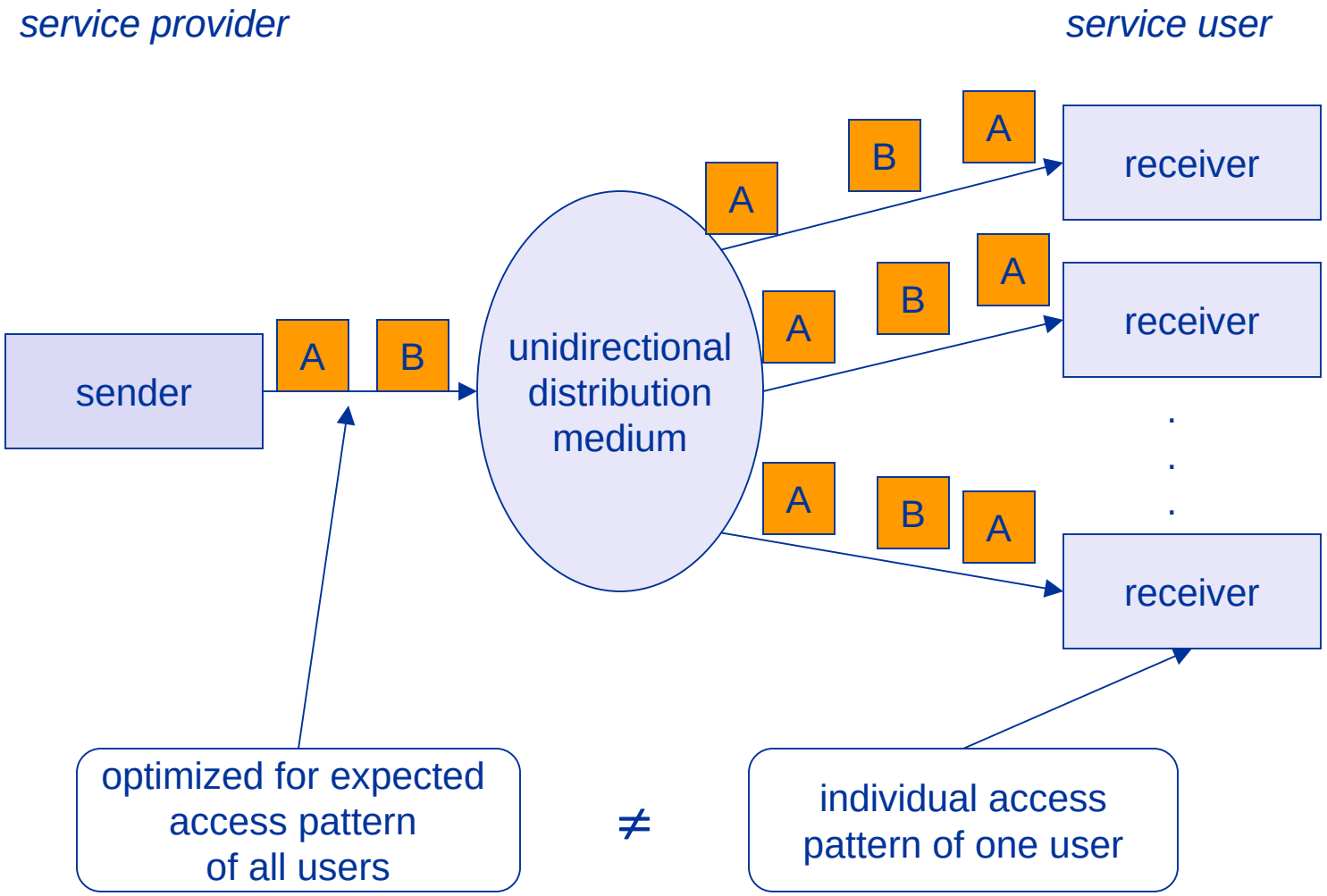
Next: Broadcast Systems

- Unidirectional distribution systems
- DAB
  - architecture
- DVB
  - Container
  - High-speed Internet

Unidirectional distribution systems

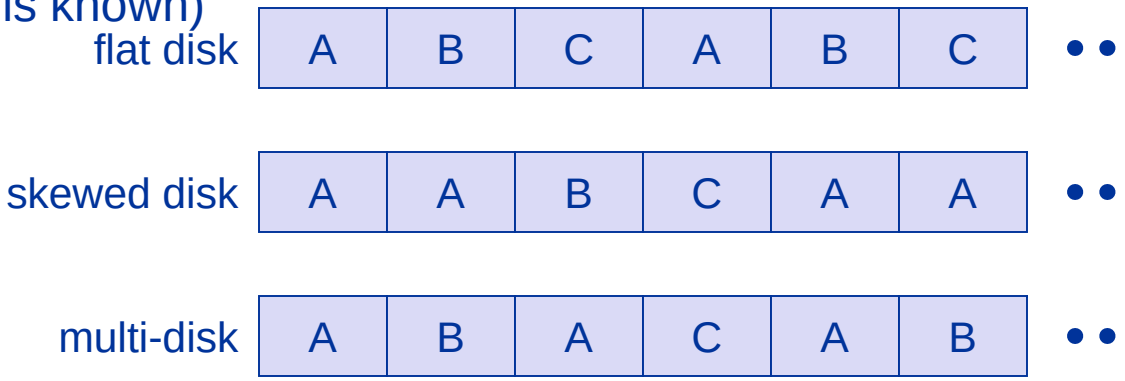
- Asymmetric communication environments
  - bandwidth limitations of the transmission medium
  - depends on applications, type of information
  - examples
    - wireless networks with base station and mobile terminals
    - client-server environments (diskless terminal)
    - cable TV with set-top box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



