

Advantages of Cloud Managed WiFi Performance Testing

Zaib Kaleem

@wlanbook

Work @AccessAgility

Presentation Topics

- Test how network will be used
- Reduce cost to test and retest
- Future proof test sensors/hardware
- Test anytime, anywhere, by anyone
- Using test tools that match device behavior
- Scale testing to network size

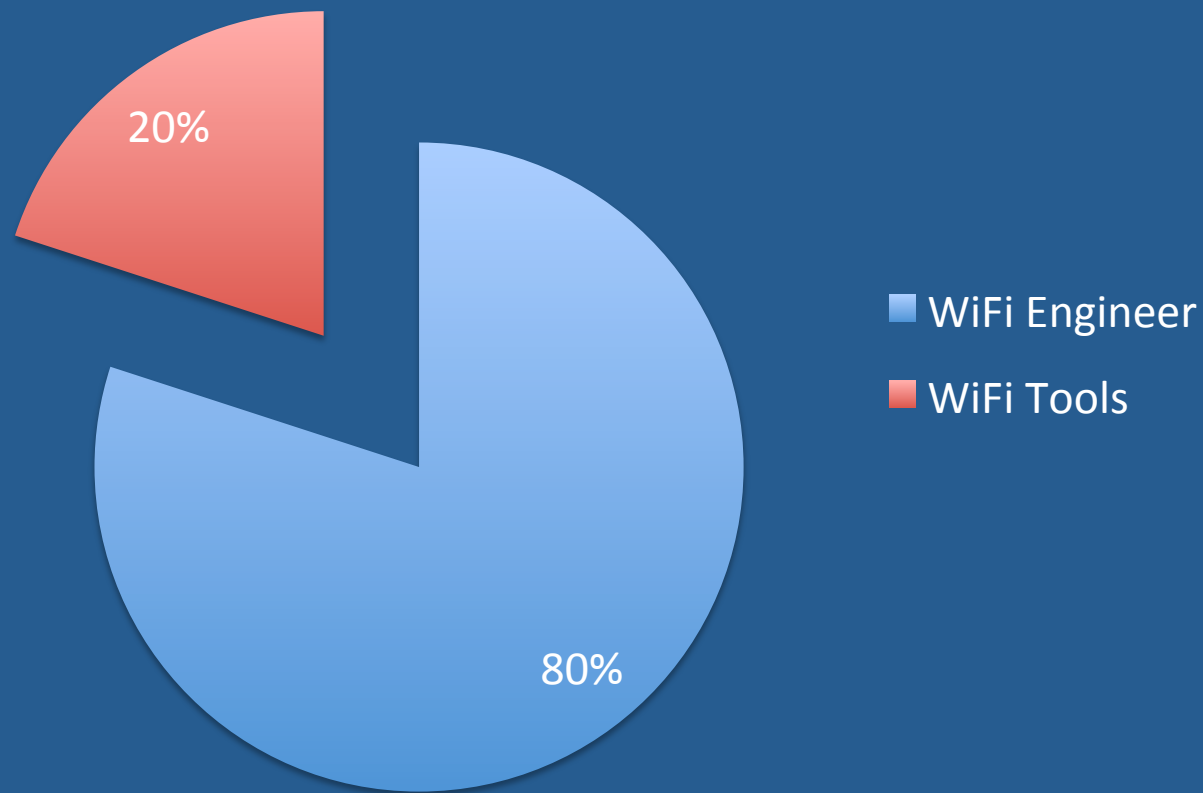


How To Engineer A Positive WiFi Experience?

Plan for how network will be used.
Design for those scenarios and test with
as many scenarios and devices as
possible.

How I Spend My Work Day

Time



Network Information Available Per Operating System*

Operating System	Throughput	Packet Loss	Delay	SSID	BSSID	Channel	Signal	Security	PHY Mode	Channel Width	Streams	Noise
Mac OS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes (Derived)	Yes	Yes	Yes
iOS Jailbreak	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes (Derived)	Yes	Yes	Yes
Windows	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Sometimes	Sometimes	No
Android	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Sometimes	Sometimes	No
iOS AirPort Utility App	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No
iOS (Developer)	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No

Derived = if max rate is 1300 Mbps, must be 11ac

Sometimes = depends on device model, chipset, OS version

*native operating system drivers

WiFi Engineer's Job Is Not Getting Easier

Predicting How Network Will Be Used Is
Difficult

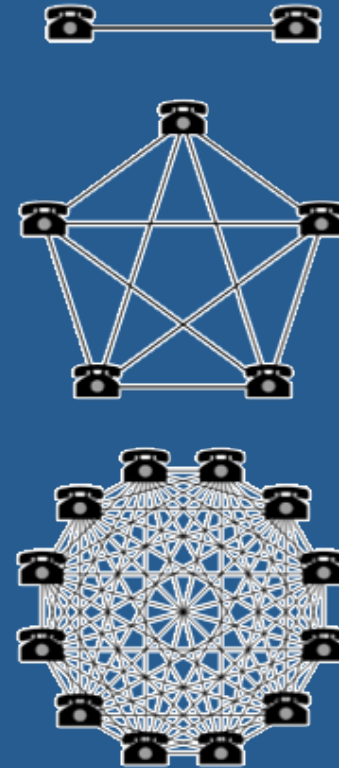
+

Bar Is Set At Home WiFi Experience

Mobile/Portable and Connected

Moore's Law 1965 – Processing power doubles every 18 months. (now doubling every three years)

Metcalfe's Law 1993 - Value of any network increases exponentially with the number of users.



McGuire's Law

"The value of any product or service increases with its mobility." - McGuire's Law 2005



What could possibly be wrong?

People Expect Free, Fast, Unrestricted WiFi Everywhere



Allie Van Dine @allie_vandine

21m

dammit **amtrak** why you blockin' my **netflix** #rude

Expand



Hillary @cookie_wolf

42m

@**Amtrak** blocked **Netflix**. I still have 2-3 more hours left on this train. I can't watch Doctor Who now. Why.

Expand



Matrika @MatrikaBT

16 May

oh my god....**NETFLIX** is blocked by @**Amtrak** wireless. Whhhhhhhhhhyyyyyyy?!?

Followed by Barack Obama and 1 other

Expand



Amtrak @Amtrak

15 May

@lesliego **Amtrak** currently has limited bandwidth. Therefore, we must block streaming media sites like **Netflix** and Hulu at this time.

View conversation



Leslie Goldman @lesliego

15 May

Why is **Netflix** blocked on **Amtrak**'s wireless? #amtrak







Followed by Nat Ives and 4 others

Expand



Bar Is Set At Home WiFi Experience

MY SPEEDTEST RESULT Mail

 DOWNLOAD 83.11 Mb/s	 UPLOAD 86.17 Mb/s
 PING: 15 ms	 RATING: ★★★★★
 CARRIER ★★★★★ VERIZON FIOS	 SERVER ASHBURN, VA

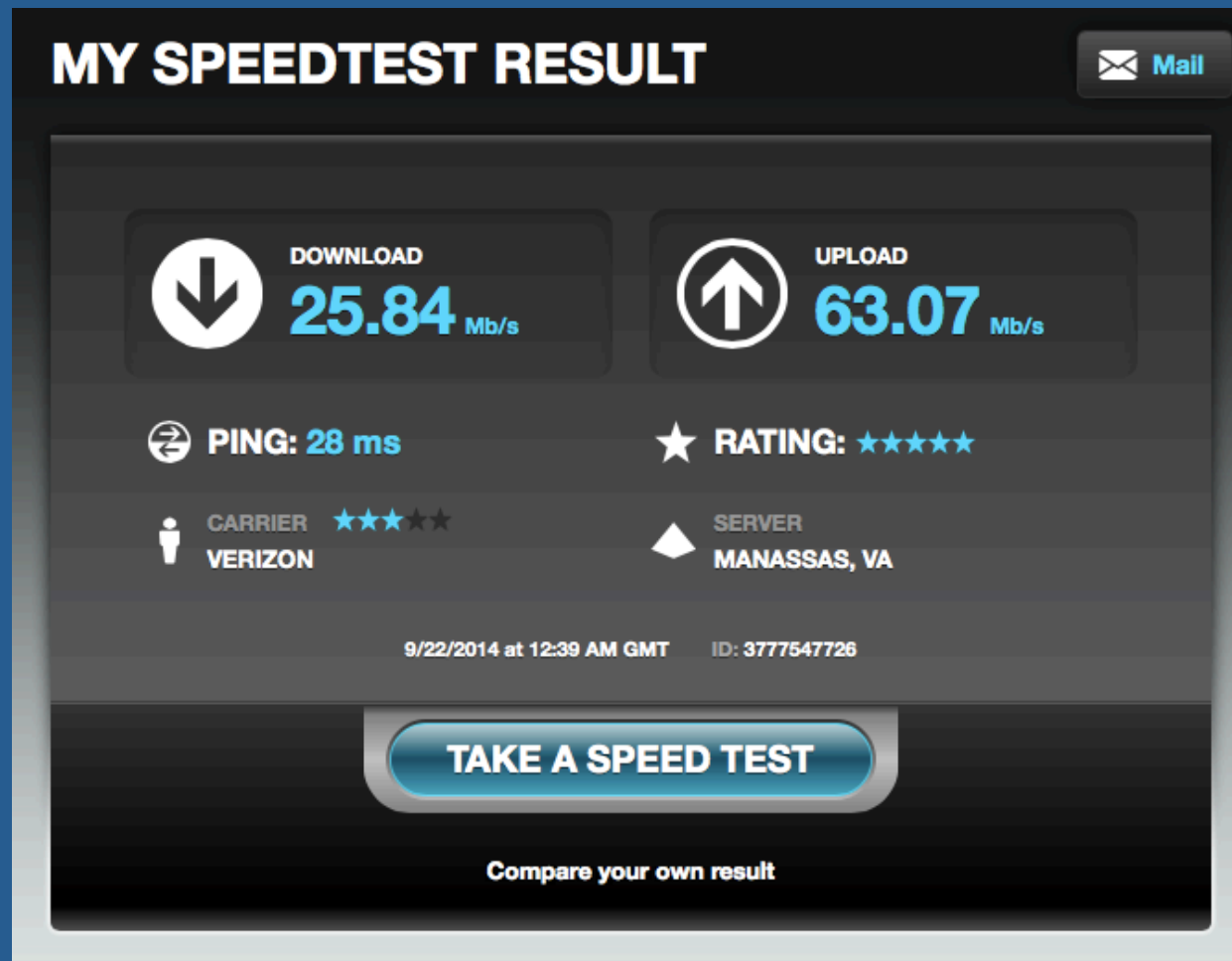
9/21/2014 at 4:56 PM GMT ID: 3776831205

TAKE A SPEED TEST

Compare your own result

Actual test from on my home wireless network. MacBook Air 2013, 3 stream 11ac access point, 8 feet
<http://www.speedtest.net/my-result/3776831205>







Airport (DCA) < Home WiFi Internet



<http://www.speedtest.net/my-result/3777547726>, MacBook Air 2013
Connected to 5 GHz, 40 MHz

Hotel WiFi < Home WiFi Internet

MY SPEEDTEST RESULT Mail

 DOWNLOAD 0.96 Mb/s	 UPLOAD 0.90 Mb/s
 PING: 60 ms	 RATING: ★★★★★
 CARRIER ★★★★★ AT&T WI-FI SERVICES	 SERVER KANSAS CITY, MO

