APT/ITU Conformance and Interoperability Event

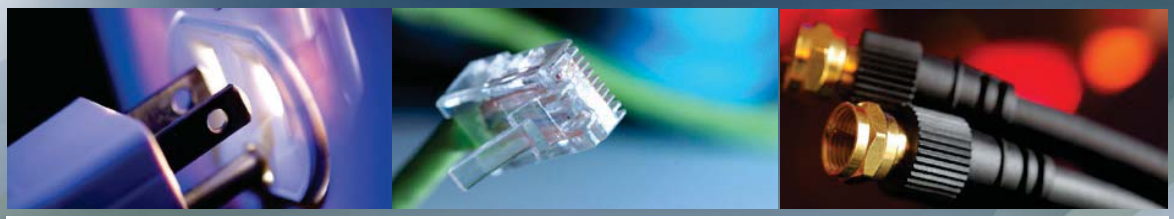
09 – 10 September 2013, Bangkok, Thailand

Document C&I/INP-12
09 September 2013

HomeGrid Forum

HOMEGRID FORUM'S C&I PROGRAM

Contact: MR. JOHN EGAN Email: jegan@marvell.com
President, HomeGrid Forum



HomeGrid Forum's C&I Program

Presented 09 Sept. 2013 to the
Joint APT/ITU Conformance and Interoperability event
Bangkok, Thailand

Presenter: John Egan
President, HomeGrid Forum
Manager, Marvell Semiconductor

HomeGrid FORUM
For any wire, anywhere in your home.™

Introduction

- **This slide deck summarizes our C&I paper**
  - Download the paper for more C&I details
- **Topics**
  - Introduction to HomeGrid Forum
  - Introduction to G.hn
  - Overview of HGF C&I Program
  - C&I Results
  - Lessons
  - Recommendations
  - Q&A

HGF – INTRO

HomeGrid Forum Primary Goals

- **Evangelize G.hn and HomePNA technologies while promoting market transition to G.hn**
  - Through Education
    - White Papers, Slides, Speaking roles
  - Meetings and Seminars
  - Interviews
  - Articles
- **State-of-the-art C&I program - certifying silicon and systems**
  - Silicon COMPLIANCE
    - Two certified as of June 2013
    - We will announce more in the coming months
  - System INTEROPERATION (and PERFORMANCE)
    - Test Specifications and Lab validated starting June 2013
    - First system certified as of Sept. 2013
- **Enhancing G.hn and wireline networking technologies**

HomeGrid Forum Members

Board of Directors (9)

ARRIS, at&t, BEST BUY, BT, CISCO, intel, MARVELL, SIGMA DESIGNS, Telefonica

Promoters (3)

Telecommunication Laboratories Chunghwa Telecom Co., Ltd., Corinex SmartGrid Connectivity, SUTTLE

Contributors (13)

BC Institute of Technology, Holland Electronics, Institute of Information Industry, Kawasaki Micro, Korea Electrotechnology Research Institute, Korea Polytechnic University, Kwangwoon University, Lantiq, Metanoia Communications Inc., Tangotec, The University of British Columbia, TRAC Global, University of New Hampshire Interoperability Lab

Adopters (23)

Actiontec Electronics, Inc., Advanced Digital Broadcast SA, Alcatel-Lucent, Calix, CAMEO Communications, Inc., COMTREND Corporation, D-Link Systems, Inc., JDSU, KAON Media, KGP Products Inc.,D/B/A Premier, Megger Instruments (was Heritage Technologies), MitraStar/ZyXel, NESS Czech, PACE, Panasonic, Sagemcom USA, SendTek Corporation, SerComm Corporation, Tatung, Technicolor SA, Inc, Teleconnect GmbH, Trendnet, Xingtera

Service Providers (20 more)

