



Southern Methodist University

EETS 8390 / CC719-N

Advanced Topics in Wireless Communications

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Lecture 6: 2G Wireless data

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Outline

- **Introduction**
- **CS Data over cellular network**
- **PS Data over cellular network**
- **Mobitex as a pure wireless packet data**



Introduction

- **2G data Market Today..**
 - Japan, Europe, US (Americas), Asia
- **2G Data services Today...**
 - Microbrowser
 - IMODE (Japan), Games, Music, shopping, stocks,..
 - WAP (Europe,..) catch up with IMODE
 - Webclipping (US) stocks, limited shopping,
 - Email and messaging
 - Imessenger (US)
 - SMS (Europe, Japan, US,..)
 - Asynchronous Fax
 - Not that popular (US, Europe,..)



Introduction

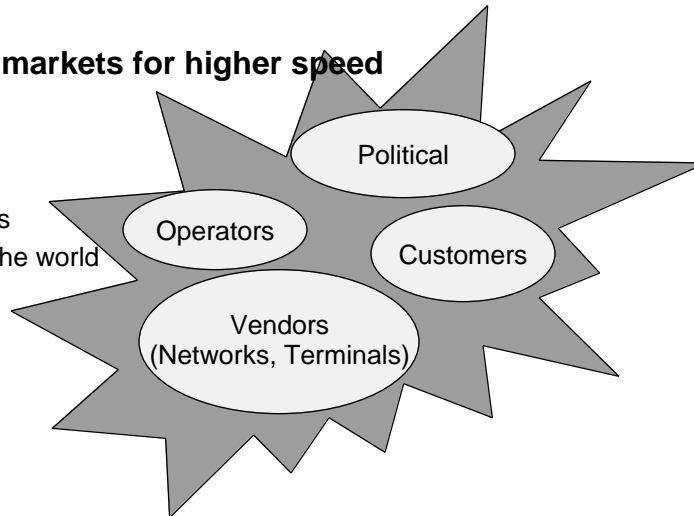
- **Service providers in the US**
 - Sprint CSD over CDMA + SMS
 - ATTW CDPD (netpocket) + SMS
 - Voicestream CSD over GSM + SMS (WAP..)
 - Cingulair (Bsouth) Mobitex (Palmpilot,..)
- **Data rates**
 - Today 9.6kbps, 14.4kbps and 19.2kbps
 - Tomorrow 115kbps (2H2001)
 - near future 384kbps,..... (2002)
 - Future above 2Mbps (beyond 2005)



Introduction

- **Potential markets for higher speed**

- Japan
- Europe
- Asia
- Americas
- Rest of the world



Circuit Switched Data (CSD)

- **Challenges**

- low speed (9.6-14.4kbps)
- Static allocation of resources
 - Radio (Time slot and RF carrier)
 - Transport (TS on T1 e.g. A' and A interfaces)
 - CN (MSC)
- Inefficient with bursty data
- Charging is high (Call duration instead of traffic usage)

- **Advantages**

- Constant QoS (throughput/Delay)
- good for symmetric constantly transmitting data applications FTP.



Circuit Switched Data (CSD)

- **Technologies**

- TDMA,
 - 9.6kbps
- CDMA,
 - 9.6kbps

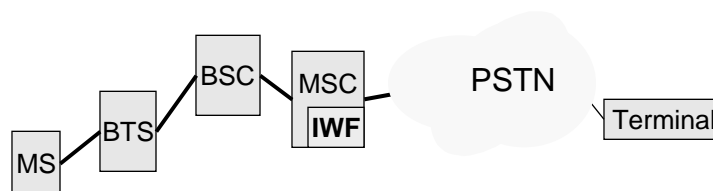
- GSM,
 - CS 9.6 kbps
 - HSCS 9.6- 14.4kbps + Multislot operation

- PDC
 - 9.6 kbps



GSM CSD

- **Radio network**
 - same as GSM
- **Transport**
 - Same as GSM
- **CN**
 - IWF either at BSC or MSC

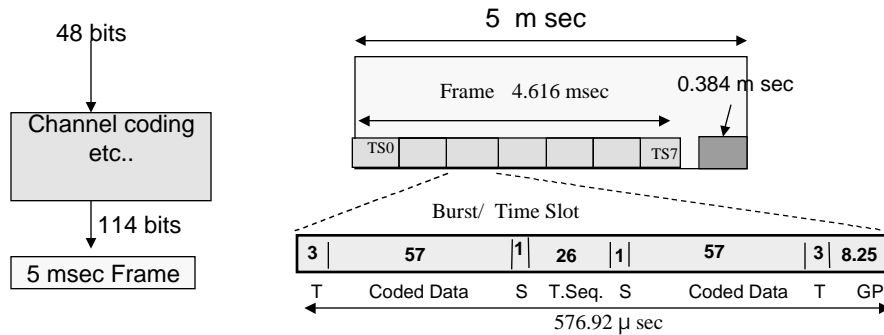




GSM CSD

• Air interface

- 5ms frame has 48 bits +12 unused bits for rate adaptation
 - $48/5 = 9.6\text{kbps}$, adapted rate is $60/5 = 12\text{kbps}$
- GSM raw data rate on air 22.8kbps per TS
 - $114 / (4.616 + 0.384) = 22.8\text{kbps}$



