Analog Mixed Signal Division

Home Networking - Strategy

A Business Perspective

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Introduction:

Service providers (also referred to as operators) are rapidly increasing access speeds to support the introduction of new video and Internet services. At the same time, home networking technologies are also evolving to keep up with these new services. The confluence of these two trends is driving operators to create comprehensive, holistic deployment strategies, encompassing not only one core technology, but a hybrid approach.

This paper describes a pragmatic approach for developing an effective home networking solution that meets new service demands, while concurrently providing an implementable plan that lowers costs over legacy installation and repair strategies.

With 4K TV on the horizon, operators must implement a home networking strategy that addresses new services in the home -- services that are reliable, low-cost, self-installable and manageable. To shorten installation and repair times, as well as lessen the need to install new wiring in the home, service providers have introduced wireless set top boxes (STB). Because of their convenience and portability throughout the home, wireless STB's have become very popular with customers. However, now that the "genie" is out of the bottle, customers have come to expect the portability of Wi-Fi based devices, such as laptops, game consoles, Smart TVs, smart phones and tablets and now, STBs. Along with this convenience comes a significant new set of issues, such as congested Wi-Fi spectrum, Wi-Fi costs, signal interference and home designs that challenge operators to maintain an acceptable level of video performance.

The traditional use of coax and twisted pair wiring, which are extensively installed in homes and apartments throughout the world, poses operational issues stemming from the higher bandwidth needed to support 4K video. With twisted pair, the bandwidth is small and coverage is often limited. Coax wiring, while providing substantial bandwidth, is burdened with splitters and connector troubles that are a constant source of problems for operators. For a time, Wi-Fi eliminated these media problems, making operators and customers happy, until the inevitable service interruptions occurred. Radio is unpredictable; what worked fine on the day of installation often fails intermittently once the installer has left the customer's home. Even with all the wireless innovation of recent years (e.g., mesh networking, MIMO, repeaters), service problems persist, as Wi-Fi technology strains to support new video services. Moreover, as Wi-Fi vendors employ increasingly complex wireless technologies to mitigate these problems, the technology costs continue to rise.

ISSI AMS proposes a new approach to home networking by combining Wi-Fi with G.hn powerline (PL) technology. With a few design modifications to any home Residential Gateway (RG), a combined Wi-Fi + G.hn home networking solution can be more effective than MoCa + Ethernet or Wi-Fi + Ethernet solution.

Combining Wi-Fi and G.hn provides operators the benefits of in-home device portability, simplified installation, and ample bandwidth for demanding future services.

Compare & Contrast

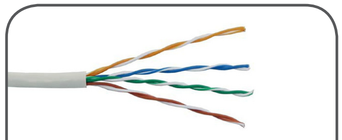
A numerical comparison of bandwidth capacity among competing technologies is easily understood, but misleading in practice. It is essential to remember that bandwidth alone is not the primary driver to any home networking decision. Operators today are increasingly combining technologies into blended solutions that can deliver ample bandwidth, while concurrently optimizing and reducing costs. A review of the advantages and disadvantages of today's technologies will show the motivation for a blended solution of Wi-Fi and G.hn,

Power Line & RF

- >98% Coverage
- Self-Installable
- Secure
- Reliable
- Low-cost
- Available anywhere in the home

Coax

- Good Capacity
- Limited in-home coverage
- Changes require technician
- Splitters connector problems



Twisted Pair

- In >99% of homes
- Limited capacity
- Requires installation
- Limited in-home outlets

Figure 1. Media Attributes

Twisted Pair

There are two types of twisted pair cabling in homes today, CAT3 and CAT5. CAT3, or ordinary telephone wiring, is present in nearly 100% of all homes and apartments. Unfortunately, CAT3 wiring is often not located at the spots within the home where Internet or video service installation is desired.   Additionally, CAT3 cannot supply the bandwidth needed to support new services. While sufficient for telephone services, CAT3 is a non-starter for services like 4K TV.

CAT5, on the other hand, can easily deliver 1 Gbps over short distances through a low-cost RJ-45 Ethernet jack. Unfortunately, it is installed in less than 3% of homes today. Additionally, CAT5 wiring, like CAT3, suffers from the same pragmatic drawback – the outlet is often not located near where the installation is desired.

A Gigabit Ethernet interface cost per device is inexpensive, but the cost of placing CAT5 wiring in homes is excessively costly. With service providers' labor rates near $60.00 per hour "loaded" (e.g., wage, benefits, truck, tools and travel times), installing CAT5 on new installation or repair orders is prohibitively expensive.

