



## 04 - System and Product Capabilities

October 2006

Belden Confidential 2006

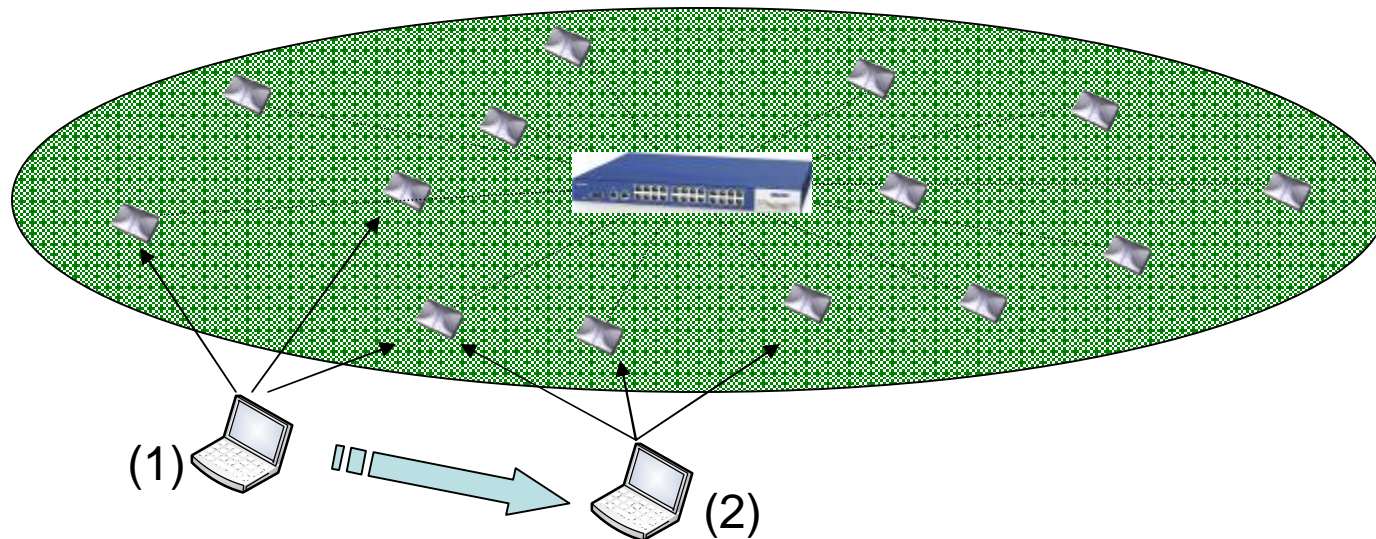
- § System Functionality
  - The Channel Blanket
  - Spectrum Reuse
  - Multi-Layer Network
  - Security
  - Management: Configuration and Monitoring
- § Design, Deploy, Validate Process
- § Product Portfolio
- § Designing for VoWLAN



# The Channel Blanket

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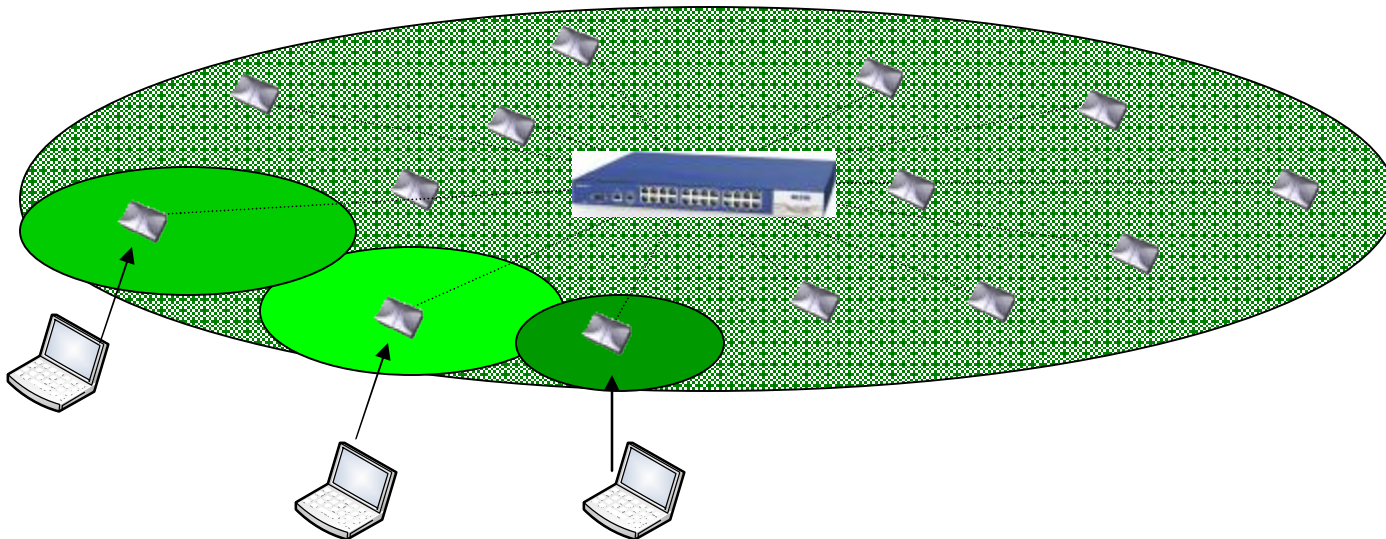
# Uplink in the Channel Blanket



