Notes

• For the sake of keeping the information of this WEBINAR to a reasonable extent, the following restrictions have been applied:
  – Although the Single Illumination System (SIS) represents a generic concept, in this Webinar only the satellite/terrestrial case will be enlightened
  – Only DVB-T2 is covered (SIS works, of course, for DVB-T as well)
  – Not each and every detail is explained – please consult the specification and the experts for learning more after this Webinar

• SIS is dedicated to Transport Streams only
• Caution – there are a number of TS re-multiplexers in the SIS chain => don’t get confused ;-)

• QUESTIONS: You can ask questions at the end of each logical section (e.g. after slide 6/6 of “TS re-multiplexing”) – see the orange circles in the bottom right corner of the related slides
Agenda

• What is DVB-SIS and why has this specification been created?

• Concept behind the DVB-SIS Standard

• Elements of the DVB-SIS Standard

• Practical example applications
What is DVB-SI-S and why has this specification been created?
What is DVB-SIS and why has this specification been created?

- **General purpose**
  - Deriving content and metadata from delivery path A (e.g. satellite) for re-delivery via path B (e.g. terrestrial)

- **History**
  - Supply of DTH receivers and terrestrial transmitter stations via separate distribution paths

- **Presence and future**
  - Feeding these destinations in a hybrid way via one distribution path => **DVB-SIS**
  - Proprietary solutions have covered that purpose so far
Concept behind the DVB-SIS Standard
Concept behind the DVB-SIS Standard - general topics

- Deriving content and metadata from delivery path A (e.g. satellite) for re-delivery via path B (e.g. terrestrial)

- Chain consists of PARENT and DAUGHTER sites (generic concept, i.e. works for different A/B combinations)
  - Network Types in between can be satellite, cable, terrestrial, anything able to carry TS’s

- Concept covers SFN needs, i.e. enables output of bit-by-bit the same T2-MI stream from each DSA belonging to the same SFN
Concept behind the DVB-SIS Standard – Interface H

- At central interface H the following data is available:
  - Service content (TV/Radio) and related PSI/SI
  - Metadata produced by the CSG

- In the end it is irrelevant how the content and metadata is produced for interface H

- The metadata enables deterministic processing on daughter site
Concept behind the SIS Standard – Parent and Daughter sites

- **Control Signal Generator (CSG):**
  - Produces all metadata required:
    - Framing & Timing Information (F&TI)
    - DSA Configuration Information (DSACI)
    - SIS Service

- **Daughter Site Adapter (DSA):**
  - Receives n TS’s at its input (interface J)
  - Allows for “out-of-band” input of DSACI via other paths (interface K)
  - Produces a single T2-MI stream at its output (interface L)
Concept behind the DVB-SIS Standard – Preparation of metadata and content on parent site

- Different types of content and related PSI/SI are provided (orange section)

- **Framing and Timing Information** is generated and carried in T2-MI packets

- Remaining **T2-MI packets** – carrying L1 signalling, T2 timestamps etc. – are produced as well (blue section)

- **DSA Configuration Information** is composed of all instructions and all metadata required on daughter site for producing the desired T2-MI stream in a fully deterministic way (red section)
Concept behind the DVB-SIS Standard – Processing of metadata and content received on Daughter site

• Extraction according to DSACI
  – Of services
  – Of components

• Preparation of terrestrial PSI/SI

• Frame building
  – According to Framing & Timing Information
  – Using deterministic multiplexing algorithm

• Output of TS for modulation
Concept behind the DVB-SIS Standard - Output to T2 modulators

- T2-MI packets are multiplexed – consisting of BaseBand Frames, L1 signalling, T2 timestamps and optionally further T2-MI packet types
- T2-MI packets are then data-piped, i.e. they are encapsulated in TS packets
- TS multiplexing stage enables the combination of TS packets carrying T2-MI packets and TS packets carrying PSI/SI for this stream
- DSA produces single T2-MI stream at interface L
Concept behind the DVB-SIS Standard - Timing

