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This is a request for filing a **PROVISIONAL APPLICATION FOR PATENT** under 37 CFR 1.53(c)**INVENTOR(S)**

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TITLE OF THE INVENTION (280 characters max)

Home Network Method and Apparatus

ENCLOSED APPLICATION PARTS (check all that apply)

☒ Specification (Number of Pages <u>10</u>)	☐ Small Entity Statement
☐ Drawing(s) (Number of Sheets <u> </u>)	☒ Patent Application Data Entry Form (1 page)
☒ Return Receipt Postcard	☐ Other (specify):

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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

- ☒ No.
- ☐ Yes, the name of the U.S. Government agency and the Government contract number are: _____

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Home Network Method and Apparatus

It should be noted that the return path frequency allocation, 5-45 MHz, as mentioned in the text, is suitable for the American DOCSIS cable modem standard. Another cable modem standard is the European standard (named DVB) and in this standard the return path frequency path is between 5-65 MHz. Further, the invention is suitable to the DVB standard, with a cut off frequency of the HPF in the TRG set to about 65 MHz.

An alternative embodiment is for the Cable Modem functionality to be located in one of the Set Top Boxes or as stand-alone device. In this case the CM functionality is not implemented in the TRG. In this embodiment the CM provides the Internet access to devices throughout the house and is connected to the home network via a Data Module (DM) or an Audio Video Module (AVM).

In this embodiment, a receiver in the TRG identifies the frequency bands that are allocated for the return path of the CM. The receiver receives and decodes this information as it is arrived to the house from the Headend via a forward channel.

In another embodiment of the home network, the home network uses frequencies in the forward channels frequency range (i.e. 50-850MHz according to US standard or 65-850 MHz according to European standard) of the Cable network. The frequency allocation (the frequencies that are used by the home network) is selectable and programmable. Such frequency allocation can be any (one or more) of the forward Cable TV channels' frequency range. The allocated channels' frequencies are either consecutive or non consecutive.

Typically the forward channels are used (or intended to be used) by the Cable operator for video broadcasting. When allocated for the home network, these channels are isolated (filtered) from the Cable TV channels, and their video content is not available inside the house. Two possible methods to select the channels exist:

1. Static Channel Select (SCS)
2. Dynamic Channel Select (DCS)

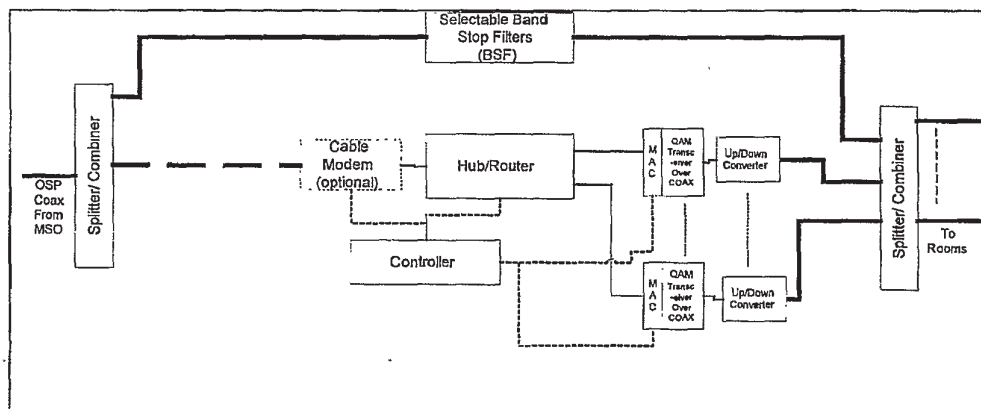
In the SCS embodiment the customer or the cable operator gives up some of the channels. Such channels can be un-used channels or channels that are in-use and which the user selects to block. In this case the channels used for the home network are determined during the installation of the system.

