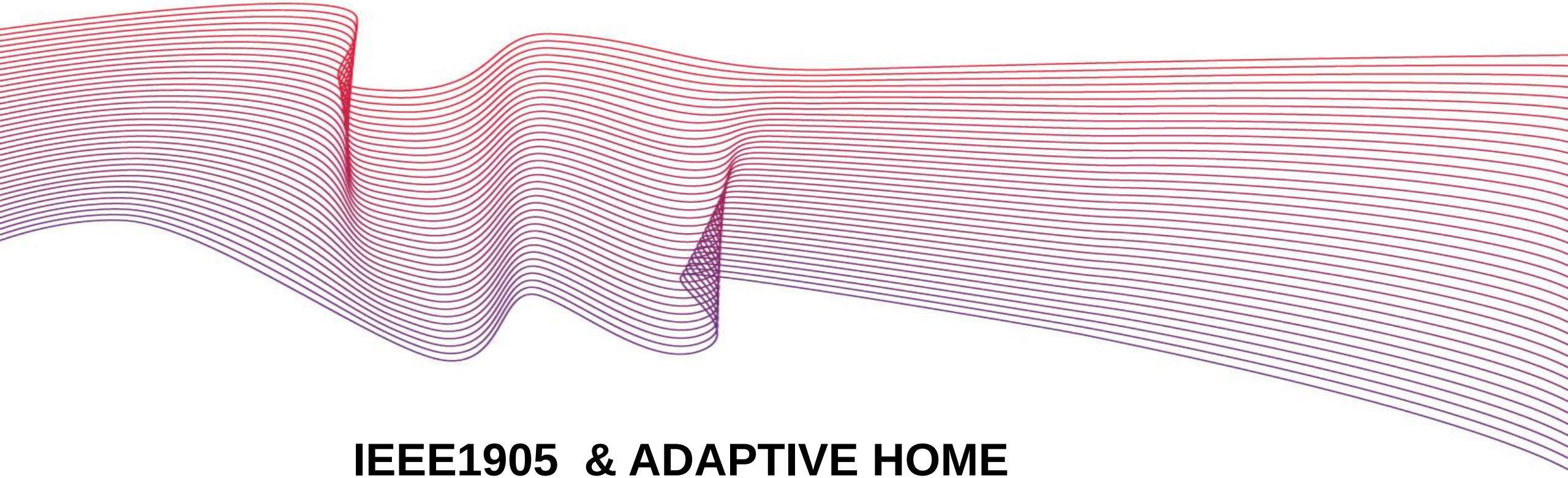


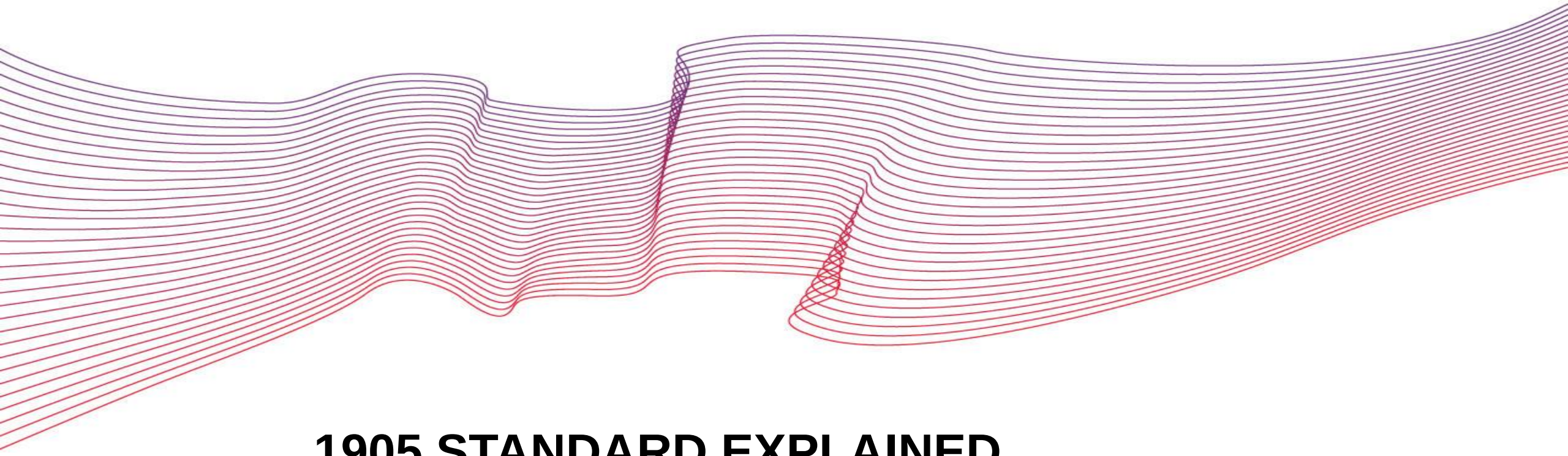
IEEE1905 & ADAPTIVE HOME NETWORKING EXPLAINED

Broadband Carrier Access

4.16 L03

CONTENT

- 1905 Standard Explained
- Adaptive Home Networking Explained
- Broadcom Reference Designs supporting IEEE1905.1
- Software Release Content
- Documentation References
- IEEE1905.1 Demo
- Adaptive Home Networking Demo
- Appendices
- References



1905 STANDARD EXPLAINED

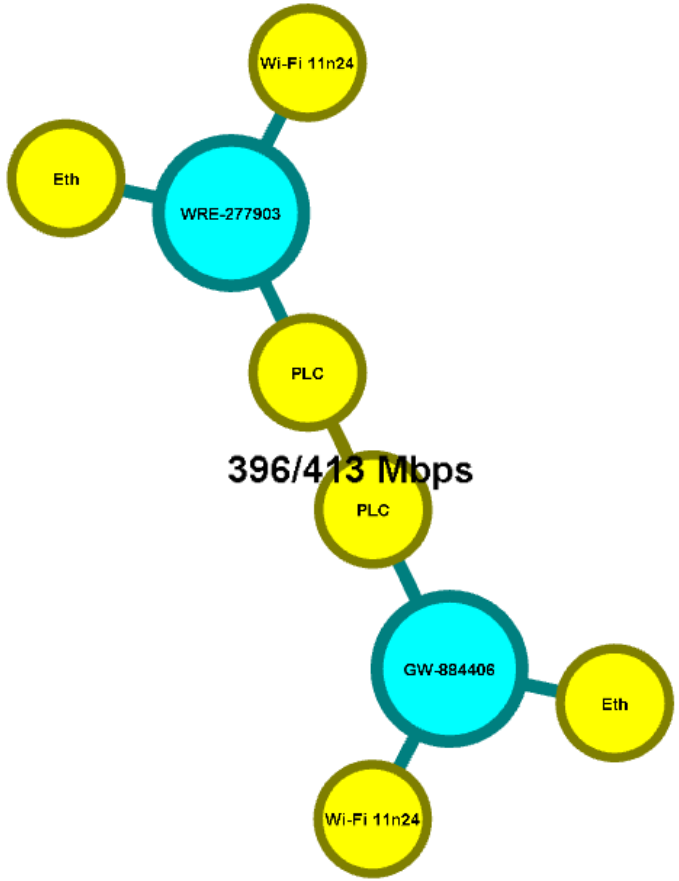
IEEE1905 BENEFITS

IEEE1905.1 is a standard which provides these features

- **IEEE1905 Topology Discovery**
  - Facilitates remote and local network administration
- **IEEE1905 Security**
  - Controls pairing of devices
- **IEEE1905 AP Auto-Configuration**
  - Facilitates Remote AP setup
- **IEEE1905 Link Metrics**
  - Statistics definition and distribution

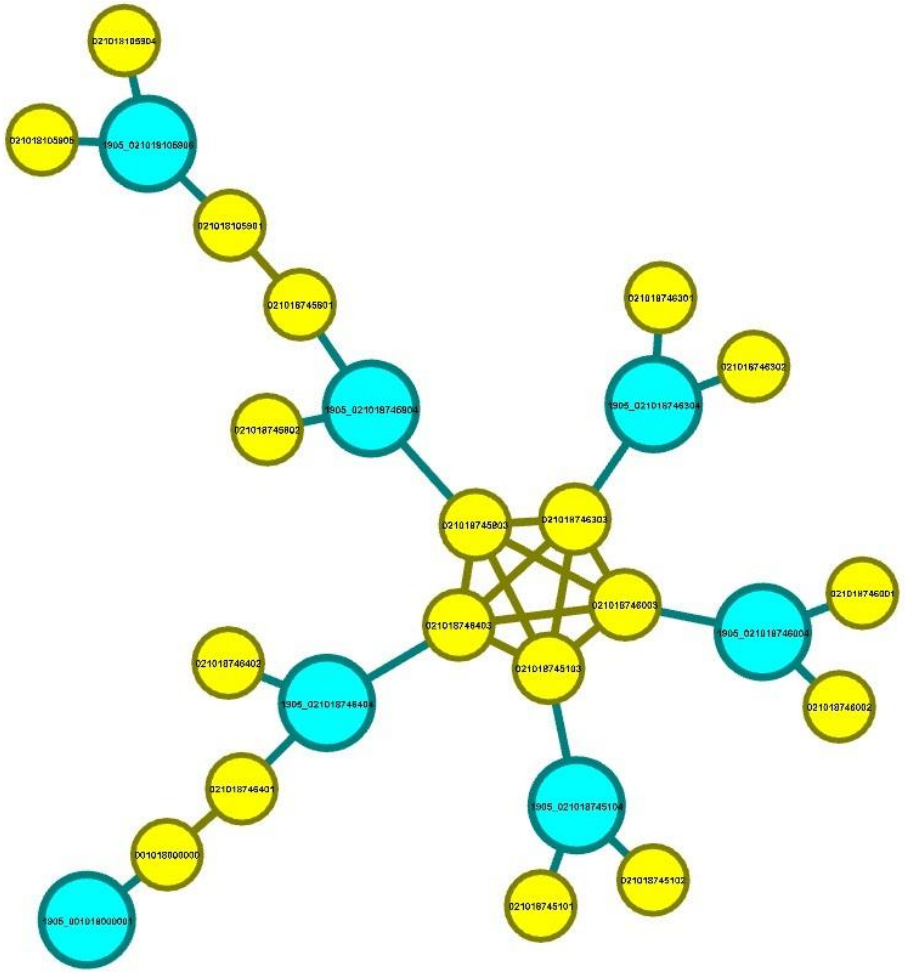
IEEE1905 TOPOLOGY DISCOVERY

- **Dynamically builds a data model of the 1905 home network**
- **Determines how each device (shown in blue) is connected to others over their interfaces (shown in yellow)**



