

Ontology of Plays for Autonomous Teaming and Collaboration.

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Abstract. *We propose a domain-level ontology of plays for the facilitation of play-based collaborative autonomy among unmanned and manned-unmanned aircraft teams in the Army's Unmanned Aircraft System (UAS) mission domain. We define a play as a type of plan that prescribes some pattern of intentional acts that are intended to reliably result in some goal in some competitive context, and which specifies one or more roles that are realized by those prescribed intentional acts. The ontology is well suited to be extended to other types of military and nonmilitary unmanned vehicle operations.*

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1. Introduction

Teams of autonomous unmanned vehicles capable of collaboration remains a highly desired goal for defense and civilian applications (Giles and Giammarco 2019; Chung 2021; Heisey et al. 2020; Heron System 2019; Noghabi 2020). In the following, we propose a domain-level ontology to facilitate teaming and collaboration for multi-agent systems (MAS)s of this sort within the Army's Unmanned Aircraft System (UAS) mission domain.

To this end, we are building the Ontology of Plays for Teaming and Collaboration (OPTaC) to support Army efforts to design, test, and operate teams of collaborative autonomous and semi-autonomous Unmanned Aerial Vehicles (UAVs). These include autonomous and collaborative teams of UAVs capable of adjusting to contingencies in highly dynamic military environments. Relevant contingencies include: gaining or losing team members, communication interruptions between members, and the need for rapid replanning to respond to unforeseen events whose type, number, and duration may be unknown in advance. Though we focus specifically on Army aviation, the ontology we present is well suited to be extended to other types of unmanned vehicle operations, both military and non-military.

At the core of the ontology is the idea of a *play*, an idea which we take from the playbooks used in football and other sports. The purpose of the use of plays in sports is to facilitate collaborative team behavior. Analogous plays designed and tested for use in military operations will similarly help to enable collaborative behavior among the different members of an autonomous UAV team by specifying the roles each member has, the corresponding rights and responsibilities each member is assigned, and the actions they should take when working together toward achieving a mission objective. OPTaC provides the vocabulary and structure to enable consistent communication and data collection by and about UAVs participating in play-based teaming and collaboration.

2 Background

2.1 Ontology

Following (Arp, Smith, and Spear 2015), we understand an ontology to be a controlled vocabulary of logically well-defined terms, hierarchically structured through type-subtype relations. The terms in an ontology are used to tag and semantically enhance diverse data in such a way as to integrate the data in a computational environment (David et al. 2011). We use Basic Formal Ontology (BFO) (Arp, Smith, and Spear 2015) as the top-level ontology which OPTaC uses as its starting point. BFO provides a set of logically defined terms of high generality – such as *object*, *role*, *function* and *process*. Building OPTaC as an extension of BFO helps to ensure a coherent logical structure to the ontology which results.

OPTaC is a *realist* ontology, meaning that its terms are intended to represent types of entities and relations *as they are in reality*. The realist principles that underlie BFO have met with considerable success already in other domains, especially in biomedicine, as can be seen in the widespread use of the ontologies curated by the Open Biological and Biomedical Ontology (OBO) Foundry, all of which are built and controlled using these principles (The OBO Foundry 2020; Arp, Smith, and Spear 2015; Kelly et al. 2021). BFO is also designated as standard, ISO/IEC 21823-2 by the International Standards Organization, and it is therefore an ideal candidate for providing a unifying framework for representing the entities and relations in our domain of interest. Other ontologies, for example DOLCE or UFO, might have been adopted as top-level ontology in this work. However, we selected BFO because of its large user base both inside and outside of military contexts and the substantial body of literature addressed to different types of audiences on how to use BFO (Smith et al. 2020).

To construct OPTaC, we extend the Common Core Ontology (CCO) ecosystem, which has been developed to support a variety of ontology initiatives in the military and intelligence arena. CCO comprises a number of open-source, mid-level ontologies designed to “represent and integrate generic classes and relations across all domains of interest” (CUBRC 2020).

