The purpose of this document is to explain the principles behind DVB subtitling and to introduce Softel digital subtitling products.

What is DVB?

DVB (Digital Video Broadcasting) is a consortium of around 300 companies in the fields of Broadcasting, Manufacturing, Network Operation and Regulatory matters that have come together to establish common international standards for the move from analogue to digital broadcasting. This common market-led initiative has resulted in DVB becoming a prominent and leading international standard and the sole choice for technologies that enable an efficient, cost effective, easy/rapid transition, higher quality and interoperable digital broadcasting.

The DVB standards for digital television have been adopted in the UK, across mainland Europe, in the Middle East, South America and in Australasia.

For further information on the DVB refer to their web site www.dvb.org

What is DVB subtitling?

The DVB group have specified the means by which one or more subtitle stream(s) can accompany any or all video services within a multiplex. This specification is known as ‘DVB Subtitling’ or ETSI 300 743 ‘DVB Subtitling Systems’.

The specification details two methods of transmitting subtitles – ‘bit-map’ and ‘code based’.

DVB subtitling relies on DVB subtitle compliant solutions at both ends of the transmission chain. Both the subtitle encoding and the decoding processes have to be DVB subtitling compliant. The presence of the DVB logo on either encoder or decoder hardware is not proof that the equipment supports DVB subtitling.

Why are subtitles important?

For two reasons: firstly for the benefit of the hard of hearing viewing community and secondly for language translation.

There is a significant percentage of any group of TV viewers who are either totally deaf or whose hearing is impaired to the extent that they prefer to use subtitles in preference to, or to complement, the audio track. It is becoming commonplace for governments to mandate increasing levels of hard of hearing subtitling as part of digital TV transmissions.

Digital broadcasting is becoming a global business and satellite transponders have no respect for geographic regions or country borders. Hence a broadcaster will often target TV channels at a viewing population who do not necessarily share a common language. DVB subtitle compliant receivers can be configured to display subtitles in a range of languages.

Where are DVB subtitles decoded and overlaid on the TV picture?

The obvious place and time to overlay DVB subtitles onto a TV picture is in the viewer’s home as he watches the TV programme using a digital receiver. Only in this way does the viewer have complete choice over whether subtitles are needed at all and if so in what language. For this to happen there has to be a digital signal path all the way into each home. This could be direct-to-home satellite, terrestrial or by digital cable television.

However it is often the case that digital services are down-linked from satellite and re-broadcast locally such that the viewer receives the signal on a conventional analogue cable or terrestrial TV network. In a hybrid system such
as this, there is the opportunity to decode and overlay subtitles in one chosen language at the downlink location prior to analogue re-broadcast. There are a number of professional DVB IRDs (integrated receiver decoder) that support DVB subtitle overlay.

**What is DVB bit-map subtitling?**

The DVB bit-map method operates by converting each subtitle row into a graphics image and transmitting it as a bit-map object.

Softel have adopted this bit-map form as the preferred standard for DVB subtitling because it passes all responsibility and control for the subtitle size, font, colour, embellishments and outline to the broadcaster. Bit-maps allow complete flexibility over how subtitles are presented to the viewer and any changes to this presentation can be made independently of the receiving hardware.

**What is DVB code-base subtitling?**

The DVB code-based method operates by transmitting each character within a subtitle using a unique character code. This method relies on the use of character code look-up tables that are shared between encoding systems and the font processor of the receiving hardware and for there to be at least one subtitle font resident in the receiver.

Although there is the payload advantage of requiring less transmission bandwidth than the bit-map method, the code-based method is seen as being inflexible and is rarely used.

All subsequent sections of this document are based around the use of bit-map subtitling.

**Are other forms of subtitling used in DVB networks?**

There are two other means of subtitling; open ‘overlay’ subtitles and Teletext subtitles.

Open subtitles are keyed onto the video picture and are thus seen by all viewers. The disadvantages of open subtitling are that the subtitles are a nuisance to those viewers that do not need them, and secondly there are technical issues arising from MPEG encoding fast moving video sequences having static captions.

Teletext subtitles are a throwback to analogue days when VBI Teletext data was often used to provide a subtitling service to viewers equipped with Teletext-capable televisions. The DVB broadcast standard continues to support Teletext services (i.e. both information pages and subtitling) and DVB receivers may optionally either decode and display Teletext services, or in the case of DVB set-top decoders they may re-insert the VBI Teletext data into the analogue video signal passing to the TV set.

