



Next Generation Wireless Management

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The State of WLAN Management Today

- Centralized architectures dominate
 - APs alone have nearly no manageable features
 - APs associate to controllers, providing
 - Individual AP feature management
 - System-wide management
- Physical views are popular
 - Heatmaps take statistics from multiple APs and combine them
 - SSIDs and such are managed at a controller level
 - Users have to override the controller level configuration to do most settings per-AP
- Automation is provided
 - Some systems automate channel and power assignments
 - Others don't require power or channel planning at all

But Change is in the Air..

- Wireless networks are growing
 - More square footage
 - More users
 - More density
 - More applications
- IEEE 802.11 is growing, too
 - More standards
 - More features
- And 802.11n is here

Problem: How to Adapt

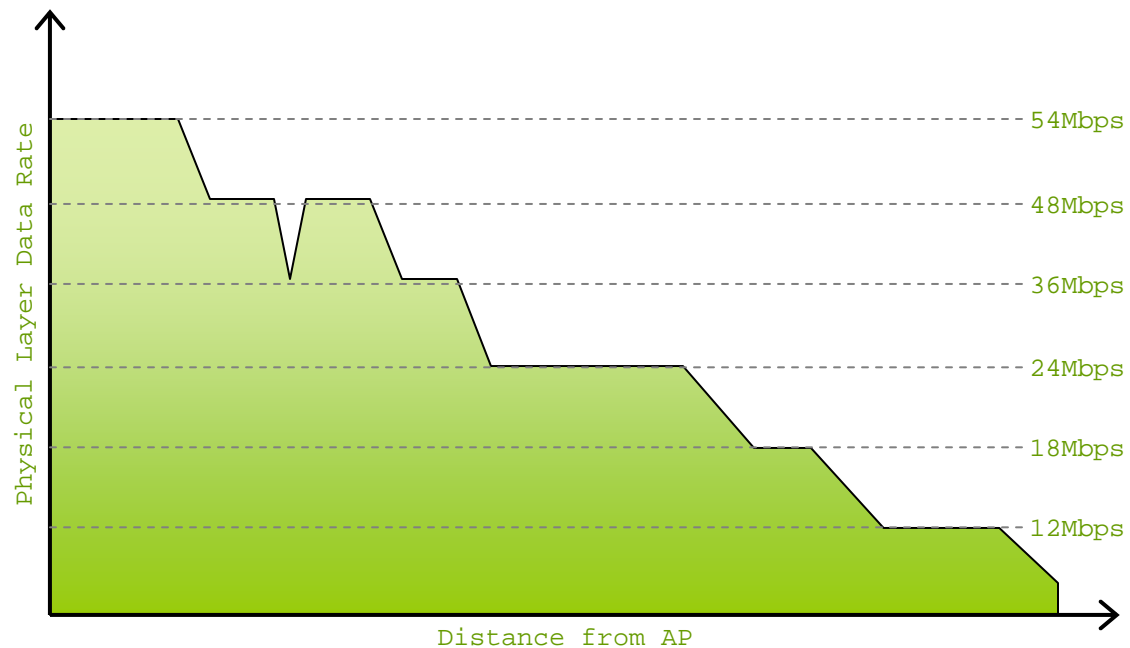
- Existing management principles don't work in the new network
- Many more types of devices: complexity is exploding
- Current tools are inadequate to solve these problems

802.11n Changes Everything

- MIMO marks a new type of RF
 - Completely new paradigm for understanding and predicting RF behavior
- Take what you know about RF and start over
- 802.11n is a framework
 - Only one flavor of 802.11g or 802.11a
 - Many different flavors of 802.11n clients
 - 2x2, 2x3, 3x2, 3x3
 - 20MHz, 40MHz
 - Short GI or not
 - That's just in Draft 2.0: more features to come!
 - Makes management of entire networks very difficult

