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"Supporting Collaboration in Collective Endeavors with a Model of Operations Intent and Effects"

Topic 10: Collaborative Technologies for Network-Centric Operations

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Abstract
The change in the use of military from traditional missions to peace-keeping and restoring societies, changes the way that doctrine, methods and procedures are developed and employed. Today a 21st century military mission involves participants from numerous countries spanning a variety of organizations (military, civil, public, governmental, NGO, private) which all need to collaborate and coordinate at multiple levels on Collective Endeavors. The shift is to allow subordinates initiative to a larger amount than before and enable new C2 processes, such as self synchronization

The uncertainty inherent in an actual mission, and the variety of potential organizations that support the mission after it is underway, makes Command Intent (CI) a critical concept for the mission team. Both humans and computerized decision support services need to have the ability to communicate and interpret a shared CI. The Operations Intent and Effects Model identify the relationships between Intent, Actions, and Effects in a decision support model. We describe this model and show how it can represent and support a wide variety of traditional and innovative military doctrine including collaboration in collective endeavors.

Keywords: Intent, Operations, Collective Endeavors, Collaboration, Planning, Linguistics

1. Introduction

In the western military doctrine the principles of Commander's Intent (here after CSI) and Command Intent (here after CI) is essential for cooperation and collaboration in collective endeavors.

CSI has evolved during military history from being the concepts, plans and will from one commander into a process where military operations are governed by planning processes of the commander's staff and the result is disseminated to the subordinates of the organization for execution. The recent shift towards Network Enabled Capabilities (here after NEC) is based on mission command and the exercise of local initiative within the framework of command intent. It is enabled by decentralization of authority and responsibility allowing subordinate commanders to plan and conduct operations based upon their understanding of the local situation (c.f. Alberts & Hayes 2007; Alberts 2007). The NEC is primarily about networking people and is characterized by (1) the absence of a single chain of command, (2) the variety of players involved in peace operations, and (3) the fact that CSI usually arises from dialogue between a commander and his staff. This new way of abstraction of CSI (cf. Alberts et al. 2000 page 157) is called Command Intent (CI) (cf. Alberts 2007, p.14).

With the change towards NEC the traditional meaning of Command and Control (C2) is not sufficient. The C2 Journal (Alberts 2007, p.17-26) introduces three new key concepts for future Command and Control namely *agility*, *focus*, and *convergence*. Agility is the critical capability that organizations need to have to meet the challenges of complexity and uncertainty; focus provides the context and defines the purposes of the endeavor; convergence is the goal-seeking process that guides actions and effects.

The pace and complexity has increased in military missions and time has become even more crucial then before. The operations require collaboration amongst participants which in turn require that relevant information is shared and understood by the participating parties. There is a need of semi-automatic and automatic processes that can support sharing and disseminating of information both in operational system but also in training environments. It is not feasible to train for every possible mission and every possible combination of teams. All teams will not be participating in exercises at the same time and the cultures, languages and doctrines are different. The operational as well as the planning and training systems need to manage this complex and dynamic environment.
The need for collaboration capabilities drives the requirement to transform to operational and simulation infrastructure that includes interoperability mechanisms that enable a more agile, dynamic and adaptive interconnection of heterogeneous operational and simulation environments.
The exchangeable information must then be as clear as possible, without ambiguity, and understandable. Clear means that the information expressions are concise and conforms to agreed doctrine, procedures and methods. Without ambiguity means that there is an explicit structure that the information can be put into and then parsed out of with only one clear and definite outcome results from the parsing. Understandable means that the semantics used in the information are available and common to all of the recipients.

In previous work by Gustavsson et al. (2008) a machine interpretable representation of Commander's Intent and in the recent work by Gustavsson et al. (2009) a formalization of operations intent and effects for Network-Centric applications have been presented. The center in those paper is to introduce and elaborate on the Operations Intent and Effects Model (OIEM). This paper focus is on intent in collaborative environments and the sharing of information. The first part of this paper presents the ideas around intent. In the second part collaboration and role of intent is discussed. Then the Operations Intent and Effects Model is presented from a collaborative view point. The model is a general and high-level description of the information constituents, their relations and causality in the view of a military planning context. The paper is ended with a discussion about the applicability of the model.

2. Intent

According to Ackoff (1999) a system that at a first glace seems to be totally mechanical and deterministic often involves humans as decision makers, for parts of the system or for the whole system. So to understand the system the goals and intents of the system has to be determined and evaluated in the process. The humans participating in such a system also have to be seen as systems with own goals. Because of their feature of choice and that they are purposeful systems they should not be seen as deterministic machines. Ackoff argues for a system of systems concept where cooperation is to be sought and that the subsystems, e.g. humans, with their goals, intent, plans and objectives need to express and exchange intent and related information with the other systems. However, Pigaue (2006) state that all intentions are not explicit declared statements, there is implicit, not articulated, intent that is as important as the explicit for the conduct of an operation.

2.1 Commander's Intent

Commander's Intent (CSI) plays a central role in military decision making and planning. CSI acts as a basis for staffs and subordinates to develop their own plans and orders that transform thought to action, while maintaining the overall intention of their commander.

> *The commander's intent links the mission and concept of operations. It describes the end state and key tasks that, along with the mission, are the basis for subordinates' initiative. Commanders may also use the commander's intent to explain a broader purpose beyond that of the mission statement. The mission and the commander's intent must be understood two echelons down.*
>
> *(US Army FM-6, 2003) Section 4-27*

Accordingly to Pigeau and McCann (2006) CSI is not only a desired End-State but also a concise expression of the purpose of the operation and 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. Klein (1994) provides a seven parts view of 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.

Traditionally CSI originates from one commander's mind and is disseminated to the echelons below. CSI rarely gets reviewed and updated. For a short duration mission, such as a deliberate attack, the original statement may remain valid throughout planning. But for longer phases the CSI might be changing in phase with the unfolding of the situation. Commanders must develop their intent within the bounds of a whole hierarchy of guiding principles that limit the types of solutions that they can entertain (c.f., Pigeau and McCann 2006).

For this work **Commander's Intent** is an intent describing military focused operations developed by a small group, e.g. staff, and a commander. Even though there is no limit to use it in other domains, for this works it is limited to the military domain.

2.3 Explicit and Implicit Intent

Pigeau and McCann (2006) introduces that intent consists of an explicit part and an implicit part. The explicit intent is the one that is publicly stated for all the HQ staff and subordinates to perceive, think about, and act upon. Theoretically, each staff and subordinate member should be able to reiterate Commander's Intent at any point during the process (Figure 2).

