SONY

Latest Developments in IP for Live Production

Norbert Paquet

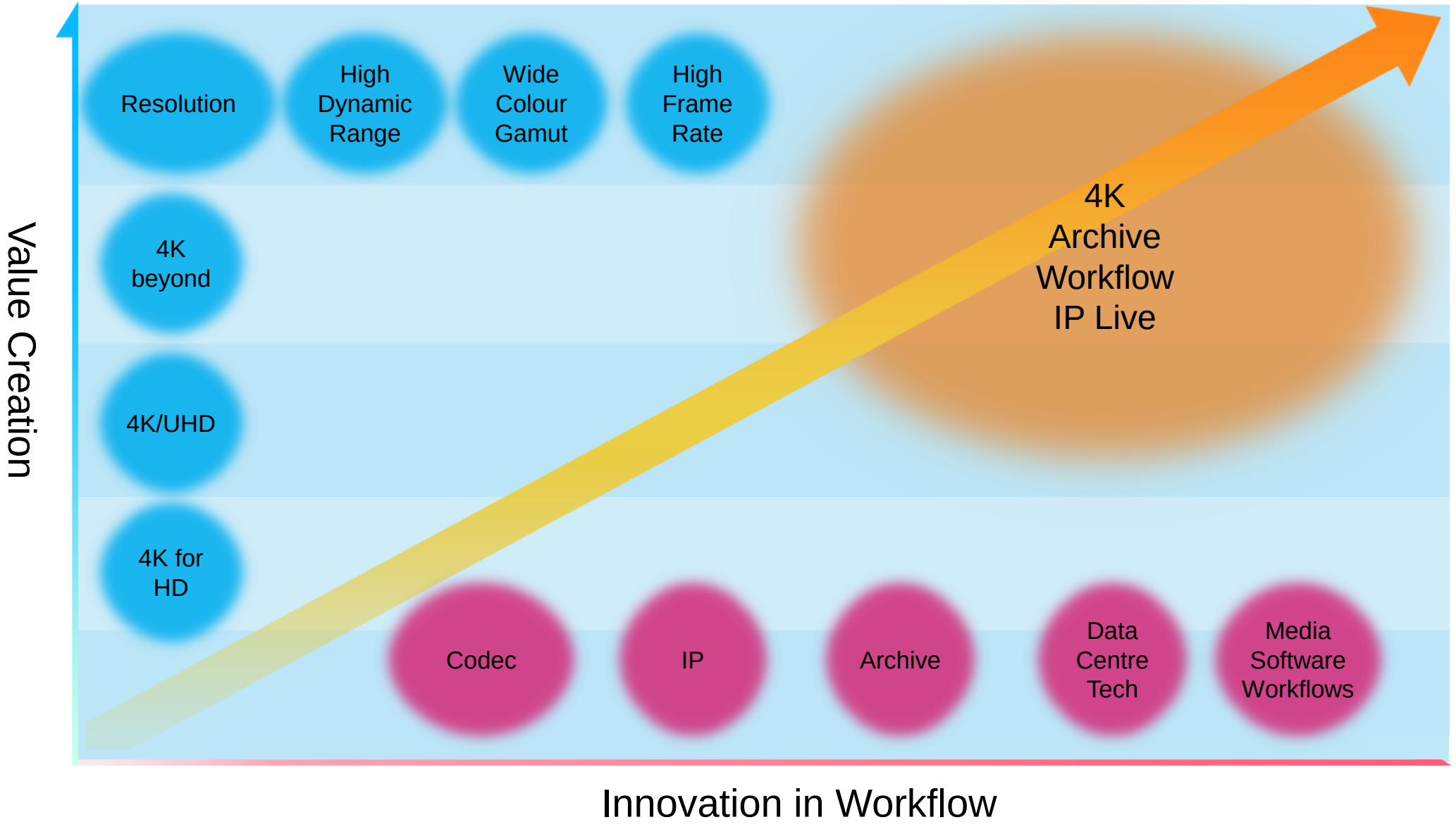
Strategic Marketing Manager

Sony Professional Solutions Europe

Challenges facing content creators / broadcasters

- Creating content that attracts viewers in an ultra-competitive market
- Protecting content of cultural importance
- Gaining viewer insight
- Monetising content
- Maximising **efficiency** through smart application of technology throughout the content production and delivery chain to **prioritise investment in content**
- Transition from CAPEX to OPEX models
- Skills and succession planning

Technology direction



4K/UHD Services are Reality

There's Excitement In Your Future.
SKY PerfecTV!

CANAL+

TRT

BT Sport

DIRECTV

kt skylife

amazon Prime instant video
Now streaming in Ultra HD

NETFLIX

ROGERS

pearl.tv 4K UHD

INSIGHT

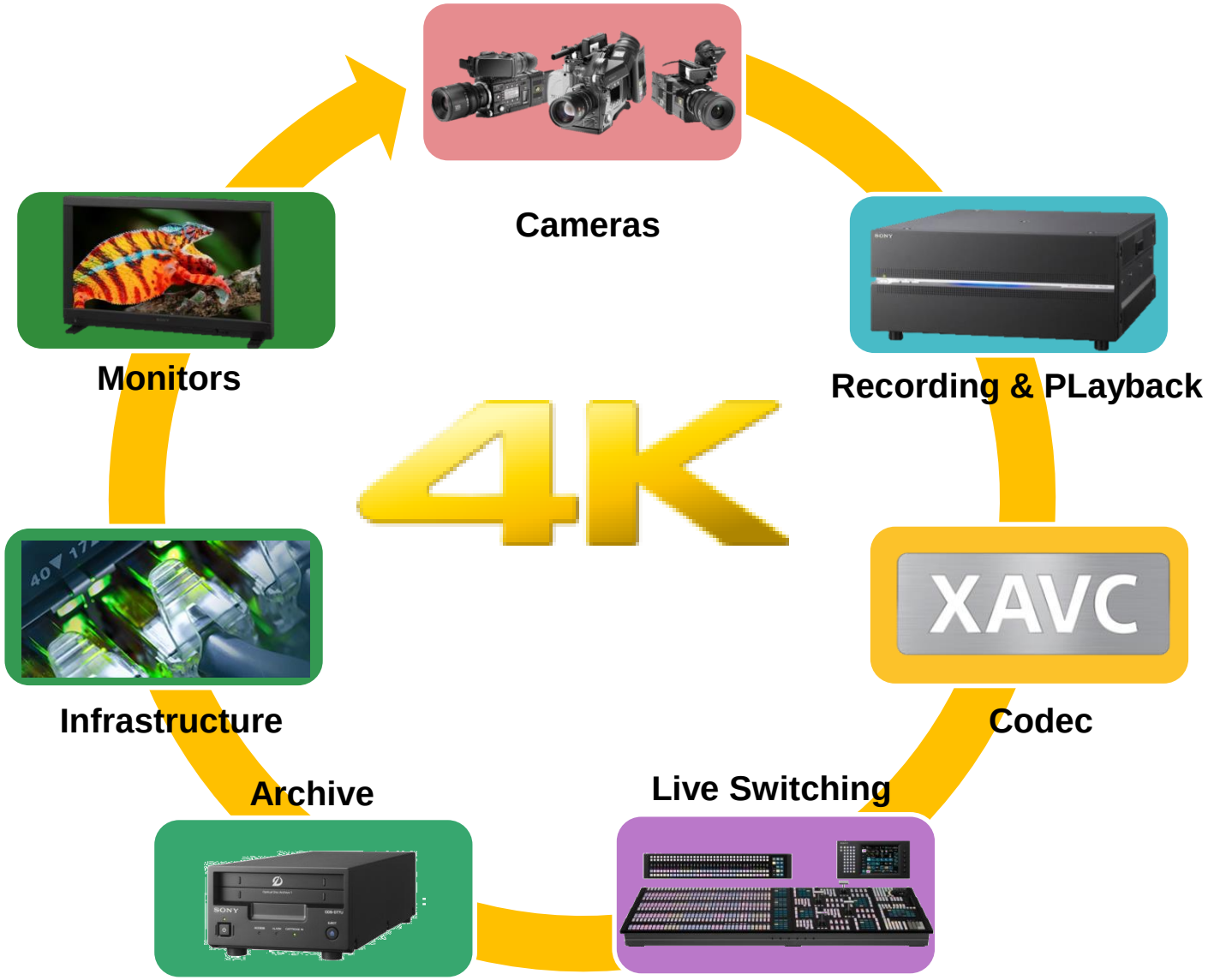
FASHION 4K

YouTube™

华数 wasu

FUN BOX ultra HD 4K

Sony Professional Solutions for 4K & HD Productions



SONY

The Infrastructure Challenge

IP for Live Production

(Supplementary information)

But WHY do we want to move to IP?

Use COTS Infrastructure

✓ Benefit from IT Industry power

Integrate file-based and live production system.

✓ Significant system efficiency gain.

Reduce investment risk

✓ Scalable systems

✓ Simple migration path to any future formats such as UHD or Frame Rate.

