Wireless Technologies

SURFnet - Relatiedagen 2002

Jan-Willem Tasking

Ericsson Telecommunicatie BV
Contents

• Evolution of Wireless Technologies
• Wireless Computing Solutions - Positioning
• WLAN Business Drivers
• WLAN Technology
• WCDMA and WLAN
• Technology Evolution, Positioning and Combining
• Summary
Wireless Evolution - Technologies

- **Wide Area Network (~10km)**
  - Analog: 1G AMPS, NMT, TACS etc
  - Digital: 2G GSM, PDC, TDMA, CDMA
  - Wideband: 3G WCDMA, EDGE, CDMA2000

- **Local Area Network (~50m)**
  - Analog: CT1
  - Digital: DECT, PHS
  - Wideband: WLAN

- **Personal Area Network (~20m)**
  - Analog: “wire”
  - Digital: Infra Red
  - Wideband: Bluetooth

- **Combined devices**
- **4G**
Wireless Computing Solutions - Positioning

- **Wide Area Network (WAN)**
  - Large coverage

- **Personal Area Network (PAN)**
  - Connectivity
  - Cable replacement

- **Local Area Network/Access**
  - Hot Spots
  - High speed

<table>
<thead>
<tr>
<th>Mobility</th>
<th>User Bitrate</th>
<th>Mbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle</td>
<td>3G Cellular</td>
<td>0.1</td>
</tr>
<tr>
<td>Walk</td>
<td>2G Cellular</td>
<td>1</td>
</tr>
<tr>
<td>Fixed</td>
<td>Bluetooth</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>W-LAN</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>LAN</td>
<td></td>
</tr>
</tbody>
</table>
UTRAN – UMTS Terrestrial Radio Access Network

Indoor/low range outdoor:
up to 2 Mbit/s

User speed maximum
10 km/h

Suburban outdoor:
at least 384 kbit/s

User speed maximum
120 km/h

Rural outdoor:
at least 144 kbit/s

User speed maximum
500 km/h

Note: The UTRA requirements are the same as for ITU-R TG 8/1
Datacom Network Terminology
Business Drivers

- Access to Internet and Intranet becomes as vital as voice telephony in business.
- With Notebooks and PDAs, data Mobility at work includes computing. Today this is done off-line.
- With W-LANs performing like wired LANs, the office notebook user will not need to dock.
  - The same applications as for stationary platforms are supported with the addition of full data mobility.

There is a strong and growing demand to be always on-line
WLAN, IEEE 802.11b

- Direct Sequence Spread Spectrum (DSSS)
- 11 Mbps (CCK), 5.5 Mbps (CCK), 2 Mbps (DQPSK), 1 Mbps (DBPSK)
- 2.4 GHz (ISM band)
- Pico-Cellular system

1GHz 2GHz 3GHz 4GHz 5GHz

GSM WCDMA License-Exempt ISM License-Exempt LAN

CCK: Complementary Code Keying (RF modulation)
DQPSK: Differential Quadrature Phase Shift Keying
DBPSK: Differential Binary Phase Shift Keying
ISM: Industrial, Scientific and Medical (radio spectrum)
802.11 Protocol Stack

These layers are specified by IEEE 802.11

- **MAC (Media Access Control) Layer**
  - The rules for accessing the wireless medium
- **PHY (Physical) Layer**
  - Radio layer
  - Modulation, coding etc.
802.11b Spread Spectrum PHY

- Direct Sequence Spread Spectrum (DSSS)
- Baseband signal is spread by a chip sequence
- All STAs and APs use the same chip sequence
  - this is not CDMA!

![Power vs. Frequency](before_spreading.png)

Before spreading

![Power vs. Frequency](after_spreading.png)

After spreading
802.11b Channels

- Frequency range: 2400-2483.5 MHz (unlicensed band!)
- Channels numbered 1-14
- Spacing between channels: 5 MHz
- 802.11b bandwith: approx. 20 MHz
- => At most 3 non-overlapping channels
  - USA: Channels 1, 6, 11 (Channels 12-14 not allowed)
  - Europe*: Channels 1, 7, 13 (Channel 14 not allowed)
  - Japan: Channel 14

\[ Channel \quad 1 \quad 7 \quad 13 \]

* Some countries are exceptions
There is also another 802.11 PHY layer: 802.11a

- Orthogonal Frequency Division Multiplexing (OFDM)
- Data rates from 6 to 54 Mbps
- 5150-5350 MHz and 5725-5825 MHz (also an unlicensed band)
- 12 non-overlapping channels
- Not allowed in Europe yet
  - Except for 5150-5250 MHz in some countries.
  - Due to lack of DFS and TPC
- Uses the same MAC layer as 802.11b

Note: SIFS and DIFS times are different for 802.11a, Backoff slots are different

DFS: Dynamic Frequency Selection
TPC: Transmit Power Control
Other 802.11 amendments (work in progress in IEEE)

- **802.11e** Quality of Service
  - To support streaming traffic and AV applications

- **802.11f** Inter-AP Protocol (IAPP)
  - Protocol for transporting information between APs

- **802.11g** Further high-speed PHY layer extension in the 2.4 GHz band
  - OFDM in the 802.11b frequency band (2400-2483.5 MHz)
  - Data rates from 6 to 54 Mbps

- **802.11h** Spectrum and Transmit Power Control
  - Will make it possible to use 802.11a (5 GHz) in Europe

- **802.11i** Enhanced Security
  - Existing 802.11 (WEP) security is broken
  - New authentication and encryption algorithms (802.1x)
WCDMA (UMTS) and 802.11b (WLAN)

- **WCDMA**
  - Up to 2 Mbps (384 kbps wide area)
  - Wide Area Coverage
  - “Anytime, Anywhere”

- **WLAN**
  - Up to 5 Mbps user bitrate (11 Mbps physical layer bitrate)
  - Local Area Coverage (up to 50 m), Pico-Cellular
  - “Sometimes, Somewhere”
Combining Air-Interfaces

WLAN

Local Area Network

Bluetooth

Personal Area Network

WCDMA
GPRS, EDGE

Wide Area Network

Not to Scale
1 Wide Area cell = ~10 000 WLAN cells
Summary

- WLAN is an Attractive Addition to GPRS/WCDMA
- Always online everywhere (indoor & outdoor)
  - WLAN - Hotspots/Pico-Cellular
  - GPRS/WCDMA - Wide Area
- Developments for improving 802.11 ongoing for
  - Cellplanning (DFS, TPC), Higher Bitrates with 802.11a, g
  - Quality of Service, Security
- Combined Solutions - Mobile Operator - WLAN
  - Roaming, WLAN access management, Reuse of Provisioning system, transport network, Billing gateway (incl. Prepaid), Subscriber and Authentication mgt.