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Implementation of System Software Upgrades in Australian DVB-T Systems Using the
Simple Profile

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1. SCOPE

This document describes the method of implementing an over the air System Software Upgrade (SSU) to DTV consumer equipment used in the reception of digital terrestrial television broadcasting in Australia.

This implementation is in accordance with ETSI standard TS 102 006 [4]. ETSI standard TS 102 006 [4], describes two profiles for implementing software upgrades to DVB-T consumer equipment in a network independent manner. This implementation uses the simple profile in a 'background' mode with minimal interaction required from the television viewer.

2. KEY REQUIREMENTS

Like all digital systems, DTV networks have a capacity to change and evolve as new software and applications are developed. Therefore the ability to automatically load and install DTV receiver software with minimal interruption in the home is a desirable feature for some receiver manufacturers.

Broadcasters and manufacturers require that the update procedure must conform to three key criteria to protect the integrity of a free to air broadcast system:

- The viewer, as the owner of the receiver, must have the ability to accept or reject updates. This may either be performed once at installation or individually as updates are detected.

- The process of upgrading shall cause minimal disruption to the viewer. If the viewer is watching a program when an update is detected, they must have the capability to reject an update and continue viewing.

- After a System Software Update has been performed, user settings like services listings (last selected service, favourites, etc) shall be preserved, whenever feasible.

The process described in this operational practice has been designed to optimise the update process to be received by the maximum number possible of the target receivers, taking into account the key criteria and nature of the DTV broadcast environment in Australia.

3. SYSTEM OVERVIEW

SSUs will be tested and transmitted in accordance with contractual arrangements negotiated between an Australian television broadcaster or broadcasters and the DTV consumer electronic manufacturer. These arrangements will cover normal commercial contractual terms and conditions and include a schedule with key technical data for the SSU playout; broadcast times, repetition rate, messaging, bandwidth allocation etc. The schedule will also specify the manufacturer's organisationally unique identifier (OUI), the target receiver model and serial number range, as applicable. Certain receiver functions must be specified in accordance with ANNEX A.

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Once a manufacturer has a download ready for broadcast, the first stage is to send it to the broadcaster or the broadcaster's approved representative (which may be a suitably qualified testing centre) for testing and certification. This testing and certification must meet the specifications outlined by Australian free-to-air television broadcasters in this operational practice. The test process will check (at a minimum) that the download operates correctly with the intended receiver, does not interfere with the operation of a wide range of other receivers already in the Australian market, and that the download performs to the rest of this process. Further details are provided in ANNEX B.

Once approved, the SSU in the form of a file will be sent to the participating broadcasters for transmission at the specified times.

The transmissions will generally occur continuously during the specified period. The download will be played out as a DSM-CC carousel integrated into the broadcaster's Transport Stream.

4. INTEROPERABILITY

4.1 Australian DVB-T System Constraints

In Australian DVB-T systems, there are normally five competing multiplex operators (broadcasters) in each market, two national services and three commercial networks. Service overlaps exist between commercial networks in some regions where eight competing multiplexes are broadcast. In remote areas only two commercial services may be available.

Although transmitters for a region tend to be co-located, there are many instances where this is not the case. DTV broadcasts are provided on Band III (VHF) and Band IV/V (UHF) and in many regions the multiplexes are split between the bands. Hence it cannot be guaranteed that each multiplex is received by all viewers.

It may be that updates will be transmitted by only one broadcaster (i.e. the *participating broadcaster*) in a region. Therefore the onus for searching for updates must be placed on the receiver, rather than on the other multiplexes broadcasting linkage information to point receivers to the update. This approach leads to the implementation model shown in Figure 2.

4.2 Proprietary and Standard SSU streams

The ETSI/DVB SSU standard currently allows two different formats of system software update data carriage in the broadcast stream:

a)   the Standard Update carousel described in Section 8 of ETSI TS 102 006 [4]

b)   proprietary format streams

Proprietary data streams will only be transmitted in exceptional circumstances by agreement between the broadcaster and manufacturer.

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4.3 DVB Interoperability Requirements

If interoperability is to be assured, broadcasters and receiver manufacturers need to comply with the following "backward compatibility" rules:

▪ Participating broadcasters shall at least support the Simple Profile as defined in Section 5.1 of ETSI TS 102 006 [4].

▪ Receivers shall at least support the Simple Profile.