Structuring transmissions - broadcast disks

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



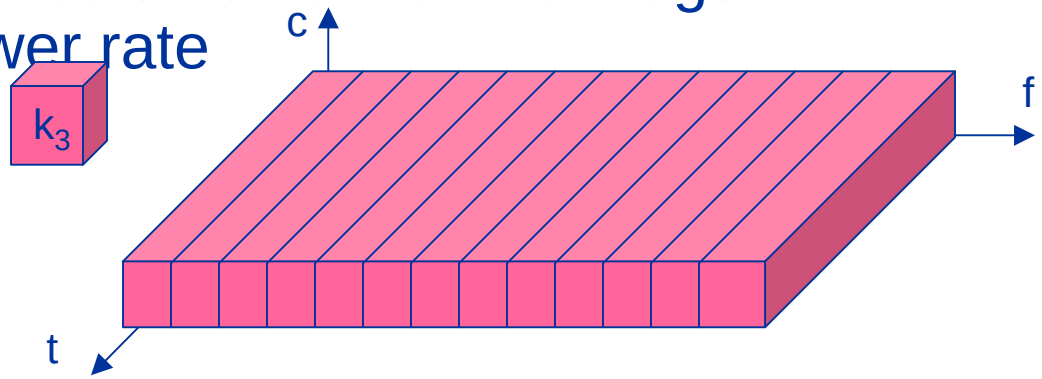
- Receiver
  - use of caching
    - cost-based strategy: what are the costs for a user (waiting time) if a data block has been requested but is currently not cached
    - application and cache have to know content of data blocks and access patterns of user to optimize

DAB: Digital Audio Broadcasting

- 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)

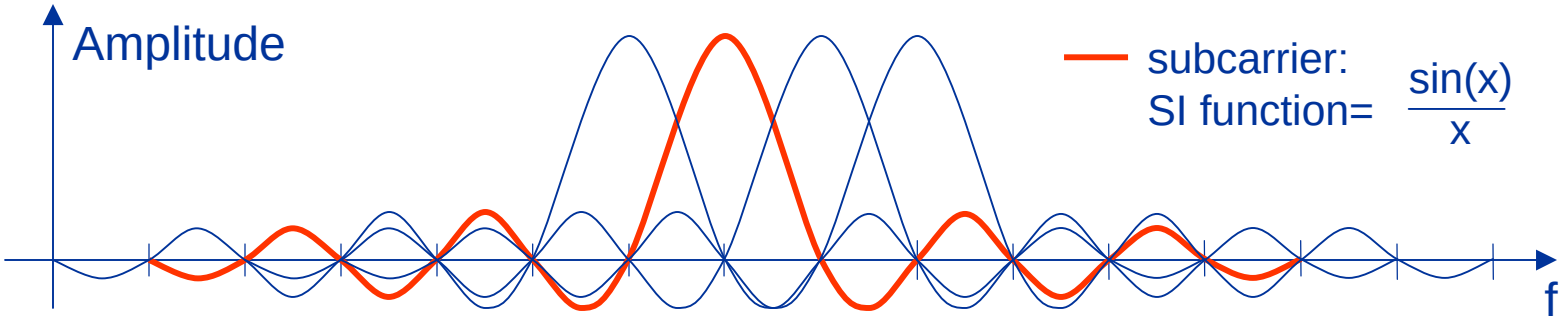
Orthogonal Frequency Division Multiplex (OFDM)

- Parallel data transmission on several orthogonal subcarriers with lower rate



Maximum of one subcarrier frequency appears exactly at a frequency where all other subcarriers equal zero

