Some CMMS Concepts

This is an attempt to identify the principal elements of CMMS, interfaces from CMMS to non-CMMS elements, and the major components of CMMS structure. This doesn't address everything about CMMS, but the hope is that it will provide a comprehensive overview of CMMS architecture, including external appearance and internal structure. Some C2 Core Data Model definitions have been included for comparison in "".

1 Introduction

We present a set of concepts that we hope can be extended to be comprehensive: These concepts follow:

- Multiple views of CMMS – Data capture, Data Interchange Format, Common Library, Data model, and Reports (complete and incomplete sets).
- Knowledge element decomposition – Unique syntax between elements, normalization of elements, relationships between elements; and unique semantics between elements.
- Two types of knowledge – universal data elements, simulation specific configuration units
- Activity descriptions, multiple elements contribute different knowledge representation capabilities -- verbs, actions, processes, missions, tasks, use cases, and interactions.
- Battlefield entity descriptions consider different types of associations for different categories of entities -- agent, organization, person, equipment, materiel, facility, feature, network, information.
- Information descriptions describe different aspects of information on the battlefield, for example, perception versus ground truth, data sent versus data received.

2 Multiple Views of CMMS

2.1 Data Capture View

The objectives of the data capture view are straightforward, provide a means for a knowledge capture team of one or more qualified personnel to capture all relevant information about the mission space, according to their assigned scope, fidelity, and resolution. A data capture view is a complete view in that all elements of CMMS should be accessible, even though in a particular body of knowledge captured, all elements may not be used. Note that while a relational database requires a context-free information representation, implicit ordering and hierarchy are permissible and even desirable in a data capture view. For example, all metadata can be captured early on, and is considered applicable to all data entered, unless the metadata is changed. Hence, one metadata entry may apply to hundreds of mission space data entries. Similarly, the name space does not need to be singular for the same reason: uniqueness can be supplied by context, explicit data structure is not (always) required.

2.2 Data Interchange Format View

The constraints and objectives of a data interchange format are similar in many ways to those of a data capture view. For example, context may be used to define relationships between data elements. Configuration unit metadata (sponsor, V&V, etc.) may be defined at the beginning of a file, and applies to all knowledge elements thereafter, until new metadata is provided.

2.3 Common Library View

Assuming that a relational database is the implementation vehicle for a common library, the common library must not only be complete, but must also be context-free. No implicit relationships because of precedence or proximity exist in a relational database, so all relationships between data entities must be defined directly by foreign keys, or indirectly by link tables. The common library must not only be complete, but also must be context-free. Furthermore, the name space of the common library must be universal, although compound names using common prefixes and suffixes can be used, provided that each prefix/suffix combination is unique.

2.4 Data Model View

Since the data model must effectively be the superset of all of the above, it must, like the common library, be complete, context-free, and have a single name space.

2.5 Reports View

Specific sets of reports may be complete or not, depending on the user's purpose. These vary depending upon the type of user.

2.5.1 Complete Report Set

Reports can almost be defined as incomplete if the data space is complex, because any report which attempts to be exhaustive will most likely be incomprehensible. However, the concept of a complete set of reports is of value. For example the set of reports representing a V&V view must be complete; else, the V&V cannot be all-inclusive.

2.5.2 Incomplete Report Set

For some purposes, an incomplete report set may be appropriate. For example, an exercise controller may know what entities must appear in his battlespace, and what processes must be executed in his battlespace. In such a situation he may be disinterested in individual task assignments.

3 Knowledge Element Decomposition

A critical issue with the following knowledge element decompositions is that they may not be uniformly applicable to the views described above.

3.1 Unique Syntax Between Elements

This is the most common reason for having multiple knowledge elements: The knowledge elements clearly have significant differences.

3.2 Normalization of elements

When it becomes clear that a knowledge element applies to groups of knowledge elements, rather than individual elements; for example, all companies of a battalion belong to the same brigade. Therefore, brigade membership does not need to be specified for each company, only for each battalion.

3.3 Unique Relationships Between Elements

Elements are differentiated in order to facilitate enforcement of common syntax and semantics; for example, a howitzer shell cannot close on an enemy position, a bridge cannot be refueled.

3.4 Unique Semantics Between Elements.

In some cases, elements are differentiated in order to clarify the semantics for a user; for example, a perception may affect an estimate prepared by a commander. The estimate, in turn, may affect the perception of a commander receiving the estimate. Even though the estimate and the perception may share the same data structure, their semantics are not the same. Ground truth may also share the data structure, while subject to still another set of semantics.

4 Knowledge Types

4.1 Universal Data Elements

These are standards, which are considered essential for clear communication of conceptual models. These are the CMMS bedrock of Common Semantics and Syntax. Included within this division are Entities, Attributes (of Entities), Verbs, and Actions.

4.2 Simulation-Specific Configuration Units

Although all CMMS is intended to be implementation independent, this is the area in which the CMMS created is expected to be dependent upon simulation scope, fidelity, and resolution, as to what knowledge is actually

collected. An important set of parameters for a configuration unit are its defined fidelity and resolution. Scope is implicit for a configuration unit in the light of entities and processes included.