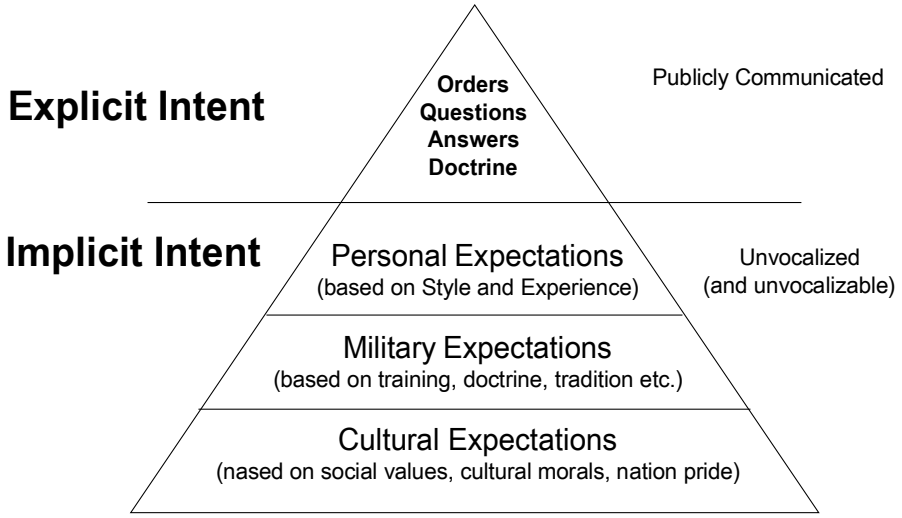

Figure 2 - After Pigeau and McCann (2006)

Implicit intent is un-vocalized expectations that the commander and all team members have. The implicit intent is developed over a longer time, prior to the mission, and consists in the style of how the commander is conducting the operations with respect to experience, risk willing, use of power and force, diplomacy, ethics, social values, moral, norms, creativity and unorthodox behavior and the concepts, policies, laws and doctrine agreed to by military, civil, organizations, agencies, nations and coalitions. The explicit intent is either vocalized (i.e. made publically notable) in doctrine, orders, statements or can be derived from questions and answers.
Implicit Intent is an internal expectation of Commander's Intent. An example is that the explicit intent stated as "to capture the hill" then the implicit intent might be "to capture the hill with minimal battle damage" or "to capture the hill with Air Force assets only." These implicit expectations depend on the staff position (e.g., planner, operator, commander, etc.). The members interpret Commander's Intent from personal expectations based on their style and experience as proposed by Pigeau and McCann (2000).

> *Thus, the Implicit Intent questions are "from perspective x, how do you interpret Commander's intent?"* (Farrell 2006)

Pigeau and McCann (2000) present how Implicit Intent can be made explicit by transforming the implicit into explicit statements. The commander can vocalize the Personal, Military or Cultural implicit intent. The commander can be monitored, e.g. by his subordinates, team members, that then draws conclusions about the commanders implicit intent and in the same way a commander can draw conclusions regarding the subordinates. In Figure 3 some mechanisms of making original implicit intent made explicit and they are: 1) Externalization is when a commander or subordinate make the internal intents explicit declared; 2) Internalization is a version of tacit learning, when a commander presents the intent and the mouth is saying something and the body language signal something different add context and meaning that are put into the mental model and affects the implicit intent; 3) Socialization is meeting and talking and performing exercises together, teaming, i.e. is to find the implicit intent and motives etc.; and 4) Dialogue is the explicit stated, vocalized publically available description of an individual's intent.

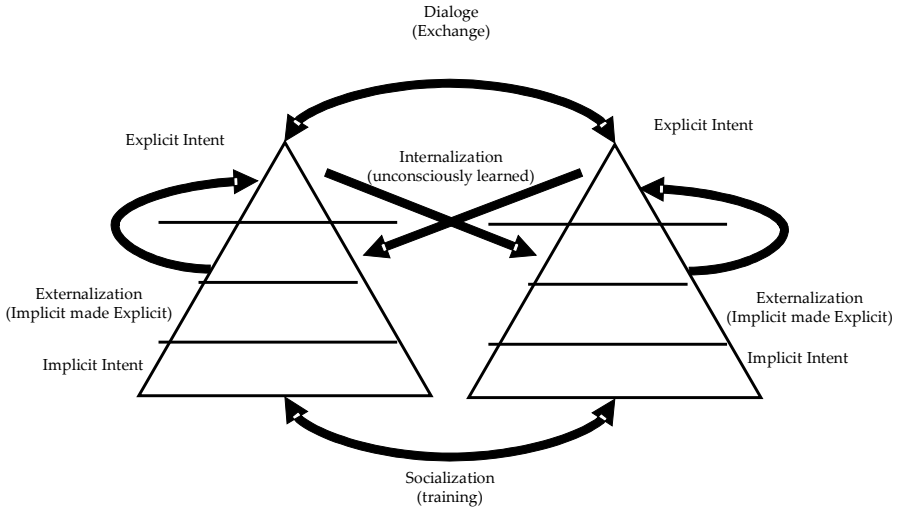

Figure 3 – Explicit and Implicit intent – collaboration (after Pigaue 2004)

2.4 Common Intent

Farrell (2006) state that today's operational environment teams need to work together towards a desired End-State. Teams with different military and civilian cultures would need that all team members establish a common understanding of the mission objectives and the Commander's intent with respect to their own competencies, authorities, and responsibilities.

Common Intent describes a socio-psychological phenomenon that seems to be evident amongst a team that achieves a common objective (Farrell, 2004). The CSI is a sort of a one person's view, but as said in the introduction "every individual have intent of her own" imply that it may not just be enough to disseminate intent amongst staff members and subordinates. Farrell states that diverse team members need to have a high degree of Common Intent to perform effectively. In such teams the commander need to ensure that the intent is perceived and understood by all team members (*cf.* Farrell 2006, Pigeau 2006).

Team members with similar awareness of the environment and CSI will produce effective team performance. On the other hand, CSI emphasizes that team members with similar expectations and values will shape their individual awareness in a way that leads to coordinated action and goal achievement (Farrell 2004).

Alberts and Hayes says that in order to allow subordinates' initiative the operations order in a Networked-centric planning process needs to be focuses on describing the CSI so that flexibility in coordination and collaboration in the dynamic environment is entailed (Alberts and Hayes, 2007). There is a need for the commander to connect the subordinates human potential (reason, opinions, questions, seek information regarding the mission) to align and be a support to the commanders own intent. (*cf.*, Pigeau, 2006, p102).

For a common intent to be realizable there need to be a single shared objective, together with a clear understanding in how that objective can be attained (Pigeau, 2006). Common intent is an idealized concept where maximum overlap, with minimum scattering, exists between the intent

of the commander and the intents of the subordinates. Knowledge of the commander needs to be shared at all levels, guiding principles, reasoning ability, and to express similar levels of commitment (Pigeau, 2006). Intent is then not only something for a commander to disseminate but to exchange, i.e. learning the team member's intent.

