MULTILATERAL INTEROPERABILITY PROGRAMME

OVERVIEW OF THE C2 INFORMATION EXCHANGE DATA MODEL (C2IEDM) (C2IEDM Overview)

Date and location of approval: 20 November 2003, Greding, Germany

This *Multilateral Interoperability Programme (MIP) Overview of the C2 Information Exchange Data Model (C2IEDM)* has been reviewed and is hereby "Approved" by the Heads of Delegation of participating nations. Release of this document to nations or agencies, who are not participants in the Multilateral Interoperability Programme including the media and general public, requires approval of the MIP Steering Group (MSG) in accordance with the policy stated in the MIP Communications and Liaison Plan (MCLiP). This document is the property of the MIP Participants and the information contained in this document shall not be communicated, either directly or indirectly, to any person or agency not authorised to receive it.

RECORD OF CHANGES PAGE

CP NUMBER	DATE ENTERED	ENTERED BY	REMARKS

CONTENTS

LIST OF FIGURES

LIST OF TABLES

PREFACE

OVERVIEW OF THE C2 INFORMATION EXCHANGE DATA MODEL (C2IEDM)

Introduction

The application of military force in the early 21st century is demanding. It covers a wide spectrum of threats and deployment scenarios that range from conventional general war through limited operations, crises response operations, asymmetric conflict, and terrorism. Unilateral capability is important to nations but most planning is made on the assumption of alliance and coalition operations in scenarios that are difficult to predict and which often arise at short notice. Thus the nature and composition of a force structure to meet military requirements will be specific to requirement and based upon a general and flexible military capability.

To achieve this, an assured capability for interoperability of information is essential. The successful execution of fast moving operations needs an accelerated decision-action cycle, increased tempo of operations, and the ability to conduct operations within combined joint formations. Commanders require timely and accurate information. Also, supporting command and control (C2) systems need to pass information within and across national and language boundaries. Moreover, tactical C2 information must be provided to the operational and strategic levels of command including other governmental departments. Additionally, forces must interact with non-governmental organisations, including international aid organisations.

The Multilateral Interoperability Programme (MIP) aims to deliver an assured capability for interoperability of information to support combined joint operations.

Multilateral Interoperability Programme (MIP)

The aim of the Multilateral Interoperability Programme (MIP) is to achieve international interoperability of Command and Control Information Systems (C2IS) at all levels from corps to battalion, or lowest appropriate level, in order to support multinational (including NATO), combined and joint operations and the advancement of digitization in the international arena.

The means to achieve this will be known as the MIP solution, which is a set of items delivered by the MIP programme at the end of each block. It includes the MIP specifications, Standard Operation Procedures and other documentation that is required for implementation of the specifications and for use of the MIP Common Interface (MCI)[1].

[1] The MCI is a logical description of the configuration of two or more implementations (in Soft and/or Hardware) of the MIP specifications that enables information exchange between two or more C2IS of different nations.

The MIP Concept

The MIP solution enables information exchange between co-operating but national C2 systems.

It is not the responsibility of MIP to specify the end system (C2IS) functional capabilities however the MIP solution has proven to be a valuable source for national C2IS development. National systems need not necessarily conform to any hardware or software standard. Typically systems will be acquired through national or NATO acquisition programmes and their architecture will conform to the national or NATO policy prevailing at the time.

The core of the MIP solution is the C2 Information Exchange Data Model (C2IEDM). It is a product of the analysis of a wide spectrum of allied information exchange requirements. It models the information that combined joint component commanders need to exchange.

The MIP solution enables C2IS to C2IS information exchange and allows users to decide what information is exchanged, to whom it flows, and when.

The overall end state is reached when the combined joint force can operate as a single, synchronized team in accomplishing its assigned mission in the modern battle space. For that a common understanding between commanders within a combined joint force conducting military operations is required. The MIP contribution to this end state is to facilitate the timely flow of accurate and relevant information through an Information Exchange Mechanism (IEM), specified within MIP, between the different national C2IS. MIP will therefore be one of the factors contributing to the realization of Network Enabled Capabilities for the commanders within a combined joint force.

MIP Baseline 1 comprises:

- The Message Exchange Mechanism (MEM) consists of a suite of formatted messages that conform to AdatP-3 Part 1, plus guidelines for their use.
- The Data Exchange Mechanism (DEM) is an automatic data push mechanism that co-exists with the MEM. When a C2 application changes the state of information that it holds, and which is recognised by the DEM, this information is automatically replicated to all other co-operating systems that have agreed to exchange this information.

With both exchange mechanisms the meaning and context of the information is preserved and requires no additional processing on receipt to make it useful. The MIP specifications enable interoperability at Degree 4.a[2] (DEM) and 2.h[3] (MEM) and functions at NATO Level 5 of System Interconnection[4].

---

[2] *The NATO Policy for C3 Interoperability* [NC3B Sub-Committee AC/322 SC/2-WP/72 (Revised) Version 4.3]: "Seamless Sharing of Information: Common Information Exchange."

In Baseline 2, MIP is expanded to extend the panoply of interoperability services provided (messaging, Web, directory, security, collaboration…).

The Programme has gone through the stages of: operational analysis, concept, feasibility, definition, development and demonstration.

The programme is focused on delivering capability in an incremental manner with the intent to achieve a 2-year delivery cycle, while in parallel the previous baselines are sustained, new operational requirements are analysed, new capabilities are agreed, and emerging technologies are explored. Nations are encouraged to align their acquisition cycles with the agreed implementation schedule. The MEM and the DEM developed in Block 1[5] will be in-service during the period 2003 – 2005 and followed thereafter with biennial capability enhancements as a target.

History

The Multilateral Interoperability Programme was established by the Project Managers of the Army Command and Control Information Systems (C2IS) of Canada, France, Germany, Italy, the United Kingdom and the United States of America in April 1998 in Calgary, Canada. MIP replaced and enhanced two previous programmes: BIP (Battlefield Interoperability Programme) and QIP (Quadrilateral Interoperability Programme). The aim of these programmes was similar to the present MIP but each was active at a different level of command.

In 2002 the Army Tactical Command and Control System (ATCCIS) programme merged with MIP. ATCCIS was founded in 1980 to see if interoperability could be obtained at reduced cost and developed according to technical standards agreed by Nations and prescribed by NATO. The programme sought to identify the minimum set of specifications, to be included within national C2 systems that would allow interoperability between them. With the publication of ATCCIS Baseline 2 the programme's mandate was complete. By 2002 the activities of ATCCIS and MIP were very close, expertise was shared, and specifications and technology was almost common. The merger of ATCCIS and MIP was a natural and positive step and this was recognised by the almost immediate publication of a NATO policy that endorses MIP[6].

---

[3] *The NATO Policy for C3 Interoperability* [NC3B Sub-Committee AC/322 SC/2-WP/72 (Revised) Version 4.3]: "Structured Data Exchange: Data Object Exchange"

[4] STANAG 5048 - *The Minimum Scale of Connectivity for Communications and Information Systems for NATO Land Forces* (Edition 5. Promulgated 16 February 2000 by NC3B Sub-Committee AC/322 SC/1). "Two systems which are open to each other, and which conform to minimum standards for information definition and transfer such that there are no fixed constraints on the extent of access by users of one system to the other, but dynamic constraints are applied to each system, in accordance with the current operational situation, such that only a user-defined subset of the total information base of one system is available to the other."

[5] The overall MIP Calendar is divided into 'Blocks' or evolutionary solutions, each block will take three years of developing and will remain 'in-service' for two years.

[6] NATO Policy on the Multilateral Interoperability Programme [NC3B AC/322-WP/0238]

MIP Organisation

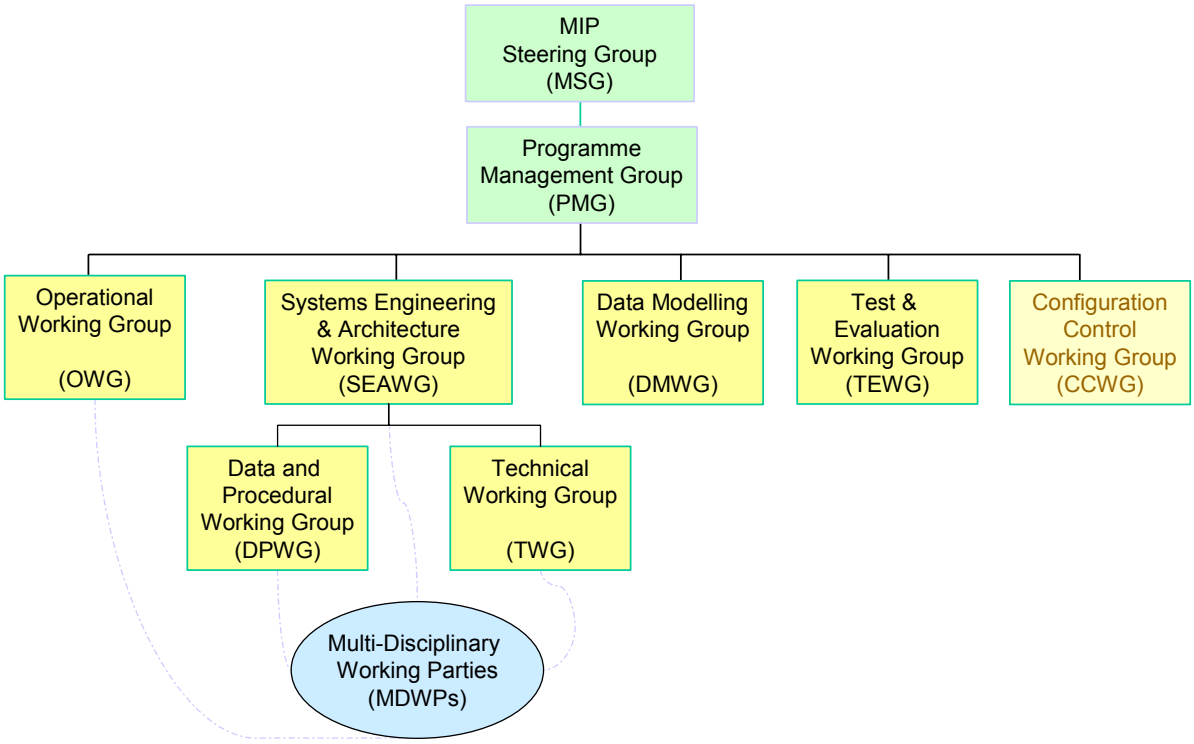
The MIP programme is not a formal NATO programme. Rather it is a voluntary and independent activity by the participating nations and organizations. The nations and HQs that are active in the MIP programme are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Spain, Sweden, Turkey, United Kingdom, United States, Regional Headquarters Allied Forces North Europe (RHQ AFNORTH) and Allied Command Transformation (ACT).

The MIP consists of Full Members[7] (nations only) and Associate Members[8] (nation and non-nation entities).

MIP is organised into 7 working groups with an executive management body and a high level steering group for resources, policy and targets. Rigour is maintained by the adoption of recognised system engineering practices. In addition to the interface specification and the exchange mechanisms, MIP also produces supporting products covering programme management, security policy, test schedules, configuration management, representative data fills, and international liaison.

[7] Full Members are nations that commit to support the collaborative development of succeeding versions of the MIP interoperability solution suitable for fielding. In addition a Full Member must express an intention to field the MIP solution. Full Members undertake to be represented in all WGs and must be prepared to expend the resources required to develop and sustain the MIP solution. A Full Member must be involved in and contribute actively to the decision-making process throughout the specification and development cycle. In addition, a Full Member is a nation that has signed the MIP Statement of Intent (SOI) regarding their participation in MIP. Full Members have voting and access rights at all meetings.

[8] Associate Members include nations and non-nation entities such as military agencies and formations, showing an interest in this programme, which have been granted Associate Member status by the MIP Steering Group (MSG). Associate Members enjoy all the rights and privileges of a Full Member as agreed by the MSG except Associate Members do not have any voting rights at meetings. Associate members need not to support all MSG/PMG and WG meetings. In addition, Associate Members accept the MIP Statement of Intent (SOI).



Implementation, Adoption and Stability

The MIP is involved in the following activities and standards:

- The (L)C2IEDM is the core of the NATO Reference Model and is also a view model of NATO Corporate Data Model (STANAG 5523 / AdatP-32).
- Implementation of the MIP specification is a NATO Force Goal (FG2802).
- NATO Policy on MIP calls for close co-ordination and re-use of the MIP specification within NATO.
- Bi-SC Automated Information System will use the MIP solution in its Land Functional Services (LandFS) to interface to national CCIS, either in HRF/LRF, CJTF or other crisis response operation or exercise[9].
- NATO Standardisation Agreement SO 01-11 calls for the implementation of MIP specifications.

[9] Bi-SC transition Management Board Report to Bi-SC CIS Board, on 25th September, 2002

- The MIP specification is well regarded in the NC3A. It is the core capability of the NC3A Integrated Data Environment prototype, a capability to integrate legacy systems.
- The MIP specification is included in the NATO C3 Technical Architecture.
- The NATO Military Criteria for High Readiness Forces (Land) Headquarters requires the use of an ATCCIS[10] compliant land information system.
- Many national C2 information systems implement MIP specifications.

Purpose

The overview presents principal features of the data structure that has been evolved to satisfy operational requirements. The primary goal is to indicate the *scope* of the model in covering information categories of interest to the operational user. Examples and explanations attempt to use operational language as much as possible.

[10] MIP is the custodian of the ATCCIS specifications.

1. INTRODUCTION

1.1 Evolution of the C2 Information Exchange Data Model (C2IEDM)

1.1.1 General

1.1.1.1 Common specification and structuring of information to be exchanged is required in order to achieve automated information exchange.

1.1.1.2 Structure of the information is expressed in a data model, built and documented in accordance with an accepted methodology. This model defines the standard elements of information (data) that form the basis for interoperability between those automated national Command and Control Information Systems (C2ISs) that accommodate the model's information structure.

1.1.1.3 Since information exchange requirements (IERs) change over time, there was a need to design a flexible generic model that could adapt over time to changing information needs and serve as a basis or hub for new systems. For these reasons the data model was initially known as the Generic Hub (GH) Data Model. The name was changed to Land C2 Information Exchange Data Model (LC2IEDM) in 1999. The current version contains considerably more joint content; as a result, the name was changed to C2 Information Exchange Date Model (C2IEDM).

1.1.1.4 Extent of requirements agreed by MIP nations is to define only the information that is to be exchanged, rather than model all of the information that would normally be required by a national system. Consequently, C2IEDM is first and foremost an ***information exchange data model***. The model can also serve as a coherent basis for other information exchange mechanisms currently lacking a unified information structure such as message formats.

1.1.1.5 As a minimum requirement, the C2IEDM must preserve the meaning and relationships of the information to be exchanged and thereby attain the interoperability associated with NATO Level 5 of System Interconnection (automated exchange of data, with user-imposed constraints, between C2IS databases).

1.1.2 Fundamental Information Structure/Data Modelling Concepts

1.1.2.1 Trying to create an information structure that represents all of the information about an arena of operations is an understandably complex task. Data modelling methodologies have adopted several conventions that parallel the military staff processes in many ways. There are three actual models that are presented in C2IEDM, namely the conceptual, logical and physical.

1.1.2.2 **Conceptual Data Model.** The Conceptual Data Model represents the high level view of the information in terms of generalised concepts such as Actions, Organisations, Materiel, Personnel, Features, Facilities, Locations and the like. This model is of interest to senior commanders wishing to verify the scope of the information structure. The presentation in this paper may be viewed as conceptual.

1.1.2.3 **Logical Data Model.** The Logical Data Model represents all of the information and is based upon breaking down (or sub-typing) the high level concepts into information that is regularly used. For example, a tank is an armoured fighting vehicle

that is a piece of equipment that is a piece of materiel. This breakdown follows human reasoning patterns and allows command and control systems to generalise by recognising, for instance, that tanks are equipment. A logical data model specifies the way data are structured with an entity-attribute-relationship diagram and supporting documentation. This model should be of interest to staff officers to ensure that the operational information content is complete. The full specification of the logical data model is to be found in MIP Working Paper 5-5.

1.1.2.4 **Physical Data Model.** Physical Data Model provides the detailed specifications that are necessary to generate a physical schema that defines the structure of a database. It is of primary concern to C2IS system developers building C2IEDM-compliant systems. The specification of the physical data model is to be found in MIP Working Paper 5-5 and in the MIP Information Resource Dictionary.

1.1.2.5 **Data Modelling Tool.** The diagrams for the model documented in this paper were created using ERwin™ Version 3.5.2 software from Computer Associates International, Inc and IDEF1X notation.

1.1.3 The Notion of a C2 Data Model as a Hub

1.1.3.1 A C2 data model of necessity must encompass information from multiple functional areas in the domain of military operations. Consequently, a C2 data model serves as a "hub" for unifying information concepts that are embodied in the data specifications of functional areas. The concept of interdependence between the C2 data model and the speciality subjects represented by functional areas is illustrated in Figure 1 below.

1.1.3.2 The desired goal in the long-run would be a federation of data specifications that use the C2 data model as the basis for functional area models. This would ensure that the data that is common between the spokes and the hub is viewed and structured in a standard way and that the data model views can be readily integrated into coherent structures wherever such integration is needed.

1.1.3.3 Initial evolution of the model benefited from inputs provided by the following functional areas: conventional fire support, barrier engineering operations, communications and electronics, and personnel administration. Other requirements that governed the evolution of the C2IEDM are documented in Chapter 2.

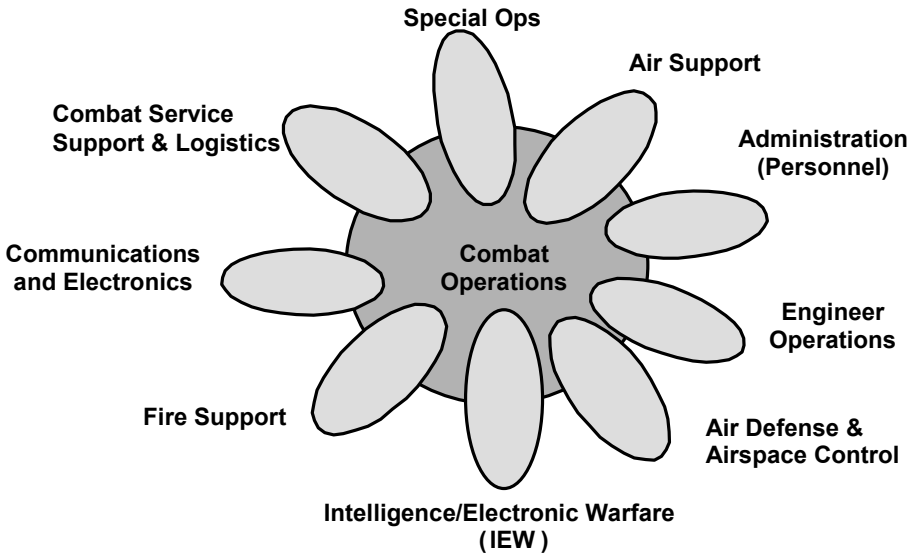


Figure 1. C2 Data in Relation to Functional Areas

1.2 Scope

The scope of the analysis carried out in the development of the C2IEDM is principally directed at producing a corporate view of the data that reflects the multinational information exchange requirements for multiple echelons in land-based wartime operations and crisis response operations (CRO) to include joint interfaces that support land operations. The data model is focused primarily on the information requirements that support the operations planning and execution activities of a military headquarters or a command post.

1.3 Structure of This Document

Organisation of this paper is summarised as follows:

a. Introduction (Chapter 1).

b. Overview of Requirements (Chapter 2). The overview provides a general statement of requirements that the data specification attempts to meet.

c. Basic Design Concepts in C2IEDM (Chapter 3). The chapter provides a general description of design considerations underlying the data model

d. Overview of the Conceptual Data Model (Chapter 4). The overview provides a description of the model in operational terms, and a summary description of the model concepts in technical terms.

e. Examples of Potential Use (Chapter 5). The short chapter suggests some applications for the data specifications.

f. Annex A—Entity-level IDEF1X data model diagram.

g. Annex B—Summary of IDEF1X Methodology and Notation.

h. Annex C—List of references.

i. Annex D—Glossary.

(This page intentionally left blank)

2. OVERVIEW OF REQUIREMENTS

2.1 Introduction

The purpose of this chapter is to provide an overview of the information exchange requirements that underpin the model.

2.2 General Requirements in ATCCIS Phase III

2.2.1 Modelling work was started early in Phase III (in 1992) without a formal statement of information exchange requirements. The Data Subgroup was staffed by a combination of serving military officers and technical experts and acted as its own source of requirements. The extensive military experience provided a good basis for the initial design. The underlying requirements corresponded in general terms to those outlined Table 1. The requirements should be viewed in the context of applicability for the *international exchange* of information between national C2 elements as well as the potential use of C2IEDM for exchange of information between C2 elements of *multinational* formations.

Table 1. Categories of Operational Information

Major Topic	Information Category
Forces (friendly and enemy)	Force composition Force disposition Force sustainment Mobility and transportation Weapons systems C4I and other information systems
Environmental conditions—physical	Land Sea Air
Environmental conditions—civil	Political Cultural Economic
Situational information	Mission C3 conditions Intelligence Targeting Deployment, movement, and manoeuvre Protection Sustainment
Operational context	Scenarios and missions involved

2.2.3 The Data Subgroup used the above table as general guidance and supplemented it with contributions and suggestions from individual delegates who used various reference documents as sources, including NATO STANAGs and messages, national field manuals and guides for tactical operations, and selected standard operating procedures. A set of general requirements that emerged over a period of time may be described by the following set of statements:

a. Objects of military significance need to be identified. In this context, "objects" refer to physical things including units, equipment, stores, personnel, facilities, geographic features, and also to non-physical concepts such as coordination points, lines, and areas. Such objects may already exist and be known; they may also be newly identified or expected in the future.

b. Individual objects must be distinguished from the classes of objects to which they belong. Many objects are of interest primarily in terms of their class or category

rather than as an individual object; for example, tanks, armoured brigades, or infantrymen.

c. Objects and their types need to be described with a number of characteristics that are sufficient for supporting command and control tasks. For example, it must be possible to describe the size of a unit, the name of a commanding officer, or the military load classification of a bridge. Such information tends to be dynamic in nature; as new information becomes available other information becomes outdated or nullified.

d. An explicit subset of the requirement in *paragraph c* is the need for information elements associated with objects to permit suitable display of the operational situation.

e. Selected information about certain characteristics of objects needs to be retained for a period of time. For example, it should be possible to keep a historical log of the location of a unit for purposes of tracking and to specify predicted future locations of a unit for purposes of planning. Such a time record is also needed for other dynamic characteristics of objects, such as their operational or personnel status and their holdings in terms of other objects (e.g., the number of troops and/or equipment in a particular unit).

2.3 Fire Support Requirements

2.3.1 Requirements were also gleaned from specialised functional areas, such as fire support. Conventional fire support includes the employment of field artillery, mortars, naval gunfire (NGF), close-in fire support (employment of rotary wing aircraft in a fire support role), and close air support (employment of fixed wing aircraft in a fire support role).

2.3.2 Fire support consists of three essential parts: command and control, target acquisition for intelligence use, and employment of attack resources. These elements constitute a good description of the more general C2 challenge.

a. Command and control. A large part of C2 activity consists of synchronisation, which is defined as the arrangement of military actions in time, space, and purpose to produce maximum relative combat power at a decisive point.

b. Target acquisition for intelligence use. Target acquisition allows the joint or combined force to detect, identify, and locate targets with sufficient accuracy and timeliness to permit their attack. It is a product of intelligence derived from comparison, corroboration, integration, analysis, and evaluation of information collected by any of the intelligence disciplines such as signals intelligence (SIGINT), human intelligence (HUMINT), and imagery intelligence (IMINT).

c. Employment of attack resources. The following attack resources may be employed in fire support: mortars, cannon (howitzers and guns), rocket and missile launchers, fixed wing aircraft, rotary wing aircraft, naval gunfire, and electronic warfare. The attack resources can be characterised as lethal or non-lethal. Lethal fire support resources include field artillery and mortars, naval gunfire, and air support. Non-lethal fire support resources include offensive electronic warfare (EW), reflected energy emitters, and smoke and illumination munitions and their delivery systems.

2.3.3 Types of information to be exchanged in multinational and joint fire support operations are exemplified by the following categories:

a. Joint and combined fire support planning, allocation of resources, and commanders' guidance.

b. Enemy and situation data including target identification and location information.

c. Fire support requests, both pre-planned and immediate, and schedule of fires.

d. Friendly force location and scheme of manoeuvre information.

e. Joint terminal control actions as provided by a forward air controller, forward observer, gunfire spot team, or laser designation team.

f. Coordination and integration of joint use of lethal and non-lethal assets.

g. Battle damage assessment information of friendly and enemy fires.

h. Ammunition status.

2.4 Requirements in Phase IV

2.4.1 The Operational Group produced a set of IERs for Phase IV in 1997. The IERs consist primarily of messages drawn from APP-9 and are referred to as Article V requirements. The IERs are listed in Table 2 in groups according to staff function under column heading "Domain."

Table 2. Initial Minimum Set of Essential IERs

Domain	Abbreviation	Short title	Source
G2	FIRST HOSTILE ACT	First Hostile Act	APP9
	INTREP	Intelligence Report	APP9
	INTREQ	Intelligence Request	APP9
	INTSUM	Intelligence Summary	APP9
	LANDINTREP	Land intelligence Report	APP9
	ENSITREP	Ennemy situation report	APP9
G3	PRESENCE	Presence	APP9
	OWNSITREP	Own Land Force Situation report	APP9
	ROEREQ	Rule of engagement request	APP9
	ROEIMPL	Rule of engagement implementation	APP9
	ASSESSREP	Commander's assessment	APP9
	NBCCDR	NBC Chemical Downwind Report	APP9
	NBCEDR	NBC Effective Downwind Report	APP9
	NBC1	NBC 1	APP9
	NBC3	NBC 3	APP9
	OPO Std 2014	Operational Order	Stanag 2014
	OPLAN	Operational Plan	Stanag 2014
	FRAGO	Fragmentary order	APP9
G4	LOGSITLAND	Logictic Situation Report Land Forces	APP9
	LOGASSESSREP	Logistic Assessrep Report	APP9
	CASAVACREQ	Casualty Evacuation request	APP9
G1	PERSREP	Personnel report	APP9
	MEDASSESSREP	Medical assessment report	APP9
	MEDSITREP	Medical Situation report	APP9
Fire	NNFP.FP	Non-Nuclear Fire Planning. FP	APP9

Domain	Abbreviation	Short title	Source
Support	FMR.FMC	Fire Mission Report. Fire mission Command	APP9
	AFU.FUS	Artillery Fire Unit Fire Unit Status	APP9
Engineer Support	BARREP	Barrier Report	APP9
	OBSREP	Obstacle Report	APP9
	DMLORD	Reserved Demolition Order	APP9
	SCATMINWARN	Scatterable Minefield Warning	APP9
	SCATMINREQ	Scatterable Minefield Request	APP9
	SCATMINREP	Scatterable Minefield Report	APP9
Air Defence	WCO	Weapons Control Order	APP9
	ADREP	Air Defence Report	APP9
Air OPS	ACO	Airspace Control Order	APP9
	AIRATTACKWARN	Air Attack Warning	APP9
	AIRREQ	Air Request	APP9
Helicopters	HELLSREP	Helicopter Landing site report	APP9
	HELQUEST	Helicopter Request	APP9
	JAATMSNO	Joint Air Attack Team Mission Order	APP9
G5	CMOSITREP	Civil/military Operation order	APP9
Elecronic Warfare	MIJIWARNREP	Meaconing,Intrusion,Jammin,Interference Warning Report	APP9
	EWRTM	EW Request/Tasking Message	APP9
G6	CCISSTAREP	CCIS Status Report	APP9
	COMSITREP	Communications situation report	APP9
	RFREQREQ	Radio Frequency Request	APP9
	RRFREQREQ	Radio Frequency Request	APP9

2.4.1 C2IEDM satisfies approximately 97% of the information content of Article V requirements.

2.5 Requirements during ATCCIS 2000 (Phase V)

2.5.1 Work on Article V requirements continued during Phase V. In addition, in 2000 the Operational Group issued an additional set of requirements referred to as Crisis Response Operations (CRO).

