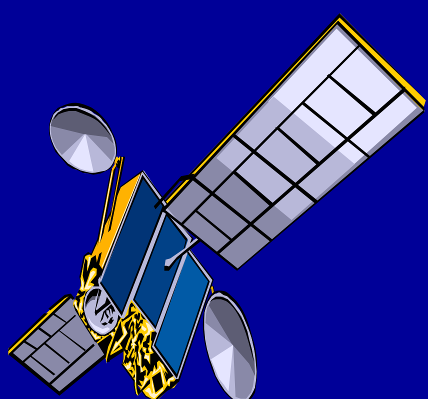
DVB-S2

EN 302 307

What future for IP services by satellite?

Alberto Morello

Chairman DVB-S2

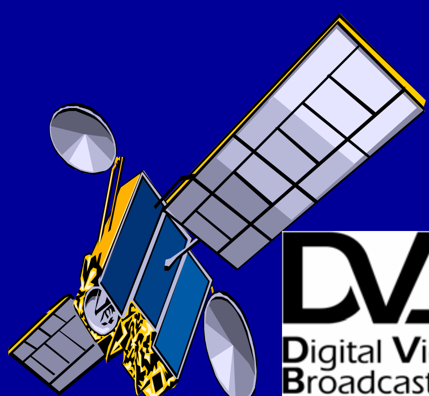


NMC SEminar

Geneva June 2006

DVB-S2
What future for IP services by satellite?

- Application scenarios
- The DVB-S2 tool-kit
- Adaptive Coding & Modulation
- The DVB-S2 interactive network architecture
- Cost savings on the satellite segment
- S2 and Mobility



DVB-S2
What future for IP services by satellite?

Application scenarios

- The DVB-S2 tool-kit
- Adaptive Coding & Modulation
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- Cost savings on the satellite segment
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Digital Video Broadcasting

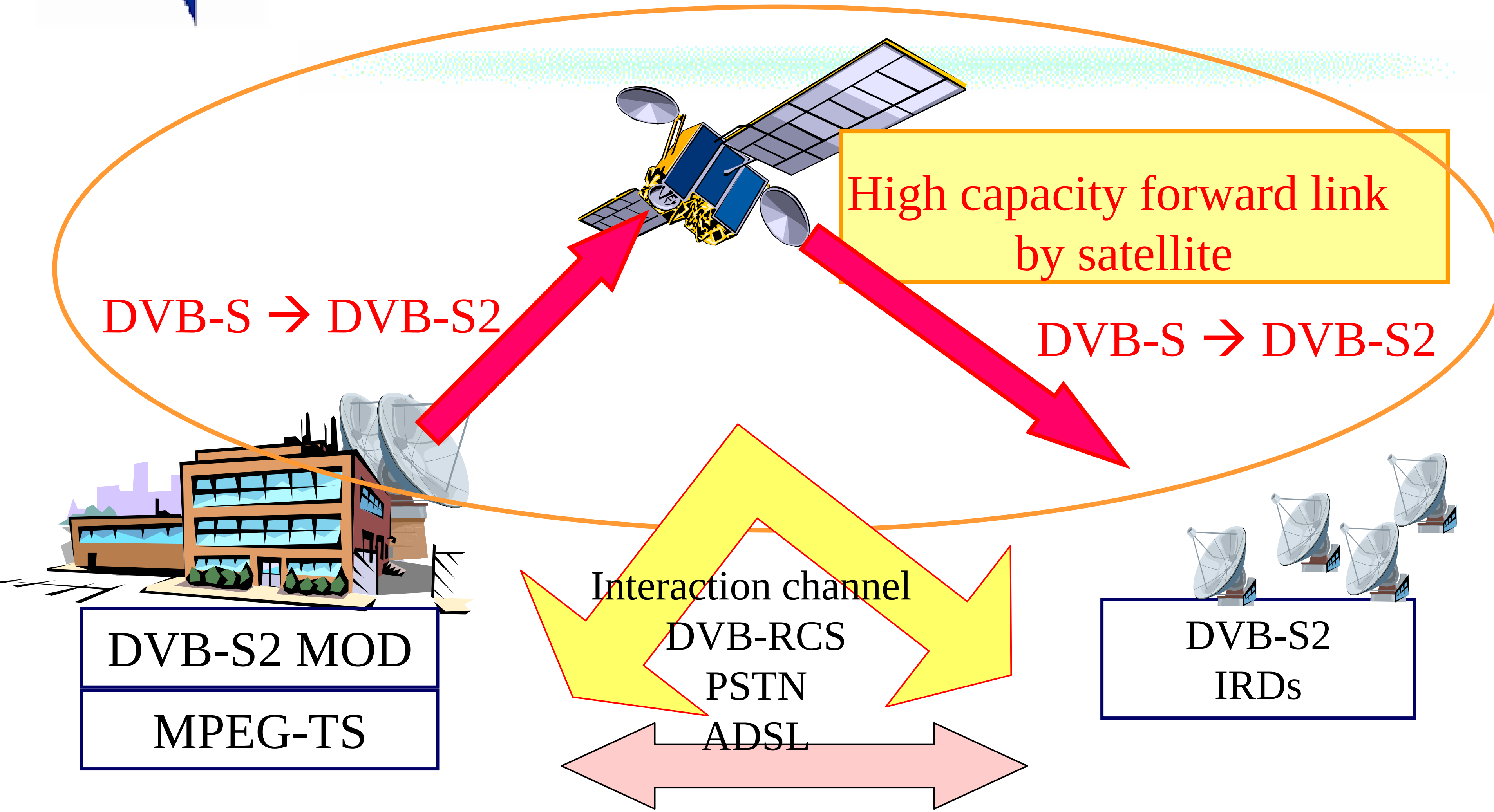
DVB-S2 application scenarios

- **broadcast applications (DTV):**
  - **Non backwards compatible**
  - **Backwards compatible to DVB-S**

- **interactive applications (including rate adaptation ACM) for corporate and consumer applications**

- **professional systems (DSNG, Internet trunking, cable feeds, ...**

DVB-S2 in the DVB chain



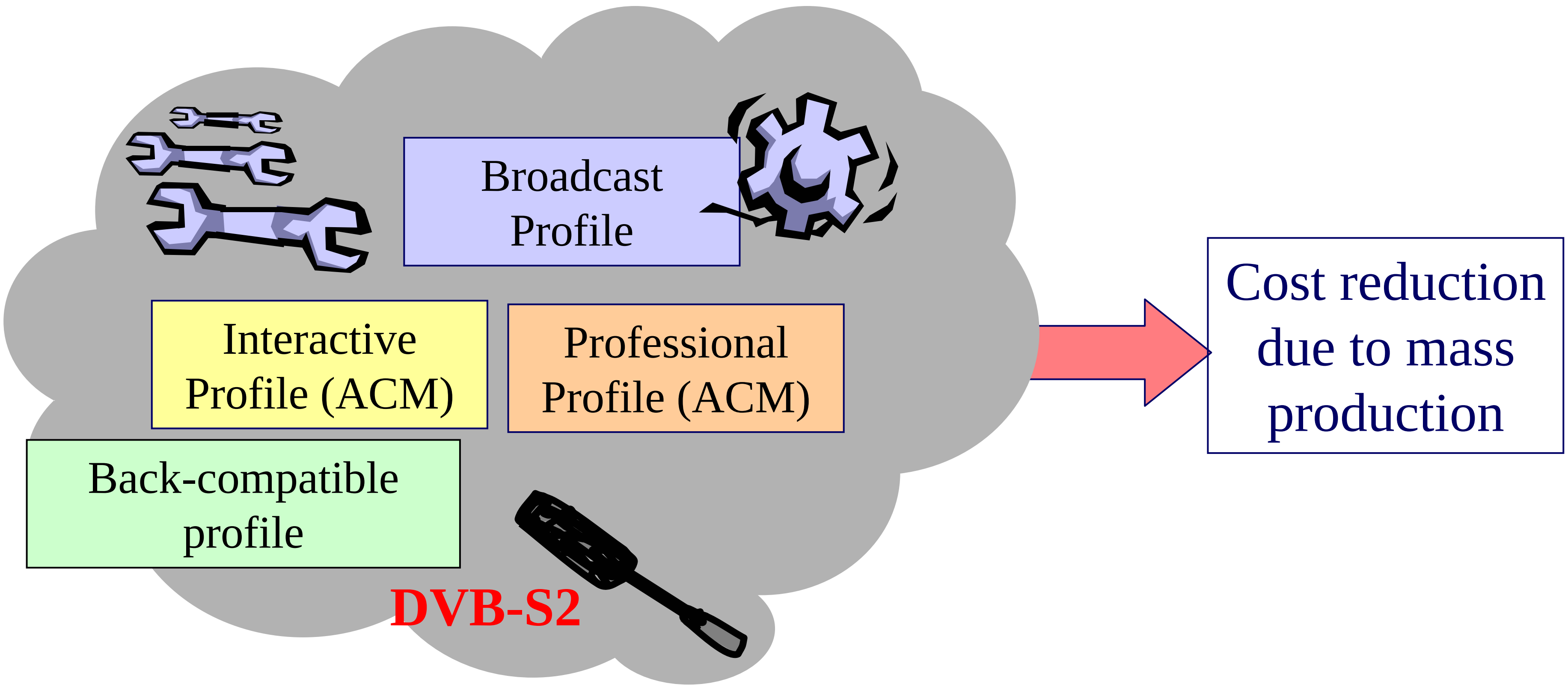
DVB-S2
What future for IP services by satellite?

