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Title: The Formal Representation of Joint Operational Relationships

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I-162 – The Formal Representation of Joint Operational Relationships

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Abstract

A primary impetus of the Global Force Management Data Initiative (GFM DI)[1] is the establishment of a transparent and universal process to manage, assess and display the world-wide disposition of US forces including availability, readiness and capability in a variable scale and/or time continuum(s). Documenting each organizational node and the multiple relationships that exist between nodes within each organization to support the force assignment, allocation, and apportionment processes is the foundation for formal expression that can be manipulated by machines. This process will enable insight into global availability of US forces and provide a means to assess risks associated with proposed allocation, assignment and apportionment options. A major task of this endeavor is the creation of joint hierarchical force structure data for every DoD organization for integration throughout the Department and across Service lines. This objective became complex as historically accepted, but informally defined, relationships associated with the assignment, allocation and apportionment processes began to be used in formal representations and manipulated by computer programs. Interactions of terms used to define relationships such as Administrative Control, Operational Control, and Combatant Command were left open to interpretation by the individual user's experience and the design of the application chosen to represent them. The variance in Service systems and use of multiple applications clouded their meaning. Even simple questions on their meaning turn into debate; for example: "can an organization have more than one simultaneous relationship of the same type?" This paper addresses this and related issues to help define operational relationships by providing recommended, definitive Joint semantics.

1. Background and Assignment of Forces

The GFM DI has two major objectives. The first is to address the fundamental technological and policy issues that hinder the production of formally represented force structure data in a form conducive to machine manipulation. The second is to expose and eliminate obstructions that

1 The GFM DI is a project operated under the auspices of the GFM Community of Interest (COI). The GFM-COI was established in the summer of 2003 by the Joint Staff, Force Structure, Resources, and Assessment Directorate (J-8) and the Office of the Under-Secretary of Defense for Personnel and Readiness (USD(P&R)). COIs are described in the *Department of Defense Net-Centric Data Strategy*, 9 May 2003; see: http://www.defenselink.mil/nii/org/cio/doc/Net-Centric-Data-Strategy-2003-05-092.pdf

prevent this data from being readily available to a diverse set of users via a single authoritative data source called an organization server (OS). The GFM Team developed a prototype using a set of force structure data "slices," one from each Service's existing program(s) of record, to demonstrate the viability and utility of this process.

A major task of the GFM DI is the creation of Service, Joint, and Office of the Secretary of Defense (OSD) organization servers that contain hierarchical force structure data in joint terms for integration across Service lines. In 2006, this became an official DOD requirement via a DOD Instruction entitled: *Organizational and Force Structure Construct (OFSC) for Global Force Management (GFM)*[2] and requires that force structure data be formally documented using unambiguous joint semantics so that sophisticated computer programs can economically exploit the data without compromising its integrity. The formal joint semantics to accomplish this are described in the Organizational and Force Structure Construct (OFSC).[3]

The OFSC builds upon the foundation provided by the Joint Pub 0-2 (JP 0-2) entitled *Unified Action Armed Forces (UNAAF).*[4] This document is the definitive starting point for defining joint command relationships. Within this document two important definitions are used in concert with the joint processes of assignment and allocation of forces.

Assigned Forces: Those forces and resources that have been placed under the Combatant Command (Command Authority) of a Unified Commander by the direction of the Secretary in his "Forces for Unified Commands Memorandum" IAW [Title] 10 USC [Section] 162. Forces and resources so assigned are available for normal peacetime operations of that command.[5]

Allocated Forces: Those forces and resources provided by the President or Secretary for execution planning or actual implementation. [6]

The formal semantics of assigned forces, or assignment, was provided in a paper presented last year at the 11th ICCRTS.[7] The remaining part of this section summarizes those results to serve as a foundation so that allocation of forces and other operational relationship can be described. A key tenet of these semantics is concisely described under the description of *Unity of Command* in JP 0-2:

Unity of Command. Unity of command means all forces operate under a single commander with the requisite authority to direct all forces employed in pursuit of a common purpose. It is the

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2 DODI 8260.03, dated 23 August 2006, signed by the Under Secretary of Defense (Personnel and Readiness). See: http://www.dtic.mil/whs/directives/corres/html/826003.htm

3 In publication. Reference will be updated in the final version of this paper. The abbreviation OFSC is confusing because it is used both to refer to the force structure semantics of the GFM DI (the GFM OFSC) and to refer to the contents of DODI 8260.03 (OFSC for GFM). In this paper OFSC always refers to the former.

