Development of a Computer Simulation Model for the Seaborne Mobile Logistic System (SMLS) at the Amphibious Task Unit/Marine Amphibious Unit (ATU/MAU) Level   Report 4114

NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

Bethesda, Md. 20034

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Computation and Mathematics Department

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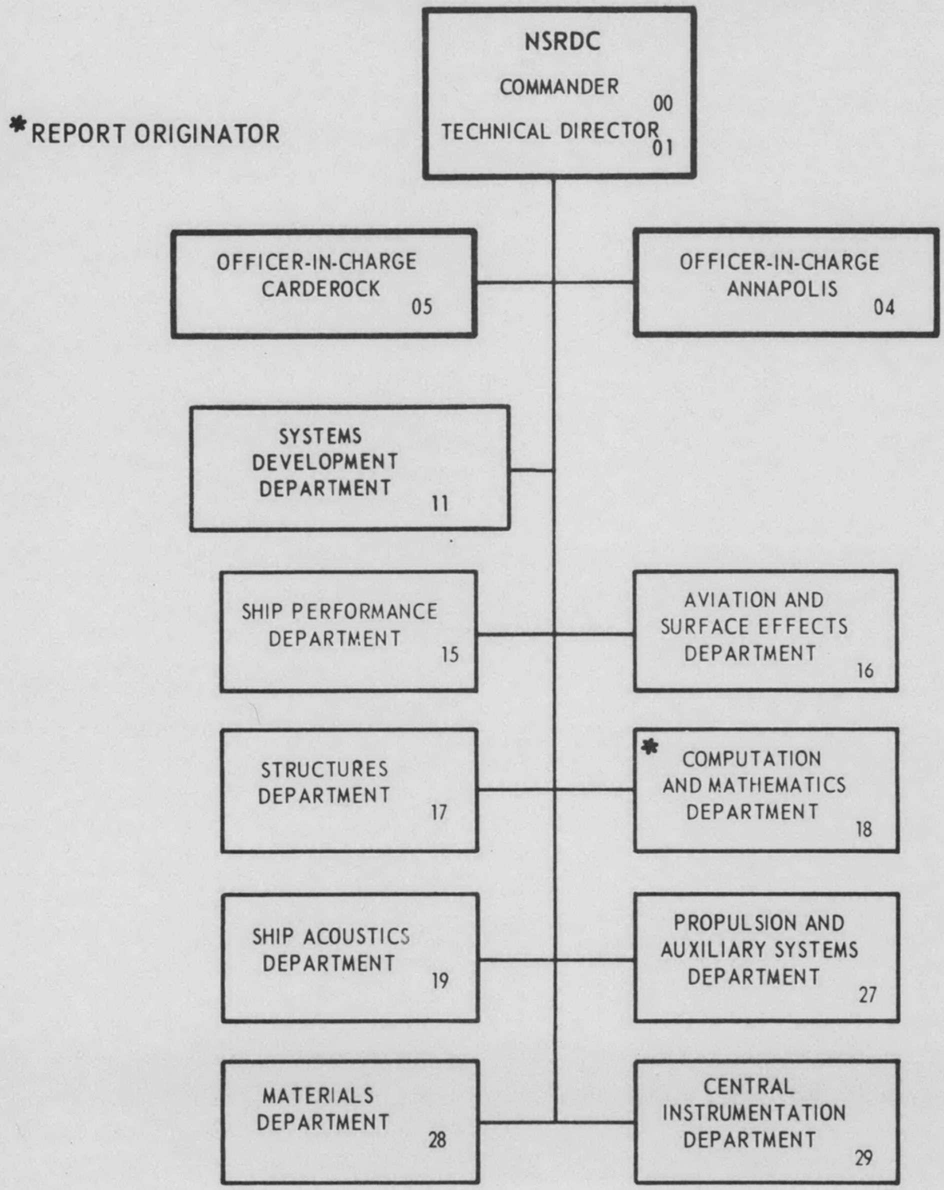

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A computer simulation model has been developed for the Seaborne Mobile Logistic System (SMLS) at the Amphibious Task Unit/Marine Amphibious Unit (ATU/MAU) level to permit evaluation of the concept. This interactive simulation model permits simultaneous evaluation of all major subsystems of SMLS. System procedures, facilities, equipment, and designs may be varied to evaluate the effects of such changes on performance of the total system in terms of a series of Measures of Effectiveness (MOE's) developed for this

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) purpose. The model is written in the simulation language TRANSIM. This report contains a description of the modeling process, the model logic flow, the input/output parameters, and the measures of effectiveness used.

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1. INTRODUCTION

The Seaborne Mobile Logistic System (SMLS) is an evolving concept for providing combat service support to a Marine Landing Force from the ships of an Amphibious Task Force which remains offshore during Landing Force operations. The SMLS concept retains the logistic support system aboard the ships and provides the necessary logistic support from the ships directly to the Landing Force elements ashore. In order to reduce the establishment of facilities ashore, SMLS makes maximum use of ship-based facilities but retains the capability to transfer the entire logistic support system ashore should circumstances dictate.

SMLS is designed to be used primarily by the smaller amphibious forces, especially an Amphibious Task Unit/Marine Amphibious Unit (ATU/MAU). SMLS will be used in crisis-control situations and in sub-theater low- and mid-intensity conflicts which are not accompanied by a significant naval threat. The SMLS Second Interim Report[1] gives a complete description of the SMLS concept.

Once operational concepts, procedures, and techniques within SMLS have been established, test and evaluation of the system may be accomplished through operational exercises or through simulated war games on the Navy Electronic Warfare Simulator (NEWS) at the Naval War College. However, these empirical methods require significant time to complete each test case, are restricted by availability of facilities, present the output in a form that requires additional analysis, and are costly in man hours and dollars. In addition, orderly control over procedure is difficult to maintain and the sequence of actions is difficult to evaluate quantitatively.

1. CNO (OP-323/CMC (A04R-bls-2) Joint Letter of 11 Oct 1973, Subj: Second Interim Report, Seaborne Mobile Logistic System (SMLS), Enclosure (1) Part I of the Second Interim Report of Refined ATU/MAU and Interim ATG/MAB Seaborne Mobile Logistic System (SMLS).

Therefore, an analytical method was needed which would alleviate these problems and permit more economical and efficient analysis of SMLS. The simulation model represents an excellent vehicle for generating analytical representations of amphibious exercises and testing the SMLS concept. In the original SMLS Study Plan[2], one element of the Naval Ship Research and Development Center (NSRDC) support to the Marine Corps Development and Education Command (MCDEC) consisted of developing a computer simulation model for SMLS. This simulation model was to be interactive to permit the simultaneous evaluation of all major subsystems (e.g., supply, medical, maintenance, transportation) of SMLS operating together as a totally integrated system, taking into account the complex subsystem interactions and interrelations. The model was constructed according to this requirement and has been used to optimize SMLS procedures.

The SMLS computer simulation model provides the following capabilities:

- A means to test policies and procedures as a supplement to fleet exercises.
- A means to study the interaction of subsystems within the SMLS concept.
- A means to modify and revise specified subsystems as desired by experts in that particular area, and to evaluate the effects of these changes on overall system performance
- A means to evaluate various SMLS configurations at low and medium levels of conflict.

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2. CNO/CMC ltr NAMAF/jin, ser 213P37 of 17 Nov 1970, Subj: Study Plan for the Seaborne Mobile Logistic System (SMLS) Task of the NAMAF Study; forwarding of; with enclosure (1), Study Plan for the SMLS task of NAMAF.

Figure 1 illustrates the methodology used in the SMLS model analysis. Various mission scenarios, logistic requirements, and SMLS resources are specified as input. Data which are dependent on mission scenario include troop lists, equipment lists, combat tempo, mission duration, ship-to-shore distance, and ship-to-battalion distance. The analyst uses the simulation model to test the system and, by comparing system performance with criteria of adequacy for each subsystem, to indicate problem areas which need detailed study. The appropriate subsystem coordinator can then suggest modifications, revisions in procedures and organization, or reallocation of resources, to obtain an improvement. These changes can then be incorporated into the simulation model and their effect on the overall system determined.

The ATU/MAU level model is the first in a series of simulation models developed for the SMLS concept. The results of analysis using the ATU/MAU model are presented in the SMLS Final Draft Report.[3] The second model developed was for the Amphibious Task Group/Marine Amphibious Brigade (ATG/MAB)[4] level of operation. The results of analysis using the ATG/MAB model are presented in the ATG/MAB analysis report.[5]

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3. Technical Director, SMLS Study, ltr D 050-41 FDMJr:jmn of 18 July 1974, Subj: Seaborne Mobile Logistic System (SMLS) Study; with Enclosure (2), Volume II Amphibious Task Unit/Marine Amphibious Unit (ATU/MAU) Analysis.

4. Hubai, P. and Fuller, J., "Development of a Computer Simulation Model for the Seaborne Mobile Logistic System (SMLS) at the Amphibious Task Group/Marine Amphibious Brigade (ATG/MAB) Level," NSRDC Report 4472 Sept 1974.

5. Hubai, P., and Fuller, J., "Analysis of Computer Simulation Results for the Seaborne Mobile Logistic System (SMLS) Concept Operating at the Amphibious Task Group/Marine Amphibious Brigade (ATG/MAB) Force Level," NSRDC Report 4473 (in review).

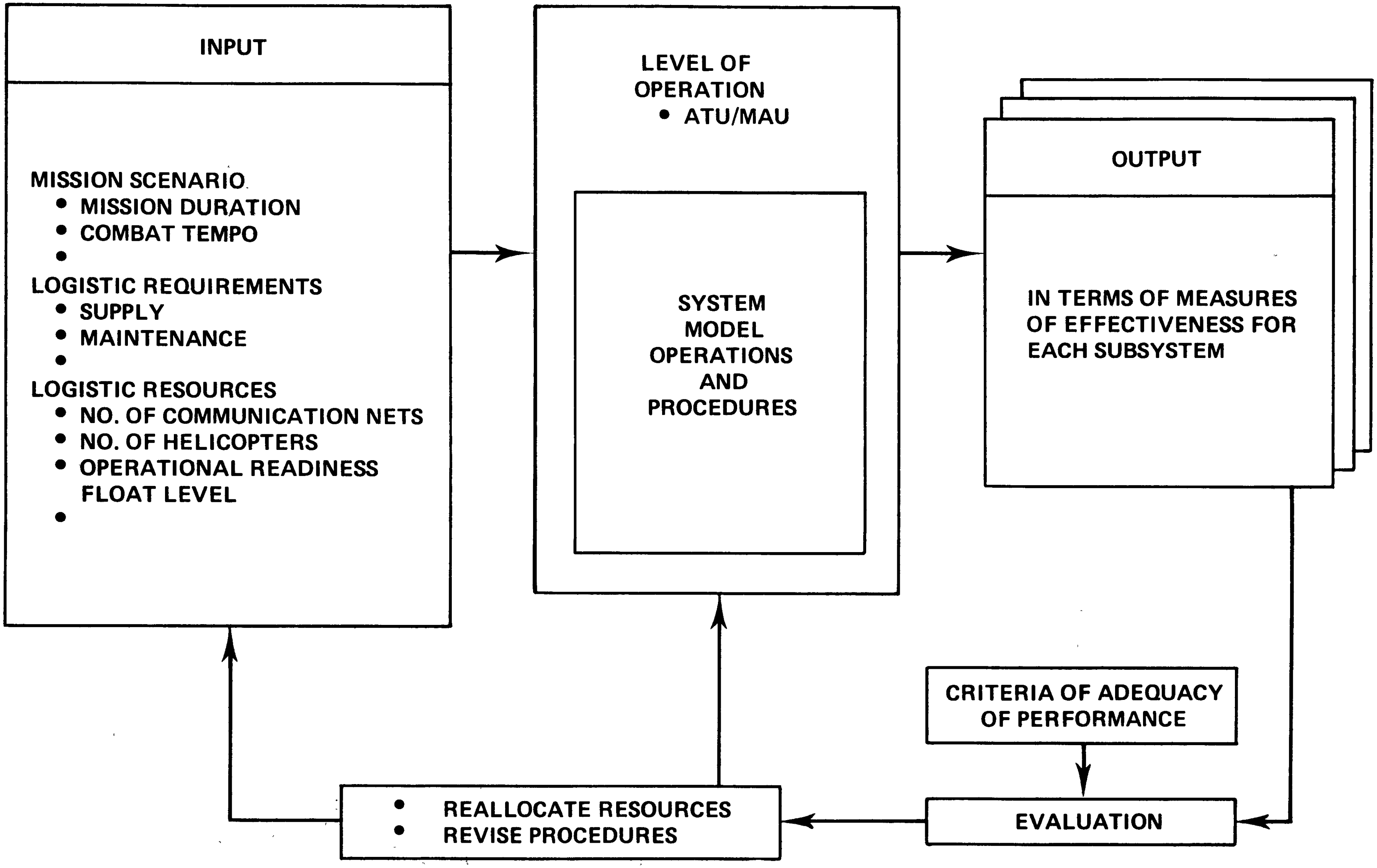

Figure 1 — SMLS Evaluation Process Using Computer Simulation

The present report describes the logic of the ATU/MAU level simulation model. Its purpose is to provide an introduction to the ATU/MAU analysis report,[3] to provide an understanding of the ATU/MAU level model, and to provide an understanding of the SMLS concept as modeled at the ATU/MAU level of operation. This report was not designed to include a user's instruction section due to the limited nature of the model's application, the difficulties encountered with the TRANSIM methodology by analysts not familiar with TRANSIM, and the current plans to discontinue use of the model when the analysis is completed unless otherwise instructed by the CNO/CMC sponsors.

2. METHODOLOGY

The SMLS simulation model was developed using TRANSIM,[6] the general-purpose simulator developed by the University of California at Los Angeles. TRANSIM is a Monte Carlo-type simulator (i.e., it accounts for random variability of a system's performance by sampling data from pre-assigned probability distributions) which allows realistic modeling of real-life problem situations. The TRANSIM simulation methodology permits analysis of individual components (e.g., supply or maintenance subsystems) of a system as parts of a total or integrated system (SMLS), taking into account complex system interrelationships and interactions. System procedures, facilities, equipment, and designs may be varied to evaluate the effects of such changes on the total system.

The TRANSIM approach defines the system to be modeled in terms of traffic units flowing through operating elements. The standard computer program of TRANSIM is not modified from one problem to another; rather, the system is modeled in basic building blocks of operating elements and traffic units. An operating element may be a ship, a coordination center, a communications network, or any other component of the system through which traffic units flow. A traffic unit may be a ship, a logistic request, equipment, or any other item which passes between operating elements. TRANSIM also defines the rules which govern the flow, the changes or traffic unit conversions which the traffic units undergo, and the service times which the traffic units experience. A service time is the period of time required for an operating element to perform its service or function for a traffic unit.

In order to model the system using the TRANSIM approach, the boundaries of the system must first be determined. The boundaries set the limit of the problem to be analyzed. The Amphibious Objective Area (AOA) sets the boundaries in the SMLS simulation model, but these

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6. "TRANSIM IV - User's Manual", University of California at Los Angeles, Report 7168, Dec 1971 (U).

boundaries could have been extended to include outside bases or CONUS. Within the system boundaries, the proper level of detail for describing the system must be chosen. This decision has far-reaching consequences in the requirement for input data, the usefulness of the simulation output, the amount of computer capacity required, and the cost of the simulation analysis.

The logic flow for the system, within the boundaries and at the chosen level of detail, is then defined in standard TRANSIM data forms. These data forms include the following information: the physical plant (i.e., the operating elements which compose the system), system traffic (i.e., traffic units and traffic unit conversions), system operating rules, and service times to perform the functions. The system operating rules include the operating schedules (specify when the facility is "open for business"), the work schedules (specify when manpower is available), and the routing rules which direct traffic units between operating elements.

When the input data are complete, they are combined with the standard TRANSIM program for the simulation of the system. The TRANSIM simulator cycles through a single program routine which at different times during the simulation represents the operation of each of the system's operating elements. Data on the characteristics of operating elements are stored in the computer core memory during the simulation run; information on traffic units is held outside the computer core memory until the traffic unit is scheduled to arrive in the system. The amount of computer core required reaches a maximum when the number of traffic units reaches a peak and does not depend on the total amount of traffic processed over the entire period.

The calendar of events controls the simulation. An event is defined as any change of state of the system; for example, a traffic unit completes a service time at an operating element. The calendar of events, a chronological listing of scheduled events, designates when and where each event will occur and identifies the traffic unit involved in the event. It uses an event-oriented clock which is incremented in a single step to the time of the next chronological event.

The TRANSIM standard program provides the output data requested by the analyst in the input data forms. The output can include a complete chronological record of all events occurring during the simulation or it may be in the form of summary statistics which give the number of traffic units at an operating element during the simulation period or which give the times traffic units remain at specific operating elements. Summary reports also provide maximum, minimum, and average values of requested parameters during the report period, as well as the frequency distribution over the report period.

3. MODEL DESCRIPTION AND LOGIC FLOW

The SMLS Simulation Model is concerned with the five areas of operation which compose the SMLS:

- Communications
- Medical/Dental
- Supply
- Maintenance
- Transportation

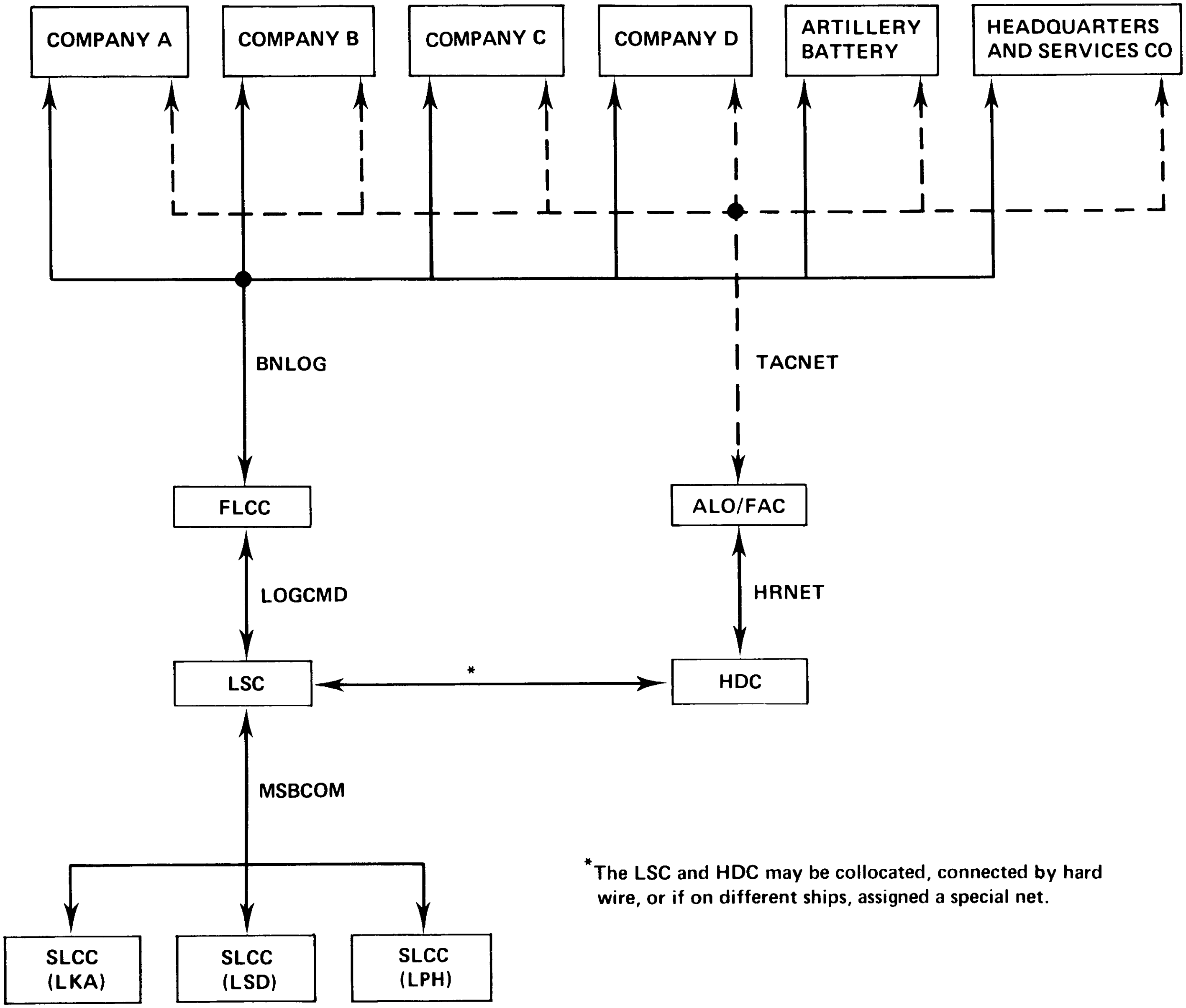
The following paragraphs describe how each subsystem has been modeled in the simulation model.

3.1 COMMUNICATIONS SUBSYSTEM

Five communication networks are currently incorporated into the SMLS simulation model. Three are SMLS logistics nets (BNLOG, LOGCMD, MSBCOM) and two are operational nets (TACNET, HRNET). For the communications networks to function effectively, the priority of a logistic message must be specified. In the simulation model, messages are transmitted in the following priority:

- Urgent medical
- Urgent supply
- Urgent maintenance
- Routine medical
- Routine supply
- Routine maintenance

A description of each communication net follows and Figure 2 shows the communication flow diagram.



*The LSC and HDC may be collocated, connected by hard wire, or if on different ships, assigned a special net.

Figure 2 – Simulation Model Communication Networks

3.1.1 Battalion Logistic Net (BNLOG)

The BNLOG provides communication between the units in the field and the Forward Logistic Coordination Center (FLCC). This is an open net; i.e., the first transmission on the net can complete its message. The simulation model selects the top priority message from each user, and from these it randomly selects one message for the next transmission.

3.1.2 Logistic Command Net (LOGCMD)

The LOGCMD provides communication between the FLCC and the Logistic Support Center (LSC). Since messages are transmitted between only two points, Monte Carlo techniques are not needed for assignment. When the LOGCMD is available, the highest priority message awaiting this net is selected for transmission. When more than one message of a given priority is awaiting transmission, the message which has been longest in the queue is chosen first.

3.1.3 Mobile Seabase Common Net (MSBCOM)

The MSBCOM provides communications between the LSC and the various Ship Logistic Coordination Centers (SLCC's) within the seabase. Since this net serves more than two locations, Monte Carlo methods are used for assignment. Selection of the next message for transmission on this net is handled in the same manner as for the BNLOG.

3.1.4 Tactical Communications Net (TACNET)

The TACNET provides communications between the units in the field and the Air Liaison Officer/Forward Air Controller (ALO/FAC) at Battalion Headquarters. For SMLS purposes, the only messages transmitted over this net are medical requests from the units. Message selection is based on priority as in the LOGCMD.

3.1.5 Helicopter Request Net (HRNET)

The HRNET provides communications between the ALO/FAC at Battalion Headquarters and the Helicopter Direction Center (HDC). The procedures of this net are the same as those of the TACNET.

3.2 MEDICAL SUBSYSTEM

Medical requests, including those resulting from dental causes, are introduced probabilistically into the model at the unit level and distributed over the day by a bi-modal normal distribution to reflect two peak periods of conflict each day. Fifty percent of the requests are assigned an urgent priority and the remainder are assigned a routine priority. The number of casualties per request is assigned to the request from a probability distribution. Each casualty of the request is then assigned the weight and volume requirements it will impose on the evacuating helicopter. All the weight and volume requirements are then consolidated with the medical request into a medical transportation request to evacuate the casualties. The destination of the medical transportation request is determined from a probability distribution determined from the characteristics of the casualty receiving ships of the task force. The medical transportation request is assigned a service time* which represents processing time for the medical transportation request at the unit level. When this service time is over, the casualties are moved to the evacuation area and the medical transportation request is ready to be passed on via the TACNET to ALO/FAC and then via the HRNET to the HDC.

When a medical transportation request arrives at the TACNET, it is assigned a service time representing transmission time on the TACNET. When this service time is over, the request is forwarded to the ALO/FAC. At the ALO/FAC, the request is assigned a service time for processing.

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*Service time assignment may be deterministic or stochastic.

When this time is over, the request is forwarded to the HRNET where it is assigned a service time for transmission on the HRNET. The request is then forwarded to the HDC.

The medical transportation request is held at the HDC until it is assigned to a helicopter. The length of time it is held is determined in the transportation subsystem (see Section 3.5) and is dependent on the priority of the request and the availability of helicopters. When a helicopter is assigned, it is assigned a service time for transit to the casualty site. A service time is assigned to represent the time required to load the casualties. The loaded helicopter proceeds to the designated casualty receiving ship, with an assigned service time for transit to the ship. The helicopter lands at the ship when deck space is available and is assigned a service time for unloading the casualties. The casualties are then taken to the casualty treatment area. The treatment of casualties is not simulated in the model.

Figure 3 shows the Medical subsystem flow diagram.

3.3 SUPPLY SUBSYSTEM

Supply requests are generated by priority at the unit level. Each request contains information on supply class, requestor, type, and quantity. The number of requests per day may be deterministic or stochastic, depending on the number of troops ashore, the combat tempo, and the priority of the request. Each request is assigned a service time for processing at the unit level. Urgent requests are forwarded via the BNLOG net to the FLCC as soon as the processing time ends. Routine supply requests are held until 2100 hours daily, at which time all routine requests at each unit are consolidated into a single request and forwarded to the BNLOG net.