• Parent Signals are timestamped
  – SIS Services hold absolute PCRs that enable deterministic timestamping for all TS packets
  – CSGs use an absolute 27 MHz clock counter that started with 0 at SIS epoch (the same epoch for DVB-T2 time, i.e. 2000-01-01 T 00:00:00 UTC)

• DSA computes deterministic timestamps on output TS(s)
  – Framing & Timing Information from SIS service gives the parameters needed

• All scheduling decisions are based on those deterministic timestamps
Concept behind the DVB-SIS Standard – Clock referencing from DSA in- to output

If. \( J_1 \)

Parent TS\(_1\) consisting of a single SIS Service carrying PCR\(_{abs}\)

Arrival timestamping

Interpolation between subsequent PCR\(_{abs}\) values

TS\(_1\) with arrival timestamps

Interpolation between subsequent PCR\(_{abs}\) values

TS\(_n\) with arrival timestamps

Parent TS\(_n\) consisting of a single SIS Service carrying PCR\(_{abs}\)

Arrival timestamping

Reference TS generation

Reference TS with packet departure time based on PCR\(_{FTSP}\)

Reference TS with packet departure time based on PCR\(_{FTSP}\)

F&TI incl. PCR\(_{FTSP}\)

PCR re-stamping

TS with PCR\(_{input}\)

PCR\(_{output}\) = PCR\(_{input}\) + (packet\(_{departure\_time}\) – packet\(_{arrival\_time}\))

TS with PCR\(_{output}\)
Elements of the DVB-SIS Standard
Elements of the DVB-SIS Standard

• Environment of standards around SIS
  – S/S2/S2X, ...., T2-MI/T-MF

• Structure of the SIS Standard:
  – Parent site:
    • Service Information (PSI/SI)
    • SIS Services
    • L1 signalling
    • Other T2-MI packet types
    • Framing & Timing Information
    • DSA Configuration Information
    • Carriage of signal components within the parent Transport Streams
  – Daughter site:
    • Bootstrapping
    • TS Remultiplexing
    • Framing
    • Extraction of T2-MI packets from signal received via interface H
    • Output processing
Elements of the DVB-SIS Standard – Environment of standards around SIS

- **DVB-SI** [EN 300 468]
- **MPEG-2 TS** [ISO/IEC 13818-1]
- **DVB-T2-MI** [TS 102 773]
- **DVB-T2** [EN 302 755]
- **UTF-8** [RFC 3629]
- **Gzip** [RFC 1952]
Elements of the DVB-SIS Standard, Parent Site
Elements of the DVB-SIS Standard

• Structure of the SIS Standard:
  – Parent site:
    • Service Information (PSI/SI)
    • SIS Services
    • L1 signalling
    • Other T2-MI packet types
    • Framing & Timing Information
    • DSA Configuration Information
    • Hiding SIS Services and sheer terrestrial services away from DTH receivers
SIS parent site elements - Service Information (PSI/SI)

- Terrestrial PSI/SI can be produced as follows – on the basis of the related satellite PSI/SI tables:
  - **Passed through**, i.e. no modification
  - **Patched**, i.e. parts of tables are modified, replaced or stuffed (size of the table remains constant)
  - **Regenerated**, i.e. the DSA produces tables based on DSACI and satellite PSI/SI
    - Virtual Arrival Timestamps (VATs) are assigned to the regenerated tables
  - The SIS standard defines the aforementioned mechanisms for these PSI/SI tables:
    - PMT, PAT, CAT, SDT, BAT, EIT
  - **Remapping**, i.e. replacement of PID’s can be applied to all tables (and to all service components)
  - CATs can also be stopped from retransmission – reflecting a change from encrypted to free-to-air provision

- All other tables required for the terrestrial transmission need to be provided by the CSG in a hidden way, i.e. “invisible” for the satellite receivers (see slides 31 to 33)
SIS parent site elements - SIS Services (1/5)

