Towards a Structured Approach for the Development of a Purpose Driven COP System

IST-043/RWS-006 Working Group 1 Report

by

Dan Agar, Hasmik Atoyan, Alexandre Bergeron Guyard, Jean-Pierre Faye, Lisbeth Rasmussen, Karin Silvervarg, Martin Taylor, Willem Treurniet

A "COP" system provides purpose driven views that lead to common understanding

SUMMARY

A COP System is a system that facilitates the development of a "Common Operational Picture". The purpose of this report is to address the requirements demanded of any such system, and to suggest an approach to satisfying those requirements.

The notion of a COP has three components: "Common", which implies that there are at least two collaborating partners; "Operational", which implies that there is a real-time element involving action involving the partners; and "Picture", which implies that each partner has some kind of vision of the situation in which the action takes place. This report addresses the first two of these components. The "Picture" aspect involves for the most part issues that do not change between displays intended for one user and displays intended to facilitate the development of a vision common to two or more partners.

INTRODUCTION

To create a "vision", a person integrates incoming data with memories and understandings already in the mind. The commonalities of background data can be enhanced by communications on widely different time scales, the immediately varying data being perhaps not very large, if the backgrounds are sufficiently similar (e.g. a blown bridge is easily described in a few bits of data, if the parties have a detailed reference map in common). This may seem self-evident, but it forms the basis of the proposed approach to the COP system. The underlying point is that when rapid cooperative action is required, very little data need be communicated between the partners, if they share (and know they share) an appropriate common background.

In military systems, common backgrounds arise in several ways, not least through the medium of training in the doctrine of the services to which the partners belong. If they have training and "culture" in common, communication of a "Common" vision is much easier than if they belong to different services (in Joint operations) or to different nations (in Coalition operations).

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A primary issue with the notion of the "Common Operational Picture" is that for the picture to be "Common", the data on which cooperating parties base their picture must be up to date. This implies communication between the databanks on which the parties base their displays. The displays normally will not be in common, unless the parties are physically together, looking at (or listening to) the same display, but they should have sufficient commonality that each party understands the other's view of a situation well enough to be able to visualise how their respective roles in any action support one another.

The nature of the operation in question is immaterial. Whether the domain be response to civil disaster, force-on-force battle, or delicate peace-keeping, the same questions of commonality of background and its effect on the amount of necessary data communication arise. Always there are the same two competing issues: the need for each partner to know that the other(s) know what they must if they are to cooperate effectively, versus the likelihood that the communication of data already known may obscure the reception of important novel data (the "clutter" problem).

With these issues in mind, the working group developed a Venn diagram approach to the description of the information sharing among the partners. Much of this report discusses the implications of the elaborated Venn diagrams.

THE BASIC VENN DIAGRAMS

For simplicity, the partners who require a COP for some cooperative operation are called "A" and "B". The basic Venn diagram is shown in Figure 1. Subsequent diagrams build upon this as a base.

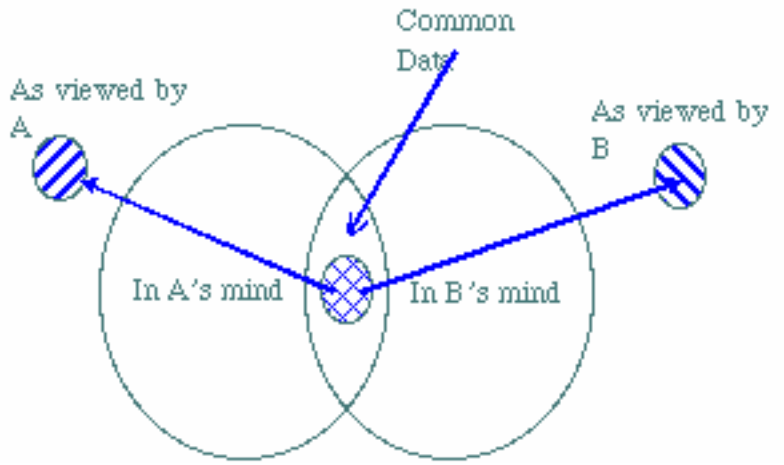

Figure 1: The Basic Venn Diagram.

The intersection of the ellipses represents the information shared between A and B. The central textured ellipse represents the data currently being discussed between A and B, which may be displayed differently to each partner.

In Figure 1, the two larger ellipses represent the whole of the knowledge and memories held by either A or B. Very little of this is relevant to the operation, and even less is shared between the partners. Some aspect of the information is currently being communicated between them, and that part either is currently shared, or

becomes so through the discussion. To represent information known by A being newly shared with B, the textured ellipse would be placed within A's ellipse, outside the intersection "lozenge".

All understanding occurs within some reference frame defined by a person's background experiences, knowledge of the current situation and its dynamics, and appreciation of incoming data. In a collaborative situation, the partners will have some commonality of background, which allows for the "Common" interpretation of situations, though their differences in background information may mean that the displays needed for them to achieve a common understanding are quite different.

