One of the results of deregulation and convergence is that multiple existing and emerging services are competing for entry into homes: dial-up and high-speed Internet access, digital video, monitored security, energy management, IP telephony, and many others. Competition allows more and more consumers to have a choice among different service providers, creating the need for easier switching and easier access to services. In the home, the number of electronic devices and appliances has been continuously increasing, creating the need to link them so that consumers can have more flexible and convenient access to services delivered to the home. Such market development seems to call for a unified, standardized interface that supports numerous services from multiple providers — a residential gateway (RG).

1 The RG Concept

The literal, generic definition of a residential gateway is a network interface device that provides means to access a service delivered to the home, such as telephony, cable TV, and online/Internet service. However, the term RG has recently taken on new connotations. While some people use "RG" as just another term for such devices as set-top boxes or modems, others say that the term refers to an entirely new concept: a whole-house intelligent network interface device.

As such, the RG has two key functions:

- the physical interface terminating external access networks and internal home networks;
- the enabling platform for residential services to be delivered to the consumer, including both existing services and new ones yet to come.

2 The Origin of the RG

For decades, communications networks that provide residential services such as energy, telephony, and cable television were developed virtually in isolation from one another. This phenomenon occurred mainly as a result of the regulatory environment, which created distinct divisions in services delivered to the home. For the past few years, however, the communications and energy utility industries have undergone a gradual
transition toward deregulation and cross-industry competition. Service providers now want to offer multiple services in cost-effective ways. Consumers, at the same time, need the ability to access multiple competing networks with convenience and the flexibility to make choices.

From home control to high-speed Internet service and IP (Internet protocol) telephony, consumers will soon be besieged by a host of emerging or newly re-imagined services, all clamoring for entry into the home. How will these different services get to the home? Will the home be able to receive them without using too many “black boxes”? More importantly, how will these services be distributed from point to point within the home?

3 The Benefits of the RG

Figure 1 illustrates the key advantages regarding the RG.

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Advantages</th>
</tr>
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<tbody>
<tr>
<td>Consumers</td>
<td>Easy access to multiple networks</td>
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<td></td>
<td>Lower prices of services</td>
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<td></td>
<td>More services</td>
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<td>One-stop shopping</td>
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<tr>
<td>Service Providers</td>
<td>Reduced costs</td>
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<td>Enabling technological updating/upgrading capabilities</td>
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<td>More revenues</td>
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<td></td>
<td>Easier network management</td>
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<td>Manufacturers</td>
<td>Standard interface</td>
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<td></td>
<td>Reduced costs of design and production</td>
</tr>
<tr>
<td></td>
<td>Convergence of network and end-device development</td>
</tr>
</tbody>
</table>

Source: The RG Group’s white paper

Figure 1
All the key advantages listed in Figure 1 are derived from the proposed design principle of the RG: a single, standardized, flexible, and future-proof network interface device through which all services are delivered to the home.

### 3.1 Benefit to Consumers

**Easy Access to Multiple Networks**
With the RG, consumers will get a user-friendly interface and have access to multiple services through any type or number of media in a seamless and transparent manner. The RG, with its plug-and-play features, hides the complexity of multiple networks and provides the ease of use that consumers demand. The RG is also capable of terminating all of the in-home networks (phone line, coax, powerline, etc.), thus providing seamless interconnections between internal and external networks.

**Lower Prices of Services**
The RG may be more cost-effective than having multiple boxes to access services. The reason is that the RG enables services through specific service/application modules that are less expensive to make and install than individual gateway devices or black boxes. For example, digital encoding and decompression can be built into the RG so that set-top boxes will be no longer needed. As technology changes, instead of replacing set-tops, a plug-in module within the RG can be replaced. This is more cost-effective than the current model of video service. Cost reductions can translate into savings passed onto consumers. Besides, the RG approach provides a common core set of protocols in a one-box design and can, therefore, enable new services at a lower cost.

**More Services**
The RG will enable a wealth of new applications and provide numerous new service options. As a single, flexible, extensible, and intelligent interface, the RG is ideal to satisfy both short-term analog needs and high-bandwidth digital services, such as high-speed Internet access, high-definition television, and services yet to come. In addition, service providers will have the ability to package various services, offering convenience and simplicity to the consumer.
One-Stop Shopping
The RG makes it more likely for consumers to receive residential services (telecommunications, entertainment, and energy services, etc.) from a single source. The emergence of standard and flexible residential gateway technology will create cross-application synergies, which allows service providers to extend their service offerings to new areas.

