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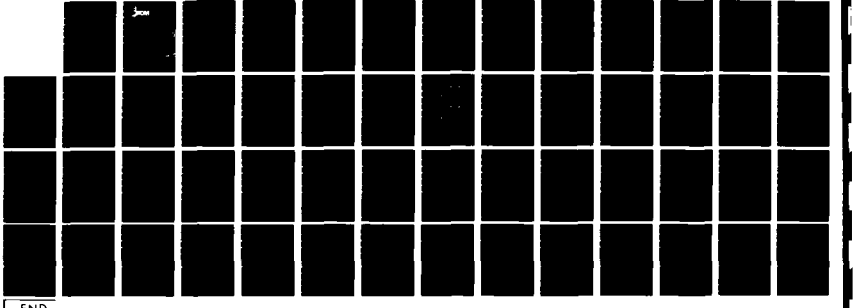

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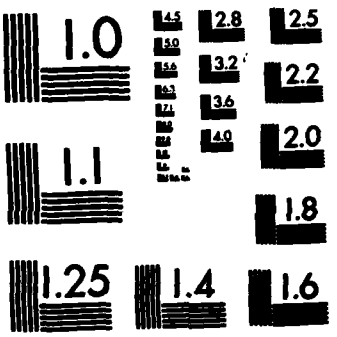

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INTEGRATED NUCLEAR AND CONVENTIONAL THEATER WARFARE SIMULATION (INWARS) LEVEL III SPECIFICATIONS VOLUME IV: COMBAT SUPPORT MODELING

This document is submitted to Headquarters, Department of the Army, Office of the Deputy Chief of Staff for Operations and Plans, ATTN: Mr. P. E. Louer (DAMO-ZD) Washington, D. C. 20310.

FOREWORD

This document is Volume IV of five volumes presenting the Level III Specifications for The Integrated Nuclear and Conventional Theater Warfare Simulation (INWARS) under development for the U.S. Army by the BDM Corporation. This volume is concerned with the modeling of Combat Support.

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CHAPTER I
INTRODUCTION

This volume discusses those functional areas of INWARS which can be described as "combat support". This includes combat service support functions -- supply, repair, and casualty treatment -- which are presented in Chapter II. It also includes information collection (or perception) which, as presented in Chapter III, focuses on basic intelligence support to the higher echelon commands. Finally, communications activities are discussed in Chapter IV.

CHAPTER II
COMBAT SERVICE SUPPORT

A. INTRODUCTION

This chapter discusses the treatment of combat service support within the INWARS model. Combat service support includes the following functions: equipment replacement, supply, maintenance and combat repair, and hospitalization. Section B provides a general overview of the combat service support system. Section C contains a discussion of the general nuclear support activities, Section D provides a detailed explanation of conventional service support activities, and Section E discusses nuclear resupply.

B. COMBAT SERVICE SUPPORT FRAMEWORK

The INWARS combat service support system will be a cyclical system with the command level headquarters or C^2I elements and their associated Combat Service Support Complex (CS^2C) as the key nodes. The nodes will be linked together by a notional resource flow network which will represent movement capabilities between the various elements. The tons of supply that can be transported over these links during each cycle will be determined outside the model by the user and should reflect the actual transportation capabilities of the links and nodes. Figure II-1 depicts a four level CS^2C in INWARS. In this figure, the basic flows are indicated for both the Red and Blue system.

As the figure suggests, the Red and Blue system need not be symmetrical. In reality, there is no Blue Army Group logistical equivalent to the Red Front logistical complex. Rather, each Blue nationality has responsibility for the resupply of its own corps. The Theater level Combat Service Support Complex will represent this multinational supply node with a direct flow of supplies to each Corps.

The resources that flow in this network of CS^2C will include: (1) supplies (POL, and ammunition), (2) major end item replacements, and (3) personnel replacements. Resources will flow in the form of "bundles" to lower CS^2C or consumers. These "bundles" will be composed from the stocks of a given CS^2C on the basis of supply/replacement rates and priorities set by the supported C^2I element. They will then be issued, dependent on transportation capability, to the lower CS^2C which, upon receipt will add the arriving resources to their own stocks. This process will occur cyclically at the time intervals suggested in Figure II-1.

In addition to resupply/replacement activities, CS^2C will reflect combat repair capabilities in terms of return of damaged major end items of equipment received from subordinate combat units. Once repaired, this equipment will go into the resource stocks of the CS^2C and become available for distribution as replacement equipment. Personnel casualties will be treated in a similar "repair" process with the recovered personnel being returned to duty through the medium of the replacement function.

C. NUCLEAR SUPPORT ACTIVITIES

Two combat service support entities will be represented in INWARS: the CS^2C described above and the Nuclear Supply Point Cluster (NSPC). The NSPC is the entity that will be used to represent the various fixed and mobile Special Ammunition Supply Points (SASP). Each NSPC will represent a number of supply sites. The number of supply sites represented by each NSPC will be defined by the user. The NSPC will stock and account for the munitions by type and yield. It will receive and ship munitions as directed by the appropriate C^2I element. Blue's NSPCs will be located at the Theater, Corps, and ATAF levels. Red's NSPCs will be located at the appropriate level CS^2C that reflects their doctrine.

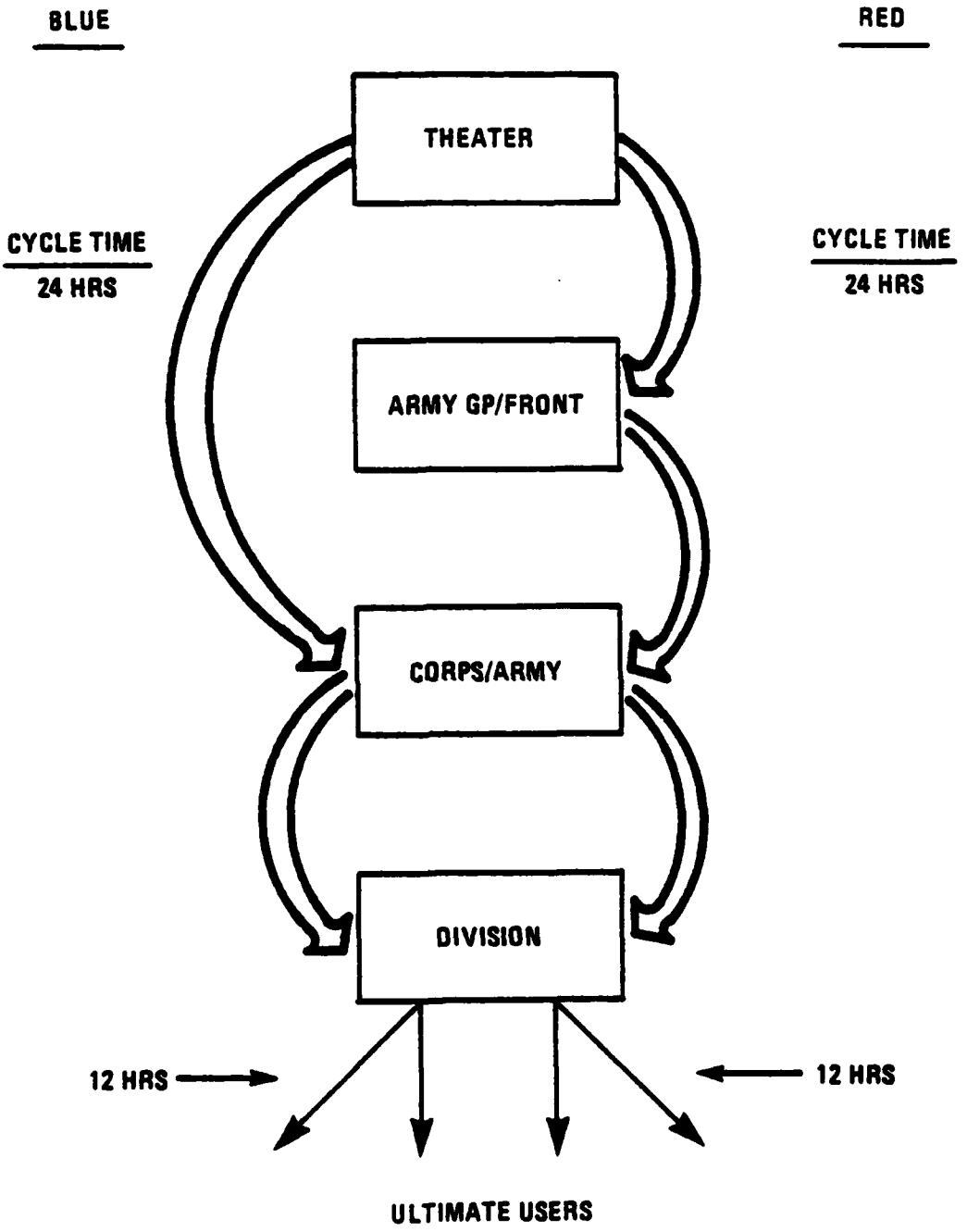

Figure II-1. Resource Provision Flow

D. COMBAT SERVICE SUPPORT ACTIVITIES

The following detailed description of the CS^2 operation relates the resources, the nature of the support complexes, the provision and regeneration of resources, and the provision cycle, along with the associated question of resource vulnerability. Figure II-2 depicts these activities.

1. Resource Categories Represented

INWARS will consider in an aggregated fashion the flow of resources which are critical in a conventional or tactical nuclear combat environment. The conventional resources considered will be bulk petroleum (POL), ammunition, (AMMO) and classes of major end items (MEI). Personnel replacement with both new troops and healed casualties, will be treated as another service support function. Nuclear munitions will be treated explicitly as to type, and yield. The consumption and inventory of POL and conventional ammo will be estimated in terms of a "standard brigade day (BDE-Day)". The selection of the BDE-Day as a unit of measurement is one of convenience. The utilization of a standard measure will allow the estimation and statement of daily operation requirements for the consuming units, and stock levels for the CS^2C in a common measure. Differing stock levels or consumption factors based on unit size, unit posture, and activity can be estimated in terms of multiple or fractions of BDE-Days of POL and AMMO.

Major end items will be considered in four classes. These are tanks, armored personnel carriers (APCs), anti-tank weapons (ATW's), and artillery (ARTY). It may be desirable to establish subclasses, particularly for disparate items (e.g., hand held ATW's, vehicle mounted ATW's), or for items distinguishable because of potential function. MEI will be kept track of as numbers of MEI. In a similar fashion, personnel (replacements) will be considered at the CS^2C as available for deployment.

