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XII EXPEDITIONARY WARFARE MODELING

A. INTRODUCTION

Expeditionary Warfare is one of the most complex forms of warfare, an intricate amalgamation of air, naval, and land forces to form a powerful, mobile, far-reaching, and quick-reacting power-projection force. An Expeditionary Force is synonymous with a system of systems, where all the elements within it are intricately linked such that any deficiency in one area will have an immense impact on the overall capability of the Expeditionary Force.

To enable a systematic and comprehensive study of Expeditionary Warfare (ExWar) and the factors that affect its performance, a simulation model was built with EXTEND™; a discrete event simulation tool. The model emulates the end-to-end processes involved in accumulating, assembling, deploying, and sustaining Expeditionary Forces ashore. It provided a means for full accounting of all the moving parts and their interactions within the ExWar system and allowed studies into the variability inherent in all these processes.

Useful data were obtained by running the model using an appropriate Design of Experiment (DOE) (see A Primer on the Taguchi Method, (Ranjit Roy, (1990)), and these data were used in a Minitab statistical program in which component systems that have the most impact on the overall effectiveness of an Expeditionary Force were identified and analyzed.

In addition, the EXTEND™ models were also extensively used in the excursion studies on The Effects of Sea Basing and The Effects of Speed. Modeling runs produced substantial data to support these studies and further reinforced their analytical effort.

B. EXTEND™

Imagine That!'s EXTEND™ is a software program that supports developing dynamic simulation models of complex processes. An EXTEND™ model is composed of components, or blocks, and their interconnections, which allows simulation of large, complex processes involving a wide variety of platforms and materials. Construction of a large-scale, detailed EXTEND™ model emulating the entire Expeditionary Operation, enabled the study of emergent behavior and the investigation of non-linear effects on the ExWar system.

C. APPROACH

To assist in designing the model to emulate the processes within an Expeditionary Operation, we used State Diagrams to identify the process flow of materials and platforms as well as the nodes that were involved in the entire operation. See Figure XII-1.

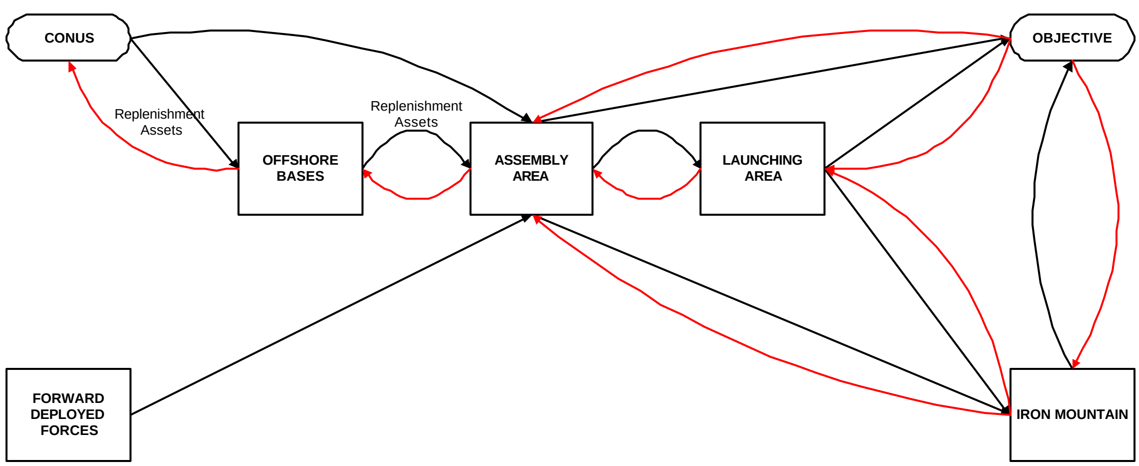

Figure XII-1: ExWar Overview State Diagram

The State Diagram allowed us to fully understand the entire mechanism of an Expeditionary Operation, starting from the Continental United States (CONUS) and going to the Objective, and ensured that all possible routes are considered.

After the State Diagram had been developed, we began building paper models; drawing out the processes which we would then code in EXTEND™. This exercise allowed us to crystallize our thoughts further and enhanced our understanding of Expeditionary Operations, as well as the EXTEND™ programming process. At the same time, throwaway models were built on certain nodes and processes that allowed us to further our understanding of the EXTEND™ software.

Throughout this planning and learning stage, we also began to work on the questions that we wanted the EXTEND™ model to provide answers for. This is especially important as it allowed us to focus on a common objective and to design the model to provide specific answers to those questions.

After extensive planning and research, we came to the conclusion that instead of building a single model that would allow us to run all types of Expeditionary concepts and architectures, it would be simpler, both from the programmer and the user point of view, for two models to be built instead. These two models will be constructed so that all three architectures (Current, Planned, and Conceptual) of interest can be studied.

D. THE TWO MODELS

1. Current Architecture

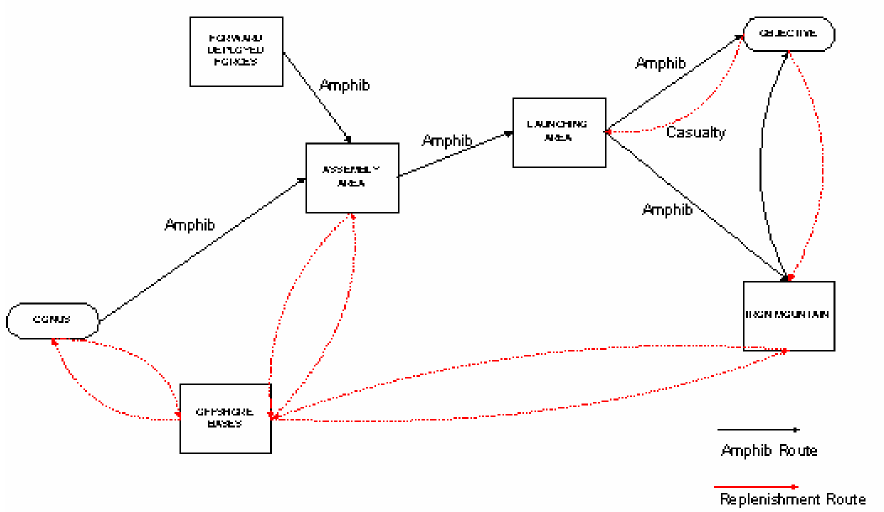

Figure XII-2: Current Architecture State Diagram

Model One was designed specifically to depict the processes for the Current architecture operating the current Concept of Operations (CONOPS). Forces from the CONUS and the forward deployed forces form a Marine Expeditionary Brigade (MEB), assembling at the Assembly Area before proceeding as a Task Force (TF) to the

Launching Area. Once the TF arrives at the Launching Area, Marine forces will be deployed in scheduled waves to both the Objective and the Iron Mountain. After the Iron Mountain is secured (after a user-specified period of time), the first wave of logistic supplies, which is provided by Maritime Pre-positioning Force (MPF) ships, supplying logistics such as food, water, ammunition, spares, etc. will begin to arrive and commence the building up of a logistic depot. Either LMSR ships or HSVs will carry out subsequent logistic supplies from the Offshore Base to the Iron Mountain.

At the same time, while fighting is ongoing at the Objective, reinforcements continue to arrive from the Iron Mountain to the Objective, supplying troops, food, water, and ammunition. This entire operation will continue for a 90-day period.

2. Planned/Conceptual Architecture

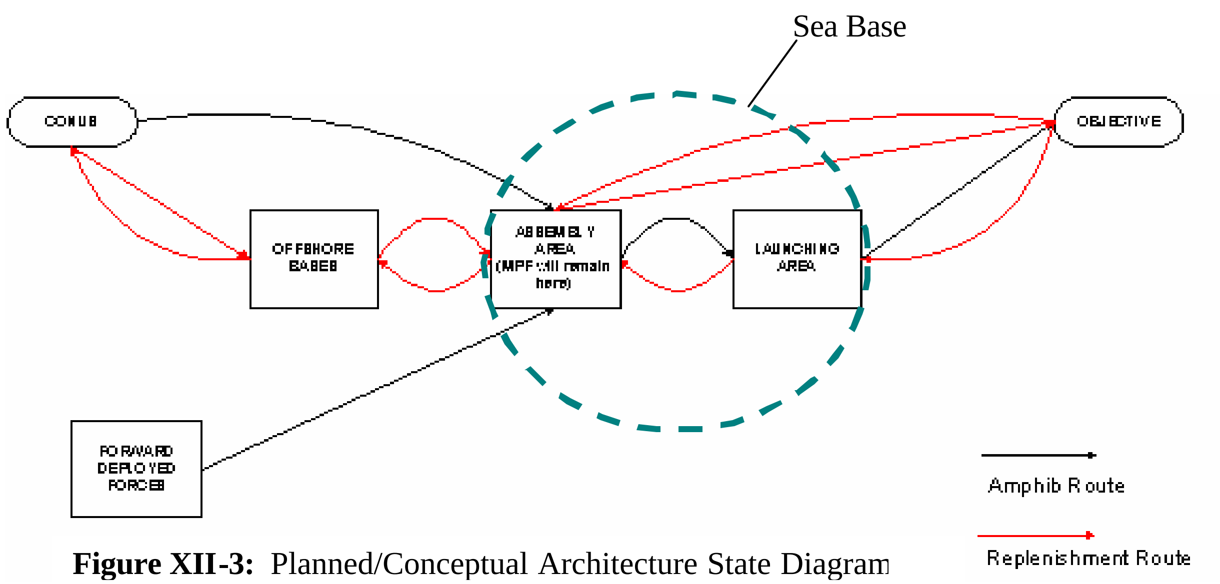

Figure XII-3: Planned/Conceptual Architecture State Diagram

Model Two was designed essentially to emulate the Expeditionary Operation processes that will allow both the Planned and Conceptual architectures to run under a new CONOPS. Central to this new CONOPS is the elimination of the need to establish an Iron Mountain (as opposed to the current CONOPS) by setting up a Sea Base to host the logistic depot.

As in the first model, this second model began with the build up of a MEB-sized force from both the CONUS and Forward-deployed forces at the Assembly Area, before proceeding as a TF to the Launching Area. Once the TF arrives at the Launching Area, Marine forces will be deployed in scheduled waves to the Objective. After all the scheduled waves have been launched, the Logistic ships stationed at the Assembly Area will begin their logistical sustainment operation. Either Light and Medium Speed Roll-On-Roll-Off (LMSR) ships or High Speed Vessels (HSVs) will transit between the Offshore Base and the Assembly Area to replenish these logistic ships. This entire operation will continue for a 90-day period. The main difference between the Planned and Conceptual architectures is that the assets used are different. See earlier chapters for details on the assets used in the two architectures.

E. AREA OF ANALYSIS

The driving factor in designing and building the EXTEND™ model was to produce a useful and relevant tool for our integrated project analysis. The output data from the models provided valuable information and insights in addressing the following issues:

1. A Total System of Systems Analysis of the Expeditionary Warfare Architecture

The model output provided a basis for analysis to determine the most effective architecture among the current, planned, and future concepts, to project and sustain an Expeditionary Force ashore.

2. Studies of the Interfaces and Synergies Among Ships, Aircraft, and System Within Architectures

The analysis of the combat power built up ashore and the logistical sustainment cycle at the Sea Base/Iron Mountain provided insights about the interfaces, synergies, and/or shortcomings among the ships, aircraft, and systems within the architectures.

3. HSV Study

Multiple runs of the model utilizing LMSRs or HSVs provided relevant data to determine the effects of these ships on the logistical sustainment capability of the Expeditionary Force.

4. Sea Basing

The modeling runs, based on the scenario, also provided the basis for analysis to determine if the proposed and future concept is able to support the Sea Base concept.

5. Significant Factors in Expeditionary Architecture

Factors that have significant impact on the capability of an Expeditionary Force to project and sustain an operation ashore can be identified through analysis of the model output. Analysis of the model output provided useful insights on where emphasis (both money and effort) should be placed to obtain a higher return in terms of warfighting capability.

F. FACTORS THAT WERE TAKEN INTO ACCOUNT IN THE MODEL

To enable us to meaningfully and realistically analyze the data obtained from the models, there is a need to ensure that most, if not all, environmental effects are accounted for in the model. However, as it is not feasible to include each and every environmental factor, an essential list was drawn up to assist us during the model design stage. The following factors are those that are taken into account in the final model coding. For details on the model, please refer to the Appendix 12-1.

1. Environmental Effects

Effects from environmental factors such as the sea-state and weather, all play an important role in affecting the performance of an Expeditionary force. Such effects range from longer transit delays for ships and aircraft to longer delays in loading and unloading cargos between ships. To account for these environmental effects, flexibility was built into the models; which will allow the user to change the transit speed of vehicles, the loading and unloading delays of cargos, and the reduced cargo capacity of a vehicle in a prevailing sea-state and weather.

2. Mine Threats

Mines are a very real threat in an expeditionary operation and they affect the speed and maneuverability of seacraft when they are transiting that area. This is especially true when enemies will mine areas that are likely to be used as landing beaches. To account for this effect in the models, it is assumed that a minesweeping operation has been carried out to establish sea-lanes in which seacraft may transit safely, but they will be limited by the number of sea-lanes available. Hence, a user may input the number of sea-lanes available between the Launching Area, the Beach, and Iron Mountain, respectively, depending on the threat posed by the mines.

3. Attrition/Casualty of Troops

Attrition of troops is accounted for in the various phases of the operation. The phases include the transit from the Launching Area to the Beach or Iron Mountain, from the Beach or Iron Mountain to the Objective, and the battle at the Iron Mountain and Objective. Attrition is imposed not only on troops, but on vehicles as well. In the models, the user is able to input the attrition rate of troops as well as air, land, and sea vehicles at the various phases, depending on the intensity of the battle. Attrition rates are used in the models, instead of probabilistic attrition because a study conducted by us showed that results obtained by using the former are within a 95% confidence interval of using the latter. The advantage of using a rate instead of probability is that it eliminates the need for multiple runs to derive a result at a statistically significant value. The details and results of the attrition rate against probabilistic attrition can be found in Appendix 12-2.

4. Reliability/Serviceability of Vehicles

In the real world, vehicles are routinely scheduled for preventive maintenance and they breakdown from time to time. In the models, a user can input the reliability figure for that particular type of vehicle, such as aircraft, Landing Craft Air Cushion (LCAC), etc., and he can also input the number of operating hours that a vehicle type would operate before standing down for a certain period for preventive maintenance. This is especially important for aircraft. This factor ensures that the number of vehicles that are available for operation at any one time is realistic.

G. LIMITATIONS OF MODELS

EXTEND™ is a very powerful simulation program that would allow almost unlimited variations in the modeling structure to realistically emulate an entire expeditionary warfare operation. However, given the limited time, the two models that were built were designed to provide specific answers to the ExWar Integrated project. Hence, there are some limitations that were inherent to these models, which could be further improved if given the time, when there is a need. Some of the existing limitations in the two models are:

1. Scheduled Assault Waves

As part of the data input prior to the simulation runs, the user is required to input the loading plan for all the scheduled waves. These scheduled waves will form the assault force that will be launched ashore. Hence, the result of the modeling runs will be very much dependent on the way these scheduled assault waves are formulated. A user would be expected to enter a realistic assault wave formation, as these models do not have built-in checks to ensure that the loading plans for the various sea and air transporters are correct.

2. Constant Rate of Consumption

The two models were built with a constant rate of consumption for the expendable resources. Depending on whether it is a surge or normal consumption period, the consumption rate of food, water, ammunition, and fuel are fixed, respectively. The depletion of these resources is only dependent on the number of troops and the usage of the vehicles at the various locations throughout an operation.

3. No Built-in Optimization Modules

The output from the models is a direct result of the input data going through a chain of events within that model. There are no optimization modules built within the models that would provide the best solution for an expeditionary operation run. For example, in a particular run, if a user decides to run the model using a 75%/25% allocation of air/sea assets, respectively, for the replenishment operations, the result for that modeling run would be based on that assumption. If the user would like to know what would the result be if the asset allocation is changed to 50%/50%, respectively, a new run will be required. There are no built-in optimization modules in the existing models that would give the user the optimum combination of asset allocation that will yield the best result.

4. General Categorization of Assets/Resources

In the two models, the resources that were emulated were placed into general categories for easy implementation and interpretation of the output results. Examples of this generalization include the placement of all truck types under a single truck category, regardless of their specific capabilities or limitations; grouping ammunition into air, ground, and naval ammunition, respectively. However, we have taken care that such categorization would still allow the models to emulate the operation as realistically as possible. For example, the generalization of the trucks will not eliminate the need to transport them from the ships to shore; thereby taxing the transporter assets, and we have also allocated only a certain percentage of these trucks for transportation purposes, providing for the fact that some of these trucks have other roles. The models could be further improved to depict a higher resolution of both assets and resources, but is not currently implemented in the existing models.

H. VALIDATION OF MODEL

One of the most important steps in modeling is validation. There is a need to validate the models to ensure that they were performing satisfactorily and producing results that can be trusted. However, it became a challenge to find data that would allow us to run and validate the models, as a model of this scale and complexity has never been built to our knowledge. After an extensive search, we were able to locate modeling data that were obtained through a model built with ARENA™ (see Kelton et al., 2002), which studied the concept of Ship to Objective Maneuver (STOM) in Sea Based logistics (see An Analysis of STOM (Ship to Objective Maneuver) In Sea Based Logistics by Kang, Doerr, Bryan, and Ameyugo, 2002).

We were able to run our EXTEND™ models with the data and obtained very similar conclusions. Generally, the results from both models concluded that the logistics sustainment for a STOM concept is highly dependent on the distance of the Sea Base from the Objective and the amount of resources to be transported ashore. However, there are slight differences in the exact data output as both the models from ARENA™ and

EXTEND™ have slightly different design considerations and assumptions. For example, in the EXTEND™ model, the number of helicopter spots onboard a ship that are available at any one time was modeled, thereby limiting the number of helicopters that may be operating at the same time. This resulted in the EXTEND™ model being more sensitive when the load to be transported ashore is increased. Please see Appendix 12-3 for details of the validation runs.

I. SCENARIO

To ensure that the modeling results would be as close to a real life operation as possible, the worst case scenario out of three possible scenarios was selected to be the setting for the modeling runs. See Chapter V for the details on the scenario used in the modeling run.

J. USER INPUT

Based on the chosen scenario and the envisaged capabilities of the United States Marine Corps (USMC), three sets of user input data were set up. We tried to use as much of the official data as possible, collated through extensive research of publications and Websites. On occasions when no formal data were available, intelligent and logical inputs were determined. Please see Appendix 12-4 for details.

K. DESIGN OF EXPERIMENTS

An equally important part of the models is a well thought-out, systematic, thorough, and organized approach towards the modeling runs. It would ensure that the inputs and outputs of the model provide a useful insight into the entire ExWar system. As ExWar is a very complex operation, with many moving components that are constantly interacting amongst themselves, there is a need to find a methodology that would allow a systematic approach to run the model and to obtain the desired results.

One such methodology is the Design of Experiments (DOE) (See R.A. Fisher, 1951, Design of Experiments).

However, as the conventional DOE method would require exhaustive modeling runs to investigate all possible conditions and all identified factors (also known as factorial design), it would be a very time-consuming and manpower intensive process. To overcome this, we were able to design a DOE that is a combination of the exhaustive factorial runs (for Design Factors) and half factorial runs (for Noise Factors) in a standardized design array that would reduce the number of modeling runs required and still retain the essential data within the modeling results. The decision for full factorial runs for the Design Factors was that they were the center of gravity of our study. As such, it would be essential that the resolution of the simulation results could allow us to investigate the full effects and interactions between design factors. As for the Noise Factors, we were interested in investigating the effects of noise on the performance of the various architectures. By using half factorial, we were still able to conduct such investigations without losing the resolution. With the optimized DOE matrix, we were able to achieve what we had set out to do using the smallest number of simulation runs. See Appendix 12-5 for the designed experimental matrix.

1. Experiment Factors

In the planning stage to develop the DOE for the model, several critical factors that define the effectiveness of an Expeditionary architecture were identified; these factors will herein be known as Design Factors. At the same time, it was also recognized that there exist factors that were not within the control of the architect, but would still have an effect on the effectiveness of the architecture; herein known as Noise Factors. All of these factors are defined below, while the detailed levels in each factor can be found in Appendix 12-6.

a. Design Factors

Architectures - Three architectures were identified in this Expeditionary Warfare study. In the current architecture, an Iron Mountain forms an integral part of the CONOPS, while the STOM concept is central to the planned and future architecture, with the main difference being the characteristics of the assets involved.

Replenishment Means - Defined as the means of replenishment to sustain the logistics depot (Iron Mountain or Sea Base) from the Offshore Base. As the project requires the study of the effects of using High-Speed Vehicles (HSVs) in lieu of existing LMSR ships for such replenishment runs, these will form the design factors here. Hence, the normalizing element will be the daily sustainment rate; i.e., one LMSR (or replenishment ship) every five days is needed to sustain the Iron Mountain/Sea Base and if HSV is used, two HSVs per day are required.

Ship to Objective Proximity - This is defined as the distance between the assault forces and the objective.

b. Noise Factors

Attrition - This attrition factor will be applicable at the following locations: Launching Area, Iron Mountain (current architecture), and the Objective. The attrition factor will affect all vehicles and troops as designed in the EXTEND™ model.

Weather - Although in realty, the weather would have an effect in virtually everything: in this DOE, in order to have better control over this factor and its effect on the model output, the weather effect will be limited to the area of operation, i.e., Launching Area, Iron Mountain, and Objective. Hence, only the following parameters will be affected by the weather in this DOE; transit speed of air and surface craft, loading and unloading delays for air and surface craft, and the loading capacity of surface craft.

Mine Threat - The mine threat in the area of operations will affect the sea room available to the Expeditionary force to project its force by seacraft. In this DOE, this factor will affect the number of sea-lanes available between the Launching Area and the Iron Mountain, and between Launching Area and Beachhead.

Consumption (Ammo and Fuel) - The consumption of ammunition and fuel by a fighting force at the Iron Mountain and Objective is directly proportional to the intensity of the conflict (i.e., stronger resistance by an enemy force will result in a higher consumption of ammunition and fuel by the Expeditionary force in combat).

L. CONCLUSION

The use of EXTEND™ models allows the study and comparison of systems of systems. Although the models designed were not a complete representation of an entire Expeditionary operation, assumptions and categorizations made in the modeling effort still allow for a common basis of comparison between the different architectures. Combined with an appropriate DOE, the models also allowed investigation into the unique characteristics of each architecture, which would have been most difficult without the model and the DOE.

