MOBILE AND WIRELESS COMMUNICATION

Course code	ESC-CSE-308G				
Category	Engineering Science Course				
Course title	Mobile and wireless communication				
Scheme and Credits	L	T	P	Credits	Semester 6
	3	0	0	3	
Class work	25 Marks				
Exam	75 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Objectives of the course:

- Understand the wireless/cellular radio concepts such as frequency reuse, handoff and interference between mobiles and base stations.
- Identify the techno-political aspects of wireless and mobile communications such as the allocation of the limited wireless spectrum by regulatory agencies.
- Understand the information theoretical aspects such as channel capacity, propagation effects, modeling the impact of signal bandwidth and motion in mobile systems.
- Describe the current and future Mobile Communication Systems, GSM, Satellite, Broadcasting, Bluetooth, Wireless LANs, Mobile Adhoc Networks.
- Describe the mobility support mechanism, WWW and WAPs.

UNIT 1

Introduction: Application, History, Market Scenario, Reference Model and Overview, Wireless Local Loop and Cellular system.

Wireless Transmission: Frequencies, Signals, Antennae, Signal Propagation, Multiplexing, Modulation, Spread Spectrum.

MAC Layer: Specialized MAC, SDMA, FDMA, TDMA – Fixed TDM, Classical ALOHA, Slotted, ALOHA, CSMA, DAMA, PKMA, Reservation TDMA. Collision Avoidance, Polling, Inhibit Sense Multiple Access, CDMA.

Broadcasting: Unidirectional Distribution Systems, Digital Audio Broadcasting, Digital Video Broadcasting, Convergence of Mobile and Broadcasting Techniques.

UNIT 2

GSM: Mobile Services, Architecture Radio, Interface, Protocol, Localization, Calling Handover, Security, New data services.

Wireless LAN: IEEE 802 11- System and Protocol Architecture, Physical Layer, MAC Layered Management.

Bluetooth: User scenarios, Physical layer, MAC Layer, Networking, Security and Link Management. Wimax

UNIT 3

Mobile Network Layer: Mobile IP-Goals, Assumptions, Requirement, Entities, Terminology, IP Packet delivery, Agent Advertisement and Discovery, Registration, Tunneling, Encapsulation, Optimization, Reserve Tunneling, Security, IPv6 , DHCP.

Mobile Adhoc Networks: Routing, Destination Sequence Distance Vector, Dynamic Source Routing, Hierarchical algorithms, Performance Metrics.

Mobile Transport Layer: Traditional TCP, Indirect TCP, Snooping, TCP, Mobile TCP, Fast-retransmission TCP, Transaction oriented TCP.

UNIT 4

Satellite Systems: History, Applications, GEO, LEO, MEO, Routing, Localization, Handover in Satellite System.

Support for Mobility: File System, WWW, HTML, System Architecture.

WAP: Architecture, Wireless Datagram, Protocol, Wireless Transport Layer Security, Wireless Transaction Protocol, Application Environment, Telephony Applications.

UNIT : 1 BROADCASTING

- Unidirectional Distribution Systems
- Digital Audio Broadcasting
- Digital Video Broadcasting
- Convergence of Mobile and Broadcasting Techniques

Unidirectional Distribution Systems(1)

A **unidirectional network** (also referred to as a **unidirectional gateway** or **data diode**) is a network appliance or device that allows data to travel in only one direction

Unidirectional network devices are typically used to guarantee information security or protection of critical digital systems, such as Industrial control systems, from cyber attacks.

Applications :

- Real time monitoring of safety-critical networks
- Secure OT – IT bridge
- Secure cloud connectivity of critical OT networks
- Database replication
- Data mining
- Trusted back-end and hybrid cloud hosted solutions (private / public)
- Secure data exchange for data marketplaces
- Secure credential/ certificate provisioning
- Secure cross-data base sharing

IT/OT convergence is the integration of information technology (IT) systems with operational technology (**OT**) systems.

Unidirectional Distribution Systems(2)

