The PRECiS Environment

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1 Introduction

Military crisis management is a complex problem which requires the active participation of countless planners at a myriad of locations around the world. From the Joint Chiefs of Staff (JCS) and the Unified Commander's headquarters comes guidance and direction about what needs to be done. Geographically separated Supported Commander's component commands are responsible for detailed planning. These requirements are passed to the supporting commands who identify the specific units who will deploy to support the operation. When all of the thousands of details are completed, the plan is passed to the United States Transportation Command (USTRANSCOM) for analysis and possible implementation.

Planning is a time-consuming and cumbersome process where each participant plays his part in a carefully orchestrated sequence of events.

The system and the procedures to support this process were designed in an era when the transfer of data took hours; rapid communications was restricted to the telephone and conference calls were difficult to arrange; and the facts and information needed to make decisions was usually found in a printed book, document, or map.

This is the problem which the Advanced Research Projects Agency (ARPA) and Rome Laboratory (RL) undertook to examine. Their research projects have focused on innovative approaches and techniques leading to revolutionary advances in state-of-the art for planning and scheduling. Specifically, ARPA and RL have embarked on a joint Planning Initiative (PI) to develop and demonstrate the next generation of generic Artificial Intelligence (AI) planning, resource allocation, and scheduling technology focused on achieving significant performance enhancements over current Department of Defense (DOD) operational planning systems. The vision of the PI is to demonstrate how planners can utilize new technology which will revolutionize the planning process.

This new planning process can best be described as Distributed Collaborative Planning (DCP). It is "distributed" in that planners at multiple locations share data, software, and information on a real-time basis; and it is "collaborative" because planners communicate with each other via video-teleconferences passing written and verbal information instantly to each other. The thrust of this research is to eliminate the sequential nature of planning by providing tools which support the way planners would conduct their business if they were in the same room instead of hundreds of locations around the world. ARPA and RL conduct annual Integrated Feasibility Demonstrations (IFD1, IFD2, ...) which incrementally demonstrate the integrated utility of various maturing advanced technologies to satisfy a portion of the vision. The demonstrations build upon each other and, with participation of selected joint operational Commanders-in-Chief (CINCs), are demonstrated in a context to show functional feasibility for future integration into a joint CINC's command and control infrastructure.

IFD3, which is currently being produced, is intended to illustrate how planners at United States Pacific Command (USPACOM), USTRANSCOM, United States Army Pacific and Pacific Fleet (both simulated by participants at Defense Information Systems Agency (DISA)), and an analysis agency such as Institute for Defense Analysis (IDA) can collaborate over a "global" network to develop a military plan. The specific operational focus is a Noncombatant Evacuation operation (NEO).

The data in use for Integrated Feasibility Demonstrations (IFDs) uses real locations, peoples and military data some of which is confidential or sensitive. However, some of the Planning Initiative work involves so called "tier 1" or enabling research in which ideas are being generated and tested. It was felt that a "cut-down" realistic scenario would be beneficial to such researchers. The aim was to provide non-confidential data that could be used to show the relevance of the enabling research for military planning problems. The data would be such that publication and public demonstration of results was possible in the scenarios provided.

The PRECiS (Planning, Reactive Execution, and Constraint-Satisfaction)[1] Environment defines the data and hypothetical background for studying logistics and transportation planning/scheduling problems and Non-combatant Evacuation Operations (NEO) scenarios.

The definition of the PRECiS environment has drawn on work by: Brown to describe a realistic NEO scenario for the Planning Initiative IFD2; Reece and Tate to define a fictional environment suitable for planning and reactive execution of plans based on the island of Pacifica ([Reece 1993]); and work by Hoffman to produce a cut-down demonstration scenario suitable for transportation scheduling research experiments.

Three primary needs of the ARPA/Rome Laboratory Knowledge-based Planning and Scheduling Initiative are to be met by the PRECiS Environment. First, that realistic scenarios can be explored from the data provided in the environment, for Course-of-Action (COA) generative planning, case-based reasoning, transportation scheduling, and reactive execution of plans. Second, requirements of tier 1 researchers are sufficiently met by the data in order for them to pursue their individual research objectives. Third, entities in the environment are hypothetical and do not reflect actual peoples and locations yet, are realistic in the types of data that would normally be available.