There are a number of disadvantages associated with Teletext subtitling of DVB services: (i) there are few DVB receivers capable of supporting the display of Teletext services. (ii), a service operator cannot be sure of the penetration of Teletext-capable televisions in viewer’s homes. (iii), Teletext decoders support only a subset of international character sets depending on where they were purchased. (iv), the Teletext support for many Middle-East and Asian character sets is either poor or non-existent. (v), Pre-prepared subtitle files may not be available in a format suitable for Teletext transmission (for example, Teletext displays a maximum of 37 characters per row whereas some subtitle workstations will create subtitle rows having 40 or more characters).

**How is each subtitle encoded into DVB format?**

Each character in a subtitle is rendered into a bit-map image following encoding rules defined locally by the DVB subtitle processor. This establishes the height and width of each character as well as any other embellishments such as italics, bold or underline. Character outlining and aliasing are also performed by the rendering process.

The colour of each pixel in the image is determined by a colour lookup table, which can contain up to 256 colour definitions.

A ‘region’ has to be created on the TV display for each row of subtitles. A region will normally have a background fill colour or transparency level associated with it.
**How is a DVB subtitle data stream constructed?**

A typical DVB multiplexed signal carries six or more separate video channels, associated audio channels, and a selection of service mapping tables and EPG information and a number of private data channels. Each of these service components is carried as a ‘transport packet stream’ within a multiplexed stream and each service is identified using a unique packet ID ‘PID’.

DVB subtitle data is carried within a private data stream. A single PID transport packet stream is generally used to carry all the subtitles associated with a single video service although it is also possible for subtitle services for multiple video channels to be carried within the same PID stream.

It is not within the remit of this document to describe fully the structure of a DVB subtitle data packet and interested readers should obtain a copy of the ETSI specification documentation. It is sufficient to say that there are a number of key components within a stream which together constitute a single subtitle service:

- The **PID** of a subtitle transport packet stream is important as DVB decoders are aware from the DVB service tables which PID streams carry subtitles for each video service in the multiplex.

- Within a transport packet stream, each individual subtitle service is identified using a unique subtitle **page ID**. The subtitle page carries information about the display of each subtitle such as the co-ordinates of the subtitle regions.

- The subtitles and other graphics are carried as **Objects** each having a unique ID so that they may be re-used where appropriate.

- Each display object (including subtitle rows) has an associated **Presentation Time Stamp (PTS)** which indicates to the DVB decoder at which point in time (relative to the main DVB PCR clock reference) the object should appear on the screen. This mechanism optimises bandwidth and simplifies multi-lingual service delivery by allowing subtitles to be pre-delivered to the decoder.

The important criteria when it comes to evaluating DVB subtitle products are (i) the quality and flexibility of the bit-map subtitling rendering process and (ii) the way in which the PTS data is handled.

**What is the typical bit rate of a DVB subtitle stream?**

A single language bit-map subtitle stream typically requires a bandwidth of between 50 to 100 kbps depending on the size and colour density of the subtitles.

To put this into perspective, an MPEG video stream might require between 2 and 4 Mbps and a complete DVB multiplex might total 20-40 Mbps.

**How are DVB subtitles broadcast?**

Firstly, subtitles are encoded into a DVB format transport packet stream (using a subtitle processor) and then the subtitle stream is multiplexed or ‘merged’ with all the other video, audio, private data and service information (using a DVB multiplexer) to form a complete DVB multiplex signal ready for broadcast.
This simplified diagram shows how DVB subtitle processors contribute transport packet streams containing subtitles to the multiplexer in the same way as MPEG encoded video and audio streams.

The data flow between subtitle processors and the multiplexer is shown as bi-directional because the subtitle processors require a real-time feed of the master clock reference (PCR) generated by the multiplexer in order to generate accurate presentation time stamps (PTS) for each subtitle.

**What form of data interface is used between subtitle processor and multiplexer?**

Data is most commonly exchanged between subtitle processor and multiplexer using ASI connections although Ethernet TCP/IP connections are also used.

ASI (asynchronous serial interface) has become the industry standard means of carrying high speed digital TV transport stream data locally between hardware units. ASI uses conventional video cable and BNC connectors and it shares many of its characteristics with the commonplace 270Mbps serial digital video interfaces used in video facilities. Although a subtitle stream occupies typically less than 100kbps, multiplexer inputs often require higher data rates to keep them alive and thus null packets are used to fill up the unused capacity on the link.