The Old Textbook RF

- Rate depends mostly on range



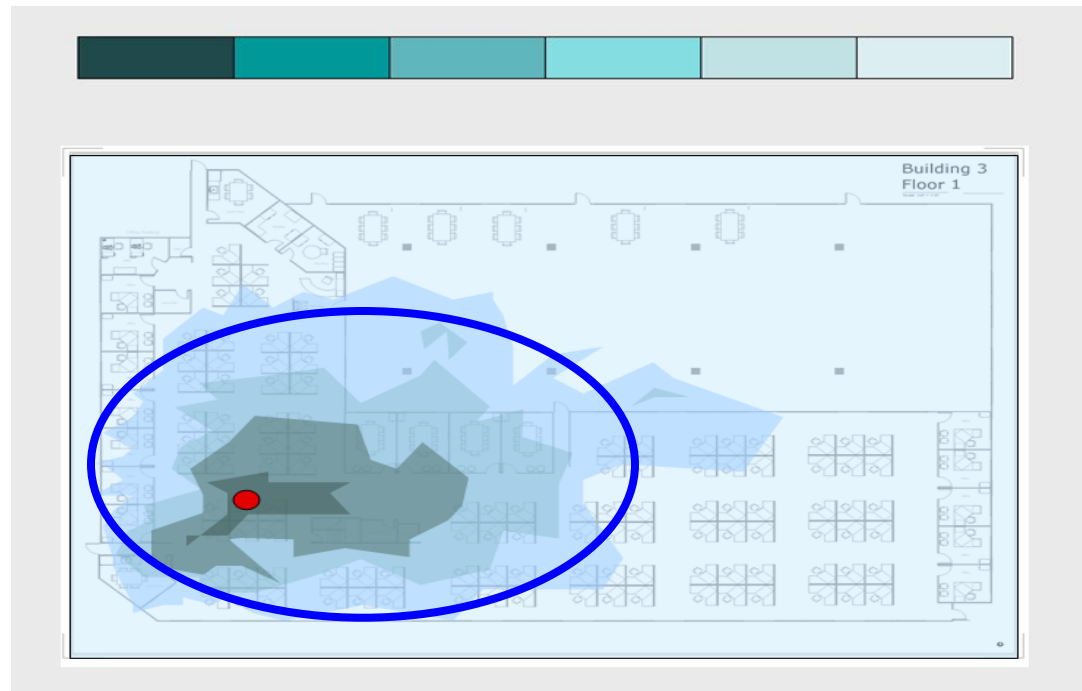
- More distance \rightarrow Less SNR \rightarrow Lower rate

The Old Textbook RF (2)

- Line of sight is good
 - To get better performance, go stand under the AP
- Less attenuators are better
 - Empty halls are the best
 - Remove clutter to improve performance
- Removing lower PHY rates can only improve throughput
 - Prevents poor-rate clients from associating
 - Shrinks effective coverage area, of course, and requires more APs

The Old Textbook RF (3)

