15TH ICCRTS
"The evolution of C2: Where have we been? Where are we going?"

Overcoming Obstacles to Collaboration
Topic 3: Information Sharing and Collaboration Processes
and Behaviors

Alternative Topics
Topic 2: Networks and Networking
Topic 5: Experimentation and Analysis

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ABSTRACT

The ability to collaborate is becoming increasingly important as militaries pushed themselves to adopt Comprehensive Approach to Operations. The introduction of new C3 technologies has further enabled the application of distributed collaboration methods between staffs of the same echelon and over echelons of command. This paper addresses the shortcomings of having such a distributed collaboration model. Over several experiments conducted by the Swedish and Singapore Armed Forces, it was consistently observed that collaboration between staffs through new C2 collaboration technology is not something that comes natural and easy to mid career and senior management military staff officers. We identified a set of behavioral and system obstacles for echelons of staff to collaborate effectively and elaborated why they occur. Participants in our five studies were army staff officers from Singapore Armed Forces and Swedish Armed Forces and the focus was on planning, and execution of a plan. Our analysis suggests that there were at least nine different obstacles to effective collaboration. The more prominent obstacles were related to mindset problems, systems limitations, resistance to accept new way of working with systems, and a strong hierarchical training tradition starting as early as their enrollment into military training. The second part of this paper is to suggest approaches to help militaries or international community to accomplish true collaboration between staffs of different organizational units over time, both in the immediate term and long term institutionalization of proven collaboration methods.

OVERCOMING OBSTACLES TO COLLABORATION

INTRODUCTION

There are two important trends that are influencing command and control (C2) development in most militaries today. The first, is the increasing capacity of sensors, networks and computers that enables militaries to access readily available information quickly; and the second, is the complexity of the battlefield situation that would necessitate the ability to collaborate and share information with one another, in order to secure the long term goals of the operation, as in the case of Afghanistan and in Iraq (cf. McChrystal, 2008). Collaboration and sharing of information by militaries these days also include non-military actors that would have significant influence on the long term goals of the operations such as government and non-government organizations.

Between 2004 and 2007 the Sweden Armed Forces (SwAF) and Singapore Armed Forces (SAF) worked together to develop and experiment collaborative C2 planning models based on the new advancements in information technology. From 2008 this effort continued with the Swedish National Defence College (SNDC) and Singapore Technologies Electronics (STEE). In five different experimental studies between 2005 and 2009 the authors of this paper had observed the act and effectiveness of collaboration performance among staff officers working within the same unit and also among staffs belonging to different echelons during military mission planning and battlefield operations. The main purpose of this paper is to present and explain some obstacles towards achieving effective collaboration that we observed during these studies. We will share our insights on why collaboration between staffs is sometimes difficult and what we think can be done about it. The first section of the paper gives a background and outlines the ideas behind our self-developed planning models and also presents the key functionality of the modern C2 technology used in the experiments, known as the MissionMate system; the second section of the paper is focused on presenting obstacles to collaboration that we have observed, and the final section outlines some ideas regarding how to further develop the ability to collaborate between staffs supported by

modern C2 technology. As a note to the reader, it is not the intent of this paper to reference or reinforce the observations and outcomes of the hypotheses developed for the 5 experiments conducted, as they have already been presented in earlier papers to different ICCRTS events.

THE EVOLUTION OF C2 WITH
IMPROVED COLLABORATION MODELS

To address "the evolution of C2", both authors co-developed a new integrated approach to military planning as an avenue to further improve shared awareness between staffs regarding command intent and the general understanding of the plan, as well as to increase speed of planning and re-planning in order to frustrate the adversary's objectives. We developed the Team Insight Model (Cheah, Thunholm, Chew, Wikberg, Andersson & Danielsson, 2005) and the Team Collaboration Model (Thunholm, Cheah, Fong, Tee, Chew & Larsson, 2006) as key innovations towards a more decisive and synchronized C2 planning and decision making process. The ideas behind TIM and TCM will be presented in the following, but first a short background.

The idea to develop faster and more collaborative planning models in order to increase shared understanding between staffs belonging to different echelons was brought about after some years of experiencing and practicing traditional hierarchical military planning process. Even with the evolution of newer technologies and information systems such as the Command Post of the Future (CPoF, Tisserand, 2007), it did not quite change the way the military did their sequential planning process (e.g. US Army, 2005). The echelon or headquarters would develop several courses of action and adopt sequential points of discussions before an official operational plan is announced by the Commander. The staffs would then develop the plan into actual Operational Orders for the next echelon of command to develop their respective and more detail operational plans within their given area of operations. This sequential process would iterate until the last Command chain would have given his orders i.e. the Platoon Commander to his soldiers. Given just a four-level echelon of command (Brigade to the Platoon), from experience, a rough order of nearly twenty to twenty-eight

hours is required for planning and rehearsals before the entire force would be ready for operations.

Given the above, there were three key areas that the authors wanted to improve for military planning process. This was done over progressive experiments and exercises beginning 2005. The authors realized that lower echelons could only begin their planning process just after receiving the formal "Orders" from their immediate higher command. To avoid misinterpretation of orders, some militaries adopted an additional step in the planning process called "Brief Back" or "Approval of Plan by Higher Command" in order to ensure that the lower echelon command's plan is tightly in tune with the higher one (e.g. NATO, 2004).

While the "Approval of Plan by Higher Command" is an important step, we felt that this is a little late in the planning cycle. If for some reasons, there was a misinterpretation of the "Orders" or "implied tasks", it gives nearly no time left for the lower echelon of command to review and re-plan to satisfy the higher command's intent. If there was a continuous generation of knowledge of the higher echelon's formulation of their plan that the lower echelon could be made aware of, perhaps the misinterpretation of the "Orders" could be avoided. It could also give the lower echelon an earlier start to their planning process that could lead to a more robust and well thought out plan. Thus, the authors' first idea was to enable "Insights" for the lower echelon of command. This was called as the Team Insight Model or TIM. The purpose of TIM was to enable the lower echelons to follow the higher echelon's planning process through the C2 supporting software. With the software, the lower echelon could also, if necessary, query on their immediate superior's planning directives and decisions well before the higher echelon develop them into Orders. Creating "Insights" would also reciprocally allow the higher echelon of Command to monitor the lower echelon's planning process and discuss with them at any point in time during the lower echelon's planning process. This means that the "Approval of Plan by Higher Command" would evolve into a deeper dialogue among the two echelons leading to a tighter integration of both plans. The TIM is described in detail in Cheah, Thunholm, Chew, Wikberg, Andersson & Danielsson, (2005).