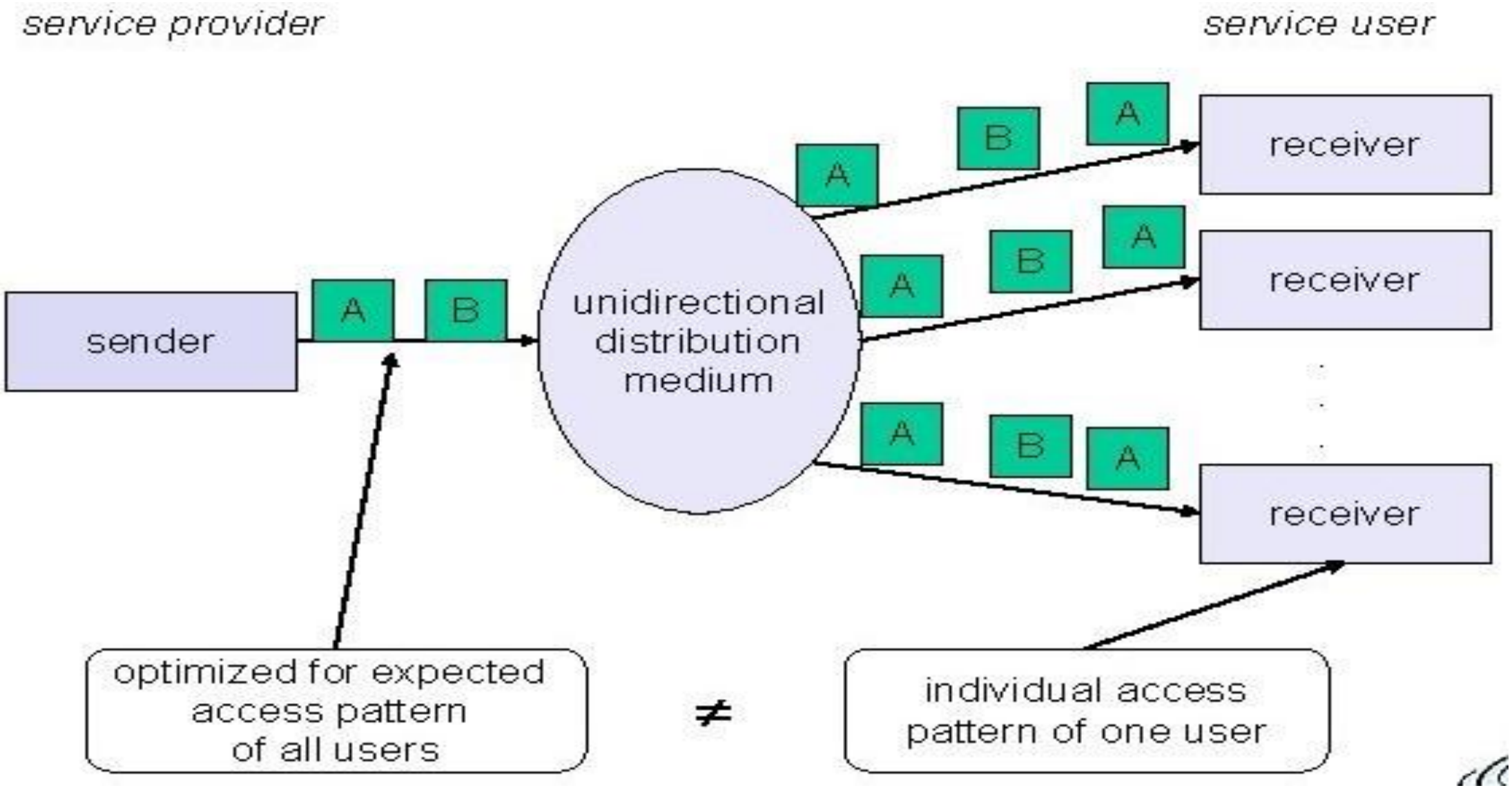
Asymmetric communication environments

- bandwidth limitations of the transmission medium
- depends on applications, type of information
- examples
  - wireless networks with base station and mobile terminals
  - client-server environments (diskless terminal)
  - cable TV with set-top box
  - information services (pager, SMS)

Special case: unidirectional distribution systems

- high bandwidth from server to client (downstream), but no bandwidth vice versa (upstream)
- problems of unidirectional broadcast systems
  - a sender can optimize transmitted information only for one group of users/terminals
  - functions needed to individualize personal requirements/applications

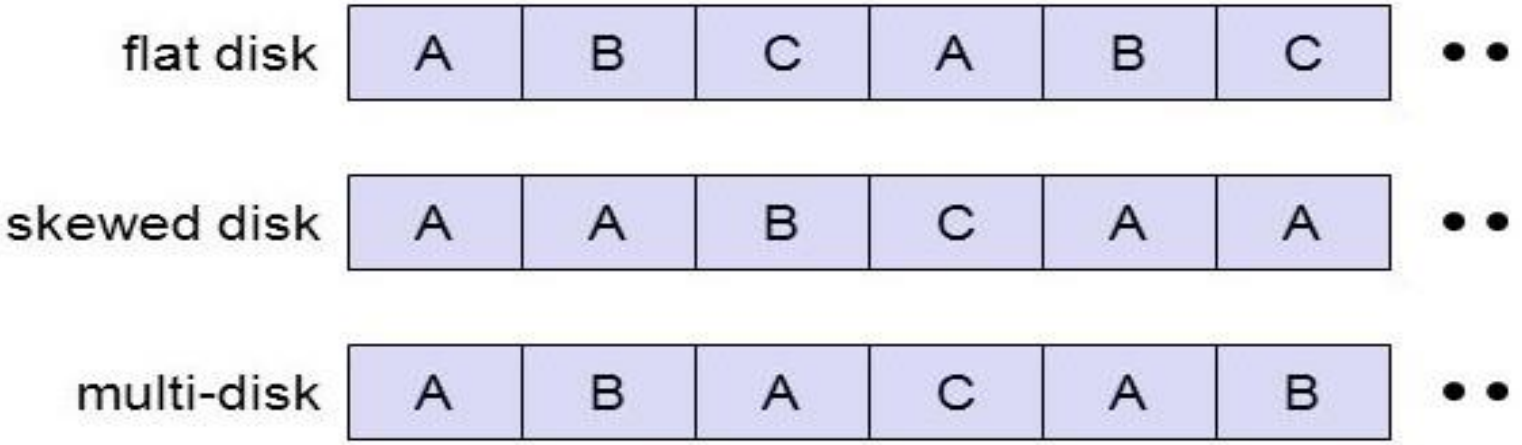
Unidirectional Distribution Systems(3)



Unidirectional Distribution Systems(4)

Sender

- cyclic repetition of data blocks
- different patterns possible (optimization possible only if the content is known)



Receiver

- use of caching
  - cost-based strategy: what are the costs for a user (waiting time) if a data block has been requested but is currently not cached
  - application and cache have to know content of data blocks and access patterns of user to optimize

Digital Audio Broadcasting (1)

Digital Audio Broadcasting (**DAB**) is a digital radio standard for broadcasting digital audio radio services in many countries around the world, defined and promoted by the WorldDAB forum.

