Conceptual Requirements for Command and Control Languages

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Observations on C-BML Activities

- Coalition Battle Management Language (C-BML) *is defined as 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 is a means of communication and not part of the cognitive process.
- BML is used to communicate to machines, and as such need to be based on the principles of logic and computation.
- Current activities are mainly driven by prototypes and demonstrations. Feasibility is proven! Now we need a **solid academic foundation** enabling practical applicable standards.

Conceptual Requirements for Command and Control Languages

Example

- General schema: WHO is doing WHAT WHERE?
  - A taskable entity (WHO)
  - Is conducting a task (WHAT)
  - At a given location (WHERE)

Is this the current location of the entity?

Or the location where the action will take place?

Or the location where the entity should be after the task has been accomplished?

Or all of the above?

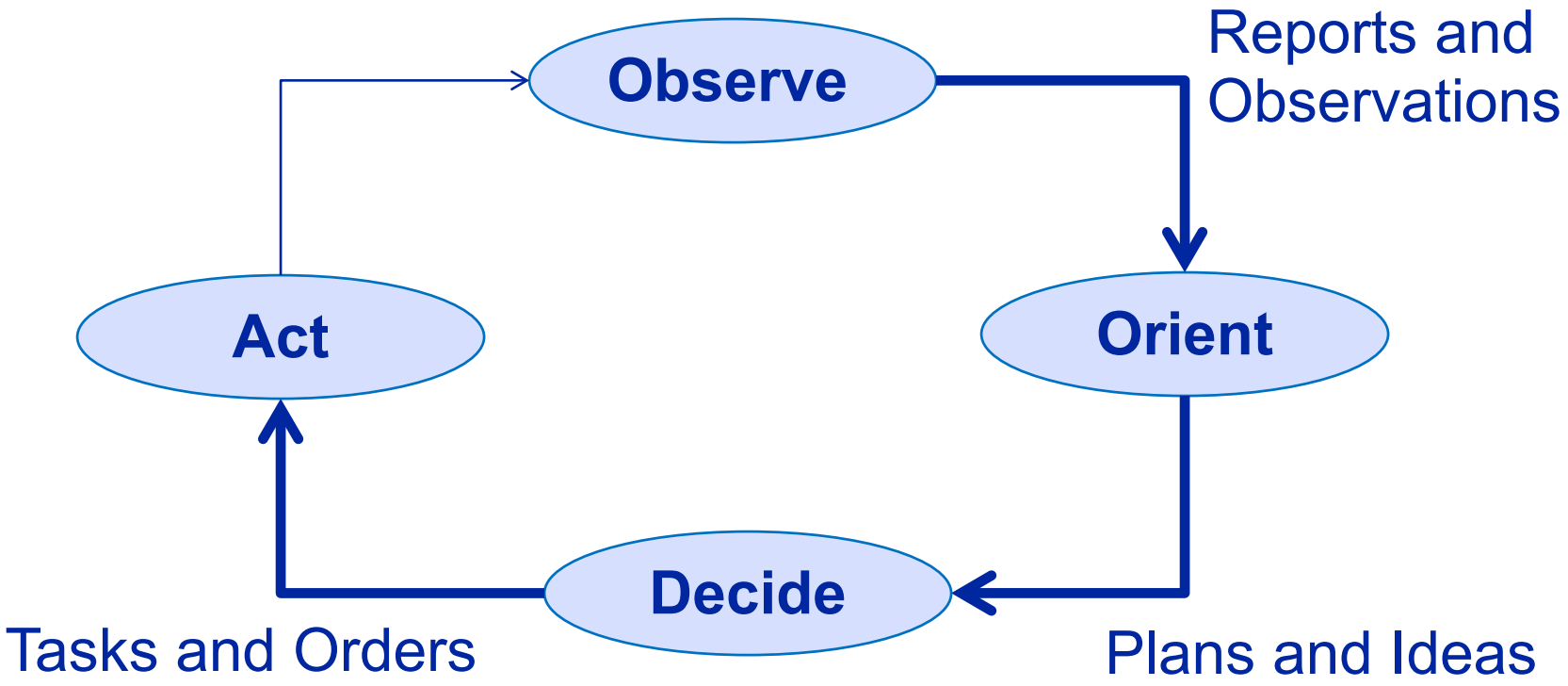
Objective of this Presentation

- Enumerating several conceptual requirements that
  - have to be supported by command and control (C2) languages in general and
  - by SISO's C-BML in particular

The conceptual requirements published in the paper 09F-SIW-075 are neither complete nor exclusive. They are meant to become the foundation for more requirements that are needed to **validate** C-BML from the operational perspective and **verify** the recommended solution from the technical perspective.

