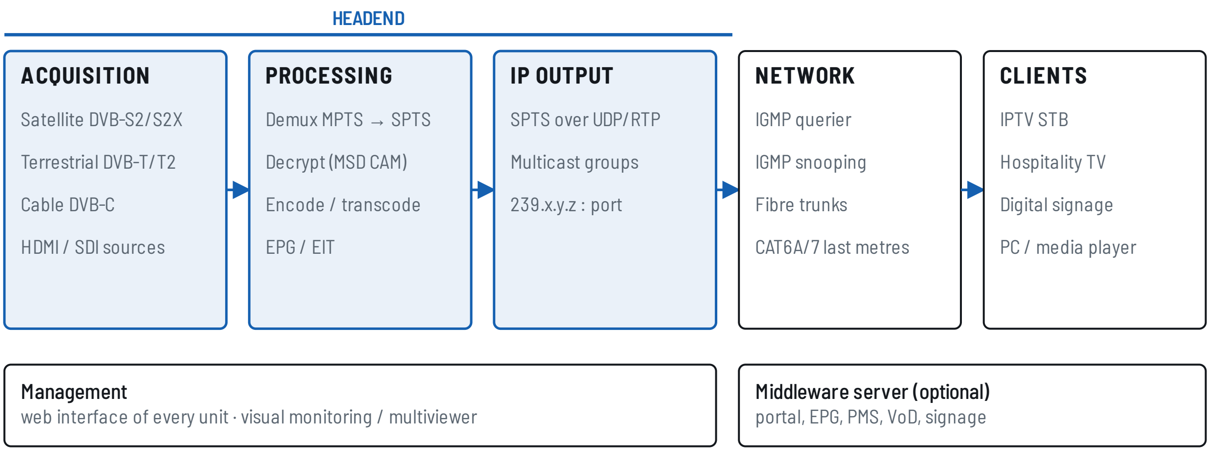
2ND EDITION 2026

IPTV · DVB · HEADEND · ENGINEERING GUIDE

IPTV Headend Planning Guide

Satellite reception basics and design guidelines for hospitality IPTV systems

IRENIS / BLANKOM · Technical guide · Ralf Riedel, Director Technical Sales & Engineering, IRENIS GmbH



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IPTV Headend Planning Guide · 2nd edition 2026 · Version 2.0, September 2026
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First edition 2022 (“A whitepaper about satellite reception basics and a design guideline for developing hospitality IPTV concepts”).

Online edition: https://www.irenis-blankom.com/iptv-headend-planning-guide/

What IPTV is – and what it is not

IPTV in this guide means linear television, streamed continuously from a central headend into a local IP network. Before you plan, be clear about what that implies.

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In this chapter

Scope of this guide
Linear streaming, not “pull” video
UDP, RTP – and why not TCP
OTT and the public internet are different

KEY POINTS

- IPTV is linear TV. The client joins a stream that is already running; it does not request a file as YouTube or Netflix do.
- With many viewers, multicast is the right model. The headend sends one copy of each channel, and the switches deliver it only where it is wanted.
- IPTV runs over UDP, optionally with RTP. TCP is built for reliable data transfer, not for live streams to many receivers.

Scope of this guide

You may be designing a new TV system, or migrating an existing coax system (SMATV or CATV) to IPTV. Either way, two topics come first: the basics of receiving satellite RF signals, and how the content of the received transponders is carried as TV and radio streams over an IP network. This guide explains both as simply as possible.

The guide concentrates on hospitality and institutional systems: hotels, hospitals, clinics, residential complexes and corporate sites. It describes **multicast** networks throughout. Unicast IPTV distribution has clear disadvantages as soon as the number of clients watching at the same time becomes significant (Chapter 15).

Linear streaming, not “pull” video

Do not confuse IPTV with pull-mode video, where you click a stored video on YouTube or Netflix and the server starts a stream just for you. IPTV is **continuous linear TV**: the headend provides every channel all the time, and the client “jumps” into a stream that is already running.

Streams can be organised in two ways:

- **Unicast (point-to-point).** Every client receives its own copy of the stream. This saves bandwidth when there are only a few clients. It needs intelligent end devices and server-side session handling.
- **Multicast (point-to-multipoint).** The headend sends each channel once, and the network switches copy it to every port that asked for it. The intelligence moves into the switches, which use IGMP (Chapter 16). Such managed switches cost more than simple ones.

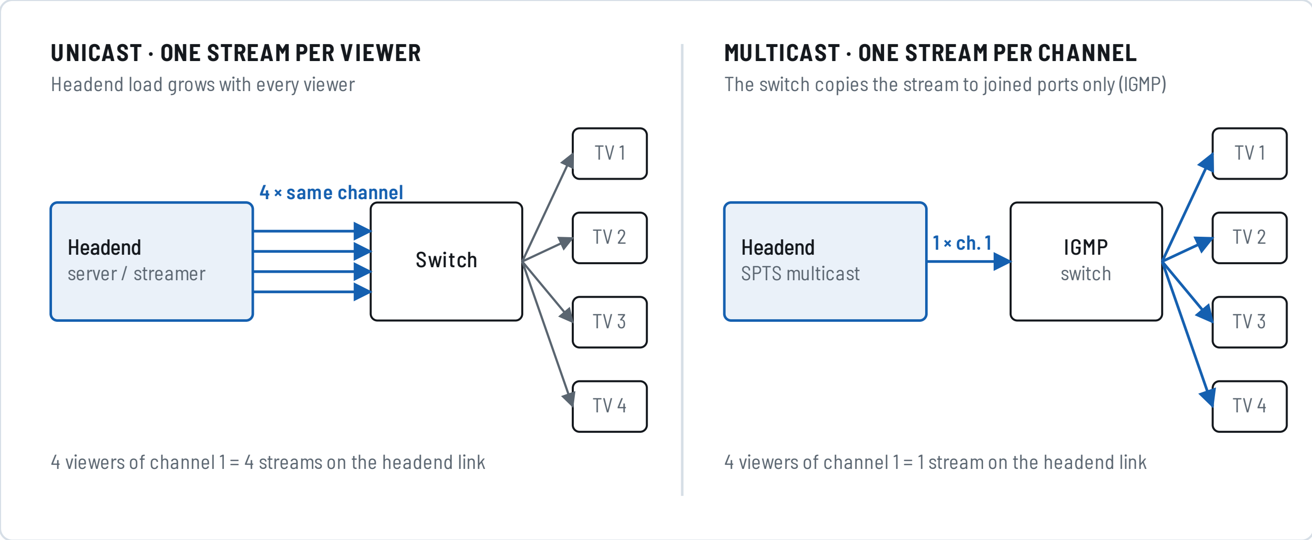

Figure 1.1 Unicast sends one copy per viewer; multicast sends one copy per channel and lets the switch replicate it.

UDP, RTP – and why not TCP

IPTV streaming uses **UDP**. UDP accepts that a packet may occasionally be lost on its way, which is the right trade-off for live video: a late packet is as useless as a lost one.

RTP can be added on top of UDP. It gives each packet a sequence number and a timestamp, so the receiver can detect losses and put packets back into the right order if necessary. This needs some extra processing and buffering in the receiver. RTP also defines a companion control protocol, **RTCP**, which by convention uses the next odd port above the even RTP port (Appendix B).

TCP is not suited to IPTV, for two reasons:

- TCP is a point-to-point connection between exactly two hosts. It cannot be multicast, so every viewer would need a separate connection.
- TCP guarantees complete, correct data. When a packet is lost, TCP stops and waits for it to be sent again. For a file or an e-mail that is exactly right: the packets may even travel over different routes, say via Frankfurt and via Tokyo, and TCP puts them back in order. For live TV, the waiting shows up as stalls and growing delay.

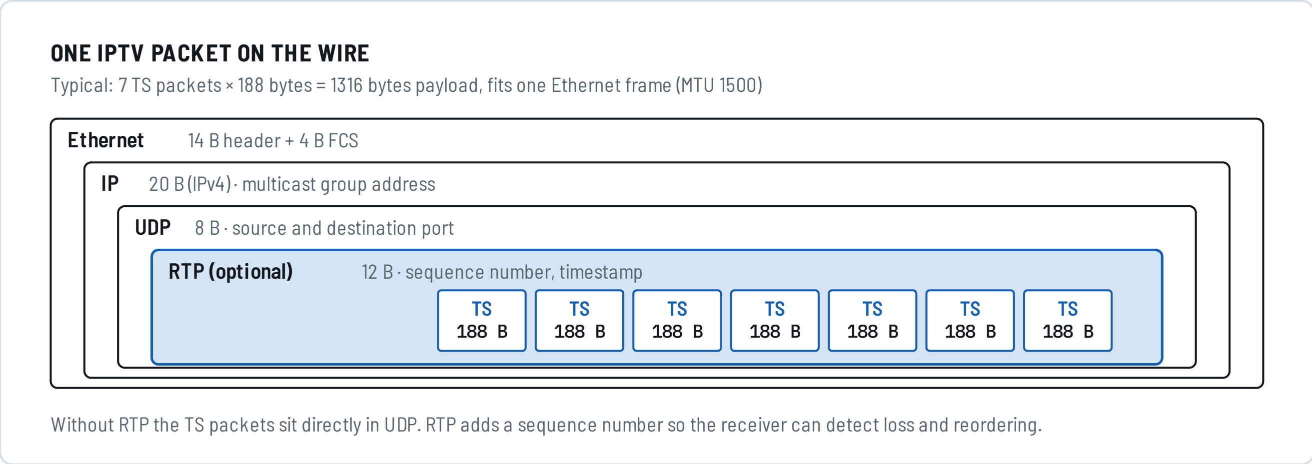

Figure 1.2 How an IPTV packet is built: TS packets inside RTP, UDP, IP and Ethernet.

OTT and the public internet are different

OTT services stream over the public internet with **adaptive bit rate** (ABR) technology: the player continuously switches between quality levels to suit the available bandwidth. Do not expect to deliver high-quality UHD streams over the public internet without adaptive bit rate streaming and a content delivery network (CDN) behind it. This guide deals with managed local networks, where multicast works and bandwidth can be planned.

> **LEARN THE VOCABULARY**
>
> IPTV brings together broadcast and IT terminology, and this chapter only scratches the surface. Make yourself familiar with the abbreviations used here. The glossary in Appendix D lists them all.

IPTV or coax distribution?

IPTV is not automatically the cheapest way to bring TV to the rooms. It pays off when it shares a network that is being built anyway.

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In this chapter Compare the whole installation, not the headend · Wi-Fi is not a distribution network for TV · Planning a new building or a renovation

KEY POINTS

- Compared with coax distribution alone, IPTV usually costs more.
- The savings come from synergy. If an Ethernet network is planned anyway, you avoid a second, parallel coax network.
- Wi-Fi is not a suitable way to distribute IPTV to many rooms.

Compare the whole installation, not the headend

On the headend alone, IPTV is usually more expensive than traditional TV and radio distribution over coax cable. The comparison changes when you look at the whole building.

Nowadays almost every hotel, hospital or office building gets a structured Ethernet network anyway. A coax system then means a **second, parallel network**: long copper runs, a tree of splitters and taps, and amplifiers that have to compensate for cable loss and slope (Chapter 5). With IPTV, TV uses the same star cabling and network design as data and telephony, so the parallel installation disappears.

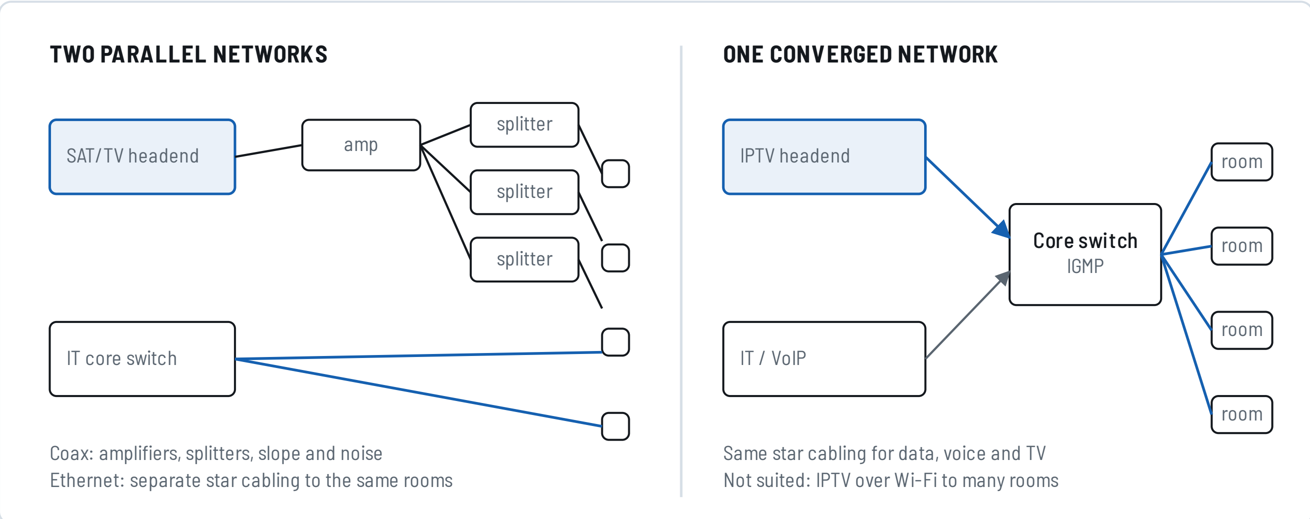

Figure 2.1 Two parallel networks versus one converged Ethernet network.

When you calculate, include:

- the cost of long coax runs and their installation,
- splitters, taps and amplifiers, and their adjustment,

- the maintenance of two networks instead of one,
- the extra services IPTV makes possible (information channels, signage, EPG, later VoD – see Chapter 22).

Wi-Fi is not a distribution network for TV

Distributing IPTV over Wi-Fi is not a good idea. Multicast over Wi-Fi is unreliable and uses a large share of the available airtime, and a single access point cannot carry dozens of TV streams to many rooms. Use cabled Ethernet to the TV or set-top box. Wi-Fi remains useful for guests' own devices and for OTT apps with adaptive bit rate.

Planning a new building or a renovation

If you are involved when the infrastructure of a new building is planned, or during a complete renovation, consider **fibre from the headend to every floor**. Electrical CAT cable has distance limits, just as coax does. A proven design is fibre trunks from the headend switch to the floor switches, and CAT6A/CAT7 double-shielded cable only for the last metres to the rooms (Chapter 8).

> **HYBRID SYSTEMS**
>
> Where a working coax network already exists, a **hybrid** system can make sense: DVB-C over the existing coax for linear TV, plus IPTV services over Ethernet. Chapter 22 describes this option.

Redundancy and availability

Everybody wants close to 100 % availability. Decide where redundancy is worth its price, and be clear about what it cannot protect.

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In this chapter What redundancy cannot cover N+1: one spare for many 1+1: a mirrored pair Checklist for the system architect

KEY POINTS

- No TV system is 100 % redundant. The satellite link between the studio uplink and your dish has no automatic backup.
- N+1 is cheaper, but the service is always interrupted while the spare takes over, and again when the repaired unit returns.
- 1+1 switches without a noticeable interruption but doubles the hardware. Use it for the channels your viewers depend on most.

A hospitality IPTV system should be available as close to 100 % of the time as the budget allows. If a channel drops out during a major sports event, guests notice at once. It is annoying, but it is entertainment, not a life-support system with its multiple independent backups, and the redundancy concept should be sized with that in mind.

What redundancy cannot cover

No design removes every risk, even with duplicated equipment. The complete chain runs from the TV studio, through the uplink and the satellite, down to all satellite receivers. There is practically no pair of independent satellites that would switch over automatically, so the chain can only be protected **from your dish onwards**.

N+1: one spare for many

In an N+1 design, one standby unit protects several active receivers or modules. Modular systems are covered in Chapter 14. When a unit fails, external control software must load the complete input and output configuration of the failed unit into the spare and bring the spare from standby into operation.

This takes time and cannot happen instantly. Bringing the repaired unit back into service causes a second interruption. The switching logic, thresholds and intervals need extensive programming. And there is an open question: what happens if a second unit fails before the first has been repaired, and there is no second spare?

1+1: a mirrored pair

A more elegant solution is automatic **1+1 redundancy**. Every active unit has its own mirror. On a failure, the pair swaps inputs and outputs automatically and practically without interruption. Only one unit may send at a time, because a multicast stream and its address must not exist twice in the network.

The cost is double hardware. Reserve 1+1 for the most important services: the channels that viewers demand most and that have the highest priority for your client.

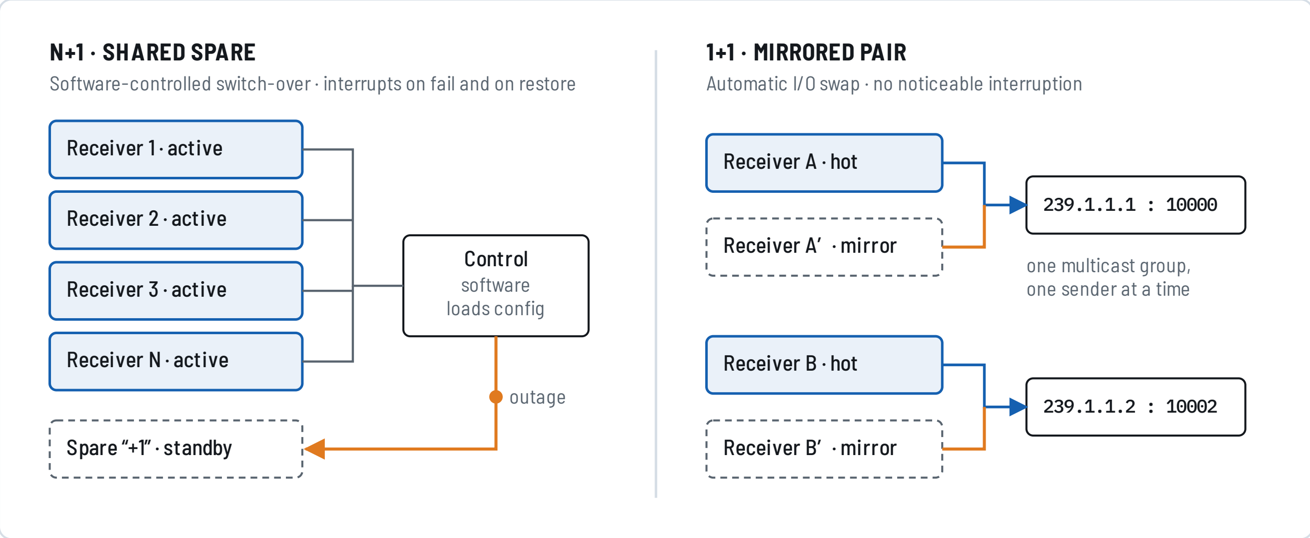

Figure 3.1 N+1 versus 1+1 redundancy.

ALARM, NOT JUST SWITCH-OVER

Combine redundancy with monitoring. When an input fails, for example because a sandstorm or thunderstorm degrades the dish-farm signal, the technicians must notice it at once so that they can repair it at the headend. Chapter 24 shows how.

Checklist for the system architect

BEFORE YOU DECIDE ON REDUNDANCY

- [ ] Cost increase compared with a non-redundant design
- [ ] Balance between seamless switching and software-controlled switching with interruptions
- [ ] Monitoring, alarms and who responds to them
- [ ] Scope: the full signal path (dishes plus master/backup headend), or only receiver/streamer backup (Chapter 7)
- [ ] Network redundancy from the headend output to the last set-top box or TV
- [ ] Power supply: if the building has no UPS, is a redundant PSU in every receiver worth it? This is partly a question of philosophy.

Pay-TV and conditional access

Pay-TV operators sell rights-protected content and want to keep control of it. That shapes what is technically and contractually possible in a headend.

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In this chapter The operator's business model | Decryption in the room | Decryption in the headend

KEY POINTS

- Pay-TV operators lose control of their content once it is decrypted in a headend, so they offer special hospitality contracts.
- A consumer CI+ module decrypts two services at most and is not intended for headend receivers.
- Headends use professional multi-service decryption CAMs (MSD CAMs), which are available only from the operator under contract.

The operator's business model

Pay-TV operators buy the rights to content such as sports events, prepare it in their studios and sell it to subscribers' set-top boxes or TV sets. They lose control over their content when a headend decrypts the DVB services and streams them unencrypted into a network. Operators therefore have separate business models for hospitality networks. The price usually depends on the number of rooms in a hotel or hospital, based on an assumed average usage.

Decryption in the room

Operators usually rent out their own or certified set-top boxes with embedded decryption. A smart card carries the subscription, and the operator's **conditional access system** (CAS) controls decryption. The next step was the **Common Interface** (CI): a slot in the receiver takes a conditional access module (CAM) with the smart card. Today, TV sets use **CI+** modules, which add stronger content protection.

Figure 4.1 A consumer CI+ module: up to two services in parallel.
Product photo: third party

A consumer CI+ module decrypts at most **two services** at the same time. Think of a dual-tuner receiver or TV with recording: you watch one channel and record a second. The CI+ specification, maintained by CI Plus LLP, is written for consumer devices.

> **CONSUMER CI+ MODULES DO NOT BELONG IN A HEADEND**
>
> Consumer CI+ modules are not intended for the CI slots of headend receivers.

Decryption in the headend

Headend receivers use professional **multi-service decryption CAMs** (MSD CAMs) in CI slots without the "+". The abbreviation to remember is **MSD CAM**. These professional modules decrypt more than two services at once. They are usually available only from the pay-TV operator, with a strict contract that the content stays inside your network and is not misused.

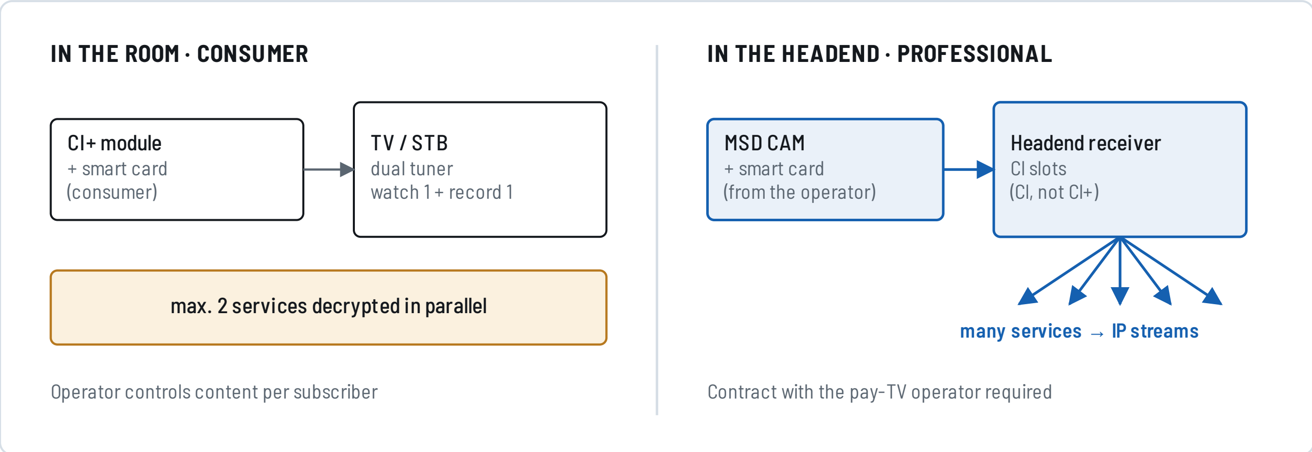

Figure 4.2 A consumer CI+ module decrypts two services at most; a professional MSD CAM in a headend receiver decrypts many.

If the operator does not supply an MSD CAM, the remaining option is decryption in the room with the operator's set-top boxes, or re-encoding the output of such boxes in the headend. Chapter 10 lists the questions to settle with the content provider.

SIGNAL RECEPTION · ENGINEERING GUIDE · CHAPTER 5

Coax RF distribution and its limits

The world may seem digital, but the signals still travel as radio frequency. On coax, distance is the enemy.

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In this chapter Digital content, analogue transport · Attenuation, slope and noise · Terminate unused outputs

KEY POINTS

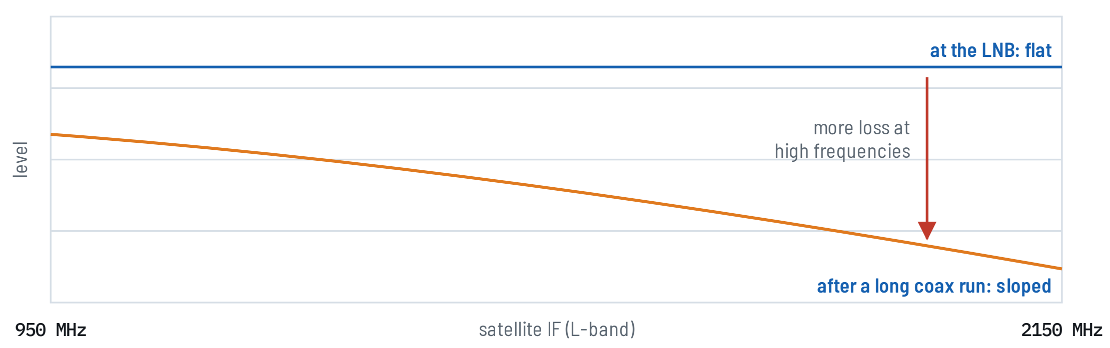
- DVB is transported as RF over the air, cable or satellite; digital only describes the content.
- Coax attenuates high frequencies more than low ones. Every amplifier that corrects this adds noise.
- Use coax only for short runs (below about 50 m) and non-critical installations. Otherwise use fibre.

Digital content, analogue transport

Today's broadcasting is **DVB** (Digital Video Broadcasting), and DVB is based on RF modulation and demodulation. The transport medium is electromagnetic waves: over the air for DVB-T/T2, in cable networks for DVB-C and from satellites for DVB-S/S2/S2X. Even Ethernet over copper sends an analogue line signal. So the world seems digital, but the transport isn't. For this chapter it does not matter which DVB variant is used.

Attenuation, slope and noise

Coax cable has limited length because of **attenuation** and **slope**. The loss rises with frequency, so after a long cable the upper end of the band is weaker than the lower end. Every time you amplify a weak, sloped RF signal you also amplify noise and reduce the signal quality (C/N, S/N). And the higher frequencies need more amplification than the lower ones. These are physical facts.



Illustration, not to scale. Keep coax runs short (< 50 m) or change to fibre.

Figure 5.1 Cable slope: long coax runs attenuate the upper end of the satellite IF band more than the lower end.

We therefore recommend coax distribution only where the distances are short (below about 50 m) and the system is not critical, for example in a residential building with a few receivers.

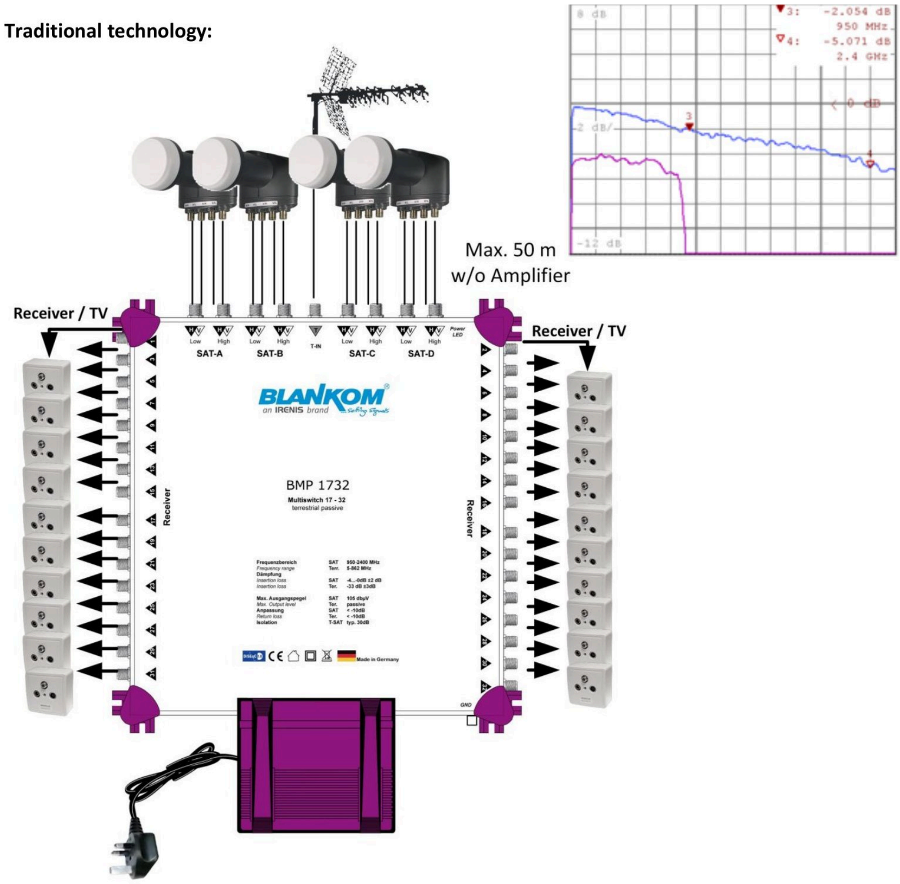


Figure 5.2 Traditional coax distribution: a 17 × 32 multiswitch feeding receivers directly, with a maximum of about 50 m without amplifier. Inset: measured attenuation over frequency.

