



Hybrid Intercom Network White Paper

Intelligent Intercom-Over-IP for International Sports Events

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3. Introduction

Clear-Com Eclipse Digital Matrix Intercom System was used to provide the communications for the opening and closing ceremonies of the 2010 Vancouver Winter Olympics and the 2010 FIFA World Cup. The native IP enabled V-Series intercom panels allowed rapid communication deployment where more traditionally connected panels would otherwise have to be planned for and individually cabled. This white paper describes how IP communication overcomes traditional problems at such types of installation venues and also discusses what to consider when deciding Intercom-Over-IP (IoIP) approach for successful and spectacular large events, making reference to specific use-cases of the 2010 Vancouver Winter Olympics and FIFA World Cup in South Africa.

4. Traditional Installations

In large stadium events, production elements and recording services such as Audio, Video, Lighting, and CCTV (Closed Circuit Television), that are controlled together with intercom, all have to be coupled between the equipment rooms and remote locations within the complex. Due to increasingly complex productions over time, the individual cable runs connected back to central equipment for each service have grown, driving up installation time and costs significantly.

The requirements for each audio/video/control service have to be carefully planned. Experience counts for a lot in being prepared for eventualities and relocations during the frenetic run-up and rehearsals. In worst cases, whole equipment racks have to be relocated and re-cabled or coupled to existing remote systems accommodating changes in the production workflow. With traditional intercoms, this would require last minute leasing of 4-wire order lines and dark fiber, and transporting equipment-carrying technicians between the send and return sites. These kinds of unplanned activities can quickly sap the ability to service the production team in a pro-active and complimentary manner.

5. Advantages of Intercom-over-IP

Today, with the advancement and expanded bandwidth of in-house IT Network infrastructure, many services can be integrated and operated over far less cabling, and in some cases even share single fiber runs. To achieve this level of streamlined cabling, this would require that today's modern digital intercom, audio and video play well together and each use standard IP-based technology.



Figure 1: V-Series 24 lever key intercom panel with native IP

Clear-Com's V-Series-IP intercom panels have a native Ethernet port that carries both duplex G.722 audio and control data between the intercom matrix and the user's panel microphone, loudspeaker or headset. The V-Series-IP panels make use of the ubiquitous availability of the IP infrastructure to enable unscheduled placement of the intercom panels anywhere within a stadium complex or remote sites. No longer do remote sites require a whole rack of localized switching matrix equipment. Now, just the users' panels need be connected to a local IT connection, which then connects them onto the central switch and interfaces. Accommodating last minute changes in production workflow, where, for example, a venue change following some unexpected development can now be achieved with a few remote fly-away panels and local link onto the IT structure.

The traditional alternative is running in more cabling, adding media conversion to fiber or multiplexers to existing fiber, adding local small matrices and interfaces and planning the installation changes. These changes do not include all the disruption to the running system which is very costly.

The choice of directly cabled and IP connected V-Series panels from the central matrix provide for either high availability over conventional CAT-5 cabling and long distance remote connection over IP. For the long distance intra-stadium cabling, fiber connected Ethernet switches can be used. If a user was setting up a closed Ethernet network purely for the connectivity of the communications within a venue, then a very simple flat switched network would be more than adequate for the extremely low data rates used by the V-Series-IP panels. However, this misses the real leap that a native IP intercom system offers.

6. Benefits of Intercom Over Real IT Networks

The real benefit of IP intercom is the capability to use *any* available existing or temporary IP infrastructure. However, this means stepping up the level of network management and filtering. The ability to protect the primary trusted network from possible threats on other networks that may be indirectly connected is essential. Equally as important is to prevent any traffic leaving the network down a remote link that is not essential to that task, both for security and bandwidth reasons. This aspect has to be resolved within the installation planning and roll-out.

For example, network switches can be used and Virtual LANs (VLANs) can be configured and segregated so that one physical infrastructure can provide many virtual networks. Using a Router/Firewall to provide DHCP addresses, routing, filtering and forwarding, can act as the bridge between all the virtual and physical networks, allowing for differing levels of access to network components to suit the various services. As an example of the extra functionality beyond simple switches, the Router/Firewall allows flexibility to comply with any request that may be received from other network providers, like segregating WAN traffic if there are multiple paths available.

7. Intercom Over Real Telco WANs

In many cases large event organizers use a local Telco operator to roll out the WAN structure between every remote venue over fiber optics. A multi-venue WAN means it can be divided into multiple VLANs, which essentially provides transparent IP data channels. However, this division of a WAN into multiple VLANs needs some consideration.

