Building

Networks

Rev 2.0

Ether
ES
Sound

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INTRODUCTION

This document is meant to help all professional audio specialists, who have already chosen or will choose EtherSound, to understand the technology and to build their network(s).

It gives a short introduction to the characteristics of Ethernet, the conception of EtherSound, and to EtherSound's interplay with Ethernet components and the Ethernet protocol. It also gives some recommendations for equipment tested at Digigram and found to comply with the EtherSound requirements.

Watch out for these symbols beside the corresponding text:

indicates that this technology is suitable for EtherSound networks.

designates that the technology or material described is to be avoided in the context of EtherSound networks.

indicates that the chapter or paragraph in question contains important additional information or differentiations, READ WITH CARE !

THE TECHNOLOGY

EtherSound uses standardized and well-proven technology from the world of digital networks, in order to cost-effectively convey high-quality audio.
The EtherSound protocol provides :

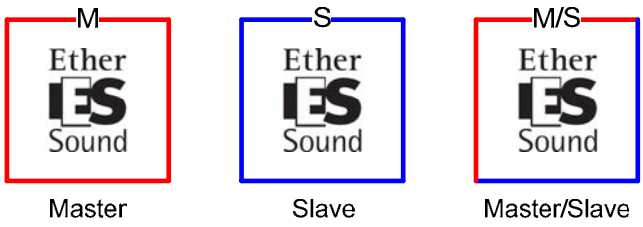
- Up to 64 channels
- 24-bit digital audio may be transported at 44.1 ,48 kHz or 96 kHz (hardware dependend)
- very low and fixed latency (125 µs)
- synchronised
- bi-directional audio and control.
- among a virtually infinite number of connected devices,
- Use of standard Ethernet components

The EtherSound protocol by Digigram is based on true Ethernet frames. It is fully compliant to Ethernet IEEE 802.3 frame format. It is full-duplex (data is sent and received simultaneously) and it requires a dedicated Fast Ethernet network, as it cannot share data with other elements on a network. Data is typically transported via Local Area Networks (LANs) with a minimum bandwidth of 100Mbps full-duplex.

TYPES OF ETHERSOUND DEVICES

There are three types of EtherSound hardware devices differing in the way they act in an EtherSound network:

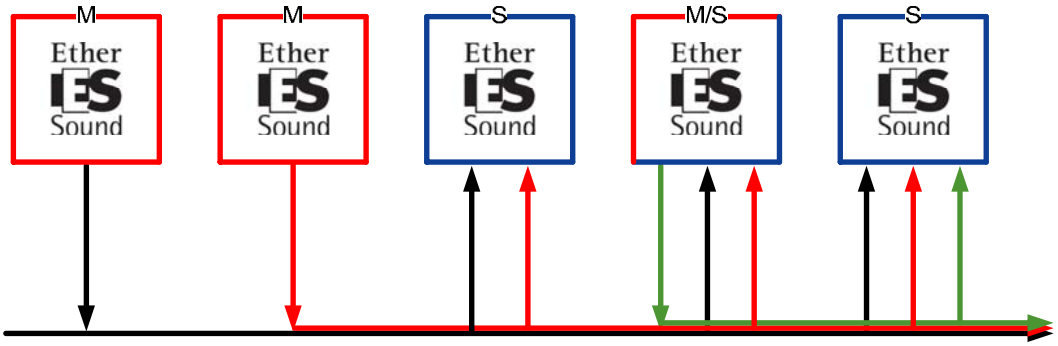
- Master (device injecting audio into the frame)
  Note: the first Master device in a network is called Primary Master
- Slave (device playing audio from the frame)
- Master/Slave (combination of both)