In the DCS embodiment the home network channels are selected dynamically by the controller in the TRG. It should be noted here, that although the number of channels transmitted over the cable and sent to the home consumer equipment is very large (at most, all forward channels (55-850 MHz) are used), only a small number of them are being used (watched) at a particular time. If for example a house has three TV tuners (set

op boxes), at most only three channels are being used simultaneously. All other channels are not viewed, and therefore, can be blocked at that particular time, without causing any harm to the cable service. In a Digital cable system, when a video channel is selected by the person watching TV, a request message is sent to the Headend via the OOB reverse data channel. The Headend then replies with a message via the OOB forward data channel. This message contains, among other information, the number of the forward channel in which the requested video channel is transmitted. This message is interpreted by the STB or by the digital cable ready TV, and the required channel is selected.

In the DCS embodiment the TRG controller selects the number of channels required for the home network from a bank of channels. The controller also monitors, via the OOB FDC the channels that are used (viewed) in the house. If it detects that a channel that is currently used by the home network is now require for video, it releases this channel and selects another channel from its channel bank, to be used for the home network.

The channels used for the home network are blocked from the outside world by a selectable band stop filter (see the following figure). The information on the selected channels is distributed to all network devices via an in-band dedicated control channel. The following is a schematic block diagram describing the TRG functionality in this embodiment:



The Band Stop Filters (BSF) isolates the internal and external cable networks. The filters allow the transparent connection of legacy TV cable network in the forward and reverse channels, while blocking the specific frequency channels that are allocated for the internal home network.

A Cable Modem (CM) that provides Internet access to the home is optionally integrated in the TRG. Alternatively, it is integrated in a set top box or exists as a stand-alone device inside the house.

The high speed data hub (or bridge) and routing functionality enables the distribution of externally generated data signals (Internet) to the in house data devices, as well as in house data networking between data devices and/or entertainment devices (like PCs and computer peripherals, DVD, TV etc...). The hub (or bridge) and routing functionality can be based on 100-Base-T Ethernet, as well as other interfaces, like IEEE 1394 Standard or Universal Serial Bus (USB).

The signals from each output port of the hub/router are quadrature amplitude modulated (QAM), with a programmable constellation size, a programmable carrier frequency, and a programmable symbol rate. The QAM signal in various embodiments is either a single carrier QAM, or multi-band QAM, which is a summation of several QAM signals with different carrier frequencies. Alternatively, in another embodiment the signal is modulated as a multi-carrier signal with approximately the same available throughput. The output-modulated signals are optionally up-converted (depending on its frequency allocation), combined with the external cable TV signal stream and are transmitted over the in-house coax wires to the various rooms.

A Media Access Controller (MAC), located between the hub/router and the QAM or multi-tone modulators provides the functionality that allows the co-existence of several data sources over the same cable (networking), e.g. arbitration, signal detection, etc.

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ATTACHMENT

The invention relates to a system and method of providing residential users with broadband access to the Internet and data & entertainment network using a single platform. The system provides the user with broadband access to both the Internet and a "no-new-wires" home-network, using the existing in-house cable TV coax wiring and in parallel to the cable TV services, leaving the legacy cable TV signals and devices (set top boxes and cable modems) untouched. The system and method enables the following key functionalities: 1) sharing the Internet access by many devices throughout the home, 2) connecting all PCs and peripherals (printer, scanner, CD etc.) using an in-home data network over the existing in home coax cable. 3) allowing any video or audio source in the home to be watched on TVs throughout the home using the in-home network as an entertainment network, and 4) providing an Intra-room backbone for a 1394 (FireWire) network over the existing in house coax cable.

The system provides benefits to the residential users as well as to Multiple System Operators (MSOs). The user is able to subscribe for a single broadband Internet access account with a service provider and enjoy access to that account from multiple devices throughout the home, thus saving unnecessary subscription costs. At the same time the user will be able to expand the usage of devices beyond the room where the device is located, thus better exploiting the investment in the device. Although the system is built to serve the end user, it is extremely favorable for the service provider. The number of services offered via the broadband access is rapidly growing. Enabling the access to the services offered through the 'fat-pipe' from multiple devices throughout the house will increase the "consumption" of offered services, leading to increase of revenue to the service provider.