With home builders placing CAT5 wiring as the standard today, ISSI AMS recommends retaining a Gigabit Ethernet port on any future RG to leverage this home wiring trend. However, the fact remains that the lower penetration rate of CAT5 wiring in homes and apartments will drive operators to consider other solutions.

Coax

The CATV industry, starting back in the late 1970's, installed coaxial cable in almost every U.S. home or apartment that it could. Coax, with its high bandwidth capacity, seemed to be the operator's final solution. But while coax did a great job for distribution of services like analog TV, later applications, such as interactive two-way data services and High Definition (HD) TV turned out to be unduly challenging.

Common signal splitters negatively impacted high bitrate interactive services. Worse, these are often installed in attics or in walls where they degrade signals, especially upstream services. To date, the imperfect solution has been to remove the splitters. This, unfortunately, brings operators back to the same challenging situations as they had with twisted pair.

The technologies that depend upon coax, such as MoCa, are directly affected by the existing installed media in the home, and the many splitters and taps inside homes that affect throughput and performance. Nothing is common, cost effective or consistent with coax as a solution, either.

The Sensible Solution: G.hn + Wi-Fi

Providing operators with a blended solution, such as G.hn and Wi-Fi, leverages the strengths of each technology and minimizes shortcomings found in other solutions.

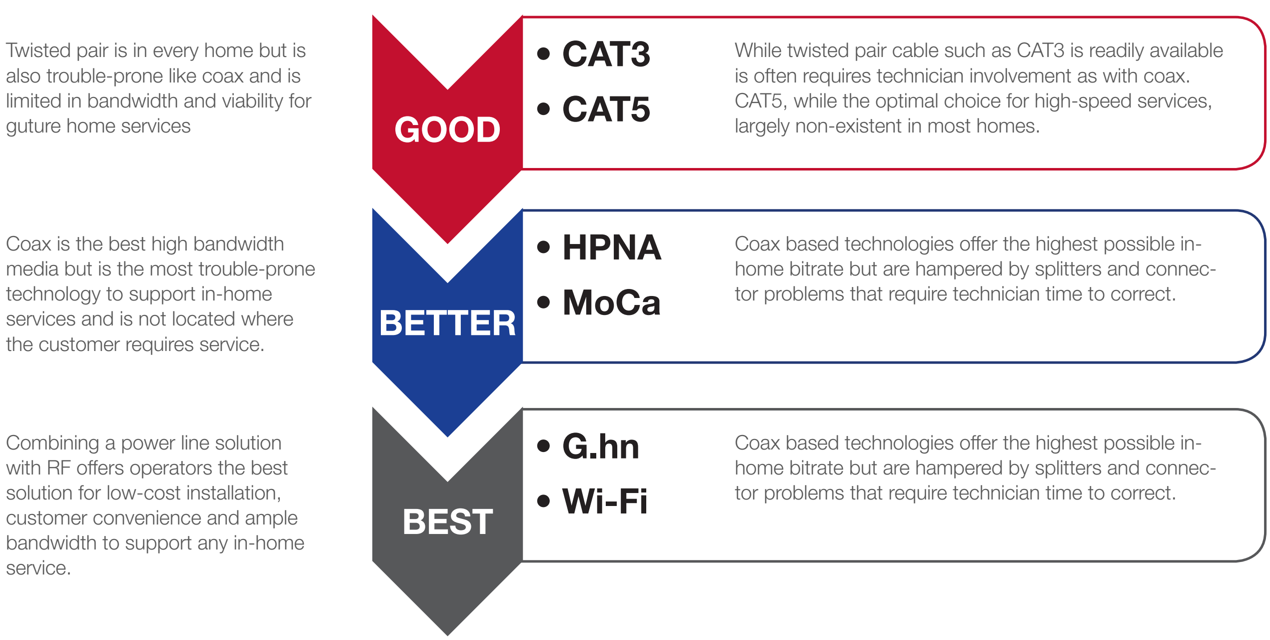


Figure 2. Solution Comparison

What if operators could deploy a set of blended technologies that is already resident in homes and apartments (> 98%), and that operates with 99% reliability? Better still, what if that solution was self-installable by the customer, offered ample bandwidth, and was less costly than either twisted pair or coax?

That answer is ISSI AMS's G.hn with Wi-Fi Solution. Using G.hn as the in-home backbone network, coverage issues are addressed by placing Wi-Fi enabled end points within a home, wherever necessary or desired. Customers would enjoy the expected convenience of wireless, without the intermittent service problems now characteristic of so many Wi-Fi setups. G.hn provides reliable, full-coverage bandwidth in the home, while Wi-Fi provides the wireless interface to customers and their devices.

