



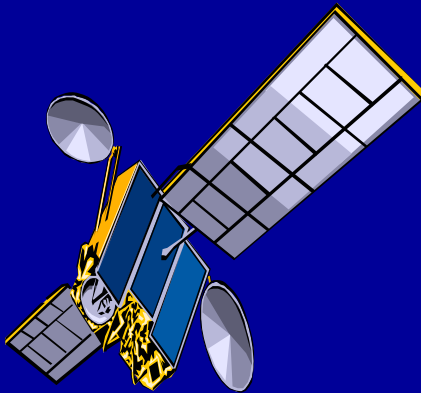
DVB
Digital Video
Broadcasting

DVB-S2
EN 302 307

What future for IP services by satellite?

Alberto Morello
Chairman DVB-S2

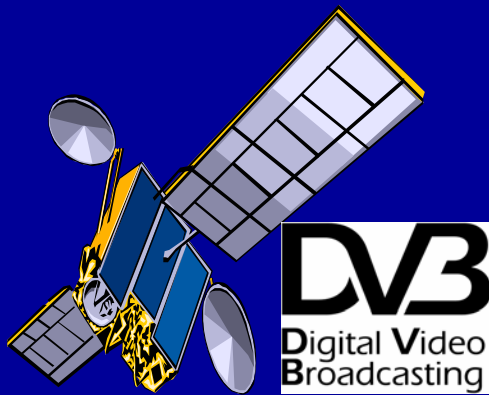
NMC SEminar
Geneva June 2006



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

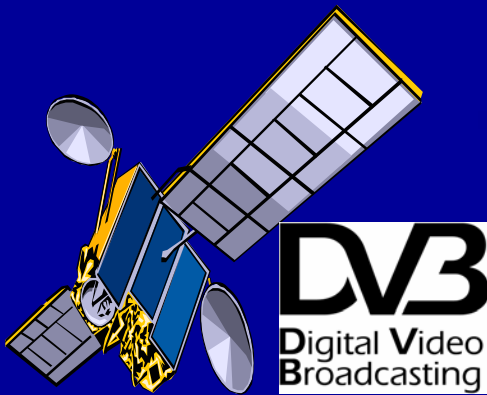


DVB-S2

What future for IP services by satellite?

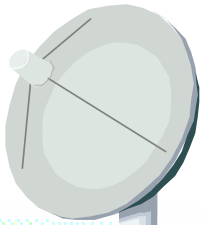
○ Application scenarios

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

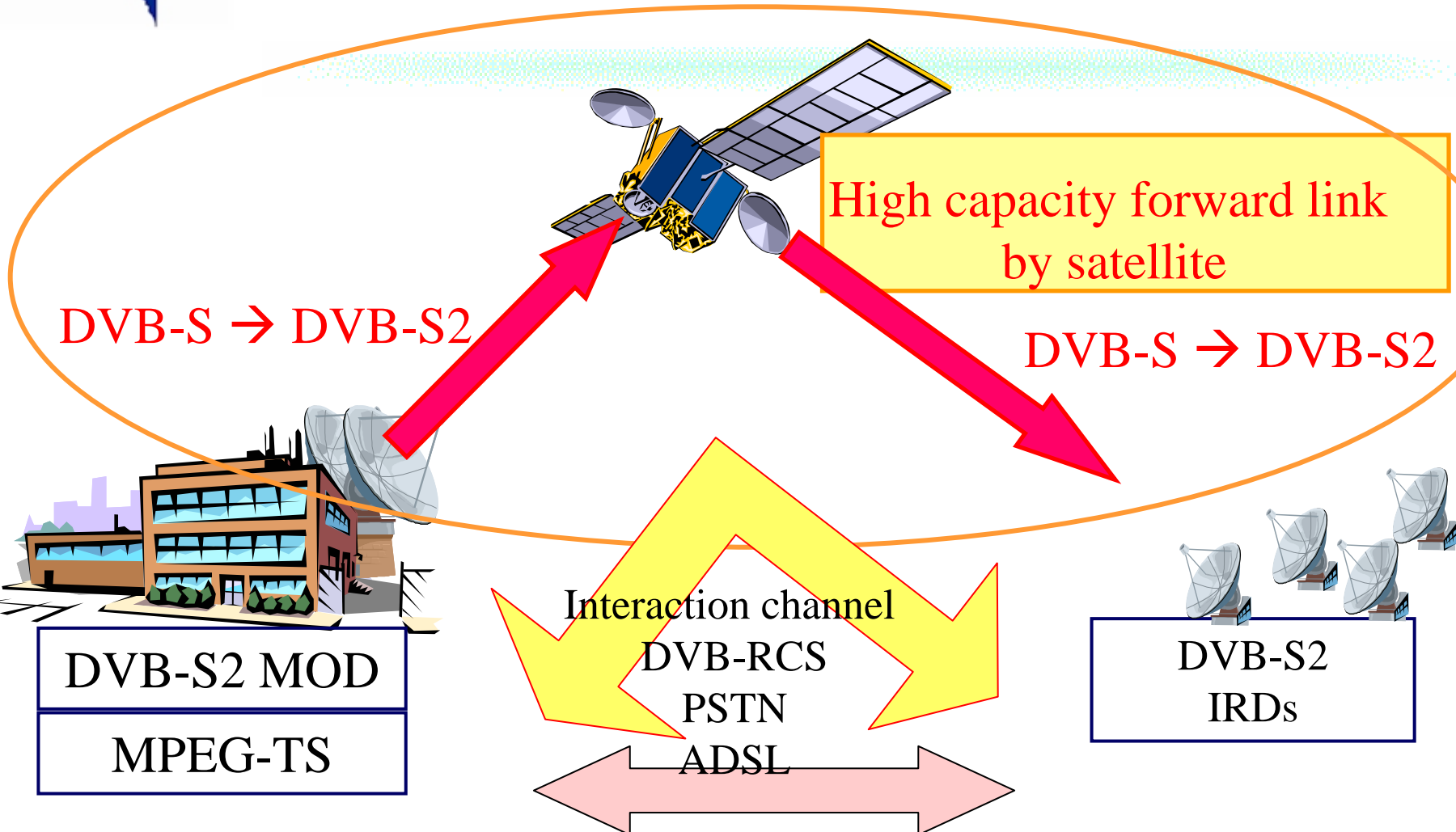


○ professional systems (DSNG, Internet trunking, cable feeds, ...)





