NOTICE

Sections of the following public record have been redacted pursuant to the Indiana Access to Public Records Act, IC 5-14-3 *et seq.* Specifically, the redacted sections are excepted from public disclosure pursuant to IC 5-14-3-4(a)(4) (concerning "trade secrets") and/or IC 5-14-3-4(a)(19) (concerning records which, if disclosed, would have a reasonable likelihood of threatening public safety by exposing a vulnerability to terrorist attack).

Response

To

Request for Information

On

An Improved Wireless E9-1-1 Voice and Data Delivery Network

Submitted to:

Indiana Wireless E9-1-1 Advisory Board

April 2004

The reader must keep in mind that this was INdigital's proposal as initially submitted to the Indiana Wireless E9-1-1 Board in April 2004. Subsequent meetings, tests, demonstrations, and other events have resulted in a number of modifications to certain elements and details of the proposal, including several functions, the pricing, and the network layout. INdigital has also become aware of and corrected a few errors in the document in subsequent submissions and information supplied to the Board. Those corrections are not reflected in this document.

However, the document still provides an accurate overview of the project provided that the reader understands the project has evolved since this document was submitted to the Board.

Byron L. Smith, December 2004

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1. INTRODUCTION

1.2 Purpose

The purpose of this document is to respond to the Request for Information (the "RFI") issued by the Indiana Wireless Enhanced 9-1-1 Advisory Board (the "Board") titled "An Improved Wireless E9-1-1 Voice and Data Delivery Network" dated February 2004 as facilitated by RL Kimball and Associates.

1.2 Primary Contractor Information

These proposals have been prepared by and are submitted by INdigital Telecom ("INdigital", or "We") 5312 West Washington Center Road, Fort Wayne, IN 46818.

Questions should be directed to Byron L. Smith, Director Government/9-1-1 Services, 260-469-2010, bsmith@indigital.net. INdigital Telecom is the primary vendor and is the single-point-of-contact for any issues related to the proposed solutions contained herein.

Equipment, services, and/or technologies from other companies, including, but not limited to, Cisco Systems, Inc., Indiana Fiber Network, MapInfo Corporation, NMS Communications, Siemens International Telecom Division, SIPquest, and Telecommunication Services Inc., are components of these proposals.

INdigital Telecom proposes to provide overall project planning and management. INdigital will integrate these products and services into the proposed solutions with the assistance of our business partners.

INdigital believes all of its business partners are invested in the success of this project. Should problems arise in the implementation of any of these proposals, INdigital will work to resolve any such issues without the involvement of the Board.

1.3 Use of this Response

This document is not a contract nor is it a quotation pursuant to any specific product, component, specification, service, or cost contained herein. If the Board finds favor with some part or all of the proposals contained in this response, INdigital will be pleased to enter into negotiations with the Board to deliver the desired products and/or services under contractual terms that are satisfactory to both parties. Other than a pledge of good faith negotiation toward a possible contractual relationship between the board and INdigital, INdigital Telecom will incur no obligation in making this response to the RFI.

Similarly, we conclude that the Board incurs no obligation in its receipt and review of this proposal, other than the protection of INdigital's intellectual property rights related to the development and exposure to concepts, architecture and designs related to and contained within the INdigital response to the RFI.

1.4 Evaluation

Every effort has been made to insure that these proposals are complete, ultimately feasible, and accurate within the scope of the RFI. INdigital has attempted to ensure that they are in compliance with the stated technical specifications of the RFI except or unless explicitly noted otherwise.

In the interest of completeness, specific brands and models of equipment, proposed circuits and circuit routes, locations of equipment, and other such details, have been included in these proposals, along with pricing estimates. However, INdigital reserves the right to substitute comparable equipment and/or functionality, provision circuits differently, or relocate equipment, if considerations such as availability, cost, technical issues, or other circumstances dictate or indicate such changes would be appropriate, necessary, or desirable.

1.5 Background

INdigital Telecom shares the Board's view that much of the present E9-1-1 infrastructure is costly, outdated, and inflexible in the face of the new demands being placed on this critical public safety system.

Some of our proposals use the most currently available telephone and data technologies for the purpose of addressing cost, quality, and network flexibility.

Each component of our proposals is a proven network element. There are new network elements that have been successfully used in other contexts and applications. Some elements have not, to our knowledge, been used in the particular mix of E9-1-1 requirements as specified in the RFI. Therefore, some uncertainty exists as to how easily some elements will integrate into a solution as described in the RFI requirements. Our business partners and INdigital have a vested and considerable long-term interest in resolving any integration difficulties that will arise, and are highly motivated and committed to overcoming these obstacles.

In order to permit the Board to choose a level of risk, reward, and cost, that it finds attractive and advances the public need, INdigital is not making a single proposal but sets out three frameworks for an initial implementation of a *Wireless Direct* network.

Generation 1 - is a <u>limited</u> proposal that maximizes the use of present network, equipment and technologies. INdigital will outline a network architecture and work plan that provides substantial initial cost savings. We refer to this as the "G-1" proposal. The G-1 proposal can be implemented as a finite project with pre-defined boundaries and objectives. The G-1 proposal can be used as a starting point that subsequently evolves into the Generation 2 proposal.

Generation 2 - Building on the foundation of the G-1 network elements, INdigital's "G-2" proposal adds components to extend the G-1 proposal. The addition of the new network elements extends the functionality of the G-2 proposal to meet and exceed the RFI baseline requirements within the limitations of the existing PSAP equipment. G-2 builds a new statewide Internet Protocol (IP) infrastructure that is the basis for implementing new E9-1-1 technology and dealing with future requirements.

Generation 3 - INdigital also includes in this response a "G-3 IP" solution that reflects our vision of the future of E9-1-1 technology and network evolution, which we believe will exist several places in the United States in the very near future. This is an extensive proposal that includes much of what was, at the recent NENA Technical Development Conference (NENA-TDC), referred to as "I1", "I2" and "I3" by the VoIP/packet committee.

Background Summary

The conservative G-1 proposal can grow and evolve into the G-2 proposal simply by adding components. The G-2 proposal can become the G-3 proposal by replacing several network elements with newer technologies, but a large part of the G-2 structure remains. In this way a series of orderly steps will allow the Board to achieve the G-3 goal with a minimum of wasted effort or public expense.

The Board may choose the G-1 proposal as an initial implementation or, the Board may choose to start immediately with the G-3 IP proposal. The Board may also choose an intermediate G-2 step as the starting point.

INdigital's goal in responding to the RFI is to empower the Board with the option of choosing what it finds to be the most attractive solution that meets the public need.

1.5.1 Traditional Solution Reference Model

Wireless Direct, implemented via a traditional time-division multiplexing (TDM) solution, would consist of these network components (see Figure 1.1):

a) Incoming trunks from the Mobile Switching Centers (MSCs) to the Selective Routers (SRs.)
b) SS7 signaling and control links ("A" or "F" links)
c) The Selective routers themselves, with their routing databases.
d) Outgoing point-to-point voice trunks from the selective routers to the PSAPs.
e) Separate point-to-point data circuits from the ALI databases to the PSAPs.

We will refer to these network components in our discussion.

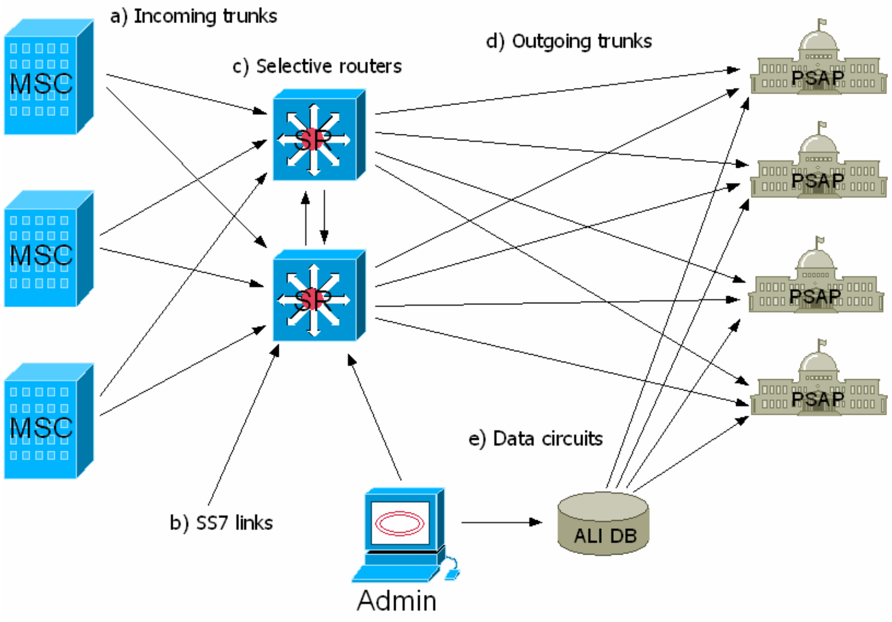

Figure 1.1 - Traditional TDM *Wireless Direct* Components

1.5.2 Distinguishing Between Signaling Information and Bearer Traffic

It will be helpful, in the discussion that follows, to observe that the information carried over the telephone network can be classified as either signaling information, such as ANI strings, busy signals, or answer signals, or bearer information, such as the actual voice or data to be communicated over the network.

Older telephone technologies used the same channel and equipment to carry both the signaling information and the bearer traffic. The CAMA trunk is a good example of this: The ANI is carried as a series of tones through the same circuits and equipment that provide the voice path through the network.

Newer telephone technologies separate the signaling and the bearer traffic. An ISUP trunk is a good example of this: The ANI is carried in an SS7 packet that is delivered via an SS7 "A" link. This is separated from the voice path, which is also called the bearer channel. Bearer information is frequently transported/delivered on a channel of a T1 digital trunk circuit.

One advantage of separating the signaling and bearer information paths in a telephone network is that functions related to signaling may be performed in equipment that is separate and distinct from equipment that carries the bearer traffic. This separation of equipment and functions will be most evident in our G-3 IP proposal.

1.5.3 Packet Multiplexing versus Time Division Multiplexing

The telephone industry today is undergoing a major technological paradigm shift: the change from time-division multiplexing to packet technologies.

The previous major technological paradigm change was the shift from analog to digital. This change began in the late 1960s, and for the regular voice telephone network, is complete today.

However, some E9-1-1 signaling methods, such as the CAMA signaling protocol used to pass ANI in much of today's wireline E9-1-1 network, remains fundamentally an analog signaling method. While CAMA can, and often does 'ride' on digital facilities, it is not a digital signaling protocol, any more than a message written in longhand and sent by FAX transmission is 'digital'. Writing and reading that type of message is very much an analog process.

We see the continued use of analog CAMA signaling as a significant limitation and problem to the development of a modern E9-1-1 network that meets today's needs.

The digital technology implemented in the telephone industry over the past 40 years is known as time-division multiplexing, or TDM. TDM is characterized by:

- Connection–oriented communications. In order to exchange information between points, circuits must be setup, used, and subsequently torn down.
- Circuit switching. Establishes an end-to-end path through the network
- "Fixed" or "dedicated" allocation of bandwidth and network resources.
- Real time delivery of information.

TDM was invented, designed, and engineered to meet the needs of voice communications.

In contrast to TDM, packet-multiplexing technology emerged in the 1970s and was initially developed to meet the needs of digital data communications.

Packet networks are characterized by:

- Connection-less communications. Packets may be sent to any destination without setting up or tearing down circuit paths.
- Packet "switching" by forwarding. There may be multiple paths through the network between the source and the destination.
- Dynamic allocation of bandwidth / network resources upon demand.
- Variable time delay in the delivery of information.

Both TDM and packet technologies have been tremendously successful in what they were originally designed to do.

In the past few years, the addition of Quality-Of-Service (QOS) features to packet networks has permitted packet networks to bear real-time services, such as voice and video information. Voice and video are treated simply as additional applications that are carried by the packet network, along with "pure" data applications.

The development of low cost, high performance microprocessors and other data technologies have lowered the cost of packet networks to the point where they can be used for both voice and data services. Packet networks offer greater feature sets and much greater flexibility at a lower cost than do traditional TDM networks. We expect this trend toward greater functionality and lower cost to continue.

Besides cost, several other features of Internet Protocol (IP) networks make them very attractive for E9-1-1. We present these features next.

1.5.4 IP Network Survivability

Inherent characteristics of the Internet Protocol (IP) permit the design of mesh networks that are highly reliable and survivable. The design of the Internet Protocol itself was motivated in part by mathematical studies of command and control requirements and solutions for the battlefield, among other considerations. These subjects remain the object of much academic research today.[1]

IP networks can economically be built in a mesh topology with multiple interconnection points, rather than in the hub and spoke models common to local telephone industry practice today. Failure or damage to a transport link in the mesh does not render the remaining elements of the mesh inoperable. In fact, the network can sustain multiple failures, often with minimal impact. Failures in a well-designed mesh network with automatic reroute capability typically cause reductions in available bandwidth, rather than complete loss of connectivity.

IP networks running robust routing protocols such as Cisco System's EIGRP can automatically reroute traffic if a part of the network fails. The connectionless packet traffic will be automatically rerouted to surviving portions of the network as soon as a router detects that an interface (usually, the associated transport facility) has failed. The use of DS1 or DS3 facilities exclusively in our G-3 design insures prompt failure detection, even if a circuit is carrying no traffic at the moment of failure. In this scenario the reroute will usually occur in sub-second time after a failure occurs.

With the foundation of good IP network design and careful implementation, a reroute caused by a facility or equipment failure should not result in the loss of a call, but only a brief "drop-out" of a syllable or two. This is a capability far beyond what is generally possible with TDM circuits, where the loss of a facility will likely cause the loss of every call that is using that facility.

As a real-life example, on 9/11/2001 in New York City, many communications services were greatly impacted. But the Internet, based on IP, continued to operate without significant impact outside the destruction zone.

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[1] We have not prepared a bibliography of academic research articles on network survivability, but a quick search of the Communications of the Association of Computing Machinery (ACM) and the IEEE returned numerous hits. For example, the following article was found as the result of a Google search in just a few minutes: "Failure-Oriented Path Restoration Algorithm for Survivable Networks" by William Lau and Sanjay Jha. The article can be found at: http://www.cse.unsw.edu.au/~wlau/paper/noms2004.pdf

1.5.5 Dynamic Bandwidth Allocation

Equally compelling for E9-1-1 are the benefits of dynamic bandwidth allocation available in an IP network with QOS features.

A significant factor in the operating costs of the present E9-1-1 systems is the use of a large number of TDM point-to-point circuits. Many of these circuits are idle for all but a few minutes a day. In a TDM architecture these circuits consume valuable telecom facilities, hour after hour, day after day, driving up cost while performing only a single function.

By contrast, the packet-based IP solution permits the network resources to be used for data communications while the voice "circuits" are idle. The QOS features insure the required bandwidth will be available for voice communications when required.

The result is that the costs of the network facilities are dispersed over multiple applications. IP networks provide resource sharing at a significant cost savings.

In fact, our estimates for a complete TDM network from just two selective routers to all the PSAPs in Indiana are roughly double the cost of a much more capable and robust IP-based solution that offers nearly ten times more bandwidth to each site.[2] (Note: This is recurring cost, not the initial cost. Over the used and useful life of the equipment, the initial cost is small compared to the recurring cost.)

The ability of IP to provide dynamic bandwidth allocation is a major factor in the difference in cost and performance between these two different architectures.

To summarize: When considering network survivability, cost, dynamic bandwidth allocation, general purpose rather than special purpose capability; for these and for many other reasons, we believe the future of E9-1-1 includes packet-based networks, and specifically, private IP networks built in a mesh configuration.

