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DigiTAG Handbook on DVB-SSU

Implementing System Software Updates on the terrestrial television platform

Digital Terrestrial Television Action Group

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Version 1.0

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Introduction

Digital terrestrial television (DTT) services are rolling out across Europe with more than half of the countries having already launched services. DTT services have proven popular with viewers with massive quantities of DTT receivers sold. It is estimated that over 35 million DTT receivers had been sold in Europe by the end of 2006.

As more and more DTT receivers enter homes, it will be increasingly difficult to make changes to the terrestrial platform without requiring viewers to purchase new receivers. This is especially true in an open, horizontal market which often characterises the DTT platform. Nevertheless, it can be necessary occasionally for broadcasters to reorganise or add new features to their service offering or manufacturers to correct operational faults in their receivers.

Because DTT receivers are based increasingly upon a combination of hardware and software systems, some such upgrades are possible without a physical change to the receiver and only require the download of new software. While these downloads can be made locally by either connecting the receiver to a computer or, for example, through the use of a memory stick, such procedures would be quite onerous for the television viewer.

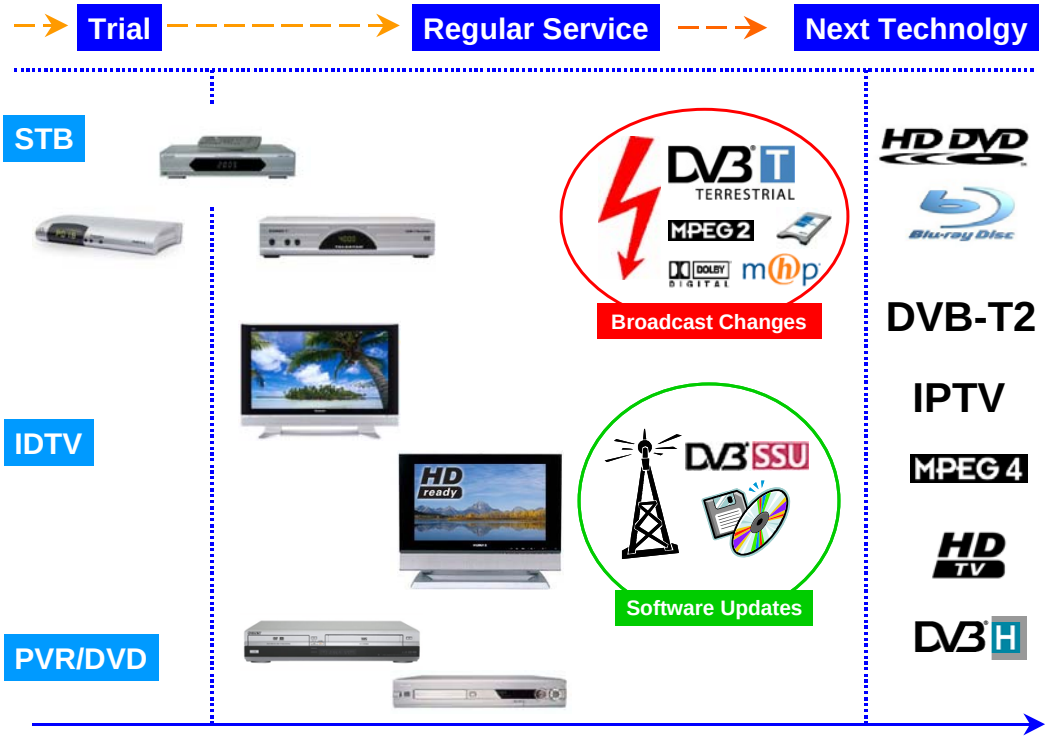
The DVB specification for System Software Updates (DVB-SSU) provides the broadcast industry with a standard means for updating DTT receivers using a broadcast channel in a simple and efficient manner that does not place any burden upon viewers. These over-the-air downloads address appropriate DTT receivers with software downloads that will improve and correct their functionality.

SSU services are beneficial to the entire broadcast industry as they help to ensure the continued maintenance of the terrestrial television platform. From the growing experience gathered from some over-the-air downloads in various countries, the DVB Project recognised the importance of an approved standard and put together a common specification for SSU services. In many European countries, this specification is either already implemented or in the planning phase.

This Handbook provides an overview of the DVB-SSU standard, including technical and business aspects, and explains the benefits that it brings to the broadcast industry as a whole. It also provides a summary of SSU activities in Europe and concludes with several recommendations on how to ensure the success of these services.

SSU on the terrestrial platform

The broadcast industry must continually offer appealing services to viewers. The intense competition in the broadcast market, does not allow for complacency. Simultaneously, the fast-pace of technological developments allows broadcast operators to be able to continually offer new and enhanced services. However, not all of these new services can be implemented at the time of launch and must instead be added as they become available.

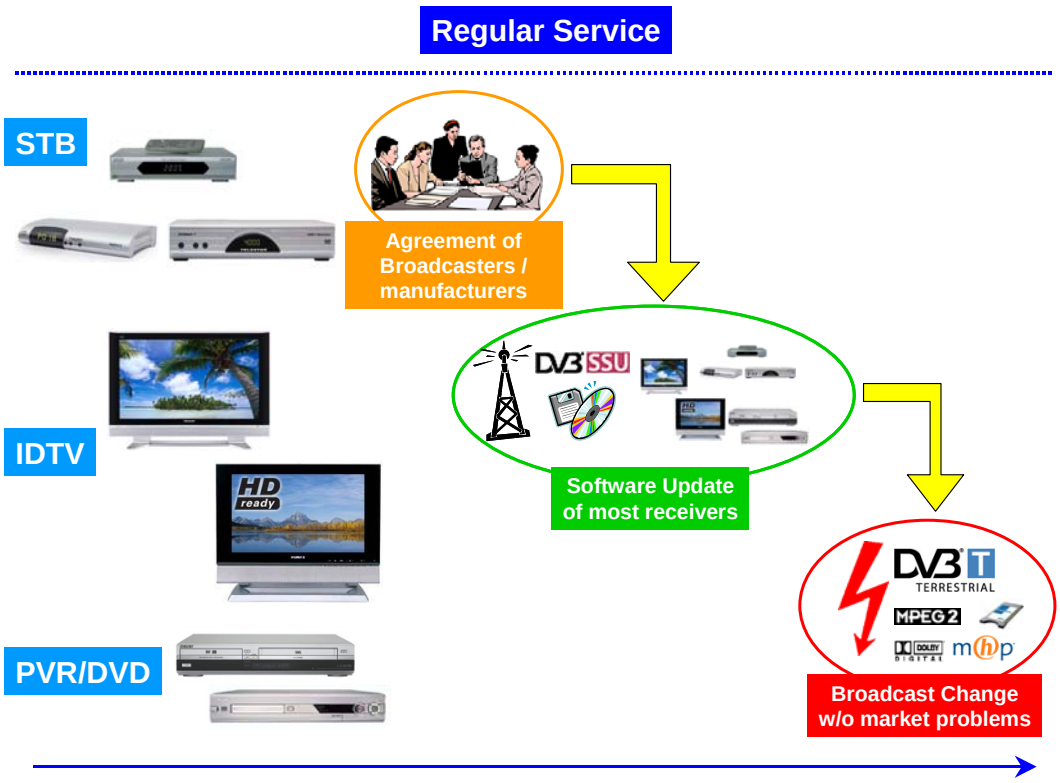


Typical DVB-T broadcast scenario

The mass market for consumer products can only support broadcast services that are clearly defined and stable over the long term based on standardised technologies such as MPEG-2 for standard-definition televison and MPEG-1 for radio. Broadcasters traditionally do not wish their viewers to risk purchasing receivers that quickly become out-of-date. Over time, as developments take place, viewers can benefit from enhanced service offerings, either by purchasing a new receiver or relying upon system software updates (SSU) for non-hardware changes.

As receivers become increasingly complex and reliant upon software, SSU becomes essential to support the evolution of services offered on all digital broadcasting platforms.