DAB is generally more efficient in its use of spectrum than analogue FM radio, and thus can offer more radio services for the same given bandwidth.

- DAB or DIGITAL AUDIO BROADCASTING is one of the biggest innovations in the radio field,which allows transmission of transmissions in a cleaner way using the digital signal.
- Advantages: Better audio quality, more user-friendly, additional content (text, images) that support the audio and potentially even new channels, as happened for the TV
- Disadvantages: coverage is not guaranteed everywhere

Digital Audio Broadcasting (2)

- Media access
  - COFDM (Coded Orthogonal Frequency Division Multiplex)
  - SFN (Single Frequency Network)
  - 192 to 1536 subcarriers within a 1.5 MHz frequency band
- Frequencies
  - first phase: one out of 32 frequency blocks for terrestrial TV channels 5 to 12 (174 - 230 MHz, 5A - 12D)
  - second phase: one out of 9 frequency blocks in the L-band (1452- 1467.5 MHz, LA - LI)
- Sending power: 6.1 kW (VHF, Ø 120 km) or 4 kW (L-band, Ø 30 km)
- Date-rates: 2.304 Mbit/s (net 1.2 to 1.536 Mbit/s)
- Modulation: Differential 4-phase modulation (D-QPSK)
- Audio channels per frequency block: typ. 6, max. 192 kbit/s
- Digital services: 0.6 - 16 kbit/s (PAD), 24 kbit/s (NPAD)

packet assembler-disassembler

Digital Audio Broadcasting (3)

MSC (Main Service Channel)

- carries all user data (audio, multimedia, …)
- consists of CIF (Common Interleaved Frames)
- each CIF 55296 bit, every 24 ms (depends on transmission mode)
- CIF contains CU (Capacity Units), 64 bit each

FIC (Fast Information Channel)

- carries control information
- consists of FIB (Fast Information Block)
- each FIB 256 bit (incl. 16 bit checksum)
- defines configuration and content of MSC

Stream mode

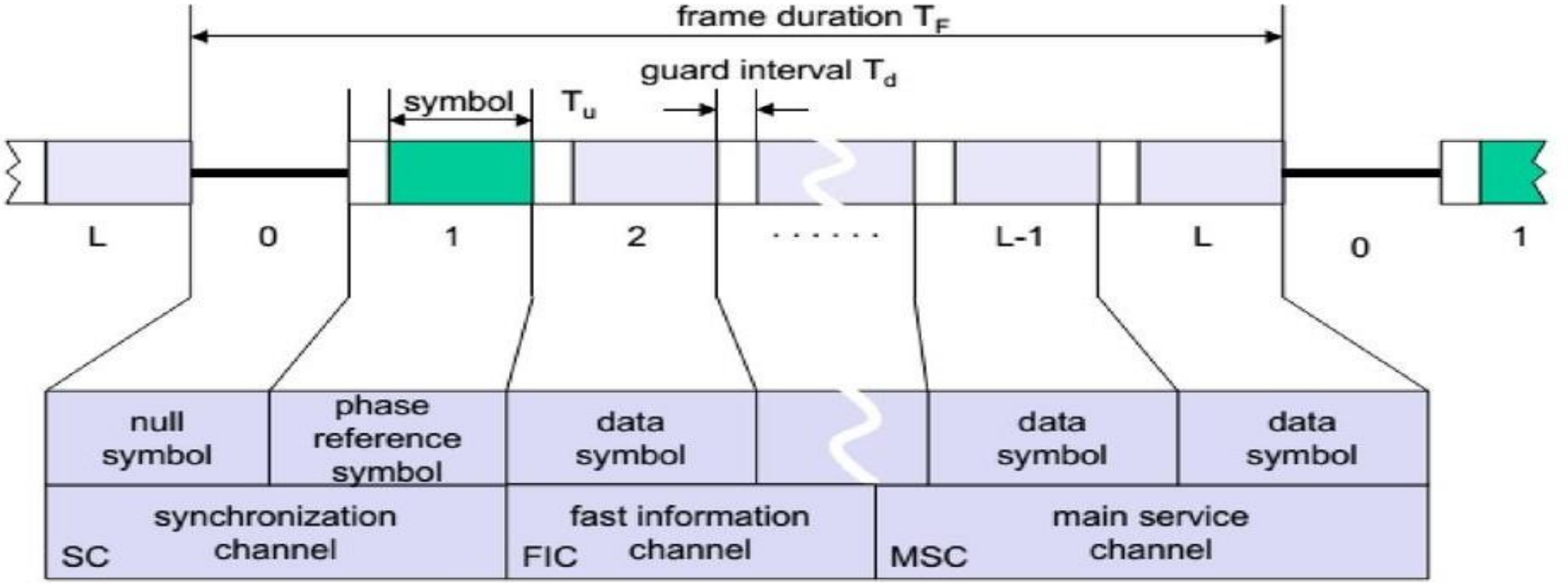
- transparent data transmission with a fixed bit rate

Packet mode

Digital Audio Broadcasting (4)

