ERICSSON

Standards for Distributing Video over IP

Including SMPTE 2022

With the broadcast and IT industries edging ever closer, the potential benefits from migrating to an all-IP environment are of particular interest to broadcasters. Streamlined IP workflows, cheaper network equipment, lower support costs and scalable systems will help drive down operating costs while enabling the delivery of new services including 4K or 1080p UHDTV and HDR formats.

With momentum towards greater use of IP network technology growing in the broadcast environment, the work of the standards bodies is also gathering pace.

Among the most prominent groups are the VSF (Video Services Forum), the EBU (European Broadcasting Union), SMPTE and more recently the newly formed IP Alliance. All of these groups have been working to meet the emerging market needs for IP standards that encourage equipment vendors to develop interoperable solutions.

For some applications proprietary systems are available but the nature of the broadcast industry favours open standards that multiple equipment vendors endorse by way of supporting. The most prominent IP standard has been the SMPTE 2022 suite of standards that were first introduced in 2007 with the SMPTE 2022-1/2 standard. Since then the SMPTE 2022 standard, as the IP market has developed, has expanded to cover more types of IP video transport. Ericsson always supports open standards where open standards exist and has been an active supporter of the SMPTE 2022 standard since its inception.

1 SMPTE 2022-1/2

The first two sections of the standard cover IP protocols for compressed, constant bit-rate video signals in MPEG-2 transport streams, based on COP3 (Code of Practice) originally generated by the Pro MPEG Forum. These, mature, parts of the standard have since been renamed SMPTE 2022-1/2 and are used by broadcasters and service providers on IP networks all over the world.

1.1 The FEC (Forward Error Protection)

Scheme requires operators to select from a number of matrices that the IP packets must be arranged in. This is defined in terms of the number of rows the IP packets are aligned in and the number of columns the IP packets are arranged in. It helps if the user has some knowledge of network performance beforehand in terms of what the network performance is. For instance;
Are there IP packets being dropped? Are the dropped packets randomly dropped? Or are packets being lost in short bursts or long bursts?
Answers to these questions will determine the mode of operation to be used and hence the network efficiency.

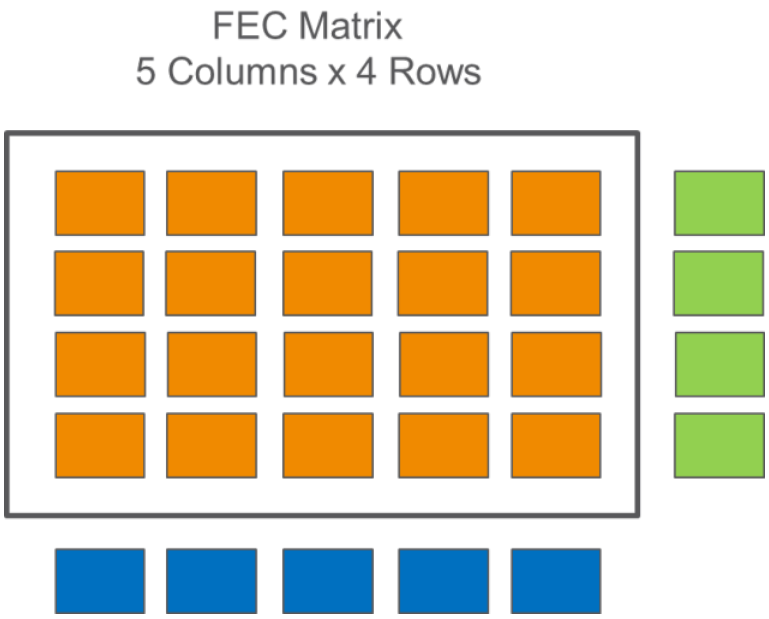

Figure 1: An FEC matrix

Figure 1 shows a number of IP packets arranged in a matrix of 5 columns and 4 rows of IP packets. The payload is shown as brown blocks with an additional row of FEC packets shown in blue and an additional column of FEC packets shown as green. This matrix would provide a reasonable level of protection against both random dropped packets and short bursts of dropped packets. However, to deliver that level of protection to 20 IP packets (5x4) a further 9 packets of FEC are required. A further consideration in using larger FEC matrices is that, particularly for contribution point top point links, latency will be increased as additional processing of the IP packets is required.

