



04 - System and Product Capabilities

October 2006

Belden Confidential 2006

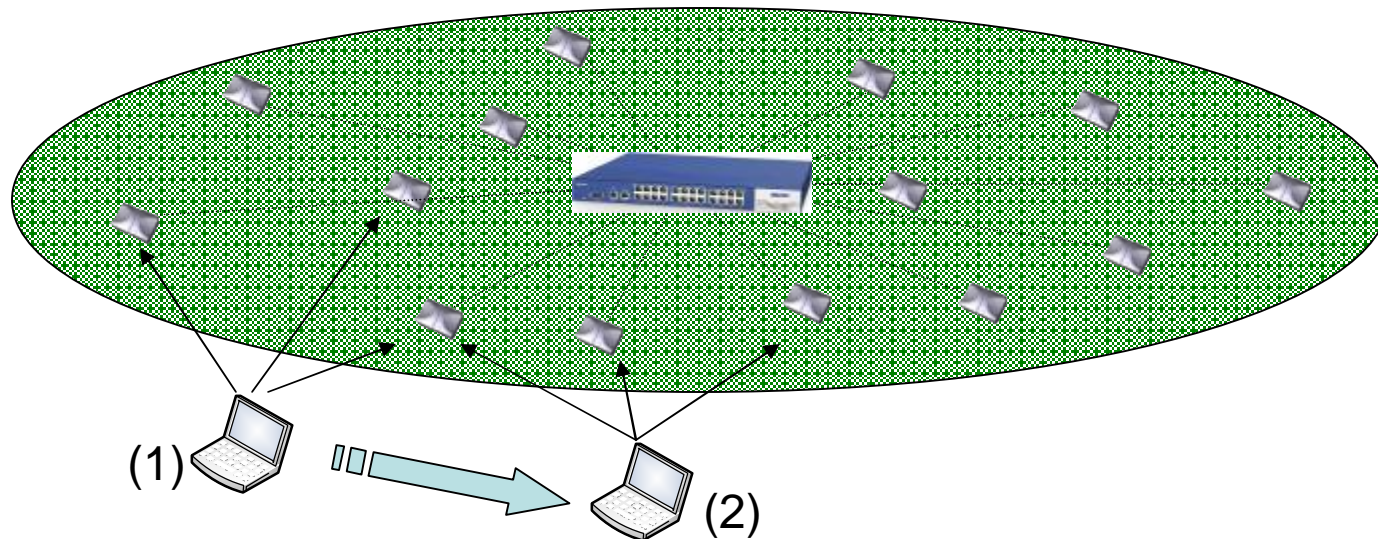
- § System Functionality
 - The Channel Blanket
 - Spectrum Reuse
 - Multi-Layer Network
 - Security
 - Management: Configuration and Monitoring
- § Design, Deploy, Validate Process
- § Product Portfolio
- § Designing for VoWLAN



The Channel Blanket

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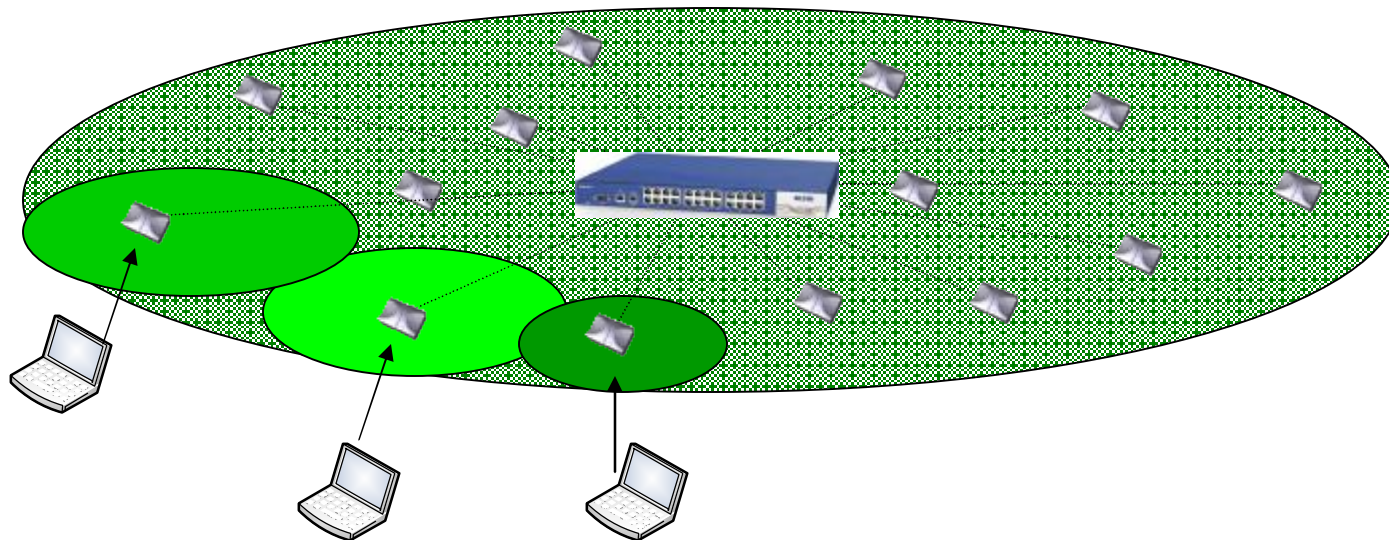
Uplink in the Channel Blanket