The second idea was a lead on from "Insights" towards "Collaboration". In simple terms, this means bringing two echelons of command to come and work together to develop a cohesive and single Order for the next lower echelon of Command. For example, a Division and her Brigade Headquarters would work together to develop an Order for the Battalion Commanders to further plan their operations. Why this idea? We made three assumptions. Firstly, we felt that the Division could leverage on the Brigade's staff to augment their planning process and have more "thinking caps" to work on their large area of operations. For example, if there were three Brigades to a Division, the Division Operations Officer would be able to utilize the three Brigades' Operations Officers to assist him/her in planning besides his/her own staff officers. Secondly, the involvement of the Brigade Staffs would eventually lead to a thorough understanding of the Division's plan without the need for a formal "Orders" session. And thirdly, the collaborative planning of the Division and the Brigade headquarters could lead to a faster planning cycle and an earlier release of the Battalion Orders. This would create more time for the Battalion to develop a robust plan against the adversary.

The Team Collaboration Model or TCM was meant for staff to work together horizontally across the entire headquarters, as well as vertically between two echelons of command. Further innovations require the Support Staffs of both echelons to get together over the use of modern C2 technology, like MissionMate, to develop a cohesive and integrated plan, as though both echelons were working as one entity in a physical location. The planning process of both echelons had to be in close time steps to each other instead of the lower echelon waiting for the full Orders from the higher echelons to begin real planning. The lower echelon not only had to participate with the higher echelon on every major step in the planning process, they could also voice their opinions to the higher echelon during each step of the planning process.

Included in the TCM, was an implied need to develop a new set of planning process to supervise how both echelons would be able to plan together simultaneously. The knowledge Battle Procedure or KBP was developed

for the Singapore experiments (Cheah & Fong, 2006) while the Integrated Military Planning Process or IMPP was developed later for the Swedish experiments (Thunholm & Lundin, 2008). Both KBP and IMPP are presented in a simplified table format in Appendix 1. Some of the experiments included both Swedish and Singaporean participants together. The KBP or the IMPP facilitated both the higher and lower echelons to synchronize their planning process and how each echelon of command would be an important stake holder in the integrated planning process. In summary, the KBP or the IMPP is the TCM's battle planning process to increase shared understanding and further reduce the overall planning time and get the force into operations much quicker as compared to a military adopting the traditional hierarchical planning process.

For both the TIM and the TCM ideas, there is a need to adopt or develop an advanced computer-based system to enable the teams to work together or collaborate, and this was our third idea. Most computer-based systems have claimed to have the ability to enable collaboration between parties (cf. CPoF used by the US Army in Iraq 2003, as reported by Tisserand, 2007). The Singapore Armed Forces (SAF) Centre for Military Experimentation (SCME), Defence Science and Technology Agency (DSTA) and STEE have developed such a computer-based system known as MissionMate, to enable deep collaboration to be conducted in real-time by many parties (Cheah, Chew & Tan, 2004). The collaboration goes to the extent of being able to draw, create folders, overlays, pan and zoom maps, while simultaneously being able to discuss in real-time with colleagues on operational plans that were seated in other rooms or places not nearby but connected over a network. MissionMate has three key sub-systems or modules namely the Team Operational Picture, an InfoHub and a Video Conferencing system. All three modules are meant to allow each user to have a total awareness of their colleagues' plans, status and actions, either in graphical drawings or in files such as Word and Powerpoint documents stored in shared folders. The Video Conferencing module was developed for formal conferences among the Staffs but it also includes a chat function as well as a one-to-one voice call that mirrors a telephone call. With MissionMate it is possible for distributed staffs to meet virtually and discuss and draw on a situation map

overlay the same way as if everyone was sitting in the same room around a table looking at the same situation map.

The development and employment of MissionMate created several new improved methods to conduct military planning. One significant method was that militaries could theoretically do away with the traditional face-to-face conferences, and these meetings could be done by teams using their desktops where staffs are seated either in the same room or separated in several adjacent rooms. The use of MissionMate would suggest the less need for the gathering of staffs formally for a conference in a meeting room. We respect the need for the gathering of staffs as this would allow the commander to have a command influence and some order and respect. However, we have also experienced that such formal meetings would lead to staffs giving informative presentation as the main time slice of the entire agenda. This leaves little time to discuss or collaborate among the staffs, which are most often done on the side and out of the commander's pre-planned conferences.

The second method was to have the Commander (Cdr) directly accessing the use of the C2 software to communicate with his sub-ordinates. Commanders often use their trusted staffs to assist them, i.e. to act as an in-between to the Commander's principle staffs, such as the Operations Officer, Intelligence Officer and so on, as well as get the necessary information from the computer. Most Commanders try to stay focus and look at the situation map to study how the adversary would react and how then the Cdr could develop a good course of action, and using Staff Assistants as his/her stand-in for emails with the subordinates. Email is of prevalent use in today's C2 system. With MissionMate, the authors wanted to encourage the Cdr themselves to use the system, because the Staff needs to dialogue closely with the Cdr rather than through the Staff Assistants, increasing the real-time collaboration environment with much less usage of the email system.

The third method was to influence the way the teams uses MissionMate. While most computer-based systems used by operational users are being taught by technical staff or engineers, with MissionMate, the teaching was

done by one of the authors, LTC (NS) Mervyn Cheah. This mirrored the DARPA's CPoF programme where ex Generals were employed to teach the users on how to use the CPoF system expertly. This is because MissionMate is not categorized as Decision Support System (or DSS in short), where technical staff can easily teach the use of the system to the user. According to Ntuen and Kim (2008) analysis, MissionMate is classified as a Sensemaking Support System or S3. They stated that the major difference between a S3 and DSS is that S3 supports sensemaking activities where visualization and team collaboration of the battlefield operations are of primary importance, while DSS are specialized modules where specific rules have already been in placed or practiced in daily operational routines or ad-hoc operational requirements. MissionMate is designed to help Commanders and all the team members assimilate information and to understand each other's tasks and plans better, and quicker as well, through a set of collaborative activities. It is more suitable for such a tool to be taught by operational users.

