

# Unified IP Infrastructure, The Future of Live Production



Hatfaludi Jozsef

## Current Issue:

## Double investment on 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



### Production is Network base

- Non-linear editing, File base
- Cost-down by COTS

### Best effort type

- Not guarantee latency/sync

### High expandability

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

### Archive





**Solution: Live production environment turns to IP w/ COTS**  
→ **Facility renewal & considering migration path to “Beyond HD”**

**Provide not only value-added solution “Beyond HD” but also total operational efficiency by IP.**

## **COTS use**

Cost-effective non-specialized IP switch can be used for synchronized low-latency AV routing to replace SDI router.

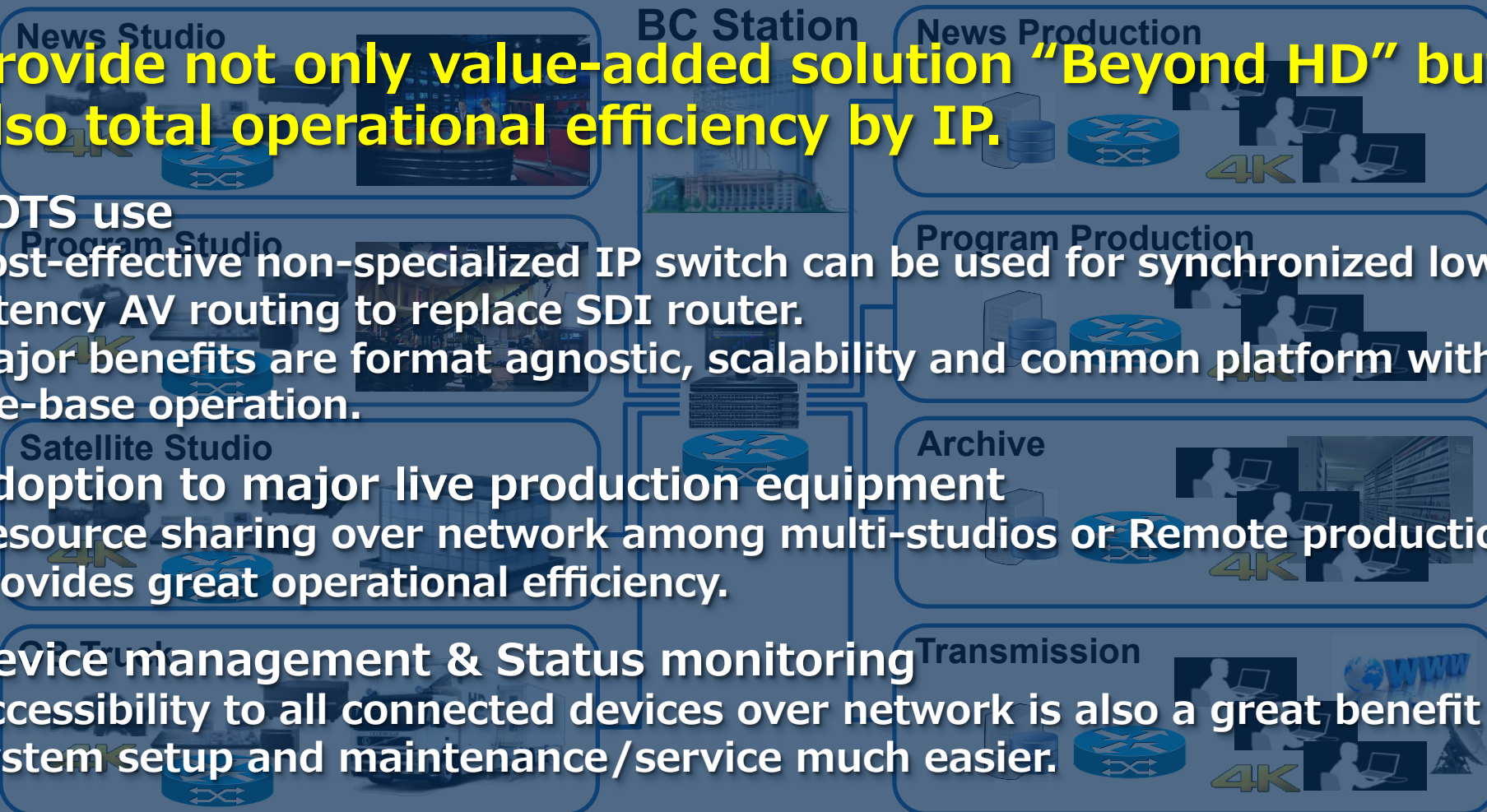
Major benefits are format agnostic, scalability and common platform with file-base operation.

**Adoption to major live production equipment**

Resource sharing over network among multi-studios or Remote production provides great operational efficiency.

## **Device management & Status monitoring**

Accessibility to all connected devices over network is also a great benefit for system setup and maintenance/service much easier.



## Interoperability

## Joint-working with industry leading partners

### Contributing to Standardization

Joint TF on Networked Media



### Expanding Alliance Partners



Converters/Routers      Multi-viewer      Graphics      Servers

IP Live Production Unit  
**NXL-IP55**



Point-to-Point



### Core Technology Development

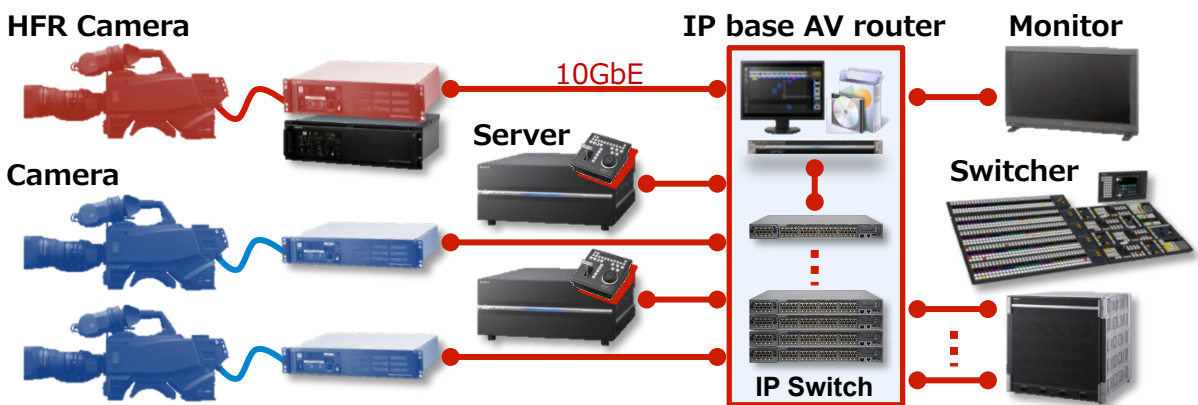
LSI & FPGA IP Core



System Manager



### Adopting to all Sony products



# Point-to-Point

# Multipoint-to-Multipoint

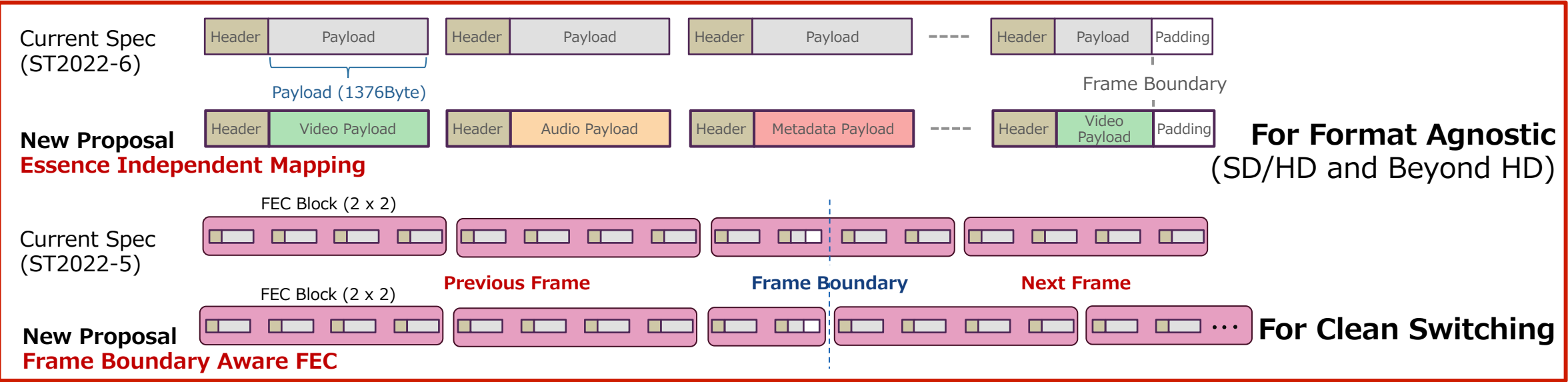


## Current SMPTE Standard for IP Transmission (ST2022-5/6/7)

- Defined for IP Contribution Purpose: Only SD/HD Uncompressed over IP Networks

Number	Issued	Outline
ST2022-5	2012	FEC for ST2022-6
ST2022-6	2012	SDI over IP Networks
ST2022-7	2013	Seamless Protection Switching

## Proposing New Standard based on Sony's NMI through VSF, SMPTE



Sony supports ST2022-6 as well from HD System Integration point of view

## 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 realign 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 real-time audio-video (AV) transfer, real-time 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.<sup>1</sup>

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 SYSTEM

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

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SMPTÉ Motion Imaging Journal // 29

March 2015

## 2. Sony's PTP proposal has been approved as ST2059-2.

It took 7 years.

SMPTE ST 2059-2:2015

### SMPTE STANDARD

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

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Approved  
March 25, 2015

## 3. Sony's LLVC (Low-Latency Video Codec) has been submitted to SMPTE as RDD (Registered Disclosure Document) and will be published shortly.

DRAFT SMPTE REGISTERED DISCLOSURE DOCUMENT

### LLVC - Low Latency Video Codec for Network Transfer

DRAFT Version 0.9 — of 2015-04-17

Warning

This document is not a SMPTE RDD. It is distributed for review and comment. It is subject to change without notice and shall not be referred to as a SMPTE RDD. Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation. Distribution does not constitute publication.

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Errors in this document should be reported to the proponent identified below, with a copy to [eng@smpte.org](mailto:eng@smpte.org).

All other inquiries in respect of this document, including inquiries as to intellectual property requirements that may be attached to use of the disclosed technology, should be addressed to the proponent identified below.

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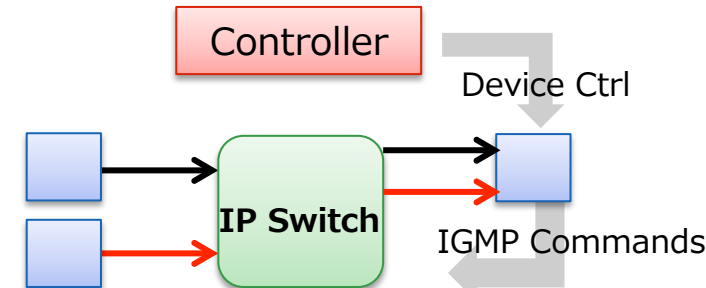
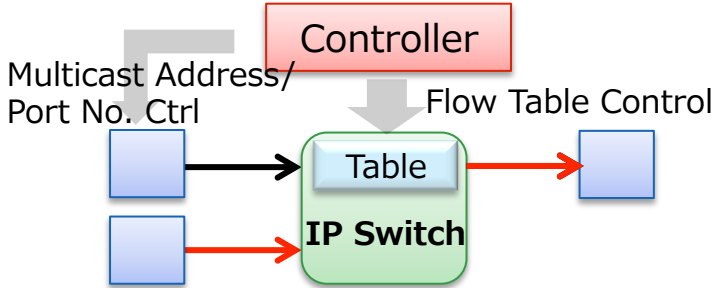
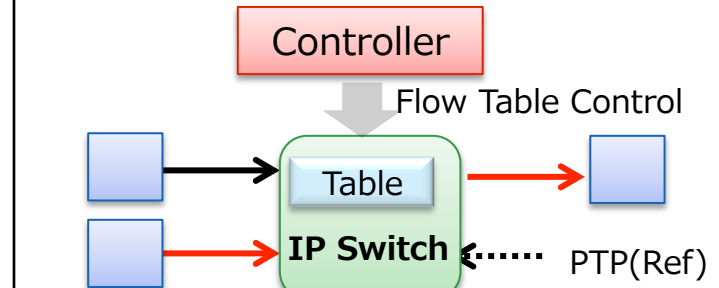
RDD 34-201X

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# Control Plane - Clean Video Switching