2.2 The Multi-Agent UAV Mission Operations Domain

The Army employs Unmanned Aerial Systems (UASs) in a variety of missions, including reconnaissance, surveillance, search and rescue, and supply delivery. An Unmanned Aerial System (UAS) is the system formed by every component necessary to the proper

functioning of a UAV, including its GPS and ground control modules, its transmission systems, camera and sensor systems, as well as the person or persons on the ground who are controlling the UAV. In their current operations, a UAS typically includes both a UAV operator and a sensor operator, who together control a single platform. An arrangement of this sort does not scale to multiple vehicles and complex situations: the workload involved where each person simultaneously controls multiple assets quickly becomes untenable. In the future, therefore, the Army envisions small numbers of UAVs working as a team, with each such UAV team being controlled, for example by one to two soldiers in a forward location on the ground, or paired with a manned flight vehicle and controlled by a crew member.

In the Army's use cases, a soldier would call a play that would efficiently command the team to carry out some mission. Each team member would understand the processes and procedures and various roles needed to carry out the mission. Roles would then be assigned to team members – both human and non-human –according to their capability to perform the activities that mission requires. A search and rescue play might consist in a team of three members, where one member has the communication capabilities required to serve as a communication relay, another member has the sensor capabilities required to perform various search patterns, and the third member has the grappling and lifting capabilities needed to retrieve equipment. Commanders would be able to adjust the particulars of the play as the environment and specific mission objectives dictate, for example adjusting timelines or areas of operation. Commanders would also be able to quickly change the play call to respond to changing circumstances. For example, a team implementing a cargo delivery play could be re-tasked with a search and rescue play and consequently re-organized into a search and rescue team on the fly.

Soldiers in manned-unmanned teams (MUM-T) would also be trained in sets of plays for given mission types, so that they are well-drilled for effective and efficient coordination with their UAV counterparts. Furthermore, play calling and training would utilize a standardized short-form vocabulary, similar to the naming practices for football plays, that are known by team members and that keep communication and user interface requirements minimal.

3. Plays, Roles, and Objectives

3.1 Central Classes

We begin by characterizing the essential entity types constitutive of the UAV mission operation process. Fundamental to that process are the following four kinds of classes:

- (1) classes of *information entities*, such as flight and reconnaissance plans and other directives given to operators or programmed into UAVs;
- (2) classes of *agents*, such as UAV operators and autonomous UAVs that send, receive, and follow directives;
- (3) classes of *processes*, such as flight, communication, and observation processes prescribed by those directives and performed by those agents; and
- (4) classes of *roles*, such as commander, operator, wingman, and decoy roles that are assigned to the participants in those processes and dictate the prescriptions each participant is responsible for.

For example, a UAV team surveillance mission operation to monitor a particular location begins with a plan or some other set of instructions. These are given to a UAV team who then implement the plan and perform the required surveillance activities where each member performs the tasks associated with the role they are assigned. We take the information that is shared and utilized in multi-agent operations to be central to facilitating collaborative processes and teamwork, and classes of sort (1) are used to identify and unify classes of sort (2), (3), and (4) above.

3.2 Plays

The central class of OPTaC is **play** (henceforth, we use bold text when referring to an **entity type** or **class**). Plays and mission playbooks have received attention in the military UAV research domain in the work of (Giles and Giammarco 2019; Chung 2021; Funk et al. 2005; Miller et al. 2005). However, this work has proceeded without the benefit of a set of well-defined and ontologically structured terms, including the key term ‘play’. A play is a piece of information that consists in a set of instructions. Like the plays in a sports team’s playbook, plays are designed to coordinate the actions of a group of agents towards the achievement of a common goal. Significant to an ontology of plays is the fact that plays refer to group acts and actors in a generic fashion, that is, in terms of the roles group members bear and the associated rights, responsibilities, and limitations those roles impart. For example, an American football screen pass play will indicate the direction and movement required of each participating player and do so according to each player’s role. Those players bearing a lineman role will have certain blocking responsibilities and have limitations on their forward downfield progress. The player bearing the quarterback role will have certain passing and feinting responsibilities along with the right to throw when and how they deem appropriate. Similarly, in the search and rescue play described in 2.2 above, the participant bearing the communication relay role will be responsible for establishing and maintaining communication between team members and their base of operations. They would also likely bear the right to adjust their altitude and modify their radio signal strength and frequency as needed to fulfill that responsibility.

