

Survey of Diego Garcia (BIOT) as a Remote Client for Telemedical Services

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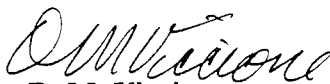
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PREFACE

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13. ABSTRACT (Maximum 200 words) The purpose of this document is to report on the results of a site survey that occurred from 19-27 April 1996 on the island of Diego Garcia, which is part of the British Indian Ocean Territory (BIOT). The objectives of the survey were (1) to assess the clinical requirements for telemedical services and (2) to evaluate the capability of a remote client to provide the communication resources for supporting these services. An assessment of the clinical needs revealed that teleradiology and video conferencing with still image transfers and whiteboarding were the major empowering services. Training aids and INTERNET video teleconferencing with one's medical peers were additional expressed needs. It was also determined that there were no specific requirements or desires for remote dental services unless it was part of a U.S. Navy-wide requisite. At present, the major stumbling block for telemedicine on Diego Garcia is the availability of affordable digital telecommunication services.					
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TABLE OF CONTENTS

Chapter One	
1.0 Telemedicine Services and Requirements for Remote Naval Stations.....	1.1
1.1 Introduction.....	1.1
1.2 Naval Medical Information Management Center Decision Paper.....	1.1
1.3 A Brief Description of Diego Garcia (British Indian Ocean Territory).....	1.2
1.4 Health Services Department, Naval Support Facility, Diego Garcia (BIOT).....	1.3
1.5 Other On-island Medical Personnel.....	1.4
Chapter Two	
2.0 Clinical Assessment.....	2.1
2.1 Clinical Environment.....	2.1
2.2 Specific Clinical Improvement Areas.....	2.2
2.3 Medical Evacuation Procedures.....	2.3
2.4 Medical Evacuation for First Trimester 1996.....	2.4
Chapter Three	
3.0 Telecommunication Resources	3.1
3.1 Framework of Telecommunication Services on Diego Garcia.....	3.1
3.2 Infrastructure of the Military and Commercial Telephone Service Providers.....	3.2
3.3 Present or Near-Term Telecommunication Resources for Telemedical Services.....	3.4
3.4 Recommended Local Connections for Switched-56 Telephony Services.....	3.5
Chapter Four	
4.0 Current Telemedical Resources on Diego Garcia.....	4.1
4.1 Digital Camera.....	4.1
4.2 PICASSO Still-Image Phone.....	4.1
4.3 Enhanced CU-SeeMe.....	4.3
Chapter Five	
5.0 Regional Telemedical Services.....	5.1
5.1 Background.....	5.1
5.2 Regional Assessment.....	5.1
5.3 A Brief Description of Diego Garcia (British Indian Ocean Territory).....	5.2
5.4 Health Services Department, Naval Support Facility, Diego Garcia (BIOT).....	5.3
5.5 Other On-Island Medical Personnel.....	5.4
Chapter Six	
6.0 Recommendations and Conclusions.....	6.1
6.1 Recommendations.....	6.1
6.2 Conclusions.....	6.3
References	
R.0 List of Reference.....	Ref.1

Chapter One

1.0 Telemedicine Services and Requirements for Remote Naval Stations

1.1 Introduction

By now, the term telemedicine has gained universal acceptance. Simply stated, telemedicine is the management and transfer by electronic means of medical information. Though this definition allows for an abundance of interpretations and implementations, the central theme usually is the distribution of medical information over disperse geographic areas for referral, consultation, record-keeping or education. Almost daily there are references to telemedicine in the media, at forums and in casual conversations. World-wide, governments are looking to incorporate various aspects of telemedicine into their health care delivery system. Countries as disperse as the Republic of Singapore, Thailand, China, Saudi Arabia, Venezuela and the United States are, either independently within their own borders or in alliance with each other, demonstrating improvements to both the quality and the timeliness of health care and maintenance. Hastened by a multitude of factors, including the ready availability of technology, cost containments resulting from government and corporate downsizing and the growing lack of public receptivity to casualties resulting from war or peacekeeping missions, the predominant user and innovator of telemedicine today is the US military.

For the past several years, the Naval Undersea Warfare Center (NUWC) has had a growing interest in incorporating telemedicine into an array of applications. Consistent with its mission to provide for and develop innovative and affordable technologies to address undersea and submarine warfare, this Center has teamed with several other organizations not only to support its primary mission areas, but to enhance the development and availability of telemedical services to US Navy personnel in remote areas. Most recently, this Center has teamed with the National Science Foundation and the Naval Medical Information Management Center to demonstrate telemedicine and to augment the medical capabilities of the Naval Medical Hospital at McMurdo Station, Antarctica.

1.2 Naval Medical Information Management Center Decision Paper

Late in December 1995, the Naval Medical Information Management Center (NMIMC) in a draft version of an abbreviated systems decision paper [Studebaker], outlined a plan to introduce telemedical services into the Health Services Department at the Naval Support Facility in Diego Garcia, British Indian Ocean Territory (BIOT). The plan called for augmenting the current medical treatment protocols and medical evacuation procedures with several remote consultative services that were either resident in the Western Pacific region or within the United States. The plan itself was divided into three phases roughly organized as i.) assessment and acquisition, ii.) installation and iii.)

Survey of Diego Garcia (BIOT) as a Remote Client for Telemedical Services

operation and evaluation. The intended time for assessment (site survey) was in the second or third quarter of calendar year 1996.

The stated benefits read as follows:

Sailors, marines, joint service personnel and other eligible beneficiaries will have access to immediate specialty care located throughout the region and Medical Treatment Facilities located in continental United States without having to travel. The result is an increase (to) our Operational Readiness because service people will spend less time away from their command.

1.3 A Brief Description of Diego Garcia (British Indian Ocean Territory)

Diego Garcia is located on an atoll in the North-Central Indian Ocean. Diego Garcia is part of the British Indian Ocean Territory (BIOT) that was formed in 1965 from territory that formerly belonged to Mauritius and the Seychelles. The island is one of 52 in the Chagos Archipelago. The archipelago, which extends over an area of 10,000 square miles, is located roughly in the center of the Indian Ocean, south of India, between Africa and Indonesia. Transit to and from the island is usually by aircraft operated under the Military Airlift Command. The two nearest points of disembarkation are Singapore and Bahrain, each about five hours flying time from the island.

The island is horseshoe shaped with a perimeter of approximately 40 miles. The enclosed lagoon is 6.5 miles wide and 13 miles long. The island covers an area of 6,720 acres. The average elevation is four feet above sea level, the maximum being 22 feet. The climate is tropical, temperatures average around 80 degrees, with a mean high of 85 degrees and a mean low of 76 degrees. The average rainfall is 102 inches per year. The island is densely vegetated. The primary trees are coconut palms, although a number of other species are present. There are a number of protected species including the coconut crab, sea turtles and free roaming donkeys. The white sandy beaches are pristine, with an abundance of small seashells and occasional examples of red and blue corals amongst the more abundant debris of white. The lagoon is a wonderful resource in which to study a wide variety of colorful sea life. Both the lagoon itself and the surrounding Indian Ocean are considered spectacular fishing areas.

