VSAT SYSTEMS

VSAT (Very Small Aperture Terminals) genesis

Some innovations progressively introduced have allowed an important technological step around 1980

- Use of higher frequencies* ⇒ Smaller antennas** ⇔ Same gain
- Greater power generation on board
- Larger antennas (multibeam) on board

→ Higher EIRP from board

- Cost reduction of:
  - Earth station technology
  - Satellite capacity

Direct to user services

** **Very Small** with respect to the **very large** antennas used until then

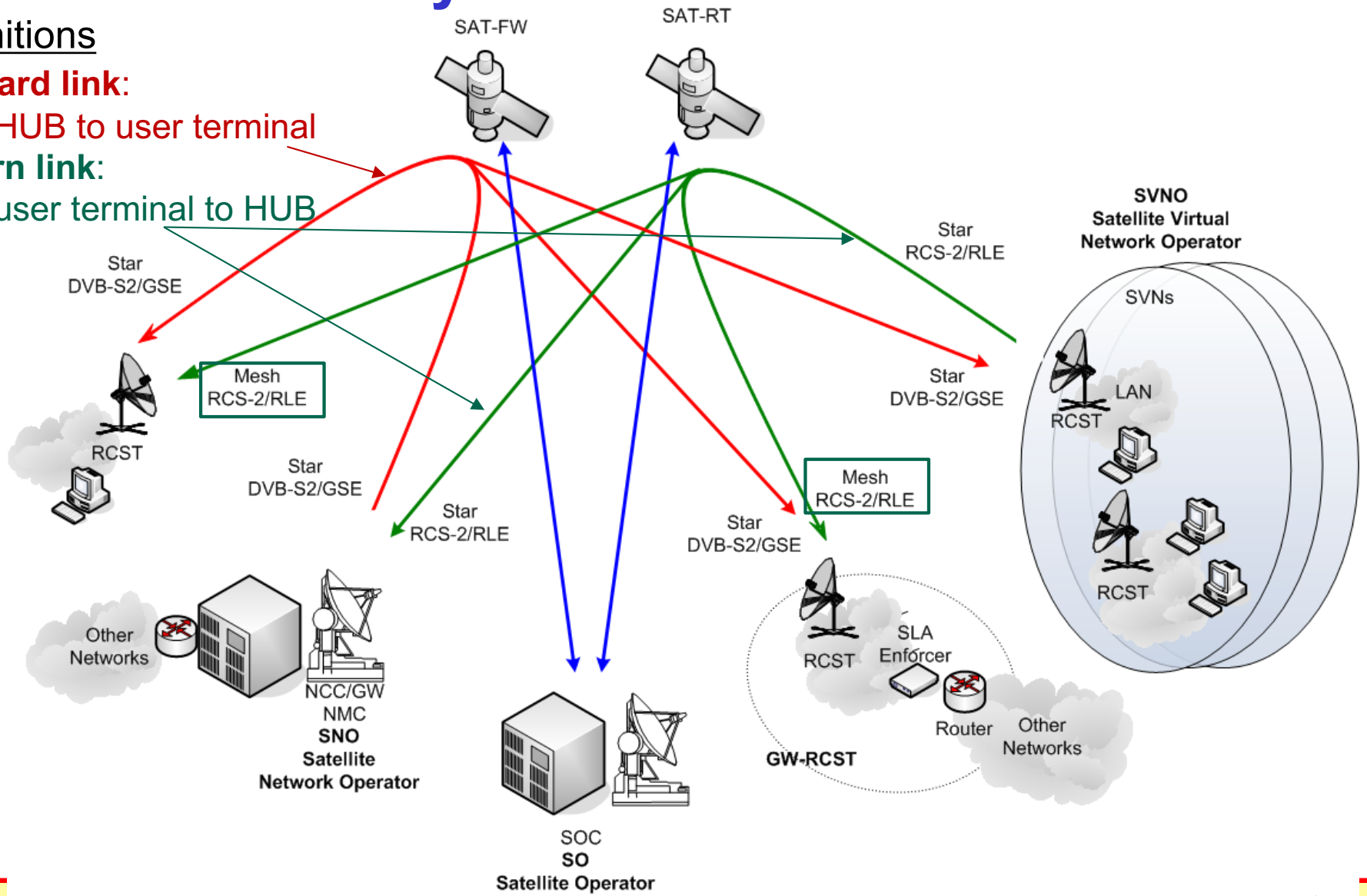
- * Higher frequencies: Ku (12-14 GHz) and since 1991 Ka (20-30 GHz)
- C band (4-6 GHz) and L band (1.5 GHz), still used, need larger antennas or it is possible to provide narrowband services

System architecture

Definitions

Forward link:
from HUB to user terminal

Return link:
from user terminal to HUB



Generalities

- VSAT = Very Small Aperture Terminal
- Antenna size in the range 0.66 m (Ka band) - 2.4 m (Ku band)
  - Small in comparison to traditional big stations for trunking services at C band
- RF power 1-4 W (no license)
- Network of small stations distributed over the coverage area
- Modem dimensions VCR like
- Low cost
- Big Gateway antenna in case of star topology (link budget)
- **Direct to user** access to satellite

Very important technological step from service point of view

- Star or mesh network topology
- VPN capability
- IP based but VSAT available before IP was deployed
- Easy to extend coverage interconnecting terrestrial tails (e.g. WiFi)
- Different standard per vendor (≈20)
- Most of the standards are
  - compliant with DVB in the forward link,
  - different in the return link
  - provide IP interface
- Fixed services
- Transportable terminals became feasible and commonly used

Applications

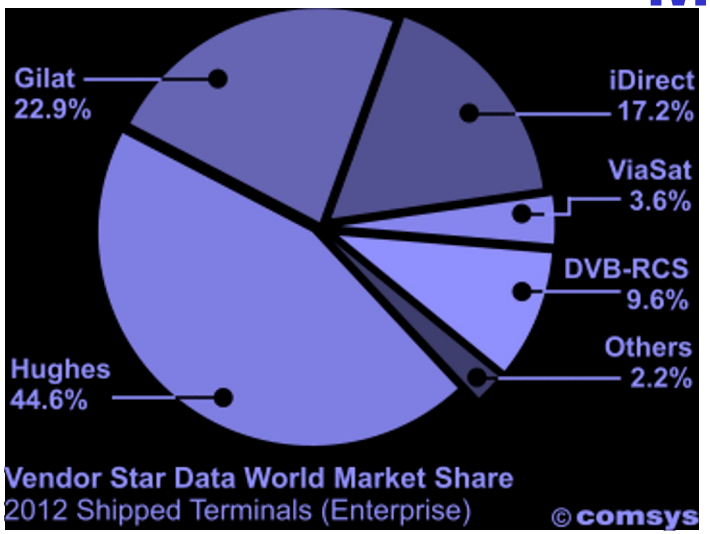
- Two way and one way (unicast) IP applications
  - both broadcast and multicast allowing interconnection with WAN and Multi-PC networks without requiring additional hardware.
- Web-Based Intranet access and Internet access.
- Virtual Private Networks (VPN) with Headquarter and offices remotely located.
- The Satellite Modem supports different applications on the same platform utilizing the same network both for interactive IP communications and for video and audio multicast streaming (called "triple play"):
  - Telephony — Real time – Latency sensitive
  - Broadband Internet access — Wide band
  - TV — Wide band

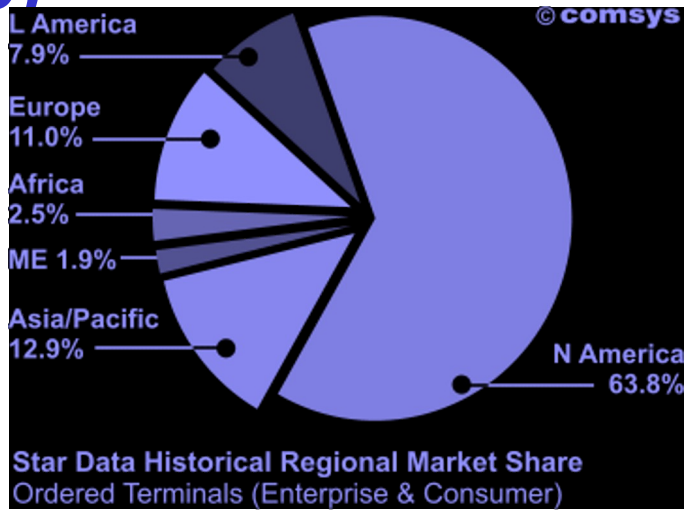
VSAT Market (2013)

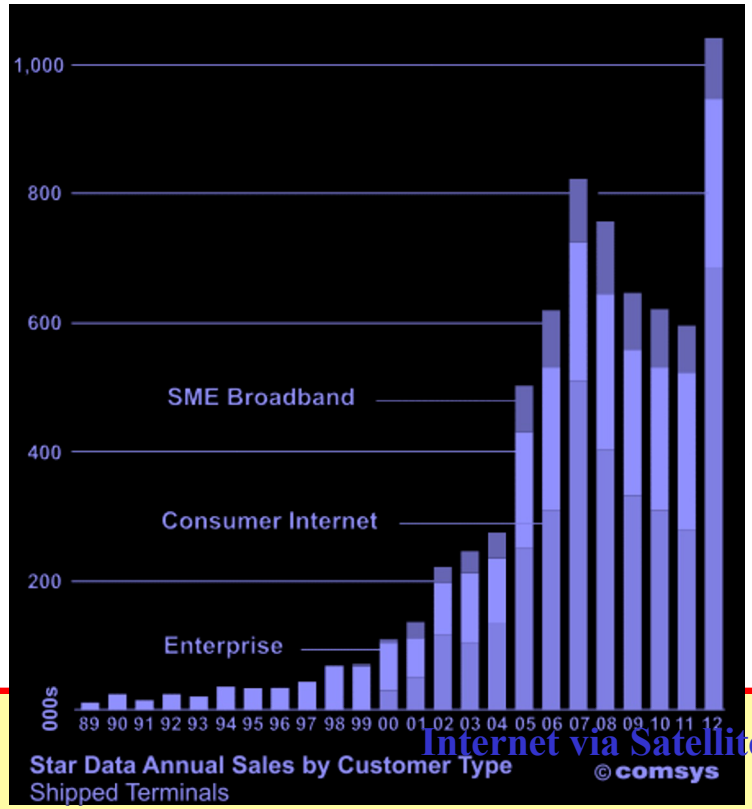
- ***Enterprise & Broadband Star Data Systems***
  - Total Number of Enterprise VSAT Terminals Ordered 3,590,310
  - Total Number of VSATs Shipped 3,513,125
  - Total Number of Sites in Service 1,600,424
  - Enterprise Sites in Service 3 Year CAGR 3.2%
  - Number of Contracts Listed in the COMSYS Database 25,716
  - Number of VSAT Operators Tracked by COMSYS 597
- ***Consumer Internet Access Star Data Systems***
  - Total Consumer Sites in Service 1,652,545
  - Total Consumer VSATs Shipped 4,038,565
  - Consumer Subscribers in Service 3 Year CAGR 4.2%
- ***DAMA Systems***
  - Total Number of Mesh/DAMA Terminals Ordered 175,880
  - Total Number of Mesh/DAMA Terminals Shipped 175,447
  - Total Number of Thick & Thin Route Mesh/DAMA Sites in Service 64,182
  - Sites in Service 3 Year CAGR -5.2%
  - Number of Contracts Listed in the COMSYS Database 5,258
- ***SCPC Systems***
  - Number of Sites in Service 34,751
  - Links in Service 3 Year CAGR -0.5%
- ***VSAT Revenues***
  - All Service Revenues $7.18 billion
  - TDMA & DAMA Hardware Revenues $1.06 billion