It should be noted that because the Simple Profile service is a subset of the UNT Enhanced Profile service, mandatory support of at least the Simple Profile implies no significant complexity for either broadcasters or receiver manufacturers.

All updates must be identified by the manufacturer's OUI and selector bytes (including intended receiver make and model identification) to identify the target group of receivers.

The inclusion of additional receiver information is recommended. This can be achieved by using the selector_byte fields in these descriptors, to provide more precise target receiver identification at the earliest SI opportunity (see Figure 1).

In Australia, the use of the DVB generic OUI (0x00015A) in the linkage_descriptor is not recommended, since the existence of a generic SSU indicator may cause receivers to frequently consume resources by searching all the broadcast Transport Streams available, in order to determine whether an SSU exists that is of relevance to it. In some receivers, this may result in annoying (channel changing) behaviour.

4.4 SSU Transfer Protocol from Receiver Manufacturers to Broadcasters

Delivery of the update to broadcasters shall conform to the following:

▪ Receiver manufacturers shall deliver to the broadcaster(s), certified software updates for broadcast. The certification process shall be subject to separate agreement between the parties, i.e.; the participating manufacturers and broadcasters, but include at a minimum, the requirements of ANNEX B.

▪ Receiver manufacturers shall deliver a Software Update carousel conforming to:

- ETSI EN 301 192 [3] and

- ETSI TS 102 006 [4];

including PAT, PMT, as an MPEG elementary stream conforming to:

- ISO/IEC 13818 – 1 [1].

The Software Update elementary stream shall be formatted into a 188 byte DVB Transport Stream. The physical aspects of delivering Software Updates to the broadcasters shall be subject to separate agreement between the parties.

▪ The Transport Stream shall consist of PIDs and tables as prescribed by the participating broadcaster.

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- The PMT of the Transport Stream supplied by the manufacturer shall contain the data_broadcast_id descriptor and the id_selector_byte field for SSU applications as defined in ETSI TS 102 006 [4]. The data_broadcast_id is set to 0x000A to indicate an SSU service. The id_selector_byte field shall then contain the syntax for the system_software_info_structure as defined in Table 4 of ETSI TS 102 006 [4].

- Other technical aspects of the Transport Stream and its contents such as Groups, Modules, file continuity and repetition rates shall conform to the recommendations of Annex B of ETSI TS 102 006 [4].

- Software Download carousel DSI and DII Messages shall be repeated in accordance with Section 9.7 of ETSI TS 102 006 [4] (at least every 5 seconds).

- Manufacturers shall provide their IEEE 802-1990 [5] OUI registration(s) to the broadcaster(s) and include the OUI in the appropriate fields of the SSU stream, in accordance with the recommendations of this document.

Alternatively, the download in a file format may be accepted by the broadcaster who will create a Transport Stream conforming to the above specifications.

5. SERVICE INFORMATION SUPPORTING SSU

5.1 Profile

The Simple Profile software update utilises signalling in the NIT (or BAT)[1] and PMT table sections (which do not require the Update Notification Table). The Simple Profile may be regarded as the less complex "over-the-air" method of software updates. The Simple Profile is designed for immediate (non-deferred) software downloads.

5.2 Participating Broadcaster Responsibility

The participating broadcaster must have the ability to multiplex in the software update Transport Stream incorporating the DSM-CC carousel, supplied by the manufacturer and modify the NIT and PMT accordingly.

The intended time availability of a download in the simple profile configuration should be no less than twenty five hours, but may be transmitted for longer periods by agreement between the participating broadcaster and manufacturer. This allows receivers to monitor arrival of a new download at any time of the day, on a daily basis.

The SSU download protocol is based on the MPEG DSM-CC data carousel specification (ISO/IEC 13818-6 [2]) and the specification for DVB data carousels (ETSI EN 301 192 [3]).

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[1] It should be noted that in the Australian Implementation of DVB-T, the BAT table is not presently used. SSU signalling shall therefore be present in the NIT, PMT and UNT sections. This is in accordance with explicit DVB preferences. Accordingly, no further references to the BAT are provided in this Operational Practice.

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5.3 Signalling in DVB SI

Manufacturer identification is in the form of IEEE 802-1990 [5] Organisationally
Unique Identifiers (OUIs) with additional selector bytes. The OUIs and selector
bytes shall be carried (refer Figure 1):

(a)   in the DVB-SI NIT Linkage descriptor (where the linkage descriptor
type is set to 0x09) and/or,

(b)   in the PMT in the data_broadcast_id descriptor, and

(c)   in the actual software update carousel (compatibilityDescriptor).