However, if given more time, the models have the potential to be further improved to a higher resolution in order to depict as close to a real operation as possible, and thus be used as an effective planning tool for ExWar. It would allow a commander to have a better appreciation of his force build-up time and the logistics requirements based on his operational plan.

M. RECOMMENDATIONS

1. Variable Rate of Consumption

The consumption rate of the resources, such as food, water, ammunition, and fuel, should be modified to be variable. This variability would inject some form of uncertainty into the model to check that the architecture would continue to perform satisfactorily under adverse conditions.

2. Detailed Sea Base Modeling

Another aspect that should be fully explored using EXTEND^{TM} is the Sea Base concept. Detailed modeling of the entire Sea Base operation, taking into account the layout and design of the ships, the storage capacity and design, the movement and tracking of stores, the movement of stores across platforms, and the detail replenishment concept of these ships, would all provide invaluable information when designing a Sea Base.

3. EXTEND^{TM} Model as a Planning Tool

The models may also be further improved upon to reflect all the details in an Expeditionary operation. These could include a more accurate representation of all the resources that are required to be transported, a more robust weather module (rather than a fixed speed reduction rate) that affects different platforms differently and a more refined attrition module. The models could then be used as a more robust planning guide in future.

REFERENCES

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Allen, P. "Situational Force Scoring: Accounting for Combined Arms Effects in Aggregate Combat Models." RAND. 1992.

LIST OF ACRONYMS AND ABBREVIATIONS

AAV	Amphibious Assault Vehicle
AAAV	Advanced Amphibious Assault Vehicle
Ammo	Ammunition
Amphib	Amphibious Units
CONOPS	Concept of Operations
CONUS	Continental United States
DOE	Design of Experiments
ExWar	Expeditionary Warfare
HSV	High Speed Vessel
LAV	Light Armored Vehicle
LCAC	Landing Craft Air Cushion
LHA(R)	Amphibious Assault Ship General Purpose (Replacement)
LHD	Amphibious Assault Ship Multi-Purpose
LMSR	Light and Medium Speed Roll-On-Roll-Off
MEB	Marine Expeditionary Brigade
MPF	Maritime Pre-positioning Force
NPS	Naval Postgraduate School
STOM	Ship to Objective Maneuver
TF	Task Force
USMC	United States Marine Corps

APPENDIX 12-1

EXTEND^{TM} ExWar Model

12-1 EXTEND™ EXWAR MODEL

A. INTRODUCTION

Expeditionary Warfare (ExWar) is perhaps one of the most complex forms of warfare, an intricate amalgamation of air, naval, and land forces to form a powerful, mobile, far-reaching, and quick-reacting power-projection force. An Expeditionary Force is synonymous with a system of systems, where all the elements within it are intricately linked such that any deficiency in one area will have an immense impact on the overall capability of the Expeditionary Force. Hence, in order to support a closer study of the ExWar system, a model was required to:

1. Allow a systematic approach to study/verify the end-to-end system processes involved in the ExWar system.
2. Provide a full accounting of all the moving parts and their interactions within the ExWar system.
3. Provide a mean to allow studies into the variability inherent in all these processes.

To support the above purpose, a simulation model was built with EXTEND™. This is a discrete event simulation software from Imagine That!® that supports development of dynamic simulation models to explore complex processes and their interrelationships. An EXTEND™ model is composed of components, or blocks, and their interconnections. "At its core, EXTEND™ is a dynamic, iconic simulation environment with a built-in development system for extensibility. It enables you to simulate discrete event, continuous, and combined discrete event/continuous processes and systems, plus allow you to build your own modules." (Imagine That!, 2000.)

B. OVERVIEW OF EXWAR MODEL

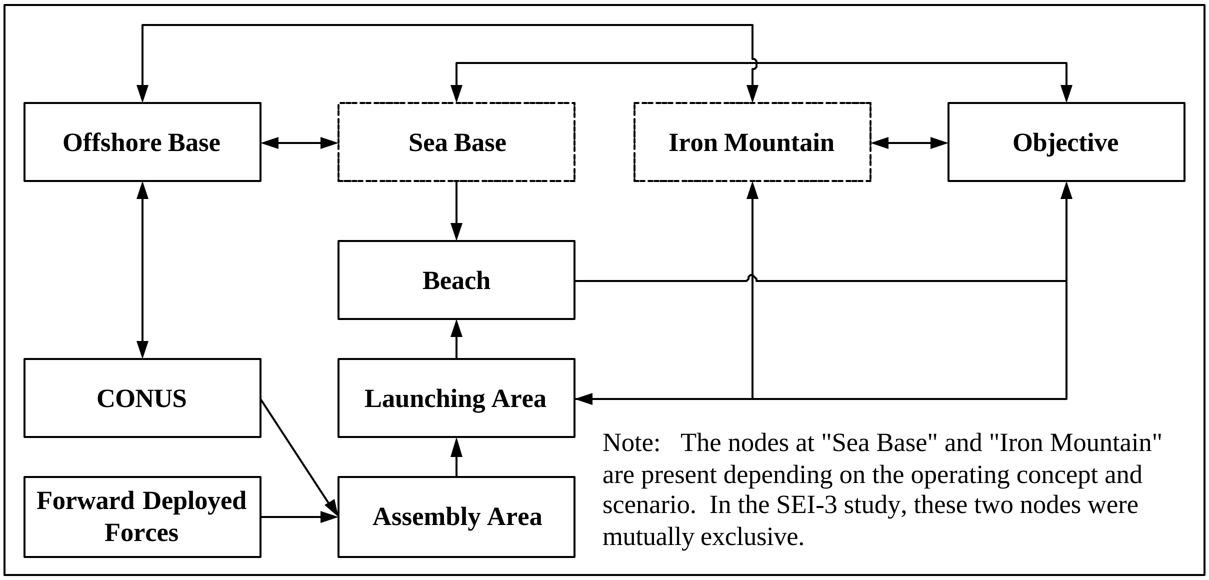


Figure 12-1-1: Overview of the ExWar model

Figure 12-1-1 shows the top-level view of the ExWar model. In a running simulation model, it will consist of seven nodes and in each node resides part of the ExWar processes in the system. And, depending on the scenario and the operating concept, two variants of the model are available to account for the presence of the Iron Mountain or the Sea Base.

The model is designed with two distinct layers: the Physical Layer at which items like transporters, troops, equipment, etc., are transacted; and the Communications Layer at which messages are exchanged between nodes to coordinate transactions on the Physical Layer, e.g., logistics demand and fulfillment. The Physical Layer serves items that flow within and between nodes. The flow of logistic resource items is generally one way, while transporters (carrying mainly the logistic items) flow both ways between the logistic depot and the Objective. The flow of items on the Physical Layer can also be represented in Figure 12-1-1.

The Communications Layer handles the messages between the nodes that are necessary to coordinate the transactions on the Physical Layer. In addition, this layer also manages the accounting of logistic demands and requests between a logistic depot (i.e., Iron Mountain or Sea Base) and the requester (i.e., Objective). This is possible through the use of global variables and the Communications Module. While the use of global variables is straightforward, the more complex Communications Model is built essentially to manage and account for logistic requests, demands and fulfillment. Flow of communications items is generally two-way in the Communications Layer, and can be represented in Figure 12-1-2.

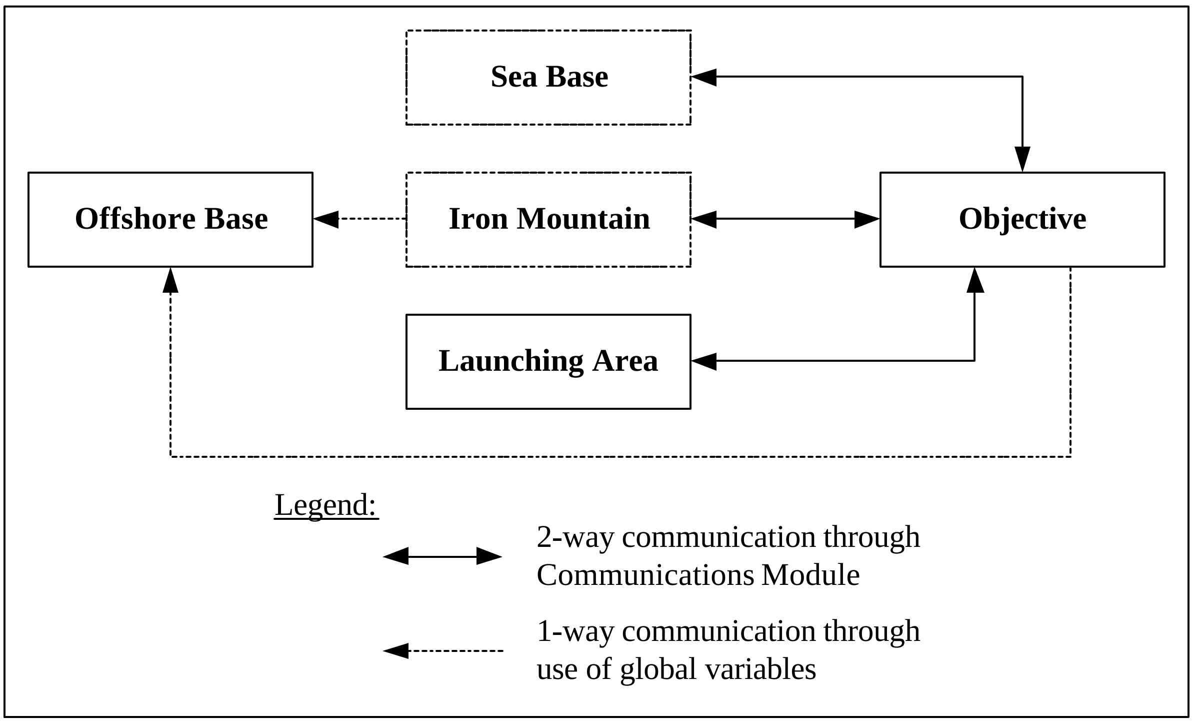


Figure 12-1-2: Overview of the Communications Layer

C. CONFIGURATION CONTROL AND CONVENTIONS

During coding and setting up of the ExWar model, we adopted a set of configuration control and conventions. This set of rules outlined how the codes should be set up to accept common user inputs, interface with the other nodes, coordinate the usage of the global and local variables, and more importantly, accept a common set of attributes. With careful observance of configuration control arrangement and conventions, we were able to encapsulate the ExWar processes at each node, and also facilitate independent coding by different members of the modeling group and allow model integration.

1. Attributes

"Attributes are a very important part of a discrete event simulation. Attributes are characteristics of an item that stay with the item as it moves through the simulation." (Imagine That!, 2000). In the ExWar model, there were essentially four categories of items flowing in the simulation: Force, Transporter, Resource, and Message. We identified each item to its type by assigning it with a unique "Object ID" ("Object ID" is an attribute which holds a value to identify the item). We used attributes to characterize and describe each of these items. For example, for an item in the Transporter category, attributes like "Food," "Ground_Ammo," etc., described how much of the logistic resource that the transporter was carrying.

In order to ensure inter-usage of common attributes between nodes, we created a global list of attributes, which would hold values as results of processes carried out within the nodes. As the item flows into another node, these attribute values would, in turn, become inputs for the processes for that node. A list of the global attributes used is shown in Table 12-1-1.

Attribute Name	Description
Obj_ID	Holds a number that identifies an item to its type.
Dest_1	ID of next destination node at Node 1 (CONUS)
Dest_2	ID of next destination node at Node 2 (Forward Deployed Bases)
Dest_3	ID of next destination node at Node 3 (Offshore Bases)
Dest_4	ID of next destination node at Node 4 (Assembly Area)
Dest_5	ID of next destination node at Node 5 (Launching Area)
Dest_6	ID of next destination node at Node 6 (Iron Mountain)
Dest_7	ID of next destination node at Node 7 (Objective)
Fuel	Amount of fuel carried by an item (gals)
Food	Amount of food carried by an item (pkts)
Water	Amount of water carried by an item (gals)
Spare	Amount of assorted spare parts carried by an item (lbs)
Troop	Number of troops carried by an item
M1A1	Number of tanks carried by an item
HMMWVs	Number of HMMWVs carried by an item
LAV	Number of Light Armored Vehicles (LAVs) carried by an item
Truck	Number of trucks carried by an item
UH1N	Number of UH-1N/Ts carried by an item
MV22	Number of MV-22s carried by an item
AAV	Number of Amphibious Assault Vehicles (AAVs) carried by an item
AAAV	Number of Advanced Amphibious Assault Vehicles (AAAVs) carried by an item
M198	Number of M198s carried by an item
LHD	Number of Amphibious Assault Ships Multi-Purpose (LHDs) present in a Force item
LHA	Number of Amphibious Assault Ships General Purpose (LHAs) present in a Force item
LSD	Number of LSDs present in a Force item
LPD	Number of LPDs present in a Force item
MPF	Number of MPFs present in a Force item
LMSR	Number of LMSRs present in a Force item
CH-46	Number of CH-46s carried by an item
CH-53	Number of CH-53s carried by an item
LCAC	Number of LCACs carried by an item
LCU	Number of LCUs carried by an item
LCM	Number of LCMs carried by an item
Ground_Ammo	Amount of assorted ground type ammunitions carried by an item (lbs)
Ship_Ammo	Amount of assorted ship type ammunitions carried by an item (lbs)
Aircraft_Ammo	Amount of assorted aircraft type ammunitions carried by an item (lbs)
Casualty	Number of casualties carried by an item

Attribute Name	Description
Own_Fuel	Item's own fuel status (for own consumption) (gal)
Fuel_Air	Item's fuel consumption during flight mode (gal/miles)
Fuel_Sea	Item's fuel consumption during sea mode (gal/miles)
Fuel_Land	Item's fuel consumption during land mode (gal/miles)
Demand_Node	Node demanding resources—only for Communications Module
Approval	Check on whether all resources demanded by Demand_Node is approved—only for Communications Module (holds either 0 or 1)
Sequence	Identifies the next node to demand resources from—only for Communications Module
Owner	Identifies the node at which an item belongs to
Status	Unit status. Dead = 0, Alive = 1
Operating_Time	Total amount of time a transporter has continuously been operating (minutes)
AirSpeed	Item's Flight Speed (miles/minutes)
WaterSpeed	Item's Water Speed (miles/minutes or knots at CONUS/Offshore Base/Forward Deployed Forces)
LandSpeed	Item's Land Speed (miles/minutes)
LA_Return	A flag to indicates that if an aircraft or seacraft will be returning back to the MEB. (For Launching Area only. 1 = Yes; 0 = No)
Tpt_ID	Value (an "Obj_ID" value) allocated to identify the transporter used to carry the resource

Table 12-1-1: List of global attributes used in the ExWar model

In the processes within a node, we experienced occasions where there was a need to use local attributes which would not be used in other nodes. To ensure consistency, we adopted a convention to append any local attribute names with "X_ABCD" where "X" was a number or acronyms to indicate the node at which it was used, and "ABCD" was the local attribute name.

2. Local Variables

Variables were used in the model to transport outputs from one code block to another as inputs. The use of variables was generally localized within the node, except for use in the communications layer. In order to coordinate the usage of variable names in the model, similar convention as for the local attribute names were adopted.

3. Units of Measure for Model Inputs

The units adopted for defining quantities were generally in U.S. units, as shown in Table 12-1-2. In code blocks where user input was required and did not conform to standard U.S. units, the required units would be indicated in the comment dialogue box of that block.

Measures	Units
Distance	Miles
Fuel	Gallons
Water	Gallons
Ammunition (assorted)	Pounds
Fuel consumption	Gallons/mile
Water consumption	Gallons/day
Food consumption	Packets of MRE/day

Table 12-1-2: List of measures and their units used in the ExWar model

D. ACCOUNTABILITIES

With the purpose of the model to account for all moving items in the model, we incorporated codes to track the accumulation, usage, decommissioning, and aggregation of these items. At the end of each simulation run, we extracted data from the various tracking points for further analysis using other software like Microsoft Excel® and Mintab®. These data capturing points were usually plotter code blocks, although other important data was also observed at other blocks, e.g., queue blocks, resource pool block, etc. For the ExWar model, resources, consumption, attrition, and combat power ashore were tracked.

1. Resources

In the model, resources were defined as items that would contribute towards the conduct of ExWar processes. For example, in the context of the simulation model, items like troops, food, LCACs, HMMWVs, M198s, etc., were considered resources. In their idle or unused states, these resources would reside in the respective resource pool blocks. In the event that more of the same items were generated or become available (due to replenishments) at that node, these new items would also be accumulated at the resource pool blocks. At any time instance during the simulation run, these blocks would indicate the amount of resource available and their utilization in the case of a closed system. The data on amount of resource available verse time could be extracted with the use of a plotter block.

Consumable resources like food, water, fuel, ammunition, and spares were also tracked similarly as with the other resources. However, we felt that expressing these resources in terms of Days-of-Supply (DOS) would be more meaningful. DOS would reflect status of how long a consumable resource would be able to sustain the forces. With consumption rates of each of these resources determined, DOS data was calculated and tracked in the simulation. This data would then be extracted after the simulation for offline analysis.

2. Consumptions

In the model, accounting of resources held at each node was done using either a resource pool or a queue (resource) code block. During the design of the model, we made two assumptions with regards to how resources, in particular fuel, would be consumed by transporters when moving from one node to another at sea. In the first assumption, consumption of resources would be accounted only when transporters had moved, or when the forces had been projected ashore. In the second assumption, when the amphibious ships, like LHAs, LHDs, etc., made administrative moves between nodes, they would not consume resources that they carried. For example, transit of amphibious ships between Assembly Area and Launching Area would not consume fuel from the stockpile that they would be carrying. We made this reasonable assumption because replenishments of these ships are made through the existing CLF assets (which were not modeled). The second assumption was held valid for ships making administrative transit between the CONUS, Offshore Base, Assembly Area, Launching Area, and Sea Base nodes.

Between Launching Area, Sea Base, Iron Mountain, and Objective nodes, transporters (e.g., LCACs, AAVs, etc.) would consume the fuel resource, and the transporter's originating node (defined by the item attribute "Owner") would be responsible for replenishing the transporter's fuel when it returned from its mission. In addition, in order to account for the maintenance necessary to keep the transporters operating, the spares resource would also be consumed at the Launching Area, Sea Base, and Iron Mountain nodes.

For the forces projected ashore, the troops would consume both water and food, measured in gallons and number of packets of Meals-Ready-to-Eat (MRE), respectively. In the model, we accounted for these consumptions once every 24 hours, and the respective resource pools would be deducted by the daily consumption rate. Similarly, the consumption of fuel, ground ammunition, air ammunition, and spares were also accounted for every 24 hours, both at the Iron Mountain and the Objective.

Due to the complexity in accounting for the consumption of the primary resources (fuel, ground ammunition, aircraft ammunition, and spares), an averaging technique was used to determine the rate of consumption for these resources. Based on data collected from previous conflicts (NATOPS Flight Manual Navy Model 1989, 1998, 2000, 2001; MAGTF Planner's Reference 2001; Jane's Online), the total amount of resources consumed was calculated and an average consumption rate was determined based on the duration of the conflicts. To account for initial surge in the resource consumption rate in order to reflect the necessary suppression fires and combat maneuvers for projection of forces ashore, we increased the average consumption rates by 50%.

3. Attrition

One of the most distinct features of the ExWar model is the accounting of attrition of transporter assets and the impact of this attrition on the sustainment of forces ashore. Most combat simulation models only account for the attrition of combat forces and fail to include the logistics assets, which play an important role in sustaining the force.

In the ExWar model, the attrition of the combat forces occurred at the objective as well as the Iron Mountain, and the attrition rates was varied based on the expected intensity of the battle, and the time lapsed since the commencement of the expeditionary operation. The detailed description of the implementation of the attrition of the combat forces can be found in the attrition module of the Objective Node.

The attrition of the transporter assets and vehicles occurred as they transited between the various nodes. In the construct of the model, our assumption was that there would only be attrition of these vehicles between the Launching Area, Iron Mountain, and the Objective Nodes due to engagements with the enemies. Another assumption made was that the node where the vehicle originated would not be notified of the attrition, and thus the node would not generate another sortie or convoy to replace the unit(s) destroyed due to attrition during transit. To account for all transporter assets at each node, a common transit attrition module was implemented for the Launching Area, Iron Mountain, and Objective Nodes. In the transit attrition module, the attrition rate would determine whether a particular transporter asset or vehicle would be destroyed due to enemy action. If the vehicle did not fall victim to enemy engagements, it would be allowed to continue to its intended destination; however, if it were destroyed, the transporter or vehicle would then be sent back to its originating node for accounting and removal from the simulation pool. Details of this implementation can be found in the Launching Area, Iron Mountain, and Objective Nodes.

4. Combat Power Ashore (CPA)

CPA was one of the outputs from the ExWar model. CPA is the aggregated score to reflect the level of firepower available at a location. In order to calculate CPA, the combat units contributing towards overall firepower were identified, and their respective Combat Power Indexes (CPI) were also determined (see Appendix 13-1 for calculation of CPIs). The CPI is the relative score assigned to individual combat unit, which weighs its contribution towards CPA. With the CPIs of each type of combat unit determined, CPA would be calculated based on the aggregated values of all the CPIs.

In the ExWar model, we measured the CPA at the Objective. This was because the rate of CPA built-up at the Objective was of interest to our study in order to determine the performance of the design factors, as well as the effects of noise factors.

E. FUNCTIONALITY DESCRIPTIONS OF PRINCIPLE NODES IN EXWAR MODEL

1. CONUS

a. Process Overview

This is one of the start points of the whole ExWar model. It is at this node that the amphibious force, consisting of LHAs, LHDs, LPDs, and/or LSDs, begins its journey to the assembly area where preparations for amphibious assault will be conducted. Depending on the type of ExWar architecture being investigated, this node also provides the initial waves of MPF ships will also be projected from CONUS to the Assembly Area. The other function of this node is also to provide replenishment runs to the Offshore Base, which provides forward logistic support to the amphibious force at the Assembly Area or the Iron Mountain. The process overview at CONUS is shown in Figure 12-1-3.