The first problem is that the LAN switches may use spanning-tree redundancy. This is often used to prevent network loops and provide redundancy. However, the WAN ports on the Telco provided switches may be configured to turn off if a spanning-tree packet is detected. A second problem is the prevention of links from two or more different parts of the network forming a loop. These LAN loops may contravene Telco WAN rules, and is often a restriction when connecting to Telco WANs.

One solution is to initially disable Spanning-tree on the relevant ports at the edge of the network and then bring each link back, each carrying different services like intercom, CCTV or digital audio, to the router as a separate VLAN. Once at the router, apply filter rules to prevent any looping data, while still allowing the IP intercom panels to connect back to the Intercom Matrix IP card.

This solution also solves another concern if there is a fault on the WAN which is out of control. To get these WAN links right, you need to understand the network you will be passing over. If it is a VLAN like the example above, then it is straightforward. If there are existing DHCP servers and other services, then you need to make a plan as to how to handle this. Will the V-Series-IP panel need to be routed? Are the required ports open on any firewalls? If there is to be IP routing, who will provide the hardware and its configuration? In addition, most importantly, who can you work with to solve these issues? It is essential to know the answer BEFORE a problem occurs.

8. Setting Up the VLAN Services

Paul Barrett, Event Communications Manager of The P.A. People, has a simple edict concerning VLANs: “Less is more.” To minimize risk, it is important to assess the risk of each roll-out on a case-by-case basis. If the only data on a network is your own, then the only VLAN separation will be between heavy multicast traffic, e.g. Cobranet audio transport and everything else. Not only does this prevent the multicast traffic swamping the network interfaces of all the other devices, but it allows you to control which network links it can use. This is especially important if using any low bandwidth wireless links.

“To date, we have not had any problems having Clear-Com IP panels co-existing with other data of any kind within the same VLAN.”

Paul Barrett
Event Communications Manager
The P.A. People

However, when providing network transport to other users, Quality of Service becomes a consideration, so it is helpful to create a VLAN just for Voice Communications, which may include both Clear-Com IP panels and other VoIP devices. Then, that VLAN can be prioritized over all others using the QoS settings in your managed switches. VLANs can also be used to provide a network path for another department from one place

to another without any risk of their data mixing with your own. Large events may require Clear-Com IP Panels, VoIP phones, IP CCTV, DMX data, Streaming HD Video, uncompressed streaming audio, file-sharing, Internet access and timecode to all share the same physical Gigabit network without any issues.

9. The Clear-Com Hybrid Network Technology

The Eclipse IP card, IVC-32, offers 32 channels of high density IP connections. IVC-32 is embedded with the I.V.Core¹ technology to intelligently route audio, providing very low latency and retaining caller metadata between users. The IVC-32 card seamlessly connects the Eclipse TDM matrix system to Clear-Com's IP-based intercom application, Clear-Com Concert.™ This type of connectivity makes it possible for PC users (local or remote) who have Concert access (See Figure 2) to instantly connect/communicate with other Concert users and traditional intercom users (wired and wireless beltpacks, panels or stations) on a single communication network, called Hybrid Network, where TDM and IP technology converge.



Figure 2: Concert virtual Intercom panel

Hybrid Network, as a communication solution, makes for a very cost-effective production intercom for large events. Because of the flexible and ad-hoc nature of the IP, permitted

users who are local, remote, or internationally (via Internet connection) can talk to the main production team, thus saving expensive hardware and pre-planning. The PC users are granted access and configured under central management control to prevent unauthorized access.

10. 2010 Vancouver Winter Olympics

The P.A.People were contracted by David Atkins Enterprises (DAE), the company who won the overall bid for organizing and executing the Winter Olympics ceremonies, to provide all audio communications associated with the Opening and Closing Ceremonies; communications within the venue as well as communications with other remote locations that were involved in the ceremonies. These outlying areas included the arena next to B.C. Place Stadium (Figure 3) (where all the athletes were staged and audio cues to enter the main venue), the IBC (International Broadcast Centre) located a few miles away, and another at Whistler Mountain ski venue.



Figure 3: B.C. Place Stadium – site of the opening and closing ceremonies

Clear-Com's I.V.Core is a breakthrough intercom technology for defining Intercom-over-IP (IoIP) intercom communications. Providing high-quality, high-bandwidth audio that will not stress an existing IP network, I.V.Core is an advanced set of software building blocks and engines for creating a real-time, dynamic distributed system with non-blocking intercom capabilities.