IEEE1905 TOPOLOGY DISCOVERY

- **Multiple 1905 devices can form a more complex network**



IEEE1905 SECURITY

- **3 Security modes defined in IEEE1905 Specification**
  - Push Button Security (similar to WPS)
  - 1905 Passphrase (requires 1905 support on Laptops, Smartphones, etc)
  - NFC (optional)
- **We implement Push Button Security**
  - Single button used for Wi-Fi, HPAV, eventually MoCA
  - Pressing the button initiates Wi-Fi WPS and HPAV UKE simultaneously
  - Requires 2 minutes to pair 2 HPAV units, or Wi-Fi client to AP
  - Once paired, a secure network is formed
  - The device where the button is pressed need not support Wi-Fi or PLC
    - Notifications are distributed inside the 1905 network to find devices supporting these protocols

IEEE1905 AP AUTO-CONFIGURATION

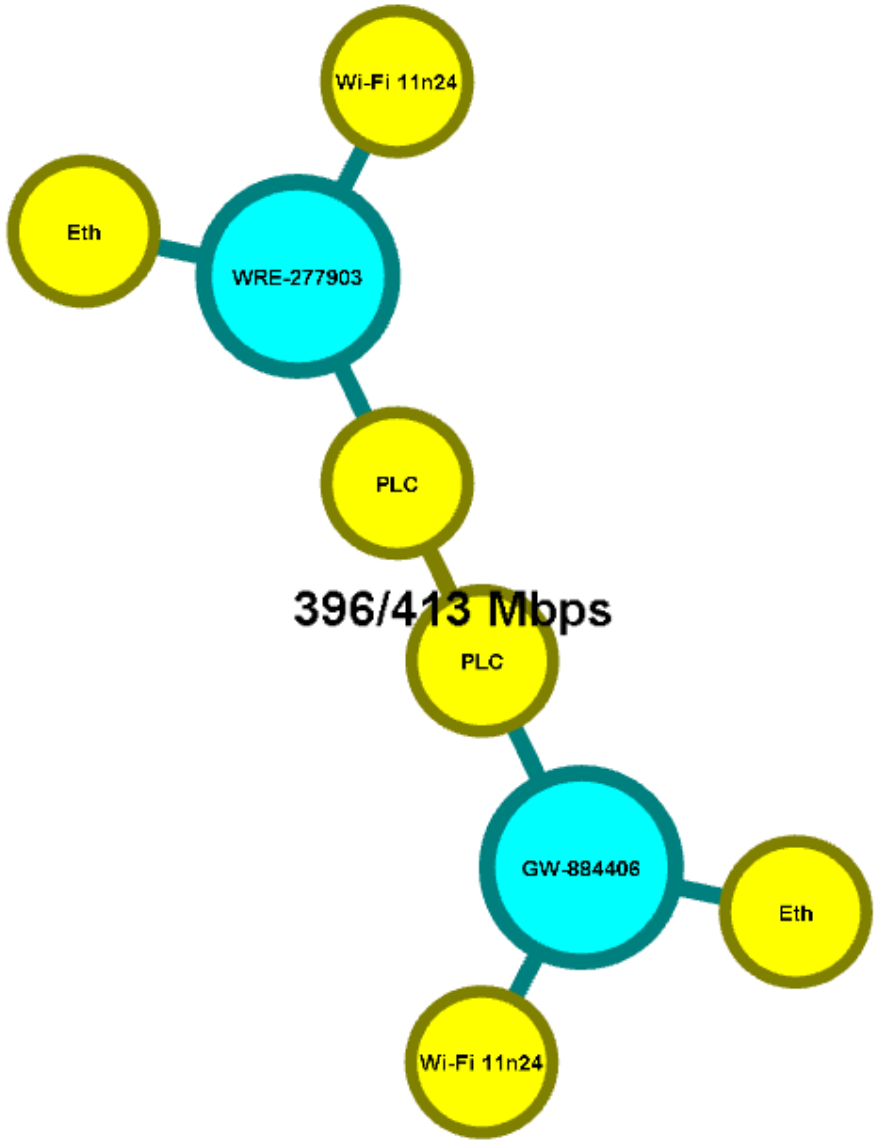
- **The Gateway will default to being a Registrar**
  - It can be configured with the Wi-Fi AP SSID, Security Mode, Passwords, etc
  - It must be WPS enabled in order to perform as a Registrar
- **The Wireless Range Extenders are Enrollees**
  - AP Auto Configuration is triggered when the enrollee joins the 1905 network
  - The enrollee automatically obtains its AP configuration from the Registrar
- **The Enrollee configuration remains in sync with the Registrar's**
  - Changes to the Registrar's AP configuration trigger notifications to Enrollees
  - Enrollees re-request their AP configuration
- **Configurations are maintained per frequency band**
  - The registrar can maintain separate configurations for 2.4 GHz and 5 GHz
  - The specification does not currently distinguish 11n & 11ac
  - The specification does not currently support multiple SSIDs per band

IEEE1905 LINK METRICS

- **Link Metrics provide statistics from each link in the network**
- **Local statistics are accumulated by each node**
- **Nodes can query each other to obtain whole network statistics**
- **Many statistics are defined by IEEE1905 specification**
- **We implemented two statistics of higher interest**
  - MacThroughputCapacity
    - The maximum MAC throughput of the Link estimated at the transmitter and expressed in Mb/s.
  - LinkAvailability
    - The estimated average percentage of time that the link is available for data transmissions.

IEEE1905 LINK METRICS EXAMPLE

- **MacThroughputCapacity**
  - 413 Mbps in this example
- **LinkAvailability**
  - 396/413 = 95.9 % in this example



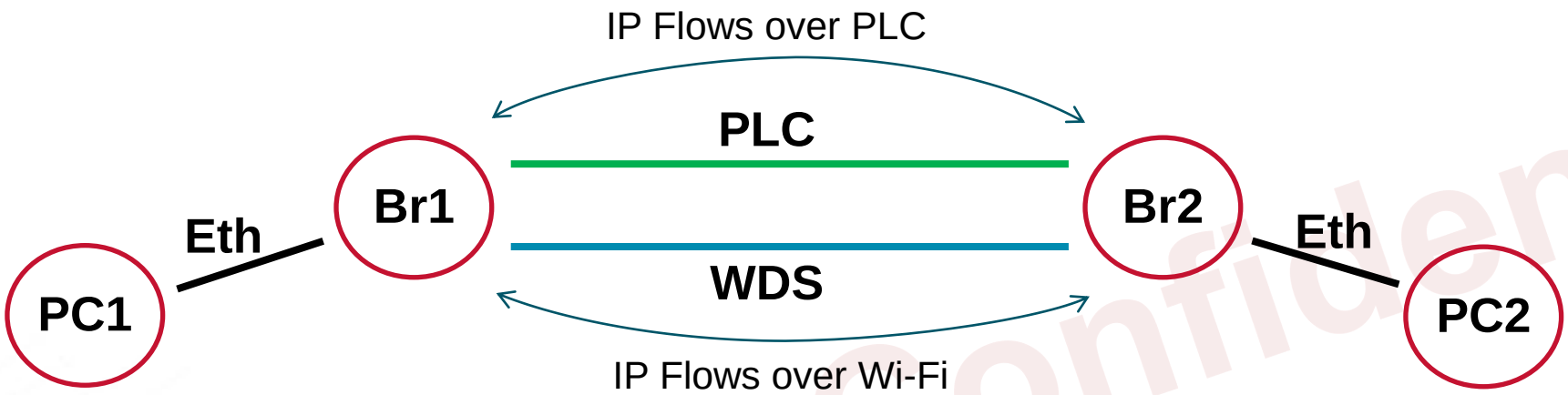
ADAPTIVE HOME NETWORKING EXPLAINED

ADAPTIVE HOME NETWORKING

Adaptive Home Networking is a proprietary concept that includes

- **Best Link Selection**
  - Occurs when multiple links are available between 2 nodes
  - A flow is assigned to the link interface having most remaining bandwidth available
- **Link Aggregation**
  - Occurs as new flows are added to the system
  - System distributes new flows based on remaining available bandwidth
  - Packets from a single flow are transmitted on a single link
- **Failover**
  - Occurs when two conditions are met
    - The remaining bandwidth on a link hits 0
    - Another link has enough remaining bandwidth to carry the traffic from the first link

ADAPTIVE HOME NETWORKING (2 NODES)



- PLC connects the two Bridge nodes (green)
- WDS is used in parallel to connect over Wi-Fi (blue)
- Spanning Tree Protocol is used to prevent loops
- Flows between PC1 and PC2 can use PLC and Wi-Fi simultaneously
- Current code supports one WDS and one PLC interface

BROADCOM REFERENCE DESIGNS SUPPORTING IEEE1905.1

BROADCOM REFERENCE DESIGNS WITH IEEE1905

- **IEEE1905 is now available on multiple platforms**
  - DSL Gateways
  - PON Gateways
  - HPAV1 Wi-Fi Ethernet Adaptors
  - HPAV2 Wi-Fi Ethernet Adaptors
  - HPAV2 Ethernet Adaptors
  - DOCSIS Cable Modem Gateways
  - Set-top Box

- **Adaptive Home Networking has limited availability**
  - DSL Gateway
  - HPAV1 Wi-Fi Ethernet Adaptors
  - HPAV2 Wi-Fi Ethernet Adaptors

REFERENCE DESIGNS

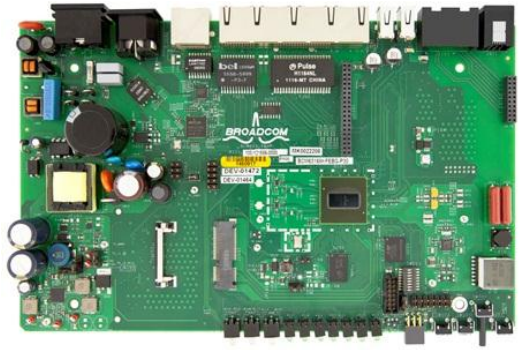
- **BCM960500WIFI**
  - HPAV2
  - GETH
  - 802.11n or 802.11ac

- **BCM960500HPAV2M_US**
  - HPAV2
  - GETH

- **BCM960500_INT_MIMO**
  - HPAV2 Adaptor card (for Gateway)
  - +63268 Not available as a ref. design
  - +63138/148REF