The number of residences connected to the Internet through broadband access is growing rapidly. Whether it is cable modem, DSL service, Satellite or FTTx, the user can enjoy always-on broadband access to practically infinite sources of data and audio-visual content. At the same time the user is offered with ever-growing variety of consumer multimedia electronic devices, such as DVD, video gaming machines, video servers (Replay devices) and so on. Whether it is from external or internal sources, the user is supplied with huge amount of content (data, video and audio) he can exploit.

This positive evolution in the available content creates a need for new technical solutions that will enable the user to best exploit this limitless information and protect his investment in access subscription and home devices. Among those requirements are:

1. The consumer wants to share the Internet access by more than one PC in the home. It makes no sense for broadband content to be limited to one device. Today the user pays the service provider a monthly fee for each broadband access account (whether it is Cable Modem or DSL). In order to share the access by more than one PC there is a need for either second subscription (expensive) or a home network.

2. A growing number of "computing" devices are added in the home, including PCs and many types of peripherals (printer, scanner, CD read/write, backup device etc.). In addition, the "old" devices tend to remain in use along with the new ones. Typically the devices are not located in the same room and there is a growing need to somehow network all these devices so they can be shared home wide. Another growing requirement is being able to share files among PCs; for example, playing MP3 music or viewing JPEG pictures stored on one PC hard drive on a PC in another room. While perceived as a natural capability in the office environment, such "network" represents a challenge in the home environment.
3. With the growing number of multimedia and audio-visual devices in the home, consumer would like to be able to enjoy their investment throughout the house. Today the usage of such a device is typically limited to the room in which the device resides, whether it is watching a DVD movie on a TV set or playing a video game from a game console. A simple action such as watching a movie from a DVD located in the basement on a TV set located in the bedroom is not possible. So there is a need for some kind of a home entertainment network that will provide such capabilities.

Several home networking solutions are available or under development. The solutions can be categorized into two groups, the "no-new-wires" and the "new-wires" approaches. Among the "no-new-wires" are the HomePNA devices for home phoneline network and the Powerline devices for home network over in-house powerlines, to name two. Among the "new-wires" approaches are Ethernet and the VESA / 1394 home network.

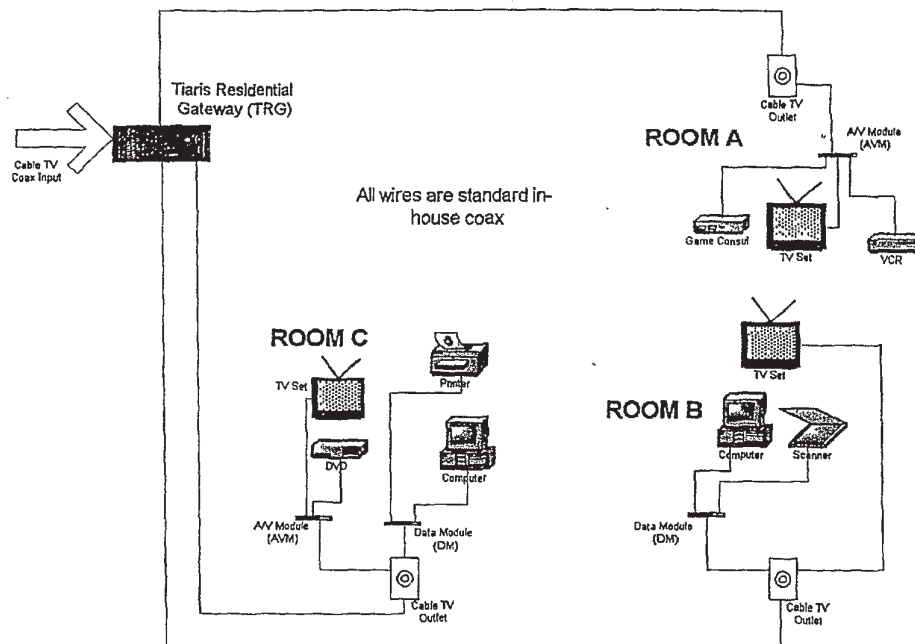
Each type of network has its pros and cons. While some of the solutions give reasonable solution for data-type networking, others are more suitable for entertainment-type networking. The present invention avoids the problems associated with these other solutions.

