *channel selection responsive to transponder select information transmitted from at least one STB*. Carnero teaches that its signal selection is performed by a microcontroller that receives information to effectuate channel selection from an input device, including via remote control. (Ex.1004-Carnero, 3:48-53 8:16-26.) STBs transmitting information used to select transponder channels was known in the art and used to make sure that STBs receive transponder channels bearing desired programs. (See, e.g., Ex. 1003-Fisk 4:1-11, 22:22-27; Ex.1026-Williams ’873, 6:35-42, 10:53-11:5; “Eutelsat Installers Guide,” 19, 27, Fig. 11 (Ex.1017-’576 Reexam, 281-82, 284-85).) Given that Carnero does not teach any particular kind of STB that is required in its system, a POSITA would have been

motivated to utilize STBs like those taught in Fisk, Williams '873, or the “Eutelsat Installers Guide,” which permit transponder selection by the user of an STB. Accordingly, it would have been obvious that the signal processing unit 400 of Carnero performed channel selection based on *transponder select information*. (*Id.*)

13[b] - “a multiport switch that receives a plurality of broadband LNB signals, selects a broadband LNB signal responsive to an LNB select signal from an STB, and outputs the selected LNB signal.”

225. This limitation is comprised entirely of admitted prior art that the '715 patent describes as conventional. As shown in Figure 1 of the '715 patent, a *multiport switch 160 receives a plurality of broadband LNB signals*.

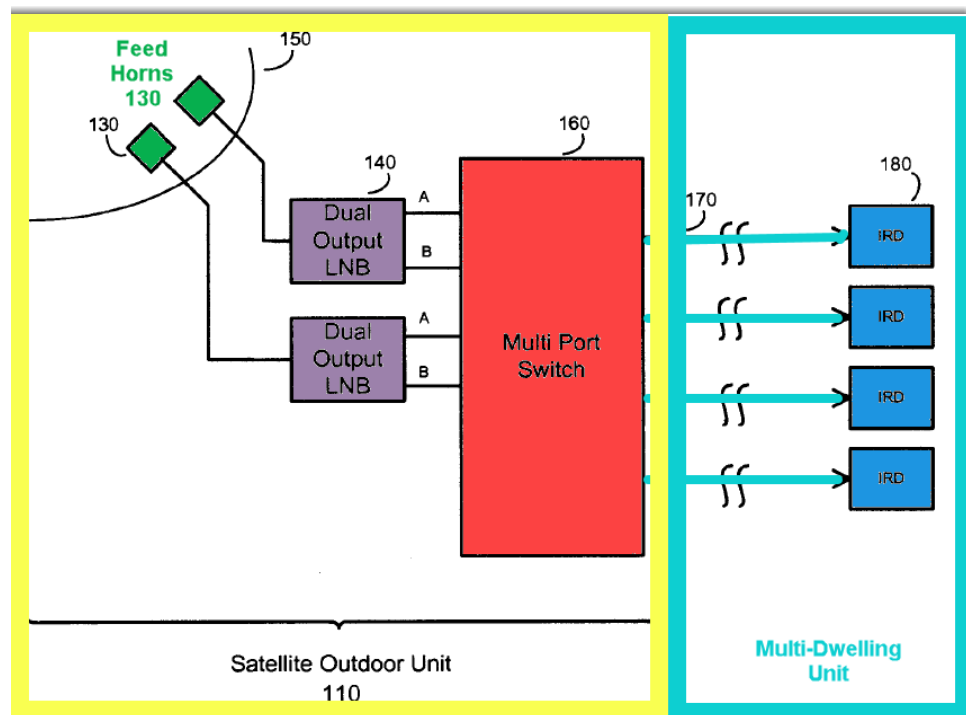


Figure 1 — '715 Patent's Video Signal Distribution System (AAPA).

226. As described in the '715 patent summary of Figure 1 and the

“conventional” system, the *multiport switch ... selects a broadband LNB signal responsive to an LNB select signal from an STB*. (Ex.1001-’715 patent, 1:21-2:2 (“The IRD 180 tunes one transponder channel [and] demodulates the IF signal from the LNB down to base band, ... [t]he received [LNB] polarization is selected by sending a voltage or other control signal to the LNB. ... the cross point switch allows any of the cables connected from the ODU to the IRDs to be switched to any of the LNBs.”) For the reasons set forth above in limitation 13[a], it would have been obvious to incorporate the legacy multiport switch into Carnero’s system to ensure compatibility for legacy STBs. Accordingly, claim 13 is obvious in view of Carnero and the general knowledge of a POSITA knowledge.

2. Dependent Claim 14

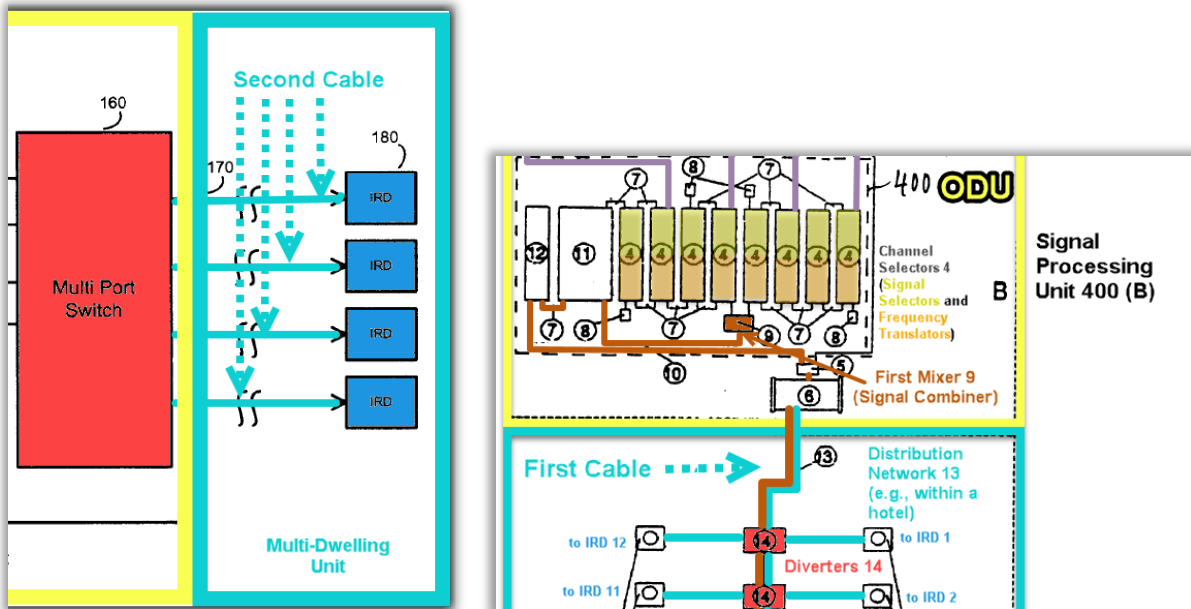
The signal distribution system of claim 13 wherein the composite signal is output to a first cable, the selected LNB signal is output to a second cable; new STBs connect to the first cable to receive the composite signal; and legacy STBs connect to the second cable to receive the selected LNB signal.

227. This claim is obvious in view of Carnero and the general knowledge of a POSITA. This claim (as with the other claims in the range of claims 13-19) describes a situation where Carnero is implemented in parallel to the legacy approach described in Figure 1, which, as described above in limitation 13[pre], would permit existing STBs to continue operation at minimal cost or complexity.

228. The “*legacy*” STBs continue to connect via a cable to the legacy multi-

port switch 180 and receive the selected LNB signal output by the switch to its respective cable. Thus, in Figure 1, each of the cables 170 is a *second cable* to which a *selected LNB signal is output* and for which *legacy STBs connect ... to receive the selected LNB signal*. Alternatively, each of the legacy STBs could connect to a single of the cables in Figure 1 with the inclusion of a conventional splitter, although each would receive the same selected LNB signal, and could not simultaneously receive a different LNB signal.

229. In parallel, the STBs capable of processing the composite signal of Carnero (the “*new*” *STBs*) receive the output of the signal processing unit 400 via “a single distribution cable 13, on which all channels, that are FM modulated, are transmitted.” (Ex.1004-Carnero, 7:20-22, Fig. 9.) Thus, the single distribution cable is the *first cable* to which *the composite signal is output* and for which *new STBs connect ... to receive the composite signal*. The below excerpts of Figure 1 (’715 patent) and Figure 10 (Carnero) show first and second cables in the context of the obvious parallel implementation.



Figures 1 ('715 Patent, left) and 3 (Carnero, right) — A Parallel Implementation of Carnero (Composite Signal Through Single Distribution Cable 13 to New STBs) and AAPA (Conventional Broadband LNB Outputs from a Switch to on Each Second Cable to Legacy STBs).

230. Accordingly, this claim is obvious in view of Carnero.

3. Dependent Claim 15

The signal distribution system of claim 13, wherein the composite signal and the selected LNB signal are output to a single cable and the composite signal is transmitted in regions of the spectrum unoccupied by the selected LNB signals.

231. This claim is obvious in view of Carnero and the general knowledge of a POSITA. While Carnero and a legacy signal distribution system could be implemented in parallel to collectively service “new” and “legacy” STBs, respectively, it would have been obvious to alternately implement them together to reduce the number of cables used to distribute signals. Carnero teaches the advantage

of distributing television signals over a single cable (Ex.1004-Carnero, 3:19-21), and in one example depicted in Figure 10, teaches adding selected transponder channels from various LNB outputs to the output from a different LNB. Specifically, selected transponder channels, shown combined on line “n”, are added to a down-converted horizontal polarization from Satellite 3, shown on line “k”, to form a signal on a single distribution cable, shown on line “o”.

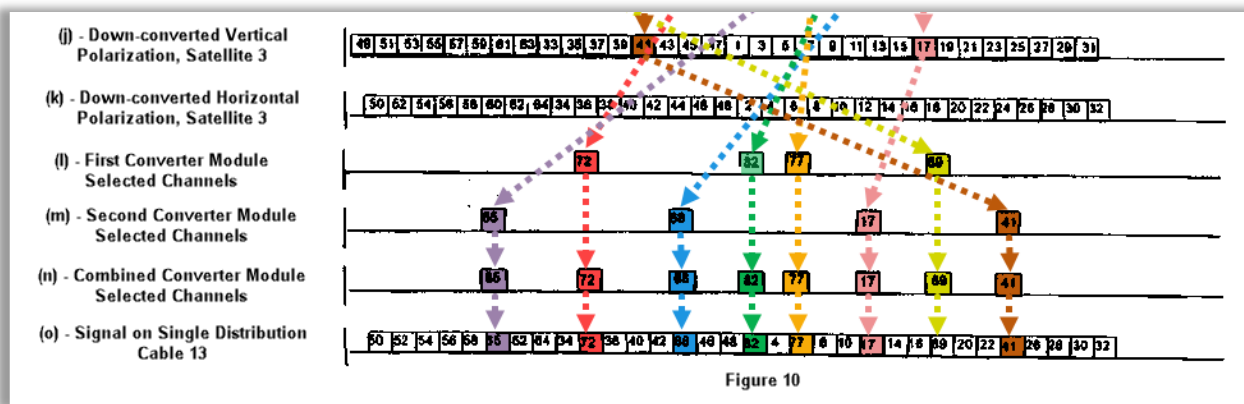


Figure 10 — Process to Create a Combined Signal for Distribution on a Single Distribution Cable 13.

232. In view of this disclosure, a POSITA would have been motivated to modify Carnero so that *the composite signal and the selected LNB signal are output to a single cable*, and would have found it obvious to do so similar to the example of Figure 10. A POSITA would have further been motivated to ensure that *the composite signal is transmitted in regions of the spectrum unoccupied by the selected LNB signals*, otherwise, transponder channels of the selected LNB signal may interfere with the composite signal and degrade the signals. Carnero’s Figure 10

shows selected transponder signals forming the *composite signal* (line “n”) in the same spectrum occupied by an *LNB signal*, because Carnero amplified the *composite signal* to override transponder channels in the *LNB signal*. However, a POSITA would not be motivated to do so when providing LNB signals to legacy STBs as it would impair the quality of the LNB signals, and in some cases, may replace transponder channels desired by legacy STBs as determined by users of legacy STBs. The obvious solution is to “stack” the bands akin to the “channel stacking” I discuss above in Section IV.D.2 (as is taught in AAPA Petruzzelli) to ensure the *selected LNB signal* and *composite signal* do not interfere with one another. Accordingly, claim 15 is obvious in view of Carnero and the general knowledge of a POSITA.

4. Dependent Claim 16

The signal distribution system of claim 15 wherein new STBs receive and decode the composite signal and legacy STBs receive and decode the LNB signals.

233. This claim is obvious in view of Carnero and the general knowledge of a POSITA. As the '715 patent recognizes, and consistent with a POSITA's general knowledge, STBs, also called integrated receiver decoders, decode received satellite television signals comprising one or more transponder channels. (Ex.1001-'715 patent, 1:21-55.) As such, a POSITA would have understood that for the STBs receiving the signal including the *composite signal* and *LNB signals* (claim 15),

“new STBs” would “receive and decode the composite signal” on the “single cable,” and “legacy STBs” would “receive and decode the LNB signals.” Accordingly, claim 16 is obvious in view of Carnero and the general knowledge of a POSITA.

5. Dependent Claim 17

The signal distribution system of claim 16 further comprising a controller that polls the STBs to determine the presence of new STBs, and if new STBs are present accept transponder select information from the new STBs and remap the selected transponder channels to regions of the spectrum unoccupied by the selected LNBs.

234. This claim is obvious in view of Carnero and the general knowledge of a POSITA. Carnero discloses an input unit 16, which has a control unit 162 connected to microprocessor 49 to facilitate transponder channel selection. (Ex.1004-Carnero, 3:48-53, 8:1-15.) A POSITA would have been motivated to ensure that the control unit 162 could both (1) ensure it was providing requested transponder channels to all STBs in the community antenna system; and (2) avoid providing the requested transponder channels at occupied frequencies (to the benefit of both the requesting “new” STBs and the “legacy” STBs receiving the selected LNBs). A *polling* operation (including by use of the wireless transmitter and receiver of the input unit 16 disclosed in Carnero at 8:23-25) was a known technique to determine the presence of devices in a network and could have been implemented by a POSITA with limited cost and complexity. And as the result of any *polling*, it would have been obvious to account for the result in subsequent signal selection of

transponder channels (including to avoid distributing selected transponder channels in occupied spectra), *i.e.*, to *accept transponder select information from the new STBs and remap the selected transponder channels to regions of the spectrum unoccupied by the selected LNBs*. Without remapping to ensure that selected transponder channels are located in unoccupied regions of the spectrum, those transponder channels may interfere with transponder channels on the selected LNBs and prevent both new and legacy STBs from providing the requested television programs. Accordingly, claim 17 is obvious in view of Carnero and the general knowledge of a POSITA.

6. Dependent Claim 18

The signal distribution system of claim 17 further comprising a controller for maintaining a channel map specifying the assigned frequency slots for transponder channels and for communicating the channel map to the STBs.

235. This claim is obvious in view of Carnero and the general knowledge of a POSITA. Carnero's input unit 16, which has a control unit 162, is a "controller for maintaining a channel map specifying the assigned frequency slots for transponder channels." The input unit 16 is connected to microprocessor 49 and provides "data of a pre-definable input and output frequency" for "input into the microprocessor 49" and used to control the signal selector. (Ex.1004-Carnero, 3:48-53, 8:1-15.) The input and output frequencies reflect *the assigned frequency slots for transponder*

channels and thus constitute a *channel map*.

236. It would have been obvious to a POSITA that the controller *communicat[es] the channel map to the STBs*. Because the frequency slots for the transponder channels are “assigned” and then “transmitted in regions of the spectrum unoccupied by the selected LNB signals” (as required by claim 15, from which this claim depends), an STB would require a mapping to know where to look for the transponder channel it requested by the transponder select information. A POSITA would have been motivated to transmit the channel map from the controller associated with Carnero’s signal selector and would have done so with limited cost and complexity, as the information could have been transmitted as part of the composite signal on the single cable. Finally, as discussed above in Section IV.E, maintaining look-up tables bearing information about where to locate television programming was known in the art, necessary to facilitate end-user selection of programs, and would not have been difficult to implement, store, and exchange. Accordingly, claim 15 is obvious in view of Carnero and the general knowledge of a POSITA.

7. Dependent Claim 19

The signal distribution system of claim 13 further comprising a controller that polls the STBs to determine the presence of new STBs, and if new STBs are present the controller accepts transponder select information from the new STBs and remaps the selected transponder

channels to regions of the spectrum unoccupied by broadband LNB signals.

237. This claim is identical to claim 17 except it depends from claim 13. It is therefore obvious in view of Carnero for the same reasons set forth above in claims 13 and 17.

VIII. SECONDARY CONSIDERATIONS OF NON-OBVIOUSNESS

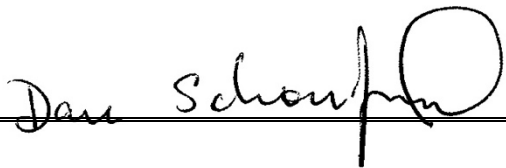
238. I am not presently aware of any secondary considerations of non-obviousness relevant to my analysis in this Declaration. To the extent Patent Owner identifies purported secondary considerations, I reserve the right to respond and supplement my analysis, if necessary.

IX. CONCLUSION

239. For the reasons set forth above, it is my opinion that all limitations of claims 1-19 of the '715 patent are disclosed in the prior art or were obvious in view of the prior art as discussed above.

I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: January 13, 2023
Dan Schonfeld, Ph.D.

By: _____

APPENDIX A

DAN SCHONFELD

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B. PROFESSIONAL BIOGRAPHY

Dr. Schonfeld received the B.S. degree in Electrical Engineering and Computer Science from the University of California, Berkeley, California, and the M.S. and Ph.D. degrees in Electrical and Computer Engineering from The Johns Hopkins University, Baltimore, Maryland, in 1986, 1988, and 1990, respectively.

In August 1990, he joined the Department of Electrical Engineering and Computer Science at the University of Illinois, Chicago, Illinois, where he is currently a Professor in the Departments of Electrical and Computer Engineering, Computer Science, and Biomedical Engineering. He has also served as Director of the University-Industry Engineering Research Center (UIERC), also known as the Manufacturing Research Center (MRC). He is also Co-Director of the Multimedia Communications Laboratory (MCL) and member of the Signal and Image Research Laboratory (SIRL).

Dr. Schonfeld has been elevated to the rank of Fellow of the IEEE “for contributions to image and video analysis.” He was also elevated to the rank of Fellow of the SPIE “for specific achievements in morphological image processing and video analysis.” Dr. Schonfeld has been elected University Scholar of the University of Illinois and received the Graduate Mentoring Award of the University of Illinois at Chicago.

Dr. Schonfeld has authored over 250 technical papers in various journals and conferences. He was co-author (with Carlo Giuliatti and Rashid Ansari) of a paper that won the Best Paper Award at the ACM Multimedia Workshop on Advanced Video Streaming Techniques for Peer-to-Peer Networks and Social Networking 2010. He was also co-author (with Junlan Yang) of a paper that won the Best Student Paper Award in the IEEE International Conference on Image Processing 2007. He was also co-author (with Wei Qu) of a paper that won the Best Student Paper Award in the IEEE International Conference on Image Processing 2006. He was also co-author (with Nidhal Bouaynaya) of a paper that won the Best Student Paper Award in Visual Communication and Image Processing 2006.

Dr. Schonfeld has served as Editor-in-Chief of the IEEE Transactions on Circuits and Systems for Video Technology. He has also served as Deputy Editor-in-Chief of the IEEE Transactions on Circuits and Systems for Video Technology as well as Area Editor for Special Issues of the IEEE Signal Processing Magazine. He has also served as Associate Editor of the IEEE Transactions on Image Processing (on image and video storage, retrieval and analysis), Associate Editor of the IEEE Transactions on Circuits and Systems for Video Technology (on video analysis), Associate Editor of the IEEE Transactions on Signal Processing (on multidimensional signal processing and multimedia signal processing), and Associate Editor of the IEEE Transactions on Image Processing (on nonlinear filtering). He has also served on the editorial board of various journal publications. He has also served as guest editor for numerous special issues in various journal publications.

Dr. Schonfeld is currently serving on the Conference Board of the IEEE Signal Processing Society. He has also served as Technical Program Chair of the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP) 2018. He was also organizer of the Thematic Symposium on Multimedia Search and Retrieval at the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP) 2009. He has also served as General Chair of the International Conference on Internet Multimedia Computing and Service (ICIMCS) 2018, the IEEE Conference on Visual Communication and Image Processing (VCIP) 2016, the Workshop on Big Data in 3D Computer Vision 2013, and the IEEE International Conference on Multimedia and Expo (ICME) 2012. He has also served as Program Chair of the IEEE Conference on Visual Communication and Image Processing (VCIP) 2015. He has also served as Technical Program Chair of the IEEE Workshop on Genomic Signal Processing and Statistics (GENSIPS) 2009 as well as Chair of the Workshop on Video Mining 2008. He has also served as Chair of the SPIE Conference on Visual Communication and Image Processing (VCIP) 2007. He was a member of the organizing committees of the IEEE International Conference on Image Processing (ICIP) 1998, 2012, 2018, and 2020, IEEE/SPIE

International Conference on Visual Communications and Image Processing (VCIP) 2007, 2010, 2015, 2016, and 2017, and IEEE Workshop on Nonlinear Signal and Image Processing (NSIP) 1997.