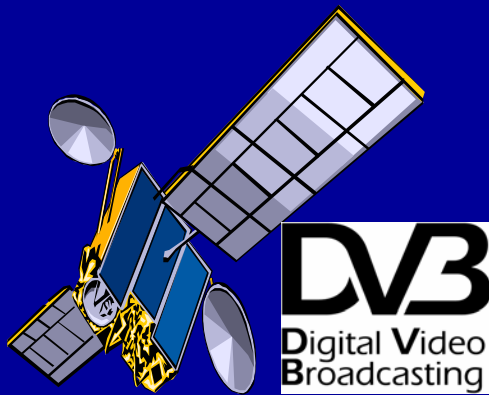
DVB-S2 in the DVB chain



DVB-S2

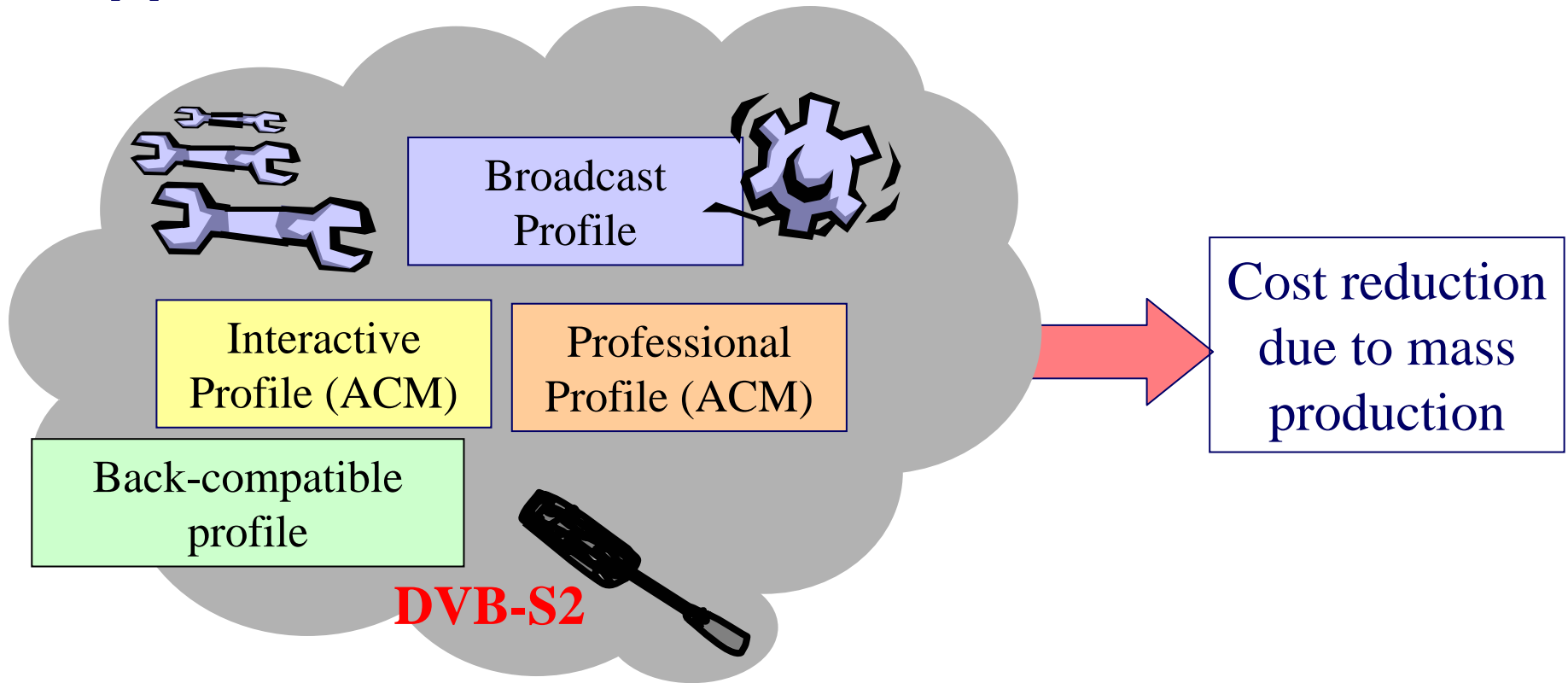
What future for IP services by satellite?

- 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



The tool-kit approach

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



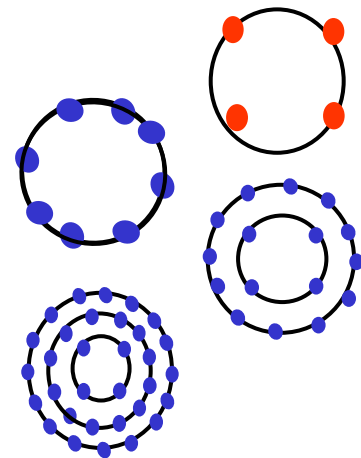
LDPC codes concatenated with BCH

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

0	QPSK	(2 bit/s/Hz)
0	8PSK	(3 bit/s/Hz)
0	16APSK	(4 bit/s/Hz): 4-12-APSK
0	32APSK	(5 bit/s/Hz): 4-12-16 APSK

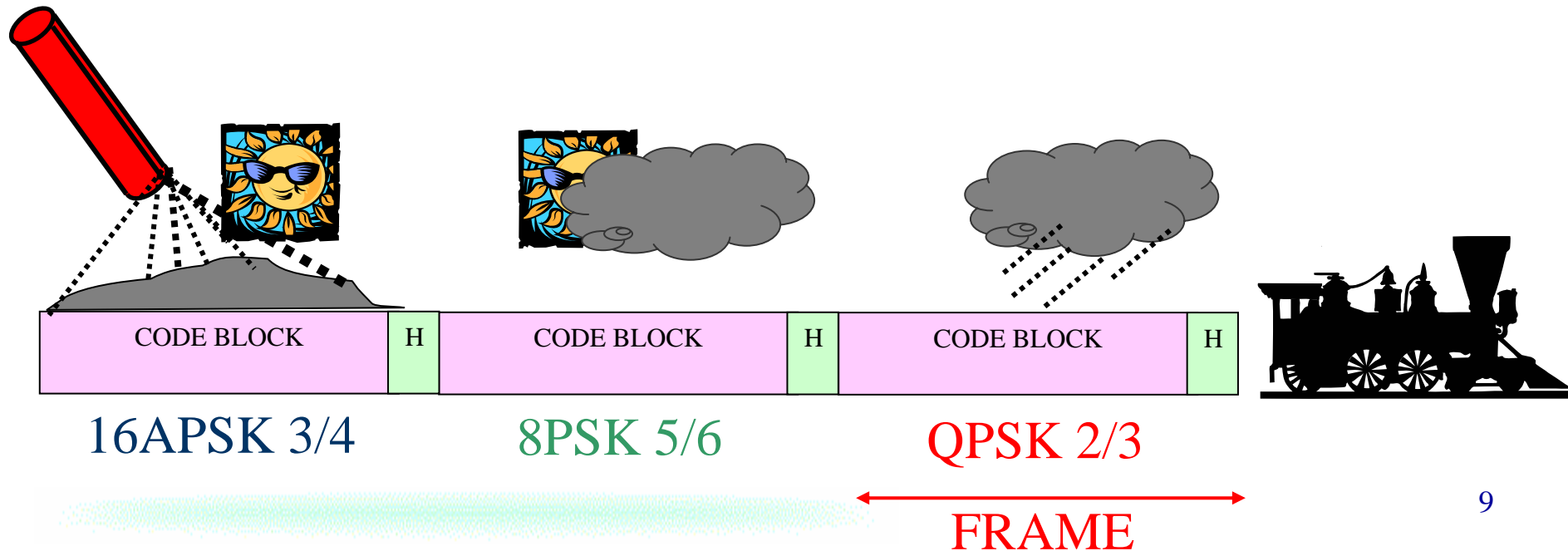




Adaptive Coding and Modulation

Framing: the "train"

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





In summary

- o DVB-S2 compared with DVB-S:
 - o 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:

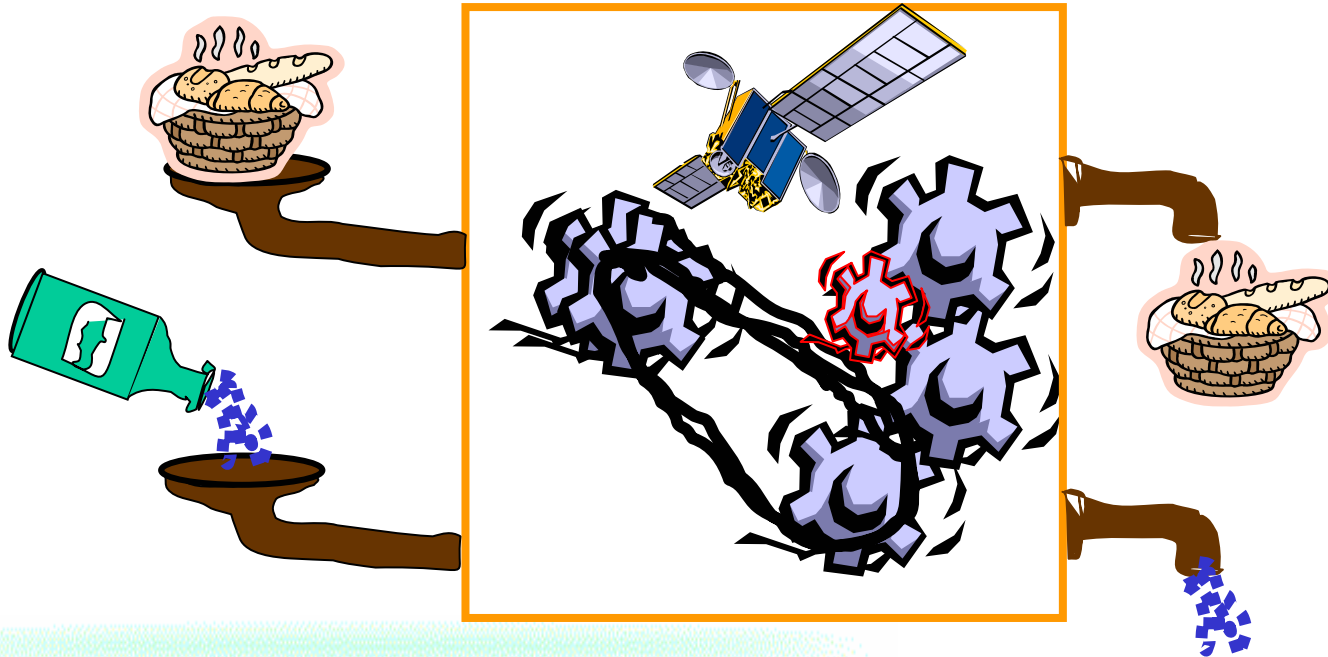
- Spectrum efficiencies from 0.5 to 4.5 bit/s/Hz
- C/N range from -2 to +16 dB (AWGN)

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

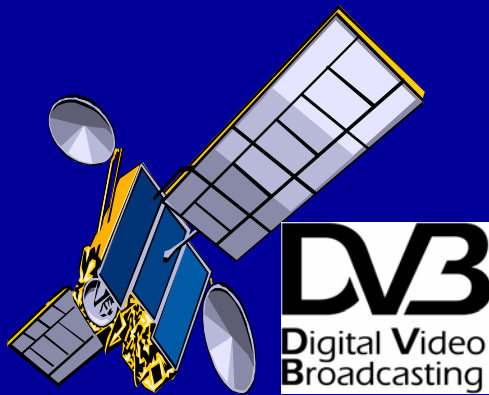
- o DVB-S2 may transport **single or multiple input streams**:
 - o MPEG-TS format
 - o generic format (e.g. IP,...)
- o Suitable for MPEG-2 TV and HDTV as well as for the new coding systems (e.g. H264/AVC, VC1)
- o Each stream may be protected in a different way



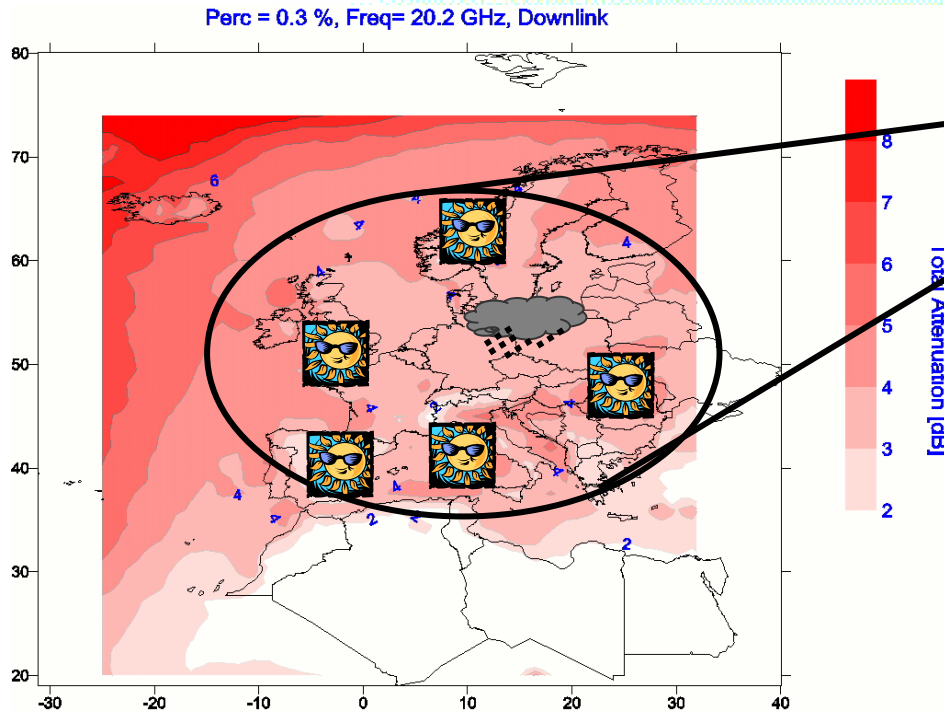
DVB-S2

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



Adaptive Coding and Modulation Unicasting versus Broadcasting

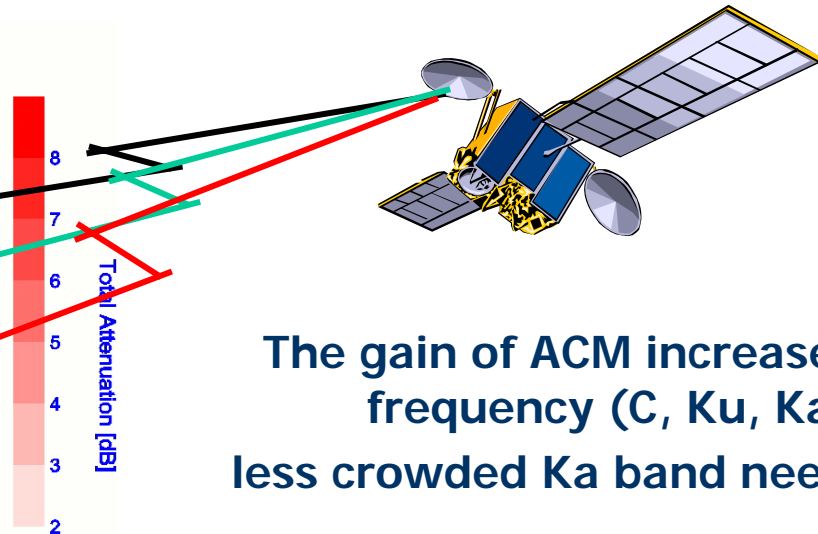
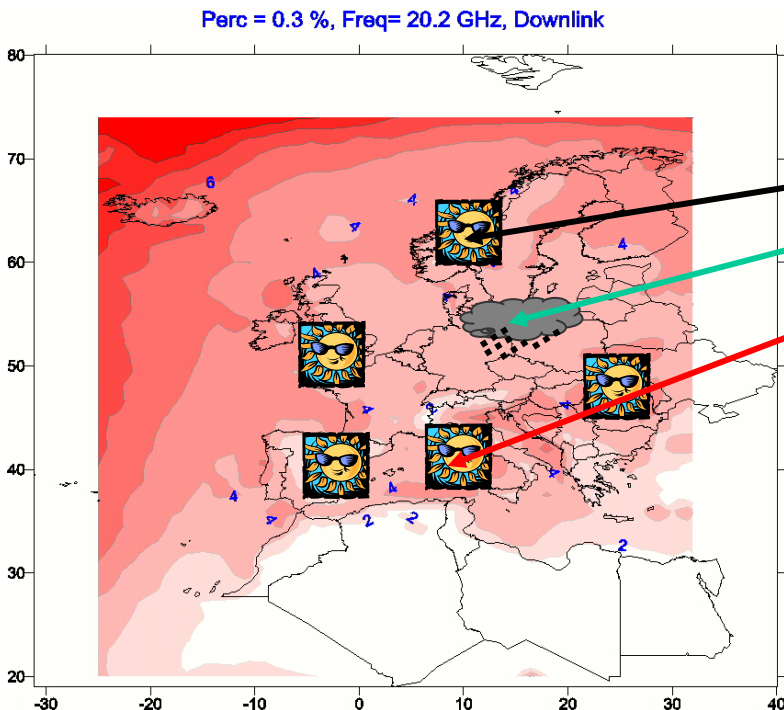