For this work **Common Intent** is an intent that is shared and understood by all participants, i.e. there is no discrepancy between the intent of participating humans. Common Intent is an idealized view of intent.

2.5 Command Intent

Pigeau (2000) also states that "In reality, it is presumed true that it is impossible to have common intent". However for a specific mission bounded for a certain time an overlap of Intent ought to be possible to achieve, e.g. The players in a soccer team all have individual goals with their lives and families, but on the soccer field they have the common intent to win the game, meaning that during the game, and in training and exercises prior to and after the game their common intent is to perform well according to the mission declared by the coach's. Such a **Common Mission Intent** is what the CSI is intended to establish. The Common Mission Intent is a workable version of Common Intent in that it directed for a specific situation, bounded by participating organization, space and time. For the operation at hand the intent is common but other intent and goals of the participating humans may differ.

However CSI is not rich enough in its representation and how it is developed according to (Alberts, et al, 2001 p143). They introduce Command Intent which is an outline of a plan, objectives to be achieved, responsibilities, linkages and schemas of maneuver, and constraints. Establishing Command Intent also involves more than one person. Traditional CSI is then replaced by an intent that arises from dialogue between commanders and key staff at more than one level. **Command Intent** is then intent developed and exchanged amongst commanders and staff at multiple levels in an organization or even across organizations, i.e. the product from the process. Practically Command intent is a Common Mission Intent developed in cooperation amongst participating commanders and staffs at more than one level.

Brehmer (2005) argues that much of the coordination can be done locally, i.e. on a lower level, without explicit orders. The higher levels of command will then have time to consider other aspects of the problems facing them. Cebrowski and Gartska (1998) state that if this local coordination is to be achieved, with unity of effort, the commander's intent must be clearly articulated. In addition carefully crafted rules of engagement (ROE) are needed (Brehmer, 2005). Thus, the loss of combat power inherent in top-down command-directed synchronization, a characteristic of more conventional doctrines is overcome, and combat is converted from a step function to a high-speed continuum (Cebrowski and Gartska, 1998). The main responsibility of the commander and staff is then to articulate intent and crafting rules of engagement (Brehmer, 2005). Brehmer states that "this does, perhaps, not come as a surprise to armed forces, which have mission tactics as the principal doctrine". Brehmer further envisions that with articulated intent larger units will be able to co-ordinate with other units and conduct the mission without any explicit directions from higher headquarters.

When going multi-national and multi-organizational it is required that information is unambiguous, understood and interpreted in a uniformly manner. The higher headquarters as well as lower echelons will have much more information available than in traditional platform-centric warfare. The Command Intent needs to be supported with a rich set of communication methods to help and clarify the verbal communication and providing that the Command Intent is made as explicit as possible.

The Command Intent (CI) is there to allow self-synchronization and to provide with understanding of the complex causes and effects. To enable self-synchronization the subordinates must be given the mandate to make their own initiatives, within the boundary of the mission. In "Rethinking Command and Control" by Curts and Cambell (2006) they address this fine line between delegating authority and maintaining and controlling hierarchy The commander delegating authority must refrain from directing the actions of subordinates, yet must also maintain some command structure. The subordinates must have the ability to work independently or with a team to achieve the mission goals. To create this empowerment the commander's information should be shared with everyone. Autonomy is created by setting boundaries and hierarchy then can be replaced by self-directed teams. As said in Gustavsson et. al. (2008) CI acts as a basis for staffs and subordinates to develop their own plans and orders that transform thought to action, while maintaining the overall intention of their commanders.

> *"Emphasis upon creation of implicit connections or bonds based upon trust, not mistrust that permit wide freedom for subordinates to exercise imagination and initiative – yet, harmonize within intent of superior commander. Benefit: internal simplicity that permits rapid adaptability."* (Boyd's notes) Balck (1980):

2.6 Awareness and Intent

In cooperative environments, i.e. purposeful systems of systems (Ackoff 1998), it is essential that the cooperating team members have the knowledge of what the other team members will do and what they intend to do. It is also a desire to unfold the intent of the adversary. Knowing own and knowing others is what forms what commonly are called Situation Awareness and defined by Endsley as:

> *Situation awareness is the perception of the elements in the environments within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future. (Endsley, 1988)*

Another close related term is Situational Awareness that is based on 1970s sport psychology and reflects "here-and-now". Hone et al., (2006) introduce a model consisting of three questions (hence the 3-Q model) that refine Endsley's definition above. The three questions are: 1) who is where?; 2) what are they doing?; and 3) what will they do?. They also define a view of awareness consisting of three types: Transitory awareness (TA), Local Awareness (LA) and Global Awareness (GA).

However situational awareness stops when assessing what they will do and do not continues to assess what do they want and why they want it. In Figure 4 the originating model is extended by a forth question: What do they want and why? This question address that the observed has an intent and goal behind their actions.