The linkage_descriptor (refer to EN 300 468 [6]) shall be carried in the first loop of
the NIT. If the country_availability_descriptor is used, the country code should be =
902 (all countries).

OUIs shall be listed in the linkage_descriptor and the list of OUIs shall be complete,
thus confidently allowing a receiver to conclude that it does not have to look
elsewhere to determine applicability.

In the case where an SSU service is temporarily absent, the OUI shall NOT be
removed from the linkage_descriptor and the linkage_descriptor (containing the
OUI) shall NOT be removed from the NIT.

Another type of linkage_descriptor, the SSU scan_linkage_descriptor (type=0x0A)
will not be transmitted in Australian DVB-T services.

5.4 Signalling in MPEG PSI

The participating broadcaster will be responsible for adding the SSU data
component from the Transport Stream supplied by the manufacturer to one or more
of their existing services to create an appropriate PMT.

The PMT of the service carrying the SSU data, shall contain the data_broadcast_id
descriptor with the data_broadcast_id set to 0x000A, indicating an elementary
stream used for the SSU service. This provides an entry point to either a standard
update carousel, or a proprietary stream, without the need for further reference from
a table. The data_broadcast_id shall be carried in the ES_info_loop of the PMT.

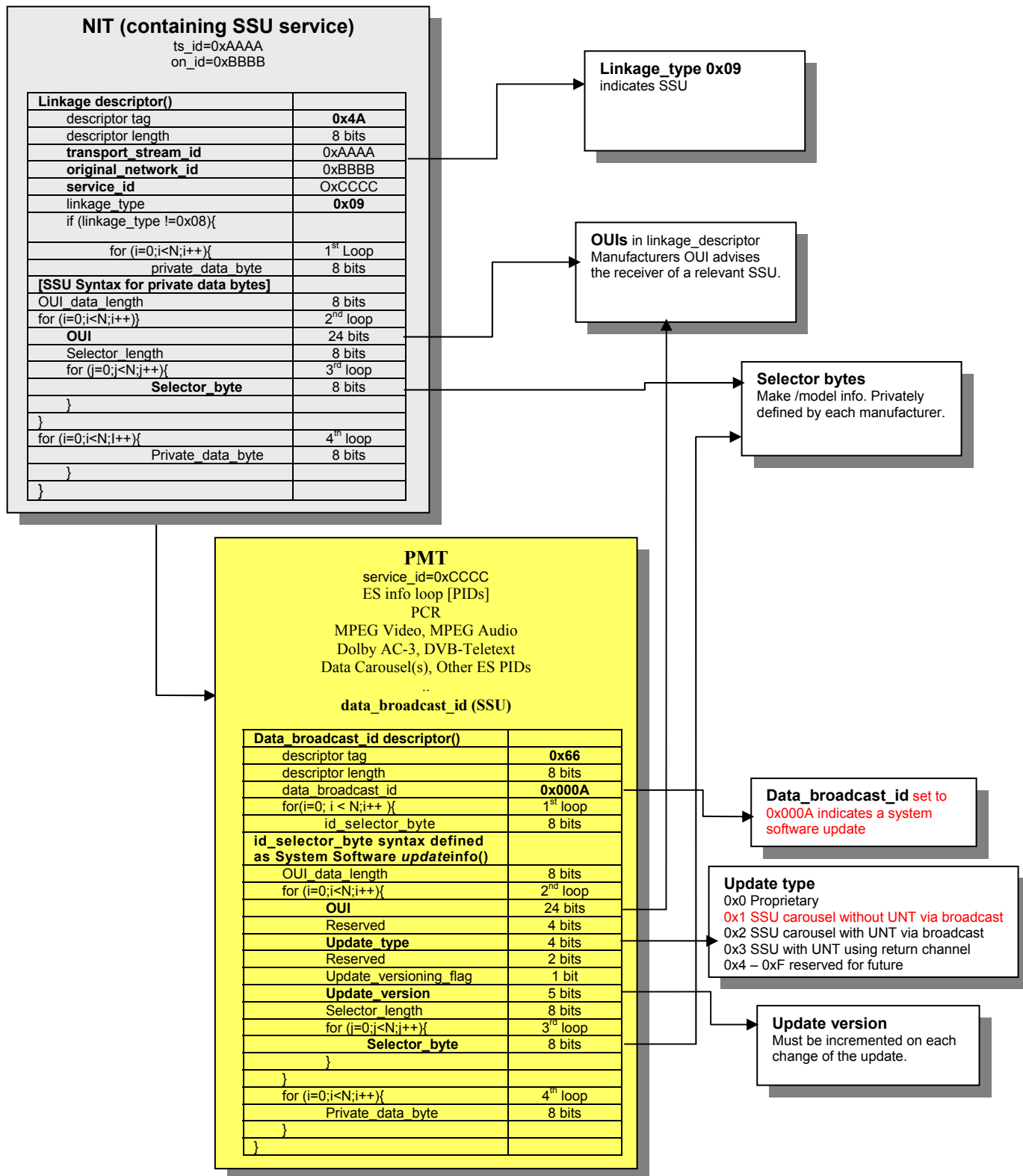If an SSU service is temporarily absent, this descriptor shall NOT be removed from
the PMT.

