Leader

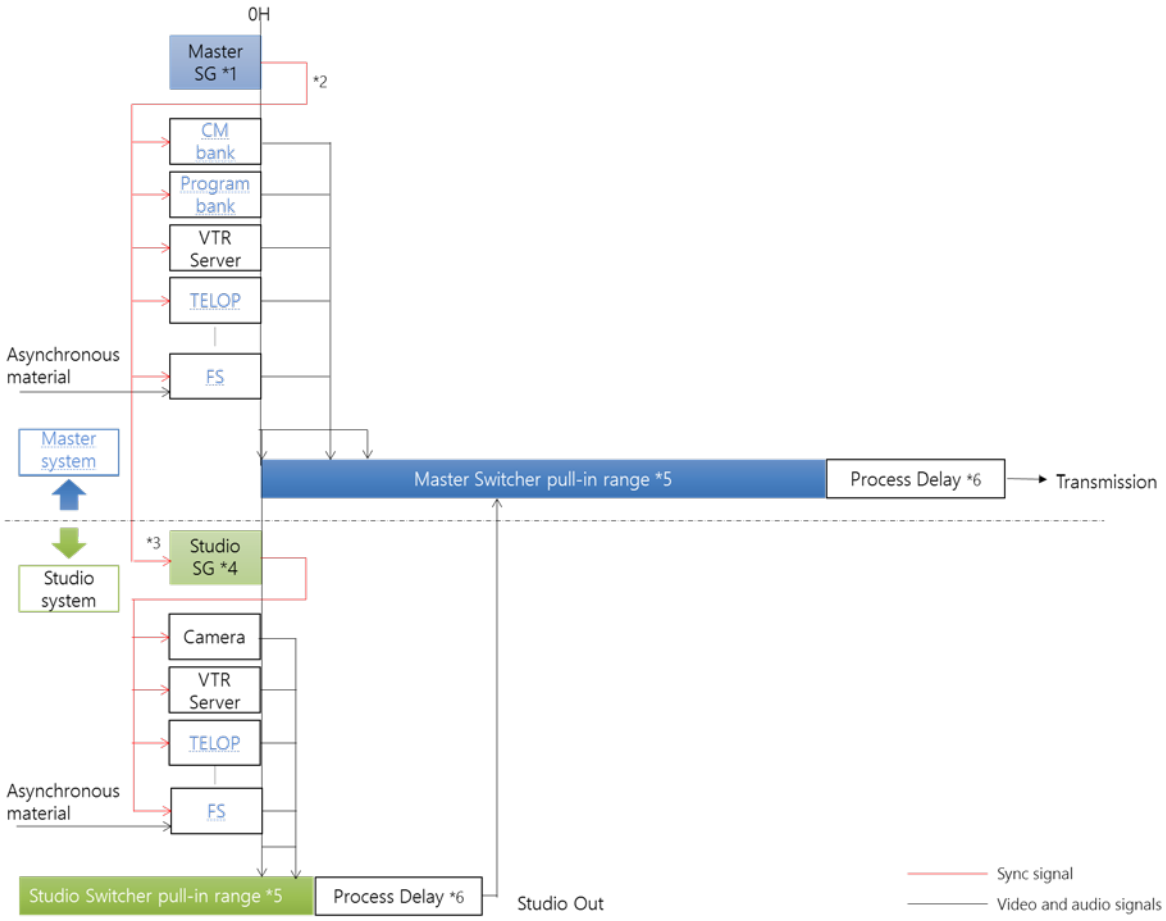
Leader Electronics Corporation Technical Information Series Vol. 01

Broadcast System Outline

The terms displayed in blue on each page are define in the glossary at the end of this document.

The content of this document is as of October 2018.

01 Conceptual Diagram of Phase in Broadcast Station



*1: Master Sync Generator
A sync generator installed in the master system.

*2: In-station synchronization signal
Also called house sync, this is the reference synchronization signal put out by the station's master sync generator. A black burst (BB) signal is used.
All systems in the station are locked to the synchronization signal output from Master Sync Generator.

*3: Sync signal Master-Slave SG
When the SG is installed in a receiving-side studio system or the like without the equipment or systems directly receiving the in-station synchronization signal distributed from the master, the receiving-side SG is called the slave side.

*4: Inter-room phase adjustment
If the studio output signal is delayed in relation to the pull-in range of the master switcher or the studio input signal is delayed in relation to the pull-in range of the studio switcher, the phase between the rooms is adjusted by advancing or delaying the output phase of the SG installed in the studio relative to the master SG. (See next section.)

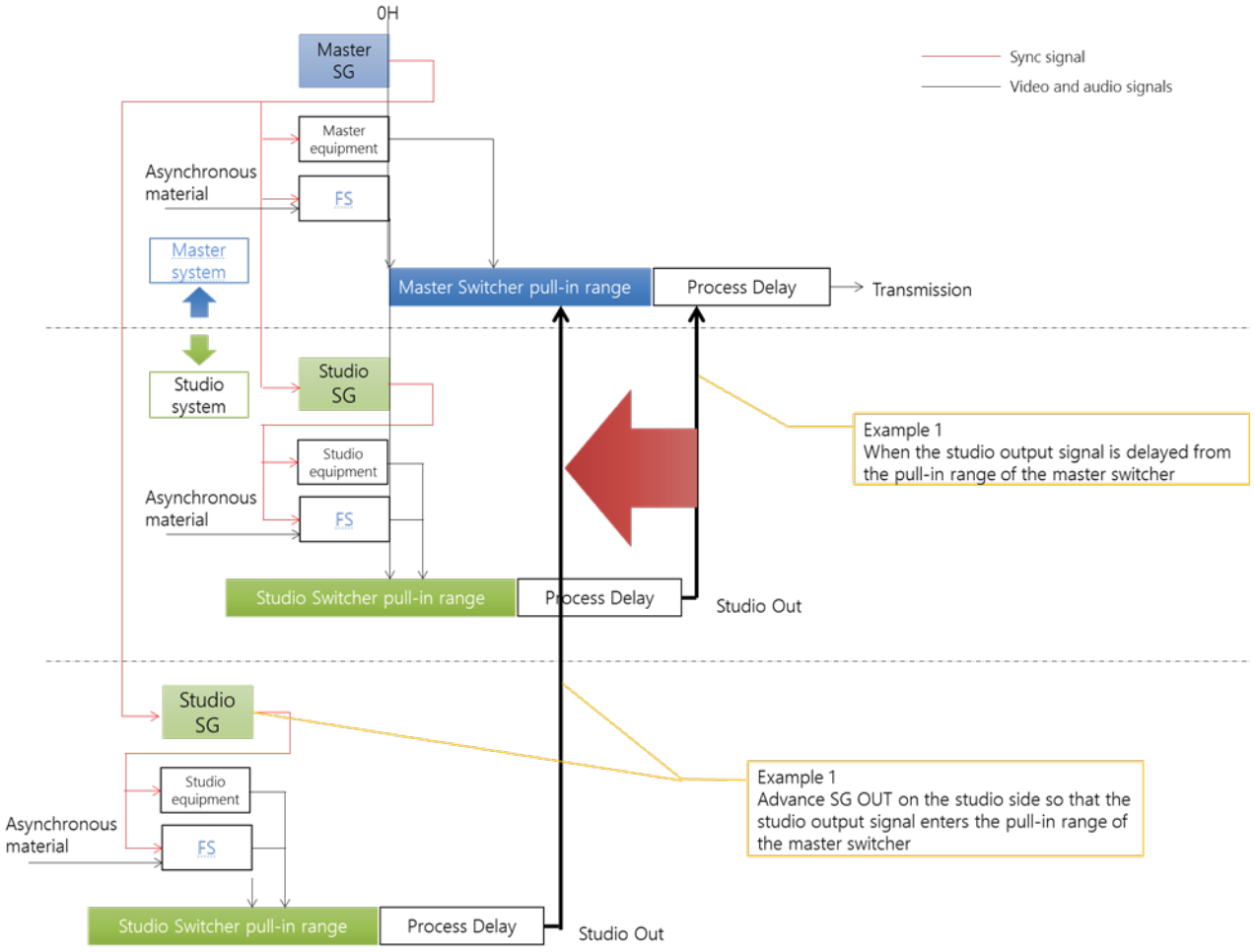
*5: Master/Studio Switcher pull-in range
This is also called the input window.
If the phase of the input signal of the switcher is within the pull-in range, the output of the switcher is output in the same phase. If it is outside the pull-in range, the video signal is delayed by 1H.
The pull-in range function is sometimes called Automatic Video Delay Line (AVDL).