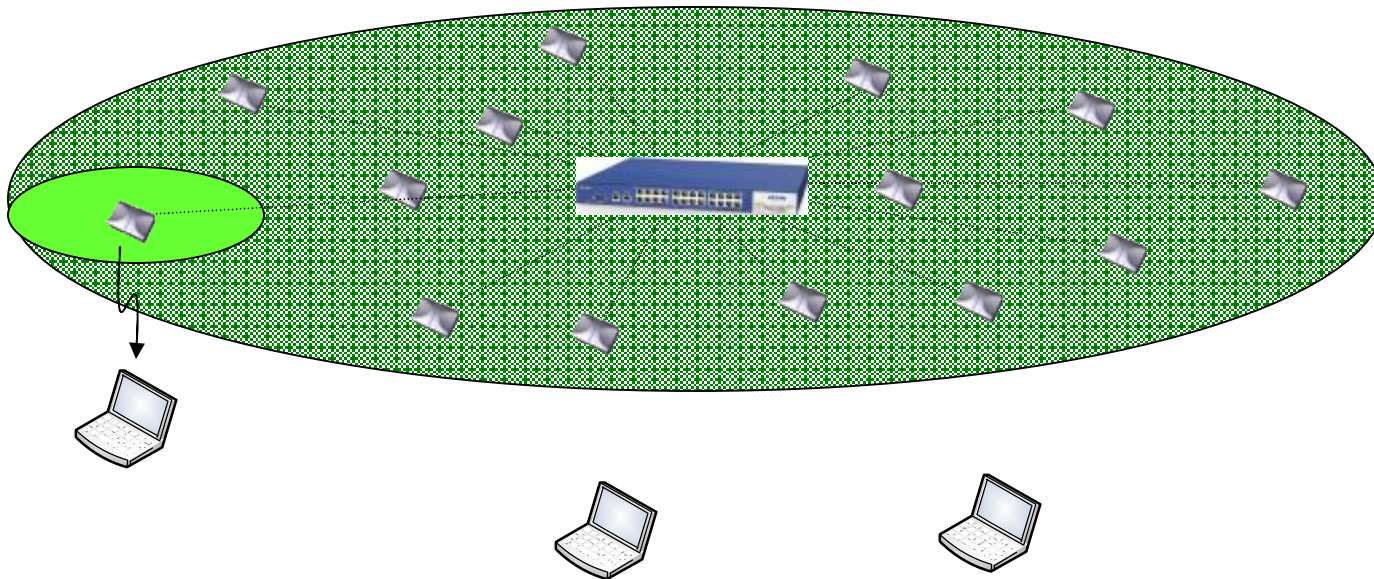
- § Uplink path diversity
  - Multiple APs “hear” the client
  - Switch receives multiple copies of the same transmission, and selects the best one – making the uplink resilient to disruption on any one individual link
- § Seamless zero-latency mobility
  - As the client moves, different APs receive 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