Both MEI and personnel will be represented at the CS^2C as either ready for deployment, or "damaged." The resource regeneration

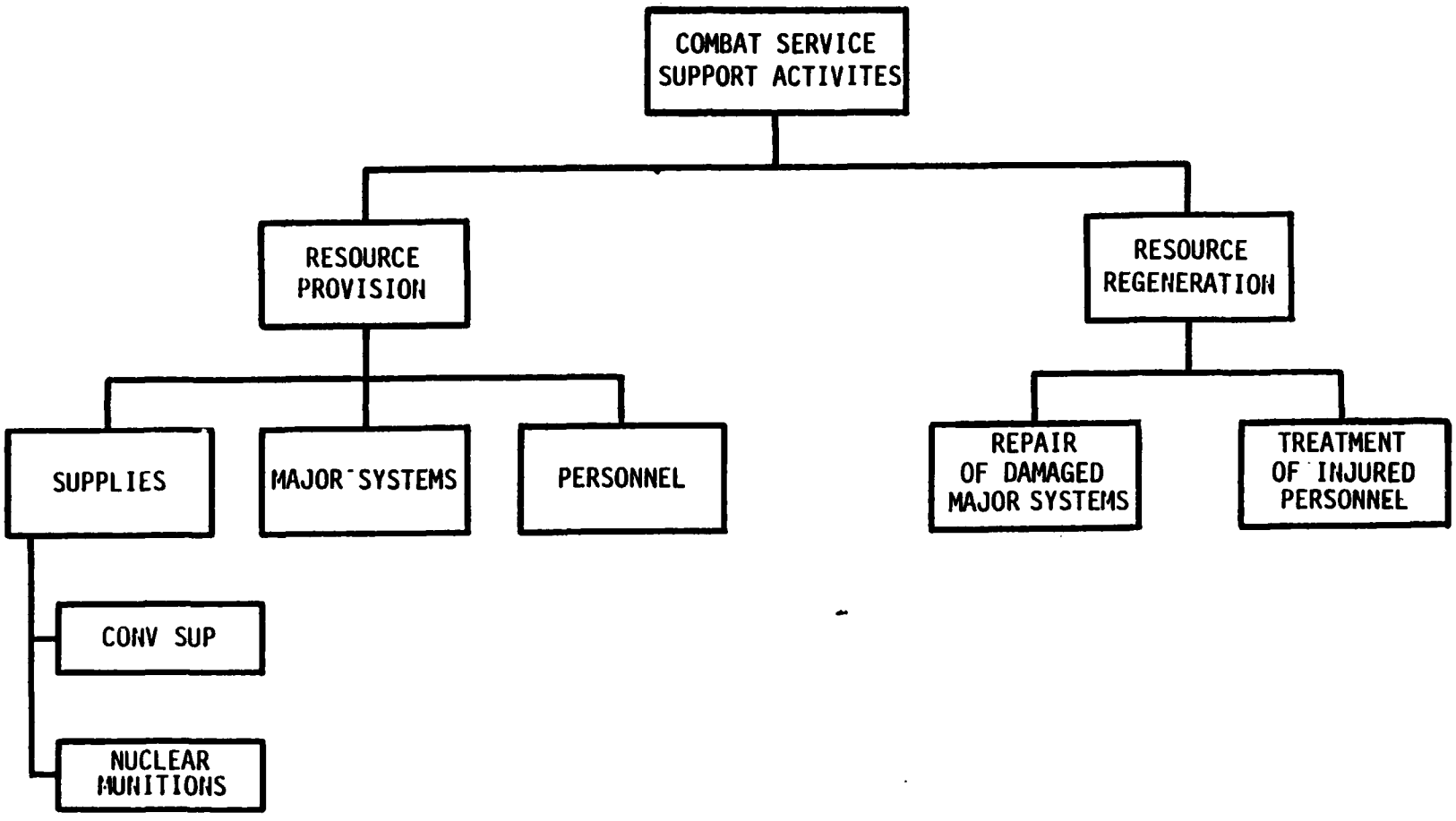

Figure II-2. Combat Service Support Activities

operation will simulate the repair or healing of the inventories, and subsequently increase the available resource while decreasing the damaged categories.

As a part of the initial input, the user will define the stocks of resources available at each CS^2C. These stocks may be increased over the course of the run by external resupply. External resupply is a term which is meant to reflect the flow of supplies from outside the (modeled) playing area. It is primarily the resupply from such areas as the Continental United States (CONUS) and from the Soviet Union. This resupply would include all the resources mentioned above: the supply of major end items of equipment for systems being played in INWARS, the normal resupply of ammunition and POL, the resupply of special ammunition such as nuclear rounds, as well as the introduction of reinforcements into the theater in terms of combat units and individual replacements. External resupply into the theater would be planned and specified by the user. The introduction of external resupplies would be scheduled to occur once a day and would be represented by an appropriate increase in stock levels at the Theater CS^2C or NSPC.

All types of resources stocked at a CS^2C will be subject to attrition if that CS^2C is attacked by enemy air or missiles. Losses will reflect the type and quantity of munitions used. Appropriate loss factors will be a user input defined in terms of resources (by type) destroyed for a given type and level of attack.

2. The Combat Service Support Complex (CS^2C): Records Structure

The CS^2C is represented in INWARS as associated with a C^2I element. Each command element has an associable CS^2C which serves the subordinate units. Figure II-3 depicts the relationship between the C^2I element and the CS^2C. The C^2I element provides guidance in terms of directives and priorities to the CS^2C entities, and the CS^2C reports the supply status back to C^2I. The CS^2C are, in INWARS, non-thinking, bookkeeping-type units, co-located with the C^2I for simulation convenience. The actual physical location of supplies, vis-a-vis command units are not relevant to the CS^2C, C^2I functional interaction. The characteristics

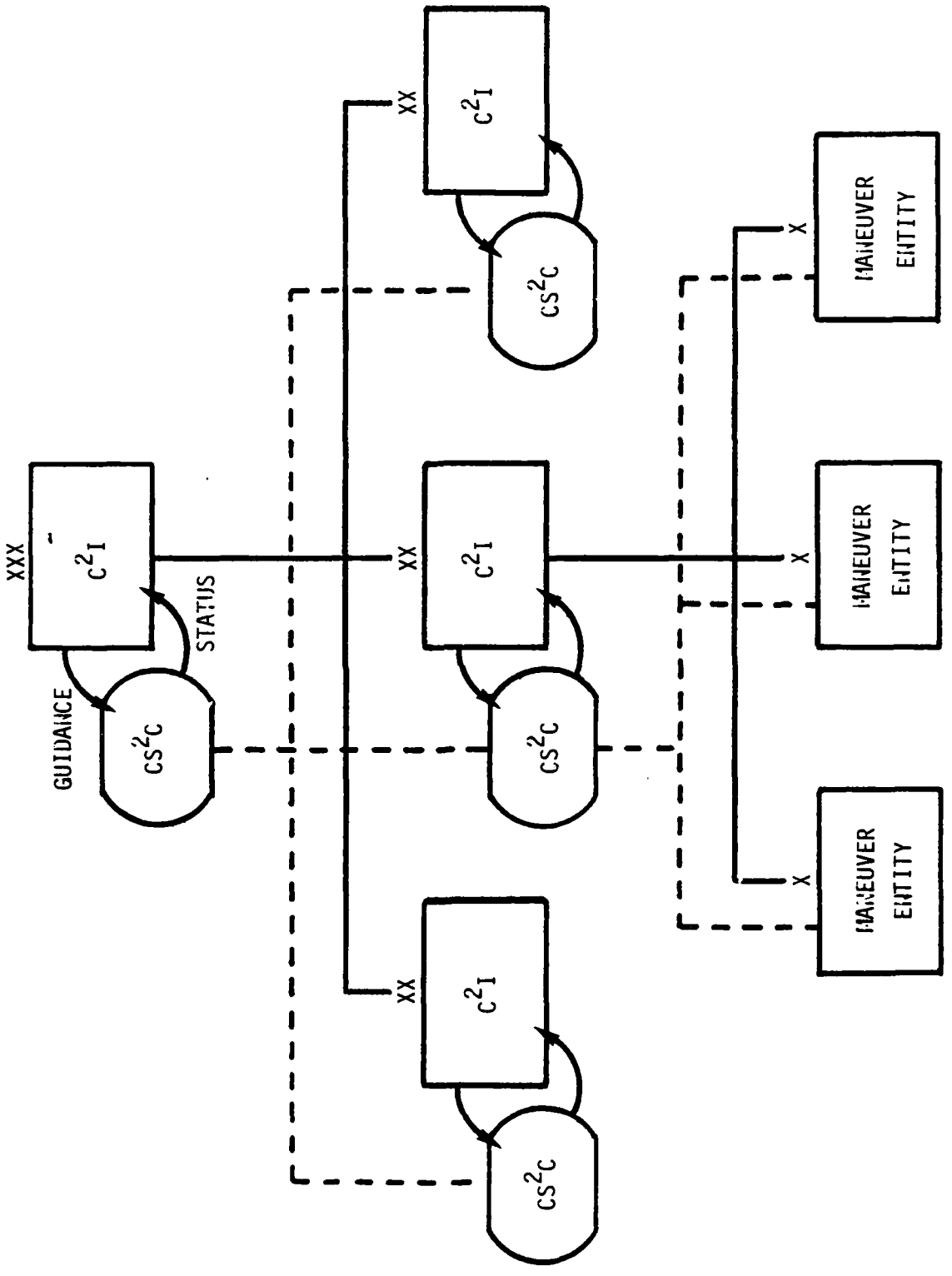

Figure II-3. CS^2C: External Relationships

of physical location are treated implicitly in the determination of damage effects.