9/22/2014 at 2:23 PM GMT ID: 3778796815

TAKE A SPEED TEST

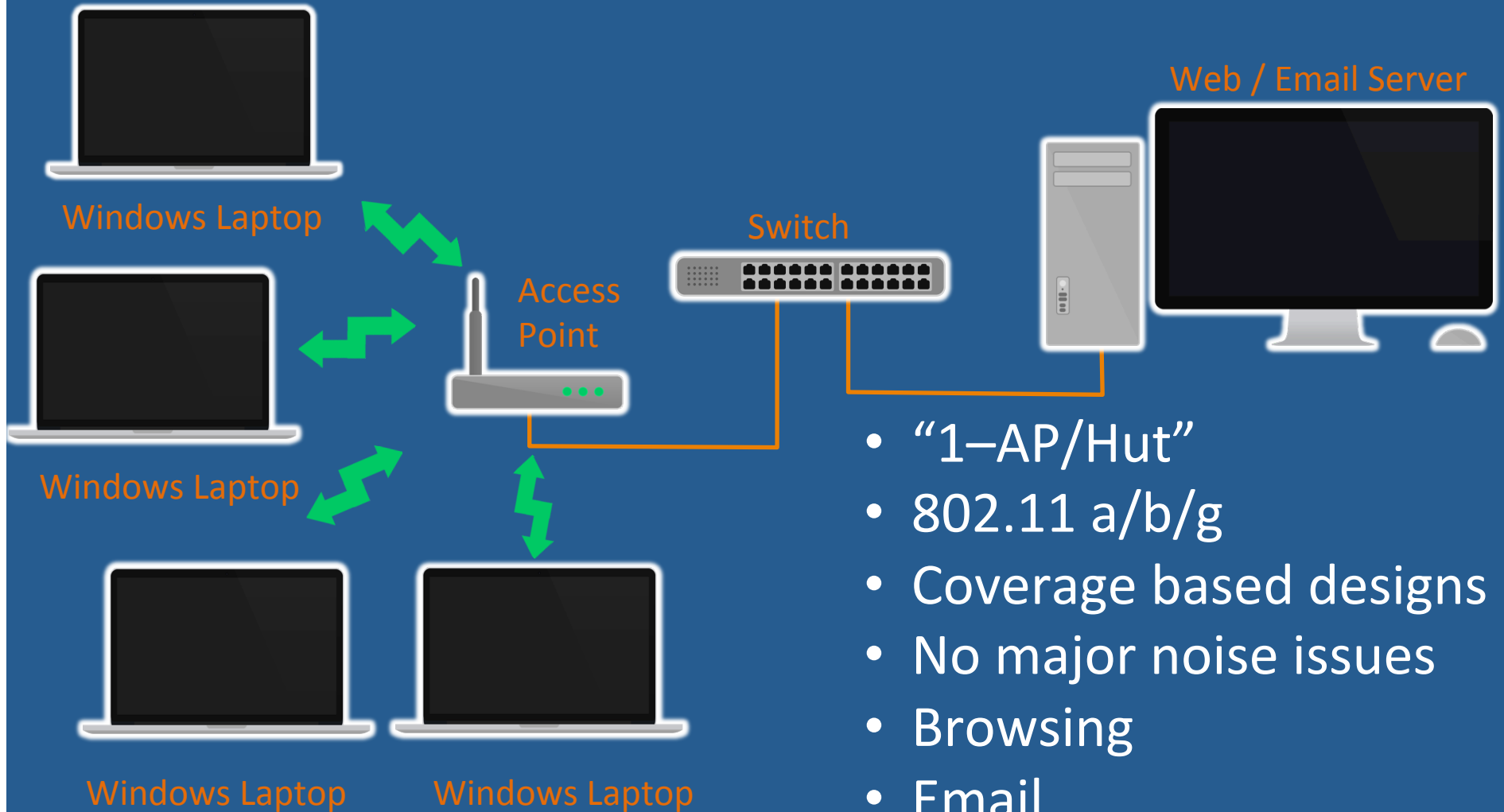
Compare your own result

<http://www.speedtest.net/my-result/3778796815>

WiFi Networks Have Changed

Design, Troubleshooting, and Testing
Techniques, and Tools Need to Keep Up

WiFi Networks 10 Years Ago Were Mainly Portable Devices (Laptops)



- “1-AP/Hut”
- 802.11 a/b/g
- Coverage based designs
- No major noise issues
- Browsing
- Email
- File Transfer

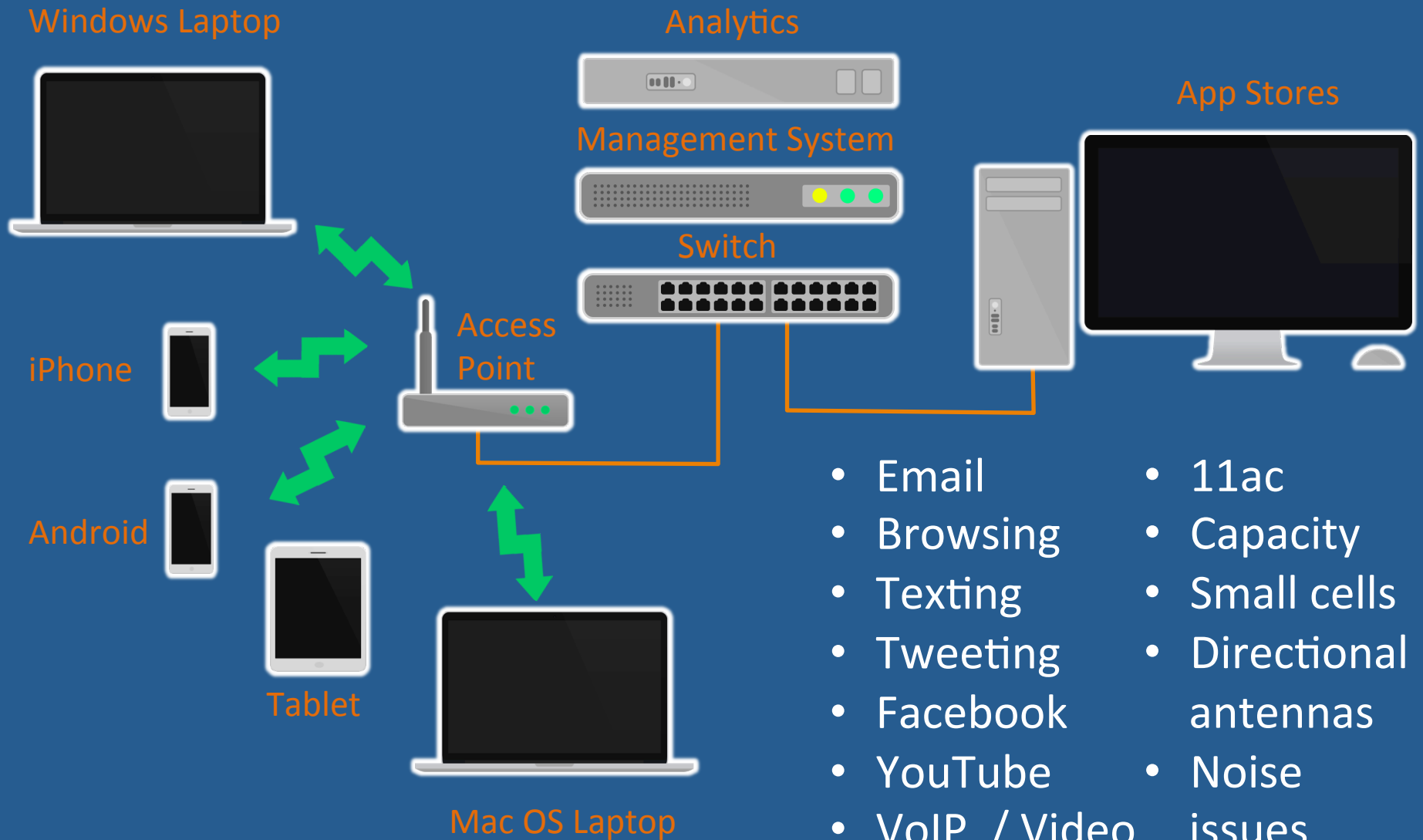
WiFi Scan/Survey + Speed Test + Adjust Placement + Configuration Tweaks (Repeat)

The screenshot displays the configuration interface for a Cisco WRT300N Wireless-N Broadband Router. The main navigation bar includes 'Wireless', 'Setup', 'Wireless', 'Security', 'Access Restrictions', 'Applications & Gaming', 'Administration', and 'Status'. The sub-navigation bar shows 'Basic Wireless Settings', 'Wireless Security', 'Wireless MAC Filter', and 'Advanced Wireless Settings'. The 'Basic Wireless Settings' section is active, showing the following configuration options:

- Network Mode: Mixed (Annotation i)
- Network Name (SSID): Default (Annotation ii)
- Radio Band: Auto (Annotation iii)
- Wide Channel: Auto (Annotation iv)
- Standard Channel: Auto (Annotation v)
- SSID Broadcast: Enabled Disabled (Annotation vi)

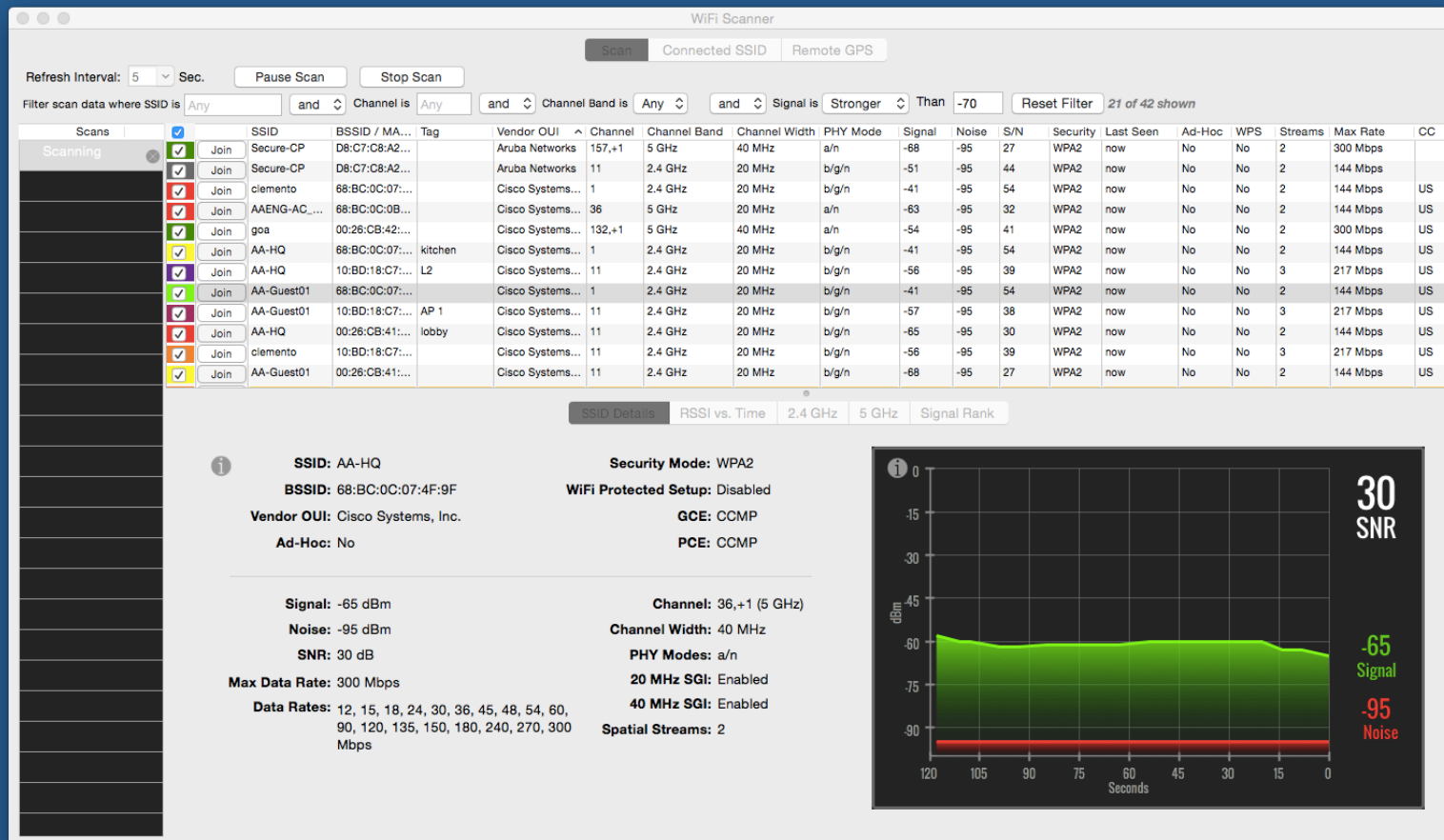
At the bottom of the page, there are 'Save Settings' and 'Cancel Changes' buttons. The Cisco Systems logo is visible in the bottom right corner.