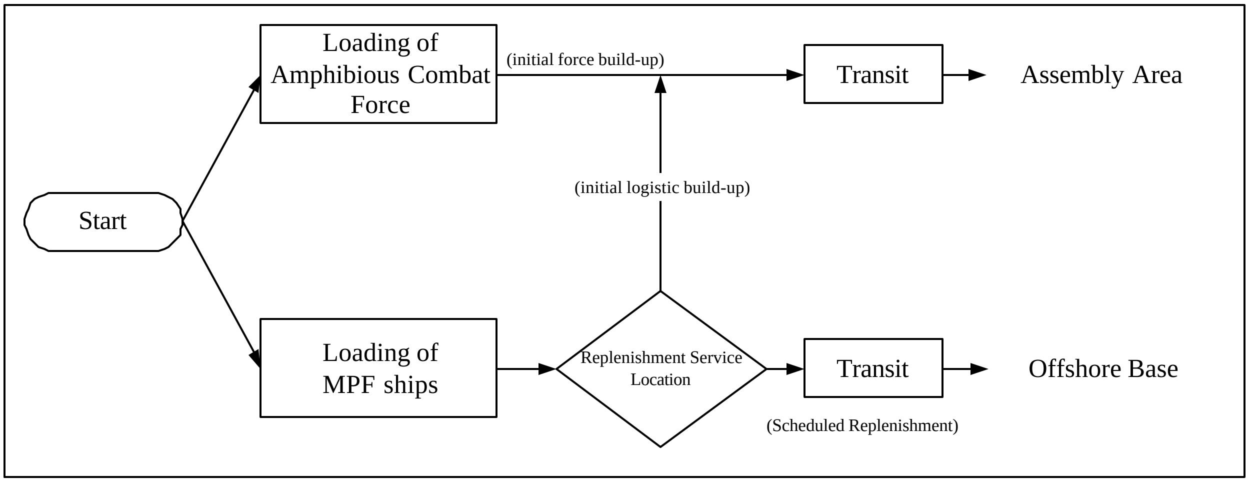


Figure 12-1-3: Overview of CONUS processes

b. Node Description

This node primarily does three functions: projection of combat amphibious force, projection of MPF ships, and performing scheduled replenishments to the offshore base. Food, fuel, and water consumption by the transporter, crew, and troops carried onboard are not be modeled during the transit phase. It is assumed that the transporter is self-sustaining during the transit, i.e., it will carry separate resources for consumption during transit, and this is not accounted for in the model.

Projection of Amphibious Force. This accounts for the part of the MEB force sailing from CONUS to the Assembly Area. On initiation, the force will undergo combat load out with delay, and on completion, transit time to the Assembly Area is accounted for. During transit to Assembly Area, fuel consumption by the amphibious force is also accounted for.

Projection of MPF Ships. Depending on the scenario, MPF ships may sail from CONUS as part of the initial force projection. These ships carry the initial logistic supplies to support the combat units at Iron Mountain or Sea Base.

Scheduled Replenishments to Offshore Base. With a standard load out of logistic supplies, regular logistic runs can be made to replenish the supplies at the

Offshore Base. The scheduled runs will be initiated when amphibious forces have landed at the Iron Mountain or at the Objective.

c. User Setup Requirements

The list of user inputs required at CONUS node is as follows:

S/No.	**Input Description**		**Units of Measure**
Projection of Amphibious Combat Force			
1.	Force Composition	LHD	Ships
		LHA	Ships
		LPD	Ships
		LSD	Ships
2.	Fuel Capacity	LHD	Gallons
		LHA	Gallons
		LPD	Gallons
		LSD	Gallons
3.	Fuel Consumption Rate	LHD	Gallons/mile
		LHA	Gallons/mile
		LPD	Gallons/mile
		LSD	Gallons/mile
4.	Aggregated loading plan for amphibious combat ships (i.e., total load out for each item)		—
5.	Aggregated loading delay for amphibious combat ships		Hours
6.	Speed of advance for amphibious combat force		Miles/hour
Projection of MPF Ships			
7.	Number of MPF ships		—
8.	Loading plan for each MPF ship		—
9.	Aggregated loading delay for MPF ships		Hours
10.	Speed of advance for MPF ships		Knots (a more convenient one for seacrafts instead of miles/minute)
Scheduled Replenishments to Offshore Base			
11.	Frequency of logistic runs to Offshore Base		Days/trip
12.	Total number of MPF/LMSR ships available for replenishment runs		Ships
13.	Number of MPF/LMSR ships/trip		Ships/trip
14.	Loading plan for each MPF/LMSR ship		—
15.	Aggregated loading delay		Hours

S/No.	Input Description	Units of Measure
16.	Speed of advance for MPF/LMSR ships	Knots (a more convenient one for seacrafts instead of miles/minute)
17.	Total number of MPF/LMSR ships available for conducting replenishment runs	Ships

Table 12-1-3: List of user inputs for CONUS node

d.

At the Node Input

Since this node is a starting point for the ExWar model, there will essentially be no input expected from other nodes. However, this node does send ships to the Offshore Base node to replenish it's the Offshore Base node's resources at regular intervals. Hence, there is an input channel to receive returning replenishment assets originating from CONUS node.

e. At the Node Output

The output from this node will be a combat unit transiting to the Assembly Area. In addition, replenishment ships will also be generated at a pre-defined interval to depart for the Offshore Base.

2. Forward Deployed Forces

a. Process Overview

This is another starting point of the ExWar model. This node simulates the pre-loaded amphibious combat forces at sea, whose purpose is to provide rapid respond to an offshore crisis. This afloat force can comprise LHAs, LHDs, LPDs, and/or LSDs. On activation of the simulation, the amphibious force will commence its journey with its pre-configured load to rendezvous with the other amphibious force at the Assembly Area. On rendezvous, this force will proceed as a MEB to the Launching Area. An overview of the processes in Forward Deployed Forces node is shown in Figure 12-1-4.

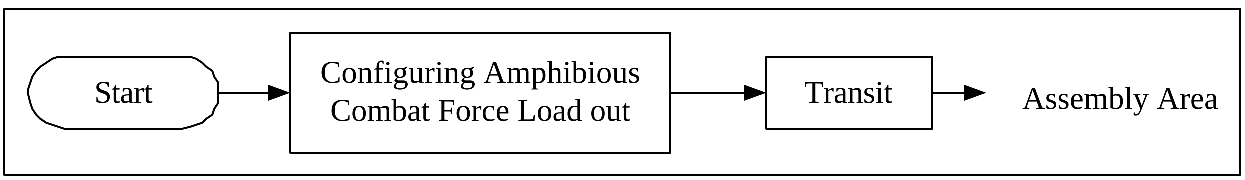


Figure 12-1-4: Overview of Forward Deployed Forces processes

b. Node Description

This node is primarily an initiation node at which a forces-afloat item is generated. Though no delay is incorporated, the force will undergo loading of a pre-configured load.

c. User Setup Requirements

The list of user inputs required at Forward Deployed Forces node is as follows:

S/No.	Input Description		Units of Measure
1.	Force Composition	LHD	Each
		LHA	Ships
		LPD	Ships
		LSD	Ships
2.	Fuel Capacity	LHD	Gallons

S/No.	Input Description		Units of Measure
		LHA	Gallons
		LPD	Gallons
		LSD	Gallons
3.	Fuel Consumption Rate	LHD	Gallons/mile
		LHA	Gallons/mile
		LPD	Gallons/mile
		LSD	Gallons/mile
4.	Aggregated loading plan for amphibious combat ships (i.e., total load out for each item)		—
5.	Speed of advance for amphibious combat force		Knots (a more convenient one for seacrafts instead of miles/minute)

Table 12-1-4: List of user inputs for Forward Deployed Forces node

d. At the Node Input

This is a start point of the simulation. Hence, there will not be inputs received from other nodes during the simulation.

e. At the Node Output

The output from this node will be a pre-configured combat unit transiting to the assembly area.

3. Offshore Base

a. Process Overview

This is a forward logistic base set up to support the forces at Iron Mountain, or at Assembly Area/Launching Area depending on the prevailing CONOPS. This forward logistic base is, in turn, supported by regular replenishments from CONUS. This node can also be configured to project replenishment forces during the initial assault. An overview of the processes in Offshore Base node is shown in Figure 12-1-5.

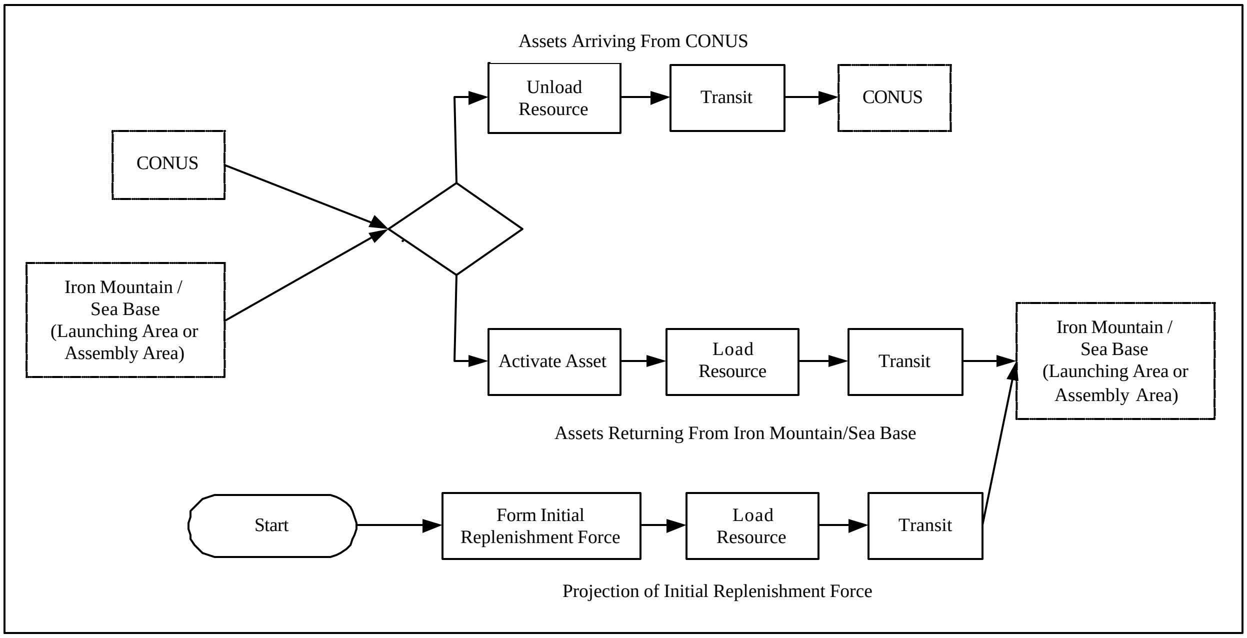


Figure12-1-5: Overview of Offshore Base processes

b. Node Description

This node serves three functions in the ExWar model: projecting the initial logistic force to the Operations Area, receiving materials from CONUS, and providing follow-on replenishment to the Operations Area. The details for each function are:

Projecting Initial Logistic Support Force. At the start of the operation, an initial logistic support force can be designed and configured with a load-out to complement the combat forces that have sailed to the Operations Area. With an appropriate logic coded at the front end of this function, this logistic force can be timed to arrive at the Operations Area based on events that are occurring at other nodes, e.g., the Launching Area.

Receiving Materials from CONUS. As the Offshore Base is a forward logistic base for the forces at the Operations Area, essential supplies are gradually being depleted as supplies are regularly being sent to support these forward forces. Hence, to sustain healthy levels of supplies at the Offshore Base, logistic ships from CONUS will arrive regularly to support the Offshore Base. When these ships arrive at the Offshore Base, unloading delay will be incorporated when supplies are offloaded into the local warehouses (which are represented by the "resource pool" block in EXTEND^{TM}). On completion of unloading, the supply ships will be sent back to the originator at CONUS.

Providing Follow-on Replenishment to the Operation Area. Besides having the ability to launch the initial logistic force to the Iron Mountain or Sea Base, the Offshore Base can also be configured to provide follow-on logistic support to the Iron Mountain or Sea Base. This follow-on support is provided through regular replenishment runs with a standard load-out using a choice of transporter, e.g., LMSR or HSV. These follow-on logistic runs will be initiated at a preset interval after the initial logistic force has been launched. After off-loading at the destination, these transporters will be sent back for re-use.

c. User Setup Requirements

The list of user inputs required at Offshore Base node is as follows:

S/No.	Input Description	Units of Measure
Projecting Initial Logistic Support Force		
1.	Time of initiation of logistic force	xth Day
2.	Aggregated loading plan (i.e., total load-out for each item)	—
3.	Aggregated loading delay	Hours
4.	Speed of advance	Knots (a more convenient one for seacrafts instead of miles/minute)
5.	Destination node (to be the same as follow-on replenishment)	—
Receiving Materials from CONUS		
6.	Aggregated unloading delay	Days

Providing Follow-on Replenishment to the Operations Area		
7.	Frequency of logistic runs	Days/trip
8.	Total number of MPF/LMSR ships available for conducting replenishment runs	Ships
9.	Number of transporters/trip	Transporters/trip
10.	Loading plan for each transporter	—
11.	Aggregated loading delay	Hours
12.	Speed of advance for transporters	Knots (a more convenient one for seacrafts instead of miles/minute)
13.	Destination node (to be the same as initial logistic support force)	—

Table 12-1-5: List of user inputs for Offshore Base node

d. At the Node Input

This node receives ships from the CONUS node to replenish its resources. As it also re-supplies the Iron Mountain or the Sea Base nodes with its transporter assets, this node expects returning replenishment ships at its input.

e. At the Node Output

At a pre-configured time, an Initial Logistic Support Force will be generated and sent to the Iron Mountain or the Sea Base. On reaching its destination, this force will remain at there till the simulation ends. The second type of output from this node is the replenishment asset generated to provide follow-on support to the Iron Mountain or the Sea Base. Lastly, as ships arrive from CONUS to replenish the Offshore Base, these ships will be sent back to their originator on completion of resource unloading.

4. Assembly Area

a. Process Overview

This node simulates an area at which amphibious combat and/or logistic forces, departing from different locations, will rendezvous as a force before proceeding to the Launching Area. An overview of the processes at Assembly Area is shown in Figure 12-1-6.

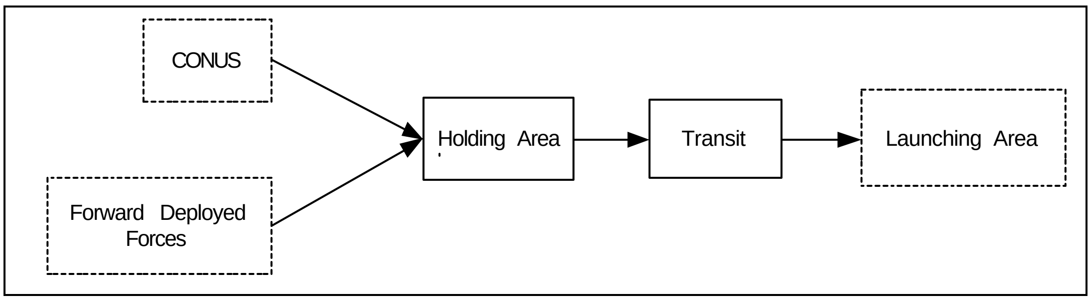


Figure 12-1-6: Overview of Assembly Area processes

b. Node Description

The process at this node is simple: To hold incoming amphibious forces and release them after the complete force is formed. Hence, a Holding functional block is incorporated here to perform this function. Once all amphibious forces (in the form of EXTEND™ items from CONUS and Forward Deployed Forces nodes) have arrived at the buffer, the consolidated force will be released with a transit delay to the Launching Area.

c. User Setup Requirements

The list of user inputs required at Assembly Area node is as follows:

S/No.	Input Description	Units of Measure
1.	Set required number (or logic inputs) to Holding block	—

Table 12-1-6: List of user inputs for Assembly Area node

d. At the Node Input

This node receives Force items from the CONUS and Forward Deployed Forces nodes.

e. At the Node Output

After all the required Force items have reached the Assembly Area, the Holding code block will release all the Force items to the Launching Area at its output.

5. Launching Area

a. Process Overview

This is the area where the amphibious force launches the MEB ashore after final preparation or holding at the Assembly Area. The MEB is launched to their next destination by employing either the air or sea transporters from the amphibious ships. It should be noted that transporters are launched based on a schedule planned by the user, with a loading plan for each wave. An overview of the node is given in Figure 12-1-7.

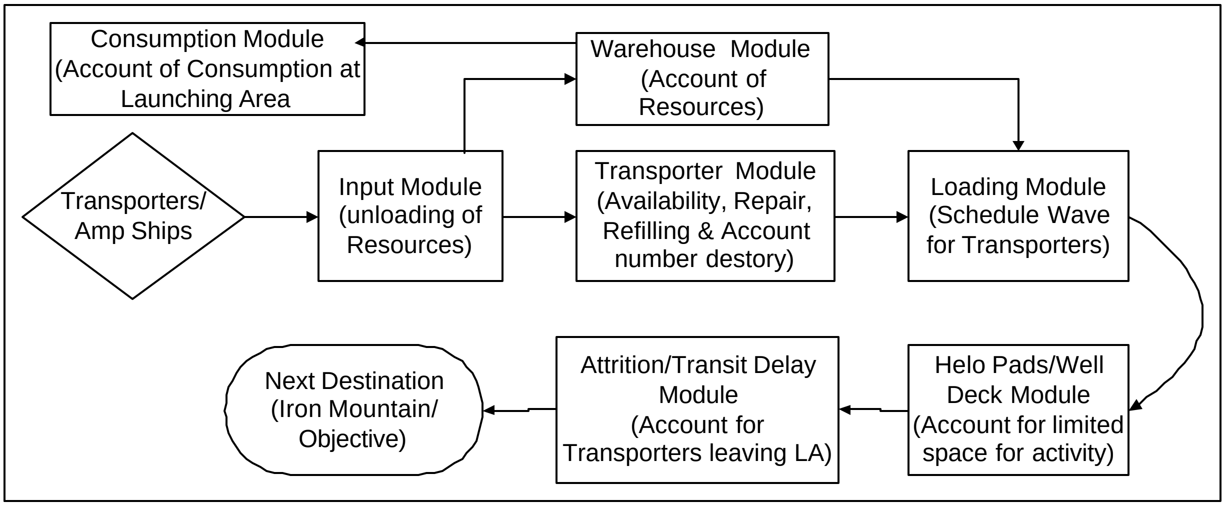


Figure 12-1-7: Overview of Launching Area processes

b. Node Description

The primary function of the node is to emulate the schedule launching of the MEB ashore. There are seven main modules in this node:

Input Module. This module is the gateway for all items entering the Launching Area. It is to account for all resources carried by transporters/ships entering the Launching Area and the unloading delay for transporters once they have landed at the amphibious ships. The critical icon here is the buffer icon in the hierarchy-block (H-block). Its function is to hold the Amphibious Ship items until all of the desired quantity of items has arrived so as to ensure the initial operational capability of the Launching Area.

Transporter Module. This module emulates the repair bays for transporters inside the ship. Its functions are to generate the initial quantity of transporters inside the ship as an item and initialize their attributes; account for the individual number of transporters that have been destroyed and to perform the check for availability, maintenance for operating threshold, and refilling of fuel for each transporter after each mission.

Warehouse Module. This is the location where all the resources in the Launching Area are accounted for. A user will be able to know the availability of particular resources here.

Consumption Module. This module accounts for the consumptions of resources at the Launching Area due to the presence of amphibious ships.

Loading Module. This module is where the resources are loaded to the transporters based on a loading plan pre-configured by the user. This module will load the transporters based on their loading delays and dispatch them to either the Objective or the Iron Mountain based on the scheduled wave in the loading plan.

Helo Pads/Well-Docks Module. Once the transporters are ready to be dispatched to next destination, they will be sent to this module. This module will control whether a transporter is cleared for leaving or entering the Launching Area based on the availability of helo pads or well-docks on the ships for their utilization.

Attrition/Transit Delay Module. This module will account for the transit delays of transporters leaving the LA to their next destinations. It will also account for the consumption of fuel by the transporters due to the transition. Before they are finally sent to their next destination, the transporters will undergo an attrition test to determine whether they will be destroyed during the transition due to the enemy threat.

c. User Setup Requirements

The list of user inputs required at Launching Area node is as follows:

S/No.	Input Description		Units of Measure
	Input Module		
1.	Number items to be held at buffer		—
2.	Unloading delay for the respective Transporter		Minutes
	Transporter Module		
3.	Transporter Attributes	Owner	—
		Obj_ID	—
		Operating time	Minutes
		Status	—

S/No.	Input Description		Units of Measure
		Own_Fuel	Gallons
		Max_Fuel	Gallons
		Fuel_Air/Fuel_Sea	Gallons/Miles
		AirSpeed/SeaSpeed	Miles/Minutes
4.	Operational Endurance for respective Transporter		Minutes
5.	Repair Time for Operational Endurance		Minutes
6.	Number of Spares consumed for Maintenance		Lbs
7.	Reliability for respective Transporter		—
8.	MTR for Reliability		Minutes
9.	Number of Spares consumed for Reliability		Lbs
10.	Fuel Capacity for respective Transporter		Gallons
11.	Refilling Time for respective Transporter		Minutes
Consumption Module			
12.	Rate of consumption for Sea Ammo at LA		Lbs/day
13.	Rate of consumption for Air Ammo at LA		Lbs/day
14.	Rate of consumption for Spare Ammo at LA		Lbs/day
Loading Module			
15.	Loading Capacity for respective Transporter		—
16.	Loading Plan for respective Transporter		—
17.	Loading Time for respective Transporter		Minutes
Helo Pads/Well-Docks Module			
18.	Number of Ships available		Ships
19.	Number of Helo Pads/ship type		Spots/Ship
20.	Number of Well-Docks/ship type		Decks/Ship
21.	Time delay on utilizing pads or decks for each respective Transporter		Minutes
Attrition/Transit Delay Module			
22.	Attrition value for respective transporter transit from node to node		—
23.	Distance from node to node		Miles

Table 12-1-7: List of user inputs for Launching Area node

d. At the Module input

The inputs to the node will be ships sent from the Assembly Area, the transporters returning from the Iron Mountain, Beach, or Objective, and air transporters from the Objective sending the casualties to the Launching Area.

e. At the Module Output

The outputs from the node will be whatever transporters are delivering combat units and logistic resources.

6. Sea Base

a. Process Overview

The Sea Base is the node where the logistic replenishment ships are based. This node is present only for the Planned and Conceptual architecture, as the Iron Mountain plays a similar role in the Current architecture to provide replenishment to the Objective. This node holds all the resources, vehicles and troops that the MEB requires. It allows for projection of forces and materials to the Objective, and it also processes demand requests from the Objective and replenishes the Objective utilizing aircrafts and seacrafts.

The Sea Base node provides accounting of the resources, seacrafts and aircrafts on the Sea Base ships. It monitors the demand for troops as well as materials by the Objective, and dynamically loads available seacrafts or aircrafts to fulfill the demands. The node takes into account loading and unloading times, landing and launching times, transit times, fuel consumptions and attritions of seacrafts and aircrafts. The node also accounts for the number of ships at the Sea Base and the available landing spots and well-docks on each ship. An overview of the interactions between the other nodes and the Sea Base node is shown in Figure 12-1-8.