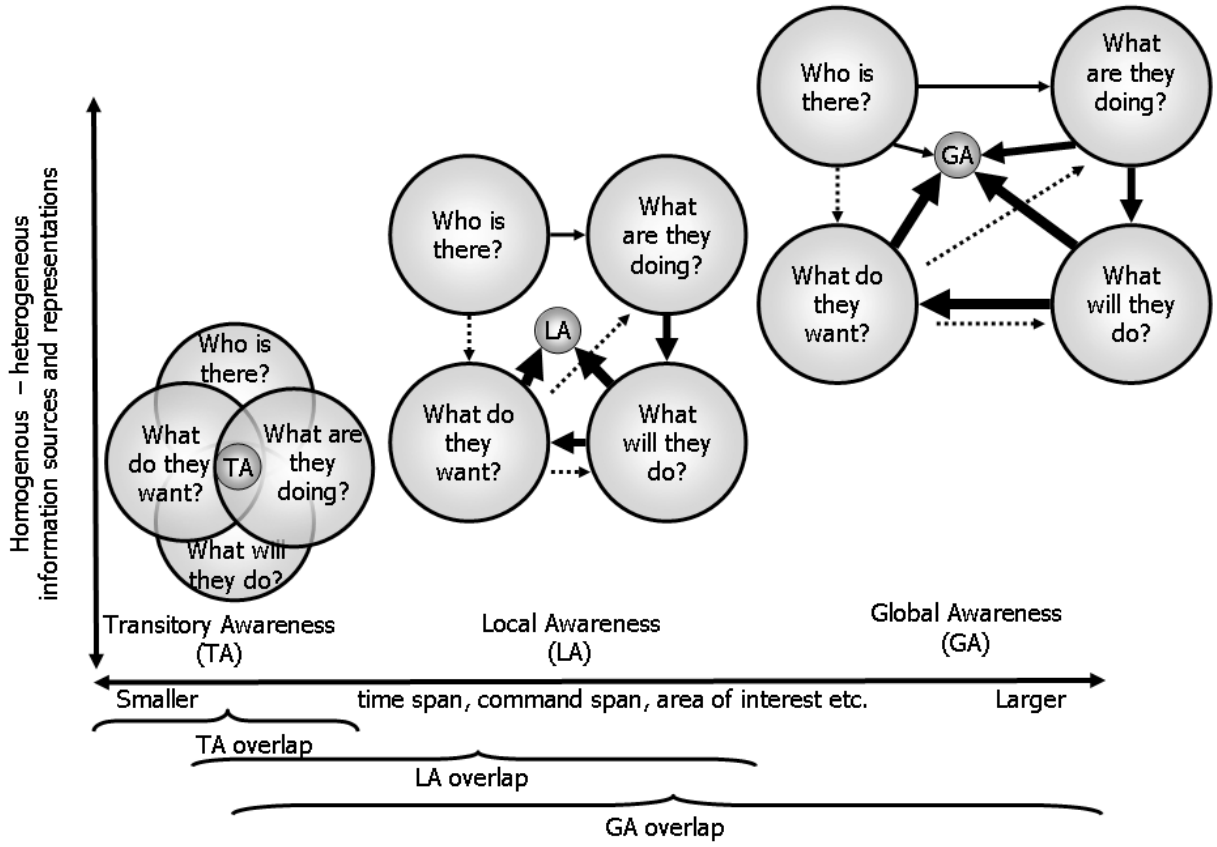

Figure 4 – Four types of awareness and the 4Q Model (Expansion of Hones 3Q model)

In TA, situational awareness is shaped irrespectively of the completeness of any or all of the answers to the three questions. The data input, processing, and reasoning overlaps. TA has a short time span, limited area and small command span. TA reflects the "here-and-now" situational awareness.

In LA, situation awareness as described by Endsley is developed in a sequential process. Endsley's three levels are: Level1) perception: provides basic perception and reduces incorrect forming of the situation (1996 Endlsey); Level 2) Comprehension: it includes how people combine and interpret information as well as store, retain and retrieve information. It also includes the integration of multiple pieces of information, and the information relevance to the individual's goals. Endsley compare this with reading comprehension as compared with just reading words. A person with level 2 SA has derived operationally relevant meaning and significance from level 1 data provided (Endlsey, 2000); and level 3) the highest level of SA is the ability to forecast future situations and events. That person has the highest level of understanding of the situation. For timely decision making the ability to anticipate future events from current situation is a key. Endsley (2000) states that experienced operators rely heavily on future projections and this is a mark of a skilled expert. The LA has an increased time span, involves a larger command span and covers a larger area than the TA.

In GA, situation awareness is covering a larger area than LA, have a larger command span and a longer time span than TA and LA. It is following the LA process but also have the property that it is not necessary to know everything, i.e. the three questions answers directly contribute to GA.
LA and GA is developed from the proposals of (Mavor et al., 1995) regarding the impact of increasing time, command span, area of interest etc. (Hone et al., 2006).

For the interested reader the commonly used model for the assessment process is the Joint Directories of Laboratories model (hence JDL-model) that describes Data and Information Fusion (c.f. Steinberg et al 1999, Hall et al 2001; Blkasch and Plano 2003; linas et al 2004).
Nikalsson et al., (2007) propose a model that combines the human centered approach to situation awareness by Boyd, Endsley, and Bedney and Meister at one hand and the JDL-Model on the other hand. The model include multiple humans and interaction possibilities between them together with multiple machines and interaction between them to allow usage of multiple sources of machine and human developed TA, LA, GA. The Situation Analysis Model for Semi-automatic, Automatic and Manual $(SAM)^2$ decision support is presented in Figure 5. The right side in the figure follows Endsley's model of situation awareness and the left is the JDL approach, between the two is where human computer interaction takes place, i.e. exchange of information from humans and machines.

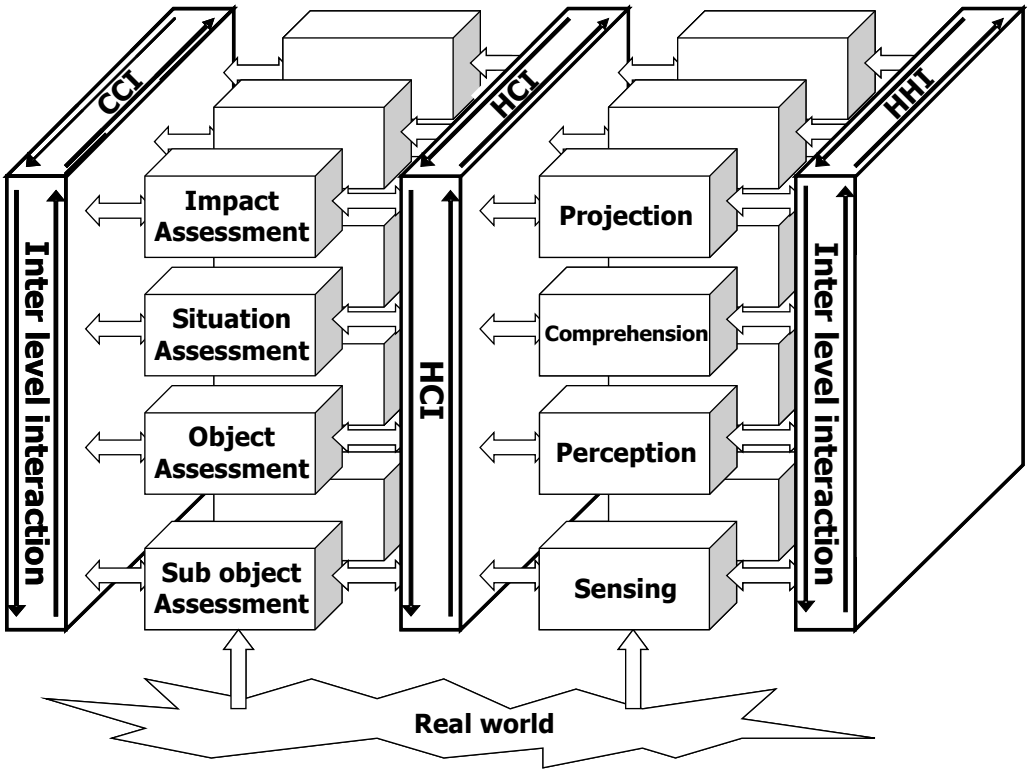

Figure 5 - Situation Analysis Model for Semi-automatic, Automatic and Manual $(SAM)^2$ decision support

The SAM model provides a model to visualize that there several sharing levels that need to be considered. Inter level interaction as well as human to human interaction, machine to machine interaction and human to machine interaction that can take place at several levels. For the exchange of human intent, i.e. a projection that is to be externalized into an explicit statement, it needs to conform to an agreed notation that can be interpreted by machines as well as humans.

