Coherent Medical Informatics

The following medical services can be supported at the same time over a single integrated nationwide mission critical information management infrastructure:

- Electronic Patient Record Management
- Patient Care Quality Assurance
- Electronic Integration of Clinical Laboratory Systems
- Health Service Administration
- Identification of Medical Crises and Their Management
- Continuing Medical Education and Remote Medical Consultation
- Facilitation of Inter/Intragroup Medical Research
- Bioterrorism Defense

The proposed solution is characterized as real-time, secure, always available, scalable, reliable, easy to use, extensible and deliverable at a fixed cost. This is possible by combining simple "network aware" building blocks to implement the patterns (common information flow elements) inherent in these traditionally independent processes. This endeavor will create a common persistent virtual workspace and knowledge base that has the potential to dramatically increase the accuracy, efficiency and productivity of our health care system. A unified medical community will also improve our quality of life and provide defense against an increasing array of insidious health threats.

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By

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1. Introduction. The medical community needs a reliable communication and information management infrastructure now. Only by improving the management of information flow will it be possible to respond in a timely fashion to a new array of health threats. The benefits of the solution presented herein range from dramatically lowering the cost of health care to shortening the development time for new cures. Every aspect of medical care is directly impacted by how efficiently information is moved through the system. Equally important is the ability to make the knowledge in the entire medical community more accessible to those areas with a shortage of key medical specialists. Considering recent world events this is a very serious development effort to the engineers on this project. Expect a level of professionalism equivalent to our passion to make a difference.

2. Statement of the Problem. In this document there is a distinction between data, information and knowledge. Take an endoscope for example. The video it outputs is data. The act of interpreting and recording what is observed generates information. Upon review of sufficient information, an individual gaining the ability to determine for example what is normal or abnormal or what causes a specific abnormality is new knowledge. This new knowledge is then used to interpret new data generating new information. This critical information flow cycle is common to all aspects of health care and is a pattern in the greatest need of automation. The efficiency, responsiveness and accuracy of this cycle can only be improved by increasing the rate of flow of data, information and knowledge throughout the entire medical community.

The medical community is compartmentalized by numerous sub-specialties. In each sub-specialty there is a diverse array of computer operating systems, computing platforms, software and medical diagnostic devices. The numerous medical diagnostic devices produce a wide range of data formats, most of which cannot be distributed over a network. This means that data and information tend to accumulate in "pools" around their source. The impact of not knowing for hours or even days that multiple people in multiple cities have been exposed to the same deadly contagion is obvious. The knowledge to identify every contagion is not equally distributed in the medical community.

Consider again the data generated by an endoscope. It is not currently economical to distribute, record, access on demand or collaborate with video. The ability for a group of medical practitioners in multiple cities to step frame by frame through endoscope video at the same time in real-time would speed up and improve the accuracy of the interpretation process. Video is one of many data formats output by medical diagnostic devices that cannot be readily interpreted in a timely fashion by an expert in a remote location. The software that controls these devices and supports data interpretation is typically stand alone, proprietary, single purpose, expensive and requires the use of highly skilled technicians. Most of these data formats are not part of the permanent patient record. Consequently, managing the information flow cycle is labor intensive and often inaccurate and unreliable for all medical facilities. These problems increase when coordinating the actions of multiple medical facilities during a crisis. Our nationwide telephone infrastructure cannot handle more than 10% of its subscribers making a phone call at the same time. During any crisis the number of phone calls always exceeds capacity denying everyone else access to all primary forms of communication (telephone, cellular, dialup Internet service and fax machines). The performance of web and email services rapidly degrades to the point of failure as demand increases. These failures occur without any malicious intent and are predictable during a crisis. Compounding the problem is that Internet web and email services are demonstrably vulnerable to cyber terrorism. The use of nuclear, biological or chemical weapons by terrorists in multiple heavily populated areas at the same time could easily exceed our medical community's ability to contain the threat. Additionally, more personnel need to be trained on how to operate in this environment than resources currently support. This reflects the absence of a common continuing medical education solution. Finally, there is no available technology to track in real-time the spread of nuclear, biological and chemical agents on a national scale.