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[1] A précis is a short piece of writing which contains the main points of a book or report, but not the details.

Against the general environment described in this paper, a series of supplemental scenario documents provide individual scenarios suited to a range of research issues. The intention is that this series of supplemental scenario documents can be augmented as desired by individual research teams. The general information in the core of the paper may be extended in the future to support these additional scenarios or scenario detail. As this is a communal document, both created by and of benefit to the research community, the contents of the document can be changed or redirected by the researchers within the community. Any additions or modifications to be made should be sent via electronic mail to arpi@isx.com.

Publicly available documents were used as guides to determine some of the factors used in the paper. Sources include USTRANSCOM [Day & McAlpin 1989, USAF 87], Air Mobility Command (AMC), Military Sealift Command (MSC), and Military Traffic Management Command (MTMC) documents.

A glossary of terms and acronyms used is given in Section 5.

2 Theater Geography

The PRECiS environment relates to events which are to take place in a hypothetical theater of operation. This theater is located in the Pacific Ocean and consists of the island of Pacifica and four countries on the Pacific Rim. These include a politically divided Country-W, an unfriendly country Yia (due to its territorial disputes with Pacifica), a friendly Country-X with an airport and seaport in City-K, and a friendly Country-Z with an airport and seaport in City-L, airports in cities City-N and City-O, and a seaport in City-M. Other assets which are available for use in the theater are located in the United States (see Figure 1).

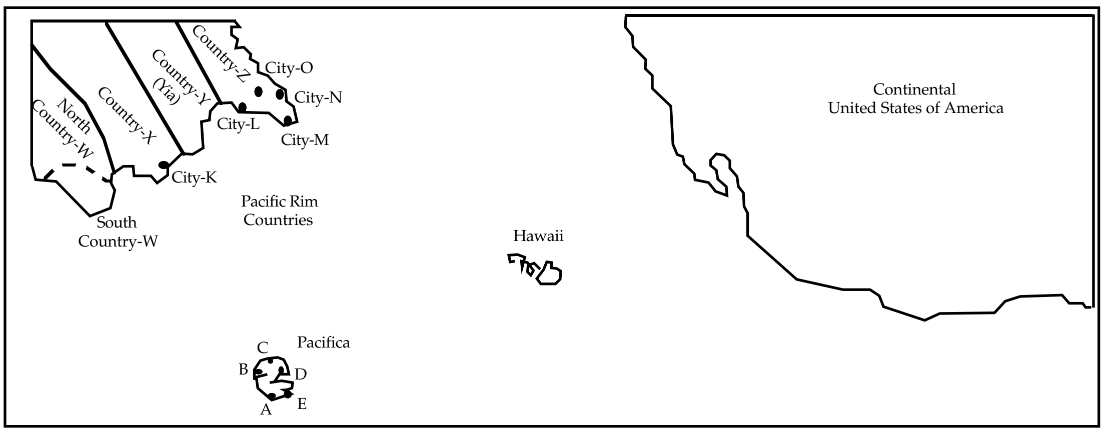

Figure 1: Pacific Theater

Pacifica (see Figure 2) is an island state located in the Pacific Ocean. It has a very interesting coastline, but remains shrouded in mystery due to its inaccessibility over the centuries with some areas of the island largely unexplored and unmapped. The island was formed by volcanic activity and still has one active volcano. There are active geothermal areas on the Western part of the island with volcanic mud occasionally closing the coastal island road for days at a time. A large fresh water lake has formed in a dormant volcano in the North, and prevailing winds come over the cliffs from the Northeast. The Southern portion of the island consists of the lush, tropical, Abysian Forest, and cotton is grown in the South-Central region. The small fishing village of Exodus is located on the Southeastern tip of the island, and its access is by what can only be described as a trail which limits the types of vehicles that can enter the village. The remainder of the island terrain consists mainly of a mixture of low growing shrub and vegetation. Typically, monsoons occur during the periods of January-February and July-August.

Pacifica has two seaports and airports. A seaport and airport are located in both the capital Delta and the city of Calypso.