Terminate unused outputs

A practical rule for every multiswitch installation: **cascade (trunk) outputs that are not in use must always be terminated** with 75 Ω terminators that include a DC block. An open output reflects signal back into the system. A terminator without a DC block short-circuits the supply voltage that the multiswitch passes to the LNBs.

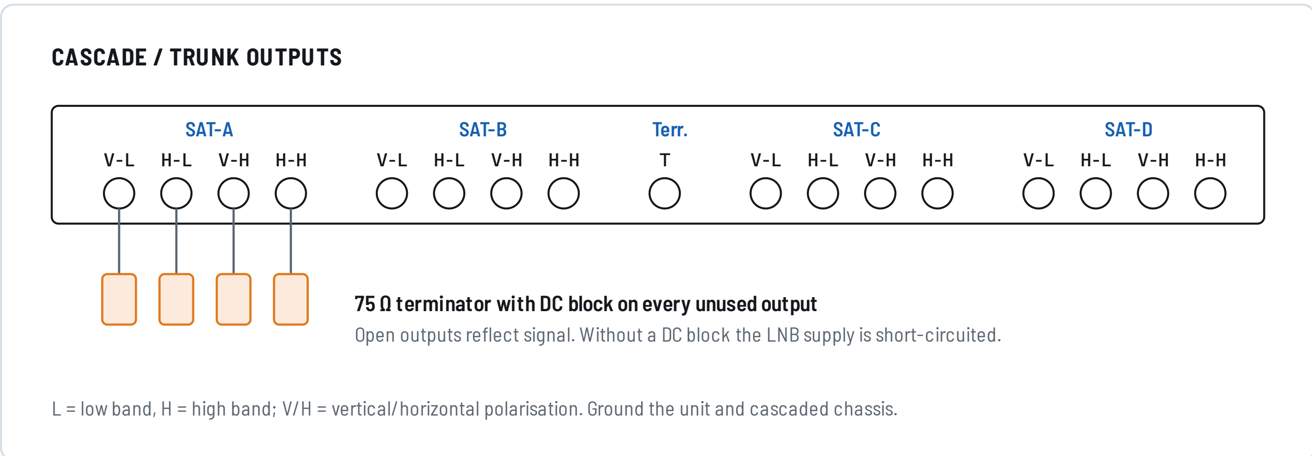


Figure 5.3 Close every unused cascade output with a 75 Ω terminator that has a DC block.

BETTER OVER DISTANCE: FIBRE

For longer distances, several buildings or critical systems, transport the satellite IF signals over optical fibre instead (Chapter 6).

SIGNAL RECEPTION · ENGINEERING GUIDE · CHAPTER 6

Satellite distribution over fibre

Optical fibre carries the complete satellite IF band over kilometres without interference. It is the modern way to connect dishes, headend and buildings.

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In this chapter One fibre, 17 wavelengths · One fibre per satellite position · Optical splitting to many buildings · Optical multiswitch

KEY POINTS

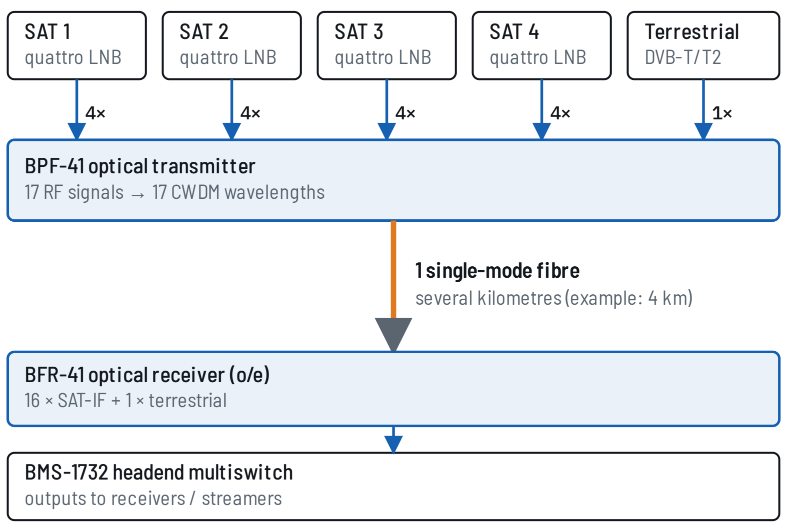
- One single-mode fibre can carry four satellite positions plus terrestrial TV on 17 CWDM wavelengths.
- Alternatively, use one fibre per satellite position and split it optically to many buildings.
- Only single-mode fibre carries RF signals. Multimode fibre is not suitable.

One fibre, 17 wavelengths

The most compact solution uses a **single fibre with 17 CWDM wavelengths**. Four satellite positions, each received with a standard quattro LNB (4 × 4 = 16 signals), plus one terrestrial DVB-T/T2 signal enter an optical transmitter. Each RF signal is put on its own wavelength. At the far end, an optical receiver converts the 17 wavelengths back into 16 satellite IF signals and one terrestrial signal, which feed a headend multiswitch.

SINGLE-MODE ONLY

RF-over-fibre systems need **single-mode** (mono-mode) fibre. Multimode fibre does not carry the RF signal.



WHY FIBRE

No electromagnetic interference
Long distances with low loss
One fibre replaces 17 coax cables
Optical splitting to many buildings

RULES

Single-mode fibre only
(multimode does not carry RF)
Terminate unused trunk outputs
with 75 Ω DC-blocked terminators

Figure 6.1 Four satellite positions and terrestrial TV on one single-mode fibre with 17 CWDM wavelengths.

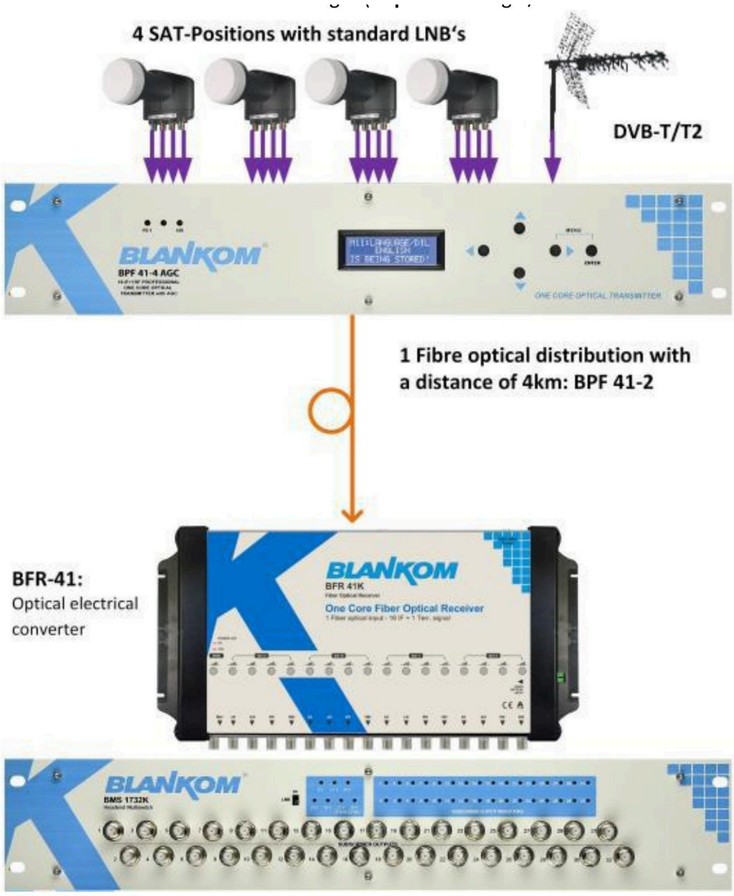


Figure 6.2 One-fibre system as installed: BPF-41 transmitter, BFR-41 receiver and a headend multiswitch.

The BPF-41 transmitter is a 19″ rack-mount unit; the BFR-41 receiver is a compact unit. Remember to terminate unused trunk outputs of the multiswitch (Chapter 5).

One fibre per satellite position

Instead of combining everything on one fibre, you can use **several single-mode fibres**, for example one per satellite position, with terrestrial signals included.

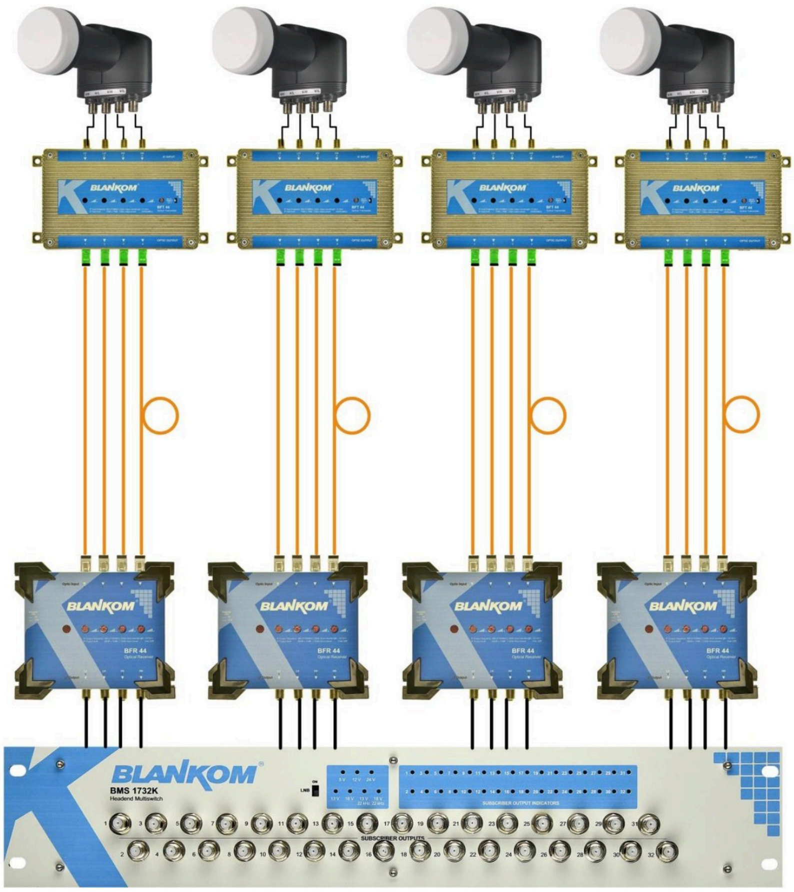


Figure 6.3 Several single-mode fibres, one per satellite position, including terrestrial signals.

For a single satellite position there are two compact solutions:

- **BPF-11/BFR-11**: one satellite position over one fibre.
- **BPF-44/BFR-44**: one satellite position over four fibres.

The transmitter (e/o) sits at the dish. The optical receiver (o/e) needs no power supply of its own, because the multiswitch powers it.

Figure 6.4 BPF-11 compact optical transmitter (e/o) for one satellite position. The picture shows the earlier model label.

Figure 6.5 BFR-11 compact optical receiver (o/e), powered from the multiswitch – no own power supply. The picture shows the earlier model label.

Optical splitting to many buildings

You can of course use more than one fibre, connect more than one LNB to the transmitter, and **split the signal optically** to distribute the same quattro-LNB satellite IF to different destinations. Depending on the fibre length, an optical attenuator may be needed. Depending on the laser power, an optical splitter of up to 32 ways can be used.

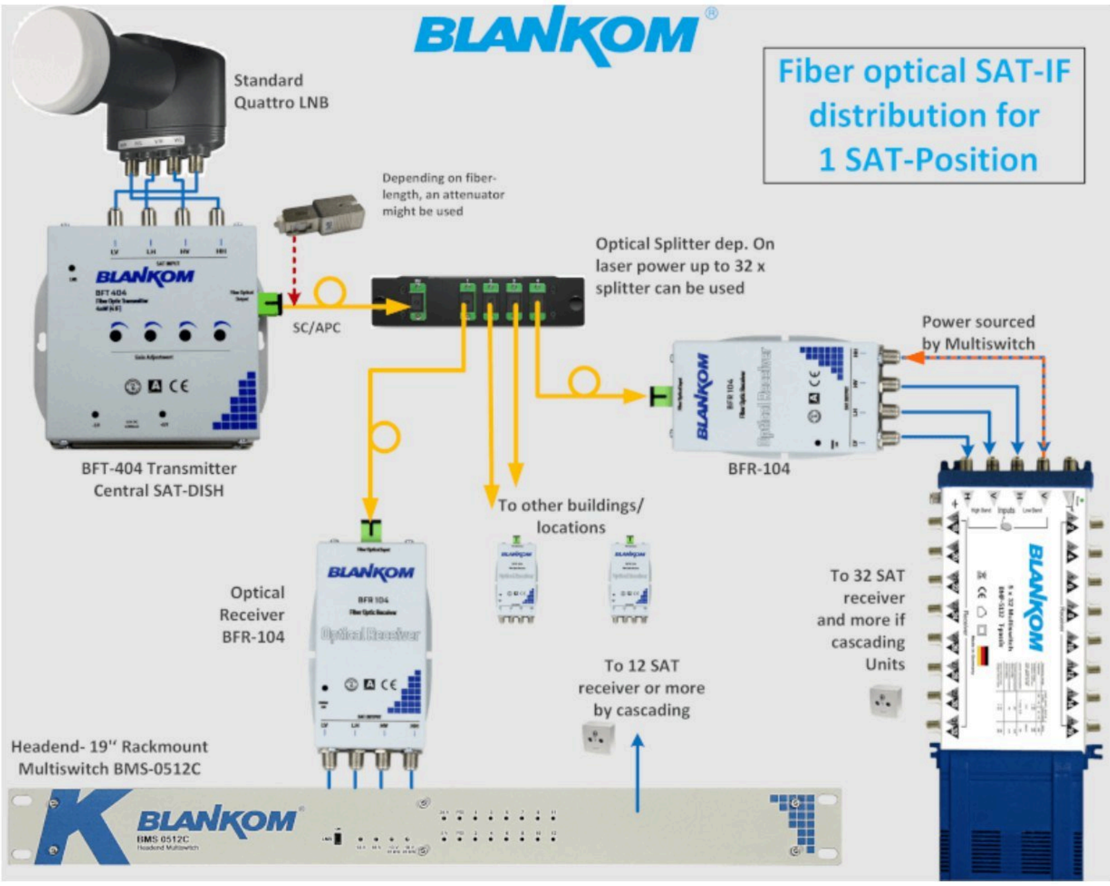


Figure 6.6 One satellite position over fibre: BPF-11 transmitter, optical splitter (up to 32 ways, depending on laser power) and BFR-11 receivers feeding multiswitches in several buildings. The drawing shows the earlier model names.

Optical multiswitch

An **optical multiswitch system** goes one step further. It serves satellite receivers or the satellite tuners of TV sets directly, for example in a development of villas or holiday homes.

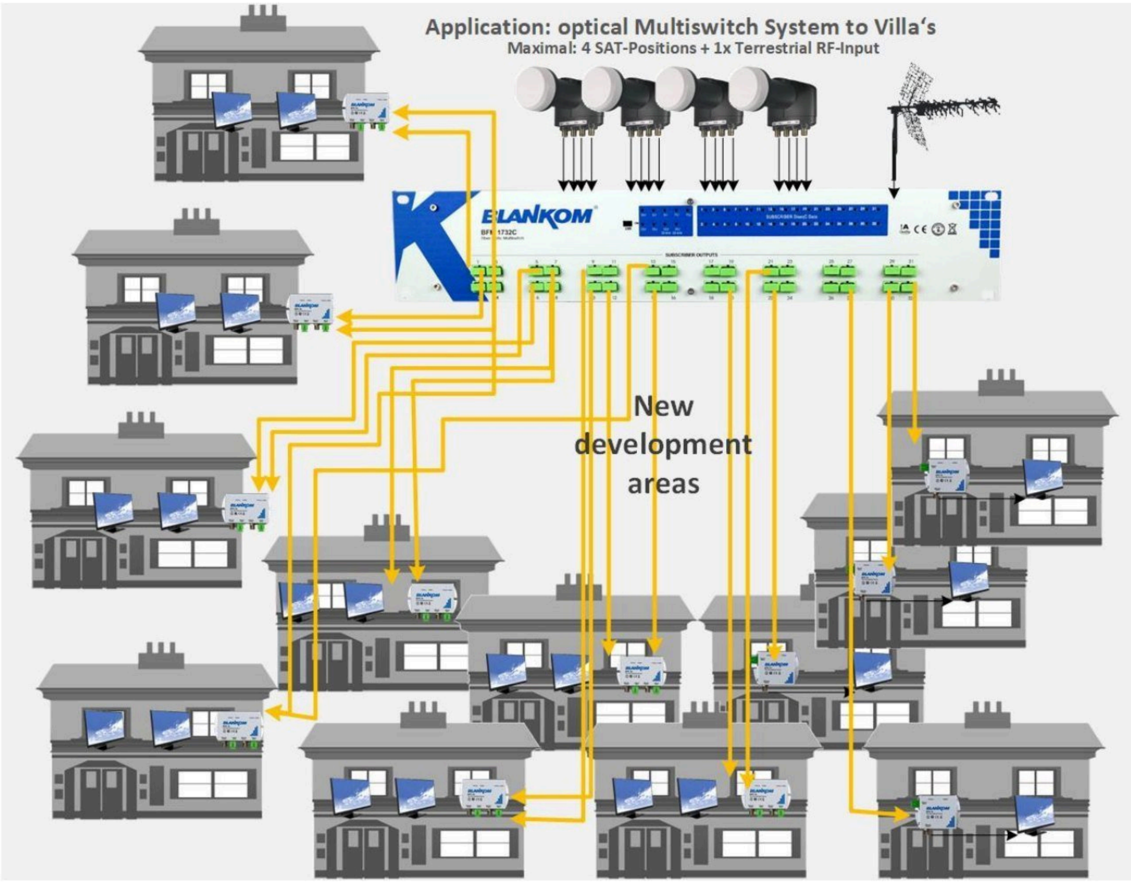


Figure 6.7 Optical multiswitch system serving satellite receivers or TV tuners directly in many houses.

CURRENT PRODUCT RANGE

The 2022 edition announced further 19″ versions and an electrical/optical redundancy switch. Ask us for the current products and versions.

SIGNAL RECEPTION · ENGINEERING GUIDE · CHAPTER 7

Satellite matrices and dish-farm redundancy

A switch matrix makes satellite IF routing remotely configurable. A redundancy switch protects the most important satellite positions against dish or LNB failure.

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In this chapter The L-band switch matrix Dish-farm redundancy

KEY POINTS

- The BMM-1716 matrix routes any of 17 inputs to any of 16 outputs, configured through a web interface.
- An automatic 1:1 redundancy switch changes from the master to a backup dish farm when an input is lost.
- You need one redundancy unit per protected satellite position. Protect only the most important positions if the budget is limited.

The L-band switch matrix

An alternative to a fixed multiswitch is a satellite **switch matrix** with an RJ45 port and a web interface, so the configuration is accessible remotely. The **BMM-1716** has 17 inputs: four satellite positions with four signals each (4 × 4 SAT) plus one terrestrial input. Its 16 outputs can be set to fixed signals. Any of the 17 inputs can be routed to any output, including the same input to several outputs.

Figure 7.1 BMM-1716 L-band switch matrix (19″, 1 RU) with web interface.

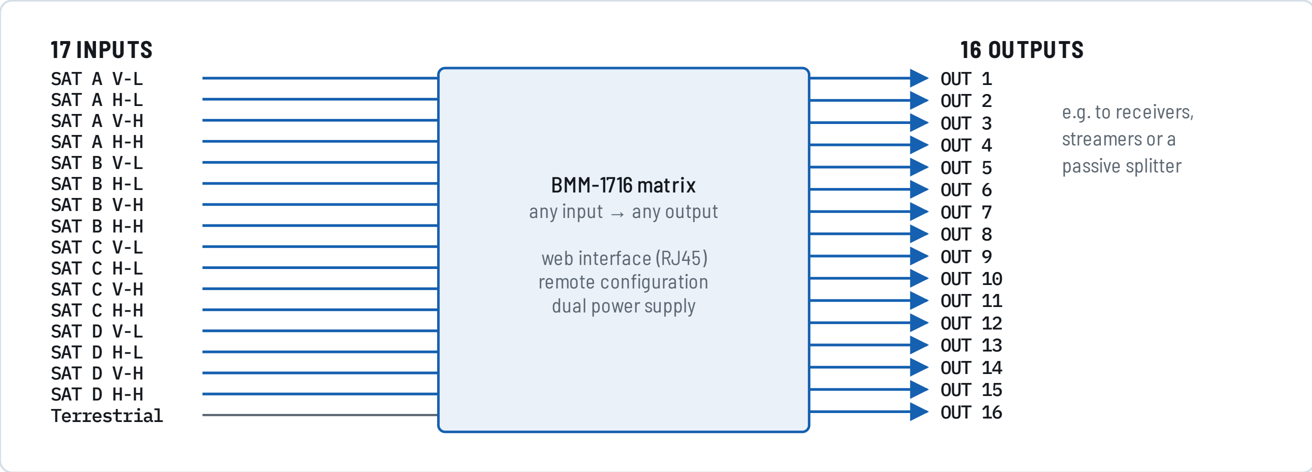

Figure 7.2 Principle of the 17 × 16 L-band switch matrix.

A passive distribution network can be connected to each output to feed a group of receivers.

Dish-farm redundancy

Now back to redundancy (Chapter 3). An automatic **master/backup dish-farm redundancy switch** in 19″ format protects up to four satellite positions. The master inputs can be electrical (coax) or optical (fibre). The backup inputs are typically fed over fibre from a second dish farm some distance away. If one of the polarisation inputs from the master farm is lost, the unit switches to the backup dish farm. It works automatically or manually.

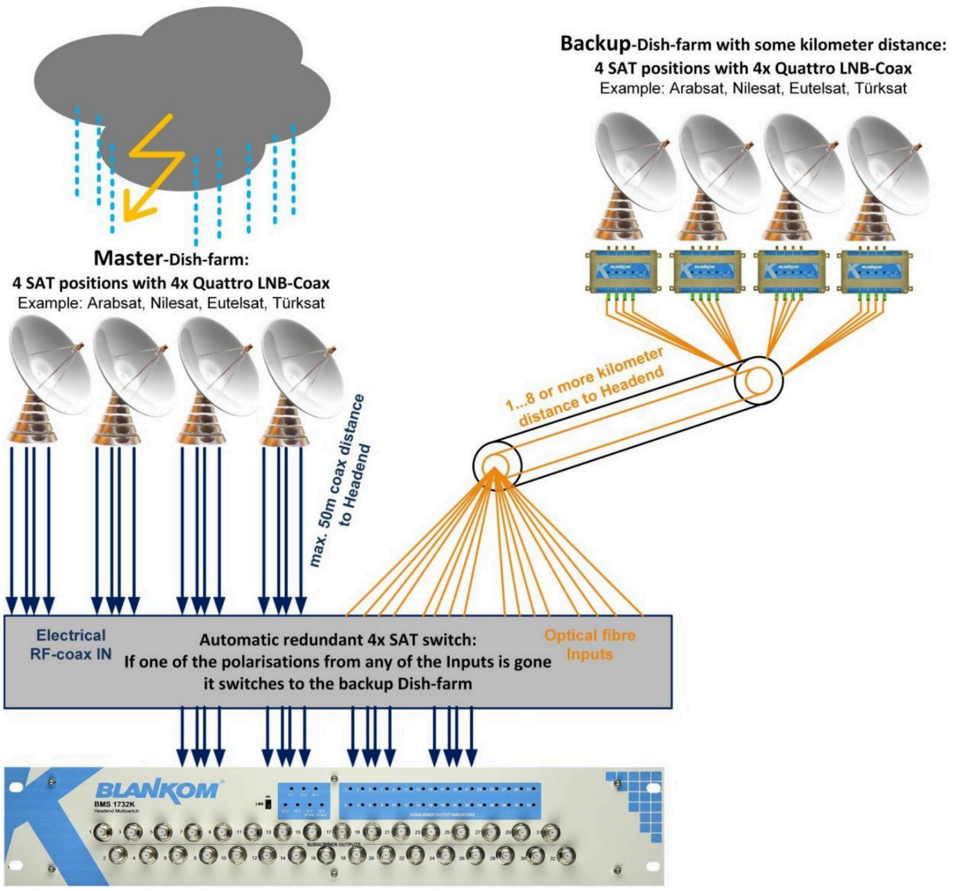

Figure 7.3 Master and backup dish farms feeding an automatic 4-position redundancy switch; the backup inputs can be optical.

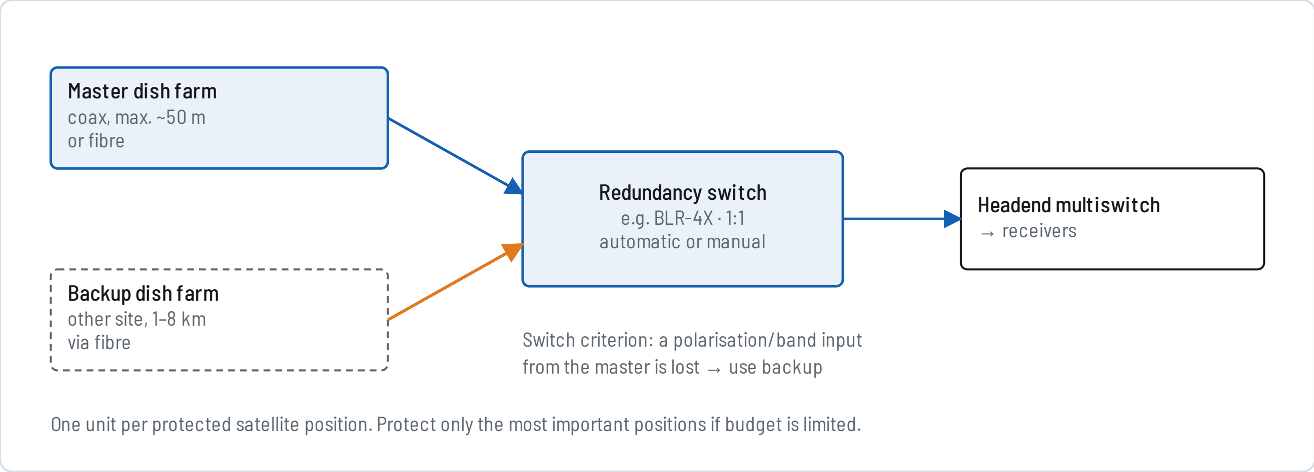

Figure 7.4 Automatic 1:1 redundancy between a master and a backup dish farm.

Figure 7.5 Multi-input redundancy unit in 19″ format.

To back up four satellite positions completely and automatically, you need four units, one per position. Some operators back up only the two most important satellite positions. That is your decision.

> **CURRENT PRODUCTS**
>
> The dish-farm redundancy unit described here is today the **BLR-4X** automatic 1:1 dish and LNB backup switch.

Installation quality: dishes, cables and connectors

A headend can only be as good as the signal it receives. Dish alignment, cables and connectors decide that quality.

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In this chapter Dishes and LNBs | Coax cables and connectors | Fibre or copper? | Ethernet cabling

KEY POINTS

- The integrator needs tools and instruments to align dishes and check the LNB signal.
- Use professional crimp or compression F connectors that match the cable diameter. Screw-on connectors are not suitable.
- Fibre beats copper over distance. For the last metres, use CAT6A/CAT7 double-shielded cable.

Dishes and LNBs

The system integrator must bring the right tools and measuring instruments (Chapter 9) to check and adjust:

- the **dishes**: correct azimuth and elevation angles, and a fixation that withstands wind and weather,
- the **signal level and quality** at the LNB outputs,
- the **cabling**: avoid long coax runs or use fibre (Chapter 6).

Coax cables and connectors

Install coax cable with care. Keep the bending radius at or above the cable maker's minimum (not less than 5 cm). Use professional **F connectors**. Do not use screw-on connectors; use crimp or self-install types, or compression connectors.

Figure 8.1 Not suitable: screw-on F connector.

Figure 8.2 Crimp or self-install F connector.

Figure 8.3 Compression F connector.

Figure 8.4 Compression tool.

Connectors are made for specific cable diameters. Thicker cables with better shielding and insulation generally perform better than cheap cables, which may be acceptable in a household but not in a professional system like the ones this guide describes. Cable quality matters as much as handling and connectors.

