Current Trends in Wireless Networking

G Santhosh Kumar
Cochin University of Science and Technology
Agenda

- Trends
- Existing Wireless Standards
  - WRAN
  - WMAN
  - WLAN
  - WPAN
- References
Some Advertisements

BSNL 3G
A generation ahead

Get ready for a faster life
BSNL presents 3G

Mobile Broadband
Jump on any moment
Vodafone Mobile Broadband can open a world of opportunity in an instant. With a range of products that are just right for the way you work and play, you'll be ready to make the most of your time.

Reliance Netconnect Broadband+
Wireless Broadband FREE Offer!
Pay Rs. 3999/- to get USB Modem & 2 months of unlimited internet usage worth Rs. 3500/- FREE
Offer valid for 1st 1Lakhs_customers
This once-in-a-lifetime offer is only available online. So book now!

I CARRY SPEED.
Presenting Photon Plus Mobile Broadband Service
- Internet speeds up to 3.1mbps
- 20 times faster than current wireless technology
What does they offer?

- Faster Access
- Mobile TV
- Video Calls
- Video Conferencing
- Online Gaming

Major Share of telecom Industry is coming from Wireless!
Scope of Wireless Technologies

- **RAN < 100 Km**
  - 802.22 (proposed)
  - 18 – 24 Mbps

- **WAN < 15 Km**
  - 802.20 (proposed)
  - GSM, GPRS, CDMA, 2.5G, 3G
  - 10 Kbps – 2.4 Mbps

- **MAN < 5 Km**
  - 802.16 a/d/e – 70 Mbps
  - LMDS – 38 Mbps

- **LAN < 150 m**
  - 11-54 Mbps
  - 802.11 a/b/e/g
  - HiperLAN/2
  - 802.11n (proposed) > 100 Mbps

- **PAN < 10 m**
  - 802.15.1 (Bluetooth) < 1 Mbps
  - 802.15.3 > 20 Mbps
  - 802.15.3a (UWB) < 480 Mbps
  - 802.15.4 (Zigbee) < 250 Kbps
Chart of the Electromagnetic Spectrum

| Wavelength (λ) (m) | 10^3 | 10^2 | 10 | 1 | 10^-1 | 10^-2 | 10^-3 | 10^-4 | 10^-5 | 10^-6 | 10^-7 | 10^-8 | 10^-9 | 10^-10 | 10^-11 | 10^-12 |
|--------------------|------|------|----|---|------|-------|-------|-------|-------|-------|-------|-------|--------|---------|---------|
| cm                 |      |      |    |   |      |       |       |       |       |       |       |       |        |         |         |
| mm                 |      |      |    |   |      |       |       |       |       |       |       |       |        |         |         |
| mil               |      |      |    |   |      |       |       |       |       |       |       |       |        |         |         |
| nm                |      |      |    |   |      |       |       |       |       |       |       |       |        |         |         |
| Å                 |      |      |    |   |      |       |       |       |       |       |       |       |        |         |         |
| pm                |      |      |    |   |      |       |       |       |       |       |       |       |        |         |         |

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\[ \lambda = 3 \times 10^8 / \text{freq} = 1/ (\text{wn} \times 100) = 1.24 \times 10^{-6} \text{eV} \]
## Radio Services in India

Ref: [http://www.wpc.dot.gov.in](http://www.wpc.dot.gov.in)

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<th>Sr. Radio Service</th>
<th>Frequency Band</th>
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<tr>
<td>1 Radio Navigation</td>
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<td>2 Mobile (Distress &amp; Calling)</td>
<td>495 – 505 kHz</td>
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<tr>
<td>3 Broadcasting</td>
<td>535 – 1605.5 kHz</td>
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<td>4 Maritime Mobile</td>
<td>2065 – 2107 kHz</td>
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<td>2170 – 2178.5 kHz</td>
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<td>2190.5 – 2194 kHz</td>
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<td>5 Fixed, Mobile, Broadcasting Radio Astronomy</td>
<td>610 – 806 MHz</td>
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<td>6 Mobile, Fixed, Broadcasting</td>
<td>890 960 MHz</td>
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<td>7 Mobile satellite</td>
<td>942 – 960 MHz</td>
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<td>8 Radio Location</td>
<td>1350 – 1400 MHz</td>
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<td>9 Mobile, Fixed, Space operation, space research</td>
<td>1710 – 1930 MHz</td>
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FCC (Federal Communications Commission), ITU (International Telecommunication Union) are the international bodies for spectrum allocation.
Mobile telephone service providers in India use GSM and CDMA technologies

- 25 MHz spectrum in 900 MHz band (890 – 915 / 935 – 960 MHz) and
- 75 MHz in the 1800 MHz band (1710 – 1785 / 1805 – 1880 MHz) is earmarked for GSM services
- Spectrum for the **3G services** (voice, data and video) is 2.1 GHz (1920 – 1980 / 2110 – 2170 MHz) band
CDMA services, 20 MHz spectrum in the 800 MHz band (824 – 844 / 869 – 889 MHz) is available