*6: Process Delay
Delay time for processing for synthesis or keying of the video signals input to the switcher.

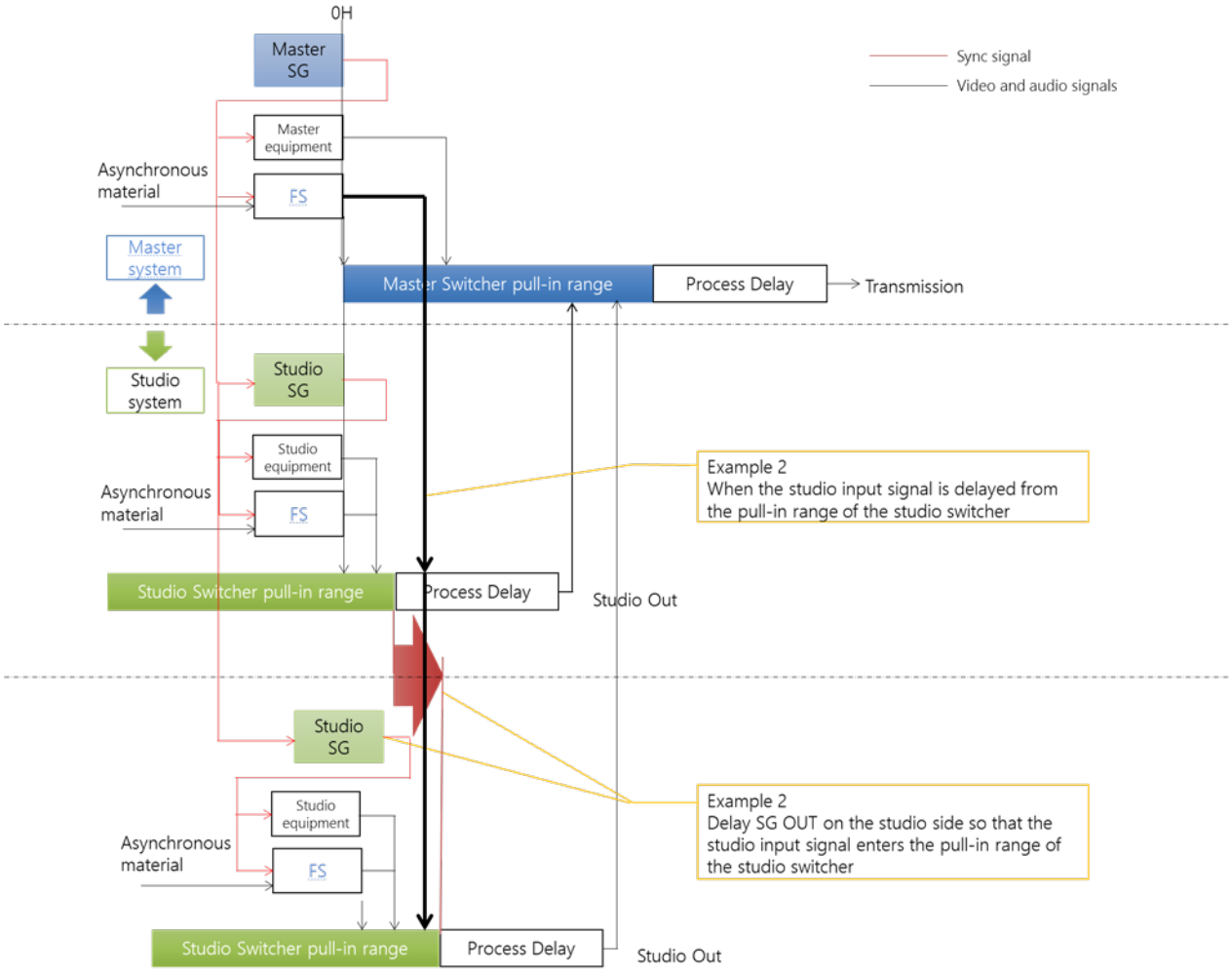
02 Inter-Room Phase Adjustment Example

If the studio output signal is delayed in relation to the pull-in range of the master switcher or the studio input signal is delayed in relation to the pull-in range of the studio switcher, the phase between the rooms is adjusted by advancing or delaying the output phase of the SG installed in the studio relative to the master SG.