- **From the previous slide**
  - AT&T
  - British Telecom
  - Chunghwa Telecom
  - Telefonica
- **Leading Service Providers**
  - Bell Canada
  - Telecom Italia S.p.a
- **Plus these others…**
  - 3 Rivers Communications
  - Bell Aliant
  - Connexion Technologies
  - Consolidated Communications
  - EATELCORP, Inc
  - GVT
  - Hawaiian Telcom
  - Highland Communication Services
  - Logic Communications
  - Moapa Valley Telephone
  - MTCC
  - New Hope Telephone Cooperative
  - Northeast Louisiana Telephone Co., Inc.
  - Phonoscope
  - Randolph Telephone Membership Corp
  - Rural Telephone Service Co.
  - Sandwich Isles Communications
  - Smithville Telecom, LLC
  - Tata Sky Ltd.
  - TBayTel
  - Triangle Communications
  - yes (DBS Satellite Services)

G.HN INTRO

Wireline technology for in-home networks

The Best Platform for IPTV Delivery in the Home
HD, 4KHD/UHD, 3D…

G.hn Intro 1

- **Best in class technology, optimized operation over <u>any wire</u> architecture**
  - Same silicon used for any wire
    - Coax (BB & RF), PLC, Phoneline/Twisted Pair, POF
  - Best noise robustness, FEC, retransmissions
    - Achieves 10^{-8} PER
  - Parameterized and Prioritized QoS
  - TDMA with Bandwidth Reservations
  - True Multicast
  - Auto-Mesh Networking
  - NDIM/Neighboring Networks
  - MIMO option
  - Very high MAC efficiency, means higher throughput, better robustness to noise

G.hn Intro 2

- **Multi-source**
  - Multiple silicon sources
- **One Technology works over any medium**
  - Reduces Costs to develop, deploy
  - Same management for all
- **Defined by Service Providers for Service Providers**
  - Standards developed in ITU-T
    - Global standards organization for Service Providers
    - SPs led requirements and standards development
  - Strict focus on delivering high QoS TDMA traffic with best in class error avoidance and noise mitigation

Major Features of G.hn

Any Wire
- Operates over any wire
  - **Coax**
  - **Copper Pair/ Phoneline**
  - Plastic Optical Fiber (**POF**)
  - **Powerline**

Performance
- **PLC** (**SISO**): 250-500 Mbps
- **PLC** (**MIMO**): 400-1000 Mbps
- **Coax** (**BB**): 700-1000 Mbps
- **Coax** (**RF**): 800-1000+ Mbps
- **Phone**: 350-700 Mbps
- **POF**: 700-1000 Mbps

Robust operation in noisy environments
- **Parameterized QoS**
- **Error Correction**

Security
- State of the art **AES 128** encryption

Coexistence
- **G.cx specification** for working with legacy PLC

Manage-ability
- Diagnosis and control compliant with **TR-69**

Mesh Networking
- Support for **extended range, automatic relays**

Low Power
- Meets EU Code of Conduct (**CoC**) for low power
- Has a complete set of **EMC** tools for managing PSD and emissions

ITU-T's G.hn Home Network Standards Family

Continuous Technology Evolution and Expansion

Standard	What	Status	Date
G.9960 (G.hn)	PHY, LCP & Architecture	Approved	2010
G.9961	DLL (MAC, LLC & APC)	Approved	2010
G.9972 (G.cx)	Legacy PLC Coexistence	Approved	2010
G.9964 (G.hn-psd)	Settings & Managing PSD	Approved	2011
G.9961 Amd 1	NDIM – Neighboring Networks	Approved	2012
G.9963 (G.mimo)	MIMO for PLC	Approved	2012
G.9980 (G.cwmp)	Remote Management (TR-069)	Approved	2012
G.9962 (G.hn-mgmt)	Management Plane, MIB	Approved	2013

Publicly available to anyone

G.9960 (PHY and System Architecture):
http://www.itu.int/rec/T-REC-G.9960/en
G.9961 (DLL):
http://www.itu.int/rec/T-REC-G.9961/en

Latest Milestones:

Sept. 2012: NDIM added to G.9961 as Amendment
July 2013: G.hn Management Approved as Standard
July 2013: IEEE 1905.1 Modifications for G.hn - Draft