Virtual production system

✓ Share resources across the network

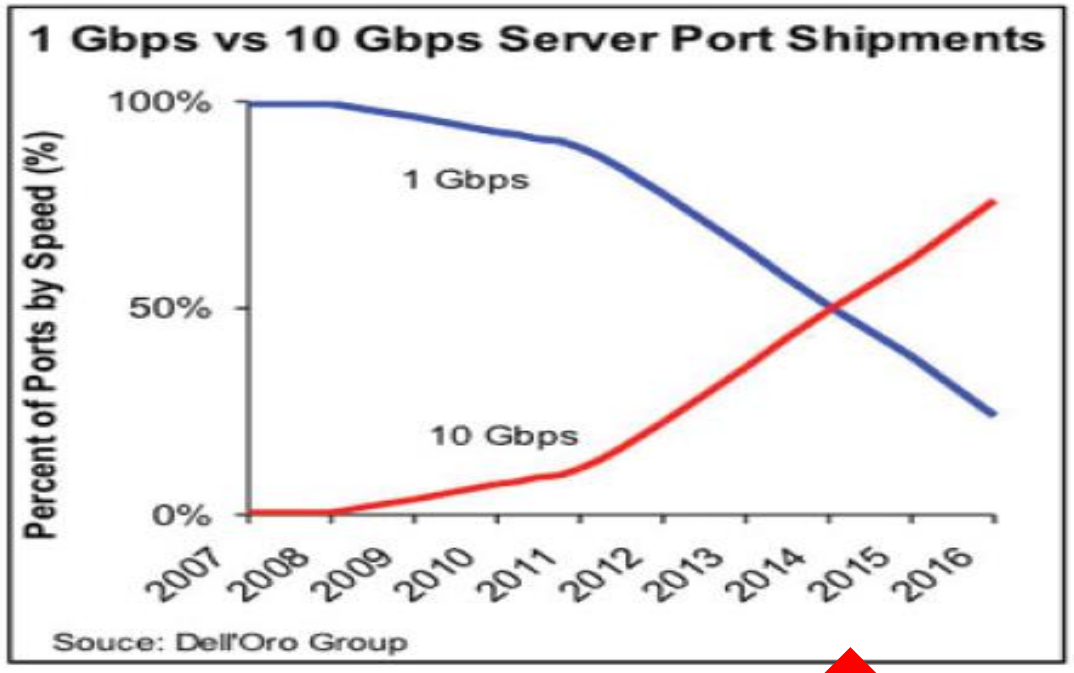
✓ Enable Remote Production

IT Industry Power

Use of Standard IT Technologies and Products

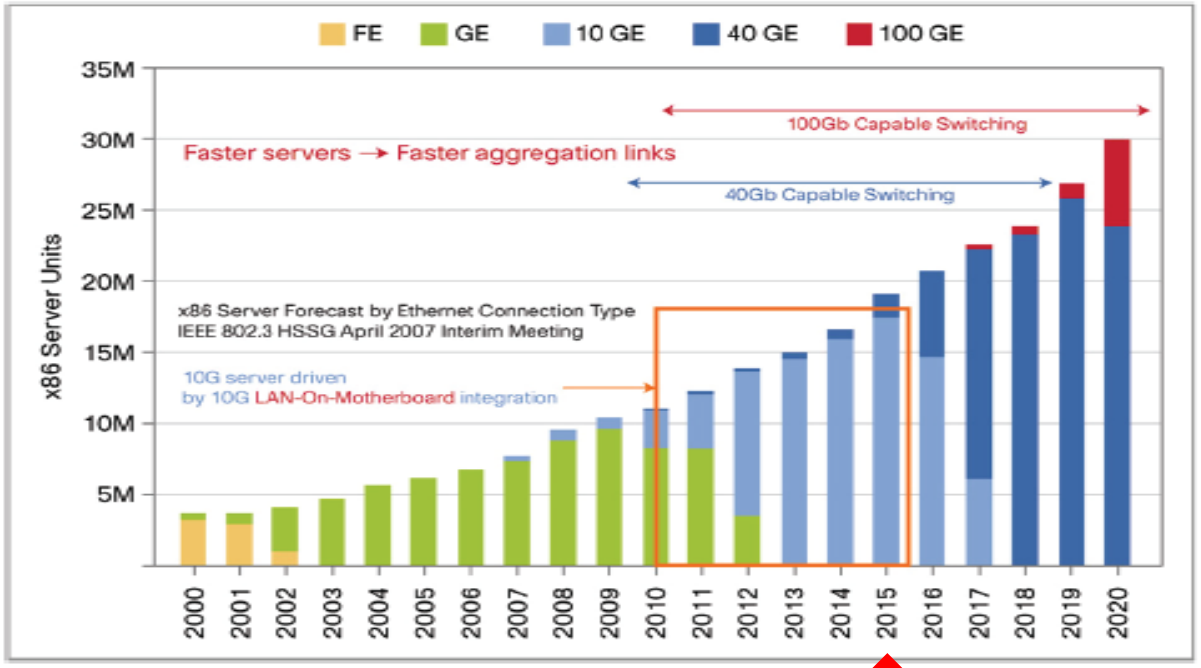
Take advantage of **COTS** (Commercial Off-The-Shelf) products at reasonable prices.

Able to improve system performance as **standard IT technologies** improve.



10Gbps Server Migration: The Post-Romley Era, "by Sameh Boujelbene, senior analyst, Dell'Oro Group, at Network World

We are here

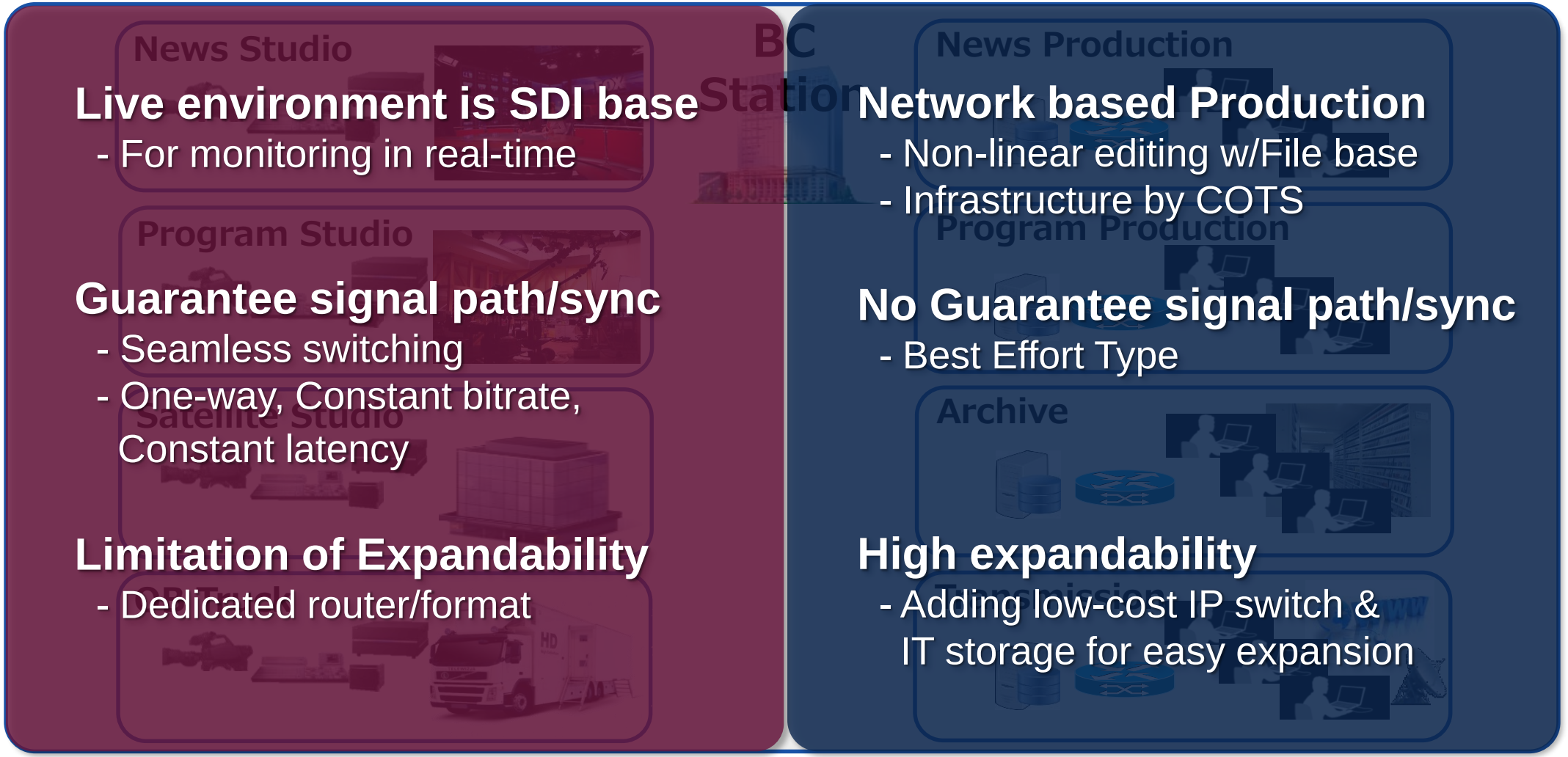


"The Market Need for 40 Gigabit Ethernet," by Gautam Chanda, 2012, Cisco Systems

We are here

Vision

Current BC infrastructure: Real-time & File-base



Live environment is SDI base
- For monitoring in real-time

Guarantee signal path/sync
- Seamless switching
- One-way, Constant bitrate, Constant latency