5 Activity Descriptions

5.1 Data Dictionary Elements

5.1.1 Verbs

Verbs are the most basic activity descriptors. They are one of the basic elements of military language. Because of the atomicity of verbs, they often have multiple descriptions and synonyms. Verb taxonomies provided an implicit specialization/generalization hierarchy.

5.1.2 Actions

Actions are a basic activity description, based on verbs and modified by subjects and objects so that the ideal of one semantic, one representation may be achieved. An action is a verb with enough context added so that the action expression is unique and context-free. Still, an action is primarily directed toward two objectives: using common military idiom, and providing unique activity identifiers. “An activity.”

5.2 Configuration Unit Items

5.2.1 Processes

A generic description of an activity, based on an action, but with descriptive content specific to a set of one or more task performers.

5.2.2 Missions

A set of processes organized into a sequence so as to potentially accomplish one or more objectives.

5.2.3 Tasks

A process made specific to a collaboration of one or more task performers and a set of use case conditions and measures of performance.

5.2.4 Use Cases

While Verbs, Actions, Processes, and Tasks may be thought of as forming a continuum, Use Cases are somewhat in a different continuum with Missions and Use Case Instances. A use case defines a stimulating event, a set of conditions and measures of performance and a sequence of tasks executed to obtain one or more objectives.

5.2.5 Use Case Instances (Scenarios, Threads)

Use Case Instances take a use case and apply a specific condition values and standards. Although not an essential part of a CMMS Configuration Unit, they may supply invaluable context information for complex activity descriptions. They represent the ultimate specification of the mission/use case continuum.

5.2.6 Interactions

Although interactions may be considered only implicit with respect to activity; nevertheless, they are an important part of well-formed activity description. Corresponding to process inputs and outputs, they specify within a use case, from what task(s) the inputs to a task are coming and to what task(s) the outputs are going. In this way, they guarantee that both sides of each stipulated transfer are present in a specification.

6 Entity Descriptions

6.1 Agent Entities

An entity capable of performing activities of military significance alone or in collaboration with other agent entities.

6.1.1 Organization

A group of people and/or organizations with the capability of performing military missions, or with the capability of performing activities of military significance. “An administrative structure with a mission.”

6.1.2 Person

An individual belonging to a military organization, or capable of performing tasks of military significance. “A human being.”

6.1.3 Equipment

A device capable of performing activities of military significance, e.g., main battle tank, radio, automobile.

6.2 Non-Agent Entities

An entity incapable of performing activities of military significance alone or in collaboration with other entities.

6.2.1 Materiel

In general, consumable items of military significance, e.g., ammunition, food, fuel. Note that a guided missile would be considered equipment, because of its volitional nature. “An item necessary to equip, operate, maintain, and support military activities without distinction as to its application of administrative or combat purposes.” (includes equipment).

6.2.2 Feature

A natural element of military significance, e.g., tree, lake, mountain. “A set of characteristics, structures, or other entities associated with a geographic location.”

6.2.3 Facility

An artificial element of military significance, e.g., fortification, bridge, road. “Real property, having a specified use, that is built or maintained by people.” “Physical property having a specified use consisting of one or more of the following: a structure, a utility system, or a roadway.”

6.2.4 Network

A logical combination of communications equipment, C4I equipment, and usage by member organizations to provide a functional communications capability.

6.2.5 Information Item

Tangible or non-tangible elements of data or knowledge, e.g., perception, message, order, assessment.

7 Information Item

7.1 Ground Truth

The aspect of the simulation representing the actual situation, including all relevent information maintained by the simulation. The stealth view in which all information is 100% accurate.

7.2 Perception

A view of the simulation representing the information acquired by a commander or a collaboration, subject to incompleteness because of non-relevance or having not requested or received relevant information, and subject to corruption because of disinformation or partial communication failure. May represent a commander's view or may represent an organization's situation board.

7.3 Assessment

An evaluation representing current perception of a situation or set of situational variables, e.g., opposing force capability to conduct war, own force capability to conduct war. Would include

7.4 Order

Direction to one or more organizations and/or persons to engage in a specific activity or set of activities. "… a request requiring performance."

7.4.1 Operation Order

"A directive issued by a commander to subordinate commander(s) for the purpose of effecting the coordinated execution of an operation."

7.5 Plan

A proposed set of future activities. "A scheme for achieving an end over time." Does not become an activity until an order to execute the plan is given.

7.6 Guidance

This is the category representing commander's guidance regarding conduct of military operations. It differs from an order in that it is more general in application. For example, commander's guidance to a fire support unit might be to give priority to armored vehicles as targets, while an order would encompass elements, such as providing fire support to a specific unit, or providing fire to a specific target. "A statement of direction."

7.7 Query

A request communicated between a person or organization and (another) person organization. This and the next element are intended to represent messages not falling into the previous information categories.

7.8 Response

A simple reply to another message between a person or organization and (another) person or organization. This could be an acknowledgment of receipt of an assessment or an order.