2.5.2 CRO requirements are listed by general category in Table 3 to indicate the general categories that are covered. The Operational Group drew upon multiple sources to produce a set that is unique to the ATCCIS programme and is not documented elsewhere.

Table 3. CRO Requirements and Fulfillment in the Model

No	IER	Percentage Complete
1	Arrest Report	100%
2	Border Crossing	100%
3	Camps	100%
4	Civil Military Operations	98%
5	Confiscated Equipment	95%
6	EOD Incident	100%

7	Holdings Parties	95%
8	Host Nation Support	100%
9	Incident Report	95%
10	Mass Graves	100%
11	Meteorology	100%
12	Personnel Identification	100%
13	PSYOPS	92%
14	Refugees and Displaced Persons	100%
	Grand Total	**97%**

2.5.3 In recognition of changing realities of potential NATO military operations, ATCCIS Heads of Delegation enlarged the scope in Phase V by adding requirements for joint interfaces that are needed to support land operations. Formal requirements were issued by the Operational Group in 2001 and are listed by general category in Table 4.

Table 4. Joint Requirements and Fulfillment in the Model

No	IER	Percentage Complete
1	Airfield zone	100%
2	Aviation areas	100%
3	Aviation route	100%
4	Command and Control-Weapon points	100%
5	Coordination Altitude	100%
6	Forward Arming and Resupply Point	100%
7	Maritime Operational Graphics	100%
8	Close Air Support Resources	100%
9	Close Air Support Status	100%
10	Naval Gun Fire Resources	100%
11	Naval Gun Fire Status	100%
12	Airfield Facility	100%
13	Air Plan - Airspace Control Order	95%
14	Air Plan - Air Tasking Order	100%
15	Harbour Facility	100%
16	Order of Battle AIR	100%
17	Order of Battle SEA	94%
18	Unit Tactical Summary	100%
	Grand Total	**98%**

2.6 MIP Phase 1 Work

2.6.1 Work on outstanding issues from the Article V, CRO and CJTF IERs continued during this phase of work.

2.6.2 The Data Modelling Working Party of the Data and Procedures Working Group was given a limited set of requirements extracted from the MIP Tactical C2IS Interoperability Requirement (MTIR). The additional requirements were derived from a comparison of MITR requirements with the data specifications already present in C2IEDM. The added requirements were specific in nature; they are listed below:

a. Identification of a service number for personnel.

b. Emission control policy for units, facilities, and equipment.

c. Mission Oriented Protective Posture (MOPP) for units.

d. NBC threat levels for control features.

e. New requirements for domain values for events, facilities and organisations.

f. Capability to specify dimensions for facilities.

3. BASIC DESIGN CONCEPTS IN C2IEDM

3.1 Capsule Overview

3.1.1 Introduction

3.1.1.1 There is no linear path that can be followed logically to its conclusion when one is dealing with a relational schema. The inherent use of relationships that underlies a relational schema guarantees that almost any part of the specification depends on one or more of other parts. Such cross-dependence makes it difficult to organise the exposition in an order that would be generally convenient for the majority of readers.

3.1.1.2 The following is a broad introduction to the design concept for the data structure itself and its potential to serve as a guide in working one's way through the documentation. The logical data structure may be thought of as consisting of four parts:

a. *Objects* of interest and their inherent properties

b. Past, present, or future *situation* as represented by facts about the objects

c. Past, present, or future *activities* that involve the objects

d. Mechanisms for grouping data into *information packages*.

3.1.2 Objects

A basic task in data specification is defining the universe of discourse. The initial step is to select the objects about which information is to be held. For C2IEDM, these are facility, feature, materiel, organisation, and person either identified uniquely as items or used according to their class or type characteristics. A fundamental design principle adopted for this model requires that every item object must be classified as a type object.

3.1.3 Situation

The word *situation* is used here to encompass a broad range of information about objects, including type-to-type relationships, item-to-type relationships other than the one cited in par 3.1.2, capabilities of either types or items, affiliation of types or items, status of items, location of items, addressing of items, and item-to-item relationships.

a. Type-to-type relationships are referred to as *establishment* in the model.

b. A most significant operational relationship between items and types deals with the notion of possession where an item object is said to own or control numbers object types (a specific unit has 5 of a given vehicle type). The model refers to this relationship as a *holding*.

c. *Capability* descriptions can be attached either to types or to items as amplifying information.

d. A requirement to assign one or more categories of *affiliation* is satisfied through an independent structure.

e. *Status* of items is specified through an extensive structure.

f. *Location* of items refers both to geographic positioning and geometries that may be assigned to them.

g. An operational need to access items by means of physical or electronic *addressing* is satisfied by means of an appropriate structure that is coupled to a specification of networks.

h. Item-to-item relationships—referred to as *associations*—are covered extensively. In addition to general relationships, there is a special specification for organisational structure that is intended to capture information such unit task organisation and order of battle.

3.1.4 Activity

Activity encompasses operational plans and orders, reports of current activity, and predictions or anticipation of future activity. Plans may be turned into orders. The basic specification of activity describes the use of objects as resources, objectives, or effects of activity. Extensions to enrich the specification of activity include rules of engagements and creation of lists of candidate targets. Further extension deals with requests in connection with intelligence collection.

3.1.5 Packaging of Information

The model contains a structure entitled REPORTING-DATA that is related to most instances of dynamic data. The specifications permit collections of individual records to be treated as a package that is referred to as *context*. Context structure has multiple uses and can be linked to items and activities. There is also a provision for assessment to be attached to a context. Finally, information of various kinds may be used to describe the characteristics of a variety of person types.

3.2 Concepts Underlying the Data Model

3.2.1 C2IEDM is intended to represent the core of the data identified for exchange across multiple functional areas and multiple views of the requirements. Toward that end, it lays down a common approach to describing the information to be exchanged in a command and control (C2) environment.

a. The structure should be sufficiently generic to accommodate joint, land, sea, and air environment concerns.[11]

b. The data model describes all objects of interest in the sphere of operations, e.g., organisations, persons, equipment, facilities, geographic features, weather phenomena, and military control measures such as boundaries.

c. Objects of interest may be generic in terms of a class or a **type** and specific in terms of an individually identified **item**. All objects *items* must be classified as being of some *type* (e.g. a specific tank that is identified by serial number WS62105B is an item of type "Challenger").

d. An object must have the capability to perform a function or to achieve an end. Thus, a description of capability is needed to give meaning to the value of objects in the sphere of operations.

e. It should be possible to assign a location to any item in the sphere of operations. In addition, various geometric shapes need to be represented in order to allow

[11] Currently, the model addresses primarily land operations and some joint interfaces. In many cases, extensions to other functional areas can be accommodated by simply adding appropriate vocabulary to the existing data elements.

commanders to plan, direct, and monitor operations. Examples include boundaries, corridors, restricted areas, minefields, and any other control measures needed by commanders and their staffs.

f. Several aspects of status of items needs to be maintained.

g. The model must permit a description of the composition of a type object in terms of other type objects. Such concepts include tables of organisations, equipment, or personnel.

h. The model must reflect information about what is held, owned or possessed in terms of types by a specific object item.

i. There is a need to record relationships between pairs of items. Key among these is the specification of unit task organisations and orders of battle.

j. The model must support the specification of current, past, and future role of objects as part of plans, orders, and events.

k. The same data structure should be used to record information for all objects, regardless of their hostility status.

l. Provision must be made for the identification of sources of information, the effective and reporting times, and an indication of the validity of the data.

3.2.2 Use of free text is to be avoided as much as possible, since there cannot be an agreed understanding of the contents.

3.2.3 Policy for information exchange is specify the **minimum set of data that needs to be exchanged** in coalition or multinational operations. Each nation or agency or community of interest is free to expand its own data dictionary to accommodate its additional information exchange requirements with the understanding that the added specifications will be valid only for the participating nation, agency or community of interest. Any addition that is deemed to be of general interest may be submitted as a change proposal within the configuration control process to be considered for inclusion in the next version of the specification.

3.3 Foundational Structural Elements

3.3.1 Entities

3.3.1.1 Basic concept in data specification is an *entity*, i.e., any distinguishable person, place, thing, event, or concept about which information is to be kept. Properties or characteristics of an entity are referred to as *attributes*. The attributes make explicit the data that are to be recorded for each concept of interest.[12] This edition of the model contains 194 entities. The entire structure is generated from 15 *independent* entities, that is, entities whose identification does not depend on any other entity. All other entities are *dependent* entities. Independent entities are defined in Table 5. The general role that each entity serves is also suggested.

[12] A summary of IDEF1X methodology and notation that is used for data specification in this document appears in Annex K.

Table 5. Independent Entities and Their Roles

Entity Name[13]	Entity Definition	Role in the Model
ACTION	An activity, or the occurrence of an activity, that may utilise resources and may be focused against an objective. Examples are operation order, operation plan, movement order, movement plan, fire order, fire plan, fire mission, close air support mission, logistics request, event (e.g., incoming unknown aircraft), or incident (e.g., enemy attack).	Dynamics (How, what, when something is to be done, is being done, or has been done.)
ADDRESS	Precise information on the basis of which a physical or electronic destination may be accessed.	Provides means to record postal and electronic addresses.
AFFILIATION	A specification of a country, nationality, ethnic group, functional group, exercise group, or religion to which membership or allegiance may be ascribed.	Provides means to assign affiliations to type or item objects.
CANDIDATE-TARGET-LIST	A list of selected battlespace objects or types that have potential value for destruction or exploitation, nominated by competent authority for consideration in planning battlespace activities.	Information to support ACTION.
CAPABILITY	The potential ability to do work, perform a function or mission, achieve an objective, or provide a service.	Indication of expected capability for types and actual capability for items
CONTEXT	A reference to one or more REPORTING-DATAs.	Packaging of information.
COORDINATE-SYTEM	A rectangular frame of reference defined by an origin, x and y axes in the horizontal plane, and a z-axis. The vertical z-axis is normal to the xy-plane with positive direction determined from the right-hand rule when the x-axis is rotated toward the y-axis.	Support to LOCATION for specifying relative geometry.
GROUP-CHARACTERISTIC	A reference to a set of characteristics that may be used for identifying a distinct collection of objects. Examples of characteristics include age group, disease, gender, language, and triage classification.	Supports the counting of types of persons according to selected characteristics.
LOCATION	A specification of position and geometry with respect to a specified horizontal frame of reference and a vertical distance measured from a specified datum. Examples are point, sequence of points, polygonal line, circle, rectangle, ellipse, fan area, polygonal area, sphere, block of space, and cone. LOCATION specifies both location and dimensionality.	Geopositioning of objects and creation of shapes (Where)
OBJECT-ITEM	An individually identified object that has military significance. Examples are a specific person, a specific item of materiel, a specific geographic feature, a specific coordination measure, or a specific unit.	Identifying individual things. (Who and What)
OBJECT-TYPE	An individually identified class of objects that has military significance. Examples are a type of person (e.g., by rank), a type of materiel (e.g., self-propelled howitzer), a type of facility (e.g., airfield), a type of feature (e.g., restricted fire area), or a type of organisation (e.g., armoured division).	Identifying classes of things. (Who and What)
REFERENCE	An allusion to a source of information that may have military significance.	Pointing to external information in support of REPORTING-DATA.
REPORTING-DATA	The specification of source, quality and timing that applies to reported data.	Support for the reporting function.
RULE-OF-ENGAGEMENT	A specification of mandatory guidance for the way a given activity is to be executed.	Support to ACTION.
VERTICAL-DISTANCE	A specification of the altitude or height of a point or a level as measured with respect to a specified reference datum in the direction normal to the plane that is tangent to the WGS84 ellipsoid of revolution.	Support to LOCATION in specifying elevation or height.

3.3.1.2 Independent entities and their relationships are illustrated in Figure 2. A dot at the end of a relationship line denotes "many." The relationships shown in this diagram are either many-to-many (solid line with two dots) or non-identifying one-to-

[13] The convention is to annotate the names of entities in capital letters and separate words by hyphens. If the name of an entity is used in plural, then a lower-case "s" is appended to the name without changing the name (e.g., the plural of CAPABILITY is written CAPABILITYs).

many (dashed line). For example, the relationship between OBJECT-ITEM and LOCATION is to be interpreted as a pair of statements that an OBECT-ITEM may have zero, one, or more LOCATIONs and that a LOCATION may apply to zero, one, or more OBJECT-ITEMs. The entities that connect to the rest of the structure by means of non-identifying relationships provide auxiliary specifications that are needed for precise definition of the concepts that are being captured. Some of the relationships are recursive, such as those relating ACTION to itself. The IDEF1X standard permits the use of many-to-many relationships only at a conceptual level in explanatory diagrams such as this one. A fully developed data model must replace the many-to-many relationships with the appropriate structures that admit only *one*-to-many relationships. The resolution of many-to-many relationships can lead to complex structures. The balance of the paper describes the result for C2IEDM.

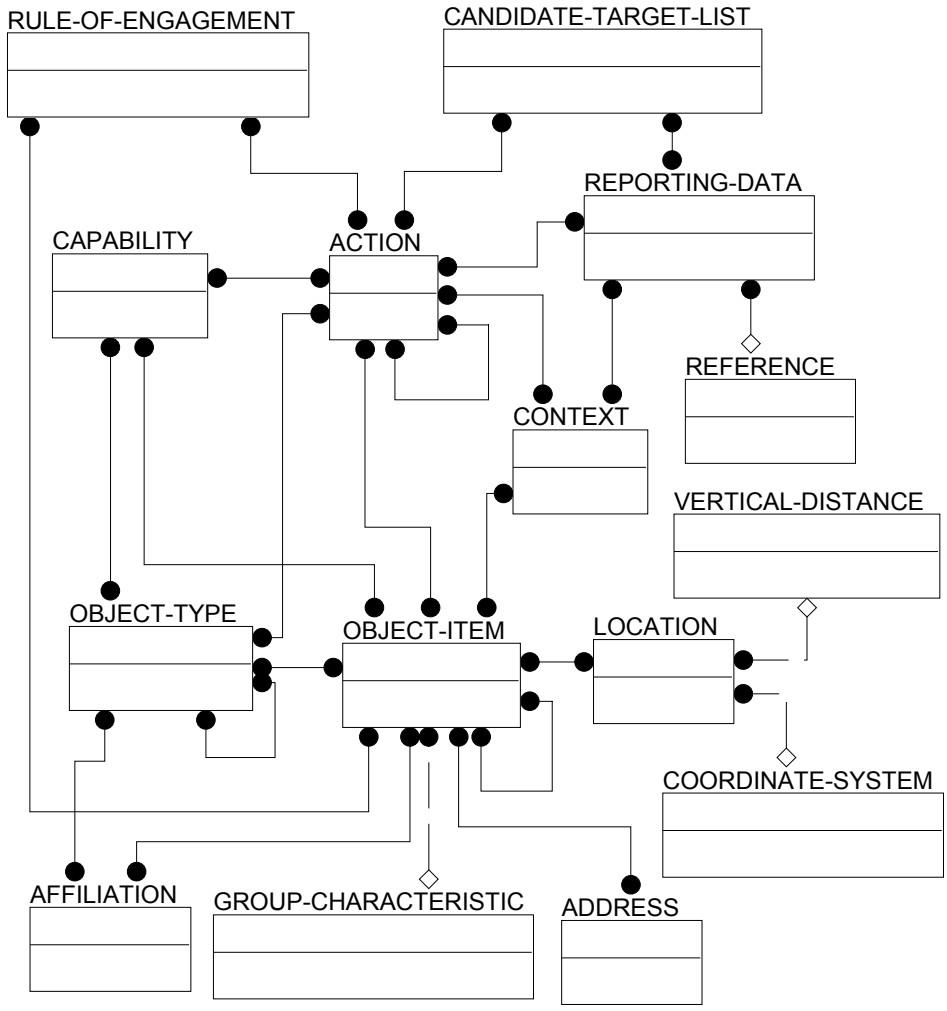


Figure 2. Independent Entities for Creating the Data Specification

3.3.1.3 All model explanations in this paper are presented at the *entity* level as is the case in the preceding figure.

3.3.2 Identifying "Things" in the Sphere of Operations

3.3.2.1 "Things" must be identified as the first step--who are the actors and what things are available to be used by or are used by the actors. Model design encompasses two categories of objects: those that can be identified individually (by name—*2 (SP) Armoured Cavalry Brigade, Jubilation T. Cornpone*, by call sign or serial number or license plate or passport number, and so on) and those that represent grouped or class properties (a tank, a ship, an M1A2 tank, a helicopter, a howitzer, a rifle, an armoured brigade, a light infantry battalion, an infantryman, a refugee). The two categories are used in parallel as basic structural elements of the model. The two structures are related to each other. Data characteristics are entered either on the item side or the type side as appropriate. Any characteristic described on the type side also applies to the item when the item is assigned a type classification. The linkage from item to type is mandatory in the model.

3.3.2.2 C2IEDM structure labels class objects as OBJECT-TYPE and individually identified instances as OBJECT-ITEM. Implicit in the distinction between type and item is the assumption that data relating to OBJECT-TYPEs will tend to be relatively *static* or *persistent* (i.e., the values of the attributes are not likely to change very often over time), whereas the data characteristics related to OBJECT-ITEMs are likely to be more *dynamic*. For example, if a characteristic is about a type (e.g., M1A1 Abrams Tank), it is an attribute of OBJECT-TYPE. Thus, calibre of main gun, track width, and load class are characteristics of OBJECT-TYPE. However, the call sign, actual fuel level, munitions holdings, and current operational status of a specific tank are characteristics of an OBJECT-ITEM. Yet, the mandatory classification of an instance of OBJECT-ITEM as an instance of OBJECT-TYPE assures that the item *inherits* all the characteristics of the type.

3.3.2.3 Item and type objects are subdivided into extensive hierarchies. The first-level hierarchy is parallel and is illustrated in Figure 3. There are five categories or *subtypes* to encompass any object within the scope of the model: facility, feature, materiel, organisation, and person. A subtype is the same thing as its parent, but it has some properties that do not apply to its siblings. A circle with two lines underneath it is a symbol for complete subtyping.[14] It means that no other category is needed in response to the set of requirements that governed evolution of the model. Definitions of subtype entities are presented in Table 6. As may be expected, the two sets of definitions are similar.

[14] Incomplete subtyping is denoted by a single line that is drawn under the circle.

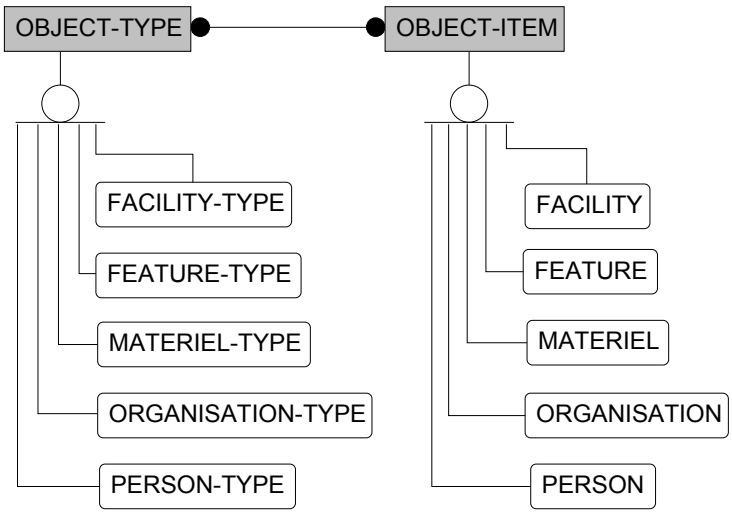


Figure 3. First Level Subtyping of OBJECT-TYPE and OBJECT-ITEM

Table 6. Definition of First-Level Subtypes

Entity	Entity Definition
FACILITY	An OBJECT-ITEM that is built, installed, or established to serve some particular purpose and is identified by the service it provides rather than by its content.
FACILITY-TYPE	An OBJECT-TYPE that is intended to be built, installed or established to serve some particular purpose and is identified by the service it is intended to provide rather than by its content. Examples include a refuelling point, a field hospital, a command post.
FEATURE	An OBJECT-ITEM that encompasses meteorological, geographic, and control features of military significance.
FEATURE-TYPE	An OBJECT-TYPE that encompasses meteorological, geographic, and control features of military significance. Examples include a forest, an area of rain, a river, an area of responsibility.
MATERIEL	An OBJECT-ITEM that is equipment, apparatus or supplies without distinction as to its application for administrative or combat purposes.
MATERIEL-TYPE	An OBJECT-TYPE that represents equipment, apparatus or supplies of military interest without distinction to its application for administrative or combat purposes. Examples include ships, tanks, self-propelled weapons, aircraft, etc., and related spares, repair parts, and support equipment, but excluding real property, installations, and utilities.
ORGANISATION	An OBJECT-ITEM that is an administrative or functional structure.
ORGANISATION-TYPE	An OBJECT-TYPE that represents administrative or functional structures.
PERSON	An OBJECT-ITEM that is a human being to whom military significance is attached.
PERSON-TYPE	An OBJECT-TYPE that represents human beings about whom information is to be held.

3.3.2.4 The next three sections present specification to describe (a) the hierarchical structure of types, (b) composition of types, and (c) the hierarchical structure of items. Major relationships that connect types and items are discussed in subsequent sections.

3.4 High-Level View of C2IEDM

3.4.1 An overview of the data model is presented in Figure 4. The nine main entities are shaded in grey. The grouping of entities is instructive in itself. The bottom part of the diagram centred about OBJECT-TYPE, OBJECT-ITEM, and LOCATION is intended to support situational awareness: what is out there, what does it have, what is it

supposed to have, where is it, what is its status, what are its relationships with other objects.

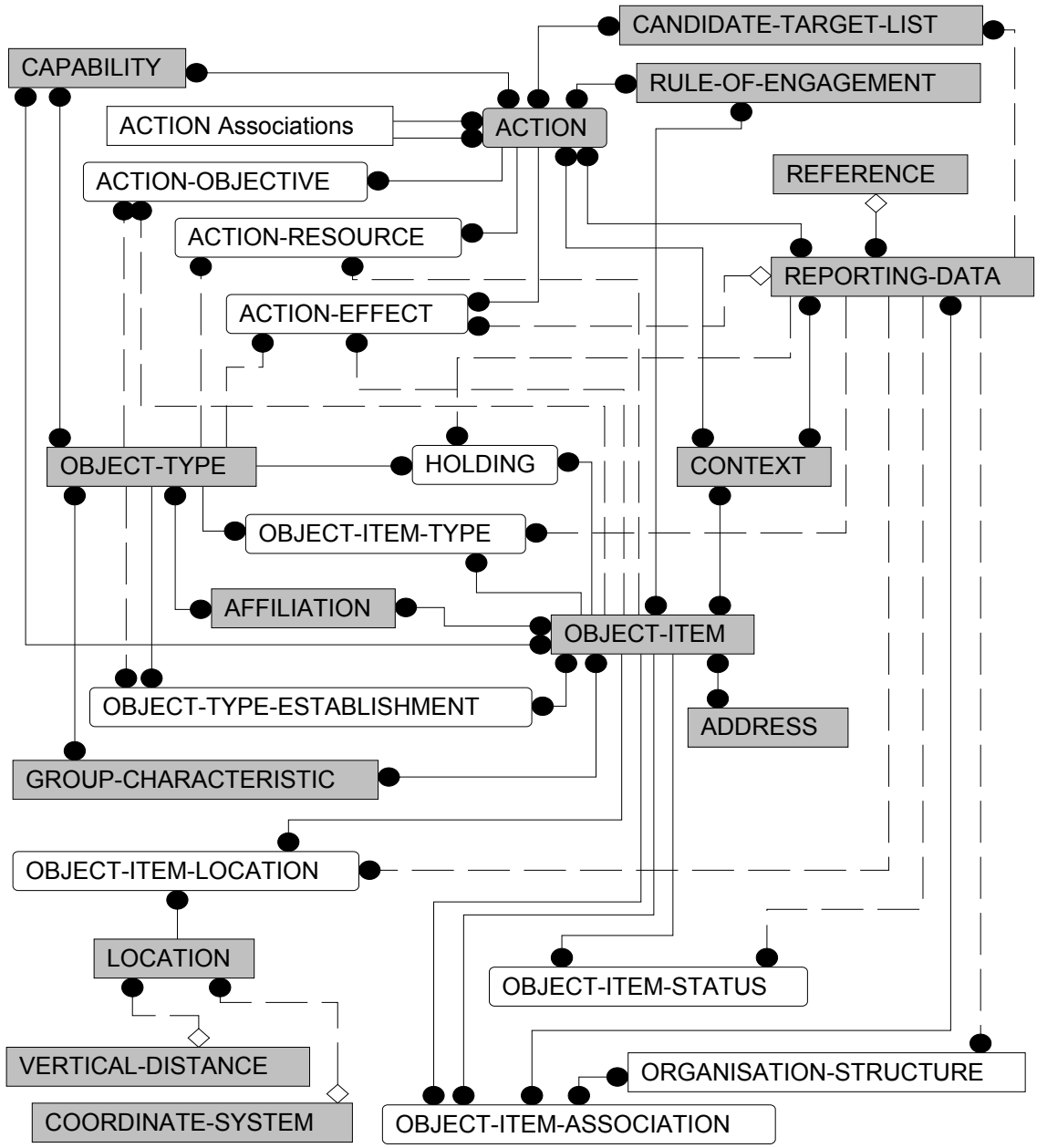


Figure 4. High-Level View of C2IEDM

3.4.2 Upper part is focused on ACTION with CAPABILITY, CONTEXT, and RULE-OF-ENGAGEMENT being oriented primarily to ACTION. Much of this data tends to be dynamic in nature: what are the objects capable of and how are they to be used, how are they being used, and what are they achieving.

