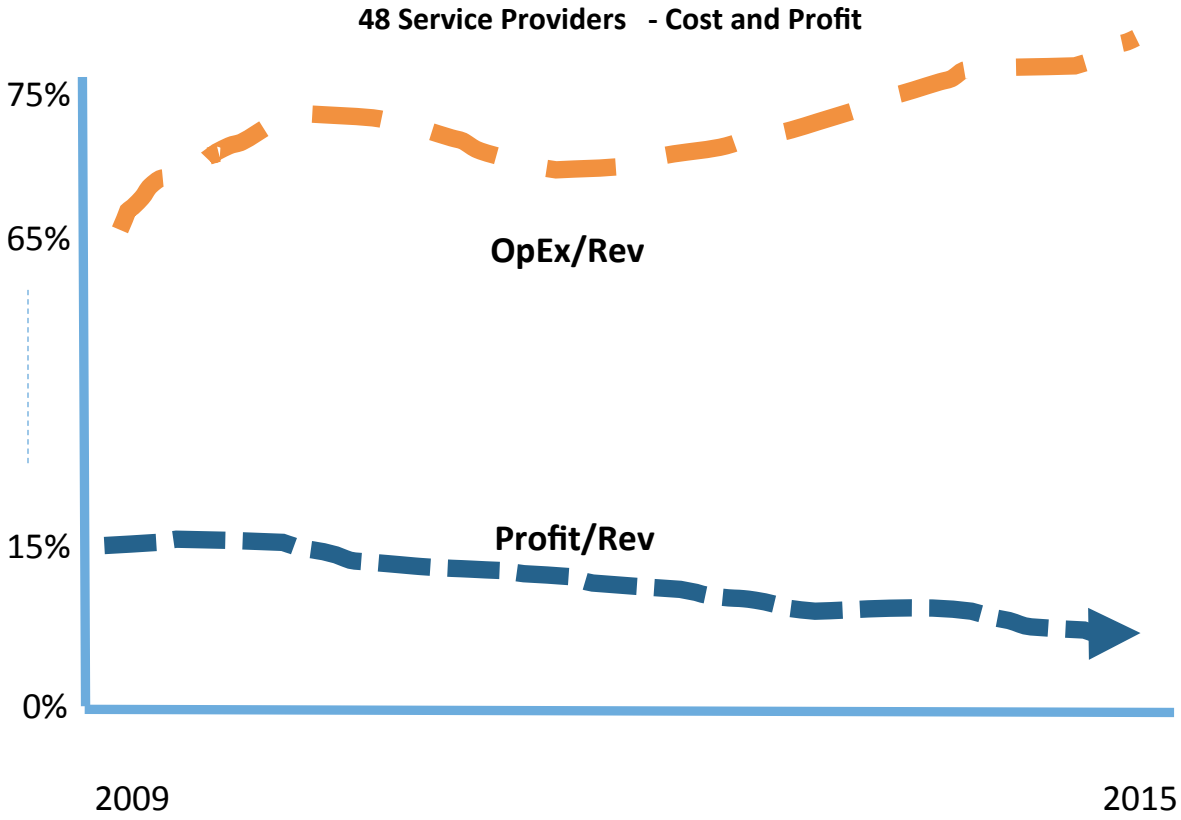
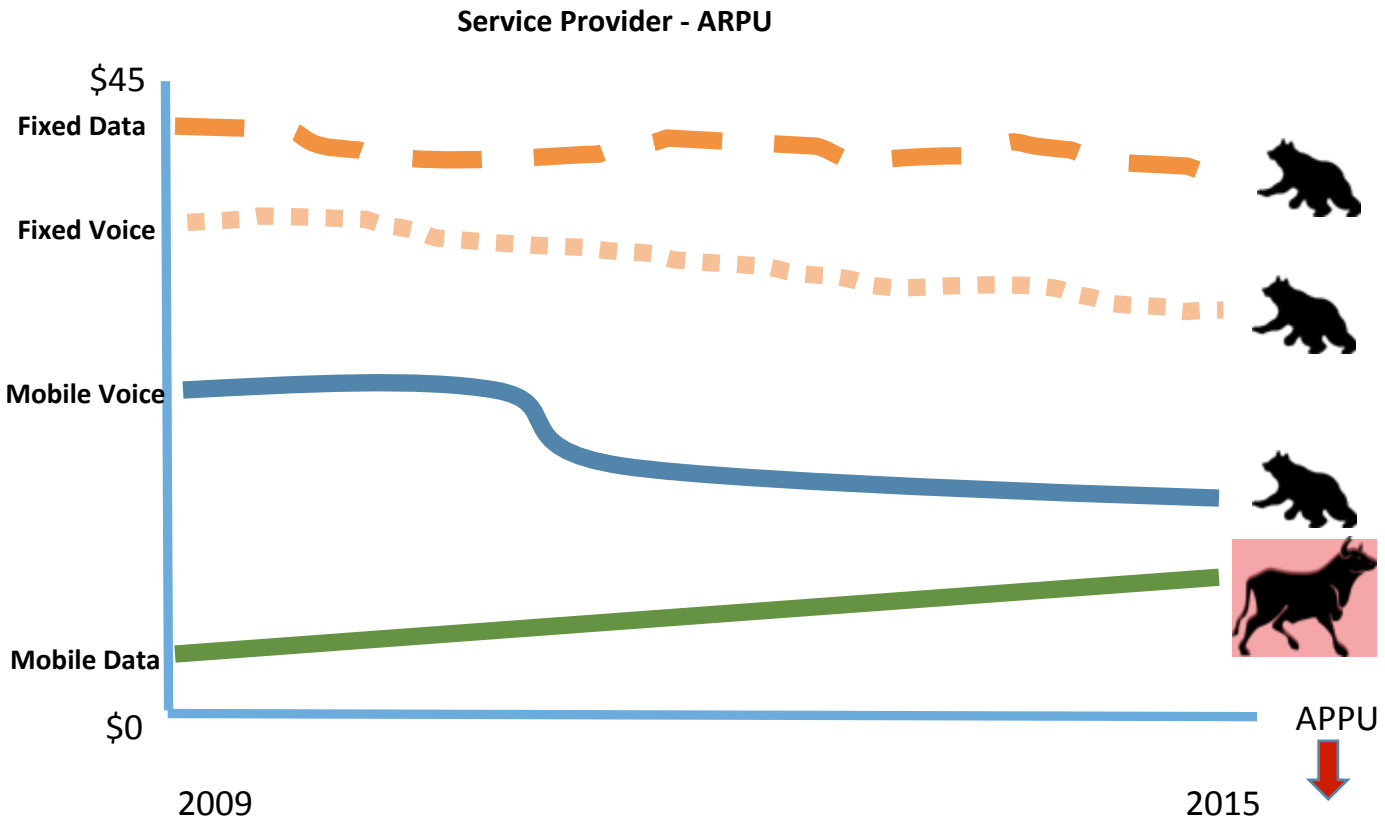
Voice Over Wi-Fi
An Economic View