WiFi Networks Today Are Mainly Mobile Devices (Tablets & Smartphones)



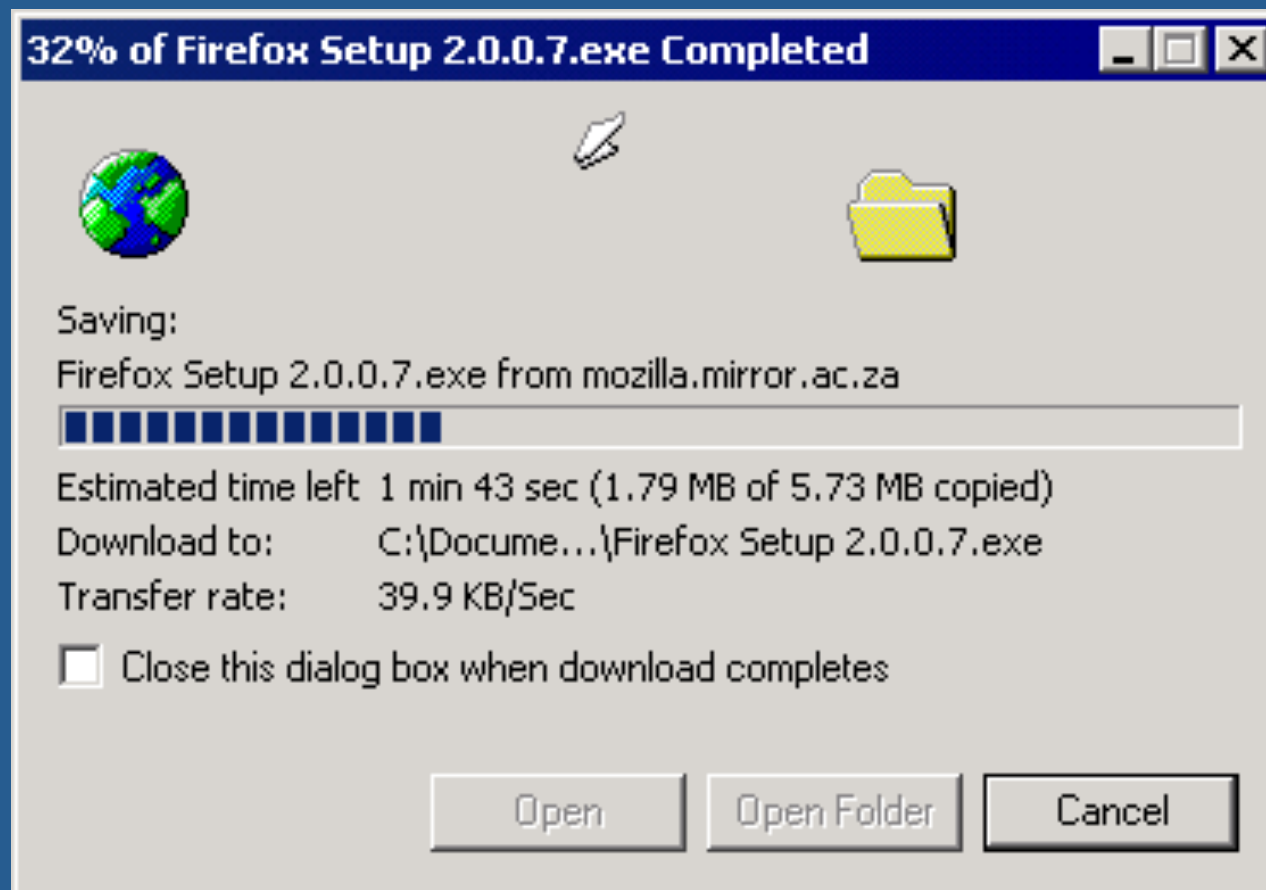
Old/Current Way Still Works + Add Mobile Testing Too

1) RF Survey



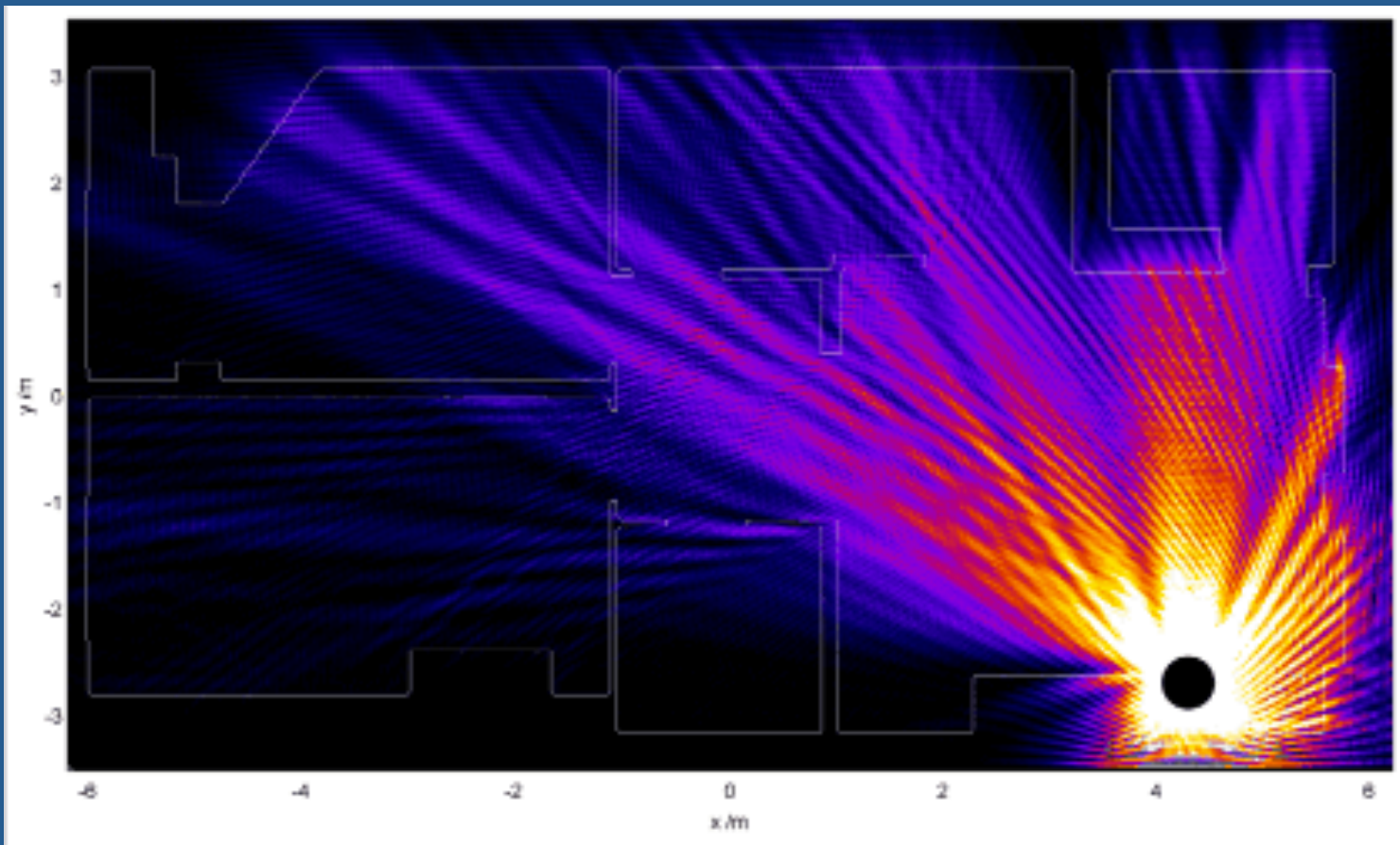
Old/Current Way Still Works + Add Mobile Testing Too

2) Throughput Testing



Old/Current Way Still Works + Add Mobile Testing Too

3) Spectrum analysis



Old/Current Way Still Works + Add Mobile Testing Too

4) Tune configuration

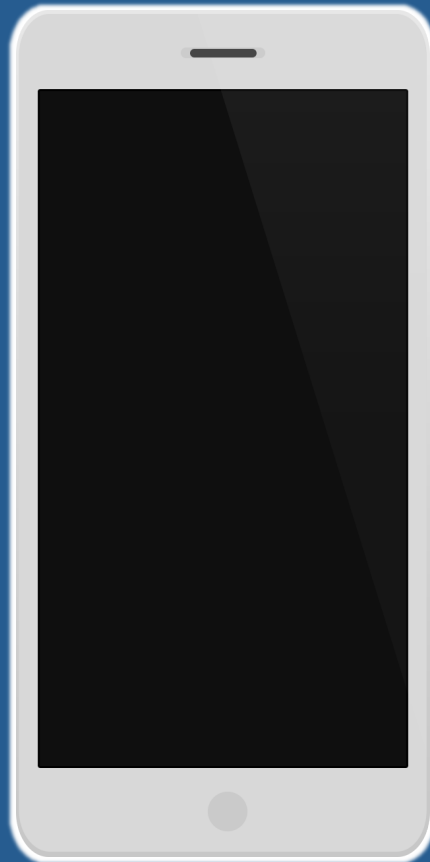
The screenshot displays the configuration interface for a Cisco WRT300N Wireless-N Broadband Router. The page is titled "Wireless" and includes a navigation menu with tabs for Setup, Wireless, Security, Access Restrictions, Applications & Gaming, Administration, and Status. The "Wireless" tab is active, and the "Basic Wireless Settings" sub-tab is selected. The settings are as follows:

- Network Mode: Mixed (annotated with **i**)
- Network Name (SSID): Default (annotated with **ii**)
- Radio Band: Auto (annotated with **iii**)
- Wide Channel: Auto (annotated with **iv**)
- Standard Channel: Auto (annotated with **v**)
- SSID Broadcast: Enabled Disabled (annotated with **vi**)

Red arrows point from the annotations **i** through **vi** to their respective settings. At the bottom of the page, there are buttons for "Save Settings" and "Cancel Changes". The Cisco Systems logo is visible in the bottom right corner.