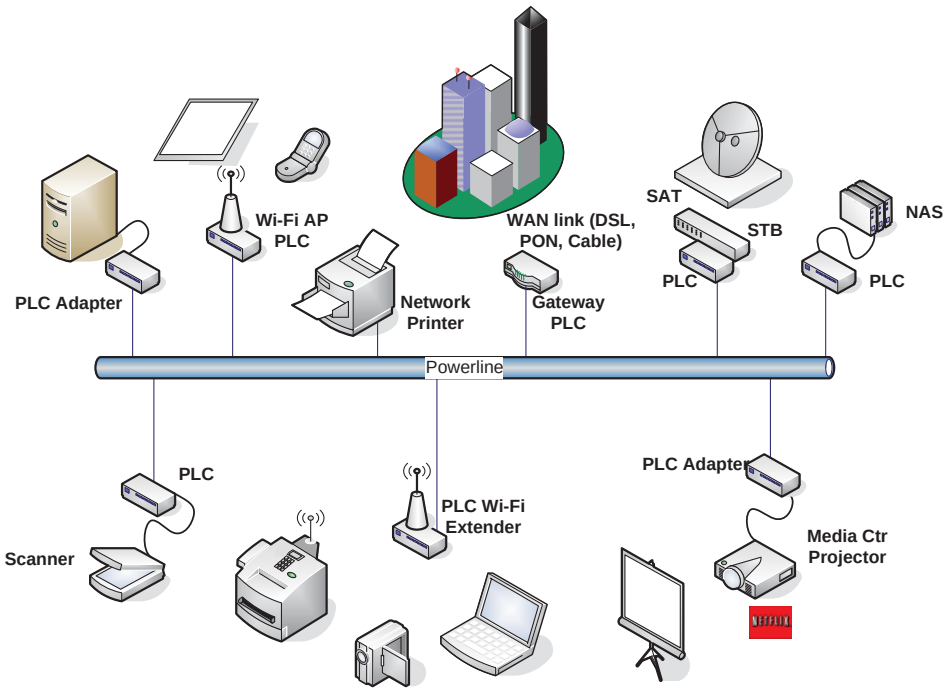
Service Provider Shifts to G.hn

- **China Telecom**
  - Trials started, Deployments planned
  - **China Unicom** has announced they will use G.hn
- **Chunghwa Telecom**
  - Tests done, Deployments planned, using certified systems
- **Telefonica**
  - Presence in 17 countries, PLC & Coax modes
- **Being evaluated by over 25 other Service Providers**
  - All SP types: Telecom, Cable, Satellite
  - Asia - Singapore, S. Korea, Japan, …
  - North & South America
  - Europe
  - Israel, India, ROW

