Wireless LAN as Mobile Radio Access Networks

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Introduction

- WLAN technology has been maturing (for over 15 years)
- Standards development (IEEE 802.11, ETSI-BRAN, MMAC) ongoing for well over a decade
- Standards-based product implementations are now a reality (many 802.11 vendors)
- Enjoying widespread adoption for use in different environments, e.g., Enterprises, Homes, Factories, Hotspots (airport, hotel, conference room, plane, train, public safety), …
A Qualitative Assessment:

WLAN relative to Wide-Area Cellular

- Significantly higher bit rates (50x and more)
- Based on unlicensed spectrum (regional 900MHz, 2.4 GHz, global 5 GHz)
- Ease and low cost for setup and use
- Faster pace of technology evolution (in PHY layers)
- Limited range (per cell)
- Limited mobility (stationary, pedestrian but without vehicular speeds)
- QoS and Security issues are no less critical

- Evolving business models (many kinds of WLAN players)
- Can uniquely compliment IMT-2000 access technologies (a competition to cellular only if not embraced in a timely manner)
Expectations for Systems Beyond IMT-2000

• Provide flexible support for a wide range of user needs with respect to speed, coverage and mobility

• Support a diverse set of radio access technologies including: High speed Wireless LAN (>100 Mbps), evolution of 3G air interfaces, and new 4G air interfaces

• Provide seamless mobility support for mobile devices with multiple access technologies that will become commonplace

• Seamless support for mobile networks (i.e., a closed group of users that moves collectively with respect to a fixed network)
Seamless Mobility

As the user moves, different access choices become available.

System enables the best choice of access network as user moves in different access environments.

Wide area cellular with:
- W-CDMA or
- IS-2000 (1X and beyond) or
- future 4G AI

Access Independent IP Core Network that:
- Is Managed
- Is Mobility Enabled
- Supports QoS and AAA

Mobile with multiple access interfaces

Wireless LAN (e.g., 802.11a/b/g or HiperLAN2 or HiSWANa)

Alternate Wired or Wireless Access Network

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Mobility between wide-area cellular network and Wireless LAN

Handoff design must account for:

- Intra-access versus Inter-access technology movement
- Intra-domain versus Inter-domain movement
- Type of service (real-time or non-real-time)
- Flexible QoS needs of mobile users

Seamless Mobility from the User perspective –
- Unified authentication / security, billing and ease of access to applications from all locations with acceptable QoS at all times
Two approaches have been proposed for coupling WLANs with Cellular Systems:

- Loosely coupled architecture
- Tightly coupled architecture
Loosely Coupled Functional Architecture

- **B-IMT2000 RAN**
- **FA_{RAN}**
- **RGW**
- **B-IMT2000 Foreign Network 2**

- **CN Correspondent Node**
- **FA Foreign Agent**
- **HA Home Agent**
- **RGW Radio Gateway**

- **PDN**

- **FA_{WLAN}**
- **FALAN**
- **AP**
- **WLAN Foreign Network 1**

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An Example Network

- Home N/W (10.1.201.X)
- Foreign N/W 1 (10.1.202.X)
- Foreign N/W 2 (10.1.203.X)

Network Components:
- HA
- FA1
- FA2
- RGW
- MN
- CN
Consider a Mobile Station that moves from its Home to Foreign Networks as shown below.
On Home NW (via WLAN)

- Home N/W (10.1.201.X)
- Foreign N/W 1 (10.1.202.X)
- Foreign N/W 2 (10.1.203.X)

Network Nodes:
- HA
- FA1
- FA2
- MN
- RGW
- CN

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Move 1: Home NW to Foreign NW 2 (B-IMT2000 RAN)
Move 2: Foreign NW 2 to Foreign NW1 (WLAN)

Move 3: Foreign NW 1 to Foreign NW 2 (B-IMT2000 RAN)
Loosely Coupled Architecture

- Access technology independent
- Widespread support in Standards Development Organizations
- Links together existing hotspot and enterprise network environments
- Implementation based on existing / proven technology
Tightly Coupled Architecture

