



IP Network Based Interoperability Solutions for Today's Mobile Radio Systems

Interoperability ... the way it *should* be.™

A Catalyst Communications Technologies White Paper

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Introduction

The events of September 11 and the subsequent establishment of a Homeland Security initiative have highlighted awareness of the need for radio communications interoperability among our public safety and first responder organizations. While many agencies and vendors have explored solutions for *Coordinated Interoperability*, there is an equally compelling need for *Immediate Tactical Interoperability*. IP Network Based Interoperability can provide a solution for both of these Interoperability needs, and Catalyst Communications Technologies has developed an IP Network Based Interoperability solution to meet the needs of planned and immediate interoperability. It is described in this paper.

Need for Interoperability

Out of the tragedy of September 11, 2001 and the ensuing creation of a Homeland Defense initiative, the recognition that many responder agencies are unable to establish radio communications with their peers has become a significant issue. Many public safety organizations, including APCO, NIJ, and PSWN, are devoting much energy to solving the interoperability problem and are challenging manufacturers to provide a solution to this multi-facet, dynamic dilemma.

The threats of terrorism, natural disaster, and multi-jurisdictional criminal activity have caused many organizations to re-examine their interoperability needs and clarify their definition of interoperability. Generally, interoperability represents the ability of personnel from one agency with one type of radio system to communicate with personnel from another agency using a different type of radio system. The scope and scale of this

requirement can be quite varied, however, as the needs grow from cross-county communications, as officers track criminals across county boundaries, to multi-agency/federal/state interoperability requirements, as represented by the response efforts on September 11, the Oklahoma City bombing, the Washington, DC area sniper incident, etc.

Also, responsible officials thinking through the problem have identified at least two different models for interoperability requirements. *Coordinated Interoperability* is a term used to describe cross agency communications that are planned for an upcoming event such as the Super Bowl. The needs are understood before the event and can be coordinated within a relatively “relaxed” timeframe. *Immediate Tactical Interoperability* is a term used to describe the need for interoperability “on the fly”, established during the incident itself. The solution to this immediate requirement is not as well developed today among manufacturers, and this paper will propose that IP Networking presents the best opportunity for meeting the needs of both *Coordinated Interoperability* and *Immediate Tactical Interoperability*.

The Argument for Network Based Interoperability

Recent attempts to define various levels of interoperability have resulted in a comprehensive list of interoperability modes, ranging from runners carrying messages on foot between incident commanders to universal replacement of the world’s mobile radio systems into a single, frequency and manufacturer specific unified system. This list, in order of preference, is presented below:

Using Own Radio

- Gateway Connecting Radio Systems
- Similar Radio Systems that allow neighbors to roam
- Mutual Aid Channels
- Talk Around