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[2] Preliminary estimate of the cost of an all TDM solution from <u>two</u> selective routers to one hundred sixty two PSAP sites: Per the RFI, a minimum of 4 voice trunks (2 from each SR) and 2 ALI circuits are required per PSAP site. Provisioned as DS0s, this implies 6 * 162 = 972 total circuits. The average length of each circuit is more than 1/4 the length of the state, assuming centrally located routers, or more than 75 miles. Assuming an average cost of about $400/month/circuit (based on tariff rates) the estimated annual cost is 972*$400*12, which is greater than $4,500,000 per year.

Preliminary estimate for an all IP network as presented in the G-3 solution from <u>multiple</u> selective routers to 162 PSAP sites: Each site is connected via 2 DS1s, but because sites are daisy-chained, the total number of DS1s in any chain is one + number of sites in the chain. If only two sites per chain then there are three DS1s for each two PSAPs = 3/2*162 = 243 DS1s. (Longer daisy chains reduce the DS1 count at the expense of the average bandwidth available to each PSAP.) Average length of a DS1 is the distance across a county, or less than 25 miles. Assuming average cost of a DS1 is $600/month, the total annual cost is 243*$600*12 < $1,750,000 per year. Estimated annual cost of the fiber ring provisioned DS3 backbone is $500,000. So the total estimated annual cost of the IP solution is less than $2,250,000 per year.

Also note that the TDM solution provides 6 * 56K = 336K bandwidth per site, statically allocated as 224K voice and 112K data, while the IP solution provides up to 3,000K dynamically allocated bandwidth per site.

1.5.6 VoIP is an Emerging Technology that Exists Today

We do not see packet technologies, and specifically, Voice-over-IP (“VoIP”) as the “future.” These technologies are here, now. Much hyped and much discussed for several years, VoIP is now being adopted at an accelerating rate.

For example, Vonage (http://www.vonage.com/) is a rapidly growing dial-tone provider that uses VoIP over the Internet as the “last mile” connection to the customer, and currently has several hundred thousand customers.

Synergy Research Group, Inc, reported in December 2003: **“**Emerging Communications Technology Outsells Traditional Gear for the First Time.” (http://srgresearch.com/store/press/12-5-03.html.) Synergy also predicts that in 2006 in the PBX market more IP PBX telephones will be sold than traditional PBX telephones.

INdigital is presently providing voice and data services to some of its business customers via packet technologies. These packet technologies provide the highest quality ISDN PRI voice telephone service. IP data traffic is also carried over the same facilities to the customer’s site. The data shares the bandwidth with the voice.

Not only do we provide this service to our customers, we use it ourselves.

INdigital’s in-house telephone system is connected to our own Central Office switch via a packet link, for demonstration purposes. Any time you call INdigital, your speech and our speech are carried over a packet link between our telephones and you. We invite you to call us, and see if you can detect the fact that we are speaking to you over a packet system. If you like, we can even put you on hold, and then you can listen to the “on hold” music for a while! A single call may be worth thousands of words.

Not all voice-over-packet systems are this mature, nor do they all work this well. However, we know that with careful product selection, a conservative design, and with a quality implementation, VoIP systems are available now that can provide the highest quality service and excellent reliability, even while significantly reducing cost and improving network flexibility.

Finally, a TDM-based solution is fundamentally a dedicated-purpose E9-1-1 networks.

The proposed G-3 IP network will not only meet the E9-1-1 requirements of the RFI, but will provide infrastructure that will support vital new public safety applications. Examples include regional/statewide/national emergency management applications, mapping applications, non-traditional communications such as instant messaging, picture-enabled cell phones, and telematics. We hope our response demonstrates that a VoIP-based solution is feasible, cost-effective, and that it can provide a solid infrastructure for the future.

1.6 INdigital's G-1 Proposal, Explained

Our first response, in the form of our G-1 proposal, is to simply install two new selective routers to terminate ISUP trunks from the wireless carriers, and then interconnect with the existing ILEC selective routers. The ILEC selective routers would then deliver the call to the PSAP exactly as it happens today.

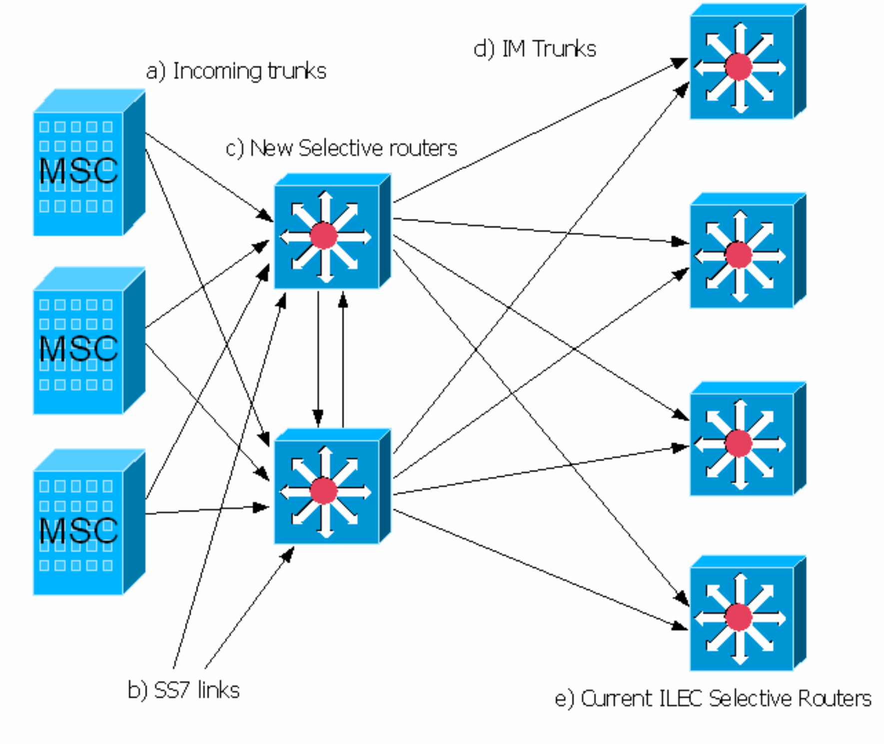

Figure 1.2 - Basic G-1 configuration

The inter-machine trunks (IMTs) from the two new selective routers to the ILEC SRs would be ISDN PRI for CML ILEC routers, or ISUP SS7 IMT to the three existing 5ESS ILEC routers.

The G-1 solution would use TDM circuits for all bearer traffic. SS7 connectivity would be provided by TSI, an SS7 aggregator used by the wireless carriers to provide network SS7 gateway mediation and control.

The G-1 solution is essentially a method of aggregating the incoming trunks in the existing Indiana E9-1-1 wireless network.

The basic G-1 proposal offers these advantages/features:

- ? Very low cost.
- ? No new tandem to PSAP trunks required.
- ? No equipment changes required at PSAP.
- ? Substantial reduction in trunk costs for the wireless carriers.
- ? Provides statewide conference/transfer capability, in principle.[3]
- ? Eliminates CAMA signaling between the wireless carrier and the ILEC SR.
- ? Provides statewide wireless traffic statistics.
- ? Provides a single point of contact for resolving wireless issues. (INdigital will contact the other LECs, as required, to resolve problems.)
- ? Simplifies provisioning for new wireless carriers.

We recognize that this "basic" G-1 configuration falls short of some of the Board's *Wireless Direct* goals. For example, it doesn't bypass the existing ILEC selective routers, but adds another router in tandem. This solution might be called (a bit tongue-in-cheek!) the *Wireless Indirect* proposal.

However, this basic G-1 configuration does solve a number of problems with the existing Indiana Wireless 9-1-1 network and does address most, but not all, of the goals as stated in the RFI in section 1.1:

It greatly reduces the total trunk count (and thereby the total cost) between the wireless carriers and the existing selective routers. It also reduces the total port count and DACS requirements at the ILEC selective routers, another cost savings.

It supports full digital signaling (using either SS7 or ISDN PRI) all the way to the existing ILEC routers, reducing call setup time. This would be seen as improved service to the public, thereby meeting the public need.

With proper ILEC and PSAP programming, three-way call conference with transfer (TWCT) should be available between any two PSAPs anywhere in the state for wireless calls, regardless of the wireline trunk plan.[3]

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[3] Statewide conference/transfer capability may be limited by legacy PSAP equipment or by ILEC SR capabilities. For example, current CML products limit speed call/outgoing trunk transfer tables to 100 distinct codes, from *00 through *99. With 162 PSAPs in the state there are not enough table entries. These limitations may apply to any solution that uses the legacy PSAP equipment.

It may be possible to devise regional transfer schemes to work-around such limitations. But INdigital cautions the Board that there will likely be unforeseen complications and limitations with such plans. We expect that eventually multi-state and even national E9-1-1 conferencing capabilities will be required.

INdigital's selective router solutions will support dial plans that would allow any PSAP to conference/transfer to any other PSAP up to thousands of PSAPs, assuming the PSAP equipment can generate dial strings with sufficient digits.

There are several downsides to this simple plan:

1) It does not address all the Board's goals and requirements, as stated in the RFI.

For example, it only partially addresses concerns about potential points of failure in the wireless network, since it does not change anything from the ILEC SR out to the PSAP. It is also not clear that this basic proposal completely addresses consistency of wireless services as seen at the PSAP, because, again, the ILEC remains between the new wireless SRs and the PSAP.

2) Some degree of ILEC cooperation will be required. For example, all the CML routers must be equipped with ISDN PRI interfaces, if not already so equipped.

3) The p-ANI selective routing database entries must be "duplicated" in both the new wireless selective routers and in the ILEC selective routers.

4) The ILEC must cooperate in programming the PSAP and the ILEC router, as needed, to pass conference/transfer requests up to the new wireless selective routers. The potential exists that the operation of the conference/transfer function would be inconsistent, depending if the transfer is being made to a PSAP serviced by the same ILEC and handled by the ILEC router, or to a PSAP serviced by a different ILEC and handled by the new wireless router.

That said, this functionality of the E 9-1-1 network does not exist today, and any vendor will face similar challenges in coordinating the programming of the various existing SR and/or ANI/ALI controllers that will be re-used in this configuration.

This basic plan could be restricted initially to the voice network only, letting the existing ALI system continue to process the p-ANI ALI requests, and saving the cost of a new ALI network. Subsequently, ALI connections could be installed to Intrado and TCS, and ALI provided through a new ALI network to those ANI/ALI controllers that do not use a "national" E9-1-1 database.

We do not discount the "one throat to choke" concept, but we see little short-term advantage to requiring the existing national ALI databases to perform their ALI dips through an Indiana wireless ALI database in this basic G-1 solution. The ILEC national databases can continue to dip Intrado/TCS directly, as they do today.

Finally, while the basic G-1 proposal would address many of the goals and requirements of the RFI at a low cost, it might be necessary to immediately begin the evolution to a "G-2" solution (and beyond) to meet the needs of new and developing public safety requirements.

1.7 INdigital's G-2 Proposal, Explained.

INdigital's G-2 proposal builds on the basic G-1 proposal by extending the new selective routers to the PSAP, fully implementing the *Wireless Direct* concept.

We propose to connect the selective routers to the PSAPs using Voice-over-IP (VoIP) transport on an extremely robust, private, secure, and managed IP mesh network. This network will exploit the network survivability, dynamic bandwidth allocation, cost savings, and other advantages of packet networks as previously explained in section 1.5.

The key feature of this proposal is a fiber-ring based network that is fully redundant and physically diverse. SONET based, it provides the IP "backbone" that blankets the state. These rings can carry VoIP and data across the LATA boundaries, saving the cost of utilizing IXC carriers (long distance companies) to provision a number of the required transport circuits.[4] Critical G-2 equipment, such as the selective routers and the gateways, will be physically located at access points on this ring.

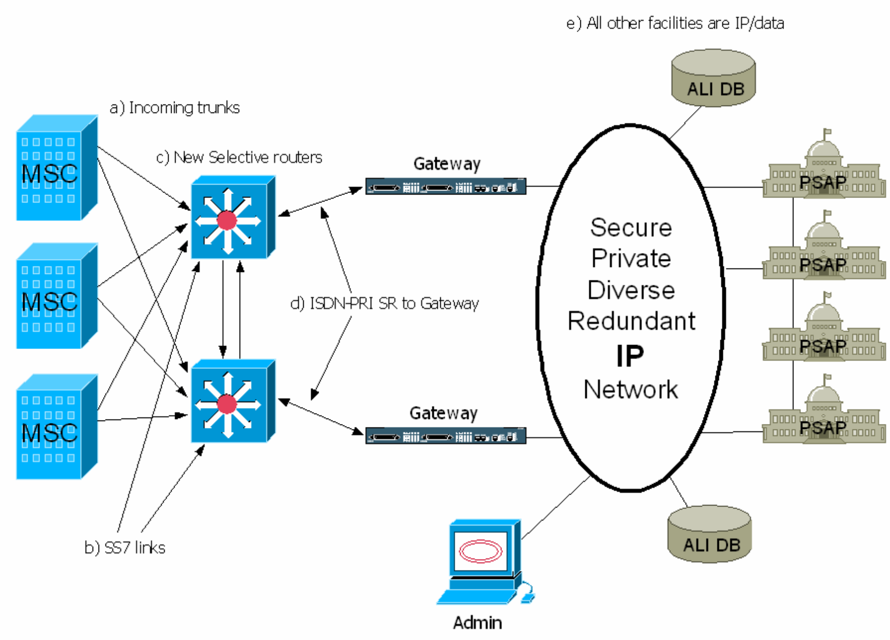

Figure 1.3 Proposed G-2 Network Components

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[4] We will implement the network in the most cost effective way that is consistent with the design goals. In some cases, it is less expensive to use an IXC to provision a circuit or carrier system due to mileage costs.

This private, secure IP network will implement QOS (Quality of service) features to insure high quality VoIP communications, while meeting and exceeding the technical requirements of the RFI for redundancy, diversity, and reliability.

The resulting network will be significantly less expensive to operate and maintain than a traditional point-to-point network of voice trunks and data circuits, even though it will provide a greater range of possibilities and future services.

In this solution, VoIP is used simply as a means of transporting voice channels from the selective routers to the PSAPs.

Outbound traffic from the selective routers is transported to the gateways on ISDN PRI facilities. The gateways convert the TDM bearer channels to VoIP packet streams. PRI channels are mapped by the gateways to specific PSAP sites, creating "virtual" voice circuits.

Equipment located at the PSAP site terminates the virtual circuits at the edges of the VoIP network.

The G-2 proposal will support a variety of solutions for the PSAP equipment. The PSAP equipment can range from IP telephones, to CAMA cards which interface with existing ANI/ALI controllers, to next generation IP PSAPs that integrate many existing and new public safety functions, depending on the needs and desires of the PSAP.

The G-2 IP network provides data connectivity at each site, as well as the voice connections. Data interfaces for traditional ALI spills are provided, as well as broadband Ethernet IP connectivity. The G-2 IP network will also support additional public safety applications, such as those presented by MapInfo in Appendix B, while also satisfying and exceeding the RFI requirements.

1.8 INdigital's G-3 IP Proposal, Explained.

INdigital's G-3 IP proposal exploits the secure, private, and managed IP network of the G-2 proposal to replace the traditional selective routers of the G-1 and G-2 proposals with call agents.

This solution may be viewed as an "all IP/VoIP" solution. We, therefore, refer to this proposal as the "G-3 **IP**" proposal. The only TDM components in this proposal are the SS7 links and trunks back to the wireless MSCs, and perhaps, the connections at the PSAP site.

The use of call agents, instead of selective routers, permits the full functionality of the IP network to be utilized.