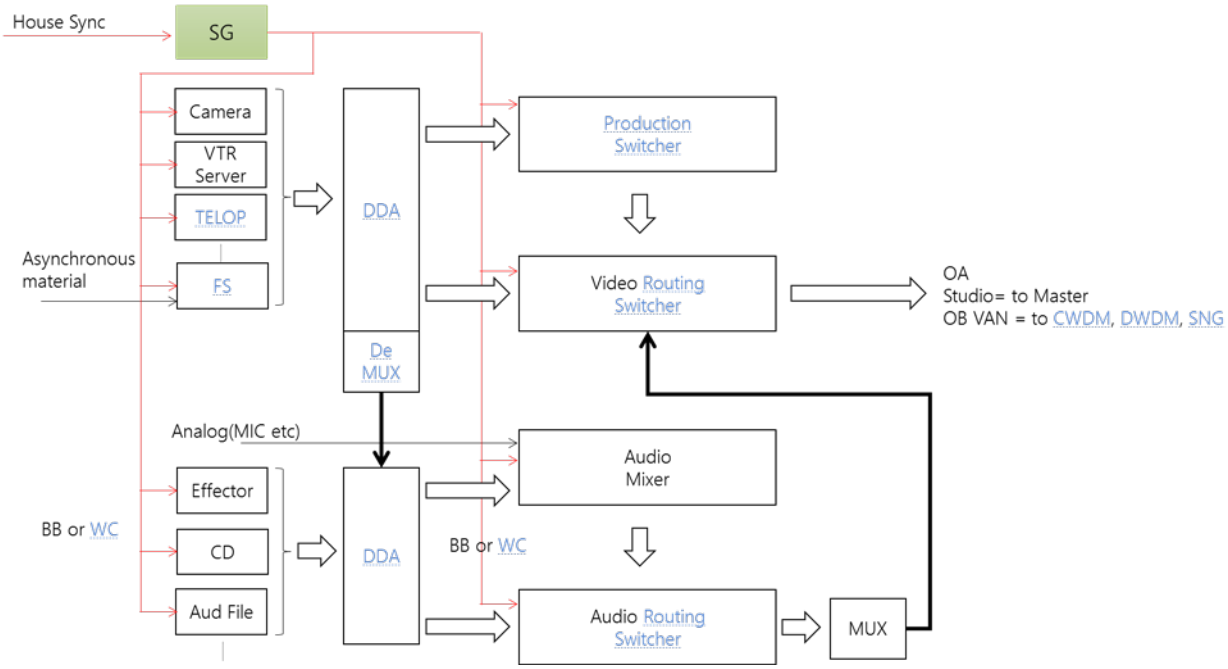
Example 1



Example 2

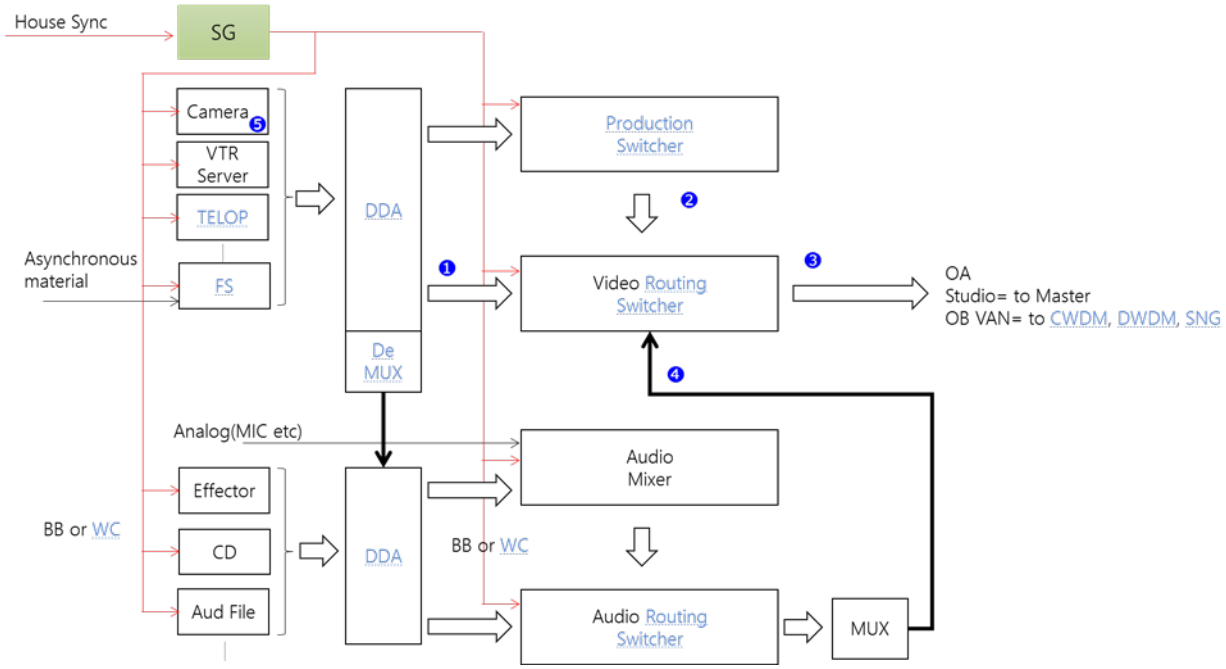

0H
Master SG
Master equipment
Asynchronous material
FS
Master system
Master Switcher pull-in range
Process Delay
Transmission
Sync signal
Video and audio signals
Studio system
Studio SG
Studio equipment
Asynchronous material
FS
Studio Switcher pull-in range
Process Delay
Studio Out
Example 2
When the studio input signal is delayed from the pull-in range of the studio switcher
Studio SG
Studio equipment
Asynchronous material
FS
Studio Switcher pull-in range
Process Delay
Studio Out
Example 2
Delay SG OUT on the studio side so that the studio input signal enters the pull-in range of the studio switcher

03 LIVE System (Outside Broadcast Van/Studio) Configuration Example



- The outside broadcast van is said to be a moving studio system, and there is no big difference from the viewpoint of the video and audio systems.
- The studio system is operated with a synchronization system locked to House Sync from the master, but the outside broadcast vans normally do not operate with House Sync, and instead the SG operates in Internal Mode.
- When two or more outside broadcast vans operate in a linked manner, one is used as the synchronization master, and the other outside broadcast van receives the synchronization signal of the master outside broadcast van and operates in the slave state.
- Either BB or WC (Word Clock, Sync) is used as the sync signal for audio equipment.

04 Waveform Monitor Application for Configuring a System



(1) Verification of the output phase of the system equipment (against the reference sync signal of the system), verification of quality (error check)

(2) Verification of the output phase of the Production Switcher (against the reference sync signal of the system), verification of quality (error check)

(3) Verification of the output phase of the studio and outside broadcast vans (against the reference sync signal of the system), verification of quality (error check)

(4) Verification of the audio system output (between channels, etc.), verification of quality (error check)

(5) Adjustment of camera output signals In addition to LEVEL and AIRS Follow, there are adjustment items such as BLACK SHADE, PEDESTAL, GAIN, GAMMA, and FLARE.

The above-mentioned waveform monitor is installed at the VE (Video Engineer) desk/seat, and monitoring and checking are conducted by switching the signals via the Video Routing Switcher. Applications (1) through (4) are not limited to the LIVE system; they apply equally to other systems (Master, etc.).

