One System to Connect them All - A Core System for Realizing Integrated Command and Control Research

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ABSTRACT

Command and Control (C2) for emergency and crisis response is an important field that poses several research challenges. This paper suggests that Command and Control should be viewed from a holistic point of view, that is the C2 activity system, and that technical C2 support systems must be understood in the broader context of the whole C2 activity system. Studying individual components of C2, such as decision-making, is important, but studying individual components mask out the complexity of C2 as a socio-technical activity. The paper presents an approach to studying C2 based on a generic C2 model combined with a technical core system for connecting different sub-technologies and services – which creates a re-configurable environment for research efforts in the field of C2 that can span different activity system parts and focus areas.

Keywords

Command and Control, Core system, Command and Control Research, Socio-technical systems

INTRODUCTION

Command and Control (C2) systems are socio-technical systems created with the intent of coordinating resources to manage an unfolding situation. While C2 systems can be fully prepared before a crisis, as seen in military organizations, the degree of preparedness varies in civilian contexts (Trnka & Johansson, 2009). Crisis response without some form of C2 has a small chance of success. C2 systems provide "a foundation for resilience and the management of emergencies and crises" (Landsberg, Schmidt, & Mudimu, 2022, p. 392).

This paper addresses the important issue of enabling holistic evaluations of C2 technologies. While studies of individual C2 support systems, such as decision support or situation awareness technologies, are common, few studies take an overall grasp of the issues of C2, especially when considering novel or prototype technologies that have not yet been integrated into existing C2 support system configurations. While many such evaluations are done with the best of intentions, they are of limited value due to the inherent limitations of the approach. These limitations can include evaluations of individual C2 support systems providing information only about the impact of a particular application and its effect on an individual decision-maker or team, or the study only considering a specific part of C2, such as planning. There are many explanations for this. First, most research or development projects have a limited scope and can only cover a specific part of a C2 system. Second, C2 systems are inherently difficult to evaluate as they often comprise a large number of technologies and individuals who are involved (Landsberg, Gleibs & Mudimu, 2023). Third, the process itself is indirect (this will be discussed further below), and it is hard to differentiate between effectiveness and efficiency (Baroutsi, 2018). However, a very practical issue also haunts C2 research, particularly research involving prototype systems (as is often the case in research):

in many cases, it is hard, if not impossible, to connect all technical systems used in the C2 system. In this work-in-progress paper, we present an effort to create a core system that makes it possible to connect a variety of C2 support systems to enable a holistic approach to C2 in crisis or emergency response, henceforth called the *Core system*. A scenario has been developed within the *WASP Research Arena for Public Safety*[1] (WARA PS) project (Andersson et al., 2021) to capture the challenges of emergency response. This scenario has been used in combination with the Core system to demonstrate the potential of emerging technologies, such as semi-autonomous drones for sea rescue. This case is presented in the paper to show how a core system that connects multiple prototype technologies can be used to study the impact of such technologies on C2. Further, the future development of the Core system is presented with an example of large-scale drone operations. These examples are both part of an overarching project arrangement called Virtual Demo (VD) which focus a number of demonstrator projects around a search and rescue scenario. To establish a firm connect with existing theories on C2, the generic model of C2 developed by Landsberg, Schmidt and Mudimu (2022) is used to show the importance of capturing the diverse aspects of C2.

COMMAND AND CONTROL – WHAT IS IT?

C2 is often considered as a core capability of crisis response (Olsén et al., 2023; Landsberg, Schmidt & Mudimu, 2022; Landsberg, Gleibs & Mudimu, 2023)., 2022), although it is often used interchangeably with "Crisis management" and similar terms. How C2 in crisis management is organized and conducted differs between different nations and even within nations (Sahin, Kapucu & Unlu, 2008). C2 as a research field is inter-disciplinary and has been approached from several scientific fields and theoretical strands (Wikberg, Granåsen & Johansson, 2021; Grant, 2018). Depending on the scientific point of departure, C2 research tend to focus on specific aspects of C2, such as decision-making (Brehmer, 2006; Bryant et al., 2004), leadership (Taylor & Rosenbach, 2005; Bullis, 2003; McCann & Pigeau, 1999), situational understanding (Boyd, 1987; Endsley, 1995), systems thinking (Lawson, 1981), adaptive capacity (Alberts & Hayes, 2003), management (Taylor, 1947), organization (Mintzberg, 1979), to mention a few.

