Command and Control Decision Aids for Robotic Autonomous Systems at the Edge

Jonathan Smith
Derek Warter
Manuel Aguas

Overview

- Who are we?
- The Goal
- The problem
- A solution
- Platform specific performance quantifications
- Aggregating heuristics
- Resilient communication protocol
- What is next?

Who are we?

DEVCOM Armaments Center

“We provide the technology for over 90% of the Army’s lethality with a focus on advanced weapons, ammunition, and fire control systems”

Intelligent Systems Branch – Networked Lethality

The goal

Enhance soldiers' lethal capabilities by allowing them to leverage autonomous assets to project force on the battlefield

Soldiers may access

- Swarms
- RCVs
- Loitering munitions
- Droppable payloads
- More…

The problem

How do we continue to increase capabilities without continually increasing the complexity to the soldiers?

How do we allow for seamless control of a mix of heterogeneous platforms?

How do we create flexibility in the system to be able to incorporate new or changing capabilities and data needs?

A solution

Provide analytics that accurately measure the capability of autonomous platforms capabilities.

Provide courses of actions (COAs) that are relevant to the soldier's mission.

Leverage a communication protocol that can encapsulate all relevant information a warfighter needs.

Platform specific performance quantification

What is the ability of a platform to engage an enemy?

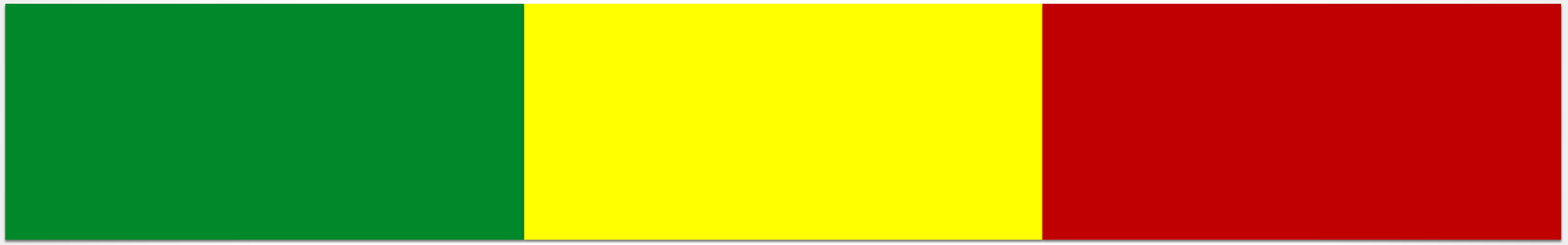
- Mobility
- Perception
- Payload
- Endurance

Platform specific performance quantification

Platform scoring is normalized to make direct comparisons easier.

Results can be bound with thresholds to establish green/yellow/red zones for rapid user assessment

Most importantly each platform is assessed by its own ability and is not “fit” into a generalized assessment model.