**Not only AV stream but also ...**

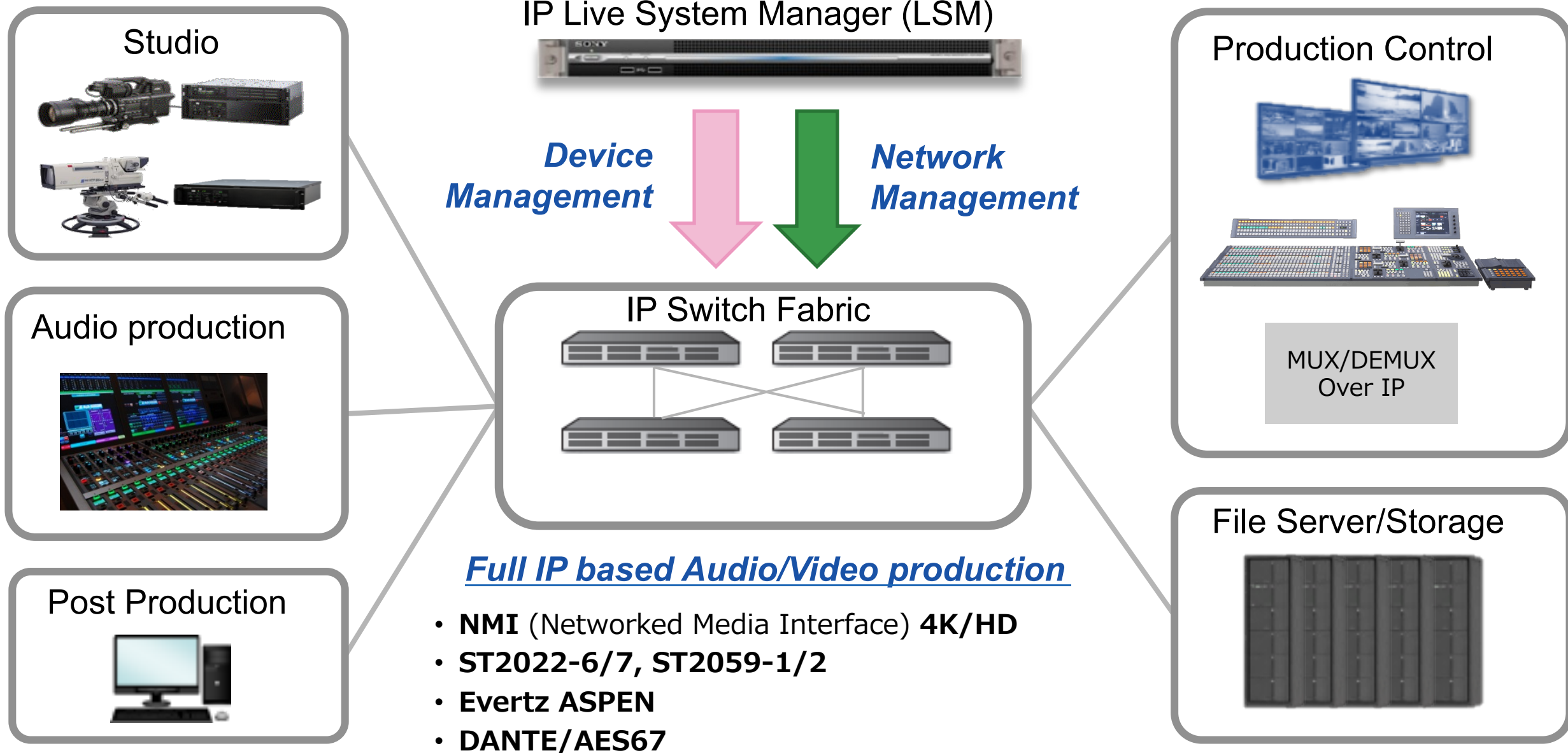
- Switching Method
- Device Control Protocol

Destination Timed Switch	Source Timed Switch	Switch (Timed) Switch
 <p>Device</p>	 <p>Device</p>	 <p>Device</p>
<ul style="list-style-type: none"> <li>• Clean Sw Control at Rx device</li> <li>• Double bandwidth is required at destination in overlap period</li> <li>• Standard IP Switch can be used</li> </ul>	<ul style="list-style-type: none"> <li>• Clean Sw Control at Tx device</li> <li>• No double bandwidth penalty</li> <li>• Very accurate sync control is required for Tx device</li> <li>• System scalability issue</li> </ul>	<ul style="list-style-type: none"> <li>• Clean Sw Control at IP Switch</li> <li>• No double bandwidth penalty</li> <li>• Special IP Switch is required</li> <li>• Clean switching is not adopted due to time reservation switch</li> </ul>

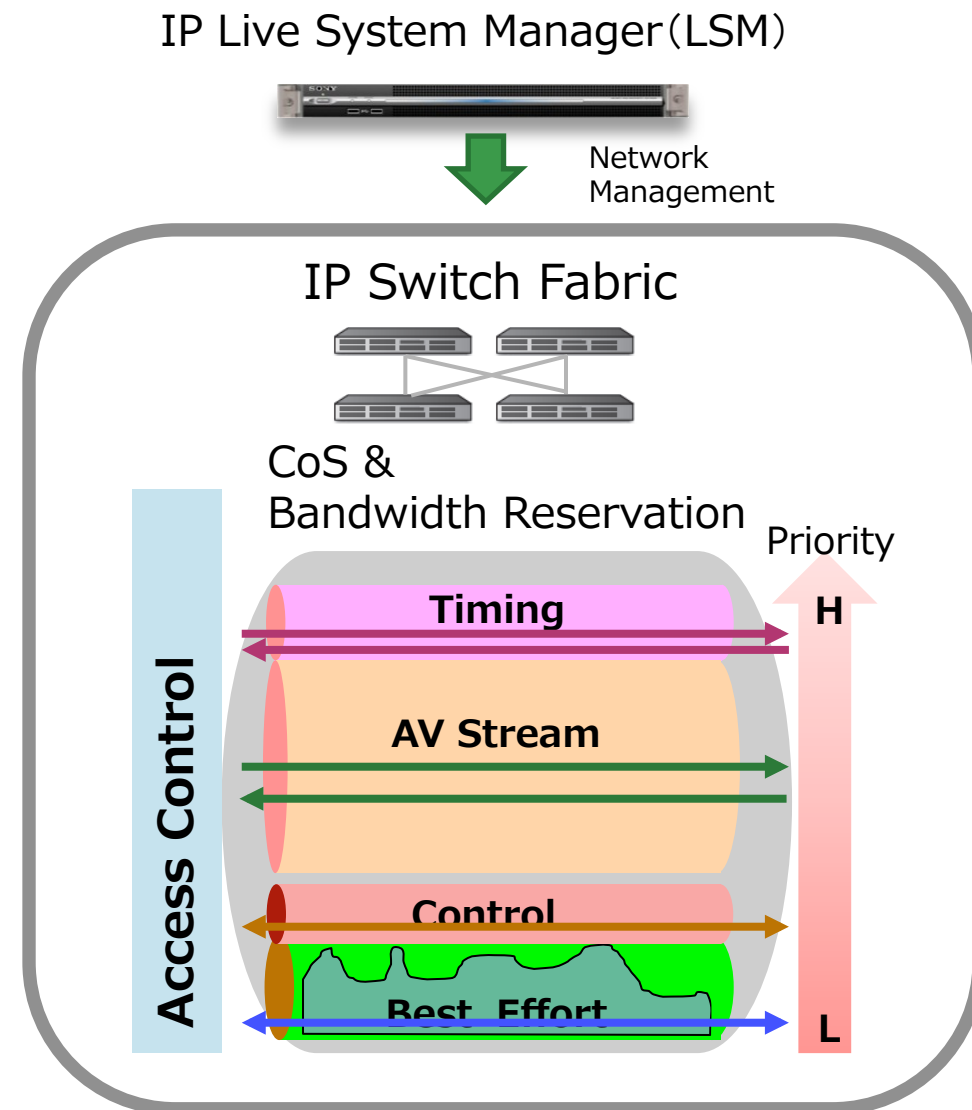


# General architecture; overview

SONY

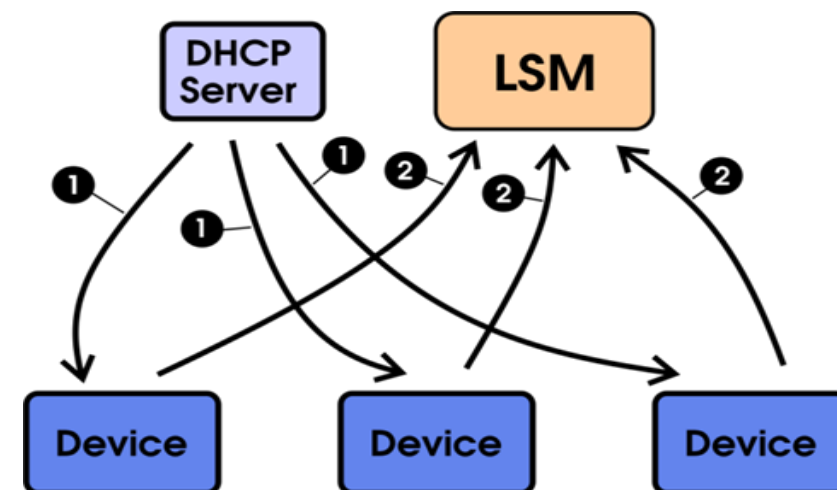


- **Network Management Service in IP Live System Manager (LSM) :**
  - QoS guarantee for AV and control traffic
  - IP switch configuration
  - Bandwidth Reservation
- **QoS Policy on IP network (Configured IP Switches with LSM):**
  - Priority based Control
  - Access Control



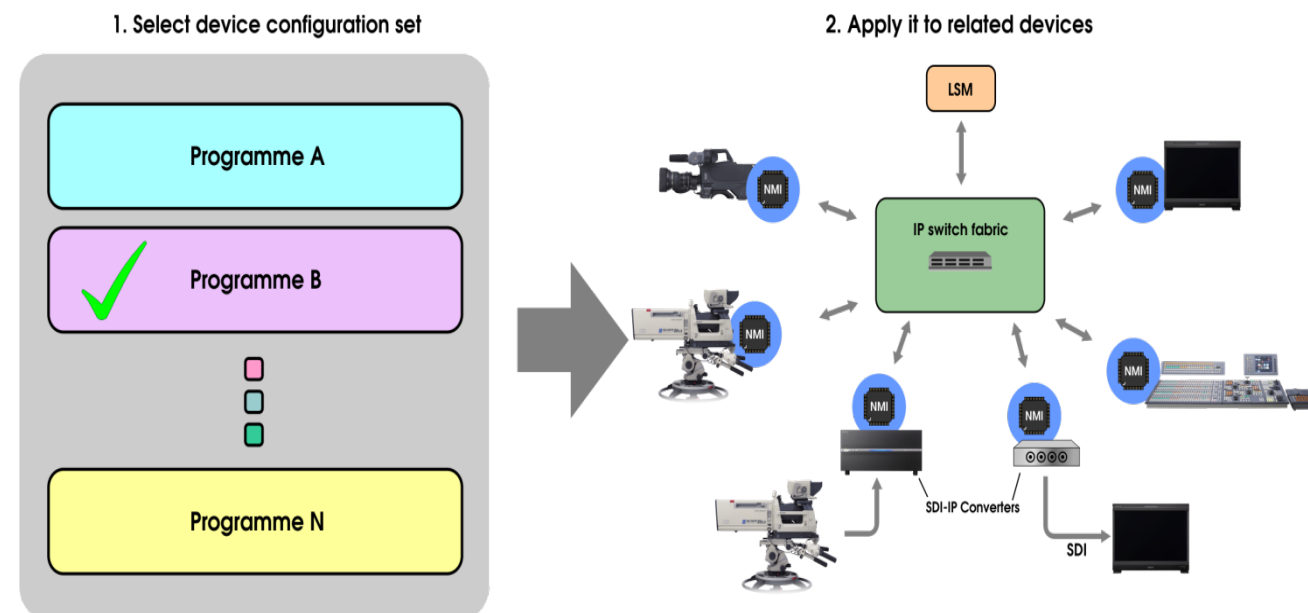
## • Plug & Play

- LSM automatically discovers NMI devices.
  1. Distribute LSM IP address to the device by DHCP option.
  2. The Device then connect to the LSM, and the LSM can discover the device.



## • Device Configuration

- The workgroup feature can be used to instantly change many configuration settings across many devices, depending on the broadcast or production scenario.



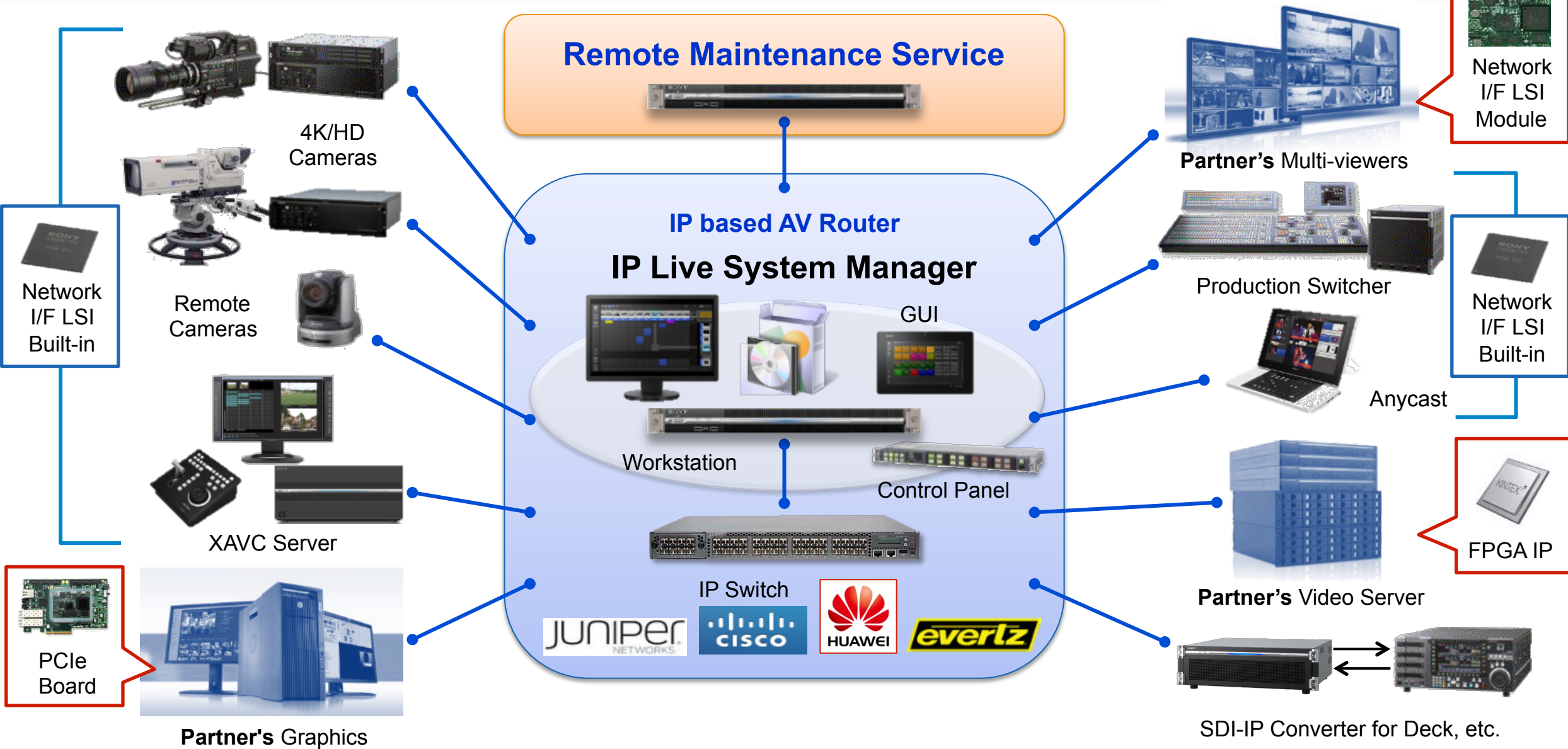


The following 36 leading companies support Sony's IP Live Production System:



# IP Live Production Overview

SONY

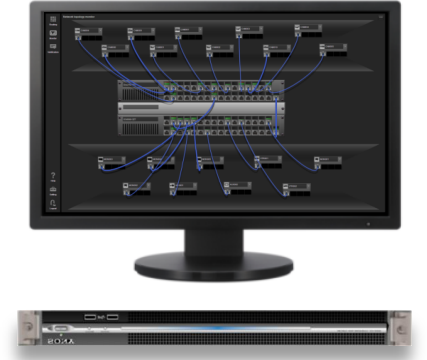


# IP Live System Manager and SDI-IP Converter

## PWS-100NM1 ; IP LIVE SYSTEM MANAGER STATION

Matrix Config. & Cross-point Switching, Network management, device management

API For Alliance Partners, Integration with   **L|S|B** 



## NXL-FR318 ; SIGNAL PROCESSING UNIT

Rack mountable frame for Networked Media Interface Converter boards

18 slots, Redundant PSU, 3RU

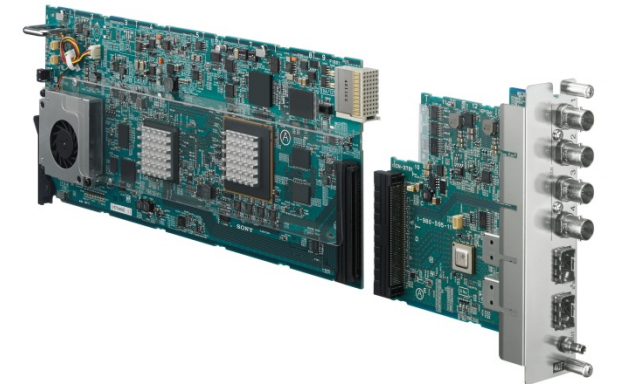


## NXLK-IP40F ; SDI-IP CONVERTER BOARD (HD/4K)

Convert SDI from/to Networked Media Interface for SD, HD and 4K

Built-in Frame Synchronizer

10G SFP+ x2 to support Hitless Failover

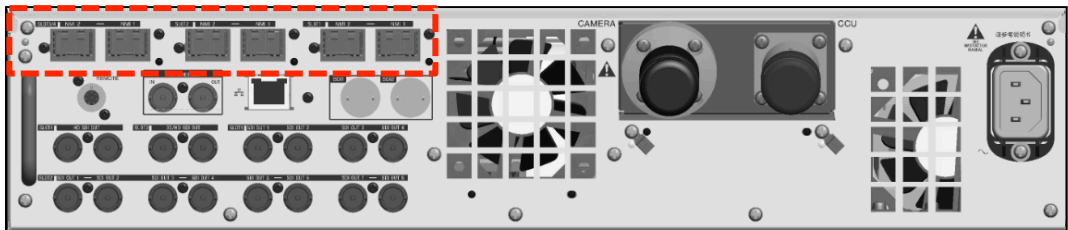




# IP-equipped products come out shortly...

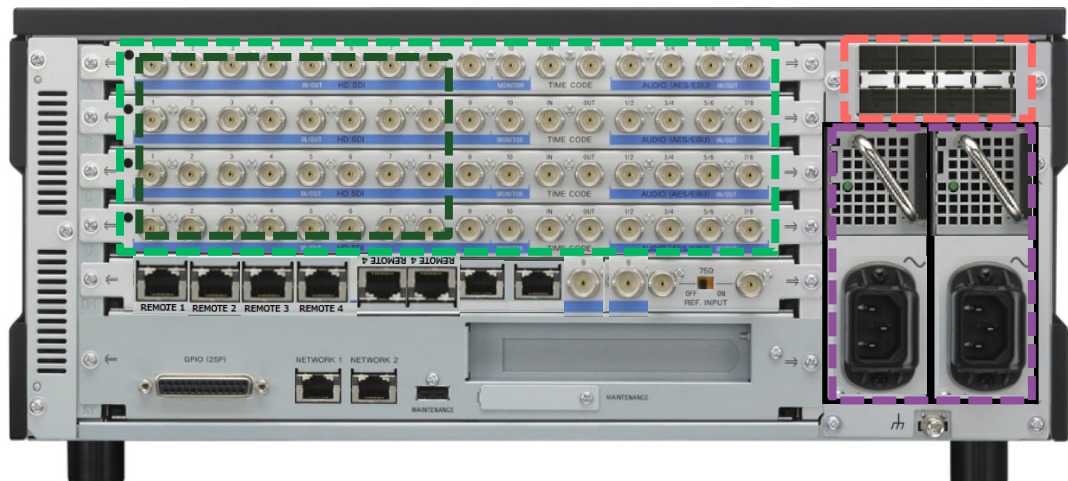
## BPU-4500

- Successor of BPU-4000



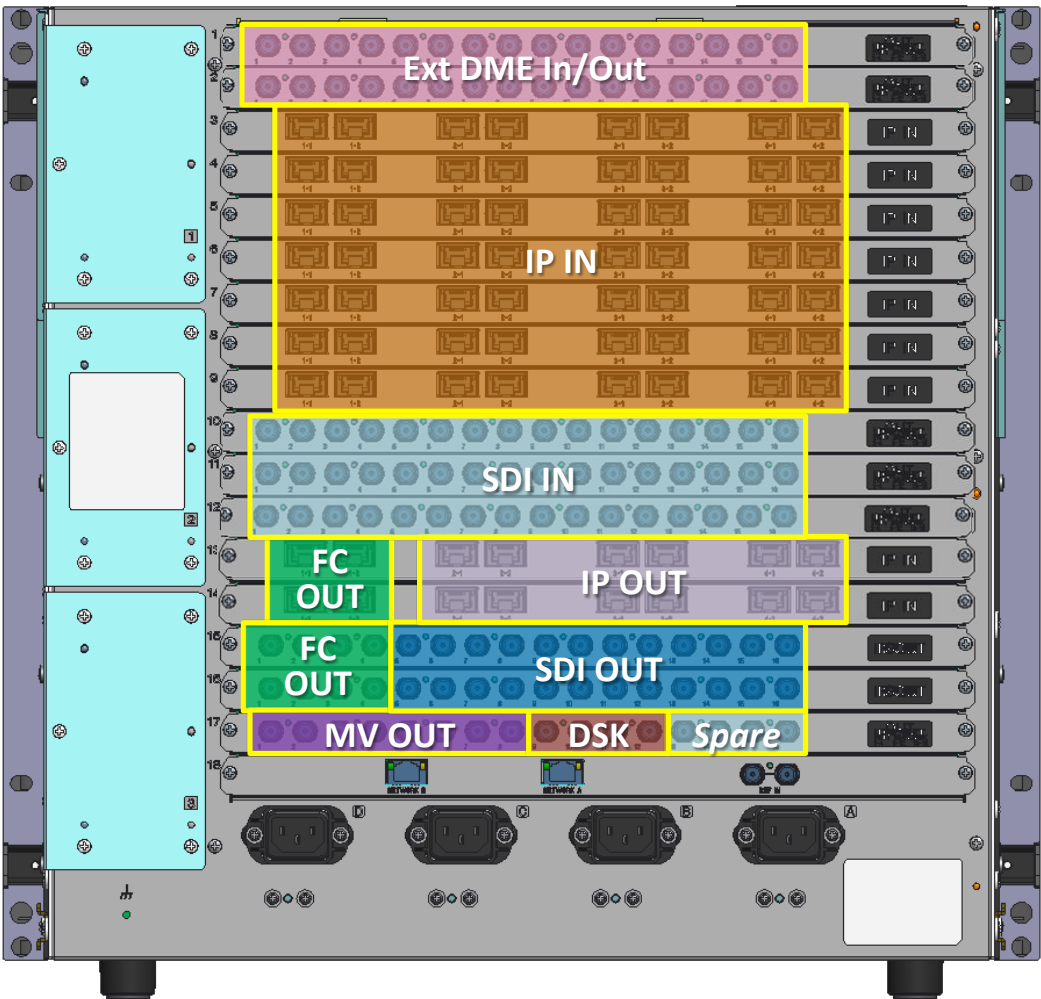
## PWS-4500

- Successor of PWS-4400



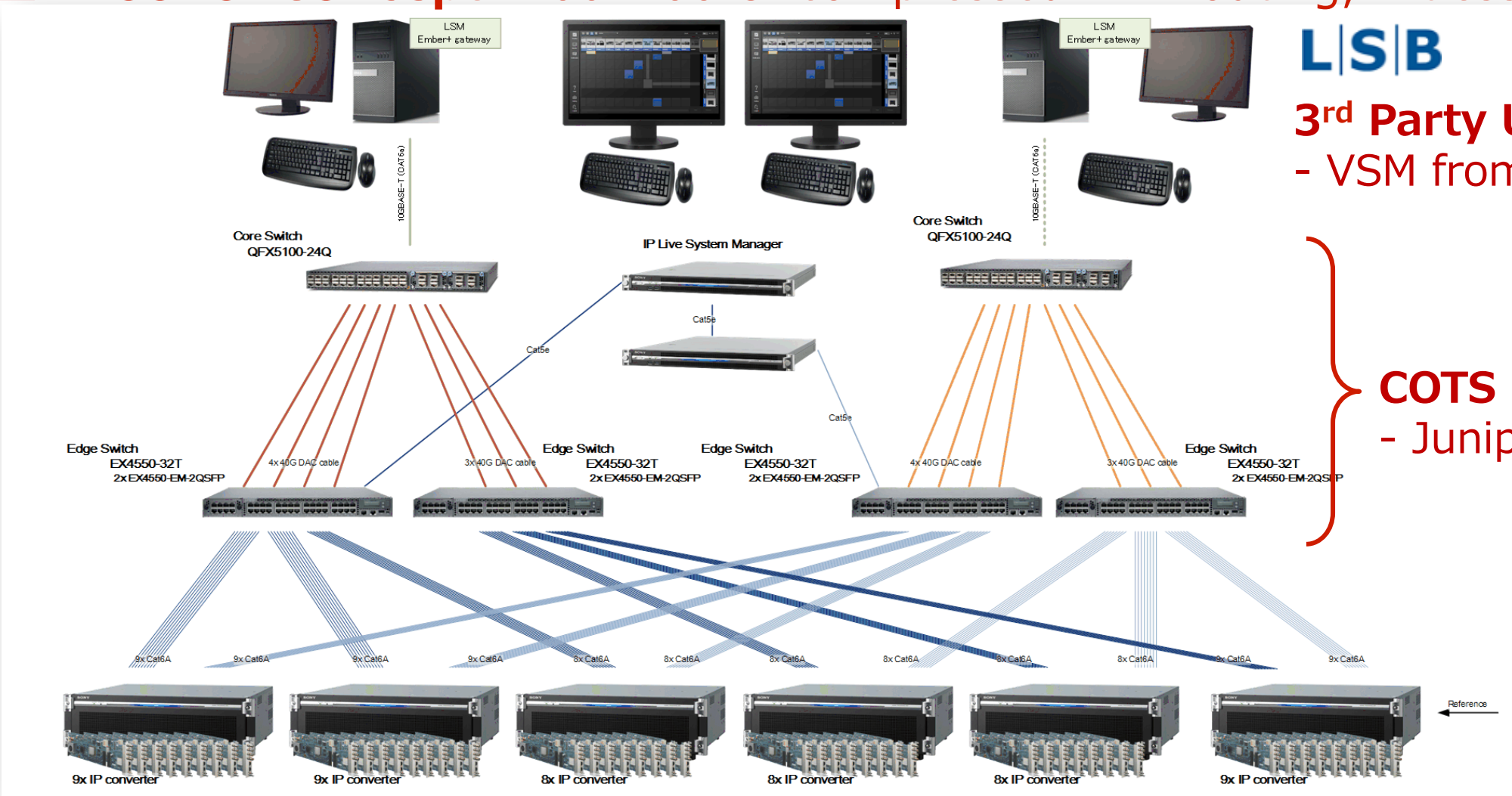
## XVS-8000

- Successor of MVS-8000X



# HD System POC (Proof of Concept) Test

✓ **Proof of Concept:** 100x100 Uncompressed HD Routing, Hitless Failover, etc.



