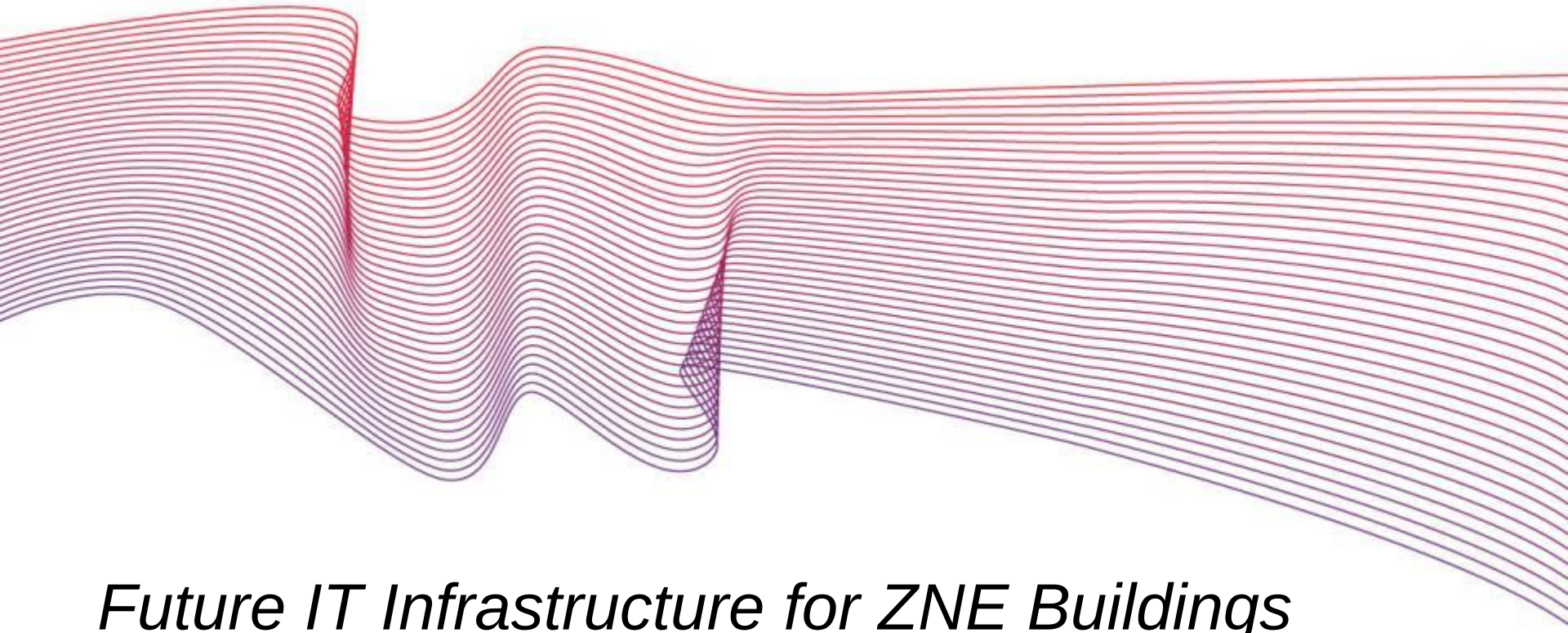

Future IT Infrastructure for ZNE Buildings

A/V In-home Networked Power Save

Stephen Palm

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CAUTIONARY STATEMENT

This presentation may contain forward-looking statements within the meaning of the federal securities laws, including the Private Securities Litigation Reform Act of 1995. These forward-looking statements may include the potential growth of the markets in which we compete and the development status and planned availability of new products. In fact, all statements that we make or incorporate by reference in the presentation, other than statements or characterizations of historical fact, are forward-looking statements. It should be clearly understood that these forward-looking statements, and our assumptions about the factors that influence them, are based on the limited information available to us at this date. Such information is subject to change, and we may not inform you when changes occur. We undertake no obligation to revise or update publicly any forward-looking statement to reflect future events or circumstances.