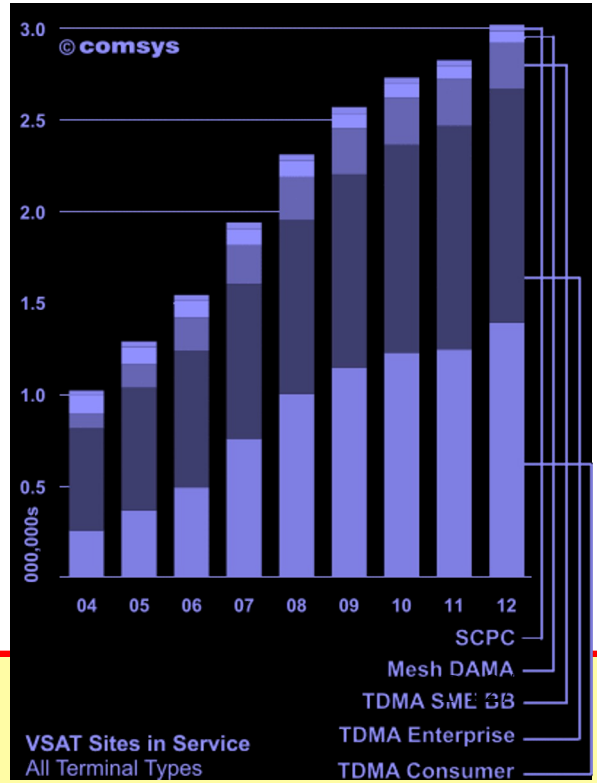
Source: Comsys

Market share (2013)









Source: Comsys
www.comsys.co.uk

VSAT Market (2016)

Enterprise & Broadband Star Data Systems	
Total Number of Enterprise VSAT Terminals Shipped	4,597,805
Total Number of Sites in Service	1,565,662
Enterprise Sites in Service 3 Year CAGR	1.3%
Number of Contracts Listed in the COMSYS Database	33,694
Number of Active VSAT Operators Tracked by COMSYS	537

Consumer Internet Access Star Data Systems	
Total Consumer Sites in Service	2,203,346
Total Consumer VSATs Shipped	6,986,801
Consumer Subscribers in Service 3 Year CAGR	5.7%

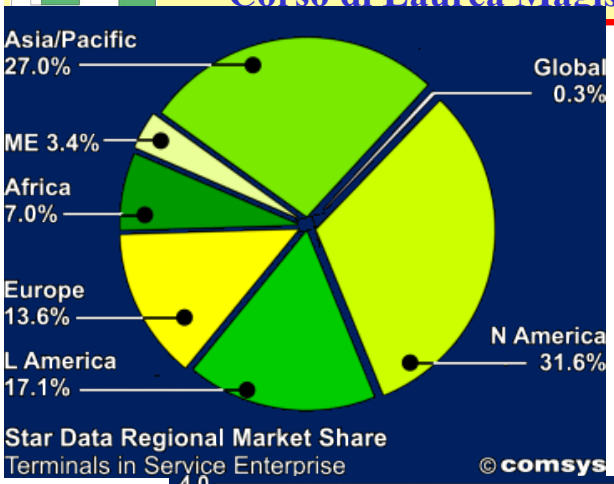
VSAT Market (2016)

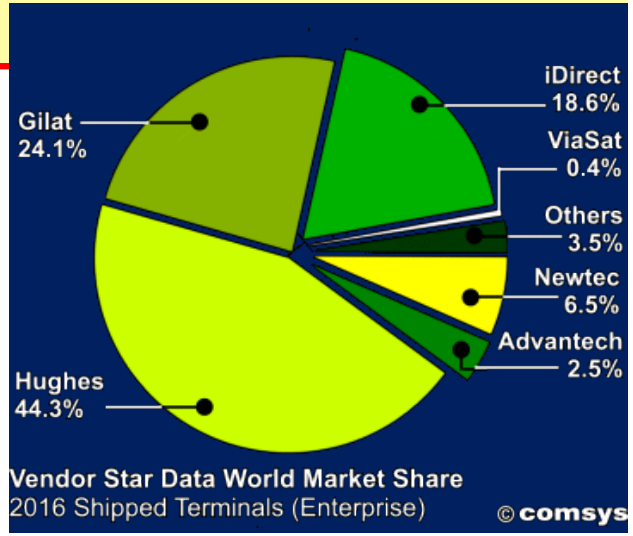
DAMA Systems	
Total Number of Mesh/DAMA Terminals Shipped	198,210
Total Number of Thick & Thin Route Mesh/DAMA Sites in Service	39,899
Sites in Service 3 Year CAGR	1.6%
Number of Contracts Listed in the COMSYS Database	6,003

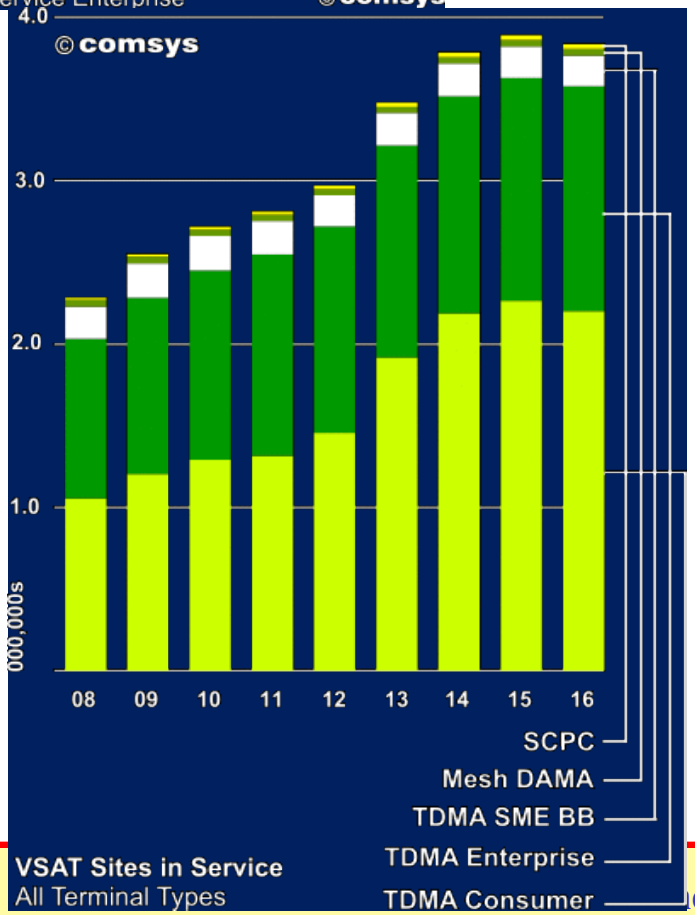
SCPC Systems	
Number of Sites in Service	29,841
Links in Service 3 Year CAGR	-4.4%

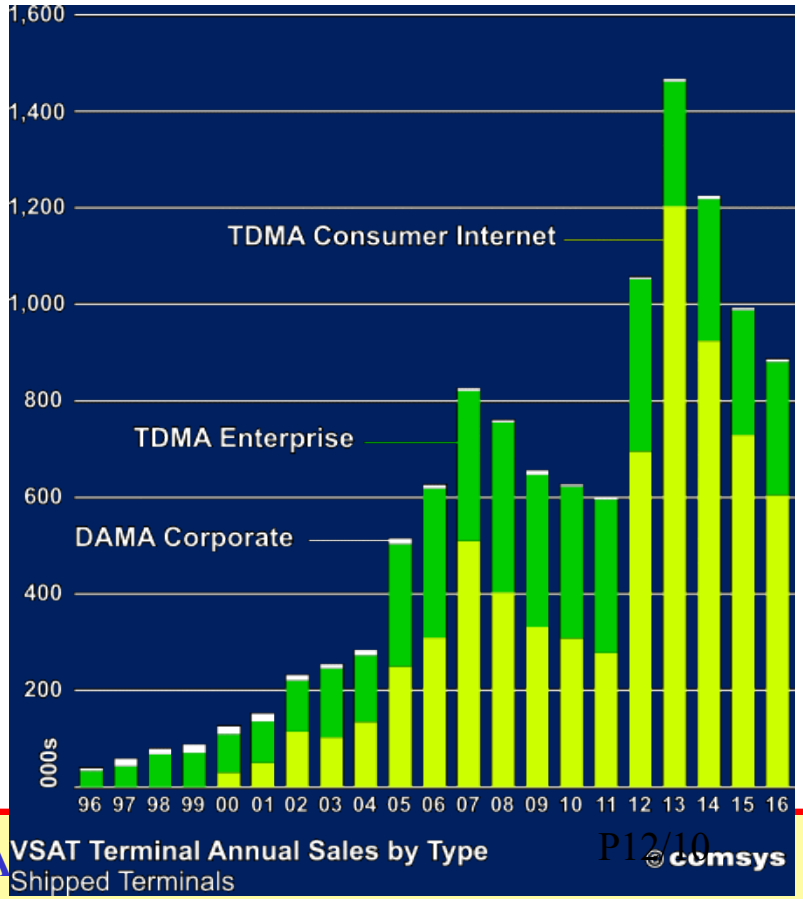
VSAT Revenues	
All Service Revenues	$8.16 billion
TDMA & DAMA Hardware Revenues	$0.96 billion

VSAT Market (2016)