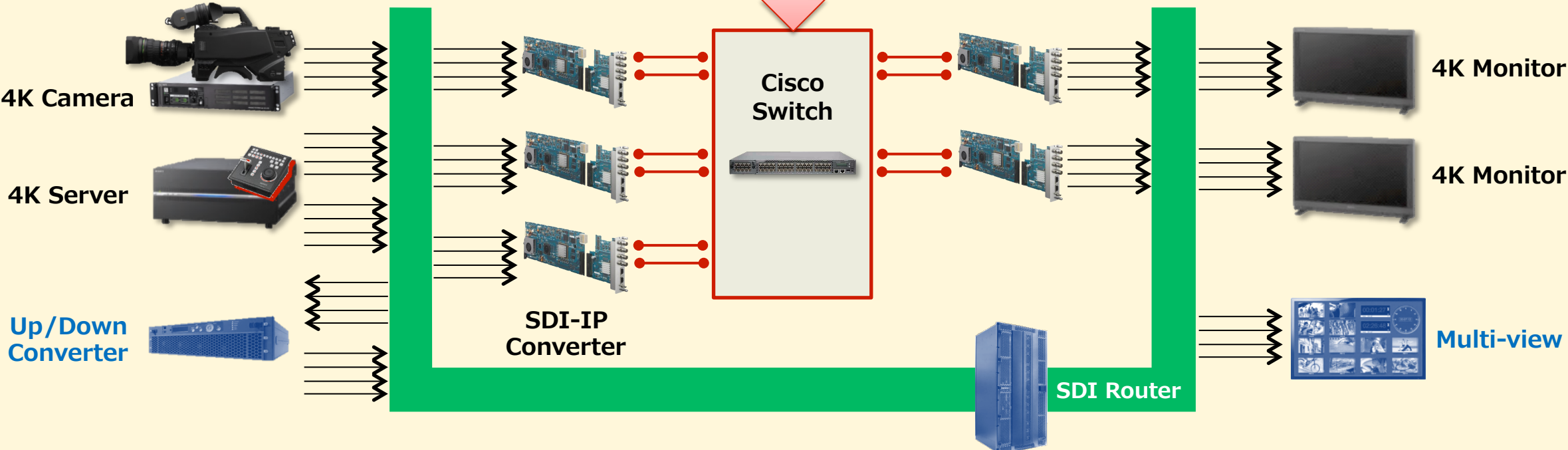
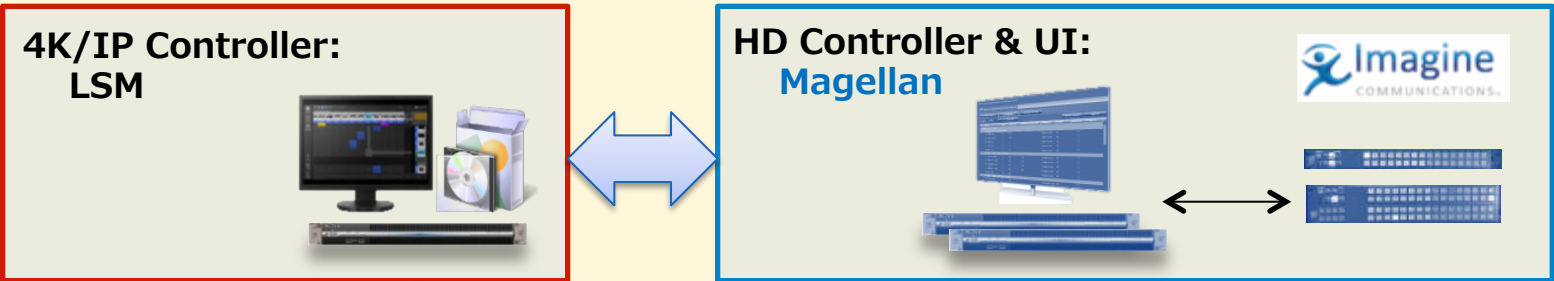
**3rd Party UI Integration:**  
- VSM from L-S-B

**COTS IP Switch Use:**  
- Juniper & Cisco

➔ **HD Middle Class IP Router for OB Truck and Studio**

## ✓ Proof of Concept: Collaboration with **Imagine**

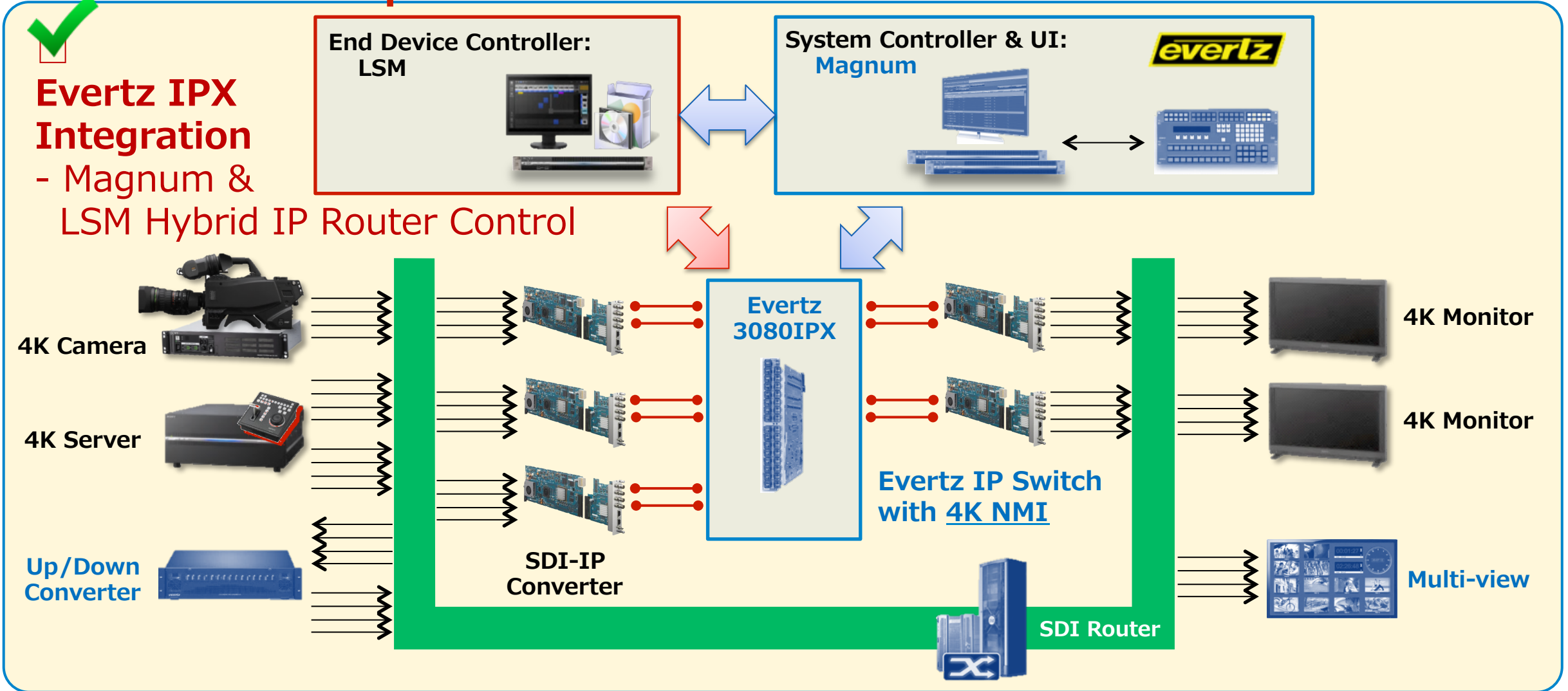
✓  
**Simple LSM⇔Magellan Integration**  
- 4K/HD Router Control



➔ **4K/IP System for OB Truck and Studio**



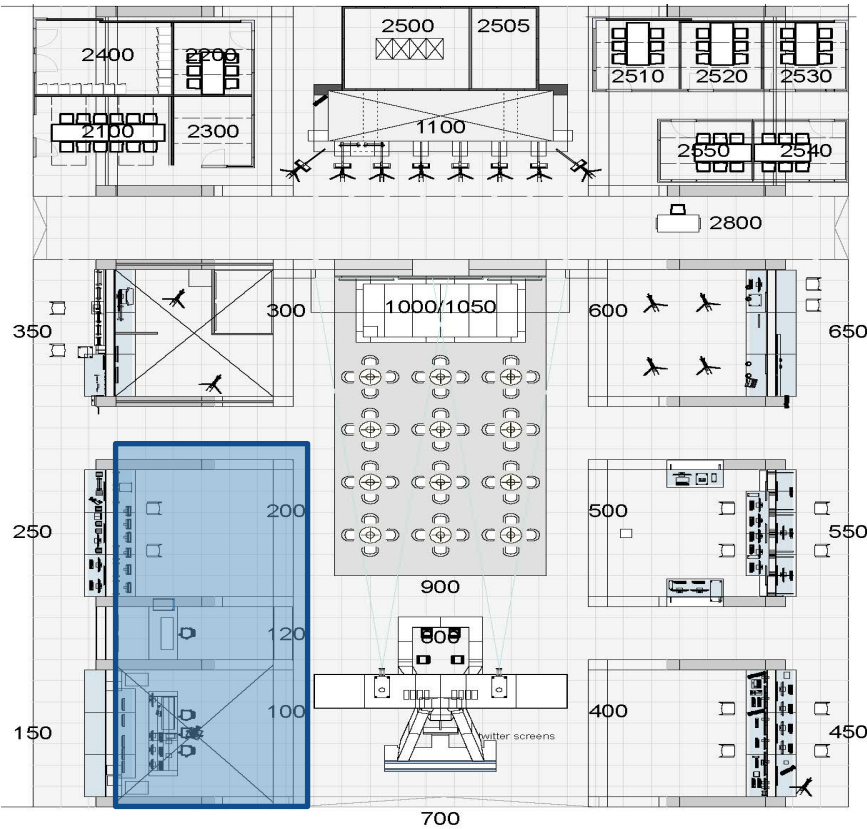
## ✓ Proof of Concept: Collaboration with Evertz



➔ 4K/IP System for OB Truck and Studio

- ✓ **Standardization & Partnership:** LLVC as SMPTE RDD & 36 Supporters  
→ IP Interoperability with 3<sup>rd</sup> Party will be ready.
- ✓ **Product Update:** Camera, Switcher, Server, LSM & Converter  
→ Targeting deliverable at Beginning of 2016
- ✓ **Proof of Concept:** 100x100 Uncompressed HD Routing, Hitless Failover, etc.  
→ HD Middle Class IP Router for OB Truck and Studio
- ✓ **Proof of Concept:** Collaboration with **Imagine**  
→ 4K/IP System for OB Truck and Studio
- ✓ **Proof of Concept:** Collaboration with **Evertz**  
→ 4K/IP System for OB Truck and Studio

# The demonstration is here!



## Format agnostic production over IP

- *HD/4K Hybrid video routing over Networked Media Interface* – Working with BPU-4500/PWS-4500/XVS-8000 over IP
- Operation by Virtual Studio Manager, **L|S|B**
- Network/device management by Sony IP Live System Manager on



## Interoperability

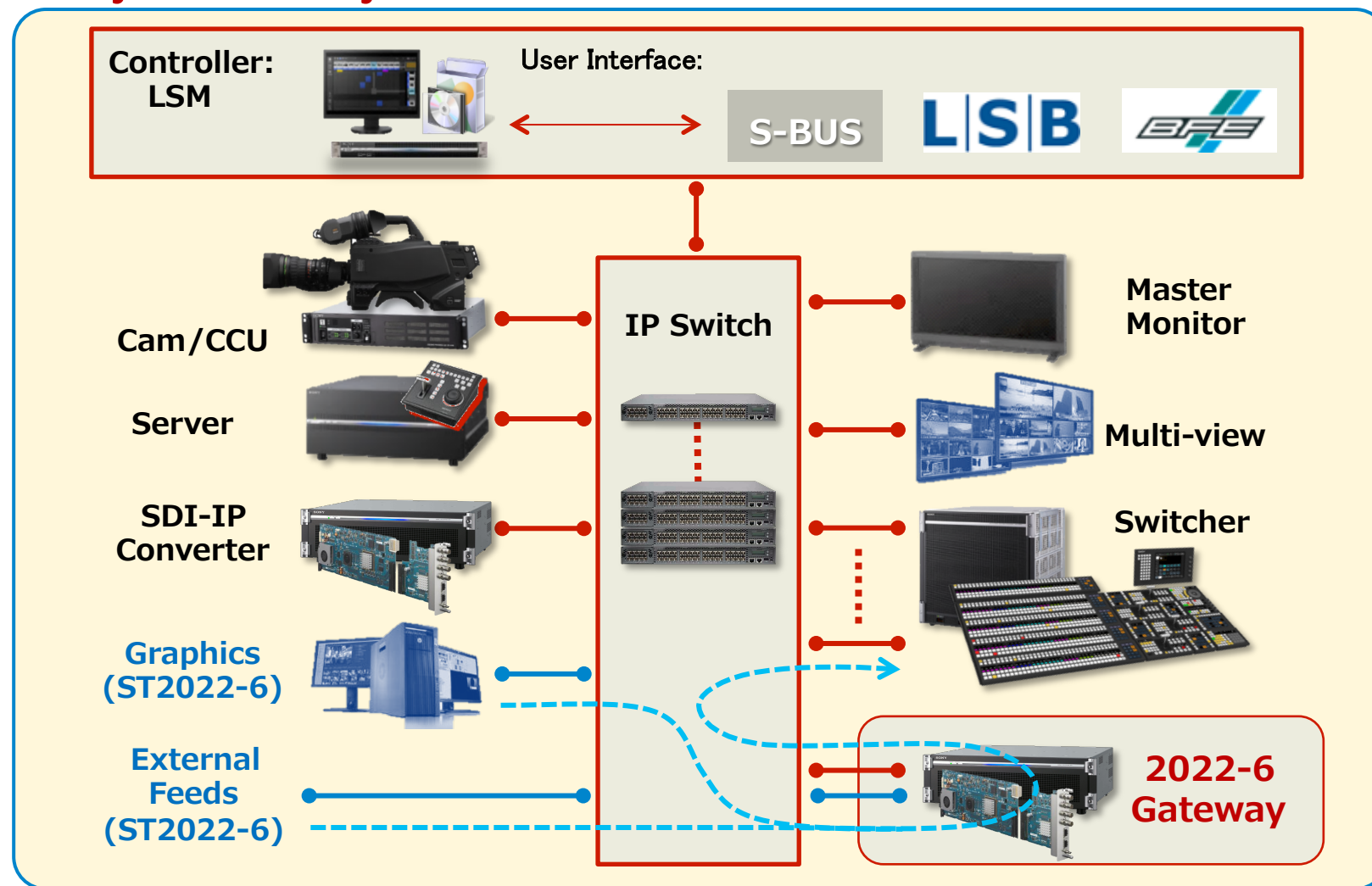
- *With Networked Media Interface and IP Live System Manager* –
- Operation by **evertz** **Imagine** **EF3**
- 36 leading companies support Sony's IP Live Production System
- The solution supporting Sony's IP Live Production System by