3.4.3 REPORTING-DATA plays a special role in the model. It records reporting data about much of the information held in the lower part of the model. It also serves as the means for that information to be used in multiple ways in developing courses of action,

allocating resources, preparing plans, and executing operations orders, all of which are in the province of the upper part of the model.

3.4.4 The upper and the lower parts are connected through a number of associative entities that are used for linking plans, orders, and requests through objectives, resources, and effects to OBJECT-TYPEs and OBJECT-ITEMs.

(This page intentionally left blank)

4. OVERVIEW OF THE DATA MODEL

The overview presents principal features of the data structure that has been evolved to satisfy operational requirements. The primary goal is to indicate the *scope* of the model in covering information categories of interest to the operational user. Examples and explanations attempt to use operational language as much as possible.

4.1 OBJECT-TYPE Hierarchy

4.1.1 The OBJECT-TYPE subtyping tree is extended beyond the first level as illustrated in Figure 5. FACILITY-TYPE and FEATURE-TYPE have two subtypes each, MATERIEL-TYPE and ORGANISATION-TYPE have extensive subtype hierarchies; and PERSON-TYPE has no subtypes. Categorisation of OBJECT-TYPE can be done in different ways. There is no right or wrong way. The structure described in the figure happens to satisfy the stated information exchange requirements most closely.

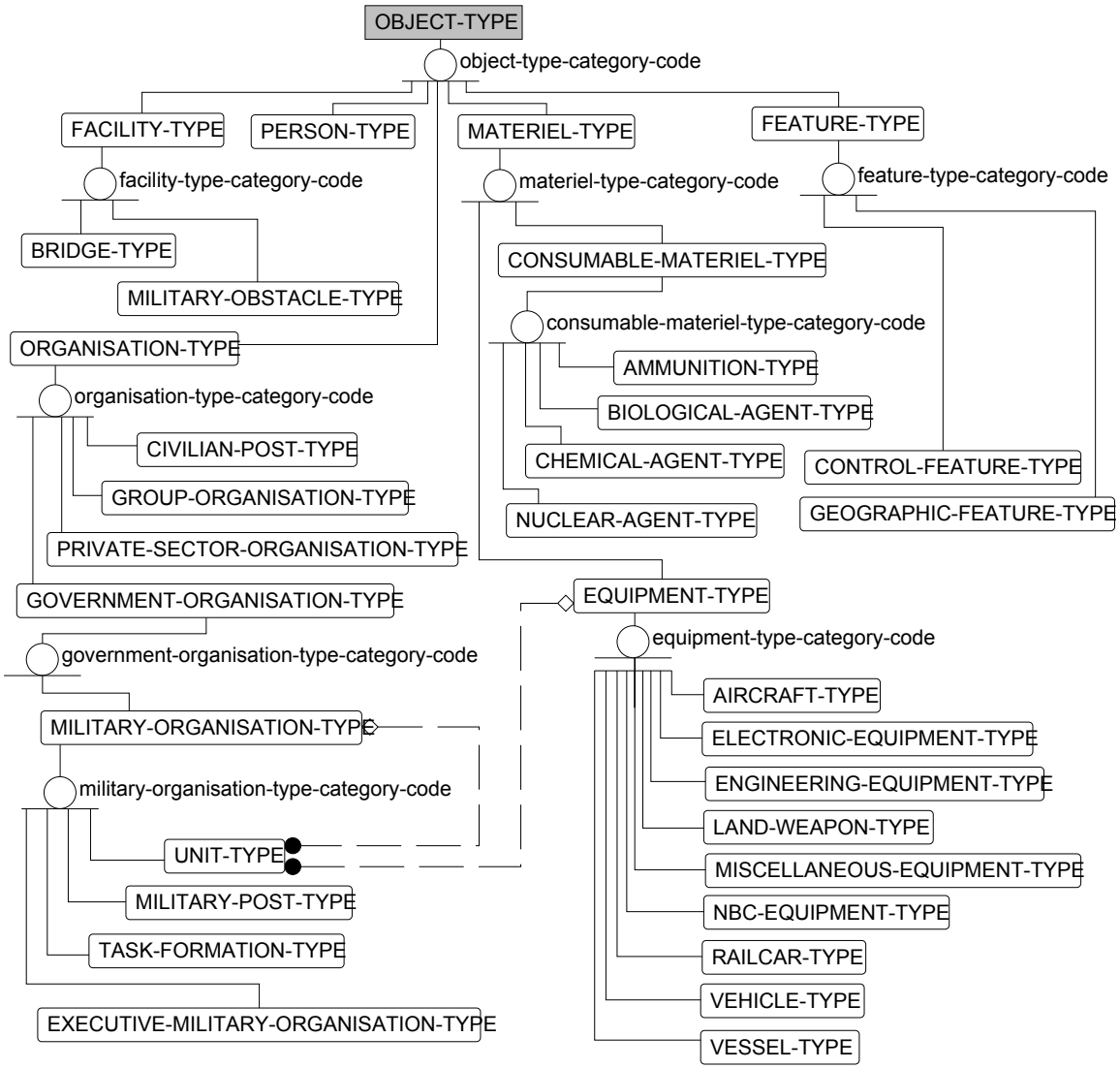


Figure 5. Entity-Level View of OBJECT-TYPE Subtype Tree

4.1.2 The specification permits a sixth categorisation of OBJECT-TYPE that is not visible in the diagram. It has the value "Unknown" in order to correspond to the same

value on the item side. This categorisation is necessary to deal with detection and tracking problems where the exact classification of the detected object cannot be determined, but its existence must be recorded and information about it must be collected.

4.1.3 Most of the categories are reasonably self-explanatory with the possible exception of GROUP-ORGANISATION-TYPE, CIVILIAN-POST-TYPE, and MILITARY-POST-TYPE. GROUP-ORGANISATION-TYPE was created in response to CRO requirements to deal with groups that are not truly organisations but have to be treated as a collective object for data purposes. Consequently, groups of people such as refugees and prisoners of war are treated as pseudo-organisations. Post type is a type of position that is filled by a single individual, such as commander of a military unit or chief of a police department. It enables a distinction between the duties inherent in a position or a billet and the person that fills that position or billet.

4.1.4 The figure displays two non-identifying relationships (dashed lines) with a diamond at one end and a dot at the other. A diamond indicates that the relationship is optional. No data need to be passed from one entity to the other. A dot has the same meaning as cited earlier—it is the *many* end of a one-to-many relationship. The relationship from EQUIPMENT-TYPE to UNIT-TYPE allows the identification of the major type of equipment that can be associated with a unit, e.g., Leopard III Main Battle Tank is the major equipment for a tank battalion. The relationship from UNIT-TYPE to MILITARY-ORGANISATION-TYPE permits a refinement in specifying headquarters units. For example, a headquarters company may be designed to serve a division or a brigade. This relationship enables an explicit association that states that an instance of a type headquarters company is intended to serve as the headquarters element of a type division.

4.2 Composition of Types (Establishment)

There is a need to specify the composition of types of objects in terms of other types. Thus, for example, a commander may specify that a certain unit type is authorised or established to have certain numbers of various types of facility or materiel; to specify that a type of unit is composed of certain numbers of other unit types; or to specify that a type of unit is composed of certain numbers of types of persons. Similarly, it may be necessary to capture bill of materials or parts list for types of equipment in support of logistics. A parts list may catalogue components of a rifle, all items of equipment expected to be present on a combat-ready main battle tank, or enumerate all weaponry and equipment that is certified as a package for safe carriage on a given model of an F-16 fighter. Generally, this is the type of information that is contained in tables of organisation and equipment, bill of materials, parts lists, and structure of a notional task force.[15] A specific statement may be that a French engineer regiment type unit has a wartime establishment of 500 regular troops, 150 drivers, 100 vehicles, 20 minelayers, and 20,000 mines. All such authorisations can be represented using the concept of *establishment*. An establishment is an authorisation or other form of specification that associates under

[15] The concept of a bill of materials (BoM) is derived from the manufacturing industry where it is defined as a document that includes manufacturer's part numbers, quantity required, device descriptions, value, type or size, and reference designators.

specified conditions an instance of one OBJECT-TYPE with a number of instances of other OBJECT-TYPEs.

4.2.1 Specification of Establishment

4.2.1.1 The structure is illustrated in Figure 6. An instance of OBJECT-TYPE may have one or more establishments assigned to it in OBJECT-TYPE-ESTABLISHMENT. The actual composition is specified in a child entity OBJECT-TYPE-ESTABLISMENT-OBJECT-TYPE-DETAIL that lists the numbers of a specific OBJECT-TYPEs authorised in the establishment. The instances of OBJECT-TYPE that appear in the detail are identified through the relationship "is-specified-as-part-of."

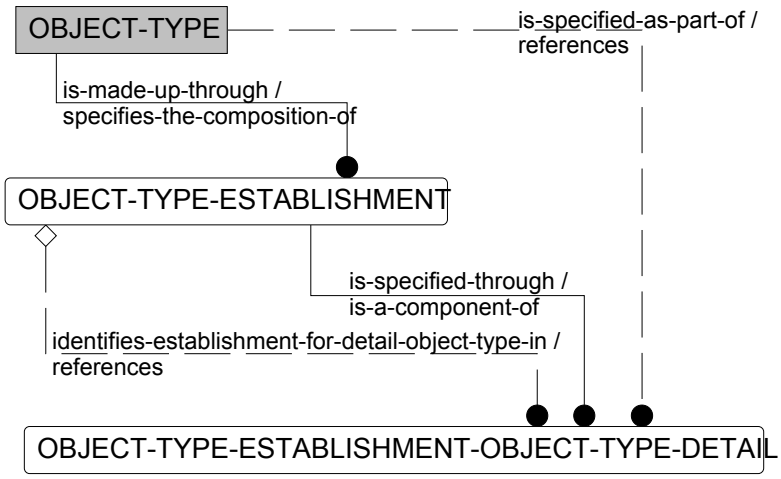


Figure 6. Specifying Establishments

4.2.1.2 The second non-identifying (dashed-line) relationship with the diamond at its head permits unambiguous re-use of data in building establishment hierarchies. For example, if a given company type has two establishments (say, summer peacekeeping and winter wartime) and it is being cited as a component of a new task force type, the relationship enables the selection of one of the two establishments.

4.2.1.3 Not all combinations of types are needed and some do not make sense. The allowable combinations are restricted by means of a business rule. Table 7 summarises such rules for establishments.

Table 7. Permissible Combinations of Types for Establishments

Detailed → / Established ↓	FACILITY-TYPE	FEATURE-TYPE	MATERIEL-TYPE	ORGANISATION-TYPE	PERSON-TYPE
FACILITY-TYPE	✓	NA	✓	✓	✓
FEATURE-TYPE	NA	NA	NA	NA	NA
MATERIEL-TYPE	NA	NA	✓	NA	✓
ORGANISATION-TYPE	✓	NA	✓	✓	✓
PERSON-TYPE	NA	NA	✓	NA	NA

Legend: ✓ = Permissible combination

NA = Not allowed

4.2.2 Assigning Establishments to Items

The assignment of establishments to instances of OBJECT-ITEM is enabled by the use of associative entity OBJECT-ITEM-OBJECT-TYPE-ESTABLISHMENT, as illustrated in Figure 7. Statements of the following kind can be recorded: As of 1 March 1997, the 19th (US) Mechanized Division is assigned a specific Type Mechanised Division Establishment for war operations in a temperate climate.

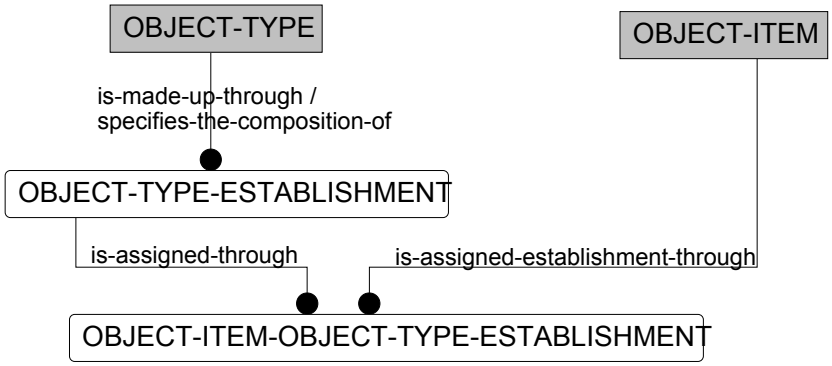


Figure 7. Assigning Establishment to OBJECT-ITEM

4.3 OBJECT-ITEM Hierarchy

4.3.1 Full OBJECT-ITEM subtype hierarchy is illustrated in Figure 8. The reader should note that the structure below the first subtype level is not parallel to the type side. The design is deliberate in response to requirements. Subtypes are created only when there are information elements that belong to a single object category. For example, there is no subtype under OBJECT-TYPE that is equivalent to METEOROLOGIC-FEATURE; yet this entity has seven subtypes of its own.

4.3.2 The specification permits a sixth categorisation of OBJECT-ITEM that is not visible in the diagram. It has the value "Unknown." It is needed for dealing with detection and tracking problems where the exact classification of the detected object cannot be determined, but its existence must be recorded and information about it must be collected.

4.3.3 Some characteristics of OBJECT-ITEM or one of its subtypes may require that multiple values be maintained in a database at the same time. The technique for handling such cases in the model is to create child entities. Child entity depends on its single parent in a one-to-many relationship. The subtype hierarchy shows 13 instances of child entities: Seven are associated with HARBOUR to provide a unified description of various facilities available at a specific harbour. The remaining six are defined below with examples that illustrate reasons for multiple values:

a. MASS-GRAVE-CONTENT—A content of bodies inside a specific MASS-GRAVE. The requirement is to specify the number of bodies according to age and gender.

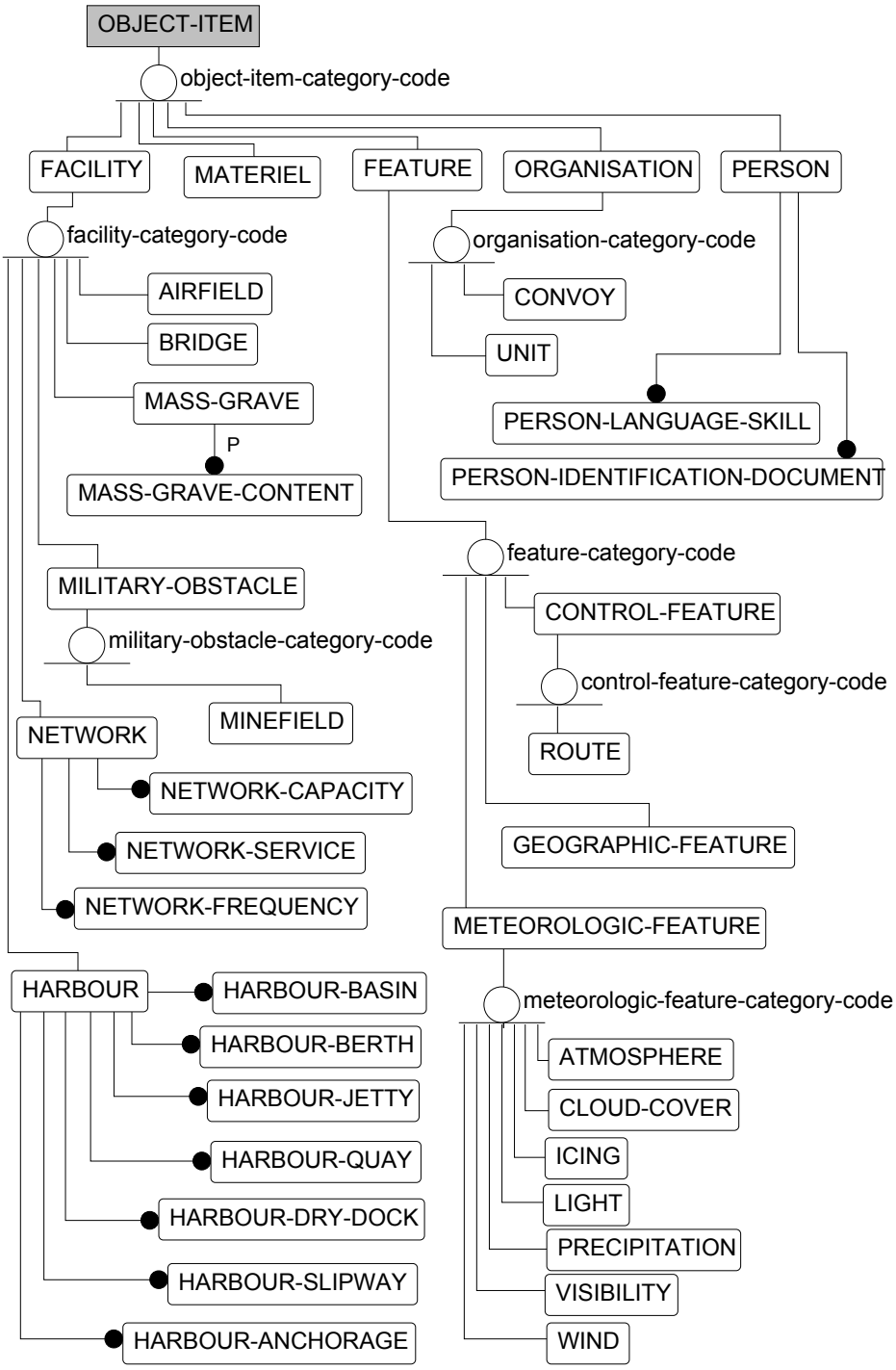


Figure 8. Entity-Level View of OBJECT-ITEM Subtype Tree

b. NETWORK-CAPACITY—An identification of the specific capacities of a NETWORK. A network may use multiple bandwidths with different protocols on each.

c. NETWORK-FREQUENCY—The specification of a discrete frequency that is used on a specific NETWORK. A network uses multiple frequencies. It may be as simple as lower and upper bounds for a band or a set of frequencies for frequency hopping radios.

d. NETWORK-SERVICE—An identification of the specific type of communications service provided by a specific NETWORK. A network may simultaneously provide several services, the Internet being a good example.

e. PERSON-IDENTIFICATION-DOCUMENT—A document used to identify a specific PERSON. Almost every person carries multiple identification documents, such as driver licenses, military identification cards, and passports.

f. PERSON-LANGUAGE-SKILL—A proficiency or ability of a specific PERSON with regard to a specific language. A person may have skills in several languages or differing reading, writing and speaking skills in the same language.

4.3.4 Three other child entities of OBJECT-ITEM are not part of the subtype hierarchy. These are OBJECT-ITEM-STATUS and OBJECT-ITEM-ACCESS, as presented in the next two sections, and OBJECT-ITEM-GROUP-ACCOUNT that is described in a subsequent section.

4.4 Specifying Status of OBJECT-ITEMs

4.4.1 OBJECT-ITEM-STATUS is a record of the perceived condition of a specific OBJECT-ITEM. One of the attributes of OBJECT-ITEM-STATUS records a particularly significant item of information: the perceived hostility classification of a specific OBJECT-ITEM. The entity-level data structure is illustrated in Figure 9.

4.4.2 Subtypes of OBJECT-ITEM-STATUS hold the attributes that are tailored to describing the status of subtypes of OBJECT-ITEM. For example, the status of an enemy military ORGANISATION (a unit) could range from *fully operational* to *destroyed*; and the status of a soldier could be *ready*, *incapacitated*, *wounded*, *absent*, *missing*, *arrested*, *captured*, or *killed*. A control feature could be *activated* or *deactivated*.

4.4.3 Additional structure for MEDICAL-FACILITY-STATUS (not shown in the figure above) provides a number of details in terms of patient types, patient arrivals, medical condition types, surgical triage, surgical backlog, disposition of patients and so on.

4.4.4 Data structure permits multiple records to be kept about the status of an instance of OBJECT-ITEM to reflect changes that occur over time or differing status assessments that may be provided about a single OBJECT-ITEM by several units or organisations, particularly when the subject of the assessment is an element of the opposing force.

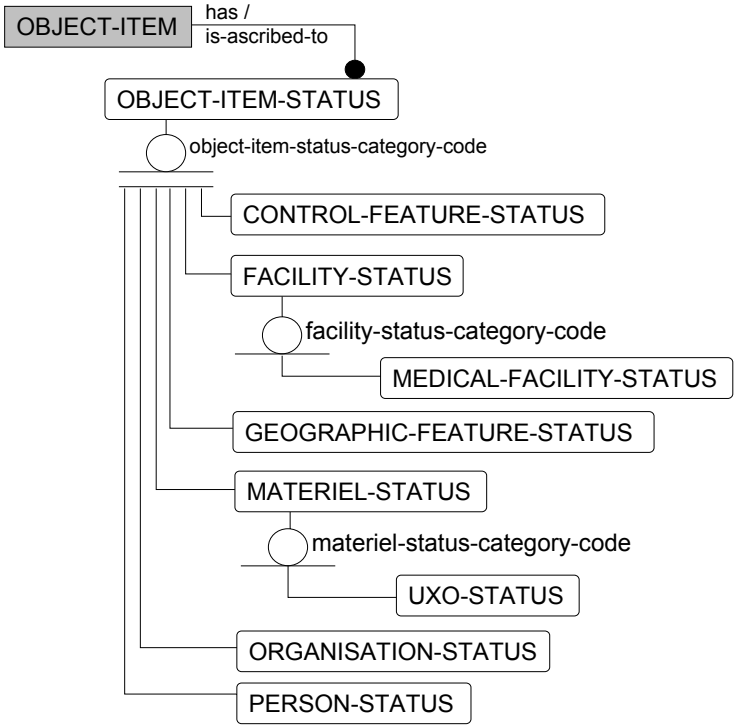


Figure 9. Structure for Specifying Status of OBJECT-ITEMs

4.5 Specifying Access to OBJECT-ITEMs

4.5.1 There can be multiple ways to contact facilities, organisations, and persons, including anything from a postal address to a telephone number to a World Wide Web listing. It also encompasses the use of call signs on radio nets since a call sign is a way of reaching a specified organisation or person and represents an address as much as an e-mail address.

4.5.2 The model permits access to be specified for any instance of OBJECT-ITEM through physical and electronic addressing. The physical addressing is a straightforward listing of the elements of an address in text form. All other accesses are defined in relation to a specified network and a specified service.

4.5.3 An instance of OBJECT-ITEM, such as a military unit, may be a subscriber to multiple services on a single network. It may also participate as a subscriber on several different networks. Subscription to a network need not be determined solely by the capabilities of equipment or software. The conditions of subscription may also be dictated by operational considerations. For example, specific permissions may be granted for active (i.e., transmitting) participation in certain networks, such as a command net or a fire support net, although any node with the proper equipment would be able to monitor traffic on the nets without active participation.

4.5.4 The structure is illustrated in Figure 10. The ADDRESS structure provides a means for specifying an access address for an object. ADDRESS is an independent entity because a given address need not be owned by a specific object. This is most obvious in case of an office or house address where the occupancy can change but the address remains the same. A similar situation can occur in the electronic world where a

telephone number may be re-assigned or an e-mail address shared by a number of individuals or offices.

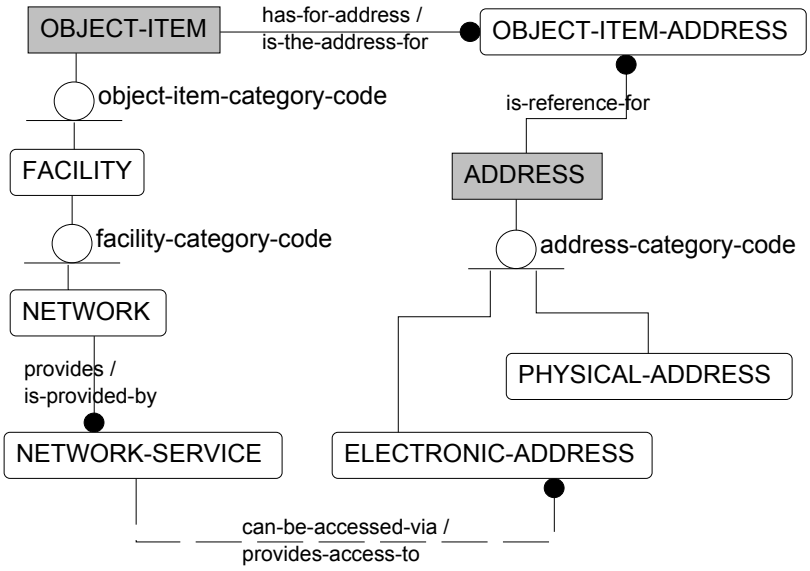


Figure 10. Providing Access to an OBJECT-ITEM through ADDRESS

4.5.5 ADDRESS has two subtypes—PHYSICAL-ADDRESS and ELECTRONIC-ADDRESS—where the actual addresses are specified. The entity ELECTRONIC-ADDRESS has a mandatory non-identifying relationship from NETWORK-SERVICE to identify the type of service and the network that provides it. The structure permits any number of access specifications to be assigned to an instance of OBJECT-ITEM through the associative entity OBJECT-ITEM-ADDRESS.

4.6 Associations between OBJECT-ITEMs

4.6.1 Specification of Associations

4.6.1.1 Every instance of OBJECT-ITEM may have some type of relationship to another instance of OBJECT-ITEM in the sense of belonging, using, controlling, being constrained by, occupying and so on. For example, a division has full command of three brigades, or full command of two and operational control of the third if the third belongs to another nation. A specific main battle tank (MBT) is issued to a certain armoured infantry company. The model uses a simple structure to capture such information, as illustrated in Figure 11. The entity OBJECT-ITEM participates in an association twice: once as a subject and once as an object. The category codes that are at the heart of the specification are aligned to read from subject to object. The status entity that is attached to each association records whether the effective time provided through REPORTING-DATA is a start or end of an association. An association can be made and broken multiple times.