4 Joint Publication 0-2 (JP 0-2): *Unified Action Armed Forces (UN AAF),* 10 July 2001. See: http://www.dtic.mil/doctrine/jel/new_pubs/jp0_2.pdf.

5 Global Force Management Guidance (GFM Guidance), 13 Jan 2006.

6 Ibid.

7 Chamberlain & Boller, *The Formal Representation of Administrative and Operational Relationships within Defense Organizational Constructs*, 11th International Command and Control Research and Technology Symposium; See CCRP Website http://www.dodccrp.org/events/11th_ICCRTS/iccrts_main.html .

foundation for trust, coordination, and teamwork necessary for unified action and requires clear delineation of responsibility among commanders up, down, and laterally.[8]

Providing a more explicit and unambiguous definition for unity of command is a primary metric for the GFM OFSC. Accomplishing this requires an understanding of four other important definitions.

Command: (DOD) The authority that a commander in the Armed Forces lawfully exercises over subordinates by virtue of rank or assignment. Command includes the authority and responsibility for effectively using available resources and for planning the employment of, organizing, directing, coordinating, and controlling military forces for the accomplishment of assigned missions. It also includes responsibility for health, welfare, morale, and discipline of assigned personnel.[9]

Command Authority: The authority that a military commander lawfully exercises over subordinates and confers authority to assign missions and to demand accountability for their attainment.[10]

Chain of Command: (DOD) The succession of commanding officers from a superior to a subordinate through which command is exercised.[11]

Command Structure: The organizational hierarchy through which leadership is exercised. The word leadership has replaced command so that the definition extends to any echelon where leadership authority is exercised, not just by official command.[12]

This difference between a command structure and chain of command is described in a previous CCRP report and is revisited in Figure 1.[13] Although both are organization tree graphs, the nodes of a command structure can be any type of organization (doctrinal, crews, billets, etc) and the links represent the decomposition of the organizations. The nodes of a chain of command are all billets (with an expected one-to-one correspondence to a person) and its links represent a reporting relationship. The two graphs are interrelated by a third type of link, named leadership links that are incorporated into the command structure. These links identify the billet that leads an organization and allows the leadership billet to reside anywhere in the command structure. The chain of command on the right is automatically derived from the command structure on the left using an algorithm provided in the referenced CCRP report. The distinction between a command structure and chain of command is important to these semantics and facilitates the understanding of the precept and principles used to define the process described in this paper.

Every individual Service member regardless of rank serves in a billet that is in one or more chains of command and is a part of the military command structure that emanates from the President.

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[8] JP 0-2, *op. cit.*, Section III-A-1-d, pg III-1.

[9] Joint Publication 1-02 (JP 1-02), *Department of Defense Dictionary of Military and Associated Terms,* 12 April 2001, as amended through 31 August 2005, pg 101. See also: http://www.dtic.mil/doctrine/jel/doddict/.

[10] Derived from a statement in JP 0-2, *op cit.*, Section III-A-1-a, pg III-1.

[11] JP 1-02, *op. cit*., pg 81.

[12] Used in the GFM OFSC and defined in Chamberlain, *op cit*.

[13] Chamberlain, Sam; *Default Operational Representations of Military Organizations*, Army Research Laboratory Technical Report: ARL-TR-2172; February 2000. See: http://www.arl.army.mil/~wildman/PAPERS/tr2172.html.