Description of the Preferred Embodiment

The system enables the residential user to share a single broadband access account as well as to share network data and audio/video devices, using devices throughout the house. The system exploits the ubiquitous in-house coax wires; an infrastructure that is by far the most suitable media for high-speed transmission among the alternatives in the home. The system uses the existing in-house cable TV coax wires as a data and audio/video network, and an intra-room backbone for IEEE 1394 standard (FireWire) transmission. Currently an intra-room backbone for the IEEE 1394 standard is only possible over new wiring (CAT-5 or Plastic fiber). With the described invention, the 1394 network standard can be delivered between rooms over existing wiring, at about 100 Mbps, eliminating the need to re-wire the house. The home network operates in parallel to the cable TV services, leaving the legacy cable TV signals and devices (set top boxes and cable modems) un-touched.

The system includes a residential gateway unit (TRG) and in-room modules: an A/V Module (AVM) and a Data Module (DM).

The following is a schematic diagram that describes the architecture of the solution:



The TRG Device:

The TRG is installed in the demarcation point of the cable TV network, replacing the legacy cable TV splitter. The TRG provides the following enhanced functionality:

- Transparently distributing the legacy cable TV signals throughout the house;
- Distributing of the Internet access signals throughout the house over the coax cables, turning every cable TV outlet in the home into an Internet access port;
- Providing a data home-network with each cable outlet serving as a network port, and the TRG serving as a hub/router; and
- Providing an entertainment network, enabling multimedia and audio-visual devices in the home to be used/watched from other devices located throughout the house.

With the system of the invention, the cable TV reverse path frequency band (5-45MHz) is allocated for the internal home network use. The internal cable TV (coax wires) network is separated from the external cable TV network by the residential gateway (TRG).

The TRG contains the following elements in order to provide the above-mentioned functionalities:

1. A passive High Pass Filter that isolates the frequencies upto 45 MHz between the in-house and external Cable networks, while maintaining forward path signals (55-850MHz) untouched.
2. A Cable Modem (CM) that provides Internet access to the home. Other type of access modems is also available if the Internet access is provided on another media than the Cable networks (e.g. a DSL modem can be used if Internet access is provided on the telephone line network).
3. A high speed data hub (or bridge) and routing functionality to enable the distribution of externally generated data signals (Internet) to the in house data devices, as well as in house data networking between data devices (like PCs and computer peripherals, Web TV etc...). The hub (or bridge) and routing functionality can be based on 100-Base-T Ethernet, as well as other interfaces, like IEEE Standard-1394 or Universal Serial Bus (USB).
4. Specific functionality that enables the seamless connection between existing internal devices like set top boxes and cable modems, that require connection to the head-end for their normal operation, and the head-end in the reverse path of the cable network. This functionality is based on specific and proprietary hardware and software as is described below.
5. Specific functionality that enables the transmission of audio/video signals between internal AV equipment (DVD, TV, CamCorders, etc...), while maintaining the legacy Cable TV service.

The following explains the method of operation of the TRG:

The legacy cable TV signal passes through a high-pass filter (passing 50-850MHz) and is transmitted un-changed to the output connectors of the TRG. These signals reach the cable TV wall outlets in the rooms as before.

In parallel, the legacy cable also connects to a standard DOCSIS cable modem (CM). The output from the CM enters the hub/router that has several output ports.

The signals from each output port of the hub/router are quadrature amplitude modulated (QAM) to QAM signals, with a programmable constellation size, over a pre-defined frequency range. As an example, with a 256-QAM modulation and a symbol rate of upto 40 MHz, the available throughput can reach upto 320 Mbps. A capability to notch filter the signal at programmable frequencies is also provided. The QAM signal in various embodiments is either a single carrier QAM, or multi-band QAM, which is a summation of several QAM signals with different carrier frequencies. Alternatively, in another embodiment the signal is modulated as a multi-carrier signal with approximately the same available throughput. The output-modulated signals are combined with the external cable TV signal stream and are transmitted over the in-house coax wires to the various rooms.