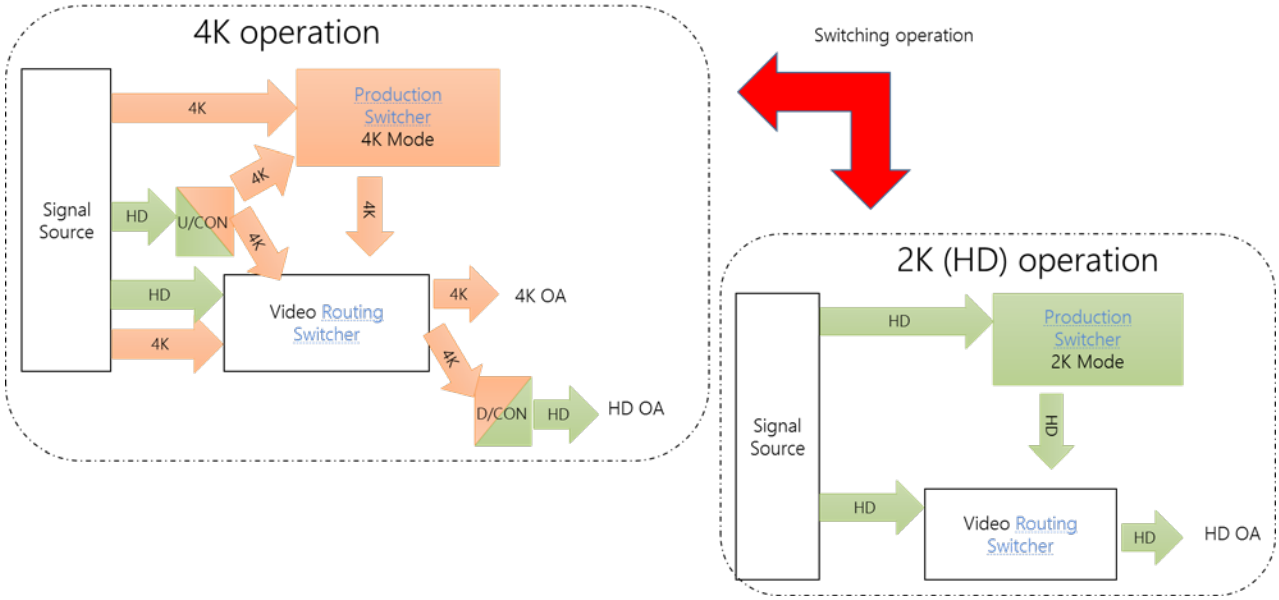
One waveform monitor for adjusting camera output signals (5) can be installed along with one camera remote panel on each camera, or one waveform monitor can be installed for multiple (3 or 4) cameras and used in 3-waveform or 4-waveform monitor mode. A rasterizer is often used in case (5).

05 4K LIVE System (Outside Broadcast Van/Studio) Configuration Example

Example 1: Switchable System

During 4K operation, the system is operated at 4K, and the 4K D/CON signal is used for 2K (HD) broadcasting.
During 2K(HD) operation, the system is switched from 4K and 2K (HD).
When only 2K (HD) broadcasting is done, management of the 4K signal, which are not used, is unnecessary, and since the 2K signal, which is the main signal, does not pass through the D/CON process, the quality of the 2K (HD) signal is guaranteed without depending on the D/CON performance.
During 4K operation, the 4K signal is the main signal, and if 2K broadcast is not really considered, this is considered to be advantageous.

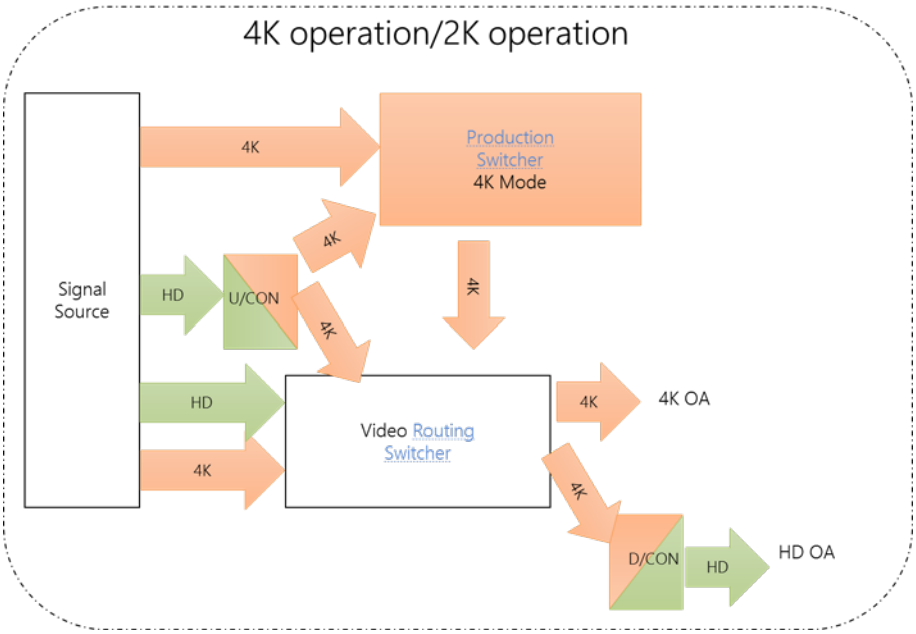
* D/CON: Down converter
* U/CON: Up converter



Example 2: UP DOWN System

The system configuration is the same as that for 4K operation of a switchable system, and the 4K D/CON signal is always used for 2K (HD) broadcasting.
This has the operational merit of eliminating the management, time, and labor requirements of switching the system between 4K and 2K (HD).
This is considered advantageous when 4K broadcasting is always used.
Since 2K broadcasting always necessitates 4K → 2K D/CON processing, attention must be paid to D/CON equipment selection. Besides resolution conversion performance, P→I conversion processing and performance verification are important.

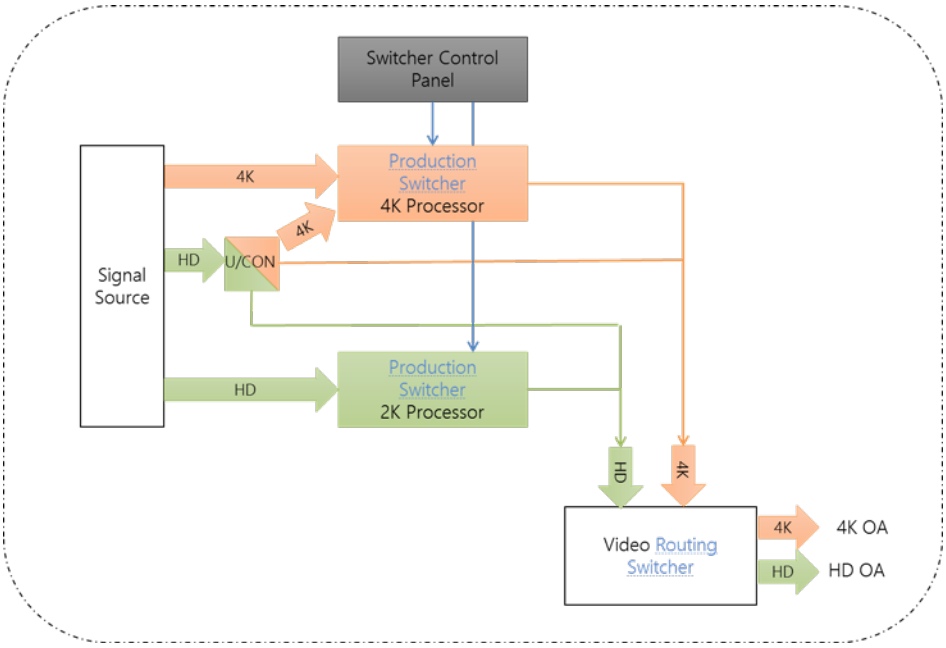
* D/CON: Down converter
* U/CON: Up converter



Example 3: Simul (Dual Processor) System

This approach consists in providing separate Production Switcher processors for 4K and 2K (HD), with production done on one control panel.
The 4K and 2K (HD) signals are processed by separate processors, and since the main line for 2K (HD) broadcasting does not pass through D/CON, the quality of the 2K (HD) signal can be guaranteed without depending on the D/CON performance. In addition, this has also the merit of eliminating the switching management, time, and labor requirements of a switchable system.
However, because two processors are installed, this approach is more costly.

