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# Harmonizing BML Approaches: Grammars and Data Models for a BML Standard

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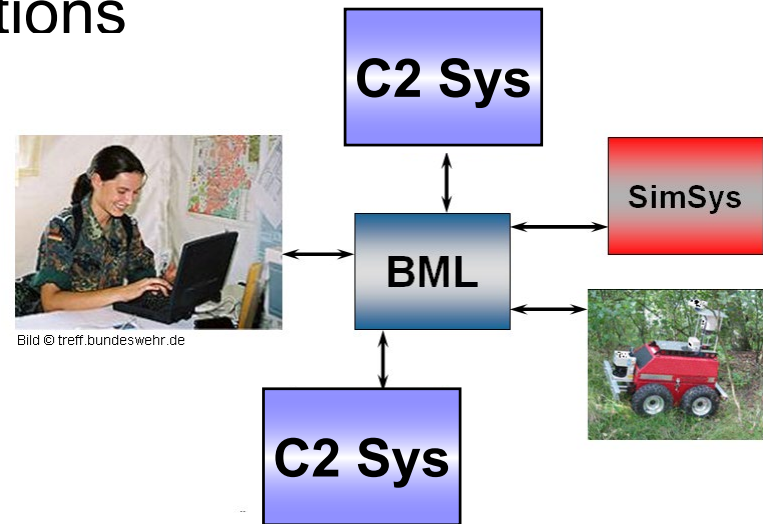


1. Introduction: About BML
2. The Model-Based Approach
3. The Doctrine-Based Approach
4. Harmonizing the Approaches
5. The Way Ahead



BML is the **unambiguous** language used

- to command and control forces and equipment conducting military operations and
- to provide for situational awareness and a shared, common operational picture.



BML facilitates the use of simulation systems for

- Staff Training and
- Decision Support

Desired functionality comprises

- Commanders use of their C2 systems to formulate their orders – such that the orders can be understood by the simulation system and such that the simulated units acts as intended – in BML.
- Simulation Systems prepare and send reports in BML.
- Agents within the systems can exchange C2 relevant information using BML.



During the last decade, promising variants of BML have been developed through different approaches.

- The “**bottom-up**” approach utilizes “**Model Based Data Engineering**” (MBDE) and focuses on the importance of transactionals in the underlying data model representation.
- *System Focus: unambiguous representation for machines*
- The “**top-down**” approach focuses on the development of a formalism using a formal grammar, the **Command and Control Lexical Grammar** (C2LG).
- *Doctrine Focus: representation of doctrinal language*



The approaches agree upon the following:

- BML expressions have to be expressible by XML.
- These expressions have to validate under a schema that should derive from an underlying grammar.
- Expressions uses the JC3IEDM terms as vocabulary.

Both approaches have been implemented using web services.



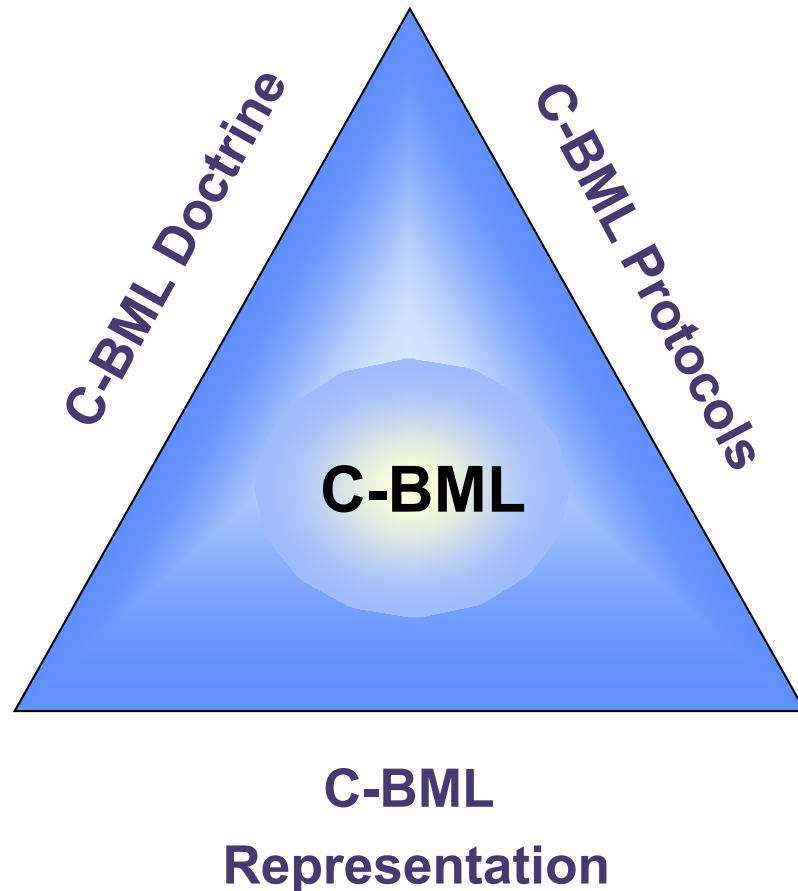
The **Model-based Data Engineering (MBDE)** approach was developed

