CP599

Evolution of a Global Military and Civilian Telemedicine Network for the 21st Century: Near Future on Demand, Space Based Delivery of Multimedia Services

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Abstract

The Medical Defense Performance Review (MDPR) was established in 1993 to help "reinvent" how health care is provided to the US military servicemen and their dependents. One of the MDPR initiatives has been to rapidly insert video conferencing, telemanagement and telemedicine technologies to improve the quality and reduce the costs

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of delivering that care from major and minor medical treatment facilities, to wherever the need exists, e.g., to patient homes and to remote military communities. The technologies and the processes now being reinvented have the potential to provide excellent access to quality health care anytime, anywhere.

A major over arching issue is the need to facilitate the evolution of high quality, financially self-sustaining telemedical services. An earlier paper[1] provided an overview of the medical initiative of the National Performance Review which stressed the initial testbed and initial interregional telemanagement deployment efforts.

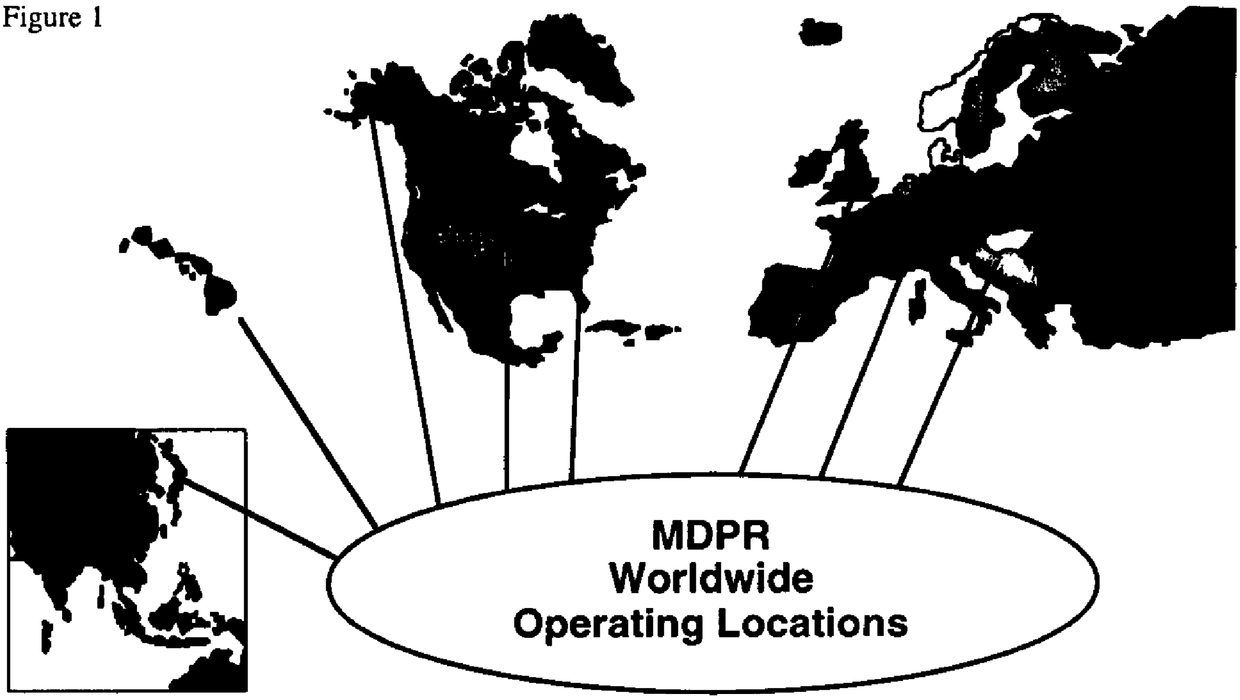
This paper stresses the more recent intraregional telemanagement and telemedicine efforts and synthesizes key success factors essential for evolving self-sustaining global telemanagement and telemedicine networks for the twenty-first century. Finally, future directions are proposed which could adapt these kinds of networks to bring about healthier military and civilian communities.

1.0 Introduction

We are pleased to be here today at the Aerospace Medical Panel Symposium. This paper updates our earlier work investigating the application of video conferencing, telemanagement and telemedicine technologies to improve access to health care, to improve the quality of care, and to reduce the cost of health care in the military. We believe these technologies have direct application to the problems that will be faced in the future to provide quality health care at reasonable, i.e., sustainable, cost. Secondly, this paper retrospectively synthesizes critical success factors and projects future directions with the assistance of the coauthors.

The opinions expressed are those of the authors and do not reflect the policy of the United States Air Force.

Figure 1



2.0 Project Background

U.S. Vice President Al Gore established a National Performance Review, the purpose of which is "to reinvent government" both to improve government services and to reduce the cost of providing these services.[2] Under the sponsorship of the National / Defense Performance Review, the Medical Defense Performance Review was established under Lieutenant General Thomas McInerney who brought in Brigadier General Peter Hoffman to direct a two-pronged effort.

One prong of the effort was focused on developing a medical provider workstation. This prototype is being developed at Scott AFB, and is documented separately.[3]

The other prong of the effort was conceived as a joint civilian and military initiative with the Office of the Air Force Surgeon General as the executive agent. This focused on a user-evaluated and user-guided, phased deployment of computer communication networks emphasizing group and desktop voice, data, image and video conferencing to support telemanagement and telemedicine. Concurrently, emphasis was given to inserting high-value-added reengineered management and clinical processes based on collaborative experiences with best-of-breed leaders of civilian telemedicine and newly-empowered military users of telemedicine.

These broad-based MDPR efforts recently received the Vice President Gore Hammer Award for excellence in reengineering. This paper focuses on the emergence of the network and its reengineered management and clinical processes which are currently being inserted and evolved worldwide. (See Figure 1, "MDPR Worldwide Operating Locations")

Collaboration of the MDPR with the joint military and civilian community has been paramount throughout the four years of the project. The MDPR has been working with the Army Medical Advanced Technology Management Office , the Naval Medical Information Center and the Office of the Assistant Secretary of Defense for Health Affairs to improve access to health care, to improve the quality of health care, and to reduce the cost of health care — goals that must be met in an environment of reduced resources in the military and civilian health care communities. Much of the current work being done by these and supporting organizations was presented at the first National Forum on Military Telemedicine in March of 1995[4] and at the Telemedicine 2000 conference held in June 1995.[5] An overview was presented to a meeting of NATO Partners for Peace in September 1995. And, more recently an overview was presented at this summer's Global Telemedicine and Federal Technologies symposium at Williamsburg, VA.[6]

Because the ability to outsource military medical services on a global basis has always been envisioned,[7,8] we have concurrently sought opportunities to work with best-of-breed military and civilian leaders and facilities, ultimately contributing to healthier military and civilian communities.[9,10] For instance, from the beginning we sought the guidance of and collaborated with best-of-breed leaders in telemedicine, such as Dr. Jay Sanders at the Medical School of Georgia, currently President of the American Telemedicine Association and coauthor of this paper. We collaborated with Jay at the First Congress of the Atlantic Rim in Boston, 1994.[11,12,13] This telemedicine presentation and demonstration reported on the pioneering efforts of the US Army (Dr. Ed Gomez, Walter Reed) and demonstrated a US Navy-developed, Joint Chiefs of Staff award-winning Multilingual Translator (Commander Lee Morin, Naval Medical Research Institute).

This collaborative activity has matured to the point where joint presentations have been delivered at Monaco, November 1995,[14,15] at the 100th Boston Marathon, July 1996[16] and at the Global Telemedicine and Federal Technologies Symposium at Williamsburg, VA, July 1996.[17] Another milestone was reached when a Collaborative Research and Development Agreement was struck between Lahey Hitchcock Clinic and the Electronic Systems Center in July 1996.[18] This agreement will enable the military medical regions within the US and Europe to import and leverage medical expertise and reengineered clinical processes in exchange for providing Lahey with expertise in the deployment of global computer communication infrastructure.