Large C/N margins for a large percentage of time (typically 4-6 dB in Ku band)

- 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

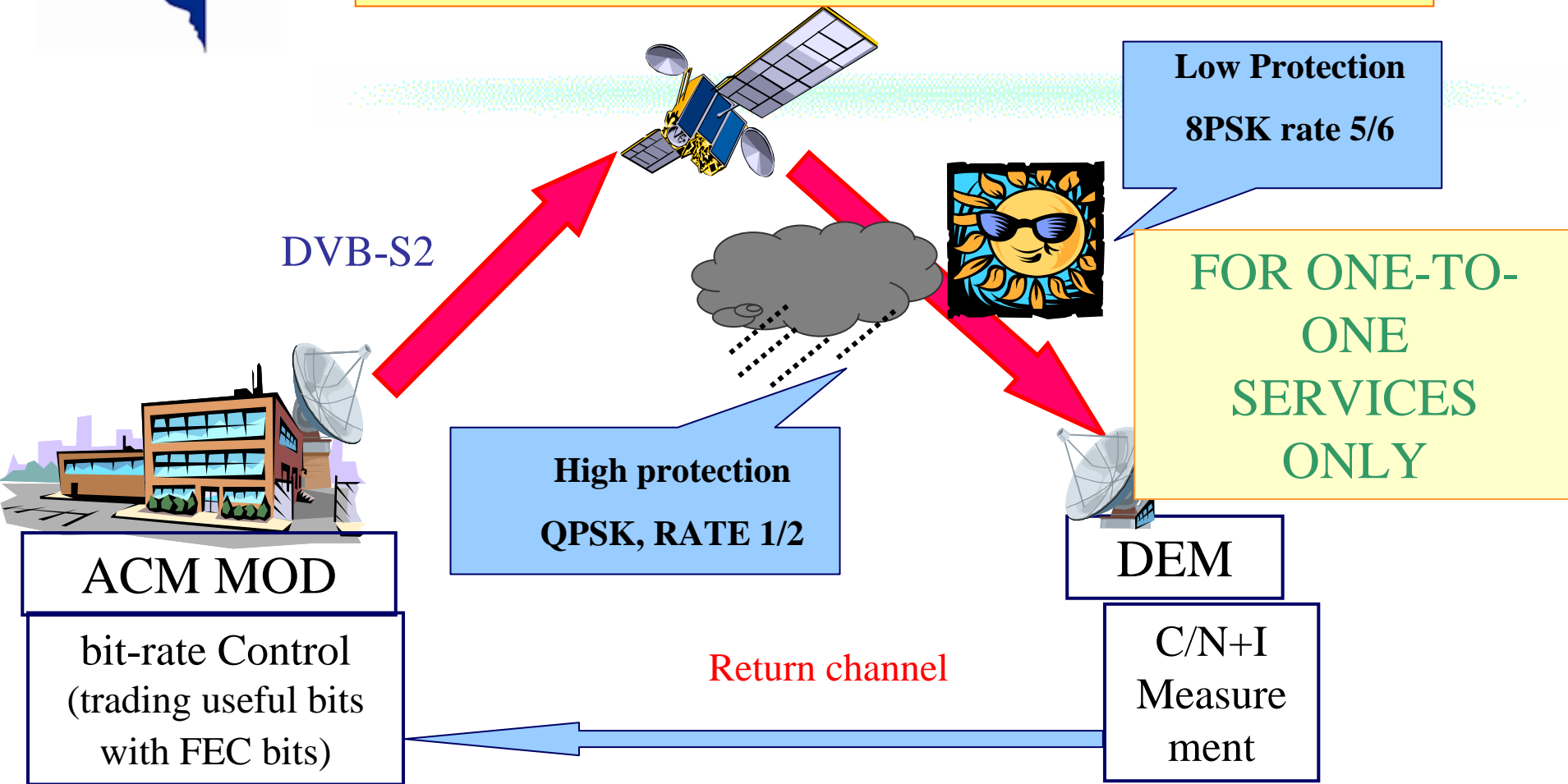
- The **DVB-S2 ACM technology** allows **FEC/modulation adaptation according to the propagation conditions** (rain/clear sky, beam centre or beam contour,)
- **each user** may operate with **very low C/N margins**, thus maximising the satellite throughput



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

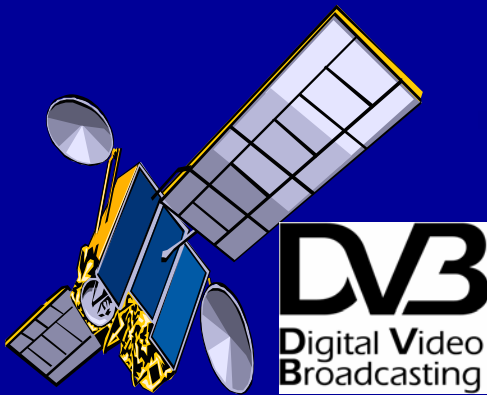
Potential ACM gain (ESA source): bit-rate x 2 in Ka band (Europe)

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

DVB-S2

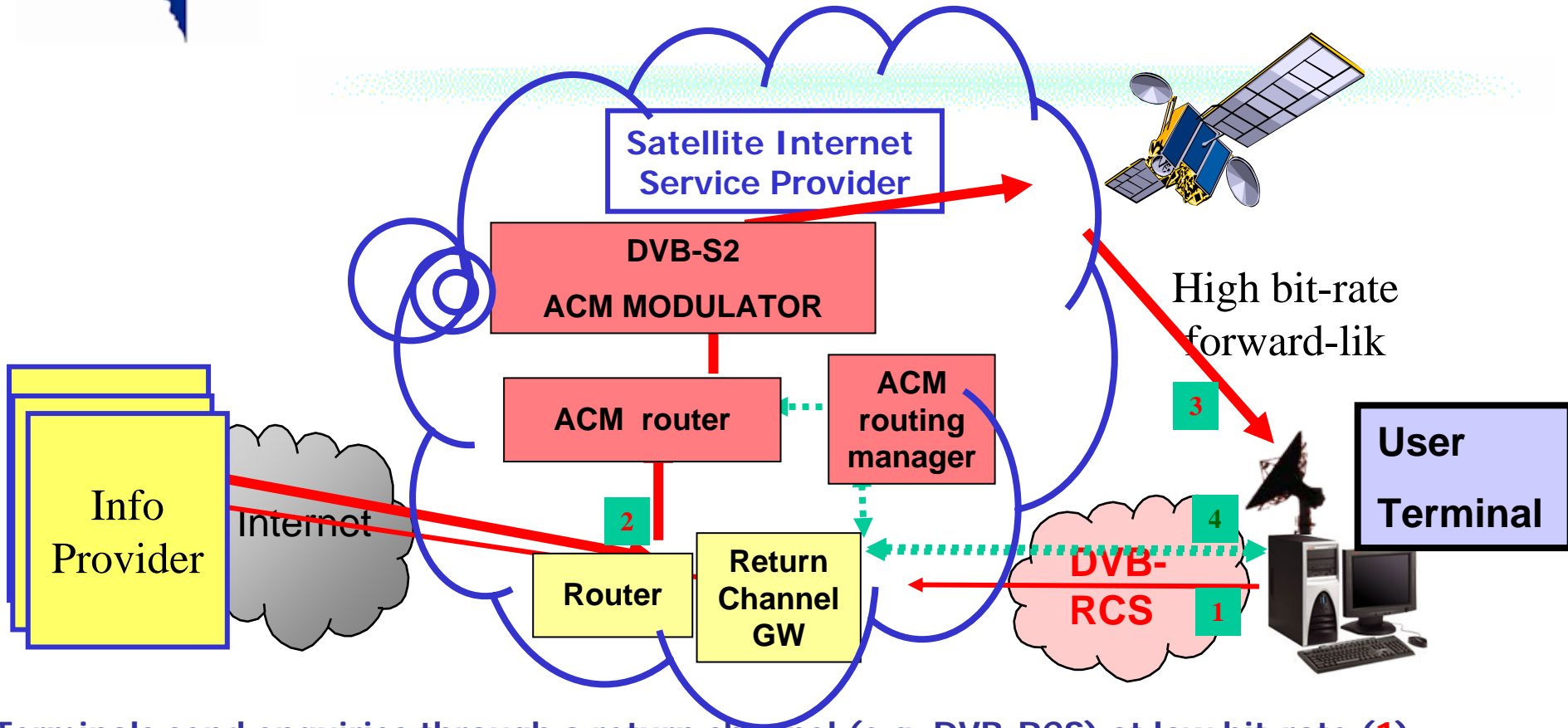
What future for IP services by satellite?

