

**TECHNICAL  
GUIDE**

**IP Network Guidance:  
HelixNet Digital Partyline**

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## Introduction | HelixNet Digital Partyline

The HelixNet Digital Partyline system offers a tremendous amount of flexibility and performance to broadcast and live productions requiring partyline/group communications. HelixNet Digital Network Partyline System delivers all the features and functions of industry-standard analog partyline systems along with digital audio clarity over 24 channels and IP connectivity via Powerline or connected Power-over-Ethernet (PoE). HelixNet operates over any standard single, twisted-pair, shielded cable (like microphone cable) using our Powerline technology. As this paper will explain, it can also be interconnected over standard IT network infrastructures via IP/LAN or IP connected Powerline.



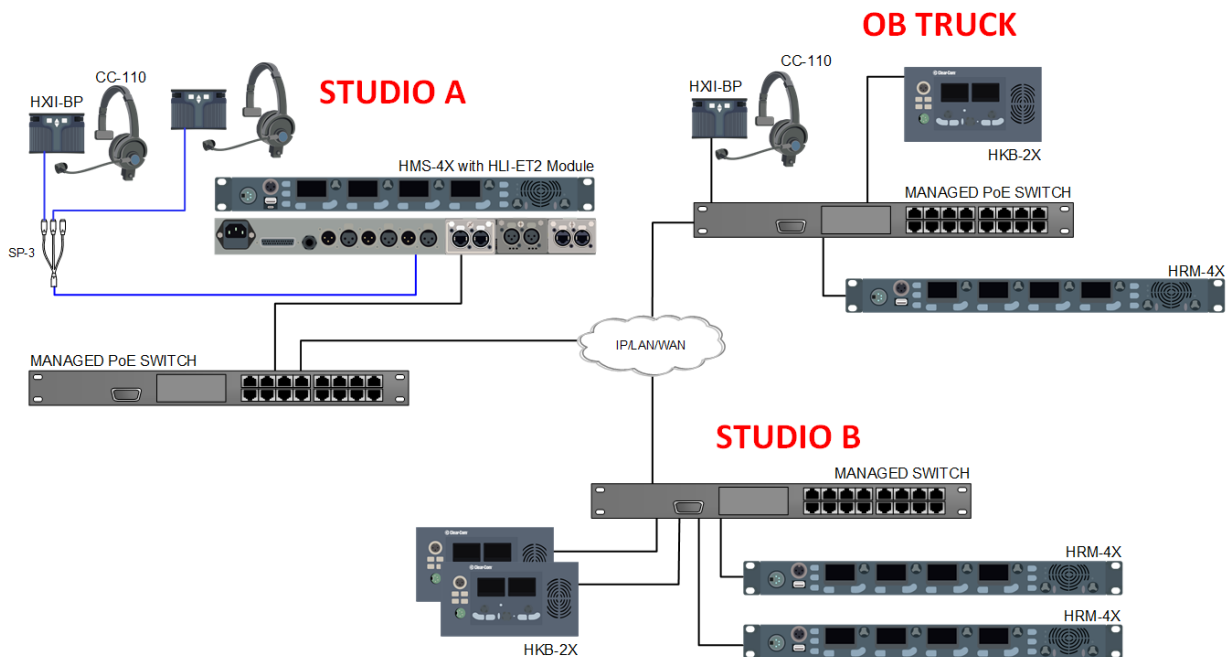
## HelixNet Network Guidance

This guide provides specifications, best practices and guidance for the integration of HelixNet into an existing or new IP network. Several of the terms used in this paper are technical in nature, please see the glossary at the end of the document for explanations and definitions.

## HelixNet “Network” Digital Partyline

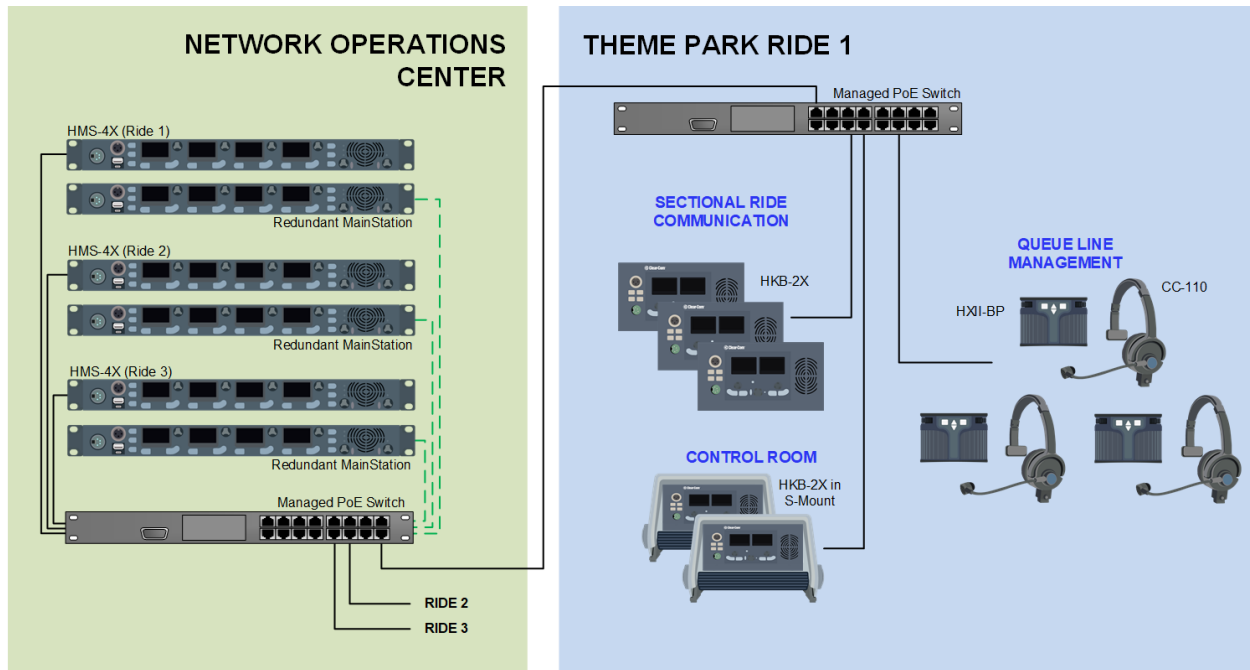
In Figure 1 (below) teams in separate studios (A and B) can communicate with an outside broadcasting truck on the same digital partyline system over their existing IP network. With cabling integration possibilities in either XLR or CAT5/6, HelixNet becomes a flexible solution in multiple scenarios.

