

**UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF TEXAS
DALLAS DIVISION**

COMMSCOPE TECHNOLOGIES LLC	)	
	)	
Plaintiff,	)	No. 3:16-cv-477
Counterclaim Defendant	)	
	)	Jury Trial Demanded
v.	)	
	)	Confidential Attorney Eyes Only
DALI WIRELESS, INC.	)	Information Subject to Protective
Defendant.	)	Order
Counterclaim Plaintiff	)	
	)	
v.	)	
	)	
COMMSCOPE TECHNOLOGIES LLC	)	
and COMMSCOPE CONNECTIVITY	)	
LLC	)	
Counterclaim Defendant	)	

Rebuttal Expert Report of Dr. Anthony Acampora
Addressing Validity of CommScope's Asserted Patents, including
U.S. Patent Nos. 9,332,402 (the '402 patent); 8,577,286 (the '286 patent);
8,326,218 (the '218 patent); 7,639,982 (the '982 patent); and 7,848,747 ("the '747 patent")

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electronic circuit may sometimes show a single DSP, but the description of the drawing will often identify the various tasks that the DSP is performing.

D. Digital Up- and Down-Conversion

128. Digital signal processing can also be applied to the process of up-converting and down-converting of band-limited analog in-phase and quadrature analog signals. Consider first the process of up-converting. One type of digital up converter is shown in Figure 14.

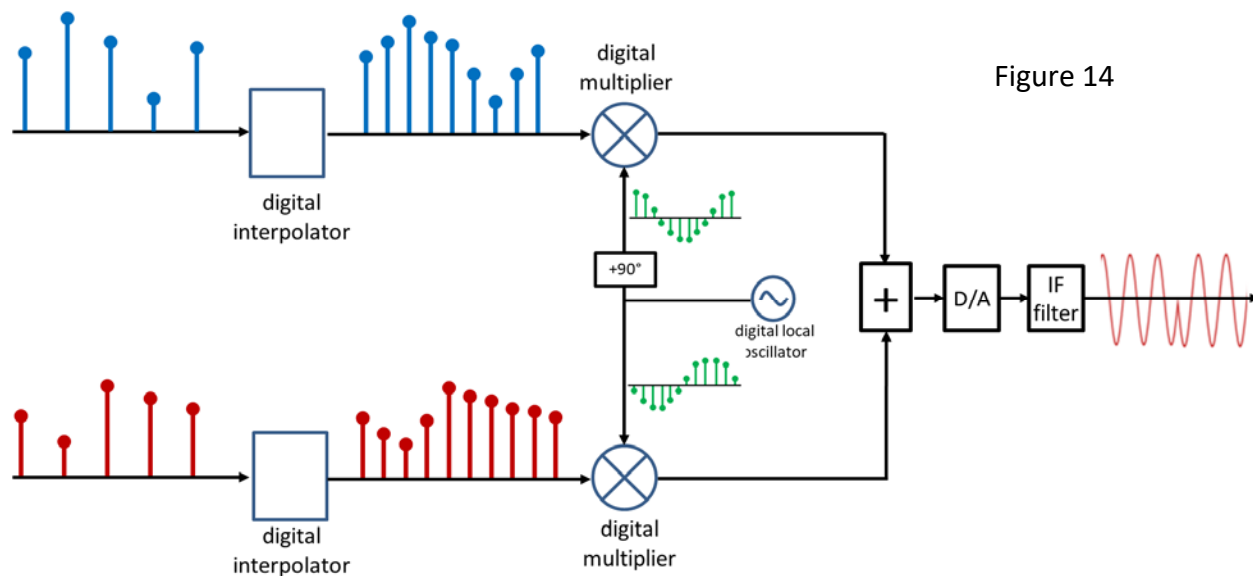


Figure 14

Presented to the digital up-converter appearing in Figure 14 are two sets of digital samples representing the band-limited in phase and band-limited quadrature signals. Sampling theory requires that these each be sampled at a rate $R > 2 \times B$, where B is the bandwidth of each component, followed by an A/D converter. Also shown in Figure 14 are two digital mixers which digitally multiply digital samples of the sine wave and sine wave phase shifted by 90° produced by a digital “local oscillator” with the interpolated quadrature and in-phase components, respectively. Suppose that the digital up conversion is to IF. Then, the sine waves shown in Figure 14 would oscillate at the IF frequency. Since IF frequency is typically much higher than the bandwidth of the I and Q signals, the samples of the two sine waves must be

taken at a correspondingly high rate so that the features of the sine waves are preserved. But the arriving I and Q samples are at a much lower rate.

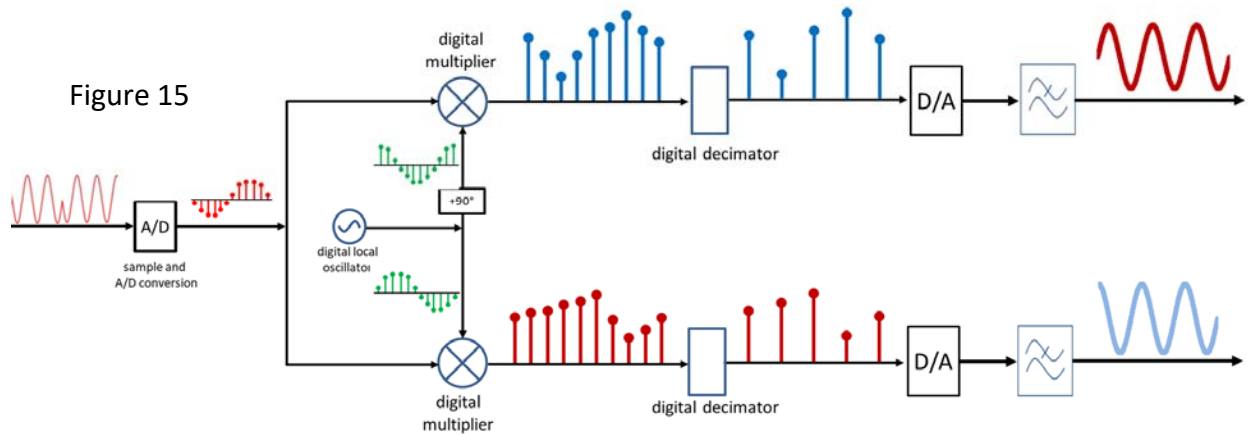
129. Accordingly, before up-converting can be performed digitally, additional samples of the I and Q must be created. Fortunately, since the original samples of the in-phase and quadrature components contain all of the information needed to reconstruct each signal in its entirety, *digital interpolation* is readily performed to “fill-in” the missing samples.

130. The up-converted samples are next summed, the sum is converted to analog samples by a D/A converter, and the analog samples are passed through an intermediate frequency filter to remove all but the analog intermediate frequency signal from the spectrum of the samples. Except for any quantization noise introduced by the original digitization of the analog in-phase and quadrature signals, the resulting signal is exactly the same as that which would be produced by an analog up-converter.

131. Digital up-conversion to a radio frequency can be performed in an analogous fashion, but the sampling frequency of the digital local oscillator (and the rate of interpolated samples) must be correspondingly higher. Up-conversion to a radio frequency signal can also be achieved by first performing a digital up-conversion to an intermediate frequency, filtering the analog samples, and up-converting from intermediate frequency to radio frequency with a conventional analog up-converter.

132. There are several other techniques that can be applied to produce process digital samples in such a way that, after filtering by an appropriately-shaped intermediate (or radio) frequency filter, will result in an analog representation of up-converted in-phase and quadrature analog signals.

133. One type of digital down-converter is shown in Figure 15. Arriving is an analog signal corresponding to in-phase and quadrature baseband signals that were up-converted to an intermediate (or radio) frequency signal.



For illustrative purposes, suppose that this signal is sampled at a rate of at least $2 \times (B + f)$, where as before, B is the bandwidth of the in-phase and quadrature signals and f is the intermediate (or radio) frequency. These samples are digitized by an A/D converter, replicated, and sent to a pair of digital multipliers where they are multiplied by digital samples of an intermediate (or radio) frequency sine wave, and 90° phase shifted sine wave, produced by a digital local oscillator. But here, since the underlying baseband signals have a bandwidth of only B , there are too many samples appearing at the output of the multipliers, that is, the sampling frequency of at least $2 \times (B + f)$ is higher than needed at the output of the digital multipliers. Accordingly, the samples are decimated, that is from the higher number of samples, a lower number of samples is generated. As explained earlier, the simplest way to accomplish this is by simply discarding unnecessary samples, that is, for each stream of samples produced by the two digital multipliers, a periodic set of samples at a rate of at least $2 \times B$ is retained; the excess samples are discarded.

Finally, the decimated digital samples are sent to a D/A converter and the analog samples are filtered by a low-pass filter adequate to recreate the original analog in-phase and quadrature signals with no aliasing distortion.

134. As with digital up-conversion, there are other techniques requiring fewer samples that can be applied to achieve digital down-conversion.

135. With regard to digital up-conversion to a radio signal, the same analog signal is produced whether the digital samples of baseband in-phase and quadrature signals are (1) digitally up-converted to an intermediate frequency, converted to an analog signal, and further up-converted to a radio intermediate frequency, or (2) digitally up-converted to a radio frequency and then converted to an analog signal. In both cases, the digitized baseband samples contain all of the information from which the correct radio frequency signal can be produced. Accordingly, the baseband samples, any intermediate frequency samples, and any radio frequency samples are all referred to as being digital RF.

136. Similarly, with regard to digital down conversion, the same analog signal baseband signals are produced whether (1) digital samples of a radio signal are digitally down-converted to an intermediate frequency, further digitally down-converted to digital baseband signals, and finally filtered to produce analog baseband signals; (2) digital samples of a radio signal are digitally down-converted to digital baseband I and Q signals, and finally filtered to produce analog baseband signals; or (3) the analog radio signal is down-converted to an intermediate frequency by an analog down-converter, sampled, digitized, and digitally down-converted to digital baseband I and Q signals, which are then converted to analog signals and filtered to produce analog baseband signals. In all cases, digitized baseband samples contain all of the information and representative of the any intermediate frequency or radio frequency

analog signals are derived and converted to analog baseband signals. Accordingly, the baseband digital samples, any intermediate frequency digital samples, and any radio frequency digital samples are all referred to as being digital RF. See, for example, the CPRI Standard, discussed below describing complex baseband IQ samples as “digitized radio”; see also T.Schilcher “RF applications in digital signal processing” CERN European Organization for Nuclear Research, CERN Accelerator School, Digital Signal Processing, Proceedings 249-283, at 253 (“The terminology ‘IQ’ originates from the representation of an RF signal which can be in either polar (amplitude/phase representation) or in Cartesian coordinates.”) Digital baseband I and Q samples are representations of the RF signal but using Cartesian coordinates, also known as in-phase and quadrature components.