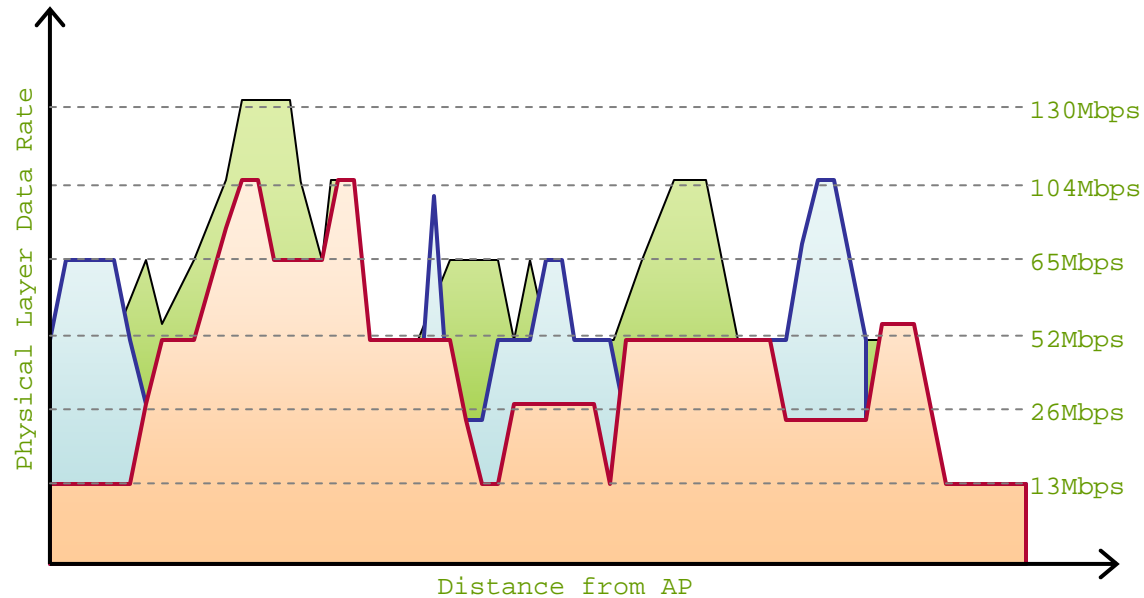
- Cells are at least somewhat round



- A range of power levels exist for an AP to tune to without breaking coverage

The New RF

- Rate and range might have little to do with each other



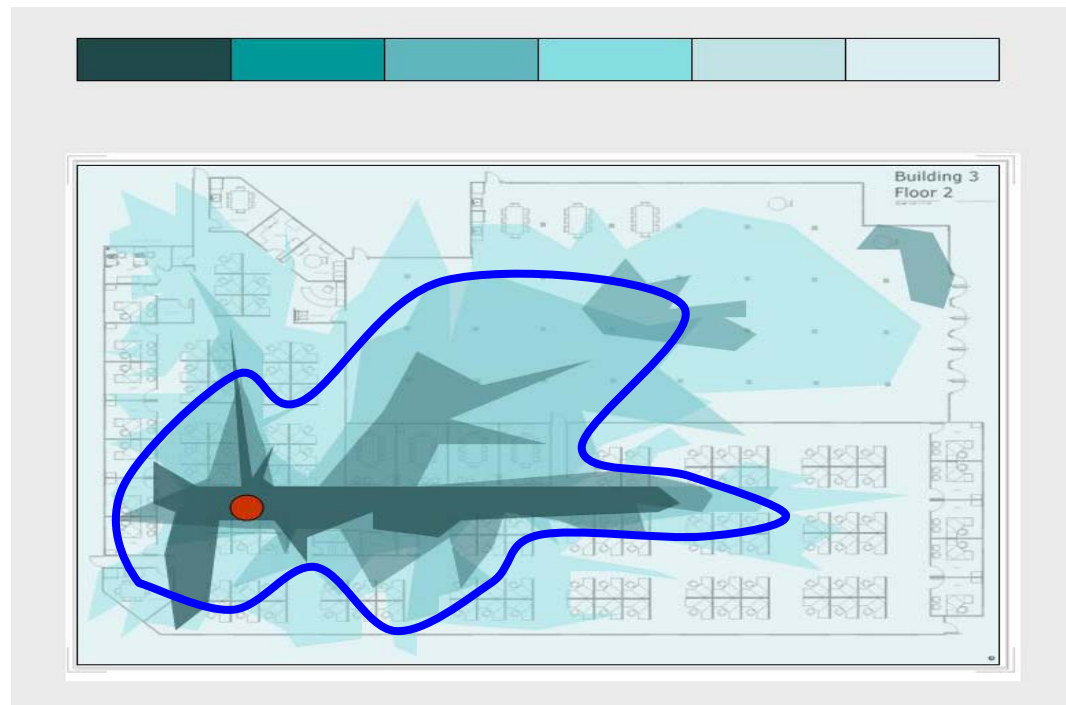
- SNR for *each* of 3 antennas matters
- Multipath!

The New RF (2)

- Line of sight can be bad
 - Sometimes, the best performance is in a hidden corner!
- More attenuators can be better
 - Empty halls can fall off flatly
 - Cluttered areas can increase MIMO, but not always...
- Removing lower PHY rates can often sacrifice throughput
 - May create coverage holes in the middle of a cell
 - May prevent clients from transmitting at all

The New RF (3)