Thus, the MDPR initiative we focused on was intended: 1) to improve the medical management, acquisition, operational and support processes within the Air Force medical community; 2) to promote collaboration among the other military services, NATO, the United Nations, other coalition partners, and the civilian health care communities. This top-down and outreach approach has successfully extended the enabling technology across regional medical organizations to evolve incrementally to a true telemedicine system serving health care providers and their patients.

The major constraints are technical interoperability and, especially, cultural issues.[19] Cultural issues most inhibit taking advantage of rapidly developing technology. To reap the full benefits of new technology requires reengineering of the organizational[20] and medical processes themselves. Health care providers and management executives who are experts in their fields are best positioned to redefine these processes and lead the changes.

3.0 Video Conferencing (VTC)

Essentially, video conferencing is a television link between two or more locations. Most early successful systems were installed in government and large corporation conference facilities. The widening acceptance of this VTC technology has lowered the cost of working and collaborating together on common projects and issues from remote sites.

The fundamental components of video conferencing systems are the basic video and audio capabilities. Other audio-video capabilities are typically integrated into corporate VTC-equipped conference rooms. These include graphic display systems such as overhead viewgraphs and 35 mm slide projectors. Auxiliary video sources such as video cassette recorders and players as well as facsimile capabilities for the exchange of printed material are often also included.

Video conferencing technology is now being extended to the desktop in personal computer systems. This has made the full range of capabilities found on personal computer systems (office automation, engineering, computing, file transfer and networking) inherent components of desktop video conferencing systems. Important among these capabilities is the ability to share computer applications, allowing conference participants to work on a shared electronic copy of documents such as budgets, reports, plans, engineering drawings, and multimedia patient records.

The market for video conferencing systems is experiencing explosive growth. This has been made possible by commercialization of technical advances in video and audio compression technology, by acceptance of internationally promulgated standards supporting proliferation of the technology, and by the increasing availability of low-cost dial-up digital communication services.

The high information content of television signals, typically computed at 90 Mbps, inhibited the development of video conferencing systems primarily due to the high cost of communication services. Contemporary compression technology enables effective interactive video and audio communication at data rates of 128 kbps, a compression ratio approaching 700:1.

Complete standards-based add-on systems for personal computers including the television camera, an audio speaker, and communication network interface are available today at costs ranging from $1300 to $8000. International standardization of video conferencing, increasing product integration and increasing production levels are expected to continue to cause prices to decline dramatically.

Worldwide dial-up digital communication services at a rate of 128 kbps are becoming increasingly available today through the ISDN BRI service offered by most telephone companies. The cost of ISDN BRI in most areas is comparable to that of two analog voice-grade telephone lines. The service is widely available today in western Europe and Japan and at many of the local exchange offices in the US. The service is expected to be a worldwide standard in the future.

4.0 Prototype Telemanagement Network

As a first step in meeting the goals of the MDPR, we focused on improving communication among top medical executives, the decision makers, in the Air Force health care community by acquiring a prototype telemanagement system. Most of the top executives are also physicians, thus providing early insight into the value of VTC, a key enabling technology supporting not only telemanagement but also later-to-be-deployed telemedicine. The prototype was installed at key locations to enable early user participation in the system design and to validate the system capability and performance prior to larger-scale deployment.

Early user participation also provided the opportunity for the real system experts, the system users, to work with and understand the possibilities of the technology, and then to reinvent how they do their jobs.[21,22] As we noted, only with changes in work processes can the full benefit of enabling technologies, such as video conferencing, be realized. Success of a prototype doctor-executive telemanagement system would also predispose support for continued infusion of the capability into the health care delivery community, thus metamorphosing to a true telemedicine system providing improved access and quality of care at reduced cost.

Data rates of 128 kbps are suitable for most medical applications. However, some future medical applications may require better video quality for video exchange. Consequently, our system has been made scalable and suitable for incremental change to provide higher performance where and when needed.

The prototype system now extends to the managers' desktops, providing live dial-up video conferencing capabilities as well as application sharing capabilities, allowing real-time collaboration on budgets, policies and other management tasks. The prototype has been found by the users to dramatically reduce the time required to make decisions. In addition, decision quality has improved through increased access to subject-matter experts. Further, greater real-time staff participation in the decision making process has created a better understanding of policies being promulgated. This has produced a greater sense of identification with new policies and hence better and quicker compliance.

The conference room and desktop video conferencing systems are installed at locations across the continental US, Hawaii and Germany. (See Figure 1, "MDPR Worldwide Operating Locations") Regional telemanagement extensions in progress include locations in Japan, Okinawa, Korea, Guam, Alaska and other countries in Europe, such as England, The Netherlands, Turkey and Italy.

In addition to the conference room and desktop capabilities, a twelve-site multipoint conferencing capability is installed in the Air Force Surgeon General's headquarters conference room in Washington, DC. The multipoint system allows twelve other locations around the world to participate in a conference, with each remote location being simultaneously both seen and heard. This system enables the Air Force Surgeons General, Lieutenant General Edgar R. Anderson, Jr. and Lieutenant General (select) Charles H. Roadman, II, and their staff to interact frequently and in real time with the corporate executive group that runs the Air Force medical service, and to have them contribute to and participate in the decision making process, resulting in better and more timely decisions. Regular meetings now include a Monday staff meeting conducted at 12:30 PM Eastern Daylight Time, with participants on-line in Germany at 6:30 PM local time and in Hawaii at 6:30 AM local time.

The primary communication services are provided by the ISDN worldwide network where available; otherwise dial-up dual switched 56 kbps services are used. In addition, INMARSAT satellite services are used to reach remote areas such as the United Nations Medical Field Hospital in Zagreb, Croatia.

The system has dramatically improved communication between the decision makers at these locations, and reduced from months to days the time to discuss, resolve and promulgate major policy and budget decisions. The reengineered management processes facilitated by this new technology have also expanded participation in decision making. This has improved the quality of the decisions and facilitated implementation of the deci-

The Video Wall

Figure 2

Lieutenant General Anderson, MD, Surgeon General of the Air Force, applauds his new "Video Wall," which provides him and his deputies the capability to conference with his global staff. Previous to this "Video Wall," his staff spent days away from work travelling to meetings and had to defray huge travel costs – allowing only quarterly staff meetings. Now the general and his deputies can have weekly meetings with global staff, dramatically reducing the time required to make decisions and increasing the involvement of the global staff, resulting in faster, better, more effective decisions and policy changes. These photos were taken during the general's first use of the Wall on 7 July 1995. Electronic Systems Center, supported by MITRE, designed the Wall based on its previous designs used in other Command Centers; this dual-use of design experience made it possible to deliver the system to the Surgeon General in only seven months.

sion as all participants have buy-in to the decision process. (See Figure 2, "The Video Wall")