Limitation of Expandability
- Dedicated router/format

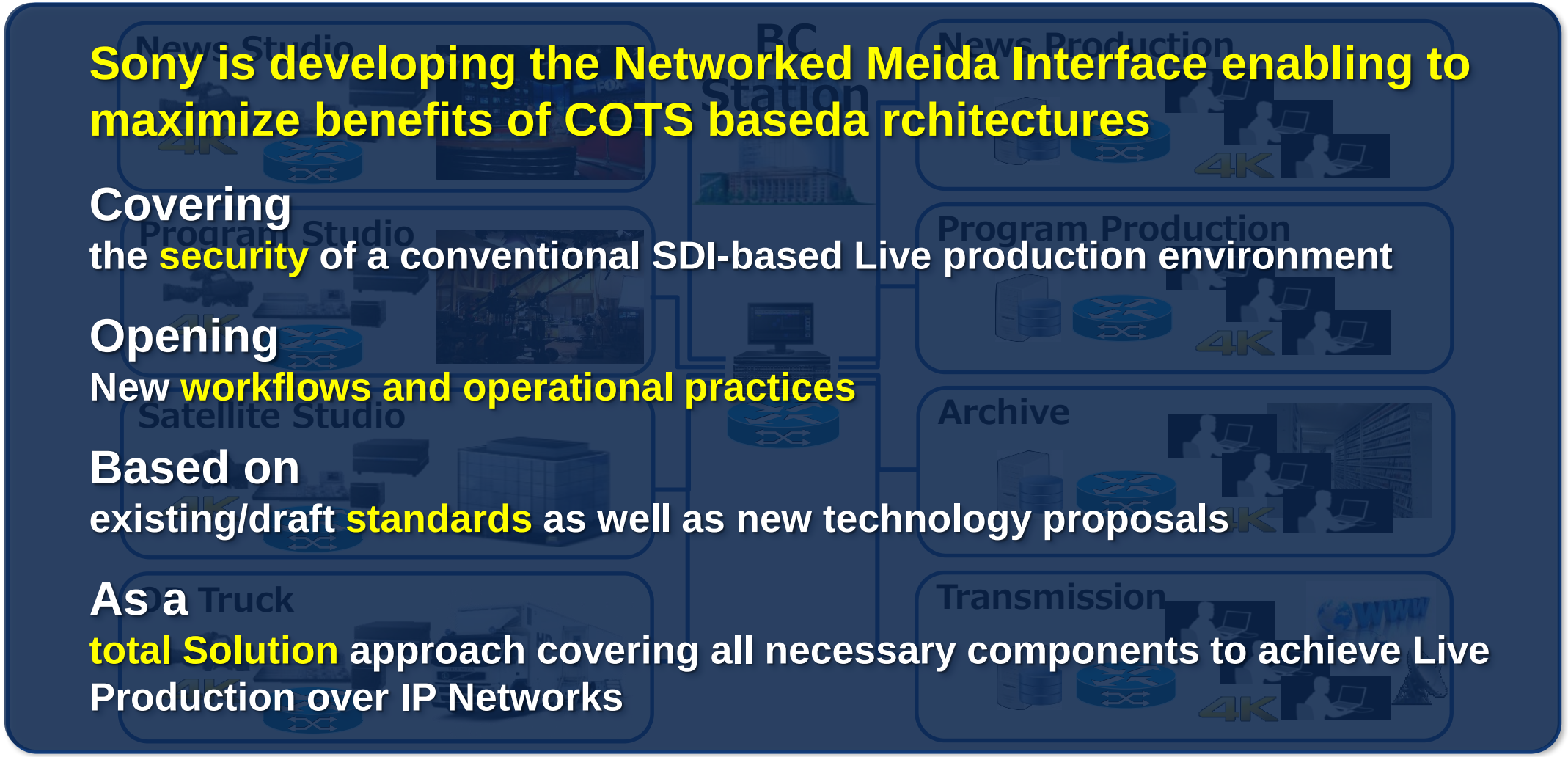
Network based Production
- Non-linear editing w/File base
- Infrastructure by COTS

No Guarantee signal path/sync
- Best Effort Type

High expandability
- Adding low-cost IP switch & IT storage for easy expansion

Vision

Unified architecture using COTS for IP Live Production



Sony is developing the Networked Meida Interface enabling to maximize benefits of COTS baseda rchitectures

Covering
the **security** of a conventional SDI-based Live production environment

Opening
New **workflows and operational practices**

Based on
existing/draft **standards** as well as new technology proposals

As a
total Solution approach covering all necessary components to achieve Live Production over IP Networks

SONY

Approach

(Supplementary information)

Approach: Joint-working with industry leading partners

Joint Taskforce on Networked Media

EBU SMPTE VSF VIDEO SERVICES FORUM

Core Technology Development

LSI & FPGA IP Core

Network Manager

3rd Party Alliance

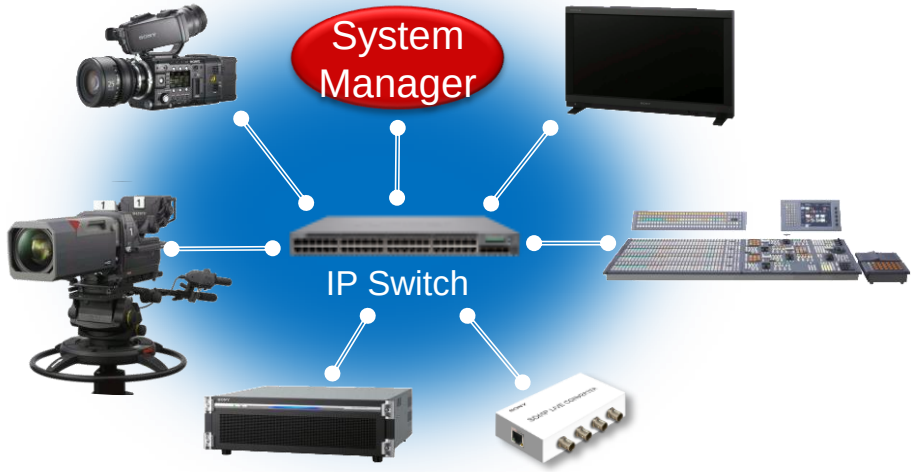
Converters/Routers

Graphics

Multi-viewer

Servers

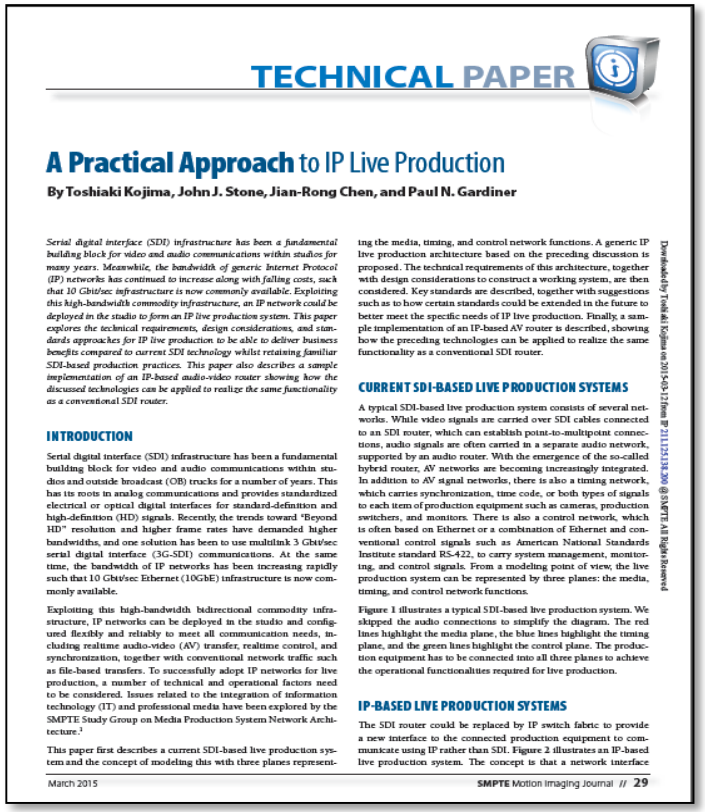
Adopting to all Sony products



Sony's Contribution to Standards

1. Practical Approach to IP Live Production (Production Format)

Essence-independent mapping, Frame boundary aware FEC, Industry Common interfaces



TECHNICAL PAPER

A Practical Approach to IP Live Production

By Toshiaki Kojima, John J. Stone, Jian-Rong Chen, and Paul N. Gardiner

Serial digital interface (SDI) infrastructure has been a fundamental building block for video and audio communications within studios for many years. Meanwhile, the bandwidth of generic Internet Protocol (IP) networks has continued to increase along with falling costs, such that 10 Gbit/sec infrastructure is now commonly available. Exploiting this high-bandwidth commodity infrastructure, an IP network could be deployed in the studio to form an IP live production system. This paper explores the technical requirements, design considerations, and standards approaches for IP live production to be able to deliver business benefits compared to current SDI technology whilst retaining familiar SDI-based production practices. This paper also describes a sample implementation of an IP-based audio-video router showing how the discussed technologies can be applied to realize the same functionality as a conventional SDI router.

INTRODUCTION

Serial digital interface (SDI) infrastructure has been a fundamental building block for video and audio communications within studios and outside broadcast (OB) trucks for a number of years. This has its roots in analog communications and provides standardized electrical or optical digital interfaces for standard-definition and high-definition (HD) signals. Recently, the trends toward "Beyond HD" resolution and higher frame rates have demanded higher bandwidths, and one solution has been to use multilink 3 Gbit/sec serial digital interface (3G-SDI) communications. At the same time, the bandwidth of IP networks has been increasing rapidly such that 10 Gbit/sec Ethernet (10GbE) infrastructure is now commonly available.

