Residential Gateways

A single device connects multiple broadband access and home networking technologies.

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The Residential Gateway (RG) is a platform for the deployment of high-speed Internet access and integrated voice, data and video services over the same high-speed pipe to different nodes (appliances) throughout the home. RGs combine the functions of a digital modem, SOHO router, or hub for Internet access to multiple information appliances.

There are different types of RGs available based on the functionality required. Devices such as set-top boxes and digital modems provide broadband access to homes and SOHOs (small office-home office). These devices will incorporate home networking functionality and evolve into gateways. In addition to these devices, a number of dedicated RGs such as home servers and SOHO routers are emerging.

Market Trends

The home networking market is fragmented and includes the following four aspects:

- Broadband access
- Residential gateways
- Home networking technologies: no new wires (phone lines, powerlines), new wires (IEEE1394, Ethernet, USB 2.0), and wireless (HomeRF, Bluetooth, DECT, IEEE802.11, HiperLAN2)
- Information/Internet appliances.

Rapid implementation of integrated value-added services with home networking is creating an explosive market for RGs. Cahners In-Stat Group predicts the RG market will rise sharply from $100 million in 2000 to $5 billion in 2005.

RGs will evolve from providing basic broadband access to providing integrated services gateways such as remote management, home automation, home security, and video-on-demand. RGs will also network multiple home networking technologies and provide protocol translation between disparate technologies.

Consortiums like the OSGi (Open Services Gateway Initiative) are working to define and promote an open RG standard for connecting the coming generation of smart consumer and small business appliances with commercial Internet services. Hurdles inhibiting the mass deployment of RGs in households include the lack of:

- Clear business models (costs of ownership)
- Customer education and mass confusion
- Support mechanisms.

Widespread deployment of gateways into homes will come in three distinct phases. While the gateway is a new term, the first phase already exists in many homes. A good number of our homes have a set-top box for receiving television broadcasts and a cable modem to connect to the Internet. Phase two will include advanced features such as broadband connectivity, home networking interfaces, and IP telephony in the RG. The third deployment phase will be powerful RGs, capable of delivering video, voice, and data throughout the home. It will also provide other services such as home automation, energy management, security control, and so on.

The RG hardware architecture will be modular, which will allow support of multiple broadband and home networking technologies. Supporting multiple technologies makes the gateway less likely to become obsolete with technology advancements. Support for modularity will fuel the evolution of RGs into a type of application server that consumers will use to distribute broadband services throughout their homes. The gateway must have a reliable and robust hardware platform, and software that is not susceptible to errors. Unlike PC users, consumers will not tolerate having to reboot their gateways. Supporting multiple services such as voice, data, and video with complete security is essential. Functions such as e-commerce transactions, remote home control, and access to authorized service providers are critical. Providing quality of service to support multiple intelligent devices from different vendors is extremely important.

RG Components

The gateway provides a unified platform to satisfy the needs of most consumers, providing infotainment and communication. Because the underlying technologies are new and evolving, the RG will evolve in its

functionality. In its basic form it will combine digital modems, home networking chipsets, and software. Additionally, all gateways will contain computing resources to support the software required to operate the device.

Various types of devices are competing for a share of the RG marketplace.

PC-Based RG (Home Servers)

The PC-based RG could be the easiest path to the RG because of PC penetration in today's affluent homes. Also, it has the processing power, includes a digital modem, and is an ideal platform for the deployment of home networking services. However, the PC has certain disadvantages. The operating systems are traditionally not robust, and PC rebooting is not acceptable in a gateway, which provides critical features such as security. Some companies have pursued PC-based architectures even within a separate RG.

Modem-Centric RGs

Traditional methods to connect to the Web have hit a technological upside. Analog modems using phone lines cannot provide bandwidth beyond 56 Kbps. Digital modems, such as cable, DSL, and satellite, provide high-speed Internet access. Satellite modems offer speeds of 400 Kbps to 38 Mbps, DSL modems offer 1.5 Mbps to 52 Mbps and cable modems process multimedia content up to 30 Mbps. Usually, the RG is sold in conjunction with value-added services. Service providers subsidize the cost of the gateway by charging for services over one to two years. Typically, the gateway is easy to install and the service provider saves money by minimizing truck rolls. The following types of broadband modems will evolve into gateways:

Cable Modems

Cable modems are client devices that provide high-speed, two-way communication (data, voice, and video) over cable TV networks to access this mix of applications.