3 Collaboration and Intent

Ackoff (1999) uses a systems theoretical view to describe how a whole system works and then identifies the key pieces and parts. The leadership in an organization, he argues, should strive to seek cooperation to make the organization work more effectively than to foster a climate of internal competition. Cooperation requires that information is shared and understood amongst the participants. While it is widely recognized (cf. Endsley 1988) that Situational Awareness is essential for operations involving a wide and diverse team of organizations, the agile development of plans and execution of actions is also important.

CI then needs to be disseminated and shared between a commander and subordinates. The current focus in Command and Control systems is to focus on the Common Operational Picture (COP), which can be role based and tailored after the human need. However there is additional information regarding the participating organizations such as their capabilities, methods, style etc. In a collaborative setting these information fragments needs to be made available for communication in a formalized way and also that the output inform of orders are communicated with minimal ambiguity.

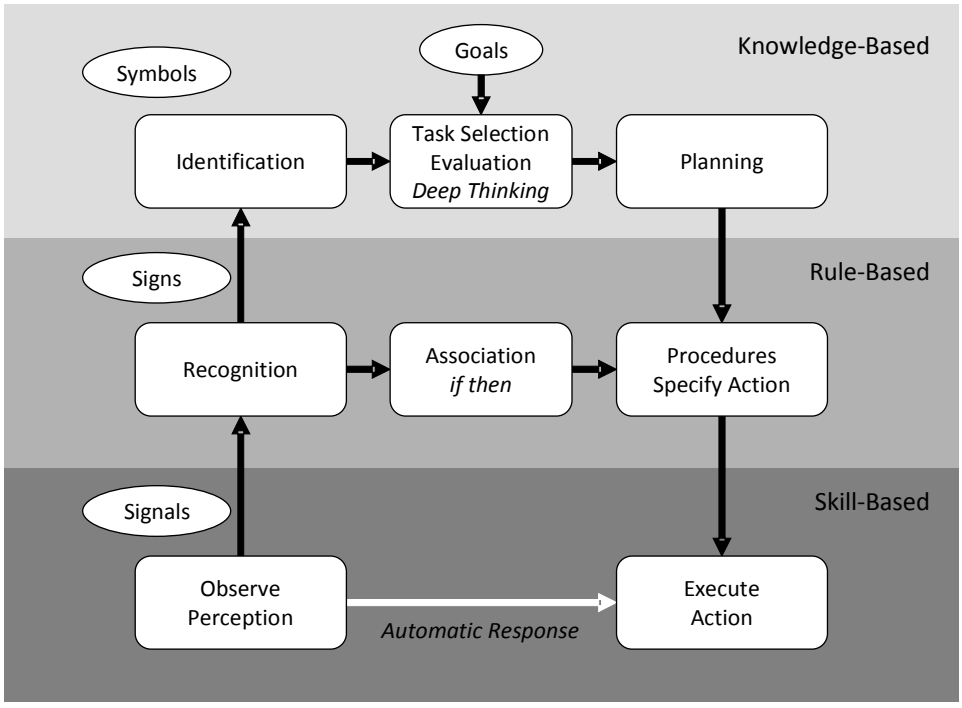

Figure 6 – Adaption of Rasmussen's levels of decision making (1983) with articulation from Hughes and Rolek (1997)

Rasmussen (1983) suggests a model that abstracts decision making in to three levels, see Figure 6. Skill-based decision making where no formal decisions are made and the execution is automatic; Rule-Based where a situation is recognized and a selection is made amongst the well-defined rules at hand; Knowledge-Based is used in complex environments and unfamiliar tasks. The purpose and goal of the task together with deep-thinking is required to produce plans.

A knowledge-based model is said to be *deliberate* since it is focused on generating, and evaluating courses of actions (Moffat, 2007) and *analytic* since it based on rational choice amongst alternatives. Opposed to the deliberate and analytic is the *rapid* (Moffatt, 2007), also

called *hasty*, decision making process which is used in a rapidly changing environment where the deliberate and analytic evaluation is to timely. Often the rapid model is using *intuitive* decision making which is making sense of the immediate situation and acts according to identified patterns which the decision maker has learned from similar situations (Klein, 1998, Moffat, 2007). However, there is nothing that hinders intuitive decision making in a deliberate process, or hinders analytic decision making in a rapid process.

Commonly used planning models are the US used Military Decision Making Process (FM-5.0 US), Operations Planning Process (OPP) used by NATO, and the Guidelines for Operational Planning (GOP) which is an adaption of the OPP for Partnership for Peace countries. The models are deliberate and analytic which means that they are knowledge-based accordingly to Rasmussen. The recent proposed Integrated Dynamic Command and Control (IDC2) by the Swedish Armed Forces (2007) also incorporate the intuitive approach as well. The overall view of these processes is that they first establish a view of the situation and then creates several of hypotheses of the situation and future before a decision is made which path to follow and develop a plan that is to be executed, i.e. following the commonly known OODA-Loop by Boyd. In the IDC2 the execution part is also defined and presented in a loop.

When conducting parallel planning with the traditional planning processes the synchronization points are when a Warning order (WARNO) or Operations Order (OPORD) is disseminated top-down, Figure 7.