* D/CON: Down converter
* U/CON: Up converter



06 HDR ↔ SDR Conversion and Color Space Conversion in UHD Production (BT2020 ↔ BT709)

There are the following four color space and intensity combinations for the SYSTEM MODE for UHD production.

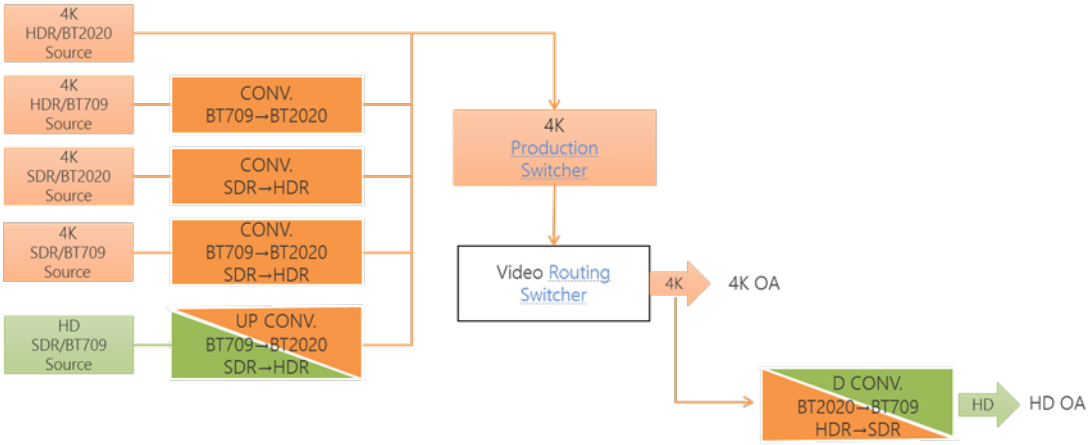
MODE	Intensity	Color Space
1	HDR	BT2020
2	HDR	BT709
3	SDR	BT2020
4	SDR	BT709

The production SYSTEM MODE is determined according to the broadcast format.
When the materials for UHD production is a mix of HDR/SDR, BT2020/BT709, materials that differ from the SYSTEM MODE are converted to the color space and intensity required by the SYSTEM MODE and production is then done in a unified format.

In the case of 2K(HD), SDR/BT709 is used, so when performing down-conversion of 2K (HD) from UHD production, color space and intensity conversion are required.

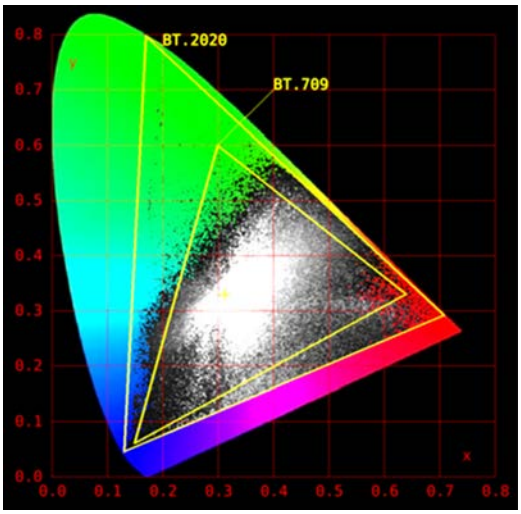
* D/CON: Down converter

Example when SYSTEM MODE = HDR/BT2020



07 Wide Color Space (BT 2020) ↔ Narrow Color Space (BT 709) Conversion Method

As a general method of converting the color space, the RGB values of the original color space are multiplied by the linear matrix and converted into RGB values of the converted color space.
When converting from BT2020 to BT709, colors outside the color space that can be expressed in the BT709 color space cannot be reproduced.
There are known methods for clipping RGB values that fall outside the BT709 color space after conversion to BT709, and conveying as much BT2020 color space information as possible by adjusting chroma with tone mapping.

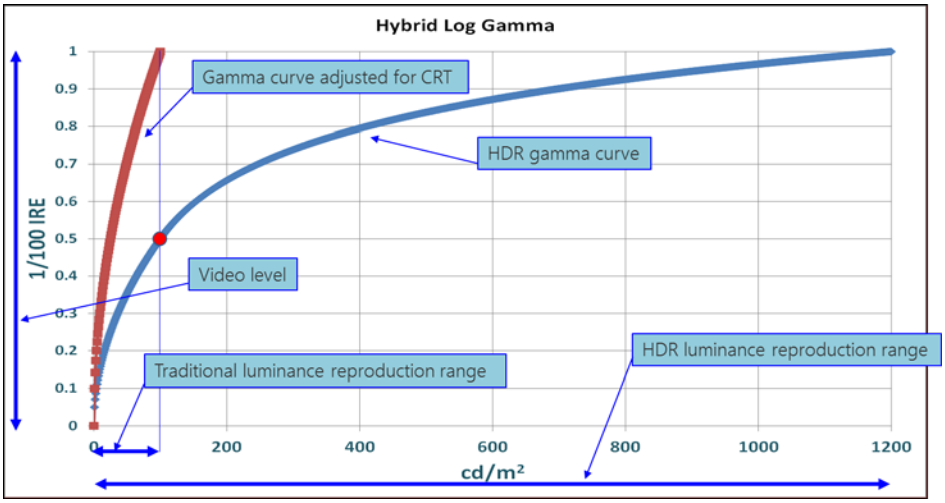


Example of BT2020 → BT709 conversion after matrix calculation

Method	Description of Conversion	Merit	Demerit
Tone mapping method	During wide color space output, converts by calculation wide color space into narrow color space so that even color information outside the narrow color space can be transmitted.	Wide color space information is transmitted to some extent.	Reduced contrast and overall change in colors may result.
Clipping method	During wide color space output, clips color information that falls outside the narrow color space by converting it to the maximum values of the narrow color space.	Colors are accurately maintained in the narrow color space range.	Information outside the narrow color space becomes solid and the image quality may be impaired.

