13TH ICCRTS
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Machine Interpretable Representation of Commander's Intent

I-188

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Objectives

- Present the Operations Intent and Effects Model (OIEM) and its application
- Present a formalization of Effects
- Present a formalization of Commander's Intent Using Expressives to convey style of Command

Complex Endeavors

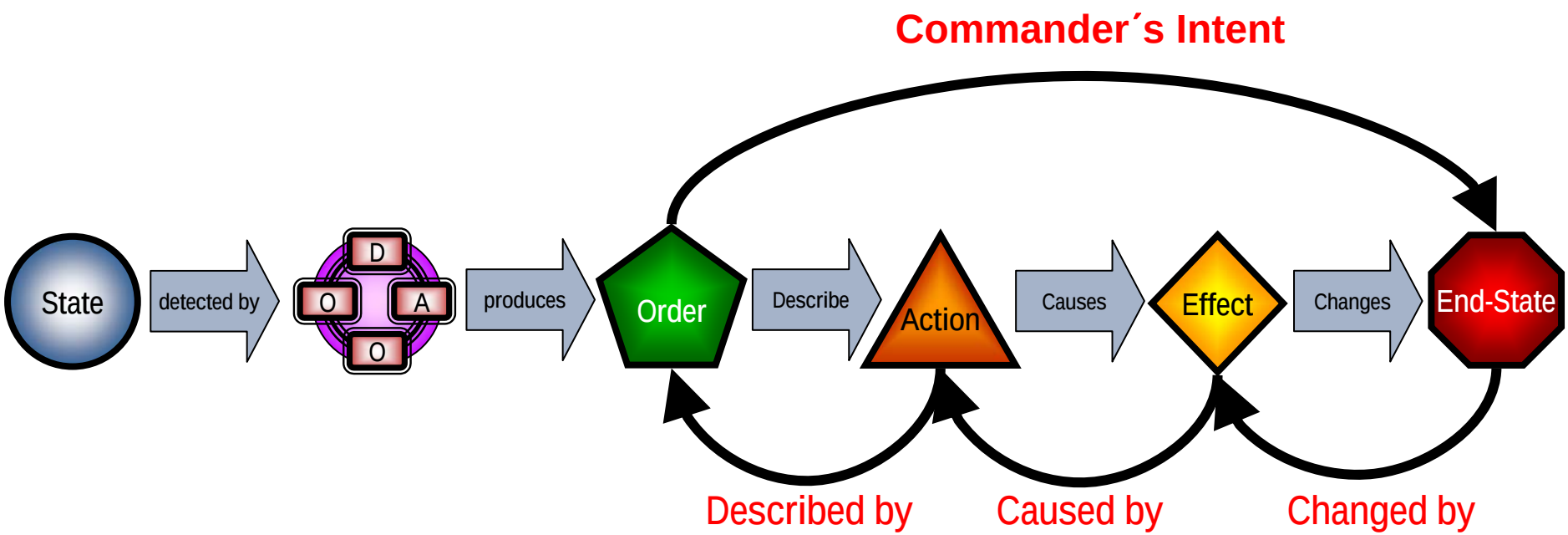
Involves a New Understanding of Missions

- Situational Awareness is essential
- Agile development of plans
- Agile execution of actions
- Intent (referred to here as Commander's Intent)

Network Centric paradigm

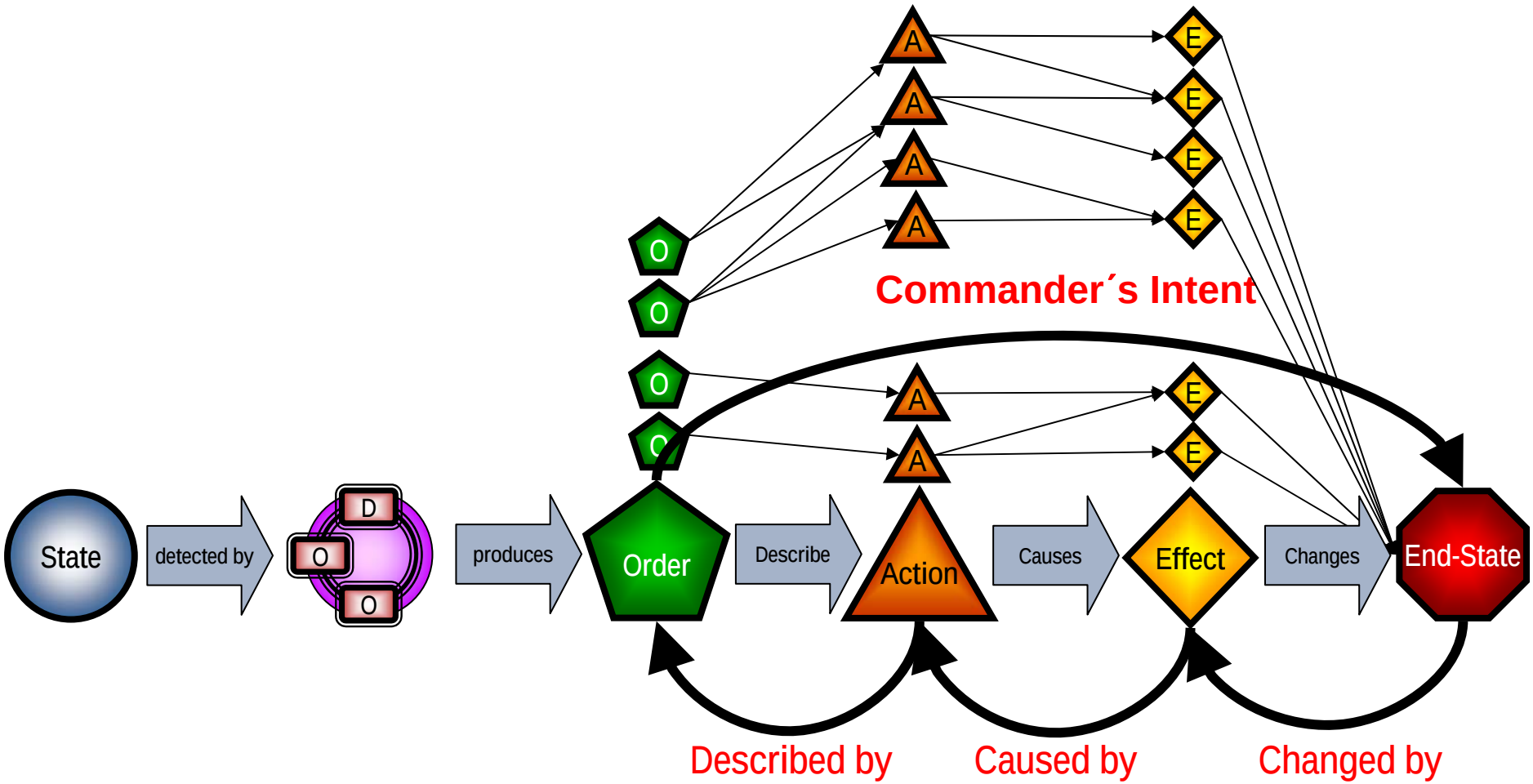
- Self Synchronization
  - Self-directed teams
  - Subordinates make their own initiatives
  - Information needs to be shared
  - autonomy is created by setting boundaries
- Understanding complex causes and effects
  - Ability to observe effects from actions
  - Actions need to be connected with kind of Effect they can deliver
    - from a positive direction [moving towards Commander's Intention/End-State]
    - and the opposite direction [moving from the desired End-State to determine which Effects are required].