Ray Mota, CEO and Principal Analyst, ACG Research
Peter Curtin, Universal Wi-Fi Solution Manager, Cisco
May 24, 2016

OPEX – BIGGEST ISSUES TO RESOLVE



SP ARPU – CAGR FLAT - NEGATIVE

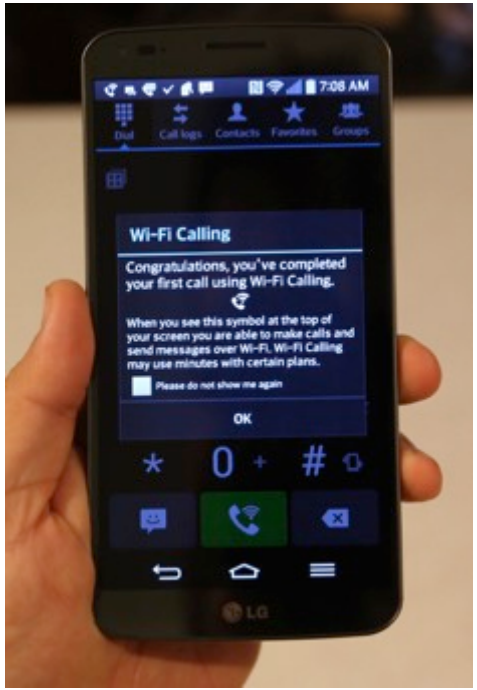


INDUSTRY PERCEPTION

VS

"2016 is the year ***VoWiFi*** moves from *a nice to have to a requirement*"

WHAT IS IT?



- You don't lose minutes
- Seamless user experience (messaging & phone)
- Same number – Same mobile service
- Works across LTE and WiFi

PURE ECONOMICS – IT'S REAL & NOW

- Growth in Smartphone
- Most already in WiFi Range

- Solves spectrum indoor coverage problem
- Solves spending on spectrum capacity cycl

Many WiFi Calling Devices

iPhone 5S, iPhone 5C, iPhone6, iPhone 6 Plus, Samsung Galaxy S5, Samsung Galaxy S6, Samsung Galaxy S6 Edge, Microsoft Lumia 640 etc.

There are also apps that emulate this service especially for Android (Sprint, O2 and Three do that)

VoWiFi Operators

- UK – EE
  - ✓ Vodafone will soon and O2 and Three offer service through apps
- US – T-Mobile and Sprint
- Due to offer VoLTE and VoWiFi this year
- VoWiFi trials all over the world

Potential Impact of VoWi-Fi on Spectrum Spending

								Estimated Impact of VoWiFi	
Country	**Auction Year**	**Total Amount paid by bidders**	**Reserve Price**	**Total Amount paid as a multiple of Reserve Price****	**Total Spectrum Capacity Auctioned** (MHz)	**Price per MHz**		**Average Annual Spectrum saved With VoWi-Fi Penetration** (1% Year 1 & 15% Year 5)	**Average Annual Financial Benefit*** (Secondary market resale or delayed spend)
USA	2015	$ 41 Billion	$ 11 Billion	**3.7x @ 273%**	65 MHz	$635 Million		14 MHz	$445 Million
UK	2013	$ 3.7 Billion	$ 2.0 Billion	**1.8x @ 81%**	250 MHz	$15 Million		9 MHz	$7 Million
Germany	2015	$ 5.7 Billion	$ 1.7 Billion	**3.4x @ 235%**	270 MHz	$21 Million		18 MHz	$19 Million
Korea	2013	$ 2.2 Billion	$ 1.3 Billion	**1.7x @ 69%**	90 MHz	$25 Million		4 MHz	$5 Million
India	2015	$17 Billion	$ 10 Billion	**1.7x @ 69%**	401 MHz	$42 Million		11 MHz	$23 Million

5% of the consumption are done outdoors	***$100 Billion Spent on RAN***
95% of the consumption are done indoors	***$1 Billion Spent on WiFi & Small Cell***

**Increased traffic on wireless networks increases the demand for the spectrum

* A projected 5 year average that assumes prices stay flat from last auction at a 20 year amortization rate

GOOGLE Fi PROJECT SUPPORTS

What is it?

Project Fi is able to seamlessly transition your calls from Wi-Fi to cell networks without ever dropping your conversation.

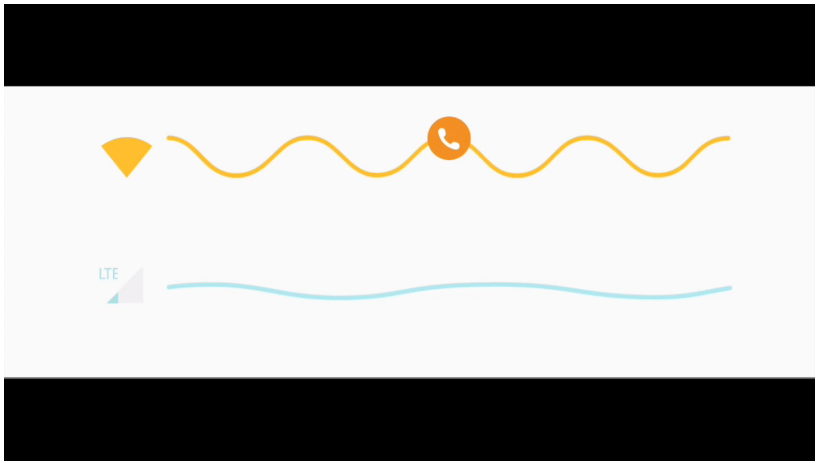
Google Sprint T-Mobile

How Google does it?