- superposition of frequencies in the same frequency range

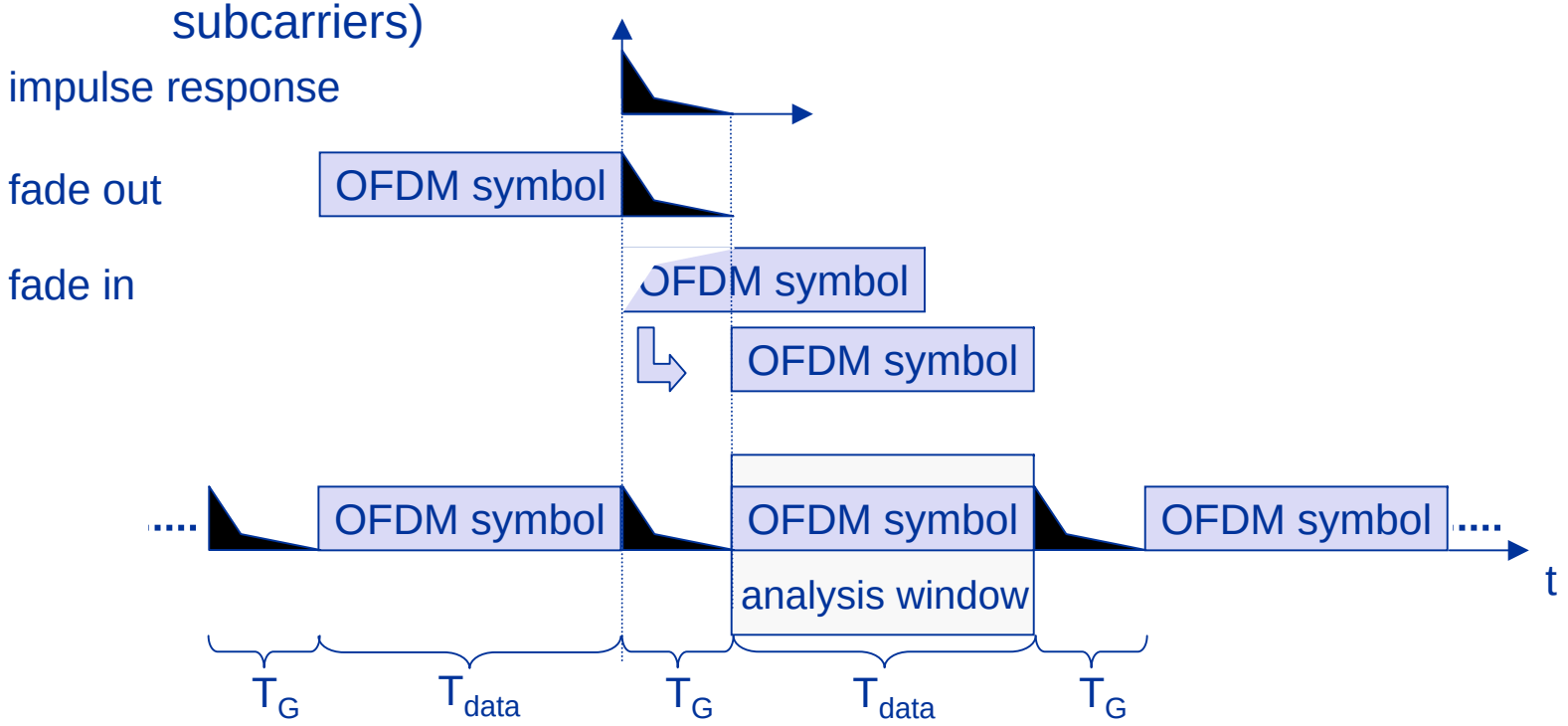


OFDM II

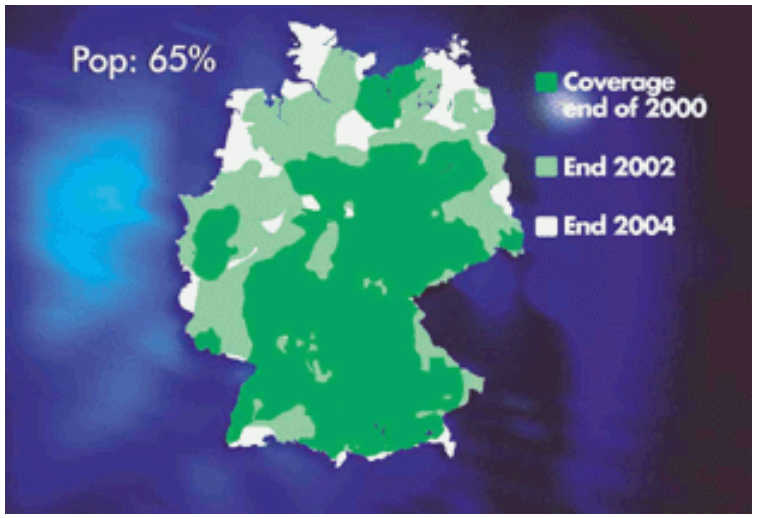
- Properties
  - Lower data rate on each subcarrier ➔ less ISI
  - interference on one frequency results in interference of one subcarrier only
  - no guard space necessary
  - orthogonality allows for signal separation via inverse FFT on receiver side
  - precise synchronization necessary (sender/receiver)
- Advantages
  - no equalizer necessary
  - no expensive filters with sharp edges necessary
  - better spectral efficiency (compared to CDM)
- Application
  - 802.11a, HiperLAN2, DAB, DVB, ADSL

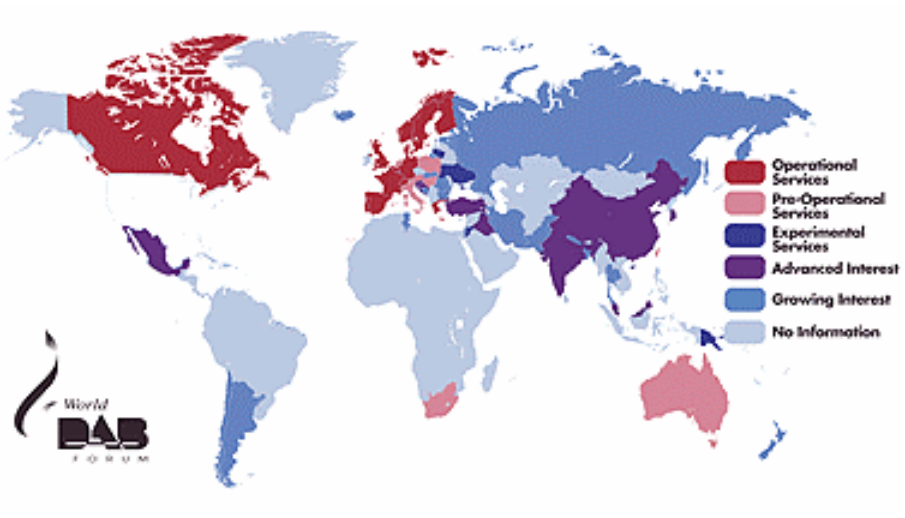
Real environments

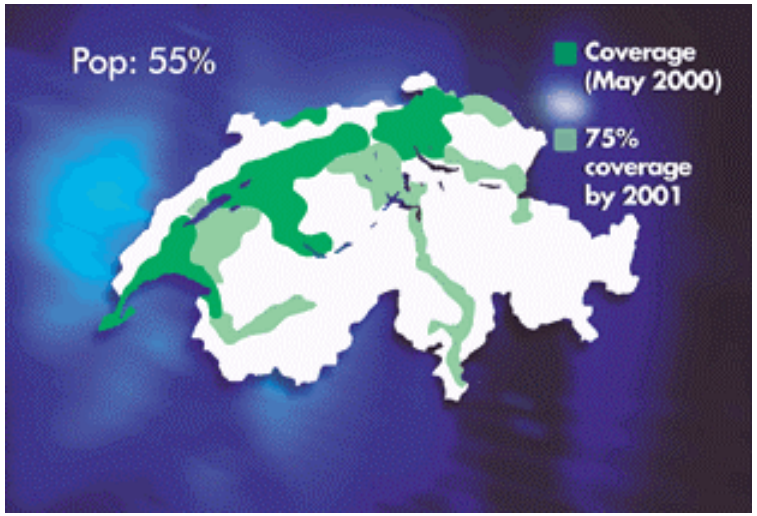
- ISI of subsequent symbols due to multipath propagation
- Symbol has to be stable during analysis for at least T_{data}
- Guard-Intervall (T_G) prepends each symbnol
- (HIPERLAN/2: T_G= 0.8 µs; T_{data}= 3.2 µs; 52 subcarriers)
  (DAB: T_{data}= 1 ms; up to 1536 subcarriers)