Operations Intent and Effects Model (OIEM)



C4I Center

Operations Intent and Effects Model (OIEM)



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Commander's Intent

1. The purpose of the task (the higher-level goals);
2. The objective of the task (an image of the desired outcome);
3. The sequence of steps in the plan;
4. The rationale for the plan;
5. The key decisions that may have to be made;
6. Antigoals (unwanted outcomes);
7. Constraints and other considerations.

Sources of Power (Klein, 1994)

Commander's Intent – Explicit vs Implict

(Pigeau and McCann 2000)

- Explicit
  - Developed close to the mission / in the mission
  - Formally described
  - Shared between commander and subordinates
  - Describes End-State, Purpose, Key Tasks
- Implicit
  - Developed over a longer time, prior to the mission
  - Not formally described
  - Not shared between commander and subordinates
  - Describes "Common-knowledge" Expressives and concepts, policies, laws and agreed doctrine by military,civil, organizations, agencies, nations and coalitions

Expressives

Style of the commander conducting the operations with respect to:

- Experience
- Risk Taking
- Use of power and force
- Diplomacy
- Ethics
- Norms
- Creativity
- Unorthodox behavior

How Should Intent be Represented for Collaborative Environments?

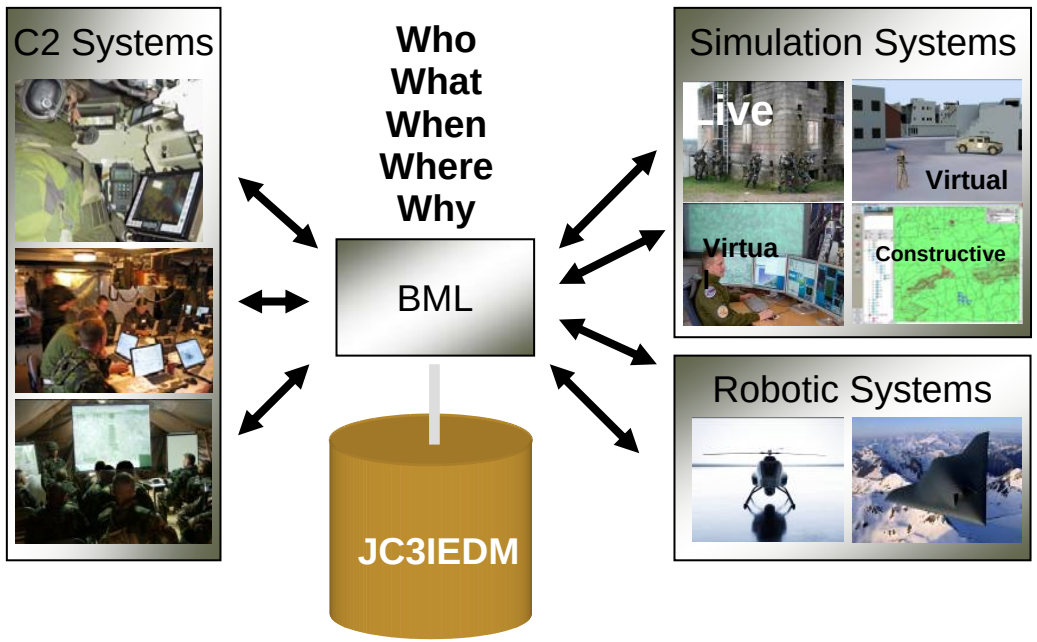
- **Clear**
  - Concise
  - conforms to agrred doctrine, procedures and methods
- **Minimun ambiguity**
  - **explicit structure with only one clear definite outcome**
- **Understandable**
  - **semantics are kept**

- What if a clear unabigious representation suitable for collaborative environments were available? What would it be like?

Formalizing Commander's Intent
Command and Control Lexical Grammar (C2LG)

(Schade and Hieb 2006, 2008 (A Linguistic Basis for Multi-Agent Coordination I-152))

- Tasking, report and Intent grammar
- The language is a context free grammar that is derived from computational linguistics



Command and Control Lexical Grammar (C2LG) – Tasks and Reports

The production rules for the basic expressions

have the following general form:

OB → Verb Tasker Taskee (Affected | Action)

Where Start-When (End-When) Why Label (Mod)*

"Verb" is an action, normally a task

"Tasker" is a "Who", the unit which commands the task

"Taskee" is a "Who", the unit which executes the task

"Affected" is a "Who", the unit which is affected by the task

"Action" is another action/task affected by the task

"Where" is a "location phrase"

"When" is a "time phrase"

"Label" is a label given to a task to allow it to be referred in other basic expressions

"Mod" refers to conditional modifiers

Command Intent

- CI→[Expanded Purpose] [Key Tasks] [End State] Expressives

- The Expanded Purpose is similar to the End State, but expresses more general aspects of the resulting situation.
- The Key Tasks are tasks and conditions that are essential to accomplishing the mission.
- The (desired) End State describes the resulting situation that is achieved when the mission is accomplished.
- The Expressives describe the style of the commander conducting the operations Expressives → Style Level

Effect Based Thinking

- A HQ analyses and decomposes the desired situation into desired Effects (physical and non-physical), links them to desired Actions (based on available resources), synchronizes the desired Effects and Actions, and develops an Effects-Based Plan.

