Overview of Draft Recommendation ITU-T G.9963 (G.hn-mimo)

A standard defining multiple-input, multiple-output (MIMO) high-speed home networking transceivers

Summary

This paper provides a high level overview of the multiple-input and multiple-output (MIMO) high-speed home networking transceivers (G.9963) and the required additions and modifications to Recommendations G.9960 and G.9961 (collectively known as the "G.hn standards") in order to provide the scope and descriptions of important features of G.9963 and the progress of the on-going standardization work in Q4/15.

ITU-T Recommendations G.9960 and G.9961 define transceivers for networking at extremely high speeds over any wireline (Powerline, Phoneline/Twisted Pair, and Coax) medium. The core focus of the standards is on home networks using G.hn transceivers; however, G.hn transceivers are defined for use in other applications as well (see Appendix VIII/G.9960). G.9960/G.9961 define a transceiver assuming a single transmit path.

The ITU-T periodically reviews new technology concepts through contributions to its work groups. This continuous review process enables new technologies to be codified into their own standards or added on to existing ones. The addition of the MIMO capability provides silicon companies with the option to develop products that incrementally improve on G.hn and help grow the market.

This paper provides an insight into MIMO technique used over wireline mediums and its realization in new Recommendation G.9963, which is focused initially on powerline, and the basic characteristics of a MIMO high-speed networking transceiver capable of operating over powerline wiring. Further study is being made in regards to the use of G.hn-mimo over other wireline mediums. While initially focused on home networks, much of the effort going into G.9963 is applicable to any multi-path medium configuration inside or outside the home.

The new Recommendation G.9963 also defines the means by which G.hn transceivers, defined by Recommendation G.9960 & G.9961, and G.9963 MIMO transceivers interoperate together when communicating together over the same wires, as G.9963 defined transceivers are simply G.hn transceivers with additional capabilities.

Introduction to MIMO

"Multiple input, multiple output" refers to a technology that has the ability to use more than one transmit path and more than one receiver path, in other words, multiple inputs to the path (or channel) referencing the transceiver's transmitters and multiple outputs from the path (or channel) referencing the transceiver's receivers. Examples of commonly used MIMO technologies are typically found in the wireless space, with the IEEE 802.11n standard defining MIMO options for WiFi transceivers.

In the wireline space, the use of multiple transmitters and/or receivers depends on the number of electrical paths between the two communicating devices. Each path requires two wires to function. In the home, there is the use of 3-wire electrical sockets in many regions. These enable G.hn-mimo devices to send and receive signals over all three wires as two logical circuits, with the earth ground acting as the common wire and then the other two leads each having their own circuit.

In wireless, MIMO technologies enable better transmission/reception in crowded environments, while moving, and under increased noise conditions. Further, when conditions are favorable, MIMO

transceivers are able to establish links at extended distances versus single input, single output (SISO) devices.

In powerline communications, the use of MIMO brings several improvements over standard SISO powerline transceivers. First, there is the ability to increase coverage in the building before the need for relays arises. Second, the ability of MIMO signals to cross over to other phases in the electrical wiring increases coverage and performance for many areas of the building. Third, there is the improved throughput as MIMO is based on a highly optimized communication scheme that sends spatially multiplexed signals over each port, with embedded self-noise cancellation techniques.

Introduction to G.9963

G.9963 specifies the basic characteristics of multiple-input multiple-output (MIMO) G.hn networking transceivers capable of operating over premises powerline wiring. This document provides a high level introduction to the required technology and additions and modifications to Recommendations G.9960 and G.9961 needed to define a MIMO G.hn networking transceiver. G.hn-mimo transceivers are able to transmit and/or receive over three powerline conductors (e.g., phase, neutral, and ground) using more than one Tx and/or Rx port, thus providing a substantially increased data rate, greater noise immunity, and enhancing the connectivity (i.e. service coverage) of the home network.

Recommendation G.9963 is in the advanced stage with many of the technical details agreed upon or defined with further study needed on specifics. Recommendation G.9963 is scheduled for formalization as a completed standard later this year. This document summarizes the major points established in G.9963 with details left for when the standard is published.

MIMO is applicable to other wireline mediums than powerlines, with further study and work being done at ITU-T in these areas.

Scope of G.9963

The Recommendation G.9963 will describe the required modifications to Recommendations G.9960 and G.9961 needed to define MIMO home networking transceivers for operation over powerline wiring. More specifically, this Recommendation includes the following:

- The PHY functional models of MIMO transceivers;
- Descriptions of the modifications (changes and additions) needed in the PHY and DLL sections relative to G.9960 and G.9961 Recommendations;
- The means by which both G.9960/G.9961 and G.9963 transceivers interoperate when communicating on the same wires (i.e., a heterogeneous G.9960/1 and G.9963 domain); and
- The means by which transmissions from G.9963 transceivers do not degrade performance of G.9960/G.9961 transceivers when operating on the same wires

A G.9963 transceiver is defined to be fully compliant with G.9960 and G.9961 Recommendations, which will ensure interoperability.