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NIT (containing SSU service)
ts_id=0xAAAA
on_id=0xBBBB

Linkage descriptor()	
descriptor tag	**0x4A**
descriptor length	8 bits
transport_stream_id	0xAAAA
original_network_id	0xBBBB
service_id	OxCCCC
linkage_type	**0x09**
if (linkage_type !=0x08){	
for (i=0;i<N;i++){	1st Loop
private_data_byte	8 bits
[SSU Syntax for private data bytes]	
OUI_data_length	8 bits
for (i=0;i<N;i++)}	2nd loop
OUI	24 bits
Selector_length	8 bits
for (j=0;j<N;j++){	3rd loop
Selector_byte	8 bits
}	
}	
for (i=0;i<N;I++){	4th loop
Private_data_byte	8 bits
}	
}	

Linkage_type 0x09
indicates SSU

OUIs in linkage_descriptor
Manufacturers OUI advises the receiver of a relevant SSU.

Selector bytes
Make /model info. Privately defined by each manufacturer.

PMT
service_id=0xCCCC
ES info loop [PIDs]
PCR
MPEG Video, MPEG Audio
Dolby AC-3, DVB-Teletext
Data Carousel(s), Other ES PIDs
..
data_broadcast_id (SSU)

Data_broadcast_id descriptor()	
descriptor tag	**0x66**
descriptor length	8 bits
data_broadcast_id	**0x000A**
for(i=0; i < N;i++){	1st loop
id_selector_byte	8 bits
id_selector_byte syntax defined as System Software *update*info()	
OUI_data_length	8 bits
for (i=0;i<N;i++){	2nd loop
OUI	24 bits
Reserved	4 bits
Update_type	4 bits
Reserved	2 bits
Update_versioning_flag	1 bit
Update_version	5 bits
Selector_length	8 bits
for (j=0;j<N;j++){	3rd loop
Selector_byte	8 bits
}	
}	
for (i=0;i<N;i++){	4th loop
Private_data_byte	8 bits
}	
}	

Data_broadcast_id set to 0x000A indicates a system software update

Update type
0x0 Proprietary
0x1 SSU carousel without UNT via broadcast
0x2 SSU carousel with UNT via broadcast
0x3 SSU with UNT using return channel
0x4 – 0xF reserved for future

Update version
Must be incremented on each change of the update.

Figure 1 **Linkage_descriptor and data_broadcast_id descriptor Syntax in SSU applications.**

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5.5 Structure of the Download Carousel

The standard two layer carousel protocol is based on the MPEG DSM-CC data carousel specification (ISO/IEC 13818-6 [2]) and the specification for DVB data carousels (EN 301 192 [3]).

The standard two layer carousel protocol described in Section 8.1 of ETSI TS 102 006 [4] is applicable to both the Simple Profile (without reference to the UNT) and the Enhanced profile (with reference to a UNT).

The carousel module numbers, group names and PIDs will be chosen in accordance with a standard template developed by broadcasters to ensure the SSU service does not interfere with other broadcast or interactive services.

