Creating a true carrier-grade WiFi Experience

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Image Source: http://www.gadget.co.za/imageLib/HomePage/WebWorld/wifi.jpg
What does “Carrier Grade WiFi” mean?

**Large Coverage Footprint**
- Outdoor
- SMB (cafes, shops, restaurants, etc.)
- Venues

**Good Bandwidth / Speeds**
- Home internet speeds on the go

**Security**
- 802.1X support
- Federated Access
- Seamless network selection

**Reliable**
- Ability to connect
- Good RF coverage
- Supporting fast handoffs (mobility)

**Easy to Use**
- Rule of 6s
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WiFi deployment approach

Build WiFi coverage in locations where users most likely want to connect

Outdoor
- Aerial strand
- Main streets
- Shop, dine, relax, wait, commute

SMB
- Small business
- Seating areas
- Waiting areas

Residential
- WG CPE
- Home network
- XFINITY WiFi

Venues
- High traffic
- Strategic venue
- ROI targets

CableWiFi
- 5 largest MSOs
- Partner sites
- Federations

Each vertical has unique use cases and user base
WiFi Access Point Configurations

Technologies used to build foundation of carrier class WiFi network

<table>
<thead>
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<th>Outdoor</th>
<th>Current Technology</th>
<th>Roadmap</th>
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Vault mounting option
Complementary Deployment Environments
small & medium business and home gateways significantly extend WiFi presence

*Approximate Philadelphia Coverage

- Outdoor units create initial, essential coverage
- SMB (small & medium business) units extend coverage to indoors and add significant number of new sites
- Home Hotspots utilize home gateways to extend coverage broadly
- Partnerships to extend footprint to out of territory locations
WiFi Deployment Footprint in US

- Boston (with HH)
- Philadelphia (with HH)
- Minneapolis (with HH)
- Washington DC
- San Francisco
- Chicago
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Speed and Throughput

- In the real world... (Some results from simulated tests)

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**Measured Throughput**

The following graph summarizes the measured throughput performance of the SUT at the specified frame sizes in bytes. Higher values indicate better overall performance. If there are more than 15 frame sizes the graph will represent a sample of the frame sizes only.

**Throughput vs. Frame size**

![Graph showing throughput vs. frame size]

The theoretical throughput of the system, as limited by the physical media, is also indicated on the above graph. The SUT throughput should ideally be as close as possible to the indicated theoretical throughput values. **NOTE:** For 11n clients the theoretical maximum assumes the Best Effort AC, AIFSn of 2, and ECWMIn of 4.
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Sample Soft-GRE Architecture Overview
Long term security goals

1. 802.1X

2. Federated Access
How HS 2.0 Works

1. 802.11u-capable AP beacons with HS2.0 support

2. Device probes with HS2.0 support

3. Device selects AP and performs ANQP request to determine what providers are supported, capabilities of the AP, etc.

4. AP responds to ANQP query with requested information

5. Device compares provisioned profile information against HS2.0 data from APs and associates to the best BSSID

Image Source: http://www.interlinknetworks.com/uploaded_images/802.1X-RADIUS-784636.jpg
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How to get good RF at carrier scale

- How to be good neighbors for public and private wifi
- Unlicensed spectrum / co channel interference
- Large number of devices still widely using 2.4

RF Challenges

- Why can’t I connect?
- Dense urban areas have lots of noise!

Image Source: Darrell’s spectrum capture: Times Square, NYC 2012
Dynamic Environment

• No control over buildings, people, materials...
• I can “see” 30 networks and can’t connect

Image Source: http://potd.pdnonline.com/2013/10/22898#gallery-5
Device Support

Device Breakdown*

- Device Type Breakdown
  - iOS 41.25%
  - Android 35.38%
  - Windows 9.21%
  - MacOS 8.76%
  - Unknown 3.08%
  - Linux 1.62%
  - Windows Phone 0.63%
  - Blackberry 0.08%

- Display Sizes
  - 1024x768 34% Laptops, iPads, Android tablets
  - 640x480 16% Larger Android and iPhone 5/s
  - 320x240 47% Older devices
  - 0x0 1%
  - unknown 3%

*Sample size is 1 porchlight (in browser notification system) from 4 different regions, Comcast snapshot sample data
Radio Power by Device

Effective Output Power be device category

- Smartphone 13-18 dBm
- Tablet 17-23 dBm
- Laptop 20-26 dBm

The case to have good mobility support

- 40-60% of all sessions are defined as a mobility event (a known active MAC address appears on a new tunnel endpoint)
- Need to mature fast transitions for secure WiFi in both controller and controller-less architecture
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