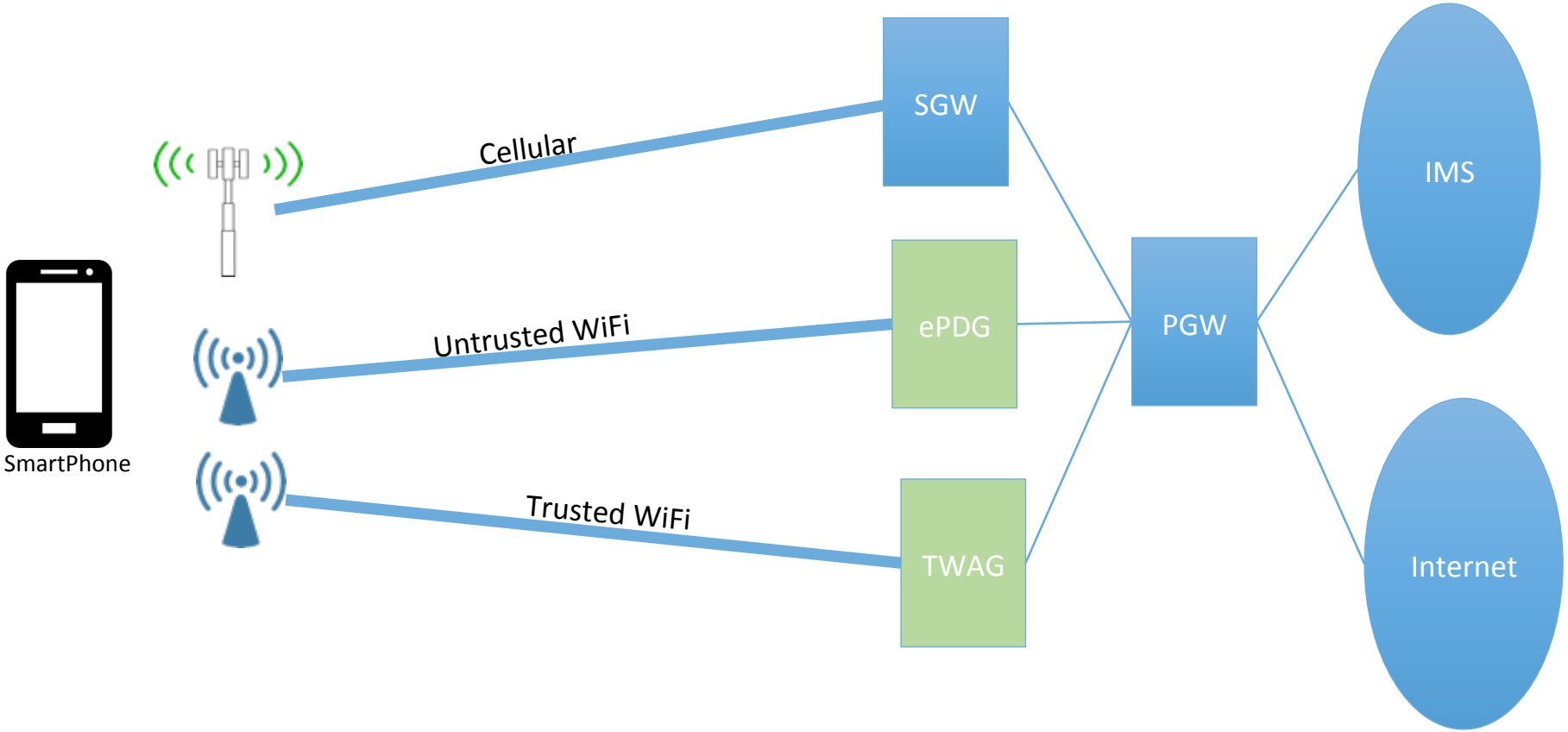
Plan starts with the Fi Basics for $20 per month. This includes:

- Unlimited domestic talk and text
- Unlimited international texts
- Low-cost international calls
- Wi-Fi tethering
- Coverage in 120+ countries

Then it's $10 per GB for data. $10 for 1GB, $20 for 2GB, $30 for 3GB and so on. That's it. With no annual contract required.
Pay for what you use.