Approaches to C2 (NATO, 2010; 2014) range from loosely organized, collaborative, and lacking centralized authority, to strict hierarchical organization with centralized mandate. Independent of how the C2 system is manifested, the purpose of C2 remains the same, to arrange activities and capabilities in time and space to create certain effects in the pursuit of specified goals (Johansson, Herkevall & Lantz, 2023). This implies that C2 comprise the activities of defining goals and coordinating resources to pursue these goals. In practice, this demands several processes to be successful, such as the ability to assess what is happening, dividing tasks and responsibilities, monitor progress, and communicating with executing parts of the concerned organizations. C2 thus consist of a number of activities which form a purposeful system – failure to do so will inevitably result in poor situational understanding, inefficient utilization of available resources, uncoordinated efforts, and possibly increased risk for responding units.

MODELS OF COMMAND AND CONTROL

A *C2 system* is comprised of the involved personnel, the equipment they use, the processes that take place, and the rules or laws that govern work. A C2 system can thus in many respects be seen as equivalent to the definition of a Socio-Technical System (Baxter & Sommerville, 2011 Emery & Trist, 1960). The important point, derived from the use of the word "system", is the holistic perspective of C2 as system created to produce not only orders, but also a system that continuously set goals, assess the situation at hand, create plans, and evaluates the effect of actions. Several attempts to create models of C2 have been made. As in the case of theoretical perspectives on C2, the models differ depending on which discipline they originate from and the purpose of the model. Roughly, a distinction can be made between structural models, that relate different components within the C2-system, decision models which describe the perception-decision-action cycle, such as Boyd's OODA-loop (Boyd, 1987), and procedural models that describe the various steps of a command cycle in terms of the C2-functions involved and their relation in time, such as Brehmer's Dynamic OODA-loop (Brehmer, 2006; 2009). There are also conceptual models that relate specific dimensions of C2 to each other, most notably the NATO SAS-050 C2 approach space (NATO, 2006). While most of these models were designed in the context of military operations, many of them have been used in the context of crisis management and response due to the lack of established model within the field of crisis management and response. Fortunately, a major research effort has been conducted by Landsberg, Schmidt and Mudimu (2022) in creating a generic model of C2 that can be used in crisis management and response research.

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[1] See http://portal.waraps.org/

A Generic Model of Command and Control

Landsberg and his colleagues endeavoured to create a generic C2 model for crisis management with the purpose of supporting research on C2 in terms of evaluation and design (Landsberg, Schmidt & Mudimu, 2022). The model is based on seven different documents from five different countries describing C2 processes for emergency response and crisis management (ibid). They also used the NATO Code for Best practice for C2 Assessment (NATO, 2002) when designing the generic C2 model to assure that it can be used for evaluation of different aspects of C2. The generic C2 model offers a variety of approaches for research, such as supporting the identification of appropriate key performance indexes (KPIs), identifying important milestones in the C2-process, and identifying relevant components to includes in the analysis (Landsberg, Schmidt & Mudimu, 2022). The model, in its simplified form, includes seven main process steps (denoted A-G, see Figure 1). Landsberg and colleagues aimed to make the model scalable in the sense that it should be applicable to a range of situations from on-site emergency response to large-scale crisis management.

