



3Gb/s SDI for Transport of 1080p50/60, 3D, UHDTV1 / 4k and Beyond

Part 1 - Standards

Your Host



- **Joel E. Welch**
Director of Professional
Development
SMPTE





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Today's Speaker



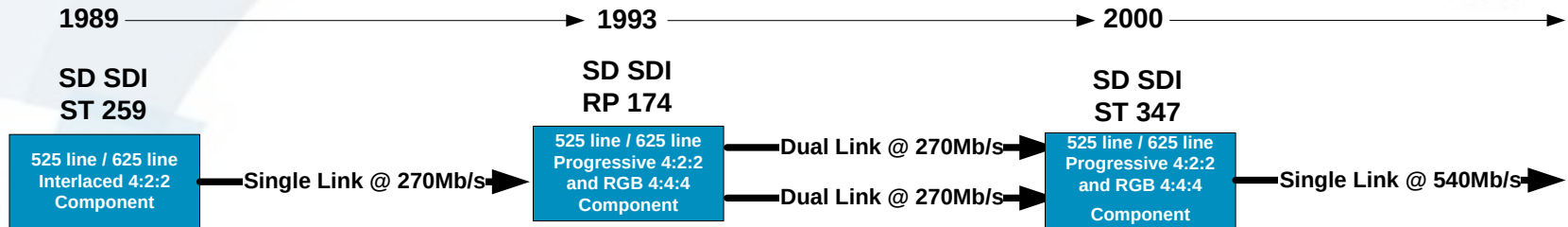
- **John Hudson**
Semtech Corp



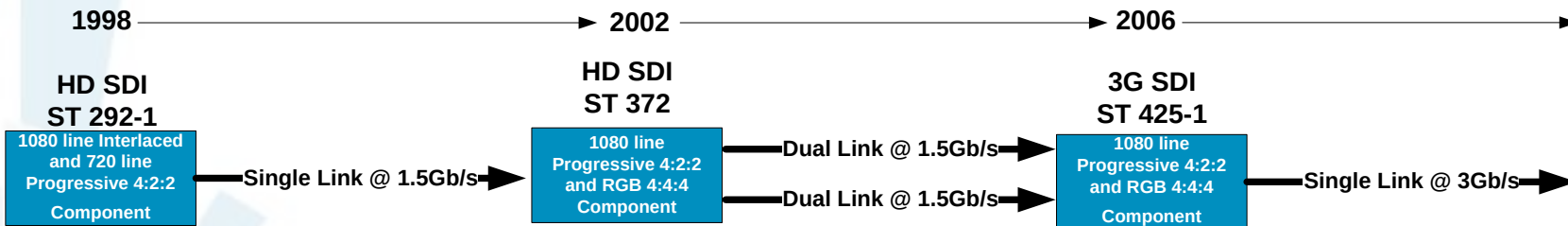
3G SDI Historical Context



SD-SDI Evolution Timeline



HD-SDI Evolution Timeline



Digital Transition (1992)



SD to HD (2001)



3G SDI (2006)

3Gb/s SDI Standards – Overview



3G SDI first standardized in 2005.....

ITU-R BT.1120

Restricted to 1920 x 1080p50 Y'C'BC'R 4:2:2 10-bit

SMPTE 3G SDI standards first published in 2006

SMPTE ST 425:2006

Video, audio and ancillary data mapping for the 3G interface

SMPTE ST 424:2006

Physical layer – 3G equivalent of ST 292-1 (1.5Gb/s SDI)

SMPTE ST 297:2006

Optical interface standard covering all SDI rates from 143Mb/s through to 3Gb/s

ST 425 - 3G SDI Mapping Standards



SMPTE ST 425 – the 3 mapping modes

Three different mapping modes are defined as:

Level A Direct Image Mapping

Level B-DL Dual Link mapping

Level B-DS Dual Stream mapping

Level A Is the direct mapping of an uncompressed images into a serial digital interface operating at a nominal rate of 3Gb/s

Level B-DL Is the mapping of ST 372 dual-link data streams into a serial digital interface operating at a nominal rate of 3Gb/s

Level B-DS Is the dual-stream mapping of two independent 1.5Gb/s video streams into a single serial digital interface operating at a nominal rate of 3Gb/s

3G SDI physical Interface



ST 424 3Gb/s SDI Signal/Data Serial Interface

This standard defines the 3Gb/s SDI physical interface

- 10-bit multiplex

- Serialization

- Scrambling

- Coding

- Electrical specifications (eye shape, jitter, return loss.....)

