CALREC

Beginners Guide to IP

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by Calrec Audio

Periodic Table of IP Elements

#	Symbol	Name
1	Ob	Outside Broadcast
3	N	Live News
4	St	Stereo Console
11	Ls	Live Sports
12	Sf	Surround Microphone
19	E	Entertainment
20	Da	Digital Assignable
21	Aq	Audio Quality
22	V	Versatility
23	Ai	On Air Inhibit
24	Ps	Presets
25	Fx	Flexibility
26	R	Redundancy
27	Os	Mic Open System
37	Wr	Houses of Worship
38	An	Audio Network Management
39	Hp	Hot Plugability
40	Fp	Fader Pitch
41	Pa	Path Interrogate
42	Bi	Big Channels
43	Af	Autofader
44	Pc	Power Consumption
45	Mc	Multi-Channel
55	M	Musical Performance
56	F	FPGA
57	Lo	Loudness
58	Ax	Automixer
59	Dx	Downmixer
60	Aa	Assistive apps
61	Us	Multiple Operation
62	Is	Inserts
63	Cf	Configurable
73	Rb	Remote Broadcasting
74	Bf	Bluefin2
75–102		
103	I	Integration
104	Mm	Mix Minus
105	Cb	Conference Bus
106	Dl	Delay
107	Eq	EQ
108	Sq	Sidechain EQ
75	H	Hydra2
76	Nm	Network Manager
77	O	Hydra2 Organiser
78	Ro	Integral Router
79	He	Network Heritage
80	Ff	Fixed Format I/O
89	Sw	SW-P-08
90	Em	Ember +
91	S	Salvos
92	Hu	H2Hub
93	Ip	Input Port Protection
94	Op	Output Port Protection

See how these elements fit into our periodic table at calrec.com

Beginners Guide to IP

IP technology is changing the broadcast industry in a revolutionary way, sweeping aside 80-year-old cable-based connections in favour of packet-switched workflows. It is transforming how audio, video and control data is encoded, transported and managed. The impact on the design of broadcast equipment is profound.

In the short term, broadcasters will need to replace existing analogue, AES3, MADI and SDI ports, with a new class of interface that enables them to connect to standard IT switch infrastructure, and adopt new control mechanisms for connection management and device discovery. As this happens, the traditional distinction between audio, video and data transports will disappear, being replaced with a single agnostic, scalable network. Gradually, old video and audio cabling will be replaced by fibres carrying IP traffic, and conventional audio and video routing equipment will be replaced by standard IT switches.

In the medium term, broadcasters' ambitions will extend beyond merely replicating existing working practices, as confidence and competence grows, and workflows will evolve to take advantage of the greater flexibility and geographical freedom now available to them.

In the longer term, the broadcast industry will further borrow from the IT industry by shifting away from bespoke hardware towards software processing running on commodity computing platforms. While not all broadcast processes will fit this model, many will, and in doing so, offer benefits in scalability and economy.

As the shift to IP infrastructure continues we will be encouraged to drop our conventional signal-based approach in favour of a services model, where content, both live and stored, may be discovered and accessed by anyone in possession of access rights and an appropriate IP connection, regardless of location.

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Beginners Guide to IP *by Calrec Audio*

Central to the use of off-the-shelf IT components is conformance to a set of standards which, together, define IP networking. This includes protocols such as RTP, IGMP and PTP, all of which are used in audio and video over IP streaming, but would be familiar to IT specialists outside the broadcast industry. Equally important are the open standards, specific to broadcasters, which define precisely how media are encoded and packetised, in order to stream in real-time. These open standards will ensure different vendor's equipment will interoperate reliably.

None of this will be straightforward.

To meet a broad range of needs, manufacturers will have to create interfaces that conform to a variety of open standards (AES67, Ravenna, TR03, TR04, SMPTE2022, and maybe more), and provide elegant solutions for controlling and managing services, flows, sync, control data, monitoring, trouble-shooting, SDN (Software-Defined Networking for over-riding the default packet-forwarding behaviour of an IP switch), based on another set of open standards.

There are huge opportunities for forward-thinking broadcasters and technology manufacturers alike, who are prepared to embrace and engage with the changes.

Calrec provides a variety of networking interfaces, including an AES67/Ravenna interface, an AVB interface, and a modular I/O Dante card that also has AES67 compatibility. In addition, Calrec provides a SMPTE 2022-6 video interface.