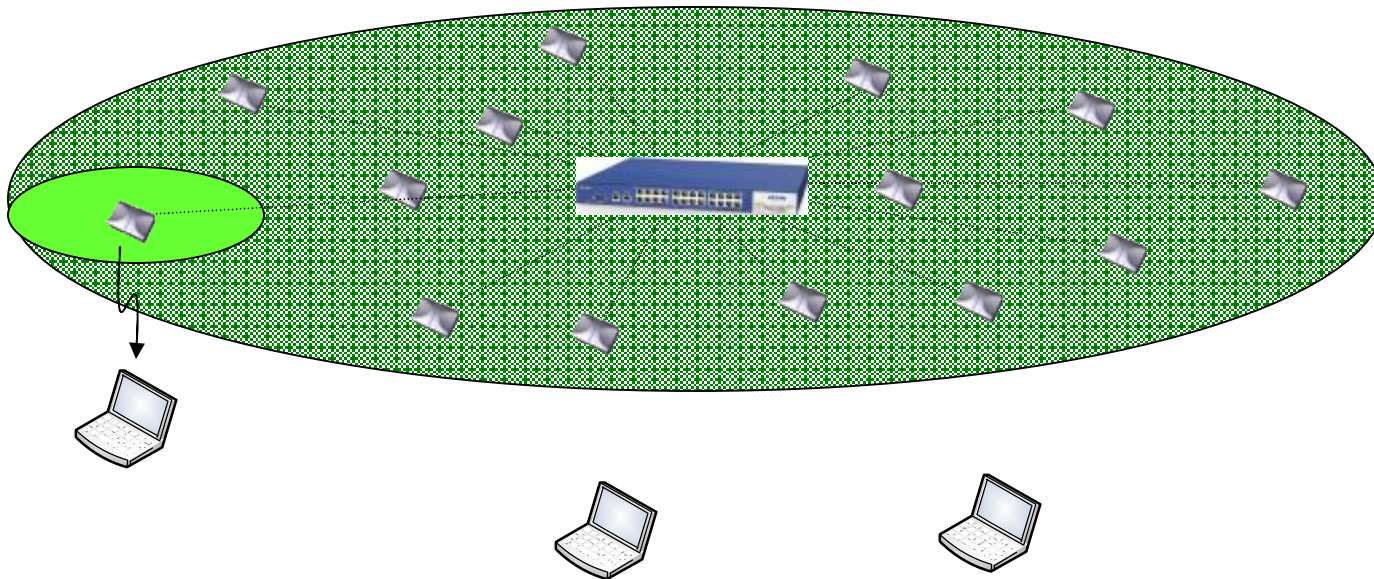
- § Uplink path diversity
 - Multiple APs “hear” the client
 - Switch receives multiple copies of the same transmission, and selects the best one – making the uplink resilient to disruption on any one individual link
- § Seamless zero-latency mobility
 - As the client moves, different APs receive the uplink transmission - this is transparent to the client and no handoff event ever occurs
- § Elimination of client balancing problem that exists in cell-based WLAN

Uplink Collision Domain

- § **FAQ: Does it mean that the entire blanket is one single uplink collision domain?**
- **A: No. The switch is “hearing” all the clients that are able to communicate inbound. The switch is “listening” to multiple uplink collision domains simultaneously**



- § The switch avoids creating co-channel interference
 - Does not permit two APs within the blanket to transmit simultaneously





Spectrum Reuse

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§ Definition

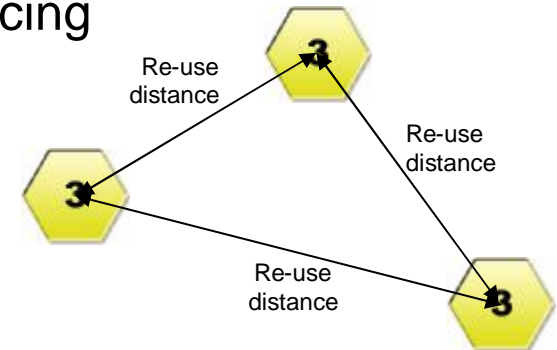
- Multiple use of the same channel, geographically separated
- Simultaneous transmission on the same channel
- Increase capacity without causing interference