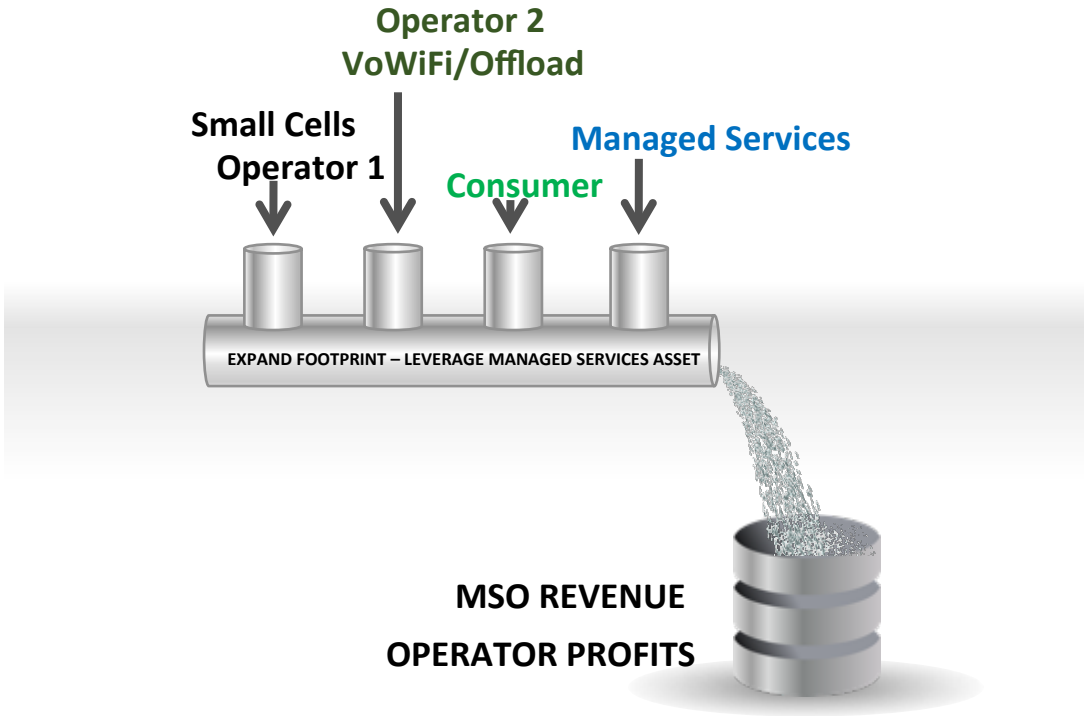


Same Core for VoWiFi & VoLTE



DAY IN THE LIFE OF MOBILE CUSTOMER

SAME ASSETS – DRIVING MORE REVENUE



Mobile Network Evolution: Voice to Internet

1981 1992 2001 2011 2020

Outdoor Coverage → **Indoor Coverage**

© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

Wi-Fi Network Evolution: Internet to IoT

Netscape

802.11
2Mbps
1997

802.11b
11Mbps
1999

802.11g/a
54Mbps
2002

802.11n
600Mbps
2007

802.11ac
3.6Gbps
2012

802.11ac
Wave 2
7Gbps
2015

Indoor Coverage → **Outdoor Coverage**

© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

95% of Data Consumption Occurs Indoors

Home **52%***

Work **33%***

Hotspot **10%***

On the Go **5%***

While Current Spend is Outdoors

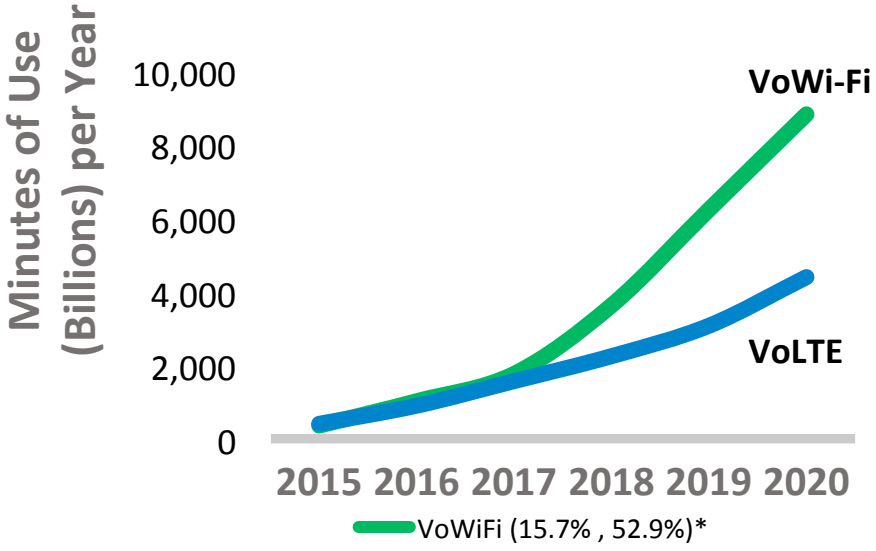
2015 Indoor Wi-Fi/Small Cell spend $1B

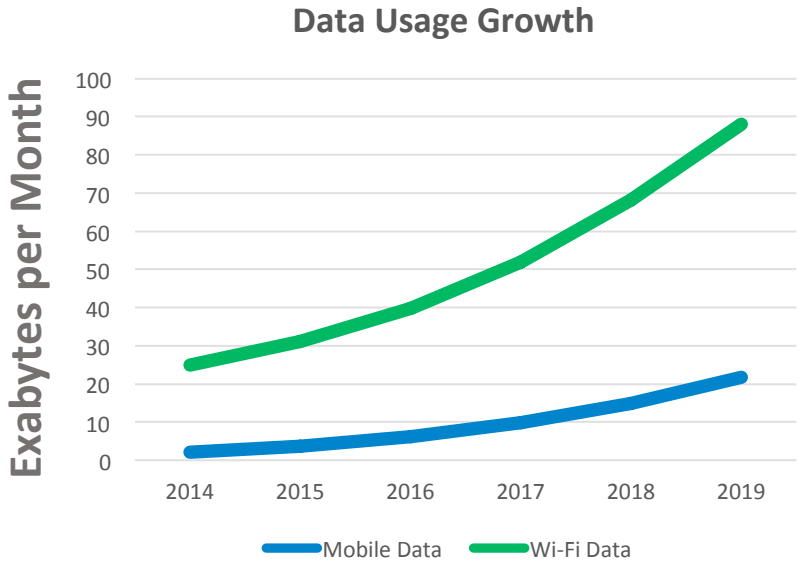
2015 Outdoor RAN spend $100B**

Source: *Cisco VNI Global Mobile Data Traffic Forecast, 2015–2020; * *ACG Research

© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

Impact of Wi-Fi





*refers to 2015 and 2020 % minutes of use

Source: Cisco VNI Global Mobile Data Traffic Forecast, 2015–2020

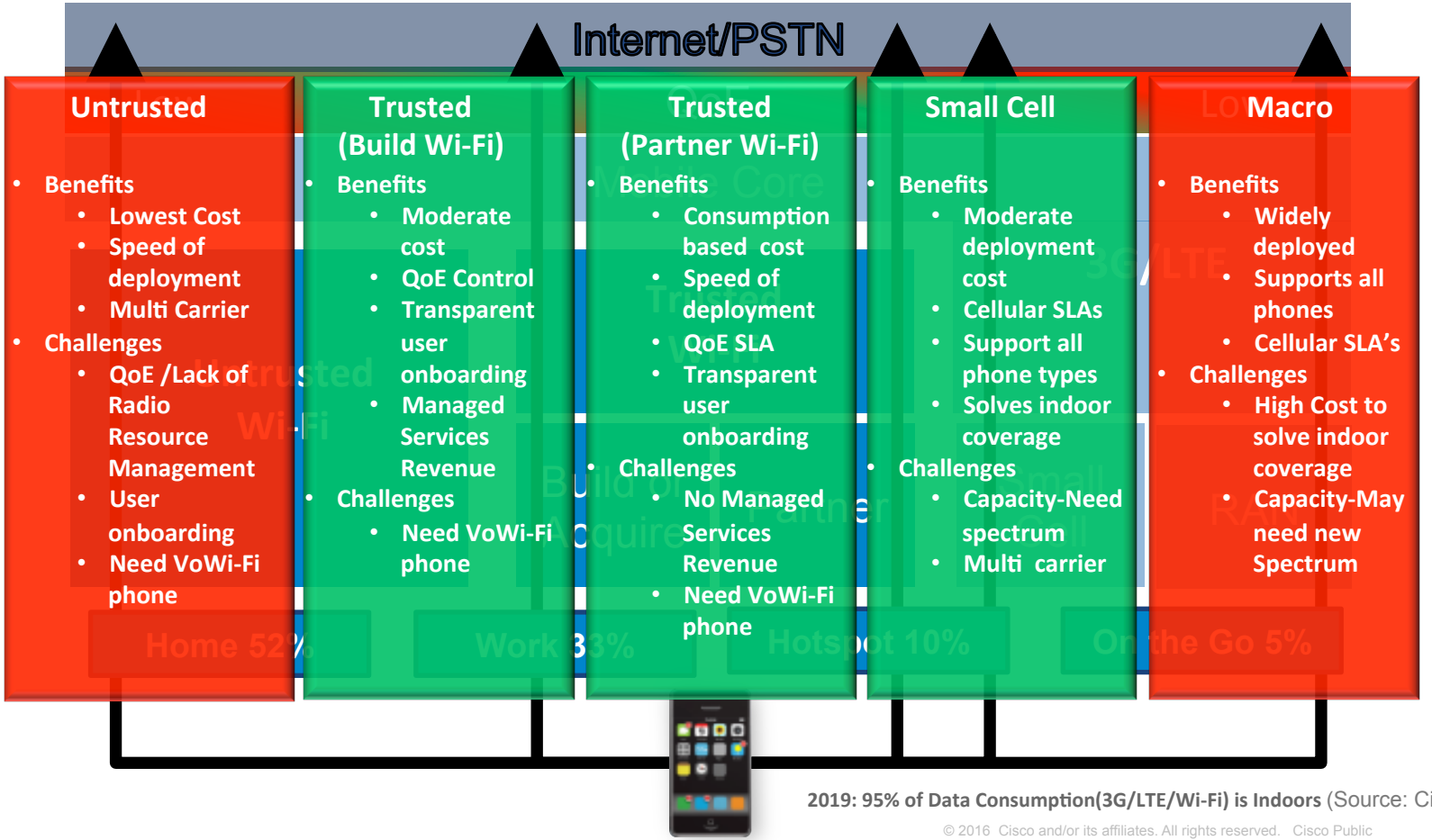
© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

Wi-Fi Suppliers and Consumers

	Wi-Fi Suppliers	Wi-Fi Consumers
Who?	Large Cable Operators Small Tier 2-5 Operators Boutique Operators (Boingo)	Cellular Operators MVNOs
Why?	• Want to monetize their existing Wi-Fi Assets • Want to differentiate their offerings (may also want to add voice)	• Need additional voice and data coverage • Need simple Wi-Fi Authentication • Concerned about Wi-Fi QoE
How?	• Upgrade Wi-Fi network to meet SLAs • Expand Coverage Footprint • Add new Wi-Fi Services (location)	• Build Wi-Fi capacity • Acquire or Partner with existing Wi-Fi Operator • Complement with Small Cell

© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

Usage and QoE Vary by Location



2019: 95% of Data Consumption(3G/LTE/Wi-Fi) is Indoors (Source: Cisco VNI)

© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

It’s All About Economics and QoE

Macro
Voice $.011/min
Data $1.64/GB

Small Cell
Voice $.01/min
Data $1.16

Managed Wi-Fi
Voice $.0034/min
Data $0.23/GB

Home Wi-Fi
Voice $.001/min
Data $0.11/GB

Home 52%*

Work 33%*

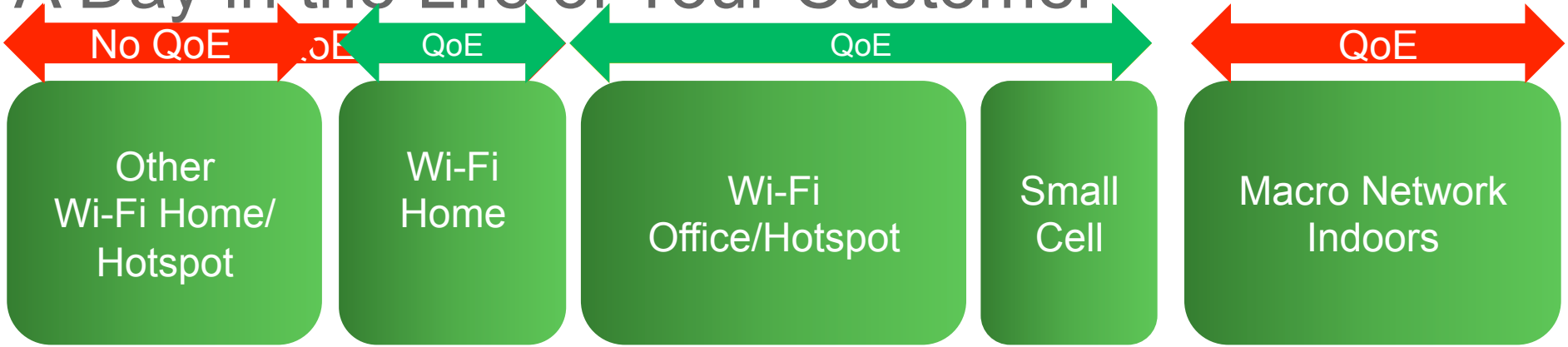
Hotspot 10%*

On the Go 5%*

Source: *Cisco VNI Global Mobile Data Traffic Forecast, 2015–2020; * *ACG Research

© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

A Day in the Life of Your Customer

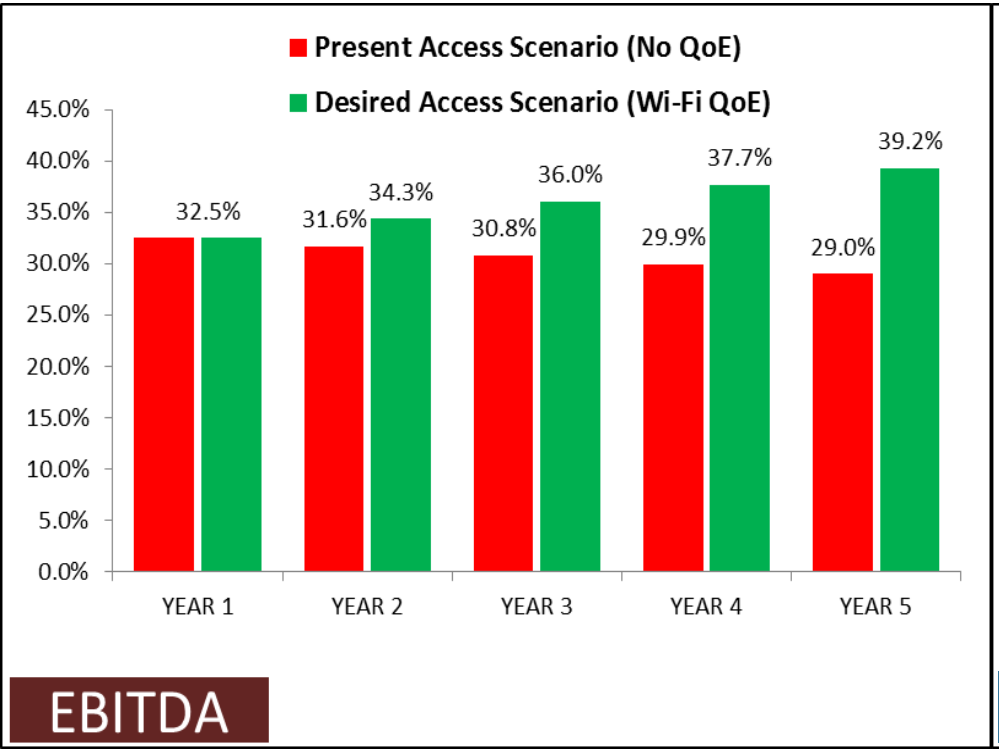


Present Access Scenario (No Wi-Fi QoE)		Other Wi-Fi Home/Hotspot	Wi-Fi Home	Wi-Fi Office/ Hotspot	Small Cell	Macro	Total
	Voice	4%	0%	1%	1%	94%	100%
	Data	N/A	0%	1%	1%	98%	100%

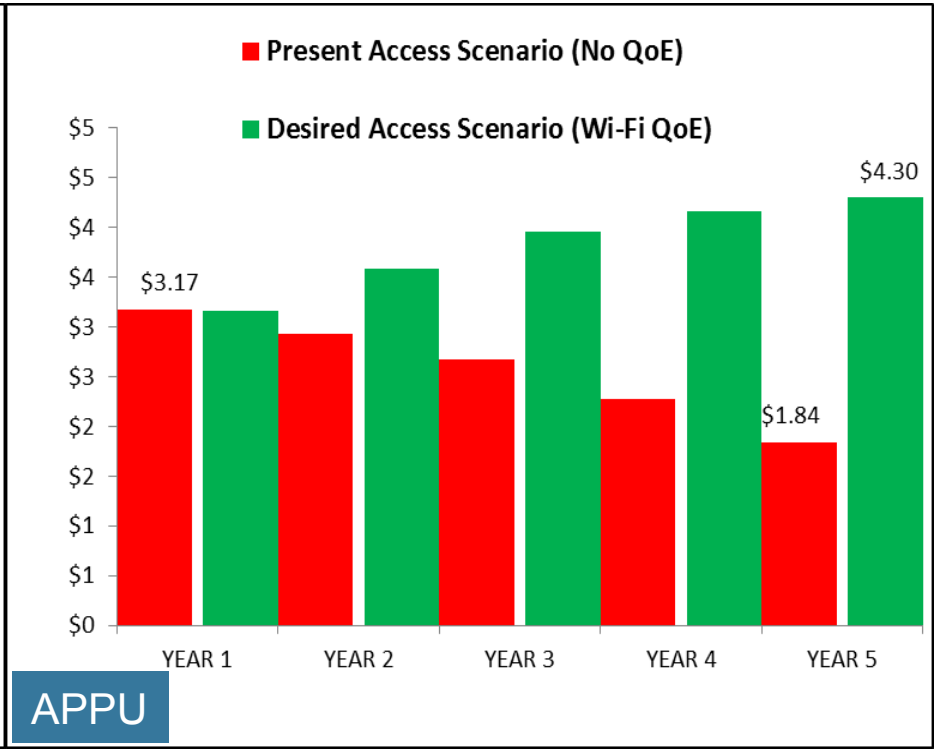
Desired Access Scenario (Wi-Fi QoE)		Other Wi-Fi Home/Hotspot	Wi-Fi Home	Wi-Fi Office/ Hotspot	Small Cell	Macro	Total
	Voice	4%	10%	15%	5%	66%	100%
	Data	N/A	16%	15%	5%	64%	100%

Voice increases from 6% to 34% and Data increases from 2% to 36% with Cisco Solution