6. REFERENCES

[1]   ISO/IEC 13818-1:2002 Information Technology – Generic coding of moving pictures and associated audio information – part 1 Systems

[2]   ISO/IEC 13818-6:1999 Information Technology – Generic coding of moving pictures and associated audio information – part 6 Extensions for DSM-CC

[3]   ETSI EN 301 192 V1.4.1 (2004-11) Digital Video Broadcasting (DVB); DVB specification for data broadcasting

[4]   ETSI TS 102 006 V1.3.1 (2004-05) Digital Video Broadcasting (DVB); Specification for System Software Update in DVB Systems

[5]   ANSI/IEEE 802-1999 IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture

[6]   ETSI EN 300 468 V1.5.1 (2003-05) Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems".

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ANNEX A.

Receiver SSU Behaviour
(Informative)

A.1 Introduction

The update procedure relies on a combination of manufacturer's software design and broadcaster transmissions. The process must allow the viewer to accept or reject updates, shall cause minimal disruption to the viewer and at the conclusion of the update return to previously stored settings including the last viewed service.

Before an update will be transmitted by a broadcaster, the processes contained in this Annex will be reviewed as part of the certification and approval activity.

A.2 Setup Menu Options

Within the user setup menu, the receiver should have some options to establish the viewer's preferences for receiving System Software Updates. These should include the following options as outlined in Table 1 below.

Table 1   SSU-Related Menu Options

Reference	Menu Parameter	Menu Options	Default Setting
1	**Allow** system software updates	Yes, No	Yes
2	Viewer **prompt** to update	Yes, No	No
3	**Time** to search for SSU	00:00, 01:00, … , 23:00	04:00

A.3 Automatic Software Update

The update process is shown in Figure 2 below. To allow for a simple user interaction, the receiver shall behave in the following manner:

1. The receiver has to be capable of automatically looking for available software upgrades over the air.

2. The automatic software upgrade procedure can be disabled by the viewer by setting Menu Reference 1 *(allow)* to "No", so that the receiver does not search for an update.

3. When the receiver looks for available software updates, it has to scan all the multiplexes in its service list.

4. The receiver will only respond to software updates for a specific model that match its OUI, model number and serial number.

5. If Menu Reference 1 *(allow)* is set to "Yes", the automatic software update scan will be performed when the receiver is set to standby or when the receiver is on (at a specified hour as set by Menu Reference 3 *(time)*).

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6. If the Menu Reference 1 *(allow)* is set to "Yes", then:

   ▪ At the time specified by Menu Reference 3 *(time)*, the receiver has to search for new software, if the receiver is on;

   ▪ At the time the procedure is started, a 30 seconds countdown will appear on screen with the following message: "The receiver will start looking for new software in … seconds, for enquiries regarding this process, please call (manufacturer's service call centre number)".

   ▪ The viewer will be able to press "OK" to permit the procedure to start immediately or "exit" to abort the procedure. Where the viewer chooses "exit", the procedure will be aborted on this occasion.

      o If there is no response from the viewer by the time the countdown completes, the procedure should start if Menu Reference 2 *(allow)* is set to "No".

      o If the Menu Reference 2 *(allow)* is set to "Yes", the procedure will be aborted on this occasion.

      o If the download search activates, the receiver should blank the video program output then display a screen indicating progress of the procedure, save the current settings then scan the NIT of all multiplexes that are listed in the receiver's service list to detect for an applicable SSU.

7. If the viewer sets the receiver into standby mode, immediately prior to entering standby mode, the unit should save the current settings then scan the NIT of all multiplexes that are listed in the receiver's service list to detect for an applicable SSU. Depending upon the manufacturer's implementation, it is recommended that a warning indication be displayed advising viewers to keep power to the unit while this process is completed.

8. If a relevant software update is detected, it should be downloaded into memory (whilst indicating progress to the viewer) and then loaded to update the receiver (by automatic rebooting, if necessary). Then the settings saved in Step 6 or 7 above should be restored. If no relevant update was detected, the saved settings should be restored returning the tuner to the last selected service and operating state.

9. If new software is found and installed, on the next channel change initiated by the viewer, the I-plate should include a message indicating that the receiver has successfully been updated. It is recommended to also include in the message a reference to, at least, the manufacturer's call centre telephone number and a web site where the description of the update and any new functionality may be found. The I-plate will normally remain visible for a duration established in the user setup menu. It is preferable that when the I-plate contains an "update successful" message, the I-plate is visible for not less than 15 seconds.

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A.4   Manual Software Update

It is desirable that a facility be provided for the viewer to manually start an update search. This may be achieved by placing the receiver in standby mode, or setting the check time to the next appropriate hour setting.