To increase network efficiency the user may select to use column only protection. Column only protection uses lower overheads but provides protection limited to random dropped IP packets. Users selecting column and row protection will gain a more robust protection against both random and bursts of dropped packet. Note Receivers may receive and decode content via an IP link where SMPTE 2022-1 FEC protection has been applied even if the Receiver does not support the standard but of course the received stream will not be protected against packet loss.

There are a number of Ericsson products that support this part of the standard including AVP 1000 1RU Network Adapter, AVP 2000 Contribution Encoder, AVP 3000 Voyager, TT6120 Stream Processor and the RX8200 Advanced Modular Receiver. For users of nCompass Connector there is a valuable option that links any events created through Connector to deliver real time data on jitter and dropped IP packets in addition to video thumbnails to help determine the level of robustness required to deliver a good quality of service required for video.

2 SMPTE 2022-3/4

SMPTE 2022-3 Relates to Unidirectional Transport of Variable Bit Rate MPEG-2 Transport Streams on IP Networks and defines IP packets for variable bit-rate MPEG-2 TS streams that are constrained to have a constant bit rate between PCR messages.
SMPTE 2022-4 Relates to Unidirectional Transport of Non-Piecewise Constant Variable Bit Rate MPEG-2 Streams on IP Networks and is similar to Part 3 but with the difference that it removes the constraint on bit rates.

These two parts of the standard support niche applications - and as such there has been limited availability of equipment that supports the standard. As few vendors support these two parts of the SMPTE 2022 standard on their equipment, they have not been included in any interoperability testing. Longer term with the industries focus turning to higher bit rate applications and virtual solutions there is unlikely to be any new developments in these areas.

3 SMPTE 2022-5/6

As technology matures and network capacities increase from 1 Gige interfaces to 10 GigE interfaces so new applications have arisen enabling broadcasters and service providers to distribute content at higher bit rates or in some case totally uncompressed. This opens the possibility of moving content end to end encapsulated as IP removing the need for expensive SDI routers and BNC cables replacing them with much lighter Ethernet cabling and basic IP switches and routers. This has resulted in the need for new sections of the SMPTE 2022 standard covering uncompressed SDI encapsulated in IP with FEC. T

The introduction of SMPTE 2022-5 Forward Error Correction for High Bit Rate Media Transport over IP Networks has its origins in 2022-1 expanding on Section 1 to allow larger row/column FEC combinations to support signals with bit rates up to 3 Gbps and beyond. SMPTE 2022-6 Relates to the Transport of High Bit Rate Media Signals over IP Networks (HBRMT)” and specifies a way to transport high bit-rate signals (including uncompressed 3 Gbps 1080p video) that are not encapsulated in MPEG-2 transport streams. The payload of SDI including video, embedded audio, and data components, are all encapsulated directly over IP. Whilst this does offer the advantages of an easy conversion to/from SDI but it also has the disadvantages that component extraction (e.g. audio) requires the SDI payload to be reconstructed, then the component to be de-embedded.

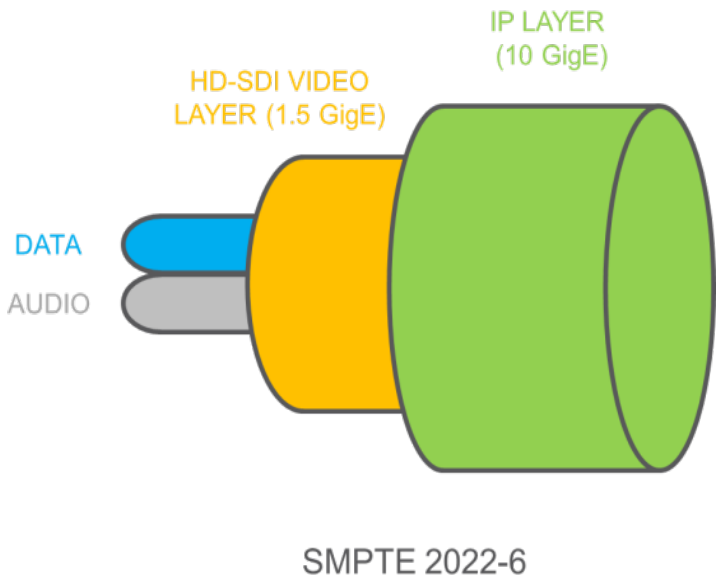

Figure 2: Composition of SMPTE 2022-6

This method also carries the overhead of SDI blanking which adds a considerable bandwidth penalty which can be between 15% and 40% depending on the frame rate and line standard. However SMPTE 2022-6 does offer a basic method of moving high bit rate content encapsulated in IP as a whole from one location to another.