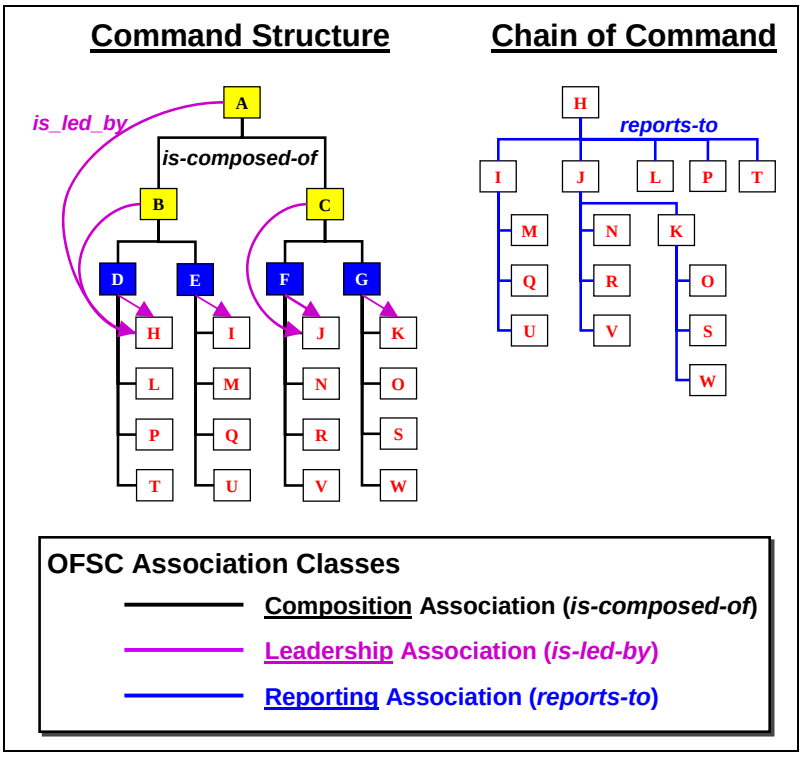

Figure 1: Command Structure and Chain of Command

There are two fundamental modes of command structures and corresponding chains of command: administrative and operational. For each Service, the administrative chain of command runs through the Secretary of Defense (SecDef), Service Secretaries and Service Chiefs while the operational chain of command runs through the SecDef and combatant commanders. Both relationships typically meet and join at the Service Component Commander level and continue to flow downward to the billets of their lowest ranking members.

The operational, or war fighting, chain of command is initiated through a process known as the *assignment of forces*. The President, through the Unified Command Plan (UCP),[14] instructs the Secretary of Defense to document his direction for assigning forces. Title 10 §162(a)[15], states:

> *"Assignment of Forces.--*
> *(1) Except as provided in paragraph (2), the Secretaries of the military departments shall assign all forces under their jurisdiction to unified and specified combatant commands…to perform missions assigned to those commands."*

Based upon direction provided by the SecDef on the number and type of forces to be assigned to each Combatant Commander, the Service Secretaries select the actual forces for assignment (i.e., they assign the forces).[16] The legal effect of this assignment process is two fold: first, it categorizes every uniform military person and military organization as either assigned or not

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[14] UCP, for brief introduction, see: http://www.defenselink.mil/specials/unifiedcommand/

[15] United States Code (USC) Online (USC Online) via GPO Access;
See: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=browse_usc&docid=Cite:+10USC162

[16] GFM Guidance, *op. cit.*

assigned to a combatant command, and second, it establishes the "Combatant Command (Command Authority)," or COCOM, of the combatant commander over the assigned forces. This is called the COCOM command relationship (in JP 0-2) and is commensurate with assignment. *Assigned* forces are uniformed military personnel under the legal authority of a combatant command, either in individual positions or in units. A unit or individual can be assigned (COCOM) to only one unified (combatant) command at a time. The assignment of these forces is relatively stable, is recorded in the GFM Guidance, and requires written approval of the SecDef to change.

The basic premise of the formal representation of assignment is that once a unit is designated for assignment, the assignment property follows the administrative command structure down to the billets of the designated unit *unless otherwise specified*. In the OFSC, provisions are defined to allow the assignment propagation process to be terminated and restarted (or redirected) to handle other cases or circumstances. The final result is that an algorithm can be executed that identifies all the assigned joint forces of a unified command by traversing the organization trees that are defined using the joint semantics of the OFSC.