A.5   Software Update Profile

It is strongly recommended that manufacturers implement the full DVB System Software Update (DVB-SSU) as defined in [4], however, at a minimum the simple profile as defined in clauses 7 and 8 of reference [4] would be required to meet this operational practice.

A.6   Transmission Characteristics

The receiver shall be able to acquire a software update with a variable bit rate opportunistic data stream.

A.7   Receiver Recovery

Manufacturers shall provide appropriate recovery measures to cope with possible receiver failure or hang-up during the software update, power loss, transmission loss or channel changes during the update process.

A.8   Receiver Performance

If an SSU OUI mismatches the receivers OUI, receivers shall ignore any table sections and carousel groups. In this way, receivers shall be robust against any ambiguity or non-compliance of such transmitted data not intended for their use.
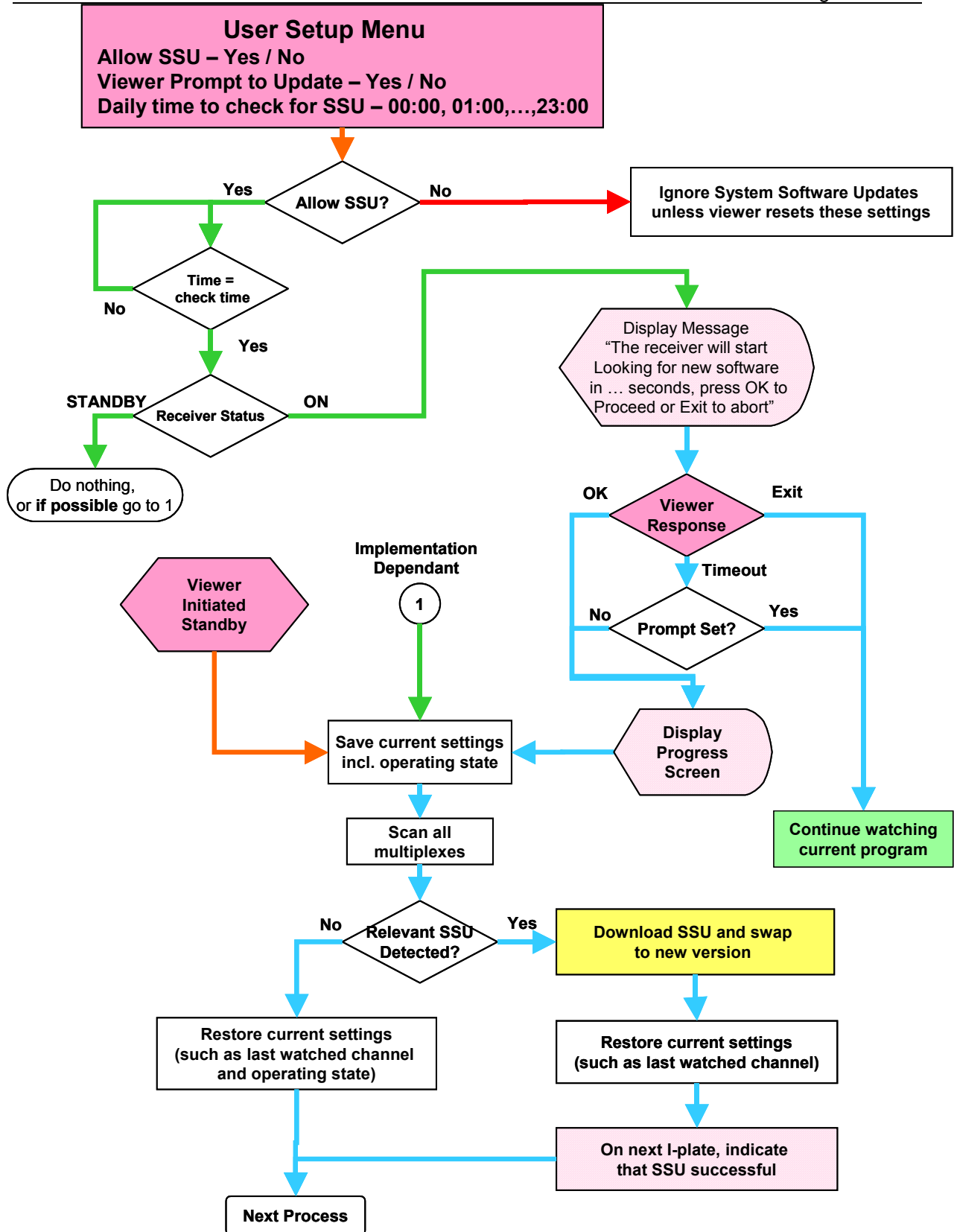
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User Setup Menu
Allow SSU – Yes / No
Viewer Prompt to Update – Yes / No
Daily time to check for SSU – 00:00, 01:00,…,23:00