Exploiting this high-bandwidth bidirectional commodity infrastructure, IP networks can be deployed in the studio and configured flexibly and reliably to meet all communication needs, including realtime audio-video (AV) transfer, realtime control, and synchronization, together with conventional network traffic such as file-based transfers. To successfully adopt IP networks for live production, a number of technical and operational factors need to be considered. Issues related to the integration of information technology (IT) and professional media have been explored by the SMPTE Study Group on Media Production System Network Architecture.[1]

This paper first describes a current SDI-based live production system and the concept of modeling this with three planes representing the media, timing, and control network functions. A generic IP live production architecture based on the preceding discussion is proposed. The technical requirements of this architecture, together with design considerations to construct a working system, are then considered. Key standards are described, together with suggestions such as to how certain standards could be extended in the future to better meet the specific needs of IP live production. Finally, a sample implementation of an IP-based AV router is described, showing how the preceding technologies can be applied to realize the same functionality as a conventional SDI router.

CURRENT SDI-BASED LIVE PRODUCTION SYSTEMS

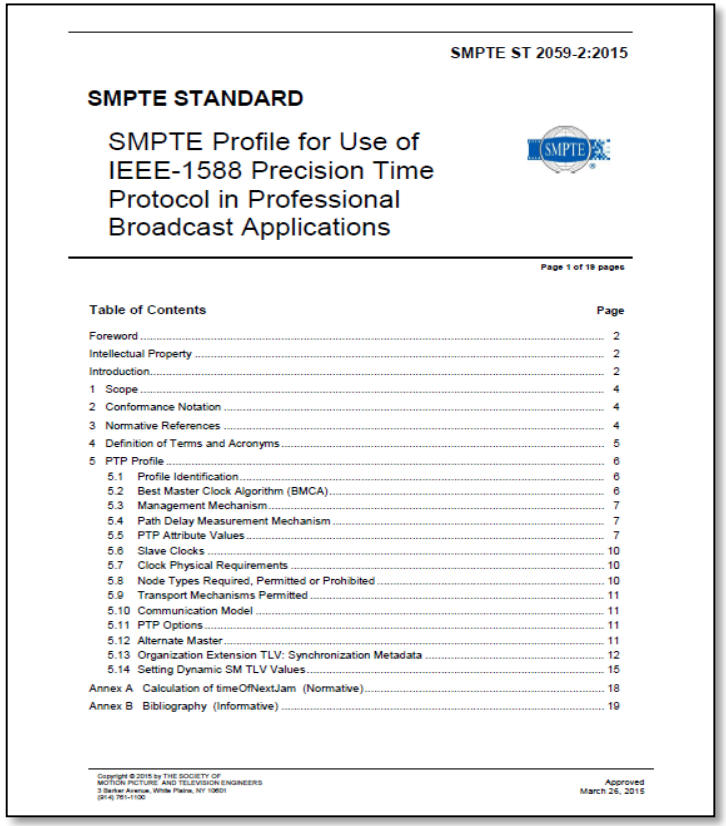
A typical SDI-based live production system consists of several networks. While video signals are carried over SDI cables connected to an SDI router, which can establish point-to-multipoint connections, audio signals are often carried in a separate audio network, supported by an audio router. With the emergence of the so-called hybrid router, AV networks are becoming increasingly integrated. In addition to AV signal networks, there is also a timing network, which carries synchronization, time code, or both types of signals to each item of production equipment such as cameras, production switchers, and monitors. There is also a control network, which is often based on Ethernet or a combination of Ethernet and conventional control signals such as American National Standards Institute standard RS-422, to carry system management, monitoring, and control signals. From a modeling point of view, the live production system can be represented by three planes: the media, timing, and control network functions.

Figure 1 illustrates a typical SDI-based live production system. We skipped the audio connections to simplify the diagram. The red lines highlight the media plane, the blue lines highlight the timing plane, and the green lines highlight the control plane. The production equipment has to be connected into all three planes to achieve the operational functionalities required for live production.

IP-BASED LIVE PRODUCTION SYSTEMS

The SDI router could be replaced by IP switch fabric to provide a new interface to the connected production equipment to communicate using IP rather than SDI. Figure 2 illustrates an IP-based live production system. The concept is that a network interface

2. Sony's PTP proposal released: ST2059-2.



SMPTE ST 2059-2:2015

SMPTE STANDARD

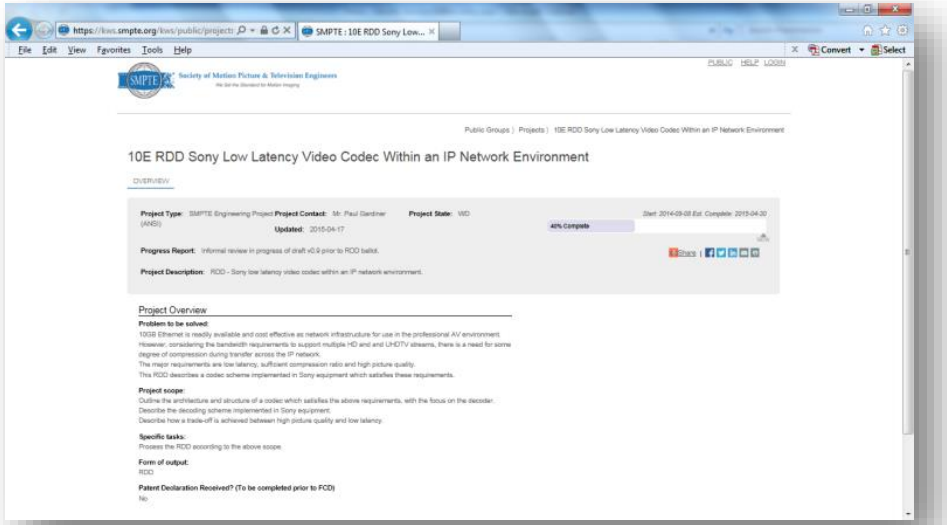
SMPTE Profile for Use of IEEE-1588 Precision Time Protocol in Professional Broadcast Applications

Page 1 of 19 pages

Table of Contents Page

Approved March 26, 2015

3. Sony's LLVC (Low-Latency Video Codec) is submitted to SMPTE as RDD (Registered Disclosure Document)



10E RDD Sony Low Latency Video Codec Within an IP Network Environment

Networked Media Interface & LLVC Supporters

The following 42 leading companies support Sony's initiative

SONY

Key Technologies & Standards

The Networked Media Interface – A full IP Live Production Solution

(Supplementary information)

The Networked Media Interface: A total Solution Approach

Video/Audio mapping

SMPTE ST 2022-6
Essence Independant Mapping (Sony)
ASPEN (Evertz)
Dante/AES67

Compression

SMPTE RDD34 LLVC

Synchronization

SMPTE ST 2059

High Availability

SMPTE 2022-7
Application (LSM) redundancy
PTP redundancy
Frame boundary awareness
FEC(Sony)

Security for Live production

TLS

Clean Video Switching

Destination timed switching

Device Management Workgroups

Managing production settings by device configuration list

Device Management Control

Networked Device Conttol Protocol(Sony)
SMPTE ST 2071 (Future)

Device Management Device Discovery

Refers to SIP (Session Initiation Protocol) architecture

Network Management Switch Configuration

VLAN
NETCONF (SDN)
System Design Tool

Network Management Bandwidth Reservation

DiffServ RFC 2474

API & Plug-in SDK

Control API for 3rd party application
Flexible to add new device to be controlled.

