

Framework Entertainment Network Technology

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1. Introduction

1.1. Why this Framework?

In the daily practice of theaters, venues, museums, and event locations, different networks are increasingly being connected to each other. FENT offers a common language and the principles for linking these networks, making it easier to connect productions to the permanent installations of theaters and venues. In this way, for example, multiple disciplines can use a single infrastructure, or guest users can temporarily integrate their system with the venue's system.

This Framework aims to create a common basis on which different parties can build without imposing an obligation or a single technical solution. It offers best practices without hindering innovation and standards without excluding flexibility.

1.2. Motivation and goal

The primary goal of this Framework is to simplify the **reliable connection** of networks within stage technology by means of:

1. **Standardized IP addressing per discipline**, so that conflicts are prevented; and
2. **Clear VLAN structures** that enable an integrated network at the hardware level but separate disciplines where desired, thereby;
3. Facilitating **compatibility** between different systems and locations.

The secondary objective is to link the protocols of different users on the linked network by:

4. Creating **protocol-specific conditions** for each discipline (such as lighting, video, and sound) and thereby;
5. Enabling **scalability** from simple to advanced implementations.

1.3. Who is FENT for?

This Framework is written for anyone working in the entertainment sector with IP-based stage technology systems:

- Technicians, engineers, and system integrators
- Theaters, pop venues, event locations, and convention centers
- Designers and consultants
- Training institutes
- System integrators
- Production companies and rental companies
- Manufacturers, sales companies

No in-depth IT knowledge is required to read this document. Some knowledge of network technology is required to implement the FENT. The emphasis is on practical applicability.

1.4. What does this Framework offer?

The Framework is not a strict set of rules, but a guiding framework. The proposed IP address range, VLAN numbers, and other preconditions can be adjusted to suit each situation. The most important thing is to work and communicate consistently with other parties when deviating from the standard principles.

1.5. Development and maintenance

This Framework was compiled by the FENT working group with the support of various sounding board groups from the field through various peer reviews. It is based on the specific requirements that are important in live entertainment, supplemented with best practices.

The current version of FENT (v1.0) contains the basis of the Framework and the discipline-specific elaboration for lighting. In future versions, in addition to the addition of audio, video, and show control specific implementations, additional topics will also be included, such as the use of a single network for multiple venues, or situations with multiple companies or bands on a single stage.

The further development of FENT is explicitly intended as a joint and ongoing process. The compilers invite other stage technology specialists to contribute to the elaboration, testing, and updating of the Framework within the FENT working group.

FENT is explicitly not a closed or fixed group of people. The Framework is designed as a living document, supported by an open, developing, and rejuvenating group of stage technology professionals, with a focus on knowledge sharing, practical experience, and advancing insight.

1.6. Reading guide

The Framework consists of the following chapters, which can be read as a whole or individually:

- **Quick start (chapter 2):** The basics needed to use the Framework, based on FENT IP addressing and a practical checklist.
- **Basic Principles and Core Concepts (Chapter 3):** Basic principles of relevant network technology that form the basis for using the Framework.
- **Discipline-specific (chapters 4 to 8):** Guidelines for each discipline (lighting, sound, video, show control) with protocol-specific points of attention.
- **Appendices and references (Chapter 10):** Sample technical lists, glossaries, references to other information. Not all terms are explicitly explained in this document. For an explanation, please refer to the glossary in section 10.3.

Explanations in the text take the following forms:

Important or critical explanation.

An explanation or example of a best practice.

Reference to another part of the Framework.

1.7. About the authors

The Framework for Entertainment Network Technology (FENT) working group emphasizes the importance of a guiding framework for the design of network-based stage technology installations and aims to play a role in this. Such a framework enables designers and users to set up these installations efficiently, reliably, and, where necessary, interconnected.

This version of the Framework was made possible thanks to the dedication and expertise of the following enthusiastic contributors:

- Andi Krijgsman
- Jeroen Seeboldt
- Dennis Slot
- Rutger van Dijk
- Arjen Bijtelaar
- Paul van Schaik
- Mark Tober
- Mike Evers

2. Quick Start

This quick start is intended to give users an overview of the principles of the Framework. It can also be used as a quick checklist when setting up a (new) network to implement compatibility with the Framework.

The purpose of the Framework is to prevent problems that hinder the proper functioning of a network. Key points of attention are potential IP conflicts and a logical separation of disciplines and protocols if the scale of the network requires it.

For additional information on the principles described here, please refer to Chapter 3 and the discipline-specific chapters.

2.1. Basic principles

The basic principle for connecting networks in stage technology/entertainment is that both networks must be suitable for connection. To this end, the Framework applies four basic principles:

- 1. FENT IP addressing is followed**
The FENT IP addressing scheme forms the basis for linking two networks. Using this scheme prevents conflicts with IP addressing.
- 2. Separate disciplines**
Separating network protocols via separate VLANs or hardware networks greatly reduces mutual interference. For some protocols, the use of VLANs is necessary.
- 3. Managed switches where necessary**
If VLAN separation is necessary when setting up the network, managed switches are required. Specific settings for protocols are correctly configured on each switch in the network.
- 4. Documentation & Communication**
Documenting and communicating the system used and the method of implementation from FENT to the receiving house or visiting production.