- **BCM96319PLC**
  - HPAV
  - 802.11n
  - FETH

- **BCM96318PLC**
  - ADSL
  - HPAV
  - FETH



- **BCM963168MP**
  - VDSL
  - HPAV
  - 1GETH, 3FETH

REFERENCE DESIGN FEATURE AVAILABILITY

Ref Design	I/F	802.11	OS	TR-069	1905	AHN
BCM960500WIFI	HPAV2	Yes	Linux	Yes	Yes	Yes
BCM960500HPAV2M_US (option 1)	HPAV2	No	Linux	Yes	Yes	Yes
BCM960500HPAV2M_US (option 2)	HPAV2	No	PLC FW	No	No	No
BCM63268 + BCM960500_INT_MIMO	HPAV2	Yes	Linux	Yes	Yes	Yes
BCM63138/148REF + BCM960500_INT_MIMO	HPAV2	Yes	Linux	Yes	Yes	No
BCM96319PLC	HPAV	11n	Linux	Yes	Yes	Yes
BCM96318PLC	HPAV	11n	Linux	Yes	Yes	Yes
BCM963168MP	HPAV	11n	Linux	Yes	Yes	Yes
BCM6838	xPON	Yes	Linux	Yes	Yes	No
BCM93385 DOCSIS	DOCSIS	Yes	Linux	Yes	Yes	No
BCM33843 + STB chip	+ MoCA	Yes	ECOS	?	Yes	No
BCM7445, 7438, + more	+ MoCA or HPAV	Yes & No	Linux	?	Yes	No

SOFTWARE RELEASE CONTENT

4.16L.01 FEATURES

- **Improved 1905 Topology Discovery**
  - Implement 1905 Link Metrics distribution across nodes
  - Add Ethernet support to our 1905 solution
- **Support for new HPAV2 Broadcom Reference Designs**
  - Duna-Standalone devices, Duna-Companion Devices
- **Flowbond Demo**
  - This will remain an experimental demo, between 2 nodes only
  - Not recommended to enable it in a product

4.16L.02 FEATURES

- **1905.1 Interoperability with other 1905.1 vendors**
  - This excludes AHN which remains proprietary experimental code
  - Certification program remains unscheduled
- **Support for new Reference Designs**
  - Duna-Standalone, Duna-Companion, xPON, CM, STB
- **Friendly names**
  - Devices now can have a short name transmitted in 1905 and displayed
- **Reduction of number of MAC addresses where possible**
  - Duna-Standalone solutions can share a MAC between internal plc0 port (GAA) and HPAV2 interface (LAA)

4.16L.03 FEATURES

- **WebUI support for 1905 control and topology display**
  - Enable/Disable 1905
  - Configure Friendly Name
  - Set as Registrar or Enrollee
  - Choose which bands are supported by AP Autoconfiguration
  - 1905 Network Topology Web page
    - External tool no longer needed
- **TR-069 - TR-181 integrating 1905 data model**
  - 1905.1 parameters are implemented
    - Exception: only the two relevant statistics are in place
    - 1905.1a is not implemented
- **Dual-band concurrent registrar**
  - Support AP Autoconfiguration for devices that have simultaneous 802.11n and 802.11ac

1905 DOCUMENTATION

- **IEEE1905.1 Standard**
  - IEEE Standard for a Convergent Digital Home Network for Heterogeneous Technologies
    - IEEE Std 1905.1™-2013
- **Broadcom IEEE1905 User Guide**
  - Found in docs/HOWTO/IEEE1905UserGuide.pdf
  - Provides details of 1905 implementation
    - Architecture
    - How to compile
    - Data-model description
    - Shell Utility
      - Display the data model: i5 dm
      - Enabling traces: i5 trace …
      - Etc.
    - API interface
  - Does not cover Adaptive Home Networking

RESTRICTIONS

- **Adaptive Home Networking is only supported as a demo**
  - It is only supported for the demos listed near the end of this document
  - We are interested in working with our customers to better define this feature
  - It is proprietary so it cannot interoperate with other vendor implementations
  - The current implementation should not be enabled in final products
    - “Flow Manager” and “Flow Bond” should be compiled out in final products

WE WELCOME YOUR FEEDBACK!

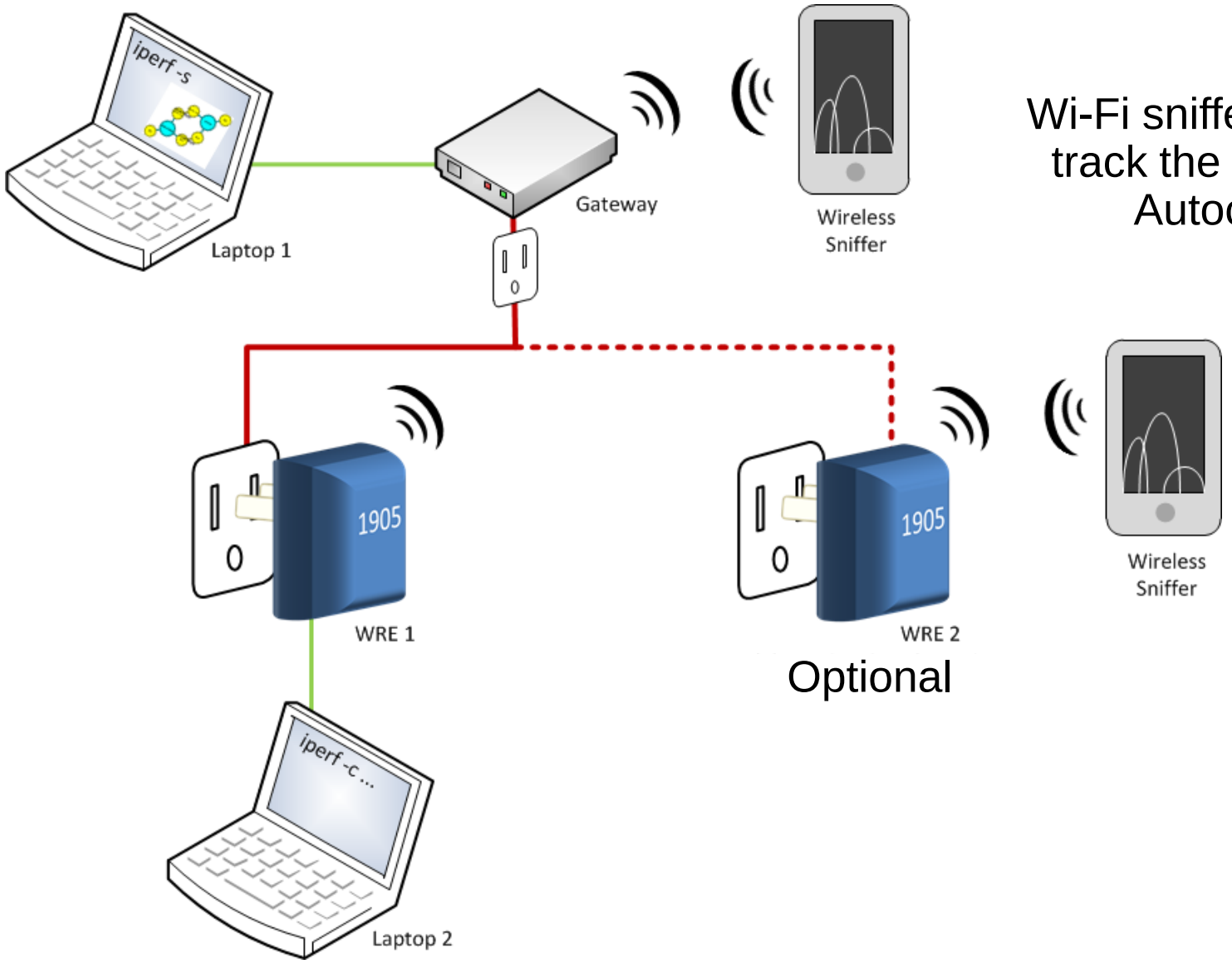
- **IEEE1905 standard is new and could be extended**
- **Adaptive Home Networking is a proprietary demo**
  - We are looking to improve it by better understanding customer needs
- **Please use the Broadcom CSP system**
  - To make suggestions
  - To ask questions
  - To work through possible issues not covered in our documents

IEEE1905.1 DEMO

1905 DEMO DEFINITION

- **1905 Demos include the 1905 features**
  - Topology Discovery, Push-Button Security, AP Auto-Configuration, Link Metrics
- **There is no restriction on which HW to use**
  - 1905 is a standard
  - Any Broadcom Reference Design previously listed can be used
  - Other Vendor implementations can also be used
- **There is (almost) no restriction on Network Configuration**
  - The network can be setup with any configuration
  - There should be only one Gateway in the network
  - There should be only one DHCP server (generally, the Gateway)
  - Keep in mind: 1905 does not define a mechanism for preventing loops
  - When demoing 1905, do not allow loops in your network
    - Do not connect Ethernet between 2 PLC adaptors, for example
- **For best results**
  - Use recent software for all devices

IEEE1905 DEMO LAYOUT



Wi-Fi sniffers can be used to track the SSIDs during AP Autoconfiguration

IEEE1905 DEMO EQUIPMENT LIST

- **Laptop 1**
  - Ethernet port configured with DHCP client
  - iperf installed
  - Configured for firewall (see Appendix D)
- **Laptop 2**
  - Ethernet port configured with DHCP client
  - iperf installed
- **BCM96168MP Gateway with 1905 enabled**
  - DHCP server enabled (should be by default)
  - ip address configured to 192.168.1.1 (should be by default)
- **BCM960500WIFI or BCM96319PLC (WRE)**
  - reset to default settings
  - should have wireless devices (11ac or 11n) compatible with Gateway

BRCM960500WIFI WIRELESS RANGE EXTENDER SETUP

- **WPS/PLC Security (upper button)**
  - Press (and release within 3 seconds) to initiate WPS and PLC security key exchange
- **Restore Defaults (lower button)**
  - Press and hold for 5 seconds to restore modem to defaults.
  - Resets all settings (Wireless, PLC default key etc.)
  - Reboots device

ALTERNATE CONFIGURATION

- **The demo instructions are written assuming a 1905 capable Gateway is used**
- **If you don't have a 1905 capable Gateway but you have 2 WREs, one of the WRE can be configured to act as the Gateway in this demo (without routing capabilities)**
  - Then the same instructions can be used, with the understanding that WRE1 is the Gateway, and WRE2 is the WRE

- **To configure WRE1 as a Gateway**
  - Plug-in WRE1 and press the "Restore Factory Defaults" push button
  - Connect the WRE1 over Ethernet to a network that will dispense IP addresses
  - Find the IP address receive by WRE1
  - Connect to the WebUI of WRE1 using http://<allocated address>
  - On the "Advanced Setup" menu item, under the "LAN" sub-item, enable DHCP server and apply
  - Disconnect the WRE1 from the Ethernet network
  - You can now use WRE1 as a gateway for the purpose of this demo
  - Do not restore WRE1 to Factory Defaults. If you do, rerun these steps