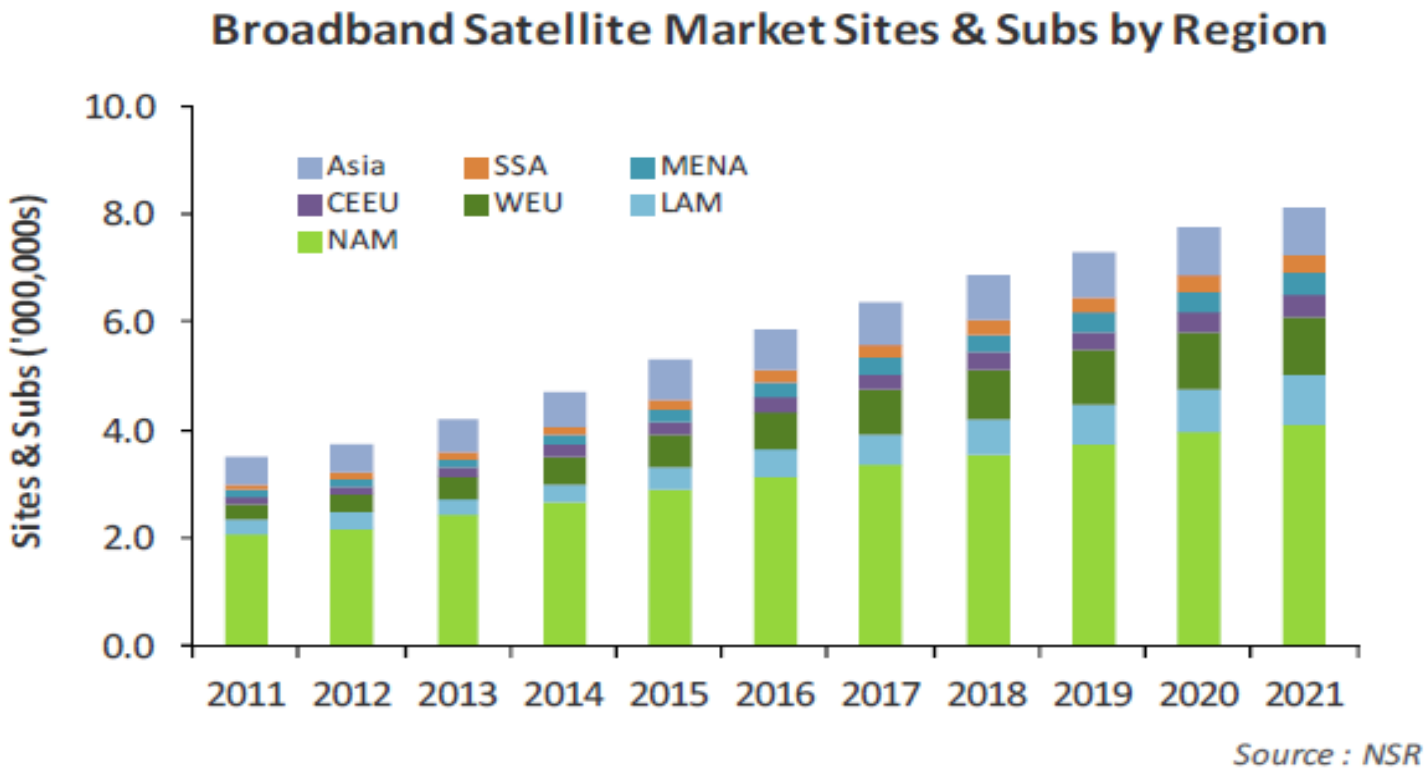








Market forecast by NSR



4.6 million net new sites/subscribers by 2021 for the total broadband satellite market

DVB IP Satellite Systems

Utilization of DVB standard for data

- DVB, initially developed for video (bandwidth demanding signal) was then fruitfully and successfully exploited for data exchange and in general for Internet access.
- DVB IP platforms use DVB-S(2) in the forward link because:
  - DVB-S(2) largely diffused, well assessed, high performance and low cost hardware (chips produced in huge quantities);
  - Robust and well validated software; able to support data delivery and streaming services based on IP over DVB S;
  - IP over DVB S is optimized for huge quantity of data via satellite; easy integration of DVB equipment for TV with those useful for data;
  - Reuse of equipment utilized for TV receiving stations (largely diffused) and the same satellites can provide capacity to both;
  - IPTV natural evolution of other already provided services (no logical step needed as in terrestrial networks, digital TV via satellite older than terrestrial).

One way and RCS systems for IP

- DVB IP systems can be classified as:
  - DVB IP one way
  - DVB RCS (Return Channel Satellite)
- Both typically utilize the DVB-S(2) standard in the forward link while:
  - One way systems can utilize terrestrial links as return channel (PSTN, ISDN, ADSL or wireless UMTS, LTE).
  - RCS systems utilize a satellite link also for the return channel
- One way systems were largely diffused until 2008/2009 mainly for consumer/home market;
- RCS systems, initially addressed to a business market, actually penetrated also consumer and SOHO markets, replacing completely one way systems.

Standard DVB IP

- IP data broadcasting in the DVB standards family (and specifically DVB-S) is defined in ETSI EN 301 192 per Data Broadcasting, describing several modes for the data distribution and in particular IP packets delivery. It is tightly coupled with other ETSI/DVB standards for DVB-S (ETS 300 421 – Framing structure, channel coding and modulation for satellite services) and DVB-SI (ETS 300 468 – DVB Service Information).
- In the specification for DVB data broadcasting, several methods are described for the delivery of digital data, as already seen in the «Encapsulation» section.
- Concerning IP, the DVB standards specifically discuss on the adaptation of previous standard (DSM-CC) for the implementation of a Multi Protocol Encapsulation (MPE) transport mode. Other modes are available (streaming, piping, carousel) but either useful for other kinds of data transmission or require additional adaptation layers to be implemented within the modem and the gateway)
- MPE specifically describes the conversion and inclusion of MAC addresses within the DVB structures, which is necessary to allow the traffic to continue on terrestrial networks after the satellite segment.
- The MPE specifications allows to define multicast and broadcast services.
- Enhanced encapsulation methods exist, and in particular ULE has been standardized by IETF (but not by DVB, so that interoperability may not be guaranteed) in IETF RFC 4326, and it can be used as alternative to MPE.

DVB IP one way platform architecture

DVB IP – Platform for Multiple Applications

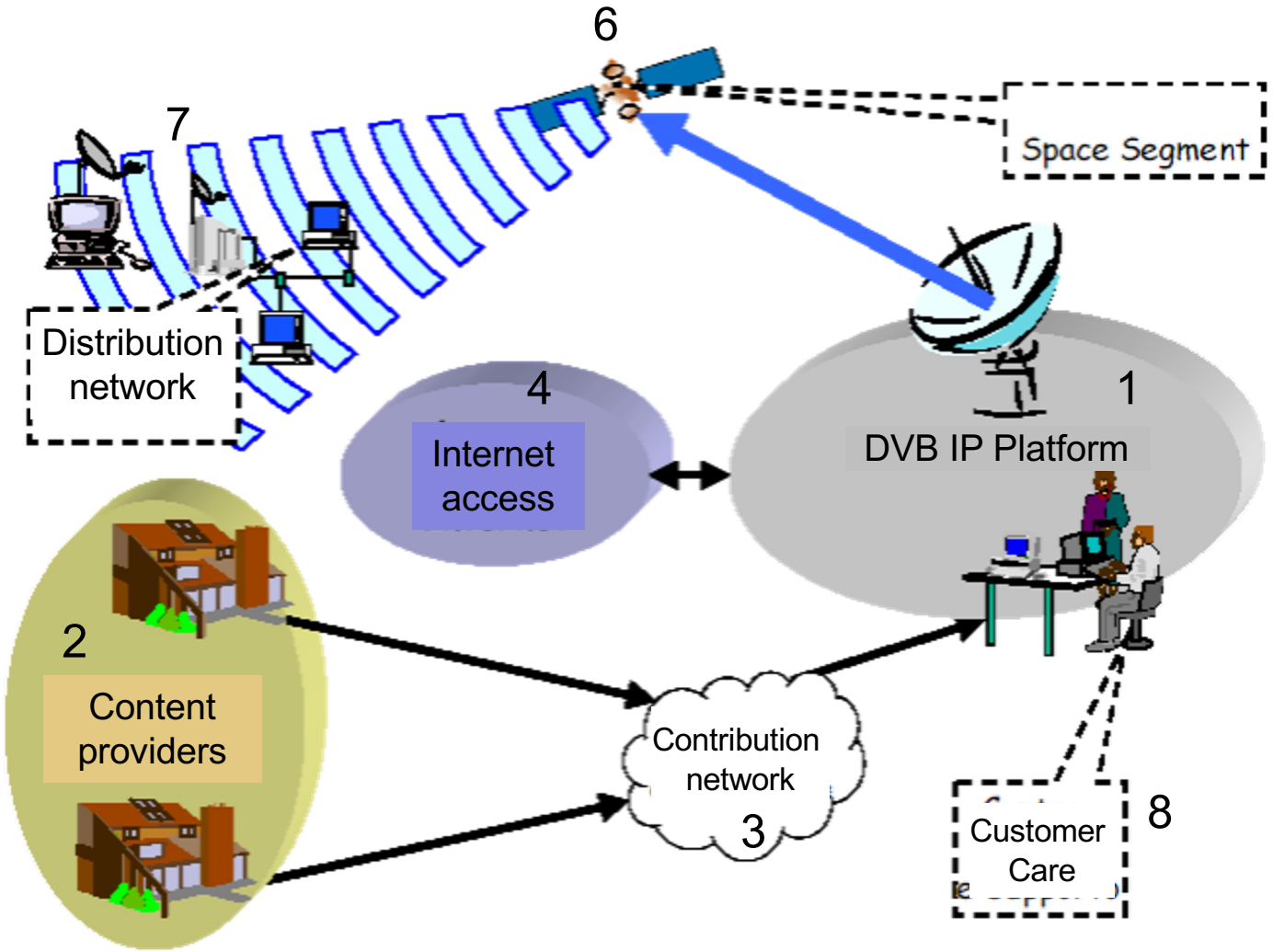
- Utilizing IP protocols over DVB for multicast services and applications, the satellite resource can be utilized very efficiently because the same information can be simultaneously transmitted to several users over the same space channel (broadcast nature of the satellite signal).