Figure 8.5 Cable diameters compared: a thick mobile-network master antenna cable next to RG174, RG58 and H2000flex.

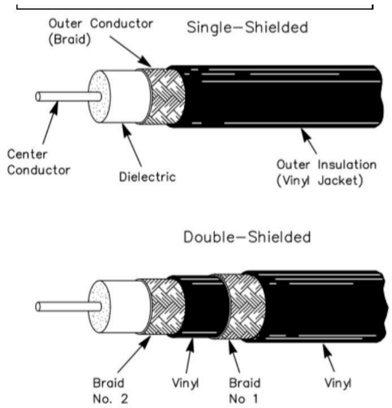


Figure 8.6 Single-shielded and double-shielded coax construction.

Fibre or copper?

	FIBRE OPTIC CABLE	COPPER (COAX / CAT)
Interference	No electromagnetic interference; does not leak into other RF links	Can pick up and radiate interference
Distance	Long distances with low attenuation	Limited by attenuation and slope
Power	Low power consumption	Amplifiers needed over distance
Splitting	Can serve many hundreds of buildings	Limited by splitter loss
Cost	Higher, but reasonable today	Lower material cost
Installation	Needs special splicing equipment	Standard tools
Robustness	Sensitive to sharp bends and buckling	More robust

Ethernet cabling

Cable quality matters for Ethernet too. Prefer **CAT6A or CAT7**, and for video streaming in particular **double-shielded twisted pair** (S/FTP).

In a new building or a complete renovation, run fibre from the headend to the floor switches and use electrical CAT6A/7 cable only for the last metres to the rooms (Chapter 2).

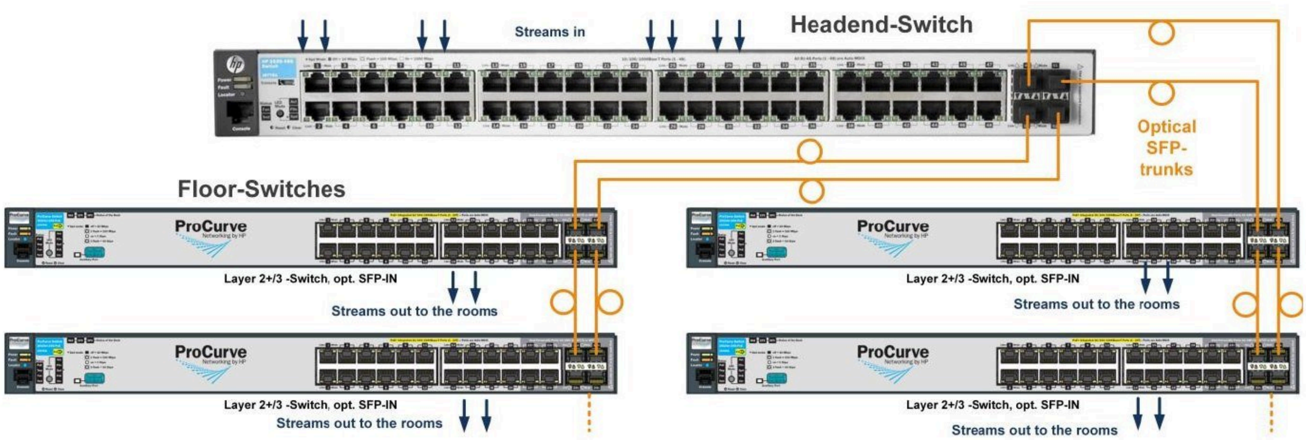


Figure 8.7 Fibre trunks from the headend switch to the floor switches; copper only for the last metres.

SIGNAL RECEPTION · ENGINEERING GUIDE · CHAPTER 9

Measuring the satellite signal

Before the signals reach the receiver-streamers, measure them. A handheld analyser shows level, carrier-to-noise ratio and slope at a glance.

IRENIS / BLANKOM · Technical guide · Ralf Riedel, Director Technical Sales & Engineering, IRENIS GmbH

In this chapter Instruments Reading the spectrum

KEY POINTS

- Measure at the LNB, at the multiswitch or matrix outputs and at the receiver inputs.
- Around 80 dBµV at a multiswitch output is a good level.
- Dish alignment, LNB focus and quality, and cable length and quality decide the signal quality.

Instruments

Before looking at content, make sure that a good-quality signal leaves the satellite multiswitch or matrix and reaches the receiver-streamers in good shape. You need a handheld instrument for this: a professional analyser, for example from PROMAX, or a less expensive semi-professional meter such as ALPSAT.

Figure 9.1 Professional analyser (PROMAX).
Product photo: PROMAX

Figure 9.2 Semi-professional meter (ALPSAT).
Product photo: ALPSAT

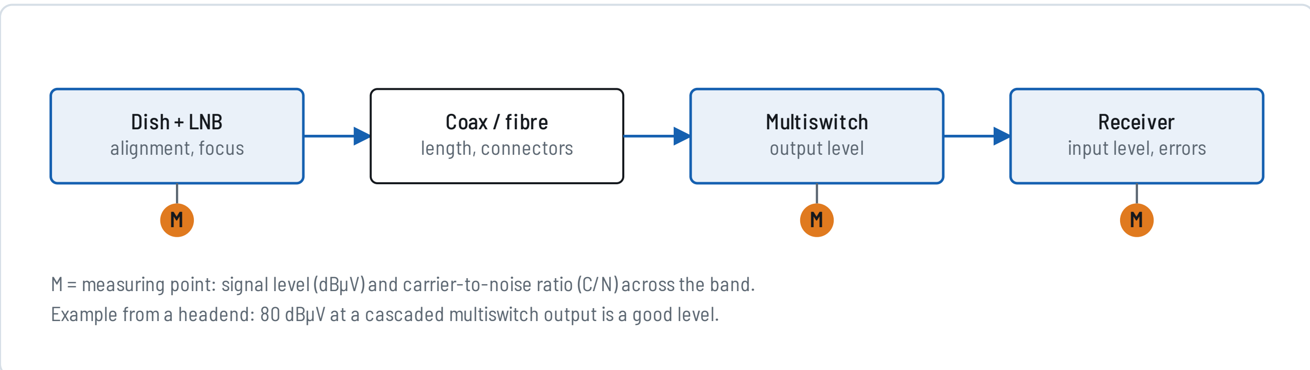


Figure 9.3 Where to measure along the reception chain.

Reading the spectrum

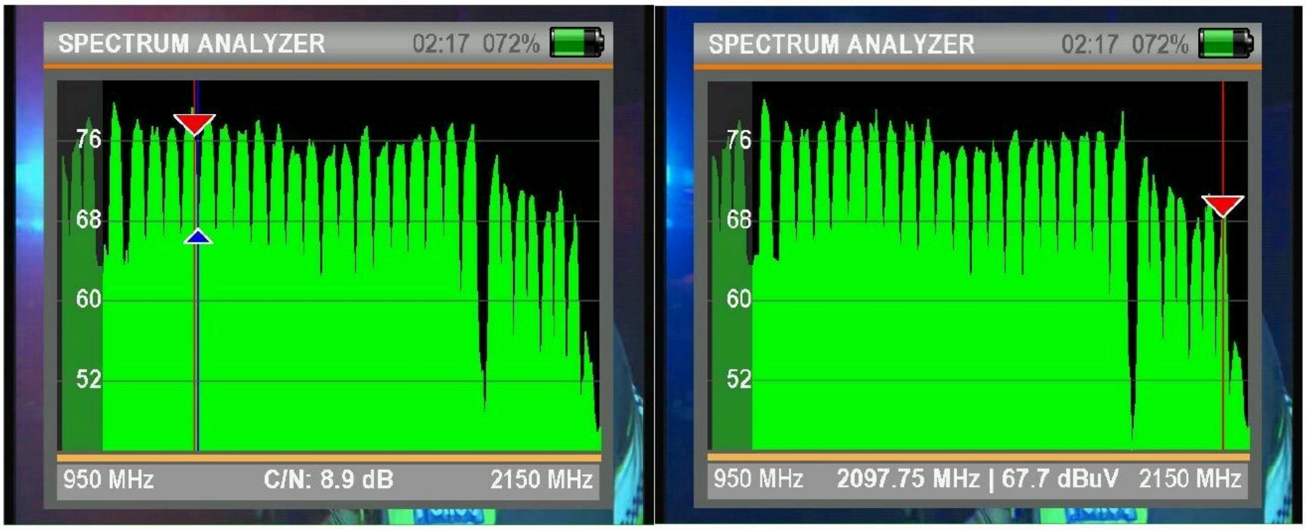


Figure 9.4 Left: C/N measurement – note the slope, i.e. higher attenuation at higher frequencies. Right: level measurement.

The left screen shows a C/N measurement. Note the **slope**: the higher frequencies are attenuated more (Chapter 5). The right screen shows the level.

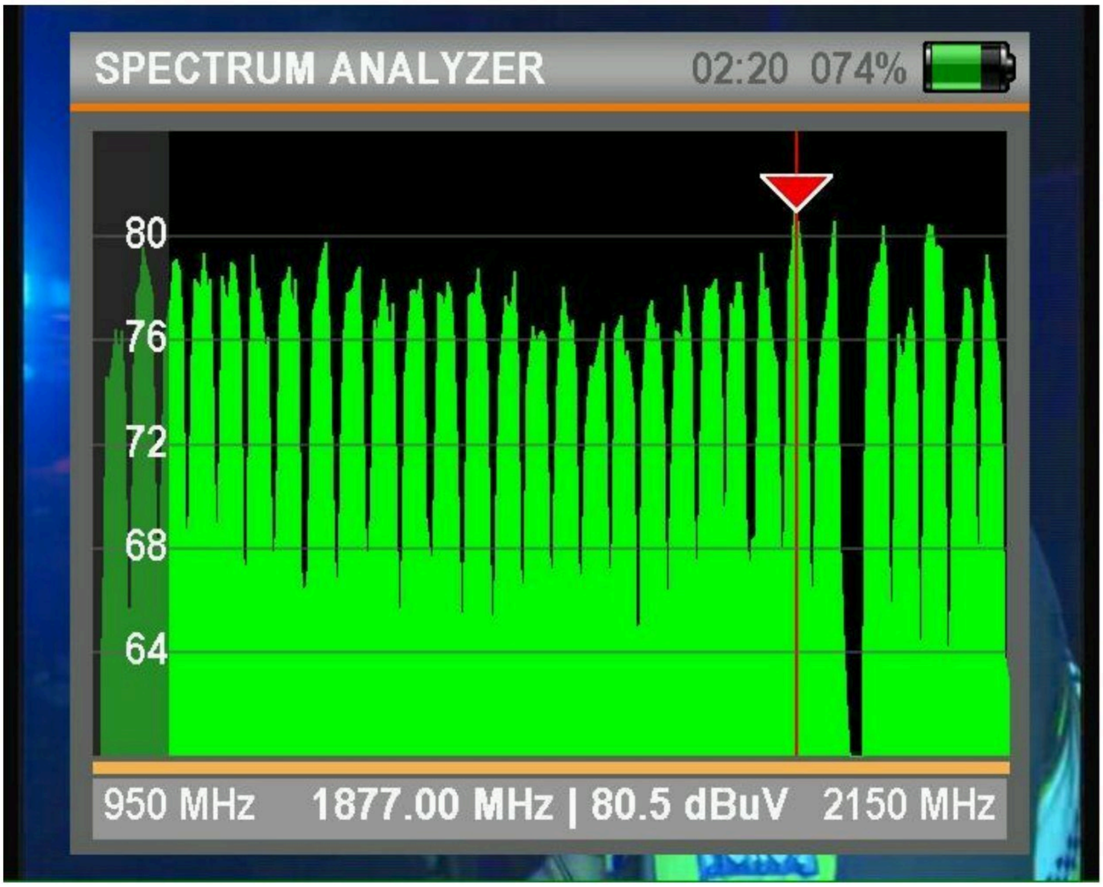


Figure 9.5 80 dBµV at a cascaded output of a BLANKOM 32-output multiswitch: a good level.

The example above shows a good output level of **80 dBµV** directly at a cascaded output of a BLANKOM 32-output multiswitch. The first two screens show ASTRA 19.2°E high band. The third shows Eutelsat Hot Bird 13°E on DiSEqC position 2, with a better-adjusted LNB at the dish.

SIGNAL QUALITY DEPENDS ON

- [ ] Dish direction and angles
- [ ] LNB focus and angle
- [ ] LNB quality
- [ ] Cable length and quality

If the level is fine but the receiver still reports errors, look into the transport stream itself (Chapter 12 and Chapter 13).

The headend: requirements and first questions

The headend is the source of every stream in the system. Invest here, and answer a short list of questions before anyone can quote a price.

IRENIS / BLANKOM · Technical guide · Ralf Riedel, Director Technical Sales & Engineering, IRENIS GmbH

In this chapter What the headend must deliver First question: where do the programmes come from? “How much for 100 channels?” What we need to know to design your headend

KEY POINTS

- The headend is the most critical part of the system. Higher investment here lowers operating costs later.
- Zapping time must be well below 3 seconds. Viewers expect at least what they know from DVB television.
- Nobody can price “100 channels” without knowing the satellites, transponders, services, decryption and client devices.

What the headend must deliver

The headend is the **source** of all your streams. Do not cut corners here: it is the most critical part of the system. It is responsible for:

- secure reception,
- decryption, if needed,
- stability and a long-term design,
- encoding,
- the quality of components and services,
- redundancy of power supplies, reception and processing (Chapter 3),
- low maintenance cost,
- additional features such as EPG and channel lists announced by SAP,
- **picture quality**, one of the key requirements for viewers,
- **zapping time** (channel change) well below 3 seconds,
- live streaming only, or additional capabilities such as PVR, VoD, social media and digital signage.

People are used to DVB television (or ATSC in the USA) and expect the same features from IPTV, or more.

Figure 10.1 People expect from IPTV at least what they know from DVB television.
Stock image

So rely on professional headend equipment and do not buy the cheapest available. A somewhat higher investment (CAPEX) pays back through lower operating costs (OPEX).

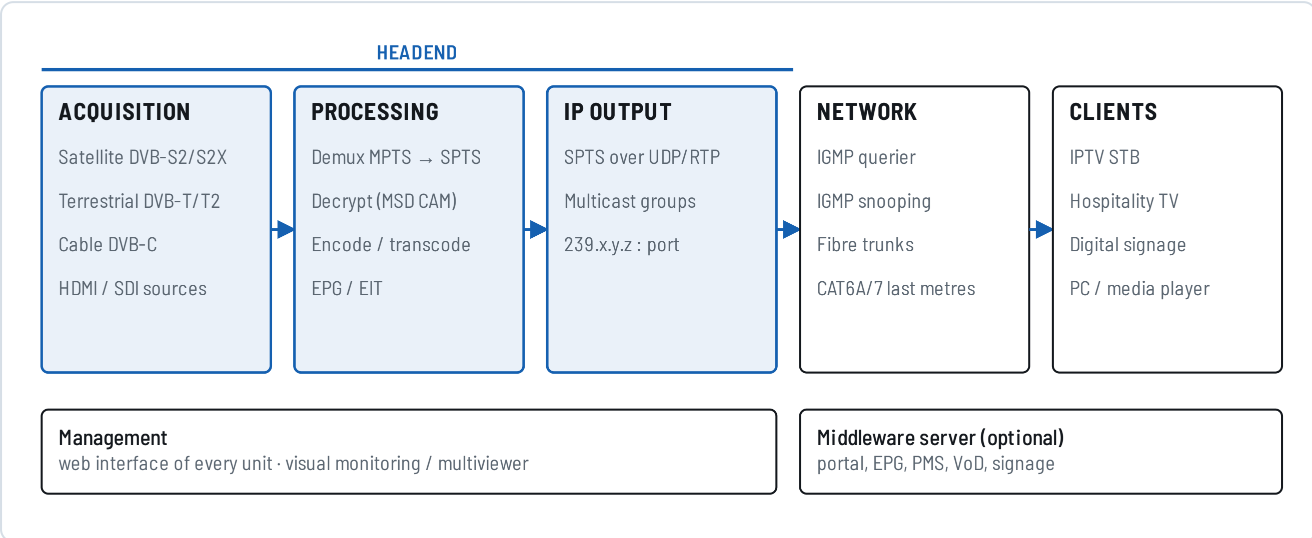


Figure 10.2 The signal path of an IPTV system, from acquisition to the client.

First question: where do the programmes come from?

- **Satellite** (DVB-S/S2)? Do you need DVB-S2X tuning capability?
- Does the receiver-streamer need **32APSK**? Most transponders use QPSK or 8PSK; only a few UHD transponders use the advanced modulations. An online calculator helps: satellite-calculations.com.
- **Terrestrial** (DVB-T/T2, ISDB-Tb)? If the TVs in the rooms have triple tuners, there is no need to insert terrestrial services into a CATV or IPTV network.
- **Cable** (DVB-C) or analogue channels? You need a DVB-C receiver-streamer, plus an analogue encoder-streamer for analogue sources.
- Do you need set-top boxes with **embedded decryption** and smart cards, whose output is then re-encoded (Chapter 4)?

"How much for 100 channels?"

We at BLANKOM/IRENIS are often asked: *Do you have IPTV?* Yes, we do. The next question is usually: *How much does it cost for 100 channels?* No serious answer is possible, whether it is 100 dollars per channel or any other figure.

Nobody can calculate a system without detailed and exact information about reception, processing, possible decryption and re-encoding, and the selection of services. The wanted services are cherry-picked from the many TV services that the satellite transponders (or DVB-T/T2/C channels) carry. Each transponder carries a **transport stream** (TS): a bouquet of services on one RF channel.

People often confuse channels and transponders. A single TV channel, correctly called a **service**, is part of a TS on one frequency (transponder). To pick one service from the bouquet, the complete transponder must be received and **demultiplexed** into its individual services, which are then streamed as single-programme transport streams (SPTS). Chapter 12 explains how.

What we need to know to design your headend

INFORMATION FOR THE HEADEND DESIGN

- [ ] Number and orbital positions of the satellites that carry the wanted services (e.g. ASTRA 19.2°E, Eutelsat Hot Bird 13°E, Nilesat, Arabsat, Türksat). There are hundreds of satellites with thousands of transponders.
- [ ] Data of every transponder to be received: position, low or high band, vertical or horizontal polarisation, frequency. This is needed to calculate the number and size of the dishes and the matrix or multiswitch ports.
- [ ] Details of every TV **service** to be streamed to IP. (“Service” is the correct term, not “channel” or “programme”.)
- [ ] Whether EPG data is needed with the streams, or skipped as in a basic package (Chapter 20).
- [ ] Availability of MSD CAMs from the pay-TV operators for encrypted content (Chapter 4).
- [ ] If only embedded decryption is possible: which set-top boxes and smart cards can be used, and which requirements the content providers set.
- [ ] Own channels to insert (hotel TV, restaurant, gym, spa …) and the encoders for them (Chapter 18).
- [ ] Whether transcoding is needed, and why: limited network speed, middleware capability, multicast or unicast load, OTT or multiscreen (Chapter 19).
- [ ] Whether re-encryption (e.g. Verimatrix, AES) is required, embedded in the set-top box.

Hotel systems often have to integrate with a building management system or with the property management system (PMS) at reception. These are nice to have, but check whether they are really necessary for television (Chapter 22).

The next chapter shows how to collect the satellite and service data.

DESIGNING THE HEADEND · ENGINEERING GUIDE · CHAPTER 11

Surveying satellites, transponders and services

A headend design starts with a spreadsheet, not with hardware. Collect satellite, transponder and service data, then document everything.

IRENIS / BLANKOM · Technical guide · Ralf Riedel, Director Technical Sales & Engineering, IRENIS GmbH

In this chapter

1 – Choose the region and the satellites
2 – Collect the transponder data
3 – Check the footprint at your site
4 and 5 – Prepare the service sheet

KEY POINTS

- Public databases such as LyngSat, KingOfSat and SatBeams give transponder data and footprints.
- The footprint at your site decides the dish size.
- A service sheet with one row per service is the basis of the headend design and of the documentation.

The satellite transponders from the various orbital positions have to be brought to the inputs of the satellite receiver-streamers. Collect the data in five steps.

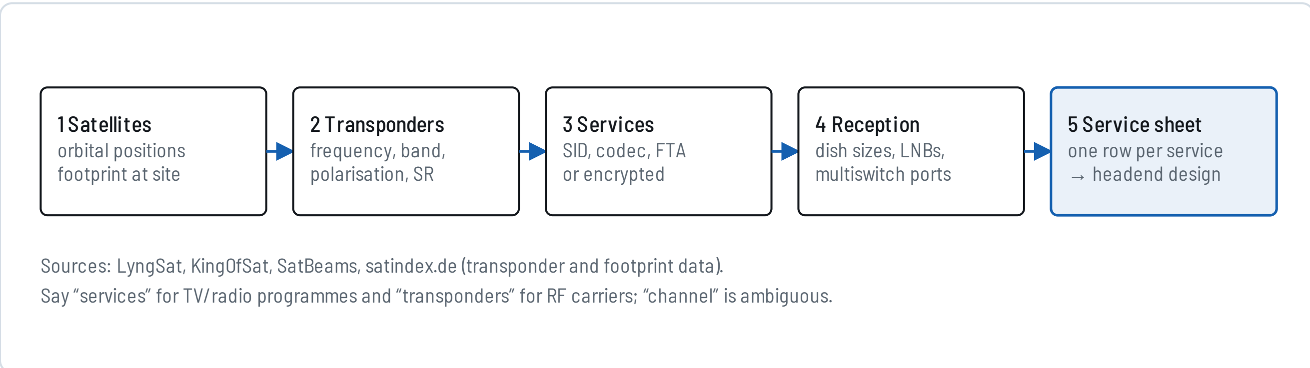
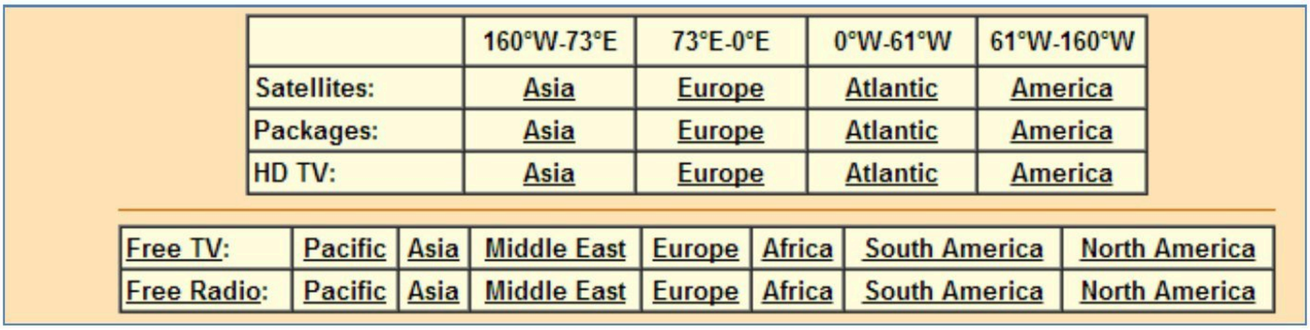


Figure 11.1 From a list of wanted services to a headend design in five steps.

1 – Choose the region and the satellites

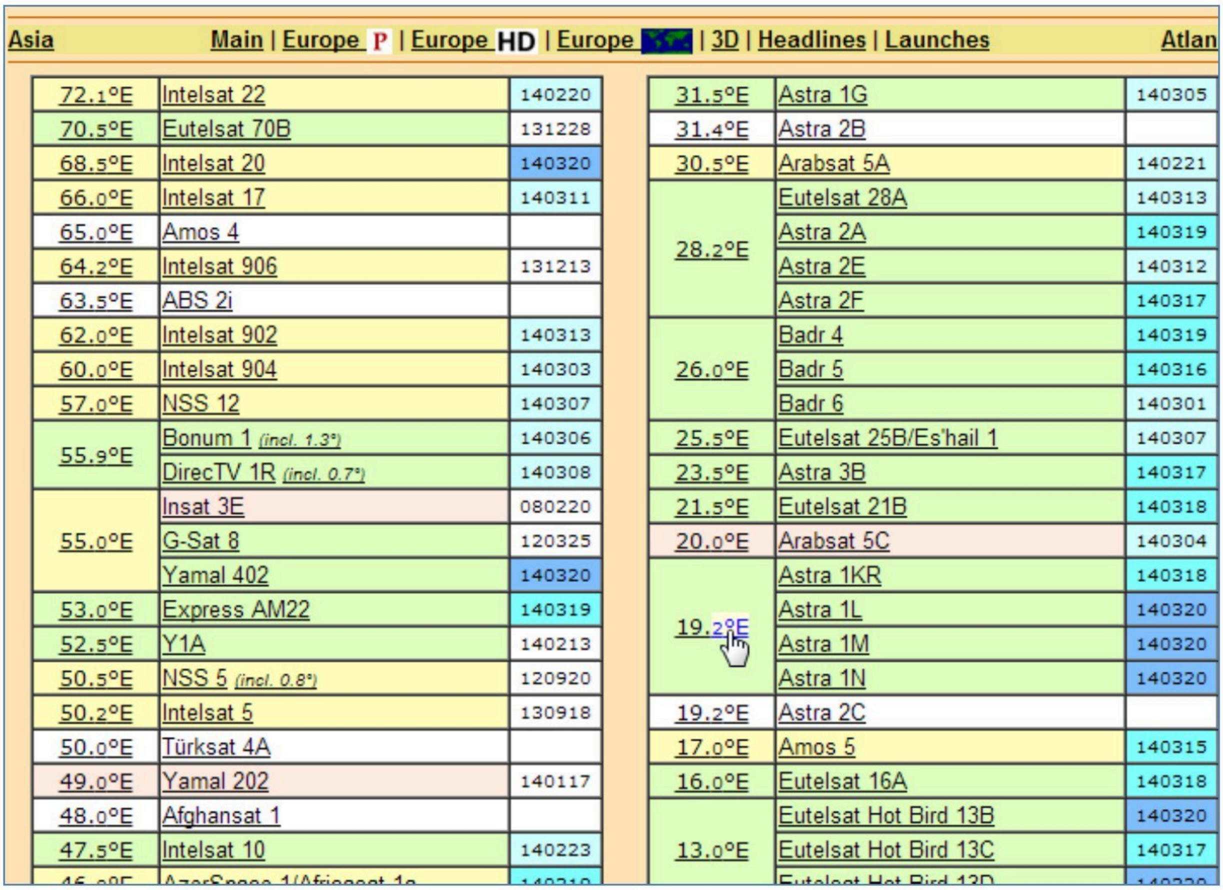
Public databases list the services on every satellite, for example LyngSat, KingOfSat, SatBeams or satindex.de.



	160°W-73°E	73°E-0°E	0°W-61°W	61°W-160°W
Satellites:	Asia	Europe	Atlantic	America
Packages:	Asia	Europe	Atlantic	America
HD TV:	Asia	Europe	Atlantic	America

Free TV:	Pacific	Asia	Middle East	Europe	Africa	South America	North America
Free Radio:	Pacific	Asia	Middle East	Europe	Africa	South America	North America

Figure 11.2 Choosing the region on LyngSat.
Screenshot: lyngsat.com



Asia Main | Europe P | Europe HD | Europe | 3D | Headlines | Launches Atlan

72.1°E	Intelsat 22	140220
70.5°E	Eutelsat 70B	131228
68.5°E	Intelsat 20	140320
66.0°E	Intelsat 17	140311
65.0°E	Amos 4	
64.2°E	Intelsat 906	131213
63.5°E	ABS 2i	
62.0°E	Intelsat 902	140313
60.0°E	Intelsat 904	140303
57.0°E	NSS 12	140307
55.9°E	Bonum 1 *(incl. 1.3°)*	140306
	DirecTV 1R *(incl. 0.7°)*	140308
55.0°E	Insat 3E	080220
	G-Sat 8	120325
	Yamal 402	140320
53.0°E	Express AM22	140319
52.5°E	Y1A	140213
50.5°E	NSS 5 *(incl. 0.8°)*	120920
50.2°E	Intelsat 5	130918
50.0°E	Türksat 4A	
49.0°E	Yamal 202	140117
48.0°E	Afghansat 1	
47.5°E	Intelsat 10	140223

31.5°E	Astra 1G	140305
31.4°E	Astra 2B	
30.5°E	Arabsat 5A	140221
28.2°E	Eutelsat 28A	140313
	Astra 2A	140319
	Astra 2E	140312
	Astra 2F	140317
26.0°E	Badr 4	140319
	Badr 5	140316
	Badr 6	140301
25.5°E	Eutelsat 25B/Es'hail 1	140307
23.5°E	Astra 3B	140317
21.5°E	Eutelsat 21B	140318
20.0°E	Arabsat 5C	140304
19.2°E	Astra 1KR	140318
	Astra 1L	140320
	Astra 1M	140320
	Astra 1N	140320
19.2°E	Astra 2C	
17.0°E	Amos 5	140315
16.0°E	Eutelsat 16A	140318
13.0°E	Eutelsat Hot Bird 13B	140320
	Eutelsat Hot Bird 13C	140317

Figure 11.3 Satellite list for the region.
Screenshot: lyngsat.com

2 – Collect the transponder data

For every transponder, note the frequency, polarisation, symbol rate, FEC, modulation and the services it carries.