Since they can choose from a range of protocol interfaces, broadcasters can be confident that they'll have Calrec's support no matter which combination of formats they use now and in the future.

Present
Audio:
Broadcast IP infrastructures are currently dominated by just a few protocols: AES67, Ravenna and Dante. And then there's AVB.
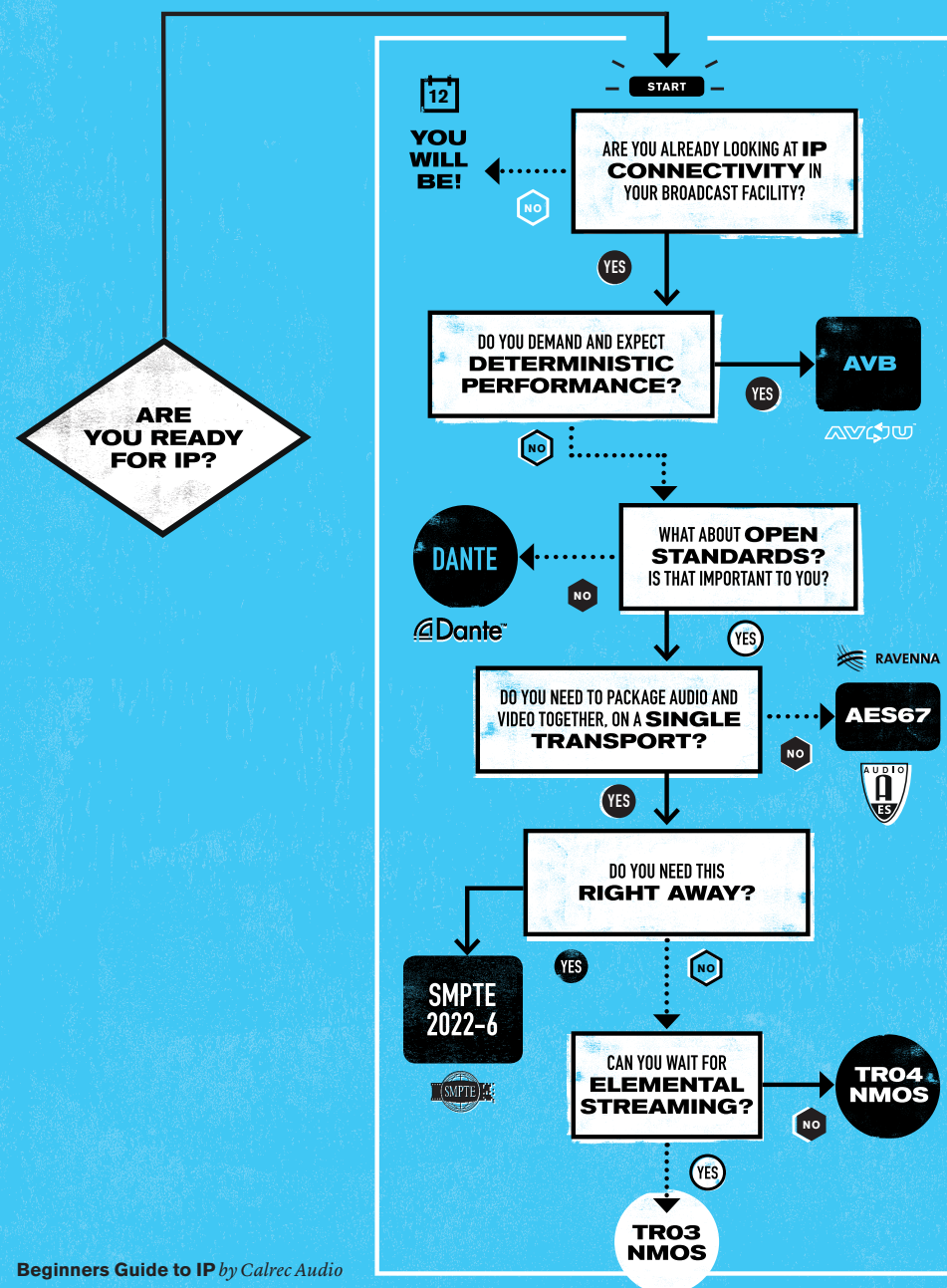
AES67

Development of AES67 began in 2010 and it was published in 2013. AES67 does not describe a full protocol, rather it defines a set of 'ground rules' that make interoperation between equipment from third parties possible. It is based on the common ground between a number of established IP-based audio networking systems including Ravenna, Livewire, Q-Lan and Wheatnet. It is the closest thing the broadcast industry has to a network solution, and led to the formation of the Media Networking Alliance (MNA) in 2014.