The goal of this document is to present a viable solution. It is now technologically and economically feasible to build a real-time, secure, always available, scalable and reliable communication infrastructure. On top of this foundation will reside a suite of standards based software tools that can resolve the medical community's information flow problems.

3. Foundational Technologies and Services. Medical informatics encompasses an extremely broad range of disciplines. It is difficult to track advances in so many disciplines. It is even more difficult to successfully identify, integrate and apply advances from multiple disciplines simultaneously to solve a particular problem. This is one of the reasons why sub-specialties in the medical community have isolated information flow. Experts in a sub-specialty tend to make choices that appear to be the shortest path to success, not choices that would deliver an interoperable solution. Fortunately, a large number of technologies and services have sufficiently matured and new technologies and services have been commercialized to make the proposed solution immediately feasible. Much of this progress has been driven by intense competition in the computing and communications industries subsequently making the solution not only immediately feasible, but also economical. The following summarizes key technologies and services that facilitate the construction of the solution:

3.1. ISO/ANSI C++ Programming Language. The International Organization for Standards (ISO) and the American National Standards Institute (ANSI) jointly standardized the C++ programming language in 1998. This relatively silent event has a profound impact on solving the information flow problems in the medical community. Extremely mature C++ compilers and integrated development environments are now available from multiple sources. Sophisticated and complex principles like inheritance, polymorphism, runtime type identification (RTTI), exception mechanisms and function overloading are now readily exploitable and no longer the major focus of a typical software development effort. These capabilities are essential to delivering highly reusable software objects. Of even greater importance is the efficiency and performance of the generated source code. C++ compilers now typically generate code so optimized that in many cases it matches the performance of what normally required hand optimization. To deliver real-time full-duplex communications in software over common packet switched networks dictates the code performance C++ now offers. A goal of the solution is to produce open source C++ template based building blocks that allow any vendor to rapidly produce device controls and data analysis tools that seamlessly integrate into the overall architecture. It is essential to base these building blocks on a reliable, international and portable (cross platform) standard. The international pervasiveness of C++ also ensures that a sufficient body of affordable skilled labor is available. This approach eliminates risks and vulnerabilities inherent in choosing a lower performance language like Java, where anti-competitive practices such as Microsoft dropping Java support in their new operating system could potentially kill a development initiative.

3.2. Supercomputer Microprocessors. IBM and Motorola have jointly delivered mass consumer affordable supercomputer performance microprocessors based on the PowerPC Reduced Instruction Set Computer (RISC) architecture. Though much of the software proposed herein would run on any platform, the delivery of a real-time universally applicable medical communication terminal requires processing power not currently available from any other source. This processor line supports a critical breakthrough of significant value. Due to its extremely large register space, 128 bit internal data bus, multiple 32, 64 and 128 bit execution units and advanced cache memory control this processor can run numerous advanced algorithms simultaneously in real-time. The following can run concurrently, entirely in software, on a single 500 MHz PowerPC processor:

- Compress and decompress a two-way live 30 frame per second video stream in real time
- Compress and decompress a two-way live audio stream in real-time
- Process multiple full-duplex communication protocol stacks
- Render a high resolution image
- Decompress and display a digital video clip from the hard disk drive
- Display a web page
- Maintain a responsive user interface

This means a desktop or laptop computer at a cost of a few thousand dollars can literally outperform the most expensive dedicated medical workstations currently utilized throughout the medical community. Any known data format utilized in the medical community can now be processed or analyzed entirely in software. This makes the manipulation of high-resolution video not only possible, but also economically feasible on a broad scale. The addition of computationally expensive tasks like natural language interfaces, speech recognition, pattern recognition, real-time data encryption and real-time data translation become relatively simple software upgrades.

