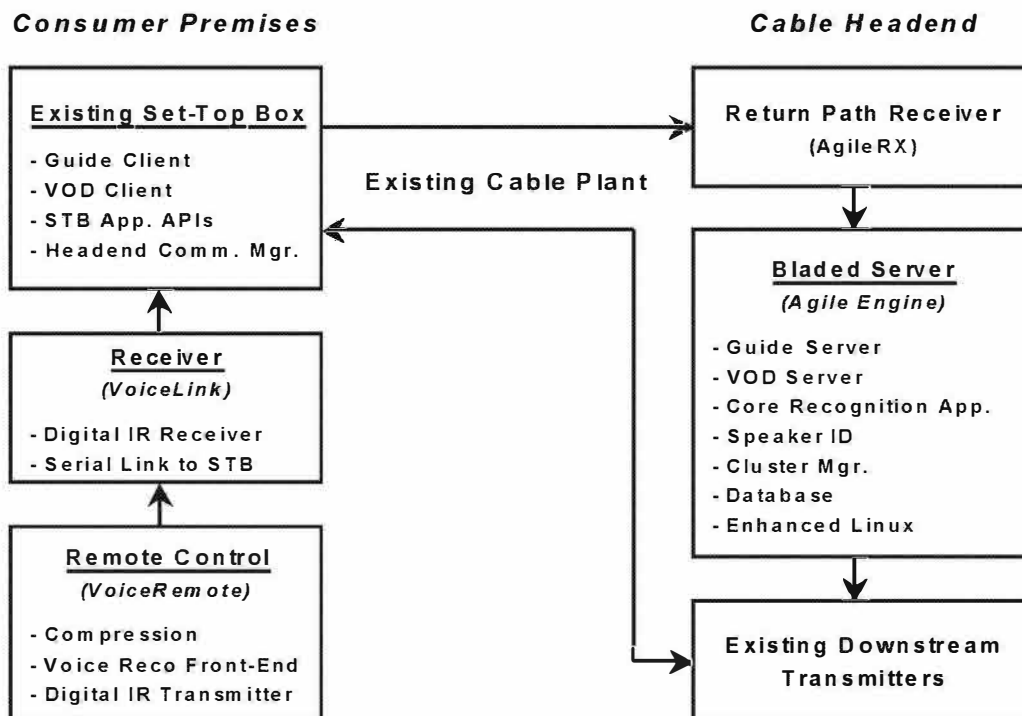


TECHNOLOGY & PRODUCTS

AgileTV's technical mission is to deliver a reliable, highly accurate, cost-effective, scalable end-to-end service that voice enables all the television programming the MSO is offering its cable subscribers. Our focus is developing and commercializing the core technologies required to deliver an advanced speech recognition product to the cable industry. We create mutually beneficial development partnerships with suppliers of Interactive Programming Guides and Video on Demand services to voice enable the products they are providing the MSOs as well.

The AgileTV service is comprised of a speech-enabled Voice-Remote remote control that transmits a compressed form of speech via IR to a small set-top box receiver, the VoiceLink. That integrates with the existing set-top boxes, which then transmits the speech request to the cable system's headend for processing.

At the headend, subscriber requests are received by a very high density return path receiver, the AgileRX then relayed to the Agile Software Engine, running on a high density compute cluster. The software translates the subscriber's request and processes it into the appropriate response, which is then sent back to the set-top box to perform the requested action on the TV.



CONSUMER PREMISES EQUIPMENT AND SOFTWARE

VoiceRemote

The VoiceRemote is the gateway to AgileTV's speech recognition service. It has all the usual button functionality of existing universal remotes, but also incorporates a small, integrated microphone and a push-to-talk button. This allows it to receive a subscriber voice request and convert them into digital form, generating a very high quality audio signal. The remote's key features include:

- A high quality noise-canceling microphone element inside an acoustically optimized housing that significantly reduces background noise.
- Through careful mechanical design and extensive acoustic testing, the VoiceRemote is engineered to ensure significantly higher speech recognition accuracy. This is an advantage over existing telephony speech systems and allows significantly higher recognition accuracy.
- Utilization of 16-bit, 16 KHz sampling converts speech commands into digital data, providing four times more information than existing telco-based systems. This increased information is especially beneficial when recognizing the higher-pitched voices of women and children.

Hardware and software are integrated into the remote to perform front end speech recognition. A microprocessor breaks down the core elements of speech into a form that is well suited for efficient speech recognition. Proprietary speech compression software compresses speech signals down to 2.5K bps with no loss of speech recognition accuracy.

After the speech signal has been preprocessed and compressed, it is transmitted from the remote control via an error-corrected data path between the remote control and the VoiceLink Receiver.

Stuff to be developed is not addressed.

Square with product features?

VoiceLink Receiver

The VoiceLink Receiver's is designed to work with the Motorola DCT-2000, which is the most widely deployed set-top box in the United States. The VoiceLink Receiver converts the transmission into serial RS-232 format. The compressed speech data is then sent to the set-top box for transmission to the headend.