- in support of **mapping of heterogeneous data representations**
- based on a **common reference model** that captures the information exchange

The basic premise of MBDE is that a system's ability to interpret information is limited by its data model.

As BML targets C2-system to Sim-system communication, the information must be rooted in a consistent representation of the C2 Infosphere.





- For MBDE, the **C-BML representation is the most significant part**, as this is what machines understand.
- Doctrine is used to define (and extend) the representation.
- Protocols transfer (valid) C-BML expressions.
- Model to start with: **JC3IEDM** (and **extend** and **enhance** in case of need).





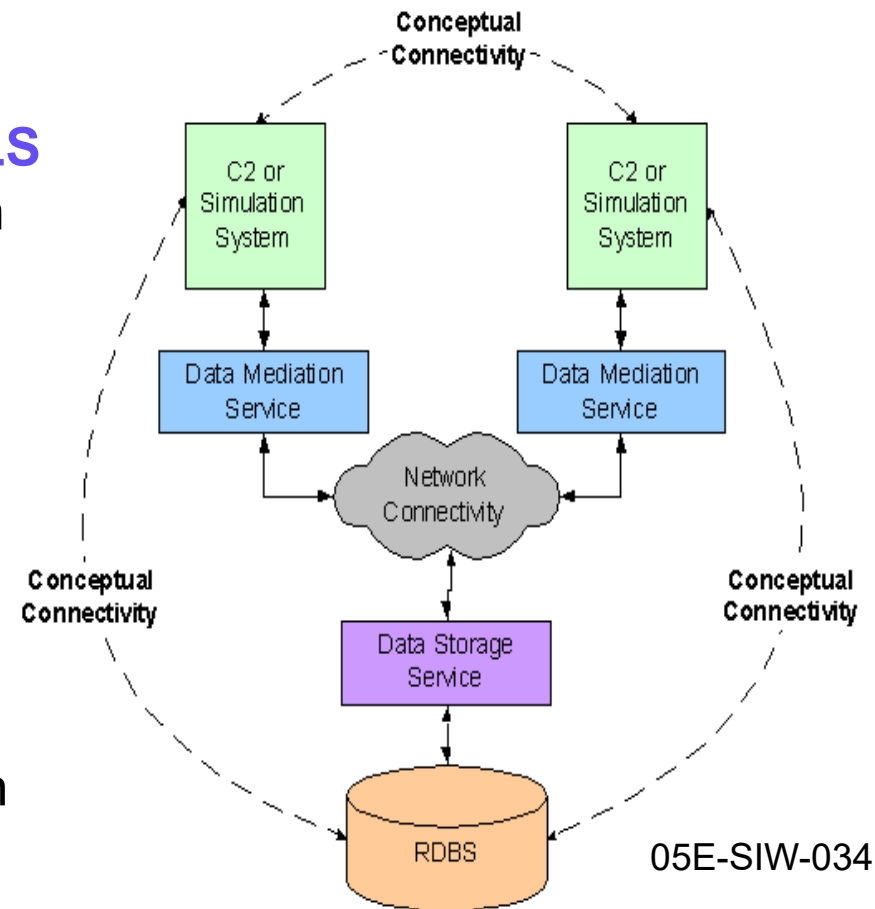
## Information Exchange within the MBDE

- is based on **TRANSACTIONALS** in the underlying representation

## Transactionals ensuring

- Consistency in the underlying representation
- Unambiguous and complete information for machines