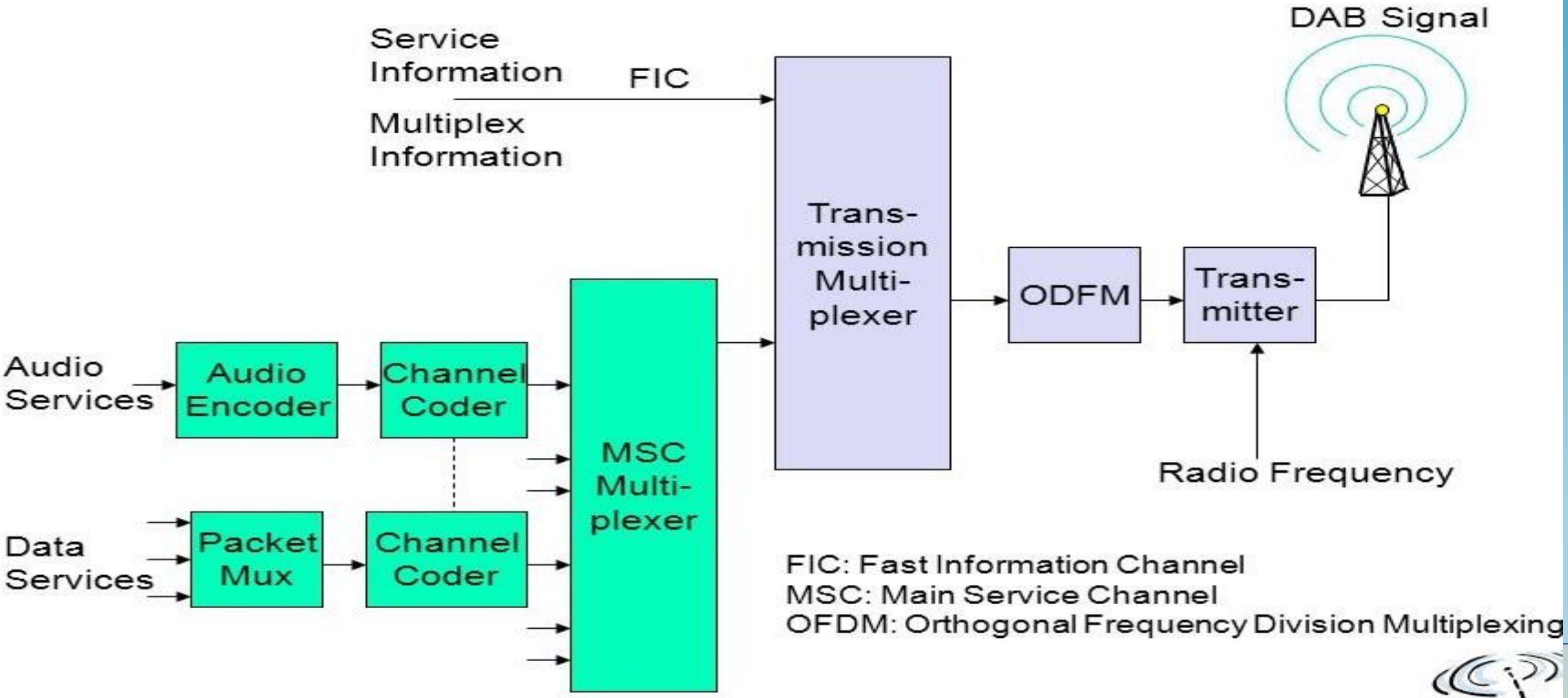
Transmission Frame

- Figure shows the general frame structure of DAB.
- Each frame has a duration T_F of 24, 48, or 96 ms depending on the transmission mode.



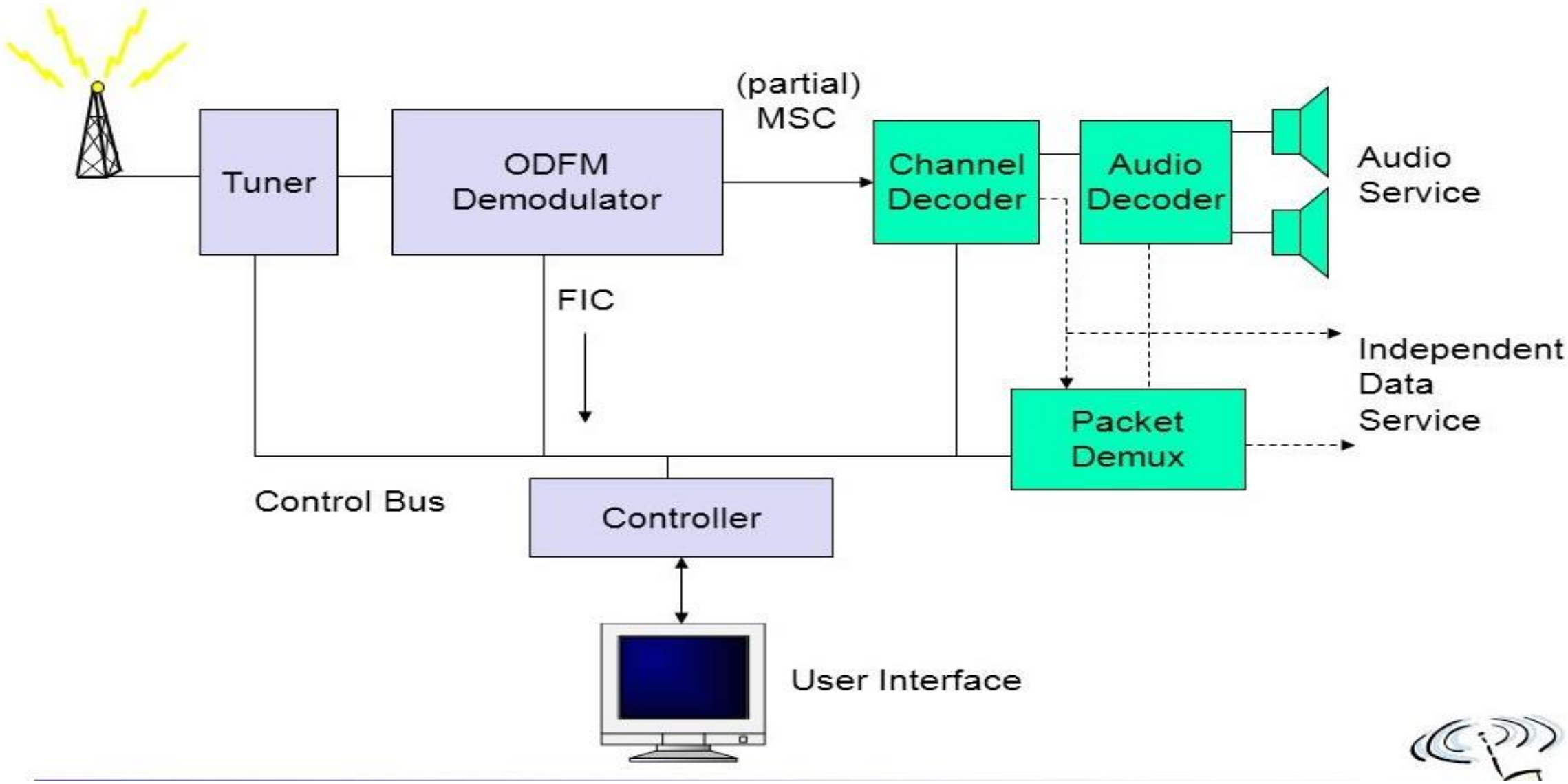
Digital Audio Broadcasting (5)

