

C4ISR ARCHITECTURE FRAMEWORK IMPLEMENTATION

LECTURE 4

C4ISR ARCHITECTURE DESIGN PROCESS

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MOTIVATION

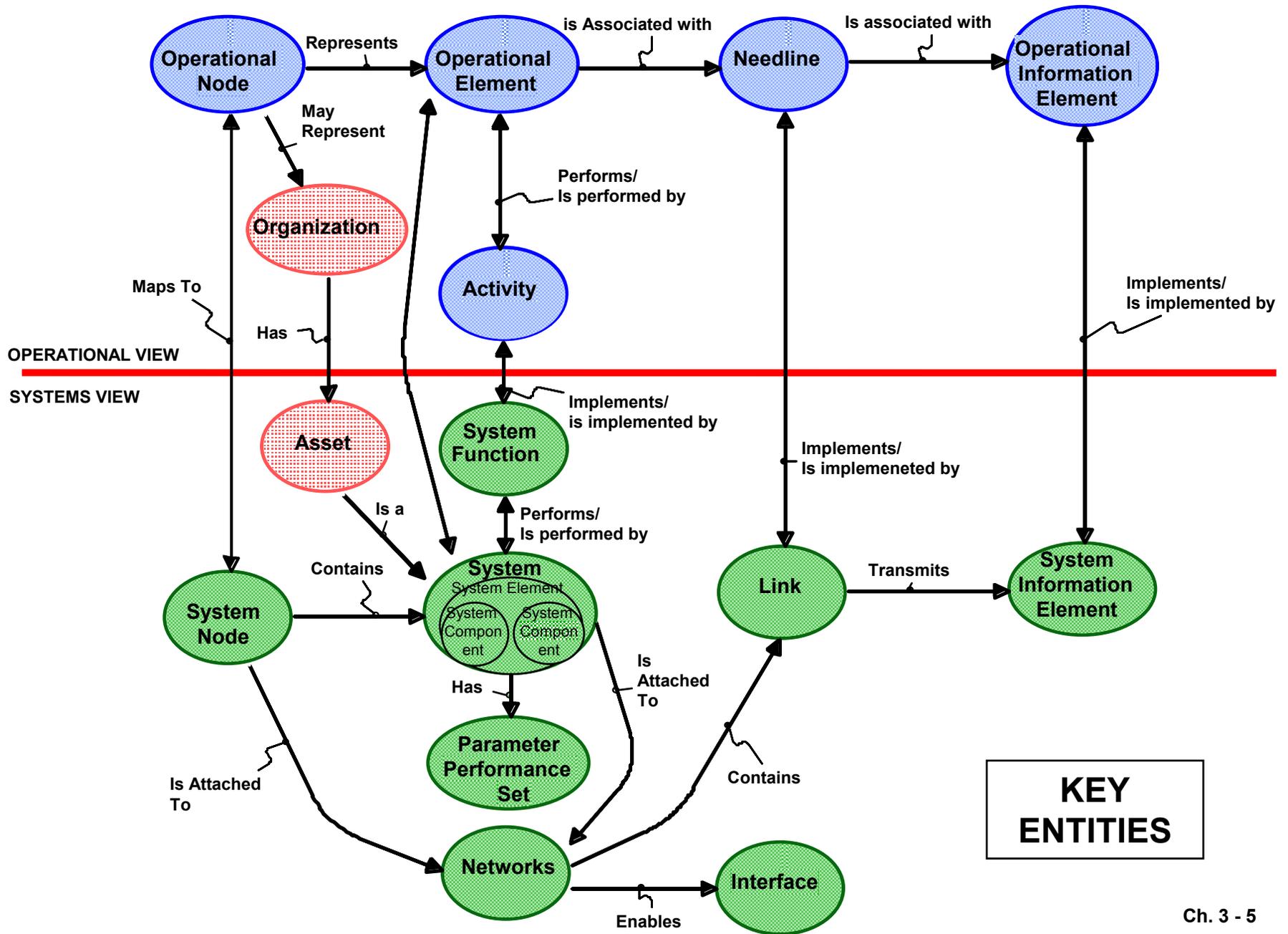
- **The C4ISR Architecture Framework (v. 2.0) provides high level guidance and a set of essential (mandatory) and supporting products for representing an architecture**
- **It does not identify a specific process for developing the architecture views and the associated products.**
- **The *essential/mandatory products* can be obtained using Structured Analysis or Object Oriented approaches**
- **The *supporting products*, as currently described, are obtainable using Structured Analysis; liberal interpretation of v2.0 enables the use of Object Oriented approaches**
- **A process is needed to**
 - **identify the relationships among products**
 - **guide in the selection of tools needed**
- **The process must be generic to accommodate current practices**

