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Voice over WLAN:

The Next Network Infrastructure Challenge

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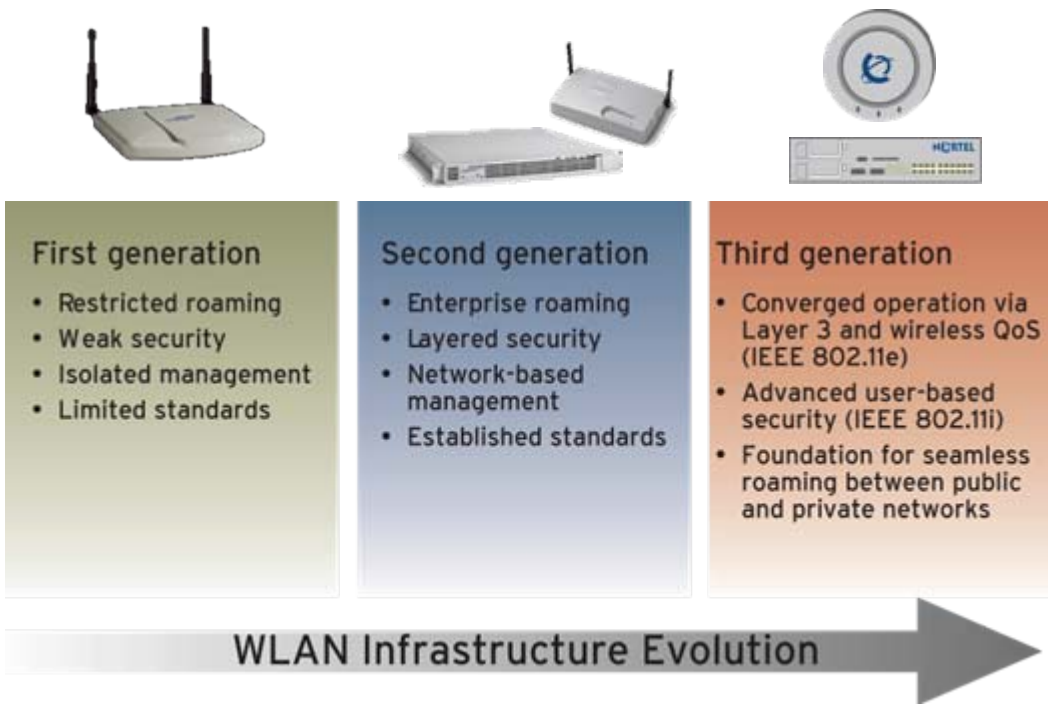
The Wireless LANscape: Evolution & IEEE Standards



- 802.11 – Original standard. FHSS and DSSS in 2.4 Ghz. 1-2 Mbps speeds.
- 802.11b – 2.4 Ghz DSSS, but higher rates up to 11 Mbps (3 channels)
- 802.11a – OFDM in 5 Ghz range (up to 13 channels)
- 802.11g - OFDM in 2.4 Ghz range (still 3 channels)
- 802.11e – QoS for 802.11a/b/g
- 802.11i – Enhanced security for 802.11a/b/g
- 802.11n – Future high speed standard for 802.11 (2.4 Ghz and 5 Ghz)

Voice over WLAN (VoWLAN) System Components

WLAN MOBILE UNIT (MU)

- A "Mobile Unit" is an 802.11 end Station (STA)
- A STA is comprised of radio, antenna, & MAC (Medium Access Control)

Distributed Coordination Function (DCF)

- Also known as CSMA/CA
- DCF guarantees fair access to the wireless medium
- Other "xCF" functions exist

WLAN ACCESS POINT (AP)

- AP(s) act like any other 802.11 STA, but have extra mgmt and control functions
- AP(s) offer "Thick" or "Thin" Architectures

CORE WIRED INFRASTRUCTURE

- Wired LAN Data Infrastructure
- Telephony Communication Server
- QoS Servers / Application Gateways

Key Challenges for VoWLAN

> In the beginning life was simple
  - Most vendors only implemented Distribution Coordination Function (DCF) and WLAN was primarily for Data use
  - There was only one queue for all the traffic (i.e. NO QoS)
  - Along came Voice and life in WLAN world got interesting …..

> Issues with Legacy 802.11
  - No way to prioritize traffic, all traffic is “best effort”
  - Throughput decreases rapidly as more stations associate
  - No admission control process
  - Negotiation of traffic specifications not possible
  - Battery life management
  - Limited security options

Addressing the challenges requires an understanding of user expectations, technology requirements for telephony, and basic WLAN operation.