The CS^2C will keep records on the resource categories previously discussed, and also information relating to the guidance received from the associated C^2I element, and capabilities information. Figure II-4 is a pictorial representation of the data structure typical for a CS^2C. Each CS^2C element will have records of the inventory on hand. Those records will be updated periodically as supplies are shipped to lower echelons, new supplies arrive from higher echelons, and damaged units are repaired, ready to return to service. The data subsets in Figure II-4 are lettered for reference with the following discussion of the record structure content.

a. CS^2C Identification

Each CS^2C will have a unique identification number facilitating cross referencing with the appropriate C^2I complex and summary routines.

b. Resources On Hand

The number of BDE-Days of conventional Ammo and POL, and the number of units of MEI and Personnel on hand are recorded.

c. Issue Capability Required

Item C refers to a set of conversion factors that are used with, but are not part of each CS^2C record. They are invarient from CS^2C to CS^2C and hence can be kept in a separate data structure eliminating unecessary redundancy. The entries will be dependent on the final form of the data utilized in the simulation, and will relate the supplies shipped to the transportation dependent issue capability. For instance, the number of BDE-Days of conventional ammunition will be stored in section b. If one wished to know the number of tons of transportation capability needed to ship 10 BDE-Days of AMMO, then one would multiply by the Standard Issue Capability required as stated in tons/BDE-Day. That would yield the number of tons to be shipped. The reason for the inclusion of these conversion factors is that the issue

a) CS^2C ID: XXXXX

b) RESOURCES ON HAND

- o Conventional Ammo: #BDE-Days
- o POL: #BDE-Days
- o MEI
  - Tanks #
  - APC #
  - ATW #
  - ARTY #
- o Personnel

c) ISSUE CAPABILITY REQUIRED

(for all resources) (TONS/BDE-DAY, BLS/BDE-Day, etc.)

d) ISSUE CAPABILITY

- o State
- o Units/period

(for all resources)

e) ISSUE DIRECTIVES (FROM C^2I)

(for all resources)

f) ISSUED TO

(for all resources) (for all subordinates)

g) DAMAGED RESOURCES

(for MEI and Personnel)

h) REGENERATION CAPABILITY

(for MEI and Personnel)

i) STATUS REPORT (TO C^2I)

Figure II-4. CS^2C Records Structure

capability will be a factor of road capacity, and the number of vehicles available.

d. Issue Capability

The issue capability for each CS^2C unit will be updated periodically and stored as the "state" variables. The form of these variables will depend on the information and estimates available. As currently envisioned, it appears appropriate to measure issue capabilities communication in tons of a maximum number of tons/period that could be shipped to the total of subordinate units. This status indicates will be influenced by the number of vehicles available, route capacity and degradation due to weather or combat environment.

This state variable will then be converted to an issue capability based on the "standard unit/period". For instance, ammo issue capability would be converted (by applying item c, above) to BDE-Days/period as a measure of maximum amount of ammo that could be supplied according to factors other than availability of stock.

e. Issue Directives

Each CS^2C will have an issue directive for each subordinate unit. This "issue directive", stated in BDE-Days of Supply, or units of MEI or personnel, comes from the associated C^2I complex. (See Volume V, Chapter IV Section F.3.e.). These directives are the results of the decision process as to the priorities for shipment to subordinate units. The issue directives are stated in forms of desired issue rates. If the resources (item b) are available and the issue capability (item d) is not exceeded, the issue directives will be fully implemented as discussed below in Section 3.

f. Issued to Subordinates

The amount to be issued to each subordinate, either the full amount according to the issue directives, or a degraded amount (proportionality applied to each subordinate) according to the shortages or issue capability degradation, is recorded, and will be "shipped" to the lower echelons the same period (but will not be available for distribution at the lower echelon until the following period).

g. Damaged Resources

This section of the records states the inventory of damaged items referred to the support complex for repair.

h. Regeneration Capability

This information relates to the repair capability of the CS^2C and will include estimates, made from data available, and the average number of units/period that can be repaired. Also included will be estimates of the average "repair rate" for casualties, however this will be stated as a fraction of the number of casualties being treated. Thus as the number of casualties increases, so will the number returned to duty each period. The precise form of this function will be developed as the data search clarifies the form of available statistics, and will be amenable to change via user input.

i. Status Report to C^2I

The status of the CS^2C, including stocks, damaged resources, degraded capabilities, and in particular unfulfilled issue directives will be periodically available to the associated C^2I unit.

3. CS^2C: Resource Provision

As noted above, supplies and replacement MEIs and personnel will be issued from higher CS^2C to lower CS^2C or consumers on a regular cyclical basis. At the start of a cycle, CS^2Cs will compose a "bundle" of resources for each lower CS^2C or consumer to be serviced. The exact quantities included in a bundle will reflect the desired issued rate guidance of the supported C^2I element and the status of subordinates as well as the stocks on hand and the issue capacity of the CS^2C. Once the "bundles" are composed, they will be issued to the lower CS^2Cs or consumers. Upon arrival, the resources in the bundle will be incorporated into the stocks of the recipient.

The issue activity is depicted in terms of input and output in Figure II-5, Issue Activity, and the process detailed in Figure II-6, Issue Process. The steps indicated in Figure II-6, detailed the order of the cyclic process. The trigger for the process is the start of the periodic issue cycle (24 hours down to Division echelon, 12 hours

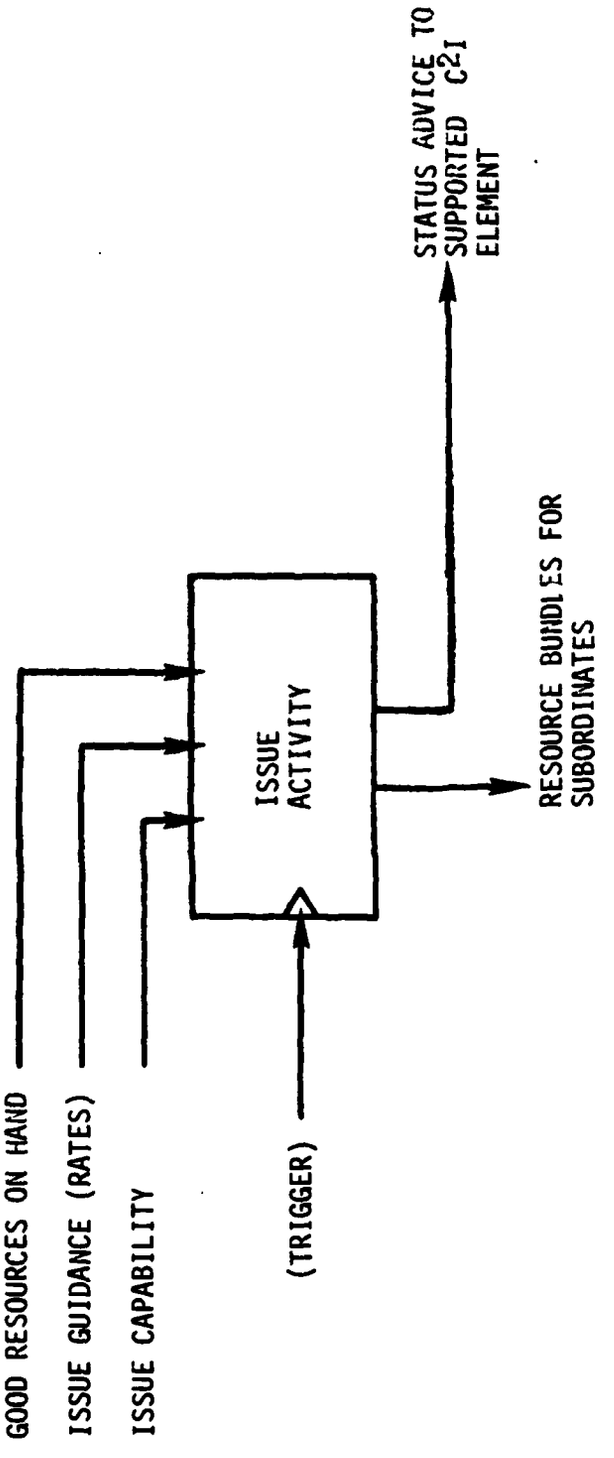

Figure II-5. Issue Activity: Input/Output

1. DETERMINE DESIRED RESOURCE BUNDLE FOR EACH SUBORDINATE CS^2C OR CONSUMER (BASED ON ISSUE RATE GUIDANCE)

2. IF THERE IS NOT A SUFFICIENT AMOUNT OF RESOURCES ON HAND TO COMPOSE THESE RESOURCE BUNDLES, THEN SCALE THE DESIRED BUNDLES DOWN TO FEASIBLE LEVELS

3. DETERMINE ISSUE CAPABILITY REQUIRED TO ISSUE FEASIBLE BUNDLES

4. IF THERE IS NOT SUFFICIENT CAPABILITY TO ISSUE THESE RESOURCE BUNDLES, THEN SCALE THE FEASIBLE BUNDLES DOWN TO ISSUABLE LEVELS

5. ISSUE THE RESULTING BUNDLES AND NOTIFY SUPPORTED C^2I ELEMENT OF ANY REDUCTIONS FROM DESIRED LEVELS.

Figure II-6. Issue Process

from DIV. to BDE). Once the issue activity is completed, new units received are added into each CS^2C resource category, along with repaired MEI, and Personnel returned to duty. This sequencing insures that receipts cannot be issued in the same cycle (See Section 5, below).

4. CS^2C: Resource Regeneration

Resource regeneration considers both combat repair of damaged MEI, and treatment of some combat casualties. Combat repair in INWARS will reflect two levels of repair: direct support (DS), and general support (GS). Direct support (DS) will be defined as that repair performed at the Division level CS^2C. General Support (GS) will be that repair performed at the Corps/Army CS^2C. Items requiring higher level maintenance will not be considered repairable within the time frame of the simulation. Figure II-7 shows the flow of the regeneration process, Figure II-8 shows its input/output structure.

Losses to major weapon systems (MEI) in combat will be immediately classified into a number of categories: lost, DS repairable, and GS repairable. The lost category will reflect the percentage of the equipment that is either destroyed beyond DS/GS repair, or not recoverable due to the battle situation. If the data is available, more than one breakout of losses will be permitted to reflect the differences in the recoverability of equipment in the attack and the defense. These breakouts will define (in terms of percentage of the losses) what fraction of the losses in an engagement will be kept at the division CS^2C and what would be sent back to the next higher level. The CS^2C complex would remove and service the losses attributable to its level CS^2C and send on the remainder to the next level. This will be accomplished as a part of the CS^2C cycle.