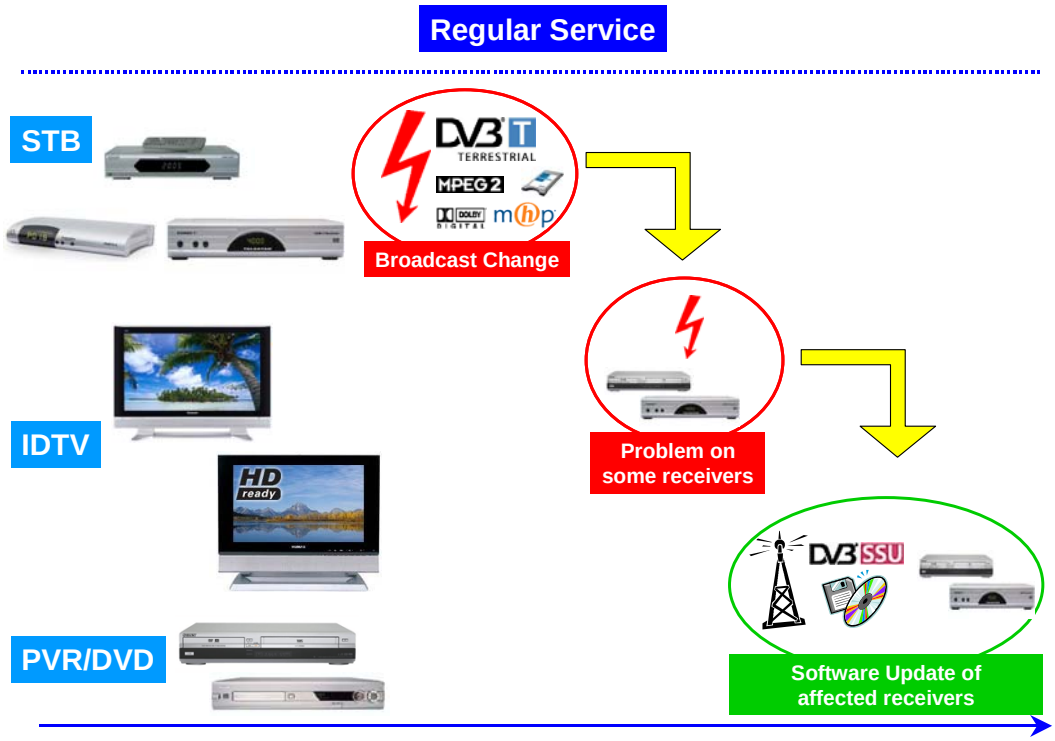
On the terrestrial platform, the usage of SSU is necessary in two circumstances: firstly, to fix bugs in a specific DTT receiver model and, secondly, to improve the broadcast offer. In either circumstance, the installed receiver base will require rectification using SSU services.



Improving the broadcast offer (update to most receivers in market)

When improving the broadcast offer through the addition of new features, all products on the market will need to be upgraded. It is usually necessary for manufacturers and broadcasters to meet well in advance to discuss any major broadcast changes to be made. In Europe, SSU has been used successfully to provide such new features as:

- Support for a 7-day electronic programme guide (EPG)
- Support for MHEG1.0.6
- Support for MHP and MHEG additions
- Implementation of a phased conditional access (CA) service
- Correction to allow for the use of a dynamic programme map table (PMT)
- Correction of signalling due to the introduction of broadcast streams from neighbouring countries
- Support for sorting received services (Logical Channel Numbering) and concealing technical data services



Fixing a specific DTT receiver model (update of some receivers in market)

In some cases, existing receivers may need to be corrected when an operational problem in standard features has been found after the launch of the receiver. These problems may be discovered only at the time of market launch should it not be possible to conduct a full field-test in one or more countries, or due to an unexpected change to the broadcast stream. Receiver field-tests vary between markets, with manufacturers conducting tests independently or with broadcasters or other testing organisations verifying minimum performance compliance.

Despite field testing, it is possible that receiver defects are only detected following launch and so need to be corrected. Rather than undertaking a product recall, SSU can be used to correct the fault. Examples of operational faults corrected in Europe include:

- Finding new broadcast service (i.e. scanning for services in the broadcast bands)
- Solving interoperability issues between interactive platforms, i.e. MHP and MHEG
- Inability to find new services due to tuning problems or identification of echos
- Better handling of service installation with multi-transmitter site reception
- Adding a manual search option in receivers which originally had only automatic search functionalities

Further examples of features that could be added or enabled using SSU include:

- DVB subtitles
- Hierarchical modulation
- Support for dual and mono audio
- Updates for MHP (for MHP-equipped receivers)
- Updates for embedded CA (for CA-embedded receivers)

However, SSU cannot enable all types of new services. This is the case for new services that require the addition of new hardware. Examples of such features that cannot be enabled with SSU include:

- Embedded CA on receivers without a smartcard reader
- Support of interactive services on zapper receivers (RAM and Flash memory, CPU constraints)
- MPEG-4 AVC on MPEG-2 receivers
- DVB-T2 on receivers with a DVB-T tuner
- Dolby digital output on receivers without SPDIF connector/interface
- Return channel on receivers without a modem

In the above examples, hardware changes are necessary to enable these features.

DVB-SSU

In a vertical market, the pay-TV operator has control of all aspects of the service - from programme source to consumer products - and therefore the advantage of making direct *over-the-air* (OTA) software upgrades using their proprietary system. Often, upgrades are made to receivers without any viewer awareness. However, in a horizontal market, over-the-air software upgrades can be much more difficult given that several operators deliver their services to a multitude of different receivers in homes.

It is for this reason that the DVB Project has developed a common approach for upgrading the software of digital receivers in a horizontal market. The DVB specification for System Software Updates (DVB-SSU) allows for software upgrades through a controlled over-the-air (OTA) download. In October 2002, the European Telecommunications Standards Institute (ETSI) approved the DVB-SSU specification [ETSI TS 102 006 V1.2.2 (2002-10)], and this was updated in May 2004 [ETSI TS 102 006 V1.3.1 (2004-05)].

DVB-SSU provides a standard mechanism for signalling the presence of a software update service and the means to carry the data for such a software update service. It builds on ISO/IEC 13818-6 [2], ETR 162 [3] and EN 300 468 [4] for signalling and EN 301 192 [5] for data carriage.

The specification provides much flexibility. When adding a new feature, broadcasters and network operators can benefit from a phased introduction to provide sufficient time to ensure that the feature functions properly and will not adversely affect other receivers in the market. The optional nature of the standard allows for further flexibility since service providers can choose between the different tools available in the specification's toolkit. Furthermore, it allows for the use of proprietary software updates alongside DVB-SSU.

DVB-SSU defines the simple and enhanced profiles for SSU, which are differentiated by the signalling of services. To guarantee compatibility, both services and receivers must be able to support the simple DVB-SSU profile. Receivers with the capability for DVB-SSU simple profile cannot support enhanced profile transmission while receivers with the capability for DVB-SSU enhanced profile will support the simple profile.

DVB-SSU simple profile

The DVB-SSU simple profile provides a standardised means for making software system updates. It defines the signalling information for locating the data transmission stream in a network using a network information table (NIT). The standard also uses the programme map table (PMT) to indicate the location of SSU service within the data transmission stream.

Upgrades can only work if the receivers targeted are switched on or in active stand-by mode, such as a special SSU-scan mode. Therefore, updates must be broadcast for several days to ensure that a maximum number of receivers are reached. The amount of time necessary to make an update using the simple profile will depend on the number of receivers estimated to be present in a given market.

The simple profile allows for several receiver models to be upgraded simultaneously from a single multiplex. However, more transmission capacity will be necessary to accommodate the several data streams.

Limitations exist with the simple profile. As more receivers enter the market, both new models and new types of receivers such as PVRs and iDTVs, that require support, current bandwidth capacity may not be sufficient. This will become a problem without the availability of additional data capacity.

Further details on the DVB-SSU simple profile can be found in the annex.

DVB-SSU enhanced profile

The DVB-SSU enhanced profile provides more flexibility and options beyond those of the simple profile. Using the Update Notification Table (UNT), receivers are able to access special information describing when and where a specific data transmission will take place. The UNT carries scheduling and targeting information, additional descriptors and other selection criteria that cannot be defined using the simple profile.

Compared with the simple profile, much less time needs to be allocated for receiver upgrades. While the necessary time needed for a software data download is similar to that of the simple profile, the total broadcasting time per model can be reduced by the aid of clear schedule information. Generally, a time slot of about one hour can be sufficient per model, which is significantly shorter than the time slot necessary for the simple profile. With the possibility of providing scheduling information within the Update Notification Table (UNT), upgrades can be made at all times of the day and night, including when receivers would normally be on stand-by.

Receivers that support the enhanced profile are also able to support the simple profile, giving the SSU service providers much flexibility in choosing which profile to use to make receiver upgrades.

Further details on the DVB-SSU enhanced profile can be found in the annex.

UK D-Book Over-the-Air Downloads (UK-OAD)

In 2000, the United Kingdom developed its own system for Over-the-Air Download (OAD) since, at the time, a standard for SSU did not yet exist. The UK-OAD system has proven to be very successful for broadcasters, network operators and manufacturers. In the period between 1 October 2004 - 30 September 2005, 138 over-the-air downloads took place. Currently, over 70 new downloads are carried out each year.