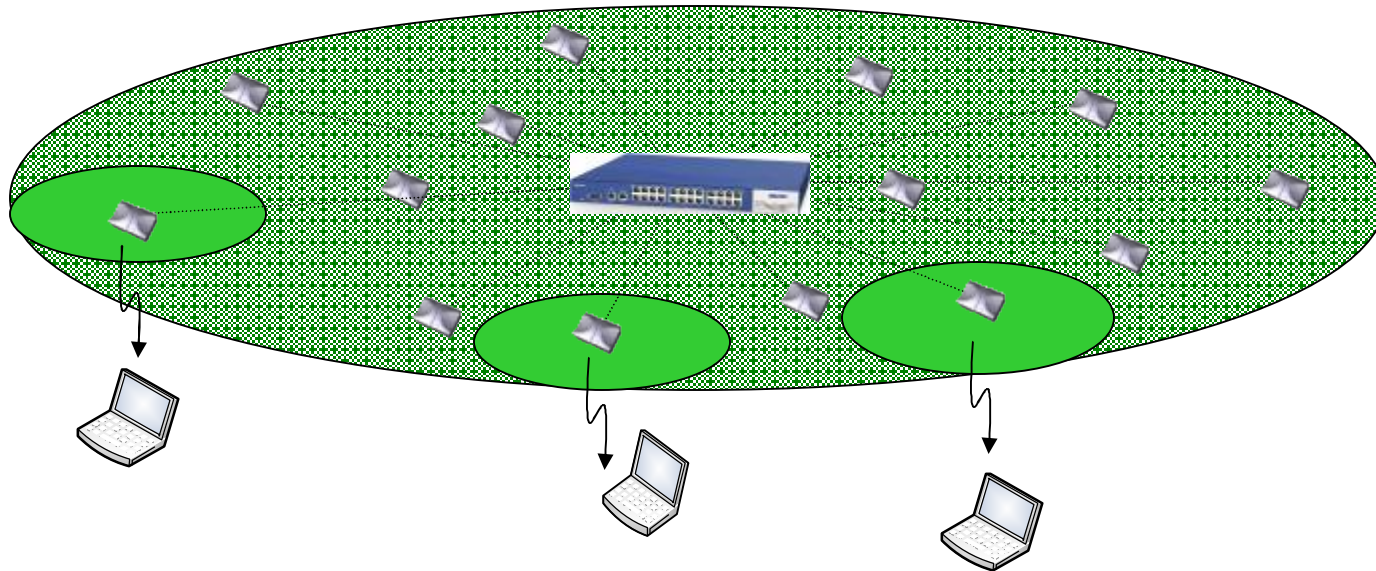
§ “Natural” Reuse is Rare in Practice

- IEEE 802.11 standard – CSMA/CA – listen before talk
- “Listen” part is governed by CCA / collision domain
 - CCA defined as -82dBm – in reality, NICs are much more sensitive
 - CCA leads to false positives and false negatives

§ Spectrum Reuse Approach

- Not limited by CCA
- Dynamic and accurate picture of RF environment
- Enables frequency re-use with closer spacing
- Benefits
 - Higher bandwidth / More users
 - Frequency reuse at an increased density
 - Avoids co-channel interference





- § Channel blanket dynamically “subdivided” into multiple collision domains, to create simultaneous multiple links without co-channel interference
- § Switch uses real-time knowledge of link differentials between all clients and all APs to determine the re-use opportunity