Using Alternate or No Radio

- Borrowed Radios
- Cell Phones
- Runners

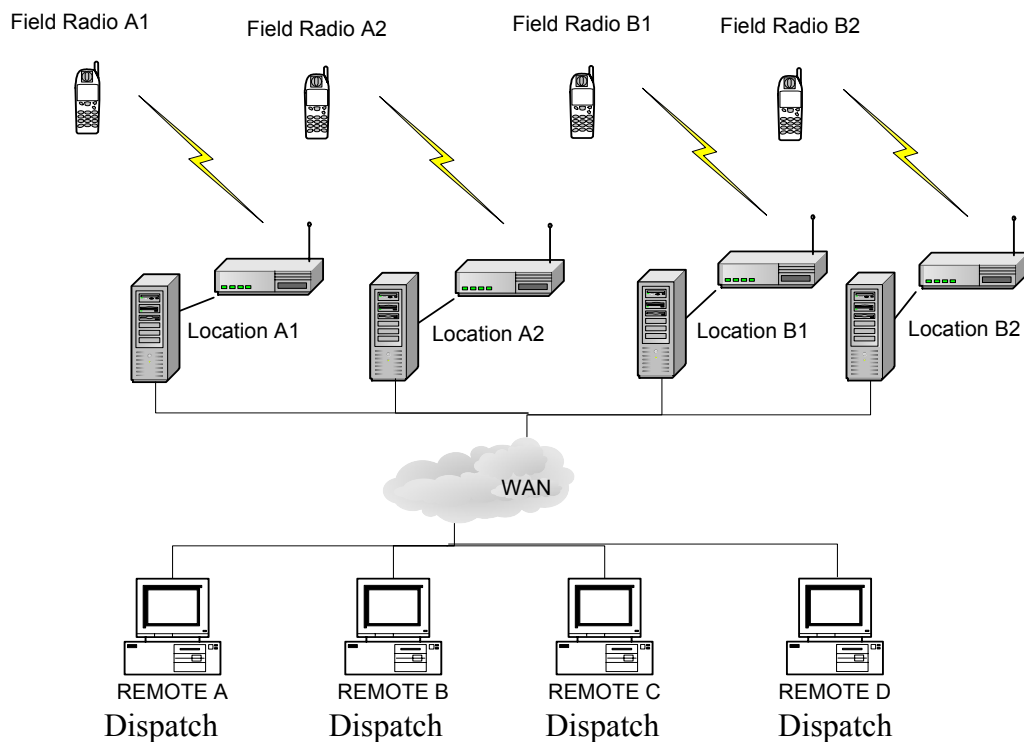
While there are diverse interoperability requirements, and subsequently a number of acceptable interoperability solutions, IP Network based Interoperability solutions represent a powerful approach.

- ❑ Existing radio systems, networks and frequencies need not be changed - saving each agency millions of dollars
- ❑ IP Network connectivity is dramatically scalable – providing immense flexibility
- ❑ Agency connectivity is easily made, easily changed, and readily available – providing cost-effective, quickly enabled links

- ❑ IP is a standard ubiquitous across all interested parties – eliminating protocol incompatibilities
- ❑ Each agency maintains control of its patch status – providing best allocation of resources and eliminating objections to joining the assembly

What is IP Network Based Interoperability?

IP Network Interoperability takes advantage of network connectivity that already exists between agencies – or that can be easily created – to route communications between channels or talk groups on one radio system to channels or talk groups on other systems when required. A device that interfaces the radio system to the network – Catalyst calls these *Gateways* – performs audio and control translation services between radio systems, and the network provides the transport facility. Architecturally, the network, connecting four systems including their Dispatch coordinators, looks like this:



This system allows portable/mobile users on Location A to communicate over the Wide Area Network and to communicate with portable/mobile users on Location B systems. The Dispatchers for these systems also are included in the conversation. Some other benefits of this architecture include the following:

Scalable Links

Internet Protocol supports millions of addresses. Mobile radio users can take advantage of this architecture to keep adding more IP Link Gateways to the community. While some hardware-based solutions limit the number of agencies that can potentially be part of a patch, an IP-based solution does not.

Cost-Effective Connectivity

This architecture eliminates dedicated circuits for routing radio traffic. The routed audio and control can share the same data pipe with email, database inquiries, file transfers, and other computer network applications. Thus a separate connection for routing occasional radio voice messages between agencies is not required. Installing microwave radios or dedicated fiber is a huge capital expense. Leasing telephone circuits presents an expensive recurring expense. The IP computer network has become the universal transport media for telephony, data, video, and now radio voice traffic. This single pipe approach is being adopted by municipalities, federal agencies, and corporations worldwide as the most cost-effective approach to communications.

The needs for interoperability are diverse and unpredictable. There are too many agencies to justify funding point-to-point circuits between each. Only the IP network can provide flexible, cost-effective connectivity for the variety of links needed to face today's challenges.

Robust Links

IP connectivity is not only cost-effective; it can also provide a more robust link. IP networks allow for alternate routing of packets. If a dedicated circuit is broken, radio connectivity is lost completely. If a packet-switched connection is broken, the IP packets can be re-routed along another path.

