Voice Over Wi-Fi
An Economic View

Ray Mota, CEO and Principal Analyst, ACG Research
Peter Curtin, Universal Wi-Fi Solution Manager, Cisco
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OPEX – BIGGEST ISSUES TO RESOLVE

48 Service Providers - Cost and Profit

OpEx/Rev

Profit/Rev

2009

2015

Transformation is required
SP ARPU – CAGR FLAT - NEGATIVE

Service Provider - ARPU

- Fixed Data
- Fixed Voice
- Mobile Voice
- Mobile Data

$0
$45

2009
2015

APPU
“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
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

Many WiFi Calling Devices

- iPhone 5S, iPhone 5C, iPhone 6, 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)

Many get poor indoor coverage – it’s not about control – it’s about quality
## Potential Impact of VoWi-Fi on Spectrum Spending

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

**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

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5% of the consumption are done outdoors

95% of the consumption are done indoors

$100 Billion Spent on RAN

$1 Billion Spent on WiFi & Small Cell
What is it?

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

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

When macro network is ready – add VoLTE support

RAY MOTA

www.acgcc.com
QOE will be a critical success factor

RAY MOTA

www.acgcc.com
SAME ASSETS – DRIVING MORE REVENUE

EXPAND FOOTPRINT – LEVERAGE MANAGED SERVICES ASSET

MSO REVENUE
OPERATOR PROFITS

Small Cells
Operator 1

Operator 2
VoWiFi/Offload

Managed Services

Consumer

Win win scenario
Mobile Network Evolution: Voice to Internet

1G  2G  3G  4G  5G


Outdoor Coverage  →  Indoor Coverage
Wi-Fi Network Evolution: Internet to IoT

Indoor Coverage

802.11
2Mbps
1997

802.11b
11Mbps
1999

802.11g/a
54Mbps
2002

802.11n
600Mbps
2007

Outdoor Coverage

802.11ac
3.6Gbps
2012

802.11ac
Wave 2
7Gbps
2015

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95% of Data Consumption Occurs Indoors

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
Impact of Wi-Fi

*refers to 2015 and 2020 % minutes of use

Source: Cisco VNI Global Mobile Data Traffic Forecast, 2015–2020
# Wi-Fi Suppliers and Consumers

## Wi-Fi Suppliers

<table>
<thead>
<tr>
<th>Who?</th>
<th>Large Cable Operators</th>
<th>Small Tier 2-5 Operators</th>
<th>Boutique Operators (Boingo)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Why?</strong></td>
<td>• Want to monetize their existing Wi-Fi Assets&lt;br&gt;• Want to differentiate their offerings (may also want to add voice)</td>
<td></td>
<td>• Need additional voice and data coverage&lt;br&gt;• Need simple Wi-Fi Authentication&lt;br&gt;• Concerned about Wi-Fi QoE</td>
</tr>
<tr>
<td><strong>How?</strong></td>
<td>• Upgrade Wi-Fi network to meet SLAs&lt;br&gt;• Expand Coverage Footprint&lt;br&gt;• Add new Wi-Fi Services (location)</td>
<td></td>
<td>• Build Wi-Fi capacity&lt;br&gt;• Acquire or Partner with existing Wi-Fi Operator&lt;br&gt;• Complement with Small Cell</td>
</tr>
</tbody>
</table>
Usage and QoE Vary by Location

Untrusted
- Benefits
  - Lowest Cost
  - Speed of deployment
  - Multi Carrier
- Challenges
  - QoE /Lack of Radio Resource Management
  - User onboarding
  - Need VoWi-Fi phone

Trusted (Build Wi-Fi)
- Benefits
  - Moderate cost
  - QoE Control
  - Transparent user onboarding
  - Managed Services Revenue
- Challenges
  - Need VoWi-Fi phone

Trusted (Partner Wi-Fi)
- Benefits
  - Consumption based cost
  - Speed of deployment
  - QoE SLA
  - Transparent user onboarding
- Challenges
  - No Managed Services Revenue
  - Need VoWi-Fi phone

Small Cell
- Benefits
  - Moderate deployment cost
  - Cellular SLAs
  - Support all phone types
  - Solves indoor coverage
- Challenges
  - Capacity-Need spectrum
  - Multi carrier

Macro
- Benefits
  - Widely deployed
  - Supports all phones
- Challenges
  - Cellular SLA’s
  - High Cost to solve indoor coverage
  - Capacity-May need new Spectrum

Home 52%
Work 33%
Hotspot 10%
On the Go 5%

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

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

Home 52%*
Work 33%*
Hotspot 10%*
On the Go 5%*

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Voice increases from 6% to 34% and Data increases from 2% to 36% with Cisco Solution.
Business Outcome Impact

Financials improve using Cisco’s Mobility Access Solution
What Problems Are We Solving?

Home Consumer
- Improve Wi-Fi Quality
- Reduce Opex on support calls

Service & Operations
- Onboard Millions of Subs
- High Availability
- Common Core Elements

Mobile
- Seamless Mobility and Coverage
- Intelligent Network Offload

Wi-Fi SON

Evolved Packet Core

VoWi-Fi & Small Cells

QoE

Scale

Performance
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**

2. Bearer creation, deletion visibility at SaMOG, ePDG & SDN API at WLC

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**Diagram:**

- **RF Insights**
- **Wi-Fi SON Framework**
- **AAA Receiver**
- **Managed Wi-Fi Access**
  - RG
  - AP
- **Wi-Fi Core**
  - WLC
  - ASR 5500 (SaMOG)
- **Small Cell**
  - SC
- **Cellular Core**
  - ASR 5500 ePDG/Hetnet
  - EPC

- **Wi-Fi Access** (Home, Office, Indoor / Outdoor Hotspots)
- **IMS APN**
- **Enterprise APN**
- **Internet APN**
“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
What is Needed to Meet QoE?

**Before**

**After**
## VoWi-Fi Key Assessment Parameters

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

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