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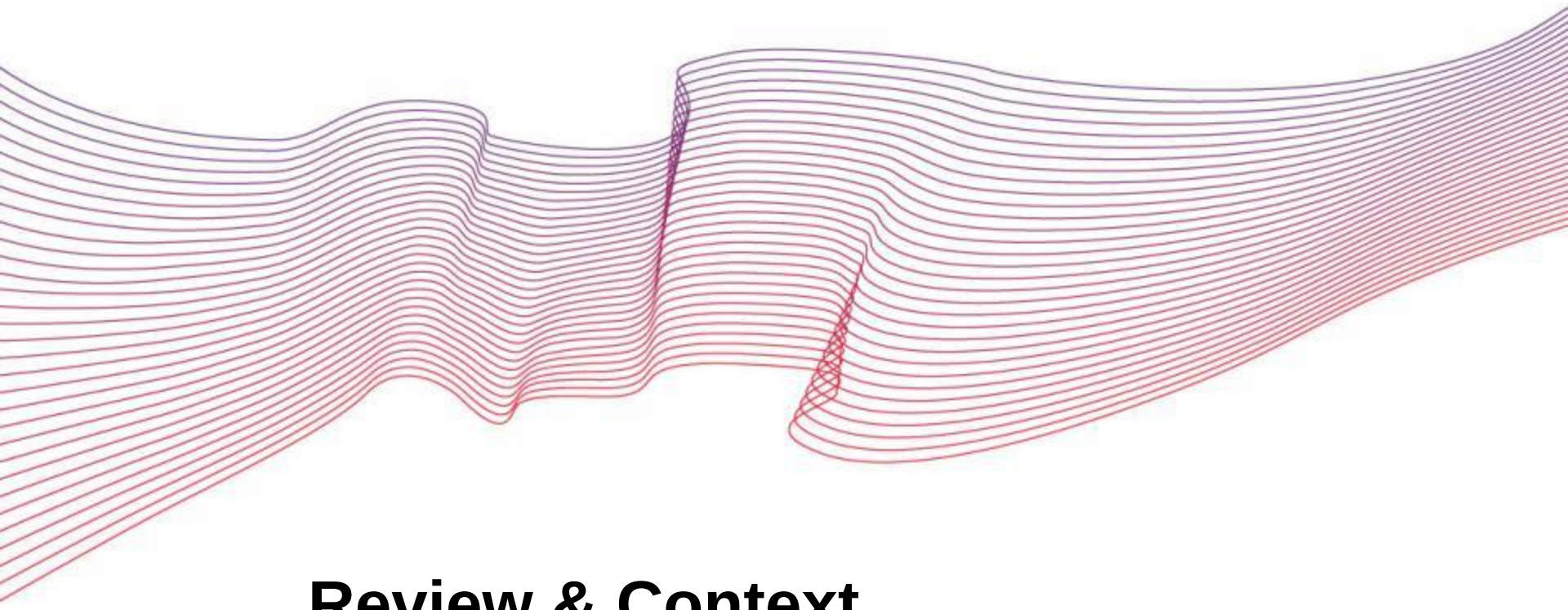
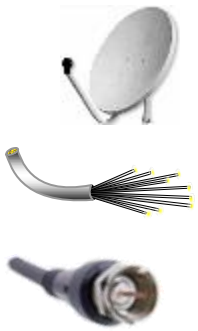
Entertainment/TV Everywhere