BRING-UP THE GATEWAY

- **Power up the Gateway**
  - Attach the Gateway to power source
  - Attach serial cable between Gateway and Laptop1 (if available)
  - Attach Ethernet cable between Gateway and Laptop1
  - Power On the Gateway

- **Press the Restore Factory Defaults on the Gateway**
  - This will ensure you start from a well know configuration
  - Alternately, the command “restoredefault” can be typed at the > console prompt

- **The Gateway should, by default, come up as 192.168.1.1**
  - From Laptop1, ping 192.168.1.1
  - From Laptop1, connect to http://192.168.1.1 and ensure that the web interface is active

VERIFY GATEWAY SOFTWARE IMAGE

- **The goal is to ensure the gateway is running a 1905 image**
  - If the current image on the Gateway does not contain 1905 software, this demo can not be run

- **Login to the serial console or telnet to 192.168.1.1 (See Appendix A)**
  - At the shell # prompt, type “i5”:

```
# i5
Usage: i5 <option>
        dm  -Display data model
        tr  -Enable function call tracing (0-Msg, 1-Tlv, 2-Dm)
        tsenable  -Toggle timestamps on call tracing (0-off, 1-on)
        wlcfg  -Wifi Autoconfig UnitTesting
        plc  -PLC actions (0 - start UKE, 1 - randomize)
        fmshow  -Display Flow Manager Database
        stop  -Stop ieee1905 daemon
        start  -Start ieee1905 daemon
        restart  -Stop and start ieee1905 daemon
        link  -Trigger Link Metric Queries
```

If an error is returned instead of a command list, the Gateway needs a new image that will support 1905.1

CONFIGURE THE GATEWAY PLC SECURITY

- **The Gateway, by default, is configured with “HomeplugAV” as the security network key**
- **For the purpose of this demo, the security key should be randomized on the Gateway**
  - Using a key different than the default key allows securing the PLC network
  - Randomizing can (and probably should) also be done at manufacturing time and saved in NVRAM

At the gateway shell prompt type:

i5 plc 1

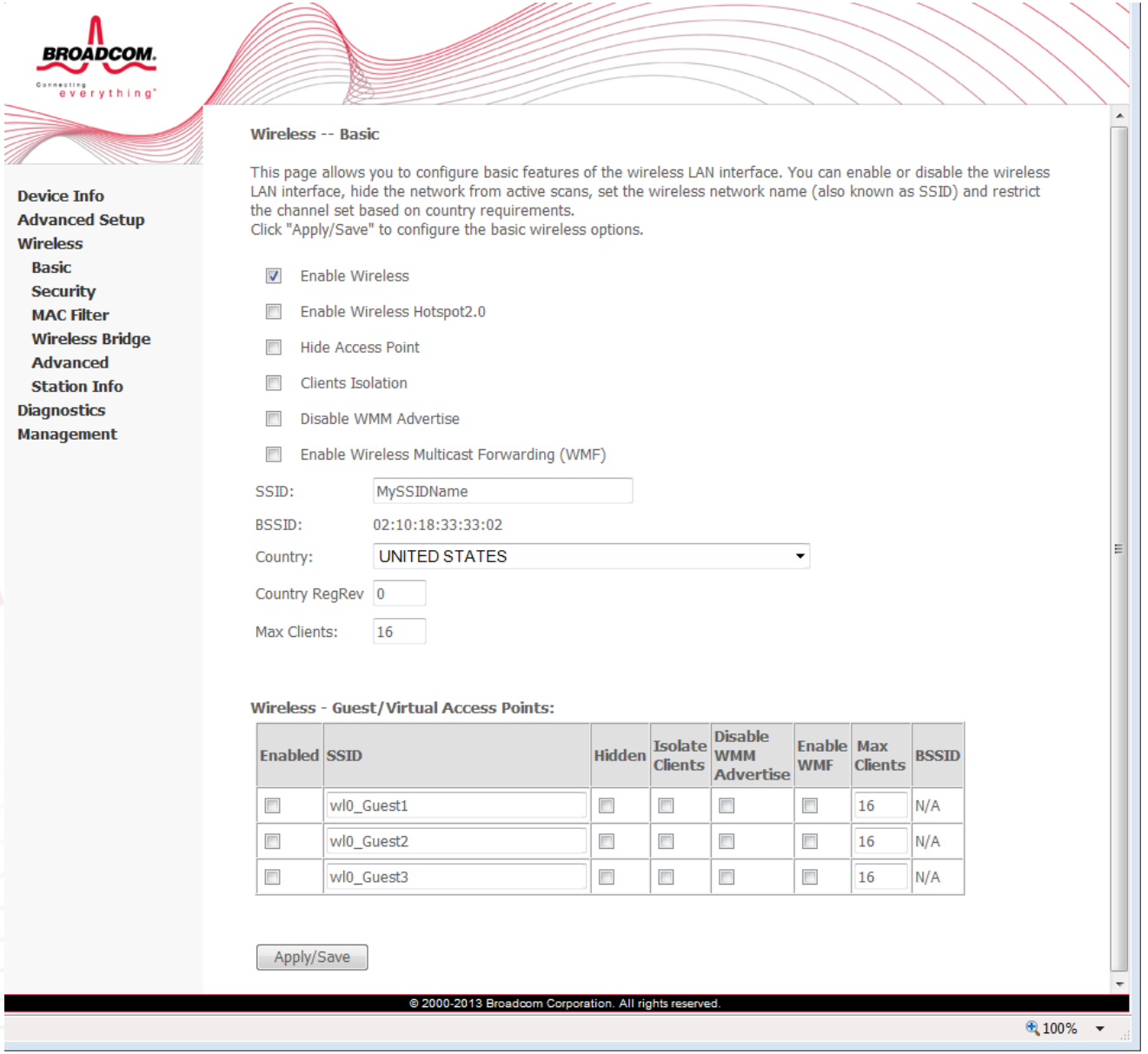
This will randomize the PLC network security key

- **If console access is unavailable, use “WireConf” to randomize the PLC key**
  - See Appendix B

CONFIGURE THE GATEWAY WI-FI SSID

- **Configure the Gateway's Wi-Fi SSID**
  - Use a web browser to reach 192.168.1.1
  - Go to Wireless->Basic
  - Choose an original SSID
    - (In this case "MySSIDName")
  - Click the "Apply/Save" button

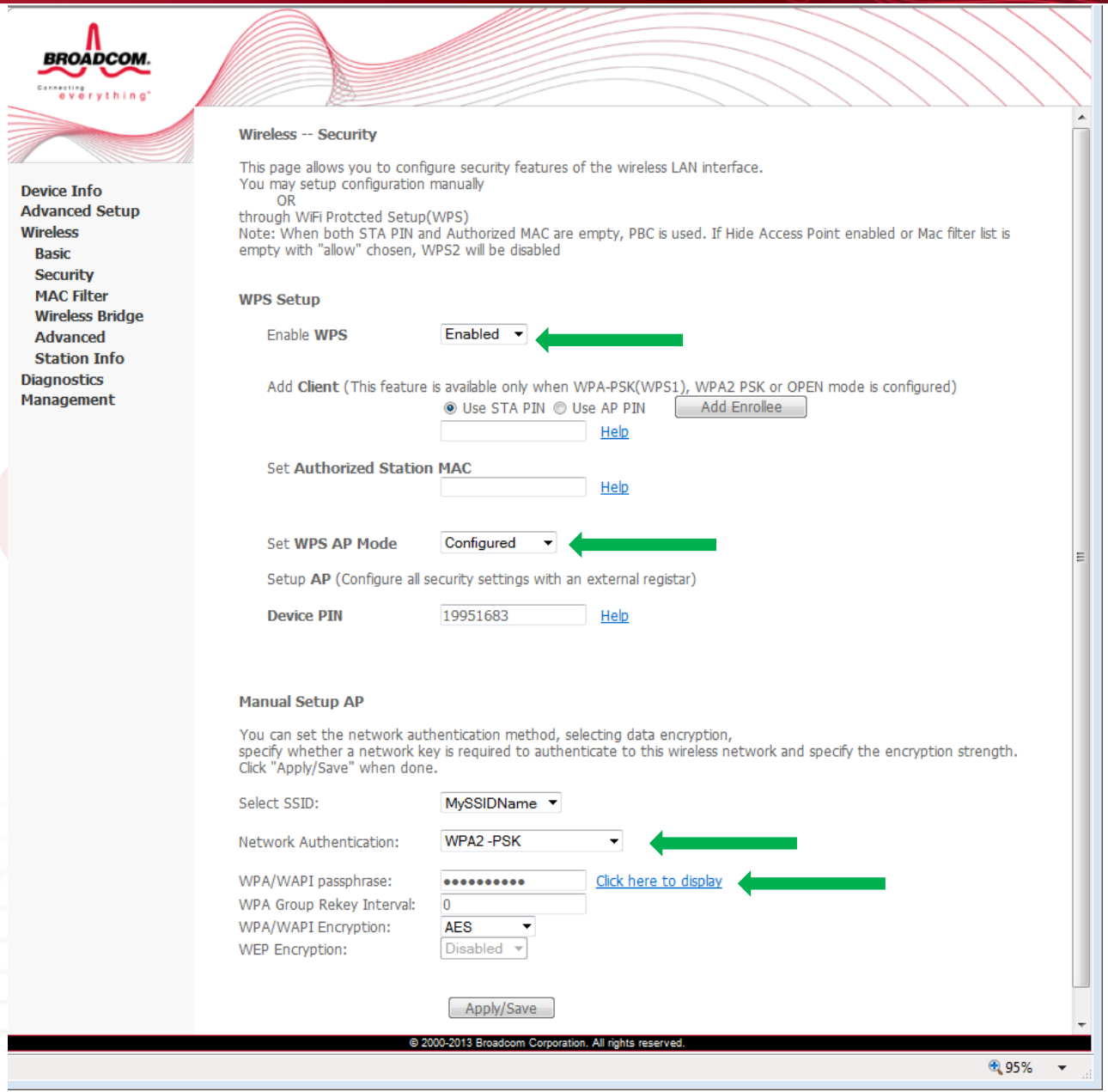
- **There will be a few seconds of delay while the Wi-Fi module sets the new parameters**