In December of 1966, the United Kingdom and the United States signed a bilateral agreement making the islands of the British Indian Ocean Territory available for defense purposes to both governments. Although both British and American flags fly over the island, British law, customs and regulations apply and are enforced by some 40 or so British nationals resident on the island. The remaining population of approximately 3300 persons is divided almost evenly between those who are attached to the American Military Command and contract personnel, primarily from the Philippines. The latest quarterly population report [Kingston] presenting the population distribution according to military grade or status and gender is shown in Table 1.1

	Officers	Enlisted	Civilians	Totals
Men	143	934	284	1339
Women	14	250	33	299
Total	157	1184	317	1638

TABLE 1.1: American Military Command Population Distribution

Population statistics broken down according to gender were not as readily available for the contract personnel. In a memorandum to the Bureau of Medicine and Surgery, populations figures for late 1993 [Taylor] indicated an approximate 9 to 1 ratio between male and female.

1.4 Health Services Department, Naval Support Facility, Diego Garcia (BIOT)

The Health Services Department is part of the Naval Support Facility Diego Garcia. The primary purpose of the Facility is to afford logistical support to the operating forces of all United States and Allied Military Forces forward deployed in the Indian Ocean and the Persian Gulf. Battle group supplies, equipment and personnel normally transit through Diego Garcia.

In addition to providing services to the personnel on Diego Garcia, the Health Services Department supports each battle group as it enters the Indian Ocean. Though the Department coordinates and manages medical evacuation procedures through normal message traffic, an onboard carrier visit to brief the Medical Department is usually required as early as possible. Diego Garcia has also been a routing point through which human remains are flown on the way to the US Air Force mortuary in Okinawa Japan.

The Health Services Department provides medical and dental care to all personnel in Diego Garcia. Two division officers, the Senior Medical Officer (SMO) and the Senior Dental Officer (SDO), report to the Department Head in all matters relating to their divisions. In certain situations, there will be occasions when the SMO reports to the Commanding and Executive Officers on matters concerning the medical condition of a patient. By its own admission [PKO Briefing], the Health Services Department has limited medical capability, being a small dispensary, not a hospital. A picture of the Department is shown in Figure 1.1.



FIGURE 1.1: *Main Entrance HSD Dispensary
Diego Garcia (BIOT)*

Survey of Diego Garcia (BIOT) as a Remote Client for Telemedical Services

Currently, there is a flight surgeon and a VP Squadron medical officer that assist the SMO, while the SDO is assisted by a junior dental officer. The normal rotation procedure places doctors on staff who are on Operational Utilization Tours. This is considered *real world* experience prior to their residency. The SMO, on the other hand, has completed residency requirements. Inpatient care is based on the availability of resources and the competence and experience of the specific medical officers.

The facility itself has six holding beds, two acute care beds and an operating room (Figure 1.2). The beds are also available for medical evacuation patients who, depending on circumstances and events, are awaiting transportation to Singapore, Japan or continental United States. In addition, there are patient examining rooms for medical and dental services, a laboratory, an X-ray facility, a pharmacy, a preventive medicine office, and a biomedical instruments repair area. Staff in the Health Service Department number around thirty-five, eight officers, approximately twenty-six enlisted and one civilian.



FIGURE 1.2: Operating Room HSD Dispensary
Diego Garcia (BIOT)

1.5 Other On-island Medical Personnel

As mentioned earlier, there are an additional 1600 residents on the island not directly part of the American military command. The largest number are contract support personnel, the majority of whom are from the Philippines, with a small minority from Mauritius. Administration of medical services to this population is provided by the BOS Contractor. A staff of two medical officers and two nurses, typically either from the Philippines or Mauritius, look after the health and medical needs of this community. When warranted, staff will either request X-rays or laboratory tests or make a referral to the Health Services Department, who in turn either honor requests, provide medical treatment, or make further referrals or recommendations for medical evacuation.

The Military Sealift Command (MSC) has two medical personnel assigned to look after personnel in the MSC unit. This survey did not identify the extent of interaction with the Health Services Department.

Chapter Two

2.0 Clinical Assessment

2.1 Clinical Environment

There is a certain feeling of isolation here on the island. At other Commands, we are so used to interacting with others, which is something you cannot do here. One can correspond with other commands by Email, but one has to make the solicitation. Other Commands really do not know that we are here. For example, it would be nice to be able to participate in Grand Rounds.

Lt. Edward Bates (Senior Nurse)

On Diego Garcia, the active duty personnel number about 1350 persons, approximately divided amongst 1080 males and 265 females. The Health Services Department staff of thirty-five provides routine and emergency medical and dental care to the island's population of 3300 people. The Health Services Department renders its services as a dispensary, not a hospital. Though its competency fluctuates with the capabilities of its changing staff, it is also supported by consultation with staff at Mount Elizabeth in Singapore. In the event that further treatment is required, the next Military Medical Treatment Center is Okinawa (Japan), followed by continental United States. When required, urgent medical evacuations are made to Singapore. At minimum, a medical officer and a nurse are required to accompany the evacuee. Such circumstances can cause additional workload problems for the remaining staff.

A listing of specific workload areas for several of the last years is presented in Table 2.1.

Workload Area	1992	1994	1995
Lab	58622	92349	87817
X-ray	2642	2994	2283
Dental	4602	3824	5070
MedEvacs	151	90	94

Table 2.1: *Listing of Selected Workload Areas for 1992, 1994 and 1995*

Though the listed years are different in character, i.e., they do not all start with the same month, they are representative of the workloads for a twelve month period. A generally consisted workload picture is presented, although the figures for 1992 indicate a fairly steep increase in medical evacuations and a lower level of lab testing.

There was no indication why the number of medical evacuation were so high. On the other hand, lab testing levels often correlate with the tour period of a particular SMO. Some Senior Medical Officers are more comfortable ordering a full compliment of Lab tests. Others are perhaps more pragmatic and limit their Lab tests to those for which there is a good turn-around period. There have been instances when Lab results do not return in time to prescribe proper treatment protocols. Often if the symptoms persist and consultation with Mount Elizabeth in Singapore is inconclusive, the patient is processed for medical evacuation.

2.2 Specific Clinical Improvement Areas

The top expressed requirement for telemedicine is teleradiology. Approximately 50 radiographic studies [Kilmer] are opened each month. Of these studies, orthopedic is by far the largest (greater than 90%) along with a few chest and an occasional gastro-intestinal study. It is felt that 10 percent of these studies would benefit from further consultation. Most cases, probably 60 percent, are a result of sports and recreational injuries. Far fewer are the result of on-the-job injuries. There are also a number of injuries that are alcohol related. Though some traumas are accidental, a small number result from deliberate actions.