The system is currently managed by the Digital Television Group's subsidiary, DTG Testing, based in Kingswood Warren using a so-called "engineering channel" provided free-of-charge

from the BBC's multiplex. Receiver upgrades are carried as a data component of the BBC interactive service.

DTG Testing provides transmission scheduling and pre-transmission testing to ensure that its users have access to the engineering channel and that their data transmissions will not adversely affect other receivers in the market. The UK-OAD system requires that receivers are switched on or in stand-by mode during the time of the data transmission, to allow for upgrades to occur at night. It is also possible for the user to manually update their receiver during the time of the data transmission. While at least 47 hours of data transmissions are allocated to each model, transmissions typically last 3 days.

The UK-OAD system allows for multiple receiver models to be addressed within a single manufacturer's download. It is also possible for multiple Organisation Unique Identifiers (OUIs) to be carried in the Manufacturer Information Structure (MIS), however this feature is not used for legal liability reasons.

However, because the number of data transmissions is expected to increase and current capacity is limited, a more flexible system is needed that makes better use of the available capacity. It is for this reason that DTG Testing is planning to migrate towards DVB-SSU, first implementing the simple profile prior to adopting the enhanced profile. Migration toward the DVB-SSU simple profile will likely begin in 2007.

NorDig Unified Receiver specification

In 1998, members of NorDig decided that all NorDig compliant receivers must support over-the-air downloads. Because the DVB-SSU standard did not exist at the time, NorDig members developed their own specification referred to as "bootloading". This specification provides for common signalling and calls for the use of a mechanism to verify that correct software files are downloaded onto receivers. It also recommends the use of segmented software files.

Because the NorDig bootloading specification does not allow for reducing playout schedules, NorDig has recommended that its members adopt the DVB-SSU standard and use the NorDig specification only as an alternative.

Proprietary update systems

Apart from DVB-SSU and UK-OAD, several proprietary update systems exist. They include variations to the UK-OAD system and the DVB-SSU standard as well as the broadcast of SSU data within the Teletext service.

However, the use of these systems is not recommended as it is not known if such data transmissions will have an adverse effects on other receivers in the market. In addition, proprietary update systems are not necessarily designed for simultaneous usage by multiple manufacturers in the same network, which can lead to sub-optimal usage of the capacity made available.

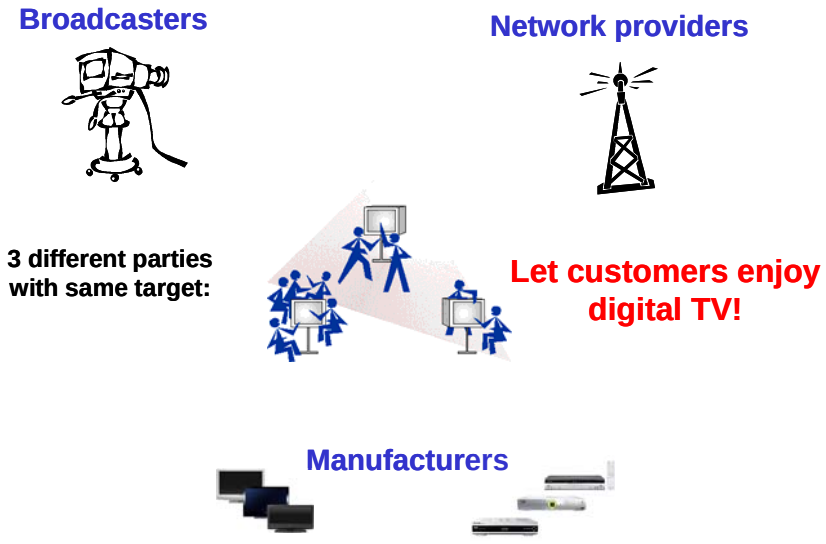
SECTION

2

DVB-SSU benefits to the broadcast industry

Perceived by some as a tool only for manufacturers, criticism of SSU has been strong. Manufacturers are accused of bringing "unfinished" products into the market and broadcasters resent serving as a "quality check" for manufacturers. But these criticisms are largely unfair.

Rather, SSU can benefit the entire value chain of the broadcast industry, from broadcasters to manufacturers to viewers. The benefits of SSU implementation are most evident in countries that have successfully adopted SSU services as part of their DTT platform.



Benefits for manufacturers

By providing a means of upgrading receivers, SSU services provide clear benefits to manufacturers, allowing them to improve their products and to ensure that their products work reliably and function correctly. In fact, manufacturers can only guarantee proper functionality at the time of product launch (e.g. by internal laboratory or field-testing), but may later find it necessary to modify receiver software in order to add new features or correct software errors.

The availability of SSU services in a digital platform eliminates the need for an expensive product recall and also helps maintain the reputation of the manufacturer. Compared to other methods that can be used to make upgrades (e.g. customer service or computer download), SSU is much simpler for the viewer and provides a more reliable means for reaching all receivers.

Benefits for broadcasters

With SSU, broadcasters are able to add over time more features to the transmissions and hence offer viewers new services. As receivers increasing rely upon software to decode and interpret broadcast functions, the software can be upgraded easily and updated to take into account new developments in the industry. By offering SSU services in collaboration with manufacturers, broadcasters can add new features and avert negative effects caused by legacy products in the market.

The introduction of a new service features, such as a 7-day EPG in the United Kingdom, has allowed both broadcasters and viewers to benefit from an improved service without needing to replace existing receivers or affecting other products in the market.

It must be recognised that the DTT platform is in continual evolution as new services become available. In order to benefit from this evolution, it is important to find a method to upgrade existing receivers without requiring viewers to constantly make new investments.

Broadcasters can also benefit from flexibility offered by SSU. Able to offer new types of service features to their viewers, they are not constrained to multicast different versions to the different types of receiver models available on the market.

Depending on how use of frequencies is licensed in a given market, broadcasters may also be able to generate revenue from the use of their broadcast capacity by manufacturers.

Benefits for network providers
It may be possible for network operators to generate revenue with the implementation of SSU services. Because the use of their network is essential to the transmission of data services, manufacturers may be asked to pay for the use of the infrastructure.

It is likely that network operators and manufacturers will work together to ensure that the data streams are transmitted with maximum efficiency and without any adverse affects on other receivers in the market. The testing of streams may be conducted by the network operator.

Benefits for viewers
The implementation of SSU services brings great benefits to viewers especially since equipment can be upgraded in a manner which is both easy and automatic. Should the receiver have a flaw, it can be fixed without requiring down-time or a return to the place of purchase. In many circumstances, viewers will never be aware of the existence of the flaw and its eventual repair.

By providing automatic upgrades to DTT receivers, viewers can benefit from new service offerings and functionality without an onerous download process or being forced to purchase a new product. This is especially useful when viewers have invested in expensive DTT receivers, such as iDTVs. By making receivers to some extent “future-proof”, viewers are guaranteed a longer product life-cycle.

Viewers, however, will need to accept that software downloads will take place automatically on their receivers without necessarily requiring their approval. But some viewers may not wish to lose the control of their receiver.

SECTION

3

DVB-SSU technical issues

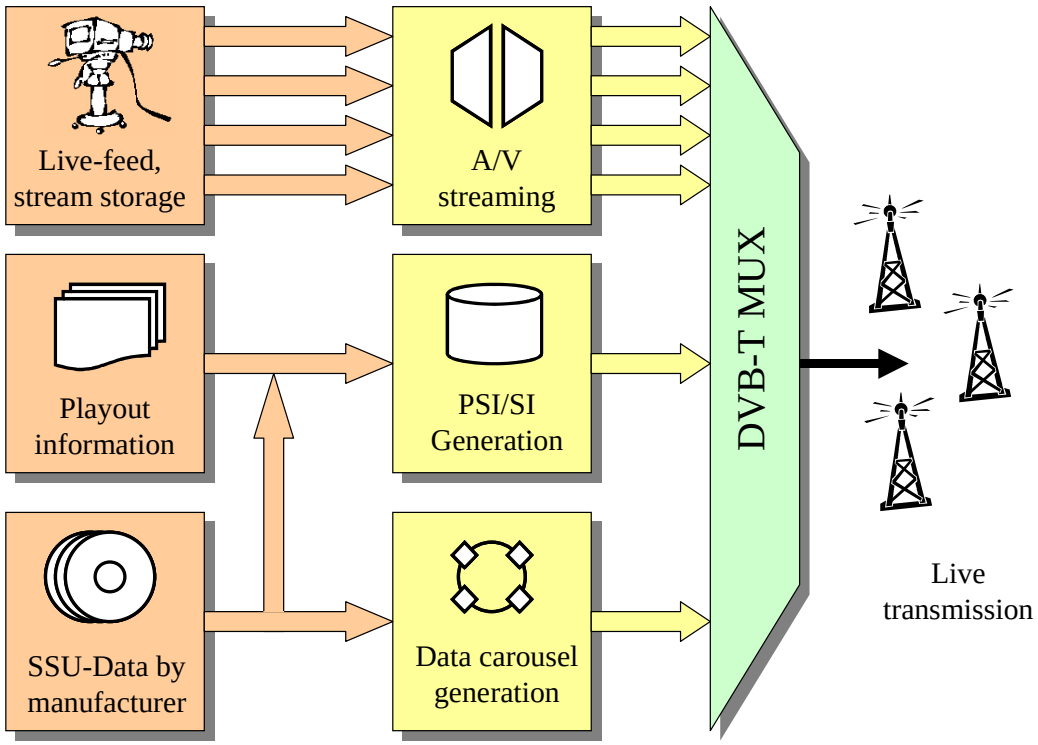
The technical parameters for an SSU data transmission depend on a variety of issues:

- The coverage of the multiplex(es) carrying the data transmission
- The available bandwidth capacity for the data transmission
- The total number of models that need to be upgraded simultaneously
- The SSU-formats used in other DTT receivers in market

This section provides an overview of the technical infrastructure necessary and gives a step-by-step illustration of DVB-SSU in action.