Examples for DAB coverage



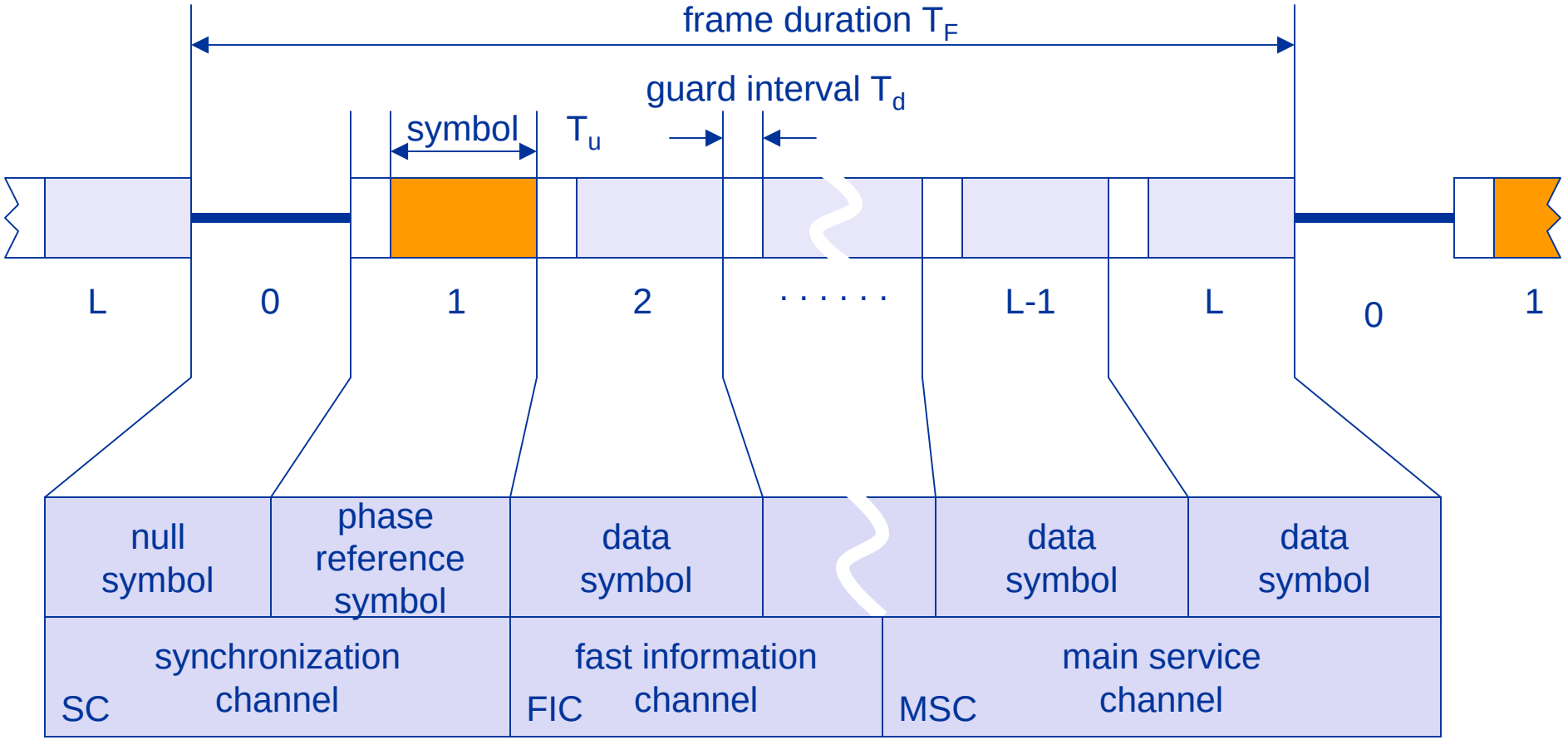




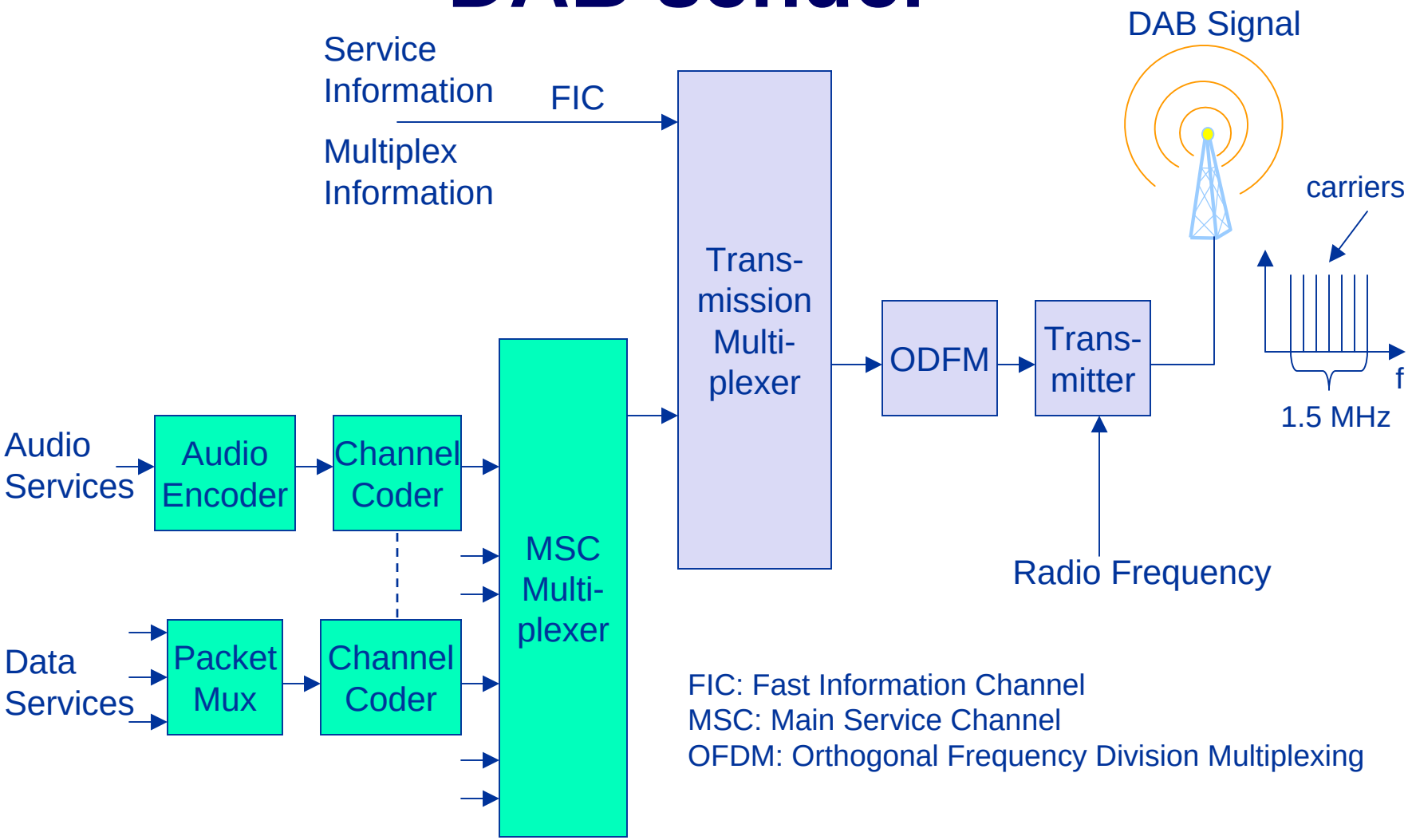
DAB transport mechanisms

- 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
  - transfer addressable packets