At the BNLOG net the request is assigned a service time for transmission. The request is then forwarded to the FLCC where it is held in a queue until the FLCC can process the request. It is assumed that only one supply request can be processed by the FLCC at a time, all urgent requests before routine requests. When the request can be processed by

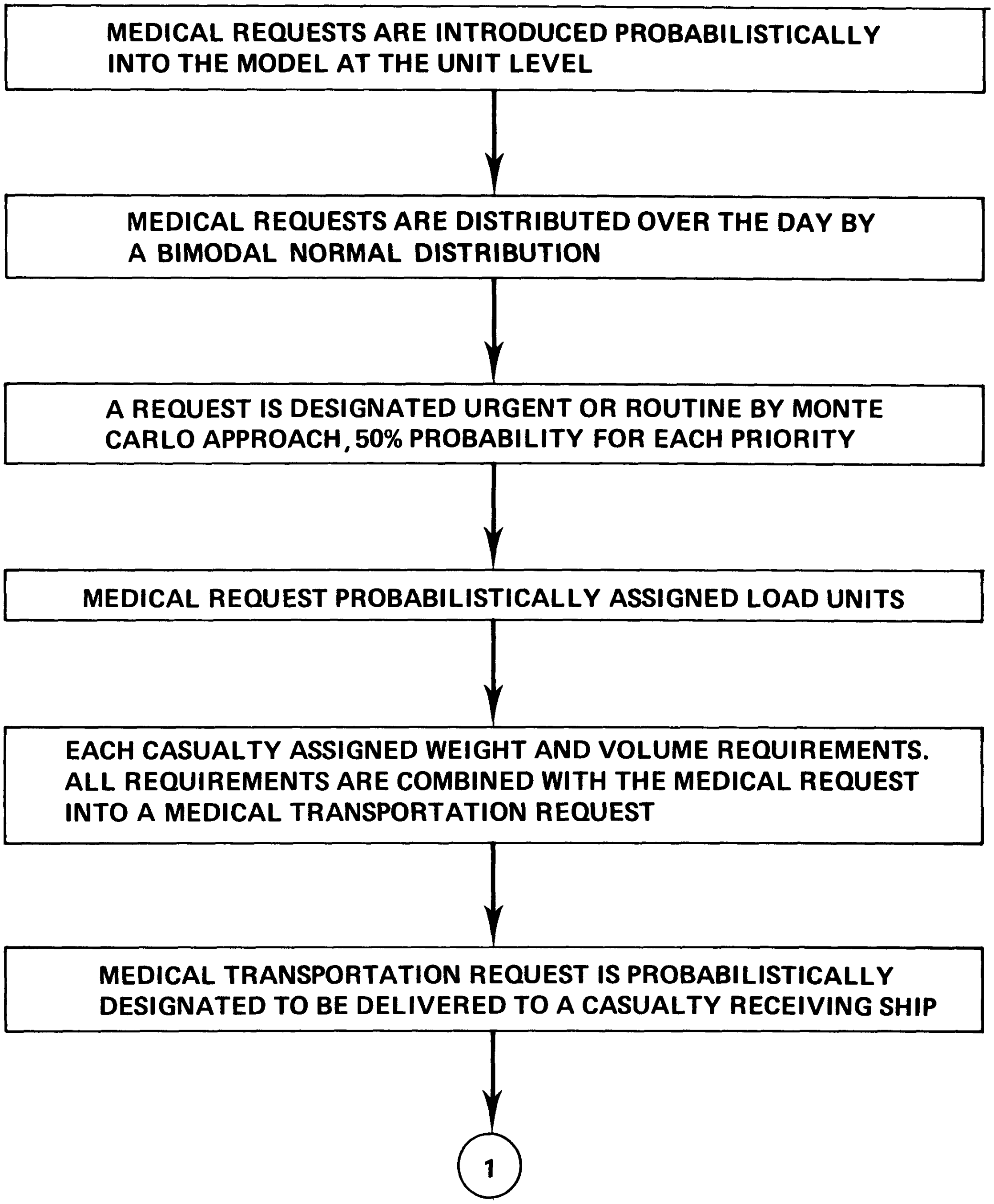


Figure 3 – Medical Subsystem Flow Diagram

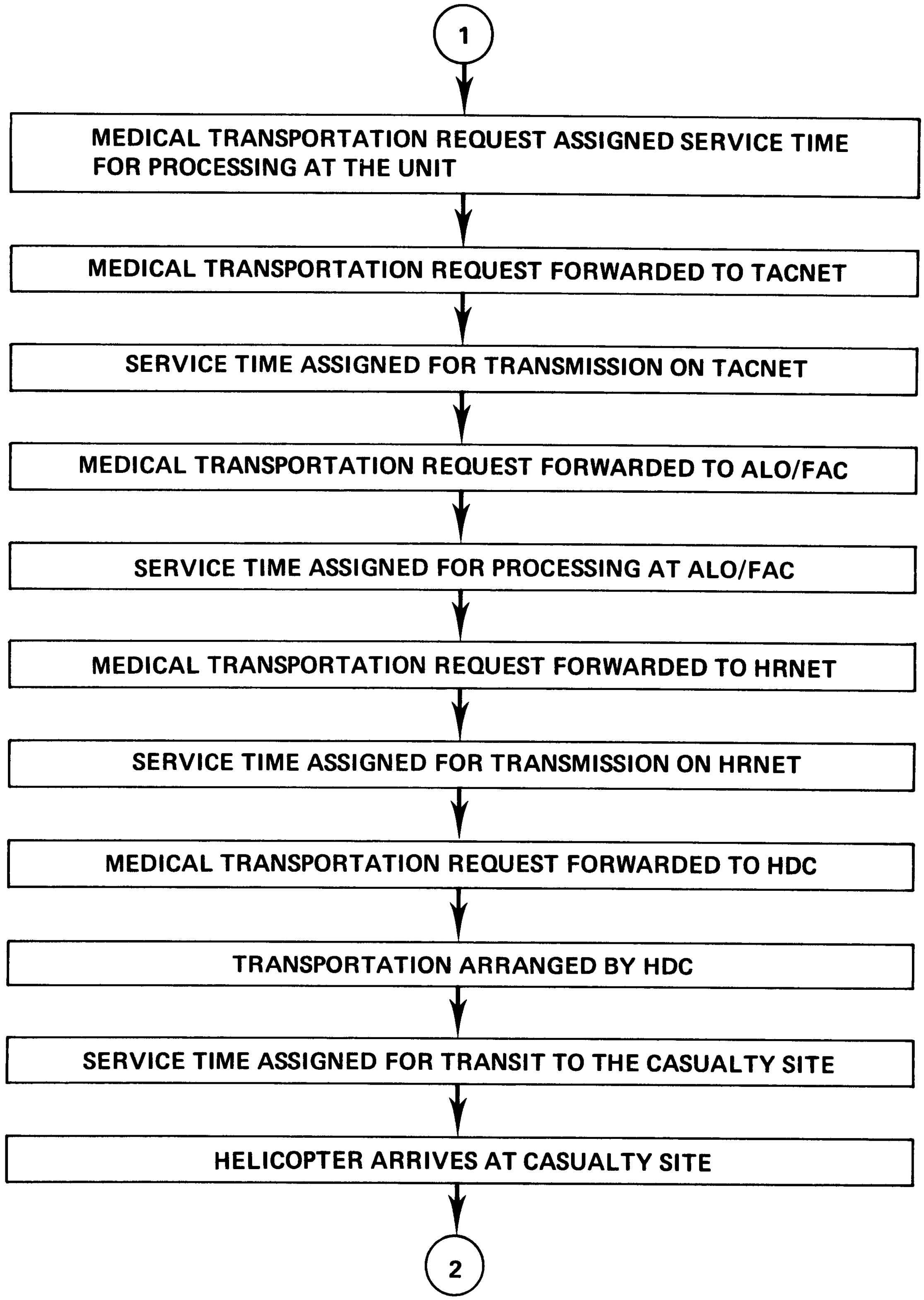


Figure 3 — Continued

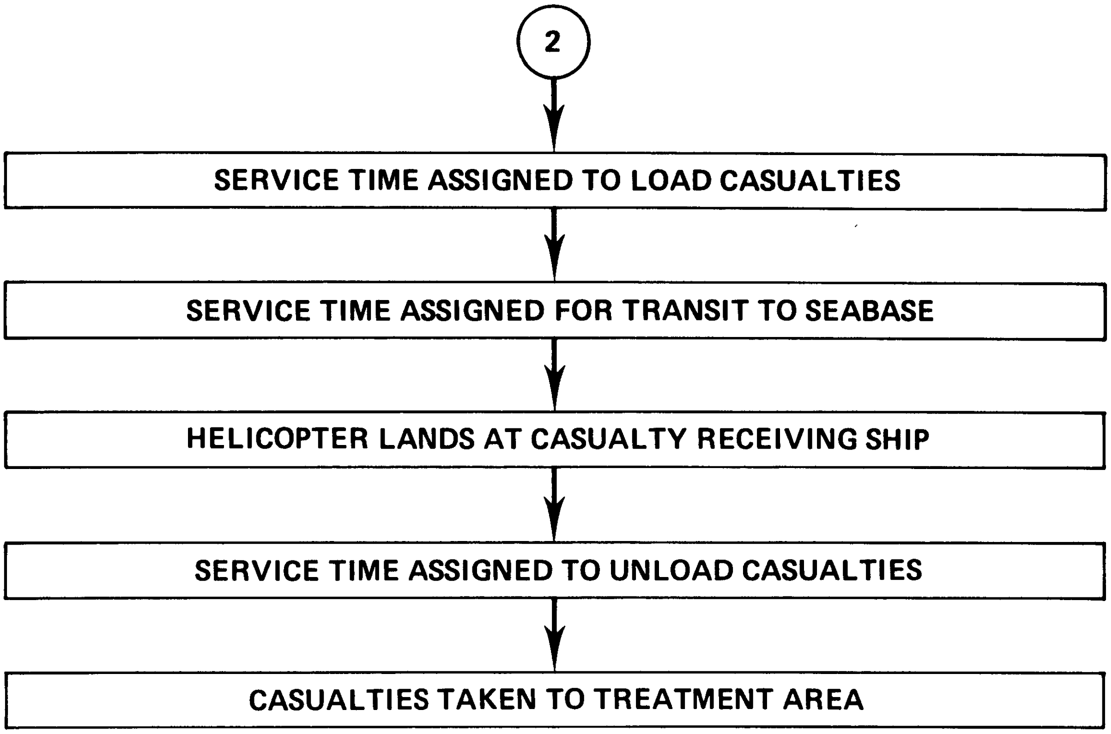


Figure 3 — Continued

the FLCC it is given a probabilistically assigned service time representing FLCC processing time. When this service time is over, the supply request is forwarded to the LOGCMD net. At the LOGCMD net the request is assigned a service time for transmission and then forwarded to the LSC, where it is held in a queue until it can be processed by the LSC Supply Coordinator. It is assumed that the LSC Supply Coordinator can process only one supply request at a time, all urgent requests before routine requests. The supply request is then assigned a service time representing LSC processing time. During LSC processing the Supply Coordinator determines which ships of the seabase the supplies will be drawn from and what quantity will be drawn from each. Messages are generated instructing one or more SLCC's to get the supplies ready for pickup.

These messages are forwarded from the LSC Supply Coordinator to the MSBCOM net. Each message is assigned a service time for transmission on the MSBCOM net and then forwarded to one or more SLCC's. At the SLCC, the message is assigned a service time representing SLCC processing time. The SLCC then issues orders to remove the supplies from storage and make them ready for pickup at the helicopter deck or staging area. A service time is assigned to the supplies representing breakout and handling time. A transportation request to deliver the supplies is generated. The supplies now wait to be picked up and the supply transportation request is sent to the MSBCOM net. At the MSBCOM net the request is assigned a service time for transmission, and then forwarded to the LSC Transportation Coordinator. The assignment of the request to the appropriate means of transportation is considered within the transportation subsystem (See Section 3.5 for details). The vehicle is assigned a service time for transit to the ship. When the vehicle arrives at the ship it is assigned a service time representing the time needed to load the supplies. After the supplies are loaded, a service time is assigned for the vehicle travel time to the unit. When the vehicle arrives at the unit a service time is assigned for unloading. The supplies are then forwarded to the requesting unit.

Figure 4 shows the Supply subsystem flow diagram.

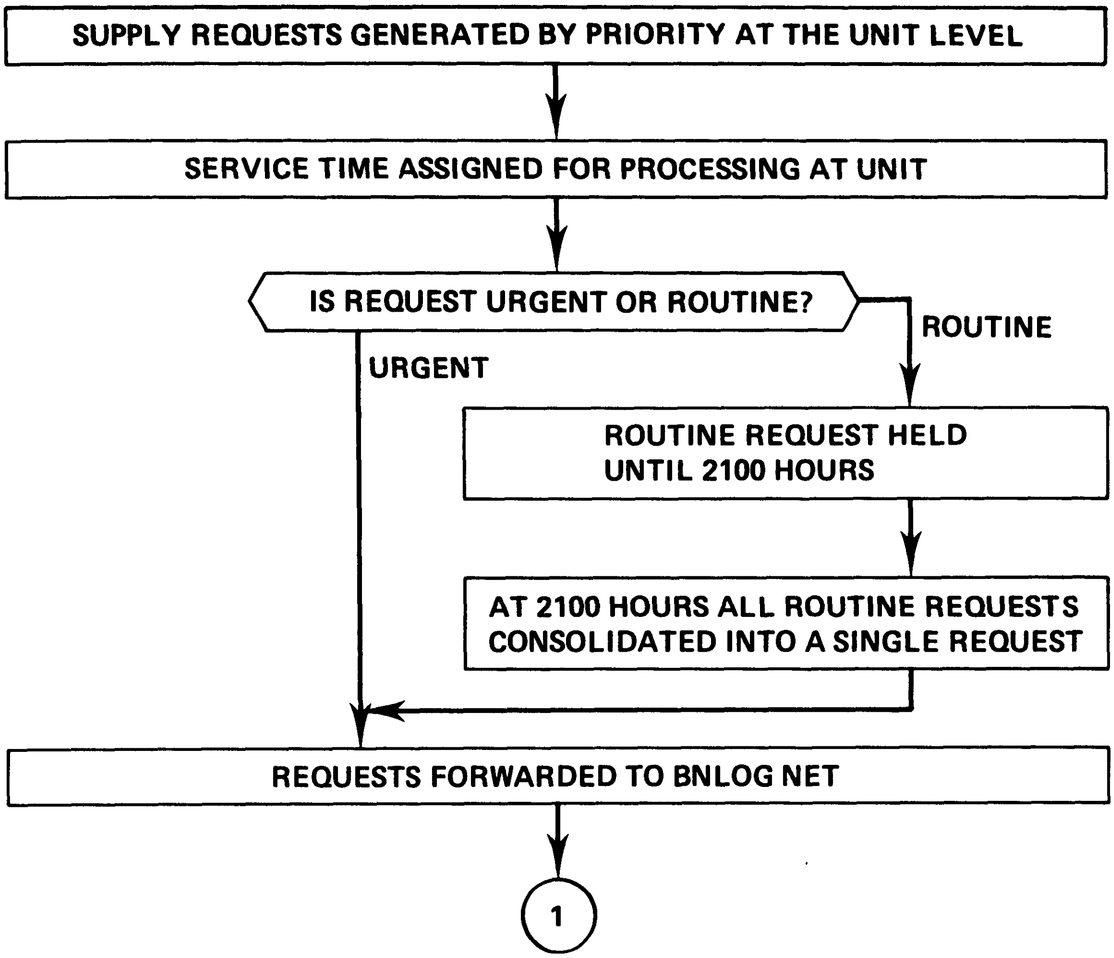
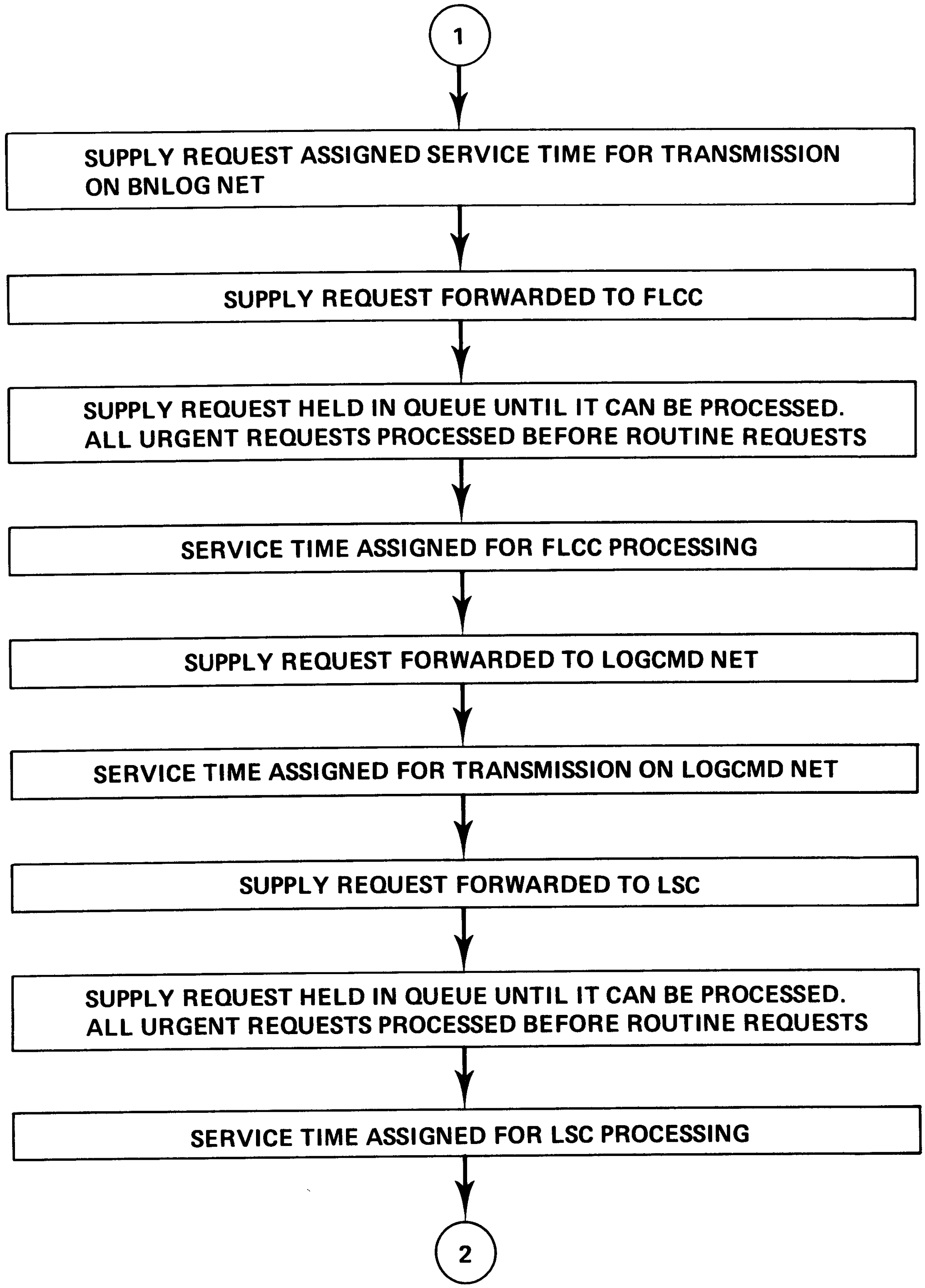


Figure 4 – Supply Subsystem Flow Diagram



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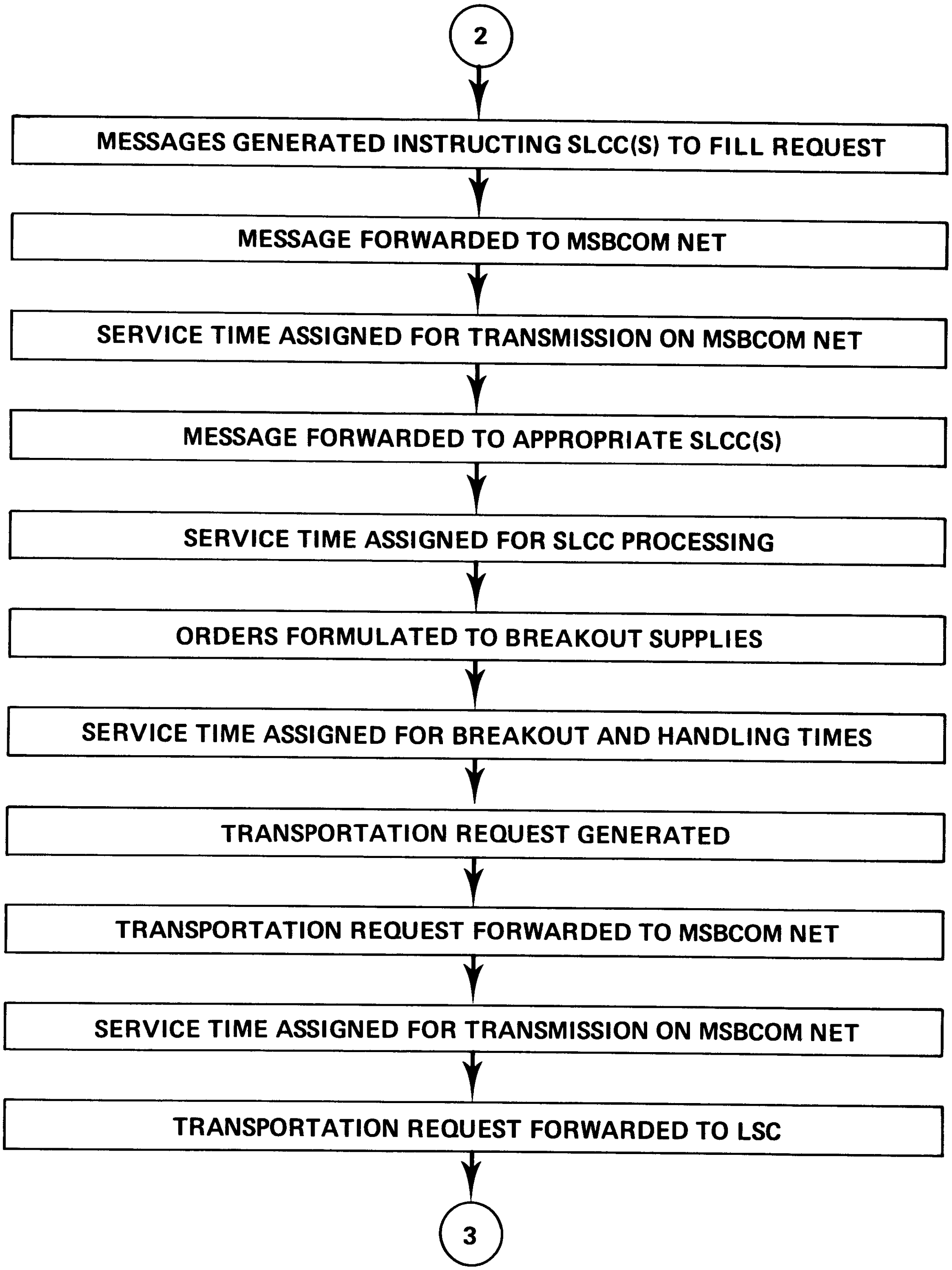


Figure 4 — Continued

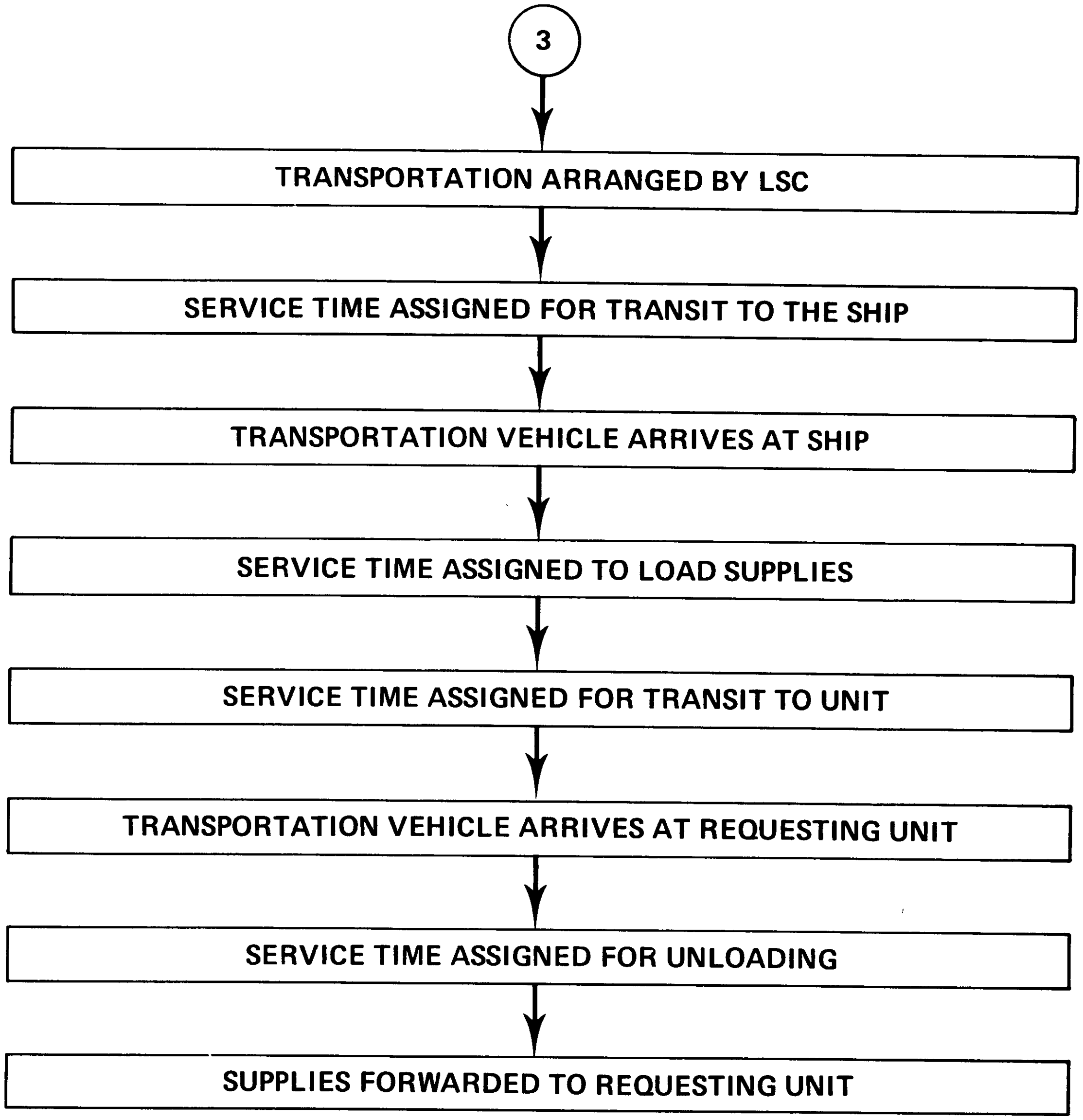


Figure 4 — Continued

3.4 MAINTENANCE SUBSYSTEM

Maintenance requests are generated by priority at the unit level and distributed over the day by a bi-modal normal distribution. The request is assigned a service time representing unit processing time. The request is then forwarded to the BNLOG net. The request is assigned a service time for transmission on the BNLOG net and then forwarded to the FLCC where it is held in a queue until it can be processed. It is assumed that only one maintenance message can be processed at a time by the FLCC, all urgent requests before routine requests. When the FLCC is able to process the request, the request is assigned a service time representing FLCC processing. The request is then forwarded to the LOGCMD net. The request is assigned a service time for transmission on the LOGCMD net and then it is forwarded to the LSC.

At the LSC, the request is held in a queue until it can be processed. It is also assumed that the LSC can process only one maintenance message at a time, all urgent requests before routine requests. A service time is assigned representing LSC processing. When the processing time is complete, the request is forwarded to the MSBCOM net. The request is assigned a service time representing transmission on the MSBCOM net and then forwarded to the appropriate SLCC. The request is held in a queue until it can be processed by the SLCC. It is again assumed that only one request can be processed at a time. When the request can be processed, it is assigned a service time for SLCC processing. The SLCC, in conjunction with the appropriate shop, formulates a recommendation for disposition of the request. The recommendation can be either to have the failed item repaired ashore by a contact team or to return it to the seabase for repair. The recommendation is then forwarded by the SLCC to the MSBCOM net. The recommendation is assigned a service time for transmission and then forwarded to the LSC.

At the LSC the recommendation is held in a queue until it can be processed by the LSC. When it can be processed, it is assigned a service time representing LSC processing. The LSC makes the final decision on the request by either upholding or reversing the recommendation. This step is accomplished in the model by means of a probability distribution which specifies the percent of the time the recommendation is upheld.

3.4.1 Repair at Seabase

If the LSC decides to have the failed item repaired at the seabase, the LSC must decide whether or not to issue a replacement item from the Operational Readiness Float (ORF). If the original request was an urgent request, a float replacement will always be sent, if available. If the original request was routine, the decision is made according to a probability distribution (specifically, 50 percent send replacement, 50 percent do not send replacement). If the LSC decides to send a replacement, a message is generated ordering the SLCC to send the replacement. The replacement order is forwarded to the MSBCOM net. At the MSBCOM net the order is assigned a service time representing transmission time on the MSBCOM net and then forwarded to the appropriate SLCC. The order is held in a queue until it can be processed by the SLCC and then a service time is assigned for SLCC processing. This service time includes the time the SLCC spends arranging for the replacement to be prepared for transportation. A service time is assigned for preparing the item for transportation and moving the item to the staging area. When this service time has elapsed, a message is generated requesting the LSC to arrange transportation for the replacement item. The transportation request is forward to the MSBCOM net. A service time is assigned for transmission on the MSBCOM net and then the message is forwarded to the LSC. Transportation is arranged by the LSC as appropriate (within the transportation subsystem). When the appropriate transportation arrives at the ship, a service time is assigned representing the time to load the item. The item is loaded and the loaded vehicle proceeds ashore with a service time assigned for transit. When the vehicle arrives at the unit, it is assigned a service time for unloading. The replacement item is then forwarded to the user.

Whether or not a replacement item is issued from the seabase, the failed item must be evacuated to the seabase for repair. To accomplish this, the LSC generates a message ordering the unit to prepare the failed item for transit to the seabase. This message is forwarded to the LOGCMD net. The message is assigned a service time for transmission on the LOGCMD net and then forwarded to the FLCC. At the FLCC, the message is held in a queue until it can be processed by the FLCC. It is assigned a service time representing FLCC processing and is forwarded to the BNLOG. The message is assigned a service time for transmission on the BNLOG net and then forwarded to the appropriate unit. When the message arrives at the unit, the failed item is assigned a service time representing the time needed to prepare the item for transit. When the item is ready for transit, the unit generates a transportation request. This request is forwarded to the BNLOG net. A service time is assigned for transmission on the BNLOG net and the request is forwarded to the FLCC where it is held in a queue until it can be processed. A service time is assigned for FLCC processing. The request is forwarded to the LOGCMD net and assigned a service time for transmission. The request is then forwarded to the LSC Transportation Coordinator. Transportation is arranged by the LSC as appropriate (within the transportation subsystem). When the appropriate transportation arrives at the unit, a service time is assigned, representing the time needed to load the item. The item is loaded and the vehicle proceeds to the seabase with a service time assigned for transit. When the vehicle arrives at the repair ship, a service time is assigned to unload the failed item.

When unloaded, the failed item is assigned a service time for movement to the shop queue. This is the location aboard ship where items are held until shop space is available. When a shop space is available, the item is moved to the shop. A service time is assigned to account for this movement time. In the shop, a service time is assigned representing the time needed to diagnose the failure. The shop makes a decision on whether or not the item can be repaired at the seabase. If the decision is to repair the item, a service time is assigned representing the time needed to repair the item. When the item has been repaired, the shop notifies the SLCC that the repair is complete. The SLCC checks on whether or not a float replacement item had been issued in answer to the original request. If a replacement had been issued, the repaired item becomes part of the ORF. If a replacement had not been issued, the SLCC orders the repaired item moved to the staging area. A service time is assigned for this movement. A transportation request is generated, requesting the return of the repaired item to the unit. The transportation request is forwarded via the MSBCOM net to the LSC, with the appropriate service time being assigned. Transportation is arranged by the LSC. When transportation arrives at the ship, it is assigned a service time for loading. The repaired item is then placed aboard the vehicle and the loaded vehicle proceeds ashore with a service time being assigned for transit. When the vehicle arrives at the unit it is assigned a service time to unload. The repaired item is then forwarded to the appropriate unit.

If the failed item cannot be repaired at the seabase, the unrepairable item is stored at the ship. The SLCC generates a message informing the LSC that the item is unrepairable. This message is forwarded to the MSBCOM net. A service time is assigned for transmission on the MSBCOM net and then the message is forwarded to the LSC. At the LSC the message is held in a queue until it can be processed. It is assigned a service time for LSC processing. The LSC then determines whether a replacement item should be sent. In the model the decision is made using a probability distribution which depends on the priority of the request. If a replacement is to be sent, procedures for having it transported ashore to the appropriate unit (as outline above) are adopted. If no replacement is to be sent, a message stating this fact is forwarded to the LOGCMD net. A service time is assigned for transmission and the message is forwarded to the FLCC. It is held in a queue and then given a service time for FLCC processing. The message is then forwarded to the BNLOG net. A service time is assigned for transmission on the BNLOG net. The message is then forwarded to the unit.

3.4.2 Repair by Contact Team

When the decision of the LSC is to have a failed item repaired by a contact team, the LSC first checks to determine whether a contact team of the appropriate type is available for assignment to the job. If a contact team is available, the LSC formulates orders assigning the contact team to the job. If a contact team of the proper type is not available, the request is held in the job queue until an appropriate type of contact team becomes available. The job queue is the assignment list where requests for contact teams are held pending the availability of a contact team. The LSC prepares the assignments as requests arrive at the LSC and as messages of contact-team availability arrive at the LSC. When the LSC can match a job and a contact team of the same type, orders are formulated assigning the contact team to the job. A service time is assigned for processing.