In virtue of this, a play can be repeatedly applied, in the same or different circumstances and by the same or different groups of agents. We further distinguish plays from similar types of generic plans and other pieces of directive information, such as a route plan or cooking recipe, in that plays are uniquely designed for securing an advantage in competitive contexts. Our domain ontology captures both the instructions that constitute plays and the entities essential to the application of those instructions.

We follow CCO in calling pieces of information ‘information content entities’ (ICEs). Thus, an ICE might be the content transmitted in an email or captured in a document. In CCO, a **directive ICE** *is_an ICE* that prescribes some process (henceforth, we use italics with underscores to refer to kinds of relations, such as *has_part*, *is_participant_in*, and *is_a*, which is equivalent to the subtype relation). For example, the instructions in a recipe for apple pie consist in a set of directive ICEs that prescribe various processes of mixing and baking ingredients. Every plan, and thus every play is a directive ICE that contains both a specification of an objective that prescribes the goal, or end state, to which that plan is directed, and a specification of some means that prescribes some intentional act or acts by which that goal is intended and expected to be achieved. For instance, whereas mixing and baking are the means, producing an apple pie is the goal

prescribed by the recipe. We classify **play** as a subtype of the CCO class **plan**, which are defined as follows:

Play =def. a Plan that prescribes some pattern of Intentional Acts that are intended to reliably result in some Goal in some competitive context, and which specifies one or more Roles that are realized by those prescribed Intentional Acts.

CCO: Plan =def. a Directive Information Content Entity that prescribes some set of intended Intentional Acts through which some Agent expects to achieve some Objective.

(Note that capitalization in the definition indicates a term that is part of the ontology or imported from CCO/BFO and is defined therein.)

Plays specify roles, occupied by agents. They thereby specify intentional acts that agents bearing those roles are responsible for performing. When an agent performs an action prescribed to them on the basis of their role, we say that the agent ‘realizes’ that role. We illustrate these relationships in Figure 1.

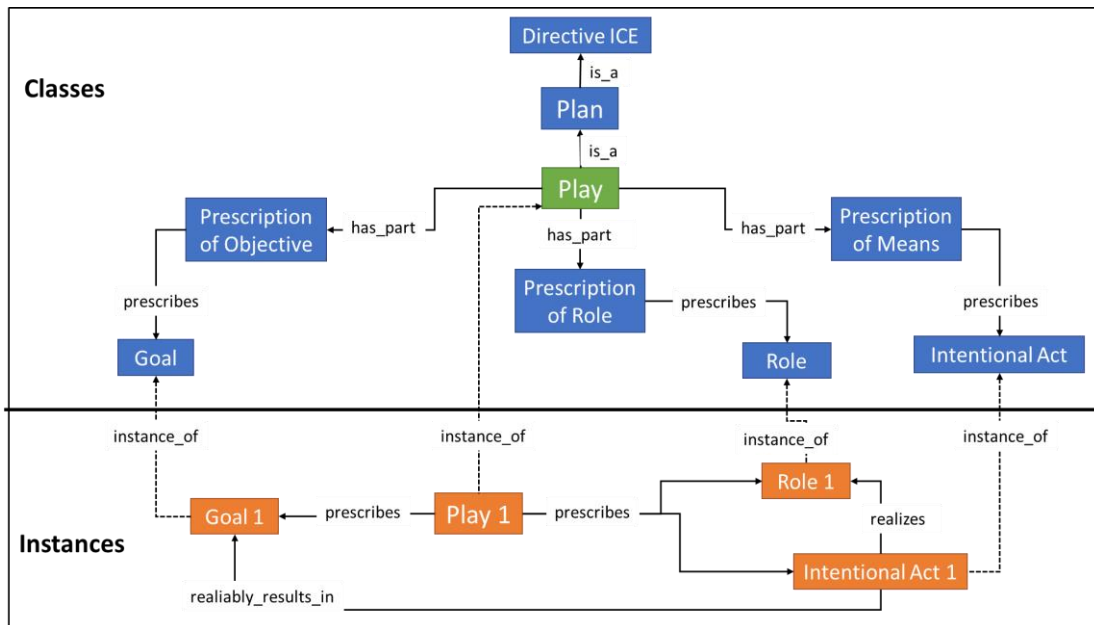


Figure 1. Basic Structure of a Play

3.3 Teams and Roles

Plays are most often used to coordinate the actions of team members, wherein team members are prescribed different tasks and responsibilities corresponding to the different roles they bear. We define **team** as follows, adapted from (Gimbel, Rasmussen, and Stern 2020):

