

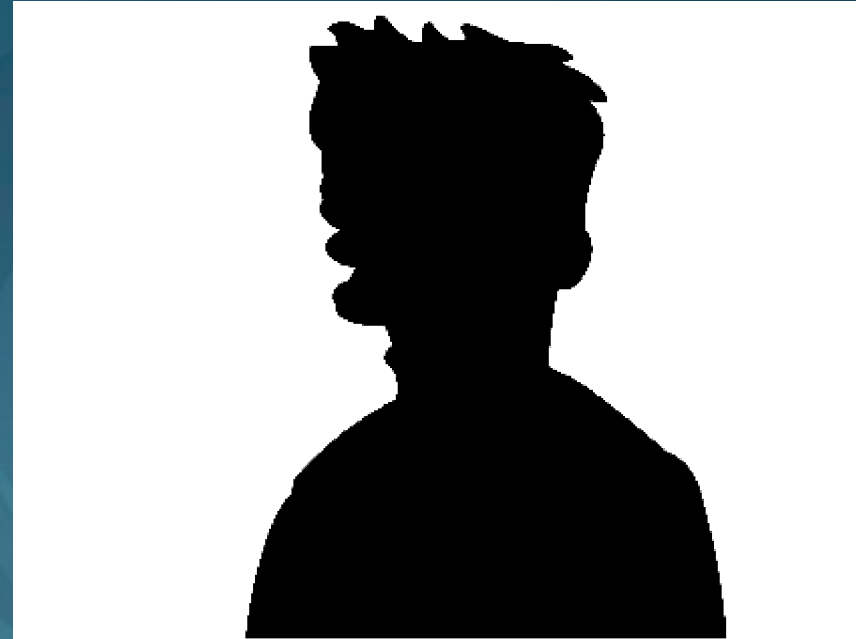


Lessons Learned from 1000 802.11n Installations

November 19, 2009

Agenda

- 👤 Introduction
- 👤 Network Design
- 👤 RF Design
- 👤 Client Considerations
- 👤 Conclusion



Introduction

- 👤 802.11n brings significant performance benefits to Wi-Fi
- 👤 But 802.11n will not deliver all its promise without proper design and roll out
- 👤 Lessons learned from our customers, including:
 - 👤 Plano (TX) School District (63 schools, 1000 Arrays)
 - 👤 Carnegie Mellon University (dorms)
 - 👤 University of Toronto (libraries, business school)
 - 👤 Research in Motion (manufacturing, office space)
 - 👤 Interop Las Vegas and New York 2009 (high density convention)