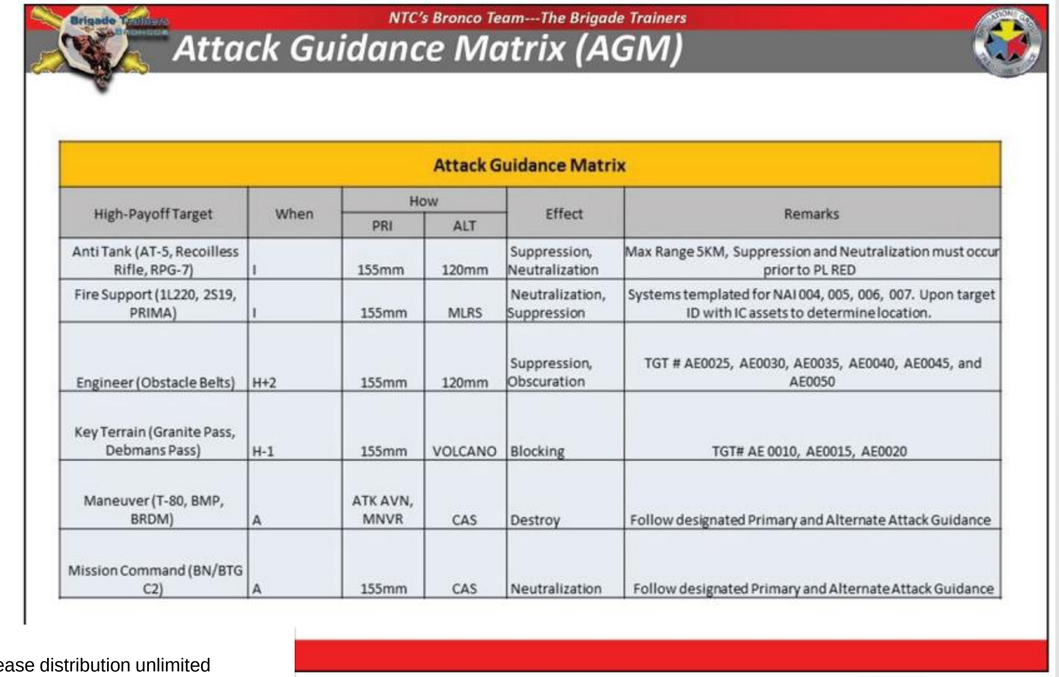


Aggregating heuristics

Dealing with small numbers of heuristics is manageable however the problem scales exponentially as effectors, targets, and actions increase.

Adding target prioritization allowed for the implementation of a greedy solution that is efficient in grappling with the combinatorial problem.

Trade off is the loss of COAs for the user



NTC's Bronco Team---The Brigade Trainers

Attack Guidance Matrix (AGM)

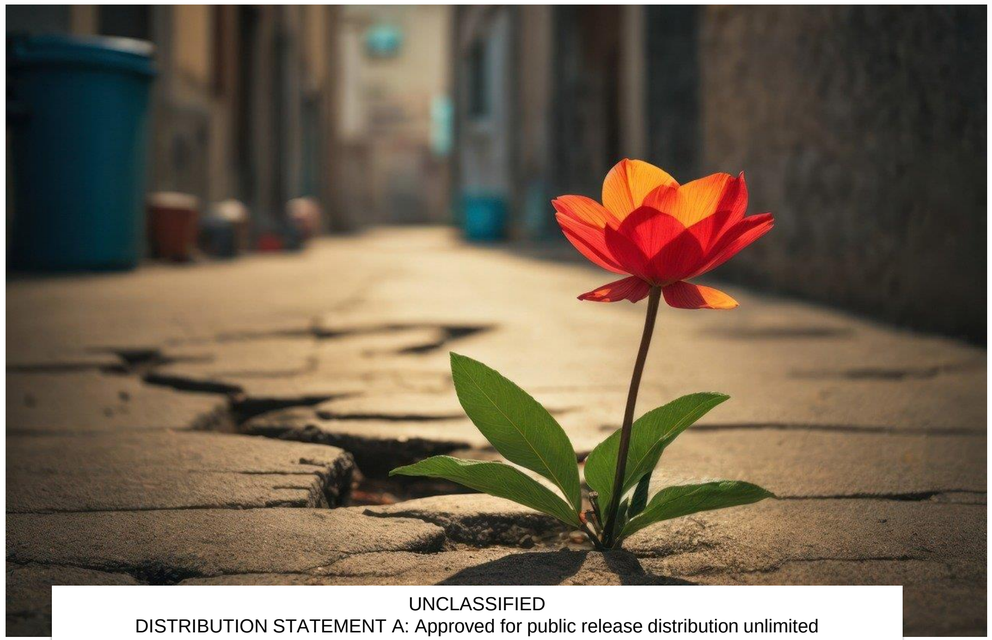
Attack Guidance Matrix

High-Payoff Target	When	How		Effect	Remarks
		PRI	ALT		
Anti Tank (AT-5, Recoilless Rifle, RPG-7)	I	155mm	120mm	Suppression, Neutralization	Max Range 5KM, Suppression and Neutralization must occur prior to PL RED
Fire Support (1L220, 2S19, PRIMA)	I	155mm	MLRS	Neutralization, Suppression	Systems templated for NAI 004, 005, 006, 007. Upon target ID with IC assets to determine location.
Engineer (Obstacle Belts)	H+2	155mm	120mm	Suppression, Obscuration	TGT # AE0025, AE0030, AE0035, AE0040, AE0045, and AE0050
Key Terrain (Granite Pass, Debmans Pass)	H-1	155mm	VOLCANO	Blocking	TGT# AE 0010, AE0015, AE0020
Maneuver (T-80, BMP, BRDM)	A	ATK AVN, MNVR	CAS	Destroy	Follow designated Primary and Alternate Attack Guidance
Mission Command (BN/BTG C2)	A	155mm	CAS	Neutralization	Follow designated Primary and Alternate Attack Guidance