CONFIGURE THE GATEWAY WIFI SECURITY

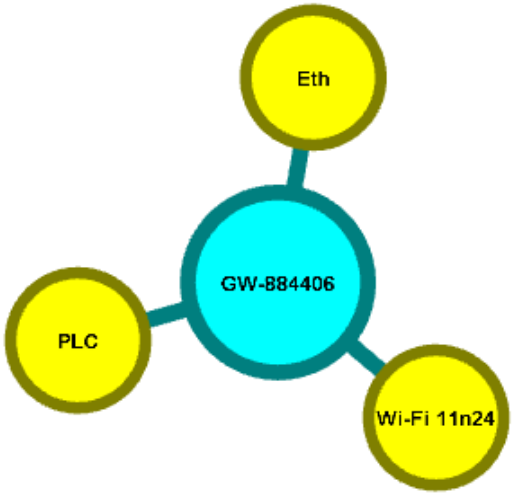
- **Configure the Gateway's Security**
  - Use a web browser to reach 192.168.1.1
  - Go to Wireless->Security
  - Set WPS to "Enabled"
  - Make sure WPS AP Mode is "Configured".
  - Set Network Authentication to WPA2-PSK
  - Select a passphrase
  - Click the "Apply/Save" button

- **There will be a few seconds of delay while the Wi-Fi module sets the new parameters**



VERIFY NETWORK TOPOLOGY

- **Browse the webpage of Gateway (192.168.1.1)**
  - Use the left pane to navigate:
    - Advanced Setup->nVoy(1905.1)->Topology
  - Blue nodes – 1905.1 supporting devices
    - GW indicates a Gateway
    - WRE indicates a Wireless Range Extender
    - ###### - the last 6 hexadecimal digits of the 1905.1 AL MAC address
  - Yellow nodes – 1905.1 interfaces
    - Eth – Ethernet
    - PLC – Power Line Communication
    - Wi-Fi 11n24 – Wi-Fi 802.11n 2.4G
    - Wi-Fi 11n5 – Wi-Fi 802.11n 5G
  - Blue lines
    - Indicates that the interface belongs to the device



CONFIGURING THE WIRELESS RANGE EXTENDER

- **Plug-in the WRE to a power source**
- **Press the “Restore Factory Defaults” (lower push button)**
  - For the purpose of this demo, we should ensure the WRE starts with a well known configuration
- **Un-Plug the WRE**
  - The demo is ready to be started

CONDITIONS PRIOR TO SECURED DEVICE PAIRING

- **Observe the Network Toplogy in the Gateway**
  - The WRE should ***not yet*** appear in the graph
  - If the WRE is appearing, execute the steps “Configuring the WRE” from the previous slides
- **Add a WRE (Wireless Range Extender)**
  - Attach WRE to power supply
  - Wait for WRE to boot up (approximately 30 seconds)
- **Observe the Network Topology**
  - The WRE should ***not yet*** appear in the Network Topology diagram because it does not share the same PLC security key with the Gateway
  - The key should have been randomized in the slide “Configure the Gateway PLC security”

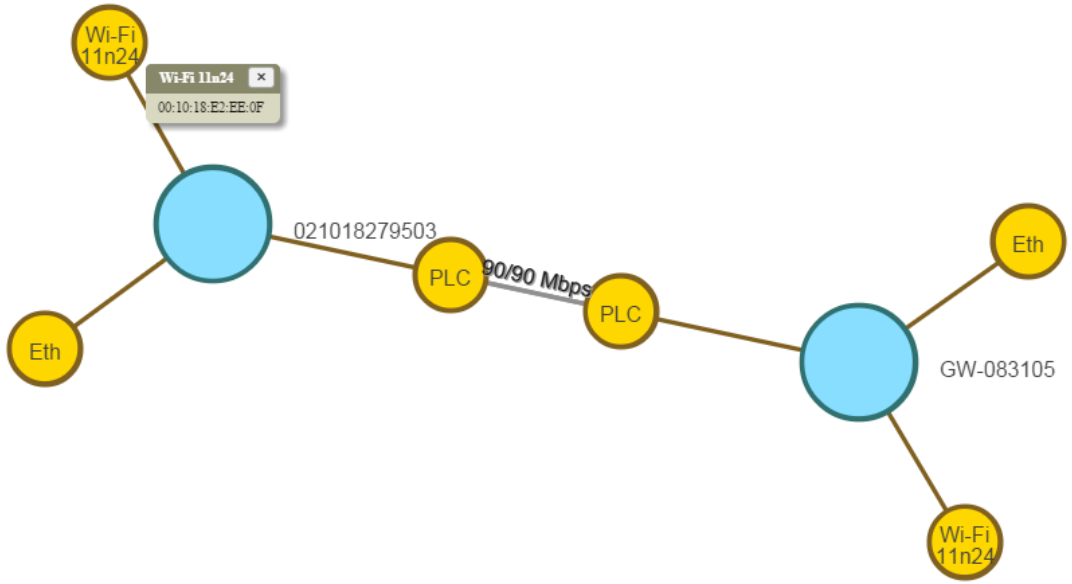
IEEE1905.1 SECURITY PUSH BUTTON

- **Synchronize the PLC Keys between the Gateway and the WRE**
  - Press 1905 Security Push Button on Gateway
  - Press 1905 Security Push Button on WRE

- **The PLC keys will synchronize and the Network Topology diagram should update**

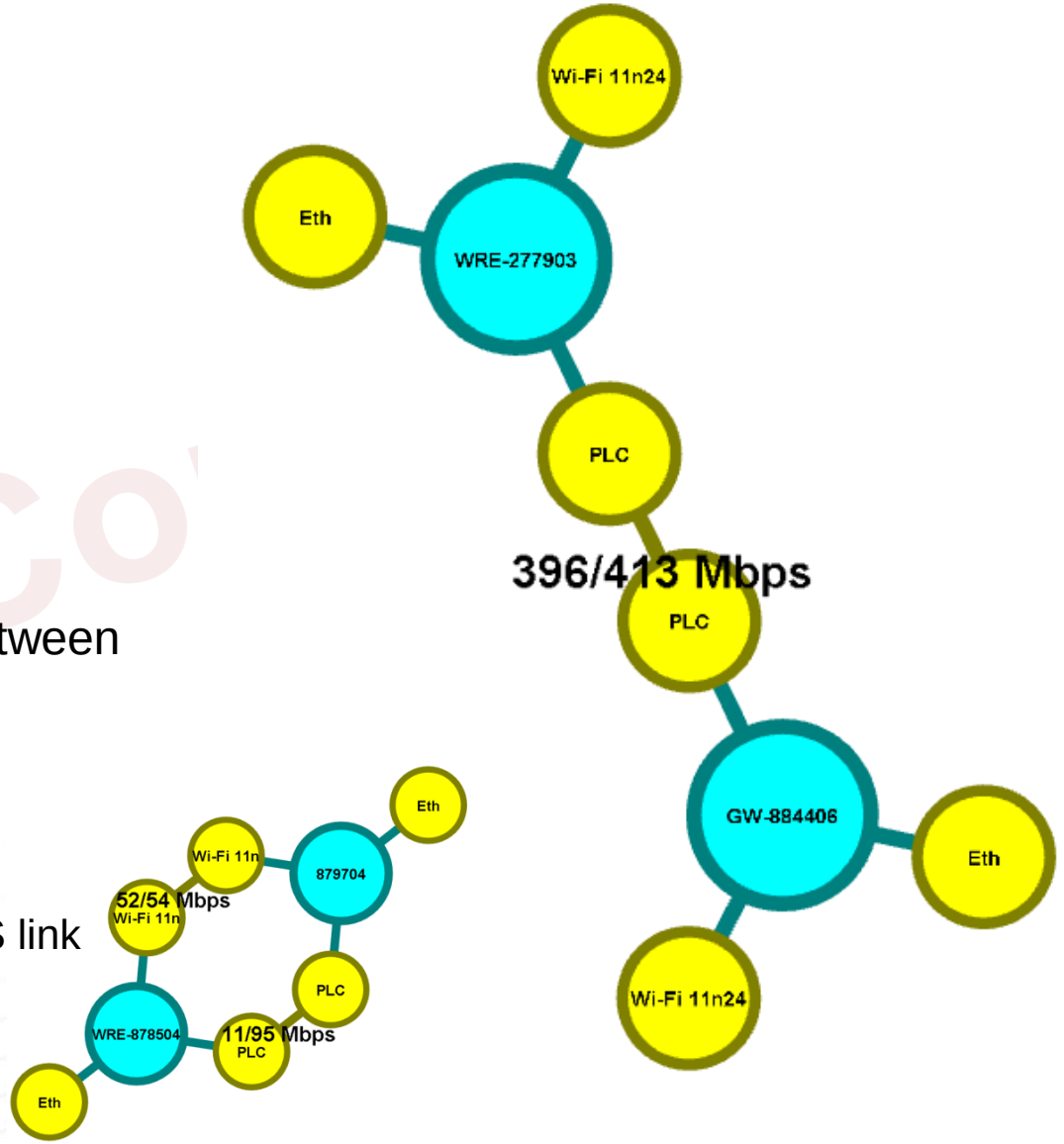
If the Diagram does not update after a few seconds, the WRE has failed to connect.