Where an ASI connection is used to feed the PCR clock reference data back to the subtitle processor, the signal often contains the complete multiplexer transport stream output. The subtitle processor then needs to extract the PCR from the stream.

The ASI interface is easier than TCP/IP to configure where there is master/standby fault tolerant hardware because ASI signals can be routed through conventional video signal matrices.

**Where do programme subtitles come from?**

At any point in a broadcast schedule there will either be no accompanying subtitles, or there may be subtitles that have been pre-prepared for the programme, or the programme may be subtitled ‘live’.

Where programmes are pre-subtitled, the subtitles may already be present on the associated video feed (ie. subtitles stored as VBI Teletext data) or they may exist as a timecoded subtitle data file (or files in the case of multi-lingual subtitles).

A DVB subtitle processing system has to be designed on a case by case basis to with regard to the source or sources of programme subtitles.

**What DVB subtitle processing products do Softel offer?**

Softel have supplied subtitling preparation, transmission, and character generator products to both broadcasters and subtitle facilities around the world for over ten years. It was therefore a natural decision for the company to develop subtitling solutions for digital TV as soon as the DVB standards were defined around 1995. Indeed, Softel were one of the first companies to offer DVB solutions and most of the early digital TV network adopters around the world such as On Digital here in the UK, Danmarks Radio in Denmark and the Australian Broadcast networks all make use of Softel DVB subtitling processors.

Softel’s DVB subtitle processor (DiSP) is part of the company’s Swift range of subtitling products (Swift subtitle workstations, Swift Character Generators and Swift TX subtitle transmission units).

Softel recognised that no two DVB subtitle systems would ever be the same and therefore the DVB product needed to be both modular and scalable in order to meet the requirements of individual installations. Thus, in each case a single or group of Softel Swift TX transmission units may be configured from the following hardware and software components:
Software

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DiSP</td>
<td><strong>Digital Subtitle Processor</strong> – A PC Windows application responsible for converting subtitle rows into DVB bit-map format and creating a DVB compliant subtitle transport packet stream output. The DiSP receives subtitle input from a number of possible sources including (i) Teletext subtitles, (ii) the file-based output from a local schedule client (see below), (iii) real-time subtitles received via local Ethernet or serial ports. A single DiSP supports one or more subtitle language streams associated with one video service. Each DiSP currently requires its own PC hardware although this may change in the future.</td>
</tr>
<tr>
<td>Config Client</td>
<td>A configuration application used to define the characteristics of each DiSP. Each processor is configured with settings such as DVB addressing, subtitle font and presentation information. Some of the DiSP settings are stored in pre-configured style sheets so that settings may be altered as required. The configuration application may be run either on the local hardware or on any other networked PC.</td>
</tr>
<tr>
<td>Schedule Client</td>
<td>The scheduling client application is used in cases where some or all of the subtitle output is derived from pre-prepared subtitle files. In such cases, the schedule client maintains a subtitle playlist defining the order in which files are transmitted. In Manual Mode, the schedule application allows files to be loaded into a playlist and for playlist events to be started and stopped by the user. In Automatic Mode, the schedule application creates a playlist derived from a 3rd party automation system, and events are initiated and stopped under automation control.</td>
</tr>
<tr>
<td>ASI Concentrator</td>
<td>A Windows application designed to concentrate a number of DVB transport packet streams from individual DiSPs across a LAN into a single multi-PID transport stream suitable for ASI connection to a DVB multiplexer.</td>
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</table>

Hardware

<table>
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<tr>
<th>Product</th>
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<tbody>
<tr>
<td>2U PC Chassis</td>
<td>A professional 2U rackmount PC with front panel display, hard disk, LS120 super drive and slots for up to three plug-in interface cards.</td>
</tr>
<tr>
<td>1U PC Chassis</td>
<td>A professional 1U rackmount PC with hard disk and a slot for one plug-in interface card</td>
</tr>
<tr>
<td>VBI Decoder</td>
<td>A plug-in Teletext decoder card and driver software designed to extract one or more Teletext subtitle streams from a video signal. Factory settings for PAL or serial digital video input.</td>
</tr>
<tr>
<td>Timecode</td>
<td>A plug-in dual mode (VITC or EBU) Timecode decoder card and driver designed for use when there is local playout of timecoded subtitle files using the schedule client application.</td>
</tr>
<tr>
<td>ASI RW</td>
<td>A plug-in ASI interface card capable of both reading and writing ASI streams.</td>
</tr>
<tr>
<td>Teletext inserter</td>
<td>A plug-in Teletext inserter card and driver software designed to provide an analogue Teletext VBI subtitle data output for installations requiring simulcast transmission of both digital and Teletext subtitles.</td>
</tr>
</tbody>
</table>

