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Coexistence and Interoperability in a mixed vendor PLC environment

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About HomeGrid Forum

HomeGrid Forum (HGF) merged with the HomePNA Alliance in May 2013, forming an industry alliance of over 70 members including some of the world's largest Service Providers, system manufacturers, and silicon companies. HGF promotes development and deployment of a single, unified, multi-sourced home networking technology, G.hn, over coax, phone wires, powerline, and plastic optic fiber while continuing to support the existing base of HomePNA deployments. HGF provides silicon and system certification through its compliance and interoperability testing programs to ensure that retail customers and service providers can have confidence in all G.hn and HomePNA products.

HGF members collectively provide an eco-system covering all aspects of the technology from Retailers to Service Providers, utilities to Smart Grid think tanks, system developers to test houses and silicon companies. Our goals include promoting the benefits of G.hn; enhancing G.hn technology to meet evolving industry requirements; ensuring interoperability, performance based on our certification program; and supporting the needs of Service Providers deploying G.hn and HomePNA technologies.

For more information on HomeGrid Forum, please visit our website at http://www.homegridforum.org

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Coexistence and Interoperability

in a mixed vendor PLC environment

Coexistence and Interoperability are very important, but often confused, concepts in the world of networking technologies. Many users mistake one for the other; leading to false expectations in the expansion of their network because of these very different concepts.

Interoperability of networking technologies (at the physical layer) occurs when different chipsets are able to send and receive data between each other. There are 2 different aspects to interoperability – functionality and performance. Basic, functional interoperability is necessary but not really sufficient. It is much better when the performance (bit rate, loss, latency) achieved by endpoints using different chipsets is close to the performance achieved by endpoints with the same chipset; this is known as a high degree of (or full), interoperability. Full interoperability is facilitated by the technology standard specifying all the details needed for implementation. Tight specifications are great for interoperability but may restrict vendor innovation and differentiation. Looser specifications allow for different implementations but make interoperability less likely.

Where devices are sold via retail outlets and marketed as the same technology, it is essential that all devices provide at least the basic degree of interoperability. When devices are supplied by service providers, they will be concerned with delivering their own performance requirements. Some providers may be happy to do this by using the same chipsets for all devices, in which case interoperability is not important. However where having multiple chipset sources available is a key requirement, then full interoperability is needed.

Certification and compliance programs provide an important service to consumers and service providers who need full interoperability, by bridging the gap between a spec that allows for innovation and a test that assures interoperability even when the features of the products may be different. Setting and testing (at least) the minimum expected interoperable performance is a large part of such certification efforts. It is important that the performance targets are neither set so low that they are perceived as useless, nor so high as to be largely unachievable or unnecessary, which might hinder the market roll-out of the technology.

A special case of interoperability is backward compatibility. Backward compatibility occurs when an implementation of a new version of a technology can also interoperate with older versions. An example of this is that 802.11g chips are able to interoperate with the older 802.11b chips, and 802.11ac interoperates with 802.11n. Backward compatibility is achieved by implementing both the old and new technology specifications in the newer device. Whenever new implementations communicate with an implementation of the old technology, they fall back to using the old technology. Ideally, the new implementations will use the new technology when communicating with other new implementations. However, if the presence of an old implementation causes all devices on a given network to fall back to the old technology, and the performance difference between old and new is significant, then backward compatibility may not be worth having. The importance of backward compatibility depends on the market penetration of the old technology, the cost of replacing the old devices, the impact on performance etc.

Coexistence is not related to interoperability. Coexistence attempts to solve the problem of devices with different (non-interoperable) technologies using the same physical network segment. There is no expectation these devices can receive/send data from/to each other. Coexistence allows different technologies to share the same frequency spectrum on the same physical medium, preferably in a fair, or controlled, fashion. When disparate technologies coexist, the performance of both is decreased. When disparate technologies are attached to the same physical powerline without employing coexistence mechanisms, their performance and behavior will be unpredictable.

In principle coexistence can be accomplished for powerline technologies using the Inter System Protocol (ISP). ITU-T G.9972 [1] defines ISP for G.hn, whereas for HD-PLC and HomePlug it is specified in IEEE 1901 [2]. ISP allows all three of these technologies to signal their presence to each other, and then use Time Division Multiplexing (TDM) to take turns using the same frequency spectrum on the same physical powerline. ISP has been implemented in some G.hn silicon, but there is no known HomePlug implementation. Where ISP is only implemented in one technology present on a physical powerline, it provides no benefit.

A method that can be used to achieve partial coexistence is for a technology chipset to include a proprietary mechanism to recognize the presence of another technology, and then take steps to decrease its impact on the other technology while mitigating impacts to itself. Steps taken may include avoiding parts of the frequency spectrum used by the other technology and limiting use of that frequency while it is being used by the other technology. Some G.hn silicon has implemented such a proprietary mechanism to allow it to coexist with HomePlug AV.

A concept that is closely related to coexistence is that of neighboring networks. This occurs where devices using the same technology are attached to the same physical medium but are used to create distinct networks that are not intended to communicate with each other. This can be very useful when neighboring dormitory rooms or apartments are supplied by common powerlines. The neighboring tenants will each want their own secured network. G.hn is the only standard for wired home networks that incorporates effective mitigation of interference from neighboring powerline technologies [3].

Interoperability, backwards compatibility, coexistence, and neighboring networks are all concepts that can have a very real impact on the usability and performance of powerline technologies. Organizations like HomeGrid Forum have an important role in pushing implementations to support these concepts where appropriate, but without introducing unnecessary cost where there is little demand or perceived benefit. HomeGrid Forum takes its role in providing information to educate potential customers about these important concepts very seriously, and works to ensure HGF marketing claims and logos provide the best possible user experience.

References:

[1] G.9972: Coexistence mechanism for wireline home networking transceivers. https://www.itu.int/rec/T-REC-G.9972/en

[2] 1901-2010: IEEE Standard for Broadband over Power Line Networks: Medium Access Control and Physical Layer Specifications. https://standards.ieee.org/findstds/standard/1901-2010.html

[3] PLC Neighboring Networks Interference: How G.hn solves PLC's Neighboring Networks interference problem. http://www.homegridforum.org/uploads/resources/tF6A/4oMq.pdf