See chapter 3 for an explanation of these principles.

2.2. Standard FENT IP scheme

For consistent implementation, we use the IP distribution below. This implementation is applicable in all situations where IP-based networks are used.

Discipline	Network ID	Group	First IP address	Last IP address
Audio	10.10.0.0/16	Location	10.10.1.11	10.10.100.250
		Production	10.10.101.11	10.10.200.250
Intercom	10.20.0.0/16	Location	10.20.1.11	10.20.100.250
		Production	10.20.101.11	10.20.200.250
Video	10.30.0.0/16	Location	10.30.1.11	10.30.100.250
		Production	10.30.101.11	10.30.200.250
Light	10.40.0.0/16	Location	10.40.1.11	10.40.100.250
		Production	10.40.101.11	10.40.200.250
ShowControl	10.50.0.0/16	Location	10.50.1.11	10.50.100.250
		Production	10.50.101.11	10.50.200.250
Management	10.90.0.0/16	Location	10.90.1.11	10.90.100.250
		Production	10.90.101.11	10.90.200.250

The table above is a simplified summary of the complete overview. A more detailed explanation of the IP scheme, including DHCP, is provided in section 3.4. The complete overview can be found in the table in chapter 9.

2.3. Complexity

FENT's principles and IP scheme can be used in various types of network structures, regardless of their complexity. The Framework is based on the use of segmented networks, allowing disciplines and protocols to function separately from each other. This separation can be implemented both in hardware and virtually.

In separate networks where disciplines use the same infrastructure and hardware, the use of **managed switches** is the starting point.

See the glossary for an explanation of managed and unmanaged switches.

See chapter 3 for an explanation of the influence of complexity within the Framework.

2.4. Hardware connection

Use the following principles for the hardware connection of two networks:

Network 1	Network 2	Key points
Unmanaged	Unmanaged	IP address range, no further network settings possible
Unmanaged	Managed	Managed switch assigns traffic to correct VLAN
Managed	Managed	VLAN numbers/names identical, all settings compatible
Special topology		Consult network administrator, pay attention to access points

Please note that different brands of network hardware may use different names for the same settings.

2.5. Quick checklist

The checklist below is a general summary for setting up and checking a network.

Hardware and switches

- Switches switched on and connected
- Cabling tested (no defective or excessively long cables)

Configuration

- VLANs set up according to plan
- QoS configured with correct DSCP values, if applicable
- For multicast protocol(s), IGMP snooping active with correct querier settings
- PTP (for audio and/or video) set correctly
- Ports set correctly
- VLAN trunking correctly set

IP and connectivity

- IP addresses assigned and documented
- Multicast tested with relevant protocols
- Internal connectivity tested (all devices accessible)

Management

- Production/technology separated from internet/office
- All changes recorded in documentation
- Back up switch configurations

For protocol-specific settings, see the sections in the chapters that deal with the specific disciplines.

3. Framework

3.1. Introduction

The use of IP networks in stage technology means that separate systems are increasingly being merged. As a result, cabling that was traditionally used separately, such as for DMX, analog audio, video, and data, is increasingly being replaced by an IP infrastructure. This combination of systems offers major advantages in terms of flexibility and cost-effectiveness, but also requires an understanding of underlying network principles.

This chapter of the Framework covers the preconditions for connecting networks, followed by an explanation of the most important network concepts that are important when connecting the various protocols over that network. These are universally applicable: from simple lighting networks to complex AV installations.

The interpretation of the basic principles used in the Framework provides users with a guiding framework for linking networks.

Some manufacturer-specific features are not mentioned in the Framework. This does not make these features any more or less relevant when setting up and using networks.

The Framework focuses on connecting a maximum of two networks: a production network and a location network. More complex scenarios, such as multi-venue festivals or the simultaneous connection of multiple productions, are not described or supported in this version of the Framework.

The starting point for linking networks in stage technology/entertainment is that both networks are suitable for linking. To this end, the Framework applies four basic principles, which are elaborated in the following sections.

The Framework can still be used in more complex situations, such as multiple productions in a single venue. These more complex situations require specialist network knowledge and very specific coordination between network users.

3.2. Network architecture

Within the Framework, we assume two types of networks: flat and segmented networks.

In a flat network, there is no separation between different protocols or disciplines, and they share the same hardware and infrastructure.

In a segmented network, different protocols and/or disciplines are separated from each other in terms of hardware or virtually. In virtually segmented networks, the different protocols are separated from each other via VLANs: although the protocols share the same hardware, they function as separate networks. This keeps network traffic completely isolated and means that the protocols can hardly influence each other.

To separate disciplines, it is also possible to use different flat networks side by side, creating a hardware separation.

3.3. Hardware connection

The way in which networks are connected to each other in terms of hardware is directly related to the architecture and type of switches used by both parties. An incorrect connection strategy can lead to network problems that are difficult to diagnose.

A successful 'hardware' connection of the networks is no guarantee that the disciplines and protocols to be connected will communicate with each other correctly or without interference. Additional settings may be necessary to achieve this.