Team =def. A Group of Agents whose members are (1) intentionally affiliated with each other and (2) bear assigned roles and responsibilities, for the purpose of achieving one or more goals through direct collaboration and distributed decision-making.

A team is formed as a result of one or more Acts of Affiliation on the part of an agent that bears the authority to add and remove members from a team. That authority may derive from the agreement of the team members themselves or from an outside source that holds authority over the agents to be affiliated and assigned to a team. We follow CCO and define Act of Affiliation as follows.

CCO: Act of Affiliation =def. A Social Act wherein an Agent unites with some other agent in an Intentional Act.

Team members are knowingly and intentionally united so that they can directly interact and work with each other towards a common goal. When team members work together towards a common end they do so through a division of labor and responsibilities. Each member of a team bears at least one team member role, and team member roles are defined by the set of responsibilities and rights a team member bears in the context of the teams functioning. We capture these responsibilities under the CCO class **action regulation**. In CCO, **action regulation** is defined as follows:

CCO: Action Regulation =def. a Directive Information Content Entity that (1) prescribes an Act as required, prohibited, or permitted, and (2) is the output of an Act which realizes some Authority Role.

We define **team member role** as follows:

Team Member Role =def. a Role that inheres in an Agent that is a member of a Team in virtue of some Action Regulation that has been (1) authoritatively assigned to that Agent and (2) that the Agent is expected to apply in their relevant team contexts.

Action regulations include various prescriptions, such as those specifying the rights, responsibilities, and limitations of team members in the context of their team's activities. For instance, a wide receiver role in football is a team member role that when borne by some agent entails that the agent is expected to act in accordance with the set of action regulations definitive of that role. For the wide receiver (WR) these would include the requirement to run certain passing routes and catch passes as part of implementing a corresponding football play. The WR role is *realized by* the team member in the performance of those prescribed acts of running and catching. Such role-defining action regulations are also often codified, as is the case when the role of a nation's president is codified in its constitution. They can also be informally stated or even implicitly understood, carried only in the relevant team members' minds (in the case of humans) or in a piece of software (in the case of machines).

Every team play specifies intentional acts according to the team member roles involved in that play, where the realization of those roles is intended to achieve the goal prescribed by that play's objective. Team member roles are both defined and assigned by the relevant authority in each team context. In the military organizational context, it is the established military authorities that define and assign team member roles. Every commander or other military authority bears some authority role, which is defined in CCO as follows:

CCO: Authority Role =def. a Role that is realized by Acts which create, modify, transfer, or eliminate Action Regulations or other Authority Roles, and inheres in an Agent in virtue of collective acceptance of that Agent's ability to issue binding directives.

For example, a flight of aircraft will typically include a flight leader and a wingman. Bearing a flight leader role entails bearing an authority role that is realized by the flight leader performing various acts of commanding in the context of their flight team's activities. This might include, for example, selecting a flight path for the team or ordering a team member to break off from the flight formation. A wingman role is a team membership role that is defined by a different set of action regulations prescribing various flight processes. In some contexts, this might include a requirement to fly behind the flight leader and guard the rear of the flight formation. A wingman role is realized when the agent bearing that role performs one or more of such required processes.

3.4 Objectives, Military Objectives, and Military Plays

Every plan, and thus every play, includes some objective that prescribes the goal to be achieved by the application of that plan. In a military plays the objectives prescribe the goal towards which some act of military force is directed (see table of definitions in Table 1 below).

Accordingly, we distinguish the different subtypes of **play** according to the kinds of goals they prescribe. For example, in football some plays are designed for the goal of *advancing the ball and scoring*, while others are designed for the goal of *preventing the opponent from advancing the ball and scoring*. These are offensive and defensive plays, respectively.