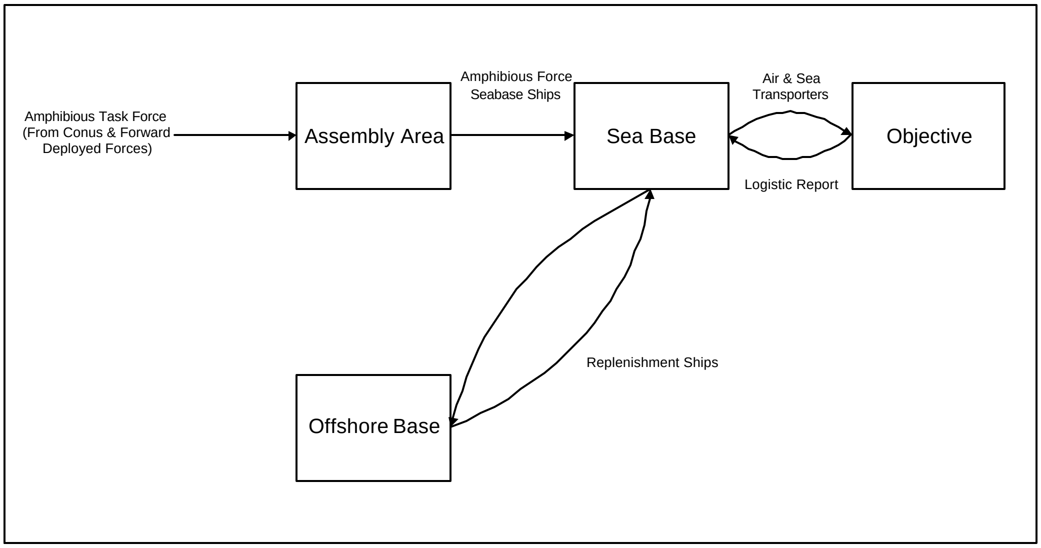


Figure 12-1-8: Overview of Interactions with External nodes

The Sea Base is operational upon the arrival of the amphibious ships. This will activate the node and initiate the build up of the MEB forces ashore via the usage of the aircrafts and seacrafts. Concurrently, the Sea Base will also be receiving demand requests from the Objective for resources, which it will attempt to fulfill using aircrafts and seacrafts to transport the required items ashore. This will deplete the level of resources at the Sea Base. Therefore, the replenishment ships from Offshore Base will perform scheduled runs to the Sea Base to re-supply the node. An overview of the processes involved in this node is shown in Figure 12-1-9.

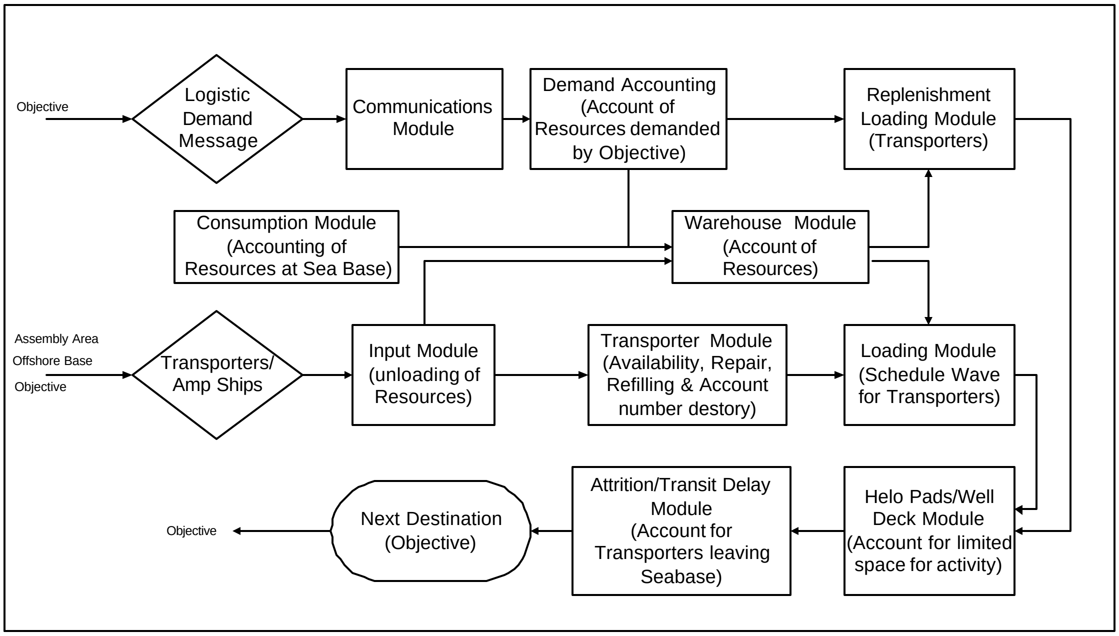


Figure 12-1-9: Overview of Sea Base processes

b. Node Description

The Sea Base node emulates the functions of the MEB's replenishments ships, which forms the Sea Base, and consists of the following main modules:

Input Module. This module reads the load attributes of ships, aircraft, and seacraft that enter the Sea Base, and unload the specified resources defined by the attributes. The resources are unloaded into the Warehouse Module that accounts for all the resources held by the Sea Base. This module also accounts for the unloading time for different ships and transporters.

Warehouse Module. This module accounts for all the resources held by the Sea Base. It accounts for the resources being transported ashore and re-supply of resources by the replenishment ships.

Consumption Module. This module accounts for the consumption of resources at Sea Base due to the presence of amphibious ships.

Transporter Module. This module accounts for the reliability and availability of aircraft and seacraft at the Sea Base. It also checks the fuel status of the transporters and refills them as necessary. This module also accounts for the number of transporters that are out-of-action.

Loading Module. This module projects the MEB ashore using a pre-planned schedule. The schedule specifies the waves and composition of forces to be carried by individual transporters in order to mimic an actual build-up plan. Resources are loaded from the Warehouse Module onto the transporters, and then sent to the Objective.

Helo Pads/Well-Dock Module. This module models the landing and taking off of the aircrafts, as well as the launching of the seacraft. It models the characteristics of the different amphibious ships at the Sea Base, e.g., the number of helicopter landing spots and well-docks available on each ship. Hence, the total number of launching platforms put an upper availability limit for both the aircraft and seacraft at any point in time.

Attrition/Transit Delay Module. This module calculates the time that individual transporters will spent in transit to the Objective. It also accounts for the fuel that the transporters consumes and logs it within the attributes of the transporters. It also determines whether each individual transporter will be out-of-action according to a user-defined attrition probability.

Communications Module. This module establishes communications between the Sea Base and the Objective for logistic requests from the Objective, in order for the Sea Base to send the required replenishments.

Demand Accounting Module. This module accounts for the demand by the Objective that was sent through the Communications Module. It also decides, based on user-inputted thresholds, whether and when to send the resources to the Objective.

Replenishment Loading Module. This module receives information from the Demand Accounting Module on what type of resources to send to the Objective. It calculates the amount of resources and selects the transport available to send the resources ashore. This module also accounts for the resources being depleted, taking them from the Warehouse Module and then sending them to the Objective.

c. User Setup Requirements

The user setup requirements for this node include:

S/No.	Input Description		Units of Measure
Input Module			
1.	Number of items to be held at buffer		—
2.	Unloading delay for the respective Transporter		Minutes
Transporter Module			
3.	Transporter Attributes	Owner	—
		Obj_ID	—
		Operating time	Minutes
		Status	—
		Own_Fuel	Gallons
		Max_Fuel	Gallons
		Fuel_Air/Fuel_Sea	Gallons/Miles
		AirSpeed/SeaSpeed	Miles/Minutes
4.	Operational Endurance for respective Transporter		Minutes
5.	Repair Time for Operational Endurance		Minutes
6.	Number of Spares consumed for Maintenance		Lbs
7.	Reliability for respective Transporter		—
8.	MTR for Reliability		Minutes
9.	Number of Spares consumed for Reliability		Lbs
10.	Fuel Capacity for respective Transporter		Gallons
11.	Refilling Time for respective Transporter		Minutes
Consumption Module			
12.	Rate of consumption for Sea Ammo at Launching Area		Lbs/day
13.	Rate of consumption for Air Ammo at Launching Area		Lbs/day
14.	Rate of consumption for Spare Ammo at Launching Area		Lbs/day
Loading Module			
15.	Loading Capacity for respective Transporter		—
16.	Loading Plan for respective Transporter		—
17.	Loading Time for respective Transporter		Minutes
Helo Pads/Well-Docks Module			
18.	Number of Ships available		Ships

S/No.	Input Description	Units of Measure
19.	Number of Helo Pads/ship type	Spots/Ship
20.	Number of Well-Docks/ship type	Docks/Ship
21.	Time delay on utilizing pads or decks for each respective Transporter	Minutes
Attrition/Transit Delay Module		
22.	Attrition value for respective Transporter transit from node to node	—
23.	Distance from node to node	Miles
Demand Accounting Module		
24.	Resources thresholds to determine whether to send the resources to the Objective	0 or 1
25.	Resources likelihood to be sent via air or sea	—
Replenishment Loading Module		
26.	Loading capacity for Transporters	—

Table 12-1-8: List of user inputs for Sea Base node

d. At the Node Input

The inputs to the node are the initial replenishment ships from the Assembly Area and, subsequently, the scheduled replenishment ships from the Offshore Base. In addition, both the air and sea transporters sent back from the Objective are inputs to this node.

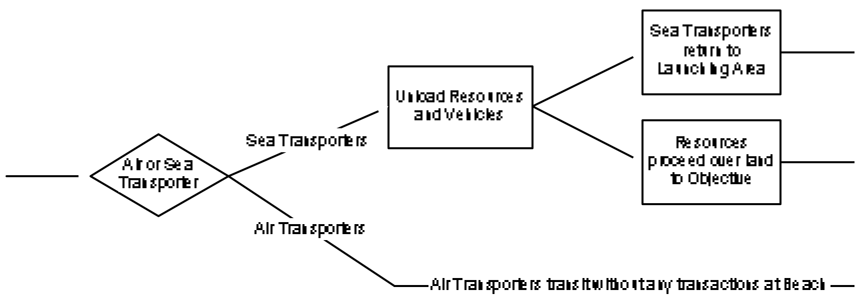
e. At the Node Output

The outputs from the node are air and sea transporters transiting to the Objective, as well as replenishment ships en route back to the Offshore Base.

7. Beach

a. Process Overview

The Beach node provides an area for the sea transporters to unload the vehicles and cargo that they are carrying, account for the unloading action (in terms of the number of sea lanes available and the time taken to unload the cargo) and the transit time required for the land vehicles to move to the Objective, and to send the sea transporters back to the Launching Area. The overview of the processes involved in this node is shown in Figure 12-1-10:



module based on the transit time (calculated by the distance divided by its speed) and its operating fuel deducted by the amount needed to reach the next destination (calculated by the distance divided by its rate of fuel consumption). As noted previously, air transporters are identified and sent directly to the Objective, as they do not perform any processes at the beach.

c. User Setup Requirements

The user setup requirements for this node include:

S/No.	Input Description	Units of Measure
1.	Number of sea lanes available	—
2.	Unloading delay for the various types of sea transports	Minutes
3.	Vehicle attributes (each set of every vehicle): Speed Rate of fuel consumption Fuel capacity	 Miles/hour Gallons/mile Gallons
4.	Distance between Beach and Launching Area	Nautical Miles
5.	Distance between Beach and Objective	Miles

Table 12-1-9: List of user inputs for Beach node

d. Node Input

The inputs to the node will be both air and sea transporters sent from the Launching Area.

e. Node Output

The outputs from the node will be sea transporters returning to the Launching Area and air and ground transporters transiting to the Objective.

8. Iron Mountain

a. Process Overview

In the model, Iron Mountain is a coastal area with port facilities that allows the unloading of replenishment ships and other sea-going crafts, and air transporters. It is a staging area where the Expeditionary Force builds up a stockpile of equipment and resources to sustain the force fighting at the Objective via ground transporters or air assets. In the model, the preferred mode of transport is via land as the throughput of the land transports is more than that of the assigned air assets. In addition to supplying the Objective with resources, the Iron Mountain is also an intermediate location for the evacuation of casualties between the Objective and Launching Area. The overview of the processes involved in this node is shown in Figure 12-1-11.

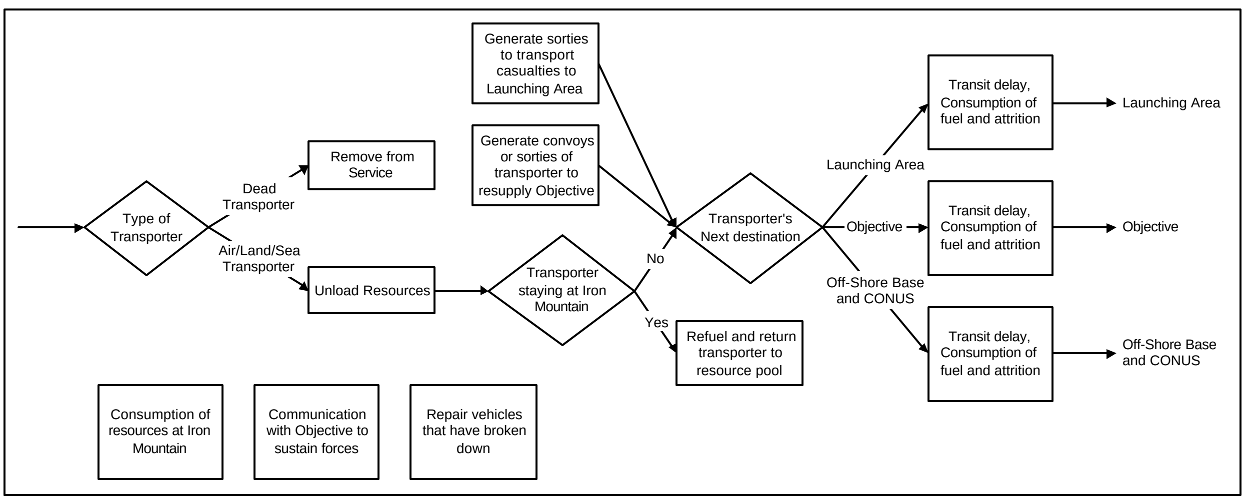


Figure 12-1-11: Overview of Iron Mountain processes

b. Node Description

The major modules in this node are Unload Resources, Consumption of Resources, Reliability and Availability of Vehicles, Transportation of Supplies to Objective, Communications, and Transit Delay, Attrition, and Consumption of

Transporter Resources. Some of these modules interact with each other by passing information and resources, while others perform their roles in isolation. Items that come into and out of the Iron Mountain node are transporters (vehicles, sea-going vessels, and aircraft) and communication messages. Casualties that originate from the Objective will be transported back to the Iron Mountain. Once there, they will be evacuated out to the Launching Area by air transporters held at the Iron Mountain.

Unload Resources Module. When a transporter first arrives at the node, its attributes will be read to determine its identity. Transporters that have been attrited will be removed from the model while ground, air, and sea-going transporters will be routed to the Unload Resources Module. In the Unload Resources Module, the number of air transporters that are allowed to unload their resources will be restricted by the number of landing spots; while the number of sea-going transporters (less those that dock along the port) will be restricted by the number of sea lanes available. The troops, casualties, water, ground ammunition, fuel, food, and all vehicles carried by the transporters will be unloaded and stored at the Iron Mountain node. The transporters will also be delayed at this module according to their unloading time.

Once a transporter finishes unloading its resources its attributes will be read again to determine if the transporter will report to the Iron Mountain node for duty or be returned to its originating node for other duties. Transporters remaining at the Iron Mountain node will be refueled and stored while those leaving the Iron Mountain node will proceed to the Transit Delay, Attrition and Consumption of Resources module.

Transit Delay, Attrition, and Consumption of Transporter Resources Module. In the Transit Delay, Attrition, and Consumption of Transporter Resources Module, the transporter will be held in this module based on the transit time (calculated by the distance divided by its speed) and its operating fuel deducted by the amount needed to reach the next destination (calculated by the distance divided by its rate of fuel consumption). The rate of attrition will also determine if the transporter will be destroyed during the transit to its next destination. Attrited transporters will be sent back to their originating node so that they can be removed from the model.

Consumption of Resources Module. Once the Expeditionary Force occupies the Iron Mountain, it begins to consume the resources that are held there in the Consumption of Resources Module. The amount of food, water, ground ammunition, air ammunition, fuel, and spares will be deducted from the resources on a daily basis, based on a pre-determined consumption rate. Attrition of Marines and generation of casualties also occur on a daily basis, based on the attrition rate for the Iron Mountain.

Reliability and Availability of Vehicles Module. Vehicles stored at the Iron Mountain node are subjected to reliability constraints through the Reliability and Availability of Vehicles Module. In this module, vehicles are removed from the resource pool based on their respective reliability rates for an interval of 24 hours (to simulate the repair of said vehicles) before they are released back into the resource pool. Vehicles taken out of service will not be made available for any missions or re-supply until they are returned back to the resource pool.

Communications Module. Communication messages that arrive from the Objective will be routed to the Communications Module. In the model, communications between the Objective and Iron Mountain nodes exist to facilitate the supply process. Every eight hours, Objective will send a message to Iron Mountain, requesting for resources that have been depleted. In the Communications Module, the message will be decoded and the amount of each resource (i.e., troops, ground ammunition, water, fuel, combat vehicles) requested by Objective will be stored. The Communications Module will then initiate the supply process by triggering a demand for transporters or combat vehicles to report to the Objective. In this supply process, the primary means is to deliver the resources using ground transporters (trucks and HMMWVs). Similarly, ground combat vehicles, with the exception of the M198 howitzer, will move independently to the Objective based on the number of each vehicles requested. The supply of M198 howitzers to the Objective will only occur if there are trucks available to tow the howitzer to the Objective. Besides the ground transporters, air transporters can also transport the mission-critical resources (i.e., water, fuel, food, and ground ammunition) to the Objective. Once the resources leave the Iron Mountain node, the Objective request stored will be deducted to reflect the completion of the entire communication and supply process.

c. User Setup Requirements

The user setup requirements for this node include:

S/No.	Input Description	Unit of Measure
Unload Resources Module		
1.	Number of sea lanes available	Each
2.	Number of landing spots available	Each
3.	Unloading delay for the various types of transports	Minutes
Consumption of Resources Module		
4.	Rate of consumption of water	Gallons/day
5.	Rate of consumption of MRE	Number of pkts/day
6.	Rate of consumption of air ammunition	Lbs/day
7.	Rate of consumption of ground ammunition	Lbs/day
8.	Rate of consumption of spares	Lbs/day
9.	Rate of attrition (dead) of Marines	Each/day
10.	Rate of attrition (casualty) of Marines	Each/day
Reliability and Availability of Vehicles Module		
11.	Availability rate for each vehicle type	Availability rate/day
12.	Duration of repair	Minutes
Transportation of Supplies to Objective Module		
13.	Vehicle attributes (for every vehicle): Speed Rate of Fuel consumption Fuel Capacity Next destination Owner Status	 Miles/minute Gallons/mile Gallons 1 through 7 6 1
14.	Amount of water transporter can carry	Lbs
15.	Amount of fuel transporter can carry	Lbs
16.	Amount of food transporter can carry	Each
17.	Number of Marines transporter can carry	Each
18.	Loading delay for transporter	Minutes
Transit Delay, Attrition, and Consumption of Transporter Resources Module		
19.	Distance between Iron Mountain and Launching Area	Miles
20.	Distance between Iron Mountain and Objective	Miles
21.	Distance between Iron Mountain and Assembly Area	Miles
22.	Distance between Iron Mountain and CONUS	Miles
23.	Rate of attrition for transporters	—

Table 12-1-10: List of user inputs for Iron Mountain node

d. At the Node Input

The inputs to the node include air and sea transporters from the Launching Area node, sea transporters from the Assembly Area and Off-Shore Base nodes, and ground transporters from the Objective node. Communication messages will also be sent into the node from the Objective node.

e. At the Node Output

The outputs from the node will be air and sea transporters returning to the Launching Area, sea transporters to the CONUS and Off-Shore Base nodes, and ground transporters to the Objective node. Communication messages will also be sent to the Objective node. The status of the primary resources (food, fuel, and ground ammunition) held at the Iron Mountain node will also be recorded for further analysis.

9. Objective

a. Process Overview

In the model, the Objective is a target area that the Expeditionary Force intends to capture. The Objective can be as far inland as 200 nautical miles (NM) and the Expeditionary Force is expected to be able to fight and sustain itself for up to 15 days with its organic assets, and indefinitely when augmented with Maritime Pre-positioned Force assets. The overview of the processes involved in this node is shown in Figure 12-1-12.

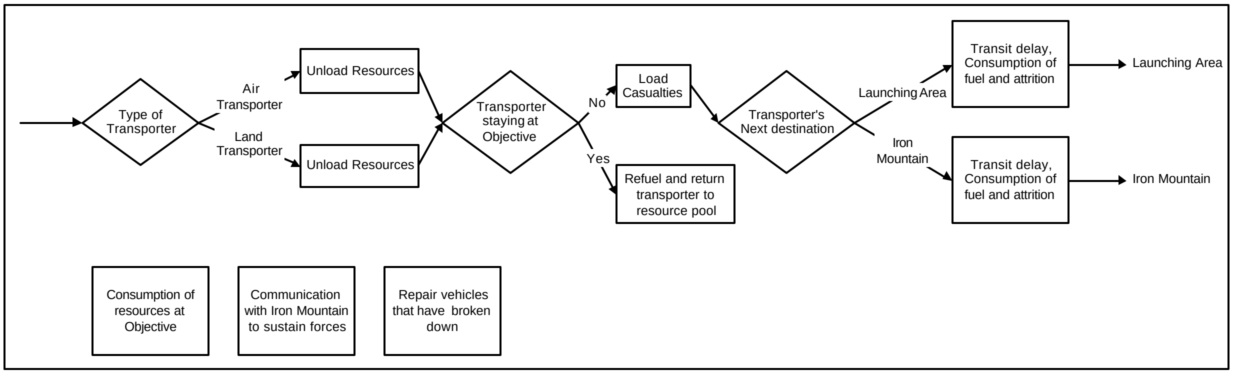


Figure 12-1-12: Overview of Objective processes

b. Node Description

The major modules in this node are Unload Resources, Consumption of Resources, Reliability and Availability of Vehicles, Attrition of Vehicles, Communications, and Transit Delay, Attrition, and Consumption of Transporter Resources. Some of these modules interact with each other by passing information and resources, while others perform their roles in isolation. Objects that come into and out of the Objective node are transporters (vehicles, sea-going vessels, and aircraft) and messages.

