Mobile Computing
Lecture 8
Digital mobile Phone Systems 1

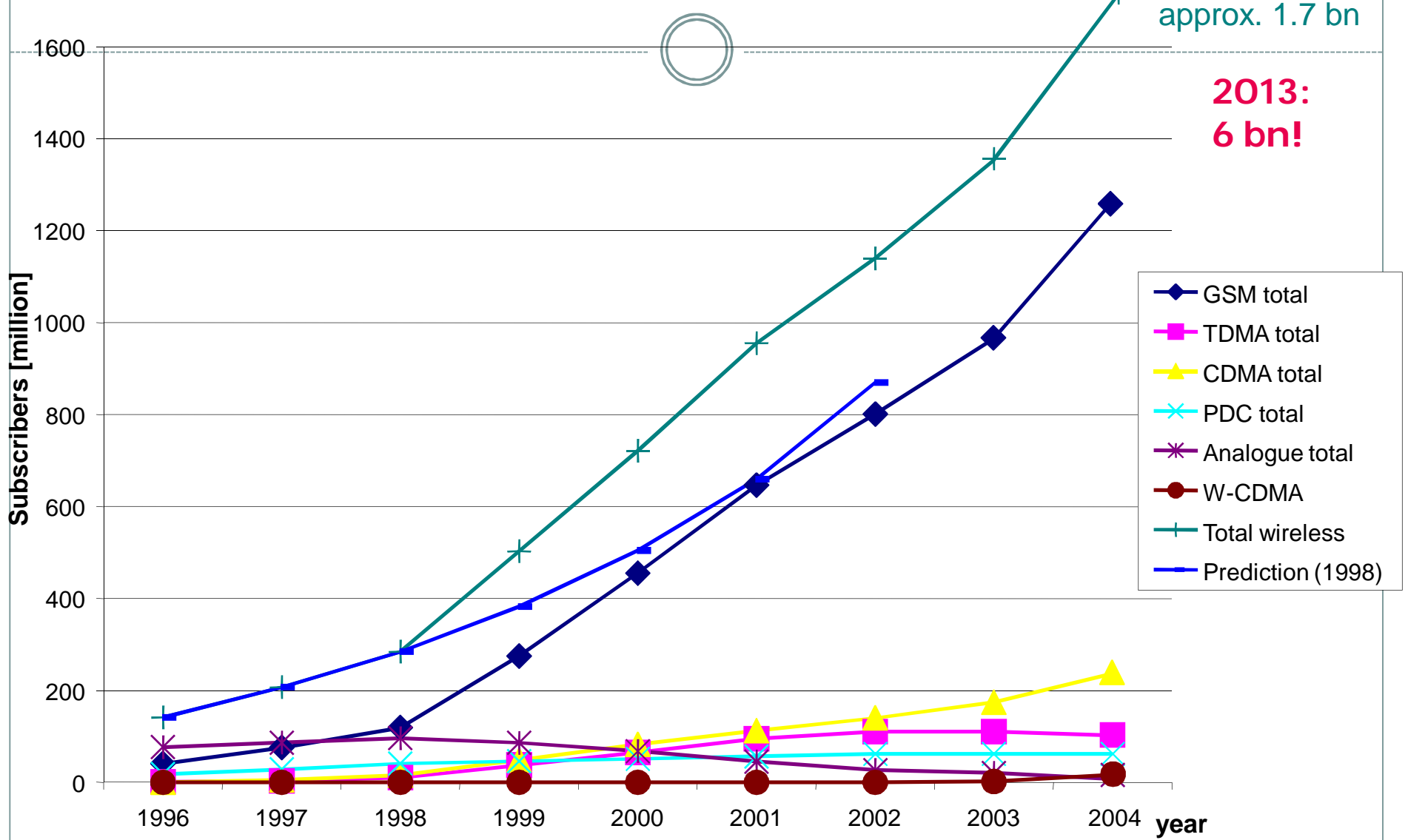