Technical infrastructure

Services require the set-up and maintenance of facilities for live data transmission. Facilities may also be set up to test the SSU data transmission in laboratory conditions prior to the live, over-the-air transmission.



Requirements for the testing facilities

It is recommended to undertake some testing beforehand to avoid the risk of problems occurring during the live data transmission. The pre-testing will likely be made by the manufacturer but will benefit from further checking by an external organisation.

Testing is also recommended to be undertaken by the SSU service provider, especially when a large number of models are to be upgraded. Such testing will help ensure that the data transmission makes the desired corrections to the targeted DTT receivers and verify that the SSU data transmission will not cause any damage to other DTT receivers in the market.

The tests performed should ensure the proper functionality of the SSU download itself onto the receiver model and subsequently that of the new software after the upgrade has been completed. It should also cross-check with other DTT models in the market to ensure against adverse effects.

The equipment necessary to perform the testing includes a play-out system, samples of the receiver model to be upgraded, and a selection of other product samples for the cross-check testing.

Alternatively, testing can be undertaken directly by the manufacturers using a test data stream provided to each manufacturer for testing to ensure against possible adverse effects on his receivers.

Requirements for the live transmission
At the time of the live SSU data transmission, the play-out system includes components such as the carousel server, modulator, multiplexer and transmitter.

If DVB-SSU is selected, the play-out system must be able to provide modifications for Programme Map Table (PMT), Network Information Table (NIT) and Download Server Initiate Message (DSI). When using the enhanced profile, the play-out system must be able to provide for usage and modification of the Update Notification Table (UNT). In addition, equipment to generate digital storage media command and control (DSM-CC) data carousel is necessary, and may, in some cases, be provided by the consumer product manufacturer.

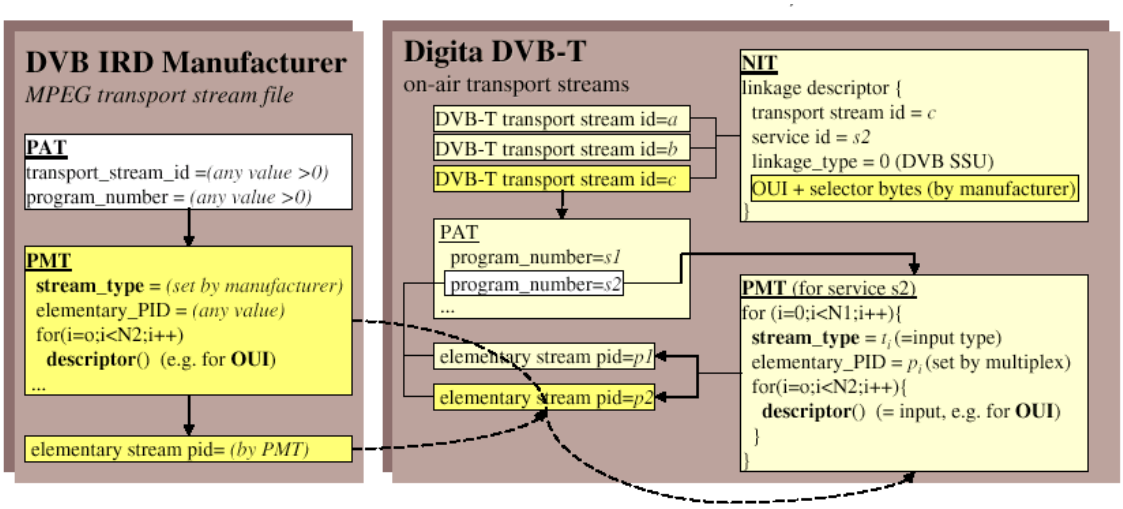
Service operators in some countries may prefer to allow manufacturers to generate and deliver the download carousel as it provides such benefits such as manufacturer confidence in the data stream, clear accountability should problems occur and a reduction in set-up costs and staff training when beginning to launch DVB-SSU services.

A DVB-SSU example
The example below illustrates the various steps that need to be undertaken for a complete SSU data transmission including the data exchange, laboratory testing, and the live broadcast.

Data Exchange
As a first step, manufacturers will need to place a request to the SSU service provider for the SSU data transmission. Agreement will need to be reached on contract related issues such as the costs and specific service request.

The manufacturer will then need to provide receiver model information (including NIT-information parameters such as OUI, OUI_data_length, selector_byte_length, selector_bytes) to the SSU service provider using such delivery formats as a CD-Rom, DVD or FTP server. The information will need to include the data format of the new software (raw binary data such as the transport stream, data carousel, flash image / update contents, etc), as well as model related information to be put in the service information (SI) signalling transmission stream.

The figure below illustrates how the manufacturer data and final signalling by the SSU service provider may be combined:

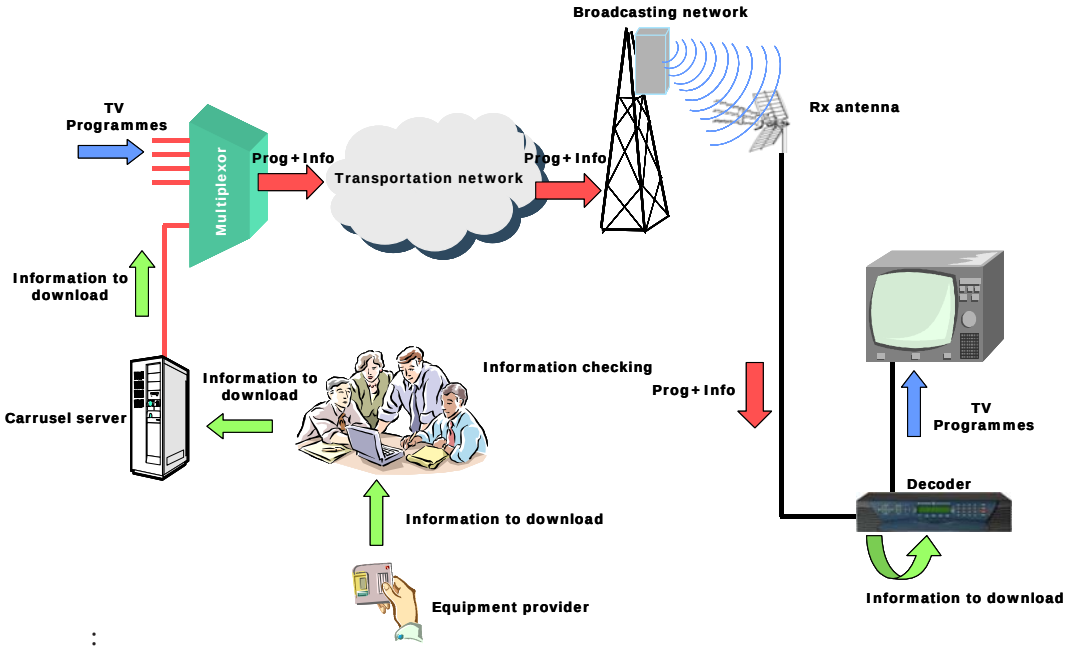


Laboratory testing
Before the live transmission of an SSU data stream, as stated earlier, it is highly recommended to undertake laboratory testing. While testing will be undertaken by the manufacturer, further testing by the SSU service provider can be beneficial.

Live broadcast
Following the confirmation that the SSU data stream functions properly, the live transmission of the SSU data stream can be initiated.

Given that conditions may vary with those in the laboratory environment (i.e. different play-out system, different settings, final data distribution to all transmitters, etc), it is important that the SSU service provider and manufacturer monitor closely the transmission process.