Make sure you did not skip any step in the previous slides



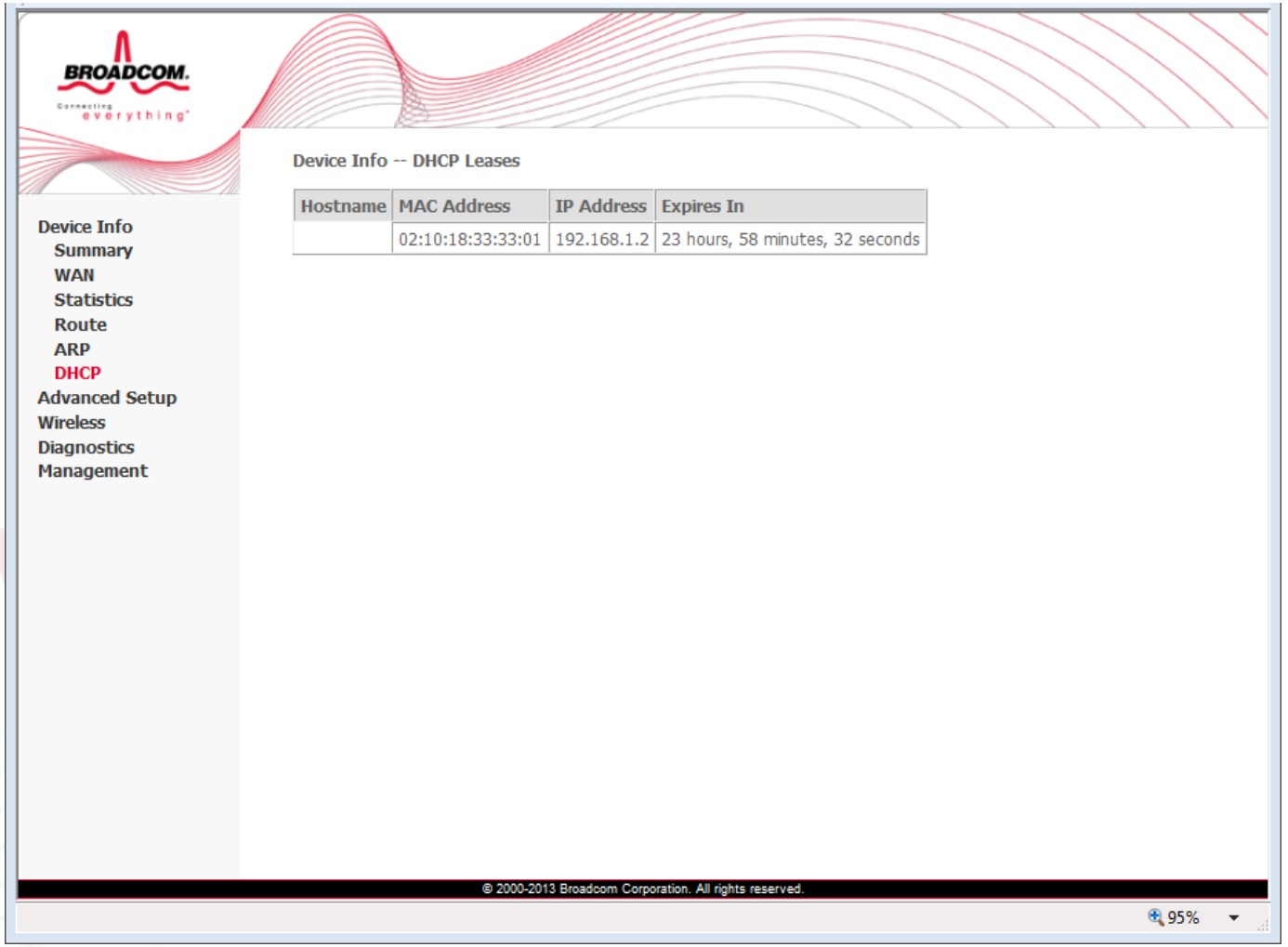
IEEE1905.1 TOPOLOGY DISCOVERY

- **The Network Topology Diagram**
  - Advanced Setup->nVoy(1905.1)->Topology
  - WRE appears
    - It has three interfaces, Eth, Wi-Fi and PLC
  - PLC-PLC link appears
    - The two nodes are joined by a yellow line
    - The yellow line indicates 1905 communication between nodes
  - Wi-Fi – Wi-Fi link may also appear
    - If you have experimental AHN compiled in your images
    - This link is created by automatically establishing a WDS link



DETERMINING THE IP ADDRESS OF THE WRE

- **Use a web browser to access Gateway**
  - http://192.168.1.1
- **Go to “Device Info” -> “DHCP”**
  - In this example, the WRE has been assigned the IP Address “192.168.1.2”



IEEE1905.1 AP-AUTOCONFIGURATION

- **Confirm that AP Autoconfiguration has worked**
  - The setting programmed into the Gateway (192.168.1.1) should have already been configured in the WRE (192.168.1.2)
- **Take your web browser to http://192.168.1.2**
- **Check Wireless->Basic**
  - Confirm the SSID matches “mySSIDName”
- **Check Wireless->Security**
  - WPS AP Mode is “Configured”
  - Network Authentication is “WPA2-PSK”
  - Verify the password if you chose to change it

Warning: the time delay between configuring the Gateway and seeing the settings appear on the WRE can be up to 20 seconds.

It is possible, therefore, to see the default settings on 192.168.1.2 for several seconds before AP Autoconfiguration goes through.

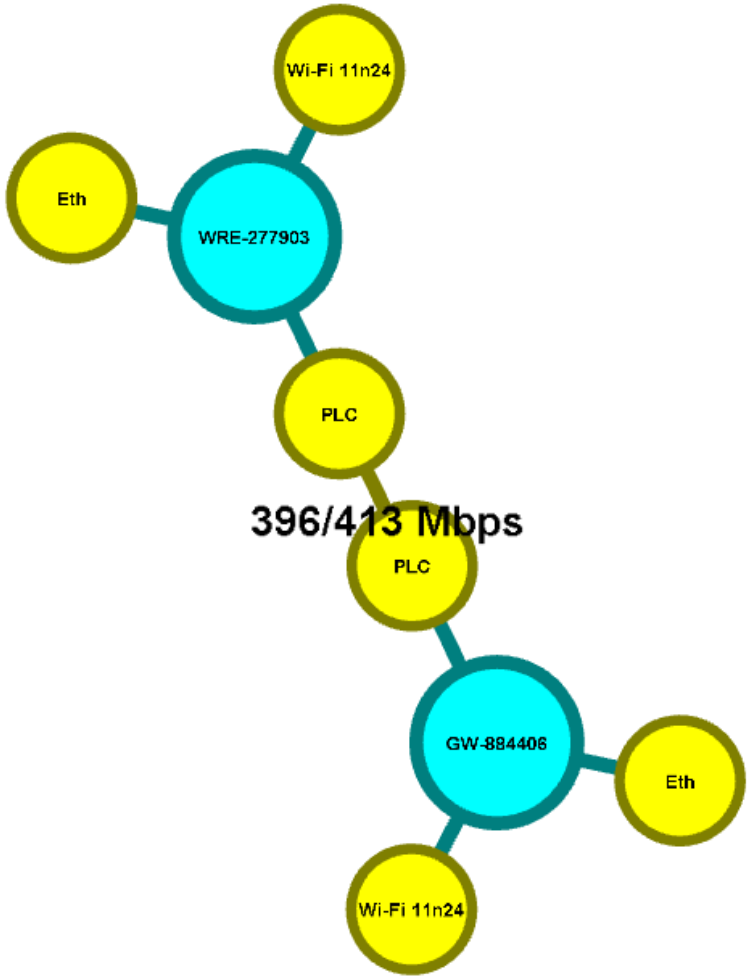
IEEE1905.1 AP AUTO-CONFIGURATION CHANGE

- **Changes made to the Gateway Wi-Fi security configuration are automatically reflected on the WRE**
- **Take your web browser to the gateway IP http://192.168.1.1**
- **Select Wireless->Basic**
  - Change the SSID from “mySSIDName” to “newSSIDName”
- **This will cause the Gateway to notify the WRE of a change**
- **Take your web browser to the WRE IP http://192.168.1.2**
- **Select Wireless->Basic**
  - Verify that the WRE SSID has changed to “newSSIDName”

IEEE1905.1 LINK METRICS

- **In the Network Topology Diagram**
  - A link metric value should appear and be updated once per second

- **Interpreting the value “396/413 Mbps”**
  - 413 Mbps - The total theoretical throughput for the link
  - 396 Mbps – the remaining bandwidth available
    - (implying that 17 Mbps is currently in use)



IEEE1905.1 LINK METRICS WITH IPERF TRAFFIC

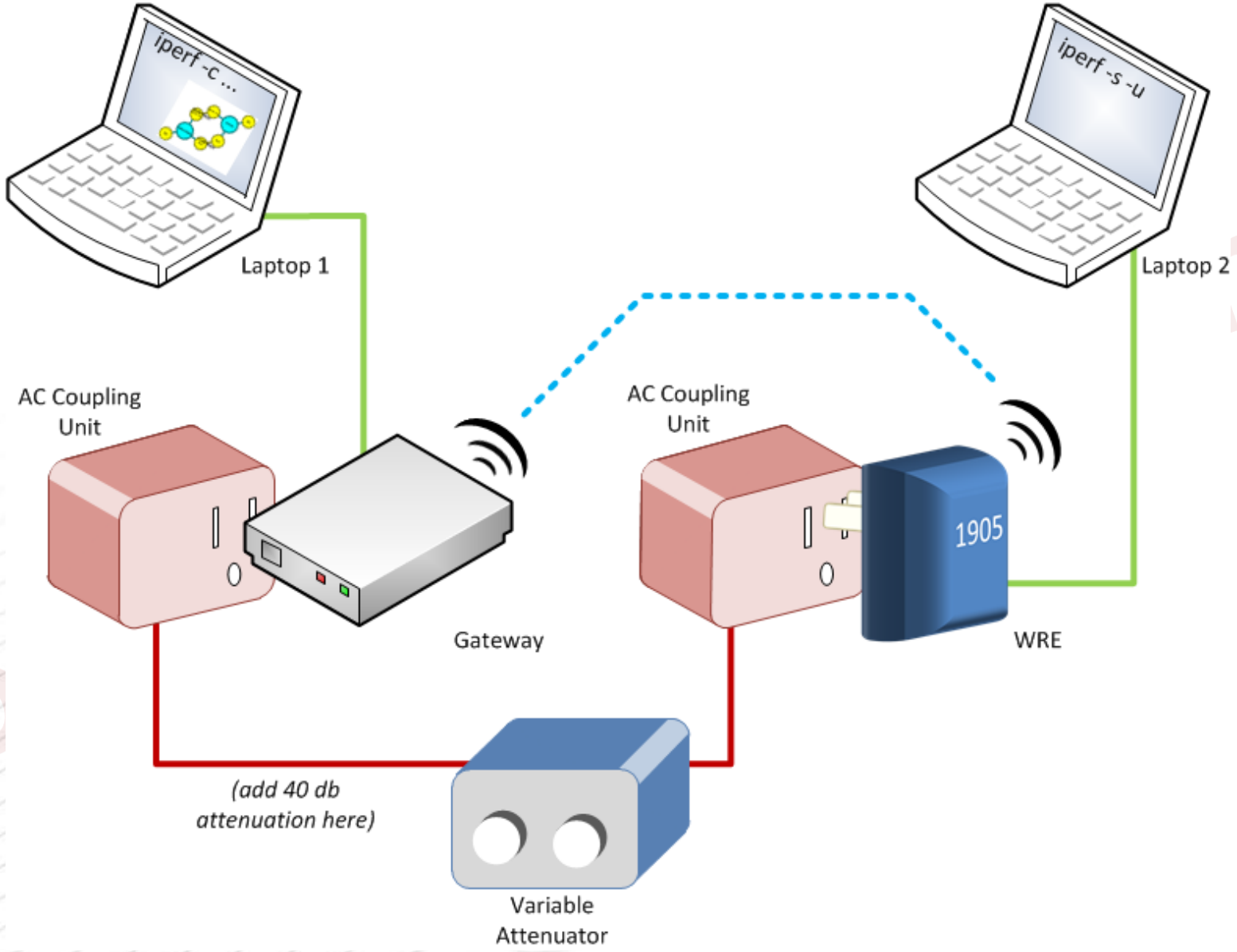
- **Run "`iperf -s`" on Laptop 1**
- **Run "`iperf -c a.b.c.d -t 20000 -i 1`" on Laptop 2**
  - *a.b.c.d* is the ip address of Laptop 1
  - Notice that iperf is passing traffic properly, and iperf statistics are being updated.
  - Notice that the Network Topology display on Laptop 1 is being updated with the correct traffic numbers