Unload Resources Module. When a transporter first arrives at the node, its attributes are read to determine its identity. Ground and air transporters are routed to the Unload Resources Module. In the Unload Resources Module, the number of air transporters that are allowed to unload their resources is restricted by the number of landing spots. The troops, casualties, water, ground ammunition, fuel, food, and all vehicles carried by the transporters are unloaded and stored at the Objective node. The transporters are also delayed at this module according to their unloading time. Once a transporter finishes unloading its resources its attributes are read again to determine if the transporter will report to the Objective node for duty or be returned to its originating node for other duties. Transporters remaining at the Objective node are refueled and stored, while those leaving the Objective node proceed to the Load Casualties Module. If there are casualties at the Objective, the transporter will be held at the Objective to load the casualties so that they can be evacuated for further treatment. The delay time for each transporter is dependent on the number of casualties that it can carry. Once the transporter is done loading the casualties, it is sent to the Transit Delay, Attrition, and Consumption of Transporter Resources Module.

Transit Delay, Attrition, and Consumption of Transporter Resources Module. In the Transit Delay, Attrition, and Consumption of Transporter Resources Module, the transporter is held based on the transit time (calculated by the distance divided by its speed) and its operating fuel deducted by the amount needed to reach the next destination (calculated by the distance divided by its rate of fuel consumption). The rate of attrition also determines if the transporter will be out-of-action during the transit to its next destination. Attrited transporters are sent back to their originating node so that they can be removed from the model. Besides availability and reliability, vehicles at the Objective are also subjected to attrition by enemy action in the Attrition module. At the end of each day, the vehicles held at the Objective node are reduced by the attrition rate determined by the user. These vehicles are taken out of the model and do not interact with the model in any other way (i.e., there is no simulation of the salvage process for damaged or destroyed vehicles).

Consumption of Resources Module. Once the Expeditionary Force occupies the Objective, it begins to consume the resources that are held there in the Consumption of Resources Module. The amount of food, water, ground ammunition, air ammunition, fuel, and spares are deducted from the resources on a daily basis, based on a pre-determined consumption rate. Attrition of Marines and generation of casualties also occur on a daily basis, based on the attrition rate for the Objective.

Reliability and Availability of Vehicles Module. Vehicles stored at the Objective node are subjected to reliability constraints through the Reliability and Availability of Vehicles Module. In this module, vehicles are removed from the resource pool based on their respective reliability rates for an interval of 24 hours (to simulate the repair of the vehicles) before they are released back into the resource pool. Vehicles taken out of service are not made available for any missions or re-supply until they are returned back to the resource pool.

Communications Module. The Objective sends requests for supplies through the Communications Module. Once the Expeditionary Force lands at the Objective, the Communications Module sends out a request message every eight hours stating the resources and vehicles that the Objective requires. The shortfall is calculated by subtracting the desired holding level (set up the user) from the actual holding at the Objective. In order to eliminate the possibility of double counting, this shortfall is subtracted by the earlier requested shortfall, but not yet fulfilled (by either the Iron Mountain node or the Sea Base node).

c. User Setup Requirements

The user setup requirements for this node include:

S/No.	Input Description	Unit of Measure
	Unload Resources Module	
1.	Number of landing spots available	—
2.	Unloading delay for the various types of transporters	Minutes
	Consumption of Resources Module	
3.	Rate of consumption of ground ammunition	Lbs/day
4.	Rate of consumption of MRE	Packets/day
5.	Rate of consumption of water	Gallons/day
6.	Rate of consumption of fuel	Gallons/day
7.	Rate of attrition (dead) of Marines	Number/day
8.	Rate of attrition (casualty) of Marines	Number/day
	Attrition of Vehicles Module	
9.	Rate of attrition of each class of vehicle	Number/day
	Load Casualties Module	
10.	Number of casualties that transporter can carry	—
11.	Casualty loading time for transporter	Minutes
	Reliability and Availability of Vehicles Module	
12.	Availability rate for each class of vehicles	—
13.	Duration of repair	Minutes
	Communications Module	
14.	Number of Marines to be maintained at Objective	—
15.	Number of M1A1 tanks to be maintained at Objective	—
16.	Number of LAVs to be maintained at Objective	—
17.	Number of AAVs to be maintained at Objective	—
18.	Number of AAAVs to be maintained at Objective	—
19.	Number of M198 howitzers to be maintained at	—

S/No.	Input Description	Unit of Measure
	Objective	
20.	Number of HMMWVs to be maintained at Objective	—
21.	Number of trucks to be maintained at Objective	—
22.	Number of packets of MREs to be maintained at Objective	—
23.	Amount of fuel to be maintained at Objective	Gallons
24.	Amount of ground ammunition to be maintained at Objective	Pounds
25.	Amount of water to be maintained at Objective	Gallons
26.	Interval between messages	Minutes
Transit Delay, Attrition, and Consumption of Transporter Resources Module		
27.	Distance between Objective and Launching Area	Miles
28.	Distance between Objective and Iron Mountain	Miles
29.	Distance between Objective and Assembly Area	Miles
30.	Rate of attrition for transporters	—

Table 12-1-11: List of user inputs for Objective node

d. *Node Input*

The inputs to the node include air and sea transporters from the Launching Area node, sea transporters from the Assembly Area and Off-Shore Base nodes, and ground transporters from the Objective node. Communication messages are also sent into the node from the Objective node.

e. *Node Output*

The outputs from the node are air transporters returning to the Launching Area and ground transporters to the Iron Mountain node. Communication messages are also sent to the Iron Mountain node. The status of the primary resources (food, water, fuel, and ground ammunition), the number of each combat force element (M1A1 tanks, LAVs, AAVs, AAAVs, M198 howitzers, HMMWVs, and troops) held at the Objective node are also recorded for further analysis.

F. PRE-SIMULATION SETUP

We created three variants of the ExWar EXTEND^{TM} Model to represent for the Current, Planned, and Conceptual architectures, respectively. Hence, the appropriate variant of the model would need to be used correctly depending on the architecture desired. With the user input file that was created for the ExWar Model, it is necessary to make the appropriate settings and key in data at each node as the initial state of the model. As the ExWar Model is an extensive and complex model, we aggregated most of the code blocks into H-blocks for easy re-use and presentation at the top level. Hence, it is necessary to enter those H-blocks to make the settings and data entry. In addition, there are two text files that would hold information pertaining to transporter preference for the air and ground transportation in the Launching Area node. These two files have to be in the same folder as the EXTEND^{TM} Model code file on the computer. Otherwise, when executed, the simulation software would return an error message.

On completion of model settings and data entry, it is necessary to make settings in the EXTEND^{TM} program itself. Firstly, the global time step has to be defined. For our study, we wished to study the processes in the resolution of time steps of minutes. Hence, the global time units under "simulation setup" was set to "minutes." This is the default time unit for all blocks that use "default" as their time units. Hence, for new code blocks that were added subsequently, extra care had to be exercised to ensure the correct time units were chosen. Depending on the length of time desired to investigate the ExWar processes, it was also necessary to set the simulation end time. In the case of our study, we set this to end at 90 days. If variability were also being used in the model, other settings in the "simulation setup" would also be necessary.

G. MODEL OUTPUTS

The EXTEND^{TM} software allows us to derive outputs in many formats. It is possible to write the outputs to a text file, generate graphs from the plotter utilities, or export entire tables out to another application (e.g., the spreadsheet program Excel) for further processing. In addition, there are dialogue boxes in certain code blocks, which may provide relevant information (such as average queue length, average wait time, etc.) that may be of importance for further analysis to be done.

In the ExWar Model, we decided that we would use the plotters to record the Combat Power Index (CPI) at the Objective. This index uses the number of each entity (troops, M1A1 tanks, LAVs, etc.) multiplied by their respective CPI to generate an aggregated CPA at the Objective at any specific point in time. To assist us in the analysis of the CPA, we have also recorded the number of troops, M1A1 tanks, LAVs, trucks, HMMWVs, M198 howitzers, AAVs, and AAAVs that are held at the Objective at times during each model run.

Besides the CPA, we also monitored the status of the logistics supplies held at the Iron Mountain/Sea Base and the Objective. At the Objective, the amount of water, food, ground ammunition, and fuel held is recorded. At the Iron Mountain/Sea Base, only the amount of fuel, food, and ground ammunition held is recorded. Water was not included as our assumption was that the Iron Mountain/Sea Base would generate the water needed to supply the Objective.

The raw outputs from EXTEND™ were processed with Excel to generate the results that facilitated our analysis. For the CPA, a threshold was set to determine the time at which this limit was breached. For the logistics supplies, the raw data was converted to show the number of days of supply that each of the nodes held instead of just how much of each supply the node held. From there, we determined the average deviation of the supplies held at the node versus the targeted profile for the analysis of the outputs.

APPENDIX 12-2

Attrition Rate Vis-À-Vis Probabilistic Attrition

12-2 ATTRITION RATE VIS-À-VIS PROBABILISTIC ATTRITION

During the planning and designing stage, we were undecided on whether an attrition rate or attrition through probability be used in the model. The main difference between the two is that the latter would require numerous runs to get a set of sample results that are representative while the formal would only required a single run, hence a savings in time required to run all the simulations. It was then decided that a mini-study should be conducted to analyze the differences between the results using the two methods, so that we could make a more informed decision.

One simulation run using an attrition rate and five simulation runs with probabilistic attrition were conducted. Graphs (see Figure 12-2-1) were then plotted to compare between these outputs and we found that by using the attrition rate, the number of troops being attrited stays within the 95% CI of the mean with the five probabilistic runs. We believe that as the number of probabilistic runs increases, thereby increasing the sample size, the mean would converge towards that of the attrition rate.

Based on this finding, we decided that using an attrition rate would be accurate enough for our purpose and the models were thus built utilizing an attrition rate.

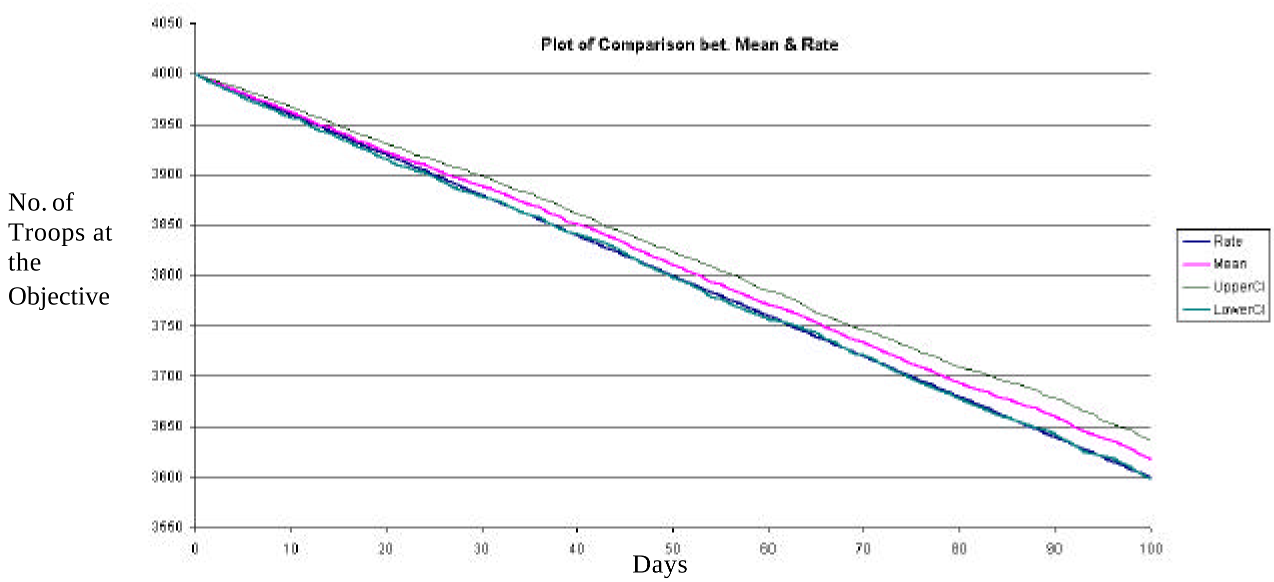


Figure 12-2-1: Plot of comparison between Attrition Rate and Probabilistic Attrition

APPENDIX 12-3

Validation of Models Data

12-3 VALIDATION OF MODELS DATA

Validation Simulation Runs Data

Attrition 0

EXTEND Model Validation Data & Results

Mission	Force Size	Daily Sustainment / Consumption Requirements				Distance (Miles)	ARENA MODEL — Mission Days - Percentage of Daily Requirements Delivered for last 5 days (days 11 - 15)					EXTEND MODEL — Mission Days - Percentage of Daily Requirements Delivered for last 5 days (days 11 - 15)				
		MRE (Pallet)	Water (Bladder)	Fuel (Bladder)	Ammo - (Pallet)		11	12	13	14	15	11	12	13	14	15
Humanitarian Assistance/ Disaster Relief	417	3	5	10	0	50	100	100	100	100	100	100	100	100	100	100
						100	100	100	100	100	100	100	100	100	100	100
						150	100	100	100	100	100	100	100	100	100	100
Non-Combatant Evacuation Operation - Sustain	651	4	8	10	2	50	100	100	100	100	100	100	100	100	100	100
						100	100	100	100	100	100	100	100	100	100	100
						150	100	100	100	100	100	100	100	100	100	100
Non-Combatant Evacuation Operation - Assault	651	4	8	10	7	50	100	100	100	100	100	100	100	100	100	100
						100	100	100	100	100	100	100	100	100	100	100
						150	100	98	96	93	93	100	100	100	100	100

Table 12-3-1: Data from Validation Modeling Runs

APPENDIX 12-4

User Input Data

12-4 USER INPUT DATA

CURRENT ARCHITECTURE

S/No.	Items	2 MEU in CONUS	1 MEU Afloat	ExWar Force (1 MEB) Exclude 6 MPS Ships	MPS (6 Ship Total)	Total for ExWar Current Architecture Modeling Force Size
	Land Vehicles					
1.	M1A1 Tanks	8	4	12	58	70
2.	Light Armor Vehicles (LAVs)	32	16	48	25	73
3.	Assault Amphibious Vehicles (AAVs)	30	15	45	109	154
4.	Advanced AAVs (AAAVs)	—	—	—	—	—
5.	M198 155mm Howitzers	12	6	18	30	48
6.	HMMWVs	200	100	300	748	1,048
7.	Trucks	60	30	90	447	537
	Air Vehicles					
8.	UH-1N Helos	6	3	9	—	9
9.	CH-46 Helos	24	12	36	—	36
10.	CH-53 Helos	20	10	30	—	30
11.	MV-22 Osprey	—	—	—	—	—
	Sea Vehicles					
12.	LHD	1	1	2	—	2
13.	LHA	1	0	1	—	1
14.	LSD	2	1	3	—	3
15.	LPD	2	1	3	—	3
16.	LCAC	15	8	23	—	23
17.	LCU	16	0	16	—	16
18.	LCM	—	—	—	—	—
	Equipment/Personnel					
19.	Troops	6,433	3,300	9,733	—	9,733
20.	Rations	289,485	148,500	437,985	875,970	1,313,955
21.	Fuel	800,000	400,000	1,200,000	2,400,000	3,600,000
22.	Ship Ammo Supplies	—	—	—	—	—
23.	Aircraft Ammo	133,920	66,960	200,880	401,760	602,640
24.	Ground Ammo	671,800	335,900	1,007,700	2,015,400	3,023,100
25.	Spares	530,800	265,400	796,200	1,592,400	2,388,600

Table 12-4-1: Current Architecture Start State Data

CONUS

1. Rate of fuel consumption (gals/day) (LHD, LSD, LPD, LHA, MPF).

Platform	(gals/mile)
LHD	38
LHA	35
LPD	31
LSD	30
MPF	84

2. Aggregated loading delay for all ships: Two days.

3. Speed of advance for the assault force (aggregated): 18 kts.

4. Fuel Capacity of ships (LSD, LPD, LHA, MPF).

Platform	Fuel	
	(tons)	(gal)
LHD	1,232	362,352
LHA	1,200	352,941
LPD	813	239,118
LSD	813	239,118
MPF	3,700	1,058,200

5. Loading Plan for Amphibious Forces and Replenishment Ships.

S/No.	Items	Amphib Force (2 MEUs)	Scheduled Replenishment (30 DOS/Load/ship) (Assuming a total of 6 ships make-up 30 DOS)
	Land Vehicles		
1.	M1A1 Tanks	8	—
2.	Light Armor Vehicles (LAVs)	32	—
3.	Assault Amphibious Vehicles (AAVs)	30	—
4.	Advanced AAVs (AAAVs)	—	—
5.	M198 155mm Howitzers	12	—
6.	HMMWVs	200	—
7.	Trucks	60	—
	Air Vehicles		
8.	UH-1N Helos	6	—
9.	CH-46 Helos	24	—
10.	CH-53 Helos	20	—
11.	MV-22 Osprey	—	—
	Sea Vehicles		
12.	LHD	1	—
13.	LHA	1	—

S/No.	Items	Amphib Force (2 MEUs)	Scheduled Replenishment (30 DOS/Load/ship) (Assuming a total of 6 ships make-up 30 DOS)
14.	LSD	2	—
15.	LPD	2	—
16.	LCAC	15	—
17.	LCU	16	—
18.	LCM	—	—
	Equipment/Personnel		
19.	Troops	6,433	—
20.	Rations (pkt)*	289,485	875,970/145,995
21.	Fuel (gal)*	800,000	2,400,000/400,000
22.	Ship Ammo (lbs)*	—	—
23.	Aircraft Ammo (lbs)*	133,920	401,760/66,960
24.	Ground Ammo (lbs)*	671,800	2,015,400/335,900
25.	Spares*	530,800	1,592,400/88,470

*10 days of MEB supplies.

6. Frequency (and how many ships) of scheduled replenishment to Offshore Base: One ship every five days.

7. Speed of advance for these scheduled replenishment ships: 15 kts.

FORWARD DEPLOYED FORCES

8. Rate of Fuel consumption (gallons/day) (LSD, LPD, LHA).

Platform	(gal/mile)
LHD	38
LHA	35
LPD	31
LSD	30
MPF	84

9. Speed of advance for the forward deployed force (aggregated): 18 kts.

10. Fuel Capacity of ships (LSD, LPD, LHA).

Platform	Fuel	
	(tons)	(gal)
LHD	1,232	352,352
LHA	1,200	343,200
LPD	813	239,118
LSD	813	239,118
MPF	3,700	1,058,200

11. Loading Plan for Afloat Amphib force.

S/No.	Items	Afloat Amphib Force (1 MEU)
	Land Vehicles	
1.	M1A1 Tanks	4
2.	Light Armor Vehicles (LAVs)	16
3.	Assault Amphibious Vehicles (AAVs)	15
4.	Advanced AAVs (AAAVs)	—
5.	M198 155mm Howitzers	6
6.	HMMWVs	100
7.	Trucks	30
	Air Vehicles	
8.	UH-1N Helos	3
9.	CH-46 Helos	12
10.	CH-53 Helos	10
11.	MV-22 Osprey	—
	Sea Vehicles	
12.	LHD	1
13.	LHA	0
14.	LSD	1
15.	LPD	1
16.	LCAC	8
17.	LCU	0
18.	LCM	—
	Equipment/Personnel	
19.	Troops	3,300
20.	Rations*	148,500
21.	Fuel*	400,000
22.	Ship Ammo*	—
23.	Aircraft Ammo*	66,960
24.	Ground Ammo*	335,900
25.	Spares*	265,400

*Five days of MEB supplies.

OFFSHORE BASES

12. Initial holding resources at Offshore Base: 0.

13. Loading/Unloading delay for incoming resources (from CONUS): Three days.

14. Frequency (and how many ships) of scheduled replenishment to Iron Mountain: One ship/five days.

15. Speed of advance for MPF ships: 15 kts.

16. Loading Plan for Replenishment ships.

S/No.	Items	Replenishment Ships (6 MPS Ships) (Total Load)/(Load/Ship)
	Land Vehicles	
1.	M1A1 Tanks	58/9
2.	Light Armor Vehicles (LAVs)	25/4
3.	Assault Amphibious Vehicles (AAVs)	109/18
4.	Advanced AAVs (AAAVs)	—
5.	M198 155mm Howitzers	30/5
6.	HMMWVs	748/124
7.	Trucks	447/74
	Air Vehicles	
8.	UH-1N Helos	—
9.	CH-46 Helos	—
10.	CH-53 Helos	—
11.	MV-22 Osprey	—
	Sea Vehicles	
12.	LHD	—
13.	LHA	—
14.	LSD	—
15.	LPD	—
16.	LCAC	—
17.	LCU	—
18.	LCM	—
	Equipment/Personnel	
19.	Troops	—
20.	Rations*	875,970/145,995
21.	Fuel*	2,400,000/400,000
22.	Ship Ammo*	—
23.	Aircraft Ammo*	401,760/66,960
24.	Ground Ammo*	2,015,400/335,900
25.	Spares*	1,592,400/88,470

*30 days of MEB supplies.

LAUNCHING AREA

17. Rate of attrition at Launching Area.[1]

Period	Attrition Rate/Day	
	Aircraft	Seacraft
1st 7 days	0.163406	0.012761
8–14 days	0.06195	0.003446
15+ days	0.039195	0.002297

18. Rate of attrition between Objective and Launching Area.

Period	Attrition Rate/Day	
	Aircraft	Seacraft
1st 7 days	0.271703	0.024276
8–14 days	0.138388	0.007657
15+ days	0.039195	0.002297

19. Rate of attrition between Iron Mountain and Launching Area.

Period	Attrition Rate/Day	
	Aircraft	Seacraft
1st 7 days	0.163406	0.012761
8–14 days	0.06195	0.003446
15+ days	0.039195	0.002297

20. Rate of attrition between Assembly Area and Launching Area.

Period	Attrition Rate/Day	
	Aircraft	Seacraft
1st 7 days	0.055108	0.005743
8–14 days	0.06195	0.003446
15+ days	0.039195	0.002297

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[1] All attrition figures are calculated based on the casualty rate estimation planning factor, extracted from Part IV of the MAGTF Planner's Reference Manual, MSTP Pamphlet 5-0.3, USMC 2001.