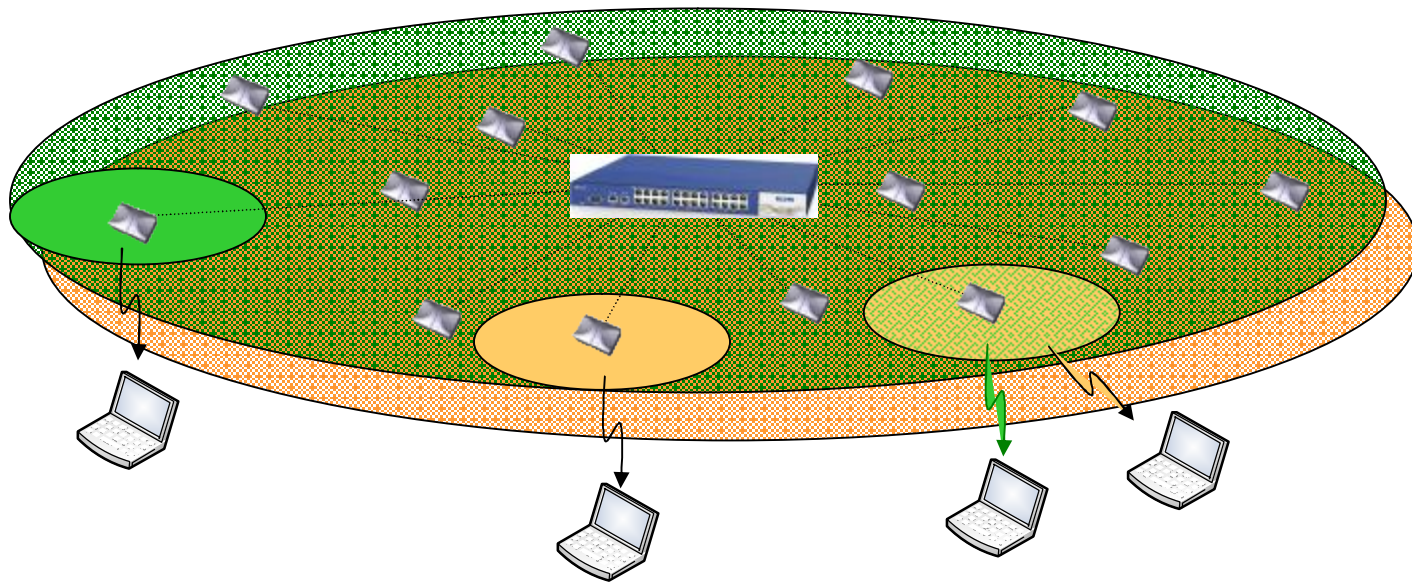


Multi-Layer Network

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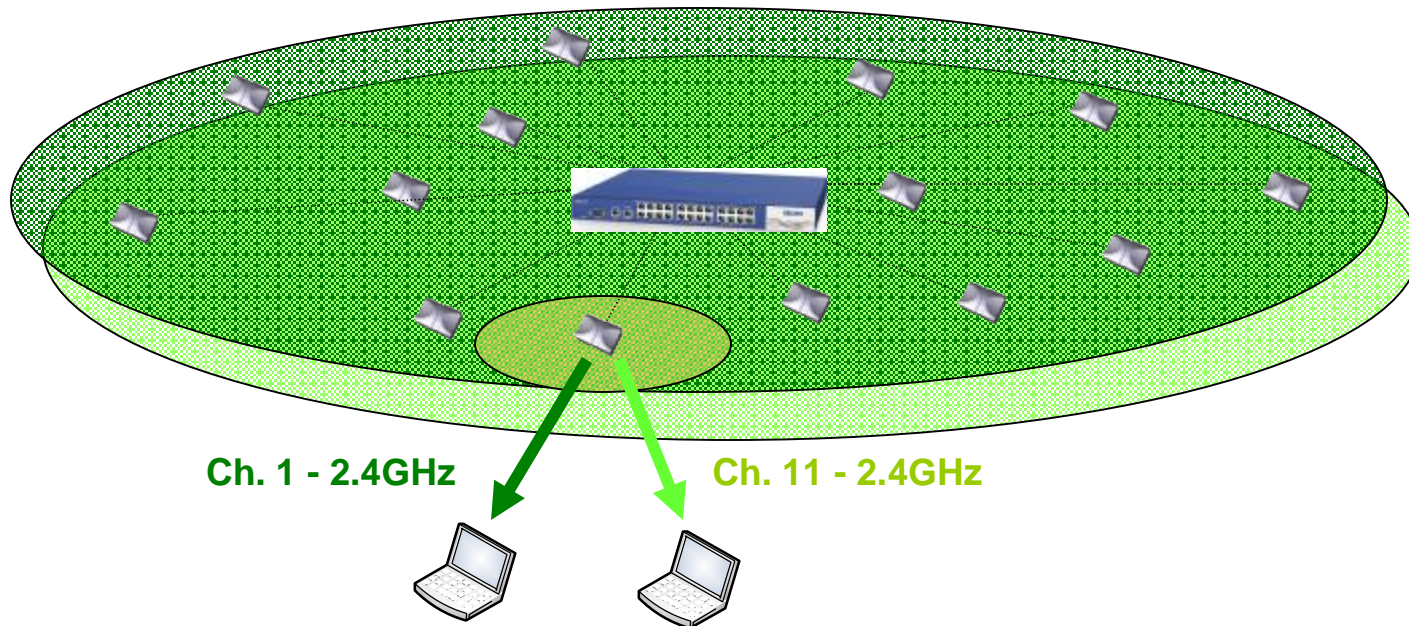
Layered System

- § Multi-radio APs enable concurrent channel blankets, on ONE network
- § Multiply local capacity
- § Guarantee QoS by reserving physical channel bandwidth for different traffic / device / user types



Same Band

- § Definition: Overlapping channel blankets on two different channels but in the same band, from the same set of APs