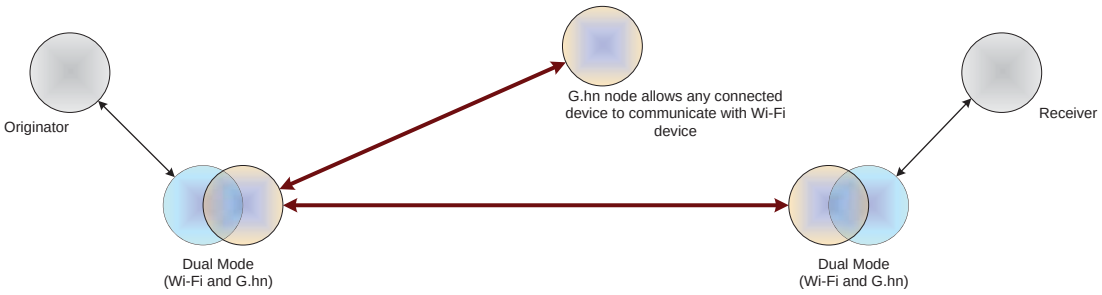
G.HN – THE HOME'S BACKBONE NETWORK

Delivering high QoS content & services throughout the home

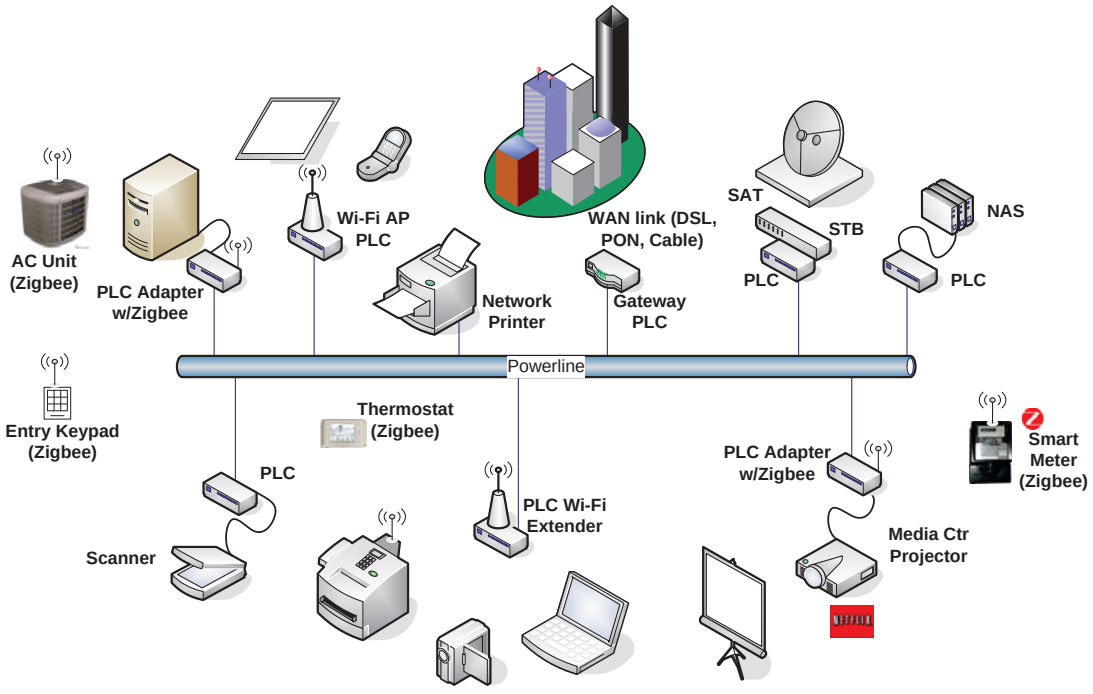
The G.hn Network (for example - PLC)



