

A plan-driven dynamic reconfiguration mechanism for C2 Communities of Interest

Topic 6: Modeling and Simulation

Topic 8: C2 Assessment Metrics and Tools

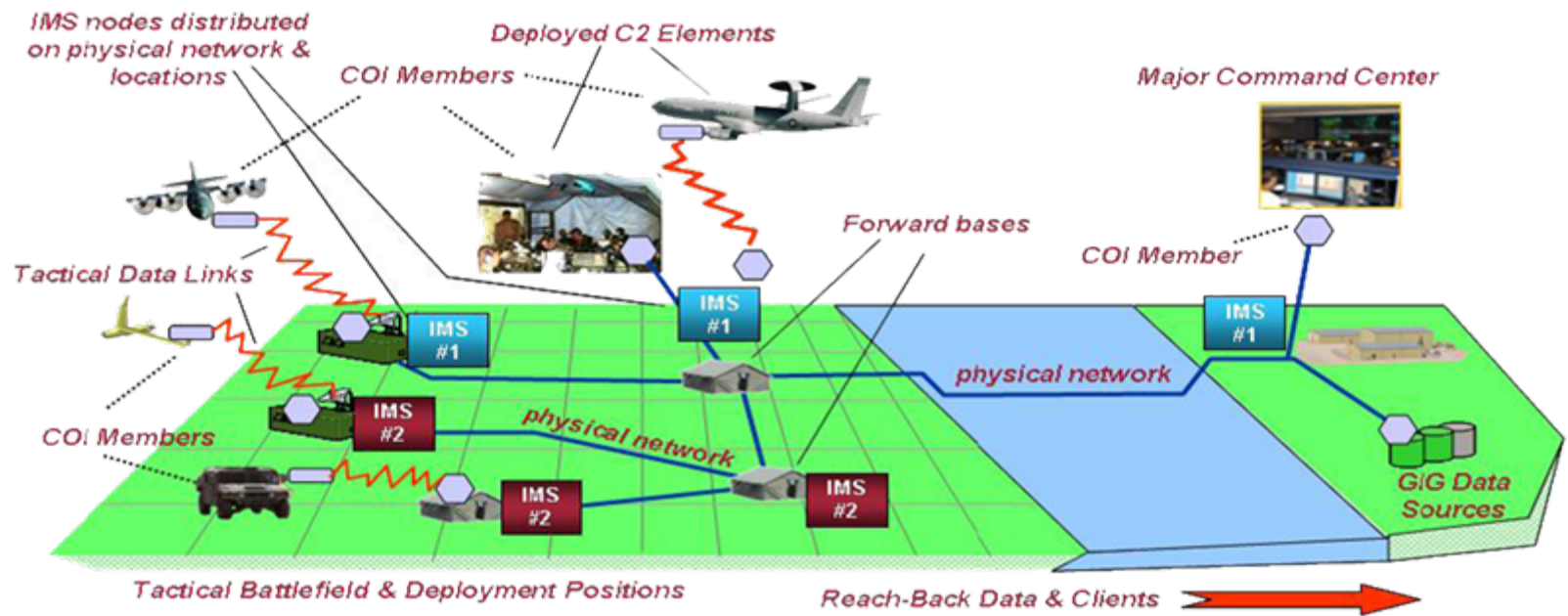
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◆ What is the C2COI ?

- ▶ A Command and Control Communities of Interest (C2COI) is a dynamically formed military organization or community for a common mission in net-centric operations, composed of distributed command and control entities (infrastructures, systems, equipments, weapons, and forces, etc.).



◆ C2COI Characteristics

Self-organization

- It can organize and manage the controlled entities according to the task and members' responsibilities or rolls, establish their relationships, decide the cooperation patterns.

Self-adaptation

- It can organize and construct the component elements self-formingly in a consistent order across space, time and function.

◆ Why we propose C2SSP?

- ▶ Normally, OPLAN is used to specify the organization and behavior of persons (units) involved in the task, which is focused on person, with unit organization as one of its core elements. When the unit organization is decided...



How to modify the information system's information exchange, data-sharing, interaction and cooperation relationships adaptive to new relationships between the troops?