- 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)



ACM & Fast-Internet Network architectures

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:

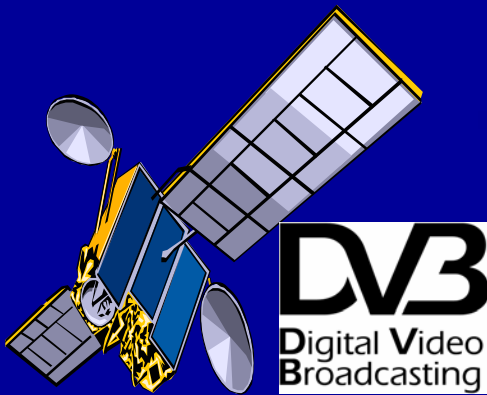
- Protection Level of the ACM,
- maximum delay (priority routing)
- minimum reserved bandwidth

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





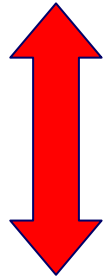
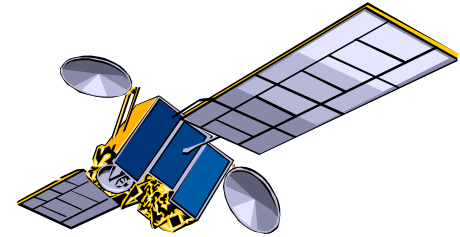
Strengths & Weakness of Broadband Satellite Interactive Services

○ Pros:

- wide coverage and fast network deployment
- do not require expensive terrestrial infrastructures: ideal to cover rural areas or developing Countries

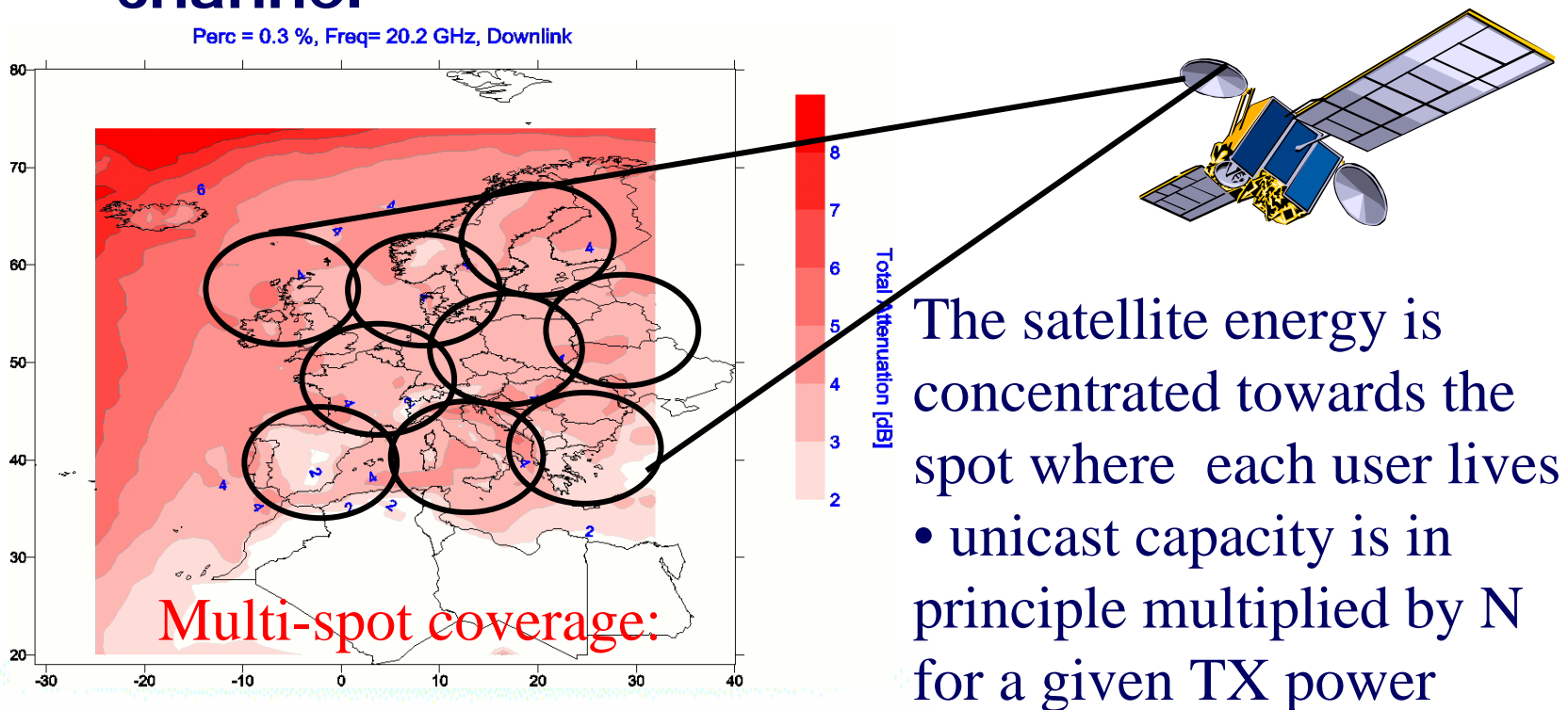
○ Cons:

- satellite capacity impacts today on the service cost for 30% - 50%
- Terrestrial ADSL cost is falling sharply



Rai 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





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

$$\text{DVB-S} \quad \frac{2.6 \text{ M€ / year}}{8500 \text{ users}} = 306 \text{ €/year (satellite capacity only)}$$

$$\text{DVB-S2} \quad \frac{2.6 \text{ M€ / year}}{22000 \text{ users}} = 118 \text{ €/year (satellite capacity only)}$$

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

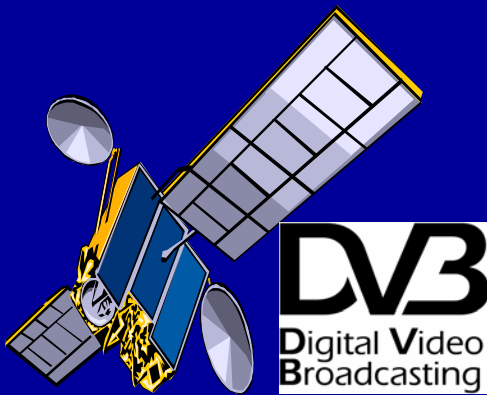
**The business case is often uncertain in developed countries
Better perspectives in large countries with low population density**