Review & Context

Yesterday – Service Providers and Retail

- One STB per TV
- CE devices difficult



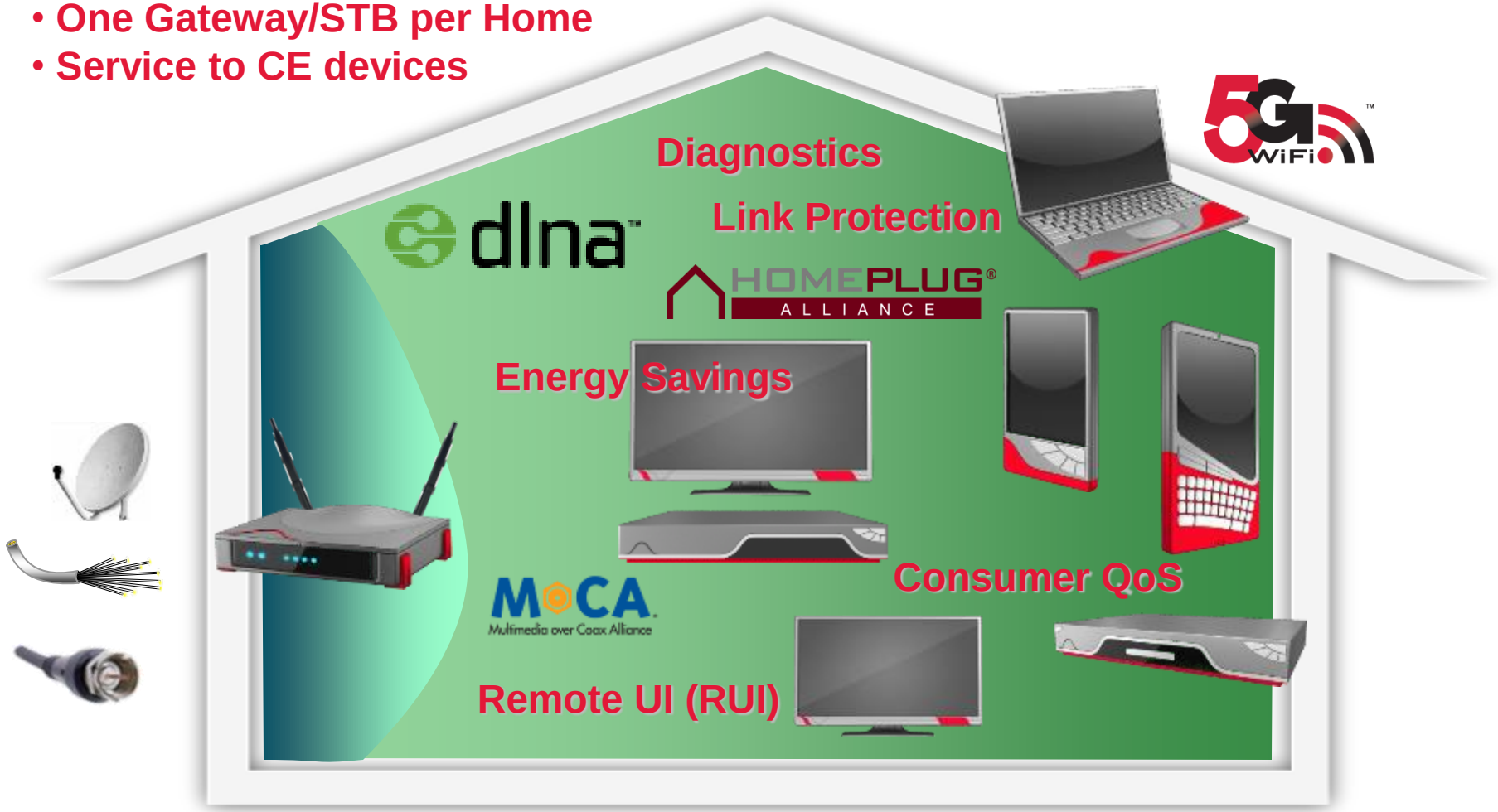
Service Provider Devices

Retail Devices with Content

Retail Devices without Content

Transition: Service Providers - DLNA CVP-2

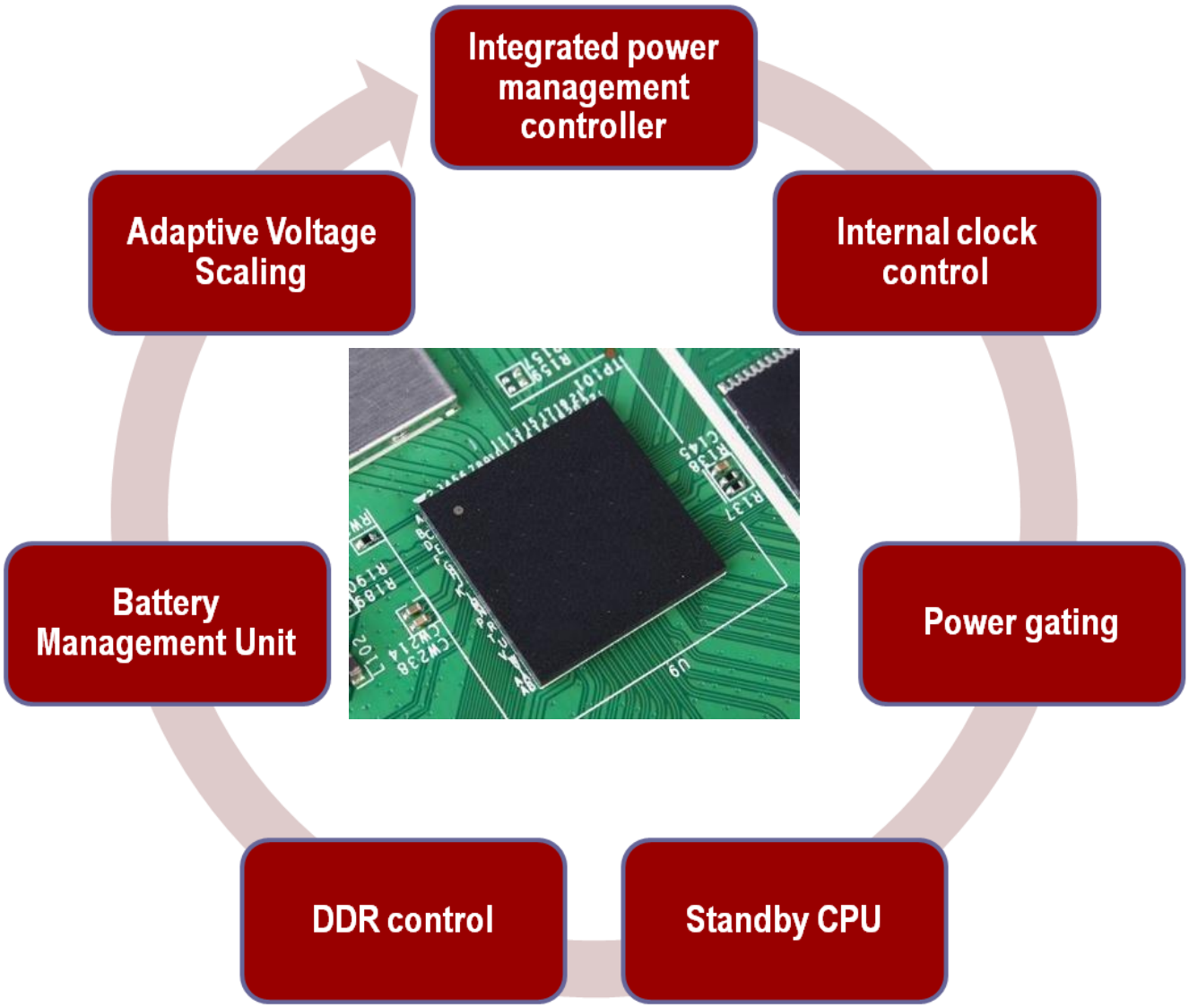
- One Gateway/STB per Home
- Service to CE devices