In the military domain, our approach is similar to what (Giles and Giammarco 2019) call “mission-based”, in the sense that it is the types of military mission operations and their corresponding objectives that distinguish play types. Our domain consists in Army aviation operations, and in this domain the Army utilizes a controlled set of strategic and tactical task terms to compose mission objectives and military operation plans. Examples of the goals prescribed by military mission objectives include gathering intelligence, attacking a target, re-supplying an advanced military force, and establishing a communication relay (DOD 2019). We define **military play** as follows:

Military Play =def. a Play for which each prescribed Intentional Act is:

- (1) some Act of Military Force, or
- (2) a process part of some Act of Military Force.

Using doctrinal sources and input from subject matter experts, we propose an initial division of the class **military play** into four principal direct subclasses, which will serve as parent classes for various lower-level military play types. These four principal subtypes (defined in Table 1) are: **effects military play**, **sustainment military play**, **intelligence gathering military play**, and **movement military play**.

The subdivision of the OPTaC class **military objective** follows a similar strategy. In Figure 2 we represent these and some additional subclass (or *is_a*) relations in the realm of military plays.

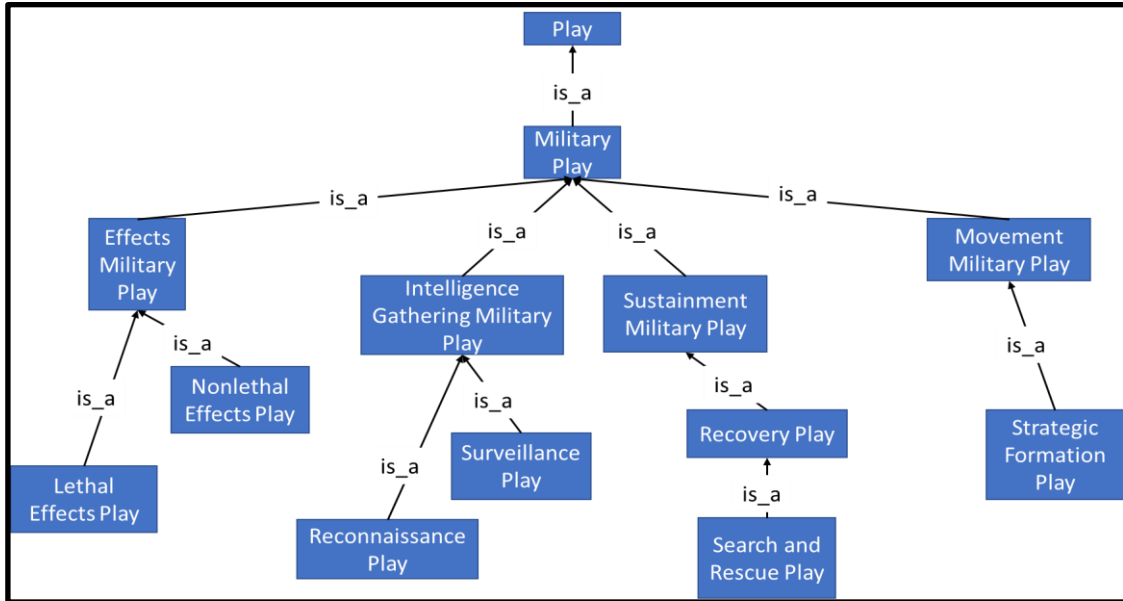


Figure 2: Hierarchy of Plays. Some subtypes of Military Play are defined in Table 1.

Plays, being plans themselves, can also include other plays as parts. For example, given a particular search and rescue objective, say: to find and recover a lost piece of equipment in a hostile region, a planner may include some strategic formation play as a part of a broader search and rescue play. This may be designed so as to best protect the search and rescue team during their ingress into enemy territory. See Figure 3.