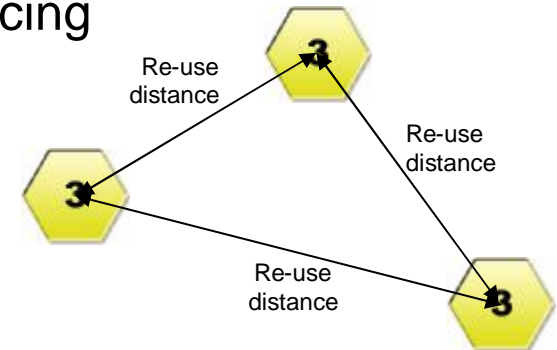
- Multiple use of the same channel, geographically separated
- Simultaneous transmission on the same channel
- Increase capacity without causing interference

## § “Natural” Reuse is Rare in Practice

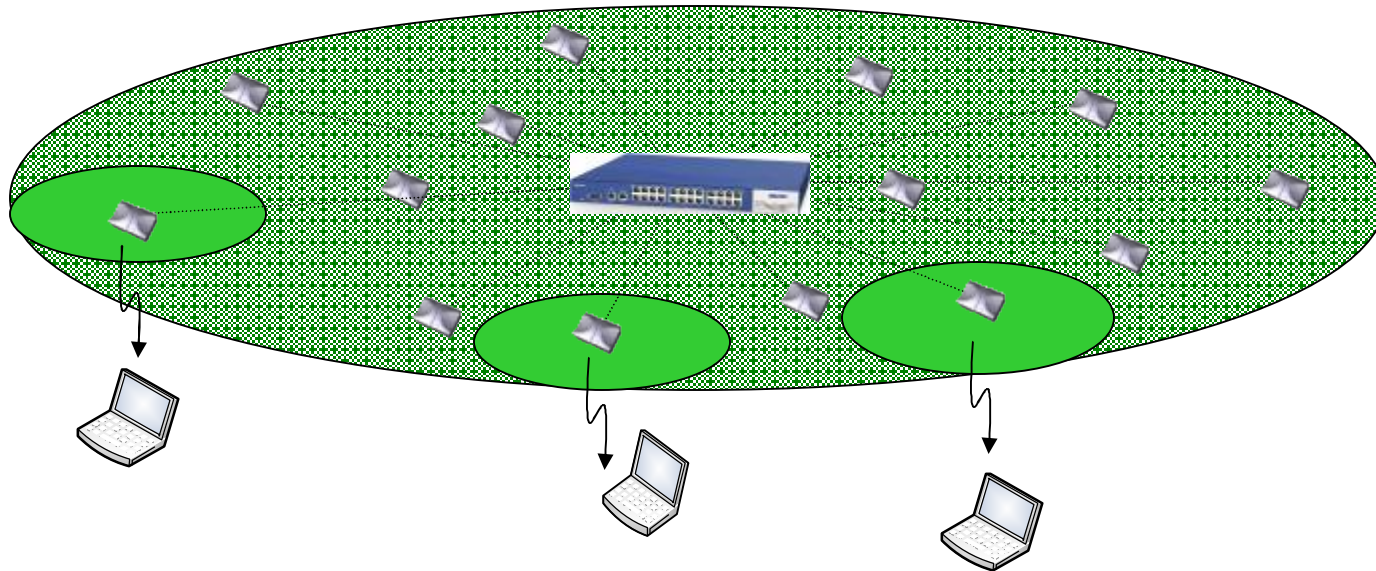
- IEEE 802.11 standard – CSMA/CA – listen before talk
- “Listen” part is governed by CCA / collision domain
  - CCA defined as -82dBm – in reality, NICs are much more sensitive
  - CCA leads to false positives and false negatives