Transmission frame

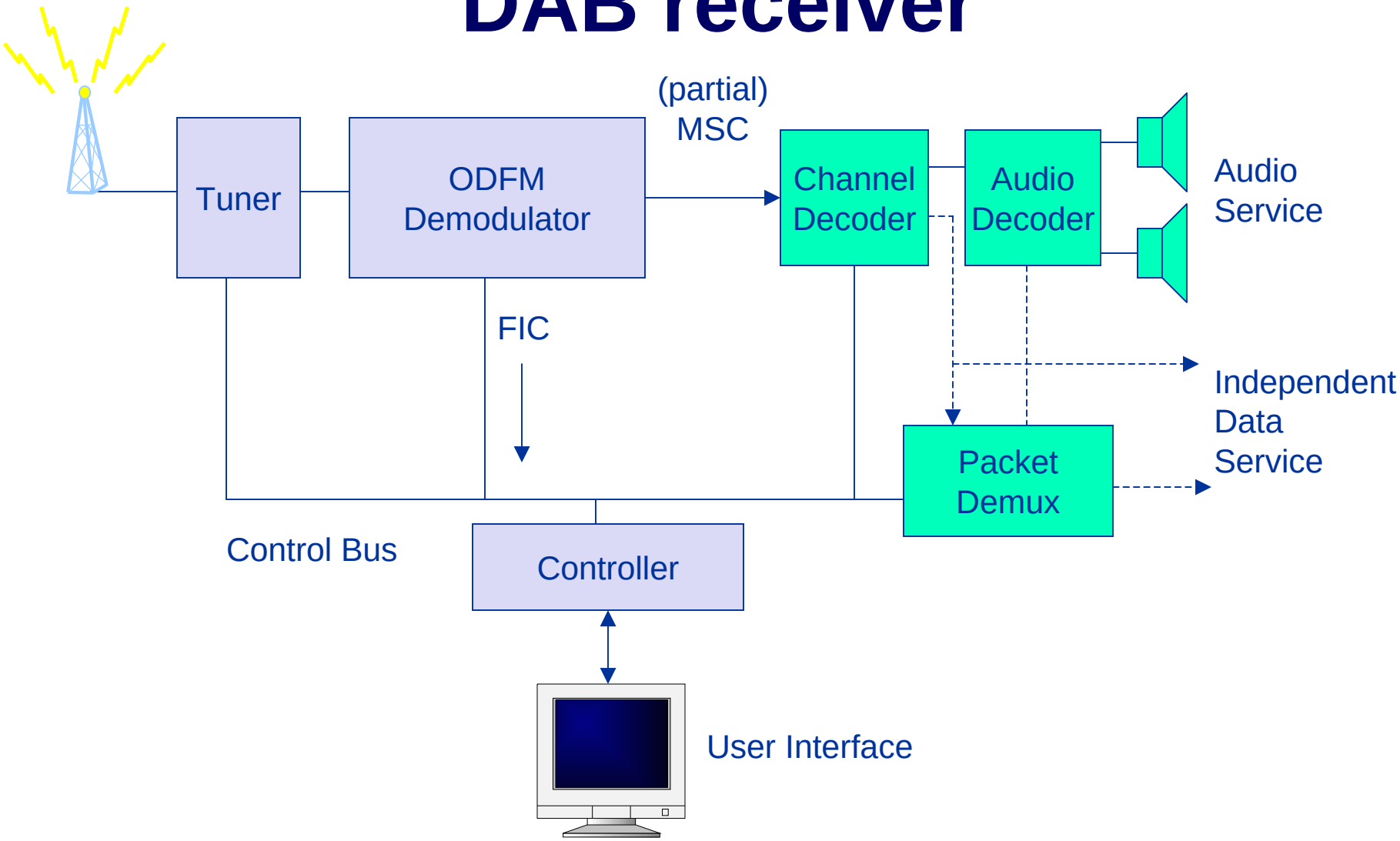


DAB sender



FIC: Fast Information Channel
MSC: Main Service Channel
OFDM: Orthogonal Frequency Division Multiplexing