But there is a

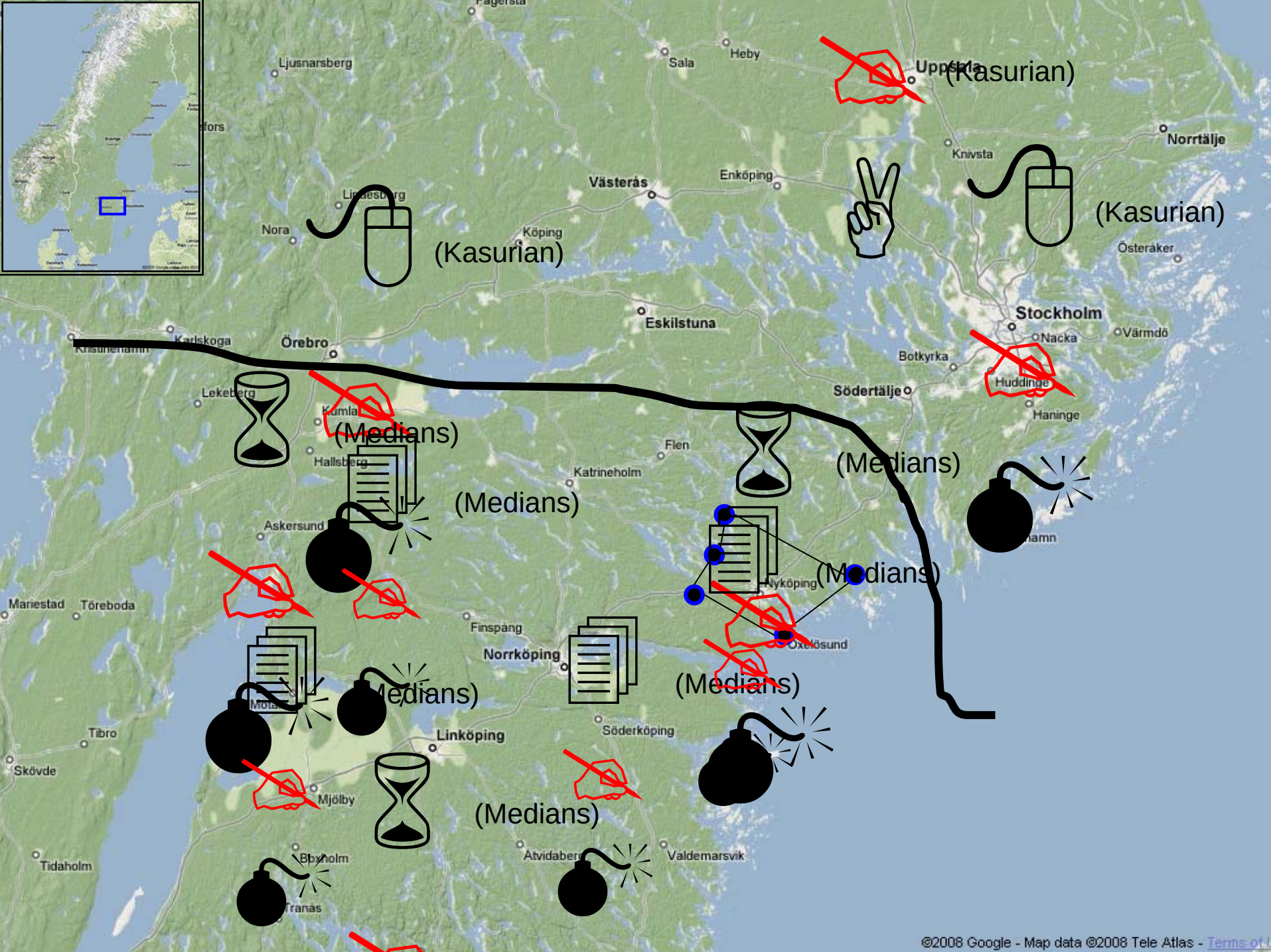
- Need to communicate Effects, End-State and Courses of Action between HQ members and Subordinate Commanders.
- Need for the Subordinate Commander to communicate the resulting plan to the HQ.

Representing Effect for Communication

- **Effect → Effect Verb Executer Affected Certainty Label**
- The verbs used in Effect can be derived from the purpose verbs found in FM 101-5, a selection of action-task-activity-code and action-effect
- Affected is a Who and can be a an environmental object as well
- Action is a What and is taken from action-task-activity-code
- Executer is a Who
- Certainty describes the certainty that the Effect can be delivered toward the Affected with the Action executed by the Executer.

Example

- The scenario is from the Swedish Land Warfare Center and is used in exercises where the battalion staff is trained.
- The Brigade commander issues an OPORD to the Battalion commander (56) pages long
- “Snippets” of the Order are used in the example to explain the OIEM model and the formalism that enables Machine Interpretation of Command Intent and in multi-agency multi-national collaboration.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Kristinehamn
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Katrineholm
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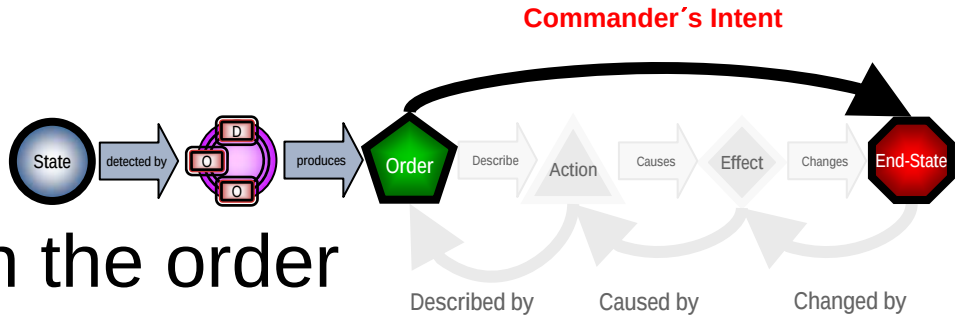
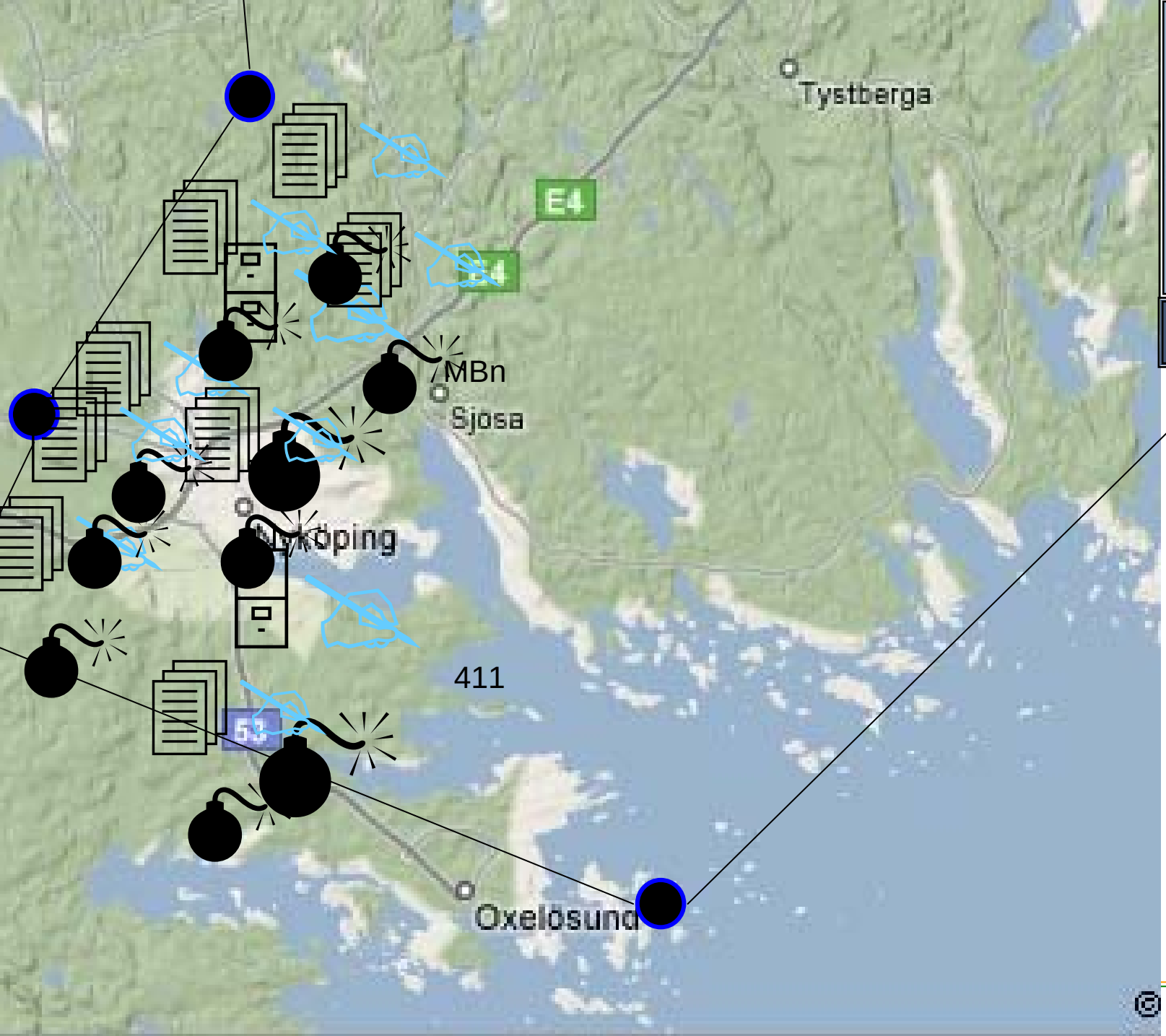
Commander's Intent