The power consumption of this processor line is so low that manufacturers will soon be selling wireless handheld systems. This allows medical practitioners to have mobile access to all of their information regardless of format. Finally, PowerPC desktop and laptop computers are available that run all popular operating systems (Windows, Macintosh, Unix and Linux) on the same computer at the same time. This capability allows legacy medical applications to run alongside the real-time object oriented standards based solution proposed herein.

3.3. Next Generation Packet Switches. The primary weakness of the current nationwide communication infrastructure is that it has been intentionally over subscribed. Many times more people have been sold access to the current telephone and Internet networks than the respective networks can support. Considering the capital cost of these legacy infrastructures this approach was economically driven. However, recent world events clearly demonstrate the flaw of not being able to communicate during a crisis. The solution is to take advantage of the new generation of packet switches that provide non-blocking wire speed packet delivery. Non-blocking means a packet can arrive at a port on a switch and be output on any one or number of other ports. Wire speed implies the switch delivers the packets to the output port(s) at the speed of the packet connectivity. The process of moving a packet through the switch adds only a minimal delay. Using this type of packet switch as the communication infrastructure building block, it is possible to construct a network of any size that guarantees every computer or network aware device has a desired minimum full-duplex network access. If a hospital chain wants every staff member to have a minimum of 256 Kbps of network access all of the time, the network can be engineered to deliver this capacity. A computer may have a gigabit Ethernet network connection, but if everyone accessed the network at the same time, all users would retain a minimum capacity to communicate instead of none at all. This is an essential ingredient to improving information flow within the medical community. It is also important to note that this approach allows a network to be built and maintained at a fixed cost. Due to the software-only approach and elimination of all proprietary hardware, there is no usage cost incurred during the communication process. This potentially represents an extraordinary reduction in the cost of medical care.

3.4. Secure Operating System. A network is only as secure as the operating systems that run on the connected computers. The project development team will work in cooperation with the Secure Trusted OS Consortium (STOS), the Defense Advanced Research Project Agency (DARPA) and the National Science Foundation (NSF) to incorporate this capability into the project.

3.5. Session Initiation Protocol (SIP). The Internet Engineering Task Force (IEFT) recently ratified SIP. SIP is a signaling protocol for conferencing, telephony, presence, event notification and instant messaging. SIP lets you know what people and what services are on line and their availability for communication or access respectively. Called presence, this capability is a significant productivity multiplier over the current inefficiency of calling people on a telephone when you have no idea if they are available or not. There is no restriction to media, data format or number of users when establishing a conference. Additionally, SIP allows communication policies and priorities to be established over a network. For example, the entire medical community can have an increasing alert status. Emergency medical personnel could be given the ability to interrupt an active communication session in order to communicate with a specialist needed for an emergency consult.

SIP can discover the availability of services. In the case of an act of war or major natural disaster that may physically destroy a significant percentage of a network, SIP can work in conjunction with other communication protocols to effectively heal and route around damaged portions of a network thus maximizing survivability.

SIP supports the delivery of billing services, consultation services, usage analysis, productivity analysis and security monitoring. SIP can provide network administrators with all of the necessary details to assist them in maintaining a secure, reliable, real-time communications infrastructure. It can also assist the entire medical community in automating the billing of online consultations and treatments.

3.6. Kerberos. Kerberos is a network authentication protocol. It is designed to provide strong authentication for client/server applications by using secret-key cryptography. A free implementation of this protocol is available from the Massachusetts Institute of Technology (MIT). Kerberos is also available in many commercial products as well. This protocol is an important element of achieving compliance with the Health Insurance Portability and Accountability Act of 1996 (HIPAA) and compliance with security measures established by the National Security Agency (NSA). The strength of Kerberos is that it authenticates every

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transaction that occurs on the network all of the time. When combined with SIP's ability to support policies and other security measures discussed in this document, it will be possible to eliminate problems like the denial of service attacks that occasionally collapse the public Internet.