E. Cellular Communication Basics

137. Cellular communication systems are systems that extend telephone and data services (such as email and web browsing) via wireless radio frequency (RF) waves to mobile devices (such as cell phones and laptop computers). Components of cellular systems include base stations, mobile devices, and infrastructure. The basic idea is to extend service from base stations to the mobile devices via wireless RF signals over a distance that rarely exceeds a few miles, and is often much less. Between the base station and the other end point of a connection (which may, for example, be a wired telephone or a web site), the signals are carried via conventional wired facilities (such as buried telephone cabling and fiber optic cables) over distances that may range up to several thousand miles. Thus, one of the responsibilities of a base station and its associated antenna system is to convert wireless RF signals into conventional wired electronic signals, and vice-versa.

138. Thus, cellular systems are essentially wireless access systems, providing access to the world-wide telecommunications infrastructure. The infrastructure consists of buried cabling and various types of switches such as Internet routers. Accordingly, it is typically only the “last mile” that uses a wireless RF signal; for most of the journey, the signals are carried by conventional, non-radio-based, cabled facilities.

139. Of course the ultimate destination of a cellular signal may be another mobile device, in which case the signal path would consist of a short wireless RF segment from the first mobile device to its base station, a long non-radio-based segment over buried cabling and other infrastructure equipment from the first base station to the destination base station (which may be several thousand miles away), and another short wireless RF segment from the destination base station to the destination mobile device.

140. Generally speaking, each base station communicates with (or “serves”) what may be a large number of mobile devices using its antenna to transmit and receive propagating wireless RF waves. Since these RF signals attenuate with distance as they propagate away from the originating antenna, a base station’s “cell” consists of the region over which the wireless RF signals sent from a base station remain sufficiently strong to be detectable at the receiving mobile devices, and vice-versa. The region over which cellular service is to be extended is divided into a set of overlapping “cells”, each of which typically has its own base station. The coverage area of a base station is often referred to as its “footprint.”

141. The direction of signal flow from the base station to a mobile device is known as the “forward” path, “downlink,” or “downstream” direction, and the direction of signal flow from a mobile device to the base station is known as the “reverse” path, “uplink” or “upstream”

direction. It is typically (but not always) the case that the downlink signals occupy a different portion of the electromagnetic radio spectrum than the uplink signals.

142. A base station is typically owned and operated by a wireless service provider using certain wireless radio frequency spectrum purchased or licensed from FCC (“licensed RF spectrum”). Since each base station is capable of serving several or many mobile devices, a mechanism is needed to allow the radio frequency resources of the base station to be shared among the mobile devices. There are several ways of accomplishing this. For simplicity, and for the purposes of this background tutorial, only one will be considered: Frequency Division-Multiple-Access (FDMA).

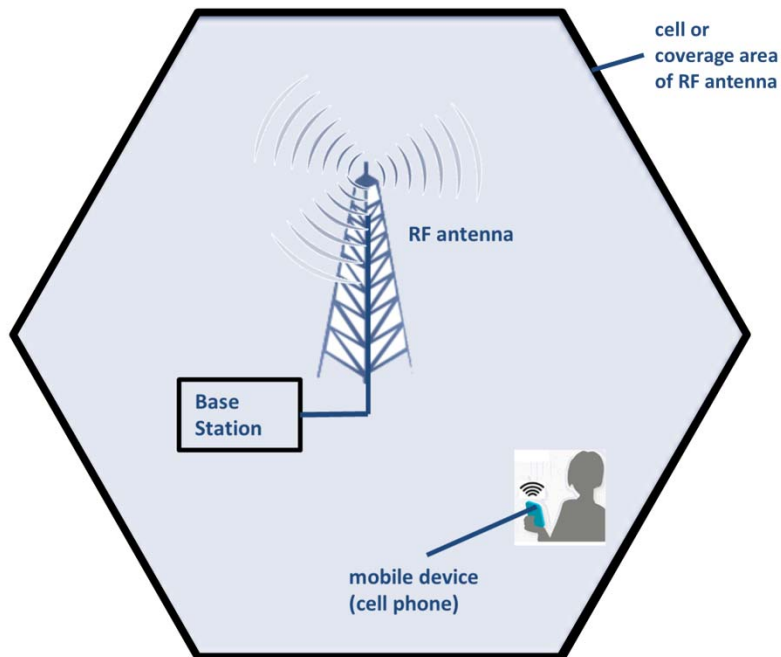
143. Consider first the downlink direction. As explained earlier, with FDMA, the downlink RF spectrum is divided into some number of non-overlapping radio channels, each capable of carrying a signal intended for one mobile device at any moment in time. Each such radio channel consists of a range of radio frequencies, with the range of frequencies assigned to one channel being different than the range of frequencies assigned to every other channel. Accordingly, each mobile device then “tunes” to the radio channel (or range of RF frequencies) that carries its downlink signal. This is similar to broadcast entertainment radio, wherein each radio transmitting station is assigned to one radio channel, and each radio receiver “tunes” to and accepts the signal from only one of the broadcasted channels.

144. In the downlink direction, the base station collects the electronic signals intended for its served mobile devices from the infrastructure, processes and converts each to an RF signal on a different radio channel, combines these radio signals (each on a different set of RF frequencies) together, and sends this composite signal to its antenna over a segment of conventional cable (that is, the signal is not yet propagating wirelessly). The function of the

antenna is to cause this composite signal to radiate into space without any underlying cable; the antenna does not separate out any of the original signals from the composite. Thus, the antenna is essentially a “transducer” which accepts an electrical RF signal (having RF spectrum and containing some arbitrary composite of underlying modulated information signals) that arrives over a segment of cable and converts it into a wireless signal that radiates, without any cabling, over the footprint of the base station’s cell; the antenna simply radiates the composite electrical RF signal with which it has been presented; the underlying information signals are irrelevant to this process. In effect, from the antenna’s perspective, it is simply transducing a single composite signal with no awareness that this composite is composed of a collection of underlying signals each of which is typically intended for a specific mobile device.

145. The following drawing illustrates radiation from a base station over the idealized hexagonal footprint of a cell.

146. The much smaller antenna in each mobile device within that cell captures a replica of the composite signal radiated by the base station’s antenna. After conversion from a radio to electrical format, the electronics within the mobile begins the process of recovering, from the composite, those underlying signals intended for itself.



147. At the base station, the process of converting the electrical signals into corresponding RF signals may be a multistage process. For example, the electrical signals might first be converted into “intermediate frequency” signals prior to final conversion into electrical RF signals. The intermediate frequency signals are similar to RF signals, but are each of a lower frequency.

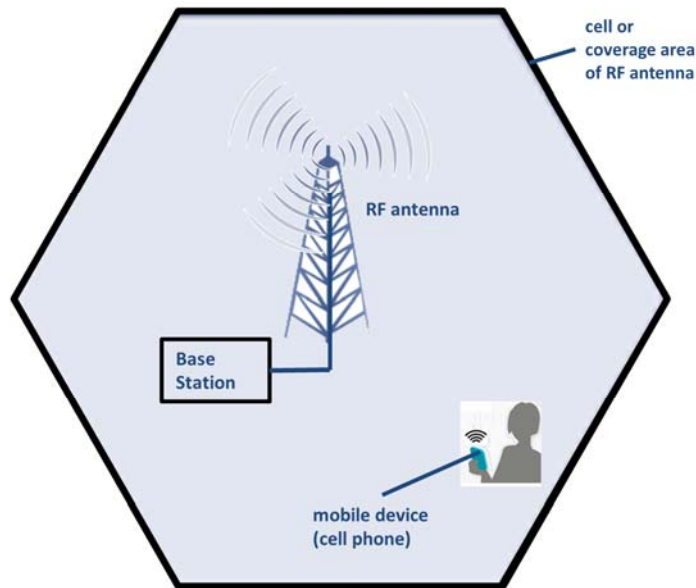
148. Similar procedures apply in the uplink direction. The uplink may be partitioned into a number of radio channels, each assigned at any given time to one mobile device. Each mobile device converts its electrical signal into an electrical RF signal over the range of RF frequencies assigned to its radio channel (again, this might be a two-step process involving a conversion first to an intermediate frequency signal), and sends this to its antenna for cable-free transmission toward the base station. The electrical RF signal (which occupies only those radio channels assigned to that mobile) is then radiated by the mobile’s antenna and becomes a wireless RF signal.

149. The base station is tuned to receive all of the RF frequencies in the service provider's uplink RF spectrum, including whatever noise or mobile uplink signals may be carried on those frequencies. The base station's antenna has no way of knowing whether the arriving RF signals are noise or data signals, or where the RF signal originates from. The base station antenna simply operates to collect the entire received wireless RF uplink spectrum and any signals which may be carried on any frequencies within that spectrum, and feeds the composite received RF spectrum into a segment of cabling (as an RF electrical signal), as if all portions of that composite RF signal had in fact originated at a single device. At this point, the base station has no way of knowing whether any mobile signals are present. Nonetheless, due to frequency division multiplexing, each of the individual RF signals that make up the composite upstream RF signal remains distinguishable since each is on its own unique set of RF frequencies. The base station then separates this composite electrical RF signal into its constituent channels and converts the signal on each channel into an electrical signal appropriate for transmission within the infrastructure (this conversion may be two step, with the signals first converted to signals at intermediate frequencies and then converted to electronic signals appropriate for delivery to the infrastructure).

150. RF spectrum is regulated by the Federal Communications Commission (FCC). Wireless service providers (such as AT&T and Verizon) purchase or license segments of broadband RF spectrum from the FCC, and then employ that RF spectrum at RF antenna sites to provide wireless service to its customers within an RF antenna's coverage area, which I have illustrated in the drawing above. The base station transmits its licensed segment of broadband analog RF spectrum to the antenna. The antenna radiates the broadband RF spectrum wirelessly to cell phones within its coverage area.

151. Each licensed RF spectrum has a bandwidth defining a range of RF frequencies, also known as RF carriers or RF carrier frequencies. The number of usable RF carrier frequencies within a segment of RF spectrum will depend on the communication scheme employed by the wireless service provider. For example, OFDMA-based schemes use very tight frequency spacing compared to conventional FDMA-based communication schemes, and thus defined more usable frequencies.