DAB sender



Digital Audio Broadcasting (6)

DAB receiver



Digital Audio Broadcasting (7)

Audio coding

- Goal
  - audio transmission almost with CD quality
  - robust against multipath propagation
  - minimal distortion of audio signals during signal fading
- Mechanisms
  - fully digital audio signals (PCM, 16 Bit, 48 kHz, stereo)
  - MPEG compression of audio signals, compression ratio 1:10
  - redundancy bits for error detection and correction
  - burst errors typical for radio transmissions, therefore signal interleaving - receivers can now correct single bit errors resulting from interference
  - low symbol-rate, many symbols
    - transmission of digital data using long symbol sequences, separated by guard spaces
    - delayed symbols, e.g., reflection, still remain within the guard space

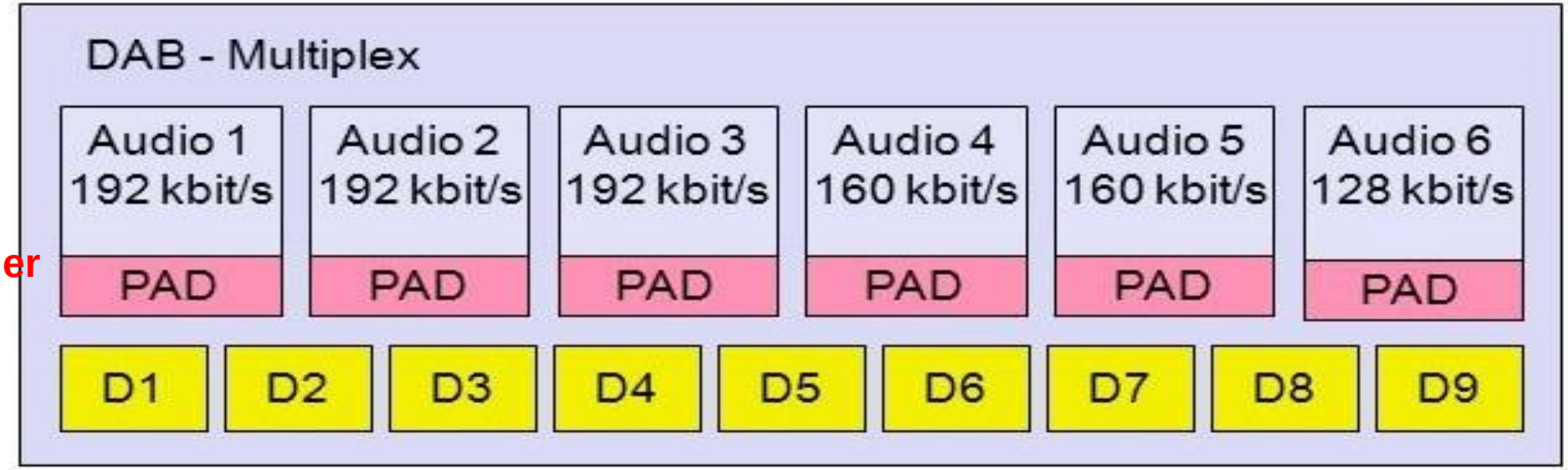
Moving Picture Experts Group

Digital Audio Broadcasting (8)