When a contact team has been assigned to a job, the LSC checks the location of the contact team. If the contact team is located at the seabase, a message assigning the job is forwarded to the MSBCOM net. The message is assigned a service time for transmission and then forwarded to the appropriate SLCC where it is held in a queue. When it can be processed, it is assigned a service time for SLCC processing. The contact team is ordered to prepare for the job and the necessary service time is applied. When the service time has expired, the SLCC generates a transportation request to deliver the contact team to the unit. The SLCC sends the request to the MSBCOM net where it is assigned a service time for transmission and then forwarded to the LSC where it is held in the queue. When the request can be processed, it is given a service time for LSC processing. Transportation for the contact team is arranged by the LSC. When the vehicle arrives at the ship, it is assigned a service time representing the time to load a contact team and then the vehicle proceeds ashore. A service time is assigned for transit. When the vehicle arrives at the unit,it is assigned a service time to unload. The contact team then proceeds to the failure site.

If the contact team assigned by the LSC is located ashore, the message assigning the contact team to a job is forwarded from the LSC to the LOGCMD net. A service time is assigned for transmission on the LOGCMD net. The message is then forwarded to the FLCC where it is held in a queue. When the message can be processed, a service time is assigned for FLCC processing and then the message is forwarded to the BNLOG net. After the service time assigned for BNLOG net transmission time has elapsed, the message is forwarded to the contact team at the appropriate unit. If the failed item and the contact team are located at the same unit, the contact team proceeds to the site of the failure. If the contact team and the failed item are at different locations, the contact team will need transportation to travel to the failure site. After a service time which allows the contact team to prepare for movement, a transportation request is generated requesting the LSC to provide transportation for the contact team. The transportation request is forwarded to the BNLOG net where it is assigned a service time for transmission. The request is then forwarded to the FLCC where it is held in a queue until it can be processed. A service time is assigned for FLCC processing and the request is forwarded to the LOGCMD net. A service time is assigned for transmission on the LOGCMD net, and the request is forwarded to the LSC where it is held in a queue until it can be processed. A service time is assigned for LSC processing. Transportation for the contact team is arranged by the LSC. When the vehicle arrives at the unit, it is assigned a service time representing the time to load. The vehicle proceeds to the contact team's destination with appropriate service time assigned for transit. When the vehicle arrives at the destination, a service time is assigned for unloading. The contact team then proceeds to the site of the failed item.

If the failure has not been diagnosed a service time is assigned representing diagnosis time. A probability distribution is used to determine whether or not the failed item can be fixed ashore. If the item cannot be fixed ashore, a message is generated indicating the non-repairability ashore of the item. The message is forwarded to the BNLOG net where it is assigned a service time for transmission and then forwarded the FLCC where it is held in a queue until it can be processed. When the message can be processed by the FLCC, it is assigned a service time representing FLCC processing time and then forwarded to the LOGCMD net. The message is assigned a service time for transmission on the LOGCMD net and then forwarded to the LSC where it is held in a queue until it can be processed. When the message can be processed, it is assigned a service time representing LSC processing time. The LSC now considers repair of the failed item at the seabase and determines whether or not a replacement item should be sent. These procedures were discussed in Section 3.4.1.

If the failed item can be repaired ashore, a probability distribution is used to determine whether additional repair parts or tools must be requested from the seabase. If additional parts or tools are required, a request is generated notifying the LSC of this fact. The request is forwarded to the BNLOG net where it is assigned a service time for transmission. The request is then forwarded to the FLCC where it is held in a queue until it can be processed. The request is then assigned a service time for FLCC processing and forwarded to the LOGCMD net. The request is assigned a service time for transmission and forwarded to the LSC where it is held in a queue. A service time is assigned for the LSC processing. A message is generated ordering the SLCC to fill the request. This message is forwarded to the MSBCOM net where it is assigned a service time for transmission. The message is forwarded to the appropriate SLCC where it is held in a queue until it can be processed. When the message can be processed, it is assigned a service time for SLCC processing. A service time is then assigned representing the time to fill the request. At the end of this service time a transportation request is generated requesting the LSC to arrange transportation for the part(s) or the tool(s) from the ship to the unit. The transportation request is forwarded to the MSBCOM net where it is assigned a service time for transmission and then forwarded to the LSC where it is held in a queue until it can be processed. When the request can be processed, it is assigned a service time for processing. The LSC then arranges the appropriate transportation. When the vehicle arrives at the ship, it is assigned a service time to load and then proceeds ashore. A service time is assigned for transit. When the vehicle arrives at the unit, it is assigned a service time to unload. The part(s) or tool(s) is then forwarded to the unit. A message is then generated notifying the LSC that the part or tool has arrived. The message is forwarded to the BNLOG net where it is assigned a service time for transmission and then forwarded to the FLCC where it is held in a queue until it can be processed. When the message can be processed, it is assigned a service time representing FLCC processing and then forwarded to the LOGCMD net. After a service time for transmission the message is forwarded to the LSC where it is held in a queue until it can be processed. When the message can be processed, it is assigned a service time for LSC processing. The LSC now decides that a contact team is required to finish the reapir. A contact team is assigned to the request when one is available.

If the contact team decides that additional parts or tools are not required, or if the failure is one for which additional parts or equipment have already arrived at the unit, a service time is assigned representing the time to fix. When this service time has elapsed, the repaired item is returned to the unit.

When messages are sent indicating that a failed item cannot be repaired ashore or that additional parts or tools are needed, or when a job is completed, the contact team generates a message notifying the LSC of the contact team's availability. The message is forwarded to the BNLOG net where it is assigned a service time for transmission. The message is then forwarded to the FLCC where it is held in a queue until it can be processed. When the message can be processed, it is assigned a service time representing FLCC processing time and then forwarded to the LOGCMD net. The message is assigned a service time for transmission on the LOGCMD net and then forwarded to the LSC where it is placed in the LSC queue.

When a message of contact team availability can be processed at the LSC, it is assigned a service time for LSC processing. Contact teams may become available either at the maintenance ship or ashore after completing a job. The LSC first checks to see if the contact team has been ashore for more than 68 hours. The 68-hour limit has been established to allow contact teams to return to the seabase to replenish their supplies of commonly needed repair parts. If the contact team has been in the field for more than 68 hours, orders are formulated instructing the contact team to return to the seabase. The message is forwarded to the LOGCMD net where it is assigned a service time for transmission on the LOGCMD net. When this service time has elapsed, the message is forwarded to the FLCC. The message is held in a queue until it can be processed. A service time is then assigned to the message representing FLCC processing time. The message is then forwarded to the BNLOG net where it is assigned a service time for transmission and then sent to the unit where the contact team is located. Since the message instructs the contact team to return to the seabase, the contact team is assigned a service time representing time needed to prepare for the return trip. A transportation request is then generated by the contact team requesting transportation from the field to the seabase. The transportation request is forwarded to the BNLOG net where it is assigned a service time for transmission and then sent to the FLCC. The request is held in the FLCC queue until it can be processed. It is assigned a service time for FLCC processing and then forwarded to the LOGCMD net. At the LOGCMD net the request is assigned a service time for transmission and then sent to the LSC where it is held in the LSC queue. When the LSC can process the request, it is assigned a service time for LSC processing. Transportation for the contact team is then arranged by the LSC (within the transportation subsystem). When the appropriate means of transportation has been provided by the LSC, the vehicle arrives at the unit. A service time is assigned representing the time to load. The vehicle then travels to the contact team's destination, with a service time being assigned for transit. When the vehicle arrives at the destination, it is assigned a service time to unload. The contact team then proceeds to the ship. If the contact team is due for a rest period, it is assigned a six-to eight-hour service time which represents the rest period. If the contact team does not need to rest, or after the rest period has elapsed, the contact team generates an available-contact-team message. This message is forwarded to the MSBCOM net where it is assigned a service time for transmission and forwarded to the LSC where it is held in the LSC queue. This contact team is then considered for assignment as requirements for contact teams occur.

If the contact team has not been ashore for more than 68 hours, the LSC next checks to determine whether a job of the proper type is in the job queue. If there are no jobs of the proper type in the job queue, the LSC then checks the location of the contact team. If the contact team is ashore, the LSC formulates orders instructing the contact team to return to the seabase. This message is processed as previously discussed. If the contact team is located at the seabase, the contact-team availability message is held in the contact team queue until a job occurs to which the contact team can be assigned.

For a CT ashore, if a job of the proper type is in the job queue, the LSC checks to determine whether the contact team requires a rest period. If a rest period is not required, the contact team is assigned to the job in the job queue. If the contact team is scheduled for a rest period, orders are formulated instructing the contact team to rest. The message is forwarded to the LOGCMD net where it is assigned a service time for transmission. The message is then forwarded to the FLCC where it is held in a queue until it can be processed. A service time is assigned for FLCC processing and then the message is forwarded to the BNLOG net. A service time is assigned for transmission on the BNLOG net. The message is then forwarded to the contact team. A six- to eight-hour service time is assigned for the rest period. When this service time has elapsed, the contact teams makes its availability known to the LSC.

Figure 5 shows the Maintenance subsystem flow diagram.

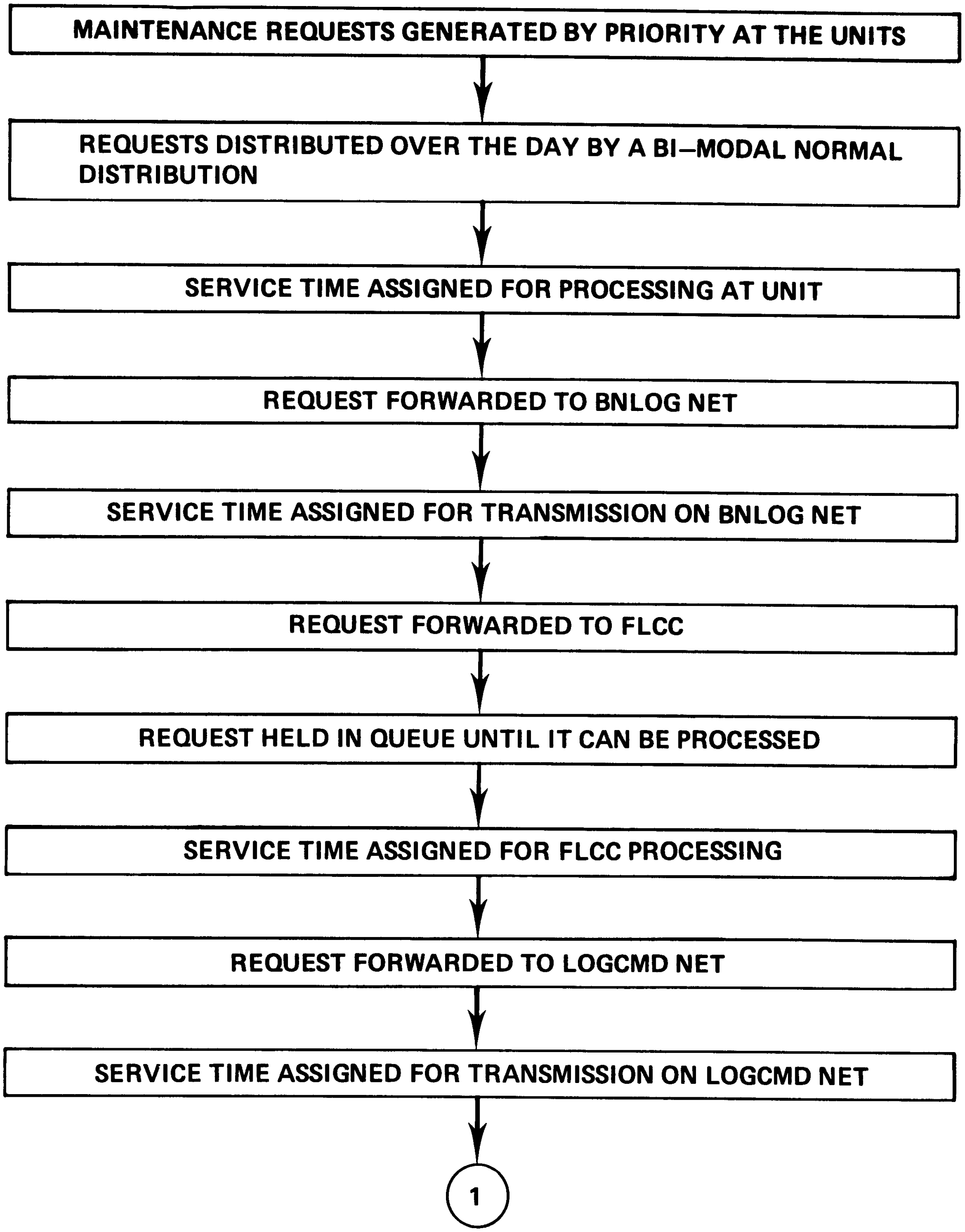


Figure 5 – Maintenance Subsystem Flow Diagram

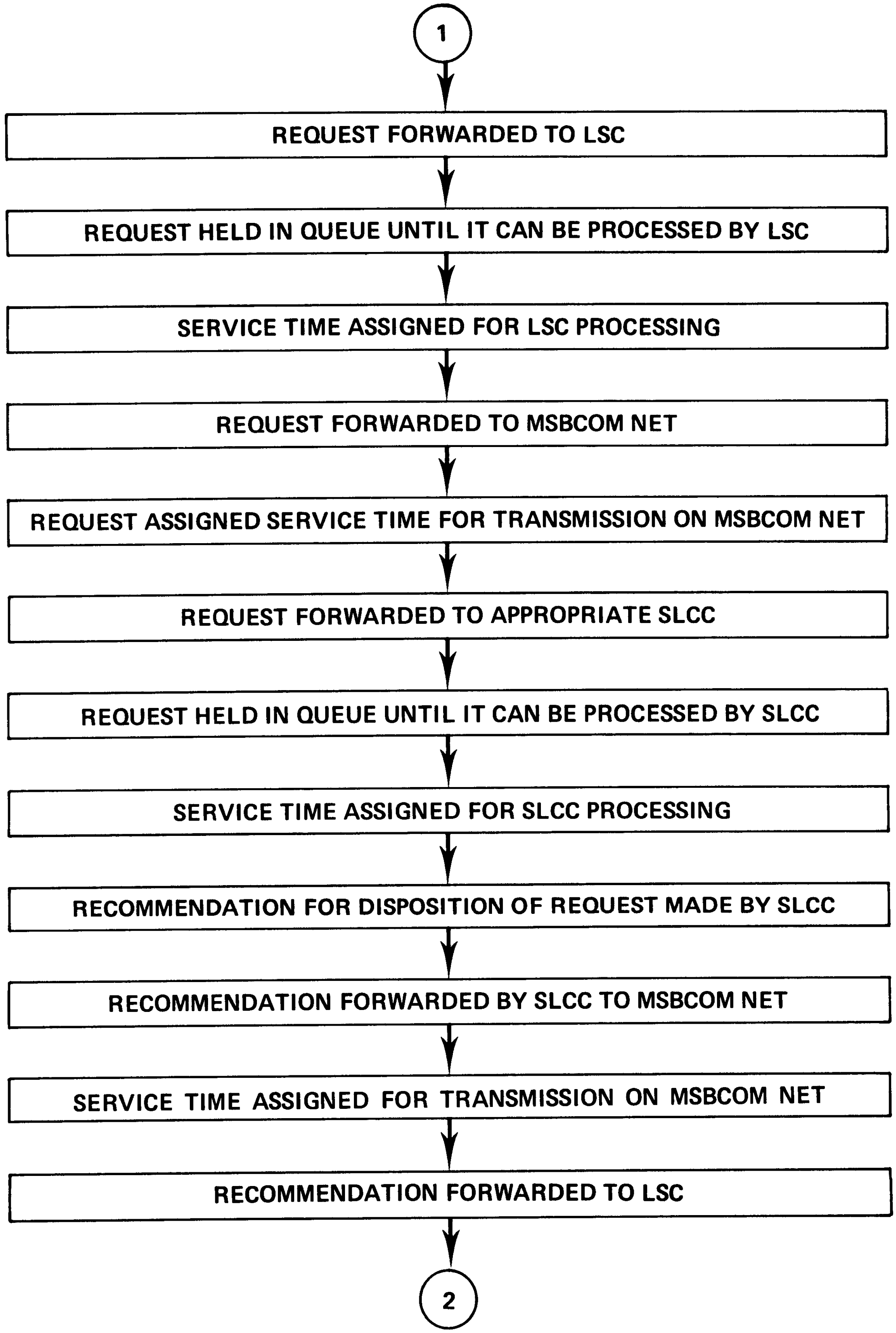
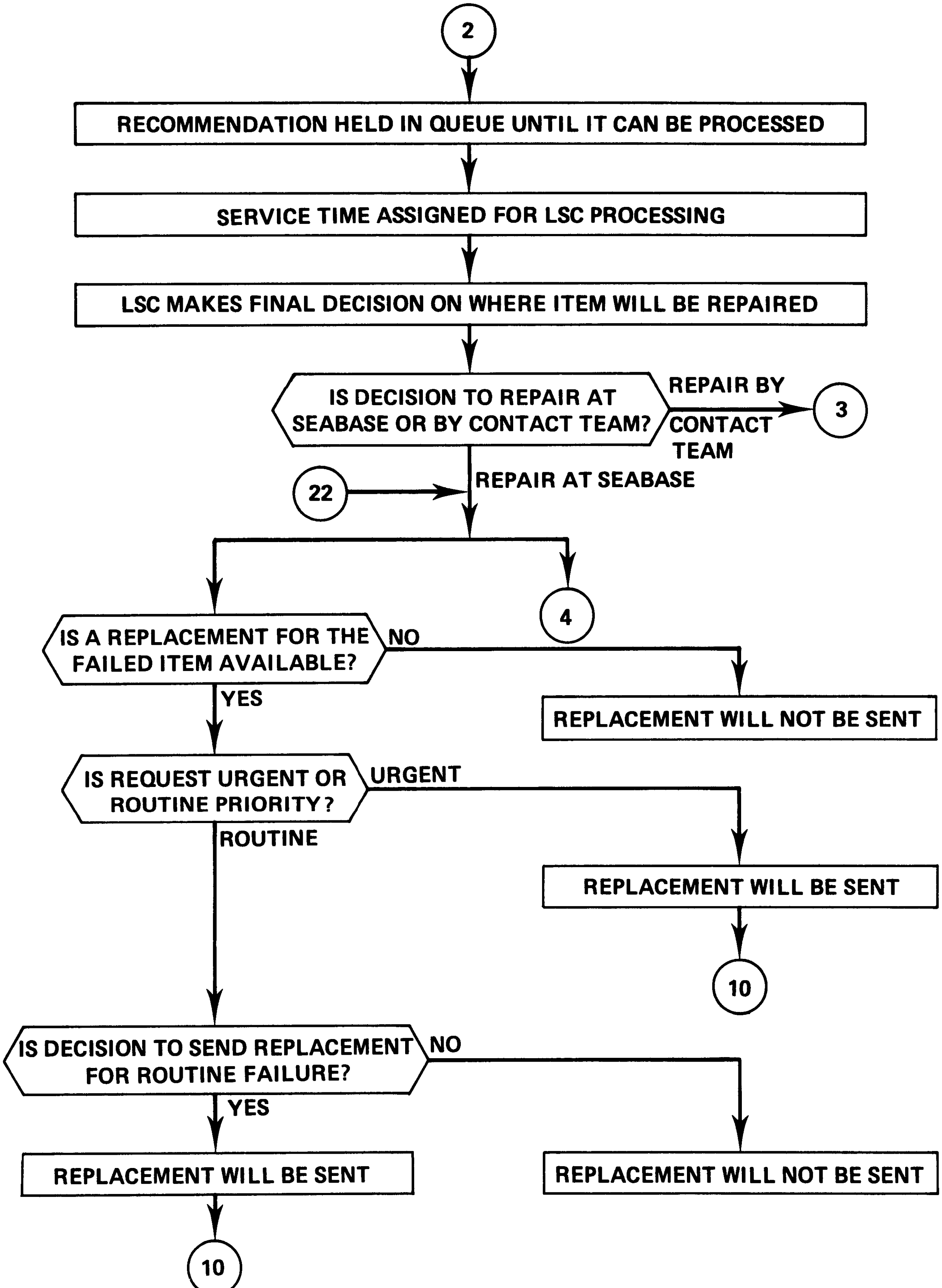


Figure 5 — Continued



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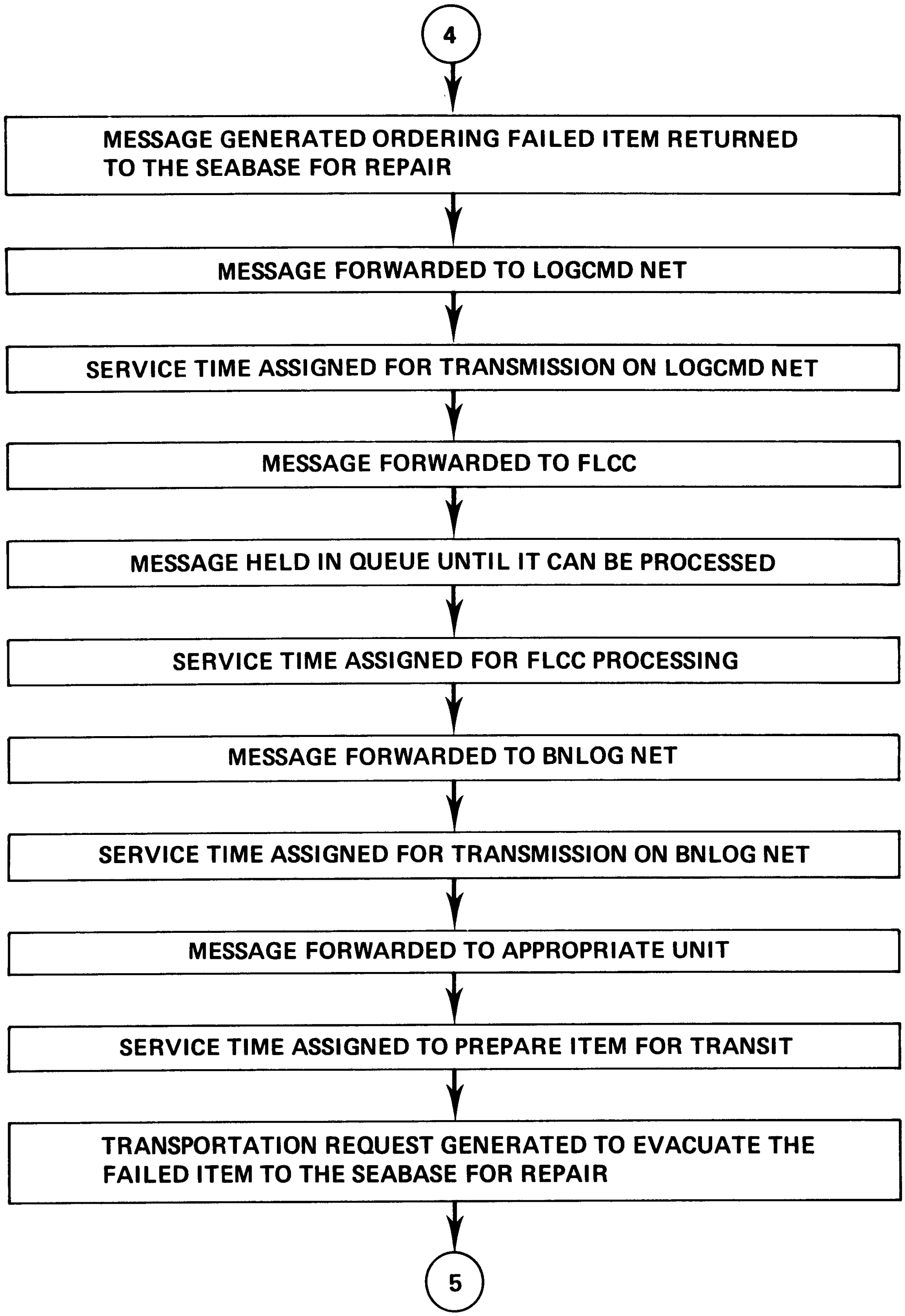

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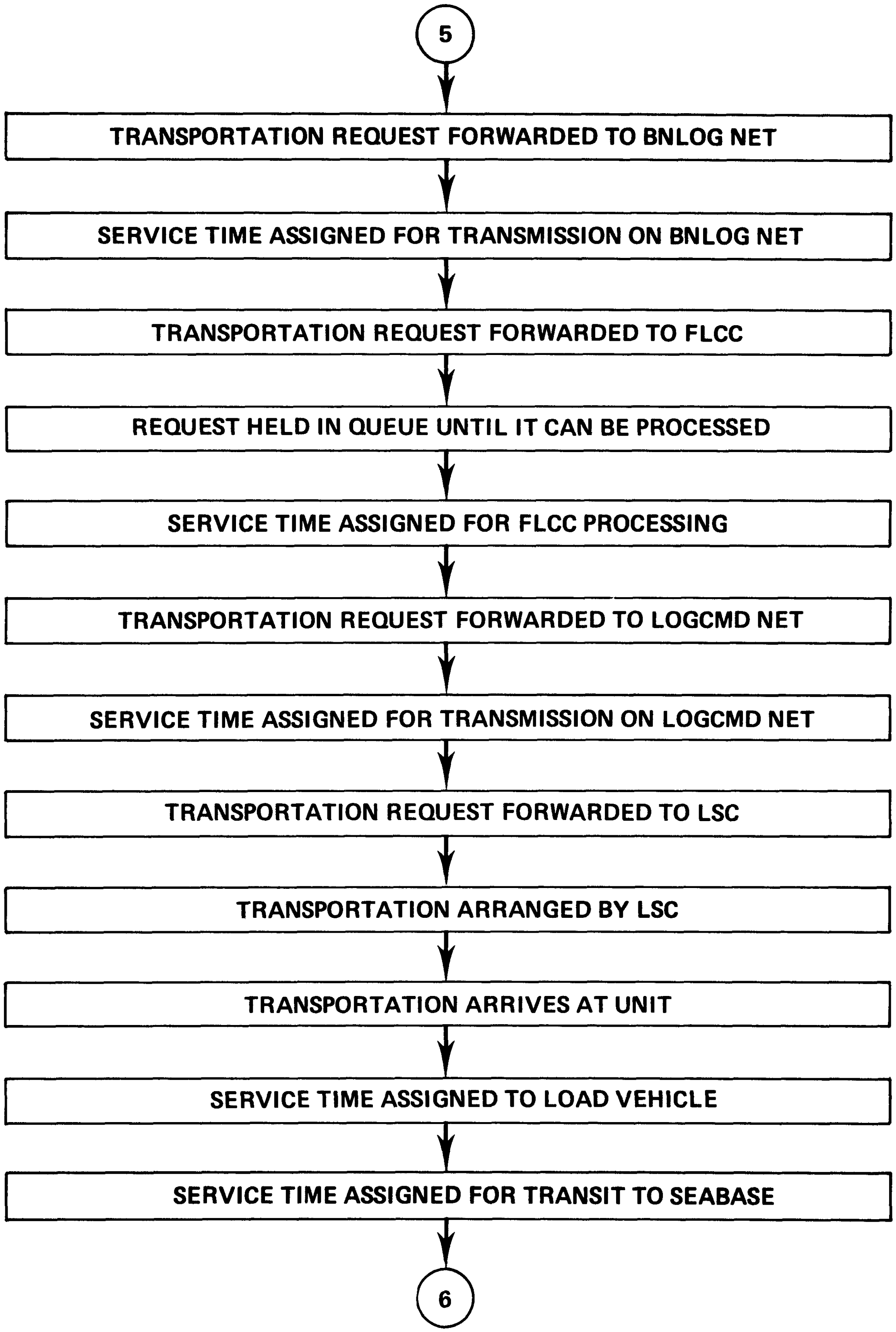

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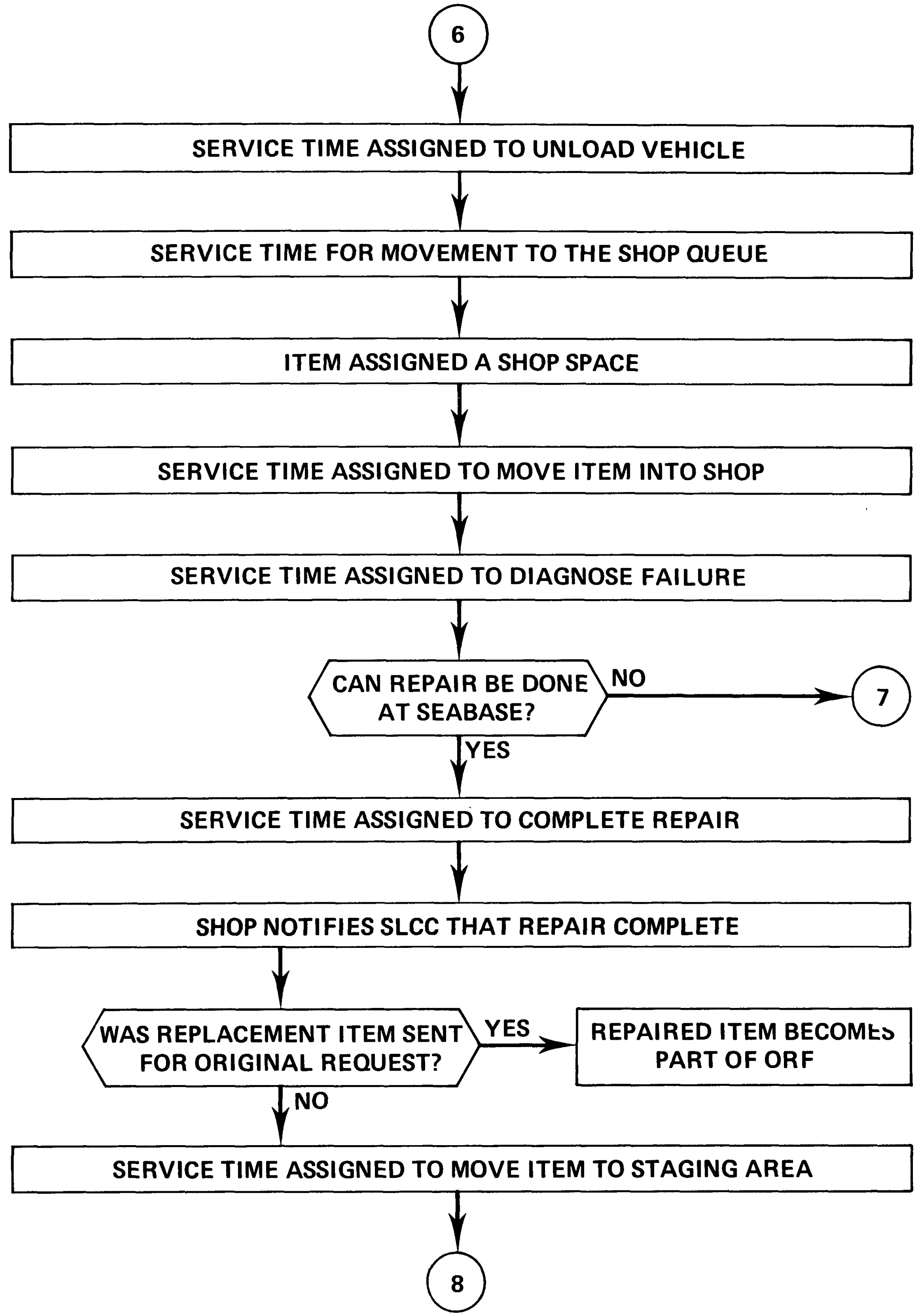