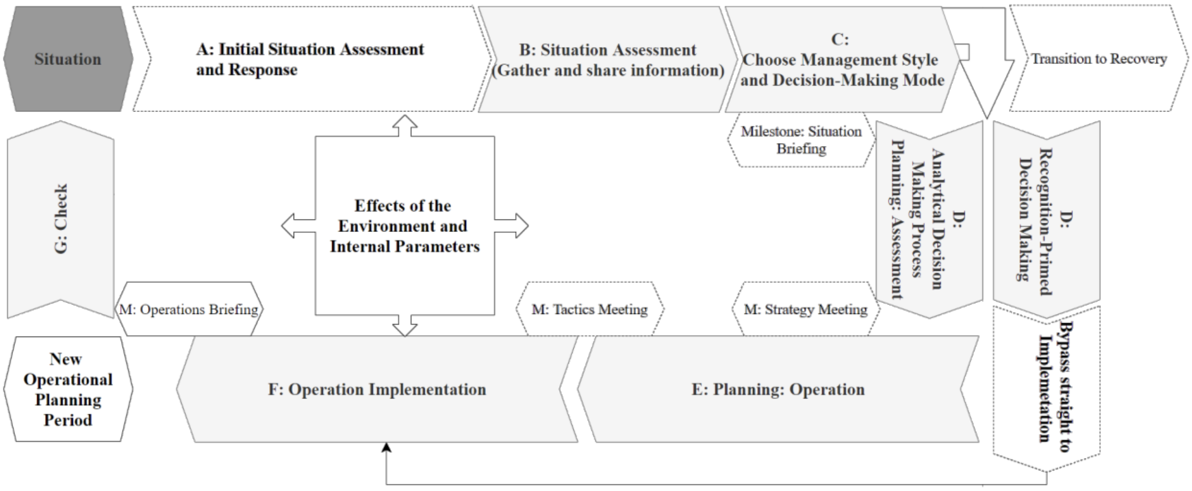

Figure 1. A simplified generic model of C2 (used with permission from the original author, Landsberg, Schmidt & Mudimu, 2022)

In the context of this paper, the model is appealing as it provides a holistic C2 model firmly based on real-world examples and best practice that can be used as a point of departure for identifying and understanding the need for connecting various C2-components and evaluate them as one system rather than isolated parts. The fact that the model is firmly based on a number of real-world C2-systems provides ecological, as well as face, validity. The fact that the model it is relatively scalable in terms of command levels also makes it relevant for many different scenarios, ranging from emergency response to crisis management. However, to make holistic evaluations or research on C2, all or most parts of the model must be in play. This demands at least one of the following things: a full-scale exercise involving all C2 functions that would be in play in a real-world case; a dedicated simulation environment that provides all C2 functions, or, a system capable of connecting a number of individual C2 functions that jointly form a complete C2 system. We argue that the latter approach is the most viable one as this creates a flexible solution that also enables joint research efforts where different research groups can provide solutions that can be developed at different paces and be brought together for more holistic evaluation. Also, such a system should be modular in the sense that it should be possible to exchange individual systems without interfering with the operation of other systems, apart from the fact that certain data generated by that function will not be generated unless it is replaced with another system. Below follows a presentation of such a Core system in the WARA PS system.

ONE SYSTEM TO CONNECT THEM ALL

Similar to the generic C2 model, the Core system of the WARA PS project constitutes a holistic approach, well suited for high level research in C2. As mentioned previously, WARA PS is a Swedish national effort to create a research arena for artificial intelligence (AI), autonomous systems, and future software systems with the aim of shortening knowledge transfer between academia and industry. This collaborative environment comprises test beds that allow for research and development of unmanned surface vehicles, drones, and underwater vehicles (Andersson, et al., 2021). The implementations in the WARA PS Core system maps well to the seven main process steps in the generic model (**Table 1**). The Core system is composed by three interacting layers: the Service layer, the Tools layer, and the Agents layer (see **Figure 2**) whom all are supported by the Core. The Core part of the system serves as a broker for messaging, packeting, rights, APIs etc. The Tools layer serves as the interface to human users and is essentially where the C2 functions can be realized, and its effects be studied. The Services layer provides necessary services to all the tools, agents and users, as well as other services available. The Agents layer connect both real-world and virtual vehicle, sensors or agents with the other layers and services. Depending on the scenario at hand, different agents, services and human-machine interfaces can be combined. The Core system is therefore flexible enough to support C2 on different levels, ranging from individuals operating equipment to more overarching orchestration of activities on tactical and strategic levels. It is domain agnostic and could be used to connect activities in different domains, such as cyberspace and the physical world. Several activities consisting of individual C2 loops working towards different goals could be set up in a collaborative environment which is transparent and accessible from a research point of view.

