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# The Right IP Format for the Right Job

## Designing Hybrid SDI/IP Workflows

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# The Right IP Format for the Right Job: Designing Hybrid SDI/IP Workflows

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## How We Got Here – From SDI Plants to IP Media Platforms

For decades, SDI has been the backbone of professional video: a deterministic serial transport that carries uncompressed signals over dedicated coax or fiber cable with built-in timing and very low, fixed latency. It replaced analog without forcing facilities to abandon existing cable plants and routing concepts, and successive generations (HD-SDI, 3G, 6G, 12G) extended the same model to higher resolutions and frame rates. In parallel, compression emerged first for contribution and distribution, enabling links such as satellite and early IP circuits to transmit high quality video at manageable bit rates.

As file-based workflows took hold and compute power increased, more of the production chain shifted onto servers, workstations, and, eventually, cloud platforms. Editors, graphics, playout, monitoring, and analysis tools have become software-based products, but the underlying plant was still largely SDI.

IP video arose to bridge that gap by treating media as data on general purpose networks, but it did not arrive as a single, unified standard. SMPTE ST 2110 was developed for uncompressed, time-aligned essences and deterministic switching in engineered facilities. NDI focused on lightly compressed, software-centric workflows on 1 GigE networks. Dante AV extended a widely used audio-over-IP ecosystem to carry video alongside audio in installed AV spaces. Protocols such as SRT and RIST addressed a separate need: moving compressed streams reliably over imperfect WAN and internet paths, especially for contribution and backhaul.

Because each of these systems optimizes for a particular mix of quality, timing, cost, and complexity, none of them simply “replaces” SDI across the board. SDI still excels where simplicity and guaranteed behavior matter most; IP systems extend what is possible in terms of routing flexibility, remote production, and integration with compute, but usually in combination with, not instead of, existing baseband.

*SDI is a dedicated, real time signal path. IP is a media platform built with and for modern computing.*

# First Principles and Decision Dimensions

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## Three Forces that Drive Design

*Every IP or hybrid workflow is ultimately shaped by three forces:*

### **Quality and headroom**

Requirements for bit depth, color space, HDR, resolution, and channel count set a floor requirement for how much data must be carried through the system. A UHD HDR show with many feeds demands more headroom than a single HD program feed, and that directly influences whether uncompressed, lightly compressed, or distribution-grade formats are realistic.

### **Determinism and timing**

Live production only works when signals arrive in the right order, at the right time. Latency, jitter, sync tolerance and the need for clean switching determine how tightly clocks must be aligned and how much buffering is acceptable. Some workflows can tolerate seconds of delay; others fail if a stream arrives even one frame early or late.

### **Compute native workflows**

Modern production leans heavily on software tools, virtualization, cloud services, and AI/ML. How much of the workflow needs to touch general purpose compute, and where that compute lives, affects choices about format, transport, and where IP endpoints should sit.

## Decision Checklist

- **I/O scalability**

How many sources and destinations does the system need to support over its lifetime? SDI routing is constrained by the finite size of each hardware crosspoint core, whereas IP switch fabrics can scale horizontally to many thousands of endpoints across the network.

- **Latency and determinism requirements**

How much end-to-end delay is acceptable? Are frame-accurate cuts and tightly locked multiviews mandatory, or can the workflow tolerate noticeable delay and variation?

- **Image quality / HDR / UHD needs**

What resolutions, frame rates, color spaces, and HDR formats must be supported now and over the expected life of the system? Are there stages where a lower bit rate representation is acceptable, and stages where only uncompressed or near lossless will do?

- **Redundancy, resilience, and failure domains**

Which parts of the signal path must survive link, node, or device failures without interruption, and which can tolerate brief outages? How many independent paths or backup modes are supportable by the team?

- **Bandwidth constraints (on-prem and contribution)**

What are the real limits on switch capacity, inter-room links, campus or metro fiber, and long haul/WAN connections? Where is bandwidth plentiful, and where is it scarce or expensive?