- End-State is described in the order

- The harbor in OXELÖSUND (X06 Y74) (SPOD) is operative and our sea assets can use it **without** risking being affected from sea, air or ground.
- SKAVSTA airport (X18 Y63) (APOD) is operative and usable to our air assets. Direct fire, SAM or mortars can **not** affect the airport.
- Brigade has at least one main supply route open from the SPOD to the APOD.
- etc …

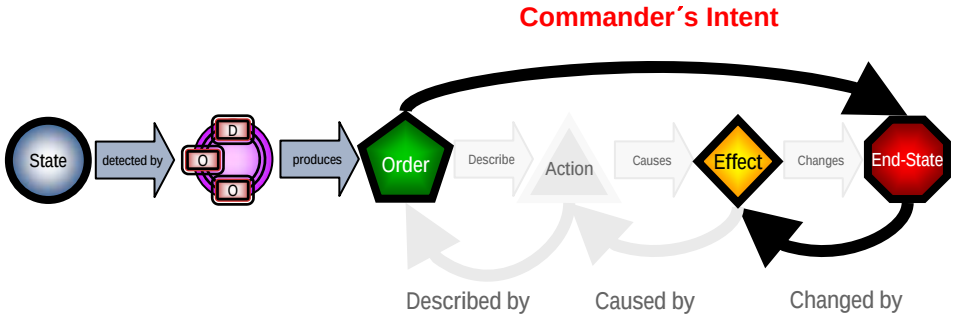


Mission Area

Representing Commander's Intent

- SKAVSTA airport (X18 Y63) (APOD) is operative and usable to our air assets. Direct fire, SAM or mortars can not affect the airport.
- [End State]→ **Status-Report** own **status-general** APOD Operational SKAVSTA airport (X18 Y63) **start at** Date-Time-5 Fact label-ES2.1
- [End State]→ **Status-Report** own **status-general** AirAssets Operational SKAVSTA airport (X18 Y63) **start at** Date-Time-5 Fact label-ES2.2
- [End State]→ **No Event-Report** NKN Direct-fire label-ES2.2 SKAVSTA airport (X18 Y63) **start at** Date-Time-5 Fact label-ES2.3

Effect



- SKAVSTA airport (X18 Y63) (APOD) is operative and usable to our air assets. Direct fire, SAM or mortars can not affect the airport.
- [End State]→ **Status-Report** own **status-general** APOD Operational SKAVSTA airport (X18 Y63) **start at** Date-Time-5 Fact label-ES2.1
- **Effect → Effect Verb Executer Affected Certainty Label**
- **E→ in-order-to cause** label-ES2.1 Hold-Defensive Bde Kasurians 100%
- **E→ in-order-to** Suppress Direct-Fire Bde Assult EnyBat 100%
- **E→ in-order-to** Suppress Mortar-Fire Bde Assult EnyCoy 60%
- **E→ in-order-to** Suppress Rocket-Fire Bde Assult EnyBat 90%

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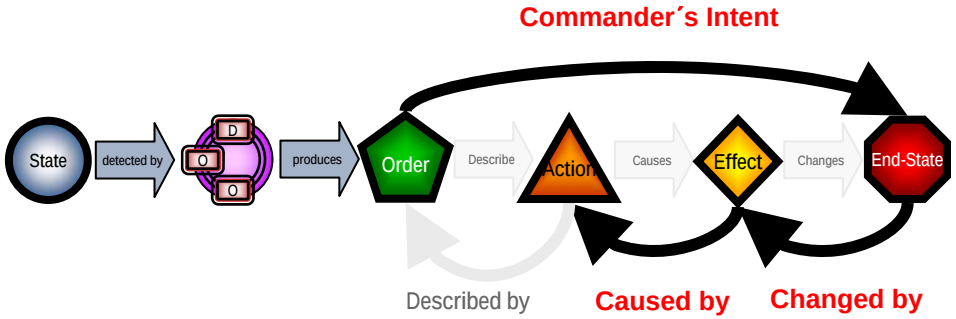
Determing Actions from Effects



E→ in-order-to Suppress Direct-Fire Assult Bde EnyBat 100%

E→ in-order-to Suppress Direct-Fire Assult MechInfBat EnyBat 80%

E→ in-order-to Suppress Direct-Fire Assult MechInfCoy EnyBat 20%

E→ in-order-to Suppress Mortar-Fire Disrupt MecInfCoy EnyCoy 60%

E→ in-order-to Suppress Mortar-Fire Assult MecInfCoy EnyCoy 60%

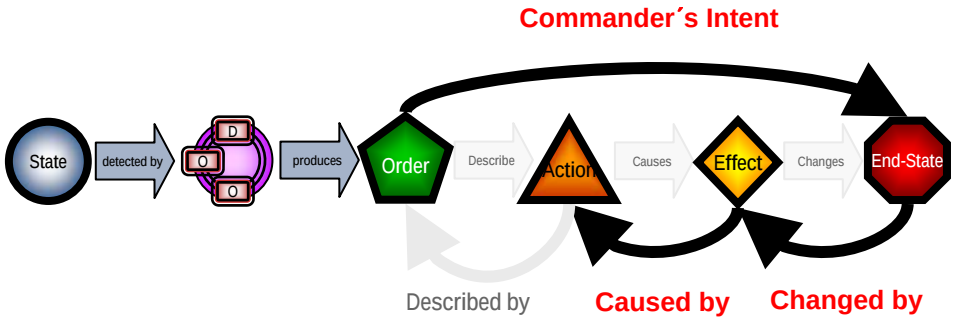
E→ in-order-to Suppress Mortar-Fire Destroy 2 Jas 39 Gripen EnyCoy 90%

