Formalizing Command Intent Through Development of a Command and Control Grammar

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Content

1. Motivation
2. A C2 Grammar for Tasking and Reporting
3. Formalizing Command Intent
4. Example
5. Conclusion

Definitions

The United States Department of Defence defines Commander's Intent as:

"A concise expression of the purpose of the operation and the desired end state that serves as the initial impetus for the planning process. It may also include the commander's assessment of the adversary commander's intent and an assessment of where and how much risk is acceptable during the operation."

The US Army in Field Manual 3-0, Operations, similarly defines Commander's Intent as:

"A clear, concise statement of what the force must do and the conditions the force must meet to succeed with respect to the enemy, terrain and the desired end state."

Motivation

Command and Control Decision Support Applications require **unambiguous communication.**

Network Centric Operations will only increase the need for more precise communications.

Military operations start with Command Intent. This has not been formalized such that it can be understood or processed by automated processes.

We will argue that one needs a formal language to communicate unambiguously.

Motivation

Why formalize Command Intent?

Not all recipients will get the intent out of a free text expression. They need a formalized intent. These include:

- Coalition forces not speaking English as their native tongue
- Simulated forces
  - For Exercises/Training
  - For Decision Support
- Future (smart) robotic forces

A Formal Language - Syntax and Semantics

- Formal Languages provide a rigorous framework for automated processing.
- The military domain provides excellent structure to terms and actions in a formal language.
- Current Message and Data-based communications do not go far enough – a **grammar** is needed to give additional meaning.
- Such a grammar provides the foundation for formalizing Command Intent

Motivation

A formal language is defined by a ***grammar***.
The grammar provides

- **a lexicon**

  in order to determine the words which may be used

  as well as their semantics (their meaning);

- **a finite set of rules**

  in order to determine how to concatenate the words

  and to give meaning to the catenations.

Lexical Functional Grammar

Lexical Functional Grammar (LFG) is a theory of grammar -- that is, in general terms, a theory of:

- syntax (how words can be combined together to make larger phrases, such as sentences)
- morphology (how morphemes - parts of words - can be combined to make up words),
- semantics (how and why various words and combinations of words mean what they mean), and
- pragmatics (how expressions are used to transmit information)

We use the Lexical Functional Grammar as the basis for the Formal Grammar.

Developing a Command and Control Grammar

We develop our C2 Grammar such that it includes both Command Intent, tasking and coordination.

Tasking → Command_Intent OB* Coord_Space* Coord_Time*

Command_Intent → [Expanded Purpose] [Key Tasks] [End State]

Where OB is a basic order expression that consists of a tasking verb and constituents

A C2 Tasking Grammar

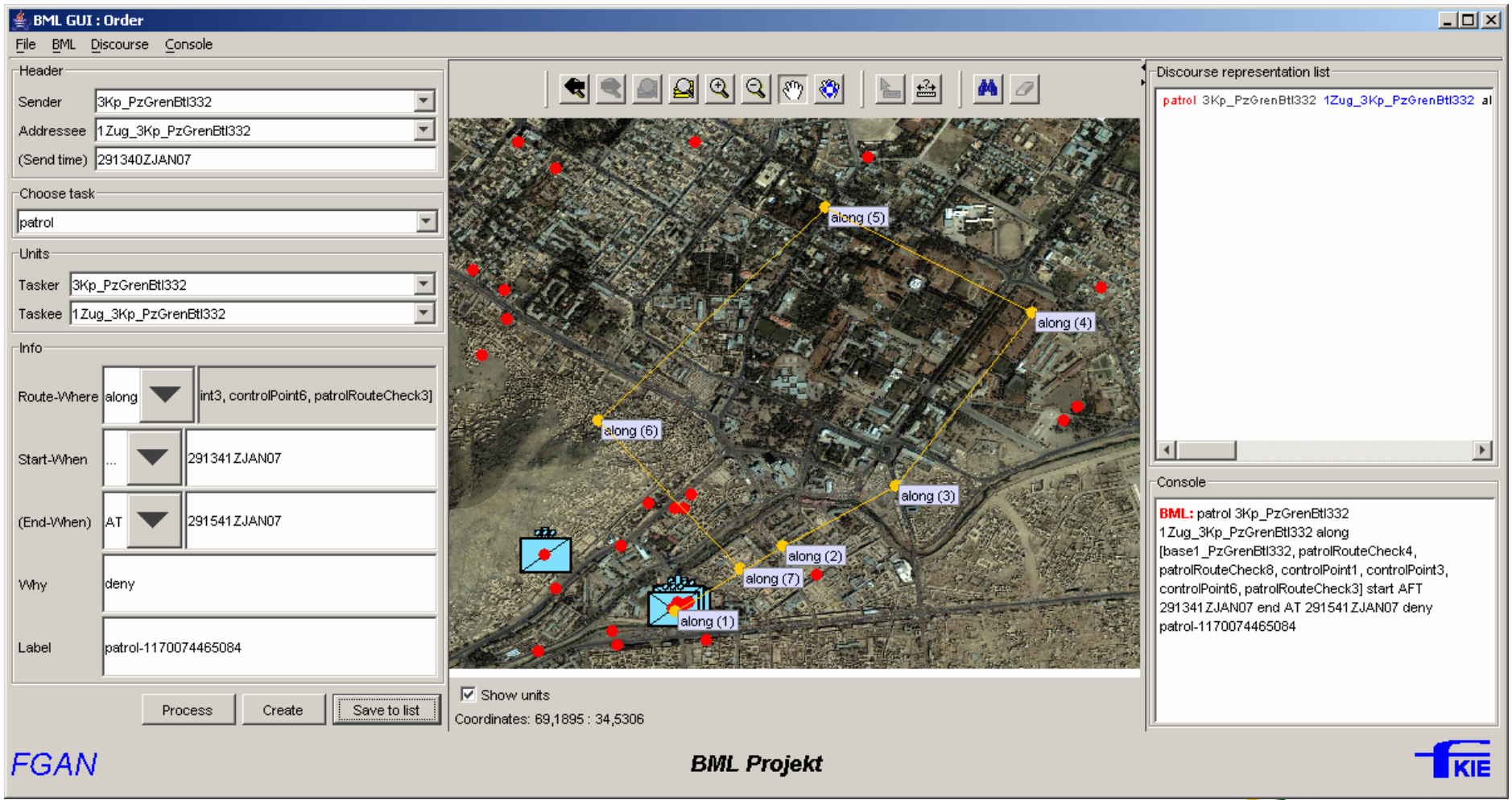
The production rules for the **basic expressions** have the following general form:

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

Example for C2 Tasking Grammar

Patrol Order Expression development



Example for C2 Tasking Grammar

Patrol Order Expression

OB → ***patrol*** Tasker Taskee Route-Where
Start-When (End-When) Why Label (Mod)*

patrol 3Kp_PzGrenBtl332 1Zug_3Kp_PzGrenBtl332

along [base1_PzGrenBtl332, patrolRouteCheck4, patrolrouteCheck8, controlPoint1, controlPoint3, controlPoint6, patrolRouteCheck3]

start aft 291341ZJAN07 ***end at*** 291541ZJAN07

in-order-to secure area_h patrol-1170074465084

A C2 Tasking Grammar

Rules for **basic expressions** (examples)

B → ***advance*** **Tasker Taskee Route-Where Start-When (End-When) Why**

B → ***ambush*** **Tasker Taskee Affected At-Where Start-When (End-When) Why**

B → ***assist*** **Tasker Taskee Action At-Where Start-When (End-When) Why**

Rules for **constituents** (examples)

Start-When → ***start*** **Qualifier1 Point_in_Time**

Start-When → ***start*** **Qualifier2 Action**

At-Where → ***at*** **Location**

Qualifier1 → **{ *AFT*, *ASAP*, *ASAPNL*, *ASAPNL*, *AT*, *BEF*, *NLT*, *NOB* }***

*Taken from the JC3IEDM-table "action-task-start-qualifier-code"

Why

In mission statements the Why provides the mission's purpose as in:

(1) Why → **in-order-to** PVerb (TaskLabel)

(2) Why → **in-order-to** cause EndStateLabel

(3) Why → **in-order-to** enable ExpandedPurposeLabel

FM 3-90 offers a list of "Purpose" verbs (Pverbs) to express the Why (e.g., divert, enable, deceive)

Using a combination of (1) and (2) or (3) allows the grammar to connect the course of action to the Command Intent

A C2 Reporting Grammar

In the same way, we developed a formal reporting grammar

We differentiate

- Reports about military tasks
- Reports about events
- Reports about status
- Reports about positions

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A C2 Reporting Grammar

Task Report

RB → Verb Executer (Affected|Action) Where When (Why) Certainty Label (Mod)*

Event Report

RB → EVerb (Affected|Action) Where When (Why) Certainty Label (Mod)*

Status Report/Position Report

RB → Hostility Regarding (Identification Status-Value) Where When Certainty Label (Mod)*

Command Intent

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

[Expanded Purpose] → RB*

[Key Tasks] → (OB|RB)*

[End State] → RB*

RB: basic report expression

OB: basic order expression

Command Intent

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

[Key Tasks] → (OB|RB)*

The Key Tasks are tasks and conditions that are essential to accomplishing the mission

Key Tasks can be formulated as both basic orders and basic reports

Command Intent

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

[End State] → RB*

The End State describes the resulting situation that is achieved when the mission is accomplished

Therefore the End State is modeled as it would be reported at the successful conclusion of the mission

This State can be represented by a combination of basic report expressions, consisting of task, event and status reports

Command Intent

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

[Expanded Purpose] → RB*

The Expanded Purpose is similar to the End State, but expresses more general aspects of the resulting situation.