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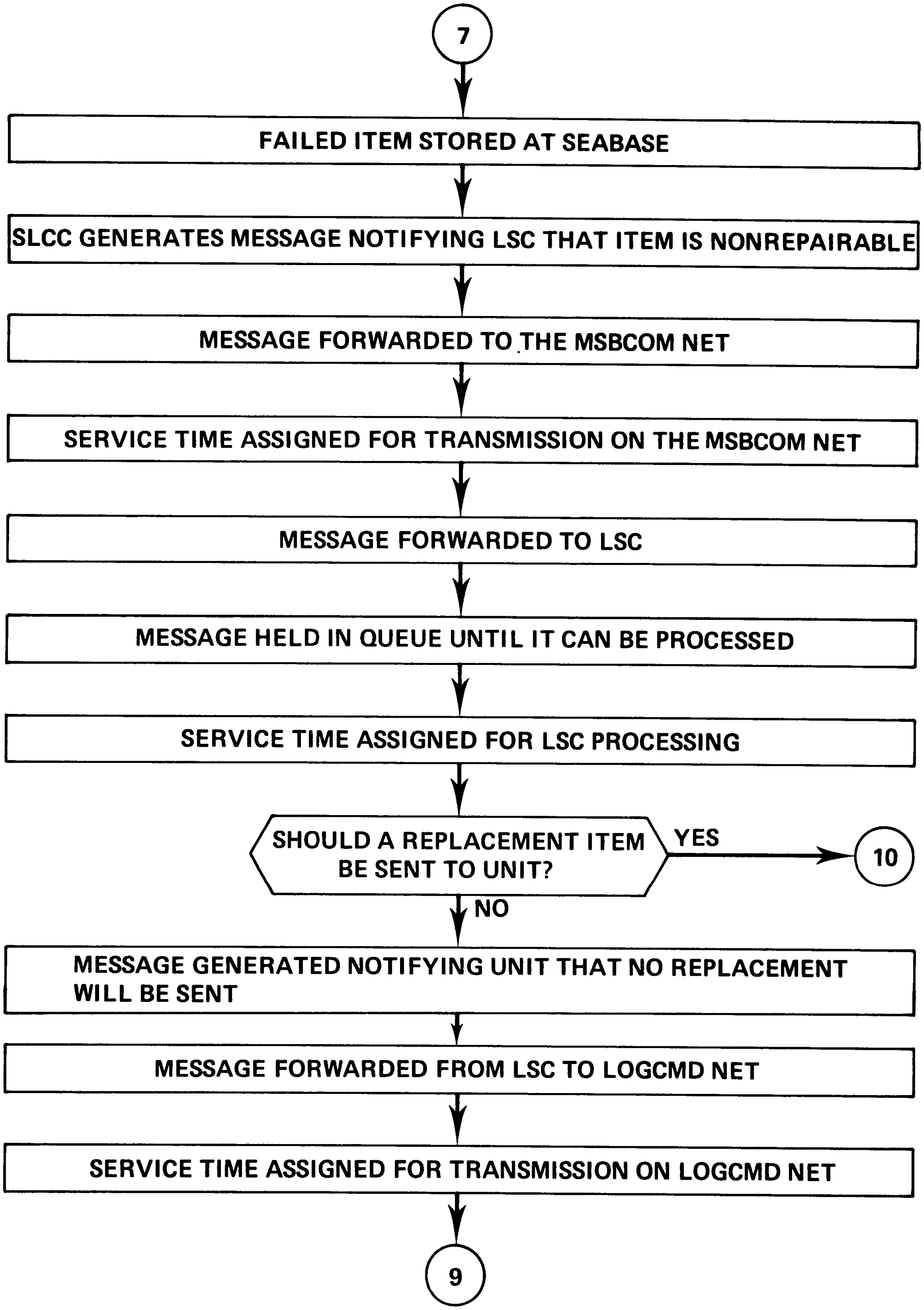

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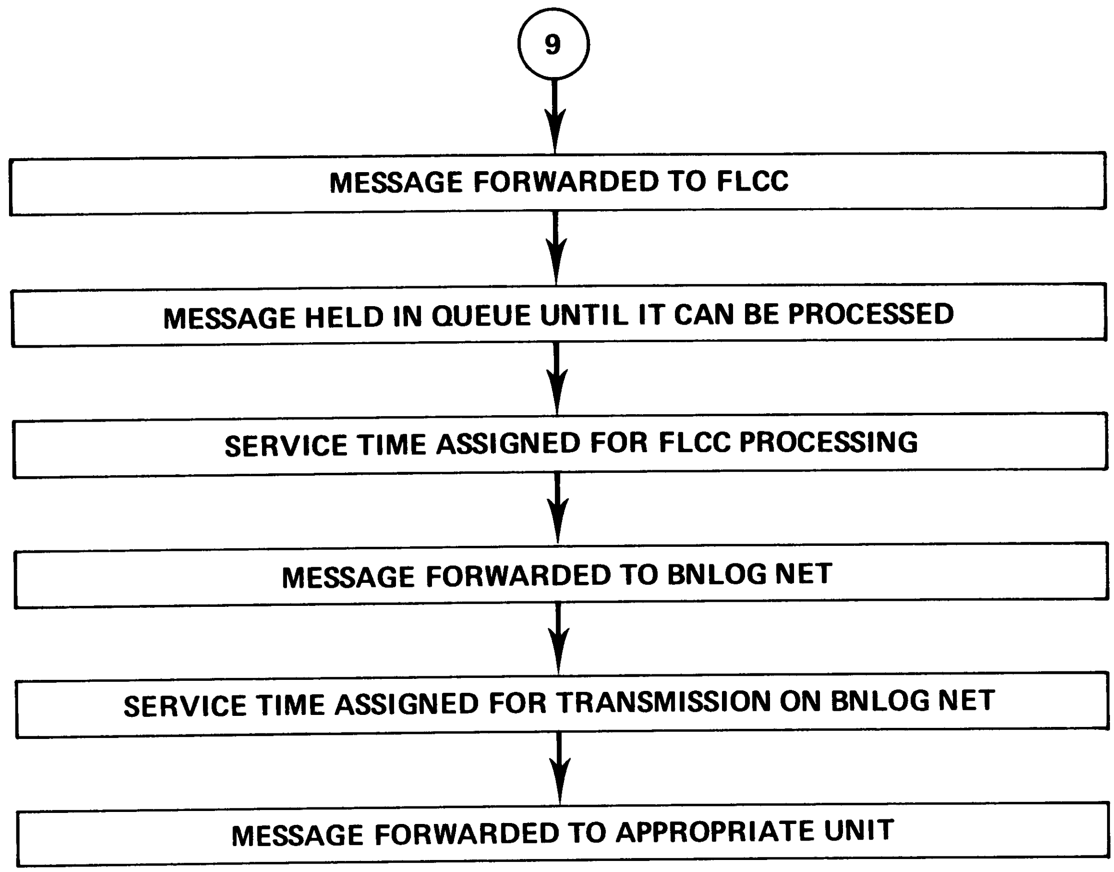

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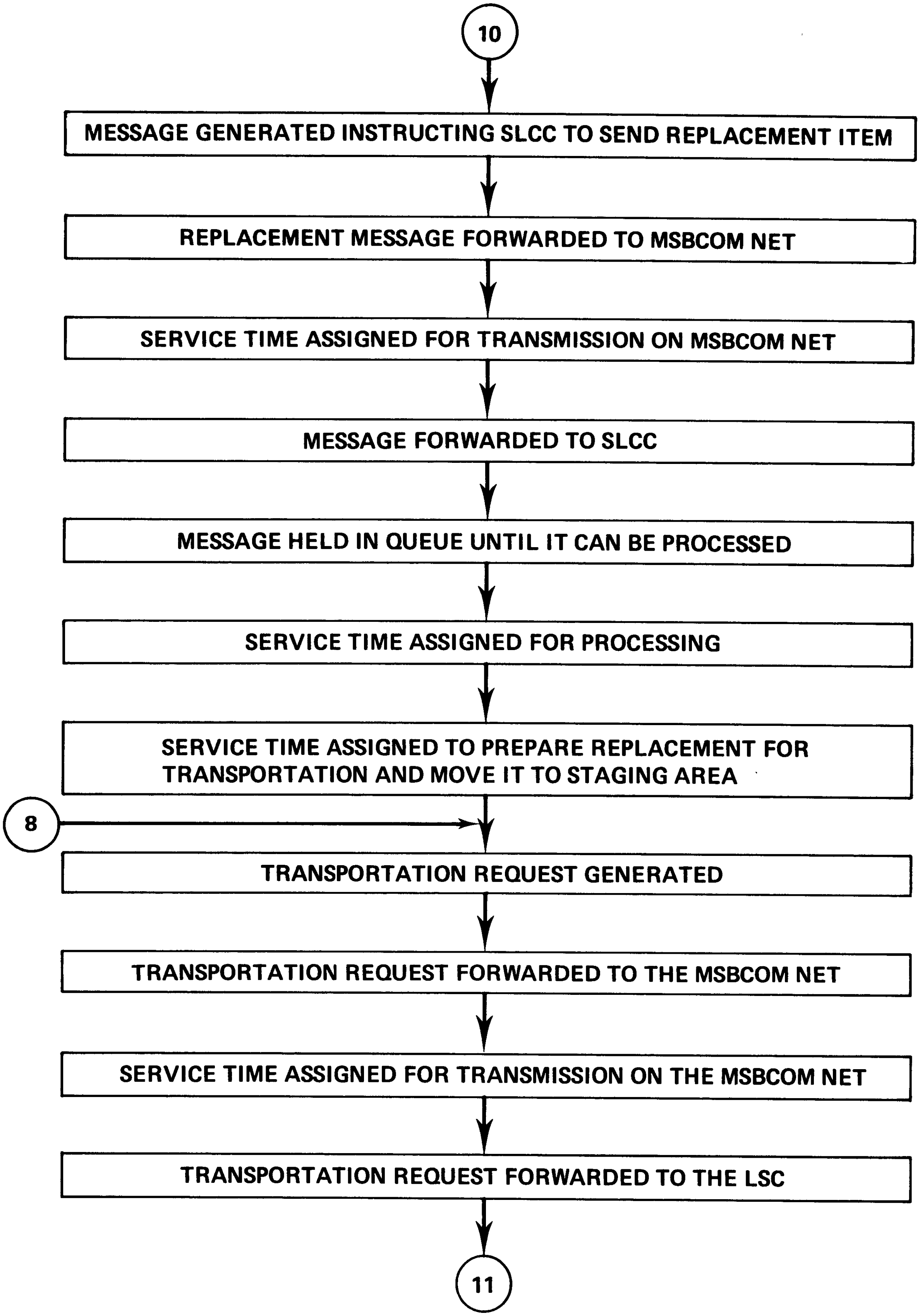

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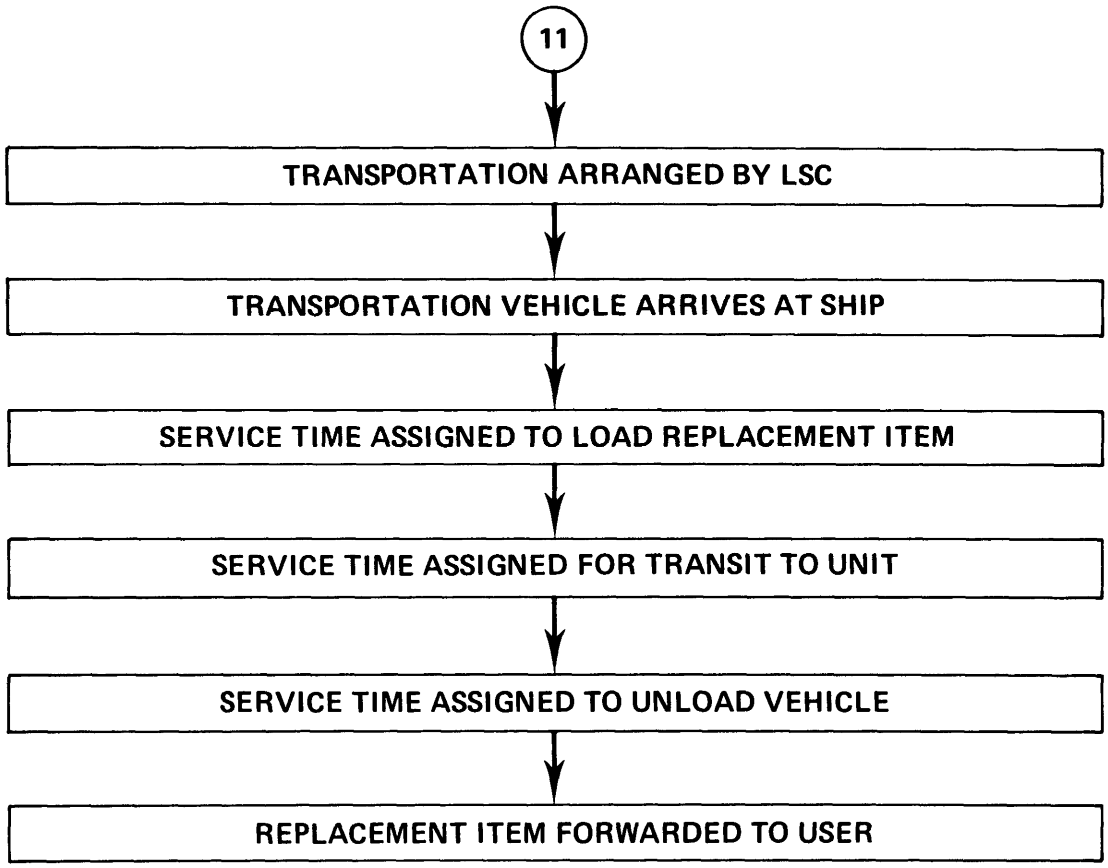

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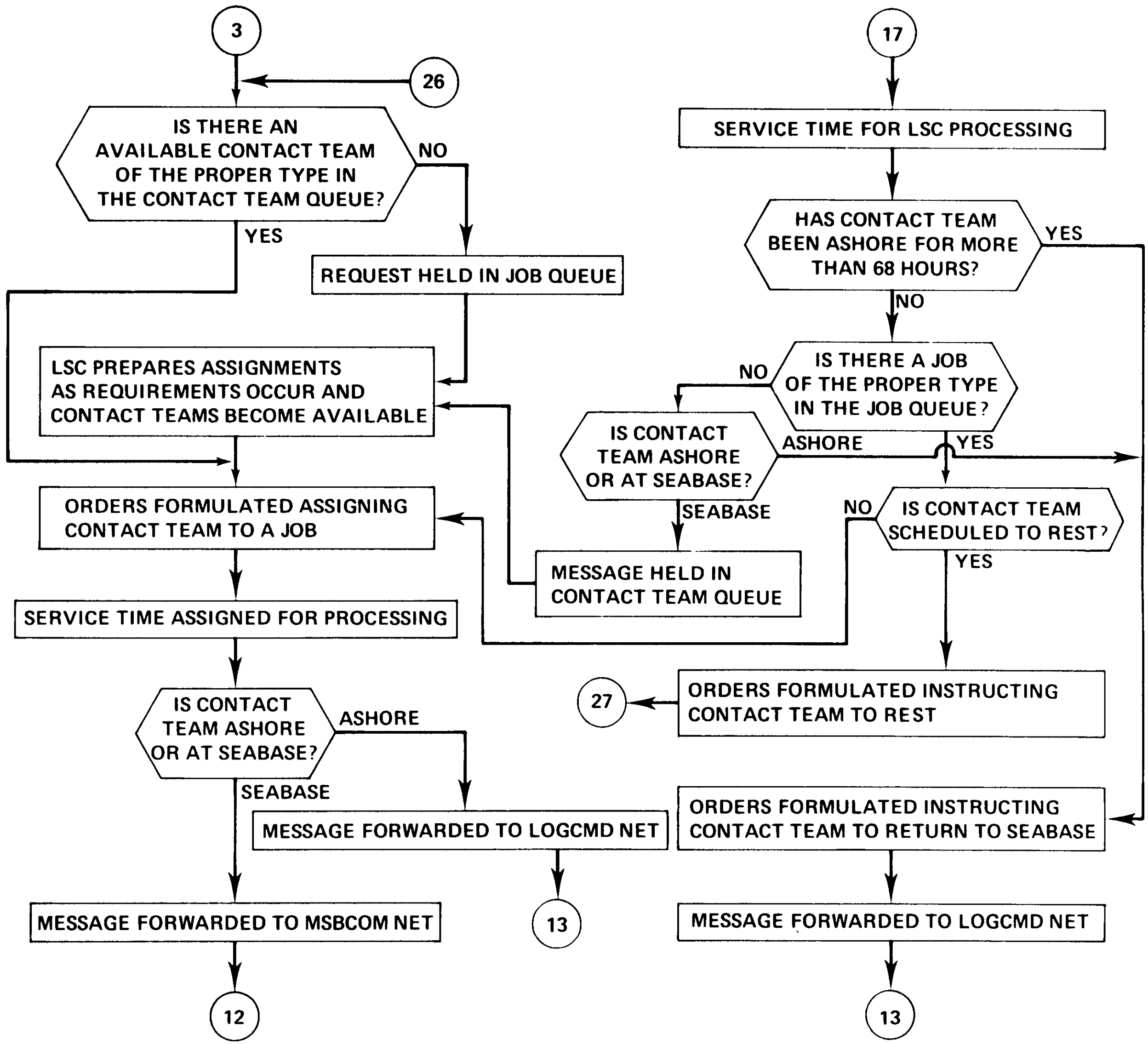

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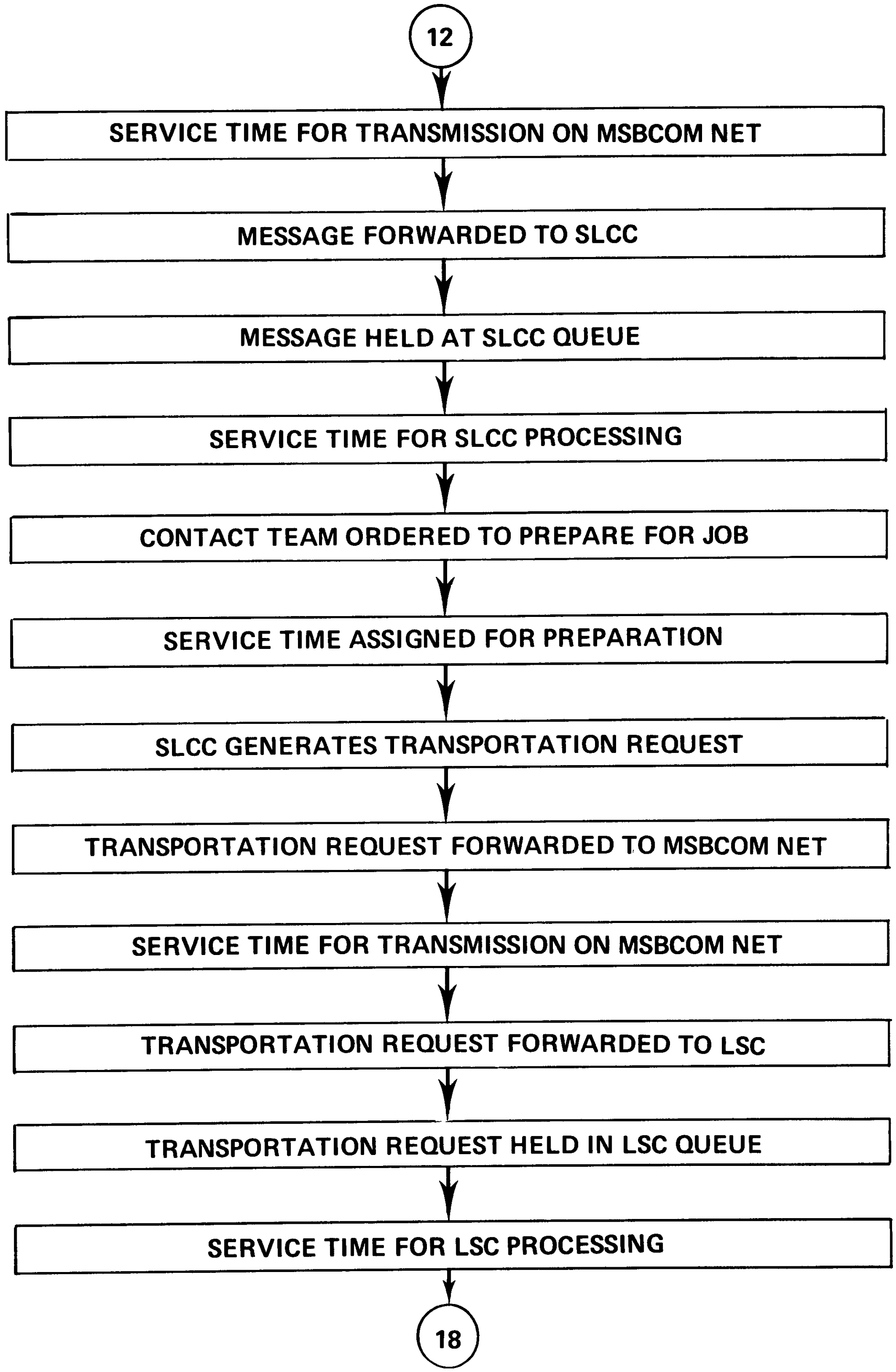

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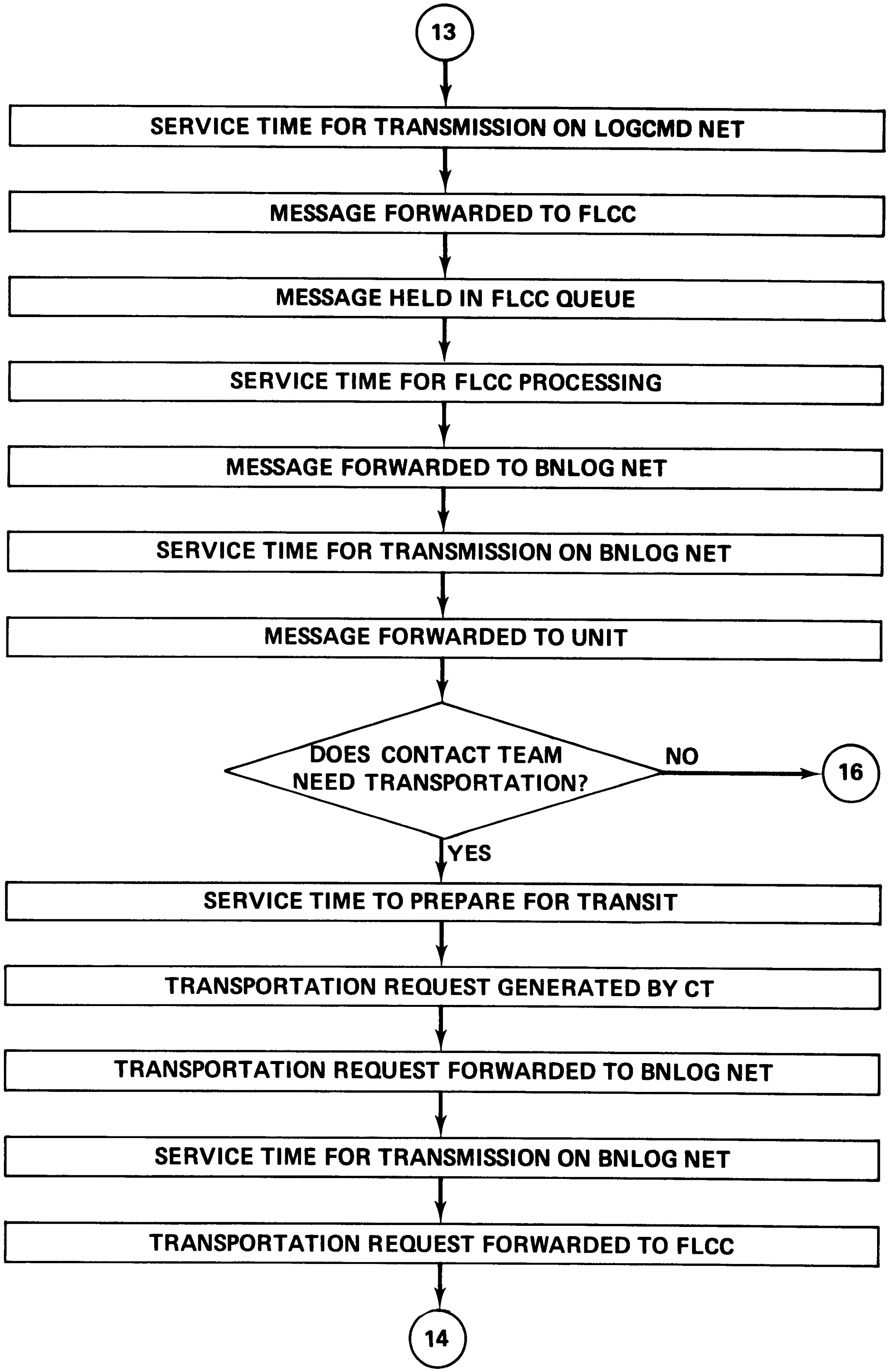

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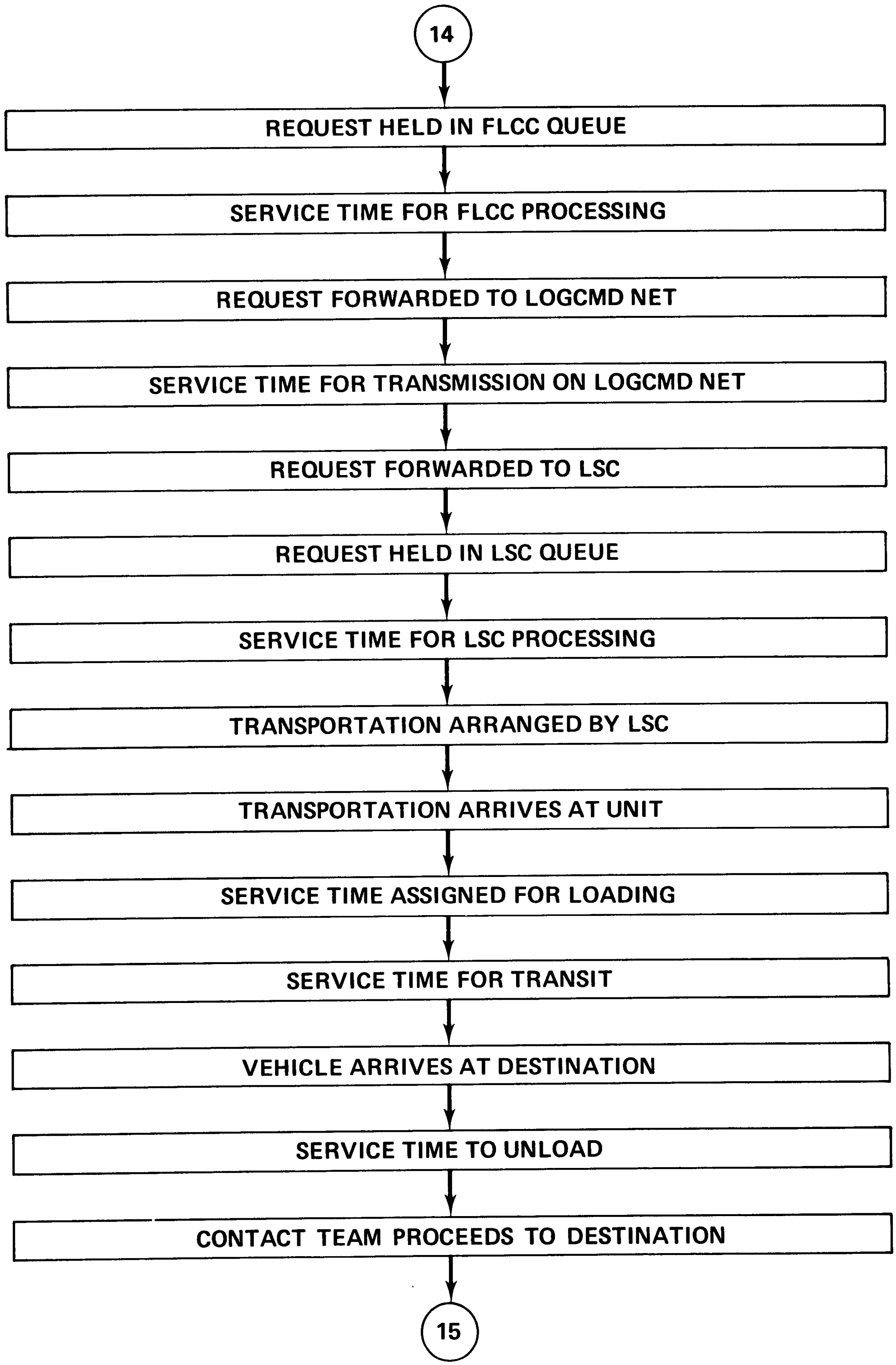