E→ in-order-to Suppress Rocket-Fire Assult MechInfBat EnyBat 80%

E→ in-order-to Suppress Rocket-Fire Assult MecInfCoy Assult EnyBat 70%

E→ in-order-to Suppress Rocket-Fire Destroy 2 Jas39 Gripen EnyCoy 90%

Determing Actions from Effects



E→ in-order-to Suppress Mortar-Fire Disrupt MecInfCoy Enycoy 60%

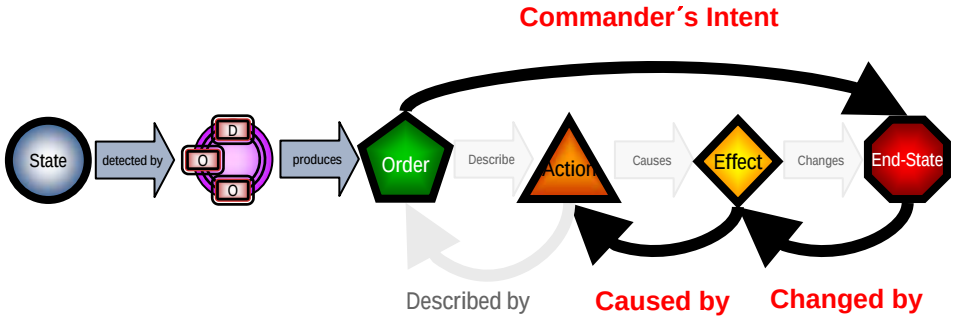
E→ in-order-to Suppress Mortar-Fire Assult MecInfCoy EnyCoy 60%

E→ in-order-to Suppress Mortar-Fire Destroy 2 Jas 39 Gripen EnyCoy 90%

When determing the Executor and Action the Certainty can in the simple case be used as the selection criteria.

In a realworld the proposed selection needs to be checked against availability future possible usage etc.

Determing Actions using Expressives



Expressives → Style Value

The usage are:

- In an operational environment where the Implicit Intent of the higher commander is made more Explicit. Enables the subordinate commanders to choose actions that leads towards the end-state.
- In a simulation environment where the goal of the Computer Generated Forces (CGF) is to utilize the CI and there is a need to communicate the implicit intent amongst the simulation models in order to get them to interact and react so that the correct Effect that leads to the desired End-State is chosen

Example:

If the commander in the example has the style of using low violence.

Expressives → [Use of power and force”] Low

The action to consider for supressing Mortar-Fire then is Disrupt.

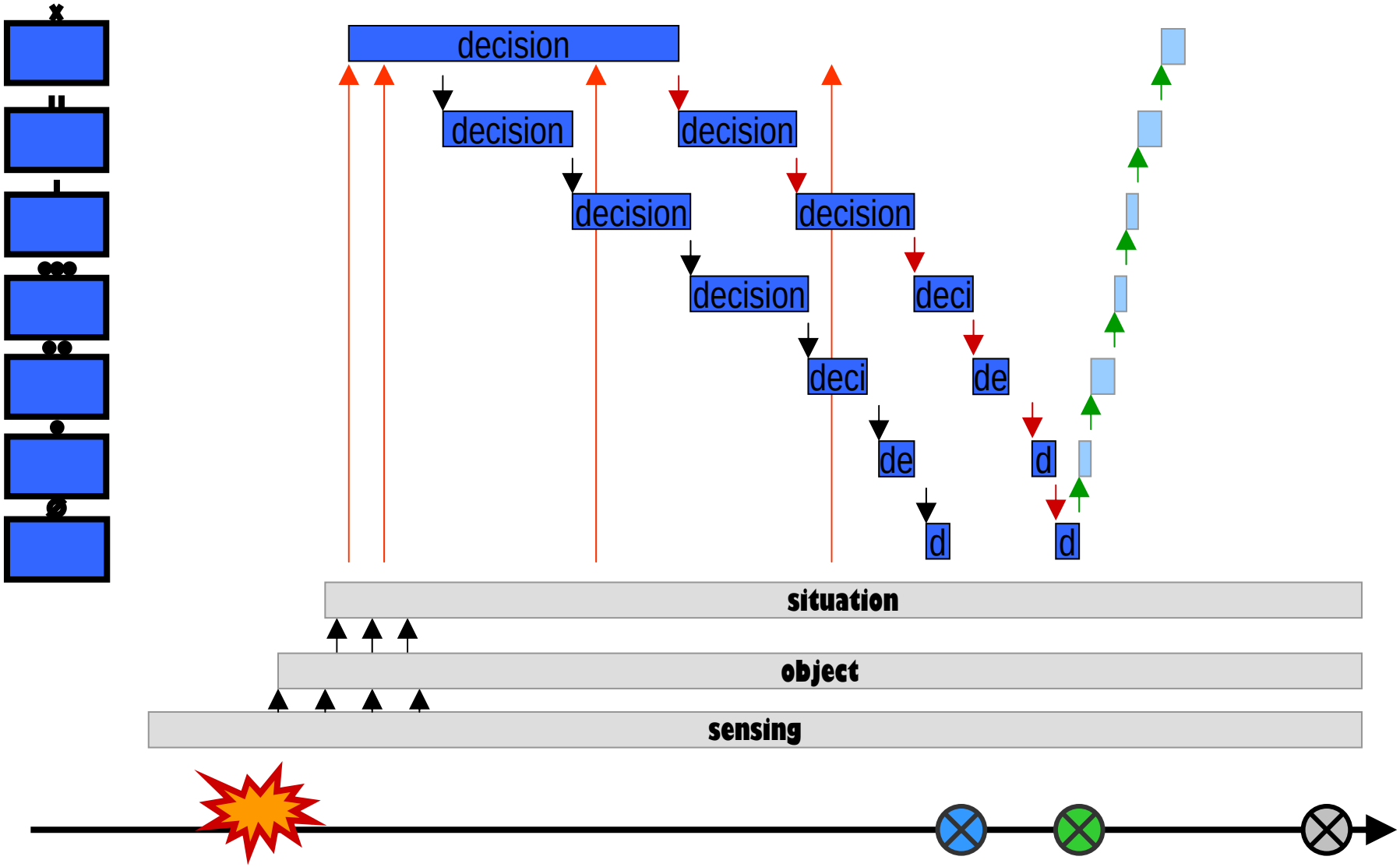
E→ in-order-to Suppress Mortar-Fire Disrupt MecInfCoy EnyCoyt 60%