ST 297:2006 Serial Digital Fiber Transmission System

This standard defines an optical fiber system for transmitting bit-serial digital signals

It is intended for transmitting SMPTE ST 259 signals (143 through 360 Mb/s), SMPTE ST 344 signals (540Mb/s), SMPTE ST 292-1/-2 signals (1.485 Gb/s and 1.485/1.001 Gb/s) and SMPTE ST 424 signals (2.970 Gb/s and 2.970/1.001 Gb/s)

In addition to optical specification, ST 297 also mandates laser safety testing and that all optical interfaces are labelled to indicate safety compliance, application and interoperability

Part 2 and 3 of this PDA provides a detailed review of the 3G SDI physical interface

Formats, Payloads, Interfaces



System Nomenclature	Horizontal Pixels	Vertical Pixels	Frames per Second (nominal)	Total Payload (nominal)	
				10-bit 4:2:0 10-bit 4:2:2	12-bit 4:2:0 12-bit 4:2:2 12-bit 4:4:4 10-bit 4:4:4
4320p60 / 59.94	7680	4320	60	48Gbit/Sec	96Gbit/Sec
4320p50	7680	4320	50		
4320p30 / 29.97	7680	4320	30	24Gbit/Sec	48Gbit/Sec
4320p25	7680	4320	25		
4320p24 / 23.98	7680	4320	24		
2160p60 / 59.94	3840	2160	60	12Gbit/Sec	24Gbit/Sec
2160p50	3840	2160	50		
2160p30 / 29.97	3840 / 4096	2160	30	6Gbit/Sec	12Gbit/Sec
2160p25	3840 / 4096	2160	25		
2160p24 / 23.98	3840 / 4096	2160	24		
1080p60 / 59.94	1920 / 2048	1080	60	3Gbit/Sec	6Gbit/Sec
1080p50	1920 / 2048	1080	50		
1080i60 / 59.94	1920 / 2048	1080	30	1.5Gbit/Sec	3Gbit/Sec
1080i50	1920 / 2048	1080	25		
1080p30 / 29.97	1920 / 2048	1080	30		
1080p25	1920 / 2048	1080	25		
1080p24 / 23.98	1920 / 2048	1080	24		
720p60 / 59.94	1280	720	60		
720p50	1280	720	50		
720p30 / 29.97	1280	720	30		
720p25	1280	720	25		
720p24 / 23.98	1280	720	24		

UHDTV

Proposed

System Nomenclature	Horizontal Pixels	Vertical Pixels	Frames per Second (nominal)	Total Payload (nominal)	
				10-bit 4:2:0 10-bit 4:2:2	12-bit 4:2:0 12-bit 4:2:2 12-bit 4:4:4 10-bit 4:4:4
4320p120	7680	4320	120	96Gbit/Sec	192Gbit/Sec
2160p120	3840	2160	120	24Gbit/Sec	48Gbit/Sec

21DC
HFR SG

Under Consideration

System Nomenclature	Horizontal Pixels	Vertical Pixels	Frames per Second (nominal)	Total Payload (nominal)
				12-bit 4:4:4
2160p120	4096	2160	120	48Gbit/Sec
2160p100	4096	2160	100	
2160p96	4096	2160	96	
2160p60	4096	2160	60	24Gbit/Sec
2160p50	4096	2160	50	
2160p48	4096	2160	48	

The Bandwidth Disparity

3Gb/s SDI Standards – Continuing Evolution



SMPTE ST 424:2012

Updates to add provisions for use of other connector types

Typical cable loss recommendation changed from -20dB to <-30dB

SMPTE ST 425:2011

Revised to include Digital Cinema production formats and add 32 channel audio support

Split into multiple parts to accommodate future revisions for stereo and high resolution images