# Contents
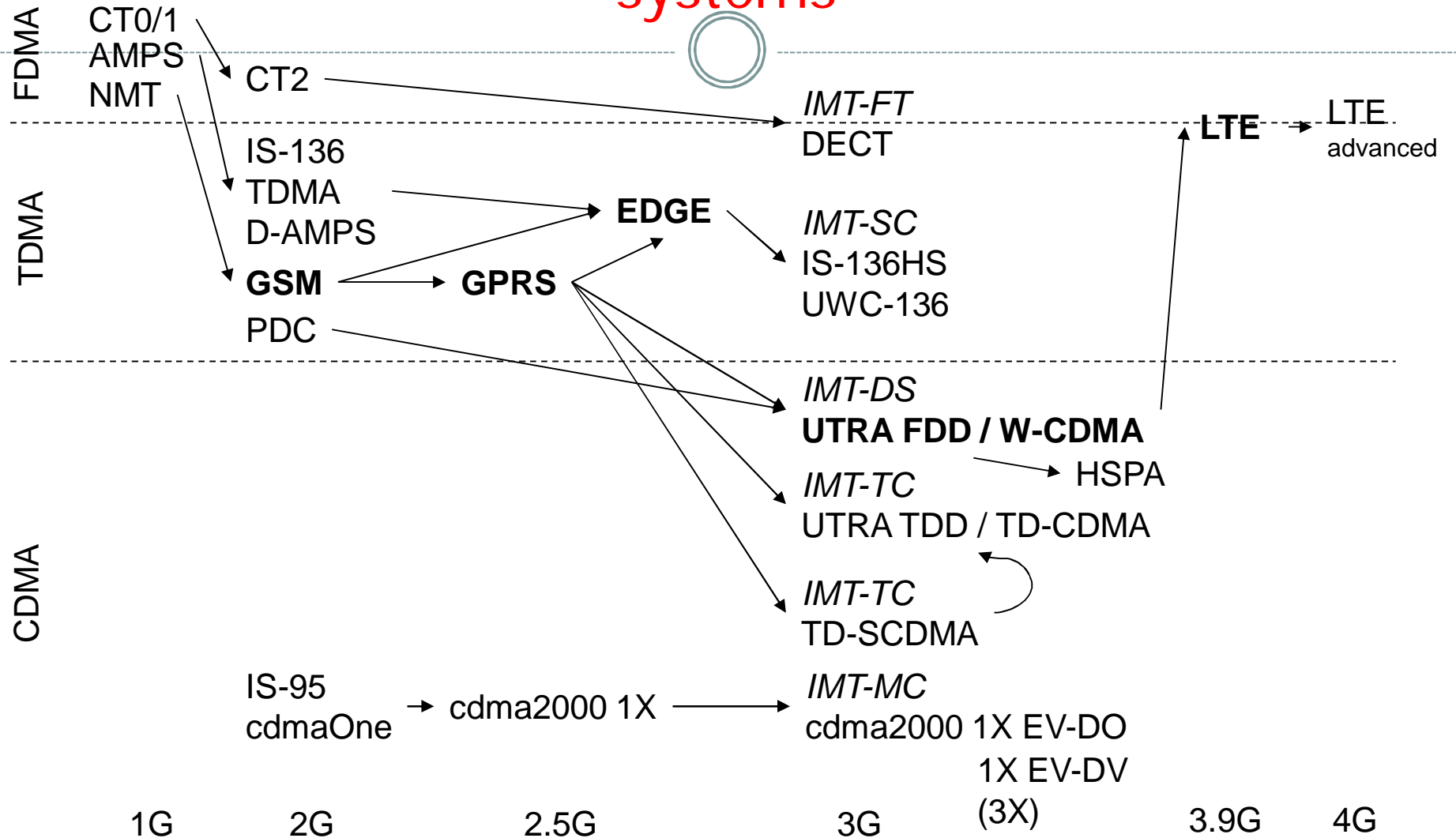
- Market
- GSM
- Mobile services