These OFSC semantics are represented using tree graphs, the details of which are well documented in previous CCRTS papers.[17] Briefly, organization tree graphs are represented via organizational elements, or OEs (the nodes) and associations (the links). The tree is called a unit and the set of associations used to define the unit, with its set of OEs, is called a command structure. Therefore, a unit is defined by a set of OEs and a command structure. Paths through the command structure represent multiple relations and are implemented via tree traversal algorithms.

OFSC relations are derived from associations as specified using a simplified version of First-Order Logic, or FOL, that uses sentences of the form $P(t_1, ..., t_n)$, where P is a predicate and $t_1, ..., t_n$ is a set or arguments.[18] The predicate RELAT is used for a relation (path) and ASSOC is used for an association (link). In both cases, there are three arguments: two variables, a superior OE followed by a subordinate OE, followed by a constant that denotes a predicate sub-type (a type of relation or association, respectively). Using tree graph vernacular, the OE variables for an ASSOC (a link) are a parent and child OE, while for a RELAT (a path) they are an ancestor and a descendant OE.

In FOL, two types of operators are used with these sentences. The first are logical operators and includes: *logical not* (denoted by the symbol "¬"), *logical and* ("AND"), *logical or* ("OR"), and *logical conditional* ("→", read "implies"). The second operator is called a quantifier and includes: the *universal quantifier* (denoted by the symbol "∀", read "for all"), and the existential quantifier ("∃", read "for some"). Quantifiers are followed by a list of applicable variables. For convenience, when appropriate, it is customary to use a single variable with the quantifier to represent all variables used as arguments. For this document, Let X = { A, B, C, D, E, F, Y }, where this set of variables represents the set of OEs. Thus, the following example is read:

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[17] See CCRP website: http://www.dodccrp.org/html3/events_past.html, or author's website at: http://www.arl.army.mil/~wildman/PAPERS/papers.html.

[18] Also called First-Order Predicate Calculus. See: http://en.wikipedia.org/wiki/First-order_logic .

$\forall_X$ ASSOC(A,B,HAD) → RELAT(A,B,ADCON)

"For any two OEs, parent A and child B, an HAD association between them implies that an ADCON relation exists between them."

This states that in the OFSC, a HAD association (yet to be defined) invokes the ADCON relation.

Assignment is defined by first defining the administrative command structure and then defining the COCOM relation. The administrative command structure is composed of associations of a category abbreviated as HAD for "has administrative control / default." The COCOM relation is initiated using an association abbreviated as COA for "COCOM / Assign" that links a unified command to the subordinate unit being assigned to it. The COCOM relation, or assignment, then propagates from the unified command to the designated unit and down the administrative command structure to its leaf nodes, which are usually billets. A set of seven FOL precepts, listed below, are used to define a system of relations for assignment.

[1] An administrative command structure is defined via the administrative control, or ADCON, relation (RELAT) that propagates via the HAD association (ASSOC).

$\forall_X$ ASSOC(A,B,HAD) → RELAT(A,B,ADCON) {→ denotes "Implies"}

[2] The ADCON relation is transitive.

$\forall_X$ RELAT(A,B,ADCON) AND RELAT(B,C,ADCON)→ RELAT(A,C,ADCON)

[3] An organization can have only one Default ADCON (HAD) association at a time.

$\forall_X$ ASSOC(E,F,HAD) → $\neg\exists_Y$ ASSOC(Y,F,HAD) {$\neg\exists_Y$ denotes "No Y Exists That"}

[4] The COCOM relation is initiated via the COCOM / Assign (COA) association:

$\forall_X$ ASSOC(A,B,COA) → RELAT(A,B,COCOM)

[5] The COCOM relation propagates down the ADCON relation.