Spectrum allotment is through e-auction
Multiple Access Methods

- **FDMA**
  - Frequency
  - Time
  - AMPS, TACS, NMT

- **TDMA**
  - Frequency
  - Time
  - TDMA, PDC
  - GSM → GPRS/EDGE

- **OFDMA**
  - Frequency
  - Time
  - HSOPA, Rev C, WiMAX

- **CDMA**
  - Frequency
  - Time
  - CDMA → EVXDO
  - UMTS → HSDPA
  - TD-SCDMA

**Generations**

1G

2G

3G

4G

1G → 2G

2G → 3G

3G → 4G
Spread Spectrum

i) $dP/df$

ii) $dP/df$

sender

iii) $dP/df$

iv) $dP/df$

receiver

v) $dP/df$

user signal
broadband interference
narrowband interference
Direct Sequence Spread Spectrum

- $t_b$: bit period
- $t_c$: chip period
Frequency Hopping Spread Spectrum

- Slow hopping (3 bits/hop)
- Fast hopping (3 hops/bit)

$t_b$: bit period
$t_d$: dwell time
Classification of Wireless technologies

- Infrastructure based
  - WLAN, WiMax, WWAN
- Adhoc
  - Bluetooth
  - MANET
  - VANET
  - WSN
Wi-Fi

- WLAN (IEEE 802.11 standard)
- Uses ISM band (2.4 GHz, 5 GHz)
- IEEE 802.11b, 2.4 Ghz, 1 Mbps
- IEEE 802.11a, 5 Ghz, upto 54 Mbps
- IEEE 802.11g, 2.4 Ghz, upto 54 Mbps
- IEEE 802.11n, (both 2.4, 5 Ghz), >100 Mbps. May replace 802.11 a/b/g
- Effective range of access point is around 100 feet
WiFi Application Scenario
WiMax

- **WIMAX** (Worldwide Interoperability for Microwave Access):
  - Protocol of communication network without wire, based on the standard IEEE 802.16
  - Allows communications over long distances than WiFi, and a greater bandwidth. Cover approximately 40km.
  - 802.16d (802.16-2004) – only fixed wireless
  - 802.16e (802.16-2005) – fixed and mobile wireless
  - Most deployment of mobile WiMAX networks has been done in the licensed (2.5GHz and 3.5GHz) and unlicensed (5.8GHz) bands.
  - Data rate depends on implementation ( ~ 70Mbps)
WiMax Application Scenario

WirelessMAN: Wireless Metropolitan Area Network

- Multi-tenant customers
- Core network
- Basestation
- SOHO customer
- Residential customer
- Repeater
- SME customer

Source: Nokia Networks
WiMax devices

A WIMAX tower

WIMAX receiver: PCMCIA card

USB Type CDMA & Wimax Modem

Intel® Centrino® Advanced-N + WiMAX 6250
Wireless Regional Area Network (WRAN)

**IEEE 802.22**

A standard for a **cognitive radio**-based PHY/MAC/air_interface

Uses the spectrum that is allocated to the TV Broadcast Service (non-interfering basis)

- white spaces within the television bands between 54 and 862 Mhz
- Range around 100 Km (capacity 18 Mbps)
- By 2010 the standard may be released
WPAN

- Wireless Personal Area Networks
  - IrDA (850 nm)
  - Bluetooth
  - Zigbee
  - UWB (Ultra Wideband IEEE 802.15.3a)
  - Wireless Sensor Network
  - 6LoWPAN
  - BAN (IEEE 802.15.6)
Bluetooth

- IEEE 802.15.1 (2.4 GHz)
- Class 1 100 mW (20 dBm) ~100 meters
- Class 2 2.5 mW (4 dBm) ~10 meters
- Class 3 1 mW (0 dBm) ~1 meter
- Version 1.2 1 Mbit/s
- Version 2.0 + EDR 3 Mbit/s
ZigBee

- Mesh technology for WPANs
- Low data rate and power consumption (1mW)
- Used for Home automation
- Conforms to IEEE 802.15.4-2003
- Uses 2.4 Ghz, 915 Mhz and 868 Mhz ISM Band
- Range is 10 – 75 m
- Application ”Wireless headphones connecting with cell phones via short-range radio”
6LoWPAN

- IPV6 for IEEE 802.15.x networks
Wireless Sensor Network
Sensor Nodes

SUN Spot

TelosB

Mica Mote
Sensor Programming

- Operating Systems
  - Tiny OS
  - Contiki OS
  - SOS
  - MantisOS
- Programming Languages
  - C/Java/NesC
Body Area Network

set of mobile and compact intercommunicating sensors, either wearable or implanted into the human body, which monitor vital body parameters and movements
Conclusion

- We have seen Emerging trends in Wireless Networks
References

- Wireless Communications and Networking by Vijay K Garg
  - Elsevier (2009)

- Ad hoc Wireless Networks – Architectures and Protocols by Sivaram Murthy & B S Manoj
  - Pearson Education (2008)

- Ad hoc & Sensor Networks – theory and applications by D P Agrawal

- IEEE Web site (ieeexplore.ieee.org)