The EIRP values are for Germany									
Astra 1KR/1L/1M/1N © LyngSat, last updated 2014-03-20 - http://www.lyngsat.com/Astra-1KR-1L-1M-1N.html									
Freq. Tp		Provider Name Channel Name		System Encryption	SR-FEC SID-VPID		ONID-TID APID Lang.	Beam EIRP (dBW) C/N lock	Source Updated
10714 H tp 49								Europe 51	D Shimoni 120530
10729 V tp 50	CANAL+	Canal +	P	DVB-S2 MPEG-4/HD Nagravision 3	22000-2/3 8PSK		1-1050	Europe 51 6.6	D Shimoni Anonymous 140318
10744 H tp 51	ARD DIGITAL	ARD Digital	A	DVB-S	22000-5/6		1-1051	Europe 51 6.5	D Shimoni N Schlammer Anonymous 140320
		Tagesschau 24	T S A	F	28721	101	102 G		
		Einsfestival	T A	F	28722	201	202 G 203 orig 206 G		
		Eins Plus	T A	F	28723	301	302 G 303 orig 306 G		
		ARTE Deutsch	T A	F	28724	401	402 G 403 F		
		Phoenix	T A	F	28725	501	502 G 503 orig		
10758 V tp 52	CANAL+	Canal +	P	DVB-S Mediaguard 2 Nagravision 3	22000-5/6		1-1028	Europe 51 6.5	D Shimoni Anonymous 140313
		LTC	A	F	29853	163	92 Sp		
		[Canal + InfoDeporte test card]			29862	4160			
	SES	SES		DVB-S2	22000-3/4 8PSK		1-1053		
		Anixe	A	F MPEG-4/HD	21100	255	259 G		
		QVC Deutschland	T S A	F MPEG-4/HD	21103	1023	1027 G		

Figure 11.4 Transponder data: frequency, polarisation, symbol rate, FEC and services.
Screenshot: kingofsat.net

3 – Check the footprint at your site

Check the reception conditions and the footprint of the satellite beams at your location to calculate the dish sizes.

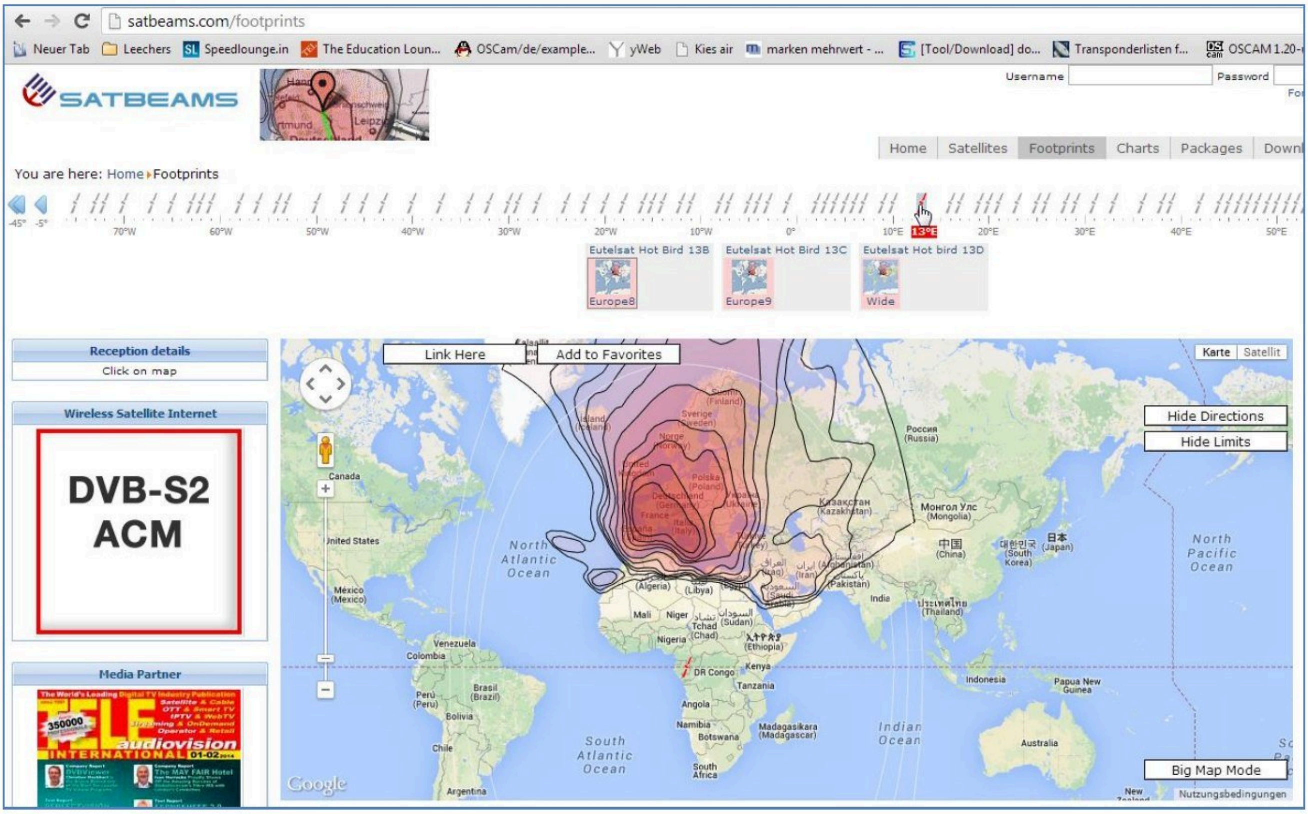


Figure 11.5 Beam footprint for the site, used to size the dishes.
Screenshot: satbeams.com

4 and 5 – Prepare the service sheet

Finally, prepare a satellite and service list, for example as a simple Excel sheet.

1	Programm	DISH-No	Transponder	Frequency [MHz]	Power [kV	Distance (Beam) [ki	Orbital position	Polarisation	Symbolrate	FEC	Modulation	SID [dez.]	Languag	Remarks	datarate [Mbit/s]
2	ARD Digital	ASTRA 1	51	10743,75			19,2° E	H	22000	5/6					33,8
3	ARD digital, ZDF Vision	ASTRA 1	11	11361,75			19,2° E	H	22000	2/3					42,6
4	Kabelkiosk Sky	ASTRA 1	65	11719,5			19,2° E	H	27500	3/4					38,0
5	Kabelkiosk	ASTRA 1	66	11739			19,2° E	V	27500	3/4	QPSK				38,0
6	BetaDigital	ASTRA 1	67	11758,5			19,2° E	H	27500	3/4					38,0
7	Digital+	ASTRA 1	68	11778			19,2° E	V	27500	3/4	QPSK				38,0
8	BetaDigital	ASTRA 1	69	11797,5			19,2° E	H	27500	3/4					38,0
9	ARD digital	ASTRA 1	71	11836			19,2° E	H	27500	3/4					38,0
10	Kabelkiosk Sky	ASTRA 1	75	11914,5			19,2° E	H	27500	9/10					38,0
11	ZDF vision	ASTRA 1	77	11954			19,2° E	H	27500	3/4					38,0
12	MTV Networks	ASTRA 1	78	11973			19,2° E	V	27500	3/4	QPSK			zeitpartagiert auf Satellit	38,0
13	Kabelkiosk Sky	ASTRA 1	79	11992,5			19,2° E	H	27500	9/10					49,2
14	Kabelkiosk Sky	ASTRA 1	81	12031,5			19,2° E	H	27500	3/4					38,0
15	Kabelkiosk Sky	ASTRA 1	83	12070,5			19,2° E	H	27500	3/4					38,0
16	ARD digital	ASTRA 1	85	12110			19,2° E	H	27500	3/4					38,0
17	RTL World	ASTRA 1	89	12187,5			19,2° E	H	27500	3/4	QPSK				38,0
18	SES Astra	ASTRA 1	91	12226,5			19,2° E	H	27500	3/4	QPSK				38,0
19	BetaDigital	ASTRA 1	92	12246			19,2° E	V	27500	3/4	QPSK			zeitpartagiert in Headend m	38,0
20	ARD digital	ASTRA 1	93	12265,5			19,2° E	H	27500	3/4					38,0
21	Kabelkiosk Sky	ASTRA 1	95	12304,5			19,2° E	H	27500	9/10					49,2
22	Kabelkiosk Sky	ASTRA 1	99	12382,5			19,2° E	H	27500	9/10					49,2
23	ARD digital	ASTRA 1	101	12421,5			19,2° E	H	27500	3/4					38,0
24	BetaDigital	ASTRA 1	103	12460			19,2° E	H	27500	3/4	QPSK				38,0
25	BetaDigital	ASTRA 1	104	12480			19,2° E	V	27500	3/4	QPSK				38,0
26	ProSiebenSat.1	ASTRA 1	107	12544,75			19,2° E	H	22000	5/6					33,8
27	SES Astra	ASTRA 1	108	12551,5			19,2° E	V	22000	5/6	QPSK			wkl: Bitrate überprüfen. Kin	42,6
28	KabelKiosk	ASTRA 1	66	11739			19,2° E	V	27500	3/4	QPSK				38,0
29	KabelKiosk	EB 9A	51	11747			9° E	H	27500	3/4	QPSK				38,0
30	KabelKiosk	EB 9A	53	11785			9° E	H	27500	2/3	8PSK				53,2
31	KabelKiosk	EB 9A	57	11862			9° E	H	27500	2/3	8PSK				53,2
32	KabelKiosk	EB 9A	58	11881			9° E	V	27500	2/3	QPSK				53,2
33	KabelKiosk	EB 9A	65	12015			9° E	H	27500	2/3	8PSK				53,2
34	KabelKiosk	EB 9A	71	12130			9° E	H	27500	3/4	QPSK				38,0

Figure 11.6 A simple service sheet in Excel: one row per service with satellite, transponder, polarisation, symbol rate, FEC, modulation and bit rate.

DOCUMENT FROM THE START

Documenting all installations and settings pays off, for the future and for the staff who come after you. Better to start documenting at the planning stage.

DESIGNING THE HEADEND · ENGINEERING GUIDE · CHAPTER 12

Inside the transport stream

A satellite transponder carries a multiplex of many services and tables. To stream single services over IP, you have to understand what is inside.

IRENIS / BLANKOM · Technical guide · Ralf Riedel, Director Technical Sales & Engineering, IRENIS GmbH

In this chapter Multiplex, CBR and VBR · Look inside with an analyser · The most important tables · PIDs and bit rates

KEY POINTS

- A transponder carries a multi-programme transport stream (MPTS). IPTV needs one single-programme transport stream (SPTS) per service.
- The PSI/SI tables (PAT, PMT, SDT, EIT, TDT/TOT ...) tell the receiver what is in the stream.
- Broadcasters sometimes send faulty tables. Only a transport stream analyser shows that.

Multiplex, CBR and VBR

A **multiplex** (mux) is a group of digital services (TV channels, radio stations, teletext, signalling and so on) that are combined for broadcasting. Even a single TV channel consists of at least two streams: video and audio. The capacity of a DVB multiplex depends on its modulation and coding parameters. Services can be combined in two ways: **constant bit rate** (CBR) encoding and **variable bit rate** (VBR) encoding.

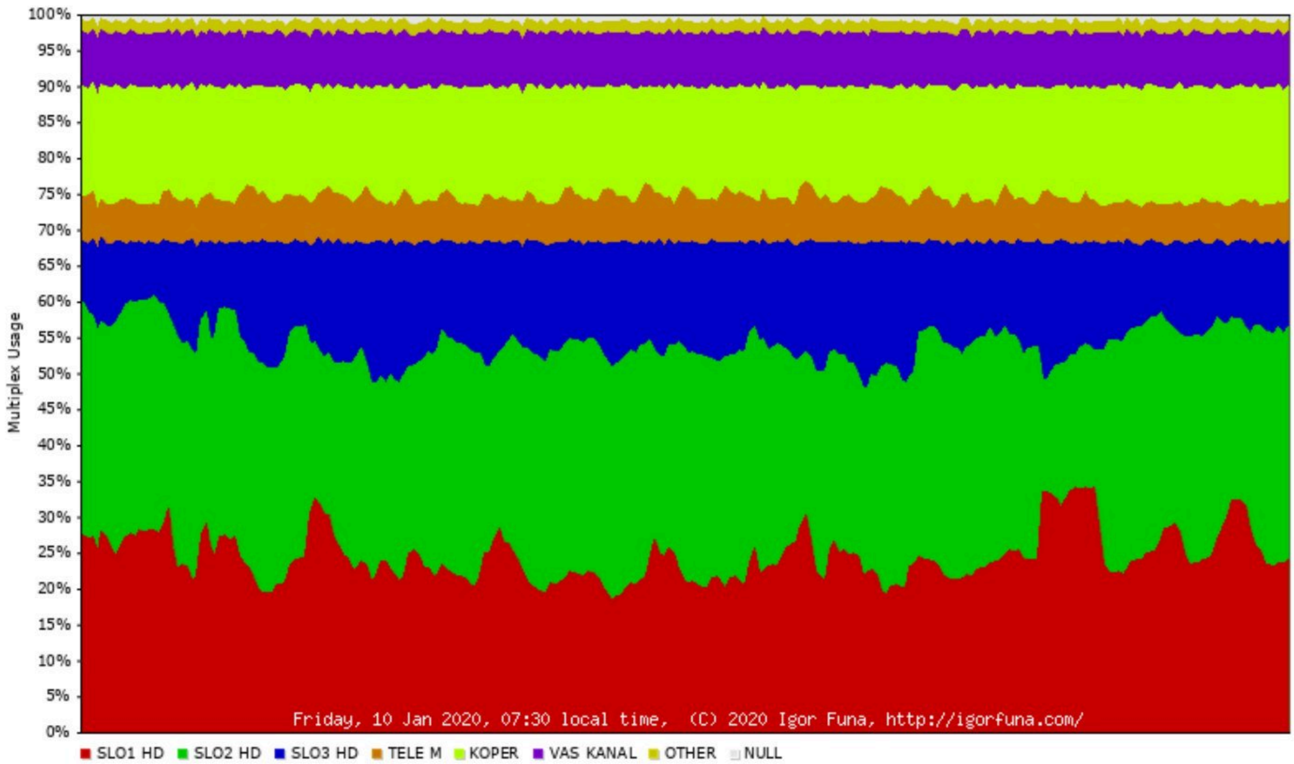


Figure 12.1 Example of the services in a transport stream multiplex over time.

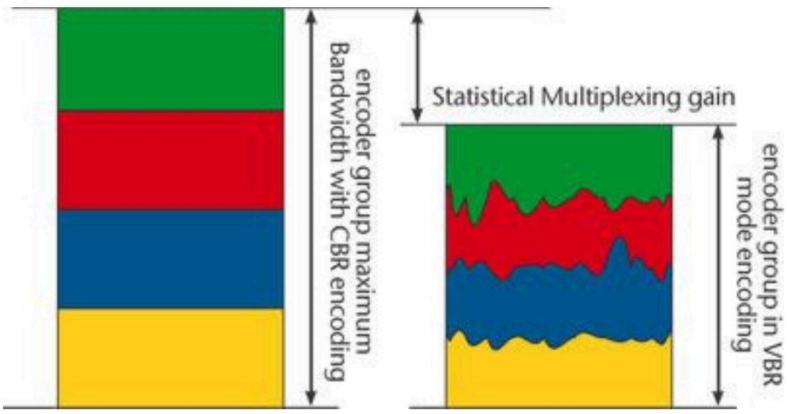


Figure 12.2 Statistical multiplexing gain: VBR encoding fits more services into the same capacity than CBR.

A transponder's multi-programme transport stream (**MPTS**) is demultiplexed into single-programme transport streams (**SPTS**). An SPTS has a variable bit rate and is not filled up with null packets. Additional data PIDs such as tables, teletext and audio fluctuate and are not constant.

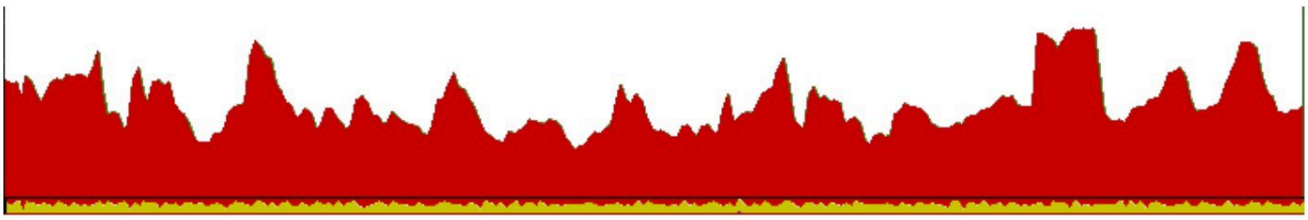


Figure 12.3 A demultiplexed SPTS has a variable bit rate and no null-packet stuffing.

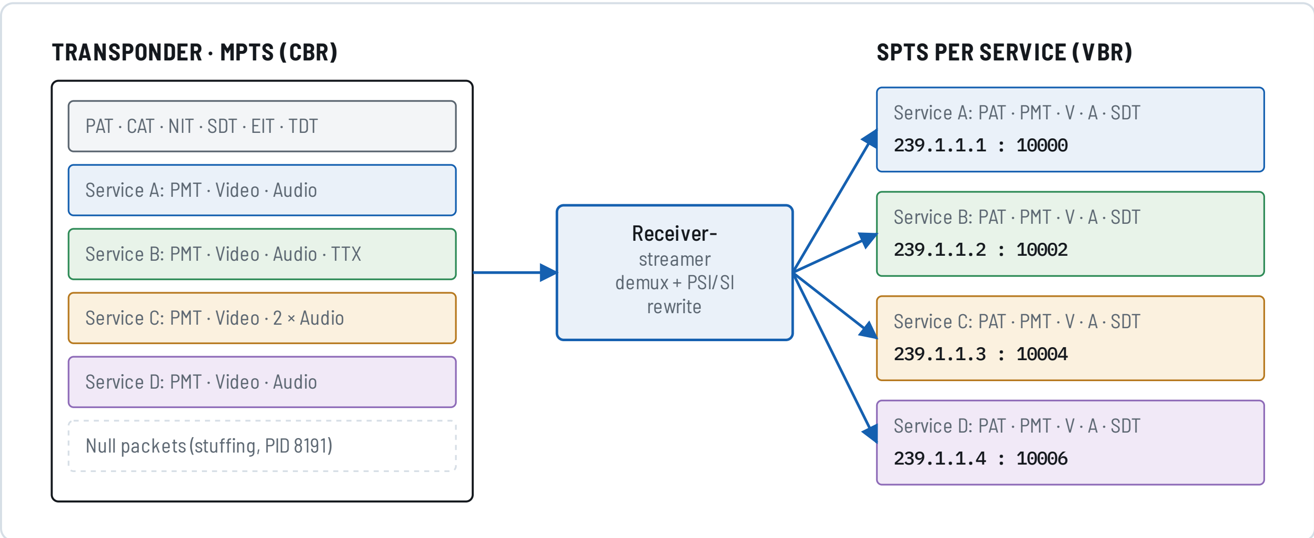


Figure 12.4 A receiver-streamer turns one transponder (MPTS) into one SPTS per service.

Look inside with an analyser

DVB is, to put it mildly, complex.

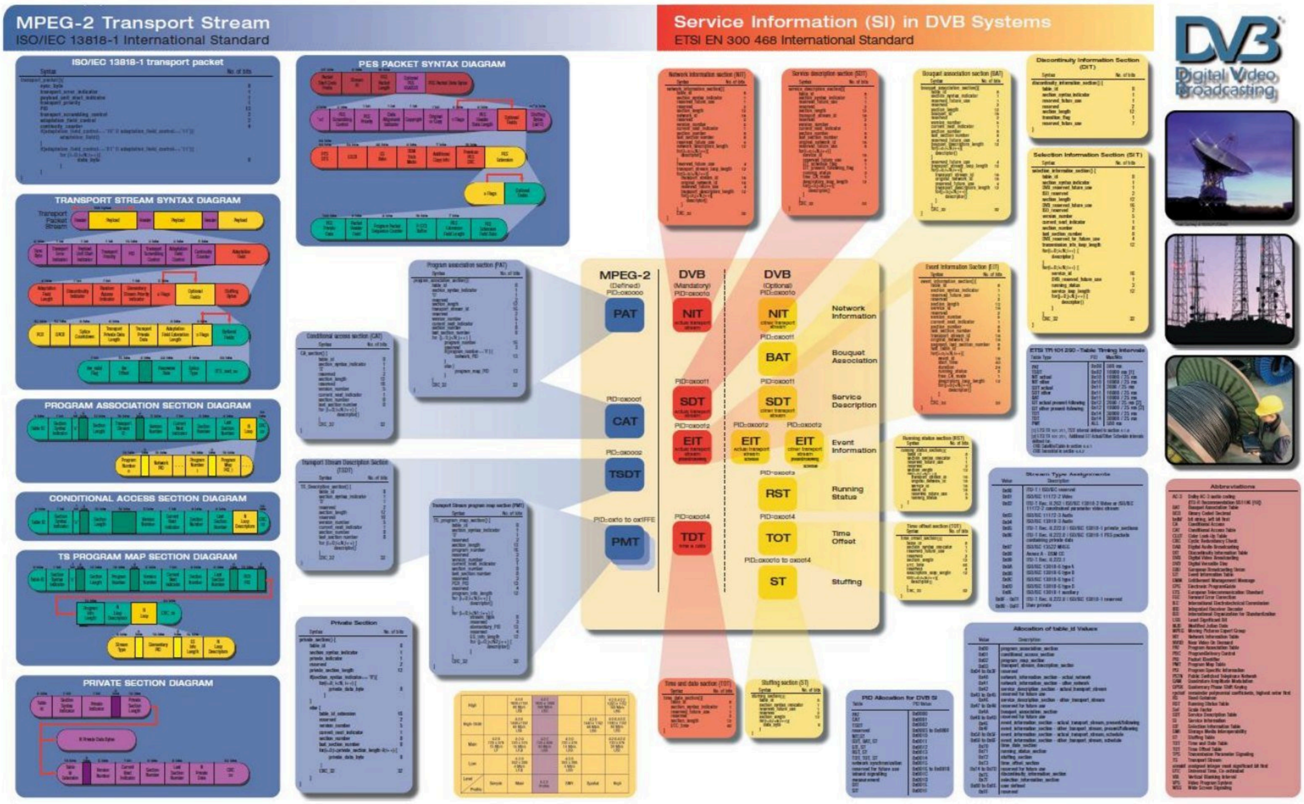


Figure 12.5 The DVB and MPEG-2 transport stream structure at a glance.
Source: DVB poster (third party)

We therefore recommend checking what the satellite transponders actually carry with a **DVB transport stream analyser**. For PCs and laptops we prefer the DekTec Fantasi (available from IRENIS Germany or PROTEL Turkey), also available as a PC card. Some broadcasters assign wrong tables or set false flag values in the uplink TS, which then comes down in every region the satellite covers. You only find such problems by looking into the stream.

Figure 12.6 USB transport stream analyser (DekTec Fantasi).
Product photo: DekTec

Figure 12.7 Analyser as PC card.
Product photo: DekTec

TSReader from coolstf.com is another PC tool, but its light version is not equal to the professional version.

A receiver-streamer can output the complete MPTS to a PC, or through an ASI output if it has one:

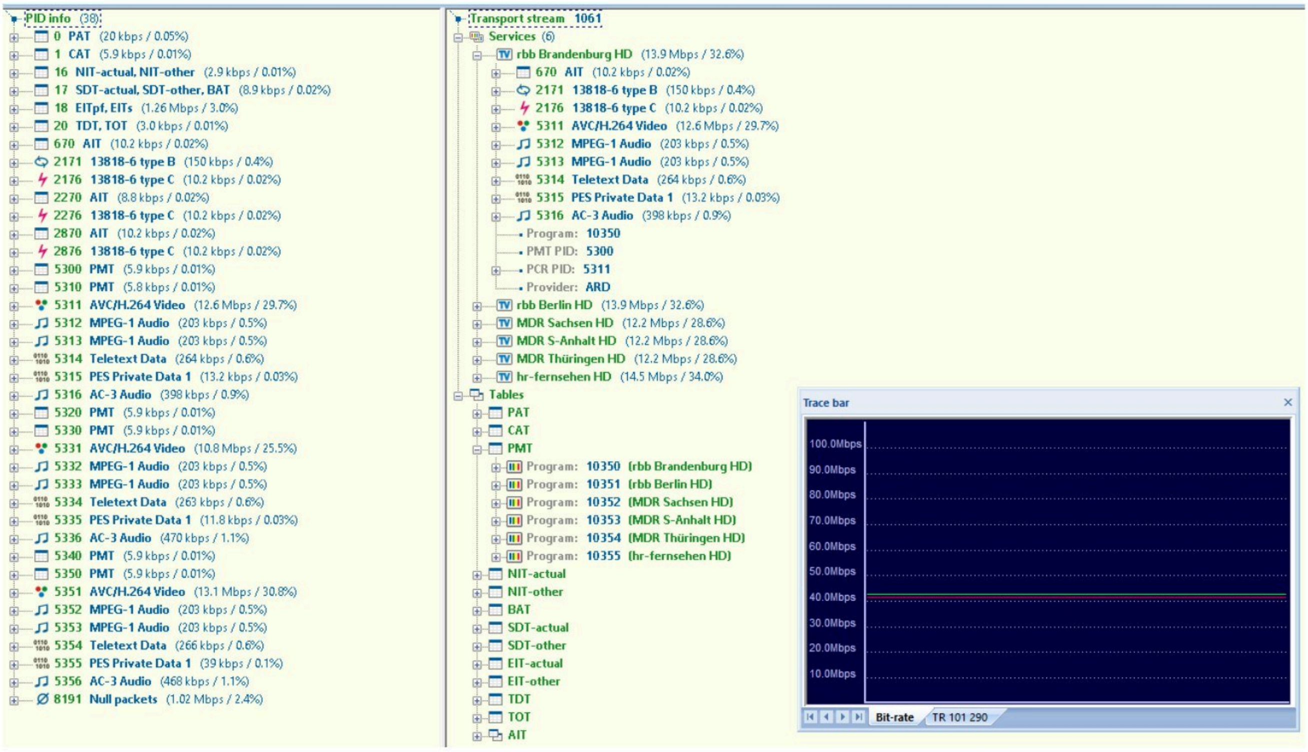


Figure 12.8 Analyser view of an MPTS from a receiver-streamer (free-to-air, therefore no EMM/ECM).

In this free-to-air example nothing is encrypted, so no EMMs or ECMs are transmitted. The CAT (PID 1) is nearly empty, but DVB requires it to be transmitted anyway. In a free-to-air SPTS it is not necessary.

The most important tables

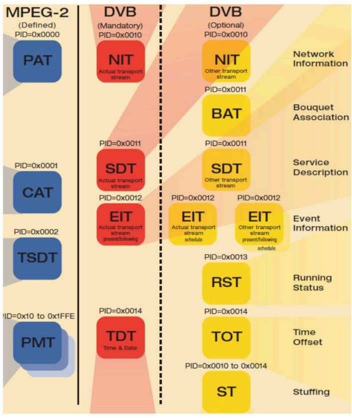


Figure 12.9 The most important MPEG-2 and DVB tables and their PIDs.

TABLE	PID	PURPOSE
PAT – Program Association Table	0x0000	One per TS; lists every programme and the PID of its PMT
CAT – Conditional Access Table	0x0001	Pay-TV: points to the EMM streams
PMT – Program Map Table	from PAT	One per TV or radio service; lists video, audio and data PIDs and the PCR PID. Can be static or dynamic (Chapter 13)
NIT – Network Information Table	0x0010	Needed only in DVB-S/S2, T/T2 and C networks
SDT – Service Description Table	0x0011	Service names and providers for all services in the TS; “SDT other” describes other transponders of the provider
TDT / TOT – Time and Date / Time Offset Table	0x0014	Date and time, and the local time offset of the broadcast region
EIT – Event Information Table	0x0012	EPG data (Electronic Programme Guide); needs a correct TDT/TOT
AIT – Application Information Table	from PMT	HbbTV for smart TVs: the red-button browser applications

The remaining tables are less important for IPTV.