The fourth method was how Commanders and Staff visualize their operational pictures. While there was an international influence on the use of the term Common Operational Picture or COP as the key to achieving synchronize visualization across the team members, we felt that COP alone is insufficient to meet the Team's visualization needs. It would just serve the Commanders, and less so for his/her staffs who would develop a COP that their Commander needs to see. Such a COP may not serve the total requirements for the Commander's Staff and his/her second echelon team. A Brigade S2, for example, would want to have a Brigade S3's picture, his/her Brigade's and parent Division Collection Officer's pictures and Commander's notes in order to derive the most practical and up-to-date enemy courses of action.

As such, MissionMate developed a Team Operational Picture or TOP. TOP is a collection of individualized Operational Pictures from the various Commanders and Staffs. With TOP, Commanders and Staffs can now easily switch in to their colleagues' Operational Pictures or Workspaces, and adopt an active discussion with their colleagues. This ability to switch or glance around your peers operational pictures is known as TeamSight

(Cheah et al, 2006). With TeamSight, it also means that Commanders can now progressively monitor their Staffs planning in action, and intercept at any point in time to add substance or to deliberate on the complexity of the operational plan.

WHERE HAVE WE BEEN WITH
IMPROVED COLLABORATION MODELS

Although none of our five studies on TIM and TCM had as its main purpose to study obstacles to collaboration, we still observed how collaboration was carried out according to the instructions in the two models. As earlier mentioned, it is not the intent to reinforce or reference the various findings and outcomes of these experiments in this paper. More importantly, in the current report, we wanted to share some important obstacles to collaboration that we observed more or less consistently over these five studies. These obstacles are connected specifically to the two collaboration models that we use. However, based on our previous military operational experience we believe these obstacles can be generalized to a great extent to other similar situations of collaboration between echelons, where the collaborating parties are using technical systems.

From observations made during the experiments, we were able to determine several different obstacles to effective collaboration (Cheah, Thunholm, Chew, Wikberg, Andersson & Danielsson, 2005; Cheah & Fong, 2006; Thunholm, Cheah, Fong, Tee, Chew & Larsson, 2006; Thunholm & Lundin, 2008; 2009). We realized that the Commanders themselves played a big impact to the team and this was a common trait for every experiment conducted. The Commanders during all experiments seemed to have a big influence on their staffs. In some of the studies we were fortunate to have willing Commanders to learn how to use MissionMate and collaborate, but in other studies the ability and interest were lower, often because of restrictions in training time as commanders were often busy with other commitments.

If the Commanders were influential and much willing to participate in experiments, it would ease the situation for experiments conducted with real operational staffs. However, we also observed a common trend that when Commanders start to realize that they had so little time left to complete their plans, they reverted away from the experiment's objective and started to conduct their own method of planning process, just so that they could complete the Operational Plan in time.

The other common trait was continual coaching of the team on the use of KBP or the IMPP. For all experiments, the team followed the new process. Because there was always some tendency for Commanders and Staffs to stray away from the prescribed new process, the authors had to constantly watch the team in action and influence the team back to the experimental agenda.

Why so? There were a number of reasons. As a start, officers who participated in the experiments were between mid-30s and mid-40s. These were mid career to senior management officers who have been fairly trained, doctrinated and had even led in practicing or customizing traditional battle planning process. In the TIM experiment, the objective of having the lower echelon listened in to the higher echelon planning process was very well received by the participants. But in the TCM experiments, many Staffs were very ingrained to the traditional planning process. Both the higher and lower echelons of command were much accustomed to the traditional planning process and how Orders were generated and the echelon responsible for it. As Orders traditionally flow from higher to lower units i.e. Higher Staffs "direct" Lower Staffs, there was very little incentive for the higher echelon to initiate much collaboration with the lower echelon. Even in a scheduled conferencing session, when it was prescribed for the lower echelon to take an active participation, during most runs, only the higher echelon seemed to dominate the discussion.

One explanation was that the lower echelon had respected the chain of command and preferred the higher echelon to solve or satisfy their situation analysis. The lower echelon only queried or discussed when the area of

operations and resources affected them, as compared to the initial intent for the lower echelon to also discuss the higher echelons' situation analysis.

The other explanation, and probably a human nature is the primary group versus secondary group thinking, a term borrowed from Sociology. We have realized that the higher echelon were more accustomed and familiar with their Staffs and could easily communicate or collaborate internally i.e. the primary group. When the higher echelon Staffs (i.e. the primary group) included members of the lower echelon Staffs (i.e. to form a secondary group) and collaborate openly with them, we consistently observed that the primary group first wanted to find a solution by themselves before they engage in secondary group collaboration. The higher echelon had viewed the lower echelon as their subordinates or juniors. They seemed to prefer to issue directives, and even if they were supposed to participate collaboratively, there was very little of such actions observed from them, as they were more focused to ensure their Commander had completed his/her agenda and issues at hand.

Mid career to senior management officers also preferred the traditional and natural face-to-face meetings. They aren't used to using computer-based collaboration. At the beginning, they seemed excited to try it, but as the battle planning process continued and they began to realize the gradual or steep rise in their workload to solving or developing the battle plans, they spontaneously avoided using the MissionMate system to collaborate and started scheduling face-to-face meetings instead. But one key observation we noted was that the face-to-face meetings were somewhat more intense as compared to traditional conferences where a majority of the time was for Staffs to brief or present to the Commander. The Commanders and Staffs were now pressed for a plan because there was a big time constrain. They began discussing intensely because there was a need to quickly get everyone to agree and start completing the plan on time.

Was there a problem with the technology then? Our findings showed that collaboration through computer-based C2 systems was not a habit for the participating officers in our experiments. We identified a couple of reasons. The first was indeed the system limitation. It would require a vast amount

of bandwidth for computer-based C2 systems to truly equal face-to-face collaboration. For example, video/audio quality had to be low resolution as the team was collaborating over more than 10 players at a time in a scheduled conference session. Also, using the MissionMate's drawing tools and pen to draw and talk was not as natural as using the pen to draw freely on the wall map or a map put on a large table and talk.

The second reason was the skill sets of these officers. Mid career and senior management officers, for a majority of them in the experiments, did not possess the techno-savvy skill sets for using computer-based collaboration system. Younger generation soldiers, on the other hand, are perhaps more accustomed to collaboration and on-line gaming software because they are into social networks as early as their primary or secondary school days. Many of these younger soldiers can multi-tasks easily. These younger soldiers have been much influence among themselves to play on-line strategy or battle games and in teams. They worked well with computers.