3.3.1. *Connecting unmanaged networks*

When both parties use unmanaged switches, the connection is relatively simple. Connect both networks via a standard Ethernet cable between the switches. The two connected networks will function as one large network in which all devices can reach each other.

To communicate with each other, both networks must use different unique IP addresses within the same subnet (FENT IP addressing).

3.3.2. Linking unmanaged and managed networks

An unmanaged switch does not have VLANs and treats all traffic as a single network segment. When connecting to a managed network with a VLAN structure, the unmanaged switch must be connected to an access port on the managed switch.

To enable this, this port on the managed switch must be set as an access port and assigned to the correct VLAN.

The connected unmanaged switch only 'sees' devices within the same VLAN. Communication with other disciplines is not possible without additional routing.

3.3.3. Connection between managed networks

When connecting two managed networks, use a VLAN connection between the two ports of the two managed switches for each discipline. It is also possible to connect multiple VLANs simultaneously using a trunk connection.

Critical point! Both networks must be configured to be compatible. Before connecting, check at least the following:

- IP address ranges (must not overlap)
- VLAN numbering and name (must be identical)
- IGMP querier settings (at least one active querier per VLAN)
- IGMP snooping settings (active on all switches)
- QoS settings (must be consistent)
- VLAN trunk settings (must be identical)

3.3.4. Special network structures and restrictions

Not all network configurations are equally suited for external connections. In advanced topologies such as spine-leaf, the backbone switches (spine) are often configured in such a way that external switches cannot be connected directly.

For spine-leaf or other complex topologies, always consult the network documentation or the responsible network administrator before creating a link.

3.4. Framework: IP address range

The FENT IP address scheme forms the basis of the link between networks and prevents conflicts. Different disciplines are assigned their own IP address range within the same umbrella network. This creates a logical structure in which the IP address provides direct information about the function of a device. This implementation can be used in all situations where IP-based networks are used, regardless of the network structure.

Clear and logical IP planning is essential when linking different networks. By using predefined ranges for each discipline, production and in-house systems can work together more easily and less configuration work is required on site. See the table below for basic IP planning per discipline.

Discipline	CIDR notation	Group	First IP address	Last IP address
AVB	10.2.0.0/16	Location	10.2.1.11	10.2.100.250
		Production	10.2.101.11	10.2.200.250
Audio	10.10.0.0/16	Location	10.10.1.11	10.10.100.250
		Production	10.10.101.11	10.10.200.250
Intercom	10.20.0.0/16	Location	10.20.1.11	10.20.100.250
		Production	10.20.101.11	10.20.200.250
Video	10.30.0.0/16	Location	10.30.1.11	10.30.100.250
		Production	10.30.101.11	10.30.200.250
Light	10.40.0.0/16	Location	10.40.1.11	10.40.100.250
		Production	10.40.101.11	10.40.200.250
ShowControl	10.50.0.0/16	Location	10.50.1.11	10.50.100.250
		Production	10.50.101.11	10.50.200.250
Function-related	10.80.0.0/16	Location	10.80.1.11	10.80.100.250
		Production	10.80.101.11	10.80.200.250
Management	10.90.0.0/16	Location	10.90.1.11	10.90.100.250
		Production	10.90.101.11	10.90.200.250

The table above is a simplified summary of the complete overview. A complete overview is included in Chapter 9.

3.4.1. Addressing scheme

The FENT IP addressing scheme forms the basis for the connection between networks and uses a single private IP address range, namely 10.x.x.x.

- The first byte within the FENT is therefore always 10.
- The second byte determines the discipline or protocol, with each discipline being assigned a strictly separate IP address range.
- The third byte can be used for a logical subdivision within a location or production.
- The fourth byte identifies the device, with addresses 1 to 10 and addresses 251 to 254 reserved for network equipment such as switches and routers.

The basis of the scheme is a clear division between the IP address range reserved for the location and the range used for production, both within a single subnet.

An example of IP addressing within a location:

10.40.x.x for the lighting network

10.40.1.x for the lighting control desks & 10.40.2.x for the DMX nodes

10.40.1.11 for the lighting control desk in the control room

When two networks are linked, devices can communicate with each other without any problems and without the risk of duplicate IP addresses. When multiple productions are linked at the same location at the same time, coordination is needed to determine who uses which addresses.

The division of IP address ranges between location and production is as follows:

- the third byte is between 1-100 for location IP addresses
- the third byte is between 101-200 for production IP addresses

3.4.2. Subnet mask

The subnet mask determines how many devices can be addressed within a single subnet. The FENT uses a /16 subnet mask (255.255.0.0), which allows for a maximum of 65,534 addresses per subnet. This ample address space offers sufficient flexibility for fixed addresses, DHCP pools, and future expansions.

3.4.3. DHCP reservation

The DHCP mechanism within IP networks ensures that devices automatically receive an IP address and configuration. The Framework allows for this type of configuration, but only for temporary equipment such as laptops and other short-term connected hardware. For these devices, the exact IP address is less critical and automatic configuration is preferred.

Within FENT, it is assumed that fixed equipment will also be assigned fixed IP addresses. This increases predictability, simplifies management, and makes troubleshooting considerably faster.