As in the G-2 proposal, critical G-3 equipment, such as the call agents and the gateways, will be physically located at access points on the backbone ring.

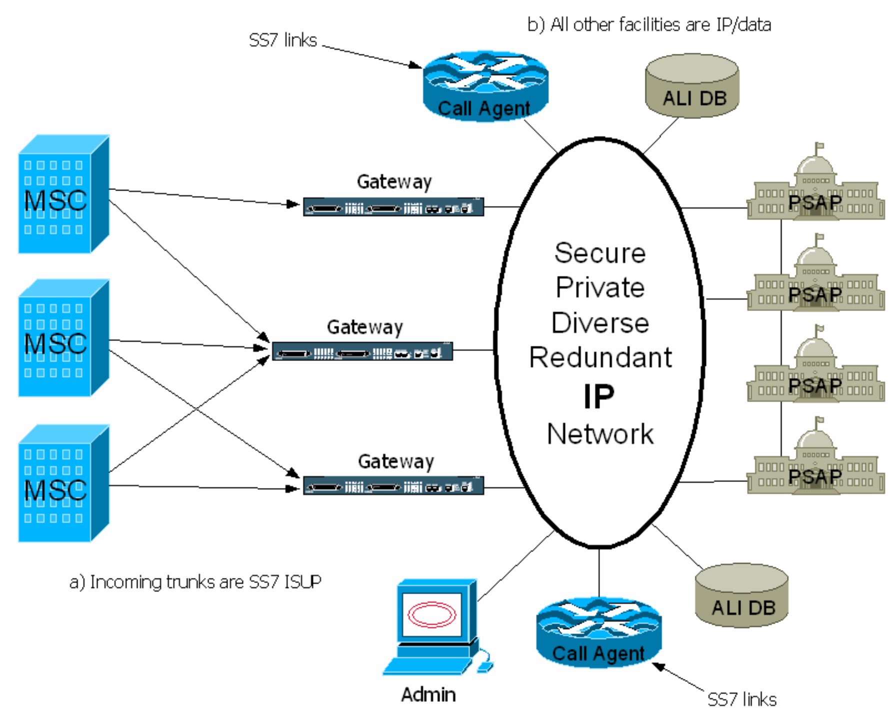

Figure 1.4 Proposed G-3 Network Components

It is important to understand that many elements required in a traditional solution take an entirely new form in the G-3 IP architecture.

For example, the IP network itself replaces the switching fabric (the crossbar, or switch block) of a traditional telephone switch. In this solution, The Network is the Switch.

In order to establish a voice path between two points in the network, the endpoints need only be informed of the IP address of the other endpoint. These endpoints then communicate by sending a stream of packets to the IP address of the other end.

The IP network routers forward the stream of packets across the various links of the network, until they reach their destination. If a link in the network becomes inoperative, the routers can forward the stream of packets via an alternate link, even while maintaining call continuity and integrity.

The call agents in figure 1.4 perform the signaling functions:

- ? They connect to the SS7 network and exchange signaling messages with the traditional telephone network.
- ? They perform the 9-1-1 routing database lookups.
- ? They send IP messages to the endpoints to establish a voice connection.

Note that the call agents deal with signaling information only. They do not carry or process any bearer information. Put another way, the voice path does not pass through the call agent. Rather, the gateways connect the voice path from the MSCs to the VoIP network.

The call agents and the gateways need not be at the same physical location, but can be at any convenient access point on the backbone ring. Multiple gateways may be used; the number of gateways is not related to the number of call agents.

1.9 Comparison of VoIP Network Components and Features

In the G-3 IP solution, the call agent performs the "intelligence" functions of the selective router. In this solution, there isn't a "selective router." Rather, the router functions are distributed between the gateways, the call agents, the IP network, and the PSAP equipment.

Multiple call agents assure redundancy and survivability. The physical location of the call agents may be anywhere on the VoIP network, which may be different from the physical location of either the PSAP or the gateway VoIP endpoints. In practice, the call agents will be located in secure Central Office facilities on the fiber ring.

In the G-2 and the G-3 solutions, the gateway becomes a bearer channel interface between the traditional telephone network and the *Wireless Direct* VoIP network.

Since these gateway devices are less expensive than a traditional 9-1-1 router there can be multiple gateways at strategic locations in the VoIP network. These locations can be chosen to minimize the cost of MSC to gateway facilities (DS1s) and to maximize the network reliability. Again, in practice, the gateways will be located at secure CO facilities on the fiber ring.

In G-3, the IP network itself steers packets to the correct destination, that is, the IP network is the primary switching element. The network provides connectivity between all the elements, and its design is the key to the reliability of the entire system.

All parts of the G-2 or G-3 IP network are provisioned over DS1 (T1) facilities or better. Although DS1 systems are more expensive than DS0 circuits, the extra cost of the DS1 is more than offset by the reduction in the total number of facilities compared to traditional voice trunk solutions. DS1 systems also provide superior monitoring and diagnostic capabilities, reducing the opportunity for finger pointing and reducing the time to repair.

The G-2 and G-3 proposals will support a variety of solutions for the PSAP equipment.

We anticipate that the next generation telephone system installed at PSAP sites is likely to be an IP-based system.

We will explain these points in additional detail as we respond to the technical requirements of the RFI.

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2 INSTRUCTIONS FOR RESPONSE AND SUBMITAL

2.5 Form of the Response

Our response has been prepared so that the organization and numbering match the RFI as closely as possible. To find our response to any specification in the RFI, simply locate the section with the identical section and first sub number in this document.

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4 TECHNICAL DESIGN AND SPECIFICATIONS

4.1 Introduction

4.2 Network Design

All our proposals provide redundant and diverse all digital networks.

All proposals use SS7, ISDN or SIP signaling to improve call setup and delivery time.

All have the capability for statewide transfer within the scope of the proposal, but some legacy equipment may not be able to support statewide transfer.

Only the number of available trunks limits the capacity of the system. All proposals are initially configured to handle up to 48 concurrent calls from <u>each</u> MSC on two DS1 (T1) systems. These capabilities are easily upgraded by installing more DS1s.

It is not likely that traffic will be evenly distributed among the PSAPs and the wireless carriers. The number of call takers available to answer calls at any moment is likely to be the "choke point" in any 9-1-1 solution, not the network.

However, should traffic studies indicate possible trunk saturation above the P.01 service grade we would install addition DS1s, as required, to meet the service standard.

We have designed the systems to be able to connect more than forty calls per second. We see no impediments to growth within the scope of any proposal. The systems can handle far more than 2,000,000 calls per year, limited (again) only by trunk/bandwidth capacity and the ability of the call takers to process the calls.

The G-1 and G-2 proposals are two-router configurations. The diversity of trunks insures that in an event of a catastrophic failure of one of the selective routers, 50% of the network capacity remains. Most failures, such as facility (DS1) failures, would have a much more limited impact.

As previously stated, the basic G-1 solution uses the present ILEC selective routers and present PSAP equipment, so the G-1 solution does not necessarily provide at least four trunks to each PSAP site. G-1 provides, as a starting point, 46 (CML) or 48 (5ESS) voice channels per ILEC selective router, which is easily expandable provided the ILEC is willing and able to connect more DS1s to their routers.

The proposed G-2 and G-3 systems are very overbuilt with respect to bandwidth. The mesh design of the IP network assures redundant and diverse connectivity from any network endpoint to any other network endpoint. These proposals fully meet and exceed the requirement of four voice and two data circuits at each PSAP site. This will be further explained below.

The G-3 IP proposal does not contain a single entity easily defined as a selective router. The SR function is distributed among several replicated network elements. The system is incrementally expandable and ultimately limited only by bandwidth.

The limited G-1 proposal may be used as a voice-network only replacement and use the existing ALI systems. The G-2 and G-3 solutions provide high-speed data connectivity to all PSAP sites. See section 4.4 for a discussion of ALI features and options.

Administrative and maintenance aspects of each system are discussed throughout Section 4, as applicable.

The G-3 IP solution is built on many of the same protocols and technologies used by Internet VoIP providers, cable telephony providers, and telematics systems. Since the G-3 system is itself a complete VoIP and IP data solution, it should prove to be exceptionally easy to integrate the G-3 IP solution with Internet VoIP, cable telephony, Automatic Crash Notification, and other emerging technologies. We believe most new technologies are likely to be based on IP and VoIP. Therefore, the proposed G-3 system should be exceptionally well positioned to be able to respond to the issues and problems posed by future technologies. These issues will also be addressed later in this section.

4.2.1.1 G-1 and G-2 Proposals – Wireless Routing

The INdigital G-1 / G-2 proposals are based on two selective routers, one located at INdigital's office at 5312 W Washington Center Rd, Fort Wayne, and the other located at Hancock Rural Telephone Corporation, 3896 N 200 W Greenfield. Both of these sites are points-of-presence on the IFN fiber ring; refer to section 4.2.5.

Each selective router will be composed of a Siemens EWSD central office switch, and an SS7 SCP (Service Control Point) that implements the 9-1-1 routing database. Each EWSD will have an SCP co-located with the switch, and interconnected via two SS7 "F" links.

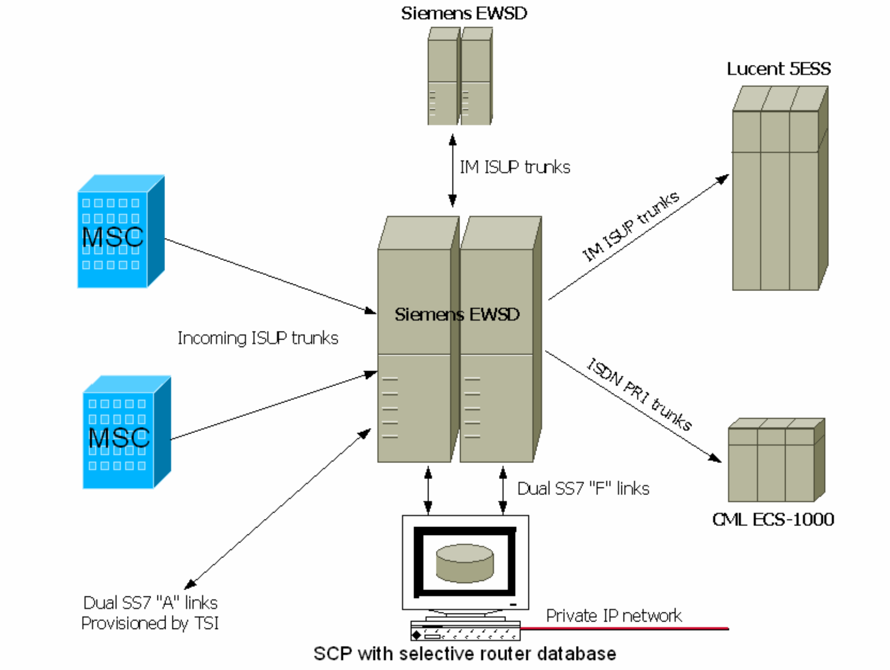

Figure 4.1 - Proposed G-1 Selective Router

Each EWSD will also have two SS7 "A" links provided by Telecommunication Services, Inc. (TSI), for SS7 signaling with the MSCs. This insures no issues will arise concerning SS7 signaling between the MSC and the EWSD.

All incoming trunks from the MSCs will be provisioned on DS1s. Two DS1s interconnect the two Siemens Selective routers for traffic overflow and for redundancy.

All outgoing trunks will also be provisioned on DS1s. All signaling on incoming or outgoing trunks is SS7 ISUP, except the signaling on outgoing trunks to the legacy ILEC CML routers (G-1) or to the VoIP gateways (G-2) is ISDN PRI. It is much less expensive to equip the CML routers for ISDN PRI than to equip them for SS7. From the Siemens EWSD point-of-view, the CML is identical to an ISDN-capable PBX. All EWSD ISDN PRI trunks in these proposals are not part of the PSTN dial plan. They are accessible only via the wireless E9-1-1 network.

Each SCP consists of two high-reliability

[This section redacted. It contains INdigital Intellectual Property.]

Translations in the EWSD route an incoming call to the other EWSD in the event of a total failure of the local SCP or an outgoing trunk, overflow or overload situation, or other special circumstance.[5]

E9-1-1 routing in the EWSD is accomplished by SS7 TCAP Advanced Intelligent Networking (AIN) 0.1 transactions between the EWSD and the SCP, as defined by ANSI T1.667-2002, and as implemented by Siemens in EWSD Release 20. These features allow the EWSD to perform the E9-1-1 routing function required by the RFI without special switch software, which is a significant cost savings. References to applicable standards and compliance statements can be found in Appendix A.

INdigital has a demonstration E9-1-1 selective router operating in its Fort Wayne office, and would be happy to demonstrate it to the Board. The demonstration router differs from the proposed solution mainly in that it does not have the [section redacted].

DS1 failures generate alarms in the EWSD, even if all circuits in the DS1 are idle. Such alarms will be handled by INdigital Telecom or by Hancock County Rural Telephone Corporation respectively, as a part of their standard operational procedures. Because these switches provide regular telephone service to each company's customers, and in order to insure the integrity of switch operation, INdigital would provide all translation and monitoring services involving the EWSD-based routers under a service contract with the Board.

Selective Routing Database (SRDB) Management, which could include maintaining and modifying the routing database, examining traffic and error logs, performing configuration functions, and other such administrative functions, can be made available directly to the Board or its agent through the SCP IP administrative interface via a VPN or other secure connection.

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[5] Caution is required when calls are forwarded to a redundant selective router. Suppose the initial router experiences a failure, such as an outgoing trunk failure, which prevents normal call processing. If the call is forwarded to the redundant router, and the redundant router experiences the same problem, it may attempt to forward the call back to the original router. This situation will quickly fill up all the router-to-router trunks, lock up the incoming trunk and all the inter-machine trunks, and leave the call in limbo. This is a more serious problem than the original failure.

The solution is that calls that arrive on the router-to-router trunks must be specially handled. If they cannot be completed normally, they must be directed to an intercept, such as a recording, rather than forwarded to another router.

4.2.1.2 G-3 IP Proposal – Wireless Routing

The G-3 IP "selective router" consists of these components:

? The <u>call agent</u>, which performs the signaling and intelligence functions of wireless routing.
? The <u>gateways</u>, which translate the voice channels from TDM to VoIP.
? The private <u>IP network,</u> which transports the VoIP packets between endpoints, replacing the switch.

Of these three components, the call agent is the most complex and it is discussed here. It is the key to the routing in the G-3 IP proposal. The gateways and the IP network are discussed later.

[Section redacted. It contains INdigital Intellectual Property.]

[Section redacted, continued.]

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All of these components communicate with each other and with other components in the system by using various message and control protocols over the IP network.

The redundant instances of these devices will be located at the INdigital Telecom site and at the Hancock County Rural Telephone Corporation site, respectively. Since both of these sites are nodes on the IFN fiber backbone, the connection between them is very high quality and very reliable. The equipment is secure at these sites, and service personal are readily available.

4.2.2 Interfaces to Network Carriers

G-1 and G-2: The wireless carriers will connect from each MSC to each Siemens ESWD via one (or more) DS1 trunk interfaces programmed for CCS/SS7 ISUP inter-machine trunks.[6]

G-3: The wireless carriers will connect from each MSC to two diversely located Cisco AS5350 / AS5400 series Universal Gateways or Cisco MGX 8500 gateways, via one (or more) DS1 systems to each gateway. These trunks will be logically equivalent to CCS/SS7 ISUP inter-machine trunks. Other trunk types can be supported, including ISDN PRI.

In all proposals INdigital plans to arrange for SS7 signaling services to the MSC through TSI.

We will obtain ALI information from any wireless carrier via Intrado or TCS. We will also be willing to obtain ALI information directly from any wireless carrier.