3.7. eXstensible Markup Language (XML). A significant barrier to the flow of information in the medical community is the number of proprietary document formats. As the applications evolve and change, older documents become difficult to manage and access. Proprietary documents are also difficult to distribute because the recipient(s) may not have the application necessary to view or use them. It is impossible or difficult to cross-reference and to organize the sub-elements of these documents for further research. XML is a standard markup language for documents containing structured information. It allows documents of any conceivable complexity to be created. It can contain sub-elements of any desired data format. Using XML for all documents and the patient record provides longevity, extensibility and persistence to the data, information and knowledge generated by the entire medical community. XML is already a key element of the HIPAA, Health Level 7 (HL7), Digital Imaging and Communications in Medicine (DICOM) and Integrating the Healthcare Enterprise (IHE) standards.

3.8. eXpress Transport Protocol (XTP). The Transmission Control Protocol (TCP) and Internet Protocol (IP) are decades old. In many cases TCP/IP is very inefficient. This is true when a large number of users are collaborating with each other at the same time during a live communication session. TCP/IP is also extremely inefficient over satellite networks. XTP is a transport layer protocol designed to provide a wide range of communication services. Rather than using a separate protocol for each type of communication, XTP's protocol options and control of the packet exchange patterns allow the application to create appropriate paradigms such as reliable datagrams, transactions, unreliable streams and reliable multicast connections. Error control, flow control, and rate control are each configured to the needs of the communication. XTP is designed specifically to embrace high-speed networks and offers a level of performance not possible with other protocols, especially over large latency or high loss links. XTP works transparently over the Internet and any IP network.

3.9. Multiprotocol Label Switching (MPLS). Currently IP networks do not have Quality of Service (QoS) capabilities. An example of QoS is a telephone call. If you make a call, it stays active until one of the parties hang up, regardless of how many other phone calls are occurring during the call. An IP network can rapidly become so congested that any active communication session can be terminated. Currently, IP networks only support policy based Class of Service (CoS). CoS can put one stream of packets at a higher priority over another, but CoS is still susceptible to network over use and congestion.

MPLS is a key development in Internet technologies that will add traffic engineering, different qualitative CoS, different quantitative QoS and Virtual Private Networks (VPN's) for IP networks. MPLS takes its characteristics directly from the Asynchronous Transfer Mode (ATM) networking standard. MPLS uses both ATM and IP as its underlying packet format definition. Currently the Department of Defense (DoD) has published its intention to standardize on ATM through its Global Information Grid (GIG) initiative. ATM is proven, very mature and provides the highest possible QoS for IP traffic. However, the business enterprise, public Internet and

Internet 2 are still focused on adding QoS to IP using MPLS. It will take years for a winner in this technological battle to surface. However, this project will deploy a "responsible party theory". A network device will not blindly dump packets onto the network. Using SIP it will signal its intentions, check the availability of a service and get permission before consuming network resources. This approach, combined with a proper network design, will provide the medical community with a superior level of QoS.

3.10. Next Generation Display Cards. Two companies, ATI Technologies and NVIDIA Corporation, are the leading manufacturers of accelerated display chips and cards. For example, the NVIDIA GeForce4 MX offers performance equivalent to high-end visualization workstations. It features a 4x speed Accelerated Graphics Port (AGP) interface with 64MB of fast Double Date Rate (DDR) memory. This new generation of display cards can render photo realistic virtual realty scenes in real-time. Using MRI imagery it would be possible to literally navigate through the human body at will. Performance at this level allows any medical practitioner to visualize any information. These cards accelerate the display of video, decompress MPEG 4 and DVD disc movies, accelerate QuickTime movies and accelerate OpenGL instructions. These chips and cards are preinstalled on most desktop and laptop computers.

This contributes to the delivery of an affordable universally applicable medical communication terminal that can support any form of real-time communication. This capability combined with the PowerPC processor will allow the medical community to use ultra high resolution imagery that supports many times more colors per pixel than the human eye can see. This facilitates automated analysis as a possible means of identifying cancerous cells through the identification of subtle differences in cell shading.