- Live Production
- Performing Arts and Theatre
- House of Worship
- Theme Park Ride Communications (Figure 2)



**Figure 1**

Because of its IP capability, HelixNet is an excellent solution for intercom communication for Theme Park Rides as shown in Figure 2 (below). A Park's Network Operations Center houses sets of HelixNet Main Stations per ride – one HMS is live production, the second is a redundant back up. The HMS connects to a local switch, the local switch then connects via CAT5/6 to a second PoE switch at the ride locale. HelixNet endpoints (HKB and HXII-BP) are placed at strategic positions within the ride to connect operators and provide a safe experience for the customer.



**Figure 2**

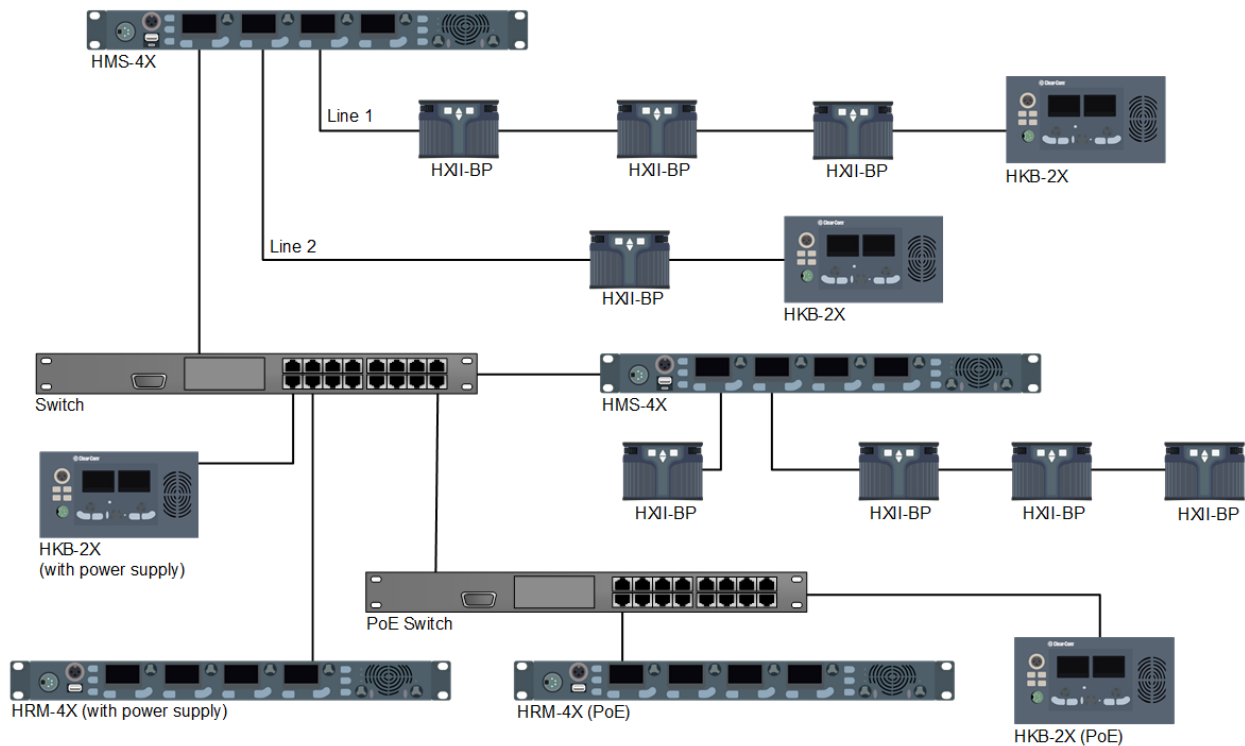
## Network Topology

The HelixNet Main Station (HMS-4X), Remote Station (HRM-4X), Speaker Station (HKB-2X) and Beltpack (HXII-BP) use a 100Mb Network Interface Card (NIC). Devices are physically added to the network by connecting the RJ45 LAN port on the device to an Ethernet switch port using a shielded CAT5 or CAT6 cable. HRM, HKB and HXII-BP units can be powered using PoE Ethernet switches or a local power supply. To connect the HMS-4X to the Ethernet switch, it must be fitted with a HLI-ET2 2-port Ethernet module (pictured). There are two ports available on each module. The HLI-ET2 ports act as two normal switch ports. They can be daisy chained together, but they do not use Spanning Tree Protocol - connecting both ports to the same switch can cause redundant paths or loops which will cause a packet storm and severely degrade both networks. Best practice would be to use one port to connect to the network switch, and the second port to daisy chain to other HelixNet or LQ devices.



**HLI-ET2 Module**

HelixNet devices can be paired/linked together across subnets. They use the mDNS protocol to auto-discover each other. Figure 3 below shows a typical network topology with HelixNet endpoints connected directly to the HMS-4X mainstation, endpoints with a local power supply connected via a switch, and endpoints connected via a PoE switch.