The Channel Blanket Advantages

1. Zero-latency mobility
 - Ideal for real-time applications
 - Ensures security session is maintained
2. Uplink Path Diversity
 - Link stability and resilience – can withstand outside interferers more effectively than a cell-base topology with a single client-AP link
3. High data-rate performance for all clients in the blanket
 - Superior throughput for all clients in the collision domain
4. Higher Bandwidth
 - Multiple uplink collision domains per channel blanket
 - Spectrum Reuse channel processing
5. Overlapping Channel Blankets from One Infrastructure
 - Multiple channels available everywhere concurrently – triple the local capacity
 - Quality of Service planning has a new dimension – the channel
6. No RF Cell Planning
 - Dramatically simplifies design, deploy, maintain – more on this later



Security

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802.11 Enterprise wide security

	Traditional	Belden
WLAN Standard Security Features (802.11i)	Yes	Yes
Security Management	Within each Access Point	On Belden Switch within secure environment
Access Point in open space which may be unsecured	Potential threat	AP is just a radio, does not contain any sensitive information
Communications between Access Point and Backbone	Open Ethernet communications	Secure Belden Protocol
Performance	Encryption may impact throughput; require other elements to compensate	Hardware-based encryption in Switch does not degrade comm performance



Management

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§ Configuration

- Switch is only point of configuration / AP has zero-footprint
 - Cell-based WLAN (and Meru's virtual cell approach) require configuration tools at the AP-level
- Configuration through web-based https:// connection
- Central Configuration
 - One Switch declared Master; Master configuration pushed to all Slaves
 - Slave switches are then individually configured for switch-specific parameters
- FAQ: Can you centrally manage 1000 APs?
 - A: Yes. The difference is that we would manage whatever number of switches connect to 1000 APs, rather than managing 1000 APs directly.

§ Monitoring

- SNMP v2 provided from the Switch
- Interface to any standard management console to receive and respond to SNMP alerts and configure the switch



Design, Deploy, Validate Process

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Anatomy of a WLAN Deal

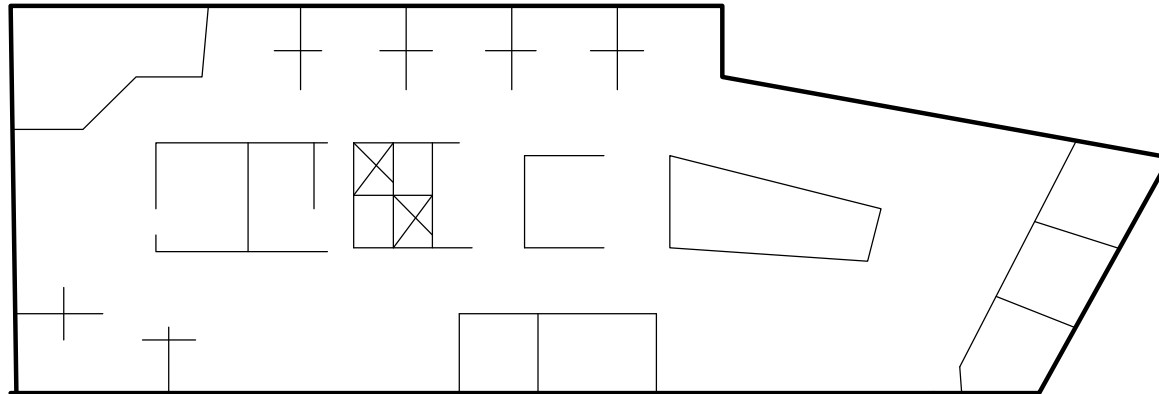
§ WLAN Infrastructure	42%	
§ Site Survey / Design	12%	
§ Management Tools	15%	} 50% of Project!
§ Cabling & Install	14%	
§ Maintenance	9%	
§ Other	8%	

Source: Gartner (March 2006)

Design, deployment, and maintenance represent a significant opportunity to increase overall Return on Investment, and lower Total Cost of Ownership

The Traditional Deal

- § Start with an office and warehouse
- § Core Question: How much gear will I need?