Dr. Schonfeld was keynote speaker at the N-Brain Alliance Launch & Product Release Conference 2018 as well as Think for Education Conference (TEC) AI+Education 2018. He was also keynote speaker at the International Conference on Wireless Communications and Signal Processing (WCSP) 2016. He was also keynote speaker at the International Conference on Intelligent Control and Information Processing (ICICIP) 2013 and International Conference on Brain Inspired Cognitive Systems (BICS) 2013. He was also plenary speaker at the IEEE/IET International Conference on Audio, Language and Image Processing (ICALIP), Shanghai, China, in 2010. He was also plenary speaker at the IEEE International Conference on Advanced Video and Signal Based Surveillance (AVSS), Genoa, Italy, in 2009. He was also plenary speaker at the INPT/ASME International Conference on Communications, Signals, and Systems (ICCSS), Rabat Morocco, in 1995 and 2001.

Dr. Schonfeld has served as Representative of Regions 1-6 (North America) in the Chapters Committee of the IEEE Signal Processing Society. He has also served as Chairman of the Chicago Chapter of the IEEE Signal Processing Society. He is currently serving on the IEEE Multimedia Communications Technical Committee and IEEE Visual Signal Processing and Communications (VSPC) Technical Committee. He has also served on the IEEE Image, Video, and Multidimensional Signal Processing (IVMSP) Technical Committee, formerly the IEEE Image and Multidimensional Signal Processing (IMDSP) Technical Committee. He also served on the American National Standards Institute (ANSI) / Underwriters Laboratory (UL) Standards Technical Panel ("STP") on Multimedia Systems.

His current research interests are in signal processing, image and video analysis, video retrieval and communications, multimedia systems, computer vision, medical imaging, and genomic signal processing.

C. RESEARCH INTERESTS

Signal Processing, Image and Video Analysis, Video Retrieval and Communications, Multimedia Systems, Computer Vision, Machine Learning, Medical Imaging, and Genomic Signal Processing.

D. HONORS AND AWARDS

IAM Patent 1000 2015: The World's Leading Patent Practitioners

The Worlds Leading Patent Litigation Expert Witnesses

Fourth Edition

2015

Graduate Mentoring Award

University of Illinois at Chicago

2014

University Scholar

University of Illinois

2010

Fellow

Asia-Pacific Artificial Intelligence Association (AAIA)

2021

Fellow

International Society for Optics and Photonics (SPIE)

“For Specific Achievements in Morphological Image Processing and Video Analysis”

2011

Fellow

Institute of Electrical and Electronics Engineers (IEEE)

“For Contributions to Image and Video Analysis”

2010

Senior Member

Institute of Electrical and Electronics Engineers (IEEE)

2005

Best Paper Award

C. Giulietti, D. Schonfeld, and R. Ansari

“A Novel Cache Optimization Algorithm and Protocol
for Video Streaming in Pure Peer-to-Peer Networks”

ACM Multimedia Workshop on Advanced Video Streaming Techniques
for Peer-to-Peer Networks and Social Networking

2010

Best Student Paper Award

J. Yang, D. Schonfeld and M. Mohamed

“Robust Focused Image Estimation from Multiple Images in Video Sequences”

IEEE International Conference on Image Processing

2007

Best Student Paper Award

W. Qu and D. Schonfeld

“Robust Kernel-Based Tracking Using Optimal Control”

IEEE International Conference on Image Processing

2006

Best Student Paper Award

N. Bouaynaya and D. Schonfeld

“Spatially-variant morphological image processing: Theory and applications”

SPIE Conference on Visual Communications and Image Processing

2006

Advising Award

College of Engineering

University of Illinois at Chicago

2013

Outstanding Associate Editor Award – IEEE Circuits and Systems Society

IEEE Circuits and Systems Society

IEEE Transactions on Circuits and Systems for Video Technology

2009

Most Active Chapter Award – IEEE Signal Processing Chicago Chapter Chair
IEEE – Region 4
2008

Service Award – IEEE Signal Processing Chicago Chapter Chair
IEEE – Chicago Section
2007

Certificate of Appreciation – IEEE Signal Processing Society
Chair, IEEE Signal Processing Chapter
Chicago Section
2006-2012

Certificate of Appreciation – IEEE Circuits and Systems Society
IEEE Circuits and Systems Society
Prize Paper Award Subcommittee
2010

Certificate of Appreciation – IEEE Circuits and Systems Society
IEEE Circuits and Systems Society
Deputy Editor-in-Chief of the IEEE Transactions on Circuits and Systems for Video Technology
2008 – 2010

Certificate of Appreciation – IEEE Circuits and Systems Society
IEEE Circuits and Systems Society
Associate Editor of the IEEE Transactions on Circuits and Systems for Video Technology
2008 – 2010

Certificate of Appreciation – IEEE Signal Processing Chicago Chapter Chair
IEEE – Chicago Section
2006

Top Reviewer Recognition Certificate
IEEE International Conference on Image Processing (ICIP)
Abu Dhabi, United Arab Emirates
2020

2018 Albert Nelson Marquis Lifetime Achievement Award
Marquis Who's Who

Who's Who in the World
2021 Edition

Who's Who in the World
2020 Edition

Who's Who in the World
2019 Edition

Who's Who in the World

2018 Edition

Worldwide Who's Who

2014 Edition

Who's Who in America (WWA)

2019 Edition

Who's Who in America (WWA)

2012 Edition

Who's Who in America (WWA)

2011 Edition

Who's Who in America (WWA)

2010 Edition

Who's Who in Engineering Education (WWE)

2002 Edition

University Fellowship

The Johns Hopkins University

1986—1990

E. IN THE NEWS

IEEE Fellow Dan Schonfeld: Helping Catch Thieves & Read Fuzzy Faxes

e-Scanfax: IEEE Chicago Section Newsletter

January 2010

<http://www.ieeechicago.org/LinkClick.aspx?fileticket=Py81tdr4GTM%3D&tabid=390&mid=884>

IEEE-Chicago Fellows Provide Words of Wisdom to New IEEE Members

e-Scanfax: IEEE Chicago Section Newsletter

May 2010

http://www.ieeechicago.org/LinkClick.aspx?fileticket=2GIDPZnZQ_M%3D&tabid=390&mid=884

What You See, What You Get

University Scholar Dan Schonfeld

Paul Francuch

UIC News

November 10, 2010

<http://www.uic.edu/htbin/cgiwrap/bin/uicnews/articledetail.cgi?id=14769>

Genomic Signal Processing May Yield Clues to Cancer Treatment

Paul Francuch

UIC News Release

November 17, 2010

[http://tiger.uic.edu/htbin/cgiwrap/bin/newsbureau/cgi-bin/index.cgi?
from=Releases&to=Release&id=3073&start=1232172000&end=1329285600&topic=2&dept=64](http://tiger.uic.edu/htbin/cgiwrap/bin/newsbureau/cgi-bin/index.cgi?from=Releases&to=Release&id=3073&start=1232172000&end=1329285600&topic=2&dept=64)

New Camera Focuses Photos After They Are Taken

Morgen Peck

InnovationNewsDaily Contributor

November 4, 2011

<http://www.innovationnewsdaily.com/camera-focuses-photos-after-2358/>

F. EDUCATION

Ph.D. July 1990

The Johns Hopkins University

Department of Electrical & Computer Engineering

Concentration: Nonlinear Signal Processing / Image Analysis

Thesis Title: "Optimal Morphological Representation and Restoration of Binary Images: Theory and Applications"

First Reader: Prof. John Goutsias; Second Reader: Prof. Victor Solo

M.S. May 1988

The Johns Hopkins University

Department of Electrical & Computer Engineering

Concentration: Speech Processing / Biomedical Signal Processing

Advisor: Prof. Moise H. Goldstein

B.S. May 1986

University of California at Berkeley

Department of Electrical Engineering & Computer Science

Concentration: Computer Engineering / Systems Engineering

Advisor: Prof. Michael J. Sabin

G. WORK EXPERIENCE

Director

Manufacturing Research Center (MRC)

University-Industry Engineering Research Center (UIERC)

College of Engineering

University of Illinois at Chicago

Chicago, Illinois

2008—2011

Professor with Tenure

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2007—Present

Professor (Courtesy Appointment)

Department of Computer Science

University of Illinois at Chicago

Chicago, Illinois
2007— 2025

Professor

Department of Biomedical Engineering
University of Illinois at Chicago
Chicago, Illinois
2021— Present

Professor

Department of Bioengineering
University of Illinois at Chicago
Chicago, Illinois
2007— 2021

Associate Professor with Tenure

Department of Electrical & Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2001—2007

Associate Professor (Courtesy Appointment)

Department of Computer Science
University of Illinois at Chicago
Chicago, Illinois
2001—2007

Associate Professor

Department of Bioengineering
University of Illinois at Chicago
Chicago, Illinois
1998—2007

Associate Professor with Tenure

Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
Chicago, Illinois
1996—2001

Co-Director

Multimedia Communications Laboratory (MCL)
Department of Electrical & Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
1997—Present

Assistant Professor

Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
Chicago, Illinois
1990—1996

Member

Signal and Image Research Laboratory (SIRL)
Department of Electrical & Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
1990—2002

Instructor

Department of Electrical and Computer Engineering
The Johns Hopkins University
Baltimore, Maryland
1987—1990

Teaching Assistant

Department of Electrical and Computer Engineering
The Johns Hopkins University
Baltimore, Maryland
1986—1990

Software Engineer

Computer Aided Design
Teledyne Systems
Northridge, California
Summer 1984—85—86

H. CONSULTING EXPERIENCE

Consultant & Expert Witness

2001—Present

Consulting Activities:

Deposition and Trial Testimony
Patent Litigation
Copyright Litigation
Trade Secret Litigation
International Trade Litigation
Customs Litigation
Contract Litigation

Areas of Expertise:

Multimedia Systems
Multimedia Retrieval, Storage, and Communication Systems
Image and Video Processing
Signal Processing and Communications

Examples of Previous Litigation Experience:

Cable Systems
Camera Systems
Graphics Processors

Image Compression Systems
Image Processing Systems
Internet Advertising
Internet Streaming
Jukebox Systems
Medical Imaging
Signal Processing
Smartphones and Tablets
Television Systems
Video-on Demand (VoD) Systems
Video Compression Systems
Video Storage Systems
Video Streaming Systems
Wireless Systems

Companies:

Served as a consultant and expert witness for various companies including ARRIS, Blackberry, Broadcom, Cablevision, Cisco, Dell, Google, Hewlett-Packard, Huawei, Motorola, NVIDIA, Panasonic, Qualcomm, Samsung, Time Warner, Zeiss.

Consultant & President

Schonfeld Consulting Corporation
Multimedia Systems
Northbrook, Illinois
2017—Present

Consultant & President

Multimedia Systems Corporation
Multimedia Systems
Glenview, Illinois
2002—2005

Consultant

Chicago Merchantile Exchange
Multimedia Communication Networks
Chicago, Illinois
1998

Consultant

PrairieComm Corp.
Multimedia Wireless Networks
Arlington Heights, Illinois
1997

I. VISITING POSITIONS

Distinguished Visiting Scholar

Advanced Analytics Institute (AAI)
University of Technology

Sydney, Australia
2012

Visiting Professor

Department of Information Engineering and Computer Science - DISI
University of Trento
Trento, Italy
May 2010

Visiting Professor

School of Computer Engineering
Nanyang Technological University
Singapore
July 2009

Visiting Associate Professor

Department of Electrical Engineering—Systems
Tel-Aviv University
Tel-Aviv, Israel
December 1996—January 1997

J. INTERDISCIPLINARY PROGRAMS

Collaborative Neuroimaging Environment for Connectomics (CoNECT)

University of Illinois at Chicago
2013—Present

Clinical and Translational Science (CCTS)

Biomedical Informatics Core Consult Group
University of Illinois at Chicago
2009—Present

Graduate Program in Neuroscience

University of Illinois at Chicago
2001—Present

Bioinformatics Program

Department of Bioengineering
University of Illinois at Chicago
2000—Present

K. PROFESSIONAL ACTIVITIES

K.1. Editorships

Editor-in-Chief (EIC)

IEEE Transactions on Circuits and Systems for Video Technology
2014—2017

Deputy Editor-in-Chief (DEIC)

IEEE Transactions on Circuits and Systems for Video Technology
2010—2013

Area Editor, Special Sections

Special Issues
IEEE Signal Processing Magazine
2009—2011

Editor

Video Search and Mining
Studies in Computational Intelligence Series
Springer-Verlag
2009

Associate Editor

IEEE Transactions on Image Processing
Image and Video Storage, Retrieval and Analysis
2007—2009

Associate Editor

IEEE Transactions on Circuits and Systems for Video Technology
Video Analysis
2006—2009

Associate Editor

IEEE Transactions on Signal Processing
Multidimensional Signal Processing &
Multimedia Signal Processing
1999—2000

Associate Editor

IEEE Transactions on Image Processing
Filtering and Enhancement
1994—1996

Guest Editor

IEEE Journal of Special Topics in Signal Processing
Special Issue on Mathematical Morphology
and Its Applications to Image and Signal Processing
2011—2012

Guest Editor

IEEE Transactions on Image Processing
Special Issue on Distributed Camera Networks:
Sensing, Processing, Communication and Computing
2010—2011

Guest Editor

EURASIP Journal on Image and Video Processing

Special Issue on Advanced Video-Based Surveillance
2010—2011

Lead Guest Editor

IEEE Journal of Special Topics in Signal Processing
Special Issue on Recent Advances in Video Processing for Consumer Displays
2009—2011

Guest Editor

IEEE Transactions on Circuits and Systems for Video Technology
Special Issue on Event Analysis in Videos
2008

Lead Guest Editor

IEEE Journal of Special Topics in Signal Processing
Special Issue on Genomic and Proteomic Signal Processing
2007—2008

Guest Editor

Journal of Advances in Multimedia
Special Issue on Plenoptic Signal and Image Processing
2007—2008

Advisory Board

Bentham Books
Bentham Science
2021—Present

Editorial Board

Sensors
MDPI
2021—Present

Editorial Board

Recent Advances in Computer Science and Communications
Bentham Science Publishers, Ltd.
2012—Present

Editorial Board

Journal of Electrical and Computer Engineering
Hindawi Publishing Corporation
2009—2019

Editorial Board

EURASIP Journal of Image and Video Processing
2009—2013

Editorial Board

IEEE Signal Processing Magazine
2008—2011

Editorial Board

Research Letters in Signal Processing
Hindawi Publishing Corporation
2007—2009

Editorial Board

Recent Patents on Computer Science
Bentham Science Publishers, Ltd.
2007—2019

Editorial Board

Recent Patents on Electrical Engineering
Bentham Science Publishers, Ltd.
2007—2012

Contributor

Science and Technology: SPIE Newsroom
Electronic Imaging and Signal Processing
2005—2008

K.2. Committees

Moving Picture, Audio and Data Coding by Artificial Intelligence (MPAI)
2020

MPEG Future
2020–Present

Ad-Hoc Committee of the Conferences Board on Flagship Conferences Future Strategy
IEEE Signal Processing Society
2020-2021

Ad-Hoc Committee on Multi-Scale Models at SPS Flagship Conferences
IEEE Signal Processing Society
2019-2020

IEEE Signal Processing (SPS) Liaison
IEEE Signal Processing Society
2019-2021

Conference Board
IEEE Signal Processing Society
2019-2020

Award Committee
Association for Computing Machinery (ACM)
ACM Multimedia
2020

Best Paper Award Selection Committee

CSV T Best Paper Award
IEEE Circuits and Systems Society
2020—2021

Best Paper Award Selection Committee

CSV T Best Paper Award
IEEE Circuits and Systems Society
2019—2020

Best Paper Award Selection Committee

CSV T Best Paper Award
IEEE Circuits and Systems Society
2013

Steering Committee

International Association for Pattern Recognition (IAPR)
Discrete Geometry and Mathematical Morphology (DGMM)
2022—Present

Travel Grant Selection Committee

IEEE Signal Processing Society
IEEE International Conference on Image Processing
2011

Steering Committee

International Society of Mathematical Morphology (ISMM)
International Symposium on Mathematical Morphology (ISMM)
2011—Present

Advisory Committee

IEEE Circuits and Systems Society
Visual Signal Processing and Communication (VSPC) Technical Committee
IEEE Conference on Visual Communications and Image Processing (VCIP)
2010—Present

Steering Committee

SPIE and IEEE Circuits and Systems Society
Conference on Visual Communications and Image Processing
2008—2010

Scientific Advisory Board

World Congress of NeuroTalk
From Nervous Functions to Treatment
Singapore Expo, Singapore
2010

Chair

Nominations and Elections Subcommittee
Image, Video, and Multidimensional Signal Processing (IVMSP) Technical Committee
IEEE Signal Processing Society
2010—2011

Honorable Member

Visual Signal Processing and Communications (VSPC) Technical Committee
IEEE Circuits and Systems Society
2018— Present

Member

Visual Signal Processing and Communications (VSPC) Technical Committee
IEEE Circuits and Systems Society
2015— 2019

Associate Member

Image, Video, and Multidimensional Signal Processing (IVMSP) Technical Committee
IEEE Signal Processing Society
2014— Present

Member

IEEE Multimedia Communications Technical Committee (MMTC) Technical Committee
IEEE Communications Society
2009— Present

Member

Image, Video, and Multidimensional Signal Processing (IVMSP) Technical Committee
IEEE Signal Processing Society
2009— 2012

Member

Image and Multidimensional Signal Processing (IMDSP) Technical Committee
IEEE Signal Processing Society
2007—2008

Member

Signal and Image Processing in Medicine Technical Committee
IEEE Circuits and Systems Society
1990—1996

Member

P2P Communication and Networking Technical Subcommittee
Multimedia Communications Technical Committee
IEEE Communications Society
2006—Present

Representative

Regions 1-6 (North America)
Chapters Committee
IEEE Signal Processing Society
2006—2012

Chairman

Chicago IEEE Signal Processing Chapter
2006—2012

Member

American National Standards Institute/Underwriters Laboratory (ANSI/UL)
Standards Technical Panels (STP)

STP 1863: Communications-Circuit Accessories

UL 1863: Standard for Communications-Circuit Accessories

STP 6065: Audio, Video And Similar Electronic Apparatus - Safety Requirements

UL 150: Standard for Antenna Rotators

UL 452: Standard for Antenna – Discharge Units

UL 469: Standard for Musical Instruments and Accessories

UL 813: Standard for Commercial Audio Equipment

UL 1412: Standard for Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances

UL 1413: Standard for High-Voltage Components for Television-Type Appliances

UL 1416: Standard for Overcurrent and Overtemperature Protectors for Radio- and Television-Type Appliances

UL 1417: Standard for Special Fuses for Radio- and Television-Type Appliances

UL 1492: Audio/Video Products and Accessories

UL 1676: Standard for Conductive-Path and Discharge-Path Resistors for Use in Radio-, Video-, or Television-Type Appliances

UL 6500: Standard for Audio/Video and Musical Instrument Apparatus for Household, Commercial, and Similar General Use

UL 60065: Standard for Audio, Video and Similar Electronic Apparatus – Safety Requirements

STP 62368: Audio/Video, Information Technology, And Communication Technology Equipment

UL 62368: Audio/video, Information and Communication Technology Equipment

STP 9990: Information and Communication Technology (ICT) Cables

UL 9990: Standard for Safety for Information and Communication Technology (ICT) Power Cables

2002—Present

K.3. Review Panels**Member**

Expert Panel
Faculty of Computing and Electrical Engineering
Tampere University of Technology (TUT)
Tampere, Finland
2011

Member

Paper Award Committee
IEEE International Conference on Advanced Video and Signal-Based Surveillance (AVSS)
Genoa, Italy
2009

Member

Technical Jury
NTT DoCoMo USA Labs Most Innovative Paper Awards

IEEE International Conference on Image Processing
San Diego, California
2008

Member

Technical Jury
NTT DoCoMo USA Labs Most Innovative Paper Awards
IEEE International Conference on Image Processing
San Antonio, Texas
2007

Member

Technical Jury
NTT DoCoMo USA Labs Most Innovative Paper Awards
IEEE International Conference on Image Processing
Atlanta, Georgia
2006

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Computing and Communication Foundations (CCF)
Image and Multi-Dimensional Signal Processing (IMDSP)
2015

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Computing and Communication Foundations (CCF)
Communications and Information Foundations (CIF)
2012

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Computing and Communication Foundations (CCF)
Communications and Information Foundations (CIF)
2011

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Information & Intelligent Systems (IIS)
Databases and Data Mining (DB/DM)
2007