GSM CSD

• Bearers

• Transparent

- based on V.110 protocol (ISDN)
- synchronous and asynchronous data
- no guarantee for data integrity
- fixed delay 100 msec end to end

• Non transparent

- uses RLP to ensure error free
- full rate 9.6kbps



GSM HSCSD

- **GSM Phase 2+ 1996**
- **Channels**
 - TCH/F4.8, TCH/F9.6, and TCH/F14.4
- **Multislot operation**
 - up to 4 TS per MS
 - 2/1, 3/1, 3/2, 4/1
 - 18 multislot classes
- **Data rates up to 57.6 kbps non transparent**
 - 4 TS mobile at TCH/F14.4 (14.4kbps/TS)
- **Data compression based on V.42bis and V.42**



ECSD

- **Enhanced Circuit switched data (Part of EDGE)**
 - Transparent
 - 9.6 to 64kbps
 - 57.6kbps nontransparent
- is achieved using 2-TS of

ECSD TCS-1

Channel name	code rate	mod.	data rate per TS
TCH/F2.4	0.16	GMSK	3.6 kbps
TCH/F4.8	0.26	GMSK	6 kbps
TCH/F9.6	0.53	GMSK	12 kbps
TCH/14.4	0.64	GMSK	14.5 kbps
ECSD TCS-1	0.42	8PSK	29 kbps
ECSD TCS-2	0.46	8PSK	32 kbps
ECSD TCS-3	0.56	8PSK	38.8 kbps



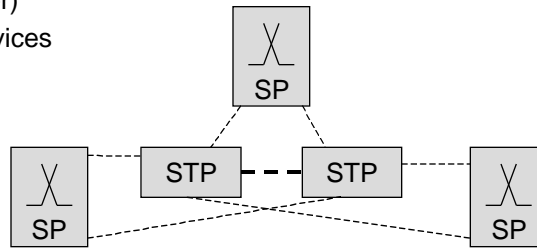
SS7 Signaling System no 7

- **Signaling information between network nodes**

- Signaling messages
 - HLR messages (authentication, location update, insert/delete user)
- Short message Services

- **Self healing net**

- **Packet switching**



- **Nodes**

- Signaling point (MSC, HLR,..)
- Signaling Transfer Point (Backbone Net)



SS7 Protocol

- **MTP-1 Physical layer**

- SS7 link is T1 64kbps/ 56kbps
- Assign in pairs. I.e use 2 T1s per link

- **MTP-2 Error handling**

(DLC)

- **MTP-3 Routing**

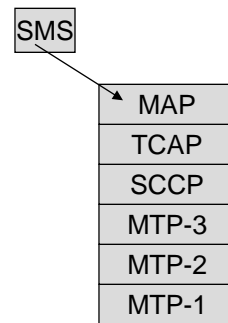
(Net)

- **SCCP, Enhanced Routing**

(Net)

- **TCAP**

(Appl.)



MTP: Message Transfer part

SCCP: Signaling Connection Control Part

MAP: Mobile Application Part (Protocol)

TCAP: Transmission capability Application Part



SS7 dimensioning

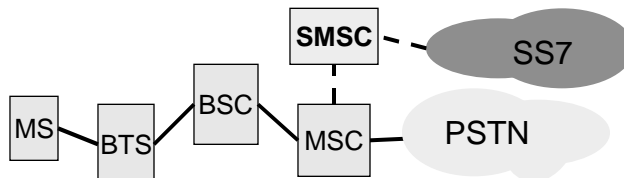
Designing the SS7 links is based on the messages at the TCAP Layer

- link load is 50% for protection
- SS7 link speed at the TCAP layer is more than 45kbps. With 50 % loading and 8 bit per octets then the speed is 2800oct/sec
- Rule of thumb
 - No of Links= Data rate/2800 Octets/sec



Short Message Services (SMS)

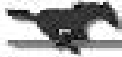
- Services
 - Paging (alphanumeric) 160 characters
 - Individual message
 - Broadcast message (road traffic, news, weather info,...)
- SMS
 - Data transfer at 600bps
 - SMS center can store and forward the SMS
 - on the SS7 network