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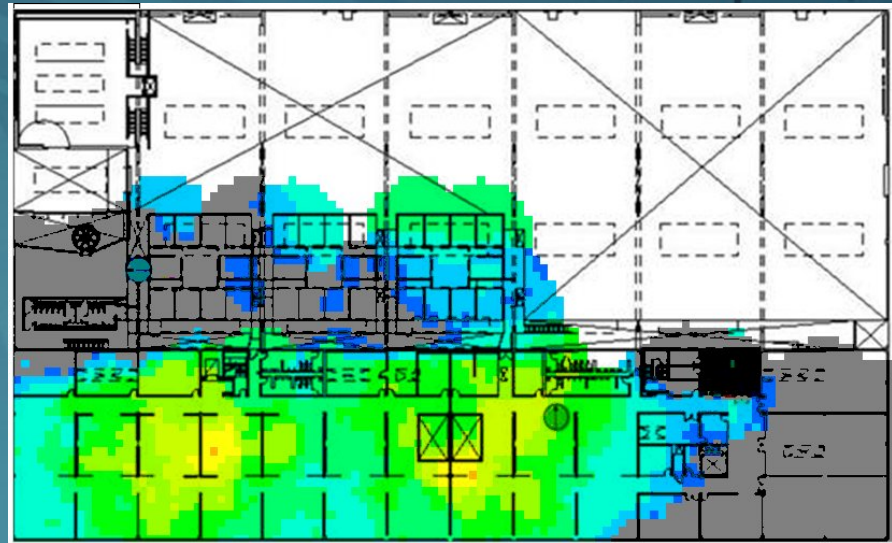
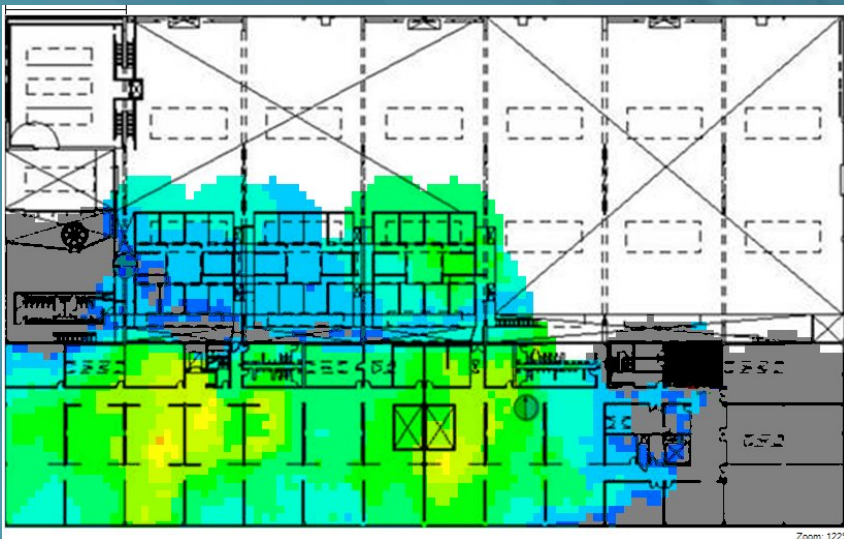
Network Design

- 👤 Proper network planning for 802.11n is crucial
 - 🔴 More likely used as primary network connection
 - 🔴 Introduces more configuration options than 802.11a/b/g
 - 🔴 Must consider support for legacy 802.11a/b/g clients

- 👤 Four key design parameters:
 - 🔴 Site surveys
 - 🔴 Device placement
 - 🔴 Security
 - 🔴 Wired network