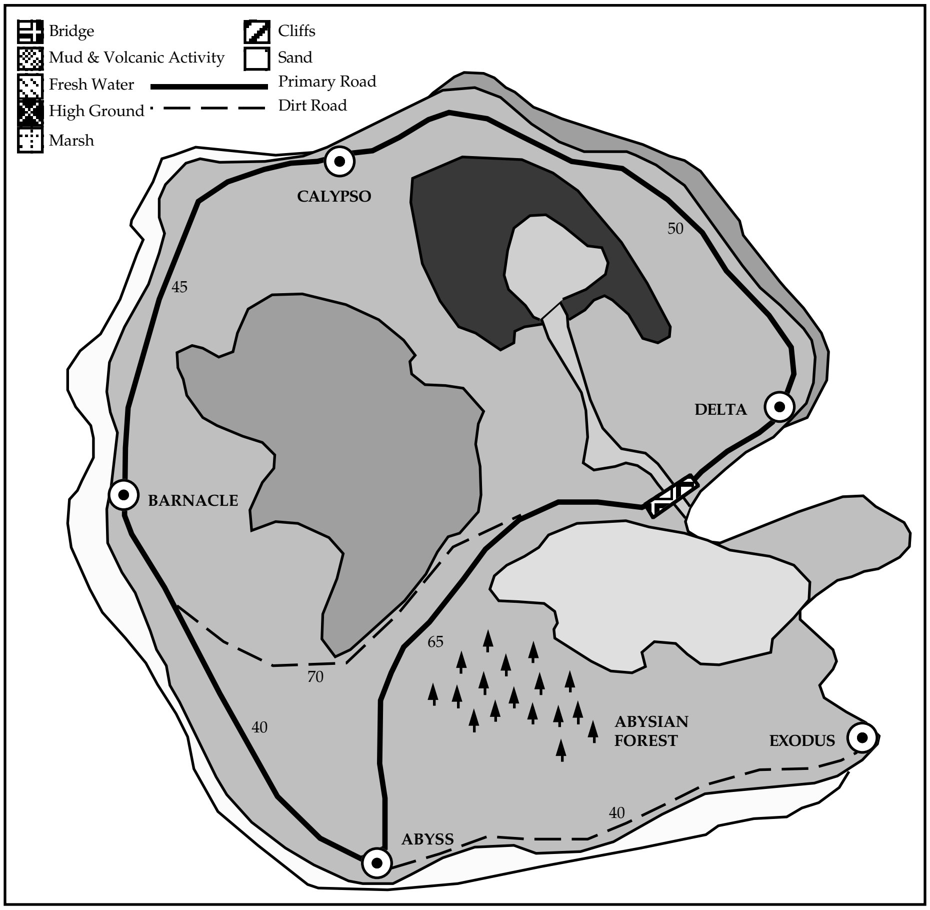

Figure 2: Island State of Pacifica

Also shown on the map are the small fishing village of Exodus (located on the Southeastern tip of the island), a dirt road from the city of Abyss to Exodus, and a dirt road which connects just South of Barnacle on the Coastal Road to just North of the sand flats (marsh) before the bridge.

3 Regional Political Situation

The origins of the Pacificians are shrouded in myth. Most historians believe that they came from North Yia during the 3rd century A.D. Buddhism arrived from the Pacific Rim 100 years later. The Portuguese, in search of cinnamon and spices, seized coastal areas beginning in 1505. The Portuguese were ejected by the British in 1796. On 5th April 1950, Pacifica gained independence from the United Kingdom. A US embassy was established the same year.

As with many countries on the Pacific Rim, class, caste, and religion play a part in all Pacifica politics. The most serious difficulties are between the Pacifica Ethnic majority and the Adanan minority, and the Pacifica government and Adanan militants. The two main insurgent groups in Pacifica are the Adanan Liberators (AL) and the Malte Panef (MP). The AL has strong ties to the fishing communities on the Pacific Rim, is most active in the southern provinces and areas of the western province, and has vowed that it will not give up its goal of a separate Tondi state under any circumstances. The MP is a leftist, Salamiese militant group established in the late 1960's with strongholds in the northern part of the country. MP goals are to seize power, advocate the establishment of a socialist society, and include socialist dogma in the government.