One other key discovery is structures. Commanders and Staffs tend to pay a lot of attention to structures. The experiments conducted did not alter the hierarchical organization but was only testing the application of TIM and more so the TCM within the same structure. If we had altered the organizational structure, it would have cluttered our experiment results because it would be difficult to determine which independent variable had a larger influence or contribution to the experiment objectives. Commanders and Staffs had already a hierarchical mindset during the experiment because the experiment did not change the current structure. We realized that collaboration with lower echelons of command especially, was not natural by default, except for issuing or receiving orders. Why so? A set hierarchical structure would denote a chain of command. This means there needs to be respect for the Commander and his Staffs of the higher echelon, especially in the military. Rank or appointment has a prestigious place in the military society. Unlike resource scheduling and planning, military planning can only be performed by trained or experienced Operations and Intelligence personnel, who are usually senior in rank. These Staffs have developed their own "art of planning". If we asked a classroom of fifty people, hypothetically speaking, to compete and develop the same military

offensive plan and we have included some 10 highly experienced personnel in this classroom, there will likely be a vast difference in the output between the forty non-experienced and ten experienced personnel. Even among the ten experienced personnel, the output will probably be different or a variation of each one of them, and each would have their own merits for the drawn plan. This is because everyone thinks differently in how to conquer or complete his tasks or objectives in a highly complex military environment. It is sometimes a game of wits between the Intelligence Officer and the Operations Officer during planning and it takes many months or years to develop into mastery. And during execution, things will also change because the actual enemy, more often than not, does not plan according to how the Intelligence Officers had plan the enemy's courses of action. It is not so easy for Intelligence Officers to predict or figure how the enemy would fight his/her battle. A hierarchical structure therefore assumes who is overall in charge, and who is overall responsible for the plan. Structure and rank matter a lot in military planning and execution, especially for the land battle. Commanders often choose their Staffs, who know or are intimately in the know of his/her requirements and his/her style of planning. We have now presented and elaborated a set of obstacles to collaboration between Staffs belonging to different echelons and they are summarized in Table 3.

Table 3. Observed obstacles to collaboration between Staffs

Obstacles	Description	Effects
High workload	When the general workload is high	Reduce the interest to collaborate between echelons and Staffs
Hierarchical mindset	When each staff think of itself as primary belonging to a specific hierarchical unit	Collaboration with other echelons of command/staff not well accepted during the planning process, except for issuing/receiving orders.
Primary group vs. Secondary group thinking	When only the members of the own section/staff is viewed as the primary group	Physical presence of own staff team members overrides the secondary group, leading to pre-

Obstacles	Description	Effects
		planning among the members of the primary group before the secondary group is invited to collaborate
Traditional flow of orders	Orders traditionally flow from higher to lower units and higher staffs "direct" lower staffs, they don't "collaborate"	No real incentive to (true) collaboration
System resistance	Collaboration through C2 systems is not trained or not a habit.	Staffs have a tendency to avoid using the computer-based tools for collaboration
System limitations	For example limited connectivity in time or bandwith, low resolution video/audio, etc	Technical problems makes network collaboration between physically distributed staffs more difficult than face-to-face-collaboration. If difficulties are frequent, the system is less and less used for collaboration.
Face-to-Face mindset	When staff members/commanders believe that face-to-face communication is the best means to collaborate and elicit understanding from the group instead of using the C2 system	Staffs have a tendency to avoid using the Computer-based tools for collaboration
Need to think first	Higher HQ/staff think that collaboration with lower staff too early in the planning cycle would create difficulties, because they themselves don't get enough time to think things over before they have to engage subordinates	Higher HQ/staff issue planning guidance to lower echelon HQ/staff instead of true collaboration with them
Want clear directives	When subordinated	True collaboration between

Obstacles	Description	Effects
from HHQ	HQ/Staff prefers clear guidance from HHQ	echelons is reduced because it disrupts the process of the subordinated staffs as they prefer clear guidance from HHQ

To sum up this section, although the participating officers in our experiments were able to follow the new planning models reasonably well, we still consistently observed troubles or obstacles for these officers to engage each other over the C2 systems. This section has highlighted the observations and insights to the obstacles of using such collaboration models. It has to be mentioned that this could not be done without having gone through several years of experiments with the users, and different sets of users, both from the Singapore Armed Forces and the Swedish Armed Forces.

WHERE ARE WE GOING WITH
IMPROVED COLLABORATION MODELS

Poole (2009, p. 758) says: "We may safely assume that future technological reliance will not decrease or diminish anytime soon". It has also been concluded in several studies on interagency collaboration (e.g. Miller, 2008) that although policies for comprehensive information sharing and collaboration between different agencies may still be lacking, the necessary culture to utilize information technology to facilitate collaboration does exist. Following this and to address the "Where are we going with improved collaboration models", we intend to embark on two strategies. First, we realized that throughout all the experiments, feedback from participants revealed the lack of time to train or familiarize themselves with both the new planning process and MissionMate system. This could have been the major cause for the hiccups or the turning back to traditional planning process when using the improved collaboration model. So, the first strategy is to suggest the "Back-to-Basics". There needs to be sufficient training time for the C2 or computer-based system used (e.g MissionMate), even without the training of the improved planning process