3.2 Benefit to Service Providers

Reduced Costs
As residential gateway technology becomes accepted and more common, the cost of services to the consumer will decrease while the number and availability of services will increase. Interface standardization will enable service providers to reap the benefits of reduced manufacturing costs due to economies of scale. Service providers are also likely to experience reduced maintenance as a result of standardization. Furthermore, the RG approach allows remote software diagnostics and extensive network monitoring to be performed, resulting in substantial labor savings on field service calls.

Enabling Technological Updating/Upgrading Capabilities
The RG concept allows for easy technological updating and upgrading by simply replacing a module or the entire unit with one that is compatible yet more technologically advanced. This will, to a great degree, eliminate the issue of obsolescence. Service providers can also easily extend their current business models and offer new services.

More Revenues
The RG enables packaged information services to the home. In addition, because of a common core set of protocols in one box and an extensible intelligent interface, service providers can achieve new revenue streams by offering new and/or differentiated services, which is an important competitive advantage. In addition, service providers can easily bundle different services together or offer them on an a la carte basis.
Easier Network Management
The RG allows one service provider to perform all security and network diagnostics from the external network interface or from a remote location. Thus, access network management will become easier.

3.3 Benefit to Manufacturers

Standard Interface
The RG approach offers a standard interconnection that will define the network interface. Different appliances and devices will be connected to the RG through in-home networks, thus enabling new multimedia services.

Reduced Costs of Design and Production
Network interface designers currently face too many protocol options at the appliance or peripheral side of the network. Standardization, on the other hand, will eliminate the need to design for multiple interfaces and lower manufacturing costs through economies of scale.

Convergence of Network and End-Device Development
Currently, the development of network technologies and advances of in-home devices have different driving forces and often occur separately. The RG approach will decouple the development of networks and end devices, hence joining advances in either area, reducing technological obsolescence, and facilitating innovation.

In sum, a single, flexible, and extensible interface provided by the RG has numerous inherent advantages that will benefit all the stakeholders. In the evolving world of multiple networks with multiple protocols, the RG is considered a necessity, not a convenience.

4 Gateway Transition: From the Past to the Present

As gateway devices are needed for the delivery of services to the home, multiple and separate gateway devices have already been installed in US residences. There is the
telephone junction box (where the drop line for voice, fax, and/or data meets the lines running to jacks in the home). There is the cable network interface unit as well as the set-top box. There are also one or more utility interfaces that are traditionally equipped with meters to determine usage. And, of course, there are millions of analog and digital modems that have found their way into Americans’ homes. Finally, some new gateway devices have been developed to enable TV-based Internet access, energy management, home automation, etc.

Although gateways were historically developed to address specific needs of specific service providers, convergence has prompted some recent developments that address the need of multiple service providers. For example, the Open Services Gateway Initiative (OSGI) is aimed at creating standardized gateway specifications for any service provider that wants to provide more services over the Internet.

5 Industries Affected by the RG

5.1 The Telephone Industry

Most of the arguments in favor of traditional telephony participation in gateway development have to do with the aftereffects of the 1996 Telecommunications Act. The Act, which brought down historic barriers to competition, will radically change the competitive landscape for telcos and help move the RG concept forward on several fronts.

The telephone industry is slowly but steadily going through dramatic changes in five key areas: the entry of local and long-distance companies into each other’s markets, the entry of cable and energy utilities into telephone service, the entry of telcos into subscription TV service, telcos’ expanded Internet access service (ranging from dial-up access to high-speed data), and telcos’ diversification into home security and other home services. These changes mean that telcos now face the challenge of protecting their traditional territory while at the same time searching for new revenue streams. The RG can certainly help telcos respond to such challenges.
The RG can support multiple services from one external network or several different external networks, whether narrowband or broadband, wireline or wireless, analog or digital. Thus, whatever network architecture telcos choose to use for existing and new services, the RG will provide a single and effective network interface. While POTS (plain old telephone service) lines have reached every home, telcos are also deploying broadband networks (e.g., digital subscriber line and hybrid fiber networks). A centralized and standardized network interface will no longer require the development of customer premises devices and access networks to take place at the same time.

The RG is also supposed to be future-proof. Thus, telcos do not need to worry about technological obsolescence, and they can add new services in the future simply by adding the appropriate interface cards or modules. This will save considerable costs over the long run.

Even though telcos already have a strong reputation for reliable service, the deployment of the RG will further improve telcos’ customer service by making it easier for customers to choose and receive the services they want. The RG will hide network complexity, provide a flexible and future-proof platform for service delivery, and help create integrated home networks. All this provides customers with convenience and service enhancement. Thus, RG deployment will significantly strengthen telcos’ customer relations.