425-0 – Index

425-1 – Replaces current 425

425-2 – A Stereo Pair of 1.5Gb/s images – tie up with ST292-2

425-3 – Single Images with payload up to 6 Gb/s, carried on 2 links

425-4 – A Stereo pair of 3 Gb/s signals on 2 links

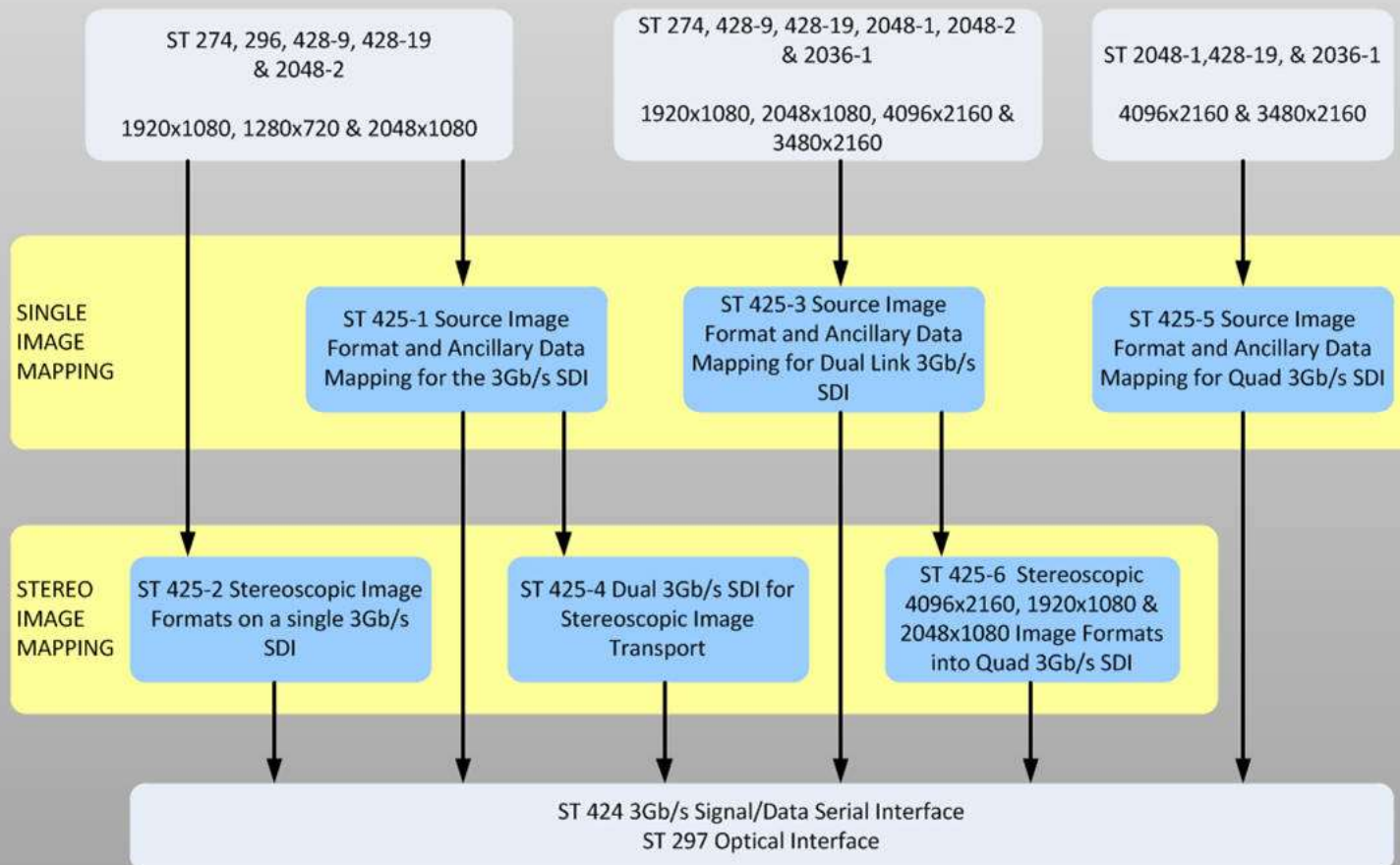
425-5 – Single Image with payload upto 12 Gb/s, carried on 4 links