Old/Current Way Still Works + Add Mobile Testing Too

5) Add mobile device testing



Challenges With Today's Mobile Devices

- WiFi is primary access method to data network and Internet
- Mixed WiFi capabilities
 - 11b, 2.4/5 GHz 11n, 11ac
 - Radio power, frequency support, roaming, battery, throughput
- Multiple operating systems (iOS, Android, Windows, Mac OS)
- Different versions of operating systems
- Bandwidth intensive applications

How Many Different Devices Should Be Tested?



iPhone / iPad Models and iOS Versions

iPad:

- 📱 iPad Air (Model A1474)
- 📱 iPad Air (Model A1475)
- 📱 iPad Air (Model A1476)
- 📱 iPad mini (Model A1489)
- 📱 iPad mini (Model A1490)
- 📱 iPad mini (Model A1491)
- 📱 iPad (4th generation Model A1458)
- 📱 iPad (4th generation Model A1459)
- 📱 iPad (4th generation Model A1460)
- 📱 iPad mini (Model A1432)
- 📱 iPad mini (Model A1454)
- 📱 iPad mini (Model A1455)
- 📱 iPad Wi-Fi 3rd generation
- 📱 iPad Wi-Fi + Cellular (model for ATT)
- 📱 iPad Wi-Fi + Cellular (model for Verizon)
- 📱 iPad 2 Wi-Fi
- 📱 iPad 2 Wi-Fi (Rev A)
- 📱 iPad 2 Wi-Fi + 3G (GSM)
- 📱 iPad 2 Wi-Fi + 3G (CDMA)

iPhone:

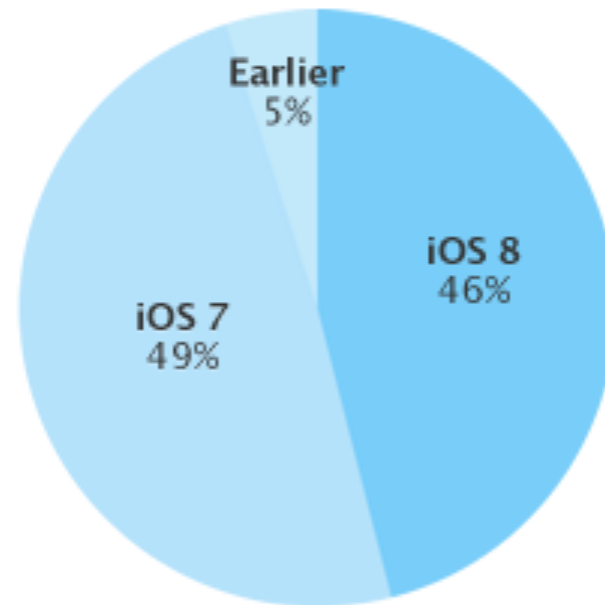
- 📱 iPhone 5s (Model A1453, A1533)
- 📱 iPhone 5s (Model A1457, A1518, A1528, A1530)
- 📱 iPhone 5c (Model A1456, A1532)
- 📱 iPhone 5c (Model A1507, A1516, A1526, A1529)
- 📱 iPhone 5 (Model A1428)
- 📱 iPhone 5 (Model A1429)
- 📱 iPhone 4s
- 📱 iPhone 4 (GSM)
- 📱 iPhone 4 (GSM Rev A)
- 📱 iPhone 4 (CDMA)

iPod touch:

- 📱 iPod touch (5th generation)

**30+ models of iPhone/
iPads that support iOS
7 or later**

**46% of devices are using
iOS 8.**



As measured by the App Store
on September 21, 2014.

Licensed and Unlicensed Google Play / Android Devices

Google Play Services ⓘ

- Initial Account Setup
- Google Maps APIs
- Play Games API
- Location APIs
- Malware Scanner
- In-App Billing
- Account authentication
- Account syncing
- Google+ Sign-in
- Google+ sharing APIs
- Google+ photo syncing
- Photosphere support
- Remote location
- Remote Wipe
- Google Settings app
- Cloud to Device Messaging

OEM pay \$75,000 for 100,000 devices, or 75¢ per device (Guardian article)

Play Store ⓘ

- Search/Now
- Calendar
- Keyboard
- Chrome
- Maps
- Gmail
- Hangouts
- Google+
- Drive
- Play Books
- Play Music
- Play Movies
- Play Magazines
- Play Games
- Voice
- Keep
- YouTube
- Wallet
- Gapps Device Policy

Android ⓘ

- Phone app
- Settings
- Lock Screen
- SystemUI
(Button bar, Notification panel)
- Application Framework & APIs
- Linux Kernel & Drivers
- Hardware support

Only “open source”, free part of Android

Google OEM Licensed Devices and Models

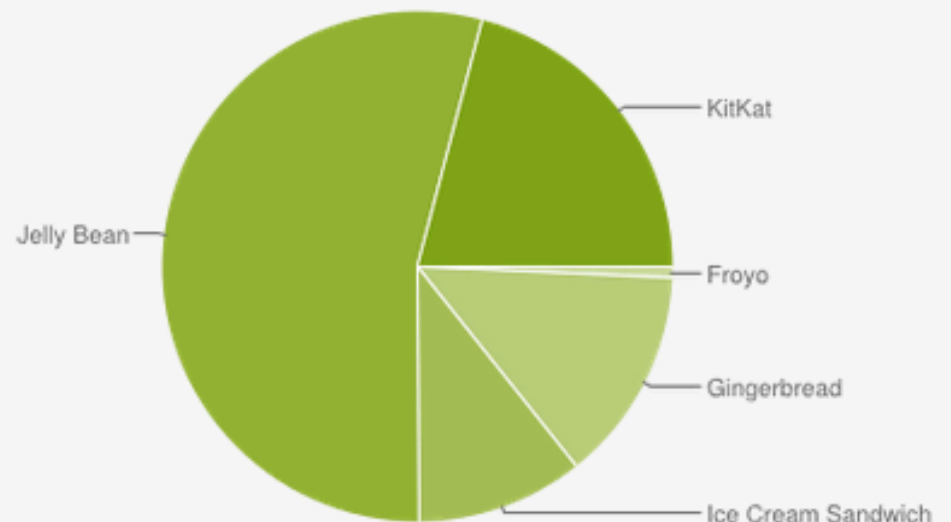
DEVICE COMPATIBILITY [Learn more](#)

All devices (7012)

Find device

**7000+ Android Phone and Tablet Models
Approved for Google Play Store as of
August 2014**

Version	Codename	API	Distribution
2.2	Froyo	8	0.7%
2.3.3 - 2.3.7	Gingerbread	10	13.6%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	10.6%
4.1.x	Jelly Bean	16	26.5%
4.2.x		17	19.8%
4.3		18	7.9%
4.4	KitKat	19	20.9%



*Data collected during a 7-day period ending on August 12, 2014.
Any versions with less than 0.1% distribution are not shown.*

High OS Fragmentation

Non Google Licensed Android Devices

- Thousands of generic media player models
- Thousands of low cost tablet models
- Amazon devices (Kindle Fire, Fire TV, Fire Phone)