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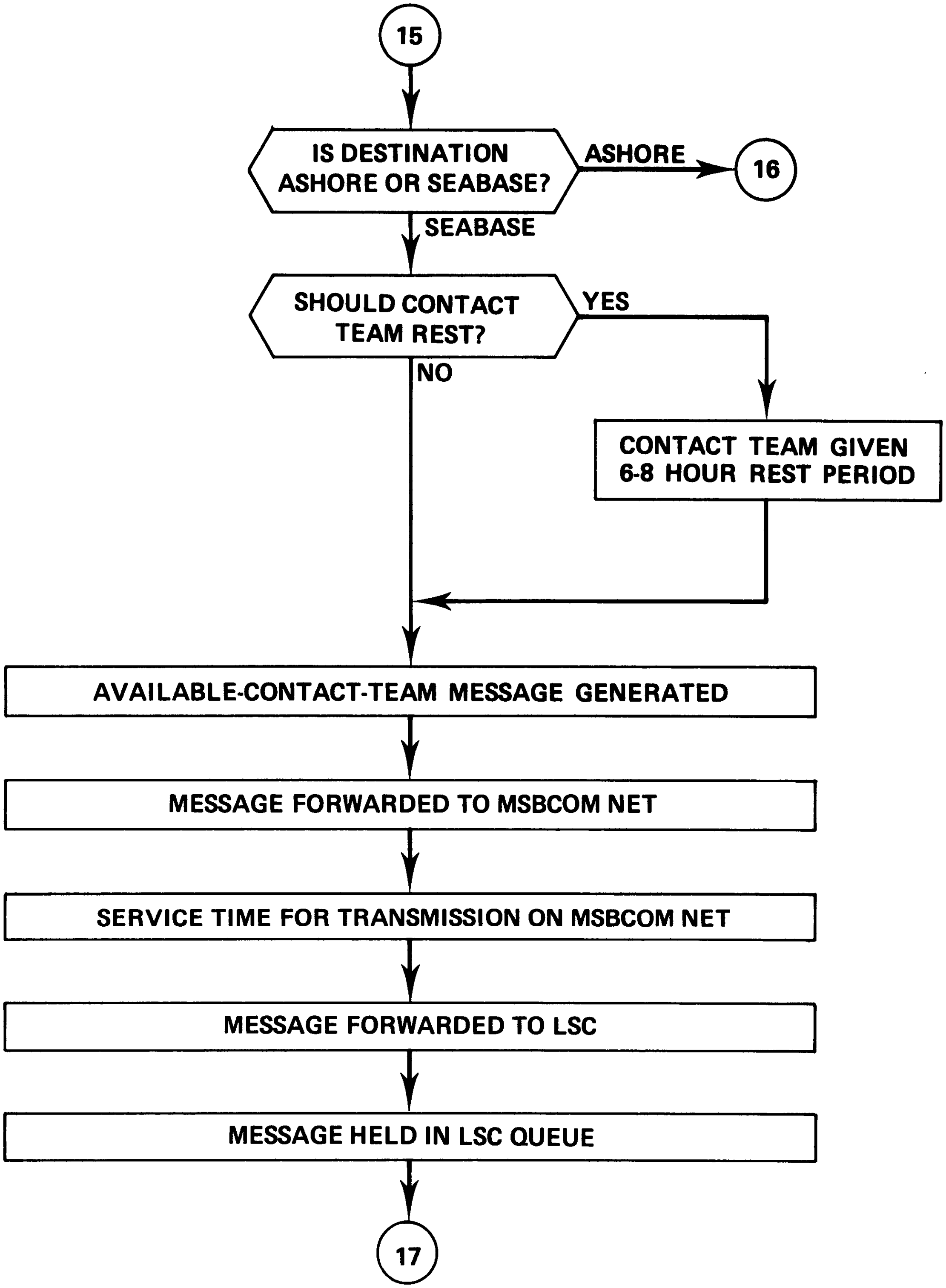

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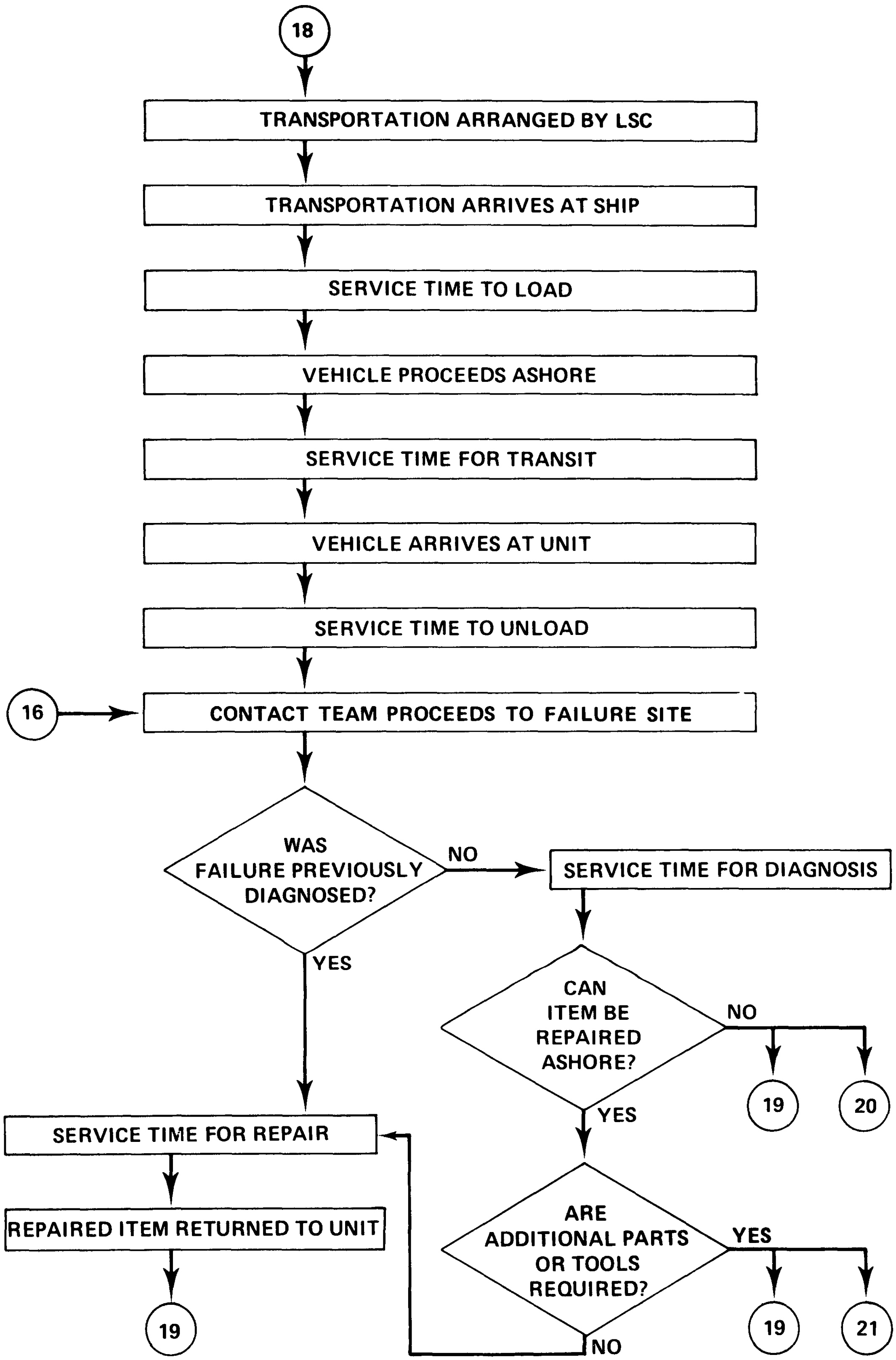

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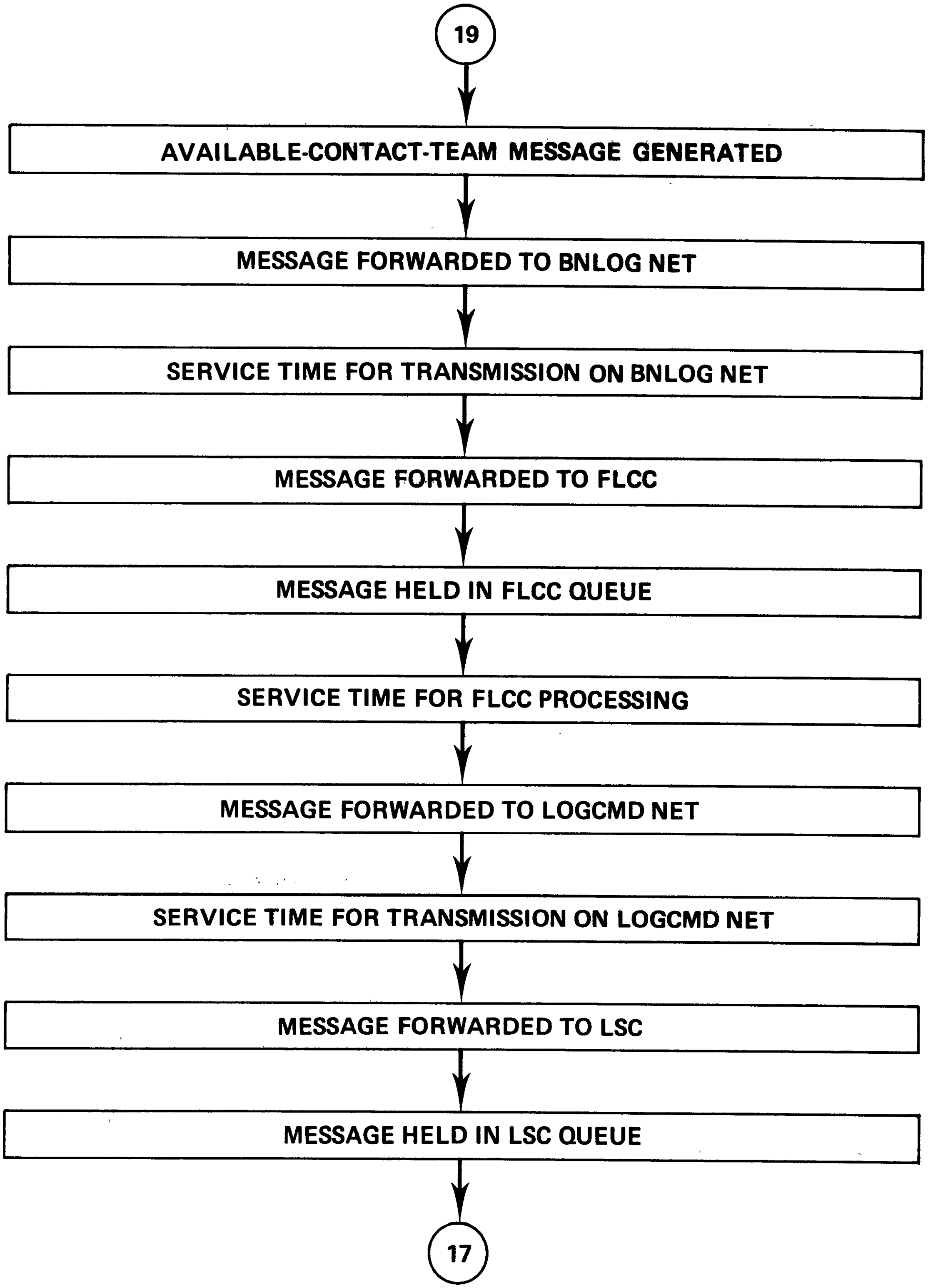

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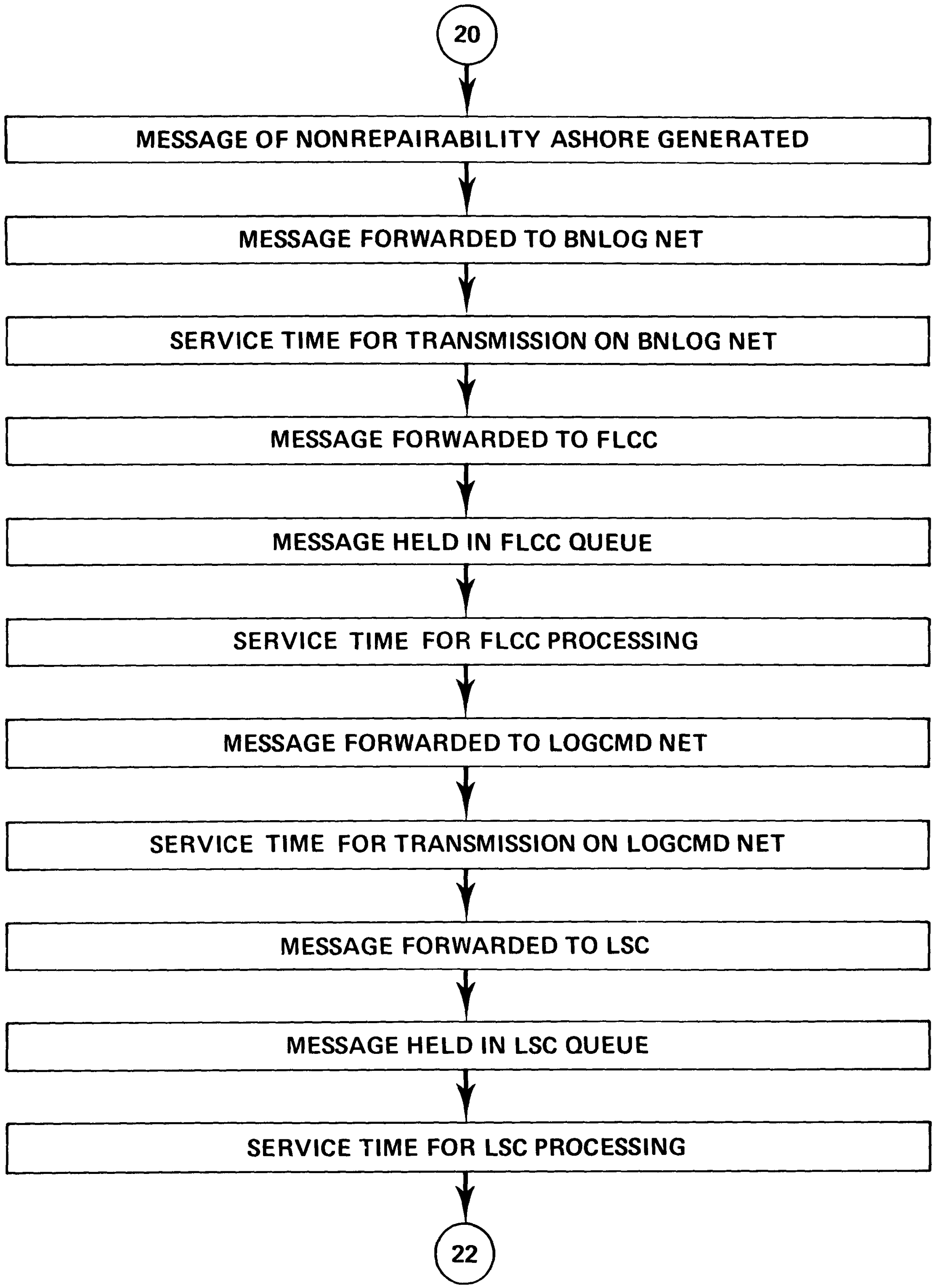

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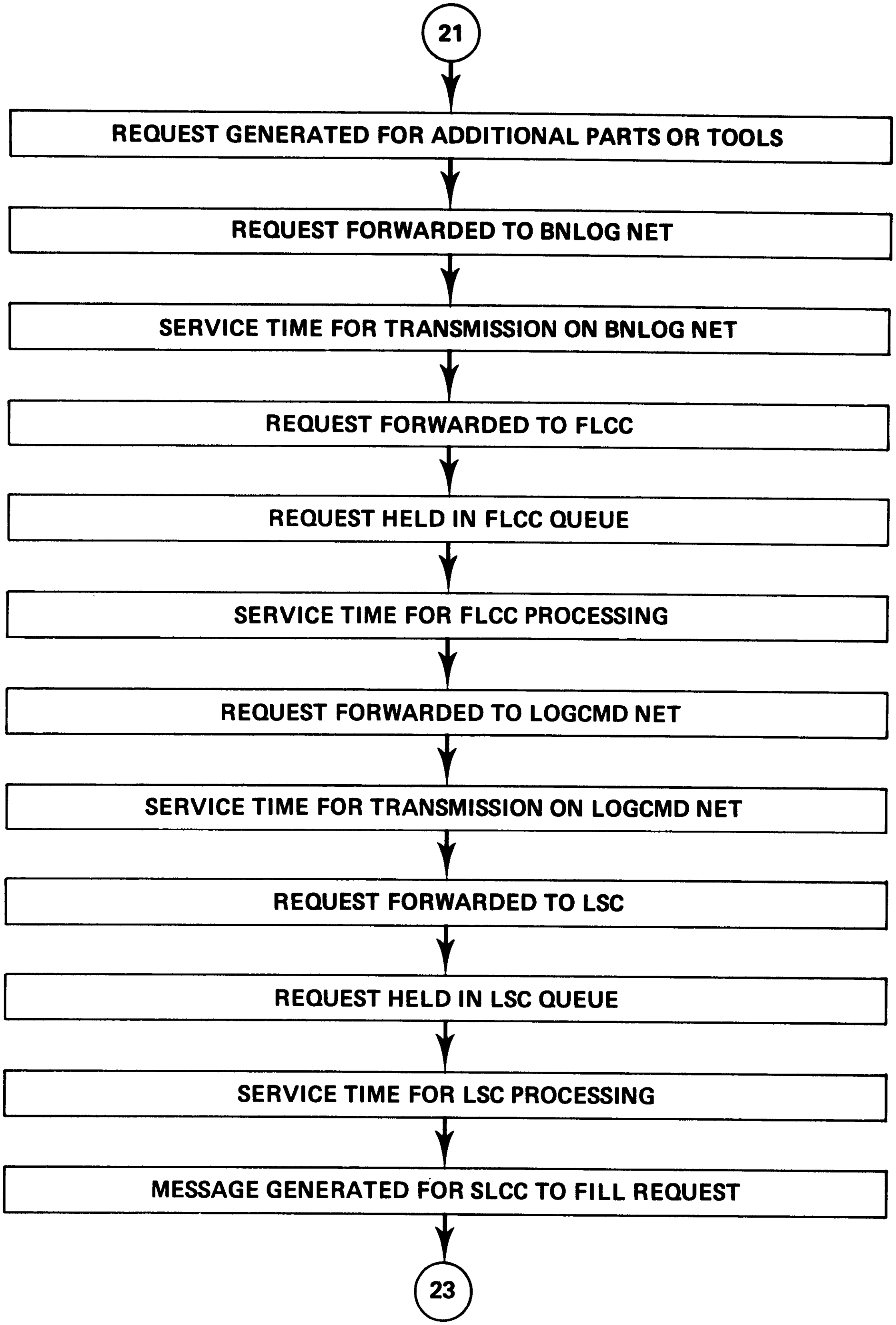

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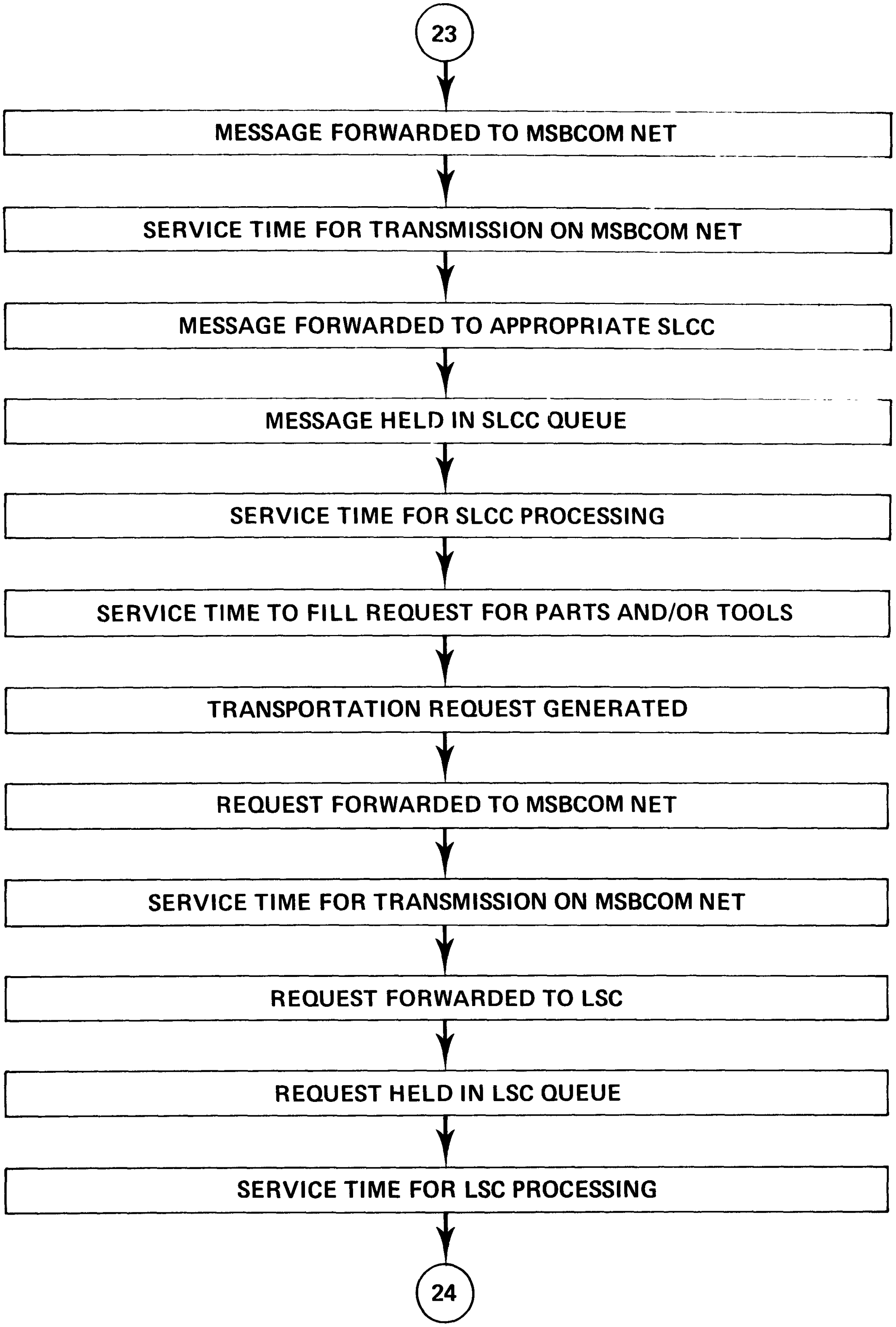

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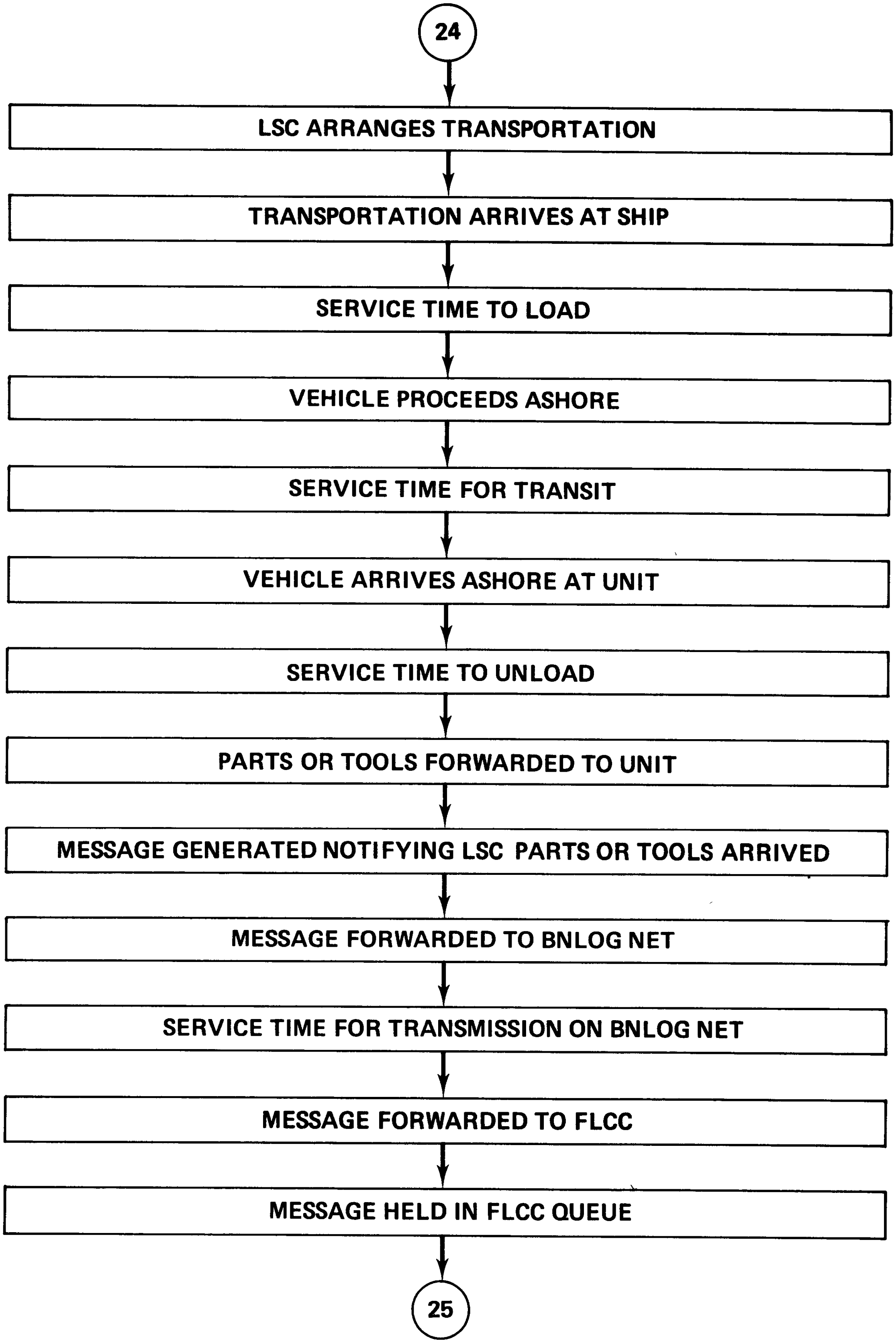

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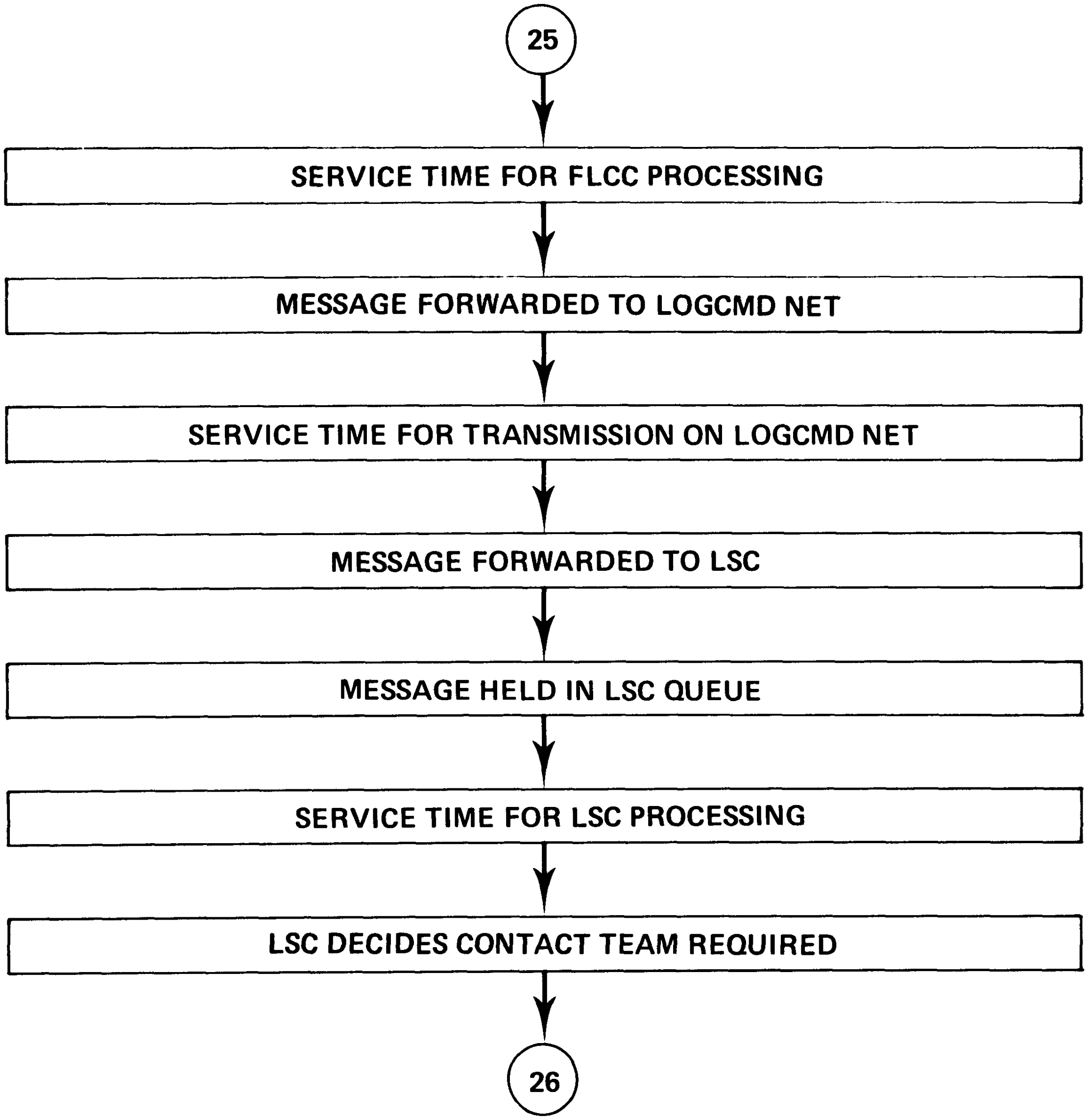