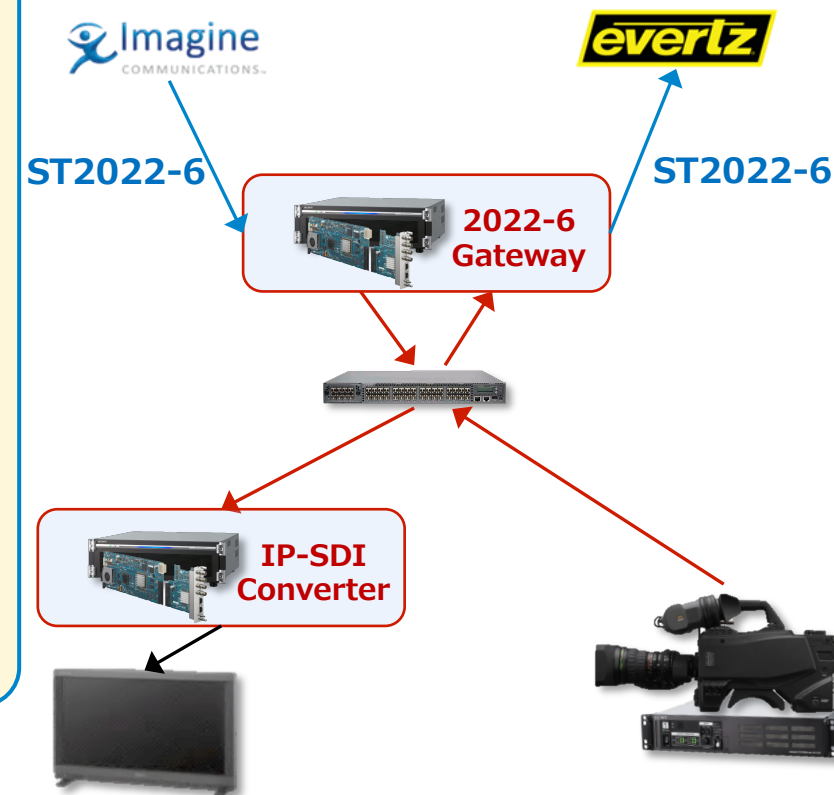
## Open standards adoption

- *SMPTE 2022 & SMPTE 2059* –

## Sony IP Live System



“2022-6 Gateway”  
as new converter card  
– ST2022-6 native device can  
be connected seamlessly.



➔ **HD IP Interoperability with 3<sup>rd</sup> Party will be ready.**



# SONY

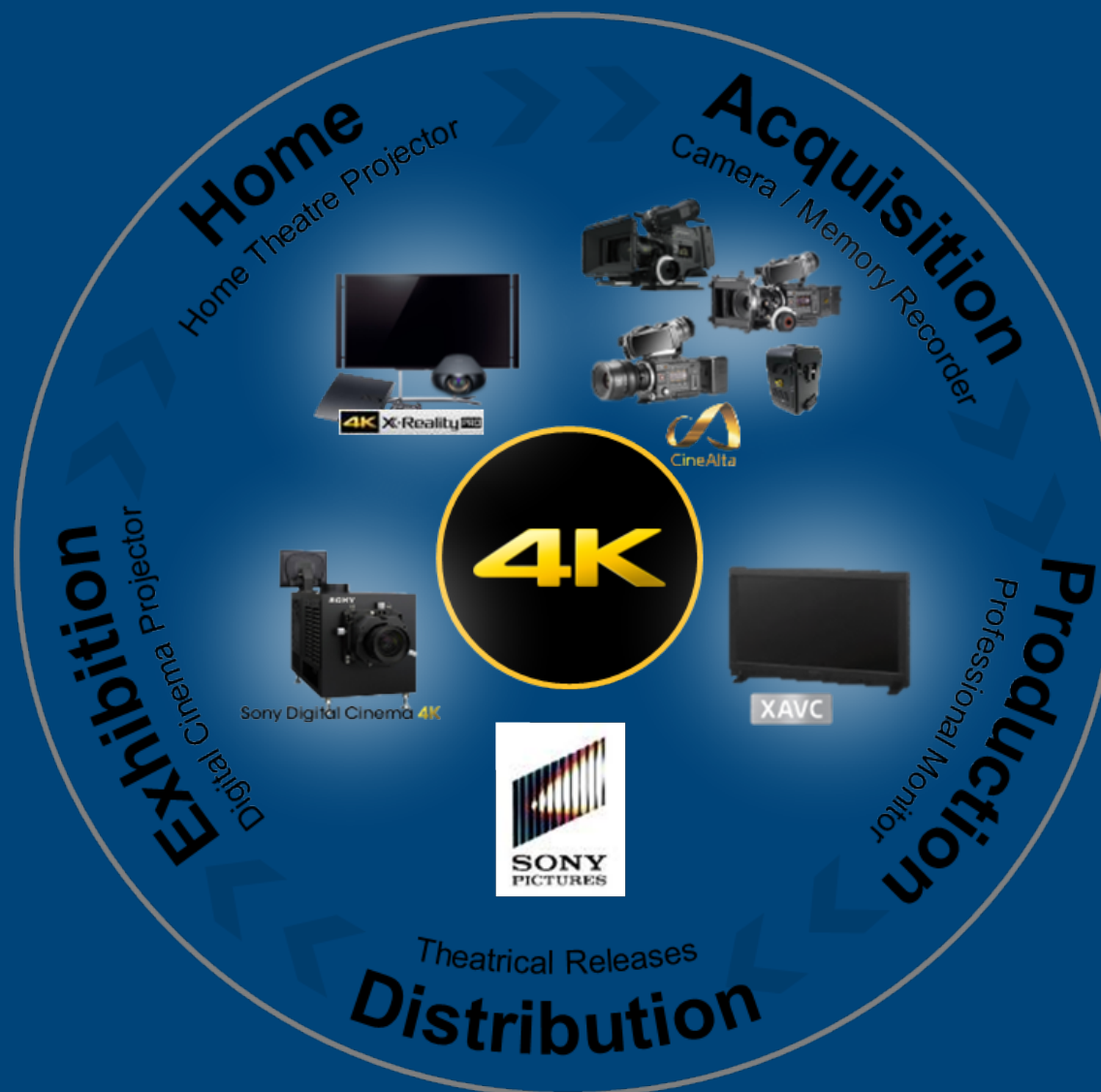
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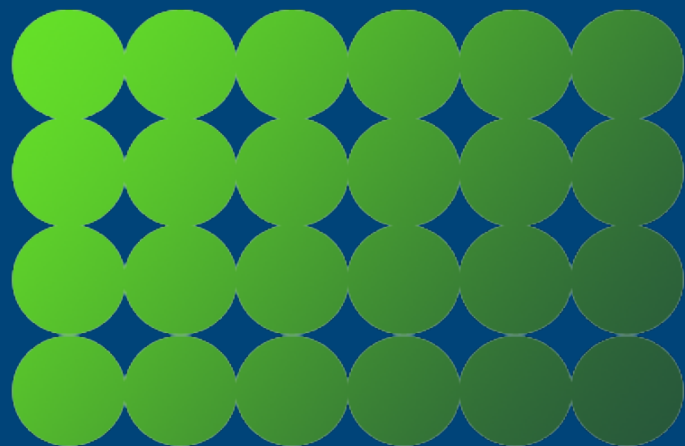
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# 4K from the lens to the living room