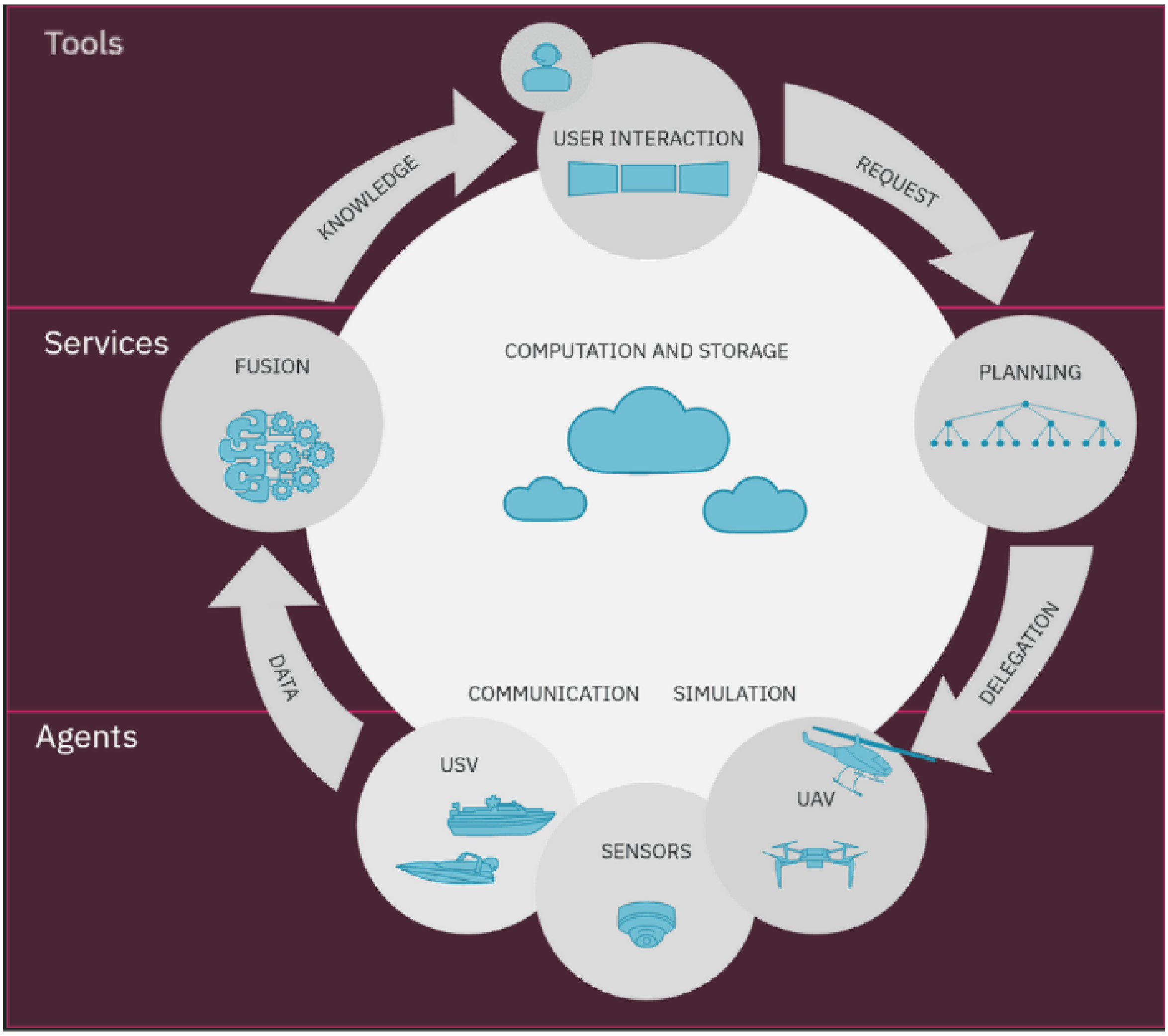

Figure 2. The Core system.

While the Landsberg generic model describes how individual C2 functions are connected through process, the Core system offers a multitude of possible configurations. The Core system can be configured to plan and organize certain aspects of C2, such as planning and analysis of sensor data, both in the form of services provided through the service layer, see **Table 1**. It can also be configured to provide situational pictures to human users, and to study their interaction and behaviour.

Below follows a description of the current status of the WARA PS Core system based on a demonstration of the system made in 2023 the *WARA PS Search and Rescue demonstrations*. This is followed by a description of a system that will be connected to the WARA PS Core system in the future, the *UTM City Drone simulation*, which will add a strategic level of operations to the overarching C2 system once incorporated with the Core system.

Table 1. Mapping the generic model to the Core system of the WARA PS case.