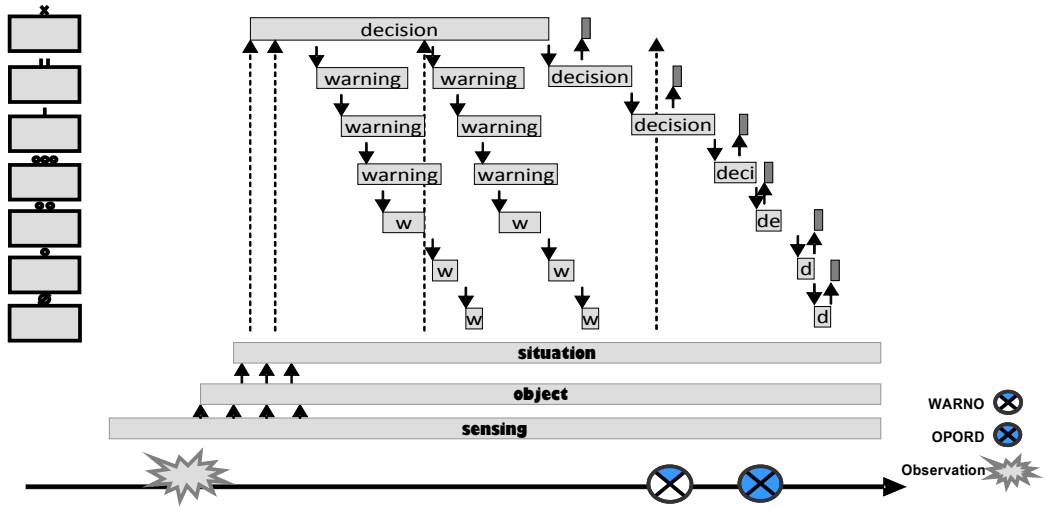

Figure 7 – Parallel planning using a traditional deliberate process

In Figure 7 something is observed and disseminated to the highest command level for analysis and planning, then a WARNO is sent downwards in the organization that provide the lower echelons to start there planning and also their preparedness of a mission to come. However this takes time and it is envisioned that in the 21st century missions there is a need for agile structures of command and control as by Alberts (2007). In such environment collaboration at multiple levels and across organization boundaries are inevitable.

The collaborative planning that involves commanders and staff at many levels induces more communication since the internal process of traditional planning allows other types of information to be exchange on a need basis. The envisioned idea is that with self-synchronization the lower organizational units more rapidly can pursuit the desired end-state, Figure 8.

The output available for participating parties are commonly the Warning Orders, Operation orders, Operation Plans and Fragmented Orders. In the development of **Course of Action** (COA) in a collaborative setting, beyond parallel planning, information regarding commonly critical factors & deductions, commander's planning guidance, knowledge of terrain, desired effect and friendly forces available needs to be exchanged. The subordinates are then able to provide the higher commander with their current assessment and status. Further, collaborative planning allows sharing ideas and concepts for COA development since the subordinate often have close knowledge of the enemy and terrain where the operation is to unfold. Therefore the information flow and information elements in COA development are of interest.

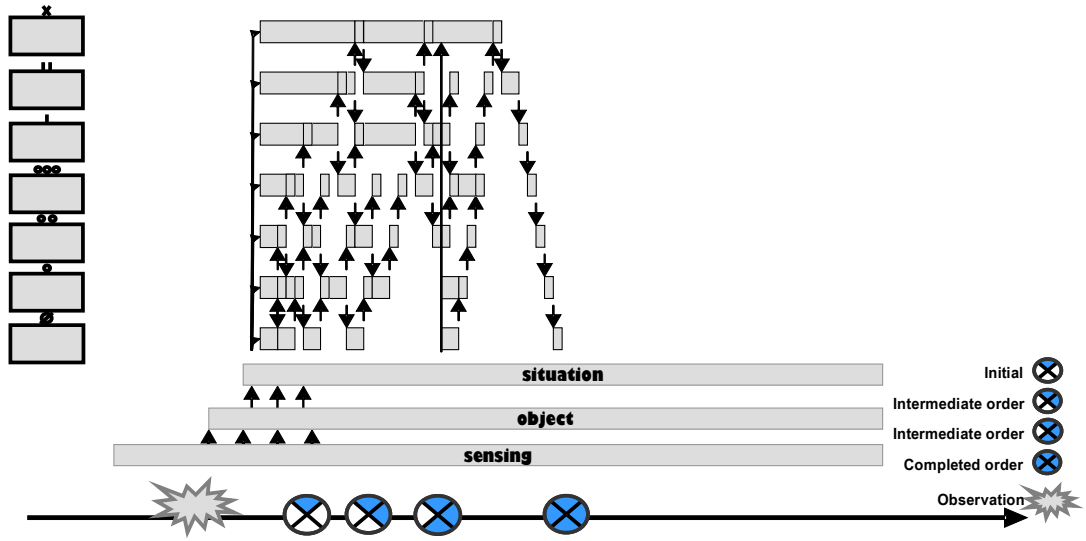

Figure 8 – Collaborative planning at many levels

From the above the model should be able to capture and express the information entities that enable for intent to be communicated. The identified information is the first three parts of an OPORD: situation, mission and execution.

In development of courses of action it is needed to describe the intention, the COA or COE in focus but also the capability of the subordinate and in a collaborative environment also the style, i.e. cultural, skill etc. In a traditional planning context the COA is action centered, in effect based the COE is effect centered and in a networked-enabled it can be both.

4. Operations Intent and Effects Model

The operations intent and effects model is visualized in Figure 9. The decision making process starts with an internal or external goal. An external goal can be of the form of an order, plan, request, or intent (depending on the decision making paradigm in focus). All of them describe what to be accomplished; the range of the input can span from a direct detailed order or an abstract representation desired end-state of the higher commander. In the suggested model this initial state is denoted Mission, taken from the DOODA-Loop and that the planning process all start with the receiving of an external mission order/request. The Mission is the input to the Decision Making (DM) process, can also be seen as the decision maker(s).

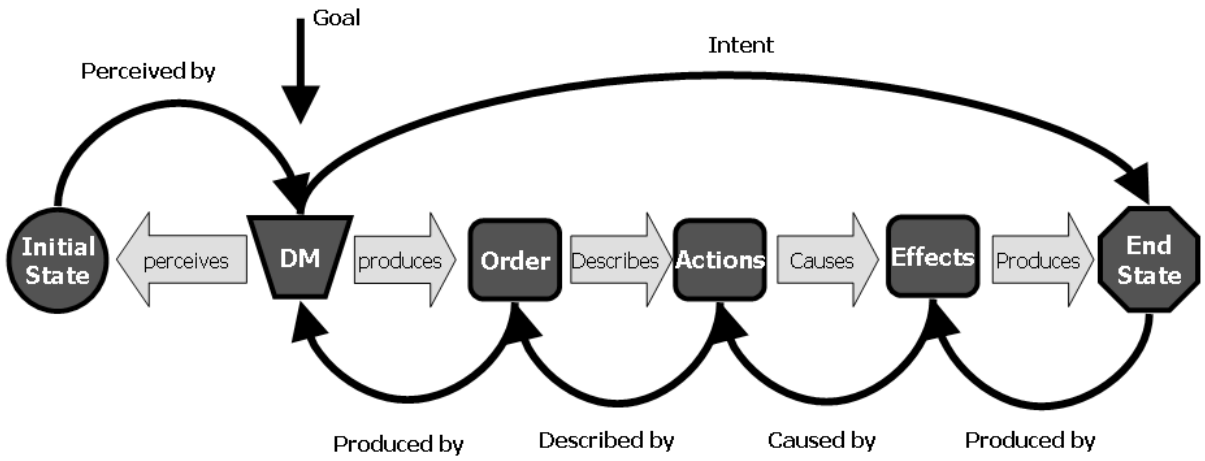

Figure 9 – Operations Intent and Effects Model

The first step is to comprehend the mission and put it into context with the surrounding environment. In this processes identification of information need is developed, e.g. Intention phase in IDC2 and Mission Analysis in Military Decision Making Process (MDMP) (US FM-5.0). Here the DM requests an awareness product TA, LA or GA from a situation assessment process, which can be described by the IPB in MDMP,
The product from the assessment process in Figure 9 is the initial state for the decision making planning process. A State describes a situation and is the physic or mental condition of objects with respect to their relations to other objects and the environment at a given moment or during an epoch in time. State is used here since it is a common term in Finite-State Machines and Control Theory; also that End-State is a key term in the decision making and planning processes, e.g. MDMP, IDC2. In general a state is a set of conditions of the system. A state could be stable

or instable and have the properties of being desirable or undesirable. In Figure 9 the Decision Making process perceives the Initial state and that the initial state is perceived by the decision making process.