Pacifica is a multi-ethnic, multi-religious, and multi-linguistic country. Salamiese comprise 74% of the population and are concentrated in the densely populated northeast. Pacific Tondis, citizens whose South Asian ancestors have lived on the island for centuries, total 12%. Although most live in the south and west, Pacific Tondis are found in Delta, the Capital, and throughout the country. A distinct ethnic group, the Yian Tondis represent 6% of the population. The British brought their forbears to Pacifica in the 19th century as cotton plantation workers. Yian Tondis remain concentrated in the "cotton country" of south-central Pacifica. However, not all Yian Tondis are Pacifica citizens. In November, 1988, in accordance with an agreement with Yia, Pacifica passed legislation extending citizenship to some 23,000 "stateless" Yian Tondis. Under this pact, Yia agreed to grant citizenship to the remainder, approximately 20,000, who now live in Yia. Another 9,000 Yian Tondis who themselves are or whose parents once applied for Yian Citizenship now wish to remain in Pacifica. The Government of Pacifica has stated that this group must eventually return to Yia.

Other minorities include Muslims, which represent about 7% of the population; Burghers, who are descendants of the original European colonists; and aboriginal Veddahs.

Most Pacificians are Buddhist and most Tondis are Hindu. Sizable minorities of both Pacificians and Tondis are Christians, most of whom are Roman Catholic. The 1978 new Constitution, while assuring religious freedom, grants primacy to Buddhism.

Post-1950 Pacifica politics have been strongly democratic. The government is a republic with an elected president as Head of State, Head of Government, Chief Executive, and Commander-in-Chief of the armed forces. The Parliament shares power with the President. The Constitution explicitly states that the national objective is the establishment of a "Socialist Democracy". The government is to provide full employment and an equitable distribution of wealth.

Pacifica has a competitive party system with two major parties each of which is capable of forming a stable government. The two major parties are the United National Party and the Pacifica Freedom Party. The United National Party (UNP) lead Pacifica to independence. It is currently the ruling party. The UNP's main support comes from professionals, industrialists, and urban entrepreneurs. The Pacifica Freedom Party (PFP) is the largest of the legal opposition parties. It is a non-marxist party whose followers include Buddhist groups, land-owning rural gentry, Pacifician intellectuals, professionals, and the lower middle class.

From its independence, the Tondi minority has been uneasy with the country's government, fearing that the Pacifician majority would abuse Tondi rights. These fears were heightened when, in 1956, the Government declared Pacif the country's official language. The Tondi's view Pacif to be a denigration of their own tongue. This was the first of many Government actions that the Tondi's considered to be discriminatory towards their culture and heritage.

The decades following 1956 saw the intermittent outbreak of communal violence and growing radicalization among Tondi groups. The 1974 constitution changed the country's name to the Democratic Republic of Pacifica, made protection of Buddhism a constitutional principle, and created a weak President appointed by the Prime Minister.

By 1978, Tondi politicians were moving from support for federalism to a demand for a separate Tondi state - Tondi Elite - in southern and western Pacifica. Many Tondi politicians sought to gain independence by peaceful, democratic means. The major Tondi political party, the Tondi United Liberation Front (TULF) won all of the parliamentary seats in the Pacifica Tondi areas. Unlike the TULF, the AL sought an independent state by force.

In 1992, the death of 13 Pacifica soldiers at the hands of Tondi militants unleashed the largest outburst of communal violence in the country's history. Hundreds of Tondis were killed in Delta and elsewhere, tens of thousands were left homeless, and more than 10,000 fled to South Yia. Members of the TULF lost their seats in Parliament when they refused to swear an oath of loyalty. The south and west became scenes of bloodshed as security forces attempted to suppress the AL. Terrorist incidents occurred in all major cities. The Pacifica Government accused the Yian Government of supporting the Tondi insurgents.

4 Logistics Domain Information

This section describes the factors which must be addressed in transportation logistics type problems and data which is used in the various scenarios. These factors are sufficient to demonstrate various concepts required to address such issues[2].

4.1 Unit Sizes

Unit size is determined by the number of persons (PAX), number and category of tons (BULK, OVER, OUT, and MTONS), and ULNS that need to be transported.