Within both the location and production series, a smaller portion is reserved for DHCP purposes. Both networks can run their own DHCP server, each with a strictly separate pool. This is important because production networks are regularly deployed at locations where there may not be a DHCP server on the location network, but where temporary devices need to be able to connect to the production network.

Please note that specific knowledge is required for this.

When a larger DHCP pool is needed, the range of static addresses can be reduced. This frees up more space for dynamic addresses without losing the structure of the addressing scheme.

The division of IP address ranges between location and production and static and dynamic allocation is as follows:

- Location
 - the third byte is between 1-99 for static IP addresses
 - the third byte is 100 for dynamic IP addresses (DHCP)
- Production
 - the third byte is between 101-199 for static IP addresses
 - The third byte is 200 for dynamic IP addresses (DHCP)

3.4.4. *Function-specific networks*

In addition to the defined IP address range for each technical discipline, such as audio, video, and lighting, FENT has reserved space for future expansions, for example for decor or hoisting techniques.

In addition, within a project, there may be a need for a separate, function-specific network for a specific production or project application. To provide for this infrastructural function, FENT has added the 10.80.0.0/16 range. It goes without saying that the use of this range must always be agreed upon and communicated in advance.

3.5. Framework: Separate disciplines

By separating network protocols via separate VLANs or hardware, mutual interference is greatly reduced.

Hardware-separated networks provide users with a clear structure. When using VLANs, disciplines are separated virtually while sharing the same hardware infrastructure. For some protocols, the use of VLANs is necessary.

3.5.1. Virtual separation, VLANs

When using VLAN separation, a series of ten VLANs is available per discipline. The additional nine VLANs can be used for additional separation or protocol redundancy.

VLAN ID	Discipline	CIDR notation
1010 (to 1019)	Audio	10.10.0.0/16
1020 (to 1029)	Intercom	10.20.0.0/16
1030 (to 1039)	Video	10.30.0.0/16
1040 (to 1049)	Light	10.40.0.0/16
1050 (to 1059)	ShowControl	10.50.0.0/16
1080 (to 1089)	Function-related Specials	10.80.0.0/16
1090 (to 1099)	Management	10.90.0.0/16
2	Reserved for AVB	n/a

The table above is a simplified summary of the complete overview.

3.5.2. Linking to multiple VLANs

It is essential that laptops and computers that need to be connected to multiple VLANs have a separate network port (NIC) for each discipline, so that the protocols remain 100% separate. If separate network ports are not possible, FENT recommends not connecting at the network level and using hardware protocols such as DMX512, AES-EBU, etc. It is possible to use the Function-Specific Special VLAN for connecting to and from equipment.

Example: Laptop with QLab that controls both audio and lighting.

3.5.3. Color coding and marking

The use of color codes and marking is very important, not only for troubleshooting, but also for creating a clear overview. This applies to both VLAN identification and the choice of patch cables. In addition to the standardized IP schemes (see appendix), FENT uses a standard color coding system for this purpose:

Color codes for RJ45 patch cables and VLAN identification:

- Audio primary = **RED**
- Audio secondary = **BLUE**
- Intercom = **GREEN**
- Video = **YELLOW**
- Light = **PURPLE**
- Showcontrol = **PINK**
- Function-related Specials = **AQUA**
- Management = **ORANGE**
- Trunk = **WHITE**

Patch cables that are permanently connected must be marked. The connectors indicate what they are connected to, and the middle of the cable indicates the function of that cable.

Temporary patch cables are only marked with their function and when they can be removed.

3.6. Framework: Managed switches where necessary

The most important considerations when choosing between a flat or segmented network are scalability, manageability, and the ability to connect reliably with other networks.

The type of switches (managed/unmanaged) that can be used depends on the network design and the protocols to be used. Managed switches are required for virtual network segmentation within the same infrastructure. If the protocols used depend on specific settings, it is essential that the settings on every switch in the network are correct.

The diagram below provides a concise overview of the differences between these networks:

	Flat network	Segmented network
Fast implementation	Excellent	Average
Scalability	Limited	Good
Redundancy	None	Basic
Multi-disciplinary	Hardware-separated	Integrated
Monitoring	Limited possibilities	Good
Audio over IP	Limited	Good
Video over IP	Limited	Good
Audio/video synchronization	Limited	Good
Connectivity	Possible	Good

3.7. Framework: documentation & communication

For the purpose of connecting networks, it is of the utmost importance that both parties know how each other's networks are structured. To this end, a standard form has been included in the Framework as an appendix to serve as a tool for this purpose.

Essential documentation includes:

- IP list(s): All devices with static addresses and/or DHCP pools
- VLAN overview(s): Which ports are in which VLANs and color code
- Topology: connections and switch locations

3.8. Use of Multicast and IGMP

Because multicast communication is used in many stage technology protocols, the use of IGMP is essential.

Without the correct IGMP settings, multicast is treated as broadcast, which can flood the network and cause devices to receive more data than they can process, resulting in malfunction.

At least one device (switch) per network is set as the IGMP querier. If there are multiple querier devices in the network, the querier with the lowest IP address will be active.

IGMP snooping is the function in managed switches that prevents network traffic from unnecessarily 'flooding' all ports. This function must be enabled on all switches in the multicast network.