Networked Media Interface

+

IP Live System Manager

+

COTS IP Switch Fabric

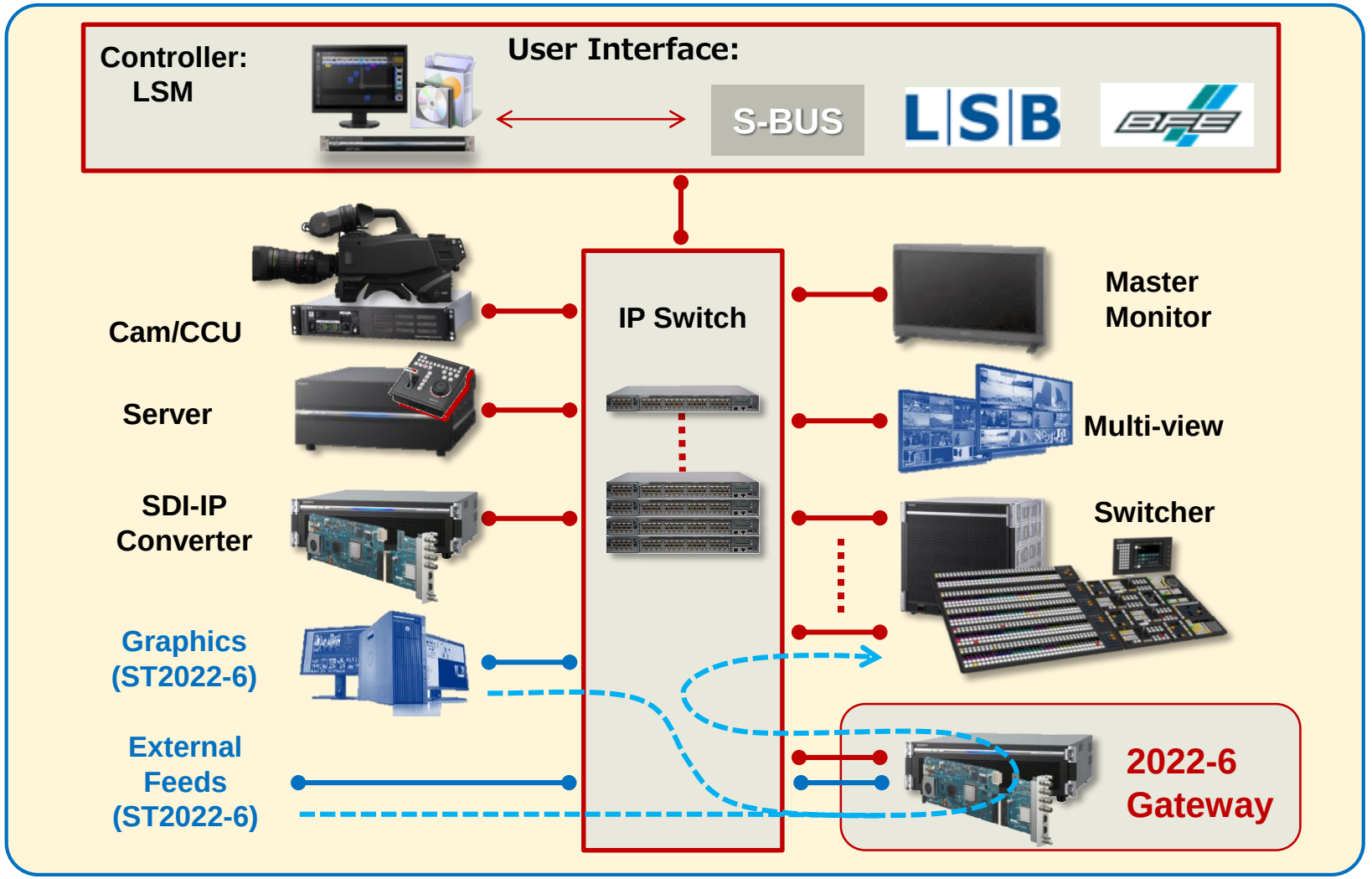
Audio & Video Mapping – SMPTE ST2022-x

- SMPTE 2022-1 “Forward Error Correction for Real-Time Video/Audio Transport Over IP Networks” (for compressed TS)
- SMPTE 2022-2 “Unidirectional Transport of Constant Bit Rate MPEG-2 Transport Streams on IP Networks”

SMPTE 2022 is originally developped as a **contribution** standard
Only for SD & HD – **No 4K** Support
No Synchronization method
No compression can be used to optimize bandwidth

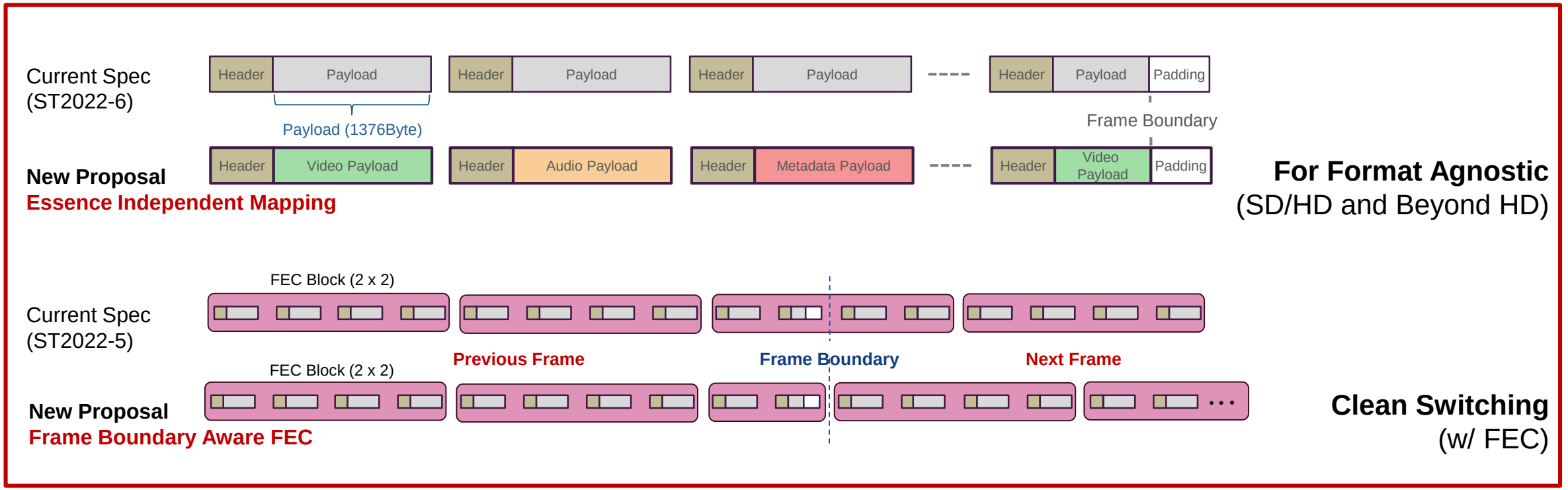
- SMPTE 2022-5 “Forward Error Correction for High Bit Rate Media Transport over IP Networks” (uncompressed only)
- SMPTE 2022-6 “High Bit Rate Media Transport over IP Networks”
- SMPTE 2022-7 “Seamless Protection Switching of SMPTE ST 2022 IP Datagrams”

Audio & Video Mapping – ST2022-6 & ASPEN Support



Audio & Video Mapping – Proposal to SMPTE

Proposed New Standard based on Sony's Networked Media Interface through VSF, SMPTE