Resilient communication protocol

The data protocol that is used must be able to deliver data with the correct resolution as required by the platform specific performance qualifiers.

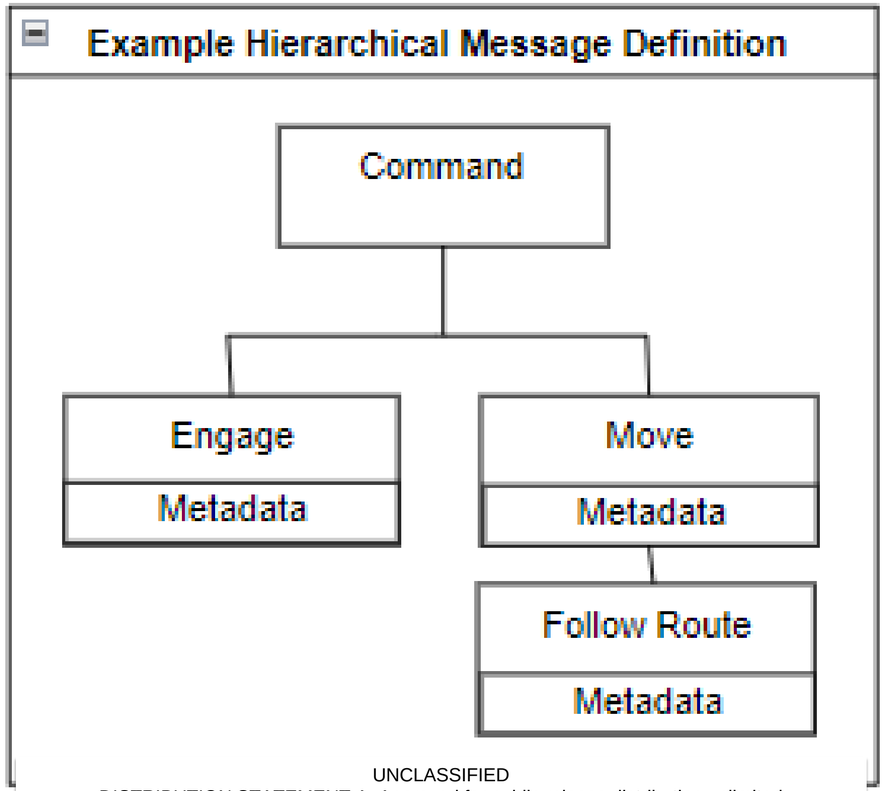
A hierarchical data structure is used to unlock polymorphism in data



