IMPROVING HOME NETWORKING SATISFACTION WITH A UNIFIED HOME GATEWAY

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Abstract

Home users are becoming more and more dependent on their home IP networks to provide services and entertainment. As the industry moves toward a unified IP infrastructure for both HSD and video, the home network will be stressed by the increasing demands of video streaming to an ever-increasing universe of devices. The home network also already supports connections for computing devices such as PCs or laptops, and service devices such as scanners or printers. Increasingly the network also must support other devices such as tablets and smart phones in WiFi mode, with more devices showing up every week. Security and Smart Grid usage monitoring and control are also likely to become more and more common, as well as other services that are still on the drawing board.

This paper discusses the variety of networking technologies used to support the current home network, and proposes strategies to improve the customer's home networking experience with a three-pronged analysis.

First, what improvements can an in-home gateway (GW) provide by coordinating traffic across the wired and wireless networks? For example, if some devices can access more than one network, the GW could influence the device's choice by enacting QoS policies on a dual band device that segregate faster devices onto one band, and slower devices onto another band.

Second, can the user be encouraged to take actions that improve the home networking experience? For example, a GW could alert the user to an intermittent WiFi problem that has a time-based signature by monitoring wireless throughput over time.

Third, if the user calls a service provider with a networking complaint, can the GW or a network monitoring system supply a CSR with enough information to point out the most likely cause or causes of the user's problem? For example, a GW might flag to the user that one device is taking up 75% of a network's bandwidth because of poor choices in network setup.

CHALLENGES OF HOME NETWORK COMPLEXITY

Not so long ago, a home network might have been a small Ethernet bridge that connected together a computer, printer, and a cable modem. As wireless home networking became less expensive and easier for a consumer to install and configure, 802.11-based networks popped up. In the current home networking scene, the list of viable home networking technologies has gotten long. Some technologies, like MoCA, have been primarily used by service operators while others like Bluetooth or Zigbee have

been driven by the consumer electronics industry.

The modern home is a fabric of networks with different capabilities that overlay each other. The following table compares some networks commonly found in a North American home.

Network	Wired/Wireless	Throuhput	Common Uses	Installer
Ethernet	Cat5	Up to 1Gigabit	Data, Video	Consumer
WiFi	2.4GHz, 5GHz	Varies with distance, interference, channel width	Data	Mix
HPNA	Phone lines	?200Mb/s, but can vary	Data, Video	Service Provider
MoCA	Coax	Up to 400Mb/s	Video	Service Provider
Bluetooth	Short range, 2.4GHz	2Mb/s	Voice, Home Control	Consumer
Zigbee	2.4GHz	20-250kb/s	Home Control	Consumer
DECT	1.9GHz	32-500kb/s	Voice	Consumer

Each of the networks above has a type of transaction for which it is best suited. The different networks also consume varying amounts of power in operation or when idle. As consumers become more conscious of energy usage, but still demand performance, the management of in-home networks needs to become more intelligent.

COORDINATION BETWEEN NETWORKS

When a Gateway is deployed in a household, it can act as the center of multiple layers of home networking. Most Gateway devices have a built-in router, often called an eRouter, to direct and police traffic among the various networks. First a review of the popular home networking technologies is appropriate.

Wireless Networking

The eRouter usually controls one or more wireless network Access Points (AP). Even though 802.11 WiFi standards have expanded into new frequency bands, consumers often do not know or understand that their WiFi devices may use different non-overlapping frequency bands. In North America, 2.4GHz and 5GHz are both allowed for unlicensed transmissions. The older

2.4GHz band is the most heavily used in most areas, but as new devices are purchased that support the 5GHz band, it is expected to gradually fill up as well.