E→ in-order-to Suppress Mortar-Fire Assult MecInfCoy EnyCoy 60%

E→ in-order-to Suppress Mortar-Fire Destroy 2 Jas 39 Gripen EnyCoy 90%

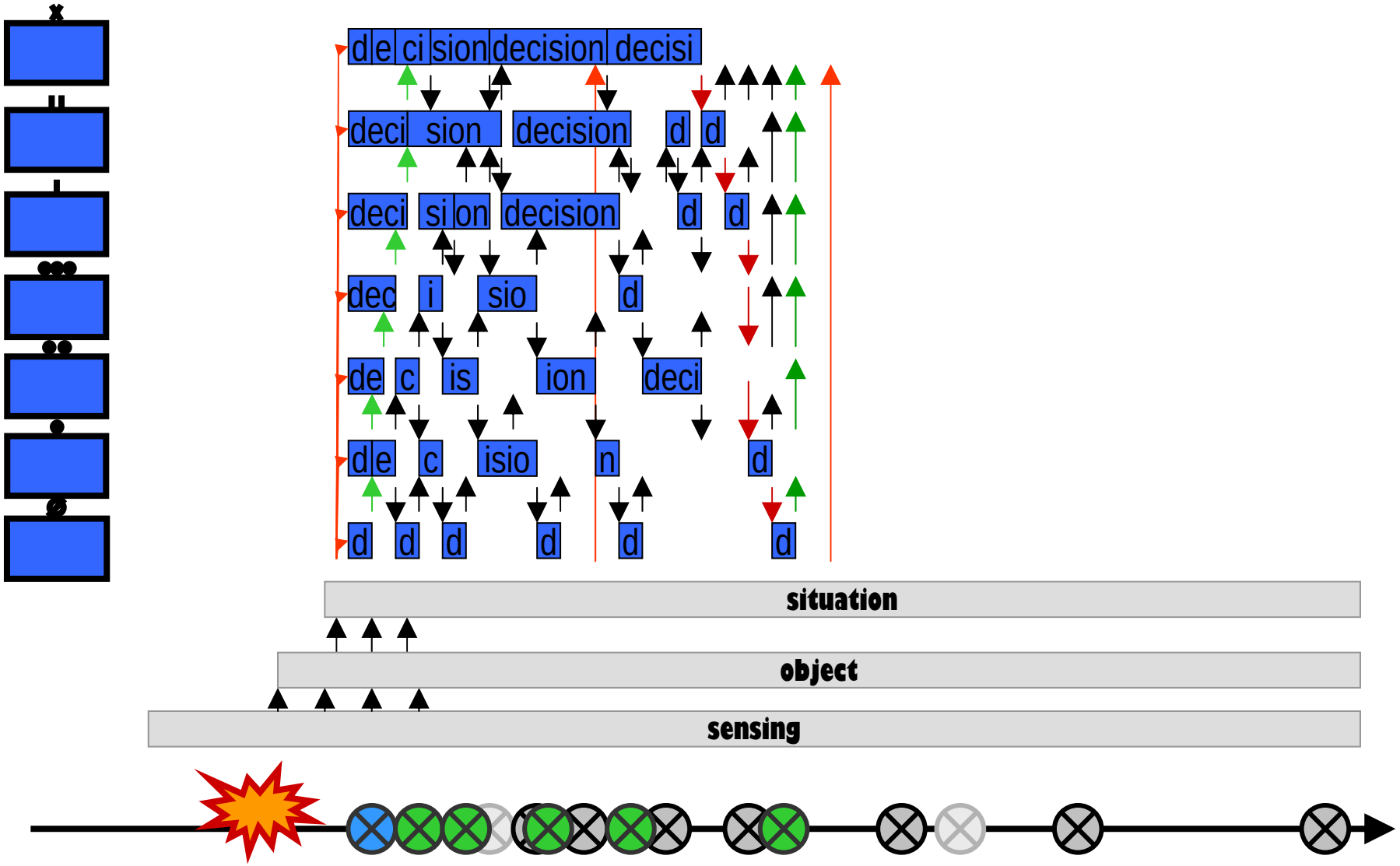
Hierarchical Decision Making (WARNO/OPORD)

with centralized information fusion

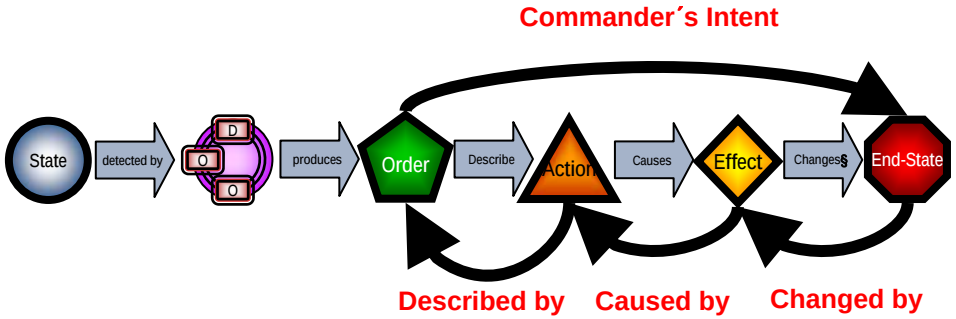


Collaborative Decsion Making

with de-centralized information fusion and constant re-planning



Summarization



- We have presented the Operations Intent and Effects Model (OIEM)– a model that relates Command Intent to Effects, and supports both traditionally military planning and Effects Based Operations.
- In order to develop collaborative decision support applications and services, computational representations of planning processes need to be developed and standardized
- Using an existing formalism called the Command and Control Lexical Grammar, we have developed several new representations for the OIEM – Expressives and Effects
- Using the OIEM and the new representations, it is possible to support collaborative planning processes, including Effects-based Planning
- These new formalisms can help in the automation of the new agile processes and collaboration used in future operations

