Society of Cable Telecommunications Engineers

SCTE CABLE-TEC EXPO '15

OCTOBER 13-16 NEW ORLEANS

Gbps Wi-Fi – Is it Driving a Home Network Topology that Requires an Access Point in Every Room?

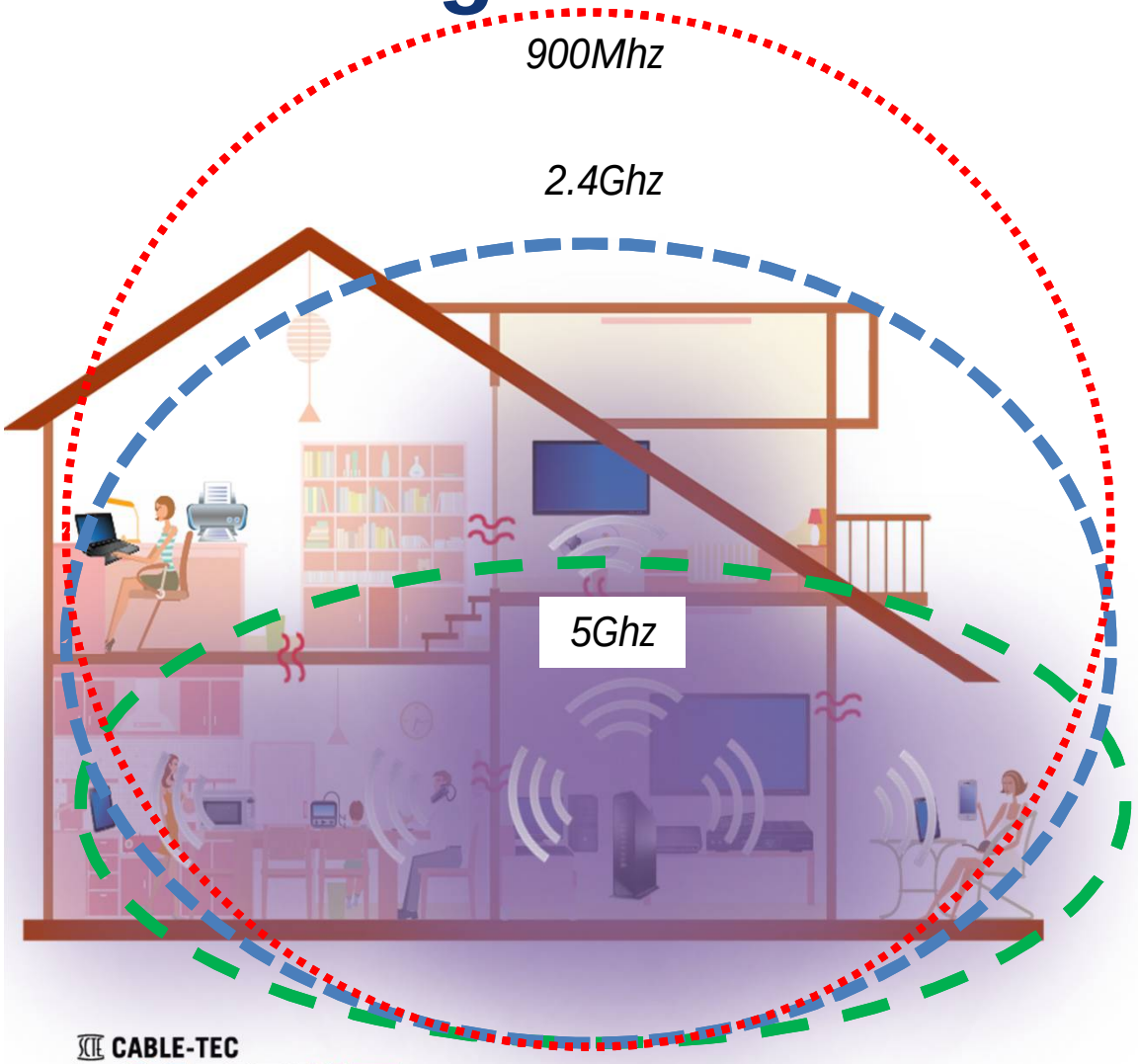
Charles Cheevers

Chief Technology Office, Customer Premises Solutions

ARRIS

Tweet about today's session #scteExpo

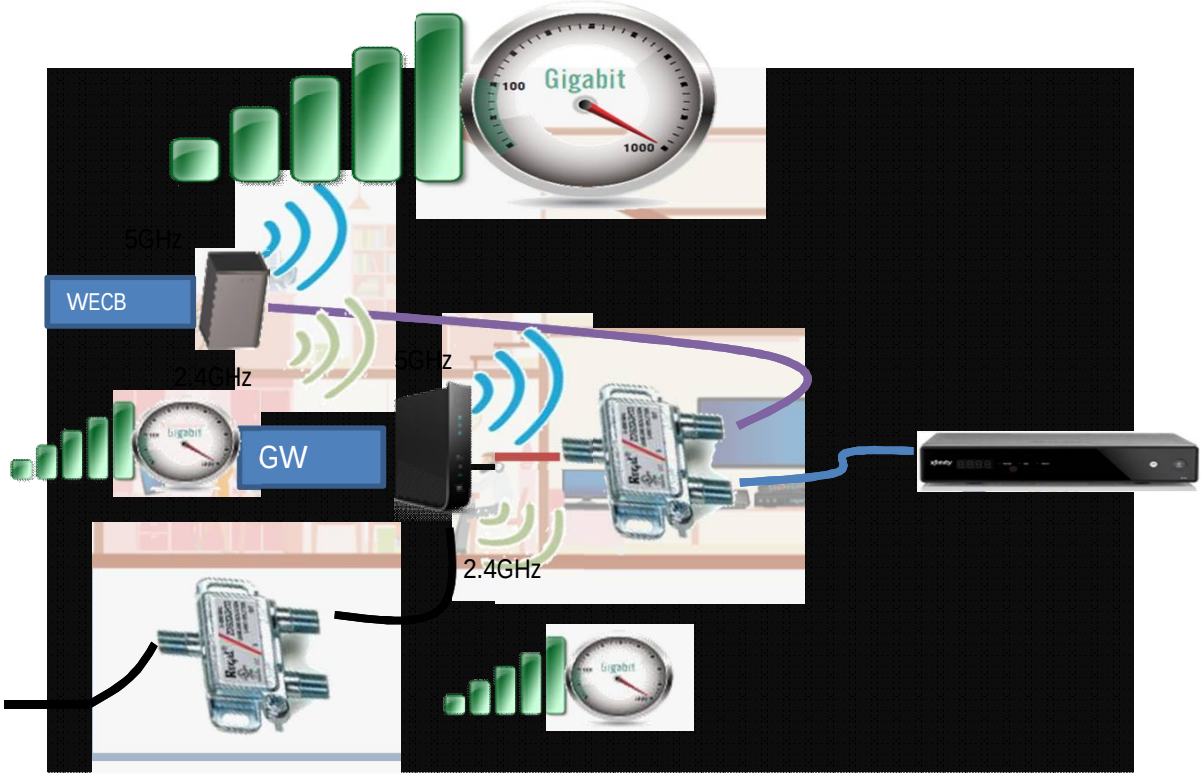
The Single Family Unit Coverage and Performance