Mobile phone subscribers worldwide

Development of mobile telecommunication systems

FDMA

CT0/1
AMPS
NMT

CT2

IMT-FT
DECT

TDMA

IS-136
TDMA
D-AMPS

GSM → **GPRS**

PDC

EDGE

IMT-SC
IS-136HS
UWC-136

IMT-DS
UTRA FDD / W-CDMA

IMT-TC
UTRA TDD / TD-CDMA

HSPA

IMT-TC
TD-SCDMA

LTE → LTE advanced

CDMA

IS-95
cdmaOne → cdma2000 1X →

IMT-MC
cdma2000 1X EV-DO
1X EV-DV
(3X)

| 1G | 2G | 2.5G | 3G | | 3.9G | 4G |

News

- 16th April 2008: The GSMA, the global trade group for the mobile industry, today announced that total connections to GSM mobile communications networks have now passed the 3 Billion mark globally. The third billion landmark has been reached just four years after the GSM industry surpassed its first billion, and just two years from the second billionth connection. The 3 Billion landmark has been surpassed just 17 years after the first GSM network launch in 1991. Today more than 700 mobile operators across 218 countries and territories of the world are adding new connections at the rate of 15 per second, or 1.3 million per day.

- 11 February 2009: The GSMA today announced that the mobile world has celebrated its four billionth connection, according to Wireless Intelligence, the GSMA's market intelligence unit. This milestone underscores the continued strong growth of the mobile industry and puts the global market on the path to reach a staggering six billion connections by 2013.

- By 2014 3.4bn people will have broadband, 80% mobile!

How does it work?

- How can the system locate a user?
- Why don't all phones ring at the same time?
- What happens if two users talk simultaneously?
- Why don't I get the bill from my neighbor?
- Why can an Australian use her phone in Berlin?

- Why can't I simply overhear the neighbor's communication?
- How secure is the mobile phone system?
- What are the key components of the mobile phone network?

GSM: Overview

- GSM
  - formerly: Groupe Spéciale Mobile (founded 1982)
  - now: Global System for Mobile Communication
  - Pan-European standard (ETSI, European Telecommunications Standardisation Institute)
  - simultaneous introduction of essential services in three phases (1991, 1994, 1996) by the European telecommunication administrations (Germany: D1 and D2) ➔ seamless roaming within Europe possible
- Today many providers all over the world use GSM (>220 countries in Asia, Africa, Europe, Australia, America)
  - more than 4,2 billion subscribers in more than 700 networks
  - more than 75% of all digital mobile phones use GSM
  - over 29 billion SMS in Germany in 2008, (> 10% of the revenues for many operators) [be aware: these are only rough numbers…]
  - See e.g. www.gsmworld.com

Performance characteristics of GSM (wrt. analog sys.)