Audio & Video Mapping – AES67 & Dante Support

High-performance streaming audio-over-IP interoperability

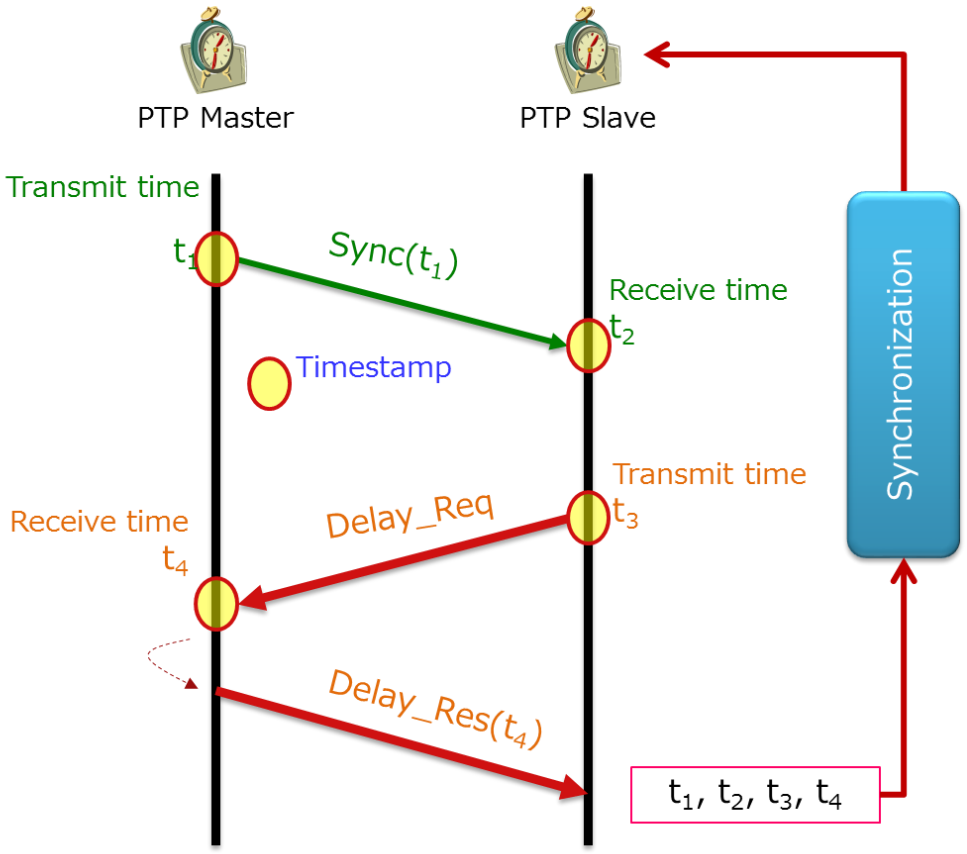
AES67

Audinate

Dante™

Synchronization – SMPTE ST2059-2

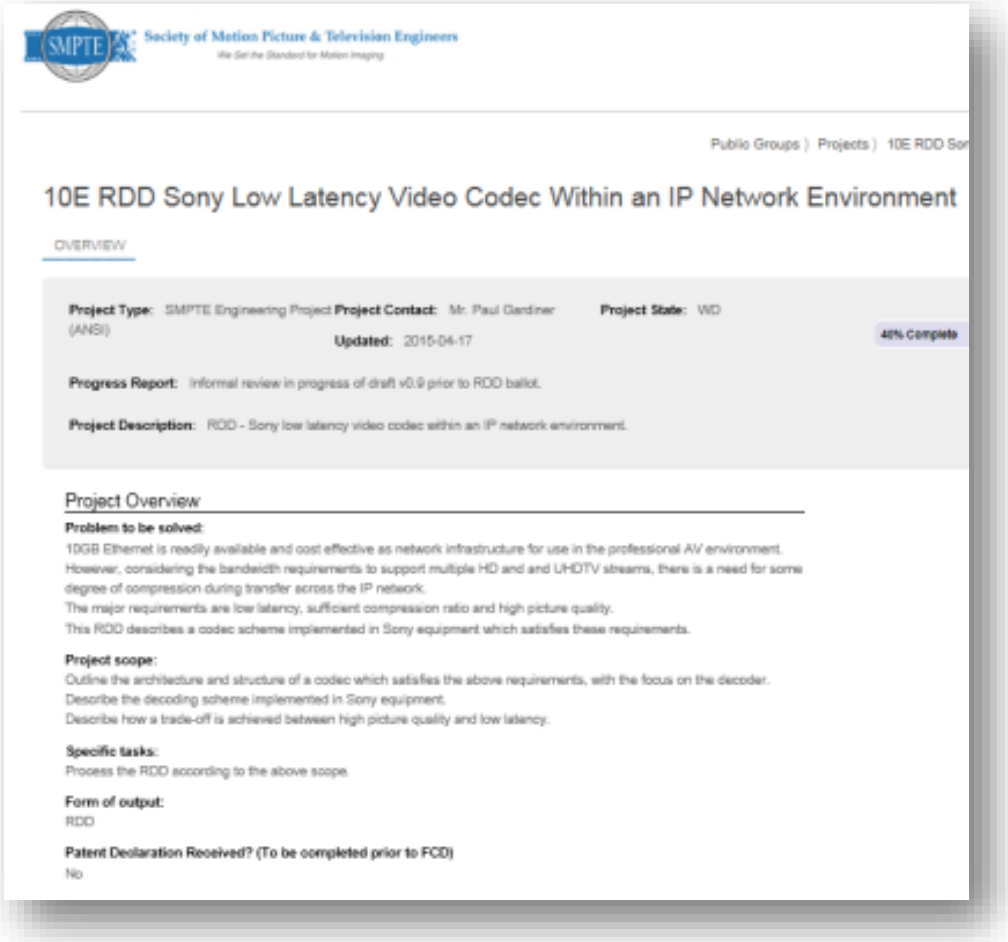
- «Precision Time Protocol SMPTE profile for time and frequency synchronization » **ST2059-2** based on IEEE1588 PTP
- All devices on the network can be synchronized by PTP (Precision Time Protocol)
- Sufficient accuracy using **any COTS network switches**
- In sub micro sec accuracy over network environment



Example of PTP Process

Compression - LLVC

- Wavelet based video codec
- Ultra-low-latency (16 lines delay for encode or decode)
- From HD to UHD & Beyond
- Open to SMPTE as RDD
- **42 Alliance Partners**



Society of Motion Picture & Television Engineers

Public Groups ⟩ Projects ⟩ 10E RDD Sor

10E RDD Sony Low Latency Video Codec Within an IP Network Environment

OVERVIEW

Project Type: SMPTE Engineering Project (ANSI) **Project Contact:** Mr. Paul Gardiner **Project State:** WD

Updated: 2015-04-17

40% Complete

Progress Report: Informal review in progress of draft v0.9 prior to RDD ballot.

Project Description: RDD - Sony low latency video codec within an IP network environment.

Project Overview

Problem to be solved:
10GB Ethernet is readily available and cost effective as network infrastructure for use in the professional AV environment.
However, considering the bandwidth requirements to support multiple HD and and UHDTV streams, there is a need for some degree of compression during transfer across the IP network.
The major requirements are low latency, sufficient compression ratio and high picture quality.
This RDD describes a codec scheme implemented in Sony equipment which satisfies these requirements.

Project scope:
Outline the architecture and structure of a codec which satisfies the above requirements, with the focus on the decoder.
Describe the decoding scheme implemented in Sony equipment.
Describe how a trade-off is achieved between high picture quality and low latency.

Specific tasks:
Process the RDD according to the above scope.

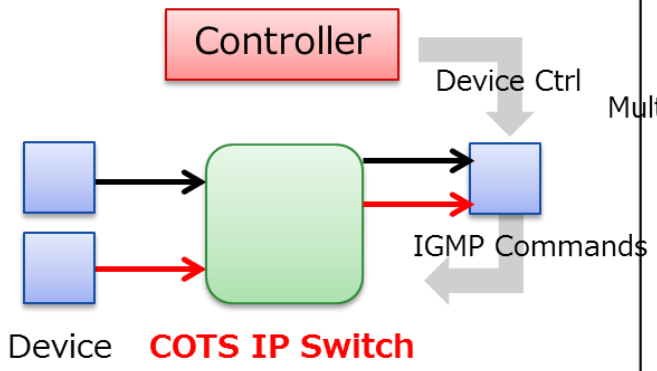
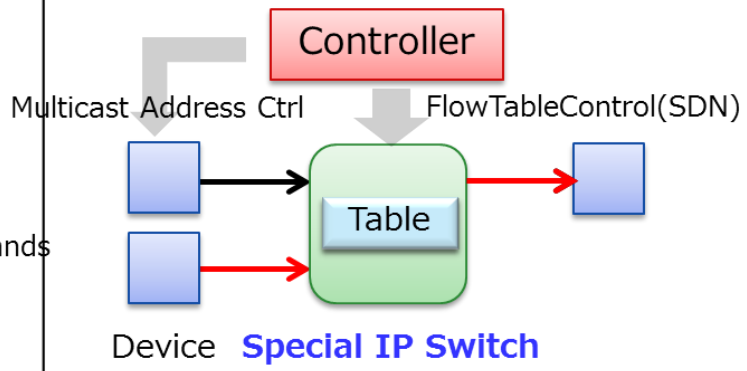
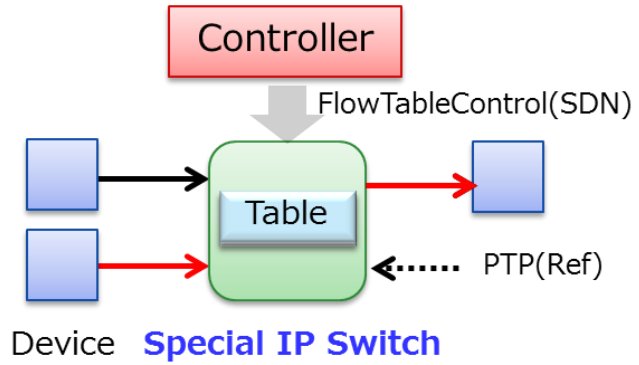
Form of output:
RDD

Patent Declaration Received? (To be completed prior to FCD)
No

Compression - LLVC

Resolution	Frame Rate	Link	Compression	YUV	bandwidth[Mbps]
HD (1280x720)	59.94p	1.5G	LLVC 2K	422	230
HD (1280x720)	59.94p	1.5G	-	422	1900
HD (1920x1080)	50i, 59.94i	1.5G	LLVC 2K	422	230
HD (1920x1080)	50i, 59.94i	1.5G	-	422	1900
HD (1920x1080)	50p, 59.94p	3G	LLVC 2K	422	410
HD (1920x1080)	50p, 59.94p	3G	-	422	3200
QFHD (3840x2160)	50p, 59.94p	3G Quad	LLVC 4K	422	4200

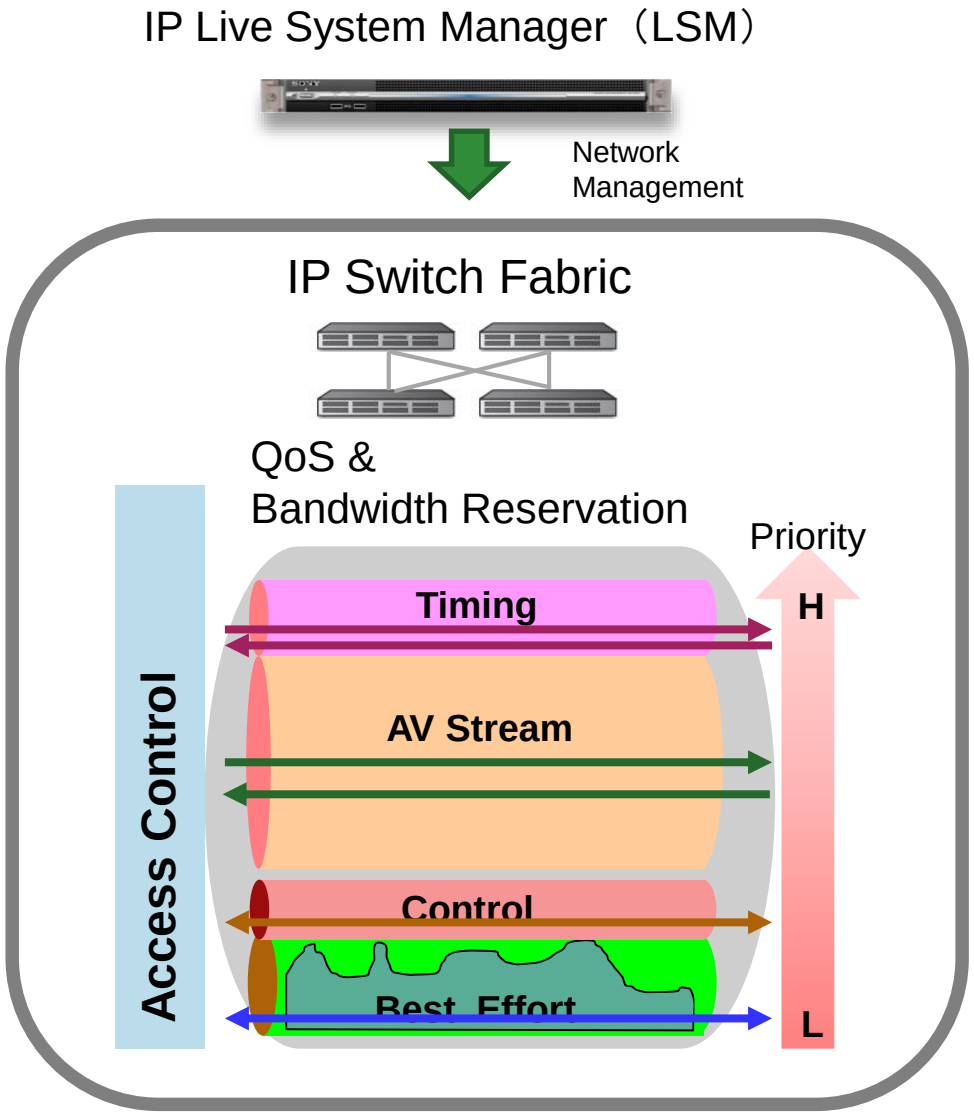
Clean Video Switching – Destination Timed Switching