Generic C2 model	Core system – Examples
A. Initial Assessment and Response	Agent layer – Agents interacting with the environment or simulated environment to collect and analyze data Service layer – anomaly and object detection on fused data to assess situation Tools layer – Brief initial Situational Picture Looped until initial situation assessed
B. Situation Assessment	Agent layer – sensor data from Agents Service layer – sensor fusion and (re)planning Tools layer – Situational Picture(s) Looped until situation assessed
C. Chose Management Style	Human Activity – Commanders must decide if they are to manage the situation based on trust and dissemination of decision rights to sub-ordinate units, or if the situation demands a more centralized, directive command style. Combinations of the approaches may occur depending on level of command and domain. Agent layer – what kind of C2 management does the agents demand? Can they be configured to act upon different styles. Service layers – what kind of structural configurations of the C2 system is possible. The Core system offers a high degree of flexibility. Tools layer – what management styles are supported by the HMI components? For example: must orders be produced in the form of directives, or does the system offer some flexibility in the formulation of orders?
D. Decision-Making	Tools layer – Decision support. Decide complexity of operation and needed amount of planning
E. Planning Operations	Tool layer – HMI for human interaction Service layer – planning of operations based on available resources and operational needs Agent layer – provide information of available agents, capabilities and services.
F. Operation Implementation	Tool layer – C2 command systems Service layer – Fusion services for analysis like object detection, anomaly detection and data fusion. Also (re)planning Agent layer – execution of orders, simulation, search, move, pickup and drop objects. Provide data for analysis.
G. Check	Tools layer: Decide if new strategy needed or operational objectives fulfilled. Services layer: Support for analysis and evaluation of operation progress.

Current Status - The WARA PS Search and Rescue Demonstrations 2023

The WARA-PS Core system has been used during demonstrations of search and rescue missions, using real and simulated unmanned arial vehicles (UAVs), unmanned ground vehicles (UGVs) and unmanned surface vechicles (USVs) together with human agents and humans in C2. The unmanned vehicles had varying degrees of autonomous capabilities and act as agents integrated in the system. They communicate using high level commands such as Search Area, Move To, Pick up and Drop. Each vehicle acts independently and interprets the commands/tasks in its context and executes based on its capabilities (see **Figure *3***). The system offers a way to communicate and share tasks and data in the same mission.

A scenario has been used in the demonstrations. In the scenario, victims of a fictive boat accident were spread out in water and on land. Victims in water were represented by floating tennis balls to challenge detection algorithms and create a fast and interesting demonstration illustrating activities and decisions. On land the victims were played by humans acting in the role as injured.

A simplified activity model of the operation conducted in the scenario was used, where the autonomous agents conducted the following activities simultaneously to search and rescue victims in the scenario. The involved agents changed activity depending on the type of task in collaboration with human decisions.

- **Prepare** for a probable upcoming situation, by placing drones and aid on right place
- **Surveillance** to detect anomalies, as an ongoing activity to identify changes or assess situation
- **Search** to detect interesting objects as an activity to assess (initial) situation
- **Inspect** detected objects to identify them as victims as candidates to rescue
- **Rescue** by delivering useful aid to identified and prioritized victims
- **Evaluate** to learn, improve and be ready for a new planning period or a new operation

In an operation all those activities are ongoing as parallel activities and agents shifts activity based on needs to perform an efficient operation.