Member

NSF Review Panel
Small Business Innovation Research (SBIR) Program
Robotics II
Phase II

2007

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Information & Intelligent Systems (IIS)
Information Management (IM)
2006

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Information & Intelligent Systems (IIS)
Information & Knowledge Management (IKM)
2005

Member

NSF Review Panel
Small Business Innovation Research (SBIR) Program
Robotics II
Phase I
2005

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Advanced Networking Infrastructure and Research (ANIR)
Information Technology Research (ITR)
Networking Research
Small Grants
2002

Member

NSF Review Panel
Small Business Innovation Research (SBIR) Program
Diagnostic Systems and Signal Processing
Phase I
2002

Member

NSF Review Panel
Computer & Information Science & Engineering (CISE)
Information Technology Research (ITR)
Biology & Information Technology
Computational Biology / Biocomputation
Medium Grants
2003

K.4. Conference Chair

General Chair

International Conference on Internet Multimedia Computing and Service (ICIMCS)
Nanjing, China
2018

Technical Program Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)
Calgary, Canada
2018

General Co-Chair

IEEE Conference on Visual Communications and Image Processing (VCIP)
Chengdu, China
2016

Program Co-Chair

IEEE Conference on Visual Communications and Image Processing (VCIP)
Singapore
2015

General Co-Chair

Workshop on Big Data in 3D Computer Vision
Held in conjunction with the IEEE International Conference on Computer Vision (ICCV)
Melbourne, Australia
2013

General Co-Chair

IEEE International Conference on Multimedia and Expo (ICME)
Melbourne, Australia
2012

Technical Program Chair

IEEE International Workshop on Genomic Signal Processing and Statistics (GENSIPS)
Minneapolis, Minnesota
2009

Chair

Workshop on Video Mining
IEEE International Conference on Data Mining
Held in conjunction with the IEEE International Conference on Data Mining (ICDM)
Pisa, Italy
2008

Chair

SPIE International Conference on Visual Communications and Image Processing (VCIP)
San Jose, California
2007

Multimedia Content Analysis Track Chair

IEEE International Conference on Multimedia and Expo
New York, New York

2009

Technical Program Committee / Area Chair

IEEE International Conference on Image Processing
San Diego, California
2008

Technical Program Committee / Area Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing
Las Vegas, Nevada
2008

Technical Program Committee / Area Chair

IEEE International Conference on Image Processing
San Antonio, Texas
2007

Associate Program Chair

ACM Multimedia
Juan Les Pins, France
2002

K.5. Organizing Committees

TBD

IEEE International Conference on Image Processing (ICIP)
Abu Dhabi, United Arab Emirates
2024

Special Sessions Co-Chair

IEEE International Conference on Image Processing (ICIP)
Abu Dhabi, United Arab Emirates
2020

Technical Program Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)
Calgary, Canada
2018

Plenary Co-Chair

IEEE Conference on Visual Communications and Image Processing (VCIP)
St. Petersburg, Florida
2017

General Co-Chair

IEEE Conference on Visual Communications and Image Processing (VCIP)
Chengdu, China
2016

Program Co-Chair

IEEE Conference on Visual Communications and Image Processing (VCIP)
Singapore
2015

General Co-Chair

Workshop on Big Data in 3D Computer Vision
Held in conjunction with the IEEE International Conference on Computer Vision (ICCV)
Melbourne, Australia
2013

General Co-Chair

IEEE International Conference on Multimedia and Expo (ICME)
Melbourne, Australia
2012

Plenary Chair

IEEE International Conference on Image Processing (ICIP)
Orlando, Florida
2012

Publications Chair

IEEE Conference on Advanced Video and Signal-based Surveillance (AVSS)
Beijing, China
2012

USA Liaison Chair

IEEE Conference on Advanced Video and Signal-based Surveillance (AVSS)
Klagenfurt, Austria
2011

Publicity Co-Chair

IEEE/SPIE International Conference on Visual Communications and Image Processing (VCIP)
Huang Shan, An Hui, China
2010

Technical Program Chair

IEEE International Workshop on Genomic Signal Processing and Statistics (GENSIPS)
Minneapolis, Minnesota
2009

Organizer

IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)
Thematic Symposium on Multimedia Search and Retrieval
Taipei, Taiwan
2009

Chair

Workshop on Video Mining
Held in conjunction with the IEEE International Conference on Data Mining (ICDM)
Pisa, Italy
2008

Chair

SPIE International Conference on Visual Communications and Image Processing (VCIP)
San Jose, California
2007

Technical Organizing Committee

IS&T/SPIE Annual Symposium on Electronic Imaging: Science and Technology
San Jose, California
2007

Publications Chair

IEEE International Conference on Image Processing
Chicago, Illinois
1998

Plenary Talks and Special Session Chair

IEEE/EURASIP Workshop on Nonlinear Signal and Image Processing
Mackinac Island, Michigan
1997

K.6. Technical Program Committees

Technical Program Committee

SPIE Conference on Video Surveillance and Transportation Imaging
San Francisco, California
2015

Technical Program Committee

SPIE Conference on Video Surveillance and Transportation Imaging
San Francisco, California
2014

Program Committee

IEEE International Conference on Automatic Face and Gesture Recognition (FG 2013)
Shanghai, China
2013

Technical Program Committee

SPIE Conference on Video Surveillance and Transportation Imaging
San Francisco, California
2013

Technical Program Committee

SPIE Conference on Visual Information Processing and Communication
San Francisco, California
2013

Technical Program Committee

ICST International Conference on

Wireless Mobile Communication and Healthcare (MobiHealth)
Paris, France
2012

Technical Program Committee

SPIE Conference on Visual Information Processing and Communication
San Francisco, California
2012

Program Committee

International Workshop on Video Event Categorization, Tagging and Retrieval (VECTaR)
Held in conjunction with the International Conference on Computer Vision
Barcelona, Spain
2011

Technical Program Committee

ICST International Conference on
Wireless Mobile Communication and Healthcare (MobiHealth)
Kos Island, Greece
2011

Technical Program Committee

SPIE Conference on Visual Information Processing and Communication
San Francisco, California
2011

Technical Program Committee

IEEE International Workshop on Genomic Signal Processing and Statistics
Cold Spring Harbor Laboratory, New York
2010

Technical Program Committee

IEEE International Conference on Multimedia and Expo (ICME)
Singapore
2010

Technical Program Committee

International Conference on Pattern Recognition (ICPR)
Track I: Computer Vision
Istanbul, Turkey
2010

Technical Program Committee

ACM/IEEE International Conference on Distributed Smart Cameras (ICDSC)
Atlanta, Georgia
2010

Technical Program Committee

IEEE Workshop on Multimedia Computing and Communications (MCC)
Held in conjunction with the International Conference on Computer Communications and Networks (ICCCN)

Zurich, Switzerland
2010

Program Committee

ACM International Conference on Bioinformatics and Computational Biology (ACM-BCB)
Niagara Falls, New York
2010

Technical Program Committee

IEEE/SPIE International Conference on Visual Communications and Image Processing
Huang Shan, An Hui, China
2010

Technical Program Committee

ICST International Conference on
Wireless Mobile Communication and Healthcare (MobiHealth)
Ayia Napa, Cyprus
2010

Technical Program Committee

SPIE International Conference on Visual Information Processing and Communications
San Jose, California
2010

Program Committee

International Workshop on Video Event Categorization, Tagging and Retrieval (VECTaR)
Held in conjunction with the Asian Conference on Computer Vision
Xi'an, China
2009

Program Committee

IEEE International Workshop on Video-Oriented Object and Event Classification (VOEC)
Held in conjunction with the International Conference on Computer Vision (ICCV)
Kyoto, Japan
2009

Program Committee / Reviewer

IEEE International Conference on Computer Vision
Kyoto, Japan
2009

Technical Program Committee

IEEE International Conference on Advanced Video and Signal-Based Surveillance (AVSS)
Genoa, Italy
2009

Technical Program Committee

IEEE Workshop on Multimedia Computing and Communications (MCC)
Held in conjunction with the International Conference on Computer Communications and Networks (ICCCN)
San Francisco, California

2009

Technical Program Committee

International Conference on Image and Graphics
Xi'an, China
2009

Program Committee

International Conference on Advances in Multimedia (MMEDIA)
Colmar, France
2009

Technical Program Committee

IEEE International Workshop on Computational Advances
in Multi-Sensor Adaptive Processing (CAMSAP)
Dominican Republic
2009

Technical Program Committee

SPIE International Conference on Visual Communications and Image Processing
San Jose, California
2009

Technical Program Committee / Reviewer

IEEE International Conference on Image Processing
San Diego, California
2008

Program Committee

IEEE Conference on Computer Vision and Pattern Recognition
Anchorage, Alaska
2008

Technical Program Committee / Reviewer

IEEE International Conference on Acoustics, Speech, and Signal Processing
Las Vegas, Nevada
2008

Technical Program Committee

IEEE International Workshop on Genomic Signal Processing and Statistics
Phoenix, Arizona
2008

Technical Program Committee

International Workshop on Multimedia Analysis & Processing (IMAP)
U.S. Virgin Islands
2008

Technical Program Committee

SPIE International Conference on Visual Communications and Image Processing
San Jose, California

2008

Program Committee

IEEE International Conference on Computer Vision
Rio de Janeiro, Brazil
2007

Technical Program Committee / Reviewer

IEEE International Conference on Image Processing
San Antonio, Texas
2007

Technical Program Committee

IEEE International Workshop on Genomic Signal Processing and Statistics
Tuusula, Finland
2007

Technical Program Committee

SPIE International Conference on Visual Communications and Image Processing
San Jose, California
2007

Technical Program Committee

IEEE International Conference on Image Processing
Atlanta, Georgia
2006

Technical Program Committee

IEEE International Workshop on Genomic Signal Processing and Statistics
College Station, Texas
2006

Technical Program Committee

SPIE International Conference on Visual Communications and Image Processing
San Jose, California
2006

Technical Program Committee / Reviewer

IEEE International Conference on Acoustics, Speech, and Signal Processing
Toulouse, France
2006

Technical Program Committee

IEEE International Conference on Image Processing
Genova, Italy
2005

Technical Program Committee / Reviewer

IEEE International Conference on Acoustics, Speech, and Signal Processing
Philadelphia, Pennsylvania
2005

Technical Program Committee
IEEE International Conference on Image Processing
Singapore
2004

Technical Program Committee
IEEE International Conference on Image Processing
Barcelona, Spain
2003

Technical Program Committee
IEEE International Conference on Image Processing
Rochester, New York
2002

Technical Program Committee
IEEE International Conference on Image Processing
Thessaloniki, Greece
2001

Technical Program Committee
IEEE International Conference on Image Processing
Vancouver, Canada
2000

Technical Program Committee
IEEE International Conference on Image Processing
Kobe, Japan
1999

Technical Program Committee
IEEE International Conference on Image Processing
Chicago, Illinois
1998

Technical Program Committee
International Symposium on Mathematical Morphology
Amsterdam, The Netherlands
1998

Technical Program Committee
SPIE International Conference on Visual Communications and Image Processing
San Jose, California
1998

Technical Program Committee
SPIE International Conference on Visual Communications and Image Processing
San Jose, California
1997

Technical Program Committee

SPIE International Conference on Visual Communications and Image Processing
Orlando, Florida
1996

Technical Program Committee

IEEE International Conference on Image Processing
Austin, Texas
1994

Technical Program Committee

IEEE International Symposium on Circuits and Systems
Chicago, Illinois
1993

K.7. Session Organizer

Chair

IEEE International Conference on Image Processing
Special Session on Face Recognition II
Orlando, Florida
2012

Organizer and Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing
Special Session on Video Search and Event Analysis
Taipei, Taiwan
2009

Organizer

Workshop on Global Multimedia Mobile Communications
University of Illinois at Chicago
Chicago, Illinois
2005

Organizer and Chair

IEEE International Conference on Image Processing
Special Session on Nonlinear Filtering
Austin, Texas
1994

Organizer and Chair

IEEE International Symposium on Circuits and Systems
Special Session on Medical Image and Signal Processing
Singapore
1991

Organizer and Chair

Conference on Information Sciences and Systems
Session on Nonlinear Image and Signal Processing I

Baltimore, Maryland
1991

K.8. Session Chair

Chair

IEEE International Conference on Image Processing
Session on Defect Removal
Taipei, Taiwan
2019

Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing
Session on Stereoscopic and 3D Processing
Brighton, United Kingdom
2019

Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing
Session on Image and Video Indexing and Retrieval
Prague, Czech Republic
2011

Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing
Session on Image/Video Semantic Understanding
Dallas, Texas
2010

Chair

IEEE International Conference on Advanced Video and Signal-Based Surveillance (AVSS)
Session on Trajectory Analysis and Learning
Genoa, Italy
2009

Chair

IEEE International Conference on Multimedia and Expo
Session on Multimedia Content Analysis and Synthesis IV
New York, New York
2009

Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing
Session on Stereoscopic and 3-D Processing
Taipei, Taiwan
2009

Chair

IEEE International Conference on Image Processing
Session on Enhancement and Denoising II

San Diego, California
2008

Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing
Session on Restoration and Enhancement
Las Vegas, Nevada
2008

Chair

SPIE Electronic Imaging Conference on Visual Communications and Image Processing
Session on Image Processing
San Jose, California
2008

Chair

IEEE International Conference on Image Processing
Session on Image and Video Restoration and Enhancement I
San Antonio, Texas
2007

Chair

IEEE International Conference on Image Processing
Session on Image and Video Filtering
Atlanta, Georgia
2006

Chair

IEEE International Conference on Multimedia and Expo
Session on Media Signal Processing
Toronto, Canada
2006

Chair

IEEE International Conference on Multimedia and Expo
Session on Multimedia Database Applications
Toronto, Canada
2006

Chair

IEEE International Conference on Multimedia and Expo
Session on Peer-to-Peer Multimedia Streaming
Toronto, Canada
2006

Chair

SPIE Electronic Imaging Conference on Visual Communications and Image Processing
Session on Computer Vision
San Jose, California
2006

Chair

IEEE International Conference on Acoustics, Speech, and Signal Processing
Session on Video Segmentation and Tracking
Philadelphia, Pennsylvania
2005

Chair

SPIE Electronic Imaging Conference on Image and Video Communications and Processing
Session on Selective Encryption for Image/Video
San Jose, California
2005

Chair

SPIE Electronic Imaging Conference on Image and Video Communications and Processing
Session on Object Tracking
San Jose, California
2005

Chair

INPT/ASME International Conference on Communications, Signals and Systems
Session on Signals and Data
Rabat, Morocco
2001

Chair

SPIE Conference on Multimedia Storage and Archiving Systems III
Session on Video Segmentation
Boston, Massachusetts
1998

Chair

IEEE International Conference on Image Processing
Session on Image Sequence Segmentation
Chicago, Illinois
1998

Chair

International Symposium on Mathematical Morphology
Session on Theory
Atlanta, Georgia
1996

Chair

INPT/ASME International Conference on Communications, Signals and Systems
Session on Signals and Data
Rabat, Morocco
1995

Chair

IEEE Workshop on Nonlinear Signal and Image Processing
Session on Mathematical Morphology and Fuzzy DSP

Neos Marmaras, Halkidiki, Greece
1995

Chair

IEEE International Conference on Image Processing
Session on Shape Representation and Image Modeling
Austin, Texas
1994

Chair

SPIE Conference on Visual Communications and Image Processing
Session on Mathematical Morphology
Boston, Massachusetts
1992

Chair

Conference on Information Sciences and Systems
Session on Signal Representation, Modeling, and Analysis
Baltimore, Maryland
1991

K.9. Panelist and Participant

Panelist

DOD Tri-Service Workshop on Stochastic Methods in Image Analysis
Session on Mathematical Morphology
U.S. Army Harry Diamond Laboratories
Adelphi, Maryland
1992

Participant

Institute for Mathematics and its Applications (IMA)
Workshop on Large Data Sets in Medical Informatics
Minneapolis, Minnesota
2011

Participant

NSF Workshop on Improving Domestic Student Participation
in Electrical and Computer Engineering Graduate Programs
University of Tennessee
Knoxville, Tennessee
2009

Participant

Workshop on Global Multimedia Mobile Communications
University of Illinois at Chicago
Chicago, Illinois
2005

Participant

Workshop on Extraction of Visual Information by Biological and Non-Biological Systems
University of Illinois at Chicago
Chicago, Illinois
2002

Participant

Workshop on Multimedia Information Systems
Capri, Italy
2001

Participant

NSF Advanced Networking Infrastructure Support
National Workshop on Developing Guidance
Research Competitiveness Program
Washington, D.C.
1999

Participant

Institute for Mathematics and its Applications (IMA)
Workshop on Applications and Theory of Random Sets
Minneapolis, Minnesota
1996

Panelist

VCIP 2015 Panel Discussion: What's Next in Visual Communications and Image Processing?
IEEE Conference on Visual Communications and Image Processing (VCIP)
Singapore
2015

K.10. Outreach Activities

Judge

Region 6 Science Fair Paper Session
Illinois Junior Academy of Science
Stevenson High School
Lincolnshire, Illinois
2022

Judge

State Science Fair Poster Session
Illinois Junior Academy of Science
Peoria Civic Center
Peoria, Illinois
2022

L. PUBLICATIONS

L.1. Thesis

- [1] D. Schonfeld, *Optimal Morphological Representation and Restoration of Binary Images: Theory and Applications*. Department of Electrical and Computer Engineering, The Johns Hopkins University, Baltimore, Maryland, 1990.

L.2. Books

- [1] C.-W. Chen, D. Schonfeld, and J. Liu, (Eds.), *Proceedings of the SPIE/IS&T International Conference on Visual Communications and Image Processing*. SPIE Press, 2007.
- [2] D. Schonfeld, C. Shan, D. Tao, and L. Wang, (Eds.), *Video Search and Mining*. Studies in Computational Intelligence Series, Springer-Verlag, 2010.

L.3. Book Chapters

- [1] M. Charif-Chefchaoui and D. Schonfeld, "Spatially-Variant Mathematical Morphology: Minimal Basis Representation," *Mathematical Morphology and Its Applications to Image and Signal Processing*. P. Maragos, R.W. Schafer, and M.K. Butt, (ed.), pp. 49-56, Kluwer Academic Publishers: Boston, Massachusetts, 1996.
- [2] D. Schonfeld, "Weighted Composite Order-Statistics Filters: Optimal Morphological Pattern Recognition," *Mathematical Morphology and Its Applications to Image and Signal Processing*. P. Maragos, R.W. Schafer, and M.K. Butt, (ed.), pp. 163-170, Kluwer Academic Publishers: Boston, Massachusetts, 1996.
- [3] D. Schonfeld, "Image and Video Communication Networks," (**Invited Chapter**). *Handbook of Image and Video Processing*. A. Bovik (ed.), Academic Press: San Diego, California, Chapter 9.3, pp. 717-732, 2000.
- [4] D. Lelescu and D. Schonfeld, "Video skimming and summarization based on principal component analysis," *Management of Multimedia on the Internet*, Lecture Notes in Computer Science, E.S. Al-Shaer and G. Pacifici (Eds.), Springer-Verlag, pp. 128-141, 2001.
- [5] F. Bashir, S. Khanvilkar, A. Khokhar, and D. Schonfeld, "Multimedia systems: Content based indexing and retrieval," (**Invited Chapter**). *Electrical Engineering Handbook*. W-K. Chen (ed.), Academic Press: San Diego, California, pp. 379-400, 2004.
- [6] S. Khanvilkar, F. Bashir, D. Schonfeld, and A. Khokhar, "Multimedia networks and communication," (**Invited Chapter**). *Electrical Engineering Handbook*. W-K. Chen (ed.), Academic Press: San Diego, California, pp. 401-425, 2004.
- [7] D. Schonfeld, "Video Communication Networks," (**Invited Chapter**). *Handbook of Image and Video Processing. Second Edition*. A. Bovik (ed.), Academic Press: San Diego, California, Chapter 9.3, pp. 1031-1064, 2005.
- [8] D. Schonfeld, "Video Communication Networks," (**Invited Chapter**). *The Essential Guide to Video Processing*. A. Bovik (ed.), Elsevier: Chennai, India, Chapter 16, pp. 473-526, 2009.