- **Compute and storage budget (on-prem vs cloud)**

How much CPU, GPU, and storage is available locally, and how much can sensibly live in the cloud? Where does it make sense to move media to the compute, and where should compute be brought to the media?

- **Security, access control, and compliance**

Are there regulatory or corporate requirements around encryption, segmentation, auditability, or data residency that affect where media can flow and which transports or architectures are acceptable?

*Representation, transport, and physical are separate design decisions.*

- **Operational complexity and staffing**

What level of day-to-day complexity can the operations team support? Do they have networking and DevOps skills in house, or does the design need to favor simpler, more appliance-like approaches?

- **Vendor lock-in risk vs standards-based approach**

Where is it acceptable to adopt a closed ecosystem to gain speed or simplicity, and where is it important to remain anchored in open standards to preserve long term flexibility and bargaining power?

# Formats, Transports, and Physical Layers – A Simple Model

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The classic Open Systems Interconnection (OSI) model breaks networking into seven conceptual layers, from physical wiring up to applications, so engineers can localize problems and describe where protocols live. This paper collapses that into three practical layers, format, transport, and physical, so you can think about picture quality, network behavior, and cabling separately.

## The Three-Layer Stack

- **Video format/codec**

This is how the picture is represented: fully uncompressed, lightly compressed high quality, visually lossless mezzanine formats such as JPEG XS, or distribution-grade codecs like H.264 and HEVC. It dictates bit rate, visual headroom, and how much processing and storage are required.

- **Transport protocol**

This is how that representation moves over a network. Examples include ST 2110/IPMX for uncompressed essences in engineered fabrics, NDI for lightly compressed LAN production, Dante AV for AV-over-IP within the Dante ecosystem, and SRT for moving compressed streams over imperfect WAN links or the Public Internet.

- **Physical/link layer**

This is the actual wire or fiber: SDI and HDMI for point-to-point baseband, HDBaseT for long-run HDMI in AV installs, and Ethernet (1/10/25/100 GigE) over copper or fiber for IP networks. It sets distance limits, connector types, and, in practice, often constrains how much bandwidth is available per hop.

*ST 2110, NDI, Dante AV, and SRT/RIST do not compete for the same job. They fill different layers of the stack and different points in the workflow.*

## Representations of Video

- **Raw/uncompressed**

Full bandwidth SDI or ST 2110 video provides bit-exact pictures with minimal and predictable latency, ideal for timing-critical switching, color work, and monitoring. It tends to be used inside controlled facilities where bandwidth is plentiful, and determinism is paramount.

- **Lightly compressed mezzanine**

Formats such as JPEG XS or proprietary mezzanine schemes inside systems like NDI or Dante AV trade some bandwidth for more manageable data rates while maintaining low latency and high visual quality. These are common in production LANs, inter-room links, and some contribution paths where capacity is constrained but timing still matters.

- **Distribution grade compressed**

Codecs such as H.264 and HEVC are optimized for delivery and long haul contribution, not frame-accurate switching. They are used heavily in Acquire and Deliver stages, for example, sending feeds over SRT, or preparing OTT outputs, but are less suited to the inner loop of fast-twitch live production.

Signals commonly move between these representations across Acquire → Produce → Deliver.

## Where Common IP Systems Fit

### ST 2110 / IPMX

ST 2110 is an SMPTE standard for carrying uncompressed video, audio, and ancillary data as separate, time-aligned essences over IP. It is used as a deterministic core media fabric in studios, control rooms, and mobile production environments.

*The right IP stack is not a standard; it is the smallest set of formats and transports that meets your latency, quality, and compute requirements.*

IPMX is based on the same ST 2110 fundamentals and extends them for Pro AV use. It adds support for HDMI and VESA display formats, compression suitable for 1 and 10 GigE networks, and timing models that do not always require frame-accurate switching.

Both systems typically run on engineered or managed networks with multicast, QoS, and standards-based control. PTP timing is mandatory in broadcast-grade ST 2110 cores and optional in many IPMX focused AV deployments.