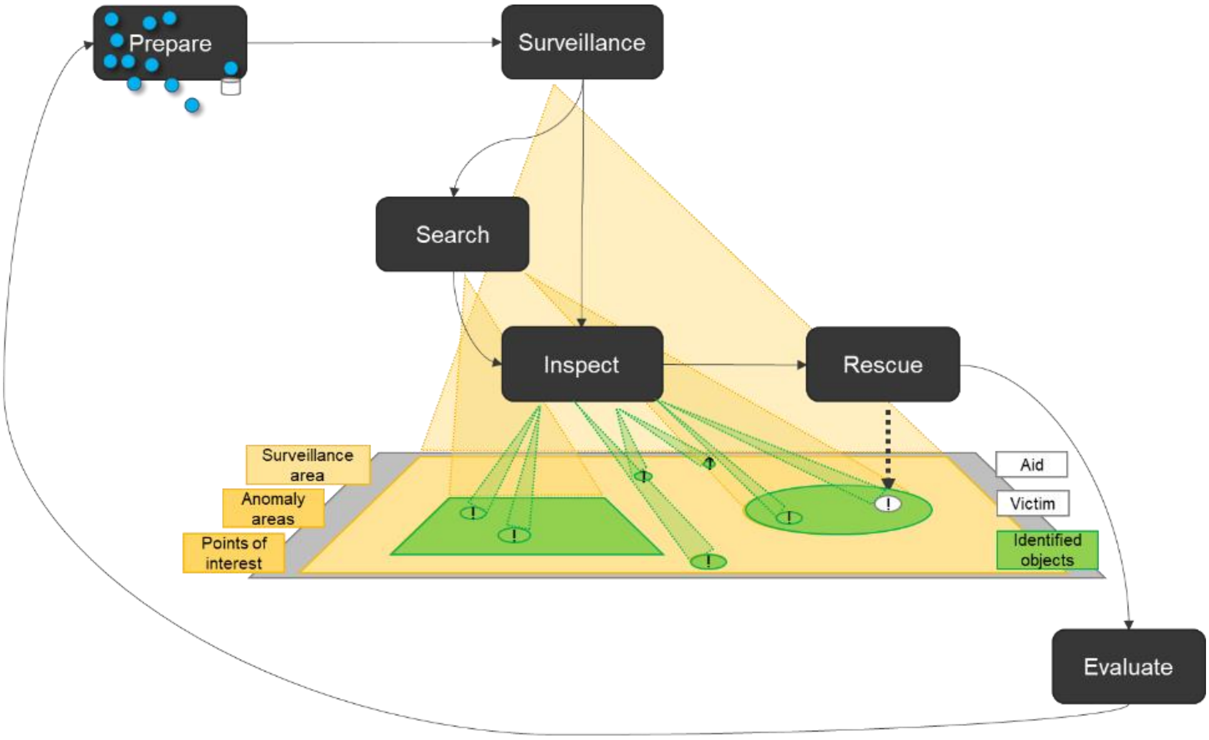

Figure 3. Activities in a search and rescue operation performed by using the WARA-PS core system with autonomous agents.

The demonstrations were performed in September 2023 in Sweden at the Gränsö drone testing range during the WARA-PS demonstration week. With an audience of over 200 persons the scenario was played multiple times on two days where the activities constantly changed due to weather and different introduced disturbances.

During the demonstrations the physical agents was represented by:

- Two UAVs flying over the scene with cameras assessing the situation performing surveillance and search for victims. To rescue they have a device to drop medical kits at safe distance from victims. The UAVs was prepared to support both activities over land and water based on upcoming needs by changes in the situation.
- One Boston Dynamics Spot robot for close inspection of detected objects. The Spot robot can also pick up the dropped medical kits and move close to victims for rescue.
- One Saab Piraya USV boat to search the sea using camera and lidar. This larger USV was meanwhile performing autonomous navigation with collision avoidance testing.
- Four small mini-USVs working together to inspect detected objects in water by moving closer to the objects detected by the Piraya USV and UAVs. Using cameras, the mini-USV supported the humans in C2 to identify and prioritize the objects as victims to be rescued.
- A human on stand-up paddle board equipped with a mobile phone application to serve with capability of moving close to victims and pick them up on the board for transport to shore.

The core system offered exchange of data and tasks to provide all agents and humans in C2 with shared situational picture including objects, victims and changes. The C2 tools used was the WARA PS *Arena Map* where two human operators supervised the operation and supported with decisions by commanding the agents. Additional instances of the C2 were active to give the audience a situational picture containing live video feeds, map and 3D overview. The USVs had their own USV C2 to supervise and make decisions on lower level to support the larger USVs (Piraya).

Communication in the system was a mix between 4G/5G, wifi and dedicated radio links. Human operators in C2, field agent on paddle board, safety pilots for the vehicles and demonstration leader used separate voice communication. Services developed from different organizations was executed in cloud and on agents to support object detection, anomaly detection and task delegation/distribution. Besides the physical agents the system introduced multiple simulated agents to investigate how the system and operation can be scaled.

There was also a couple of other separate demonstrations ongoing simultaneously using air space and facilities that was coordinated to give audience an insight of how the core system and resources can be used and what has been done during past year. Collected data as positions, decisions and video was recorded for analysis and evaluation. Besides the shared recording many of the involved systems has their own storage of information to be extracted and used for research purposes and to improve she systems.