- 2.4GHz predominant Wi-Fi technology
  - Range issues for ~35% of NA Homes
- 5Ghz the solution for IP Video and High Bandwidth
  - Exacerbates the Range issue
- For Gbps speeds in all corners of the house – and even the Garden locations – definitely going to need additional AP augmentation

DOCSIS 3.1 Access Speeds driving Gbps Wi-Fi expectations in the home

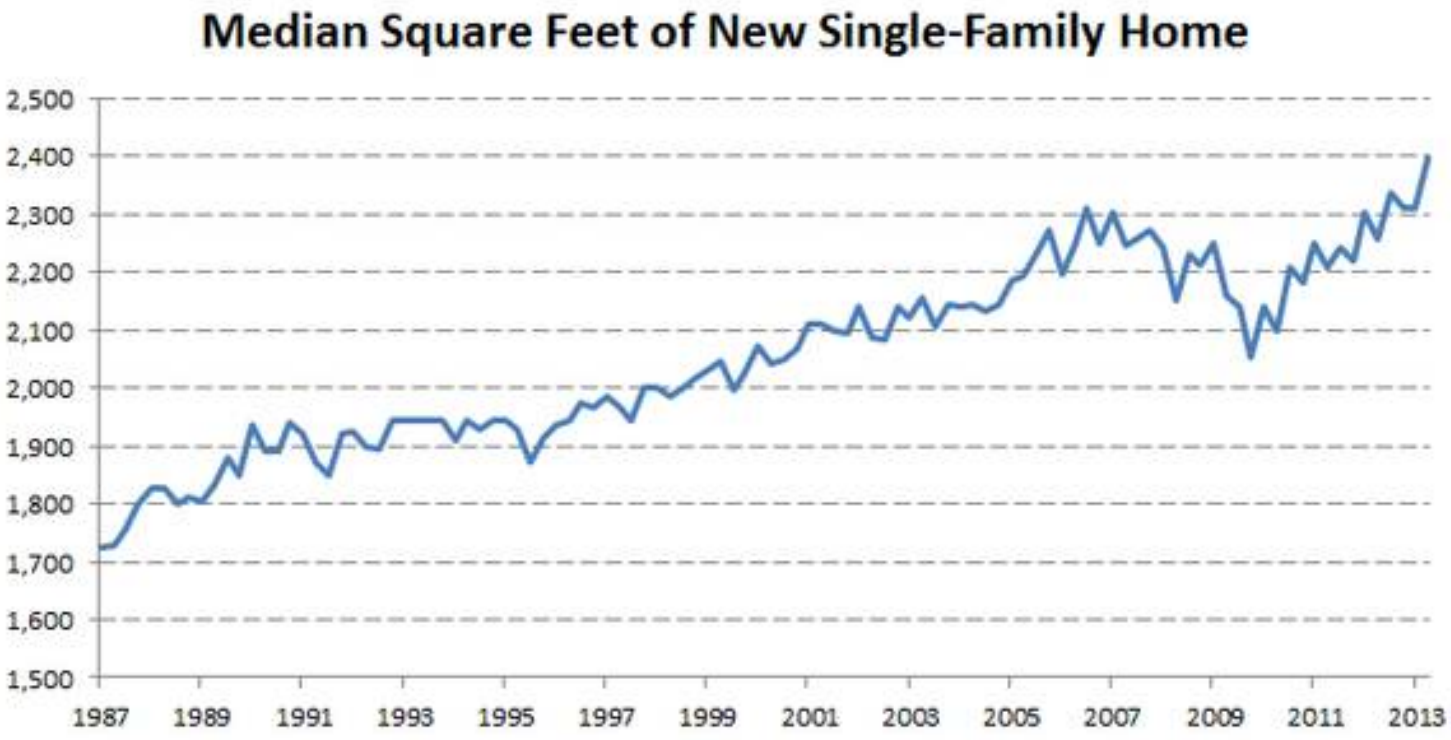
High Speed Wi-Fi extension 4x4, 8x8



DOCSIS 3.1 5Gbps on WAN

DOCSIS 3.1 offers 5Gbps burst capabilities to the consumer home
Enables Gbps Wi-Fi Topline Service
Consumers will want LAN speeds to match WAN speeds

Home Average 2,400 square feet in NA



2014 CHARACTERISTICS OF NEW HOUSING
Single-family Houses Completed, Units in Multifamily Buildings Completed, Units in Multifamily Buildings Started, Multifamily Buildings Completed, Single-Family Houses Sold, Contractor-Built Houses Started
U.S. Department of Housing and Urban Development
OFFICE OF POLICY DEVELOPMENT AND RESEARCH
U.S. Department of Commerce
Economics and Statistics Administration
U.S. CENSUS BUREAU

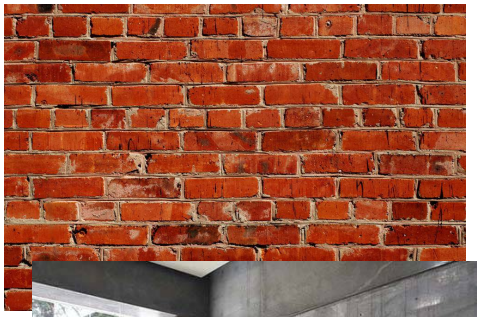
Laws of Physics – the Equalizer

Building Materials absorb and attenuate Wi-Fi signals

Maybe we need to think differently about Wi-Fi coverage ?

Attenuation Properties

Attenuation Properties of Common Building Materials		
Building Material	2.4 GHz Attenuation	5 GHz Attenuation
Solid Wood Door 1.75"	6 dB	10 dB
Hollow Wood Door 1.75"	4 dB	7 dB
Interior Office Door w/Window 1.75"/0.5"	4 dB	6 dB
Steel Fire/Exit Door 1.75"	13 dB	25 dB
Steel Fire/Exit Door 2.5"	19 dB	32 dB
Steel Rollup Door 1.5"	11 dB	19 dB
Brick 3.5"	6 dB	10 dB
Concrete Wall 18"	18 dB	30 dB
Cubical Wall (Fabric) 2.25"	18 dB	30 dB
Exterior Concrete Wall 27"	53 dB	45 dB
Glass Divider 0.5"	12 dB	8 dB
Interior Hollow Wall 4"	5 dB	3 dB
Interior Hollow Wall 6"	9 dB	4 dB
Interior Solid Wall 5"	14 dB	16 dB
Marble 2"	6 dB	10 dB
Bullet-Proof Glass 1"	10 dB	20 dB
Exterior Double Pane Coated Glass 1"	13 dB	20 dB
Exterior Single Pane Window 0.5"	7 dB	6 dB
Interior Office Window 1"	3 dB	6 dB
Safety Glass-Wire 0.25"	3 dB	2 dB
Safety Glass-Wire 1.0"	13 dB	18 dB