**Which subtitle disk formats can be loaded into a Swift TX unit?**

Swift TX units are primarily designed to import industry standard EBU3264 subtitle files. In the case of non-Latin character sets (such as Asian, Chinese, and Arabic), files can also be transferred from Softel’s Swift subtitle preparation workstation using a Softel file format (based on the ESEF extended subtitle exchange format).

Softel can also provide file format converter utility software that supports a wide range of 3rd party subtitle file formats (for example RAC, PAC, Cheetah, NCI Cap)
How do you configure a Swift TX Teletext to DVB subtitle transcoder?

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<tr>
<td>2U Swift TX</td>
<td>DISP</td>
<td>2U chassis</td>
</tr>
<tr>
<td></td>
<td>Config Client</td>
<td>VBI Decoder</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASI RW</td>
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</tbody>
</table>

The configuration application is used to specify the Teletext subtitle page number(s) to be converted into DVB format and the presentation styles.

There is a finite delay between decoding each subtitle and outputting it to the multiplexer, however the delay is certainly less than the time taken to MPEG encode the video so overall the subtitles are presented at the correct time.

What are the advantages in using Teletext to DVB subtitle transcoders?

If the subtitles are already present as VBI Teletext data within the video signal as it reaches the MPEG encoding process, then there is no need for the subtitle processors to interface to the station playlist automation systems. Instead, the subtitles are detected automatically as they arrive and transcoded in realtime. This can simplify the complexity of the subtitling installation and makes the subtitle units independent from the automation systems.

Where the video channels are coming off local video servers or VTRs, the subtitles may be pre-encoded into the video as vbi Teletext data using a conventional Swift TX subtitle disk reader and VBI inserter. Where video programmes are already Teletext-subtitled, or where the broadcaster has access to subtitle files for the programme in Teletext format, then Softel would recommend the standard Teletext subtitle VBI data format be used. If, however, the subtitle disks are received in a more general format (especially if they are in a non-latin character set, or if subtitle rows exceed the maximum 37 characters allowed in Teletext subtitles), then Softel would suggest that the subtitles are VBI encoded using a unicode-based Teletext private data format.

What is the most effective way of configuring more than one channel of Teletext subtitle transcoders?

Digital TV systems are very rarely limited to a single video channel, so Softel have ensured that there is a scalable solution for multi-channel installations. Simply replicating the single channel Swift TX transcoder in one possible solution, but, considering both physical rackspace and the number of ASI connections to the multiplex hardware, Softel offer an alternative approach:
In this configuration, the 2U Swift TX subtitle unit is acting as both subtitle processor and ASI concentrator. The remaining 1U Swift TX units act as single channel DVB transcoders but their DVB transport packet stream outputs are routed via a local LAN to the ASI concentrator which then outputs the individual streams together on a single ASI connection to the DVB multiplexer.

The ASI concentrator also reads the multiplex PCR clock reference and distributes PCR across the LAN to the other Swift TX units so that they can correctly timestamp each subtitle.

The configuration of these units is as follows:

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<tr>
<td>2U Swift TX &amp; ASI combiner</td>
<td>DiSP</td>
<td>2U chassis VBI Decoder ASI RW</td>
</tr>
<tr>
<td></td>
<td>Config Client</td>
<td></td>
</tr>
<tr>
<td>1U Swift TX</td>
<td>DiSP</td>
<td>1U chassis VBI decoder</td>
</tr>
<tr>
<td></td>
<td>Config Client</td>
<td></td>
</tr>
</tbody>
</table>

How can you protect a multi-channel configuration against unit failure?

The operator has first to decide how important the subtitling service is to his customers and his business, and then design the system architecture to meet this objective.

If the operation is manned at all times, and a subtitle service failure of 30 minutes is acceptable, then a warm standby replacement unit would suffice. If a subtitle service failure is not acceptable, then a hot-standby configuration is required.