DAB receiver



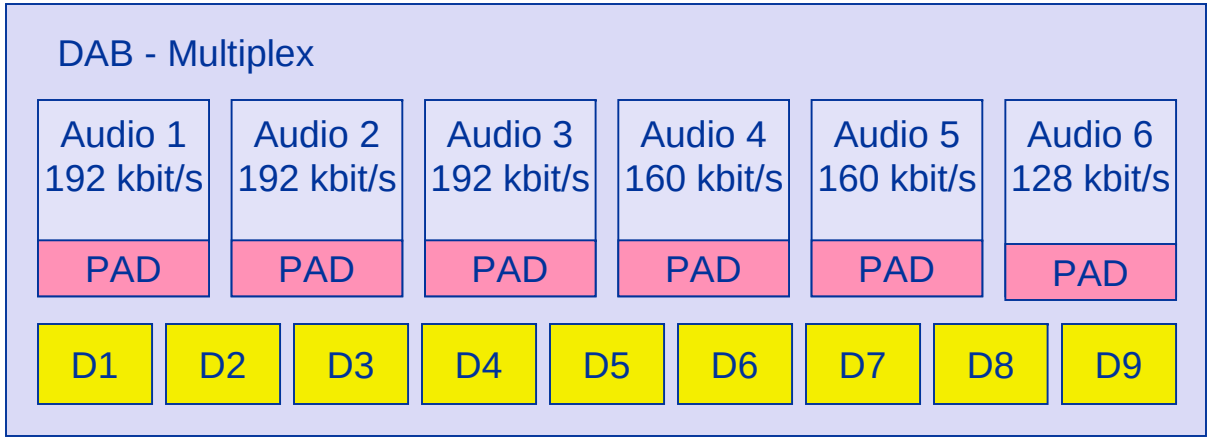
Audio coding

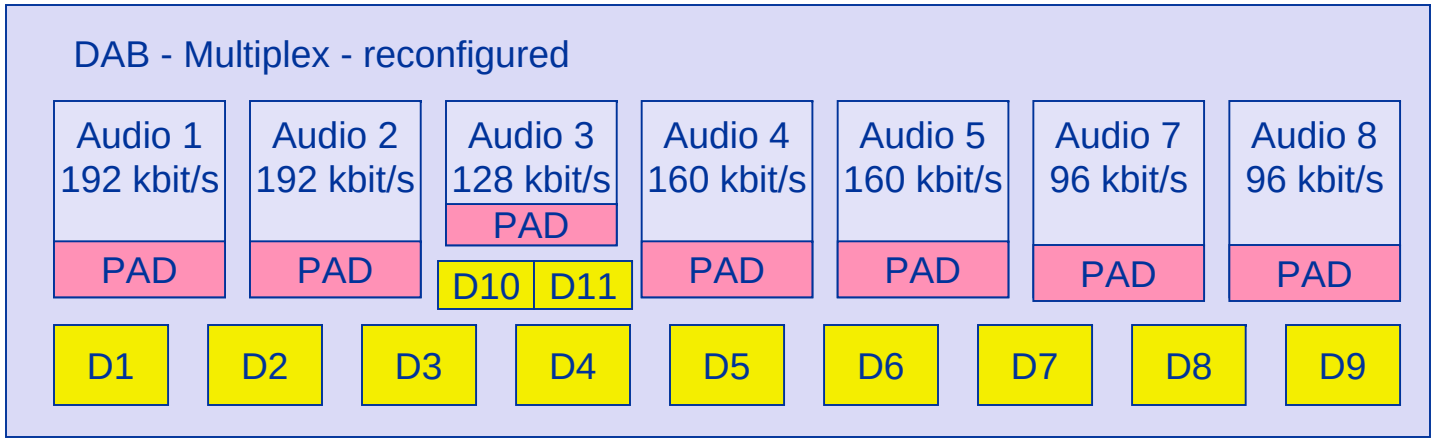
- Goal
  - audio transmission almost with CD quality
  - robust against multipath propagation
  - minimal distortion of audio signals during signal fading
- Mechanisms
  - fully digital audio signals (PCM, 16 Bit, 48 kHz, stereo)
  - MPEG compression of audio signals, compression ratio 1:10
  - redundancy 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

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

Example of a reconfiguration



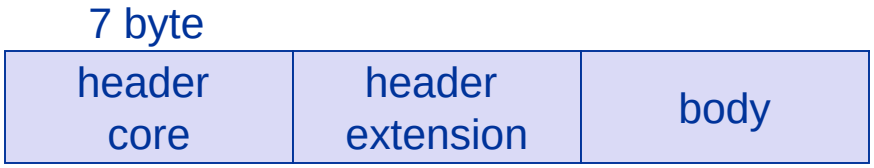


Multimedia Object Transfer Protocol (MOT)

- 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

MOT structure

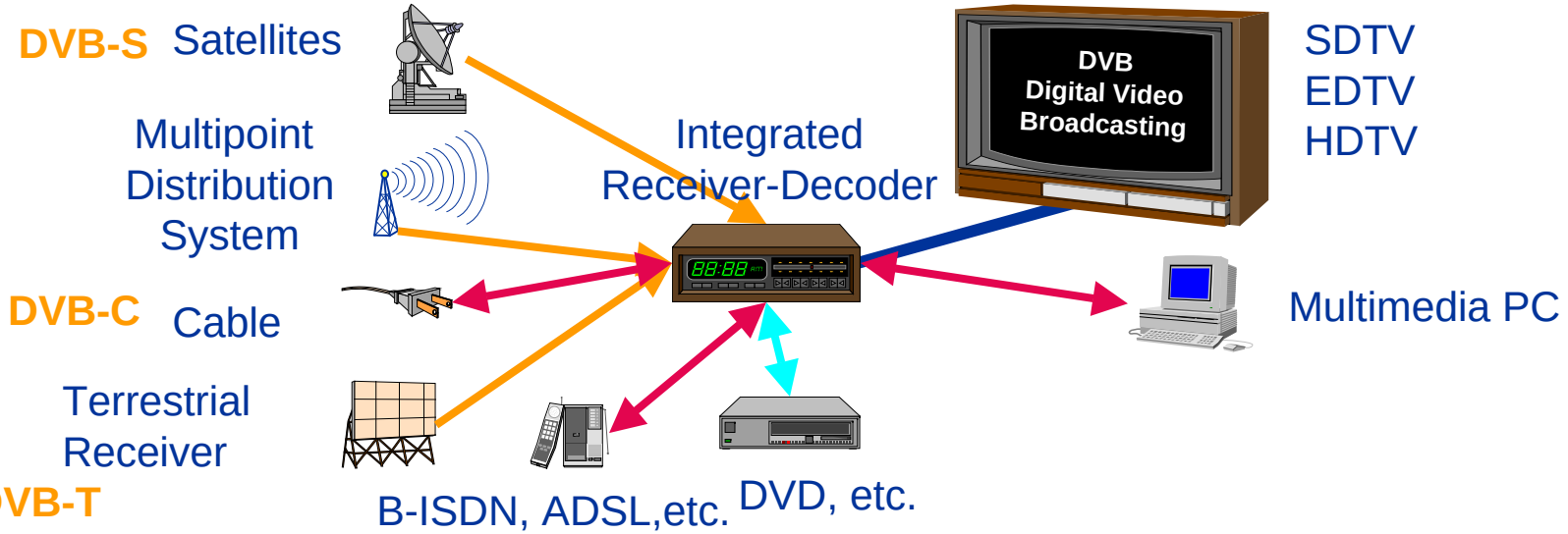
- MOT formats
  - MHEG, Java, JPEG, ASCII, MPEG, HTML, HTTP, BMP, GIF, ...
- Header core
  - size of header and body, content type
- Header extension
  - handling information, e.g., repetition distance, segmentation, priority
  - information supports caching mechanisms
- Body
  - arbitrary data