The figure below shows the basic data flow for a live SSU data transmission:



:

- **Information to download:** Information provided by the manufacturer that will be transmitted on the DTT network and collected by the manufacturer's receivers.
- **Carousel server:** Transferring parameters control and signal generation.
- **Multiplexer:** Combines the television signal with other data signals, including the SSU data stream.
- **Transportation and broadcasting network:** Data transport to the point from which the information will be transmitted.
- **Rx antenna and receiver:** End user must have the appropriate DTT installation in order to be able to receive the SSU data stream.

The SSU data stream can be delivered on a separate channel or, as preferred, on an existing channel offering television services.

SECTION

4

DVB-SSU business issues

Setting up the necessary infrastructure to implement an SSU service requires cooperation between the various members of the broadcast industry. Broadcasters and manufacturers will need to work together to decide which types of upgrades should be made, network operators will need to make available their transmission network and, depending on who has been allocated frequencies, will need to make capacity available. Government regulators can play a key role in ensuring that the continual availability of an engineering channel is established in network operator licenses.

Together, the broadcast industry will need to determine how costs are shared and clearly define roles and responsibilities.

Costs

A number of costs are associated with the implementation of SSU service, some costs related to the set-up of facilities and equipment, and others for the operation and maintenance of the service.

Funding is needed for both the testing and live data transmissions, although the costs associated with testing are optional, but may save significant expense later. Testing costs include the technical equipment for the test play-out system, laboratory facilities and the manpower to conduct the testing.

In terms of the live data transmissions, costs will include the transmission capacity, the technical equipment for the live play-out system, the manpower to prepare and maintain the live transmission and the facilities for such work.

Roles and responsibilities

At the simplest level, SSU services requires the agreement between the manufacturer and the SSU service provider. However, in a horizontal broadcasting market, the SSU service will likely be provided by a number of parties including network operators, broadcasters and governmental bodies. This will help to ensure that the process is managed smoothly and provides benefits to all those involved.

A number of issues that will need to be determined in an SSU service contract or memorandum of understanding include: operating rules, service availability, fees, confidentiality, legal liability and communication provisions.

Operating rules

The rules of operation for the SSU service will need to clearly specify the following:

- SSU format to be used for the data transmission:
    - DVB-SSU simple or enhanced profile
    - Multiple manufacturers per carousel
    - Usage of several multiplexes
    - Signalling (NIT/BAT, PMT, …)
- Delivery format of SSU data from the manufacturer
- Delivery schedule (how many days/weeks in advance?)
- Definition of tests to be performed by SSU-provider
- Definition of tests to be performed by manufacturer
- Minimum and maximum bit-rate (also for testing purpose)
- When to switch-off the data transmission should a problem occur
- The reliability of the timing (TDT&TOT) for the enhanced profile

It will also be necessary to formulate the criteria determining which receivers are to be updated. Such criteria could include the market penetration of a given model, its price-range or placement in the product lifecycle. As the cost of the upgrade may be high, without any direct return on investment, a manufacturer may not want to upgrade all of his receiver models.

Service availability
The service availability will determine such issues as time slots and coverage. Manufacturers must know when the data transmissions will take place, the time as well as the number of days that they will be available. This information will allow them to estimate the number of receivers in the market that have acquired the given upgrade.

Because not all DTT multiplexes have the same level of coverage, only those with the highest population coverage can ensure the availability of the SSU data transmission to a high percentage of receivers. Generally, the multiplex with the highest level of coverage is used to transmit SSU services, and it is important to understand the precise regional distribution and coverage of the given multiplexes.

Fees
The services rendered by the SSU service provider normally will entail a transmission cost to manufacturers. Different pricing models exist and can include the following possibilities:

- Registration fee + yearly fee + download fee
- Fee per download (daily, weekly, monthly, yearly…)
- Fee per receiver in market

In addition, a fee may be associated with access to the transmission capacity by the frequency license holder. The use of the transmission capacity to send data services will need to be valued in comparison with the alternative use for transmitting television services.

Confidentiality
At all stages in the process, manufacturers will want to ensure a high level of confidentiality. The SSU service provider must guarantee to guard against the distribution of confidential information.

Legal liability
Manufacturers and SSU service providers must put in place mechanisms in preparation for if something should malfunction during the SSU data transmission. For example, if incorrect data is transmitted and some receivers in the market experience an adverse effect as a result of the transmission?

While both the manufacturer and SSU service provider will take step to guard against such occurrences, they must be prepared for the eventuality that such a scenario arises even if so far such a scenario has never occurred.

In the United Kingdom, the SSU service provider limits his liability by sending a copy of the data transmission stream to the network operator upon reception from the manufacturer and prior to undertaking any tests. This helps DTG Testing ensure that should any errors exist in the SSU data, they have originated from the manufacturer.

It is also important to reserve the right to refuse a data transmission should the integrity of the data be questioned. In the United Kingdom, all received files for over-the-air downloads are posted on an FTP site that can be accessed by members of DTG Testing for trialing on their products.

The issue of liability becomes important in the case of the involvement of multiple manufacturers in a single carousel. As none of the contributing manufacturers will be responsible for the final carousel, it is difficult to determine the responsibility should a problem arise.
In this case, liability can be limited by providing manufacturers with a separate digital storage media command and control (DSMCC) carousel for their updates. The manufacturer is able to supply the SSU data information directly in a transport stream that can then be used for the data transmission stream, and by doing so, takes the responsibility should any errors occur.

Finally, difficulties can be encountered in products made by manufacturers no longer in business. In this case, the responsibility for making software upgrades or addressing problems that the products may have is not clear.

Communication with retailers and the public
Because SSU results in a change to a product in the home, information must be clearly communicated to retailers and the general public. Generally, manufacturers provide such information through their customer services as well as their retail channels.

In the United Kingdom, DTG Testing publishes on its website (www.dtg.org.uk/retailer/download_schedule.pl) the schedule of current and upcoming over-the-air downloads so that retailers and the general public can have advance notice of activities. This information is unofficially copied by other websites and the schedule is often a subject for discussion by digital television enthusiasts on various Internet forums, such as "Digital Spy" (www.digitalspy.co.uk/forums).

Business models used in Europe
Different SSU business models have been adopted in Europe. The type of business model adopted is usually dependent on how broadcast frequencies are regulated and how transmission capacity is made available to manufacturers.

Because of the coverage obligations usually placed on public service broadcasters, they operate multiplexes with the highest population coverage levels. Generally, SSU services are transmitted from these multiplexes in order to be able to target a high number of receivers.

It can be expected, therefore, that public service broadcasters should determine how best to manage SSU data transmissions from their multiplexes. They may select either a network operator or an independent third party to operate the data transmissions. Alternatively, as in the United Kingdom, the data transmissions can be managed by the same organisation responsible for certifying receivers entering into the market.

SSU management by network operator
The network operator can function as the SSU service provider. Given his existing infrastructure, he is in a strong position to be able to transmit data services alongside television and radio services.

In countries where broadcast frequencies are allocated to network operators, they can allocate capacity for the data transmission, as well as carrying out the broadcast of it. Alternatively, the public service broadcaster may select the network operator to manage his frequencies reserved for data transmissions.

This business model can be used when only a single incumbent network operator serves the whole broadcast market. It has been used in Finland and Spain and is likely to be used in Germany and Norway.

SSU management by third-party
An independent third-party can also operate as the SSU service provider. However, he will need to source the necessary capacity from the broadcaster (or multiplex operator) as well as use the infrastructure belonging to the network operator.

This model is used when several network operators provide services in a given country. Rather than selecting one (or several) network operators to manage SSU services, an independent third-party is responsible for the upgrades and helps to ensure transparency, efficiency and fair access to all manufacturers in the market.

Countries that have adopted this model include France via the Association de Téléchargement Hertzien (ATH) with Cognacq-Jay Image and in the United Kingdom via DTG Testing.

SSU management based on receiver certification
Some countries have set up an organisation to provide receiver certification prior to the receiver's entry into the market. This same organisation can also serve as the SSU provider, especially since it will likely have tested the receiver to ensure that the SSU specifications had been included prior to launch into the market.

In countries that have adopted this model, the organisation responsible for receiver testing works in close collaboration with the network operator. This model has been adopted in Austria and Sweden. Interestingly in Sweden, manufacturers need to negotiate directly with the DTT service provider Boxer for the data transmission capacity although the network operator Teracom is responsible for the testing, approval and downloading of the software.

SECTION

5

SSU status in Europe

Most countries in Europe have adopted or plan on adopting SSU services on the terrestrial platform. However, not all countries as yet use the DVB-SSU standard.

