

ELIST 8.7 Transportation Model

Decision and Information Sciences Division

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ELIST 8.7 Transportation Model

by
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CONTENTS

| | | |
|---|--|------|
| ACRONYMS AND ABBREVIATIONS | | viii |
| ABSTRACT | | 1 |
| 1 INTRODUCTION | | 1 |
| 2 MOVEMENT REQUIREMENTS..... | | 3 |
| 2.1 ETPFDDs..... | | 3 |
| 2.2 Theaters of Operation | | 4 |
| 2.3 RLNs in a Theater | | 4 |
| 2.4 Level of Detail | | 5 |
| 2.5 Projection | | 6 |
| 2.6 RLN Movements and Activities | | 6 |
| 3 COMMODITIES | | 9 |
| 3.1 Commodities in the Simulation | | 9 |
| 3.2 Commodity Data..... | | 10 |
| 3.3 Commodity Movement Rules..... | | 11 |
| 3.4 Commodity Assignment Rules | | 12 |
| 4 NETWORK..... | | 13 |
| 4.1 Node..... | | 13 |
| 4.2 Intersection..... | | 15 |
| 4.3 Installation..... | | 15 |
| 4.4 Link..... | | 16 |
| 5 VEHICLES AND ASSET POOLS..... | | 17 |
| 5.1 Vehicles..... | | 17 |
| 5.2 Ships vs. Ship Types..... | | 17 |
| 5.3 Individual vs. Capability Vehicle Model | | 17 |
| 5.4 Asset Pools..... | | 18 |
| 5.5 Behavior of Vehicles Not in Use | | 19 |
| 5.6 Fuel Consumption..... | | 19 |
| 6 ASSET/MODE SELECTION..... | | 21 |
| 6.1 Model Mode/Source vs. JOPES Mode/Source | | 21 |
| 6.2 Mode/Source Rules..... | | 22 |

CONTENTS (CONT.)

| | | |
|------|--|----|
| 6.3 | Mode and Vehicle Selection During the Simulation | 23 |
| 6.4 | Pre-sending Assets | 25 |
| 7 | ROAD TRANSPORTATION | 27 |
| 7.1 | Truck Data | 27 |
| 7.2 | Tractor and Trailer Data..... | 27 |
| 7.3 | Truck and Trailer Payloads..... | 29 |
| 7.4 | Node Data and Truck Loading Activities | 30 |
| 7.5 | Road Link Data..... | 32 |
| 7.6 | Serial Moves | 33 |
| 7.7 | Travel Schedules..... | 33 |
| 7.8 | Road Movement Methodology | 34 |
| 7.9 | Military Self Deployed | 35 |
| 7.10 | Military Direct Delivery | 36 |
| 7.11 | Commercial Direct Delivery..... | 36 |
| 7.12 | Line Haul | 37 |
| 7.13 | Delivery Routes | 38 |
| 8 | RAIL TRANSPORTATION | 39 |
| 8.1 | Railcar Data | 39 |
| 8.2 | Railcar Payloads..... | 39 |
| 8.3 | Node Data and Railcar Loading Activities..... | 40 |
| 8.4 | Train Assembly and Travel Schedule..... | 42 |
| 8.5 | Rail Link Data..... | 43 |
| 8.6 | Rail Movement Methodology..... | 44 |
| 9 | AIR TRANSPORTATION..... | 47 |
| 9.1 | Aircraft Data | 47 |
| 9.2 | Aircraft Payloads | 48 |
| 9.3 | Airport Data | 49 |
| 9.4 | Airport Ramp Data..... | 49 |
| 9.5 | Strategic Air Operations | 50 |
| 9.6 | Intratheater Air Movement Methodology..... | 51 |
| 9.7 | STAR Routes | 52 |
| 10 | WATER TRANSPORTATION..... | 53 |
| 10.1 | Ships and Ship Types..... | 53 |
| 10.2 | Ship Payloads..... | 54 |
| 10.3 | Port Data | 55 |

CONTENTS (CONT.)

| | | |
|-------|---|----|
| 10.4 | Berth Group Data..... | 57 |
| 10.5 | Berth Data..... | 57 |
| 10.6 | Crane Data..... | 58 |
| 10.7 | Berth and Crane Selection..... | 59 |
| 10.8 | Strategic Ship Operations..... | 62 |
| 10.9 | Ship Onload and Offload Activities..... | 63 |
| 10.10 | Waterway and Shipping Lane Link Data..... | 64 |
| 10.11 | Intratheater Ship Movement Methodology..... | 65 |
| 11 | PIPELINE..... | 67 |
| 11.1 | Pipeline Link Data..... | 67 |
| 11.2 | Pipeline Methodology..... | 67 |
| 12 | ROTARY WING..... | 69 |
| 12.1 | Rotary Wing Data..... | 69 |
| 12.2 | Rotary-Wing Payloads..... | 69 |
| 12.3 | Rotary-Wing Movement Methodology..... | 70 |
| 13 | ROUTES..... | 71 |
| 13.1 | General..... | 71 |
| 13.2 | Single-Mode Routes..... | 71 |
| 13.3 | Air Routes..... | 72 |
| 13.4 | Multimode Routes..... | 72 |
| 13.5 | Alternate Node Routes..... | 73 |
| 14 | STORAGE..... | 75 |
| 14.1 | Node Attributes..... | 75 |
| 14.2 | Scenario Attribute..... | 75 |
| 14.3 | Use in Simulation..... | 75 |
| 15 | DOCUMENTATION..... | 77 |
| 15.1 | Node Attribute..... | 77 |
| 15.2 | Scenario Attribute..... | 77 |
| 15.3 | Use in Simulation..... | 77 |

CONTENTS (CONT.)

| | | |
|------|--|----|
| 16 | NONMOVEMENT RLN REQUIREMENTS | 79 |
| 16.1 | Arriving Enablers | 79 |
| 16.2 | Arriving Assets | 79 |
| 16.3 | Marry-up and Assembly Requirements | 80 |
| 17 | MASTER SCENARIO OF EVENTS LIST | 81 |

TABLES

| | | |
|-----|---|----|
| 3-1 | Commodity Load Types | 9 |
| 3-2 | Commodity Attributes | 10 |
| 4-1 | General Node Attributes | 13 |
| 4-2 | General Link Attributes | 16 |
| 7-1 | Truck Attributes | 27 |
| 7-2 | Tractor Attributes | 28 |
| 7-3 | Trailer Attributes | 28 |
| 7-4 | Node Attributes for Truck Loading | 30 |
| 7-5 | Road Attributes | 32 |
| 7-6 | Node Attributes for Road Movement | 35 |
| 8-1 | Railcar Attributes | 39 |
| 8-2 | Node Attributes for Railcar Loading | 41 |
| 8-3 | Rail Link Attributes | 43 |
| 8-4 | Node Attributes for Rail Movement | 45 |
| 9-1 | Fixed-Wing Aircraft Attributes | 47 |
| 9-2 | Airport Attributes | 49 |

TABLES (CONT.)

| | | |
|------|---|----|
| 9-3 | Ramp Attributes | 49 |
| 10-1 | Ship Type Attributes | 53 |
| 10-2 | Additional Ship Attributes..... | 54 |
| 10-3 | Port Attributes | 56 |
| 10-4 | Berth Attributes | 58 |
| 10-5 | Crane Attributes | 59 |
| 10-6 | Waterway Link Attributes | 64 |
| 11-1 | Pipeline Attributes..... | 67 |
| 12-1 | Rotary-Wing Aircraft Attributes | 69 |
| 13-1 | Multi-mode Route Transition Hours | 73 |

ACRONYMS AND ABBREVIATIONS

| | |
|--------|---|
| AMP | Analysis of Mobility Platform |
| APOD | air port of debarkation |
| BB | breakbulk |
| CIN | Cargo Increment Number |
| CONUS | continental United States |
| DST | destination |
| ELIST | Enhanced Logistics Intratheater Support Tool |
| ETPFDD | Expanded Time-Phased Force Deployment Data |
| FO | follow-on |
| GEOLOC | Geolocation Code |
| GUI | graphical user interface |
| HET | heavy equipment transport(able) |
| ILOC | intermediate location |
| JOPEs | Joint Operation Planning and Execution System |
| LAD | latest arrival date |
| LIN | Line Increment Number |
| MHE | materiel handling equipment |
| MLC | military load class |
| MOG | maximum on ground |
| MSEL | master scenario of events list |
| NA | not applicable |
| NISC | Naval Intelligence Support Center |
| OCONUS | outside the continental United States |
| ORG | origin |
| PAX | personnel |
| POD | port of debarkation |
| POE | port of embarkation |
| POL | petroleum, oil, and lubricants |

| | |
|-------|-----------------------------------|
| RDD | required delivery date |
| RLD | ready-to-load |
| RLN | Requirement Line Number |
| RORO | roll on, roll off |
| SA | staging area |
| SIL | strategic ILOC |
| TIL | theater ILOC |
| TPFDD | Time-Phased Force Deployment Data |
| TSB | theater staging base |
| TTP | trailer transfer point |
| ULN | Unit Line Number |
| UTC | Unit Type Code |
| WFS | war fight start location |

UNITS OF MEASURE

| | |
|-------|-----------------------------|
| cbbl | hundreds of barrels |
| cont | container stack height |
| ft | foot, feet |
| gal | gallon(s) |
| hr | hour(s) |
| in. | inch(es) |
| lb(s) | pound(s) |
| m | meter(s) |
| mi | mile(s) |
| mph | miles per hour |
| mton | measurement-ton |
| pax | personnel |
| sqft | square feet |
| st | short ton |
| TEU | twenty-foot equivalent unit |

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ABSTRACT

The Enhanced Logistics Intratheater Support Tool (ELIST) Version 8.7 is a software tool designed to allow military analysts to model the deployment of cargo and personnel through one or more theaters of operation. For a theater within the continental United States (CONUS), movement is from origin fort, through any intermediate staging or other location(s), to the ports of embarkation. For theaters outside of the continental United States (OCONUS), movement is from ports of debarkation through staging areas, theater-staging bases to in-theater destinations, usually tactical assembly areas and optional follow-on locations. This document defines the modes of operation, parameters, algorithms, and heuristics used by the model. All design and implementation decisions are derived from this document. Validation and verification of the model are based on this document.

1 INTRODUCTION

This document describes the operations of the Enhanced Logistics Intratheater Support Tool (ELIST) Version 8 simulation. All types of movements and activities modeled by the system are described, as well as *how* they are modeled. The data and parameters used are also described. All of the data required for the model are included in a scenario. Each scenario is stored on disk in a data directory. Scenario data fall into the following categories, some of which are described in detail in this document:

- Movement requirements: expanded time-phased force deployment data (ETPFDD),
- Network,
- Assets,
- Theaters, and
- Simulation parameters.

A familiarity with time-phased force deployment data (TPFDD) data is assumed.

ELIST can be run in stand-alone mode or in the Analysis of Mobility Platform (AMP). The differences between these two modes of operation will be pointed out throughout this document.

This document is the basis for the design of the model. Therefore, it is essential that any ambiguities or errors are identified and eliminated as soon as possible. Note that the parts of the model that have not been implemented in ELIST 8 are denoted as *Not Implemented*.

2 MOVEMENT REQUIREMENTS

2.1 ETPFDDs

- 2.1.1 An ELIST8 scenario simulates the movement requirements of one or more ETPFDDs. Each ETPFDD in a scenario has a sequence number (for identification purposes) and an offset number. The offset is a number of days that every movement requirement of that ETPFDD will be pushed back in the scenario.
- 2.1.2 Each ETPFDD is composed of standard TPFDD data: requirement line numbers (RLNs) with cargo details (including unit equipment, supplies, and troops) and a movement plan for each RLN. This plan includes the RLN's origin (ORG), which is often located in the continental United States (CONUS); port of embarkation (POE); port of debarkation (POD); destination (DST); and an optional intermediate location. Each leg of movement can have both a required mode of transport and a required delivery date.
- 2.1.3 ETPFDDs differ from TPFDDs by including any or all of the following:
- **Additional movement location types** consisting of four origin-intermediate locations (OIL, OI1, OI2, OI3), a strategic intermediate location (ILOC) (SIL), a staging area (SA), a theater ILOC (TIL), a theater staging base (TSB), a war fight start location (WFS), and four additional follow-on locations (FO1, FO2, ...);
 - **Optional delays at the locations;**
 - **Marry up** (at or before the TPFDD destination) and assembly of RLNs and groups of RLNs; and
 - **Relationships between RLNs** for subordination and support relationships.
- 2.1.4 A redeployment ETPFDD may be included in the scenario. Such an ETPFDD has the same unit line numbers (ULNs) that have been deployed in earlier movements in another ETPFDD. These units are modeled and reported independently in the redeployment case. However, if the ULN contributed assets to movement capabilities (see Arriving Enablers on page 79), those assets will be removed at the time of redeployment. Likewise, if the ULN contributed resources at its destination (see Arriving Enablers on page 79), those resources will also be removed.

2.2 THEATERS OF OPERATION

- 2.2.1 ELIST simulates the deployment in one or more non-intersecting theaters. Often the entire ETPFDD is not included in a scenario. Each theater is defined by a list of Country/State/Region codes. Each country or state can be in only one theater in a scenario.
- 2.2.2 In an ELIST-AMP run, a typical scenario includes a CONUS theater and one or more theaters outside of CONUS (OCONUS). In CONUS, the RLNs will generally move from their ORG to a POE specified by the federation (which may be different from the POE specified in the ETPFDD). ELIST will also load the RLNs onto federation-specified strategic assets. Later, in the foreign theaters, the federation will supply the RLN arrivals with strategic assets at PODs, and ELIST will simulate their movement requirements from that location forward.
- 2.2.3 In an ELIST stand-alone run, all the theater simulations are independent, and movement requirements are based only on the times and locations in the ETPFDD and other scenario data.

2.3 RLNs IN A THEATER

- 2.3.1 The RLN movements to be modeled in each theater are determined by the simulation parameter:

- General: Flow Unsourced RLNs (which applies to all theaters);

and the theater parameters:

- Scope: ORG to POE;
- Scope: POE to POD;
- Scope: POD to DST; and
- Scope: Make RLNs with Missing Projection Available.

All of these options can be **on** or **off**. Either a single movement leg or multiple adjacent legs can be selected for each theater (i.e., ORG to POE and POD to DST cannot be turned on without POE to POD). The final parameter, *Make RLNs with Missing Projection Available*, only applies to an ELIST stand-alone run.

- 2.3.2 In order to be included in a theater simulation, an RLN must have movements between locations within the theater. For example, if the ORG-to-POE scope is selected for Theater A, all RLNs with ORG and POE in Theater A's countries will have that leg simulated in Theater A. If all three scope options are turned on for a theater, all the RLN

movement requirements that are within the theater countries will be simulated. (Note that a theater cannot include ORG to POE and POD to DST without also including POE to POD.)

- 2.3.3 Normally, the ORG, POE, POD, and DST should be defined in the ETPFDD for each RLN. (Additional movement locations are optional.) However, it is not always the case that definitions are complete. In ELIST stand-alone, for an RLN to be included in the simulation, both nodes of a scope (e.g., POD and DST) must be defined, must be in the same theater, and must exist as nodes in the network. In ELIST-AMP, only the ORG must be defined for inclusion in the ORG-to-POE theater — AMP will provide the POE at runtime. Likewise, only the DST must be defined for inclusion in the POD-to-DST theater of an ELIST-AMP run. If the POE or POD is defined but is not in the theater, that RLN movement will not be included.
- 2.3.4 An additional possibility for theater inclusion of an RLN is if its POE and/or POD are undefined while its ORG and the DST are defined and in one theater: ELIST will simulate the move from ORG to DST (assuming all three scopes are turned on).
- 2.3.5 In ELIST stand-alone, an RLN will be rejected from simulation if the last location in the theater does not have a valid required date in the ETPFDD.
- 2.3.6 In ELIST-AMP, an RLN will be rejected for the POD-to-DST leg in the theater if the required time at the DST is undefined.
- 2.3.7 If an RLN has any additional locations specified in the ETPFDD, those locations must be in the same theater as the rest of the leg locations and must be defined in the network in order for the RLN to be included in that theater simulation.
- 2.3.8 An RLN will be rejected for the POD-to-DST theater if its model mode-source is set to REJECT, even if the locations are in the theater. (See section 6.2, Mode/Source Rules.)
- 2.3.9 If an RLN in the ETPFDD is unsourced, the scenario option, *Flow Unsourced RLNs*, must be true for that RLN to be included in the scenario.