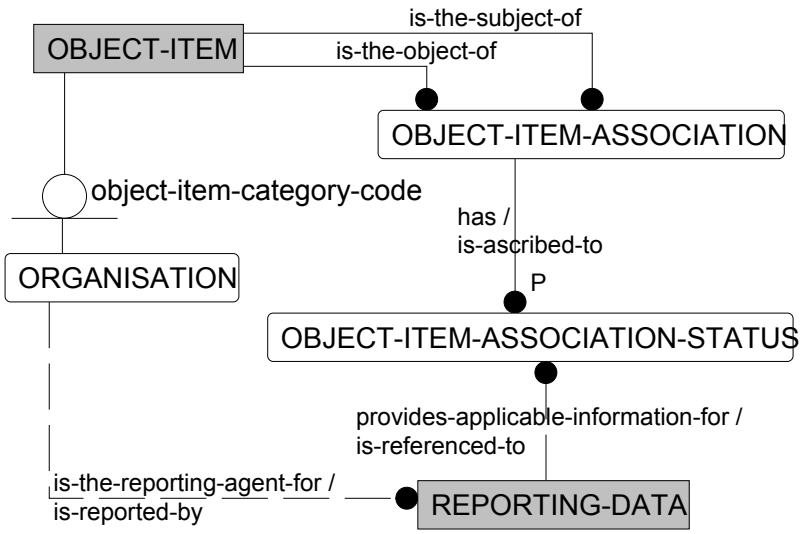


Figure 11. Associations among OBJECT-ITEMs

4.6.1.2 Those OBJECT-ITEM associations that are deemed necessary to support C2 are supported in C2IEDM in the form of associations shown in Table 8. The meaning of associations for eleven OBJECT-ITEM relationships are specified by a category code and in some cases an additional subcategory code. The allowable values for each association are listed as a business rule. Some examples of potential associations are illustrated in Table 9.

Table 8. Valid OBJECT-ITEM Associations

	Object OBJECT-ITEM							
Subject OBJECT-ITEM	**CONTROL-FEATURE**	**FACILITY**	**FEATURE**	**GEOGRAPHIC-FEATURE**	**MATERIEL**	**ORGANISATION**	**PERSON**	**Not known**
CONTROL-FEATURE	Yes	Yes	—	Yes	Yes	—	—	—
FACILITY	—	Yes	Yes	—	Yes	—	—	Yes
FEATURE	—	Yes	—	—	—	—	—	—
GEOGRAPHIC-FEATURE	—	Yes	—	—	—	—	—	—
MATERIEL	—	Yes	Yes	—	Yes	—	Yes	Yes
ORGANISATION	Yes	Yes	—	Yes	Yes	Yes	Yes	Yes
PERSON	—	Yes	Yes	—	Yes	—	Yes	Yes
Not known	Yes	Yes	—	Yes	—	—	—	—

Table 9. Examples of Associations

(a) Category Value *Serves as*

Serves as →	ORGANISATION	MATERIEL	CONTROL-FEATURE	FACILITY
ORGANISATION	Org1 serves as an enemy unit (Faker, in an exercise)			
MATERIEL		A truck serves as a bus	A light ship serves as an air control point	A truck serves as an obstacle
GEOGRAPHIC-FEATURE			A river serves as a boundary	A cave serves as an hospital (or a wine cellar!)
FACILITY			A windmill serves as a contact point, land	A school serves as an hospital

(b) Category Value *Is situated in*

Is situated in →	CONTROL-FEATURE	GEOGRAPHIC-FEATURE	FACILITY
ORGANISATION	Org1 is situated in Area of operation 1	Org1 is situated in Cave1	Org1 is situated in Wine cellar1!!!
MATERIEL	Aircraft1 is situated in Air air corridor1	Guns1 is situated in Natural cave1	Truck1 is situated in Hangar1
CONTROL-FEATURE	Area of operation1 is situated in Area of operation2		MeetingPoint1 is situated in School1
GEOGRAPHIC-FEATURE	River1 is situated in Area of operation 1	Lake1 is situated in Natural cave1	
FACILITY	Field Hospital1 is situated in AreaofOps1	Field Hospital1 is situated in Cave1	Field Hospital is situated in School1

4.6.2 Organisational Structure

4.6.2.1 It is difficult to infer organisational hierarchies purely from instances stored in OBJECT-ITEM-ASSOCIATION. The hierarchy can only be inferred from an exhaustive examination of relationship records. This section describes data specifications to enable appropriate relationships to be described explicitly as part of a recognised group, such as an order-of-battle (ORBAT) or a unit task organisation (UTO).

4.6.2.2 The structure is illustrated in Figure 12. ORGANISATION-STRUCTURE is a child of ORGANISATION to serve as the top-level entity that together with ORGANISATION-STRUCTURE-DETAIL identifies all instances of OBJECT-ITEM-ASSOCIATION that pertain to the specific instance of ORGANISATION-STRUCTURE. This specification enables the re-use of any relationship recorded in OBJECT-ITEM-ASSOCIATION in multiple instances of ORGANISATION-STRUCTURE. ORGANISATION-STRUCTURE is linked to ACTION-TASK through an optional non-identifying relationship that enables a given structure, such as UTO, to be associated with a plan or an operations order.

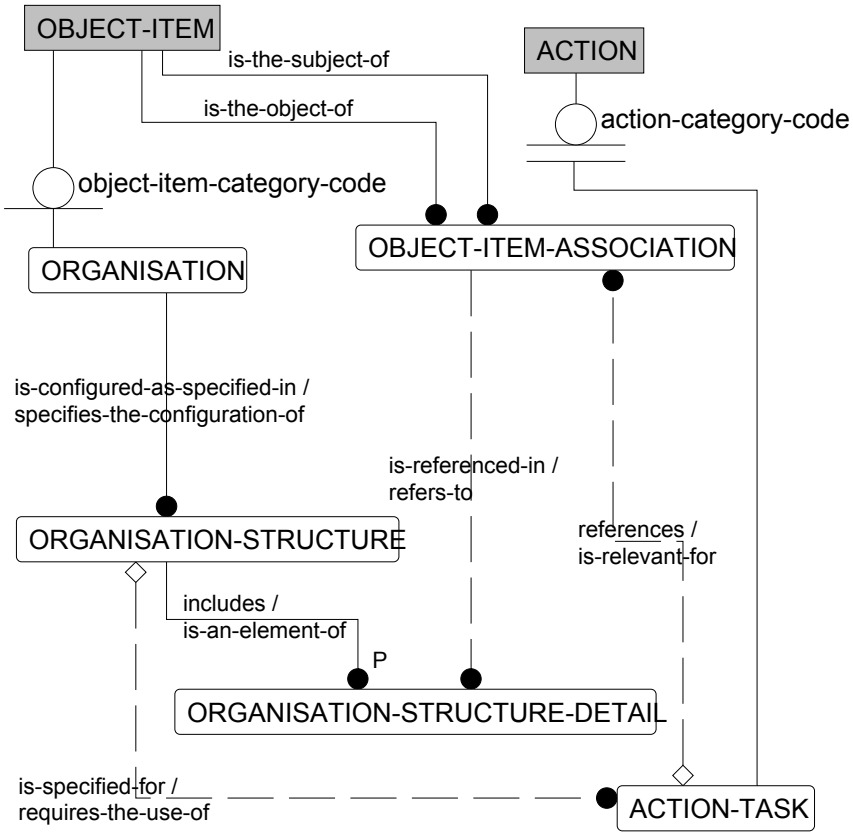


Figure 12. Specifying Organisational Structure

4.7 Capabilities of Items and Types

4.7.1 Specifying and monitoring capability of objects can be an important factor within the military planning process. Knowledge about capability may help in analysis of feasible actions that are open to friendly forces or in assessing the likelihood of actions that may be open to enemy forces. Capability statements can also be subject to various kinds of conditions. For example, the speed with which a vehicle can manoeuvre over land may depend on the type of terrain, and the range of a weapon may depend on the type of ammunition that is used. Capability structure is designed to embody two concepts: the need to characterise capability itself and to link it to other parts of the model that use specifications of capability. The structure is illustrated in Figure 13.

4.7.2 CAPABILITY is defined as the potential ability to do work, perform a function or mission, achieve an objective, or provide a service. The entity represents the list of generic capabilities that are available to objects and their types. This list covers a diverse range of abilities such as their maximum speed or their maximum storage capacity, some of which may not be applicable to certain classes of objects. The list of abilities is stored in the attributes capability-category-code and capability-subcategory-code. The category-code refers to a general class of abilities (e.g., the ability to transport things) while the subcategory-code refers to a single ability within that class (e.g., the ability to transport a given amount of liquid).

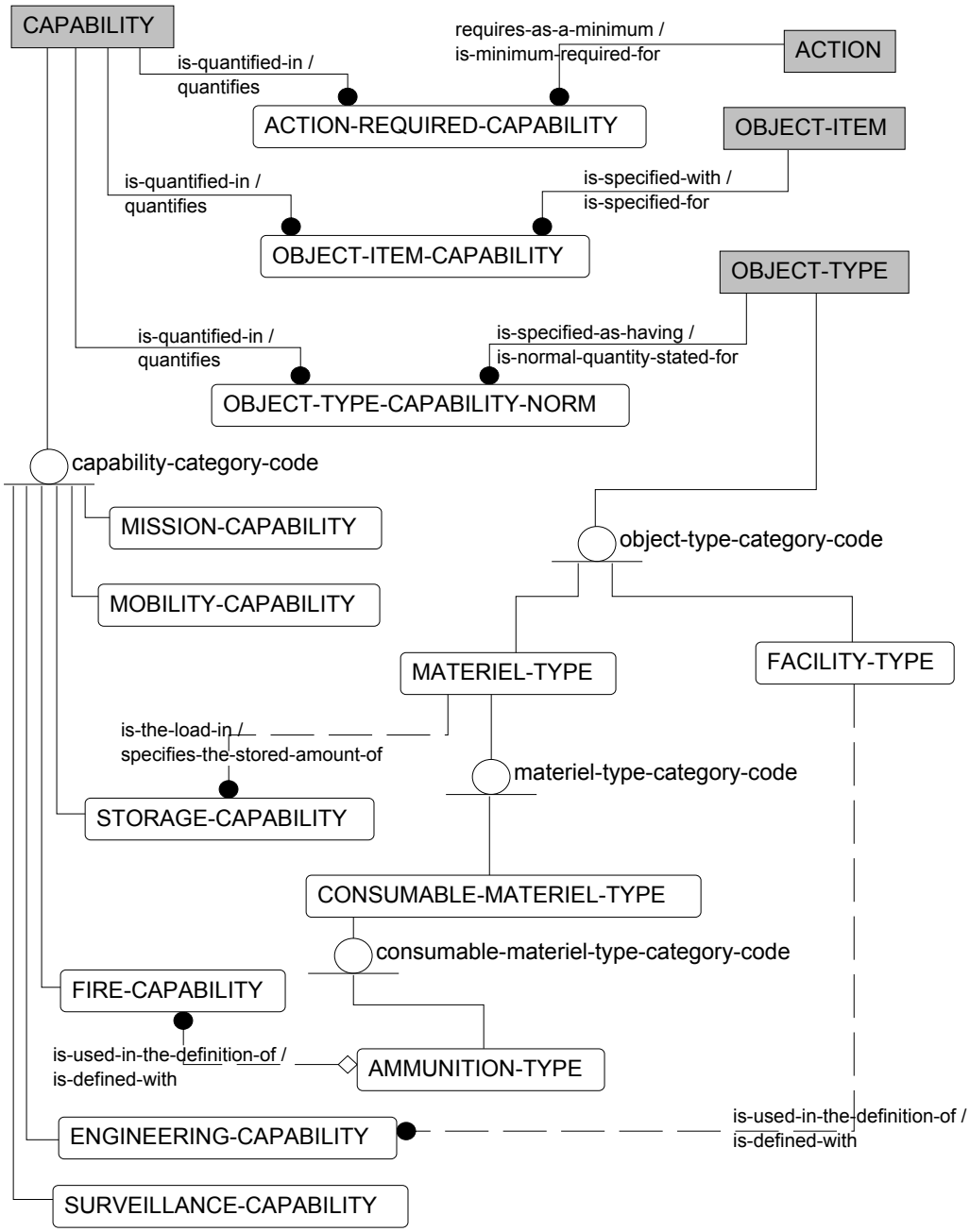


Figure 13. Specifying Capabilities of Objects

4.7.3 Subtypes of CAPABILITY add amplifying information for certain classes of capability. Some are linked to subtypes of OBJECT-TYPE in order to permit more precise specification. For example, FIRING-CAPABILITY is linked to AMMUNITION-TYPE and STORAGE-CAPABILITY is linked to MATERIEL-TYPE.

4.7.4 CAPABILITY is linked to three independent entities in order to provide the following functions:

a. Specify the expected or normal capability for OBJECT-TYPEs.

b. Estimate or record the actual capability of OBJECT-ITEMs.

c. State (through ACTION-REQUIRED-CAPABILITY) the *required capability* of OBJECT-ITEMs or OBJECT-TYPEs when they are needed as resources for carrying out ACTIONs.

4.7.5 Expected / Normal Capability. The entity OBJECT-TYPE-CAPABILITY-NORM is defined as the standard value of a specific CAPABILITY of an OBJECT-TYPE. Since the entity relates to types rather than items, the data it contains will tend to be static. The entity represents staff planning data concerning the capabilities of different OBJECT-TYPEs. The data can be used to:

a. Provide a broad threat analysis in terms of enemy or potentially hostile OBJECT-TYPEs.

b. Assist in the selection of friendly OBJECT-TYPEs for the tasks to be done.

c. Aid an application program in classifying OBJECT-TYPEs in accordance with operational user's preferences.

4.7.6 Actual Capability. The capabilities of individual OBJECT-ITEMs may differ from the norm due to attrition or other factors. OBJECT-ITEM-CAPABILITY holds the perceived value of a specific CAPABILITY of an OBJECT-ITEM where it differs from the norm or where there is no norm. As well as recording detail of friendly troops, OBJECT-ITEM-CAPABILITY could hold a threat analysis for individual enemy OBJECT-ITEMs, e.g., an enemy tank regiment may have demonstrated a capability to move at a faster rate than its OBJECT-TYPE-CAPABILITY-NORM.

4.7.7 Required Capability. It is necessary to be able to specify a required CAPABILITY in order to complete an ACTION. This enables optimal resource usage for planning as well as for managing resources during the life of an ACTION. This subject is elaborated when extensions to ACTION structure are presented.

4.8 Positioning and Geometry for OBJECT-ITEMs

4.8.1 Concept for Representing Location and Geometry

4.8.1.1 The data structure under the independent entity LOCATION captures two distinct but related concepts of interest to planners and operators:

(a) Specification of geometry that is required to describe objects;

(b) Placement of objects or their geometry with respect to the Earth's surface or with respect to each other.

4.8.1.2 The ability to specify geometry permits the description of various open or closed boundaries, such as areas of responsibility, orbits, phase lines, and objectives, as well as the shape of airfields, runways, ammunition dumps, and a security fence surrounding an ammunition dump. The positioning of objects with respect to the Earth's surface is achieved by linking the entity OBJECT-ITEM to the LOCATION entity.

4.8.2 Overview of Location Structure

4.8.2.1 Overall structure for specifying location and geometry is shown in Figure 14 at the entity level. The LOCATION structure is self-contained and largely independent of other parts of the model. One exception occurs when a coordinate system is set up

relative to some battlefield object. This is shown by the relationship between OBJECT-ITEM-LOCATION and OBJECT-REFERENCE.

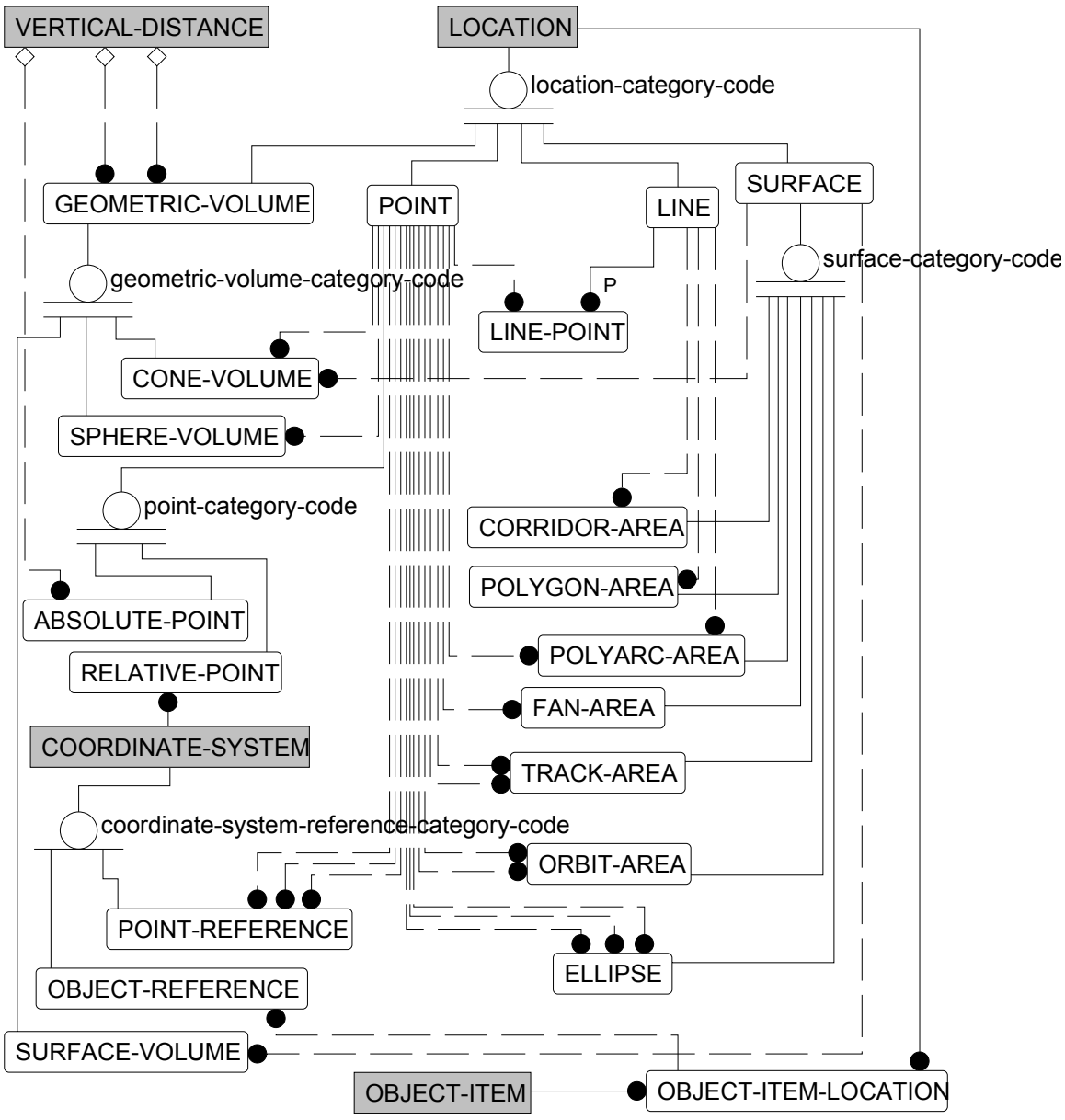


Figure 14. Entity-Level View of the LOCATION Structure[16]

4.8.2.2 The basic element is a point; it plays a role in generating every other geometric construct in the specification. The location of the point can be expressed either in absolute terms with respect to a standard description of the earth's surface or in relative terms with respect to another point that may be absolute or relative itself. The vertical distance for a point may be specified in several ways: as a measured altitude with respect to mean sea level, a measured height with respect to ground or water level, a pressure

[16] The relationship between COORDINATE-SYSTEM and RELATIVE-POINT is non-identifying (dotted line) but appears to be identifying (solid line) in the figure.

altitude or pressure height, or simply stated to be the local surface, as would be the case for an armoured vehicle moving through the countryside.

4.8.2.3 Lines are generated from a series of points that are connected in a specified order. The part of a line between two successive points is a line segment; a sequence of connected line segments defines the line, or more properly a *polygonal path*. A line may close on itself if the first and last points that define the line are the same; in this case a line may serve as a boundary for a surface. If the first and last points are not the same, then the line is an open line, such as a phase line or a one-way route.

4.8.2.4 Surfaces are built either directly from lines or the points provide part of the specification. For example, a polygon area is defined by a closed boundary line. An ellipse is completely defined by three points. Almost any figure, even an ellipse, could be approximated by a polygonal area; however, it is somewhat more efficient to provide explicit specifications for some of the figures that are called for in the operational requirements, and in some cases it is essential since not all geometric aspects can be completely described by polygons. For example, the specifications for corridor, orbit, and track require additional parameters as will be described in subsequent sections.

4.8.2.5 Most volumes are built by using the horizontal projection of a surface onto the Earth's surface to define the outer boundaries of a general cylinder and to specify the top and bottom vertical distances to close off the volume. Thus, any of the geometric figures that are constructed as surfaces can be the basis for a volume. Two additional volume geometries—cones and spheres—do not follow this pattern and require individual specifications.

4.8.3 Supporting Structures

LOCATION structure is supported by additional specifications for vertical distance and a coordinate system to enable relative geometry. The independent entity VERTICAL-DISTANCE is a specification of the altitude or height of a point or a level as measured with respect to a specified reference datum in the direction normal to the plane that is tangent to the WGS84 ellipsoid of revolution. Specification of COORDINATE-SYSTEM enhances functionality of LOCATION by establishing a local reference frame. COORDINATE-SYSTEM has two subtypes: one defines a coordinate system with respect to an arbitrary point and the second with respect to location of an object. If the object is moving or changing its orientation, then the coordinate system is also changing. Any geometry that is specified relative to this coordinate system will also move with it.

4.8.4 Linking LOCATIONs and OBJECT-ITEMs

Model construct relates OBJECT-ITEM to LOCATION through the associative entity OBJECT-ITEM-LOCATION. The overall view for associating objects with LOCATION is presented in Figure 15. OBJECT-ITEM-LOCATION has a data attribute in OBJECT-ITEM-LOCATION to give operational meaning, as needed, to any geometry specified in LOCATION.

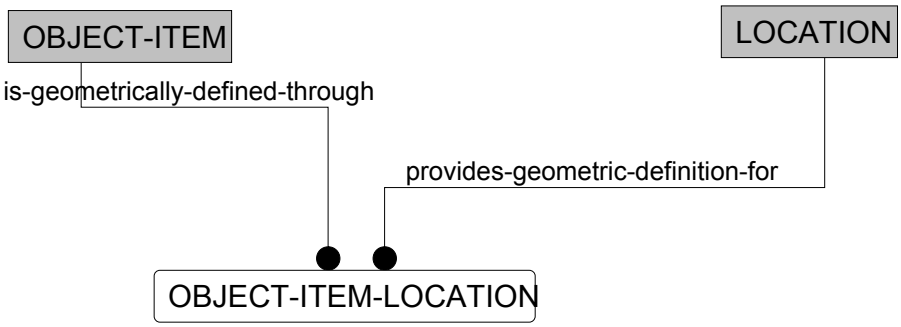


Figure 15. Assigning Position and Geometry to OBJECT-ITEMs

4.9 Relationships between Items and Types

This section deals with three sets of direct relationships between items and types: classification of items according to type, possession of types by items, and the identification of organisational responsibility for selected reporting codes associated with types of materiel.

4.9.1 Classification of OBJECT-ITEMs by Type

4.9.1.1 A specific OBJECT-ITEM must be associated with at least one instance of OBJECT-TYPE. This is a fundamental structural feature of the model. Data elements are defined on the type or item side as is most appropriate and the information needs to be shared between the two sides. The ability to classify OBJECT-ITEMs as OBJECT-TYPE makes any information that is stored as type data applicable to the item. Thus, any characteristic of an item that can be described as a type property does not need to be carried as an attribute on the item side.

4.9.1.2 The linkage between item and type permits the recording of differing interpretations of what the type of an item may be, especially in regard to opposing forces or any other assessment that is based on uncertain or incomplete information. For example, Unit A may classify an unknown object first as a vehicle, then successively (as better information becomes available) an armoured vehicle, a tank, a main battle tank, and a T72. It also permits the recording of differing interpretations of the same object by different organisations. Unit B may be looking at the same object as Unit A but classify it successively as a vehicle and an APC. The structure also enables a history of classifications to be kept as a means for understanding the decisions that were made at the time a classification was considered valid. In other words, the data may be able to provide exonerating evidence in case of a court martial.

4.9.1.3 The associative entity OBJECT-ITEM-TYPE is defined as a record of the perceived classification of a specific OBJECT-ITEM as a specific OBJECT-TYPE. The structure is illustrated in Figure 16. The relationship is read as follows: an OBJECT-ITEM is classified as one or more OBJECT-ITEM-TYPEs. The letter P at the "many" end stands for "positive." P designation makes the classification of an instance of OBJECT-ITEM mandatory rather than optional. Note that any number of instances of OBJECT-TYPE may be carried as reference data without being associated with any instance of OBJECT-ITEM.

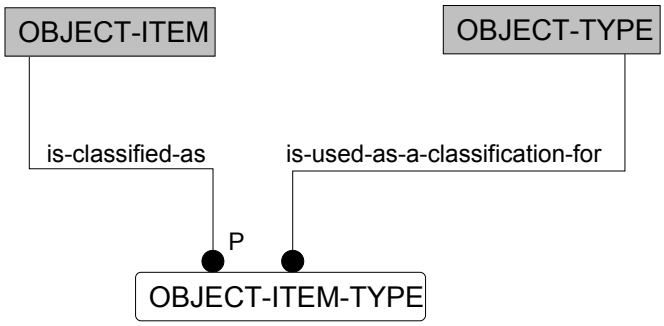


Figure 16. Assigning Type Classification to an OBJECT-ITEM

4.9.2 Holdings by Items

4.9.2.1 The concept of holding addresses the association of a specific object (OBJECT-ITEM) with a class of objects (OBJECT-TYPEs) where the relationship is defined by the general notion of inclusion in the sense of ownership, possession, assignment, or control. The staff officer may wish to know how many tanks of a given type a certain unit possesses and how many of them are operational, or how many enemy companies there are within a given area, or how many rounds of an ammunition type are stored in a particular arsenal, or how many cargo pallets are contained on a particular airlift aircraft, or how many mechanics does a given maintenance company have, or which types of weapons and sensors are held by a specific weapons platform (e.g., the load of weapons carried by a specific close air support aircraft). This type of information can be recorded in the data structure that is described in this section.

4.9.2.2 Holding specifies what an OBJECT-ITEM actually has or is estimated to have at a particular time. The holding may be an estimate for a future date, such as the expected count of a given type of equipment a week from now. In this way, expected replenishment or repair of materiel can be reflected in the holdings that serve as one of the sources of information for combat operations planning.

4.9.2.3 The key requirement in specifying holdings for the purpose of exchange of information is assumed to be the total quantity and the part of the total that is considered to be in an operational status. Consequently, a simple structure is used in the model, as shown in Figure 17.

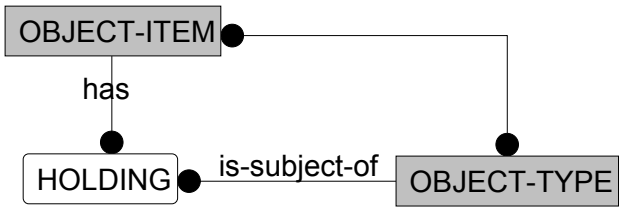


Figure 17. Accounting for Holdings by an OBJECT-ITEM

4.9.2.4 The figure illustrates two fundamental relationships:

a. An OBJECT-ITEM is the holder cited for a HOLDING.

b. An OBJECT-TYPE is included in a HOLDING.