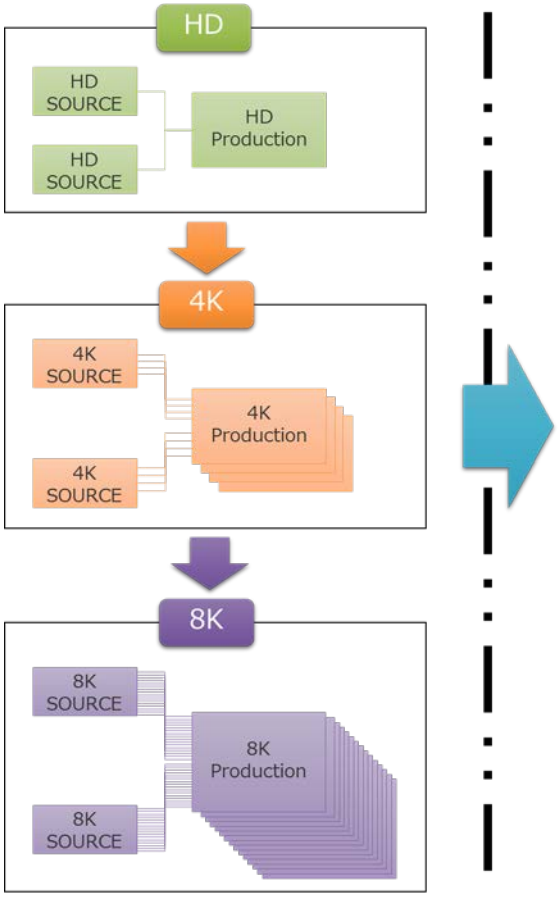
08 HDR / SDR

High Dynamic Range (HDR) technology capable of expressing brightness more than 10 times greater than that of conventional broadcasting was made into an international standard, BT.2100, in 2016.
SDR ↔ HDR conversion requires changing the dynamic range, and this involves tone mapping, gamma characteristics conversion, knee adjustment, etc.



* When 50% is set as the reference white in the HLG method

09 HD→UHD (4K→8K) Migration

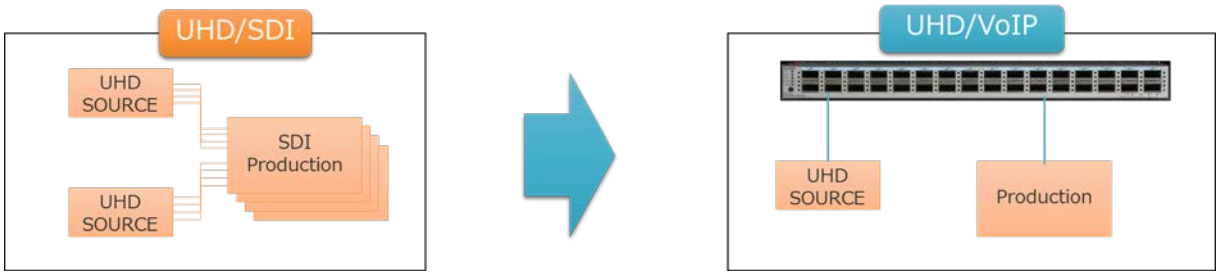


Comparison of SDI and IP transmission

	12G SDI	VoIP Video over IP
Merits	Same operation as before, various kinds of management are possible. Video output is possible just by connecting.	General-purpose IP switches can be used. Scalability, scale merit, and cost merit through use of general-purpose IP switches. Freedom from transmission distance constraints through use of optical fiber cable. Elimination of restrictions on the installation location of equipment makes it possible to realize equipment centralization and remote production. Compatibility with other IT-based systems and sharing of resources
Issues	Limitation on transmission distance of coaxial cable. System size, router size, cost, space Limitation on high frequency characteristics	Acquisition of knowledge about new IP equipment such as IP address setting, human resource development IP signal blanking switching

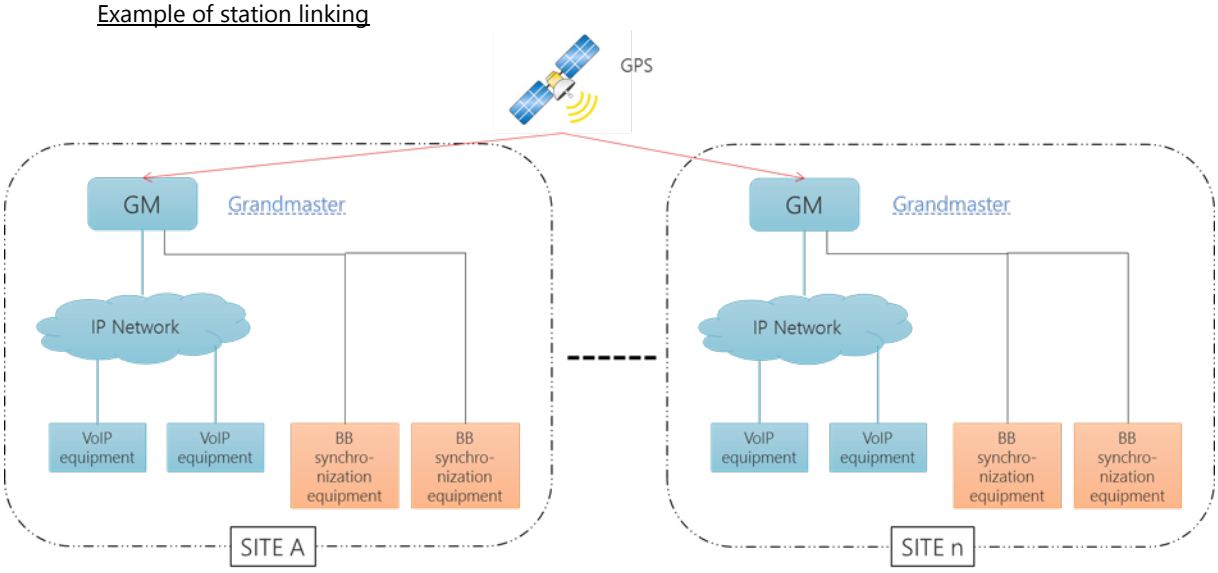
* SDI transmission	* Uncompressed IP transmission line
HD=1.5G SDI x1	10Gbps
4K=3G SDI x4 or 12G SDI ×1	25Gbps or 40Gbps
8K=3G SDI x16 or 12G SDI×4	100Gbps