Vancouver's Intercom Reach

The communications infrastructure consisted of fixed wired Clear-Com intercom systems including Eclipse Digital Matrix Intercom System with Analog Partyline Systems, and with mobile communications using Motorola two-way radios. In total, the B.C. Place Stadium venue had roughly 80 analog beltpacks, 80 Eclipse V-Series panels and 500 mobile 2-way radios. All radio channels were integrated into the Eclipse matrix intercom system via Clear-Com's FOR-22 dual channel radio interfaces allowing Show Production to direct operations to the mobile artists and technicians.



Figure 4: The Comms Control position showing V-Series panels with expansion panels.

- Matrix: Clear-Com Eclipse Omega with 176 CAT-5 ports and 64 IP ports.
- 80 x beltpacks
- 80 x Clear-Com Eclipse V-Series panels (Figure 4)
- 2 x V-Series panels at International Broadcast Centre (IBC) over IP
- 2 x V-Series panels at Whistler remote site over IP
- ~16 x V-Series panels at various locations within the B.C. Place stadium over IP
- 1 x Clear-Com Concert server
- 12 wired Partylines mixed at the Eclipse matrix frame

Vancouver IT Networks

All Olympic locations were IP connected over a low latency Bell Canada 400Mbit/s fiber network. Within B.C. Place, multimode IP fiber rings were segmented across Juniper routers with four optical ports on the fiber-ring side, and CAT-5 copper drops on the "comms" side. Rings and routers were configured to provide multiple overlaid rings for redundancy. The B.C. Place network not only provided audio and communications, but it also included video for MPEG4 CCTV feeds. Typical bandwidth usage was 45Mbits/s for video and comms. The maximum fiber run lengths were between 400-500m (1,300 to 1,600 feet).

The combination of direct-cabled V-Series and IP-connected V-Series panels worked extremely well together in this system architecture and gave P.A. People a big benefit in cabling efficiency, and reduced setup time. For example, the Radio room on the ground floor (the area where 2-way radios are logged in and out to users) ran two V-Series IP panels. This room would have been hard to reach by conventional radial CAT-5 cabling.

There were two separate links into the Bell Canada Network for two separate venues. It was critical that no data was ever sent between these links as Bell would have seen this as a loop and disallowed it. By bringing these links in to the Juniper Netscreen Router/Firewall as two separate interfaces, it allowed only the one port required by the Clear-Com IP panels to pass, eliminating any risk.

Cost and Time-Saving Solutions

A remote link example was the Olympic Whistler Mountain site, which was several miles away. The cost of running dedicated cables (fiber or copper) to a dedicated local intercom matrix for only two people was much more expensive by several thousand dollars than by providing simple IT connection to two local V-Series IP panels over the existing IP Network. The days needed to plan, install and reconfigure system devices in order to accommodate last minute intercom needs is thus saved by the simple strategy of using ad-hoc, natively IP-connected panels. The V-Series panels do not even require local interfaces.

“The opening ceremony went extremely well from an intercom perspective. The IP panels worked flawlessly and the remote site (IBC) came through crystal clear. I know the V-Series IP panel should not sound as good as a normal panel, but it REALLY does!”

Paul Barrett
Event Communications Manager
The P.A.People

Critical positions such as Producer, Production Stage Manager and Show Caller had direct analog connections back to the frame. These connections have exactly the same operational functionality as the IP panels and to all panel users’ work locations, regardless of the local connection type. The direct connection has less risk being independent of another network, unlike a WAN infrastructure, but not by much in a well planned IT network.

However, users do not know they are connected to the intercom matrix over IP and the only comments about IP panels are from audio people. They may notice the band limiting and the small latency when dealing with people who are in earshot. The latency is no issue functionally; the PA system has latency due to its digital processing. The band-limiting may simply mean keeping anyone who might talk to the PA system off IP to ensure they sound full.

11. 2010 FIFA World Cup

The FIFA Soccer World Cup in South Africa used all V-Series IP panels and no conventionally connected audio/data panels to the central matrix equipment for the Opening Ceremony (See Figure 5 and 6). The IP matrix to panel connections also carried SMPTE timecode and program audio, using spare audio channels to other local devices, thus saving additional cabling.

