

## Other Wireless Technologies

WiMAX, Bluetooth, HiperXAN

## Wireless WANs



- **Mobitex (1986)**
  - ♦ First data-only WWAN
  - ♦ 8 kbps only (throughput 4-4.6 kbps)
  - ♦ Up to 10 seconds RTT
  - ♦ Ericsson, Swedish Telecom
  - ♦ Not IP based
  - ♦ Emergency communications
  - ♦ 30 km cell diameters
  - ♦ 10-30 channels, 1-4 channels per base station
  - ♦ Each channel = two frequencies (up- and downlink, but half-duplex with end-stations)
  - ♦ MTU=545 Bytes (512 bytes user data)
  - ♦ [www.mobitex.org](http://www.mobitex.org)

## Wireless WANs



- **DataTAC**
  - ◆ Aka "ARDIS" (USA)
  - ◆ Motorola mid-1980s
  - ◆ Non-IP based, data-only
  - ◆ Cells with 20 km diameters
  - ◆ MTU=2048 bytes
  - ◆ 4.8 - 19.2 kbps

## Wireless WANs



- **Cellular Digital Packet Data (CDPD)**
  - ◆ IBM & McCaw Cellular Communications, early 1990s
  - ◆ Reuses unused channels in the Advanced Mobile Phone Service (AMPS)
    - AMPS = 1st generation analog cellular network in USA
  - ◆ Utilizes existing AMPS infrastructure
  - ◆ CSMA variant: Digital Sense Multiple Access (DSMA)
  - ◆ IP service, MTU = 2048 bytes
  - ◆ 19.2 kbps (throughput 10 kbps, RTT approx 4 sec)

## General Packet Radio Service (GPRS)



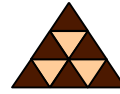
- **GPRS defined by ETSI in late 1997**
  - ♦ Transitional technology towards 3G networks
  - ♦ "GSM Phase 2+" aka "2.5G"
- **Overlaid to GSM network**
  - ♦ Voice and data share same BW and infrastructure
- **Introduces packet switching in a circuit-switched architecture**
- **Regular IP network**
  - ♦ Mobile devices are IP end systems
  - ♦ MTU = 1500 bytes (as usual)
- **Also uses GMSK modulation**

## GPRS – Details (1)



- **Different mobile host classes**
  - ♦ Class A: TX & RX of voice & data at the same time
  - ♦ Class B: TX & RX either voice or data but not simultaneously
  - ♦ Class C: User must select either GSM or GPRS network
- **Each GSM time-slot is now a shared resource**
  - ♦ Any mobile host can use it for TX or RX
  - ♦ One mobile host can allocate up to all eight timeslots in the same TDMA frame

## GPRS – Details (2)



- **Four different channel coding schemes**
  - ♦ **CS1 (8.8 kbps)**
    - Many FEC bits, used mainly for signalling and upon poor conditions
  - ♦ **CS2 (13.3 kbps)**
  - ♦ **CS3 (15.6 kbps)**
    - Most often used
    - Supports up to 124.8 kbps per 200 kHz channel (=one TDMA frame)
  - ♦ **CS4 (21.4 kbps)**
    - Only few FEC overhead
    - Supports up to 171.2 kbps per TDMA frame
    - Rarely used because of too much retransmissions

## GPRS – Details (3)



- **Full-duplex communication between mobile host and base station**
  - ♦ But can be asymmetric (different downlink and uplink rates)
- **GSM Association defined 12 "multislot classes" for GPRS**
  - ♦ Each class is associated with a maximum number of uplink and downlink time-slots (per host)
    - "M+N", M...downlink slots, N...uplink slots
    - Class 1 is "1+1", Class 2 is "2+1", ... , Class 12 is "4+4"
  - ♦ Additionally each class has an "active slot constraint" K
    - A host cannot use more than K active slots simultaneously
    - For example, Class 12 has K=5, that is only "4+1", "3+2", "2+3", or "1+4" slots can be used simultaneously

## Enhanced Data for GSM Evolution (EDGE)



- Is an "Enhanced GPRS"
- Nine coding schemes
  - ◆ MCS1-MCS4 use GMSK like GPRS and similar radio rates
  - ◆ MCS5-MCS9 uses the more efficient 8-PSK
    - MCS6 supports 29.6 kbps per timeslot
    - MCS9 supports 59.2 kbps per timeslot
    - Typically only MCS7 is deployed with all eight slots which results in a (shared) 384 kbps

## WWAN Comparison

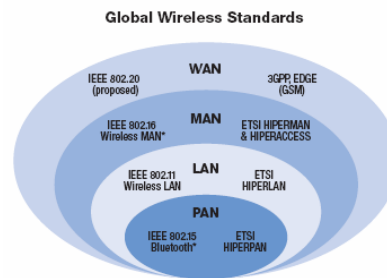


- Mobitex and GPRS are the most widely deployed WWANs
  - ◆ 1 billion GSM subscribers
  - ◆ 1 million Mobitex users
- Mobitex revival through Blackberry
  - ◆ Wireless E-Mail applications
  - ◆ Also revived DataTAC

## Other Wireless Technologies



- **Worldwide Interoperability for Microwave Access Forum (WiMAX)**
  - ♦ 802.16 and HiperMAN
  - ♦ Existing products very expensive (10-100 times than WLAN)
  - ♦ Cisco is member of the WiMAX forum but only acts as adviser (no products from Cisco yet)
- **Main goal: Last mile**



Source: www.intel.com

## 802.16 - "IEEE Wireless MAN" (OLD)



- **Air Interface for Fixed Broadband Wireless Access Systems**
- **April 2002: 802.16, 10-66 GHz**
- **Jan 2003: 802.16a, 2-11GHz, also non-LOS**
- **Broadband Last Mile**
- **Up to 75 Mb/s, up to 50 km (typical 5-10 km)**
- **3400-3600 MHz and 5725-5850 MHz**
- **OFDM**

## 802.16 – WiMAX (NEW)



- **Worldwide Interoperability of Microwave Access**
  - ♦ Similar than WiFi but improved performance (goal)
  - ♦ Up to 50 km
- **Also uses LLC (allows bridging)**
- **Framework standard – allows several PHY's**
- **No contention but scheduled timeslot by base station**
  - ♦ Station must only compete once during initial entry into the network
  - ♦ Timeslot can be enlarged and reduced
- **Support for mesh networks**
- **Frequencies**
  - ♦ Originally defined in 10-66 GHz range
  - ♦ 802.16a added support for 2-11 GHz range (lots of ISM bands there)



## XMax – "xG Technology"



- **New competitor to WiMAX**
- **Flash signaling**
  - ♦ Ultra broadband, below noise floor
  - ♦ Should be non-interfering with legacy RF equipment
- **"Index-N" encoding to reduce sideband emissions and maximize data rates**
- **"Variband" allows rate adaptation**