- Cells are unpredictably odd shaped



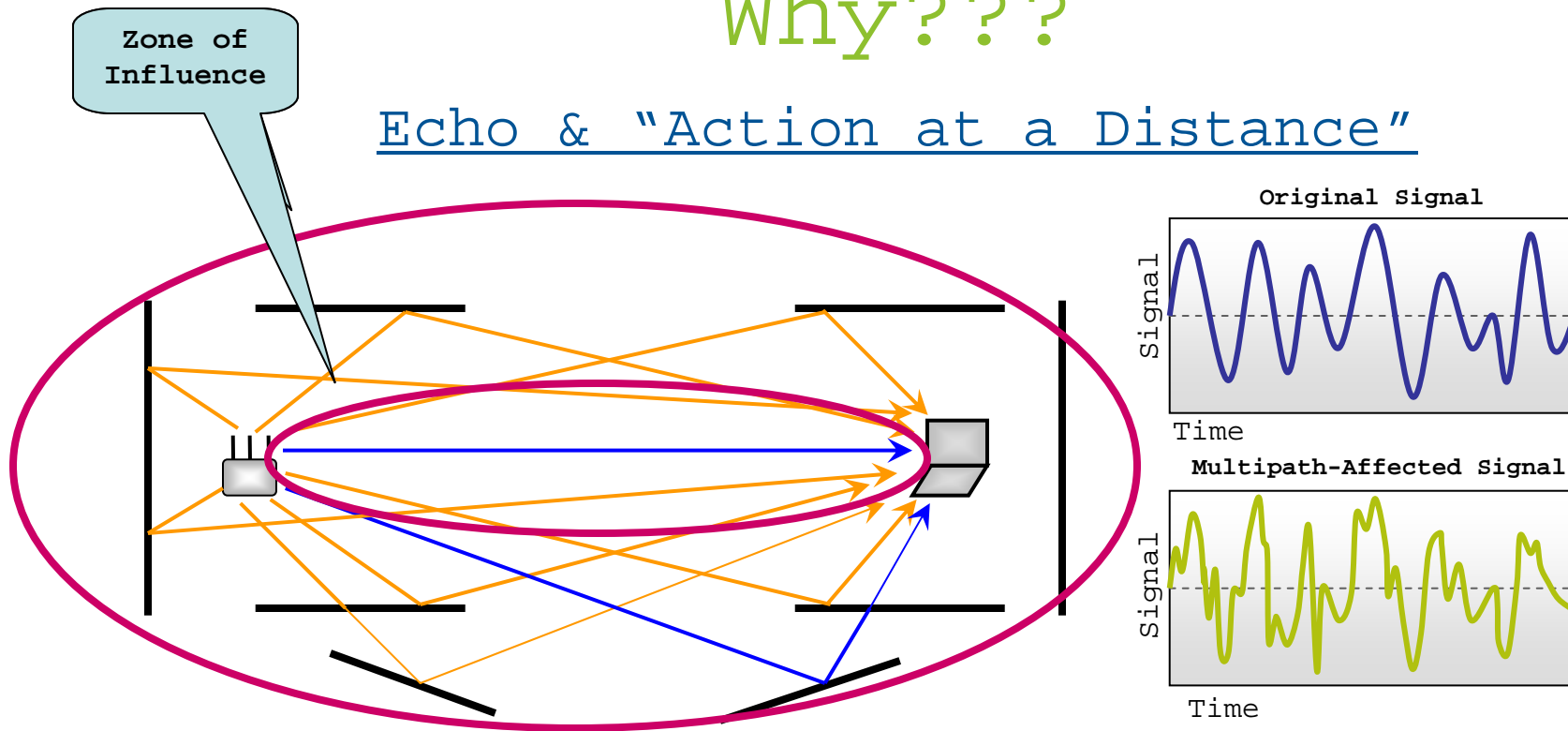
- Cells don't always grow or shrink with power level changes

The New RF (4)

- Higher throughput and higher scale lead to 10-fold increase in statistics
- Higher variability leads to severe undersampling problems

Why???