152. As explained earlier, an information signal or original data signal (also known as original baseband signal, e.g., voice, video, computer data) refers to the signal before it has been encoded or modulated onto an RF frequency carrier. So that the information can be transmitted wirelessly, the base station will encode or modulate information signals onto RF carrier frequencies. The wireless communication protocol (4G, 3G etc) employed by the service provider determines how the information signals are encoded onto the RF carrier frequencies. The level of activity within the wireless network will determine how many of the RF frequencies have been encoded with information signals. Regardless of which, if any, RF frequencies have been encoded with information signals, the composite of all the RF frequencies within the licensed spectrum is transported to the co-located RF antenna where it is wirelessly propagated throughout the radio cell. At a high level, the following drawing illustrates the downstream path from the information signals received by the base station to the RF antenna which wirelessly transmits the RF spectrum to the mobile device that receives the RF spectrum and unpacks or demodulates the information signals from the RF spectrum.



153. Between the base station and mobile device, the service provider generally allows no access to the information signals encoded or carried on the RF spectrum. Thus, whether the RF spectrum carries video or voice information on any particular RF frequency, or no information, is known only to base station that packages the data and the cell phones that receive and unpack any data from the RF spectrum.

F. Propagation Impairments

154. Propagating RF signals suffer from a number of impairments. RF signals suffer impairments both when transmitted wirelessly and also when transmitted over cables. As already mentioned, wireless RF signals attenuate with distance as they propagate away from the radiating antenna.

155. Also, wireless RF signals may be blocked by physical impairments encountered along the path from the transmitting to receiving antenna. For example, a large building in the line-of-sight path between the transmitting and receiving antennas may reflect a large portion of

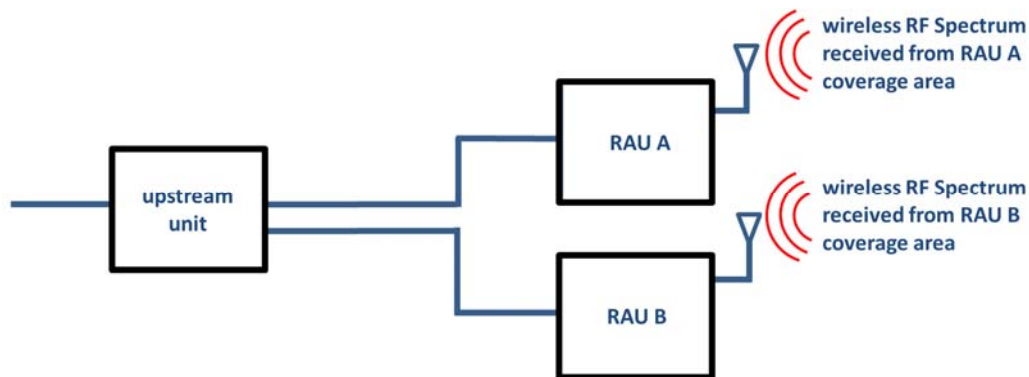
receives a composite uplink RF signal over a segment of cable). Numerous variations of the above concepts are possible.

H. Relationship to the Asserted Patents

172. The asserted patents relate to a distributed antenna system for the digital transport of RF signals in a cellular wireless communication system (which I will refer to as a “digital DAS”).

1. The ‘402 Patent Family

173. Each of the patents in the ‘402 patent family (‘218, ‘286, ‘402, and ‘982 patents) share a common specification. At a high level, the ‘402 patent family is directed to a digital DAS having multiple distributed remote antenna units, with each remote antenna unit transmitting a digital recording of a composite signal contained within certain received wireless RF spectrum (e.g., the service providers licensed RF spectrum) to a shared upstream unit (e.g., a host unit).

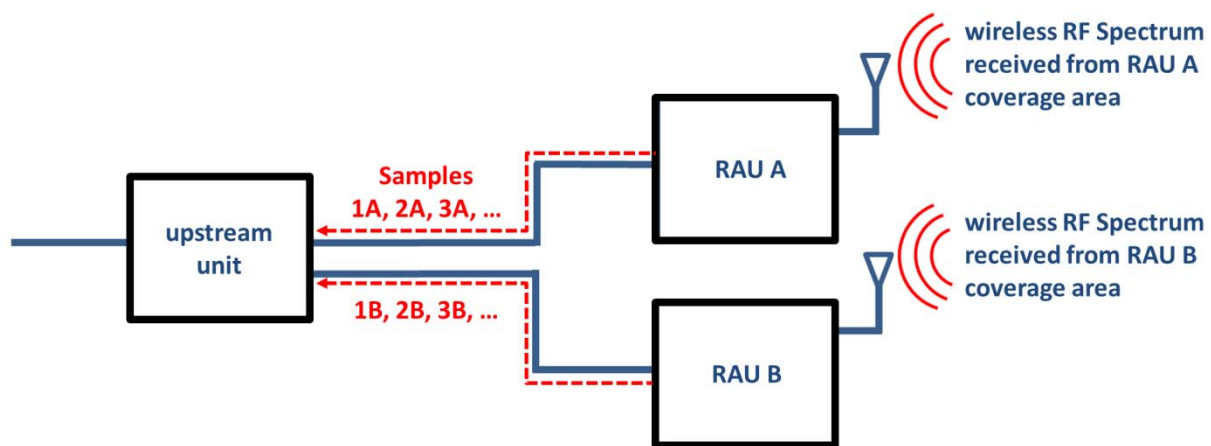


174. In the uplink, each remote antenna unit: (a) receives a composite signal contained within the wireless RF spectrum (and whatever noise or mobile radio signals carried thereon) from its coverage area, (b) agnostically records the wireless RF spectrum (i.e., without regard to what’s carried thereon – noise or data, and without knowing what communication protocol was

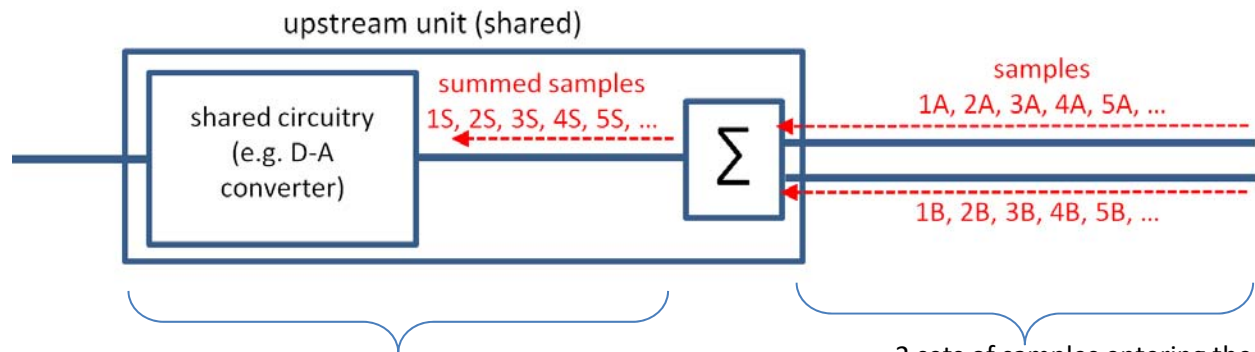
used by any received cell phone transmissions) by sampling the entire composite signal at a sampling rate sufficient to allow the subsequent recreation of the composite signal, (c) generates a digital sequence by converting each sample into its digital representation, and (d) transmits the digital sequence to a shared upstream host unit. Since the digital sequence was created by digitizing samples of the composite signal received by the antenna, it is representative of the received RF spectrum, that is, it is a digital record the composite received signal. Sampling may be done prior to any down-conversion, after down-conversion to an intermediate frequency, or after down-conversion to I and Q baseband. Moreover, sampling may be done at RF or IF and the digital representation of the samples may be digitally down-converted and decimated. It is even possible that sampling and digitization might be done after down-conversion to IF or baseband I and Q and that digital up-conversion with interpolation be done prior to sending the digital stream created from the digital samples back to the upstream unit.

175. It is important to understand that this process of creating a digital representation of the composite signal contained within the wireless radio spectrum does NOT involve any separation of the composite into any underlying individual signals sent by the mobile stations. In fact, no such signals may even be present. (For example, there may be no mobile stations contained within the footprint of that remote antenna unit.) The remote antenna unit merely treats the composite signal that is received by its antenna (which may consist of the superposition of background noise, interference from other unaffiliated radio transmissions and any number of mobile signals each on its own radio channel) as a single signal occupying the entire wireless radio spectrum. It is this composite signal that is sampled, digitized, and sent to the upstream unit as a digital sequence representing a digital record of that composite signal.

176. Moreover, whether the digital stream is created from baseband I and Q samples, from samples at IF, or from samples at RF, it is still a digital representation of the same single composite RF signal that arrived at the antenna, that is, it is a digital RF signal comprised of digital RF samples. As explained earlier, the spectrum of the underlying composite signal is the same, independent of the center frequency. Accordingly, digitized samples taken at RF, IF, or baseband are representative of the same analog RF signal that arrived at the antenna.