Subsequent versions of the VoiceLink Receiver will replace the serial connector with a USB connector, which will enable integration of voice services with all other digital set top boxes, including Motorola, Scientific-Atlanta, Pace, Sony, Pioneer, and Samsung.

In order to reduce costs, the product is transitioning from an analog FM IR design, to a digital IR design. This effort will require six man-years of effort, including use of outside contractors. In volume production, CPE costs will drop from \$22.00 to \$15.50 per unit.

Set-Top Box

AgileTV platform software runs on the set-top box in a very small footprint. There are two primary components which control the applications programs

- *Actuator*, which speech enables the set-top box. It provides communication with the VoiceLink Receiver and the headend speech processing software. It also provides the visual feedback on the TV to let the user know that speech processing is underway.

- *Applifier*, which simplifies the process of creating speech-enabled applications programs and user interface elements. It also contains the core APIs that interface with set top box applications programs.

Agile's initial cable deployment will include:

- *VoiceGuide*, which has been developed in partnership with Source Media/Insight Communications to deliver a voice enabled guide with enhanced navigational capabilities, referred to as SpeechScan and SpeechSearch, that make finding desired content both easier and faster.
- *VoicePlay*, a voice enhanced VOD navigator developed in conjunction with SeaChange International, the largest cable VOD supplier. VoicePlay mirrors the look and feel of VoiceGuide, so that viewers have a consistent user interface for both the cable and on demand programming being offered by the MSO.

AgileTV's initial set-top box platform services have worked well in deployment. Additional set-top box applications are being designed and commercialized, to better support large-scale deployments. New features are also planned, which will provide the user with voice enabled capability over favorite programming, program reminders, recommendations, and parental control. Total develop will require roughly six man-years of effort.

CABLE HEADEND SOFTWARE

All of Agile's headend software runs on top of the Linux operation system. Since any changes to the operating system "kernel" must be released to the public domain, all of Agile's enhancements have been carefully architected to ensure that important value-add are free from Open Source restrictions. This is accomplished by moving as much functionality as possible into user programs rather than the core Linux kernel.

The primary headend software components are:

- Application servers that support set-top box applications programs
- Speech services that are the heart of the AgileTV system
- Platform services that make the AgileTV system possible and economical

Application Servers: For each set-top application program that AgileTV voice-enables, a small corresponding application server program is written to run on the Agile Engine. The approach simplifies the process of voice-enabling third party applications and speeding integration efforts. These application servers have four primary duties:

- Retrieving "metadata" that describes all content being managed, such as a list of sports programs on cable, or a list of movies by genre that are available on a VOD server.
- Merging the content list with the desired speech commands that will be supported by the voice-enabled application.
- Compiling speech "grammars", which are the set of commands most often used by the viewer while choosing or watching a TV program.
- Issuing appropriate action commands to the set-top box as speech requests are recognized

The application servers have corresponding server components for the CPE VoiceGuide and VoicePlay. Further improvements will focus on the development features that help support large scale deployments. Approximately eight man years will be required to create this robustness.

Though this is a large task, risk has been mitigated by previous voice-enabling efforts and the use of well documented, standards-based interfaces.

Headend Speech Software: The core of the AgileTV service is the speaker-independent speech recognition system, *AgileVoice*. Based on the commercial Speechworks Recognizer speech system, AgileVoice has been extended by Speechworks and AgileTV to support unique enhancements. AgileTV also builds its own acoustic models which results in significantly enhanced speech recognition accuracy.

AgileTV's speech software supports dozens of different acoustic models simultaneously. Most commercial speaker-independent systems use just one or two acoustic models for each language. AgileTV automatically assigns each subscriber request to an acoustic model that most closely matches their individual voice characteristics. In a typical large scale deployment it can support dozens of different acoustic models simultaneously. This greatly improves speech recognition accuracy, which enables better support for age, gender-based, and regional accent variation. The system also continuously adapts its acoustic models to the speakers that are using the service, which continues to increase speech accuracy over time.

Another proprietary core speech technology provide for speaker identification within the acoustic profiles for that subscriber's household. If chosen as an option, the service, *AgileID*, requires less than 90 seconds of speech to identify the characteristics of an individual voice. This allows services like parental control over viewable content, spending limits, Tcommerce, and personalization of services.

When AgileTV was first formed, speech recognition was considered a major technological challenge. The current 8-bit, 8 KHz speech platform has been successfully deployed in the field for more than ten months. An additional six man-years of effort will be required to integrate 16-bit, 16 KHz support and acoustic models, automatic acoustic profiles, and AgileID components. Each of these concepts has been already proven.

Headend Platform Services:

AgilePilot: AgileTV provides an autonomous management application, which allows straightforward installation and daily management of the AgileTV service and also increases system reliability. This application, AgilePilot, provides task management, fault detection and recovery, and unified system management.