Blood testing procedures and capabilities are felt to be adequate considering the geographic location. Equipment that is currently considered marginal is in the process of being upgraded. Tests that cannot be performed locally are dispatched to Okinawa. This can inject a five to six day delay before the results are returned. Some concern was expressed about this delay as it may cause unnecessary deterioration in blood samples for certain tests. It is not known why samples are not flown either to Singapore or to Yokota for testing.

The reading of pap smears [Page-Rivera] is another problem. Approximately 25 percent of all samples that arrive in Okinawa are either air dried or heat contaminated. Again and again, the state-of-the-art capability of the Singaporean hospital system continues to be expressed. One continues to hear various senior staff members making the recommendation to institute Singapore as a regional hub.

It has also been observed [Bates] that at the Naval Computer Telecommunications Station (NCTS) there seems to be a high occurrence of hypertensive cases. Again, no supporting statistical studies have been done to bear out this observation, however there are approximately 20 radio men (first class) who are currently being monitored. One can only conjecture as to possible causes: environment, level of responsibility, work schedules, security and the flip side, the inability to off-load job related stress after hours through normal verbal transactions.

It has been observed by several medical care practitioners [Bates, Quinn] at Health Services Department that there is a high number of miscarriages, although there are no hard comparisons with other similar populations. Normal practice is to off-island an expectant, active duty member by the 20th week of pregnancy. There are no provisions on island to

deal with premature births. To off-island such an infant would be extremely risky as there are no incubators either on the island or on any of the aircraft

Current training aids are limited to video tapes, books, periodicals and classes at temporary duty stations. Additional aids would be beneficial such as the *VIPER* interactive courseware unit, the new video disk formats for interactive training developed by the Interactive Media Lab at Dartmouth Medical College for staff training in patient counseling and education, and the Medical Language Translator for both practice and practical applications

2.3 Medical Evacuation Procedures

The specific US Air Force procedures for medical evacuations on scheduled flights are outlined in US Air Force Regulations AF 74-11 and AF 74-28. Reference [4] states that a litter patient be charged for three seats while an ambulatory patient is charged for one. In addition, two to three seats are required and charged for accompanying medical personnel. In 1995 cited charges were approximately \$350.00 per passenger seat between Singapore and Diego Garcia. However current costs are believed to be in the neighborhood of \$675.00. Normally routine medical evacuees depart on scheduled flights. The flights may be either a charter operated DC-8 or a USAF C-141 flying either of which operate under the authority of the Military Airlift Command.

For urgent medical evacuations, a non-scheduled flight has to be arranged. The cost for non-scheduled flights between Diego Garcia and Singapore dramatically increases. In the case of on-island originated flight evacuations, estimates of a one way P-3 flight from Diego Garcia to Singapore range from \$25,000 to \$45,000. Crew sizes extend from 9 to 11 crew members, usually sufficient for crew augmentation. At least one night's stay in Singapore is the norm with per diem costs approximately \$200.00 per person. Paya Lebar, the Singapore Air Force Base that serves as the base for all US flight operations in Singapore, levies no specific landing fees. However the airport is normally only open Monday through Friday from approximately 0800 to 1800, holidays excluded. On the other hand Changi, Singapore's commercial international airport, is open around the clock and reportedly waives landing fees for medical emergencies. Compared to Paya Lebar, refueling costs are approximately 20% higher at Changi.

Besides the scheduled flights and the P-3 transfers that may involve up to eight hours to enact, not to mention the additional 60 to 90 minutes of flight time, there are non-scheduled, mission related flights that land periodically at Diego Garcia and which could be called upon in an emergency for a medical evacuation. For example a US Air Force flight mission on its return leg to Yokota AFB could be diverted to Singapore.

The general policy for evacuation is to discharge all DoD civilians to Singapore. Active duty members usually transfer to Japan. Philippine contract personnel on the island who work for BJS and who number approximately 1500 persons, are first treated by their own local doctors within their base compound. When warranted, medical referrals are first handled by the Health Services Department, who either treat or make recommendations for medical evacuation to Singapore. As a last resort, the patient is repatriated back to the Philippines

Another class of medical treatment involves third country nationals. For third country nationals who are evacuated due to medical emergencies typically occurring at-sea, the proximity to Singapore is considered an advantage as many vessels have an agent there. Once the ship's company releases a letter guaranteeing payment usually through the ship's bursar, the NSF Comptroller formulates and coordinates all charges. Other procedures may

involve representation and assurity guarantees from the national's embassy in Singapore. Further problems can arise for transfers while in Singapore. Should the individual's passport documents be in question, beside financial guarantees, there may be requirements for military escort.

2.4 Medical Evacuation for First Trimester 1996

Table 2.2 lists the medical evacuations for the first four months of 1996. It presents a number of interesting points. Four of the cases (16 percent), including the one urgent case, were evacuated to Mount Elizabeth in Singapore. Four of the routine evacuations, again 16 percent, were for alcohol abuse. Eleven (44 percent) of the twenty-five cases were classified [Quinn] as being likely candidates for telemedical services. These last are indicated with a grey background along with their ID entry number. Specifically, ID 2, 8, 9, 13, 16, 18, 19, 20, 21, 22, and 25 numbers were considered medical situations that would likely benefit from further telemedical consultation.