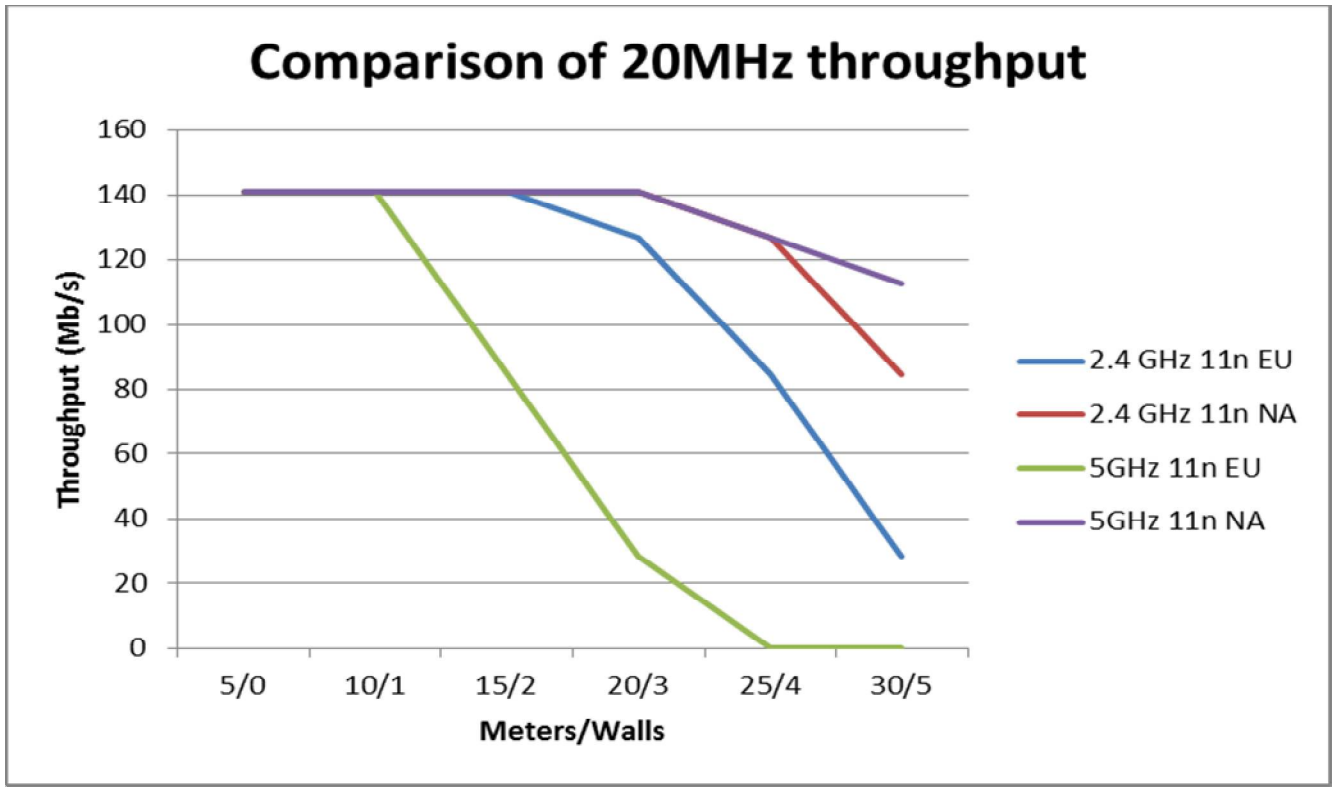
Bad

Worse

Worst

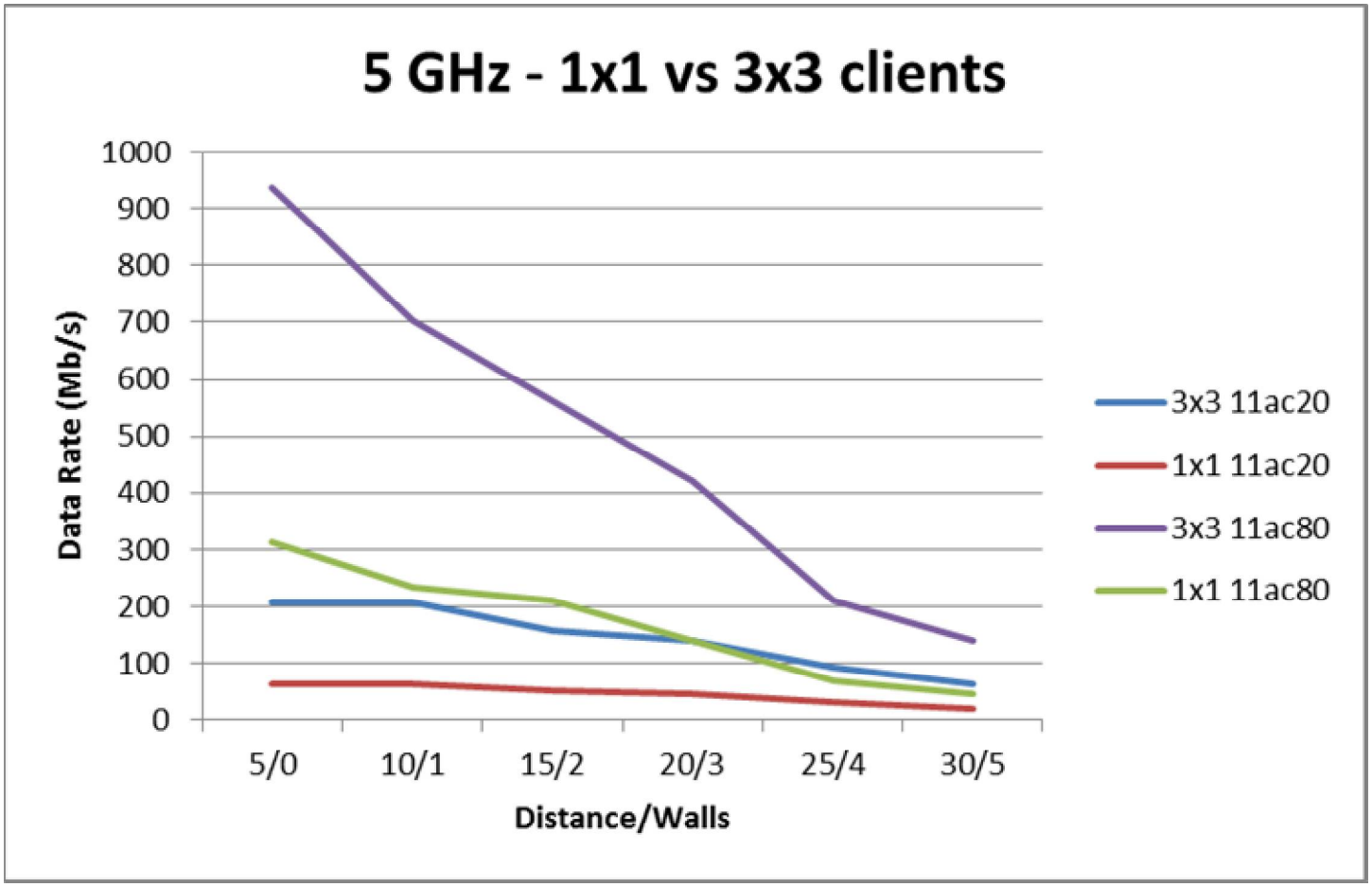
Garden Wi-Fi Killer

Difference in Global House construction materials



Outside the US the challenge can be more difficult both from construction materials (more concrete and brick) and density of housing.