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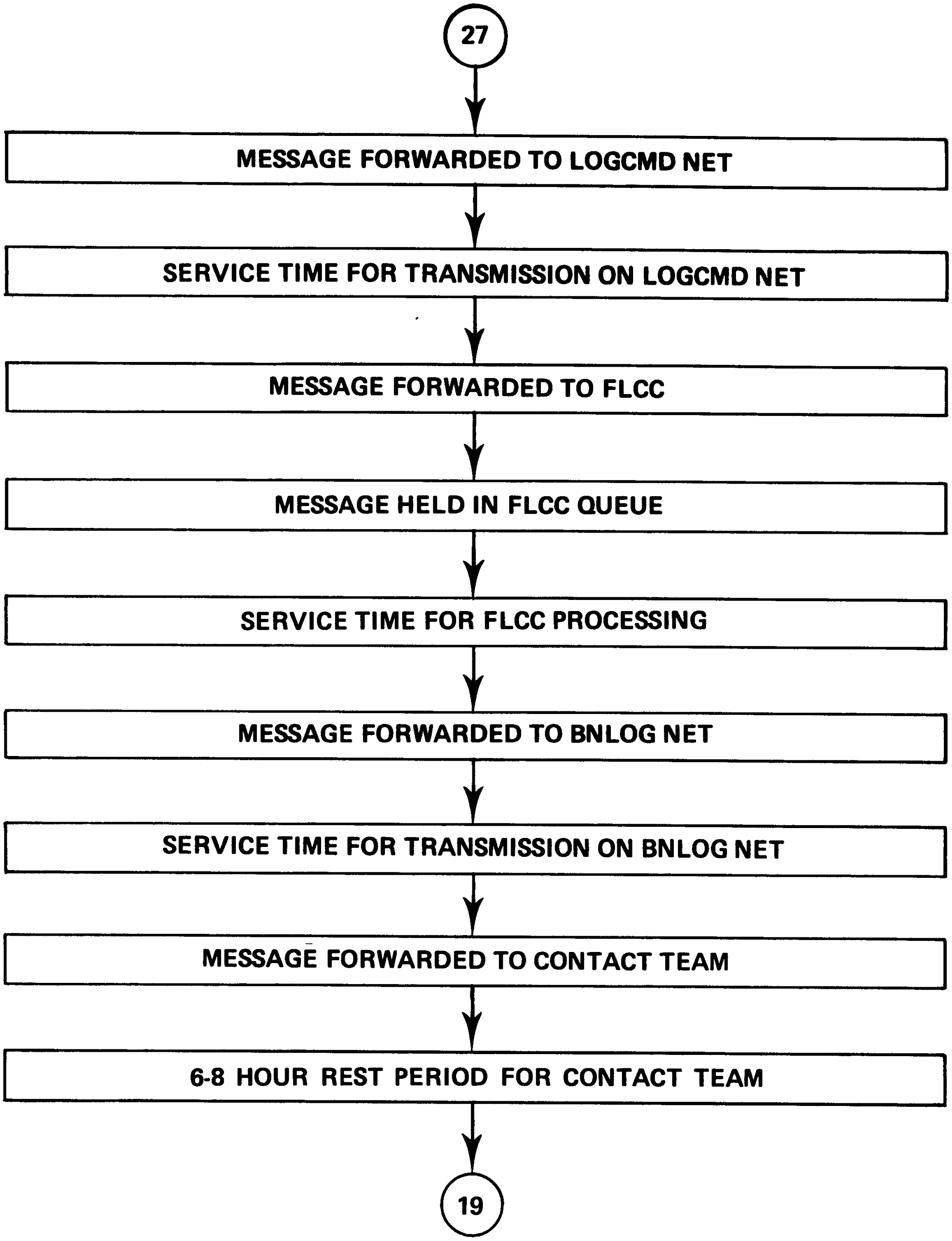

Figure 5 — Continued

3.5 TRANSPORTATION SUBSYSTEM

3.5.1 General

Transportation requests from all subsystems are sent to the LSC to be assigned the proper type of transportation. Transportation assets available to SMLS include helicopters, landing craft, and trucks. The LSC decides which mode of transportation (surface or air) to use for a given priority mission. A service time is assigned representing the time needed to determine the mode of transportation. Transportation requests designated for landing craft are forwarded to the Primary Control Ship (PCS); those designated for trucks are forwarded to the FLCC; and requests for helicopters are held by the LSC until they can be compiled into helicopter loads. When helicopter loads have been compiled, the LSC notifies the Helicopter Direction Center (HDC), which is responsible for the execution of the delivery.

Figure 6 shows the logic flow for the designation of the mode of transportation.

3.5.2 Transportation by Helicopters

3.5.2.1 Operation Procedures for Helicopters

Helicopters are stored at the LPH when not in service. Three conditions must be satisfied for a helicopter to enter service. First, it must have fuel. If the helicopter does not have fuel, it is assigned a service time representing the time to refuel. Second, if the time of day is <u>not</u> between 0600 and 2100 hours, there must be an urgent transportation request in the transportation request queue. Third, if the transportation request queue contains only routine requests, the time of day must be between 0600 and 2100 hours for a helicopter to make its availability known. If the helicopter has fuel, the second and third conditions are checked. If either condition is not fulfilled, the helicopter waits until the appropriate time of day or until an urgent request occurs. When the conditions for a helicopter to enter

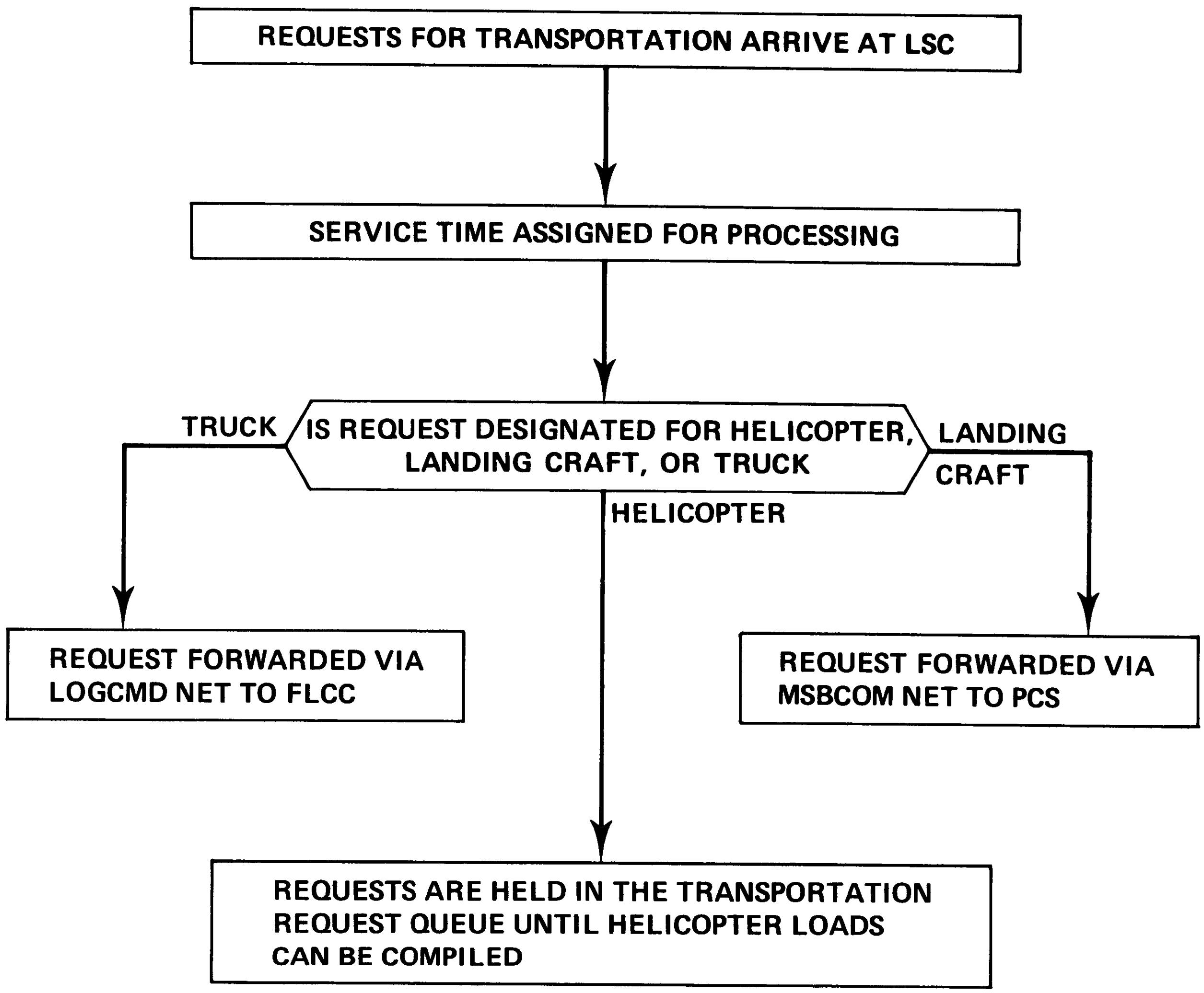

Figure 6 – Designation of the Mode of Transportation

service are satisfied, the helicopter sends a helicopter-available message to the HDC. This message specifies the type of helicopter, its location, and its available flight time. After the message has been sent the helicopter waits for a mission to be assigned.

When the LSC and HDC have established the helicopter's assignment, the helicopter will be ordered either to perform a mission or to return to the LPH. When the helicopter receives its orders, it checks whether it has been ordered to pick up a load at its current location. If it has, a service time is assigned representing the time needed to load the helicopter. Once the helicopter is loaded, or if no load was to be picked up, the helicopter take off and a service time is assigned representing the transit time to the helicopter destination. After this service time has elapsed, a helicopter returning to the LPH for refueling or reassignment lands on the LPH when deck space is available, and helicopters for other destinations land when landing space is available.

When the helicopter lands at its destination, the model checks to determine whether it is carrying a load for this destination. If it is, a service time is assigned representing unloading time. Next the model determines whether the helicopter has completed its mission. If the mission is not completed, a service time is assigned to load the remaining items cited in the helicopter orders; and the helicopter then takes off and proceeds to its destination. If, however, the helicopter has completed its mission, the model determines whether the helicopter has enough remaining flight time available to accept another mission. If it does not have enough flight time, the helicopter is ordered to return to the LPH for refueling; and the helicopter takes off and proceeds to the LPH. If flight time is still available, the model checks the conditions involving the time of day and the transportation-request queue. If these conditions are satisfied, the helicopter makes its availability known to the HDC. The helicopter then waits for orders to be assigned. If these conditions are not satisfied, the helicopter is ordered to return to the LPH. In either case, the helicopter takes off and proceeds to its assigned destination.

Figure 7 shows the logic for helicopter operations.

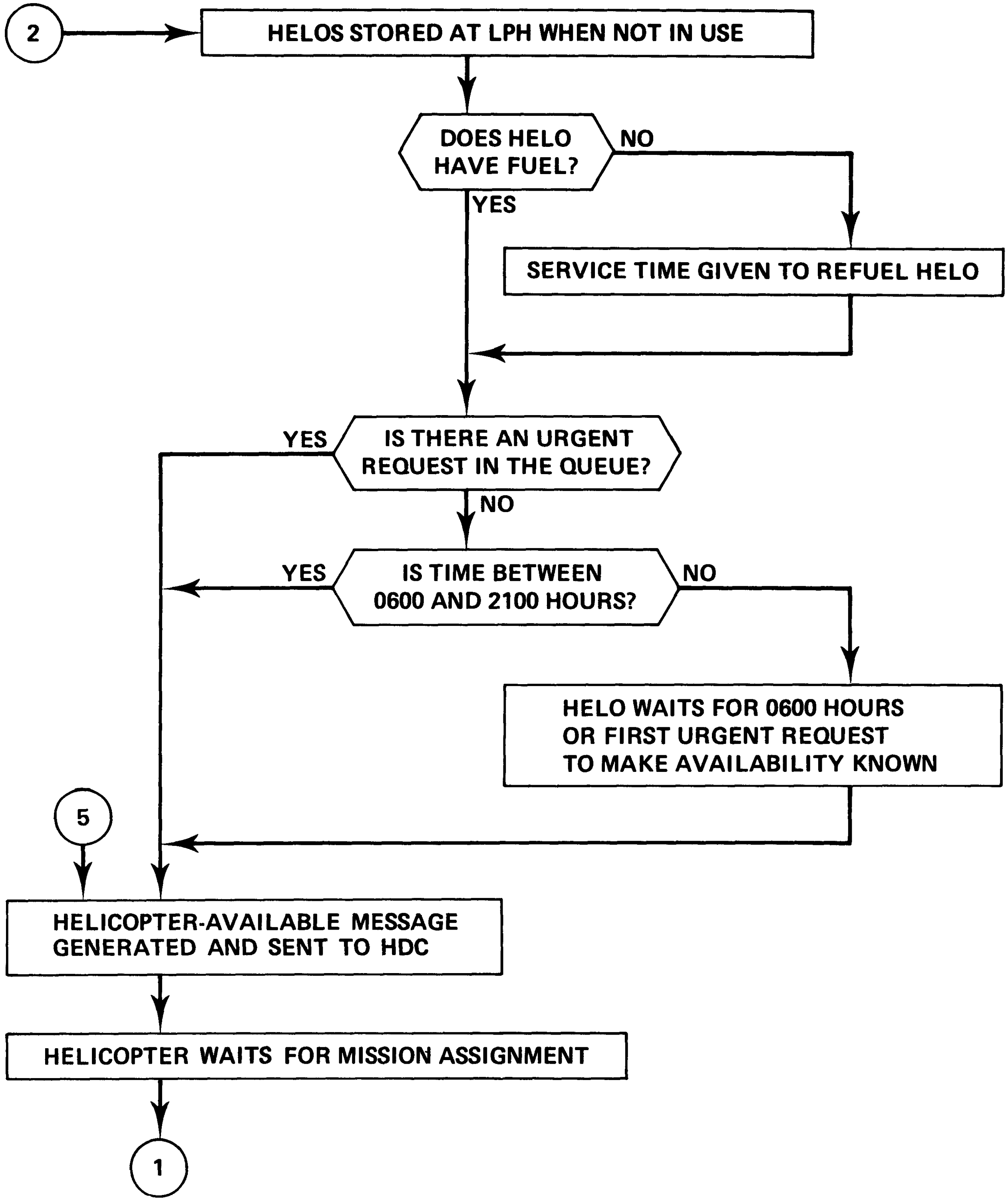

Figure 7 – Helicopter Operation Flow Diagram

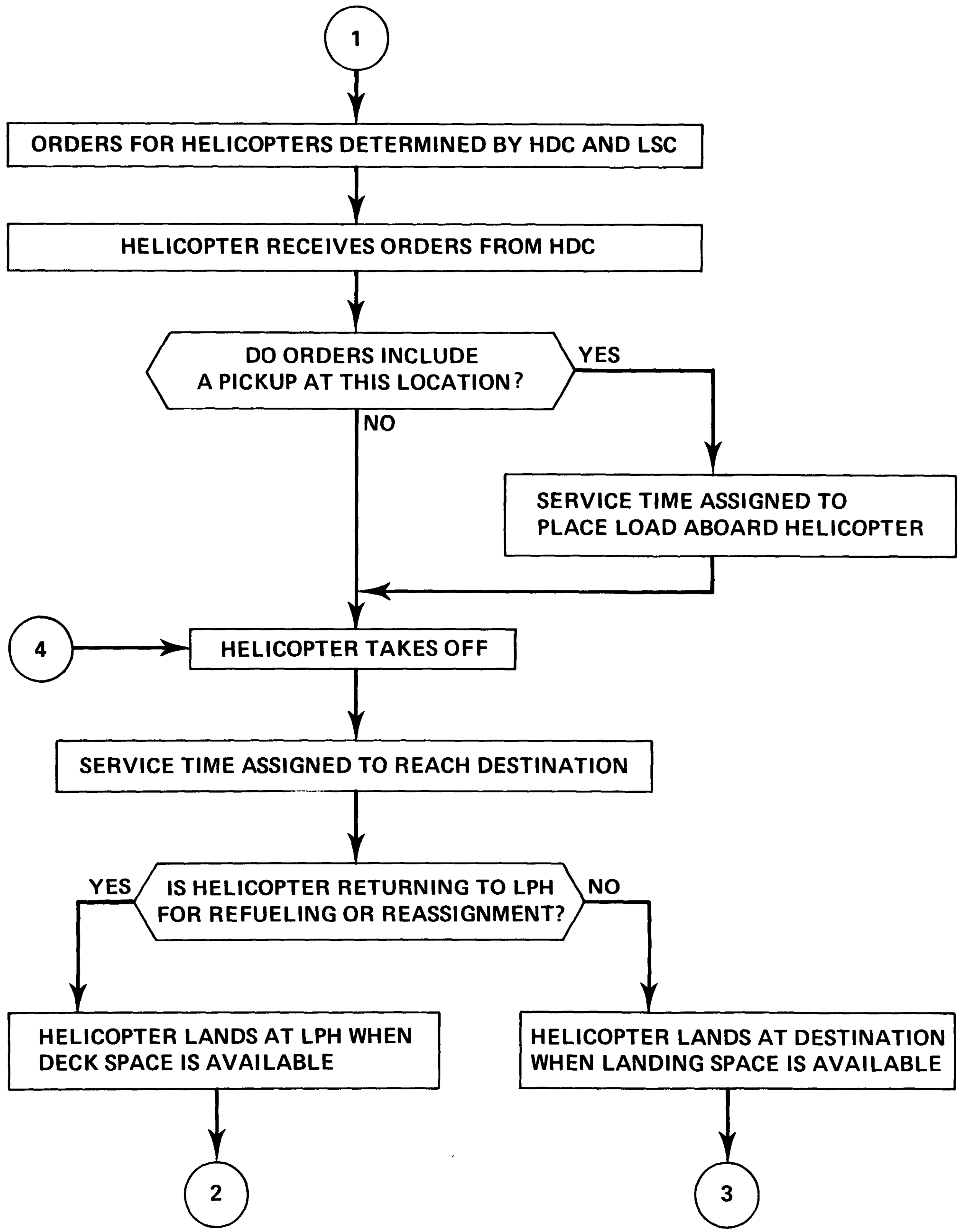

Figure 7 — Continued

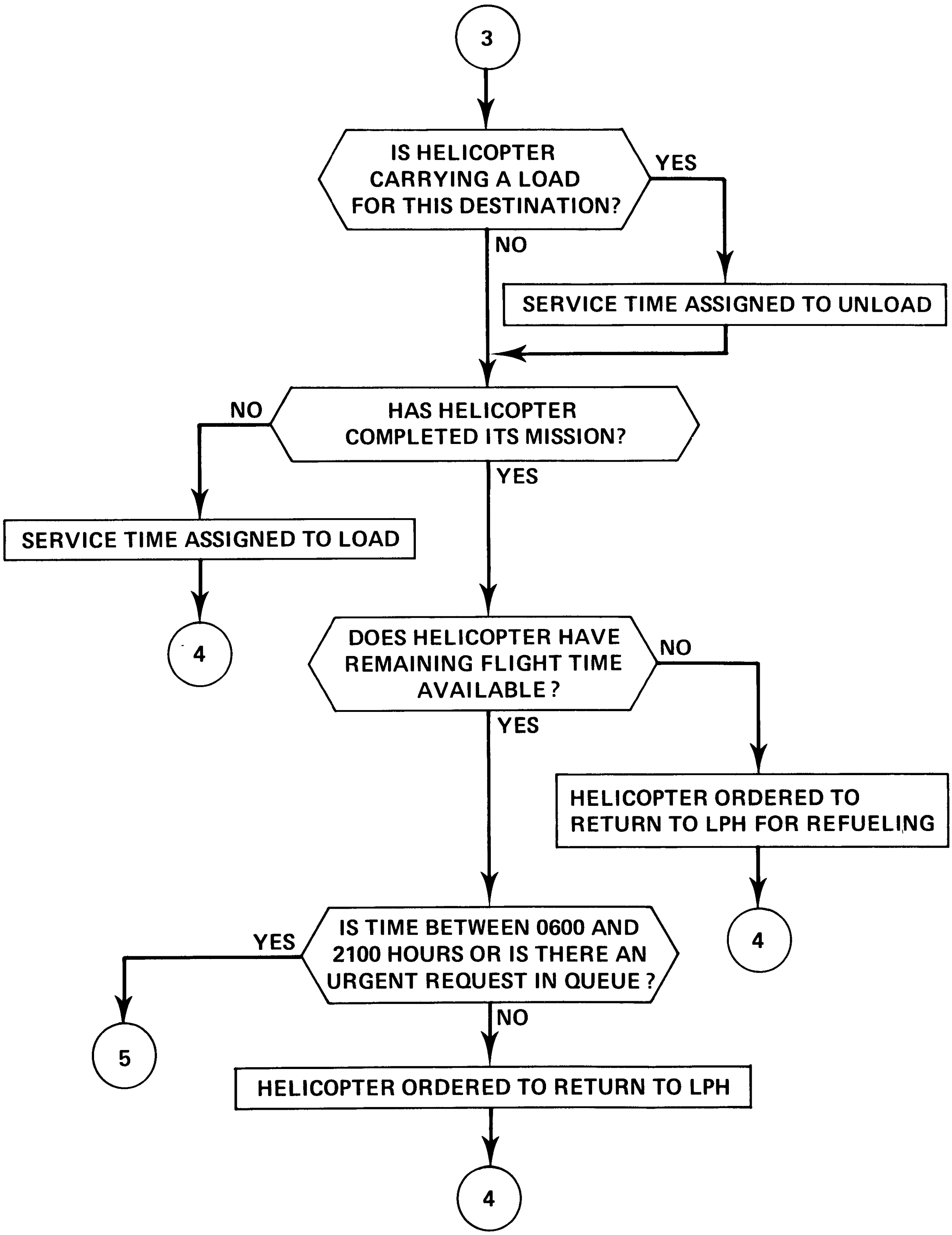

Figure 7 — Continued

3.5.2.2 Assignment of Helicopter Loads

Messages of helicopter availability arrive at the HDC from helicopters which become available either at the LPH or at other locations. The messages are held in a queue until they can be processed. In the model it is assumed that the HDC can process only one message at a time. When the message can be processed, it is assigned a service time representing HDC processing time. The HDC then checks the status of the transportation-request queue. If there are no jobs in the queue which may require helicopter transportation, a message will be generated instructing helicopters not located at the LPH to return to the LPH. This message is forwarded to the individual helicopters. If there is a request for a helicopter in the transportation request queue, the HDC generates a message notifying the LSC of the availability of the helicopter. This message is forwarded to the LSC. In the model, the HDC and LSC are assumed to be located aboard the same ship. Therefore, message are transferred between HDC and LSC by voice or telephone. In actuality, the agencies may be located aboard different ships and a communication network may have to be established.

Transportation requests which are designated by the LSC for helicopter delivery are held in the transportation request queue until they can be assigned to a helicopter load. When the helicopter-available message arrives at the LSC, it is held in a queue until it can be processed. It is assumed that the LSC can process only one such message at a time. When the message can be processed, it is assigned a service time representing LSC processing time. The LSC then selects from the transportation request queue the top priority request which the helicopter can satisfy. The decision is based on a comparison of time, weight, and cube specifications of the request with time, weight, and cube capabilities of the helicopters. The first request selected for the load is called the initial request. Once the initial request is selected, the points between which the helicopter will travel are determined. The helicopter will travel from its current location to the pickup location specified by the initial request, if the two points are not the same, and then to the delivery location contained in the initial request. The load carried between the pickup and delivery points specified in the initial request is called the primary load. A load carried between the current location of the helicopter and the pickup point of the primary load is called the secondary load. A term secondary load is thus not used when the current location of the helicopter and the pickup point of the initial load are the same.

The model next determines whether the initial request is to be transported by external or internal carriage. If the carriage is external, no further loads can be added to the initial request. Therefore, the primary load is complete. If the carriage is internal, the LSC adds other requested loads moving between the pickup and delivery points of the initial request until either the weight or volume capabilities of the helicopter are fully utilized, or until there are no requests remaining which can be considered. When the LSC has selected as many requests as possible, the primary load is complete.

The model then determines whether a secondary load can be carried. A secondary load will not be added when the current location of the helicopter is the same as the pickup location of the primary load or when there are no requests in the transportation request queue requiring transportation from the location of the helicopter to the pickup location of the primary load. If a secondary load is possible, the top priority request is selected from the requests under consideration. If this request is for external carriage, the secondary load is complete. If the first request selected is for internal carriage, the model adds other requests to the secondary load until either the capabilities of the helicopter are fully utilized or until there are no requests left to be considered. When as many requests as possible have been selected, the secondary load is complete.

When both the primary and secondary loads have been completed, all requests selected are consolidated into a load order. The load order is fowarded from the LSC to the HDC. The order is held in a queue until it can be processed by the HDC. A service time is then assigned representing HDC processing time. The HDC then forwards the load order to the appropriate helicopter.

Figure 8 presents the logic flow for the assignment of helicopter loads.

3.5.3 Transportation by Landing Craft

Landing craft are stored at the seabase when not in use. Requests which have been designated for landing-craft transportation are held in a queue at the PCS until the load can be assigned to a landing craft. Hourly the model checks the queue and assigns loads. A load will be compiled for each pickup location from which supplies have been requested, with the model attempting to maximize the utilization of the landing craft's weight and volume capabilities by sending the smallest craft capable of handling a given load. When a load has been compiled, a check is made of the pickup location of the load. If the pickup location is at the seabase, the load is assigned to a landing craft at the seabase, and a message is forwarded to the landing craft notifying it of this fact. A service time is assigned for the landing craft to travel to the pickup point. A service time is then assigned representing the time to load. The landing craft then proceeds ashore, the appropriate service time being observed by the model. When the landing craft arrives at the beach, it is assigned a service time to unload. The model then determines whether the landing craft has been assigned a load on the return trip. If a return load has been assigned, a service time is assigned to load the landing craft. A service time is then assigned representing the time to travel from the beach to the seabase. When the landing craft arrives at the seabase, it is assigned a service time to unload. The landing craft is then stored at the seabase until another load is assigned. If, after unloading at the beach, no return load is assigned, the landing craft is ordered to return to the seabase. A service time is assigned for travel to the seabase and the landing craft is stored until reassigned.