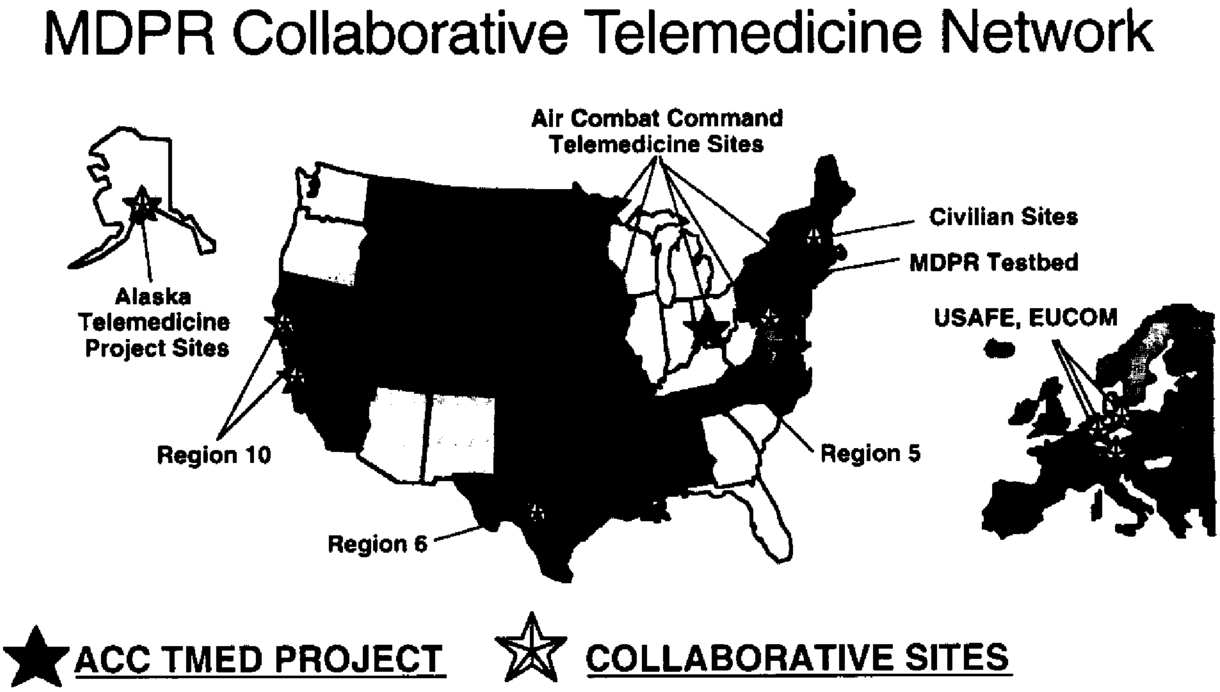
5.0 Telemedicine

As video conferencing is changing the way the world meets, telemedicine will change how health care providers are trained and how health care providers deliver medical services to their patients. Video conferencing is a key enabling technology for telemedicine applications. Pioneering efforts to develop telemedicine capabilities have been done by Dr. DeBakey of the Baylor College of Medicine,[23] Dr. Jay Sanders, Director of the Telemedicine Center at the Medical College of Georgia,[24] and others.[25] Continuing medical education and consulting services are becoming increasingly available via telecommunications links. The future promises to include operations conducted on patients by remote physicians.

In support of the MDPR, we are now reaching out across various regional organizations towards the health care providers and remote patients and adding telemedicine capabilities to existing systems. Our first application has been to fill in the specialty and subspecialty gaps at smaller hospitals and remote military communities, under the direction of Colonel Klaus Schafer, MD, Command Surgeon, Air Combat Command. The concept for a prototype "Telemedicine Consultation Suite" that follows was prepared by Dr. B. Hadley Reed.[26]

Figure 3 – Telemanagement of medicine uniquely provides cost-saving capabilities to the medical manager. Telemanagement of medicine also provides important insights which can be used by senior management to assess telemedicine projects particularly when those projects have key elements which include "soft dollar" justifications. The pictured office includes desktop VTC, a VCR for recording or showing videos and a document camera to show the picture or briefing slide "worth a thousand words." Because the equipment is standards-based, it can be used to interact with the Video Wall (See Figure 2), other individual colleagues or multipoint meetings of colleagues who use standards-based equipment.

Figure 4



Empowered regional champions spearheading collaborative telemanagement and telemedicine efforts in other areas are: Colonel Locker, MD, US Air Forces Europe; Colonel Farmer, US European Command, Office of the Command Surgeon; Lt Colonel Sietsema, California; Dr. Pierce, Alaska. Overall telemedicine concept of operations and guidance is being provided by Dr. Sanders. US Air Force strategic management guidance and vision is being provided by Colonel Benge, MD. Significant clinical insights are being provided by Boston area hospitals and clinics. (See Figure 4, "MDPR Collaborative Telemedicine Network")

The heart of the system is the prototype telemanagement system components. (See Figure 3, "Telemanagement of Telemedicine") To these we are adding a suite of medical equipment that allows a specialist at a remote facility to see and hear the patient, in conjunction with a general practitioner, nurse or other health care aide with the patient.

Importantly, the initial MDPR clinical trials are driven by the needs of the users, and so are not "technology push driven," but are based on the business case analysis referenced above. The most promising specialty areas for telemedicine applications have been identified as allergy, cardiology, dermatology, mental health, neurology, pulmonary / respiratory, and ophthalmology. Underutilized specialists in these areas are available at military medical centers.

The prototypes will be tailored to the needs of the provider facility, and outfitted with suitable medical instrumentation to provide a remote specialist at the military medical center audio, visual, graphic (e.g., EKG) and other real-time medical data to enable an effective consultation with the patient and the local health care provider. The goals of the clinical trials are to assess the cost and benefits of telemedicine capabilities in the selected environments. Our measures of effectiveness are now being defined, but they will address the need to capture and document expected cost savings resulting from decreases in outpatient referrals and expected improvements in the quality of care. The results of the prototype evaluation should be able to guide planning for future use and deployment of telemedicine capabilities in the Army, Navy, Air Force and civilian communities alike.

We believe this medical technology has the potential to have an even greater effect than the advent of the telephone, which enabled a local healthcare provider with a question simply to call a remote expert with a quick question. The obvious limitation of telephone technology has always been the difficulty the local provider has had in adequately describing the situation to the expert over the phone without the clarifying assistance of pictures, graphics or motion.

The ability to dial up the expert consultant in such a way that the consultant can see the patient with the physical finding, even hear the auscultation and view the x-rays, will dramatically enhance any provider's ability to deliver the best care to each patient fast, with less cost for outside consults. Further, the local provider gains insights and expertise from the remote consultant, thus providing better patient, provider, consultant teamwork in the course of treatment and specialized teaching for the provider at the time of relevance and need.

Other cost reductions are related to reduction of lost patient work time. Reduction of lost work time includes travel to and from remote medical facilities, processes that today can take as long as five to seven days for a single appointment. In addition, the loss in work-related productive effort resulting from this travel is a more subtle, but significant, cost. Employers who are mindful of the full cost of the medical benefits they provide do not find these work- and travel-related costs trivial.