The MNA consists of a host of like-minded technology companies – including Calrec – to promote AES67 as the common interchange of digital media between different IP networking platforms. AES67 continues to evolve - the Video Services Forum's set of technical recommendations (TR-03 and TR-04) covering the transport of media content in elementary essence flows specifies AES67 as the transport protocol for elementary audio streams.

Ravenna

Ravenna was officially launched at IBC 2010 by ALC Networx and is described as a technology for real-time transport of audio and other media data in IP-based network environments. Ravenna is an open technology which has adapted standard network protocols for use primarily in the professional broadcast market. It uses RTP streaming and Bonjour for service discovery (see "Control" later in this document.)

Ravenna can operate in existing network infrastructures and can operate in an AES67 compliant profile.

A wide range of companies, including Calrec, is signed up to the Ravenna ecosystem. Companies who are producing Ravenna-compatible equipment include Calrec, Lawo, Merging, Sonifex, AEQ and Riedel.

Dante

Dante was developed in 2006 by Audinate and is the most established of these protocols. The biggest difference between Dante and both AES67 and Ravenna is that Dante is proprietary, rather than an open standard. Despite this, there are thousands of Dante-enabled products available, and many technology companies – including Calrec – work with Audinate to provide compatible equipment.

AVB, aka TNS (Time Sensitive Networking)

AVB is an open standard promoted by the AVNU Alliance, a group of industry stakeholders promoting AVB as a route to interoperability between manufacturers.

AVB is different to AES67, Ravenna and Dante, using etherframes rather than IP packets to transport data, which means that AVB is not an AoIP protocol. Unlike AoIP protocols, AVB networks cannot extend across routers or bridges. In other words, they are geographically limited to LAN segments. A further limitation is that AVB networks require AVB-enabled switches and hubs.

The trade-off is a guarantee that AVB networks are completely deterministic – you get out exactly what you put in. Also, AVB is set up on the "stream" principle; its DECC (Discovery, Enumeration, Connection and Control) protocol establishes connections over the network and presents a view of all AVB devices on that network.

For broadcast audio, AVB offers data sharing with no risk to priority audio services.

Controlling Media Streams

While there has been some industry success in agreeing a common transport mechanism for IP audio, there has been less success in agreeing how IP streams can be managed.

To fully realise the benefits of IP it must be possible for a device (or end point, as IP jargon terms it) to join a network, and discover for itself all the streams (or services) available on the network. It must do this in order to allow a human operator to see the available streams and to make choices about which to connect to.

Firstly, this process requires that all devices participate in an agreed 'discovery' scheme. Secondly, as the list of connected devices changes, the discovery mechanism must allow for dynamic tracking of available streams. Thirdly, once a stream has been discovered, detailed information must be provided by the transmitting device giving details of exactly how to listen to, and decode, that particular stream. These details are known as a session description, and include sample rate, encoding mechanism, sample depth, number of channels and multicast IP.

A popular service discovery mechanism, originally developed by Apple Corp, is Bonjour, with other mechanisms including SAP and SIP. For a network of devices to work together it is necessary for them all to support a common discovery mechanism.

Unfortunately, the AES67 standard does not mandate the use of a particular discovery mechanism. This is because each have their own strengths and weaknesses, and the authors of AES67 felt that manufacturers ought to have the freedom to choose a mechanism that best matches particular application. While this positon is supportable, its unfortunate consequence is that products with non-matching discovery mechanisms will not be able to inter-operate. In other words, they will remain unaware of each other's presence on the network.

This table lists three streaming implementations that are all AES67 compatible, but unable to inter-operate because their discovery mechanisms are incompatible. For a network implementation to be successful, network designers must be careful to select devices that have compatible discovery mechanisms.