- Typical supported applications based on Multicast connectivity:

  - Web Caching vs ISP PoP
  - Business TV
  - DVD Video Distribution
  - News Distribution
  - Distance learning
  - Teleconference
  - Telemedicine

DVB IP One way Network elements

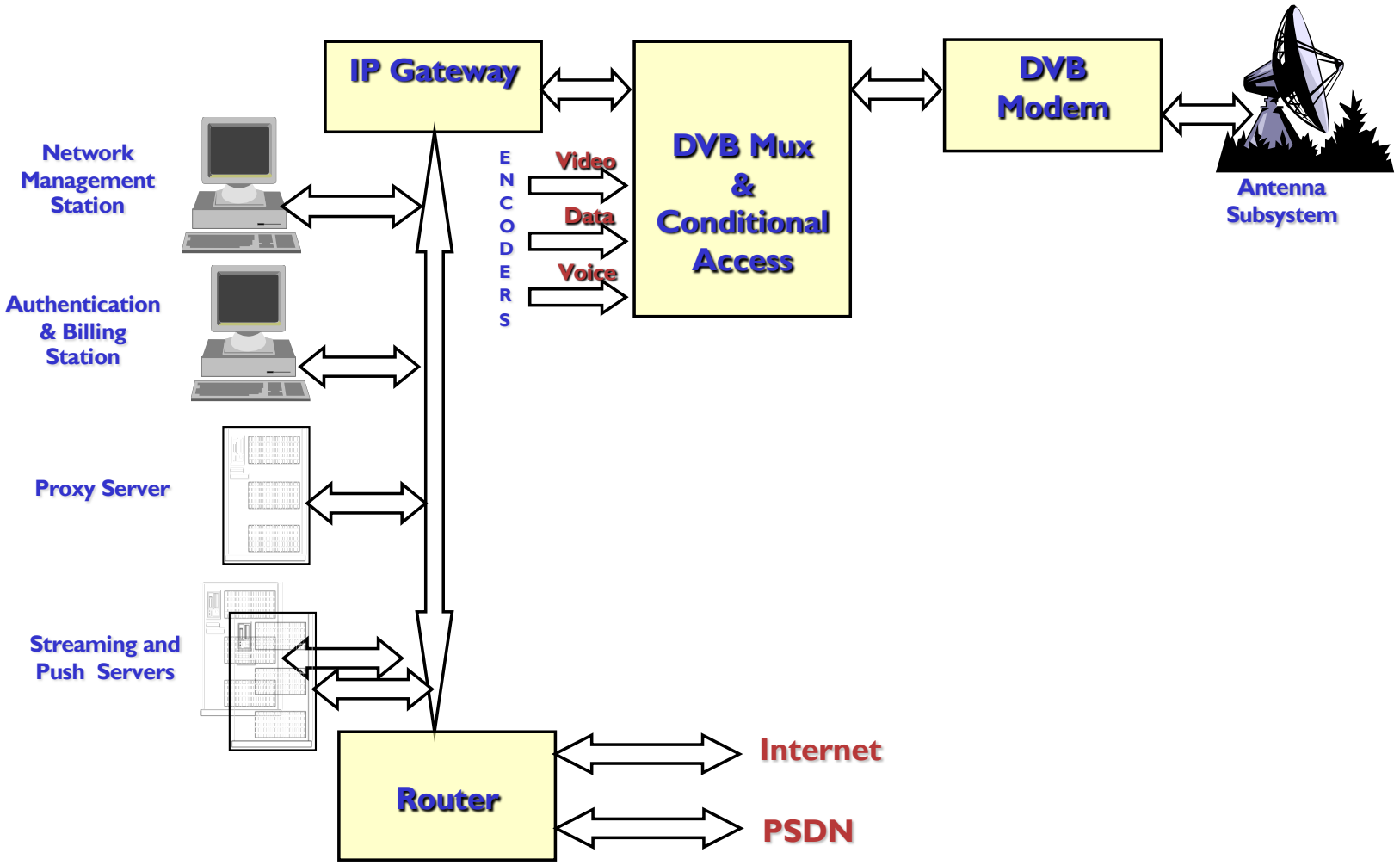
1. DVB IP Platform
2. Content providers
3. Contribution network
4. Internet access
5. PSTN/ISDN access (optional)
6. Space segment
7. Distribution network (user terminals)
8. Customer Care



DVB IP One Way platform components

1. Satellite Uplink with transmission equipment to transmit in Ku or Ka band 38-45 Mbit/s to the satellite;
2. DVBS/S2 Modem including FEC RS/Convolutional or TurboCoding or BCH/LDPC;
3. DVB Mux (Remultiplexer) and Conditional Access;
4. IP Gateway with MPE capabilities (MPEG2 Protocol Encapsulator);
5. Proxy Server to access the Internet;
6. Streaming and Push Servers;
7. Access to Internet Backbone;
8. Access to PSTN/ISDN/ADSL for contributions and terrestrial return channel management.

DVB IP platform block diagram



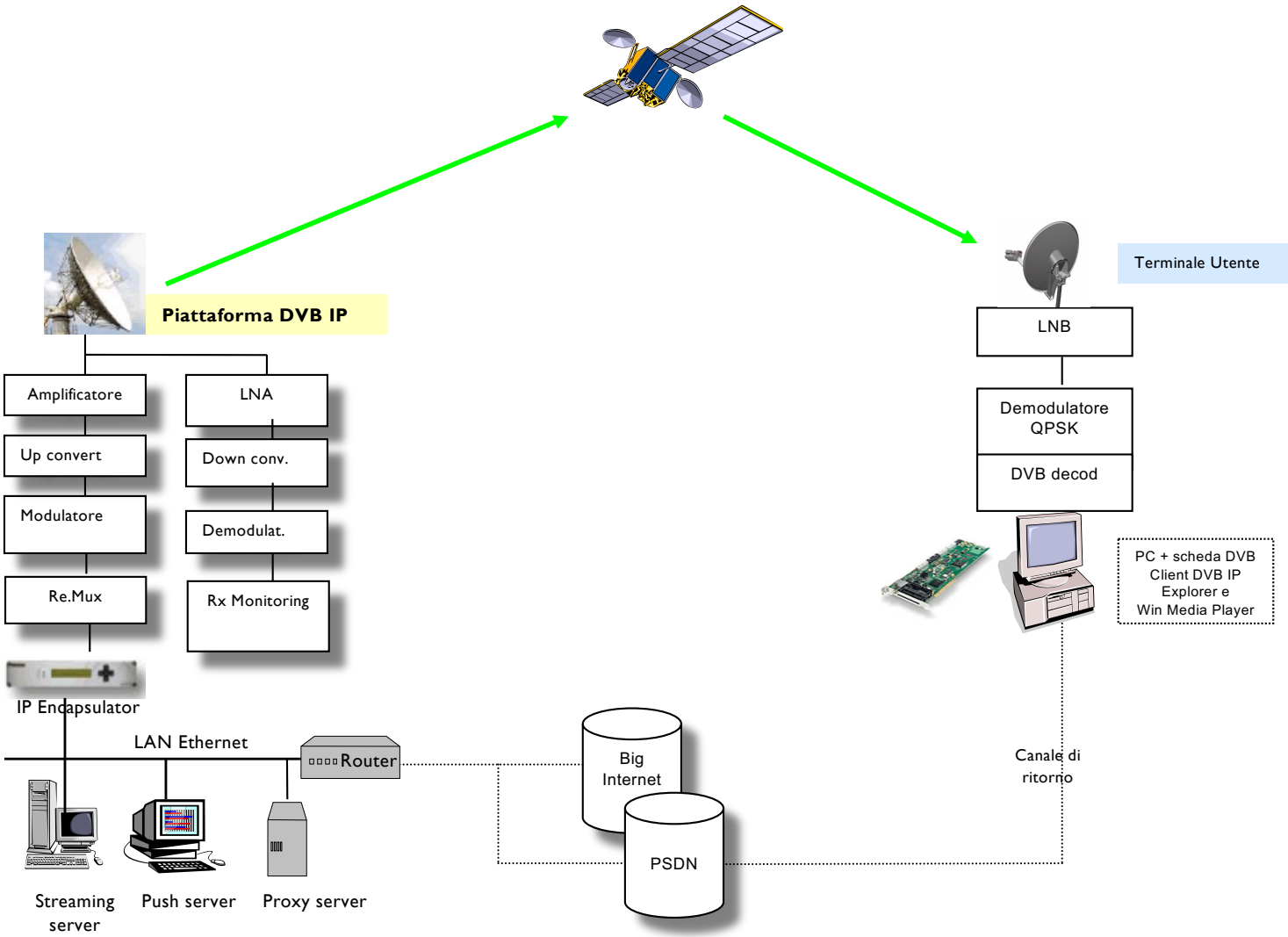
DVB IP platform functionalities (1/2)

- **Proxy Server** receives requests of data from fast internet service users and takes the action to search contents throughout the network to forward them to dedicated servers; requests reach the station through terrestrial internet link and the local ISP;
- In the **Push Server** the most interesting contents are uploaded from terrestrial contribution network; data are classified and prepared to be downloaded to terminals set up in Push state; contents are selected according to importance degree and agreements with customers and/or content providers;
- The **Streaming Server** provides a huge bouquet of data: audio (MP3), video and TV channels (MPEG4); the server receives in input flows from contributors that provide live or recorded programmes.

DVB IP platform functionalities (2/2)

- The **IP Gateway** (IP Encapsulator) receives IP datagrams of the Ethernet from Proxy, Push and Streaming Servers; selects and encapsulates packets in the MPEG2 Transport Stream of DVB or DVBS2 (ULE, GSE). It acts as Gateway, acquires and processes data, checks quality and security, and prepares them for multicast distribution;
- The **Remultiplexer,** connected to the IP Gateway, receives a set of data DVB streams and multiplexes them generating a single synchronous transmission;
- The **DVB Modulator**, connected to Re-Multiplexer, implements FEC (RS-Convolutional or Turbo Coding or BCH/LDPC) and then modulates the digital signal;
- The **Satellite Uplink** with transmission equipment to transmit in Ku or Ka band 38-45 Mbit/s to the satellite; the modulated flow at IF is first converted at Ku/Ka band (14/30 GHz) and then amplified by a 100-400 Watts amplifier (depending on carriers) to be transmitted by the antenna to the satellite. The transmitting UpLink antenna is usually about 6.5 m of diameter in Ku band to ensure BER in the order of 99.97%.