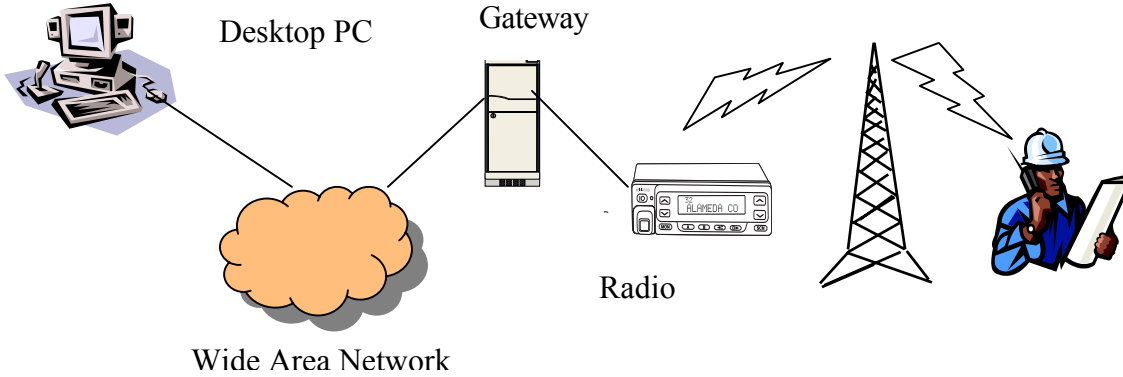
Similarly, a centralized switch for interoperability presents a single point of failure. If that hardware device becomes inoperable, then all connectivity is lost. On the other hand, the IP-based network approach distributes the routing function across many devices, significantly increasing the likelihood that the message will get through.

Catalyst's IP Link™ – Coordinated Network Based Interoperability

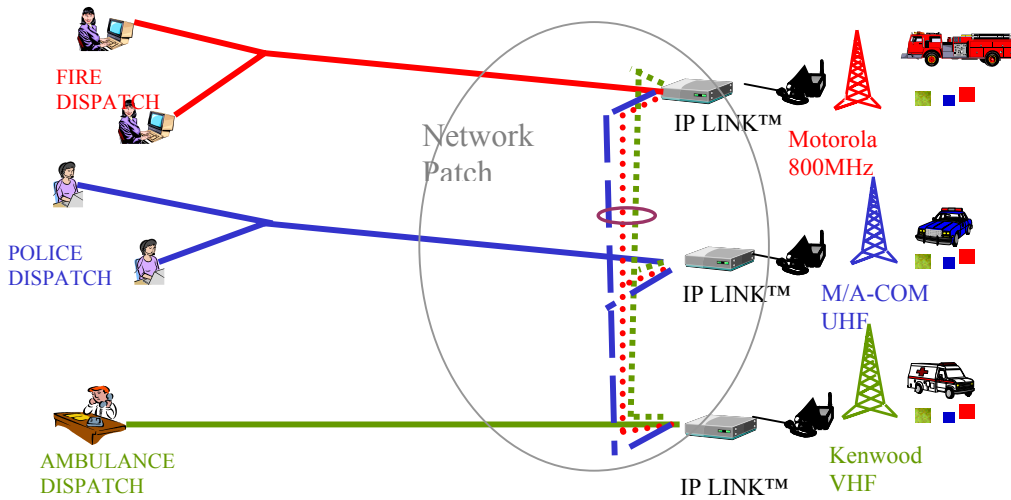
Summary/Overview

IP Link™ works in conjunction with Catalyst's line of VoIP dispatch products. IP Link can be added to any of these products to link disparate radio system together. Catalyst customers can easily add the IPL functionality to their existing VoIP dispatch system. New Catalyst customers can benefit from the inherent dispatch capabilities that the solution provides such as providing back up consoles, providing radio communications

for an emergency operations center, providing a powerful trouble-shooting tool for maintenance personnel, etc.



Catalyst's current line of Radio over IP products allow Desktop Dispatch to field radios over IP Networks. IP Link patches Gateways together, allowing field users to communicate through the network, even if they are on different systems, from different manufacturers, on different frequencies.



Catalyst's new IP Link Network Based Interoperability solution allows Gateways to be linked together over networks, providing portable-to-portable communications between systems of different frequencies and manufacturers.