Status of SSU implementation	Countries
Implementing DVB-SSU	Austria Denmark Finland France Germany Italy Netherlands Spain Sweden
Implementing over-the-air downloads (using another system)	Hungary* Norway Sweden (manufacturer can use proprietary SSU) United Kingdom* (*) planning to migrate to DVB-SSU
Undertaking DVB-SSU trials	Czech Republic Norway UK (in planning)
No SSU offering via DVB-T services	Belgium Switzerland

DVB-SSU profile used

Among those countries implementing or planning to implement the DVB-SSU standard, most will use the simple profile. However, some countries have recommended the use of the enhanced profile.

DVB-SSU profile used	Countries
Simple	Finland Italy Norway Denmark France Netherlands Spain UK
Enhanced	Germany UK (usage planned) Spain (recommended) Sweden
Undecided	Hungary Austria (all formats allowed)

In addition, some countries have also established further technical guidelines for the use of the DVB-SSU standard. This has been the case in France, while the Nordic countries (Finland, Norway and Sweden) ensure adherence to the DVB-SSU guidelines established by NorDig.

Capacity available

To ensure that the necessary capacity is available for SSU data transmission, most countries have set aside permanent capacity. In other countries, capacity is made available at specific times of the day.

Capacity availability	Countries	
Permanently allocated	Austria	Finland
	France	Germany
	Hungary	Norway
	Spain	Sweden
	UK	Denmark

A continuously available bit-rate has been agreed in Finland, France (20 kbit/s), Spain (32-128 kbit/s), Sweden and the UK (50 kbit/s). In general, more than one simultaneous download per multiplex is possible or expected. This is the case in Finland, Hungary, Italy, Norway, Spain, Sweden and the UK.

In Sweden, approximately 100-200 kbit/s has been allocated for all SSU services. Those SSU services which require longer time slots are allocated a higher initial capacity generally between 100-150 kbit/s which is later reduced to 30-50 kbit/s.

Capacity is available at a charge in almost all countries although it has been free-of-charge up until now in Italy. Hungary and Portugal have not yet decided whether or not to charge manufacturers for the use of the capacity.

Testing facilities

To ensure that a planned SSU data transmission will not adversely impact other DTT receivers in the market, extensive testing of the proposed data transmissions are undertaken prior to the live, over-the-air transmission. Countries that have set up a special laboratory to carry out these pre-tests include:

Austria	Denmark
Finland	France
Italy	Netherlands
Norway	Spain
Sweden	United Kingdom

SECTION

6

Key recommendations

In order to implement a successful SSU system, DigiTAG recommends several key actions. They include the adoption of the DVB-SSU standard, the harmonisation of guidelines across Europe, close cooperation between the different members of the broadcast industry, the reliance upon a single SSU service provider and the allocation of continuous capacity reserved for SSU data transmissions.

Adoption of the DVB-SSU standard

SSU services provide the opportunity for broadcasters and manufacturers to upgrade DTT receivers that are already distributed in the market. Broadcasters can add new features while manufacturers can ensure the proper functionality of their receivers.

The use of the DVB-SSU standard offers many advantages. It is based on a public specification known to all manufacturers and works in such a way as to prevent adverse effects on other products in the market. It is designed for simultaneous usage by multiple manufacturers on the same network, making efficient use of the bandwidth capacity available.

The DVB-SSU simple profile is already successfully used to upgrade receivers in the market. But given that the number of receiver models in the market will increase rapidly in the coming years, better efficiency will be achieved through the use of the DVB-SSU enhanced profile.

It is reasonable to consider initially implementing the simple profile and upgrade to the enhanced profile at a later stage since the majority of manufacturers have included the software to manage both profiles in their receivers.

Many manufacturers have already implemented the DVB-SSU standard in their DTT receivers. This means that countries that have recently launched DVB-T services can subsequently implement DVB-SSU without making any modifications to the existing receivers in the market.

By adopting the DVB-SSU standard, countries can benefit from shared knowledge and resources. They can leverage the information learned in one country and apply it to their situation. Such sharing will help in the development of the most efficient use of the SSU system.

Streamlined approach to SSU implementation

While both the DVB-SSU simple and enhanced profiles offer many options, the broadcast industry can benefit from the consistent selection of certain elements from the DVB-SSU toolkit. Given the number of options available as part of the DVB-SSU standard, it may be worthwhile to streamline and simplify some options, such as pre-testing, while others can be eliminated.

Basic recommendations include:

- The use of separate digital storage media command and control (DSM-CC) carousels for each receiver model with separate packet identifiers (PID) rather than the use of multiple carousels with one PID. However, this will require agreement from the network operator.
- Provision of the SSU data in a transport stream or DSM-CC section format will ensure the manufacturer's responsibility over the data stream and, should a problem with the SSU download occur, the issue of liability can be easily resolved.
- The proper broadcast of such service information (SI) as the time and date table (TDT) and the time offset table (TOT) to ensure the functionality of scheduled SSU services using the enhanced profile.
- Given that limited capacity is available, manufacturers should ensure that the size of their SSU download file is not so large that it will cause problems with the SSU data transmission cycle time. Should it be necessary to send a large date file, the notification mechanism in the enhanced profile can inform viewers that an update

is necessary. The notification message can also be used as a means to reach a maximum number of receivers without needing to broadcast the data transmission stream for extended periods of time.

Work has begun in the United Kingdom to define additional recommendations which allow for the migration from the simple to the enhanced profile.

Close cooperation within the broadcast industry

The members of the terrestrial television industry, broadcasters, network operators, manufacturers and governmental bodies, need to work closely together to ensure the successful implementation of DTT services. To help achieve this aim, many countries have established national DVB-T bodies to provide the broadcast industry with a forum for discussion of many of the key issues affecting the DTT platform.

DVB-T forums can help facilitate the discussion within the broadcast industry for the establishment of a successful SSU service. Manufacturers need to work together with broadcasters and/or multiplex operators to obtain access to the necessary capacity for the SSU data transmissions. Likewise, broadcasters need to work with manufacturers to ensure that proper upgrades to DTT receivers are made to allow viewers to access the latest features of their broadcast services. Government bodies may be able to facilitate the availability of frequency capacity for data transmissions.

Cooperation is necessary to ensure equitable access to the data transmission channel by all manufacturers. The broadcast industry needs to agree to the terms of SSU services including such issues as the definition of broadcast and receiver specifications. It will also be important to exchange other types of broadcast information, such as planned broadcast changes and possible future technologies for receivers and transmitters, to guarantee a reliable and stable DVB-T market. This will best be achieved through a continuous and open flow of information among members of the broadcast industry.

Single SSU service provider

To achieve maximum transparency and guarantee equitable access to the capacity reserved for data transmissions, it is recommended that a single provider manages the SSU service. This will also help ensure that a high percentage of receivers can be reached efficiently.

In a scenario where multiple operators provide SSU services, manufacturers will need to choose between one or several operators to ensure that a maximum coverage area is reached. This will lead to an inefficient use of capacity as duplicate data streams may need to be transmitted by the different service providers over the same coverage area. As an alternative, it could be possible for the service providers to form a partnership for the provision of SSU services or at least ensure a non-discriminatory cooperation for the basic signalling stream.

Bandwidth capacity allocated for data transmissions

To ensure that SSU services are possible, it will be necessary that bandwidth is made available, either within a channel offering television services or on a channel reserved for data transmissions. Such capacity could be voluntarily provided by broadcasters or made available as a requirement set by the government.

Such allocation will ensure that manufacturers continually have access to a data transmission stream and reduce inefficiencies in negotiations for access. It will also allow for a stable business model to be established and for an SSU service provider to be set up to offer services.

SSU service capacity should be made available on the multiplexes with the highest population coverage to ensure that SSU services can reach a maximum number of households simultaneously. Multiple SSU service transmissions using several parallel multiplexes should be avoided.

Conclusions

The terrestrial platform will continually evolve to remain an effective and competitive broadcasting platform. As part of this evolution, the terrestrial platform will require a method for upgrading and fixing consumer products. However, making upgrades in a horizontal market has special challenges given the number of different operators and manufacturers involved in the delivery of services.

Against this background, the DVB Project developed a standard that allows for upgrades to be made to consumer receivers in a manner that is not cumbersome for the viewer. Also important for the horizontal market, this standard does not adversely affect other types of receivers.

Choosing not to implement SSU services can have a significantly negative impact on the DTT market. Without an easy means for upgrading existing products, viewers will lose confidence in the platform and in time turn to other television platforms such as satellite or cable.

A loss of viewer confidence is detrimental to all players on the terrestrial platform. Manufacturers risk future revenue streams and lose the loyalty of their consumer. Network operators and broadcasters may find that viewers no longer rely upon the terrestrial platform for their television reception which can threaten their claim to use the UHF and VHF frequencies for the provision of broadcast services.