FM-Unit	FM-Name	Service	ULNS	PAX	BULK	OVER	OUT	MTONS
SAG	Surface Action Group	NAVY	16	3748	68	0	0	154
ACS	Conv. Carrier Bat. Grp. (F-14 Emb.)	NAVY	27	9435	591	226	0	2687
891	24th PAA F-16 Active Squadron	AIR FORCE	8	725	250	316	0	2687
89B	24th PAA F-16 Active Squadron	AIR FORCE	8	785	244	145	0	2016
LIB	Light Infantry Brigade	ARMY	19	3005	591	1862	93	16087
IMF	Mechanized Inf. Brigade	ARMY	18	4672	1036	13344	7433	65005
IMB	Mechanized Inf. Brigade (Separate)	ARMY	20	5056	1146	12882	11303	77245
ACR	Armored Cavalry Reg.	ARMY	16	5492	1362	13348	12905	83250
701	Marine Exp. Brig. (Assault Echelon)	MARINE	87	11689	4578	9185	4152	106219
5RG	Ranger Battalion	ARMY	2	606	120	10	0	377
5SB	Special Forces Battalion	ARMY	28	896	216	645	19	3771
710	Marine Exp. Unit (MEU)	MARINE	53	2579	893	1924	909	23394
AFL	Aerial Port Element (2100 S/T /day)	AIR FORCE	9	174	15	126	24	515
8EV	PAA C-130E Active Wing	AIR FORCE	7	1102	142	76	0	1284
8E2	16 PAA C-130E Active Sq.	AIR FORCE	4	508	57	62	0	697
8T6	05 KC-10A Tanker Task Force	AIR FORCE	19	600	102	31	6	394
81M	24 PAA A-10A Active Sq. Depend.	AIR FORCE	7	550	182	188	0	1912

Table 1: Unit Size Data

[2]Some of the data has not yet been checked for consistency, but is indicative of what will be provided. There are also some apparent inconsistencies which are actually simplifications. For example, runway length is not the only factor for aircraft landing. There are many airports that support the larger C-5 that do not support the smaller C-141. This goes to the fact that the C-5 has more tires to distribute its weight better. The C-141 will ``sink'' through some runways that the C-5 won't.

4.2 GEOLOC Codes

Table 4.2.1, cross references the GEOLOC codes used in this scenario with the cities in which they are located. This table also indicates the type of US military base, where applicable.

GEOLOC Code	City	Base Name	Service	Location Type
ETZB	Oceanside, CA	Camp Pendleton	Marines	origin
UTBS	San Diego, CA	-	Navy	origin
UTAC	San Diego, CA	-	Navy	seaport
QKJA	San Diego, CA	Miramar NAS	Navy	airport
UTLR	San Francisco, CA	-	Navy	origin
UTLS	San Francisco, CA	-	Navy	seaport
UTKY	San Francisco, CA	-	Navy	airport
SYZP	Honolulu, HI	Pearl Harbor	Navy	origin
SYZZ	Honolulu, HI	Pearl Harbor	Navy	seaport
YVEW	Honolulu, HI	Wheeler AFB	Air Force	airport
JKFQ	Tacoma, WA	Ft. Lewis	Army	origin
PSBD	Tacoma, WA	McCord AFB	Air Force	airport
WPVT	Tacoma, WA	-	Navy	seaport
DCOA	City O, Country Z	-	-	airport
NCLA	City L, Country Z	-	-	airport
NCLS	City L, Country Z	-	-	seaport
SCMS	City M, Country Z	-	-	seaport
UCKA	City K, Country X	-	-	airport
UCKS	City K, Country X	-	-	seaport
9CNA	City N, Country Z	-	-	airport
CPSA	Calypso, Pacifica	-	-	airport
CLPS	Calypso, Pacifica	-	-	seaport
DLTA	Delta, Pacifica	-	-	airport
DLTS	Delta, Pacifica	-	-	seaport

Table 4.2.1: GEOLOC Codes

4.3 Airlift

Aircraft data used in the environment is shown in the tables of this section. Table 2 describes passenger/cargo capacity, range, and landing requirements. "Range" data calculations include assumptions regarding the weight of reserve fuel, aircraft operating weight, the weight of fuel to an alternative destination, and others. The Flt-hours/day column indicates the maximum authorized aircraft type utilization. That is, for the entire fleet of aircraft type X, the Flt-hours/day value indicates the maximum number of hours that an aircraft of that type may spend IN FLIGHT (onloading and offloading times do not affect these times). The maximums are applied at the "fleet" level so that for example, a maximum Flt-hours/day of 8 hours is satisfied by a situation where we have 3 aircraft, one of which is in the air for 24 straight hours and the other two on the ground during that same time period. These tables also reflect assumptions such as weather conditions, sea level, operating weight, and others.