- Communication
  - mobile, wireless communication; support for voice and data services
- Total mobility
  - international access, chip-card enables use of access points of different providers
- Worldwide connectivity
  - one number, the network handles localization
- High capacity
  - better frequency efficiency, smaller cells, more customers per cell
- High transmission quality
  - high audio quality and reliability for wireless, uninterrupted phone calls at higher speeds (e.g., from cars, trains)
- Security functions
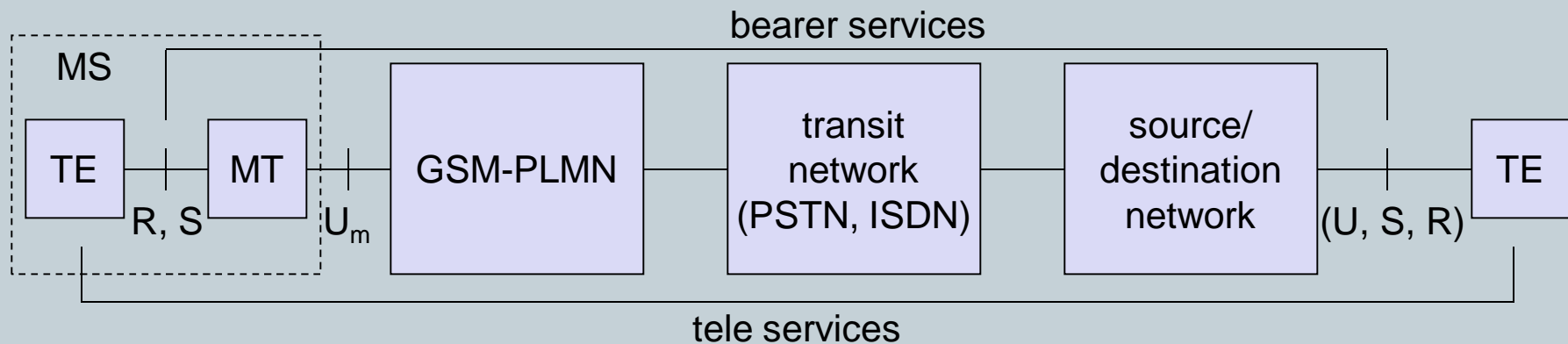 - access control, authentication via chip-card and PIN

Disadvantages of GSM

- There is no perfect system!!
  - no end-to-end encryption of user data
  - no full ISDN bandwidth of 64 kbit/s to the user, no transparent B-channel

- reduced concentration while driving
- electromagnetic radiation

- abuse of private data possible
- roaming profiles accessible

- high complexity of the system
- several incompatibilities within the GSM standards

GSM: Mobile Services

- GSM offers
  - several types of connections
    - voice connections, data connections, short message service
  - multi-service options (combination of basic services)
- Three service domains
  - Bearer Services
  - Tele Services
  - Supplementary Services

bearer services

MS					
TE	MT	GSM-PLMN	transit network (PSTN, ISDN)	source/ destination network	TE

R, S U_m (U, S, R)

tele services

Bearer Services

- Telecommunication services to transfer data between access points
- Specification of services up to the terminal interface (OSI layers 1-3)
- Different data rates for voice and data (original standard)
  - data service (circuit switched)
    - synchronous: 2.4, 4.8 or 9.6 kbit/s
    - asynchronous: 300 - 1200 bit/s
  - data service (packet switched)
    - synchronous: 2.4, 4.8 or 9.6 kbit/s
    - asynchronous: 300 - 9600 bit/s

- Today: data rates of approx. 50 kbit/s possible – will be covered later! (even more with new modulation)

Tele Services I

- Telecommunication services that enable voice communication via mobile phones
- All these basic services have to obey cellular functions, security measurements etc.
- Offered services
  - mobile telephony
    primary goal of GSM was to enable mobile telephony offering the traditional bandwidth of 3.1 kHz
  - Emergency number
    common number throughout Europe (112); mandatory for all service providers; free of charge; connection with the highest priority (preemption of other connections possible)
  - Multinumbering
    several ISDN phone numbers per user possible

Tele Services II

- Additional services
  - Non-Voice-Teleservices
    - group 3 fax
    - voice mailbox (implemented in the fixed network supporting the mobile terminals)
    - electronic mail (MHS, Message Handling System, implemented in the fixed network)
    - Short Message Service (SMS)
      alphanumeric data transmission to/from the mobile terminal (160 characters) using the signaling channel, thus allowing simultaneous use of basic services and SMS
      (almost ignored in the beginning now the most successful add-on! – but more and more replaced by IP-based messaging)

Supplementary services

- Services in addition to the basic services, cannot be offered stand-alone
- Similar to ISDN services besides lower bandwidth due to the radio link
- May differ between different service providers, countries and protocol versions
- Important services
  - identification: forwarding of caller number
  - suppression of number forwarding
  - automatic call-back
  - conferencing with up to 7 participants
  - locking of the mobile terminal (incoming or outgoing calls)
  - …