Deployed Telemedicine Concept

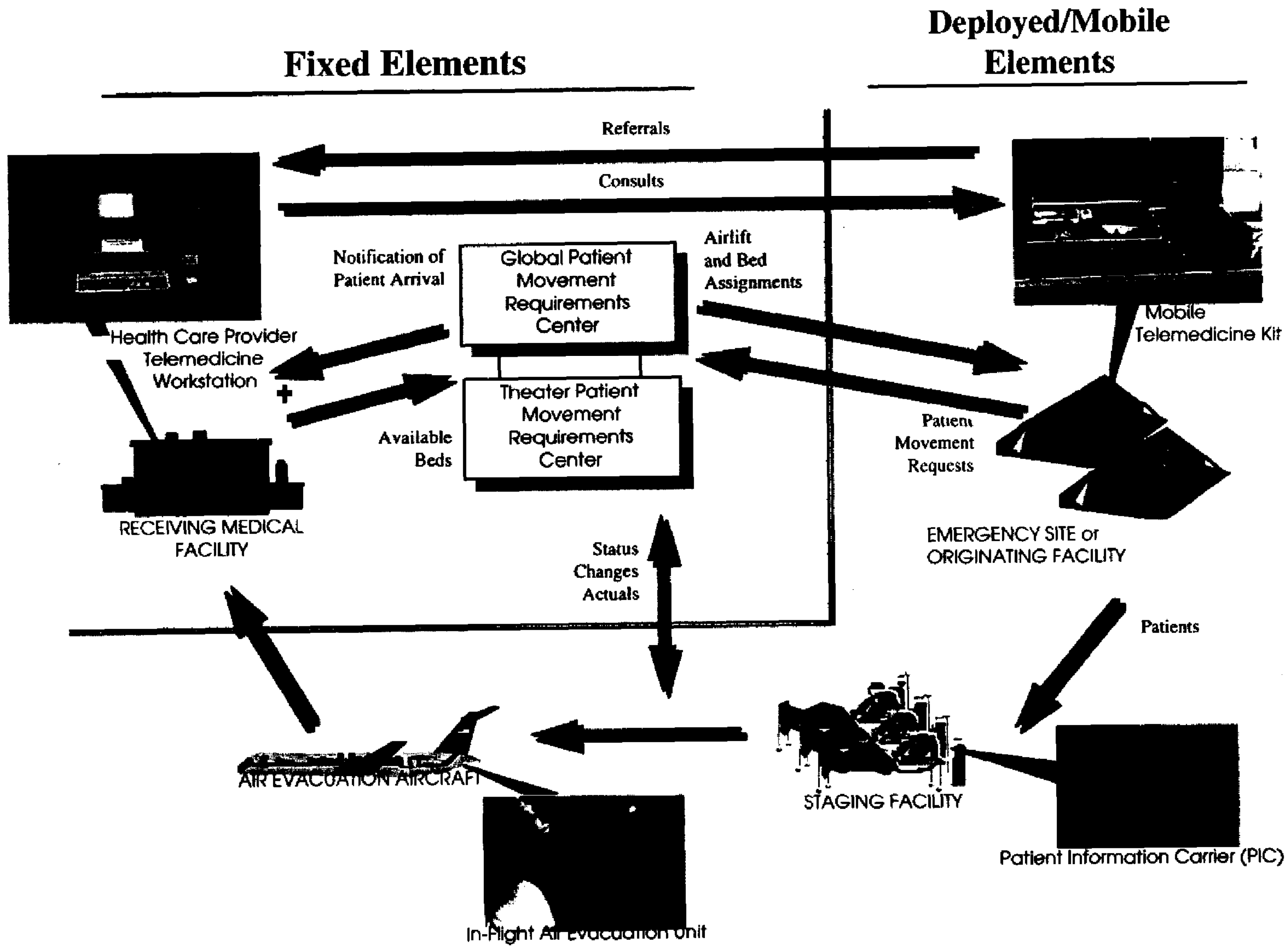
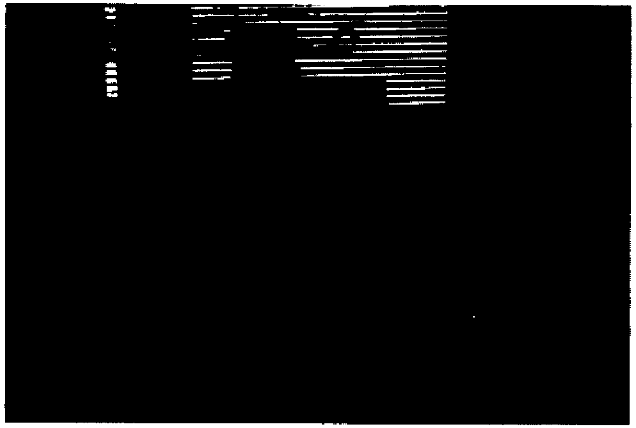


Figure 5

Deployed Telemedicine Concept (Selected Equipment)

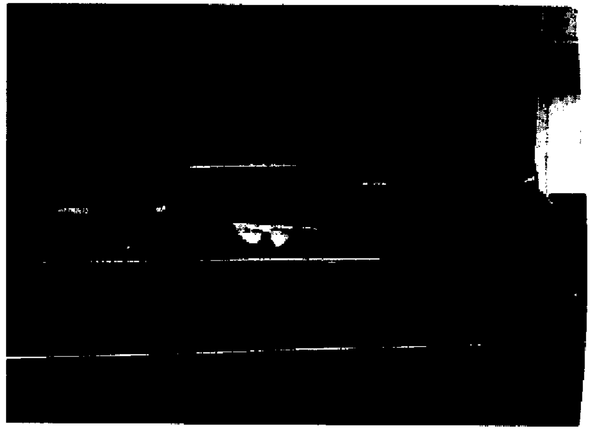


Health Care Provider Telemedicine Workstation

The Health Care Provider Telemedicine Workstation needs to be part of the provider's normal work space. In the case of a local health care provider, appropriate specialty peripheral medical equipment is part of the Workstation. Our experience to date indicates that the document camera is valuable to many specialities. This scene depicts also the electronic equivalent of a stethoscope and a pharyngoscope. A consultant may not need all the data acquisition equipment needed by the local health care provider because he or she will evaluate, not generate, the data. (See Figure 5 on the previous page for a more Spartan suite of equipment.)

The ability to have, to generate and to communicate essential patient information in-flight is one important part of providing an uninterrupted continuum of care to a patient being evacuated. This hand-held computer for recording in-flight patient information is being developed and refined for Air Mobility Command in partial fulfillment of this requirement.

In-Flight Air Evacuation Unit



Mobile Telemedicine Kit

By selecting and integrating telemedical equipment which can be carried easily to the patient in the field, medical expertise can be brought to the patient and consultative services can be delivered from afar. In effect, the doctor with the needed specialty expertise is brought to the patient, rather than taking the time and wasting the "golden hour" taking the patient to the doctor.

Figure 5 continued

Further, greater timeliness of treatment has always been known to have great medical benefit as well as to be a major cost reducer.

6.0 Telemanagement and Telemedicine Testbed

While group video conferencing technology is mature and to a large extent interoperable due to the international video conferencing standards, desktop technology is just emerging. Many different incompatible approaches are being pursued. Telemedicine technology is even more immature.

Proprietary video and audio compression techniques are being implemented by some vendors to optimize performance over local area networks, which are outside the scope of the current H.320 international VTC standard designed for ISDN services. Other vendors are using techniques to transmit out-of-band in a local area by using spare telephone wire, or by riding on the copper conductors that may be used for the local area network transmission media. Further, standards are not yet in place for applications sharing and other features now part of desktop video conferencing systems.

The desktop products also differ in terms of performance and features. Similarly, telemedicine systems which are based to a large extent on integration of other commercial off-the-shelf medical, video and audio components, also represent a new technology which is yet to be proven in use.

To address these kinds of interoperability issues and to evaluate and test candidate products, we have put in place a distributed interoperability and product evaluation testbed. (For example, see Figure 5, "Deployed Telemedicine Concept" and Figure 6, "A Spectrum of Needs Met by a Spectrum of Equipment")

The testbed has been instrumental in helping us achieve our success in many ways. It has:

- facilitated product evaluation and selection,
- provided a means to evaluate alternative system's performance and stability,
- allowed early user participation in defining requirements, evaluating system concepts, and in selecting products,
- helped vet potential system alternatives with selected users prior to deployment. This has facilitated our providing the right technological tool to the user as opposed to mandating the use of a technological tool on the user,
- provided a tool for the project office — improving communication among the project team members, i.e., the customers and the project office, and
- functioned as an important tool for providing telemaintenance and teletraining support, thus reducing operations and maintenance costs.