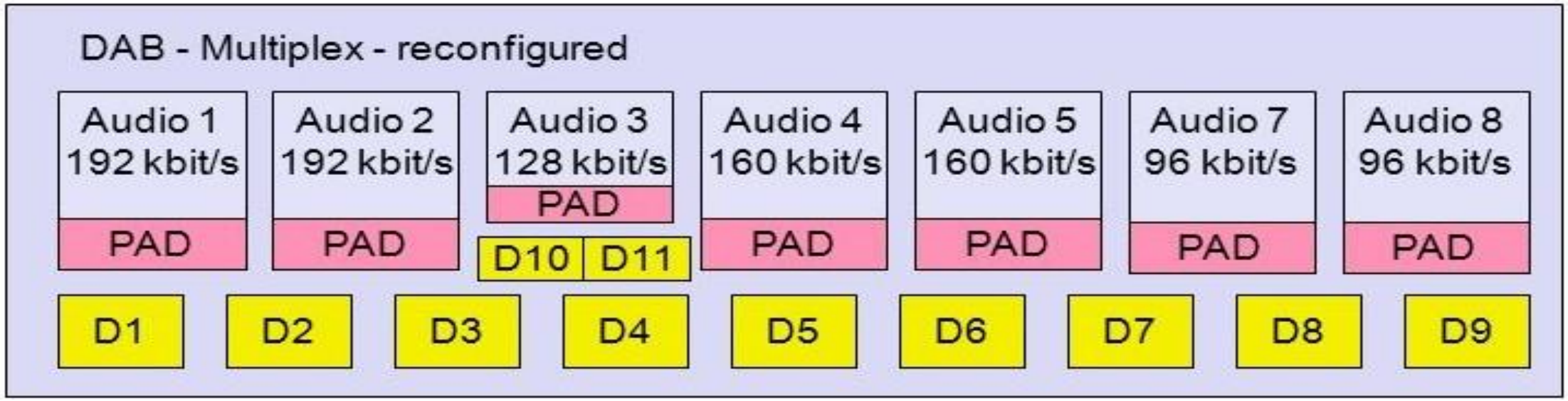
Bit rate management

- a DAB ensemble combines audio programs and data services with different requirements for transmission quality and bit rates
- the standard allows dynamic reconfiguration of the DAB multiplexing scheme (i.e., during transmission)
- data rates can be variable, DAB can use free capacities for other services
- the multiplexer performs this kind of bit rate management, therefore, additional services can come from different providers

Digital Audio Broadcasting (9)



ssembler
embler



Digital Audio Broadcasting (10)

Multimedia Object Transfer Protocol (MOT)

Problem

- broad range of receiver capabilities
  audio-only devices with single/multiple line text display, additional color graphic display, PC adapters etc.
- different types of receivers should at least be able to recognize all kinds of program associated and program independent data and process some of it

Solution

- common standard for data transmission: MOT
- important for MOT is the support of data formats used in other multimedia systems (e.g., online services, Internet, CD-ROM)
- DAB can therefore transmit HTML documents from the WWW with very little additional effort

Digital Audio Broadcasting (11)

MOT structure

MOT formats

- MHEG, Java, JPEG, ASCII, MPEG, HTML, HTTP, BMP, GIF, ...

Joint Photographic Experts Group

Multimedia Hypermedia Experts Group

Header core

- size of header and body, content type

Header extension

- handling information, e.g., repetition distance, segmentation, priority
- information supports caching mechanisms

Body

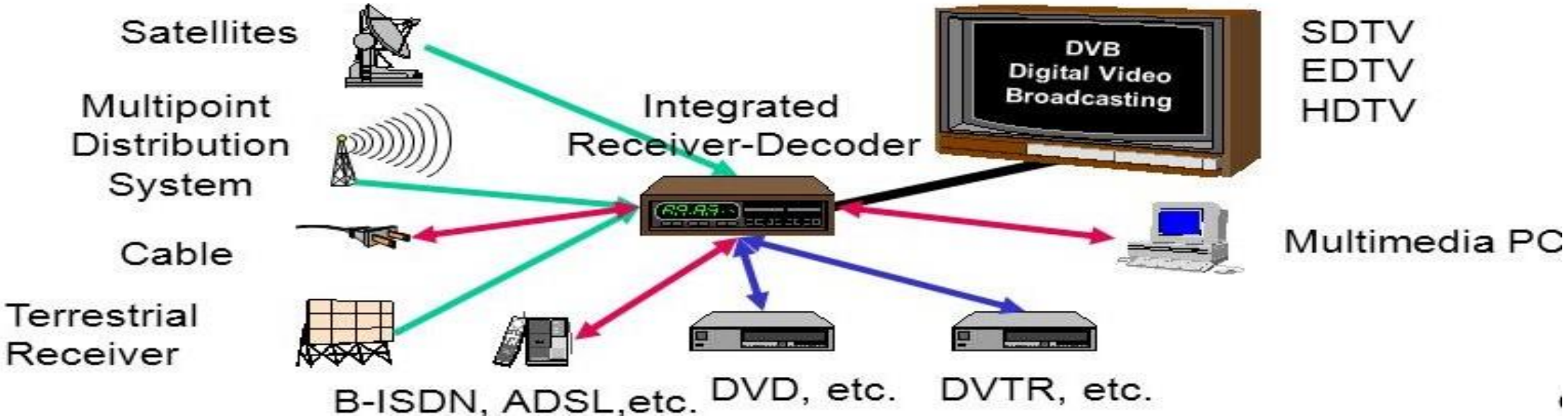
- arbitrary data

DAB allows for many repetition schemes

- objects, segments, headers

Digital Video Broadcasting (1)

- 1991 foundation of the ELG (European Launching Group)
  goal: development of digital television in Europe
- 1993 renaming into DVB (Digital Video Broadcasting)
  goal: introduction of digital television based on
  - satellite transmission
  - cable network technology
  - later also terrestrial transmission