### NDI

NDI is a software-centric ecosystem that carries lightly compressed video over standard 1 GigE networks, with encoding/decoding and routing largely handled in software. It fits well in mixed PC/video environments, smaller studios, corporate and education facilities, and graphics-heavy workflows, where flexibility and quick deployment outweigh the need for fully deterministic, uncompressed operation.

### Dante AV and Dante audio

Dante is widely used for audio over IP in installed sound and broadcast/AV hybrid environments. Dante AV extends the same ecosystem to video, aligning video and audio routing and timing within a single managed system.

It is typically used in structured AV spaces such as boardrooms, classrooms, campuses, and houses of worship, where predictable behavior on standard gigabit networks and unified AV control are more important than maximum visual headroom.

### SRT

SRT is used for contribution and backhaul rather than as a full media system. It carries compressed streams reliably over lossy networks, with encryption, and is commonly used between sites, to and from cloud environments, or for remote participation.

*SRT is a transport, not a media format. It carries already encoded video streams reliably over lossy networks, with encryption, and is used for contribution and backhaul between sites, to and from cloud environments, or for remote participation.*

*In typical deployments, SDI and HDMI handle local point-to-point links, HDBaseT extends HDMI within rooms and venues, ST 2110 or Dante AV connect larger zones, NDI serves software-heavy nodes, and SRT bridges distant locations, each selected where its role aligns with the job.*

Table – Comparing Main IP Systems

Aspect	ST 2110	IPMX	NDI	Dante AV
Primary use case	Core media fabric in broadcast plants, OB trucks, and large control rooms; uncompressed, facility-wide routing.	Pro AV HDMI/PC-style and compressed video with HDCP and related display/control, based on the ST 2110 family but optimized for AV workflows.	Software-centric production on LANs; mixed PC/video environments and smaller studios.	AV routing in structured spaces; unified audio + video for rooms and campuses within the Dante ecosystem.
Typical representation	Uncompressed video, audio, and ANC as separate essences (ST 2110-20/30/40) in managed IP media cores.	Lightly compressed or uncompressed video plus audio and control; AV-friendly profiles derived from ST 2110/IP-related standards.	Lightly compressed video with audio embedded in the same stream.	Lightly compressed video with Dante audio carried in parallel over the same Dante network.
Network requirements	Engineered or managed 10/25/100 GigE fabrics with PTP, multicast, QoS, and bandwidth planning for predictable operation.	Managed 1/10 GigE media networks with multicast, QoS, DHCP-friendly behavior, and optional PTP; tuned for AV switch and display environments.	Typically 1 GigE LAN using standard switching; no strict PTP requirement.	Typically 1 GigE LAN with Dante clocking and managed switches suitable for real-time AV traffic.

Table – Comparing Main IP Systems (*cont.*)

Aspect	ST 2110	IPMX	NDI	Dante AV
Timing/ determinism	Built for deterministic, frame-accurate switching with PTP-based timing and well-defined buffering in the core.	Shares the same timing model and PTP foundations as ST 2110, but often deployed where looser timing and non-frame-accurate switching are OK.	Low latency, but timing characteristics depend on LAN design and endpoint implementation.	Tight AV sync within the Dante ecosystem; designed for predictable, room-scale and campus-scale behavior.
Typical latency	Sub-frame to a few frames through a well-designed core, depending on processing and path length.	Low to a few frames, depending on compression profile, processing, and AV use case (e.g. display extension vs. simple routing).	Low but variable; highly dependent on implementation choices and network load.	Low and bounded for typical room/campus links when the network is configured to Dante guidelines.
Operational complexity	Highest: requires IP media expertise, PTP design, multicast engineering, and broadcast-grade operations practices.	High–moderate: shares much of the ST 2110/IP media stack but targets AV workflows and tools, easing some operational and deployment aspects.	Moderate: easier to deploy; often managed by video/IT generalists and production staff.	Moderate: AV-focused; typically managed by AV/IT staff familiar with Dante audio workflows.
Integration focus	Broadcast infrastructure, multivendor interoperability, NMOS-based control, and deep integration with legacy SDI/IP.	Extension of the ST 2110/IP standards stack into Pro AV, bridging broadcast and AV workflows and enabling HDMI/PC-style device integration.	Software tools, graphics, small studios, streaming/production appliances, and cloud/hybrid.	Installed AV for rooms and campuses; crossover audio/video scenarios where Dante audio is already present.