7.0 Prototype Network Current Status

7.1 Significant New Global Capabilities Achieved Rapidly by Investing $10 Million from Multiple Sponsors and Leveraging the Billion Dollar Public Network

Over the past four years a number of sponsors have augmented the efforts of the Air Force Office of the Surgeon General, our primary sponsor. The funding provided by the Office of the Air Force

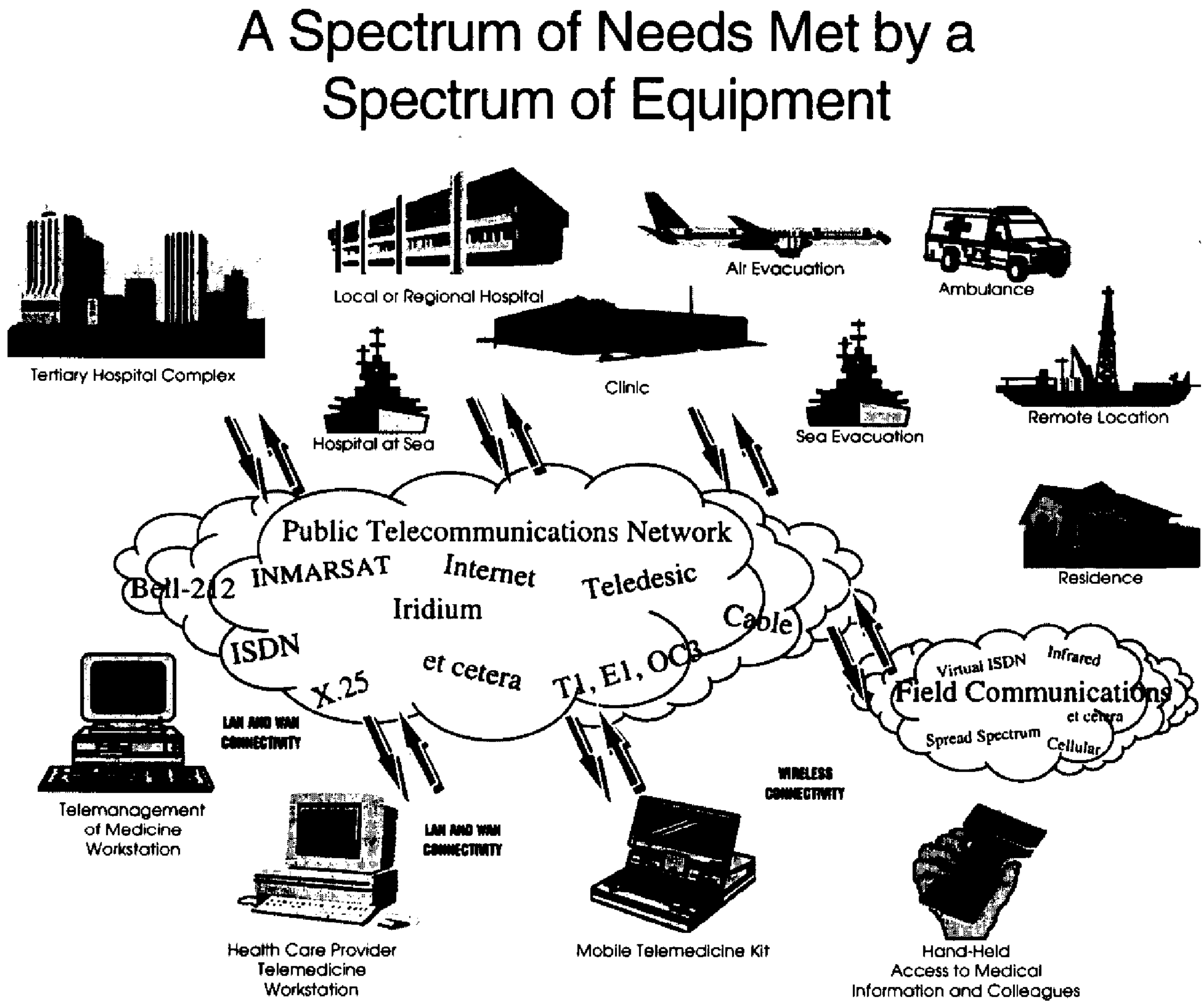


Figure 6 – To achieve its promise, telemedicine must link the patient and the proximate health care giver to the expert, the consultant. This requires that telemedicine be globally interoperable, just as the telephone has achieved such interoperability to maximize utility and, in turn, to maximize resultant markets.

Surgeon General was nearly doubled by others who saw the value of deploying a global network to support an integrated telemanagement and telemedicine network. Further, this network leveraged the hundreds of millions of dollars being invested by commercial enterprises in the global information infrastructure. Beyond this, another form of leverage was taken advantage of by employing the talents of the Air Force's Electronic Systems Center and the MITRE Corporation who had over decades been developing and deploying command and control centers and interoperable networks which had very similar characteristics to the telemanagement and telemedicine network needed by the Surgeon General.

7.2 Air Force Surgeon General Network Achieving $3 to $6 Million in Savings Annually from Investment of $4.5 Million over Four years

The Surgeon General's telemanagement system, has significantly enhanced the capability for making timely decisions. Annual savings have accrued not only in the form of improved decision making, but also in reduced management, training and medical travel costs and reduced time away from primary duty station conservatively estimated at $3 to $6 million per year,[27] a half-year payback, which can be leveraged to extend the global network and further enhance the savings.

Awareness of the improvements generated by the interregional medical decision support capability has stimulated regional medical commanders to provide similar capabilities on an intraregional basis. Supplementing the Surgeon General's regional VTC bridging capabilities, the intraregional VTC bridging capabilities will dramatically reduce telephone costs and increase the flexibility of how doctors and medical executives can be brought together while working apart. Thus, the enhanced decision support and cost savings generated by the system will intensify as the intraregional bridges are brought on line.

7.3 Spectrum of Interoperable, Integrated, Commercial-Off-the-Shelf Telemedicine Prototypes Developed and Currently Being Deployed That Can Rapidly be Adapted to Military and Civilian Local Telecommunications Infrastructures and Medical Needs

Our challenge in 1996 and 1997 is to reengineer the clinical decision support processes to facilitate communications between patients and their local doctors who can then collaborate with a distant medical consultant to create a close patient-doctor-consultant treatment team. This will result in quicker and more accurate treatment in cases requiring consultations and will result in CME-like experiences by the local doctor. (See Figure 5, "A Spectrum of Needs Met by a Spectrum of Equipment")

As of 1996 progress towards this end has been made by designing and implementing a telemedicine testbed in collaboration with the Air Force Air Combat Command. This testbed's design followed the expert leadership of Dr. Jay Sanders and Lahey Hitchcock Clinic and relied on experience gained during the Texas Prison Telemedicine project led by Dr. Bob Brecht.[28] An important testbed design feature stemming from this collaborative approach was to integrate the telemedical instruments into the physician's desktop computer along with video teleconferencing.

Our design contrasts with placing a telemedicine center hundreds of feet from the normal examining room environment. The technology-driven design of these large telemedicine centers has generally resulted in expensive centers, and limited use has resulted from the distance from the patient. These two factors, high cost and low usage, have reduced the actual and perceived cost-effectiveness potential of telemedicine. The cost-effectiveness of our efforts has been increased from this perception in a number of ways, two of which are: 1) to lower the equipment cost by scaling the equipment to the needs of the user as articulated by the user and 2) to emplace the equipment where needed as articulated by the user, typically the examination room or the doctor's office.

Further, deployment of the testbed equipment has been such that existing consultative patterns are duplicated. This results in the least perturbation of already existing doctor-consultant relationships. Both fiscal and medical impact measurement techniques have been overlaid on the testbed trials in a fashion which will also allow comparison of results with other telemedicine trials.