5.2 The Cable Television Industry

Cable’s pipe into the home offers far more bandwidth than twisted pair copper lines and can potentially provide more services without requiring investment in more bandwidth. While conventional coax cable only has one-way capabilities, cable companies have been committing significant resources to upgrading their plant to two-way. Since the RG enables many new services, cable companies will be able to leverage their broadband networks more effectively.

The cable industry has launched three important initiatives to bring new services to the home: DOCSIS (Data Over Cable Service Interface Specifications), OpenCable, and
PacketCable. All three initiatives are administered by the cable industry’s research and development consortium: Cable Television Laboratories Inc. (CableLabs). These efforts reflect the cable industry’s commitment to providing a broad range of services beyond traditional video programming.

The new services that the cable industry is providing or plans to offer can all be enabled by the RG. While advanced set-top boxes do deliver digital video, video-on-demand, high-speed Internet access, and even telephony, the RG solution will eliminate the need of installing a new set-top box, provide all the services such a box can deliver, and support many other services as well. Thus, cable’s participation in RG development serves the industry’s need to become a major player in a new era of convergence.

The RG can also help the cable industry improve its image. The industry’s past service record has been besmirched by common complaints from customers of waiting all day for cable technicians to install cable boxes or fix service glitches, discontent due to rate hikes, and other customer service problems. The RG approach will be a good solution to this problem, as it makes installation, service provisioning, and maintenance significantly easier.

In the past few years, the quality alternative offered by direct-broadcast satellite (DBS) companies has forced the cable industry to begin repairing its image of poor customer service. While cable’s fear of telcos’ entry has somewhat subsided, the threat of telcos’ rebuild will never go away. Cable’s participation in RG development will better prepare cable to answer competition’s encroachment with comparable and perhaps even better services.

5.3 The Energy Utility Industry

Some of the likeliest supporters of the RG concept come from the energy-utility industry. In fact, utilities have been testing the water of many different kinds of services beyond the delivery of energy. The provisioning of new services, particularly energy management, often requires the installation of a new gateway. Thus, utilities are among the early pioneers of new gateway development and deployment.
Deregulation is forcing energy utilities to pursue/examine new services to retain customers and obtain additional revenue streams. The service portfolio of utilities may include energy management, security monitoring, home control, etc., as well as voice, video, and Internet access. Theoretically, the RG is capable of supporting all existing residential services and future services that have yet to emerge. Thus, the RG is an ideal device for utilities seeking to diversify their businesses. In addition, the RG provides utilities with an opportunity to take advantage of their extensive but underutilized broadband networks.

The two-way, interactive nature of most of the envisioned services for the RG will result in a more positive relationship between the utility and its customers. As it now stands, utilities rarely hear from their customers unless there is a service problem or the customer has a complaint.
The RG’s two-way nature also allows utilities to extract information from the homes that they serve. This capability will make automatic meter reading (AMR) much easier and can also be used for outage detection to allow the utility to restore interrupted service more quickly.

Although some utilities have backed away from value-added services and new business ventures, there is still significant interest from the industry as a whole in converging businesses. Parks Associates believes that utilities will continue to support or participate in RG development.

6 Other Industry Participants

The discussions above have focused on the major providers of voice, video, data, and energy services to the home. However, the RG concept also has important implications to a few other industries, including computer, consumer electronics, home security, home control (home automation), and home networking. This section deals briefly with the relevance of RG development to these industries.

6.1 The Computer Industry

The RG needs processing hardware and software components, which the computer industry has the expertise to provide, so RG development naturally depends on computer companies’ participation. The computer industry has already expanded into many new areas of business, blurring the boundaries between computing and communications. Such business expansion makes the computer industry a natural player in RG development.

The computer industry stands to benefit greatly from the promotion of both the residential gateway and in-home networks. Processing power will be needed to receive signals from external networks and route them via various in-home transmission media. By allowing more services into the home, the RG could allow computer companies to push more computing devices for newly developing in-home networks. As the consumer PC market grows nearly saturated, the industry seeks to capture sustainable revenues
from new products. The computer-based or information-based services supported by the RG serve the needs of computer companies to capture new revenue streams.

Another factor to consider is the growing number of households with more than one PC. Multiple-PC households represent an opportunity to establish in-home data networks that allow users to share computing resources. The RG will facilitate the sharing of such resources.

However, RG development may have a negative impact upon the computer industry in that a full-fledged RG may eliminate the need to develop new set-top boxes and other single-function gateway devices in which the computer industry has an increasing stake. Also, a digital modem is one of the likely components of a centralized RG, which will eliminate the need to have a separate or upgraded modem installed in a computer for Internet access.