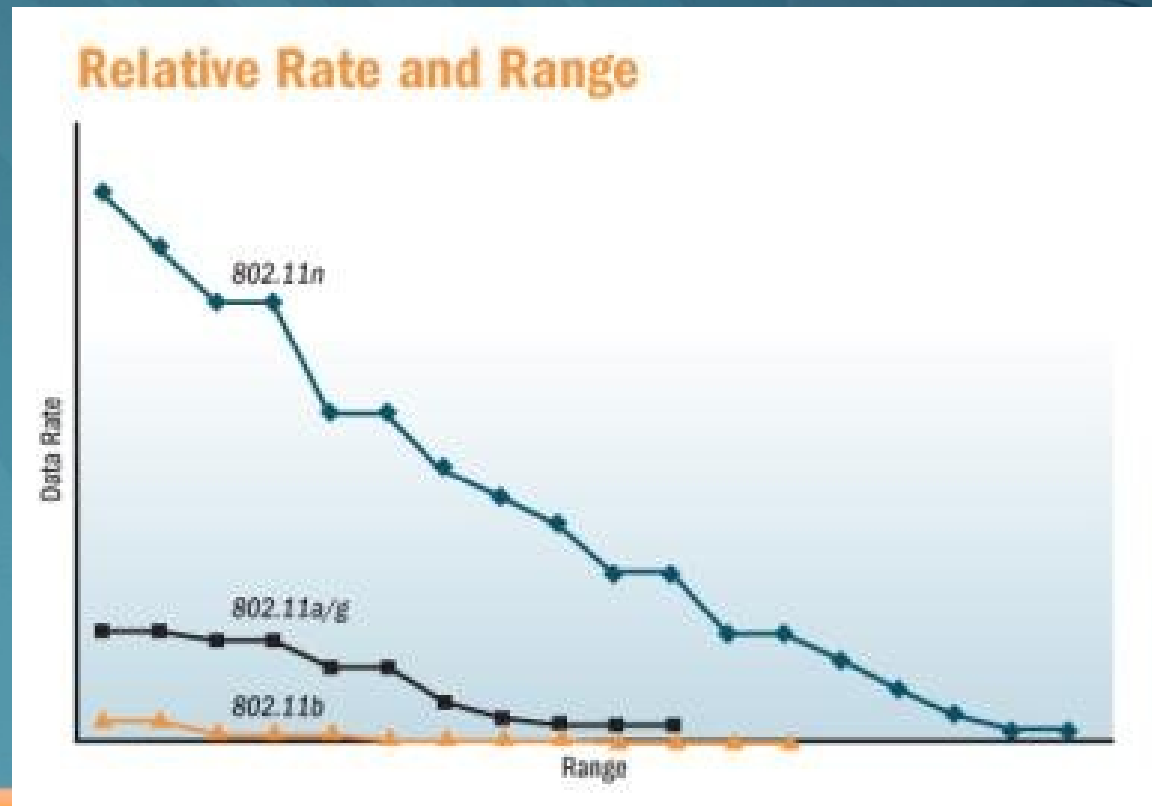
Site Surveys

- 👤 Live (active) site surveys are the only way to determine true coverage
- 👤 **Lesson Learned:** 802.11n signal propagation is more dependent on the environment than 802.11a/b/g
- 👤 802.11n is optimized for 5GHz operation where there is 8X more bandwidth than 2.4GHz, but propagation characteristics are different
- 👤 **Lesson Learned:** Perform site surveys in both 2.4G and 5G at the same time, or as a shortcut, only in 5G since 2.4G coverage will be better



Device Placement

- 📶 802.11n has greater signal propagation than 802.11a/b/g, but distant stations and too many stations per radio will lower performance
- 📶 **Lesson Learned:** Do not create large cell sizes for an 802.11n design if you want to achieve best performance
- 📶 The vast majority of 802.11n networks still need to support legacy 802.11a/b/g clients
- 📶 **Lesson Learned:** Do not create cell sizes for an 802.11n design greater than for an 802.11a/b/g if you want legacy device support



Security

- 🗣️ Per latest Wi-Fi Alliance certification, TKIP and WEP do not operate above 54Mbps data rates, plus both have been cracked
- 🗣️ **Lesson Learned:** Use WPA2/AES encryption for 802.11n deployments – anything else is a compromise on security and performance
- 🗣️ 802.11n operates 6-8X faster than 802.11a/g and thus encryption must be performed 6-8X faster.
- 🗣️ **Lesson Learned:** Check the encryption performance of your wireless controllers and/or APs – many cannot handle the load (oversubscribed).

Wired Network

- 👤 Many existing wireless networks are deployed with 10/100 Ethernet connections to the APs. 802.11n can run >100Mbps on just 1 radio.
- 👤 **Lesson Learned:** Don't presume an upgrade from 802.11a/b/g APs to 802.11n in place. The switch/cabling infrastructure must support Gigabit Ethernet to take full advantage of 802.11n's performance.
- 👤 Network traffic patterns will change between an 802.11a/b/g network and 802.11n, especially if designed for ubiquitous coverage
- 👤 **Lesson Learned:** The core network may need to be re-evaluated by the increased traffic load of 802.11n and traffic tromboning in controller-based networks

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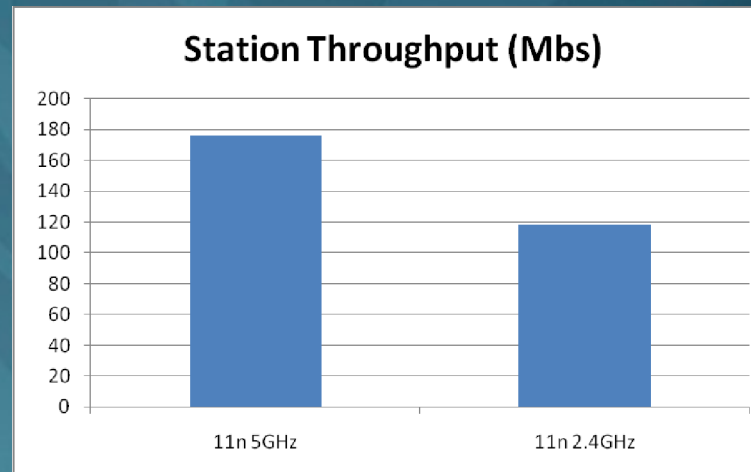
RF Design