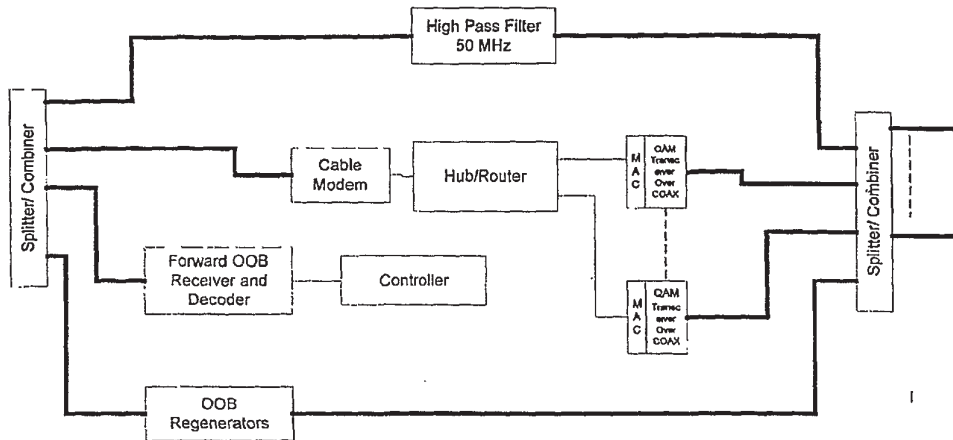
The system utilizes the 5-45MHz frequency spectrum for the home network. This frequency band is used by the Cable operators for reverse path signals, i.e. signals that are transmitted from in-home devices, such as set top boxes (STB) and Cable modems, back to the cable Headend. These signals include the Reverse Data Channel (RDC) Out Of Band (OOB) signaling from STB to the head-end, and the Reverse Data Channel of

Cable Modems. These signals should be transmitted seamlessly to the head-end, in order to insure a proper operation of the STBs and CMs, in conjunction with the internal in-house network. The actual frequency allocations for the reverse channels are programmable and are determined by the head-end. The bandwidth for each channel is small compared to the 5-45 MHz frequency range. Moreover, generally (but not necessarily) all STBs and all CMs in the house use the same programmable frequencies for their return channel. The programmable frequency allocation is determined by the Headend equipment and is transmitted to the in house devices via a forward data channel of the STB and CM or via the SNMP (Simple Network Management Protocol) channel of the Cable Modem. This information is transmitted from the head-end at frequencies above 50 MHz, and therefore, is delivered transparently to the in house devices, through the high pass filter (HPF) in the TRG.

The TRG contains functionality that enables the proper transmission of the return path in conjunction with the home network. It includes the following:

1. Identification of the actual allocated frequency (as allocated by the Headend) for each STB and CM. This is achieved by receiving and decoding the OOB Forward Data Channel (FDC), and extracting the required information. A Cable Modem and an OOB FDC receiver in the TRG provide for this functionality.
 2. Control of the internal network so that it will not transmit any signals in the OOB RDC and CM RDC frequencies. In one embodiment a notch filter(s) filters the QAM signals at the specific frequency bands. In another embodiment the corresponding tones of multi-carrier signals are silenced.
 3. Reception of the in-house generated OOB RDC and CM RDC at the TRG, and retransmission of the received signals to the external network. In this way, the HPF, which isolates the internal and external Cable networks at the 5-45 MHz band, is by-passed by the TRG for the transmission of the RDC signals. This is achieved in the TRG by RDC Regenerators (receivers – transmitters). At the Regenerator the RDC signals from the STB or CM are received, down-converted and demodulated and then re-modulated and up-converted to the required transmitted frequency, and transmitted over the external cable network. In another embodiment, the RDC signals in the internal network interface cables are isolated by filters from the network signals at the TRG internal cable interface, and reproduced at the TRG interface to the external network by either digital signal processing or analog filtering. In each embodiment, the regenerated signal is combined to the external coax cable by a RF combiner.
- In yet another embodiment, the method to enable the connection of the internally generated RDC signals with the external cable network is by applying a programmable narrow analog band pass filter (BPF).