3.9. Use of Quality of Service (QoS)

Quality of Service (QoS) determines which network traffic is given priority when the network is used in virtually segmented networks. This makes it possible to give priority to specific protocols. This can be important in stage technology networks because the protocols used have different tolerances for delay and packet loss.

discipline	priority QoS	description
Audio	Very high	Highest priority, because delays or packet loss are immediately audible as disturbances or dropouts in audio.
Video	High	Very important, especially for live and interactive applications, because image loss or stuttering is immediately visible.
Show control	Medium	Slightly less sensitive to minor delays or packet loss; no immediately audible/visible consequences as with audio/video.
Light		QoS is not relevant to current lighting protocols, as these protocols do not use mechanisms where QoS affects operation.
Management	Low	Delay has no critical effect; packet loss can always be requested again.

3.10. Use of Energy Efficient Ethernet

Quite a few switches use IEEE 802.3az Energy Efficient Ethernet. This energy-saving technology introduces delays and variations in data throughput.

Please note: switches that use Energy Efficient Ethernet are unsuitable for applications such as audio or video if this function cannot be disabled.

3.11. Use of Redundancy

In stage technology, particularly in audio and video applications, network redundancy may be necessary to ensure the continuity and reliability of systems. Protocols such as Dante and other Audio over IP solutions, as well as certain video-over-IP systems, support a primary and secondary network structure for this purpose.

Within FENT, network redundancy is approached functionally. This means that redundancy is only applied where the application actually requires it, for example in the case of critical audio signals or show-essential video connections. Redundancy is not a standard requirement, but a design choice.

If redundancy is applied, primary and secondary networks must be logically and physically separated, with separate VLANs, IP address ranges, and preferably separate switch infrastructure. It is expressly not the intention that redundant networks should still introduce a single point of failure via shared components.

The chosen form of redundancy, including the underlying network architecture, must always be agreed upon and documented in advance within the project.

This will be discussed in more detail in future chapters on discipline-specific components, such as audio and video.

3.12. Use of PTP synchronization

For audio and video over IP applications, accurate time synchronization between systems is essential. For this purpose, PTP (Precision Time Protocol) is used in stage technology. PTP ensures that all devices involved have a common, highly accurate clock, which is a prerequisite for stable and predictable operation of these systems. The application of PTP within FENT always depends on the chosen technology and the requirements of the system.

When PTP is part of the network design, this must be explicitly taken into account during setup. This requires suitable network components, careful positioning of clock sources, and a clear demarcation of PTP traffic within the network. Uncontrolled use of PTP can lead to instability and undesirable system behavior.

Further elaboration also follows in the discipline-specific chapters, such as audio and video.

4. Discipline-specific: Lighting

4.1. Introduction

Lighting networks are often the first introduction to IP-based stage technology. Whereas DMX was the standard for many years with its 512 channels per universe via XLR cables, DMX-over-IP, such as the sACN and Art-Net protocols, offers fundamental advantages. A single cable for all universes, flexible routing, and the ability to have multiple sources work together.

This chapter covers the specific aspects of lighting networks: from protocol choices to universe mapping and priority management.

4.2. IP & VLAN layout

VLAN 1040 is for connecting the discipline-specific lighting network. See below for the IP address range section. The other VLAN numbers 1041 to 1049 are reserved for expansions within lighting technology.

VLAN	VLAN Name	CIDR notation	Group	First IP address	Last IP address
1040	LIGHTING	10.40.0.0/16	Location	10.40.1.11	10.40.99.250
			Location DHCP	10.40.100.11	10.40.100.250
			Production	10.40.101.11	10.40.199.250
			Production DHCP	10.40.200.11	10.40.200.250

4.3. Standard protocol for connection

FENT uses the sACN protocol (ANSI E1.31) for connecting the lighting network. The reasons for this are its multicast-based structure, scalability, and use of priorities.

FENT realizes that there will always be users who use Art-Net, as not all applications and equipment support sACN. Therefore, the use of both protocols cannot be ruled out.

It is important to emphasize that sACN and Art-Net can operate on the same network without any problems or conflicts. For this reason, FENT uses a single shared IP address range and a single VLAN for lighting in general. When necessary, for example if Art-Net is used for a specific component in addition to the general lighting on sACN, this can be separated if desired by using a separate VLAN and/or IP address range, for example VLAN 1041.

4.4. sACN

4.4.1. Multicast

The sACN protocol is primarily multicast. This offers the advantage that network traffic can be optimized using IGMP, see section 3.8. sACN can also be sent as unicast by the transmitter.

With multicast sACN, it does not matter whether the transmitter and receiver are in the same IP address range. A lighting console in the 10.42.0.0/16 range of the production can send data to a node in the 10.41.0.0/16 range of the house, provided that both are in the same VLAN.

4.4.2. Universe distribution (sACN)

An sACN universe can be addressed with a number between 1 and 63,999. Universe conflicts arise when multiple sources use the same universe number without clear priority agreements.

FENT uses the following sACN universe classification:

Owner	Note	Universe Series
Location	Fixed installation	1-1000
Production	temporary installation	1001-2000
Reserved	large productions or future growth	2001-5000

4.4.3. Priorities (sACN)

sACN supports priorities from 0-200 (default 100). A higher priority value takes precedence over a lower priority. This function can be set on the lighting control desk per universe and in some cases even at DMX channel or parameter level.