Supporting all Phases

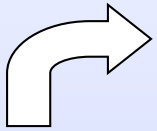
- BML in Boyd's decision cycle: The OODA-Loop



Supporting the Planning

- WHO WHAT WHERE WHEN WHY
- The WHO in the planning phase are WHO-Types
  - It is not necessary to know the exact item that conducts a tasks
  - It is necessary to know a WHO-Type that has the capability to conduct a task
- WHO-Types and CAPABILITIES are required for planning
- They can be instantiated when a plan is chosen and needs to be changed into an order

Decision Matrix for a Concept of Operation

	**Process1**	**Process2**	**Process3**	**Process4**
Process5	Event6	Event4	Event9	Event27
Process2	Event8	Event5	Event10	Event54
Process3	Event3	Event7	Event12	Event43
Process8	Event12	Event6	Event46	Event87

Conceptual Requirements for the Planning Phase

- *The planning phase is concerned with general abilities normally captured by **types** of actions, processes, and entities that are in principle able conduct them.*
- *For short term planning, the abilities available in the **sphere of influence** may have to be taken into account as well.*
- *Planning applications need therefore the ability to communicate **general** and **actual** or **instantiated** abilities for the conducted as well as the targeted side regarding general and actual and instantiated properties of actions and processes*

Supporting the Tasking

- We are talking to systems:
- **Unambiguous definition of constraints and objectives** for each task is needed
- Examples
  - *DO NOT CROSS COORDINATION LINE ALPHA BEFORE 071400NOV OR BEFORE YOUR RIGHT NEIGHBOR SECURED OBJECTIVE ALPHA*
  - *REACH YOUR OBJECTIVE BETA WITHIN 5 HOURS WITH NOT MORE THEN 20% CASUALTIES REDUCING THE ENEMY DOWN TO AT LEAST 70%*

Conceptual Requirements for the Tasking Phase

- *Unambiguous communication of **instantiated** abilities and constraints.*
- *If planning is merged into tasking, this should be doable be **assigning instantiating objects** – entities, actions, and processes – to the types of the planning phase.*
- *It needs to be assured that the **available** ability covers the **required** ability.*
- *It must also be allowed that objects that expose the **needed ability** can be assigned even if their type does not necessarily expose this ability (Example: using a personnel intense artillery unit conducting police operations).*

Constraints to be communicated

- Spatio-temporal and Operational Constraints
  - *Temporal Considerations*
    - Timing of Operations
    - Start- and end-time
  - *Spatial Considerations*
    - Location of Operations
    - Excluding Areas
  - *Operational Considerations*
    - Orchestration of Operations
    - Defining operational events (triggers)

Temporal Considerations

- Time calculus to allow machine to reason over time
- Example: Allen's Temporal Intervals
  - X **before** Y (X ends before Y starts)
  - X **meets** Y (Y starts when X ends)
  - X **overlaps** Y (X starts before Y ends)
  - X **during** Y (Y starts before X starts and Y ends before X ends)
  - X **starts** Y (X and Y start at the same time)
  - X **finishes** Y (X and Y end at the same time)
  - X **equal** Y (x and Y start and end at the same time)

Spatial Considerations

- Space calculus to allow machine to reason over space
- Example: Randell et al.'s Spatial Logic
  - A is **disconnected** from B
  - A is **part** of B
  - A is a **proper part** of B
  - A is an **equivalent coincident** of B
  - A **overlaps** B
  - A **partially overlaps** B
  - A **externally connects** with B
  - A is a **proper connected part** of B
  - A is a **proper non-connected part** of B

Operational Considerations

- Constraints like "the logistical situation is sufficient to enable the attack" must be captured.
- This needs to be translated in "enough fuel and ammunition is for the current operation available."
- However, how much fuel depends on the terrain, the weather, and the category of operation, the amount of ammunition needed depends on the enemy, the education of the own soldiers, etc.
  - *Example: Schnurer's geospatial operators to detect tactical situations, such as a break-through, an open flank, etc.*

Conceptual Requirements from Spatio-Temporal and Operational Constraints

- *"**WHAT-WHEN**" combinations are much more complex than it has been addressed so far.*
- *Need to capture and communicate **tactical situations** on the battlefield in machine understandable form.*
- *Closely related to **situational awareness***
  - *the same functionality is needed to support cognitive processes based on spot-reports and snap-shots of situations, as provided by common operational pictures*

Metrics for Success

- Metrics are not only needed to measure the success of an operation, they are also needed to measure thresholds of constraints for operations or tasks
- Example of Measures of Merit that can be used to define Metrics: NATO Code of Best Practice for C2 Assessment
- **Accomplishment** driven versus **Avoidance** driven Objectives need to be communicated

Accomplishment

- Reach a certain end state, such as
  - Building a bridge
  - Arriving at a given time at a given place

Avoidance

- Avoid a certain end state, such as
  - Enemy takes our positions
  - Own casualties exceeds certain thresholds

Conceptual Requirements from Metrics Necessities

- *Metrics (measure of success) must be based on **operational** warfighter definitions*
- *Metrics shall not be based on model artifacts*
- *Metrics must be communicated in **machine-understandable** form*

Summary

- The traditional 5 W “Who is do What, Where, When, and Why” are not sufficient
- Spatio-temporal and operational constraints with enabling metrics are needed as well.
- These concepts then need to be composed based on construction mechanisms, such as grammars, production rules, or other adequate mathematical tools.
- While the construction mechanism is important to support parsers, the focus of conceptual work should lie on the underlying conceptual model, as only common conceptualization enable the lossless mediation between viewpoints represented by alternative implementations.