21. Rate of Food consumption (MRE, pkt/day/troop): N/A.

22. Rate of Water consumption (gal/day/troop): N/A.

23. Rate of Air Ammo consumption (lbs/day): 13,392 lbs/day.

24. Rate of Land Ammo consumption (lbs/day): 0.

25. Rate of Sea Ammo consumption (lbs/day): 5,000 lbs/day.

26. Rate of Spare Parts consumption (lbs/day): 5,000 lbs/day.

27. Unloading delay for transporters (LCAC, LCM, LCU, CH-53, UH-1N, CH-46, MV-22).

Platform	Load	Unload
	(minutes)	
LCAC	45	15
LCM	30	15
LCU	90	30
CH-53	20	20
UH-1N	10	10
CH-46	15	15
MV-22	20	20

28. Speed of Air transporters (CH-53, UH-1N, CH-46, MV-22).

Platform	Cruise Speed	
	(kts)	(mile/min)
MV-22	240	4.6
CH-53	150	2.9
CH-46	120	2.3
UH-1N	120	2.3

29. Speed of Surface transporters (LCAC, LCU, LCM, etc.).

Platform	Cruise Speed	
	(kts)	(mile/min)
LCAC	35	0.7
LCU	8	0.2
LCM	12	0.23

30. Fuel Capacity of all Air and Sea vehicles (i.e., CH-53, UH-1N, CH-46, MV-22, LSD, LPD, LCAC, etc.).

Platform	Fuel	
	(tons)	(gal)
LHD	1,232	362,353
LHA	1,200	352,941
LPD	813	239,118
LSD	813	239,118
MPF	3,700	1,088,235
LCAC	17	5,000
LCU	11	3,220
LCM	2.65	780

Platform	Fuel Capacity	
	(lbs)	(gal)
MV-22	9,849	1,448
CH-53	15,483	2,277
CH-46	4,488	660
UH-1N	1,835	270.5

31. Load Capacity of all Air and Sea vehicles and limitations of each vehicle or resources (e.g., M1A1 cannot be airlifted; CH-53 can carry X number of troops, etc.).

CURRENT

Platform	Number	Load/Platform						
		Pers	CH-46E	CH-53E	LCAC	LCU	Well-Deck Spot	Helo Spot
LPD-4	1	930		4	9 LCU		1	2
	2				2 LCAC			
LSD-49	3	500	2	0	4 LCAC		1	2
LHA	1	1,703	10	6	1 LCAC & 7 LCU		1	9
LHD	2	1,870	10	6	3 LCAC		1	9
LCAC	23	5/120						
LCU	16	11/400						

32. Minimum Logistical level to be held at Launching Area.

Aircraft	AH-1W	CH-46	CH-53	UH-1N
Number at Launching Area	12	30	27	9

All other logistical items (food, water, fuel, ammo, etc.): 0.

33. Operating hours for transporters (i.e., MV-22, CH-53, LCAC) before they go for maintenance and servicing time.

Platform	Operating Endurance	Repair	Remarks*
	(hours)		
MV-22	96	24	Classified
CH-53	96	24	Classified
CH-46	96	24	Classified
UH-1N	96	24	Classified
LCAC	48	24	Classified
LCU	48	24	Classified
LCM	48	24	Classified
M1A1	120	24	Classified
LAV	120	24	Classified
AAV	120	24	Classified
M88A1-E1	120	24	Classified
HMMWVs	240	24	Classified
MK48	240	24	Classified

*Note: True values are classified; use these for illustrative purposes only.

34. Reliability figures for equipment and repair time.

Equipment	Ships	Sea Transporters		Aircraft	Land Platforms	
		LCAC	LCM/LCU		Tracked	Wheeled
Reliability	1.0	0.7	0.8	0.7	0.8	0.95

MTR (for all equipment): 24 hours.

35. Loading Plan (Appendix C) for buildup of the MEB ashore: See Annex C.

IRON MOUNTAIN

36. Number of sea lanes: 12 lanes.

37. Number of landing spots: 36 landing spots.

38. Rate of attrition at Iron Mountain.

Period	Attrition Rate/Day					
	Troops			Aircraft	Seacraft	Land Vehicle
	Killed	Wounded	Total			
1st 7 days	0.004479	0.01045	0.014929	0.271703	0.024276	0.007743
8–14 days	0.002326	0.005427	0.007753	0.138388	0.007657	0.005698
15+ days	0.000885	0.002065	0.00295	0.039195	0.002297	0.002931

39. Rate of attrition between Iron Mountain and Objective.

Period	Attrition Rate/Day					
	Troops			Aircraft	Seacraft	Land Vehicle
	Killed	Wounded	Total			
1st 7 days	0.004479	0.01045	0.014929	0.271703	0.024276	0.007743
8–14 days	0.002326	0.005427	0.007753	0.138388	0.007657	0.005698
15+ days	0.000885	0.002065	0.00295	0.039195	0.002297	0.002931

40. Rate of attrition between Iron Mountain and Launching Area.

Period	Attrition Rate/Day				
	Troops			Aircraft	Seacraft
	Killed	Wounded	Total		
1st 7 days	0.002511	0.005859	0.00837	0.163406	0.012761
8–14 days	0.000947	0.00221	0.003157	0.06195	0.003446
15+ days	0.000885	0.002065	0.00295	0.039195	0.002297

41. Rate of attrition between Iron Mountain and Assembly Area.

Period	Attrition Rate/Day				
	Troops			Aircraft	Seacraft
	Killed	Wounded	Total		
1st 7 days	0.002511	0.005859	0.00837	0.163406	0.012761
8–14 days	0.000947	0.00221	0.003157	0.06195	0.003446
15+ days	0.000885	0.002065	0.00295	0.039195	0.002297

42. Rate of Food consumption (MRE, pkt/day/troop): Three pkts/day/troop.

43. Rate of Water consumption (gallons/day/troop).

Temperate Zone	
Sustain	Min
7.0 GPM	4.1 GPM
Artic Zone	
7.6 GPM	4.6 GPM
Arid Zone	
14.1 GPM	6.4 GPM
Tropical Zone	
8.9 GPM	5.9 GPM

44. Rate of Fuel consumption (gallons/day): See matrix.

Iron Mountain		
	Surge	**Sustain**
	Day 1-3	**Day 4-TBD**
Fuel	96,000 gal/day	16,000 gal/day
Ground Ammo	41,850 lbs/day	13,392 lbs/day
Air Ammo	16,740 lbs/day	13,392 lbs/day
Other Cargo and Spares	53,080 lbs/day	47,772 lbs/day

45. Unloading delay for transporters (LCAC, LCM, LCU, CH-53, UH-1N, CH-46, MV-22).

Platform	Load	Unload
	(minutes)	
LCAC	45	15
LCM	30	15
LCU	90	30
CH-53	20	20
UH-1N	10	10
CH-46	15	15
MV-22	20	20

46. Speed of Air transporters (CH-53, UH-1N, CH-46, MV-22).

Platform	Speed	
	(kts)	(mile/minute)
MV-22	240	4.6
CH-53	150	2.9
CH-46	120	2.3
UH-1N	120	2.3

47. Fuel Capacity of Air transporters (CH-53, UH-1N, CH-46, MV-22).

Platform	Fuel Capacity	
	(lbs)	(gals)
MV-22	9,849	1,448
CH-53	15,483	2,277
CH-46	4,488	660
UH-1N	1,835	270.5

48. Speed of Land vehicles (Trucks, HMMWVs, AAV, AAAV).

Platform	Speed	
	(mph)	(mile/minute)
M1A1	42	0.7
LAV	62	1.03
AAV	25 land/6 water	0.42/0.1
AAAV	30 land/25 water	0.5/0.42
M88A1-E1	30	0.5
HMMWVs	60	1
MK48	57	0.95

49. Fuel Capacity of Land vehicles (Trucks, HMMWVs, AAV, AAAV).

Platform	Fuel (gal)
M1A1	505
LAV	71
AAV	171
M88A1-E1	400
HMMWVs	25
MK48	150

50. Minimum force level at Iron Mountain to launch mission.

a. Minimum force level to be kept at Iron Mountain for force protection: 10%.

b. Minimum force level to be accumulated at Iron Mountain before forces are dispatched to help capture objectives: 20%.

51. Minimum Logistical level to be held at Iron Mountain: 15 days of supplies.

52. Reliability figures for equipment and repair time.

Equipment	Ships	Sea Transporters		Aircraft	Land Platforms	
		LCAC	LCM/LCU		Tracked	Wheeled
Reliability	1.0	0.7	0.8	0.7	0.8	0.95

MTR: 24 hours.

53. Load capacities for ground, sea, and air transports (either/or).

Type	Troops (crew + troops)	Water (gals)	Food (Number of MRE)	Fuel (gals)	Ground Ammo (lbs)	Spares/Others (lbs)	Casualties
Percentage by Sea Transporter	50	50	50	50	50	50	10
Percentage	50	50	50	50	50	50	90

Type	Troops (crew + troops)	Water (gals)	Food (Number of MRE)	Fuel (gals)	Ground Ammo (lbs)	Spares/Others (lbs)	Casualties
by Air Transporter							
Truck [1]	2+24	900	2,340	900	5,102	5,102	20
HMMWV	2+8	0	936	0	2,374	2,374	5
UH-1N/T	4+4	0	468	0	1,000	1,000	3
CH-46	5+12	400	1,404	400	3,000	3,000	8
CH-53	3+24	1,200	6,084	1,600	12,000	12,000	18
LAV	3+6	0	0	0	0	0	4
AAV [2]	3+22	0	0	0	0	0	18
LCAC	5+120	3,600	66,924	3,600	132,000	132,000	100
LCU	11+400	3,600	201,708	3,600	396,000	396,000	300
MV-22	8+24	800	3,744	800	8,000	8,000	18
C-Helo[3]	5+48	2,400	6,552	2,500	20,000	20,000	38
AAAV	3+17	0	0	0	0	0	12
HLCAC	5+160	5,400	161,460	5,400	316,800	316,800	120
LCU(R)	13+500	5,400	357,084	5,400	594,000	594,000	400

Type	M1A1 Tanks	Light Armor Vehicles (LAVs)	M198 155mm Howitzers	HMMWVs	Trucks
Percentage by Sea Transporter	100	100	50	50	100
Percentage by Air Transporter	0	0	50	50	0
Truck [1]					
HMMWVs					
UH-1N/T					
CH-46					
CH-53			1	1	
LAV					
AAV [2]					
LCAC	1	4	2	12	4
LCU	2	5	4	6	4
MV-22			1	1	
C-Helo[3]			1	2	1
AAAV					
HLCAC	2	10	4	16	6
LCU (R)	3	8	4	12	6

OBJECTIVE

54. Number of sea lanes: 12 lanes.

55. Number of landing spots: 36 landing spots.

56. Rate of attrition at Objective.

Period	Attrition Rate/Day					
	Troops			Aircraft	Seacraft	Land Vehicle
	Killed	Wounded	Total			
1st 7 days	0.007056	0.016464	0.02352	0.398154	0.04075	0.012997
8–14 days	0.00417	0.00973	0.0139	0.229623	0.014565	0.01084
15+ days	0.002141	0.004995	0.007136	0.113369	0.005105	0.006512

57. Rate of attrition between Objective and Iron Mountain.

Period	Attrition Rate/Day					
	Troops			Aircraft	Seacraft	Land Vehicle
	Killed	Wounded	Total			
1st 7 days	0.004479	0.01045	0.014929	0.271703	0.024276	0.007743
8–14 days	0.002326	0.005427	0.007753	0.138388	0.007657	0.005698
15+ days	0.000885	0.002065	0.00295	0.039195	0.002297	0.002931

58. Rate of attrition between Objective and Launching Area.

Period	Attrition Rate/Day				
	Troops			Aircraft	Seacraft
	Killed	Wounded	Total		
1st 7 days	0.004479	0.01045	0.014929	0.271703	0.024276
8–14 days	0.002326	0.005427	0.007753	0.138388	0.007657
15+ days	0.000885	0.002065	0.00295	0.039195	0.002297

59. Rate of attrition between Objective and Assembly Area.

Period	Attrition Rate/Day				
	Troops			Aircraft	Seacraft
	Killed	Wounded	Total		
1st 7 days	0.004479	0.01045	0.014929	0.271703	0.024276
8–14 days	0.002326	0.005427	0.007753	0.138388	0.007657
15+ days	0.000885	0.002065	0.00295	0.039195	0.002297

60. Rate of Food consumption (MRE, pkt/day/troop): Three pkts/day/troop.

61. Rate of Water consumption (gallons/day/troop).

Temperate Zone	
Sustain	**Min**
7.0 GPM	4.1 GPM
Artic Zone	
7.6 GPM	4.6 GPM
Arid Zone	
14.1 GPM	6.4 GPM
Tropical Zone	
8.9 GPM	5.9 GPM

62. Rate of Fuel consumption (gallons/day): See matrix.

Objective		
	Surge	**Sustain**
	Day 1-3	**Day 4-TBD**
Fuel	24,000 gal/day	64,000 gal/day
Ground Ammo	41,850 lbs/day	53,568 lbs/day
Air Ammo	0	0
Other Cargo and Spares	5,308 lbs/day	5,308 lbs/day

63. Rate of Air Ammo consumption (lbs/day): See matrix.

64. Rate of Land Ammo consumption (lbs/day): See matrix.

65. Rate of Sea Ammo consumption (lbs/day): N/A.

66. Rate of Spare Parts consumption (lbs/day): See matrix.

67. Unloading delay for transporters (LCAC, LCM, LCU, CH-53, UH-1N, CH-46, MV-22)

Platform	**Load**	**Unload**
	(minutes)	
LCAC	45	15
LCM	30	15
LCU	90	30
CH-53	20	20
UH-1N	10	10
CH-46	15	15
MV-22	20	20

68. Speed of Air transporter (CH-53, UH-1N, CH-46, MV-22).

Platform	Speed	
	(kts)	(mile/min)
MV-22	240	4.6
CH-53	150	2.9
CH-46	120	2.3
UH-1N	120	2.3

69. Fuel Capacity of Air transporters (CH-53, UH-1N, CH-46, MV-22).

Platform	Fuel Capacity	
	(lbs)	(gals)
MV-22	9,849	1,448
CH-53	15,483	2,277
CH-46	4,488	660
UH-1N	1,835	270.5

70. Speed of Land vehicles (Trucks, HMMWVs, AAV, AAAV).

Platform	Speed	
	(mph)	(mile/min)
M1A1	42	0.7
LAV	62	1.03
AAV	25 land/6 water	0.42/0.1
AAAV	30 land/25 water	0.5/0.42
M88A1-E1	30	0.5
HMMWVs	60	1
MK48	57	0.95

71. Fuel Capacity of Land vehicles (Trucks, HMMWVs, AAV, AAAV).

Platform	Fuel (gal)
M1A1	505
LAV	71
AAV	171
M88A1-E1	400
HMMWVs	25
MK48	150

72. Reliability figures for equipment and repair time.

Equipment	Ships	Sea Transporters		Aircraft	Land Platforms	
		LCAC	LCM/LCU		Tracked	Wheeled
Reliability	1.0	0.7	0.8	0.7	0.8	0.95

MTR: 24 hours.

73. Resource level to be maintained at objective.

Resource	Number Maintained	Daily Usage	Number of Days of Supplies
Troops	4,400		
Ground Ammo (lbs)	334,800	66,960lbs/day x 5 days	5
Food (pkts of MRE)	660,00	4,400 x 3 pkts/day x 5 days	5
Water (gal)	195,800	4,400 x 8.9 gal/day x 5 days	5
Fuel (gal)	400,000	80,000 gal/day x 5 days	5
M1A1	58		
LAV	48		
AAV	109		
M198	36		
HMMWVs	276		
Trucks	126		

User Input – Distances Based on Burma Scenario (Miles)

		CONUS (San Diego) (1)	Fwd Deploy Forces (Japan) (2)	Offshore Base (Diego Garcia) (3)	Assembly Area (>250 NM) (4)	Launching Area/Sea Base (>50 NM) (5)	Landing Beach (6)	Iron Mountain (Chaungzon) (7)	Objective (Mawlamyine) (8)
From	CONUS (San Diego) (1)		8,630	11,222	8,100	8,330	8,377	8,380	8,387
	Fwd Deploy Forces (Japan) (2)			2,373	7,574	7,804	7,854	7,854	7,861
	Offshore Base (Diego Garcia) (3)				2,032	2,262	2,323	2,326	2,319
	Assembly Area (>250 NM) (4)					230	278	281	288
	Launching Area/Sea Base (>50 NM) (5)							51	58
	Landing Beach (6)							3	10
	Iron Mountain (Chaungzon) (7)								7
	Objective (Mawlamyine) (8)								

S/No.	Items	Object ID	Fuel Consumption Rate (gal/mile)
	Land Vehicles		
1.	M1A1 Tanks	1	1.8
2.	Light Armor Vehicles (LAVs)	2	0.9
3.	Assault Amphibious Vehicles (AAVs)	3	Land 0.6; Water 4.07
4.	Advanced AAVs (AAAVs)	4	Land 1.3; Water 6.15
5.	M198 155mm Howitzers	5	0
6.	HMMWVs	6	0.1
7.	Trucks	7	0.5
	Air Vehicles		
8.	UH-1N Helos	101	800 lbs/hr (.85 gal/mile)
9.	CH-46 Helos	102	1,400 lbs/hr (1.49 gal/mile)
10.	CH-53 Helos	103	4,000 lbs/hr (3.4 gal/mile)
11.	MV-22 Osprey	106	350 lbs/hr (.179 gal/mile) (airplane mode)
	Sea Vehicles		
12.	LHD	201	38
13.	LHA	202	35
14.	LSD	203	31
15.	LPD	204	30
16.	MPF	205	84
17.	LMSR	206	90
18.	LCAC	207	11
19.	LCU	208	0.65
20.	LCM	209	0.65
	Equipment/Personnel		
21.	Troops	301	—
22.	Rations	302	—
23.	Water	303	—
24.	Fuel	304	—
25.	Ship Ammo	305	—
26.	Aircraft Ammo	306	—
25.	Ground Ammo	307	—
26.	Casualties	308	—
	Others		—
27.	MEF	401	—
28.	MEB	400	—
29.	MEU	402	—
30.	Spares (Spare Parts for repair, etc.)	403	—

PLANNED ARCHITECTURE

S/No.	Items	2 MEU in CONUS	1 MEU Afloat	ExWar Force (1 MEB) Exclude 6 MPS ships	MPF(F) (6 Ship Total)	Total for ExWar Current Architecture Modeling Force Size
	Land Vehicles					
1.	M1A1 Tanks	8	4	12	58	70
2.	Light Armor Vehicles (LAVs)	32	16	48	25	73
3.	Assault Amphibious Vehicles (AAVs)	—	—	—	—	—
4.	Advanced AAVs (AAAVs)	30	15	45	109	154
5.	M198 155mm Howitzers	12	6	18	30	48
6.	HMMWVs	200	100	300	748	1,048
7.	Trucks	60	30	90	447	537
	Air Vehicles					
8.	UH-1T Helos	6	3	9	—	9
9.	CH-53 Helos	20	10	30	—	30
10.	MV-22 Osprey	24	12	36	—	36
11.	Heavy Lift Aircraft	—	—	—	—	—
	Sea Vehicles					
12.	LHD	—	—	—	—	—
13.	LHA (R)	2	1	3	—	3
14.	LSD-49	2	1	3	—	3
15.	LPD-17	2	1	3	—	3
16.	HLCAC	10	6	16	—	16
17.	LCU (R)	10	2	12	—	12
18.	LCM	—	—	—	—	—
	Equipment/Personnel					
19.	Troops	6,400	3,200	9,600	—	9,600
20.	Rations	289,485	148,500	437,985	875,970	1,313,955
21.	Fuel	800,000	400,000	1,200,000	2,400,000	3,600,000
22.	Ship Ammo Supplies	—	—	—	—	—
23.	Aircraft Ammo	133,920	66,960	200,880	401,760	602,640
24.	Ground Ammo	671,800	335,900	1,007,700	2,015,400	3,023,100
25.	Spares	530,800	265,400	796,200	1,592,400	2,388,600

Table 12-4-2: Planned Architecture Start State Data

CONUS

74. Rate of Fuel consumption (gallons/day) (LHD, LSD, LPD, LHA, MPF).

Platform	(gal/mile)
LHD	38
LHA (R)	47
LPD-17	32
LSD	30
MPF (F)	90

75. Aggregated loading delay for all ships: Two days.

76. Speed of advance for the assault force (aggregated): 18 kts.

77. Fuel Capacity of ships (LSD, LPD, LHA, MPF).

Platform	Fuel	
	(tons)	(gal)
LHD	1,232	352,352
LHA (R)	1,600	470,588
LPD-17	1,077	316,765
LSD	813	239,118
MPF (F)	4,000	1,176,471

78. Loading Plan for Amphibious Forces and Replenishment Ships.

S/No.	Items	Amphib Force (2 MEUs)	MPF Forces	Scheduled Replenishment (30 DOS/Load/ship) (Assuming a total of 6 ships make-up 30 DOS)
	Land Vehicles			
1.	M1A1 Tanks	8	—	—
2.	Light Armor Vehicles (LAVs)	32	—	—
3.	Assault Amphibious Vehicles (AAVs)	—	—	—
4.	Advanced AAVs (AAAVs)	30	—	—
5.	M198 155mm Howitzers	12	—	—
6.	HMMWVs	200	—	—
7.	Trucks	60	—	—
	Air Vehicles			
8.	UH-1T Helos	6	—	—
9.	CH-53 Helos	20	—	—
10.	MV-22 Osprey	24	—	—
11.	Heavy Lift Aircraft	—	—	—
	Sea Vehicles			
12.	LHD	—	—	—
13.	LHA (R)	2	—	—

S/No.	Items	Amphib Force (2 MEUs)	MPF Forces	Scheduled Replenishment (30 DOS/Load/ship) (Assuming a total of 6 ships make-up 30 DOS)
14.	LSD-49	2	—	—
15.	LPD-17	2	—	—
16.	HLCAC	10	—	—
17.	LCU (R)	10	—	—
18.	LCM	—	—	—
	Equipment/Personnel			
19.	Troops	6,400	—	—
20.	Rations (pkt)*	289,485	—	875,970/145,995
21.	Fuel (gal)*	800,000	—	2,400,000/400,000
22.	Ship Ammo (lbs)*	—	—	—
23.	Aircraft Ammo (lbs)*	133,920	—	401,760/66,960
24.	Ground Ammo (lbs)*	671,800	—	2,015,400/335,900
25.	Spares*	530,800	—	1,592,400/88,470

*10 days of MEB supplies.