Answering the Call – The Traditional Way

§ People Skills

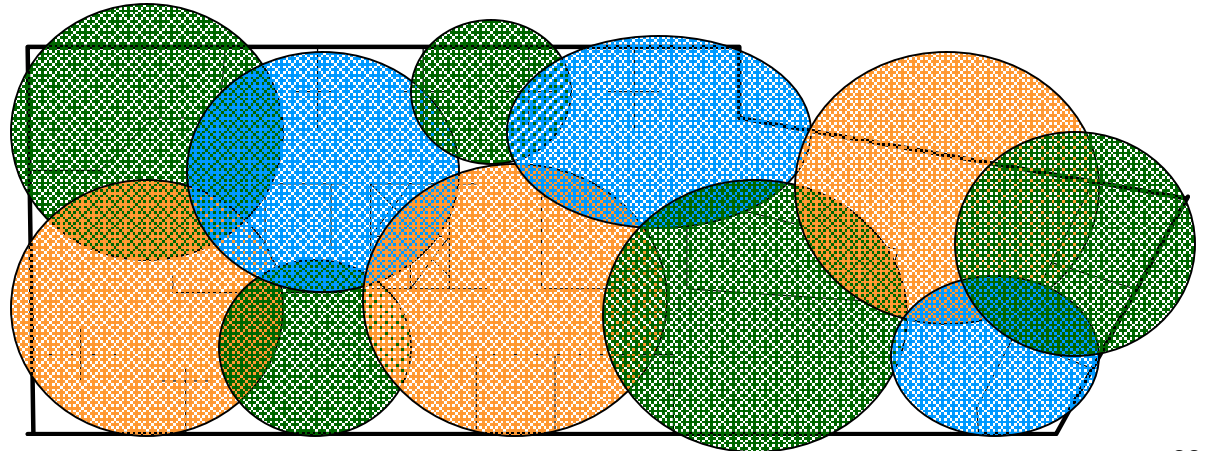
- RF engineer – signal propagation, interference analysis, signal shaping with antenna, trained on “air analyzers”, voice quality assessments
- Network engineer – IP mapping, load balancing, routing

§ Tools

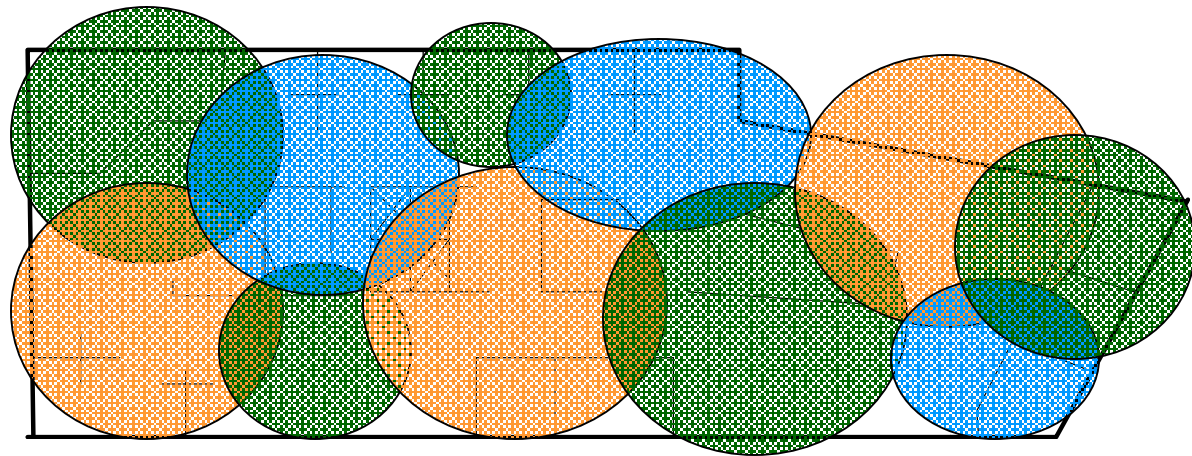
- RF propagation prediction
- Air analyzer
- Network throughput meter

Design – A Multi-Variable Problem

- § Number and Location of APs – a function of desired data rate
- § Channelization – 3 channels at 2.4GHz
- § Co-Channel Interference – a function of channel reuse
- § AP-to-AP Overlap Zones – impacts handoff and client distribution
- § Collision domain sharing – impacts bandwidth / throughput
- § Transmit Power
- § Antenna Type

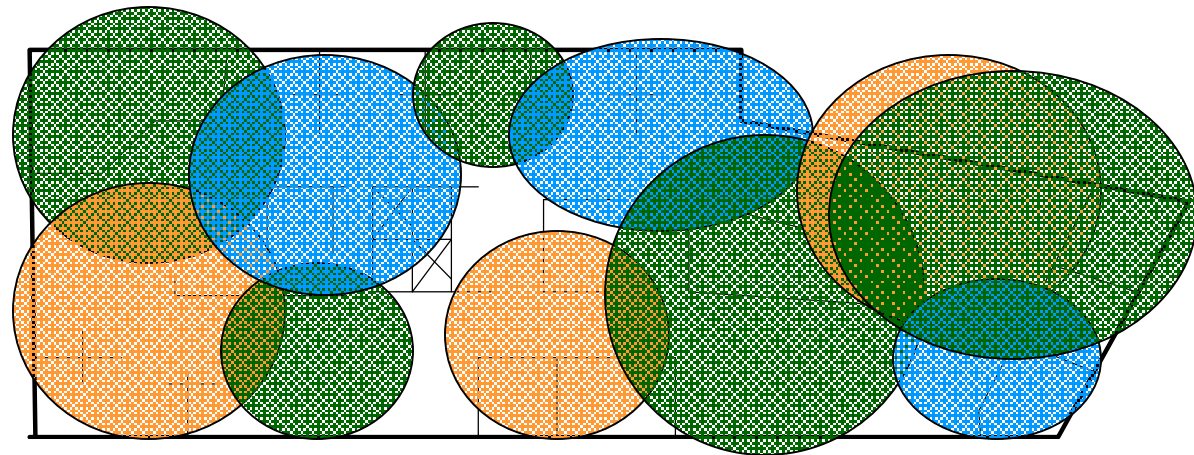


- § Configure each AP and switch
- § Create IP map to assign IP address to each AP