2.4 LEVEL OF DETAIL

- 2.4.1 Cargo components of an RLN are represented at different levels of detail in the TPFDD. In the ELIST simulation, cargo can be modeled at either level 3 or level 4 (not including personnel [PAX] and petroleum, oil, and lubricants [POL], whose representations do not change). The theater parameter *TPFDD detail to model* can be set to *level 4* or *level 3*. If the setting is *level 3*, no cargo will be modeled as level 4 even if that data are in the TPFDD. If the setting is *level 4*, all RLN details with level 4 data will be modeled as such.

- 2.4.2 The level 3 model setting allows more accurate matching of cargo records between ELIST and other federation models that do not have level 4 cargo representations.

2.5 PROJECTION

- 2.5.1 An ELIST scenario may include a **projection** of the ETPFDD. A projection captures how each piece of equipment, cargo, or personnel was deployed in a simulation scenario. Projections are used for incorporating results from other models, such as JFAST and MIDAS, which feed strategic arrivals into the theater. For a POD-to-DST theater, a projection will provide strategic ship and plane arrivals with manifests that ELIST then uses to override the POD times and locations in the ETPFDD. Projection data are only used with ELIST stand-alone.
- 2.5.2 The theater parameter, *Make RLNs with Missing Projection Available*, applies to the POD-to-DST legs of ELIST stand-alone scenarios. If there is no arrival information for an RLN at its POD (either no projection or no information on the RLN in the projection), the model will make the RLN available to move at that location on the latest arrival date (LAD).

2.6 RLN MOVEMENTS AND ACTIVITIES

- 2.6.1 An RLN in an ELIST theater starts out either arriving at a POD location on a strategic asset, or being available at an ORG, POE, or POD location as described above. If arriving on a strategic ship or aircraft, the first activity of the unit or supplies is to:
- Offload from strategic asset.
- 2.6.2 ELIST simulates the subsequent movements and activities of the RLN through the theater based on requirements taken directly from the ETPFDD. ELIST models the following RLN activities taken from the ETPFDD:
- Movement to a location either by the ETPFDD specified mode or by a model-selected mode;
 - Delay, either for a period of time or until a specific time; and
 - Marry up.
- 2.6.3 The simulation parameter, Travel mode, determines whether the mode from the ETPFDD must be used for all RLN movements, or whether the model can use the mode it determines is best. If the travel mode is “specified in reqts,” the RLN must use that mode for that leg. If it cannot, then it will be put in the error queue. If the travel mode is “model selected,” the modes in the ETPFDD are ignored. If the value of travel mode is “specified

then model,” the RLN will travel by the ETPFDD mode if possible; otherwise an alternate mode will be used.

2.6.4 In ELIST-AMP, a theater modeling the ORG-to-POE leg must get run-time POE assignments from the federation. Thus, each RLN moving to a POE has some additional activities. At its ready-to-load date (RLD), the RLN becomes available and can perform any required activities up to the movement to POE. The RLN will delay at the location just before the POE and will:

- Wait for a move request from the federation.

This location will be the ORG or the final origin ILOC defined in the ETPFDD.

After the RLN receives its move request, it will travel to the specified POE. There it will obtain a strategic asset assignment, also from the federation. Once the ship or aircraft arrives, the unit or supplies will:

- Load onto the strategic asset.

2.6.5 Additional RLN activities that are not represented in the ETPFDD can also be specified in the scenario. These include:

- Application of unit enablers to theater resources (see Arriving Enablers on page 79).
- Application of unit vehicles to theater asset pools (see Arriving Enablers on page 79).
- Reconfiguration of cargo increment numbers (CINs).

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3 COMMODITIES

3.1 COMMODITIES IN THE SIMULATION

- 3.1.1 A commodity is a classification of cargo, personnel, or POL. Each detail of an RLN that is moved in an ELIST simulation must have an assigned commodity. Within the simulation, an item's commodity type determines what modes and assets can be used to move the item and what resources are required for strategic and intratheater asset loading and offloading.
- 3.1.2 Each commodity has one of the seven possible load types (also called Commodity Categories) listed in Table 3-1. Commodity load types are static and have one or more standard units of measure. Different units are used for certain operations; for example, breakbulk, roll on/roll off (RORO), and containers are measured in square feet for storage operations.
- 3.1.3 Secondary and Secondary PAX are special categories for cargo and PAX, respectively, that for modeling purposes do not require resources, assets, or time in order to move in the simulation. (These are items closely associated with other components of the unit such that in reality they always travel with or on the other components, such as vehicle drivers.) They will, however, perform delays as required.

TABLE 3-1 Commodity Load Types

| Name | ELIST Units ^a | TPFDD Units ^a |
|---------------|--------------------------|--------------------------|
| PAX | pax | pax |
| POL | cbbl | cbbl |
| Breakbulk | st (sqft) | st sqft |
| RORO | vehicle (st, sqft) | st sqft |
| Container | container (st, sqft) | st sqft mton |
| Secondary | st | st sqft |
| Secondary PAX | pax | pax |

^a pax = personnel; cbbl = hundreds of barrels; st = short ton; sqft = square feet; mton = measurement-ton.

3.2 COMMODITY DATA

3.2.1 Each commodity, depending upon its load type, has the attributes presented in Table 3-2. The square-feet-per-short-ton ratio and area-stow percent are only required for breakbulk and RORO commodities. Heavy equipment transportable (HET) only applies to RORO commodities. The 40-foot (ft) attribute applies only to container commodities. Containers are 40 ft if this attribute is true; otherwise they are 20 ft.

TABLE 3-2 Commodity Attributes

| Attribute | Units ^a |
|--|---|
| Name | NA |
| Load Type | [PAX, POL, breakbulk, RORO, container, Secondary PAX, Secondary] |
| Amount per Vehicle | TPFDD unit/vehicle |
| Square-Feet-per-Short-Ton Ratio (if breakbulk or RORO) | sqft/st |
| Area Stow Percent (if breakbulk or RORO) | % |
| Heavy Equipment Transport (if RORO) | [true, false] |
| Forty Foot (if container) | [true, false] (true if 40-ft container type; false if 20-ft container type) |
| Hot | [true, false] |

^a NA = not applicable; sqft = square feet; st = short ton.

3.2.2 The *amount per vehicle* ratio is used to convert a TPFDD level-3 detail commodity to vehicle or container equivalents where required. The following numbers are always calculated if the exact value is not available:

- Number of vehicles of RORO cargo.
- Number of vehicles for self transportation of any commodity category.

The value is calculated by:

$$\text{ceiling}(st / \text{amount per vehicle})$$

- Number of containers of Container Cargo.

The value is calculated by:

$$\text{ceiling}(\text{mton} / \text{amount per vehicle})$$

If the commodity is PAX or POL, and self transportation is called for, the *st* would be replaced by *pax* or *cbbls*, respectively.

- 3.2.3 The *square-feet-per-short-ton ratio* is used to determine the area of breakbulk and RORO cargo when an actual square-foot value is not available. Area is used to measure storage and vehicle loading.
- 3.2.4 The *area stow factor* is used for determining the area required for loading the breakbulk or RORO commodity onto transport vehicles. The stow factor is a percentage of the total area that can actually be used when loading this type of commodity. For example, if the stow factor is 60% and 100 sqft of cargo is to be loaded, it will consume $100 \text{ sqft} \times 100 / 60 = 167 \text{ sqft}$.
- 3.2.5 The *heavy equipment transport* (HET) attribute of a commodity can be set to *true* to indicate that the commodity is heavy equipment transportable. In the model, this setting is only used for routing. In a scenario, certain road routes can be designated as HET routes. If a HET route exists between two locations, it must be used for all HET cargo traveling by road between those locations.

3.3 COMMODITY MOVEMENT RULES

- 3.3.1 Each commodity must have, for each theater, an associated preference-ordered list of rules that describe how the commodity can be transported within that theater. Each rule specifies either:
- A vehicle type (e.g., if it is a trailer, line-haul transport is implicitly required),
or
 - A mode (e.g., SELF) implies the cargo itself is a vehicle or otherwise requires no asset for movement).
- 3.3.2 Each rule can be constrained by a minimum or maximum travel distance requirement (e.g., this asset can be used if the distance is less than 30 miles).
- 3.3.3 Each rule can also be limited to some time span in the simulation — specified by a *start day*, an *end day*, or both. (The time window is applied when the cargo is available to move. If there is a delay acquiring assets, the rule may be used after the *end day*.)

3.4 COMMODITY ASSIGNMENT RULES

- 3.4.1 Rules are used to assign an ELIST commodity to each detail of each RLN in the ETPFDD, as well as to each dynamic CIN in an ELIST-AMP run. A commodity has one assignment rule. Commodity assignment is the same across all scenario theaters.
- 3.4.2 The rules are evaluated in *assignment priority* order for each detail. Each detail gets assigned the commodity of the first rule that evaluates to *true*; no lower-priority rules are evaluated for that detail. If all rules fail, the cargo defaults to the last commodity.
- 3.4.3 Commodity assignment rules can have conditions based on any of the fields of the ETPFDD, including unit attributes, cargo type and size, and movement locations and required dates.

4 NETWORK

An ELIST infrastructure network is composed of nodes (and intersections), transportation links, and other geographically located data objects. The network can be displayed on the map, and the object data can be accessed via the map. Each type of network object is described here briefly.

4.1 NODE

A node is a location such as a city, seaport, or depot. Table 4-1 shows the attributes that can be defined for every node.

TABLE 4-1 General Node Attributes

| Attribute | Units ^a |
|------------------------|--------------------|
| Name | NA |
| GEOLOC | NA |
| Installation Type | [Node] |
| Available Military | [Yes/No] |
| Coordinates | decidegrees |
| Country State Code | NA |
| Country State Name | NA |
| Elevation | m |
| Icon Color | blue, green, etc. |
| Icon Name | NA |
| Node/Link Type | NA |
| Container Stack Height | cont |
| Documentation | vehicle/day |
| Equipment Storage | sqft |
| PAX Storage | pax |
| POL Storage | cbbl |
| Staging Area | [Node] |
| Theater Staging Base | [Node] |
| Installation | NA |

^a NA = not applicable; m = meter(s) ; sqft = square feet;
pax = personnel; cbbl = hundreds of barrels.

Any activity specified in the ETPFDD that is to be simulated in ELIST must occur at a node with a valid geolocation code (GEOLOC) (i.e., defined in GEOLOC data).

In addition to these attributes, a number of other attributes must be defined at a node depending on the types of deployment activities that will occur there. Attributes required for a specific mode of travel originating or finishing at a location will be described later in the sections on that mode of movement.

Following are descriptions of the node attributes that are used during the simulation for all modes of transportation.

- **Available Military.** A value of *Yes* means this node can be used as a transfer point on a multimode route.
- **Container Stack Height.** This attribute is the number of containers that will be stacked vertically in storage (Equipment Storage) at the node. All containers consume cargo storage area as follows: cargo storage area = container sqft / Container Stack Height.
- **Documentation.** The documentation rate at a node is the amount of equipment and supplies at that location that can officially be documented as having been “transferred.” Documentation is expressed in terms of the number of vehicles (refer to section 15, Documentation).
- **Equipment Storage.** This attribute is the area in square feet available at the node to store unit equipment and supplies. All breakbulk, RORO, and container commodities that are at the node but are not loaded onto a vehicle and are not at their final destination consume storage area (refer to section 14, Storage).
- **PAX Storage.** This attribute (perhaps unfortunately named) is the maximum number of people that are at the node but are not on a vehicle and are awaiting further movement.
- **POL Storage.** This attribute is the capacity in cbbls available to store POL at the node. All POL commodities that are at the node but are not loaded onto a vehicle and are not at their final destination consume POL storage.
- **Staging Area.** This attribute is another nearby node that serves as the staging area for this node. It will only be used for nodes that are PODs.
- **Theater Staging Base.** This is another nearby node that serves as the theater staging base for this node. It will only be used for nodes that are DSTs.
- **Installation.** This attribute is the installation with which this node is associated, if one exists. See below.

- 4.1.1 Airport is a type of node. In order to accommodate aircraft arrivals and departures, an airport must have at least one ramp.
- 4.1.2 Ramp is an airport feature with a capacity to process (onload or offload) a certain number of aircraft and a capacity to park a certain number of aircraft.
- 4.1.3 Seaport is a type of node. In order to accommodate ship activities, a seaport must have at least one berth group.
- 4.1.4 Berth Group is a seaport feature composed of a number of contiguous, ordered berths.
- 4.1.5 Berth is a section of a berth group with uniform attributes, such as depth, against which a ship's attributes must match in order to accommodate the ship or some portion of the ship and thus allow it to be unloaded or offloaded.
- 4.1.6 Crane is a feature at a seaport used to lift container, breakbulk, and RORO cargo onto and off of ships. Each crane record may represent one or more cranes. Each record has a specified set of berths at which its cranes can work.
- 4.1.7 Dualport is a type of node that has all of the capabilities and requirements of a seaport and an airport at one GEOLOC.

4.2 INTERSECTION

An intersection is used only to connect two or more links of any modes. It has no attributes except geographical coordinates.

4.3 INSTALLATION

An installation is a group of closely located nodes. A node can be in only one installation. For the purposes of the simulation, cargo and personnel can move between nodes within an installation instantly and without the use of vehicles, links, or other resources.

Each node within the installation determines what node to use when moving by a certain mode. The installation has a set of default nodes to use for each mode, and then each node has an override list, where the user can specify a different node on the installation for moves of a certain mode.

The simulation will always use the original node if the capability for the required mode exists. If there is no capability for the required mode, the simulation will check the node to see what installation node to use to move by the mode. The simulation will then "magic move" (i.e., perform the move without requiring time, resources, or assets) the requirement to the specified installation node and ship out of that node.

4.4 LINK

Each link represents an infrastructure capability for transport of a certain mode from one node or intersection to another. Each link in the network is a road, a rail, a waterway or shipping lane, or a pipeline. Table 4-2 lists the basic link attributes shared by all modes of link. Additional attributes associated with specific modes are described in later sections on transportation of each mode type.

TABLE 4-2 General Link Attributes

| Attribute | Units ^a |
|--------------------|------------------------|
| Name | NA |
| From Node | [Node or Intersection] |
| To Node | [Node or Intersection] |
| Link Type | NA |
| Length | mi |
| Line color | red, green, etc. |
| Line style | solid, dashed, etc. |
| Line width | [1, 2, 3] |
| Available Military | [Yes, No] |

^a NA = not applicable; mi = miles.

4.4.1 If *available military* is *No*, the link will not be used in any routes for movement in the simulation.

5 VEHICLES AND ASSET POOLS

An ELIST scenario has data on a complete set of vehicle types and characteristics that include every type of asset that might be used. In general, this data set remains fairly constant among most scenarios.

Asset pools for each theater describe the vehicles available to move requirements within that theater. Each asset pool contains specific types and numbers of vehicles, and each associates regions of operation and other information with the use of its vehicles.

5.1 VEHICLES

- 5.1.1 Vehicle types include truck, tractor, trailer, railcar, fixed-wing and rotary-wing aircraft, ship, and ship type. The data associated with each type are shown in the attribute tables that appear later in this document.
- 5.1.2 Each vehicle type has a value for *percent availability*. Availability is the default percentage of vehicles that are assigned to a scenario and are actually available for use at one time. For example, if 100 vehicles are in a pool, and their availability is 90%, only 90 vehicles will be simultaneously usable in the simulation.
- 5.1.3 Each truck, trailer, and tractor type is defined as *military* or *not military* (i.e., commercial). These types may have different operational requirements in the simulation.
- 5.1.4 Tractors and trailers are modeled separately for line-haul use only. In other cases, tractor-trailer pairs are modeled as trucks.