This information exchange is defined on the logical level, i.e. no database is needed for the implementation.



MBDE ensures that all required information for systems is provided (mandated properties in the transactional).

MBDE provides rules for

- *enhancement* (modification and refinement of existing concepts) and
- *extension* (addition of new concepts).

Valid expressions in the representation are valid C-BML expressions.

JC3IEDM is recommended as the initial representation!



- The doctrine-based approach (the C2LG approach) recognizes the widespread use of **NATO STANAG 2014** that defines the Five Paragraph Operational Order format.
- US Lt. Col. ret. Scott Carey and Col. ret. Martin Kleiner (both GMU) mapped this order format into an XML schema.
- In the following, we will focus on paragraph 3 “execution”, subparagraph b “**Tasks/Missions to Maneuver Units**”.



Doctrinally, the assignments in “**Tasks/Missions to Maneuver Units**” use the so-called “5W” format.

The five Ws are

**Who What Where When Why**



**Who**, **What**, **Where**, **When**, and **Why** determine the form of a basic order expression (OB) in the C2LG.

C2LG's general Format for Tasking:

OB → **Taskverb** Tasker **Taskee** (Affected) **Where** **StartWhen**  
(**EndWhen**) **Why** (Mod) Label

Example:

**block** BTL **COY-A** **at** phase line Tulip  
**start nlt** time\_point\_0 label-task-168;



A C2LG expression consists of “**constituents**” that match to the 5 Ws.

The sequence of these constituents is fixed.

In addition, the Where, When, and Why constituents start with specific key words. Both properties together guarantee that the expressions can be analyzed, automatically.

Example:

**block** BTL **COY-A** **at** phase line Tulip  
*start nlt* time\_point\_0 label-task-168;



## Problematic Aspects I:

C2LG expressions *have a different structure* than related JC3IEDM constructs.

I.e., C2LG can in general be mapped by so-called “weak composites,” that require additional information to be added in the mapping process.

In short, for C2LG orders and reports work is needed to map their content (the information to be exchanged) to JC3IEDM structures.



## Problematic Aspects II:

The C2LG approach refers to military business objects by name only.

This means the respective *names must be unique and known to all systems* that communicate via C2LG expressions. Otherwise communication will fail.

This problem does not apply to the Model-Based approach as it does not necessarily require unique names, but rather information in context to unambiguously identify such objects.





## Problematic Aspects III:

BML expressions that are formulated by using the Model-Based approach inherit their structure from the data model that is used as common reference model.