The End State is about the resulting situation form the military perspective whereas the Expanded Purpose also considers other factors, e.g., political, consequences and results.

Being the description of a state, Expanded Purpose again is represented by basic report expressions

Example from MIP Multi-National Exercise (2003)

MNC Commander's Intent My intent is to direct two-division movement from Tactical Assembly Area (TAA) to blocking positions along PL TULIP. In the event of incursion by BRADYLAND forces, MNC forces will not allow their progress north of the buffer zone. Keys to success include safe arrival at PL TULIP, construct and occupy blocking positions along PL TULIP, to prohibit the advance of enemy forces beyond the northern boundary of the buffer zone. The main effort is the counterattacks to eject the BRADYLAND forces from GENERICLAND and restore the international border. The end state is achieved when the UN recognized border between BRADYLAND and GENERICLAND is re-established.

Expanded Purpose

CI → [Expanded Purpose] [Key Tasks] [End State]
[Expanded Purpose] → RB*

My intent is to direct two-division movement from Tactical Assembly Area (TAA) to blocking positions along PL TULIP. In the event of incursion by BRADYLAND forces, MNC forces will not allow their progress north of the buffer zone. Keys to success include safe arrival at PL TULIP, construct and occupy blocking positions along PL TULIP, to prohibit the advance of enemy forces beyond the northern boundary of the buffer zone. The main effort is the counterattacks to eject the BRADYLAND forces from GENERICLAND and restore the international border. The end state is achieved when the UN recognized border between BRADYLAND and GENERICLAND is re-established.

Status-Report neg ***hostile position*** combat-unit **at** BUFFER ZONE **at** TP6 RPTFCT label-ep-a;

Task-Report ***establish*** MNC "stabilized area" **at** GENERICLAND **start at** TP6 RPTFCT label-ep-b;

Key Tasks

CI → [Expanded Purpose] [Key Tasks] [End State]
[Key Tasks] → (OB|RB)*

My intent is to direct two-division movement from Tactical Assembly Area (TAA) to blocking positions along PL TULIP. In the event of incursion by BRADYLAND forces, MNC forces will not allow their progress north of the buffer zone. Keys to success include safe arrival at PL TULIP, construct and occupy blocking positions along PL TULIP, to prohibit the advance of enemy forces beyond the northern boundary of the buffer zone. The main effort is the counterattacks to eject the BRADYLAND forces from GENERICLAND and restore the international border. The end state is achieved when the UN recognized border between BRADYLAND and GENERICLAND is re-established.

move MNC OPEN **from** TAA **to** PL TULIP **start at** TP4 **in-order-to** enable label-kt-b label-kt-a;

occupy MNC OPEN combat zone **at** BUFFER ZONE **start nlt** TP5 **in-order-to** enable label-es-a label-kt-b;

counterattack MNC OPEN Enemy **at** BUFFER ZONE **start nlt** TP5 **in-order-to** enable label-es-a label-kt-c;

End State

CI → [Expanded Purpose] [Key Tasks] [End State]
[End State] → RB*

My intent is to direct two-division movement from Tactical Assembly Area (TAA) to blocking positions along PL TULIP. In the event of incursion by BRADYLAND forces, MNC forces will not allow their progress north of the buffer zone. Keys to success include safe arrival at PL TULIP, construct and occupy blocking positions along PL TULIP, to prohibit the advance of enemy forces beyond the northern boundary of the buffer zone. The main effort is the counterattacks to eject the BRADYLAND forces from GENERICLAND and restore the international border. The end state is achieved when the UN recognized border between BRADYLAND and GENERICLAND is re-established.

Task-Report *establish* MNC border **at** "UN Recognized Border"
end nlt TP6 RPTFCT **in-order-to** secure label-es-a;

Command Intent and Agility

- Forces knowing the command intent can react or adjust to unforeseen circumstances which might otherwise adversely affect their execution of an operation
- However, Command Intent is not currently modeled in most models and there is no standard methodology for doing so
- Robotic Forces also require Command Intent if able to respond and adapt to broken or incomplete plans
- As more information is available in Network-Centric Operations Command Intent is more important and a formalization of it is needed for future automated decision support systems

Thanks for Your Attention !

Questions and Comments are appreciated.