## § 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



# Spectrum Reuse



- § 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

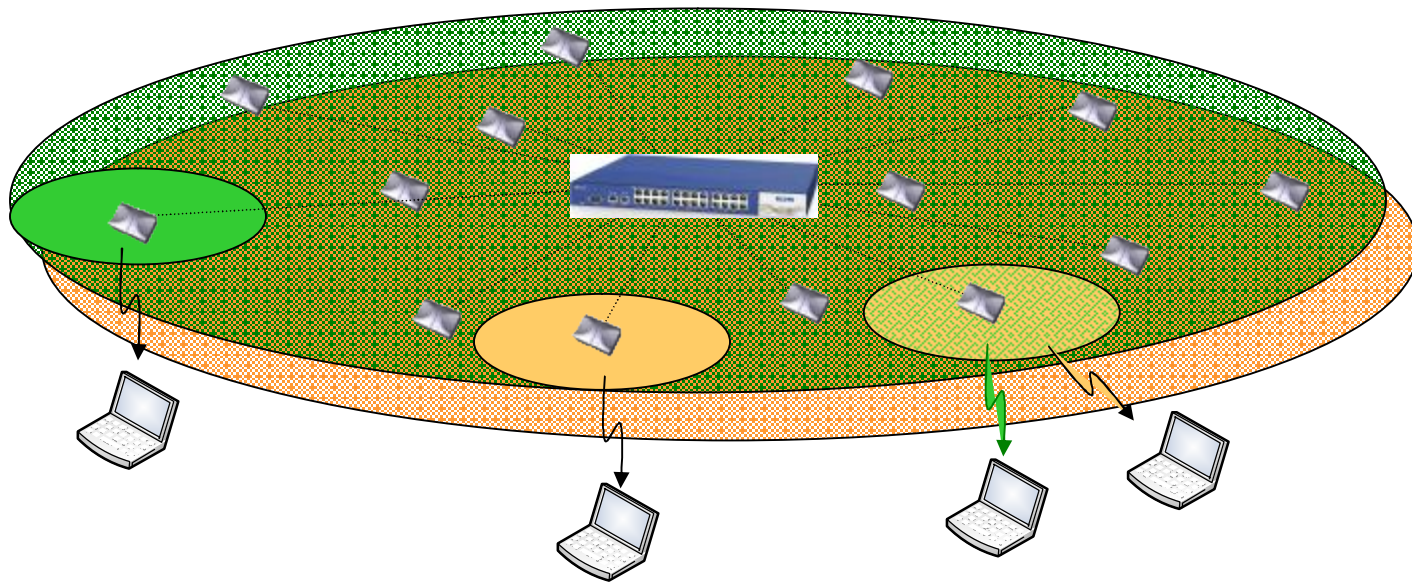


# Multi-Layer Network

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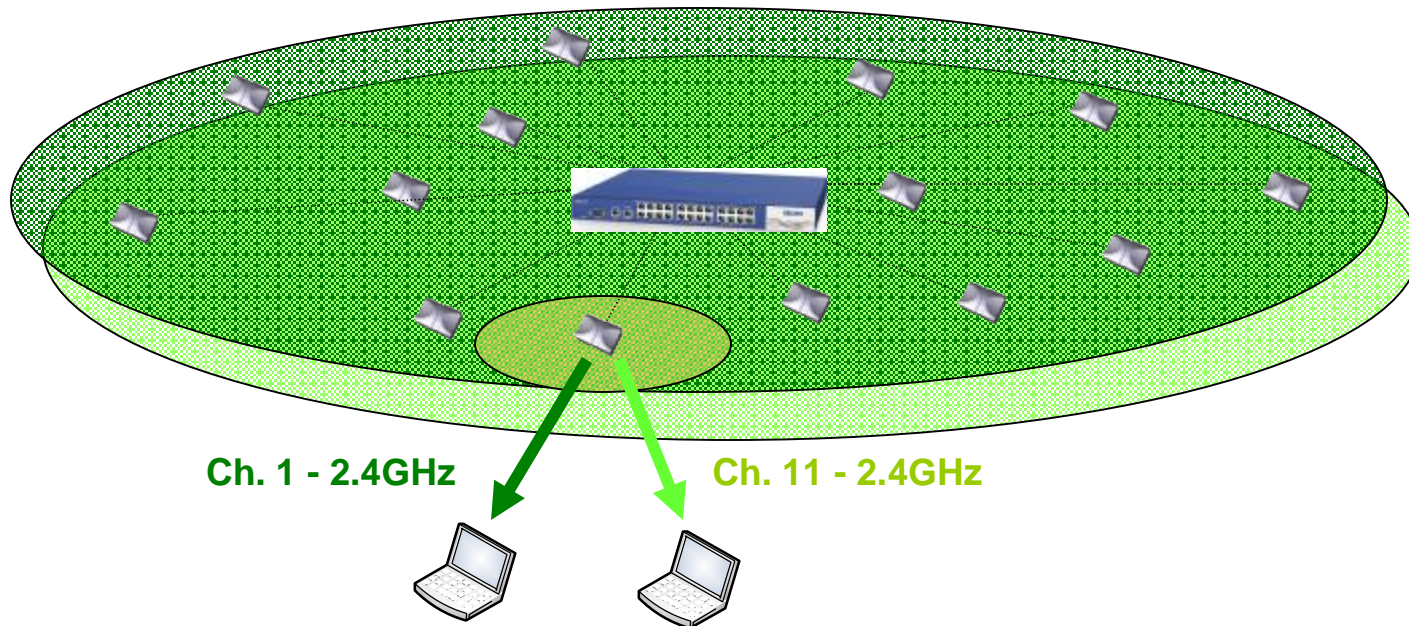
# Layered System