ID	SEX	A/C	MTF	U/P/R	DIAGNOSIS	SERVICE	DATE REGULATED	DATE DEPARTED	COMMENTS
1	M	KC-10	TRIPLER	R	THYROID SCAN	ENT	02-Jan-96	04-Jan-96	
2	M	KC-10	YOKOTA	R	FX R. HAND	ORTHO	03-Jan-96	04-Jan-96	
3	M	KC-10	MT. ELIZABETH	U	L. ORBITAL FX.	NEURO SURG	04-Jan-96	04-Jan-96	CIV HUM. FRENCH NAT'L/ SEA RESCUE
4	F	KC-10	YOKOTA	R		PSYCH	03-Jan-96	07-Jan-96	
5	M	C-141	OKINAWA	R	LEVEL III/ETOH	PSYCH	15-Jan-96	16-Jan-96	
6	M	C-141	OKINAWA	R	LEVEL III/ETOH	PSYCH	19-Jan-96	23-Jan-96	
7	M	C-141	TRIPLER	R	DEPRESS/SUICIDAL IDEATION	PSYCH	19-Jan-96	23-Jan-96	SENT TO SAN DIEGO AFTER EVAL AT TRIPLER
8	M	C-141	YOKOTA	R	R/O CONDUCTION DISTURBANCE	CARDIOLOGY	18-Jan-96	23-Jan-96	
9	F	KC-10	OKINAWA	R	LOWER BACK PAIN	ORTHO	19-Jan-96		WILL NOT RETURN
10	M	C-141	YOKOSUKA	R	VARIOCELE	UROLOGY	20-Jan-96		
11	F	KC-10	MIRIMAR	R	LEVEL III/OBESITY	PSYCH	31-Jan-96	01-Feb-96	
12	M	KC-10	OKINAWA	R	R/O DYSTHYMIA VS. PRS DISORD	PSYCH	30-Jan-96	04-Feb-96	
13	M	KC-10	OKINAWA	R	"HTN, R/O ADRENAL THYROID Dz"	INT/MED	10-Feb-96	11-Feb-96	
14	M	KC-10	YOKOSUKA	R	LEVEL II/ETOH	PSYCH	09-Feb-96	11-Feb-96	RETURNED 3/13/96
15	M	KC-10	MT. ELIZABETH	R	"HTN, ABNORMAL CXR"	INT MED	20-Feb-96	22-Feb-96	FEM BYPASS DONE; PT RETURNED
16	M	KC-10	OKINAWA	R	IMPINGMENT SYNDROME	ORTHO	06-Mar-96	20-Mar-96	RET DATE 3/29/96
17	M	DC-8	YOKOSUKA	R	LEVEL II/ETOH	PSYCH			
18	M	KC-10	YOKOSUKA	R	FX R. HAND	ORTHO	19-Mar-96	21-Mar-96	
19	F	KC-10	YOKOSUKA	R	R. FIBROCYSTIC BREAST CHANGES	INT MED	22-Mar-96	24-Mar-96	RETURNED 4/7/96
20	M	KC-10	YOKOSUKA	R	R/O PEYRONIE'S DZ	UROLOGY	22-Mar-96	27-Mar-96	
21	F	C-141	YOKOSUKA	R	EUTHROID GOITER	ENT	28-Mar-96	02-Apr-96	RETURNED 4/12/96
22	M	C-141		R	HNP	NEUROLOGY	01-Apr-96	02-Apr-96	WILL NOT RETURN
23	M	P3	MT. ELIZABETH	P	UNSTABLE ANGINA	CARDIOLOGY	17-Apr-96	18-Apr-96	"WNR, CK'D OUT AMA FROM MT. ELIZ"
24	M	DC8	MT. ELIZABETH	R	MOBITZ II AV BLOCK	CARDIOLOGY	22-Apr-96	24-Apr-96	
25	M	DC8	YOKOSUKA	R	PROSTATITIS/SOMATOFORM DISORD	UROLOGY/INT MED	22-Apr-96	24-Apr-96	

Table 2.2: Presentation of Medical Evacuation Information for the First Trimester of 1996

Chapter Three

3.0 Telecommunications Resources

3.1 Framework of Telecommunication Services on Diego Garcia

The primary resource to enable telemedicine is of course telecommunications. At Diego Garcia (BIOT), this is also the major stumbling block. Presently for Diego Garcia, there are 17 DSN telephony trunk lines that are linked by military satellite communications (MILSATCOMM) to DISA PAC at Fort Buckner in Okinawa, Japan. Each trunk line is a 64 kbps circuit. This is schematically shown in Figure 3.1. Each subscriber's call is then further routed from this point of presence. Unfortunately, the trunk lines are routed through Fort Buckner as segmented lines, i.e., digital-to-analog-to-digital. This fact precludes the allocation of any two trunks for telepresence services.

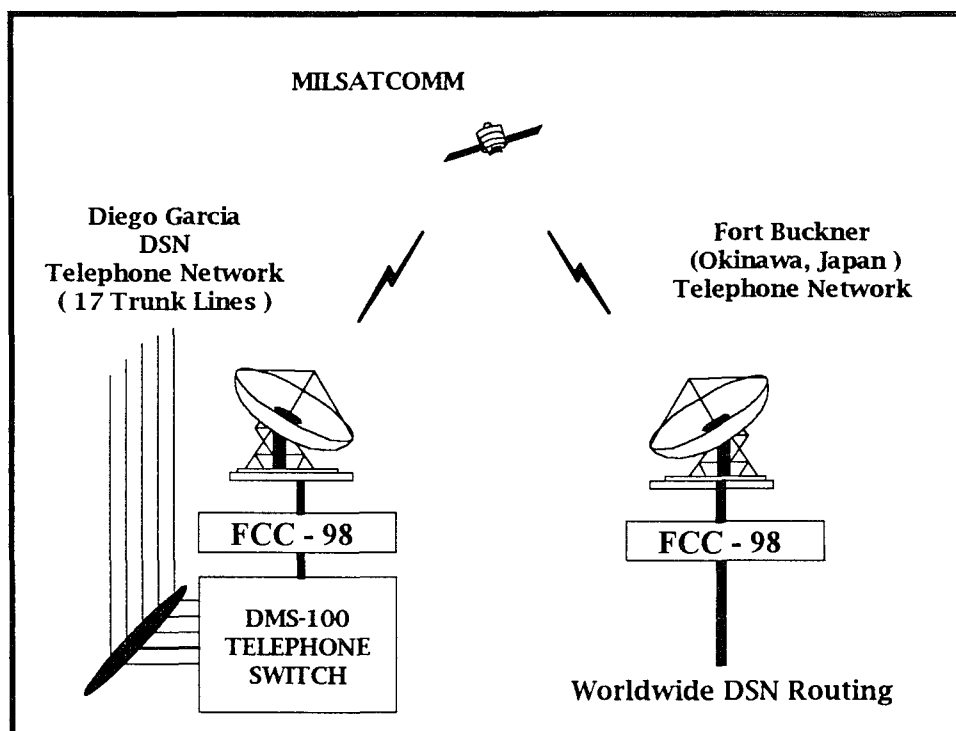


FIGURE 3.1: DSN Telephony Network Routing for Diego Garcia (BIOT)

The sole [Smith] commercial public telephone service provider on Diego Garcia is Cables and Wireless, a British firm with headquarters in London, England. At the time that this report was being prepared, British Telecom was negotiating to acquire Cables and Wireless. Commercial worldwide telephony services are provided through a lease arrangement with

Survey of Diego Garcia (BIOT) as a Remote Client for Telemedical Services

MCI and AT&T in the United States. MCI has the lease for the International half circuit from the space segment to the US point of presence, while AT&T is contracted to provide the telephone services stateside.

The space segment is the INTELSAT 7 satellite. The satellite, commonly referred to as 359 because of its longitudinal position over the earth's surface, is geosynchronous over the west coast of Africa. The actual US point of presence is in Andover, MA. Elevation angle to the satellite at Diego Garcia is between 7° and 8°, while in the United States it is about 5°. The link itself had been considered to be the longest commercial link in the world, although some circuits between Siberian Russia and the United States are vying for that title. Satellite position corrections are received weekly and preprogrammed into the island's satellite tracking unit.