4.9.2.5 The HOLDING structure illustrated in the figure permits the participation of any of the OBJECT-ITEM subtypes with any of the OBJECT-TYPE subtypes. If any restriction were to be placed on allowable combinations of items and types for HOLDING, it would have to be done with business rules.

4.9.2.6 Previously discussed *establishment* indicates what an organization or materiel is supposed to be composed of; HOLDING captures what the organization or materiel actually contains. In other words, the difference between HOLDING and establishment is that whereas establishment details what an OBJECT-TYPE is authorised to have in terms of other OBJECT-TYPEs, HOLDING details what an OBJECT-ITEM actually has (or is thought to have) at a particular time. This concept enables the establishment of logistic/personnel replenishment requirements as well as an assessment of organizational capability.

4.9.3 Identifying Reportable Items

4.9.3.1 An organisation, such as NATO HQ or a regional headquarters, may create lists of materiel types using a standard coding scheme for reporting purposes. One such specification is a Land Forces Reportable Item List (LFRIL). An organisation may choose to create a LFRIL in order to enforce standard reporting about equipment (type of materiel) that its subordinate organisations hold.

4.9.3.2 The model includes an entity ORGANISATION-MATERIEL-TYPE-ASSOCIATION in order to enable the designation of instances of MATERIEL-TYPE with a LFRIL code. The linkage to organisation is necessary since the codes and the membership of the list can vary according to the organisation that creates the list. The structure is illustrated in Figure 18.

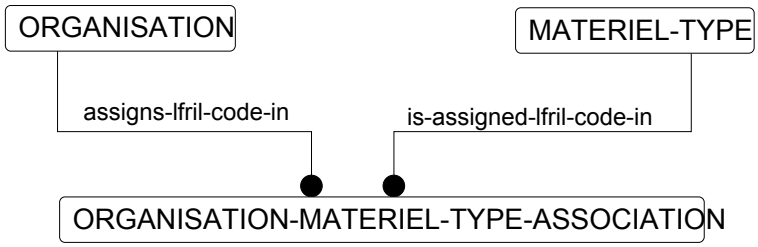


Figure 18. Assigning LFRIL Designation to MATERIEL-TYPE

4.10 ACTION: Planning and Conducting Operations

4.10.1 Introduction

4.10.1.1 The discussion now turns to the second major structural part of the model. This chapter describes the basic concepts for representing *activity* in the model. The independent entity ACTION is the root for this representation. The related structure includes mechanisms for specifying items or classes as resources and objectives for activity, recording effects of activity, classifying activities as planned tasks or unplanned

events, keeping status of activities, and relating activities to each other functionally and temporally.

4.10.1.2 ACTION together with its substructures specifies and describes operations planned for or carried out in the sphere of operations. It is also used to describe unplanned happenings that are of military interest. The underlying concept for modelling ACTIONs is based on a statement in which something carries out an activity to affect something at some time. Within the model, the "something" within the basic action statement is described by an OBJECT-TYPE or an OBJECT-ITEM. Thus, OBJECT-TYPEs and OBJECT-ITEMs are related to ACTION in two distinct ways: as resources and as objectives. There is yet a third relationship between ACTION and operational objects that characterises the effects of ACTIONs. The three principal relationships are illustrated in Figure 19. The figure also shows two associations that link sets of ACTIONs functionally and temporally. Complex statements, such as operations orders, can be constructed by relating simple statements in cascading hierarchies.

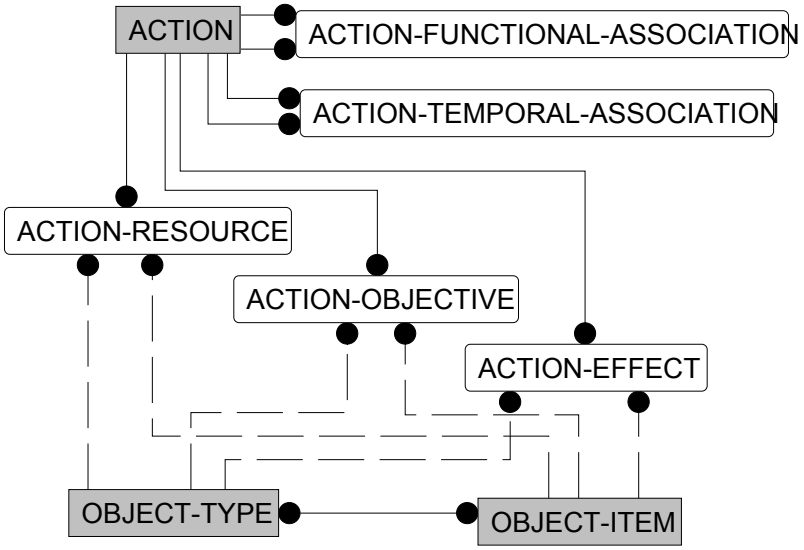


Figure 19. Basic ACTION Structure

4.10.2 Role of Objects as Resources, Objectives, and Subjects of Effects

4.10.2.1 Entities ACTION-RESOURCE and ACTION-OBJECTIVE have been introduced in order to be able to assign roles to OBJECT-ITEMs and OBJECT-TYPEs as part of an ACTION specification.

4.10.2.2 ACTION-RESOURCE is defined as an OBJECT-ITEM or an OBJECT-TYPE that is required, requested, allocated or otherwise used or planned to be used in conducting a specific ACTION. ACTION-RESOURCEs are those OBJECT-ITEMs and OBJECT-TYPEs that have been specified as the things performing, things being used in or allocated to, or things whose use is qualified in some way, in carrying out a specific ACTION.

4.10.2.3 ACTION-OBJECTIVE is defined as the focus, in terms of an OBJECT-ITEM or OBJECT-TYPE, in conducting a specific ACTION. ACTION-OBJECTIVEs are

those OBJECT-TYPEs or OBJECT-ITEMs that are specified to be (or excluded from) the focus of an ACTION.

4.10.2.4 As an example of resources and objectives, the 11th (NL) Air Mobile Brigade may use 4 Chinook helicopters (an ACTION-RESOURCE) to transport 100 troops to a landing zone (ACTION-OBJECTIVE).

4.10.2.5 Effectiveness of operations needs to be monitored and the potential effects of planned or pending activity need to be estimated. To this end, ACTION-EFFECT is defined as a perceived effectiveness of a specific ACTION against a specific item or its type. For example, the reported result may be that the enemy force has been diminished by at least 50 percent and the enemy position was captured.

4.10.2.6 The ACTION-EFFECT estimate specifies a quantity if the objective is an OBJECT-TYPE, or a fraction if the objective is an OBJECT-ITEM. Operations performance could be evaluated by comparing ACTION-EFFECTs to stated ACTION-OBJECTIVEs. It should be noted that ACTION-EFFECT permits the capture of information about effects of ACTIONs on objects that are not necessarily the objectives of the ACTION. This can be referred to as *collateral damage,* for example, the intended target was an ammunition plant but a nearby hospital was hit.

4.10.3 Relating ACTIONs

4.10.3.1 General. The promulgation and understanding of an operations order is dependent upon the complex linkage of a series of assigned actions (tasks). These tasks are ***linked functionally*** (e.g. The Corps Barrier Zone Completion is decomposed into several Divisional Barrier Zone tasks which is then further decomposed into Brigade Barrier Zone tasks and so on). There is also a ***temporal*** dimension that indicates that Action A cannot start before Action B is completed (e.g., A unit cannot achieve Phase Line 2 until it has achieved Phase Line 1. The model provides two associative entities that specify the dependencies between ACTIONs and allow for the creation of hierarchies:

a. ACTION-FUNCTIONAL-ASSOCIATION caters to functional relationships; and

b. ACTION-TEMPORAL-ASSOCIATION caters to time-specific dependencies between ACTIONs.

4.10.3.2 ACTION-FUNCTIONAL-ASSOCIATION. The entity ACTION-FUNCTIONAL-ASSOCIATION records the relationship of a specific ACTION as being dependent on, supporting, or derived from another specific ACTION. The categories of association include the following phrases:

> Has as a provisional sub-ACTION, Has as a sub-ACTION, In order that, In response to, Is a modification of, Is a prerequisite for, Is a template for, Is an alternative to, Uses as a reference.

The simplest relationship is where an ACTION includes a number of other subordinate ACTIONs. This is represented in Figure 20, where Action 2 is the major action that is supported by Action 1. Action 1 consists of four ACTIONs (Action 3 to Action 6); three of the actions are subordinated to Action 1 directly (Action 3 to Action 5), while the fourth action (Action 6) is subordinated to Action 5. In this example, the relationship hierarchy

can be represented by the phrases as "Is a sub-Action of" in case of connecting lines and "In order that" for the support.

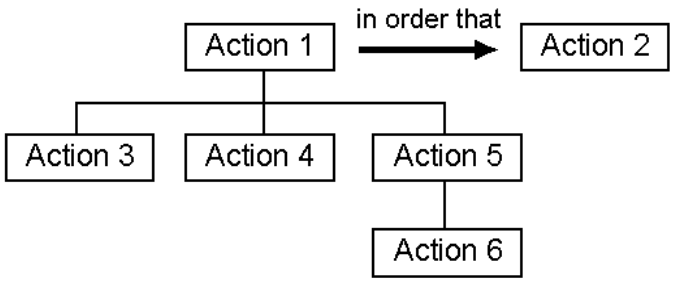


Figure 20. An Example of ACTION Hierarchy

4.10.3.3 ACTION-TEMPORAL-ASSOCIATION. The timings of sub-actions that are part of a complex action will frequently be interdependent. The entity ACTION-TEMPORAL-ASSOCIATION is designed to handle the data requirements associated with temporal dependencies between ACTIONs. ACTION-TEMPORAL-ASSOCIATION is the assignment of an ACTION (i.e., ACTION-TASK) to be time-dependent for its execution on another ACTION (e.g., ACTION-EVENT or ACTION-TASK).

4.10.3.4 Absolute Temporal Dependence. There are several ways to establish temporal dependence. The simplest method and one that does not require the entity ACTION-TEMPORAL-ASSOCIATION is through the use of absolute time when such specification is appropriate. In this method, the absolute start and end times are specified using the attributes in ACTION-TASK (to be described) so that the sub-tasks are carried out in the correct sequence.

4.10.3.5 Relative Temporal Dependence. The required start time of the overall action may not be known, or perhaps the unit tasking the ACTION is flexible with regard to the exact time the sub-actions are to start or end provided they start or end at some time relative to another action. In order to specify temporal dependence the concept of temporal relationships has been employed. These are characterised by phrases such as “Starts at the end of,” “Starts during and ends after,” and “Starts at the same time and ends after.” These temporal relationships permit specification of the *relative order* in which ACTIONs are to occur without stating any actual times.

4.10.3.6 Offset Temporal Dependence. The temporal association also provides the flexibility of specifying *fixed offset intervals*, wherein a subject ACTION is to start at some specified time interval before or after a particular reference point in the object task. For example, the transportation of troops may be part of a larger mission to attack a position held by the enemy, requiring that the movement to the landing zone be executed 30 minutes before the attack starts.

4.10.3.7 ACTIONs can be related together in very complex ways using the concepts of absolute time, temporal relationships, and temporal relationships with offset intervals. It is possible to formulate plans without specifying a particular start time (or H-hour) while still being able to specify the interrelated time dependencies between its constituent sub-actions. In order to fix a start time for such a plan, it is merely necessary

to introduce a new ACTION, with a specified planned start time, and relate it to the ACTIONs to be initiated, e.g., H-hour will be 0900, 15 August 2002.

4.10.4 Subtypes of ACTION

4.10.4.1 ACTION structure is used to describe different kinds of activities that entail different data requirements. For that reason, ACTION is subtyped into ACTION-EVENT and ACTION-TASK. The structure is shown in Figure 21. Status entities allow progress of activities to be recorded. Two entities—NBC-EVENT and ACTION-EVENT-DETAIL—are associated with ACTION-EVENT to handle specialised data requirements.

4.10.4.2 ACTION-TASK is defined as an ACTION that is being or has been planned and for which the planning details are known. It concerns those ACTIONs over which control can be exercised or which are predicted (such as friendly operations, and those enemy activities that are being anticipated as a result of intelligence assessment). It can represent actions that are typically found in plans, orders, and requests.

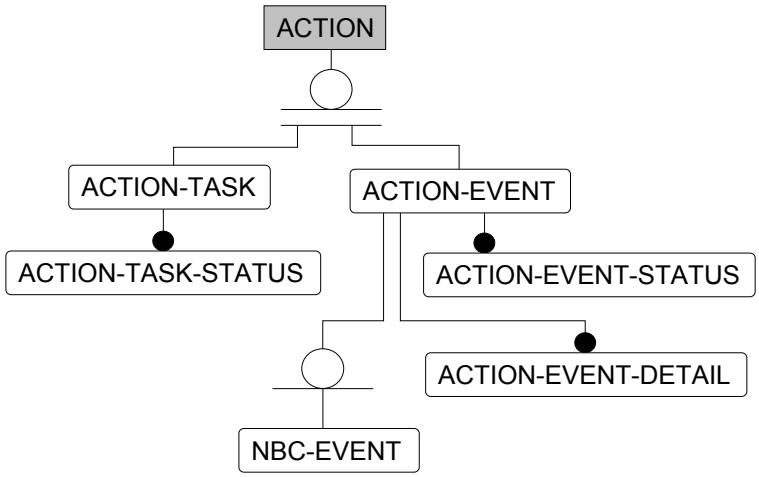


Figure 21. ACTION Subtype Structure

4.10.4.3 ACTION-EVENT is defined as an ACTION that is an incident, phenomenon, or occasion of military significance that has occurred or is occurring but for which planning is not known. This entity is intended to capture ACTIONs that simply occur and need to be noted. An ACTION-EVENT may trigger an ACTION-TASK. For example, the encounter of a scattered minefield near the landing zone will result in an evasive manoeuvre. An observer in the field may also use ACTION-EVENT to report his sightings that result from a recorded ACTION-TASK of which he has no knowledge.

4.10.4.4 Status entities permit the monitoring of the effectiveness and progress of both tasks and events as follows:

a. ACTION-TASK-STATUS captures the perceived appraisal of the planning and execution progress of a particular ACTION-TASK in fractional terms or through the reporting of actual starting and ending dates and times.

b. ACTION-EVENT-STATUS reports the perceived appraisal of the actual progress of an ACTION-EVENT as determined by the reporting organisation. The progress is

estimated fractionally at a given date and time; therefore, fraction 0 would coincide with a starting date and time and fraction 1 with the end.

4.10.4.5 Using Effectiveness and ACTION-TASKS. ACTION-TASK-STATUS specifies the progress of the ACTION-TASK towards completion without referring to the actual effectiveness of the ACTION-TASK with respect to specified objectives. This can be used to monitor the progress of occurring ACTION-TASKs, as well as to provide an estimate of future progress of planned, expected, or ordered ACTION-TASKs.

4.11 Broadening Functionality of ACTION

4.11.1 Introduction

A number of model constructs add to the scope of data that can be captured to enrich a specification of ACTION:

a. Marking objectives
b. Extending specification of ACTION-OBJECTIVE to TARGET
c. Extending specification of ACTION-TASK to REQUEST
d. Specifying required capabilities
e. Designating roles of an organisation with respect to ACTION
f. Specifying constraints or guidance on the use of ACTION-RESOURCE
g. Imposing rules of engagement
h. Providing CANDIDATE-TARGET-LIST as an aid in operational planning
i. Linking ACTION to CONTEXT as a mechanism for specifying or recording starting, intermediate, or ending conditions.

4.11.2 Marking ACTION-OBJECTIVE-ITEM and Its Role as a Target

4.11.2.1 Some instances of ACTION-OBJECTIVE-ITEM may need to be marked in some way either to avoid fratricide or more often to be designated as targets. The instances of ACTION-OBJECTIVE-ITEM that are actually targets require additional data specifications. The latter use entails two entities—TARGET and its child entity TARGET-PERSONNEL-PROTECTION. The structure for marking and targets is illustrated in Figure 22.

4.11.2.2 ACTION-OBJECTIVE-ITEM-MARKING is defined as the technique of indicating the position of an ACTION-OBJECTIVE-ITEM at a given time for the benefit of a using ORGANISATION.. It is used to specify requirements, plans, and results of marking an ACTION-OBJECTIVE-ITEM position or an associated reference position. Assignment of the resource that provides marking services is specified in ACTION-TASK. ACTION-OBJECTIVE-ITEM-MARKING provides an opportunity to add coordinating details for the user of the marking services.

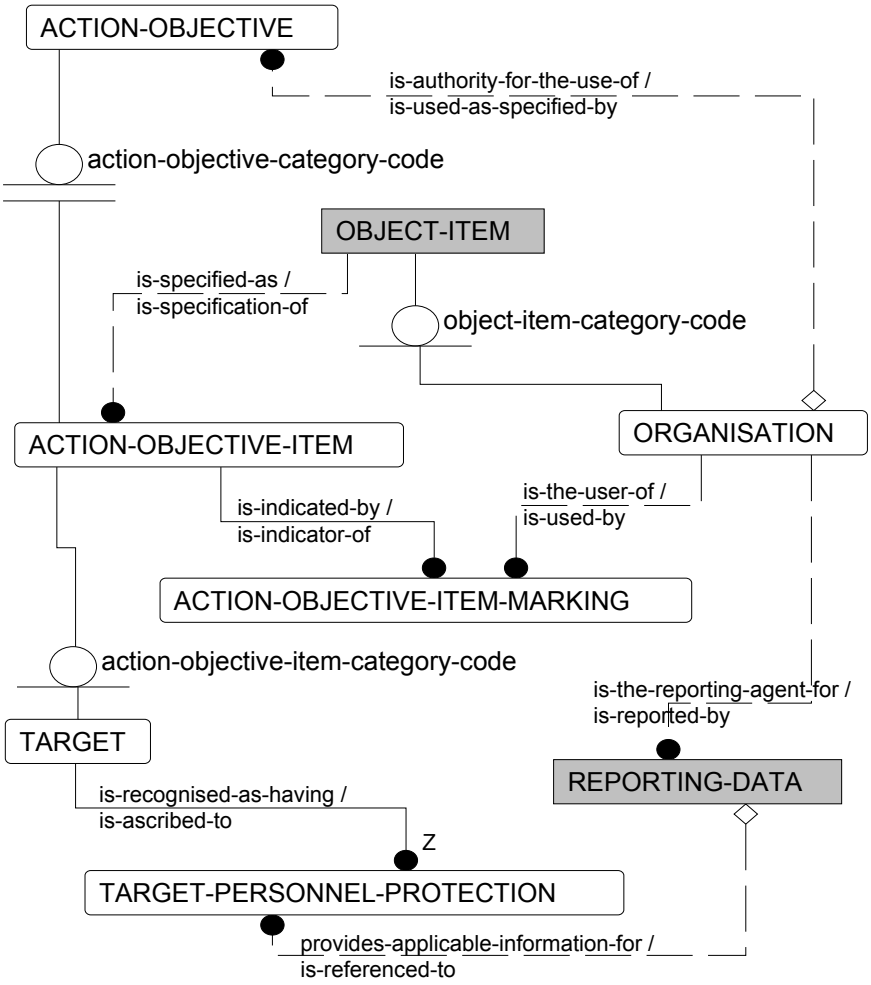


Figure 22. TARGET Structure

4.11.2.3 TARGET is a subtype of ACTION-OBJECTIVE-ITEM. It is defined as an ACTION-OBJECTIVE-ITEM that is subject to capture or destruction by military forces or against which military intelligence operations are directed. Essentially, TARGET provides additional data about an ACTION-OBJECTIVE-ITEM when it is the focus of air-defence, direct fire support, reconnaissance, and other operational tasks.

4.11.2.4 TARGET-PERSONNEL-PROTECTION is defined as an assessment of the general protective posture of personnel with respect to first and second volleys for the specific TARGET. The protective posture refers to states such as standing, prone, dug in, and under cover. It captures the change of state, if any, between the first volley and the second volley. For example, personnel may have been prone at the first volley, but may be dug in at the second volley.

4.11.3 REQUEST for Intelligence and Combat Information

4.11.3.1 Requests for intelligence need to be linked to the products of surveillance and reconnaissance. A REQUEST is a special instance of ACTION-TASK that can use all the functionality of the ACTION structure to specify a requirement to collect information. The execution planning in response to the request would be done within the same structure as any other ACTION. Once the collection is complete, one or

more REQUEST-ANSWERs can be created. The structure for REQUEST-ANSWER is illustrated in Figure 23.

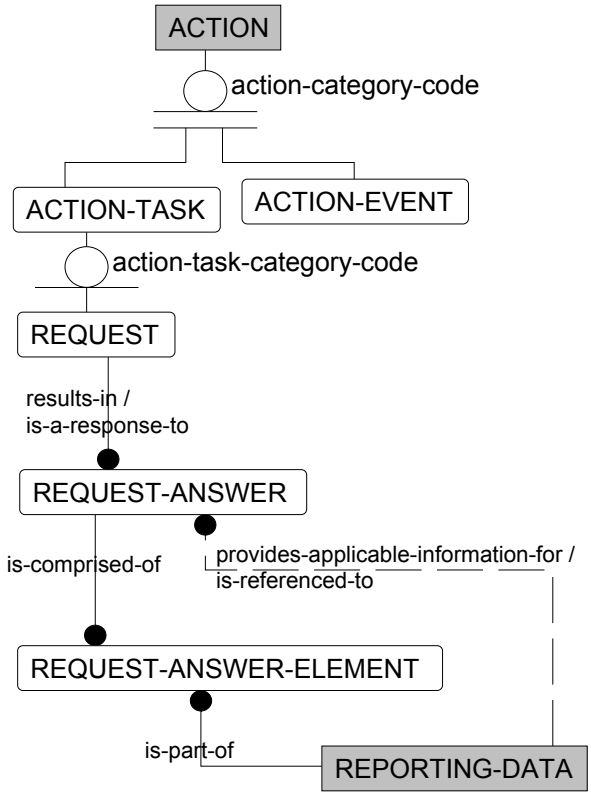


Figure 23. REQUEST Structure

4.11.3.2 Affirmative REQUEST-ANSWER indicates that additional information may be recorded elsewhere in the model. The pointer to such information is implemented through the entity REQUEST-ANSWER-ELEMENT. For example, a hostile unit may have been located at a given coordinate as a result of a search for enemy units in a prescribed region. This information would be recorded in OBJECT-ITEM-LOCATION that is linked to REPORTING-DATA (subject to be described in a subsequent section). An instance of REQUEST-ANSWER-ELEMENT would then be able to indicate the correct instance of REPORTING-DATA that is part of the REQUEST-ANSWER.

4.11.3.3 Negative entry in REQUEST-ANSWER is actually a genuine piece of information that cannot be recorded elsewhere. If the search for hostile units results in none being found, then that finding is recorded in REQUEST-ANSWER.

4.11.4 Capabilities Required for an ACTION

4.11.4.1 The ability to specify a required CAPABILITY in order to complete an ACTION is necessary for planning optimal employment of resources and for managing resources during the life of an ACTION. ACTION-REQUIRED-CAPABILITY is defined as the specific CAPABILITYs required to satisfy an agreed operational need (an ACTION).

4.11.4.2 Use of this construct permits the matching of the available capabilities of objects or their types to the required capabilities in the selection of the most appropriate resources. Also, if the ACTION-REQUIRED-CAPABILITY is known, and, if a resource that was selected to match a CAPABILITY was suddenly not available or was no longer able to provide the requisite CAPABILITY, it alerts the planner that he should re-allocate replacement assets.

4.11.5 Role of an ORGANISATION with Respect to an ACTION

4.11.5.1 Specifying Additional Roles. The addition of an associative entity between ACTION and ORGANISATION (ORGANISATION-ACTION-ASSOCIATION) permits the explicit specification of any role or roles that an ORGANISATION may have in relation to an ACTION over and above those implicit in the role of an organisation as an ACTION-RESOURCE. The roles could include initiation, coordination, planning, authorisation, oversight, distribution of orders and so on.

4.11.5.2 Specifying Commander's Intent/Concept of Operations. The second, important function of the entity ORGANISATION-ACTION-ASSOCIATION is to enable the specification of commander's intent or concept of operations for an ACTION. Generally, this would be the top-level or mission task statement for a unit.

4.11.6 Guidance for Use of Resources

4.11.6.1 The structure consists of ACTION-RESOURCE-EMPLOYMENT and its subtype ACTION-AIRCRAFT-EMPLOYMENT. These entities enable the operational planner to provide additional guidance in the employment of resources either in relation to a specific objective or independently of it. Currently, the model features a single subtype for aircraft employment; however, the structure can be readily extended to provide guidance in other areas as operational information exchange requirements dictate. The structure is illustrated in Figure 24.

4.11.6.2 ACTION-RESOURCE-EMPLOYMENT is defined as the procedure for using a specific OBJECT-TYPE or OBJECT-ITEM against an objective in an ACTION. ACTION-RESOURCE-EMPLOYMENT is a dependent entity, derived from the relationship "is used according to/describes use of" from ACTION-RESOURCE. In addition, there is a non-identifying relationship "is the subject of/is relevant for" from ACTION-OBJECTIVE to ACTION-RESOURCE-EMPLOYMENT.

4.11.6.3 ACTION-AIRCRAFT-EMPLOYMENT is defined as the procedures which guide the utilisation of an ACTION-RESOURCE that is capable of atmospheric flight. The structure is currently used to specify some restrictions on aircraft employment that are intended to avoid harm to friendly troops and that also may be useful for de-conflicting fires. The main data elements are: approach offset code, terminal attack direction angle, egress direction angle, deplanement method code, and inflight report requirement indicator code.

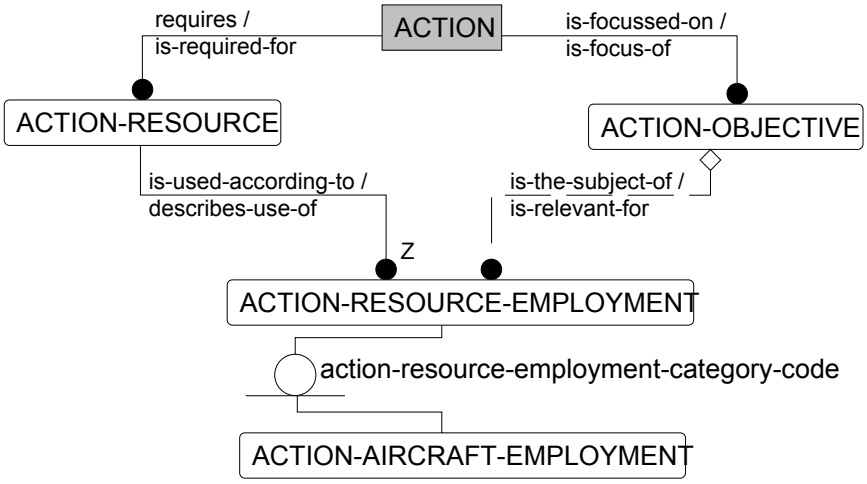


Figure 24. ACTION-RESOURCE-EMPLOYMENT Structure

4.11.7 Rules of Engagement

4.11.7.1 Rules of engagement need to be applied to operational activities. The functions include the imposition of a rule of engagement by an authorising agency, a request to be relieved from a rule of engagement and the consequent authorisation for relief if appropriate, and a request that a rule of engagement be imposed and the consequent authorisation for it if appropriate. The model incorporates for this purpose a structure consisting of three entities: RULE-OF-ENGAGEMENT, ACTION-TASK-RULE-OF-ENGAGEMENT and ORGANISATION-ACTION-TASK-RULE-OF-ENGAGEMENT-STATUS. The structure is illustrated in Figure 25.