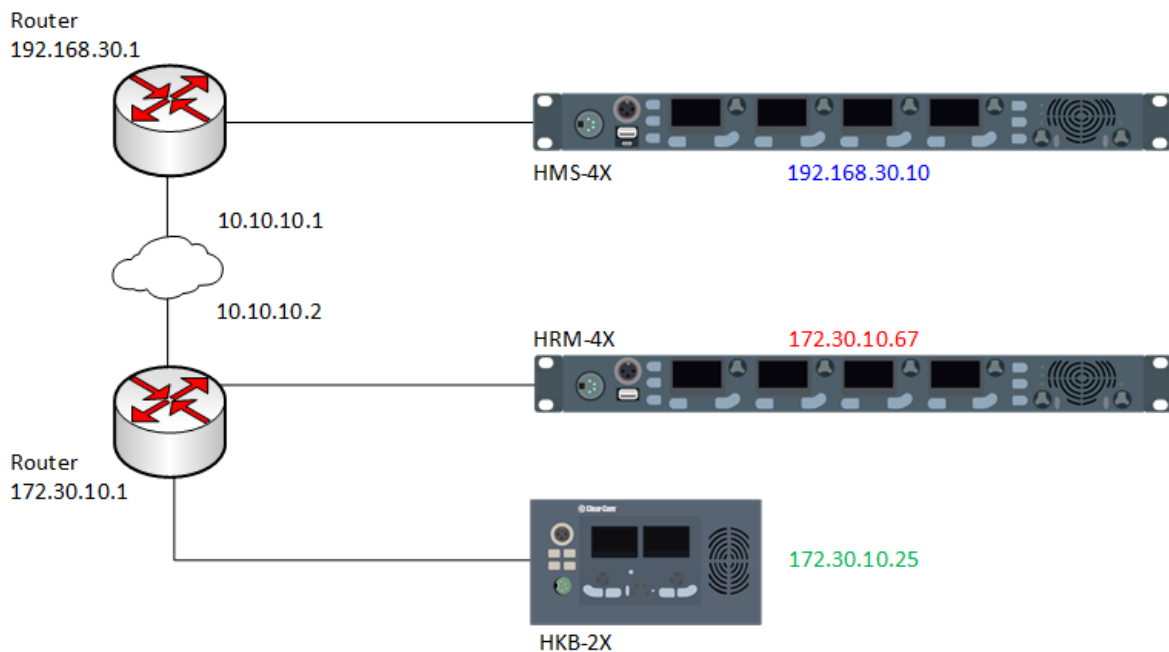


**Figure 3**

## Network Configuration

### Connecting Across Routable Subnets

Company networks typically have multiple subnets or VLANs. IP routers are already configured to route IP traffic across those subnets. The HMS and HRM/HKB/HXII-BP must have their IP address, Subnet mask and Gateway set properly (all automatically done when there is a DHCP server available on the network). If the HRM/HKB/HXII-BP is deployed on a different subnet, you will need to Pair to Station by entering the IP address of the HMS (Pair to Station by Name is not available in the Figure 4 example below). “Pair to Station by Name” is discussed later in this document.



**Figure 4**

#### HMS Network Configuration:

IP Address: 192.168.30.10

Subnet Mask: 255.255.255.0

Gateway: 192.168.30.1

#### HRM Network Configuration:

IP Address: 172.30.10.67

Subnet Mask: 255.255.0.0

Gateway: 172.30.10.1

Pair to Station: 192.168.30.10

#### HKB Network Configuration:

IP Address: 172.30.10.25

Subnet Mask: 255.255.0.0

Gateway: 172.30.10.1

Pair to Station: 192.168.30.10

### Connecting Across Non-Routable Subnets

The second scenario occurs when an HMS is in a private/separate network, not directly reachable from where the HRM/HKB is located. A reachable IP router/gateway, on the network where the HMS is located, must be configured to forward all the IP traffic for port 6001 TCP/UDP to the HMS (Figure 5):