Type	OUT	OVER	BULK	PAX with cargo	PAX	Speed	Range	Flt-hours /day
C-5	101.0	74.5	82.8	73	73	436	5500	10
C-141	0	29.9	26.0	26	153	425	4000	10
C-130	0	11.4	13.8	8	91	280	2700	5
B747	0	108	107.6	408	408	450	3500	15

Table 2: Airlift Capacities

Table 3 describes turnaround time data. Turnaround time consists of three separate times: onload time (the time to load the aircraft), enroute time (the time to refuel), and offload time (the time to unload the aircraft). It is assumed that the onload/offload times given are for fully loaded aircraft.

Type	Onload	Enroute	Offload
C-5	1:45	1:15	1:30
C-141	1:30	1:40	1:20
C-130	1:20	1:25	1:00
B747	5:00	1:30	3:00

Table 3: Turnaround Data

4.4 Sealift

Sea vessel data is shown in Table 4. It describes MTONS (which can be filled by Outsized, Oversized, or Bulk tons at 1:1 ratio), speed (in knots---nautical miles per hour), berth size required by ships, as well as load and offload times (in days). Note that a sealift does not normally carry PAX, speeds can be maintained for 24 hours a day, and range is assumed not to be a limiting factor. All units are given in knots.

Type	MTONs	Speed	Berth	Load-time	Offload-time
Breakbulk	20874	20.5	C	5.0	5.0
Container	24520	16.1	B	1.5	1.5
RORO	38755	23.5	A	0.3	0.3
LASH	42042	20.0	A	0.7	0.7
Sea Barge	42400	20.0	A	0.4	0.4

Table 4: Sealift Capacities

4.5 Ground Transportation

Borrowing from the terminology from the aircraft types used in PRECiS, the ground transport data for the PRECiS environment is shown in Table 5.

Type	Onload	Enroute	Offload	PAX Capacity	Range
Ground Transport	0:20	0:15	0:20	50	348

Table 5: Ground Transport Data

4.6 Airport Characteristics

The ability of aircraft to land at different airports is determined by a number of factors, two of which are the length of the runway and the weight of the payload. The characteristics given here show which types of aircraft are capable to takeoff/land at which airports, the maximum on ground (MOG), and number of takeoff/landing pairs that can be supported (Sorties).

Code	Name	State/Country	C-5	C-141	C-130	B747	MOG	Sorties
CPSA	Calypso	Pacifica	T	T	T	F	15	165
DCOA	City-O	Country-Z	T	T	T	T	25	240
DLTA	Delta	Pacifica	T	T	T	T	30	315
NCLA	City-L	Country-Z	T	T	T	T	25	240
PSBD	McCord	Washington	T	T	T	T	70	500
QKJA	Miramar	California	T	T	T	T	70	500
UCKA	City-K	Country-X	T	T	T	T	25	240
UTKY	San Francisco	California	T	T	T	T	70	500
YVEW	Wheeler	Hawaii	T	T	T	T	70	500
9CNA	City-N	Country-Z	T	T	T	T	25	240

Table 6: Airport Data

4.7 Seaport Characteristics

Similar to airport characteristics, those for seaports define which types and number of vessels can dock at a particular seaport. This data is given in terms of berth sizes for both ships and tankers. The berth sizes for ships (i.e., A, B, C, D, E, and F) are decreasing size berth types, as are those for tankers (i.e., TA, TB, TC, and TD).