(although training should also be done with the system and the planning model together). There is evidence from several reports indicating that the more the user is familiar with the system and how to use the functionality (for example drawing tools, functionalities and the TeamSight capabilities in the MissionMate system), the higher the chance they will adapt well and thus overcome the challenges to good collaboration much more ably (e.g. Steinhauser, 2008) . If we look at the figure 1 below, we have expressed that for a team to be cohesive and effective, the people must learn to work well together to achieve process effectiveness, knowledge interoperability and team interoperability. What is important to note is that the Centre of Gravity for all three of these objectives is the need for good interaction and communications, as shown in the orange circled region. This is the region where MissionMate was meant to facilitate, which are essentially idea exchange, information sharing and preparedness to network among peers during execution.
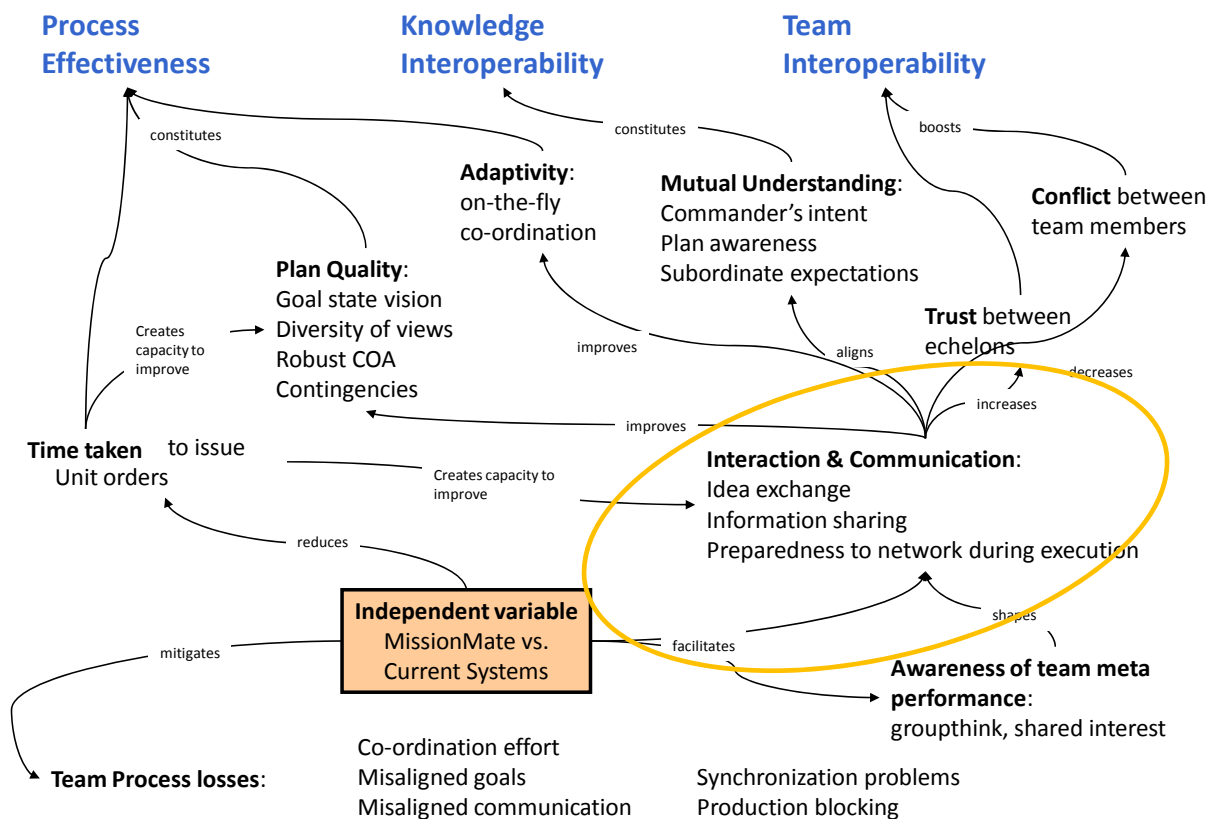

Figure 1: Facilitating Team Interaction and Communication

If we extend this further, we hypothesize that with better interaction and communication it would improve the team's adaptivity, mutual understanding of the Commander's intent, trust and even reduce or resolve conflicts between team members.

How can we achieve this? One good starting point is for Command and Staff Courses or any military institutions, Colleges or Schools to encourage or constantly practice collaboration process through C2 systems during their courses. It would be useful for these institutions to implement the use of a C2 system at the beginning of the course work, and get the students, both juniors and mid-careers into the habit of using collaboration features as frequently as possible such as in study groups, discussion topics and map planning exercises. As an example, both the authors had initiated this for SNDC. SNDC started to use MissionMate for their Command and Staff Courses in 2008 and 2009 and provided each student with notebooks (Thunholm & Lundin, 2008; 2009). A non-collaborative version of MissionMate with a basic map planning feature was installed into each student's notebook so that they could familiarize themselves with the drawing and map planning functionalities. With such practice or self-learning environment, students should find it easier to work on the collaborative MissionMate and exploit the features of TeamSight more readily. They could then gradually be introduced to the planning model to use together with the C2 system.

Along the way, we have to continually review or refine the current KBP and IMPP vis-à-vis the current hierarchical structures. If hierarchies remain as the most critical component in missions, then perhaps, there is a need to rethink and review how much integration it should be in a military planning process. Militaries that are strong in maintaining their hierarchical structures may not find the TCM (as instantiated by the KBP or IMPP, see Appendix 1) as easily applicable. They could or would find a less collaborative model (e.g. the TIM) more applicable and possibly this is about the best compromise between today's practice and tomorrow's new methodology of planning process.

However, if militaries do still want to adopt the TCM, even with the hierarchical structures, then they must be open to a few conditions. First and foremost, hierarchical structures must develop a cohesive teamwork between the higher and lower echelons, and the lower echelons must be treated as equals by the higher echelons. Without this condition, the obstacles or challenges to collaboration would still be quite prominent. Secondly, the higher echelon should not see the presence of the lower echelon as a burden. Instead, they should leverage on their assistance as much as possible. They should see them as additional staffs to the higher echelon's functions. For example, the higher echelon's Intelligence Officer could now utilize the lower echelons' Intelligence Officer for the higher echelon tasks. Of course one would be concern about the lower echelons' Commander, who seemed to have Staffs reporting away from him and helping the cause of the higher echelon's task and issues at hand. Such conflict should be resolved before a planning operation begins. If the lower echelon staffs start to assist the higher echelon, the lower echelon would have a good understanding of the intent well before the lower echelon receives their Orders to perform improve planning on their respective area of operations. And thirdly, the flow of collaboration cannot be one-way. This means the higher echelon cannot be the only one to ask the lower echelons to help them but also vice versa.