3.2 Infrastructure of the Military and Commercial Telephone Service Providers

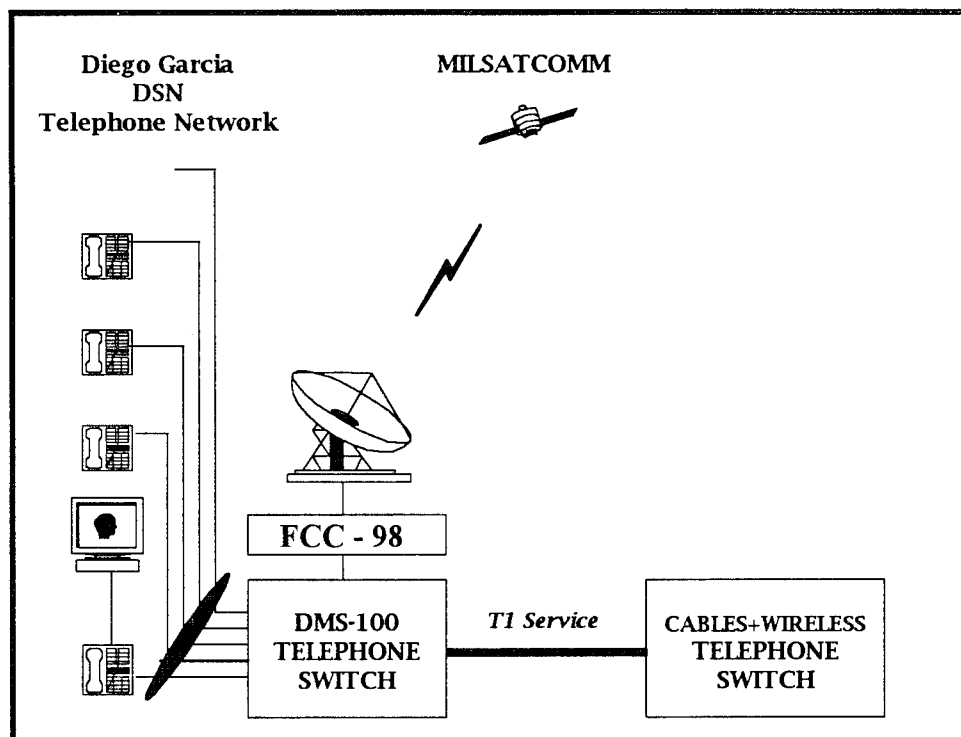


FIGURE 3.2: DSN Telephony Network Commercial Tie-in for Diego Garcia (BIOT)

Figure 3.2 illustrates the tie-in between the US Navy's DSN intra-island telephone network, its offshore connection to MILSATCOMM and the commercial network provider (Cables and Wireless). Telephone tariffs for normal voice grade are listed in Table 3.1, while the known commercial and leased services provided by Cables and Wireless to INTELSAT are illustrated in Figure 3.3. The tariffs reflect the recent telephone tariff reductions that were instituted on 1 April 1996. The minimum charge is one minute, with fractional charges incurred thereafter in six second increments. Though voice grade, these digital lines are

CHAPTER THREE: Telecommunication Resources

Zone	Country	US Dollar Cost per Minute
1	US and the UK	1.50
2	Philippines	2.00
3	Rest of the World	2.00
4	INMARSAT	13.00

TABLE 3.1: Cables and Wireless Telephone Tariffs

providing data services up to 19.2 kbps. Part of the performance restriction is due to the low elevation angle to the satellite

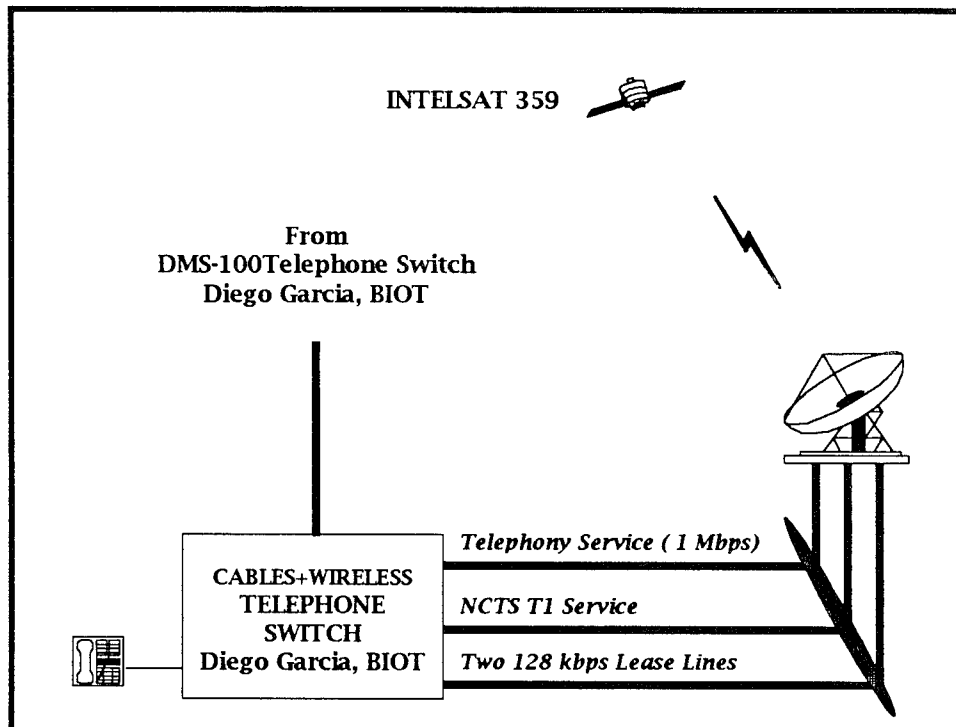


FIGURE 3.3: Commercial Services Provided by Cables and Wireless in Diego Garcia (BIOT)

At the present[Lacambra], approximately 25 percent of the DSN telephone calls cannot be processed because of trunk limitations. Current studies indicate a need for six to seven additional trunk lines. Because of space restriction on the space segment, no additional DSN telephony services are in the offing from milsat communications. The only alternative is to procure these lines from a private, i.e., commercial, service provider. To partially relieve the constriction on the military satellite communications services, there is an effort afoot, coordinated by DISA, to remove all DSN telephony services for Diego Garcia. The 17 existing trunk lines (nominally 64 kbps per trunk line), and seven additional ones, would convert all DSN telephony on the island to digital services. The resultant T1 service grade would be provided through a commercially lease service.

In this regard, there are two major stumbling blocks. The first is the cost [Kikuta] of the undertaking, estimated to be in the neighborhood of \$1.1 million per year. This is based on monthly recurring costs of \$90k to the point of presence in Andover, but does not include a tie circuit to the nearest DSN network entry point. The costs [Lacambra] could be recouped,

if each of the approximate 3100 subscribers were charged a flat tariff of \$40.00 per month. The second problem is backhaul. Since most DSN traffic from Diego Garcia is to the Pacific region, rerouting all DSN traffic to the Pacific region via the East Coast is considered problematic. Other Pacific space segments are being considered, but no solutions at present appears in the offing.