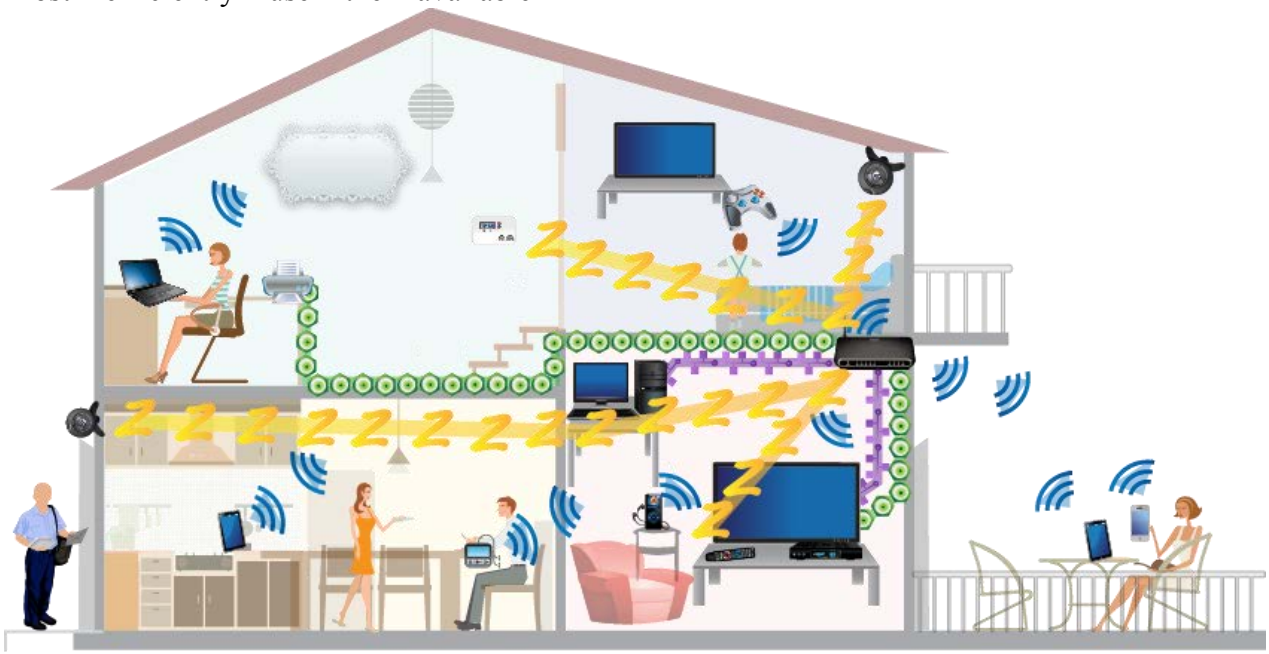
Within the 802.11 standards are many tools that can be used to enforce Quality of Service (QoS) expectations. A service might be set up on one RF band or the other. The eRouter through the AP setup might have several Service Set Identifiers or SSIDs. An SSID can act like a sub-network within the larger WiFi channel. A device that wanted to stream video, for example, might be directed to use a specific SSID that had a higher priority within the eRouter than another SSID that was used for best effort data. Many APs can also monitor their local RF signals, and determine the best RF channels within each RF band. The "best channel" determination is not a static decision, but an ongoing process that must continue as long as there is activity on the network. By monitoring traffic patterns, monitoring RF activity, or by prior provisioning, a Gateway's eRouter and AP can direct traffic across the WiFi networks to most efficiently use the available RF resources. A WiFi Alliance initiative called Wireless Multimedia Extentions (WME or WMM) can also be used to provide prioritized treatment to different types of traffic, such as video vs. best effort data.

Ethernet Networking

Most Gateway devices still have Ethernet ports. Older devices may still have 10/100 ports, but the most modern Gateways will have Gigabit Ethernet ports. The raw throughput and reliability of wired connections are still valued by many consumers. The eRouter can apply policies and QoS standards to the Ethernet ports, just as it can to the other networks. Ethernet also has the advantage of providing a consistently low power method of passing data, as compared to WiFi or MoCA.

HPNA/G.hn Networking

A less common home networking option, HPNA, makes use of the home telephone wiring for data transmission. The ITU G.hn specification also can use twisted pair wiring or powerline connections or coax networks,



but it is not commonly found in CATV gateways.

MoCA Networking

The Multimedia Over Coax Alliance standardized a home networking technology that can utilize the home coax network without interfering with DOCSIS or analog video transmissions. MoCA home networking has primarily been used by the MSOs and Telcos for video distribution but as the price of consumer products comes down gradually, its use is broadening from just operator video to more general high speed data distribution within the house.