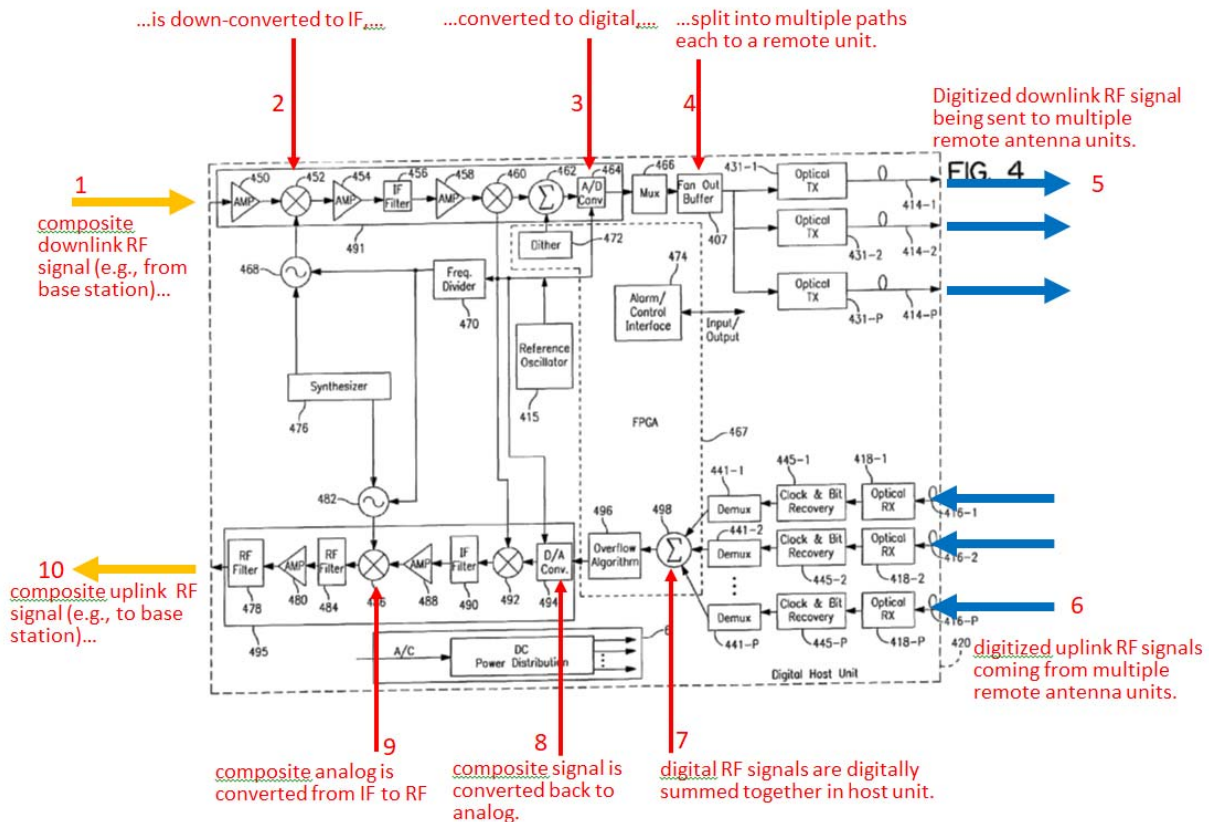
177. The shared upstream unit receives the sequence of samples from the respective remote antenna units and digitally sums the corresponding digital samples from the respective remote antenna units by mathematically adding corresponding digital values of the recorded samples. The digital summing results in one set of digital samples representing a composite RF spectrum for all the remote antenna units.



After summing, only 1 set of summed samples (e.g., 1S = 1A + 1B) continues upstream. As a result, any further upstream circuitry in the host, such as the digital-to-analog converter, is shared by both remote units. From the perspective of the base station and the circuitry upstream from the digital summer, the signal appears as if it was collected by a single antenna, not multiple antennas.

2 sets of samples entering the upstream unit representing RF spectrum as heard by two different remote antenna units (RAU A and RAU B)

178. Figure 4 from the specification of the '402 patent family is reproduced below. It is a block diagram for a host unit described in the specification. I have annotated Figure 4 to describe the downlink and uplink paths.



179. In the downlink direction, the specification discloses a distributed antenna system in which a distribution unit (called the host unit in the specification) down-converts a composite downlink RF signal to an intermediate frequency (see #2 above), converts this into a sequence of digitized samples (see #3 above – more about this in just a moment), and delivers this sequence of digitized samples over a fiber optical cable to each of several remote antenna units (see #4 and #5 above). At each remote antenna unit, the arriving stream of digital samples is first converted back into the composite intermediate frequency signal from which it was derived, then is up-converted back to the composite electrical radio signal, and then is delivered to its antenna for free space radiation.

180. Note that the above drawing represents one embodiment of the '402 patent. As explained earlier with regard to the uplink direction, it is also possible for digitized samples of

the composite RF signal presented by the base station, or for digitized samples of baseband I and Q, to be sent to each remote unit. Also, it is possible for the digitized samples that are sent to be created from a DUC or DDC procedure. In all cases, the digital samples that are sent are digital RF.

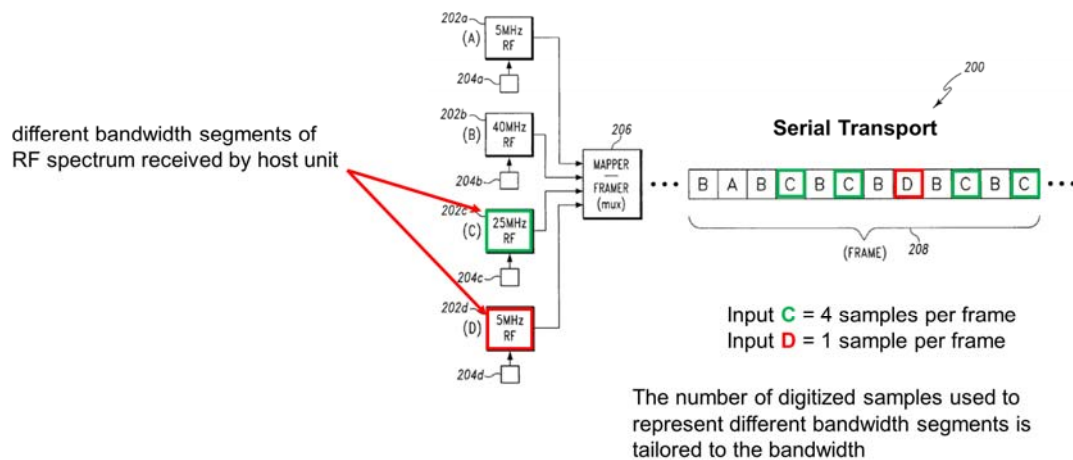
181. In the uplink direction, each remote receives the wireless RF spectrum from its coverage area, converts this to an electrical RF signal, down-converts the RF signal to an intermediate frequency signal which is converted into a sequence of digital samples and sent over a fiber optical cable upstream to the host unit. As previously explained, for each remote antenna unit, the sequence of digital samples sent to the host unit is a digital representation of the RF spectrum (and whatever noise, interference, or mobile signals, if any, are carried thereon) received from the remote antenna unit's coverage area. The host unit receives the sequence of digital samples from each of the remote antenna units and digitally sums the corresponding samples (see #7 above), resulting in one sequence of samples, instead of multiple. The summed digital samples are then converted into a composite analog signal (see #8 above). After conversion to analog, the signal is upconverted (translated) to IF via analog mixer. The composite intermediate frequency signal is then converted (translated) to a composite RF signal (see #9 above) for delivery to the base station (see #10 above). As before, although the above drawing represents one embodiment of the '402 patent, it is also possible for digital RF stream arriving from each remote unit to be at RF, IF, or baseband (I & Q), for digital summing to be done directly on those arriving samples or after up conversion (to IF or RF) or down-conversion (from RF or IF). Also, it is possible for the digitized samples that are summed are the result of a DUC or DDC procedure. In all cases, the digital samples that are summed are digital RF, and are the summed samples. The composite RF signal corresponding to these summed samples may

involve analog up conversion in addition to, or as an alternative to, digital up-conversion. In all cases, the same composite analog RF signal is sent to the base station. The base station (but not the host unit) then proceeds to process this composite so as to recreate the underlying individual mobile signals and distributes these to the wireline infrastructure.

2. The '747 Patent

182. The '747 patent discloses a distributed antenna system having a host that makes more efficient use of the downlink serial transport. The specification discloses a host unit that receives inputs of different bandwidth segments of RF spectrum. For each bandwidth segment, the host includes circuitry for generating a stream of digital samples representing the bandwidth segment. The rate of sampling is tailored to the bandwidth of each bandwidth segment which improves the digital data rate of the transmission over the cable.

183. This is illustrated in Figure 2 of the '747 patent, which I have reproduced below with my comments.



184. The left side of Figure 2 shows the different bandwidth segments of received RF spectrum. The bandwidth of each bandwidth segment is illustrated as being 5 MHz, 40 MHz, 25 MHz, and 5 MHz for segments A-D respectively. The right side of Figure 2 shows the serial

of the original filing, and (b) sufficiently enables a person skilled in the art make and use the claimed invention without undue experimentation.

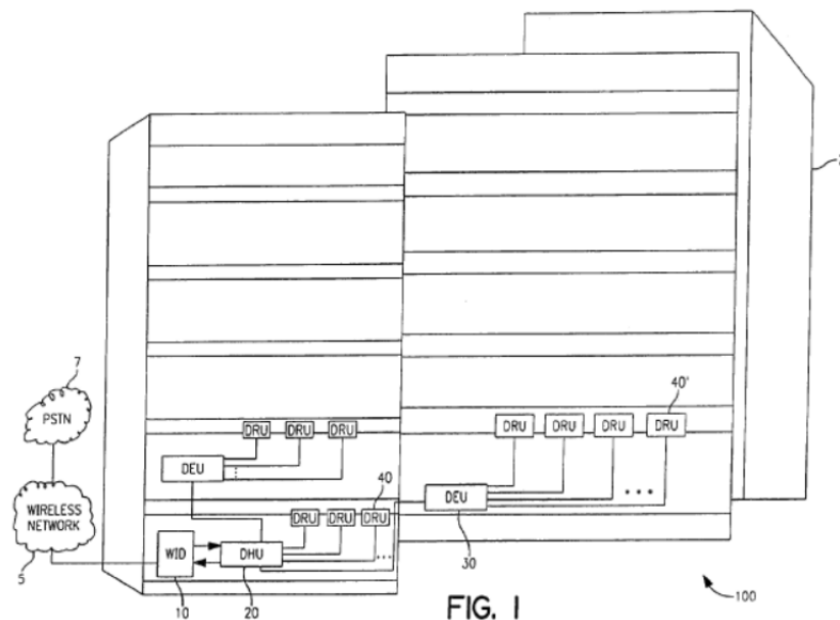
A. “shared circuitry” (‘982 patent, claim 1)

315. I disagree with Dr. Bims’ assertion in declaration (¶¶ 227-239) and report (¶¶ 238-254) that the intrinsic evidence fails to inform one of skill in the art what “shared circuitry” means or that one of skill in the art would not be able to understand what is claimed by “shared circuitry.”

316. Claim 1 of the ‘982 patent specifically calls out “at least two digital remote units coupled to the host unit” and that the host unit includes shared circuitry for distributing signals between “the digital host unit and the at least two digital remote units.” As if this was not clear enough, during prosecution history the patentee explained that a prior art transceiver circuit was not shared because “There is no teaching whatsoever in Russell that a transceiver unit 130 can be used to serve multiple remote units 102. ...Russell clearly shows only a single pair of fibers going to a single remote antenna unit 102.” From these teachings it would have been understood by one of ordinary skill in the art that “shared circuitry” was intended to mean circuitry that is used to support more than one remote unit.