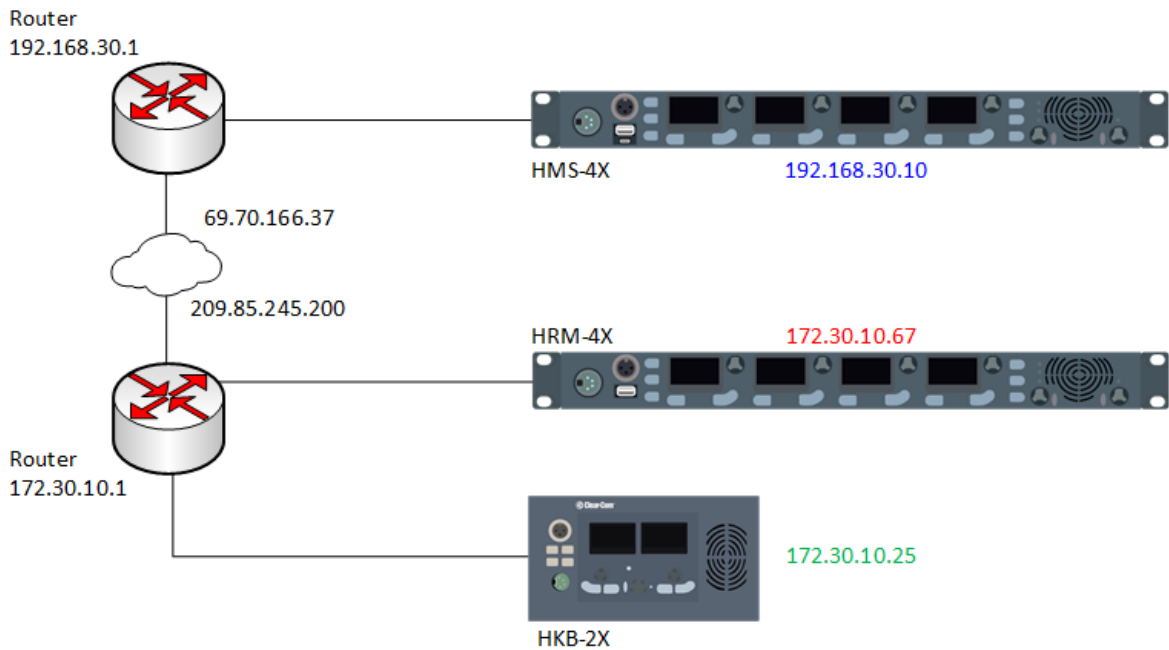


Figure 5

#### HMS Network Configuration:

IP Address: 192.168.30.10

Subnet Mask: 255.255.255.0

Gateway: 192.168.30.1

Here the Router on the HMS side must port-forward everything from 6001 TCP/UDP to 192.168.30.10:6001

#### HRM Network Configuration:

IP Address: 172.30.10.67

Subnet Mask: 255.255.0.0

Gateway: 172.30.10.1

Pair to Station: 69.70.166.37

#### HKB Network Configuration:

IP Address: 172.30.10.25

Subnet Mask: 255.255.0.0

Gateway: 172.30.10.1

Pair to Station: 69.70.166.37

It should be noted that HelixNet reserves the 10.0.0.0/16 network for connecting HelixNet devices by powerline – placing HelixNet devices/systems on 10.x network may cause issues.

### **Firewall: TCP/UDP IP Ports**

To support remote connectivity of HelixNet endpoints external to a LAN or WAN, port forwarding rules will be needed to achieve the required connectivity to the HMS that has been set into Link-Master mode. Listed below is the Port # and a description of what the opened port provides access to.

- Port 6001 TCP - Pairing with HKB-2X, HRM-4X, HXII-BP, Authenticate, update, and reboot
- Port 6001 UDP - Audio
- Port 80 HTML – Core Configuration Manager (not recommended as management of the system should be limited to a device within the secured network)

### **Link-Master Mode**

To create a Link-Group, you must designate one unit as Link-Master in the Core Configuration Manager (CCM). The Core Configuration Manager (CCM) interface provides an intuitive software utility for HelixNet on any browser-enabled platform. The CCM facilitates a quick and simple means of configuring any devices in a Link-Group, including role-based configuration of endpoints, save and restore, and live monitoring of all system components.

The Link-Master designation serves three main purposes:

- It facilitates Link-Group membership.
- It is the owner of configured Role information, meaning that Roles will only persist (be maintained consistently) if the Link-Master is operational.
- It is responsible for the synchronization and distribution of both configuration (Roles) and device availability status throughout the Link-Group.

Note: Clear-Com recommends that the IP address of the Link-Master is allocated statically. When allocated by DHCP, the IP address can change. If this happens the Link-Members will no longer be able to reach the Link-Master device, and Role information may not be available.

Note: Any device can be set to Link-Master or Link-Member. The default setting for HelixNet linking mode is Link Disabled.

HelixNet devices that are not identified as master will have the designation of Link-Member. Joining a device to a Link-Group requires that device to be set to Link-Member which will prompt the user to enter the IP address of the Link-Master. Once joined to the Link-Group, all devices attempt to connect to all other devices within the group.

- Configuration and control of any device is possible through any other unit in the group
- Configuration information is both distributed and persisted within every node of the group
- The Link-Group significantly reduces loss of service within the set group

### **HelixNet Pairing by Name**

HKB-2X, HRM-4X, and HXII-BP on the same subnet can pair to a system by name. The system uses mDNS to propagate HMS and HRM (when configured as an expansion host) presence in a network. As a device populates its mDNS entry, it specifies an ID, an IP address, a name and a list of services.

When configuration changes, the mDNS entry is updated and all devices connected “by name” will update and re-pair/link/expand as required.

## **NETWORK INSTALLATION**

### **Managed Ethernet Switch**

When connecting HelixNet to a managed network switch, ensure that the connection performs at a minimum of 100Mb full duplex.

If the system is using more than one switch, ensure that the bridge between the switches also operates at a minimum of 1Gb full duplex. When using a managed switch, the port connected to the HelixNet Main Station and endpoints should be set at 100Mb versus letting the port auto-negotiate.

Note: You do not need to set all ports to 100Mb, only the ones connected to the HMS-4X, HRM-4X, HKB-2X & HXII-BP.

We recommend the following specifications when selecting a managed switch to use with HelixNet:

- 100/1000Base-T Layer 3 Managed Switch
- QoS support with the audio traffic prioritized over other data
- If Energy Efficient Ethernet is supported, ensure it is disabled
- SPF/Mini-GBIC support

If connecting two or more switches together, we recommend the bridge / link ports between the switches supports at least 1GB.

HelixNet tags relevant packets at DSCP=41, Assured Forwarding (AF) beginning with version 4.2 and onwards. Previous versions used DSCP=46.

## Unmanaged Ethernet Switch

Clear-Com strongly suggests using a managed switch. Unmanaged switches have several features hardcoded into the system, many of which can greatly hinder audio communication. Port speed, QoS and Energy Efficient Ethernet "Green" settings need to be configurable to successfully deploy an IP based HelixNet intercom system.

If you have no other alternative, use an unmanaged switch where port speed is 100Mb, full duplex (port speed is 100Mb in and out). And ensure the unmanaged switch does **NOT** have Green Energy Efficient settings hard coded into the system.

## Hubs

Hubs should not be used with HelixNet. A Hub's all port transmission will crash the HelixNet Network.