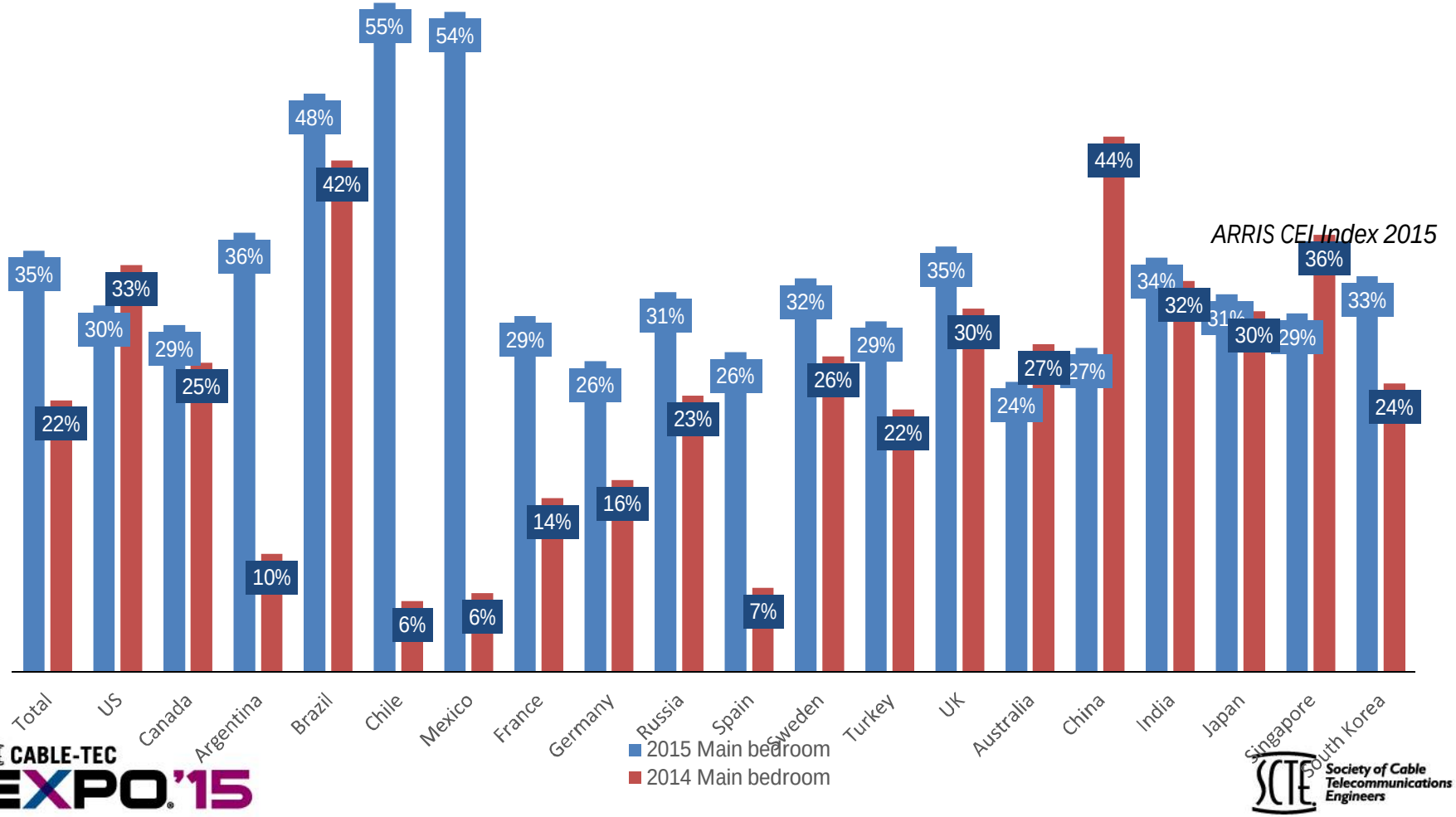
5Ghz is the Gbps transport
But needs help…



Throughput comparison for 3x3 versus 1x1 clients at 5 GHz (meters/walls – X axis)

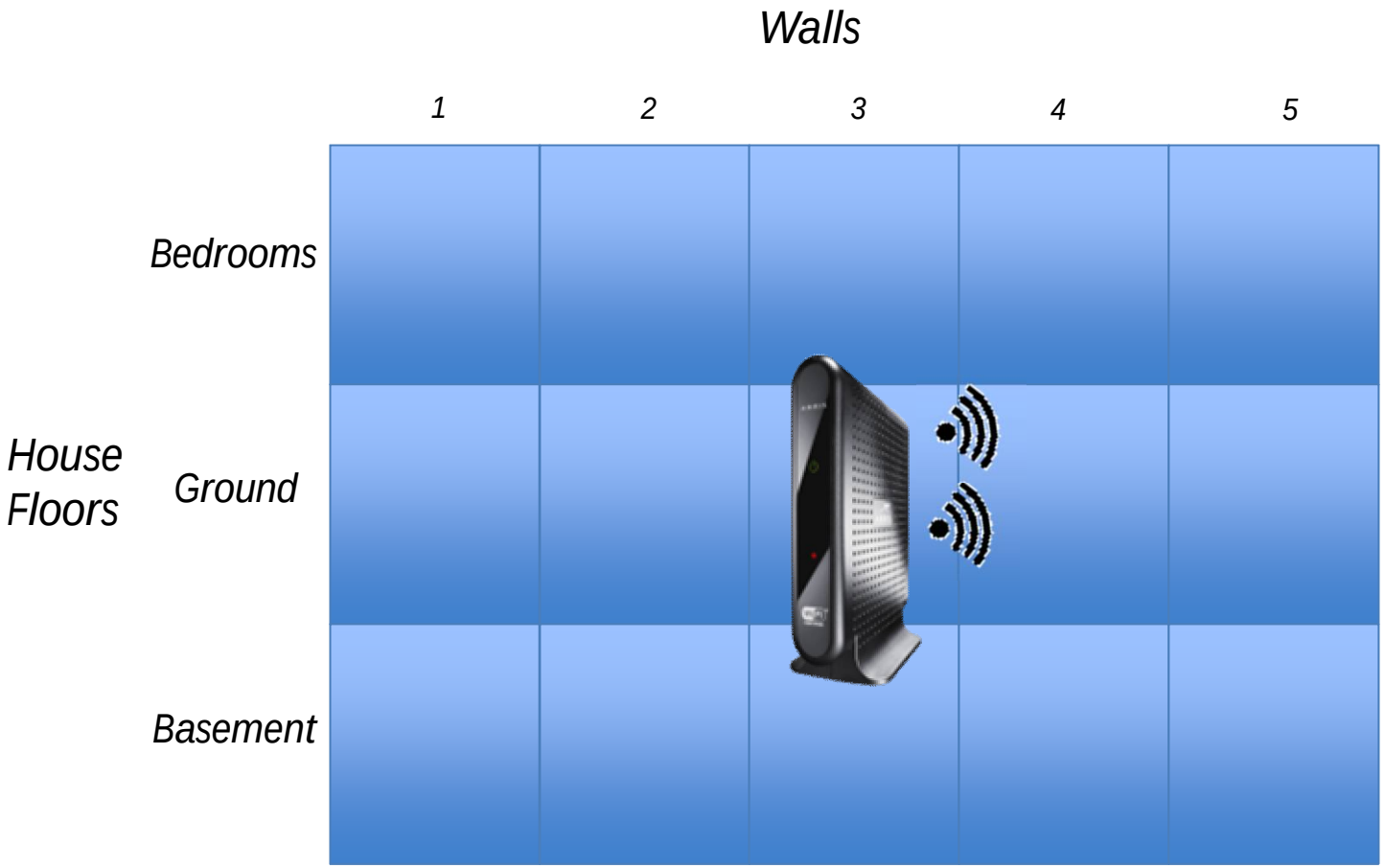
Bedroom is the place where most video streaming takes place