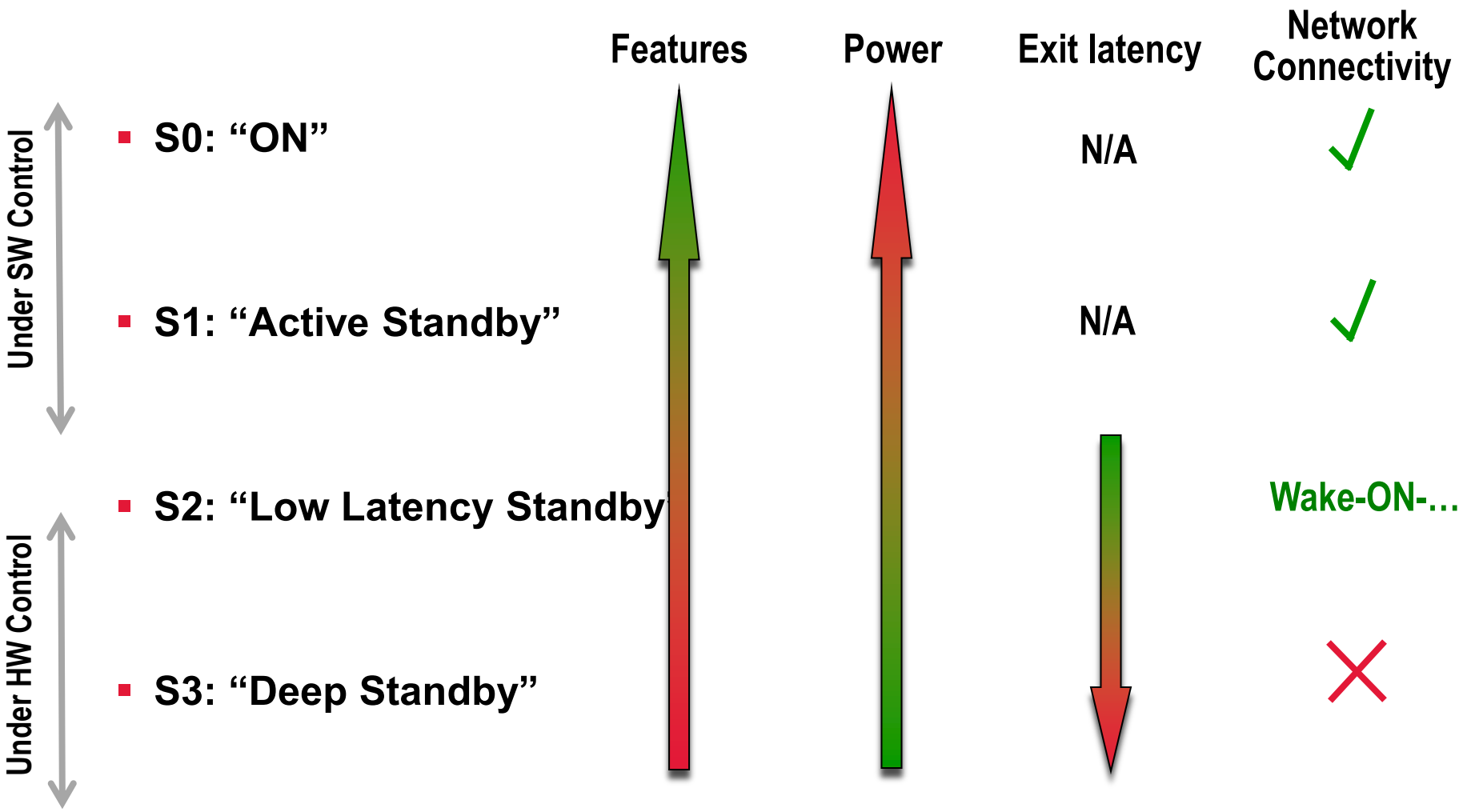
Service Provider Device

Retail Devices Enjoying Content

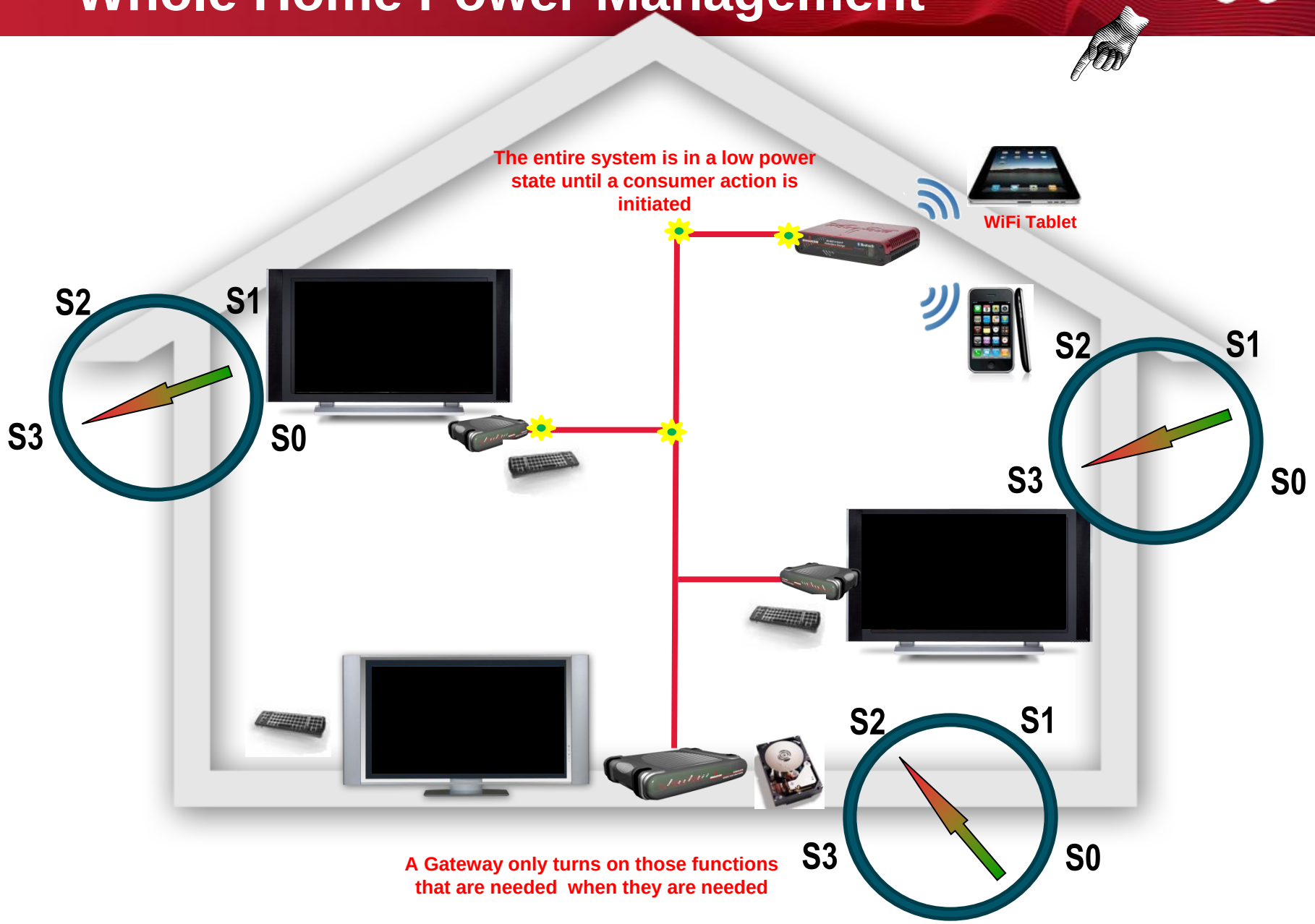
SoC Comprehensive Power Management



IP STB SoC Power States



Whole Home Power Management



Network Challenges / Opportunities

- **Link Connectivity Technology Power states**
  - MoCA 2.0, HomePlug AV2.0
- **Modular Functionality**
  - DLNA/UPnP Low Power Service Subscription
- **Methods of waking up interfaces and functions**
  - DLNA/UPnP Low Power Wake On
- **Discovering device that are “asleep”**
  - DLNA/UPnP Low Power Proxy
- **Power optimizing hybrid links**
  - IEEE 1905.1