- SIS Services are consisting of
  - $\text{PCR}_{\text{abs}}$: provides absolute time reference
  - F&TI: gives instructions to build a deterministic framing structure for modulation
  - DSACI: enables configuration of DSA processing
  - SIS-specific PSI/SI: elements of signalling needed by terrestrial PSI/SI reconstruction

- There is a single “Primary SIS Service” for a targeted terrestrial modulation
  - F&TI comes from Primary SIS Service
  - On other (secondary) SIS Services F&TI is not required
SIS parent site elements - SIS Services (2/5)

- **PCR\textsubscript{abs}**
  - Is mandatory for all SIS Services
    - Declared in SIS Service PMT through PCR\_PID
    - Carried with usual adaptation field mechanism
  - Is an absolute time reference that starts with value 0 at SIS epoch (1\textsuperscript{st} January 2000, 00h00)
  - Enables deterministic **packet arrival timestamping** of all TS packets from parent signals
    - used in deterministic multiplexing algorithm
    - used in the arithmetic operations for PCR correction
Framing & Timing Information (F&TI)

- Holds framing structure of the terrestrial modulation
  - See slides 27 and 28

- A single source of F&TI is used for a single terrestrial modulation

- F&TI is optional for other parent signals that contribute to the same terrestrial modulation (but would be ignored by the DSA ...)

**Diagram:**
- PSI/SI Server to RF Modulator
- CS_{G_n} to DVB_{TS} Remultiplexer
- Control to F&TI
SIS parent site elements - SIS Services (4/5)

- **DSACI**
  - Is an XML configuration file for the DSA
  - Is structured by groups of configuration elements
  - Is either
    - Provided in-band on a dedicated PID of the Primary SIS Service
    - Provided out-of-band to the DSA
SIS prent site elements - SIS Services (5/5)

- SIS-specific PSI/SI, e.g.
  - PATs for terrestrial TSs (with PID ≠ 00_{16})
  - PMTs for sheer terrestrial services, or modified PMTs of hybrid services, that are not regenerated
  - In the extreme case, all terrestrial PSI/SI tables could be provided this way, but that is not an efficient solution
SIS parent site elements - Layer 1 signalling, other T2-MI packet types

- L1 signalling is generated by the Control Signal Generator (CSG) completely
  - The CSG produces T2-MI packets of types ... 
    • ... 10_{16} (L1-current) and 11_{16} (L1-future), if needed 
    • ... 20_{16} (DVB-T2 timestamps) 
    • ... all other required T2-MI packet types (apart from 00_{16} (BBF’s))
  - L1 signalling is relevant for the BaseBand Frame builder being part of the DSA
  - The CSG also produces Framing & Timing Information (F&TI) – T2-MI packet type F0_{16} – for building Interleaving and BaseBand Frames on Daughter site in a deterministic way – see previous and later slides
    • These T2-MI packets are not output from the DSA to the T2 modulators
SIS parent site elements – Framing & Timing Information (1/2)

• Provides metadata required by the DSA for
  – Deterministic building of frames
    • DVB-T2: BBFRAMES, Interleaving frames and T2-frames
    • DVB-T: mega-frames
  – Deterministic allocation of TS packets to Interleaving Frames
SIS parent site elements – Framing & Timing Information (2/2)

- **DVB-T2 case**
  - SIS syntax for F&TI fits in the payload of a new T2-MI packet type (0F₁₆)
  - F&TI transmitted through usual data piping with L1, DVB-T2 timestamp, FEF...

```c
for (u=0; u < number_of_PLPs; u++) {
    plp_id;
    int1_frame_start;
    MATYPE;
    TTO;
    FIRST_ISCR;
    BUFS;
    FIRST_DFL;
    FIRST_SYNC;
    NEXT_FIRST_SYNC;
    MODE;
    PCR_FTSP;
    Frame_Pkt_Count;
    DPCR_IF;
}
```
SIS parent site elements – DSA Configuration Information (1/2)