## Connecting HelixNet to Your Network

Integrating HelixNet into your network may need an IP addressing scheme defined with the help of your IT department. We recommend using a STATIC IP address for the HelixNet Main Station then leaving all other HelixNet devices on DHCP. However, there are a few scenarios where DHCP may not be desirable.

- In a large HelixNet systems with roughly 30 HRMs, 10 HKBs and 10 beltpacks, a DHCP server may not assign addresses to devices fast enough for a network this size. In this case, it is better to utilize static IPs for each device.
- When a port on a Cisco switch starts up, there is a Spanning Tree Protocol (STP) exchange before IP traffic starts flowing properly. This exchange can take up to a minute to complete. In this situation HelixNet devices configured for DHCP addressing will often timeout before receiving its initial IP address. They will retry and get a proper IP address a minute later, but our recommendation in this case is to either use static IP addresses or enabling PortFast on Cisco switches port.

If no DHCP server is found, the Main Station and all other HelixNet devices will revert to an unused link-local address in the 169.254.0.0/16 block - devices on this subnet block will then be discovered by the Main Station. If neither of these options are used, the Networking menu on the device allows you to disable DHCP and set static IP addresses.

## **Disable IGMP Snooping**

IGMP snooping is a tool used to make network traffic more efficient. A switch with IGMP snooping enabled will typically only send data to nodes that have an existing relationship with the sender. Because IGMP snooping is covered by two overlapping standards, one from IEEE and one from IETF, implementation can vary depending on the manufacturer.

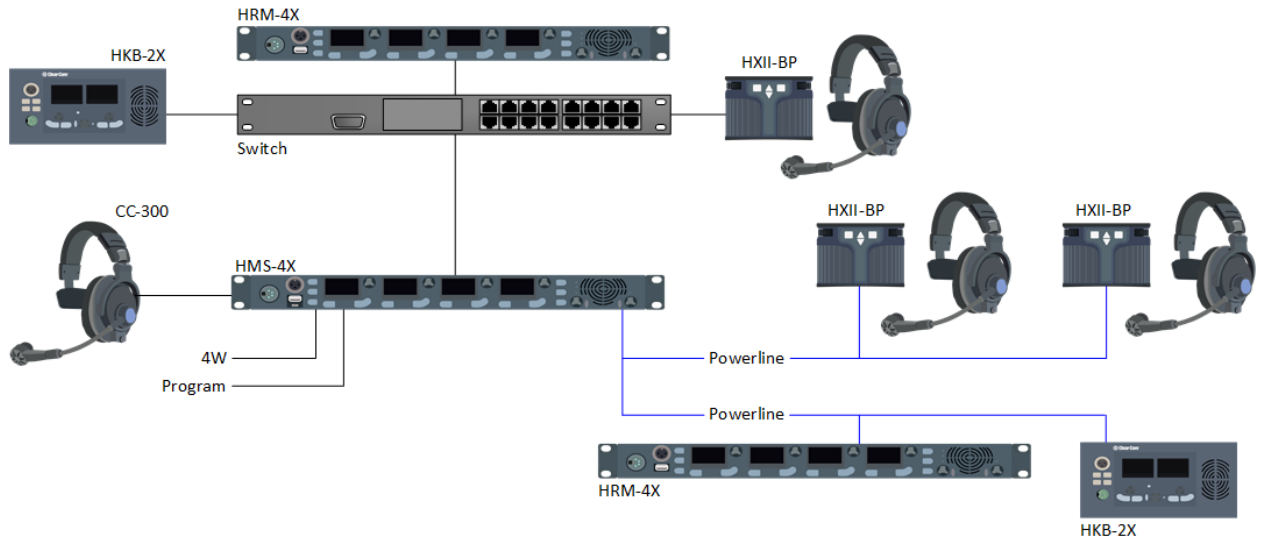
When connecting HelixNet equipment together, IGMP snooping should be disabled. With HelixNet, especially during discovery/linking, data needs to flow throughout the network so all HelixNet equipment (endpoints and devices) capture data they need. Additionally, if you experience a problem where HelixNet station names are disappearing from linking/pairing/expansion menus, it could be caused by the snooping feature. IGMP reportedly can also cause issues with Bonjour/mDNS and PTP.

Example: NetGear / Extreme switches have IGMP enabled by default. Ensure that ""block unregistered multicast"" is set to off. This is a scenario where IGMP snooping blocks traffic that must be allowed for mDNS and PTP.

If your network runs services that require IGMP snooping, we recommend using Cisco switches.

## HelixNet Audio Bandwidth

Bandwidth required is based around the Audio stream – there is additional data on the network, but it is not significant. Audio runs at 300kbps per audio stream. Figure 6 (below) shows a typical HelixNet system with four endpoints (HelixNet Devices) connecting to the Main Station over powerline, and three endpoints (HelixNet Devices) connecting to a switch, which in turn connects to the same Main Station.