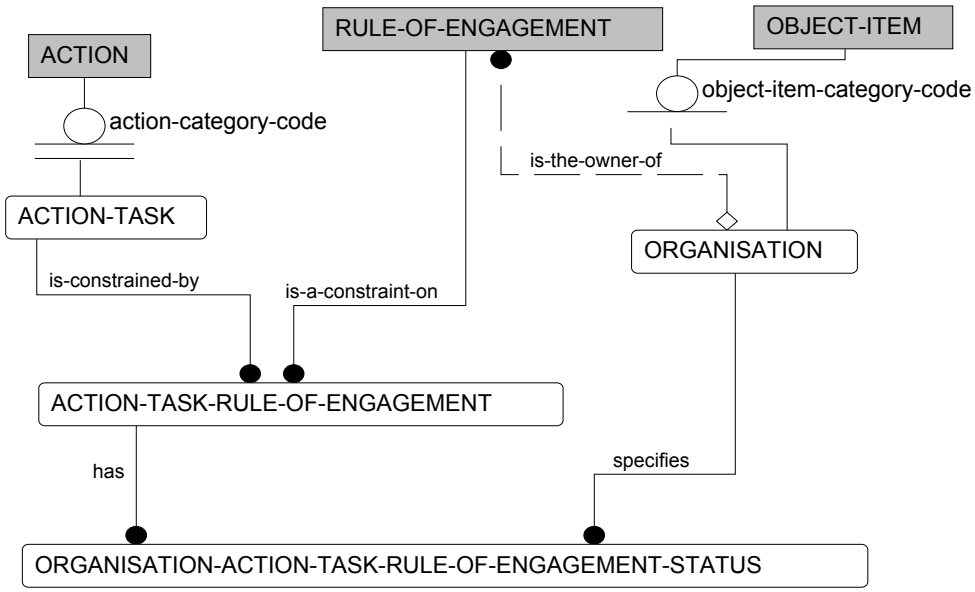


Figure 25. RULE-OF-ENGAGEMENT Structure

4.11.7.2 RULE-OF-ENGAGEMENT is defined as a specification mandatory guidance for the way a given activity is to be executed. In essence, it provides a list of rules.

4.11.7.3 ACTION-TASK-RULE-OF-ENGAGEMENT is defined as the imposition of a specific RULE-OF-ENGAGEMENT on a specific ACTION-TASK. It permits the linking of specific rules to a specific ACTION-TASK.

4.11.7.4 ORGANISATION-ACTION-TASK-RULE-OF-ENGAGEMENT-STATUS is defined as the status of the relationship between a specific ORGANISATION and a specific ACTION-TASK-RULE-OF-ENGAGEMENT with respect to a request for an application, a request for cancellation, or an authorisation.

4.11.8 Candidate Target Lists

4.11.8.1 The primary purpose of this structure is to enable the building of target lists for consideration during planning processes. The notion of a potential target is different from the notion of TARGET (a model entity) that is actually specified as an objective of an activity. The structure permits the nomination of targets at any number of echelons with or without a change in target numbering. An item or type may be nominated as a target multiple times, possibly with a different activity focus in each nomination. The authorisation of candidate targets may also occur at multiple levels.

4.11.8.2 The structure for identifying potential targets includes two tiers of entities: the first to create candidate target lists and the second to itemise candidate targets individually. The model contains the entities CANDIDATE-TARGET-LIST and CANDIDATE-TARGET-DETAIL for this purpose. There is also a provision to specify authorisations for lists in their entirety and individual targets separately. The data structure consists of CANDIDATE-TARGET-LIST-AUTHORISATION and CANDIDATE-TARGET-DETAIL-AUTHORISATION. Since target lists are often likely to be related to each other, such as battalion and brigade-nominated lists with division lists, the model includes the CANDIDATE-TARGET-LIST-ASSOCIATION. A similar provision is made for relating individual targets, for example, the elements of a complex target such as a military airbase, a major logistics facility, or a naval port, through the entity CANDIDATE-TARGET-DETAIL-ASSOCIATION. The structure is illustrated in Figure 26.

4.11.8.3 CANDIDATE-TARGET-LIST structure can be used to create prioritised lists of individually identified candidates. For example, Division A could nominate a specific enemy brigade for attack, a specific radar site for intercept activity, and a specific area in which friendly fire is to be avoided because a long-range reconnaissance patrol may be occupying it. The same structure can also be used to create targeting objectives by classes that may reflect the commander’s intent: for example—in order of priority—command-and-control centres, armoured fighting vehicles, POL supplies, and fire-control radars. Target lists can also be nested.

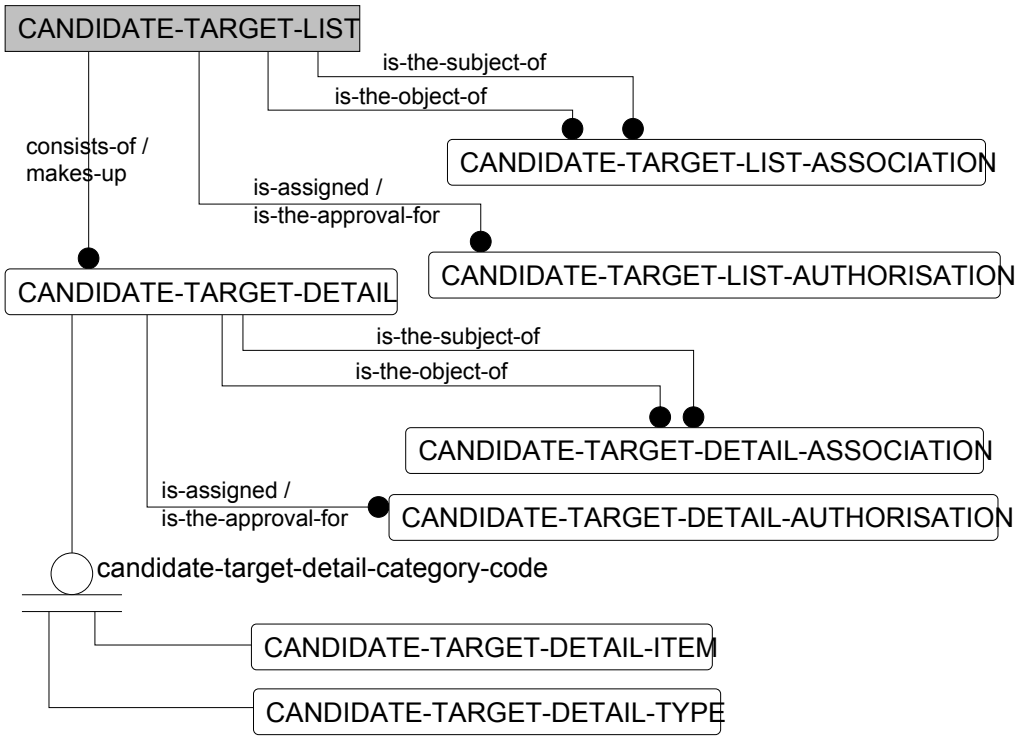


Figure 26. Candidate Target Structure

4.11.8.4 Nomination and authorisation of candidate targets is intended to be used in the operational planning process. The model structure that permits candidate target lists and individual candidate targets to be associated with the ACTION structure is illustrated in Figure 27. The primary connection is from CANDIDATE-TARGET-LIST to ACTION-TASK.

4.11.8.5 A connection also exists for individual candidate targets through the relationships “may be specified as” from CANDIDATE-TARGET-DETAIL-ITEM and CANDIDATE-TARGET-DETAIL-TYPE to ACTION-OBJECTIVE-ITEM and ACTION-OBJECTIVE-TYPE. These relationships permit an explicit association between a target nomination and the designation of any item or type as a planned objective of a specific ACTION.

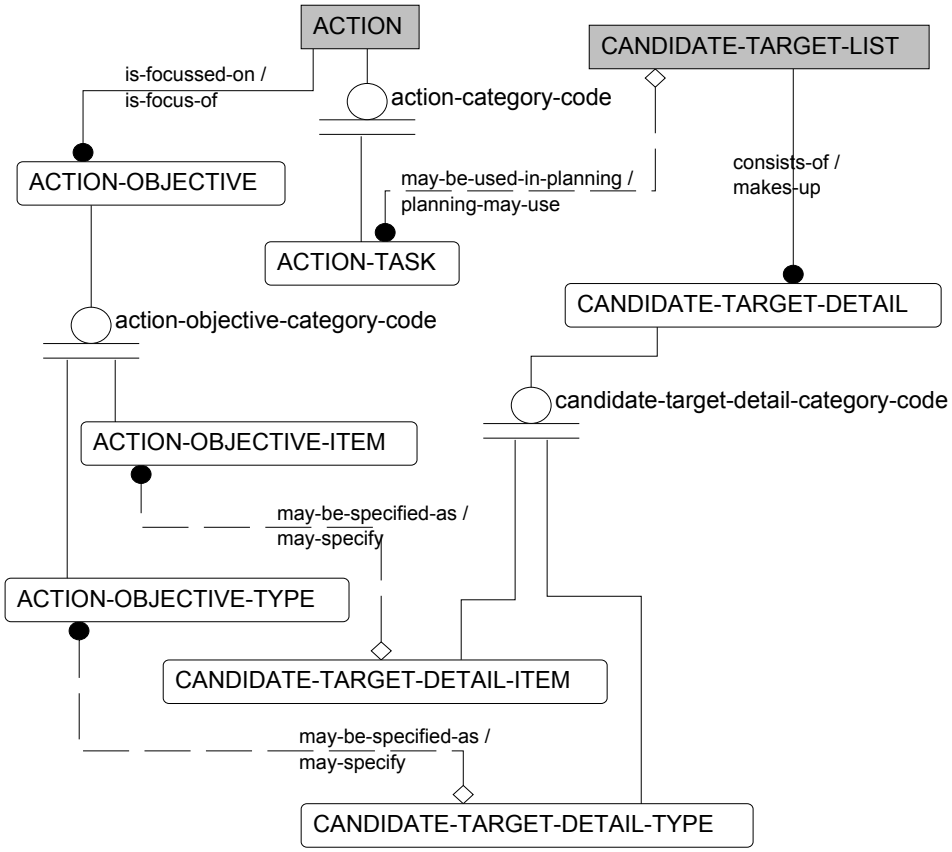


Figure 27. Linking Candidate Targets to Operations Planning

4.11.9 Context for an ACTION

4.11.9.1 CONTEXT structure enables the specification of related data of the type that is referred to as an operational overlay. The planner can use the CONTEXT information to judge the merits of a plan or an order, and to assess a need for changes. Details of CONTEXT usage are presented in the next section.

4.11.9.2 ACTION-CONTEXT links ACTION to CONTEXT. In general, CONTEXT helps to set the whole situation, background, or environment relevant to a particular ACTION. It can specify conditions that must precede an ACTION or those that should result from the execution of an ACTION. It can also be used to impose additional constraints on ACTIONs and to preserve a historical sequence of snapshots of the actual execution of plans.

4.12 Data about Reported Data

4.12.1 Introduction

4.12.1.1 Considerable amount of information about situation in an operational arena consists of reports by persons or organisations. These generally refer to dynamic data, such as location, status, holdings, associations, and classification, regardless of whether the information refers to friendly, neutral, or hostile elements. It is also important to know for each report the source, the effective starting or ending date and time for the estimate, the reporting date and time, and the degree of validity of the estimate. The

model capture both the substantive information in numerous entities and the reporting information in REPORTING-DATA and its subtypes.

4.12.1.2 Amplifying information enables a staff officer to compare different reports and make a sensible interpretation of the data. It also allows the staff officer to enter his own perception of reality based upon the raw data; this may be particularly applicable to an intelligence function that produces correlated information at a higher quality level.

4.12.1.3 REPORTING-DATA permits a mechanism for maintaining a historical record that applies not only to the past and present, but also to the future. Thus, it is just as easy to record that the *required* stockage level of an ammunition stock should be 10,000 three days from now as it is to record that the *reported* stockage level yesterday was 8,200.

4.12.1.4 REPORTING-DATA is linked to many entities through a non-identifying relationship "provides applicable information for." Most relationships require that a record in REPORTING-DATA be created for every new set of dynamic information. The reasons are twofold. If information is provided without an indication of the source, the validity, and the applicable times, it raises questions as to the source (Who says so?), the quality (Is this information verified?), and timing (When did it happen and when was this reported?). A secondary reason is to provide a capability to refer to each item of dynamic information when that information is required to create a broader context for information—a topic discussed in Section 3.12.

4.12.2 REPORTING-DATA Structure

4.12.2.1 REPORTING-DATA is defined as the specification of source, quality and timing that applies to reported data. Its structure is illustrated in Figure 28. It has a mandatory relationship to ORGANISATION whose role is that of a reporting agent. Its two subtypes serve to specify timing information. It has an optional relationship to REFERENCE.

4.12.2.2 Ability to cite sources of information that are external to the data structures is useful. The sources could be ADatP-3 messages, printouts of electronic mail, memoranda of telephone conversations, and other physical storage means that need to be consulted. REFERENCE provides this functionality. REFERENCE pointers can be associated with one or more instances of REPORTING-DATA in order to amplify the data that is referred to by REPORTING-DATA.

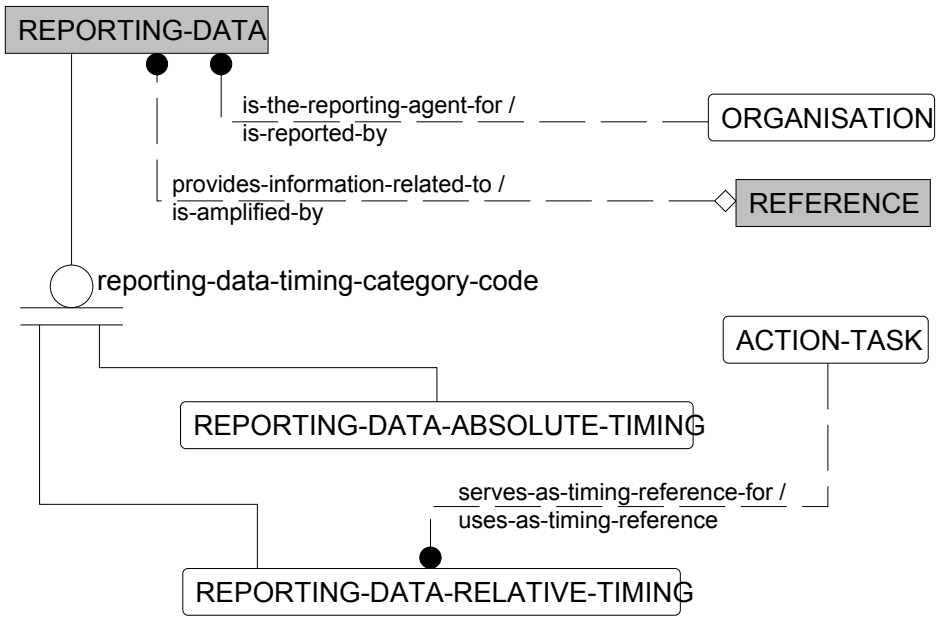


Figure 28. Structure for REPORTING-DATA

4.12.3 Specifying Time

4.12.3.1 Time[17] points and time periods having a specific military significance need to be specified; for example, the starting time of an action, the reporting time of a situation report, and the period of time covered by a weather forecast. There is also a need to specify time as fixed or relative:

a. Fixed (*absolute*) with respect to the standard calendar (e.g., 120700Z Sep69)

b. *Relative* with respect to an arbitrary origin that may be unspecified (e.g., D+3).

Absolute and relative time characteristics are captured in subtypes REPORTING-DATA-ABSOLUTE-TIMING and REPORTING-DATA-RELATIVE-TIMING.

4.12.3.2 REPORTING-DATA-ABSOLUTE-TIMING is defined as a REPORTING-DATA that specifies effective date and time that are referenced to Universal Time. The specified epoch can be in the past, the present, or the future. The date follows the Gregorian calendar and the 24-hour clock time is defined with respect to Universal Time.

4.12.3.3 Effective time can also be relative. REPORTING-DATA-RELATIVE-TIMING is defined as a REPORTING-DATA that specifies effective timing that is referenced to a specific ACTION-TASK. Relative timing makes operational sense only in relation to planned activities; consequently, the origin of the time scale is established in reference to an instance of ACTION-TASK.

[17] The word "time" when used in the context of natural language refers to the general notion of time that encompasses collectively the specific meanings of the class words "date" and "time."

4.13 CONTEXT Structure

4.13.1 Introduction

4.13.1.1 CONTEXT provides a mechanism for pointing to one or more records in numerous tables and treating them as a single group or package of data that can stand alone as part of situational awareness or be linked to instances of ACTION, OBJECT-ITEM or REPORTING-DATA. It depends on multiple connectivity that REPORTING-DATA has to other entities in the model.

4.13.1.2 CONTEXT can be used to group data without creating new information, such as a collection of data that is relevant to the situation, background, or environment for a particular ACTION. It can specify conditions that must precede an ACTION or those that should result from the execution of an ACTION. Planners can use the context information to judge the merits of a plan or order, and make changes in plans in order to respond to a changing situation. Commanders can use the context information to choose between multiple courses of action. The construct can also be used to re-capture a situation as it existed at some time in the past or is expected to exist at a future date.

4.13.1.3 Grouping of data by means of CONTEXT can also help to manage dynamic information by helping to prevent inadvertent loss of significant information that may not be recognised as such if it is not linked to a situational description.

4.13.2 CONTEXT Structure

The CONTEXT structure is shown in Figure 29. Basically, it can collect any number of pointers to instances of REPORTING-DATA through CONTEXT-ELEMENT.

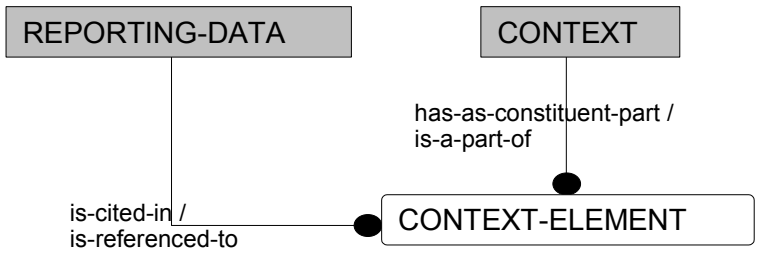


Figure 29. CONTEXT Structure

4.13.3 Overview of CONTEXT Functionality

4.13.3.1 CONTEXT structure serves several different functions through relationships to other entities. These are shown in Figure 30 at the entity level. Each of the individual functions is marked with a "Function x" block in the diagram as a reference for discussion.

4.13.3.2 *Function 1* relates an instance of CONTEXT to an instance of OBJECT-ITEM.

4.13.3.3 *Function 2* refers to the potential for adding a limited amount of free text to any context. Addition of text in CONTEXT-ASSESSMENT is optional, but if an assessment is added it becomes an integral part of "context."

4.13.3.4 *Function 3* permits creation of new data to be linked to an existing "context." One of its uses is to record the results of data correlation or data fusion. An intelligence analyst may create an intelligence appreciation about the location of an enemy unit by basing it on a number of different observations. The analyst then creates an entry in OBJECT-ITEM-LOCATION with an associated entry in REPORTING-DATA that points through CONTEXT to all the data being used. For example, an analyst's Reporting Data 4 may be associated with previous Reporting Data 1, Reporting Data 2, and Reporting Data 3. The new estimate itself needs to be described by a suitable REPORTING-DATA. This is done through CONTEXT-REPORTING-DATA-ASSOCIATION that relates a specific CONTEXT as a subject with another REPORTING-DATA as an object. The relationship is characterised by the following values: Implies, Is confirmed by, Is a correction of, Is defined to be, Is negated by, Is superseded by.

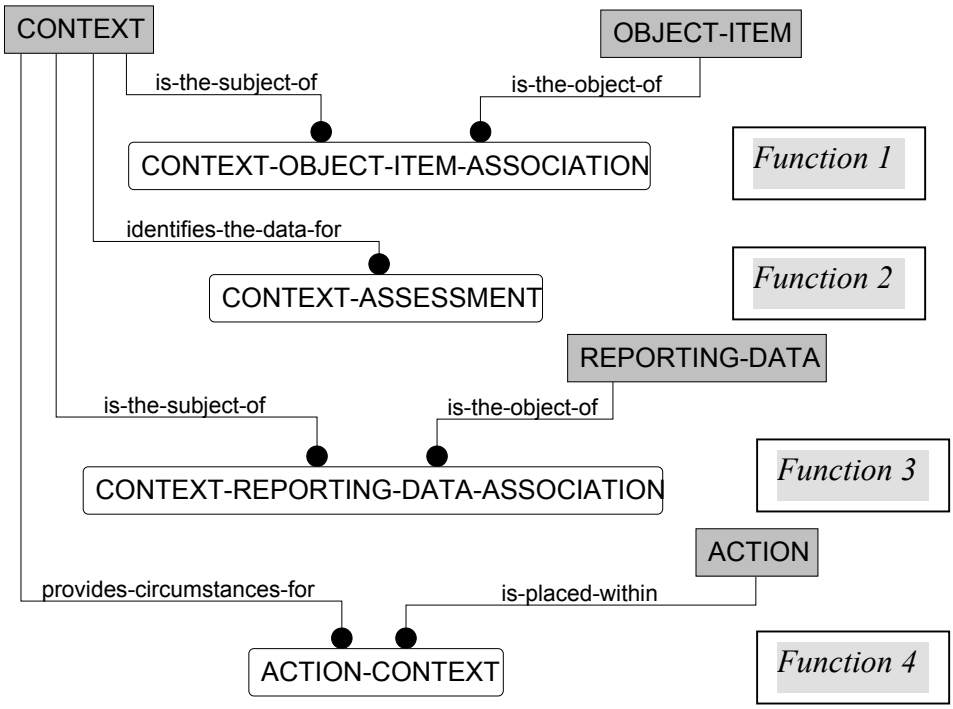


Figure 30. CONTEXT Functionality

4.13.3.5 *Function 4* relates an instance of CONTEXT to an instance of ACTION. This is an important linkage that permits a considerable amount of information to be coupled to plans and orders.

4.14 Attaching Affiliation to Items and Types

4.14.1 General Description

4.14.1.1 There is a need to identify, for various reasons, one or more associations according to country, nationality, ethnicity, or allegiance. It is quite conceivable to have a person of one nationality, associated with a country that is different from his nationality, and owing allegiance to yet another entity that may not even be a country.

4.14.1.2 The independent entity AFFILIATION has five subtypes that constitute rationally organised sets of values to enable the tagging of types or items in more than the single nationality characteristic. AFFILIATION has a non-identifying relationship to OBJECT-TYPE to set the persistent type characterisitic. In addition, AFFILIATION is linked to OBJECT-ITEM to enable the specification of individual exceptions to the type characterisation associated with the item.

4.14.1.3 The structure is illustrated in Figure 31.

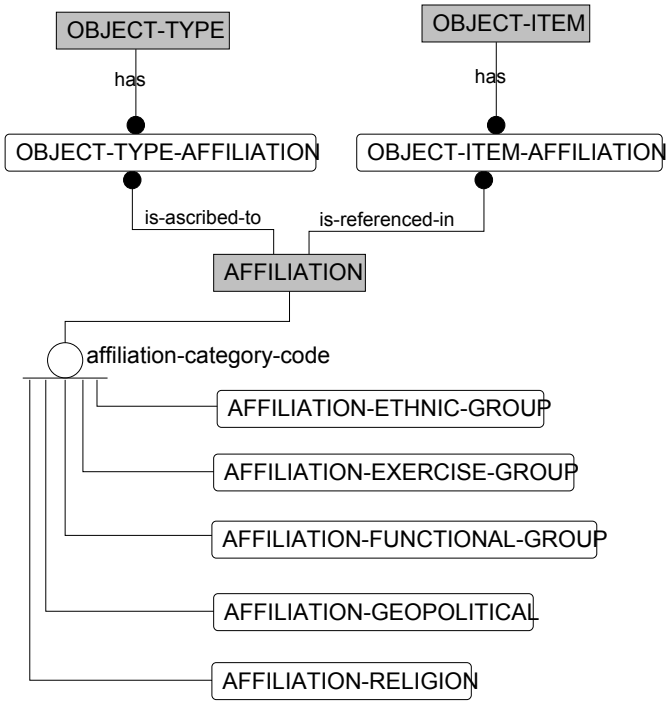


Figure 31. Structure for Specifying Affiliations

4.14.2 Specification of ALLEGIENCE and Its Subtypes

4.14.2.1 An AFFILIATION is defined as a specification of a country, nationality, ethnic group, functional group, exercise group, or religion to which membership or allegiance may be ascribed. The subtype AFFILIATION-ETHNIC-GROUP provides a list of ethnic groups. AFFILIATION-EXERCISE-GROUP specifies military, civil, or combined exercise groups constituted for purposes of training. It has a *name* attribute that permits the entry of any ad hoc description of a suitable group. AFFILIATION-FUNCTIONAL-GROUP specifies groups characterised by their primary purpose. It also has a *name* attribute that permits the entry of any ad hoc description within criminal, multinational, and terrorist categories. AFFILIATION-GEOPOLITICAL provides a list of countries or political entities. The list includes country or nationality codes that have been aligned with country code list in ISO 3166. AFFILIATION-RELIGION provides a list of religions.

4.14.2.2 Subtypes AFFILIATION-FUNCTIONAL-GROUP and AFFILIATION-EXERCISE-GROUP enable specification of groups as data since it is

difficult to determine in advance all the potential functional groups, and it is equally indeterminate how many exercise countries or other objects may be needed.

4.14.3 AFFILIATION Relationships

4.14.3.1 An OBJECT-TYPE-AFFILIATION is defined as a relationship between a specific OBJECT-TYPE and a specific AFFILIATION that identifies an inherent allegiance. This entity is to be used routinely to assign a permanent normal or persistent affiliation to an instance of OBJECT-TYPE. Because each instance of OBJECT-ITEM must be associated with at least one instance of OBJECT-TYPE, the item inherits allegiance characteristics from the type.