317. In his declaration on claim construction, Dr. Bims identified that same interpretation for “shared circuitry” (i.e., the one easily derived from the claim language itself) as a possible interpretation. In doing so, Dr. Bims also points to support for that same interpretation in the specification, drawings, and prosecution history. Bims decl, ¶¶ 233 and 236 (citing to reproduced Fig. 1 of the ‘982 patent); Bims report, ¶244 (noting that for his report Dr. Bims deletes Fig. 1 of the ‘982 patent which illustrates one Digital Host Unit being shared by multiple Digital Remote Units).

318. In his declaration, Dr. Bims first refers to the '982 patent's specification and Fig. 1 and admits that one interpretation (i.e., that "shared circuitry" was intended to mean circuitry that is used to support more than one remote) is illustrated in Fig. 1 of the '982 patent. Bims decl, ¶ 233. He explains that: "the circuit or *circuitry components could be shared with other devices that the Digital Host Unit (DHU) communicates with, such as ... one or more Digital Remote Units (DRUs), one or more Digital Expansion Units (DEUs), etc., illustrated in FIG. 1* of the '982 Patent:" Bims decl, ¶ 233 (emphasis added). Immediately following this proposed interpretation for "shared circuitry", Dr. Bims reproduced Fig. 1 -- the Figure he concedes illustrates his proposed interpretation. Bims decl, ¶ 233.



319. In my view Fig. 1 makes it very easy for the reader to understand what Dr. Bims was saying about what "shared circuitry" could mean, i.e., it is what is illustrated in Fig. 1. Fig. 1 in fact shows multiple Digital Remote Units (DRUs) and multiple Digital Expansion Units (DHUs) all communicating with the wireless network (e.g., in the upstream to a base

station) along a path that includes a shared Digital Host Unit (DHU). That illustrated communication path employs a shared Digital Host Unit to communicate with the wireless network. As recognized by Dr. Bims, in part of that communication path, there is “shared circuitry” in the Host Unit, and it refers to circuitry components “shared with other devices that the Digital Host Unit (DHU) communicates with, such as ... one or more Digital Remote Units (DRUs).”

320. Dr. Bims then turns to the prosecution history in paragraph 236 of his declaration and acknowledges that it also supports the very same interpretation he proposed as being supported by the specification and Fig. 1, stating:

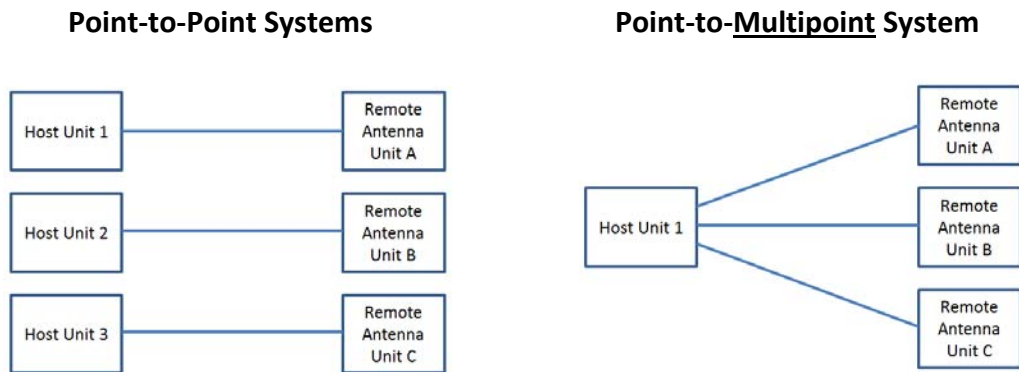
Based on the above assertion by the Applicant [during prosecution], it would appear that the *Applicant intended the “shared” portion of the “shared circuitry” to refer to the circuitry that is shared by a Digital Host Unit (DHU) between or with two or more Digital Remote Units or DRUs (referenced as DRUs 40 in FIG. 1 reproduced above).*

Bims decl, ¶ 236 (emphasis added). Therefore, Dr. Bims concedes that at least in light of the prosecution history, one of skill in the art would understand the meaning of shared circuitry.

321. In his expert report, Dr. Bims describes the same interpretation as being supported by the specification, illustrated by Fig. 1, and supported by the prosecution history because, in Dr. Bims’ words, the “Applicant intended” that meaning for shared circuitry. When drafting his expert report, however, Dr. Bims chose not to reproduce Fig. 1 and thus also dropped the reference to Fig. 1 being “reproduced above,” a Figure that in my view makes this basic issue very simple to understand.

322. That the claims call out shared circuitry in the host makes sense, given that one of the problems identified in the specification that is overcome by the invention is that prior digital systems were point-to-point. The specification explains that in a point-to-point system, each

remote antenna unit required its own host unit to be the upstream RF to digital interface. See ‘402 Spec at 2:32-46 / ‘982 Spec at 2:19-33. The specification explains that having a separate host unit for every remote unit (especially where installations might have 20 remote units in one building) requires too much equipment and cost.

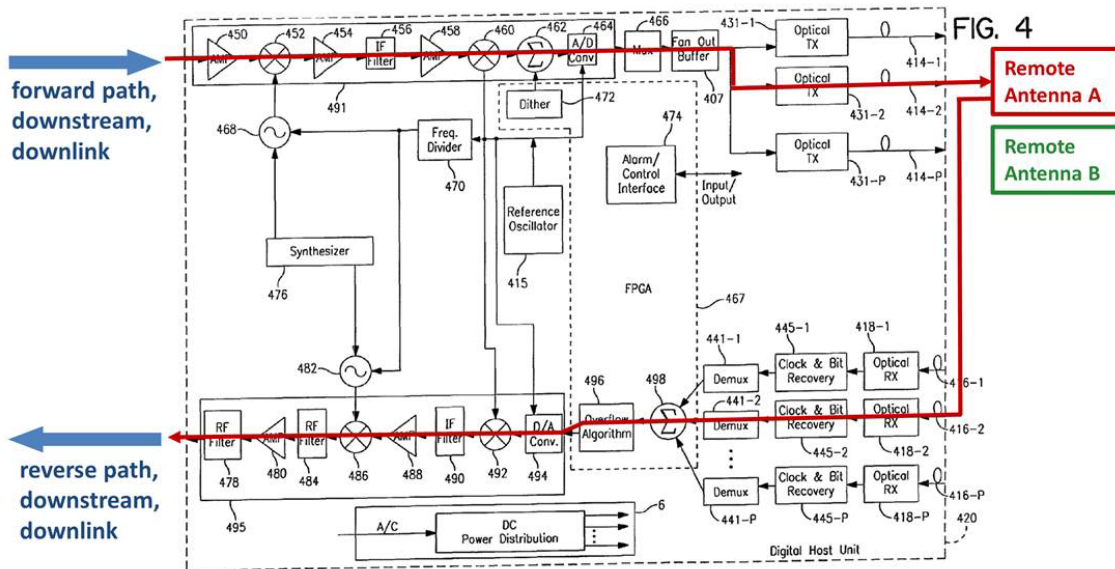


Therefore, the intrinsic evidence teaches not only that “shared circuitry” is circuitry in one host that is used to serve multiple remote units, but also the intrinsic evidence teaches which circuitry we should expect to be shared, that is, the circuitry which is the “RF to digital interface” in the host. This is exactly what we see in the exemplary embodiment of Figure 4.

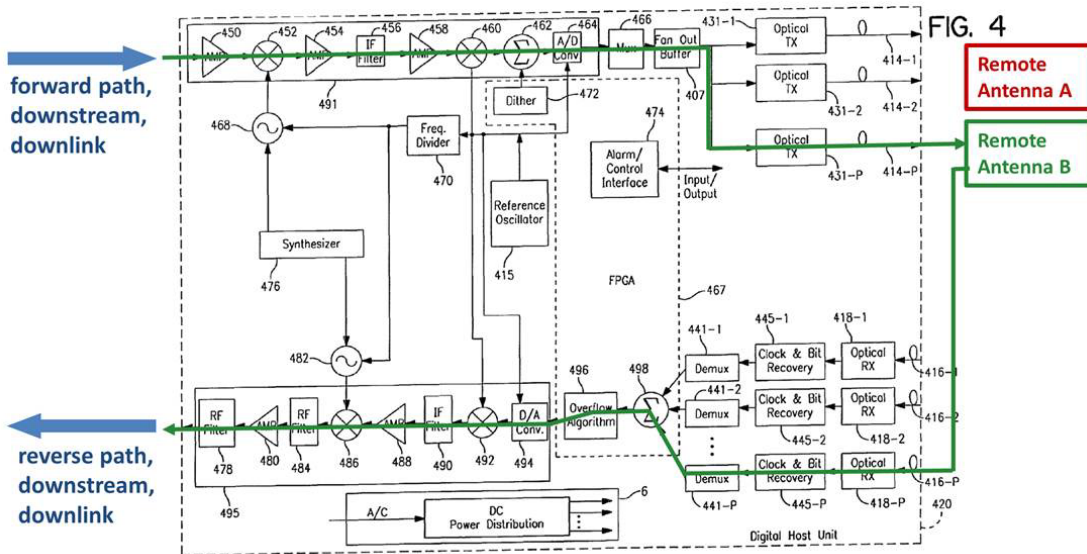
323. To illustrate the point made in the previous paragraph, Figure 4 (a circuit drawing for a host unit) is annotated in each of Drawings A, B, and C below. With reference to the circuitry for the host unit of Figure 4, in Drawing A, I show the downstream or forward path to Remote Antenna A, and the upstream or reverse path from Remote Unit A. In Drawing B, I show the downstream or forward path to Remote Antenna B, and the upstream or reverse path from Remote Unit B. Drawing C shows the forward and reverse signal paths for both Remotes A and B. As I have noted in Drawing C, we can easily see that the circuitry in the host unit that forms the RF to digital interface (both in the upstream and in the downstream) is used to support multiple remote units.