According to surveyed literature it is evident that decision making and planning starts with the ability to perceive (Endsley 1988), observe (Osinga 2007) and by experiencing the situation in a changing context (Klein 1994, p25). The world, i.e. the Ground Truth State (GS), that is monitored by a human or a machine is biased and can be seen as lenses that refract the viewed state into a perceived sate, i.e. Perceived Truth State (PS). (Schatuk, 2005)
Initial State (IS) is the PS that is initially used for a decision making process. The intent is product that contains the desired *End-State* (ES), which is a description of how the situation ought to look like for when the intent is reached. In an executing model there exist a series of current states, reiterate the forward and backward chaining earlier.
An End State is a set of desired conditions which will achieve the strategic objectives. The End-State is a special state since it describes the detectable situation that is defined in the Command Intent. From Klein (1994) two of his seven parts of Intent describe the desired outcome, i.e. the objective of a task and anti-goals.
Between the *initial state* and *end-state* a transition needs to be made. The difference between the desired End-State and the Initial State portray the gap that either a direct or indirect transition actions need to fill. A direct state transition action move towards the End-State with one action, An indirect state transition action on the other hand consist of a series of states that need to be archived before reaching the end-state. Such indirect state transition actions may actually increase the "distance" between the current-state and the end-state. In a plan, these extra states between the initial state and end-state is called *Key Points* that might be needed to pass to reach the end-state or that they are *Decisions Points*, i.e. that a decision needs to be made that in the planning could not be foreseen what to be. A *current state* finally is the state the system presently is facing.
Common Intent is of interest with respect to how it is communicated in the different planning processes, both internally and externally. In Figure 9 the decision making planning process develops a Command Intent describes the End-State.
An effect is an abstraction of a purpose and is the physical, functional, or psychological outcome, event, or consequence that results from specific military or non-military actions. It should be achievable, and measurable. An effect is put upon an adversary and actions are carried out by own. Thus, the effect is changing the *initial state* in to the *end-state*, i.e. that the effect *produces* the end-state. The more probable situation is that a series of states are passed before reaching the end-state. The End-State is produced by Effects and Effects Produces the End-State.
An objective is the intended state of affairs to be achieved by the aggregation of specified Effect(s). A Decisive Effect is an effect that will either achieve an end state or complete a phase in a military operation. Second and Third Order Effects are the tightly inter-linked flow-on outcomes from actions, or 1st order effects, which magnify the impact of the original action and are aimed at influencing the will of an individual or organization. An Enabling Effect is an effect that adds to the system of effects designed to produce a decisive effect.
There is a hierarchy of effects and that effects can consists of effects.
In Figure 9 the arrow denotes that effects are caused by actions and that the causality is that actions cause effects.
In MDMP and GOP/OPP as well as IDC2 the format is an OPORD which indicates that Situation, Mission, Execution, Service Support, and Command and Signal are declared. However, if it is a rapid or hasty planning then the order is a FRAGO containing only the most necessary

items. Often *Actions* are found in a written *Order* or plan and an order describes actions and actions are describe by an order.

Development of COA/COE can use backward chaining, forward chaining or a combination of both. In a backward chaining process the decision making process receives a mission goal and perceives an initial state. From analytic or intuitive decision making an intention to reach the end-state is developed. What effects is needed to produce the end-state and what actions are needed to produce those effects. If not the identified effects and actions are applicable onto the initial state, the state where the action can be exercised is used as the next-to-last state, and so on. Eventually the initial state is reached and within the decision making process a selection amongst alternatives are made and an order can be produced.
In a forward chaining process the decision making process receives a mission goal and perceives an initial state. From analytic or intuitive decision making an intention to reach the end-state is developed. Then the question is what actions can cause effects to change the initial state towards the end-state. The next feasible state is used as a new turn, the next after that, and so on. Eventually the end state is reached and within the decision making process a selection amongst alternatives are made and an order can be produced.

In developing of the Operations Intent and Effects Model a review of decision theory and models have been performed including Classic Decision Making (c.f. Lipshitz et al. 2001), Judgment Decision Making (c.f. Kahneman and Tversky (1974) and Davis (1983)), Naturalistic Decision Making (c.f. Klein (1994) and Zsambok (1997)), OODA-Loop (c.f. Osinga (2007)) , DOODA-Loop (C.f. Brehmer 2005), MDMP (US FM-5.0), GOP, EBAO, IDC2. Put into Rasmussen's levels of decision making they can be said to co-exist and then the focus is what kind of information that is needed to exchange and share in a collaborative setting. The models and methods have been used to find the information constituents and determine the casualty and relations amongst them to enable a formalism to be developed. In the collaborative planning view, Figure 10, the information exchange amongst participants is presented.

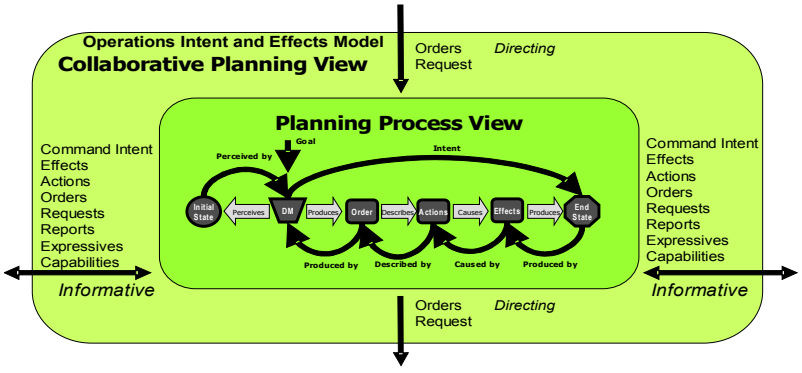

Figure 10 – OIEM Collaborative Planning View

The vertical information of orders and requests are the input and output from a collaborative planning process. An order is something that is dictated to be executed, i.e. within the same chain

of command, a request is something that another organization or agency might ask for. The horizontal information constituents are information that is exchanged in collaborative planning and are: Command Intent, Effects, Actions, Orders, Requests, Reports, Expressives, and Capabilities. In the work of Schade & Hieb 2006, 2008 a formalism is presented that enables automatic exchange and dissemination of the information. In the work of Gustavsson et al 2008 and 2009 the formalism has been extended to allow communication of effects and Expressives (c.f. Gustavsson 2008, 2009 and Hieb Schade 2006, 2008).