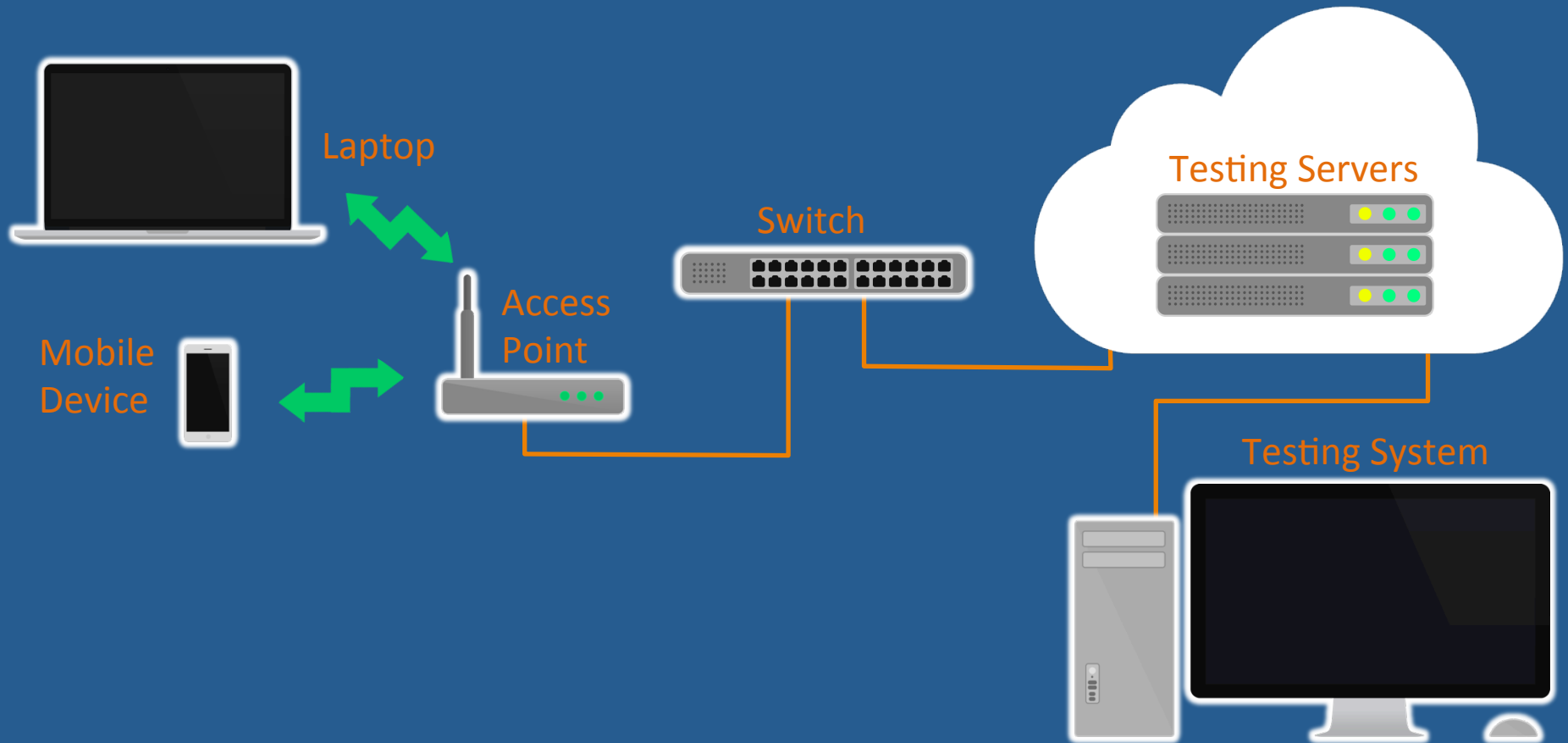


Rethink Testing

Cloud + Apps + Proximity + Users

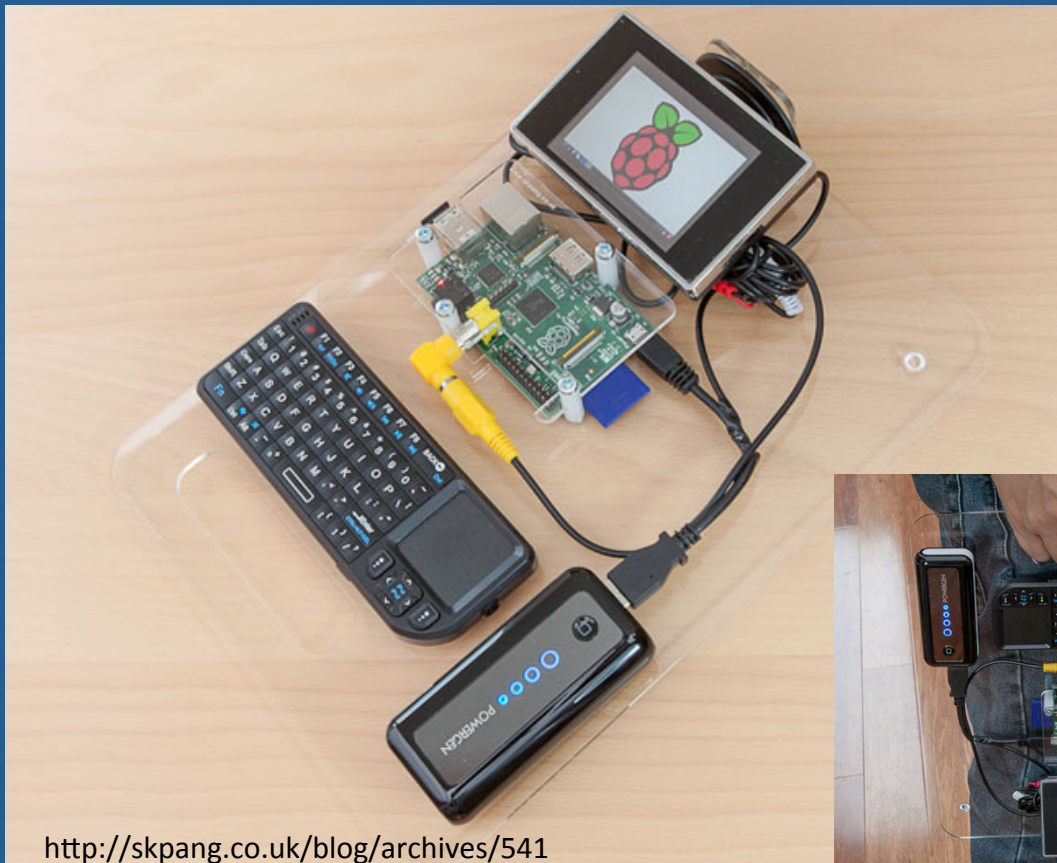
Connected: Move Testing System to Cloud

- Test 24/7 via Internet
- Reduce need for internal servers
- Spread cost of solution across multiple users/organizations
- Reduced hardware, software, and time required to maintain servers

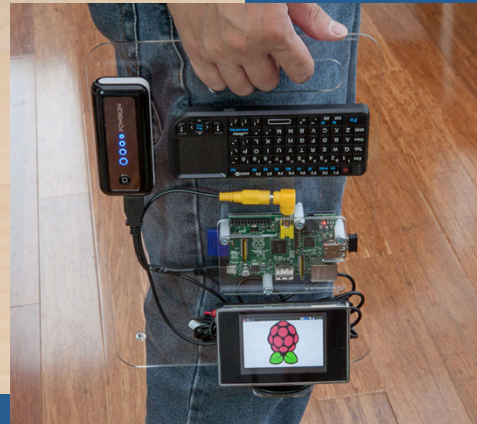


Portable: Use Mobile Devices for Testing

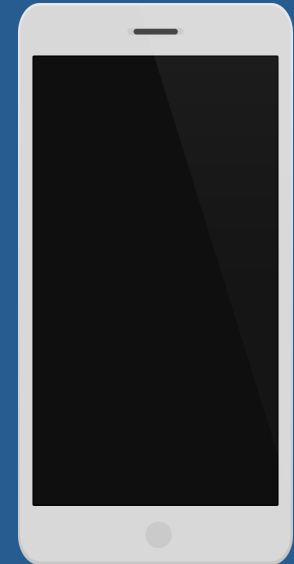
- Best to test with devices that will be deployed or expected on network
- Avoid using/building a device you will not see on network



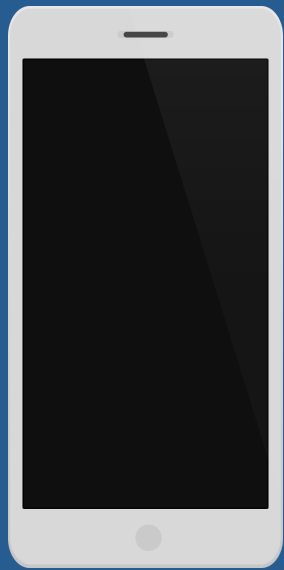
<http://skpang.co.uk/blog/archives/541>



!



Simple: Test Anytime, Anywhere, By Anyone



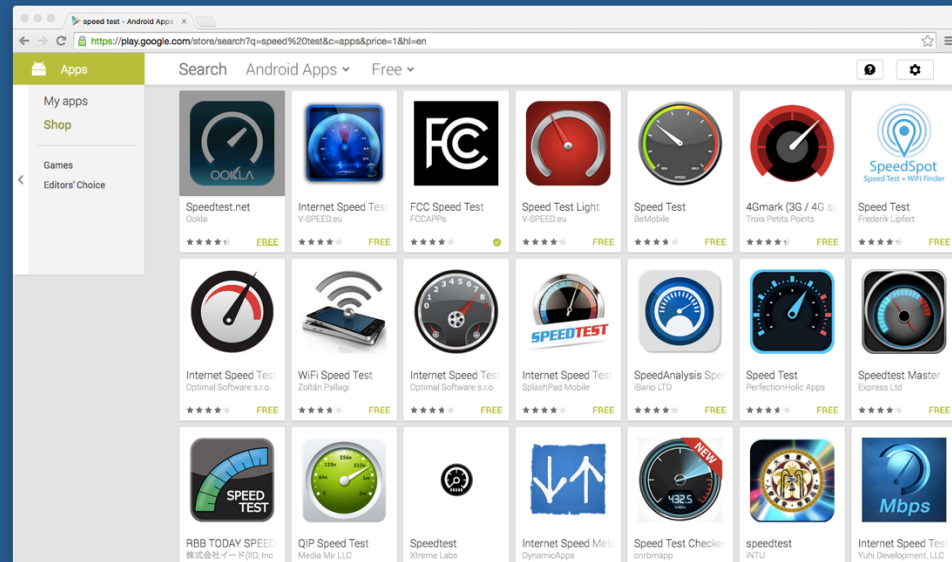
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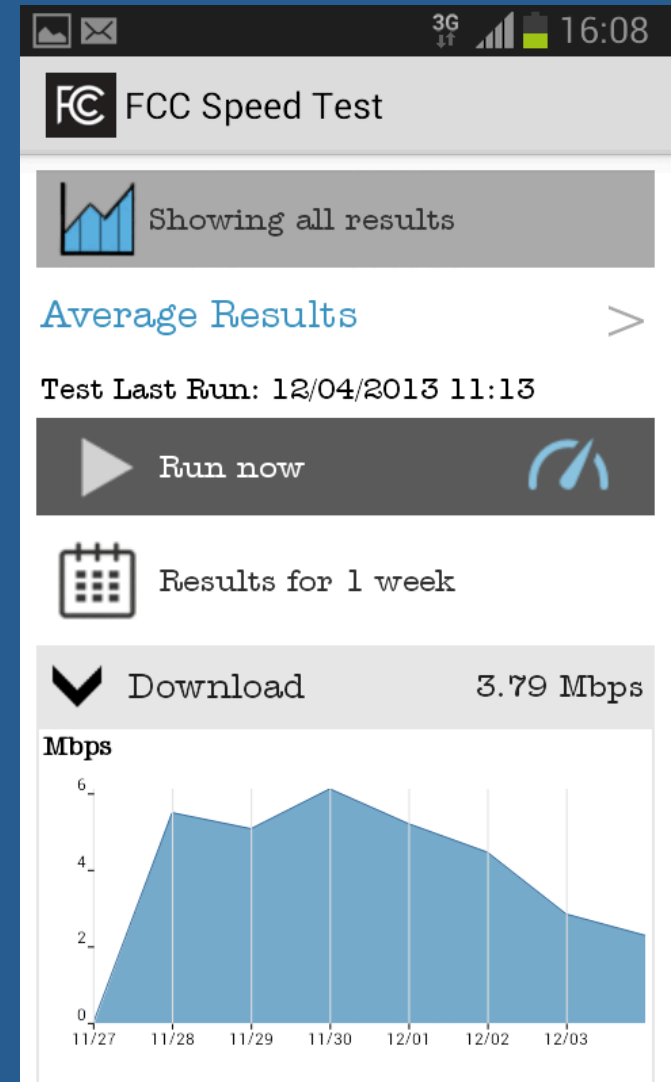


50+ free apps
on Google Play
store for speed
testing



Standalone Speed Testing Tools

- “Speed testing” apps great start for home use or quick view of speed in select areas
- Store test on device data for analysis over time
- Email/export results
- Social media sharing of results

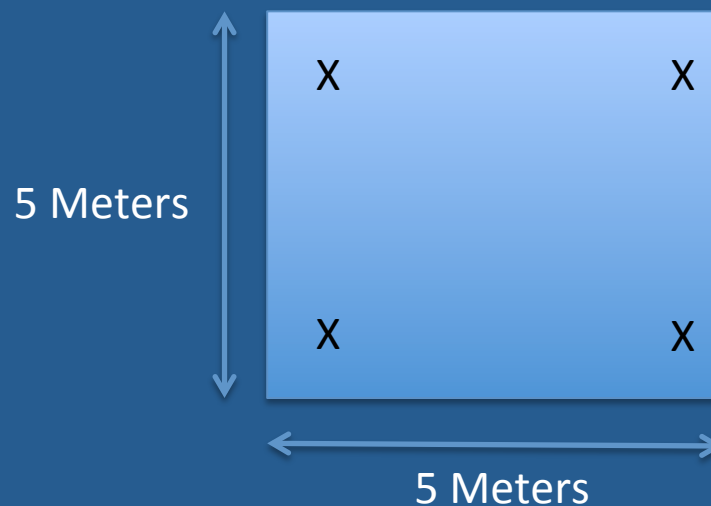


Manually Scaling Mobile Testing Tools

Collect More Data Points

- Enough test locations to match potential user locations and signal variations in survey area

Building1.Floor1.Room1.Left



More Testers

- Depends on size of area
- Record data in format that allows summarization
- Collect as many data types as possible (RSSI, noise, throughput, etc.)

Location ID	Tester 1	Tester 2	Tester 3	Tester 4	Min	Max	Avg.
A.B.C.D Format							
Building1.Floor1.Room1.Cube1							
Building1.Floor1.Room1.Cube2							
Building1.Floor1.Room1.Cube3							
Building1.Floor1.Room2.Left							
Building1.Floor1.Room2.Right							
Building1.Floor2.Room1.Cube1							
Building1.Floor2.Room1.Cube2							

A photograph of a lighthouse on a rocky cliff at dusk. The lighthouse is white with a black top and has a beam of light shining across the sky. To the left of the lighthouse is a large white house with a red roof. The sky is a deep blue with some clouds. The ocean is visible in the background, and the foreground is a rocky shore with waves crashing against the rocks.