Similar to 802.11 WiFi, MoCA has more than one version available with different capabilities, using different amounts of RF bandwidth and providing different amounts of data throughput. A MoCA network operates within a certain frequency band; usually for MSOs, the D band between 1150 and 1650 MHz is used. Within that block of available bandwidth, the network can automatically settle on the best channel within that block of bandwidth or be directed to use a particular channel. Depending on the MoCA version, the channel bandwidth can change from 50MHz (MoCA1.1) to 100MHz (MoCA2.0) to 200MHz (MoCA2.0 with bonding).

MoCA has a QoS feature called pQoS, parameterized QoS. This feature allows filters to be set within the MoCA network to protect data flows. For example, an IP STB may require a dedicated pQoS flow for its video feed, but a MoCA/Ethernet bridge used for high speed data may just receive best effort treatment on the same network.

Bluetooth and Zigbee

Bluetooth and Zigbee services have not typically been considered part of the home data network, but as their popularity increases and the scope of services provided by operators increases, they will become more important. Bluetooth usage is usually very short range and relatively low bandwidth. Zigbee has been utilized for home control applications and for remote controls under the trade name RF4CE.

Coordination Across Networks

As consumer electronic devices become more sophisticated, a tendency has developed for many devices to have more than one choice of LAN interface. For instance, many printers and computers come standard with both wired and wireless interface choices. As the eRouter in a Gateway oversees network traffic within the home, it could act to improve the overall network performance by selectively directing devices to use one interface or another.

For example, a home network might have a laptop that can work in the 2.4GHz band or the 5GHz band, a MoCA to WiFi bridge that supports WiFi clients in the basement and 3 IP Settop Boxes (STBs) that can connect to the GW over MoCA or 5GHz wireless. The Gateway can balance the needs of the various clients as their activity occurs. During the day when the consumer is working in his basement office and the STBs are unused, the MoCA bridge could be allowed to have the majority of the MoCA wired bandwidth. The STBs could be directed to shut down their MoCA circuits to save power, and just listen over WiFi for any system updates. Later in the day as activity shifts in the household, the eRouter might monitor the non-video MoCA traffic. As STBs begin requesting video