- Task management controls the execution of applications on the Agile Engine. AgilePilot sequences the flow of across the processors, and provides workload and resource balancing for maximum efficiency. The integrated task assignment also sharply reduces the complexity of creating and deploying scalable interactive applications.
- Fault and recovery quickly identifies hardware or software faults, and corrects them as soon as possible. AgilePilot continually scans the system for potential problems. Temporary failures are handled transparently by restarting the offending processor. For more serious failures, AgilePilot automatically reconfigures resources to map around the defective component while continuing service operations.
- AgilePilot can manage large deployments of over 100 CPUs as though it were a single processor. AgilePilot offers powerful querying and management tools, which allows operators to examine service and capacity utilization, system status and history, and key operations metrics. In the event that manual intervention is required, AgilePilot provides a sufficient detail to assist in rapidly identifying causes, which speeds problem resolution.

AgileStore: Maintenance of data protection while still providing a reliable, scalable interactive service is addressed through a global database/cache manager that is optimized for the delivery of Cable's programming and interactive services. This service, AgileStore, has a unique distributed architecture which dramatically improves the scaling of the AgileTV service by efficiently managing an inter-processor cache for all shared data objects. This allows additional processors to be added to the system at any time, with near-linear performance scaling. AgileStore also uses network data replication and automatic failover to ensure that the vast majority of hardware or software failures will not result in service disruption. Application performance is maximized because applications can be easily repartitioned if necessary.

Initial versions of AgilePilot and AgileStore have been quite effective, and are largely responsible for the high reliability of AgileTV's first deployment. Ongoing effort will primarily be focused on continued scaling enhancements, extending failover support, and major extensions to the system management and diagnostic tools. AgileTV's headend platform services will require approximately eight man-years of additional development resources.

CABLE HEADEND HARDWARE

AgileEngine: AgileTV's service was specifically designed to scale effectively through the use of clustering technology. Clustered systems work best in situations where many different users are performing the same basic tasks, which is exactly the environment in which the AgileTV service resides. Clustering allows the use of inexpensive commodity off-the-shelf hardware while still offering linear performance of both performance and cost; scaling only requires adding more servers.

AgileTV's headend software approach moves the complexity of scalable application development out of the application and into the platform services. Additionally, AgilePilot and AgileStore allow the cluster to be managed as a single system.

Software development has been done on X86 Linux, which simplifies deployment, reduces capital requirements, and increases hardware availability. Current hardware support requires one to two employees.

AgileRX Return Path Receiver: In the existing Motorola DCT-2000 cable installations, there is limited return path bandwidth available from subscribers' homes back to the cable headend. Existing return path receiver equipment was designed for occasional responses to queries from the headend. The Agile service requires rapid communication from the set-top box to the headend.

The core technology used to accomplish this is software-defined radio, which is widely used in cellular phone base stations. The result is a high-speed analog/digital converter which samples each RF input quickly enough to capture the entire frequency spectrum used for the set-top box return path, the AgileRX.

Each AgileRX RF input can demodulate up to twenty return path channels per RF input. This provides density that is up to 100 times higher than conventional equipment and much less expensive. Compared to Motorola's current product, which sells for \$18.00 per subscriber, the AgileRX solution will cost roughly \$1.00 per subscriber.

The AgileRX's core Xilinx front-end is approximately 70% complete. Extensive simulation results verify the validity of the approach. The software effort is aided by one of the leaders of the software-defined radio technique, which has made development much more efficient. Full development of the AgileRX will require an additional eight man-years of effort, plus \$2.7 million for contractors, NRE, prototypes, and tooling.

MANAGING RISKS

AgileTV knows that risk management is essential to successful technology development. Expert advice has been sought early in the design process to ensure the feasibility of design approaches. Extensive input has also been achieved from senior technical personnel at the MSOs and suppliers to the industry to ensure the Agile development process delivers what the client desires. Multiple alternatives are evaluated to provide flexibility of design. Our staff freely communicates differing approaches, and the best ideas evolve from open debate.

FUTURE DEVELOPMENT PLANS

Because the service will be deployed by several MSOs, integration with additional guide services and VOD suppliers will be required. The service will also be adapted to work with a wide range of set-top boxes, including the Motorola DCT-6200 series and the Scientific Atlanta Explorer series.

Beginning in early 2006, AgileTV will deploy limited interactive information services that provide frequently accessed Internet content to the consumer's television. Cable's "Walled Garden" package includes services such as local weather information, sports scores, and stock quotes. The ease of speech control is an important enabling technology to drive more widespread adoption of interactive applications. By the end of 2006, AgileTV will introduce interactive games. Speech control will make it easier to play basic games such as BlackJack or Solitaire. Richer, more complex games will also benefit.

Long term candidates for speech control include:

- Personal Video Recorders, such as TIVO
- Additional on-demand content, such as Music On Demand.
- Personalized services, such as a personal agent that scans news sources and delivers only the content of interest
- Home Control and automation
- Interchange of audio messages instead of text messaging

In the very long term, there is a possibility of speech-to-text applications. Continued advances in speech recognition could support voice dictation of email or text chat.