**Demo: Intelligently Scaling
Performance Testing Data Collection**

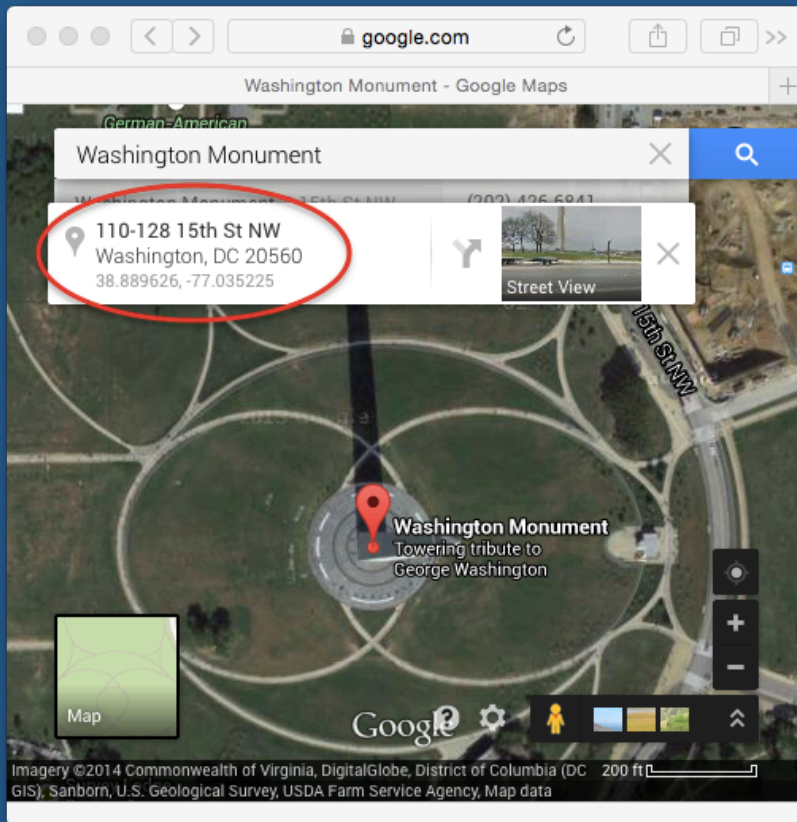
iBeacons for Proximity

- Bluetooth 4.0
 - 2.402 GHz to 2.480 GHz range
 - Frequency hopping (1600 times per second)
 - 79, 1 MHz wide channels overlap 802.11 channels 1-12
 - Classic Bluetooth (keyboards, mouse, flash drives)
 - Bluetooth high speed
 - Bluetooth low energy (BLE)
 - Bluetooth LE (BLE) specification used to create chipsets
 - » Chipsets are used in devices
 - iBeacons – devices that meet Apple's proximity specification
 - UUID
 - Major
 - Minor

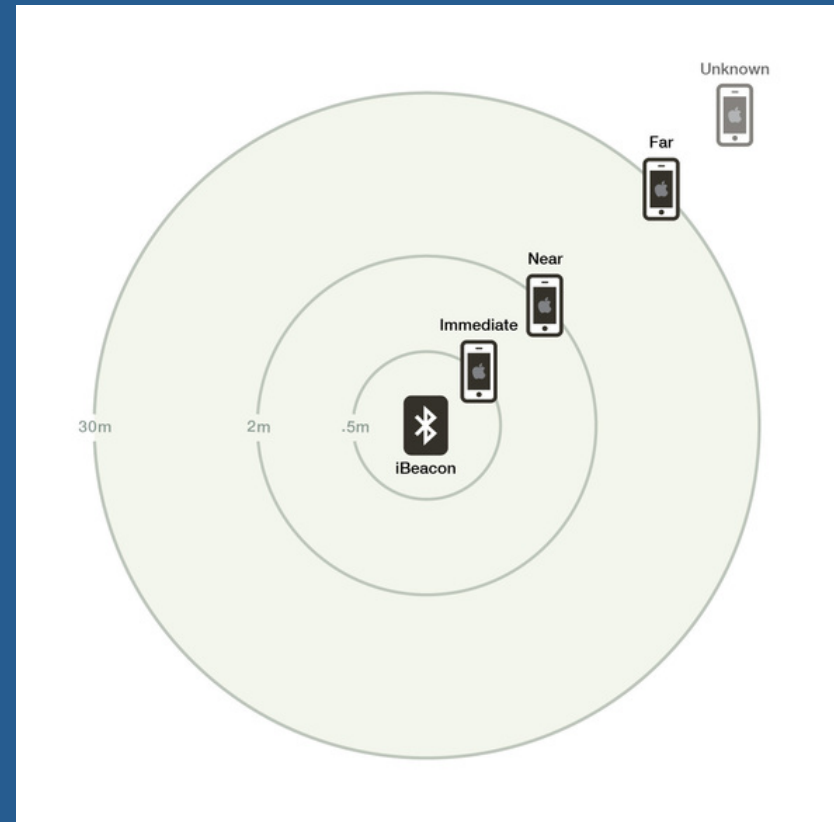


Location vs. Proximity

- GPS provides location



- iBeacons provide proximity



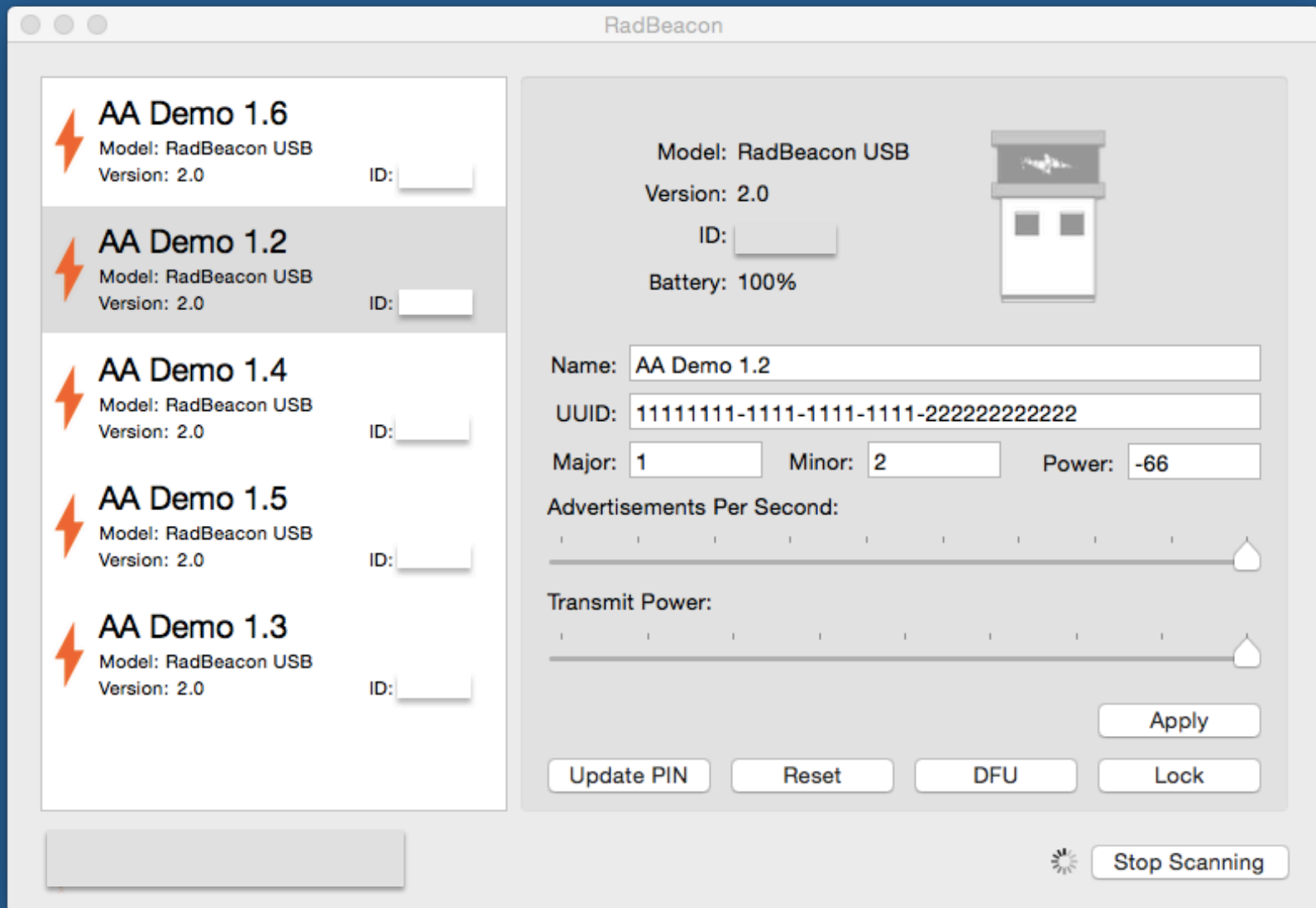
Adding Proximity to Testing Using iBeacons

- UUID, **major**, **minor** values to creation location structure
- UUID - 11111111-1111-1111-1111-222222222222 (Location ID)
- **Major – 1 (Building 101)**
- **Minor – 2 (Conf. Room)**
- Minor – 3 (Server Room)
- Minor – 4 (Break Room)
- Minor – 5 (Lobby)
- Minor – 6 (Storage)



Small USB powered
iBeacon - \$29 / each

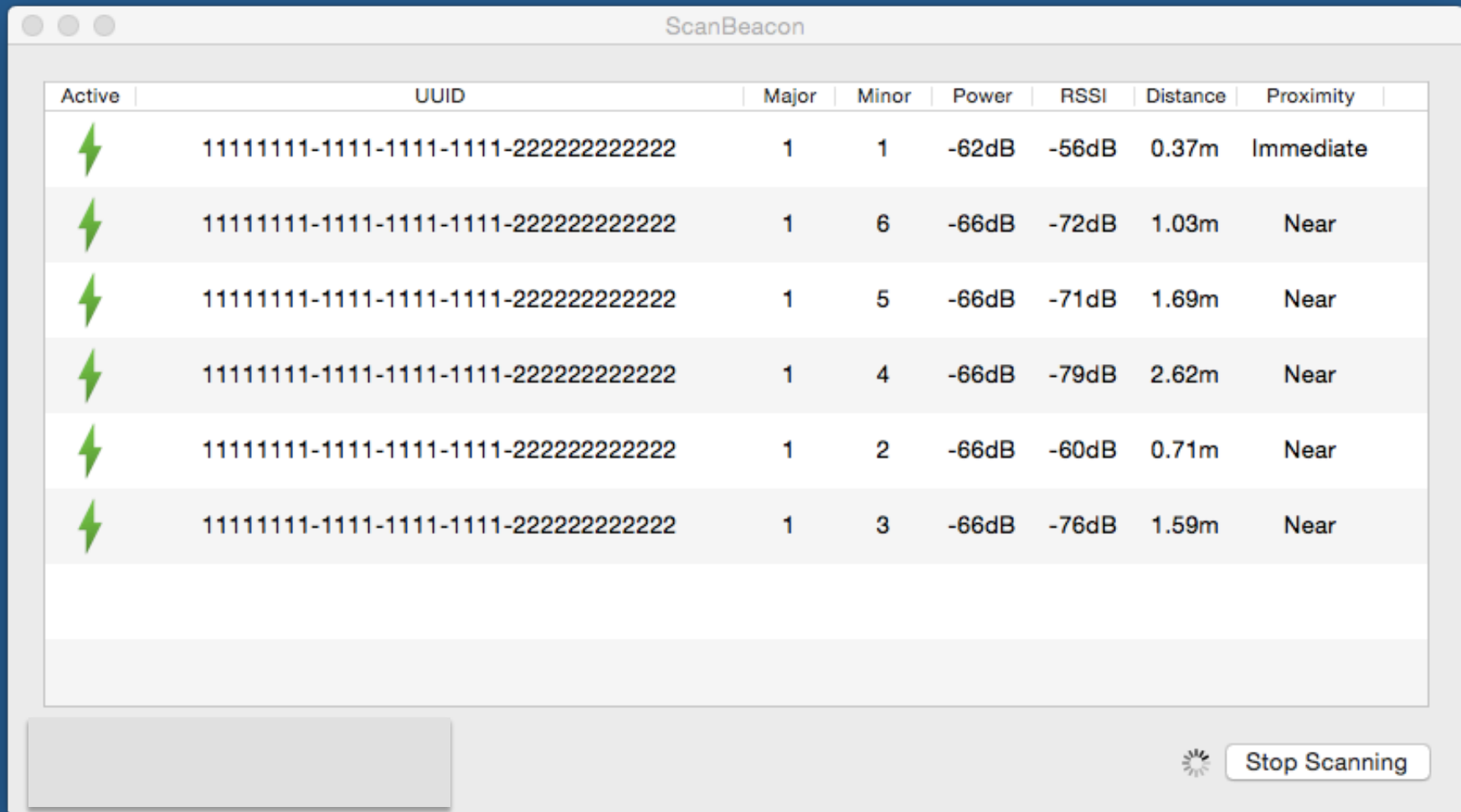
Configure iBeacons Using Manufacturer Utility