FENT suggests the following priority classification:

Owner	Note	Priorities
Location	Permanent installation	50-99
Production	Temporary installation	100-149
Location	specials such as step and lock lighting	150-199
Emergency provision		200

For example: The lighting console of a theater sends sACN with priority 99. As soon as the production console sends sACN with priority 100 or higher, it takes control of the universes used.

4.5. Art-Net

4.5.1. Broadcast

Art-Net was originally a broadcast-only protocol. Since Art-Net 2, unicast support has been added as an option, whereby the transmitter sends the data to one specific receiver. From Art-Net 4 onwards, unicast is preferred by the protocol and RDM has also been added.

4.5.2. Universe distribution (Art-Net)

An Art-Net Universe can be addressed with a Net (0-127), subnet (0-15), and a universe (0-15). Not all devices support the use of the Net address. FENT recommends keeping the Net address at its default value. This gives 256 possible universes (16 x 16) using the notation Subnet.Universe:

Owner	Comment	Universe Series	Number of universes
Location	Permanent installation	0.0 – 7.15	128 universes
Production	temporary installation	8.0 - 14.15	112 universes
Reserved	large productions or future growth	15.0 - 15.15	16 universes

4.5.3. Priorities (Art-Net)

The Art-Net protocol does not have a priority mechanism. If there are multiple transmitters for the same universe, there are receivers that can merge this. This is receiver/brand-dependent, which is why FENT recommends one active transmitter per universe.

4.5.4. IP addresses (Art-Net)

To use Art-net, the transmitter and receiver must be in the same IP address range, which is 10.40.0.0/16 within the FENT.

Art-net can also use the 2.0.0.0/8 range. In combined networks where, for example, the internet also runs, this can cause problems. That is why the FENT has opted to use the 10.0.0.0/16 range.

4.6. RDM

The RDM protocol is an extension of the DMX protocol and can be used to remotely change and read settings from connected fixtures via the DMX line. FENT recommends disabling RDM functionality when connecting two networks, as production equipment can change essential settings in the venue's equipment and vice versa.

Critical point: If RDM is enabled, the DMX addresses and personalities of the lighting fixtures used can be changed via the production lighting console, for example, which means that the location lighting console no longer has control over the lighting set.

If RDM functionality is still desired, FENT recommends the following procedure:

- RDM is disabled by default.
- RDM is enabled for the required DMX line, in consultation between the venue technician and production.
- After making the changes, RDM is turned off again.

4.6.1. RDM over Ethernet

RDM functionality via Ethernet can be achieved using Art-Net 4 or RDMnet (ANSI E1.33). RDMnet is the ACN protocol that handles RDM traffic and is therefore a separate addition to sACN (Streaming ACN).

There are currently three options available for using Ethernet for DMX, including RDM communication:

- Art-Net v4: for DMX and RDM
- sACN for DMX and Art-Net v4 for RDM
- sACN for DMX and RDMnet for RDM

4.6.2. RDMnet scope/broker

A network with RDMnet can be divided into one or more so-called scopes. Within a scope, devices can communicate with each other and be managed centrally; outside that scope, this is not possible.

Each scope has a maximum of one broker. The broker acts as the central hub within the RDMnet network, distributing messages, such as setting changes, to the fixtures and ensuring that all connected controllers are automatically notified as soon as changes are made.

The broker can be integrated into a lighting console, but can also run as a standalone application.

When using RDMnet, FENT recommends the following procedure:

- Location uses a scope containing the name of the location.
- Production uses a scope containing the name of the production.

This way, both the location and the production have their own broker and RDM functionality.

5. Discipline-specific: Audio

Audio technology over IP, planned expansion

6. Discipline-specific: Intercom

Intercom technology over IP, planned expansion

7. Discipline-specific: Video

Video technology over IP, planned expansion

8. Discipline-specific: ShowControl

ShowControl over IP, planned expansion

9. VLAN and IP-table

VLAN ID	VLAN Name	Discipline	Group	First IP adres	Last IP adres
1010	AUDIO-PRI	Audio Primary	Venue	10.10.1.11	10.10.99.250
			Venue DHCP	10.10.100.11	10.10.100.250
CIDR notation	Subnet	Color	Production	10.10.101.11	10.10.199.250
10.10.0.0/16	255.255.0.0	Red #FF0000	Production DHCP	10.10.200.11	10.10.200.250

VLAN ID	VLAN Name	Discipline	Group	First IP adres	Last IP adres
1015	AUDIO-SEC	Audio Secondary	Venue	10.15.1.11	10.15.99.250
			Venue DHCP	10.15.100.11	10.15.100.250
CIDR notation	Subnet	Color	Production	10.15.101.11	10.15.199.250
10.15.0.0/16	255.255.0.0	Blue #0000FF	Production DHCP	10.15.200.11	10.15.200.250

VLAN ID	VLAN Name	Discipline	Group	First IP adres	Last IP adres
1020	INTERCOM	Intercom	Venue	10.20.1.11	10.20.99.250
			Venue DHCP	10.20.100.11	10.20.100.250
CIDR notation	Subnet	Color	Production	10.20.101.11	10.20.199.250
10.20.0.0/16	255.255.0.0	Green #00FF00	Production DHCP	10.20.200.11	10.20.200.250