- [9] X. Ma, X. Chen, A. Khokhar, and D. Schonfeld, "Motion trajectory-based video retrieval, classification, and summarization," *Video Search and Mining*. Studies in Computational Intelligence Series, Springer-Verlag, pp. 53-82, 2010.
- [10] J. J. GadElkarim, D. Schonfeld, O. Ajilore, L. Zhan, A. Zhang, J.D. Feusner, P. M. Thompson, T. J. Simon, A. Kumar, and A. D. Leow, "A framework for quantifying node-level community structure group differences in brain connectivity networks," *Medical Image Computing and Computer-Assisted Intervention – MICCAI, Lecture Notes in Computer Science*. Vol. 7511, pp. 196-203, 2012.
- [11] N. Bouaynaya, R. Shterenberg, D. Schonfeld, and H. M. Fathallah-Shaykh, "Intervention and Control of Gene Regulatory Networks: Theoretical Framework and Application to Human Melanoma Gene Regulation," F. Emmert-Streib, and M. Dehmer, Matthias (eds.), *Statistical Diagnostics for Cancer: Analyzing High-Dimensional Data*. Wiley-VCH, Quantitative and Network Biology, 2013.
- [12] S. Friedland, Q. Li, D. Schonfeld, and E. A. Bernal, "Two algorithms for compressed sensing of sparse tensors," Boche H., Calderbank R., Kutyniok G., Vybíral J. (eds.), *Compressed Sensing and its Applications*. Springer-Verlag, pp. 259-281, 2015.
- [13] I. Fortel, M. Butler, L. E. Korthauer, L. Zhan, O. Ajilore, I. Driscoll, A. Sidiropoulos, Y. Zhang, L. Guo, H. Huang, D. Schonfeld, and A. Leow, "Brain dynamics through the lens of statistical mechanics by unifying structure and function," *Medical Image Computing and Computer-Assisted Intervention – MICCAI, Lecture Notes in Computer Science 11768*. (D. Shen et al., Eds.). Springer Nature Switzerland AG, pp. 503-511, 2019.

L.4. Journal Editorials

- [1] D. Schonfeld, J. Goutsias, I. Shmulevich, I. Tabus, and A.H. Tewfik, "Introduction to the issue on genomic and proteomic signal processing," *IEEE Journal of Selected Topics in Signal Processing*, Special Issue on Genomic and Proteomic Signal Processing, vol. 2, pp. 257-260, 2008.
- [2] S.-F. Chang, J. Luo, S. Maybank, D. Schonfeld, and D. Xu, "An Introduction to the special issue on event analysis in videos," *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 18, pp. 1469-1472, 2008.
- [3] D. Schonfeld, "Perspectives on special issues," *IEEE Signal Processing Magazine*, vol. 26, issue 5, 2009.
- [4] D. Schonfeld, "The evolution of signal processing," *IEEE Signal Processing Magazine*, vol. 27, issue 5, 2010.
- [5] R. Chellappa, W. Heinzelman, J. Konrad, D. Schonfeld, and M. Wolf, "Introduction to Special Section on Distributed Camera Networks: Sensing, Processing, Communication, and Implementation," Special Section on Distributed Camera Networks: Sensing, Processing, Communication, and Implementation, *IEEE Transactions on Image Processing*, vol. 19, pp. 2513-2515, 2010.
- [6] D. Schonfeld, J. Biemond, G. de Haan, and A. Kaup, "Introduction to the issue on recent advances in video processing for consumer displays," *IEEE Journal of Selected Topics in Signal Processing*,

Special Issue on Recent Advances in Video Processing for Consumer Displays, vol. 5, pp. 213-216, 2011.

- [7] L. Di Stefano, C. Regazzoni, and D. Schonfeld, "Advanced Video-Based Surveillance," *EURASIP Journal on Image and Video Processing*, Special Issue on Advanced Video-Based Surveillance, Volume 2011, Article ID 857084, 2 pages, 2011.
- [8] D. Schonfeld and D. Li, "Signal Processing Trends in Media, Mobility, and Search," *IEEE Signal Processing Magazine*, vol. 28, issue 4, 2011.
- [9] L. Najman, J. Barrera, B. S. D. Sagar, P. Maragos, and D. Schonfeld, "Introduction to the issue on filtering and segmentation with mathematical morphology," *IEEE Journal of Selected Topics in Signal Processing*, vol. 6, pp. 737-738, 2012.
- [10] D. Schonfeld, "Editor-in-chief message," *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 24, pp. 181-182, 2014.
- [11] D. Schonfeld, "Editor-in-chief message," *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 25, p. 181, 2015.

L.5. Refereed Journal Papers

- [1] D. Schonfeld and J. Goutsias, "Optimal morphological pattern restoration from noisy binary images," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 13, pp. 14-29, 1991.
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- [179] D. Aggarwal, M. Zafar, D. Schonfeld, K. Avanaki, "Deep learning-boosted photoacoustic microscopy with an extremely low energy laser," *Proceedings of the SPIE BiOS Symposium Conference on Photons Plus Ultrasound: Imaging and Sensing*, San Francisco, California, 2022.
- [180] D. Aggarwal, M. Zafar, T. Islam, D. Schonfeld, R. Manwar, and K. Avanaki, "E-Unet: a deep learning method for photoacoustic signal enhancement," *Proceedings of the SPIE BiOS Symposium Conference on Photons Plus Ultrasound: Imaging and Sensing*, San Francisco, California, 2023.
- [181] L. Saint-Martin, D. Aggarwal, R. Manwar, D. Schonfeld, and K. Avanaki, "Study the relationship between the skull physical characteristics and transcranial aberrated acoustic signal features: a phantom study," *Proceedings of the SPIE BiOS Symposium Conference on Photons Plus Ultrasound: Imaging and Sensing*, San Francisco, California, 2023.

- [182] M.M. Karaman, S. Maraka, T. Valyi-Nagy, S. Khalid, K. Slavin, G. Atwal, A. Daher, G. Dan, A. Scotti, Schonfeld, and X.J. Zhou, “Establishing a correlation between diffusion heterogeneity and tissue structural heterogeneity using stereotactic biopsies on brain tumors,” *Proceedings of the Annual Meeting of the International Society of Magnetic Resonance Imaging in Medicine (ISMRM)*, Toronto, Ontario, Canada, 2023.

L.7. Presentations

- [1] N. Bouaynaya and D. Schonfeld, “Protein communication channel: Analysis of proteomics and genomics based on signal processing and communication,” *The Fourth Annual Chicago Biomedical Consortium Symposium*, Chicago, Illinois, 2006.
- [2] N. Bouaynaya and D. Schonfeld, “Protein communication channel: Analysis of proteomics and genomics based on signal processing and communication,” *Biomedical Informatics Workshop*, Chicago, Illinois, 2006.
- [3] M. Dutta, D. Schonfeld, S. Liao, and M. Stroschio, “Quantum Dot Blinking: Physical Limit for Nanoscale Optoelectronic Device,” *International Workshop of Computational Electronics*, Amherst, Massachusetts, 2007.
- [4] C. Chen and D. Schonfeld, “Spectral analysis of unstructured plenoptic sampling,” *Illinois Computer Vision Workshop*, Toyota Technological Institute at Chicago, Chicago, Illinois, 2009.
- [5] S. Zhao, D. Tuninetti, R. Ansari, and D. Schonfeld, “On the distortion exponent of block-fading Gaussian channels,” *Proceedings of the Information Theory and Applications Workshop*, San Diego, California, 2010.
- [6] N. Bouaynaya and D. Schonfeld, “Inverse perturbation for optimal intervention in genetic regulatory networks,” *Institute for Mathematics and its Applications (IMA) Workshop on Large Data Sets in Medical Informatics*, Minneapolis, Minnesota, 2011.
- [7] N. Bouaynaya and D. Schonfeld, “Intervention and control of large-scale gene regulatory networks,” *Institute for Mathematics and its Applications (IMA) Workshop on Large Data Sets in Medical Informatics*, Minneapolis, Minnesota, 2011.
- [8] J. J. GadElkarim, D. Schonfeld, O. Adjilore, A. Kumar, P. M. Thompson, and A. D. Leow, “Partition the human brain with binary trees using simulated annealing,” *Annual Meeting of the Organization for Human Brain Mapping (OHBM)*, Beijing, China, 2012.
- [9] Q. Li, D. Schonfeld, and S. Friedland, “Generalized tensor compressive sensing,” *Matheon-Workshop Compressed sensing and its Applications*, (Invited Lecture), Berlin, Germany, 2013.
- [10] C. Agarwal, E. Schonfeld, D. Schonfeld, B. Mokhlesi, and B. Prasad, “Predicting blood pressure response to sleep apnea treatment,” *IEEE International Conference on Biomedical and Health Informatics (BHI)*, Chicago, Illinois, 2019.

- [11] C. Agarwal, I. Imayama, E. Schonfeld, D. Schonfeld, B. Mokhlesi, and B. Prasad, "Prediction of acute blood pressure response to obstructive apneas and hypopneas using routine polysomnography data," *International Conference on Sleep & Breathing*, Tampere, Finland, 2019.

L.8. Patents

- [1] D. Schonfeld, K. Hariharakrishnan, P. Raffy, and F. Yassa, "Object tracking using adaptive block-size matching along object-boundary and frame skipping when object motion is low," U.S. Patent No. 7095786, Patent Issued August 28, 2006.
- [2] D. Schonfeld, K. Hariharakrishnan, P. Raffy, and F. Yassa, "Occlusion/disocclusion detection using K-means clustering near object boundary with comparison of average motion of clusters to object and background motions," U.S. Patent No. 7142600, Patent Issued November 28, 2006.
- [3] W. Qu, D. Schonfeld, and M. Mohamed, "Method and Apparatus to Disambiguate State Information for Multiple Items Tracking," Patent Application, Filed October 13, 2006.
- [4] W. Qu, D. Schonfeld, and M. Mohamed, "Method and Apparatus to facilitate use of conditional probabilistic analysis of multi-point-of-reference samples of an item to disambiguate state information as pertains to the item," Patent Application, Filed December 15, 2006.
- [5] D. Schonfeld and N. Bouaynaya, "Dynamic tree programming – Extension of the Viterbi algorithm to multidimensional systems," Provisional Patent, Filed February 19, 2006.
- [6] D. Schonfeld, K. Hariharakrishnan, P. Raffy, and F. Yassa, "Object tracking using adaptive block-size matching along object-boundary and frame skipping when object motion is low," Patent Application 12/324,481, Filed November 26, 2008.
- [7] D. Schonfeld, K. Hariharakrishnan, P. Raffy, and F. Yassa, "Occlusion/disocclusion detection using K-means clustering near object boundary with comparison of average motion of clusters to object and background motions," U.S. Patent No. RE42790 E, Patent Issued October 4, 2011.

M. KEYNOTE AND PLENARY TALKS

Stochastic noise process enhancement of nonlinear filtering

INPT/ASME International Conference on Communications, Signals and Systems
Rabat, Morocco
1995

VORTEX: Video Retrieval and Tracking from Compressed Multimedia Databases

INPT/ASME International Conference on Communications, Signals and Systems
Rabat, Morocco
2001

MotionSearch: Content-Based Video Retrieval and Activity Recognition in Video Surveillance

IEEE International Conference on Advanced Video and Signal Based Surveillance (AVSS)
Genoa, Italy
2009

Distributed Multi-Camera Networks: Graphical Models, Tensor Representation, and Plenoptic Functions

IEEE International Conference on Networking, Sensing, and Control (ICNSC)
Chicago, Illinois
2010

Signal Processing for Distributed Multi-Camera Networks: Theory and Applications

IEEE/IET International Conference on Audio, Language and Image Processing (ICALIP)
Shanghai, China
2010

The Visual Brain: Biologically-Inspired Imaging and Vision

International Conference on Intelligent Control and Information Processing (ICICIP)
International Conference on Brain Inspired Cognitive Systems (BICS)
Beijing, China
2013

Distributed Multi-Camera Networks: Graphs, Grammars, and Tensors

International Conference on Wireless Communications and Signal Processing (WCSP)
Yangzhou, China
2016

University of Illinois – New Oriental Artificial Intelligence Research Laboratory

N-Brain Alliance Launch & Product Release Conference
New Oriental AI Research Academy
Beijing, China
2018

AI Technology in Education and Academic Thinking

Think for Education Conference (TEC) AI+Education
Beijing, China
2018

Advances in Deep Learning: Theory and Applications

IEEE International Conference on Computer, Electrical and Communication Engineering (ICCECE)
Kolkata, India
2023

N. INVITED SEMINARS

Optimal morphological representation and detection of binary images

Department of Electrical Engineering and Computer Science
Northeastern University
Boston, Massachusetts
1990

Optimal morphological representation and detection of binary images

The Johns Hopkins University
Applied Physics Laboratory

Laural, Maryland
1990

Optimal morphological representation and detection of binary images

Center for Automation Research
University of Maryland
College Park, Maryland
1990

Optimal morphological representation and restoration of binary images: Theory and applications

Department of Electrical and Computer Engineering
Illinois Institute of Technology
Chicago, Illinois
1990

Optimal morphological representation and restoration of binary images: Theory and applications

Department of Electrical and Computer Engineering
University of California
Santa Barbara, California
1990

Optimal morphological representation and restoration of binary images: Theory and applications

Department of Electrical Engineering and Computer Science
Northwestern University
Evanston, Illinois
1991

Morphological image processing and analysis: Theory and applications

Department of Electrical and Computer Engineering
University of Illinois
Urbana-Champaign, Illinois
1992

Morphological image representation: Theory and applications

DOD Tri-Service Workshop on Stochastic Methods in Image Analysis
U.S. Army Harry Diamond Laboratories
Adelphi, Maryland
1992

Morphological representation of nonlinear filters: Theory and applications

Department of Electrical and Computer Engineering
Illinois Institute of Technology
Chicago, Illinois
1993

Morphological image representation: Theory and applications

ONR Workshop on Vision and Optical Information Processing
Arlington, Virginia

1994

Nonlinear Signal and Image Processing

Department of Electrical Engineering and Computer Science

University of Illinois

Chicago, Illinois

1996

Nonlinear Operators: Theory and Application to Image Processing and Communications

School of Electrical and Computer Engineering

Technion – Israel Institute of Technology

Haifa, Israel

1996

Stochastic Noise Process Enhancement of Nonlinear Filtering

Department of Electrical Engineering

Northern Illinois University

DeKalb, Illinois

1996

Morphological Signal and Image Processing: Theory and Applications

Department of Electrical Engineering—Systems

University of Tel-Aviv

Tel-Aviv, Israel

1997

VORTEX: Video Retrieval and Tracking from Compressed Multimedia Databases

Department of Electrical and Computer Engineering

Illinois Institute of Technology

Chicago, Illinois

2001

Mathematical Morphology and Computer Vision

University of Illinois at Chicago

Chicago, Illinois

2002

VORTEX: Video Retrieval and Tracking from Compressed Multimedia Databases

Department of Electrical and Computer Engineering

Drexel University

Philadelphia, Pennsylvania

2002

**Time-Series Analysis Based on Statistical Signal Processing:
Segmentation, Prediction, and Tracking**

Global Electronic Trading Company (Getco)

Chicago, Illinois

2004

Particle Filtering for Head Tracking in Wireless Communications

Motorola Research Labs

Schaumburg, Illinois
2004

Real-Time Video Communications: Compression, Tracking, Retrieval, and Networking

University of Illinois
Chicago, Illinois
2005

Real-Time Video Tracking and Retrieval from Multimedia Databases

Motorola Research Labs
Schaumburg, Illinois
2005

**Real-Time Multiple Object Tracking and Motion Trajectory-Based Video Databases:
Indexing, Retrieval, and Activity Recognition**

Hewlett-Packard Research Labs
Haifa, Israel
2005

Real-Time Video Tracking Based on Particle Filtering

University of Illinois
Chicago, Illinois
2005

**Real-Time Collaborative Distributed Tracking and Trajectory Analysis from Multiple
Camera and Sensor Networks**

School of Electrical and Computer Engineering
Purdue University
West Lafayette, Indiana
2005

**A New Method for Multidimensional Optimization and Its Application in Image and Video
Processing**

Department of Electrical Engineering and Computer Science
Northwestern University
Evanston, Illinois
2006

Protein Communication System: Evolution and Genomic Structure

Department of Electrical and Computer Engineering
University of Illinois at Urbana-Champaign
Urbana-Champaign, Illinois
2006

Protein Communication System: Evolution and Genomic Structure

Bioinformatics Group
Mathematics and Computer Science Division
Argonne National Laboratory
Argonne, Illinois
2006

**Distributed Image and Video Processing:
Directed Graphs, Bayesian Estimation, and Hidden Markov Models**
College of Information Science and Engineering
Graduate School
Chinese Academy of Science
Beijing, P.R. China
2007

**Distributed Image and Video Processing:
Directed Graphs, Bayesian Estimation, and Hidden Markov Models**
Visual Computing Group
Microsoft Research Asia
Beijing, P.R. China
2007

**Distributed Image and Video Processing:
Directed Graphs, Bayesian Estimation, and Hidden Markov Models**
School of Electronic and Information Institute
Tongji University
Shanghai, P.R. China
2007

**Distributed Image and Video Processing:
Directed Graphs, Bayesian Estimation, and Hidden Markov Models**
School of Automation
Institute of Automation
Hangzhou Dianzi University
Hangzhou, P.R. China
2007

**Distributed Image and Video Processing:
Directed Graphs, Bayesian Estimation, and Hidden Markov Models**
Department of Information Science and Electronic Engineering
Institute of Information and Communication Systems
Zhejiang University
Hangzhou, P.R. China
2007

InteractiveVision: Distributed Image and Video Processing
Intellectual Property Technical Lecture Series
McAndrews, Held & Malloy, Ltd.
Chicago, Illinois
2007

**Distributed Image and Video Processing:
Directed Graphs, Bayesian Estimation, and Hidden Markov Models**
Departments of Computer Science and Electrical & Computer Engineering
Technion, Israel Institute of Technology
Haifa, Israel
2007

MotionSearch: Content-Based Video Retrieval and Classification

Joint Chapters of the IEEE
Rochester, New York
2008

Evolution and Genomic Structure: A Signal Processing Perspective

Bioinformatics Cluster
University of Rochester
Rochester, New York
2008

Evolution and Genomic Structure: A Signal Processing Perspective

Department of Electrical Engineering
Columbia University
New York, New York
2008

Evolution and Genomic Structure: A Signal Processing Perspective

Department of Electrical Engineering and Computer Science
Northwestern University
Evanston, Illinois
2008

MotionSearch: Content-Based Video Retrieval and Classification

Distinguished Speaker in the Joint College Colloquium Series
College of Engineering and Information Technology and College of Science and Mathematics
Department of Applied Science
University of Arkansas at Little Rock
Little Rock, Arkansas
2008

Evolution and Genomic Structure: A Signal Processing Perspective

Department of Electrical and Computer Engineering
University of Wisconsin – Madison
Madison, Wisconsin
2008

MotionSearch: Content-Based Video Retrieval and Classification

Department of Electrical & Computer Engineering
Tufts University
Medford, Massachusetts
2009

MotionSearch: Content-Based Video Retrieval and Classification

Department of Electrical & Microelectronics Engineering
Rochester Institute of Technology
Rochester, New York
2009

MotionSearch: Content-Based Video Retrieval and Classification

School of Computer Engineering

Nanyang Technological University
Singapore
2009

Distributed Multi-Camera Networks: Graphical Models, Tensor Representation, and Plenoptic Functions

Department of Electrical and Computer Engineering
Illinois Institute of Technology
Chicago, Illinois
2010

Personalized Visual Interaction: Robust Video-Conferencing and Human-Computer Interaction Using a Two-Camera Computer System

Qualcomm Corp.
San Diego, California
2010

Evolution and Genomic Structure: A Signal Processing Perspective

Department of Information Engineering and Computer Science - DISI
Microsoft Research-University of Trento Centre for Computational and Systems Biology
University of Trento
Trento, Italy
2010

A Novel Cache Optimization Algorithm and Video Streaming Protocol for Pure Peer-to-Peer Networks

Motorola Research Labs
Schaumburg, Illinois
2010

Distributed Multi-Camera Networks: Graphical Models, Tensor Representation, and Plenoptic Functions

Research Center of Automation
Northeastern University
Shenyang, P.R. China
2010

Distributed Multi-Camera Networks: Graphical Models, Tensor Representation, and Plenoptic Functions

School of Automation and Electric Engineering
Zhejiang University of Science and Technology
Hangzhou, P.R. China
2010

Distributed Multi-Camera Networks: Graphical Models, Tensor Representation, and Plenoptic Functions

Center for OPTical IMagery Analysis and Learning (OPTIMAL)
State Key Laboratory of Transient Optics and Photonics
Xi'an Institute of Optics and Precision Mechanics
Chinese Academy of Sciences
Xi'an, P.R. China

2010

Distributed Multi-Camera Networks: Graphs, Grammars, and Tensors

Dean's Leadership in Innovation Seminar Series

Advanced Analytics Institute (AAI)

University of Technology

Sydney, Australia

2012

Genomic Signal Processing: Evolution, Structure, and Regulation

Dean's Leadership in Innovation Seminar Series

Advanced Analytics Institute (AAI)

University of Technology

Sydney, Australia

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Distributed Multi-Camera Networks: Theory and Applications

Harbin Engineering University (HEU)

Harbin, China

2014

Distributed Multi-Camera Networks: Theory and Applications

Electrical and Computer Engineering Graduate Program

Ryerson University

Toronto, Canada

2014

Genomic Signal Processing: Evolution, Structure, and Regulation

Distinguished Lecturer Seminar Series

Electrical Engineering Department

The Pennsylvania State University

University Park, Pennsylvania

2015

Genomic Signal Processing: Evolution, Structure, and Regulation

School of Electrical & Electronic Engineering

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2015

O. GRADUATE STUDENTS AND VISTING SCHOLARS

O.1. Visiting Scholars

Mohammed Charif-Chefchaoui

Department of Electrical Engineering and Computer Science

University of Illinois at Chicago

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1995

Position: Director and Professor, National Institute of Postes and Telecommunications, Morocco.