Link Connectivity 2.0 Power States

Deployed Home Networking Technologies

- **Energy Efficient Ethernet (EEE) is not really applicable to Home Networking**
  - Most homes do not have Ethernet (CAT-5/6) between rooms
  - Even if present, is not always in convenient location

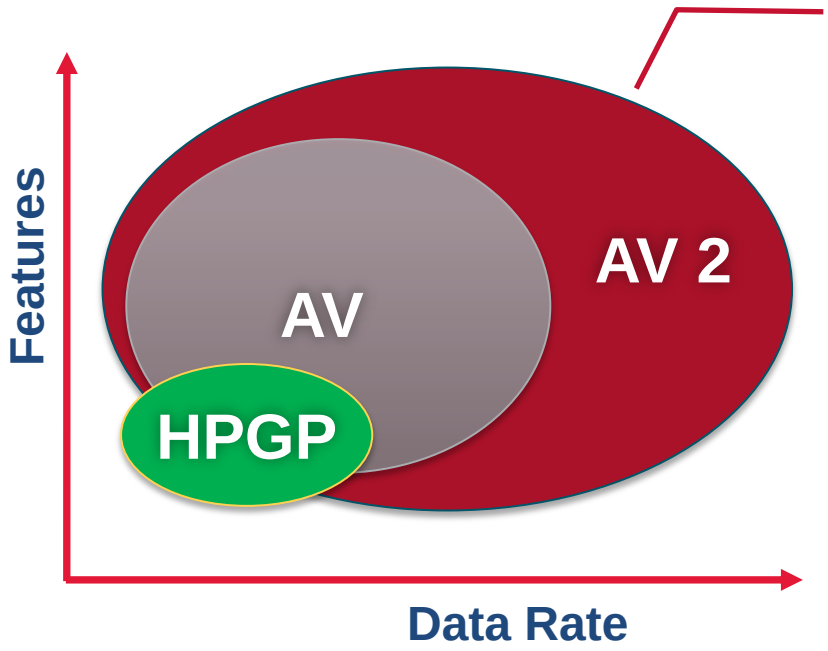
- **So most service providers end up deploying "No New Wires" networking technologies:**
- **HomePlugAV / Green PHY over electrical mains**
- **MoCA over TV/Cable/Satellite coaxial cabling**
- **Wi-Fi – no wires**

MoCA 2.0 Power States

- M0 (Active):
  - Normal Operating Mode: Full Functionality
- M1 (Low Power Idle):
  - Lower power than M0
  - RX Only Mode: Node stays “ranged” on the network, but does not transmit data packets
  - Can be returned to M0 via Wake on MoCA (WoM) packet
- M2 (Standby):
  - Lower power than M1
  - Monitors Beacons every 10ms – 100ms: Minimal active state, but has a relatively fast path for readmission
  - Can be returned to M0 via Wake on MoCA (WoM) packet
- M3 (Sleep):
  - Lower power than M2
  - Issues Heartbeat every 1 – 255 seconds: Inactive state, but Network Controller reserves the Sleeping Node’s place on the network
- A MoCA 1.x node in MoCA network operates in Power State M0 only

HomePlug Family Relationships

- **HomePlug AV2 and HomePlug Green PHY are based on AV**
  - AV2 is AV enhanced
  - Green PHY is AV simplified



- 30-86 MHz additional spectrum
- 2xN MIMO with beamforming (N=2,3 or 4)
- Selection diversity

- High efficiency packet structure
- Power control strategies
- Power save modes

DLNA Energy Management

Network Power Signaling

- **Device Services and Interfaces are modular**
  - The entire set of functional blocks inside a Physical Device will not simply be in "sleep" or "awake". Some may be "awake" while some may be "asleep".
- **Internal power controller makes all decisions about how to manage its resources within a physical device.**
  - An external requesting device cannot really know the details inside of another physical device.
  - Multiple clients will have unique requests
- **Even when power saving, network communication must be maintained.**
  - May have delayed/discard characteristics in some power states.
  - Devices are meaningless without network connectivity
  - Home network connectivity can never really be totally asleep...

