About Bitrates

Application note

Nomenclature

There is some confusion in the IT world about the prefixes "kilo" and "mega". For example, "kilo" used in combination with "Byte" mostly means a multiplication by a factor of 1024 (1 kByte = 1024 Bytes). In combination with "Hertz" however, the same prefix must likely mean a multiplication by a factor of 1000 (1 kHz = 1000 Hz). When someone talks about one kBit it might be either 1000 Bits or 1024 Bits – you cant be sure.

In this document "Hertz", "bits per second", "bytes per second" and similar units will be converted into each other and it is therefore important to have a consistent idea of what "kilo" and "mega" stand for on the following pages:

- "kilo" (or "k") stands for a multiplication by a factor of 1000.
- "mega" (or "M") stands for a multiplication by a factor of 1000000.

We will try to stay in the decimal system wherever possible. If necessary, the follwing prefixes will be used for the binary multiplicators:

- "kibi" (or "Ki") stands for a multiplication by a factor of 1024.
- "mebi" (or "Mi") stands for a multiplication by a factor of 1048576 (1024 × 1024).

Furthermore the following abbreviations are used:

- "b" for Bit
- "B" for Byte
- "ps" for per Second

Example: 1 Mbps = 1000000 Bits per Second

For more information see:
Europe: http://www.iec.ch/zone/si/si_bytes.htm
America: http://physics.nist.gov/cuu/Units/binary.html

About Transport Stream Packets

All data (video, audio, tables, ...) in any MPEG Transport Stream are encapsulated in Transport Stream Packets (TSPs). Each of those packets contains exactly 188 Bytes of data of which the first four bytes are header bytes. There may be more than those four header bytes, so it is not guaranteed that the remaining 184 Bytes are always available for payload. A video stream for example will probably contain a TSP with an extended header (called "adaption field").

When we talk about the "net datarate", we refer to the amount of those 188 Byte Packets that we can pass on in a given amount of time. So, a connection with the net datarate of 1 MByte per second can transport 5319.1 TSPs per second. The net datarate includes the overhead for all TSP headers. Consistently, datarates given by devices that output an MPEG Transport Stream also include that overhead. If an MPEG Encoder is set to output 5 MBits of video data per second it will actually produce a little less video data (about 2%) so that the net datarate of the outgoing Transport Stream is 5 MBits per second.

Depending on the physical layer, there may be some error correcting code data (ECC) attached to the TSP. DVB usually uses 16 Bytes of ECC so that a TSP with ECC data is 204 Bytes long. ATSC on the other hand uses 20 Bytes of ECC so that a TSP with ECC data is then 208 Bytes long.

The ECC data is not included in the net datarate. This means that a link that is physically capable of transporting one MBit per second can transport approximately 613 TSPs with DVB ECC (1000000 / (8 × 204) = 613). The net amount of data in those 613 TSPs is only 921952 Bits (613 × 8 × 188 = 921952). Consequently, a one Mbps link has a net datarate of about 0.922 Mbps when TSPs with DVB ECC are transmitted over it.

About Physical Media

The most common transport media for Transport Streams is probably the air where DVB-S, DVB-T, ATSC and their successors bring television to people all over the world, quickly followed by cable networks with DVB-C modulation.

For the interconnection of components at playout / headend sites, ASI and SPI have been specified. A variant of SPI is used as the standard interconnection for the DVB components sold by SR-Systems. Converters from and to ASI are of course available.

In addition to ASI and SPI, the transportation of Transport Streams over IP Networks (IPTV) is constantly gaining momentum. There are various methods to encapsulate TSPs in IP packets, but the most common one packs up to eight TSPs together with an RTP header into one UDP packet.

About SPI

If you are building DVB Systems with SR-Systems / maintech components, understanding SPI is crucial.

SPI is a parallel synchronous interface where 8 Bits are transmitted at each clock cycle. The clock can be driven by either the transmitter or the receiver and the physical data rate of the SPI connection is defined by the clock speed. A clock speed of 1 MHz gives a physical data rate of 1 MBps (1000000 Bytes per second) or 8 Mbps (8000000 Bits per second). When there is no data to send, the sender can unset the data valid signal after every TS packet until there is data available again.

TSPs can be transmitted over SPI as 188-Byte-Packets, as 204-Byte-Packets (with DVB ECC) or (in rare cases) as 208-Byte-Packets (with ATSC ECC). For most of our components the output is configurable to 188-Byte-Packets or 204-Byte-Packets.

Using 188-Byte-Packets (which is the right choice in most cases) makes datarate calculations easier as the net datarate is equivalent to the physical datarate which is again equivalent to the clock rate in Bytes per second (or eight times the clock rate in Bits per second).

The clock signal on the SPI cable must be driven by exactly one device; the device at the other end must be configured to receive the clock signal. As a rule of thumb one can say that the clock should go with the data which means that the device supplying the data also generates the clock while the device receiving the data also receives the external clock.

For encoders and tuner modules this is automatically handled by the modulators / multiplexers – you just need to select "Tuner" or "Encoder" for an input port and the clock stuff is automatically set up the right way.

The 34-Pin Transport Stream ports on SR-Systems / maintech components contain the SPI signals, additional control ports (I2C, UART, GPIOs) and a +5V power supply. Please read our "Cable Guide" for more information on how to choose the right cable type.

About ASI

ASI is a serial interface which physically transmits 270 Mbs (270000000 Bits per second) over 75 Ohm coaxial cable. It is found on most professional and high-end broadcast equipment. ASI uses a 8-in-10 code that transmits 10 Bits for every byte of data and can transport 188-Byte-Packets or 204-Byte-Packets. The net data rate with 188-Byte-Packets is 27 MBps or 216 Mbps. The net data rate with 204-Byte-Packets is 24.88 MBps or 199 Mbps. For almost all use cases, the ASI link capacity can be assumed as "high enough".

Converting between SPI and ASI

The SR-Systems ASI-Out module converts from SPI to ASI and can be configured to send either 188-Byte-Packets or 204-Byte-Packets on the ASI output. The SPI input accepts TSPs with or without ECC data. The ASI-Out board always expects an external SPI clock. So whenever you connect something to an ASI-Out module, make sure its output generates the clock signal. As data on the SPI Input will probably arrive slower than the ASI output speed (199 or 216 Mbps), the ASI-Out module will generate stuffing symbols (special bit-sequences that are ignored by the receiver – do not confuse with stuffing TS Packets) whenever there is no data to send.

The SR-Systems ASI-In module converts from ASI to SPI. It also accepts both 188-Byte-Packets and 204-Byte-Packets on the ASI Input. The clock signal for the SPI output is automatically recovered from the incoming data. So whenever you connect something to an ASI-In module, make sure to configure the input port to accept the external clock.

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We are happy to receive your comments and questions.

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