3.3 Present or Near-Term Telecommunication Resources for Telemedical Services

Prior to December of 1995, there was no possibility for digital services on Diego Garcia. There were two distinct telephony services, one provided by the US Navy over its DSN trunk lines and the other, by Cables and Wireless. In actuality, if offices required both modes of service they were equipped with two phones. In December 1995, the situation changed. The US Navy [Haft] replaced the outdated Stromberg-Carlson switch with a used Northern Telecom DMS-100 switch. The DMS-100 is capable of and currently equipped to provide switched-56 service and by implication, video conferencing. Today all telephone lines, with very minor exceptions, are first routed through the DMS-100. Commercial calls are then passed over the T1 service line to the Cables and Wireless switch, while DSN traffic is routed to the NCTS R-Site Tech Control (Receiver Site Technical Control).

As mentioned earlier, the DSN trunks are a segmented service. At Tech Control, the T1 service lines are broken down to analog via D-4 channel banks. The analog is then fed into a FCC-98 for transmissions over the space segment. The analog lines are then received in Fort Buckner and converted to digital. A total digital service could be provided through to Fort Buckner via the T1 service line from the DMS-100 switch. This could be fed directly into the FCC-98, but would require the use of digital cards in the D-4 channel banks at Tech Control and the insertion of digital cards in the FCC-98's both in Diego Garcia and in Fort Buckner.

Thus as of this writing, there are no provisions for digital services via the DSN network. The situation is quite different on the commercial side. There is a T1 service provided to NTCS at its C-Site. However the leased service runs quite high. Monthly recurring costs for the International Half Circuit Cost are in the neighborhood of \$60k. This is the share paid to Cables and Wireless and does not include the stateside Half Circuit Cost. Currently, NCTS has not given any other base tenants on Diego Garcia a sub-lease for a fractional T1 service.

In an effort to obtain a monetary baseline for commercial telecommunication services independent of any fractional T1 service from NTCS, a request for an estimate of such services from Cables and Wireless was initiated. The request, for planing purposes, was put into writing by this author [Katan] to the Manager at Cables and Wireless. The response [Fleming] noted that current lease arrangements with the US Navy for 64 kbps services were amounting to \$10,000 per month for the Half Circuit Cost. In addition, the distant end would require an additional Half Circuit Cost. Quotes for that cost could be obtained directly from appropriate stateside companies such as AT&T and MCI, or Cables and Wireless could provide such estimates.

The letter contained a further summary of costs as follows:

Although Space Segment Charges increased last year I am confident that our half circuit charges will not need to exceed \$10,000 per 56kb circuit per month. Fixed costs would be around \$140,000. If you commit to a five year contract then I believe that C&W would consider self-financing the equipment purchase.

Again these costs are only Half Circuit Cost for Diego Garcia to and from the satellite; the stateside Half Circuit Cost needs to be estimated. In addition, two 56 kbps circuits are required to support minimum teleradiology and video teleconferencing.

3.4 Recommended Local Connections for Switched-56 Telephony Services

Independent of the service provider, installation in the Clinic of both the video conferencing and radiographic application will each require [Bruner] interface units to the DMS-100 switch. The interface units could be shared if each application was connected to an A/B switch and manually switched. Under this mode of operation, each switched-56 line will require a Motorola UDS DU-170 Data Unit inserted between the A/B switch output and the telephone switch. The DMS-100 will need to be populated with Northern Telephone NT 6X71 AC line cards. Given that V.35 will be emanating from the A/B switch, a twisted pair could be run to the clinic from the telephone switch.

Chapter Four

4.0 Current Telemedical Resources on Diego Garcia

4.1 Digital Camera

The Health Service Department has been experimenting with a digital camera for the last several months. The camera, a CHINON ES-300, was borrowed from the MWR (Morale, Welfare and Recreational) Department in Diego Garcia. To date the camera has been used to record the physical assets of the Health Services Department (e.g., Figures 1.1 and 1.2 of this report), as well as a small number of X-rays films. The later have been informally evaluated by the medical staff for viewing and consultation quality. Though not of diagnostic quality, the capability does provide limited still-image assessments for grand rounds and teleconferencing.

The camera has a 3X zoom lens and is equipped with near infra-red automatic focus and built-in sensor flash. It comes with an INTERLINE Transfer ½" CCD pickup device with 410,000 pixels and 8-bit, color digitization. One MByte of flash memory provides five pictures in super fine resolution mode (640 x 480 pixels), ten pictures in fine resolution (640 x 480 pixels), or forty pictures in normal resolution (320 x 240 pixels). The communication interface is either RS232C or RS-422 connected to the memory card.

4.2 PICASSO Still-Image Phone

For the past several years, Tripler Regional Medical Center (TRMC) in Honolulu has served as the medical referral Center for the Western Pacific. As part of its mandate to increase quality medical care to some of the poorer islands within the Micronesian group, TRMC installed PICASSO still-image phones on a number of the islands. Through this procedure, a video camera and a video monitor can be connected to the PICASSO unit to view and capture images. Medical and/or dental referrals can be conducted on-line as the image is transferred to a consulting facility. The image transfer takes about 45 seconds and is compatible with 9.6 kbps quality telephone lines. Either party can point to or annotate areas on the image with a locally installed mouse. In addition to the referral facility at TRMC, there are a small number of facilities on the East Coast of the United States, including one at Emory University.

While in Tripler Regional Medical Center, a PICASSO unit was offered [Floro] on a short-term loan basis for use on Diego Garcia. The demonstration period is scheduled to last approximately six months, concluding late in calendar year 1996. The unit has been installed in the Health Services Department on Diego Garcia. This author successfully demonstrated image transfers between the Health Services Department and Emory University over existing telephone lines through the transfer of an X-ray image of a hand and the receipt of an infected inner ear image. A block diagram of the test setup is shown in Figure 4.1. Table 4.1 provides a telephone listing, including known contacts, of all the known participating PICASSO sites.