Several ALI interfaces will be supported as needed. Examples are Intrado's SALI interface, TCS's ENG-3001 interface, JSTD 036 "E2+", and "traditional" ALI database dips.

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[6] The Siemens EWSD can accept two stage eight digit CAMA trunks with a zero info digit only, which means the trunk would be dedicated to seven digit ANI or pANI values from a single NPA/NDP. However, since this type of trunk does not improve call setup time, we offer it only if the wireless carrier cannot provide an appropriate SS7 trunk. The Board should know that we could accept this type of signaling, if needs be, for backward compatibility. We do not expect this to apply to any modern MSC.

Although not directly part of the proposal we are willing to work with any wireless carrier to dip the carrier’s PDE or MPC/SCP directly, especially to the purpose of implementing location-based routing. We are also willing to work towards implementing the Calling Geodetic Location Parameter in the SS7 ISUP messages per ANSI T1.628-2000 as a means of passing location information to the selective router with the initial call setup, if an MSC will support this capability. We are also willing and expect to develop other ALI interfaces as new standards and requirements emerge, such as SIP and XML. NENA is currently studying several such protocols for ALI applications.

NCAS, CAS, and H-CAS

Our view is that the terms CAS, NCAS, and H-CAS apply mostly to ANI delivery in a CAMA trunk environment. In CAS and H-CAS, additional information (the Call Back Number, or CBN) accompanies the pANI signal on the CAMA trunk, which is delivered by enhanced MF (EMF) signaling. “Pure” CAS does not support wireless Phase II, as CAS does not do an ALI dip back to the MPC/PDE. Phase II requires such an ALI dip.

NENA TID 05-501 not withstanding, we are not quite sure how to apply these terms to trunks that deliver pANI via ISUP signaling. Although it may possible to send EMF signals in the bearer channel of an ISUP trunk, that defeats, in our view, the purpose of using CCS/SS7 trunks from the MSC to the selective router.

ISUP trunks are constrained by the information elements available in the ISUP messages and how the mobile switches populate them. NENA TID 05-501 describes several ISUP parameter options, and where the pANI (ESRK) and CBN appear in the ISUP message, with these options.

In the G-1 solution, this information is simply passed to the legacy ILEC router as SS7 or ISDN PRI, to be used by the ILEC router according to its capabilities.

In the G-2 / G3 IP solutions, the ISUP data is converted to a VoIP signaling protocol (MCGP or H.323 for G-2, SIP for G-3) and the data is then sent via the IP network to the termination equipment at the PSAP.

The type of interface used at the PSAP determines how the H.323, MGCP, or SIP message is used.

In the case of CAMA cards at the PSAP, the pANI will be turned back into a ten-digit enhanced MF spill on the analog E9-1-1 trunk, and the CBN will be lost.

We propose the following solutions should a wireless carrier insist on doing “pure” CAS.

G-2 scenario: The SCP will build an ALI record from the pANI and CBN. The ALI system (section 4.4) will then steer to the SCP to access the "CAS" ALI record.

G-3 scenario: The [redacted] will send the ISUP data to the ALI server, where a "CAS" process will build an ALI record from the pANI and CBN. The ALI system will then steer to the CAS process to retrieve the record.

We don't see H-CAS as a particular problem, because the system can basically ignore the CBN that accompanied the ISUP message and perform the ALI dip.

Note that a future IP-enabled PSAP, freed from the limitations of CAMA signaling, would have full access to the ISUP information from the signaling gateway. In this scenario, there is no longer a CAS, NCAS, H-CAS distinction.

In all proposals, the pANI is delivered as a part of the SS7 call setup messages between the MCS and the SR. The pANI is ultimately used as an ESRK to query the ALI database from the appropriate source, that is, from Intrado, TCS, direct from the wireless carrier, or, if needed, a "CAS" database.

Inter-company coordination and interoperability issues

If INdigital is the successful contractor for the Indiana *Wireless Direct* project, we will provide technical specifications, telephone assistance, and testing support to wireless carriers and other providers (e.g. VoIP providers) who need to connect to the new network.

Should a problem arise, the strategy is to first identify and understand the nature of the problem. Doing this may mean man-hours spent in mutual testing with the other provider, capturing data and sharing the results.

Once the problem is understood then a means of resolution can be devised. Devising the resolution may require negotiation, effort, and expense on the part of either or both parties.

Many problems, once identified and understood, are easily resolved. A typical problem would be a configuration mismatch between the new wireless network and the connecting company that is quickly and easily fixed.

More difficult are problems relating to protocol and standards interpretations and their realization in implementations. Resolving such problems often requires the involvement of equipment vendors, and give and take on both sides. INdigital will work with equipment vendors, both our vendors and the connecting companies' vendors, to supply documentation, to provide test results, and to consider possible solutions, such as bringing out-of-spec equipment into compliance, exploring alternative solutions, or devising work-around solutions.

Part of our strategy is to use standards-based equipment from large, established companies, e.g. Siemens and Cisco, to provide the interfaces to connecting companies. This reduces the likelihood that serious interoperability issues will arise. Our experience is that these companies are very good about fixing problems with their equipment if it can be determined that the problem is non-compliance with an applicable standard that is part of the product specification.

On the other hand, our experience suggests that large, established companies do not readily modify their products to meet the special needs of projects like the Indiana *Wireless Direct* effort.

For this reason, we have chosen to partner with companies like MapInfo, NMS Communications, and SIPquest, to supply components that involve the more specialized functions of the network. These are smaller, more flexible vendors who share our interest in the success of this project, and who are committed to addressing any issues that might arise.

We pledge to approach such issues in a spirit of cooperation, and we would expect the same from a connecting company with whom an interoperability issue has arisen.

4.2.3 Integration

Traditional 9-1-1 terminologies uses the adjective “integrated” to describe an E9-1-1 system that uses the selective router as the ANI/ALI controller. The selective router queries the ALI database with the ANI or the pANI, receives the result, and communicates the ALI data to a dispatcher position that answers or joins the call.

The now-obsolete Rockwell router and terminals was an example of an integrated PSAP.

Today, the CML ECS-1000 may be used both as a router and as an ANI/ALI controller, and when used in this way the CML is typically located at the ILEC central office. If CML terminals are located at the PSAP and served directly from the router, then this configuration of CML equipment can also be considered an “integrated” 9-1-1 system.

In most integrated systems, the communication of ALI data between the SR and the PSAP CPE uses proprietary protocols and/or transport methods which may or may not be published.

In a “non-integrated” solution, the selective router is separate from the ALI system. The SR simply delivers the ANI and the voice part of the call to the correct PSAP. The SR has no role in the ALI retrieval other than forwarding the ANI or pANI to the PSAP.

The PSAP equipment queries the ALI database (which may be stored locally or remotely) using the ANI provided by the SR, and displays the ALI data to the correct dispatcher. If a call is transferred, the SR retransmits the original ANI to the new site. That site initiates another ALI retrieval to populate the local dispatcher's screen.

Non-integrated 9-1-1 solutions decouple the SR from the PSAP equipment. In a non-integrated solution, the SR can be replaced independently from the PSAP equipment.

In an integrated solution, replacing the SR usually requires replacement of all integrated PSAP equipment. This happened at a number of locations around the United States when Rockwell discontinued its router.

In a non-integrated solution, the selective router database is derived from the same database management system that produces the ALI data, as separate operations.

Our G-1 and G-2 proposals are definitely non-integrated solutions. The proposed Siemens EWSD selective routers play no role in the ALI system.

In the G-1 proposal, the present ALI system could remain in service indefinitely or, the ALI system could be replaced with another ALI system at the time the proposal is implemented. As a third option, the present ALI system could be replaced with a different ALI system at another time as a separate step.

The G-2 proposal provides a data infrastructure all the way to the PSAP, which is used in our non-integrated ALI system described in section 4.4.

Our G-3 IP proposal does not easily fit the above classification scheme.

In order to perform location-based routing, at least the position information (which is usually thought of as part of the ALI information) must be retrieved early in the call processing, before final call routing is performed.

This information could be a part of the ISUP messages per ANSI T1.628. (But to our knowledge, no wireless carrier has an MSC that does this today. We would be pleased to hear from a carrier with this capability.) Then, position information would accompany the pANI information as part of the call setup. Note that the ISUP message would not include the entire ALI record. In a sense, the ISUP transmitted position information is "extended ANI" information.

IP technology will cause some changes in our terminology.

In our G-3 IP proposal, we plan that the SIP proxy server will query the ALI database (either Intrado or TSC or other) in an attempt to obtain early lat/long information that can be used to route the call. If this succeeds, the SIP proxy will post the ALI record for subsequent query. (PSAP "pull".)

In any event, G-3 IP will transmit the ALI over the same IP network infrastructure that carries the voice. In this sense, both our G-2 and G-3 solutions are "integrated."

However, we will split the ALI data from the voice channel at the PSAP site, if required, in order to accommodate present-day PSAP equipment.

In the future, we expect an all IP PSAP would obtain the ALI data on the same IP connection that supplies the voice channel, in a totally "integrated" way.

The future calling device will generate its own ALI data, since IP phones, Automatic Crash Notification systems, and wireless GPS phones are "intelligent" devices compared to a POTS analog phone, which is "dumb." The intelligent devices potentially know better than some distant database where they are located.

This dynamically created ALI data would then be transmitted as part of the call setup in VoIP networks. NENA is today investigating the use of IP protocols (such as XML) to transmit ALI.

In such a world, ALI databases as we know them today will fade into the background, to be used only for wireline calls.

4.2.4 System Configuration

All the proposals make use of facilities of Indiana Fiber Network.

Indiana Fiber Network (IFN) is owned by INdigital, by Hancock Rural Telephone Corporation, and by seventeen other business partners. All IFN owners are independent telephone companies operating in the state of Indiana. IFN provides facilities and services to its owning companies.

Indiana Fiber Network provides a fiber-optic communications facility that circles the state. This facility is fully diverse and automatically redundant, and can provide state-of-the-art voice and data communications services. See figure 4.5

INdigital will use IFN to provision portions of DS1 (T1) carrier systems from the MSCs to the G-1 selective routers or G-3 IP gateways, as needed and appropriate. Those portions of the DS1 systems that ride within the IFN infrastructure are fully protected.

[Map redacted for security reasons]

Figure 4.5 - Indiana Fiber Network facilities

4.2.4.1 G-1 and G-2 System Configuration – Common Elements

The G-1 architecture is essentially that of Figure 1.2. (See page 10.)

The G-2 architecture is essentially that of Figure 1.3. (See page 13.)

The left-hand sides of these diagrams, through the EWSD routers, are identical.

A DS1 will be provisioned from each wireless carrier's MSC(s) to each selective router. These facilities may traverse a portion of the IFN network, be provisioned through a connecting ILEC or IXC, or any combination of these.

Every effort will be made to insure each DS1 system from each wireless carrier to each selective router does not ride common higher-level facilities, such as the same DS3. INdigital may employ various strategies, such as ordering each facility through a different IXC, to obtain diversity to the maximum degree possible.

Two DS1s, dedicated to wireless E9-1-1, will connect the two EWSD selective routers. These DS1s will be provisioned on IFN facilities.

In the G-1 proposal a DS1 will be provisioned from each EWSD selective router to each ILEC selective router. Again, every attempt will be made to insure facilities terminating on the same ILEC SR are diverse to the maximum degree possible.

INdigital has interconnection agreements with all major players in Indiana and anticipates no problem in ordering these facilities.

A total failure of a DS1 facility in the G-1 proposal would interrupt and terminate any currently active calls on that facility. The diverse and redundant facilities of IFN enhance the reliability of those portions of the DS1s that are transported by IFN.

The two Siemens EWSD switches are carrier grade switches, are totally independent of each other, and each has its own SCP. The Siemens switch is highly redundant internally. For example, it has redundant features in its switch block and redundant processors.

The redundant operation of the SCP was previously described. A total SCP failure would result in the default routing of new 9-1-1 calls to the other EWSD switch, where they should be routed appropriately. An SCP failure would have no impact on connected calls.

Since one half of the circuit paths from each MSC to each PSAP traverse one switch, a catastrophic switch failure would impact, at most, ½ the network, leaving the other half operational. A switch failure might interrupt and terminate up to all the calls being handled by that switch. Fortunately, carrier grade switches are designed to make such an event extremely rare.

More likely, a component of the switch would fail. E9-1-1 callers would not notice many component failures, for example an SS7 "A" link SILT card failure.

More obvious would be the total failure of a DS1 port, the consequences of which would be identical to the failure of the DS1 system itself.

The Siemens switch, as is typical of carrier-grade switches, is self-monitoring and performs many self-tests both automatically and upon operator command. Both internal and external failures that are detected (including high bit error rate "soft" failures) will cause the associated facility to be disabled and external alarms raised.

For example, if a DS1 facility begins to exhibit excessive slips, bi-polar violations, or sync pattern problems, the switch will automatically place the interface in a blocked state and raise an alarm. Placing a system in a blocked state does not terminate active circuits on the facility, but will prevent idle circuits from being used until the facility is repaired and the operator manually restores the interface to service.

4.2.4.2 G-2 and G-3 IP System Configuration and Architecture

The G-3 IP architecture is essentially that of figure 1.4. (See page 15.)

The right-hand sides of figures 1.3 and 1.4, from the gateways on, are identical.

In these solutions INdigital will use IFN to provision a DS3 loop around the state to a number of connection points. This loop will be the "Backbone" of the IP network. Again, the IFN facility insures that the DS3 loop is diverse and protected.

The IP network consists of:

? The very high-speed (DS3) private IP "backbone" transported on a fiber ring.
? Dual DS1 connections to each PSAP site for redundancy. The DS1s are daisy-chained from PSAP to PSAP in short chains.
? The ends of the DS1 chains terminate on the fiber backbone or at a point in another chain. The resulting topology is a "mesh." See the right side of figure 1.3 or 1.4 for the concept. Note the PSAP in the middle of a "chain."
? QOS features on the IP network assure bandwidth-on-demand availability for high-quality voice grade service
? Unsurpassed bandwidth and scalability.

Figure 4.6 shows a possible layout of the G-2 / G-3 IP network.

The red lines represent the IFN DS3 backbone. The blue lines are DS1 chains. Yellow lines are DS1's provisioned through an IXC.

[Map redacted for security reasons]

Figure 4.6 G-2 / G-3 IP network to Central Offices

Figure 4.6 shows DS1 connections to all central offices required to access all PSAPs, except for offices in the Gary and Indianapolis areas, which were omitted for clarity.

The local drops to each PSAP are not show. Some offices serve multiple PSAPs.

The DS1s do not interconnect at the C.O. Rather, they extend through the C.O. to the PSAP and then back and then continue to the next PSAP or C.O. in the chain.

The longest chains traverse eight PSAPs. The average chain is about 6 PSAPs.

Several lines that appear to end without closing a chain are, in fact, two DS1s that loop back, but due to the scale of the diagram are not evident.

The layout presented represents an attempt to use known high-quality DS1 facilities (such as fiber, where we know it exists) in a cost-effective way, while preserving the goal of high reliability achieved through diversity and redundancy. Some changes to this plan will occur in an actual implementation as provisioning realities become evident.

A list of the exchanges comprising the DS1 chains show in figure 4.6 follows. All “joins” are additional T1 connections to the Cisco routers at PSAP sites.

[Table redacted for security reasons]

DS1 chains

[Table redacted for security reasons – continued]

PSAP Site Equipment

The following diagram displays the termination equipment at a typical PSAP site.