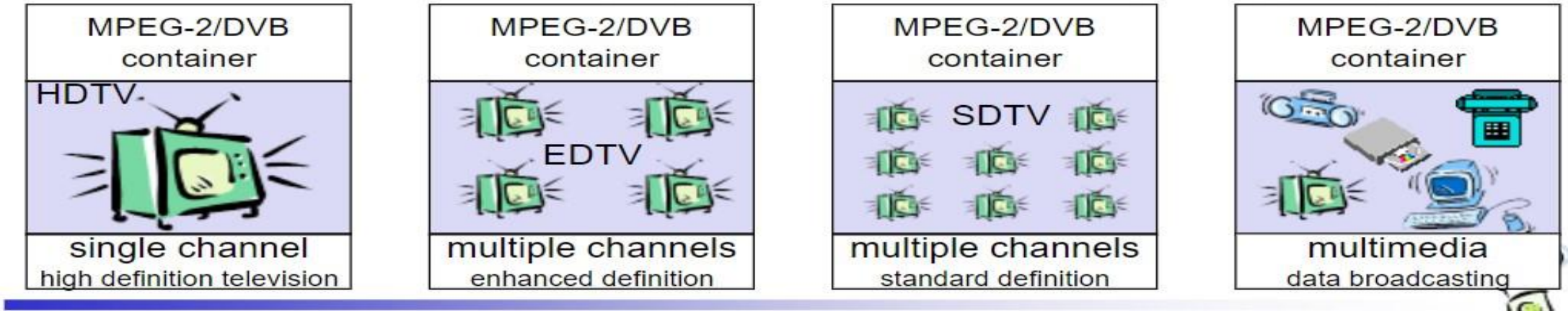


Digital Video Broadcasting (2)

DVB Container

DVB transmits MPEG-2 container

- high flexibility for the transmission of digital data
- no restrictions regarding the type of information
- DVB Service Information specifies the content of a container
  - NIT (Network Information Table): lists the services of a provider, contains additional information for set-top boxes
  - SDT (Service Description Table): list of names and parameters for each service within a MPEG multiplex channel
  - EIT (Event Information Table): status information about the current transmission, additional information for set-top boxes
  - TDT (Time and Date Table): Update information for set-top boxes

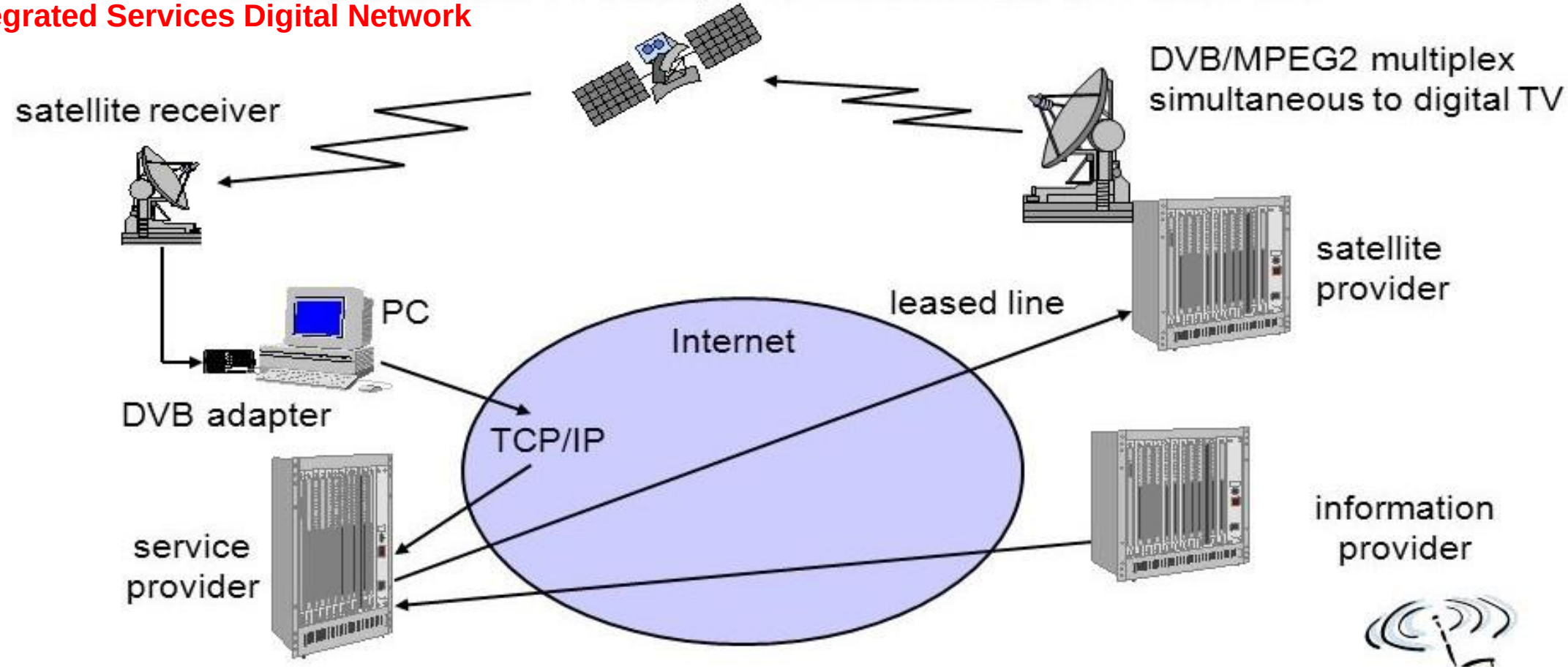


Digital Video Broadcasting (3)

Asymmetric data exchange

- downlink: DVB receiver, data rate per user 6-38 Mbit/s
- return channel from user to service provider: e.g., modem with 33 kbit/s, ISDN with 64 kbit/s, ADSL with several 100 kbit/s etc.

Integrated Services Digital Network



Digital Video Broadcasting (4)

Global System for Mobile communication

Convergence of broadcasting and mobile comm.