UNI-DIRECTIONAL AND BI-DIRECTIONAL ETHERSOUND

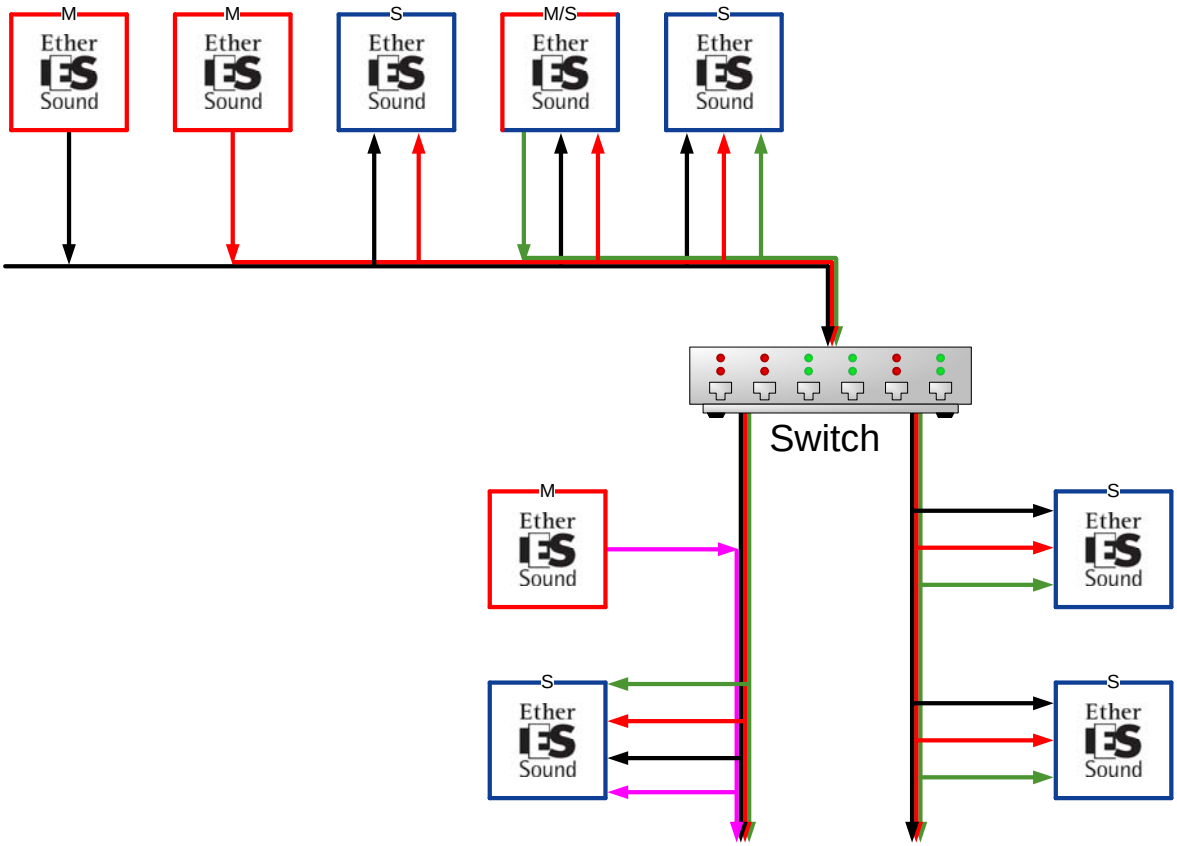
Uni-directional EtherSound

In uni-directional mode, the equipment situated further down the chain (downstream) will only be able to read the audio data inserted by equipment further up (upstream).



Daisy chained EtherSound devices
(example, the arrows representing different channels of audio data inserted into or read from EtherSound frames)

Thanks to a switch, EtherSound devices may use a Star architecture:

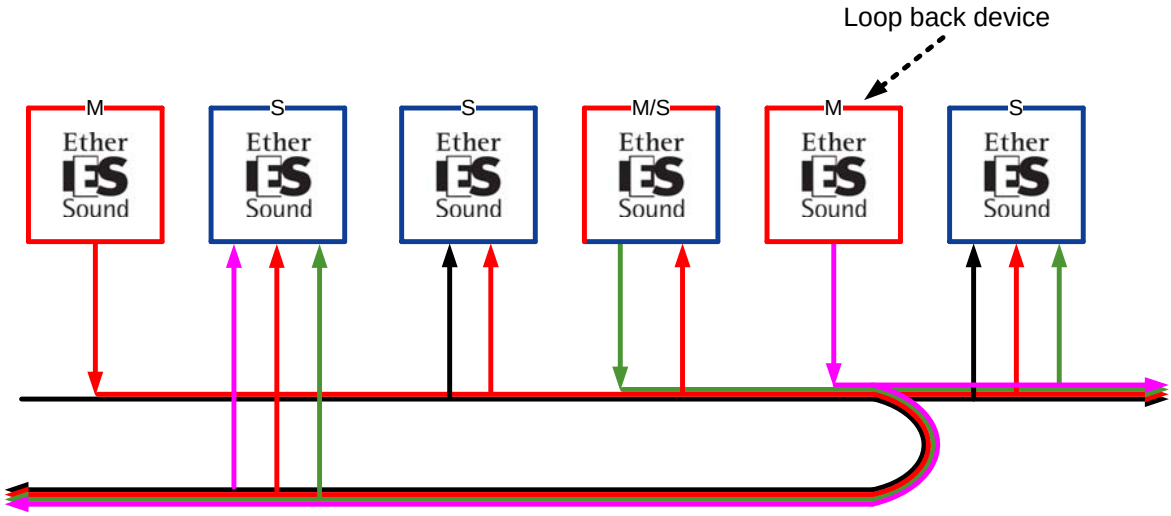


Daisy chained + Star EtherSound devices
(example, the arrows representing different channels of audio data inserted into or read from EtherSound frames)