$\forall_X$ RELAT(A,B,COCOM) AND RELAT(B,C,ADCON) → RELAT(A,C,COCOM)

[6] Propagation of the COCOM relation is suspended if a COCOM / Unassign (COU) association is presents (with the HAD association). More formally, we stipulate that:

$\forall_X$ RELAT(A,B,COCOM) AND ASSOC(B,C,COU) → ¬RELAT(A,C,COCOM)

[7] There can be only one COCOM relation at a time.

$\forall_X$ RELAT(E,F,COCOM) → $\neg\exists_Y$ RELAT(Y,F,COCOM)

A consequence of this last statement is that a propagating COCOM relation is always overridden by a direct COCOM/Assign (COA) association that begins a new COCOM relation. One can derive that:

$\forall_X$ ASSOC(A,B,HAD) AND ASSOC(C,B,COA) → RELAT(C,B,COCOM).

In other words, if OE B has associations to two parents, A and C, and a direct COA association exists to C, then B is COCOM through C regardless of what relation propagates through A.

These seven statements define the assignment property and can be used to answer the question: "Who is assigned to Unified Command X?" **Figure 2** illustrates a set of associations that define force assignment.

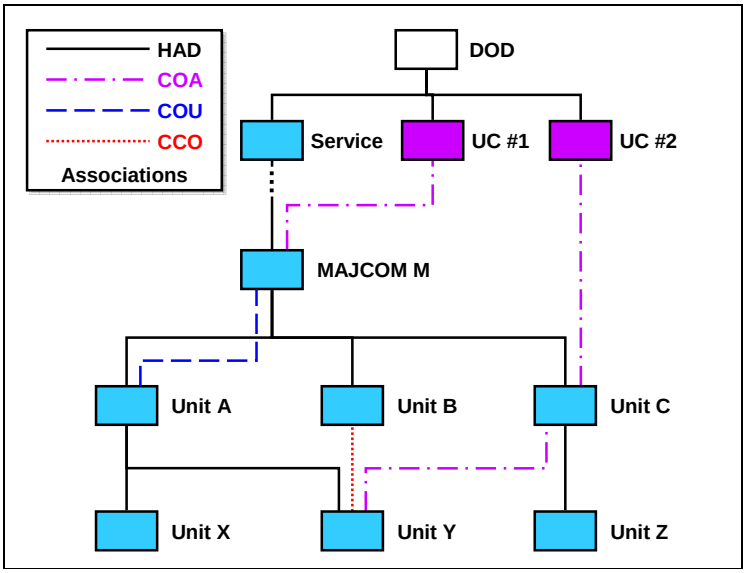

Figure 2: Associations Used For Assignment

Based upon the associations provided and the application of the seven FOL rules, one can derive that:

- MAJCOM M, and Unit B are assigned to UC #1.
- Unit C, Unit Z, and Unit Y are assigned to UC #2.
- Unit A and Unit X are not assigned to any unified command.

The next section will provide the semantics to also derive that:

- Unit Y is allocated to UC#1 via Unit B;
  that does not change that fact that Unit Y is assigned to UC#2

2. Allocation of Forces

Beginning with the definition of JP 0-2, the taxonomy illustrated in **Table 1** has been developed for the DoD Levels of Authority. The interesting distinction of this taxonomy is the inclusion of ADCON as a command authority which is not explicitly stated in JP 0-2. It is presumed this is due to the joint operational nature of the joint publication and lack of a requirement to define individual Service business practices. Based upon the definition of command authority presented previously (see page 3), it seems clear that commanders exercising their administrative chain of command share similar authorities as when they exercise their operational counter parts. Therefore, although ADCON typically defines a Service, vice joint process, it should be included as a command authority that is well documented and shared with the joint community.