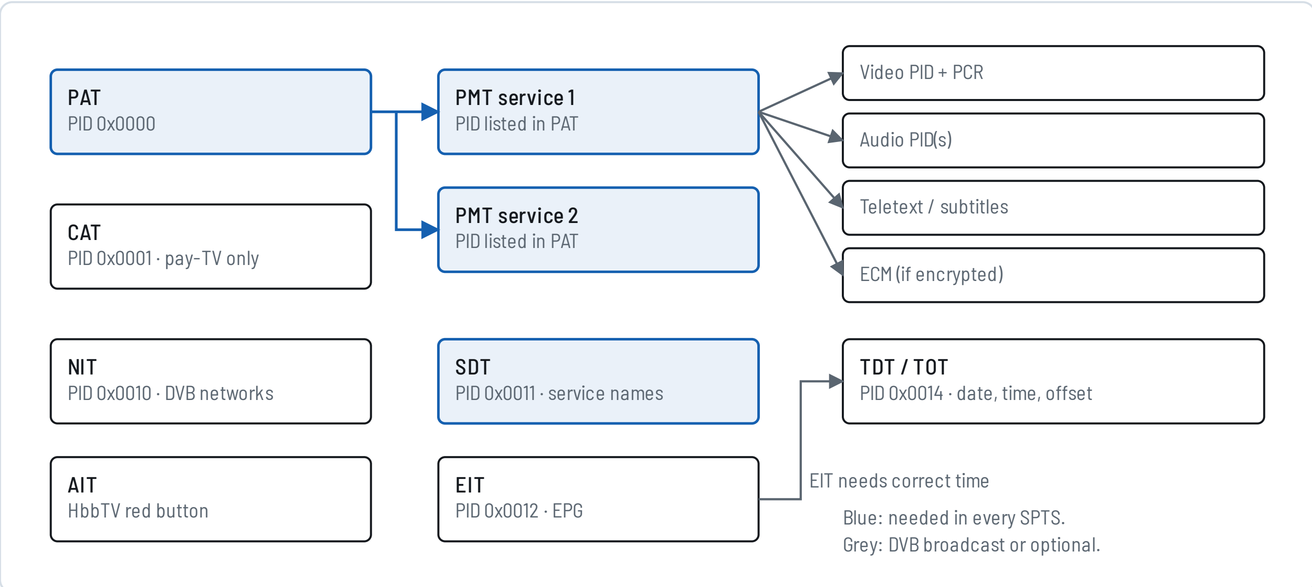


Figure 12.10 How the PSI/SI tables refer to each other.

PIDs and bit rates

Every table and elementary stream is identified by a **Packet Identifier** (PID), written in hexadecimal or decimal. Some PIDs are fixed, others variable. PID 0 is always the PAT. The EIT is on PID 18 decimal (0x0012). The highest PID, 8191 (0x1FFF), is reserved for null packets. They fill up a constant-bit-rate TS to the fixed capacity of the DVB modulator.

The capacity of a DVB-C channel follows from its parameters: useful bit rate = symbol rate × bits per symbol × 188/204. For 256-QAM (8 bits per symbol) at 6.952 MBd this gives about **51.3 Mbit/s**; at 6.9 MBd about 50.9 Mbit/s.

Most single-programme IPTV streams, demultiplexed from the MPTS, are **VBR** streams. They contain only the necessary tables: no NIT, no BAT and so on, because those are needed only in real DVB broadcasting. Here is an example of the tables in an SPTS, with the PIDs in hexadecimal:

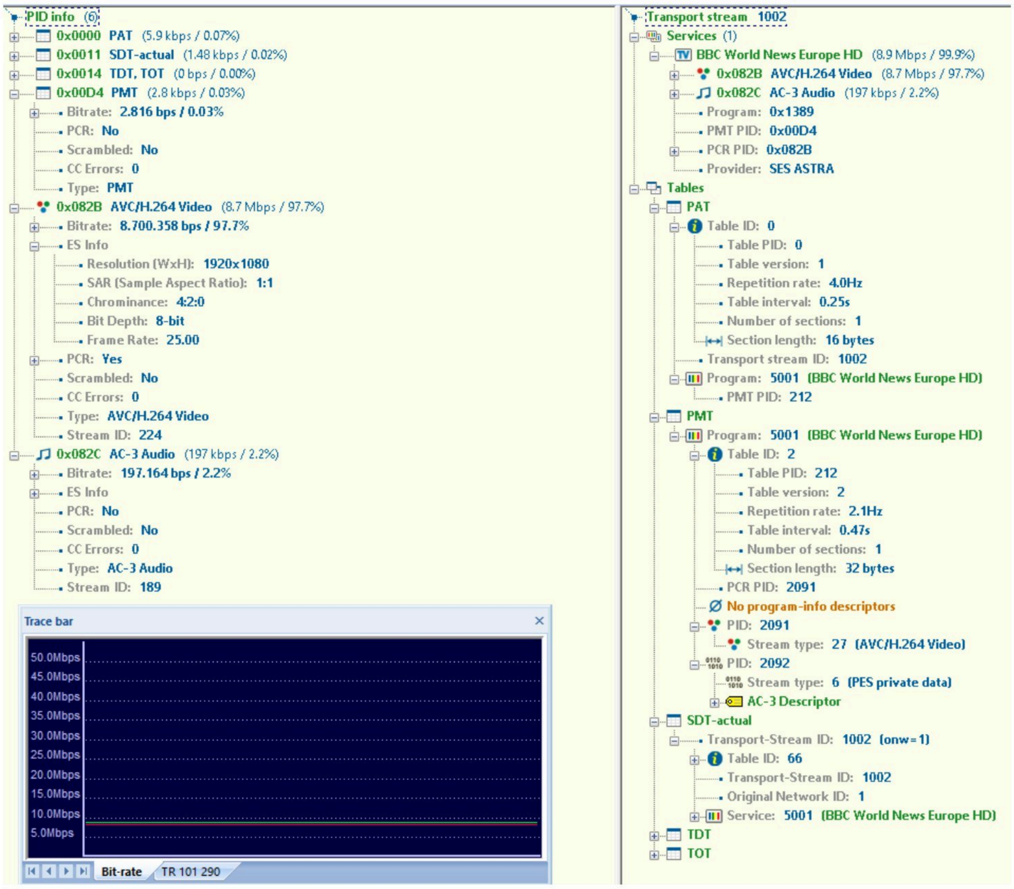


Figure 12.11 Tables of an SPTS (BBC World News Europe HD), PIDs in hexadecimal.

This SPTS of BBC World News Europe HD is a nearly constant data stream. It shows how much information is packed into these tables.

PCR timing, continuity errors and dynamic PMTs

Three stream properties decide whether pictures stay smooth and correct. The PCR sets the decoder clock, the continuity counter reveals lost packets, and dynamic PMTs switch regional content.

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In this chapter Jitter and the program clock reference · Continuity counter errors · Dynamic PMTs

KEY POINTS

- The PCR is sent at least every 100 ms. The permitted PCR jitter is ±500 ns.
- Rising continuity counter (CC) errors usually point to a weak RF input signal.
- Dynamic PMTs change the PIDs of regional services during the day. Basic headends do not follow them.

Jitter and the program clock reference

Jitter, meaning variations in packet timing, can arise on the DVB path as well as over Ethernet. There is a way to measure and correct it: the **program clock reference** (PCR), which is part of every DVB stream.

For a decoder to present synchronised content (for example audio that matches its video), a PCR is transmitted at least **once every 100 ms** in the adaptation field of an MPEG-2 transport stream packet. DVB measurement guidelines (ETSI TR 101 290) are stricter and flag intervals above 40 ms. The PMT of each programme names the PID that carries its PCR (`pcr_pid`).

The decoder uses the PCR to generate its **system time clock** (STC). When correctly implemented, the STC is a highly accurate time base for synchronising the audio and video elementary streams, and all MPEG-2 timing refers to it. For example, the presentation time stamp (PTS) is relative to the PCR.

The PCR has two parts. The first 33 bits count at 90 kHz, and the last 9 bits count at 27 MHz. The maximum permitted **PCR jitter is ±500 ns**.

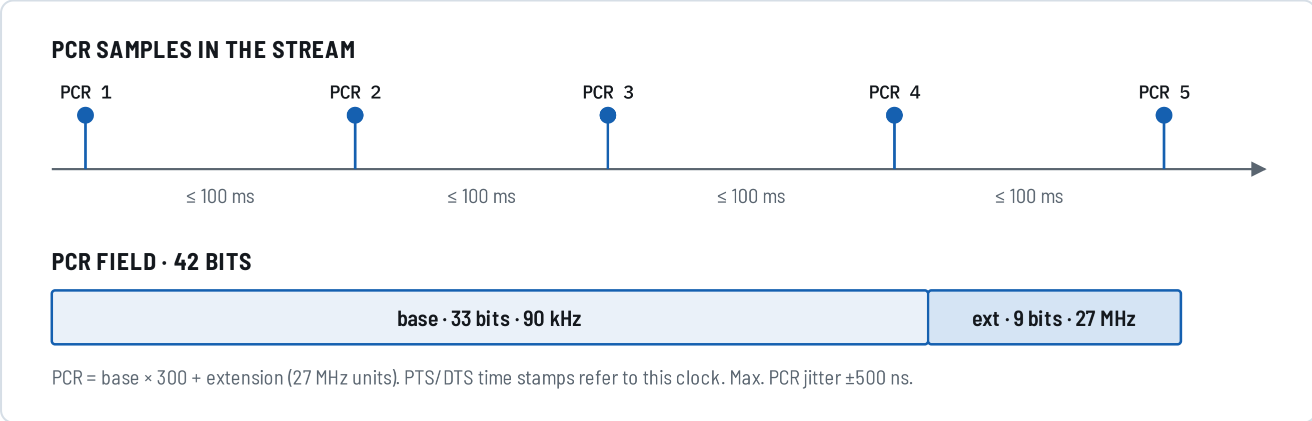

Figure 13.1 The program clock reference: interval and structure.

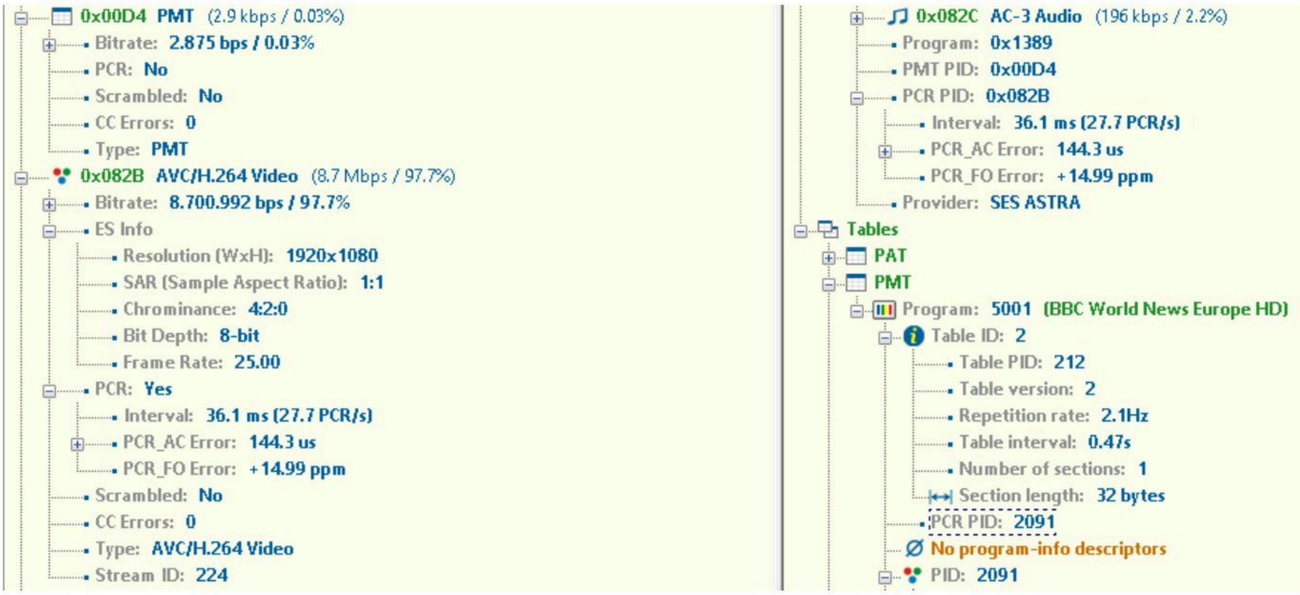

Figure 13.2 PCR interval, PCR accuracy and CC errors as shown by the analyser.

Continuity counter errors

Every PID except the null PID 8191 carries a 4-bit **continuity counter** (CC). It counts from 0x0 to 0xF and increments per PID, but only in packets that carry payload. A missing value means that a packet was lost.

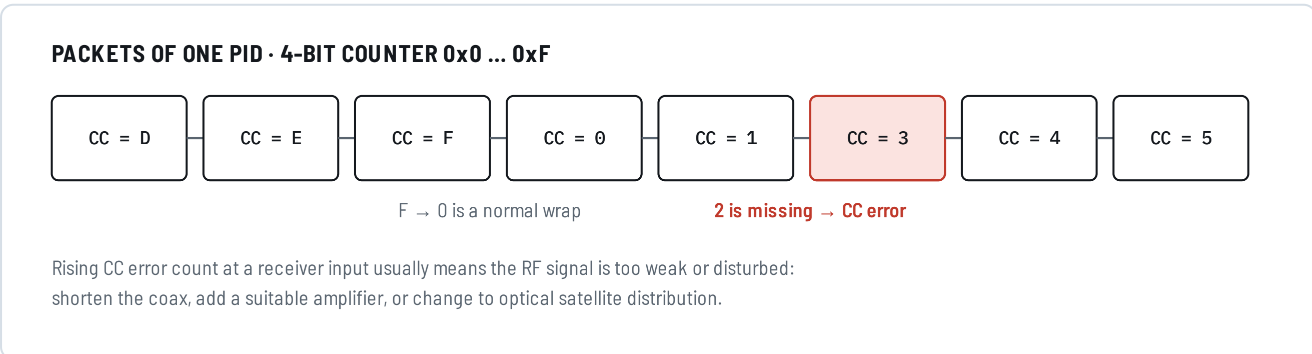

Figure 13.3 A gap in the continuity counter reveals a lost packet.

If the analyser shows CC errors rising over time, the RF input signal of the satellite receiver is probably too weak. Use shorter coax cables or an amplifier, or change to optical satellite distribution (Chapter 6).

Dynamic PMTs

Some broadcasters change their PMTs during the day. The example below is a German public broadcaster with regional programmes. For most of the day, every regional service is linked to the main programme in its PMT. Between 18:00 and 20:00 the regional services switch to their own local content: the PMTs change and point to different audio and video PIDs.

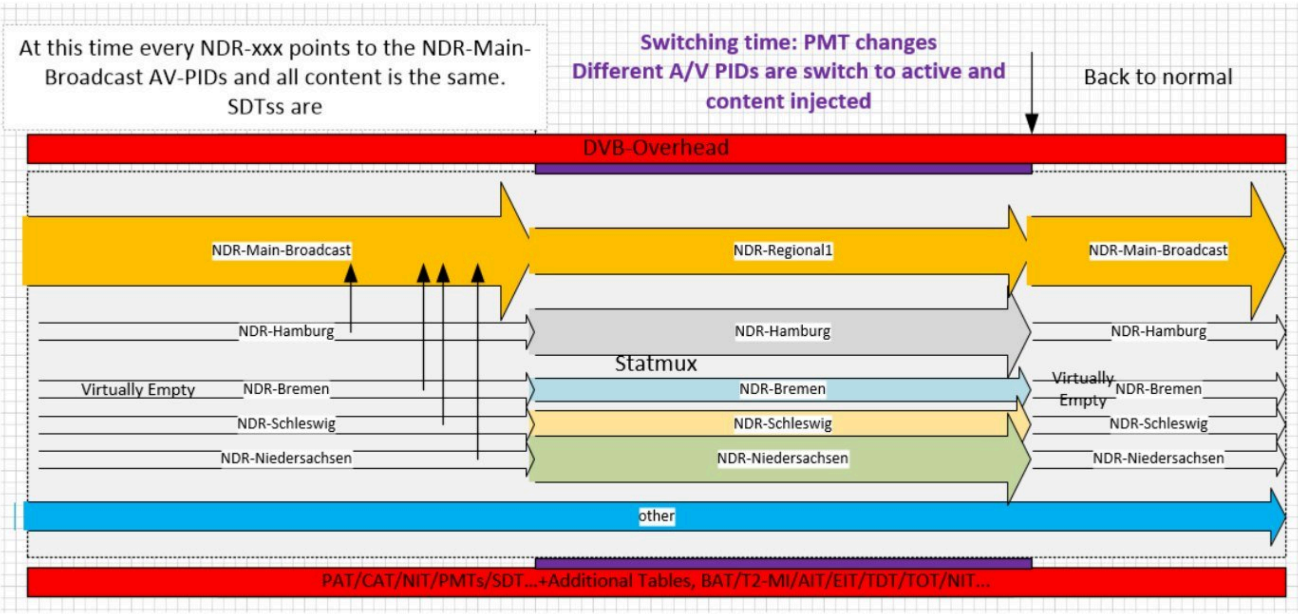

Figure 13.4 Dynamic PMT at a German broadcaster: regional content between 18:00 and 20:00, linked to the main programme for the rest of the day.

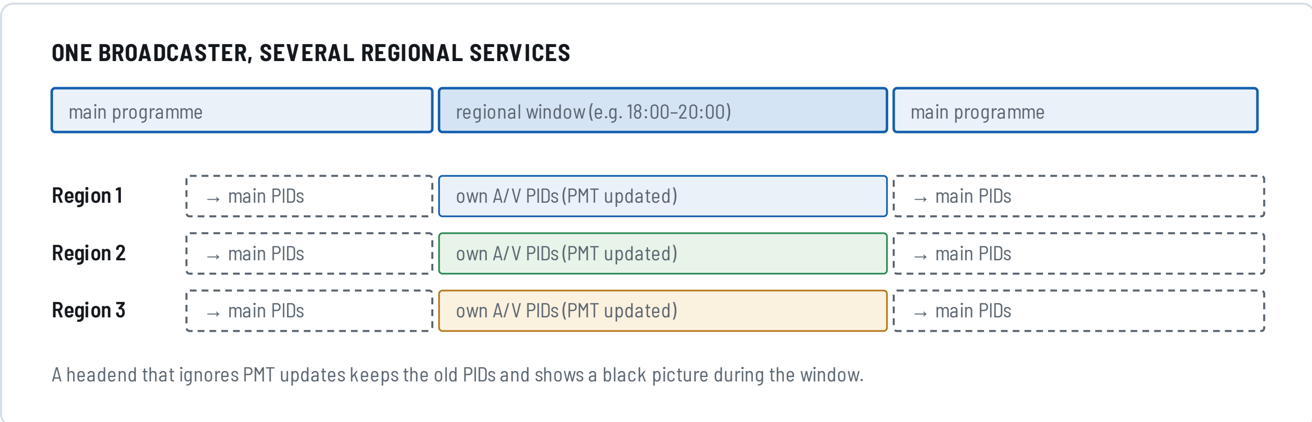

Figure 13.5 Dynamic PMT: regional services switch to their own PIDs during a regional window.

A headend that does not follow such PMT changes keeps the old PIDs and delivers a black picture or the wrong programme during the regional window. The next chapter shows which headend class handles this.

Choosing the headend class

The functions described in the previous chapters separate the market into classes of DVB receiver, demultiplexer and streaming equipment.

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In this chapter Basic class High class Comparison

KEY POINTS

- Basic systems such as the BLANKOM IGS series are cost-effective but do not demultiplex the EIT or follow dynamic PMTs.
- High-class modular platforms such as Teleste Luminato handle every DVB function, offer 1+1 redundancy and come with a service agreement.
- Choose the class that matches the tier of the whole system (Chapter 22).

Basic class

The low-cost basic system does not, for example, demultiplex the EIT or follow dynamic PMTs (Chapter 13). An example is the **BLANKOM IGS series**.

Figure 14.1 Basic class: BLANKOM IGS series gateways.

Less expensive solutions usually have no redundant power supply and are not modular. They often have only one RJ45 Gigabit Ethernet (GbE) port for the data streams.

High class

The high-class system is built on the modular **Teleste Luminato** platform, for which IRENIS is the sole distributor for the Middle East and Africa. Technically it takes up to 24 satellite inputs, with or without CAM slots for decryption. It supports every DVB function needed, including manipulation of every PID and its content in the streams. It comes with a mandatory service level agreement (SLA) of at least one year, and offers an autonomous 1+1 redundancy option and a second power supply.

Figure 14.2 High class: Teleste Luminato modular platform, also available as hospitality version L4H.
Product photo: Teleste

A hospitality version, **L4H**, includes demultiplexing for a number of services. The platform has two NMS ports, two GbE ports (SFP) and a wide range of modules, including scrambling (DVB encryption as well as stream encryption), a PSI/SI editor and many more professional features.

Comparison

	BASIC CLASS	HIGH CLASS
Example	BLANKOM IGS series	Teleste Luminato (L4H for hospitality)
EIT (EPG) demultiplexing	No	Yes, plus EPG module (Chapter 20)
Follows dynamic PMTs	No	Yes
PID and table manipulation	Basic	Every PID, PSI/SI editor
Satellite inputs	Per unit	Up to 24, modular
Decryption	Depends on model (CI slots)	CAM slots available
Redundant power supply	Usually not	Optional second PSU
1+1 redundancy	–	Autonomous 1+1 option
Stream ports	Often one GbE RJ45	2 × GbE (SFP) + 2 × NMS
Encryption	–	DVB scrambling and stream encryption
Service agreement	Optional	Mandatory SLA, at least 1 year

Between these two, mid-class systems add functions such as EPG support, with or without a middleware server (Chapter 22).

Multicast or unicast, and stream addressing

Multicast or unicast is a question of balance. With multicast, a clean address and port plan prevents conflicts and overloaded clients.

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In this chapter Multicast or unicast? Address and port plan Why IGMP is essential: a bandwidth example

KEY POINTS

- Many clients watching at the same time → multicast. Only a few clients → unicast can be an advantage.
- Give every stream its own multicast address from 239.0.0.0/8 and its own UDP port.
- A headend easily sends more than 1 Gbit/s in total. Without IGMP snooping, clients with 100 Mbit/s ports are overloaded.

Multicast or unicast?

At this point you choose between a unicast and a multicast system. It is a question of balance:

- If **many IPTV clients are online at the same time**, multicast is better.
- If only **a few clients** are usually online, unicast can be an advantage. Every user gets an individual stream, so the question is bandwidth.

Multicast needs IGMP management in the network switches (Chapter 16). Unicast does not, because the headend server addresses each stream directly to its client. That makes the server side more demanding to program. We therefore decided on **multicast**, together with our partner for IPTV middleware, OmniscreenTV.

Address and port plan

RECOMMENDATION

Set up the multicast addresses of your video streams according to the IANA assignments (Appendix A). Use the administratively scoped range **239.0.0.0/8** and avoid reserved addresses. Give every stream its own address, e.g. 239.1.1.1, 239.1.1.2, 239.1.1.3 ..., and its own **UDP port** above 10000. With RTP, use even port numbers: 10000, 10002, 10004 ... (Appendix B).

SERVICE	MULTICAST GROUP	UDP PORT
Service 1	239.1.1.1	10000
Service 2	239.1.1.2	10002
Service 3	239.1.1.3	10004
...	...	...

Why a separate port per stream, even though the addresses differ? A host that opens a port receives all multicast traffic arriving on that port and must filter out the wanted stream, which costs processing. When each stream arrives on its own port, the host can simply ignore traffic on ports it has not opened. Choose ports that do not clash with existing services or with the operating system's ephemeral port ranges.

Do not use addresses from 224.0.0.x: they clash with routing and discovery protocols, and the stream may fail. Also keep public and private IPv4 addresses apart when you assign the IPTV streams and the device management addresses (Appendix A).

> **NETWORK EQUIPMENT**
>
> We usually do not supply the network equipment for projects. Our partners, the local system integrators, normally provide it.

Why IGMP is essential: a bandwidth example

Many set-top boxes and TV sets have only a **100BASE-T** Ethernet port. A headend's streams add up to around 850 to 920 Mbit/s per Gigabit port. If a client received all streams, it would be overloaded.

Example: a headend with 2 × GbE outputs sends 200 streams at an average of 6 to 8 Mbit/s (SD and HD services mixed). That is about **1.4 Gbit/s** in total.

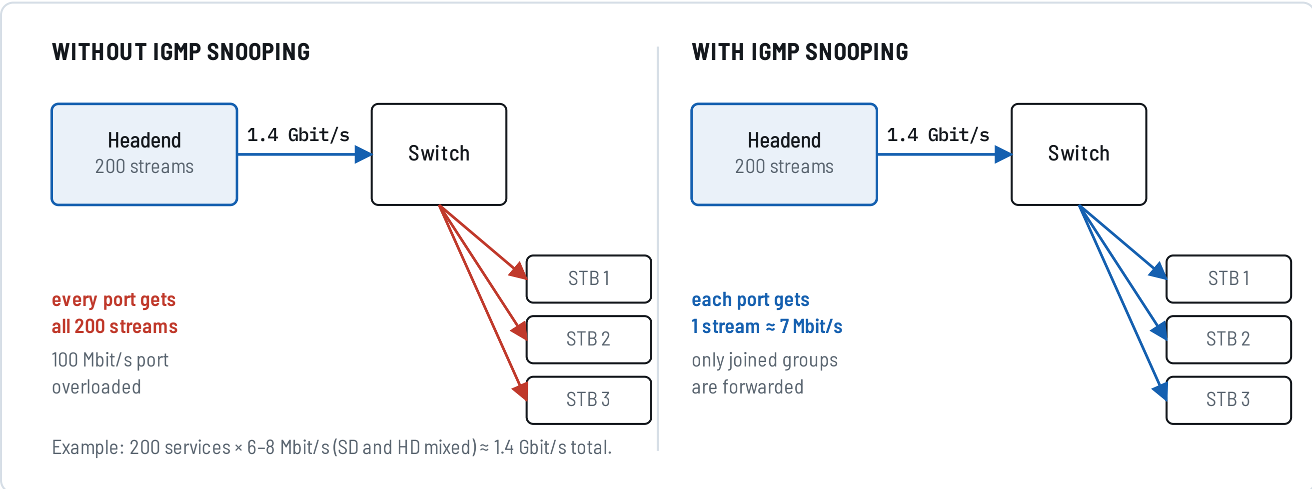

Figure 15.1 Without IGMP snooping every port receives every stream.

The solution is IGMP. It is the subject of the next chapter.

IGMP querier and snooping

IGMP is the key to multicast IPTV. It makes sure that each switch port receives only the streams its client has asked for.

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In this chapter What IGMP does · Querier and snooping · Without IGMP

KEY POINTS

- One IGMP querier (a Layer 3 switch or router) sends periodic queries; the clients answer with membership reports.
- Snooping switches listen to this exchange and forward each group only to the ports that joined it.
- Recommended switches support IGMP v2 or v3 with snooping (Layer 2+); a Layer 3 switch acts as the querier.

What IGMP does

The **Internet Group Management Protocol** (IGMP) lets hosts tell the network which multicast groups they want to receive. A router or Layer 3 switch uses it to learn where specific multicast traffic is needed. There are three versions: IGMPv1 (RFC 1112), IGMPv2 (RFC 2236) and IGMPv3 (RFC 3376).

Multicast-aware switches are now common in the network cores of businesses and universities that move heavy traffic. Multicast filtering works through dynamic group management. Ideally, all multicast traffic is blocked until a member of the group requests it. The default behaviour depends on the switch manufacturer.

Querier and snooping

The **IGMP querier** is the router or switch that owns the group lists. It sends group membership queries at regular intervals, collects the membership reports from active members and updates the group membership tables.

A Layer 2 switch with **IGMP snooping** passively listens to the IGMP query, report and leave messages exchanged between multicast routers or switches and the multicast hosts. From these it learns the group membership of each port and forwards multicast traffic accordingly. IGMP snooping creates no additional network traffic and greatly reduces the multicast traffic through the switch.