Problem: availability of Ka band satellite capacity

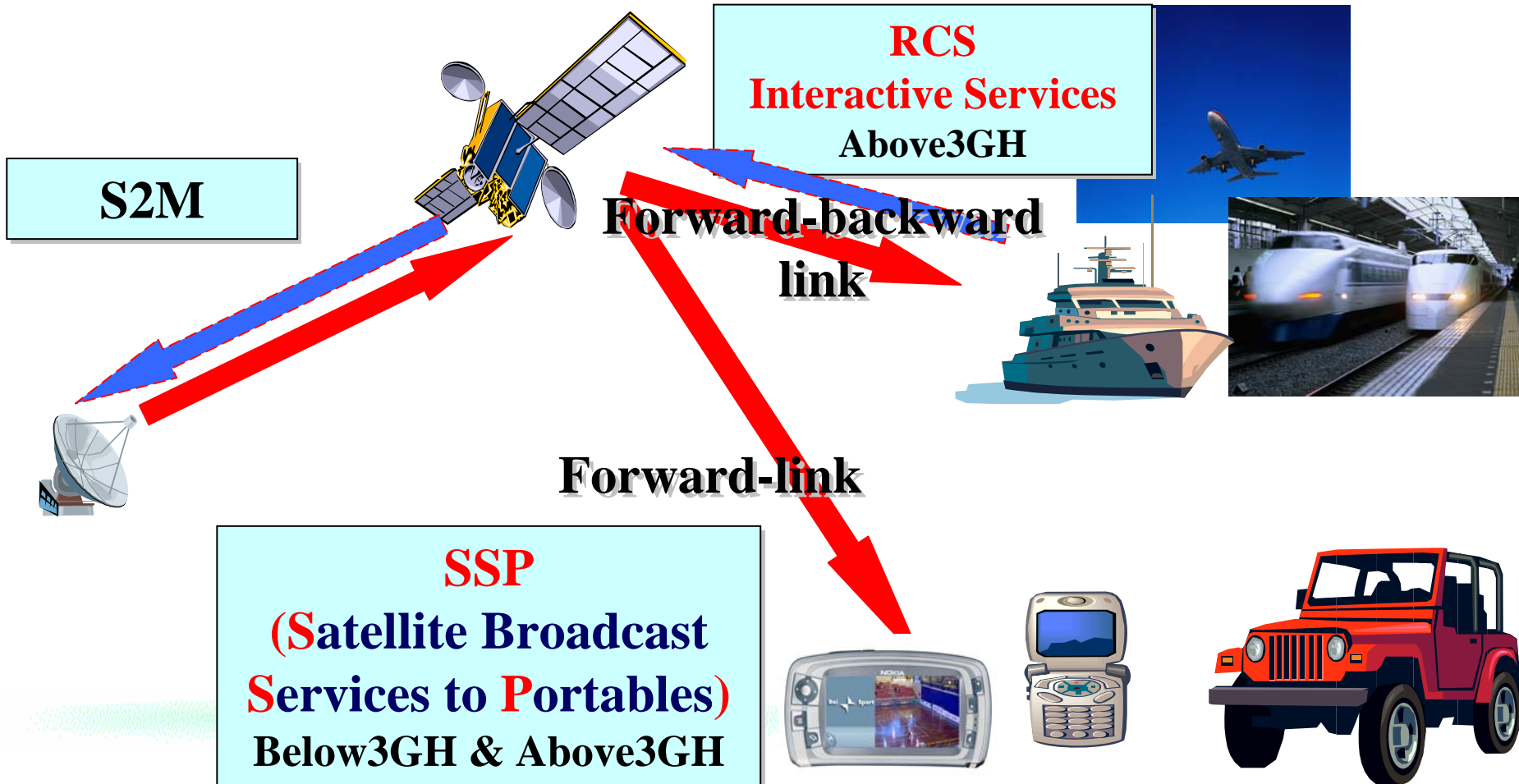
DVB-S2

What future for IP services by satellite?

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- Cost savings on the satellite segment
- **S2 and Mobility**