- Application scenarios
- **The DVB-S2 tool-kit for interactive services:**
  - **Advanced coding and modulation**
  - **Transparency to any data format**
- Adaptive Coding & Modulation
- The DVB-S2 interactive network architecture
- Cost savings on the satellite segment
- S2 and Mobility

Digital Video Broadcasting

The tool-kit approach

DVB-S2 is a single system for the various application scenarios



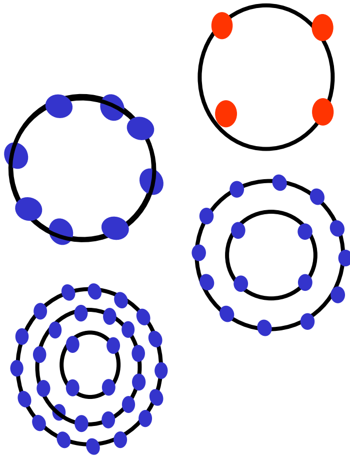
LDPC codes concatenated with BCH

Available code rates:

1/4, 1/3, 2/5, 1/2, 3/5, 2/3,
3/4, 4/5, 5/6, 8/9, 9/10

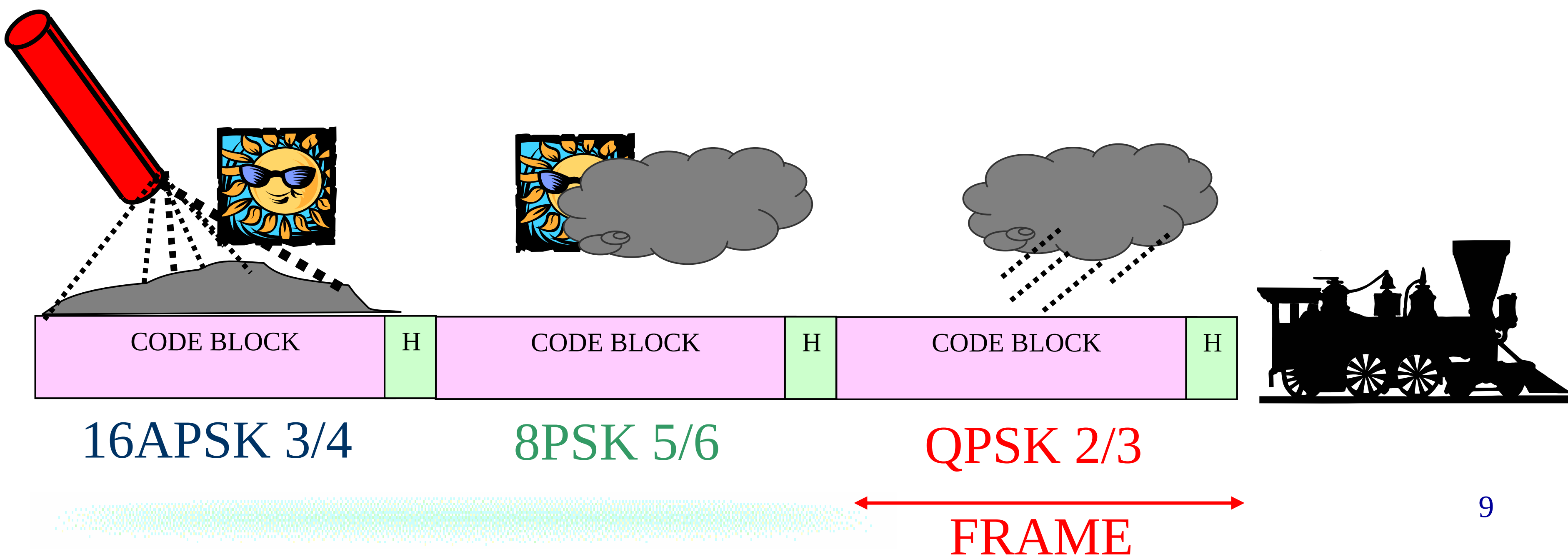
Available modulations

- o **QPSK** **(2 bit/s/Hz)**
- o **8PSK** **(3 bit/s/Hz)**
- o **16APSK** **(4 bit/s/Hz): 4-12-APSK**
- o **32APSK** **(5 bit/s/Hz):4-12-16 APSK**



Adaptive Coding and Modulation
Framing: the "train"

- The transmission is organised in **FRAMES** (train wagons)
  - For ACM, protection may change frame-by-frame
- The Header (wagon numberplate) contains:
  - synchronisation and signaling bits (modulation, coding,..)



In summary

- DVB-S2 compared with DVB-S:
  - bit-rate capacity gain (same C/N and symbol-rate):
    - **25-35% depending on modes and applications**

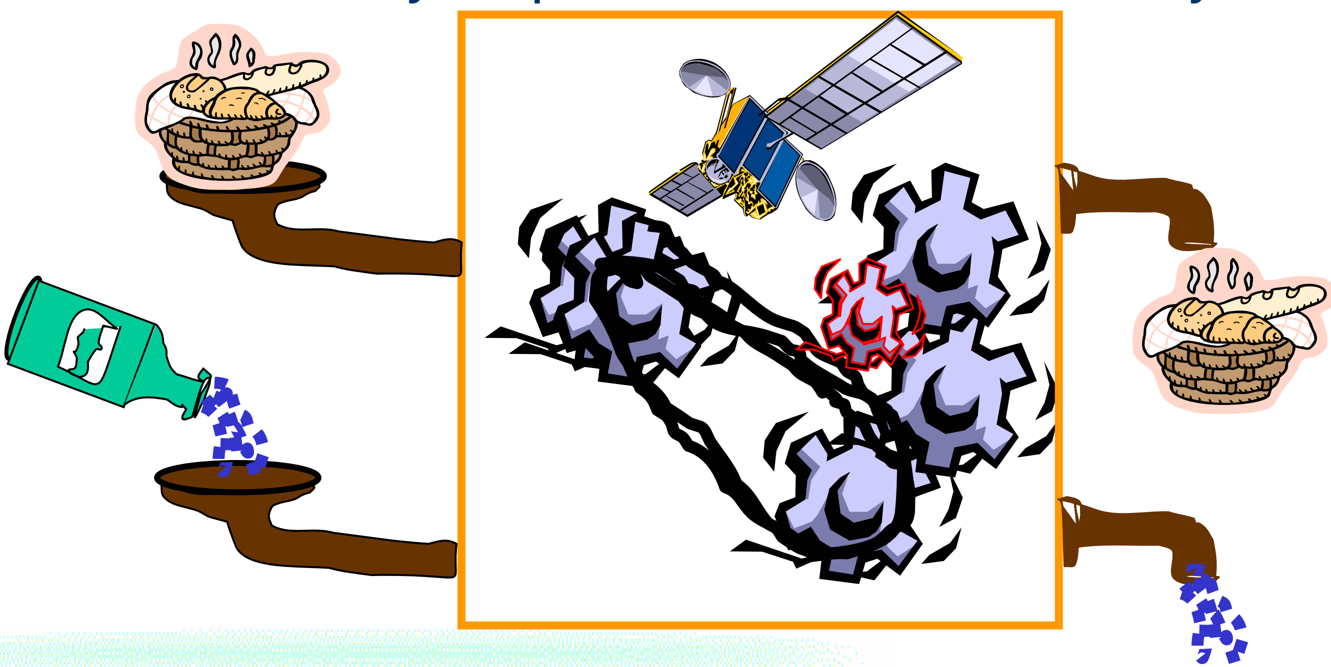
Large flexibility to potentially match any transponder characteristics:

- Spectrum efficiencies from 0.5 to 4.5 bit/s/Hz
- C/N range from –2 to +16 dB (AWGN)

0.7 – 1 dB from the Shannon limit probably means that:
"In the course of our lifetime we will never have
to design another system for satellite broadcasting"

Transparency to any data format

- DVB-S2 may transport single or multiple input streams:
  - MPEG-TS format
  - generic format (e.g. IP,..)
- Suitable for MPEG-2 TV and HDTV as well as for the new coding systems (e.g. H264/AVC, VC1)
- Each stream may be protected in a different way

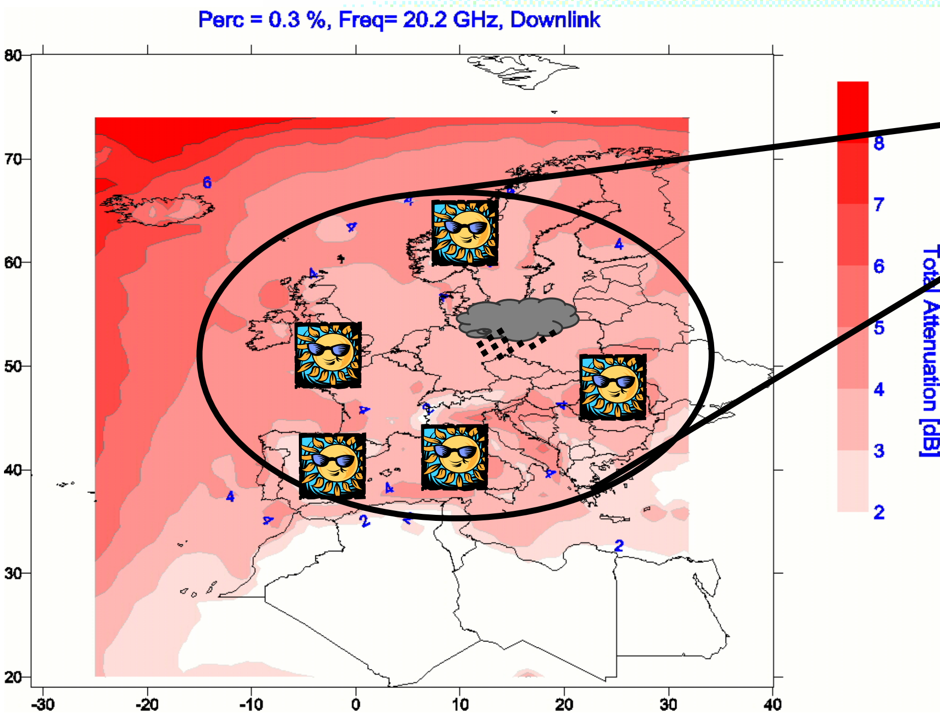


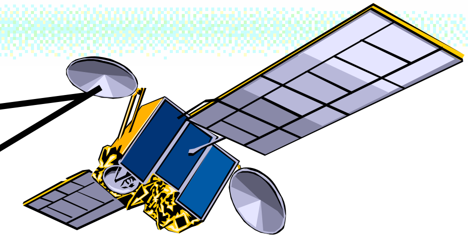
DVB-S2
What future for IP services by satellite?

- Application scenarios
- The DVB-S2 tool-kit for interactive services
- **Adaptive Coding & Modulation**
- The DVB-S2 interactive network architecture
- Cost savings on the satellite segment

Digital Video Broadcasting

Adaptive Coding and Modulation
Unicasting versus Broadcasting



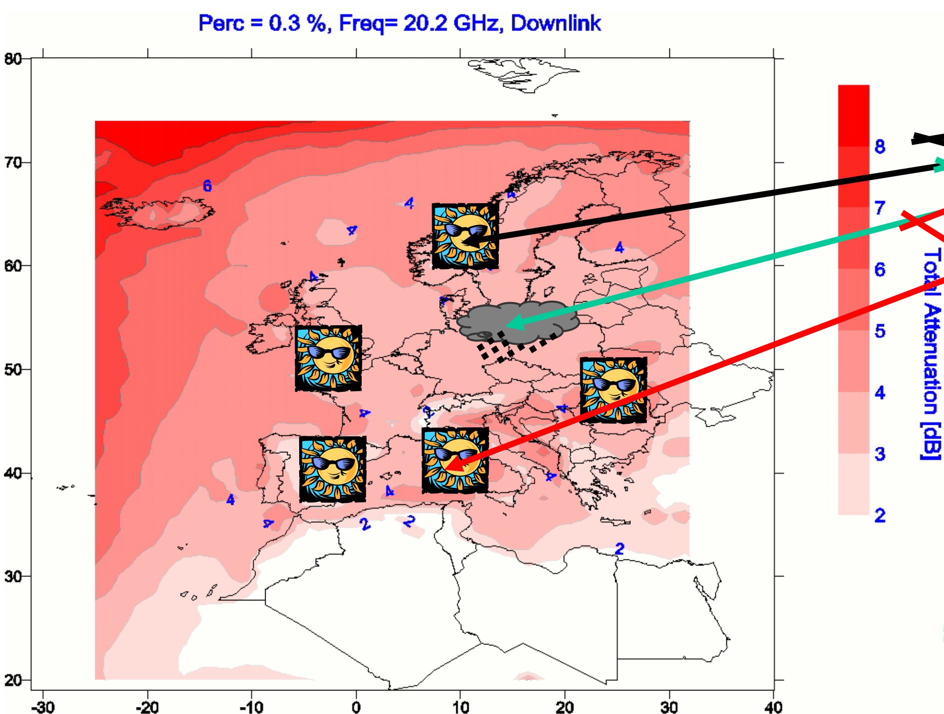


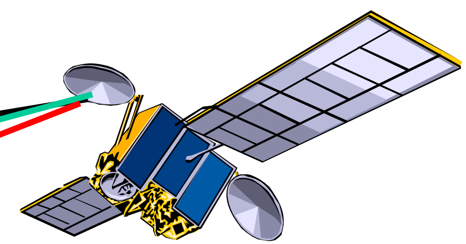
Large C/N margins for a large percentage of time (typically 4-6 dB in Ku band)

- Currently the DVB IP/Unicast services by satellite make use of DVB-S in the forward path
- DVB-S has been developed for broadcasting applications where the physical layer protection is constant for every service and is constant in time **(link optimisation for the worst case: worst service, worst minute , worst location)**