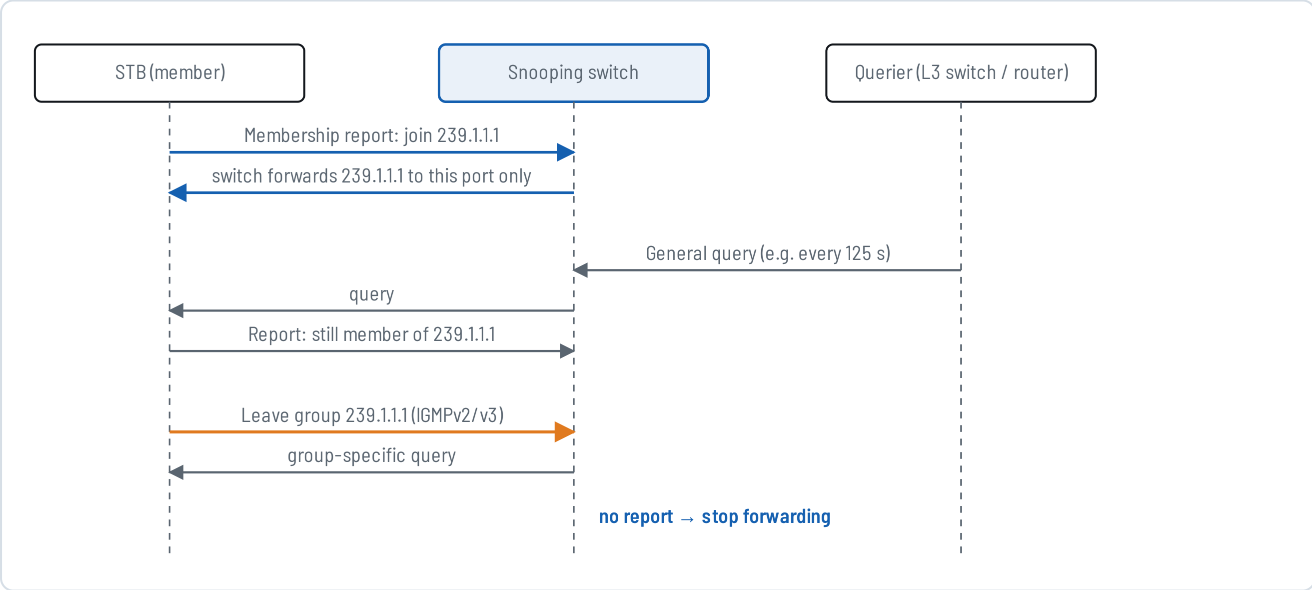

Figure 16.1 IGMP join, query and leave between set-top box, snooping switch and querier.

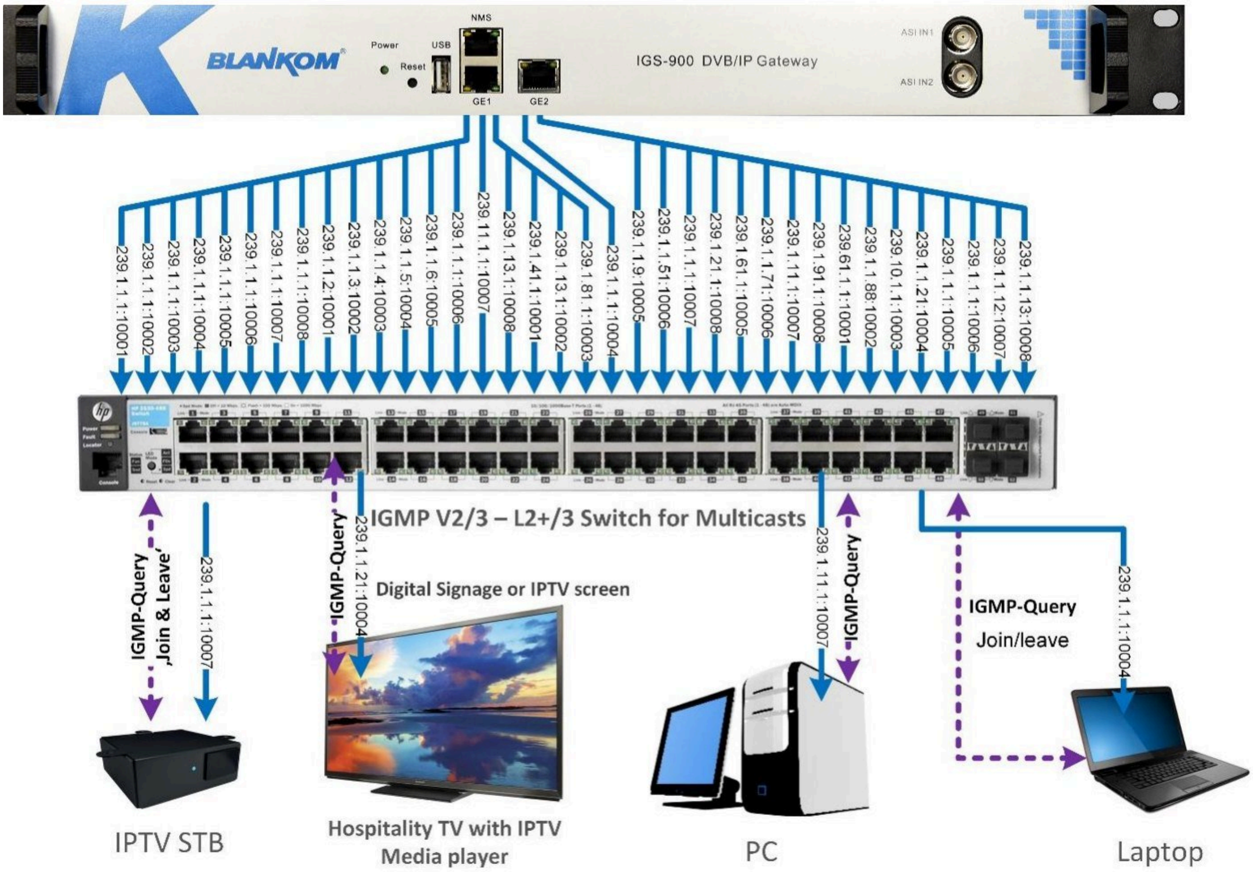

Figure 16.2 A DVB/IP gateway sending multicast streams into an IGMP v2/v3 switch, with clients joining and leaving groups.

Without IGMP

Without IGMP querying and snooping, the switch treats multicast like a broadcast and forwards every packet to **every port** (Chapter 15). If your network core does not support IGMP querying and snooping, the streams still work, but the network carries very high traffic loads. In that case, isolate the streaming nodes, for example in a separate VLAN, so that the streams do not travel alongside the normal network traffic.

> **RECOMMENDATION**
>
> Use switches with **IGMP v2 or v3 snooping** and full IGMP support (often called Layer 2+). One **Layer 3 switch** acting as the IGMP querier is the best solution.

A related topic is the IPv4 address plan: keep public and private addresses apart (Appendix A).

Bringing in internet streams: SRT, RTMP and HTTP

Public live streams arrive as unicast. A network with hundreds of TVs needs them as multicast, so a gateway converts them.

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In this chapter Unicast from the outside The protocol converter

KEY POINTS

- Streams from broadcasters or private content providers usually arrive as RTMP, HTTP or SRT, all unicast.
- SRT is the preferred unicast protocol today, with encryption and packet-loss recovery.
- An IP-to-IP gateway converts unicast to multicast so that hundreds of clients can watch.

Unicast from the outside

If you want to import public live streams, for example from broadcasters or private content providers, they usually arrive as **RTMP** or **HTTP**, or increasingly as **SRT**, which is the preferred unicast streaming protocol today.

In a native IPTV network with many clients, TVs or set-top boxes (let us say hundreds), as in hospitality networks, each unicast stream must be converted to multicast. You need a unicast-to-multicast converter.

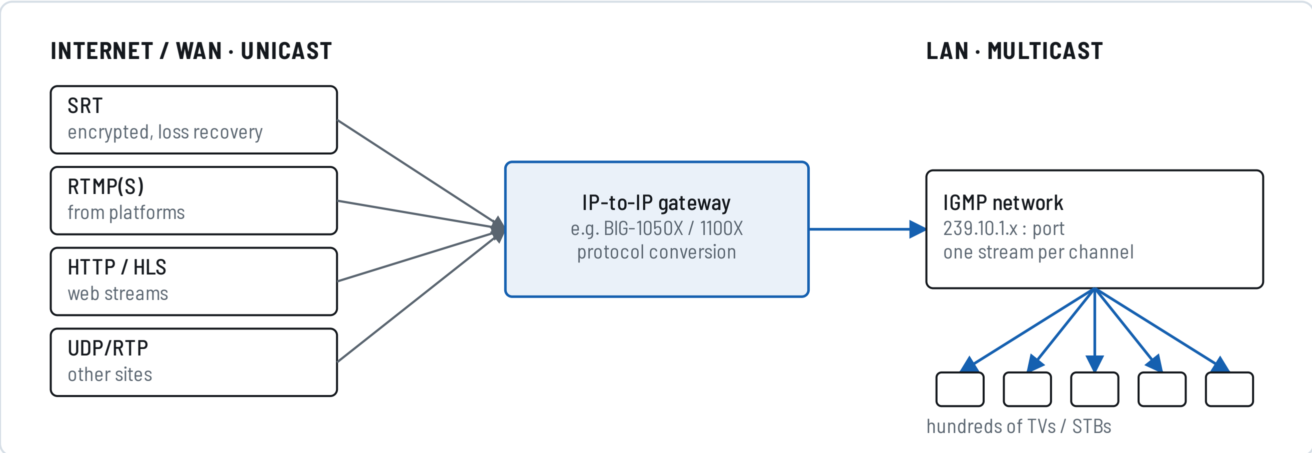

Figure 17.1 Unicast streams from the internet converted to multicast for the local network.

The protocol converter

The **BIG-1050X** is a versatile tool for unicast and multicast stream conversion. It is also available as the larger **BIG-1100X** for 100 streams.

Figure 17.2 BIG-1050X IP-to-IP gateway (BIG-1100X for 100 streams).

Figure 17.3 BIG-1050X converting SRT, RTSP, RTMP, HTTP and UDP streams, unicast and multicast, for decoders and modulators.

The converted multicast streams follow the same address and port plan as the satellite services (Chapter 15).

Encoders and decoders

Encoders bring your own content into the IPTV system. Decoders take streams back to SDI or HDMI where a screen or broadcast equipment needs them.

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In this chapter Your own channels Encoder types Decoders

KEY POINTS

- Encoders insert own channels such as hotel TV, restaurant, gym or spa information.
- Multi-protocol encoder-streamers support SRT, RTMP, RTSP, HTTP, HLS and UDP/RTP. Headend encoders mostly use UDP/RTP.
- IP decoders with SDI outputs are the counterpart for monitor walls and broadcast equipment.

Your own channels

Encoders are useful for inserting your own information channels into the system: hotel TV, restaurant, gym, spa and so on. There are several types, from single-channel units to multi-channel units.

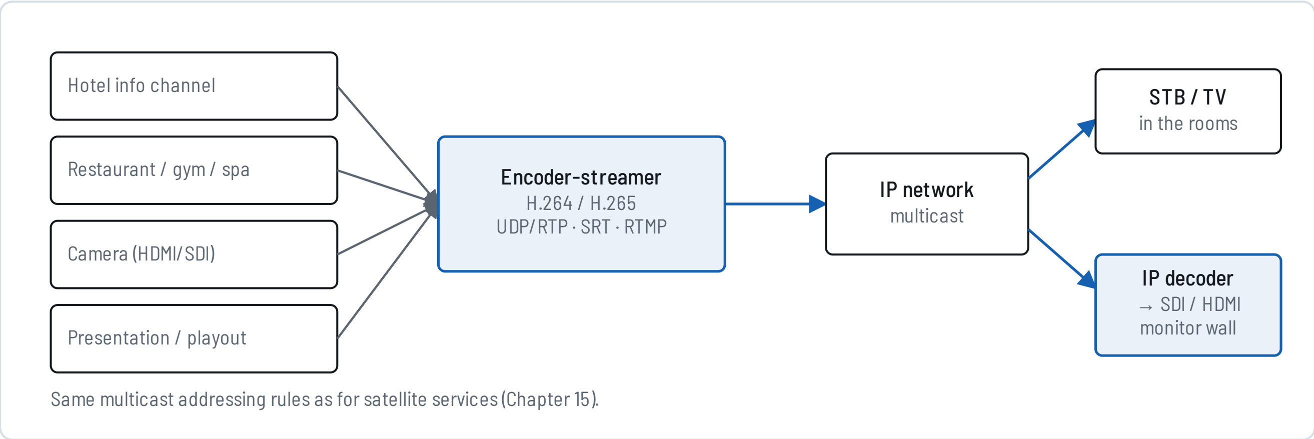

Figure 18.1 Encoding own content into the IPTV system and decoding it back to SDI/HDMI.

Encoder types

The compact, boxed encoder-streamers shown below are multi-protocol units. They serve many applications, from hotel TV and surveillance cameras to live streaming on internet platforms and digital signage.

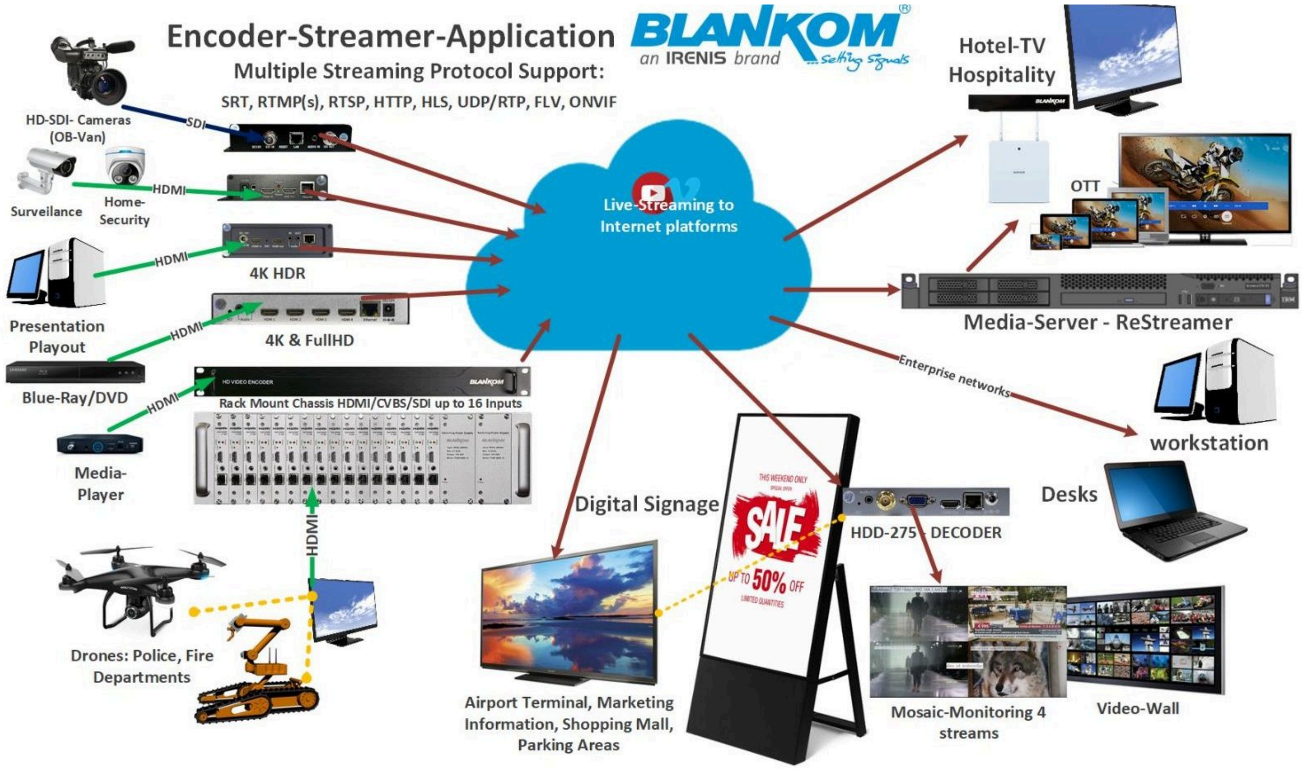

Figure 18.2 Applications of multi-protocol encoder-streamers.

Headend encoders and decoders mostly support UDP/RTP, and some also RTSP/RTP. Broadcast-grade encoders with SDI and/or HDMI inputs are the **MPE-4001**, the **MPE-4400** and the **MPE-4200 S/H**. The MPE-4000 shown below is end-of-life; its successor is the MPE-4001.

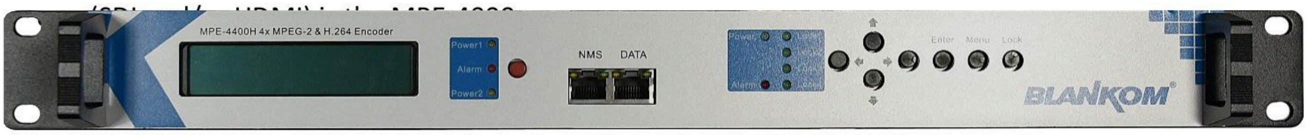

Figure 18.3 Broadcast-grade SDI/HDMI encoder of the MPE series. Shown: MPE-4000 (end-of-life, successor MPE-4001).

Decoders

The counterpart is an IP-to-HD-SDI decoder of modular design, the **IGS-2000/4000/6000**, with two, four or six SDI outputs:

Figure 18.4 IP to HD-SDI decoder, modular with 2, 4 or 6 SDI outputs.

IP decoders with a mosaic view also serve for monitoring (Chapter 24).

ENCODING, TRANSCODING AND EPG · ENGINEERING GUIDE · CHAPTER 19

Transcoding and the minimum SPTS

If the network cannot carry the streams as received, transcode them. Whatever the stream, the set-top box needs a minimum set of tables to decode it.

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In this chapter When transcoding is needed The minimum content of an SPTS

KEY POINTS

- Transcode when bandwidth is limited, for example on DSL lines to hospital bed terminals or in shared corporate networks.
- Specify for every stream the number, input and output formats, resolution and sampling rates. They drive licence and hardware costs.
- A minimal SPTS carries PAT, PMT, SDT, optionally TDT, the video with PCR and the audio.

When transcoding is needed

Bandwidth can be a problem in an existing network, for example in a hospital with 12 Mbit/s DSL lines to the bed terminals, or in a corporate office network. Mechanisms such as VoIP and QoS priorities, or Wi-Fi, also have to be considered. Then it may be necessary to **transcode** the streams to lower bit rates.

Figure 19.1 BTR-6000 IP-to-IP transcoder.

A transcoder such as the **BTR-6000** (today BTR-6000V) re-encodes the bit rate and the video and audio codecs, for example from H.264 to H.265 video and from MPEG-1 Layer II stereo to AAC audio.

The BTR-6000V does more than transcode single streams. It also accepts a complete MPTS, picks out individual TV services, transcodes them and outputs them as SPTS or as a new MPTS. It can also multiplex services into an MPTS.

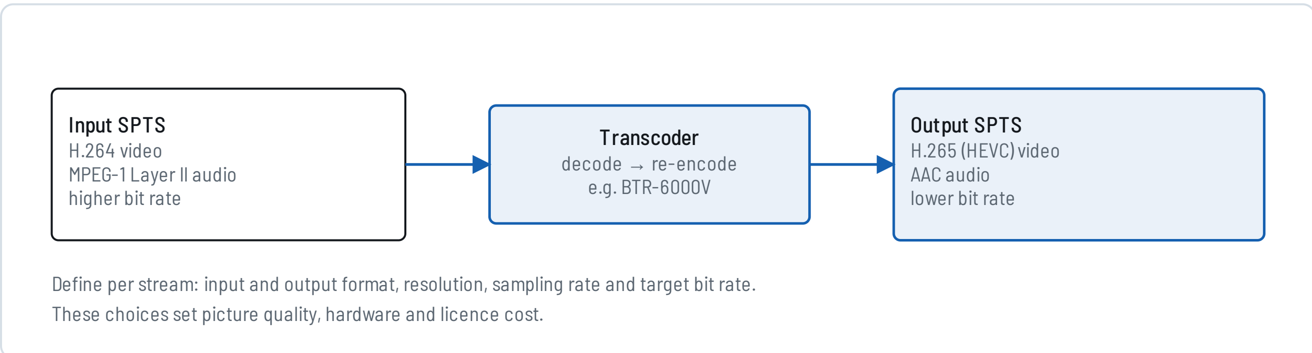

Figure 19.2 Transcoding to a more efficient codec and a lower bit rate.

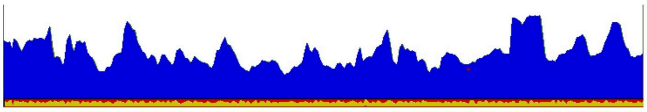

Figure 19.3 Bit rate before transcoding.

Figure 19.4 Bit rate after transcoding: lower and more even.

QUESTIONS TO SETTLE BEFORE TRANSCODING

- [ ] Why is it needed: limited network speed, the capability of the middleware, or the streaming method (multicast or unicast) and its load?
- [ ] Is OTT or multiscreen a must or a nice-to-have? It needs an extra media server.
- [ ] The exact number of streams, and the conversion from which input format to which output format.
- [ ] The sampling rates (picture quality). They affect licence costs and the hardware and software capabilities needed.

The minimum content of an SPTS

A minimal single-programme transport stream contains the **PAT, SDT, TDT (not mandatory) and PMT**, plus the **audio and video, including the PCR**.

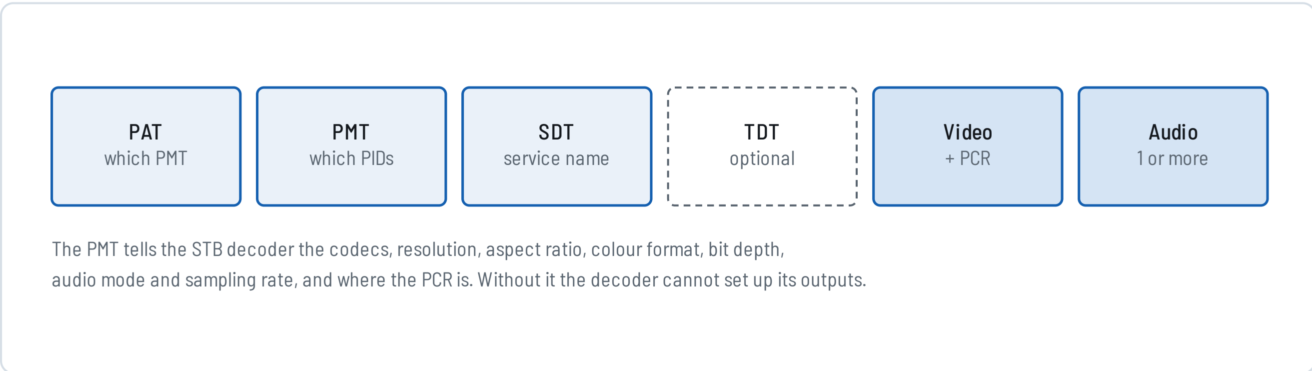

Figure 19.5 The minimum content of a single-programme transport stream.

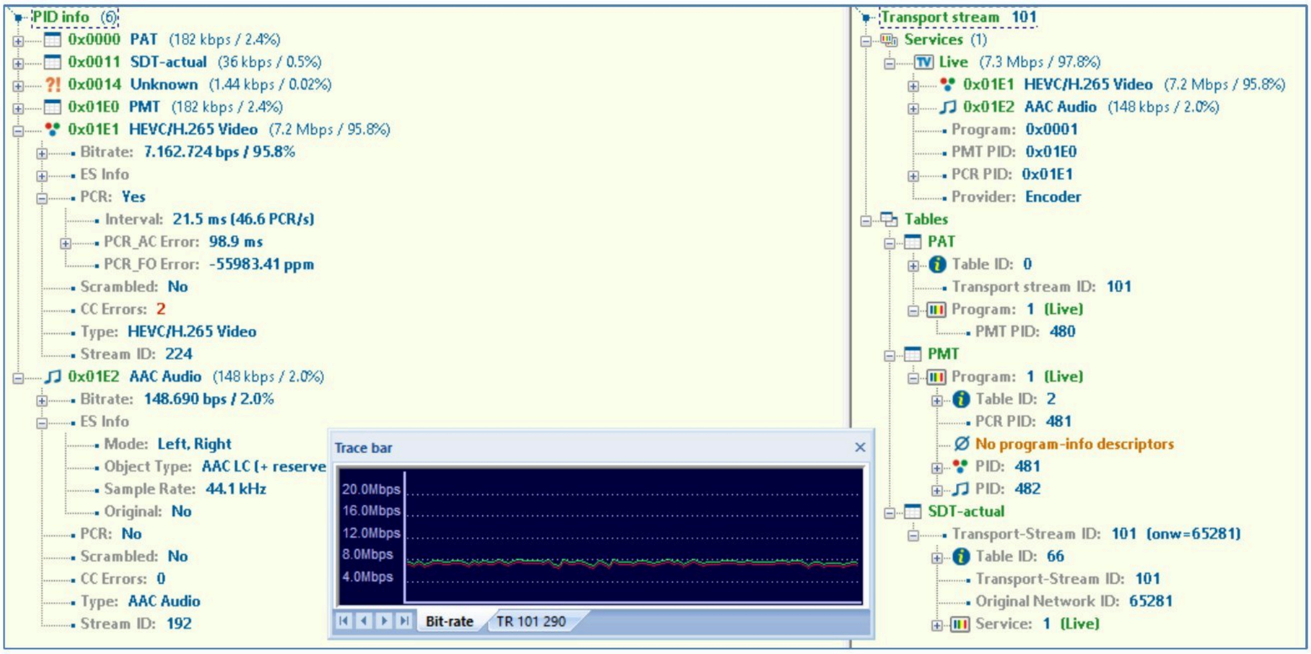

Figure 19.6 Analyser view of a minimal SPTS.

Look more closely and you see that the tables carry the information the decoder needs:

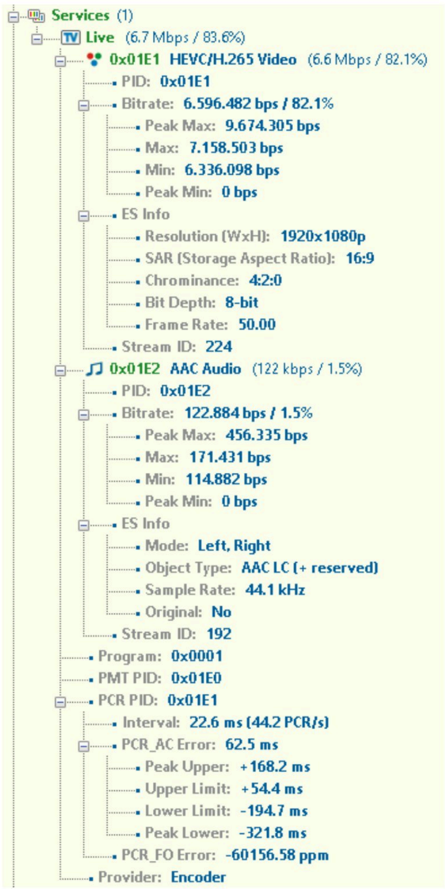

Figure 19.7 The details carried in the tables: codecs, resolution, aspect ratio, colour format, bit depth, audio mode, sampling rate and PCR.

WHAT THE TABLES TELL THE DECODER

- [ ] The audio and video codecs in use
- [ ] The resolution and aspect ratio
- [ ] The colour scheme (chroma format)
- [ ] The bit depth
- [ ] Stereo or surround sound (Dolby) mode
- [ ] The sampling rates
- [ ] The PCR information
- [ ] The name of the service
- [ ] The name of the provider

This is the minimum information that the decoder chip in an IPTV receiver needs to decode the audio and video codecs and set its own parameters. Only then can it deliver proper video and audio through its outputs (HDMI, analogue RCA, S/PDIF) to the flat-screen TV.

EPG and EIT processing

Viewers expect a programme guide. The EPG data is in the satellite multiplex, but it has to be demultiplexed and rewritten for every single stream.

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In this chapter The EIT in the transport stream EPG modules and XMLTV

KEY POINTS

- The EIT (PID 0x12) is linked to the SDT and to the service IDs. Demultiplexing it needs SID remapping.
- Basic linear systems show at most present/following information, and only if the set-top box supports it.
- An EPG module can also generate the EIT from XMLTV files or internet EPG services. The EPG is essential for PVR recording.

The EIT in the transport stream

The **EPG** (Electronic Programme Guide) is carried in the **Event Information Table** (EIT) of the transport stream, on PID 18 decimal (0x12). The EIT combines several kinds of information in one table construct.

To attach the EPG to a single SPTS, the EIT must be **demultiplexed**. The EIT is linked to the SDT, where flags (on or off) show whether EIT data is present, and to the service ID (SID) of every TV service in the tables. So when services are remapped, the SID remapping must also be applied to the demultiplexed EIT, and the result rewritten into the injected table carousel.

- The EIT is a **data carousel** that deletes past information and adds new information periodically. It is a dynamic table, and processing it costs CPU runtime.
- In a basic linear IPTV system this works at best partly, displaying present and following information if the set-top box supports it.
- Middleware servers often generate their own EPG database for the set-top boxes and show it as HTML pages. They check and extract the EIT data to keep their database up to date.
- The EPG is always necessary for the PVR recording feature of middleware server systems.