If the pickup location of the load is the beach, the PCS determines whether a landing craft is available at the beach or whether a landing craft in transit to the beach can be assigned the load. If such a craft is available, the load will be assigned to it. The message is forwarded to the landing craft when it is at the beach. A service time is then

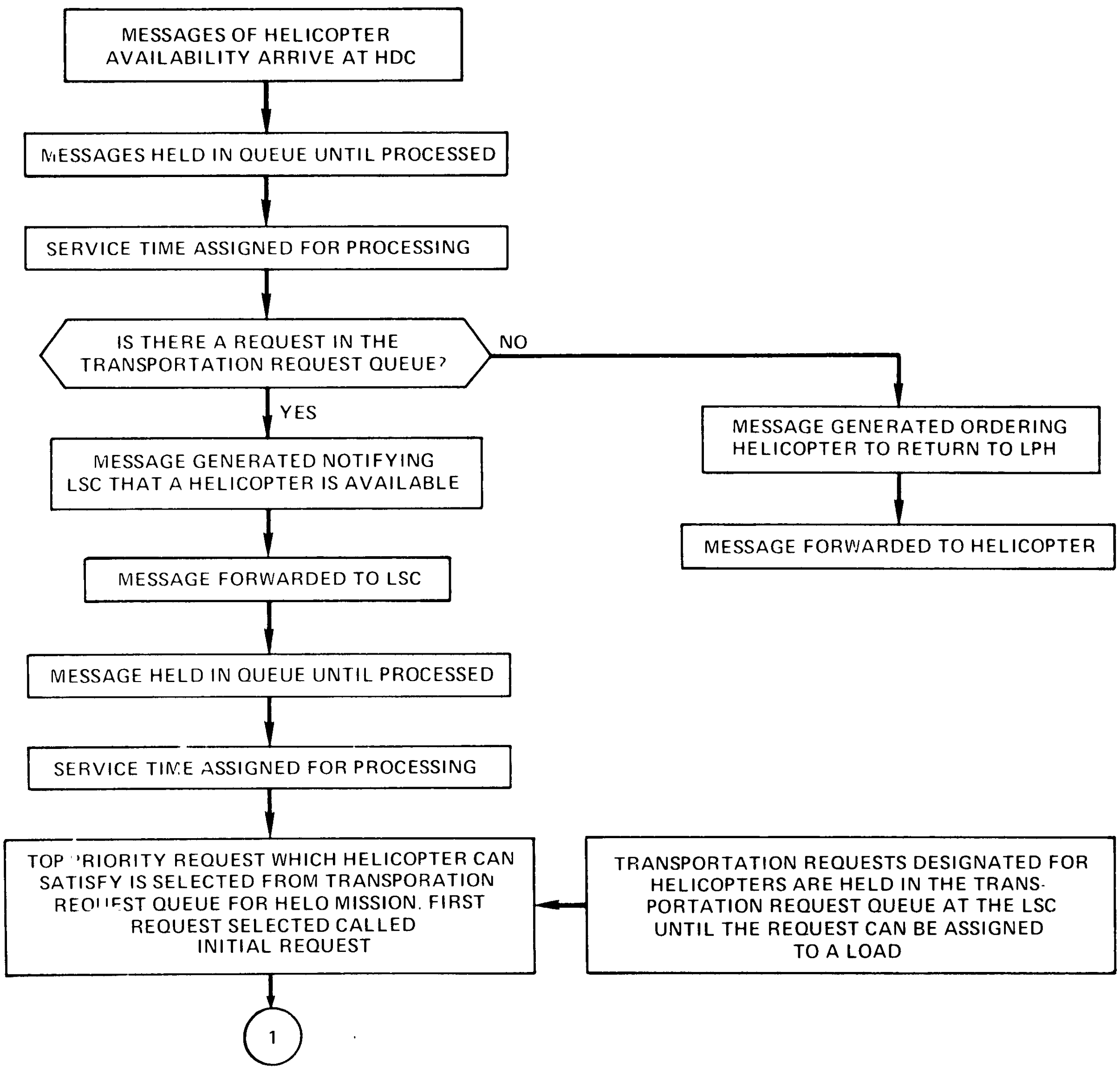

Figure 8 – Assignment of Helicopter Loads Flow Diagram

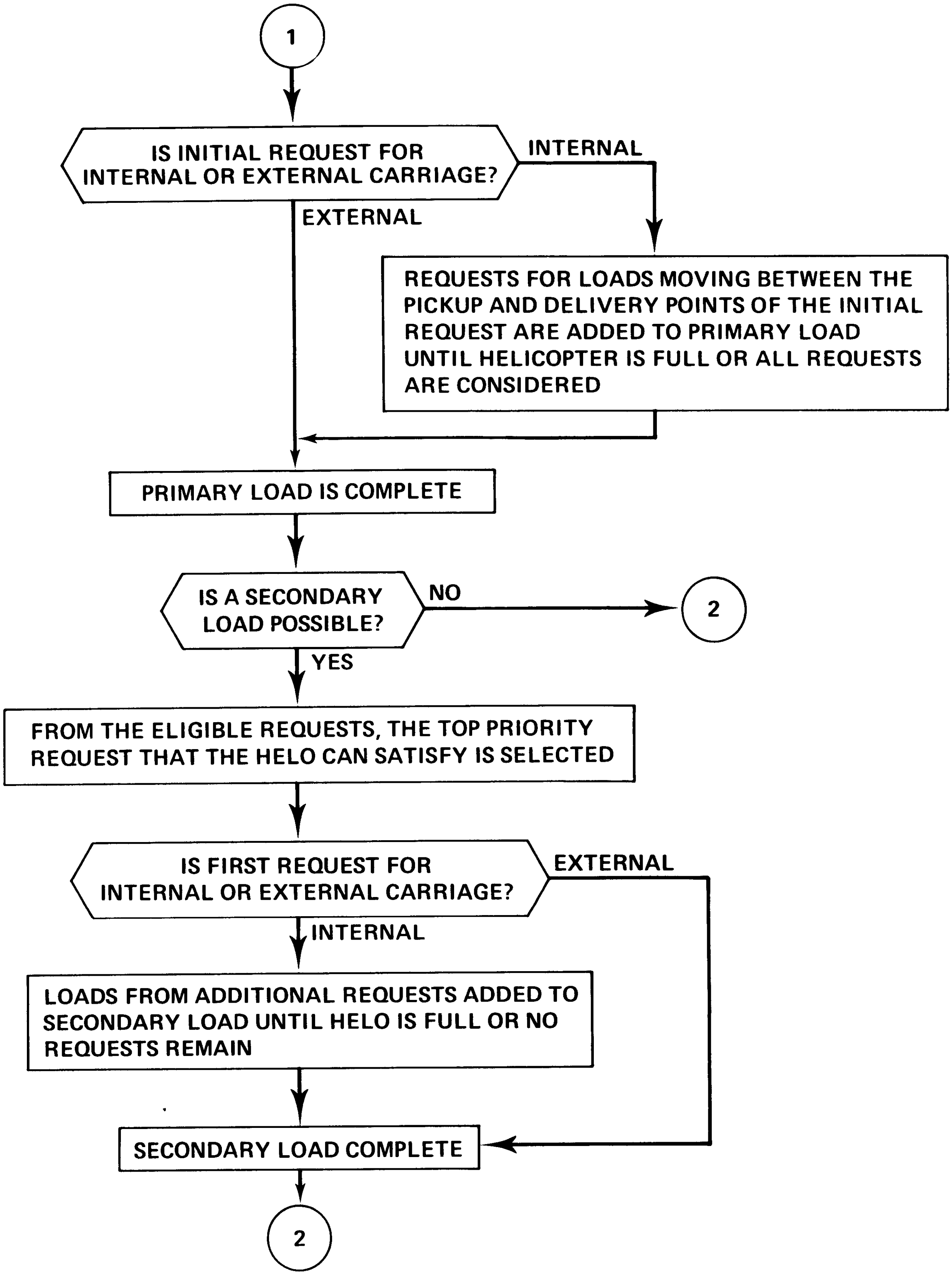

Figure 8 – Continued

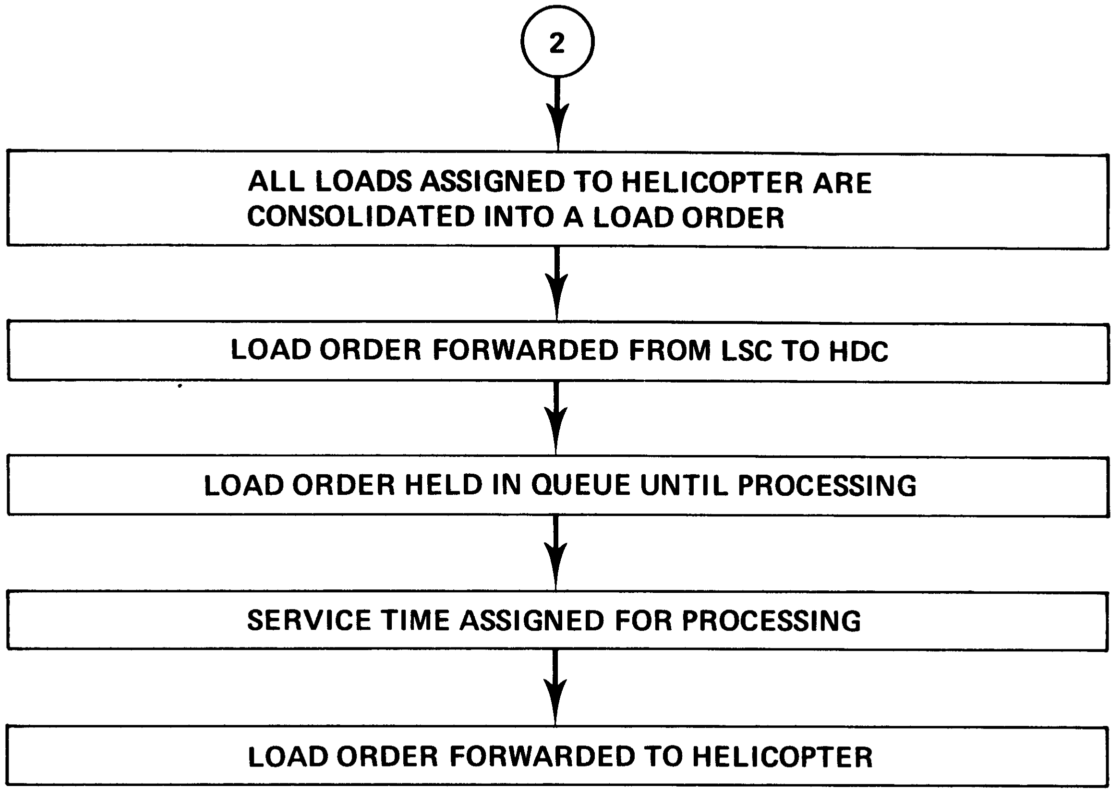

Figure 8 — Continued

assigned to load the vehicle. The loaded vehicle then proceeds to the seabase, the appropriate service time being applied for transit. When the landing craft arrives at the seabase, it is assigned a service time to unload. The landing craft is then stored until reassigned.

If a load at the beach cannot be assigned to a landing craft at the beach, the model assigns the load to a landing craft at the seabase. A message is forwarded to the landing craft notifying it of this fact. After a service time for transit to the beach, the landing craft is assigned a service time representing the time to load. A service time representing transit time from the beach to the seabase is then assigned to the vehicle. When the landing craft arrives at the seabase, it is assigned a service time to unload. The landing craft is then stored until the PCS assigns another mission.

Figure 9 shows the landing-craft flow diagram.

3.5.4 Transportation by Truck

Requests which have been designated for truck transportation are held in a queue at the FLCC until loads are compiled. Hourly the model compiles loads based on pickup location and the weight and volume capabilities of the trucks. When the loads have been compiled, the model determines whether a truck is available at the pickup point of the load. If a truck is available at the pickup location, a message is generated assigning that truck to fulfill the request. If a truck is not available at the pickup location, a message is generated assigning a truck at the FLCC to fulfill the mission. In either case the message is forwarded to the truck.

Trucks are stored at the FLCC when not in use. When a truck receives an assignment, the model determines whether the truck is already located at the pickup point of the load. If it is not, a service time is assigned for travel to the pickup point. A service time for loading the truck and a service time for transit to the destination of the load are then assigned. When the truck arrives at the destination, a service time is assigned for unloading.

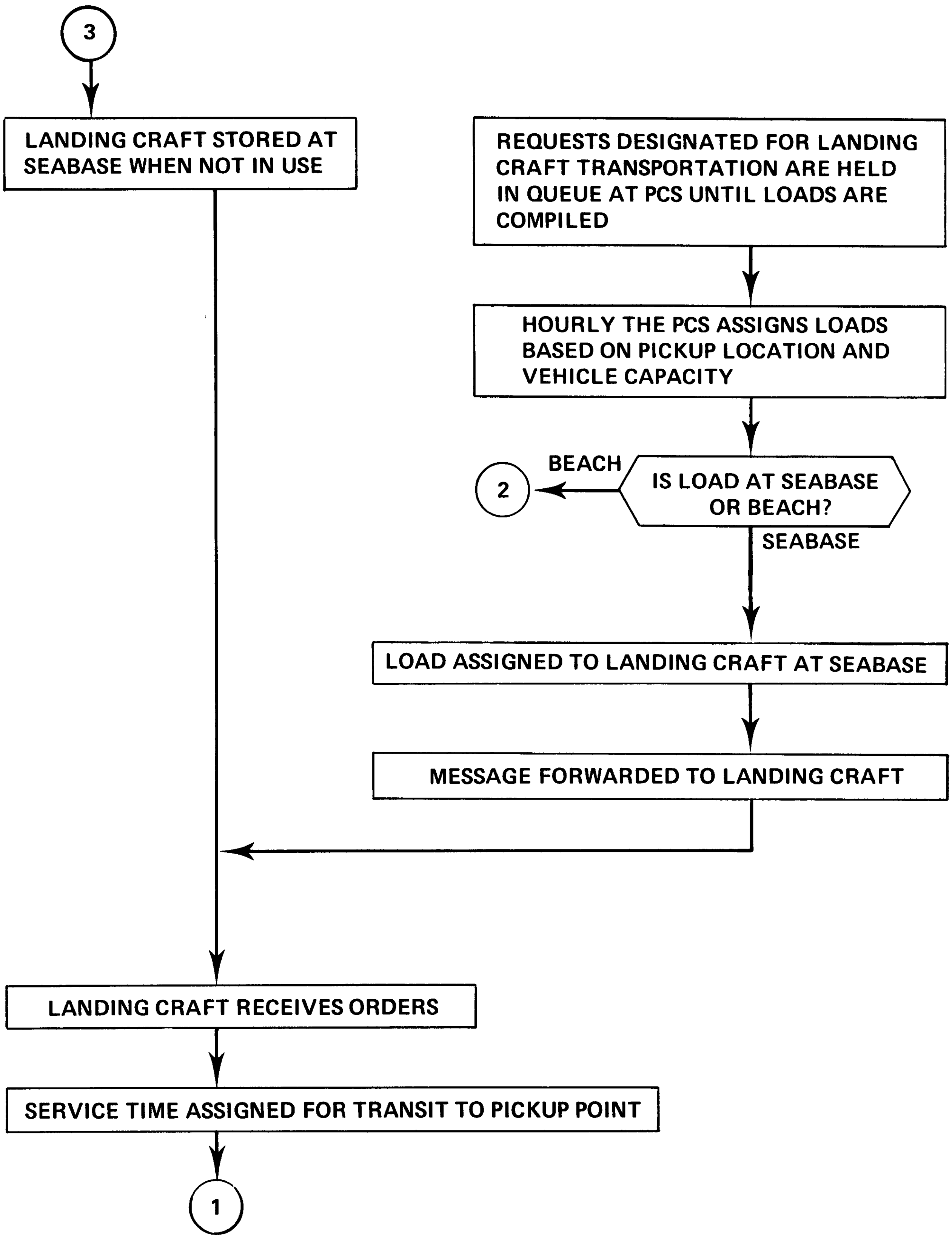

Figure 9 — Landing Craft Flow Diagram

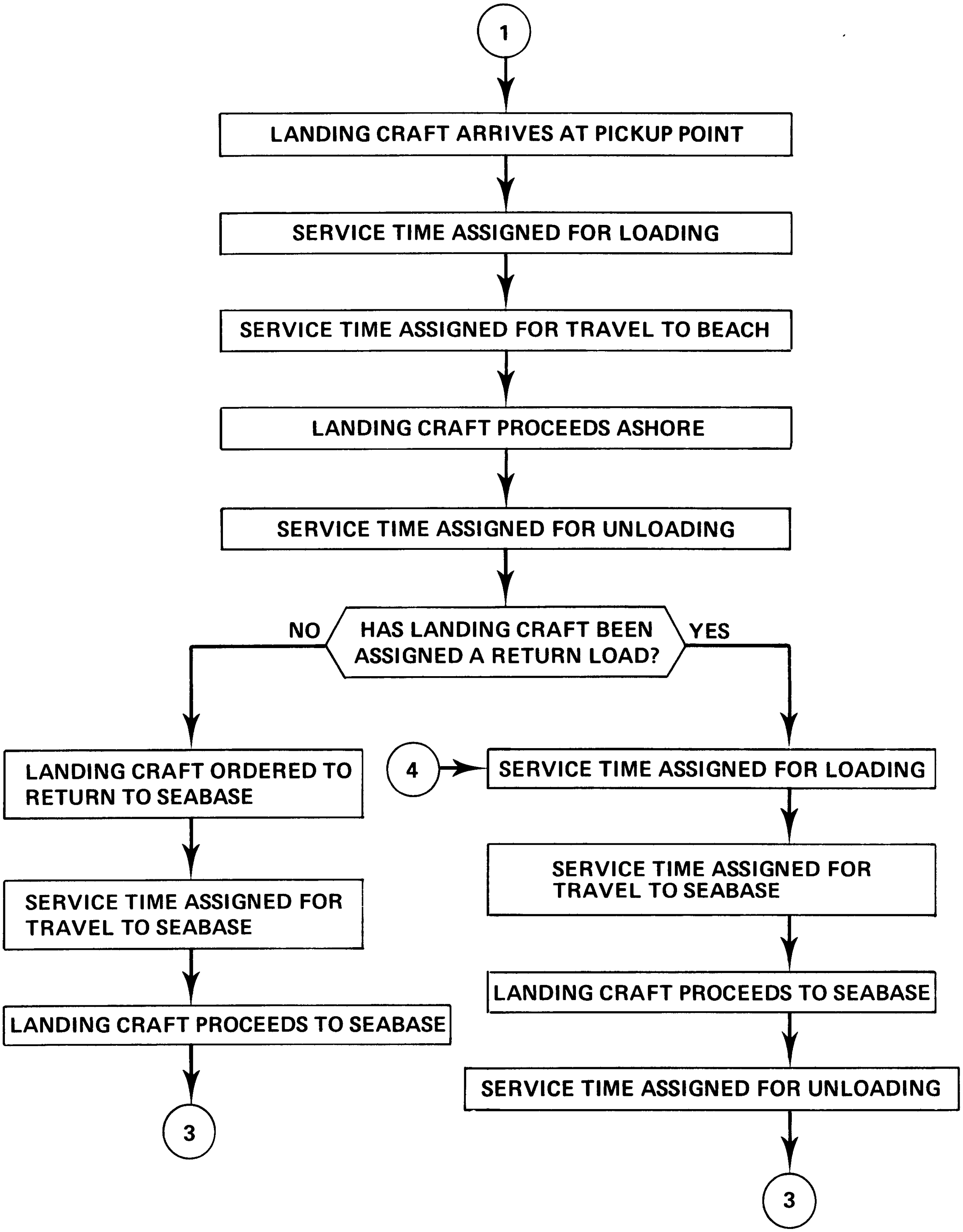

Figure 9 – Continued

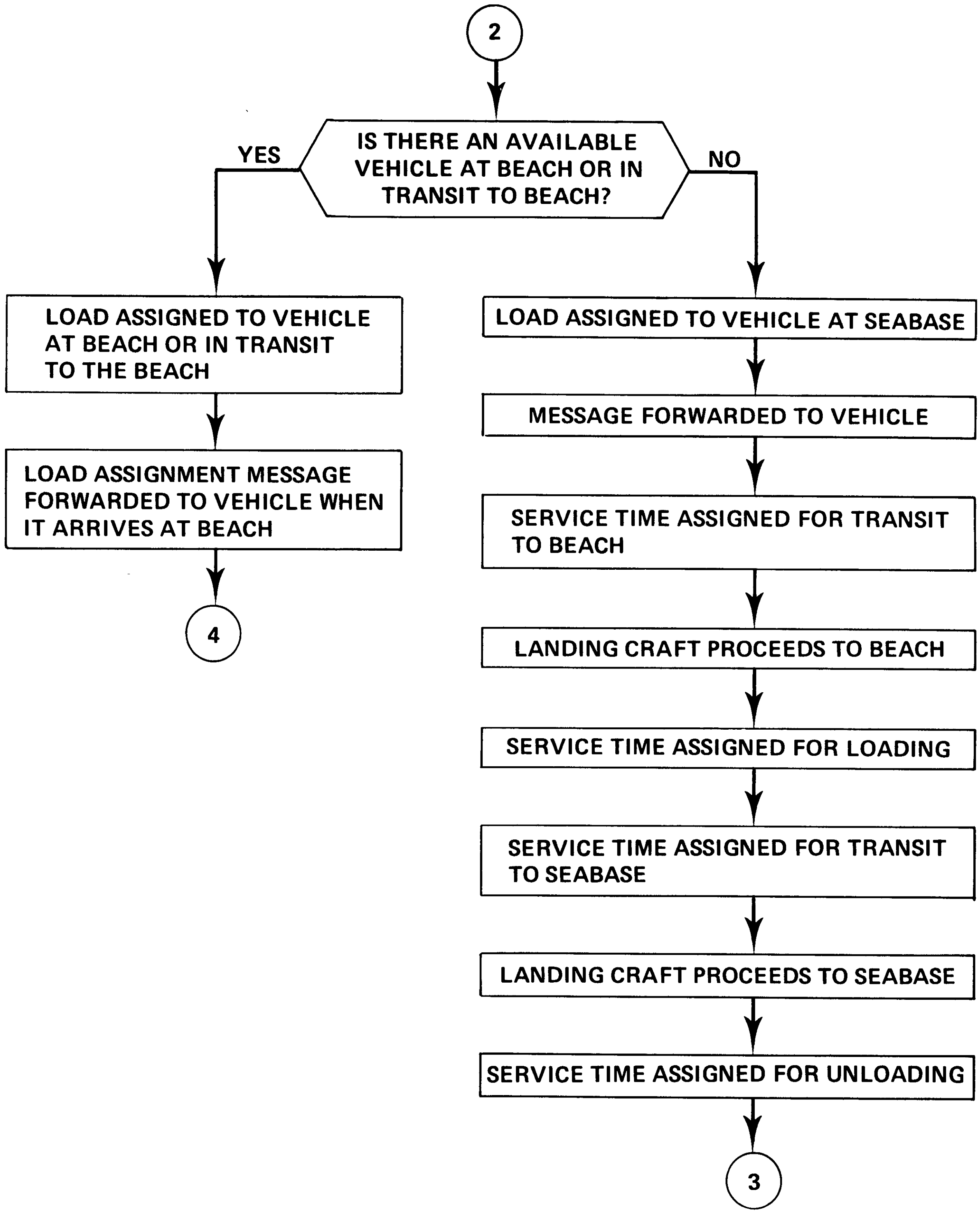

Figure 9 — Continued

The model will assign the truck another mission if there is a requirement that can be assigned. If another load is assigned, the procedures discussed previously are followed. If another load is not assigned, the truck is ordered to return to the FLCC. The truck is assigned a service time representing transit time to the FLCC. When the truck arrives at the FLCC, it is stored until reassigned by the FLCC.

Figure 10 presents the flow diagram for transportation by trucks.

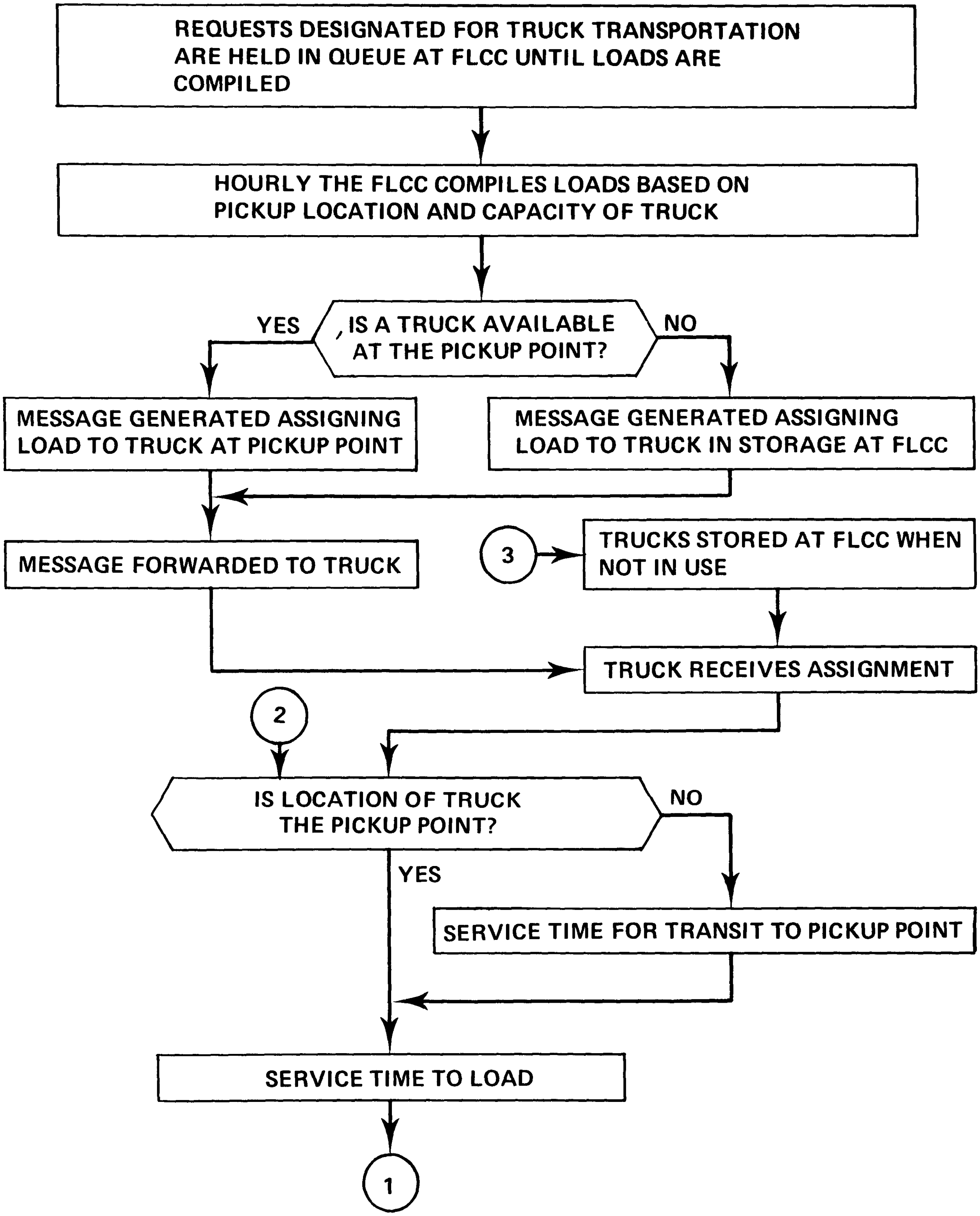

Figure 10 – Truck Transportation Flow Diagram

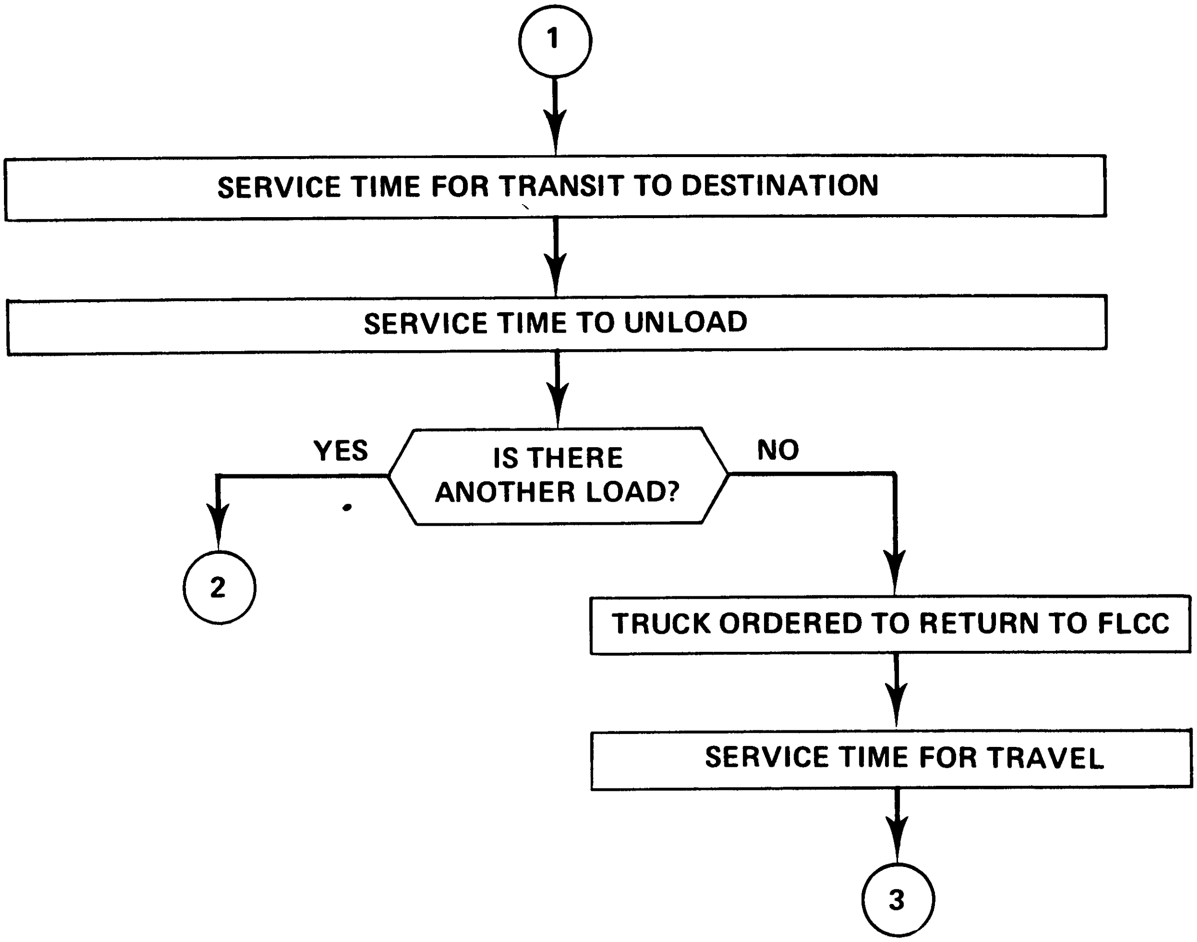

Figure 10 — Continued

4. SMLS SIMULATION MODEL INPUT PARAMETERS

Development of the SMLS simulation model required identification of input parameter requirements. These requirements were presented to the SMLS study team of the Marine Corps Development and Education Command (MCDEC) at Quantico, Virginia. MCDEC, working with various agencies and commands, then developed the data base presented in this section by establishing realistic quantitative values for these input parameters for operational situations.

4.1 SCENARIOS

Two general scenarios, considered to be typical of the kinds of situations an SMLS-configured ATU/MAU would face, were developed for evaluation in the simulation model. The first is a 10-day fairly intense conflict (for a MAU), and the second is a 90-day crisis-control/counterinsurgency situation. Once the scenarios were developed, the data developers were able to define the combat tempo, tactical requirements, ground combat elements, equipment lists and usage rates, and medical-casualty and supply usage rates.