Destination Timed Switch	Source Timed Switch	Switch (Timed) Switch
		
・Clean Sw Control at Rx device ・Double bandwidth is required at destination in overlap period ・**COTS IP Switch can be used**	・Clean Sw Control at Tx device ・No double bandwidth penalty ・Very accurate sync control is required for Tx device ・System scalability issue **(Under Development)**	・Clean Sw Control at IP Switch ・No double bandwidth penalty ・Special IP Switch is required **(Under Development)** ・**Clean switching is not adopted due to time reservation switch**

Network Management

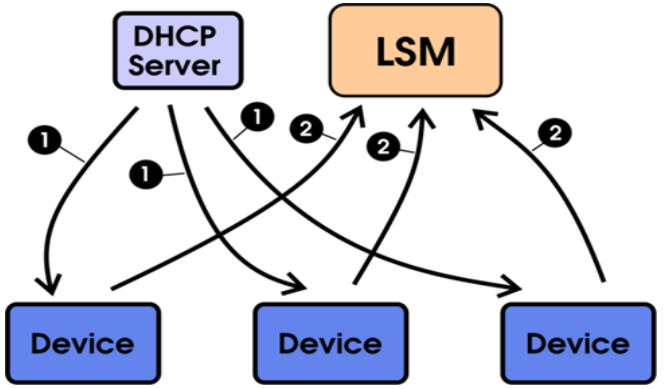
- Network Management Service integrated in the IP Live System Manager (LSM) :
  - **QoS** guarantee for AV and control traffic
  - **IP switch configuration**
  - **Bandwidth Reservation**

- QoS Policy on IP network (Configuration of IP Switches with LSM):
  - Priority based Control
  - Access Control

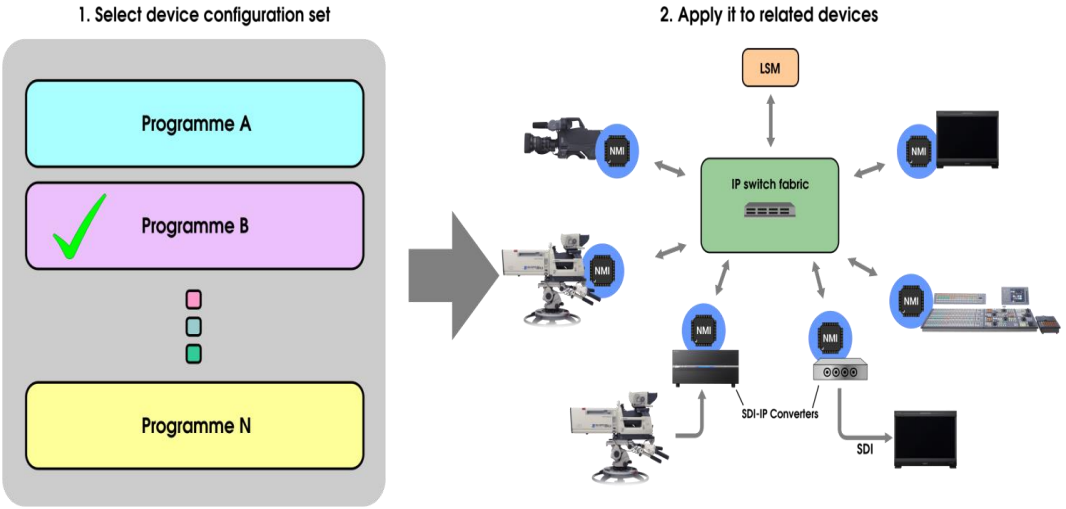


Devices Management

- **Plug & Play**
  - Live System Manager discovers **automatically** new Networked Media Interface Devices



- **Smart Device Configuration**
  - Take Control of the Devices
  - Create Workgroups to manage pre-saved configurations



The Networked Media Interface: A total Solution Approach

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API & Plug-in SDK

Control API for 3rd party application
Flexible to add new device to be controlled.

Networked Media Interface

+

IP Live System Manager

+

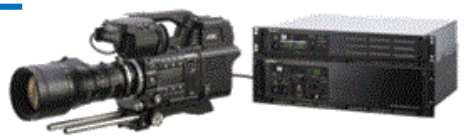
COTS IP Switch Fabric

SONY

Implementation Plan

(Supplementary information)

IP Live Production Overview

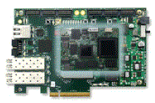


4K/HD Cameras

Remote Cameras

XAVC Server

Network I/F LSI Built-in



PCIe Board

Partner's Graphics

Remote Maintenance Service

IP based AV Router

System Manager Software

GUI

Workstation

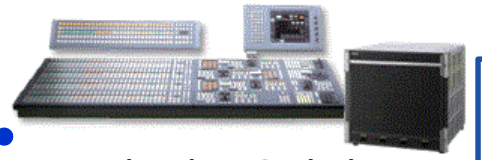
Control Panel

IP Switch

JUNIPER NETWORKS CISCO HUAWEI everlz

Partner's Multi-viewers

Network I/F LSI



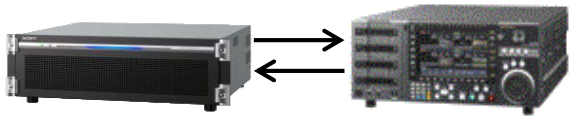
Production Switcher

Network I/F LSI Built-in

Anycast

Partner's Video Server

FPGA IP



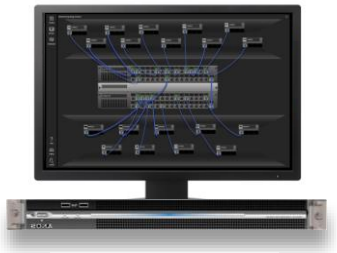
SDI-IP Converter for Deck, etc.

Networked Media Interface - Products Roadmap

Sony Products from Jan 2016

NXL-FR318

NXLK-IP40F



PWS-100NM1

XVS-8000

PWS-4500

BPU-4500

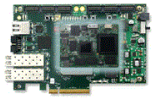
Components for 3rd Party

Networked Media Interface LSI – Sony
Available now!

Networked Media Interface SDK & API – Sony
Available now!

Networked Media Interface FPGA Core – Macnica
(for Altera)
End 2015

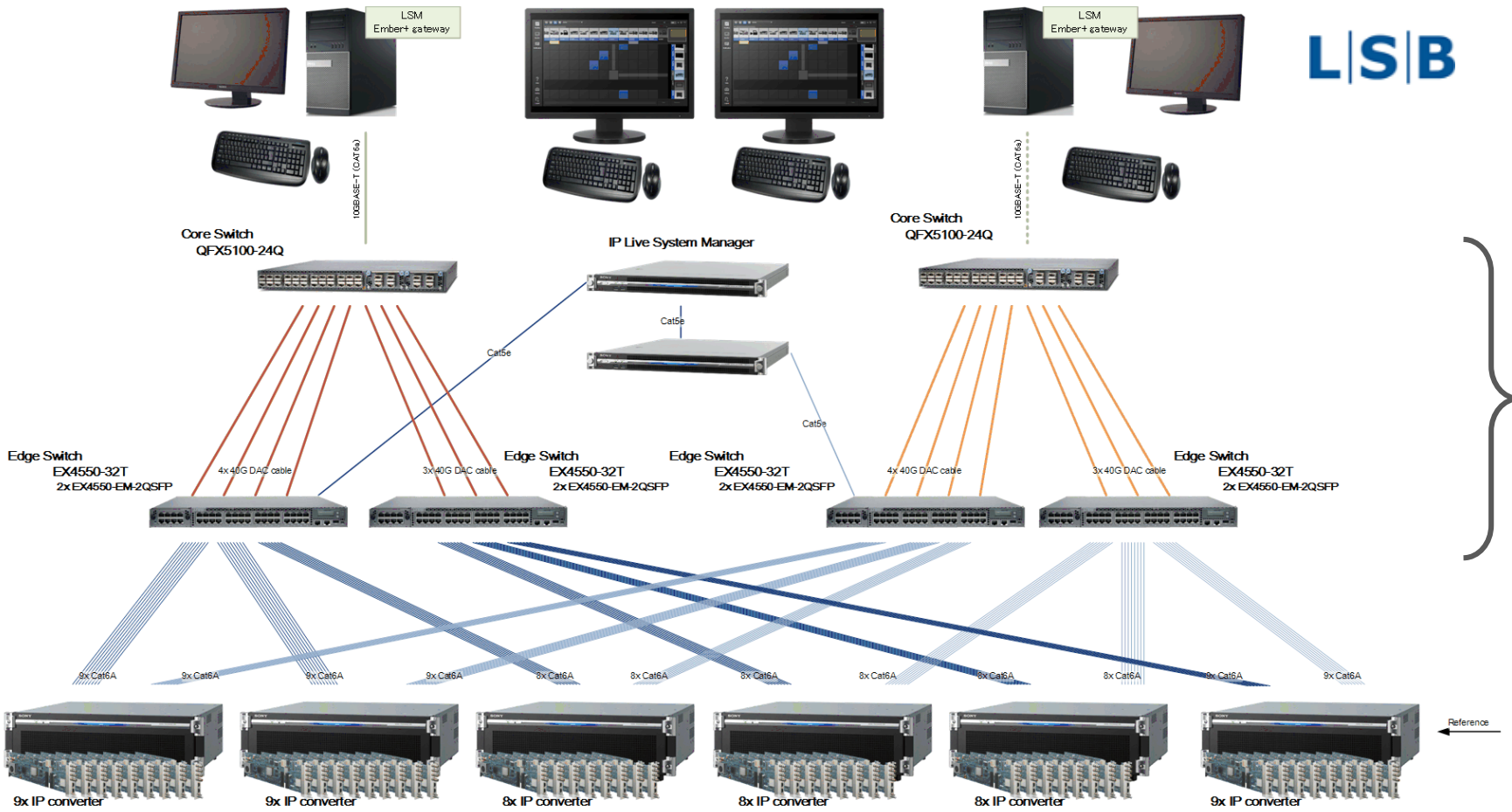
Networked Media Interface FPGA – Xilinx
From Mid/2016