- DAB allows for many repetition schemes
  - objects, segments, headers

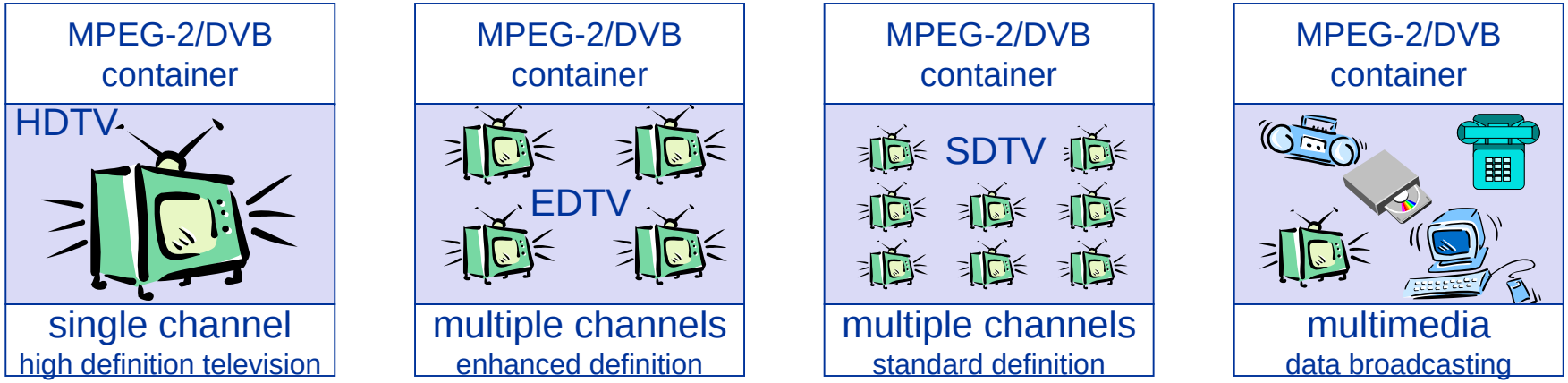
Digital Video Broadcasting

- 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



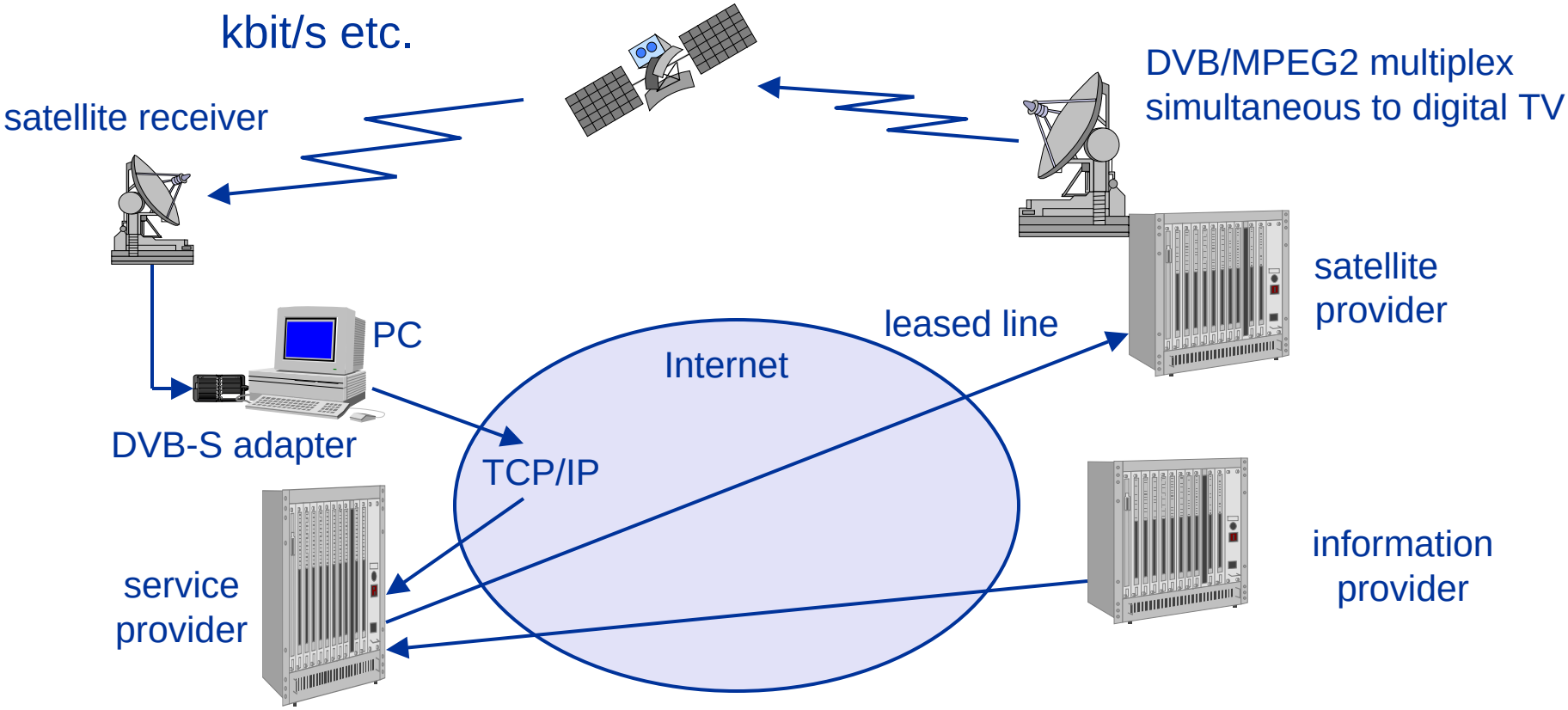
DVB Container

- 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

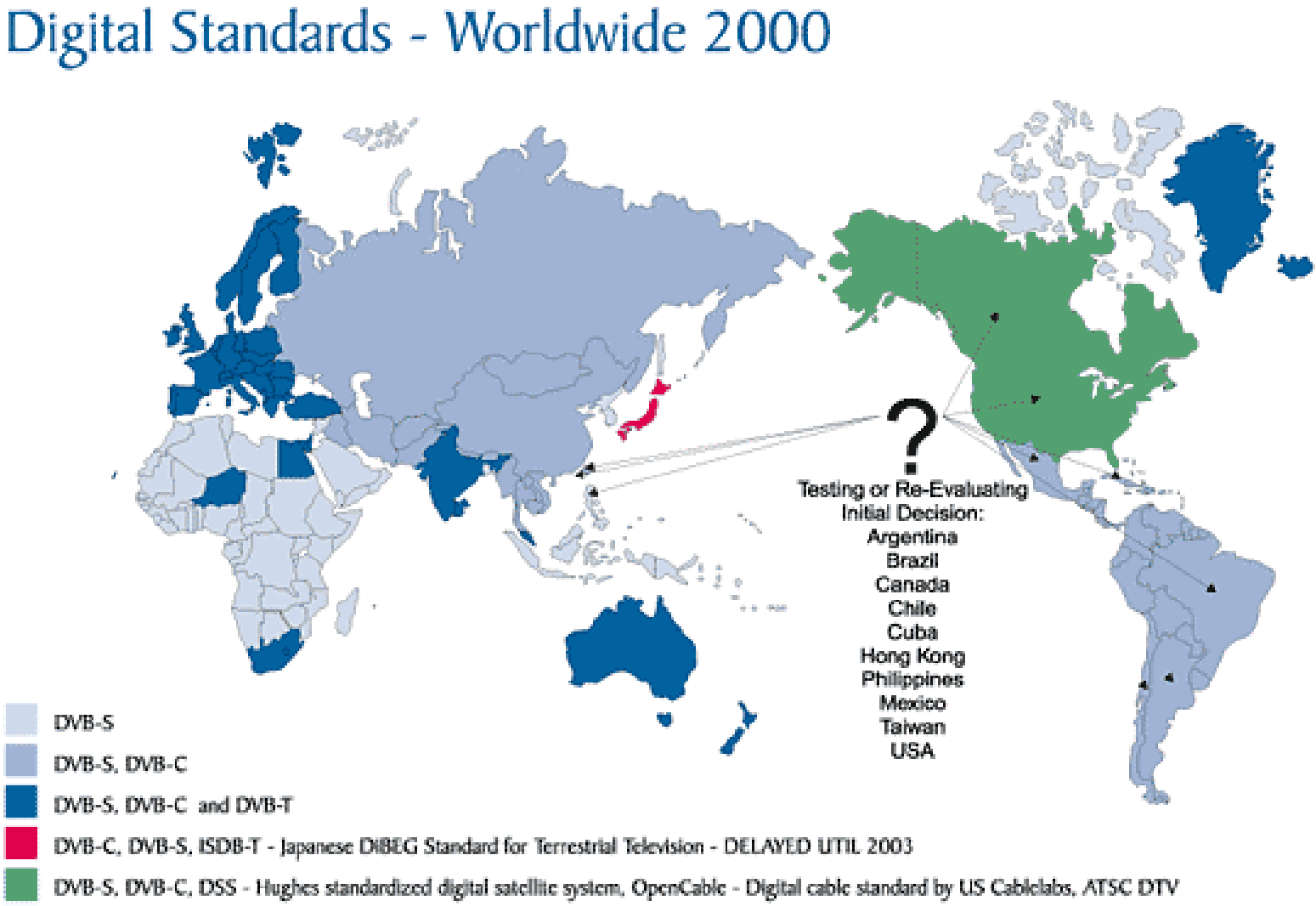


Example: high-speed Internet access