The VSF (Video Service Forum) have staged a number of equipment tests that have successfully demonstrated equipment interoperability of SMPTE 2022-6 and the investigations into this part of the standard is continuing to evolve resulting in Technical Recommendation's TR-03 (VSF) and TR-04 (VSF). These two recommendations have been generated to address concerns raised during the SMPTE 2022-6 interoperability tests largely about how to handle the embedded elements such as audio.
Whilst SMPTE 2022-6 enables the carriage of uncompressed video, with embedded audio and data, in a 10 GigE pipe the range of applications will always limit this part of the standard. For point to point content delivery where there are no requirements to break out any of the individual elements such as audio for processing then this standard will be suitable. However it is likely that this limitation will make users look at the alternatives such as TR-03.

4 TR-03 (VSF)

To address some of the feedback from the VSF interoperability tests TR-03 has been generated. Technical recommendation TR-03 (VSF) incorporates video specified as RFC4175, audio specified as AES67 and IEEE PTP providing the timing. Data encapsulation is not yet defined but is being worked on by the IETF. Therefore all 4 components are encapsulated in IP separately.

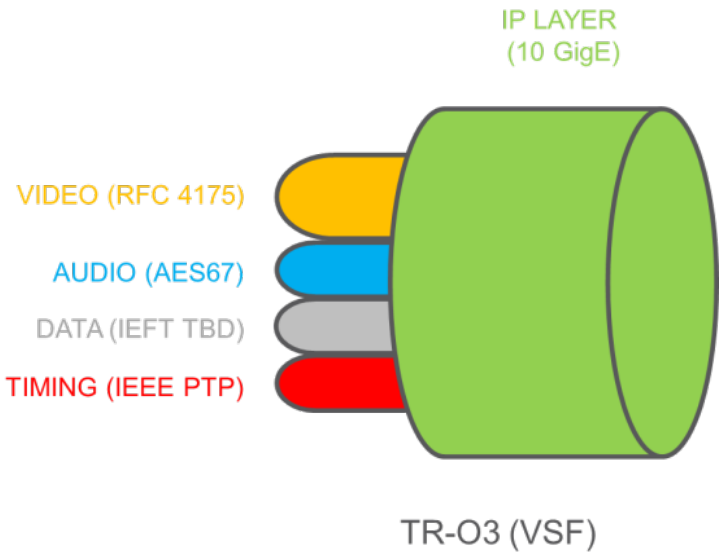

Figure 3: 2 Composition of TR-03 (VSF)

This has the advantage of more efficient bandwidth use, and easy extraction of audio and data components however it also has the disadvantage of a more difficult conversion to/from SDI. However this part of the standard will become increasingly important as broadcasters and service providers transition to an all IP network.
Ericsson recognise this recommendation offers significant improvements when compared to SMPTE 2022-6 and as the market develops is increasingly likely to be supported on equipment in many cases replacing SMPTE 2022-6.

5 TR-04 (VSF)

TR-04 (VSF) can cause some confusion due to being a mixture of pure SMPTE 2022-6 and TR-03 (VSF). It allows operators to use SMPTE2022-6 video, with separately encapsulated timing, audio and data components. So, it is effectively the same as TR-03 (VSF) with SMPTE2022-6 video instead of RFC4175.

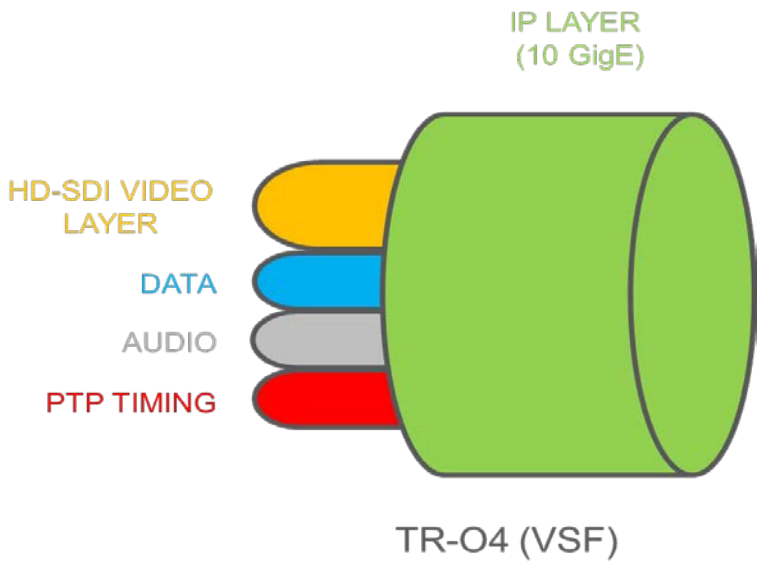

Figure 4: 2 Composition of TR-04 (VSF)