The broadcast industry as a whole is encouraged to recognise the benefits of SSU services and cooperate in their implementation.

Abbreviations

CA	Conditional Access
DDB	Download Data Block message
DII	Download Info Indication message
DSI	Download Server Initiate message
DTT	Digital Terrestrial Television
DSM-CC	Digital storage media command and control
EIT	Event Information Table
EPG	Electronic Programme Guide
FTA	Free-to-Air
iDTV	Integrated Digital Television Set (internal digital receiver)
LCN	Logical Channel Numbering
MHEG	Multimedia and Hypermedia information coding Expert Group
MHP	Multimedia Home Platform
MIS	Manufacturer Information Structure
NIT	Network Information Table
OAD	Over-Air-Download
OUI	Organization Unique Identifier
OTA	Over-the-Air
PID	Packet IDentifier
PMT	Programme Map Table
SI	Service Information
SSU	System Software Update
STB	Set-Top Box (external digital receiver)
TDT	Time Date Table
TOT	Time Offset Table
UNT	Update Notification Table
VBI	Vertical Blanking Interval

Annex: DVB-SSU technical information

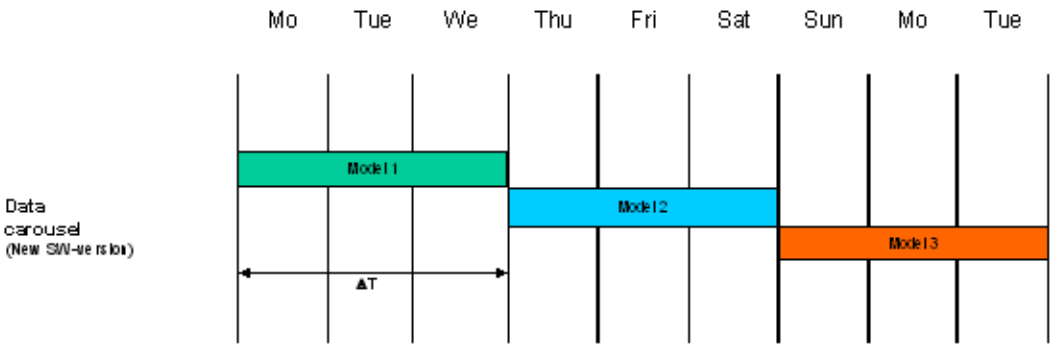
This section provides further technical information about the DVB-SSU simple and enhanced profiles.

DVB-SSU Simple Profile
The features for the DVB-SSU simple profile are:

- Possibility for the data transmissions of several manufacturers within a single carousel
- Possibility for the carriage of multiple carousels within a multiplex (depending on the SSU provider's specification)
- Possibility for cross-carriage of signalling
- A stream type descriptor in the PMT identifying the data carousel stream of type 0x0B or 0x0D or 0x80 - 0xFF (user private).
- A quasi-static data_broadcast_id descriptor in the stream identifier descriptor in the PMT of the program to which the SSU is attached. This will carry the correct data_broadcast_id value (0x0A) for the DVB-SSU service. This descriptor may be present even when there is no active download carousel service.
- NIT linkage descriptor has to be carried, based on a standard linkage structure of type 0x09 for a local (same transport stream and service) pointer, or 0x0A to point to another transport stream where a local linkage descriptor can be found. The value of OUI can be set to 0x015A ('DVB' value).
- The actual identification in terms of the manufacturer, model, etc. carried in a data structure of the DSI.

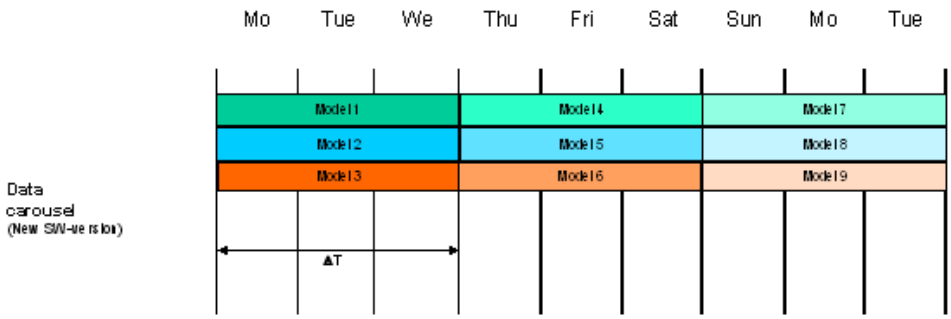
Example of DVB-SSU simple profile
An SSU data transmission using the simple profile must be available for no less than two hours (assuming a software footprint of maximum of 8 Mbyte and a bandwidth of 64kbit/s: >6-8 cycles). This allows sufficient time for the receiver to monitor the arrival of the new data transmission stream. Several cycles are necessary to allow for possible reception problems of the data packages.

Generally, however, SSU data transmissions are broadcast for several days in order to reach a maximum number of receivers. Depending on the situation agreed between the manufacturer and the SSU service provider, other rules may be applicable.



Example 1: DVB-SSU simple-profile using a 3 day slot per model

However, the DVB-SSU simple profile allows for the simultaneous transmission of SSU data streams for several models. This is shown in the example on the next page.



Example 2: DVB-SSU simple profile using a 3 day slot and simultaneous transmission of 3 data streams

Note that ΔT is determined by the SSU service provider.

The advantages of the DVB-SSU simple profile include the possibility to upgrade several models at the same time should enough capacity be available. It is a proven method that has been used successfully in several European markets. However, it is not feasible for upgrading a very high number of different receiver models, or the total amount of bit-rate needed for each model is relatively high.

DVB-SSU Enhanced Profile

Compared with the simple profile, the DVB-SSU enhanced profile includes the use of the Update Notification Table (UNT) to signal when an SSU data transmission will take place and make reference to the data carousel using a combination of the association_tag and the component_tag. The data carousel can be on air for relatively short periods of time. This saves bandwidth, and the SSU data transmission can be broadcast at certain times when more capacity is available such as late at night.

Key features of the enhanced profile:

- Signalling in the NIT is the same as the one used in the simple profile.
- In the PMT, the UNT elementary stream is referenced by a DSMCC-UN message (stream_type 11). Either the manufacturer OUI or the DVB-OUI (0x00015A) are recognized and require the receiver to check the UNT for the version and availability of the SSU data transmission.
- In the PMT, another DSMCC-UN message contains the component tag that corresponds with the assocication_tag in the UNT. This message contains the PID of the data carousel.

Optional features:

- Software can be marked as beta release
- SSU can be addressed to certain devices only (e.g. with certain individual MAC addresses, Smart Card numbers, or serial numbers)
- If manufacturer decides to transmit several SSUs in one data carousel, individual downloads can be organised by UNT (indicating which download is intended to which devices)
- A text can be transmitted via SSU, which describes new software (this text can be displayed by the consumer device)

Key features of the UNT:

- Contains schedule and model information:
    - Schedule: Start&End time, steady/periodic, duration.
    - Model: Manufacturer, model, version.

- Many different schedule options are possible, i.e. daily or hourly slots, periodically (long or short term)
- SSU service provider determines the scheduling option.
- Manufacturer determines the model information.
- The compatibility_descriptor contains a system_hardware_descriptor or a system_software_descriptor with the triplet manufacturer-ID, model and version.
- The ssu_location_descriptor maintains the association tag, needed to identify the data carousel in the PMT.
- As an option, more details like the target MAC or IP address, serial number, update description, etc can also be used.

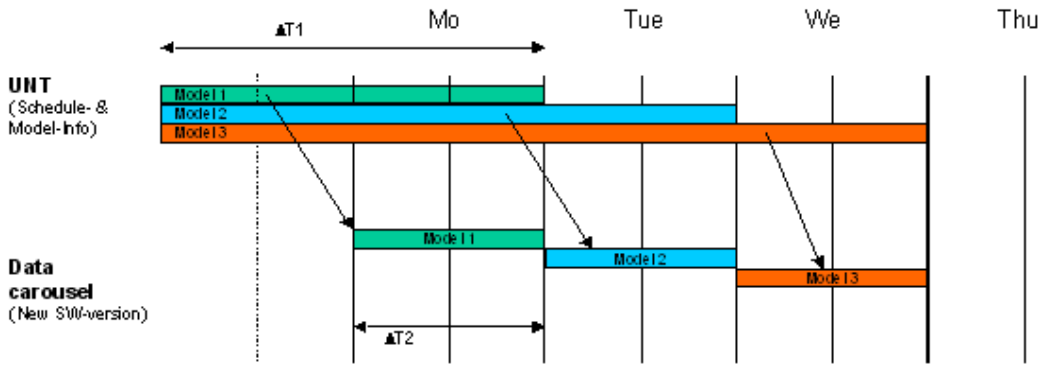
Key features of the data carousel:

- Contains binaries of the SSU data transmission (i.e. the real download data).
- Transmission refers to the schedule as described in the UNT.