In which rooms in your household do you use the following to watch media/TV shows? (subscription streaming in main bedroom)

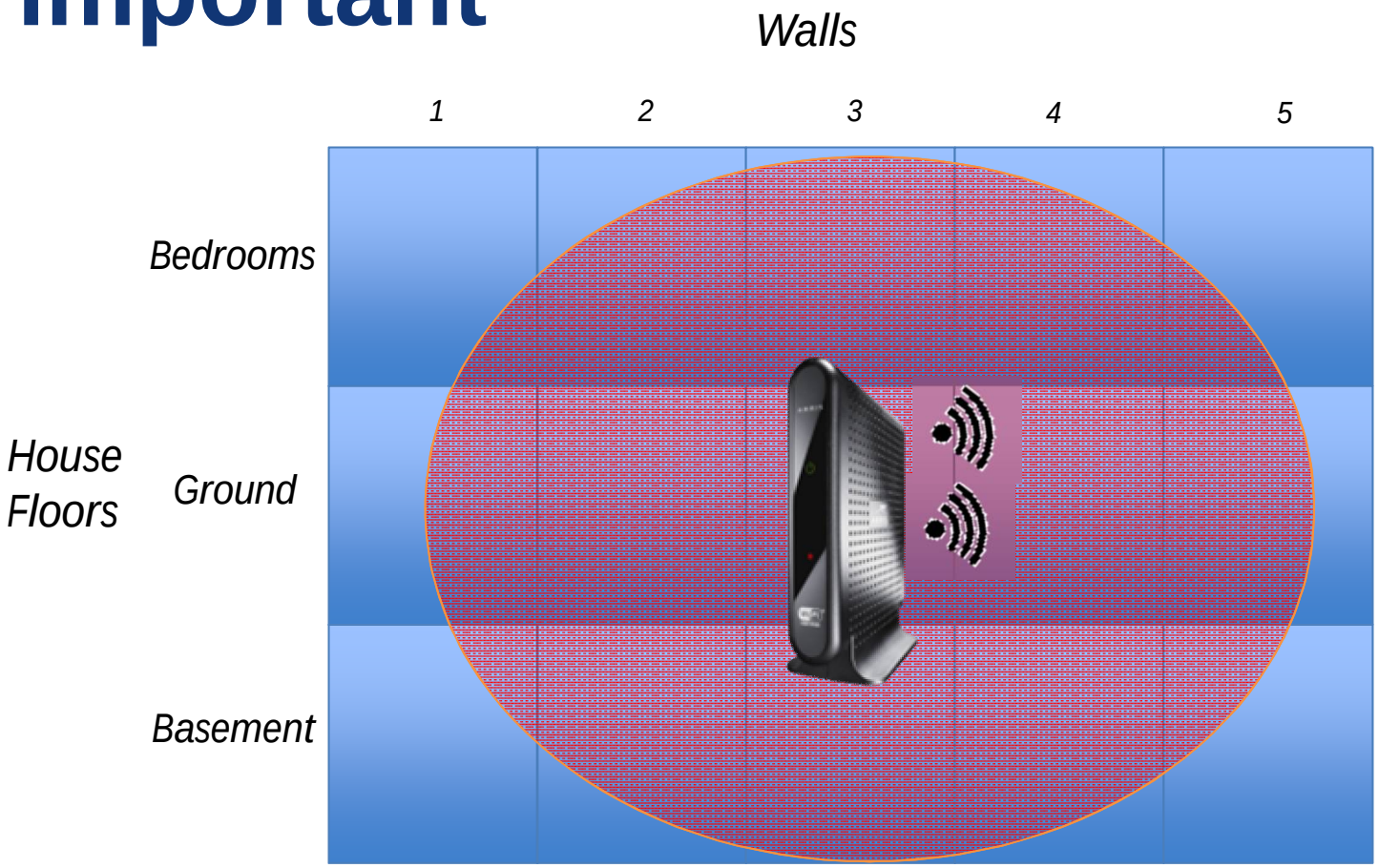


ARRIS CEI Index 2015

Central Placement of AP is important

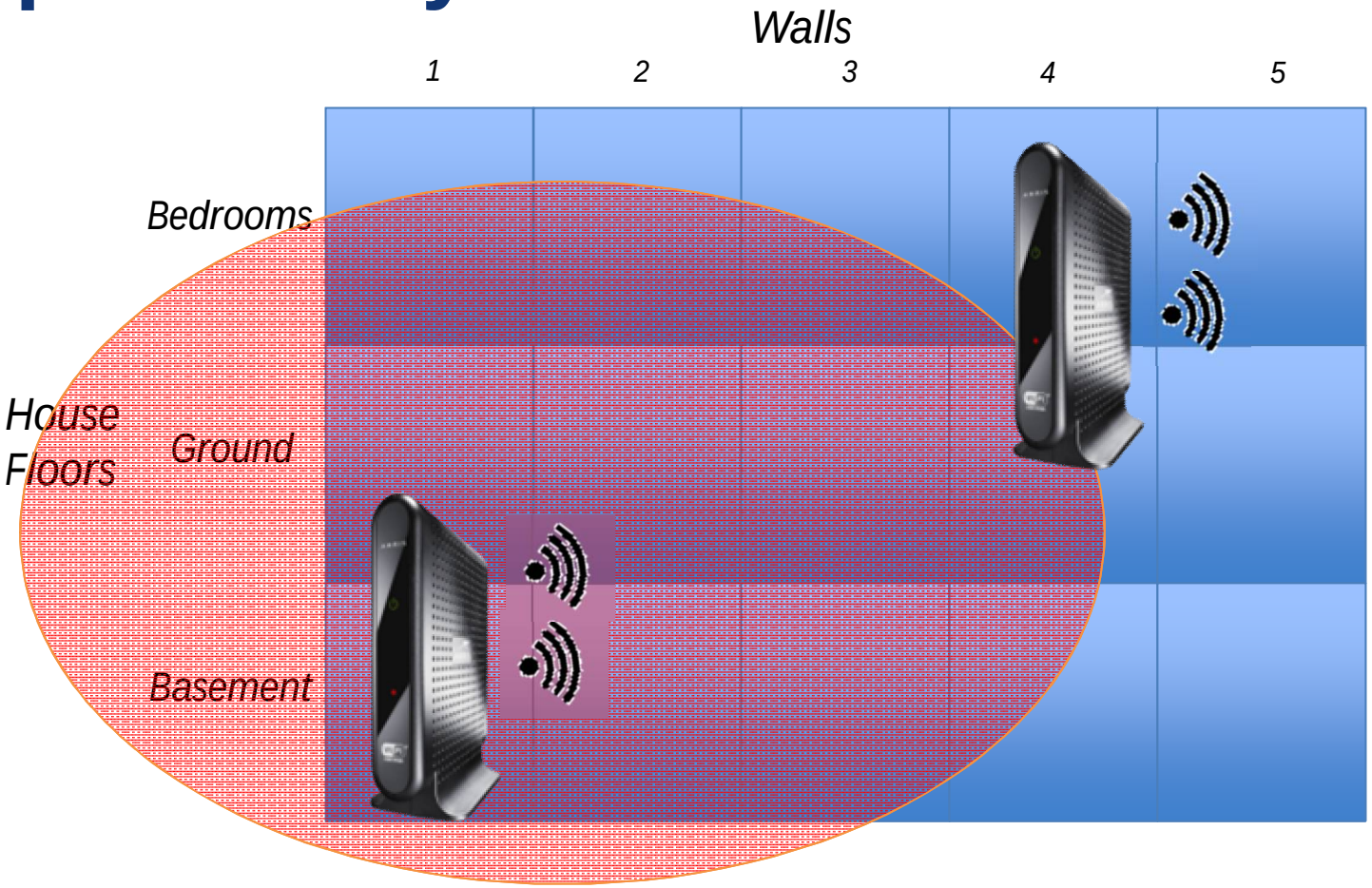


Central Placement of AP is important



Optimal Central Location for base AP – 8x8 MU-MIMO can potentially offer Gbps in homes < 2,500 sq ft with a single Radio