- § 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

	<b>Traditional</b>	<b>Belden</b>
<b>WLAN Standard Security Features (802.11i)</b>	Yes	Yes
<b>Security Management</b>	Within each Access Point	On Belden Switch within secure environment
<b>Access Point in open space which may be unsecured</b>	Potential threat	AP is just a radio, does not contain any sensitive information
<b>Communications between Access Point and Backbone</b>	Open Ethernet communications	Secure Belden Protocol
<b>Performance</b>	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

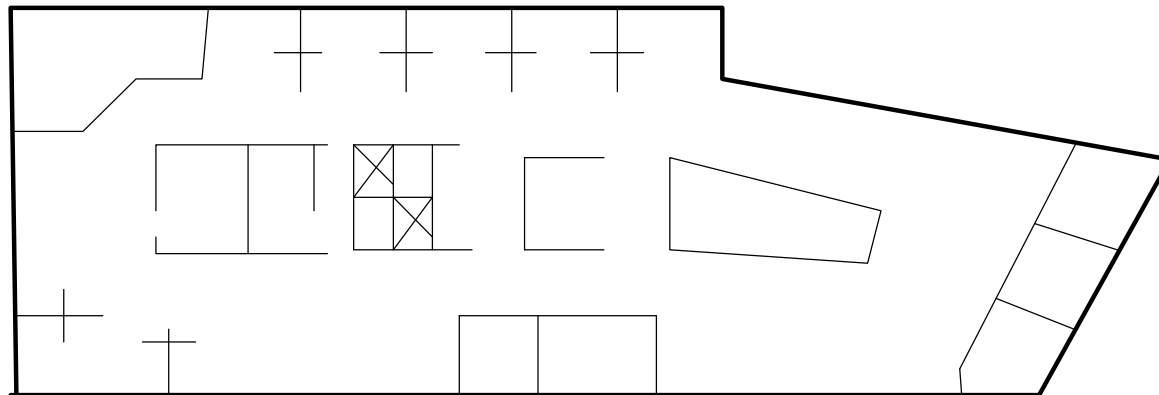
§ WLAN Infrastructure	42%	
§ Site Survey / Design	12%	
§ Management Tools	15%	} <b>50% of Project!</b>
§ Cabling & Install	14%	
§ Maintenance	9%	
§ Other	8%	