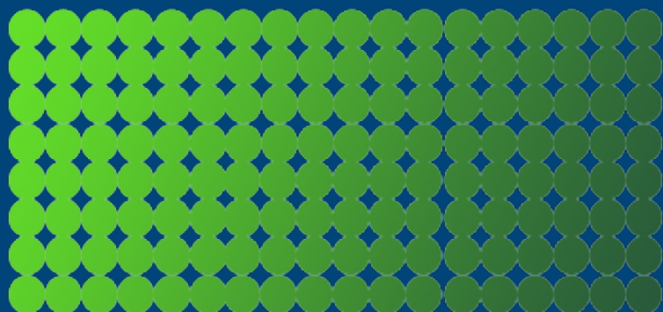
# 4K



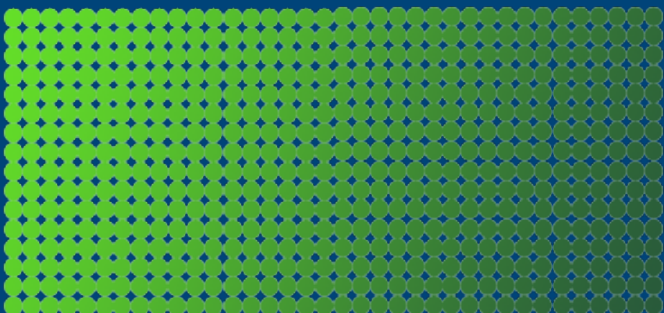
# Standard Definition to 4K



Standard definition – 480



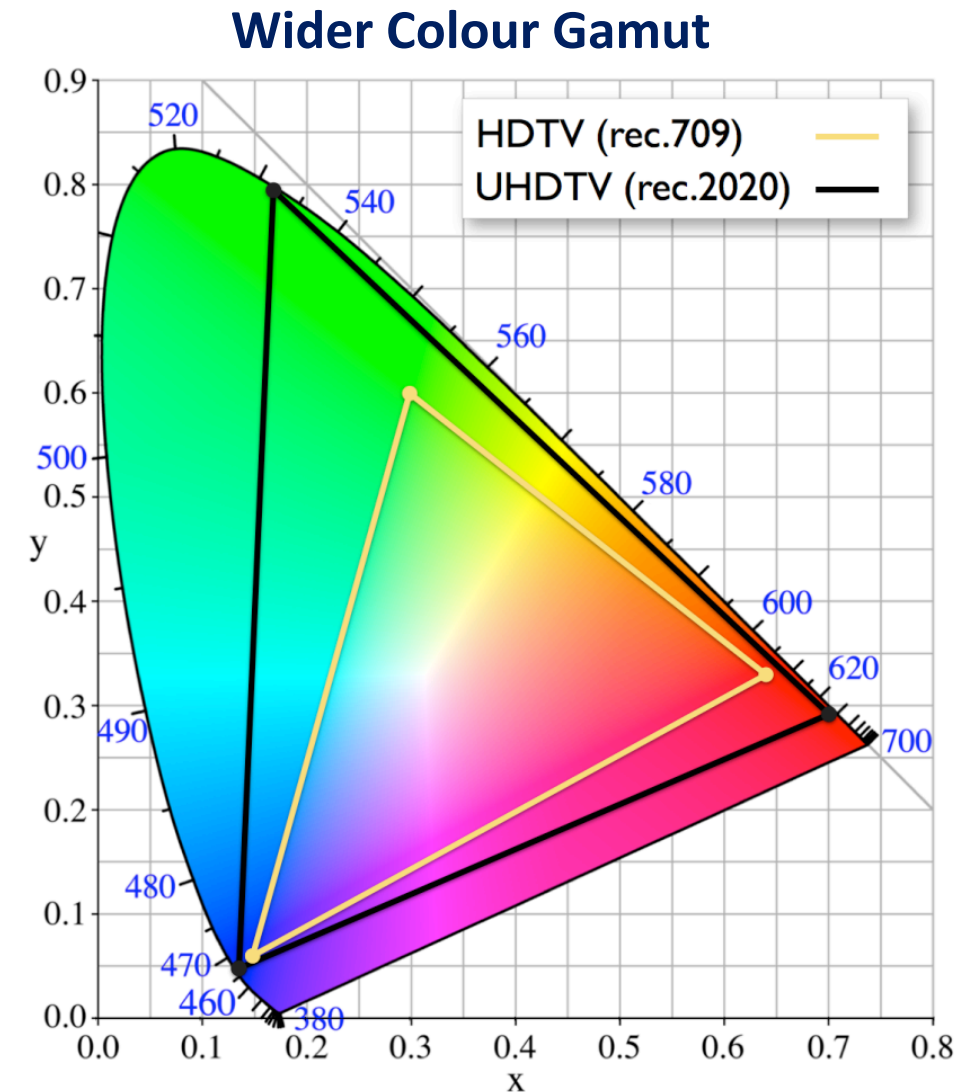
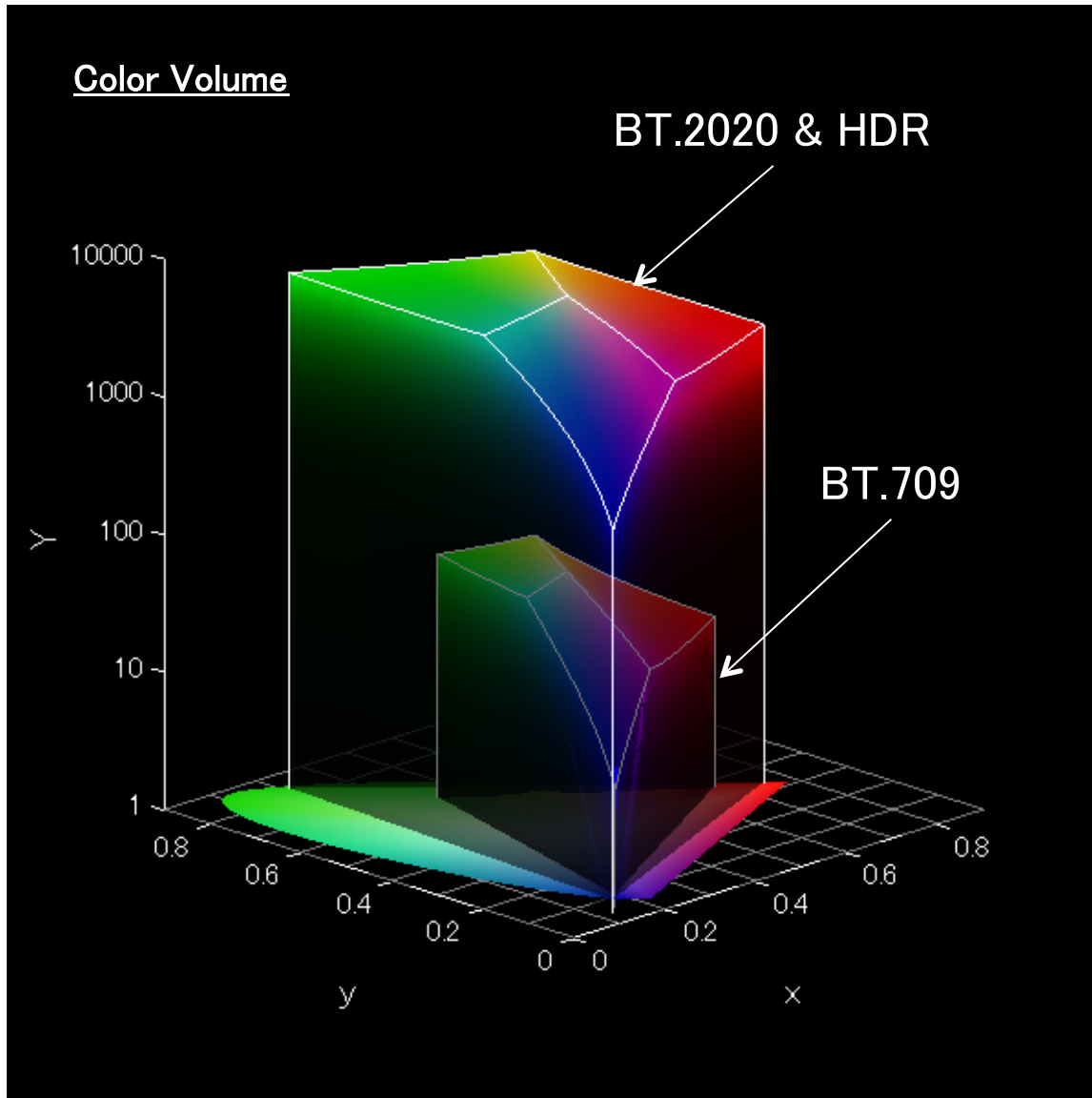
HD – 1080



4K (4096 x 2160)  
QFHD (3840 x 2160)

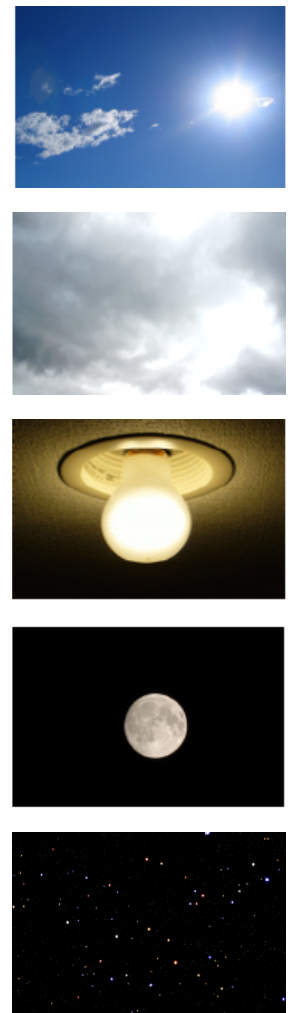


# But it's not just about "Brightness"



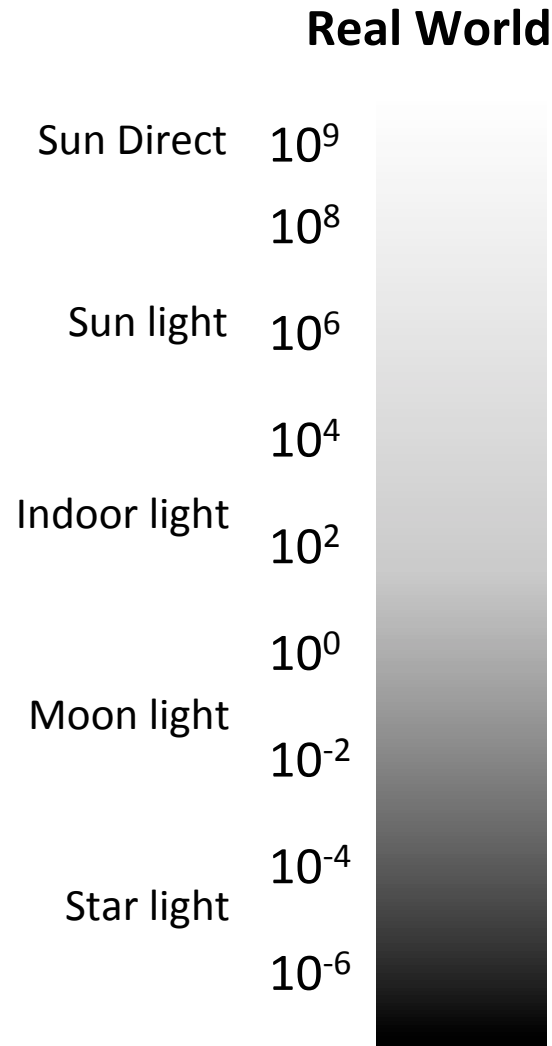


# HDR in 5 minutes!

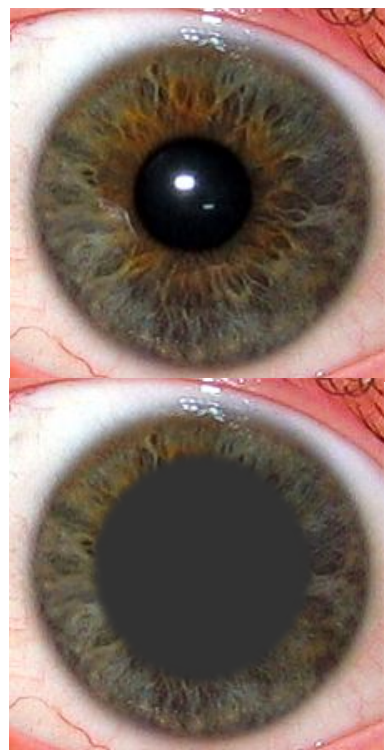
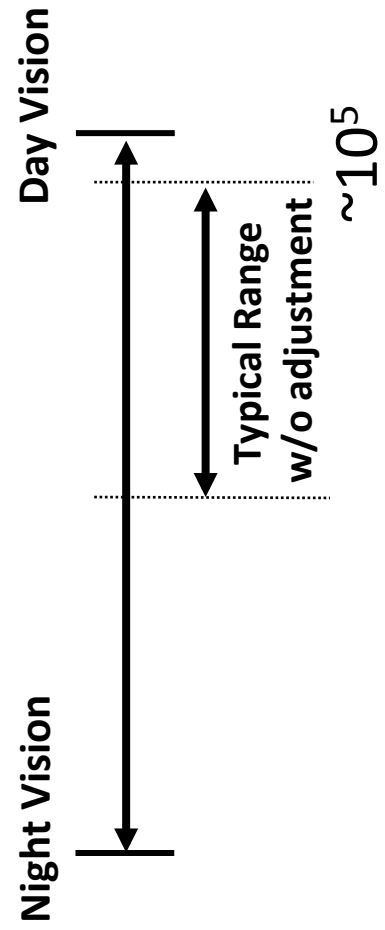


Luminance Levels

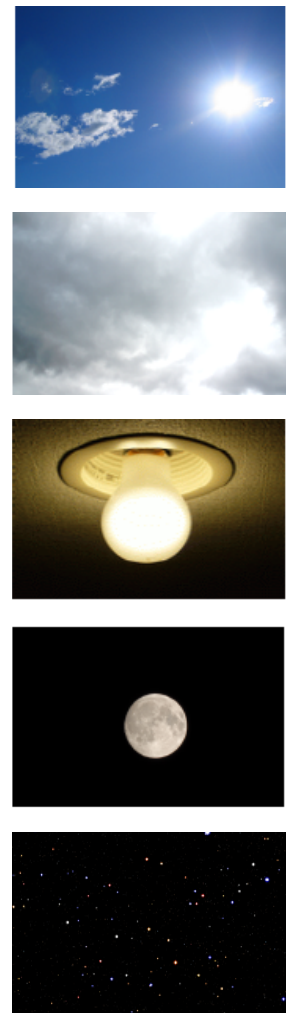
[cd/m<sup>2</sup>]



## Human Vision



# HDR in 5 minutes!

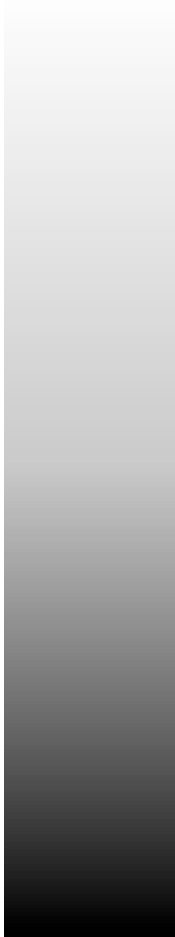


Luminance Levels

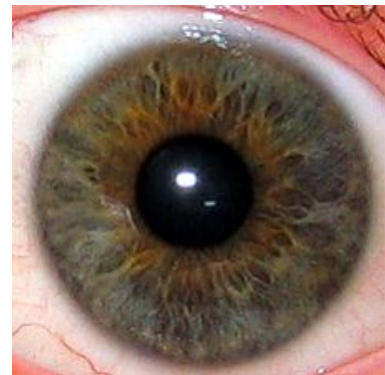
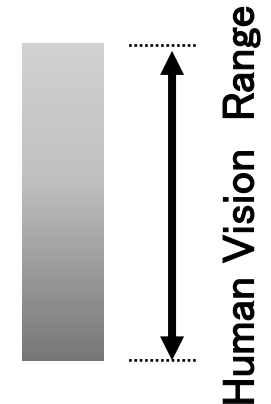
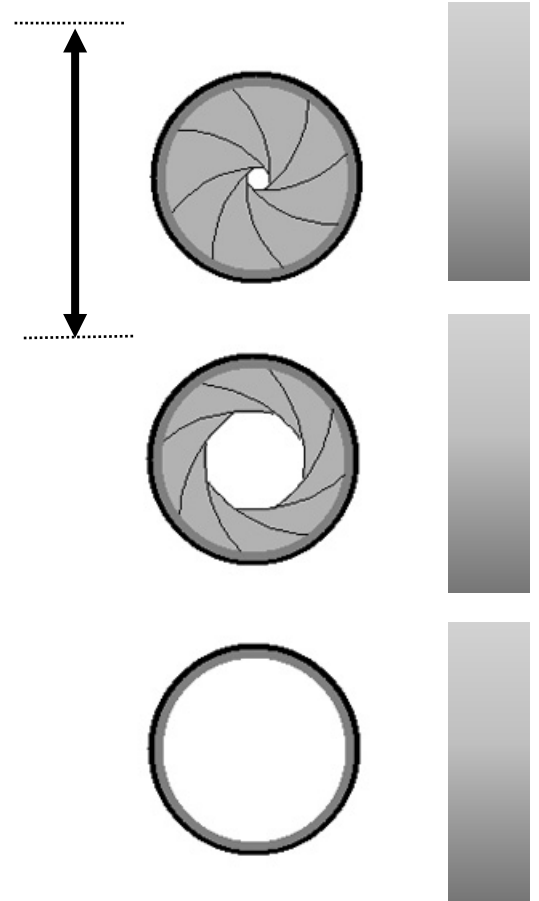
[cd/m<sup>2</sup>]

Sun Direct	10 <sup>9</sup>
Sun light	10 <sup>6</sup>
Indoor light	10 <sup>2</sup>
Moon light	10 <sup>-2</sup>
Star light	10 <sup>-6</sup>