- Access technology dependent
- WLAN appears subservient to Mobile RAN
- Lack of support due to high level of standardization effort
- Higher complexity for cellular interworking
- Longer time to develop
<table>
<thead>
<tr>
<th>Attribute</th>
<th>802.11</th>
<th>802.11a</th>
<th>802.11b</th>
<th>802.11g</th>
<th>HiperLan/2</th>
<th>MMAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency range</td>
<td>2.4 - 2.4835 GHz (100 mw max)</td>
<td>U-NNI (USA) bands 5.15 - 5.25, 5.25 - 5.35 and 5.725 - 5.825 GHz</td>
<td>2.4 - 2.4835 GHz (ISM band in N. America, Europe &amp; Asia)</td>
<td>2.4 - 2.4835 GHz</td>
<td>5GHz (HiSWANa) 25/27GHz (HiSWANb)</td>
<td></td>
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<tr>
<td>Physical Layer</td>
<td>FHSS</td>
<td>OFDM</td>
<td>Barker (mandatory) CCK (mandatory) PBCC (optional) DSSS</td>
<td>Barker, CCK, OFDM (mandatory) PBCC-22 (optional) CCK-OFDM (optl.)</td>
<td>OFDM BPSK, QPSK, 16QAM, 64QAM</td>
<td>Coded OFDM BPSK, 16QAM, 64QAM</td>
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<td></td>
<td>DSSS</td>
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<td>DSSS</td>
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<td>Infrared</td>
<td>OFDM</td>
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<tr>
<td>Channel Width</td>
<td>1 MHz</td>
<td>8 channels each 22 MHz</td>
<td>22 MHz 3 without overlap</td>
<td>22 MHz 3 without overlap</td>
<td>22 MHz</td>
<td>4 channels 20MHz each</td>
</tr>
<tr>
<td></td>
<td>3 without overlap</td>
<td></td>
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<tr>
<td>Throughput (Mbps)</td>
<td>1, 2</td>
<td>6,12,24 (mandatory) 9,18,36,48,54 (optional) (speed varies as distance from Access Point)</td>
<td>1,2, 5,5,11 Mbps using Dynamic Rate Shifting 7 Mbps (expected)</td>
<td>1,2, 5,5,11, 6,12,24 5,5,11,22,33 6,9,12,18,24,36,48,54</td>
<td>6,9,12,18, 27,36,54</td>
<td>6 to 54 Mbps 27 Mbps nominal</td>
</tr>
<tr>
<td>Medium Access Control protocol</td>
<td>Same as 802.11b</td>
<td>Same as 802.11b</td>
<td>CSMA/CA with Distributed Coord. func (mandatory) Optional Point CF</td>
<td>Same as 802.11b</td>
<td>Reservation TDMA w/ TDD 2 ms frame</td>
<td>TDMA-TDD, central control + dynamic slot assignment</td>
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### Additional WLAN standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Status</th>
<th>Description</th>
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<tr>
<td>802.1X</td>
<td>Completed in 2001</td>
<td>Comprehensive security framework for all IEEE 802 LANs including wireless. Includes authentication (EAP and Radius) and key management.</td>
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<tr>
<td>802.11i</td>
<td>Expected in 2002</td>
<td>Wireless specific security functions that work in conjunction with 802.1x</td>
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<td>802.11d</td>
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<td>Protocol to let 802.11 device to receive regulatory information for self-configuration</td>
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<td>802.11e</td>
<td>Expected in 2002</td>
<td>QoS mechanisms in support of all IEEE 802.11 PHY interfaces</td>
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<td>802.11f</td>
<td>Expected in 2002</td>
<td>Defines protocols for communication between APs (Inter-Access Point Protocol)</td>
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<td>802.11h</td>
<td>Expected in 2002</td>
<td>Spectrum and Transmit Power management extension techniques (5GHz in Europe)</td>
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<tr>
<td>802.11 WNG</td>
<td>Started 1/2002</td>
<td>WLAN Next Generation study group (peak rate &gt; 100 Mbps)</td>
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Conclusions

- Wireless LANs will continue to become faster, cheaper, reliable and ubiquitous
- Useful compliment to the wide area cellular access technologies
- Market evolution will likely result in multiple access technologies supported by seamless mobility solutions
References


ITU Seminar on IMT-2000 and Systems Beyond, Ottawa, Canada, 28 May 2002
References