3.11. Global Fiber Network. Over the past several years all major telephone and network carriers have competed against each other in constructing fiber optic networks. Several companies have each installed tens of thousands of miles of fiber and conduit. They installed empty conduit for the later addition of fiber without having to dig up the ground again. They installed fiber, but left a percentage of it disconnected. This is called dark fiber in the communication industry. They also activated a significant amount of fiber through the use of ATM and IP switches with Wave Division Multiplexing (WDM) fiber optic interfaces. Of note is the fact that, year after year, they have been able to double the number of simultaneous frequencies of light they can pump down a single strand of fiber. For example, jumping from 64 to 128 channels is the equivalent of increasing the bandwidth by 640 billion bits of information per second. There is literally an astronomical amount of bandwidth available. There has been so much competition that the prices continue to drop. There is sufficient network bandwidth in the United States to put every hospital, clinic, research facility and medical school on the same real-time reliable communication network at the same time. This could be done for a fixed cost per year.

3.12. Secure Hosting Services. Companies like Exodus Communications have built numerous secure data centers globally. These facilities host the packet switches, servers and storage arrays for the Internet and large private corporate networks. These facilities are earthquake proof, climate controlled, have redundant power and connectivity and are ultra secure. In fact, the financial community puts their servers in vaults within these secure facilities. In the case of Exodus, their facilities are considered a national asset by the federal government.

Additionally, all of the fiber optic backbones connect to these data centers. By placing switches and servers in these data centers it would be possible in less than two years to put every hospital, clinic, research facility and medical school on the same real-time reliable communication network. Again, this could be done for a fixed cost per year.

3.13. Advanced Encryption Standard (AES). The National Institute of Standards and Technology (NIST) has recently announced the approval of the Federal Information Processing Standard (FIPS) for the Advanced Encryption Standard, FIPS-197. This standard specifies Rijndael as a FIPS-approved symmetric encryption algorithm that may be used by U.S. Government organizations (and others) to protect sensitive information. There is a 128 bit, 192 bit and a 256 bit version of AES. Assuming that one could build a machine that could recover 255 keys in a second, then it would take that machine approximately 149 thousand-billion (149 trillion) years to crack a 128-bit AES key. To put that into perspective, the universe is believed to be less than 20 billion years old.

3.14. Open Graphics Language (OpenGL). OpenGL is a cross-platform standard for 3D rendering and 3D hardware acceleration. The software runtime library ships with all Windows, Macintosh, Linux and Unix systems. OpenGL delivers fast and complete 3D hardware acceleration, makes real-time 3D effects possible, is designed to support future innovations in software and hardware and is very stable. This standard graphics language will play a key role in the real-time visualization of information in the medical community.

3.15. QuickTime. QuickTime is a package of system-level code, with C programming interfaces, that higher-level software can use to control time-based data. In QuickTime, a structure of time-based data is called a movie. With QuickTime, applications can create, display, edit, copy, and compress movies and movie data in most of the same ways that they currently manipulate text and still-image graphics. Besides processing video data, QuickTime can handle still images, animated images (sprites), vector graphics, multiple sound channels, MIDI music, 3D objects, virtual reality panoramas and objects, and even text. It can add a wide range of media-rich features to any application. QuickTime is the ideal cross platform format to record the output from any medical diagnostics device that generates video. In fact, it is ideal for recording any biosignal considering the temporal aspect of this type of data. Outside of the Microsoft Windows operating system, QuickTime is on more computers than any other software on the planet making it sufficiently pervasive for this application.

3.16. JPEG 2000. The JPEG 2000 initiative is intended to provide a new image coding system using state of the art compression techniques, based on the use of wavelet technology. Its architecture lends itself to a wide range of uses from portable digital cameras, advanced pre-press, medical imaging and other key sectors. JPEG 2000 refers to all parts of the standard. Part 1 was approved as an International Standard at the end of 2000; there are currently 8 other parts in progress. The Digital Imaging and Communications in Medicine (DICOM) standards group has adopted JPEG 2000 for the medical community. The solution proposed herein will include extremely optimized JPEG 2000 algorithms that support real-time transmission, rendering and zoom capabilities.