- 👤 Proper RF design for 802.11n is crucial to achieve promised performance gains
 - 🔧 More knobs to tune
 - 🔧 More spectrum to manage
 - 🔧 More compatibility items to consider

- 👤 Three key design parameters:
 - 🔧 5GHz vs. 2.4GHz
 - 🔧 Channel bonding
 - 🔧 802.11a/b/g support

5GHz vs. 2.4GHz

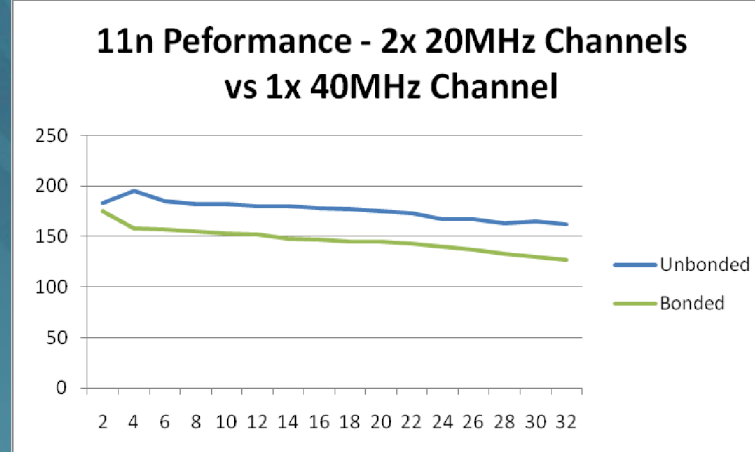
- 👤 802.11n is optimized for performance in 5GHz
- 👤 **Lesson Learned:** Data throughput with 802.11n in 5GHz is typically between 1.5:1 and 2:1 greater than that achievable in 2.4GHz



- 👤 **Lesson Learned:** Be ware of 2.4GHz only clients and their 802.11n impact – iPhones/Touches and many Netbooks do not support 5GHz
- 👤 **Lesson Learned:** Many APs have fixed 2.4G and 5G radios. If possible, buy software selectable radios for greatest design/migration flexibility

Channel Bonding

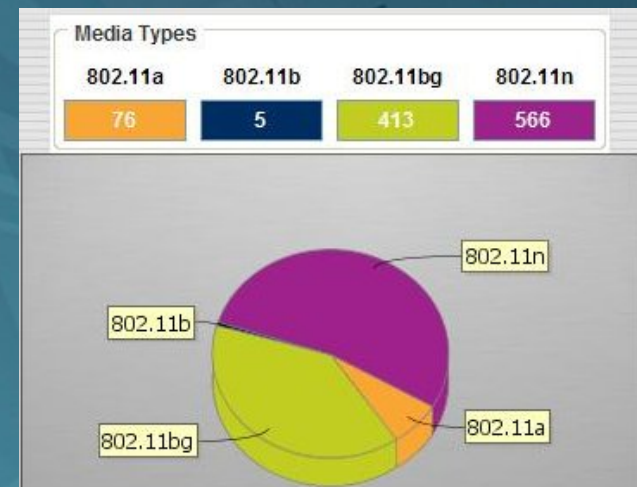
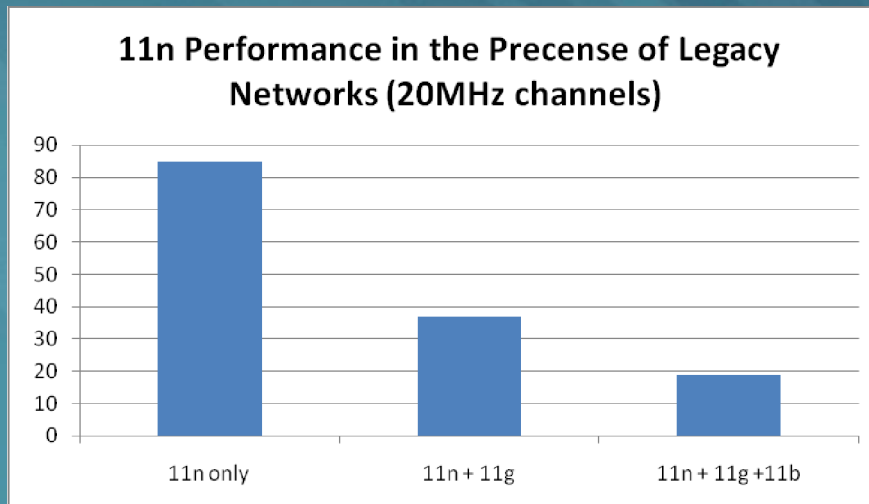
- 👤 Channel bonding doubles the bandwidth of a channel in 802.11n but caution must be taken in using it
- 👤 **Lesson Learned:** In high density, high performance environments, using 2 unbonded channels provides more performance than 1 bonded