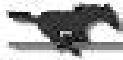
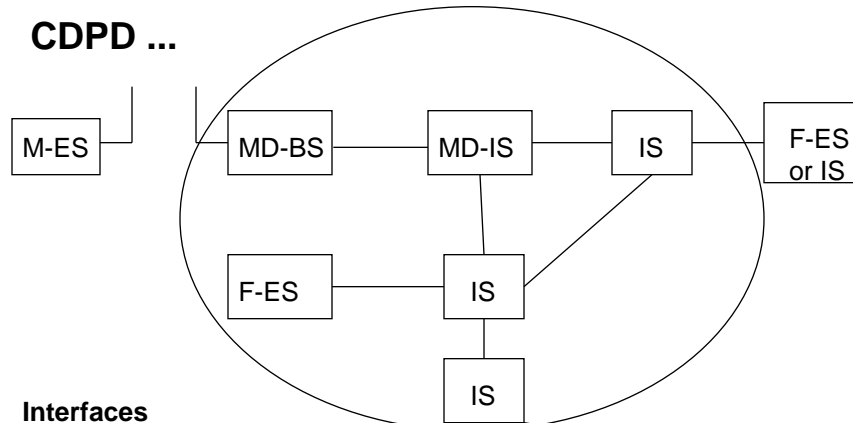
Cellular Digital Packet Data CDPD

- **Developed by IBM and many cellular vendors**
- **Uses CS TDMA/AMPS network**
- **release 1.0 1993, 1.1 Dec 1994**
- **Provide packet data services on a non-interfering basis**
 - Hopping between the inactive voice carriers
 - MSC tells the CDPD Net of the activity on the carriers
 - CDPD BS sniffer
 - Dedicated channel for CDPD
- **Applications**
 - e.mail (alpha numeric paging)
 - Field services
 - Package delivery tracking
 -



CDPD Features...

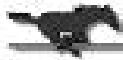
- **30KHz**
- **GMSK modulation**
- **RS channel coding**
- **TCP/IP**
- **raw Data rate 19.2kbps on air,**
- **radio block 21.875 ms.**
- **850MHz spectrum**

**CDPD ...****Interfaces**

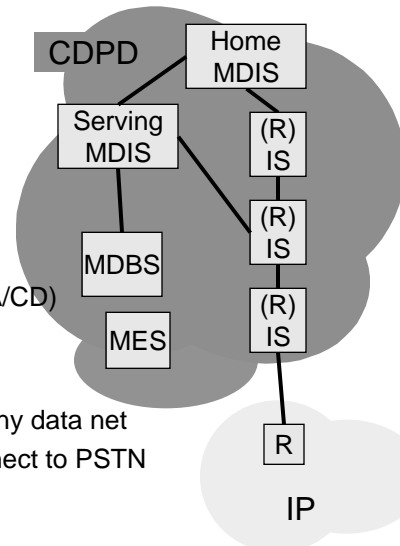
A interface: Airlink, (MES and MDBS) air interface GMSK

E Interface: External, (CDPD IS and external network) IP

I Interface: Inter-service, (Between 2 CDPD networks)

**CDPD ...**

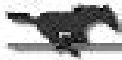
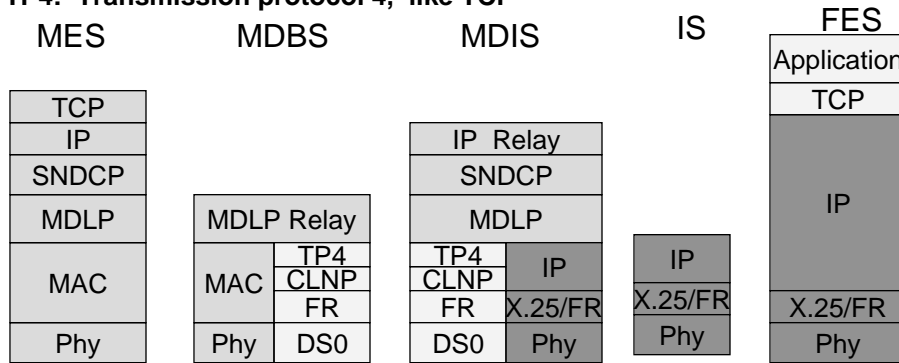
- **M-ES : the MS**
- **IS: Intermediate system**
- **F-ES: Fixed End System**
- **MD-BS: the base station**
 - TCP/IP over the Air interface
 - radio resource management
 - MAC is Slotted Digital SMA (SDSMA/CD)
- **MD-IS: the Switch**
 - Switching/Routing
 - Gateway and can be connected to any data net
 - provide CS modem emulator to connect to PSTN