# Notes on Control and Timing Behavior

## Determinism and Timing

In professional live television, deterministic behavior is mandatory. Determinism means timing is guaranteed: frames are generated, transported, and presented in a known order, at precisely defined instants, with tightly bounded delay through the chain. Without determinism, you do not get what you planned for; you get whatever the system delivers at that moment.

SDI plants enforce determinism with house sync (black burst or tri-level) and genlock. A common reference is distributed to cameras, switchers, servers, and multiviewers; each device locks its internal clock to that reference, so frame boundaries are aligned across the facility. The switcher cuts only on those boundaries. When devices are not locked to the same reference, frames drift, and you see switching artifacts, mis-timed keys, and loss of audio-video sync.

IP transport does not provide this timing behavior by itself. Media is carried as packets over shared networks, and packet forwarding is not aware of the video frame structure. Deterministic IP workflows, therefore,

introduce a precise network time and require media devices to follow it. In ST 2110 systems, this is done with PTP (Precision Time Protocol, IEEE 1588): a Time Transmitter distributes time, devices lock their clocks, and essences are timestamped against that clock. Receivers use timestamps and bounded buffers to realign streams and reconstruct frame boundaries so switching, keying, and monitoring happen at defined instants, not on best-effort packet arrival.

Hybrid SDI/IP facilities derive both house sync and PTP from the same clock. A timing generator outputs black burst/tri-level for SDI and PTP for IP, all locked to a disciplined source, typically GPS. SDI devices genlock to the video reference; IP devices lock to PTP; both follow one timebase. An SDI frame boundary and an IP timestamp then represent the same moment, and deterministic behavior extends across SDI and ST 2110 as a single system.

# Notes on Control and Timing Behavior

## Orchestration and Control

Orchestration is the function that keeps track of media devices, the streams they can send and receive, and how those streams are connected at any given time. Control is the set of mechanisms, panels, GUIs, and APIs, used by operators and automation systems to change those connections.

In SDI plants, routing is handled by the SDI router: inputs and outputs are fixed BNCs, and a crosspoint defines which input is connected to which output. Devices are not discovered; they are wired. Timing is provided by a facility-wide reference (house sync), to which the router and other video devices are genlocked, so that clean, synchronous switching is possible. Router control itself is concerned with managing crosspoints rather than device discovery or timing.

In IP plants, routing is expressed as streams on a shared network. Each device may expose multiple senders and receivers. Before a stream can be used, the system needs to discover the device, understand the formats each sender actually produces, and know how to instruct receivers to subscribe to specific streams. Orchestration maintains this model and applies changes when routes are added, removed, or modified.

In many ST 2110 systems, this is done using NMOS (Networked Media Open Specifications) from AMWA. NMOS IS 04 defines how devices and their resources register with a central registry and how other systems discover them. NMOS IS 05 defines how a controller requests a connection between a sender and a receiver and how that connection is applied. Other NMOS specifications cover related tasks such as channel mapping and system parameters.

In parallel, other orchestration and control frameworks are also used in practice, such as Ember+ and various vendor-specific controllers, which provide similar registration and connection-management functions within their respective ecosystems.

Vendor control systems and device-specific APIs sit alongside NMOS. Some devices do not yet support NMOS; others expose extra capabilities only through vendor protocols or REST interfaces. Real deployments typically combine these: NMOS for discovery and basic connection management, vendor control for product-specific behavior, and direct APIs for automation, monitoring, or integration with scheduling and playout.

Orchestration also has to take the underlying network into account. In larger or more distributed systems, the controller needs to respect link capacities, multicast group assignments, VLANs, and security boundaries. Setting up a connection may therefore involve not only telling an endpoint to subscribe to a flow, but also coordinating with switch or SDN controllers to ensure the required traffic can traverse the intended path without oversubscribing links or violating segmentation.