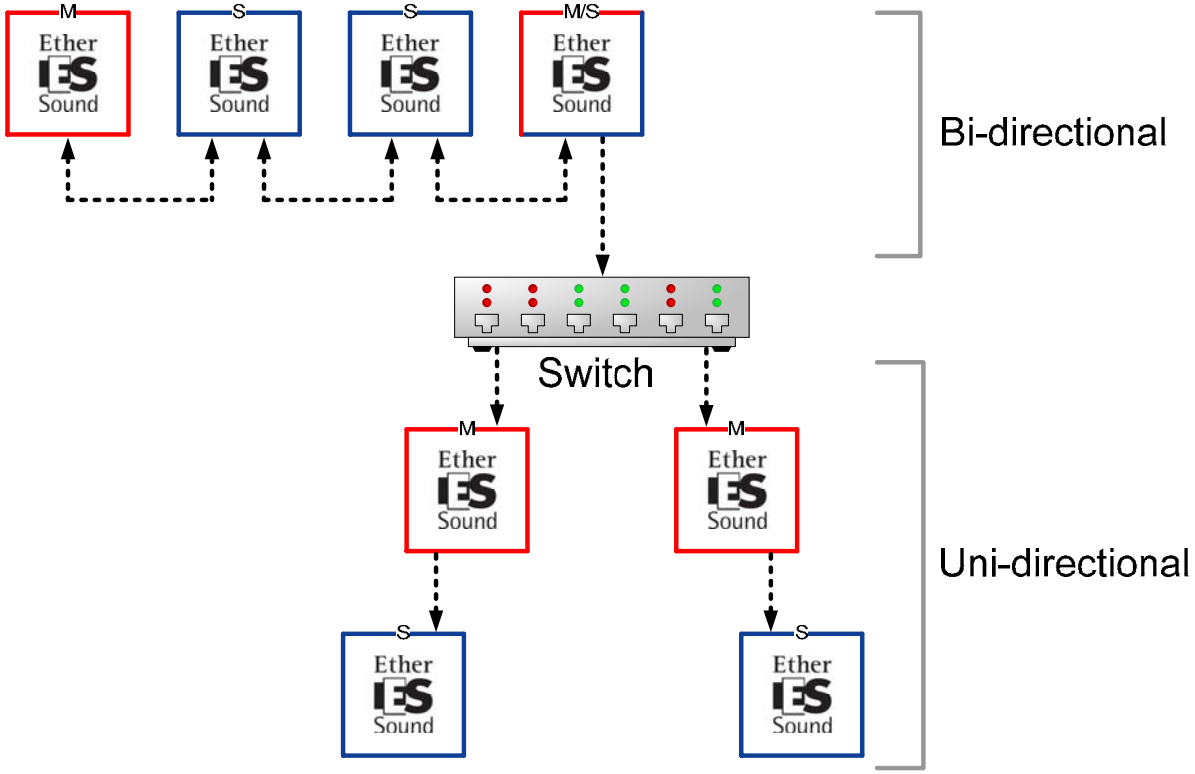
Bi-directionnal EtherSound

In bi-directional mode, the equipment further down the chain will be able to read the audio data from equipment situated both further up and further down in the chain.

EtherSound is bi directionnal on the first daisy-chain. On this chain, you select a 'loop back device' to create an 'end of loop' and send the frame back with the audio data.



EtherSound is bidirectionnal until the first switch. Control data are systematically bi-directional, whatever the topology of the network and wheter or not a switch is present



Control data are systematically bi-directional, whatever the topology of the network and wheter or not a switch is present.

ETHERNET CABLES

The EtherSound network uses standard computer network components. In a standard network, loosing frames doesn't disturb the system, because the frame will be prompted for again.

EtherSound is an audio protocol with very low latency, therefore a loss of frames must be avoided. Consequently, EtherSound requires a very reliable and dedicated network.

Twisted Pair

Twisted pair is similar to the telephone cable that may already be installed in your building and available for network use. There are several grades of cables, each higher grade offering better performance. Levels 1 to Level 4 are not compatible with a 100 Base-T network.

CAT5, 5e, 6, 7 cables

Level 5 cable supports transmission rates of up to 100 Mbps (200 Mbps in full-duplex), CAT5e even 1 Gbps - it is the most common today. Category 6 supports up to 10 Gbps.

Horizontal (solid) cable and patch (stranded) cable

For computer networks you have two kinds of cables:

Horizontal cable is the cable used inside walls and ceiling.

Patch cable more flexible, is used for versatile termination between wall outlet and device, or between devices. These cables are explicitly labeled "PATCH".

The horizontal cables offer less attenuation with distance but are more difficult to handle.

They are recommended for fixed installations with cables passing through walls and for long distances.

Patch cables are easy to use but are less suitable for long distances because of their greater attenuation.

The cable industry has understood the problematic of a strong but easy to use cable. This is why you can now find cables dedicated to Live Sound installations. You can find a (non-exhaustive) list on the www.EtherSound.com web site.

To know whether a cable is EtherSound compatible, please refer to the list of cables tested on www.EtherSound.com. If a cable presents the minimum electrical characteristics for a CAT5 point-to-point link recommended in the TIA568B standard, this cable should be perfectly suitable for an EtherSound application (see table below).

Frequency (MHz)	Insertion Loss (dB)	NEXT (dB)	PS NEXT (dB)	ELFEXT (dB)	PS ELFEXT (dB)	Return Loss (dB)
1.0	2.2	>60	>57	57.4	54.4	17.0
4.0	4.5	53.5	50.5	45.4	42.4	17.0
8.0	6.3	48.6	45.6	39.3	36.3	17.0
10.0	7.1	47.0	44.0	37.4	34.4	17.0
16.0	9.1	43.6	40.6	33.3	30.3	17.0
20.0	10.2	42.0	39.0	31.4	28.4	17.0
25.0	11.4	40.3	37.3	29.4	26.4	16.0
31.25	12.9	38.7	35.7	27.5	24.5	15.1
62.5	18.6	33.6	30.6	21.5	18.5	12.1
100	24	30.1	27.1	17.4	14.4	10.0

Our experience demonstrates that the length that can be reached with the different types of cables is generally around:

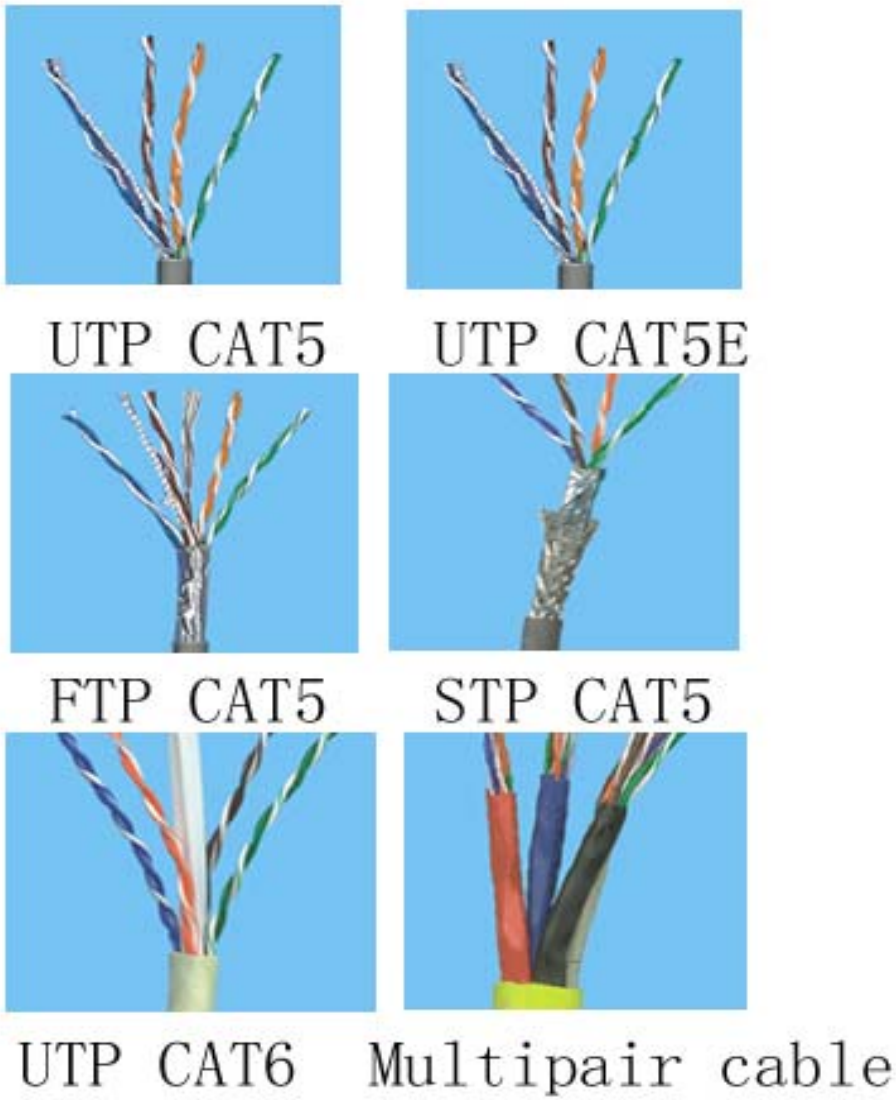
- 50-90m for the patch cables
- 90-150 for horizontal cables

The list available on the www.ethersound.com website provides the maximum suitable length for each cable that has been tested.

UTP, FTP (ScTP), STP, SFTP cables

- UTP stands for Unshielded Twisted Pair. It is the most common type of cabling used in desktop communications applications.

- FTP stands for Overall Foil Shielded Twisted Pair (ScTP for Screened Twisted Pair): Cable is wrapped with an aluminized plastic foil)
- STP stands for Shielded Twisted Pair: Screen is made of copper braid.
- SFTP stands for Overall Braid + Foil Shielded Twisted Pair: Foil screen and braid shield.



Fiber Optic

Fiber Optic is similar to twisted pair but does not conduct electricity. It is used in situations where a network may suffer from environmental conditions (e.g. lightning), such as for example in LAN connections between buildings. Fiber optic is also very valuable where electronic emissions or electro-magnetic interferences may have an impact on the network, e.g. on particular factory floors. Furthermore, fiber optic cables and Ethernet standard allow for segments up to several kms long and thus permit to connect remote nodes and buildings that otherwise would not be accessible.

There are two types of fiber optic:

- Monomode fiber (maximum distance 70km)
- Multimode fiber (maximum distance 2km)

Fiber optics are fragile and therefore not recommended for mobile installations.
To use Fiber Optic cable in EtherSound networks, Media Converters must be used.

Media Converters successfully tested at Digigram

Product	Manufacturer	Model, tested functions
Media Converter	Level One	FVT-0100TXFC, 100 Mbps port
Media Converter	D-Link	DMC-300SC
Media Converter	Allied Telesyn	MC102XL

Many switches have also optical ports.

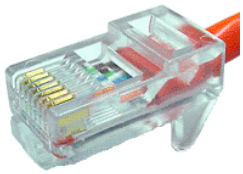
CONNECTORS

For mobile application, we strongly recommend the use the HARTING® and Neutrik® ETHERCON® connectors.

HARTING® (RECOMMENDED): The RJ45 is really robust and you have a Push-Pull system to avoid an extraction of the copper cable

ETHERCON® (RECOMMENDED): They give good contact between the metal case of the equipment and the cable shielding. Above all, they ensure a vigorous connection similar to the one of XLRs.

RJ45 (NOT RECOMMENDED FOR MOBILE INSTALLATIONS): They are very fragile (the plug is only held in the socket by a tiny plastic flap). Contact between the metal case and the cable sheathing is insecure. However, they remain the only solution if advanced switches are used. For fixed installations, RJ45 cables may be used if not subjected to handling.



Unshielded RJ45 (PROHIBITED): The use of an unshielded connector will expose the installation to problems arising from electromagnetic interference or emission.

SWITCH SOLUTIONS

Hubs

Due to their internal architecture, repeater hubs MUST NOT be used in EtherSound networks.

Switches

Layer 2 (*Data Link Layer*) switches

It is recommended to use Layer 2 switches. On this layer, analysis of frames is simple and thus transmission is fast. As the EtherSound protocol contains exclusively layer 2 information, switches other than layer 2 must not be used.

VLAN

These layer 2 switches can be either managed or unmanaged; managed switches are necessary to set up VLANs (Virtual Local Area Networks). These VLANs may be interesting to use in two scenarios:

- you want to use and administration network and EtherSound on the same network: EtherSound requiring a dedicated network you'll have to separate this network into two VLANs using a switch.
- you want to manage several EtherSound networks from a central point, so you link them using a switch.

Layer 3 (*Network Layer*) and Layer 4 (*Transport Layer)* switches, Routers

As opposed to Layer 2 switches, the switching decision of these devices is based on the IP header of each frame. Theses switches use other protocols which disturb the EtherSound protocol. Numerous layer 3 or 4 switches allow disabling these protocols. Then your switch becomes a "layer 2" switch.