Flexible Interoperability

IP Link allows any agency to talk radio-to-radio with any other group of agencies. The connections can be set, modified, and torn down in seconds. Any agency with an IPL Gateway can participate in the call. The diagram below is an IP Link setup window that demonstrates some of the simple commands for setting up and activating patches.



Dispatchers can pre-configure sets of agencies for a patch but leave the patch disabled. Thus radio traffic stays only within the agency until the patch is needed. With a few clicks of a mouse, the authorized dispatcher can enable the pre-configured patch, allowing direct radio-to-radio communications with the other agencies. The dispatcher can modify the patch by deleting or adding channels or talk groups from the patch.

Peer-to-Peer Interoperability

IP Link allows each agency to set up and tear down a patch with any other willing agency. Each agency is a peer. There is no central switch or central over-ride. Each Gateway can be individually set to allow patches or not allow patches. Thus the supervisor for each agency makes the final decision if his agency will participate. All agencies are peers, eliminating the need to request a patch from a third party. If two agencies want to create a patch, they simply do so directly. Since each Gateway may only be a member of one patch at a time, by consenting to being part of a patch, the supervisor blocks other agencies from bringing his Gateway into a different patch. Only those dispatchers with access to a Gateway can modify a patch including that Gateway; thus the patch is restricted to a pre-defined community.

First Syllable

The first syllable can often be the most critical part of a message. There's a big difference between "shoot" and "don't shoot." Some interoperability solutions lose that critical first syllable because they use a VOX circuit. Other times syllables or even words are lost because the secondary system takes times to get access to a channel. (Trunking systems can take from 250 ms to tens of seconds to provide channel access.) Important messages are lost in the process.

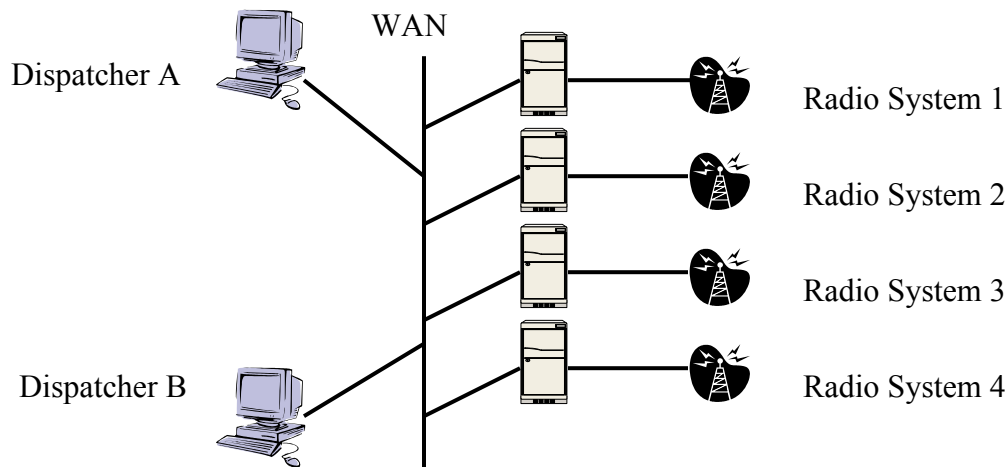
IP Link buffers the entire voice message until the secondary system is ready to play it. VOX circuitry is not used in IP Link. The radio Gateway stores the packets from the last call that came across the network until the attached radio is ready to transmit that message. Thus if the secondary system is a trunked system that takes a full second to provide channel access for the desired talk group, then the radio Gateway will wait the full second to send the voice message so that the trunked system can transmit the entire call. Similarly, if the trunked system is busy with another call and queues the attached radio, the radio Gateway will continue to store that voice message until there is a free channel.

Architecture & Functionality

IP Link is an additional software module that runs on a Catalyst Gateway. The IP Link module works in conjunction with the server application for IP Radio™, IP Fleet™, IP Base™, IP Tone™, or Network Access Radio™. Hence IP Link can be added to existing installations of all of these products and can even be used to route audio from radio-to-radio between the different types of systems that these products support, listed below.