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

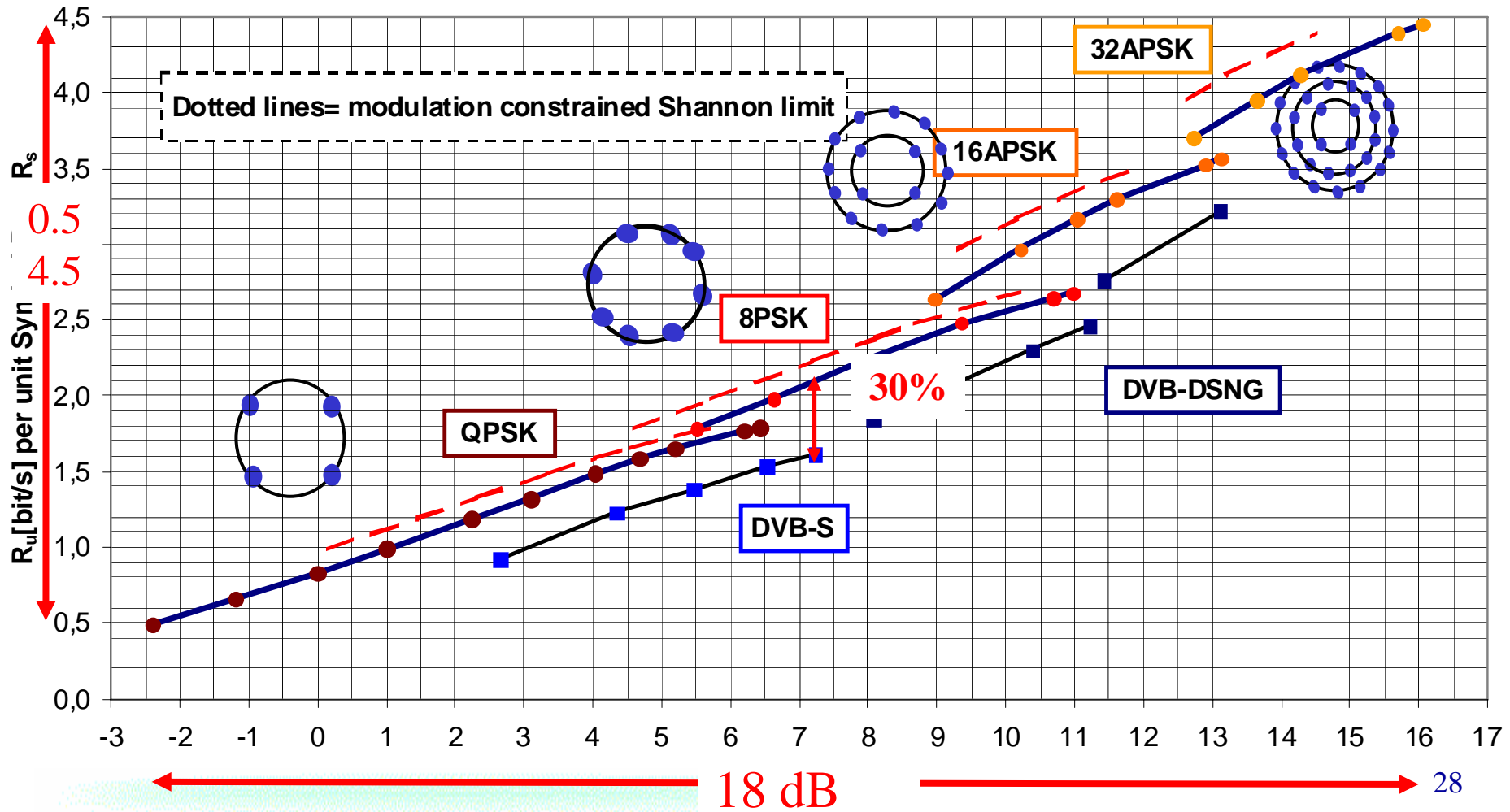


Thank you for your attention



Capacity & C/N requirements The Transmission modes

Spectrum efficiency versus required C/N on AWGN channel



← 18 dB → 28 →

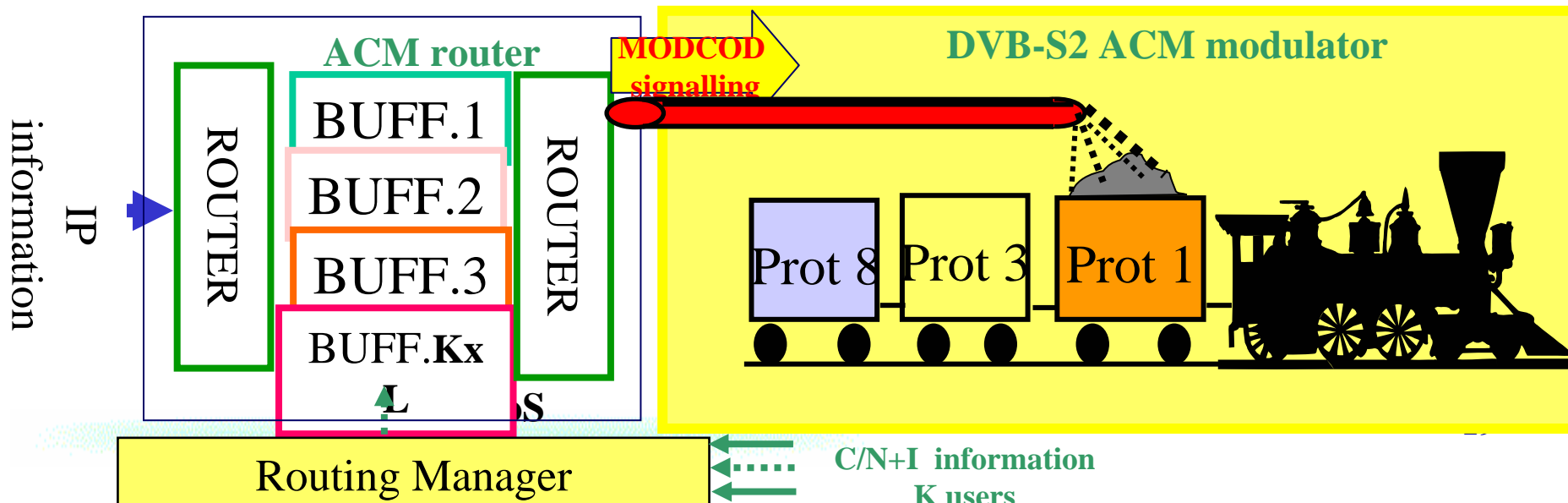


Adaptive Coding & Modulation

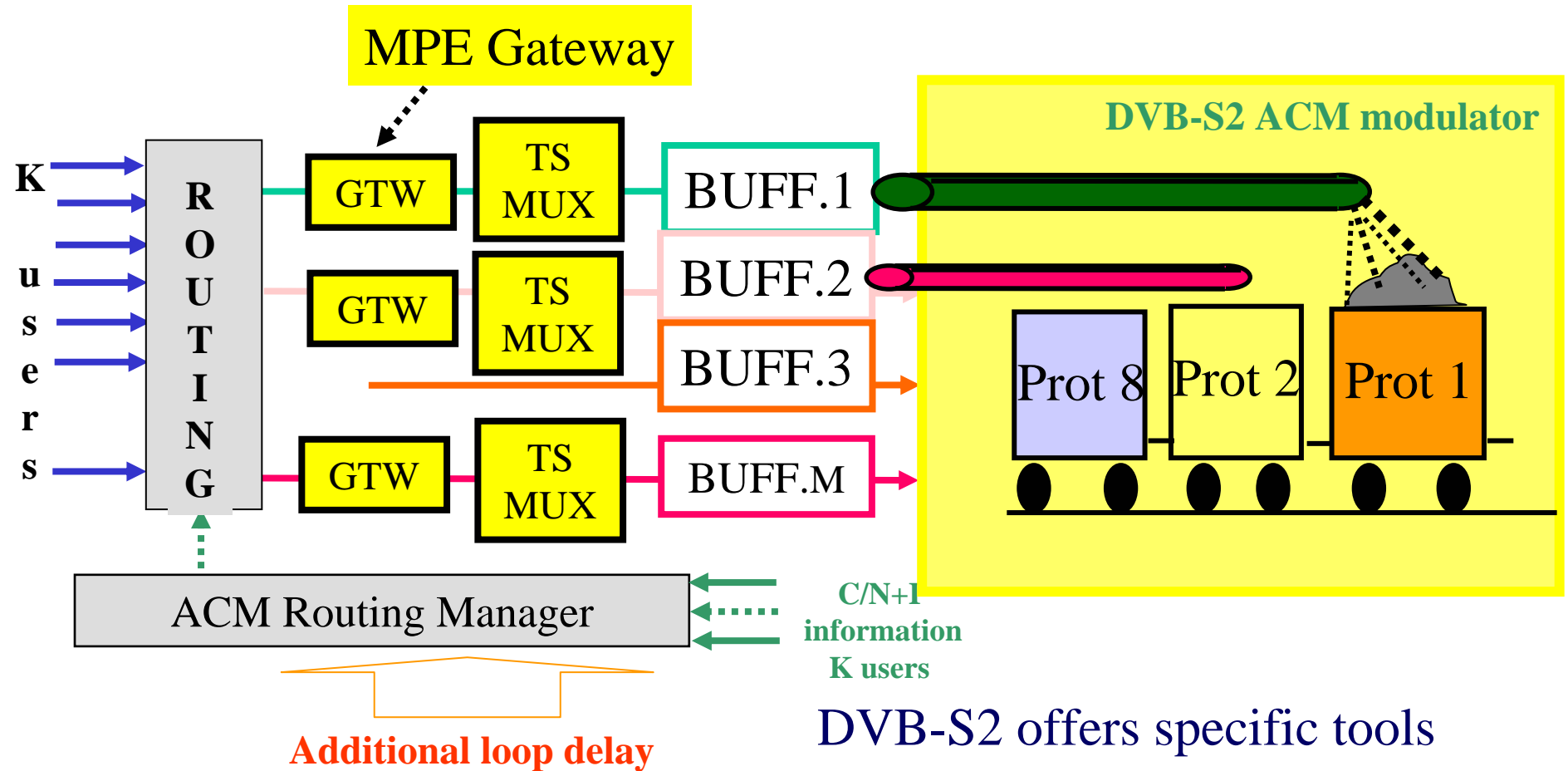
Fast Internet Services

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

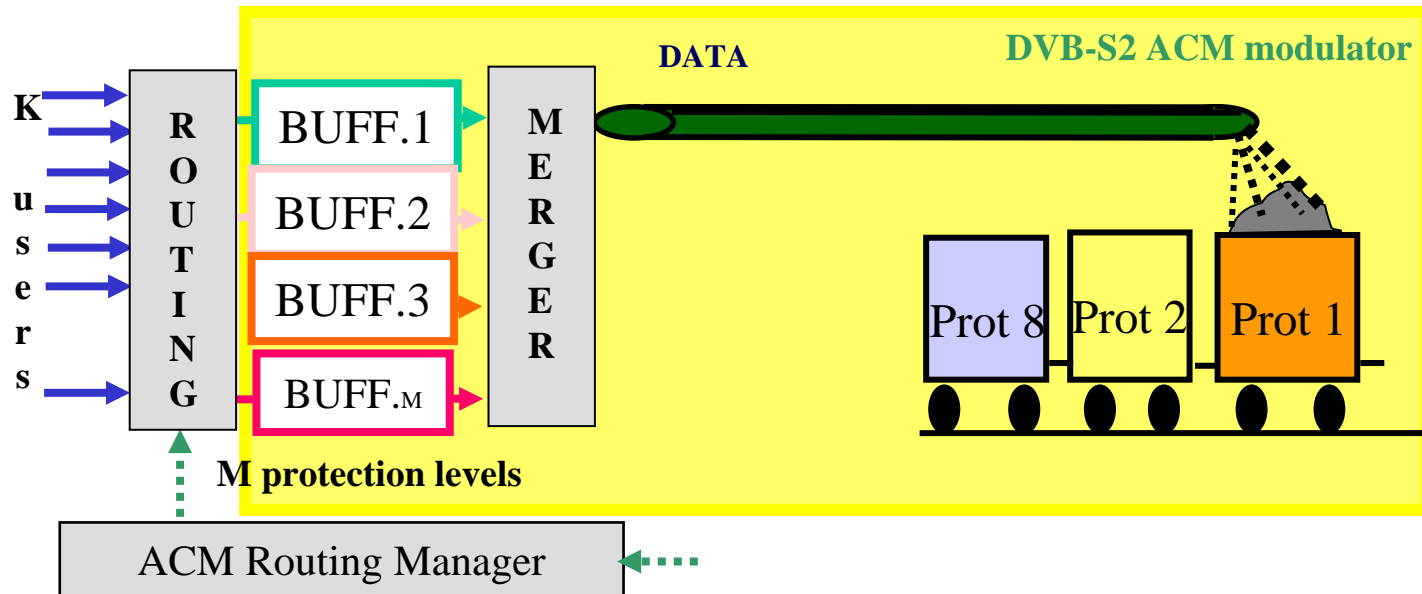


IP over MPEG TS (one TS per protection level)