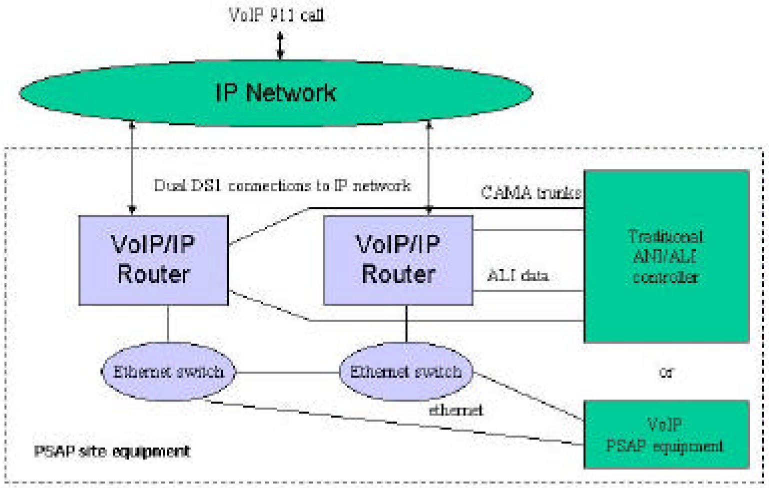


Figure 4.7 - Typical G-2 / G-3 IP PSAP terminations

Note that each of the two (or more) DS1s terminated at each PSAP site connects back to the backbone ring via two separate DS1 paths. See Figure 4.6.

Each PSAP will be equipped with redundant Cisco routers, with each router terminating one of the first two DS1s. Redundant ethernet switches interconnect the routers. The failure of any single device is the equivalent to a failure of either DS1 system, which is discussed in this section below.

If the PSAP CPE requires conventional CAMA trunks, the Cisco routers will be equipped with CAMA VIC or FXO VIC2 cards. These cards were designed to provide 8 or 10 digit ANI spills to conventional 9-1-1 routers and controllers from a VoIP network. These interfaces are discussed further in section 4.2.5 below.

Conventional ALI delivery is available from the router's RS-232 AUX ports.

If the PSAP can support IP telephony (even with a single IP telephone such as a Cisco 7960 or equivalent, no other equipment required) then that phone can be connected to one of the ethernet switches. In the G-3 IP proposal, such a phone could simply become an extension on the private statewide phone system, as well as a potential PSAP terminal. This will also be discussed in section 4.2.5.

In other words, the G-3 IP system is more than an E9-1-1 system. It is a complete private telephone system, and more.

Bandwidth and system capacity, G-2 and G-3 IP proposals

Potentially, any PSAP site has up to 3 Megabits of bandwidth available, if all the PSAPs sites between them and the backbone are idle.

Allowing about 80K for a high quality voice channel, each PSAP has a potential for up to 40 voice circuits without any over-subscription of bandwidth.

Based on INdigital's experience with sharing voice and data in a packet network where "silence suppression" is used, nearly 2 Megabits of data bandwidth will still be usable at a PSAP site, even if all voice channels are in use. This happens because both sides of each voice channel are not normally in use at the same time, and because there are pauses in conversations, which dynamically frees up bandwidth.

In reality, the voice bandwidth can be over-subscribed nearly 50% without detectable degradation of voice quality, and several hundred kilobits per second of data will still get through.

The voice capacity of the network doubles if the voice bandwidth is dropped to 40K bits per second. This is still very good quality voice. Many cell phone systems use the equivalent of 16K voice, so the proposed G-3 IP network voice quality would still significantly exceed the available cell phone voice quality.

Other PSAPs on the same daisy chain share this 3 Megabits of bandwidth.

Assuming a worse case situation were all PSAPs are busy, and where there are eight PSAPs on the chain, at least 5 full bandwidth (80K) voice channels are available per PSAP with 250 K bits / sec data per PSAP, without voice channel over-subscription. Such a worse case situation would be an extremely rare event, considering that most rural PSAPs can handle a maximum of two calls at a time, and that most hours are busy only for a few minutes per hour.

The effect of a single failure of a DS1 or terminating equipment would be, worst case, to reduce the above bandwidth numbers in half. In most cases, this would not be noticeable anywhere in the system, except on the network monitoring point(s).

Note that a DS1 failure in the G-2 or G-3 IP solution would not likely interrupt any active calls, including calls passing through the failed DS1. The EIGRP routing protocol would quickly redirect the VoIP packet stream through the alternate path(s) to the PSAP, and the conversation could continue. Most VoIP devices will not drop a call due to a temporary interruption of the packet stream.

Two DS1 failures in the same chain could isolate the PSAP(s) located between the failures. This is quite unlikely, except between the PSAP site and the local Central Office, where both DS1s are likely to be provisioned in the same cable pair. A cable cut between a Central Office and a PSAP will likely “get” both DS1s, but isolate only that one PSAP, and not likely effect other PSAPs. Note that this problem exists in almost any solution, unless two or more circuits can be provisioned diversely between the PSAP and the Central Office.

If a daisy chain terminates both ends at the same location on the backbone ring, two routers and ports will be provided to interconnect to the backbone. This prevents a single point-of-failure at the backbone connection.

4.2.4.3 Example of 9-1-1 Call Processing in the G-3 IP Network

The following should help clarify how the G-3 solution works. Figure 1.4 is reproduced below to assist in identifying network elements in the following discussion.

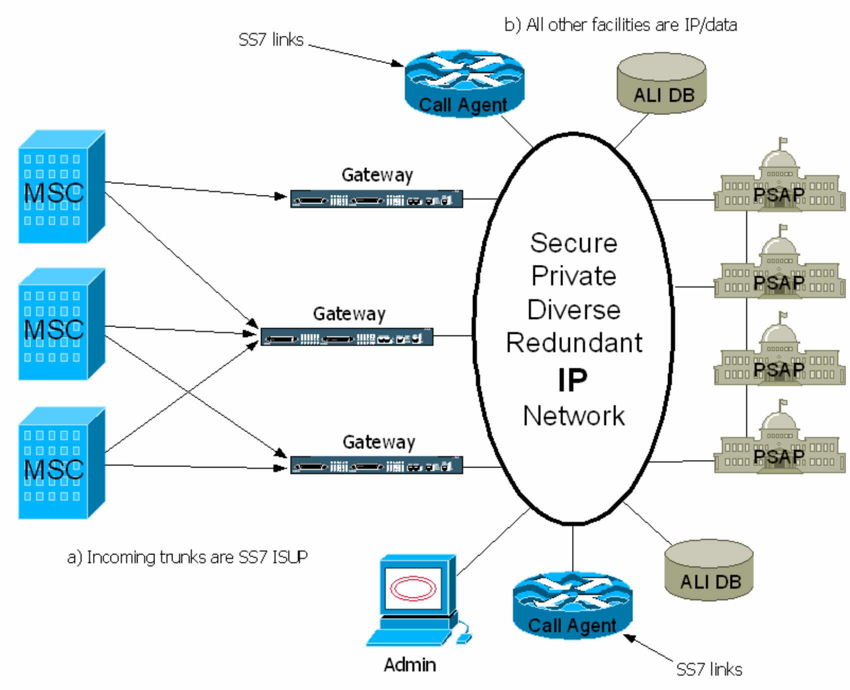


Figure 1.4 Proposed G-3 Network Components

Suppose an MSC receives a 9-1-1 call that must be connected to a PSAP.

The MSC generates an SS7 ISUP Initial Address Message (IAM) that the SS7 network delivers to the appropriate call agent for processing. All SS7 ISUP messages contain a trunk identification code (CIC) that associates each particular SS7 message with a particular bearer channel facility.
If a call agent is inoperative for any reason, the SS7 message is automatically sent to the redundant agent. This is a function of the SS7 network. This IAM message is the identical mechanism the MSC uses to connect "normal" calls to the PSTN via ISUP trunks.

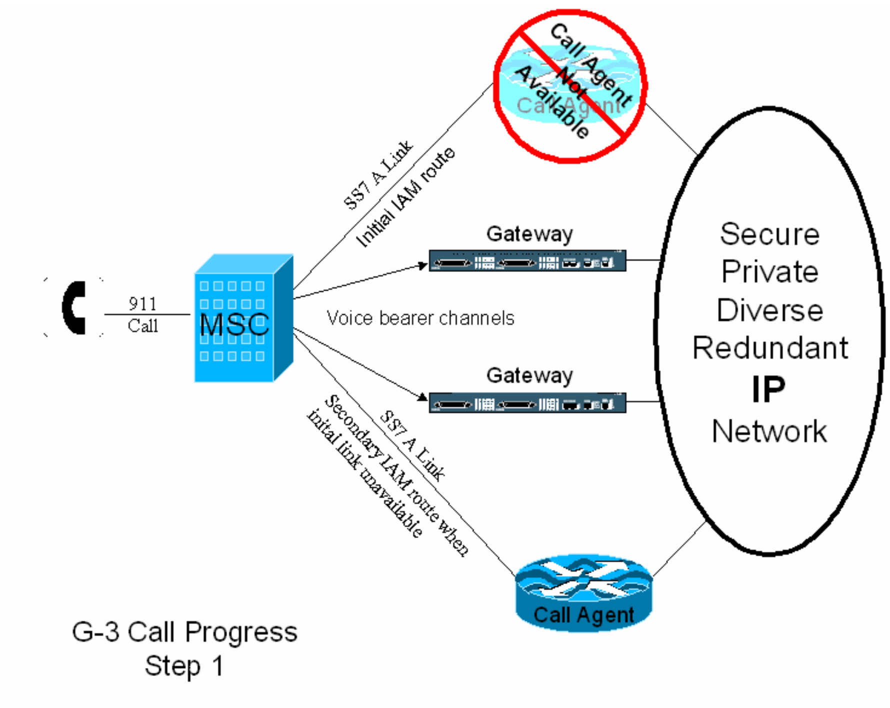


Figure 4.8

The IAM message contains information such as the called party number, which in the emergency case is the number "9-1-1" itself. It also contains the calling party number, which in the emergency case is the pANI number that routes the call.

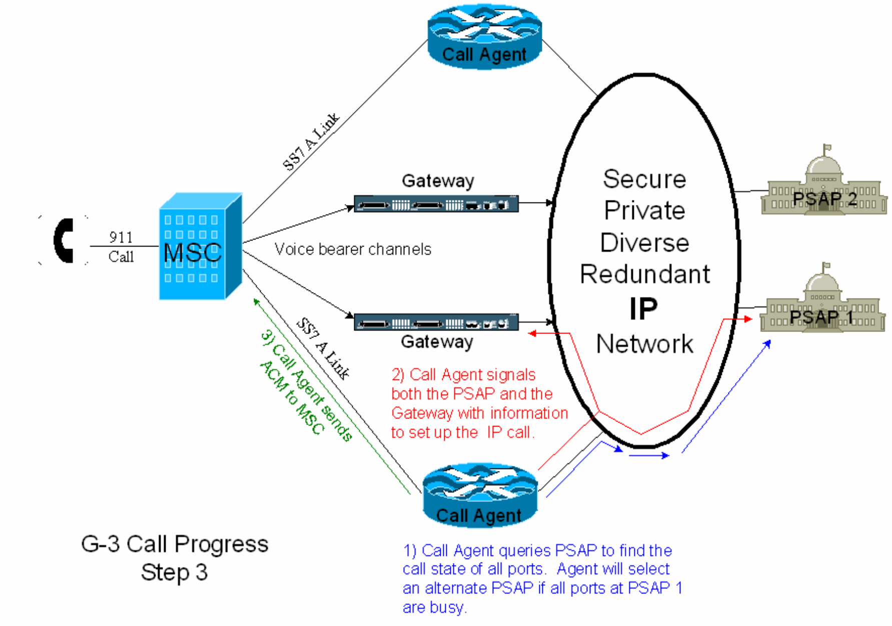
If lat/long location information is available with the call, the call agent looks up the PSAP associated with the caller’s location by using technology provided by MapInfo Corporation. (Location-based routing.) If Lat/Long is not available in a timely fashion, the call agent looks up the pANI in the 9-1-1 routing database and determines the PSAP that should receive the call.

[Figure containing INdigital Intellectual property redacted.]

Figure 4.9

The call agent then checks if an idle port is available at the destination PSAP. If all ports at the PSAP are busy or the PSAP is not reachable, the call agent selects an appropriate alternate PSAP.

When an idle port is available at the PSAP, the call agent sends IP call control messages, (such as SIP or MGCP, depending on the protocol in use) to the gateway and to the PSAP. These messages contain the IP address of each endpoint in the IP network for the bearer traffic. They also set the phone to ring at the PSAP.



3) Call Agent sends ACM to MSC

2) Call Agent signals both the PSAP and the Gateway with information to set up the IP call.

1) Call Agent queries PSAP to find the call state of all ports. Agent will select an alternate PSAP if all ports at PSAP 1 are busy.

Figure 4.10

The call agent also sends an ISUP Address Complete Message (ACM) back through the SS7 network to the originating MSC. This tells the mobile switch that the destination phone is ringing.

When the phone is answered at the PSAP, the call agent sends an Answer Message (ANM) back through the SS7 network to the originating switch, and sends any necessary call control messages to the PSAP and gateway to complete the call.

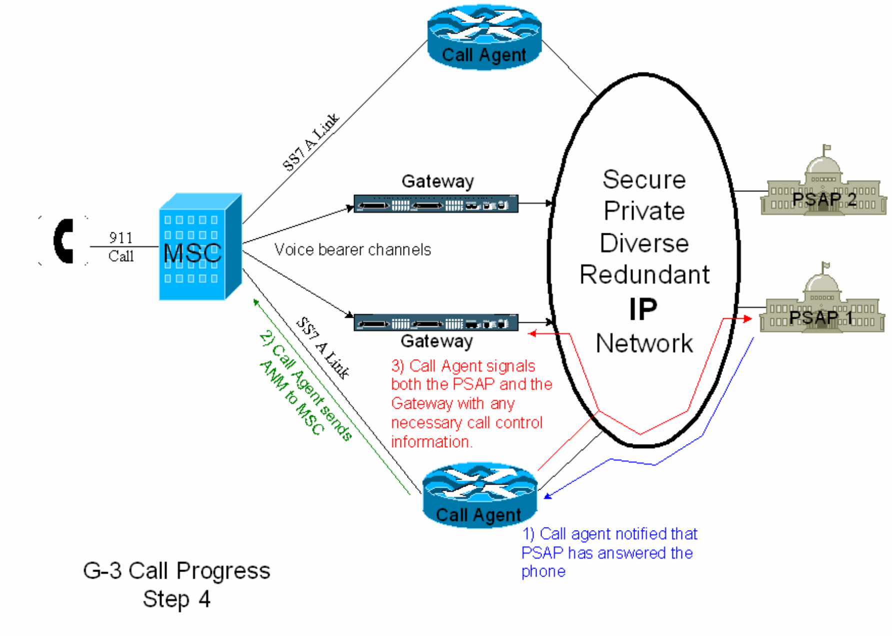


Figure 4.11

At this point, the call is in progress, and may proceed without any further action on the part of the call agent. The bearer path is from the MSC to the gateway over a T1, then via the IP network to the PSAP equipment. Again, the bearer path does not include the call agent.

If the call agent were to fail at this point, it would not have any impact on the existing calls in progress, as the call agent is not involved in maintaining the bearer path.

The call agent becomes involved in the call again only when the call is terminated, or if the PSAP indicates it wishes to conference or transfer the call with another site. When these events occur, another series of signaling messages are exchanged with the various elements involved with the call, that is, the PSAP equipment, the gateway, or the originating switch. The call agent completes these functions, then again drops out of the call process until another action is required.

4.2.5 Trunking

All of our solutions are designed to support SS7 ISUP and ISDN PRI trunk types.