ADAPTIVE HOME NETWORKING DEMO

ADAPTIVE HOME NETWORKING DEMO DEFINITION

- **Adaptive Home Networking Demos include the AHN features**
  - Best Link Selection, Link Aggregation, Failover
- **Not all Broadcom Reference Designs currently support AHN**
  - See the “Reference design feature availability” slide for a detailed list
- **There are restrictions on the network configuration**
  - See the following slides that list the possible configurations
  - Configurations that are not listed are not supported
  - AHN automatically disables itself when in unsupported configurations
- **For best results**
  - Use recent software for all devices
  - Use the same software release for all devices
  - Only use the network configurations listed

AHN DEMO LAYOUT



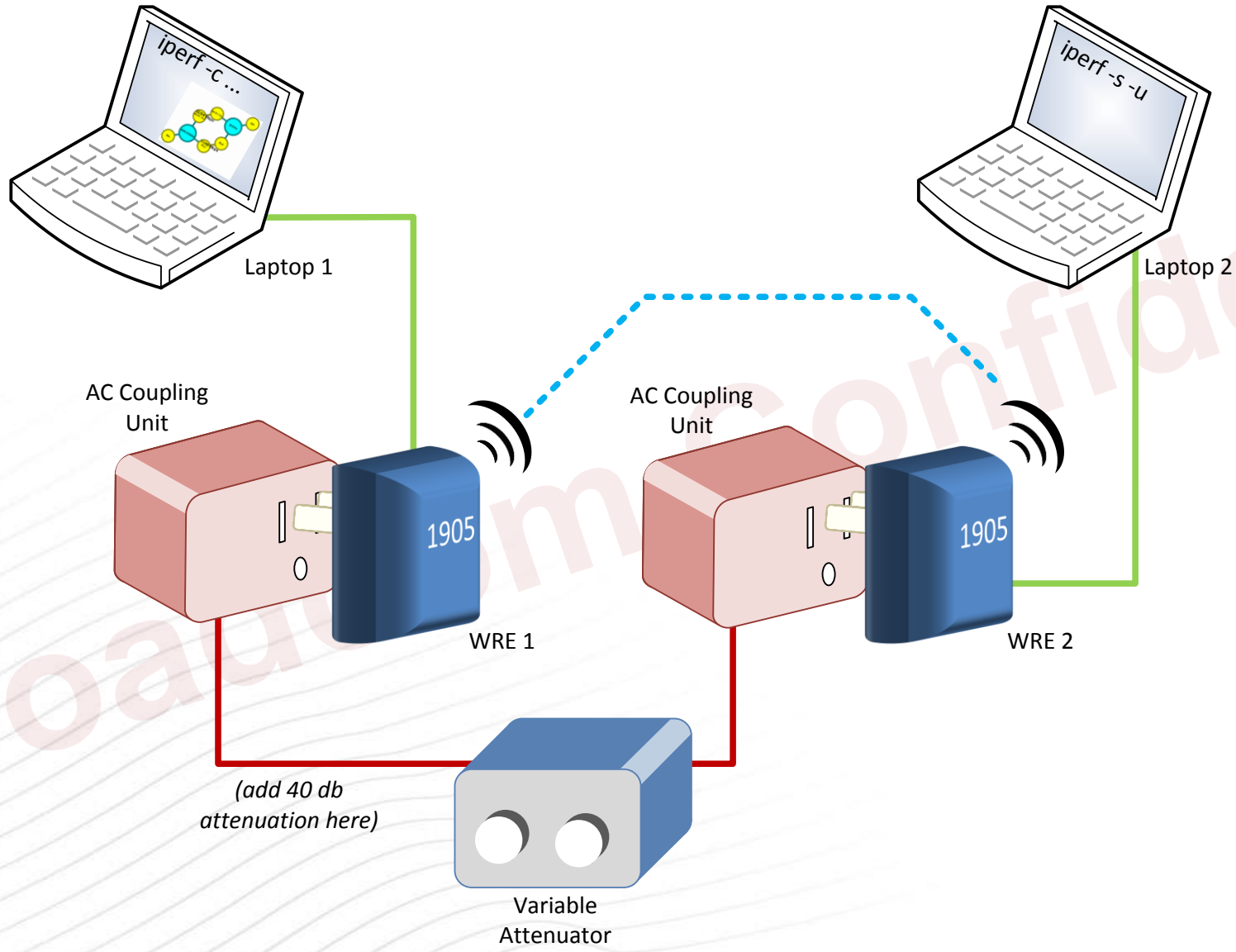
AHN DEMO EQUIPMENT LIST

- **Laptop 1 & Laptop 2**
  - Same as in the IEEE1905.1 demo
- **BCM96168MP Gateway with IEEE1905.1 enabled**
  - Configured after completing IEEE1905.1 Demo
- **BCM960500WIFI or BCM96319PLC (WRE)**
  - Configured after completing IEEE1905.1 Demo
- **Two AC coupling units**
- **One Variable Attenuator**
  - These allow controlling the PHY rate on the PLC interface
- **Additional attenuators**
  - As needed

AHN ALTERNATE CONFIGURATION

- **The AHN demo instructions are written assuming a 1905 capable Gateway is used**
- **If you don’t have an AHN capable Gateway but you have 2 WREs**
  - You can use 2 WREs to perform the AHN demo
  - You have to follow the same instructions as in the IEEE1905.1 demo instructions
- **Such alternate configuration is intended for demo purposes**
  - Not intended as a product
- **The WRE1 must be seen as the Gateway in the rest of the instructions**