79. Frequency (and how many ships) of scheduled replenishment to Offshore Base: One ship every two weeks.

80. Speed of advance for these scheduled replenishment ships: 15 kts.

FORWARD DEPLOYED FORCES

81. Rate of Fuel consumption (gallons/day) (LSD, LPD, LHA).

Platform	(gal/mile)
LHD	38
LHA (R)	47
LPD-17	32
LSD	30
MPF (F)	90

82. Speed of advance for the forward deployed force (aggregated): 18 kts.

83. Fuel Capacity of ships (LSD, LPD, LHA).

Platform	Fuel	
	(tons)	(gal)
LHD	1,232	352,352
LHA (R)	1,600	470,588
LPD-17	1,077	316,765
LSD	90	25,740
MPF (F)	4,000	1,176,471

84. Loading Plan for Afloat Amphib force.

S/No.	Items	Afloat Amphib Force (1 MEU)
	Land Vehicles	
1.	M1A1 Tanks	4
2.	Light Armor Vehicles (LAVs)	16
3.	Assault Amphibious Vehicles (AAVs)	—
4.	Advanced AAVs (AAAVs)	15
5.	M198 155mm Howitzers	6
6.	HMMWVs	100
7.	Trucks	30
	Air Vehicles	
8.	UH-1T Helos	3
9.	CH-53 Helos	10
10.	MV-22 Osprey	12
11.	Heavy Lift Aircraft	—
	Sea Vehicles	
12.	LHD	—
13.	LHA	1
14.	LSD	1
15.	LPD	1
16.	HLCAC	6
17.	LCU	2
18.	LCM	—
	Equipment/Personnel	
19.	Troops	3,200
20.	Rations*	148,995
21.	Fuel*	400,000
22.	Ship Ammo*	—
23.	Aircraft Ammo*	66,960
24.	Ground Ammo*	335,900
25.	Spares*	265,400

*Five days of MEB supplies.

OFFSHORE BASES

85. Initial holding resources at Offshore Base: 0.

86. Loading/Unloading delay for incoming resources (from CONUS): Three days.

87. Frequency (and how many ships) of scheduled replenishment to Iron Mountain: One ship/five days.

88. Speed of advance for MPF ships: 15 kts.

89. Initial holding resource (i.e., total resources present at Offshore Base which includes those already loaded onboard MPF ships).

S/No.	Items	Total Resource
	Land Vehicles	
1.	M1A1 Tanks	58
2.	Light Armor Vehicles (LAVs)	25
3.	Assault Amphibious Vehicles (AAVs)	—
4.	Advanced AAVs (AAAVs)	109
5.	M198 155mm Howitzers	30
6.	HMMWVs	748
7.	Trucks	447
	Air Vehicles	
8.	UH-1T Helos	—
9.	CH-53 Helos	—
10.	MV-22 Osprey	—
11.	Heavy Lift Aircraft	—
	Sea Vehicles	
12.	LHD	—
13.	LHA	—
14.	LSD	—
15.	LPD	—
16.	HLCAC	—
17.	LCU (R)	—
18.	LCM	—
	Equipment/Personnel	
19.	Troops	—
20.	Rations*	874,970
21.	Fuel*	2,400,000
22.	Ship Ammo*	—
23.	Aircraft Ammo*	401,760
24.	Ground Ammo*	2,015,400
25.	Spares*	1,592,400

*30 days of MEB supplies.

90. Loading Plan for Replenishment ships.

S/No.	Items	Replenishment Ships (6 MPS Ships) (Total Load)/(Load/Ship)
	Land Vehicles	
1.	M1A1 Tanks	58/9
2.	Light Armor Vehicles (LAVs)	25/4
3.	Assault Amphibious Vehicles (AAVs)	—
4.	Advanced AAVs (AAAVs)	109/18

S/No.	Items	Replenishment Ships (6 MPS Ships) (Total Load)/(Load/Ship)
5.	M198 155mm Howitzers	30/5
6.	HMMWVs	748/124
7.	Trucks	447/74
	Air Vehicles	
8.	UH-1T Helos	—
9.	CH-53 Helos	—
10.	MV-22 Osprey	—
11.	Heavy Lift Aircraft	—
	Sea Vehicles	
12.	LHD	—
13.	LHA	—
14.	LSD	—
15.	LPD	—
16.	H LCAC	—
17.	LCU (R)	—
18.	LCM	—
	Equipment/Personnel	
19.	Troops	—
20.	Rations*	874,970/145,830
21.	Fuel*	2,400,000/400,000
22.	Ship Ammo*	—
23.	Aircraft Ammo*	401,760/66,960
24.	Ground Ammo*	2,015,400/335,900
25.	Spares*	1,592,400/88,470

*30 days of MEB supplies.

LAUNCHING AREA AND SEA BASE

91. Rate of attrition at Launching Area and Sea Base.

Period	**Attrition Rate/Day**	
	Aircraft	**Seacraft**
1st 7 days	0.163406	0.012761
8–14 days	0.06195	0.003446
15+ days	0.039195	0.002297

92. Rate of attrition between Objective and Launching Area and Sea Base.

Period	Attrition Rate/Day	
	Aircraft	Seacraft
1st 7 days	0.271703	0.024276
8–14 days	0.138388	0.007657
15+ days	0.039195	0.002297

93. Rate of attrition between Iron Mountain and Launching Area and Sea Base.

Period	Attrition Rate/Day	
	Aircraft	Seacraft
1st 7 days	0.163406	0.012761
8–14 days	0.06195	0.003446
15+ days	0.039195	0.002297

94. Rate of attrition between Assembly Area and Launching Area and Sea Base.

Period	Attrition Rate/Day	
	Aircraft	Seacraft
1st 7 days	0.055108	0.005743
8–14 days	0.06195	0.003446
15+ days	0.039195	0.002297

95. Rate of Food consumption (MRE, pkt/day/troop): N/A.

96. Rate of Water consumption (gallons/day/troop): N/A.

97. Rate of Air Ammo consumption (lbs/day): 13,392 lbs/day.

98. Rate of Land Ammo consumption (lbs/day): 0.

99. Rate of Sea Ammo consumption (lbs/day): 5,000 lbs/day.

100. Rate of Spare Parts consumption (lbs/day): 5,000 lbs/day.

101. Unloading delay for transporters (LCAC, LCM, LCU, CH-53, UH-1N, CH-46, MV-22).

Platform	Load	Unload
	(minutes)	
HLCAC	45	15
LCM	30	15

LCU (R)	90	30
CH-53	20	20
UH-1T	10	10
CH-46	15	15
MV-22	20	20

102. Speed of Air transporters (CH-53, UH-1N, CH-46, MV-22).

Platform	**Cruise Speed**	
	(kts)	**(mile/min)**
MV-22	240	4.6
CH-53	150	2.9
CH-46	120	2.3
UH-1T	120	2.3

103. Speed of Surface transporters (LCAC, LCU, LCM, etc.).

Platform	**Cruise Speed**	
	(kts)	**(mile/min)**
HLCAC	35	0.7
LCU (R)	15	0.29
LCM	12	0.23

104. Fuel Capacity of all Air and Sea vehicles (i.e., CH-53, UH-1N, CH-46, MV-22, LSD, LPD, LCAC, etc.).

Platform	**Fuel**	
	(tons)	**(gal)**
LHD	1,232	352,352
LHA (R)	1,600	470,588
LPD-17	1,077	316,765
LSD	90	25,740
MPF (F)	4,000	1,176,471
LCA (H)	16	4,706
LCU (R)	3.5	1,029

Platform	**Fuel Capacity**	
	(lbs)	**(gal)**
MV-22	9,849	1,448
CH-53	15,483	2,277
UH-1T	2,584	380

105. Load Capacity of all Air and Sea vehicles and limitations of each vehicle or resources (e.g., M1A1 cannot be airlifted; CH-53 can carry X number of troops, etc.).

PLANNED								
Platform	Number	Load/Platform						
		Pers	MV-22	CH-53E	HLCAC	LCU (R)	Well-Deck Spot	Helo Spot
LPD-17	1	806	2	2	6 LCU (R)		1	2
	2				2 HLCAC			
LSD-49	3	500	2	0	2 HLCAC		1	2
LHA (R)	3	1,894	12	6	2 HLCAC & 2 LCU (R)		1	9
HLCAC	16	5/160						
LCU(R)	12	13/500						
MPF(F)	6	500					1	9

106. Operating hours for transporters (i.e., MV-22, CH-53, LCAC) before it goes for maintenance and its servicing time.

Platform	**Operating Endurance**	**Repair**	**Remarks***
	(hours)		
MV-22	96	24	Classified
CH-53	96	24	Classified
CH-46	96	24	Classified
UH-1T	96	24	Classified
HLCAC	48	24	Classified
LCU (R)	48	24	Classified
LCM	48	24	Classified
M1A1	120	24	Classified
LAV	120	24	Classified
AAAV	120	24	Classified
M88A1-E1	120	24	Classified
HMMWVs	240	24	Classified
MK48	240	24	Classified

*Note: True values are classified; use these for illustrative purposes only.

107. Reliability figures for equipment and repair time.

Equipment	**Ships**	**Sea Transporters**		**Aircraft**	**Land Platforms**	
		LCAC(H)	**LCM/LCU(R)**		**Tracked**	**Wheeled**
Reliability	1.0	0.7	0.8	0.7	0.8	0.95

MTR (for all equipment): 24 hours.

108. Minimum Logistical level to be held at Sea Base.

a. 15 days of supplies for MEB.

109. Load capacities for ground, sea, and air transports (either/or).

Type	Troops (crew + troops)	Water (gals)	Food (Number of MREs)	Fuel (gals)	Ground Ammo (lbs)	Spares/Others (lbs)	Casualties
Percentage by Sea Transporter	50	50	50	50	50	50	10
Percentage by Air Transporter	50	50	50	50	50	50	90
Truck [1]	2+24	900	2,340	900	5,102	5,102	20
HMMWV	2+8	0	936	0	2,374	2,374	5
UH-1N/T	4+4	0	468	0	1,000	1,000	3
CH-46	5+12	400	1,404	400	3,000	3,000	8
CH-53	3+24	1,200	6,084	1,600	12,000	12,000	18
LAV	3+6	0	0	0	0	0	4
AAV [2]	3+22	0	0	0	0	0	18
LCAC	5+120	3,600	66,924	3,600	132,000	132,000	100
LCU	11+400	3,600	2,017,08	3,600	396,000	396,000	300
MV-22	8+24	800	3,744	800	8,000	8,000	18
Heavy Lift Aircraft	5+48	2,400	6,552	2,500	20,000	20,000	38
AAAV	3+17	0	0	0	0	0	12
HLCAC	5+160	5,400	161,460	5,400	316,800	316,800	120
LCU(R)	13+500	5,400	357,084	5,400	594,000	594,000	400

Type	M1A1 Tanks	Light Armor Vehicles (LAVs)	M198 155mm Howitzers	HMMWVs	Trucks
Percentage by Sea Transporter	100	100	50	50	100
Percentage by Air Transporter	0	0	50	50	0
Truck [1]					
HMMWVs					
UH-1N/T					
CH-46					
CH-53			1	1	
LAV					
AAV [2]					
LCAC	1	4	2	12	4

LCU	2	5	4	6	4
MV-22			1	1	
Heavy Lift Aircraft			1	2	1
AAAV					
HLCAC	2	10	4	16	6
LCU (R)	3	8	4	12	6

OBJECTIVE

110. Number of sea lanes: 12 lanes; if mined, only 6 sea lanes.

111. Number of landing spots: 36 landing spots; if mined, only 18 landing spots.

112. Rate of attrition at Objective.

Period	**Attrition Rate/Day**					
	Troops			**Aircraft**	**Seacraft**	**Land Vehicle**
	Killed	**Wounded**	**Total**			
1st 7 days	0.007056	0.016464	0.02352	0.398154	0.04075	0.012997
8–14 days	0.00417	0.00973	0.0139	0.229623	0.014565	0.01084
15+ days	0.002141	0.004995	0.007136	0.113369	0.005105	0.006512

113. Rate of attrition between Objective and Iron Mountain.

Period	**Attrition Rate/Day**					
	Troops			**Aircraft**	**Seacraft**	**Land Vehicle**
	Killed	**Wounded**	**Total**			
1st 7 days	0.004479	0.01045	0.014929	0.271703	0.024276	0.007743
8–14 days	0.002326	0.005427	0.007753	0.138388	0.007657	0.005698
15+ days	0.000885	0.002065	0.00295	0.039195	0.002297	0.002931

114. Rate of attrition between Objective and Launching Area.

Period	**Attrition Rate/Day**				
	Troops			**Aircraft**	**Seacraft**
	Killed	**Wounded**	**Total**		
1st 7 days	0.004479	0.01045	0.014929	0.271703	0.024276
8–14 days	0.002326	0.005427	0.007753	0.138388	0.007657
15+ days	0.000885	0.002065	0.00295	0.039195	0.002297

115. Rate of attrition between Objective and Assembly Area.

Period	Attrition Rate/Day				
	Troops			Aircraft	Seacraft
	Killed	Wounded	Total		
1st 7 days	0.004479	0.01045	0.014929	0.271703	0.024276
8–14 days	0.002326	0.005427	0.007753	0.138388	0.007657
15+ days	0.000885	0.002065	0.00295	0.039195	0.002297

116. Rate of Food consumption (MRE, pkt/day/troop): Three pkts/day/troop.

117. Rate of Water consumption (gallons/day/troop).

Temperate Zone	
Sustain	**Min**
7.0 GPM	4.1 GPM
Artic Zone	
7.6 GPM	4.6 GPM
Arid Zone	
14.1 GPM	6.4 GPM
Tropical Zone	
8.9 GPM	5.9 GPM

118. Rate of Fuel consumption (gallons/day): See matrix.

Objective		
	Surge	**Sustain**
	Day 1-3	**Day 4-TBD**
Fuel	108,000 gal/day	72,000 gal/day
Ground Ammo	61,000 lbs/day	61,000 lbs/day
Air Ammo	0	0
Other Cargo and Spares	5,308 lbs/day	5,308 lbs/day

119. Rate of Air Ammo consumption (lbs/day): See matrix.

120. Unloading delay for transporters (LCAC, LCM, LCU, CH-53, UH-1N, CH-46, MV-22).

Platform	Load	Unload
	(minutes)	
HLCAC	45	15
LCM	30	15

LCU (R)	90	30
CH-053	20	20
UH-1T	10	10
CH-46	15	15
MV-22	20	20

121. Speed of Air transporter (CH-53, UH-1N, CH-46, MV-22).

Platform	**Speed**	
	(kts)	**(mile/min)**
MV-22	240	4.6
CH-53	150	2.9
CH-46	120	2.3
UH-1T	160	3.1

122. Fuel Capacity of Air transporters (CH-53, UH-1N, CH-46, MV-22).

Platform	**Fuel Capacity**	
	(lbs)	**(gals)**
MV-22	9,849	1,448
CH-53	15,483	2,277
CH-46	4,488	660
UH-1T	2,584	380

123. Speed of Land vehicles (Trucks, HMMWVs, AAV, AAAV).

Platform	**Speed**	
	(mph)	**(mile/min)**
M1A1	42	0.7
LAV	62	1.03
AAAV	30 land/25 water	0.5/0.42
4M88A1-E1	30	0.5
HMMWVs	60	1
MK48	57	0.95

124. Fuel Capacity of Land vehicles (Trucks, HMMWVs, AAV, AAAV).

Platform	**Fuel (gal)**
M1A1	505
LAV	71
AAAV	230
M88A1-E1	400
HMMWVs	25
MK48	150

125. Reliability figures for equipment and repair time.

Equipment	Ships	Sea Transporters		Aircraft	Land Platforms	
		LCAC	LCM/LCU		Tracked	Wheeled
Reliability	1.0	0.7	0.8	0.7	0.8	0.95

MTR: 24 hours.

126. Resource level to be maintained at objective.

Resource	Number Maintained	Daily Usage	Number of Days of Supplies
Troops	4,400		
Ground Ammo (lbs)	334,800	66,960 lbs/day x 5 days	5
Food (pkts of MRE)	66,000	4,400 x 3 pkts/day x 5 days	5
Water (gal)	195,800	4,400 x 8.9 gal/day x 5 days	5
Fuel (gal)	400,000	80,000 gal/day x 5 days	5
M1A1	58		
LAV	48		
AAV	109		
M198	36		
HMMWVs	276		
Trucks	126		

User Input – Distances Based on Burma Scenario (Miles)

		CONUS (San Diego) (1)	Fwd Deploy Forces (Japan) (2)	Offshore Base (Diego Garcia) (3)	Assembly Area (>250 NM) (4)	Launching Area/Sea Base (>50 NM) (5)	Landing Beach (6)	Iron Mountain (Chaungzon) (7)	Objective (Mawlamyine) (8)
From	CONUS (San Diego) (1)		8,630	11,222	8,100	8,330	8,377	8,380	8,387
	Fwd Deploy Forces (Japan) (2)			2,373	7,574	7,804	7,854	7,854	7,861
	Offshore Base (Diego Garcia) (3)				2,032	2,262	2,323	2,326	2,319
	Assembly Area (>250 NM) (4)					230	278	281	288
	Launching Area/Sea Base (>50 NM) (5)							51	58
	Landing Beach (6)							3	10
	Iron Mountain (Chaungzon) (7)								7
	Objective (Mawlamyine) (8)								

Item Resources – Extend Modeling for ExWar

S/No.	Items	Object ID	Fuel Consumption Rate (gal/mile)
	Land Vehicles		
1.	M1A1 Tanks	1	1.8
2.	Light Armor Vehicles (LAVs)	2	0.9
3.	Assault Amphibious Vehicles (AAVs)	3	Land 0.6; Water 4.07
4.	Advanced AAVs (AAAVs)	4	Land 1.3; Water 6.15
5.	M198 155mm Howitzers	5	0
6.	HMMWVs	6	0.1
7.	Trucks	7	0.5
	Air Vehicles		
8.	UH-1T Helos	101	800 lbs/hr (.85 gal/mi)
9.	CH-46 Helos	102	1,400 lbs/hr (1.49 gal/mi)
10.	CH-53 Helos	103	4,000 lbs/hr (3.4 gal/mi)
11.	MV-22 Osprey	106	350 lbs/hr (.179 gal/mi) (airplane mode)
	Sea Vehicles		
12.	LHD	201	38
13.	LHA (R)	202	47
14.	LSD	203	32
15.	LPD-17	204	30
16.	MPF (F)	205	90
17.	LMSR	206	90
18.	HLCAC	207	16
19.	LCU (R)	208	0.86
20.	LCM	209	0.65
	Equipment/Personnel		
21.	Troops	301	—
22.	Rations	302	—
23.	Water	303	—
24.	Fuel	304	—
25.	Ship Ammo	305	—
26.	Aircraft Ammo	306	—
25.	Ground Ammo	307	—
26.	Casualties	308	—
	Others		
27.	MEF	401	—
28.	MEB	400	—
29.	MEU	402	—
30.	Spares (spare parts for repair, etc.)	403	—

CONCEPTUAL ARCHITECTURE

S/No.	Items	1 MEU in CONUS and 1 MEU in Offshore Base	1 MEU Afloat	ExWar Force (1 MEB) Exclude ExWar – log ships	3 ExWar-log Ship	Total for ExWar Current Architecture Modeling Force Size
	Land Vehicles					
1.	M1A1 Tanks	40	18	58	12	70
2.	Light Armor Vehicles (LAVs)	17	8	25	48	73
3.	Assault Amphibious Vehicles (AAVs)	—	—	—	—	—
4.	Advanced AAVs (AAAVs)	73	36	109	45	154
5.	M198 155mm Howitzers	20	10	30	18	48
6.	HMMWVs	498	250	748	300	1,048
7.	Trucks	298	149	447	90	537
	Air Vehicles					
8.	UH-1T Helos	6	3	9	—	9
9.	CH-53 Helos	—	—	—	—	—
10.	MV-22 Osprey	64	32	96	—	96
11.	Heavy Lift Aircraft	16	8	24	—	24
	Sea Vehicles					
12.	ExWar-cbt	4	2	—	—	6
13.	ExWar-log	—	—	—	3	3
14.	LSD-49	—	—	—	—	—
15.	LPD-17	—	—	—	—	—
16.	HLCAC	8	4	12	—	12
17.	LCU (R)	8	4	12	—	12
18.	LCM	—	—	—	—	—
	Equipment/Personnel					
19.	Troops	7,200	3,600	10,800	3,000	13,800
20.	Rations	578,970	297,000	875,970	437,985	1,313,955
21.	Fuel	1,600,000	800,000	2,400,000	1,200,000	3,600,000
22.	Ship Ammo supplies	—	—	—	—	—
23.	Aircraft Ammo	267,840	133,920	401,760	200,880	602,640
24.	Ground Ammo	1,343,600	671,800	2,015,400	1,007,700	3,023,100
25.	Spares	1,061,600	530,800	1,592,400	796,200	2,388,600

Table 12-4-3: Conceptual Architecture Start State Data

CONUS

127. Rate of Fuel consumption (gallons/day) (LHD, LSD, LPD, LHA, MPF).

Platform	(gal/mile)
ExWar-cbt	542
ExWar-log	542
LHD	38
LHA (R)	47
LPD-17	32
LSD	30
MPF (F)	90

128. Aggregated loading delay for all ships: Two days.

129. Speed of advance for the assault force (aggregated): 18 kts.

130. Fuel Capacity of ships (LSD, LPD, LHA, MPF).

Platform	Fuel	
	(tons)	(gal)
ExWar-cbt	18,457	5,428,710
ExWar-log	18,457	5,428,710
LHD	1,232	352,352
LHA (R)	1,600	470,588
LPD-17	1,077	316,765
LSD	813	239,118
MPF (F)	4,000	1,176,471

131. Loading Plan for Amphibious Forces and Replenishment Ships.

S/No.	Items	Amphib Force (2 MEUs)	MPF Forces	Scheduled Replenishment (30 DOS/Load/ship) *Assuming a total of 6 Replenishment ships make up 30 DOS
	Land Vehicles			
1.	M1A1 Tanks	40	—	—
2.	Light Armor Vehicles (LAVs)	17	—	—
3.	Assault Amphibious Vehicles (AAVs)	—	—	—
4.	Advanced AAVs (AAAVs)	73	—	—
5.	M198 155mm Howitzers	20	—	—
6.	HMMWVs	498	—	—
7.	Trucks	298	—	—

	Air Vehicles			
8.	UH-1T Helos	6	—	—
9.	CH-53 Helos	—	—	—
10.	MV-22 Osprey	64	—	—
11.	Heavy Lift Aircraft	16	—	—
	Sea Vehicles			
12.	ExWar-cbt	4	—	—
13.	ExWar-log	—	—	—
14.	LSD-49	—	—	—
15.	LPD-17	—	—	—
16.	HLCAC	8	—	—
17.	LCU (R)	8	—	—
18.	LCM	—	—	—
	Equipment/Personnel			
19.	Troops	7,200	—	3,000/1,000
20.	Rations (pkt)*	578,970	—	875,970/145,995
21.	Fuel (gal)*	1,600,000	—	2,400,000/400,000
22.	Ship Ammo (lbs)*	—	—	—
23.	Aircraft Ammo (lbs)*	267,840	—	401,760/66,960
24.	Ground Ammo (lbs)*	1,343,600	—	2,015,400/334,800
25.	Spares*	1,061,600	—	1,592,400/88,470

*30 days of supplies for two MEUs.