3.17. Genesis. Genesis is a collaborative application framework and development environment written in ISO/ANSI C++. Genesis cleanly and precisely defines the elements of the human to computer interface. The complexities of the network architecture, communication protocol, signaling, operating system, computing platform, media format, performance, drag and drop, undo and redo, persistence and user interaction with data become virtually transparent to the software developer. Genesis deploys an extraordinarily scalable, real-time, robust, portable and open approach to managing every aspect of how a user interacts with information delivered over a network. Additionally, Genesis facilitates a new classification of communication called Coherent Collaboration. A large group of users can interact with any media format at the same time in real-time over any distance. Each user can interact with and manipulate any component of a document independently while all participants see the results of each other's work at the same time. Both the user interface and data state machines of all applications participating in a live session are synchronized reliably. Through persistence and unlimited undo/redo a group of users can collaborate to solve any conceivable problem. They can move forward and backward in time (undo/redo), resume, pause, bring in additional expertise and in general reduce the cost and time of solving virtually any information flow problem.

Genesis utilizes a highly structured approach to data modeling in order to automate the difficult aspects of building a user interface based application. The fundamental building blocks consist of "Nodes" and "Attributes". A Node is an object that contains Attributes. An Attribute is a single item of data. There are six predefined Attributes consisting of String, Long, Enumerator, Boolean, Floating Point and Color. Nodes can be linked together into lists and trees by forming parent-child relationships. Data models of virtually any complexity can be created. Utilizing Genesis's Nodes and predefined Attributes provides "code-less" functionality. The code-less functionality includes user interface event handling, persistence (through automatic XML generation), undo and redo, drag and drop, broadcasting and listening, structured garbage collection, an abstract plugin architecture, node duplication, display and manipulation of trees and lists, file synchronization and collaboration. This allows Genesis to be used to develop any conceivable application for the medical community.

4. Elements of the Solution. There are clearly identifiable patterns of information flow common across bioterrorism defense, medical crisis management, patient care, patient record management, clinical systems, health service administration, medical research and continuing medical education. The client software, server software, computers, switches, servers, storage arrays and network summarized below are completely "blind" to any differences between these different information flow problems. This is fundamentally very simple, guarantee the packets containing the data or information move reliably from point A to point B all of the time. This represents true convergence. There is no longer a difference between audio, video, a medical image, a document, a patient record to this architecture. Only the last module of software responsible for interfacing with the user has any understanding of how to render, visualize, or playback the received data or information and how to manage interaction with the user. Any computer connected to this network in any location can be dynamically reconfigured at any time to possess the desired combination of software modules. A nurse's workstation could be used to instantly activate a bioterrorism support module and collaborate with a group of specialists on a suspected Anthrax case. The level of code reuse and subsequent performance advantages of this approach will contribute directly to the stability, reliability and maintainability of this comprehensive solution.

The following summarizes the ten elements that comprise the entire architecture. The detailed development priorities, requirements and functional specifications will be made available to partners upon request.

4.1. Service Client. The Service Client manages all basic communication services and hosts any combination of Service Modules. It handles the following:

- Login
- Authentication
- Session management
- Network status
- Service Module selection
- Help Desk support

The level of abstraction used by this approach is unique. For example, there is no distinction between accessing a patient record and making an audio or video call to another person. Both are sessions that you initiate, put on hold, terminate or add parties to. By adding other parties (users) to an active session the entire group can collaborate and communicate with the active data or information. From an audio only teleconference to a group of doctors reviewing the same patient record, the underlying communication session management is identical to the Service Client software.

4.2. Service Modules. A Service Module manages the flow between the user and the desired service, information, data or device. It handles all of the user interface elements and user interaction. The code that manages the user interface is actually in the Service Client. This makes the Service Modules very small. A Service Module can be completely dynamic in that it does not need to reside on the computer the user requests it from. If the user has the authority to access a Service Module they can use it at any time from any computer connected to the network.