7.4 Stage Set for Further Enhancing Delivery of Medical Care by Integrating Telemanagement, Telemedicine and Continuing Medical Education (CME)

In 1996 we also learned how to deliver telemedicine when the patients and the doctors are far apart from each other. The stage has been set to link isolated patients and care providers to distant, more capable care providers. This form of telemedicine will at first be used to provide better and more timely care for Air Force personnel in isolated locations or locations where limited military medical staff is available. As this technology and clinical practice evolves, we anticipate that better medical care will become available to many who now have medical care constrained because of distance between patient and provider. Beyond this, the interaction between the remote higher-qualified or more specialized doctor and the on-scene provider will enhance the on-scene provider's medical skills much more effectively than current approaches to CME.

8.0 Near Future on Demand, Space Based Delivery of Multimedia Services

8.1 Air Force, Joint Community and Civilian Trends

Our sense is that the thrust of our current efforts could help the Air Force, as well as NATO and Transatlantic communities, to enhance current telemedicine initiatives by making them more mobile, to provide in-flight capabilities and to assist in consolidating, integrating and standardizing capabilities useful to the joint community. (See Figure 5, "Deployed Telemedicine Concept")

Alongside Air Force initiatives, Army and Navy telemedicine initiatives are rapidly emerging.[29] Ongoing telemedicine initiatives are available by accessing the Office of the Secretary of Defense for Health Affairs Home Page, http://www.ha.osd.mil/index.html. The major challenge will be concurrently to reduce medical and command and control fragmented development efforts, to insert new technology and to make the new capabilities interoperable and easier to use.[30,31,32]

Healthy cities and regional networks are paralleling military telemedicine efforts. Civilian efforts could leapfrog military efforts once the commercial communications infrastructure becomes more robust, secure and less costly and once state licensing constraints are removed. Significant telemedicine efforts are currently under way at leading-edge cities and regions with extensive medical facilities, such as those in Massachusetts, Texas, Georgia and Washington, DC. Each of these regions is also beginning to link with each other and reach out to global sites in significant need of health care.[33,34]

8.2 New "Race In Space" To Support Contingencies, Trade and Tourism

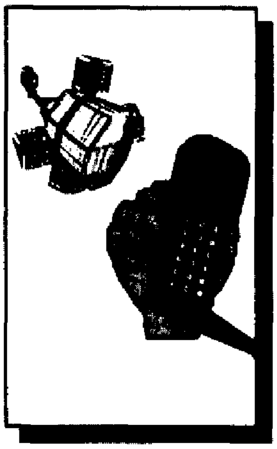
Annually, hundreds of billions of dollars are being spent by international consortiums to build and enhance a commercial global grid of telecommunications networks linking continents under the sea, on the ground and in space.

Medical teams, as well as warriors and businessmen should be ready to benefit from this huge commercial and military investment.

In space there is a new economic war[35] and satellite race[36] (See Table 1, "The New Satellite Race") being driven by common needs for multimedia services of globally deployed military, businessmen and travelers, (See Table 2, "Information Service Needs of the Modern Traveler"), rapid advances in infrastructure (See Figure 7, "Rapidly Emerg-

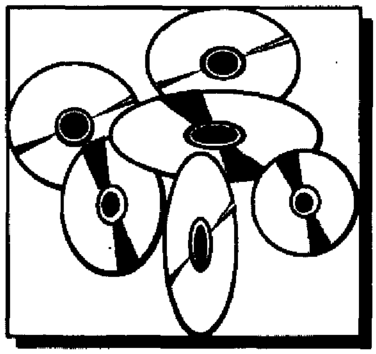
Rapidly Emerging SATCOM Services

Odyssey



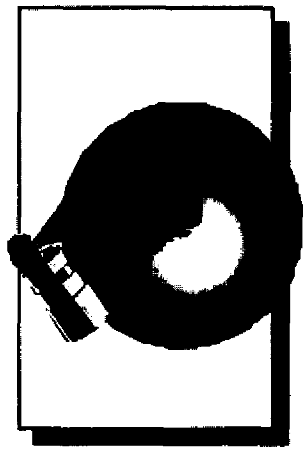
Personal Communications Systems
- "Big LEOs"
- Voice and Data
- Odyssey, Iridium, Globalstar, ICO

CD Radio



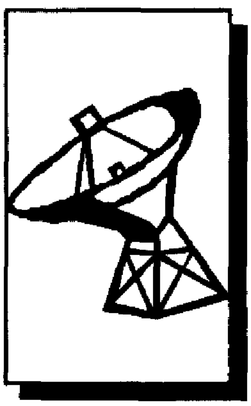
Digital Audio Radio
- CD Quality Sound
- Mobile Terminals
- CD Radio, Primosphere

Orbcomm



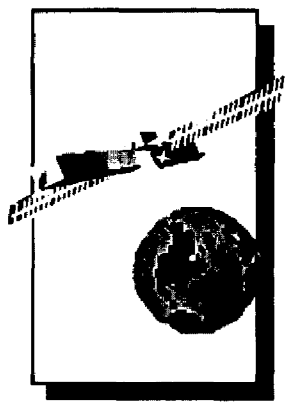
Global Data Services
- "Little LEOs"
- Email, paging, telemetry
- Orbcomm, Starsys, VITA

DirecTV



Direct Broadcast Systems
- High Power Satellites
- 18" Terminals
- Future data/Internet Services
- DirecTv, Primestar, Dish Network

Spaceway



Ka-Band Broadband Services
- New 20/30 GHz Band
- Bandwidth on Demand
- Spaceway, AT&T,
- VoiceSpan, GE Amercomm,
- AstroLink, Cyberstar

Figure 7

Table 1. The New Satellite Race (Major Players)*

PROJECT	FUNCTION	SATELLITES	COST (in billions)	LEAD BACKER
Teledesic	High-speed data, teleconferencing	288	$9.0	Craig McCaw
Iridium	Voice, fax, paging	66	5.0	Motorola
SkyBridge	Data	64	3.9	Alcatel-Loral
Celestri	Data, broadcast and video	63	12.9	Motorola
Globalstar	Voice	48	2.5	Loral
ICO Global Communications	Voice	12	4.6	Hughes/Comsat

* Source: The Wall Street Journal, 17 June 1997, page A3

ing SATCOM Services") and profitable communications ("to/from") products and services.[37]

8.3 US Joint and Transatlantic Community Recent Efforts To Commercialize and Share What Works to Accelerate Growth of Healthy Regions

The purpose of this section is to highlight recent US, joint community and international efforts to commercialize low cost, interoperable telehealth products and stimulate in various Transatlantic and other regions, KISS-proof (Keep It Simple, Sam, proof of concept) initiatives.

For instance, by replicating in various NATO countries, easy to implement, low-cost, self-sustaining projects that leverage or link to the rapidly emerging global communications grid, isolated, remote NATO military units can become familiar with basic store and forward clinical decision support services augmented as required by low-data-rate video conferencing to emergency rooms in NATO countries. *This model can then be shared, adapted and enhanced to support the global needs of businessmen and tourists and vice versa.* Furthermore, as we attempt to expand NATO and transition downward the American presence in Bosnia, we can leave in place a "Medical Partners for Peace" service delivery system that, hopefully, will be used to reduce tension.