*Some of doctrinally meaningful C2LG expressions do not match this structure.*

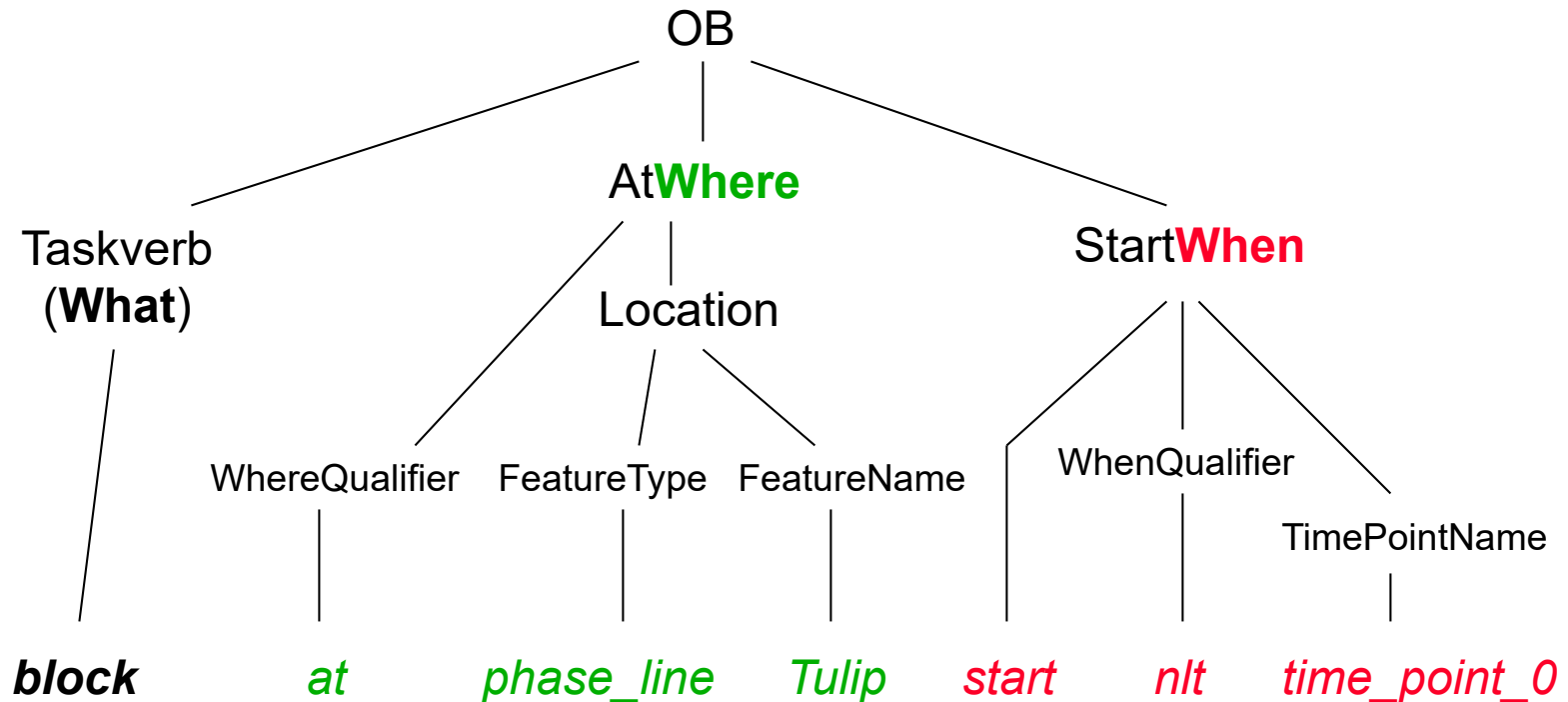
E.g., if no extensions to the JC3IEDM are used, the expression

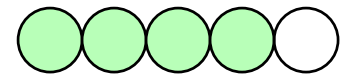
*block at phase line Tulip start nlt time\_point\_0*

is structured by the C2LG as follows:



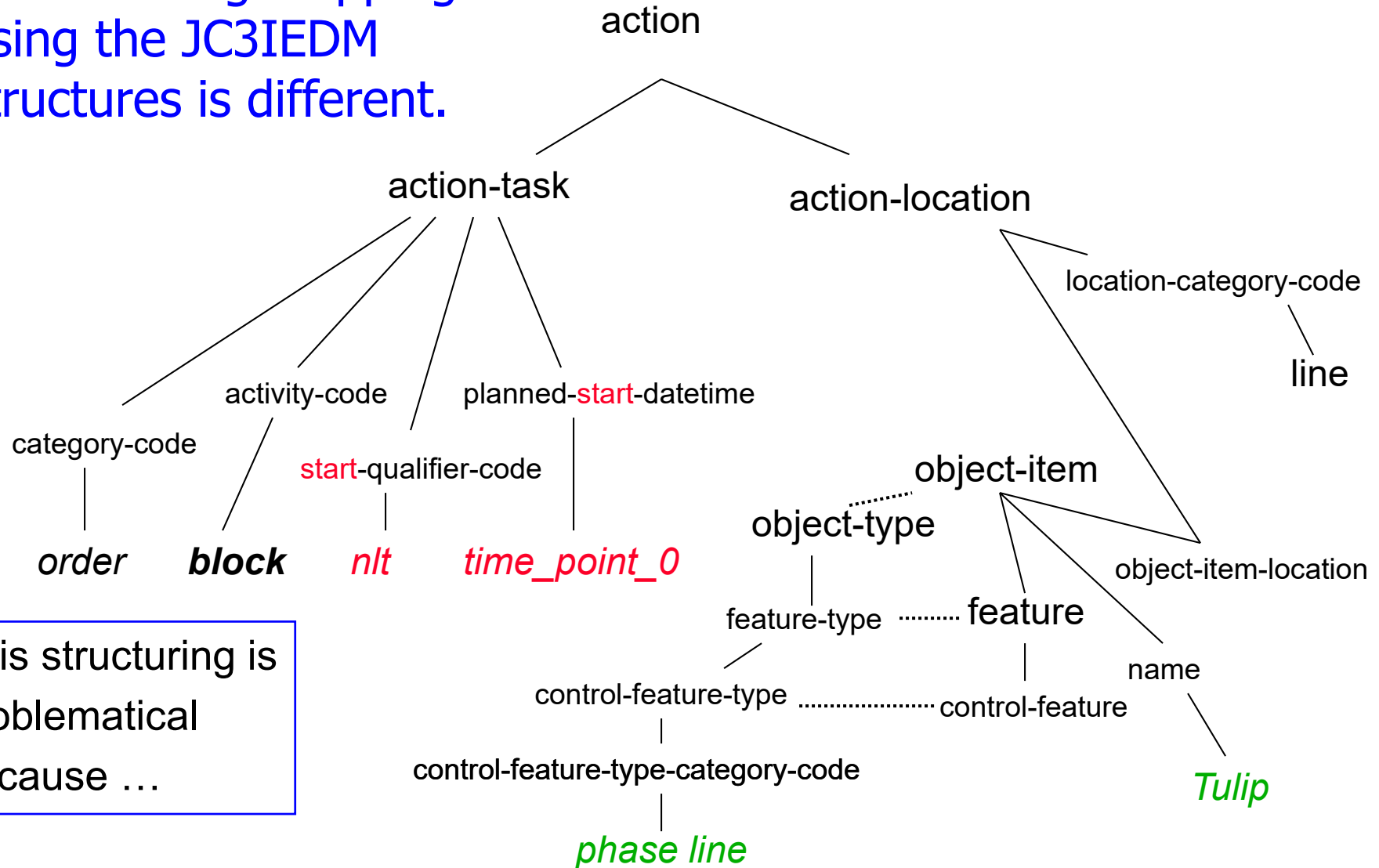
The respective C2LG grammar tree shows the expected structure. If the term is operationally meaningful, this structure must be supported by an implemented model.