A way to view staff collaboration in a brigade or battalion is made in Figure 11 where horizontal planning is conducted, i.e. all participants belong to the same staff but can originate from various nations, agencies etc. Traditionally the blackboard in the figure is a map with several of overlays. With digitalization of the support systems new approaches of staff collaboration can be utilized. For example Virtual Collaboration Desks (VCD) (Louvieris et al. 2008, 2009) staff members can still participate in planning activities when being geographically separated.

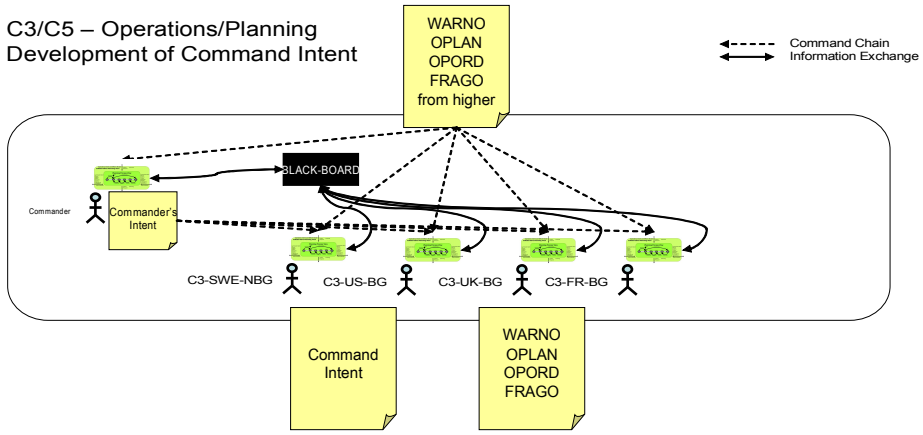

Figure 11 – Horizontal collaborative planning

In Figure 12 one dimension further is introduced when commanders, staff and participants at multiple levels can be included into a planning process. The OIEM is not any different than in the former example, the addition is the complexity that collaboration amongst many levels and many organizations introduce. There is not a single black-board, i.e. Common Operational Picture, there is many since the participant organizations may have a whole set of objectives that leads them to participant in several missions with various participants. It is then even more important to articulate not only the operational and mission specific information but also in which way the operations and missions are to be conducted. What cultural and doctrinal aspects will influence the execution of the actions by a specific participant? In the work of Gustavsson et al. (2008b, 2009) **Expressives** is introduced that captures the style of organizations and commanders such as: experience, risk taking, use of power and force, diplomacy; ethics; norms; morale; creativity; and unorthodox behavior. The use of Expressives can range from where participants express their style to other participants or by staff that develop models over the participants to be used in COA

development and war gaming. In both cases expressives is a support to better understand the collaboration participant's capabilities and conduct of operations.

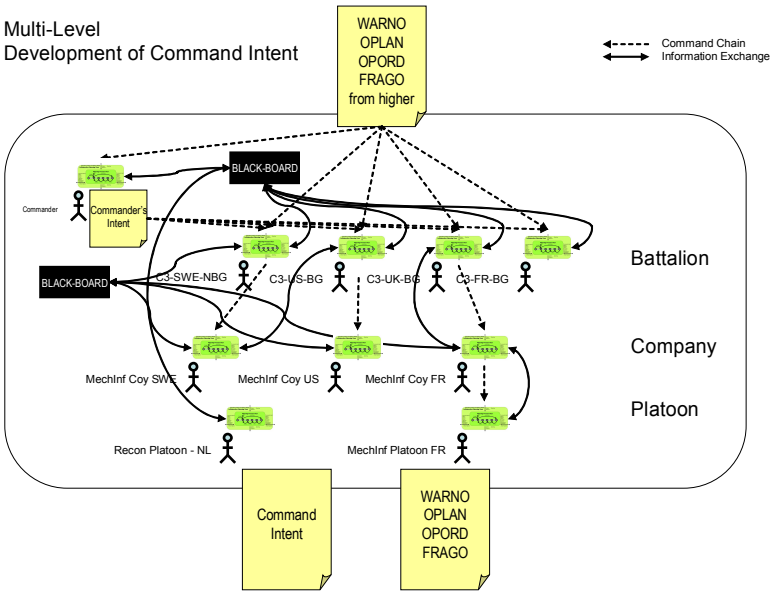

Figure 12 – Multi Level development of Command Intent

5. Discussion

The Battle Management Language (BML) was formally defined by Carey et al. (2001). 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".
In more recent work BML has then evolved into an ongoing standardization effort of a Coalition Battle Management Language (C-BML) (Blais et al. 2005, Blais et al 2008) that still has the overall purpose of allow exchange of C2 and simulation information with minimal ambiguity. With the use of a BML, it should be possible for C4I systems, simulation systems, and emerging robotic forces to communicate unambiguously with any of these other types of systems. Such system-to-system communication is demanding enough when it involves systems within the same organization. It grows even more complex and demanding when incorporating other organizations and nations.
In the work by Schade & Hieb 2006, 2007, 2008 they have developed a grammatical language for that is built upon the BML effort and was only for military purpose into a multi agency operational language which could serve as the hub needed for digitalized blackboards or for exchange and dissemination of mission information. In the work of Gustavsson et al. (2008a, 2008b, 2009) enhancements to the formalism has been proposed introducing representations such as Effects and Expressives to allow for collaborative planning. Then it is envisioned that CI will be more widely available and precise. Future planning systems will need to make use of a machine interpretable format of intent. To describe CI so that it can be provided to a command structure there needs to be a reference in every order pointing towards the intent. The intent should be represented so it can be interpreted by a commander or by a Computer Generated Force. This allows the language to be used not only in representation of goal states in a CGF to determine if the effect/intent has occurred, but also in operational information fusion systems as the hypothesis that is searched for. Digitalization and formalisation proposed by Schade and Hieb (2006,2007,2008) and enhanced by Gustavsson et al. (2008a, 2008b, 2009) together with VCDs

such as (Louvieris et al 2008, 2009) and interoperability infrastructures such as proposed by (Gustavsson et al. 2004, 2007) together can provide mechanisms that can lead to better subordinates´ initiative.

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