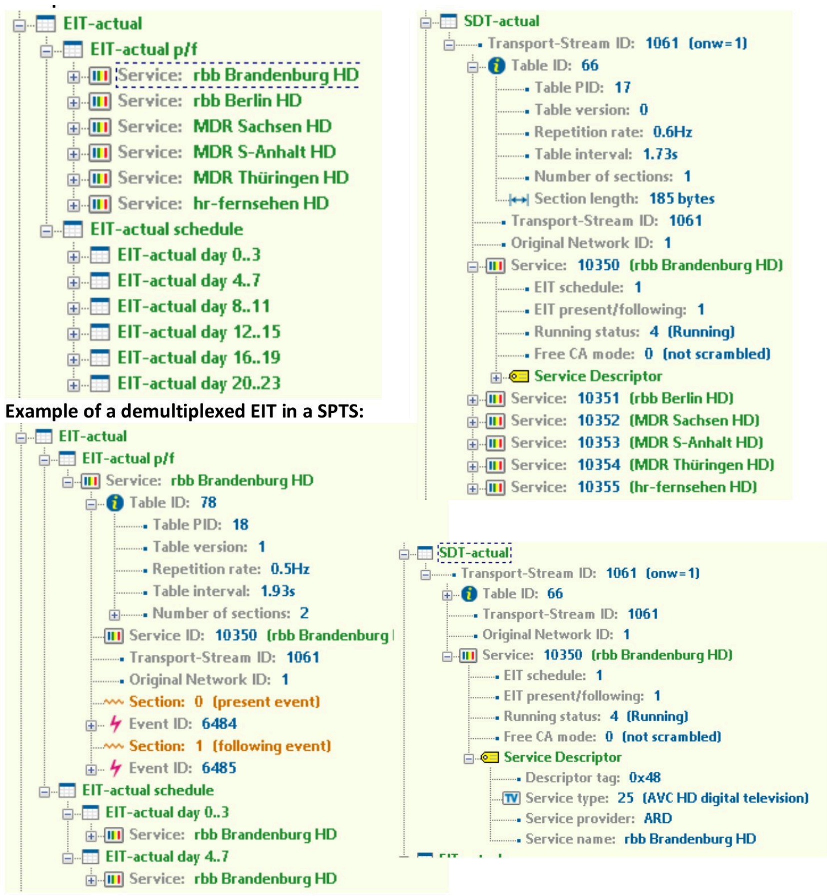

Figure 20.1 Top: the full EIT of an MPTS and the EIT flags in its SDT. Bottom: a demultiplexed EIT in an SPTS.

EPG modules and XMLTV

Advanced high-class IPTV streamers such as the Luminato should make use of the EIT (Chapter 14). If you, as the operator, want to process EIT and EPG for your IPTV system, an extra **EPG module** is available. It serves the EPG and can also import XMLTV database files, process them and inject the data into your SPTS.

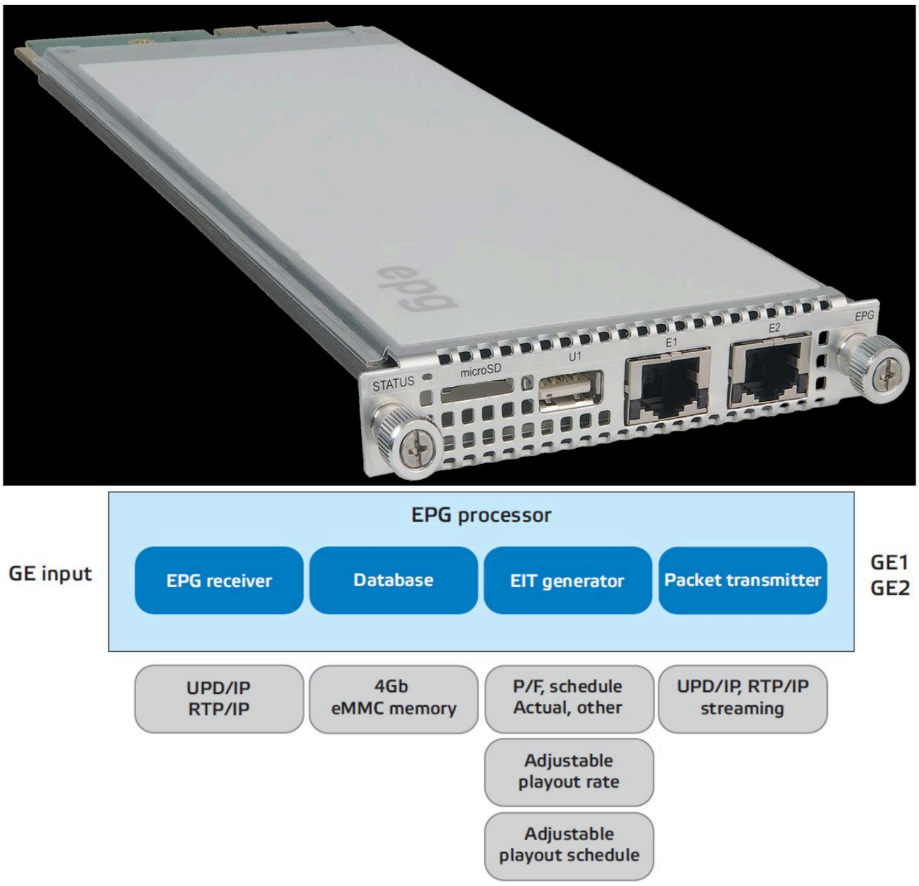

Figure 20.2 EPG processor module and its function blocks.
Product photo and diagram: Teleste

According to the manufacturer, the EPG module creates full EPG information, including present/following and a schedule for the actual and other transport streams. The playout rate and schedule can be controlled, and the languages defined in order of priority. User-defined profiles allow flexible outgoing EIT streams and efficient use of bandwidth.

Any Luminato receiver module can deliver EIT information to the EPG processor module. The module can also receive EPG data over IP, from the operator's internal network or from the internet, for example from a hosted EPG data service. File-based XMLTV data can be processed and played out as well.

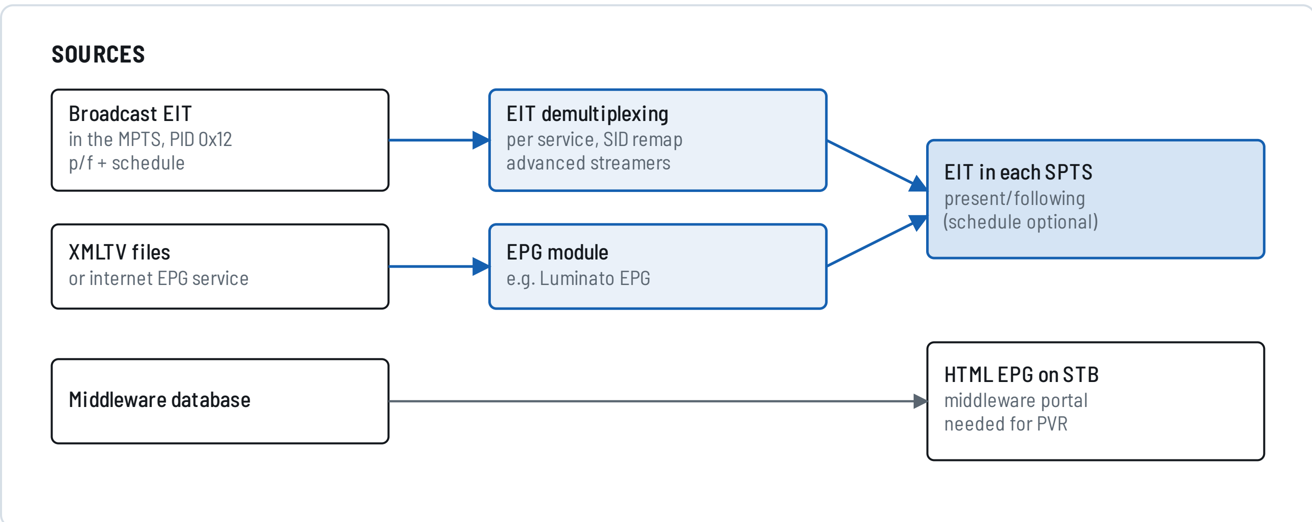

Figure 20.3 Three routes to EPG data in an IPTV system.

CLIENTS, SERVICES AND OPERATION · ENGINEERING GUIDE · CHAPTER 21

Set-top boxes, hospitality TVs and digital signage

The client decides what the guest actually sees. For digital signage it must be simple, and for interactive services it must work with the middleware.

IRENIS / BLANKOM · Technical guide · Ralf Riedel, Director Technical Sales & Engineering, IRENIS GmbH

In this chapter Set-top boxes · Digital signage · Hospitality TV sets · Plan the clients for the future

KEY POINTS

- Set-top boxes differ widely in chipset, features and price.
- A digital signage box must start straight into its first multicast stream, with no portal or menu.
- Hospitality TVs and set-top boxes must support the middleware you plan to add later. Check compatibility from the start.

Set-top boxes

Many types of set-top box are available, with more or less modern chipsets, a wide range of prices and very different features.

Digital signage

Digital signage means displaying the same content all the time over IPTV: advertising, news or information screens, for example in airport terminals or shopping centres. For this you need only a simple box. It gets its address automatically from a DHCP server and has one multicast address, or a few, configured.

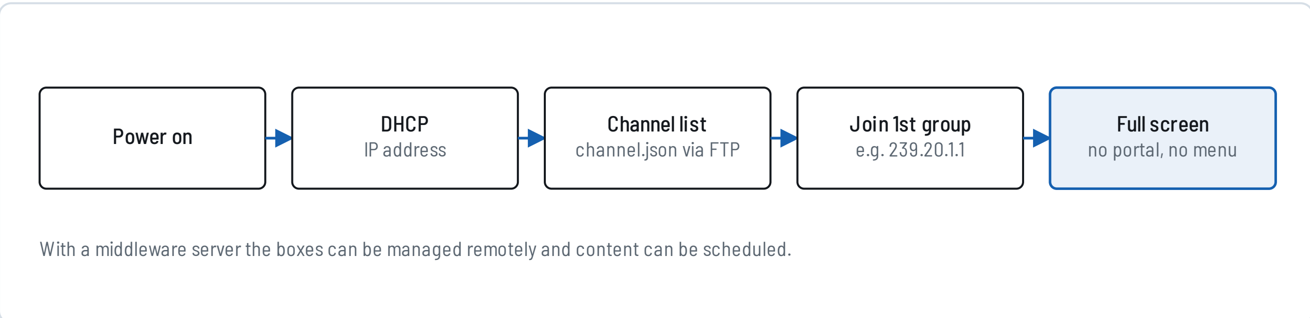

Figure 21.1 Start-up sequence of a digital signage set-top box.

After power-up, the box must always start with the first service (multicast address) in its channel list, **without showing an interactive menu or portal** as other boxes do.

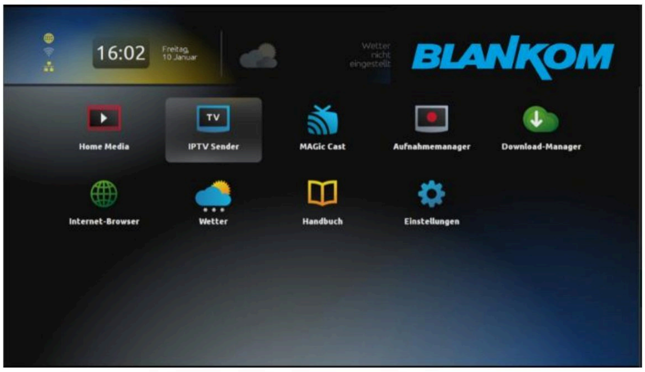

Figure 21.2 What a signage box must not show: an interactive start portal.

Figure 21.3 What it should show: the pre-programmed first service, full screen.
Screenshot of a broadcast programme (NDR)

Our inexpensive HD MPEG-4 IPTV set-top box, the **OmniscreenTV M15**, supports this. It is configured by transferring a `channel.json` file to it via FTP. It can therefore be used for digital signage in a basic linear IPTV system, as can the **BLANKOM 6800+** set-top box (HEVC and 4K).

Figure 21.4 OmniscreenTV M15 HD set-top box.

Figure 21.5 BLANKOM 6800+ set-top box (HEVC, 4K).

These boxes are very small, so mounting them behind a flat screen is easy. The infrared receivers are usually sensitive enough even behind a TV set, provided the IR window is not covered and faces the ceiling, which reflects the IR signal.

Digital signage is more convenient with our partner's **Amino-based boxes**, which work in combination with the **OmniscreenTV middleware server**.

Figure 21.6 Amino-based set-top box.
Product photo: Amino

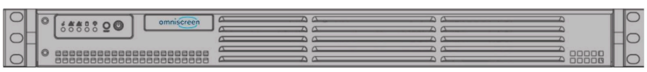

Figure 21.7 OmniscreenTV middleware server (example picture – size and model depend on features and storage).

The advantage in a mid-class or high-class system with an OmniscreenTV server: all signage set-top boxes can be managed remotely, and content can be changed and scheduled automatically. For full details of the OmniscreenTV system, please refer to its own brochure.

Hospitality TV sets

Philips Hospitality PRO-TV sets can be used directly as IPTV clients.

The following hospitality TV sets work with the OmniscreenTV API:

- Vestel MB90/95 and MB110 (a separate firmware management app is required)
- Philips 5010, 5011, 7011, 5014 and 6014; the xx14 series properly supports Android apps and Chromecast
- LG Pro:Centric
- Sony
- Samsung AE690 series; support for the newer Tizen models was in development

> **CHECK THE CURRENT LIST**
>
> Technical details are subject to change without notice. Ask us for the current compatibility list before choosing TV sets.

Plan the clients for the future

Consider the client devices, whether set-top boxes or TV sets, from the beginning, so that you do not fall into traps later:

- **Samsung** smart and hospitality TVs can work as basic linear IPTV receivers but need a tool for the channel set-up. When an OmniscreenTV middleware server is installed later, an app must be installed on the supported TV sets.
- **Basic standalone IPTV set-top boxes** usually cannot work with the middleware system. We can adapt them, but it costs several man-months of work, so it is not cheap.

Chapter 22 describes the system tiers and how they grow.

System tiers and growth path

A hotel wants its guests to feel at home and come back. Which IPTV tier serves that goal depends on the hotel, and every tier can grow.

IRENIS / BLANKOM · Technical guide · Ralf Riedel, Director Technical Sales & Engineering, IRENIS GmbH

In this chapter The guiding idea · Three tiers, plus hybrid · Grow with the business · Please decide

KEY POINTS

- Three tiers – basic linear, mid-class with middleware, and premium with VoD, PVR and OTT – plus a hybrid DVB-C and IPTV option.
- Each tier needs different technology, after-sales service and support. A premium system is not available at an entry-level price.
- Start with a basic system and grow, but choose clients that support the later middleware from the beginning.

The guiding idea

A hotel always has to make its guests comfortable so that they return to the hotel, or the chain, on their next visit: *come to us and feel at home.*

Three tiers, plus hybrid

A scalable IPTV system is available in different sizes:

- A **basic** linear TV system for channel zapping only, usually possible without any middleware server (3-star).
- A **mid-class** system with add-on features such as a PMS interface, information channels and basic interactivity for the room, set-top box or TV. A middleware server is needed (4-star).
- A **premium** 5-star system with features such as PMS, timeshift, OTT, PVR, video on demand (VoD) and hotel information pages such as restaurant menus, possibly including Wi-Fi to the rooms. One or more servers are needed.
- A **hybrid** system of DVB-C over coax plus IPTV and its additional services.

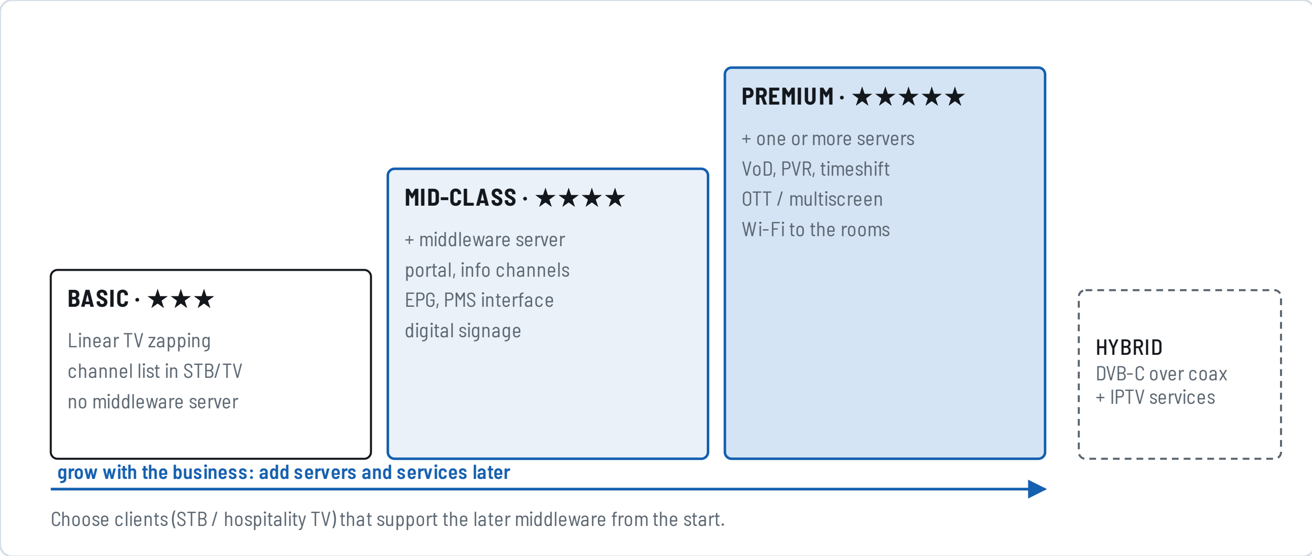

Figure 22.1 System tiers and the growth path between them.

All of these differ in technology and implementation, and also in after-sales service and support. Do not expect a premium system for the price of an entry-level one.

Grow with the business

A basic linear system can be extended later: first with a middleware server and digital signage features, later with an additional server for VoD or OTT services.

Consider the client devices, whether set-top boxes or TV sets, from the beginning, so that you do not fall into traps (Chapter 21).

Integration into building management systems, or into the property management system (PMS) at reception, is often requested. These are nice-to-have functions. Check whether they are really necessary in your project: this is television, not a life-support system.

Please decide

CHOOSE YOUR TIER

- ☐ **Simple, basic and economical:** linear IPTV.
- ☐ **Mid-class:** with added features such as EPG support (Chapter 20), with or without a middleware server.
- ☐ **Advanced high class:** more comfort, in the price range of broadcast equipment.

The next chapter shows reference designs for satellite concepts and headends.

Reference designs and a case study

Once the data from the previous chapters is available, we design the headend. These examples show typical results, from compact to complete.

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In this chapter Satellite reception concepts · Headend examples · Case study: a 3-star hotel in Germany

KEY POINTS

- Satellite concepts range from two positions over coax to four positions over fibre with automatic master/backup switching.
- Headends range from a basic linear system without a server to a complete platform with middleware and digital signage.
- Reserve space in the rack for later receiver-streamers.

Satellite reception concepts

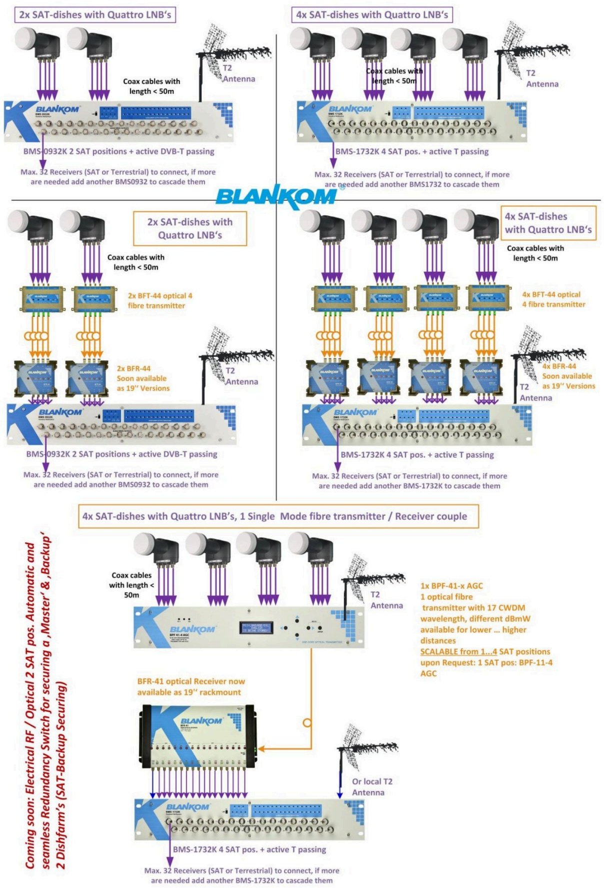

Figure 23.1 Satellite reception concepts: 2 or 4 positions over coax, over fibre, and with automatic master/backup switching.

Headend examples

With the data collected as described in Chapter 10 and Chapter 11, we can design the right professional multi-input headend for you. It may look like this system:

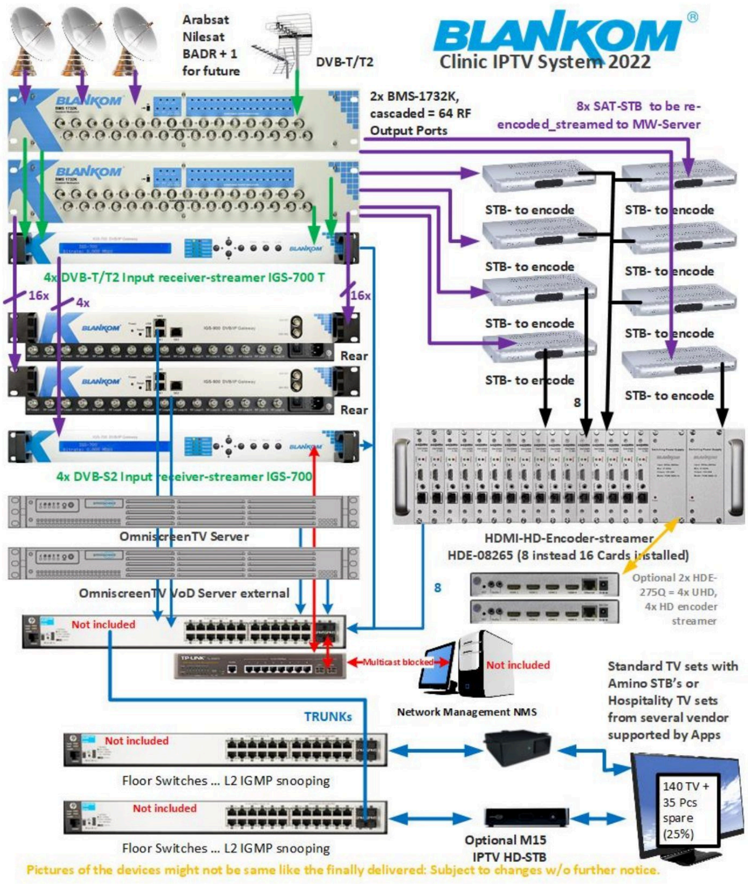

Figure 23.2 Clinic IPTV system (2022): 64 RF outputs, DVB-S2 and DVB-T/T2 receiver-streamers, re-encoded STB channels, HDMI encoders, OmniscreenTV server and IGMP floor switches.

Or like this complete system, with every DVB and IPTV streaming capability you could wish for:

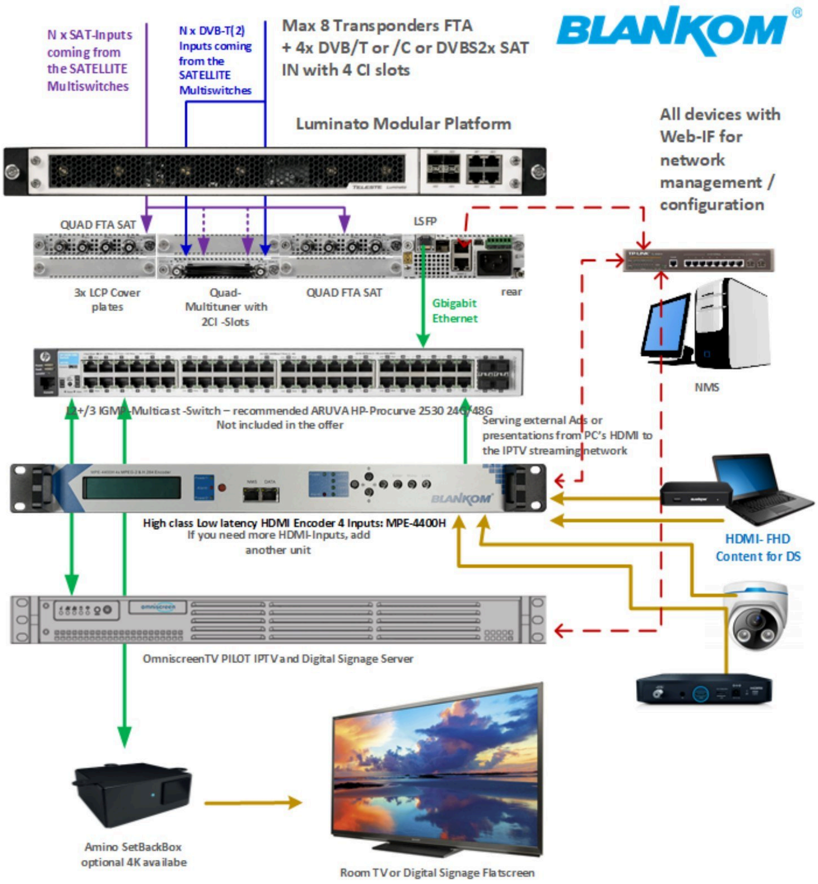

Figure 23.3 High-class system on the Luminato platform with low-latency HDMI encoder, OmniscreenTV server and digital signage.

Or like this cost-effective linear IPTV system:

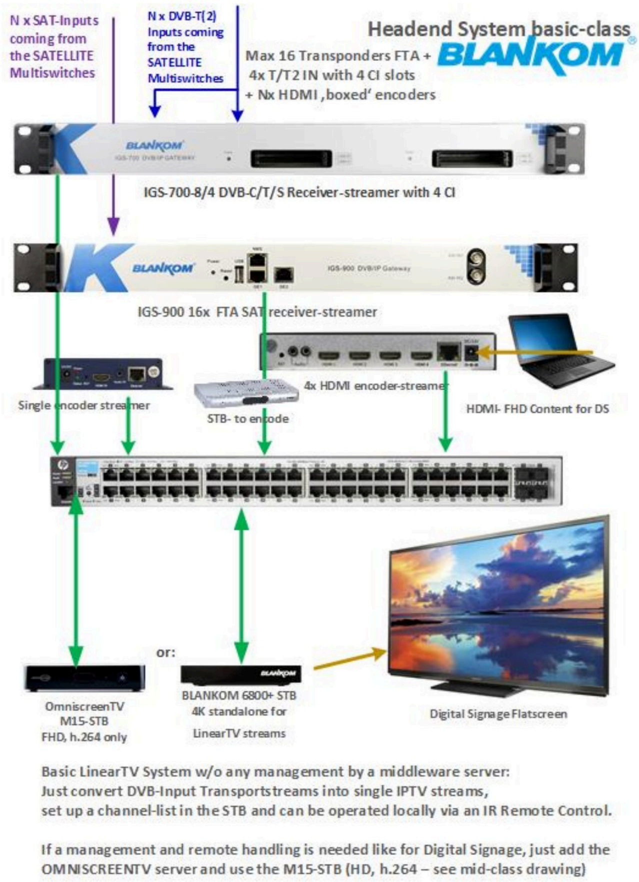

Figure 23.4 Cost-effective basic linear IPTV system with IGS receiver-streamers, HDMI encoders and M15 or 6800+ set-top boxes.

A basic linear TV system without any management by a middleware server simply converts the DVB input transport streams into single IPTV streams. A channel list is set up in the set-top box, which is operated locally with an infrared remote control. If management and remote handling are needed, for example for digital signage, add the OmniscreenTV server and the M15 set-top box (HD, H.264; see the mid-class drawing).