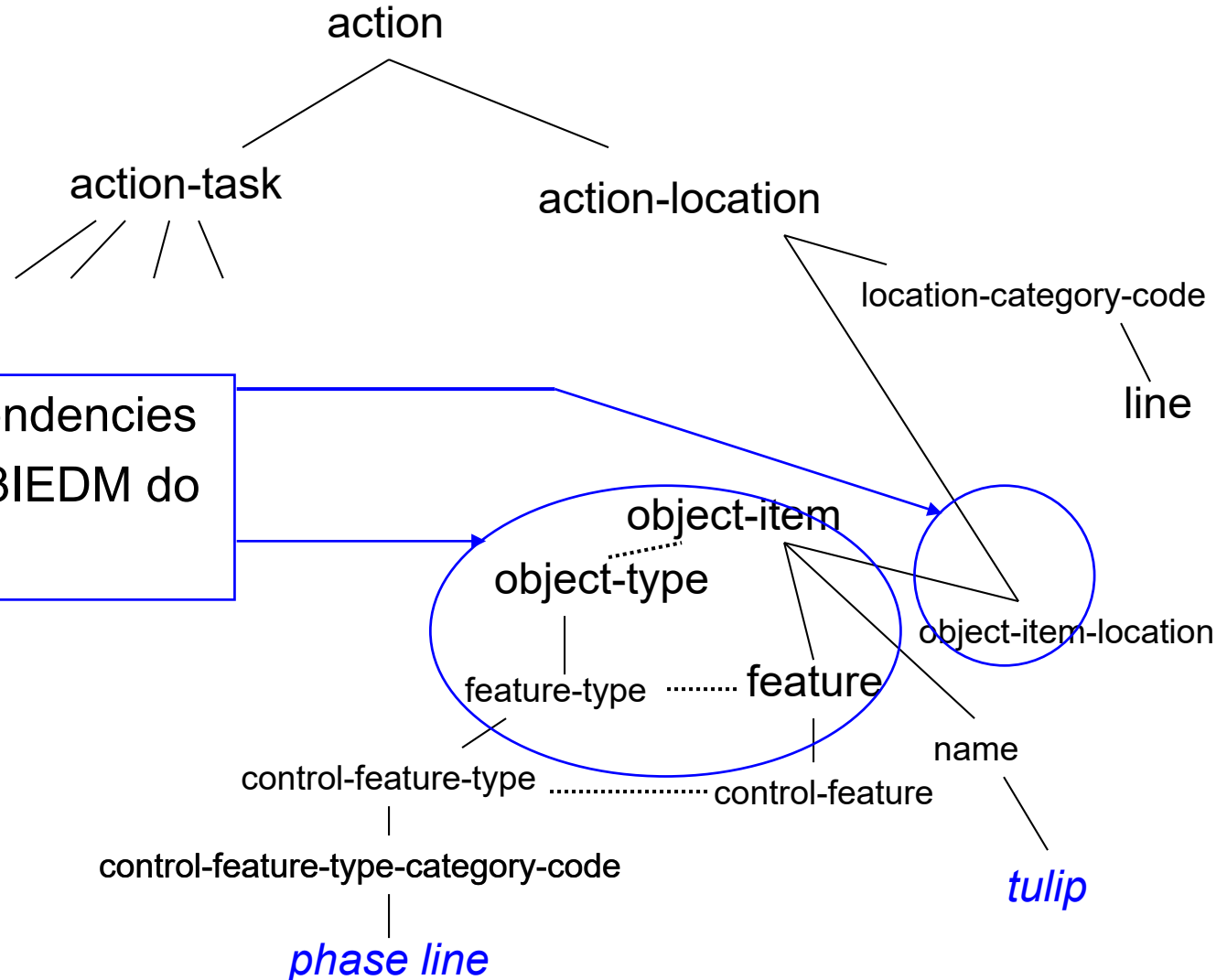


# Harmonizing the Approaches

The resulting mapping using the JC3IEDM structures is different.



This structuring is problematical because ...



## Problematic Aspects IV:

BML expressions that are formulated by using the Model-Based approach depend on the C-BML representation.