Adaptive Coding and Modulation
Unicasting versus Broadcasting

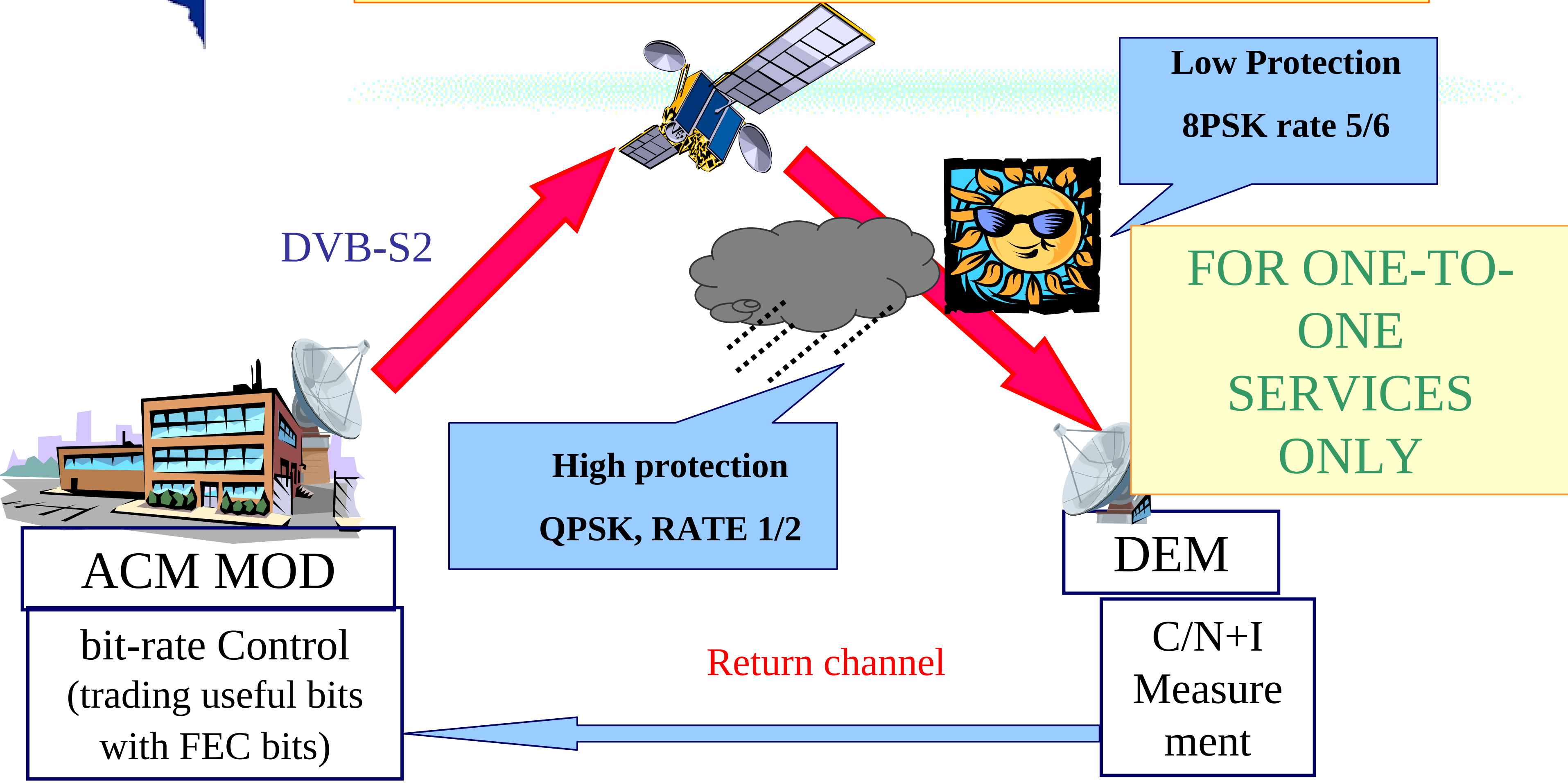
- **The DVB-S2 ACM technology** allows **FEC/modulation adaptation according to the propagation conditions** (rain/clear sky, beam centre or beam contour, ….)
- **each user** may operate with **very low C/N margins**, thus maximising the satellite throughput





The gain of ACM increases with frequency (C, Ku, Ka): less crowded Ka band needs ACM!

Adaptive Coding and Modulation
How does it work?



DVB-S2 performs this adaptation independently user-by-user

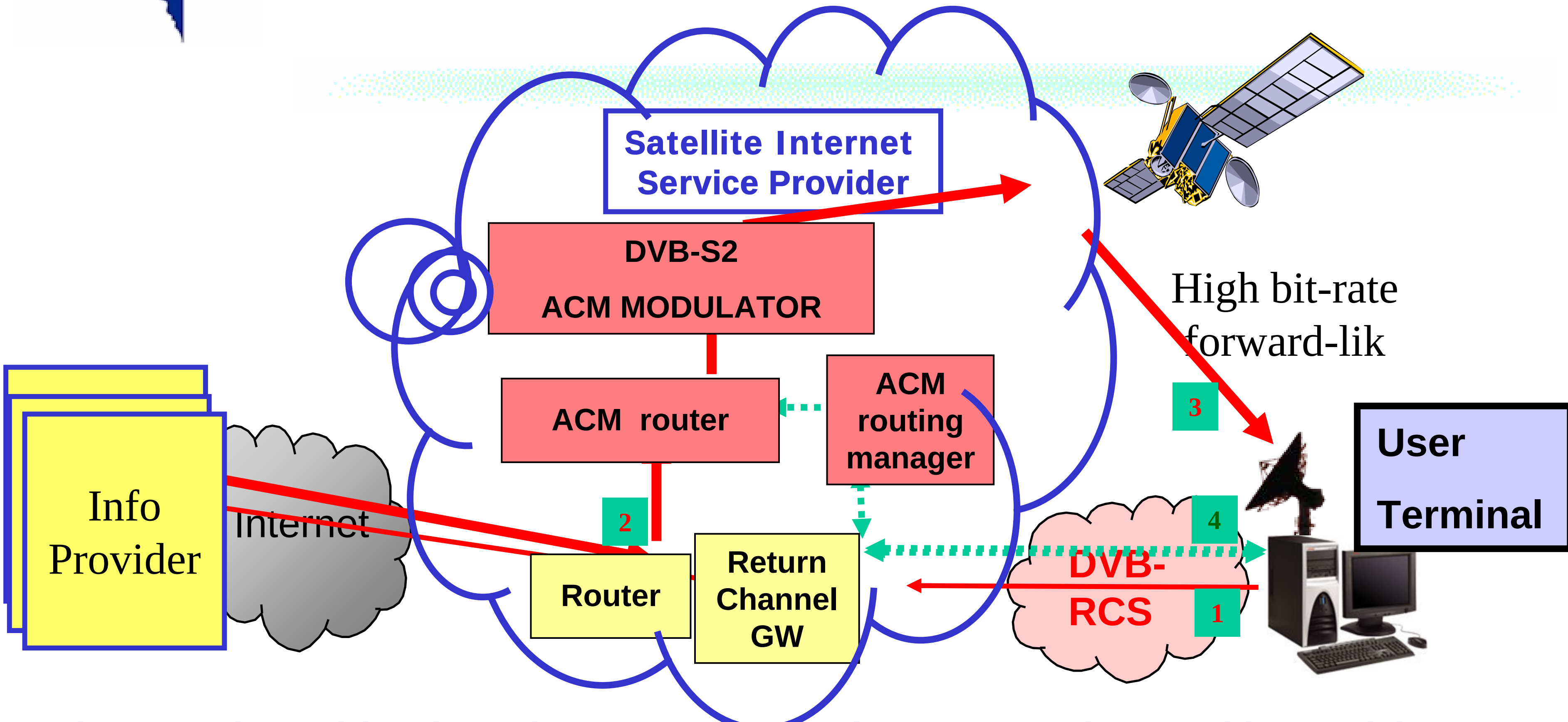
Potential ACM gain (ESA source): bit-rate x **2** in Ka band (Europe)

DVB-S2-ACM gain versus DVB-S: bit-rate x 1.30 (FEC) x **2** (ACM)=**2.6**

DVB-S2
What future for IP services by satellite?