Yuesong Lin

Department of Electrical and Computer Engineering
University of Illinois at Chicago
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2007

Position: Professor, Institute of Information and Control, Hangzhou Dianzi University, Hangzhou, P.R. China.

Haihong Chi

Department of Electrical and Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2010

Position: Associate Professor, College of Automation, Harbin Engineering University (HEU), Harbin, P.R. China.

Claudio Piciarelli

Department of Electrical Engineering and Computer Science
University of Illinois at Chicago
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2010

Position: Postdoctoral Fellow, Department of Mathematics and Computer Science, University of Udine, Udine, Italy.

O.2. Postdoctoral Fellows

Mohammed Charif-Chefchaoui

Department of Electrical Engineering and Computer Science
University of Illinois at Chicago
Chicago, Illinois
1994

Position: Director and Professor, National Institute of Postes and Telecommunications, Morocco.

O.3. Visiting Students

Alessio Dore

Department of Electrical and Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2008

Former Position: Doctoral Candidate, DIBE - Department of Biophysical and Electronic Engineering, University of Genova, Genoa, Italy.

Current Position: Postdoctoral Fellow, Imaging Sciences Centre, Institute of Biomedical Engineering, Imperial College, London, United Kingdom.

Yunmei Gong

Department of Electrical and Computer Engineering

University of Illinois at Chicago
Chicago, Illinois
2008-09

Current Position: Doctoral Candidate, Information and Communication Engineering, College of Electronics and Information Engineering, Tongji University, Shanghai, P.R. China.

Nicola Piotto

Department of Electrical and Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2010

Current Position: Doctoral Candidate, Department of Engineering and Computer Science – DISI, Multimedia Signal Processing and Understanding Lab – MMLab, University of Trento, Trento, Italy.

O.4. Doctoral Students

Mohammed Charif-Chefchaoui

“Morphological Representation of Nonlinear Filters: Theory and Applications”

Department of Electrical Engineering and Computer Science
University of Illinois at Chicago
Chicago, Illinois
1993

Former Position: Professor, National Institute of Postes and Telecommunications, Rabat, Morocco.

Current Position: Director, National Institute of Postes and Telecommunications, Rabat, Morocco.

Dan Lelescu

“VORTEX: Video Retrieval and Tracking from Compressed Multimedia Databases”

Department of Electrical Engineering and Computer Science
University of Illinois at Chicago
Chicago, Illinois
2000

Former Position(s): Senior Research Scientist, Lead of Algorithms Group, Compression Sciences, Campbell, California, USA; Senior Researcher, NTT DoCoMo Communications Laboratories USA, San Jose, California, USA; Principal Scientist, Advanced Imaging Research & Development Laboratory, Micron Technology, California, USA; Chief Scientist, Pelican Imaging Corporation, Mountain View, California, USA; Chief Scientist, Emergent VR, Campbell, California, USA.

Current Position: Engineer, Apple, Cupertino, California, USA.

Bulent Cavusoglu

“Real-Time Content-Based Video Communications over Heterogeneous Networks”

(Jointly Supervised with Prof. Rashid Ansari)

Department of Electrical & Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2005

Current Position: Professor, Ataturk University, Erzurum, Turkey.

Faisal Bashir

“MotionSearch: Object Motion Trajectory-Based Video Search and Classification System”

(Jointly Supervised with Prof. Ashfaq Khokhar)

Department of Electrical & Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2006

Internship: Mitsubishi Electric Research Laboratory (MERL), USA.

Former Position(s): Intern, Mitsubishi Electric Research Laboratory (MERL), Cambridge, Massachusetts, USA; Senior Imaging Scientist, Retica Systems, Inc., Waltham, Massachusetts, USA; Senior Vision Engineer, Heartland Robotics, Cambridge, Massachusetts, USA.

Current Position: Senior Principal Engineer – Advanced Development Group, Security and Detection Systems, L-3 Communications, Woburn, Massachusetts, USA.

Wei Qu

“Real-Time Distributed Video Tracking of Multiple Objects from Single and Multiple Cameras”

Department of Electrical & Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2006

Internship: Mitsubishi Electric Research Laboratory (MERL), USA; Siemens Medical Systems, USA.

Former Position(s): Senior Research Scientist, Motorola Research Labs, Schaumburg, Illinois, USA; Senior Scientist, Siemens Medical Solutions USA, Hoffman Estates, Illinois, USA; Associate Professor, Graduate University of Chinese Academy of Sciences, Beijing, China; CEO Special Assistant, Director of Technology, President of CSST Research, Hong Kong; Vice President, R&D, Special Assistant to CEO, President of Beijing Research Institute, Beijing, China; Co-Founder, SmartVision Technology, Beijing, China.

Current Position: President, Artificial Intelligence Research Institute, New Oriental Education & Technology Group Inc., Beijing, China.

Nidhal Bouaynaya

“Analysis of Proteomics and Genomics Based on Signal Processing and Communication Theory”

Department of Electrical & Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2007

Former Position: Assistant Professor, Department of Systems Engineering, University of Arkansas at Little Rock, Little Rock, Arkansas, USA.

Current Position: Associate Dean for Research & Graduate Studies, Rowan University, Glassboro, New Jersey, USA.

Hunsop Hong

Constrained and Hierarchical Density Estimation for Image Reconstruction and Sensor Networks

Department of Electrical & Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2008

Current Position: Senior Research Engineer, Samsung Information Systems America, Irvine, California, USA.

Pan Pan

Video Tracking Based on Particle Filters: Particle Allocation, Graphical Models, and Performance Evaluation

Department of Electrical & Computer Engineering

University of Illinois at Chicago
Chicago, Illinois
2009

Internship: NTT Research Laboratory, Japan; Mitsubishi Electric Research Laboratory (MERL), USA.
Former Position: Senior Researcher, Project Manager, Fujitsu Research and Development, Beijing, China.

Current Position: Technical Director, Alibaba Group, Beijing, China.

Xiang Ma

Motion Trajectory-Based Video Retrieval and Recognition: Tensor Analysis and Multi-Dimensional Hidden Markov Models

(Jointly Supervised with Prof. Ashfaq Khokhar)

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2009

Internship: Knowledge Media Institute, Open University, United Kingdom; Siemens Medical Solutions USA, Hoffman Estates, Illinois, USA; Computer Vision Research Engineer, IntuVision, Inc., Woburn, Massachusetts, USA.

Former Position: Senior Research Scientist and Engineer, IntuVision, Inc., Woburn, Massachusetts, USA; Lead Engineer – 3D Maps & Reality Capture Processing, Nokia, Chicago, Illinois, USA; Research Manager, Manager of Engineering – Computer Vision, Artificial Intelligence R&D, HERE Technologies, Chicago, Illinois, USA.

Current Position: Applied Science Manager – Computer Vision and Artificial Intelligence, Amazon, Boston, Massachusetts, USA.

Junlan Yang

Virtual Video Enhancement for Handheld Mobile Cameras: Stabilization, Auto-Focus, and Super-Resolution

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2009

Internship: Ricoh Research Laboratory, Menlo Park, California, USA; Sharp Laboratories of America, USA.

Former Position: Senior Software Engineer, iKoa Corporation, Menlo Park, California, USA; Research Scientist, Marseille Networks, Santa Clara, California, USA.

Current Position: Software Engineer, Google LLC, Mountain View, California, USA.

Chong Chen

Multi-Camera Vision Systems: Distributed Pose Estimation and Plenoptic Imaging

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2009

Internship: Siemens Research Laboratory, USA; FX Palo Alto Laboratory (FXPAL), USA; Abbott Laboratories, USA.

Former Position: Senior Research Engineer, Samsung Information Systems America, Irvine, California, USA.

Current Position: Video Engineer, Apple, Cupertino, California, USA.

Xu Chen

Localization and Trajectory Estimation of Mobile Objects from a Single Sensor

(Jointly Supervised with Prof. Ashfaq Khokhar)

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2010

Internship: Institute of Electrical Engineering, Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland; Kodak Research Laboratories, USA.

Former Position(s): Postdoctoral Fellow, Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, Michigan, USA; Postdoctoral Fellow, Department of Electrical and Computer Engineering, Duke University, Durham, North Carolina, USA; Senior Researcher, Sharp Laboratories of America, Camas, Washington, USA.

Current Position: Senior Machine Learning Developer, SAS, Cary, North Carolina, USA.

Lei Gao

Compiler Optimization for Translating Software Binaries onto FPGAs

(Jointly Supervised with Prof. Prith Banerjee)

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2010

Internship: Binachip, Inc., Chicago, Illinois, USA.

Former Position: Senior Engineer, Binachip, Inc., Chicago, Illinois, USA.

Current Position: Staff R&D Engineer, Synposis, Inc., Marlborough, Massachusetts, USA.

Liuling Gong

Machine Learning for Signal Processing:

Geometry, Kernels, and Symbolic Sequences

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2010

Internship: eBay Research Labs, USA.

Former Position: Postdoctoral Fellow, Center for the Study of Complex Systems, University of Michigan, Ann Arbor, Michigan, USA; Seismic Imager, CGGVeritas, Houston, Texas, USA; Data Scientist, GE Oil & Gas, Houston, Texas, USA.

Current Position: Data Scientist, Equinor, Houston, Texas, USA.

Songqing Zhao

Multiple Description Coding for Correlated Multi-Path Networks

(Jointly Supervised by Profs. Rashid Ansari and Daniela Tuninetti)

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2010

Internship: Mitsubishi Electric Research Laboratory (MERL), USA.

Former Position: Voice and Data Quality Engineer, Voice & Data Quality and Performance Analysis Group, Alcatel-Lucent, Murray Hill, New Jersey, USA.

Current Position: Senior Wireless Engineer, Apple, Cupertino, California, USA.

Xiangqiong Shi

Bayesian Networks: Performance Analysis of Loopy Belief Propagation

(Jointly Supervised with Prof. Daniela Tuninetti)

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2011

Internship: Motorola Research Labs, Schaumburg, Illinois, USA; Technicolor, Research & Innovation, Princeton, New Jersey, USA; Nokia Research Center, Palo Alto, California, USA.

Former Positions: Software Engineer, Volkswagen of America, Electronics Research Lab, Herndon, Virginia, USA; Software Engineer, Apple, Cupertino, California, USA.

Current Position: Software Engineer, Ouster, San Francisco, California, USA.

Liming Wang

Genomic Signal Processing and Regulatory Networks: Representation, Dynamics and Control

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2011

Former Position: Postdoctoral Fellow, Department of Electrical Engineering, Columbia University, New York, New York, USA; Postdoctoral Associate, Department of Electrical and Computer Engineering, Duke University, Durham, North Carolina, USA; Postdoctoral Associate, Department of Electrical and Computer Engineering, Ohio State University, Columbus, Ohio, USA.

Current Position: Lead Data Scientist, HERE Technologies, Chicago, Illinois, USA.

Jing Huang

Distributed Signal and Image Processing:

Particle Filters, Context Grammars, and Dynamic Games

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2013

Internship: Fuji Xerox Palo Alto Laboratory (FXPAL), Palo Alto, California, USA; Motorola Mobility, Applied Research Center, Libertyville, Illinois, USA; Nokia Research Center, Berkeley, California, USA.

Former Positions: Software Development Engineer, TeraRecon, Inc., Foster City, California, USA; Senior Deep Learning Software Engineer, Intel Artificial Intelligence, Intel Corporation, Santa Clara, California.

Current Position: Software Engineer, Microsoft Artificial Intelligence & Research, Bellevue, Washington, USA.

Qun Li

Multilinear Algebra in High-Order Data Analysis: Retrieval, Classification and Representation

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2013

Internship: Xerox Research Center, Xerox Innovations Group, Webster, New York, USA.

Former Positions: Research Scientist, Xerox Research Center, Xerox Innovations Group, Webster, New York, USA; Research Scientist, PARC, A Xerox Company, Palo Alto, California, USA.

Current Position: Senior Data Scientist, Microsoft, Bellevue, Washington, USA;

Johnson Jonaris GadElkarim Keiriz

From Micro to Macro: A Study of Human Brain Structure Based on Diffusion MRI and Neuronal Networks

(Jointly Supervised by Profs. Alex Leow and Richard Magin)

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2013

Former Position: Postdoctoral Fellow, Department of Psychiatry, University of Illinois, Chicago, Illinois, USA; Lead Developer, nView medical Inc., Salt Lake City, Utah, USA; Research Scientist, Tamaggo, Montreal, Quebec, Canada; Research Scientist – Senior Software Engineer, Object Research Systems (ORS) Inc., Montreal, Quebec, Canada; Research Associate, Electronic Visualization Laboratory (EVL), University of Illinois at Chicago (UIC), Chicago, Illinois; USA.

Current Position: Principal CT Software Engineer, Canon Medical Research USA, Inc. Vernon Hills, Illinois, USA.

Lingdao Sha

When Sparsity Meets Graphs, Images, Structured and High-Dimensional Data

(Jointly Supervised with Prof. Jing Wang)

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2018

Current Position: Senior Machine Learning Scientist, Tempus Labs, Inc., Chicago, Illinois, USA.

Haoyu Wang

Depth-constrained Feature-based Stitching System for Stereoscopic Panoramic Video Generation

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2019

Current Position: Computer Vision Engineer, Blackmagic Design, Colorado Springs, Colorado, USA.

Mehdi Sharifzadeh

Steganography and Steganalysis of Raw and Compressed Image Data

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2019

Internships: Software Engineering Intern, Google Brain, Mountain View, California, USA; Data Scientist Intern, Western Digital, Milpitas, California, USA; Data Scientist Intern, SanDisk, Milpitas, California, USA.

Previous Position: Research Engineer, Snap, Inc., Santa Monica, California, USA.

Current Position: Software Engineer, Google, Inc., Los Angeles, California, USA.

Chirag Agarwal

Robustness and Explainability of Deep Neural Networks: Architectures and Applications

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2020

Internships: Research Intern, Geisinger Health Systems, Danville, Pennsylvania, USA; Research and Development Intern, Kitware Inc., Clifton Park, New York, USA; Imaging Science Intern, Tempus Labs Inc., Chicago, Illinois, USA; Computer Vision / Augmented Reality Intern, Robert Bosch LLC, Farmington Hills, Michigan, USA.

Previous Position: Postdoctoral Research Fellow, Department of Computer Science, Department of Biomedical Informatics, and Business School, Harvard University, Cambridge, Massachusetts, USA.

Current Position: Research Scientist, Media and Data Science Research Laboratory, Adobe Research, Bangalore, India.

Mohammed Aloraini

Digital Media Forgery Detection

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2020

Current Position: Assistant Professor, Qassim University, Buraydah, Qassim, Saudi Arabia.

Igor Fortel

Excitation-Inhibition Balance: A Study of Brain Network Dynamics Using Statistical Mechanics

(Jointly Supervised by Prof. Alex Leow)

Video Steganography

Department of Biomedical Engineering

University of Illinois at Chicago

Chicago, Illinois

2021

Current Position: Systems Design Engineer, T-Mobile, Chicago, Illinois; Research Specialist, University of Illinois at Chicago, Chicago, Illinois.

O.5. Masters Thesis Students

Vladimir Pavlovic

“Stochastic Noise Process Enhancement of Hopfield Neural Networks”

(Jointly Supervised with Prof. Gary Friedman)

Department of Electrical Engineering and Computer Science

University of Illinois at Chicago

Chicago, Illinois

1993

Position: Associate Professor, Department of Computer Science, Rutgers University, New Jersey, USA.

Deepak K. Bal

“Transmission of Real-Time MPEG-2 Video Over Differentiated Services Networks”

(Jointly Supervised with Prof. Rashid Ansari)

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2003

Position: Takata, Inc., Michigan, USA.

Karthik Hariharakrishnan

“Visual Tracking: New Methods Using Adaptive Block Matching and Particle Filters”

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2003

Internship: NeoMagic Corp., USA.

Previous Position(s): National Instruments, India; Motorola, India; Senior Design Engineer, ARM, Ltd., United Kingdom.

Current Position: Staff Software Engineer, ARM, Ltd., United Kingdom.

Subhash Balam

“Associative Processors for Video Coding”

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2004

Position: Senior Staff Engineer/Manager, Qualcomm Corp., California, USA.

Emir Mulabegovic

“Lightweight Streaming Protocol for Real-Time Video Communications”

(Jointly Supervised with Prof. Rashid Ansari)

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2005

Former Position: PCTEL, Illinois, USA.

Current Position: Systems Architect, Personal, Inc., Sarajevo, Bosnia and Herzegovina.

Andrea De Mauro

“A Peer-to-Peer Network for Real-Time Multiple-Description Video Communications Using Multiple Paths”

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2006

Former Position: Financial Solutions Systems Analyst, Procter & Gamble, Newcastle, United Kingdom.

Current Position: Business Intelligence Manager, Procter & Gamble, Newcastle, Rome, Italy.

Claudio Rossi

“A Partially-Reliable Multihomed Transport Protocol for Real-Time Multiple-Description Multimedia Traffic”

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2006

Position: Area Manager, IBM, Milan, Italy.

Amita Talati

Design and Evaluation of Data Compression and Decompression Applications on Field Programmable Gate Arrays

(Jointly Supervised with Prof. Prith Banerjee)
Department of Electrical & Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2008

Former Position: Customer Applications Engineer, Newark Corporation, Cleveland, Ohio, USA.
Current Position: Senior Engineer, Newark Corporation, Cleveland, Ohio, USA.

Carlo Giulietti

A Novel Cache Optimization Algorithm and Protocol for Video Streaming in Pure Peer-to-Peer Networks
Department of Electrical & Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2010
Position: Software Engineer, Astek, Sophia Antipolis, France.

Edmond Gjondrekaj

Clustering and Similarity Analyses of miRNA Assay by Means of Reprogrammable Devices
Department of Electrical & Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2010

Alberto Mannari

Enhanced Frame Buffer Management for HEVC Encoders and Decoders
Department of Electrical & Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2015
Position: Specialist Electronics Engineer, Teoresi Inc., Burr Ridge, Illinois.

Vasundhara Goyal^[1]

Generation of Stereoscopic Video From Monocular Image Sequences Based on Epipolar Geometry
Department of Electrical & Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2017

Akreem Talal Mohammed Saeed

Location Based Assistant on Android Platform
Department of Electrical & Computer Engineering
University of Illinois at Chicago
Chicago, Illinois
2017

Lorenzo Norcini

Attention-Guided Mask Propagation for Video Object Segmentation
Department of Computer Science
University of Illinois at Chicago
Chicago, Illinois

2019

Position: Software Engineer, Amazon, Seattle, Washington.

Francesca Pistilli

GraphPointNet: Graph Convolutional Neural Network for Point Cloud Denoising

Department of Electrical & Computer Engineering

University of Illinois at Chicago

Chicago, Illinois

2019

Position: Doctoral Student, Politecnico di Torino, Turin, Italy.