The G-1 and G-2 solutions will support any additional trunk type supported by the Siemens EWSD switch.

As a Class 5 switch possessing Class 4 features, this includes an extensive range of CCS (common channel signaling, or SS7) and CAS (MF signaling) types common in the telephone industry, such as Feature Group C, Feature Group D, tie trunks, end-office to tandem trunks, operator trunks, etc. The EWSD supports more than 150 trunk types. The EWSD translates the signaling between the trunks in appropriate ways for the PSTN network.

However, the EWSD has limited support for traditional 9-1-1 CAMA MF trunks. The only 9-1-1 types presently supported are incoming or outgoing two stage 8-digit 9-1-1 CAMA trunks, and the NPD value must be zero. That is, the signaling on these trunks is of the form:

KP 911 ST   KP 0 NXX-XXXX ST

The second stage can be invoked either by a second wink or by a loop seizure.

This means the EWSD can provide limited backward compatibility to 9-1-1 CAMA signaling, the main restriction being that all traffic on a specific 9-1-1 CAMA trunk group must share a common NPA code.

Since the G-1 and G-2 proposals do not plan or anticipate any CAMA connectivity to the EWSD, we do not see this as a significant restriction.

Siemens will provide quotations for software modifications to support additional trunk types on the EWSD. Such changes can be relatively expensive.

The G-3 IP proposal will support any TDM trunk signaling type supported by the [redacted] and the Cisco AS 5350 Universal Gateway combinations. The universal gateways generally support switching between:

? SS7 to PRI, PRI to PRI, and PRI to SS7
? SS7 to CAS, and PRI to CAS
? CAS to CAS
? TDM to VoIP

See the Cisco documents included in Appendix A.

The Cisco AS 5350 Universal Gateways are software controlled devices that, in principle, can be programmed to handle about any type of in-band analog signaling desired, not limited to MF and DTMF. They can perform announcements, provide IVR (integrated voice response) features, and dynamically respond to VoiceXML documents. For example, we have seen a universal gateway used to implement a "time and temperature" announcement using inputs from a web server.

(Think of the possibilities for 9-1-1. For example, a PSAP might post announcements related to certain events, such as an evacuation, accident at a certain location, etc., and quickly transfer callers to that announcement, all administered via a web browser. However, we have limited experience with these devices at this time, and such schemes out outside the scope of the RFI.)

Page [redacted] document lists PSTN signaling and protocol support. In short, the [redacted] can convert just about any type of SS7 or ISDN signaling to one of these VoIP protocols: MGCP (Media Gateway Control Protocol), H.323 (an older VoIP control protocol), or SIP (Session Initiation Protocol).

The only occasion we expect to do CAMA signaling would be to interconnect to a legacy ANI/ALI controller that cannot support ISDN. In order to generate CAMA signals, we will use the Cisco VIC2 FXO card in the Cisco router, which can generate several common E9-1-1 MF CAMA strings, including:

KP NPD NXX-XXXX ST, and
KP 0 NPA-NNX-XXXX ST,

in response to VoIP control protocol commands (such as H.323.) See the Cisco VIC2-2FXO document in Appendix A for further details.

This gives the G-2 and G-3 IP solutions the ability to output-pulse traditional 9-1-1 CAMA signals for interfacing to legacy equipment or external 9-1-1 systems.

4.2.6 Scalability

We see no practical scalability limitations with the Siemens EWSD based selective router. The EWSD can be expanded to accommodate hundreds of DS1 connections, and hundreds of thousands of individual DS0s. The EWSD and the E9-1-1 SCP can connect more than twenty calls per second each router, and maintain cross-connects for tens of thousands of calls at a time. In normal daily operation, these switches operate at well below 10% of their capacity at all times.

We also see no practical scalability limitations with the G-3 IP solution. If more incoming trunk connections are needed, add more gateways. If more bandwidth is needed, add more DS1 facilities. If the backbone becomes a choke point, upgrade the backbone to OC3. If the SIP proxy server is overloaded, upgrade the hardware platform to a higher speed processor or install additional proxy servers.[7] This system

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[7] The call agent configuration should be able to support many times the expected call volume. We do not anticipate a need to upgrade these devices before they are rendered obsolete by newer solutions.

may be expanded incrementally for at least an order of magnitude (and more likely two orders of magnitude) before serious architectural limitations become apparent.

4.2.7 Improved Quality of Service

We expect both solutions will provide improved call setup time by replacing the existing MSC to SR CAMA trunks with SS7 trunks. The G-3 solution offers sub-second setup time all the way to the PSAP or ANI / ALI controller, unless location-based routing is employed. If the ANI/ALI controller can accept ISDN connections, this should result in a further improvement of call setup time.

The G-3 IP system is location-based routing capable, which should provide a significant payback in quality of service by getting the call to the correct jurisdiction the first time.[8]

However, location-based routing is constrained by the speed with which the carrier's PDE system can determine the position of the caller. The MapInfo server can be programmed with a maximum time for which it will wait for position information before releasing the call. The maximum delay is an administrative policy decision.

Location-based routing may enable some PSAPs (typically, municipalities) that are secondary PSAPs today with respect to wireless E9-1-1 calls to become primary PSAPs, since the routing decision would not be constrained by cell tower face.

4.2.8 Transfer of Wireless E9-1-1 Calls

All our proposals have the switching capability for statewide (and even national) transfer, and for the regeneration of ANI when transferred to ALI capable equipment.

We do have concerns about implementing statewide transfer with existing equipment. Full statewide transfer may not be feasible with the present mix of equipment

The G-1 and G-2 solutions will implement a 3 or 4 digit private Centrex-like dial plan on the EWSD to provide a statewide transfer capability.

The G-3 IP solution will also implement a 3 or 4 digit private statewide dial plan on the SIP server. There is additional signaling flexibility in the VoIP solution.

Transfer in G-1 may be hampered by the ability of existing PSAP and ILEC routers to "pass up" transfer requests.

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[8] We are aware that some wireless carriers may be implementing Phase II location based routing today, by choosing a pANI based on position information determined before the call is forwarded to the ILEC router. Our proposals will support this scheme, but G-3 IP can also support location-based routing for other carriers that choose to route based on cell tower face only.

More problematic is that the ILEC router must be able to generate at least a 3-digit dial string. This will likely be a significant problem for the CML ILEC routers and for some PSAPs. Our concern is that the present CML routers will not support any outbound digits other than "*xx" on the PRI.

This would limit the dial plan to a maximum of 100 PSAPs. An overlapping dial plan might support a regional transfer capability, but frankly, we are quite uncertain about being able to set this up without encountering unexpected limitations.

In G-2, if the PSAP equipment can hook flash and then generate DTMF tones from an operator keypad while connected to a 9-1-1 caller on a CAMA, BRI, or PRI trunk, we believe we can implement a statewide transfer feature with the proposed system.

Transfer in G-3 IP would be similar to G-2, but we may also be able to support systems that cannot hook-flash, by decoding an extended key-press during the call.

If the PSAP is equipped with IP phones, conference or transfer to another phone in the network is simply a "standard" VoIP network function, similar to transfers on a traditional PBX or key system.

4.2.9 Operating Expense Reduction

As suggested in the RFI, all solutions provide a substantial DS1 facility reduction between the MSCs and the SRs over the present system.

Instead of dually connecting to up to 14 selective routers, each of the 14 MSCs connects a single DS1 to two selective routers or two of four gateways. The total incoming DS1 count is reduced from near 200 to about 32. Indeed, the G-1 proposal can be viewed as essentially a trunk consolidation scheme.

In the G-1 proposal, 28 new DS1s are needed to connect the ILEC selective routers, and there are two new DS1s between the two new wireless selective routers. The result is that the G-1 DS1 count is about 25-30 percent of the existing system.

Also, the number of ports on the ILEC selective routers is reduced, as are possible DACS charges at the ILEC routers.

These savings are reduced by the cost of operating the new selective routers. Approximately 32 DS1 interfaces will be required on each EWSD. Budgetary pricing for the G-1 solution is in section 5.

It is not unreasonable to expect a saving on the order of $100,000 per month with the G1 solution.

The G-2 and G-3 IP proposal will replace nearly 200 DS1s with approximately 32 incoming and 200 IP network DS1s, so the total DS1 count is increased about 15%.

However, the DS1s distances will be quite a bit shorter, so the net DS1 cost will be reduced.

In the G-2 and G-3 solutions, all ILEC SR connection charges are eliminated. Also eliminated are present dedicated wireless PSAP trunks, nearly all dedicated wireless ALI circuits, and ILEC wireless ALI charges.

This is offset by the cost of the IP backbone network, the cost of maintaining the network equipment, the operating costs of the SRs or the call agents, the ALI system, the network monitoring system, and services and support.

INdigital does not have access to all present costs, so it is difficult to estimate the impact of a G-2 or G-3 IP solution. We hope the final figure for the G-2 and G-3 IP solutions will provide a modest savings. However, we believe these solutions offer a tremendous improvement in value for the citizens of Indiana.

In particular, the G-3 IP solution brings a number of value-added features not normally present in a 9-1-1 solution. For example, the SIP proxy and the [redacted] are capable of much more than simply being a 9-1-1 router.

Depending on PSAP equipment, the G-3 IP system implements a full, statewide private, and reliable telephone system between the PSAPs. That is, a PSAP could originate a call to another PSAP over the G-3 system without impacting its 9-1-1 capability, or using the public switched telephone network. This could be a valuable asset in daily operations as well as during certain types of emergencies.

Indeed, to access the full benefits of the G-3 IP solution will eventually require additional or replacement equipment at PSAP sites. The good news is that we believe this equipment will be significantly less expensive than traditional E9-1-1 equipment. For example, we can simply add an IP telephone set at each dispatcher’s position, and gain the statewide calling capability, among other things. Present market prices for such telephones are $100 to $350 each, depending on features.

With IP telephones with a sufficiently large LCD display (the $350 model) a server added in the G-3 IP network could “push” data, including ALI data, to the telephone’s display. This can be a simple and inexpensive work-around for PSAPs who chose not to use present equipment for the new wireless solution.

Many PSAPs already have quality LANs and PC systems in place that can avail themselves of new possibilities and applications as they are implemented on the G-3 IP network

4.2.10 Congestion

We identify two choke points in the system. The first is the dispatch center itself, that is, the number of operators available to handle calls. The second is the facilities between the MSC and the wireless selective router or gateway.

Our G2 and G3 IP proposals can deliver multiple wireless calls to a PSAP up to the number of trunks provisioned for the site. In other words, if the PSAP wishes to accommodate four incoming trunks, then the selective router can deliver a maximum of four concurrent calls to the PSAP. How those calls are handled at the PSAP (e.g. put in queue or not answered) depends on PSAP operational policy and equipment.

No queuing of calls at or by the wireless selective router is provided for in the G-1 and G-2 proposals.

Call queuing by the call agent is a future possibility in the G-3 IP solution, when working with totally IP-based PSAP CPE. The IP world provides the opportunity for a wealth of new call handling processes not generally available with traditional equipment.

If all trunks to a PSAP are busy, are inoperative, or are not answered (seized by the PSAP CPE) within 20 seconds, then the selective router or call agent will redirect the call to an adjacent PSAP according to an overflow plan. Such redirections can occur an arbitrary number of times, finally terminating on an announcement.
The overflow plan could be specified on a trunk group by trunk group basis.

Concerning the MSC to SR trunks: We would expect the wireless carrier to divide the incoming trunks into multiple groups, with each group associated with a smaller number of PSAPs, such as a region of the state.

The wireless carrier will determine the action taken when a trunk group is filled.

The reason for dividing the incoming trunks into groups is so that an incident at one part of the state could not tie up all facilities and prevent wireless calls in other regions from being handled.

The present wireless E9-1-1 implementation in Indiana uses MSC trunk groups to choke incoming traffic. We anticipate continuing to use this scheme in the short run, although on a slightly larger scale.

4.2.11 – 4.2.12 IP and Cable Telephony

Both VoIP and Cable Telephony technologies are emerging, particularly with respect to E9-1-1 practices and standards. In fact, the transport system for most Cable Telephony systems is packet-based, and is commonly VoIP. The issues are likely to be quite similar, so we address both of them here together.

There are several choices for VoIP / Cable Telephony support, depending on the method(s) the provider selects to implement E9-1-1.

If a provider chooses to imitate a wireless Phase II provider, then they can access any of our proposed solutions in the same way as any wireless carrier. That is, the provider can trunk to the selective routers, send a pANI to route to a PSAP, and use a ALI database provider such as Intrado, TCS, or provide their own ALI database.

However, “native” VoIP support is easily added to the G-3 IP proposal.

The key element is to add a proxy gateway between the service providers network (which could be the Internet) and the G-3 IP network, as shown in figure 4.12. Of course, this gateway should be implemented redundantly and diversely.

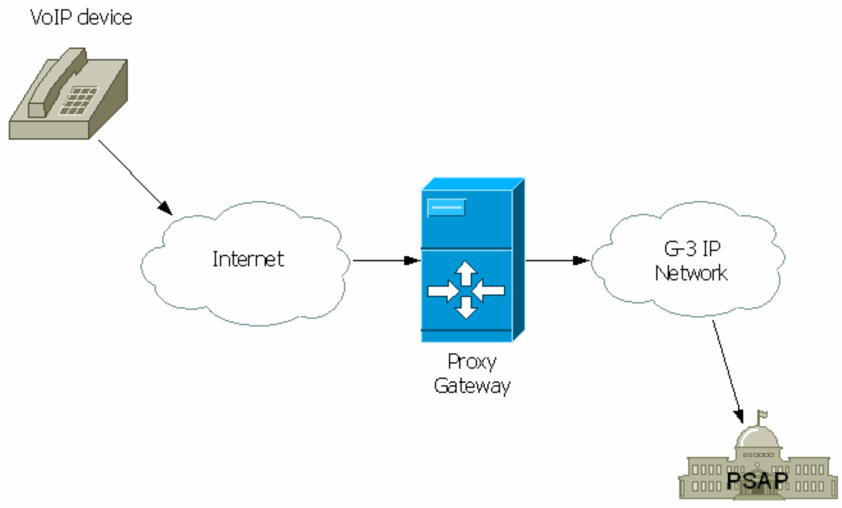

Figure 4.12 - Proposed G-3 IP proxy gateway

The purpose of the proxy is to provide security for the G-3 IP wireless E9-1-1 network. Only the proxy's "outside" IP addresses and ports would be exposed to the outside network. To the Internet, these gateways would appear to be another VoIP device. It would not be possible to "ping" or access any internal address in the G-3 IP network, or to send arbitrary messages into the network. Only VoIP protocols and E9-1-1 messages would be recognized and accepted by the proxy.

Additional gateways could provide similar connections to additional Cable Systems or VoIP networks as needed. The number of gateways is not constrained.

Routing in such a system would either be by a pANI provided by the service provider or by a latitude/longitude, likely provided by the calling device. The call setup information would include at least one of these values.

We believe that in these systems the calling device will ultimately provide the ALI data, rather than a separate ALI database. The ALI data will probably be in the form of a geographic location (latitude / longitude) but could be a street address. This data will be exchanged between the caller and the PSAP using IP protocols, such as XML. This exchange can occur over the same IP infrastructure that provides the voice path between the caller and the PSAP.

VoIP E9-1-1 protocols and practices are still under discussion by NENA, VON, and other interested parties in the public safety industry. However, our G-2 and G-3 infrastructures use standard VoIP technologies and protocols, and our G-3 IP proposal has a great deal of capability already in the proposal in the form of the [Redacted] SIP proxy, and our ALI steering system described in section 4.4.