- The DVB-S2 tool-kit for interactive services:
- Adaptive Coding & Modulation
- **The DVB-S2 interactive network architecture**
- Cost savings on the satellite segment
- S2 and mobility

ACM & Fast-Internet
Typical Network architecture



Terminals send enquiries through a return channel (e.g. DVB-RCS) at low bit-rate (1)

The Satellite Internet Service Provider routes user enquiries via Internet, and routes the Info Provider's replies via satellite (2,3)

ACM is achieved via an ACM routing manager, which negotiates the service level / error protection with the user terminal via the return link (4)

Policies for Service Level control (external from DVB-S2)

The ACM Router sends the IP packets to the right DVB-S2 protection layer, at the right instant, according to the SLA

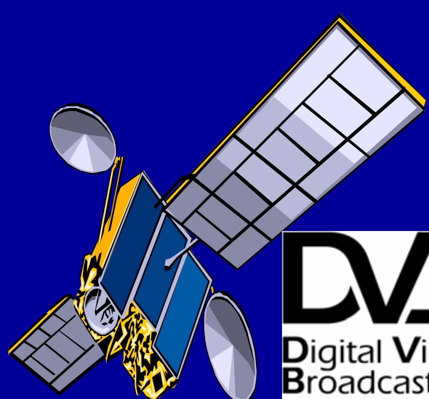
A Service Level may be based on:

- Protection Level of the ACM,
- maximum delay (priority routing)
- minimum reserved bandwidth

DVB is developing a new encapsulation protocol for IP over S2 (provisional name: GSE)

DVB-S2
What future for IP services by satellite?

- The DVB-S2 tool-kit for interactive services:
- Adaptive Coding & Modulation
- The DVB-S2 interactive network architecture
- **Cost savings on the satellite segment**:
  - DVB-S2 ACM + Multi-spot satellite
  - Dimensioning the space resources for fast-Internet services
  - Comparison of DVB-S2 space segment cost and ADSL flat fares
- S2 and Mobility

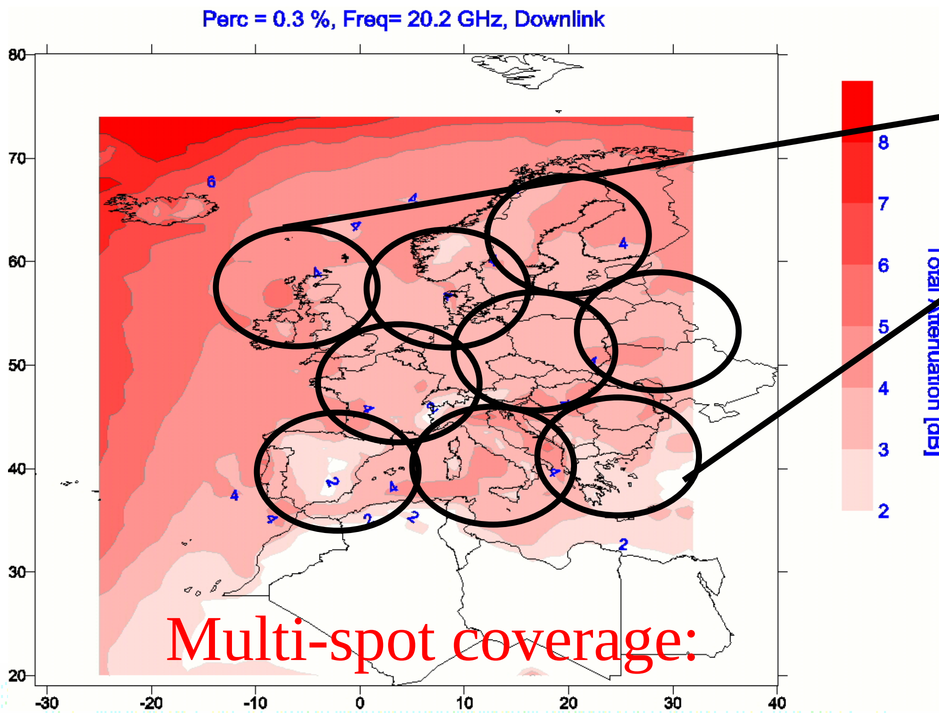


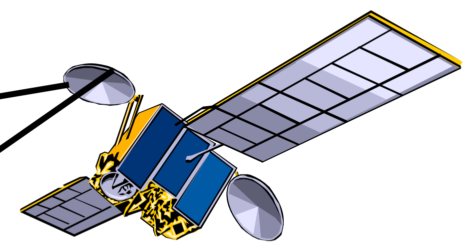
Strengths & Weakness of Broadband Satellite Interactive Services

- **Pros:**
  - wide coverage and fast network deployment
  - do not require expensive terrestrial infrastructures: ideal to cover rural areas or developing Countries
- **Cons:**
  - satellite capacity impacts today on the service cost for 30% - 50%
  - Terrestrial ADSL cost is falling sharply

Requirements for new generation Broadband Satellite Interactive Services

- **COST SAVING through a cocktail of technologies: DVB-S2 (Improved FEC and ACM), Multispot coverage, DVB-RCS interactive channel**





The satellite energy is concentrated towards the spot where each user lives

- unicast capacity is in principle multiplied by N for a given TX power

Fast Internet Services

Example of DVB-S2 space segment cost and ADSL

National Ka-band Spot-beam, BW=72 MHz

Transponder cost : around 2.6 M€/year

IP traffic: 8% peak active users; guaranteed capacity:100 kbps

DVB-S $\dfrac{2.6 \text{ M€ / year}}{8500 \text{ users}}$ = 306 €/year (<u>satellite capacity only</u>)

DVB-S2 $\dfrac{2.6 \text{ M€ / year}}{22000 \text{ users}}$ = 118 €/year (<u>satellite capacity only</u>)

ADSL (flat) = 200-250 €/year (in Italy , 2006, <u>full service)</u>

The business case is often uncertain in developed countries
Better perspectives in large countries with low population density
Problem: availability of Ka band satellite capacity

DVB-S2
What future for IP services by satellite?

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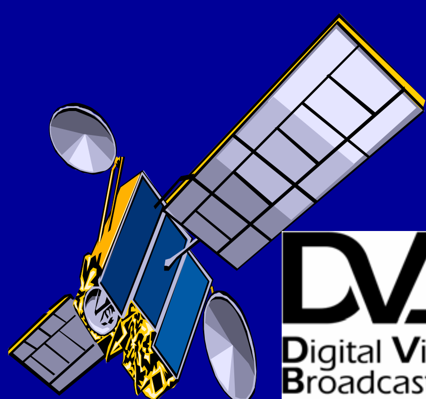
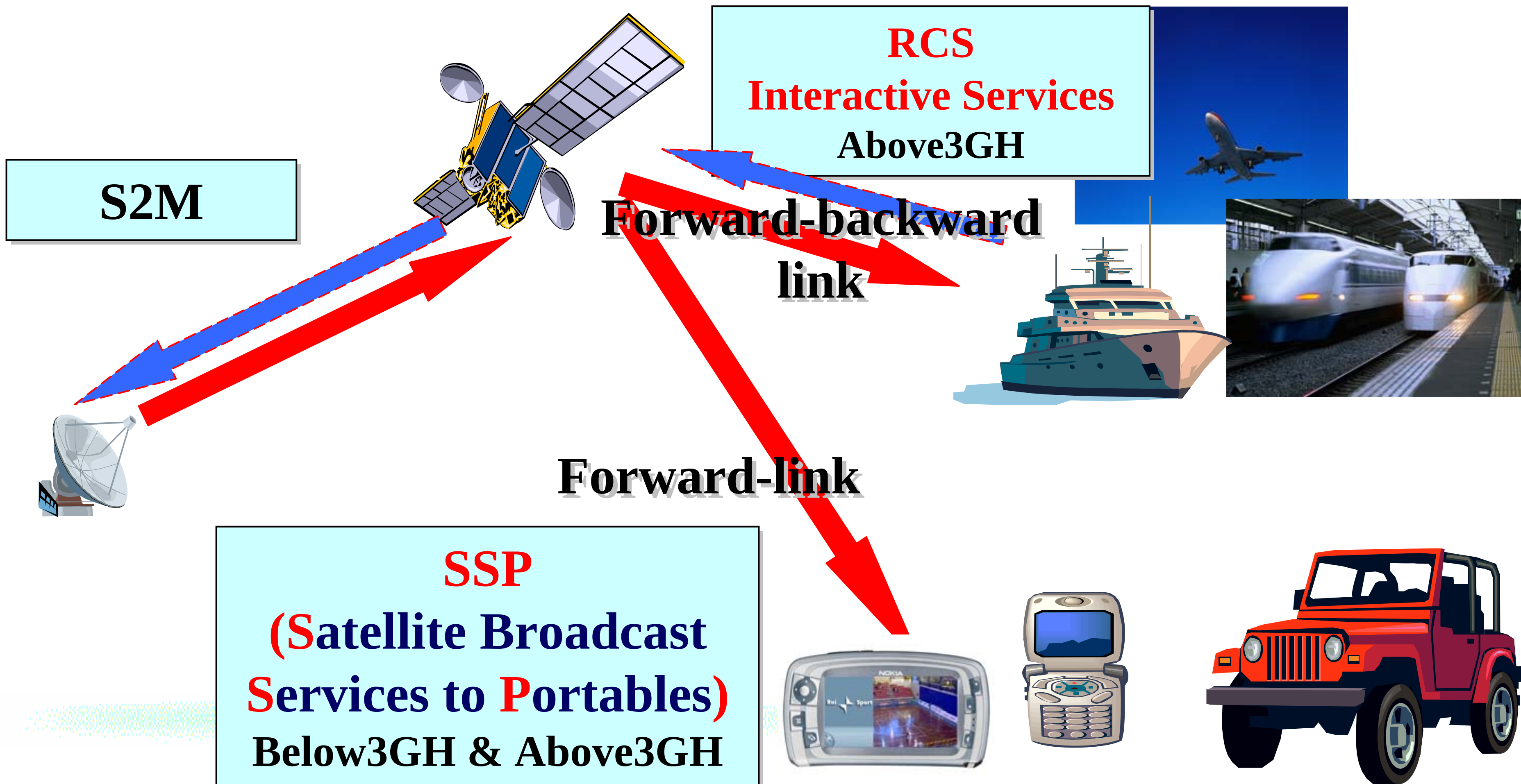
- **S2 and Mobility**