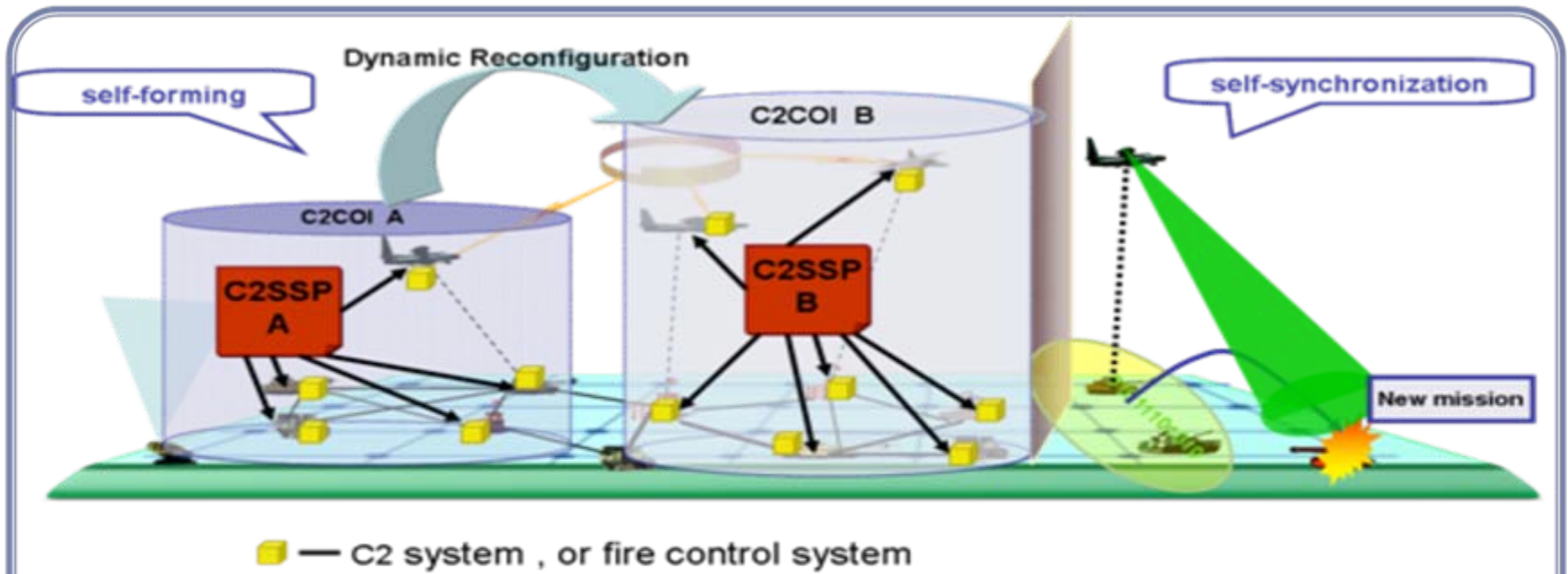
How to prune, allocate and reconfigure the internal function modules of C2 systems?



How to define and adjust C2 processes dynamically, has to be scheduled uniformly and adjusted dynamically before the action taking or system running.

In this paper, the concept of C2COI System Support Plan (C2SSP) is proposed, based on which, a plan-driven dynamic reconfiguration mechanism for the C2COI is developed.

◆ C2SSP Conceptual Model



C2SSP is a kind of system support plan which prescribes the organization structure, capabilities and behaviors of systems according to the unit organization represented in the operational plan, in order to accomplish system's automatic configuration, dynamic reconfiguration and sequential execution.



◆ C2SSP Conceptual Model

Definition:

- $\delta: U \rightarrow S$
- U: refers to C2 entity space (troops or units, platforms, and weapons).
- S: refers to controlled entity space (C2 systems and fire control systems).
- δ : refers to the mapping from U to S, i.e. C2SSP.

The concept of C2SSP is proposed based on the following prerequisites:

- C2 unit organization is one of the core element of C2COI, which focuses on the relationship of units and the assignment of equipment resource.
- The C2COI organizations have worked out an operational plan or unit organization plan
- The C2 system is robustly networked, ability-based, and task-oriented.
- The C2 system is based on Service-Oriented Architecture, whose constitutor services may be registered internal ones or the authorized external ones distributed on network.
- In this paper, the reconfiguration focuses on system integration level.

◆ C2SSP Descriptive Model

- ▶ The descriptive model of C2SSP is described in sets.
- ▶ Definition:
C2SSP is a set named CP, and $CP = A \cup E \cup R \cup S$.