4.14.3.2 An OBJECT-ITEM-AFFILIATION is defined as a relationship between a specific OBJECT-ITEM and a specific AFFILIATION. This entity is intended to record exceptions to affiliations identified in OBJECT-TYPE and may include the following cases:

a. Affiliations that differ from the type affiliation that are inherited through OBJECT-ITEM-TYPE.

b. Serial affiliations that represent succession of affiliations over time.

c. Multiple affiliations that are valid at the same time.

4.15 Counting Persons by Group Characteristics

4.15.1 Introduction

4.15.1.1 Article V First Hostile Act and multiple CRO requirements point to a need to count PERSON-TYPEs grouped by one or more characteristics that in effect stratify or segment a given population. The data structure described in this section permits the counting of PERSON-TYPEs according to one or more characteristics. It enables the reporting of the number of killed and injured as the result of a bomb explosion or some other form of attack. It also satisfies a number of CRO requirements for accounting of refugee camp occupants. For example, one could express how many young girls from Kosovo are afflicted with diphtheria.

4.15.1.2 The structure is presented in Figure 32.

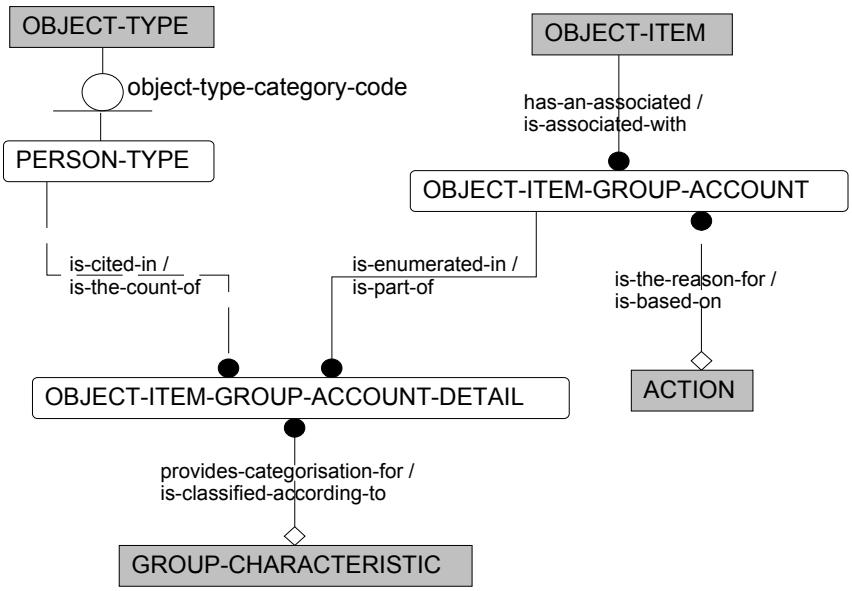


Figure 32. Structure for Counting PERSON-TYPEs

4.15.2 Description of Counting Structure

4.15.2.1 The structure is made up of two principal parts. The first consists of the entity OBJECT-ITEM-GROUP-ACCOUNT and its child OBJECT-ITEM-GROUP-ACCOUNT-DETAIL. These entities permit as many groupings to be accounted for as is necessary for an instance of OBJECT-ITEM at a specified time. The actual count is specified in OBJECT-ITEM-GROUP-ACCOUNT-DETAIL together with an attribute that further qualifies the count to account for morbidity and other states that the counted group may occupy. The count could be for a refugee camp, hospital, POW camp, or another facility; an organisation; a geographic location; a control feature; or even a meteorolgic feature, such as an area affected by a tornado. The second part is the GROUP-CHARACTERISTIC entity. It permits as many factors to be entered as needed simultaneously in order to capture the required stratification. Thus, we could be talking about the number of Algerian adult females who happen to be Catholic and are infected by smallpox and are triaged as T4.

4.15.2.2 The current design permits group counting only for instances of PERSON-TYPE that are identified through a mandatory non-identifying relationship from PERSON-TYPE to OBJECT-ITEM-GROUP-ACCOUNT-DETAIL. The limitation is due to the set of operational requirements that pointed only to types of persons. The structure can be generalised to encompass OBJECT-TYPE or additional structure could be added to accommodate likely counting possibilities for other types, such as MATERIEL-TYPE.

4.15.2.3 The characteristics that apply to any particular group that is to be counted may be drawn from the native attributes of the entities OBJECT-TYPE, PERSON-TYPE, and GROUP-CHARACTERISTIC. The relationship between GROUP-CHARACTERISTIC and OBJECT-ITEM-GROUP-ACCOUNT-DETAIL has been made optional to permit cases where the grouping inherent in the definition of PERSON-TYPE

(that necessarily includes OBJECT-TYPE) provides an adequate set of discriminators for the desired count.

4.15.2.4 The underlying cause or causes for the reported counting must be specified through the ACTION structure. The specific link is the optional non-identifying relationship from ACTION to OBJECT-ITEM-ACCOUNT. The ACTION structure enables the identification of the agent (ACTION-RESOURCE) and the "target" (ACTION-OBJECTIVE) as appropriate.

4.15.3 Specification of Counting Structue

4.15.3.1 A GROUP-CHARACTERISTIC is defined as a reference to a set of characteristics that may be used for identifying a distinct collection of objects. The characteristics that can be selected are age group, gender, disease type, disease transmissibility indicator, language, and triage code.

4.15.3.2 An OBJECT-ITEM-GROUP-ACCOUNT is defined as a reference to accounting for a set of groups that are associated with the specific OBJECT-ITEM at the time specified by REPORTING-DATA. The accounting may result from or be affected by a specific ACTION.

14.15.3.3 An OBJECT-ITEM-GROUP-ACCOUNT-DETAIL is defined as the total count and condition of a specific group included in a specific OBJECT-ITEM-GROUP-ACCOUNT. The group is defined as a specific PERSON-TYPE that may also be categorized by a specific GROUP-CHARACTERISTIC. The key attributes account for the number in a group and a qualifier that adds descriptors such as ailing; captured; deserted; killed; or missing.

(This page intentionally left blank)

5. EXAMPLES OF POTENTIAL USE

5.1 Producing Plans

The model supports the planning process by capturing information at each stage, and permitting a variety of planning options to be examined. The steps in planning may include the following:

a. Create a new ACTION-TASK or specify new parameters for an existing ACTION in order to take the initiative or to respond to an ACTION-EVENT.

b. Add detail to the ACTION-TASK by using the functional and temporal associations. This permits the subdivision of the plan into sub-activities with differing functional and temporal relationships to the high-level plan.

c. Identify the ACTION-OBJECTIVEs in terms of OBJECT-TYPEs and/or OBJECT-ITEMs. This is the mechanism for identifying key objectives in terms of enemy units, facilities, and materiel (e.g., destroy a bridge in enemy held territory).

d. Search for the required CAPABILITYs to perform the ACTION. This is the process of matching the appropriate ACTION-RESOURCE to meet the requirements of a specific ACTION. For example, crossing of an obstacle requires the employment of an engineer UNIT-TYPE with the appropriate CAPABILITY, and the movement of personnel requires vehicles or aircraft with the appropriate payloads.

e. Allocate OBJECT-TYPE as an ACTION-RESOURCE to a ACTION-TASK based on its CAPABILITY-NORM. Having identified the requirement for troop-carrying vehicles, this step requires the allocation of, for example, 12 Blackhawk helicopters.

f. In order to determine what resources are available for this ACTION, search for OBJECT-ITEMs whose OBJECT-ITEM-CAPABILITY matches the CAPABILITY-NORM for their type. For example, the 3rd US Aviation Brigade may have 24 Blackhawk helicopters and the 1st US Marine Expeditionary Force may have 12.

g. Allocate individual OBJECT-ITEMs as ACTION-RESOURCEs to an ACTION-TASK. Twelve Blackhawk helicopters from the 3rd US Aviation Brigade are designated to perform the task.

h. Define CONTROL-FEATUREs to support the ACTION. Such features may be air corridors, low-level transit routes, or target areas.

5.2 Generating Orders

Once the planning process is complete, an order can be generated by simply converting the status of a particular plan, or a series of plans, from “plan” to “order.”

5.3 Reporting of Status

Status reporting deals with a wide range of objects, from an individual soldier to a complete situation report. The entities used to generate such reports encompass most of the data model. The following is a sample of possible applications:

a. The OBJECT-ITEM-STATUS entity can be used to record information about individual OBJECT-ITEMs (e.g., Sgt. T. Hanks is wounded in action; 15 (GE) Panzer Division is fully operational).

b. ACTION-TASK-STATUS may be used to provide updates on the dynamics of the situation (e.g., minefield laying 70 percent complete, estimated time of completion + 2 hours).

c. ACTION-EVENT-STATUS provides a means of reporting unplanned activity (e.g., flooding started at 1626 on 18 July 2000).

d. OBJECT-ITEM associations can be used to specify a friendly/enemy order of battle (in particular, ORGANISATION-ORGANISATION-ASSOCIATION).

e. Establishments and HOLDING can be used to indicate surpluses or deficiencies (e.g., 1 (DA) Mechanised Brigade has a holding of 50 Leopard I main battle tanks whereas it is established to have 56).

ANNEX A GLOSSARY

1 R Irish	The Royal Irish Rangers
2 RTR	Royal Tank Regiment (UK)
AAP	NATO Standardisation Agreements and Allied Publications
ABCA	Australian, British, Canadian, and American—a target numbering scheme
ACO	Airspace Control Order
AD	Air Defence
ADatP	Allied Data Publication
AFNORTH	Allied Forces Northern Region
AFV	Armoured Fighting Vehicle
AH	Attack Helicopter
AIRCENT	Allied Air Forces Central Europe
AK	Alternate Key
AOI	Area of Interest
AR	Armored – US designation
ARM	ATCCIS Replication Mechanism
Armd	Armoured
Arty	Artillery
ATCCIS	Army Tactical Command and Control Information System
ATO	Air Tasking Order
AUS	Australia
ATCCIS	Army Tactical Command and Control Information System
AUT	Austria
Bde	Brigade
BE	Basic Encyclopedia—a target numbering scheme
BEL	Belgium
BFV	Bradley Fighting Vehicle
Bn, BN	Battalion
Bty	Battery
C2	Command and Control
C2IEDM	Command and Control Information System
C2IS	Command and Control Information Systems
C3	Command, Control and Communications
C3I	Command, Control, Communications, and Intelligence
CAN	Canada
CAS	Close Air Support
CAV	Cavalry
CBT	Combat
CCEB	Combined Communication Electronic Board
CCIS	Command and Control Information System
cGY	Centigray
CET	Combat Engineer Tractor
CIS	Communications and Information System
CJTF	Combined Joint Task Force
CMO	Civil/Military Operations
COE	Common Operating Environment
COORD	Coordinate, Coordination; Coordinating Point
Coy, COY	Company
CP	Command Post; Control Point; Concrete Piercing; Checkpoint
CRO	Crisis Response Operations
CRUD	Create, Read, Update, Delete rules

CSS	Combat Service Support
CZE	Czech Republic
DBMS	Database Management System
DEM	Data Exchange Mechanism
DES	Data Exchange Schema
DEU	Germany
DIGEST	Digital Geographic Information Exchange Standard
Div, DIV	Division
DNK	Denmark
DoD	Department of Defense (US)
DPC	NATO Defence Planning Committee
DS	Direct Support
E-Mail	Electronic Mail
ELINT	Electronic Intelligence
EMCON	Emission Control
Engr	Engineer, Engineering
EOD	Explosive Ordnance Disposal
EQPMT	Equipment
ESP	Spain
EW	Electronic Warfare
F-kill	Firepower Kill (criterion)
FA	Field Artillery
FACC	Feature and Attribute Coding Catalog (Volume 4 of the DIGEST standard)
FFIRN	Fixed Field Indicator Reference Number
FIBE	Field Initiated Basic Encyclopedia—a target numbering scheme
FIPS	Federal Information Processing Standard (US)
FK	Foreign Key (a key inherited by a child entity from a parent entity)
FRA	France
FS	Fire Support
GBPS	Gigabits per second
GBR	Great Britian
GEW	Global Early Warning
GIS	Geographic Information System
GRC	Greece
HELO	Helicopter
HQ	Headquarters
HUMINT	Human Intelligence
HUN	Hungary
ICE	Information Content Element
ID	Identification; Identifier
IDEF	Integrated Computer-Aided Manufacturing (CAM) Definition (Language)
IDEF0	IDEF for Activity/Process Modelling
IDEF1X	IDEF for Data Modelling
IE	Inversion Entry
IEEE	Institute of Electrical and Electronic Engineers
IER	Information Exchange Requirement
IEW	Intelligence Electronic Warfare
IFF	Identification Friend/Foe
IMINT	Imagery Intelligence

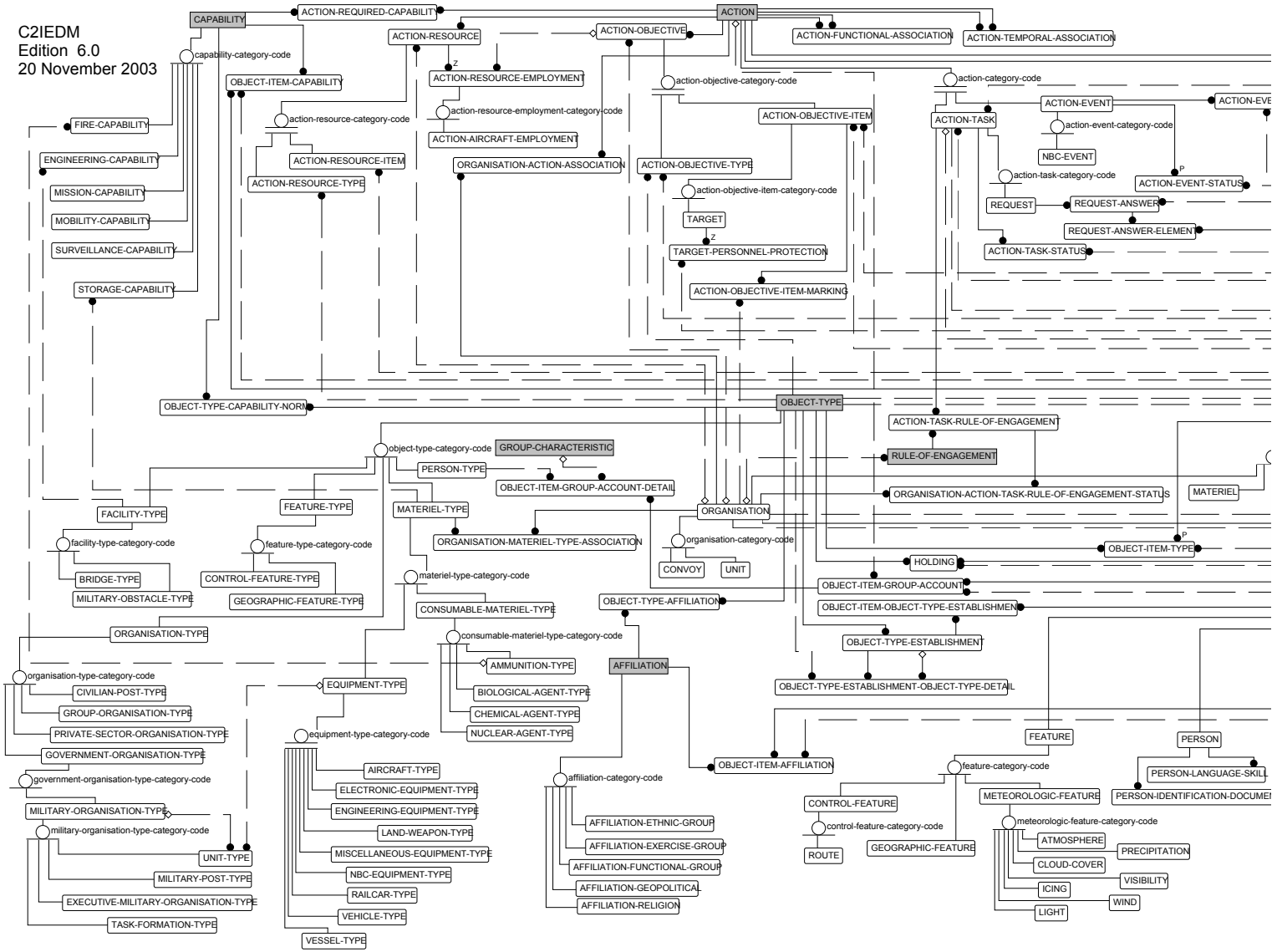
Inf, INF	Infantry
INTEL	Intelligence
INTSUM	Intelligence Summary
IRD	Information Resource Dictionary
ISO	International Standards Organisation
ITA	Italy
JCS	Joint Chiefs of Staff
JTF	Joint Task Force
K-Kill	Permanent Kill (“unserviceable” criterion)
LC2IEDM	Land C2 Information Exchange Data Model (former name of the C2IEDM)
LFRIL	Land Forces Reportable Item List (NATO)
LTU	Lithuania
M-Kill	Mobility Kill (criterion)
MAS	Military Agency for Standardisation
MBT	Main Battle Tank
MEM	Message Exchange Mechanism
MET	Meteorology, Meteorological
MIP	Multilateral Interoperability Programme
MIRD	MIP Information Resource Dictionary
MLC	Military Load Classification
MLRS	Multiple Launch Rocket System
MND	Multi-National Division
MOD	Ministry of Defence
MOPP	Military Oriented Protective Posture
MOOTW	Military Operations Other Than War
MSL	Mean Sea Level
MTF	Message Text Format, Medical Treatment Facility
MTIR	MIP Tactical C2IS Interoperability Requirement
NATO	North Atlantic Treaty Organisation
NBC	Nuclear, Biological and Chemical
NDAO	NATO Data Administration Office
NLD	The Netherlands
NOR	Norway
OOB	Order of Battle
OPCOMD	Operational Command
OPCON	Operational Control
OPFOR	Opposing Forces
OPLAN	Operational Plan
ORBAT	Order of Battle
POL	Poland, Petroleum, Oil, and Lubricant
POW	Prisoner of War
PRT	Portugal
PSO	Peace Support Operations
Ptn, PTN	Platoon
PSO	Peace Support Operations
PUB	Publication
RDBMS	Relational Database Management System

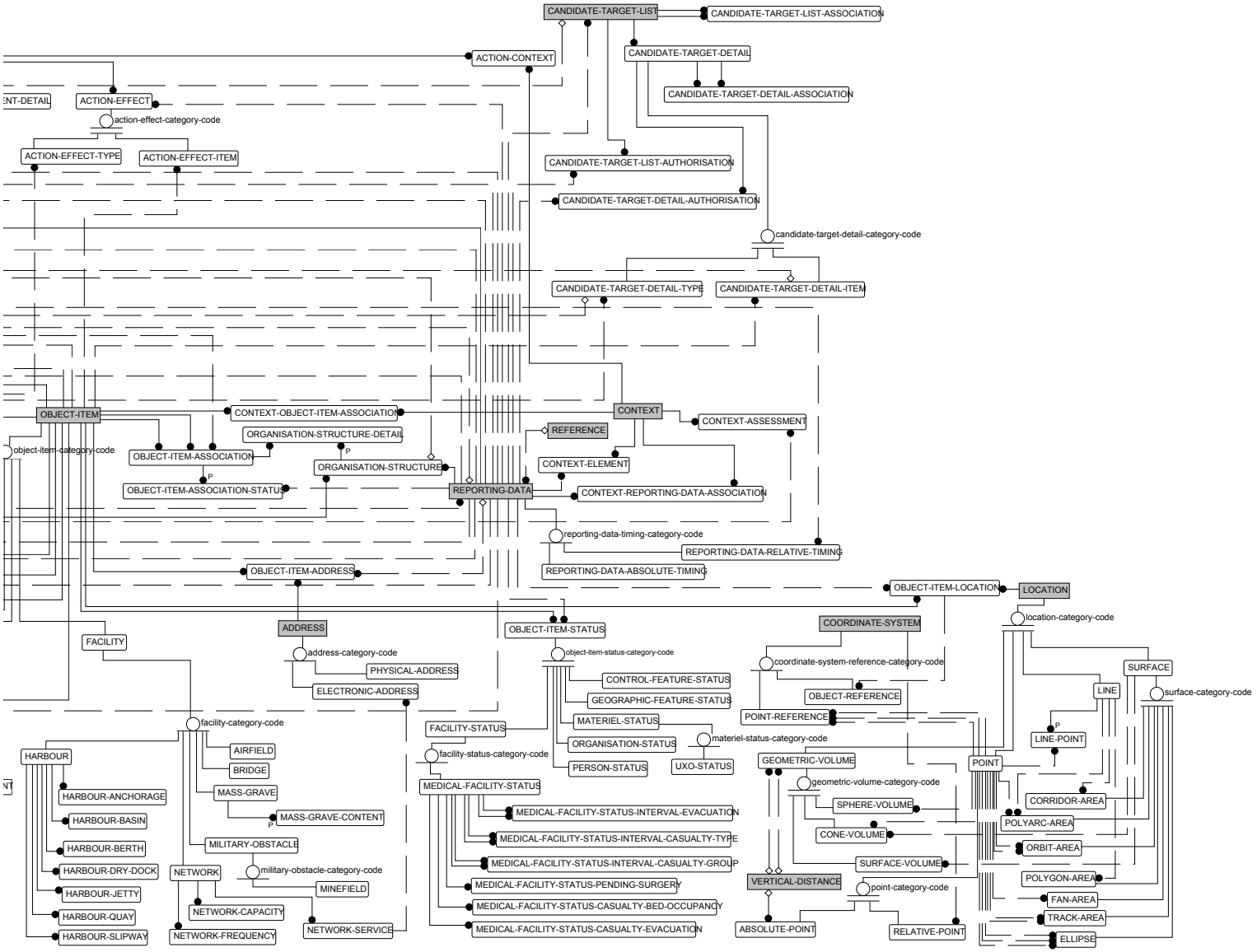
Recce	Reconnaissance
REF	Reference
Rgt, REGT	Regiment
Rh	Rhesus factor in blood typing
RHA	Royal Horse Artillery (GBR)
ROE	Rules of Engagement
RTR	The Royal Tank Regiment
SACEUR	Supreme Allied Commander Europe
SHAPE	Supreme Headquarters Allied Powers Europe
SHORAD	Short Range Air Defence
SIGINT	Signals Intelligence
SITREP	Situation Report
SOHB	Staff Office Handbook (GBR)
SQL	Standard Query Language (ISO)
Sqn	Squadron
STANAG	NATO Standardisation Agreement
Std	Standard
SWE	Sweden
TGT	Target
TOE	Table of Organisation and Equipment
TOO	Table of Organisation
TUR	Turkey
UAV	Unmanned Aerial Vehicle
UCADMIN	Under Command for Administration
UN	United Nations
USA	United States
UTO	Unit Task Organisation
UXO	Unexploded Ordnance
VMF	Variable Message Format
WGS-84	World Geodetic System (reference standard)
WP	Working Paper

ANNEX B MODEL VIEW AND IDEF1X METHODOLOGY

(This page intentionally left blank)

APPENDIX B-1 ENTITY LEVEL VIEW OF C2IEDM


C2IEDM
Edition 6.0
20 November 2003
CAPABILITY
ACTION-REQUIRED-CAPABILITY
ACTION
ACTION-RESOURCE
ACTION-OBJECTIVE
ACTION-FUNCTIONAL-ASSOCIATION
ACTION-TEMPORAL-ASSOCIATION
capability-category-code
OBJECT-ITEM-CAPABILITY
ACTION-RESOURCE-EMPLOYMENT
action-objective-category-code
action-category-code
ACTION-EVENT
FIRE-CAPABILITY
action-resource-category-code
action-resource-employment-category-code
ACTION-OBJECTIVE-ITEM
ACTION-TASK
action-event-category-code
ENGINEERING-CAPABILITY
ACTION-AIRCRAFT-EMPLOYMENT
NBC-EVENT
ACTION-RESOURCE-ITEM
ORGANISATION-ACTION-ASSOCIATION
ACTION-OBJECTIVE-TYPE
action-task-category-code
ACTION-EVENT-STATUS
MISSION-CAPABILITY
ACTION-RESOURCE-TYPE
action-objective-item-category-code
REQUEST
REQUEST-ANSWER
MOBILITY-CAPABILITY
TARGET
REQUEST-ANSWER-ELEMENT
SURVEILLANCE-CAPABILITY
TARGET-PERSONNEL-PROTECTION
ACTION-TASK-STATUS
STORAGE-CAPABILITY
ACTION-OBJECTIVE-ITEM-MARKING
OBJECT-TYPE-CAPABILITY-NORM
OBJECT-TYPE
ACTION-TASK-RULE-OF-ENGAGEMENT
object-type-category-code
GROUP-CHARACTERISTIC
RULE-OF-ENGAGEMENT
PERSON-TYPE
OBJECT-ITEM-GROUP-ACCOUNT-DETAIL
ORGANISATION-ACTION-TASK-RULE-OF-ENGAGEMENT-STATUS
MATERIEL
FACILITY-TYPE
FEATURE-TYPE
MATERIEL-TYPE
ORGANISATION
facility-type-category-code
feature-type-category-code
ORGANISATION-MATERIEL-TYPE-ASSOCIATION
organisation-category-code
OBJECT-ITEM-TYPE
HOLDING
BRIDGE-TYPE
CONTROL-FEATURE-TYPE
materiel-type-category-code
CONVOY
UNIT
OBJECT-ITEM-GROUP-ACCOUNT
MILITARY-OBSTACLE-TYPE
GEOGRAPHIC-FEATURE-TYPE
CONSUMABLE-MATERIEL-TYPE
OBJECT-TYPE-AFFILIATION
OBJECT-ITEM-OBJECT-TYPE-ESTABLISHMENT
ORGANISATION-TYPE
consumable-materiel-type-category-code
OBJECT-TYPE-ESTABLISHMENT
organisation-type-category-code
AMMUNITION-TYPE
AFFILIATION
EQUIPMENT-TYPE
OBJECT-TYPE-ESTABLISHMENT-OBJECT-TYPE-DETAIL
CIVILIAN-POST-TYPE
BIOLOGICAL-AGENT-TYPE
GROUP-ORGANISATION-TYPE
CHEMICAL-AGENT-TYPE
PRIVATE-SECTOR-ORGANISATION-TYPE
NUCLEAR-AGENT-TYPE
equipment-type-category-code
FEATURE
PERSON
GOVERNMENT-ORGANISATION-TYPE
OBJECT-ITEM-AFFILIATION
feature-category-code
PERSON-LANGUAGE-SKILL
government-organisation-type-category-code
AIRCRAFT-TYPE
affiliation-category-code
CONTROL-FEATURE
METEOROLOGIC-FEATURE
PERSON-IDENTIFICATION-DOCUME
MILITARY-ORGANISATION-TYPE
ELECTRONIC-EQUIPMENT-TYPE
AFFILIATION-ETHNIC-GROUP
control-feature-category-code
meteorologic-feature-category-code
military-organisation-type-category-code
ENGINEERING-EQUIPMENT-TYPE
AFFILIATION-EXERCISE-GROUP
ATMOSPHERE
LAND-WEAPON-TYPE
ROUTE
GEOGRAPHIC-FEATURE
PRECIPITATION
UNIT-TYPE
MISCELLANEOUS-EQUIPMENT-TYPE
AFFILIATION-FUNCTIONAL-GROUP
CLOUD-COVER
MILITARY-POST-TYPE
NBC-EQUIPMENT-TYPE
AFFILIATION-GEOPOLITICAL
VISIBILITY
EXECUTIVE-MILITARY-ORGANISATION-TYPE
RAILCAR-TYPE
ICING
AFFILIATION-RELIGION
WIND
TASK-FORMATION-TYPE
VEHICLE-TYPE
LIGHT
VESSEL-TYPE