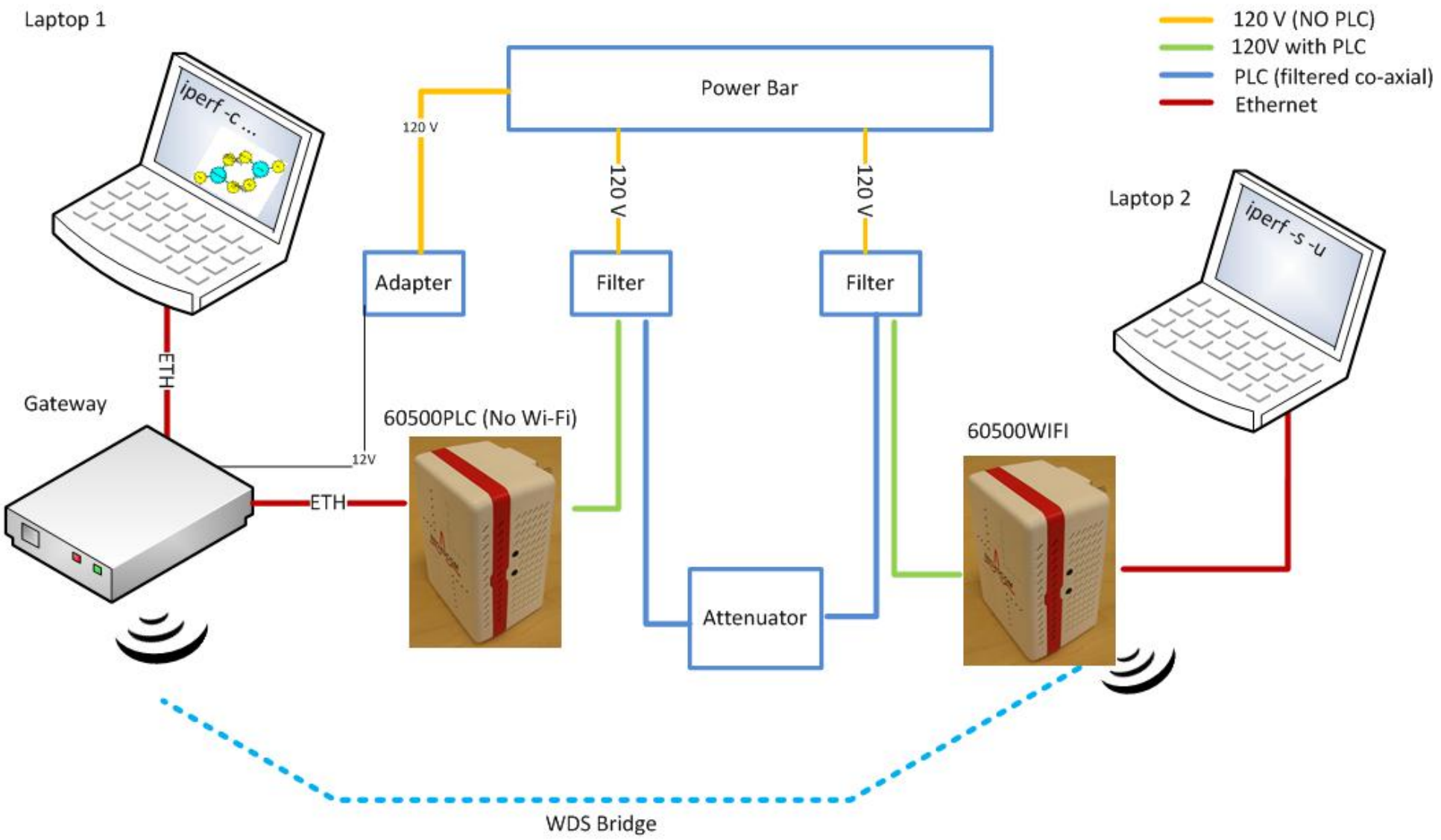
AHN ALTERNATE CONFIGURATION LAYOUT



AHN THIRD ALTERNATE CONFIGURATION

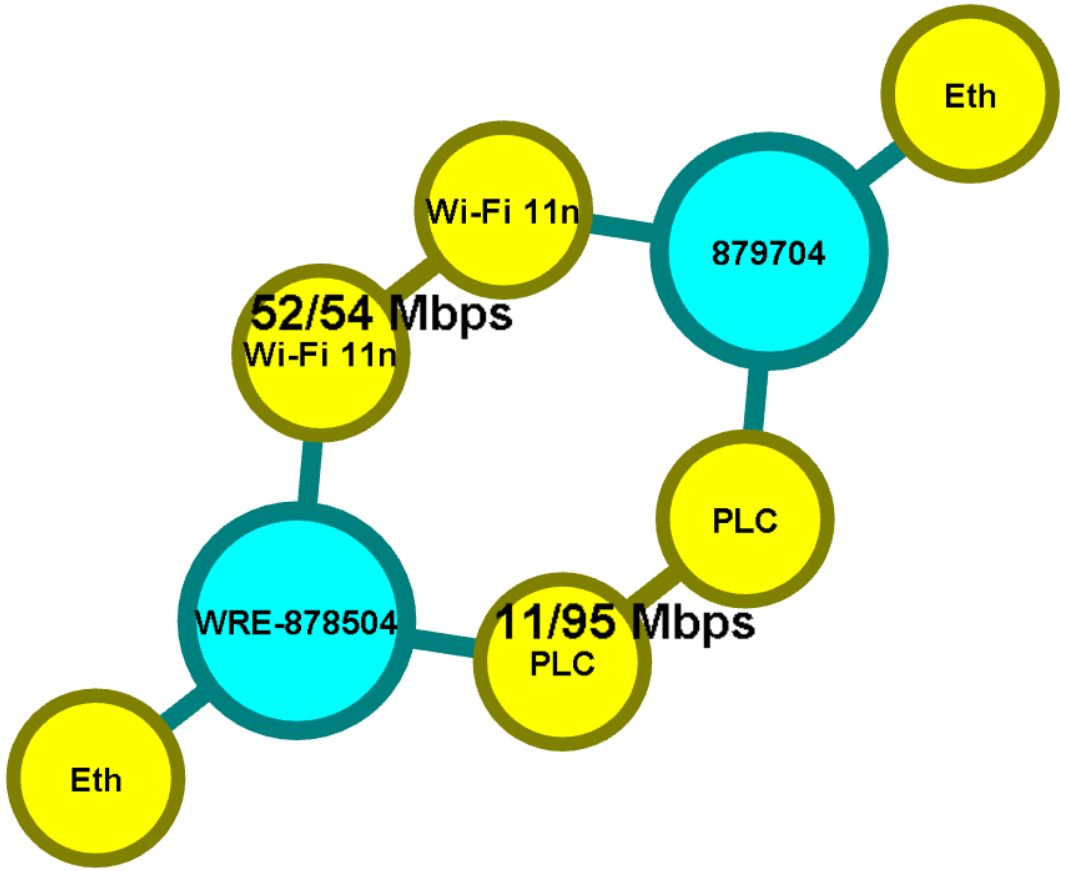
- **The Gateway and its local PLC devices may not be integrated**
  - The PLC device is external
  - Everything else is the same
- **Requires special software image and configuration of the Gateway**
  - Not currently supported in our software release
- **The rest of this demo is otherwise exactly the same**

AHN THIRD ALTERNATE CONFIGURATION LAYOUT



AHN DEMO SETUP

- **AHN Demo starts where the IEEE1905.1 demo ends**
  - Please follow the steps of the IEEE1905.1 demo first
- **In the Network Topology Display, you should get a graph similar to this:**



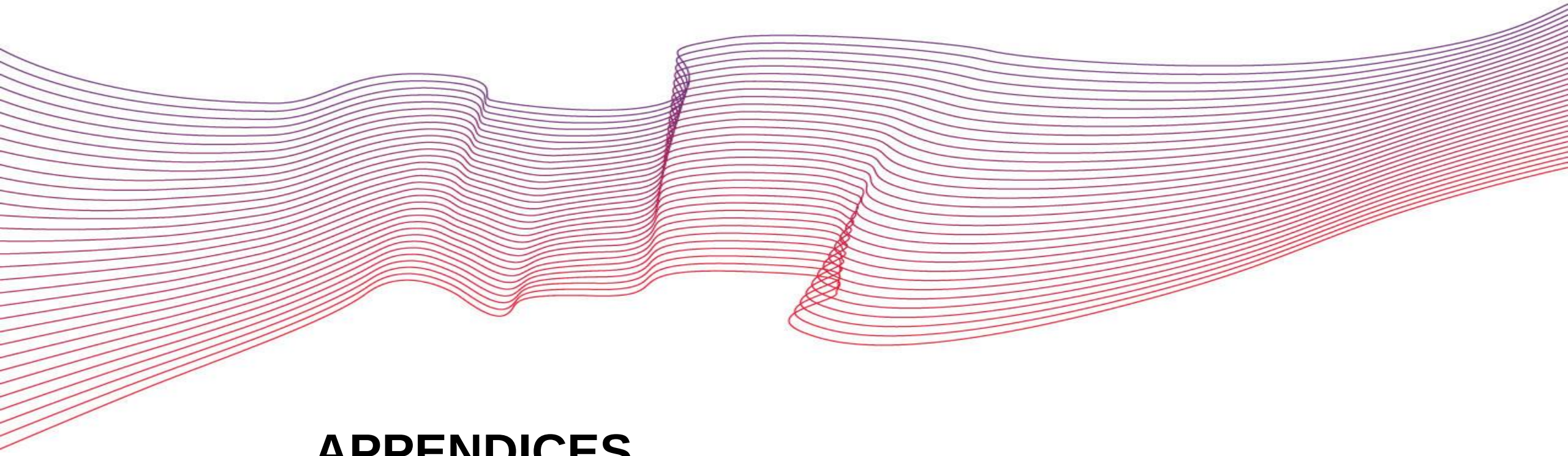
AHN DEMO SETUP

- **Run "`iperf -s -u`" on Laptop 2**
  - *Important – this must be on Laptop 2 otherwise wireless statistics could be displayed incorrectly.*
  - *Also note the -u which was not present in Demo 1*
  - *I also helps to run ipconfig to determine the ip address of the laptop for next step*

AHN DEMO WALKTHROUGH

- **Set attenuation on powerlines between the Gateway and the WRE such that the Network Topology diagram shows much lower bandwidth for PLC than for wireless.**
- **Run "`iperf -c a.b.c.d -t 20000 -i 1 -u -b 10m`" on Laptop 1**
  - *a.b.c.d* is the ip address of Laptop 2
  - *10m* is less than half the available bandwidth on the wireless connection – do not forget the m
  - Notice on the Network Topology diagram that traffic is passing traffic through wireless
- **Decrease attenuation on powerlines**
  - Notice that flows do not migrate to PLC at this point
- **Run "`iperf -c a.b.c.d -t 20000 -i 1 -u –b 10m`" on Laptop 2 in second console window**
  - Notice that new flow is added to PLC.
- **Increase attenuation to max again – note: do this slowly otherwise the link will go down, and full failover code will take effect.**
  - Notice that flows migrate from PLC to wireless when PLC can no longer support the flows.

(note: stop iperf sessions before rerunning demo)



APPENDICES

APPENDIX A: CONSOLE LOGIN

- **Most console commands will be run from the shell**
- **Login to the shell using a console program over the serial connector**
  - Login: admin
  - Password: admin
  - > sh
  - #
- **The commands in this demo will be entered from the "#" shell prompt**

- **Alternatively: log in via telnet session**
  - The IP address of the device must be known
  - telnet 192.168.1.1
  - Login and password are as above

APPENDIX B: WIRECONF

- **WireConf is a Broadcom proprietary utility used for configuring the PLC firmware**
- **Our only use for it in this document is the randomizing of PLC security keys**
  - On bootup, a default PLC key is used, which allows devices with PLC interfaces to link up. We want to simulate, in our demo, a release of software in which devices boot up with different, randomized keys.
- **Run the WireConf application on a PC/laptop**
  - Connect the PC/laptop to the device whose PLC key is to be randomized
  - The device's MAC Address should appear in the left pane of the WireConf utility
  - Select the device (by its MAC Address)
  - Under Configuration, select "Change Network"
  - Select "SIMPLECONNECT" and enter a PLC key (minimum 8 characters)
  - The device being randomized will reset

APPENDIX C: PITFALLS, AND THINGS TO WATCH OUT FOR

- **Traffic not showing up on Network Topology (demo 2)**
  - When passing UDP traffic using iperf (-u option), the flow may not make it to the far side, yet iperf will not notify you that anything is wrong (you will still see outputs ‘Sending 30 Mbps traffic...’). This is likely a firewall error. Check that your windows firewalls are setup properly (instructions to do this are on an earlier slide).
  - A WRE is not aware of how much traffic it is receiving through wireless (it only knows how much it is sending), thus if the iperf server is on the wrong laptop, it may appear as though no traffic is passing even though it is.
  - If you forget to put the m at the end of the iperf bitrate, it will default to kilobytes which will be too low to register in the Network Topology graph

APPENDIX C: PITFALLS, AND THINGS TO WATCH OUT FOR (CONT'D)

- **PLC link goes down when adjusting attenuation**
  - When turning the attenuator dial, the variable attenuator actually disconnects the signal completely for a brief moment. When turning the dial rapidly, these moments can completely block all control signals causing the link to go down
- **Laptops cannot ping each other**
  - we've encountered an error where the GW is able to ping both laptops, both laptops can ping the GW, but the laptops could not ping each other. This seems to be related to a corrupt arp table in one of the laptops. The simplest solution is to change the subdomain that everything is connected to. This involves resetting the ip on the gateway and rebooting it.
- **Demo 2, wireless traffic moves back to PLC**
  - If you have a bad wireless traffic connection and the maximum throughput drops below the transmitted amount, the traffic will failover to PLC as you are increasing the attenuation. Not much can be done about this (you could use a really low traffic rate when sending over wireless).

APPENDIX D: CONFIGURING FIREWALL FOR LAPTOP

- **Configure Laptop firewall for iperf (Windows only)**
  - In windows control panel, network and sharing, locate the port that corresponds to the WRE device. Under the network name there should be a hyperlink to either “Home Network”, “Work Network” or “Public Network”. Click on this and select “Work Network”
  - Go back to Control Panel. Select Windows Firewall
  - Click on “Allow a program or feature through Firewall”
  - Click on “Allow other program” button. Add iperf. Ensure Home/Work checkbox is checked

REFERENCES

- **IEEE Std 1905.1™-2013**
  - IEEE Standard for a Convergent Digital Home Network for Heterogeneous Technologies
  - IEEE Communications Society

- **IEEE1905.1 User Guide**
  - In our Broadcom DSL/PON software release document folder
  - docs/HOWTO/IEEE1905UserGuide.pdf