DVB IP System block diagram



DVB IP «One way» home equipment

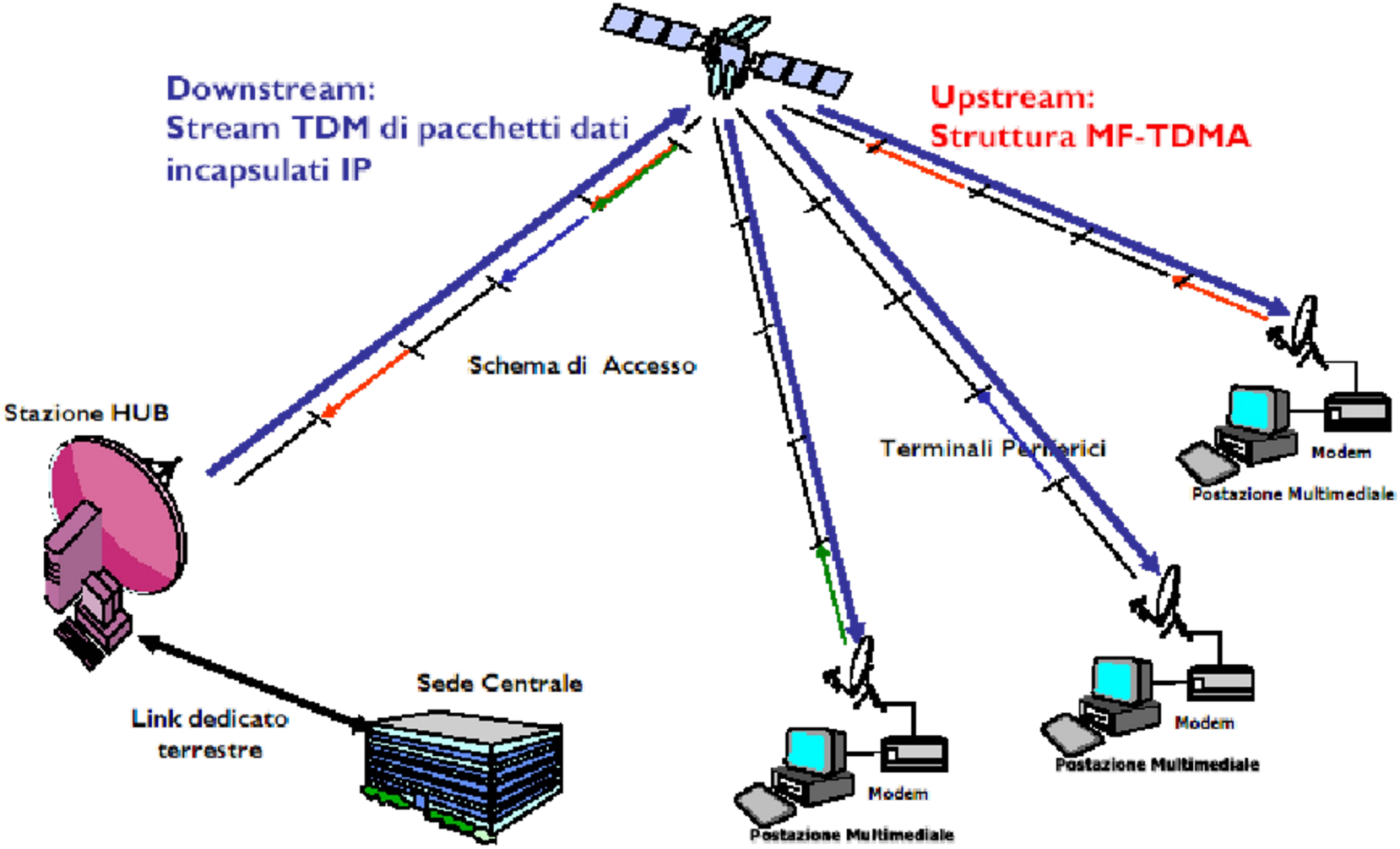
1. Receiving antenna (75-95 cm diameter parabolic dish for Ku band, smaller if for Ka band);
2. LNB which amplifies and converts the received signal from Ku/Ka band to L band (950-1700 MHz);
3. Multimedia PC;
4. DVB Card (PCI, USB or PCI-e) which works both as demodulator and as DVB IP Decoder;
5. Normal and service-specific (e.g., Streaming and Push Application services) software running on the PC operating System;
6. ISDN/PSTN/ADSL connection to manage the return channel.

Architecture of two way DVB (IP) RCS Platform (Return Channel on Satellite)

Standard DVB IP RCS

- Several implementations of two ways satellite networks
- To make many technologies interoperable, a standard was defined at European level to regulate the diffusion of star networks with proprietary standard difficult to interface with other technologies;
- The DVB RCS standard is an evolution of the TDM TDMA networks where the TDM carrier (with bit rate up to 38 Mbit/s), transmitted by the Master station, carries the multiplexed data packets in the time domain towards all the peripheral terminals of the network and the TDMA carriers (with bit rate up to 2048 kbit/s) instead are shared among the peripheral stations to connect the Master Station.
- The DVB-RCS offers a return channel associated to the satellite link of each terminal which allows to use real time interactive applications with information flows greater than DVB IP and big enough to enjoy many wide band applications with acceptable quality.
- DVB-RCS systems can also support full mesh architecture.

RCS return link TDM - TDMA



ETSI DVB RCS standard

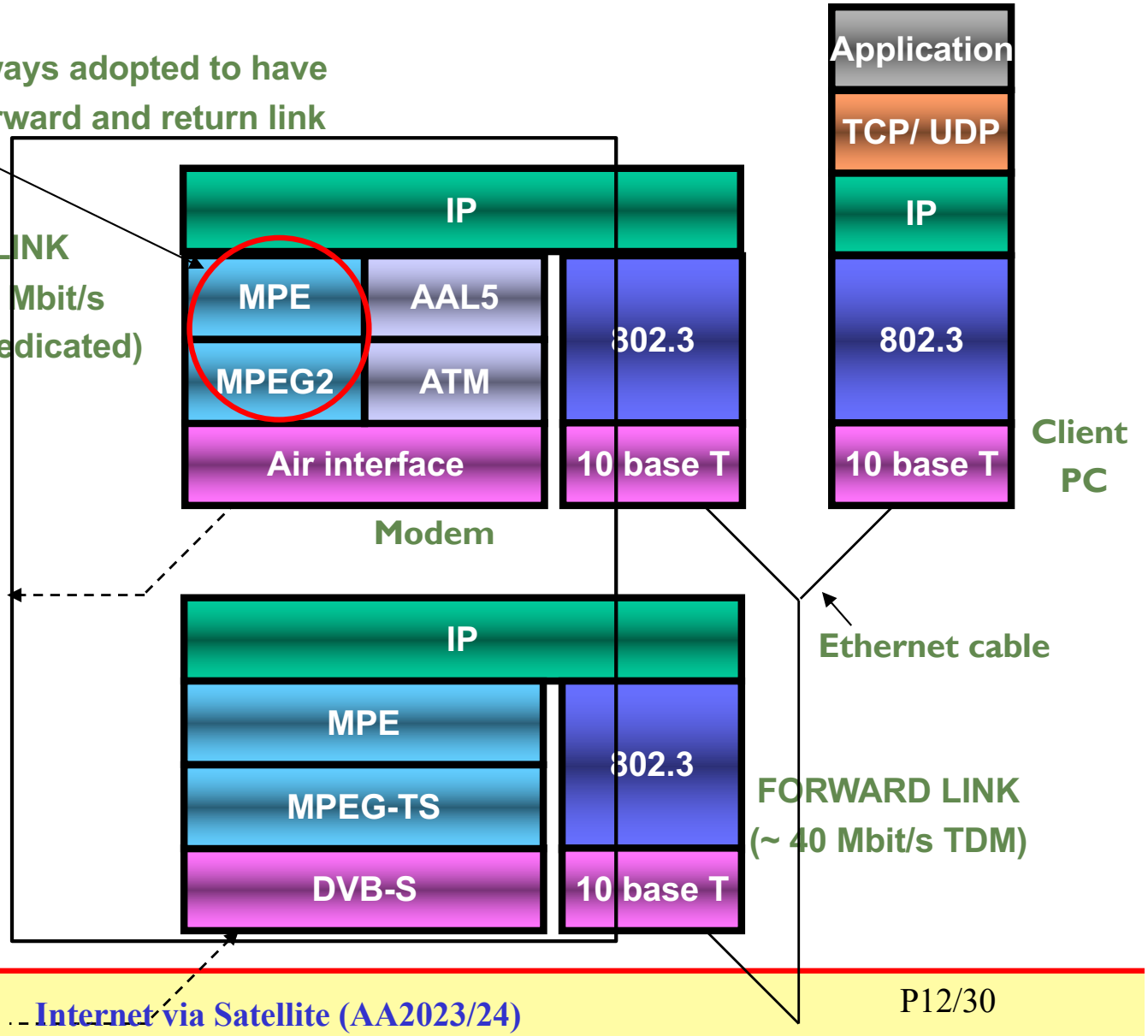
- DVB and ETSI standardized RCS broadband return link over satellite specifications in DVB-RCS EN 301 790 and TR 101 (Guidelines) to apply and extend the definition of DVB-IP DVB-ETSI EN 301 192 also to the return channel. RCS acronym stands for Return Channel Systems;
- DVB-S(2) channel for IP data reception is called Forward Channel and RCS standard describes the Return Channel;
- Return channel capacity is nominally up to 2048 kbit/s working in Multi Frequency TDMA (MF-TDMA) to allow sharing of the same medium to multiple terminals (RCS Terminals or RCST);
- MPEG-TS can be used as MAC layer also for the return link (as it is for DVB-S forward link) and adopting MPE encapsulation for both links. Nevertheless, for RCS the use of ATM and AAL5 is the default mode for the return link.

Forward path	
Transmission system	DVB-S according to ETS 300 421
Satellite Signaling Data Encapsulation	According to DVB SI (ETS 300 468), DVB RCS (EN 301 790) and DVB-DATA (EN 301 192
RX Intemediate Frequency	950 – 2150 MHz

Return path	
Modulation and Coding	According to DVB RCS (EN 301 790): QPSK with concatenated coding (Reed Solomon + convolutional coding)
Access scheme	MF-TDMA (Multi-Frequency Time Division Multiple Access) with capacity assignment on a frame-by-frame basis
Protocols supported	IP over ATM
Symbol Timing Control	Derived from NCR in forward DVB MPEG-2 data stream