- 👤 **Lesson Learned:** Some clients do not operate properly with bonded channels and will move from 5G to 2.4G – something you want to avoid

802.11a/b/g Support

- 👤 802.11n signal propagation is more dependent on the environment than 802.11a/b/g
- 👤 **Lesson Learned:** 802.11b significantly kill 802.11n performance – remove them from the network entirely if at all possible
- 👤 **Lesson Learned:** Usually fewer 11b clients in a network than you might think – probably better to just buy a few 11a/g/n adapters



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- 👤 **Client Considerations**
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Client Considerations

👤 802.11n migration must carefully consider the clients

- 🔴 Easier if and when buying new clients
- 🔴 Tougher if working with older legacy clients
- 🔴 More compatibility items to consider

👤 Three key considerations:

- 🔴 Performance
- 🔴 Band/Channel preference
- 🔴 Homogeneous networks

Client Performance

- 👤 802.11n client performance can vary **greatly** between NIC brands
- 👤 **Lesson Learned:** Assume nothing – when moving to 802.11n, test all your existing clients and any new ones before buying

Manufacturer	Auth/Encrypt	Downstream	Upstream	Total
Laptop 1	OPEN	127.1	127.3	254.4
Laptop 1	WPA2-PSK/AES	126.2	126.0	252.2
Laptop 2	OPEN	74.0	85.5	159.5
Laptop 2	WPA2-PSK/AES	80.1	67.7	147.8
Laptop 3	OPEN	36.3	30.2	66.5
Laptop 3	WPA-PSK/AES	22.7	20.5	43.2