Wall placement of 8x8 GW will potentially need Extension

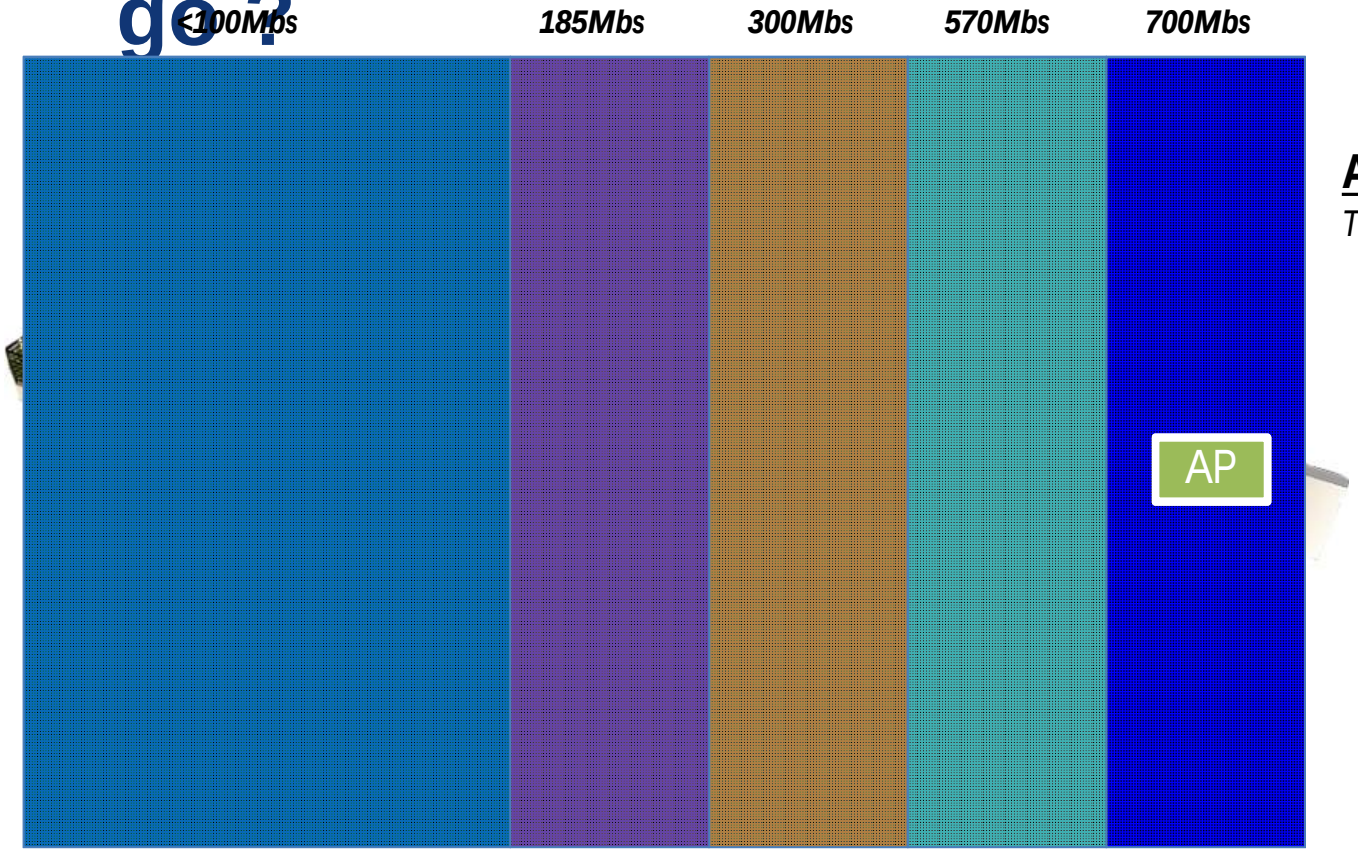


Basement and at outdoor wall location for base AP – 8x8 MU-MIMO may potentially need augmentation with Extender at furthest points in home's <2,500 sqft

Disappearing Mbps – Where did they go ?

Even in a reasonably sized home its not possible to deliver Gbps beyond a couple of walls

Disappearing Mbps – Where did they go?