425-6 – A Stereo Pair of 6Gb/s signals, transported via 4 links

The 3Gb/s SDI Standards suite



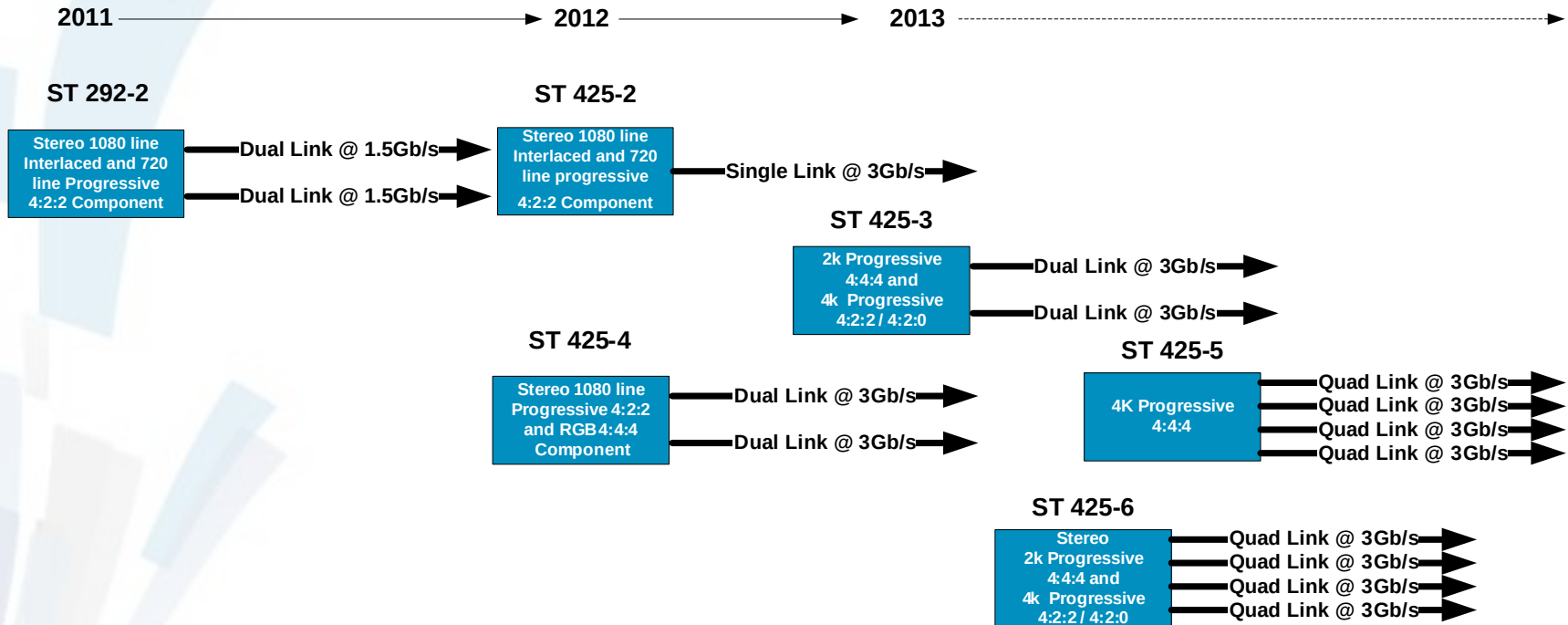
CURRENT STANDARDIZATION ACTIVITIES



Multi-link 3G SDI



Continued SDI Evolution Timeline



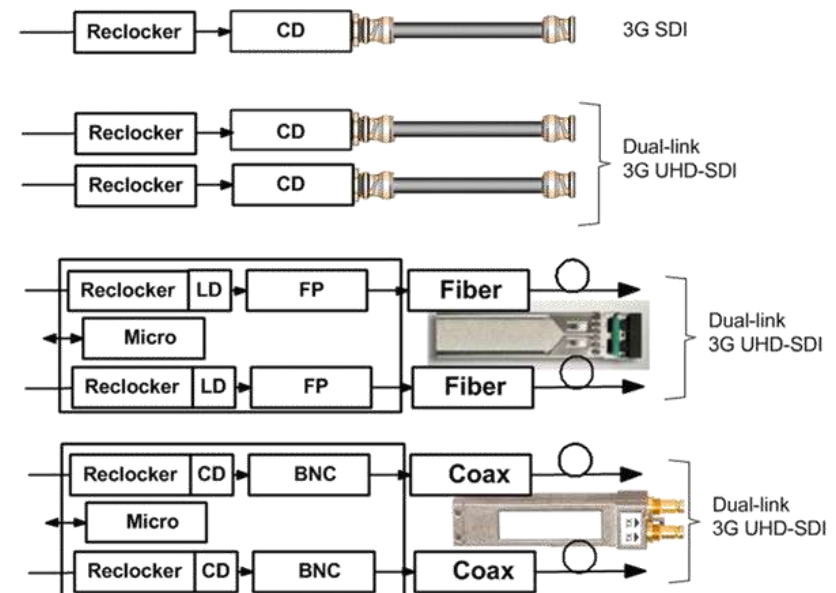
The 3G SDI Document suite



Extending the ST 425 document suite in support of HDTV and 2K D-Cinema production with higher resolution (bit depth and sampling)

High Dynamic Range (HDR) HDTV and 2K D-Cinema Production

System Nomenclature	Horizontal Pixels	Vertical Pixels	Frames per Second (nominal)	Total Payload (nominal)	
				10-bit 4:2:2	12-bit 4:2:2 12-bit 4:4:4 10-bit 4:4:4
1080p60 / 59.94	1920 / 2048	1080	60	ST 425-1 Single-link 3G	ST 425-3 Dual-link 3G
1080p50	1920 / 2048	1080	50	ST 372 Dual-link 1.5G	
1080i60 / 59.94	1920 / 2048	1080	30	ST 292-1 Single-link 1.5G	ST 425-1 Single-link 3G
1080i50	1920 / 2048	1080	25		ST 372 Dual-link 1.5G
1080p30 / 29.97	1920 / 2048	1080	30		
1080p25	1920 / 2048	1080	25		
1080p24 / 23.98	1920 / 2048	1080	24		
720p60 / 59.94	1280	720	60		ST 425-1 Single-link 3G
720p50	1280	720	50		
720p30 / 29.97	1280	720	30		
720p25	1280	720	25		
720p24 / 23.98	1280	720	24		