Place iBeacons At Desired Locations



Confirm iBeacon Setting Using Scanner

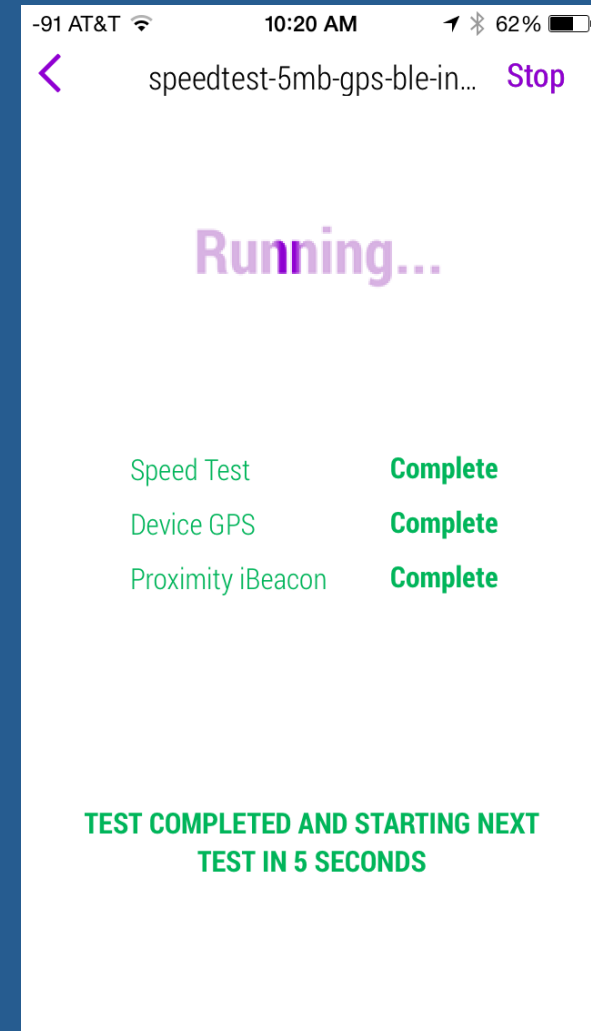


The screenshot shows a window titled "ScanBeacon" with a table of detected iBeacons. The table has columns for Active status, UUID, Major, Minor, Power, RSSI, Distance, and Proximity. There are six rows of data, each with a green lightning bolt icon in the Active column. At the bottom right, there is a "Stop Scanning" button with a loading icon.

Active	UUID	Major	Minor	Power	RSSI	Distance	Proximity
	11111111-1111-1111-1111-222222222222	1	1	-62dB	-56dB	0.37m	Immediate
	11111111-1111-1111-1111-222222222222	1	6	-66dB	-72dB	1.03m	Near
	11111111-1111-1111-1111-222222222222	1	5	-66dB	-71dB	1.69m	Near
	11111111-1111-1111-1111-222222222222	1	4	-66dB	-79dB	2.62m	Near
	11111111-1111-1111-1111-222222222222	1	2	-66dB	-60dB	0.71m	Near
	11111111-1111-1111-1111-222222222222	1	3	-66dB	-76dB	1.59m	Near

Demo: Proximity Aware WiFi Testing Using iBeacons

- Test
 - Launch App
 - Put smartphone in pocket
 - Walk to various locations
 - App performs test
 - WiFi scan
 - Speed test
 - Proximity / iBeacon scan
 - Save results
 - Upload to cloud server
 - Repeat



Results Logged Including Detected iBeacons

Dashboard | Wireless Scan | Performance | Configuration | Account | ↻ | Last Updated: 10:2

Beacons

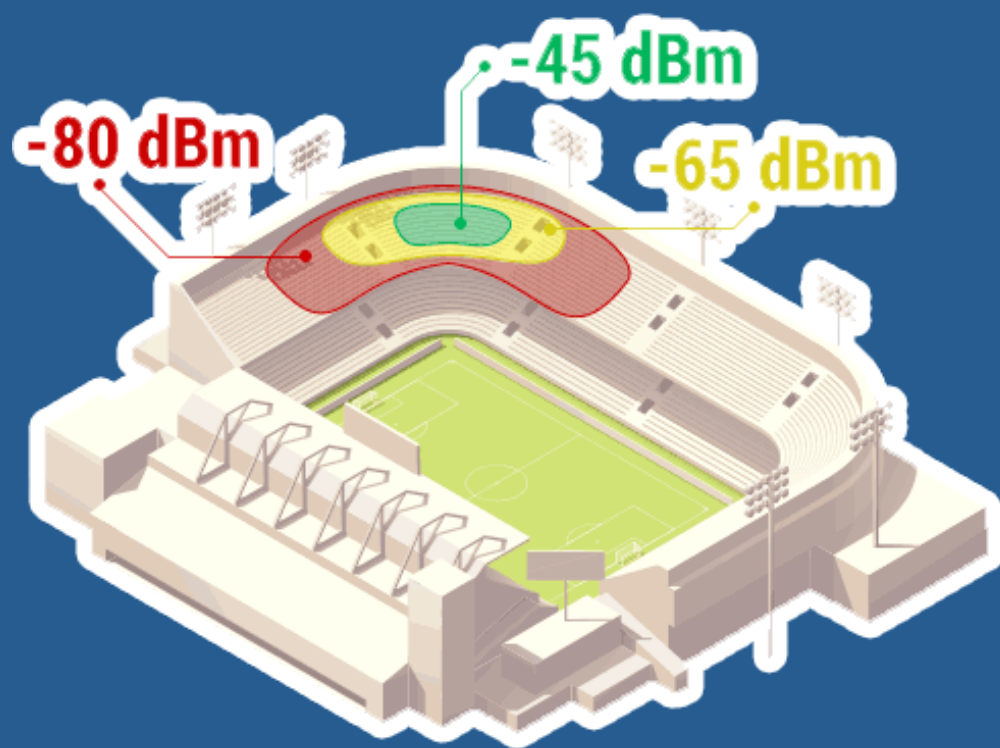
- [-] [✓] [📁] H00K95
 - [-] [✓] [📁] 11111111-1111-1111-1111-222222222222
 - [-] [✓] [📁] 1
 - [-] [✓] [📁] 3
 - [✓] [📱] iPho
 - [✓] [📱] iPhone (-78)
 - [-] [✓] [📁] 2
 - [✓] [📱] iPhone5cdma (0)
 - [✓] [📱] iPhone (0)
 - [-] [✓] [📁] 1
 - [✓] [📱] iPhone5cdma (0)
 - [✓] [📱] iPhone (-58)
 - [-] [✓] [📁] 6
 - [✓] [📱] iPhone5cdma (0)
 - [✓] [📱] iPhone (0)
 - [-] [✓] [📁] 5
 - [✓] [📱] iPhone5cdma (0)
 - [✓] [📱] iPhone (0)
 - [-] [✓] [📁] 4
 - [✓] [📱] iPhone5cdma (0)
 - [✓] [📱] iPhone (-74)

Summary | Speed Test

Agent Name	BSSID	SSID	Channel	Download Speed
iPhone	68:BC...	AA-HQ	52	46.4 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	45 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.89 Mbps
iPhone	68:BC...	AA-HQ	52	44.72 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.61 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.46 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.4 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.38 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.38 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.3 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.28 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.28 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.27 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.23 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.18 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.14 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.13 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.13 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.12 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.06 Mbps
iPhone5cdma	68:BC...	AA-Guest01	52	44.05 Mbps

11111111-1111-1111-1111-222222222222 - Right click for more options

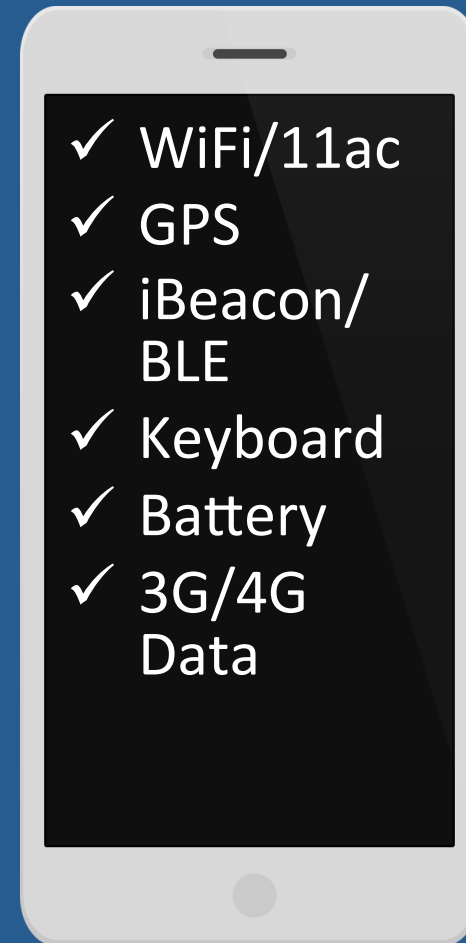
What About Very Large Networks?



- How many data points are enough?
 - Collect at every seat/classroom/desk?
 - Multiple times per location?
 - Before event/school/work?
 - During event/school/workday?
- Collect data from multiple testers
 - Location of tester
 - Internet and local speed testing
 - Summarize data
- What to collect?
 - Coverage area (RSSI & SNR)
 - Channel Info (ACI & CCI)
 - Throughput
 - Latency

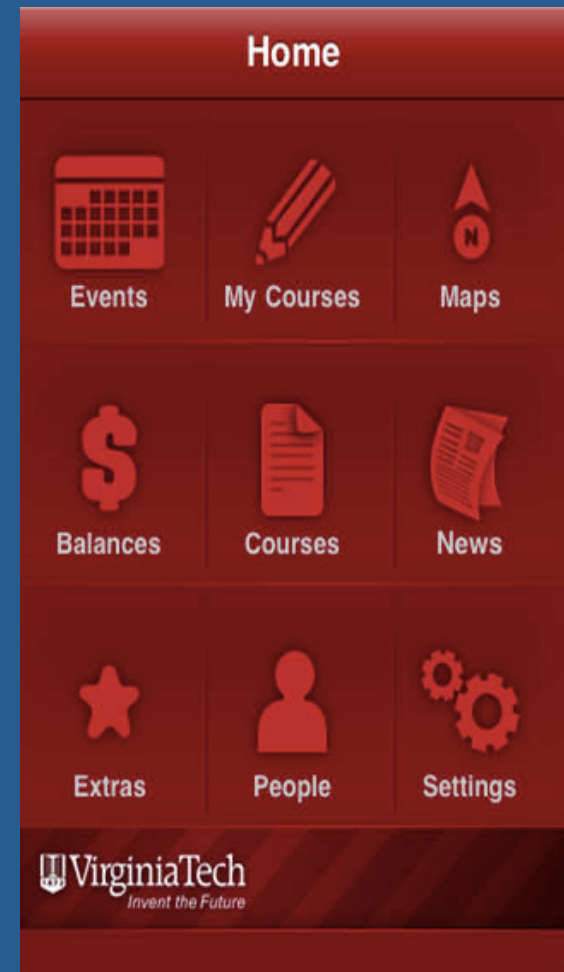
Ideal Network Testing Sensor

- Mobile / Portable
- Low cost
- Match user devices
- Match user behavior
- Other sensors
 - Touch ID
 - Barometer
 - Three-axis gyro
 - Accelerometer
 - Proximity sensor
 - Ambient light sensor



Who Should Test?