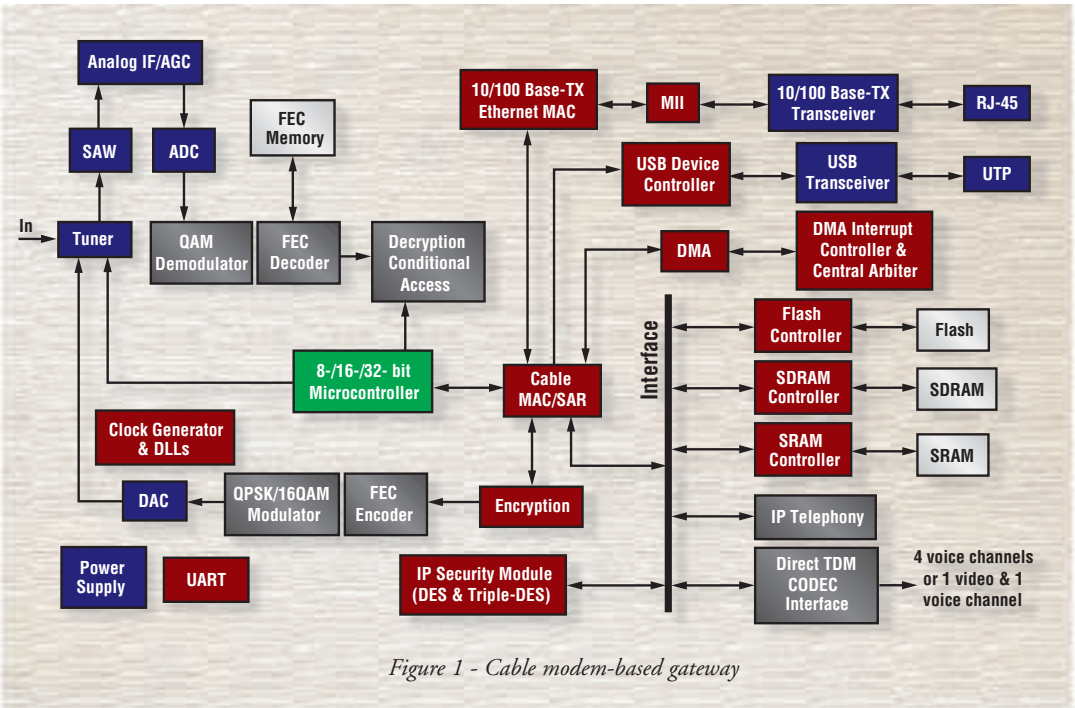

Figure 1 - Cable modem-based gateway

Cable modems provide an always-on connection, thus eliminating the slow and frustrating procedure of establishing a dial-up connection.

A standard cable modem has two connections; one port connected to the TV outlet on the wall and the other to the home network. The cable modem communicates over the cable network to a device called a CMTS (Cable Modem Termination System), which is a central device for connecting the cable TV network to a data network (Internet).

Theoretically, cable modems are capable of receiving and processing multimedia content at 30 Mbps. However, subscribers can expect to download information at 1.5 Mbps, because multiple users in the neighborhood share the bandwidth. Operators define a portion of the frequency spectrum to carry the data. The downstream path (head-end to home network) lies between 50 MHz and 750 MHz. The 5 MHz to 42 MHz frequency range transmits information from the home network to the head-end. Cable modems receive and transmit TCP/IP traffic, including multimedia content and Internet access.

The tuner in the cable modem receives a digital signal from the network and isolates a particular channel that contains the Internet data. It then converts the signal from RF levels back to baseband. The baseband output signal from the tuner is then forwarded to a demodulator. The demodulator samples the signal and converts it to a digital bit-stream. The bit-stream contains video, audio, and IP data. Once the bit-stream is recovered it is forwarded to a forward error correction (FEC) unit and checked for problems. The signal is then passed into the control unit and further to the home network using one of the high-speed data port interfaces.

In a cable modem-based gateway, as shown in Figure 1, programmable logic solutions provide system interfacing (PCI, UART, DMA), encryption, interfacing to several home networking technologies (Ethernet, USB 2.0, HomePNA), ASSP functionality (such as cable MAC), and glue logic.