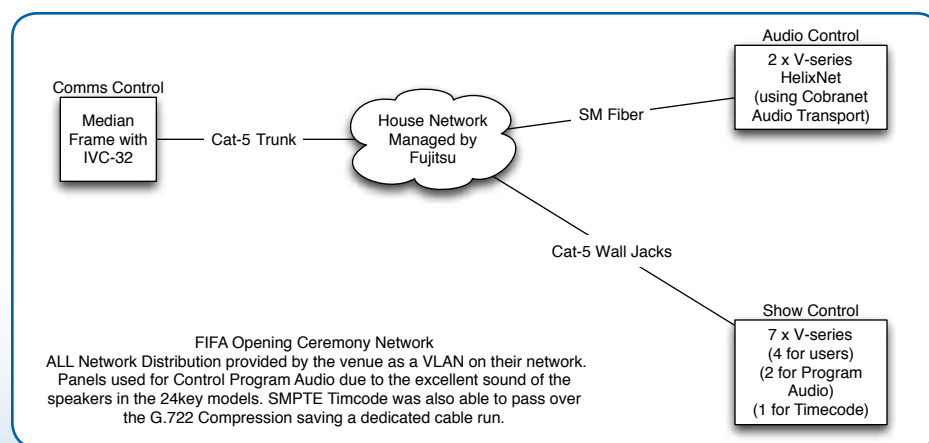


Figure 5: FIFA World Cup Intercom for Opening Ceremony

The ability to utilize the existing network infrastructure within the building enabled the audio crew to deliver the audio and intercom system within the time and labor constraints imposed by excessive delays in customs clearance and venue access. The freedom to deploy a panel anywhere where data jacks were available, gave great flexibility to the system design.

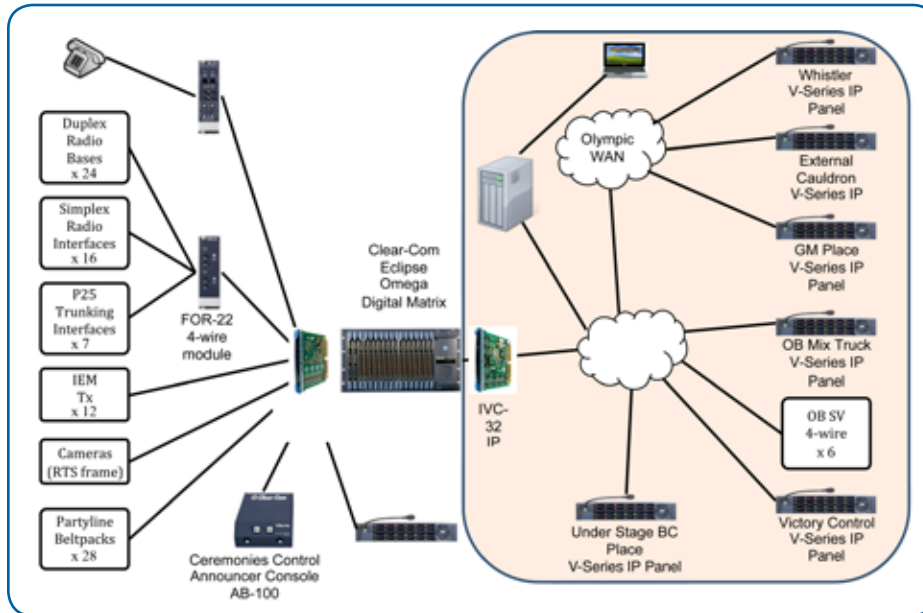


Figure 6: Hybrid Network and Conventionally-cabled system components were used at FIFA Opening Ceremony.

12. Acknowledgement

The Clear-Com Team would like to acknowledge Paul Barrett, Technical Engineer of The P.A. People, who is a specialist contractor in the areas of Sound Reinforcement, Performance Lighting, Audio Visual Systems, Video and Communications. Paul was interviewed and provided information about advantages and clarifications of use of V-Series IP panels over his installations.



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About Clear-Com®

Clear-Com, an HME company, is a global provider in professional voice communications systems since 1968. We develop and market proven intercom technologies such as Analog & Digital Partyline, Digital Matrix, Wireless and Intercom-over-IP systems for critical communication applications in broadcast, performance venues, military, government and enterprise markets. Recognized for our legacy of intercom innovations, production teams around the world have come to depend on Clear-Com for clear, reliable and scalable communications solutions.

About HM Electronics, Inc. (HME)

A privately held company founded in 1971, HME has continued to be a leading provider of innovative technology focused on enhancing productivity and customer service for multiple markets including pro audio, sports, and restaurants. HME developed the first wireless intercom system for pro audio and continues to introduce exciting, cutting-edge wireless intercoms that enhance communications, increase productivity and facilitate creativity for virtually any application.

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