In the multi-channel configuration above a second 2U Swift TX unit could be pre-configured with style sheets for each of the units in the system. In the event one of the units failed, the warm standby could be installed and the appropriate style sheet selected.

For an N+1 hot standby configuration a second 2U Swift TX unit would be installed on the network along with a signal router to take care of re-routing signal inputs and outputs when the warm standby was required to take over from a failed unit in the system:

The management of a hot-standby implementation requires some additional software and hardware product items:
Software

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<tr>
<td>Status Monitor</td>
<td>A process that checks and reports the health status of other local Swift TX units. The process will normally run on the standby unit so that take-over can be initiated and also on one other unit to monitor the status of the standby unit.</td>
</tr>
<tr>
<td>Matrix control</td>
<td>The standby unit runs a process which re-routes matrix signal inputs and outputs in the event of take-over. If one of the 1U Swift TX units fails, the appropriate Teletext subtitle inputs signals needs to be switched to the input of the standby unit. If the Master 2U Swift TX ASI combiner fails, the hot switch-over becomes more complex: both ASI outputs from Master &amp; Standby ASI combiners are routed through the matrix so the standby signal would be selected, in addition to re-routing the Teletext subtitle input.</td>
</tr>
</tbody>
</table>

Hardware

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<tbody>
<tr>
<td>Routing Matrix</td>
<td>Softel will recommend router matrix hardware that most suits each configuration. Most matrix hardware supports both ASI and serial digital video connections but the combination of ASI and analogue video inputs will require bespoke solutions.</td>
</tr>
</tbody>
</table>

How do you configure a subtitle file-based DVB subtitle system?

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<td>Timecode</td>
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<tr>
<td></td>
<td>Schedule client</td>
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</tr>
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</table>

In manual mode, the Swift TX may be used to load one or more subtitle file into a local playlist and control subtitle output using simple start, pause and stop commands. Once a subtitle event is started, the unit will output the subtitle that matches the timecode input. The subtitle files must be loaded to the unit hard disk before transmission (either by floppy input or by LAN file transfer). The Swift TX front panel LCD display and keypad is designed to allow the unit to be used in simple one-shot manual mode without the need for an external VGA monitor.

It is more likely, however, that the DVB subtitle units will be used in automatic mode in an on-air transmission suite where the units interface to the master programme playlist automation server. This interface allows the Swift TX unit to construct a local playlist of all programme events that are due to be subtitled and it responds to event ‘play’, ‘pause’ and ‘stop’ commands from the remote system. An operator alarm is raised if a one or more subtitle files for a subtitled programme is not found.

For more information on third party automation system playlist interfaces supported by Swift TX, please refer to the Technology Partners section on [www.softel.co.uk](http://www.softel.co.uk).
How does the file-based Swift TX configuration scale in a multi-channel environment?

The disk-based subtitle solution scales in the same way as the Teletext to DVB product. The difference is that both 1U and 2U devices are fitted with the Timecode hardware option in place of the VBI decoder and that the schedule client software is required on all units.

In a multi-channel file-based system, Softel recommend the use of a subtitle file store unit. This is a rack-mounted Windows PC with a hard disk drive large enough to accommodate storage for all the programme subtitle files used across the system. Prior to transmission, each Swift TX transfers a copy of the file(s) to local disk so that the service is not dependant on a single point of failure.

How do you protect a file-based transmission system against unit failure?

The same warm or hot standby unit options are available as for the Teletext to DVB transcoder units. The only difference is that, in the case of the hot-standby solution, provision has to be made through the matrix for routing the appropriate timecode and playlist connection to the hot-standby unit in the case of unit failure.

How does Swift TX support both Teletext transcoding and file-based DVB subtitling?

In some cases it is necessary for the DVB subtitle process to accept subtitles from various different sources depending on the actual TV programme or event. One example would be the case where commercials are subtitled using Teletext data present in the video input but programmes are subtitled using local subtitle files.

![Diagram of Swift TX configuration]

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<td>DiSP, Config Client, Schedule client</td>
<td>2U chassis, Timecode, VBI Decoder, ASI RW</td>
</tr>
</tbody>
</table>

The schedule client has to understand when to select Teletext input and when to select file-based output. This may optionally be controlled by the playlist interface, or one or other of the sources can be programmed to overrule the other when there is input conflict.