10 IP System Synchronization Concept



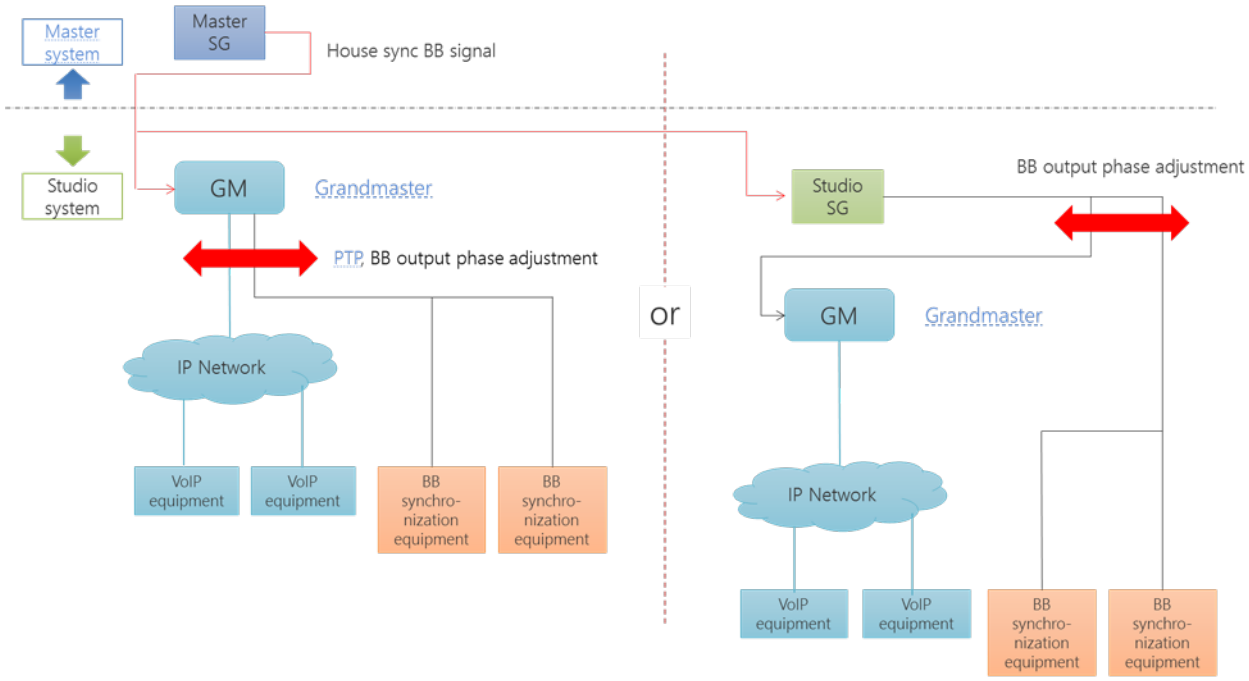
Blanking switching is a function that is not necessary for IP, but is an essential requirement in the broadcasting industry.
Blanking switching of IP signals is realized by using PTP (Precision Time Protocol), which is a time synchronization protocol conforming to SNMP ST 2059-2.

Example of station linking



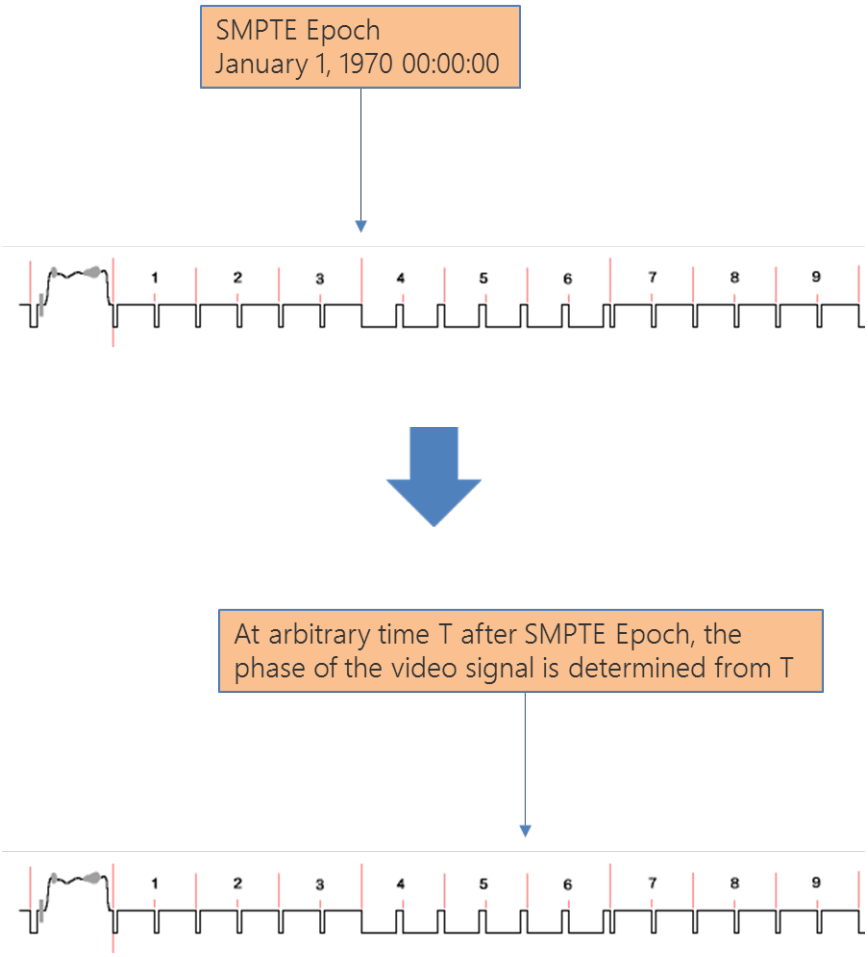
In the case of frame synchronization between in-station systems, when it is difficult to receive GPS signals in all systems (rooms), or if the BB synchronization signal of the master system is House Sync and the reception side system advances/delays the phase relative to the master House Sync for phase adjustment among the rooms, it may not be possible to link everything by GPS as in the case of inter-station linkage. In this case, the GM must have a function to adjust the PTP and BB output phases according to the BB signal of master House Sync.