O.6. Masters Project Students

Neil Zalut

“Linear Restoration of Medical Images: An Overview”

Department of Electrical Engineering and Computer Science

University of Illinois at Chicago

Chicago, Illinois

1993

Branislav Kisacanin

“A Fast Thresholded Linear Convolution Representation of Morphological Operations”

Department of Electrical Engineering and Computer Science

University of Illinois at Chicago

Chicago, Illinois

1993

Alan Baumgartner

“Morphological Segmentation of Computed Tomography Images”

Department of Electrical Engineering and Computer Science

University of Illinois at Chicago

Chicago, Illinois

1994

Alvin Ng

“Spatially-Variant Morphological Skeleton Representation”

Department of Electrical Engineering and Computer Science

University of Illinois at Chicago

Chicago, Illinois

1994

Smriti Anand

“Efficient Fast Reconstruction Algorithms in Computerized Tomography”

Department of Electrical Engineering and Computer Science

University of Illinois at Chicago

Chicago, Illinois, May 1995

Stephan W. Wegerich

“Subband Image Restoration and Blur Identification Using the EM Algorithm and Cross-Filtering”

Department of Electrical Engineering and Computer Science

University of Illinois at Chicago
Chicago, Illinois
1995

Robert Werckmeister

“Performance Analysis of Video Communications in Multimedia Networks”
(Jointly Supervised with Prof. Ouri Wolfson)
Department of Electrical Engineering and Computer Science
University of Illinois at Chicago
Chicago, Illinois
1996

Margaret Kelton

“A Fast Method for Transform Conversion for Use in Image Processing”
Department of Electrical Engineering and Computer Science
University of Illinois at Chicago
Chicago, Illinois
1998

Kailash Ravishankar

“Frequency Prediction of High-Order Autoregressive Moving Average Sequences”
Department of Electrical Engineering and Computer Science
University of Illinois at Chicago
Chicago, Illinois
1998

Amir Yafe

“Transmission of MPEG-2 Streams Over Packet-Switched Networks”
Department of Electrical Engineering and Computer Science
University of Illinois at Chicago
Chicago, Illinois
1998

Steven J. Doering

“Digital Modulation: Applications to CDMA Communication Systems (IS-95)”
Department of Electrical Engineering and Computer Science
University of Illinois at Chicago
Chicago, Illinois
1999

Abhijit Bhattacharya

“MPEG-1 and H.263 Video Decoding on Motorola GSM Cellular Phone”
Department of Electrical Engineering and Computer Science
University of Illinois at Chicago
Chicago, Illinois
1999

Qin Cai

“Differentiated Transmission of MPEG-2 Video Bitstream Over Communication Networks”
(Jointly Supervised with Prof. Rashid Ansari)
Department of Electrical Engineering and Computer Science

University of Illinois at Chicago
Chicago, Illinois
2000

P. RESEARCH GRANTS

D. Schonfeld (PI)
“Morphological image representation: Theory and applications”
Office of Naval Research (ONR)
\$150,000
1991-1995

S. Corson (PI) and D. Schonfeld (Co-PI)
“Parallel processing research”
University of Illinois
Campus Research Board (CRB)
\$14,995
1994-1995

R. Ansari (PI), P. Hesketh (Co-PI), and D. Schonfeld (Co-PI)
“One-step process for instant ticket validation”
GTECH Corporation
\$5,000
1997

D. Schonfeld (PI)
“National Communications Forum”
International Engineering Consortium (IEC)
\$500
2000

D. Schonfeld (PI)
“Real-Time Very-Low Bit-Rate MPEG-4 Video Compression for Wireless Communication Application”
Neomagic Corporation
\$69,553
2001-2003

A. Khokhar (PI), R. Ansari (Co-PI), R. Grossman (Co-PI), D. Schonfeld (Co-PI), and C. Yu (Co-PI)
“High-Speed Terabyte Storage Server Based on Intelligent Disk Technology”
Army Research Office (ARO)
DURIP Program
\$422,626
2002-2004

D. Schonfeld (PI)
“Computer Architectures for Real-Time Video Communications”
Neomagic Corporation
\$76,075

2002-2004

M. Dutta (PI) et al.
“Design of a Super-Biological Eye Sensor System”
Defense Advanced Research Projects Agency (DARPA)
Army Research Office (ARO)
\$200,000 (Seed Project)
2002-2003

D. Schonfeld (PI)
“OMAP Code Composure Studio Software for Real-Time Video Communications”
Texas Instruments, Inc.
DSP University Program
\$4,500
2003

D. Schonfeld (PI)
“Real-Time Object Tracking of Video Sequences on Associative Processor Arrays”
Neomagic Corporation
\$68,750
2003-2005

D. Schonfeld (PI)
“Real-Time Low-Power High-Quality Interactive Video Telephony
for Wireless Communication Applications”
Motorola, Inc.
\$19,331
2004-2005

D. Schonfeld (PI)
“Real-Time Low-Power High-Quality Interactive Video Communications
for Video Animation and Stereography”
Motorola, Inc.
\$22,000
2005-2006

D. Schonfeld (PI)
“Real-Time High-Quality Video Communications from Handheld Cameras
Using Video Stabilization and Auto-Focus”
Motorola, Inc.
\$75,000
2005-2008

D. Schonfeld (PI)
“Interactive Video Communications Based on Stereographic Imaging
From a Single Camera”
Motorola, Inc.
\$22,000
2006-2007

A. Khokhar (PI) and D. Schonfeld (Co-PI)

“MotionSearch: Motion Trajectory-Based Object Activity Retrieval and Recognition from Video and Sensor Databases”

National Science Foundation (NSF)

\$410,000

2006-2009

D. Schonfeld (PI)

“Real-Time Financial Forecasting Based on Statistical Signal Processing: Correlation Analysis and Fast Algorithms”

Gelber Group

\$66,522

2006-2007

D. Schonfeld (PI)

“Signal Communication and Processing in a RFID Sensor Network System”

Your Life Essentials

\$4,000

2006-2008

D. Schonfeld (PI)

“MobilePlenoptics: Panoramic Video Communications in Mobile Devices”

Motorola, Inc.

\$22,000

2007-2008

D. Schonfeld (PI)

“Machine Learning and Event Detection in Biological Systems”

VG Bioinformatics, Inc.

\$40,000

2007-2008

A. Khokhar (PI) and D. Schonfeld (Co-PI)

“International Supplement to MotionSearch: Motion Trajectory-Based Object Activity Retrieval and Recognition from Video and Sensor Databases”

National Science Foundation (NSF)

\$37,468

2007-2008

D. Schonfeld (PI)

“InteractiveVision: Collaborative Multiple-Input-Multiple-Output Inverse Problems with Application in Image and Video Processing”

National Science Foundation (NSF)

\$232,496

2007-2010

A. Khokhar (PI) and D. Schonfeld (Co-PI)

“Research Experiences for Undergraduates (REU) Supplement to MotionSearch: Motion Trajectory-Based Object Activity Retrieval and Recognition from Video and Sensor Databases”

National Science Foundation (NSF)

\$12,000

2008-2009

D. Schonfeld (PI)
“Real-time Superresolution for Enhanced Video Streaming”
iKoa Corporation
\$25,000
2008-2009

D. Schonfeld (PI)
“Tracking Performance Evaluation based on a Reflective Model and Perturbation Analysis”
Mitsubishi Electric Research Laboratories (MERL)
\$1,228
2009

R. Magin (PI), M. Ragozzino (Co-PI), K. Rockne (Co-PI), T. Royston (Co-PI), and D. Schonfeld (Co-PI)
“Acquisition of a High Field Magnetic Resonance Imaging System for Science and Engineering Research”
National Science Foundation (NSF)
\$1,995,000
2009

D. Schonfeld (PI), N. Bouaynaya (Key/Senior Personnel), and H.M. Fathallah-Shaykh (Key/Senior Personnel)
“Minimal-Perturbation Dynamic Control of the Melanoma Gene Regulatory Network” (R01)
National Institutes of Health (NIH)
\$1,200,000
2010-2015

X. Joe Zhou (PI), D. Schonfeld (Co-PI), H. Engelhard (Co-PI), R. Magin (Co-PI), and T. Valyi Nagy (Co-PI)
“Probing Intra-voxel Tissue Heterogeneity Using MRI” (R01)
National Institutes of Health (NIH)
NIH R01EB026716-01
\$2,173,399
2018-2023

D. Schonfeld (PI)*
“University of Illinois - New Oriental Artificial Intelligence Research Laboratory (UINO-AIRL)”
New Oriental Education & Technology Group Inc.
\$1,600,425
2019-2024

* Funding was approved by the research sponsor but declined by the university because of potential conflict with export controls.

B. Prasad (PI), D. Schonfeld (Co-Investigator), S. Basu (Collaborator), M. Maienschein-Cline (Collaborator)
“Machine Learning and Exosome Derived Biomarkers of Obstructive Sleep Apnea Induced Hypertension”
National Institutes of Health (NIH)
NIH R01EB026716-01
\$676,935

Q. ADMINISTRATIVE ACTIVITIES

Q.1. Administrative Positions

Director

University-Industry Engineering Research Center (UIERC)

College of Engineering

University of Illinois at Chicago

2008—2011

Supervisor

Web Development

Department of Electrical & Computer Engineering

University of Illinois at Chicago

2001—2002

Director

Timetable Schedule

Department of Electrical Engineering & Computer Science

University of Illinois at Chicago

1999—2000

Q.2. University Committees

Co-Chair

University All-Campus Promotion and Tenure Committee

University of Illinois at Chicago

2010—2011

Member

Graduate College Executive Committee

University of Illinois at Chicago

2020—2022

Member

COVID-19 Relief Fund Application Review Committee

University of Illinois at Chicago

2022

Member

Dean Review Committee

University of Illinois at Chicago

2017—2018

Member

Graduate Mentor Award Committee

University of Illinois at Chicago
2014—2016

Member
Chancellor's Graduate Research Fellowship Program
University of Illinois at Chicago
2014—2016

Member
University Vision and Strategy
University of Illinois at Chicago
2012—Present

Member
University Ad-Hoc Advisory Committee for the Office of Faculty Affairs
University of Illinois at Chicago
2012—2013

Member
University Task Force to Review Non-Tenure Promotion Guidelines
University of Illinois at Chicago
2011—2012

Member
University Promotion and Tenure Norms and Criteria Committee
University of Illinois at Chicago
2011—2012

Member
University Honorary Degree Nominating Committee
University of Illinois at Chicago
2010—2011

Member
University Promotion and Tenure Seminar Panel
Natural Science, Health Science, and Engineering
University of Illinois at Chicago
2010—2011

Member
University All-Campus Promotion and Tenure Committee
University of Illinois at Chicago
2008—2011

Member
University Campus Research Board Committee
University of Illinois at Chicago
2001—2004

Member
University Awards Committee

University of Illinois at Chicago
1998—2001

Member

Student Appeals Board

University of Illinois at Chicago
2004—2005

Q.3. College Committees

Member

College Executive Committee

College of Engineering
University of Illinois at Chicago
2009-2012, 2015-2017; 2019-2020; 2022-2023

Member

Dean of the College of Engineering Search Committee

College of Engineering
University of Illinois at Chicago
2007-2008

Member

Wexler Chair in Information Technology Search Committee

College of Engineering
University of Illinois at Chicago
2006

Member

Advisory Committee for Bioinformatics Program in Bioengineering

University of Illinois at Chicago
2000—2010

Chair

Networking Curriculum Subcommittee

College of Engineering
University of Illinois at Chicago
2005

Member

Departmental Reorganization and Formation Committee

College of Engineering
Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
1999—2000

Q.4. Departmental Committees

Mentoring Coordinator

Department of Electrical & Computer Engineering

University of Illinois at Chicago
2021—Present

Chair

Departmental Faculty Search Committee

Department of Electrical & Computer Engineering
University of Illinois at Chicago
2006-2008; 2010-2011; 2016-2017

Chair

Departmental Grievance Committee

Department of Electrical & Computer Engineering
University of Illinois at Chicago
2013—2019

Chair

Departmental Research & Colloquium Committee

Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
1996—1998; 2003—2004

Chair

Departmental Seminar Committee

Department of Electrical & Computer Engineering
University of Illinois at Chicago
2008—2010

Chair

Departmental Web Committee

Department of Electrical & Computer Engineering
University of Illinois at Chicago
2001—2003

Chair

Departmental Web & Computer Committee

Department of Electrical & Computer Engineering
University of Illinois at Chicago
2020-2021

Member

Department of Mathematics, Statistics, and Computer Science

Personnel Review Committee for Jing Wang
2020—2021

Member

Departmental Advisory Committee

Department of Electrical & Computer Engineering
University of Illinois at Chicago
1995—1996; 1998—1999; 2000—2002; 2004—2005; 2007—2010; 2015—2016; 2022—Present

Member

Departmental Computer Committee

Department of Electrical & Computer Engineering
University of Illinois at Chicago
1990—1992; 2001—2004

Member

Departmental Computer & Web Committee

Department of Electrical & Computer Engineering
University of Illinois at Chicago
2013—2016

Member

Departmental Diversity & Inclusion Committee

Department of Electrical & Computer Engineering
University of Illinois at Chicago
2020—2021

Member

Departmental Electronics Instructional Laboratory Committee

Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
1997—1998

Member

Departmental Faculty Search Committee

Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
1994—1995; 1998—2001; 2006—2008; 2010-2011; 2016—2017; 2021—Present

Member

Departmental Graduate Admission and Recruitment

Department of Electrical & Computer Engineering
University of Illinois at Chicago
2022—Present

Member

Departmental Graduate Committee

Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
1995—2000; 2011—2015

Member

Departmental Grievance Committee

Department of Electrical & Computer Engineering
University of Illinois at Chicago
2012—2021

Member

Departmental Promotion & Tenure Committee

Department of Electrical & Computer Engineering
University of Illinois at Chicago

1996—Present

Member

Departmental Research & Colloquium Committee

Department of Electrical Engineering & Computer Science

University of Illinois at Chicago

1992—1998; 2001—2004

Member

Departmental Scholarship Committee

Department of Electrical Engineering & Computer Science

University of Illinois at Chicago

1990—1996

Member

Departmental Scholarship & Awards Committee

Department of Electrical & Computer Engineering

University of Illinois at Chicago

2019—Present

Member

Departmental Seminar Committee

Department of Electrical & Computer Engineering

University of Illinois at Chicago

2008—2013

Member

Departmental Undergraduate Committee

Department of Electrical & Computer Engineering

University of Illinois at Chicago

1998—2003; 2005—2011; 2015—2019

Member

Departmental Web Committee

Department of Electrical & Computer Engineering

University of Illinois at Chicago

2000—2011

Member

Departmental Web & Computer Committee

Department of Electrical & Computer Engineering

University of Illinois at Chicago

2019-2021

Q.5. Curriculum Committees

Chair

Departmental Communications and Networks Curriculum Subcommittee

of the Undergraduate and Graduate Committees

Department of Electrical & Computer Engineering
University of Illinois at Chicago
2001—2002; 2004

Chair

Departmental Signal Processing Curriculum Subcommittee
of the Undergraduate and Graduate Committees
Department of Electrical & Computer Engineering
University of Illinois at Chicago
2011

Member

Departmental Communications Curriculum Subcommittee
of the Undergraduate and Graduate Committees
Department of Electrical & Computer Engineering
University of Illinois at Chicago
2011

Member

Departmental Communications and Networking Curriculum Subcommittee
of the Undergraduate and Graduate Committee
Department of Electrical & Computer Engineering
University of Illinois at Chicago
2001—2002; 2004

Member

Departmental Computer Engineering Curriculum Subcommittee
of the Undergraduate and Graduate Committee
Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
1998—2002

Member

Departmental Electrical Engineering Curriculum Subcommittee
of the Undergraduate and Graduate Committee
Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
1996—2000

Member

Departmental Imaging Curriculum Subcommittee
of the Undergraduate and Graduate Committees
Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
1993

Member

Departmental Information and Computer Systems Curriculum Subcommittee
of the Undergraduate and Graduate Committees
Department of Electrical & Computer Engineering
University of Illinois at Chicago

2011

Member

Departmental Masters of Engineering Program Subcommittee
of the Graduate Committee
Department of Electrical & Computer Engineering
University of Illinois at Chicago
2005

Member

Departmental Multimedia Curriculum Subcommittee
of the Undergraduate and Graduate Committees
Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
2005

Member

Departmental Networking Curriculum Subcommittee
of the Undergraduate and Graduate Committees
Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
1999—2000; 2005

Member

Departmental Signals and Systems Curriculum Subcommittee
of the Graduate Committee
Department of Electrical & Computer Engineering
University of Illinois at Chicago
2004

Member

Departmental Signal Processing Curriculum Subcommittee
of the Undergraduate and Graduate Committees
Department of Electrical & Computer Engineering
University of Illinois at Chicago
2011

Member

Departmental Signal Processing and Communications Curriculum Subcommittee
of the Undergraduate and Graduate Committees
Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
1991

Member

Departmental Student Cheating Policy Subcommittee
of the Undergraduate Committee
Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
1999

Member

Departmental Teaching Assistant Assignment Subcommittee
of the Undergraduate Committee
Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
1996—1997

Member

Departmental Teaching Assistant Award Subcommittee
of the Scholarship Committee
Department of Electrical Engineering & Computer Science
University of Illinois at Chicago
1994

Q.6. Qualifier Committees

Chair

Departmental Communications Qualifier Committee
Department of Electrical & Computer Engineering
University of Illinois at Chicago
2003—2004; 2012

Chair

Departmental Computer Communication Network Qualifier Committee
Department of Electrical & Computer Engineering
University of Illinois at Chicago
2002—2003; 2005

Chair

Departmental Signal Processing Qualifier Committee
Department of Electrical & Computer Engineering
University of Illinois at Chicago
1991—1995; 2001; 2002; 2008—2014, 2015—Present

Member

Departmental Communications Qualifier Committee
Department of Electrical & Computer Engineering
University of Illinois at Chicago
1997—2004; 2009—2014

Member

Departmental Computer Communications Networks Qualifier Committee
Department of Electrical & Computer Engineering
University of Illinois at Chicago
2002—2005

Member

Departmental Computer Vision Qualifier Committee
Department of Electrical Engineering & Computer Science
University of Illinois at Chicago

1993—2001

Member

Departmental Signal Processing Qualifier Committee

Department of Electrical & Computer Engineering

University of Illinois at Chicago

1991—2001; 2004—Present

Q.7. Research Laboratories and Centers

Director

University-Industry Engineering Research Center (UIERC)

College of Engineering

University of Illinois at Chicago

2008—2011

Co-Director

Multimedia Communications Laboratory (MCL)

Department of Electrical & Computer Engineering

University of Illinois at Chicago

1997—Present

Member

Departmental Signal and Image Research Laboratory (SIRL)

Department of Electrical & Computer Engineering

University of Illinois at Chicago

1991—2002

R. TEACHING ACTIVITIES

R.1. The Johns Hopkins University

ECE 137

Digital Signals and Systems

Fall 1987

ECE 137

Digital Signals and Systems

Fall 1988

ECE 137

Digital Signals and Systems

Fall 1989

R.2. University of Illinois at Chicago

EECS 212

Signal Processing

Fall 1990

EECS 212

Signal Processing

Winter 1991

EECS 416

Advanced Topics in Digital Signal Processing

Spring 1991

EECS 417

Digital Signal Processing

Fall 1991

EECS 554

Estimation Theory

Fall 1991

EECS 311

Communication Engineering

Spring 1992

EECS 554

Estimation Theory

Fall 1992

EECS / BioE 479

Real-Time Data Processing

Spring 1993

EECS / BioE 479

Real-Time Data Processing

Fall 1993

EECS 516

Optimal and Adaptive Digital Filters

Fall 1993

EECS 517

Image Processing

Spring 1994

EECS / BioE 479

Real-Time Data Processing

Fall 1994

EECS 517

Image Processing

Spring 1995

EECS 531

Detection and Estimation Theory
Spring 1995

EECS / BioE 479
Real-Time Data Processing
Fall 1995

EECS 517
Image Processing
Spring 1996

EECS 531
Detection and Estimation Theory
Spring 1996

EECS 530
Statistical Communication Theory
Fall 1996

EECS 517
Image Processing
Spring 1997

EECS / BioE 407
Pattern Recognition
Fall 1997

EECS 530
Statistical Communication Theory
Fall 1997

EECS / BioE 407
Pattern Recognition
Spring 1998

EECS 517
Image Processing
Spring 1998

EECS 517
Image Processing
Motorola Campus
Spring 1998

EECS 171
Introduction to Programming
Summer 1998

EECS 516
Optimal and Adaptive Digital Filters
Fall 1998

EECS 530

Statistical Communication Theory
Motorola Campus
Fall 1998

EECS 418

Digital Signal Processing II
Spring 1999

EECS 517

Image Processing
Spring 1999

EECS 531

Detection and Estimation Theory
Motorola Campus
Spring 1999

EECS 171

Introduction to Programming
Summer 1999

EECS 417

Digital Signal Processing I
Fall 1999

EECS 491

Multimedia Communication Networks
Spring 2000

EECS 311

Communication Engineering
Summer 2000

EECS 491

Multimedia Communication Networks
Internet Course (Preparation)
Fall 2000

EECS 516

Optimal and Adaptive Digital Filters
Fall 2000

EECS 531

Detection and Estimation Theory
Fall 2000

EECS 491

Multimedia Communication Networks
Internet Course

Spring 2001

EECS 517

Image Processing
Spring 2001

EECS 171

Introduction to Programming
Summer 2001

ECE 516

Optimal and Adaptive Digital Filters
Fall 2001

ECE 531

Detection and Estimation Theory
Fall 2001

ECE 434

Multimedia Communication Networks
Internet Course
Spring 2002

ECE 517

Image Processing
Spring 2002

CS 102

Introduction to Programming
Summer 2002

ECE 433

Computer Communication Networks
Fall 2002

ECE 434

Multimedia Communication Networks
Fall 2002

ECE 333

Computer Communication Networks
Laboratory (Preparation)
Spring 2003

ECE 311

Communication Engineering
Fall 2003

ECE 434

Multimedia Communication Networks
Fall 2003

ECE 517

Image Processing
Spring 2004

ECE 434

Multimedia Communication Networks
Fall 2004

ECE 516

Optimal and Adaptive Digital Filters
Fall 2004

ECE 517

Image Processing
Spring 2005

ECE 311

Communication Engineering
Summer 2005

ECE 434

Multimedia Systems
Fall 2005

ECE 516

Optimal and Adaptive Digital Filters
Fall 2005

ECE 517

Image Processing
Spring 2006

ECE 311

Communication Engineering
Summer 2006

ECE 434

Multimedia Systems
Fall 2006

ECE 516

Optimal and Adaptive Digital Filters
Fall 2006

ECE 531

Detection and Estimation Theory
Spring 2007

ECE 311

Communication Engineering

Summer 2007

ECE 434

Multimedia Systems

Fall 2007

ECE 516

Optimal and Adaptive Digital Filters

Fall 2007

ECE 531

Detection and Estimation Theory

Spring 2008

ECE 434

Multimedia Systems

Fall 2008

ECE 516

Optimal and Adaptive Digital Filters

Fall 2008

ECE 530

Random Signal Analysis

Spring 2009

ECE 517

Image Processing

Fall 2009

ECE/BIOE 407

Pattern Recognition

Spring 2010

ECE 434

Multimedia Systems

Fall 2010

ECE 530

Random Signal Analysis

Spring 2011

ECE 434

Multimedia Systems

Fall 2011

ECE 530

Random Signal Analysis

Spring 2012

ECE 594

Machine Learning
Spring 2012

ECE 434
Multimedia Systems
Fall 2012

ECE 517
Image Processing
Fall 2012

ECE 530
Random Signal Analysis
Spring 2013

ECE 434
Multimedia Systems
Fall 2013

ECE 517
Image Processing
Fall 2013

ECE 434
Multimedia Systems
Fall 2014

ECE 517
Image Processing
Fall 2014

ECE 434
Multimedia Systems
Fall 2015

ECE 517
Image Processing
Fall 2015

ECE 434
Multimedia Systems
Fall 2015

ECE 517
Image Processing
Fall 2015

ECE 407
Pattern Recognition
Spring 2016

ECE 530
Random Signal Analysis
Spring 2016

ECE 434
Multimedia Systems
Fall 2016

ECE 517
Image Processing
Fall 2016

ECE 407
Pattern Recognition
Spring 2017

ECE 434
Multimedia Systems
Fall 2017

ECE 517
Image Processing
Fall 2017

ECE 517
Image Processing
Spring 2018

ECE 530
Random Signal Analysis
Spring 2018

ECE 434
Multimedia Systems
Fall 2018

ECE 517
Image Processing
Fall 2018

ECE 530
Random Signal Analysis
Spring 2019

ECE 434
Multimedia Systems
Fall 2019

ECE 517
Image Processing
Spring 2020

ECE 530

Random Signal Analysis
Spring 2020

ECE 434

Multimedia Systems
Fall 2020

ECE 530

Random Signal Analysis
Spring 2021

ECE 531

Detection and Estimation Theory
Spring 2021

ECE 434

Multimedia Systems
Fall 2021

ECE 517

Image Processing
Fall 2021

ECE 530

Random Signal Analysis
Spring 2022

ECE 531

Detection and Estimation Theory
Spring 2022

ECE 434

Multimedia Systems
Fall 2022

ECE 517

Image Processing
Fall 2022

ECE 530

Random Signal Analysis
Spring 2023

R.3. University of Trento**Content-Based Video Analysis: Tracking, Retrieval, and Classification**

