



IEEE 802.11 Overview (2)

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Outline

- IEEE 802 Standards
- IEEE 802.11 Overview
- IEEE 802.11 Services
- History and present of IEEE 802.11



IEEE 802.11 Family

Standards	Band (GHz)	Raw Throughput	Typical Throughput
802.11	2.4	2Mbps (Legacy)	
802.11a	5	54Mbps	20 Mbps
802.11b	2.4	11Mbps	5 Mbps
802.11g	2.4	54Mbps	20 Mbps
802.11n	2.4 / 5	300, 600 Mbps	130 Mbps



IEEE 802.11 Family

Task Group	Descriptions
802.11c	Improves interoperability
802.11d	Multiple Regulatory Domains (Improve Roaming; New country)
802.11e	Quality of Service (QoS); prioritizing voice or video
802.11f	Inter-Access Point Protocol (IAPP)
802.11h	Supports measuring and managing the 5-GHz radio signals in 802.11a
802.11i	Enhanced Security (repairs WEP weakness)
802.11j	Extensions for Japan
802.11k	Passing specific radio frequency health and management data to higher-level management apps.



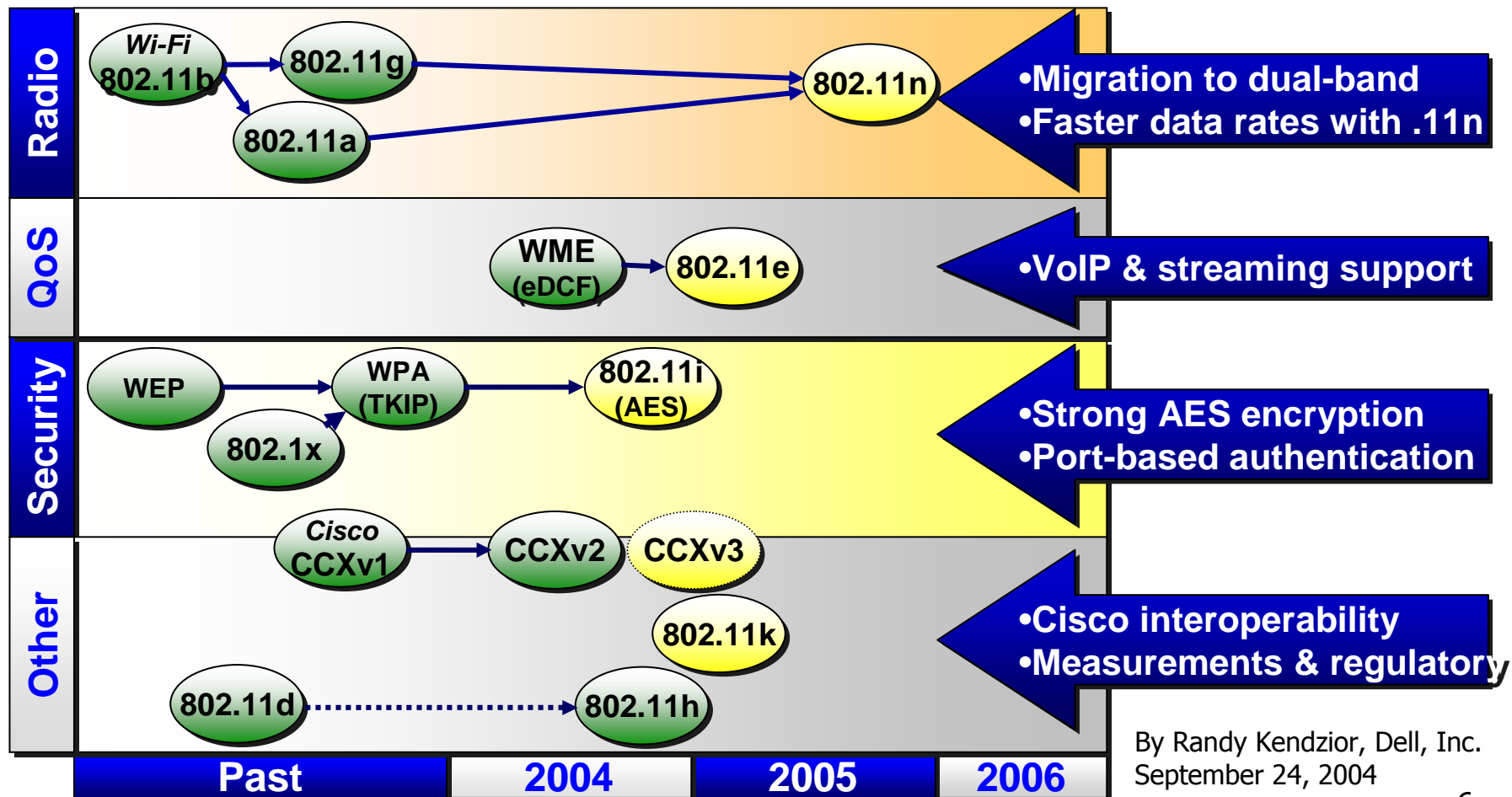
IEEE 802.11 Family

- [IEEE 802.11p](#) - WAVE - Wireless Access for the Vehicular Env. (e.g. ambulances and passenger cars) (working - 09?)
- [IEEE 802.11r](#) - Fast [roaming](#) (08)
- [IEEE 802.11s](#) - Mesh Networking, [Extended Service Set](#) (ESS)
- IEEE 802.11T - Wireless Performance Prediction (WPP) – (cancel ?)
- [IEEE 802.11u](#) - Interworking with non-802 networks (for example, cellular) (proposal evaluation - March 2010?)
- [IEEE 802.11v](#) - Wireless [network management](#) (early stages - 2010?)
- [IEEE 802.11w](#) - Protected Management Frames (early stages - 2009?)
- [IEEE 802.11y](#) - 3650-3700 MHz Operation in the U.S. (2008)



WLAN Technology Roadmap

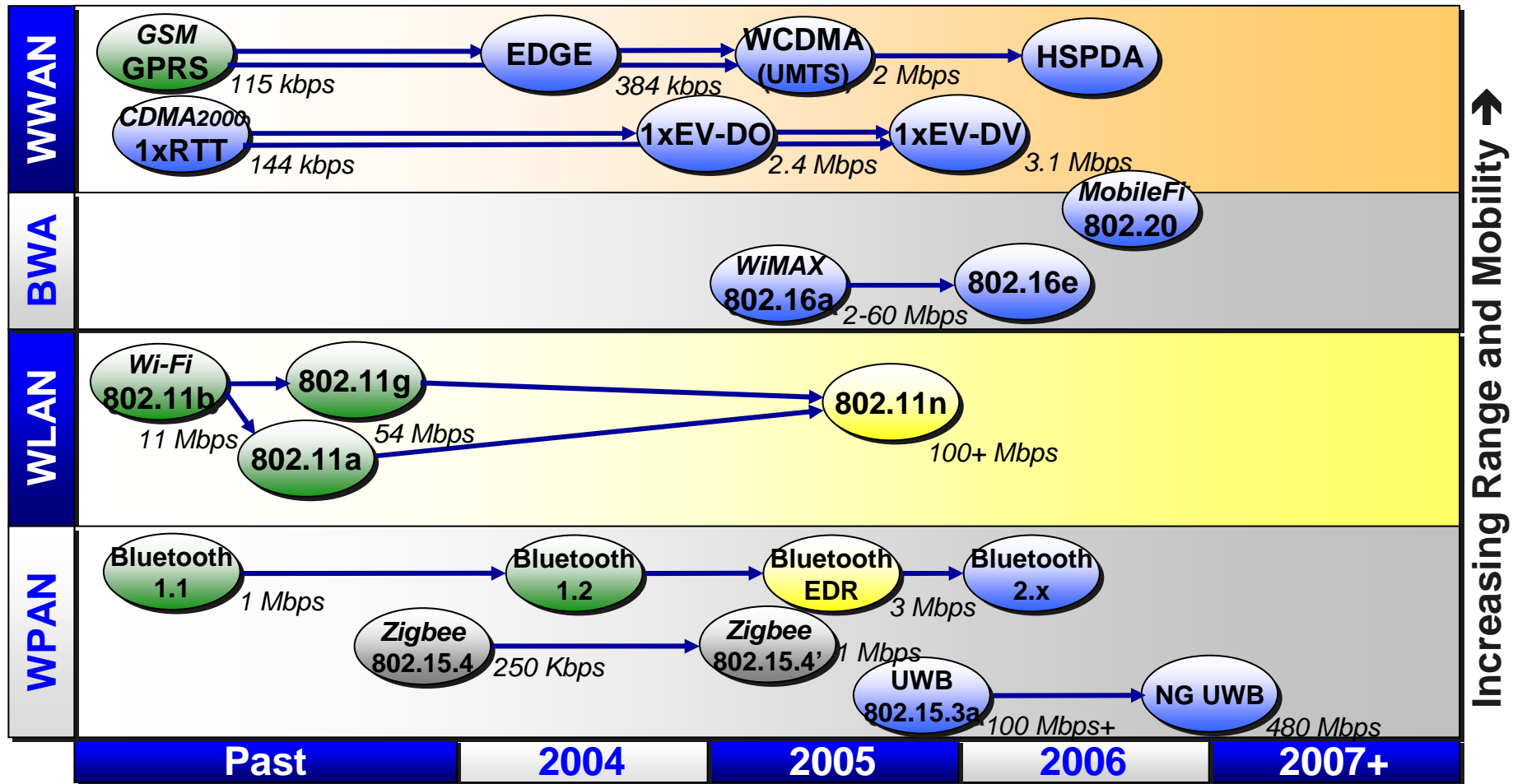
WLAN standards will emphasize throughput, QoS, security & management...