4.1.1 10-Day Intense Conflict

In the 10-day intense conflict (i.e., intense for a MAU) four infantry companies, a headquarters and service company, and artillery and tanks are located ashore. This scenario is characterized by a high ammunition usage rate, a fairly high casualty rate, considerable air movement, and low cross-country ground vehicle movement. This scenario can be envisioned as a mission requiring the MAU to hold a key piece of terrain (e.g., a mountain pass) or a man-made facility (harbor/airfield) for a short period of time, either to await follow-on forces or as a means to evacuate U.S. nationals.

4.1.2 90-Day Crisis-Control Situation

In the 90-day crisis-control/counterinsurgency situation, three infantry companies, a battalion headquarters, and limited combat support elements are located ashore. This mission is characterized by a low ammunition usage rate, a low casualty rate, considerable air movement, and high cross-country ground vehicle movement. This scenario can be envisioned as a mission to assist a friendly government undergoing temporary internal problems.

4.2 COMPOSITION OF THE AMPHIBIOUS TASK UNIT

The simulation model has been designed to provide all logistic support from three types of ships considered essential for SMLS operations: a large helicopter platform ship, a bulk-storage supply ship, and a well-deck ship to launch and retrieve landing craft. The following list gives respectively the types of ships considered in the model, along with their logistic functions:

- o LPH (helicopter transportation, medical, maintenance)
- o LKA (medical, supply, maintenance)
- o LSD (supply, maintenance, boat transportation)

The characteristics (e.g., helicopter deck capacities, medical capacities, supply breakout times) of these ships were established in the model logic or input to the model, but the model is not limited to these three ships, having been written in a general manner whenever possible. Thus the LSD could be exchanged for an LPD by replacing the LSD characteristics by LPD characteristics. Similarly, the LKA and LSD could be replaced by two LPD's. However, as presently written for a MAU-size force, no more than three ships (one of each type) can be utilized in the model.

4.3 COMPOSITION OF THE GROUND ELEMENT ASHORE

The compositions of the ground elements ashore for the 10-day and crisis-control scenarios are listed, respectively, in Tables 1 and 2.

4.4 LIST OF EQUIPMENT ASHORE

The equipment used ashore by the ground element is listed in Tables 3 and 4 for the ten-day and crisis-control scenarios, respectively.

TABLE 1 - COMPOSITION OF THE GROUND ELEMENT ASHORE (MEN) FOR THE 10-DAY SCENARIO

	Rifle Companies				Headquarters and Service	Artillery Battery
	A	B	C	D		
Infantrymen	207	207	207	207	-	120
Communications	-	-	-	-	8	-
Forward Air Controller	5	5	-	-	-	-
Forward Observer	4	4	4	4	-	-
106-mm Recoilless Rifle	-	-	-	-	40	-
81-mm Mortar	-	-	-	-	96	-
Medical Corpsmen	11	11	11	11	-	-
Helicopter Support Team	-	-	-	-	17	-
Engineer	-	-	-	-	33	-
Interrogation Team	-	-	-	-	3	-
Battalion Command Group	-	-	-	-	14	-
	227	227	222	222	211	120

FLCC

Tank Platoon	30
Shore Party Platoon	46
Amphibian Tractor Platoon	42
FLCC Operations	30
	148

TOTAL - 1,377

TABLE 2 - COMPOSITION OF THE GROUND ELEMENT ASHORE (MEN) FOR THE CRISIS-CONTROL SCENARIO

	Rifle Companies			Headquarters and Service
	A	B	C	
Infantrymen	207	207	207	-
Communications	-	-	-	8
Forward Air Controller	-	-	-	10
Forward Observer	4	4	4	-
106-mm Recoilless Rifle	9	9	9	-
81-mm Mortar	22	22	22	-
Medical Corpsmen	11	11	11	-
Helicopter Support Team	2	2	2	-
Engineer	6	6	6	19
Interrogation Team	-	-	-	3
Battalion Command Group	-	-	-	14
	261	261	261	54

FLCC

Shore Party Platoon	28
FLCC Operations	30
	58

TOTAL - 895

TABLE 3 - EQUIPMENT ASHORE FOR THE 10-DAY SCENARIO

ITEM DESCRIPTION	TAM#	EACH RIFLE CO.	H&S CO.	ARTILLERY BATTERY	FLCC	TOTAL
Truck, Cargo, M151A1	D1160	-	1	-	6	7
Trailer, 1/4-T, M416	D0840	1	4	1	4	13
Truck, Platform, M274	D1100	2	18	-	-	26
Truck, Cargo, M35A2C	D1030	-	-	6	10	16
Trailer, M105A2	D0860	-	-	-	5	5
Truck, Cargo, 3/4-T, M37	D1010	-	-	-	7	7
M49 Refueler	D1110	-	-	-	2	2
M149 Water Trailer	D0880	-	-	-	6	6
Forklift 6,000-lb, RT	B2560	-	-	-	3	3
Tractor, M64, EIMCO	B2400	-	-	-	1	1
Tractor, Full Tracked, M450	B2445	-	-	-	1	1
Ambulance, M718	D0890	-	-	-	1	1
LVTP-7	E0830	-	-	-	10	10
Tank, M48A3	E1850	-	-	-	7	7
Howitzer, 105-mm	E0640	-	-	6	-	6
Rifle 106-mm	E1480	-	8	-	-	8
Mortar 81-mm	E1090	-	8	-	-	8
Launcher, Rkt., 3.5"	E0920	6	8	-	-	32
Launcher, Grenade, M79	E0890	9	-	-	-	36
Dispenser, Riot-Control	E0320	-	2	-	-	2
Machine Gun, 7.62-mm, M60	E0990	6	11	4	2	41
Machine Gun, .50-Cal.	E0980	-	-	4	-	4
Rifle, 5.65-mm, M16	E1400	180	135	95	62	1012
Pistol, .45 Cal.	E1180	47	76	25	86	375
Generator Set, 3Kw, 60HZ	B0730	-	1	-	1	2
Generator Set, PU-668	B0840	-	-	-	1	1
Generator Set, PU-348	B0890	-	-	-	1	1
Control Set, Radio AN/GRA-6	A0320	-	3	2	-	5

TABLE 3 - EQUIPMENT ASHORE FOR THE 10-DAY SCENARIO (Cont'd)

ITEM DESCRITPION	TAM#	EACH RIFLE CO.	H&S CO.	ARTILLERY BATTERY	FLCC	TOTAL
Control Set, Radio AN/GRA-39A	A1730	-	6	7	4	17
Radio Set AN/GRC-125	A1800	1	3	1	-	8
Radio Set AN/MRC-83	A1900	-	-	-	1	1
Radio Set AN/MRC-87	A1910	-	1	-	-	1
Radio Set AN/MRC-109	A1920	-	2	1	-	3
Radio Set AN/PRC-25	A2000	7	8	7	9	52
Radio Set AN/PRC-41	A2010	1	-	1	-	5
Radio Set AN/PRC-47	A2020	-	1	1	1	3
Radio Set AN/PRC-77	A2050	1	8	-	2	14
Switchboard SB-22PT	A2480	-	4	3	1	8
Telephone Set TA-312/PT	H2443	-	25	20	10	55
Telephone Set TA-1/PT	H2442	-	12	-	-	12
Telegraph Terminal GRP AN/TCC-14	A2580	-	-	-	1	1
Teletypewriter Set AN/GGC-3	A2660	-	-	-	1	1
Teletypewriter Set AN/TGC-14A-V	A2670	-	-	-	1	1
Radio Terminal Set AN/TRC-166	A2184	-	1	-	1	2
Radio Set AN/MRC-134	A2182	-	1	-	1	2

TABLE 4 - EQUIPMENT ASHORE FOR THE CRISIS-CONTROL SCENARIO

ITEM DESCRIPTION	TAM #	EACH RIFLE CO.	H&S CO.	FLCC	TOTAL
Truck, Cargo M151A1	D1160	-	1	6	7
Trailer, 1/4T M416	D0840	1	4	4	11
Truck, Platform M274	D1100	6	2	-	20
Truck, M35A2C	D1030	-	-	10	10
Trailer, M105A2	D0860	-	-	5	5
Truck, Cargo, 3/4-T, M37	D1010	-	-	7	7
M49 Refueler	D1110	-	-	2	2
M149 Water Trailer	D0880	-	-	6	6
Forklift 6,000-lb, RT	B2560	-	-	3	3
Tractor, M64, EIMCO	B2400	-	-	1	1
Tractor, Full Tracked, M450	B2445	-	-	1	1
Ambulance, M718	D0890	-	-	1	1
Rifle 106-mm	E1480	2	-	-	6
Mortar 81-mm	E1090	2	-	-	6
Launcher, Rkt, 3.5"	E0920	6	8	-	26
Launcher, Grenade, M79	E0890	9	-	-	27
Dispenser, Riot Control	E0320	-	2	-	2
Machine Gun, 7.62-mm, M60	E0990	6	11	2	31
Rifle 5.56-mm, M16	E1440	205	27	34	676
Pistol, 45 Cal.	E1180	56	27	24	219
Generator Set, 3Kw, 60Hz	B0730	-	1	1	2
Generator Set, PU-668	B0840	-	-	1	1
Generator Set, PU-348	B0890	-	-	1	1
Control Set, Radio AN/GRA-6	A0320	-	3	-	3
Control Set, Radio AN/GRA-39A	A1730	-	6	4	10
Radio Set, AN/GRC-125	A1800	1	3	-	6
Radio Set, AN/MRC-83	A1900	-	-	1	1
Radio Set, AN/MRC-87	A1910	-	1	-	1
Radio Set, AN/MRC-109	A1920	-	2	-	2

TABLE 4 - CONTINUED

ITEM DESCRIPTION	TAM #	EACH RIFLE CO.	H&S CO.	FLCC	TOTAL
Radio Set AN/PRC-25	A2000	7	8	0	29
Radio Set AN/PRC-41	A2010	1	-	-	3
Radio Set AN/PRC-47	A2020	-	1	1	2
Radio Set AN/PRC-77	A2050	1	8	2	13
Switchboard SB-22PT	A2480	-	4	1	5
Telephone Set TA-312/PT	H2443	-	25	10	35
Telephone Set TA-1/PT	H2442	-	12	-	12
Telegraph Terminal GRP AN/TCC-14	A2580	-	-	1	1
Teletypewriter Set AN/GGC-3	A2660	-	-	1	1
Teletypewriter Set AN/TGC-14A-V	A2670	-	-	1	1
Radio Terminal Set AN/TRC-166	A2184	-	1	1	2
Radio Set AN/MRC-134	A2182	-	1	1	2

4.5 TRANSPORTATION ASSETS

The transportation assets available to the MAU consist of helicopters, landing craft, and trucks. The transportation system, as modeled, is designed to use effectively all transportation assets available to the MAU. Therefore, high priority items are transported by helicopter whenever possible, while low priority items may go by surface means (landing craft and trucks).

4.5.1 Helicopter

Helicopter assets available to the MAU are the same for both the 10-day and crisis-control scenarios. Table 5 lists the types of helicopters, the number embarked with the MAU, and the availability rates used in the model. Applying these availability rates to the number of each type of helicopter embarked gave the average number of each type available at any one time to perform either logistic or tactical missions.

TABLE 5 - HELICOPTER ASSETS

Type	Number Embarked	Average Percent Available	Average Number Available At a Given Time
CH-46D/F	10	75	7
CH-53D	4	65	2
UH-1N	2	75	1

4.5.2 Landing Craft

Landing craft embarked with the MAU consisted of six LCM-6's, four LCM-8's, and two LCU-1610's. The availability rate was assumed to be 90%. The number embarked was considered the number available. These quantities were used for both scenarios.

4.5.3 Motor Transport

Twenty-four M-35 2 1/2-ton trucks were considered embarked with the MAU. Sixteen were placed ashore in the 10-day scenario and ten were placed ashore in the crisis-control scenario. The quantity ashore was considered the number available to perform logistic and tactical missions.

4.6 TACTICAL TRANSPORTATION REQUIREMENTS

In SMLS, transportation assets are used for both logistic and tactical purposes. To realistically determine the response to logistic requirements and the utilization of the transportation assets, tactical transportation requirements (as opposed to logistics transportation requirements) must also be considered. Therefore, tactical transportation requirements, which would degrade availability of transportation assets for logistic purposes, were developed for each scenario.

4.6.1 The 10-Day Scenario

Tactical transportation requirements for the 10-day scenario consist of a 10-mile lateral shift of a company every second day and a 2-hour airborne sweep by a platoon on alternate days. For the company shift, CH-53 and CH-46 helicopters are used with a launch time of 0800 hours. For the airborne sweep, CH-46 helicopters are used with launch times of 0800 hours on D+3, 1000 hours on D+5, 1200 hours on D+7 and 1400 hours on D+9.

4.6.2 The Crisis-Control Scenario

In the crisis-control scenario, a one-hour airborne sweep by a platoon is carried out every day using CH-46 helicopters. Three 17-man patrols are made each day using M-35 trucks beginning at 0600 and ending at 1800 hours. Also, beginning on D+3 and every third day thereafter, one infantry company is returned to the seabase by M-35 trucks and landing craft, and a replacement company is brought ashore.

4.7 MEDICAL CASUALTY RATE

Medical casualties were generated using an exponential distribution to establish the number of casualties, and were distributed over the day between 0300 and 2100 hours using a bi-modal normal distribution with peaks at 0730 and 1630 hours. The 10-day scenario used an exponential distribution with an average of six casualties per 1000 troops per day. The crisis-control scenario used an exponential distribution with an average of three casualties per 1000 troops per day. These casualty rates included only the wounded who needed treatment at the seabase; thus, casualties handled entirely by the medical personnel ashore were not considered. The priorities of the casualties were assigned as half urgent and half routine, each case decided randomly from a probability distribution. Personnel killed in action (KIA) were considered routine. Eighty percent of the casulties were evacuated to the LPH and the rest to the LKA, each case decided randomly from a probability distribution.

4.8 DAILY RESUPPLY REQUIREMENTS

Daily resupply from the seabase to the MAU ashore consists mainly of food and water (CLASS I), fuel (CLASS III), and ammunition (CLASS V). The resupply rates are determined by the number of men ashore and by the usage rates of the equipment ashore (for Classes III and V), which vary between the scenarios.

4.8.1 The 10-Day Scenario

The daily resupply requirements of Classes I, III, and V supplies for the landing force during the 10-day scenario are listed in Table 6. These requirements are considered to be of a routine priority. In addition to the daily resupply requirements, which are deterministic, some probabilistic resupply is simulated. Two types of probabilistic resupply are considered; routine Class IV (fortification material) and urgent Class V resupply. Seventy-five percent of the time there is no Class IV request on any given day, and during the remaining 25% of the time there is one Class IV request per day. The requestor of the Class IV

TABLE 6 - DAILY RESUPPLY REQUIREMENTS FOR THE 10-DAY SCENARIO

	Meal, Combat Individual (Cases)	Water (Gallons)	Fuel, Compressed Trioxane (Cases)	Sundry Packs (Cases)	Gasoline (Gallons)	Diesel (Gallons)	Ammunition (Pounds)
Rifle Company	56	225	1	3	20	0	1,080
Headquarters and Service Company	53	215	1	3	330	0	11,500
Artillery Battery	30	120	1	1	55	165	29,900
FLCC	37	150	1	2	165	3,636	11,700

Note: Water is delivered in 5-gallon cans; gasoline is delivered in 55-gallon drums, except to the rifle company, where it is delivered in 5-gallon cans; diesel for the artillery battery is delivered in 55-gallon drums, and for the FLCC in three M49A2C refuelers.

supplies is chosen with equal probability from among all units of the landing force. The time of occurrence of the request is probabilistically chosen using the following distribution: 10% between 0400 and 0800 hours, 80% between 0800 and 1600 hours, 10% between 1600 and 2000 hours. The request consists of 1600 pounds of fortification material.

Urgent resupply of Class V material is probabilistically generated as follows: 10% of the days, no request; 80% of the days, one request per day; 10%, two requests per day. These requests were probabilistically distributed over the day as follows: 10% between midnight and 0400 hours, 20% between 0400 and 0800 hours, 40% between 0800 and 1600 hours, 10% between 1600 and 2000 hours, and 20% between 2000 and 2400 hours. These requests are probabilistically divided into three groups. Group I requests, which occur 70% of the time, are distributed with equal probability among the rifle companies; each shipment weighs 2100 pounds. Group II requests, which occur 25% of the time, are distributed 70% to the artillery battery, 20% to the Headquarters and Service Company, and 10% to the FLCC; each shipment weighs 5000 pounds. Group III requests, which represent the remaining 5% of the requests, are distributed with equal probability among the rifle companies; each shipment weighs 200 pounds.

4.8.2 The Crisis-Control Scenario

The daily resupply requirements of Class I, III, and V supplies for the landing force during the crisis-control scenario are listed in Table 7. Probabilistic resupply requirements are not generated for the crisis-control scenario.

4.9 MAINTENANCE REQUIREMENTS AND ASSETS

The simulation model does not consider each individual item of equipment. Instead, equipment is grouped into four commodity classes: engineering, ordnance, motor transport, and communications and electronics. Operational readiness float items are also grouped by commodity class. Table 8 lists, by commodity class, the number of shop spaces in the

TABLE 7 - DAILY RESUPPLY REQUIREMENTS FOR THE 90-DAY CRISIS-CONTROL SCENARIO

	Meal, Combat Individual (Cases)	Water (Gallons)	Fuel, Com-Pressed Trioxane (Cases)	Sundry Packs (Cases)	Gasoline (Gallons)	Diesel (Gallons)	Ammunition (Pounds)
Rifle Company	66	255	1	3	110	0	1,860
Headquarters and Service Company	14	50	1	1	275	0	240
FLCC	15	60	1	1	220	1,212	65

Note: Water is delivered in 5-gallon cans; gasoline is delivered in 55-gallon drums; diesel is delivered in one M49A2C refueler.

TABLE 8 - NUMBER OF SHOP SPACES AND CONTACT TEAMS ABOARD SHIPS OF THE SEABASE

Commodity Class	Number of Shop Spaces	Number of Contact Teams
Motor Transport	2	2
Communications and Electronics	2	3
Engineering	1	1
Ordnance	1	2

maintenance shops aboard the ships of the seabase and also the number of contact teams for each commodity class. The shop capacities and numbers of contact teams were the same for both scenarios.

4.9.1 Maintenance Requirements for the 10-Day Scenario

Maintenance requests for the 10-day scenario are generated by commodity class, based on the equipment list of Table 3. Table 9 lists the maintenance-request generation data for the 10-day scenario. An explanation of the request-generation data follows Table 9. By grouping the failures per 24-hour period by commodity class, the number of failures per day can be determined by commodity class. Table 10 lists the number of maintenance requests per day for each commodity class. The last column of Table 9 lists the number of ORF items available to the MAU. These are also grouped by commodity class. Maintenance requests are generated by the model using an exponential distribution with the average number of requests per day for each commodity class being the quantity specified by Table 10. The requests are distributed over the day by a bi-modal normal distribution to reflect two peak periods of activity each day.

Once a request is generated the model assignes an echelon of failure: either second, third, fourth, or discard. First-echelon failures, those repairable by the user, are not considered. A second-echelon failure is a minor failure which can be fixed ashore most of the time. Third-echelon failure is an intermediate failure which can be fixed ashore some of the time. Fourth-echelon failure is a major failure which can only be fixed at a maintenance shop at the seabase. Discard is an irreparable failure. Contact teams are assigned to fix a second-echelon failure 90% of the time, and third-echelon failures 64% of the time. In the remaining cases the failed piece of equipment is evacuated to the seabase for repair. These data are summarized in Table 11.

TABLE 9 - MAINTENANCE REQUEST GENERATION DATA FOR THE 10-DAY SCENARIO

TAM[1] Number	Number[2] in MAU	MTBF[3]	Utili-[4] zation Factor	$MTBF_a$[5]	Failures[6] per 24-Hour Period	Failures[7] Per 10-Day Period	Number[8] of ORF Items
MOTOR TRANSPORT							
D1160	7	57	3	456	.37	4	2
D0840	13	1800	9	4800	.17	2	2
D1100	26	57	3	456	1.37	14	0
D1030	16	84	6	336	1.14	11	1
D0860	5	1800	9	4800	.07	1	1
D1010	7	84	6	336	.50	5	0
D1110	2	84	6	336	.14	1	0
D0880	6		9	4800	.03	0	1
D0890	1	57	9	152	.19	2	0
ORDNANCE							
E0640	6	1000	85	282	.51	5	0
E1480	8	500	7	1714	.11	1	0
E1090	8	2000	50	960	.20	2	1
E0920	32	28	3	224	3.40	34	2
E0990	41	10,000	225	1067	1.00	10	3
E0980	4	5000	166	723	.13	1	0
E1180	375		1	11040	.80	8	14
E0830	10	32	10	77	3.12	31	0
E1850	7	48	10	115	1.46	15	1
ENGINEER							
B2560	3	75	8	225	.32	3	0
B2400	1	55	5	264	.10	1	1
B2445	1		9	144	.17	2	0
B0730	2	54	20	65	.70	7	0
B0840	1	54	20	65	.40	4	1
B0890	1	54	20	65	.40	4	0

TABLE 9 - CONTINUED

TAM[1] Number	Number[2] in MAU	MTBF[3]	Utili-[4] zation Factor	$MTBF_a$[5]	Failures[6] Per 24-Hour Period	Failures[7] Per 10-Day Period	Number[8] of ORF ITEMS
C O M / E L E C							
A0320	5	**200**	16	300	.40	4	2
A1730	17	200	16	300	1.36	14	1
A1800	8	200	16	300	.64	6	0
A1900	1	200	16	300	.08	1	0
A1910	1	200	16	300	.08	1	0
A1920	3	200	16	300	.24	2	0
A2000	52	200	16	300	4.16	42	9
A2010	5	200	16	300	.40	4	0
A2020	3	200	16	300	.24	2	1
A2050	14	200	16	300	1.12	11	2
A2480	8	1200	16	1800	.11	1	0
H2443	55	150	16	225	5.87	59	0
H2442	12	100	16	150	1.92	19	0
A2580	1	1200	16	1800	.01	0	0
A2660	1	100	16	150	.16	2	0
A2670	1	100	16	150	.16	2	0
A2184	2	390	16	585	.08	1	0
A2182	2	390	16	585	.08	1	0

EXPLANATION OF THE MAINTENANCE REQUEST GENERATION DATA

[1]TAM NUMBER: Identification number for end item from USMC Table of Authorized Materiel

[2]NUMBER IN MAU: Number of end items ashore

[3]MTBF: Mean time between failures; for the motor transport, engineer, and communications and electronics commodity classes, the units are hours; for the ordnance commodity class the units are in rounds (Rds) of ammunition fired.

[4]UTILIZATION FACTOR: Number of hours each end item is used per day; for the ordnance commodity class it is the number of rounds of ammunition fired per day.

[5]$MTBF_a$: Mean time between failure adjusted; $MTBF_a = \frac{24 \cdot MTBF}{UTILIZATION\ FACTOR}$

[6]$FAILURES\ PER\ 24\text{-}HOUR\ PERIOD = \frac{24 \cdot NUMBER\ IN\ MAU}{MTBF_a}$

[7]FAILURES PER 10-DAY PERIOD = 10 · FAILURES PER 24-HOUR PERIOD

[8]NUMBER OF ORF ITEMS: Number of items available to be used as replacement items

TABLE 10 - NUMBER OF DAILY MAINTENANCE REQUESTS FOR THE 10-DAY SCENARIO

Commodity Class	Average No. of Requests/Per Day
Motor Transport	4
Communications and Electronics	17
Engineer	2
Ordnance	11
TOTAL	= 34 per day

TABLE 11 - FAILURES BROKEN DOWN BY FAILURE ECHELON AND CONTACT-TEAM OR SEABASE REPAIR (PERCENTAGES)

Failure Echelon	Percent Failures This Echelon	Percent Failures Repaired by Contact Team	Percent Failures Repaired At Seabase
Second	64	90	10
Third	24	64	36
Fourth	10	0	100
Discard	2	-	-

Table 12 lists the mean times to repair (MTTR's) in hours, by failure echelon, for repair either in a shop at the seabase or by a contact team ashore.

TABLE 12 - MEAN TIME TO REPAIR (MTTR) IN HOURS

Failure Echelon	Repair at Shop	Repair by Contact Team
Second	0.5	0.5
Third	4.0	2.0
Fourth	24.0	--

4.9.2 Maintenance Requirements for the Crisis-Control Scenario

Maintenance requests are generated for the crisis-control scenario in the same manner as for the 10-day scenario. Table 13 lists the maintenance-request generation data for the crisis-control scenario, based on the equipment list of Table 4. Table 14 lists the average number of maintenance requests per day by commodity class. Assignments of failure echelon, contact-team or seabase repair, and MTTR are handled in the same way as for the 10-day scenario (Tables 11 and 12).

4.10 DISTANCE PARAMETERS

Various ship-to-shore and shore-to-company distances can be used in the simulation model. The distances used are listed in Table 15. The distance between infantry companies is always 0.5 mile.

4.11 MISCELLANEOUS INPUT PARAMETERS

Other input parameters were used in the data base for the simulation model. These include service times for message transmission on the various communication nets, processing times at the control agencies, probability distributions for decision-making criteria at the control agencies, characteristics of transportation assets, etc. Quantitative values for these parameters are listed in the SMLS Final Draft Report.[3]

TABLE 13 - MAINTENANCE REQUEST GENERATION DATA FOR THE CRISIS-CONTROL SCENARIO

TAM[1] Number	Number[2] in MAU	MTBF[3]	Utili-[4] zation Factor	$MTBF_a$[5]	Failures[6] per 24-hour period	Failures[7] per 10-day period	Number[8] of ORF items
MOTOR TRANSPORT							
D1160	7	57	6	228	.74	7	2
D0840	11	1800	6	7200	.04	0	2
D1100	20	57	6	228	2.10	21	0
D1030	10	84	9	224	1.07	11	11
D0860	5	1800	9	4800	.03	0	1
D1010	7	84	9	224	.75	8	0
D1110	2	84	9	224	.21	2	0
D0880	6	1800	9	4800	.03	0	1
D0890	1	57	6	228	.11	1	0
ORDNANCE							
E1480	6	500	1	12000	.01	0	0
E1090	6	2000	6	8000	.02	0	1
E0920	26	28	1	672	.93	9	2
E0990	31	10000	28	8571	.09	1	3
E1180	219	460	1	11000	.48	5	14
ENGINEER							
B2560	3	75	8	225	.32	3	0
B2400	1	55	10	132	.18	2	1
B2445	1	54	9	140	.17	2	0
B0730	2	54	20	65	.70	7	0
B0840	1	54	20	65	.40	4	1
B0890	1	54	20	65	.40	4	0
COM/ELEC							
A0320	3	200	16	300	.24	2	2
A1730	10	200	16	300	.80	8	1
A1800	6	200	16	300	.48	5	0
A1900	1	200	16	300	.08	1	0
A1910	1	200	16	300	.08	1	0
A1920	2	200	16	300	.16	2	0
A2000	38	200	16	300	3.04	30	9
A2010	3	200	16	300	.24	2	0
A2020	2	200	16	300	.16	2	1
A2050	13	200	16	300	1.04	10	2
A2480	5	1200	16	1800	.06	1	0
H2443	35	150	16	225	3.73	37	0
H2442	12	100	16	150	1.92	19	0
A2580	1	1200	16	1800	.01	0	0
A2660	1	100	16	150	.16	2	0
A2670	1	100	16	150	.16	2	0
A2184	2	390	16	585	.08	1	0
A2182	2	390	16	585	.08	1	0

TABLE 14 - NUMBER OF DAILY MAINTENANCE REQUESTS FOR THE CRISIS-CONTROL SCENARIO

	Average No. of Request Per Day
Motor Transport	5
Communications and Electronics	12
Engineering	2
Ordnance	2
	TOTAL 21 per day

TABLE 15 - SMLS SIMULATION MODEL DISTANCE PARAMETERS (MILES)

Ship to Shore	Shore to Company	Ship to Company
4	3	7
10	10	20
4	20	24
20	20	40
20	40	60

Note: This table lists the alternative possible ship-to-shore distances which can be used by the model. The user may specify which ship-to-shore distances he desires to use.

5. SMLS SIMULATION MODEL MEASURES OF EFFECTIVENESS

In order to evaluate the SMLS concept, certain parameters which describe the system performance or measures of effectiveness (MOE's) have been developed. The MOE's provide data on the time needed to fulfill requirements (response time), the availability of assets, the utilization of assets, and the length of the waiting lists or queues at various locations. Availability, as defined for MOE's, is the precentage of the time that an asset is available for assignment to a request or mission. Utilization is the time that an asset is in use. Table 16 lists the MOEs developed for use in the simulation model.

TABLE 16 - MEASURES OF EFFECTIVENESS FOR USE IN THE ATU/MAU SMLS SIMULATION MODEL

SUBSYSTEM	MEASURE OF EFFECTIVENESS
Medical	o time from occurrence of casualty until transportation arrives
	o time from occurrence of casualty until arrival at ship
Supply	o time from staging of supplies at seabase until transportation arrives
	o time from submission of request until arrival of supplies at requesting company
Maintenance	o maximum and average length of shop queue by type of commodity class
	o maximum and average time in shop queue by type of commodity class
	o maximum and average length of contact-team queue by type of commodity class
	o maximum and average time in contact-team queue by type of commodity class
	o maximum, average, and minimum maintenance response time by type commodity class
	o ORF level for given commodity class
Transportation	o helicopter utilization by type
	o landing craft utilization by type
	o truck utilization by type
	o helicopter utilization by class of service
	o landing craft utilization by class of service
	o truck utilization by class of service
	o number of helicopters which can be assigned missions vs time
	o number of landing craft which can be assigned missions vs time
	o number of trucks which can be assigned mission vs time
Communications	o length of message queue for each net vs time
	o utilization of each net

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