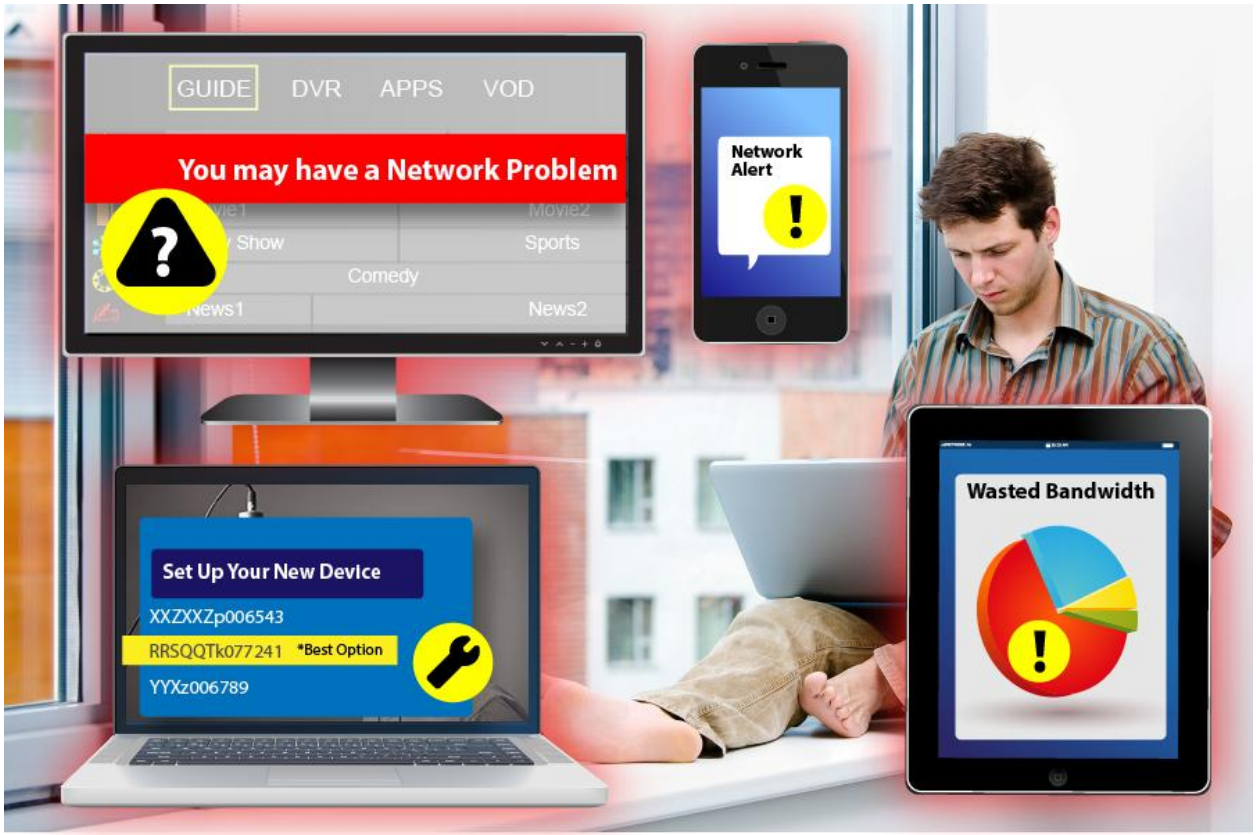
sessions, it would balance the amount of MoCA HSD traffic against the amount of 5GHz WiFi traffic and decide on a session by session basis if the STB should be served over WiFi or MoCA. There could be a fixed rule that the STBs get top priority on the MoCA link that would potentially lead to the HSD traffic over MOCA getting much poorer performance when video traffic was also competing for bandwidth. But, if the Gateway's eRouter can balance traffic across the networks by intelligently directing clients to the best interface, the same home networks can provide enhanced performance leading to a better customer experience.

In this example, the client devices had WiFi and MoCA networking available. Even if the second network is not capable of carrying much data, like Zigbee, it could still be used to communicate state information to remote clients. For example, a client with MoCA or WiFi and Zigbee could shut down the high bandwidth/high power MoCA or WiFi subsystem, and just watch over Zigbee for a wakeup indication. Zigbee was specifically deigned to be low power and low cost – it would make sense to utilize it more widely for control communications to save power.

USER INTERACTIONS

Consumers can also be given information by the Gateway to allow them to help improve their in-home network experience. Most shared media networks, such as MoCA or WiFi, can have their performance substantially degraded by the presence of clients conforming to older standards. The Gateway's eRouter can detect the presence of older technology on the home network, and make recommendations to the home user.

The recommendations might take the form of graphs showing how much bandwidth each connected device takes up typically on the network. The recommendations could also highlight user selections that may not be the best for performance. For example the user might have selected a particular WiFi frequency band based on the network characteristics when the system was being set up. The Gateway or eRouter might send an alert to the user indicating that the best



channel selection is now different and request that the user enable auto-selection or allow the Gateway to switch channels.

The user could be presented with recommendations by many means. The Gateway could email notifications to the consumer or post notifications to the user over social media. If a video service is being provided, the Gateway could pass user messages to the user interface application so that they could reach the user the next time they watch video programming.

The recommendations themselves might alert the user that one or more devices are slowing down the entire network with the consumer advised of some possible actions: take that device offline, change the offending device's settings to ones that will give the network better performance, or change some settings on the eRouter based on actual usage trends. Other actionable items could include reporting that some high-powered access points are showing up and causing interference. The consumer might be able to relate those itinerant APs to friends of his teenage children coming over.