132. Frequency (and how many ships) of scheduled replenishment to Offshore Base: One ship every two weeks.

133. Speed of advance for these scheduled replenishment ships: 15 kts.

FORWARD DEPLOYED FORCES

134. Rate of Fuel consumption (gallons/day) (LSD, LPD, LHA).

Platform	**(gal/mile)**
ExWar-cbt	542
ExWar-log	542
LHD	38
LHA (R)	47
LPD-17	32
LSD	30
MPF (F)	90

135. Speed of advance for the forward deployed force (aggregated): 18 kts.

136. Fuel Capacity of ships (LSD, LPD, LHA).

Platform	Fuel	
	(tons)	(gal)
ExWar-cbt	18,457	5,428,710
ExWar-log	18,457	5,428,710
LHD	1,232	352,352
LHA (R)	1,600	470,588
LPD-17	1,077	316,765
LSD	90	25,740
MPF (F)	4,000	1,176,471

137. Loading Plan for Afloat Amphib force.

S/No.	Items	Afloat Amphib Force (1 MEU)
	Land Vehicles	
1.	M1A1 Tanks	18
2.	Light Armor Vehicles (LAVs)	8
3.	Assault Amphibious Vehicles (AAVs)	—
4.	Advanced AAVs (AAAVs)	36
5.	M198 155mm Howitzers	10
6.	HMMWVs	250
7.	Trucks	149
	Air Vehicles	
8.	UH-1T Helos	3
9.	CH-53 Helos	—
10.	MV-22 Osprey	32
11.	Heavy Lift Aircraft	8
	Sea Vehicles	
12.	ExWar-cbt	2
13.	ExWar-log	—
14.	LSD-49	—
15.	LPD-17	—
16.	HLCAC	4
17.	LCU (R)	4
18.	LCM	—
	Equipment/Personnel	
19.	Troops	3,600
20.	Rations*	297,000
21.	Fuel*	800,000
22.	Ship Ammo*	—
23.	Aircraft Ammo*	133,920
24.	Ground Ammo*	671,800
25.	Spare*	530,800

*Five days of MEB supplies.

OFFSHORE BASES

138. Initial holding resources at Offshore Base: 0.

139. Loading/Unloading delay for incoming resources (from CONUS): Three days.

140. Frequency (and how many ships) of scheduled replenishment to Iron Mountain: One ship/every week.

141. Speed of advance for MPF ships: 15 kts.

142. Initial holding resource (i.e., total resources present at Offshore Base, which includes those already loaded onboard MPF ships).

S/No.	Items	Total Resources
	Land Vehicles	
1.	M1A1 Tanks	12
2.	Light Armor Vehicles (LAVs)	48
3.	Assault Amphibious Vehicles (AAVs)	—
4.	Advanced AAVs (AAAVs)	45
5.	M198 155mm Howitzers	18
6.	HMMWVs	300
7.	Trucks	90
	Air Vehicles	
8.	UH-1T Helos	—
9.	CH-53 Helos	—
10.	MV-22 Osprey	—
11.	Heavy Lift Aircraft	—
	Sea Vehicles	
12.	ExWar-cbt	—
13.	ExWar-log	3
14.	LSD-49	—
15.	LPD-17	—
16.	HLCAC	—
17.	LCU (R)	—
18.	LCM	—
	Equipment/Personnel	
19.	Troops	3,000
20.	Rations*	4,379,850
21.	Fuel*	12,000,000
22.	Ship Ammo*	—
23.	Aircraft Ammo*	2,008,800
24.	Ground Ammo*	10,077,000
25.	Spares*	7,962,000

*300 days of MEB supplies.

143. Loading Plan for Replenishment ships.

S/No.	Items	Replenishment Ships Assuming 6 ships make up 30 DOS (Total Load)/(Load/Ship)
	Land Vehicles	
1.	M1A1 Tank	58/19
2.	Light Armor Vehicles (LAVs)	25/8
3.	Assault Amphibious Vehicles (AAVs)	—
4.	Advanced AAVs (AAAVs)	109/36
5.	M198 155mm Howitzers	30/10
6.	HMMWVs	748/249
7.	Trucks	447/149
	Air Vehicles	
8.	UH-1T Helos	—
9.	CH-53 Helos	—
10.	MV-22 Osprey	—
11.	Heavy Lift Aircraft	—
	Sea Vehicles	
12.	ExWar-cbt	—
13.	ExWar-log	—
14.	LSD-49	—
15.	LPD-17	—
16.	HLCAC	—
17.	LCU (R)	—
18.	LCM	—
	Equipment/Personnel	
19.	Troops	3,000/1,000
20.	Rations*	875,970/145,995
21.	Fuel*	2,400,000/400,000
22.	Ship Ammo*	—
23.	Aircraft Ammo*	401,760/66,960
24.	Ground Ammo*	2,015,400/334,800
25.	Spares*	1,592,400/88,470

*30 days of MEB supplies.

LAUNCHING AREA

144. Rate of attrition at Launching Area.

Period	Attrition Rate/Day	
	Aircraft	Seacraft
1st 7 days	0.163406	0.012761
8–14 days	0.06195	0.003446
15+ days	0.039195	0.002297

145. Rate of attrition between Objective and Launching Area.

Period	Attrition Rate/Day	
	Aircraft	Seacraft
1st 7 days	0.271703	0.024276
8–14 days	0.138388	0.007657
15+ days	0.039195	0.002297

146. Rate of attrition between Iron Mountain and Launching Area.

Period	Attrition Rate/Day	
	Aircraft	Seacraft
1st 7 days	0.163406	0.012761
8–14 days	0.06195	0.003446
15+ days	0.039195	0.002297

147. Rate of attrition between Assembly Area and Launching Area.

Period	Attrition Rate/Day	
	Aircraft	Seacraft
1st 7 days	0.055108	0.005743
8–14 days	0.06195	0.003446
15+ days	0.039195	0.002297

148. Rate of Food consumption (MRE, pkt/day/troop): N/A.

149. Rate of Water consumption (gallons/day/troop): N/A.

150. Rate of Air Ammo consumption (lbs/day): 13,392 lbs/day.

151. Rate of Land Ammo consumption (lbs/day): 0.

152. Rate of Sea Ammo consumption (lbs/day): 5,000 lbs/day.

153. Rate of Spare Parts consumption (lbs/day): 5,000 lbs/day.

154. Unloading delay for transporters (LCAC, LCM, LCU, CH-53, UH-1N, CH-46, MV-22).

Platform	Load	Unload
	(minutes)	
HLCAC	45	15
LCM	30	15
LCU (R)	90	30
Heavy Lift Aircraft	15	15
CH-53	20	20
UH-1T	10	10
CH-46	15	15
MV-22	20	20

155. Speed of Air transporters (CH-53, UH-1N, CH-46, MV-22).

Platform	Cruise Speed	
	(kts)	(mile/min)
MV-22	240	4.6
CH-53	150	2.9
Heavy Lift Aircraft	220	4.2
CH-46	120	2.3
UH-1N	120	2.3

156. Speed of Surface transporters (LCAC, LCU, LCM, etc.).

Platform	Cruise Speed	
	(kts)	(mile/min)
HLCAC	35	0.7
LCU (R)	15	0.29
LCM	12	0.23

157. Fuel Capacity of all Air and Sea vehicles (i.e., CH-53, UH-1N, CH-46, MV-22, LSD, LPD, LCAC, etc.).

Platform	Fuel	
	(tons)	(gal)
ExWar -Cbt	18,457	5,428,710
ExWar -Log	18,457	5,428,710
LHD	1,232	352,352
LHA (R)	1,600	470,588
LPD-17	1,077	316,765
LSD	90	25,740
MPF (F)	4,000	1,176,471
HLCA	16	4,706
LCU (R)	3.5	1,029

Platform	Fuel Capacity	
	(lbs)	(gal)
Heavy Lift Aircraft	15,400	2,264
MV-22	9,849	1,448
CH-53	15,483	2,277
UH-1T	2,584	380

158. Load Capacity of all Air and Sea vehicles, and limitations of each vehicle or resources (e.g., M1A1 cannot be airlifted; CH-53 can carry X number of troops, etc.).

CONCEPTUAL (Concept 2-For Extend Modeling Input)

Platform	Number	Load/Platform						
		Pers	MV-22	Quad-tilt	HLCAC	LCU (R)	Well-Deck Spot	Helo Spot
ExWar Cbt	6	1,800	16	4	2 HLCAC and 2 LCU(R)		1	12
ExWar Log	3	1,000	-	-	-		1	12
HLCAC	12	5/160						
LCU (R)	12	13/500						

159. Minimum Logistical level to be held at Launching Area.

Aircraft	AH-1Y	MV-22	Heavy Lift Aircraft	UH-1T
Number at Launching Area	12	30	10	9

All other logistical items (food, water, fuel, ammo): 0.

160. Operating hours for transporters (i.e., MV-22, CH-53, LCAC, before they go for maintenance and their servicing time).

Platform	Operating Endurance	Repair	Remarks*
	(hours)		
Heavy Lift Aircraft	96	24	—
MV-22	96	24	Classified
CH-53	96	24	Classified
CH-46	96	24	Classified
UH-1T	96	24	Classified
HLCAC	48	24	Classified
LCU (R)	48	24	Classified
LCM	48	24	Classified
M1A1	120	24	Classified
LAV	120	24	Classified
AAAV	120	24	Classified

M88A1-E1	120	24	Classified
HMMWVs	240	24	Classified
MK48	240	24	Classified

*Note: True values are classified; use these for illustrative purposes only.

**161.	Reliability figures for equipment and repair time.**

Equipment	Ships	Sea Transporters		Aircraft	Land Platforms	
		LCAC(H)	LCM/LCU(R)		Tracked	Wheeled
Reliability	1.0	0.7	0.8	0.7	0.8	0.95

MTR (for all equipment): 24 hours.

**162.	Minimum Logistical level to be held at Sea Base.**

**a.	15 days of supplies for MEB.**

**163.	Load capacities for ground, sea, and air transports (either/or).**

Type	Troops (crew + troops)	Water (gals)	Food (Number of MRE)	Fuel (gals)	Ground Ammo (lbs)	Spares/Others (lbs)	Casualties
Percentage by Sea Transporter	50	50	50	50	50	50	10
Percentage by Air Transporter	50	50	50	50	50	50	90
Truck [1]	2+24	900	2340	900	5,102	5,102	20
HMMWVs	2+8	0	936	0	2,374	2,374	5
UH-1N/T	4+4	0	468	0	1,000	1,000	3
CH-46	5+12	400	1,404	400	3,000	3,000	8
CH-53	3+24	1,200	6,084	1,600	12,000	12,000	18
LAV	3+6	0	0	0	0	0	4
AAV [2]	3+22	0	0	0	0	0	18
LCAC	5+120	3,600	66,924	3,600	132,000	132,000	100
LCU	11+400	3,600	201,708	3,600	396,000	396,000	300
MV-22	8+24	800	3,744	800	8,000	8,000	18
Heavy Lift Aircraft	5+48	2,400	6,552	2,500	20,000	20,000	38
AAAV	3+17	0	0	0	0	0	12
HLCAC	5+160	5,400	161,460	5,400	316,800	316,800	120
LCU (R)	13+500	5,400	357,084	5,400	594,000	594,000	400

Type	M1A1 Tank	Light Armor Vehicle (LAV)	M198 155mm Howitzers	HMMWVs	Trucks
Percentage by Sea Transporter	100	100	50	50	100
Percentage by Air Transporter	0	0	50	50	0
Truck [1]					
HMMWVs					
UH-1N/T					
CH-46					
CH-53			1	1	
LAV					
AAV [2]					
LCAC	1	4	2	12	4
LCU	2	4	4		
MV-22			1	1	
Heavy Lift Aircraft			1	2	1
AAAV					
HLCAC	2	10	4	16	6
LCU (R)	3	8	4	12	6

OBJECTIVE

164. Number of sea lanes: 12 lanes; if mined, only four sea lanes.

165. Number of landing spots: 36 landing spots; if mined, only 18 landing spots.

166. Rate of attrition at Objective.

Period	Attrition Rate/Day					
	Troops			Aircraft	Seacraft	Land Vehicle
	Killed	Wounded	Total			
1st 7 days	0.007056	0.016464	0.02352	0.398154	0.04075	0.012997
8–14 days	0.00417	0.00973	0.0139	0.229623	0.014565	0.01084
15+ days	0.002141	0.004995	0.007136	0.113369	0.005105	0.006512

167. Rate of attrition between Objective and Iron Mountain.

Period	Attrition Rate/Day					
	Troops			Aircraft	Seacraft	Land Vehicle
	Killed	Wounded	Total			
1st 7 days	0.004479	0.01045	0.014929	0.271703	0.024276	0.007743
8–14 days	0.002326	0.005427	0.007753	0.138388	0.007657	0.005698
15+ days	0.000885	0.002065	0.00295	0.039195	0.002297	0.002931

168. Rate of attrition between Objective and Launching Area.

Period	Attrition Rate/Day				
	Troops			Aircraft	Seacraft
	Killed	Wounded	Total		
1st 7 days	0.004479	0.01045	0.014929	0.271703	0.024276
8–14 days	0.002326	0.005427	0.007753	0.138388	0.007657
15+ days	0.000885	0.002065	0.00295	0.039195	0.002297

169. Rate of attrition between Objective and Assembly Area.

Period	Attrition Rate/Day				
	Troops			Aircraft	Seacraft
	Killed	Wounded	Total		
1st 7 days	0.004479	0.01045	0.014929	0.271703	0.024276
8–14 days	0.002326	0.005427	0.007753	0.138388	0.007657
15+ days	0.000885	0.002065	0.00295	0.039195	0.002297

170. Rate of Food consumption (MRE, pkt/day/troop): Three pkts/day/troop.

171. Rate of Water consumption (gallons/day/troop).

Temperate Zone	
Sustain	**Min**
7.0 GPM	4.1 GPM
Artic Zone	
7.6 GPM	4.6 GPM
Arid Zone	
14.1 GPM	6.4 GPM
Tropical Zone	
8.9 GPM	5.9 GPM

172. Rate of Fuel consumption (gallons/day): See matrix.

Objective		
	Surge	**Sustain**
	Day 1-3	**Day 4-TBD**
Fuel	108,000 gal/day	72,000 gal/day
Ground Ammo	61,000 lbs/day	61,000 lbs/day
Air Ammo	0	0
Other Cargo and Spares	5,308 lbs/day	5,308 lbs/day

173. Unloading delay for transporters (LCAC, LCM, LCU, CH-53, UH-1N, CH-46, MV-22).

Platform	**Load**	**Unload**
	(minutes)	
HLCAC	45	15
LCM	30	15
LCU (R)	90	30
CH-53	20	20
UH-1T	10	10
Heavy Lift Aircraft	15	15
CH-46	15	15
MV-22	20	20

174. Speed of Air transporter (CH-53, UH-1N, CH-46, MV-22).

Platform	**Speed**	
	(kts)	**(mile/min)**
Heavy Lift Aircraft	220	4.2
MV-22	240	4.6
CH-53	150	2.9
CH-46	120	2.3
UH-1T	160	3.1

175. Fuel Capacity of Air transporters (CH-53, UH-1N, CH-46, MV-22).

Platform	**Fuel Capacity**	
	(lbs)	**(gals)**
Heavy Lift Aircraft	15,400	2,264
MV-22	9,849	1,448
CH-53	15,483	2,277
CH-46	4,488	660
UH-1T	2,584	380

176. Speed of Land vehicles (Trucks, HMMWVs, AAV, AAAV).

Platform	Speed	
	(mph)	(mile/min)
M1A1	42	0.7
LAV	62	1.03
AAAV	30 land/25 water	0.5/0.42
M88A1-E1	30	0.5
HMMWVs	60	1
MK48	57	0.95

177. Fuel Capacity of Land vehicles (Trucks, HMMWVs, AAV, AAAV).

Platform	Fuel (gal)
M1A1	505
LAV	71
AAAV	230
M88A1-E1	400
HMMWVs	25
MK48	150

178. Reliability figures for equipment and repair time.

Equipment	Ships	Sea Transporters		Aircraft	Land Platforms	
		LCAC	LCM/LCU		Tracked	Wheeled
Reliability	1.0	0.7	0.8	0.7	0.8	0.95

MTR: 24 hours.

179. Resource level to be maintained at objective.

Resource	Number Maintained	Daily Usage	Number of Days of Supplies
Troops	4,400		
Ground Ammo (lbs)	334,800	66,960 lbs/day x 5 days	5
Food (pkts of MRE)	660,00	4,400 x 3 pkts/day x 5 days	5
Water (gal)	195,800	4,400 x 8.9 gal/day x 5 days	5
Fuel (gal)	400,000	80,000 gal/day x 5 days	5
M1A1	58		
LAV	48		
AAV	109		
M198	36		
HMMWVs	276		
Truck	126		

User Input – Distances Based on Burma Scenario (Miles)

		CONUS (San Diego) (1)	Fwd Deploy Forces (Japan) (2)	Offshore Base (Diego Garcia) (3)	Assembly Area (>250 NM) (4)	Launching Area (>50 NM) (5)	Landing Beach (6)	Iron Mountain (Chaungzon) (7)	Objective (Mawlamyine) (8)
From	CONUS (San Diego) (1)		8,630	11,222	8,100	8,330	8,377	8,380	8,387
	Fwd Deploy Forces (Japan) (2))			2,373	7,574	7,804	7,854	7,854	7,861
	Offshore Base (Diego Garcia) (3)				2,032	2,262	2,323	2,326	2,319
	Assembly Area (>250 NM) (4)					230	278	281	288
	Launching Area (>50 NM) (5)							51	58
	Landing Beach (6)							3	10
	Iron Mountain (Chaungzon) (7)								7
	Objective (Mawlamyine) (8)								

Item Resources – Extend Modeling for ExWar

S/No.	Items	Object ID	Fuel Consumption Rate (gal/mile)
	Land Vehicles		
1.	M1A1 Tanks	1	1.8
2.	Light Armor Vehicles (LAVs)	2	0.9
3.	Assault Amphibious Vehicles (AAVs)	3	Land 0.6; Water 4.07
4.	Advanced AAVs (AAAVs)	4	Land 1.3; Water 6.15
5.	M198 155mm Howitzers	5	0
6.	HMMWVs	6	0.1
7.	Trucks	7	0.5
	Air Vehicles		
8.	UH-1T Helos	101	800 lbs/hr (.85 gal/mi)
9.	Heavy Lift Aircraft	102	4,000 lbs/hr (3.4 gal/mi)
10.	CH-53 Helos	103	4,000 lbs/hr (3.4 gal/mi)
11.	MV-22 Osprey	106	350 lbs/hr (.179 gal/mi) (airplane mode)
	Sea Vehicles		
12.	ExWar-cbt	201	542
13.	Exwar-log	202	542
14.	LSD	203	32
15.	LPD-17	204	30
16.	MPF (F)	205	90
17.	LMSR	206	90
18.	HLCAC	207	16
19.	LCU (R)	208	0.86
20.	LCM	209	0.65
	Equipment/Personnel		
21.	Troops	301	—
22.	Rations	302	—
23.	Water	303	—
24.	Fuel	304	—
25.	Ship Ammo	305	—
26.	Aircraft Ammo	306	—
25.	Ground Ammo	307	—
26.	Casualties	308	—
	Others		
27.	MEF	401	—
28.	MEB	400	—
29.	MEU	402	—
30.	Spares (spare parts for repair, etc.)	403	—

APPENDIX 12-5

The ExWar DOE Matrix

12-5 THE EXWAR DOE MATRIX

Noise Factor								
Cons. Rate	High	Low	High	Low	High	Low	High	Low
Mine Threat	Low	Low	High	High	High	High	Low	Low
Weather	Good	Good	Poor	Poor	Good	Good	Poor	Poor
Attrition	High	High	High	High	Low	Low	Low	Low
Sim. Run	1	2	3	4	5	6	7	8

Sim Run	**Design Factors**			**Results**							
	Architecture	Repl. Means	Ship to Obj Proximity	1	2	3	4	5	6	7	8
1	Current	MPF	Close								
2	Current	MPF	Far								
3	Current	HSV	Close								
4	Current	HSV	Far								
5	Planned	MPF	Close								
6	Planned	MPF	Far								
7	Planned	HSV	Close								
8	Planned	HSV	Far								
9	Conceptual	MPF	Close								
10	Conceptual	MPF	Far								
11	Conceptual	HSV	Close								
12	Conceptual	HSV	Far								

APPENDIX 12-6

Design and Noise Factors

12-6 DESIGN AND NOISE FACTORS

Design Factors

Architecture:

	Setting
Current	Current ExWar Concept
Planned	Planned ExWar Concept
Future	Future ExWar Concept

Replenishment Means:

	Setting
LMSR	Speed – 15 kts Frequency of Runs – Once every five days Load Configuration – See Appendix 4 Number of crafts – 1
HSV	Speed – 30 kts Frequency of Runs – Once every day Load Configuration – See Appendix 4 Number of crafts – 2

Ship to Objective Proximity:

	Setting
Close	58 NM
Far	108 NM

Noise Factors

Attrition:

	Setting
High	Scenario driven - See Appendix 4
Low	Scenario driven - See Appendix 4

Weather:

	Setting
Good	Surface craft transit at input speed Aircraft transit at input speed No increment in loading delay No reduction in surface craft load capacity
Poor	Surface craft transit speed reduced by 50% Aircraft transit speed reduced by 30%[2] Air and Surface craft load times increased by 25% Surface craft load capacity reduced by 50%

Mine Threat:

	Setting
Low	12 landing lanes available
High	4 landing lanes available

Consumption: (Ammo and Fuel)

	Setting
High	Surge Rate Consumption for to be increased by 10 % for 10 days followed by Sustainment Rate through the rest of the campaign (see Appendix 4 for details of Sustainment Rate)
Low	Surge Rate Consumption for 3 days followed by Sustainment Rate through the rest of the campaign (see Appendix 4 for details of Sustainment Rate)

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[2] In a moderate increment weather condition, aircraft's effective transit speed is affected equally on both way of transit, e.g., 25 kts faster on away leg (tail wind) and 25 kts slower on the return leg (head wind). However, in increment weather, aircraft's transit route is likely to be adjusted and would effectively be longer. As such, the effective transit time will be longer. To model this effect on EXTEND™, the aircraft transit speed is reduced by a percentage.