Using both RF spectrum (2.4 and 5.0 GHz) and power line media inside the home, this combination of technologies results in complete device portability, combined with the overall reliability of any well-installed wired media. With a blended solution like G.hn and Wi-Fi (both international standards), operators have interoperability across both technologies, and a broad vendor selection. All Wi-Fi and G.hn suppliers have enhancements, but with ISSI AMS's blended G.hn + Wi-Fi solution, operators would have at their fingertips capabilities that exceed those of both coax and twisted pair solutions.

When operators use G.hn, the projected coverage is 98%. This coverage is achieved at the time of service installation, and is sustainable over the course of service in that home -- first time, every time. This attribute is key to ensuring that operators do not have to "re-trip" a technician to the home a week or a month after the initial installation. With wireless coverage shrinking as a result of crowded spectrum and increasing interference, the customer is assured of greater than 98% connectivity back to their RG, even for the most challenging use cases.

How Much In-Home Bandwidth Is Really Needed?

There are always debates over how much bandwidth is required in the home. The most common answer is: "the same as my access network." The truest answer is the one that takes the real –world environment into account, and is based upon a set of customer services in the home. Let us explore this further.

Network access speeds today are 1 Gbps. While operators are planning multi-gigabit to the home, this paper is focused on what is available today – 1 Gbps. Not all neighborhoods or apartments enjoy 1 Gbps service availability, although customers expect their home networks to match their access speed bit for bit.

While trends in home networking are moving toward higher bitrates, the reality is that the speed limitations for customers with 1 Gbps network are most often limited not by their home network, but rather by the Internet sites they visit, and the metropolitan or national backbone networks used to deliver services to their 1 Gbps network access port.

Telecom and Internet service providers understand well that the "engineering" or "managed" backbone networks and associated origin servers that deliver content are a crucially limiting factor. Regardless of the customer's access speed, congested origin servers and/or backbone networks will, without exception limit speeds to below the customer's access speed during the network busy hours and days of week.

The aggregate in-home bandwidth must be engineered based upon the services and use cases in the home, rather than simply expecting in-home bandwidth to match the customer's network access speed bit for bit. If operators were required to match their offered network bandwidth (either metro and national backbones) to the sum of all their customer's access speeds into homes, these services would be unaffordable and highly over-engineered for the brief period of time each day or week when the peak traffic occurs.

That same thinking applies to the network inside the home. Contrary to some current opinions, home networks should be designed and implemented based upon a set of dominant use cases. Unlike metro and national backbone networks, whose costs are broadly shared across an operator's full set of customers (business & consumer), home network costs are borne solely across a single customer. It is unreasonable to expect customers will pay for this level of service, given other bottlenecks in the service chain.

While the amount of in-home bandwidth is important it is the quality over the quantity that counts more for the end user and what consumers experience most directly. Technology that offers plentiful bandwidth for 4K video, genuinely seamless whole-home coverage, and friendly, plug-and-play setup are equally important (if not more so) to delivering both customer satisfaction and operator service profitability. A G.hn backbone with a Wi-Fi device interface is the best in-home solution that blends together service requirements, customer satisfaction and cost.

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Use Case

To illustrate the in-home bandwidth challenge let us begin with an example that assumes a 4K television (TV) service that consumes an estimated 19 Mbps per 4K TV channel. With four (4) – 4K simultaneous sessions totaling 76 Mbps of TCP traffic (this includes live or in-home DVR to STB traffic streams), this service would represent the majority of in-home traffic. In addition, a video game console running interactive games, which are more dependent on latency than bandwidth for a satisfying experience, adds approximately 1 Mbps of traffic.

Of course, no in-home network would be complete without a complement of Smart Phones and Touch Pads running video sessions (OTT and conferencing) consuming an estimated 9 Mbps.

Finally, one must count laptops, desktop PCs or other Internet services, such as security camera or monitoring services. These can easily total 4 Mbps. This scenario is represented in Table 1.

SERVICE	DOWNSTREAM (MBPS)	UPSTREAM (MBPS)	NOTE
4KTV Streams	72	4	These streams are highly asymmetric
Game Console	0.75	0.25	Latency is the critical performance requirements
Phones & Pads	6	3	Slightly asymmetric
Laptops/PC/Other services	3	1	Includes FTP, software updates & security services
	81.75	8.25	

Table 1. In-Home Bandwidth Requirement Use Case

The in-home bandwidth requirement for this use case would be 90 Mbps of TCP traffic. Even though some of this traffic is upstream and some is downstream, the aggregate total must be handled by the home network, so the example will proceed using the figure of 90 Mbps.