Set A is the description of C2SSP's basic attributes and profile information, including identification information, planning time, planner, involved mission and the attached C2COI's ID.



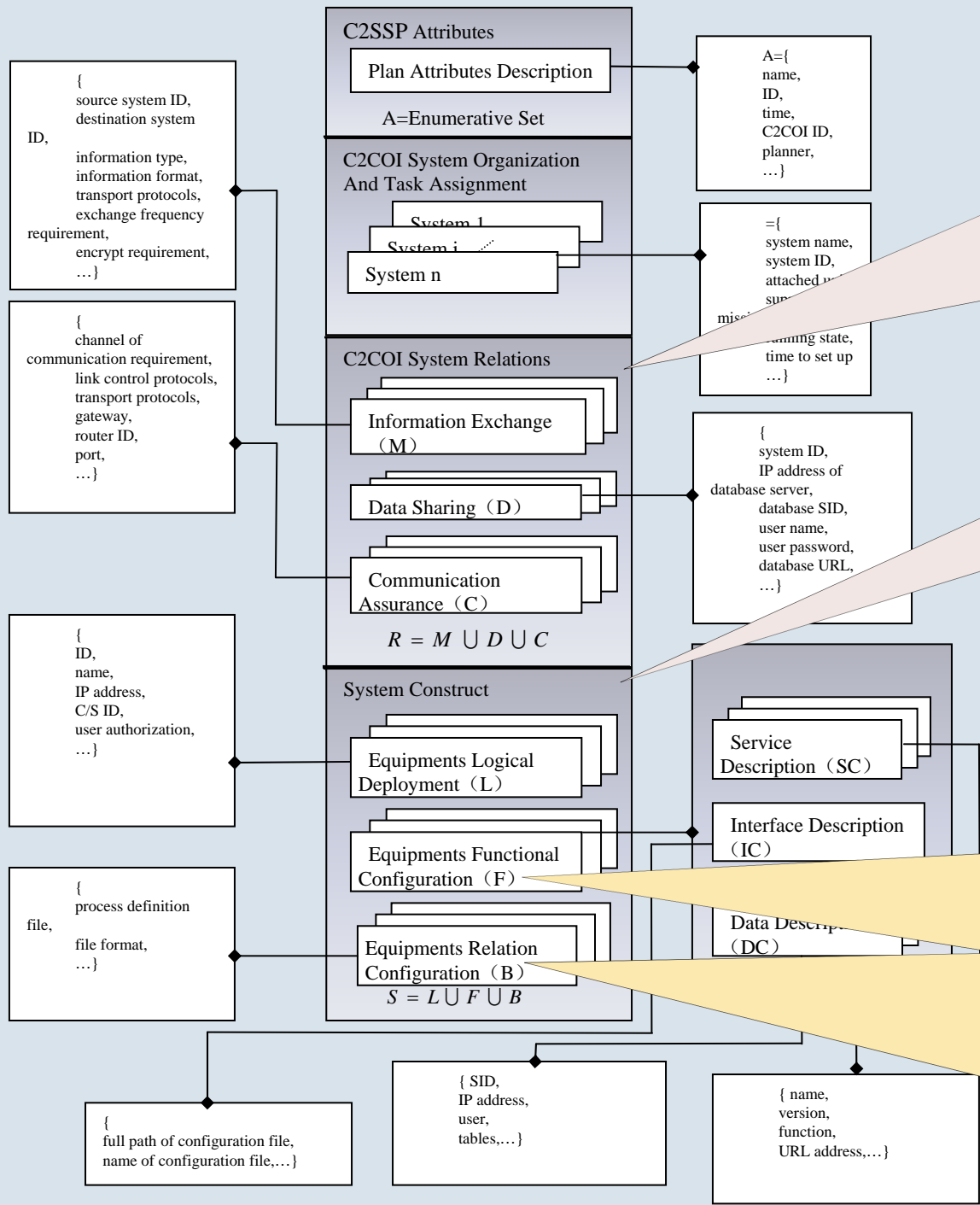
Set E is the system organization and mission assignment according to the C2COI's unit organization, including the common basic system information such as ID, name, type, attached unit, time to set up, and the mission to support.



Set R describes the relationships between systems present in set E.