Each level CS^2C would have an associated capability to repair major end items (MEI). This capability will be expressed in rates of repair. These rates will be a function of the type weapon system. Each major end item (MEI) will have an associated repair rate for each level CS^2C. Thus, a given level CS^2C will process different type weapon systems at different rates. As major end items are repaired they will

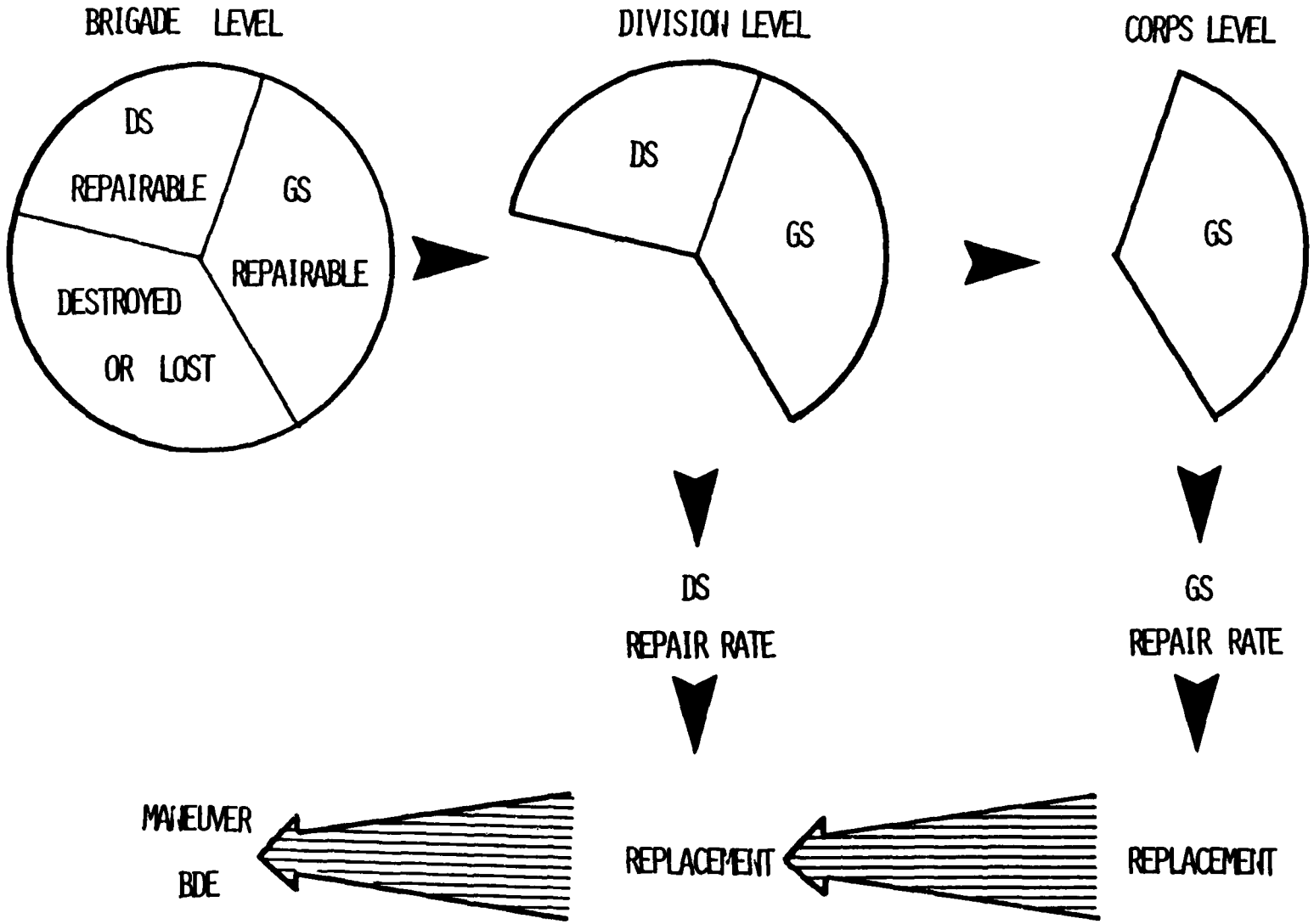

Figure II-7. Resource Regeneration Flow

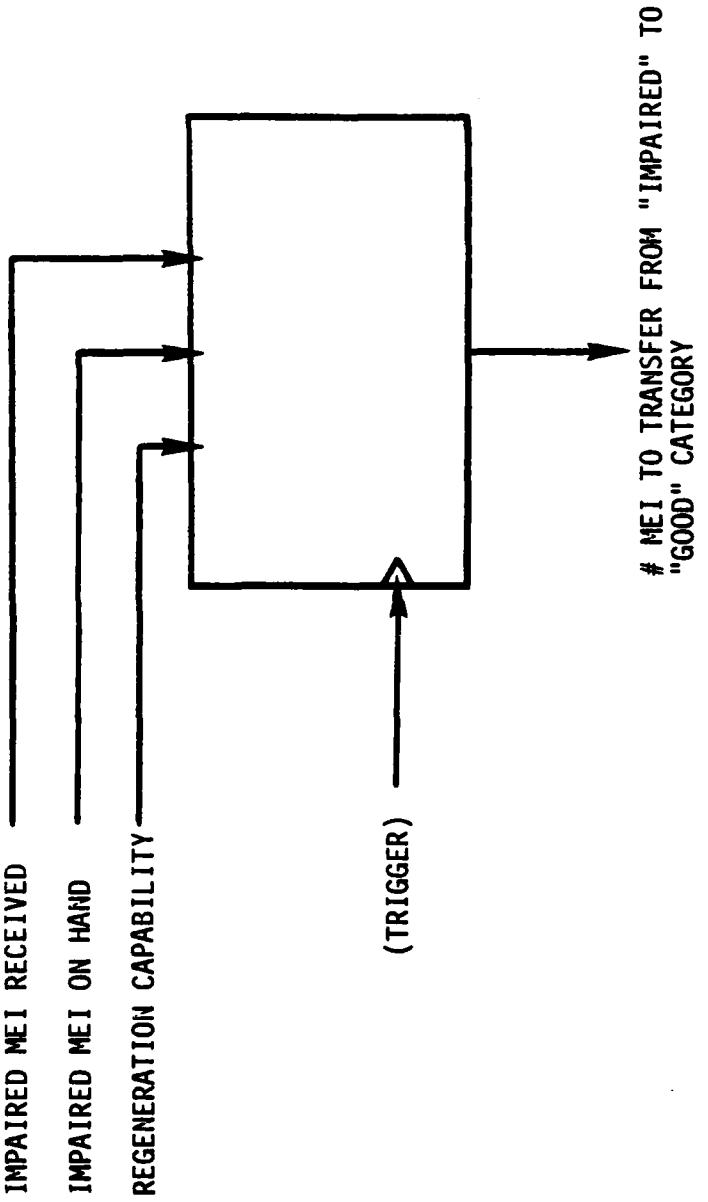

Figure II-8. Regeneration Activity: Input/Output

be placed in the major end item stocks, and will thus become available for redistribution through the regular supply/replacement cycle. Eventually, this equipment will arrive at a unit for use.

Combat casualties will be accounted for in INWARS by a cycle similar to that described for combat repair. Personnel losses will be characterized as to the level of hospitalization that will be required by a fractional breakout of the losses. This breakout will include the fraction that are lost, i.e., dead. Each hospital level within the CS^2C will isolate the wounded identified as "repairable" at that particular level and evacuate the remainder to the next highest level. At this time, there are no plans to include different breakouts, i.e., "profiles" for different type injuries such as chemical, nuclear and conventional. If this proves to be of significance and the data is available, it will be incorporated.

As individuals at the various level hospitals become fit for duty, they will be placed into the individual replacement stocks of the CS^2C, at an average number-per-period and will thus become available for reassignment to a unit.

5. CS^2C: The Provision Cycle

The CS^2C functions will be updated on a periodic basis as previously suggested. The cycle will begin each 24 hours, with supplies entering at the theater level. This will trigger the provision cycle which will move down the echelons, performing the CS^2C updating for the period. The supplies will filter down to Brigade level where they will be consumed according to estimates of consumption rate's appropriate.

At each CS^2C, the order in which the events occur is as follows:

- Calculate provision of supplies to subordinates based on C^2I priorities, stocks on hand, and issue capability
- Issue to subordinates decreasing resources on hand
- Increase resources according to resources delivered from higher CS^2C

- Determine regenerated resources (MEI and Personnel)
- Add regenerated resources to resources on hand
- Add damaged resources received from subordinates.

Thus, provision of resources to subordinates is out of the initial stock level, and is not influenced by subsequent delivery of items from higher echelons, or receipt of damaged items.

6. CS^2C: Vulnerabilities

The CS^2C are vulnerable to attack by air or surface to surface missiles. As indicated in Figure II-9, attacks may destroy resources, degrade, issue capability, and impair regeneration capacity. Transportation units, LOCs, and supplies are not separately targetable, but are vulnerable to a notional attack of the entire CS^2C function, with damage dependent on the level and type of attack.

E. NUCLEAR MUNITIONS RESUPPLY

In reality, nuclear munitions will be located in a number of sites and supply points that are being represented in INWARS by NSP clusters. These nuclear supply point clusters (NSPC) will be located at basically three locations: theater, corps and air bases. The exact number of supply sites in a cluster will be defined in the input. For example, each corps, in reality, has two Special Ammunition Supply Points (SASP) associated with it. The NSPC at each corps level headquarters in this example would accordingly be composed of two supply sites implicitly located relative to the Corps C^2I element.

In addition to NSP clusters, nuclear munitions can be located with firing/using units. Nuclear capable artillery and missile battalions will have a capability to carry and store its own prescribed nuclear load. This mobile storage location, known as a Field Storage Location (FSL), will be implicitly incorporated into the battalion itself.

Note that the division will not have any nuclear supply sites associated with it. Rather, the munitions will be located at the various

- VULNERABLE TO ATTACK
  - AIR
  - SURFACE-TO-SURFACE MISSILES
- FORM OF ATTACK
  - AGAINST CS^2C ITSELF RATHER THAN LOCATION OR CS^2C COMPONENTS
- POTENTIAL EFFECTS OF ATTACK
  - DESTRUCTION OF RESOURCES ON HAND ("ATTACK ON STORAGE FACILITIES")
  - DEGRADATION OF ISSUE CAPABILITY ("ATTACK ON SUPPLIES IN TRANSIT AND LOC")
  - DEGRADATION OF REGENERATION CAPABILITY ("ATTACK ON MAINTENANCE FACILITIES")

Figure II-9. CS^2C Vulnerabilities

FSLs. Division, however, will keep track of the nuclear munitions by type and yield.

Resupply of nuclear munitions will not occur on a cyclical basis. Rather, resupply directives will be a part of the order releasing nuclear weapons for use. Resupply for blue will occur in the manner shown in Figure II-10. The location and flows for red nuclear munitions will reflect their doctrinal behavior.