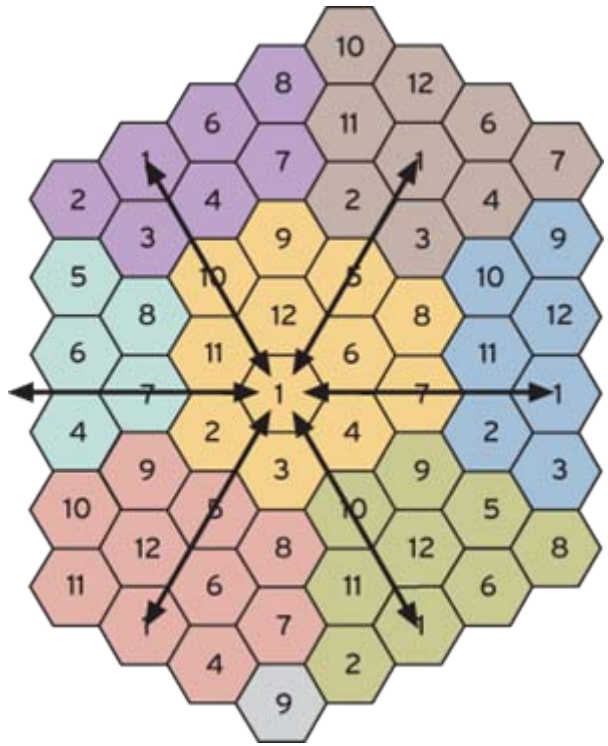
Key Considerations for VoWLAN:
System Planning

- Current WLAN solutions support dynamic selection of both 2.4GHz and 5GHz frequency bands, however most VoWLAN devices are only 802.11b today
- Site Survey... More than Analytical tools
  - Ensures that the wireless networks is optimally designed and configured to support voice by confirming RF coverage, cell overlap, channel allocation and reuse, packet transmission quality, and other wireless LAN infrastructure configurations.

Standard	Attribute	Comment for VoWLAN
IEEE 802.11a	Thirteen (in US) 54-Mbps channels in 5GHz ban	Number of channels eases coverage planning for voice roaming in multi-storey buildings
IEEE 802.11b	Three 11-Mbps channels in 2.4GHz band	Installed base support drives need for dynamic 802.11a/b operation
IEEE 802.11g	Three 54-Mbps channels in 2.4GHz band	Improved performance over 802.11g negated when any 802.11b users present

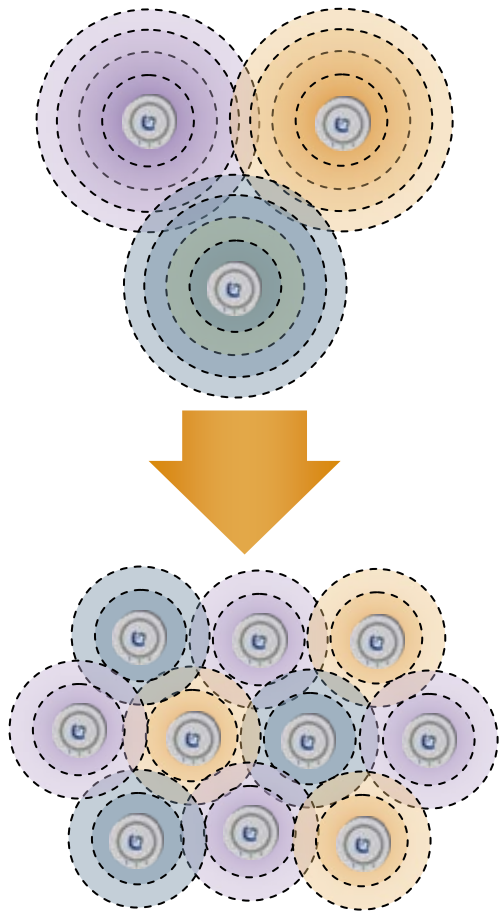
Key Considerations for VoWLAN:
Cell Planning

- Needed to provide continuous coverage and capacity for voice roaming.
- The radio channel used by a given access point (AP) can be adjusted to avoid interference between adjacent APs.
- As deployment increases, cell planning ensures that adjacent APs aren't using the same frequencies.
- Radio signals operate in three dimensions



Key Considerations for VoWLAN:
Protocol and MAC Overhead

- The best data bandwidth available for sharing among users close to an AP is:
  - Approx. 5 and 32 Mbps on 11b and 11a, respectively, with 1500 byte packets.
  - For more typical 450 byte packets, the bandwidth drops to 3 and 15 Mbps
- A 64-kbps G.711 coded voice signal takes up approx. 200 kbps over the WLAN; an 8-kbps G.729 coded voice signal takes 144 kbps.
- Enough bandwidth is needed to serve the expected load and can be done by increasing the density of APs in the coverage area.