All receivers that support the DVB-SSU enhanced profile are also able to support the DVB-SSU simple profile. However, a receiver that supports only the DVB-SSU simple profile will not be able to find an SSU data transmission that uses the DVB-SSU enhanced profile. This is because the DSMCC-UN message for the data carousel in PMT for the DVB-SSU enhanced profile does not contain any information about the manufacturer of the SSU data transmission in the data carousel. Furthermore, it does not contain a data_broadcast_id_descriptor identifying the SSU data transmission. The only descriptor is the stream_identifier, referenced by the ssu_location descriptor in the UNT.

Examples of DVB-SSU enhanced profile

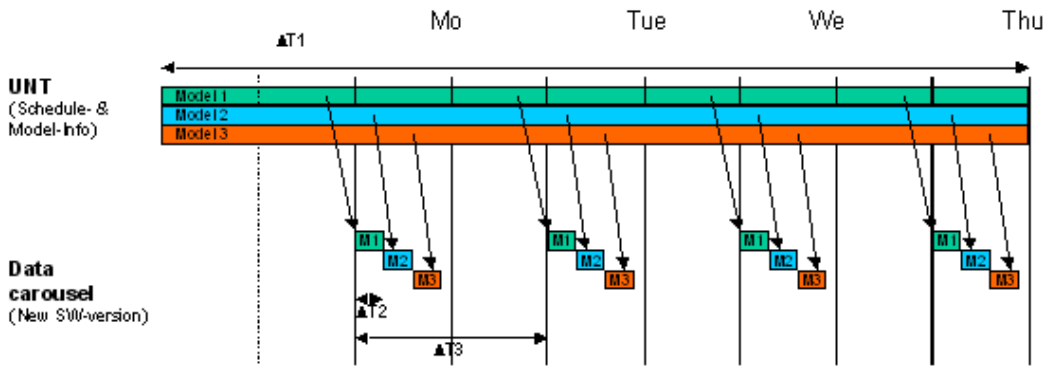
The broadcast of data transmissions using the DVB-SSU enhanced profile data transmissions are similar to broadcasts using the DVB-SSU simple profile. However, the duration of the time slot for each model can be significantly reduced since the receiver is informed of the SSU data transmission schedule. Nevertheless, periodic data transmission for a given model is recommended since it is impossible to know with certainty if all receivers will have received the upgrade at the time of the broadcast.



Example 1: DVB-SSU enhanced profile with 1-day-slot per model

Note that ΔT1, ΔT2 and total duration are determined by the SSU service provider.

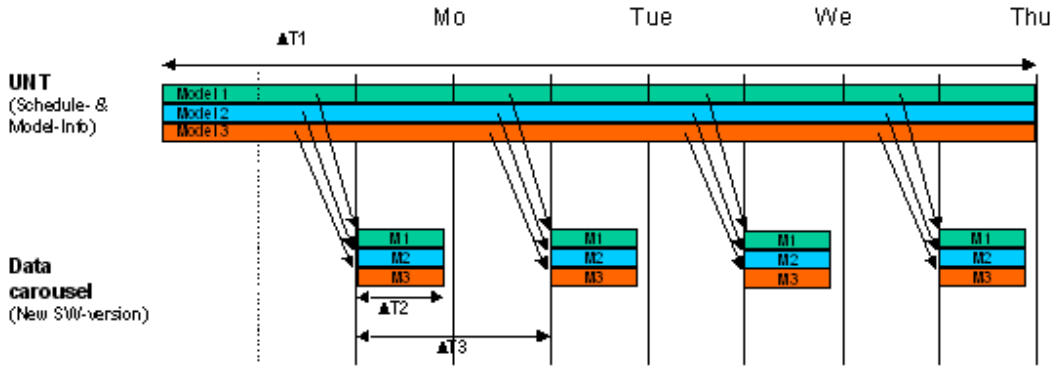
The advantage of this example is that the total amount of bandwidth used is much lower than with the DVB-SSU simple profile. However, this example cannot be used to upgrade several different receiver models simultaneously.



Example 2: DVB-SSU enhanced profile with periodic hour slots per model

Note that ΔT1, ΔT2, ΔT3 and the total duration are determined by the SSU service provider.

The advantage of this example include the opportunity to upgrade a large number of different receiver models. In addition, the SSU data transmission can take place at night when more bit-rate capacity is available. This model provides relative ease-of-use to the SSU service provider. However, in this example, only one model is updated at a time.



Example 3: DVB-SSU enhanced profile with periodic hour slots and several models upgraded simultaneously

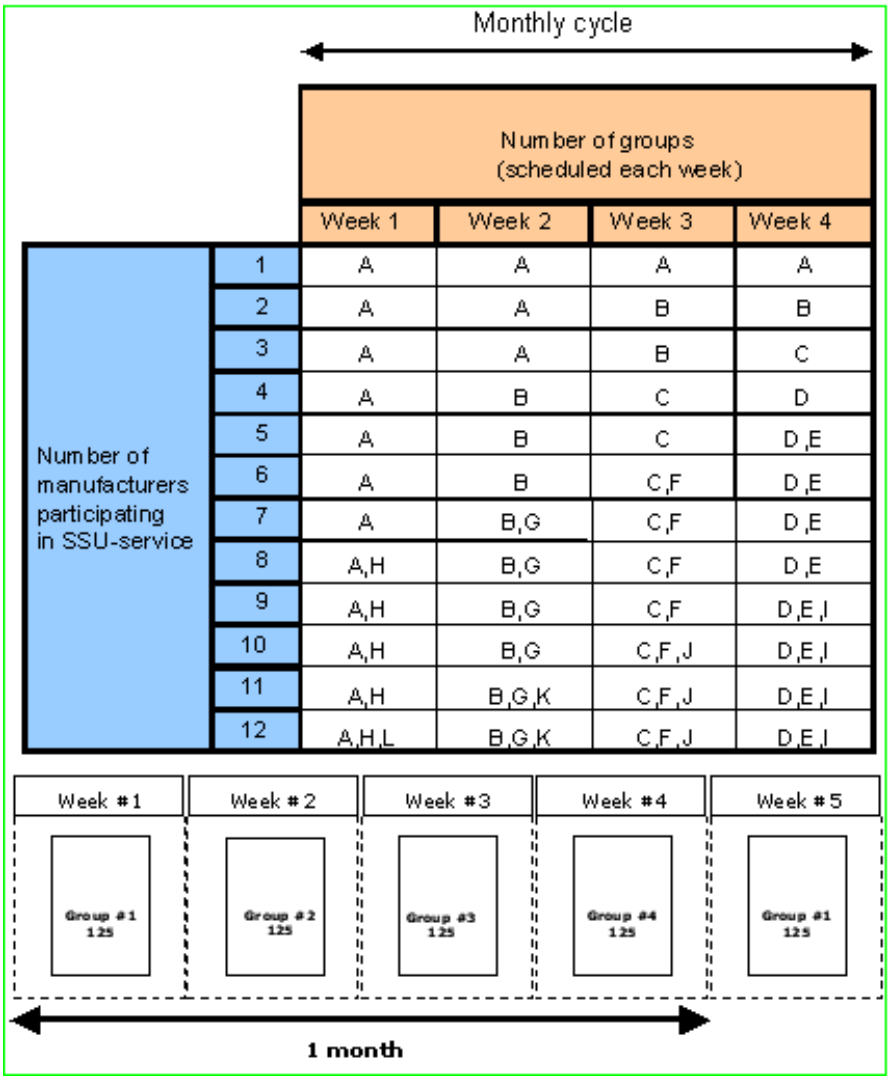
Note that ΔT1, ΔT2, ΔT3 and the total duration are determined by the SSU service provider.

The advantages of this method include the opportunity to upgrade a large number of different receiver models simultaneously. The SSU data can be transmitted at night when more bit-rate is available. However, this example can be more difficult for the SSU service provider to handle than the previous two examples.

Other options are also supported by DVB-SSU Enhanced Profile including UNT with clear link to data carousel.

Schedule configuration

The figure below shows a possible schedule configuration depending on the total number of receiver models to be upgraded.



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[2] ISO/IEC 13818-6: “Information technology; Generic coding of moving pictures and associated audio information; Part 6: Extensions for DSM-CC” 1998-09-01.

[3] ETSI ETR 162: “Digital Video Broadcasting (DVB); Allocation of Service Information (SI) codes for DVB systems”.

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[5] ETSI EN 301 192 “Digital Video Broadcasting (DVB); DVB specification for data broadcasting”.

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