The following lists some of the initial Service Modules that will be developed. The development tools will be made available so that anyone can build a Service Module for any purpose.

- Contact management
- Audio conferencing
- Video conferencing
- Collaboration
- Application sharing
- Patient record management
- Patient account management
- Work flow management
- Scheduling
- Continuing education
- Content author
- Telephone
- Medical diagnostic device interface
- Crisis operation management
- 911 management

There are several items of note. The video conferencing Service Module will support video from any source from an endoscope to a Cable TV channel and will include the ability to record a session. The collaboration Service Module is a DICOM compliant tool. It will possess a wide array of tools that let a group of medical practitioners collaborate with and analyze any resolution of medical imagery in real-time over the network. The continuing education Service Module will support both synchronous and asynchronous learning (self-paced and leader lead learning). It will have access to an archive of course content developed by the content author Service Module. An analysis of medical diagnostic devices in the industry will be conducted. Each device will get its own Service Module. The software development tools to do this will be available to all manufacturers. The crisis operation management Service Module will provide the basic functionality to coordinate resources during a crisis. The underlying reliability of the basic communication features will provide an immense value to this process.

Finally, a 911 management Service Module will be developed. The 911 dispatcher in each community is the first person to know of any and all problems. View the 911 dispatcher as the nation's early warning sensor. The medical community and any government agency monitoring specific information on the network will know when an accident, disaster or attack occurs. This supports the shortest possible response time if the correct measures are put in place to objectively initiate a response.

4.3. Server Software. The Server Software manages the underlying functionality that facilitates the communication and collaboration processes. The following summarizes a few of its responsibilities:

- Login management
- Authentication management
- Account management
- Multipoint service management
- Asset and database management
- Network traffic management

4.4. Developer Support. A complete set of development tools and sample Service Modules will be produced and made available.

4.5. Account Management. The Account Management software will be treated as a controlled item. With it an administrator can create service accounts, establish privileges and establish policies.

4.6. Help Desk. The Help Desk software is a special version of the Service Client that lets a help desk agent provide any level of support for any user anywhere on the network at any time.

4.7. Service Hosting. The Service Hosting document defines the engineering, configuration, procedures and policies needed by a hosting service provider to host the Server Software.

4.8. Network Design. The Network Design document defines the engineering, configuration, procedures and policies needed by a network service provider to implement and maintain the network.

4.9. Medical Service Workstations. There will be four different Medical Service Workstation configurations consisting of conference room, desktop, laptop and a handheld configurations. Working with the chosen manufacturer these systems will have the processor(s), memory, display card, storage capacity and display configuration necessary to handle any medical communication and information management problem. The design, configuration, setup and usage documentation will allow any medical practitioner to easily setup and use the respective workstation. This will include a wide range of peripheral and cable options. These options will include items like video cameras, microphones and numerous cable options and instructions necessary to interface the workstation with a very wide range of medical diagnostic devices. A 911-dispatcher variant of this workstation concept will include control of radios.

4.10. Medical Diagnostic Devices. It is possible for a medical practitioner to remotely control virtually any medical diagnostic device and to access the data it generates from anywhere on the network. Through an exhaustive analysis of the medical industry a detailed approach will be developed. Since many of these devices output only analog data, the appropriate digitizers will have to be identified or built. There are numerous patterns in the human to device interface, which will be automated in software. This will be part of the development software, which will be provided to the manufacturers of the supported devices.

5. Conclusion. The medical community's need for a common reliable communication infrastructure is extremely obvious. Unfortunately, the barriers of cost and complexity have been too high, until now. By taking immediate advantage of numerous rapidly maturing open standards from multiple disciplines it is possible to affordably deliver a complete and flexible solution at a fixed cost. It is difficult for people to comprehend how rapidly a contagious disease can spread, particularly if it is spread intentionally. This engineering effort will deliver a solution that allows the medical community to provide a defense against this insidious threat. This solution will also dramatically increase the entire medical community's ability to improve our quality of life.