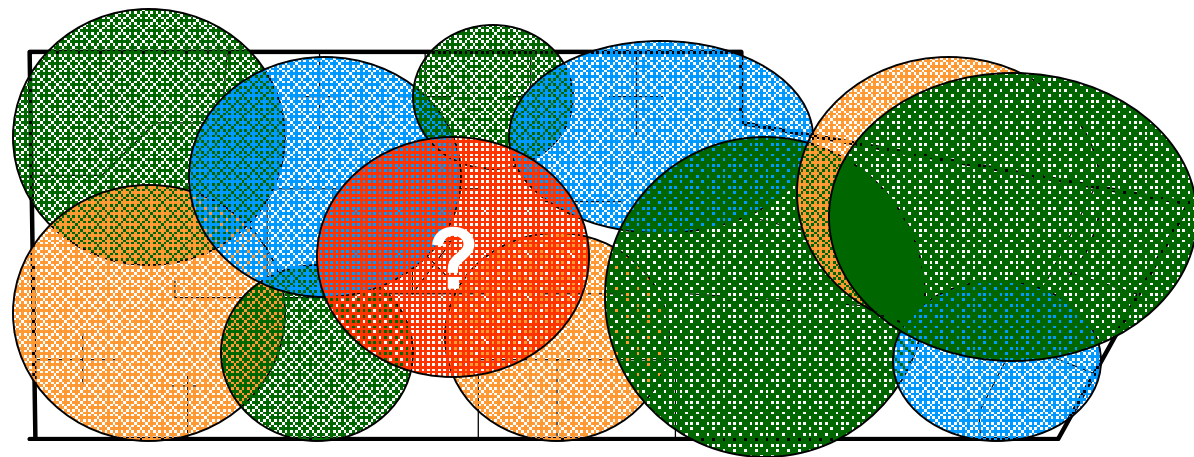
Validate

- § For each AP, measure actual downlink data rate
- § Identify overlap, assess handoff points
- § Measure throughput per AP, and at the switch (aggregate) – is collision domain sharing occurring?



Adjust

- § Dead Spot – start over with channelization; may need to change data rate target
- § Co-channel interference – re-channelize, adjust power



Design	<ul style="list-style-type: none">§ Number and Location of APs§ Channelization§ Co-Channel Interference§ Predict Overlap Zones§ Predict Collision Domain Sharing§ Transmit Power§ Antenna Type
Deploy	<ul style="list-style-type: none">§ Configure each AP and Switch§ Create IP map to assign IP address to each AP
Validate	<ul style="list-style-type: none">§ For each AP, measure downlink data rate§ Find overlap zones – measure handoff effectiveness§ Identify collision domain sharing – aggregate throughput
Adjust	<ul style="list-style-type: none">§ Re-channelize, re-model

<p>Design</p>	<ul style="list-style-type: none"> § Number and Location of APs § Channelization § Co-Channel Interference § Predict Overlap Zones § Predict Collision Domain Sharing § Transmit Power § Antenna Type
<p>Deploy</p>	<ul style="list-style-type: none"> § Configure each AP and Switch Configure Switch only § Create IP map to assign IP address to each AP One IP for switch
<p>Validate</p>	<ul style="list-style-type: none"> § For each AP, measure downlink data rate § Find overlap zones – measure handoff effectiveness § Identify collision domain sharing – aggregate throughput § Measure desired data rate for channel – one pass
<p>Adjust</p>	<ul style="list-style-type: none"> § Re-channelize, re-model § Add and/or move one AP – no config, no re-planning

Design, Deploy and Maintain

- § The Belden solution significantly lowers the burden, complexity, and risk of WLAN deployment.
- § Total Cost of Ownership will typically be at least 25% lower with Belden than with any other solution.