By Randy Kendzior, Dell, Inc.
September 24, 2004



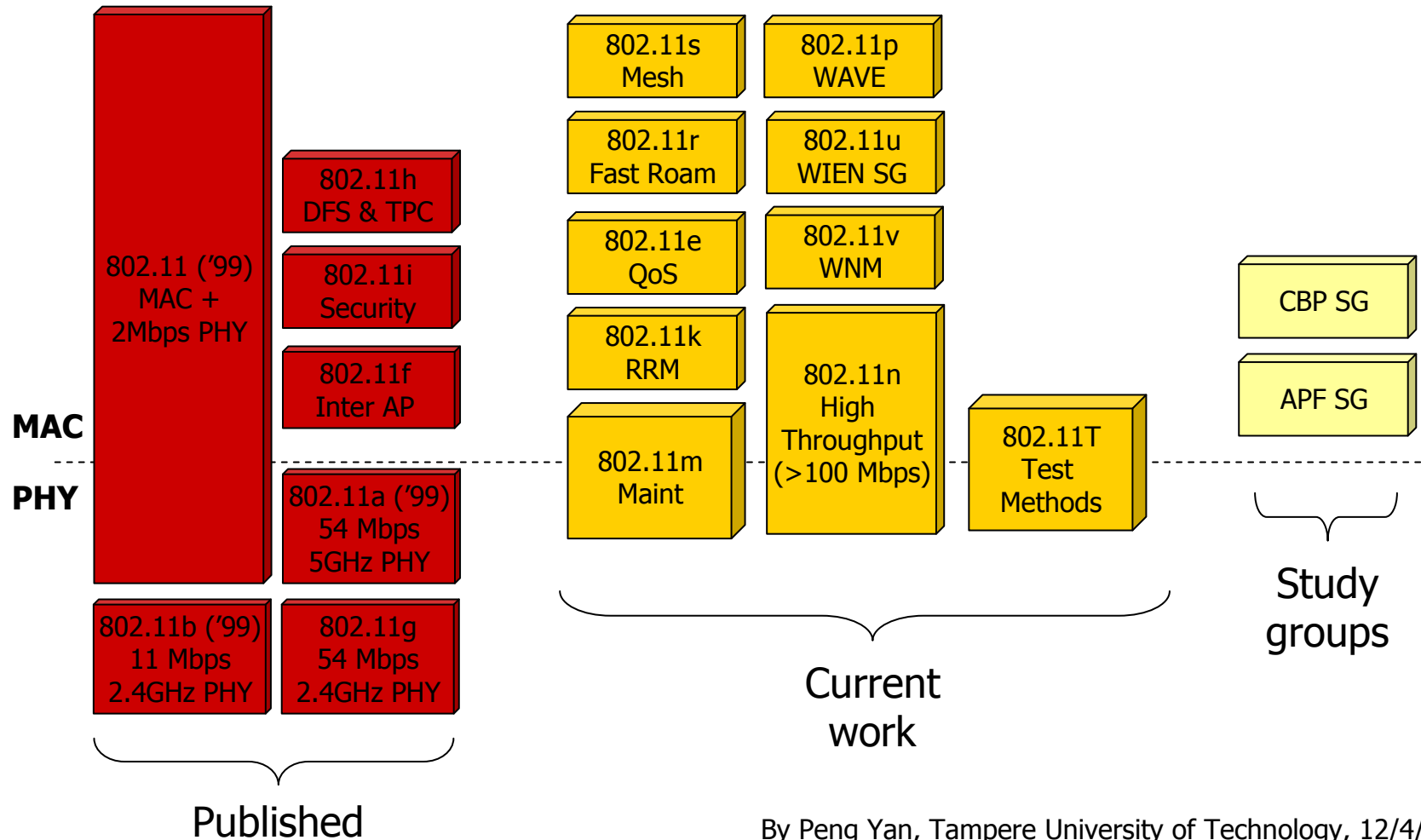
Wireless Technology Roadmap



By Randy Kendzior, Dell, Inc. September 24, 2004



IEEE 802.11 Standards





History: 802.11 Legacy

- 1997: First standard
 - Standard name: IEEE 802.11-1997
 - Updated: IEEE 802.11-1999
 - Starting Point for “Standard-based WLAN”
- For 2 Mbps: (fallback to 1 Mbps – Noisy): Direct sequence Spread Spectrum (DSSS) modulation
- For 1-2 Mbps Frequency Hopping Spread Spectrum (FHSS)
- Both operate in ISM band 2.4 GHz
- FHSS, DSSS, and infrared medium



802.11b

- 802.11b-1999
- Range 50 – 100 m. (depends on obstacles)
- Omnidirectional antenna
- Indoor / Outdoor / Point-to-point (high-gain external antennas)
- Max throughput of 11 Mbit/s (5.5, 2, 1 Mbps)



802.11b

- Attenuation: Metal, Thick walls, Water, etc.
- ISM Band 2.4 GHz; DSSS; CSMA/CA
- 14 overlapping ch. (Different ch. for different countries)
 - 3 simultaneously ch. (such as 1, 6, and 11)



802.11a

- 2001 (802.11a-1999)
- Max throughput of 54 Mbps (Normally around 20 Mbps)
- ISM Band 5 GHz (FCC may open more spectrum)



802.11a

- 12 nonoverlapping channels,
 - 8 dedicated to indoor
 - 4 to point to point
- Not widely deployed (US. / Japan)
 - 802.11b popularity
 - Less range / More attenuation
 - Lack of roll back compatibility (now support a,b,and g)
 - In Europe considering HiperLan2



802.11g

- 3rd quarter 2003
- ISM Band 2.4 GHz
- Max throughput of 54 Mbps (Net 24.7 Mbps)
- Fully backwards compatible with 802.11b
- Dual-band / Tri-mode
 - supporting a, b, and g
 - A single wireless card / Access point



802.11n

- Established in Sep 2003
- 2 Competing Alliances (for the draft 802.11n)
 - Task group n synchronization (TGn Sync)
 - World Wide Spectrum Efficiency (WWiSE)
- Both agree on the usage of multiple input multiple output (MIMO) antenna technology
- Mostly differences on channel bandwidth allocation, PHY (OFDM) and MAC
- Max throughput (MAC SAP) ≥ 100 Mbps