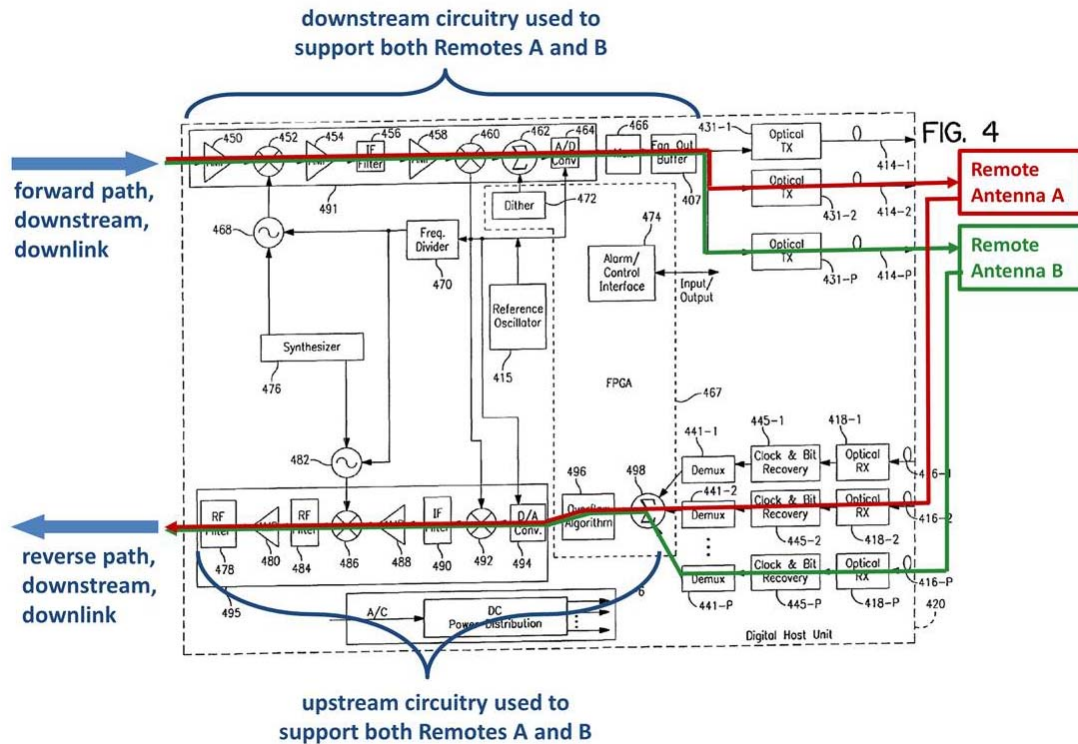
Drawing A

downstream path to Remote Antenna A (upper red line →)
 upstream path from Remote Antenna A (lower red line ←)

**Drawing B**

downstream path to Remote Antenna B (upper red line →)
 upstream path from Remote Antenna B (lower red line ←)

**Drawing C**



324. It is not difficult to determine which circuitry in the host is used to support multiple remote units. As suggested in the background of the specification, the shared circuitry in the downstream includes, for example, the circuitry in box 491, the mux 465, and fan out buffer 431 that form the RF to digital interface. These circuits accept an incoming RF signal, amplify, filter and downconvert that signal, digitize the signal, and then multiplex and split that signal for distribution to multiple remote units. The signal being delivered to more than one remote unit will have passed through at least these same circuits together. The same is true in the upstream or uplink direction. Starting with the summing unit 498 of the FPGA, the overflow algorithm and the circuits of box 495, the signals from multiple remote antenna units pass through the same circuits together as a composite signal. Because these RF to digital interface circuits are being used to support multiple remote units, the remote units are sharing these circuits in the host, both in the downstream and in the upstream directions respectively.

325. One of skill in the art would easily be able to identify which circuits in the host

were being used to support multiple remote units, and, in the disclosed embodiment, for example, the shared circuits include the RF to digital interface circuits (things like the mixers and the analog to digital and digital to analog converters). The disclosed embodiment, however, achieves considerable cost savings by using its RF to digital interface to support multiple remote units, not just one. Sharing these circuits among multiple remote units is made possible, for example, by the addition of the digital summer and the splitter (which are also shared circuitry).

326. In summary, the intrinsic record including the claims, the specification, the drawings including Figs. 1 and 4, and the prosecution history reasonably inform someone skilled in the art about what “shared circuitry” means. My declarations submitted in the claim construction proceedings were used to create slides for the hearing. Reproduced below are slides on this issue that in my view provide an excellent summary on this issue.

“shared circuitry”	
CommScope: Not indefinite	Dali: Indefinite
’982 Patent Claim 1: “the digital host unit includes <u>shared circuitry</u> that performs... distribution of ...signals <u>between the digital host unit and the at least two digital remote units...</u>”	
Claim language – demonstrates “shared circuitry” is circuitry that serves multiple remotes	
Prosecution – demonstrates “shared circuitry” is circuitry that serves multiple remotes:	
Applicant respectfully traverses the assertion that “it is clear that the digital transmitter/receiver circuits of the transceiver unit 130 would be <u>shared</u> by digital remote units 102.” In the system of Russell, a separate transceiver unit 130 is used for each remote antenna unit 102. There is no teaching whatsoever in Russell that a transceiver unit 130 can be used to serve multiple remote units 102. FIG. 13 of Russell clearly shows only a single pair of fibers going to a single remote antenna unit 102. Also, FIG. 13 shows that <u>analog</u> upstream signals from the main cell antenna and analog upstream signals from the transceiver unit 130 are combined in the base station 106’ by an analog combiner. 5/27/09 Amendment, p.27; see Bims Decl. ¶1236; Acampora Resp. ¶124-25.	
Dr. Bims <u>admits</u> POSITA would understand from this passage that “shared circuitry” is circuitry that is shared by multiple remotes. Bims Decl. ¶1236.	

Slide 49

"shared circuitry"

CommScope: Not indefinite	Dali: Indefinite
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'982 Patent Claim 1: "the digital host unit includes **shared circuitry** that performs... distribution of ...signals between the digital host unit and the at least two digital remote units..."

Specification explains why "shared circuitry" is in the claims:

15 Digitization of the RF spectrum prior to transport solves many of these problems. The level and dynamic range of digitally transported RF remains unaffected over a wide range of path loss. This allows for much greater distances to be covered, and eliminates the path loss compensation problem. However, this has been strictly a point-to-point architecture.

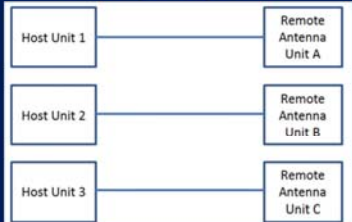
20 One drawback with digitally transported RF in a point-to-point architecture is the equipment and cost requirement. A host RF to digital interface device is needed for each remote antenna unit. In particular, for use within a building or building complex the number of RF to digital interface devices and the fiber to connect these devices is burdensome. For

25 example, in a building having 20 floors, the requirement may include 20 host RF to digital interface devices for 20 remote antenna units, 1 per floor. In some applications more than one remote antenna unit per floor may be required. As a result,

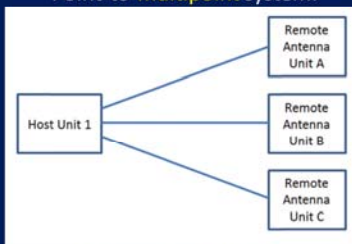
30 there is a need in the art for improved techniques for distributing RF signals in TSBs, which would incorporate the benefits of digital RF transport into a point-to-multipoint architecture.

'982 Patent, col. 2:14-33

Point-to-point systems:



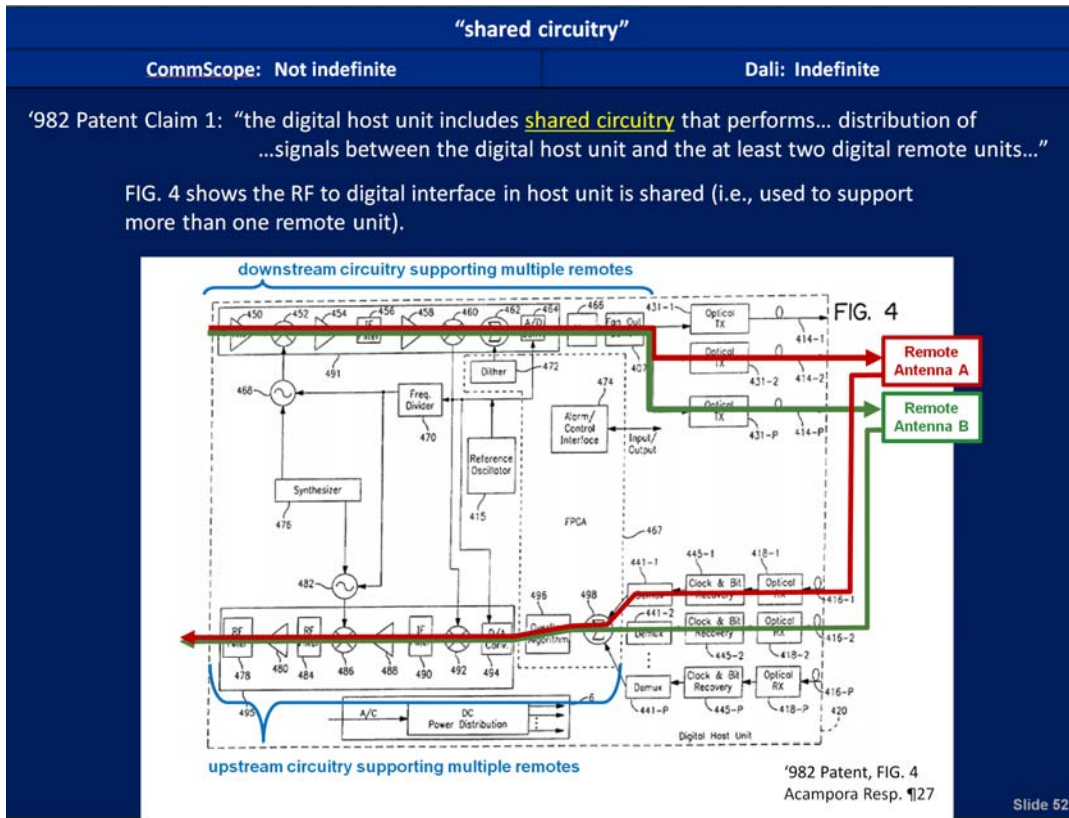
Point-to-multipoint system:



Acampora Resp. ¶126. Slide 50

"shared circuitry"	
CommScope: Not indefinite	Dali: Indefinite
'982 Patent Claim 1: "the digital host unit includes <u>shared circuitry</u> that performs... distribution of ...signals between the digital host unit and the at least two digital remote units..." Specification explains why "shared circuitry" is in the claims: Digitization of the RF spectrum prior to transport solves 15 many of these problems. The level and dynamic range of digitally transported RF remains unaffected over a wide range of path loss. This allows for much greater distances to be covered, and eliminates the path loss compensation problem. However, this has been strictly a point-to-point architecture. 20 One drawback with digitally transported RF in a point-to-point architecture is the equipment and cost requirement. A <u>host RF to digital interface device is needed for each remote antenna unit</u>. In particular, for use within a building or building complex the number of RF to digital interface devices and 25 the fiber to connect these devices is burdensome. For example, in a building having 20 floors, the requirement may include 20 host RF to digital interface devices for 20 remote antenna units, 1 per floor. In some applications more than one remote antenna unit per floor may be required. As a result, 30 there is a need in the art for improved techniques for distributing RF signals in TSBs, which would incorporate the benefits of digital RF transport into a point-to-multipoint architecture. '982 Patent, col. 2:14-33 Expect: RF to digital interface to be shared (i.e., used to support more than one remote unit).	