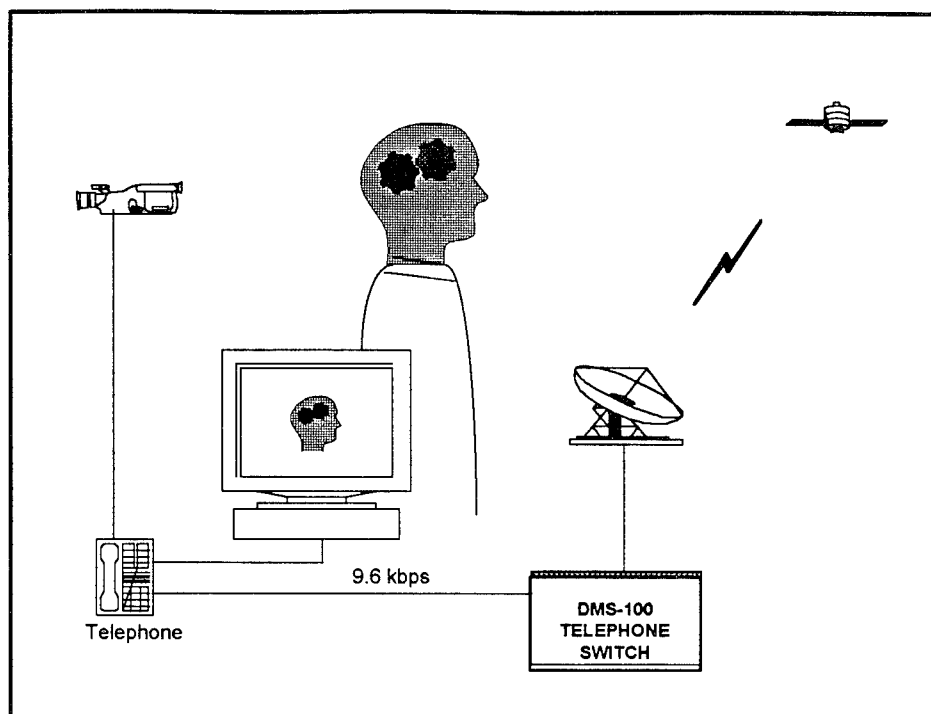


FIGURE 4.1: PICASSO Telemedical Image Transfer Teleconference

LOCATION	CENTER	SOURCE	TELEPHONE NUMBER
Tripler Army Medical Center	AKAMAI Project Office	Maj. F.C. Floro	808-836-2476
Tripler Army Medical Center	Telemedicine Clinic	PICASSO	808-433-2911
Tripler Army Medical Center	Emergency Room	PICASSO	808-433-4978
Tripler Army Medical Center	Telemedicine Clinic	Switched-56	808-843-2386
Barking Sands, Kauai		PICASSO	808-471-6203
Pohupei	Medical School	Main Office	691-320-2328
Pohupei	Medical School	PICASSO	691-320-3703
Pohupei	Medical School	FAX	691-320-2305
Pohupei	Hospital	PICASSO	691-320-5394
Palau		Main Office	680-488-2555
Palau		PICASSO	680-488-8663
Palau		FAX	680-488-1211
Palau		Dr. Yano	680-488-2687
Palau		Ward	680-488-9916
Kosrae		PICASSO	691-370-3703
Johnston Island		PICASSO	808-441-2868
Johnston Island		PICASSO	808-441-2869
Wake Island		PICASSO	808-424-2756
Emory University		Main Office	404-727-8218
Emory University	Dr. Jeff Dunbar	PICASSO	404-727-1273
Alaska		PICASSO	907-443-3462
Project Office		PICASSO	301-619-2072

TABLE 4.1: Telephone listing known participating PICASSO sites.

4.3 Enhanced CU-SeeMe

A Connectix QuickCam digital camera, the latest White Pine version of Enhanced CU-SeeMe software and a US Robotics 14.4kbps/28.8 kbps modem were provided to the staff of the Health Services Department for video teleconferencing over telephone circuits. The recommended minimum data rate for audio group collaboration is 14.4 kbps, while for video the rate is 28.8 kbps.



FIGURE 4.2: CU-SeeMe Local Video Session

As all modem lines going through the DMS-100 switch are limited to 9.6 kbps, including Email and INTERNET access, no group collaboration is at present possible. An example of a local video session with the system hardware and software installed is shown in Figure 4.2. These resources are retained by the Health Services Department for group collaboration in the event data rates are increased in the near-term on Diego Garcia.

Chapter Five

5.0 Regional Telemedical Services

5.1 Background

While gathering information on the medical services rendered in Singapore, it became evident that improvements in the quality and cost efficiencies of healthcare provided by telemedicine could be extended to the Southeast Asia region. From a US military point of view, this region contains populations of active duty personnel and accompanied family members that are in numbers quite similar to Singapore, at least for the five major centers: Bangkok, Hong Kong, Manila, Jakarta and Kuala Lumpur. Current arrangements provide for medical and dental care in each of the host nations, usually by host nation nationals who have usually been trained to Western practice standards, or it allows non-nationals to be used as consultants on an advisory basis. Often complex specialty or sub-specialty opinions require referrals to Singapore, with the attendant impact on travel budgets and medical resources.

5.2 Regional Assessments

In a recent Southeast Asia regional assessment (TRICARE) that included Singapore, Jakarta, Manila, and Kuala Lumpur, several commonalities in the delivery of healthcare to American personnel and their families were noted. One is the gradual migration from service-for-fee to a medical capitated contract. Another is a common regional model for healthcare that Singapore's Glen Eagles Hospital is implicitly providing through its expansion in the region. In addition to Singapore, there is a Glen Eagles Hospital in Jakarta, with another scheduled to open next year in Kuala Lumpur.

Though the situations are quite similar for both medical and dental care, the impact on physician consultants, physician assistants, nurse practitioners, dentists and orthodontists varies from country to country. In some situations, the embassy clinic is the Primary Care Manager with referrals to host nationals for specific or emergency cases. In others the embassy clinic is too small and most treatment requires immediate referral to locally contracted care providers. In each of the four capital cities, inpatient services are provided at several hospitals.

In position paper [Hahn] to the Commander in Chief, US Pacific Fleet, it was proposed that in addition to active duty personnel, accompanied family members be covered under regional dental specialty-care umbrella. Table 5.1 illustrates the number of active duty personnel and accompanied family members stationed in the Southeast Asian region, as well as in adjacent countries.

Survey of Diego Garcia (BIOT) as a Remote Client for Telemedical Services

City, Country	Active Duty Personnel	Accompanied Family Members
Singapore, Singapore	144 plus 239 forward deployed	235
Bangkok, Thailand	100	250
Jakarta, Indonesia	52	87
Manila, The Philippines	30	35
Hong Kong	10	19
Kuala Lumpur, Malaysia	20	43
New Delhi, India	Unknown	25
Colombo, Sri Lanka	11	13
Dhaka, Bangladesh	8	4
Rangoon, Myanmar	10	6
Hanoi, Viet Nam	Unknown	Unknown
Phnom Penh, Cambodia	Unknown	Unknown
Katmandu, Nepal	Unknown	Unknown

TABLE 5.1: *Populations levels of US Active Duty Personnel and Accompanied Family Members in Central and Southeast Asia*

Under this proposal, contracted dental care would be provided by local civilian dental specialists with the assigned US Navy Dental Officer as contract gatekeeper. Initially Singapore would be the primary referral site, with Bangkok later coming on-line as a secondary referral site.