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

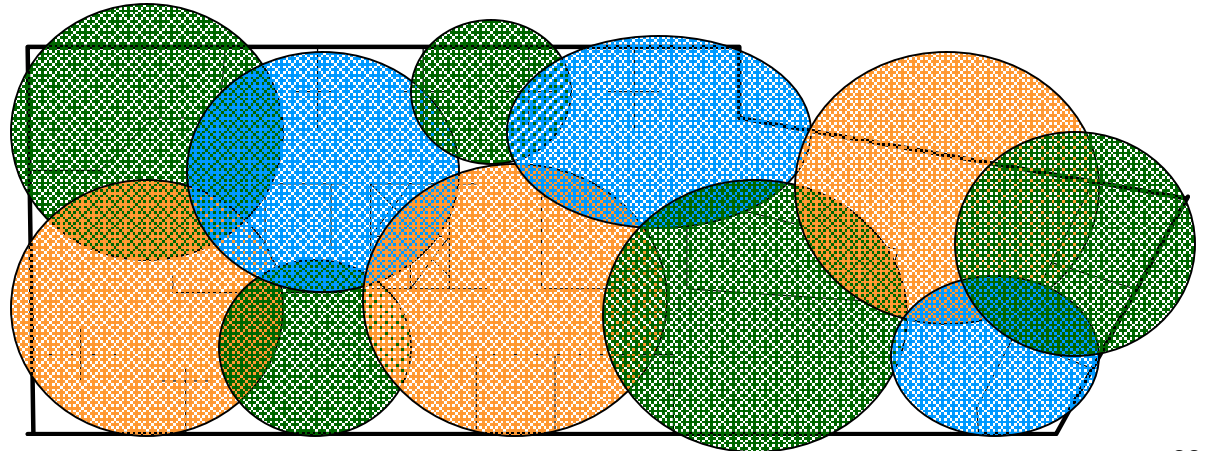
- RF engineer – signal propagation, interference analysis, signal shaping with antenna, trained on “air analyzers”, voice quality assessments
- Network engineer – IP mapping, load balancing, routing

## § Tools

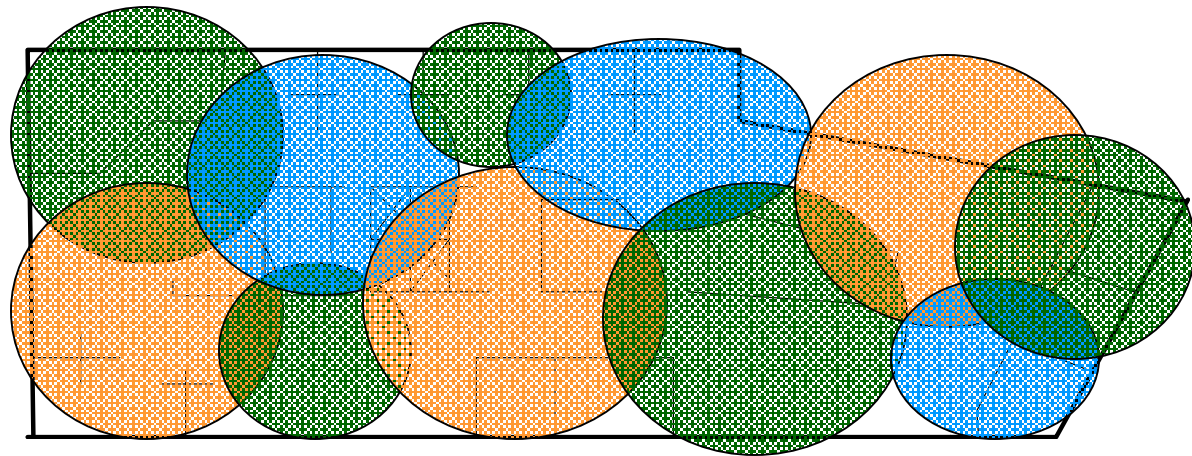
- RF propagation prediction
- Air analyzer
- Network throughput meter