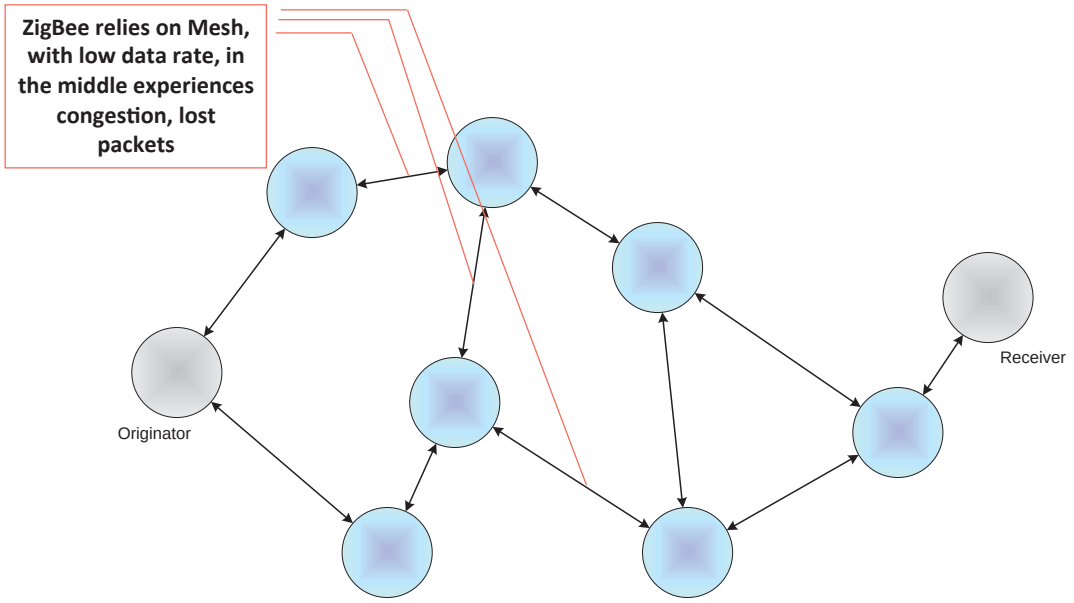
G.hn Linking Wi-Fi Extenders and APs



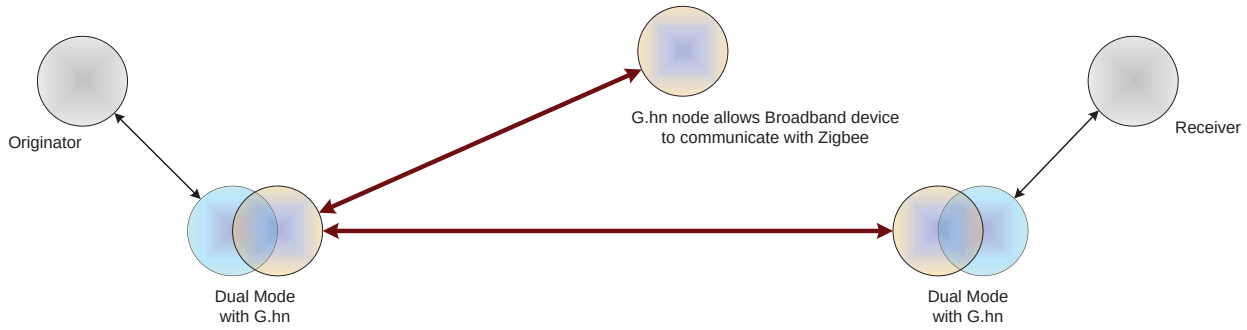
Adding Other Service Platforms off a G.hn Backbone



ZigBee Mesh Networks Alone



ZigBee with G.hn Backbone (similar to Wi-Fi model)



Summary

- **G.hn links all high demand, high QoS fixed devices**
  - Gateways
  - Set Top Boxes
  - TVs with embedded G.hn, etc.
- **G.hn links all wireless APs and Extenders**
  - Enables high traffic with handover
  - Reduces demand on RF, reducing congestion
- **G.hn link for all low bit rate networks**
  - Eliminates congestion, adds stability and throughput
- **The perfect backbone for the evolving home network**
  - IoT, Home Automation, Security, Energy Management

COMPLIANCE & INTEROP

C&I Program - Objectives

Provide a state-of-the-art C&I program for certifying both silicon and systems

Ensure the highest level of compliance, interoperability, and performance

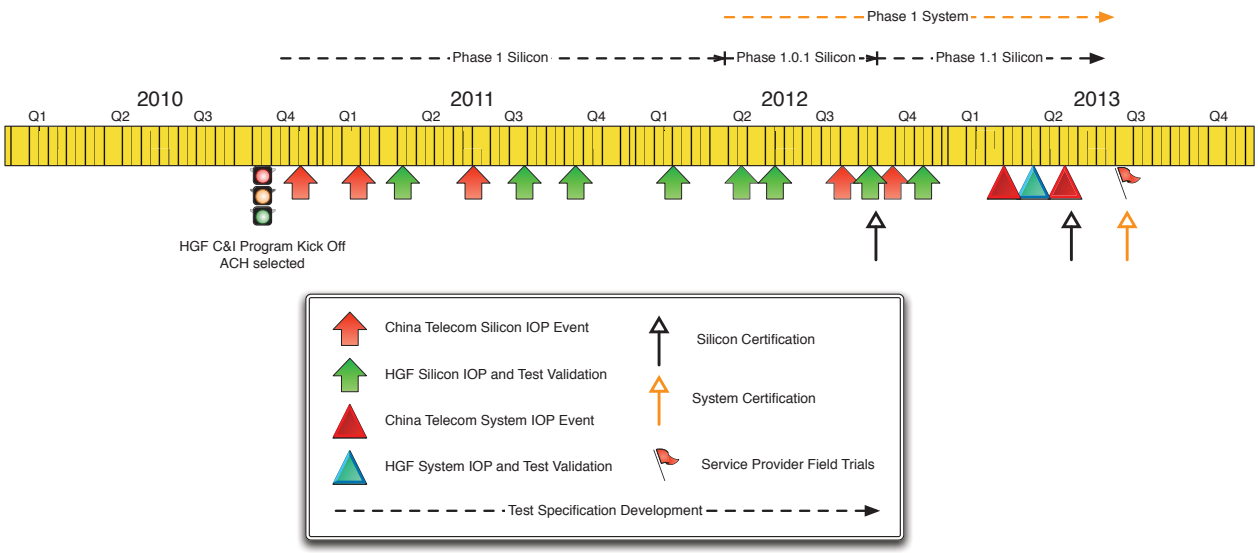
G.hn silicon complies to the latest standards and HGF requirements