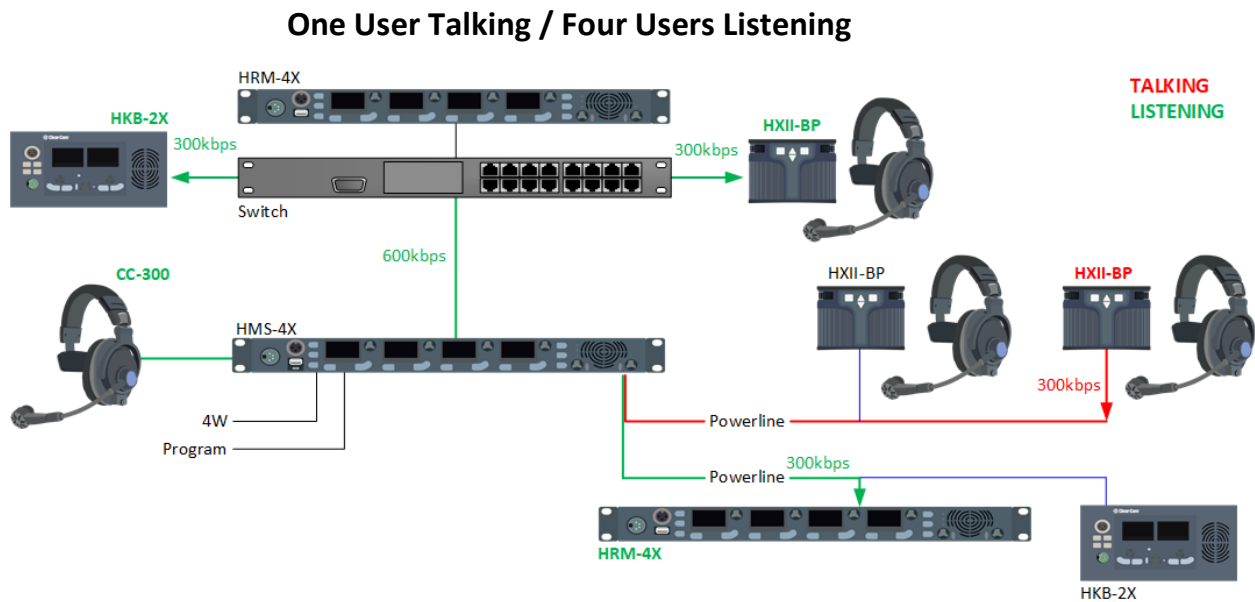
**Figure 6**

- Each HelixNet device transmits at 300 kbps when a user is talking.
- The HMS-4X only routes audio where appropriate, between an audio source and a listening destination. Audio mixing is done at each destination.
- An audio source is sent once to the HMS-4X. The HMS-4X then sends the audio stream point-to-point to each destination that is currently listening to that source.
- Talk pressed/latched = 300kbps is sent to HMS-4X.
- Each 2W/4W/PGM port when assigned = 300kbps is sent internally to HMS-4X.
- PGM on an HRM if assigned = 300kbps for the mic, 300kbps for PGM/SA
- No Talk or No Assignment = no audio is sent to HMS-4X.

Note: Enabling VOX on 2-wire or 4-wire port will significantly reduce the bandwidth as otherwise, audio will always be sent from the I/O source to any listener in the system. The same occurs for the distribution of the Program.

- Audio and Data sent will max out at 1.2Mbps per destination.
- Between linked HMS-4X stations, each audio source is sent once, and only if a user is listening on the second HMS-4X.

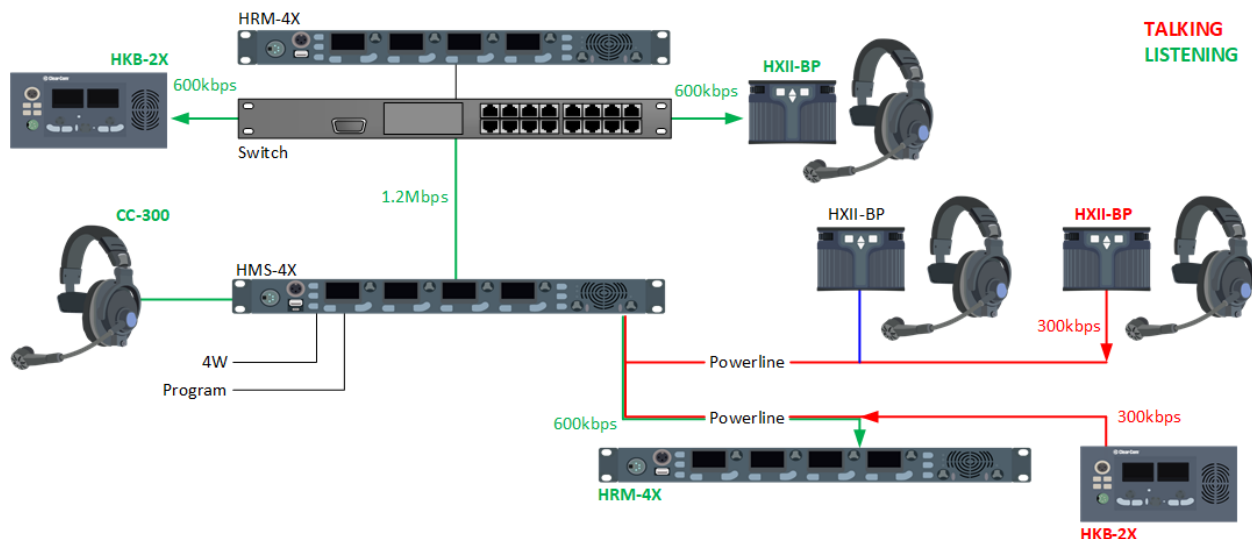
Based on the bandwidth allocations noted, the HelixNet system in Figure 7 (below) will carry the talker's 300kbps to the HMS-4X. One listener is on the Main Station, and the three end points receive 900kbps combined.



**Figure 7**

Figure 8 increases the number of talkers to two, on the same channel, with the same four endpoints listening.

## Two Users Talking on Same Channel / Four Users Listening



### Figure 8

## Examples

Workflow (worst-case scenarios where most or all talk keys are latched):

**Theater:** 1 HMS-4X, 20 HXII-BP, 8-10 channels. 1 Production channel, HXII-BP evenly distributed on other channels (3-4 persons per channel), all over IP (connected to a single 24 port switch)

Rehearsal: All Talk latched, many people listening to 2-3 persons talking at the same time.