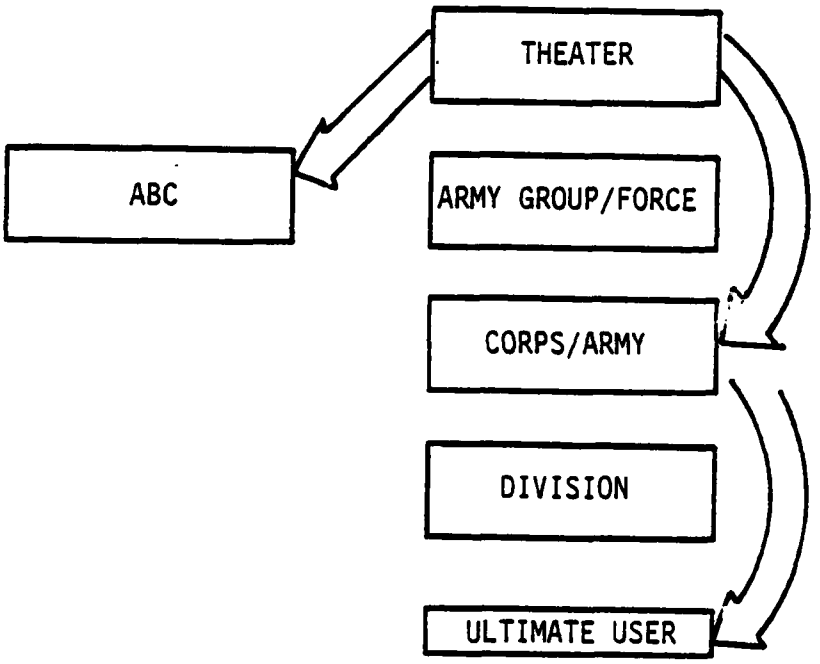

Figure II-10. Flow of Blue Nuclear Munitions

CHAPTER III
INFORMATION COLLECTION

A. INTRODUCTION

Information collection activities in INWARS will represent the direct perception of information about the situation. It is through collection activities that force elements obtain basic information about the battlefield situation. The information resulting from collection activities may implicitly reflect certain specialized processing such as imagery interpretation or pattern analysis. However, collection activities do not include the more complex processing by which C^2I elements integrate perceptions into a coherent understanding of the situation. This higher order processing is explicitly performed by C^2I elements--collection provides the basic information inputs. In essence, information collection merely provides the bridge from the physical to the mental.

The treatment of information collection in INWARS has been guided by two basic aims. The first aim is to avoid detailed representations of sensing and interpretive information processing while still permitting explicit information integration by C^2I elements. Consequently, the information resulting from collection activities in INWARS will be of far higher quality and refinement than "raw" sensory inputs; nonetheless, this information will not provide a complete, coherent "picture" of the battlefield situation without further processing and integration. The second aim has been to enable commanders--C^2I elements--a certain amount of control over how their perception capabilities are used to "look at" the battlefield. Consequently, generic PHOTINT and SIGINT agencies will be explicitly represented operating under the direction of appropriate C^2I elements; all other sensing capabilities have been combined into inherent collection capabilities associated with appropriate force elements.

Section B below discusses the two basic forms of information collection treated in INWARS, (self-perception and intelligence collection) and provides a general discussion of the representation. The remainder of this

chapter focuses on the explicit intelligence collection entities treated in INWARS, namely PHOTINT and SIGINT agencies. Section C discusses the representation of these agencies while Section D concerns their activities. Finally Section E presents the treatment of the collection process in INWARS, paying special attention to the problem of representing information incompleteness and imperfection in a deterministic model.

B. FORMS OF INFORMATION COLLECTION IN INWARS

Two basic forms of information collection are distinguished in INWARS: (1) self-perception, concerning information collected (perceived) by a force element about itself, and (2) intelligence collection, concerning information collected about the enemy or the environment.

1. Self-perception

Self-perception concerns that information which a force element "collects" about itself. The categories of information associated with self-perception are presented in Figure III-1. Essentially, they reflect an Order of Battle (OB) type unit description, supplemented by the "Enemy Activities Against" category. Certain categories may not be germane to certain types of units. Moreover, the exact information descriptors (codes) within a category will vary among force elements: the status and operations of a combat service support complex would be described in very different terms than those of a maneuver brigade.

All force elements in INWARS will have a self-perception capability. This capability concerns only the force element itself. In particular, the self-perception capability of a C^2I element extends only to the element itself (considered as a command post), not the total force organization it commands. Thus, for example, a Corps C^2I element will know its own status as a command post, but will have to rely on reports from its divisions, combat service support complex, missile pool, and other subordinates to understand its overall status as a Corps.

Self-perception information will be accurate, reliable, and timely in INWARS. It has been decided that the additional run time and storage

COMPOSITION

- TYPE (C^2I ELEMENT, MANEUVER BRIGADE, AIR BASE CLUSTER, ETC)
- LEVEL OF COMMAND (THEATER, ARMY GROUP/FRONT, ETC)
- IDENTIFY (INTERNAL "NAME")
- PARENT/SUBORDINATES

DISPOSITION

- LOCATION (CURRENT HEX LOCATION)
- DEPLOYMENT/POSTURE (CONFIGURATION, NUCLEAR/CHEMICAL READINESS, ETC)
- MOVEMENT (DIRECTION, SPEED)

STATUS

- STRENGTH/CHANGES
- RESOURCES/CHANGES (E.G., CAPABILITY TO ISSUE, CAPABILITY TO LAUNCH)

OPERATIONS

- MISSION
- OBJECTIVE
- ACTIONS/ACTIVITIES
- CONTROL MEASURES
- OPERATING THRESHOLDS

ENEMY ACTIONS AGAINST

- GROUND ATTACKS BY ENEMY
- ENGAGEMENT BY ENEMY FIRE (ARTY, CAS, MISSILE; NUC/CHEM)

Figure III-1. Self-Perception Information Categories

requirements to introduce imprecision or perceptual delays into self-perception is not warranted by the additional realism obtained (especially in view of data availability). Of course, the reporting of self-perception information among C^2I elements will be subject to a communications delay and will thus preclude instantaneous responses to developing situations.

2. Intelligence Collection

Intelligence collection represents the collection of information relating to the enemy. The generic categories of information involved in intelligence collection are presented in Figure III-2. Note that information relating to enemy force units essentially reflects an Order of Battle orientation. However, partial information in the composition, disposition, and status categories will also serve the target acquisition function. Thus, under the status category, an explicit distinction has been made between estimated strength and acquired strength; this provides for the case when a larger unit has been identified but only a portion of its component units have been acquired in sufficient detail for targeting.

Information resulting from intelligence collection activities will generally be incomplete; additionally, the availability of the information (for response or reporting) will be appropriately delayed to reflect the need for such information processing as imagery interpretation or pattern analysis. However, the requirement that INWARS be completely deterministic precludes representation of the collection of erroneous information. Hence, such information as is collected will be generally accurate.

Intelligence collection activities and capabilities will be treated in two principal ways in INWARS. First, force elements will be included to represent certain key collection agencies--imagery and signals intelligence elements. These will be associated with--and directed by--appropriate C^2I elements; they will provide deep coverage of the enemy area but will possess limited collection assets, thus requiring allocation decisions on the part of the controlling C^2I element.

Second, all maneuver brigades/regiments and C^2I elements will have an inherent intelligence capability reflecting other implicit sensing and

ENEMY FORCE UNITS

- COMPOSITION
  - TYPE
  - LEVEL OF COMMAND
  - IDENTITY
  - PARENT/SUBORDINATES
- DISPOSITION
  - LOCATION
  - DEPLOYMENT/POSTURE
  - MOVEMENT
- STATUS
  - ESTIMATED STRENGTH
  - ACQUIRED STRENGTH
  - RESOURCES/CHANGES
  - CAPABILITIES/CHANGES
- OPERATIONS
  - MISSIONS
  - OBJECTIVES
  - ACTIONS/ACTIVITIES
  - CONTROL MEASURES

ENEMY SITUATION FEATURES

- CONCENTRATIONS
- LARGER UNIT MOVEMENTS
- INDICATORS

Figure III-2. Self-Perception Intelligence Information Categories

observation capabilities. This inherent capability will be represented by a fixed "field of view" or area about the element's location; collectively, these fields of view will provide limited coverage into the enemy area as well as providing coverage of the friendly rear area.

C. INFORMATION COLLECTION AGENCIES

As noted above, force elements representing airborne imagery and signals intelligence collection agencies will be explicitly included. There are three basic reasons for the explicit, separate treatment of these two types of agencies:

- PHOTINT and SIGINT collection agencies represent the principal means of surveillance and reconnaissance deep into enemy areas; as such they are especially important to higher level commanders.
- PHOTINT and SIGINT collection assets ~~are~~ limited--it is not possible to look deeply into all areas of the battlefield at the same time. Accordingly, the allocation of these assets represents an important decision option to higher level commanders.
- PHOTINT and SIGINT collection agencies offer significantly different perception capabilities in terms of type and quality of information produced. This impacts not only on the results of their employment but also on the employment decision.

The remainder of this chapter is devoted to a discussion of the representation of those two types of collection agencies, their collection activities, and the processes by which those activities "perceive" information about the situation.

1. Airborne Imagery Collection Agencies (PHOTINT Elements)

Airborne imagery collection agencies representing Air Force and Army assets will be included in INWARS. Air Force assets will be controlled by the ATAF/TAA C^2I elements; this control will reflect not only the local ATAF/TAA needs but also the daily sortie allotments of the Theater C^2I element and the specific requests of the associated Army Group/Front C^2I elements. Information produced will be disseminated to the ATAF/TAA and/

or Army Group/Front C^2I elements as appropriate. Army assets will be controlled by the Corps/Army C^2I elements and will disseminate to those elements.

Collection assets under the control of these agencies will be able to "look at" regions (i.e., sets of hexes) up to some maximum depth in enemy territory. Employment decisions by the controlling C^2I elements will determine just what regions are to be observed. Since there are limited collection assets, only a limited number of missions will be able to be accomplished in a given period of time. Imagery collection assets will generally be subject to attrition.

As a consequence of these mission-directed looks, airborne imagery collection assets will be able to observe and thus perceive certain types of information about force elements in the regions observed. Figure III-3 synopsizes the basic PHOTINT perception capabilities to be represented. Also included is a broad assessment of the quality of the resulting information which may vary with local conditions.

2. Signals Intelligence Collection Agencies (SIGINT Elements)

Signals intelligence collection agencies representing Army assets will be explicitly included in INWARS. Army assets may operate under the control of any appropriate level C^2I elements and would disseminate back to those elements; it is envisioned that only Theater and Corps/Army level SIGINT elements will be explicitly treated in INWARS.