Digital Video Broadcasting

DVB-S2 in hybrid mobile satellite/terrestrial networks



S2 and Mobility

Why S2 system should be in the family of SSP and RCS technologies for mobile reception (satellite path)?

- In case of single-carrier-per-transponder, a "quasi-constant-envelope" signal shows about >2 dB gain against an OFDM signal (cons: cannot be re-used on the terrestrial path in SFN)
- S2 is a state-of-art system by satellite (FEC, Variable coding and modulation, flexibility)

S2 mobility tools will be specified by DVB before Autumn - Winter 2006

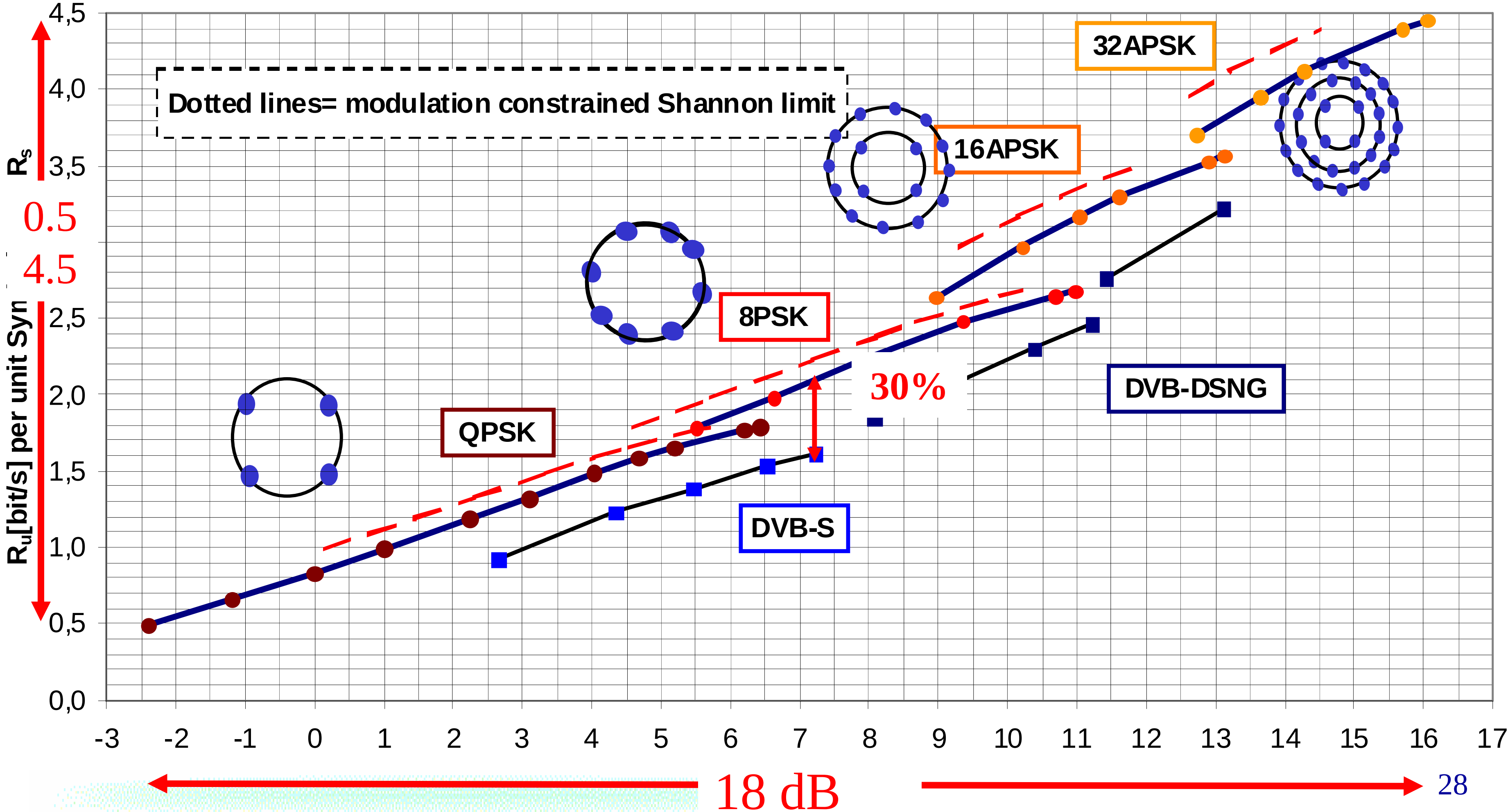
Conclusions

- DVB-S2, the new DVB system for broadband satellite applications, offers **powerful tools for interactive services**
- **Large Countries,** with difficulty to bring terrestrial Internet infrastructures everywhere, may rapidly set-up a fast Internet infrastructure at reasonable operational costs
- A recent commercial study forecasts revenues for 1.3 Billion US$ in 2005-2009 by DVB-S2 equipment (**70% for Interactive services**)
- Mobility is the next frontier for interactive services based on S2

Thank you for your attention

Capacity & C/N requirements
The Transmission modes

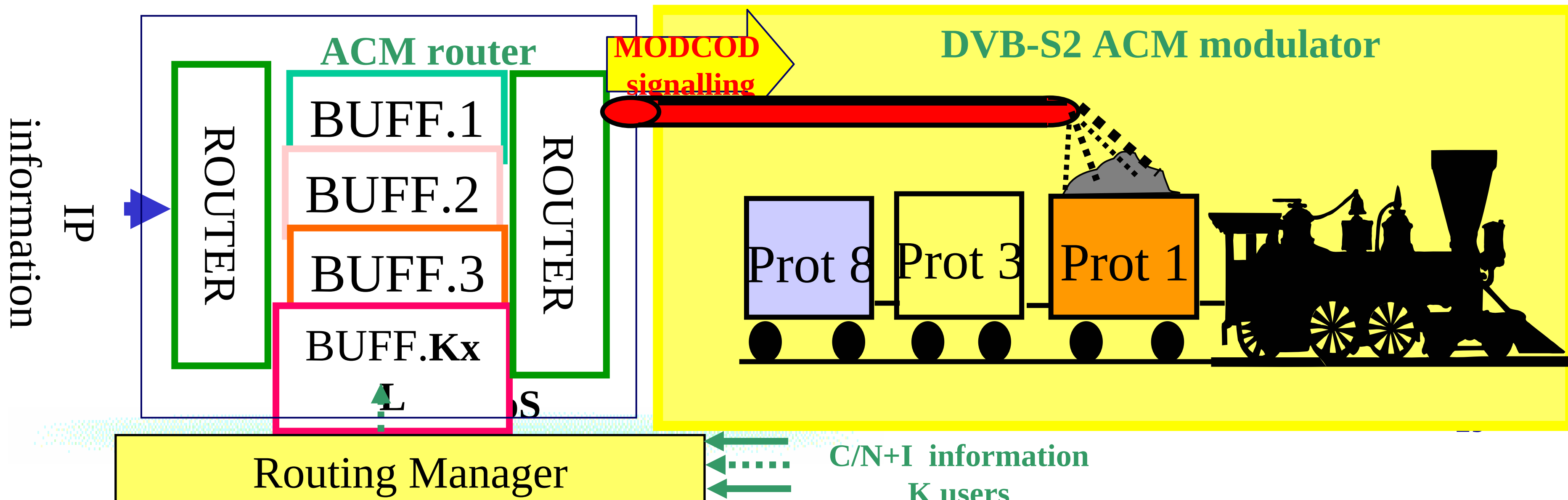
Spectrum efficiency versus required C/N on AWGN channel