Bandwidth usage:

- 300kbps from each HXII-BP to switch
- 600-900kbps from switch to each HXII-BP
- $20 \times 300\text{kbps} = 6\text{Mbps}$  from switch to HMS-4X
- $20 \times (600-900) = 12-18\text{Mbps}$  from HMS-4X to switch

**Larger Theater:** 3 linked HMS-4X, 39 HXII-BP evenly distributed over the 3 HMS-4X, 15 channels.

Rehearsal: All Talk latched, many people listening to 2-3 persons talking at the same time.

Bandwidth usage:

- 300kbp from each HXII-BP to switch

- 600-900kbps from switch to each HXII-BP
- From switch to each HMS-4X
  - o  $13 \times 300\text{kbps} = 3.9\text{Mbps}$  from switch to HMS-4X (for HXII-BP)
  - o  $2 \times 13 \times 300\text{kbps} = 7.8\text{Mbps}$  from switch to HMS-4X (for receiving 13 audio sources from each other two HMS-4X)
  - o Total = 11.7Mbps
- From switch to each HMS-4X to switch
  - o  $13 \times (600-900) = 7.8-11.7\text{Mbps}$  from HMS-4X to switch (for HXII-BP)
  - o  $2 \times 13 \times 300\text{kbps} = 7.8\text{Mbps}$  from HMS-4X to switch (for sending 13 audio sources over to other two HMS-4X)
  - o Total = 15.6 – 19.5Mbps

Up to 64 HelixNet endpoints (user station / port) can be connected over a network, making it important to understand and calculate the bandwidth needs for the HelixNet system.

Endpoints are assigned to devices as follows:

- One (1) endpoint for HXII-BP-X4/HKB-2X
- Two (2) endpoints for HXII-BP-X5 (binaural uses 2 ports)
- Two (2) endpoints for HMS (Mic/Headset/Loudspeaker is one, PGM is the other)
- One (1) endpoint per 2-wire/4-wire port (i.e. 2 endpoints per HelixNet module or LQ)
- Two (2) endpoints for each module installed – HLI-2W2, HLI-4W2
- Three (3) endpoints for HRM (Mic/Headset/Loudspeaker is one, 4-wire PGM input is the second, 4-wire SA Out is the third) however if PGM and SA is not assigned, the HRM would be one (1)

Utilizing more than 64 endpoints may result in choppy audio and a sluggish system response. On IP connected endpoints, you will see the blinking “Paired” icon as audio packets are lost. On powerline, the bandwidth available is shared between equipment on that line and is reduced the further you are from the HMS-4X. The number of bars of the powerline icon indicates how much bandwidth you have. At two bars, or less, you may begin to experience choppy audio. Additionally, A resource meter on CCM will display the bandwidth available on the respective system.

Clear-Com has developed a powerline calculator to not only manage bandwidth, but to also assist you in cable length and power limits. The [calculator](#) can be found [here](#):

<https://clearcom.com/DownloadCenter/technicaldocs/HelixNetCablingCalculator/index.html>

In general, depending on the number of devices on a network, users will experience some latency. The table below describes what you can expect over powerline or IP.

Specification	Value
<b>Latency on Powerline</b>	30-80ms (Depends on cable type and length, and how many devices are connected. The greater the number of devices, the greater the latency.)
<b>Latency over IP Network</b>	75-80ms Beltpack-to-Beltpack (Powerline) 30-35ms Beltpack-to-Beltpack (Ethernet) 40-60ms Beltpack-to-4Wire (Powerline) 30-35ms Beltpack-to-4Wire (Ethernet) 30-35ms HMS-to-HMS (linked transport of audio)
<b>Bandwidth Used</b>	300kbps per active Talker
<b>IP Version</b>	IPv4

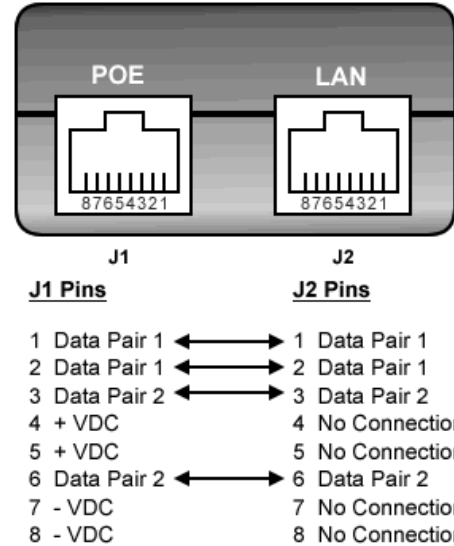
## PoE Specification

We have designed all HelixNet devices to comply with the IEEE 802.3af-2003 PoE standard which states up to 15.4 W of DC power on each port. These devices require no more than 12.95W to operate. (15.4W delivered from the power source with some allowance for loss in the cable). Ensure the total wattage on the PoE switch can deliver to the total number of PoE devices connected. Most PoE switches SHARE the total wattage across all ports.

The following devices can be powered by PoE:

- HelixNet Remote station (HRM-4X)
- HelixNet Speaker station (HKB-2X)
- HelixNet II Beltpack (HXII-BP) - the HXII-BP only uses 4W of PoE power

This IEEE 802.3af standard RJ45 PoE pinout chart shows what pins carry power for the BP.