Allow SSU?
Yes
No → Ignore System Software Updates unless viewer resets these settings

Time = check time
No
Yes

Receiver Status
STANDBY
ON

Do nothing, or **if possible** go to 1

Display Message "The receiver will start Looking for new software in … seconds, press OK to Proceed or Exit to abort"

Viewer Response
OK
Exit
Timeout

Prompt Set?
No
Yes

Viewer Initiated Standby

Implementation Dependant
1

Save current settings incl. operating state

Display Progress Screen

Continue watching current program

Scan all multiplexes

Relevant SSU Detected?
No
Yes → **Download SSU and swap to new version**

Restore current settings (such as last watched channel and operating state)

Restore current settings (such as last watched channel)

On next I-plate, indicate that SSU successful

Next Process

Figure 2   Simple Profile Receiver with Automatic SSU Checking

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ANNEX B

SSU Testing and Certification
(Normative)

B.1 Introduction

This Annex details the requirements for testing and certification of a manufacturer's download before agreement will be provided by the broadcaster for transmission.

B.2 Test Procedures

Prior to transmission of a download, the SSU in the form of a Transport Stream and a number of target receivers (to be specified) will be provided to the broadcaster or broadcaster's approved representative to conduct testing to ensure the requirements of this operational practice are met and that there will not be an adverse impact on receivers in the general community.

One or more of the receivers will remain with the broadcaster or broadcaster's representative to be added to a population of receivers representative of the majority of receivers in the general community (the '*receiver farm*'). These receivers will be used to test isolation against future receiver downloads from other manufacturers. The manufacturer must also provide a mechanism for returning the receiver to the original software version to allow multiple tests to be conducted.

The following tests will be conducted on the Transport Stream and receivers. Other tests may be added by the broadcaster.

- Check validity of the OUI with IEEE documentation

- Analyse Transport Stream to check PMT, OUI, selector bytes etc against documentation supplied by the manufacturer

- Integrate Transport Stream with broadcaster live stream and check modifications to NIT and PMT

- Connect receivers to the integrated Transport Stream and check operation of the download procedure with the receiver in the following modes:

    o Receiver operating (ON) and *No* menu selection

    o Receiver operating (ON) and *Yes (allow), Yes (prompt)* menu selections

    o Receiver operating (ON) and *Yes (allow), No (prompt)* menu selections

    o Receiver in Standby

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- Check target receiver returned to the last selected service in each case

- Interrupt download by removing the RF, removing the power and by changing the channel, then check operation of the receiver

- Check that when receivers are upgraded with the download, that no further action is taken by the receiver when detecting the download

- Re-power the target receivers and re-check for correct operation
- Check receiver farm (excluding the target receivers) for no interaction with SSU or aberrant behaviour including a re-power of receivers

B.3 Schedule Data

Table 2 provides a sample schedule which should be incorporated into the agreement between the broadcaster and the manufacturer to capture the necessary information associated with the SSU.

Table 2   Pro Forma Agreement Schedule Data

Broadcaster	(insert name)	
Manufacturer	(insert name)	
Applicable Broadcast Licence Areas		
Parameter	**Value**	**Units / Notes**
SSU Playout Start Date / Time		DD:MM:YYYY HH:MM
SSU Playout End Date / Time		DD:MM:YYYY HH:MM
SSU File Size		kbytes
Average Bandwidth Allocation	50	kbit/s
Average Repetition Rate		seconds
Target Receivers		
Model Number		
Serial Number Range		
Transport Stream Information		
Manufacturer's OUI		
Model Number selector bytes		
Serial No. Range selector bytes		
Packet Identifiers		
Program Map Table (PMT)	0x….	Hex
Program Clock Reference (PCR)	0x1FFF	Hex
DSM-CC Sections	0x….	Hex
Other Information		
I-plate Message Text		
Documentation	(list attachments)	