6.2 The Consumer Electronics Industry

Like the computer industry, the consumer-electronics industry will benefit from RG development, as new services enabled by the RG will generate a greater demand for consumer electronics. For example, the RG will facilitate multi-room distribution of audio and video signals, and home theater aficionados will welcome new sources of high-quality source material for viewing.

On the other hand, the RG will very likely eliminate the need for various types of electronic gadgets or “black boxes” supporting different types of services and entertainment activities, hence creating a negative impact on some traditional sources of revenue for the consumer electronics industry. For example, a sophisticated RG will eliminate the need to have a different receiver box for viewing different DBS programming in additional rooms.
6.3 The Home Security Industry

Monitored home security already employs a combination of internal and external communications networks to accomplish its task: receiving input from sensors and performing an action based on that input. Thus, it is a good fit for the RG.

The RG will also enhance monitored security functionality. Although the security systems installed in US residences have numerous features, the RG can enable additional functions. For example, by allowing access to other home subsystems such as the heating, ventilation, and air-conditioning (HVAC) system or the lights, the gateway could help the security system to better protect the home from fire damage and help occupants find their way to safety.

6.4 The Home Control Industry

The home control (or automation) industry is moving toward tight coupling and highly integrated systems. The RG could act as the means for subsystems to communicate with each other and the outside world. The industry may also look to the RG to enable their biggest potential customers — such as telcos and energy utilities — to purchase large open subsystems for service delivery.

Many home control functions should be attractive to utilities contemplating energy management programs. Lighting and appliance control, as well as programmable thermostats, can be interfaced with time-of-use pricing from the utility to help homeowners reduce their bills (or to help utilities shift demand away from peak times).

The major inhibitor to the home control industry's participation in RG development is that the industry typically focuses on controllers, modules, and in-home networking protocols rather than the interface device that terminates external networks. Thus, like the security industry, home control manufacturers and installers may not see a strong enough reason to participate actively in RG development.
6.5 The Home Networking Industry

One of the key characteristics of a centralized RG is that it serves as an intelligent interface between external access networks and in-home networks. Thus, companies that have a stake in the home networking business also have a big role to play in RG development.

Home networking has become one of the hottest areas in the communications, computer, and semi-conductor industries. Various proprietary networking technologies and consortium-based efforts have suddenly emerged, competing for a foothold in this burgeoning market.

Home networking is aimed at linking computers, computer peripherals, appliances, and other electronic devices together so that accessing services to the home will be more convenient. Thus, the RG will significantly enhance the functionality of in-home networks. In fact, some new home networking products already come with a gateway device, although such a gateway does not meet the RG definition. Parks Associates believes that RG products and home networking will serve as drivers to each other's market penetration. The development of in-home networks creates the need for a new gateway product that can integrate separate in-home networks; at the same time, the RG needs in-home networks in order to deliver all the services to end-user devices.

7 RG Standards Initiatives

Since the original RG Group was created, there have been several standards initiatives. This section describes the most important ones.

7.1 TIA TR41.5 Committee

The TIA (Telecommunications Industry Association) TR41.5 Committee has attempted to create standards specifications for a gateway device that includes the following features:
• The physical interface to terminate all external access networks to the home, with multiple residential services being delivered over each type of access network.

• The enabling platform for residential services to be delivered to the consumer, or the termination point of internal home networks.

The proposed standard, originally referred to as a multimedia premises reference architecture, will be called TIA/EIA/TSB 110; however, the development of the RG standard has been slow. The services supported by the TIA RG concept include the following:

• Telecommuting
• Internet Access
• Distance Learning
• Telemedicine
• Video Telephony
• Home Appliance Management and Integration
• Security Systems Management
• In-Home Power Regulation and Management
• Automated Meter Reading
• Neighborhood Cordless Roam Phones
• Video delivery
• Virtual VCR and Video on Demand
• Video Intercom
• CD Jukebox
• Online Advertising and Electronic Catalogs
• Video Casino

Parks Associates expects TIA to continue to work on gateway specifications. TIA is also cooperating with another organization developing a residential gateway standard, as discussed next.
7.2 ISO/IEC's HomeGate

ISO (the International Organization for Standardization) and the IEC (the International Electrotechnical Commission) have proposed a residential gateway model for HES (Home Electronic System). This model is called HomeGate, defined as the connection between a WAN and an in-home LAN. HomeGate's functions include WAN termination, protocol translation, resource arbitration, firewall security, and privacy assurance.

Working Group 1 of ISO/IEC JTC 1/SC 25 developed the first specification of HomeGate in October 1998. The working group has been seeking comments by developers of residential and commercial gateways. The HomeGate specification will eventually become part of a new standard under development: Interconnection of Information Technology Equipment.