Ongoing Development – Integrating the UTM City Drone Simulation at the Strategic C2 Level

An example of adding new integrated functionality, to combine lower levels of C2 with higher levels, in the WARA PS systems is the *Unmanned traffic management, for air traffic in cities* (UTM City) platform (Westberg, Palmerius & Lundberg, 2022; Lundberg, Arvola & Palmerius, 2021). The Core system contains a mission-management component, the *Arena Map*, where resource usage can be planned, as well as specific routes to use for drones in the air, at sea, on land. UTM City adds capabilities for coordinating the use of physical air space between co-located missions. The UTM CITY platform is a collection of software for drone traffic simulation and control. It is the result of eight years of research on drone traffic planning and management, visualization, and human-automation interfaces. The platform consists of two main parts: a drone traffic infrastructure simulator that we call *dronesim*, and a user interface for this simulator.

The *dronesim* module handles the simulation of all activities involved in drone traffic, and has been designed to test separation of concerns and communication between the actors by isolating the simulation of 1) drone operators, setting up drone activities, sending plans for authorization and controlling the drone flight, 2) airspace authority, holding the airspace design, responding to queries about traffic situation, and validating, modifying and authorizing flight plans, and 3) activities performed by a unmanned traffic control officer (UTCO).

The *user interface* module connected to this simulation module provides a 3D map over the designated area and simple means to activate various data and layers, and two different menus for scenario control and air traffic management, respectively. The menu for scenario control provides means to draw activities for drone operators on the map, for automatically generating potentially hundreds of drones quickly and with little effort. The menu for air traffic management lets the user control airspace parameters, such as minimum allowed distances, as well as create, activate/deactivate and adjust no-fly-zones.

The dronesim module automatically reacts to airspace changes, sending signals to the affected operators that their plans need to be renegotiated. They will subsequently calculate new plans based on the remainder of their ongoing activities and submit these for authorization. The airspace authority uses the airspace configuration to adjust these plans if necessary and responds with the updated plans. The UTM CITY platform also has a streaming log module, to capture what goes on in the system, for real-time analysis or after-action review.

By the integration of this functionality in the WARA PS case, yet another concrete implementation related to the generic model is available for the study of C2, especially concerning drone traffic planning and management. Not only are such studies supported by the implemented functionality, but also by the C2 contextual framework of the Core system of the WARA PS case, see **Figure *2***, and **Table *1***.

In a simulation, UTM CITY operators can work on a more strategic level than when using the Mission Management module in the Core System. In UTM CITY, common airspace structures are established, such as flight common-use routes or airspace areas for shared operational spaces, as well as flight levels, geofences and geocages for isolation of operation. In the Mission Management component, the Arena Map of the Core System, different agents can request routes or destinations or geofences, that are then coordinated in UTM CITY. UTM CITY can also perform basic simulations of prototype services such as mass-deliveries and surveillance, point-to-point deliveries – to be able to identify and foresee problems in the airspace by stressing and simulating situations rapidly (but not on a detailed level). By connecting the sub-systems in the Core System, mission management can be studied at the same time as airspace management, in an integrated Virtual Demonstration; or a Physical-virtual Demonstration, or a purely physical demonstration.

Thus, in a setting such as a search-and-rescue mission, different teams need to collaborate and act together. The use of airspace for their missions can then be coordinated in the UTM CITY platform. In future versions of UTM CITY, surface mission areas or sub-surface mission areas could also be managed in similar ways.

DISCUSSION – CREATING A HOLISTIC C2 RESEARCH ENVIRONMENT

Creating conditions for holistic research on socio-technical C2 activity systems is possible. Far too often, aspects of C2 are studied, such as individual ICT components supporting situational pictures, communications, social media analysis etc. While these efforts are both necessary and admirable, they are also problematic from a systems point of view. When studying “bits and pieces”, we mask out some of the actual complexity of a C2 system, both in terms of the complexity of interconnected technical systems and in terms of inter-personal aspects of C2. It should also be noted that creating a system like the Core system is not done to impose control over several interconnected systems – it is done to be able to study how C2 manifests and evolves in different scenarios under different configurations of C2 capabilities. The focus is thus on interconnectedness rather than control, on the ability to farm data from a multitude of systems, and on the possibility to study C2 as a whole rather than individual components.