5.2 SHIPS VS. SHIP TYPES

- 5.2.1 An ELIST scenario includes data for specific ships (e.g., the Enterprise) in addition to ship types. *Ships* generally represent strategic ships; these data are used for berthing, loading, and offloading strategic arrivals and departures in the model. These ships cannot be assigned to theater asset pools.
- 5.2.2 *Ship types* represent intratheater ships, barges, and ferries. These ships can be in the pools and are used in the simulation to move units and supplies within each theater.

5.3 INDIVIDUAL VS. CAPABILITY VEHICLE MODEL

Vehicles used by the simulation are modeled either as *individual* or *capability* resources. Individual vehicles are fully tracked by the simulation, including all movements whether loaded

or empty. Capability assets are tracked only when in use to transport cargo. In this type of aggregate asset modeling, vehicles are instantly available at any location served by the pool when they are not in use. **Ship assets are always modeled individually.** The model type is associated with an asset pool — all vehicles in a pool have the same model type.

5.4 ASSET POOLS

5.4.1 An asset pool is a group of vehicles that serve the same area and are all initially located at the same place — the asset pool home node. Each pool has a classification indicating how its vehicles are to be used. Options are:

- Direct Delivery,
- Delivery Route (See Delivery Routes on page 38),
- Line Haul Tractors,
- Line Haul Trailers, and
- STAR Route (See STAR Routes on page 52).

A pool may only contain vehicles appropriate to its classification (e.g., trailers in the Line Haul Trailer pool).

5.4.2 All of the vehicles in an asset pool have the same model: either individual or capability. As mentioned earlier, ships may only be in an individually modeled asset pool. In addition, delivery route and STAR route assets will always be individually modeled.

5.4.3 A pool has a home node — a location where all the pool's assets will be initially located. An asset pool's theater is determined by the theater of the home node. All pool vehicles will only operate within its theater. An asset pool may also have a set of nodes at which its vehicles can pick up cargo — defined by *pickup locations served*. If an asset carries cargo to a node outside of this set, it cannot carry cargo on its return trip. In addition, a set of *delivery locations served* can be specified. Vehicles can only carry cargo to a location in this set. All pickup and delivery locations must be in the same theater as the home node. An empty set of pickup or delivery locations indicates that any node in the theater may be served by the vehicles for that activity.

5.4.4 Each asset pool has a priority. During the simulation, when all other factors are equal (e.g., availability, delivery time), an asset from a higher-priority pool will be used first.

5.4.5 Vehicles are specified for an asset pool by type, number of vehicles, start day, end day, and percent available. The maximum number of vehicles usable at any one time during the scenario is the percentage available multiplied by the number of vehicles — shown as *Num Avail*. Optional start and end days of availability can also be specified for each vehicle record. In the simulation, if a final time is specified, use of a vehicle can sometimes extend past this time (e.g., when a trip takes longer than expected).

- 5.4.6 Each vehicle record in an asset pool has a priority. Again, all other factors being equal, an asset from the higher-priority record will be used first.
- 5.4.7 The home node of each asset pool that contains fixed-wing aircraft must be an airport, the home node of a ship must be a port, the home node of a tractor or trailer must be a trailer transfer point (TTP), and the home node of a railcar must be a rail head. Otherwise, these assets cannot be used during the simulation.

5.5 BEHAVIOR OF VEHICLES NOT IN USE

The simulation parameter, *send idle assets to home node*, specifies what an asset pool vehicle will do after it completes a delivery. If *send idle assets to home node* is *true*, and if there is nothing waiting for the asset, it will travel directly its home node. If this parameter is *false*, an unneeded vehicle will remain where it is. In either case, if cargo is queued for the asset type, it will travel directly to where it is needed.

5.6 FUEL CONSUMPTION

- 5.6.1 Although fuel consumption is recorded during the simulation, fuel itself is not modeled as a resource required for vehicle movement.
- 5.6.2 Each trip made by road, fixed- or rotary-wing aircraft, or water asset records a fuel usage value at the trip's origin. The amount of fuel is based on the distance to be traveled and the *fuel consumption* rate of the vehicle.

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6 ASSET/MODE SELECTION

6.1 MODEL MODE/SOURCE VS. JOPES MODE/SOURCE

6.1.1 ELIST uses **model mode/source** values in selecting the transportation for each RLN required movement during the simulation. These mode/source values are scenario specific and may be different from the **JOPES mode/source** values found in the ETPFDD. A term alternately used for JOPES mode/source is **preferred mode/source**.

6.1.2 Each location type (e.g., OIL, POE, DST) that is defined for an RLN will have an associated model mode/source that applies to the transportation leg from the previous location to that location.

6.1.3 The possible model mode/source values are:

- **Optional.**
- **Air** — on an asset or an organic aircraft.
- **Air on Asset** — nonorganic aircraft.
- **Air Self** — organic aircraft.
- **Helo** — on an asset or an organic rotary-wing aircraft.
- **Helo on Asset.**
- **Helo Self.**
- **Rail.**
- **Pipeline.**
- **Road.**
- **Road on Asset.**
- **Road Self** — organic vehicle.
- **Road, Commercial** — only commercial vehicle.
- **Road, Host Nation** — only host nation vehicle.
- **Road, Military** — only military vehicle.

- **Water.**
- **Water on Asset.**
- **Water Self.**
- **Reject** — This value for *any* activity of an RLN causes rejection of the RLN from *all* theaters.
- **Available** — This value for *any* activity of an RLN causes the RLN to be available to move at the first location in *all* theaters.
- **No Movement** — not used by ELIST.
- **Strategic** — If on POD, ELIST will not simulate that leg (except in the case where both the ORG-to-POE and POD-to-DST moves are also in the same theater).
- **In Place** — not used by ELIST (JOPES mode/source In Place is used).

6.2 MODE/SOURCE RULES

6.2.1 Model mode/source values are generated by the scenario mode/source rules. These rules are applied to each movement leg of each RLN in the ETPFDD, as well as to federation-generated movements when running ELIST-AMP.

6.2.2 Each model mode/source can have only one rule. Model modes can be assigned based on JOPES mode/source and movement leg (i.e., origin: ORG to POE, strategic: POE to POD, or theater: POD to DST, and further). For example, this rule assigns model mode/source Reject:

```

If ( ( Leg=S || Leg=T )
    && ( PreferredModeSource=AM
        || PreferredModeSource=AN
        || PreferredModeSource=AS
        || PreferredModeSource=PG
        || PreferredModeSource=SN
        || PreferredModeSource=SP
    )
)
Then
    ModelModeSource=UA: Reject

```

6.2.3 Mode/source rules are evaluated in priority order; for each activity, the first rule with conditions evaluating to *true* will assign the model mode/source. No other rules will be

evaluated for that activity. If a location activity does not match the conditions for any of the scenario rules, it will be assigned the model mode/source of the last rule, whether the conditions evaluate to *true* or not.

6.3 MODE AND VEHICLE SELECTION DURING THE SIMULATION

6.3.1 The scenario's simulation parameter *Travel Mode* determines whether the transportation mode used in the ELIST simulation for a required movement must be the model mode/source. The possible settings for *Travel Mode* are:

- Specified in Reqs — The mode determined by the mode/source rules MUST be used. If this selection is not possible, the requirement will go in the error log. If multimode routing is enabled, a multimode route is also allowed, as long as the longest leg of the route is the required mode. ELIST will select among possible vehicles of the required mode on the basis of the earliest delivery time.
- Model Selected — ELIST will determine the mode/asset for each requirement based on earliest delivery time only.
- Specified then Model — The mode determined by the mode/source rules must be used if it is possible, including the option of a multimode route if the longest leg is the required mode. (See feasibility checks below.) If the required mode is found to be impossible, ELIST will select a feasible alternate.

6.3.2 To select the mode and/or assets for some amount of a commodity required to travel from one node to another, the simulation creates a mode-selection event. This event uses the following procedure:

First, each of the commodity's allowed movement rules for the appropriate theater is evaluated for travel mode restriction (described above) and for feasibility. This evaluation includes:

- Comparing the simulation time to the time constraints of the rule, if they exist;
- Making certain that a route exists, or, if the asset rule has a distance constraint, making certain that a route exists that meets the constraint;
- For water assets, checking that both the from and to nodes are seaports; and for aircraft, checking that both are airports; and
- Ensuring that a vehicle exists that can carry the specific cargo (if it is a level 4 item), that the vehicle is in an asset pool that serves the route, and that it is possible for the vehicle to reach the cargo pickup location.

If multimode routing is enabled for the scenario, and any multimode routes exist for which the first leg of the route is appropriate for one of the commodity movement rules, then the above checks are performed for each movement rule on each subsequent leg of the route.

- 6.3.3 If no mode or vehicle is possible for the movement requirement, the event goes into the error queue.
- 6.3.4 If the only possible transport modes available after this evaluation of the rules are self moves (no vehicle required), the movement will start immediately by using the fastest mode. Otherwise, the requirement is placed in queues for each of the feasible assets identified. There may be more than one queue for each vehicle type if it is possible to use that vehicle type from more than one asset pool. (A queue can exist for each asset pool/vehicle combination.)
- 6.3.5 After the new requirement is put into a queue, some times are calculated or estimated for that cargo and vehicle (i.e., queue). These times are used by the simulation to select a vehicle type for the fastest delivery of the cargo.

An **expected travel time** for the vehicle/requirement combination is calculated by using the fastest possible route and the vehicle speed and by adding the vehicle onload and offload times. This time is only calculated once.

Two **expected wait times** for each asset pool/vehicle combination (i.e., each queue) are calculated by ordering all of the waiting requirements in the queue by RLN priority and by using the expected completion times of all the assets' current activities and the travel times to the locations at which the assets are needed. (Note that travel times of empty assets are only included if the asset pool model is individual, not capability.) Wait times are determined by temporarily associating the next available assets with the next highest-priority events. The first wait time is the delay expected before an asset of this type could pick up some of this cargo. If the amount of cargo fits in a single vehicle, the second wait time is the same as the first. Otherwise, the second wait time is the delay expected before all of the cargo could be picked up by this type of asset. Each existing asset is only used once in making these calculations (i.e., no look-ahead calculations are carried out beyond one round trip); therefore, lower-priority events may remain without known wait times. These events are given expected wait times of 999 days for that asset pool/vehicle.

Finally, an **expected start time** based on infrastructure availability is calculated for each asset/mode. This time is estimated from any events currently waiting for the route (and any overlapping routes that share constrained links) and on the delays indicated by any constrained resources at the location or destination that would impact the move.

The **expected delivery time** for a requirement by a particular asset is calculated as:

$$\text{expected travel time} + \max(\text{current time} + \text{expected wait time}, \text{expected start time}).$$

- 6.3.6 The expected wait times are recalculated frequently when a requirement is added or removed from a queue and when vehicles are added or removed. If in *use optimal asset* mode, these times are also calculated when a requirement is tagged or untagged for a particular asset (thus removing it from contention for other assets even though it remains in other asset queues).
- 6.3.7 Each requirement waiting for transportation is assigned a priority for each asset queue in which it waits. The event will have different priorities for different queues (i.e., different asset types or different asset pools). These priorities depend on the best expected delivery time of any asset/mode that can satisfy the requirement, as well as the priority of the requirement (e.g., RLN required delivery date [RDD]).

In *use optimal asset* mode, any assets that are expected to deliver the requirement more than 1 hour (hr) later than the best asset is given a do-not-move priority. If not in *use optimal asset* mode, the cutoff is 4 hr. Otherwise, the difference in time is used to lower the requirement priority to determine the event's priority in a particular asset queue, as follows:

$$\text{priority}^{\text{asset}} = \text{priority}^{\text{RLN}} + 100 \times (\text{expected delivery time}^{\text{asset}} - \text{min expected delivery time})$$

Therefore, the top-priority asset for an event will be the asset expected to accomplish moving the requirement by the earliest time.

- 6.3.8 When a queue is triggered, events in the queue execute in order of priority for that asset type as long as available assets remain. Events with a do-not-move priority will not be executed. An event takes itself out of all asset queues if it successfully acquires enough vehicles. If some vehicles are acquired but not enough, the cargo will split, and the part with vehicles will move forward.
- 6.3.9 If a queue represents a tracked (i.e., not a capability) asset, unused assets are sent (in asset transfer events) to locations where they are needed. After all requirement events in the queue that could possibly be successful are executed, and requirements and unused vehicles both exist, these vehicles are matched with requirements which are then tagged for them. Then, transfer events are created for the newly matched vehicles.

6.4 PRE-SENDING ASSETS

- 6.4.1 ELIST has an option to send vehicles to meet cargo in anticipation of required movements. (Generally, ELIST evaluates movement requirements when they are ready to move, not before.) This simulation parameter, *pre-send assets*, can set *on* or *off*.
- 6.4.2 This function only looks at certain requirements — namely, movements immediately following initially known RLN arrival and available events. In a CONUS simulation, for example, many RLNs are considered “available” at their ORGs on their RLDs. If there is a required move from the ORG at a known time (i.e., not in ELIST-AMP where the RLN

must wait for a move request from the federation), ELIST will process this requirement in advance of the RLD in order to send assets to be available when the RLN cargo is ready to move. ELIST also pre-sends assets for movements after strategic arrivals generated from a projection in an ELIST stand-alone simulation.

6.4.3 Movement requirements are evaluated in the following way when selecting assets and determining when to transfer them.

- During simulation initialization, the cargo is evaluated for possible vehicle types as described in section 6.3.2 but using the future time when the cargo will be available to move. The possible vehicle types and associated travel times are recorded.
- All of the vehicles needed at the same time and the same location are summed up. The transfer times from the best asset pools are determined and are rounded up to 2 hours, 4 hours, or a maximum of 6 hours.
- Events (DecideToSendAsset events) are scheduled at this amount of time ahead of the cargo ready-to-move time. This type of event specifies the vehicle type and the cargo for which assets are needed but not a specific asset pool.
- At the scheduled time during the simulation, the event will execute: if this type of asset is available, those vehicles will be transferred to the pickup location and matched with the appropriate cargo. If there are other cargo items already queued for the asset, the DecideToSendAsset event will queue as well.
- If the event is not able to obtain assets before the cargo ready-to-move time, the pre-send event is discarded, and the normal asset acquisition takes place.

7 ROAD TRANSPORTATION

7.1 TRUCK DATA

Table 7-1 lists the truck attributes used by the simulation.

TABLE 7-1 Truck Attributes

| Attribute | Units ^a |
|----------------------|--------------------|
| Type | NA |
| LIN | NA |
| Weight Capacity | st |
| POL Capacity | gal |
| Container Capacity | TEU |
| PAX Capacity | pax |
| Cargo Width | in. |
| Cargo Length | in. |
| Bed Height | in. |
| Curb Weight | st |
| Rate of March | mph |
| Onload Time | hr |
| Offload Time | hr |
| Military | [Yes, No] |
| Percent Availability | % |
| Fuel Consumption | mi/gal |

^a NA = not applicable; Not Used by ELIST;
 st = short ton; gal = gallon(s); TEU = twenty-foot
 equivalent unit; pax = personnel; in. = inch(es);
 mph = miles per hour; hr = hour; mi = mile(s).

7.2 TRACTOR AND TRAILER DATA

Tractors and trailers are specified and modeled as separate entities only for line haul operations. Table 7-2 lists the tractor attributes, and Table 7-3 lists trailer attributes.

TABLE 7-2 Tractor Attributes

| Attribute | Units ^a |
|----------------------|--------------------|
| Type | NA |
| LIN | NA |
| Curb Weight | st |
| Rate of March | mph |
| Military | [Yes, No] |
| Percent Availability | % |
| Fuel Consumption | mi/gal |

^a NA = not applicable; Not Used by ELIST;
 st = short ton; mph = miles per hour;
 mi = mile(s); gal = gallon(s).