ST 424 3Gb/s Signal/Data serial Interface
ST 297 Optical Interface

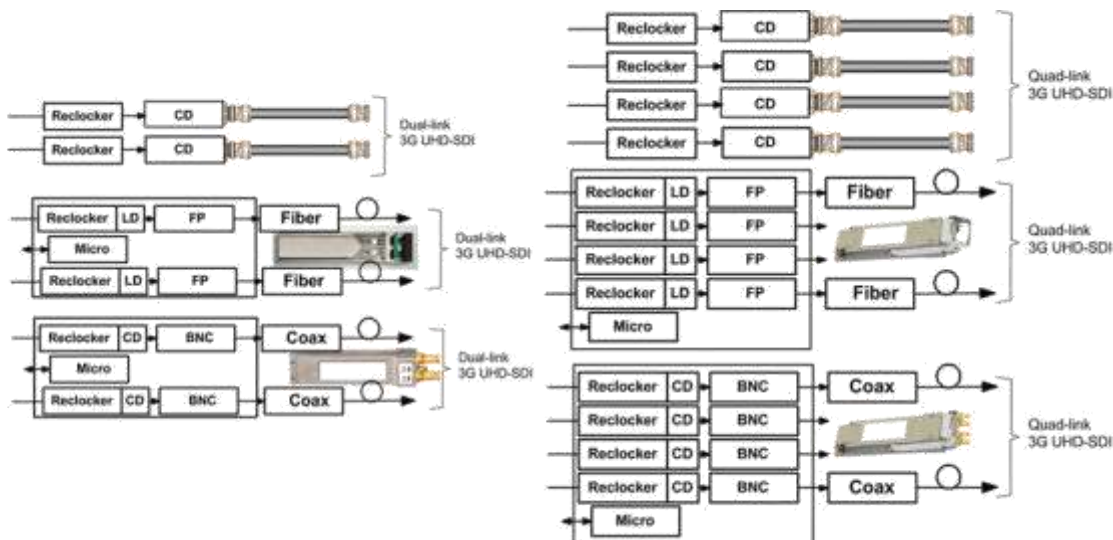
The 3G SDI Document suite



Extending the ST 425 document suite in support of HFR 2K D-Cinema production

Under Consideration: HFR 2K D-Cinema Production

System Nomenclature	Horizontal Pixels	Vertical Pixels	Frames per Second (nominal)	Total Payload (nominal)
				12-bit 4:4:4
1080p120	2048	1080	120	ST 425-5 Quad-link 3G
1080p100	2048	1080	100	
1080p96	2048	1080	96	
1080p48/47.95	2048	1080	48	6Gbit/Sec



ST 424 3Gb/s Signal/Data serial Interface
ST 297 Optical Interface

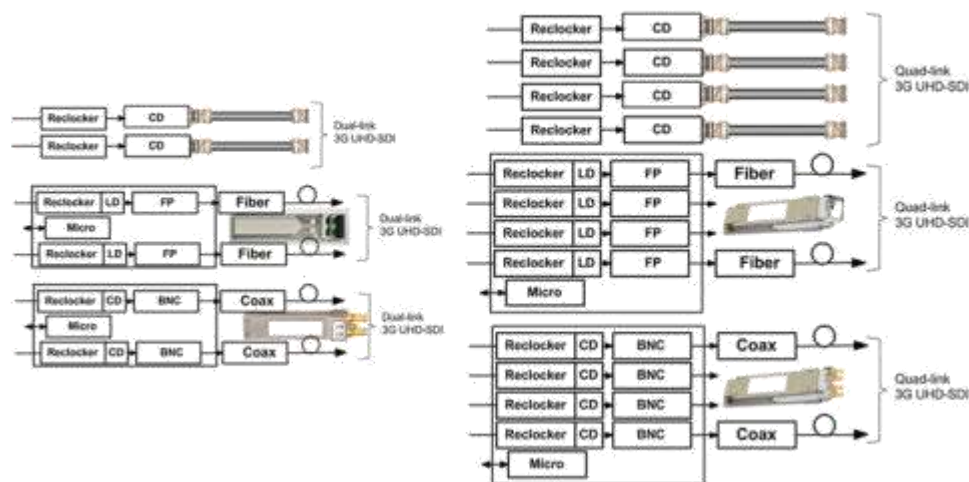
The 3G SDI Document suite



Extending the ST 425 document suite in support of Stereoscopic 3D HDTV and 2K D-Cinema production

3D HDTV and 2K D-Cinema Production

System Nomenclature	Horizontal Pixels	Vertical Pixels	Frames per Second (nominal)	Total Payload (nominal)	
				10-bit 4:2:2	12-bit 4:2:2 12-bit 4:4:4 10-bit 4:4:4:4
1080p60 / 59.94	1920 / 2048	1080	60	ST 425-4 Dual-link 3G	ST 425-6 Quad-link 3G
1080p50	1920 / 2048	1080	50		
1080i60 / 59.94	1920 / 2048	1080	30	ST 425-2 Single-link 3G ST 292-2 Dual-link 1.5G	ST 425-4 Dual-link 3G
1080i50	1920 / 2048	1080	25		
1080p30 / 29.97	1920 / 2048	1080	30		
1080p25	1920 / 2048	1080	25		
1080p24 / 23.98	1920 / 2048	1080	24		
720p60 / 59.94	1280	720	60		
720p50	1280	720	50		
720p30 / 29.97	1280	720	30		
720p25	1280	720	25		
720p24 / 23.98	1280	720	24		