Adaptive Coding & Modulation
Fast Internet Services

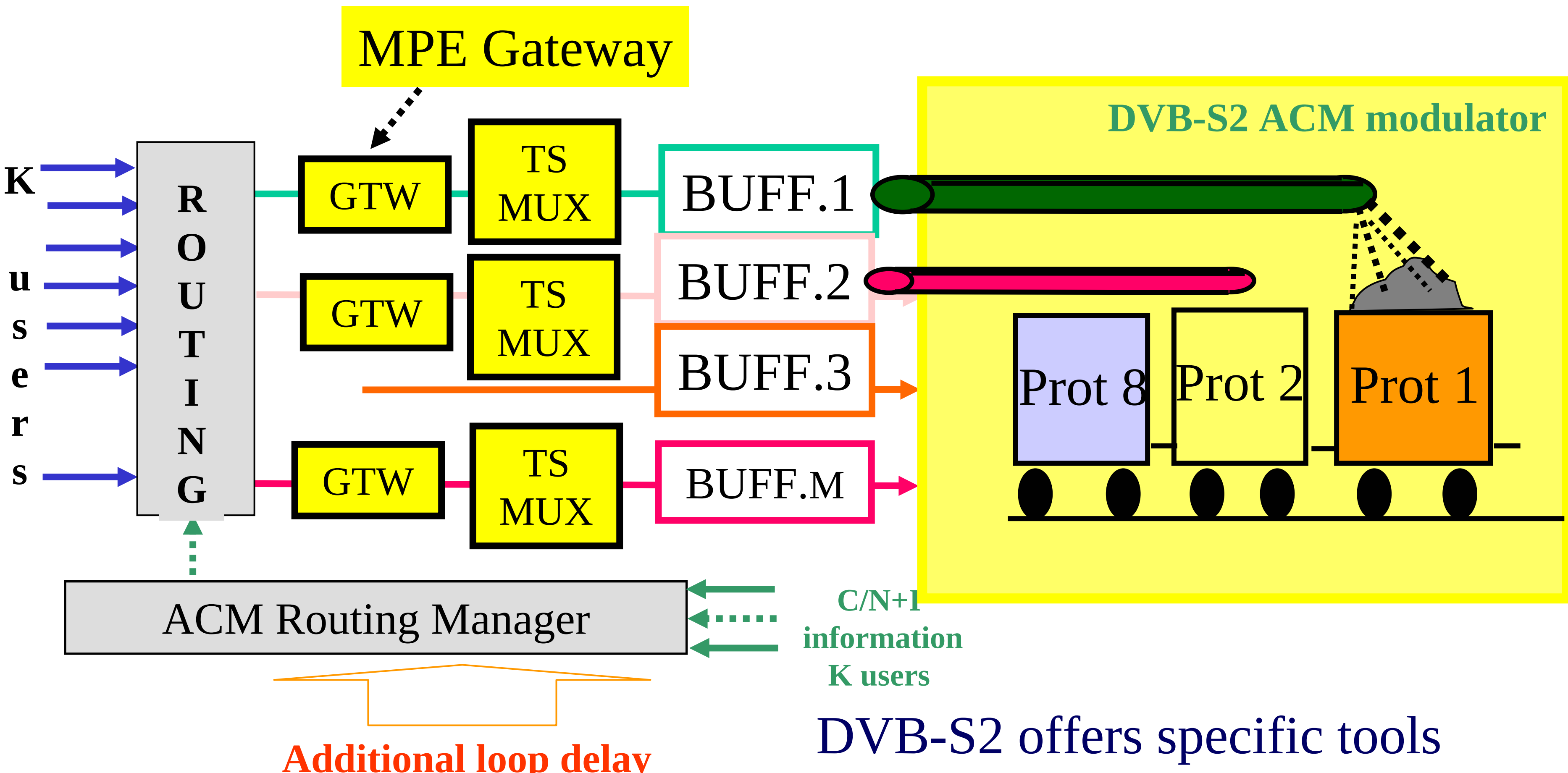
IP over generic streams

- IP traffic is split in different buffers according to required protection, priority...
- A router loads users' data on the "train wagons", according to the required protection . A wagon may be loaded by traffic from different users. TM-GBS is developing a new IP encapsulation protocol (GSE)
- The train composition (% of low-protected and high-protected wagons) may change in time, according to the traffic needs



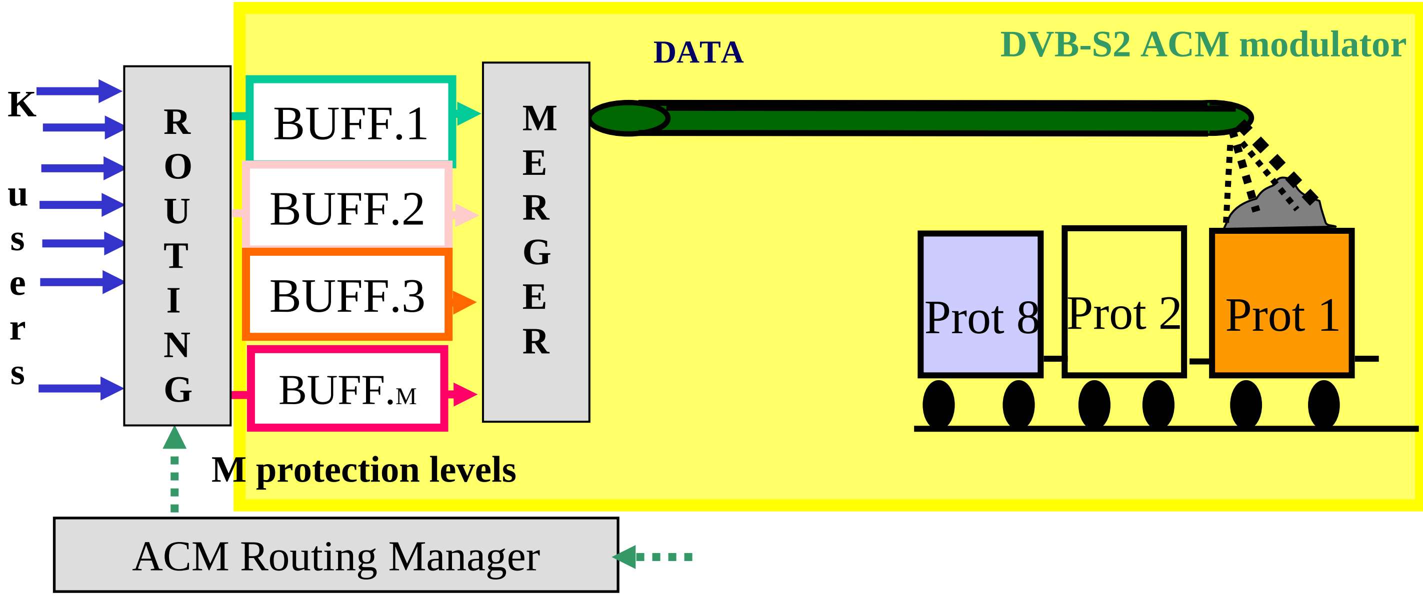
Adaptive Coding & Modulation
Fast Internet Services