Set S is the key element of C2SSP, including structure and deployment information about C2 systems in set E, such as deployments of clients and servers, reconfiguration of software and predefined processes of command and control.

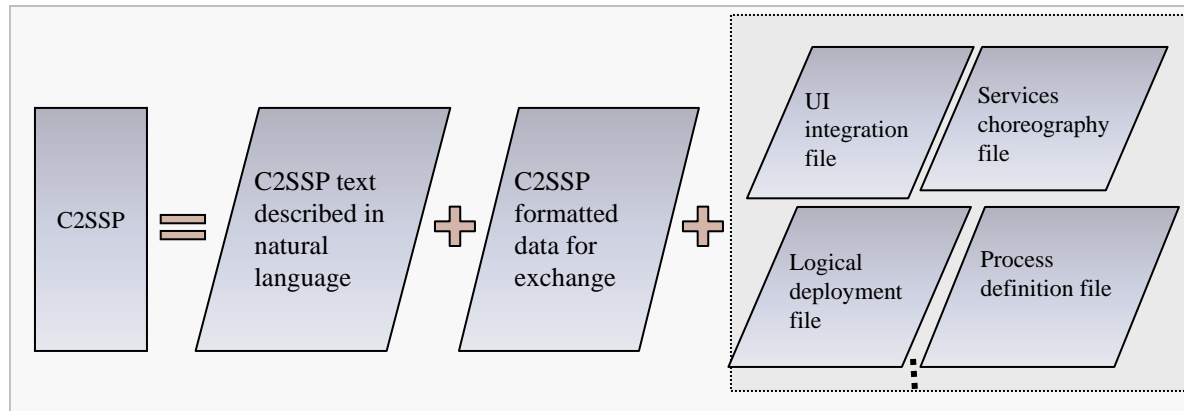


It describes the relationships between systems present, including communication assurance, information exchange and data sharing relationships, in which, the information exchange subset is consistent with the system-system matrix described in DoDAF2.0, including the information elements to exchange, attributes of elements, and attributes of the exchange.

This is the key element of C2SSP, including structure and deployment information about C2 systems, such as deployments of clients and servers, reconfiguration of software and predefined processes of command and control.

B—Definitions of system processes or business flow, describing the relations between seats or control units, including plan approval, plan circulation, cooperation and interaction between the seats or equipments. As the business process can be defined and adapted dynamically, the definition of process in C2SSP is mainly targeted at those definite, necessary, predefined and default processes. The course of defining process is as well as service choreography, with the output as formatted data file, which can be parsed and executed by process engine automatically as well.

◆ The Form of C2SSP and Its Planning Tool



Integrate with OPLAN planning tools, exchange information with OPLAN planning systems, and parse the unit organization data in the OPLAN to provide a reference to system organization and task assignment.



Provide graphical edit mode, so as to facilitate user deployment and configuration of seats, servers, controlled units, user interfaces, and business processes.



Offer a variety of views to show the relationships of system information exchange, data sharing and the network communication assurance.



Support management of multiple plan sets, and quick generation of new plans based on existing ones, and Generate various formatted data files mentioned in above.

◆ One of the user interfaces in the developed C2SSP planning tool

The screenshot displays the C2SSP_TOOL interface with the following components:

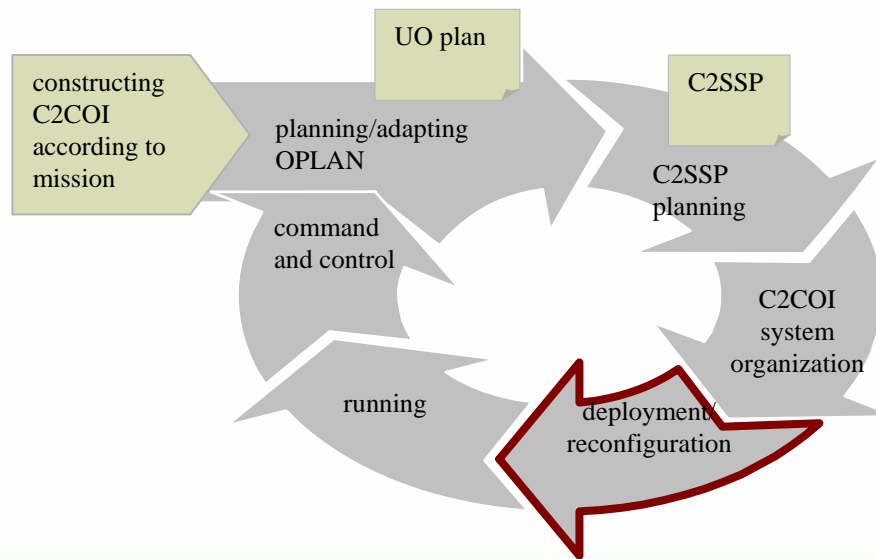
- OPLAN Panel:** A tree view on the left showing a hierarchy from Local Unit to Unit 1 through Unit 9.
- Relationship of data sharing:** A central diagram showing a central Local Unit icon with arrows pointing to nine individual Unit icons (Unit 1 to Unit 9).
- Attached systems:** A panel on the left showing System 1 and System 2.
- System Organization view:** A tabbed interface with options for System Organization view, System Deployment view, Equipment Deployment view, and Process Predefinition View.
- Information assurance table:** A table with columns for Factors and Values, listing various system parameters.
- System Information tabs:** A row of tabs at the bottom for System Information, File Exchange, Information Exchange, Communication Assurance, and Data Sharing.

Callout boxes provide additional context:

- Unit organization of C2COI described in OPLAN:** Points to the OPLAN tree view.
- Views of system organization and information exchange relations according to the unit organization in OPLAN:** Points to the central diagram.
- Systems of selected unit:** Points to the Attached systems panel.
- The matrix of system-system information exchange:** Points to the Information assurance table.

Factors	Values
Name	
Absolute time to set up	
Running state	
Application server IP address	
Server registry IP address	
System ID	
Host ID	
Entity ID	
Battle orientation	
Support troop	
Relative time to set up	
Attached unit ID	

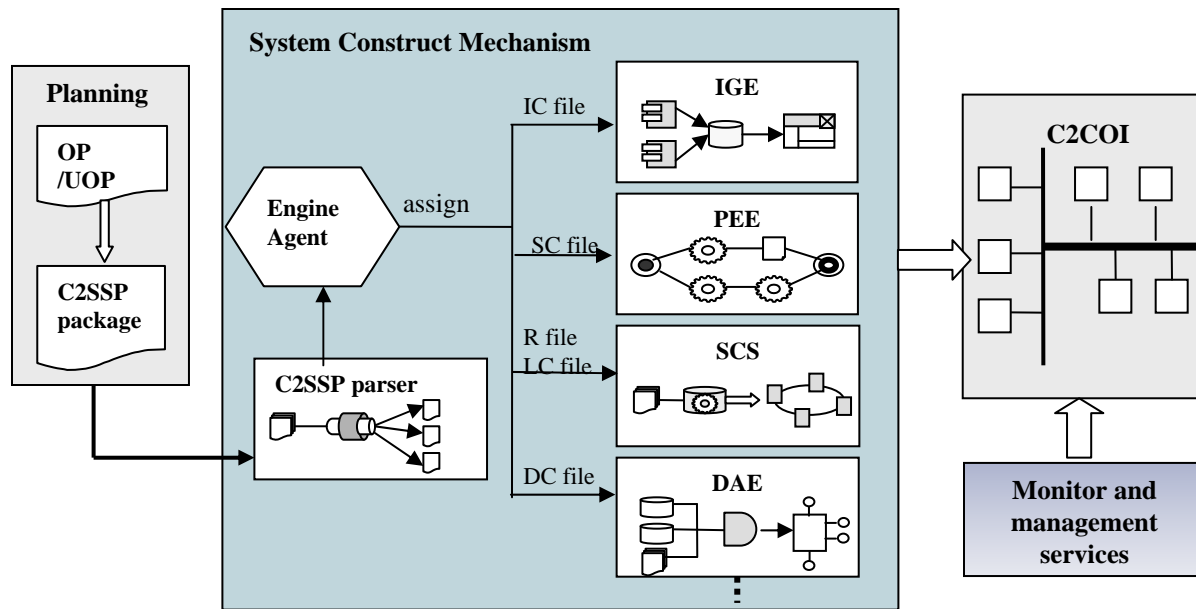
◆ Closed Loop of the Mechanism



Based on the above C2SSP descriptive model, this section elaborates the implementation of the dynamic reconfiguration mechanism of C2COI. As is called plan-driven mechanism, it starts from OPLAN planning, and ends into a closed loop: OPLAN planning→C2SSP planning→C2COI system organization→system deployment→running→C2→planning/adaptation→reconfiguration.