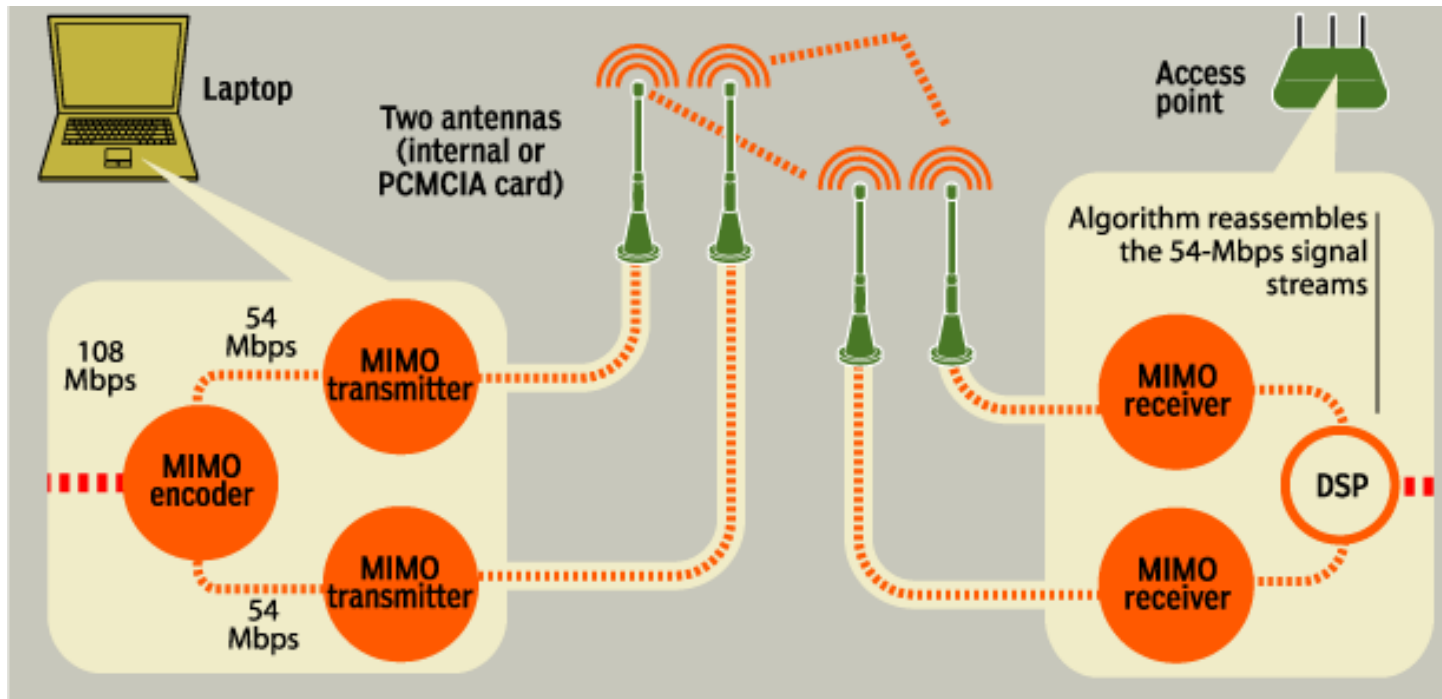


Status 802.11n

- June 2007 Draft 2.0 (Official → device)
 - Draft N, Pre-N
- May 2008 Draft 4.0
- Jan 2009 Draft 7.0
- May 2009 Draft 10.0 (Working)
- Qualcomm introduces “WCN1312” (June 2009)
 - Single-Chip 802.11n Wireless LAN Solution for Handsets and Mobile Devices
 - 2.4 GHz, data rates up to 72 Mbps



MIMO



- MIMO encoder
 - divides 108 Mbps \rightarrow 2 x 54 Mbps Stream
 - One antenna / stream on same radio channel



802.11n Channel Bandwidth

- TGn Sync uses 40 MHz channels in the 5 GHz spectrum, the same one used by 802.11a
- WWiSE prefers 20 MHz channels in the 2.4 GHz consistently used 802.11b/g spectrum



Application Comparison

- 802.11a/b/g focus on computer networking
- 802.11n interests on broad communication and entertainment areas
 - Consumer applications like HDTV
 - Streaming video



802.11 Wi-Fi



- Specification defined by IEEE (not compatibility guarantee)
- A special group, Wi-Fi Alliance
 - Group of manufacturer
 - Test compatibility
 - Guarantees interoperability (by issue Wi-Fi Trademark)
 - Start with 802.11b → Dual band/Tri mode (a, b, or g)
 - Security standard Wi-Fi Protected Access (WPA)



802.11e

- MAC Enhancements for Quality of Service in the capabilities and efficiency of the protocol.
- VoIP