DLNA / UPnP Network Power Save

Service Provider Device

Retail Devices Enjoying Content

DLNA / UPnP Network Power Signaling

- **DLNA Low Power / UPnP EnergyManagment Service**
- **http://upnp.org/specs/lp/energymanagement1/**
- **Service Subscription**
  - Allows clients to indicate which resources are needed from a server
  - Server can make informed choices on how to reduce its power while limiting disruption to the clients that depend on it.
- **WakeOnPatterns**
  - “Wake On” does not really have standards.
  - Allows a device to advertise on the network this specifics of signaling (ie, Wake On Patterns) to change its network interface state.
- **Proxied Network Interface Information –**
  - Allows a server device to be immediately discoverable by client devices even if the server devices network interfaces are currently non-active.

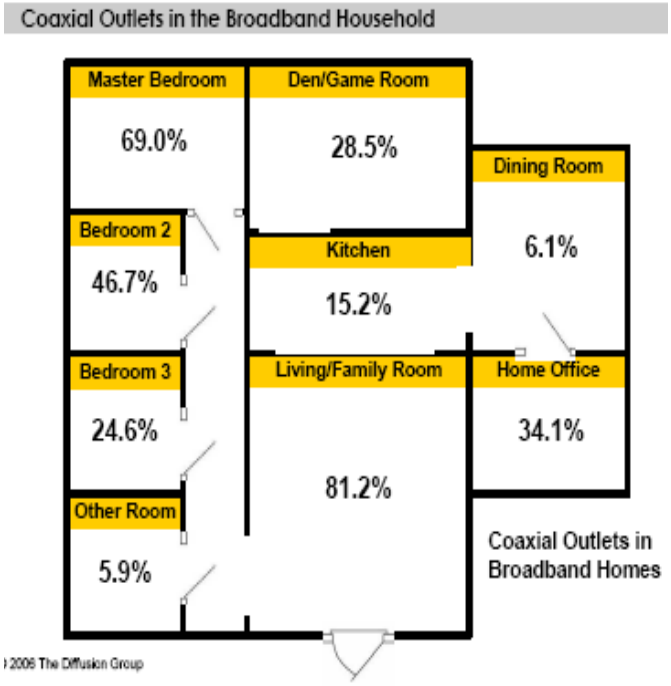
Network Interface Mode of Operation

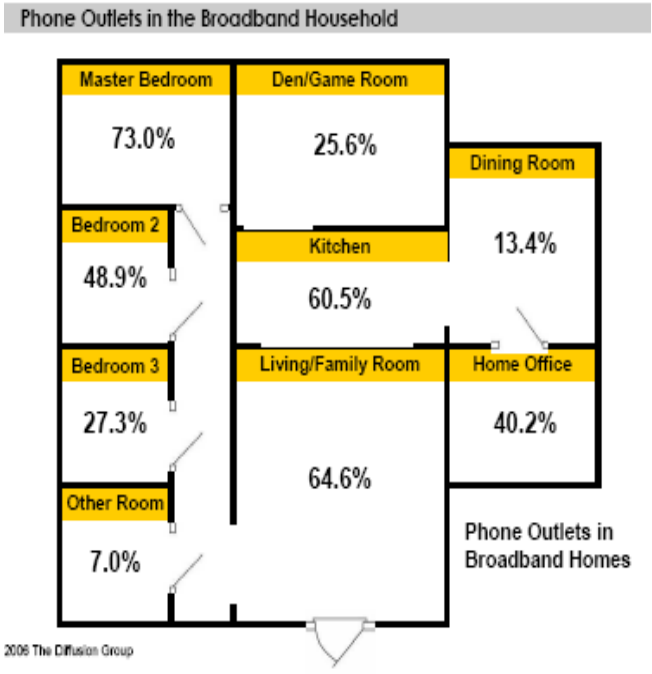
- ***IP-up***: IP interface is fully operational. UPnP services may be available
- ***IP-up-Periodic***: IP interface will be periodically unavailable for durations of 2 second or less when the physical interface is placed in a low power mode of operation
- ***IP-down-no-Wake***: IP interface is down
- ***IP-down-with-WakeOn***: IP interface is down. IP interface can be woken externally
- ***IP-down-with-WakeAuto***: IP interface is down in doze state for duration of more than 2 seconds. IP interface will be woken internally only
- ***IP-down-with-WakeOnAuto***: IP interface is down in doze state for duration of more than 2 seconds. IP interface will be woken internally or can be woken externally

IEEE 1905 Hybrid Networking

No single connectivity technology has 100% Coverage in every region in every home