Assume a 2x2 80MHz Client

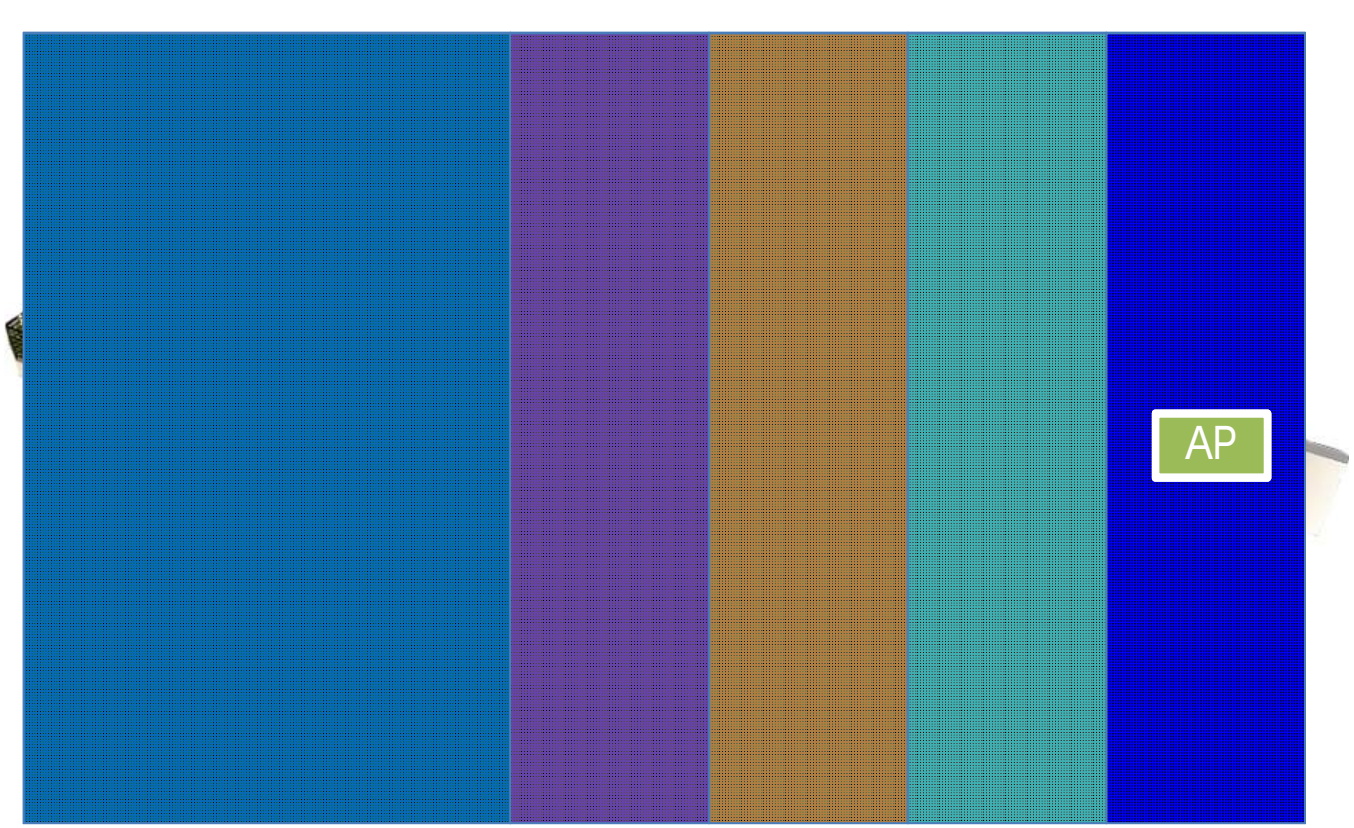
Theoretical 700Mbs

- *1 Wall – 570Mbs*
- *2 Walls – 300Mbs*
- *3 Walls – 185Mbs*
- *4 Walls - <100Mbs*

Even today with 2x2 Clients they cannot realize there true 5GHz speeds

With the emergence of more 3x3 clients in the future – they wont be able to realize their Gbps performance capability

8x8 MU-MIMO – Some Promise



Assume clients are 4 2x2 160MHz MU-MIMO

Theoretical 5700Mbs

1 Wall – 4000Mbs
2 Walls – 2000Mbs
3 Walls – 1000Mbs
4 Walls - <500Mbs
5 Walls - < varies to 100dB path loss < 100Mbs

Note – Stud partition type walls

8x8 MU-MIMO may allow the average US home to receive near Gbps speeds from a single centrally placed Access Point

Devices are improving their ingest of Wi-Fi speeds - (slowly)

Tablet Make	Wi-Fi Performance
Apple iPad Air™ and Mini™	Dual Band 2x2:2 a/b/g/n/ac
Samsung Galaxy Tab™	Dual Band 2x2:2 a/b/g/n/ac
Lenovo Yoga Pad™	Dual Band 2x2:2 a/b/g/n – upgradeable to ac
ASUS Transformer T100™	Dual Band 1x1:1 a/b/g/n/ac
ASUS P1801-T™	Dual Band 2x2:2 a/b/g/n only
Microsoft Surface Pro 3™	Dual Band 2x2:2 a/b/g/n upgradeable to ac

Streaming Set-top Box Make	Wi-Fi Performance
Roku 3	Dual Band 2x2:2 a/b/g/n only
Apple TV	Dual Band 1x1:1 a/b/g/n only
Amazon Fire TV	Dual Band 2x2:2 – a/b/g/n
Google Chromecast	Single Band 2.4 GHz only 1x1:1 b/g

Smart Phone Make	Wi-Fi Performance
htc One M9	Dual Band 2x2:2 a/b/g/n/ac
iPhone 6 and iPhone6s	Dual Band 1x1:1 a/b/g/n/ac
LG G4	Dual Band 1x1:1 a/b/g/n/ac
Google Nexus 6	Dual Band 2x2:2 a/b/g/n/ac
Samsung Galaxy Note 4, S6, S6 Edge	Dual Band 2x2:2 a/b/g/n/ac
Sony Xperia Z3	Dual Band 1x1:1 a/b/g/n/ac

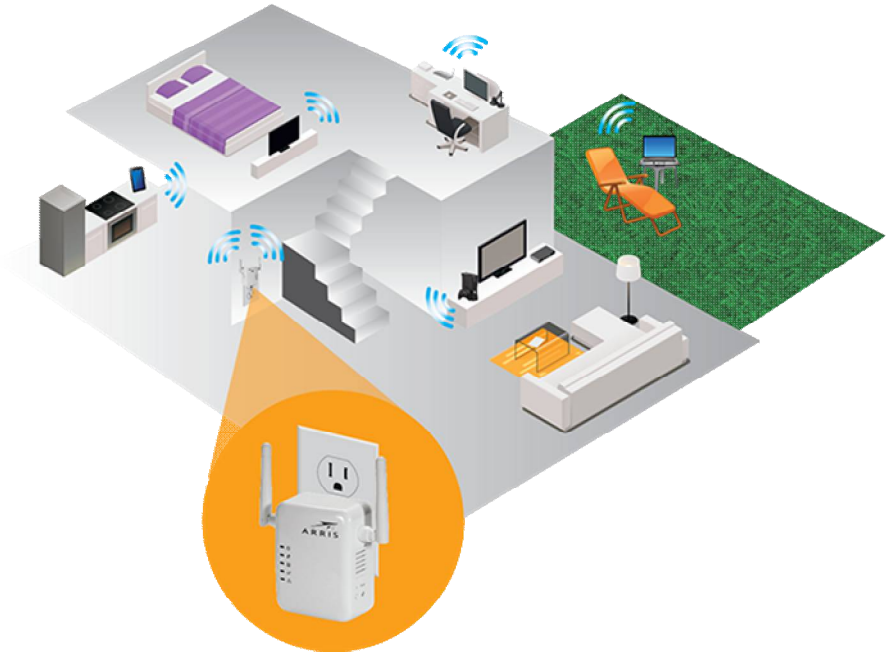
Gaming Console Make	Wi-Fi Performance
Microsoft Xbox One™	Dual Band 2x2:2 a/b/g/n/ac (Initial Devices were n only)
Sony PS4™	Dual Band 1x1:1 only
Xbox360™	Built in 2.4 GHz 1x1:1 g – Adaptor used for better Wi-Fi
Sony PS3™	Single Band 2.4 GHz 1x1:1
Nintendo wii U™	Single Band 2.4 GHz 1x1:1
Sony Xperia Z3™	Dual Band 1x1:1 a/b/g/n/ac

Higher end devices moving to 3x3

60Ghz services also starting to roll out

Solution requires more Wi-Fi extension devices in the home

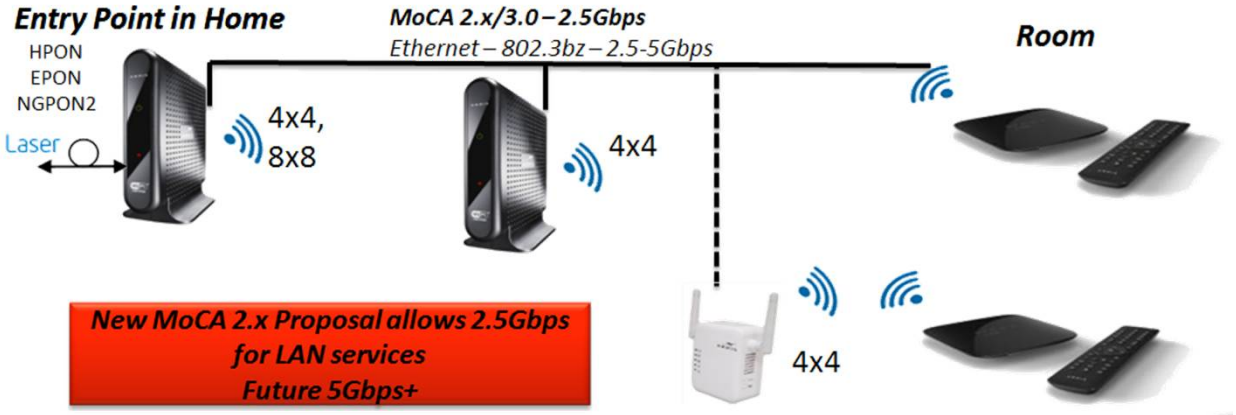
- Augmenting the home with extension devices
  - 5Ghz extension specifically
  - General coverage improvements but also potential interferers
- Gbps Wi-Fi requires almost in room Access Point coverage
  - Trend towards multiple **lower power** Access Points vs One Single Gateway
  - 40% of current homes require second access point to support Video over Wi-Fi reliably at 5Ghz
  - Gbps Wi-Fi may requires 3-4 AP's for larger homes