Our business partners are dedicated to the implementation of VoIP E9-1-1 systems, and INdigital has no doubt that they will be willing to work with us to implement new standards as they emerge.

Much of this discussion can also be applied to telematics and other non-traditional communications systems.

Clearly, the G-2 / G-3 IP infrastructure would put Indiana in a leadership position in implementing these new E9-1-1 technologies.

4.3 Selective Router / Database Facilities

4.3.1 – 4.3.3 Security, Monitoring and Logging

The proposed INdigital router and database facilities (the facility) will adhere to generally accepted standards for telecommunications central office construction. Where physically feasible the facility will be secured with fencing to limit accessibility and provide a secure perimeter.

INdigital monitors the facilities [redacted for security reasons]. Video files are archived daily to a backup storage server. Further, video files will be archived weekly to compact disk and stored off site in a secure storage facility.

Access to the facility premise is controlled by swipe card controlled access which operates the door locks and logs the name of the person to whom the card was issued as well as the date and time the card was used. The system also logs the entry door used to access the facility so if necessary the logs can be cross-referenced to the video file archive to verify the identity of the person using the card. The system logs will be archived daily to a backup server for storage and transferred weekly to a compact disk and stored off site in a secure storage facility.

The facility will be alarmed for fire and intrusion detection and this system will be monitored 24x7 by an external security provider. The fire and intrusion detection system will also maintain logs which are archived daily to a backup server and transferred weekly to compact disk and stored off site in a secure storage facility.

4.3.4 Emergency Power

INdigital proposes that the Selective Router/Database will be supplied with backup power similar to that commonly found in a telecommunications central office. Backup power will consist of a string of DC batteries capable of maintaining system operations for eight (8) hours if the facility is cut off from shore power. The batteries will be backed up by an on site diesel powered generator capable of maintaining facility operation for a minimum of Seventy-Two (72) hours. The facility will be equipped with an external connection where a portable generator can be attached in the event that on site backup power systems should fail.

Where possible, equipment within the facility will run off of –48V DC power supplies. The facility will also be equipped with power inverters capable of converting –48V DC to 120V AC in the event that some equipment will run only on standard AC current. In that way, the facility will be under power at all times through the DC batteries. In the event of a power failure the batteries will continue to supply power to the equipment running on both DC and AC current.

When a power failure is detected, a switch will close which will allow the diesel generator to start automatically. In the event that the generator fails to automatically start, it will be equipped so the engine can be started manually. Once the generator has started, a transfer switch will automatically engage and allow current to flow from the generator to the facility. If the transfer switch fails to automatically engage it will be equipped so that it can be engaged manually. The facility will also be equipped with a secured, weather tight connection mounted in the outside wall, which will allow a portable generator to supply power in the event that the on site generator fails.

Once shore power has been restored by the local utility, the transfer switch will automatically begin drawing power again from the local utility. Once the facility power is fully restored to shore power, the on site generator will automatically shut down.

INdigital exercises the generator once a week for 30 minutes to ensure that all of the emergency power systems are functioning properly.

4.3.5 Redundancy and Diversity

The facility is connected to the proposed network resources by a DWDM Fiber ring. The proposed IP network backbone will be provisioned on a SONET ring, which by the nature of SONET technology is redundant. If one half of the ring is damaged or cut, the active path of the circuit automatically switches to the standby side of the circuit.

[Text redacted for security reasons]

4.3.6 Environmental

The property on which the facility was constructed passed a phase I environmental site assessment. Copies of the report can be made available upon request. The building itself is situated on two acres of ground with the closest neighboring building approximately 300 ft away.

4.3.6.1 Fire

The exterior of the building is steel and concrete construction, which will minimize exposure to fire from outside sources. It is a non-smoking facility and is fitted with a fire detection system to protect the facility from interior sources of fire.

4.3.6.2 Flood

The facility was not constructed in a flood plain. The property is equipped with a retention pond and an adequate tile system to keep surface water from accumulating.

4.3.6.3 Hazardous Materials

The facility is only exposed to those hazardous materials necessary for normal operations.

Diesel fuel for the on-site generator is housed in its own cement block room separate from the central office. Access to the generator room is through its own exterior entrance. The generator room cannot be accessed from the interior of the building.

The lead-acid batteries are well maintained and kept separate from the functioning electronic equipment in the central office.

4.3.6.4 Other Situations

The facility is situated in a rural setting. This minimizes exposure to hazardous situations by keeping the site isolated from other buildings and traffic. Although the facility is physically isolated, it is located close enough to the urban area that it enjoys very easy access to the fiber facilities of a number of different carriers.

4.3.7 Lightning Protection

The facility is protected from lightning incursion using generally accepted grounding and lightening protection practices.

AC shore power entering the building is protected against lightening using a Northern Technologies surge protector.

The building exterior is protected with lighting spikes, which are bonded directly to the building ground field using 2/0 cable.

The facilities water service pipe is also bonded directly to the building ground field through the master ground bar.

Copper cable entrance to the building is limited to a single cable providing local telephone service through the ILEC. This entry cable is bonded directly to the building ground field.

All other communications in and out of the building occur over fiber optic facilities.

4.3.8 AC Power Installation and Labeling

The facility is constructed according to applicable electrical codes and good practice. The installation is typical of telephone company facilities. Isolated ground outlets are used extensively through out the equipment rooms, and identified by code-specified orange coloring. Equipment room outlets are labeled with circuit numbers to match distribution panel labeling.

4.3.9 Grounding

Geotech, Inc., 4900 Cascade Road S.E., Grand Rapids, MI, designed the facility grounding system.

The facility is equipped with a ground field. A 2/0 copper wire surrounds the facility buried approximately 36” below grade. 10’ copper rods are CAD welded to the wire at 20’ intervals and extend downward into the ground. The wire is bonded to a master ground bar located in the central office.

A master ground bar serves as the common connection to ground. Structural Steel, AC Power, Water Service pipe, as well as doorframes and all equipment grounds are bonded to the master ground bar.

Comment: Insert an explaination how this system will provide protection against ground looping and ground fault problems.

A post construction test by Geotech, Inc., measured (meggered) the Central Office Ground Field at 0.39 Ohms. The Multi-Grounded Neutral (MGN) of the commercial power meggered at 0.33 Ohms.

Drawings of the facility grounding system can be supplied upon request.

4.4 ALI system

INdigital’s proposed ALI system will support Phase I and Phase II wireless ALI as required by current FCC orders and rulings.

Our proposed solutions expect wireless carriers to deliver calls to the network via CCS/SS7 trunks. The proposed systems will utilize standard information elements in ISUP and Q.931 messages, such as called party number and calling party number, as keys to access ALI information.

ALI information may be retrieved from dynamically created data in external wireless ALI databases, for example, Phase II lat/long data. Alternatively, static ALI records may be retrieved from an external ALI database or the INdigital ALI database. Phase II systems require dynamic ALI record creation.

ALI re-bids, both manual and automatic, will be supported.

Our system will meet NENA-2 requirements, and we will implement newer NENA ALI recommendations as they become available and as is appropriate in the proposed system.

A Datamaster ALI Record Management System is proposed to support maintenance of the ALI database. The Datamaster DBMS will be initially licensed to support up to 100,000 records, which should be more than adequate for all pANI values likely to be used in Indiana. The size of the database license can be increased for an additional fee.

The INdigital ALI system will “steer” an ALI request to an ALI source based on Company ID associated with any ANI or pANI value, or based on another identifier (e.g. IP address) associated with any ANI or pANI value. It will return the reply to the originating ANI/ALI controller or call taker position. If the ANI value is not recognized, that is, not in the database, the steering will occur to a default ALI source configured on an ANI/ALI controller or call taker position basis.

A special capability of the proposed system is the ability to re-format ALI reply messages from each ALI database into a “standard” form for presentation to the query source. This permits a greater degree of uniformity to be obtained. This also eases the task of implementing E9-1-1 to PSAP mapping system, or E9-1-1 to PSAP CAD system interconnections, as well as reducing call taker workload.

The proposed system can handle multiple ALI requests concurrently. It is limited by the ability of external databases to handle such multiple concurrent requests.

All ALI requests and replies are logged with date and time in a form that may be easily retrieved for subsequent examination. A “debug” mode collects additional details to assist in problem resolution that would otherwise fill log files quickly with repetitive and routine data, such as handshake signals.

The design of the ALI software makes modifications, such as inclusion of new data elements and protocols, relatively simple, fast, and inexpensive.

Static ALI data maintained by INdigital will be stored in an SQL-based database.

Seven-by-twenty-four service and support for the ALI system will be available through the same means we service and support other components of these proposals.

4.4.1 ALI Database Configuration

4.4.1.1 Overview

Traditional E9-1-1 systems presume the collection of ALI records into a database. The database can be located at the PSAP site or at a remote service provider site.

These architectures have worked well in the wireline E9-1-1 world, where the ALI records are basically "static." That is, an ALI record doesn't change until a wireline telephone is connected, disconnected, or moved, which is infrequent for any record.

Also, wireline telephones are basic instruments that provide access to the wireline telephone network, but generally do not contain other information or information processing abilities. We sometimes say wireline telephones are "dumb" devices.

Wireless telephones, on the other hand, are mobile devices that increasingly contain considerable information manipulation capability, including the ability to determine where they are located. This information is bound to be more accurate and up-to-date than trying to post the same information into a traditional ALI database. Wireless ALI data is dynamic, rather than (relatively) static.

These same statements are also generally true of emerging communications systems such as VoIP and telematics, which support considerable portability, if not outright mobility. Because of the processing power that these devices contain, they can be described as "smart" devices.

We believe that in the future ALI data will originate from the caller's instrument. ALI databases, as we know them today, will gradually disappear.

The ALI system changes, therefore, from a role of information retrieval from a database, to a role of communicating information from the caller's instrument to the call taker. In effect, the new ALI system is basically an information switch.

But this is precisely what the G-2 / G-3 IP network provides: It is an information switch and a communications system. The "switching" of information by the network is based on IP addresses.

The challenge is to provide interfaces that will allow this network to connect to and communicate with legacy and emerging systems, to perform the required protocol conversions, and to correctly label information packets with IP addresses so that they arrive where they are needed and wanted, accurately, and in a timely fashion.

Our ALI proposal is based on this view. We see our system more as an ALI steering (or ALI switching) system, with protocol conversion, rather than as an ALI database.

However, we do provide a “traditional” ALI database as a component in the system. It appears just as another source of ALI data to the core ALI switch.

4.4.1.2 ANI Delivery

Ultimately, with legacy PSAP equipment, the ANI or pANI is delivered to the PSAP’s ANI/ALI controller (or integrated selective router) serving the PSAP. The ANI/ALI controller then queries the ALI database using the pANI as an ESRK, a process described as a “pull” system. The ANI/ALI controller may then “push” the data to the screen of the call taker who answers the call.

In the G-1 scenario, the pANI is passed on to the ILEC selective router as SS7 or ISDN PRI messages. This is faster than the CAMA signaling that is in use today from most MSCs to the ILEC SR. After the ILEC SR, the signaling is the same as it is today, which is generally CAMA.

In the G-2 system the EWSD selective routers convert the pANI to ISDN PRI. The gateways transmit the pANI over the IP network using either the H.323 or MGCP protocol. For PSAPs that only support CAMA trunks, the pANI is converted back to CAMA by the G-2 / G-3 IP PSAP equipment. See figure 4.7 on page 40 and section 4.2.5.

The G-3 IP system converts the pANI from SS7 to SIP in the [redacted]. The SIP proxy server routes the call and transmits the pANI to the PSAP as a SIP message for an IP capable PSAP. If the PSAP requires CAMA, the Cisco routers at the PSAP converts the VoIP signaling back to enhanced MF signaling.

4.4.1.3 ALI Connections for Traditional ANI/ALI Systems.

Traditional ANI/ALI controllers use 9.6 K serial data connections for the ALI query.

Rather than provision dedicated data circuits for this purpose, our G2 / G3 IP proposals will connect the PSAP ALI connections through the same private, secure IP network that is used to deliver the voice portion of the call.

Each Cisco router at the PSAP sites has an RS-232 AUX port capable of 9.6K serial data communication that will directly interface to a traditional ANI/ALI controller’s serial data ports. This connection is shown in figure 4.7 on page 40. The Cisco IOS supports “raw” telnet IP connections to these ports.

The redundant ALI servers make telnet connections to each PSAP site through the IP network, each ALI server to one Cisco router at each site. This creates “virtual” serial data circuits from the ALI servers to the PSAP equipment through the G-2 / G-3 IP network. See figure 4.14 on page 63. These circuits possess all the redundancy provided by the G-2 / G-3 IP network.

Alternatively, the PSAP equipment can communicate directly with the ALI servers via TCP/IP through one or more ethernet connections at the PSAP site. INdigital will be happy to work with a CPE vendor to provision ALI connections in this way.

Next, we discuss several ALI scenarios for PSAPs that are presently connected to an external service-provider ALI database.

Scenario #1: The PSAP's ANI/ALI controller has additional ALI data ports available and the controller is able to recognize pANI numbers and "steer" wireless ALI requests ports connected to the proposed G-2 / G-3 IP ALI network.

This is the easy case. We connect to the additional data ports, and set up steering. If the call is a wireless call, the ALI request will be steered to the wireless ALI network.

Scenario #2: The PSAP's ANI/ALI controller does not have additional ALI ports, and/or cannot recognize pANI numbers and steer ALI requests.

In this case, wireless ALI must be provided to the PSAP by the wireline ALI database today. That is, the PSAP makes all ALI requests to the wireline database, which then queries wireless databases as needed.

In order to use our proposed ALI system and satisfy the intent of the RFI, the PSAP would need to move its ALI connections to the G-2 / G-3 IP network, and make ALI requests through the Indiana wireless ALI system.

Our ALI system would then forward wireline ALI requests back to the PSAP's traditional ALI service provider, thus inverting the present relationship between "national" wireline ALI databases and wireless ALI databases.

If the traditional ALI service provider owns and/or maintains the PSAP's equipment, then the their cooperation would be required to make this change.

These PSAPs could directly benefit from the *Wireless Direct* effort, because if they receive all ALI through the new wireless network, then they would no longer need their existing ALI connections. These connections are probably provisioned on dedicated circuits that are being paid for, directly or indirectly, by the PSAP today.

Note that a PSAP that falls in scenario # 1 also has the option of doing all ALI dips through the new wireless network, with a similar possible savings.

PSAPs with on-site ALI databases will already be able to separate wireline and wireless ALI requests if they have implemented Phase I or Phase II. We see no significant issue in connecting such sites to the proposed wireless network.

4.4.1.4 G-2 / G-3 IP ALI Architecture

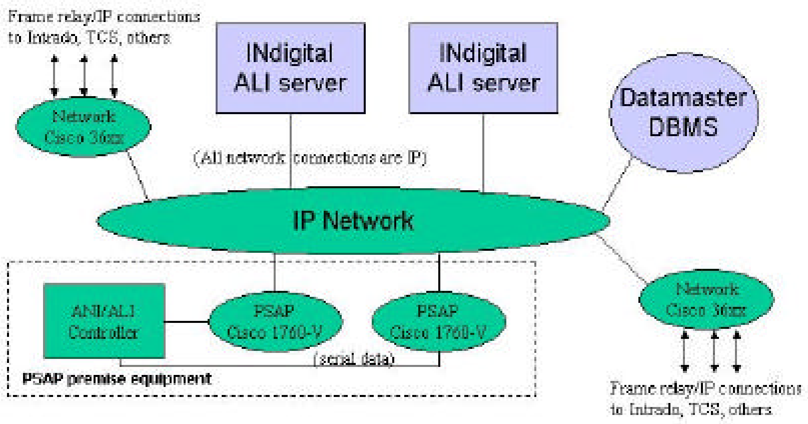

Figure 4.14 - Gen 2 / Gen 3 IP ALI System

Figure 4.14 shows the proposed ALI system.