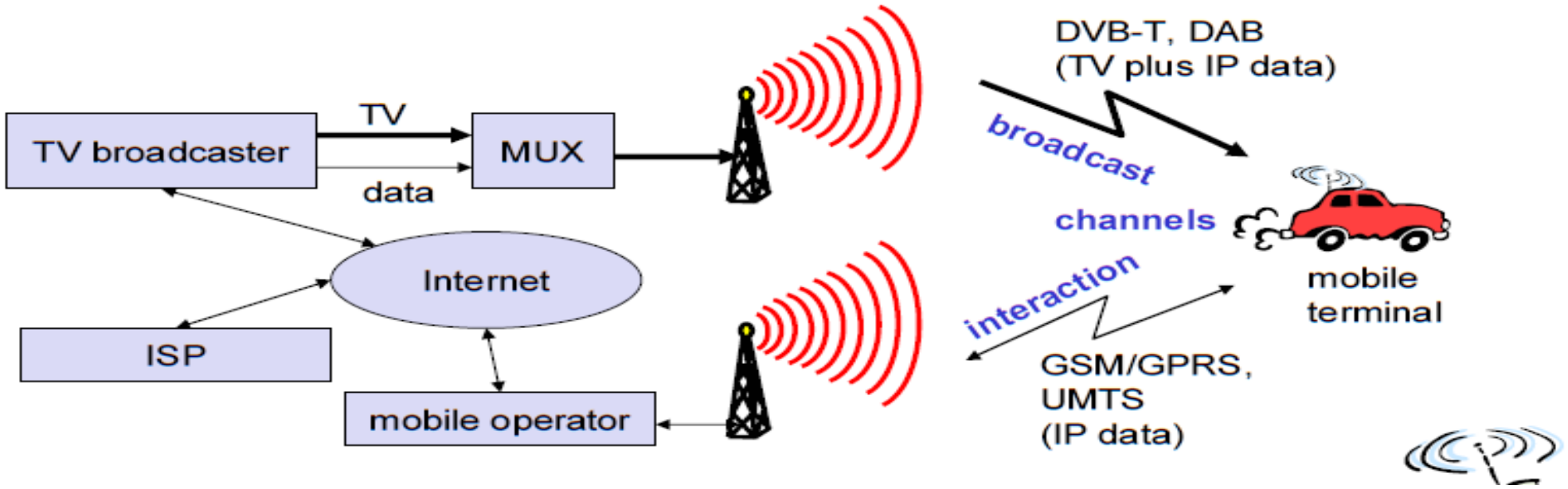
Definition of interaction channels

Digital enhanced cordless telecommunications

- Interacting/controlling broadcast via GSM, UMTS, DECT, PSTN, …

public switched telephone network

Example: mobile Internet services using IP over GSM/GPRS or UMTS as interaction channel for DAB/DVB



Digital Video Broadcasting (5)

Comparison of UMTS, DAB and DVB

Universal Mobile Telecommunications System

	UMTS	DAB	DVB
Spectrum bands (depends on national regulations) [MHz]	2000 (terrestrial), 2500 (satellite)	1140-1504, 220-228 (UK)	130-260, 430-862 (UK)
Regulation	Telecom, licensed	Broadcast, licensed	Broadcast, licensed
Bandwidth	5 MHz	1.5 MHz	8 MHz
Effective throughput	30-300 kbit/s (per user)	1.5 Mbit/s (shared)	5-30 Mbit/s (shared)
Mobility support	Low to high	Very high	Low to high
Application	Voice, data	Audio, push Internet, images, low res. video	High res. video, audio, push Internet
Coverage	Local to wide	Wide	Wide
Deployment cost for wide coverage	Very high	Low	Low

Convergence of Mobile and Broadcasting Techniques(1)

Definition of Convergence

- Provision of various communication services like text, data, image and video over the existing infrastructure
- Development of new infrastructure for handling multimedia transmission
- Managing of technologically and commercially distinct markets such as Broadcasting, Publishing, Cable TV, Fixed Voice, Cellular Mobile Services and Internet Services
- Integration and dimming of territory between broadcasting and communication

Broadcasting	One side transmission for unspecified majority – public benefit and regularity of contents are important
Communication	Interactive transmission among specific mutual – communication security and technological and economical regulation are important

→ Data Broadcasting
Webcasting

➢ Emerging new service with characteristics of both typical broadcasting and communication

Convergence of Mobile and Broadcasting Techniques(2)

Definition of Convergence : exa

	Content	Example
Business	– Providing communication service by broadcasting service provider as communication service provider – Merging and subsidiary business	– Cable TV service provider provides communication service such as Internet access service
Network	Common use of transmitter that can use same network both in broadcasting and communication	– Communication Satellite Service – Providing cable TV business by communication service provider
Service	Providing intermediary service between broadcasting and communication	– IP multicast using communication satellite – Providing contents using streaming technology – Interactive TV
Device	Convergence of device that can be used in both communication and broadcasting	–Internet device using TV Set –Broadcasting using mobile

Convergence of Mobile and Broadcasting Techniques(3)

Drivers of Convergence

- Technology
  - Digitisation of transmission and switching networks
  - Global networks based on packet switching and open standards (IP)
  - Increase in Processing power of Computers.
  - Emergence of new applications (ICT) leveraging enhanced software capabilities
  - Evolution of Broadband technologies(xDSL, CMTS, HFC, Broadband wireless– Fixed/ Mobile, Satellite).
- Market
  - New markets and services such as Multimedia services,Video on demand, Interactive TV, Pay TV,Cable telephony,Unified Messaging services, Internet Telephony etc.
  - Integration of content service providers with access providers.
  - Emergence of new Market players based on Potential of ICT

THANKS