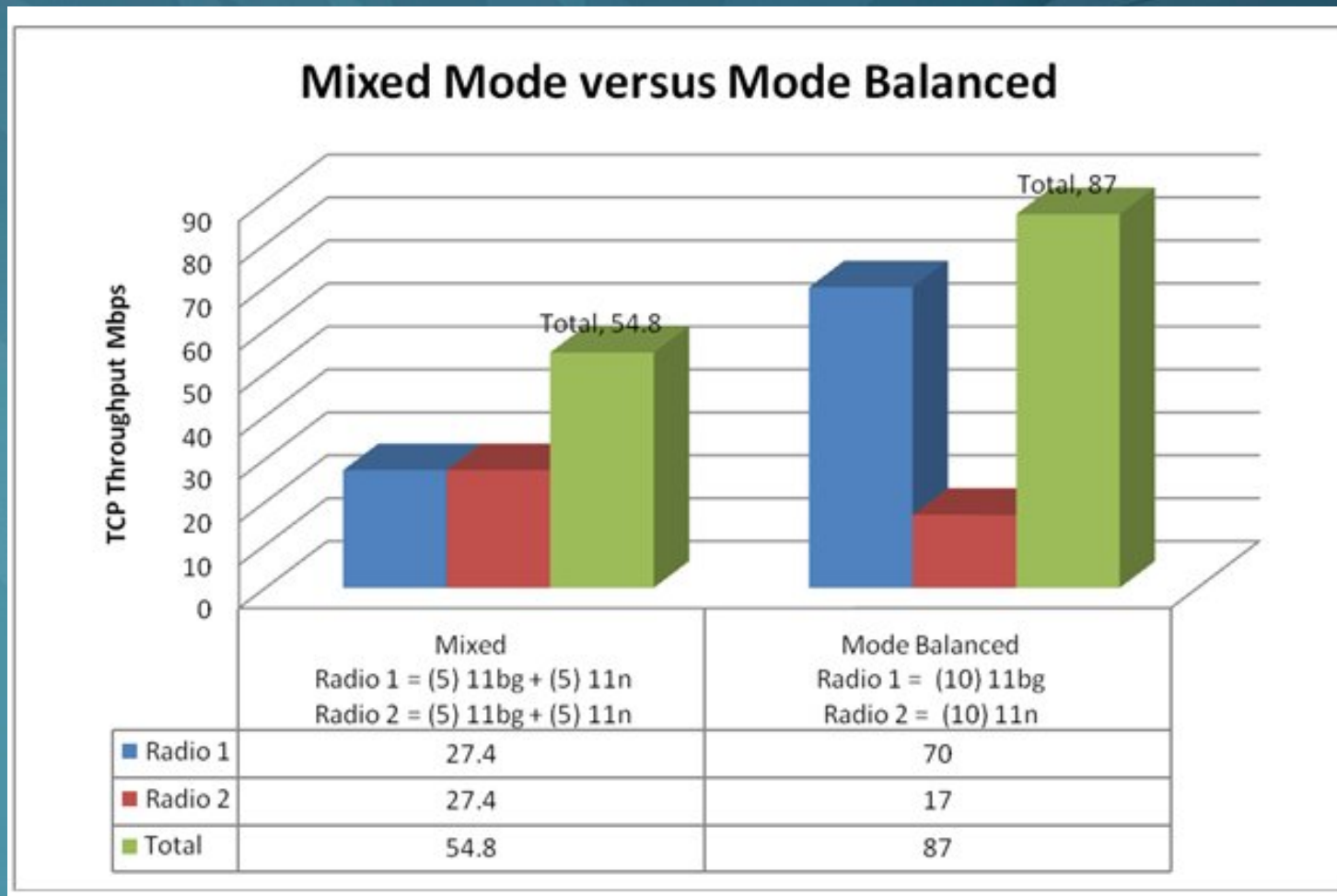
- 👤 **Lesson Learned:** All clients do not support all 802.11n features, such as bonding, 2 spatial streams, etc. If the client is not at the support level of the AP, you will not be able to take advantage of all 11n's performance.

Band/Channel Preferences

- 👤 Clients make the decision as to what radio they connect to, not the AP
- 👤 Many older clients favor 2.4G over 5G channels.
- 👤 **Lesson Learned:** Not all clients support all available 5GHz channels and some have issues with certain channels. Test first before channel design.
- 👤 **Lesson Learned:** Make sure client drivers are updated to latest versions to ensure best 5G utilization.
- 👤 **Lesson Learned:** If necessary, set the clients to 5G only.
- 👤 **Lesson Learned:** Stations can be coaxed to 5G by tuning 2.4G radio power down and leaving 5G at maximum.

Homogeneous Networks

- 👤 Significant variety in supported clients will hinder 802.11n performance
- 👤 **Lesson Learned:** When possible, use the same Wi-Fi adapters across all network users
- 👤 **Lesson Learned:** Buying new external adapters can be a quick and relatively inexpensive way to refresh the client base without completely turning them over



Conclusion

- 👤 For the effort and cost of upgrading to 802.11n, **do it right the first time:**
 - 🔊 To realize its benefits
 - 🔊 To achieve longevity of your network
- 👤 Many 802.11a/b/g networks today are being upgraded after just 2 years in service
 - 🔊 You don't want to plan your 802.11n network for the same life cycle, plan for a 5 year lifespan
- 👤 The most important lessons
 - 🔊 Focus on 5G!
 - 🔊 Get rid of 802.11b if you can!
 - 🔊 Test everything!



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