The second strategy is to push the boundary of the current TIM and TCM towards edge level collaboration. The authors termed this as the Team Edge Model or TEM. TEM will be the next mode of improved collaboration, and is about "Power to the Edge". There are two approaches to TEM. The first is obviously to review and propose a restructuring of the current hierarchical structure and adopt a collaborative decision-making process with all the stake holders. TEM is about a total change structure and about new way to work, be it for a military or civil organization. It is also the model we felt that will help in our research to improve militaries in their deepest Achilles heel i.e. replanning (Klein, Wiggins & Lewis, 2003; Klein, Klinger & Lewis 2004). Today's echelons of command, because of the "passed-down" Orders and plans, takes a long duration before the highest chain of command is able to realize the need to replan. The response time for the lower echelon to feedback up one intermediate level may be fast, but the

intermediate echelon of command going up one more level higher, may be a bit later (cf. Thunholm, Ng, Cheah, Tan, Chua & Chua, 2009). Considering a few more intermediary echelons, one can appreciate the time it takes for the highest echelon to be able to map her picture before deciding to replan. Because of the time lag, the situation picture by which the highest echelon decides to start replanning may have already changed in a fast pace battle.

Can the TEM still be applied to militaries or para-militaries continuing to adopt the hierarchical structure? Yes and this is the second approach. The intent is not to unravel the institutionalized hierarchical structure but to identify points of collaboration (POC) within the battle planning and execution process where edge-level type of collaboration and decision making is still possible. An obvious application is the collaboration among Company and Platoon Commanders that are on a mission relating to a similar location or area of operations and the need to co-ordinate boundaries, fires, entry zones, phases of operations and target objectives. It could also be applied to a group of Air Defence operators who are distributed around the land forces and all having the same task to protect the land forces from air attacks coming at any directions.

For the headquarters and their hierarchical structure, an example would be the development of the fire support plan, with the need to collaborate closely with the Operations Officer, Intelligence Officer, lower echelons' Battery Command Posts, the Signal Officer and the Logistic Officer to materialize a good deployment, displacement and a fire plan. There are clearly many more points of collaboration available to apply TEM and this is an area we will study much in detail. The goal is to improve the integrated team interaction and communication process at identified POC areas. The TEM strategy will be our next research area towards improved collaboration models and how teams can improve their replanning process during the execution phase.

So, how could we do it? One approach is to develop a series of military micro-world scenarios, based on lessons from current operations, and having participants to use MissionMate in order to plan and replan in short time scenarios including several possible POCs. This would give us insights

on how to further develop both the C2 system and the planning model in order to facilitate online collaboration between distributed staffs. The other possible option is for the authors to investigate whether MissionMate could be added to or merge with other forms of established Micro-world systems such as ELICIT (Ruddy, 2007) and D3-Fire (Svenmark & Brehmer, 1991).

CONCLUDING REMARKS

As a closing, a lot of significant effort has gone to conduct experiments involving both TIM and TCM by the Singapore and Swedish Armed Forces as well as a combination of both Forces. The authors have made some deductions and conclusions of "Where have we come with improved collaboration models". We have also established the "Where we are going with improved collaboration models" and the journey is still some road away for militaries to overcome obstacles to collaboration through modern C2 systems and achieve a natural collaborative process among one another and among echelons of command. Having said this, the authors are opened and willing to work with other militaries wanting to use collaboration techniques to improve their team battle planning process. We have already noted the need for Command and order leading to the foundation of echelons of command, thus the application of TIM or TCM to improve team interaction and communication. This paper is just a prelude to the authors' campaign with Team Edge Model. We will start to establish a better sense of how we can define, elaborate further and apply TEM at the next ICCRTS.

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Appendix 1

The Knowledge Battle Procedure for TCM

The intent of this document is to explain how the Division or the Coalition Task Force (CTF) and the Bde/Bn can use the Team Collaborative Model (TCM)[2] with TeamSight[3] C2 Systems to help them plan better and faster.

TCM is about using the Knowledge Battle Procedure (KBP) with TeamSight and get staff to co-operate in near real-time on activities together. The intent is to determine the ability for CTF and Bde planning to be conducted cohesively and simultaneously, and not sequentially. TCM is about being able to get several (2 or 3) hierarchical echelons to work in parallel such that the overall team performance is more effective, efficient and dynamic. In the process, time is created to allow the team to be adaptable should the situation changes rapidly.

The idea is to have the 2 Bdes and the Homeland Security Force as an extension of the CTF staff functions i.e. like another Support staff but performing the Bde tasks in parallel, while the CTF is doing her deliberate planning process. When the G3 has finished his task for example, the Bde can proceed to do the Bde plans. With TeamSight, this can be done in parallel just like together with the Support Staff functions. This allows the CTF and Bde staff to work 2 to 3 levels down and allow the Bde to participate in the planning with the idea to gain more insights, sometimes even to give divergent views, co-operation and cohesion between the CTF and Bde.

The TeamSight system consists of 2 or more types of collaboration:

> a. <u>Map</u>. Map collaboration will be for planning and situation awareness.

> b. <u>Mind</u>. Mind collaboration will be for presentation, getting ideas from the rest, collaboration in other non-map related activities such as charts, graphs, photos, etc.

> c. <u>Chat</u>. This is for text chat.

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2 TCM was experimented with SCSC students in 2005. Refer to CCRTS 2006 paper on the experiment used.
3 TeamSight is a concept that allows divergence of views as well as enable collaboration of disparate teams needing to work together. Refer to 10th ICCRTS paper on CPA and TeamSight experiments.

d. <u>VC</u>. This is for voice and video conferencing.

Although there is a prescribed timing for KBP, there is no fix rule. And it all depends on the time allotted. The 2 most important events in the KBP as a general rule are the mission analysis and the development of the Orders to the executing agencies i.e. the Company Commanders, the Artillery Units, the Homeland security force, etc. This is a guide. At any time, we need to know 2 things:

a. The commander's intent. What he/she wants and how he/she wants it orchestrated is critical to the entire civil-military campaign objectives. It is important for all staff at all echelons preferably to know his intent, his ideas and his guidance. This will drive the rest of the staff and sub-commanders to follow accordingly.

b. The Execution Orders. The CTF HQ and the Bdes must know that the end-state of the planning is to give Orders to the Company Commanders, and not to the Bde Commanders or the Battalion Commanders. In other words, they need to give the detail tasks to the Company Commanders, rather than say to complete their task only at each echelon of HQ planning and leave the rest to the sub-ordinate Commanders to do finish the job.