TABLE 7-3 Trailer Attributes

| Attribute | Units ^a |
|----------------------|--------------------|
| Type | NA |
| LIN | NA |
| Weight Capacity | st |
| POL Capacity | gal |
| Container Capacity | TEU |
| Cargo Width | in. |
| Cargo Length | in. |
| Bed Height | in. |
| Curb Weight | st |
| Military | [Yes, No] |
| Onload Time | hr |
| Offload Time | hr |
| Percent Availability | % |

^a NA = not applicable; Not Used by ELIST;
 st = short ton; gal = gallon(s); TEU = twenty
 foot equivalent unit; in. = inch(es); hr = hour(s).

7.2.1 Tractors can only pull certain types of trailers. This data is defined in the vehicle matching data in which each tractor has a list of associated trailers.

7.2.2 A tractor-trailer travels at the tractor's rate of march.

7.3 TRUCK AND TRAILER PAYLOADS

7.3.1 The amount of cargo that a truck can carry is limited by its attributes: *PAX capacity*, *POL capacity*, *weight capacity*, *container capacity*, and cargo area. The cargo area of a truck is calculated by multiplying *cargo width* times *cargo length*.

- Only one category of cargo will be loaded at a time: PAX, POL, RORO, breakbulk, or container.
- **PAX** can be loaded up to the amount of the vehicle's *PAX capacity*.
- **POL** commodities can be loaded up to the amount of the vehicle's *POL capacity*.
- The summed weight of all **RORO**, **breakbulk**, or **container** cargo is limited by the truck's *weight capacity*. However, if a vehicle is listed in a commodity's movement rules, that vehicle can always carry at least one level 4 item, one piece of equipment, or one container of that commodity, regardless of weight.
- **Containers** can be loaded up to the amount of vehicle's *container capacity*, but the weight of the loaded containers cannot exceed the *weight capacity* of the vehicle, except as noted in the previous bullet.
- The summed area required by all **RORO** or **breakbulk** cargo is limited by the truck's cargo area. The stowage area required by a piece of cargo is calculated as its footprint divided by its commodity's *area stow percent* times 100. However, if a vehicle is listed in a commodity's movement rules, that vehicle can always carry at least one level 4 item or one piece of equipment of that commodity regardless of size.

7.3.2 A truck is considered fully loaded and ready to depart if it holds at least an adequate load. If the vehicle is carrying less than an adequate load, it will wait up to a maximum amount of time for additional cargo (with the same destination). If, after waiting, no new cargo is ready at the location, the vehicle will depart.

The theater parameters, *adequate truck load* (in percent) and *maximum truck wait*, are the values used to determine load and wait times for partially loaded vehicles. If the *adequate truck load* is 50%, a truck is adequately loaded if it has used 50% of its capacity for the current cargo type.

7.4 NODE DATA AND TRUCK LOADING ACTIVITIES

Table 7-4 lists the node attributes for loading cargo onto and off of trucks and trailers.

TABLE 7-4 Node Attributes for Truck Loading

| Attribute | GUI ^a Name | Units |
|--|---------------------------------------|---------------|
| Infrastructure rate for on-/offloading breakbulk (BB) cargo from trucks | Road BB Infrastructure On/Off | vehicle/day |
| MHE rate for on-/offloading breakbulk cargo from trucks | Road BB MHE On/Off | vehicle/day |
| Personnel rate for on-/offloading breakbulk cargo from trucks | Road BB Personnel On/Off | vehicle/day |
| MHE rate for on-/offloading containers from trucks | Road Cont MHE On/Off | container/day |
| Personnel rate for on-/offloading containers from trucks | Road Cont Personnel On/Off | container/day |
| Infrastructure rate for on-/offloading POL from trucks | Road POL Infrastructure On/Off | vehicle/day |
| Personnel rate for on-/offloading POL from trucks | Road POL Personnel On/Off | vehicle/day |
| Infrastructure rate for on-/offloading RORO cargo from trucks | Road RORO Infrastructure On/Off | vehicle/day |
| Personnel rate for on-/offloading RORO cargo from trucks | Road RORO Personnel On/Off | vehicle/day |
| Maximum number of loaded trucks and trailers at one time | Road Max Loaded | vehicle |

^a GUI = graphical user interface; BB = breakbulk; MHE = materiel handling equipment.

Different use rates for same personnel resources.

- 7.4.1 Each of these attributes specifies the capability of a resource in the node. The personnel working to load trucks at a location perform the loading for all of the commodity types. Therefore, when some breakbulk cargo is loaded, for example, the remaining capability to load containers, POL, and RORO cargo is decreased by the percent used.

All of the infrastructure and materiel handling equipment (MHE) resources are only used for one commodity load type and are independent.

The use of different resources for infrastructure, MHE, and personnel allows arriving unit MHE or personnel (enablers) to increase the available offload capability up to the fixed infrastructure limit.

- 7.4.2 The time taken to onload a truck is either the time needed by the slowest resource or the onload time of the truck, whichever is longer. Offload time is equivalently calculated. For instance, if loading 2 containers onto a vehicle, where the MHE rate for container cargo is 24 containers per day, the time required by that resource would be 2 hours. (Assume the Personnel rate of loading containers is greater, such as 100 containers per day.) If the onload time attribute of the truck were 1.5 hours, the time used for the load event would be 2 hours. At most locations, the load event times will end up being the truck onload and offload times.
- 7.4.3 The loading of any cargo onto a truck requires a unit of *road max loaded*. The *road max loaded* attribute reflects the space available for loading activities, and once this number is reached, no more loading activities are performed. An additional benefit of this constraint is that it keeps the model from tying up resources (vehicles) if they cannot be used. (The resource is released when the loaded truck departs from the node.)
- 7.4.4 The loading of breakbulk cargo onto or off of a truck requires infrastructure, MHE, and personnel resources.
- 7.4.5 The loading of RORO cargo onto or off of a truck requires infrastructure and personnel resources.
- 7.4.6 The loading of POL cargo onto or off of a truck requires infrastructure and personnel resources.
- 7.4.7 The loading of container cargo onto or off of a truck requires MHE and personnel resources. The infrastructure container on-/offload capability for road assets is considered to be unconstrained.
- 7.4.8 PAX load themselves and do not require any asset resources.
- 7.4.9 When any cargo is loaded onto a vehicle, the storage space it was occupying at the node is released.

7.5 ROAD LINK DATA

Table 7-5 lists the road link attributes used by the simulation.

TABLE 7-5 Road Attributes

| Attribute | Units ^a |
|--------------------------|----------------------|
| From Node | Node or Intersection |
| To Node | Node or Intersection |
| Percent Civilian Traffic | % |
| Available Military | [Yes, No] |
| Length | mi |
| Node Travel To | Node or Intersection |
| One-way | [Yes, No] |
| Road Rate | vehicle/day |
| Road Rate of March | mi/hr |
| Height Limit | in. |
| MLC Limit | NA |
| Weight Limit | st |
| Width Limit | in. |

^a mi = miles; hr = hour; NA = not applicable; in. = inch(es);
st = short ton.

- 7.5.1 Roads are modeled as two distinct directional links. For reporting purposes, forward travel is *from node* toward *to node*, and return travel is *to node* toward *from node*.
- 7.5.2 *Road rate* is the capacity or the number of vehicles that can start onto the link (in each direction) during a certain time period. The actual entry rate available during the simulation will be decreased by the *percent civilian traffic*.
- 7.5.3 The *road rate of march* is the expected rate of travel on the link, including short periodic stops and delays.
- 7.5.4 Road links can be one way; however, they default to two-way road links. One-way links will have a node value for the *node travel to* attribute, which will be one of the link endpoints.
- 7.5.5 If the *available military* value is *no*, the link will not be used in the scenario.

7.5.6 No level 4 cargo with dimensions that exceed any of the link limits will travel over the link (on a truck or organically). These limits include height, width, and weight.

7.6 SERIAL MOVES

7.6.1 Travel by trucks in serial (convoy) formation may be required in a theater for various asset configurations. Serial size is controlled by the theater parameters, *minimum vehicles/serial* and *maximum vehicles/serial*. A serial size will never be greater than the maximum value, but it may be smaller than the minimum value.

7.6.2 No extra time is modeled for the assembly of a serial.

7.6.3 A spacing distance between serials leaving the same location is enforced. The distance (in feet) is specified in the theater parameter, *serial spacing*.

7.6.4 Serials consume an equivalent amount of link capability as the same number of individual trucks.

7.6.5 When some vehicles have been waiting at a node for a serial to form, and a length of time has passed with no new vehicles showing up, the waiting vehicles will move forward, even though they number less than the *minimum vehicles/serial*. This time is defined in the scenario parameter, *maximum serial wait*.

7.6.6 A serial travels at the slowest of these three speeds: the scenario's *serial rate of march*, the slowest vehicle's *rate of march*, and the link's *rate of march*.

7.7 TRAVEL SCHEDULES

7.7.1 A theater can have assigned travel schedules for various types of road movements. Such a travel schedule is a rotating sequence of pairs of travel hours (travel and rest combinations), for example, 6 hr of travel with 2 hr of rest; 4 hr of travel with 10 hr of rest, 6 hr of travel with 2 hr of rest, and so on. The default values are "continuous" travel.

7.7.2 ELIST can have travel schedules for three types of road movements: *military self deployed schedule*, *military schedule* (for direct delivery), and *commercial schedule*. Any trips with assets of these types will follow the appropriate theater schedule, whether they move in a serial or individually.

7.7.3 Each movement that uses a schedule begins that schedule as it leaves the point of origin. The schedule will only affect trips longer than the first travel time. No carryover between separate or return trips occurs.

7.7.4 During the rest periods, the vehicles are considered to be off the road (not blocking or affecting link capability).

7.7.5 Asset pool vehicles without cargo do not follow any trip schedule.

7.8 ROAD MOVEMENT METHODOLOGY

7.8.1 Cargo is assigned a road mode and vehicles as described in Asset/Mode Selection on page 21.

7.8.2 A road vehicle (or set of vehicles) will be committed to move a particular load or partial load of RLN cargo provided the following conditions are met:

- If a road route exists that is usable by the scenario and by the cargo (commodity and dimensions), and the route has a nonzero rate (current availability is not required), and
- If the location's *road max loaded* has sufficient current availability for the number of vehicles, and
- If the route destination's *vehicle entry queue* has a nonzero current availability.

As soon as a vehicle is committed to a movement, the *road max loaded* resource will be consumed. If any of these conditions is not met, the cargo movement requirement event will wait in the appropriate queues while other movement options are evaluated.

7.8.3 After a vehicle is committed to some cargo, the onload activity will take place, and the cargo will be removed from storage at the node.

7.8.4 ELIST has four configurations for road travel: military self deployed, military direct delivery, commercial direct delivery, and line haul.

Table 7-6 lists the node attributes for road movement.

TABLE 7-6 Node Attributes for Road Movement

| Attribute | Units ^a |
|---------------------------------------|--------------------|
| Military Self-Deployed Road Clearance | vehicle/day |
| Vehicle Entry Queue | vehicle |
| Documentation | vehicle/day |
| Equipment Storage | sqft |
| PAX Storage | pax |
| POL Storage | cbbl |
| Height Limit | in. |
| MLC Limit | NA |
| Weight Limit | st |
| Width Limit | in. |

^a sqft = square feet; pax = personnel; cbbl = hundreds of barrels; in. = inch(es); MLC = Military load class; NA = not applicable; st = short ton.

7.9 MILITARY SELF DEPLOYED

- 7.9.1 All unit equipment organically moving without a transportation asset (mode/source road self) travels in military self-deployed formation.
- 7.9.2 If the theater parameter, *serials required for military self-deployed*, is true, military self-deployed moves follow the procedure described earlier in section 7.6, Serial Moves.
- 7.9.3 Self-deployed unit equipment follows the theater's *military self-deployed schedule*, if it is defined. (See section 7.7, Travel Schedules.)
- 7.9.4 Self-deployed unit equipment requires *military self-deployed road clearance* capability at the origin to start the trip.
- 7.9.5 A truck arriving at its destination enters that node's *vehicle entry queue*.
- 7.9.6 To enter the node and leave the entry queue, a truck requires the following resources:
- *Military self-deployed road clearance*,
 - *Documentation* (which may or may not constrain movement), and
 - *Equipment storage, PAX storage, and/or POL storage* for the cargo (if this is not its final destination; storage also may or may not constrain movement based on the scenario parameter).

7.10 MILITARY DIRECT DELIVERY

7.10.1 A military direct delivery is the transport of cargo using a military asset truck or tractor-trailer.

7.10.2 Node clearance is not a factor for direct deliveries.

7.10.3 Military direct deliveries must travel in serials if required by the theater parameter, *serials required for military direct delivery*. (See section 7.6, Serial Moves.)

7.10.4 The serial follows the theater's *military direct delivery schedule* if it is defined. (See section 7.7, Travel Schedules.)

7.10.5 Vehicles arriving at their destination enter that node's *vehicle entry queue*.

7.10.6 To enter the node and leave the outside queue, the vehicles require the following:

- *Documentation* (which may or may not constrain movement) and
- *Equipment storage, PAX storage, and/or POL storage* (if this delivery point is not the cargo's final destination; storage also may or may not constrain movement based on the scenario parameter).

7.11 COMMERCIAL DIRECT DELIVERY

7.11.1 A commercial direct delivery is the transport of cargo using a commercial truck or tractor-trailer.

7.11.2 Node clearance is not a factor for direct deliveries.

7.11.3 Commercial direct deliveries must travel in serials if the theater parameter, *serials required for commercial direct delivery*, is true. (See section 7.6, Serial Moves.)

7.11.4 The serial follows the theater parameter trip schedule, *commercial schedule*. (See section 7.7, Travel Schedules.)

7.11.5 Arriving vehicles enter the *vehicle entry queue* of the destination.

7.11.6 To enter the node and leave the queue, vehicles require the following:

- *Documentation* (which may or may not constrain movement), and
- *Equipment storage, PAX storage, and/or POL storage* (if this delivery point is not the final destination; storage also may or may not constrain movement based on the scenario parameter).

7.11.7 After a loaded transport enters its destination, the cargo is offloaded as described in section 7.4 on load activities.

7.12 LINE HAUL

- 7.12.1 Line haul movement can be modeled in ELIST by using the *Line Haul Tractors* and *Line Haul Trailers* asset pools. Each such asset pool's home node automatically becomes a TTP, and its service area defines the routes each group of tractors or trailers will cover.
- 7.12.2 For cargo to move by line haul, a line haul route must exist. A line haul route is one or more segments of line haul from a pickup location to a delivery location with any number of TTPs in between. Currently, a line haul route will be found by ELIST only if any required TTPs are actually on the shortest road route from the pickup location to the delivery location. Cargo will use one trailer and one or more tractors to reach its destination.
- 7.12.3 A trailer asset is loaded at the cargo origin node and is not unloaded until it reaches its destination.
- 7.12.4 A tractor is assigned only for the route segment to the next TTP, where it leaves the loaded trailer, collects an empty trailer if one is waiting, and returns home immediately with or without a trailer.
- 7.12.5 After being delivered to a TTP that is not the final destination, a trailer undergoes a delay before it can continue. This delay time is specified in the scenario parameter, *line haul transition time* (2–3 hr), and represents all required activities including coupling with a new tractor. A tractor can be acquired for the next leg of the line haul at any time during or after this delay.
- 7.12.6 A tractor-trailer only leaves a TTP during its hours of operation, that is, between the TTP's *hours of operation start* and *hours of operation end* (point-of-interest attributes).
- 7.12.7 Line haul tractor-trailers travel in serials if required by the theater parameter, *serials required for line haul*.
- 7.12.8 Arriving vehicles enter the *vehicle entry queue* of the destination. Tractor-trailers are counted as one vehicle.
- 7.12.9 To enter the node, the tractor-trailers require the following:
- *Documentation* (if documentation is required), and
 - *Equipment storage, PAX storage, and/or POL storage* for loaded cargo (if there is no waiting tractor for the next leg of line haul).

- 7.12.10 There is no constraint on the total number of vehicles that can enter or exit a node (gate clearance). It is assumed that this would not constrain the node more than the access roads.
- 7.12.11 Cargo is offloaded from the trailer at its delivery location using the same procedure as for any other road vehicle.