Information and Communication Technology (ICT) – International Doctoral School

Department of Information Engineering and Computer Science
University of Trento
May 2010

APPENDIX B

APPENDIX B TO SCHONFELD DECLARATION - Claim Chart of U.S. Provisional Patent Application No. 60/284,593 (Ex. 1029) against Published Claim No. 1 of Davis (Ex. 1004)

Limitation No.	Published Claim 1 of Davis	Supporting Disclosure of U.S. Provisional Patent No. 60/284,593 (“Davis Provis.”)
1[pre]	1. A satellite communication system, comprising:	<i>See, e.g.:</i> • Davis Provis. at 3: Current satellite antennas use cables to connect the antenna with what is commonly called the “indoor unit”, the device that the user connects to to [sic] send/receive data. (Data can include digitized A/V material, such as DIRECTV). As satellite based services evolve, more and more cables are required. Units are now being built that have 2 receive cables, or a receive and transmit cable. In the short term the number of cables could increase to 5 or 10 with currently envisioned services. This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding any new cables. EXPLAIN THE PURPOSE AND ADVANTAGES OF YOUR INVENTION (WHAT WILL THE INVENTION ... DO BETTER THAN DONE PREVIOUSLY?) • Minimizes number of cables to be run from the outdoor unit (maximum 2); • Minimizes cables to be run between outdoor unit and any particular indoor unit • Allows mazy indoor units to access one outdoor unit. • Allows new indoor units/new services to be added after initial installation without any new cables • Greatly simplifies installation in MDU's (Multi dwelling units) • Enables subscription services like home security and diagnostics/maintenance of appliances.

APPENDIX B TO SCHONFELD DECLARATION - Claim Chart of U.S. Provisional Patent Application No. 60/284,593 (Ex. 1029) against Published Claim No. 1 of Davis (Ex. 1004)

Limitation No.	Published Claim 1 of Davis	Supporting Disclosure of U.S. Provisional Patent No. 60/284,593 (“Davis Provis.”)
1[a]	at least one satellite antenna for receiving a signal transmitted from a satellite, wherein said satellite antenna includes at least one Low Noise Block (LNB) converter;	<i>See, e.g.:</i> • Davis Provis. at 3: Current satellite antennas use cables to connect the antenna with what is commonly called the “indoor unit”, the device that the user connects to to [sic] send/receive data. (Data can include digitized A/V material, such as DIRECTV). As satellite based services evolve, more and more cables are required. • Davis Provis. at 7: This invention uses the same connectivity as the multiswitch on the ODU side (one cable for each LNB) but replaces the multiswitch to IDU cable with a LAN. To do this, this invention has receivers inside for each LNB that convert the RF input to digital base band information.
1[b]	an interface device including a connection to said LNB,	<i>See, e.g.:</i> • Davis Provis. at 5: The interface between the indoor units(s) and outdoor unit of DirecPC/DIRECTV/DirecWay/Spaceway all could use this invention. ... Wireless connections between ODU and IDU have been proposed before. As far as I know, these have been analog repeaters of the signals on the IDU/ODU cable, and performing allocated [sic] the same functions as the cable. Using a LAN allows multiple access, and greatly increased flexibility for future services via an industry standard method. • Davis Provis. at 7:

APPENDIX B TO SCHONFELD DECLARATION - Claim Chart of U.S. Provisional Patent Application No. 60/284,593 (Ex. 1029) against Published Claim No. 1 of Davis (Ex. 1004)

Limitation No.	Published Claim 1 of Davis	Supporting Disclosure of U.S. Provisional Patent No. 60/284,593 (“Davis Provis.”)
		This invention uses the same connectivity as the multiswitch on the ODU side (one cable for each LNB) but replaces the multiswitch to IDU cable with a LAN. To do this, this invention has receivers inside for each LNB that convert the RF input to digital base band information. This digital baseband information can be filtered to discard unwanted information, can be compressed if it is not already, and can be encrypted for privacy if desired. The digital baseband data is then multiplexed together and sent via the LAN to the receiving IDU(s). Data can be sent point to point or broadcast.
1[c]	and further including a connection to a local area network (LAN) connecting together a plurality of indoor units (IDUs),	<i>See, e.g.:</i> • Davis Provis. at 3: As satellite based services evolve, more and more cables are required. Units are now being built that have 2 receive cables, or a receive and transmit cable. In the short term the number of cables could increase to 5 or 10 with currently envisioned services. This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding any new cables. • Davis Provis. at 5: The interface between the indoor units(s) and outdoor unit of DirecPC/DIRECTV/DirecWay/Spaceway all could use this invention. ... Wireless connections between ODU and IDU have been proposed before. As far as I know, these have been analog repeaters of the signals on the IDU/ODU cable, and performing allocated [sic] the same functions as the cable. Using a LAN allows multiple access, and

APPENDIX B TO SCHONFELD DECLARATION - Claim Chart of U.S. Provisional Patent Application No. 60/284,593 (Ex. 1029) against Published Claim No. 1 of Davis (Ex. 1004)

Limitation No.	Published Claim 1 of Davis	Supporting Disclosure of U.S. Provisional Patent No. 60/284,593 (“Davis Provis.”)
		greatly increased flexibility for future services via an industry standard method. • Davis Provis. at 7: This invention uses the same connectivity as the multiswitch on the ODU side (one cable for each LNB) but replaces the multiswitch to IDU cable with a LAN. To do this, this invention has receivers inside for each LNB that convert the RF input to digital base band information. This digital baseband information can be filtered to discard unwanted information, can be compressed if it is not already, and can be encrypted for privacy if desired. The digital baseband data is then multiplexed together and sent via the LAN to the receiving IDU(s). Data can be sent point to point or broadcast.
1[d]	wherein said interface device converts said transmitted signal received from said LNB into a digital baseband signal to be transmitted across said LAN to at least one of the plurality of IDUs.	<i>See, e.g.:</i> • Davis Provis. at 7: This invention uses the same connectivity as the multiswitch on the ODU side (one cable for each LNB) but replaces the multiswitch to IDU cable with a LAN. To do this, this invention has receivers inside for each LNB that convert the RF input to digital base band information. This digital baseband information can be filtered to discard unwanted information, can be compressed if it is not already, and can be encrypted for privacy if desired. The digital baseband data is then multiplexed together and sent via the LAN to the receiving IDU(s). Data can be sent point to point or broadcast.

APPENDIX C

**APPENDIX C TO SCHONFELD DECLARATION - Subject Matter Support Chart of U.S. Provisional Patent Application
No. 60/284,593 (Ex. 1029) for Cited Disclosure of Davis (Ex. 1004)**

Specification Passages Cited from Davis	Supporting Disclosure for Subject Matter of Passage Cited from U.S. Provisional Patent No. 60/284,593 ("Davis Provis.")
[Abstract] A satellite communication system including an interface device for distributing satellite signals received from an outdoor unit (ODU) to a plurality of indoor units (IDUs) connected to a local area network (LAN), at a particular site. Only two cables, a power cable and a cable connected to the LAN, must be installed between the interface device and the site containing the IDUs. Accordingly, the installation of IDUs at a site is simplified and has the flexibility of allowing future satellite based services to be added without requiring the installation of new cables between the ODU and the IDUs. The satellite communication system also permit flexibility among connected devices, including to which other devices they are connected, how they are connected to other devices and what types of connections are used.	• Davis Provis. at 3: Current satellite antennas use cables to connect the antenna with what is commonly called the "indoor unit", the device that the user connects to to [sic] send/receive data. (Data can include digitized A/V material, such as DIRECTV). As satellite based services evolve, more and more cables are required. Units are now being built that have 2 receive cables, or a receive and transmit cable. In the short term the number of cables could increase to 5 or 10 with currently envisioned services. This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding any new cables. EXPLAIN THE PURPOSE AND ADVANTAGES OF YOUR INVENTION (WHAT WILL THE INVENTION DO BETTER THAN DONE PREVIOUSLY?) • Minimizes number of cables to be run from the outdoor unit (maximum 2); • Minimizes cables to be run between outdoor unit and any particular indoor unit • Allows many indoor units to access one outdoor unit. • Allows new indoor units/new services to be added after initial installation without any new cables

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No. 60/284,593 (Ex. 1029) for Cited Disclosure of Davis (Ex. 1004)**

Specification Passages Cited from Davis	Supporting Disclosure for Subject Matter of Passage Cited from U.S. Provisional Patent No. 60/284,593 ("Davis Provis.")
	• Greatly simplifies installation in MDU's (Multi dwelling units) • Enables subscription services like home security and diagnostics/maintenance of appliances. • Davis Provis. at 5: The interface between the indoor units(s) and outdoor unit of DirecPC/DIRECTV/ DirecWay/Spaceway all could use this invention. ... Wireless connections between ODU and IDU have been proposed before. As far as I know, these have been analog repeaters of the signals on the IDU/ODU cable, and performing allocated [sic] the same functions as the cable. Using a LAN allows multiple access, and greatly increased flexibility for future services via an industry standard method. • Davis Provis. at 7: This invention uses the same connectivity as the multiswitch on the ODU side (one cable for each LNB) but replaces the multiswitch to IDU cable with a LAN. To do this, this invention has receivers inside for each LNB that convert the RF input to digital base band information. This digital baseband information can be filtered to discard unwanted information, can be compressed if it is not already, and can be encrypted for privacy if desired. The digital baseband data is then multiplexed together and sent via the LAN to the receiving IDU(s). Data can be sent point to point or broadcast.

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No. 60/284,593 (Ex. 1029) for Cited Disclosure of Davis (Ex. 1004)**

Specification Passages Cited from Davis	Supporting Disclosure for Subject Matter of Passage Cited from U.S. Provisional Patent No. 60/284,593 ("Davis Provis.")
	Data to be transmitted over the satellite and control data for the receivers in this invention is sent over the LAN to the unit from the transmitting IDU. A cable connectin [sic] exists from this invention to the transmitter on the ODU, as is current practice.
[¶4] Satellite antennas generally comprise a parabolic dish preferably constructed of metal, which reflects and focuses the incoming signals toward a feedhorn. The feedhorn is a device that is positioned in front (usually supported by an arm structure) for gathering the focused signal and sending it to a Low Noise Block converter (LNB). The LNB converts a whole band, or block, of frequencies received from the feedhorn into a lower band, while also providing electronic amplification of the received signal. Together, the satellite antenna, feedhorn, and LNB may comprise what is called an outdoor unit (ODU).	• Davis Provis. at 3: Current satellite antennas use cables to connect the antenna with what is commonly called the "indoor unit", the device that the user connects to to [sic] send/receive data. (Data can include digitized A/V material, such as DIRECTV). As satellite based services evolve, more and more cables are required. • Davis Provis. at 7: This invention uses the same connectivity as the multswitch on the ODU side (one cable for each LNB) but replaces the multswitch to IDU cable with a LAN. To do this, this invention has receivers inside for each LNB that convert the RF input to digital base band information.
[¶5] Coaxial cables connect the LNB of the ODU at the satellite antenna to an indoor unit (IDU), which is a unit that may comprise a receiver or a transceiver allowing a user to receive and/or transmit data over the satellite network. One or more of the cables connecting the IDU to the LNB is used to supply the LNB with power, while data is communicated between the LNB and the IDU through one or more other cables.	• Davis Provis. at 3: Current satellite antennas use cables to connect the antenna with what is commonly called the "indoor unit", the device that the user connects to to [sic] send/receive data. (Data can include digitized A/V material, such as DIRECTV). As satellite based services evolve, more and more cables are required. Units are now being built that have 2 receive cables, or a receive and transmit cable. In the short term the number of cables could increase to 5 or 10 with currently envisioned services. This invention replaces these cables with one (power) or two

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Specification Passages Cited from Davis	Supporting Disclosure for Subject Matter of Passage Cited from U.S. Provisional Patent No. 60/284,593 (“Davis Provis.”)
	(power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding any new cables. EXPLAIN THE PURPOSE AND ADVANTAGES OF YOUR INVENTION (WHAT WILL THE INVENTION DO BETTER THAN DONE PREVIOUSLY?) - Minimizes number of cables to be run from the outdoor unit (maximum 2); - Davis Provis. at 5: The interface between the indoor units(s) and outdoor unit of DirecPC/DIRECTV/ DirecWay/Spaceway all could use this invention. ... Wireless connections between ODU and IDU have been proposed before. As far as I know, these have been analog repeaters of the signals on the IDU/ODU cable, and performing allocated [sic] the same functions as the cable. Using a LAN allows multiple access, and greatly increased flexibility for future services via an industry standard method. - Davis Provis. at 7: Current practice will often use what is called a “multiswitch” in an installation. This is a device that has one cable for each LNB on the ODU side, and one cable for each IDU satellite input on the IDU side.

**APPENDIX C TO SCHONFELD DECLARATION - Subject Matter Support Chart of U.S. Provisional Patent Application
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Specification Passages Cited from Davis	Supporting Disclosure for Subject Matter of Passage Cited from U.S. Provisional Patent No. 60/284,593 ("Davis Provis.")
	The multiswitch is responsible for connecting the correct LNB to each IDU as commanded by the IDU. This multiswitch can be co located with the antenna, or remotely mounted. This invention uses the same connectivity as the multiswitch on the ODU side (one cable for each LNB) but replaces the multiswitch to IDU cable with a LAN. To do this, this invention has receivers inside for each LNB that convert the RF input to digital base band information. This digital baseband information can be filtered to discard unwanted information, can be compressed if it is not already, and can be encrypted for privacy if desired. The digital baseband data is then multiplexed together and sent via the LAN to the receiving IDU(s). Data can be sent point to point or broadcast. Data to be transmitted over the satellite and control data for the receivers in this invention is sent over the LAN to the unit from the transmitting IDU. A cable connectin [sic] exists from this invention to the transmitter on the ODU, as is current practice.
[¶6] As satellite based services continue to evolve, the number of cables required for communicating data between the LNB and the IDU will increase. Already, satellite services, which include digital television subscription services such as DIRECTV®, can require multiple cables between the ODU and the IDU. For example, subscribers who also want to view local stations may be required to connect an analog antenna to the ODU for receiving analog radio or television signals (which should be captured and digitized prior to further processing). In this case, even more cables are required for connecting the LNB and the antenna outputs, respectively,	• Davis Provis. at 3: Current satellite annntennas use cables to connect the antenna with what is commonly called the "indoor unit", the device that the user connects to to [sic] send/receive data. (Data can include digitized A/V material, such as DIRECTV). As satellite based services evolve, more and more cables are required. Units are now being built that have 2 receive cables, or a receive and transmit cable. In the short term the number of cables could increase to 5 or 10 with currently envisioned services. This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly

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Specification Passages Cited from Davis	Supporting Disclosure for Subject Matter of Passage Cited from U.S. Provisional Patent No. 60/284,593 ("Davis Provis.")
to the receiver and local antenna feed of the subscriber's television.	increasing the flexibility of the installation to allow future services without adding any new cables. • Davis Provis. at 5: The interface between the indoor units(s) and outdoor unit of DirecPC/DIRECTV/ DirecWay/Spaceway all could use this invention.
[¶7] Other satellite based services are currently offered which use different cables for different satellites, different polarities, and different functions (for example, both a data transmit and data receive cable) to connect the ODU and the IDU. Additional services may further require multiple transmit and receive cables. Services currently envisioned for the near future may require up to five or ten cables.	• Davis Provis. at 3: Current satellite antennas use cables to connect the antenna with what is commonly called the "indoor unit", the device that the user connects to to [sic] send/receive data. (Data can include digitized A/V material, such as DIRECTV). As satellite based services evolve, more and more cables are required. Units are now being built that have 2 receive cables, or a receive and transmit cable. In the short term the number of cables could increase to 5 or 10 with currently envisioned services. This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding any new cables. • Davis Provis. at 5: The interface between the indoor units(s) and outdoor unit of DirecPC/DIRECTV/ DirecWay/Spaceway all could use this invention.
[¶10] For the conventional satellite communication system described above, the addition of new services after the initial installation of the system can be quite inconvenient.	• Davis Provis. at 3: Current satellite antennas use cables to connect the antenna with

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Each new service may require one or more additional cables to be connected between the ODU (either directly from an LNB or from a multiswitch) and the IDU corresponding to the new service. With respect to the example discussed above, if a person living in the building wanted to receive satellite based Internet service (e.g., DIRECPC® or any other information, such as streaming audio and/or video or voice over IP) to his/her home, a new cable must be installed between the multiswitch and a new receiver connected to the person's personal computer (PC). The installation of such cables in a building can be quite complex, expensive and time consuming.	what is commonly called the "indoor unit", the device that the user connects to to [sic] send/receive data. (Data can include digitized A/V material, such as DIRECTV). As satellite based services evolve, more and more cables are required. Units are now being built that have 2 receive cables, or a receive and transmit cable. In the short term the number of cables could increase to 5 or 10 with currently envisioned services. This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding any new cables. EXPLAIN THE PURPOSE AND ADVANTAGES OF YOUR INVENTION (WHAT WILL THE INVENTION DO BETTER THAN DONE PREVIOUSLY?) • Minimizes number of cables to be run from the outdoor unit (maximum 2); • Minimizes cables to be run between outdoor unit and any particular indoor unit • Allows many indoor units to access one outdoor unit. • Allows new indoor units/new services to be added after initial installation without any new cables • Greatly simplifies installation in MDU's (Multi dwelling units) • Enables subscription services like home security and

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Specification Passages Cited from Davis	Supporting Disclosure for Subject Matter of Passage Cited from U.S. Provisional Patent No. 60/284,593 ("Davis Provis.")
	diagnostics/maintenance of appliances. • Davis Provis. at 5: The interface between the indoor units(s) and outdoor unit of DirecPC/DIRECTV/ DirecWay/Spaceway all could use this invention. • Davis Provis. at 7: Current practice will often use what is called a "multiswitch" in an installation. This is a device that has one cable for each LNB on the ODU side, and one cable for each IDU satellite input on the IDU side. The multiswitch is responsible for connecting the correct LNB to each IDU as commanded by the IDU. This multiswitch can be co located with the antenna, or remotely mounted.
[¶11] Further, conventional satellite systems can be quite inflexible. The number of IDUs that can be connected to a multiswitch is limited. When all of the outputs of the multiswitch are occupied, the addition of new services and/or new IDUs would necessitate a reconfiguration of the ODU. Also, current multiswitches are only able to feed each output of a dual LNB into a limited number of receivers. For instance, many of the available multiswitches can distribute a dual LNB output to two different receivers, resulting in a limit of four receivers being connectable to each dual LNB. To allow for more receivers, one would be required to install at least one additional LNB or multiswitch.	• Davis Provis. at 3: Current satellite antennas use cables to connect the antenna with what is commonly called the "indoor unit", the device that the user connects to to [sic] send/receive data. (Data can include digitized A/V material, such as DIRECTV). As satellite based services evolve, more and more cables are required. Units are now being built that have 2 receive cables, or a receive and transmit cable. In the short term the number of cables could increase to 5 or 10 with currently envisioned services. This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding any new cables.