However TR-04 (VSF) does have the advantages of an easier audio and data component extraction (they are carried separately), and easier extraction of SDI (though audio and data need to be re-embedded). The main disadvantage is the carriage of the SDI blanking overhead can contribute between 15% and 40% overheads depending on frame rate and line standard.
With current interface speeds of 10 GigE used in SMPTE 2022-6, TR-03 and TR-04 then the delivery of uncompressed 4K UHDTV is not possible. At this moment in time there are a number of proprietary solutions that fill the current void but as demand for 4K UHDTV content delivery increases it is expected this will addressed through the SMPTE 2022 standards too. However this will depend on demand and timescales are yet to be determined.

6 SMPTE 2022-7

There are multiple levels of providing equipment and service level redundancy and the method deployed normally is dependent on the operators level of risk aversion. Traditional methods for providing service redundancy require a control and management platform with expensive SDI routers. As a device fails the control platform receives a critical alarm and configures the alternative device designated in the system controller. Whilst this switchover at the head end happens very quickly it does normally mean there is a delay in the Decoder at the far end receiving the service and this results in the receiver losing lock for a while disrupting service delivery. Worst case the video service can be lost for 20-30 seconds.

One of the biggest fears of an operator using fibre networks is a fibre cut where typically a builder, or similar, has dug though the fibre. Until recently there has been no protection against this happening and operators wanting to have service redundancy have been forced to use a satellite system as back-up. Naturally this is an expensive option and new alternatives have been sought resulting in the generation of SMPTE 2022-7 sometimes known as “Hitless Switching or Seamless Switching”. This standard defines a way to send two matching streams of packets typically from a source encoder to a destination device typically a receiver using diverse routes. At the receive end the receive device will decode the primary service (stream). However on detection of a fault the units will automatically, and seamlessly, switch to the secondary service (stream). This allows a perfect video signal to be reconstructed at the receiver as long as both paths do not fail simultaneously.

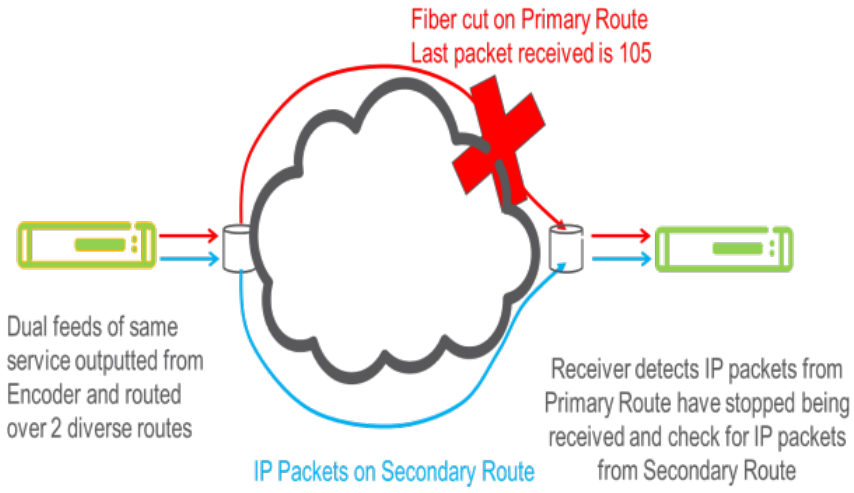

Figure 4: SMPTE 2022-7

Ericsson solutions that support SMPTE 2022-7 include the RX8200 Advanced Modular Receiver which will support the standard during the first half of 2016. As the broadcast industry starts gearing up to deliver new services to the consumer in UHDTV there is still work to be done in terms of end to end IP workflows and network infrastructure. The SMPTE suite of standards has been instrumental in providing the basis for an IP architecture to-date. However the work around TR-03 needs to be agreed and completed before it can replace the current proprietary solutions leading to a successful migration from traditional SDI architectures to new all IP architectures.