To achieve this vision and strategy, KISS-proof products (i.e., low cost, commercial off the shelf desktop/laptop computers with attachable medical devices and standards based collaborative software capable of performing in low cost "store and forward" internet and ISDN video conferencing modes, with optional wireless and satellite capabilities for even more remote and aeromedical evacuation environments) were acquired, integrated and tested in conjunction with Air Force, Army, DOD Health Affairs, civilian testbeds and the Combined Unified Battlefield Environment (CUBE) of the Electronic Systems Center (ESC). Next, a phased worldwide telemanagement network was implemented. Subsequent steps implemented telemedicine and/or teletraining capabilities in Missouri, Nebraska, Ohio, California, Alaska and NATO countries. (See Figure 4, "MDPR Collaborative Telemedicine Network" and Figure 5, "Deployed Telemedicine Concept")

To share these ABCs of telemedicine, the Atlantic Rim Network, led by James H. Barron, JD, organized an historic first: a Transatlantic Telemedicine Summit in Boston in May 1997. Nearly 250 leaders in telemedicine (policy makers, health care and technology providers) from various countries convened (under the chairmanship of Doctors Jay Sanders and Jean-Pierre Thierry) to learn of residual constraints and to share lessons-learned insights.

Concurrently, these leaders were exposed also to a dozen specific examples of low-cost interoperable telemedicine projects which could be replicated in their various Transatlantic or NATO countries.[38] One result is an accelerated NATO related regional effort which is now underway in Canada. The initiative is led by The Augmented Reality Testing Integration and Communications (ARTIC) LAB (www.digital-fx.ca) which was recently opened by the Right Honorable Jean Chrétien, Prime Minister, Canada, who was also a VTC participant at the Summit.

The Atlantic Rim Network is preparing multimedia proceedings and organizing follow on activities to assist US Joint Community, Health and Human Services regions, NATO and other countries[39] to rapidly digest, adapt and adopt insights presented at this Symposium. Plans are also underway to hold a 1998 Transatlantic Telemedicine Summit in Europe.

Key among the insights presented at the Boston Summit were telemedicine, trauma care training, disease control and aeromedical evacuation. This Rotterdam Symposium highlights the pioneering efforts of USTRANSCOM/Air Mobility Command[40] and DOD Health Affairs Region 6[41] in aeromedical evacuation and NATO efforts in telemedicine.

Table 2. Information Service Needs of the Modern Traveler[43]

Information User:	Military Commander	Business Executive	Global Employee
Information Need:			
Telephony (Voice)	x	x	x
Voice recognition	x	x	x
E-Mail	x	x	x
FAX	x	x	x
File exchange	x	x	x
Application download	x	x	x
Remote database access	x	x	x
Internet Access	x	x	x
High resolution image	x	x	x
Video conference	x	x	x
Audio broadcast	x	x	x
Data broadcast	x	x	x
Receive video broadcast	x	x	x
Transmit video broadcast	Possible	Unlikely	Unlikely
Data security	Multi-level classified	Privileged	Privileged

x = strong requirement

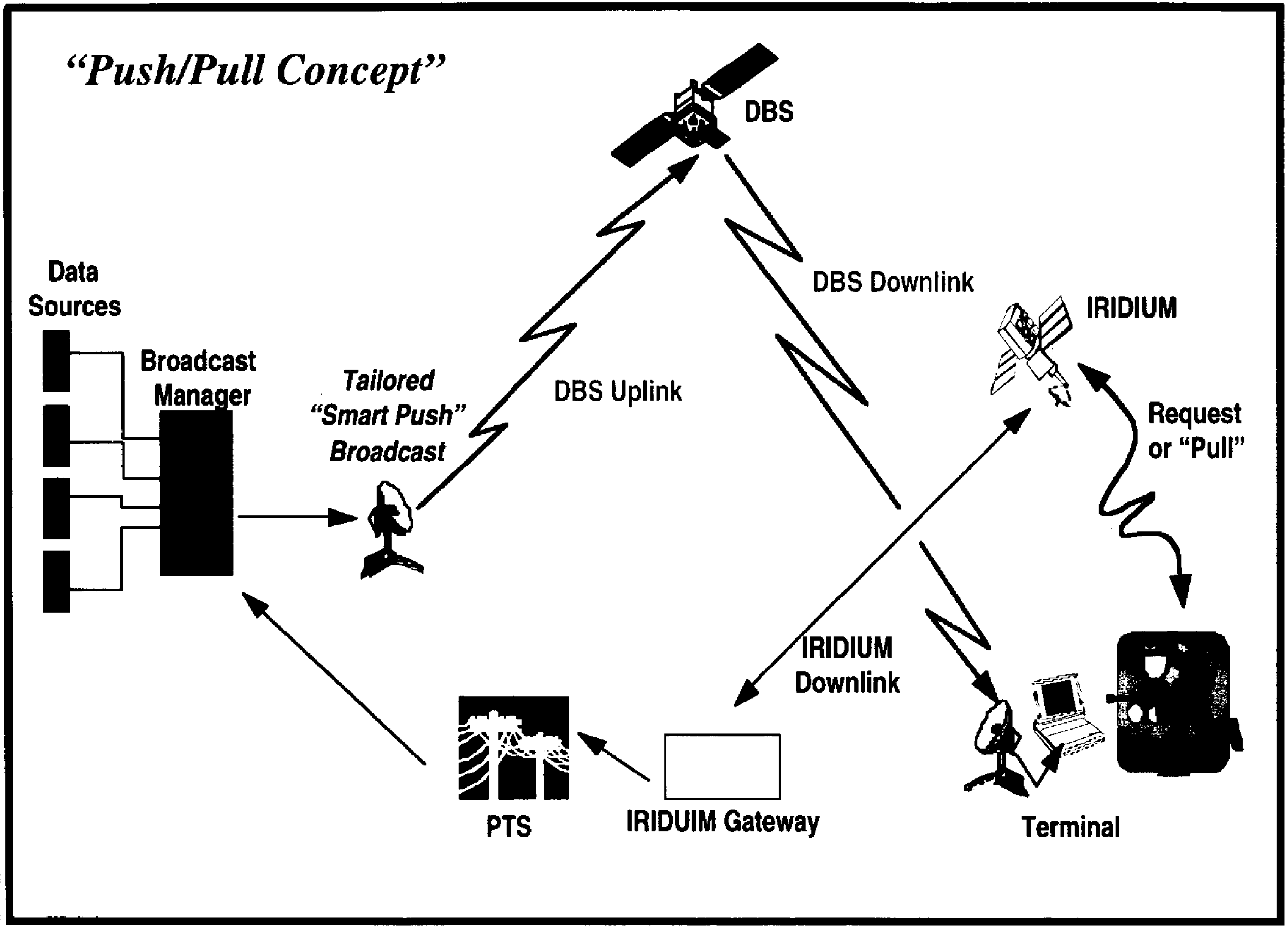

"Push/Pull Concept"
DBS
Data Sources
Broadcast Manager
Tailored "Smart Push" Broadcast
DBS Uplink
DBS Downlink
IRIDIUM
Request or "Pull"
IRIDIUM Downlink
PTS
IRIDUIM Gateway
Terminal

Figure 8

8.4 Revolutionary New Space Based Services in 1998

This ongoing activity sets the stage for near future, on-demand, space based delivery of multiple information services.

The basic concept of how these new services will be requested and delivered is illustrated by the "Push/Pull Concept." (See Figure 8) An information request or "pull" is executed by a remote warrior, medic, businessman or tourist using a hand held device similar to a cellular phone (e.g., Iridium subscriber set). The signal is picked up by a constellation of low earth orbiting satellites (Big LEOs) which use "on board processing" and "cross linking" capabilities to hop across satellites and down to the regional "gateway" nearest the desired destination. Here the signal is converted to a format understood by the phone system and sent to the intended receiver.

If a response requires a multimedia high speed broadcast the return broadcast is sent to the appropriate mix of commercial and/or military "direct broadcast satellites" (DBS) to the requester's earth station. This ground terminal could be a low cost, commercially available "lapsat" (e.g., Direct PC) or a more complex and costly terminal, depending upon security and access issues or desired format of the request (e.g., text).