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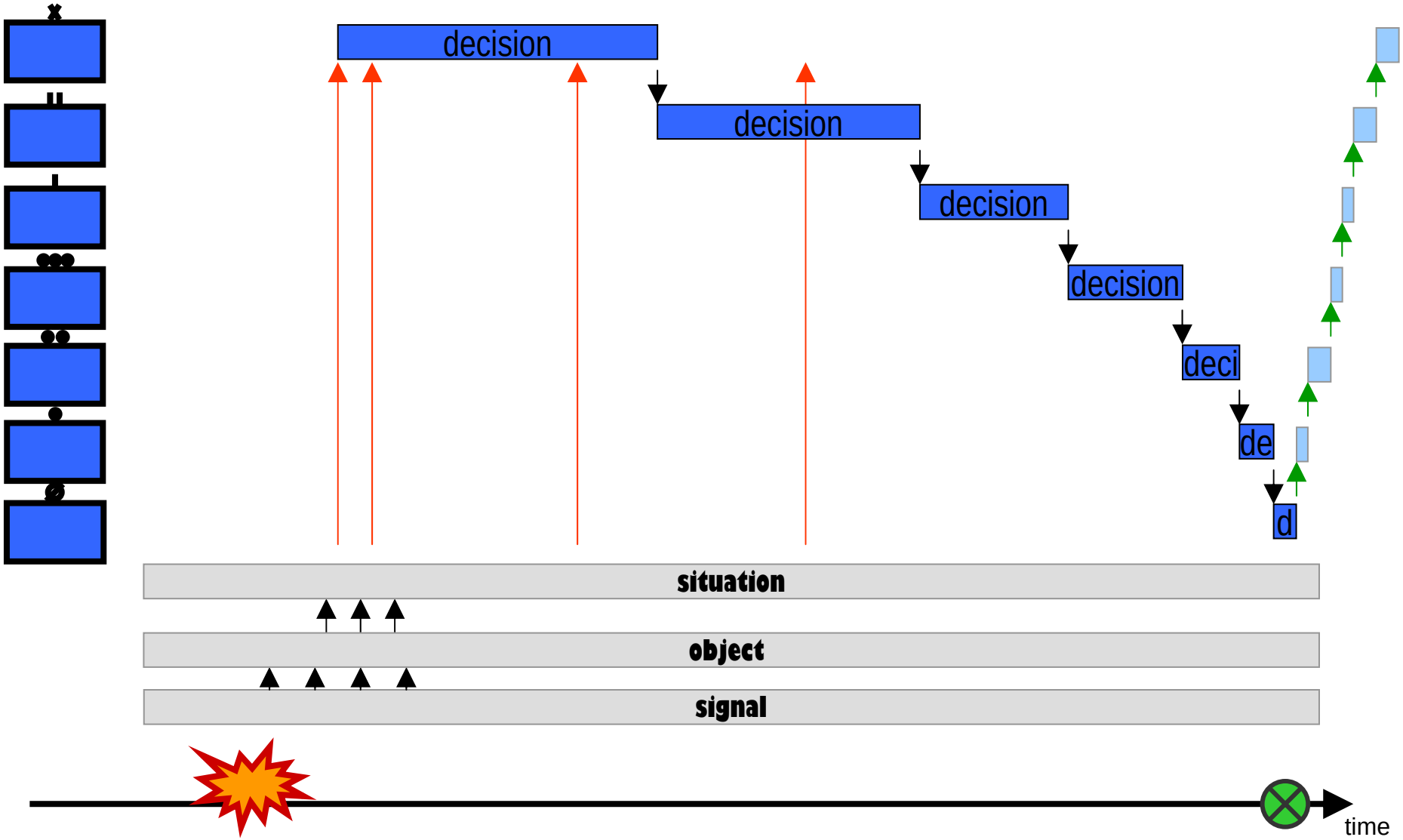
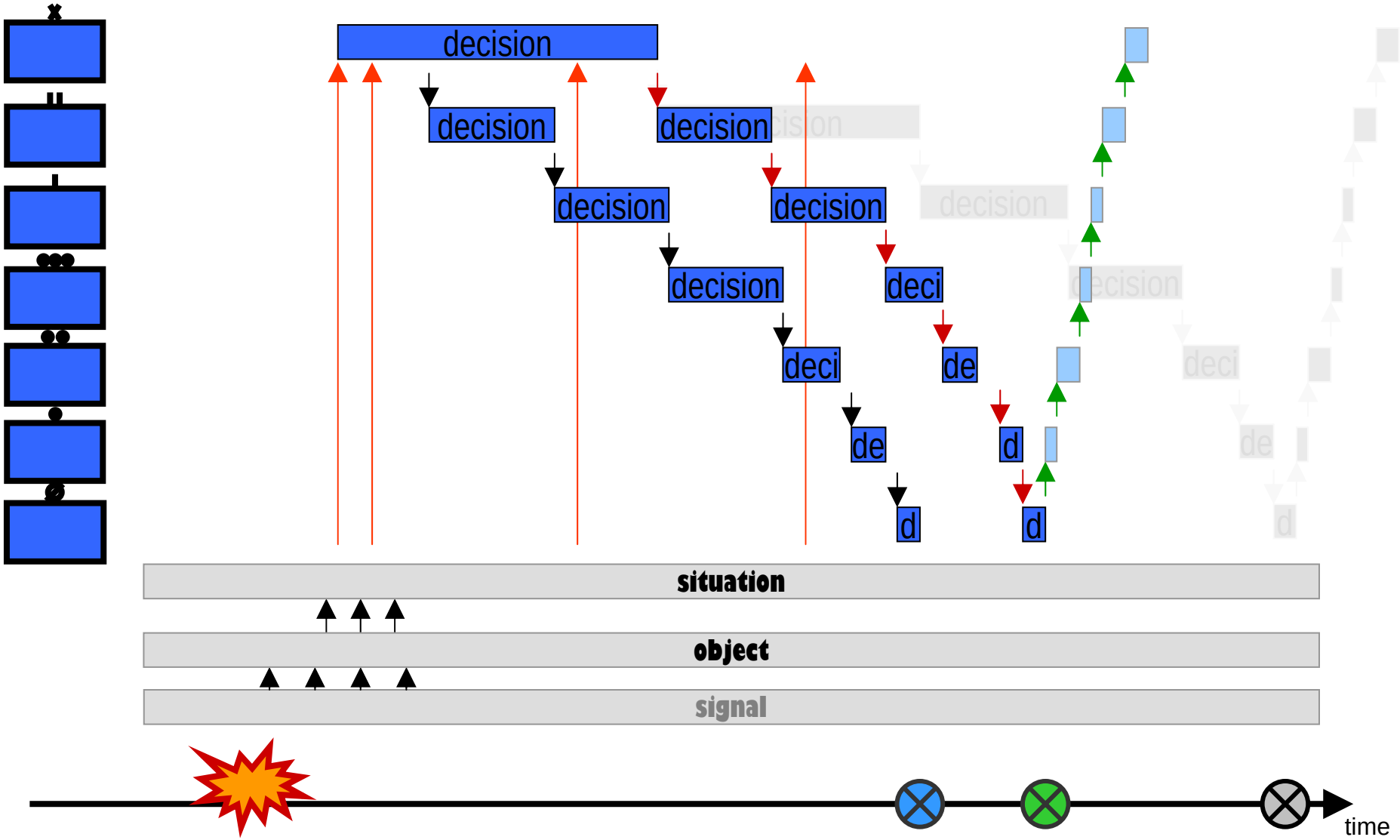
Hierarchical Decision Making
with centralized information fusion