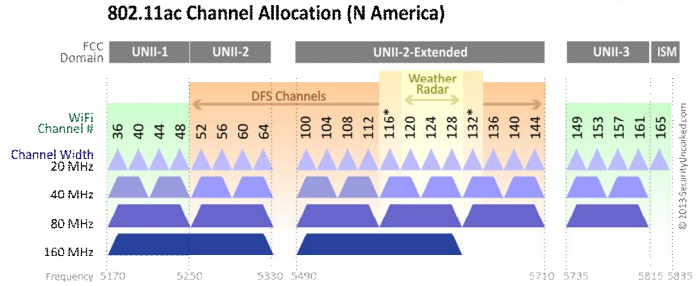


Shift towards Wi-Fi based Video Services

- Move to Wi-Fi IP STB for Additional Outlet services
- Requires additional Wi-Fi extension device to create robust Wi-Fi network for 4K Video delivery over Wi-Fi
- Requires S/W solutions for
  - Optimized Wi-Fi configuration
  - QoS Control
  - Customer Self Healing and Troubleshooting

Extension Architectures – Wired and Wireless





MoCA 2.5 and 3.0 offer good scope for home Backbone

Front Haul and Backhaul Channel Wi-Fi to Wi-Fi extenders also offer options for Gbps extension

Blueskies : Gbps Wi-Fi Home Architecture

Considerations

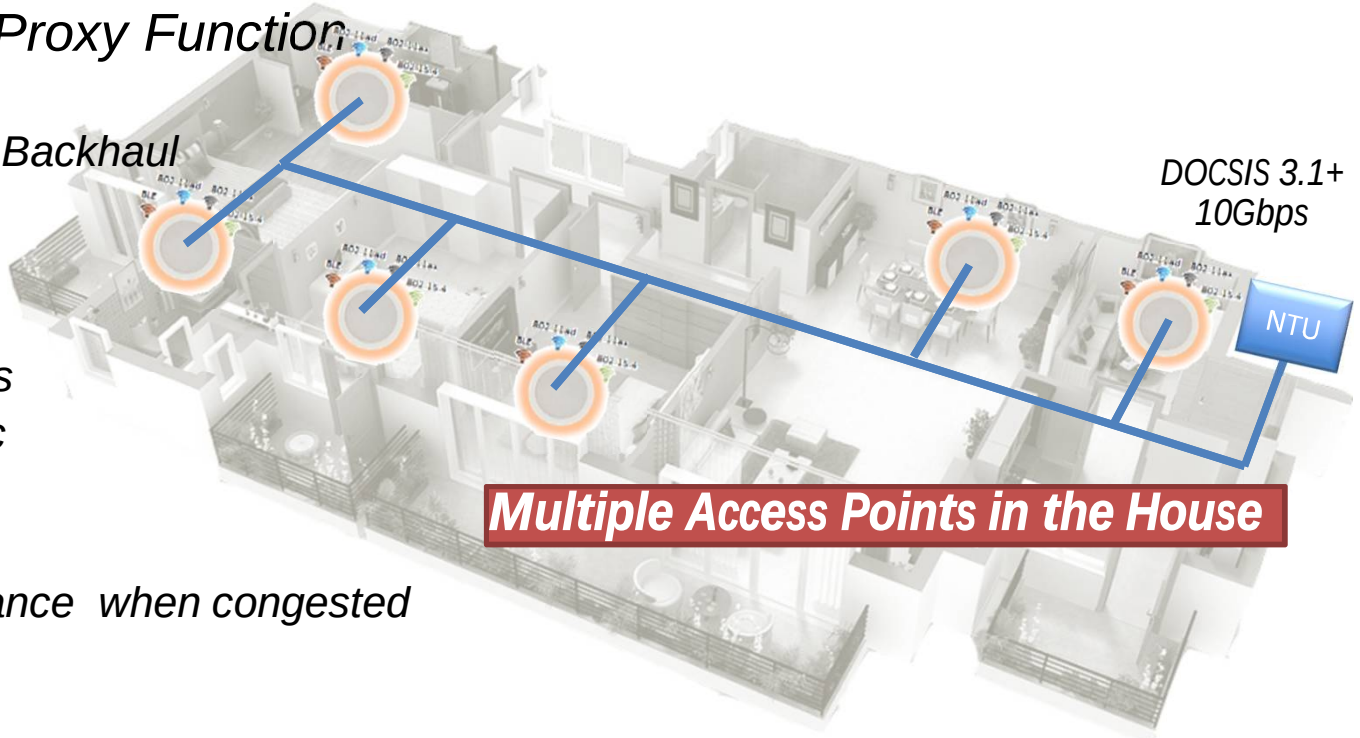
Multiple low power AP's vs Single High Power Radio

Wi-Fi AP Control/Proxy Function

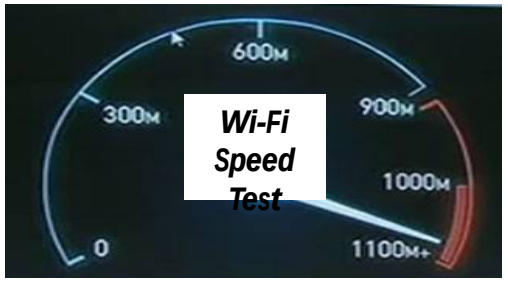
Requires High Speed Backhaul
- *MoCA 3.0*
- *Wi-Fi WAN*

802.11ad/ay – 20Gbps
- *Fast in Room Sync*

802.11ax
- *Improved performance when congested*



Conclusions
Latency matters



- Aspire to architect Gbps networks in the home and settle for something less (but not a lot)
- Recognize that technologies like 60GHz Fast Sync are coming and need to play well with Wi-Fi
- Recognize that 8x8 and MU-MIMO may get single radio efficiencies of 1 per US average home when placed in central location
- A Home Backbone is critical to this new architecture – MoCA 2.5, 3.0 , G.hn and 802.3bz are important standards we need to use
- We should look at the opportunity with Wi-Fi to Wi-Fi extension with 5 GHz channel capacity and see can we leverage a better Wi-Fi repeater technology that can scale to Gigabit performance.
- Software is key to managing this – so start looking at Wi-Fi Controller solutions both GW and Network based
- Silicon innovation needs direction for this next step – we can give it to our partners

Society of Cable Telecommunications Engineers

SCTE CABLE-TEC EXPO '15

OCTOBER 13-16 NEW ORLEANS

Charles Cheevers

Charles.Cheevers@arris.com

Carol Ansley

JR Flesch

Kurt Lumbatis

ARRIS