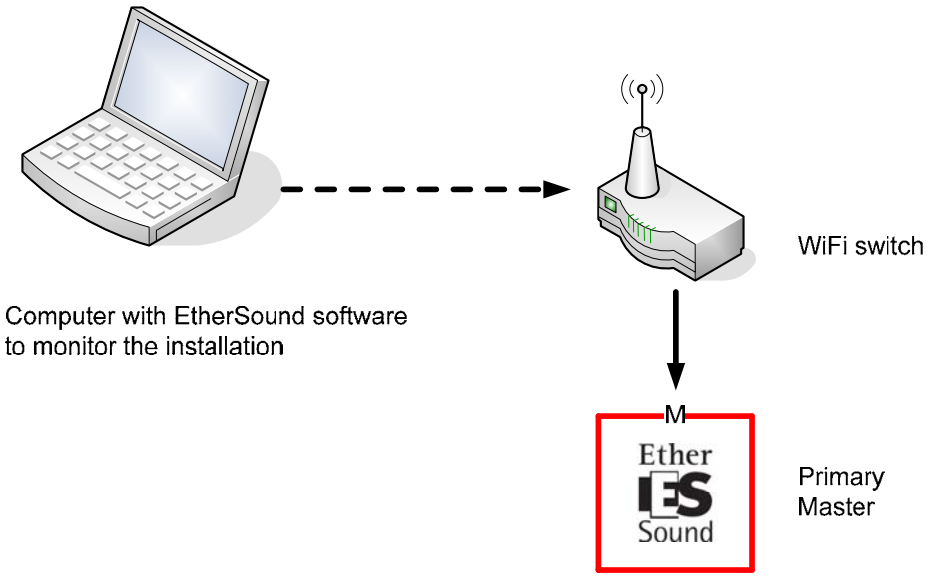
For the use of VLAN, Spanning-Tree, and Frame Tagging, see the chapter on topology.

Wireless for the audio frame

Wireless LANs are not suitable for EtherSound networks due to significant bandwidth limitations.

Wireless for control

The wireless bandwidth is enough and gives the possibility of using a WIFI connection between a control computer and a wireless “borne” connected to the Primary Master.



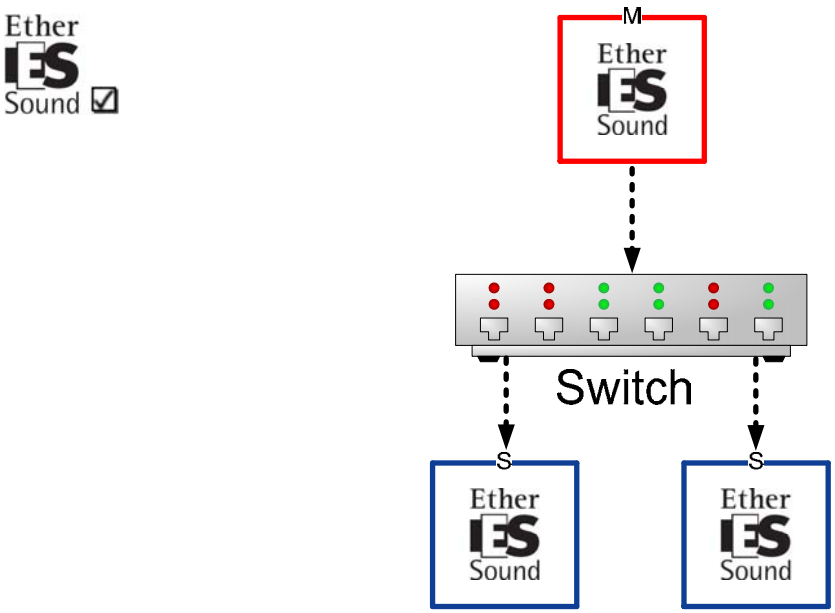
Manual switch

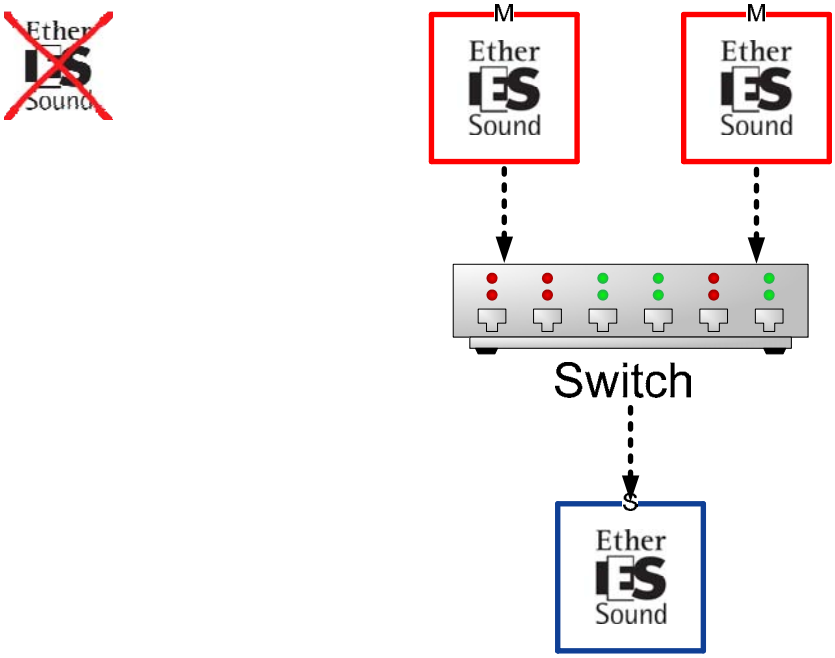
Such a device allows switching between 2 Primary Masters. It can be useful to implement a redundant source (for example: 2 consoles)