ST 424 3Gb/s Signal/Data serial Interface
ST 297 Optical Interface

The 3G SDI Document suite

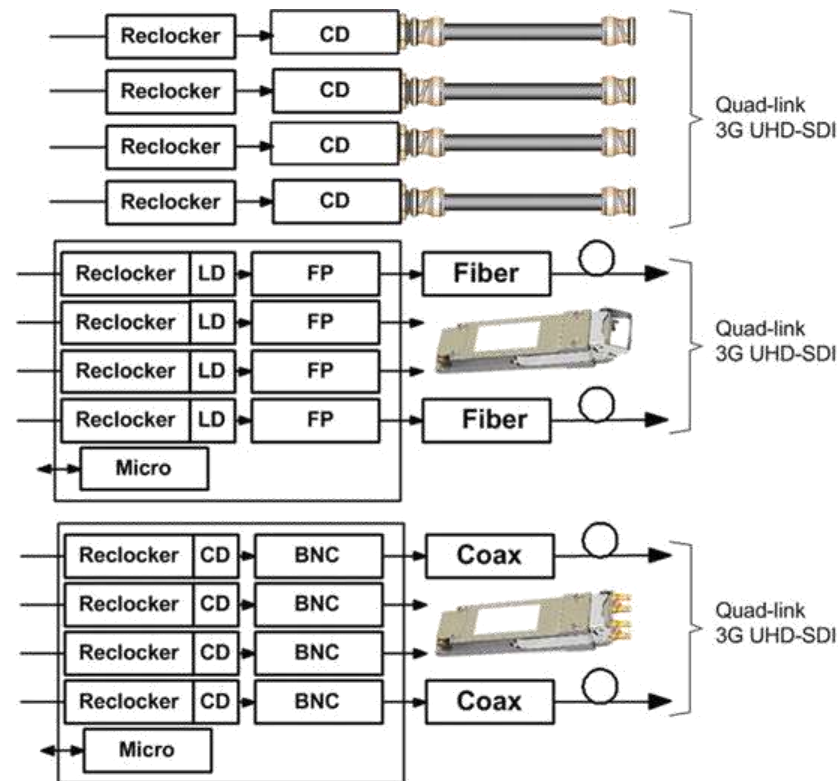


Extending the ST 425 document suite in support of Stereoscopic 3D HDTV and 3D HFR 2K D Cinema production

3D HFR 2K D-Cinema production

System Nomenclature	Horizontal Pixels	Vertical Pixels	Frames per Second (nominal)	Total Payload (nominal)	
				10-bit 4:2:2	12-bit 4:2:2 12-bit 4:4:4 10-bit 4:4:4:4
1080p120	2048	1080	120	ST 425-6 Quad-link 3G	
1080p100	2048	1080	100		
1080p96	2048	1080	96		
1080p48/47.95	2048	1080	48		ST 425-6 Quad-link 3G

Under Consideration linear frame rates (1/2 quoted fps per eye)



ST 424 3Gb/s Signal/Data serial Interface
ST 297 Optical Interface

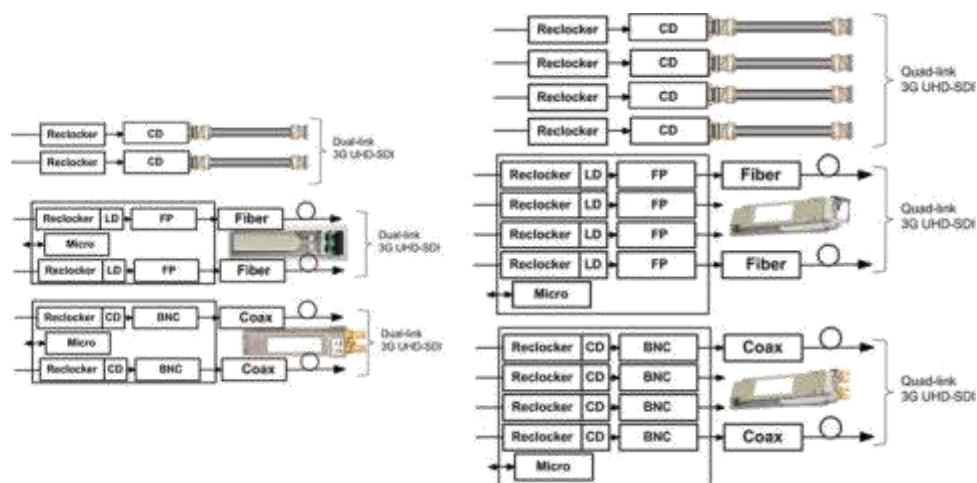
The 3G SDI Document suite



Extending the ST 425 document suite in support of 4K D-Cinema and UHDTV-1 production