Device	Discovery	Transport
Ravenna	Bonjour	RTP/UDP
Audinate AES67	SAP	RTP/UDP
'Pure' AES67	SIP	RTP/UDP

Calrec's approach is to design end points that support multiple protocols simultaneously, making them network-agnostic, and capable of working with a wide range of devices from different vendors.

Other Questions of Control

Connecting devices on an IP network allows them to stream audio to one another, as well as the opportunity for more sophisticated control integration. An example might be where a mixing console is connected to a stream from a third-party vendor's mic amp unit. In this case, the mixing console operator may want to be able to control the analogue gain of the mic amplifier in the third-party unit. Another example might be where someone wishes to take control of the AES67 connection management of a device from a remote location. In both these cases, a control mechanism is required that allows one device to control aspects of another device, over an IP connection.

There are several control mechanisms that may be utilised, such as AES70 and EMBER+. These are sophisticated protocols that use a server-client model and do not generally require vendor-specific extensions in order to allow control of most functions.

A device may advertise its AES70 server using Bonjour, allowing potential controllers to discover it. The protocol allows user-defined controls to be discovered, and contains pre-defined objects for complex controls like routing, clock management and stream management. It is early days for AES70 and it remains to be seen how widely it is adopted.

Video

Since its introduction in 1989, the common denominator of video transport has been the Serial Digital Interface, or SDI. SDI is a video transport that may also carry audio and ancillary data.

First introduced in 2007, SMPTE 2022 is a family of standards that describe methods for encapsulating digital video transport over an IP network;

SMPTE-1, -2, -3, and -4 are concerned with compressed video on MPEG-TS streams.
SMPTE-5 covers SDI with forward error correction.
SMPTE-6 deals with SDI.
SMPTE-7 covers SDI with hitless protection (stream merging).

SMPTE 2022 -5, -6 and -7 may be thought of as the IP counterparts to SDI. They encapsulate the SDI data stream in its entirety, in IP frames, complete with audio and ancillary data. This makes it suitable for transportation over an IP network. However, the process of encapsulation destroys the sync information that is implicit in the SDI line rate, and this must be transported separately. This nasty little problem has been solved by the creation of a further SMPTE standard, ST2059, which describes a means for transporting sync information over an IP network using an IT standard known as PTPv2.

SMPTE 2022-5, -6 and -7 video is something of a compromise. Certainly it allows the transportation of video over IP, but it makes the job of extracting audio and ancillary data even more expensive, in hardware resources, than it already is with SDI. A more elegant solution to transporting video, audio and data streams that are logically linked (as part of the same TV program) is to use elemental flows. This is described in the next section.

Elemental Streaming

As the broadcast industry continues to embrace IP we can expect single network infrastructures to be used to convey video, audio, sync and control data, as well as providing conventional network services such as file transfers, telephony, email and internet access.

It will no longer be necessary to combine media streams into a single transport as with SDI. It will be more convenient to stream the elements of a programme individually, removing an encoding and decoding stage entirely. The video, audio and data components of a programme may be logically linked, at a control level, while remaining separate at a transport level. This means that a device that is only interested in the audio portion of a programme need only receive the audio stream, and can ignore the video portion of the programme.

This approach is called elemental streaming.

There are several approaches to elemental streaming, including IP Live (devised by Sony), ASPEN (based on MPEG-TS), and TR03 and TR04, from the Video Services Forum (VSF). Of these, TR03 looks likely to become the most widespread.

The broadcast industry has learned its lesson from the chaotic development of audio networking, where multiple proprietary technologies hindered the development of a standards-based approach. Its approach to the development of elemental streaming is far more structured. A joint taskforce, JT-NM, was set up to research broadcast industry requirements of IP networking.

JT-NM developed a reference architecture which offered a technology-agnostic model to meet these requirements, identify candidate technologies and encourage industry organisations to codify the standards on which the next generation of products will be built.