Certified CE and Service Provider G.hn systems are guaranteed to interoperate and meet baseline performance levels

Goal: Certified G.hn

- **Brand new technology**
- **Start C&I from scratch**
  - Cannot rely on past testing or technology definitions
  - Typically, new tech takes about 4 years to achieve Interoperation
- **HGF C&I Program started Nov. 2010**
  - Selected Test House
  - In 24 months first silicon Compliance Certification achieved
  - In 30 months second silicon Compliance Certification achieved
  - In 30 months system testing ready
  - In 33 months certified our first system
- **But, the market wanted it "yesterday…"!**
  - China Telecom held their own events in addition to HGF
    - Held the first G.hn IOP event
    - April-May 2013 event focused on system performance and IOP
    - Now moving to trials and deployments

Timeline



The C&I Program

➲ Accredited Test House

- TRaC Global - UK

➲ C&I Work Group

- Chair – Abdul Khan – contractor to HGF
  - Members
    - Active: Marvell, Metanoia, Sigma, TangoTec, TRaC
    - Open to all HGF members above Adopter level
  - Have held Service Provider member specific meetings
  - Partnered with BBF for SP requirements and input
  - Defining Tests based on G.hn standards and HGF requirements
  - Writing all documentation
  - Technical Task Force
    - Chaired by TRaC
    - Focused on defining test specifications, validating tests and steps

Lessons Learned

- **Avoid the "Golden Node" situation**
- **Interoperation mandated and worked on from start**
- **Vendor cooperation at a high level**
  - CTC & HGF pushed this
- **Get test plans done, then have validation with optimization efforts at the test house with the TTF**
- **Ensure Service Providers are involved from the start**
  - Hold meetings seeking input, sharing information
  - Provide information and documentation
- **Once program running, get labs close to ODMs/OEMs**
- **Define and enforce rules on derivatives**
- **Have best in class documentation early on**

Recommendations

- **Have strict requirements and testing to avoid FM band interference by any PLC technology operating at 80 MHz or above (or lower where FM band is lower)**
- **Make G.9964 the PLC PSD management specification for all PLC systems, and other wire types, too**
- **Neighboring PLC networks have severe cross-interference in high density multi-dwelling buildings**
  - G.hn PLC mode has NDIM and avoids this
  - G.hn can have G.9972 to avoid that PLC which also supports the ISP protocol (IEEE 1901)
  - NDIM mandatory for all PLC, and any 1901 PLC deployed where G.hn will be must be verified to have ISP

Follow Up

- **Associated detailed paper on the event web site**
- **HomeGrid has a substantial amount of literature on our web site**
  - http://www.homegridforum.org/content/pages.php?pg=resource_overview
  - Neighboring Networks interference – NDIM
  - PLC MIMO
  - Examples of adding G.hn where other networks exist
    - Convergence of HomePNA and G.hn
    - G.hn and HomePNA Today
- **Reach out to us**
  - Request discussions with our C&I people over G.hn planning and testing

Join Us

- **Service Providers can be HGF members at no fee**
  - Membership level allows SPs to be in any of our Work Groups
    - We adjust WG conf. calls to meet the time zone of participants, so Asian members have convenient schedules
  - We seek SP input frequently on issues of importance
  - We have road map updates we publish for members to keep them aware of where we are going
- **Regulators and SDOs have HGF liaison agreements**
  - We have a liaison agreement with ITU-T, of course
  - We want dialogs with regulators globally
- **Questions for HomeGrid?**

president -at- homegridforum.org

Thank You

HomeGrid Forum Certified **G.hn** Products

The mark of Certified Compliance, Interoperability, and Performance

www.homegridforum.org