Case study: a 3-star hotel in Germany

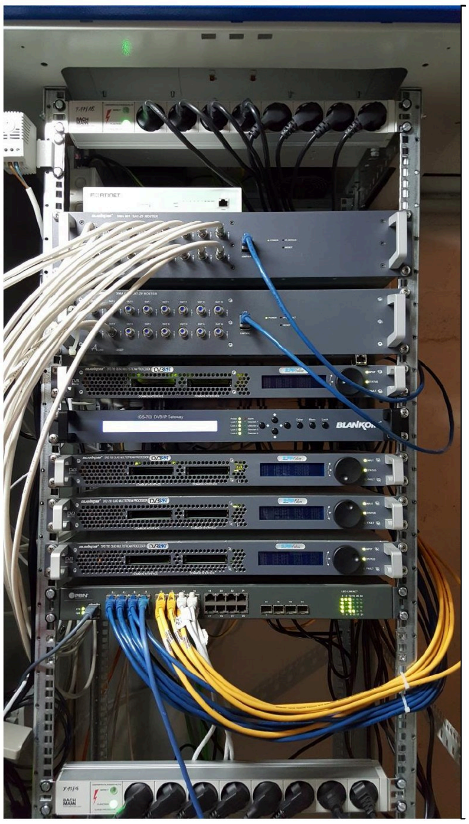

Figure 23.5 Basic BLANKOM headend in a German 3-star hotel.

ITEM	SOLUTION
Equipment	Older BLANKOM devices mixed with a new one
Satellite positions	2
Clients	Samsung hotel TV sets
Satellite distribution	2 × 19″ satellite matrix, cascaded
Network	Layer 2+ switch with IGMPv3
Streaming	Multicast to the floors
Services	About 125 TV services and several radio streams
Middleware server	None
VoD	None
Other	Wi-Fi hotel management on top
Future	Reserved space for more receiver-streamers for later upgrades

YOUR PROJECT

Send us your service list, satellite positions and number of rooms. Our engineers in Germany will propose a headend design and quotation (request a quote).

CLIENTS, SERVICES AND OPERATION · ENGINEERING GUIDE · CHAPTER 24

Monitoring the headend

Every modern headend unit is configured and checked through a web browser. For the TV services themselves, a screen that shows them all is the most practical monitor.

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In this chapter Web interface Visual monitoring

KEY POINTS

- Each headend unit is configured, and its status checked, through its own web interface.
- For TV, visual monitoring on a mosaic decoder (multiviewer) is usually enough. A black tile shows at once that a service has failed.
- Place the multiviewer where staff see it every day, for example in the IT room or the facility manager's office.

Web interface

Configuring equipment through a web browser is state of the art. Every headend unit has its own web interface for configuration and for checking its status. No additional management software is needed for this.

Visual monitoring

Modern headend units are managed over Ethernet with TCP/IP and HTTP. But we are talking about television streams, not critical life-support systems. If a transponder fails (Chapter 3), it is annoying, but a visual monitoring system is fully sufficient for a TV network. **IP decoders with a mosaic view** (multiviewer) show all services on one screen.

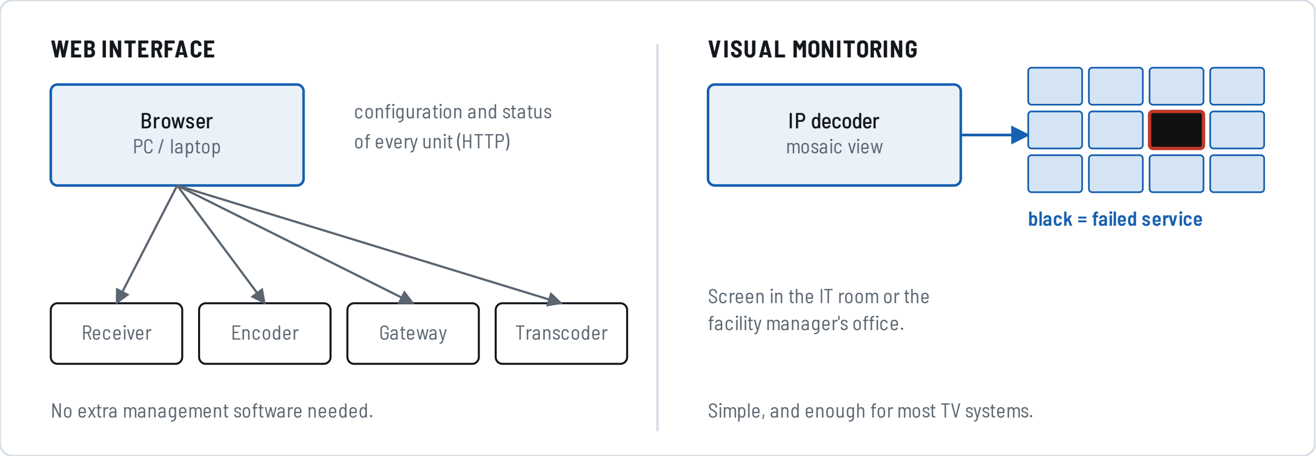


Figure 24.1 Configuration and status through each unit's web interface, and visual monitoring of all services on a mosaic decoder.

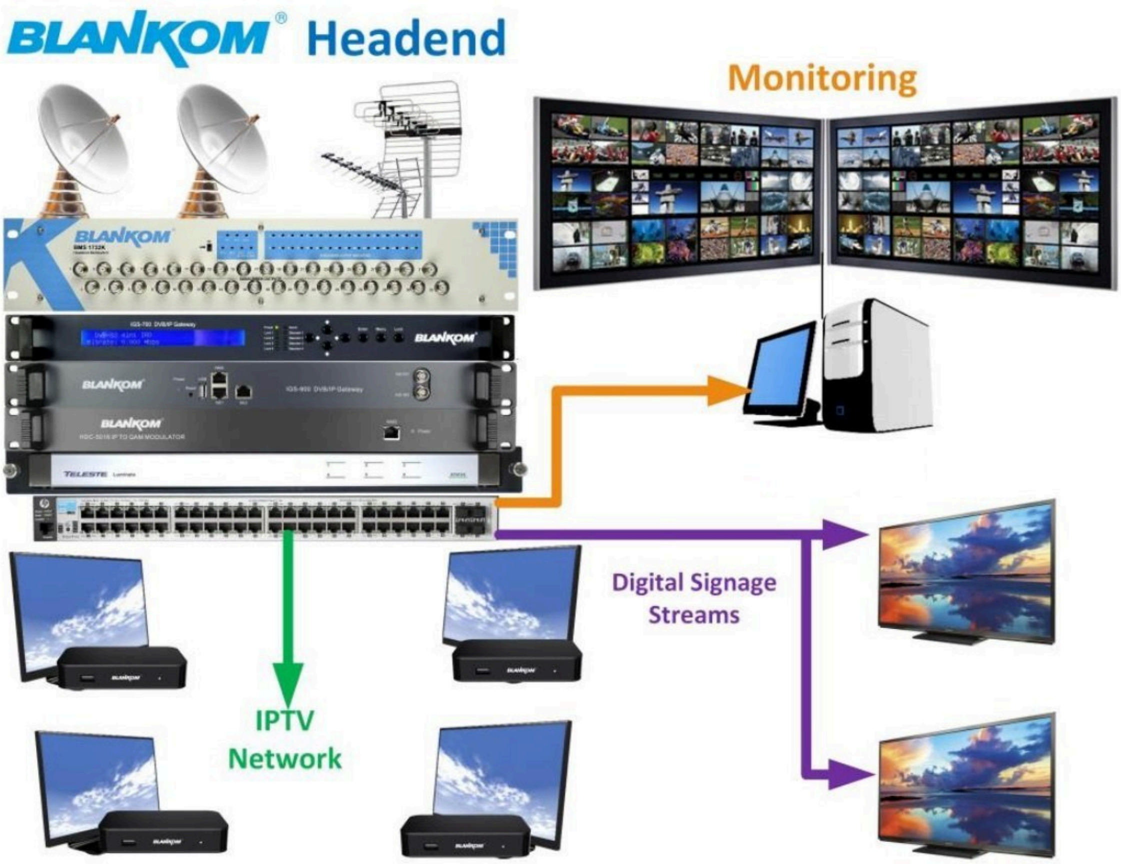


Figure 24.2 Visual monitoring of all services on a multiviewer wall next to the headend.

The monitor can be installed in the headend itself, which is usually the IT room, in the facility manager's office, or wherever suitable. If a service goes black, the staff will notice it soon and can send a technician to check the headend and the satellite distribution. Some technicians call this *sneaker redundancy*: put on your running shoes and go to the headend.

For mission-critical video, where interruptions are not acceptable, combine automatic 1+1 redundancy (Chapter 3) with continuous visual monitoring.

REFERENCE · ENGINEERING GUIDE · APPENDIX A

IPv4 multicast and reserved address ranges

A reference for the address plan. Which multicast blocks exist, which one to use for IPTV, and which IPv4 ranges are reserved.

IRENIS / BLANKOM · Technical guide · Ralf Riedel, Director Technical Sales & Engineering, IRENIS GmbH

In this chapter Multicast and IPTV · IANA multicast address blocks · Reserved and private IPv4 ranges

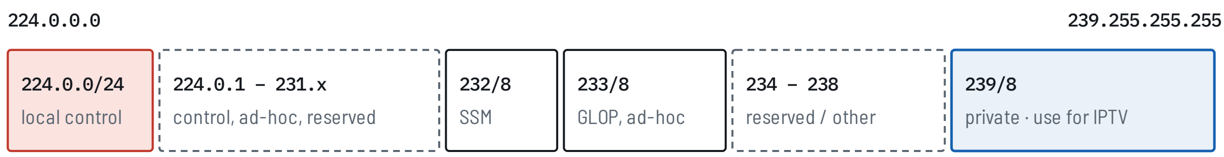
KEY POINTS

- Multicast addresses run from 224.0.0.0 to 239.255.255.255.
- Use 239.0.0.0/8, the administratively scoped range reserved for private use, for IPTV.
- Never use 224.0.0.0/24. It is reserved for local network control, and routers do not forward it.

Multicast and IPTV

Multicast sends UDP packets from one source to many receivers. It is used, for example, to stream from a satellite or DVB-T receiver to many receiving PCs or set-top boxes, or to feed several streaming servers from one encoder output. Multicast works only with UDP. It is not possible with TCP, because TCP is a two-way connection between exactly two hosts. Multicast is most commonly used with RTP and MPEG-2 TS.

The extensions a host needs to support IP multicasting are specified in RFC 1112. The multicast address space runs from **224.0.0.0 to 239.255.255.255**.



Widths not to scale. Recommended plan: one group per service from 239.x.y.z, e.g. 239.1.1.1, 239.1.1.2, …
and a separate port per stream (RTP: even ports, e.g. 10000, 10002, 10004 …).

Do not use 224.0.0.x: it clashes with routing and discovery protocols and the stream may fail.

Figure A.1 The IPv4 multicast address space. Use 239.0.0.0/8 for IPTV.

IANA multicast address blocks

BLOCK	RANGE	NOTE
Local Network Control Block	224.0.0.0 – 224.0.0.255 (224.0.0/24)	Routing and discovery protocols; never forwarded by routers, whatever the TTL
Internetwork Control Block	224.0.1.0 – 224.0.1.255 (224.0.1/24)	Control protocols across networks
AD-HOC Block I	224.0.2.0 – 224.0.255.255	Assigned individually
Reserved	224.1.0.0 – 224.1.255.255 (224.1/16)	
SDP/SAP Block	224.2.0.0 – 224.2.255.255 (224.2/16)	Session announcements
AD-HOC Block II	224.3.0.0 – 224.4.255.255	Assigned individually
Reserved	224.5.0.0 – 224.251.255.255	
DIS Transient Groups	224.252.0.0 – 224.255.255.255 (224.252/14)	
Reserved	225.0.0.0 – 231.255.255.255	
Source-Specific Multicast	232.0.0.0 – 232.255.255.255 (232/8)	SSM, IGMPv3
GLOP Block	233.0.0.0 – 233.251.255.255	Derived from AS numbers
AD-HOC Block III	233.252.0.0 – 233.255.255.255 (233.252/14)	
Unicast-prefix-based	234.0.0.0 – 234.255.255.255 (234/8)	
Administratively scoped	239.0.0.0 – 239.255.255.255 (239/8)	**Private use – use for IPTV**

Source: IANA IPv4 Multicast Address Space Registry (summary). Check the registry for the current state.

> **RECOMMENDATION**
>
> Choose multicast addresses according to the IANA registry. We recommend the range **239.0.0.0 to 239.255.255.255**, which is reserved for private use. Addresses in 224.0.0.x can clash with existing services and cause your stream to fail. Plan the ports as well (Chapter 15, Appendix B).

Reserved and private IPv4 ranges

Keep public and private addresses apart when you assign IPTV streams and device management addresses.

RANGE	USE
10.0.0.0/8	Private networks (RFC 1918)
172.16.0.0/12	Private networks (RFC 1918)
192.168.0.0/16	Private networks (RFC 1918)
100.64.0.0/10	Shared address space for carrier-grade NAT (RFC 6598)
169.254.0.0/16	Link-local, when no DHCP address is available (RFC 3927)
127.0.0.0/8	Loopback (the host itself)
0.0.0.0/8	“This network”, valid only as a source address
192.0.2.0/24, 198.51.100.0/24, 203.0.113.0/24	Documentation and examples
198.18.0.0/15	Benchmark testing
224.0.0.0/4	Multicast (see above)
240.0.0.0/4	Reserved for future use
255.255.255.255	Limited broadcast

Source: IANA IPv4 Special-Purpose Address Registry (summary).

REFERENCE · ENGINEERING GUIDE · APPENDIX B

UDP ports, the UDP header and RTP/RTCP

A reference for stream parameters. Which ports to choose, what the UDP header contains, and how RTP and RTCP share a port pair.

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In this chapter Stream parameters at a glance · Port ranges · The UDP header · RTP and RTCP ports

KEY POINTS

- Choose IPTV ports from the user (registered) range 1024–49151, preferably 5004 and above and outside the ephemeral ranges.
- With RTP, use even ports. RTCP uses the next odd port.
- The UDP header is 8 bytes; IPTV packets typically carry 7 × 188 = 1316 bytes of TS payload.

Stream parameters at a glance

PARAMETER	RECOMMENDATION
Transport	UDP, optionally with RTP
Destination address	Multicast group from 239.0.0.0/8 (Appendix A)
Destination port	Any port above 1024 that is not otherwise used; better 5004 and above. With RTP use even numbers.
Payload	MPEG-2 transport stream, typically 7 × 188 bytes per packet

Port ranges

IANA divides the 65,536 port numbers into three ranges:

- **0–1023: system or well-known ports.** Avoid them.
- **1024–49151: user or registered ports.** Assigned by IANA to specific protocols and applications, but usable wherever the port is not in use. Choose IPTV ports here.
- **49152–65535: dynamic or private ports.** IANA suggests this range for ephemeral ports.

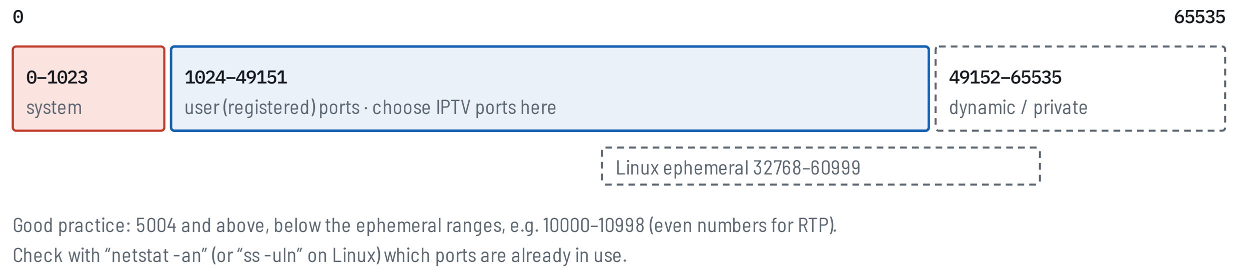

Figure B.1 UDP port ranges and where IPTV ports belong.

Ephemeral ports are the temporary ports an operating system assigns to outgoing connections. Windows since Vista and Server 2008 uses the IANA range 49152–65535 by default. Many Linux kernels use 32768–60999. Older systems used 1025–5000. Your IPTV ports must not clash with existing services or with these ranges. Use one of the unassigned user ports (1024–49151). You can check which ports are in use with `netstat -an` (as administrator on Windows) or `ss -uln` on Linux.

Use a different UDP port for every stream, even when the multicast addresses already differ (Chapter 15).

The UDP header

The UDP header consists of four fields of 2 bytes (16 bits) each.

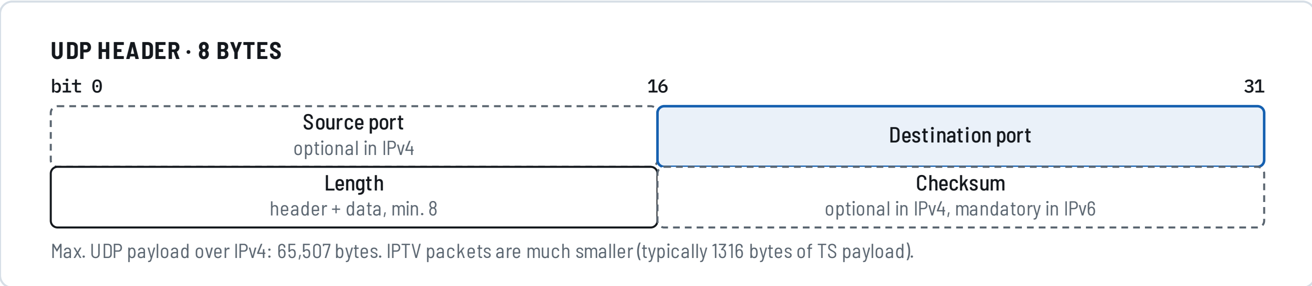

Figure B.2 The 8-byte UDP header.

- **Source port** identifies the sender's port, where a reply should go if needed. If unused, it is zero. It is optional in IPv4, and in IPv6 too.
- **Destination port** identifies the receiver's port and is required.
- **Length** is the length in bytes of the UDP header plus the data. The minimum is 8 bytes, the length of the header alone. The field allows up to 65,535 bytes, but over IPv4 the data is limited to 65,507 bytes (65,535 – 8-byte UDP header – 20-byte IP header). IPv6 jumbograms can exceed 65,535 bytes; the length field is then set to zero (RFC 2675).
- **Checksum** can be used to check header and data for errors. It is optional in IPv4 and mandatory in IPv6. If unused, it carries all zeros.

RTP and RTCP ports

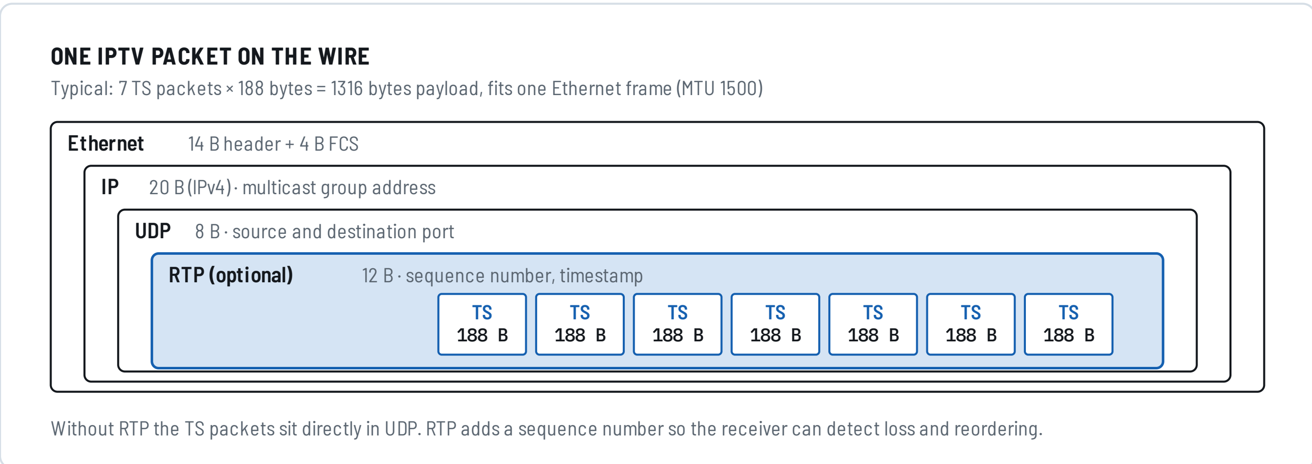

Figure B.3 How an IPTV packet is built: TS packets inside RTP, UDP, IP and Ethernet.

RFC 3550 (section 11) defines how RTP and its control protocol RTCP share ports when they run over UDP:

- RTP **should** use an **even** destination port number, and the corresponding RTCP stream **should** use the next higher (**odd**) port.
- If an application takes a single port number and derives the RTP/RTCP pair from it, an odd number is replaced by the next lower even number, which becomes the base of the pair.
- If the RTP and RTCP ports are set by separate, explicit parameters (for example through a signalling protocol), the even/odd rule may be ignored, although an even/odd pair is still encouraged.
- The RTP and RTCP ports **must not be the same**, because the receiver relies on them to separate RTP data from RTCP control packets.
- In a unicast session, both participants may use the same port pair. A participant must not assume that the source port of incoming RTP or RTCP packets can be used as the destination for its own packets.
- RTCP sender reports (SR) combine information about a participant's outgoing data with reception reports about incoming data. A participant that is not actively sending sends receiver reports (RR) instead.

Source: RFC 3550, section 11 (summary).

IPTV planning checklist

All the questions of this guide on one page. Work through the list before you ask for a quotation; it is also the basis of the project documentation.

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KEY POINTS

- Answer these questions before any headend can be designed or priced.
- Each item links to the chapter that explains it.
- Send the completed list with your request for a quotation.

PROJECT AND SCOPE

- [ ] Type of site and number of rooms or TV points (Chapter 1)
- [ ] Is an Ethernet network being built anyway, or does coax already exist? IPTV, coax or hybrid (Chapter 2, Chapter 22)
- [ ] Target tier: basic, mid-class or premium (Chapter 22)
- [ ] Which services need redundancy, and what level: N+1 or 1+1 (Chapter 3)

RECEPTION

- [ ] Satellite positions and footprint at the site; dish sizes (Chapter 11)
- [ ] Transponder list: frequency, band, polarisation, symbol rate, modulation (Chapter 11)
- [ ] Coax lengths; is fibre needed (Chapter 5, Chapter 6)?
- [ ] Multiswitch or matrix ports, and dish-farm redundancy (Chapter 7)
- [ ] Terrestrial (DVB-T/T2) and cable (DVB-C) inputs (Chapter 10)
- [ ] Measuring instruments and acceptance measurements (Chapter 9)

HEADEND

- [ ] Service list: one row per service, FTA or encrypted (Chapter 11)
- [ ] MSD CAMs and contract with the pay-TV operator, or embedded decryption (Chapter 4)
- [ ] DVB-S2X / 32APSK needed? (Chapter 10)
- [ ] Headend class: EIT demultiplexing, dynamic PMT, redundant PSU, modular (Chapter 14)
- [ ] Own channels to encode (hotel TV, restaurant, gym, spa ...) (Chapter 18)
- [ ] Internet streams to convert from unicast to multicast (SRT, RTMP, HTTP) (Chapter 17)
- [ ] Transcoding: number of streams, input and output formats, bit rates (Chapter 19)
- [ ] EPG: none, present/following, or full schedule; source EIT or XMLTV (Chapter 20)
- [ ] Re-encryption (e.g. Verimatrix, AES) required? (Chapter 10)

NETWORK

- [ ] Multicast address and port plan from 239.0.0.0/8 (Chapter 15, Appendix A, Appendix B)
- [ ] Total bandwidth of all streams, and GbE ports on the headend (Chapter 15)
- [ ] Switches with IGMP v2/v3 snooping; one IGMP querier (Layer 3) (Chapter 16)
- [ ] Fibre trunks to the floors; CAT6A/7 S/FTP for the last metres (Chapter 8)
- [ ] Who supplies and configures the network: the local integrator (Chapter 15)

CLIENTS AND SERVICES

- [ ] Set-top boxes or hospitality TVs; compatibility with the planned middleware (Chapter 21)
- [ ] Digital signage screens: number, content, start-up behaviour (Chapter 21)
- [ ] Middleware functions: portal, PMS interface, VoD, PVR, OTT (Chapter 22)

OPERATION

- [ ] Monitoring: status via web interface, visual multiviewer (Chapter 24)
- [ ] Service agreement (SLA) (Chapter 14)
- [ ] Documentation of all settings, started at the planning stage (Chapter 11)
- [ ] Rack space reserved for later expansion (Chapter 23)

REFERENCE · ENGINEERING GUIDE · APPENDIX D

Glossary of abbreviations

IPTV combines broadcast and IT vocabulary. These are the abbreviations used in this guide.

IRENIS / BLANKOM · Technical guide · Ralf Riedel, Director Technical Sales & Engineering, IRENIS GmbH

KEY POINTS

- Broadcast terms (DVB, MPTS, PMT ...) and IT terms (IGMP, UDP, VLAN ...) meet in every IPTV project.
- Say “service” for a TV or radio programme and “transponder” for an RF carrier.
- Chapter references show where each term is explained.

TERM	MEANING
8PSK, QPSK, 16/32APSK	Satellite modulation schemes (phase-shift keying)
AAC	Advanced Audio Coding, audio codec
ABR	Adaptive bit rate streaming (Chapter 1)
AIT	Application Information Table (HbbTV) (Chapter 12)
ASI	Asynchronous Serial Interface, for transport streams
ATSC	Advanced Television Systems Committee, US digital TV standard
BAT	Bouquet Association Table
CAM	Conditional Access Module (Chapter 4)
CAPEX / OPEX	Capital / operating expenditure
CAS	Conditional Access System
CAT	Conditional Access Table (Chapter 12)
CATV	Cable television
CBR / VBR	Constant / variable bit rate (Chapter 12)
CC	Continuity counter (Chapter 13)
CDN	Content delivery network
CI / CI+	Common Interface / Common Interface Plus (Chapter 4)
C/N, S/N	Carrier-to-noise / signal-to-noise ratio (Chapter 9)
CWDM	Coarse wavelength division multiplexing (Chapter 6)
DHCP	Dynamic Host Configuration Protocol
DiSEqC	Digital Satellite Equipment Control
DSTP, S/FTP	Double-shielded twisted pair (Chapter 8)
DVB-S/S2/S2X, -T/T2, -C	Digital Video Broadcasting via satellite, terrestrial, cable
ECM / EMM	Entitlement control / management messages (pay-TV)
EIT	Event Information Table (Chapter 20)
EPG	Electronic Programme Guide (Chapter 20)
FEC	Forward error correction
FTA	Free-to-air
GbE	Gigabit Ethernet
H.264 / H.265 (AVC / HEVC)	Video codecs
HbbTV	Hybrid broadcast broadband TV
HLS	HTTP Live Streaming
IANA	Internet Assigned Numbers Authority (Appendix A)
IGMP	Internet Group Management Protocol (Chapter 16)

TERM	MEANING
IRD	Integrated receiver-decoder
ISDB-Tb	Integrated Services Digital Broadcasting, terrestrial (Brazil variant)
L-band / SAT-IF	Satellite intermediate frequency, 950–2150 MHz (Chapter 5)
LNB	Low-noise block downconverter
MPEG-1 Layer II (MP2)	Audio codec used in DVB
MPTS / SPTS	Multi- / single-programme transport stream (Chapter 12)
MSD CAM	Multi-service decryption CAM (Chapter 4)
NIT	Network Information Table (Chapter 12)
NMS	Network management system
OTT	Over-the-top (internet) delivery
PAT / PMT	Program Association / Program Map Table (Chapter 12)
PCR	Program clock reference (Chapter 13)
PID	Packet identifier (Chapter 12)
PMS	Property management system (hotel)
PSI/SI	Program Specific Information / Service Information
PSU	Power supply unit
PTS / DTS	Presentation / decoding time stamp (Chapter 13)
PVR	Personal video recorder
QAM	Quadrature amplitude modulation (DVB-C)
QoS	Quality of service
RTCP	RTP Control Protocol (Appendix B)
RTMP / RTSP	Real-Time Messaging / Streaming Protocol (Chapter 17)
RTP	Real-time Transport Protocol (Chapter 1, Appendix B)
SAP	Session Announcement Protocol
SDI	Serial digital interface (Chapter 18)
SDT	Service Description Table (Chapter 12)
SFP	Small form-factor pluggable (network module)
SID	Service ID (Chapter 20)
SLA	Service level agreement (Chapter 14)
SMATV	Satellite master antenna television
SR	Symbol rate
SRT	Secure Reliable Transport (Chapter 17)
SSM	Source-specific multicast (Appendix A)

TERM	MEANING
STB	Set-top box (Chapter 21)
STC	System time clock (Chapter 13)
TCP / UDP	Transmission Control / User Datagram Protocol (Chapter 1)
TDT / TOT	Time and Date / Time Offset Table (Chapter 12)
TS	Transport stream
UPS	Uninterruptible power supply
VLAN	Virtual LAN
VoD	Video on demand
XMLTV	XML file format for EPG data (Chapter 20)

More questions?

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