Motorola's Iridium capabilities will be globally operational starting in the fourth quarter of 1998. Shortly thereafter, US/NATO units, as well as businessmen, will be able to call in "information strikes" tailored to their warfighter, medical or business needs anytime from anywhere.

An airborne delivery of similar services to enroute or returning or evacuating global military, business or civilian travelers is shown in Figure 9. Envisioned here is a similar request for a "common operating picture" by the warrior or just-in-time trauma care training by an air crew/attendant.

The "push/pull" is handled through a space network ("internet in the sky") similar to that just discussed. The return signal could be received by a phased array antenna on the skin of the aircraft and distributed via an on-board "server" to satisfy the differing needs of crew and passengers.

Space based (direct broadcast satellite) delivery of television and data services to aircraft has already been demonstrated (e.g., in the Joint Warrior Interoperability Demonstrations). On demand, space based, transmission of voice and data from aircraft (e.g., via INMARSAT and AFSATCOM) has been a reality since about 1980. Integration of the two functions into a push/pull service should not be a major undertaking.

Therefore, such a system shortly can be delivering a variety of entertainment, business and aid services to airborne civilian and military travelers which will augment today's civilian and military aeromedical evacuation.[42]

8.5 The Future IS Conditional

In conclusion, this revolutionary delivery of robust space based information services will soon be able to augment deploying and deployed contingency units. However, cost effective, medically valuable services will depend upon how well we learn success/failure lessons from the already deployed KISS-proof concept initiatives and the growing investment being made in high cost, pro-

Civil/Military Joint Operational Concept

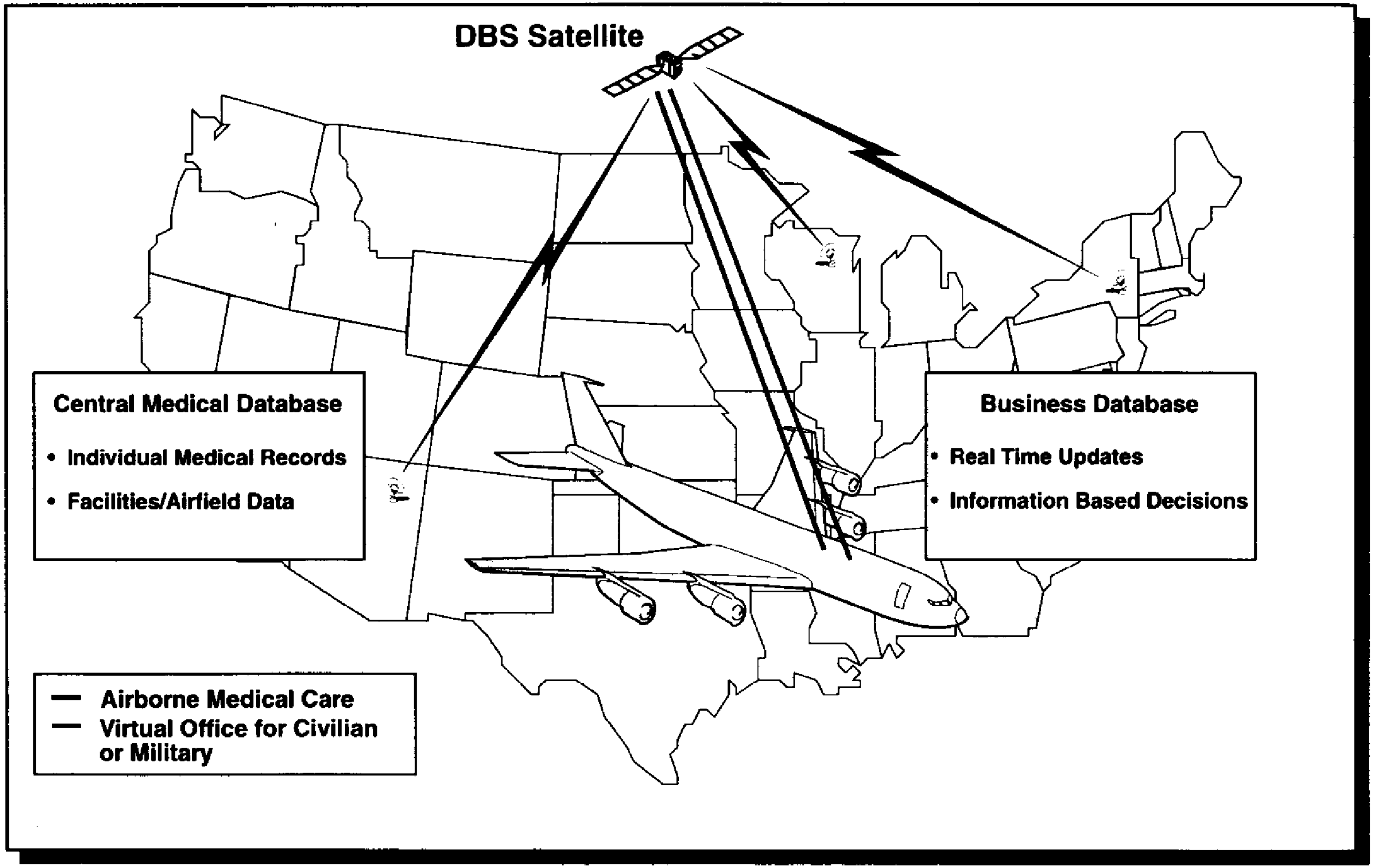


Figure 9

prietary equipment acquisitions.

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39 We are reminded by Frank Davidson, JD, DHL (Hon.) of the worldwide interest and building recognition and support of telemedicine:

The Transatlantic Telemedicine Summit has had global repercussions, thanks to the presence of a strong team of liaison participants not just from the West, but from Japan and other countries outside the Western Hemisphere. Governor Ota of Okinawa dispatched a group of experienced specialists: Professor Manabu Nakagawa, advisor to the Prime Minister, and Mr. Kada, both of the burgeoning Peace Engineering Institute, who emphasized how telemedicine and teletraining will enhance trade and tourism, along the lines discussed at the Spring 1997 meeting at Harvard and MIT with the governor where he was presented the Rensselaerville Institute's Theodore Roosevelt Peace Engineering Award. More recently, the Tama Conference in Japan presaged a substantial development program for the widespread application of telemedicine training and technology in Asia and elsewhere.

All in all, we are witnessing a prototype for the next century of macro-engineering: the coalitions now a-building are intersectoral, interdisciplinary and international; there is a dynamic and cooperative relationship between civilian enterprises and military institutions, with university campuses in the role of catalytic centers for specific, practical initiatives. This ripening technology has enlisted the support of the younger generation of doctors and engineers, with leading roles being played by pioneers such as Dr. Jean-Pierre Thierry and Marie-Gabrielle Verdier. France's Association Louis Armand, led by Henri Teissier du Cros (a conseiller d'état honoraire) has provided intellectual support; Thierry Gaudin of the Foundation Prospective 2100 follows these events closely and with understanding. And the International Association of Macro-Engineering Societies, headed by Uwe Kitzinger, CBE, has provided diplomatic and practical insights that have helped keep the entire program "on track."

In this context, the proliferation of telemedicine initiatives may be viewed as a harbinger of still further macro-engineering initiatives from whose accomplishment may emerge a unified whole. For, as Arthur Waldron has taught us, the Great Wall of China was, in fact, the end result of centuries of local and regional efforts to build defensive works of limited range and purpose. Dr. Peter Glaser, the famous inventor of the Solar Power Satellite, has dubbed this process "terracing." Each terrace of achievement , once built and operational, serves as a foundation for ensuing steps. And the habit of collaboration across institutional and geographical boundaries will foster a nurturing climate that will indeed accelerate the establishment of "a sustainable health care society," in the words of Manabu Nakagawa, chair of the Tama Renaissance Symposium.

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