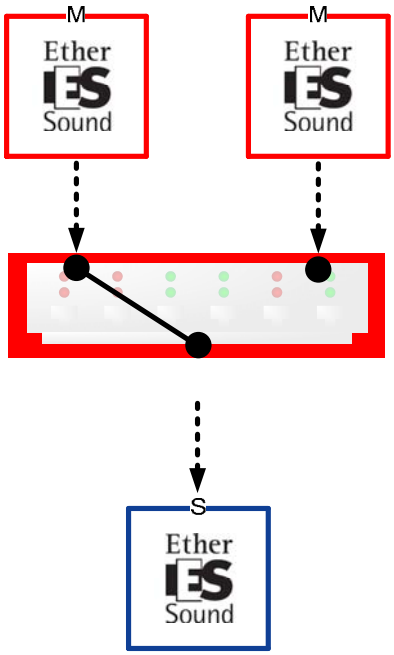
See also the topology part.

TOPOLOGY

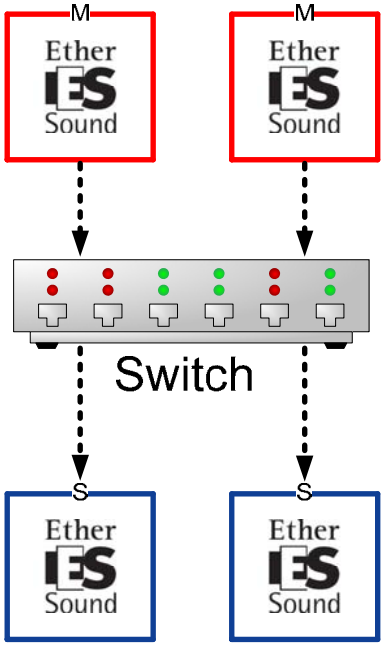
We will consider some easy architectures to study their EtherSound compatibility. For examples of realized applications please take a look at the document: "***How to build your application with EtherSound***" on the Digigram website



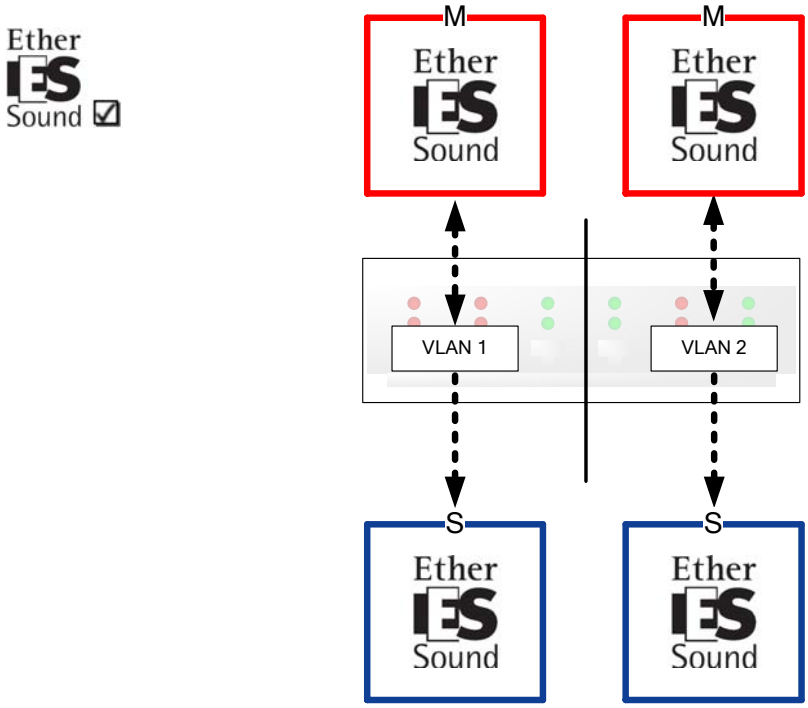




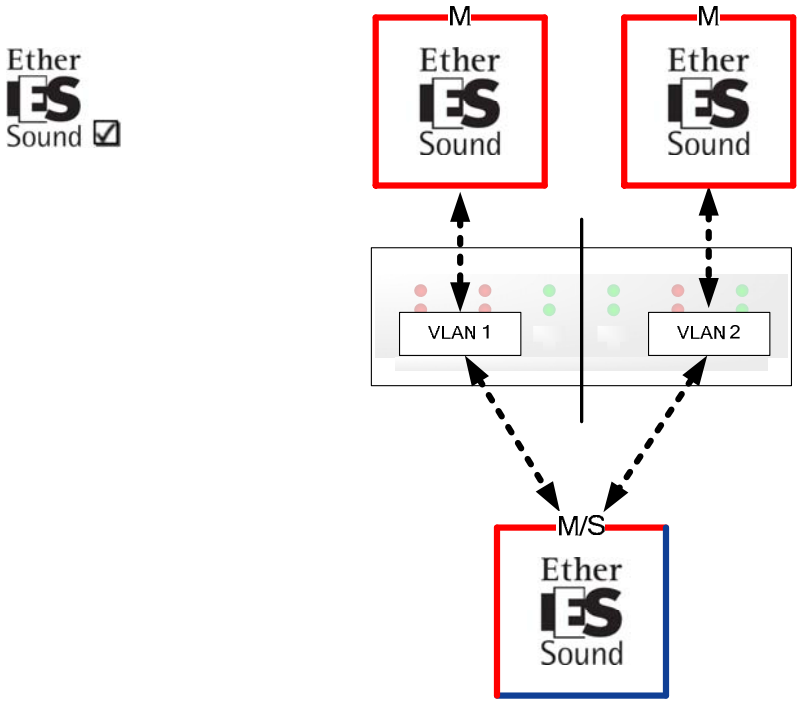
If you use a manual switch, you can commute from one EtherSound network to another.
In this example: from one Primary Master to another one.