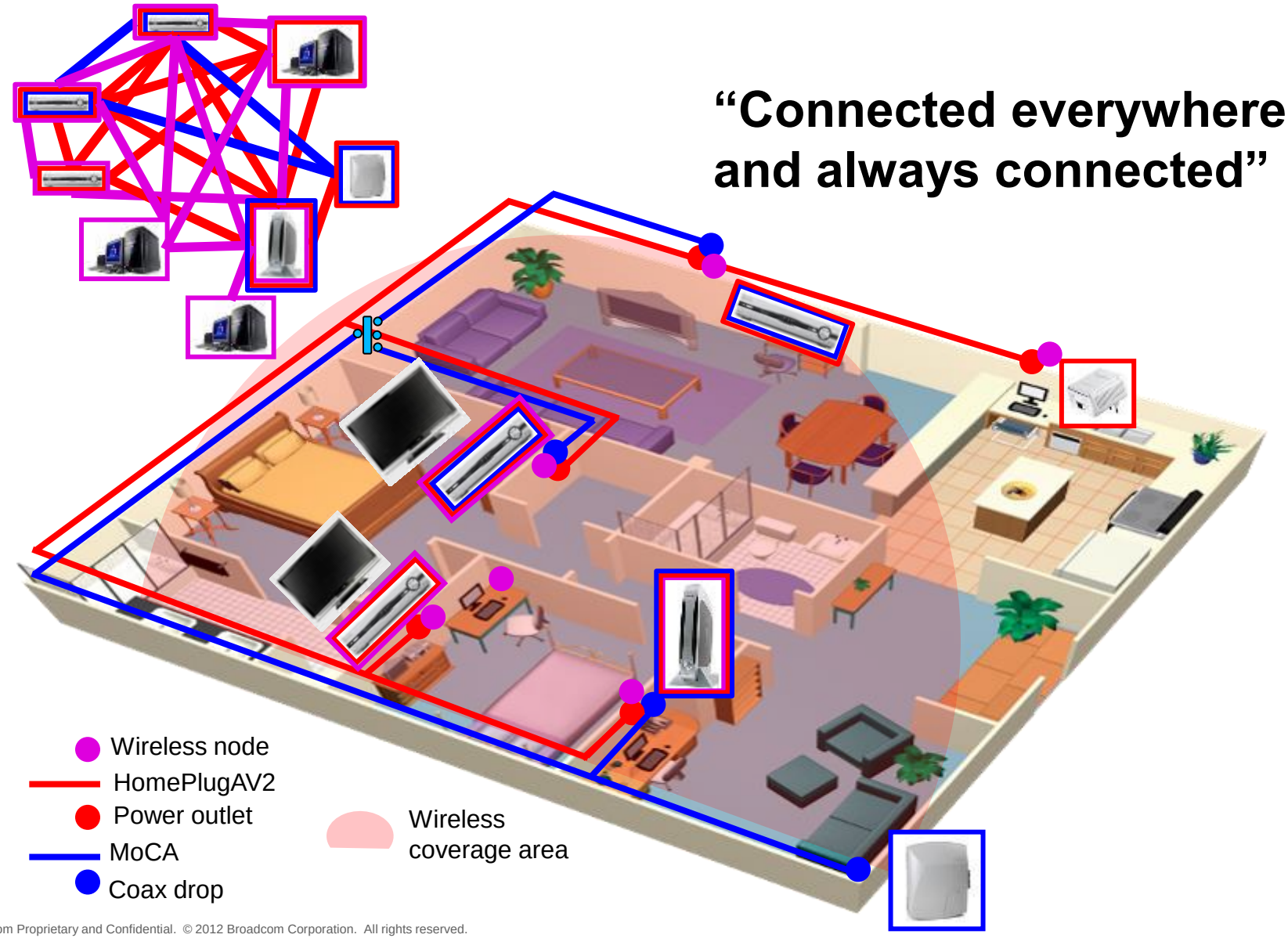
- As of 2008, only 11% of homes have CAT5
- Part of a home may be on the other PLC phase reducing performance
- Wi-Fi coverage is dependent on construction and density





Seamlessly add multiple connectivity technologies and the picture changes

1905 Solution Using MoCA+ HomePlug + Wi-Fi



IEEE 1905.1 Key Features

- Topology Discovery
- Diagnostics
- Enabler for enhanced path selection
- **Enabler for enhanced power management (by optimizing network power usage across different technologies)**
  - Use the most efficient interface
  - Turn off unnecessary interfaces
  - Turn on interfaces when needed

Integration with Internet of Things (IoT)

Summary In-home Network Power Saving

- **Link Connectivity Technology Power states**
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Thank You