DVB RCS protocol stack

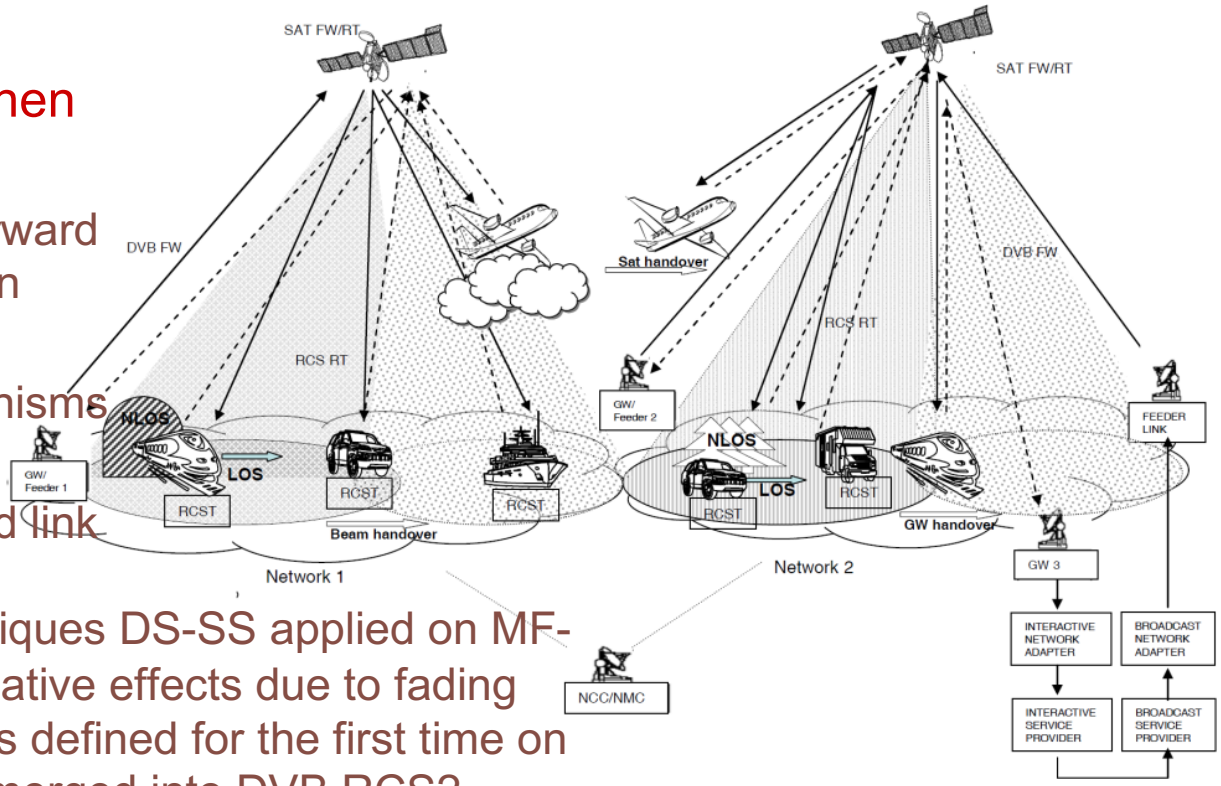
Optional but in practice always adopted to have the same stack on both forward and return link



- For the forward channel IP/MPE over MPEG-TS in DVB-S (already analysed in previous block)
- For the return channel two options: AAL5/ATM (default) or IP/MPE over MPEG-TS
- Below, at physical layer, the already analysed air interface is used.

RCS evolution

- DVB-RCS 1st generation was then extended to:
  - Use DVB-S2 (CCM) on the forward link and signalling on the return channel to support VCM/ACM
  - Define communication mechanisms MESH/DAMA (RCS-RCS like)
  - Define specific FEC on forward link for NLOS transmissions
  - Define spread spectrum techniques DS-SS applied on MF-TDMA burst to reduce the negative effects due to fading and mobility. Such technique is defined for the first time on DVB-RCS+M (Mobility), then merged into DVB RCS2
  - Handover procedure between satellites
  - Support for Random access on traffic (TRF) slots for sensor networks/IoT (Aloha access with simpler hardware)

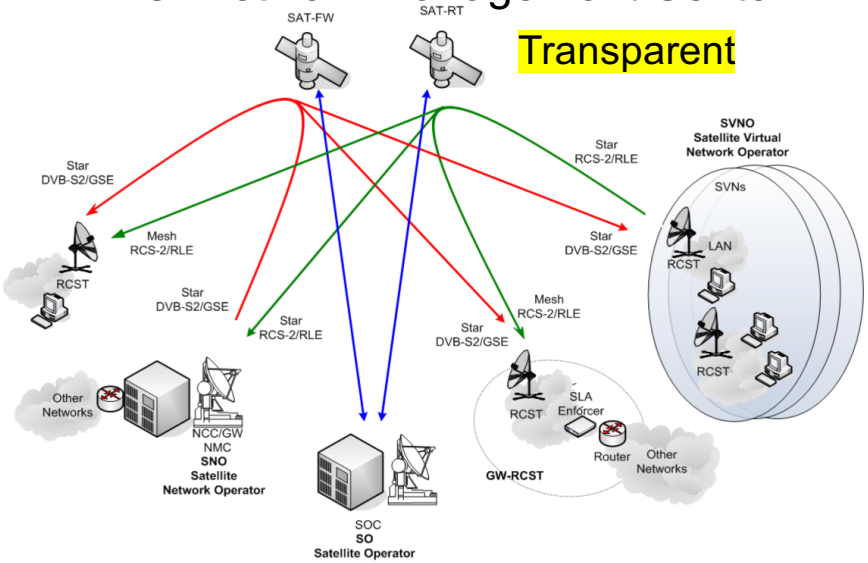


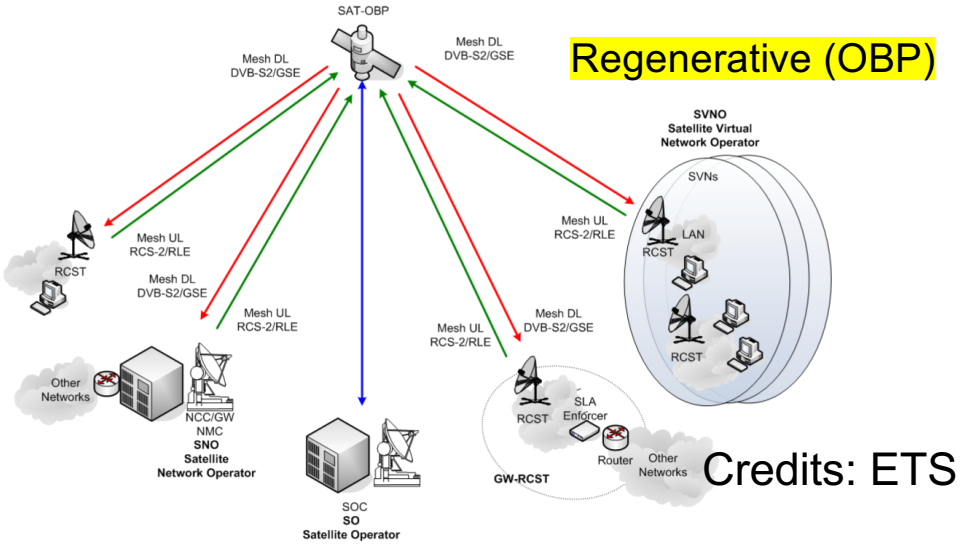
DVB-RCS2 (2nd generation)

- The 2nd generation of DVB RCS introduces some technological innovations but also the harmonization and standardization of lower layers jointly with higher layers.
- In the **Lower layers**, further optimization of the «air interface» are introduced with respect to RCS (modulation, coding, adaptivity, Random Access for **IoT** with CRDSA, etc.).
- In the **Higher layers**, network operations, system management and control are introduced to achieve better interoperability between HUB and terminal that in the previous version were not standardized but reason of possible failure.
  - Considering that high level requirements can be different depending on the kind of service (mobile, maritime, fixed, etc.) a set of standard profiles are defined to guarantee interoperability.
- Finally, specifications include both Star and Mesh topology (before just star) as well as the use of regenerative satellites.

DVB-RCS2

NMC: Network Management Center





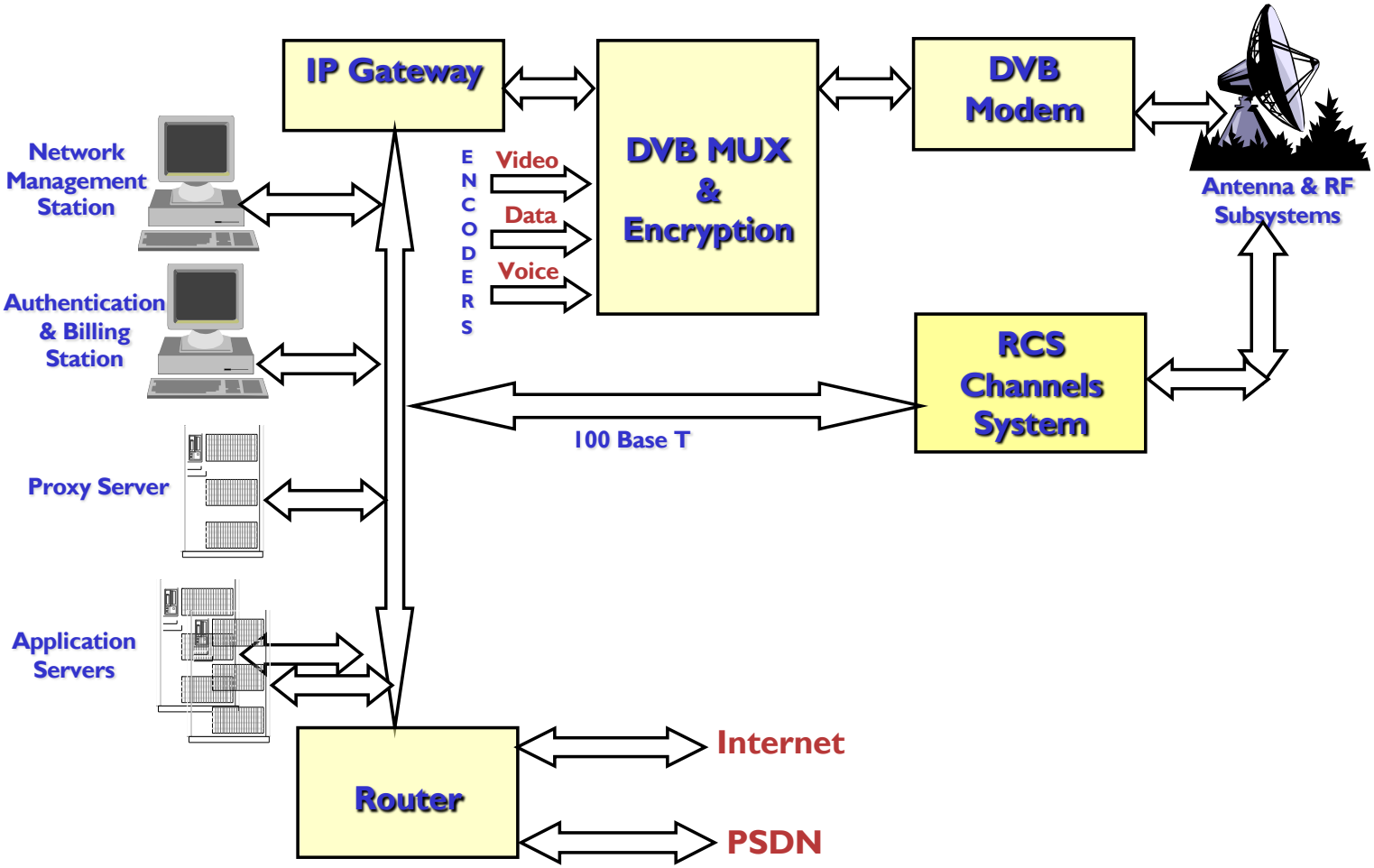
Credits: ETSI

From guidelines **ETSI TS 101 545-1**:

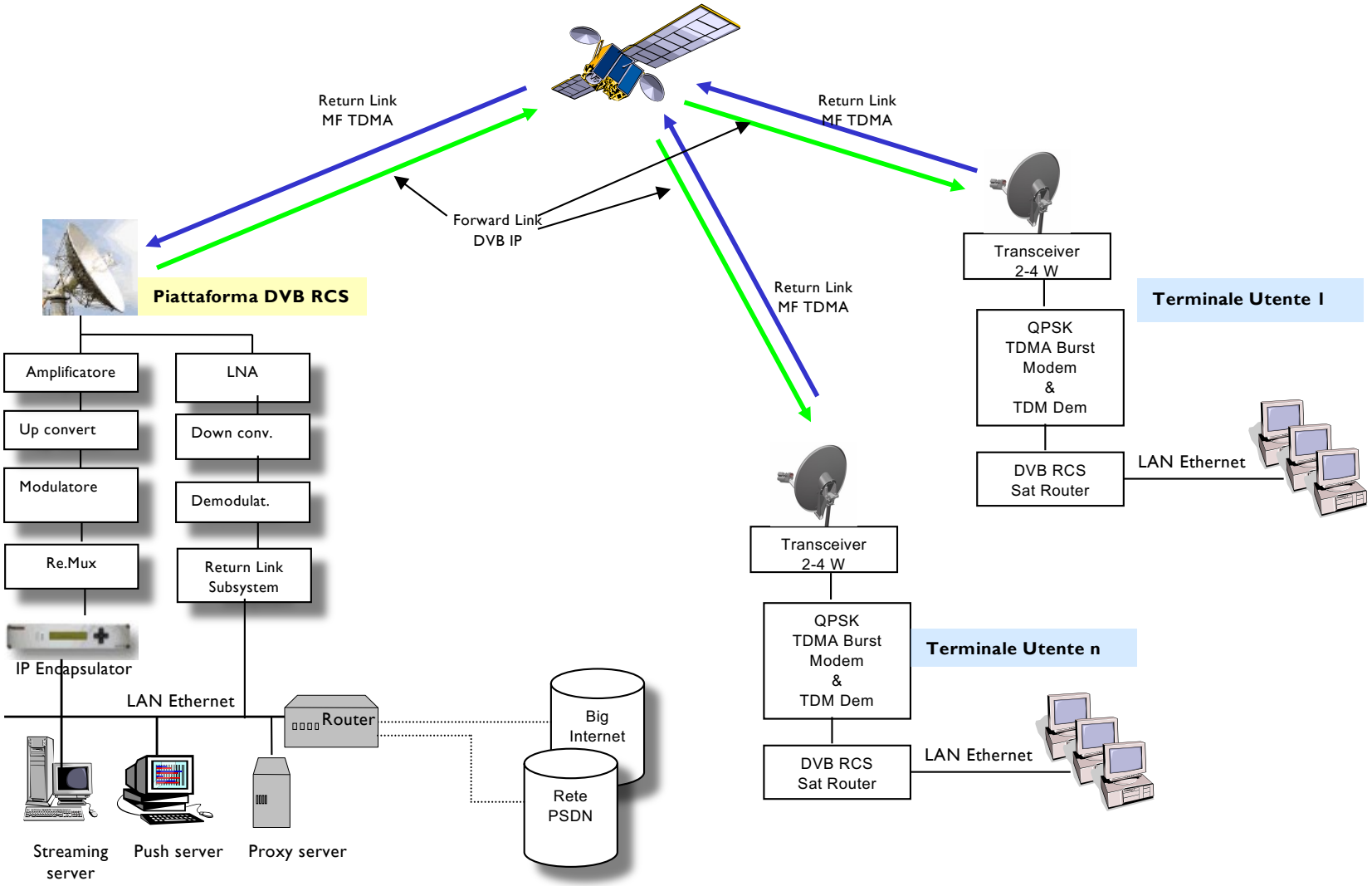
"DVB-RCS2 is the standard conceived to provide a standardised broadband interactivity connection as an extension of the Digital Video Broadcasting Satellite systems. It defines the MAC and physical layer protocols of the air interface used between the satellite operator hub and the interactive user terminal as well as the network layer and the essential functions of the management and control planes of the terminal. It embraces the GSE and the DVB-S2 standards […]"

"While the basic MF-TDMA nature of the return link has been retained from DVB-RCS to DVB-RCS2, incompatible changes have been introduced to the encapsulation (variable-payload RLE vs. fixed-payload ATM/MPEG), FEC coding, burst formatting, modulation (extension to 8PSK and 16QAM) and dynamic operation (rapid changes to the time slot parameters)"

DVB RCS platform block diagram



DVB RCS System block diagram



Costs and service fares

- Costs of DVB RCS terminals (including installation), being RX-TX, are between € 200 and € 500 euro;
- Terminals for mesh networks are more expensive (up to 10 times greater);
- Service fares are quite complex, different for forward and return link, for different orbital positions and strongly dependent on user needs;
- Big satellite operators offer also hosting services at different levels (subnetwork on its NCC, equipment, equipment+personnel, etc.) to smaller operators or to big customers who want to manage an own network or subnetwork.

DVB-RCS and DVB-RCS like two way operational platforms

- The market offers different solutions to set up two way satellite communication systems, some are DVB RCS but most of them are DVB RCS like based on proprietary standards (usually the difference is limited on the return link).
- Some standards, initially proprietary, are then made available to allow to realize interoperable terminals
- VSAT multi-standard are also available
- For sake of synthesis some example of VSAT networks will be presented:
  - Hughes HX System (Hughes Network Systems)
  - SES platforms
  - Surfbeam 2 (VIASAT)

Hughes HX System

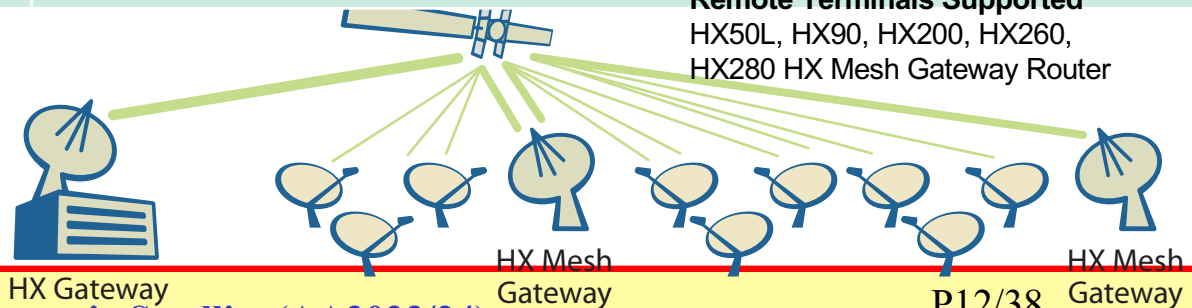
Gateway features

- Compact hub configuration
- Intelligent, protocol-sensitive bandwidth assignment for optimum performance and efficiency for each application
- Dynamically assigned CIRs per remote or group of remote terminals
- High-performance IP feature set End-to-end network security
- Advanced network management capabilities including detailed remote diagnostics
- Active redundancy for all critical components
- Optional mesh controller for supporting single hop remote-to-remote connectivity

Forward channel	
Standard	DVB-S2 with Adaptive Coding and Modulation
Frequency Bands	Full C, Extended Ku, Ka, X
Modulation	QPSK/8PSK/16APSK
Symbol Rates	1 to 45 Msymb/s (in steps of 0.5 Msymb/s)
DVB-S2 Encoding	LDPC with BCH outer code, ACM capable 1/2, 3/5, 2/3, 3/4, 5/6, 8/9, or 9/10
Bit Error Rate	10-10 or better

FDMA/TDMA (IPoS) Return Channel	
Modulation	OQPSK
Coding Rates	Adaptive Coding 1/2, 2/3, 4/5 with TurboCode 1/2, 2/3, 4/5 and 9/10 with LDPC
Symbol Rates	256, 512, 1024, 2048, 4096, 6144 ksymb/s x 1, 2, 4, 8 (256 ksymb/s); x 1, 2, 4 (512 ksymb/s); x 1,2 (1024 ksymb/s and 2048 ksymb/s
Channel Rate	256 ksymb/s to 9.8 Msymb/s
TDMA Spreading Factors	x1, 2, 4, 8 (256 ksymb/s); x1, 2, 4 (512 ksymb/s); x1,2 (1024 ksymb/s and 2048 ksymb/s

Remote Terminals Supported
HX50L, HX90, HX200, HX260,
HX280 HX Mesh Gateway Router



SES two way platforms

	iDirect Velocity	Gilat SkyEdge 2c
Segment	Mobility (aero, maritime), enterprise	Fixed Data (enterprise, mobile backhaul, consumer)
Scope	Global	Regional (Europe)
Capacity	Ku	Ka
Architecture	Star	Star
Outbound	DVB-S2	DVB-S2 / S2x
Inbound	MF-TDMA Proprietary (DVB-RCS-based)	MF-TDMA Proprietary (DVB-RCS-based)

FORWARD CHANNEL	RETURN CHANNEL	MODEM INTERFACES	MANAGEMENT	ENVIRONMENTAL AND MECHANICAL
Standard: DVB-S2/DVB-S2X Adaptive Coding and Modulation (ACM)	**Access Scheme:** Adaptive TDMA	**RF Input / Output:** - Two female F connectors, 75 Ω - RF in frequency - 950-2300MHz - RF outfrequency-950-2300MHz	**IP Features:** IPv4 (IPv6 over L2oS), TCP, UDP, ICMP, DHCP, NAT/PAT, DNS, ROHCv2, RIPv2, IGMPv2-v3, L3, ICMP	**Dimensions:** 478x114x182 mm (WxDxH)
Carrier Rate: 1Msps-45Msps 5Msps-100Msps	**Inbound Rates:** Symbol rate - 128Ksps-7.5Msps	**Data Interfaces:** LAN: One 10/100/1000 Mbps Ethernet	**Security:** - AES-256 bit link encryption	**Operating Voltage:** 100V-240V AC
Modulation: QPSK, 8PSK, 16APSK, 32APSK, 64APSK, 128APSK, 256APSK	**Modulation:** BPSK, QPSK, 8PSK, 16QAM	**Management Interface:** LAN: One 10/100/1000 Mbps Ethernet		**Operating Temperature:** 0°C to +40°C
Coding: LDPC	**Coding:** 2D 16 state			
FEC:1/4, 8/9	**FEC:** 1/2, 6/7			

iDirect
iQ Desktop Satellite Modem

SES two way platforms (2)