VLAN ID	VLAN Name	Discipline	Group	First IP adres	Last IP adres
1030	VIDEO	Video	Venue	10.30.1.11	10.30.99.250
			Venue DHCP	10.30.100.11	10.30.100.250
CIDR notation	Subnet	Color	Production	10.30.101.11	10.30.199.250
10.30.0.0/16	255.255.0.0	Yellow #FFFF00	Production DHCP	10.30.200.11	10.30.200.250

VLAN ID	VLAN Name	Discipline	Group	First IP adres	Last IP adres
1040	LIGHTING	Lights	Venue	10.40.1.11	10.40.99.250
			Venue DHCP	10.40.100.11	10.40.100.250
CIDR notation	Subnet	Color	Production	10.40.101.11	10.40.199.250
10.40.0.0/16	255.255.0.0	Purple #A000FF	Production DHCP	10.40.200.11	10.40.200.250

VLAN ID	VLAN Name	Discipline	Group	First IP adres	Last IP adres
1050	SHOWCONTROL	ShowControl	Venue	10.50.1.11	10.50.99.250
			Venue DHCP	10.50.100.11	10.50.100.250
CIDR notation	Subnet	Color	Production	10.50.101.11	10.50.199.250
10.50.0.0/16	255.255.0.0	Pink #FF7FFF	Production DHCP	10.50.200.11	10.50.200.250

VLAN ID	VLAN Name	Discipline	Group	First IP adres	Last IP adres
1080	SPECIAL	Function-related	Venue	10.80.1.11	10.80.99.250
			Venue DHCP	10.80.100.11	10.80.100.250
CIDR notation	Subnet	Color	Production	10.80.101.11	10.80.199.250
6750	255.255.0.0	Aqua #80FFFF	Production DHCP	10.80.200.11	10.80.200.250

VLAN ID	VLAN Name	Discipline	Group	First IP adres	Last IP adres
1090	MANAGEMENT	Management	Venue	10.90.1.11	10.90.99.250
			Venue DHCP	10.90.100.11	10.90.100.250
CIDR notation	Subnet	Color	Production	10.90.101.11	10.90.199.250
10.90.0.0/16	255.255.0.0	Orange #FF8000	Production DHCP	10.90.200.11	10.90.200.250

10. Attachments

10.1. VLAN and IP table

For the VLAN and IP table as a separate document, see the website

<https://www.fent-tech.nl/download/iptabel>

10.2. Technical list

For the technical list, also known as a rider in certain circles, see the website

<https://www.fent-tech.nl/download/technischelijst>

10.3. Key terms

This guide contains a collection of the most important terms that recur regularly. The key terms are explained briefly in alphabetical order so that everyone knows exactly what we are talking about. This creates a common language that helps to prevent misunderstandings and makes the guide easier and clearer to use. This list is by no means exhaustive, but contains the terms that are most important for this subject.

See also: <https://www.fent-tech.nl/download/kernbegrippen>

AES67

Open standard for Audio-over-IP that offers compatibility between different systems (such as Dante and Ravenna).

Access port

Access ports are network ports on a managed switch for a single VLAN.

Art-Net

Art-Net is a protocol developed by Artistic Licence that sends DMX and, from version 4 onwards, RDM data via IP networks. It supports both unicast and broadcast and is widely used in theaters and at live events. Art-Net was originally designed for use within a closed network, typically with IP addresses in the 2.x.x.x range (subnet 255.0.0.0). Although this is still the standard, Art-Net 4 can now also function seamlessly within other IP address ranges.

AVB (Audio Video Bridging)

AVB is a set of IEEE standards for transporting time-critical audio and video signals over Ethernet, with guaranteed bandwidth and low, predictable latency at its core. AVB requires specific, AVB-compatible network components and operates within a strictly controlled network architecture.

Broadcast

Traffic sent to all devices in a network segment. Often undesirable because it impacts performance.

Compatibility

The ability of different systems, devices, and protocols to communicate and work together, regardless of manufacturer or technology. In stage technology, this means that equipment from different brands can reliably exchange data within the same network.

Dante

Commonly used Audio-over-IP protocol from Audinate. Features very low latency and redundancy.

DHCP (Dynamic Host Configuration Protocol)

Protocol that automatically assigns IP addresses. Often used in stage technology networks for predictability and troubleshooting purposes.

DSCP (Differentiated Services Code Point)

This is a field in the IP header (in the Type of Service / ToS byte) that allows network equipment to see how important a data packet is. You use DSCP to control Quality of Service (QoS): certain packets are given priority or different treatment in switches and routers.

FENT (Framework Entertainment Network Technology)

See chapter 1.

IGMP (Internet Group Management Protocol)

The Internet Group Management Protocol (IGMP) is a network protocol that allows devices to subscribe to and unsubscribe from multicast groups. This allows data to be sent efficiently from a single source to multiple recipients, a process known as multicasting. Devices send IGMP messages via local Ethernet switches to an IGMP querier to indicate which multicast streams they want to receive. Thanks to IGMP, multicast traffic is only forwarded to Ethernet switches and devices that explicitly request those specific streams. This prevents network pollution and increases the stability and predictability of the network.