In practice, both Singapore and Bangkok could become the two hubs within a telemedical network, exchanging information and resources with each other, in addition to managing their specific remote clients. Services provided could include teleradiology and video teleconferencing for both medical and dental care. The actual teleresources of each remote client would be determined during an on-site assessment of the clinical needs and available telecommunications services. Singapore could serve as the referral center for Hong Kong, Jakarta, Manila and Kuala Lumpur; Bangkok in turn would support the remaining sites.

Chapter Six

6.0 Recommendations and Conclusions

6.1 Recommendations

In the process of surveying the Health Services Department as a remote telemedical client, several additional factors were uncovered that can, if properly addressed, improve the delivery of healthcare in Diego Garcia (BIOT). While this report originally focused on assessing three major areas for future benefit from telemedical services, namely i.) clinical needs, ii.) various costs associated with a medical evacuation and iii.) available military and commercial communication resources, several factors, as they are practiced today, were evident. The absence of sufficient training aids, the lack of instituted consultation programs, the long time-delays (due to large geographic distances) associated with off-island diagnostic tests and lab results [Page-Rivera], the limited availability of aircraft and the shortened (12 month) tour of duty all contribute to abridging the range and timeliness of procedures that may be offered at Diego Garcia. Of these, probably only the first two - training aids and consultation programs - could realistically be improved in the short term.

To be sure the introduction of telemedical services, particularly teleradiology and video teleconferencing with still image whiteboarding, can enliven the learning process and by extension, broaden the overall capacity of the medical staff [Updegrove]. Perhaps just as central as the scheduled introduction of telemedical services, is the institutional recognition by Navy Medical of the healthcare system that the three major hospitals in Singapore represent. Their formal incorporation into the healthcare process with the Health Services Department on Diego Garcia would acknowledge and legitimize a process that only exists de facto. Their level of care, long considered exceptional, could be incorporated into the contractual arrangement [Brown] the US military exercises in the Republic of Singapore. As the US military shifts towards limited capitated medical care in this region, the opportunity for more coordinated approaches to routine healthcare, as well as medical crisis intervention, opens up for Diego Garcia.

Specifically, the following recommendations for the Health Services Department in Diego Garcia (BIOT) are offered:

- In the area of staff training programs:
 - * provide a *VIPER* interactive courseware unit and various subject area training programs.
 - * provide various interactive video disk programs produced by the Interactive Media Lab for the Foundation for Informed Medical Decision Making and Dartmouth Medical School.

Survey of Diego Garcia (BIOT) as a Remote Client for Telemedical Services

- In the area of patient interaction:
 - * provide a *Medical Language Translator* unit to interface the HSD care provider with the many international patients who are usually in crisis, often as a result of traumatic injury.
- In the area of medical consultation:
 - * provide an additional *PICASSO* unit and install it in Mount Elizabeth Hospital in Singapore.
 - * as the quality of telephony services improve, i.e., once the minimum modem dial-up rate is 28.8 kbps, install Enhanced CU-See-Me desktop video conferencing software in the HSD in Diego Garcia and in corresponding regional medical clinics or aid stations to circumvent the sense of isolation that several healthcare providers have mentioned.
- In the area of telecommunication resources:
 - * convene a meeting with Naval Computer and Telecommunications Station in Diego Garcia, with its Master Station in Guam or with its parent organization in the Washington, DC area to determine the feasibility of leasing a fractional T1 service.
 - * convene a meeting with DISA (Washington, DC) to clarify the upgrading of the DoD Digital Switch Network plans for the Western Pacific theater.
 - * enter in negotiations with Cables and Wireless in Diego Garcia (BIOT) for a more favorable lease structure or tariff arrangement.
- To address the Southeast Asia regional issues:
 - * convene a meeting with the Medical Aid Station in Sembawang (Republic of Singapore) to further refine the medical services, including dental, that would benefit from the introduction of telemedicine.
 - * approach Singapore Telecom to help formulate telecommunication cost structure for such services, at least between Singapore, the regional hub, and Manila, Jakarta, Bangkok, Hong Kong and Kuala Lumpur.

6.2 Conclusions

The purpose of this document was to report on the results of a site survey on Diego Garcia (BIOT) that occurred 19-27 April 1996. The objective of this survey was to (1) assess the clinical requirements for telemedical services and (2) evaluate, as a remote client, the communication resources to support these services. An assessment of the clinical needs revealed that teleradiology and video conferencing with still image transfers and whiteboarding were the major empowering services. Training aids and INTERNET video teleconferencing with one's peers were additional expressed needs. It was also determined that there were no specific requirements or desires for remote dental services, unless it was part of a US Navy-wide requisite [Leal].

At present the major stumbling block for telemedicine on Diego Garcia is the availability of affordable digital telecommunication services. This is part of a larger problem in telephony services provided through the DoD's Digital Switched Network. These resources, as currently invested, are inadequate to satisfy the present demand. In economic terms, there is no elasticity in the services. Future relief depends on specific decisions by policy makers and telecommunication system managers at government agencies like DISA. The current imposed limit on DSN telephone services on Diego Garcia is 9.6 kbps. However, the Tripler Regional Medical Center's *PICASSO* system currently on loan to the Health Services Department through the end of this calendar year, can immediately begin to bridge the gap by jump-starting telemedical services for Diego Garcia.

Another aspect of improved healthcare for Diego Garcia involves husbanding the resources that are normally called upon during both routine and crisis situations. Singapore is logistically, and as a medical service provider, an extremely favorably next destination. It is about half the geographic distance and approximately one-third the travel time closer than either Yokota or Okinawa, Japan. This plus the excellent relationship that exists between the Health Services Department and Mount Elizabeth Hospital in Singapore and the additional DoD contractual agreements with Mount Elizabeth, Glen Eagles and East Shores for active duty military and family members in the Republic of Singapore, opens up additional avenues of cooperation.

Full telemedical services can be provided either through a lease arrangement with Cables and Wireless, the local telephone service provider or through a leasing arrangement from NCTSDG for fractional T1 service. At this juncture, the former is rather expensive, while the latter might be impossible due to security issues. Consultations with program managers at DISA (Washington, DC) should be initiated to request a replacement in the DSN links with Fort Buckner (Japan) of the existing analog segments with digital segments. In the short term this may be the best approach to provide affordable telecommunication services into the Western Pacific theater as it by-passes the issue of commercial tariffs. In the long term, however, commercial tariffs may become competitive as more telecommunication services are introduced to the various communities on Diego Garcia.

Beyond the specifics of telemedical services for Diego Garcia lies the larger question of providing improved healthcare to the active duty personnel and family members stationed throughout Southeast Asia and the Indian subcontinent. The small populations, the great travel distances and expenses and the limited availability of healthcare providers strongly suggests the employment of telemedicine to maintain the deliverance of quality healthcare and maintenance at reasonable costs. Fortunately for some locations, particularly in Southeast Asia, there are effective telecommunication resources at reasonable costs.

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