Satellite Modems

Similar to the cable operators, satellite service providers deliver broadband connections to their subscribers. Consumers who connect their home networks to a satellite broadband platform are accessing a shared medium that is broadcasting at rates up to 38 Mbps. The transmission speeds from the service provider to the home is high, but the upload speeds are limited to a dial-up, telephone modem transmission rates.

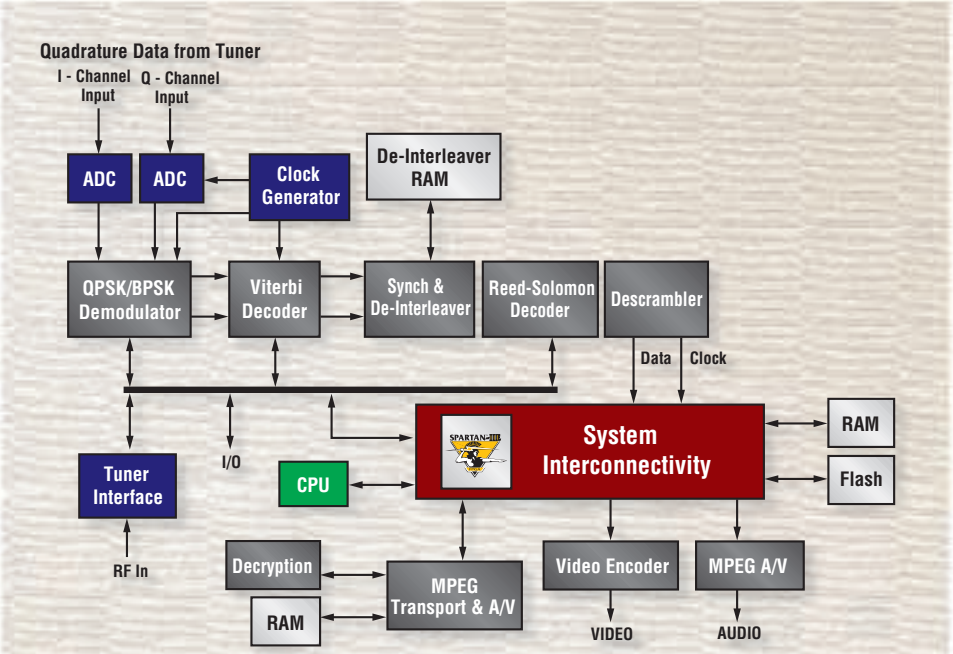

Figure 2 - Satellite modem-based gateway

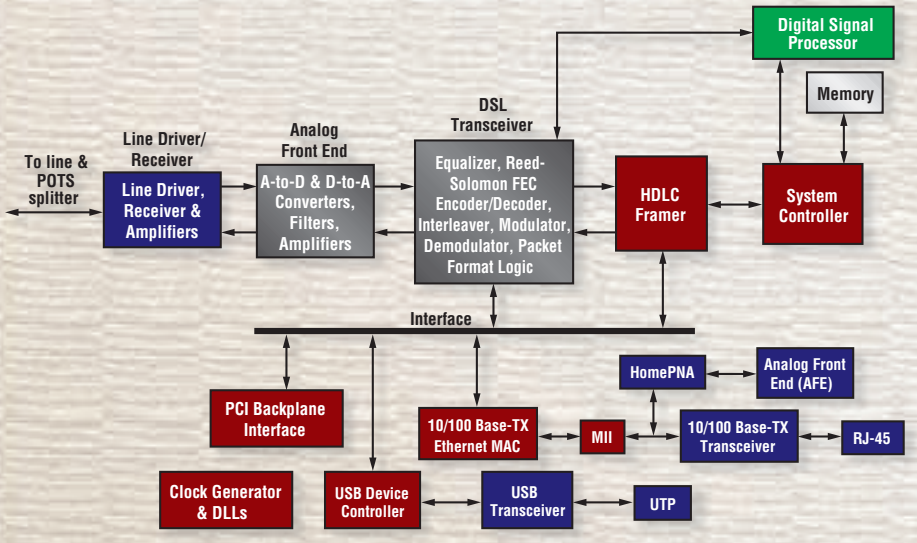

Figure 3 - DSL modem-based home gateway

This high-speed connection is facilitated through a dish and satellite modem.