IGMP snooping

IGMP snooping is a feature on Layer-2 (and higher) Ethernet switches that regulates multicast traffic within a local area network (LAN). By actively analyzing IGMP messages, or snooping, the switch learns which devices are interested in which multicast data streams, such as sACN universes or Dante streams. If a port does not send IGMP messages, IGMP snooping will block multicast traffic to and from that port.

IGMP querier

An IGMP querier is an essential part of a multicast network. The querier acts as the director of multicast traffic and periodically checks which devices are still active members of multicast groups and where they come from. Without an active querier, the switches in the network lose this information and multicast traffic will eventually be treated as broadcast, with all the consequences that entails.

Latency

Delay in data transport. Critical for audio and video; slightly less so for light.

Managed Switch

A managed switch is a network switch that can be configured and managed. This type of switch offers features such as VLAN configuration, Quality of Service (QoS), IGMP multicast management, monitoring, and security settings.

Multicast

A transmission method in which a single sender sends data to multiple receivers. Within Ethernet networks, this only occurs to devices that actively register for it.

Stage technology

Stage technology encompasses the technical disciplines, installations, and resources necessary for staging theater performances, concerts, events, and presentations. This includes lighting, sound, video, and show control systems, rigging, stage mechanics, and the associated networks and infrastructure.

Private IP Address

IP addresses that are only used within a local network (e.g., 10.x.x.x, 172.16–31.x.x, 192.168.x.x).

PTP (Precision Time Protocol, IEEE 1588)

Protocol for synchronizing devices with high precision.

QoS (Quality of Service)

Network setting that determines which traffic is given priority.

RDMnet

RDMnet is the protocol for sending RDM information over an IP network, as defined in the ANSI E1.33 standard.

Redundancy

The duplication of connections or systems to compensate for failures.

Example: Dante supports Primary and Secondary networks; if one cable is interrupted, the audio stream continues to run.

Router

Device that can send traffic between different networks (unlike a switch, which only works within a single network).

sACN (Streaming Architecture for Control Networks)

Standard protocol for sending DMX over an IP network, defined in the ANSI E1.31 standard.

Subnet / Subnet mask

Determines which IP addresses fall within the same network.

UDP (User Datagram Protocol)

Transport protocol without error checking or retransmission, but very fast and suitable for real-time applications.

Unicast

Communication from one sender to one receiver.

Unmanaged switch

An unmanaged switch is a simple network switch that does not offer any configuration options. Devices are automatically connected to each other on a plug-and-play basis, without the ability to set network parameters or management functions. This type of switch is particularly suitable for small or non-critical networks where flexibility and advanced management are not necessary.

VLAN (Virtual Local Area Network)

Virtual separation within a single hardware network.

VLAN trunking

VLAN trunking is a technique used to transport multiple VLANs simultaneously over a single hardware network connection (e.g., an Ethernet cable or switch port). In short, instead of pulling a separate cable for each VLAN, the VLAN packets are "tagged" and sent together over a single trunk link.

11. Responsibility and follow-up

11.1. Disclaimer

The authors of this document have taken the utmost care to draw up a Framework that is as complete and thorough as possible, based on the knowledge, insights, and technical specifications available at the time. Nevertheless, it cannot be ruled out that unintentional errors or omissions may have crept into the document.

The authors accept no liability for any damage, malfunctions, or other consequences resulting from incorrect interpretation, incomplete application, or incorrect implementation of the guidelines described in this document. Responsibility for the design, implementation, and management of technical systems remains with the parties involved at all times.

In addition, it should be noted that technical protocols, standards, and product specifications are subject to change. Specific technical requirements may have been modified during or after the preparation of this document. Users of this Framework are expected to verify the information in this document and to use the document as a guideline, not as a binding technical specification.

11.2. Roadmap and future

This document forms the basis of the Framework and, at this stage, focuses primarily on the generic network structure and underlying principles. Various discipline-specific chapters, including audio, intercom, video, and show control, will be further elaborated and supplemented in subsequent phases. This will explicitly address the associated protocols and preconditions, such as PTP, time code, and other relevant technical provisions. The use of a single network for multiple venues, or situations with multiple companies or bands on a single stage, will also be included in a subsequent version of the Framework.

Further elaboration will be based on a global phasing plan. In the coming six months, the focus will be on the disciplines of audio and intercom. In the following six months, the chapters on video and show control will be elaborated. This schedule is indicative and may be adjusted depending on available capacity, new insights, and external developments.

11.3. Version list

Here is a general version list of the FENT document:

Version	Date	Description
V 0.9.0	2025-11-11	<i>Internal version for sounding board group, presented in Houten</i>
V 0.9.3	2025-12-18	<i>Internal version for Christmas reading working group</i>
V 0.9.4	2026-01-06	<i>Internal version for final checks working group</i>
V 1.0.0	2026-01-13	First public version, presented at CUE 2026
V 1.1.0	2026-04-16	Revised version, color codes and typos

For the latest version of this document, see: <https://www.fent-tech.nl/download/framework>