Real World



Camera Iris

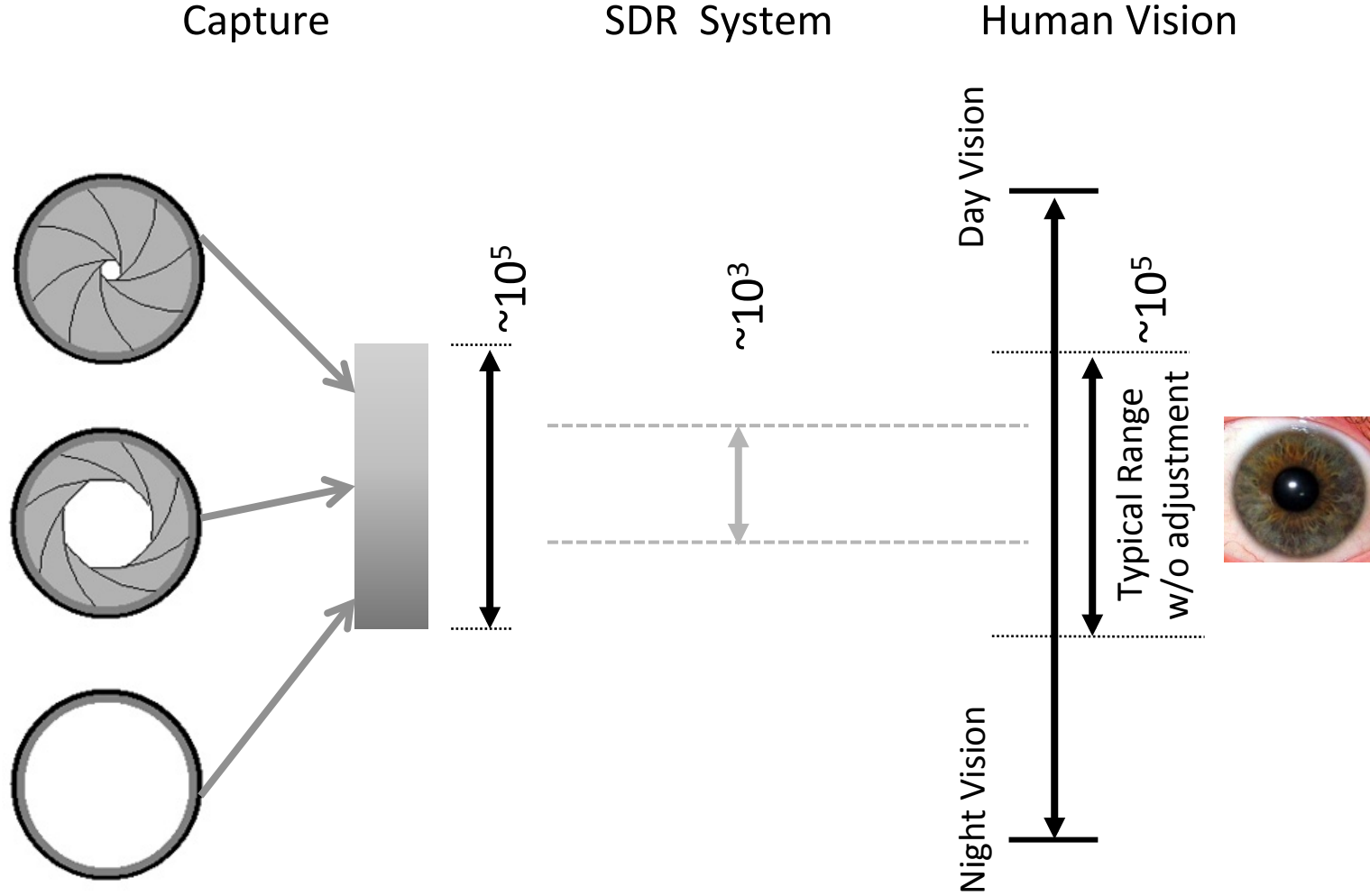
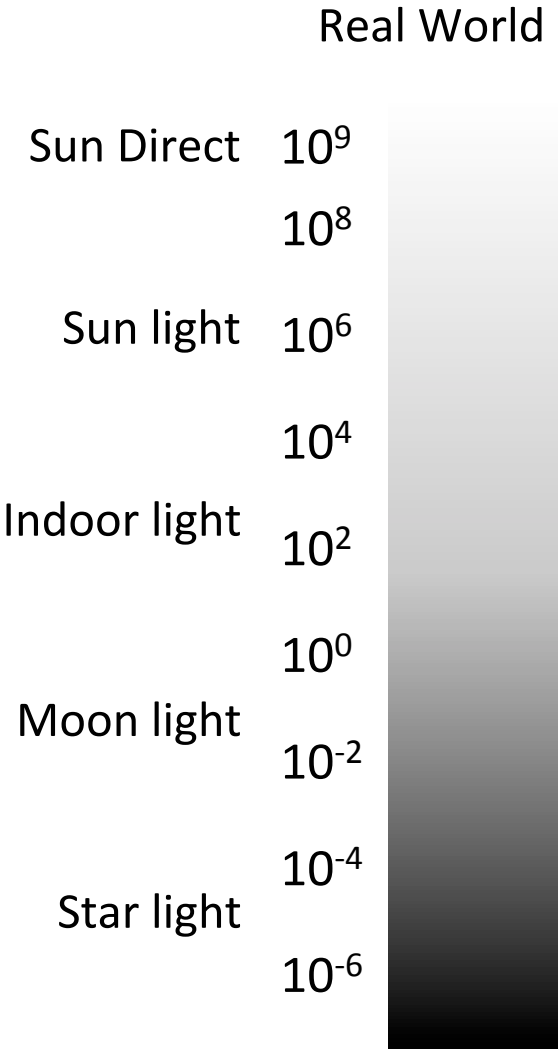


# HDR in 5 minutes!



[cd/m<sup>2</sup>]

**Luminance Levels**

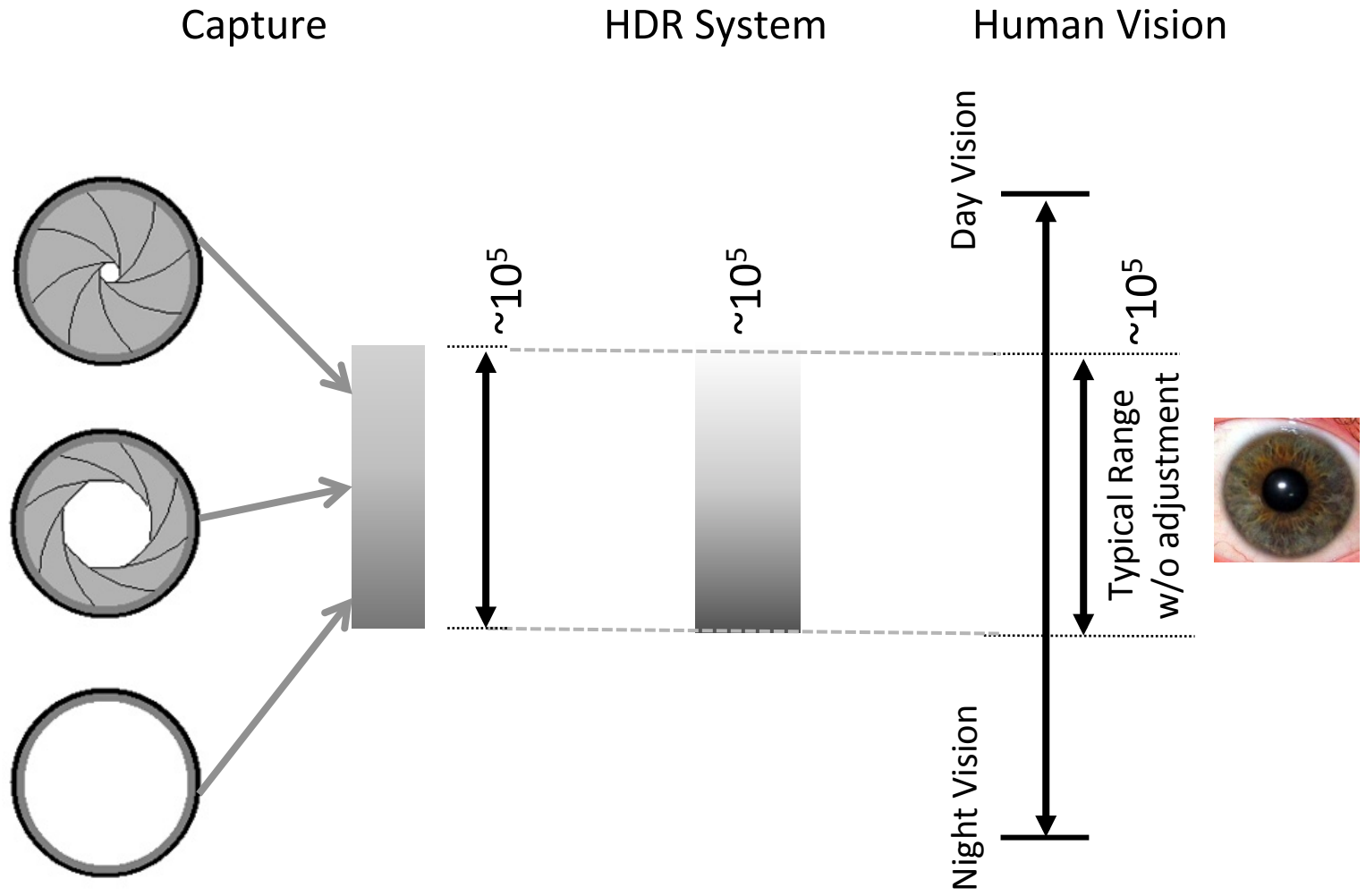
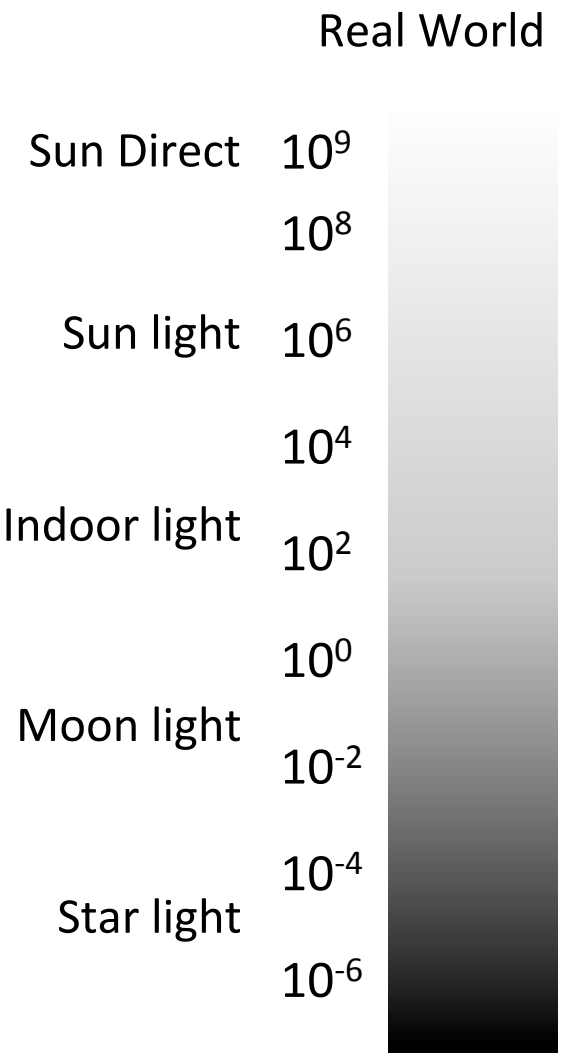


# HDR in 5 minutes!



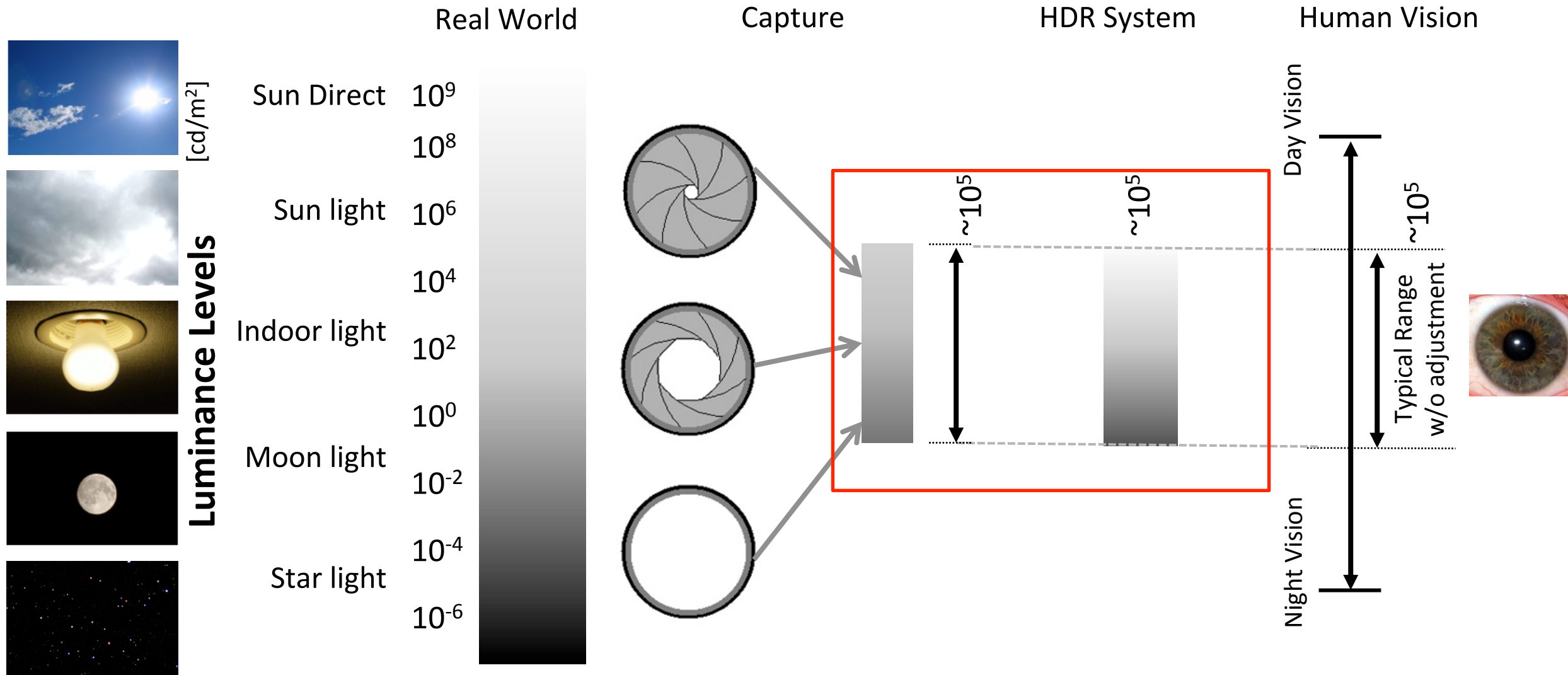
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Luminance Levels