3.5 Additional Ontological Elements

Beyond acts, agents, and roles, there are often other entities involved in the prescriptions of a given play. For example, football plays will often refer to formations, field positions, and passing routes. Depending on the processes prescribed, military plays will also refer to other entities relevant in the military context and essential to a given type of play. In the Army UAS mission context these may include, for example, qualities such as a flight formation or flight altitude, spatial boundaries and regions such as a line of departure and flight path, targets such as a named area of interest or enemy air defense system, capabilities such as a radar jamming capability or high-altitude flight capability, and many other common generic components of the military operational environment. OPTaC in conjunction with CCO has extensive resources for representing these kinds of entities some of which are defined in Table 1.

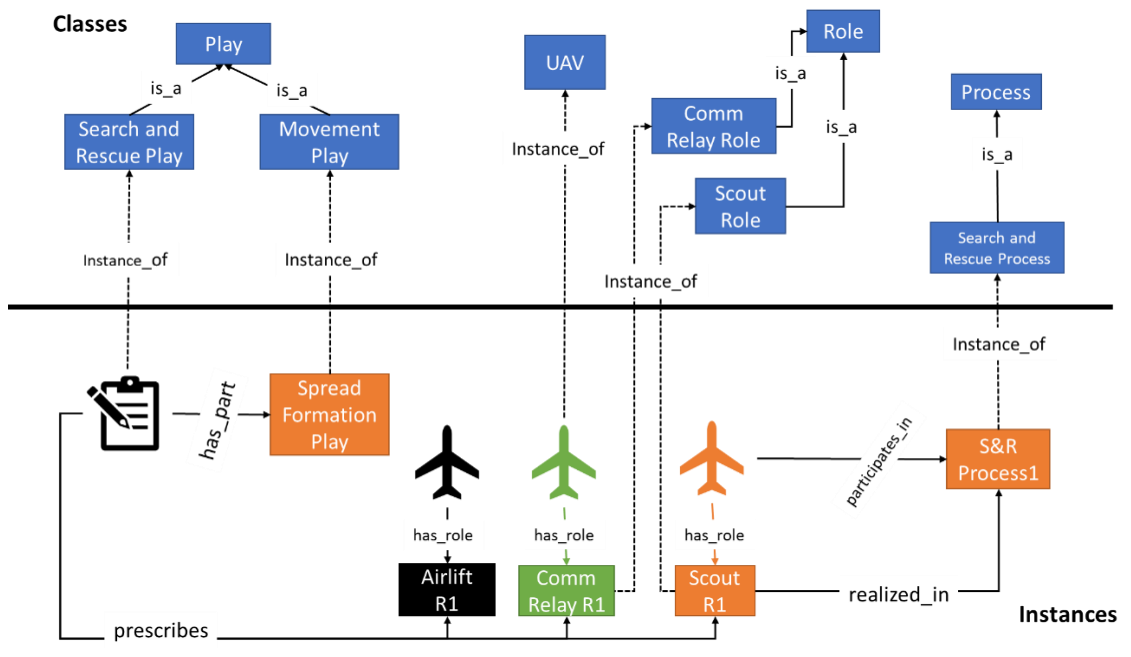


Figure 3. Search and Recue play with Strategic Formation play as part.

4 Discussion

4.1 Team Member Selection Process

An ontology enhances the data in our knowledge base with a consistent structure of relations and well-defined terms so that inferences can be drawn from data tagged with the terms from that ontology. An ontologically structured knowledge base of plays provides for inferences from mission type to play type, and thus to participant and agent requirements. Queries can be formulated to retrieve information about the entities required for the application of this or that play. Example of the sorts of questions we want to be able to answer are: What team is a given agent a member of?, What play is being run and by whom?, What role does each participant bear?, What sorts of team members and capabilities are required to run a given play? For example, since plays prescribe processes that require agents as their participants and those agents must bear the requisite types of capabilities necessary to fulfill certain roles required to run the play effectively, we can derive which capabilities (and entities bearing those capabilities) are required from the knowledge of the play type at issue. Then, if the data about which agents bear the requisite capabilities are integrated with the play data, complete knowledge necessary to assign play roles effectively can be inferred seamlessly by computer reasoners. This, in turn, helps planners to identify, for example, the required sensor or other required system (or parts) which bear those needed capabilities along with the assets that have those parts.