Above this, third party control and automation layers provide application-level behavior: recalling router and multiviewer layouts, coordinating SDI and IP paths, driving ingest and playout according to a rundown, or integrating cloud-hosted processing. In pro AV environments, similar principles apply, but orchestration often spans HDMI, HDBaseT, Dante audio, Dante AV, NDI, and sometimes ST 2110/IPMX, with room control systems exposing a simplified interface for tasks such as source selection and room combine/divide.

## Applying the Decision Checklist

Consider a hypothetical mid-size live sports production with:

- Multiple cameras on site and some specialty POVs.
- A central control room in another city.
- Requirements for near real time replays, on-prem commentary, and multi-platform delivery.

### • Latency and determinism

Talent interaction and replay demand low end-to-end delay and frame-accurate switching in the control room, so the production core leans toward uncompressed SDI or ST 2110 with solid clocking, rather than fully compressed LAN workflows. Contribution links can tolerate more latency, but not seconds.

### • Image quality / HDR / UHD

If the event is produced in UHD HDR but some outputs are HD SDR, the Acquire and Produce stages should preserve full quality, uncompressed or lightly compressed, so that down-conversion and HDR/SDR transforms happen with maximum headroom, pushing heavier compression to the delivery edge.

### • Redundancy and failure domains

If the event has contractual uptime requirements, contribution paths may need diverse SRT routes, and the core may need redundant SDI/ST 2110 paths. That steers the design toward formats and transports supported by mature redundancy patterns, rather than experimental stacks.

### • Bandwidth constraints

If intercity links are limited to a few hundred megabits, the camera feeds must be compressed for the hop, e.g., H.264/HEVC over SRT, while still decoding to uncompressed in the control room. Inside the facility, 10/25 GigE or SDI can carry uncompressed essences.

### • Compute and storage budget

If significant replay, graphics, or AI-based analysis is planned in the cloud, it may make sense to terminate some contribution feeds directly in compute environments using IP transports, rather than hauling everything back on baseband. If compute is mostly on-prem, more processing stays inside the SDI/ST 2110 core.

### • Security and compliance

Use of public internet connectivity for contribution pushes toward encrypted transports, such as SRT, RIST, and RTMP, with clear segmentation between production networks and external paths.

### • Operational complexity and staffing

If the team has limited IP networking experience, it may make sense to keep the most complex work on SDI or to reserve ST 2110 for clearly defined parts of the plant, and use simpler ecosystems like NDI or Dante AV where 'plug and play' behavior is more important than maximum flexibility.

### • Vendor lock-in vs standards

If the organization wants to avoid dependence on a single ecosystem, the inner loop of the workflow may favor ST 2110 and SDI, with NDI or Dante AV used in targeted roles rather than as the sole backbone.

If you prioritize deterministic switching and tight monitoring over maximum flexibility, favor SDI or ST 2110 in the production core and treat compressed IP and WAN protocols as edges.

If you prioritize rapid deployment and software integration on a single site over absolute timing, consider a software-centric IP system such as NDI or Dante AV for parts of the workflow, anchored by SDI where timing is most critical.

If constrained contribution links dominate your design, plan to compress early for transport, then return to uncompressed or mezzanine formats where operators work.

# Deployment Patterns and Workflows

Most real systems are hybrids. Teams keep SDI and HDMI where they still make sense. The patterns below are starting points: they show how formats and transports line up with the work, and where infrastructure pieces such as gateways, frame synchronizers, and IP endpoints usually land.

## Pattern 1 – REMI / Remote Sports with ST 2110 and SDI Core

In a remote sports workflow, cameras, comms, and some replay devices live at the venue, while the main control room sits in another city. Operators need low operational latency and clean switching in the core; the venue and control room are joined by WAN links that force compression.

- **Acquire**

Cameras and replay sources at the venue output ST 2110 and SDI. These signals are treated as the “truth” for image quality and timing.

- **Transport to core**

At the venue edge, encoders compress selected feeds to H.264, HEVC, JPEG XS, or JPEG 2000 and send them over SRT to the central facility. Contribution links may be redundant or run over diverse paths.