Slide 51



327. In his expert report, Dr. Bims turns to the **extrinsic record** and creates confusion where none exists.

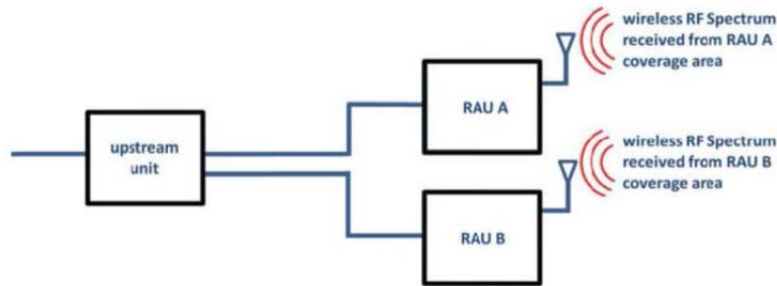
328. First, referring to the two declarations I submitted during claim construction proceeding, Dr. Bims isolates phrases from my first report and suggests that what I said in my first report is not consistent with what I said in my second report. That is not true.

329. Below I have included excerpts from first declaration for claim construction (I have highlighted certain text included in the excerpts).

330. In my first declaration, I introduce the '402 patent family (which includes the '982 patent) as shown below, showing multiple remotes communicate with the wireless network along a path that includes a shared host unit. See excerpt below.

1. The '402 patent family

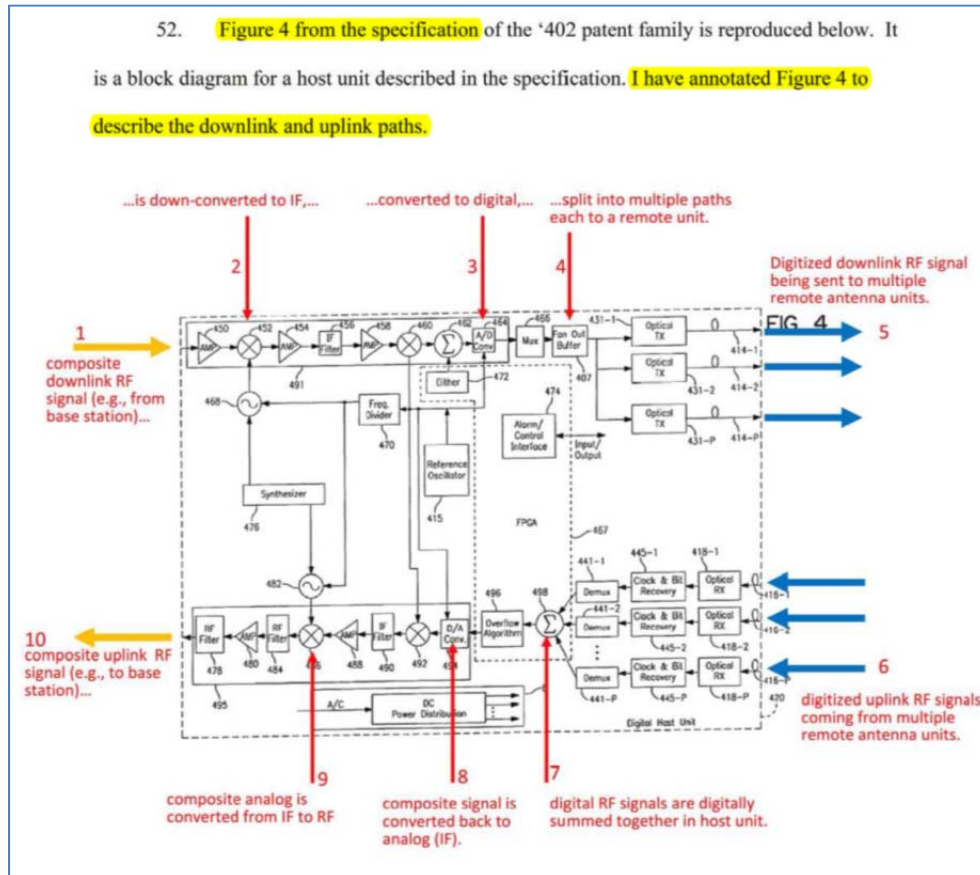
49. Each of the patents in the '402 patent family ('218, '286, '402, and '982 patents) share a common specification. At a high level, the '402 patent family is directed to a digital DAS having multiple distributed remote antenna units, with each remote antenna unit transmitting a digital recording of certain received wireless RF spectrum (e.g., the service providers licensed RF spectrum) to a **shared upstream unit (e.g., a host unit).**



50. In the uplink, each remote antenna unit: (a) receives the wireless RF spectrum (and whatever noise or data signals carried thereon) from its coverage area, (b) agnostically records the wireless RF spectrum (i.e., without regard to what's carried thereon – noise or data, and without knowing what communication protocol was used by any received cell phone transmissions) by generating a sequence of digital samples representing the received RF spectrum, and (c) transmits the sequence of digital samples to **a shared upstream host unit.**

331. As shown in the following three excerpts from my first declaration, I also refer to Figure 4, and, as I did in my second declaration, I describe the uplink and downlink and communication paths and point out multiple examples of shared circuitry both in the uplink and downlink paths. In the third excerpt below, I again point to the “circuitry in the digital host unit that supports more than one digital remote unit” and, just as I did with respect to Fig. 4, I point to exemplary circuitry in the communication path (e.g., the “shared analog to digital converter”). Thus, Dr. Bims assertion that in my first declaration, I “summarily defined this term [shared circuitry] as ‘circuitry in the digital host that supports more than one digital remote unit’ without

any detailed support from the specification” is simply not true.



In the downlink direction, the specification discloses a distributed antenna system in which a distribution unit (called the host unit in the specification) down-converts a composite downlink RF signal to an intermediate frequency (see #2 above), converts this into a sequence of digitized samples (see #3 above – more about this in just a moment), and delivers this sequence of digitized samples over a fiber optical cable to each of several remote antenna units (see #4 and #5 above). At each remote antenna unit, the arriving stream of digital samples is first converted back into the composite intermediate frequency signal from which it was derived, then is up-converted back to the composite electrical radio signal, and then is delivered to its antenna for free space radiation.

53. In the uplink direction, each remote receives the wireless RF spectrum from its coverage area, converts this to an electrical RF signal, down-converts the RF signal to an intermediate frequency signal which is converted into a sequence of digital samples and sent over a fiber optical cable upstream to the host unit. For each remote antenna unit, the sequence of digital samples sent to the host unit is a digital representation of the RF spectrum (and whatever noise or data is carried thereon) received from the remote antenna unit's coverage area. The host unit receives the sequence of digital samples from each of the remote antenna units and digitally sums the corresponding samples (see #7 above), resulting in one sequence of samples, instead of multiple. The summed digital samples are then converted into a composite analog signal at intermediate frequency (see #8 above). The composite intermediate frequency signal is then converted into a composite electrical RF signal (see #9 above) for delivery to the base station (see #10 above).

C. Indefiniteness

84. I am informed that Dali has asserted that multiple claim limitations in the '402 patent family are indefinite. I am also informed that, to date, Dali has not articulated any reasons why it believes these claim terms are indefinite. In the following section I address each of the claim terms identified by Dali, stating why these claim terms are not indefinite, but I specifically reserve the right to supplement my opinion once I am provided with any explanation or bases as to why Dali believes these terms are indefinite.

85. As mentioned above, I have been informed that claim language is indefinite if it fails to inform, with reasonable certainty, those skilled in the art about the scope of the invention.

a. shared circuitry ('982, claim 1)

86. The phrase "shared circuitry" is not indefinite. One of ordinary skill in the art would understand with reasonable certainty that this language is referring to the **circuitry in the digital host unit that supports more than one digital remote unit.** For example, in the host unit **there are not multiple analog-to-digital converters, one for generating a signal for each remote unit.** Instead, there is one shared analog-to-digital converter and that analog-to-digital converter **is used for supplying a signal to multiple remote units.** **Multiple remote units share this circuitry.** **Therefore, it is shared circuitry.** This is one of the features that distinguishes the disclosed point-to-multipoint digital transport system from a simpler point-to-point digital transport system mentioned in the background of the specification. See 2:32-41. In a point-to-point system, none of the circuitry in the host unit is shared. The entire host unit must be duplicated for each remote antenna unit in a point-to-point system. This is one of the problems that is addressed by the disclosed invention. By sharing circuitry within the host unit among multiple remote antenna units, the invention achieves significant cost advantages.

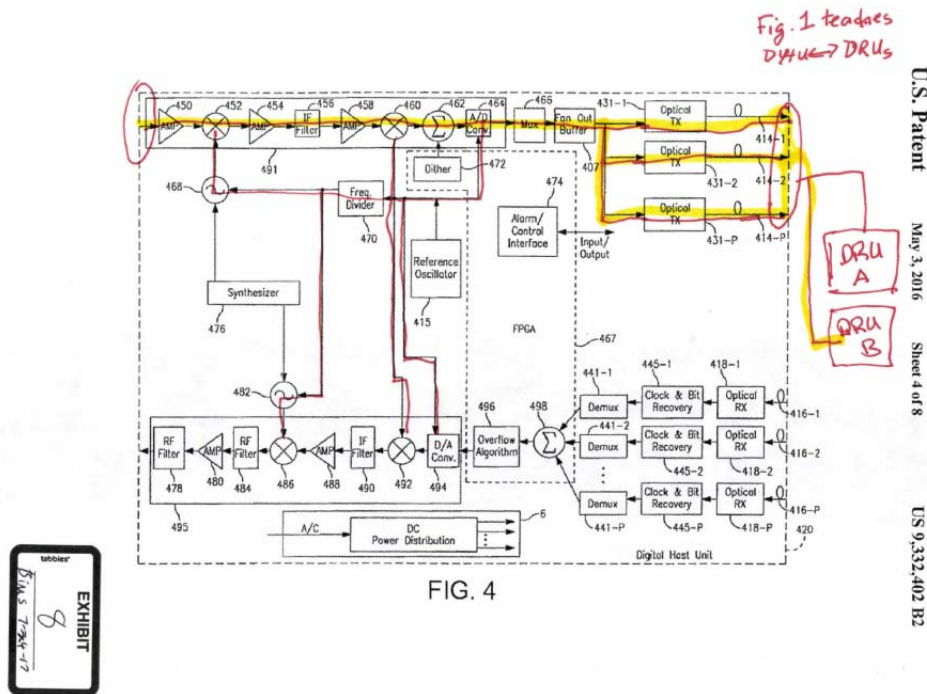
[REDACTED]

335. In this regard, I have reviewed Dr. Bims deposition. He was asked the following question.

8 Q. Yeah, so I'm referring to figure 4 and
9 the circuitry in figure 4 that you gave some opinions
10 about as to what "shared" means, and I'm puzzled by
11 why you can't identify the downlink path from the
12 input to the digital host unit to the multiple
13 outputs to the digital remote units. Is it something
14 that you didn't look at in giving your opinion in
15 this case?