Example of inter-station linking



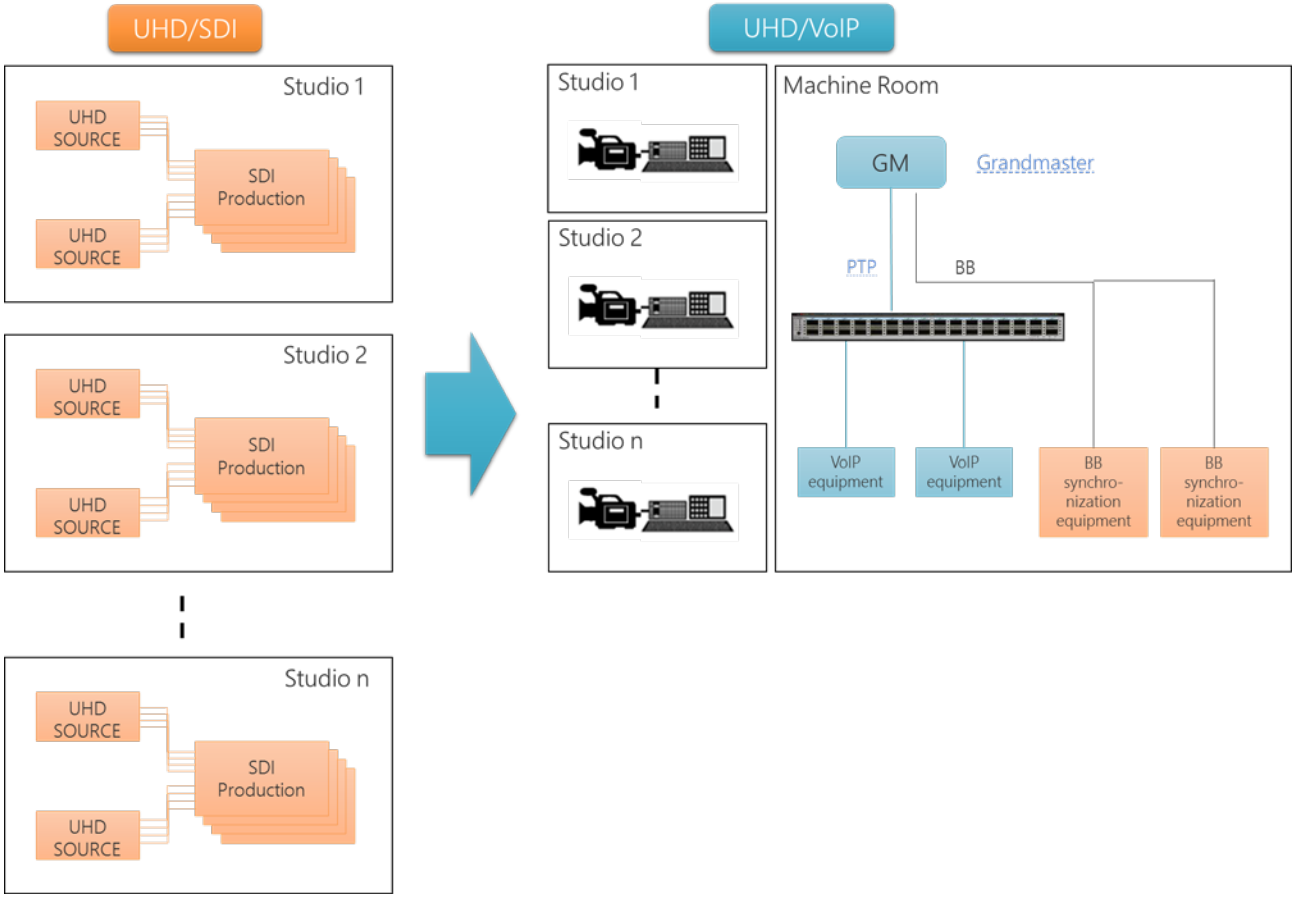
11 Relationship between PTP and Synchronization Signals

The starting point on the time of the video signal is defined so that the phase of the video signal is determined from the time.
SMPTE Epoch was defined with January 1, 1970 of TAI (Temps Atomique International) as the starting point.
SMPTE Epoch was defined at the falling edge of the vertical drive signal.
SMPTE ST 2059 defines a phase calculation method, among other things.
Obtaining the time from PTP allows determination of the phase of video signals.



12 IP System Construction Example (Remote Production)

Remote production is a system that allows the reduction of personnel expenses and time required to set up relay sites by, for example, installing only a camera at the relay location without dispatching outside broadcast vans, and operating the camera at the TV station head office via the IP network.
The elimination of restrictions on the installation location of equipment makes it possible to realize equipment centralization and remote production.



13 Glossary

Term	Definition
CWDM / DWDM	= Coarse / Dense Wavelength Division Multiplexing Output by multiplex transmission by optical fiber. DWDM offers better bandwidth but it is more difficult to handle it is also more expensive.
DDA	Signal distributor. Sometimes a selector function is provided.
DeMUX	= Demultiplexer Device that separates audio from program material.
FS	= Frame Synchronizer Device that synchronizes an asynchronous video signal with an in-station synchronization signal. Built-in frame memory, timing adjustment of input video is done automatically.
Grandmaster	The network time synchronization system by PTP is composed of a master machine that supplies the reference time and slave machines that synchronize with the reference time by communicating with the master machine. The master machine is called the Grand Master Clock (GMC).
Production Switcher	Used to select between various video sources as well as mix video and add special effects.
PTP	= Precision Time Protocol A technology to synchronize devices connected by LAN with high accuracy. PTP allows synchronization with an accuracy of 100 nanoseconds or greater. Defined in IEEE-1588.
Routing Switcher	A device that can freely control signal flow with multiple inputs and multiple outputs. Program material is automatically distributed to each line.
SNG	= Satellite News Gathering A relay system that uses communication satellites. A collective term for systems that transmit video and audio, which are program material from a relay destination, to radio stations via satellite through radio waves.
Sync	Refers to a composite sync signal (a signal obtained by taking a color burst signal from a black burst signal), or a horizontal sync signal or vertical sync signal.
TAI	= Temps Atomique International International Atomic Time. An internationally defined and managed time standard in which time kept by atomic clocks is called atomic time. TAI defines the second as “the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom”.

Term	Definition
TELOP	A data generation device for superimposing characters (for example superimposed subtitles) and graphics on images. Also called “superimposer.”
WC	= Word Clock Sync signal for audio synchronization. It is synchronized with the video synchronization signal with a rectangular wave of 48 kHz.
Gamma characteristics	Originally, this refers to the non-linear display characteristics of a display. More recently, it is used as a method to reproduce wide luminance information with the concept of HDR in mind and it is sometimes called EOTF (Electro Optical Transfer Function). Correcting nonlinearity of a display on the camera side is called gamma correction or inverse gamma, but like for EOTF, that concept has been expanded and it is sometimes called OETF (Optical Electro Transfer Function).
Keying	Processing that extracts or replaces part of the video and/or audio. Chroma keying removes only background colors such as blue backgrounds using during shooting, while luminance keying uses luminance information.
Tone mapping	This is a method for obtaining video with a dynamic range of another standard by compressing or expanding the dynamic range, changing levels, etc. It changes the tones of the entire image or part of the image.
Knee	This is a function to compress the luminance component of the video signal in order to keep the signal for high brightness parts of an object within the dynamic range of the camera, to prevent overblown highlights.
Program bank, CM bank	Equipment for saving programs and commercials and sending them according to the broadcasting service. They get the “bank” part of their name from that fact that they are like banks in terms of being repositories (in this case, data).
Black burst (BB) signal	An NTSC (or PAL) composite video signal composed of a composite sync signal and a color burst signal and whose video component corresponds to the black level. It is used as a synchronization signal.
Blanking switch	Blanking switching is switching a video signal to the same vertical blanking interval of another signal during the vertical blanking interval during which image scanning is not performed in order to allow replacement of the video signal in a way that does not disturb the image.
Master system	Equipment for sending out to the transmitter programs or commercials that have been produced at a studio in the broadcasting station or away from the broadcast station, according to the broadcasting service schedule.

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