- **Produce**

In the control room, those feeds are decoded back to uncompressed and brought into an ST 2110/SDI core for switching, replay, graphics, and monitoring. Operators work in an environment with deterministic timing and tight multiviewing.

*Every show is a chain of deliberate format changes: stay uncompressed or mezzanine where operators work; compress only where distance or distribution demand it.*

- **Deliver**

Program and clean feeds leave the core as MPEG-TS for affiliates, compressed IP streams for OTT and social platforms, and ST 2110 conversion to SDI or HDMI for in-venue displays or local recorders.

- **Typical AJA roles**

- BRIDGE LIVE 12G-4, BRIDGE LIVE 3G-8, and BRIDGE LIVE IP at contribution boundaries, encoding and transporting feeds between venue and production center.
- IPT/IPR or IP25-R units at baseband ↔ ST 2110 boundaries and as monitoring endpoints from the IP fabric to SDI/HDMI displays.
- FS-HDR and FS4 at format and timing choke points, for example, aligning SDI feeds before encode or handling HDR/SDR and frame rate conversion on the IP edge.
- Ki Pro recorders on site or in the control room for high quality, independent capture of program or ISO feeds.

## Pattern 2 – All IP or IP-First Studio / Control Room

In a new build or major refurbishment, facilities choose an ST 2110 core from day one, then use NDI or Dante AV at the edges where software or installed AV tools dominate.

- **Scenario**

Studio floors, control rooms, and machine rooms are connected by an IP fabric instead of a large SDI router. Cameras may be ST 2110 native, and most production devices support ST 2110, SDI, or both.

- **Core choices**

- ST 2110 carries uncompressed video, audio, and ANC data through the core, with PTP timing and multicast routing.
- NDI or Dante AV handle specific roles such as graphics workstations, small “sidecar” studios, or room-based AV where a fully engineered ST 2110 deployment would be overkill.
- SDI and HDMI remain at device edges for cameras, legacy gear, and local monitoring.

- **Where AJA fits**

- IPT/IPR and IP25-R Mini-Converter endpoints bridge SDI/HDMI gear into and out of the ST 2110 core and feed monitors and multiviewers.
- KONA IP25 cards in workstations ingest ST 2110 essences for graphics software and playout the modified media.
- ColorBox and FS-HDR sit at key points where color, HDR/SDR, and timing must be controlled between SDI and IP domains.

## Pattern 3 – Campus / Corporate / Education AV

On campuses, in corporate environments, and in education, the goal is to connect many rooms and spaces with reliable AV, modest budgets, and IT-friendly tools. Latency budgets are looser than in broadcast, but ease of deployment and day-to-day operation is critical.

- **Scenario**

Classrooms, lecture halls, meeting rooms, and a small studio or control room share sources and feeds. IT staff manage the network; AV staff handle endpoints and room behavior.

- **Choices**

- Dante audio for microphones, playback, and program sound, often extended with Dante AV for room-to-room video.
- NDI for software-centric roles such as lecture-capture appliances, PCs, and small studios, especially where integration with production software matters.
- SDI in specific spots where existing cameras, recorders, or switchers require it, or where longer, predictable point-to-point runs are needed.

- **AJA roles**

- Dante AV 4K-R and Dante audio embedders (DANTE-12GAM/OG-DANTE-12GAM) to bring Dante networks into SDI infrastructures and displays.
- BRIDGE NDI 3G to move SDI signals into and out of NDI-based production and streaming tools.
- BRIDGE LIVE IP for transport and distribution of IP video between buildings, campuses, remote rooms, centralized production resources, and cloud-based services.
- HELO Plus and Ki Pro GO2 for lecture capture and streaming/recording in rooms and small control spaces.
- Io and KONA devices to connect workstations running software-driven production, editing, or streaming to SDI and HDMI endpoints.

## Pattern 4 – Government / Council / Parliament Hybrid

Government chambers, council rooms, and parliaments need long-running systems that support translation and accessibility, provide public streams, and produce reliable archives.