Networked Media Interface PCIe – Advantec
End 2015

Networked Media Interface PCIe – Matrox
Under development

HD System - 100x100 Uncompressed HD Routing

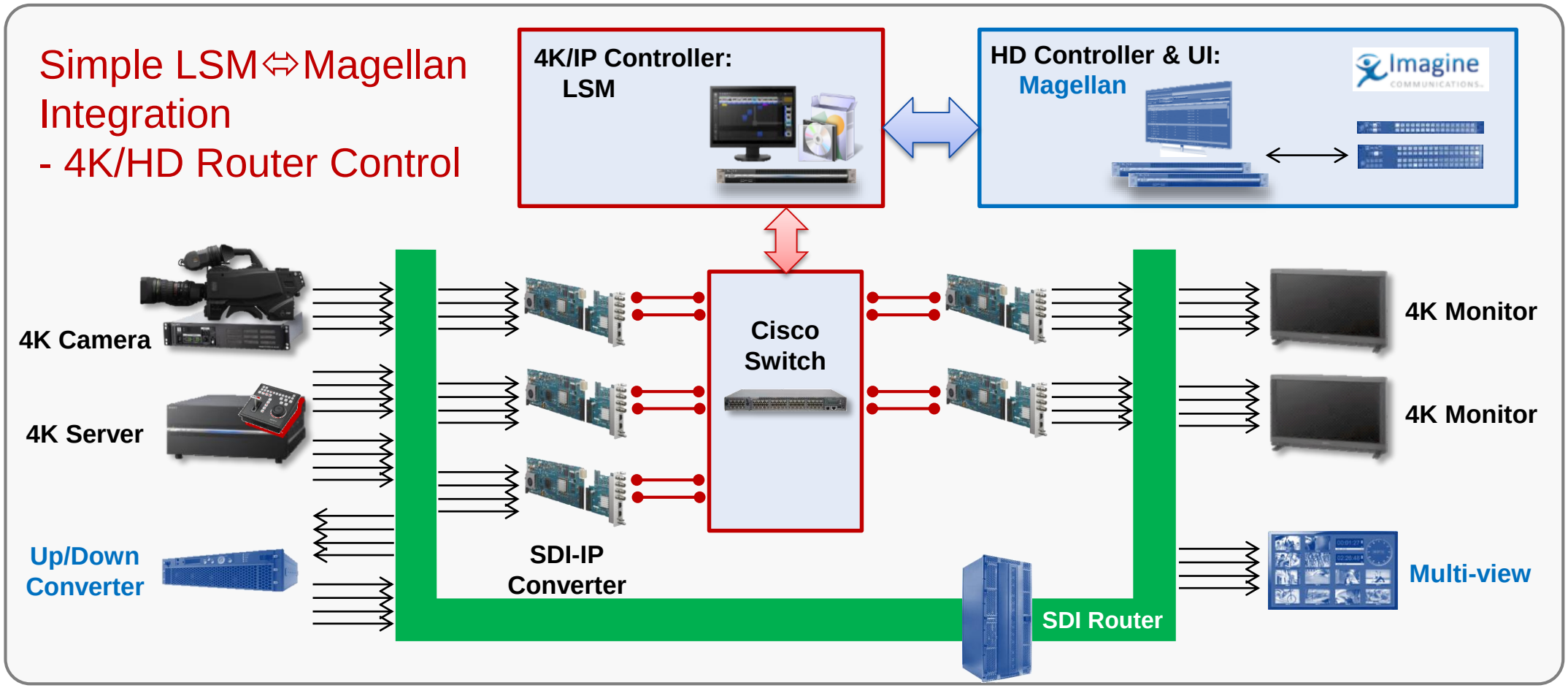


L|S|B

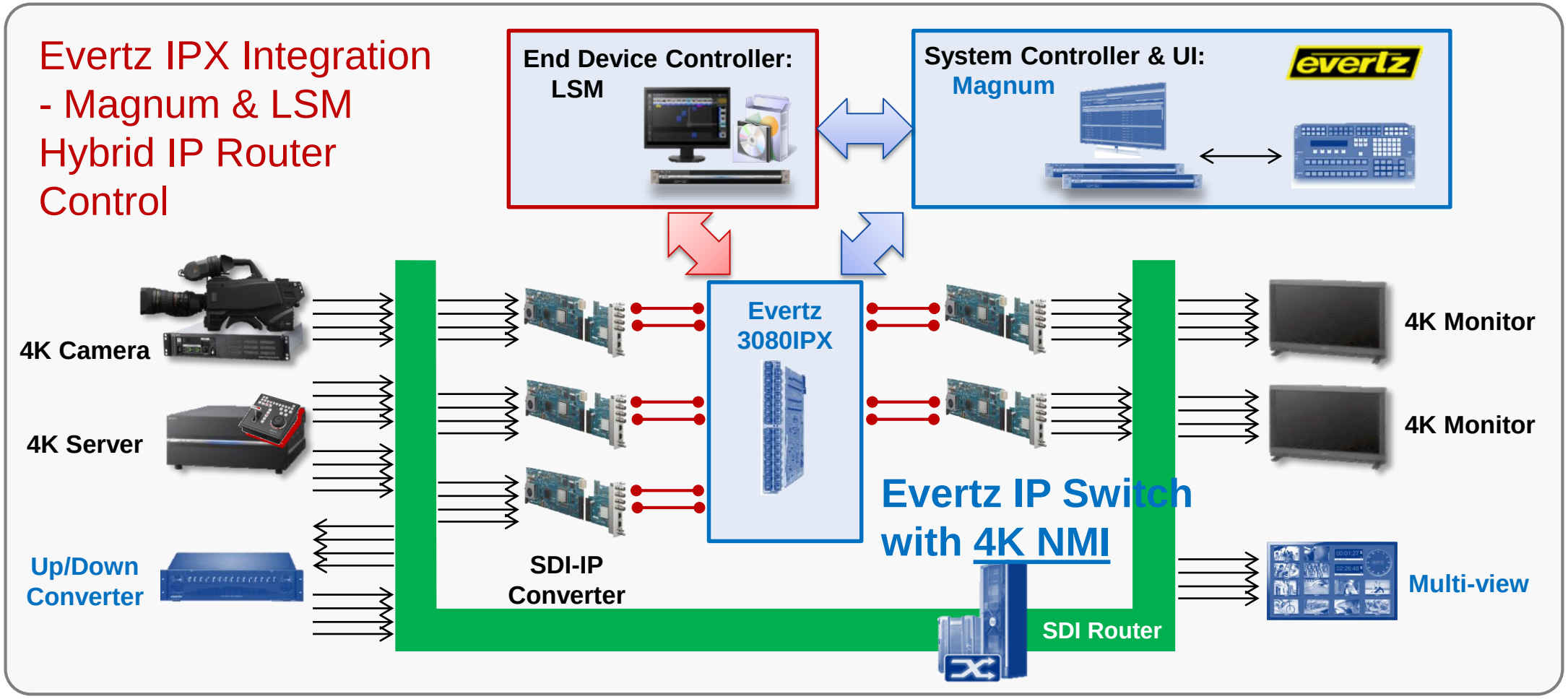
3rd Party UI Integration:
VSM from L-S-B

Multivendor
COTS IP Switch Use:
Juniper & Cisco
+ Traffic Injection

4K/HD Hybrid System w/ Imagine Integration



4K/HD Hybrid System w/ Evertz Integration



Summary

IP for Live Production should maximize the benefits of IP
COTS Based System, Resources Sharing, Virtualization enablement

The Networked Media Interface is a full Architecture Solution
Takes into account all the components required for IP Live Production

Packetization format agnostic: Support of SMPTE2022-6 & ASPEN
Interoperability with current HD Products

Standardization & Partnership: LLVC as SMPTE RDD & 42 Supporters
Interoperability with 3rd Party – Components available from Fall 2015

Implementation is ongoing**:** Camera, Switcher, Server, LSM & Converter
Targeting deliverable at Beginning of 2016

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