7.13 DELIVERY ROUTES

- 7.13.1 Delivery routes can be set up as part of a scenario. This activity is modeled as a type of asset pool containing only road vehicles that make deliveries from a hub location (the home node) to multiple locations on the specified route. Only delivery route assets will deliver cargo to more than one location in ELIST.
- 7.13.2 A delivery route in a scenario is a specialized asset pool with the following data:
- An ordered set of locations that makes up the route, including a home node; and
 - Any number of trucks.
- 7.13.3 Any cargo, whose commodity can be moved by a participating vehicle type, can be moved by the delivery route.
- 7.13.4 In the current implementation, deliveries are only made from the home node and only when there is cargo requiring delivery.
- 7.13.5 One vehicle can carry cargo to multiple destinations on the route and will always make stops in the order specified in the route. A vehicle will not make stops at locations where there is no delivery, so the actual paths taken between locations may vary. If there is a full truck load going to one location, the asset will go directly there and return.

8 RAIL TRANSPORTATION

8.1 RAILCAR DATA

Table 8-1 lists the railcar attributes.

TABLE 8-1 Railcar Attributes

| Attribute | Units ^a |
|----------------------|--------------------|
| Type | NA |
| LIN | NA |
| Weight Capacity | st |
| POL Capacity | gal |
| Container Capacity | TEU |
| PAX Capacity | pax |
| Cargo Width | in. |
| Cargo Length | in. |
| Levels | Levels |
| Gauge | NA |
| Onload Time | hr |
| Offload Time | hr |
| Percent Availability | % |

^a NA = not applicable; Not used by simulation;
 st = short ton; gal = gallon(s);
 TEU = twenty-foot equivalent unit;
 pax = personnel; in = inch(es); hr = hour(s).

8.1.1 Rail prime movers (engines) are not modeled in ELIST.

8.2 RAILCAR PAYLOADS

8.2.1 The amount of cargo that a railcar can carry is limited by its attributes: *PAX capacity*, *POL capacity*, *weight capacity*, *container capacity*, and cargo area. The cargo area of a railcar is calculated by multiplying *cargo width* times *cargo length* times *levels*.

- Only one category of cargo will be loaded at a time: PAX, POL, RORO, breakbulk, or container.
- **PAX** can be loaded up to the amount of the vehicle's *PAX capacity*.

- **POL** commodities can be loaded up to the amount of the vehicle's *POL capacity*.
- The summed weight of all **RORO**, **breakbulk**, or **container** cargo is limited by the railcar's *weight capacity*. However, if a vehicle is listed in a commodity's movement rules, that vehicle can always carry at least one level 4 item, one piece of equipment, or one container of that commodity, regardless of weight.
- **Containers** can be loaded up to the amount of vehicle's *container capacity*; however, the weight of the loaded containers cannot exceed the *weight capacity* of the vehicle, except as noted in the previous bullet.
- The summed area required by all **RORO** or **breakbulk** cargo is limited by the railcar's cargo area (i.e., *cargo width* × *cargo length* × *levels*). The stowage area required by a piece of cargo is calculated as its footprint area divided by its commodity's *area stow percent* times 100. However, if a vehicle is listed in a commodity's movement rules, that vehicle can always carry at least one level 4 item or one piece of equipment of that commodity regardless of size.

8.2.2 A railcar is considered fully loaded and ready to depart if it holds at least an adequate load. If the vehicle is carrying less than an adequate load, it will wait up to a maximum amount of time for additional cargo (with the same destination). If, after waiting, no new cargo is ready at the location, the vehicle will depart.

The theater parameters, *adequate railcar load* (in percent) and *maximum railcar wait* are used to determine loads and wait times for partially loaded railcars. If the *adequate railcar load* is 50%, a railcar is adequately loaded if it has used 50% of its capacity for its current cargo type.

8.3 NODE DATA AND RAILCAR LOADING ACTIVITIES

Table 8-2 lists the node attributes for loading cargo onto and off of railcars.

TABLE 8-2 Node Attributes for Railcar Loading

| Attribute | GUI ^a Name | Units |
|--|---------------------------------------|---------------|
| Infrastructure rate for on-/offloading breakbulk cargo from railcars | Rail BB Infrastructure On/Off | railcar/day |
| MHE rate for on-/offloading breakbulk cargo from railcars | Rail BB MHE On/Off | railcar/day |
| Personnel rate for on-/offloading breakbulk cargo from railcars | Rail BB Personnel On/Off | railcar/day |
| Infrastructure rate for on-/offloading containers from railcars | Rail Cont Infrastructure On/Off | railcar/day |
| Number of lifts for on-/offloading a container from railcars | Container Lifts On/Off Rail | [1,2] |
| MHE rate for on-/offloading containers from railcars | Rail Cont MHE On/Off | container/day |
| Personnel rate for on-/offloading containers from railcars | Rail Cont Personnel On/Off | container/day |
| Infrastructure rate for on-/offloading POL from railcars | Rail POL Infrastructure On/Off | railcar/day |
| Personnel rate for on-/offloading POL from railcars | Rail POL Personnel On/Off | railcar/day |
| Infrastructure rate for on-/offloading RORO cargo from railcars | Rail RORO Infrastructure On/Off | railcar/day |
| Personnel rate for on-/offloading RORO cargo from railcars | Rail RORO Personnel On/Off | railcar/day |
| Maximum number of loaded railcars in node at one time | Rail Max Loaded | railcar |
| Maximum number of railcars that can be loaded per day | Rail Total On/Off | railcar/day |
| ^a GUI = graphical user interface; BB = breakbulk; MHE = materials handling equipment. | | |
| Different use rates for same personnel resources. | | |

- 8.3.1 Each of these attributes specifies the capability of a resource in the node. The personnel working to load railcars at a location perform the loading for all of the commodity types. Therefore, when some breakbulk cargo is loaded, for example, the remaining capability to load containers, POL, and RORO cargo is decreased by the percent used.

All of the infrastructure and MHE resources are only used for one commodity load type and are independent.

The use of different resources for infrastructure, MHE, and personnel allows arriving unit MHE or personnel (enablers) to increase the available offload capability up to the fixed infrastructure limit.

- 8.3.2 The time taken to onload a railcar is either the time needed by the slowest resource or the onload time of the railcar, whichever is longer. Offload time is equivalently calculated.
- 8.3.3 Before a railcar can get assigned to cargo for a movement from a location, a unit of *rail max loaded* is required at the location. The *rail max loaded* attribute reflects space available for loading activities, and once this number is reached, no more loading is performed. An additional benefit of this constraint is that it keeps the model from tying up railcars if they cannot be used. (The resource is released when the train departs from the node.)
- 8.3.4 The rail infrastructure is assumed to be limited to a total number of railcars that can be loaded regardless of cargo type. The attribute, *rail total on/offload*, constrains the total number of railcars per day that can be loaded or unloaded.
- 8.3.5 The loading of breakbulk cargo onto or off of a railcar requires infrastructure, MHE, and personnel resources.
- 8.3.6 The loading of RORO cargo onto or off of a railcar requires infrastructure and personnel resources.
- 8.3.7 The loading of POL cargo onto or off of a railcar requires infrastructure and personnel resources.
- 8.3.8 The loading of container cargo onto or off of a railcar requires infrastructure, MHE, and personnel resources. The loading of containers to and from rail is limited by infrastructure because a sufficient loading area must be adjacent to the track for the MHE to work. The number of lifts required for loading containers onto or off of railcars can be 1 or 2. If this attribute is 2, the MHE resources required for each container are doubled.
- 8.3.9 PAX load themselves and do not require any resources.
- 8.3.10 When any cargo is loaded onto a railcar, all storage space it was occupying at the node is released.

8.4 TRAIN ASSEMBLY AND TRAVEL SCHEDULE

- 8.4.1 There are theater-defined values for the minimum and maximum numbers of railcars that will comprise a train, *minimum railcars/train* and *maximum railcars/train*. These values should consider terrain and other conditions. The maximum number of cars is preferred. If there are less than the minimum railcars for a train, these loaded assets will wait up to

the *maximum train wait* (after the latest railcar was added) for additional railcars before proceeding with less than the minimum.

- 8.4.2 A theater can define a *train travel schedule*. Such a trip schedule is a cycling sequence of pairs of travel hours (travel and rest combinations), for example, 6 hr of travel with 2 hr of rest; 4 hr of travel with 10 hr of rest, 6 hr of travel with 2 hr of rest, and so on. The default value is “continuous” travel. All trains in the theater will use this schedule.
- 8.4.3 Any train that has a noncontinuous schedule starts that schedule as it leaves the point of origin. The schedule will only affect trips longer than the first travel time. No carryover between separate or return trips occurs.
- 8.4.4 During the rest periods, the railcars are considered to be off the main rail line (not blocking or affecting link capability).
- 8.4.5 Trains without cargo do not follow any trip schedule.

8.5 RAIL LINK DATA

Table 8-3 lists the rail link attributes.

TABLE 8-3 Rail Link Attributes

| Attribute | Units ^a |
|--------------------------|--------------------|
| Rail Rate | railcar/day |
| Rail Rate of March | mph |
| Weight limit | st |
| Height limit | in. |
| Width limit | in. |
| Percent Civilian traffic | % |
| Gauge | NA |
| Tracks | [single, double] |

^a NA = not applicable; Not used by simulation; st = short ton; in. = inch(es); mph = miles per hour.

- 8.5.1 If *tracks* value is *single*, rails are modeled as one link on which travel can occur in both directions. The numbers of vehicles using the link are recorded separately for forward travel (*from node* toward *to node*) and return travel (*to node* toward *from node*). The total number of railcars that can traverse the link in either direction is the *rail rate*. Actual entry rate available to the simulation is decreased by the *percent civilian traffic*.

- 8.5.2 If *tracks* value is *double*, two separate tracks are modeled; one for each direction. The rail rate is available for both directions. Actual entry rates available to the simulation are decreased by the *percent civilian traffic*.
- 8.5.3 *Gauge* of rail links will be used to ensure consistent and appropriate gauge rail routes (*Not Implemented*).

8.6 RAIL MOVEMENT METHODOLOGY

- 8.6.1 Cargo is assigned a rail mode and vehicles as described in Asset/Mode Selection on page 21.
- 8.6.2 A railcar (or set of railcars) will be committed to move a particular load or partial load of RLN cargo if the following conditions are met:
- If a rail route exists that is usable by the scenario and by the cargo (commodity and dimensions) and the route has a nonzero rate (i.e., current availability is not required), and
 - If the location's *rail max loaded* has sufficient current availability for the number of vehicles, and
 - If the route destination's *railcar entry queue* has a nonzero current availability.

As soon as a railcar is committed to a movement, the *rail max loaded* resource will be consumed. If any of these conditions are not met, the cargo movement requirement event will wait in the appropriate queues while other movement options are evaluated.

- 8.6.3 After a railcar is committed to some cargo, the onload activity will take place, and the cargo will be removed from storage at the node.
- 8.6.4 Loaded railcars with the same destination are assembled into trains as described earlier. The assembly itself does not take any simulation time but there may be waiting.
- 8.6.5 Railcars departing from a location are constrained by clearance. A railhead has a limiting *rail clearance* rate — a maximum number of railcars that can exit (or enter) the node on one day.
- 8.6.6 Each departing railcar also requires documentation, which may or may not be constraining based on the simulation parameter *documentation constrains flow*.
- 8.6.7 Travel speed of rail movements is the slower of the theater parameter, *rail rate of march*, or the rail link speed. Trains follow the scenario parameter, *train travel schedule*, for travel and rest times.

8.6.8 Once a train has departed from a location, it cannot be interrupted and will arrive at its destination after the travel time. Trains arriving at a node take a space in the *railcar entry queue*.

8.6.9 Railcars can enter the location when:

- There is *rail clearance* available,
- The number of railcars at the node is less than the value for *max railcars at node*,
- Storage (*equipment storage*, *PAX storage*, and *POL storage*) is available for the contents of the railcar (if the simulation parameter *storage constrains flow* is true, and if this is not the final destination of the cargo), and
- Documentation (per railcar) is available (if the simulation parameter *documentation constrains flow* is true).

Table 8-4 lists the node attributes for rail movement.

TABLE 8-4 Node Attributes for Rail Movement

| Attribute | Units ^a |
|---------------------|--------------------|
| Rail Clearance | railcar/day |
| Railcar Entry Queue | railcar |
| Documentation | vehicle/day |
| Equipment Storage | sqft |
| PAX Storage | pax |
| POL Storage | cbbl |
| Height Limit | in. |
| MLC Limit | NA |
| Weight Limit | St |
| Width Limit | in. |

^a NA = not applicable; sqft = square feet; pax = personnel; cbbl = hundreds of barrels; in. = inch(es); st = short ton.

8.6.10 After a loaded railcar enters its destination, the cargo is offloaded as described in section 8.3 on load activities.

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9 AIR TRANSPORTATION

9.1 AIRCRAFT DATA (FIXED WING)

The attributes for fixed-wing aircraft are listed in Table 9-1.

TABLE 9-1 Fixed-Wing Aircraft Attributes

| Attribute | Units ^a |
|-----------------------------------|-----------------------|
| Type | NA |
| LIN | NA |
| Parking Type | [Wide, Narrow, Small] |
| Weight Capacity | st |
| PAX Capacity | pax |
| Container Capacity | TEU |
| Door Height | in. |
| Door Width | in. |
| Cargo Bay Width | in. |
| Cargo Bay Length | in. |
| Onload Time | hr |
| Offload Time | hr |
| Expedited Time | hr |
| En route Time | hr |
| USE Rate | hr/day |
| Percent availability | % |
| Block speed for | |
| distance <=500 | nautical-mi/hr |
| 500 < distance <=1000 | nautical-mi/hr |
| 1000 < distance <=1500 or greater | nautical-mi/hr |
| Strategic | [true, false] |
| Display Color | blue, black, etc. |

^a NA = not applicable; Not used by simulation; st = short ton; pax = personnel; TEU = twenty-foot equivalent unit; in. = inch(es); hr = hour; mi = mile.

9.1.1 The *percent availability* and *USE rate* attributes of an aircraft are related by the function:

$$\% \text{ Availability} = \text{Use Rate} / 24 \times 100.$$

9.1.2 The number of aircraft used by the simulation is the number assigned in each asset pool reduced by the *percent availability* (or the *use rate* described above).

9.1.3 Fixed-wing aircraft can be modeled either as individual assets or as aggregate capability assets. If individual modeling is chosen, the home node of the asset pool to which the aircraft are assigned must have sufficient parking (maximum on ground) MOG for all planes. If capability modeling is chosen, however, the aircraft will not consume MOG while it is not in use.

9.2 AIRCRAFT PAYLOADS

9.2.1 Aircraft cannot carry POL commodities.

9.2.2 The amount of cargo that an aircraft can carry is limited by its attributes: *PAX capacity*, *weight capacity*, and *container capacity*.

- **PAX** can be loaded up to the amount of the aircraft's *PAX capacity*, regardless of any other cargo on the vehicle.
- Any TPFDD level 4 items with known dimensions must fit the aircraft's door. Specifically:

$$\text{height} \leq \text{door height AND (width} \leq \text{door width OR length} \leq \text{door width)}$$

- The summed weight of all **RORO**, **breakbulk**, and **container** cargo is limited by the aircraft's *weight capacity*. However, if a vehicle is listed in a commodity's movement rules, that vehicle can carry one level 4 item, one piece of equipment, or one container of that commodity, regardless of weight (as long as it fits through the door).
- **Containers** can be loaded up to the amount of vehicle's *container capacity*, but the weight of the loaded containers cannot exceed the *weight capacity* of the vehicle except as noted in the previous bullet.

9.2.3 Note that in ELIST-AMP, the aircraft payload constraints will be ignored for loading strategic aircraft if the simulation parameter, *Constrain Aircraft Loads*, is false.

9.3 AIRPORT DATA

9.3.1 The attributes for airports are provided in Table 9-2. (These are in addition to the attributes of all nodes shown in Table 4-1.)