Smaller cells increase WLAN capacity through channel reuse.

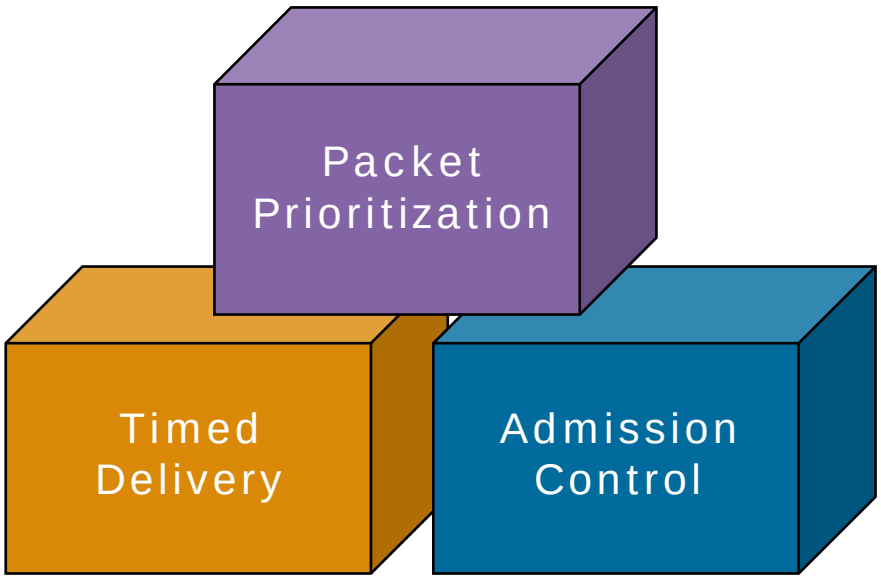
MAC and protocol overheads and bandwidth tradeoffs have to be factored in to user expectations and capacity planning.

Key Considerations for VoWLAN:
Quality of Service (QoS)

- The WLAN radio channel is accessible to a number of mobile clients and the AP.
- QoS is needed to consistently deliver voice quality over a broad range of conditions... it's more than bandwidth packet prioritization.
- Even if bandwidth is over-engineered, traffic growth, pattern changes, and network connection failures can still affect wireless IP Telephony.
- Ensuring an end-to-end QoS deployment, following IEEE 802.1p/Q and DiffServ, is essential.

Without QoS, traffic may experience differing amounts of packet delay, loss, or jitter, which can cause speech break-up, clipping, audio pops and clicks.

Key Considerations for VoWLAN:
Quality of Service (QoS) Building Blocks



Essential QoS Components for VoWLAN

> **Packet Prioritization**
- Recognizes high priority packets
- Minimizes latency and ensure timely delivery

> **Timed Delivery**
- Provides devices with pre-determined 'rest' periods in order to: Conserve power, Scan neighboring APs, Roam to better signal AP

> **Admission Control**
- Allocates available bandwidth for associated devices based on traffic requirements (Avoids oversubscription)

The role of QoS is to consistently deliver voice quality over a broader range of conditions, including number of users and data traffic loads.

Key Considerations for VoWLAN:
QoS Implementation Options

> IEEE 802.11e Standard

- Wi-Fi Multimedia (WMM) - Packet Prioritization
- Unscheduled Automatic Power Save Delivery (U-APSD) - Timed Delivery
- Traffic Specification (TSPEC) - Admission Control

> SpectraLink Voice Priority (SVP)

- Simple protocol ID tagging to identify voice packets
- Power Management and Admissions Control
- Flexible for QoS in legacy 802.11 infrastructures