The concept should be to just work on 1 'Common' Reference Orders, and to start the development of the CRO as early as after Mission Analysis. The following is a guide:

a. Enemy
    (1) Enemy Situation and ORBAT
    (2) Enemy COA down to Company levels
b. Own Forces
    (1) ORBAT
c. Mission
d. Concept of Operations
    (1) Commander's Intent (CTF)
    (2) Phases of Operations and Success Conditions
    (3) Grouping and Tasks
    (4) Fire Support Tasks
    (5) Air Support Tasks

(6) Navy Support Tasks
(7) Engineer Tasks
(8) Intel Support Tasks
f. CSS
g. C4 and Co-ordinating Instructions

The complete guide for the KBP for the TCM is as shown below. The idea of TCM is parallelism in action. To get everyone in action in parallel, the CTF HQ must do 2 things; one, use the Bde staff as an adjunct to the CTF in helping out with the plans (ECA); and two, allocate the area of responsibility to the sub-units as early as during the Prelim planning stages.

Table 1: The KBP for TMC.

S/n	Outputs	CTF Staff	Bde/Bn Staff	Est Duration	Remarks
1	**Warning Order**				
2	**Preliminary Planning**				
2.1	Time Schedule for the Planning Process to the point of order release to direct sub-ordinates	G3 will co-ordinate with Bde S3 on the integrated time-table	S3 will co-ordinate with the G3 on the integrated time-table	-	Use of the Time Chart on either PowerMap or PowerMind. Use of the PowerMind to publish table of events and necessary agenda.
2.2	CTF Prelim Planning (this is Step 1 to 3 of the original Division BP)	G2 and G3 work on the various factors identified for Terrain Study and how it would affect HHQ mission and goals <mark>List the conclusions from Terrain Study at a Conference.</mark>	Bde S2 and S3 participates with G2 and G3 on the various factors identified for Terrain Study, identify areas necessary for Bde and how it would affect HHQ mission and goals <mark>List additional conclusions from Terrain Study at a Conference.</mark>	5 hrs	Bde use Team-Sight for working together with the CTF HQ during CTF HQ study of Terrain. Be able to interact, disagree at times, with the CTF HQ during conclusions of Terrain Study. Use of VOIP/Video Conferencing and Chat tools for collaboration . <mark>This stage is a truncated process in the experiment. It is usually a 1 day process for the Div/CTF to conduct preliminary planning</mark>.
2.3	**HHQ Orders and Prep for Mission Analysis**	CTF clarify Orders with HHQ and attend HHQ staff group. CTF prepare for Mission Analysis	Bde will read the HHQ Orders on the website. Bde will prepare for Mission Analysis. As the Bde does not attend HHQ Orders, it has time to conduct their own Mission Analysis before the CTF does. Bde discusses - HHQ Goals, - CTF EOT, - EEI, - OIR, - identify critical problems that may	**2 hr**	HHQ Issue Orders and post it on Website or on Documents. This time is used to clarify Orders given by HHQ. In this case, it is through the Singapore/US Embassy. All staff will also have more detail briefings from the Staff Group, and will also prepare for the coming Mission Analysis (not played)

S/n	Outputs	CTF Staff	Bde/Bn Staff	Est Duration	Remarks
			affect Div mission		
2.4	**Mission Analysis**		**Bde Comd, S2, S3** and **FSCOORD** participate actively, while **Bde 2I/C, Dy S3, Dy S2** and **FSCC S3** prepare for the next stage of the BP.	**2 hr**	While MA is being conducted, Bde staff that is not participating will develop further their own Bde EOT for the Div sector. This will readily prepare them for the "Develop the Plan" phase.
2.4.1	Understand the Mission	G3 states HHQ Goal States and HHQ success factors, conditions, ROE and contingencies	Participate and listen		
2.4.2	Effects of Terrain	To recap and refine the template for EOT for enemy and own forces of CTF. This can be done because they have done their own Prelim Planning. G2 talks on EOT for enemy, G3 talks on EOT for own and FS/T talks on EOT for FS/T.	Bde discusses additions to the EOT		
2.4.3	Other Factors	Specialists to provide other factors that may influence or limit the mission. For example, RCP by AG2, Adj units by G3, FSCM by FS/T, Pol-Mil to discuss Political sentiments, Police deployments, CBRE discusses potential attacks, etc	Bde provide inputs on Readiness levels		
2.4.4	Issue of CPG by CTF Comd	Issue EEI and OIR Issue Various Concept of Operations to meet HHQ Goal State. Issue Required Actions and Information to accomplish Div Mission (possible Success Conditions) Identify Critical Problems that may affect the mission ==Conduct Pre-Mortem and select 1 Concept of Ops==	Bde provides additional inputs on critical problems that may affect the mission. ==Bde involve in selecting 1 Concept of Ops with the CTF and involve in the conduct of CTF Pre-Mortem==		==List needs for immediate action== PowerMind created to scribe discussion and commander's intent. ==Intervention by **CTF2IC**: Pre-Mortem is crystal gazing the ball and identify problems with each concept of ops before choosing the most suitable concept of ops for development of plans.== Also use PowerMind to get comments from the rest.
2.5	**Develop a Plan**			**13 hr**	
2.5.1 2.5.2	Develop ECA Develop Ops Plan and Support Plans	G2 staff to develop ECAs with the Bde S2 down to Coy resolution. This includes enemy concept, enemy deployment, enemy reinforcement and	G2 staff to develop ECAs with the Bde S2 down to Coy resolution. This includes enemy concept, enemy deployment, enemy reinforcement and	7 hr	==Preliminary Intelligence Support Plan – EEI and OIR== During Develop a Plan Stage, PowerMind should be use to port plans and write remarks or possible request.