Table 1: Derived Taxonomy of the DOD Levels of Authority

I. Command Authority
  A. ADCON [Administrative Control]
  B. Command Relationships (Operational in Nature)
    1. COCOM [Combatant Command (Command Authority)]
    2. OPCON [Operational Control]
    3. TACON [Tactical Control]
    4. Support
      a. General
      b. Mutual
      c. Direct
      d. Close
II. Coordinating Authority
III. DIRLAUTH [Direct Liaison Authorized]

The focus of this discussion is the topic listed as part I-B of the taxonomy entitled *Command Relationships*. By DoD definition:

Command Relationships: The interrelated responsibilities between commanders, as well as the operational authority exercised by commanders in the chain of command; defined further as combatant command (command authority), operational control, tactical control, or support.[19]

Further, JP 0-2 states:

> When transfer of forces to a joint force will be *permanent* (or for an unknown but long period of time) the forces should be reassigned. Combatant commanders will exercise combatant command (command authority) and subordinate joint force commanders (JFCs) will exercise operational control (OPCON) over *reassigned* forces.
>
> When transfer of forces to a joint force will be temporary, the forces will be attached to the gaining command and JFCs [Joint Force Commanders] will normally exercise OPCON over the attached forces.

The first statement refers to the assignment process (or assignment of forces) that was reviewed in the previous section that uses the ADCON and COCOM (I-B-1 in **Table 1**) command authorities to implement the representation. The second statement (and second part of the first statement) refers to the *allocation* process. The other command relationships (I-B in **Table 1**) will be used to formally define the allocation of forces, and in particular, the OPCON relation. These relationships are normally manipulated by operational systems that actively track changes and support day to day activities.

Table 2 enhances the taxonomy for the levels of authority by adding other properties of the command relationships as described in JP 0-2:[20]

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[19] JP 1-02, *op. cit.*, pg 104.

Table 2: Inherited Properties of Command Relationships

The **Combatant Command (Command Authority)**, or **COCOM**, command relationship allows:

- Budget and Planning, Programming, and Budgeting System Input
- Assignment of subordinate commanders
- Relations with Department of Defense Agencies
- Convene courts-martial
- Directive authority for logistics
- *Plus all OPCON Command Authority (OPCON is inherent in COCOM)*

The **Operational Control**, or **OPCON**, command relationship allows:

- Authoritative direction for all military operations and joint training
- Organize and employ commands and forces
- Assign command functions to subordinates
- Establish plans and requirements for intelligence, surveillance, and reconnaissance activities
- Suspend subordinate commanders from duty
- *Plus all TACON or Support command authorities.*

The **Tactical Control**, or **TACON**, command relationship allows:

- Local direction and control of movements or maneuvers to accomplish mission

The **Support** command relationship allows:

- Aid, assist, protect, or sustain another organization

When a unit is assigned to a combatant command, unless otherwise noted, that commander exercises all of the authorities listed above (since COCOM implies OPCON and OPCON implies TACON, etc.).

However, it is very common for forces to be transferred between combatant commands without transferring COCOM authority, especially those assigned to Joint Forces Command (JFCOM) that serves as the "conventional force provider" for other combatant commands and includes nearly all conventional forces based in the continental U.S.

In instances when forces are *allocated*, or attached, to another combatant command for actual employment, a command relationship that is less authoritative than COCOM is invoked and it is typically OPCON.[21] When this occurs, the assigned combatant commander becomes the supporting COCOM, who relinquishes the implied OPCON portion of his COCOM authority as OPCON is delegated/re-allocated to the gaining/supported COCOM commander. This typically provides the gaining/supported combatant commanders with sufficient power and authority required to execute their assigned missions. An important point is that *changes in allocation do*

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[20] JP 0-2, *op cit.*, Figure III-1. Command Relationships, pg III-2.

[21] Recall from JP 0-2: "When transfer of forces to a joint force will be temporary, the forces will be attached to the gaining command and JFCs will normally exercise OPCON over the attached forces."

not result in corresponding changes in assignment, and this must be incorporated and clearly expressed into all formal joint representations and semantics.