Product	Trunked System	Conventional	Notes
IP Tone	SmartNet, SmartZone, P25, EDACS, LTR, etc.	Yes	Standard EIA Tone Control
IP Radio	EDACS, ProVoice	Yes	Advanced Functionality
IP Fleet	LTR	Yes plus FleetSync	Advanced Functionality
Network Access Radio	SmartNet, SmartZone, P25, EDACS, LTR, etc.	Yes	PTT Control Only
IP Base	None	Yes	Voltage Control

Each Catalyst Gateway provides the interface between a fixed mobile radio or base station and the IP network. The Gateway lends its IP address to the fixed radio so that audio can be routed to the radio for transmission over the air. Radio signals received by the fixed radio are demodulated, decrypted, and converted to base band audio by that fixed radio. The base band audio is then routed to the Gateway. The Gateway converts the audio to compressed, digital packets and routes it to the appropriate IP addresses across the network. These IP addresses could be other Gateways or Remote PCs used as dispatch positions.



When a patch is active, the audio is routed directly from Gateway to Gateway. If the secondary Gateway is busy or otherwise unable to immediately transmit the audio, it will buffer the audio of the last call. When the talk group or channel is available, the Gateway will key the attached transceiver and route the audio to it. The radio then transmits the audio so that field radios monitoring that group or channel will hear the audio.

Each Gateway may only be part of one active patch at a time. However, the IP Link system provides for up to twelve pre-configured patch scenarios for each Gateway. These scenarios, or storm plans, can be stored in the Gateway even while it is part of another active patch. The dispatcher can disable the first patch, and then enable another pre-configured patch scenario with a different set of Gateways.

IP Link, IP Network Interoperability, and *Immediate Tactical Interoperability*

The above discussion demonstrates the versatility and flexibility of IP Network Interoperability and an implementation by Catalyst Communications Technologies that provides exceptional flexibility for agencies wishing to establish simple IP network based Interoperability, activated by Dispatchers and Supervisors in a *Coordinated* fashion. Catalyst can demonstrate these capabilities today! What about the needs for *Immediate Tactical Interoperability*?

The first stage of *Immediate Tactical Interoperability* is addressed through the distributed architecture of IP Link. Every agency is an equal partner in this solution. With IP Link technology, the decision to join or opt out of a patch is made by each agency rather than by a third party with this architecture. The choice to create or modify a link can be made much more quickly.

The use of the IP network to provide connectivity also addresses the needs of *Immediate Tactical Interoperability*. All 18,000 public safety agencies could have an address on the

IP Link Interoperability map. Groups of agencies can quickly band together in unanticipated communications nets to address urgent needs. (This concept is similar to the concept of Fax machines – each IP Link Gateway becomes more powerful as additional Gateways are added to the network, much like fax machines which are useless by themselves but very powerful due to the large deployment of other fax machines interconnected via phone lines.)

The next stage in achieving *Immediate Tactical Interoperability* challenges **how** the patch is set up. This issue creates a clear differentiation between *Coordinated Interoperability* and *Immediate Tactical Interoperability*. Catalyst is working with customers like you to establish the protocol for responder generated, on demand, *Immediate Tactical Interoperability*. IP Network Based Interoperability solutions from Catalyst take advantage of existing and planned computer and network technologies to implement on-demand Interoperability from the field. What are missing are rules for allowing interoperability and an indication from the user group – you, the readers – of acceptable and unacceptable setup routines. Catalyst invites you into this discussion to enable effective *Immediate Tactical Interoperability*, as the process and procedure attributes - and not technology - appear to be the primary challenge to overcome.

Summary

This paper has proposed IP Network Based Interoperability as a leading candidate to solve many of the Interoperability problems facing public safety and first responder organizations today and has shown how a new Catalyst product, IP Link, executes and solves the challenges of *Coordinated Interoperability* and *Immediate Tactical Interoperability*. For more information, or to discuss how Catalyst can help solve your Interoperability requirements, please contact us at 434-582-6146 or info@catcomtec.com.



For more information about Catalyst Communications Technologies and our products, please visit www.catcomtec.com or call us at 434.582.6146.

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