We have exemplified how the integration of a new component in the Core System can enable a new kind of integrated study of C2. Rather than starting from scratch to study collaborative mission-management and operational space management, the Core System integrates two separate modules (Mission Management and Operational Space Management). By doing so, it is also integrated into the larger whole of the Core System, to make use of other components, and enabling other kinds of studies. For instance, to include studies of autonomous systems operation across mission management and operational space management. While this example focuses on drone operations in emergency response, this must not be the case. The Core system has general capabilities to connect other kinds of systems. As can be seen in **Table *1***, the word “agent” must not be equivalent to a drone, and services and tools must not be specific to drone operations. In this sense, using the generic model has expanded the focus of the Core system by looking beyond demonstrations of emergency response with drones to a more holistic view of experimentation and research on C2 systems. For example, the mission management system, which can be used on the operative level for A. Initial Assessment and Response, B. Situational Assessment, and F. Operational Implementation, can be combined with the UTM City system to include D. Decision Making and E. Planning Operations on the strategic level. Further, these systems were developed independent of each other, now coming together under the Core system umbrella.

Bringing Research Into the Picture

The WARA PS Core system example demonstrates how a usable research tool for C2 can represent a concrete representation of relevance to the generic C2 model, and at the same time allow for variations in implementation of relevance for applied C2 research. Therefore, the Core system is also well suited for studies of the main processes, their interdependence, and their internal characteristics. Indeed, the Core system has been described as “a system architecture for industrial and academic collaboration” (Andersson et al., 2021). On the one hand, adding of components can enable operational capabilities, to carry out exercises. On the other hand, can also add research capabilities such as logging and recording of exercises. When integrating components, it is important to integrate both kinds of capabilities, to enable studies that go across different C2 activities. As pointed out by Landsberg, Gleibs and Mudimu (2023) in their systemic approach to C2 assessment, C2 can, and possibly must, be evaluated on several levels. They suggest that C2 systems can be evaluated in terms of *physical characteristics*, *structures and processes*, and *C2 system effectiveness*. The Core system focus mainly on creating conditions for evaluating C2 system effectiveness but can naturally be used to examine the other levels as well. The modularity of the system may create some challenges in this regard as a joint analysis of a multitude of supporting systems and services on all core system levels (Tools, Services, Agents) must be conducted to understand the physical level, which the systemic approach of Landsberg and colleagues describe in terms of bandwidth, connectivity, and computer capacity. However, structure and process, described in terms of for example time to complete tasks, time to transfer information, number of personnel involved in different activities etc (Landsberg, Gleibs & Mudimu, 2023) could easily be captures by comparing different parts of an implemented scenario with different inputs to, and interactions with, Core system components. The third level, C2 system effectiveness is in the Landsberg and colleagues framework proposed to evaluate situational awareness, workload, sensemaking, synchronization of effort, communication, and leadership (ibid.). These aspects of C2 are also possible to evaluate in the context of the Core system, but we suggest that focusing on scenario-based measures of success could be an addition. Measuring human factors aspects of C2 such as situational awareness and workload is interesting if we want to understand how different C2 components impact humans in the system, but we also need to keep focus on the overarching performance of the C2 system and evaluate the effects on human operators in the light of this.

The WARA PS core system is dynamically adjustable for applied studies of C2. This means that a wide range of research questions can be, and has been studied, of which some examples has been provided above. The way the WARA PS scenario and the implementation in the core system has been designed, makes it not only suitable for system research, but also for research on methods and approaches. Since also future capabilities, not yet realised in today's practise is represented, it is well suited for applied research of future challenges and possibilities in C2. The main goal for the future development of the Core system is therefore to create possibilities for connecting further, and future, systems to the environment.

CONCLUSIONS

To create possibilities for holistic evaluations of socio-technical C2 activity systems, it is important to not only be able to connect different C2 solutions, but also that capabilities for studying C2 are in place. The Core system is based on modularity and interconnectedness rather than a tailor-made approach for studying a specific problem. Instead, it can be configured to enable applied research on a number of issues related to C2 in emergency and crisis response. A case describing such research, as well as suggestions for future development has been described above in terms of the WARA PS Gränsö demonstrations and the UTM City simulator. The generic C2 model by Landsberg, Schmidt and Mudimu (2022) has been used to show how the layers of the Core system can be connected to a model of C2 to assure that all relevant aspects of C2 are captured. Using such a model of C2 is necessary to assure that no aspects of C2 are neglected. Further, the generic model can be used to understand what parts of C2 a newly developed technology can support, and how it is related to other C2 systems, i.e. what types of connectivity it must have to be part of the whole. The generic C2 model also provide key performance indicators that are useful for evaluating the impact of different kinds of C2 support systems or agents, for example in the form of drones or new autonomous capabilities.

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