TABLE 9-2 Airport Attributes

| Attribute | Units |
|--------------------------|-----------|
| Hours of Operation Start | 0–24 |
| Hours of Operation End | 0–24 |
| Ramps | ramps |
| Alternate Airport | [Airport] |
| Not used by simulation. | |

9.3.2 An airport must have one or more ramps defined in order for the airport to be able to onload or offload planes.

9.4 AIRPORT RAMP DATA

9.4.1 Table 9-3 shows the attributes for ramps.

TABLE 9-3 Ramp Attributes

| Attribute | Units |
|-------------------------|-------------------|
| Parking MOG | |
| Wide body | |
| Narrow body | Planes |
| Small body | |
| Working MOG | |
| Wide body | |
| Narrow body | Planes |
| Small body | |
| Number of Fuel Hydrants | Hydrants |
| Hot Cargo | [Hot, Cold, Both] |

- 9.4.2 The *working MOG* and the *parking MOG* of an airport ramp are represented in terms of three airframe types: wide body, narrow body, and small body. Each of these values represents the capability of the entire ramp, so that using some percent of the ramp for one type of aircraft decreases the remaining capability for all types.
- 9.4.3 *Parking MOG* depends on the physical characteristics of the airport. *Working MOG* represents the number of planes for which cargo processing resources are available. Working MOG and parking MOG are considered independent.
- 9.4.4 Limited parking MOG does not constrain movement in the system.
- 9.4.5 The cargo's hot/cold rating must match with the ramp's ability to handle such cargo. For example, an aircraft with hot and cold cargo must use a ramp with a *Hot Cargo* attribute value of *Both*.

9.5 STRATEGIC AIR OPERATIONS

- 9.5.1 Strategic aircraft arrivals require a working space at a ramp in order to be offloaded. *Working MOG* is the only resource required for offloading cargo from an aircraft.
- 9.5.2 If no working MOG capability is available at any of the airport's ramps, the plane will attempt to acquire a parking space while waiting for working MOG. If neither resource is available, the event waits in queues for both resources, and the plane could be considered to be in a holding pattern. Note that in a CONUS scenario, ELIST has no control over the times of strategic air arrivals.
- 9.5.3 Landing, taxiing, and parking times are included in the event duration based on block speeds and are not explicitly modeled.
- 9.5.4 The duration of the offload activity depends on the aircraft's *offload time*. After the offload time, all cargo is available to continue movements. Alternately, in ELIST-AMP, if MIDAS indicates the aircraft is to be expedited (e.g., no fueling is to be performed), the offload activity duration depends on the aircraft's *expedited time*.
- 9.5.5 All cargo is stored at the airport after it is offloaded from a plane unless the airport is the cargo's final destination in the scenario. (See section 14, Storage, on page 75.) If the scenario parameter, *storage constrains flow*, is true, cargo (except PAX) cannot be offloaded when no storage space is available.
- 9.5.6 All breakbulk, RORO, and container cargo must be documented as it is removed from a plane. (See section 15, Documentation, on page 77.) If the scenario parameter, *documentation constrains movement*, is set to true, documentation capability must be available in order to offload these types of cargo.

- 9.5.7 If the simulation parameter *Constrain Aircraft Loads* is true, ELIST will use its payload rules when loading the cargo in the manifest from the federation. ELIST may not load all cargo in the manifest if the cargo exceeds the ELIST load rules. If *Constrain Aircraft Loads* is false, ELIST will load all of the available cargo.
- 9.5.8 As soon as offloading of the strategic aircraft has been completed, the plane departs (not modeled), and the working space becomes available. No refueling is modeled.
- 9.5.9 Strategic and intratheater air movements (load/unload) use the same airport resources.

9.6 INTRATHEATER AIR MOVEMENT METHODOLOGY

- 9.6.1 Aircraft at a location (APODs) always use *parking MOG*, if it is available, even when empty or not in use.
- 9.6.2 Aircraft require *working MOG* capability in order to be loaded or offloaded. If no working MOG space is available, the plane cannot be loaded or offloaded.
- 9.6.3 Fixed-wing aircraft are not sent to a destination unless a *working MOG* is expected to be available. A schedule of expected arrivals is maintained for each airport; it is based on aircraft currently loading or offloading, aircraft en route to the airport, and scheduled strategic arrivals.
- 9.6.4 Fixed-wing air transport requires an airport at the origin and the destination. An air route exists between any two airports and is always unconstrained. By default, air routes are direct routes (there are no links); however, the route between two airports can be specified to take a different path. (See ROUTES.) The duration of the trip is the route distance divided by the appropriate *block speed* for the distance. Block speeds incorporate take-off, landing, and taxi time, so these are not explicitly modeled. If the distance ≤ 500 nautical miles, *Block Speed 500* is used; if the distance > 500 and $\leq 1,000$ nautical miles, *Block Speed 1,000* is used; otherwise, *Block Speed 1,500* is used.
- 9.6.5 All cargo is stored at the airport after it is offloaded from a plane unless the airport is the cargo's final destination in the scenario. (See section 14, Storage, on page 75.) If the scenario parameter, *storage constrains flow*, is true, cargo (except PAX) cannot be offloaded when no storage space is available.
- 9.6.6 All breakbulk, RORO, and container cargo must be documented as it is removed from a plane. (See section 15, Documentation, on page 77.) If the scenario parameter, *documentation constrains movement*, is true, documentation capability must be available in order to offload these types of cargo.
- 9.6.7 As soon as offloading of an aircraft has been completed, it releases the working space. No refueling is modeled.

9.7 STAR ROUTES

- 9.7.1 STAR routes or channels can be set up as part of a scenario. This activity is modeled as regularly scheduled air transport over a set route.
- 9.7.2 A STAR route in a scenario is a specialized asset pool with the following data:
- An ordered set of airports that makes up the route, including a home node;
 - A set of aircraft which must be of the same type but may have various intervals of availability; the route will begin flying when the first plane is available;
 - A stop duration — the minimum time a plane will spend at each location; and
 - Home-departure frequency — if enough aircraft exist, a plane will depart the home node regularly at this frequency. If not enough planes exist, the frequency will automatically be reduced to one at which regular departures can be made.
- 9.7.3 Each plane flying in a STAR route will start at the home airport and stop at each node in the route in order. At each location, it will first drop off any cargo going to that location and then load anything waiting that fits onto the aircraft. In the current implementation, deliveries are made only to locations between the current location up to and including the home node (i.e., cargo is not carried past the home node).
- 9.7.4 In ELIST-AMP, the flights will continue as long as the aircraft are available and as long as the simulation continues. In ELIST stand-alone, the flights will stop when no cargo is pending for the route, and no future movement requirements exist.
- 9.7.5 Any RLN commodity that can be moved by the route's aircraft type can be moved on the STAR route.

10 WATER TRANSPORTATION

10.1 SHIPS AND SHIP TYPES

10.1.1 Specific individual ships, as well as ship types, are used in ELIST. Ship type attributes are shown in Table 10-1. Ship types have a name and a Line Item Number (LIN); specific ships are identified by a name, a NISC (Naval Intelligence Support Center) and/or Lloyd's number, and a type. Table 10-2 lists the attributes that specific ships require, in addition to the ship type attributes.

TABLE 10-1 Ship Type Attributes

| Attribute | Units ^a |
|----------------------------|--------------------|
| Name | NA |
| LIN | NA |
| Length | ft |
| Beam | ft |
| Draft | ft |
| Capacity | |
| Container | TEU |
| RORO | sqft |
| Breakbulk | st |
| Tanker | cbbl |
| PAX | pax |
| Maximum Cargo Weight | st |
| Rate of March | mph |
| Percent Availability | % |
| Strategic | [true, false] |
| RORO | |
| Onload Rate | vehicle/day |
| Offload Rate | vehicle/day |
| Apron Width Required | ft |
| Number of Cranes (on ship) | crane |
| Maximum Working Cranes | crane |
| Container | |
| Onload Rate | cont/day/crane |
| Offload Rate | cont/day/crane |
| Breakbulk | |
| Onload Rate | st/day/crane |
| Offload Rate | st/day/crane |
| Fuel Consumption | lbs/hr |

^a NA = not applicable; ft = feet; TEU = twenty-foot equivalent unit; sqft = square feet; st = short ton; cbbl = hundreds of barrels; pax = personnel; mph = miles per hour; lbs = pounds; hr = hour.

TABLE 10-2 Additional Ship Attributes

| Attribute | Units |
|-----------|-----------------|
| Lloyds | NA ^a |
| NISC | NA |
| Source | NA |
| Ship Type | NA |

^a NA = not applicable.

10.1.2 Note that throughout this document, the term “ship” is used to refer to any water-going vessel, including ferries and barges.

10.1.3 Ship types are used by ELIST in asset pools for intratheater transportation. Specific ships are used as strategic ships in AMP, and ELIST loads or offloads these ships at theater exit and entry ports.

10.1.4 If *RORO onload rate* and *RORO offload rate* are nonzero, the ship is considered a RORO ship from which RORO cargo can roll on and roll off (no cranes required). In order to roll on and off cargo, a minimum apron width is required for the berth. This width is the *Apron width required*.

10.1.5 *Maximum working cranes* is the number of cranes that can work to load this ship at one time. It is also the maximum number of seaport cranes that will be assigned to this ship when it berths.

10.2 SHIP PAYLOADS

10.2.1 Cargo is only loaded onto ship types that can carry that commodity based on the commodity movement rules.

10.2.2 The amount of cargo that a ship can carry is limited by its capacity attributes for containers, RORO area, breakbulk weight, POL, and PAX. In addition, each ship has a total weight capacity that will not be exceeded.

- The summed weight of all **PAX**, **POL**, **RORO**, **breakbulk**, and **container** cargo is limited by the ship’s *maximum cargo weight*. However, if a vehicle is listed in a commodity’s movement rules, that vehicle can always carry at least one level 4 item, one piece of equipment, or one container of that commodity, regardless of weight. This exception generally would not come into play with ships.

- **PAX** can be loaded up to the amount of the ship's *PAX capacity* as long as the maximum cargo weight is not exceeded. (The weight of one pax is considered to be 0.175 short tons.)
- **POL** commodities can be loaded up to the amount of the ship's *tanker capacity* as long as the *maximum cargo weight* is not exceeded. The weight of the POL is calculated using the conversion factors 4200.0 gal/cbbl, 0.1493 gal/lb, and 2000 lb/st.
- **Containers** can be loaded up to the amount of ship's *container capacity* as long as the *maximum cargo weight* is not exceeded.
- **Breakbulk** cargo can be loaded up to the *breakbulk capacity* as long as the *maximum cargo weight* is not exceeded.
- **RORO** cargo is limited by the ship's RORO area as well as *maximum cargo weight*. The stowage area required by a piece of cargo is calculated as its footprint divided by its commodity's *area stow percent* times 100.

10.2.3 Note that in ELIST-AMP, the payload constraints will be ignored for loading strategic ships if the simulation parameter, *Constrain Ship Loads*, is false.

10.3 PORT DATA

10.3.1 In order for shipping operations to be modeled at a port, it must have one or more berth groups defined for it. Each berth group has an ordered list of berths, which represent a continuous edge of a dock or wharf along which ships can be berthed.

In addition, cranes are required for seaport operations other than roll-on/roll-off and POL loading. Cranes are defined to serve only certain berths. POL operations require available POL connections at a berth.

10.3.2 Personnel resources required for port operations are associated with the port as a whole. These resource capabilities, as well as other port attributes, are listed in Table 10-3.

10.3.3 Ship onload and offload activities are limited to the port's hours of operation. (Note that these hours, just like all dates, represent a global time and are not adjusted by time zone.)

10.3.4 The cargo processing rates for a seaport (as well as the port's berths) are based on a full 24-hr day. If a seaport's hours of operation are less than 24 hours, the processing rates will not be fully attainable. Effective rates can be calculated as the *given rate* \times hours in operation / 24.

10.3.5 The port attribute, *maximum military ships*, limits the number of ships in the simulation that can be berthed anywhere in the port at one time.

TABLE 10-3 Port Attributes

| Attribute | GUI Name | Units ^a |
|---|----------------------------|----------------------|
| Hours of Operation Start | Hours of Operation Start | 0–24 |
| Hours of Operation End | Hours of Operation End | 0–24 |
| Maximum Military Ships | Maximum Military Ships | Ship |
| Personnel rate for offloading breakbulk cargo from ships | Sea BB Offload Personnel | st ^a /day |
| Personnel rate for onloading breakbulk cargo to ships | Sea BB Onload Personnel | st/day |
| Personnel rate for offloading containers from ships | Sea Cont Offload Personnel | cont/day |
| Personnel rate for onloading containers to ships | Sea Cont Onload Personnel | cont/day |
| Personnel rate for offloading RORO cargo from ships | Sea RORO Offload Personnel | vehicle/day |
| Personnel rate for onloading RORO cargo to ships | Sea RORO Onload Personnel | vehicle/day |
| Different use rates for same personnel resources. | | |
| ^a st = short ton; cont = container(s). | | |

10.3.6 All movements of breakbulk, container, or RORO cargo on or off of a ship at any of the port's berths require port personnel. Each personnel rate (e.g., *breakbulk offload rate, personnel*; *breakbulk onload rate, personnel*; *container offload rate, personnel*) can be interpreted as the maximum capability of all port personnel to load the specific type of cargo, assuming that unlimited infrastructure and MHE capabilities are available.

These rates are interdependent such that if one rate is consumed, it consumes the capability from all three rates. For example, a given port has the following capabilities:

- Breakbulk offload rate, personnel: 1,000 st/day,
- Container offload rate, personnel: 200 containers/day, and
- RORO offload rate, personnel: 1,000 vehicles/day.

If, on a given day, 60 containers are offloaded, then 30% of the personnel offload capability at the port is consumed (60/200). In addition, if 500 st of breakbulk cargo are offloaded, an additional 50% of the offload personnel offload capability is consumed

(500/1,000). In effect, this leaves 20% of the personnel offload resources remaining, which could be used to unload 200 st of breakbulk, 40 containers, or 200 vehicles.

10.3.7 Ships and boats within the theater (inland waterway movement) use the same ports and the same on- and offload capabilities as used for strategic movements.

10.4 BERTH GROUP DATA

Berth groups have no attribute data. A berth group consists of one berth or an ordered set of berths that are adjacent and connected but with potentially different attribute values, such as depth. A ship can dock against a single berth or against a set of adjacent berths within a berth group as long as all of the attributes of those berths have appropriate values.

A berth group does have a utilization factor, which initially is always 1 or 100%, but can be changed via a master scenario of events list (MSEL) event such as from AMP. Berth utilization represents the percent of berth group capabilities that are usable at the current simulation time.

10.5 BERTH DATA

10.5.1 Table 10-4 lists the attributes for berths. The entire length of a berth has the same value for each attribute.

10.5.2 To be used in a scenario, a berth must be available. If the value of *berth availability* is “available” or “not available,” that alone determines whether the berth can be used. If the value of *berth availability* is “use default,” the value of the attribute *available military* determines whether that berth can be used.

In addition, a window of availability may be set using the berth’s *from day* and *to day* attributes. (The port’s hours of operation also affect when berth operations occur.)

10.5.3 Ships at this berth must have at least the distance, *ship spacing*, between them.

10.5.4 Berth overhang is a maximum distance that a ship’s length can extend off a berth while still undergoing on- and offload operations. An overhang is only considered for the first and last berths in a group.

10.5.5 In order to handle container and breakbulk cargo, a berth must have one or more cranes assigned to it. These cranes can be used at any location/ship along the berth but can serve only one ship at a time.

10.5.6 Only POL ships (ships that are carrying POL cargo) can berth on berths with 1 or more POL Connections.

TABLE 10-4 Berth Attributes

| Attribute | Units ^a |
|--|---|
| Berth Type (determines default values) | NA |
| Cranes Serving | [list of cranes] |
| Berth Availability | [Use Default, Available, Not Available] |
| Available Military | [Yes, No] |
| From Day | C-day |
| To Day | C-day |
| Berth Length | ft |
| Berth Depth | ft |
| Berth Width | ft |
| Berth Overhang | ft |
| Apron Width | ft |
| Hot Cargo | [Hot, Cold, Both] |
| Ship Spacing | ft |
| POL Connections | # connections |
| Tanker On/Off Per Ship | cbbl/day |

^a NA = not applicable; C = commencement; ft = feet; cbbl = hundreds of barrels.