Notional SIGINT collection assets under the control of these agencies will be able to intercept enemy message transmissions in a given range up to some maximum range into enemy territory. These will be explicit intercepts of messages transmitted (see Chapter IV, below, for further discussion of message transmission). SIGINT employment missions will specify the particular regions to be surveilled. By setting appropriate missions, controlling C^2I elements can, to an extent, "focus" their SIGINT assets on broad surveillance or more specific "reconnaissance" type missions.

As a consequence of communications intercepts, SIGINT elements will be able to perceive certain information about the associated enemy

INFORMATION CATEGORY	PERCEIVABLE*	QUALITY
ENEMY FORCE UNITS		
• COMPOSITION		
•• TYPE	X	CRUDE
•• LEVEL OF COMMAND	X	CRUDE
•• IDENTITY	--	--
•• PARENT/SUBORDINATES	--	--
• DISPOSITION		
•• LOCATION	X	GOOD
•• DEPLOYMENT/POSTURE	X	MEDIUM
•• MOVEMENT	X	MEDIUM
• STATUS		
•• ESTIMATED STRENGTH	X	MEDIUM
•• ACQUIRED STRENGTH	X	GOOD
•• RESOURCES/CHANGES	X	CRUDE
•• CAPABILITIES/CHANGES	X	CRUDE
• OPERATIONS		
•• MISSIONS	--	--
•• OBJECTIVES	--	--
•• ACTIONS/ACTIVITIES	--	--
•• CONTROL MEASURES	--	--
ENEMY SITUATION FEATURES		
• CONCENTRATIONS	X	MEDIUM
• LARGER UNIT MOVEMENTS	X	MEDIUM
• INDICATORS	X	MEDIUM

* WEATHER PERMITTING

Figure III-3. PHOTINT Perception Capabilities

force elements. These perceptions may implicitly involve specialized processing such as traffic analysis or communications content analyses. Figure III-4 synopsizes the basic perception capabilities to be attributed to SIGINT elements in INWARS. Again, a general assessment of the quality of the resulting information is provided. Note that SIGINT elements offer a potentially broader and better source of information than PHOTINT. However, note also that perception of many of the categories of information depend on interception of appropriate messages transmitted in an unsecure mode. Since this is not under the control of the SIGINT element, it may be significantly harder to realize the potentials of SIGINT than those of PHOTINT.

D. COLLECTION ACTIVITIES

The representation of the intelligence collection process in INWARS wll essentially involve four distinct collection activities: (1) collection tasking, in which the controlling C^2I element specifies regions to be surveilled as well as effort to be devoted on a region-by-region basis; (2) collection preparation, in which the tasked collection agency "configures" its collection assets to accomplish the task; (3) collection, during which the actual perception processes occur in accordance with the configuration of the collection asset, and (4) collection reporting, during which the collected information is disseminated back to the controlling C2I element.

1. Collection Tasking

The tasking activity is accomplished by C^2I elements during operations development in accordance with the doctrinal requirements of the operation and will not be discussed further here (see Volume V, Chapter IV, Sections B.2.b. and G for a description). It is important to note the form of a collection tasking here, however. A collection tasking may be regarded as an operations directive to a collection agency. In INWARS, such a tasking will essentially consist of a list of collection specifications; each individual specification will identify a particular

INFORMATION CATEGORY	PERCEIVABLE	QUALITY
ENEMY FORCE UNITS		
• COMPOSITION	X	GOOD
•• TYPE	X	GOOD
•• LEVEL OF COMMAND	X	GOOD
•• IDENTITY	X	GOOD
•• PARENT/SUBORDINATES	X	GOOD
• DISPOSITION		
•• LOCATION	X	MEDIUM
•• DEPLOYMENT/POSTURE	X	GOOD
•• MOVEMENT	X*	GOOD
• STATUS		
•• ESTIMATED STRENGTH	X*	GOOD
•• ACQUIRED STRENGTH	X*	GOOD
•• RESOURCES/CHANGES	X*	GOOD
•• CAPABILITIES/CHANGES	X*	GOOD
• OPERATIONS		
•• MISSIONS	X*	GOOD
•• OBJECTIVES	X*	GOOD
•• ACTIONS/ACTIVITIES	X*	GOOD
•• CONTROL MEASURES	X*	GOOD
ENEMY SITUATION FEATURES		
• CONCENTRATIONS	--	--
• LARGER UNIT MOVEMENTS	X*	MEDIUM
• INDICATORS	X*	GOOD

*NOTE: PERCEIVABILITY DEPENDS ON THE INTERCEPTION OF UNSECURE COMMUNICATIONS INVOLVING THIS INFORMATION CATEGORY

Figure III-4. SIGINT Element Perception Capabilities

collection agency, a particular region to be surveilled, and an indication of the relative collection effort to be devoted to surveilling that region. Regions will be limited to quadrilaterals. Relative collection effort will be expressed as a fraction of the total effort available. Hence, the sum of the relative efforts over all specifications in the task list must be less than or equal to 1.0. (In the Level II Specifications, it was stated that collection taskings could specify regions or force elements to be surveilled. However, it is believed that an adequate representation can be based on surveillance of regions alone, thus eliminating the need for two distinct task preparation and execution processes.)

2. Collection Preparation

Upon receipt of a collection tasking from the supported C^2I element, the tasked collection agency will prepare to execute the task by appropriately configuring its assets. For Air Force PHOTINT agencies, this takes the form of defining specific air reconnaissance mission package requests which are then processed by Air Base clusters as described in Volume III; a similar process will be employed for Army PHOTINT agencies. For SIGINT agencies, preparation takes the form of allocating available notional SIGINT assets among the specified regions in accordance with the specified fractional effort. (This is essentially an internal modeling function and does not involve any explicit changes such as movement.) Note that in both cases, preparation will be represented as a "mechanical" activity not requiring explicit mental processes--rather the mental processes are involved in the generation of the collection tasking.

3. Collection

Once preparation is complete, the collection activities begin. The collection activities of PHOTINT and SIGINT agencies are represented in different ways in INWARS. PHOTINT collection activities are represented by the explicit composition and launch of requested air reconnaissance mission packages. This is accomplished by air base clusters in accordance with the reconnaissance mission requests from the associated PHOTINT agency during preparation for collection. Of course, the launch of these packages is also contingent on the capability of the air base and favorable weather

and day/night states. By contrast, SIGINT collection activities are represented implicitly in the form of a "receptivity" to message transmissions by enemy units in the regions surveilled.

In order to more precisely characterize the representation of collection activities in INWARS, it is necessary to introduce some terminology. First, the basic collection system of a collection agency is the smallest system capable of undertaking collection activities. The basic collection systems of PHOTINT and SIGINT agencies in INWARS are, respectively, the individual reconnaissance aircraft and the notional SIGINT assets. Basic collection systems are the "assets" which a collection agency configures during preparation for collection. Several may be assigned to observe the same region; for example, an air reconnaissance mission package may contain several individual reconnaissance aircraft. Second, the basic unit of collection of a collection agency is the simplest unit of activity which can produce a coherent information collection when carried out by a single basic collection system. The basic units of collection of PHOTINT and SIGINT agencies in INWARS are, respectively, the reconnaissance mission and the transmission intercept (note that this latter may be decomposed into secure transmission intercept and insecure transmission intercept).

In essence, collection activities can be characterized as the completion of a sequence of basic units of collection. Indeed, as will be discussed in Section E below, the representation of information collection is structured around the completion of basic units of collection. For this reason, the notion of a collection event may be introduced to identify the completion of a basic unit of collection by one or more basic collection systems. In INWARS, the occurrence of a collection event marks a point at which the information possessed by a collection agency is updated.

Occurrences of PHOTINT and SIGINT collection events are scheduled in different ways in INWARS. PHOTINT collection events are scheduled to occur at a certain time following the return of an air reconnaissance mission package to its air base cluster; this delay reflects the time to process and interpret the imagery produced by the mission package. SIGINT

collection events are scheduled to occur at a certain time following the transmission of a message by an enemy unit in a region under surveillance; here, too, the delay reflects expected processing and interpretation time. The difference in the scheduling of PHOTINT and SIGINT collection events reflects the difference between PHOTINT collection activity and the more passive--and less controllable--SIGINT collection activity.

4. Collection Reporting

As the collection activity proceeds and information about enemy force elements increases, the collection agencies will disseminate this information back to the supported C^2I elements. In INWARS, the supported C^2I element will always have direct access to the information possessed by a given collection agency. Thus, explicit dissemination to the supported command will not be represented. (However, dissemination from the supported C^2I element to other C^2I elements is explicitly treated as a part of the communications process as described in Chapter IV, below.)

E. REPRESENTATION OF INFORMATION COLLECTION

The preceding section presented the representation of the various activities involved in information collection by PHOTINT and SIGINT agencies. In this section, the representation of the information collected and the processes by which at dynamically increases and decreases over time are presented. Subsections 1-4 concern enemy force element information and subsection 5 concerns situation features information. Subsection 6 then presents an assessment of the approach.

1. Representation of Information about Enemy Force Elements

In INWARS, the information about enemy force elements possessed by a collection agnecy will be represented as a stock. More precisely, it will be represented as a collection of stocks organized into a matrix-like structure where the rows are indexed by enemy force elements and the columns are indexed by type of information. Figure III-5 illustrates this structure. The first row represents the stock of information possessed about the enemy force element whose internal model "name" is '06492'.

INFORMATION STOCKS OF A PARTICULAR
COLLECTION AGENCY

ENEMY FORCE ELEMENT/ TYPE INFORMATION	COMPOSITION	DISPOSITION	STATUS	OPERATION
06492	1.5	0.9	1.1	0.3
08112	0.1	1.1	0.0	0.0
14655	0.9	0.4	0.1	0.2

Figure III-5. Representation of Information about Enemy Force Elements

The columns relate to the types of information which are possessed about the units. Notice that those types of information correspond to the basic categories of intelligence information about enemy units as portrayed in Figure III-2. The values entered in the cells of the matrix represent the stock of information of the column's type about the row's unit possessed by the collection agency. Thus, for example, the stock of composition information possessed about a unit 06492 is of "size" 1.5.

These stock sizes are interpreted in terms of the ability of the collection agency to access (true) information in that category about the referenced enemy unit. In INWARS, this ability will be present or absent depending on whether the stock is greater or smaller than some threshold (set arbitrarily at 1.0). For example, the collection agency characterized in Figure III-5 would be able to access only composition and status information about unit 06492.

Given the representation of information as a matrix of stocks, the processes by which the stocks change over time may be characterized as follows: (1) stock values increase as basic units of collection are completed by the collection agency's assets; (2) stock values decrease over time reflecting the aging and decay of information collected earlier. Figure III-6 presents an example of both types of changes for a presumed SIGINT collection agency.