Continued Overleaf

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THE ROAD TO IP

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2008–10
IEEE launches AVB standard in 2010 following the formation of the AVNU Alliance in 2009

AVNU

Audinate launches Dante in 2008

Dante

ALC5Networx launch Ravenna as an open standard

RAVENNA

2012
JT-NM PHASE 1
SMPTE, VSF and EBU create a joint taskforce on networked media

AUDIO AES

AES publishes first version of AES67

2013
SMPTE publish ST2022-6

SMPTE

2014
The Media Networking Alliance (MNA), comprising manfacturers and broadcasters, is formed to advocate for AES67

JT-NM publish a blueprint for broadcast network infrastructures

JT-NM REFERENCE ARCHITECTURE

TR-03 TR-04
SMPTE publish ST2059 for distribution of sync over PTPv2

SMPTE

2015
The Advanced Media Workflow Association (AMWA) produce draft standards for NMOS, in line with JT-NM

AMWA

networked media NMOS open specifications

The Alliance for IP Media Solution (AIMS) form, promoting the adoption and development of open protocols for media over IP

AIMS Alliance for IP Media Solutions

2016
Interoperation testing, demonstrations and plugfests help technology to mature

AUDIO AES

AES70 Protocol for control over IP

THE FUTURE
SUPPORT FOR NEW FORMATS

MORE FLEXIBLE, DISTRIBUTED WORKFLOWS

CLOUD DEPLOYMENTS

PACKET-BASED TRANSPORTS

SYSTEM ARCHITECTURE AND CONTROL

ELEMENTAL FLOWS

IP WITH CURRENT WORKFLOWS

ELEMENTAL FLOW DEPLOYMENTS

Hydra2

Calrec provides a variety of networking interfaces, including an AES67/Ravenna interface, an AVB interface, and a modular I/O Dante card that also has AES67 compatibility. In addition, Calrec provide a SMPTE 2022-6 video interface.

Each element of Calrec's protocol range redundantly connects to Calrec's Hydra2 and appears like any other I/O resource on the Hydra2 network. This means each resource is able to tap into Hydra2's integral suite of management tools, such as remote configuration patching, port protection, alias files, virtual patchbays, and access rights.

Offering a complete range of protocol interfaces means broadcasters can be confident that they'll have Calrec's support no matter which combination of formats they use – both now and in the future.

Find Out More

Calrec	www.calrec.com
AES	www.aes.org
Aims	aimsalliance.org
AMWA	www.amwa.tv
Audinate	www.audinate.com
AVNU Alliance	avnu.org
MNA	medianetworkingalliance.com
Ravenna	www.ravenna-network.com
SMPTE	www.smpte.org

C A L R E C

									18
									2 Cl Clear
				13	14	15	16	17	
				5 A Apollo	**6 Ar** Artemis	**7 Sm** Summa	**8 B** ?	**9 C** Core	**10 It** Intuitive
				13 T Trust	**14 Rc** Routercore	**15 Io** IO	**16 Rd** Redundancy	**17 Gp** GPIO	**18 Cr** Colourful
10	11	12							
28 Au Automation	**29 Re** Live Reconfiguration	**30 U** Unlimited VCA Groups	**31 Co** Cooperation	**32 Fc** Focus	**33 Or** Orange Box	**34 Cu** Cat5	**35 Fe** Fibre	**36 Vf** Visual Feedback
46 P Power	**47 Cm** Compact Design	**48 Mr** Flexible Metering	**49 In** Innovation	**50 Ma** In-house Manufacturing	**51 Rp** Reputation	**52 Vi** Virtualisation	**53 Sp** Split Core	**54 Ea** Ease of Operation
64 Cs CSCP	**65 Rl** Reliability	**66 Df** Dual Faders	**67 Ld** Market Leading	**68 Ts** Multiple Test Points	**69 Rs** Relationships	**70 Su** Support	**71 Sc** Sidecar	**72 Er** Ergonomic
109 Dy Dynamics	**110 Ch** Channel Facilities	**111 Ga** Next Gen Audio	**112 Q** Quality	**113 Hi** History	**114 Ev** Environment	**115 Eg** Engineering	**116 Ao** Networking	**117 Ng** Easy to Navigate

81	82	83	84	85	86	87	88
Md Modular I/O	**L** Low Latency	**Tr** Transparent Routing	**Pp** Plug and Play	**Ag** Network Agnostic	**D** Dante	**Ae** AES67 / Ravenna	**Se** SMPTE2022
95	96	97	98	99	100	101	102
Nr Full Network Redundancy	**Pf** Port and Folder Management	**Sb** Scalable	**Fd** Fault Detection	**Ac** Access Rights	**Pb** Hydra Patch Bays	**Al** Alias Files	**Hd** High Headroom

See how these elements fit into our periodic table at calrec.com

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