336. Bims deposition transcript at p. 72. Later in his deposition at page 80 of his deposition transcript he drew the downlink path in Fig. 4 to DRU A (in red) and then drew the downlink path in Fig. 4 to DRU B (yellow highlighter). See Bims deposition Exhibit 8. What is important is that even Dr. Bims was able to demonstrate through Exhibit 8 that he understood there were many examples of circuitry in the digital RF interface shared by DRU A and DRU B

(see e.g., the overlapping red/yellow paths commencing at the upper left hand corner of Exhibit 8 (Fig 4) to the “Fan Out Buffer” 407. After the Fan Out Buffer one skilled in the art would know at that point the signal paths do not overlap and, thus proceed from that point on separate paths to their respective outputs at the upper right hand corner of Exhibit 8 (Fig. 4).

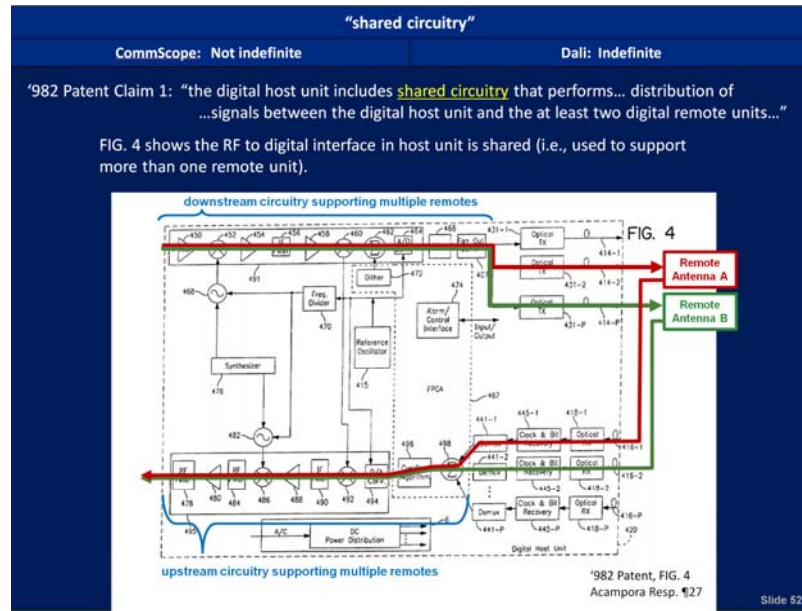


U.S. Patent May 3, 2016 Sheet 4 of 8 US 9,332,402 B2

337. Even by Dr. Bims account, there are clear examples of shared circuitry in the shared part of the signal paths. Nonetheless, he first contends that it's too imprecise as to where the signal splits out at the FAN out buffer. Dr. Bims is quibbling about a minor point. There is no question that the signal is split out after the fan out buffer 407. Dr. Wala and I agree on this point.

338. Second, Dr. Bims contends that there is confusion whether the circuits such as the synthesizer 476 are shared circuitry. Again, a person of skill in the art reading the specification would first understand the importance of examining whether the downstream and the upstream signal paths include circuitry supporting multiple RAUs (see, e.g., slide 52 below). Slide 52

identifies clear examples of shared circuitry in both the downstream signal path and upstream signal path, and in my view reasonably inform someone skilled in the art about what “shared circuitry” means. If there are other components such as the synthesizer 476 that supports, for example, a circuit component in either the upstream or downstream shared signal path (as illustrated slide 52 below) then that component would also be considered shared circuitry.



339. In sum, the intrinsic record including the claims, the specification, the drawings including Figs. 1 and 4, and the prosecution history reasonably inform someone skilled in the art about what “shared circuitry” means. Therefore, I disagree with Dr. Bims’ statements to the contrary in his declaration (¶¶ 227-239) and his report (¶¶ 238-254).

340. **(written description and enablement)** I have also considered Dr. Bims statement that “shared circuitry” as recited in the claim fails the written description and enablement requirements. Dr. Bims’ conclusory statement is not analysis of these issues.

341. As noted, Dr. Bims does not provide any separate analysis of the written description or enablement issues. In other words, the only support he provides for the written description and enablement contention is his view that the term is indefinite.

342. Share circuitry is recited as follows in the claim: “the digital host unit includes shared circuitry that performs ... distribution of ... signals between the digital host unit and the at least two digital remote units ...”

343. As discussed above, “shared circuitry” is not indefinite. The history of Dali and Dr. Bim’s contentions discussed above and the lack of any indefinite rejections by the patent examiners show that Dali and Dr. Bims are creating confusion where none exists. Further, knowing that claim terms are viewed through the lens of a person skilled in the art in view of the intrinsic record (e.g., the claim language, the written specification, the drawings, and the prosecution history), it is clear that there is more than adequate patent disclosure as filed, including the written specification and drawings (including Figs. 1 and 4),⁴ to establish that the patent as originally filed (a) reasonably conveys to that person that the inventor had possession of the claimed subject matter at that time of the original filing; and (b) sufficiently enables a person skilled in the art make and use the claimed invention without undue experimentation.

⁴ See also CommScope’s response to interrogatory no. 30 wherein Dali was provided for a more detailed listing of cites to the specification for certain claim language of CommScope’s asserted patents.

[REDACTED]

[REDACTED]

[REDACTED]

d. “wireless” (‘286 Patent, claims 1, 23, ‘402 Patent, claims, 1, 20)

408. I disagree with Dr. Bims that the use of the term “wireless” or “wireless radio frequency spectrum” is vague, unclear, or indefinite. The term appears, for example, in the ‘286 patent at claims 1 and 23. Using the term “wireless” in the claims to emphasize that the “radio

frequency spectrum” being received and digitized by the remote antenna units is spectrum that is associated with wireless communications is entirely consistent with the fundamental goal of antenna systems, which is to support wireless communications. That one of skill in the art would understand antenna systems to be employing radio frequency spectrum for wireless communications, admittedly would not need to be stated, but stating explicitly what would already be implicitly understood by one of skill in the art does not make the term “wireless” or “wireless radio frequency spectrum” indefinite or confusing.

409. Multiple Dali patents use the phrase “radio frequency” in combination with the word “wireless”, for example in the phrase “wireless radio frequency (RF) transmitter.” See, e.g., 8,224,266 at 1:24-25 (“wireless radio frequency (RF) transmitter”); 9,112,549 at 2:39-42 (“a wireless RF signal”); 9,077,297 at Abstract (“wireless RF signals”).

410. My declarations submitted in the claim construction proceedings were used to create a summary slide addressing “wireless” as used in the claims. I have reproduced that slide below.

“wireless”

E.g., ‘286 Patent Claim 1: “...**wireless** radio frequency spectrum...”

“Wireless” merely emphasizes that the radio frequency spectrum being received and digitized by the remote units is RF spectrum **that is associated with wireless communications.**
 -- Acampora Resp. ¶55

Wireless and RF are not redundant. Dali itself repeatedly uses “wireless” in combination with “radio frequency” or “RF” in its patents:

Dali Patent No. 8,224,266 (“ wireless radio frequency (RF) transmitter”)	-- A434 at 1:24-25)
Dali Patent No. 9,112,549 (“a wireless RF signal”)	-- A448 at 2:39-42
Dali Patent No. 9,077,297 (“ wireless RF signals”)	-- A486 at Abstract

Acampora:

“That one of skill in the art would understand antenna systems to be employing radio frequency spectrum for wireless communication, admittedly would not need to be stated, but **stating explicitly what would already be implicitly understood by one of skill in the art does not make the term ‘wireless’ or ‘wireless radio frequency spectrum’ indefinite or confusing.**”

Slide 76

411. I have reviewed Dr. Bims expert report with respect to this claim term and it does not change my opinion. At paragraph 469, Dr. Bims suggests that I have not provided any explanation to distinguish between radio frequency spectrum and wireless radio frequency spectrum. Dr. Bims is wrong. As I said in my prior responsive declaration and as repeated above, stating explicitly what would already be implicitly understood by one of skill in the art does not make the term “wireless” or “wireless radio frequency spectrum” indefinite or confusing. Further, Dr. Bims states that I point out that Dali’s own patents use the term “wireless” in combination with “radio frequency.” Dali’s own use of the phrase that Dr. Bims is discussing, in my opinion demonstrates that Dr. Bims’ opinion of indefiniteness is unreasonable. That Dali itself uses this phrase in its own patents shows that those of skill in the art do not become confused or unable to understand the meaning to be given to these terms when used in combination. Evidence of how those of skill in the art use a phrase seems to be entirely relevant to whether or not the phrase is indefinite to those of skill in the art.

- e. **“wireless spectrum comprises a cellular radio frequency spectrum and any modulated transmissions from the wireless units carried by the cellular radio frequency spectrum of the wireless spectrum (‘402 Patent, Claim 16)**

412. **(written description and enablement)** I disagree with Dr. Bims that this phrase lacks written description or enablement. This limitation largely parallels the limitations discussed above (e.g., the limitation in claim 1 of the ‘218 patent that recites “a respective original upstream wireless signal comprising the upstream radio frequency spectrum and any upstream transmissions”) and is supported by the same passages of the specification already cited and discussed above with respect to the similar language in claim 1 of the ‘218 patent. The phrase adds that the radio frequency spectrum is “cellular” and that the transmissions from the wireless units are “modulated.” Both of these limitations are supported and enabled by the