The topologies hereafter are to be used preferably with fixed installations:

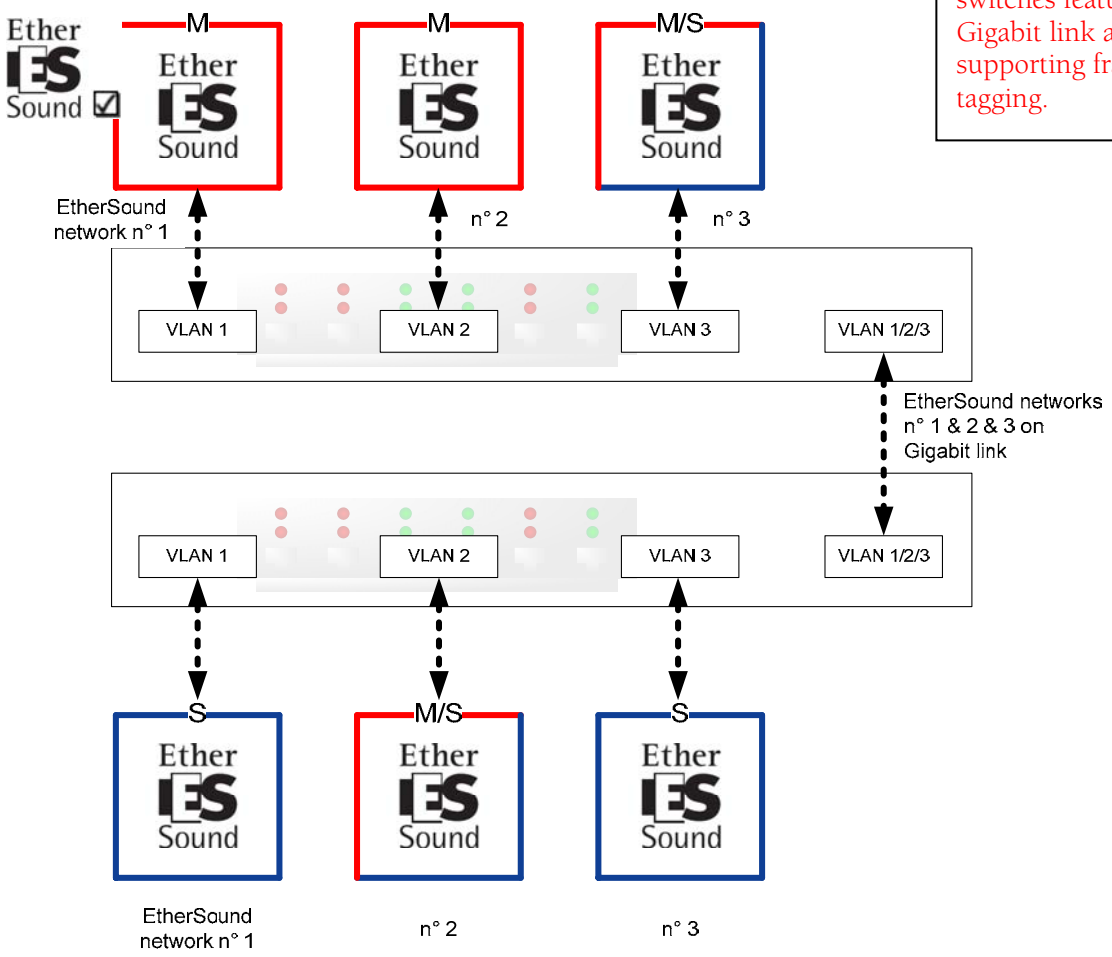


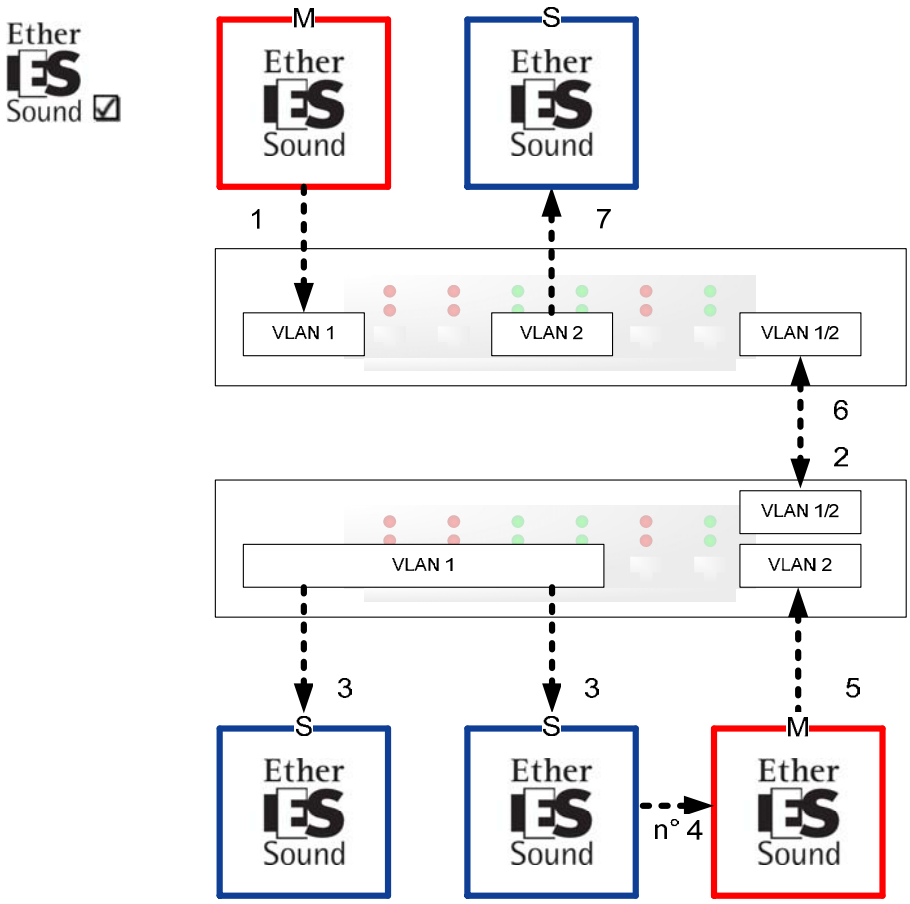
If you use a VLAN, you will be able to separate the two EtherSound networks. You can also separate an EtherSound network from an administration network.