- 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, DSL with several 100 kbit/s etc.



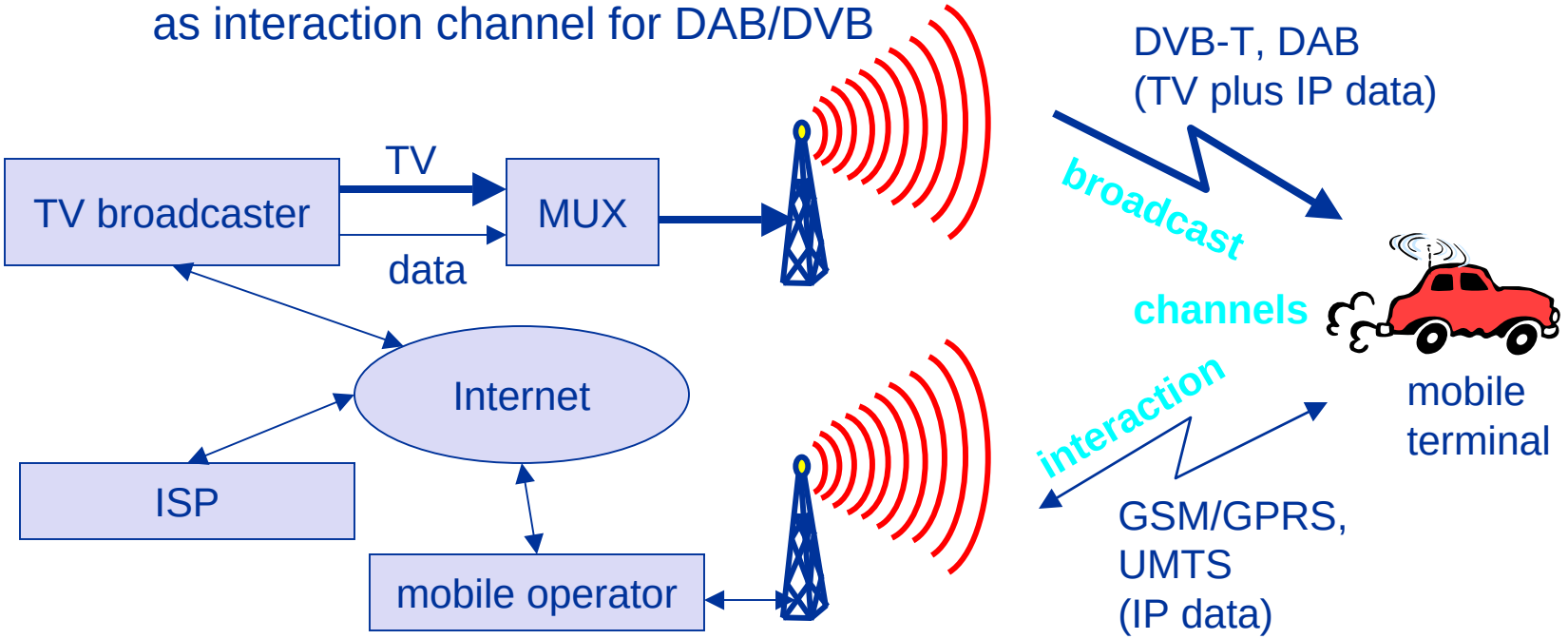
DVB worldwide



Convergence of broadcasting and mobile comm.

- Definition of interaction channels
- Interacting/controlling broadcast via GSM, UMTS, DECT, PSTN, …

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



Comparing UMTS, DAB and DVB

	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