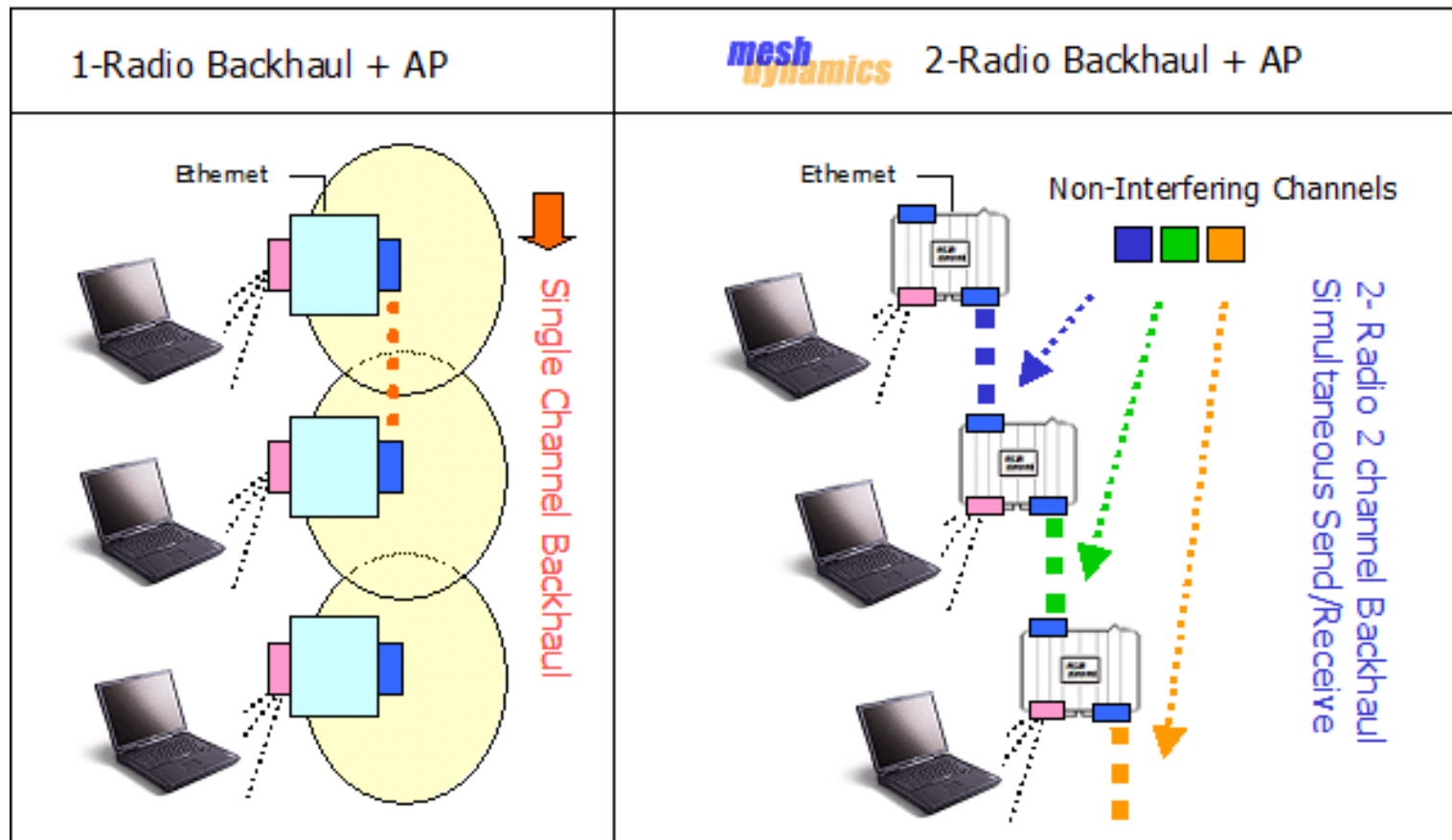


IEEE 802.11i

- Weakness reports in the WEP
- Create a larger number of initialization vectors for encryption.
- Dropping “WEP2” → Change to Temporal Key Integrity Protocol (TKIP)
 - a key retains its security over a period of time
- Need 802.1x
 - Authenticating method
 - Some weaknesses (man-in-the-middle style interception)



MeshDynamics



Since 2002, www.meshdynamics.com/MDPerformanceAnalysis.html