This is only possible with a switch managing an independant table of MAC addresses for each VLAN.

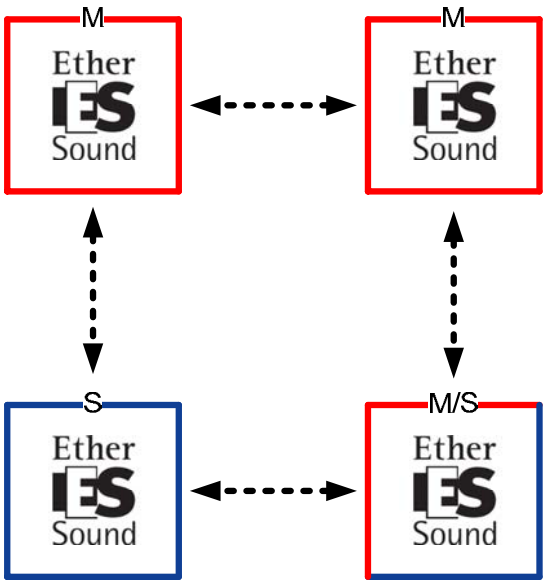
For this architecture, use switches featuring a Gigabit link and supporting frame tagging.



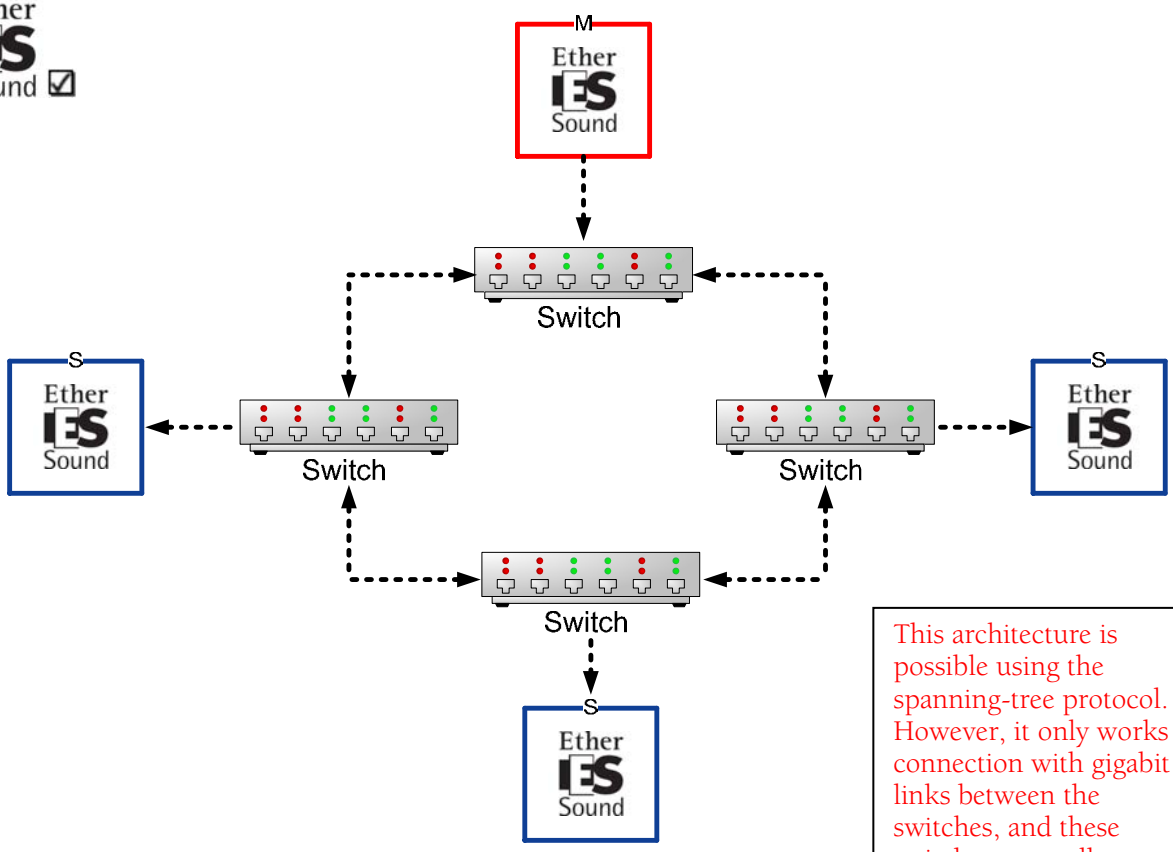


For this architecture, use switches featuring a Gigabit link and supporting frame tagging.

This architecture allows for example to bring back an input to the beginning of the network from a location situated after a switch.



This is not possible for the time being, a solution is currently under development.



This architecture is possible using the spanning-tree protocol. However, it only works in connection with gigabit links between the switches, and these switches must allow disabling the spanning tree protocol on the ES device ports.