- DSACI contains
  - Global configuration items
    - Target current_DSA_group_id
    - Application time of the configuration
  - Input configuration items
    - Define the input TSs sources according to TS_id, ON_id.
    - Contain the PMT_PID of the SIS service (relevant for OOB delivery of DSACI)
    - Allow identification of primary parent signal
  - Re-multiplexing configuration items
    - Details on following slide
  - Output configuration items
    - Define which terrestrial standard is addressed
    - Add PSI/SI elements for DVB-T2-MI
SIS parent site elements - DSACI (2/2)
Re-multiplexing configuration

• Output TS mapping
  – Global attributes of output TS

• PID level routing and processing
  – Routes and PID translations

• Service level processing
  – Service related PSI/SI attributes and processing algorithm

• PSI/SI operations and/or regenerations
  – TS wide PSI/SI attributes and processing algorithm
SIS parent site elements – Hiding SIS Services away from DTH receivers (1/3), PMT

**PMT for SIS Services** (Primary and other):

- Terrestrial metadata connected to a hybrid or a sheer terrestrial service or service component becomes part of an SIS Service or is regenerated on the basis of related satellite tables

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**data_broadcast_id = 00E_{16} for SIS specification** (from range "reserved for general registration through the DVB Project Office (see http://www.dvbproject.org/)"

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**stream_type = 06_{16} for all SIS-specific metadata (T2-MI already uses this stream_type)**

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**id_selector_byte = 01_{16} for F&TI**

**id_selector_byte = 02_{16} for DSACI**

**id_selector_byte = 03_{16} for terrestrial PSI/SI tables belonging to a hybrid or sheer terrestrial service/service component** (definition specific to each data_broadcast_id)

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SIS parent site elements – Hiding SIS Services and sheer terrestrial services away from DTH receivers (2/3), SDT

**SDT for SIS Services and sheer terrestrial services, both to be hidden away from satellite receivers**

```
service_type = 0C_16 for whatever hidden SIS-specific service (0C_16 is for „data broadcast service“)
```
SIS parent site elements – Hiding SIS Services and sheer terrestrial services away from DTH receivers (3/3), Summary

• All sheer terrestrial services and SIS Services are accompanied by service_type $0C_{16}$ (data broadcast service) in the SDT (service descriptor)

• The Primary SIS Service (one per terrestrial output = current_DSA_group_id) consists of
  – $PCR_{abs}$ (mandatory)
  – F&TI (mandatory)
  – DSACI (optional)
  – Terrestrial-only PSI/SI tables belonging to hybrid or sheer terrestrial services, including PATs (for terrestrial TSs, with PID $\neq 00_{16}$) and PMTs (all optional)
    • In case such tables are provided, they have to be part of an SIS Service

• Other SIS Services (one per Parent Signal) consist of
  – $PCR_{abs}$ (mandatory)
  – F&TI (optional)
  – DSACI (optional)
  – Terrestrial-only PSI/SI tables belonging to hybrid or sheer terrestrial services, including PATs (for terrestrial TSs, with PID $\neq 00_{16}$) and PMTs (all optional)
    • In case such tables are provided, they have to be part of an SIS Service
Elements of the DVB-SIS Standard, Daughter Site
SIS daughter site elements – DSA-internal structure

Input processing

Manual configuration

Extract DSAGI

IF J1

Arrival time - stamping

IF Jn

Selection of content input PIDs

Arrival time - stamping

Selection of table input PIDs

Table selector/ Input PID remapper

Table patching

Table regeneration

Determine TS generation/ Input time stamping

Reference TS generation

PSI/SI table processing

Input PID remapper

Input processing

TS re-multiplexing

Framing

Extract TS Splitting

Partial mode adaptation

Inter - leaving Framing

Null Packet Deletion

DVB - T2-MI multi - plexing

Data piping

Parent TS

Data de-piping

De- multiplexer

Parent TS

Data de-piping

De-multiplexer

F & TI (T2-MI packet type R016)

L1-current (T2-MI packet type 1016)

All other T2-MI packet types – apart from 0016 (not permitted in SIS System)

Extraction of T2-MI packets & output processing
(Data de-piping & piping of T2-MI packets)
Elements of the DVB-SIS Standard