QoS techniques are done by the Access Point as well as the end device

Key Considerations for VoWLAN:
Security

- **Wired Equivalent Privacy (WEP)**
  - Original Wi-Fi security standard shown to have severe security weaknesses
- **Wi-Fi Protected Access (WPA)**
  - Intermediate solution to help solve WEP insecurities
- **IEEE 802.11i Standard (WPA2)**
  - Advanced Encryption Standard (AES) block cipher
    - 802.1X for authentication (entailing the use of EAP and an authentication server) and pre-shared key mode (PSK)
    - Robust Security Network (RSN) for keeping track of associations
    - AES-based CCMP (Counter Mode with Cipher Block Chaining Message Authentication Code Protocol) to provide confidentiality, integrity and origin authentication.
- **IP security (IPsec) and Virtual Private Networks**
  - Was and is commonly used in place of WEP (legacy networks)
  - Very flexible, but also increases the solution's complexity and processing overhead

Key Considerations for VoWLAN:
Other Areas

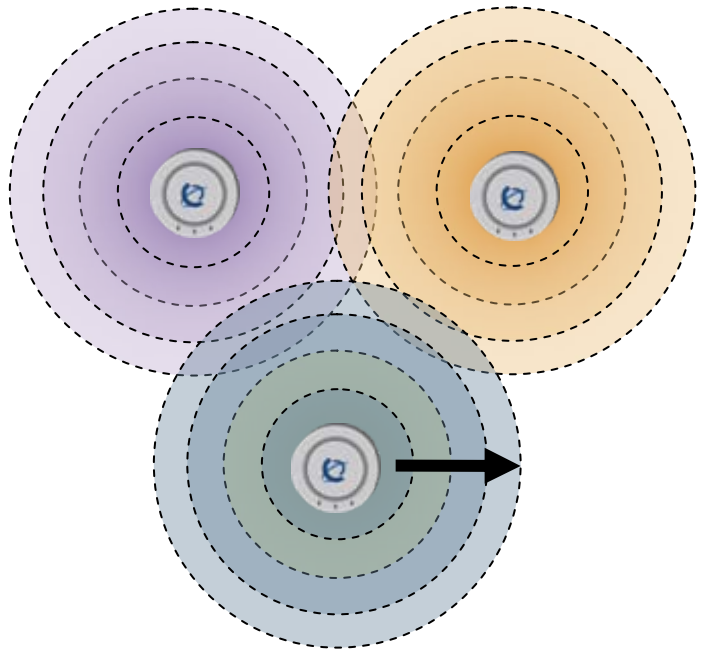
- Need to assess site security and roaming requirements as part of the overall WLAN deployment plan
  - Virtual LANs (VLANs) can be used to segregate traffic into different security classes.
- 802.11b/g Compatibility
  - Compatibility causes significant impact to 802.11g throughput (802.11g has a OFDM encoded “preamble” - Means 802.11b cannot see 802.11g frames without “help”)
- Avoid “Closed System” Networks
  - Extended Service Set ID (ESSID) was never meant to be a password, and using "broadcast" is not a security risk. Devices erroneously try to roam to the “closed” AP (Causes call drops, poor service).
- Recommend to disable channel tuning, power tuning, active scan within the wireless LAN infrastructure.

Closing Thoughts

- VoWLAN technology is somewhat complex, but solutions and techniques exist today to provide a quality VoWLAN implementation
- Things to keep in mind:
  - Site Survey (More than Analytical tools)
  - Plan coverage and capacity
  - Scale capacity the right way
  - Evaluate available QoS mechanisms
  - Plan your support strategy
- Simplify:
  - Security mechanisms
  - ESSIDs
- Do not overlook manageability of the solution

Key Considerations for VoWLAN:
Reach & Signal Strength

- WLAN systems operate over limited distances and include:
  - Adaptive coding to lower the bandwidth of a channel as a signal weakens from distance or obstructions.
  - Different bandwidths that can be dynamically assigned to mobile devices allowing increased range (coverage) when operating at reduced transmission rates.
- For VoWLAN, APs should not be configured to limit the transmission to only the higher rates because the coverage area of the AP will be greatly reduced.



Smaller cells increase WLAN capacity through channel reuse.

Key Considerations for VoWLAN:
Radio Channel Impairments

- Sites will need to take into account the impact of radio channel impairments, reach and signal strength, in addition to overhead, as all have a bearing on packets sent across the network, whether voice or data.
- WLAN signals may interfere with other devices like cordless phones, Bluetooth devices, microwaves, and even other WLAN APs.
- Engineering radio frequency (RF) coverage for the VoWLAN solution to -70dBm or stronger provides an adequate buffer for propagation challenges such as physical obstructions, interference and multi-path effects that impact both signal strength and quality.