- ~~Small internal group of testers~~
- Actual users with user's mobile device
- Incentivized models work
 - Waze – Real-time traffic and road info
 - Speedtest.net – ISP speeds
 - OpenSignal – Cell tower signals
- Embed into existing apps
 - School/fan/company apps

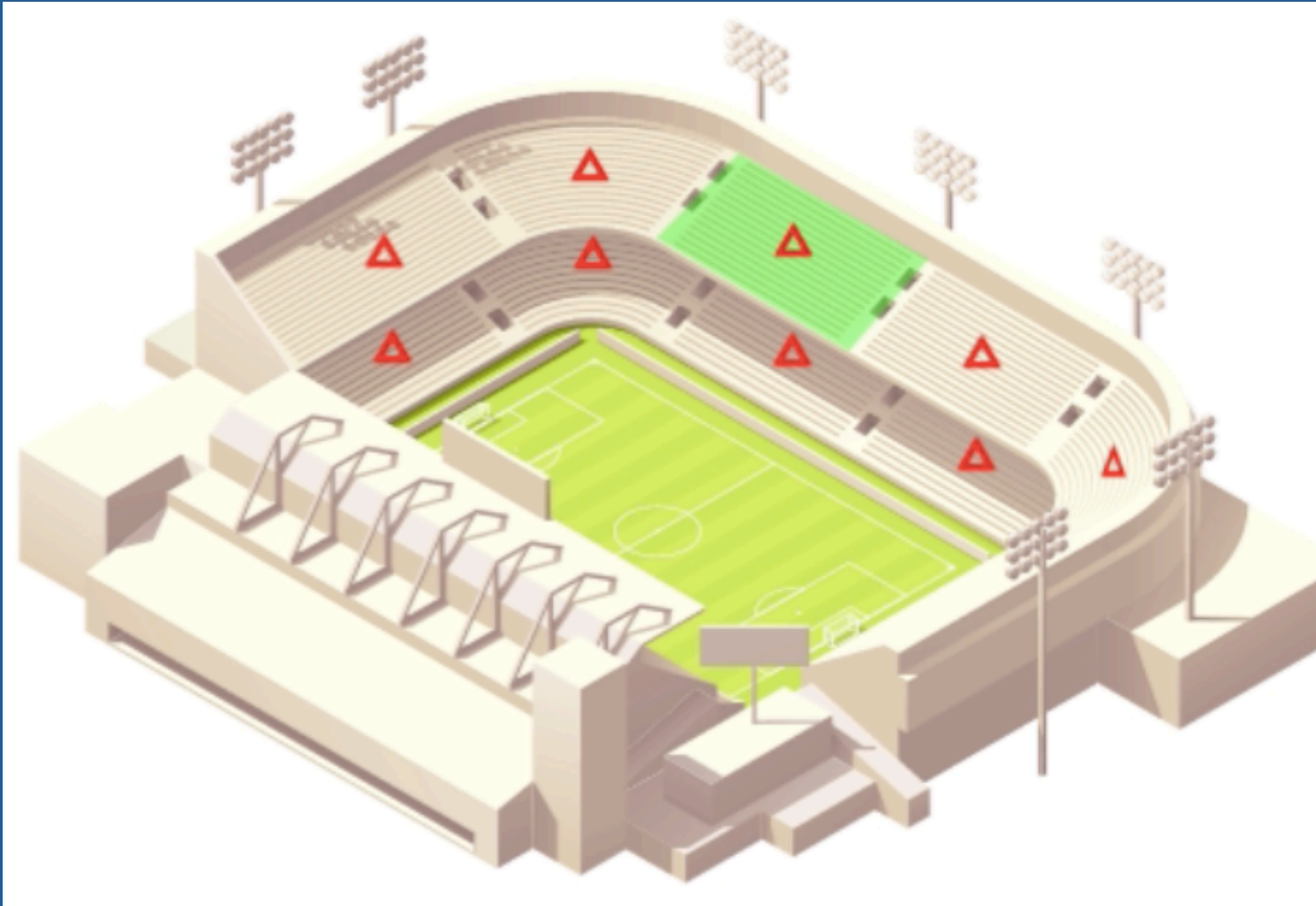


When To Test?

- ~~Fixed time for testing/monitoring~~
- Testing should be continuous
 - Passive – monitoring, minimal data impact on network
 - Active – Speed test, delay
- Note time of various events during testing
 - Before game, start of game, half time, end of game, scoring event
 - Start of work day, lunch break, end of work day
 - Start of school, lunch, end of school

Example: Stadium App With Integrated Testing Feature

Video



<http://youtu.be/LZVcA2l8YHU>

Location Aware Crowd Sourced Testing

Measure network performance at of different devices at various locations.

Incentives:

- Community – better WiFi for all
- Accomplishments - top testers, fastest device
- Informational – best WiFi, worst WiFi
- Social sharing – “I just tested speed at dining hall”
- Paid testers / employees

Test Plan:

- Recruit users/ guests/fans/ employees to test
- Download app
- Connect to test network
- Run tests

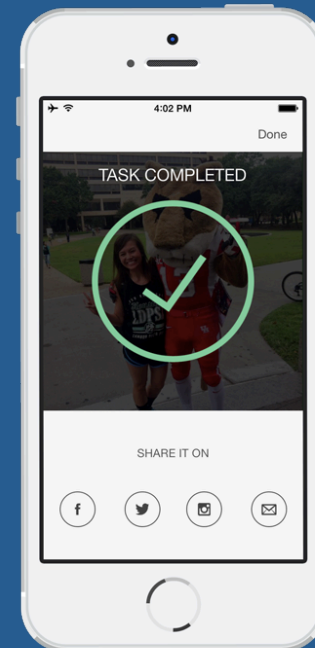
Tools:

- Speed test app
- Multiple clients
- Multiple users
- Location (iBeacon, GPS, Location ID)

Example: WiFi Scavenger Hunt



- Connect to SSID
- Download app
- Look for waypoints/markers
- Submit tests results
- Receive reward



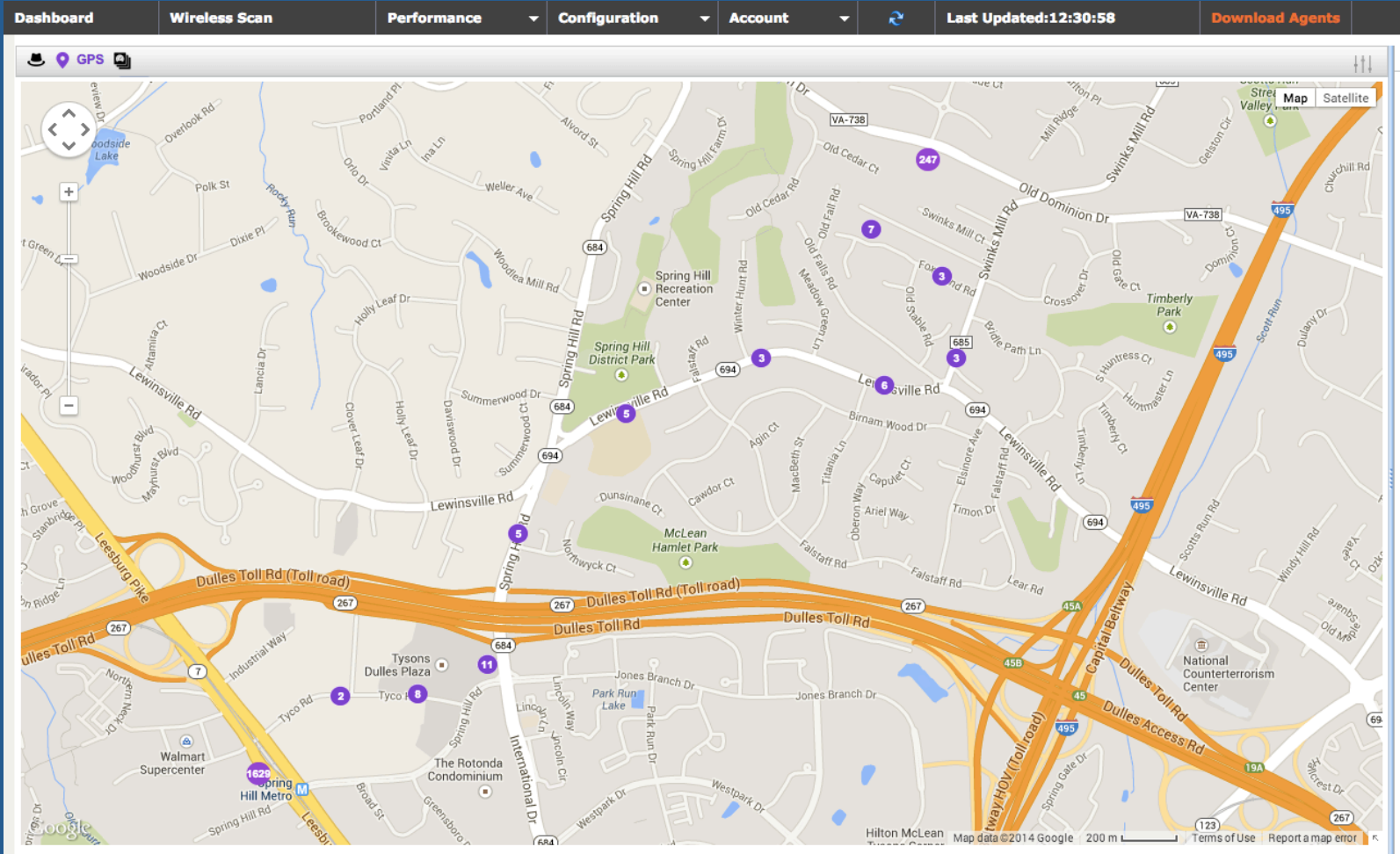
Ideal Testing System

- **Cloud Servers** – Min. investment in hardware
- **Mobile Devices/Laptops** – Match user devices, test anywhere, test anytime
- **RF Aware** – Signal/RSSI, channels, BSSID, SSID
- **Location Aware** – GPS, iBeacon, user defined
- **Crowd-sourcing** – Complete testing app or feature of existing app used by users already
- **Active Testing** – Throughput, delay, packet loss

Dashboard Phone for Directions – Why Not WiFi Performance Testing?



GPS + WiFi Scanning + Speed Testing



Did You Know Farmers Are Using Drones To Monitor Crops, Cattle?



Imagine the Possibilities



Would you rather walk while surveying outdoors or fly?

Testing Involves More Than Wireless....

- Laptops
- Access Points
- Controllers
- Switches
- Media Players / Apple TVs
- **Mobile Devices**
 - Throughput
 - Delay
 - Packet loss
 - WiFi
- Authentication
- Roaming
- Guest Access
- Firewall
- Spectrum (Channel Plan, Coverage, Noise)
- Security

Take Away

- Test in a lab environment with same equipment and clients planned for install
- After deployment test again to confirm network meets or exceeds lab results
- Make configuration changes as needed / tune network
- **Continuous monitoring and testing**

Questions?

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