Figure 2 illustrated this situation. The association used in the OFSC to invoke the OPCON relation is named CCO for "Command & Control (CMDCTL) / OPCON." The red, dotted line between Units B and Y denoted this association. Therefore, one can state that "Unit Y is OPCON to Unit B," or more formally, ASSOC(Unit B, Unit Y, CCO). If one uses the semantics for assignment that is describe by rules [1] – [7] on page 6 and whose association are also included in **Figure 2**, one can derive that:

Unit B is *assigned* to Unified Command (UC) #1 because:
ASSOC(UC#1, MAJCOM M, COA), and
ASSOC(MAJCOM M, Unit B, HAD), therefore
RELAT(UC#1, Unit B, COCOM)

Unit Y is *assigned* to UC #2 because:
ASSOC(UC#2, Unit C, COA), and
ASSOC(Unit C, Unit Y, COA), therefore
RELAT(UC#2, Unit Y, COCOM)

The semantics of allocation must be defined such that even though Unit Y is assigned to UC #2, designating Unit Y as OPCON to Unit B (that is assigned to UC #1) does not change Unit Y's assignment (i.e., their COCOM command relationship).

The OPCON command relationship has the following properties similar to COCOM. Recall that these are true unless otherwise specified:

[8] The OPCON relation is invoked via the CCO association.

$\forall_X$ ASSOC(A,B,CCO) → RELAT(A,B,OPCON)

[9] The OPCON relation propagates down the ADCON relation.

$\forall_X$ RELAT(A,B,OPCON) AND RELAT(B,C,ADCON) → RELAT(A,C,OPCON)

[10] There can be only one OPCON relation at a time.

$\forall_X$ RELAT(E,F,OPCON) → $\neg\exists_Y$ RELAT(Y,F,OPCON }

A consequence of this last statement is that a direct CMDCTL/OPCON (CCO) association always overrides a propagating OPCON relation and begins a new one. One can derive that:

$\forall_X$ ASSOC(A,B,HAD) AND ASSOC(C,B,CCO) → RELAT(C,B,OPCON

In other words, if OE B has associations to two parents, A and C, and a direct CCO association exists to C, then B is OPCON through C regardless of what relation, including an OPCON relation implied by a COCOM relation, propagates through A. As with COCOM, a relation invoked by a direct association always overrides an implied relation.

By definition, a unit can not be allocated to the combatant command to which it is assigned; a unit is allocated to a different combatant command. A similar derived rule that facilitates the

definition of allocation would be that an OPCON association from a unit assigned to a different combatant command results in allocation, or formally stated, if A is a unified command, then:

$\forall_X$ RELAT(A,B,COCOM) AND ¬RELAT(A,C,COCOM) AND ASSOC(B,C,OPCON)
→ RELAT(A,C,OPCON), or C is *allocated to* Unified Command A.

To reiterate, this defines the property that any propagating OPCON relation, to include one implied as part of a COCOM relation, is over ridden by an OPCON relation invoked by a direct (CCO) association. In this case, direct means by an association with the same arguments (OEs) as the relation.

Notice that this conforms to the rules of assignment. The addition of any command relationship does not change the ADCON relation. Since the COCOM relation propagates via the ADCON relation, and it has not changed, assignment is not changed. In essence, both a COCOM and OPCON relation are simultaneously propagating down the same ADCON relations, but they originate from different sources. In **Figure 2**, one can derive that

Unit Y is *allocated* to UC #1 because:
RELAT(UC#2,Unit Y,COCOM), and
RELAT(UC#1,Unit B,COCOM), and
ASSOC(Unit B, Unit Y,CCO), therefore
RELAT(UC#1, Unit Y, OPCON).

Notice that the command relationships share the common traits that, one, they propagate down the (Default) ADCON relation, and two, a direct relation overrides an implied one. These constraints are necessary for the semantics to mimic the actual situation.

Another trait common to the command authorities is that only one relation within each command relationship type can exist at a time. This appears to be an imperative property to maintain unity of command. The extent that this is true for all the command authorities is currently being debated. It is true, by definition, for Default ADCON and COCOM (e.g., a unit can be assigned to only one combatant command). It is presumed to be true for OPCON and TACON, with TACON following the same rules as COCOM and OPCON. However, the Support command relationships are more subtle and difficult to assess.

3. Support Relationships – Future Study

The extent that the support command authority that includes Direct, General, Mutual, and Close Support, can be formally quantified is currently being debated as its definition has been left purposely vague to allow flexibility in its use. This is emphasized via JP 0-2:[22]

> The support command relationship is, by design, a somewhat vague but very flexible arrangement. The establishing authority (the common superior commander) is responsible for ensuring that both the supported and supporting commander understand the degree of authority that the supported commander is granted.