NETWORK MAINTENANCE SUPPORT

The Gateway can provide information to the MSO's back office systems to enhance proactive network maintenance as well as interactions with the consumer. The eRouter within the Gateway can monitor conditions on various home networks and, through the Gateway's cable modem, the Gateway can also monitor its DOCSIS connection. The previous section dealt with using LAN information to advise the consumer of impending issues, or possible solutions to reduced network performance, but some problems may not be solvable by the consumer, or they may not understand enough technical details to troubleshoot the issue. This section discusses areas where the Gateway can assist in troubleshooting

Home LAN Troubleshooting

The Gateway can monitor, usually through the eRouter, all of the home networks. Depending upon the amount of storage available, it can record anomalous events such as a burst of strong interference on the 2.4GHz band, or loss of communications with a MoCA device. The event storage is most useful if it has time-stamps.

When a consumer calls a Customer Service Representative (CSR) with a problem, the Gateway can provide information to help track down the actual issue. For example, the consumer may be having difficulties with their wireless connection. Because wireless problems are often interference related, it is common for WiFi problems to come and go. If the Gateway has no historical information, then the consumer may experience frustration reporting a problem from the night before that is no longer evident in the morning. The CSR can only question the consumer about what might have happened and it is unlikely that the problem can be effectively resolved. If the Gateway records problematic events, then the CSR can see records of events that may be contributing to the poor performance experienced by the consumer.

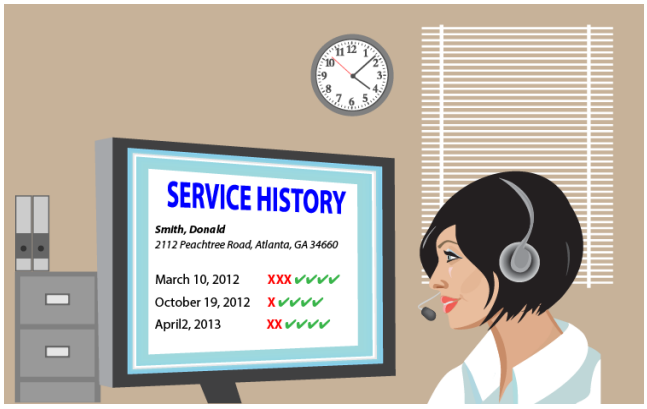
The Gateway can also identify to the CSR items that may be affecting the user's home networking performance. Even if the Gateway also has provided feedback to the consumer directly, the consumer may still call

a CSR for assistance understanding the problems and what actions can be taken to resolve them. If the CSR has access to the Gateway's recommendations and the data that it used to develop them, the CSR can explain the situation to the user more effectively, and hopefully ensure that the consumer has an excellent experience with swift resolution of any problems. For example, the Gateway might report that while the Gateway and other MSO clients are MoCA 2.0, the consumer may have purchased a MoCA1.x device that is lowering the performance of the network. Similarly, the wide variety of WiFi standards may result in the consumer not selecting the most effective settings in the WiFi network. If the user has allowed the Gateway to automatically configure itself, then the problem could have been resolved without the consumer's knowledge. If the options are not available to automatically configure the attached client devices, then the Gateway is dependent on the CSR explaining to the consumer how the settings are impacting network performance, and how to improve the network's performance.

IN SUMMARY

As MSOs deploy advanced Gateway devices that support multiple home networking technologies and have greater computing capacity than past generations of customer premises devices, the opportunity exists to utilize this technology to provide better home networking experiences to the consumer.

With multiple overlapping home network technologies in the Gateway and in some clients, the Gateway can take an active role in determining how to best utilize the networks for optimum performance and increased power savings. It can direct which network technologies are used and when by the attached devices to ensure the consumer's experience is optimized.



The unique position of the Gateway in the home can also allow it to provide feedback to help the consumer solve their own problems whenever possible. This capability has two benefits, the consumer gets better network performance without having to wait for an MSO technician to help them, and the MSO avoids spending valuable technician time on problems that the Gateway can diagnose and guide the consumer to solve independently.

Finally, for some problems, MSO involvement is unavoidable, but the Gateway can provide invaluable data to the operator that can pinpoint the most likely area at issue. The data may allow a CSR to guide the consumer through configuration options or other actions that will avoid a truck roll.

The new generation of advanced Gateway devices offers capabilities to provide the consumer with improved home networking performance and offers MSOs the potential for operational improvements and cost savings.