10.6 CRANE DATA

10.6.1 Table 10-5 lists the attributes for crane objects. Cranes are associated with a seaport and can be assigned to work any number of berths (not berth groups) at the port.

10.6.2 Each crane record can represent one or more cranes using the *quantity* attribute. These cranes will always be assigned to a berth as a group but can work different ships.

10.6.3 To be used in a scenario, a crane must be available. If the value of *crane availability* is “available” or “not available,” that alone determines whether the cranes of that record can be used. If the value of *crane availability* is “use default,” the value of the attribute *available military* determines whether that crane (or cranes) can be used.

10.6.4 Four types of cranes are modeled: container, gantry, mobile, and wharf cranes. The crane type is used to set the default attribute values. In addition, a ship has different preferences for different types of cranes at the time of ship berthing.

TABLE 10-5 Crane Attributes

| Attribute | Units ^a |
|------------------------|---|
| Crane Type | NA |
| Quantity | cranes |
| Berths Served | [list of berths] |
| Crane Availability | [Use Default, Available, Not Available] |
| Available Military | [Yes, No] |
| From Day | C-day |
| To Day | C-day |
| Breakbulk Offload Rate | st/day |
| Breakbulk Onload Rate | st/day |
| Container Offload Rate | cont/day |
| Container Onload Rate | cont/day |

^a NA = not applicable; C = commencement; st = short ton; cont = container(s). Different use rates for same crane resource.

10.6.5 Each crane has four rates associated with it but can carry out only one activity at a time. If a crane used half of its daily capability offloading breakbulk, for instance, only half of the container offload capability would remain for that day.

10.6.6 Incoming unit MHEs (enablers) are assigned to a specific crane record at a port in order to enhance the port's capability. Any of the load rates can be supplemented, as well as the quantity.

10.6.7 RORO cargo can be treated as breakbulk for ship loading and offloading. That is, RORO cargo can be loaded by using cranes (and measured in short tons). This treatment will occur only if rolling on or off is impossible.

10.6.8 A crane is assigned to a ship when it berths, and it remains in use for the duration of the ship's stay at the berth.

10.7 BERTH AND CRANE SELECTION

10.7.1 When a ship arrives at a seaport either to offload or onload cargo, the available berth spaces are rated based on the ship's characteristics and its cargo. The ship is assigned the best space currently available based on those parameters. If no appropriate berth spaces exist, the ship event is put into the simulation error queue. If no appropriate berths are available, the ship waits in the seaport queue. The exception to this approach is a RORO ship with RORO cargo. If a RORO berth exists that allows roll-on and roll-off for this ship, the ship will wait for a RORO berth, even if other possibilities with cranes exist.

10.7.2 When a ship needs to berth, all berth groups with unused space are checked for possible berthing spaces. Each possible space is given a rating. Within a berth group, the first space rated is the end of the berth group. Next, the start of the berth group is rated, and if the berth group is made up of more than one berth, the position at the start of each berth is also checked. If the berth group currently has any ships on berth, the space right after the used length is also rated. Only lengths of the berth group that are unoccupied are evaluated.

The first, best-rated position for each berth group is noted. From among these choices, the space with the best rating at the port is selected for the ship. If multiple spaces have the same best rating, the space on the shortest berth group is chosen.

10.7.3 A ship can only be assigned an available (as specified in the scenario) and unused section of berth that meets its specifications for length, depth, width, apron width (if RORO), and cargo hot/cold classification. In addition, a ship requiring cranes for load operations will not berth if no cranes are available. All of the following conditions must be true for all berths of the potential berth space:

- If not using any overhang, unused contiguous berth group length \geq ship length + berth's *ship spacing* if another ship is berthed adjacent to the space + berth's *ship spacing* if a third ship is berthed on other side of the space.
- If using overhang, the free berth length must be on one of the ends of the berth group, and the berth must have overhang. A ship may only have 25% of its length hanging off of the berth. POL ships may berth entirely on overhang.
- Berth *depth* \geq ship *draft* + 2 ft for all berths used.
- Berth *width* \geq ship *beam* + 2 ft for all berths used.
- If using roll-on/roll-off operations, berth apron width \geq ship *apron width required* (ft).
- If the ship is carrying POL cargo, the berth must have available POL connections.
- If the ship has hot cargo, the berth's hot cargo rating must be *hot* or *both*; if the ship has cold cargo, the berth's rating must be *cold* or *both*; if the ship has both hot and cold cargo, the berth's rating must be *both*. (All unrated cargo is assumed to be cold.)

10.7.4 Berth space rating and selection include crane assignment if cranes are needed. Ratings are integer values of 1 and higher, where 1 is the best rating. The following rules are used for rating a space for offload or onload on the basis of the ship type and cargo. (Onload rates would be used for rating a berth for onload.) Space rating assumes that the berth

space has been dimensionally matched with the ship as described in the previous section. Each space may include more than one berth from the group.

10.7.4.1 If the ship is a RORO ship (ship's RORO onload rate or RORO offload rate is nonzero) and the cargo is at least partially RORO:

- If the minimum berth *apron width* \geq ship *apron width required* the rating is 1. (Minimum berth *apron width* is the narrowest *apron width* of all berths included in the space.)
- If the minimum berth *apron width* $<$ ship *apron width required* and the percent by weight of the RORO cargo $<$ 50%, the rating is 4.
- If the minimum berth *apron width* $<$ ship *apron width required* and the percent by weight of the RORO cargo is $>$ 80%, the rating is 6.
- If the minimum berth *apron width* $<$ ship *apron width required* and the percent by weight of the RORO cargo is between 50% and 80%, the rating is 5.

10.7.4.2 If the ship is a tanker with only POL cargo (and possibly PAX cargo):

- If the highest berth *tanker on off per ship* rate is 0, the rating is 99. (Highest berth *tanker on off per ship* rate is the best rate of all berths included in the space.)
- If the berth has no available POL connections, the rating is 99.
- If the highest berth *tanker on off per ship* rate is greater than GOOD_RATE (100,000 cbbl/day), the rating is 1.
- If the highest berth *tanker on off per ship* rate is less than BAD_RATE (100 cbbl/day), the rating is 5.
- If the highest berth *tanker on off per ship* rate falls between GOOD_RATE and BAD_RATE, the rating is 2, 3, or 4.

10.7.4.3 If the ship has only PAX cargo, the rating is 1.

10.7.4.4 Otherwise, berth rating depends on the available cranes:

- If possible, the maximum number of cranes is assigned to the ship (ship's *max working cranes*).
- In general, cranes are selected in order of preference: container crane, gantry crane, wharf crane, mobile crane, and, finally, a TACS (tactical

auxiliary crane ship) crane, which is a crane on board the ship to be loaded.

- If a ship has any container cargo, at least one crane with container capability must be assigned. If a ship has any breakbulk cargo, at least one crane with breakbulk capability must be assigned. If that is impossible, the space will get the rating of 99.
- If a ship has more than 50% container cargo and a second crane is allowed, a crane with container capability will be preferred.
- For each crane (of the number of desired cranes) that is not available, the rating is increased by 3.
- For each onboard crane assigned, the rating is increased by 1.
- If no cranes are available, and the ship has no shipboard cranes, the rating is 99.

10.8 STRATEGIC SHIP OPERATIONS

- 10.8.1 Strategic ship arrivals require berth space to be offloaded. If no appropriate berth space is available, the ship waits in the seaport queue until space becomes available.
- 10.8.2 The current number of ships berthed must be less than the port's *maximum military ship* in order for an additional ship to be berthed. The ship event will wait in the seaport queue if this is not the case.
- 10.8.3 The activity of moving a ship to a berth and securing it takes the amount of time specified in the simulation parameter, *time to berth*.
- 10.8.4 After a ship berths, all offload manifest cargo is offloaded. The time required for offloading depends on the rates and availability of the assigned cranes and required resources as described in the next section.
- 10.8.5 If the ship has an onload manifest from AMP, the cargo ready at the port will be unloaded as described in the following section. If there are manifest items that have not arrived at the port, the ship may wait for the additional cargo. The simulation parameters, *wait for expected cargo* and *expected cargo load for wait (%)*, define whether a strategic ship will wait at berth for cargo that has not arrived. If manifest items are scheduled to arrive at the port within the wait time, and that cargo is at least the percent of the ship's total load defined by *expected cargo load for wait*, the ship will wait. Otherwise, it will depart as soon as the unloading of ready cargo is completed.

- 10.8.6 If the simulation parameter *Constrain Ship Loads* is true, ELIST will use its payload rules when loading the cargo in the manifest from the federation. ELIST may not load all cargo in the manifest if the cargo exceeds the ELIST load rules. If *constrain ship loads* is false, ELIST will load all of the available cargo.
- 10.8.7 After any load activities are complete, the strategic ship departs, and the berth space becomes available. The time required to move a ship from a berth is specified in the simulation parameter, *time to deberth*.
- 10.8.8 Strategic and intratheater ships use the same seaport resources.

10.9 SHIP ONLOAD AND OFFLOAD ACTIVITIES

- 10.9.1 Loading cargo on a ship or offloading cargo from a ship can only occur during the port's hours of operation.
- 10.9.2 Breakbulk, RORO, and container cargo must be documented as it is loaded onto or off of a ship. (See section 15, Documentation, on page 77.)
- 10.9.3 All cargo is put into storage at the port after it is taken off of a ship, unless the seaport is the cargo's final destination. (See section 14, Storage, on page 75.)
- 10.9.4 If berth group *utilization factor* (which can only be set from AMP or via an MSEL) is less than 1.0, it reduces all of the onload and offload rates at the berth. This utilization factor does not include the rate of PAX unloading or offloading.
- 10.9.5 Cargo is unloaded or offloaded in chunks whose size is determined by the amounts that can be loaded during the simulation parameter *seaport interval*.
- 10.9.6 Loading personnel on or off occurs at the scenario parameter *PAX load to/from ship rate*. PAX loading will occur at the same time that other commodities are loaded.
- 10.9.7 Loading POL commodities on or off occurs at the highest *tanker on/off per ship* rate of all the berths the ship is against (times the utilization factor) that have an available POL connection. POL loading will occur at the same time as other commodities are loaded.
- 10.9.8 Rolling RORO cargo on and off of a RORO ship at a port requires a RORO berth. This is determined by whether the berth *apron width* \geq the ship's *required apron width*. Both the personnel on- or offload capability from the port and the RORO onload or RORO offload capability of the ship are needed to move RORO cargo. The on- and offload rates are reduced if the utilization factor is less than 1.
- 10.9.9 If RORO cargo cannot be rolled on or off because of ship or berth limitations, it can be loaded as if it were breakbulk cargo.

- 10.9.10 Loading breakbulk commodities requires crane capability and port personnel capability. If more than one type of crane is assigned to the ship, breakbulk loading utilizes gantry and wharf cranes first. The on- and offload rates are reduced if the utilization factor is less than 1.
- 10.9.11 In ELIST-AMP, breakbulk cargo may be unloaded or offloaded without cranes as if it were RORO cargo if the manifest from the federation indicates the load rule = 2. This circumstance may occur for small amounts of breakbulk on RORO ships.
- 10.9.12 Loading container commodities requires crane capability and port personnel capability. If more than one type of crane is assigned to the ship, container commodity loading uses container cranes first. The on- and offload rates are reduced if the utilization factor is less than 1.

10.10 WATERWAY AND SHIPPING LANE LINK DATA

- 10.10.1 Waterways and shipping lanes are modeled identically in ELIST. Providing two classifications allows different default attributes and separate display options. Table 10-6 lists the waterway link attributes.

TABLE 10-6 Waterway Link Attributes

| Attribute | Units ^a |
|------------------------|--------------------|
| From Node | [Node] |
| To Node | [Node] |
| Length | mi |
| Waterway Rate | ship/day |
| Waterway Rate of March | mph |
| Available Military | [Yes, No] |

^a mi = miles; mph = miles per hour.

- 10.10.2 Waterway links are modeled as one on which travel can occur in both directions. The numbers of vehicles using the link are recorded separately for forward travel (*from node* toward *to node*) and return travel (*to node* toward *from node*).
- 10.10.3 A link will not be used in any routes for any transport if *available military* is “no.”

10.11 INTRATHEATER SHIP MOVEMENT METHODOLOGY

- 10.11.1 Cargo is assigned a water mode and to vehicles as described in section 6, Asset/Mode Selection, on page 21.
- 10.11.2 Intratheater movement by water requires network route capability, which means that all water routes require links in the network. While links are naturally used to represent rivers, they are also required from port to port through bays and oceans where travel by barge or ship is planned.
- 10.11.3 The travel time for a water movement is calculated by using the route distance and the travel speed, which is the minimum value of the ship speed and the route speed.
- 10.11.4 A ship only takes up berth space while it is being loaded or unloaded. If it is not in use, it is “at the port” but does not require any constrained space (a berth space).
- 10.11.5 When ship transport is planned, cargo accumulates in storage at the port until the *minimum load* of cargo that is appropriate for a ship type is waiting. At that time, if a ship is waiting at the port, it is berthed. If a ship is waiting elsewhere, however, it is sent to the seaport and berthed upon arrival. If no ship is free, the cargo continues to accumulate and wait. If no berth is free, the ship waits in the seaport queue.
- 10.11.6 A minimum load for a ship is calculated as the scenario’s intratheater watercraft *minimum load* (%) \times the applicable ship capacity attribute / 100. If a ship can carry more than one type of cargo, a minimum load for the ship is considered to be a minimum load of any one cargo type. Adequate loads are calculated in the same way by using the scenario’s intratheater watercraft *adequate load* value.
- 10.11.7 Once a minimum load has accumulated, and a ship has been requested, that cargo is committed to travel by the requested ship type. Waiting cargo that has not been committed can still be moved by other modes as assets become available.
- 10.11.8 The activity of moving a ship to a berth and securing it takes the time that has been specified in the scenario parameter, *time to berth*.
- 10.11.9 Once a ship has berthed, unloading to the ship continues until either there is no more cargo waiting at the port or the ship is full. If the ship is full, it will depart. If no cargo remains and the ship is not full but it has at least an adequate load, it will also depart. Otherwise, it will wait a maximum amount of time for additional cargo and then depart. This duration, *max wait for adequate load*, is a scenario intratheater watercraft loading parameter.
- 10.11.10 As cargo is loaded onto a ship, it is removed from storage, and if the cargo is breakbulk, RORO, or containers, it must be documented.
- 10.11.11 After a ship arrives at its destination, it is berthed and offloaded as described earlier.

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11 PIPELINE

11.1 PIPELINE LINK DATA

Table 11-1 lists the pipeline attribute.

TABLE 11-1 Pipeline Attributes

| Attribute | Units ^a |
|--------------------|----------------------|
| From Node | Node or Intersection |
| To Node | Node or Intersection |
| Available Military | [Yes, No] |
| Length | mi |
| Pipeline Rate | cbbl/day |

^a mi = miles; cbbl = hundreds of barrels.

- 11.1.1 Only POL-type cargo commodities with a *pipeline (SELF)* movement rule can be moved by pipeline.
- 11.1.2 The direction of flow is not recorded for pipeline links. Flow in either direction can occur up to the *pipeline rate*.

11.2 PIPELINE METHODOLOGY

- 11.2.1 No assets are needed to move bulk POL via pipeline; only route capability is required.
- 11.2.2 POL enters (and leaves) the pipeline in chunks whose size is determined by the amount that can be moved during the simulation parameter, *pipeline interval* (hours). For example, if a pipeline route's most constraining link has a rate of 24,000 cbbl/day, and the pipeline interval is 2 hours, then every 2 hours, 2,000 cbbl can arrive at the route destination.
- 11.2.3 ELIST 8 assumes that the pipeline is loaded with fuel. POL delivered via pipeline arrives instantaneously, and distance (length) is not a factor.
- 11.2.4 POL requires storage at the destination if it is not the RLN's final destination in the scenario. If storage is required but not available, the POL waits at the destination. (The trip will not be postponed for lack of storage.)