FORWARD CHANNEL	RETURN CHANNEL	MODEM INTERFACES	ENHANCED FEATURES	ENVIRONMENTAL AND MECHANICAL	OUTDOOR UNIT (ODU)
Standard: DVB-S2 Adaptive Coding and Modulation (ACM)	**Access Scheme:** MF-TDMA, Dynamic Channels	**RF Input / Output:** - Two female F connectors, 75 Ω - RF in frequency - 950-2300MHz - RF outfrequency-950-2300MHz	**IP Features:** IPv4/IPv6, TCP, UDP, ICMP, DHCP, NAT/PAT, DNS Caching, cRTP, IGMPv2, SIP, DiffServ	**Dimensions:** 153x140x35 mm (WxDxH)	**Frequency Bands:** C, Ku, Ka
Carrier Rate: 1.5Msps-67Msps (235Mbps)	**Inbound Rates:** Symbol rate - 128Ksps-6Msps	**Data Interfaces:** Ethernet 10/100/1000BaseT RJ-45, 802.1Q VLAN	**Security:** - AES-256 bit link encryption - IPSEC Client - ACL Firewall - X.509 Terminal Authentication	**Operating Voltage:** 100V-240V AC Auto Range	**Transmit Power:** Via IDU DC insertion up to 4W BUC
Modulation: QPSK, 8PSK, 16APSK, 32APSK	**Modulation:** BPSK, QPSK, 8PSK, 16QAM	**Management Interface:** - Web-based local management - Full FCAPS management - Remote software upgrades over the air - SNMP	**Application Acceleration and Protocol Optimization** - TCP acceleration - HTTP web pre-fetch acceleration and compression	**Operating Temperature:** 0°C to +50°C	**Antenna Size:** 0.76m and higher
Coding: LDPC, BCH	**Coding:** TPC			**Certifications:** CE, FCC, EMC	**Operating T:** -40°C to +60°C
FEC: 1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10	**FEC:** 1/3, 2/5, 1/2, 2/3, 3/4, 4/5, 6/7				

GILAT
SKYEDGE II-C GEMINI-I

VIASAT Surfbeam 2

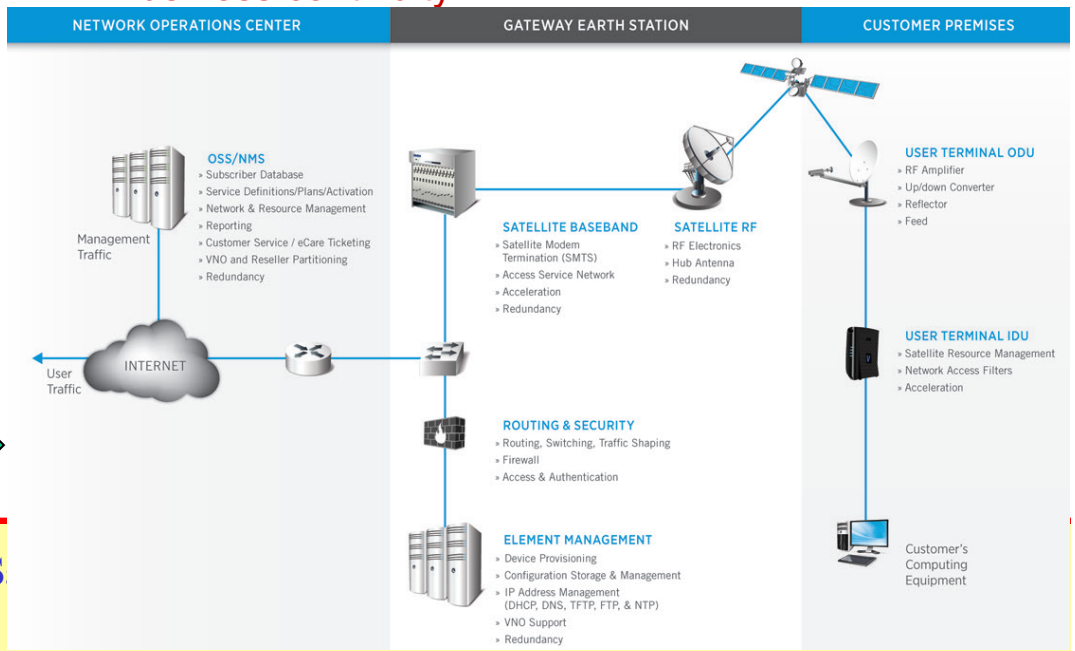
Features and Benefits

- Next-generation broadband-over-satellite system for high capacity satellites
- Highly scalable, modular architecture
- Optimized for bent-pipe Ka-band spot beams with frequency reuse
- Highly efficient forward-link modulation and coding
- Adaptive coding and modulation
- Highly efficient return-link modulation, coding, and MAC protocols
- Return channel modem burst rates of up to 10 Msps (up to 20 Msps with premium user terminals)
- High density hub equipment—up to 1 GHz4 of bandwidth in only 13 rack units
- Embedded acceleration
- Easy to use network management system
- Easy integration with your business systems
- Multiple remote terminals for residential, enterprise, portable, and mobile user applications

End User Applications

- High-speed Internet web browsing
- Real-time video streaming and video downloads
- IP-based voice and video (IP-TV, video telepresence)
- Internet and Outlook/Exchange email
- SharePoint, CRM/ERP applications
- Configurable as a Layer 2 or Layer 3 network device for total enterprise networking flexibility
- Internet multitasking, such as web browsing while talking on an IP soft phone
- Multicast media and content delivery
- Remote connectivity (temporary and nomadic sites)
- Business continuity

SURFBEAM 2 NETWORK DIAGRAM



TooWay

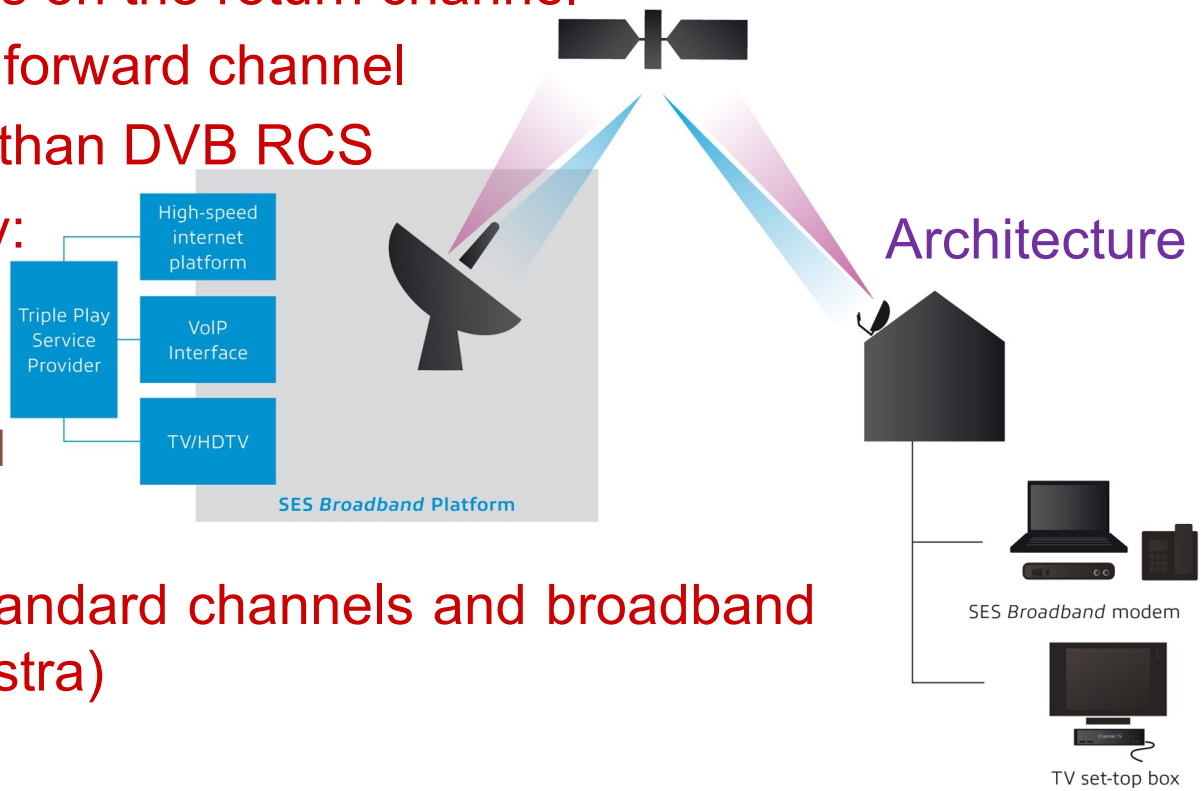
- Standard IPoS, return channel TDM not compatible with DVB-RCS
- Standard de facto in USA, it is experiencing a significant market penetration in Europe
- Linkstar terminals

Tooway – Surfbeam2 Ka SAT

- Evolution of Tooway compliant with KaSat Eultelsat satellite – Multibeam for broadband services
- On the market since 2012:
  - http://www.open-sky.it/tooway/
  - http://www.tooway.com/

SES Broadband (former Astra2Connect)

- Based on return channel at medium/low bit rate SatMode (GMSK modulation). Proprietary standard (Sat3Play technology)
- Use of DVB-RCS standard to manage the access to the channel and to share resources on the return channel
- Use of DVB-S2 in the forward channel
- Outdoor unit cheaper than DVB RCS
- Services like 3ple play:
  - Voice
  - Wide band Internet
  - Video streaming and on demand
- Possibility to get tv standard channels and broadband connectivity (19° E Astra)



Eutelsat DVB RCS System

- The Eutelsat DVB RCS system has the forward link at 45 Mbit/s and the return link up to 2048 kbit/s. The return channel provides bandwidth on demand with a MF-TDMA discipline and has a turbo coding compliant to DVB RCS standard to improve throughput.
- It supports IP routing , IP multicasting, IP QoS and TCP spoofing up to 10 Mbit/s of unicast throughput. The DVB RCS based on LinkStar has a Web-based NMS system very simple to use and set up, providing traffic statistics and detailed records of the calls.
- The user terminal for typical applications with return channel at 384 kbit/s is equipped with a 2W RF transmitter and an antenna of 96 or 120 cm diameter (depending on the site location with respect to the coverage pattern).
- The LinkStar technology provides a low cost solution for: Internet access, Digital media streaming, Video-conferencing, Distance education, File transfer, Multicasting, Private Virtual Networks PVN, etc.
- The Eutelsat DVB RCS operates on Atlantic Bird 2 satellite.

DVB RCS EMS user Terminal

Transmit Frequency Range	29.50 - 30.00 GHz
Receive Frequency Range	10.70 - 12.75 GHz
Polarisation	(orthogonal) linear, transmit and receive polarisation planes aligned dual polarisation reception, single polarisation transmission
SIT-Antenna Diameter	0.75 m to 1.20 m
SIT EIRP	45 – 50 dBW (@ -20 dBc spectral re-growth outside of occupied bandwidth)
Maximum Data Rate	384 kbit/s to 2048 kbit/s
Data Rate Granularity	Rate based: 16 kbit/s, Volume based: per cell

Eutelsat DVB RCS System Architecture