Most TCP traffic translated to UDP throughput is slightly less than double (though ISSI AMS's G.hn Prime can offer TCP traffic at 90% of UDP rates); therefore we will assume 40% TCP overhead due to Wi-Fi as the limiting technology, which would make our in-home UDP bandwidth requirement 150 Mbps. Put another way, a UDP network capable of 150 Mbps will carry 90 Mbps of TCP traffic. The difference is largely packet re-transmission, which rises as the network begins to drop packets.

Since UDP traffic roughly translates to 90% of the media's physical rate, 166 Mbps is the target physical rate. The difference between the UDP and the physical media rates is attributed to overhead and error correction. Based upon our use case, the in-home network and supporting technologies must have a minimum physical rate of 166 Mbps.

While this may seem lower than expected, the essential requirement is that this rate must be sustainable and available throughout the entire home. Adequate, reliable, in-home coverage for every home is a more challenging requirement for operators than raw bandwidth. Vendors can claim multi-gigabits throughput of their technologies and solutions, but they rarely provide supportable claims of coverage and availability.

Wi-Fi blended with an embedded G.hn solution can balance in-home bandwidth, coverage and availability to make this solution extensible and cost effective in all homes.

Business / Cost Justification

Operators have included WiFi as standard in RGs since its beginnings, but adding new technologies such as G.hn must be cost justified.

Looking at the relative cost differences for a next generation RG unit, one assumes that Wi-Fi is resident, and that its incremental cost has already been included into RG BOM (bill of materials). Whether adding G.hn to the power supply, or embedding it directly into the RG itself, the additional RG cost is estimated at less than $10.00.

Since G.hn or Wi-Fi is not complete without the end device supporting one or both technologies, the operations scenario suggests embedding the Wi-Fi. This is the current plan of record. But when Wi-Fi is not capable of supporting all the in-home services, a G.hn bridge unit can be sent to the customer. A G.hn bridge unit costs less than $20.00. Another option, a G.hn enabled Wi-Fi extender, which costs below $40.00.

With G.hn, operators can offer customers a solution they can purchase through local retail outlets. This gives Product Marketing teams the option to generate incremental revenue outside the broadband service offering, further establishing brand loyalty and reducing customer churn.

If the service provider chooses to supply units at no expense, the operator's out-of-pocket cost for handling the customer's call, mailing and the G.hn unit would be less than $45.00 ($20 for G.hn bridge, $5 shipping, and $20 customer care call). How does this scenario compare cost-wise to the conventional plan of dispatching a technician? A truck roll today for repair is estimated on average at 2 hours. With "loaded labor rates" near $60.00 per hour, a truck roll to resolve a home network problem can easily cost an operator over $140.00. (2 hours x $60.00/hour + $20.00 for customer care handling).

Compared to a Wi-Fi / G.hn solution of $45.00, there would be a $95.00 savings per home visited to clear reported trouble. Applying this $95.00 savings to the annual in-home service call volumes associated with networking faults, it becomes obvious that operational savings can be large.

Annual Savings

Continuing our example, if an operator's average in-home connectivity (e.g., Wi-Fi, MoCA, HPNA, CAT3 wiring) trouble report rate is 2% per 100 connected homes/month, and there is an installed base of 10M customers (e.g., Internet or video customers), this equates to 24,000 trouble calls per year (10M ÷ 100 * 0.02*12).

At a cost difference of $95.00 per trouble cleared (Truck Roll of $140.00 versus a Wi-Fi G.hn Solution of $45.00 = $95.00), that results in $2.16M savings annually. Labor costs are increasing and technology costs are dropping, so an operator can expect these savings to increase further over time.

It is understood that to achieve this business case. The operator would likely reduce work force, and there is always a reluctance to reduce skilled technician staff. In actuality however, the operations business case is about future cost avoidance, and not a workforce reduction. Freezing service technician levels as service volumes grow is a much easier business case to implement. With the Wi-Fi / G.hn solution, more customers can be served by the same workforce, thereby justifying the shift to this solution.

Because engineering organizations are typically tasked with defining the "Solution", their operations counterparts would welcome a plan which helps them manage installation and repair staffing levels, as new customers are added and volumes increase.

Conclusion

ISSI AMS offers a fully interoperable G.hn solution, along with performance enhancements such as G.hn Prime, which increases in-home power line performance. Combining ISSI AMS's G.hn technology with Wi-Fi ensures ample bandwidth, low cost operations, reliability, and most importantly, fully wireless and portable operations inside the home, which will always meet the customer's demands.

ISSI AMS looks forward to helping you develop "best-in-class" solutions, and providing customized plans for your technical and operations environments.