[22] JP 0-2, *op cit*., pg III-9.

To date, the OFSC only addresses direct and general support, and then only at a cursory level. It appears that some success may be achieved addressing relation initiation, propagation, and concurrency, but most details must be described using additional attributes that define the conditions specified by the superior commander establishing the support relationships. The Direct and General Support relations both have invocation associations, but it is debatable as to whether the concept of propagation applies to support. The question of concurrent relations, that is, multiple relations of the same type, seems to vary by situation. By its very nature, Direct Support may follow the single relation rules as the other types of command relationships. For example, if one is to "answer directly to the supported force" it seems conceivable to limit the number of simultaneous direct support relations to one. Otherwise, if one is directly supporting more than one other force, conflicts would be bound to occur. However, for the other cases of support (general, mutual, and close) perhaps the best one can do is qualify the associations and relations.

The General Support relation is of special interest in the OFSC because of its use in the GFM Guidance document to describe relationships between forces assigned to combatant commands. The GFM Guidance states that:

> A Service component commander may be tasked as a supporting commander for more than one combatant command, buy this arrangement does not constitute a COCOM relationship. Unless otherwise specified by the Secretary of Defense, the commander tasked as a supporting commander to additional combatant commands maintains a *general support* relationship for planning and coordinating regarding the combatant commands assigned missions and forces.[23]

This definition is exploited to justify the use the OFSC General Support relation to build composition associations between supporting commander billets and supported commands. Perhaps the General Support relations can be more tightly defined if the term "whole force" is carefully scrutinized. If the meaning of "whole force" is restricted to a specific hierarchy (such as that force lead by the establishing commander) then a single simultaneous relation is conceivable. However, if "whole force" means that any arbitrary set of supported units can be named, then qualifications (e.g., such as prioritization) will have to be specified to differentiate between relations.

4. Summary

This paper recommends formal semantics to represent the relationships established by the joint processes of assignment and allocation to facilitate manipulation of force structure data by sophisticated computer programs. The semantics are being developed as part of the GFM DI's Organizational & Force Structure Construct (OFSC) to represent both administrative and operational situations. The OFSC provides the semantics for both the default data to be located in Service, Joint, and OSD organization servers, and by the operational systems that are initialized using the default force structure data as their own data before manipulating it to support operational requirements or their intended design functions.

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[23] GFM Guidance, *op. cit.*, Section III, SERVICE COMPONENT ASSIGNMENT SUMMARY, 1.b.

The OFSC includes both administrative and operational modes of representation because they are tightly intertwined. Organization structures are represented using tree graphs where the nodes are aggregation points, called organizational elements, and the links are associations that denote the aggregation (or composition) of the organizational elements. A set of composition associations is called a command structure that can be based on multiple relationships. Paths through the command structure represent relations that are defined in joint publications. Two relations, ADCON (administrative control) and COCOM (combatant command (command authority)) were described in a previous ICCRTS paper that focused on the joint assignment process. The focus of this paper was the OPCON (operational control) relation that is used to document the allocation process. Both the assignment and allocation processes can share the same nodes to express the subtle distinctions between the force at rest and the changes required to support operational requirements that exist within every organization. At the point of aggregation where the force assignment and allocation relationships are one and the same they can propagate down the ADCON relationship. Therefore, basic rules are defined that describe the prioritization of this propagation. Two fundamental constraints were introduced: first, an association (or direct link) always overrides the propagation of a like relation, and two, only one relation of a type is allowed at a time. By implementing these and other OFSC semantics, unity of command is maintained and expressed as clean, well defined chains of command.

These common, joint semantics enable the integration of reliable authoritative force structure data among deployed battle command and other operational systems in a form conducive to machine manipulation. This allows computer programs to provide an integrated framework for a better common understanding of the Department's operations that will facilitate discussions that produce solutions to both the routine and sophisticated challenges of managing the force.

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