- **Scenario**

One or more chambers with SDI and HDMI cameras, confidence and public displays, language services, and recording; content is streamed to the public and stored for long-term access.

- **Requirements and mix**

- SDI/HDMI cameras and switchers for predictable, long-runtime operation in the room.
- Dante audio for microphones, interpretation, and distribution to assistive listening systems.
- Optionally Dante AV or NDI for distribution to overflow rooms, meeting spaces, or secondary production tools.
- IP contribution or backhaul to data centers or cloud platforms for streaming, VOD, and archival systems.

- **AJA roles**

- BRIDGE LIVE 12G-4 and BRIDGE LIVE 3G-8 for SDI↔IP contribution at the chamber edge and data-center side, including SRT/HLS streams for public and inter-facility delivery.
- IPT, IPR, and IP25-R Mini-Converters and BRIDGE NDI 3G as SDI/HDMI↔IP endpoints for cameras, switchers, multiviewers, overflow-room displays, and NDI-based secondary production.
- FS-HDR, FS4, and other FS frame synchronizers at timing/format choke points, preserving ANC data such as closed captions while aligning and converting SDI feeds before IP transport.
- Ki Pro recorders or KONA desktop I/O cards with AJA Control Room for high-quality local program/ISO recording, ingest, and operator monitoring of SDI and HDMI paths.

These patterns are meant to be recognizable, not prescriptive. The key is to match formats, transports, and AJA building blocks to the actual work and constraints in each case.

## Unified Matrix (Reference Tool)

For each production type and stage, the matrix below highlights which combinations are most common.

Production type	Acquire	Produce	Deliver
<b>Sports</b>	Main cameras and replay over SDI or ST 2110 (uncompressed); some specialty or remote feeds over compressed IP (SRT, NDI) into gateways.	ST 2110 or SDI core for deterministic switching and replay; limited use of LAN IP (NDI/Dante AV) at graphics and analysis edges.	MPEG-TS for affiliates; H.264/HEVC over SRT/RIST for contribution; OTT outputs over HLS/DASH; SDI/HDMI for in-venue displays.
<b>News</b>	Studio cameras and key sources on SDI or ST 2110; field and remote guests arriving as compressed IP feeds (SRT, bonded links, contribution platforms).	SDI or ST 2110 core in the main gallery; LAN IP (NDI/Dante AV) for graphics, virtual sets, and small side studios.	MPEG-TS to broadcast chain; IP delivery to OTT and web; contribution links to bureaus and partners over SRT or similar.
<b>Corporate</b>	Room cameras, PCs, and codecs via HDMI/SDI; remote speakers and feeds via UC platforms or compressed IP (SRT/WebRTC).	Mix of SDI for event switchers and LAN IP (NDI/Dante AV) for rooms, PCs, and small studios.	Streaming over H.264/HEVC via RTMP/HLS; recorded files for VOD and internal portals; HDMI/SDI/HDBaseT for in-room and signage displays.

Production type	Acquire	Produce	Deliver
<b>Education</b>	Classroom and lecture cameras via HDMI/SDI; screen capture and laptops over HDMI or NDI; occasional external sources over SRT or similar.	LAN IP (NDI/Dante AV) for lecture capture and small studios; SDI where existing switchers or recorders demand it.	H.264 streaming to LMS/portals and public platforms; local recording for archive and course reuse; HDMI/HDBaseT for room and overflow displays.
<b>Worship</b>	Cameras and computers via HDMI/SDI; some NDI or Dante AV devices in newer installs; occasional remote or overflow feeds over IP.	Compact SDI or NDI switchers; Dante audio and sometimes Dante AV for distributed sound and video.	H.264/HEVC streams to web and apps; recordings for later viewing; HDMI/HDBaseT to in room and lobby displays.
<b>Government</b>	Chamber and committee cameras on SDI; microphones and interpretation over Dante audio; occasional remote participation via compressed IP.	SDI core for reliability and long runtimes; LAN IP (Dante AV/NDI) for overflow rooms, signage, and secondary production.	Public streams over H.264/HEVC (HLS/RTMP); archival files for records systems; SDI/HDMI feeds to in-building and broadcast partners.
<b>Events / Live Venues</b>	Stage cameras on SDI or ST 2110; media servers and laptops over HDMI/SDI or NDI; remote contributions over SRT when needed.	SDI or ST 2110 backbone for main show switch; LAN IP (NDI/Dante AV) for auxiliary rooms, IMAG feeds, and creative add-ons.	In-venue SDI/HDMI/HDBaseT to LED walls and projectors; H.264/HEVC streams for remote audiences; contribution feeds to broadcasters over SRT or MPEG-TS.