## SUPPORT

### Technical Questions

Try our Clear-Com Solution Finder knowledgebase of FAQs, resolutions to problems, and "How do I...?" Information was provided by expert Clear-Com product and technical teams and customers like you. Solution finder is located here: <http://www.clearcom.com/support/clearcom-solution-finder>

### Technical, Service and Repair Issues

Find your regional Support Contact here: <http://www.clearcom.com/contact/support-contacts>  
Or submit a question online, and a member of the Technical Support staff will respond within 24 hours:

<http://www.clearcom.com/support/support-request>

### Technical Training

Clear-Com offers a wide range of training classes on communication technologies and product-specific operations. Training can be delivered at Clear-Com College (Alameda, CA - USA), Clear-Com Academy (Cambridge, UK), Clear-Com Think Academy (Poway, CA - USA), or customized for delivery at your site with your equipment. Some classes may qualify for CTS® RU credits. For more information on topics,

## GLOSSARY

### HelixNet Terms

#### **Core Configuration Manager (CCM)**

The Core Configuration Manager (CCM) interface provides an intuitive software utility for HelixNet on any browser-enabled platform. The CCM facilitates a quick and simple means of configuring any devices in a Link-Group, including role-based configuration of endpoints, account management (Agent-IC, SIP and IVC-32-HX cards), save and restore, and live monitoring of all system components.

#### **Endpoint**

A point in the system where audio data can be delivered and consumed, versus a “device” which has the capability to route audio to an endpoint.

#### **HMS-4X**

The HMS-4X is a 1RU digital partyline main station that provides power and up to 12 networked channels of audio. A single Main Station can support up to 20 digital beltpacks on a single powerline cable.

#### **HRM-4X**

The HRM-4X is a 4-channel 1RU digital partyline headset and speaker Remote Station that connects to HelixNet HMS-4X Main Stations and other HelixNet user stations over a single shielded twisted-pair cable. The HRM-4X can be locally powered via an external power supply or third-party Power-over-Ethernet (PoE) power source.

#### **HKB-2X**

The HKB-2X is a 4-channel, two-display with shift page, flush mount digital partyline headset and Speaker Station that connects to HelixNet Main or Remote Stations over a single shielded twisted-pair cable. The HKB-2X can be locally powered via an external power supply or third-party Power-over-Ethernet (PoE) power source.

#### **HXII-BP**

The HXII-BP is a rugged and ergonomically designed 2-channel digital partyline beltpack. A beltpack can have access to two of any twenty-four available system channels over a single shielded twisted-pair cable or Power-over-Ethernet (PoE).

#### **HLI-ET2**

The HLI-ET2 is an Ethernet LAN network interface module for the HMS-4X main station that enables a dual LAN interface to link to other HMS-4X main stations, connect to HRM-4X remote stations or HKB-2X speaker stations, and LQ Series devices.

## Internet / Network Terms

### **Bandwidth**

Bandwidth is also defined as the amount of data that can be transmitted in a fixed amount of time. For digital devices, the bandwidth is usually expressed in bits per second (bps) or bytes per second and expresses the amount of data required. For analog devices, the indicated bandwidth of the audio is expressed in cycles per second, or Hertz (Hz).

### **DHCP**

DHCP is controlled by a DHCP server that dynamically distributes network configuration parameters, such as IP addresses, for interfaces and services

### **Gateway**

A default gateway in computer networking is the node that is assumed to know how to forward packets on to other networks

### **Hub**

Hubs are commonly used to connect segments of a LAN. A hub contains multiple ports. When a packet arrives at one port, it is copied to the other ports so that all segments of the LAN can see all packets.

### **Managed / Unmanaged Switch**

A managed switch can be configured to prioritize LAN traffic so the most important information gets through. An unmanaged switch on the other hand behaves like a “plug and play” device. It cannot be configured and simply allows the devices to communicate with one another.

### **mDNS**

multicast Domain Name System (mDNS) resolves host names to IP addresses within small networks that do not include a local name server.

### **Powerline**

A communication method that uses electrical wiring to simultaneously carry both data and electric power using similar cabling and topologies used for analog intercom.

### **Power over Ethernet (PoE)**

This allows a single ethernet cable to provide both a data connection and electric power to devices such as wireless access points, IP cameras, and VoIP phones.

### **Quality of Service (QoS)**

QoS is a feature of routers and switches which prioritizes traffic so that more important traffic can pass first. The result is a performance improvement for critical network

traffic. QoS equipment is useful with VoIP phones or in LANs with high volumes of local traffic.

### **Router**

A router is a device that joins networks together and routes traffic between them. A router will have at least two network cards (NICs), one physically connected to one network and the other physically connected to another network.

### **Spanning Tree Protocol (STP)**

A network protocol that builds a logical loop-free topology for Ethernet networks. The basic function of STP is to prevent bridge loops and the broadcast radiation that results from them.

### **Static IP**

A static IP address is an IP address that was manually configured for a device, versus one that was assigned via a DHCP server. It's called static because it doesn't change.

### **Subnet**

A subnetwork or subnet is a logical subdivision of an IP network. The practice of dividing a network into two or more networks is called subnetting.

### **TCP**

TCP (Transmission Control Protocol) is a standard that defines how to establish and maintain a network conversation via which application programs can exchange data. TCP works with the Internet Protocol (IP), which defines how computers send packets of data to each other

### **UDP**

(User Datagram Protocol) is an alternative communications protocol to Transmission Control Protocol (TCP) used primarily for establishing low-latency and loss tolerating connections between applications on the Internet.

## About Clear-Com

Clear-Com, an HME company, is a trusted global provider of professional real-time communications solutions and services since 1968. We innovate market proven technologies that link people together through wired and wireless systems.

Clear-Com was first to market portable wired and wireless intercom systems for live performances. Since then, our history of technological advancements and innovations has delivered significant improvements to the way people collaborate in professional settings where real-time communication matters. For the markets we serve -- broadcast, live performance, live events, sports, military, aerospace and government -- our communication products have consistently met the demands for high quality audio, reliability, scalability and low latency, while addressing communication requirements of varying size and complexity. Our reputation in the industry is not only based on our product achievements, but also on our consistent level of customer engagement and dedication to delivering the right solutions for specialized applications, with the expertise to make it work. Around the globe and across markets, Clear-Com's innovations and solutions have received numerous awards and recognitions for ingenuity and impact to customers.

## Clear-Com Offices

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