In a satellite modem, the interface receives digital signals from the satellite network and isolates channels containing Internet data. The host interface provides an interface between the satellite modem and home network, using USB and PCI host interfaces. System glue interconnects the CPU and memory components with the host and satellite interfaces. Satellite modem-based gateways, shown in Figure 2, include satellite modem ASSPs and home networking ASSPs. These ASSPs provide high-speed (data, voice, and video) access (using the satellite broadband network) and network these information appliances. Programmable logic provides system interconnectivity solutions to network appliances using disparate technologies such as phone lines or Ethernet connections.

DSL Modems

Broadband modems based on DSL technology support data transmission over standard telephone lines up to 50 times faster than the analog modems. An Asymmetric Digital Subscriber Line (ADSL) circuit consists of two ADSL modems connected by a copper twisted-pair telephone line.

To maintain backward compatibility with the standard telephone system and to avoid disruption of service due to equipment failure, the voice part of the frequency spectrum is separated from the digital modem circuitry by means of a passive filter called a "POTS splitter." Hence, if the ADSL service fails, the POTS service is still available. Under this configuration, voice calls and Internet data are transmitted simultaneously over the same broadband DSL pipe. When an ADSL transmission is received at the central office, a more advanced POTS splitter is used to send the voice traffic to the public telephone network and data to the Internet.

DSL gateways provide DSL functionality and network information appliances. Programmable solutions are ideal for interfacing multiple home networking technologies (such as HomePNA, Ethernet, and USB 2.0) and system interfaces such as PCIs.

Digital Set-Top Boxes (STBs)

In the early 1970s, the only piece of equipment that people needed to watch TV was a standard television that they were able to purchase at a local store. In the 1980s, this simple model began to change. Cable and satellite providers required the consumer to connect their TVs to their networks. Also, operators decided to scramble TV signals, requiring a special box to de-scramble the signals at the consumers home.

Today digital television requires an STB to receive and decode digital transmissions into a form suitable for display on analog television sets. They are installed and configured by the local cable, terrestrial, or satellite service provider.

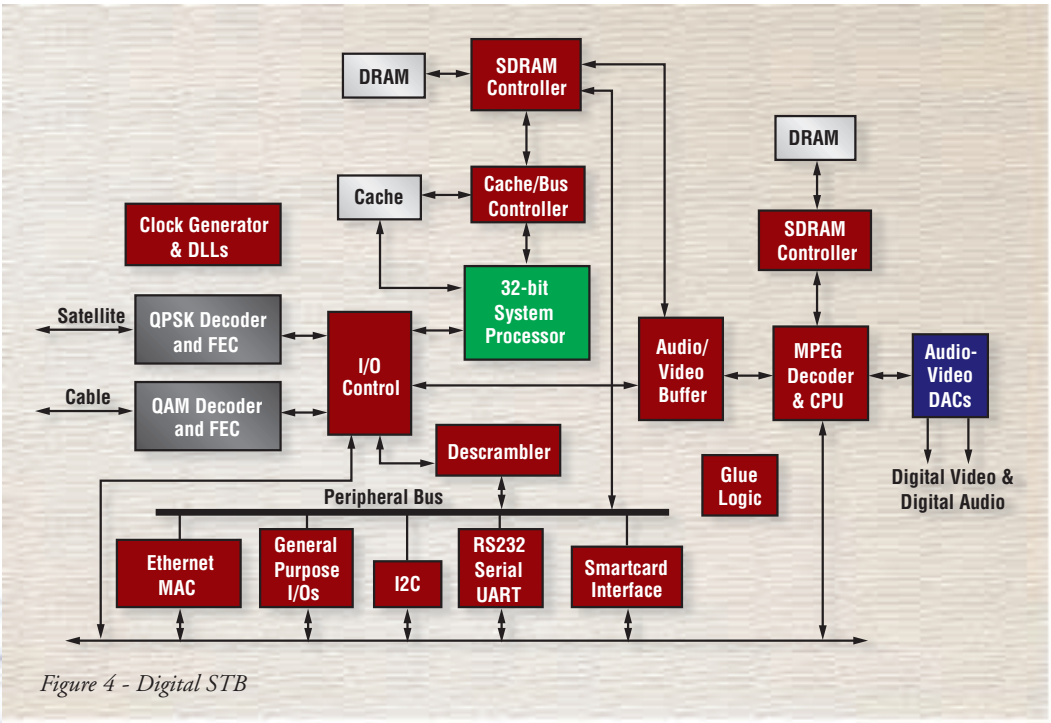

Figure 4 - Digital STB

STBs usually have cable or satellite modem chips to bring broadband and TV signals to the home. Other ASSPs/ASICs handle and process digital video and audio services. These application-specific devices communicate with each other via buses on the system board. The CPU is responsible for coordinating the different components. With additional features, STBs will require higher performance CPUs to keep pace with increased data throughput.