According to both TIA and ISO/IES officials, the model from TIA and the ISO/IES’s HomeGate may look very similar. The two organizations have pledged to work together so that they can create a single standard, and Parks Associates expects that they will continue to work on their respective gateway specifications. Eventually, they will seek to adopt a single, international standard for the residential gateway.

7.3 Open Services Gateway Initiative (OSGI)

In March 1999, 15 leading technology companies announced an alliance, called the Open Service Gateway Initiative (OSGI), 1 to establish a specification for an open service gateway. The goal of OSGI is to create an open interface for connecting consumer and small business appliances with Internet services. Unlike TIA's effort, which focuses on the hardware side of the RG, OSGI aims at a standardized software environment for connectivity between the wide area network and appliances or a local area network (LAN). OSGI will enable, consolidate, and manage voice, data, Internet, and multimedia communications to and from the home and small office. The Service Gateway will also function as an application server for a range of other high-value services such as energy
measurement and control, safety and security services, health care monitoring services, device control and maintenance, electronic commerce services, and more.

OSGI focuses on the application layer and can be integrated in whole or part in existing product categories such as (digital and analog) set-top boxes, cable modems, routers, residential gateways (hardware), alarm systems, energy management systems, consumer electronics, PCs, and more. OSGI will accomplish this by adopting existing Java standards, such as Jini, and by integrating with other non-Java standards such as HAVi. OSGI will also be designed to complement and enhance existing and emerging residential networking technologies (CEBus, LONWORKS, VESA, Bluetooth, HomePNA, HomeRF, HAVi, etc.).

According to the OSGI Consortium, the Service Gateway is essentially an embedded server inserted into the network to connect the external Internet to internal clients. Services are delivered from Internet service providers (ISPs) to the SG or internal clients (appliances). Examples of OSGI applications include the following:

- Energy load management throughout the home
- Remote monitoring of home status and security
- Home automation
- Health care
- Home appliances monitoring via the Internet
- Shared Internet access via a single point
- Home networking
- Electronic commerce

## 8 RG Development Paths

In Parks Associates’ opinion, future RG development will continue to evolve along two major paths: the type(s) of external access network an RG product terminates and the type(s) of services an RG product enables. These two development paths generate four major RG segments.

1 www.osgi.org.
Among these four segments, service-specific gateways are the most mature in the market. Parks Associates anticipates that for the foreseeable future, there will be more industry efforts on developing “convergence” and “thin-server” gateways than on the “whole-house” gateway. The reason is that “convergence” and “thin-server” gateways are directly tied to individual service providers’ business strategies. For example, cable operators that want to provide integrated video, data, and voice services via their HFC network must have an enabling platform: an advanced set-top box or some other convergence gateway device. Similarly, utilities that want to offer value-added services need to deploy energy management systems that come with thin servers functioning as gateways.
It is self-evident that the whole-house gateway represents the ultimate and most challenging goal of RG development.

9 The Business Case Going Forward

The service-specific gateways include traditional gateway devices and some new devices as well, such as ADSL modems, cable modems, and wireless phone systems that have some networking capabilities. They are gateways in a broad sense of the word. Such devices are deployed by individual service providers or can be purchased and installed by consumers themselves. As stated earlier, these gateways are the most mature among the four RG segments classified by Parks Associates.

Parks Associates believes that most of the RG development efforts for the near future will focus on convergence gateways and thin-server gateways. Cable operators, the RBOCs, GTE, major long-distance phone companies, and some newly emerged competitive
access providers are all attempting to provide multiple, integrated services via their own access networks. Because a convergence gateway is tied to a specific access network and a specific access provider’s business model, incentives to develop such an RG device are strong. Either the service provider or the consumer will own the RG device, although Parks Associates expects the former to own the box at least initially.

The thin-server gateway segment addresses a variety of specific services, such as remote home control, energy management, residential security, IP telephony, etc., and the access networks connected to the gateway can include POTS lines, ADSL, coax, wireless, etc. Unlike the whole-house RG, however, a thin-server gateway will not be used to terminate all external access networks. Instead, it will most likely interface with one or two of them, depending on what external network is used to deliver the services enabled by the RG device.

Parks Associates believes that this RG segment is best suited for the provision of IP-based services that can be delivered via multiple types of access media. It is also suitable for the delivery of value-added services from energy utilities, which have expressed renewed interest in this market. ISPs have also been searching for ways to deliver new services to the home. A thin-server gateway will provide the enabling platform. The Open Services Gateway Initiative (OSGI) represents the most recent effort in enabling more IP-based services to the home.