The following is a schematic block diagram describing the TRG functionality:



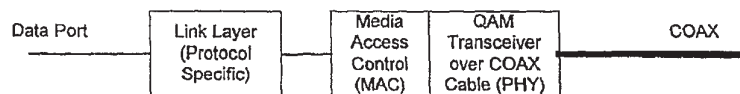
Data Module:

The Data Module (DM) is the device that enables the multi-room networking of data devices such as PC, PC peripheral and Web TV. A DM is located in each room where data devices are used. The DM is connected between the Coax outlet and a data port of a data device. The interface to data device can be either Ethernet or USB or IEEE-1394.

The DM receives a data stream from a data device through its data port and converts it to a modulated analog signal over the coax cable, combined with the Cable TV stream. In the other direction the DM receives an analog signal over the coax cable and converts it into a data signal.

Each of the network devices is automatically assigned a specific address that is internal to the in-home network, so that multiple devices can simultaneously connect to the Internet using a single Internet account, as well as to connect one to the other through the hub located in the TRG

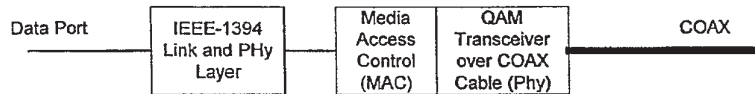
The DM includes an ISO Physical (PHY)-layer block, a MAC (Media Access Controller) and a Link Layer block. The PHY-layer implements and decodes the actual signals transmitted over the coax. The modulation scheme is same as that of the TRG. The Media Access Controller (MAC) provides the functionality that allows the co-existence over several data sources over the same cable (networking), e.g. arbitration, signal detection, etc. The link layer provides the interface to a well-used protocol as USB, IP or IEEE-1394.



Audio/Video Module:

The Audio/Video Module (AVM) is the device that enables the multi-room networking of entertainment devices. An AVM is located in each room where entertainment devices are used. The AVM is connected between the coax outlet and an IEEE Standard -1394 input of an entertainment device.

The AVM receives a digital A/V stream from entertainment A/V devices (i.e. DVD, VCR etc.) through 1394 interface and converts it to a modulated analog signal over the coax cable, combined with the Cable TV stream. On the other direction the AVM receives an analog signal over the coax cable and converts it into IEEE Standard -1394 signals.



Two embodiments of A/V network exist, analog and digital. In the analog embodiment the A/V network is analog. In the analog case, the A/V stream is modulated and up-converted to a pre-defined "private channel" and is transmitted over the home cable network as a regular TV channel. The "private channel" is either channel 3 or 4 (typically assigned for VCR) or any other channel allocated for that purpose. The "private channel" can now be watched from any TV in the home that is connected to the network. A/V devices located in other rooms are controlled via a remote control device. In the digital embodiment, where 1394 interface is used, the A/V stream remains digital at the home-network frequency band, and is transmitted to any TV in the home through 1394 interface (in that case the home network is used as 1394 backbone.)

In addition to the functionality of the system described, the system permits expansion to the following capabilities:

- The system permits a video server (such as Replay device or others) to connect to the TRG. Similarly to the functionality described for the AVM above, the server is connected to the in-home network and can be watched from any TV in the home. The server is connected to the home data network and to the Internet through the TRG hub. This adds a very attractive functionality, enabling the user to program the device for recording from every PC in the home or from any PC outside the home through a secured access via the Internet.
- Bridge devices to other type of home networks also can be connected to the system. For example, a bridge unit connected to a HomePNA extends the network to other devices equipped with standard HomePNA interface. Similarly, a bridge device located at the TRG, may connect the system to a Bluetooth or other wireless LAN, supporting mobile devices in the home that are equipped with such network capabilities (i.e. connecting a laptop computer to the Internet and to the home data network).