It also helps collected data about plays already realized to be analyzed for the sake of lessons learned, and following (Limbaugh et al. 2020), for the benefit of outcomes based optimization of play design and team compositions that could potentially use AI techniques. Using BFO and CCO classes such as **capability**, **function**, and **artifact function**, under which various types of UAV capabilities would fall, OPTaC can be

extended to include existing and future types of capabilities and functions. Using BFO and CCO more generally ensures compatibility with other military ontologies being developed in the context of the DoD/IC ontology foundry.

4.2 Planning and Play Selection Process

For the same reasons as above, plays and complexes of plays can be modified and combined to meet the requirements of the changing operational environment. A playbook provides a tool to help facilitate this sort of re-planning process, and the ontology provides a relational structure that facilitates rational play selection and composition. For example, with access to ontologically tagged data, a team facing an unexpected obstacle or revised mission objective can query different plays and processes to determine which plays are available, given their current capabilities, while meeting their mission objective needs. If no satisfactory options for their current mission are found, queries for more appropriate plays calling for different or additional capabilities may be performed, possibly leading the team to request and acquire a new team member.

4.3 Shared mission understanding.

A set of plays tagged with an ontology is readable and useable by both humans and machines, which generates a shared understanding of both the information content contained in the plays and the entities that information content is about. Thus, teams applying plays would have available to them a uniform vocabulary for inter- and intra-team communication about various aspects of their current mission operations: their plays, objectives, goals, prescribed actions, roles, capabilities, qualities, locations, and so forth.

5. Conclusion

One of the defining characteristics of collaborative action is that collaborators intend to accomplish the same goal, and to accomplish it together as a group. We claim that collaborative behavior is facilitated by the sharing and utilization of data about the entity types presented here. In an ideal collaborative team system, each participating agent knows, for example, which play is assigned, what role and corresponding responsibilities they have when that play is carried out, who else is participating and what their roles are, and therefore, what tasks others are responsible for performing. OPTaC provides definitions and a relational structure for a knowledge base of these types of entities, and it thereby provides an important component for the facilitation of play-based collaborative processes for teams consisting of machines or both machines and humans. Although OPTaC was initially developed for Army UAS use cases, it is applicable to other military domains and services as well as non-military human-machine teaming in areas such as disaster relief and emergency first responder services.

We envision this ontology as a first step towards an ontology of collaborative processes, but one that also takes into account the cognitive and dispositional aspects and interrelations that define collaboration as found in the work of (Gilbert 1990; Castelfranchi 2006; Chwe 2001; Bratman 2014).