# 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

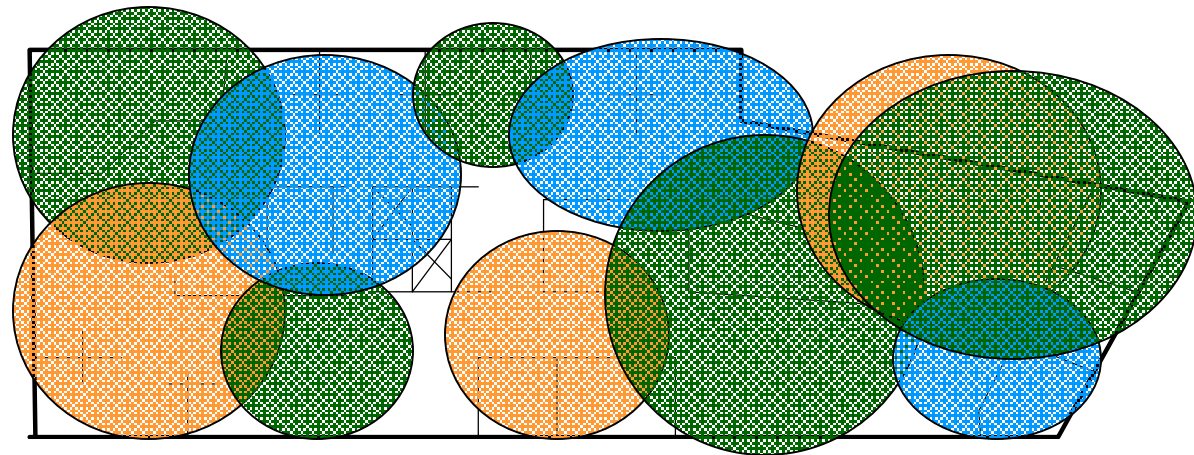


- § Configure each AP and switch
- § Create IP map to assign IP address to each AP



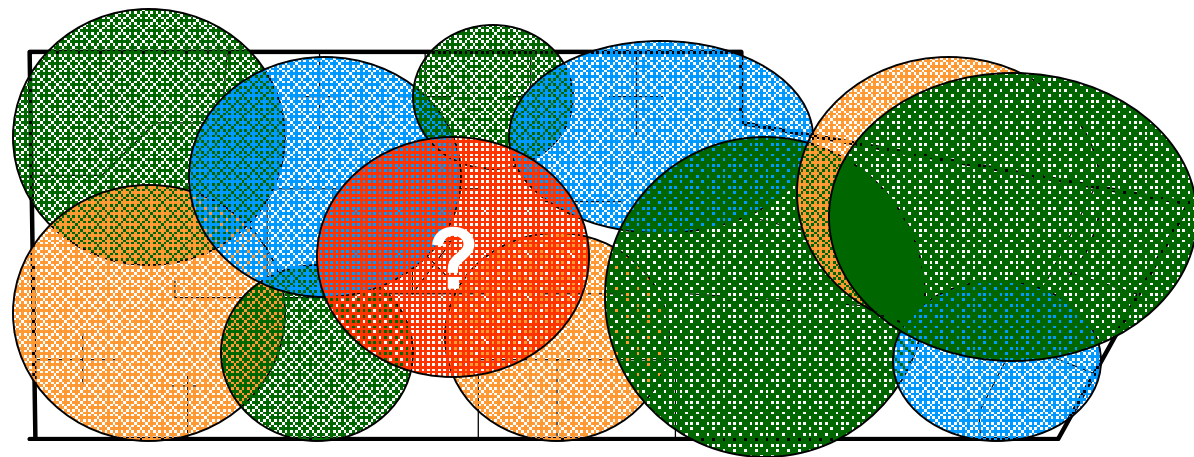
# Validate

- § 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



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

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

## 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

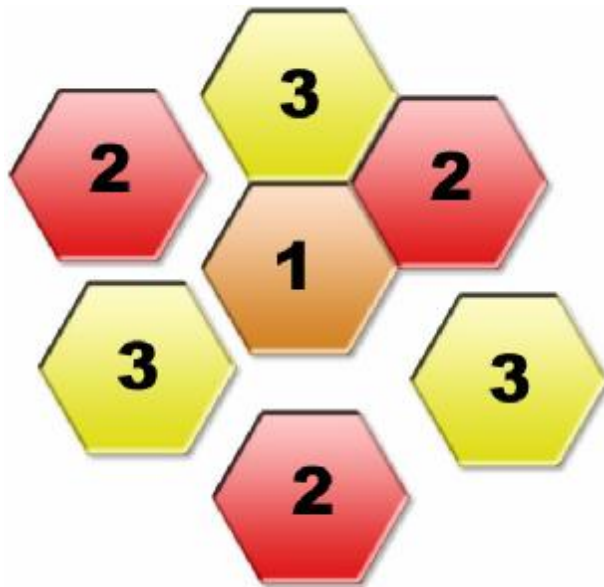
### § Quality of Service - Co-Existence with Data

- 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?

# Coverage and Capacity

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)



# Battery Life

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