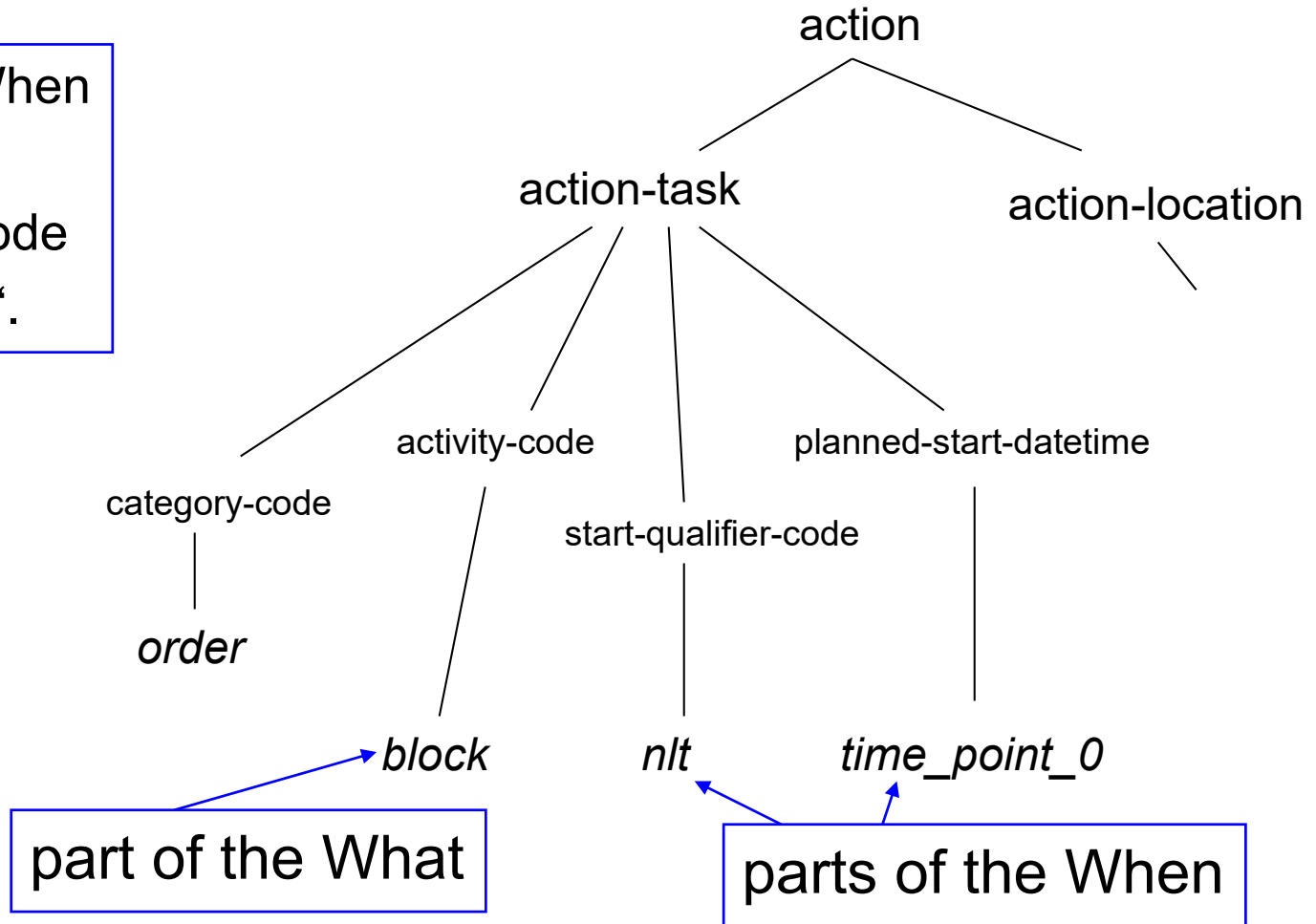
*If concepts are insufficiently captured in the CRM, the resulting language cannot overcome this shortfall.*

Example:

The temporal modifier and the modified concepts (dateline) are not modeled under one concept, but are distributed and only loosely coupled.