# Where AJA Fits in These Designs

The patterns in this paper assume that formats and transports will continue to change. Treating infrastructure as standards-based, format-agnostic building blocks allows systems to serve different roles over time.

AJA's role in these designs is to provide those building blocks, grouped around the problems engineers actually have to solve:

## Gateways and contribution encoders

BRIDGE LIVE IP, BRIDGE LIVE 3G-8, BRIDGE LIVE 12G-4, and HELO Plus handle encode/decode and protocol translation at the edges of the system. They move signals between formats and contribution protocols such as SRT or HLS. BRIDGE NDI 3G provides gateway functionality between SDI and NDI networks.

*Hybrid is the steady state. Design around clean SDI/IP boundaries and standards based building blocks, not a single IP system.*

## SDI ↔ IP and IP ↔ SDI endpoints

Mini-Converters such as IPT, IPR, and IP25-R act as termination points between SDI/HDMI and ST 2110 networks. They are where cameras, switchers, multiviewers, workstations, and displays connect to the IP fabric, making it possible to add IP to an SDI plant or retain SDI islands around an IP core.

## Timing, color, and format infrastructure

FS-HDR, ColorBox, and OG-ColorBox provide HDR/SDR and color transforms and format conversion at key choke points. FS units function as frame synchronizers and scalers, keeping signals aligned in time and appearance as they cross between SDI, ST 2110, NDI, Dante AV, and compressed paths.

## Capture and monitoring

Ki Pro recorders, Desktop I/O cards, and AJA Control Room support recording, analysis, and operator monitoring. They enable capture of clean copies of critical feeds, monitoring of IP and SDI paths, and connection between production software and external I/O.

## Ingest, playback, and editing

KONA and Corvid cards and I/O devices provide ingest, real-time playback, and I/O for editing, graphics, and production applications. They also support server-based playout for channel and clip playback workflows. T-TAP Pro provides high-quality monitoring output from editing, graphics, and production applications to professional SDI and HDMI displays.

Across these groups, control and integration matter as much as signal paths. Many AJA devices expose APIs and, where appropriate, support open control mechanisms such as NMOS, allowing integration with orchestration and automation platforms. This supports systems where routing, monitoring, and failover are driven from a common control layer, even when workflows mix SDI, multiple IP systems, and cloud services.

## Conclusion and Next Steps

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IP video is not a single technology choice. It is a set of options that must be matched to the work being done. The right design for any facility depends on what is produced, how sensitive the workflow is to latency and timing, where people and equipment are located, and how much operational change the organization can absorb at once. For most teams, hybrid operation using SDI and HDMI alongside ST 2110, NDI, Dante AV, and WAN transports is the long-term reality.

Effective system designs separate decisions about representation, transport, and physical connectivity, then apply those decisions consistently across a small number of repeatable patterns.

When planning new builds or upgrades, teams can implement a selected pattern without committing to a single ecosystem. This keeps systems adaptable as formats, transports, and operational needs evolve.

[www.aja.com/solutions/ip-solutions](http://www.aja.com/solutions/ip-solutions)

## About AJA Video Systems, Inc

Since 1993, AJA Video has been a leading manufacturer of video interface and conversion solutions, bringing high quality, cost effective digital video products to the professional, broadcast and postproduction markets. AJA products are designed and manufactured at our facilities in Grass Valley, California, and sold through an extensive sales channel of resellers and systems integrators around the world. For further information, please see our website at [www.aja.com](http://www.aja.com).

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