Data polymorphism

High level messages are defined

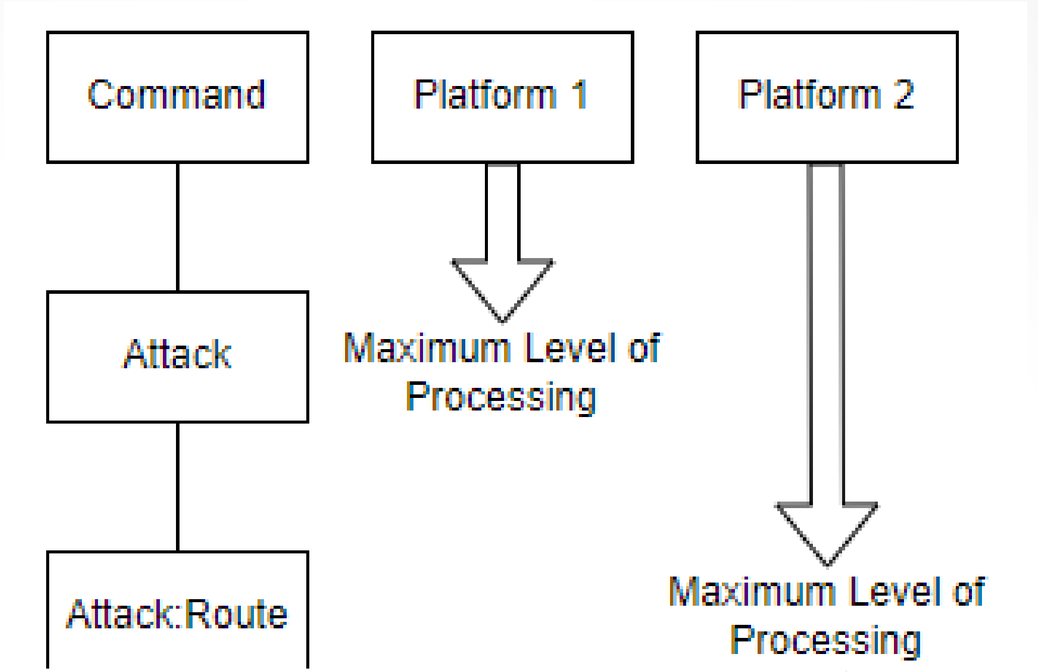
Messages are decomposed to the maximum level of resolution desired.



Message consumption

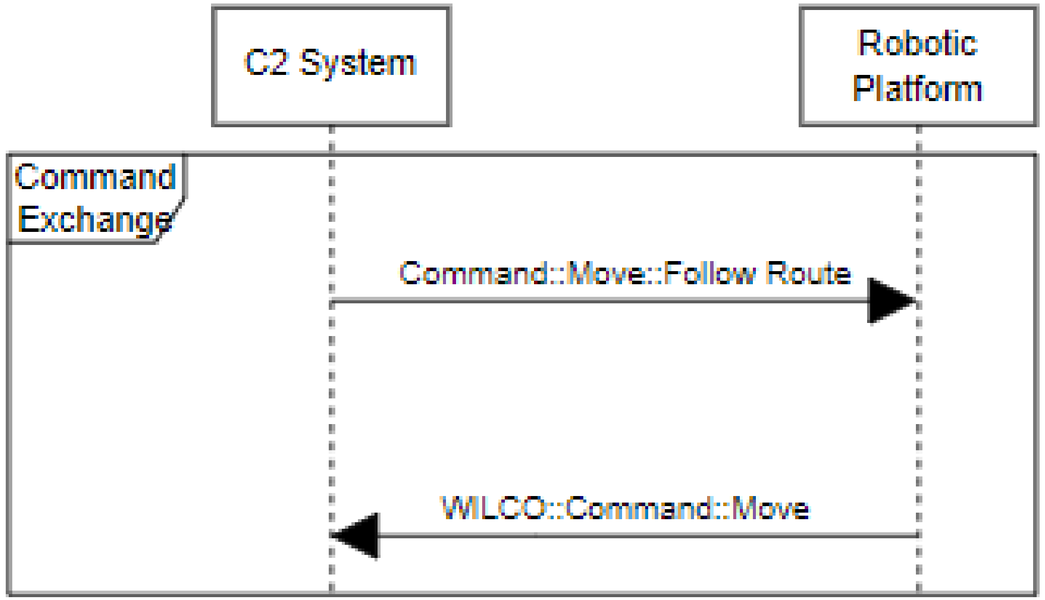
Top down interpretation ensures that platforms interpret the messages to the level they can comply.

Meta data is associated with each resolution level appropriate to the granularity of the message



Closing the loop

Platforms indicate their level of compliance by reflecting the message back to the originator.



Resilient data protocol benefits

Allows for the resolution of capabilities to be expanded without requiring rework of systems implementing the protocol.

Allows for a single message to be issued and it interpreted at each systems capability level.

Allows for operators to be informed of compliance level.

What is next?

Continue working with partners for determining methods of evaluating layered effects

Open up heuristic evaluation to user defined and network communicated heuristics

Evaluate results against alternative approaches such as historically/simulation trained ML models.

Questions