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Specification Passages Cited from Davis	Supporting Disclosure for Subject Matter of Passage Cited from U.S. Provisional Patent No. 60/284,593 (“Davis Provis.”)
	EXPLAIN THE PURPOSE AND ADVANTAGES OF YOUR INVENTION (WHAT WILL THE INVENTION DO BETTER THAN DONE PREVIOUSLY?) - Minimizes number of cables to be run from the outdoor unit (maximum 2); - Minimizes cables to be run between outdoor unit and any particular indoor unit - Allows many indoor units to access one outdoor unit. - Allows new indoor units/new services to be added after initial installation without any new cables - Greatly simplifies installation in MDU's (Multi dwelling units) - Enables subscription services like home security and diagnostics/maintenance of appliances. - Davis Provis. at 7: Current practice will often use what is called a “multiswitch” in an installation. This is a device that has one cable for each LNB on the ODU side, and one cable for each IDU satellite input on the IDU side. The multiswitch is responsible for connecting the correct LNB to each IDU as commanded by the IDU. This multiswitch can be co located with the antenna, or remotely mounted.
[¶12] It would be advantageous to simplify the installation of multiple IDUs at a particular site, while reducing the number of cables required for such an installation. It	Davis Provis. at 3: This invention replaces these cables with one (power) or two (power

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would also be advantageous to substantially increase the number of IDUs that can access a single ODU. Further, it would be advantageous to allow for new IDUs and/or new services to be installed at a particular site without needing to install more cables.	plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding any new cables. EXPLAIN THE PURPOSE AND ADVANTAGES OF YOUR INVENTION (WHAT WILL THE INVENTION DO BETTER THAN DONE PREVIOUSLY?) - Minimizes number of cables to be run from the outdoor unit (maximum 2); - Minimizes cables to be run between outdoor unit and any particular indoor unit - Allows many indoor units to access one outdoor unit. - Allows new indoor units/new services to be added after initial installation without any new cables - Greatly simplifies installation in MDU's (Multi dwelling units) - Enables subscription services like home security and diagnostics/maintenance of appliances.
[¶13] The present invention provides an interface that connects the plurality of LNB outputs to a local area network (LAN), which is connected to each IDU at a particular site. In particular, for each LNB at the ODU side, the interface of the present invention includes a receiver that converts the radio frequency (RF) signal	Davis Provis. at 3: This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding

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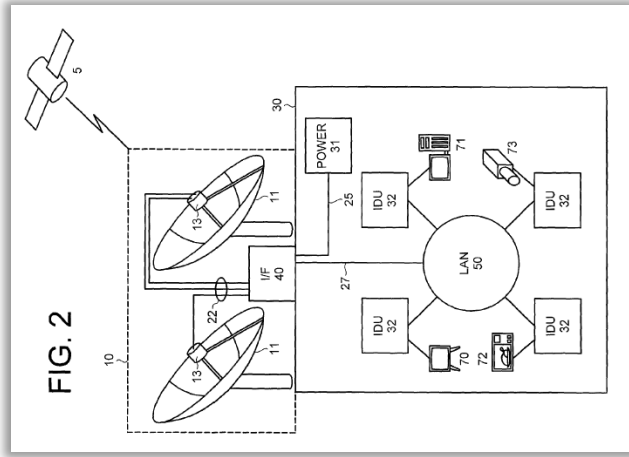
Specification Passages Cited from Davis	Supporting Disclosure for Subject Matter of Passage Cited from U.S. Provisional Patent No. 60/284,593 (“Davis Provis.”)
from the LNB output into digital baseband information. This digital baseband information from each LNB output can be filtered, compressed and encrypted by the interface before being multiplexed together and sent by means of the LAN to the corresponding IDUs. The data can be sent to directly to its intended IDU using point-to-point communications, or alternatively, can be broadcast to each IDU.	any new cables. • Davis Provis. at 5: The interface between the indoor units(s) and outdoor unit of DirecPC/DIRECTV/ DirecWay/Spaceway all could use this invention. ... Wireless connections between ODU and IDU have been proposed before. As far as I know, these have been analog repeaters of the signals on the IDU/ODU cable, and performing ollocated [sic] the same functions as the cable. Using a LAN allows multiple access, and greatly increased flexibility for future services via an industry standard method. • Davis Provis. at 7: Current practice will often use what is called a “multiswitch” in an installation. This is a device that has one cable for each LNB on the ODU side, and one cable for each IDU satellite input on the IDU side. The multiswitch is responsible for connecting the correct LNB to each IDU as commanded by the IDU. This multiswitch can be co located with the antenna, or remotely mounted. This invention uses the same connectivity as the multiswitch on the ODU side (one cable for each LNB) but replaces the multiswitch to IDU cable with a LAN. To do this, this invention has receivers inside for each LNB that convert the RF input to digital base band information. This digital baseband information can be filtered to discard unwanted information, can be compressed if it is not already,

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	and can be encrypted for privacy if desired. The digital baseband data is then multiplexed together and sent via the LAN to the receiving IDU(s). Data can be sent point to point or broadcast. Data to be transmitted over the satellite and control data for the receivers in this invention is sent over the LAN to the unit from the transmitting IDU. A cable connectin [sic] exists from this invention to the transmitter on the ODU, as is current practice.
[¶36] In the satellite communication system illustrated in FIG. 1, the satellite signals may already be encrypted when they are received by ODU 10 and sent to the IDUs 32A and 32B. Accordingly, IDUs 32A and 32B may comprise Integrated Receiver Decoders (IRDs), which include a processor for decrypting or descrambling the received signal. Further, IRDs may perform other functions, such as providing an electronic program guide (EPG) or recording certain programs on satellite TV signals.	• Davis Provis. at 3: Current satellite anntennas use cables to connect the antenna with what is commonly called the "indoor unit", the device that the user connects to to [sic] send/receive data. (Data can include digitized A/V material, such as DIRECTV). As satellite based services evolve, more and more cables are required. • Davis Provis. at 7: Current practice will often use what is called a "multiswitch" in an installation. This is a device that has one cable for each LNB on the ODU side, and one cable for each IDU satellite input on the IDU side. The multiswitch is responsible for connecting the correct LNB to each IDU as commanded by the IDU. This multiswitch can be co located with the antenna, or remotely mounted.
[¶37 & Figure 2] FIG. 2 illustrates an exemplary embodiment of the present invention where an interface device 40 connects the LNB 13 of an ODU 10 to multiple IDUs in conjunction with a wired LAN 50. The ODU 10 includes one or more satellite antennas 11, each of which	• Davis Provis. at 3: Current satellite anntennas use cables to connect the antenna with what is commonly called the "indoor unit", the device that the user connects to to [sic] send/receive data. (Data can include digitized A/V

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includes one (or more) LNB 13. The LNB outputs are then connected via cables 22 to the interface device 40. Interface device 25 includes two output cables, including a power cable 25 connected to power source 31 within site 30, and a LAN connection 27 that is connected to LAN 50 running through site 30. The LAN 50 is connected to a plurality of IDUs 32. FIG. 2 as illustrated shows a dedicated cable 27 for the LAN connection. An existing cable, such as power cable 25, could also be used for the LAN connection.	material, such as DIRECTV). ... This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding any new cables. EXPLAIN THE PURPOSE AND ADVANTAGES OF YOUR INVENTION (WHAT WILL THE INVENTION DO BETTER THAN DONE PREVIOUSLY?) • Minimizes number of cables to be run from the outdoor unit (maximum 2); • Minimizes cables to be run between outdoor unit and any particular indoor unit • Allows many indoor units to access one outdoor unit. • Allows new indoor units/new services to be added after initial installation without any new cables • Greatly simplifies installation in MDU's (Multi dwelling units) • Enables subscription services like home security and diagnostics/maintenance of appliances. • Davis Provis. at 5: The interface between the indoor units(s) and outdoor unit of DirecPC/DIRECTV/ DirecWay/Spaceway all could use this invention.



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	... Wireless connections between ODU and IDU have been proposed before. As far as I know, these have been analog repeaters of the signals on the IDU/ODU cable, and performing allocated [sic] the same functions as the cable. Using a LAN allows multiple access, and greatly increased flexibility for future services via an industry standard method. • Davis Provis. at 7: This invention uses the same connectivity as the multiswitch on the ODU side (one cable for each LNB) but replaces the multiswitch to IDU cable with a LAN. To do this, this invention has receivers inside for each LNB that convert the RF input to digital base band information. This digital baseband information can be filtered to discard unwanted information, can be compressed if it is not already, and can be encrypted for privacy if desired. The digital baseband data is then multiplexed together and sent via the LAN to the receiving IDU(s). Data can be sent point to point or broadcast. Data to be transmitted over the satellite and control data for the receivers in this invention is sent over the LAN to the unit from the transmitting IDU. A cable connectin [sic] exists from this invention to the transmitter on the ODU, as is current practice.

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[¶38] The interface device 40 may be configured as part of the ODU 10, as shown in FIG. 2, and may even be integrated into a satellite antenna 11. Alternatively, the interface device 40 may be located apart from the ODU 10, either inside the building 30 (such as an attic) or at another outdoor location (such as on the roof). The interface device 40 may receive a single cable 22 from each LNB 13 at ODU 10. The interface device 40 may be connected to the ODU 10 via transmission cables (not shown). The transmission cables may allow the interface device 40 to send a signal to a satellite antenna 11, which is configured to transmit the signal to another site via satellite 5.	• Davis Provis. at 7: Current practice will often use what is called a "multiswitch" in an installation. This is a device that has one cable for each LNB on the ODU side, and one cable for each IDU satellite input on the IDU side. The multiswitch is responsible for connecting the correct LNB to each IDU as commanded by the IDU. This multiswitch can be co located with the antenna, or remotely mounted. This invention uses the same connectivity as the multiswitch on the ODU side (one cable for each LNB) but replaces the multiswitch to IDU cable with a LAN. ... Data to be transmitted over the satellite and control data for the receivers in this invention is sent over the LAN to the unit from the transmitting IDU. A cable connectin [sic] exists from this invention to the transmitter on the ODU, as is current practice.
[¶39] As shown in FIG. 2, each IDU 32 is associated with one or more satellite services. Such services may include satellite television 70, satellite based Internet service for a device 71, diagnostics/maintenance of appliances 72, and home security 73. Services such as appliance diagnostics/maintenance 72 and home security 73, may require data to be measured or collected at their corresponding IDUs 32 and transmitted back to a central processing location (not shown) for analysis. Conventional satellite communication systems (e.g., the system illustrated in FIG. 1) would require both a	• Davis Provis. at 3: Current satellite anntennas use cables to connect the antenna with what is commonly called the "indoor unit", the device that the user connects to to [sic] send/receive data. (Data can include digitized A/V material, such as DIRECTV). As satellite based services evolve, more and more cables are required. ... This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to

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receiving and transmitting cable to connect these IDUs 32 to the multiswitch 20. However, by connecting the interface device 40 to each IDU 32 via LAN 50, the interface device 40 can both transmit and receive data from all of the IDUs 32 connected to a single data bus.	allow future services without adding any new cables. EXPLAIN THE PURPOSE AND ADVANTAGES OF YOUR INVENTION (WHAT WILL THE INVENTION DO BETTER THAN DONE PREVIOUSLY?) • Minimizes number of cables to be run from the outdoor unit (maximum 2); • Minimizes cables to be run between outdoor unit and any particular indoor unit • Allows many indoor units to access one outdoor unit. • Allows new indoor units/new services to be added after initial installation without any new cables • Greatly simplifies installation in MDU's (Multi dwelling units) • Enables subscription services like home security and diagnostics/maintenance of appliances. • Davis Provis. at 5: The interface between the indoor units(s) and outdoor unit of DirecPC/DIRECTV/ DirecWay/Spaceway all could use this invention. • Davis Provis. at 7: Data to be transmitted over the satellite and control data for the receivers in this invention is sent over the LAN to the unit from the transmitting IDU. A cable connectin [sic] exists from this invention to

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	the transmitter on the ODU, as is current practice.
[¶41] The elements of the LNB interface 41 may be conventional elements, such as a tuner/demodulator pair for processing an input from each cable 22. The tuner/demodulator pair processes an RF input from each cable 22 and produces a corresponding digital output. The digital outputs from each tuner/demodulator pair are multiplexed together and sent to the received signal processing and encryption unit 44. Similarly, the output from the transmission signal processing unit 42 is demultiplexed into plural inputs, sent to tuner/modulator pairs for conversion back into RF signals and sent out of cables 22.	• Davis Provis. at 7: This invention uses the same connectivity as the multiswitch on the ODU side (one cable for each LNB) but replaces the multiswitch to IDU cable with a LAN. To do this, this invention has receivers inside for each LNB that convert the RF input to digital base band information. This digital baseband information can be filtered to discard unwanted information, can be compressed if it is not already, and can be encrypted for privacy if desired. The digital baseband data is then multiplexed together and sent via the LAN to the receiving IDU(s). Data can be sent point to point or broadcast.
[¶45] The operation of the interface device 40 will now be described in connection with FIGS. 2 and 5. Once the RF signal transmitted by a satellite 5 is received into a particular LNB 13, the signal may be sent to a corresponding input/output port of LNB interface 41. The RF signal may then be sent to the received signal processing and encryption unit 44, where the signal is converted into a digital baseband signal. The received signal processing and encryption unit 44 may perform other signal processing on the baseband signal, such as filtering noise and other unwanted information. In addition, the received signal processing and encryption unit 44 may encrypt the digital baseband signal, such that only IDUs having a certain decryption key will be able to decrypt the signal and access the information contained	• Davis Provis. at 7: Current practice will often use what is called a “multiswitch” in an installation. This is a device that has one cable for each LNB on the ODU side, and one cable for each IDU satellite input on the IDU side. The multiswitch is responsible for connecting the correct LNB to each IDU as commanded by the IDU. This multiswitch can be co located with the antenna, or remotely mounted. This invention uses the same connectivity as the multiswitch on the ODU side (one cable for each LNB) but replaces the multiswitch to IDU cable with a LAN. To do this, this invention has receivers inside for each LNB that convert the RF input to digital base band information. This digital baseband information can be filtered to discard unwanted information, can be compressed if it is not already, and can be encrypted for privacy if desired. The digital baseband data

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therein.	is then multiplexed together and sent via the LAN to the receiving IDU(s). Data can be sent point to point or broadcast.
[¶46] The processed digital signal may then be sent to the network protocols and services processing unit 45, which assembles the data into message packets, determines the destination address of each packet, and controls the transmission of such packets according to a set of network protocols. The specific software for running these network protocols may be stored in controller 43. The message packets are then transmitted to the LAN 50 through LAN interface 46 and LAN cable 27.	• Davis Provis. at 3: This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding any new cables. • Davis Provis. at 5: Using a LAN allows multiple access, and greatly increased flexibility for future services via an industry standard method. • Davis Provis. at 7: The digital baseband data is then multiplexed together and sent via the LAN to the receiving IDU(s). Data can be sent point to point or broadcast.
[¶47] In an exemplary embodiment, the network protocols and services unit 45 may employ point-to-point communications to transmit packets of the baseband signal directly to the IDU 32 for which the signal is intended (e.g., signals are sent directly to the receiver at the site 30). The network protocols and services unit 45 may alternatively broadcast data packets to every IDU 32 in site 30. In this alternative embodiment, each IDU 32 may include a processor for examining the received packet	• Davis Provis. at 3: This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding • Davis Provis. at 5:

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and determining whether the data in the packet is intended for that IDU 32, or for another. Further, the network protocols and services processing unit 45 may be configured to choose between point-to-point or broadcast transmission of each baseband signal packet.	Using a LAN allows multiple access, and greatly increased flexibility for future services via an industry standard method. • Davis Provis. at 7: The digital baseband data is then multiplexed together and sent via the LAN to the receiving IDU(s). Data can be sent point to point or broadcast.
[¶51] According to the embodiment illustrated in FIG. 2, the wired LAN 50 is preferably configured as a baseband network, such as Ethernet, token ring, ARCNET, USB, USB2, 1394 or FDDI. Such networks can be implemented by connecting the interface device 40 and each IDU 32 to a common data bus running through the site 30. This configuration avoids the need of installing a separate cable between a multistitch 20 and each IDU 32 within the site. Therefore, multiple satellite services can be implemented in a particular site 30 without requiring multiple cables running throughout the site 30.	• Davis Provis. at 3: This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding any new cables. EXPLAIN THE PURPOSE AND ADVANTAGES OF YOUR INVENTION (WHAT WILL THE INVENTION DO BETTER THAN DONE PREVIOUSLY?) • Minimizes number of cables to be run from the outdoor unit (maximum 2); • Minimizes cables to be run between outdoor unit and any particular indoor unit • Allows many indoor units to access one outdoor unit. • Allows new indoor units/new services to be added after initial installation without any new cables

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[¶53] In a further exemplary embodiment, the wired LAN 50 may employ the Transmission Control Protocol/Internet Protocol (TCP/IP) and include a connection to the Internet, for example, through high-speed leased lines or through a telephone wires connected to an Internet Service Provider (ISP). In such an embodiment, satellite based Internet service, such as DIRECPC®, may be provided to IDUs 32, which comprise receiver components connected to, or installed in, PCs or other processing devices. However, according to this embodiment, satellite Internet services are not limited to IDUs 32 connected to PCs. Such an IDU 32 may be connected to a television, personal digital assistant (PDA), or any other electronic device through which a user can access the Internet.	• Greatly simplifies installation in MDU's (Multi dwelling units) • Davis Provis. at 3: This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding any new cables.
[¶55] By utilizing the wired LAN 50 of the present invention, a plurality of IDUs 32 (PCs) configured for satellite Internet service can receive content from the same satellite antenna 11 without requiring a plurality of cables running from the ODU 10 to the IDU. Further, each IDU 32 can transmit requests over the same cable connection, which connects the data bus of LAN 50 to the ISP.	• Davis Provis. at 3: This invention replaces these cables with one (power) or two (power plus phone, or power plus wired LAN), using industry standard interface mechanisms, while simultaneously greatly increasing the flexibility of the installation to allow future services without adding any new cables. EXPLAIN THE PURPOSE AND ADVANTAGES OF YOUR INVENTION (WHAT WILL THE INVENTION DO BETTER THAN DONE PREVIOUSLY?) • Minimizes number of cables to be run from the outdoor unit

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	(maximum 2); - Minimizes cables to be run between outdoor unit and any particular indoor unit - Allows many indoor units to access one outdoor unit. - Allows new indoor units/new services to be added after initial installation without any new cables - Greatly simplifies installation in MDU's (Multi dwelling units) - Davis Provis. at 5: The interface between the indoor units(s) and outdoor unit of DirecPC/DIRECTV/ DirecWay/Spaceway all could use this invention. - Davis Provis. at 7: Data to be transmitted over the satellite and control data for the receivers in this invention is sent over the LAN to the unit from the transmitting IDU. A cable connectin [sic] exists from this invention to the transmitter on the ODU, as is current practice.
[¶56] Further, the present invention is in no way limited to satellite Internet services, where requests must be transmitted over a physical cable to the ISP. In another exemplary embodiment, requests for digital content may be transmitted from an IDU 32 over the LAN 50 to interface device 40, which forwards the request to an antenna 11 for transmission to a satellite 5. Accordingly,	Davis Provis. at 7: Data to be transmitted over the satellite and control data for the receivers in this invention is sent over the LAN to the unit from the transmitting IDU. A cable connectin [sic] exists from this invention to the transmitter on the ODU, as is current practice.

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the satellite 5 may relay the request to a satellite antenna 11 of a satellite based ISP.	
[¶75] It is noted that in a preferred embodiment, the ODU 10 is located outside on a building top and the interface device 40 is located inside relatively close to the ODU 10, for example in an attic or other storage space of the building. However, the interface device 40 could also be located outside as an integral part of the ODU 10. Further, the LAN 50 (wired or wireless) may be located near the interface device 40 or nearer to the IDUs 32. It is also contemplated that the transmitter/receiver 42 could be an integral part of the ODU 10 or the interface device 40.	• Davis Provis. at 7: Current practice will often use what is called a “multiswitch” in an installation. This is a device that has one cable for each LNB on the ODU side, and one cable for each IDU satellite input on the IDU side. The multiswitch is responsible for connecting the correct LNB to each IDU as commanded by the IDU. This multiswitch can be co located with the antenna, or remotely mounted. This invention uses the same connectivity as the multiswitch on the ODU side (one cable for each LNB) but replaces the multiswitch to IDU cable with a LAN.