Within the context of the Workshop, the COP is, at least in part, mediated through data stored electronically. The basic Venn diagram requires the computer's role to be represented. It is most convenient to illustrate the computer as a third partner, which, like the humans, holds data, some of which is known to one or both of the humans, and some of which, though accessible, is not presently known to either, as suggested in Figure 2.

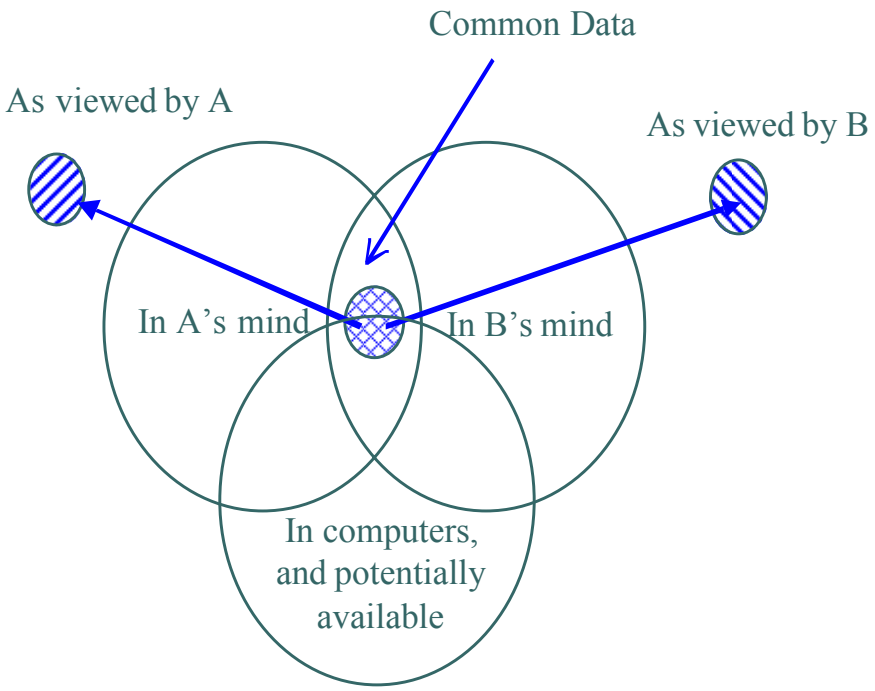

Figure 2: Incorporating the Computer as Intermediary and as Potential Data Source.

The communication between the partners may be done both through the computer and through normal human communication media. Although the computer is shown as singular, the two partners are more likely to use different computers, linked by some data communications medium, and using shared data models.

To execute the operation successfully, the partners may need more information than is available to either, and some of it may not yet be in the electronic database, either. To represent this fact, one final elaboration of the Venn diagram is required.

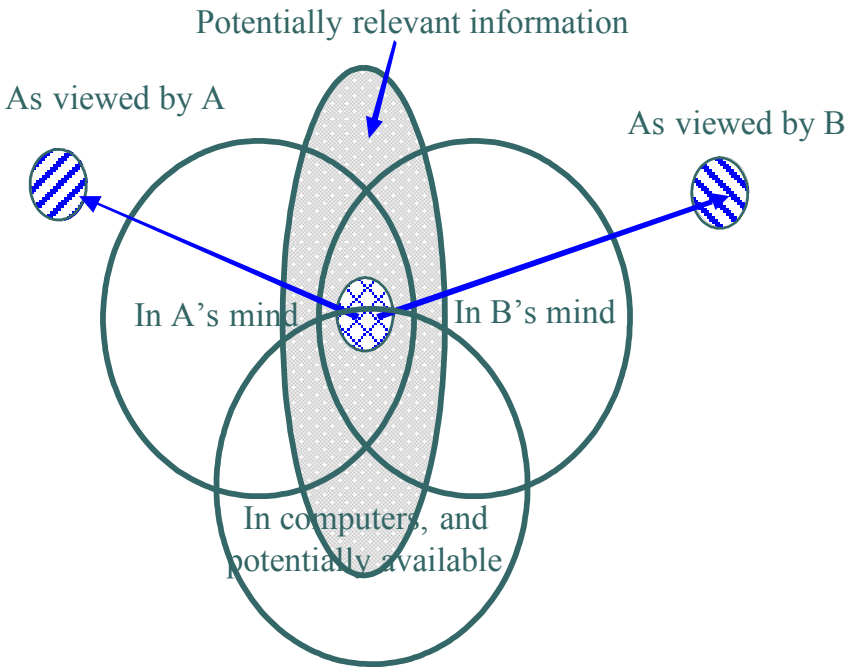

Figure 3

Although A and B know much of the potentially relevant data, some of what is known is not shared, some is known to neither, but is accessible in the computer database, and some is not known.

The grey area in Figure 3 represents all the information that would be needed to ensure a successful operation. Some is known to both partners and is in the database of the computer. Much of this would be factual material relating to the operation or to the doctrines within which the operation exists. Some is known to the humans but is not in the computer. This region would include, for example, the knowledge each has of the other from having worked together on other occasions, or from having shared experiences of other kinds. It is interpersonal, and a considerable part of it may be of an intuitive nature, not easy to reduce to a form that could be computerized.