2. Increases in Information Stocks

Every occurrence of a collection event involving assets of a particular collection agency will cause that agency's information stocks to be increased. The steps in this process are as follows. First, the agency's existing information stock matrix is surveyed to determine whether the enemy force element(s) perceived during the event is already included. If it is not, an appropriately indexed row is added to the matrix. In either case, the values on the appropriate row are incremented by a fixed (user-input) amount. The increments may (and usually will) differ among the types of information (columns). Moreover, these increments may vary depending on the type of collection event which initially caused the updating. This provides a means to represent differences between PHOTINT

DESCRIPTION/ TYPE INFORMATION	COMPOSITION	DISPOSITION	STATUS	OPERATION
INFORMATION STOCK ON ENEMY FORCE ELEMENT AS OF 1200	1.5	0.9	1.1	0.3
SIGINT COLLECTION EVENT (INTERCEPT OF OPEN TRANS-MISSION) ADDING TO STOCKS AT 1220	+0.4	+0.2	+0.3	+0.2
SIGINT COLLECTION EVENT (INTERCEPT OF SECURE TRANS-MISSION) ADDING TO STOCKS AT 1230	+0.2	+0.1	0.0	0.0
PERIODIC (INTERNAL) DECAY OF INFORMATION STOCKS AT 1259	-0.2	-0.5	-0.3	-0.1
INFORMATION STOCK ON ENEMY FORCE ELEMENT AS OF 1300	1.9	0.7	1.1	0.4

Figure III-6. Example Changes in the Information Stocks Concerning a Particular Enemy Force Element

collections and SIGINT collections (and, for that matter, between types of SIGINT collections--secure versus open transmission intercepts).

3. Decreases in Information Stocks

To reflect the aging and decay of information as the situation evolves, the information stocks of PHOTINT and SIGINT agencies will be subjected to a periodic decrementing process. Decrements will be uniform for all enemy units (rows) but may vary among information types (columns). This provides a mechanism to represent the relative "volatility" of different types of information (e.g., composition information is considerably less volatile than disposition information). Should the information stocks on a particular enemy unit ever become uniformly decreased to zero, that unit will be deleted from the stock matrix in order to conserve space.

4. Representation of Acquired Strength

As was noted in Section B.2 above, there is an explicit distinction between estimated strength and acquired strength. The treatment in terms of information stocks represents the ability to access information about enemy units and this provides for the estimated strength category. Acquired strength will accordingly be represented as a fraction which is proportional to the stock of status information.

5. Representation of Situation Features

The discussion thus far has concerned the representation of information collected about enemy force elements. However, as discussed in Section B.2 above, intelligence collection can also produce information about such situation features as concentrations, larger unit movements, and indicators. This form of perception will be directly represented in INWARS as discussed below.

a. Concentrations and Movement

These features will be perceived on the basis of the true situation. In other words, if a larger unit is concentrated in, or begins to move in a region surveilled by the collection unit of a particular collection agency, then that agency will perceive the feature. Following a suitable delay time, the feature will be accessible to the controlling C^2I element which will incorporate the feature into its Understanding of

the Situation. (See Volume V, Chapter II, Section C.4 for the representation of situation features information, and Chapter III, Section B.2.c for the representation of the incorporation process.)

b. Indicators

Indicators perceived by INWARS collection agencies will be limited to nuclear and chemical activitiy. As presently envisioned such indicators will include:

(1) launch activities of SSM pools,

(2) changes in nuclear/chemical readiness of force elements and other adaptive measures, and

(3) messages relating to nuclear or chemical activity.

If such activities occur in a region surveilled by the collection assets of an appropriate agency, then that agency will perceive the activity. As above, an appropriate indicator will be accessible to the controlling C^2I element following a suitable delay time.

6. Assessment of Approach

The limitations of this approach to the treatment of information collection are readily apparent--it provides a very simplified representation of a very complex activity. Nonetheless, operating within the framework of deterministic modeling, it is felt that the approach outlined provides a reasonable representation without excessive run-time or storage utilization. For example, although the information "collected" is accurate, it is incomplete and delayed; moreover, the degree of incompleteness and delay are dependent on how collection assets are utilized as well as on the situation. Finally, a certain amount of growth and expansion is possible within the general approach. For example, the values of the various information stocks could be used as indices of information precision instead of simple indicators of information availability (relative to a preset threshold). Test and experimentation may reveal that some of these possibilities are desirable for development during the refinement of Basic INWARS.

CHAPTER IV
COMMUNICATIONS

A. INTRODUCTION

Communications activities and processes have an important impact on decision making behavior and C^2I activities in that they involve the transmission of information among force elements. Accordingly, the INWARS representation of communications will provide for the explicit transfer of information in a suitably coded form. This will include not only message transmission, but also the formulation of messages by senders and subsequent interpretation by receivers. These activities will be driven by a series of standard message formats reflecting status reports, intelligence reports, requests, and directives. Message transmission will be conducted over communications links representing an aggregate of all modes of communications between force elements (radio, wire, messenger). Transmission will be represented in the form of a time delay between completion of message formulation and initiation of message interpretation. Section B presents the communications network structure envisioned for INWARS. Section C discusses message structure and types of formats to be included in INWARS, Section D discusses communications activities and Section E presents the representation of transmission by a time delay.

B. INWARS COMMUNICATION NETWORK

The communication network in INWARS represents the possibilities for communication among force elements in the simulation. Each force element serves as a node in this network; hence, every force element can talk to at least one other force element. Links in the network represent communications possibilities: if there is a link from force element A to force element B, then A can talk to B, and B can talk to A. Thus, links represent two-way communications possibilities. A link in the INWARS network is intended to represent an aggregation of all actual modes of communication (radio, wire, messages) between the linked force elements.

The structure of the INWARS communication network--i.e., what force elements are linked--will be founded on the command and control structure: every force element will be able to talk to: (1) its immediate superior (if any), and (2) its immediate subordinates (if any). Additionally, the network will reflect operational coordination by including communication links between adjacent force elements above Division. Finally, certain additional communications linkages may be included to reflect special operational patterns of communications such as the direct Corps-ATAF communications. Figure IV-1 illustrates the basic INWARS communications network structure.

C. MESSAGE STRUCTURE

Messages will be explicitly represented in terms of their information content (coded in a suitable form). A range of standard message formats specifying particular information content--i.e., particular types of information codes--will be defined. These will guide the formulation and interpretation of the corresponding messages. Each message will consist of a header block and a content block as described below.

1. Message Header Blocks

Message-header blocks will contain such information as sender code, receiver code(s), and date-time-group. Also included in the header will be a priority indicator and a secure transmission indicator. These two indicators may affect the delay time associated with the transmission of that message; additionally, the secure transmission indicator will impact on the ability of opposing SIGINT elements to obtain information from an interception of the message. Certain additional bookkeeping information such as message type code, etc., will also be included. This will be used to internally access appropriate message formulation and interpretation routines.

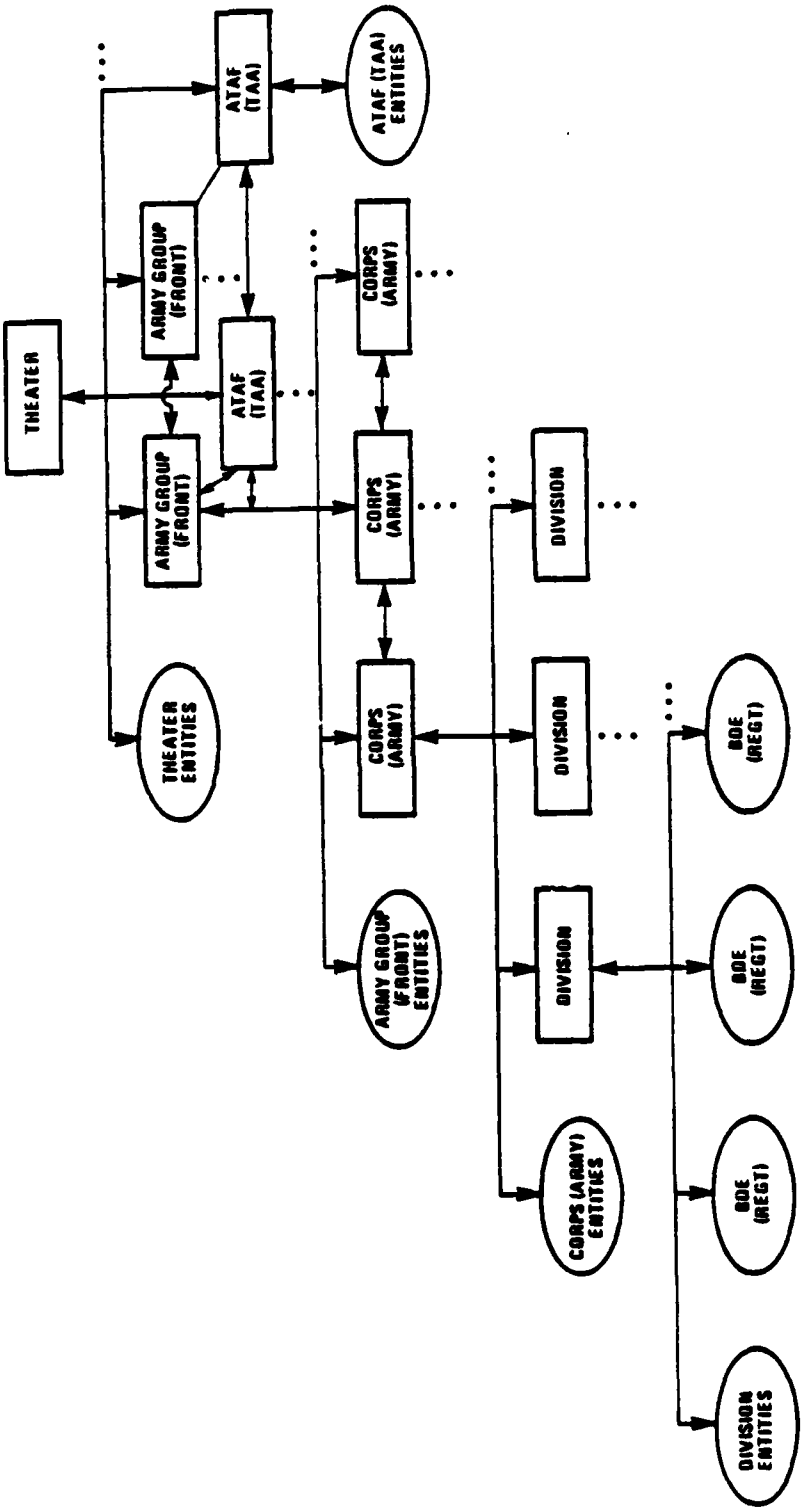

Figure IV-1. INWARS Communication Network Structure

2. Content Blocks

A variety of different content blocks will be utilized to represent different types of messages. In broad terms, INWARS messages may be of four basic types: (1) status reports, (2) intelligence reports, (3) requests, and (4) directives.

a. Status Report Content Blocks

Status reports concern a force element's own status. They will contain coded information obtained directly through self-perception or derived by C^2I processes from subordinate status reports. Status report may flow upwards (subordinate-to-superior), laterally (adjacent-to-adjacent), or downwards (superior-to-subordinate) in INWARS. Different types of status report types are required to represent the variety of potential status reporting conditions.