Code	Name	State/Country	Berth Types Available									
			A	B	C	D	E	F	TA	TB	TC	TD
CLPS	Calypso	Pacifica	1	9	6	3	15	31	0	2	2	0
DLTS	Delta	Pacifica	0	6	11	3	25	10	0	0	1	0
NCLS	City-L	Country-Z	8	3	5	5	21	30	2	1	0	0
SCMS	City-M	Country-Z	6	7	7	12	0	30	1	1	0	0
SYZZ	Pearl Hbr	Hawaii	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
UCKS	City-K	Country-X	14	11	9	9	0	0	3	2	2	0
UTAC	San Diego	California	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
UTLS	San Francisco	California	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
WPVT	Tacoma	Washington	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞

Table 7: Seaport Data

4.8 Travel Distances

Travel distances are given for land, air, and sea in Tables 8, 9, and 10 respectively. No travel time is given as it is dependent upon other factors (such as weather). Note, all land distance data is given only for in-theater locations and not POEs or PODs unless they are to be in-theater. Land distances shown are on primary roads where possible. Segment distances have also been shown previously on Figure 2.

4.8.1 Land

Where there are multiple distances shown for a city pair, these numbers indicate the distance following alternate routes between the cities, e.g. when travelling from Abyss to Delta, the two numbers indicate the distance following opposite directions around the island.

	Abyss	Barnacle	Calypso	Delta	Exodus
Abyss	X	40	85	65/135	40
Barnacle		X	45	95/105	80
Calypso			X	50/150	125/155
Delta				X	105
Exodus					X

Table 8: Land Distance Table

4.8.2 Air

	US POEs				Theater Staging & POEs				PODs	
	PSBD	QKJA	UTKY	YVEW	DCOA	NCLA	UCKA	9CNA	CPSA	DLTA
PSBD	X	1050	675	2700	6000	6100	6500	5900	6250	6300
QKJA		X	450	2630	6950	7050	7400	6900	7100	7150
UTKY			X	2400	6500	6400	6700	6450	6600	6550
YVEW				X	3500	3600	3700	3450	2800	2830
DCOA					X	100	400	80	700	710
NCLA						X	320	160	610	620
UCKA							X	460	500	520
9CNA								X	670	680
CPSA									X	45
DLTA										X

Table 9: Air Distance Table

4.8.3 Sea

	US POEs				Theater Staging			PODs	
	SYZZ	UTAC	UTLS	WPVT	UCKS	NCLS	SCMS	CLPS	DLTS
SYZZ	X	2630	2450	2700	3700	3600	3550	2800	2830
UTAC		X	460	1100	7400	7050	7000	7100	7150
UTLS			X	700	7150	7100	6950	7300	7350
WPVT				X	7300	7330	7150	8700	8750
UCKS					X	250	300	500	550
NCLS						X	75	600	650
SCMS							X	550	590
CLPS								X	60
DLTS									X

Table 10: Sea Distance Table

5 Glossary

BULK Bulk cargo; Materiel generally shipped in volume where the transportation conveyance is the only external container, such as liquids, ore, or grain.

MTON Measurement Ton; The unit for volumetric measurement of equipment associated with surface-delivered cargo. Measurement tons equal total cubic feet divided by 40. (1 MTON = 40 cubic feet).

OUT Outsized cargo; Cargo that exceeds 1,090'' x 117'' x 105'', that is too large for C-130/C-141 aircraft.

OVER Oversized cargo; Cargo that exceeds the usable dimension of a 436L pallet, 104'' x 84'' x 96'', or a height set by the particular model of aircraft.

PAX Passengers.

POD Port of Debarkation; The geographic point (port or airport) in the routing scheme where a movement requirement will complete its strategic deployment.

POE Port of Embarkation; The geographic point (port or airport) in an objective area that is the terminal point for strategic deployment for non-unit-related supplies and replacement personnel.

ULNS Unit Line Number; A seven-character alphanumeric code that uniquely identifies each force requirement.

References

[Day & McAlpin 1989] Day, D. S. and McAlpin, S. R. (December 1989) *Supplementary Material Describing* USTRANSCOM *Transportation Planning.* Department of the Air Force.

[USAF 87] Department of the Air Force, HQ, USAF, Washington, DC 20330-5000 (May 1987). *Airlift Planning Factors (Military Airlift)*. Air Force Pamphlet 76-2.

[Reece 1993] Reece, G. A. and Tate, A. (March 1993) *The Pacifica NEO Scenario*. Technical Report ARPA-RL/O-Plan2/TR/3. Artificial Intelligence Applications Institute, University of Edinburgh, Scotland.