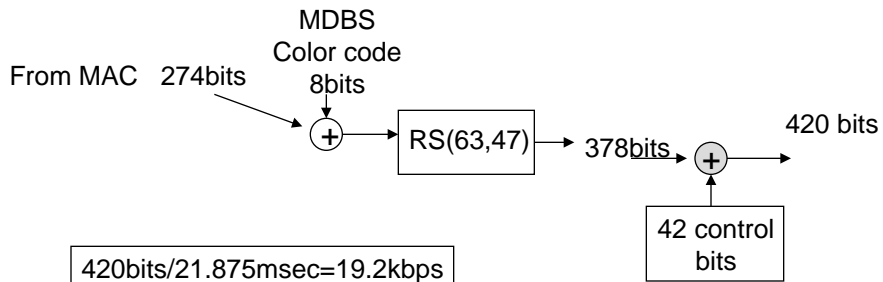
CDPD Protocol Stack

MDLP: MD link protocol , error correction,.. Encapsulate
SNDCP: Header compression, segmentation, sequencing, encryption
CLNP: connectionless Net Protocol, for routing between MDBS, and MDIS
TP4: Transmission protocol 4, like TCP



CDPD ...

- **The data rates**
 - Raw data rate 19.2 kbps
 - Data rate at MAC layer is $274/21.875 = 12.52\text{kbps}$
- **Channel color code**
 - 8 bits to identify the cell (to detect CCI)





CDPD ...

- **Application level throughput**

- TCP 336 byte
- TCP/IP headers 40Bytes
- TCP/IP OH ratio = $40/(40+336)=10.6\%$
- Assume the SNDCP+MDLP+ MAC Headers= 10 bits
- Total over head ratio at MAC = $50/(50+336)=13\%$

- In a CDPD block, the TCP/IP OH bits are
 $13\% * 274=36$ bits

Application level throughput

$(274-36)/21.875=10.88$ kbps no retransmission and no queuing



Mobitex Packet data network

- **First network in Stockholm 1986**

- Can support voice and data
- Mainly for Data

- **Bell south almost Nationwide 90% (RAM data 1991)**

- PalmIIV (web clipping, e.mail up to 20KByte FTP)
- Indoor coverage from outdoor cells
- open architecture and intelligent networkVPN
- Hierarchical network architecture

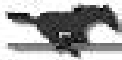
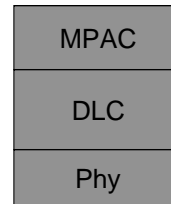


Mobitex

• Features

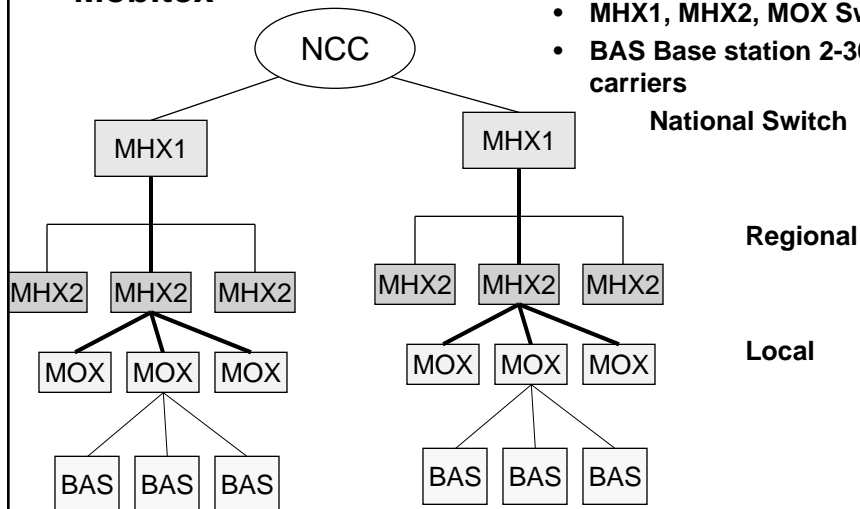
- GMSK ,12.5kHz channel BW
- Power 100mW- 4/10W.
- 8kbps Raw data rate
- Packet size 512Byte using proprietary Net protocol MPAC .
- Reservation Slotted ALOHA (R-S-ALOHA)
- UL 896-901MHz, DL 935-940MHz

- User Data rate on MPAC << 8kbps why?!



Mobitex

- **NCC Network Control Center**
- **MHX1, MHX2, MOX Switches**
- **BAS Base station 2-30 RF carriers**





GPRS Introduction

- GPRS History
 - conceived in 1992
 - First standard 1997
 - GSM 03.64 V. 6.1.0 By ETSI

	Circuit Switched (CS)	Packet Switched (PS)
Traffic	large volume	- Frequent small Volume - infrequent medium volume
Charging	minute	volume Kbyte
Speed	14.4kbps/TS up to 4TS	13.4kbps/TS up to 8TS



reading

- **Mobitex and CDPD**
 - chapter 33
- **TETRA**
 - chapter 33