IMPLICATIONS FOR THE DESIGN OF A COP SYSTEM

The different areas are labelled numerically in Figure 4, as a guide to the following discussion. In Figure 4, the area representing the data currently under discussion (the textured area labelled "9") has been moved to overlap parts of areas 4, 5, 7, and 8. The significance of this will be discussed below. Only areas relating to partner A have been numbered, since the discussion is completely symmetric with respect to the two partners.

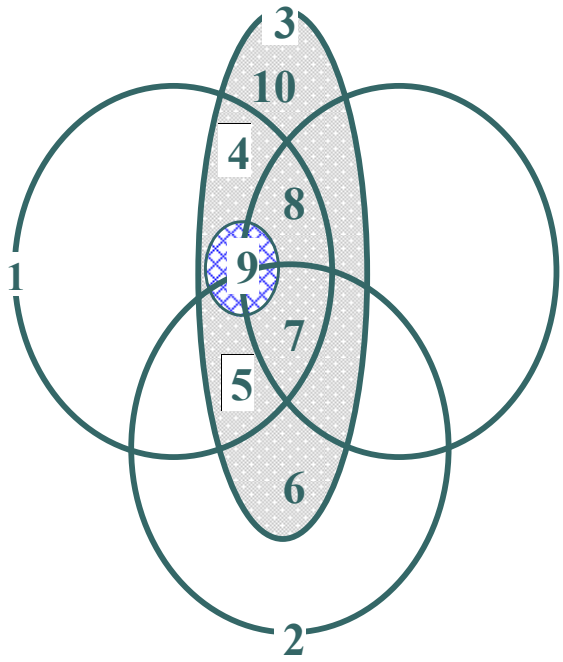

Figure 4: Data/Information/Knowledge Areas of Different Significance to the Developing COP.

The different areas are:

1) Everything known to A, whether relevant to the operation or not.
2) Everything potentially accessible in the computer data structures.
3) (The grey area) Everything relevant to the operation. Potentially all of area 3 could be included in the COP, but in practice it may not be necessary for B to have access to all of A's operation-relevant information.
4) Potentially relevant data known to A but not to B or the computer.
5) Potentially relevant data known to A and in the computer's dataspace.
6) Potentially relevant data in the computer's dataspace, accessible but not yet known to either partner.
7) Shared information also in the computer's dataspace.
8) Shared information not in the computer's dataspace.
9) Data under discussion. Any data in area 9 that is also in area 4 or 5 would move into area 8 or 7 as a consequence of the discussion. In other words, it should become known to B, if the communication is effective.
10) Potentially relevant data not known to either partner and not in the computer's dataspace. This area represents possible danger. If either partner is aware of the possibility to seek out some of the data in this area (by tasking sensors, for example, or by querying other authorities) the data might be movable into one of the other areas. But some data in area 10 will always remain, only to be encountered later in the form of a welcome or unwelcome surprise.

The Venn diagram suggests that in order to create an effective COP, as much information as possible should be moved from areas 4, 5 and 6 into areas 7 and 8, though it might well be most effective for the data in area 6 (in the computer's dataspace) to be left in that area until needed, provided that the possibility of displaying that information is known to A or B.

"Provided that the possibility of displaying that information is known to A or B" indicates a significant problem with the Venn diagrams. They have no representation of whether A knows that B knows or does not know information that is shared (B does know it) or not shared (B does not know it). In other words, A and B may share knowledge of some information, which is therefore properly included in area 7 or 8, but neither may realize that the other does know it. Alternatively, A may not realize that B does not know some critical item. The COP system should have some way whereby the partners can probe each other's understanding. It incorporates a dialogue possibility beyond that suggested by the existence of the textured ellipse "9".

One of the most important types of information that should be shared is the goals, missions, or intentions of the collaborators in the operation. To take a caricature of an example, suppose A has been ordered to blow a bridge, and B has orders to cross the river spanned by the bridge. B's mission would be substantially affected if A were to blow the bridge before B crossed it! Clearly, the partners must have access to information about each other's intentions, though that information should not be allowed to clutter displays of other material germane to the operation.

The mention of goals and their disturbance immediately brings to mind the "TAGCI" (Generic Architecture and tasks for interface design) concept presented at this workshop by Heureux, Duquet and Fiset. TAGCI represents a person's main goal as the root of a tree of sub goals and sub-sub goals, with which is paired another tree of potential impediments and threats that might lead to failure to achieve the corresponding goal or sub-goal. In the context of the COP, each partner's goals and subgoals present potential threats to the other's ability to achieve their goals, and thus present threats to the success of the operation for which the COP is constructed.

Heureux et al. say: "One of the ways TAGCI uses to represent domain knowledge is a functional model named Goal Tree Success Tree (GTST), which has been specifically developed for complex applications and is relatively simple to implement." If this and other TAGCI procedures prove viable, they could presumably be used to ensure that the goals of each partner either can be shown not to threaten the goals of the other, or are incorporated in the shared information space of the Venn diagrams. It would therefore seem reasonable to ask whether the TAGCI approach should not be incorporated in the design of a COP system, and to form part of the structured approach to COP system design implied by the considerations in this report.