Business Outcome Impact



EBITDA

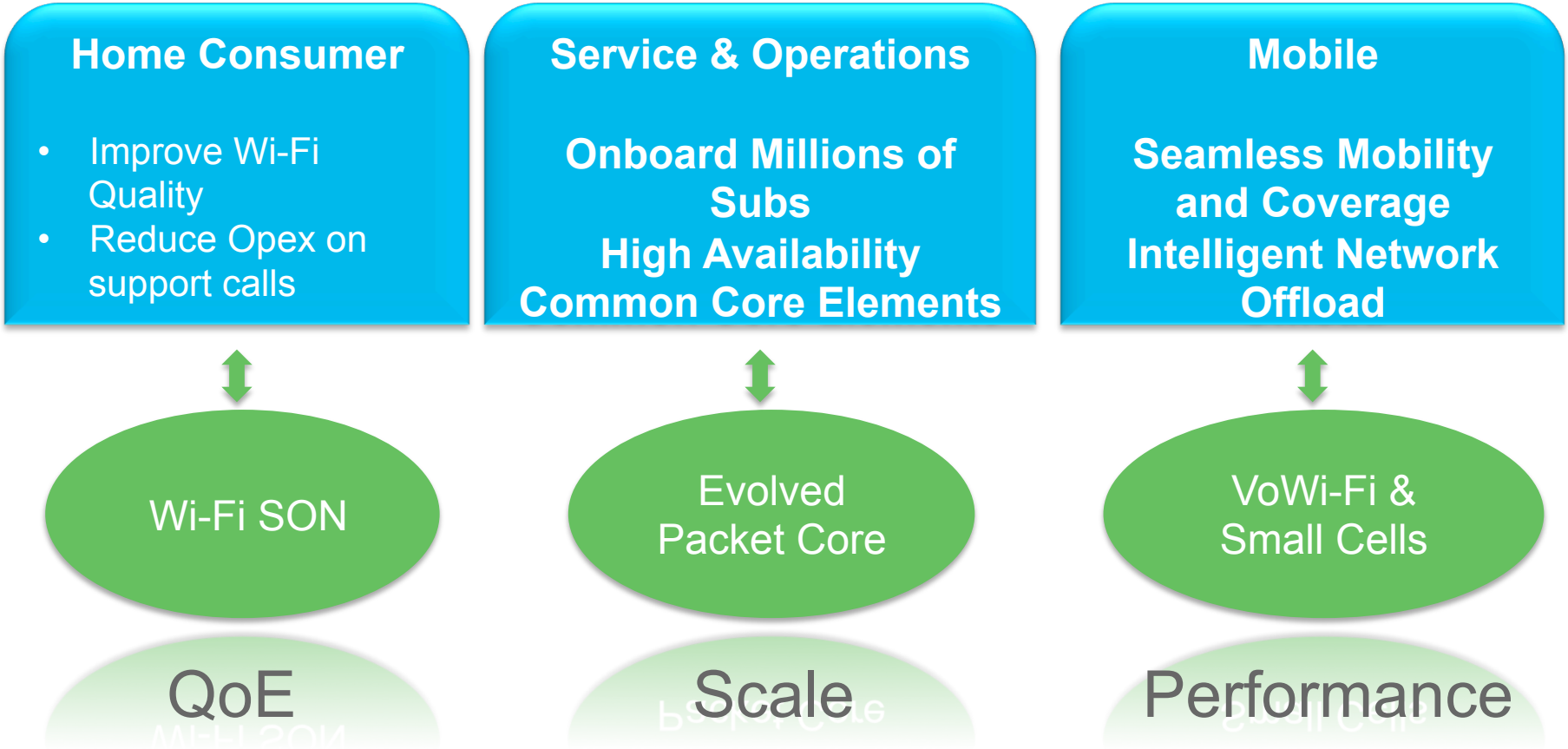


APPU

Financials improve using Cisco's Mobility Access Solution

© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

What Problems Are We Solving?



© 2011 Cisco and/or its affiliates. All rights reserved.

© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

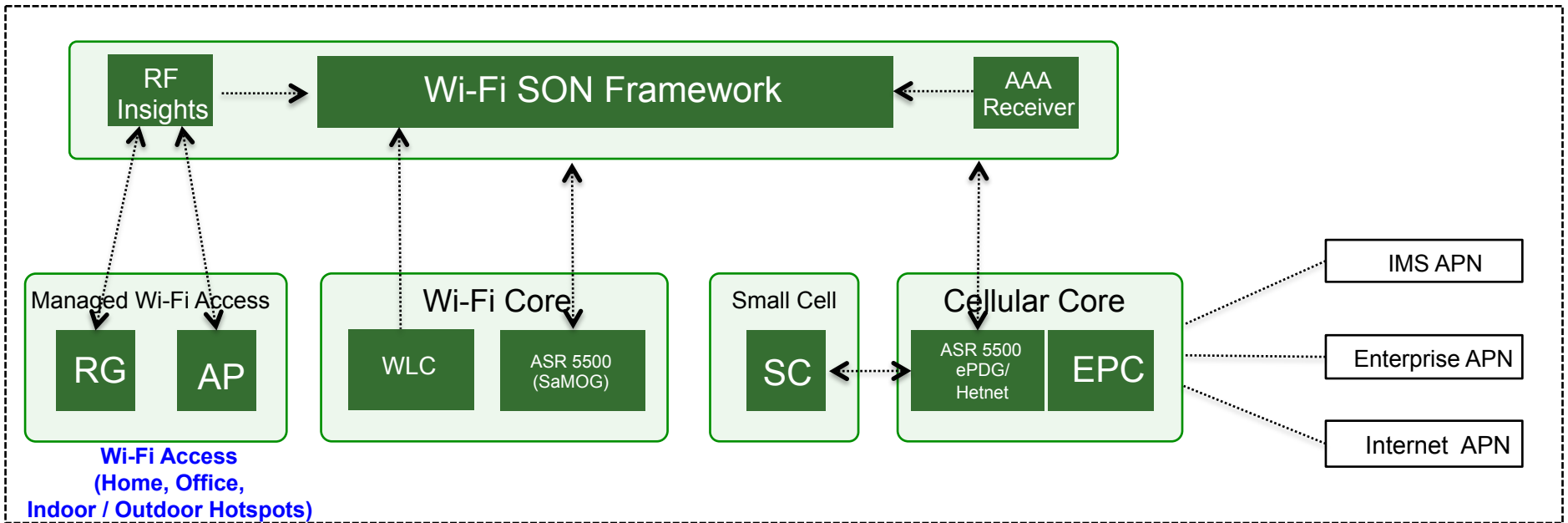
Why Cisco?

Scale & Performance

1. Supports Millions of Session & Tunnel scale to address Wi-Fi subscriber growth
2. Provides High Availability at Product & end to end Solution level

Quality of Experience

1. Voice & Data Readiness: E2E Jitter & Latency analysis to Optimize & Prioritize.
2. Bearer creation, deletion visibility at SaMOG, ePDG & SDN API at WLC



Trusted Wi-Fi Use Case: Wi-Fi SLA

"Sprint last year inked a Wi-Fi offload deal with Boingo that calls for Sprint's Android and iOS smartphone customers to automatically switch to Boingo hotspots in roughly three dozen major U.S. airports. Peterson said that Boingo had to increase the density of its Wi-Fi networks in order to ensure that Sprint customers making Wi-Fi calls while strolling through an airport would remain connected."