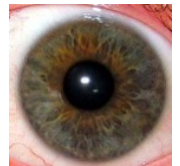
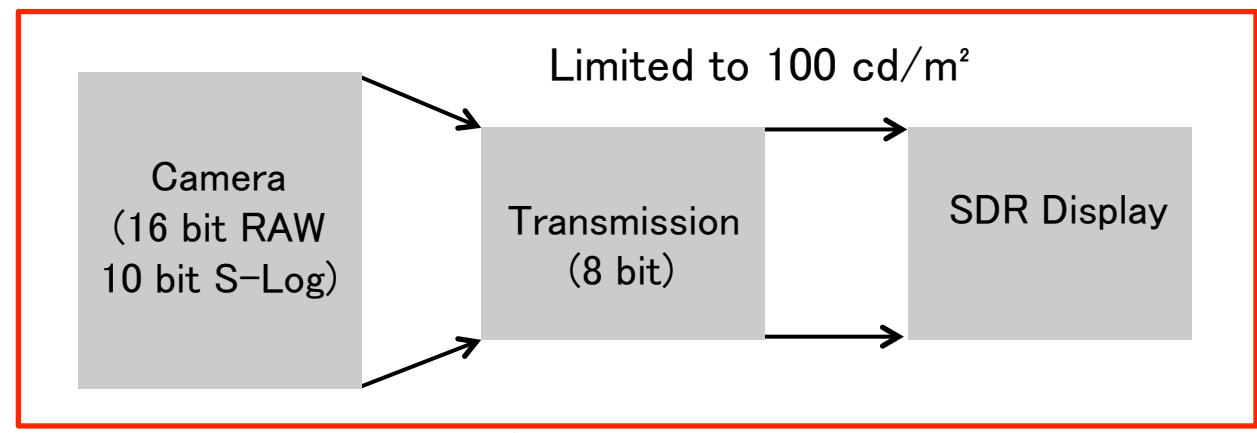
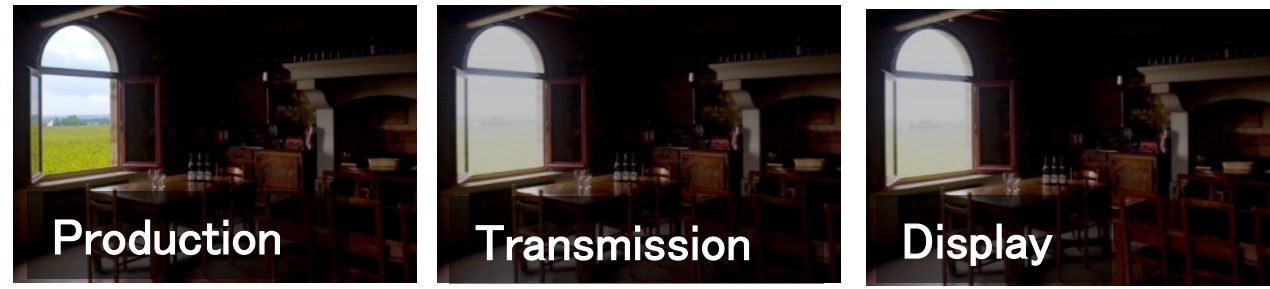
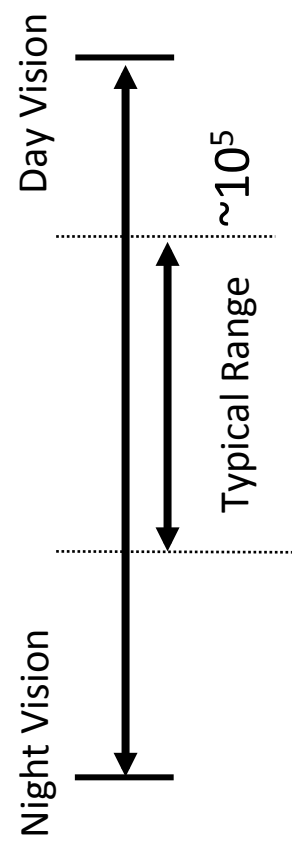




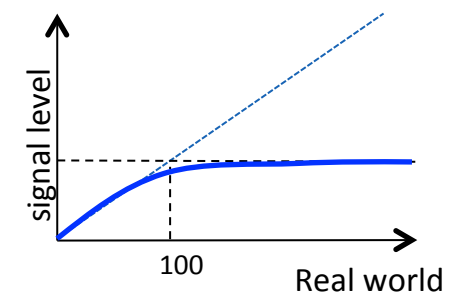
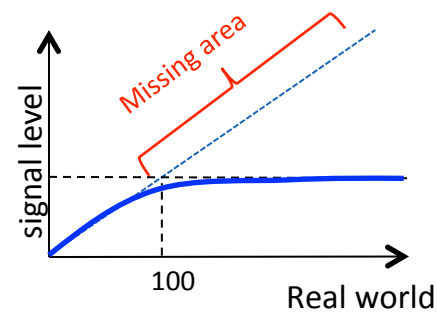
# HDR in 5 minutes!



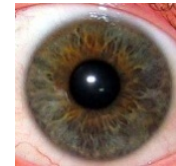
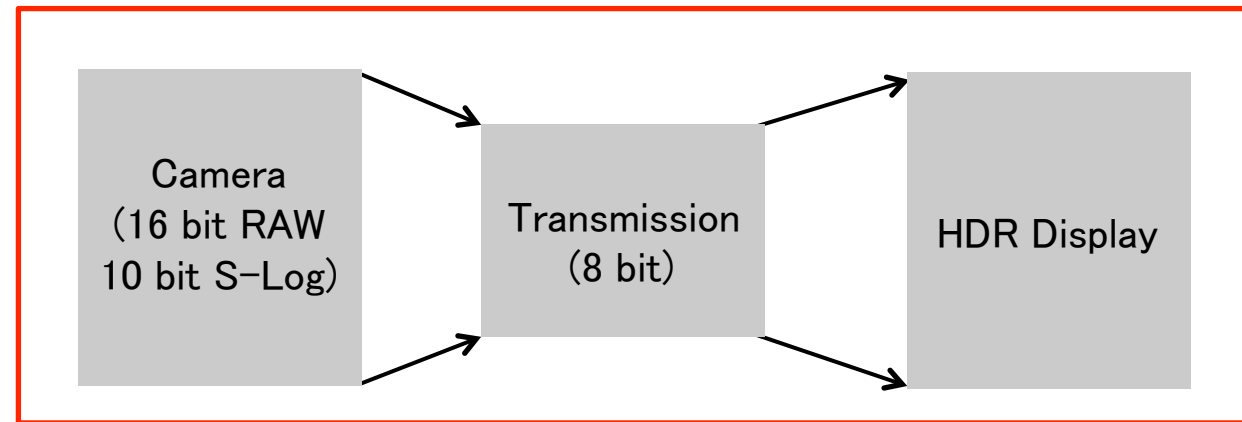
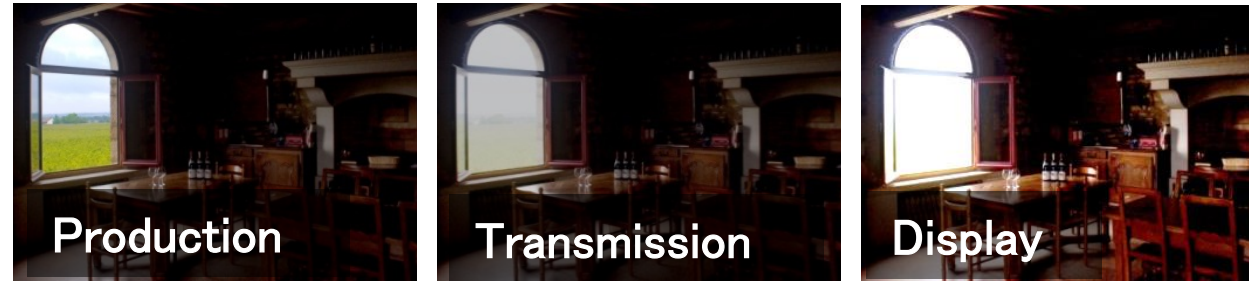
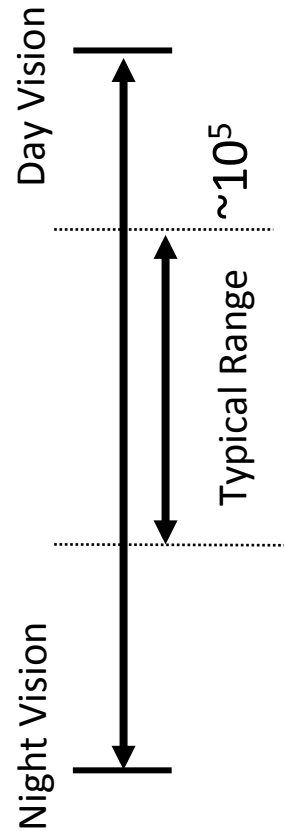
# HDR in 5 minutes!



**Compress**

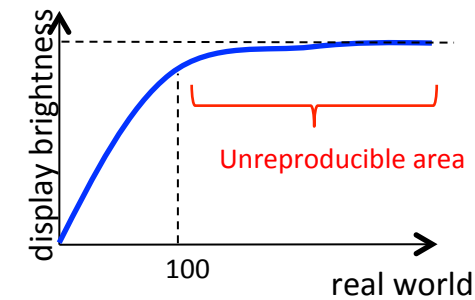
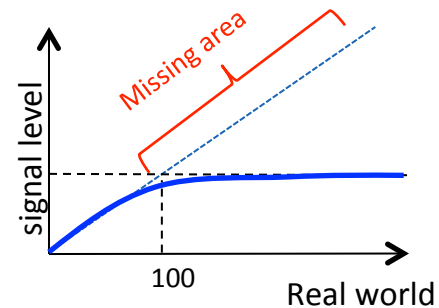


# HDR in 5 minutes!

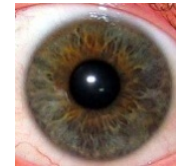
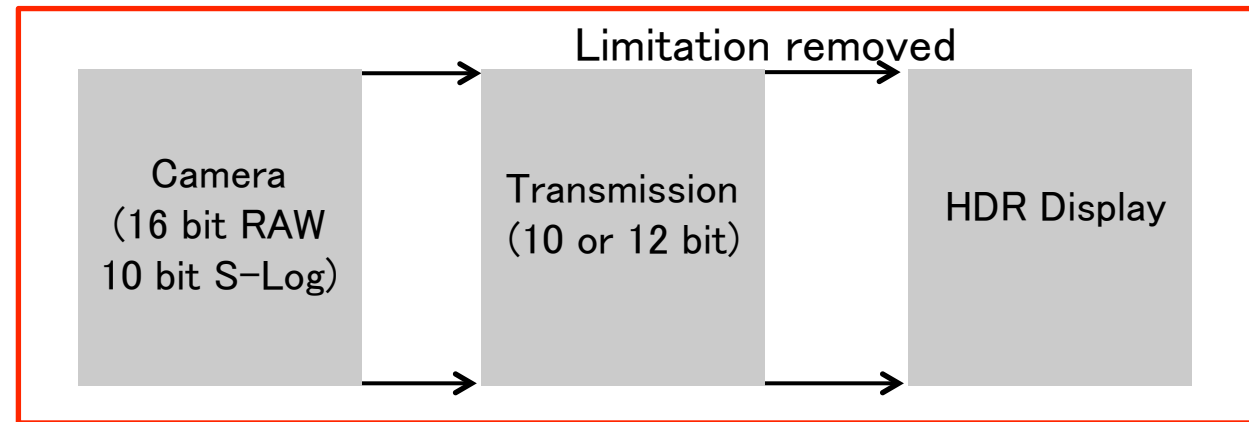
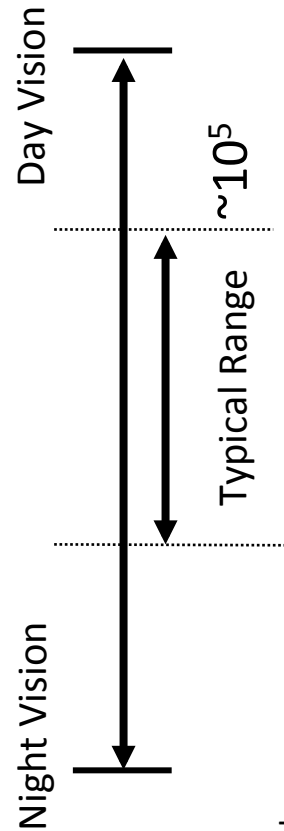


**Compress**

**Expand**



# HDR in 5 minutes!



**Data compression**

**Display mapping**