The ALI system hardware consists of two high-reliability servers located at the selective router/call agent sites on the IP backbone ring. These servers run the ALI communications, ALI steering, ALI formatting, and ALI protocol conversion processes.

These servers will operate in a master/slave relationship. All of the above processes will run on both servers at the same time, and these processes are independent from each other. All processes will read and write the local ALI databases and other persistent data, such as log files, from and to the master server only. If the master server fails, these processes will fall back to the slave server.

The master server will replicate all persistent data to the slave server regularly, so that in a fail-over situation, the standby data will be at most a few hours old.

All changes to the master server will be check-pointed and logged to the slave server. Should a restart or rebuild be required, no information should be lost. A failure could interrupt transactions in progress at the moment of the failure, however. This should be an extremely rare event.

The ALI database and other persistent data are stored in a SQL database.

The Datamaster DBMS can be run from appropriately capable workstations anywhere in the network. The Datamaster software accesses its own SQL database, and produces update files for the running server database. Updates can occur manually or automatically. The Datamaster DBMS application gives administrative access to the ALI database.

4.4.2 Connectivity to Multiple Wireless Carriers and ALI Databases

Figure 4.15 is a logical diagram of the ALI server software processes, excluding the SQL server itself:

[Figure containing INdigital Intellectual Property redacted.]

All external connections are via the IP network.

The ALI server runs a number of virtual terminal sessions. These sessions are the logical endpoints of the “virtual serial data circuits” that terminate on the AUX ports of the Cisco routers at the PSAP sites. These ports are connected to the ANI/ALI controller at the far end.

Other connections are possible. Connections to IP-enabled PSAPs are simply software “sockets” that are assigned to an IP address and port. Other communications protocols can be added as needed.

An ALI request from any of these sources is passed to the ALI steering process. This process looks up the ANI or pANI in the steering database. The steering database is ultimately simply a list of pANI values and pointers to the associated ALI database.

The request is then forwarded to the ALI formatting process, which (at this point) simply forwards the request to the correct protocol process associated with the desired ALI database.

The protocol process creates messages in the communications language of the associated ALI database, and forwards the request to the ALI database. This database can be an external database such as Intrado, TCS, the INdigital local ALI database, or one of several wireline databases. These communications leave the ALI server typically as raw IP telnet messages, but other communications protocols are possible.

The telnet messages from the protocol converter process are assigned to IP addresses to Cisco routers that terminate data links with remote ALI databases. Typically, these data links are IP over Frame Relay, provisioned on 56K DDS data circuits.

The routers simply forward the telnet packets from the ALI server protocol process to the external database. Typically, these connections will be from backbone routers, but they could be made to any IP router located anywhere in the network that is equipped with the correct interface and that is connected to a data circuit to the external database provider. Security policies and network address translation (NAT) can be applied to these links, so that only communications to/from the ALI server process is possible from these external connections.

When the ALI database responds, the reply string is extracted from the communications protocol, such as SALI or E2+, and sent to the ALI formatting process. The formatting process is a simple text editor that interprets a command string that is associated with the particular ALI database. The action is to change the reply string into a “standard” format. In this way, the INdigital ALI system can bring consistency to the PSAP ALI display while processing data from many sources.

After the reply is formatted, it is returned to the steering process, which in turn sends the result back to the PSAP via the correct virtual terminal or communications process that originated the query.

Other ALI databases, such as out-of-state systems, can, in principle, query the Indiana wireless ALI database by a process similar to that used by any PSAP. The number of external ALI databases that can be supported is not constrained.

4.4.3 Data Integrity

The main obstacle to performing re-bids, regardless of the source, is caching of ALI data at some point in the system so that re-bids return the cached value, rather than a refreshed value.

We do not intend to implement this form of caching anywhere in this system. The large bandwidth available should permit multiple re-bids to occur from any source without significant problem or serious impact. We do not plan to “time-out” any ALI record. All ALI records remain accessible until replaced or explicitly deleted.

We believe the previous discussion addresses other data integrity and quality issues, so they are not repeated here.

4.4.4 Dynamic Updates of X, Y

The proposed system supports multiple re-bids to any ALI database. We see no obstacle to supporting dynamic X, Y at any reasonable refresh rate. The proposed system is limited only by the ability of the ALI source to support dynamic X, Y.

4.4.5 Boundaries Data Updates

Standard E9-1-1 ALI database management systems generate ESN values from the MSAG. Making MSAG changes effectively moves boundaries. The Datamaster DBMS product provides for a traditional MSAG, and can generate appropriate ALI database updates that occur as a consequence of an MSAG change.

With regards to wireless ALI, the ALI data record typically comes from the wireless carrier through a wireless ALI database provider. Except for a CAS Phase I implementation, we don’t have much control over the ALI record information content. The ALI record is generated by external sources.

However, a problem area with current wireless ALI for call takers is the listing of emergency responders. This listing is based on association with a pANI or on association with a tower / cell site, if any such listing is provided at all.

The ALI filter function of the ALI server might be adapted to “merging” a local provider record with a remotely accessed ALI record for the purpose of adding emergency responders to the ALI display locally. However, this is not part of our original design.

We also doubt the usefulness of such a scheme in a Phase I environment. The call taker has to determine the exact location of the caller anyway, and then select the appropriate responders according to local policy and practice.

Phase II implementations offer many more possibilities. The location-based routing discussed in 4.2 would be a first step in addressing these issues.

Our MapInfo partners would be willing to address this subject as a part of their considerable line of map-enabled products. See, for example, their proposal for a statewide Critical Area Response Manager (CARM) system in Appendix B.

4.4.6 E2+ ALI Standard

The architecture of the ALI system as described in 4.4.2 above permits it to accommodate a variety of ALI protocols, including J-STD-036 "E2+". We are willing to develop protocol converters for this and other protocols, as required.

This particular protocol comes from an SS7 origin. It is particularly complex, and offers little in return for the effort, unless the ALI provider wishes to provide connections to a wireless ALI database only via the SS7 network, in which case it is the only game in town.

We believe most providers will prefer to implement wireless ALI database connections via simpler interfaces, such as Intrado's SALI interface, which provides all Phase I and Phase II data, and more, at a lower cost. For this reason, INdigital doubts this particular protocol will play a significant role in new implementations.

4.4.7 Quality of Service

The reduced call setup time provided by the use of SS7 or ISDN signaling to the PSAP site speeds the delivery of ANI to the ANI/ALI controller. The sooner the controller obtains the ANI, the sooner it can launch the query to the ALI database.

The ALI system described here was built for functionally and flexibility to meet future needs. It is based on high-speed digital technology throughout. We believe future E9-1-1 developments, such as pure IP solutions, will lead to improved ALI delivery times.

In the present Phase II environment, faster ALI delivery, if done before Phase II data is available, may not be an asset.

INdigital's solution prepares Indiana for the future, while providing the highest quality service within the context of the present environment.

4.5 System Maintenance and Monitoring

The topics covered in this section discuss various issues relating to the installation and on going operation of our proposal. The board should realize that these discussions are a starting point. Even when plans are formalized for implementation, if INdigital is involved in the project, we intend to keep an open mind about how network operations should be conducted.

A solid foundation is essential for on going maintenance and operations. We feel it is equally essential to keep an open mind, so that if a better, more efficient way of doing things is found, we can make changes for the best over all network performance, and ease of use for our customers and our staff.

4.5.1 Contact

INdigital Telecom has technicians on call 24 hours a day, 7 days a week. If a customer needs to speak with someone after hours, they leave a voice mail at our service number. The voice mailbox sends out a page to a technician who then responds to the voice mail as appropriate. Our on call technicians are very conscientious about responding to urgent messages promptly and courteously.

All of INdigital’s equipment is monitored by a computer system that continually polls individual circuits and equipments for their operational status. If a circuit or piece of equipment fails, technicians are notified automatically, with codes that identify the failing item. Often a technician will respond to network trouble before the customer even knows that there is a problem.

All technicians are equipped with a pager and a cell phone, and can be reached throughout the state.

4.5.2 Monitoring

Network monitoring will be accomplished using a combination of Cisco Discovery Protocol (CDP) and SNMP. Cisco Works LAN manager (See data sheet in Appendix A) and other monitoring applications will run on diverse computers located on the network and will automatically notify a technician by pager and e-mail when a problem is discovered.

The monitoring hardware and software will be co-located with other network elements and share the same security, power and network access.

Because G-3 utilizes an IP network, technicians can troubleshoot problems, and dispatch a field technician when necessary, from nearly any workstation that has access to the network.

4.5.3 Maintenance

Preventive Maintenance will be under contract. We propose that field technicians making one site visit per year will accomplish preventive maintenance. Preventative maintenance will follow guidelines set out by the various equipment manufacturers.

Upgrades and scheduled maintenance will be accomplished during a normal maintenance window, to be defined in cooperation with the concerned parties.

Software updates and upgrades will be applied to network hardware only if there are significant reasons for applying them, such as problem resolution, needed feature enhancements, or security issues. If it is determined that updates or upgrades are necessary, they will be thoroughly tested off of the network before being applied.

Application of software upgrades will be thoroughly planned to minimize any impact to the network. All affected parties will be notified a week in advance and again the day of the planned maintenance. The maintenance notice will include a description of the maintenance to be performed as well as the time and expected duration that the network may be affected. All affected parties will be notified again when the maintenance has been successfully completed. Note that the redundant design of the network proposals implies that except in exceptional circumstances, most upgrades can be performed without affecting service.

4.5.4 Response

Once a technician has been notified of network trouble, they will respond as soon as possible. In no case shall the initial response exceed 1 hour.

The technician may contact the person or agency reporting trouble by phone if necessary to obtain more information. After the initial assessment the technician will again call the reporting party to keep them informed of what the trouble is and what steps are being taken to clear it. The lead technician will continue to update the reporting party on progress in clearing the trouble at least once every 4 hours until the trouble is cleared.

4.5.5 Reporting

The agency operating the network will operate and maintain a trouble ticketing system. This system will be used to log all trouble reports and outages.

The ticketing system will be capable of generating reports detailing the number of troubles reported, the agency reporting trouble, average response times and average duration of outages or trouble.

4.5.6 Training

Technical and support personnel will initially receive equipment specific training through the manufacturer or a manufacturer certified trainer. Once the initial staff has been trained on the operation and maintenance of the equipment and the network, the company administering the network will develop internal training standards and requirements that will specifically address the uniqueness of Indiana’s wireless direct network.

New employees beyond the startup staff will be trained according to those standards that are developed. Those standards may include manufacturer certification and on the job training with experienced staff members.

Since the G-2 and G-3 proposals involve the support and operation of a large IP network consisting mostly of Cisco Systems equipment, our initial assessment is that there should be a minimum of two Cisco Certified Network Professionals (CCNP) and three Cisco Certified Network Administrators (CCNA) on staff at all times.

4.5.7 Spare Parts

The network administrators will develop a database to maintain detailed information about all of the equipment installed in the network. The database may be associated with the trouble ticketing system or other network operations software packages.

The database will contain specific information including equipment serial and model number, software revision level, card or module revision numbers, etc. The database will also contain in-service dates and an ongoing log of maintenance and upgrades.

An associated database of spare parts will also be maintained. Work orders will be generated for any maintenance or upgrades performed on network equipment and the database will be updated each time spare equipment is used. A report will be generated which will notify operations management and purchasing personnel when spares have been used and need to be replaced.

Spares will be strategically located throughout the network so that they are easily accessible. The location of spares will also be tracked through the spares database.

The spares inventory will be considered in all maintenance and upgrade planning to ensure the compatibility of all cards and modules with any software or hardware changes.

4.6 Training

Dissemination of information and allowing discussion about the proposed network will be key to a successful implementation.

We feel that meetings with the wireless and wireline service providers involved will be key to gaining their cooperation and making for as smooth an implementation as possible.

Providing information and allowing for discussion with the PSAP users and administrators will be another key factor in gaining their trust and confidence as the network is developed and implemented.

Information and discussion meetings scheduled regularly through out the project will help keep everyone involved, up-to-date and "on the same page".

4.6.1 Training Methodology

We see initial training for system users and service providers being provided in stages, as the system is being installed and implemented. It is our intention to hold classes in three regional locations, North, Central and South, so that users can easily drive to training classes. This will help keep the time and expense involved to a minimum. Whenever possible training sessions will be designed around half-day or one-day sessions, again to minimize cost and scheduling impact on the using agencies.

When appropriate and possible, training sessions will include hands-on or demo systems. Feedback to students will be provided by testing materials, and to instructors and curriculum designers by means of student evaluations of classes, materials, and instructors. Some such evaluations may be delayed so that the student has an opportunity to determine the effectiveness of the training based on actual use of the material covered in the course.

Agencies should plan on sending trainers to the initial classes as well as system users. Trainers from different agencies will be provided materials as needed so they can, in turn, train new personnel as they are hired, and train existing personnel as they wish.

Training materials should be evaluated on a regular bases, at least annually, for relevance and accuracy. Any outdated or inaccurate materials will be updated and distributed. If significant operational changes need to occur, "train the trainer" sessions will be held so that all agencies can update their personnel on the changes with a minimum of expense.

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5 PRICING

Notes and pricing basis

Our pricing is based on tariff rates and full retail prices. We have chosen not to use discount pricing in order to help insure that we have provided the Board with upper bounds on our proposals, since we understand price may affect the feasibility of any project. Also, since there are uncertainties with certain details, using non-discounted pricing gives us some "room" in case an actual implementation has some unplanned costs. We would hope an actual implementation would finally be 10% to 20% less expensive than we have estimated here.

Network

[Superseded text redacted]

PSAP site installation

PSAP site installation is based on three site visits. The first visit is for site survey and agreement on location of equipment, power connections, etc. The second visit occurs after installation of the DS1s, and makes both network and CPE connections. The third site is planned to resolve any integration issues that might occur.

We have not provided any site prep allowance for the PSAP. We assume most PSAPs will have an equipment room able to accommodate the modest termination equipment.

Monitoring and Trouble Reporting

We assume the network monitoring and will be performed through INdigital's automated monitoring processes as described in section 4.5, and trouble reported through our voice mail system.

This system has been in use at INdigital for a number of years, and we serve some demanding and high stakes business customers. Our customer's report our service is second to none, and we believe our monitoring system is an important factor in that success.

Our automated system provides top quality service while controlling labor costs. INdigital will be happy to estimate other monitoring systems if the Board does not find favor with the proposed arrangement.

Training estimates

Our training estimates are based on the following:

Train a total of 500 operators / operator trainers in a ½ day pre-install information session and ½ day commissioning session on two different days. Assuming a class of about 15-16 students implies a total of about 60 ½ day sessions. After the initial implementation, we estimate 6 sessions per year.

Train a total of 100 administrators in one ½ day pre-install and one full day operational sessions. Assuming a class of about 10 students, this implies a equivalent of 15 full-day sessions. After initial implementation, we estimate 2 sessions per year.

Require two CCNP and three CCNA (or better) qualified personnel on staff at all times. After initial certification, we assume at least one replacement of each per year. We assume other technicians will receive approximately 2 weeks of on-the-job training per year.

Initial course development costs have been included as one-time costs in the estimates.

Optional Items

Optional items are listed but not included in the totals.

Depreciation / Obsolescence

No allowance / budget has been provided for long-term replacement of the proposed system.

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6.0 Appendix A

[Section redacted for security and Intellectual Property reasons]

Appendix B:

[Section redacted for security reasons and Intellectual Property reasons.]