◆ Mechanism Implementation



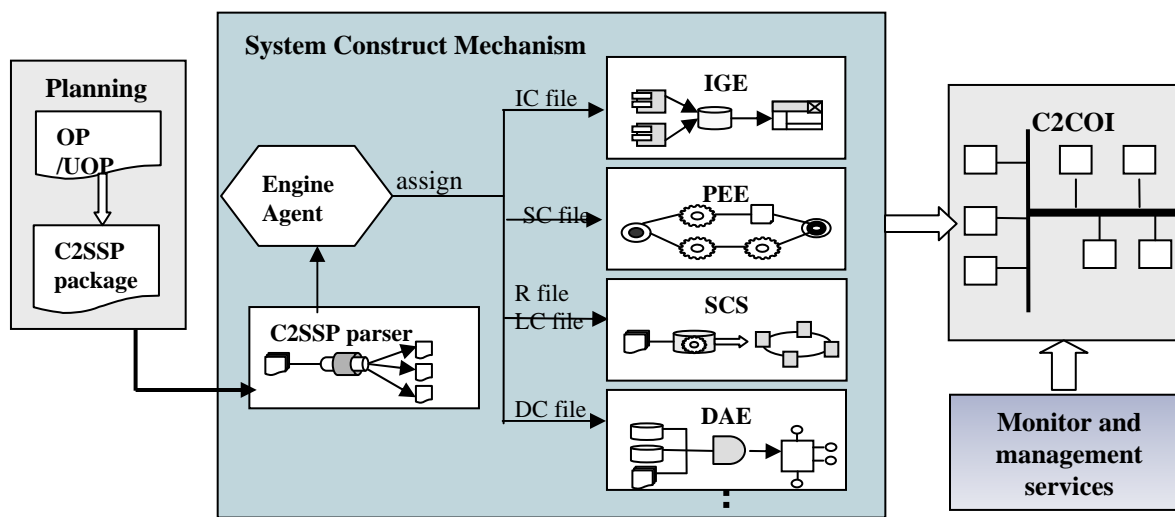
• Draw the C2SSP based on operational plans or unit organization plans, package and distribute it to each system in C2COI.

• By receiving the C2SSP package, each system parse it using C2SSP parser, and decompose it into various configuration files required in system construction.

• Submit these configuration files to the engine agent, which is in charge of assigning each file to the corresponding execution engine and controlling the execution order.

• Each execution engine executes following its configuration file, so that the system is constructed automatically.

• Monitor the status of plan execution by the monitor and management services provided by each execution engines.



IC file	Configuration files for client interfaces, including the interface layout settings, and the data, events, messages exchanged among application components.
SC file	Configuration files for services registration, management, organization and business process definition.
R file	Configuration files for relationships on information exchange, data sharing and network communication assurance among internal and external systems.
LC file	Configuration files for equipment deployment and user management inside the system.
DC file	Configuration files for data access.
Interface Generation Engine(IGE)	Automatic generation of the client software according to the interface configuration files, and presentation of various data used in displaying, business processes, and requisitions.
Process Execution Engine (PEE)	Execution of the control flow following the process definition file, and integration of the services according to the service configuration file, so as to realize auto-execution and effective management of business processes (commercial products such as WPS of IBM).
System Configuration Service (SCS)	Accomplishment of the deployment and management of seats, servers and controlled units inside the system, and configuration of the information exchange relationships among internal and external systems.
Data Access Engine (DAE)	Provision of uniform, transparent, consistent and immediate access to the heterogeneous data.

◆ Conclusions

- 1 Explore a way of self-forming reconstruction of C2 system in net-centric environment to meet the requirement of the agile organization and dynamic construction of Command and Control Communities of Interest.
- 2 Extend the categories of operational plans.
- 3 The concept of C2SSP is proposed with its descriptive model given, an example C2SSP planning tool is shown.
- 4 Develop a dynamic reconfiguration mechanism (plan-driven mechanism) of C2COI.
- 5 Establish a closed loop mechanism focused on C2SSP.
- 6 Further research will be focused on C2SSP evaluation and optimization.

Thank you!