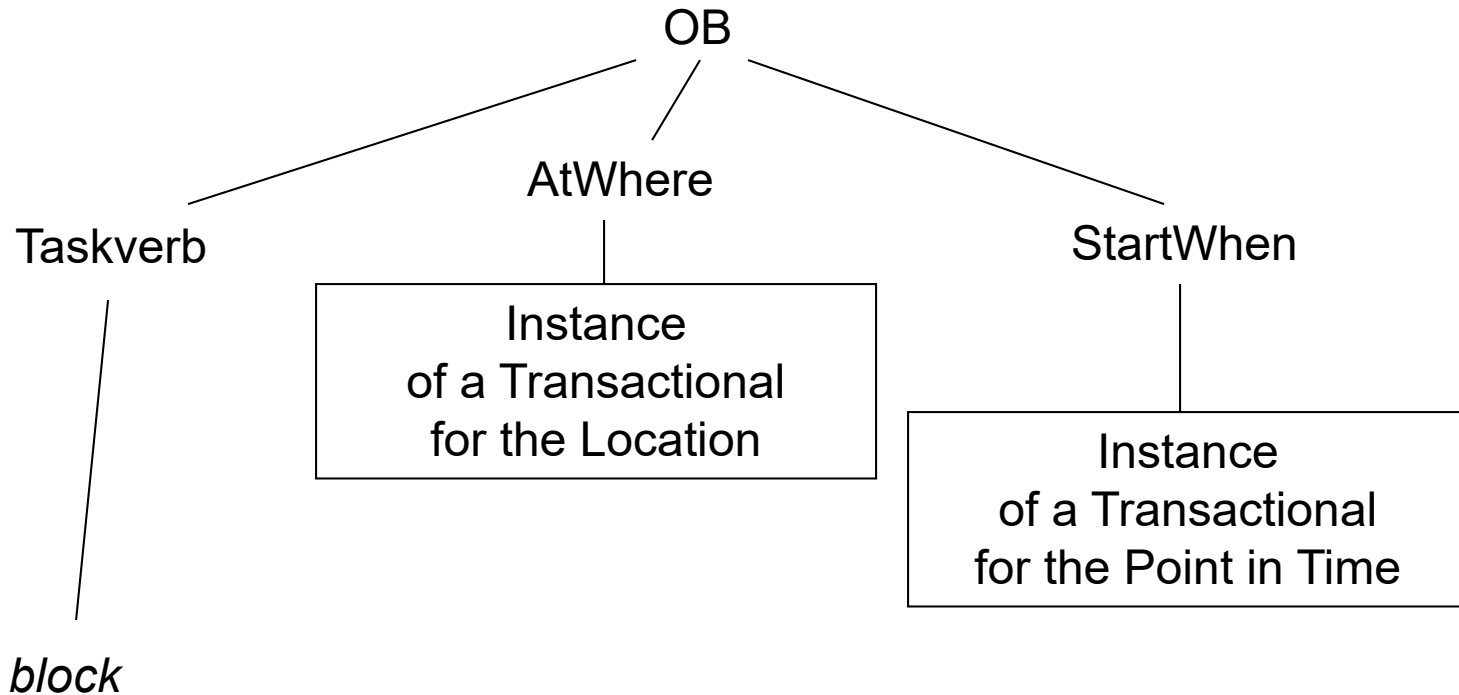
What and When are merged under the node "action-task".



## Recommended Solution

- Use the rules of C2LG down to the level of constituents. This grants the doctrinal structuring of the expressions.
- Constituents become transactionals of the representing common reference model.
- The transactional grants the correct mapping of the military business objects (the C2LG constituents only refer to by name) and all the required data that come with them into the JC3IEDM.

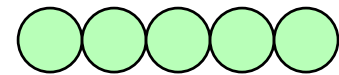






- The main contribution of the model-based approach becomes therefore the *unambiguous definition of model-based transactionals* for definition purposes as well as for migration and implementation purposes. It enforces C2 system implementation constraints in a standardized way.
- C2LG derives necessary constituents and new sentences following a approach from Computational Linguistics. C2LG is not constrained by implementation details of C2 systems, but is based on the evaluation of doctrine and results in a *formal language that specifies sentences and constituents* derived from operational needs.





- The suggested harmonization supports the **current standardization progress** for C-BML under the leadership of **SISO**.
- Our recommendation preserves the advantages of both approaches under discussion:
  - It preserves **doctrinal structure** of BML expressions.
  - It also preserves the **ability to exchange information** among systems using operational C2 data models.
- In addition, the MBDE provides the means for incorporation of doctrine-motivated changes into the JC3IEDM.



# QUESTIONS

Yes what?

Yes, Sir!