Programmable logic devices address the fundamental disconnect between application-specific devices. Time to market and the ability to upgrade quickly after the sale is imperative for a successful product. Programmable devices provide the cutting edge advantage over ASSPs by bringing products first to market – and having the ability to add features remotely to STBs already deployed in homes.

Need for Programmable Solutions

For RGs to be successful, programmable solutions will have to be at the heart of the system. While programmable logic solutions can perform the functions of cable MAC SAR, DSL receiver chipset, and satellite modem chip, their advantage is in interfacing the different broadband and disparate home networking technologies. They provide an ideal interface to access home networking technologies for protocol translation.

Programmable solutions provide the ability to interface multiple hard-disk drives and proprietary interfaces, and provide encryption capabilities using DES, triple DES, and even proprietary encryption schemes. They also provide system interface functions such as PCI, USB, and so on.

Conclusion

The primary function of the RG is to provide broadband connectivity to the home through cable, xDSL, satellite, and wireless technologies. Secondly, RGs provide home networking capabilities and distribute broadband information through appliances using technologies such as phone lines or wireless LANs. They also provide a unique platform for the deployment of value-added services and aftermarket upgrades. Programmable logic is necessary for the success of RGs, providing time-to-market and time-in-market advantages of interfacing disparate technologies and system interfaces.

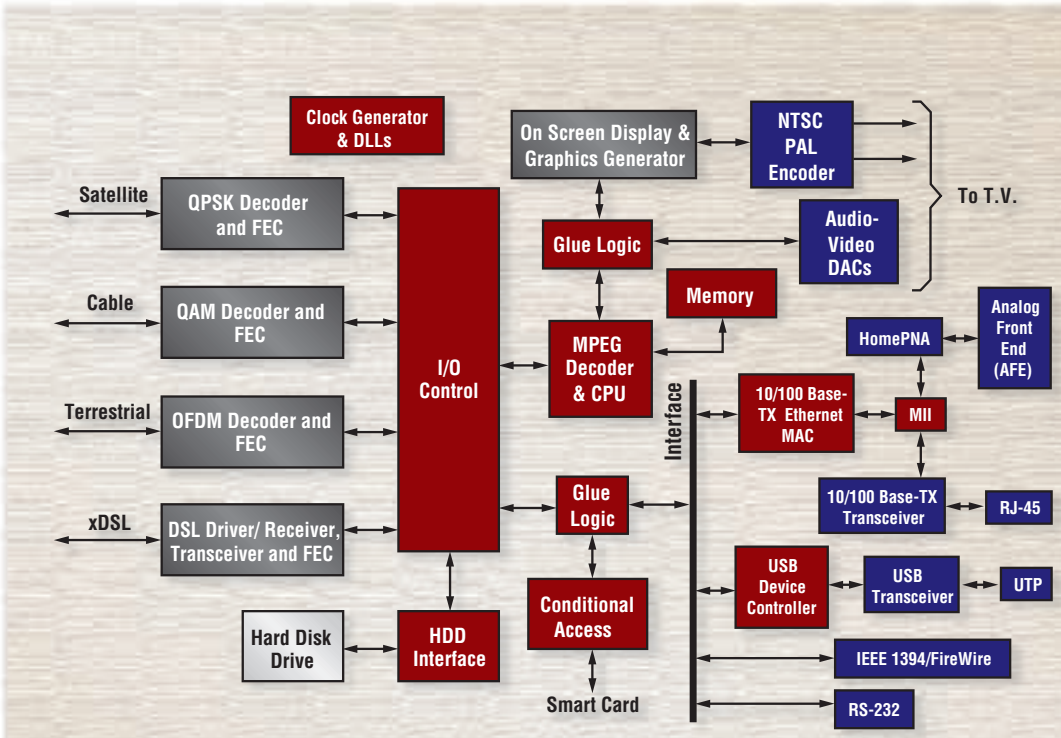

Figure 5 - Residential Gateway