S/n	Outputs	CTF Staff	Bde/Bn Staff	Est Duration	Remarks
		conduct of battle. G3 to develop one course of action with the Bde S3. Bn and Coy level resolution. This includes rough concept of ops, own forces units allocation, route of approach (offence), end-state of COA. G3 to develop Success conditions. CTF and Bde Spt Staff to develop plans concurrently with the Ops Plan CTF Comd supervises the CTF plans while his staff are developing the plans. He will look at areas to disagree and highlight it out.	conduct of battle. G3 to develop one course of action with the Bde S3. Bn and Coy level resolution. This includes rough concept of ops, own forces units allocation, route of approach (offence), end-state of COA. G3 to develop Success conditions. CTF and Bde Spt Staff to develop plans concurrently with the Ops Plan Bde Comd supervises the Bde plans while his staff works with the CTF staff. He will look at areas to disagree and highlight it out.		**CTF2IC** gathers all Bde 2I/C and do a sub-task study on how to react to the Ops Plan before the wargaming starts. This is done only after the Ops Plan has been developed. Planning may not take the whole 7 hours. Wargaming could start as soon as plans are completed. If the wargaming shows that the plans are inadequate, there is allowance for revisiting the planning phase. CTF AG3, Bde AS3 and Bn Staff commence preparing Orders. Create a PowerMind folder to put the necessary documents. This need not be transferred to Word and powerpoint and email out.
2.5.3	Wargaming	Present and deliberate all plans (including support and Bde plans) prior to Wargaming. Conduct Action-Reaction. This includes support plans. Wargaming procedure sequence is as follows: G2-S2 ECA, followed by reaction from G3-S3, FST-FSCC, Engr, G4-S4 and Sig CO and OC. Then **CTF2IC** and Bde 2I/C react, alternate again. CTF to also conduct Contingency Plans Subsequent actions by other support plans may follow if significant to highlight.	Bde Comd, Bde 2I/C, FSCOORD, S2 and S3 participates. Bde Staff presents ECA after CTF ECA, Ops Plan after Div Ops Plan, Support Plans in sequence after Div Support Plans. Bde participates in Action-Reaction. Bde to also conduct Contingency Plans	5 hr	CTF uses Time-Slider and PowerMind to conduct Wargaming. In this KBP, **CTF2IC** -Bde 2I/C will play the Comd of the Enemy (G2-S2). His role is to help put forward a strong enemy system. **CTF2IC**, together with the Bde 2I/C do the reaction in the wargaming as an intervention. His intervention stamps not from just reacting to the actions of the G3 and Spt staff, but also to take the advantage and challenge Blue through deception and other means.
2.5.4	Operationalise the Plan	Finalise all the necessary Plans to achieve the desired Goal State. CTF to finalise success conditions and Contingency Planning	Finalise all the necessary Plans to achieve the desired Goal State. Bde/Bn to finalise success conditions and Contingency Planning	1 hr	Quiet time for the CTF and Brigade staff to work on their plans prior to submission to MINDEF/DoD CTF/Bde/Bn post their plans on PowerMind so that it can be accessible by HHQ and LHQ.
2.6	**MINDEF/DoD Clarification of Plans**			**1 hr**	
2.7	**Compilation of Orders**			**0.5 hr**	Improve the content on the PowerMind Orders

S/n	Outputs	CTF Staff	Bde/Bn Staff	Est Duration	Remarks
3.	**Bn Orders to LHQ**		Issue Operational Orders and Issue Orders to the LHQ	**0.5 hr**	
4.	**Final Co-ord**	CTF conducts Final Co-ord.	Bde/Bn involve in Final Co-ord	**1 hr**	CTF finalises ==critical event list== and other information and conveyed to the Cdrs. Critical event list to be put on PowerMind for monitoring.
5.	**Execution**	All staff to use CATISA to monitor activities and discussion.	All staff to use CATISA to monitor activities and discussion.		If any re-planning occurs, it should also be done in parallel. There should be continuous monitoring and discussion while the battle is on.

The Integrated Mission Planning Process (IMPP)

The IMPP is a planning guide for integrated planning, where the Land Component Command (LCC) has the initiative and drives the process and where the participating staffs use the Mission Mate (MM) C2 system in the planning process. There are two guiding ideas behind integrated planning. The first idea is for the integrating units to work *together* in order to be able to develop their orders almost simultaneously, leading to an efficient time saving that could be better spent on other tasks. The second idea is to increase the level of *mutual understanding* regarding the meaning of the mission, the intent how to solve it and the details of the plans developed by the units involved. A proper mindset of the participants should be that integrated planning is not about two hierarchical levels developing plans in parallel, rather, it is mainly about one integrated organization making its' plans together.

The start of the planning process should be synchronized between LCC and the brigades (Bdes). The Bdes must be aware that LCC will not be able to give them all necessary details for the Bdes to be able to start their process immediately. For example, force structure and tasking to the brigades cannot be decided early in the first preliminary goal state dialogue. However, this should not prevent the brigade staff from initializing their own planning process in parallel. The brigade planning process will have to start with a wider focus and by building situation awareness the bde staff will be able to assist the LCC staff and provide ideas, insights and suggestions on force structure and tasking to the Bde. This means that the Bde planning process normally will be somewhat compromised. The brigade may have to reiterate its' own Goal State Analysis after the CONOPS dialogue with LCC, because the initial Goal State dialogue between the LCC and the Bdes will not be detailed enough for the Bdes to finalize their own Goal State Analysis, however, this may give rise to better mutual understanding of the situation. Knowing the LCC plans and being involved early, helps to influence and integrate the overall plan much more easily and quickly, with better co-ordination and higher quality output as compared to sequential planning.

This version of the IMPP as displayed in Table 1 assumes that both LCC and the BDE are developing their own OPORD so this version of the IMPP is not completely integrated as in the TCM model, because the two Staffs are not developing one single (integrated) OPORD.

Table 2: IMPP in headline format. Differences between LCC and Bde planning process is indicated by *italics* in the column describing the BDe process. Formal steps for integration is indicated in **bold.**

LCC	BDE
1. Prepare timeline and integration plan, planning overlays and planning documents.	1. Prepare timeline and integration plan, planning overlays and planning documents.
2. Conference on the Current Situation	2. *Listen in (to LCC)*
3. Goal State dialogue	**3. Goal State Dialogue (with LCC)**
4. Situationanalysis	4. *Conference on the Current Situation, and listening in to LCC*
5. Concept Courses of Action	5. *Situationsanalysis and Listening in to LCC*
6. Criteria For Success	6. *Listening in to LCC*
7. CONOPS-dialogue	**7. CONOPS-dialogue w LCC**
8. CONOPS-presentation (within LCC Staff)	8. *Listening in to LCC, Concept COAs (for the BDE), (complementing situation analysis)*
9. OPORD development	9. *Criteria For Success*
10. OPORD development	10. *CONOPS-presentation (for the BDE)*
11. OPORD issue prlim and prepare WG	11. OPORD receive/develop (for BDE)/prepare WG
12. Wargaming	**12. Wargaming**
13. Decide (about the LCC plan)	13. Decide (about the BDE plan)
14. OPORD complete (for LCC)	14. *OPORD develop*
15. OPORD issue complete	15. *OPORD receive complete from LCC*
	16. *OPORD adjust/complete for BDE*
	17. *OPORD issue (to Bns)*