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12 ROTARY WING

12.1 ROTARY WING DATA

Table 12-1 lists the rotary-wing aircraft attributes.

TABLE 12-1 Rotary-Wing Aircraft Attributes

| Attribute | Unit ^a |
|----------------------|-------------------|
| Type | NA |
| LIN | NA |
| PAX Capacity | pax |
| Weight Capacity | st |
| Container Capacity | TEU |
| Onload Time | hr |
| Offload Time | hr |
| Rate of March | mph |
| Percent Availability | % |

^a NA = not applicable; pax = personnel; st = short ton; TEU = twenty foot equivalent unit; hr = hours; mph = miles per hour.

12.2 ROTARY-WING PAYLOADS

12.2.1 The amount of cargo that a helicopter can carry is limited by its attributes: *PAX capacity*, *weight capacity*, and *container capacity*.

- Only one category of cargo will be loaded at a time: PAX, RORO, breakbulk, or container.
- **PAX** can be loaded up to the amount of the vehicle's *PAX capacity*, regardless of any other cargo on the vehicle.
- **POL** commodities are not carried by rotary-wing assets.
- The summed weight of all **RORO**, **breakbulk**, and **container** cargo is limited by the helicopter's *weight capacity*. However, if a vehicle is listed in a commodity's movement rules, that vehicle can always carry at least one level 4 item, one piece of equipment, or one container of that commodity, regardless of weight.

- **Containers** can be loaded up to the amount of vehicle's *container capacity*, but the weight of the loaded containers cannot exceed the *weight capacity* of the vehicle except as noted in the previous bullet.

12.2.2 A helicopter is considered fully loaded and ready to depart if it holds at least an adequate load. If the vehicle is carrying less than an adequate load, it will wait up to a maximum amount of time for additional cargo (with the same destination). If, after waiting, no new cargo is ready at the location, the vehicle will depart.

The theater parameters, rotary-wing aircraft *adequate load* (in percent), and *maximum wait for adequate load* are used to determine loads and wait times for partially loaded vehicles.

12.3 ROTARY-WING MOVEMENT METHODOLOGY

12.3.1 Rotary-wing transportation requires helicopter MOG at both the pick-up and delivery locations. There are no route limitations.

12.3.2 Cargo is assigned a helicopter mode and vehicles as described in section 6, Asset/Mode Selection, on page 21.

12.3.3 Departing helicopters require 1 unit of documentation.

12.3.4 Helicopters travel at their *rate of march*. For the rotary-wing (SELF) movement of unit equipment, the rate of march of a UH-60 is used. (If UH-60 is not a defined rotary-wing vehicle, ELIST will use rate of march of the first rotary-wing aircraft in the scenario.)

12.3.5 Arriving helicopters require 1 unit of documentation, storage for RLN cargo, and helicopter MOG in order to offload.

12.3.6 Offload of cargo takes the vehicle's *offload time*. Onload of cargo takes *onload time*.

13 ROUTES

13.1 GENERAL

- 13.1.1 In ELIST, all simulated movements between two locations require a route. Road, rail, water, and pipeline routes are constrained. Fixed-wing and rotary-wing air routes are unconstrained. Generally, ELIST will automatically find and use appropriate routes. If a scenario requires the use of particular paths or must prevent the use of some paths, this can be specified manually.
- 13.1.2 Automatic route finding will occur when a scenario is loaded, during initialization, and during the simulation. All routes that have been found, whether used or not, can be seen in the routes tables after a simulation. *Infeasible* routes are routes that have been searched for but do not exist or are not usable.
- 13.1.3 Routes only exist within a theater and never pass out of that theater.
- 13.1.4 Manually defined routes have a *source* value of *user*. Only *user* routes (and any other routes with the same origin and destination as a user route) are saved in the scenario definition files.

13.2 SINGLE-MODE ROUTES

- 13.2.1 Road (and line haul), rail, waterway, and pipeline routes consist of a set of connecting links of the proper mode. Air and helicopter routes have an origin and a destination but no links. Fixed-wing air routes can only exist between two airports. Water routes can only exist between two seaports.
- 13.2.2 Road and rail links and as well as nodes have limits to the size of cargo that can traverse them. Road and rail routes are assigned limits derived from the most constraining limits of all of their links and nodes. Cargo with dimensions (level-4 TPFDD) must meet the height, weight, and width limits of any route it uses.
- 13.2.3 ELIST searches for all routes needed on the basis of the movement requirements at the time the scenario is loaded. A route of each mode is found (or is found to be infeasible) for each origin-destination pair. By default, ELIST finds the shortest-distance routes. Alternately, a fastest or greatest capacity search can be performed.
- 13.2.4 All road and rail routes found must meet the simulation parameters for *default road/rail route limits* for height, width, weight, and MLC. Both nodes and links along the route must meet these criteria.

- 13.2.5 Additional routes will be found as needed during the simulation execution. New routes will be searched for if the existing routes are impossible for a movement — not when the existing routes are busy.
- 13.2.6 Multiple routes of the same mode can exist between two nodes. If a road or rail route is needed for an oversized piece of cargo that does not fit on the default route, ELIST will look for an additional route. Routes can also be selected and saved manually. Each route is assigned a priority. The route with the priority 1 is designated as the primary route and will be used first.
- 13.2.7 A road route can be designated HET, military self deployed (convoy), military direct delivery, or commercial direct delivery. If a route between two nodes is so designated, any movement of that type must use that route. Only one route of each type can exist between two nodes.

13.3 AIR ROUTES

- 13.3.1 Fixed-wing and rotary-wing routes do not have any links and by default exist between any two airports. The length of an air route is its calculated great circle distance.
- 13.3.2 If the direct air route is not the desired route, a different route can be manually created. The new route will be used for all air travel between that origin and destination.

13.4 MULTIMODE ROUTES

- 13.4.1 If the simulation parameter *multi-mode routing* is *enabled*, ELIST will simulate a required movement by using multiple legs of travel of different modes if it determines that is the fastest or only way to satisfy the requirement. In order to make a multimode move, there must be a multimode route defined.
- 13.4.2 Some multimode routes will be defined automatically. The types of multimode routes that will automatically be found are air-road combinations and water-road-rail combinations. A specific route with any other combination of modes must be manually defined.
- 13.4.3 ELIST uses a shortest-time algorithm to find multimode routes. The time for each link is based on its attributes of distance and rate of march. Transitions from one mode to another can only occur at nodes that have the attribute *available military = yes*. Predetermined times are used for a mode transition, both in route finding and in route selection during the simulation.
- 13.4.4 When a multimode movement is simulated, the actual activity times for onload and offload are used — not these fixed transition times.

13.4.5 Table 13-1 shows the mode-to-mode transition times in hours used for route finding and for route selection during the simulation. Certain mode combinations are discouraged by using an artificially large transition time.

TABLE 13-1 Multi-mode Route Transition Hours

| From Mode | To Mode | | | | | |
|-----------|---------|-------|-------|----------|-------|------|
| | Road | Rail | Water | Pipeline | Air | Helo |
| Road | 0.0 | 3.25 | 6.0 | 2.0 | 5.4 | 3.0 |
| Rail | 3.25 | 0.0 | 5.25 | 2.25 | 94.65 | 3.25 |
| Water | 5.0 | 4.25 | 0.0 | 4.0 | 96.4 | 95.0 |
| Pipeline | 2.0 | 2.25 | 5.0 | 0.0 | 94.4 | 2.0 |
| Air | 4.74 | 94.74 | 96.7 | 93.7 | 0.0 | 94.7 |
| Helo | 3.0 | 93.25 | 96.0 | 92.0 | 95.4 | 0.0 |

13.4.6 ELIST searches for multimode routes whenever it searches for single-mode routes.

13.5 ALTERNATE NODE ROUTES

13.5.1 Alternate node routes are multimode routes that make use of hub locations that are pre-specified in the scenario and associated with movement requirement origins and destinations. Generally, there would be a short road movement to the alternate node, where a mode transition to a longer air, water, or rail leg would take place, either to the destination or to an alternate node of the destination.

13.5.2 If the simulation parameter, *alternate node routing is enabled* and alternate nodes are defined, ELIST will use alternate node routes. **Alternate node routes will only be used in cases where no single mode or multimode route is feasible.**

13.5.3 An alternate node route makes use of an alternate node defined for the origin of a required movement and/or an alternate node defined for the destination of the movement. If more than one possible multimode route exists using the alternate nodes, ELIST will use the one it expects to be the fastest.

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14 STORAGE

14.1 NODE ATTRIBUTES

Cargo awaiting further movement or undergoing a delay must be stored. Attributes defined under Point of Interest provide the amounts of storage space available at a node. Breakbulk, RORO, and container cargo all use the *equipment storage* area. Personnel use the *PAX storage*, and POL cargo uses *POL storage*.

14.2 SCENARIO ATTRIBUTE

The simulation parameter, *storage constrains flow*, determines whether the limited amounts of equipment storage and POL storage can actually constrain movement to and at a node, or whether the amounts “used” will be recorded only. PAX “storage” never constrains movement, but the amount of en route people at a location over time is recorded, including any overflow.

14.3 USE IN SIMULATION

14.3.1 If storage constrains flow:

- When all of the storage area at a node is in use, nothing else can be offloaded in that area (from any asset type, including ship, truck, etc.).
- If a line-haul tractor arrives with a loaded trailer and a trailer is in storage awaiting pickup, the trailers will be swapped without requiring storage area for both trailers. (Currently, trailers do not require storage; Not Implemented.)
- Loaded tractor trailers participating in a line haul will not move to a node where storage is full but will wait at the origin (of the required movement) until storage space is available (unless a trailer is waiting to return) (Not Implemented).
- If vehicles are backed up to some level outside of a node (because of the lack of available storage, documentation, or offload resources), no transport assets are assigned to trips going to that destination. Cargo waits at origins, and assets are used for other destinations.

14.3.2 Loaded vehicles waiting to depart do not use storage. Empty truck and trailer assets do not use storage. RLN cargo or personnel at its final destination does not use storage.

- 14.3.3 Equipment storage is measured by area (in square feet). The effective storage area is calculated by the node's *equipment storage* (area in square feet) \times *storage utilization factor* / 100. The *storage utilization factor* is a scenario parameter with a default of 60%.
- 14.3.4 Containers can be stacked up to the *container stacking height* of the node. Storage consumed for containers is $\text{container sqft} / \text{container stacking height}$.
- 14.3.5 When cargo is loaded onto a vehicle, it is removed from the storage area.

15 DOCUMENTATION

15.1 NODE ATTRIBUTE

The documentation rate at a node is the amount of equipment and supplies at that location that can be officially documented as having been “transferred.” Documentation is expressed in terms of number of vehicles.

15.2 SCENARIO ATTRIBUTE

The scenario parameter, *documentation constrains movement*, determines whether the limited amount of documentation “resources” will actually constrain movement to and at a node, or whether the number of transfers will be recorded only.

15.3 USE IN SIMULATION

15.3.1 Each time one of the following activities is performed, it must be documented:

- Onload to or offload from a strategic platform, and
- Arrival or departure of an intratheater vehicle carrying RLN cargo.

15.3.2 A typical cargo documentation team can work 750 vehicles per day.

15.3.3 The documentation for each type of movement is tracked as follows:

- Loading to or from a strategic asset is recorded in vehicles or vehicle equivalents based on the commodity load category for breakbulk, RORO, and container cargo. Personnel and POL are not documented.
- For road and rail intratheater movements of RLN items, documentation is recorded in vehicles or in vehicle equivalents if no assets are being used. Personnel and POL are not documented.
- For water or air intratheater movements of RLN items, documentation is recorded in vehicle equivalents of the cargo (not the asset).
- Assets moving without cargo are not documented.

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16 NONMOVEMENT RLN REQUIREMENTS

16.1 ARRIVING ENABLERS

- 16.1.1 An enabler is a component of an RLN that is used after its arrival in the theater to enhance the capability of one or more network resources to assist in the movement or loading of other cargo.
- 16.1.2 The resources affected must be located at the theater destination of the RLN.
- 16.1.3 Only RLNs in the scenario having a UTC identified as an “enabler UTC” can become arriving assets. These UTCs are defined in the reference data, UTC Enablers. This data also includes the resource type(s) and capability associated with the UTC. The resource(s) and capability amount can be modified in the scenario for specific RLNs.
- 16.1.4 When the RLN closes at its scenario destination, the enabler activates and the capabilities of the resources are increased, generally for the duration of the scenario.
- 16.1.5 If an RLN with arriving enablers is redeployed (see ETPFDD, section 2.1.4), their capabilities will be removed at that time.

16.2 ARRIVING ASSETS

- 16.2.1 An arriving asset is a component of an RLN that is used after its arrival to assist in the transport of other items. It has a vehicle type and designated asset pool in the scenario.
- 16.2.2 Only RLNs in the scenario having a UTC identified as an “arriving asset UTC” can become arriving assets. These UTCs are defined in the reference data, UTC Vehicles. These data include the vehicle type and number of vehicles associated with the UTC. The number of vehicles can be modified in the scenario for a specific RLN.
- 16.2.3 After completing their last required movement, arriving assets become the number of vehicles assigned in the scenario. If the asset type is individual capability, the vehicles become available at their current location (the scenario destination of the RLN). Vehicles that become available outside of the area of operation for the asset pool will immediately travel to the pool’s home.
- 16.2.4 The vehicle can become active at its destination for a time specified by one of these options:
- From the time of arrival for the remainder of the simulation (*when arrived*),
 - From the time of arrival for a certain duration (*duration*),

- At a specific time until another time or for the remainder of the simulation (*window*), or
- Not available to simulation (*tactical*).

16.2.5 If an RLN with arriving assets is redeployed (see ETPFDD, section 2.1.4) while its vehicles are still active, the vehicles will be disabled at that time (or at the end of their current activity).

16.3 MARRY-UP AND ASSEMBLY REQUIREMENTS

16.3.1 A marry-up or assembly requirement can be specified for a group of RLNs (including split RLNs) that are identified in the ETPFDD with a common parent in the unit hierarchy.

16.3.2 A marry-up activity is specified for a parent RLN by location type (i.e., staging area [SA]). All components of the RLN with movements to the given location type are included in a marry-up activity. More than one marry-up may occur for a single parent RLN if some of its components have different locations for the marry location type. For example, some units may have the SA at node A, and some may have node B as the SA. In this case, if marry-up is required at the SA, the units going to node A will marry there, and the units going to node B will perform an independent marry-up at node B.

16.3.3 The marry-up activity can be specified to occur either before or after the optional delay at the node.

16.3.4 During marry-up, personnel and cargo wait at the location until the *percent for delivery/marry/assembly* of the total personnel and cargo arrives at the location. These components then continue with their remaining movement requirements. The *percent for delivery/marry/assembly* is a simulation parameter.

16.3.5 If PAX are involved in a marry-up activity, following completion of that activity, these personnel do not require external transportation assets. It is assumed that they are carried by organic transport (i.e., via their own equipment).

17 MASTER SCENARIO OF EVENTS LIST (MSEL)

- 17.1.1 Activities modeled in ELIST not specific to RLNs but needed in the scenario may be included in the MSEL.
- 17.1.2 An MSEL event changes the capability of one or more resources on a certain day. The event may also specify an end day on which the change in capability will be reversed. For instance, an MSEL event can reduce a road rate by 75% from day 13 to day 20.
- 17.1.3 In addition to being defined in the scenario, an MSEL event may also be passed to ELIST-AMP from the federation.
- 17.1.4 An event can apply to one or more network objects of the same type — including nodes, links, ramps, berths, and cranes.
- 17.1.5 The capability of the resource can be changed by a delta amount, multiplied by a factor, or set to a specific value. At the end time, the amount of change to the capability is reversed. For example, if a capability is multiplied by 2 and goes from 10 st/hr to 20 st/hr, when the end time occurs, 10 st/hr will be subtracted, regardless of the total capability of the resource at that time.

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