CANDIDATE-TARGET-LIST
CANDIDATE-TARGET-LIST-ASSOCIATION
ACTION-CONTEXT
CANDIDATE-TARGET-DETAIL
CANDIDATE-TARGET-DETAIL-ASSOCIATION
ACTION-EFFECT
action-effect-category-code
ACTION-EFFECT-TYPE
ACTION-EFFECT-ITEM
CANDIDATE-TARGET-LIST-AUTHORISATION
CANDIDATE-TARGET-DETAIL-AUTHORISATION
candidate-target-detail-category-code
CANDIDATE-TARGET-DETAIL-TYPE
CANDIDATE-TARGET-DETAIL-ITEM
OBJECT-ITEM
CONTEXT-OBJECT-ITEM-ASSOCIATION
CONTEXT
CONTEXT-ASSESSMENT
ORGANISATION-STRUCTURE-DETAIL
REFERENCE
object-item-category-code
OBJECT-ITEM-ASSOCIATION
ORGANISATION-STRUCTURE
CONTEXT-ELEMENT
OBJECT-ITEM-ASSOCIATION-STATUS
REPORTING-DATA
CONTEXT-REPORTING-DATA-ASSOCIATION
reporting-data-timing-category-code
REPORTING-DATA-RELATIVE-TIMING
REPORTING-DATA-ABSOLUTE-TIMING
OBJECT-ITEM-ADDRESS
OBJECT-ITEM-LOCATION
LOCATION
location-category-code
ADDRESS
OBJECT-ITEM-STATUS
COORDINATE-SYSTEM
FACILITY
address-category-code
object-item-status-category-code
coordinate-system-reference-category-code
SURFACE
PHYSICAL-ADDRESS
CONTROL-FEATURE-STATUS
LINE
surface-category-code
OBJECT-REFERENCE
GEOGRAPHIC-FEATURE-STATUS
ELECTRONIC-ADDRESS
POINT-REFERENCE
MATERIEL-STATUS
LINE-POINT
facility-category-code
FACILITY-STATUS
ORGANISATION-STATUS
materiel-status-category-code
GEOMETRIC-VOLUME
POINT
HARBOUR
AIRFIELD
facility-status-category-code
PERSON-STATUS
UXO-STATUS
BRIDGE
geometric-volume-category-code
HARBOUR-ANCHORAGE
MASS-GRAVE
MEDICAL-FACILITY-STATUS
SPHERE-VOLUME
CORRIDOR-AREA
HARBOUR-BASIN
MASS-GRAVE-CONTENT
MEDICAL-FACILITY-STATUS-INTERVAL-EVACUATION
POLYARC-AREA
HARBOUR-BERTH
MILITARY-OBSTACLE
MEDICAL-FACILITY-STATUS-INTERVAL-CASUALTY-TYPE
CONE-VOLUME
ORBIT-AREA
HARBOUR-DRY-DOCK
NETWORK
military-obstacle-category-code
MEDICAL-FACILITY-STATUS-INTERVAL-CASUALTY-GROUP
SURFACE-VOLUME
POLYGON-AREA
HARBOUR-JETTY
MINEFIELD
MEDICAL-FACILITY-STATUS-PENDING-SURGERY
VERTICAL-DISTANCE
point-category-code
FAN-AREA
HARBOUR-QUAY
NETWORK-CAPACITY
MEDICAL-FACILITY-STATUS-CASUALTY-BED-OCCUPANCY
TRACK-AREA
HARBOUR-SLIPWAY
NETWORK-FREQUENCY
NETWORK-SERVICE
MEDICAL-FACILITY-STATUS-CASUALTY-EVACUATION
ABSOLUTE-POINT
RELATIVE-POINT
ELLIPSE

(This page intentionally left blank)

APPENDIX B-2 SUMMARY OF IDEF1X METHODOLOGY AND NOTATION

B-2.1 Introduction

B-2.1.1 Whenever data structures and business rules required to support a business area need to be specified, it is convenient to build a so-called data model in order to capture that information. A data model is, therefore, a description of the organisation of data in a manner that reflects the information structure of an enterprise. It encompasses the entity definitions, relationships, and the integrity constraints through which the information created and used by the functional activity is managed, and from which standard data are created.

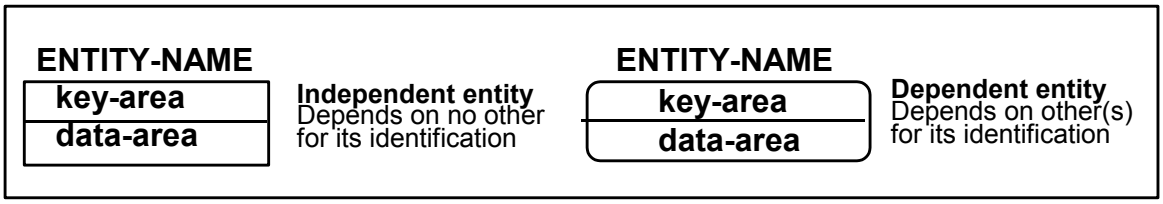
B-2.1.2 Having identified what a data model is, one still needs a structured syntax to begin expressing the information structure of the business. IDEF1X, a methodology created to help design data, provides such a structured environment, with special focus on relational constructs.

B-2.1.3 The following sections provide a brief description of the IDEF1X syntax as discussed in Thomas A. Bruce's book *Designing Quality Databases with IDEF1X Information Models* [Bruce 1992a].

B-2.2 Entities and Attributes

B-2.2.1 An entity is anything about which information is stored in a data base. In a conceptual schema language, it is any concrete or abstract thing of interest, including associations among things.

B-2.2.2 IDEF1X distinguishes between independent and dependent entities. Figure K-1 shows the symbols associated with independent and dependent entities. The kind of information stored in the database is, loosely speaking, the attributes or properties which describe the entity. For instance, if PERSON is an entity in a given data model, then person-name, person-social-security-number, person-address, etc., may all be properties or attributes of that entity for the purposes of that enterprise. Attributes are divided into key-attributes and non-key-attributes, i.e., those used to uniquely identify the entity and those properties of the entity not used for that purpose.



Note: The area above the line is reserved for the identifying keys.

Figure B-1. IDEF1X Symbols for Independent and Dependent Entities

B-2.2.3 The IDEF1X syntax further categorises attributes according to its diverse uses in either the key-area or the data area of the entity. Table B-1 summarises these different usages.

Table B-1. IDEF1X Attribute Notation

attribute (FK)	**Foreign Key** Primary key of another entity contributed by a relationship
role.name.attribute (FK)	**Role Name** New name for a foreign key connoting its use.
attribute (AKn)	**Alternate Key** Alternate unique identifier of the entity
attribute (IEn)	**Inversion Entry** Non-unique access identifier of the entity
group.(c1,c2,c3)	**Group Attribute** Attribute is a group containing the listed constituents.
attribute(fk1,fk2,fk3)(FK)	**Unified Foreign Key** Listed foreign keys are unified to a single foreign key attribute

B-2.3 Category Notation

B-2.3.1 A data model may contain a series of entities that share one or more attributes. IDEF1X provides a method for aggregating these common attributes into a base entity, while retaining the subtypes with their unique properties. This avoids unnecessary duplication of attributes and helps with the book-keeping of the model.

B-2.3.2 Figure B-2 shows the two types of category supported by IDEF1X. If the listing of the subtypes is exhaustive, the category is complete and the double line is used to indicate this fact. If the subtypes depicted are only a fraction of the complete set then the category is incomplete and only one line is used in the symbol. The subtypes of the generic parent inherit all the attributes of that parent, but are not limited to spawning their own unique relationships and subtypes if necessary.

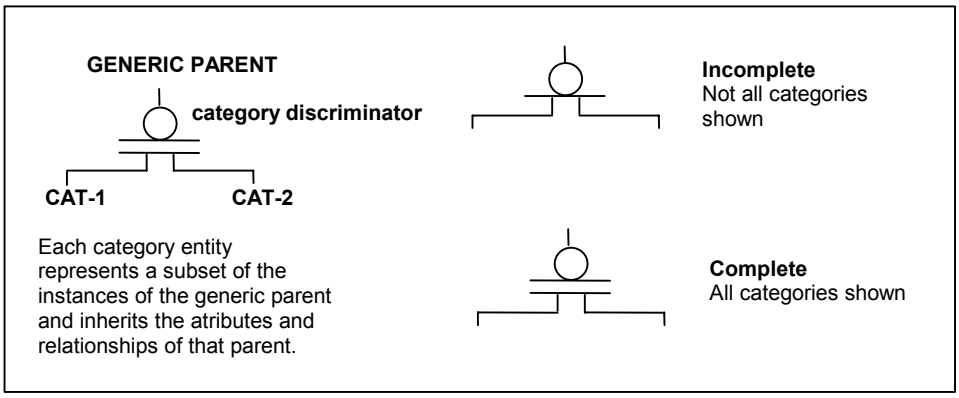


Figure B-2. IDEF1X Syntax for Entity Categories

B-2.4 Relationship Notation

IDEF1X allows three main types of relationship, namely, identifying relationships, non-identifying relationships and non-specific relationships. (See Figure B-3.)

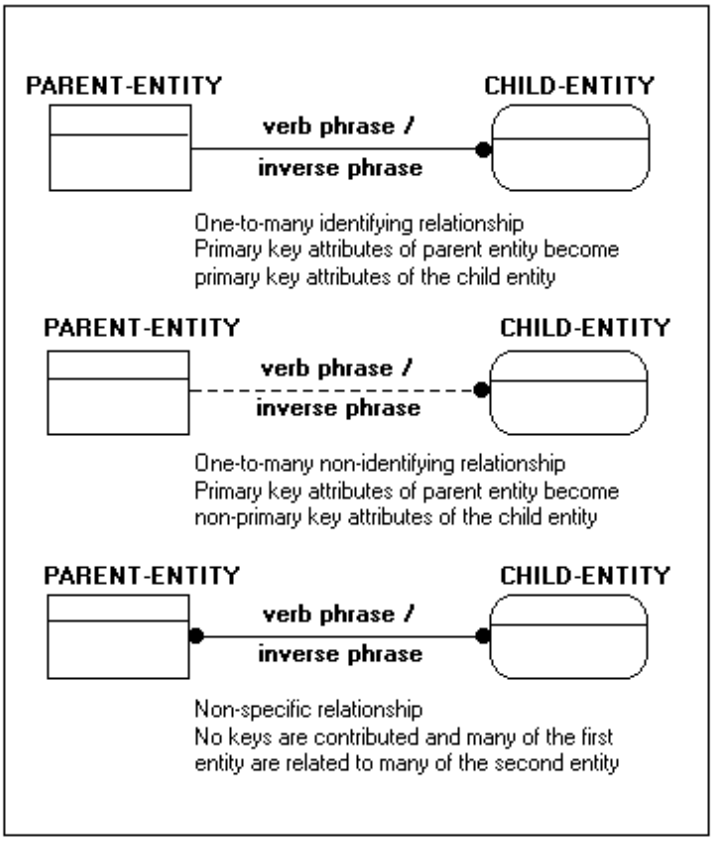


Figure B-3. IDEF1X Relationship Notation

B-2.5 Cardinality Notation

A further aspect of a relationship is its cardinality. The first two relationships shown in Figure B-3 (above) were one-to-many, that is, where at least one parent entity has zero or more child entities associated to it. There are, however, situations in which zero or one parent entity may have zero or more child entities associated to it, or where it is guaranteed that there is either at least one parent or one child present in the relationship in combination with zero or more of the other kind. Figure B-4 depicts all these combinations diagrammatically.

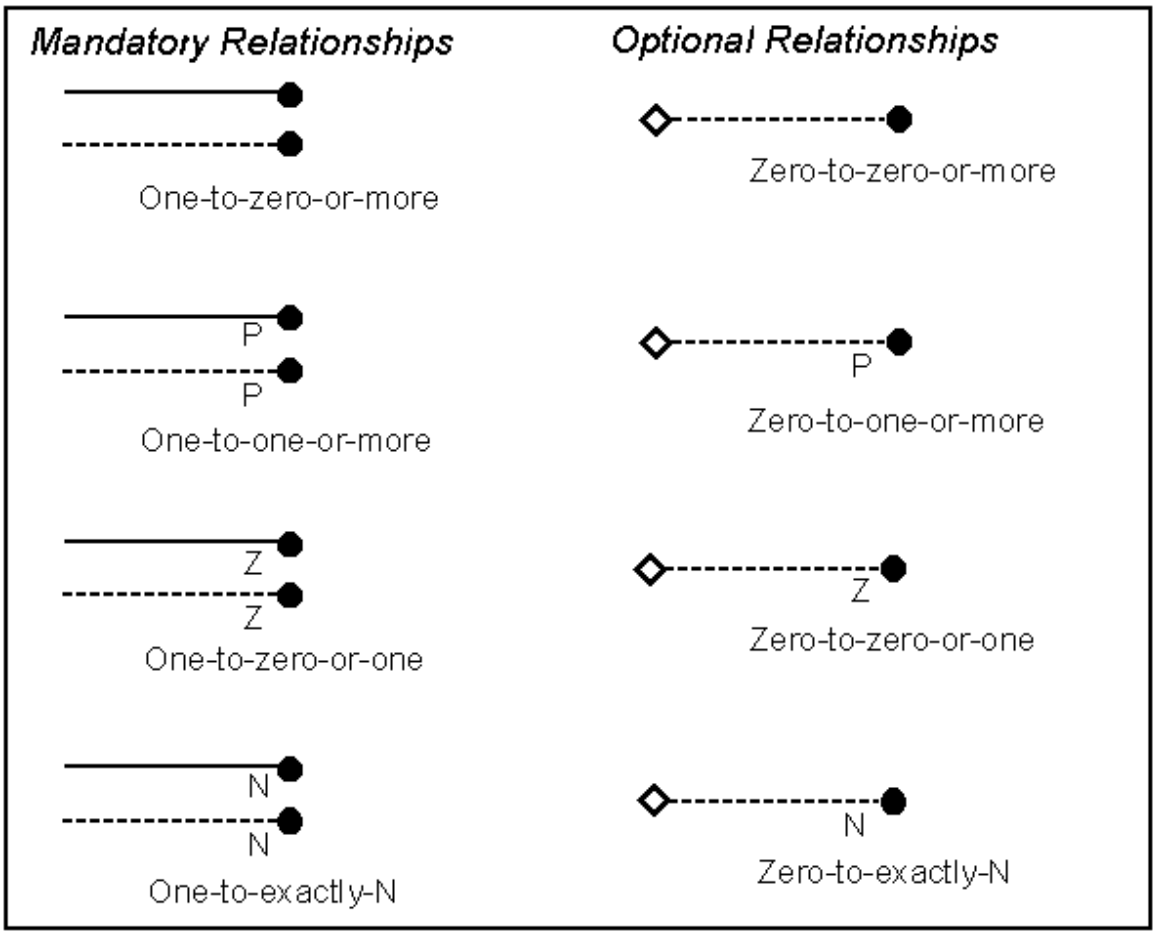


Figure B-4. IDEF1X Cardinality Notation

ANNEX C REFERENCES

AAP-6 (V) 1998	*NATO Glossary of Terms and Definitions,* AAP-6(V),NATO Military Agency for Standardisation, September 1998, NATO UNCLASSIFIED.
ACCS 1995a	NACMA Working Paper *Volume 1 ACCS Conceptual Data Model,* Version 1.8, SHAPE Technical Centre, The Hague, The Netherlands, 23 June 1994 (made available to ATCCIS on 21 March 1995) NATO UNCLASSIFIED.
ACCS 1995b	NACMA Working Paper *Volume 2 ACCS Conceptual Data Model Data Dictionary,* Version 1.6, SHAPE Technical Centre, The Hague, The Netherlands, 23 June 1994 (made available to ATCCIS on 21 March 1995) NATO UNCLASSIFIED.
ACE Directive 80-50	*Operational Information Exchange System – General Instructions*, *Volume 1*, SHAPE, 30 November 1992, NATO UNCLASSIFIED
ADatP-3 1999	*ADatP-3 Baseline 11.0.1 (CD-ROM)*, HQ NATO C3S-IOB, Brussels, Belgium, 1 July 1999, NATO UNCLASSIFIED.
AFATDS IRS 1992	*Interface Requirements Specification for the AFATDS Version 1,* ACCS-A2-204-010C, US Army Communications and Electronics Command, 18 December 1992, UNCLASSIFIED.
AIntP-3 1994	AIntP-3, *Military Intelligence Data Management and Exchange Concept*, October 1994, NATO UNCLASSIFIED: Volume 1, *Military Intelligence Data Management and Exchange Concept* Volume 2, *Data Dictionary.*
APP-6 1990	*Military Symbols for Land-Based Systems*, APP-6, Military Agency for Standardisation (MAS), 19 November 1984, NATO UNCLASSIFIED (with change pages dated June 1988 and May 1990).
APP-6A 1997	*Military Symbols for Land-Based Systems*, APP-6A, Military Agency for Standardisation (MAS), 1 September 1997, NATO UNCLASSIFIED.
APP-9 1997	*A Compendium of Allied Land Forces Messages (Change 1) (CD-ROM),* 1997*,* NATO UNCLASSIFIED
ATCCIS WP ADatP-32 2000	ADatP-32, T*he Land C2 Information Exchange Data Model*, Edition 2.0, 31 March 2000, ATCCIS WG, SHAPE, Belgium (NU). **NOTE: This paper was published with the intent of making it a draft ADatP-32.**
ATCCIS WP 3-1 2002	ATCCIS WP 3-1, *Data Naming Procedures for the ATCCIS Data Model,* Edition 5.0, 18 March 2002, ATCCIS PWG, NATO UNCLASSIFIED.
ATCCIS WP 3-5 1997	ATCCIS Working Paper 3-5, ATCCIS Data Management, Draft Edition 1.0, 19 September 1997, ATCCIS PWG, SHAPE, Belgium (NU)
ATCCIS WP 3-6 2002	ATCCIS Working Paper 3-6, ATCCIS Key Management – A Strategy for the Generation of Unique Keys, Edition 5.0, 18 March 2002, ATCCIS PWG, SHAPE, Belgium (NU)
ATCCIS WP 4-1 2002	ATCCIS WP 4-1, *ATCCIS Information Resource Dictionary (AIRD)—Definition of Structure and Contents,* Edition 5.0, 18 March 2002, ATCCIS PWG, NATO UNCLASSIFIED.
ATCCIS WP 4-2 1994	ATCCIS WP 4-2, AIRD Management Procedures, Edition 2.0, 2 June 1995, ATCCIS PWG, NATO UNCLASSIFIED.
ATCCIS WP 5-5 2002	ATCCIS Working Paper 5-5, THE LAND C2 INFORMATION EXCHANGE DATA MODEL, Edition 5.0, 18 March 2002,, ATCCIS WG, SHAPE, Belgium (NU)
ATCCIS WP 7L, 1989	ATCCIS WP 7L, *Operational and Procedural Requirements for Data Management and Standardization,* Edition 1, June 1989, ATCCIS PWG, NATO UNCLASSIFIED.
ATCCIS WP 7N 1990	ATCCIS WP 7N, *Standardization of Data for Interoperability,* Edition 1, September 1990, ATCCIS PWG, NATO UNCLASSIFIED.

ATCCIS WP 10 1990	ATCCIS WP 10, *Information Flow Requirements and Products for Each Key Task,* Edition 2, September 1990, ATCCIS PWG, NATO UNCLASSIFIED.
ATCCIS WP 14, 1990	ATCCIS WP 14, *Information Exchange Requirements Between Headquarters,* Edition 2, September 1990, ATCCIS PWG, NATO UNCLASSIFIED.
ATCCIS WP 25 1994	ATCCIS WP 25, *Technical Standards for Command and Control Information Systems (CCISs) and Information Technology,* February 1994, ATCCIS PWG, NATO UNCLASSIFIED.
ATP-27(B) 1993	*Offensive Air Operations* – ATP-27(B) (STANAG 3736), NATO UNRESTRICTED, 18 November 1993.
ATP-27(C) 1999	*Air Interdiction and Close Air Support* – ATP-27(C) (STANAG 3736), NATO UNCLASSIFIED, June 1999.
ATP-35A 1995	*Land Force Tactical Doctrine,* ATP-35(A) (STANAG 2868, Edition 4.0), Military Agency for Standardization, December 1995, NATO UNCLASSIFIED.
ATP - 45 (B)	*Reporting Nuclear Detonations, Biological And Chemical Attacks, and Predicting and Warning Of Associated Hazards And Hazard Areas (Operators Manual),* ATP-45(B) (STANAG 2103, Edition 8.0) NATO, NATO UNCLASSIFIED
BI-MNC Reporting Directive	*Operations/Situations Reports, Volume III*, SHAPE, 1 August 1997, NATO UNCLASSIFIED/PfP Releasable
Bruce 1992a	*Designing Quality Databases with IDEF1X Information Models,* Thomas A. Bruce, Dorset House Publishing, 1992, UNCLASSIFIED.
C-M(55) 15	*C-M(55) 15 FINAL, Security within the North Atlantic Treaty Organisation, Inclosure C, Section 2,* 15 Oct 97 Issue 3 NATO UNCLASSIFIED
DIGEST 1994	*Digital Geographic Information Exchange Standard (DIGEST), Edition 1.2, Volumes 1-4, January 1994, NATO UNCLASSIFIED.*
DIS 10032 1991	DIS 10032, *Information Technology - Reference Model on Data Management,* International Organisation for Standardization (ISO) and International Electrotechnical Commission (IEC), 13 May 1991, UNCLASSIFIED.
FACC 1994	*Part 4 Feature and Attribute Coding Catalog (FACC), Digital Geographic Information Exchange Standard (DIGEST),* Edition 1.2, Defense Mapping Agency, January 1994
FIPS PUB 183 1993	*Integration Definition for Function Modeling (IDEF0),* FIPS Pub 183, December 1993, National Institute of Standards and Technology.
FIPS PUB 184 1993	*Integration Definition for Information Modeling (IDEF1X),* FIPS Pub 184, December 1993, National Institute of Standards and Technology.
ISO/IEC 9075 1992	ISO/IEC 9075:1992, Database Language SQL
ISO 3166-1	ISO 3166-1: 1997, Codes for the representation of Names of Countries and their Subdivisions – Part1: Country codes
Joint Pub 1-02 1998	*Department of Defense Dictionary of Military and Associated Terms (Includes US Acronyms and Abbreviations and NATO Terms (English Only)),* Joint Publication Number 1-02, Joint Chiefs of Staff, May 1998, UNCLASSIFIED.
Military Standard 6040 2001	USMTF: *U.S. Message Text Formatting Program,* Military Standard 6040, DISA/JIEO, 31 March 2001, RESTRICTED USE.
MIP MIRD 2003	MIP MIRD, *MIP Information Resource Dictionary*, Edition 6.0, 20 November 2003 MIP PMG, NATO UNCLASSIFIED
MIP MTIR	MIP MTIR, *MIP Tactical C2IS Interoperability Requirement*, Draft, June 2003 MIP PMG, NATO UNCLASSIFIED

MIP WP 3-13 2003	MIP WP 3-13, *Guide To Change Proposals For MIP Data Specifications*, Edition 6.0, 20 November 2003 MIP PMG, NATO UNCLASSIFIED.
MIP WP 5-7 2003	MIP WP 5-7, *Overview of The C2 Information Exchange Data Model (C2IEDM)*, Edition 6.0, 20 November 2003 MIP PMG, NATO UNCLASSIFIED.
MIP WP 5-14 2003	MIP WP 5-14, *Management Process For Data Specification Against Requirements*, Edition 6.0, 20 November 2003 MIP PMG, NATO UNCLASSIFIED.
NATO Reference Model	*NATO Reference Model*, Version 3.0, NATO Data Administration Office (NDAO), NATO UNCLASSIFIED, March 2003
Oxford English Dictionary 1999	*Oxford English Dictionary, Second Edition, 1999* Oxford University Press, 1999.
STANAG 1241	STANAG 1241: *NATO Standard Identity Description Structure for Tactical Use*, NATO RESTRICTED, 16 October 1996.
STANAG 2014	STANAG 2014. *Warning Orders, Operation Orders and Administrative/Service Support Orders*, (Edition 8), NATO UNCLASSIFIED, October 1997
STANAG 2021	STANAG 2021: *Military computation of Bridge, Ferry, Raft and Vehicle Classifications*, NATO UNRESTRICTED, 18 August 1990.
STANAG 2116	STANAG 2116: *NATO Codes for Grades of Military Personnel*, NATO UNRESTRICTED, 13 March 1996.
STANAG 2356	STANAG 2356: *Comparative Formation Unit Designations*, NATO UNRESTRICTED, 21 March 1991.
STANAG 5620 ND	STANAG 5620: *Standards for the Interoperability of Fire Support ADP Systems,* Part II, Annex E, *ADatP-3 Formats,* (27 Mar 1987) NATO UNCLASSIFIED.
US AR 310-25 1986	US Army Regulation 310-25, *Dictionary of United States Army Terms*, Headquarters Department of the Army, 21 May 1986.
US FM 101-10-1/1 1987	US Army Field Manual 101-10-1/1, *Staff Officers' Field Manual Volume 1: Organizational, Technical, and Logistical Data*, Headquarters Department of the Army, October 1987.
US FM 101-10-1/2 1987	US Army Field Manual 101-10-1/2, *Staff Officers' Field Manual Volume 2: Organizational, Technical, and Logistical Data Planning Factors*, Headquarters Department of the Army, October 1987.
US TB 55-46-1 1991	US Army Technical Bulletin 55-46-1, *Standard Characteristics (Dimensions, Weight, and Cube) for Transportability of Military Vehicles and Other Outsize/Overweight Equipment*, Department of the Army, 1 January 1991.

(This page intentionally left blank)