- Structure of the SIS Standard:
  - Daughter site:
    - Bootstrapping
    - TS re-multiplexing
    - Framing
    - Extraction of T2-MI packets from signal received via interface H
    - Output processing
SIS daughter site elements – Bootstrapping

• The first step is to tune the receivers in front of the DSA to those satellite channels, which provide the content & metadata required for composing the terrestrial multiplex(es)
  – This can e.g. be done manually and is not within the scope of the SIS spec

• Next step is to find the DSA Configuration Information (DSACI)
  – In-band, the following parameter settings have to be provided manually to the DSA:
    • The [TSid/ON ID/Program Id] triple corresponding to the Primary SIS Service in the relevant Parent Signal where the DSA will find the current DSACI component
    • The current_DSACI_group_id identifying the current DSACI that this particular DSA shall use
  – Out-of-band, the following parameter settings have to be provided manually to the DSA:
    • The path or location – e.g. URL, drive and directory – where the DSA can find the current DSACI file
    • The current_DSACI_group_id identifying the current DSACI that this particular DSA shall use
SIS daughter site elements – TS re-multiplexing (1/6)

Input processing

TS re-multiplexing

PSI/SI table processing

Selection of table input PIDs → Table selector/Input PID remapper → Table patching → Table regeneration → Reference TS generation

Input processing:
- Manual configuration
- Extract DSACI
- In-band
- Arrivals time-stamping

TS re-multiplexing:
- Parent TS F
- Parent TS
- Parent TS

PSI/SI table processing:
- Selection of content input PIDs
- Input PID remapper

Selection of content input PIDs → Input PID remapper

Data de-multiplexing:
- Parent TS

Data de-multiplexing:
- F&I (T2-MI packet type R016)
- L1-current (T2-MI packet type 1016)
- All other T2-MI packet types – apart from 0016 (not permitted in SIS System)

DVB-T2-MI multiplexing:

Data piping:

TS re-multiplexing:
- DVB-T2-MI multiplexing

Output TS with re-stamped PCRs

PLP n
PLP 1

Partial mode adaptation
Inter-leaving Framing
Null Packet Deletion
BaseBand Framing

Data de-multiplexing:

All other T2-MI packet types – apart from 0016 (not permitted in SIS System)
SIS daughter site elements – TS Remultiplexing (2/6)

• Arrival timestamping
  – “packet arrival time” is computed by $\text{PCR}_{\text{abs}}$ interpolation

• VAT
  – Virtual Arrival Time is used for regenerated (PSI/SI) packets
  – VAT computation is configured by DSACI
Selection and remapping of relevant content from input TS(s)

- Input PSI/SI tables
- Input service(s) (component(s)) content
SIS daughter site elements – TS Remultiplexing (4/6)

- Processing and generation of PSI/SI according to DSACI
  - Input table PID remapping
  - Input table patching
  - Table regeneration
SIS daughter site elements – TS Remultiplexing (5/6)

- Generation of Reference Transport Streams
  - RTS is a placeholder with timestamped null packets
    - Timestamps are “packet departure times”
    - Timestamps are computed according to F&TI
  - Parent TS content and regenerated PSI/SI will replace null packets of RTS
SIS daughter site elements – TS Remultiplexing (6/6)

• Placement of incoming packets in the outgoing TS
  – Scheduling algorithm decisions based on computed:
    • “packet arrival times”
    • “packet departure times”
  – Deterministic PCR correction applied
SIS daughter site elements – Framing

1. **Selection of content input PIDs**
2. **Selection of table input PIDs**
3. **Table selector/Input PID remapper**
4. **Table patching**
5. **Table regeneration**
6. **Reference TS generation**
7. **Partial mode adaptation**
8. **Inter-leaving Framing**
9. **Null Packet Deletion**
10. **Baseband Framing**
11. **Data piping**