Echo & "Action at a Distance"



- Without multipath
 - The useful parts of the signal are between the AP and client
- With multipath
 - **The whole area around the devices matters**

Affected Management Tools

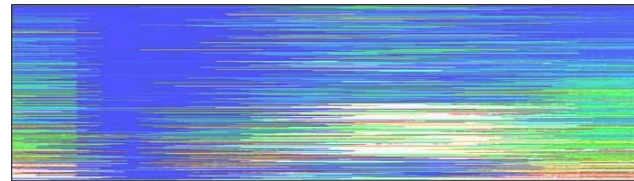
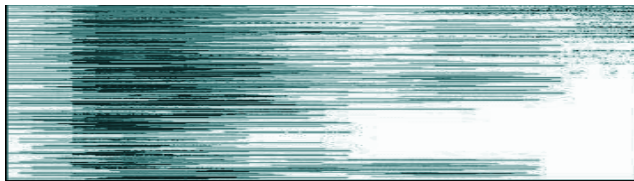
- RF Planning and Site Survey
 - Accuracy is nearly impossible
 - RF environment is dynamic in multiple dimensions
 - Time
 - Location
 - Orientation of device
 - Position of user
 - RSSI-based measurements are no longer an indicator of expected performance
- Automatic Tuning
 - Power level adjustment has very little to work with
 - Coverage holes or weak spots form because of environmental factors that cannot be controlled by the AP

Affected Management Tools (2)

- Statistics and Monitoring
 - Properly functioning network may have far higher moment-to-moment variability
 - Trending and alarm thresholds are very difficult to set
 - Outage criteria is different for each device and location
 - Current visualization tools are nearly useless
 - Not enough sampling in space and time to show real behavior

Stop-gap Solutions

- Portable Spectrum Analyzers
 - Can be embedded in APs or Cardbus cards for laptops
 - Provides colorful views of spectrum usage over time and frequency



- Clearly more advanced than just RSSI measurements
- Can show overlapping interference from non-Wi-Fi sources

Stop-gap Solutions (2)

- Problems
 - Current systems cannot analyze multipath as it applies to MIMO
 - No guarantee that what the analyzer sees, a client will
 - Too much inherent uncertainty in the environment anyway
- Key Takeaway
 - Not clear what to do with the information you get

Results

- Too much data!
- Would require the administrator to become a full-on RF engineer

Proposal: Next Generation Wireless Management

- Self-monitoring
 - Not just automated
- Remote diagnostics
- Network-focused
 - Not system focused or node focused
- New generation RF intelligence

Self-monitoring Networks

- Motivation
 - Too much information for an admin to monitor
 - Most knobs are limited in use
- Heavy-duty data gathering and processing
 - Should handle the flood of data from large networks and 802.11n throughputs
 - Needs to make correlations in real-time
- No automation: Tuning-free Networks
 - Most knobs need to be removed
 - Emphasis placed on avoiding problems in the first place
 - Network should take care of managing wireless resources

Remote Diagnostics

- Motivation
 - Large or multi-campus networks
 - On-site visits to each building or campus are prohibitive
- Should use clients to get information from the network
 - 802.11k allows AP to request stats from each client
- Outage-focused, not just detail-focused
 - Needs to emphasize detecting outages or poor performance *per client*
 - Should dispense with generic heatmaps and AP-focused statistics

Network Focus

- Motivation
 - Current systems are good at showing statistics in colorful ways
 - But that information is not terribly useful
 - Real end-to-end measurements are needed
- From statistics and heatmaps to Network Health
 - Would Rank and rate clients by observed end-to-end quality
 - Correlates into real, manageable areas based on physical properties
 - Not your ordinary *dashboard*
- Reduce complex information into stages
 - Would show outages first; hide details
 - Troubleshooting: must show details at a finer level for the physical area around the trouble spot
 - Traffic flow analysis for real problems: packet captures are not enough and not very useful

New RF Intelligence

- Motivation
 - RSSI is not enough
 - Spectrum analysis is too much for user, not enough for system
- Real, client-based RF tracking
 - Not just loss rate and RSSI
 - Should track EVM, signal quality, burst loss
 - Must correlate from multiple APs simultaneously
- Should actively monitor effectiveness of MIMO and 802.11n features
 - Must change behavior, not just adjusts parameters, based on results
 - Should provide outage and effectiveness reports to the administrator about new RF in action

Summary

- New Wi-Fi technology and faster speeds require a new set of management tools
- Old tools and stop-gaps unable to solve new problems
- New management solutions will take over processing the details
 - From autotuning to tuning-free
 - From site survey to remote diagnostics
 - From heatmaps to real network health
 - From PhD-level RF to Real Performance