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



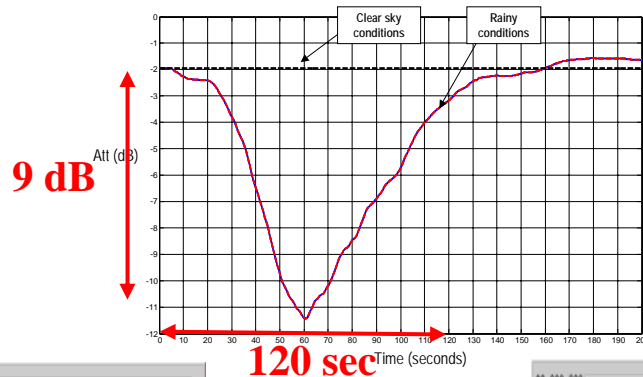
Source: esa



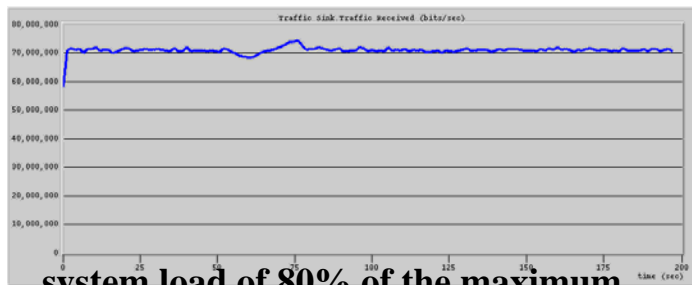
- Dynamic performance under fading conditions
- (throughput / delay)

Simulation assumption:

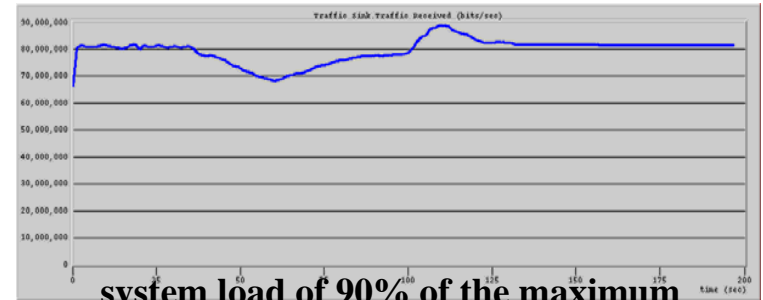
- No IP packet loss via an infinite input buffer
- Round robin policy



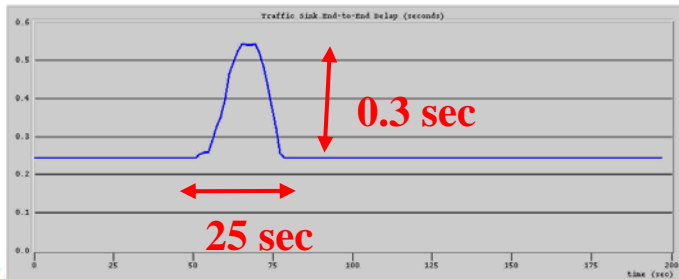
9 dB Rain attenuation peak at Ka band



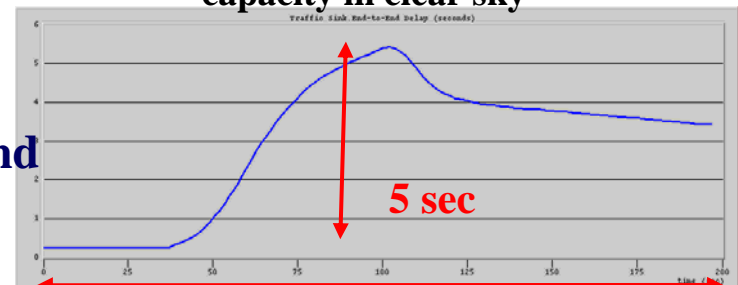
system load of 80% of the maximum capacity in clear sky



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

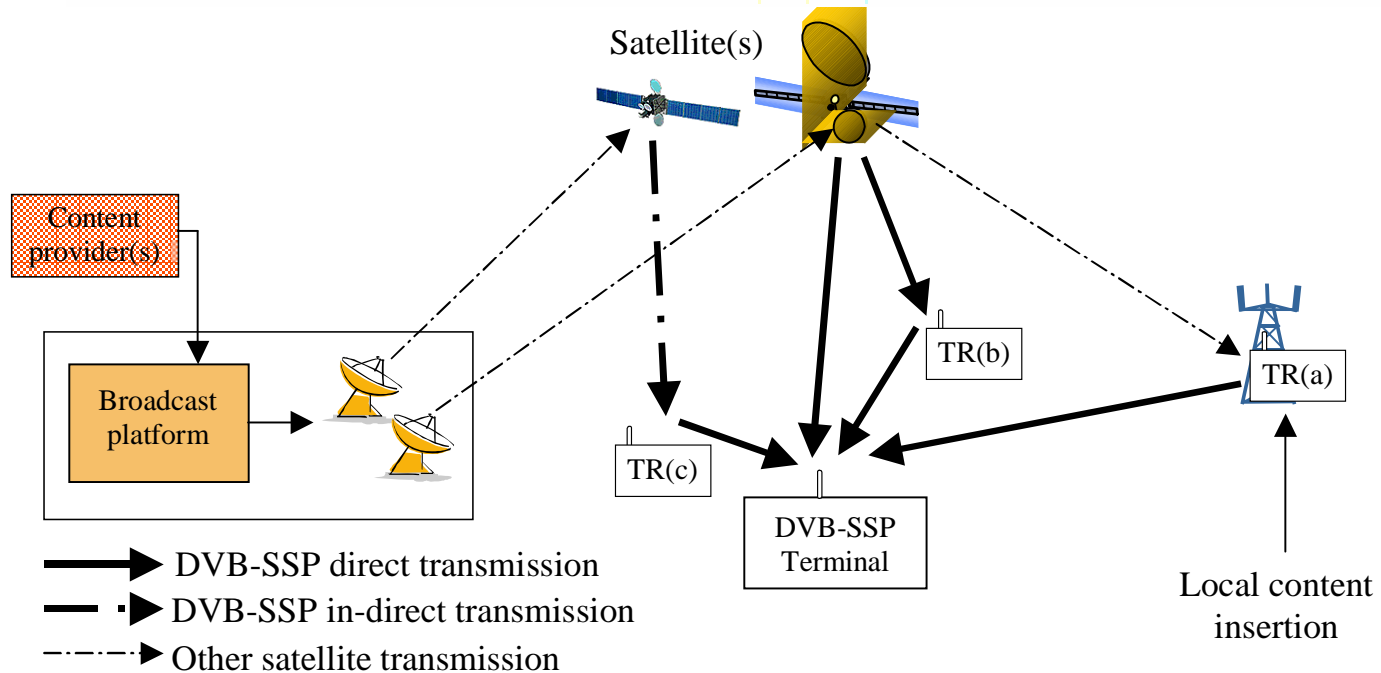


System end-to-end delay



200 sec

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