**Key Points:**
- **Manual configuration**
- **In-band**
- **Arrival time-stamping**
- **Parent TS F**
- **F&TI (T2-MI packet type R016)**
- **L1-current (T2-MI packet type 1016)**
- **All other T2-MI packet types – apart from 0016 (not permitted in SIS System)**
- **Data de-piping**
- **De-multiplexer**
- **DVB-T2-MI multi-plexing**
- **Output TS with re-stamped PCRs**

**Framing Components:**
- **Framing**
- **TS Splitting**
- **Parent TS F**
- **Data piping**
- **PLP**
- **Parent TS 1**
- **Parent TS n**
- **Framing**
- **Null Packet Deletion**
- **Inter-leaving Framing**
- **Table patching**
- **Table selector/Input PID remapper**
- **Table regeneration**
- **Arrival time-stamping**
- **Selection of content input PIDs**
• Building Interleaving Frames and BaseBand Frames (BBF’s) – widely consisting of well-known T2 machinery:
  – TS Splitting (optional)
    • When multiple input MPEG-2 TSs are transmitted via a group of PLPs, splitting of input TSs into partial TSs (carried via data PLPs) and a partial TS carrying common data (carried via the associated common PLP) can be applied in order to save signalling overhead.
  – Partial mode adaptation might consist of
    • SYNC byte removal, dummy ISSY insertion (if applicable), dummy DNP insertion (if applicable) and/or dummy CRC-8 insertion (if applicable).
  – Interleaving framing
    • The bits of the partially mode-adapted Transport Stream are allocated to Interleaving Frames according to F&TI instructions.
  – Null packet deletion (optional)
    • In the case of Transport Streams consisting of a large percentage of null-packets (→ variable bitrate) TS null-packets shall be removed in order to avoid unnecessary transmission overhead.
    • The process is reversed at the receiving end in a fully deterministic way.
  – Baseband framing
    • The bits allocated to an Interleaving Frame are mapped onto the number of BBFRAMEs indicated in the dynamic L1 signalling for the relevant PLP and Interleaving Frame.
SIS daughter site elements – Extraction of T2-MI packets & output processing

- Extraction of T2-MI packets & output processing (T2-MI packet depiping & piping)
SIS daughter site elements – Extraction of T2-MI packets from signal received via interface H

- T2-MI packets are received by the DSA embedded in TS packets (→ data piping)
- All T2-MI packets are decapsulated from the aforementioned TS packets
- Depending on the T2-MI packet type, the DSA applies a different processing:
  - Packet type \( \text{00}_{16} \) (Baseband Frame) is not permitted for SIS usage and is trashed
  - Packet types not equal to \( \text{00}_{16} \) (Baseband Frame), \( \text{10}_{16} \) (L1-current) or \( \text{F0}_{16} \) (F&TI) are simply piped through and are encapsulated again in TS packets for insertion into the output T2-MI stream
  - Packet type \( \text{10}_{16} \) is used for configuring the DSA output stream and is in the end encapsulated again in TS packets as mentioned above
  - Packet type \( \text{F0}_{16} \) (F&TI) is also used for configuring the DSA output stream, but is discarded after processing and does not become part of the DSA output stream
SIS daughter site elements – Output proc.

- T2-MI packets are multiplexed – consisting of:
  - Content-carrying packets (BaseBand Frames) produced by the DSA
  - L1 signalling packets received from the CSG(s)
  - Optionally further T2-MI packet types also received from the CSG (but no BBF type packets)

- T2-MI packets are then data-piped, i.e. they are encapsulated in TS packets for provision to T2 modulator(s)

- TS multiplexing stage enables the combination of TS packets carrying T2-MI packets and TS packets carrying PSI/SI for this stream

- DSA produces single T2-MI stream at interface L, i.e. a stream of T2-MI packets contributing to T2 transmission frames of one type, e.g. T2_SISO (T2-Base SISO)
  - Mix of frame types – e.g. T2-Base SISO and T2-Lite SISO – would conceptually require multiple DSA's
Practical example applications
Practical example applications – Re-using part of one satellite signal
Practical example applications – Re-using parts of several satellite signals
WEBINAR on the DVB Single Illumination System

https://www.dvb.org/events/webinars

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