4K D-Cinema and UHDTV-1 production

System Nomenclature	Horizontal Pixels	Vertical Pixels	Frames per Second (nominal)	Total Payload (nominal)	
				10-bit 4:2:0 10-bit 4:2:2	12-bit 4:2:0 12-bit 4:2:2 12-bit 4:4:4 10-bit 4:4:4
2160p60 / 59.94	3840 / 4096	2160	60	ST 425-5 Quad Link 3G	
2160p50	3840 / 4096	2160	50		
2160p50	4096	2160	48		
2160p30 / 29.97	3840 / 4096	2160	30	ST 425-3 Dual-link 3G	ST 425-5 Quad-link 3G
2160p25	3840 / 4096	2160	25		
2160p24 / 23.98	3840 / 4096	2160	24		



ST 424 3Gb/s Signal/Data serial Interface
ST 297 Optical Interface

3G SDI – Some things to Consider



General Issues for 1080p50/60

Both Level A and Level B-DL mapping modes have similar capabilities BUT they are not compatible

For 1080p50/60, conversion between Level A and Level B-DL introduces a delay of at least one video line on each conversion

Conversion of signals with embedded audio or other ancillary data may increase the delay and introduce additional complexity to correct the positioning or timing of some ancillary data packets

Some devices process signals internally using a different standard to their own input/output standard. It is always advisable to confirm these devices compensate for any conversion delay internally before installation

Users should establish capabilities of proposed purchases before designing new installations

Facility designers may wish to select one mapping format (Level A or Level B-DL) for each facilities routing / vision mixer signal “cloud”

3G SDI - Some things to Consider



Switching Regions

For Level A and Level B-DS, the serial stream switch point is defined in SMPTE RP 168:2009

For Level B-DS (carriage of two 1.5Gb/s streams on a single 3Gb/s link), there is no requirement for frame alignment of each image. If the two images are not frame aligned, video switching could be adversely effected

Users and facility designers should always ensure that Level B-DS equipment guarantees frame alignment.

ST 352 Payload ID

The use of the SMPTE ST 352 Payload ID is mandatory due to the large number of different video formats that can be carried in the 3 Gb/s interface

Without the payload ID, it is not possible to correctly identify all of the supported formats or mapping modes purely from inspection of the payload data

Users should ensure that any proposed new purchases support ST 352 payload ID before designing new installations

3G SDI – Some things to Consider



Embedded audio

Level A, Level B-DL and Level B-DS can all carry up to 32 audio channels but channel assignments and identification are different

Level A uses 8 separate audio groups (of 4 channels each) - in accordance with ST 299-1 AND ST 299-2 - all 32 channels are uniquely identified

Level B-DL uses two streams of 4 audio groups (of 4 channels each) - in accordance with ST 299-1 - identical channel numbers are used but channels 1~16 can only be differentiated from channels 17~32 at the ST 372 Dual-Link (Link A / Link B), level

Level B-DS is similar to Level B-DL carrying two links of 16 channels but there is no defined channel assignment for this mapping

End-users and facility designers should ensure that audio embedders / de-embedders correctly identify audio channel mapping in mixed Level A / Level B systems

Extra care should be taken in 3G system upgrades to ensure that these new audio embedding capabilities are handled transparently throughout the plant

Summary



In summary, the 3G SDI Document suite is continuing SMPTE's evolutionary approach to the development of the SDI interface

This approach allows broadcasters to extend their ROI (return On Investment), for capital purchases recently made as part of their 3G-SDI core infrastructure upgrade, while they transition to supporting emerging production image formats

Dual-link 3G-SDI and quad-link 3G-SDI provides a very pragmatic solution to solving the bandwidth disparity problem for (arguably), the most common 2D and 3D HDTV, 2K, 4K D-Cinema and UHD TV-1 production requirements

Beyond 3G SDI



Eventually, as stereoscopic 3D, 4K D-Cinema and UHD TV1 / UDHTV2 production moves from “application and infrastructure islands” to mainstream production requirements, a new core-infrastructure and real-time media streaming interface data rate and build out will be required

The evolution of the SDI interface continues in SMPTE with the formation of the 32NF70 Working Group on UHD-SDI....

But that's a topic for another time

Q & A



- **John Hudson**
Semtech Corp



Host:
Joel E. Welch