1) Regular Status Report

Regular status reports reflect the normal transmission of status information from subordinate-to-superior on a regular periodic basis. In fact, this reporting is stimulated by the passage of a doctrinally prescribed period of time (e.g., every two hours when in contact with the enemy). Regular status reports will contain a "key" which allows the superior unit to access the status of the reporting unit.

2) Spot Status Report

Spot status reports reflect the transmission of information relating to an exceptional event and are accordingly stimulated by the occurrence of that event. In INWARS, spot status reports will include the reporting of:

- Initial contact with enemy units;
- Loss of contact with enemy units;
- Nuclear or chemical attack on self or adjacent friendly units; and
- Violation of operating thresholds specified by the superior (including speed thresholds, casualty thresholds, or logistics thresholds--as discussed in Volume V, Chapter IV, Section F.4).

b. Intelligence Report Content Blocks

Intelligence reports concern the environment or the enemy, and will contain coded information obtained directly through intelligence perception or derived by C^2I processes from intelligence reports received from other force elements. Intelligence reports may flow upwards, laterally, or downwards in the communications network. As with status reports, a range of intelligence report types are required to represent the variety of potential intelligence reporting conditions.

1) Regular Intelligence Reports

Regular intelligence reports reflect the periodic transmission of a complete intelligence "picture" of the situation to immediate superiors, adjacent, and subordinates. As with regular status reports, the reporting is stimulated by the passage of a specified period of time. Also as with status reports, regular intelligence reports will transfer a "key" which allows the receivers to access the intelligence perceptions of the reporting unit.

2) Spot Intelligence Reports

Spot intelligence reports reflect the transmission of exceptional or newly perceived information about the enemy or the situation and are accordingly stimulated by such a-perception event. In INWARS, spot intelligence reports will provide for the reporting of:

- Initial detection of an enemy unit;
- Subsequent identification of detected enemy units;
- Acquisition, for targeting purposes, of detected enemy units;
- Concentrations of larger enemy units;
- Movement of larger enemy units;
- Indications of impending enemy nuclear or chemical activity; and
- Nuclear or chemical attack on nearby enemy unit.

c. Request Blocks

Requests express a force element's needs or desires for support from some other force element. Request block formats cover a range of support needs: reinforcement, fire support, air support, logistics

support, and information. The information codes contained in the request block will specify the type of support, the "extent" of support desired, and, perhaps, certain other information such as a time by which the support must be received in order to be useful. Requests will only be transmitted upwards and laterally in the INWARS communications network.

d. Directive Blocks

Directives express orders and command guidance controlling the actions of force elements; as such, directives implement the plans and decisions of higher level force elements. Directive block formats may include missions, objectives, control measures, resource allocations, and opening thresholds. Specific information within these categories will vary depending on the type of force element being directed; hence, a range of directive block formats will be required. Directives may reflect a complete operations order, or fragmentary amendments and modifications to an existing operations order. Directives will only flow downward in the INWARS communications network.

D. COMMUNICATIONS ACTIVITIES

All force elements in INWARS will have communications capabilities. The "intent" of a force element to use these capabilities to transmit a message to another force element may originate in a variety of ways (e.g., regular reporting intervals, exceptional reporting conditions, new intelligence perceptions, or need to implement a plan or decision). Once such intent has originated, however, three basic types of activities are involved in effecting the communication: formulating the message, transmitting the message, and interpreting the message.

1. Message Formulation

Message formulation is accomplished by the sending force element. It involves selecting a message type format and filling appropriate information codes into both the header and content components. Completing the header involves entering date-time group, receivers, and other information. In particular, this includes message priority and secure transmission

indicators; these will be selected for each message, on the basis of predefined rules (reflecting "Standard Operating Procedures"). Message formulation in INWARS will be driven by message formats.

2. Message Transmission

Once the message is formulated, the sending force element may initiate transmission to the designated receiver. Specific transmission procedures involving acknowledgement or verification may vary among message types. In the simulation, however, such procedures will be implicitly represented by the receipt of the message at some time after the initiation of transmission. In some cases, however, this delay process will be "short-circuited" by allowing instantaneous transmission of information. Specifically, all transmissions between entities and C^2I elements will be instantaneous while all transmissions among C^2I elements will be subject to delays as discussed in Section E below. This modeling approach allows savings in run-time and storage requirements while still permitting representation of those delays of fundamental importance to INWARS, namely delays among C^2I elements.

3. Message Interpretation

Once the message has been received, the receiving force element may interpret it. In general, interpretation involves responding to the content of the message. This will vary widely depending on the type of force element receiving the message, the type of message, and its content. In players--"thinking" C^2I elements--interpretation may involve a sequence of mental activities to analyze and assess the information; in lower level force elements, interpretation may simply cause a change of control or behavioral parameters.

E. REPRESENTATION OF TRANSMISSION BY TRANSMISSION DELAY

Message transmission among C^2I elements will be represented by means of a time delay reflecting time elapsed between the completion of message formulation (by the sender) and the beginning of message interpretation (by the receiver). This delay will be used in "scheduling" an event

representing the interpretation of the message by the receiver. Essentially, the delay must be computed as a function of the sender, the intended receiver, and the message. However, it is desirable that the delay also be sensitive to: (1) level of communications activity in the local communications network; (2) nuclear effects causing loss of certain communications capabilities (i.e., radio); (3) priority of the message; and (4) security of transmission. At the same time, it is necessary that the delay be deterministic and capable of rapid computation (considering all sensitivities). Finally, it is desirable that the form of the delay representation be extendable to more elaborate aspects of communications including, e.g., electronic warfare (which will not be treated in INWARS).

1. Form of the Delay Model

As was noted in the Level II Specifications, various computational approaches ranging from table look-up to simple queuing models are possible. However, on grounds of simplicity and computational speed, a table look-up method with additional scaling has been selected for INWARS. Figure IV-2 presents the mathematics of the approach. Essentially, a base delay factor is looked-up in a table based on the side of the sender, the echelon of the sender, the echelon of the receiver, and the length of the message. (Two message lengths will be utilized--"long" for regular status reports, intelligence reports, and whole operations directives; "short" for spot reports, requests, and fragmentary operations directives.) The base delay factor is then scaled by a message priority factor and a nuclear effect factor. The message priority factor scales the base delay up or down depending on the relative priority of the message. The nuclear effect factor scales the base delay up to reflect the impact of nuclear effects on communication (blackout and EMP). Notice that the nuclear effect factor is taken to be the largest of the nuclear effects (delays) sustained by the sender and intended receiver of the message. These separate delay factors are set for appropriate unit as a part of the overall computation of the effect of nuclear weapons (i.e., in the processing of a nuclear weapon employment event). The factors themselves would be set to a high level to reflect the temporary disruption of communications following nuclear weapons employment. This would be reduced over time to a level commensurate with the permanent damage to communications equipment.

Suppose C^2I element I sends message M to C^2I element J. Then the transmission delay will be represented by:

TRANSDELAY (I,M,J) = BASEDELAY*PRIORITYF*NUCLEARF

where:

(1) BASEDELAY represents the expected delay in transmitting a "standard" message of length M from a typical unit at the echelon of I to a typical unit at the echelon of J. That is

BASEDELAY = BASEDELAY (SIDE(I), LENGTH(M), ECH(I), ECH(J)

where: SIDE(I) = the side of I (NATO,WP)

LENGTH(M) = the length of message M (short or long, depending on the type of message)

ECH(I) = the echelon of C^2I element I (Theater,...,Division)

(2) PRIORITYF represents an expected increase (decrease) in expected delay for messages of lower (higher) priority than the "standard" message. This factor is determined by the priority of message M; that is,

PRIORITYF = PRIORITYF (PRIORITY(M))

where: PRIORITY(M) = the priority of messages M as contained in its header block

(3) NUCLEARF represents an expected increase in expected delay due to I or J having been subjected to nuclear communications effects. That is

NUCLEARF = MAX (NDELAYF(I), NDELAYF(J))

where: NDELAYF(I) = the nuclear communications delay factor of unit I.

Figure IV-2. Form of Transmission Delay Computation

2. Data Availability

A preliminary survey of data concerning communications delay and related matters has revealed: (1) an absence of data which could be used directly in any model of transmission delays at the level of communications aggregation necessary in INWARS, and (2) a scarcity of data concerning delays in communications among higher echelon command element. Consequently, it has become apparent that no matter what form of modeling is employed, delay data will have to be estimated. On the other hand, it does appear that such information as communications requirements and lower echelon delay data provides a basis for making delay estimates which are reasonable for the purposes of INWARS. This is, of course one reason for selecting a direct and simple form of modeling--to make the estimation of data a more direct and simpler task.

3. Limitations and Rationale

It is apparent that this simple transmission delay computation will not provide highly accurate delays sensitive to the situation. In fact, perhaps the most significant limitation, from a theoretical point of view, is the decoupling of the delay from the level of communications activity in the local communications network--queuing effects are only represented in an expected value sense. The rationale for this approach, however, is that the additional storage and computational time required for a more accurate and sensitive representation are not justified in view of the quality of supporting data (discussed above) and the overall role of transmission delays in INWARS. This role can be characterized as follows: transmission delay is one component in determining the overall delays between the recognition of events by one C^2I element and the response to those events by another C^2I element. Other components in this overall delay are reaction times (as discussed in Volume V, Chapter VII, Sections B and C). Given the limited availability of reaction time data, it makes little sense to have a highly accurate representation of transmission delays--all the accuracy would be lost in the summing with reaction delays. On grounds of giving INWARS consistent resolution and detail, there is little need for a highly detailed representation of transmission delays.

The simple form presented above does offer possibilities for expansion. Specifically, other delay scaling factors could be included to represent, e.g., communications jamming or even local communications activity level.

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