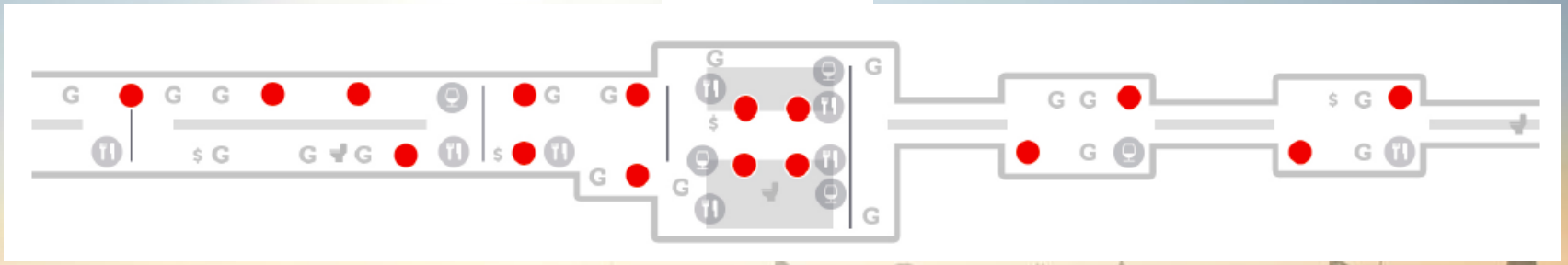
Fierce Wireless
Feb 2016

METRIC	DESCRIPTION (w/SLA)	RECOMMENDED SLA
Bandwidth	• **Audio Streaming** (50Kbps to 320Kbps per stream, including headers and error recovery overhead) • **Video Streaming** (200Kbps to 2.5Mbps per stream, few video conferencing software use multiple concurrent streams) **NOTE:** Uplink throughput can be anywhere from 500Kbps to 1Mbps	Audio: **160Kbps** (DL) Video: **2.5Mbps** (DL) Uplink: **1Mbps**
Packet Loss	• Desired: < **1%** • Acceptable < **2%**	< **2%**
Jitter	• Desired: < **50ms** • Acceptable < **250ms**	< **250ms**
End to End Latency	• Desired: < **150ms** • Acceptable < **200ms** **NOTE:** Voice of Wi-Fi call will start to deteriorate noticeably with latency of more than 200ms	< **200ms**
UDP/TCP Transport	• **Both TCP/UDP** shall be used for real time Multimedia traffic	**UDP** and **TCP**

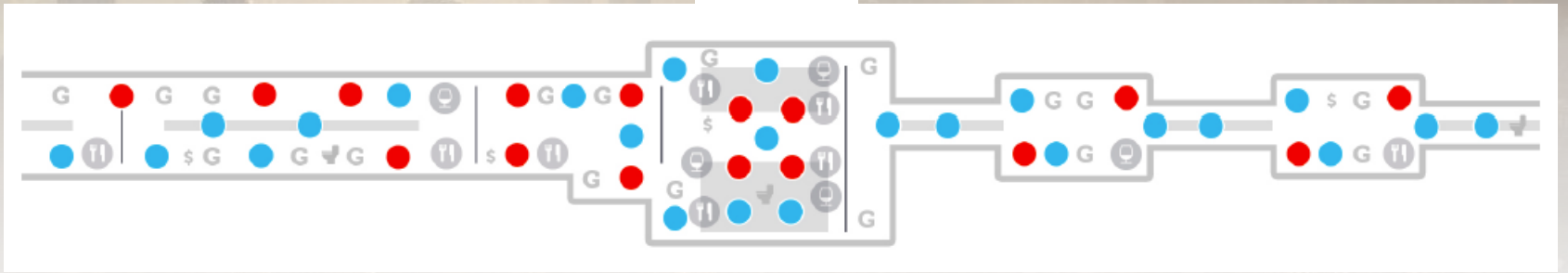
© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

What is Needed to Meet QoE?

Before



After



© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

VoWi-Fi Key Assessment Parameters

Requirement	Parameter	Min.	Max.	NOTES
Call capacity (concurrent)	VoWi-Fi bandwidth (BW)	5%	25%	Use AP Planner to estimate # calls
Call quality	Packet loss	N/A	1%	Connection stats
	Cell-edge RSSI	-74dBm	-62dBm*	Passive site-survey**
Network capacity	Channel BW [5GHz]	40MHz*	80MHz	Set in RRM/DCA
	Channel utilization (CU) [5GHz]	N/A	50% > VoWi-FI BW	CU stats
	Interference (AirQuality) [5GHz]	90%	N/A	CleanAir stats

* For High-density (HD) designs (30+ active users/AP)
** Virtual (3D) or physical

© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

VoWi-Fi 5GHz Benefits

- High voice quality needs low packet-loss & jitter
  - Both tend to be low IF the interference is Wi-Fi-based (Carrier-Sense-Multiple-Access or CSMA) since voice takes precedence over data
  - Non-Wi-Fi interference (e.g. 2.4GHz BlueTooth) does NOT use CSMA and thus causes higher loss & jitter
  - AirQuality (AQ) is measure of non-Wi-Fi interference and in 5GHz channels AQ can be high (90+%)
- 2.4GHz channel reuse is HIGH (N=3)
  - High co-channel-interference (CCI) -> unwanted CU
- 5GHz channel reuse can be LOW (N=6,12,24,…)
  - Low CCI → Low unwanted CU → more voice & data capacity
  - Lower channel BW (40Mhz) significantly reduces CCI

© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

Other Considerations for VoWi-Fi

- Network QoS features
  - Packet Inspection and prioritization
  - WMM support on device and APs
- Optimized Roaming
  - RSSI Issues
  - VoLTE Handoffs
- APs
  - Capacity under load
  - Radio Flexibility and control
- Small Cell Deployment
  - AP/Small Cell Integration
- Switch Capacity (Wave 2 capable?)

© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

Conclusions

- Get voice and data off macro network inside buildings
- Voice and data offload are key to maintain profitability
- Trusted Wi-Fi is necessary to ensure QoE for Hotspots
- Wi-Fi SON is necessary to ensure QoE in the Home
- Acquisition or Partnering with Wi-Fi Operators may be the quickest way to broaden coverage and reduce cost

© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public

Thank You

© 2016 Cisco and/or its affiliates. All rights reserved. Cisco Public