IP over MPEG TS (one TS per protection level)



DVB-S2 offers specific tools
For Transport Stream delivery over ACM

Adaptive Coding & Modulation
Fast Internet Services



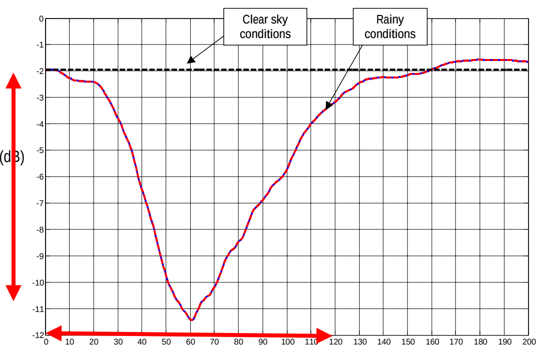
- Routing policy has an impact on the dynamic performance (throughput/delay characteristic):
- Under system overload, round-robin policy (basic S2 option) assigns the S2 time resources:
  - 1/2 to QPSK, 1/3 to 8PSK, 1/4 to 16APSK, 1/5 to 32APSK
- A **weighted** round robin policy may reduce resources to users under fading conditions, thus improving the system throughput

Source: esa

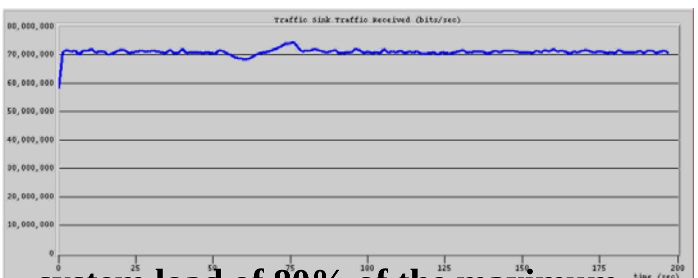
- Dynamic performance under fading conditions
- (throughput / delay)

Simulation assumption:

- No IP packet loss via an infinite input buffer
- Round robin policy

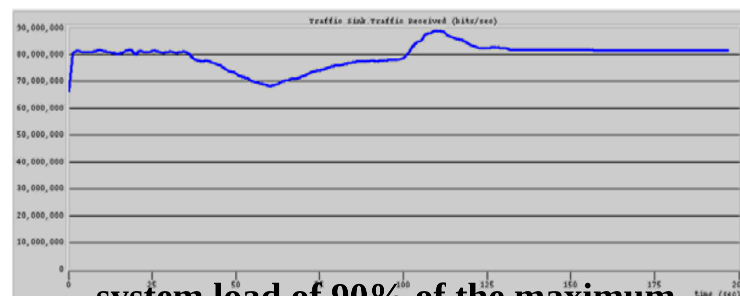


9 dB Rain attenuation peak at Ka band

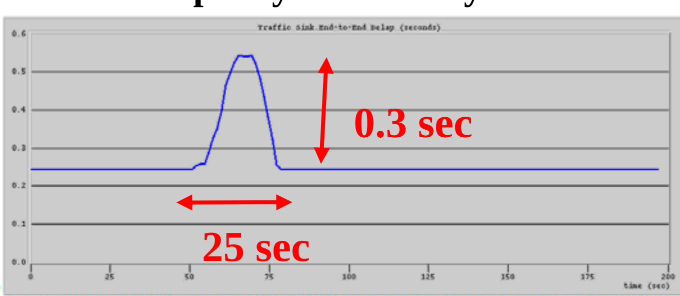


system load of 80% of the maximum capacity in clear sky

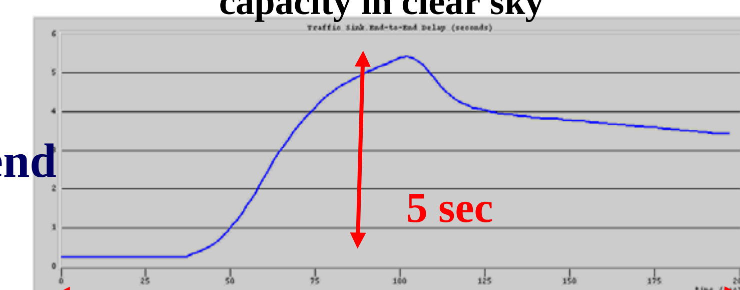
System throughput



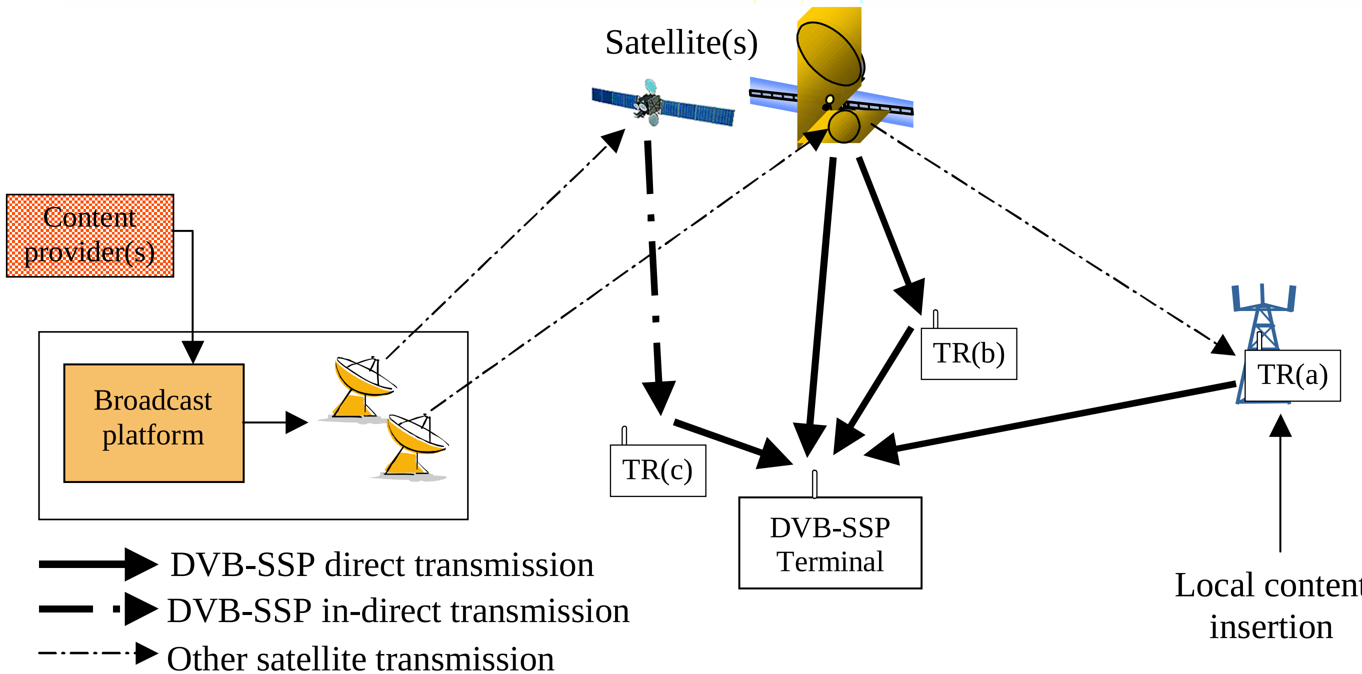
system load of 90% of the maximum capacity in clear sky



System end-to-end delay



The SSP scenario: hybrid satellite – terrestrial networks to serve mobile terminals



TR(a): Terrestrial repeater collocated with mobile cell site or standalone providing local content insertion
TR(b): Terrestrial Repeater providing local on-frequency re-transmission
TR(c): Terrestrial Repeater providing local translation of DVB-SSP in-direct transmission signal to DVB-SSP direct transmission signal

DVB-S2 is focusing on the satellite path only