Table 1. Table of Selected Terms, Definitions, and Descriptions

Term	Description
Goal	=def. an Entity which is prescribed by some Objective.
<i>in_competition_with</i>	<i>x</i> is <i>in_competition_with</i> <i>y</i> means: <i>x</i> is an Agent and <i>x</i> intends some Goal <i>g</i> ₁ <i>y</i> is an Agent and <i>y</i> intends some Goal <i>g</i> ₂ either [<i>x</i> achieving <i>g</i> ₁ is either (a) incompatible with <i>y</i> achieving <i>g</i> ₂ or (b) makes <i>y</i> achieving <i>g</i> ₂ either less likely, more difficult, or less valuable], or vice versa for <i>y</i> achieving <i>g</i> ₂
Play	=def. a Plan that prescribes some pattern of Intentional Acts that is intended to reliably result in some Goal in some competitive context, and which specifies one or more Roles that are to be realized by the prescribed Intentional Acts. <i>w</i> is a Play means: <i>w</i> is a Plan <i>x</i> is an Objective which prescribes some Intentional Act <i>a</i> _o , and <i>w</i> includes <i>x</i> <i>y</i> is a Directive ICE which prescribes some set <i>A</i> of one or more Intentional Acts, and <i>w</i> includes <i>y</i> <i>z</i> is a Descriptive ICE which describes some set <i>R</i> of one or more Roles, and <i>w</i> includes <i>z</i> Roles <i>r</i> ₁ ,... <i>r</i> _{<i>n</i>} in <i>R</i> are realized by one or more of the Intentional Acts <i>a</i> ₁ ,... <i>a</i> _{<i>n</i>} in <i>A</i> the Intentional Acts <i>a</i> ₁ ,... <i>a</i> _{<i>n</i>} in <i>A</i> are expected to reliably result in <i>a</i> _o <i>w</i> is intended to be implemented in a context in which two or more Agents are <i>in_competition_with</i> one another with respect to either <i>a</i> _o or some other Goal the achievement of which is influenced by <i>a</i> _o
Military Play	=def. a Play for which each prescribed Intentional Act is either: some Act of Military Force; or, a process part of some Act of Military Force.
Effects Military Play	=def. a Military Play for which the Goal is some intended Change to some Material Entity occupying a Military Operational Area, which: results in either decreased advantage for some Enemy or increased advantage for the Agent implementing the Play, or some Ally; and, is neither an Act of Intelligence Gathering, an Act of Strategic Motion, nor an Act of Military Sustainment.
<i>has_advantage_over</i>	=def. a relation holding between two Agents that are in competition with respect to one or more Goals, wherein one Agent is more likely to achieve their intended Goal than the other due to certain Capabilities inhering in either that Agent or one or more Material Entities directly accessible to them.
<i>is_advantageous_for</i>	<i>x is_advantageous_for y</i> means: <i>x</i> is a Continuant, and <i>x</i> bears some Capability <i>c</i> that is realized in some process <i>p</i> <i>y</i> is an Agent, and <i>y</i> is <i>in_competition_with</i> some other Agent <i>z</i> with respect to one or more Goals <i>c</i> being realized in <i>p</i> increases the likelihood that <i>y</i> achieves their intended Goal over which they are in competition with <i>z</i>
Military Operational Area	=def. an Operational Area in which a Military Operation is conducted. (Adapted from “operational area” in DOD Dictionary)

Lethal Effects Play	=def. an Effects Military Play for which the intended Goal is to eliminate or damage beyond repair either (a) some life-sustaining Function of some Organism or Group of Organisms or (b) some Capability of some Material entity which partly constitutes the Combat Power of some Enemy.
Non-Lethal Effects Play	=def. an Effects Military Play for which the intended Goal is to temporarily block the realization of either (a) some Agent Capability of some Organism or Group of Organisms or (b) some Capability of some Material Entity which partly constitutes the Combat Power of some Enemy.
Movement Military Play	=def. a Military Play for which the intended Goal is an Act of Strategic Motion.
Act of Strategic Motion	=def. an Act of Motion that places oneself, one's Group, or some Ally in a position of advantage with respect to achieving some Goal.
Strategic Formation Play	Movement Military Play for which the intended Goal is an Act of Strategic Motion that involves the Military Force bearing some Configuration that <i>is advantageous for</i> that Military Force.
Intelligence Gathering Military Play	=def. a Military Play for which the intended Goal is an Act of Intelligence Gathering.
Surveillance Military Play	=def. an Intelligence Gathering Military Play for which the intended Goal is an Act of Surveillance.
Act of Surveillance	=def. An Act of Intelligence Gathering that involves "the systematic observation of aerospace, cyberspace, surface, or subsurface areas, places, persons, or things by visual, aural, electronic, photographic, or other means." (Adapted from DOD Dictionary)
Sustainment Military Play	=def. a Military Play for which the intended Goal is some Act of Military Sustainment.
Act of Sustainment	=def. an Intentional Act involving the provision of resources necessary to maintain or improve some activity.
Operational Reach	=def. the Spatiotemporal Region within which some Military Force can successfully realize its military-related Capabilities. (Adapted from "operational reach" in DOD Dictionary)
Enemy Military Force	=def. a Military Force that bears an Enemy role.
Flight Formation	=def. a Configuration which inheres in an Object Aggregate during a flight process and having only Aircraft as member parts.
Flight Path	=def. a Vehicle Track for an Aircraft during some Flight Process
CCO: Intentional Act	=def. An Act in which at least one Agent plays a causative role and which is prescribed by some Directive Information Content Entity held by at least one of the Agents.
CCO: Information Content Entity	=def. A Generically Dependent Continuant that generically depends on some Information Bearing Entity and stands in relation of aboutness to some Entity.

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