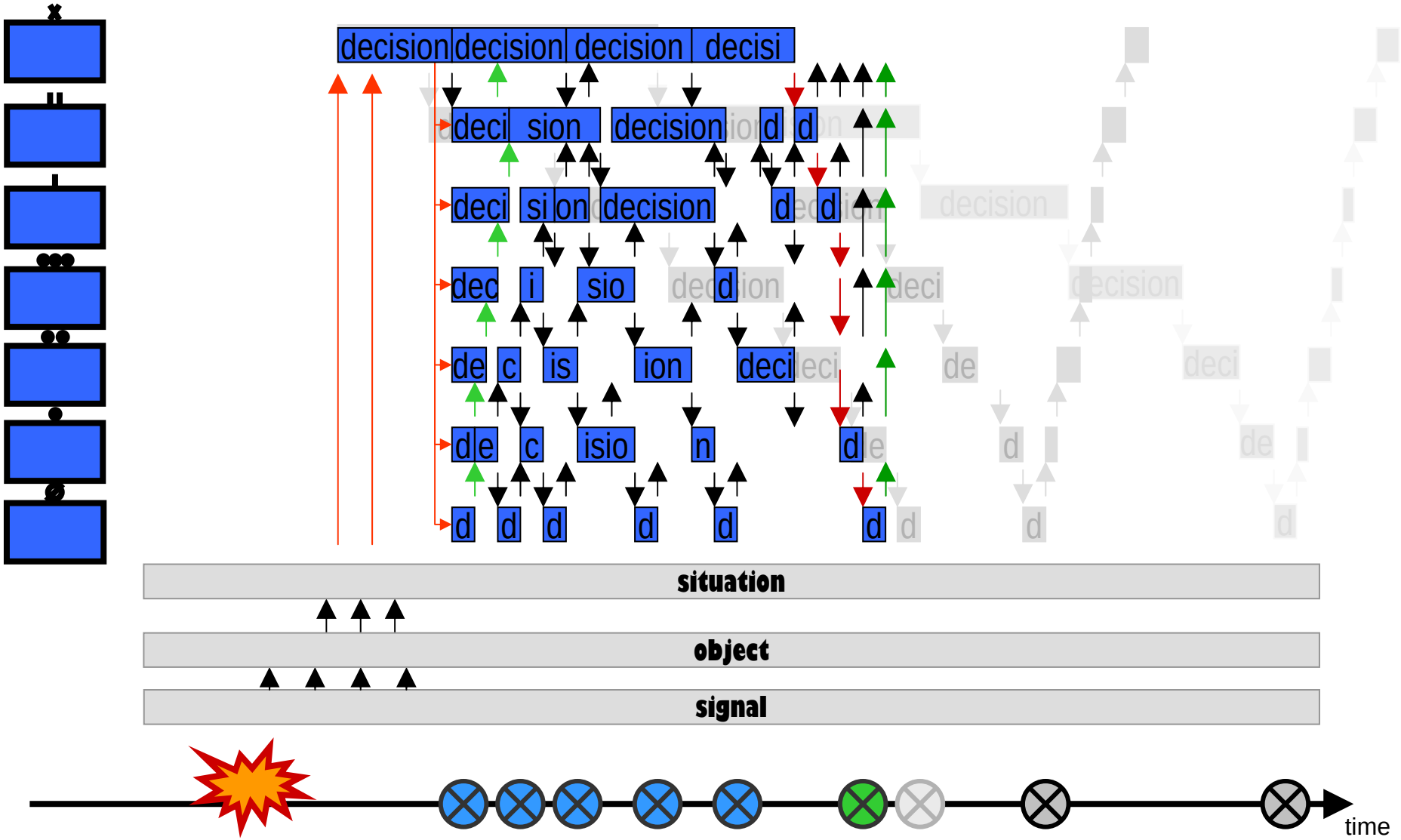
Hierarchical Decision Making (WARNO/OPORD)

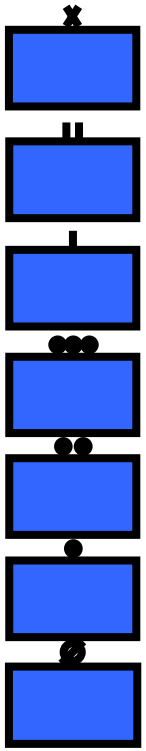
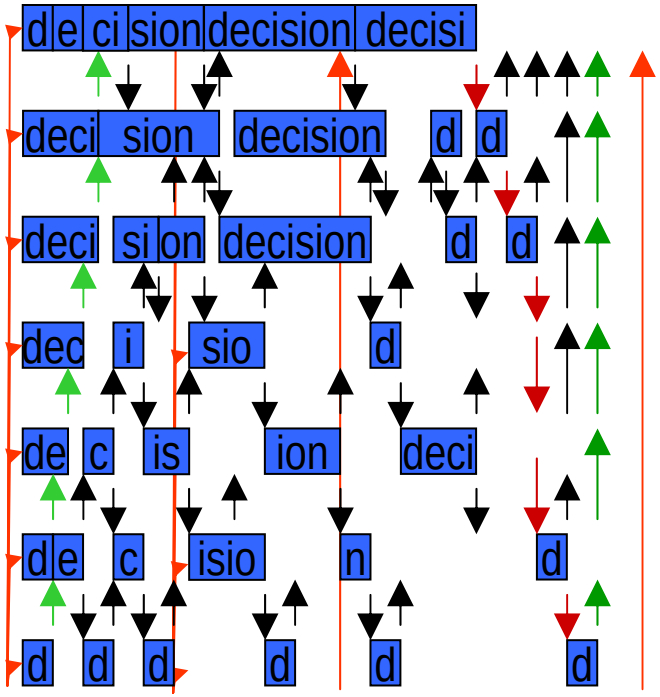
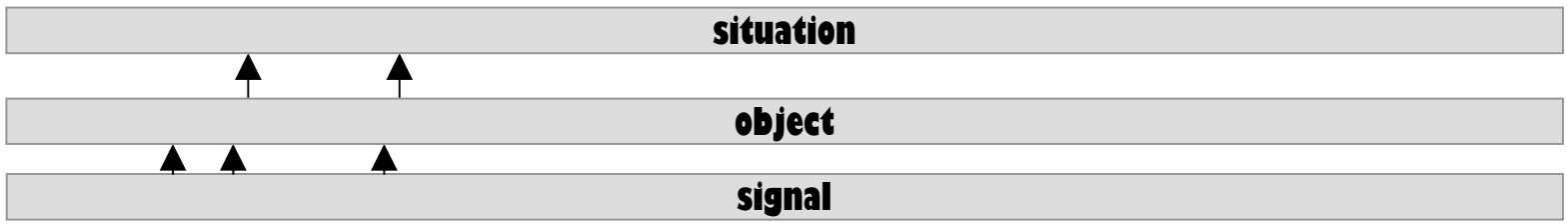
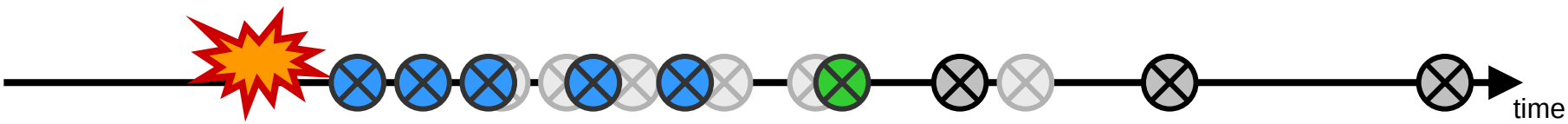
with centralized information fusion



Collaborative Decision Making

with centralized information fusion and constant re-planning



Collaborative Decsion Making

with de-centralized information fusion and constant re-planning