Product Portfolio

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- § BWS-8008 – 8-port WLAN Switch
 - Supports up to 8 XtraThin APs (2-radio)
 - 100Mbps backbone to the LAN
 - Hardware based 802.11i encryption
 - Delivers PoE to the APs
- § BWS-8024 – 24-port WLAN Switch
 - Supports up to 24 XtraThin APs (2-radio)
 - Two 1000Mbps backbone to the LAN
 - Hardware based 802.11i encryption
 - Delivers PoE to the APs
- § BWAP-200 XtraThin AP
 - XtraThin - No intelligence in the device
 - Two 802.11a/b/g compliant radios
 - 100Mbps backbone to the WLAN switch
 - 802.3af Power over Ethernet (PoE)





Designing for VoWLAN

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§ Coverage

- Location – broader than where you have data today
- Strength – voice will require stronger signal to ensure voice quality
- Uplink Stability – voice requires uplink to be resilient to signal fades

§ Capacity

- Most Wi-Fi phones are 802.11b, not g or a, which will impact data users

§ Mobility

- Users will not tolerate packet processing delays in voice calls – experienced when a phone moves from one cell to another
- Security may worsen the handoff delay

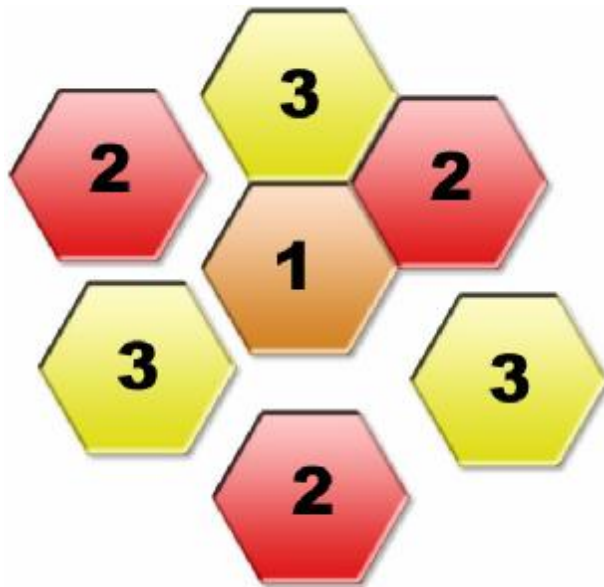
§ Quality of Service - Co-Existence with Data

- 802.11 is defined for a shared medium – unmanaged voice and data contention will degrade system performance for all

§ Phone Battery Life

- 802.11 protocol causes handsets to consume more battery power than other technology

Cell Layout



- Each Access Point (AP) is assigned a channel
- Two APs on the same channel must be physically separated to avoid interference

Belden Blanket Layout



- Each channel is placed everywhere
- Central switch control prevents interference
- Creates overlapping channel “blankets”

How does each of these topologies handle the “Top 5” VoWLAN Considerations?

Requirement: Coverage with 11Mbps capacity everywhere at all times

Cell Layout

- § Placement of APs is constrained by co-channel interference



Belden Blanket Layout

- § APs placed in any density, in any location
- § “Stacked” capacity from blankets
- § Uplink stability via multiple receivers



Requirement: Eliminate or minimize delays caused by “roaming”

Cell Layout

- § Handoff between APs causes delay that needs to be minimized
- § Caching of security keys
- § Need fast association mechanism
- § Wait for 802.11r specification



Belden Blanket Layout

- § “Roaming” is completely eliminated
- § Security unaffected by mobility
- § Requires no special client capability



Requirement: Prioritize voice versus data based on user service needs

Cell Layout

- § All APs and all channels are shared by all user types (voice/data & b/g modes)
- § Wait for 802.11e for traffic priority
- § Call Admission Control for throttling number of voice calls



Belden Blanket Layout

- § Different traffic and user types are segregated on different blankets, guaranteeing QoS
- § 802.11e used within a blanket for dual traffic devices (data/voice PDAs)



Requirement: Maximize battery life of voice handsets

Cell Layout

§ Maximum data rate is rarely achieved, which lengthens transmit times and shortens battery life



Belden Blanket Layout

§ Denser coverage + maximum data rate minimizes transmit time, which lengthens battery life



Summary - Voice Over WLAN Comparison

	Cell Layout Approach	Belden Blanket Layout Approach
Coverage and Capacity	<ul style="list-style-type: none"> • Limited by co-channel interference. • Aggregate capacity impacted by higher AP density. • Mixed-mode users lower local capacity. 	<ul style="list-style-type: none"> • No co-channel interference. • Aggregate capacity increases with AP density. • “Stacked” channel blankets increases local capacity.
Mobility	<ul style="list-style-type: none"> • AP roaming causes latency and jitter. • 802.11r intends to mitigate this, but requires client changes. 	<ul style="list-style-type: none"> • No roaming in the channel blanket = zero-latency mobility. • No client modifications necessary.
Quality of Service	<ul style="list-style-type: none"> • Voice and data users compete. • 802.11e partially mitigates contention, but requires client changes. • No solution for mixed-mode contention. 	<ul style="list-style-type: none"> • Voice/data and b/g users do not compete, via physical channel segregation. • No client modifications necessary.
Battery Life	<ul style="list-style-type: none"> • The denser the coverage, the higher the client transmit data rate. • The higher the data rate, the shorter each transmission, the longer the battery life. 	