PROCESS FOR PRODUCT DEVELOPMENT

- **A six stage process has been developed for generating the Essential and Supporting products for the Operational and Systems architecture views**
- **The process has been derived by approaching the problem from the systems engineering point of view and using Structured Analysis; alternative processes are possible**
- **Each product has been perceived as an Entity containing data; a formal Data Model was derived showing the relationship among the various entities**
- **The relationships among the entities induced a partial ordering of the entities which led to a series of steps for their production**
- **The process utilizes existing tools and techniques to derive the requisite products and is compatible with the development of an Executable model**

KEY ENTITIES

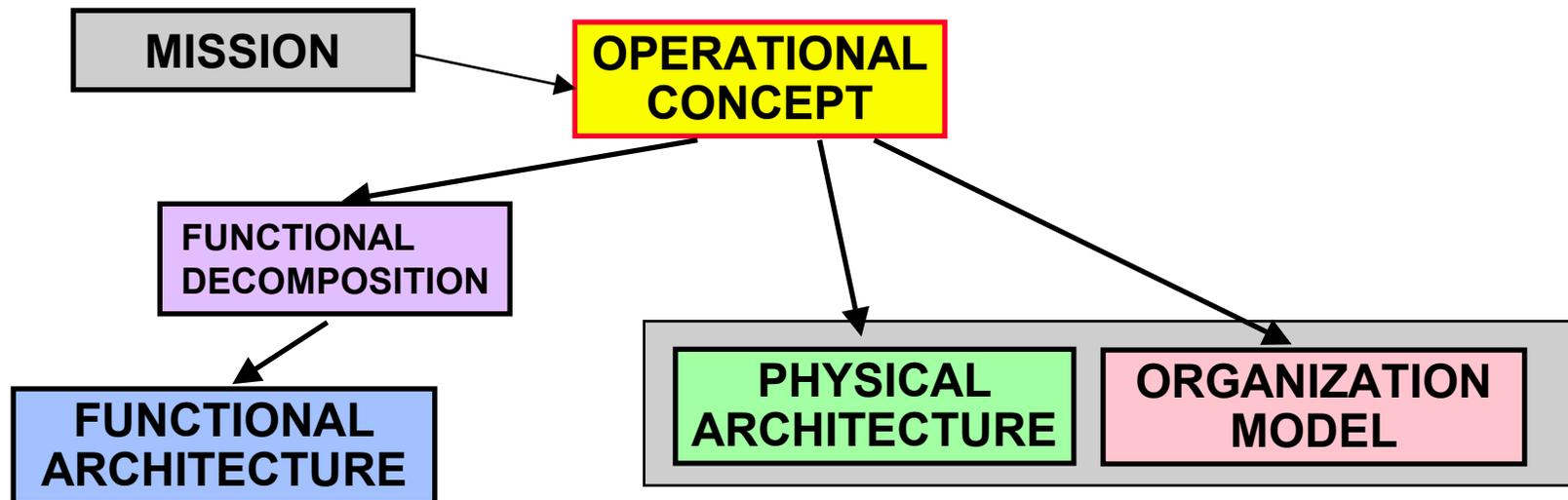
- **Operational Nodes and Operational Elements**
- **Activities** (Operational)
- **Needlines**
- **Operational Information Elements**
- **Organization** (Organizational)
- **Asset**
- **System, System Element, System Component**
- **System Function**
- **System Node**
- **Link** (Systems)
- **System Information Element**
- **Performance Parameter Set**
- **Networks and Interfaces**

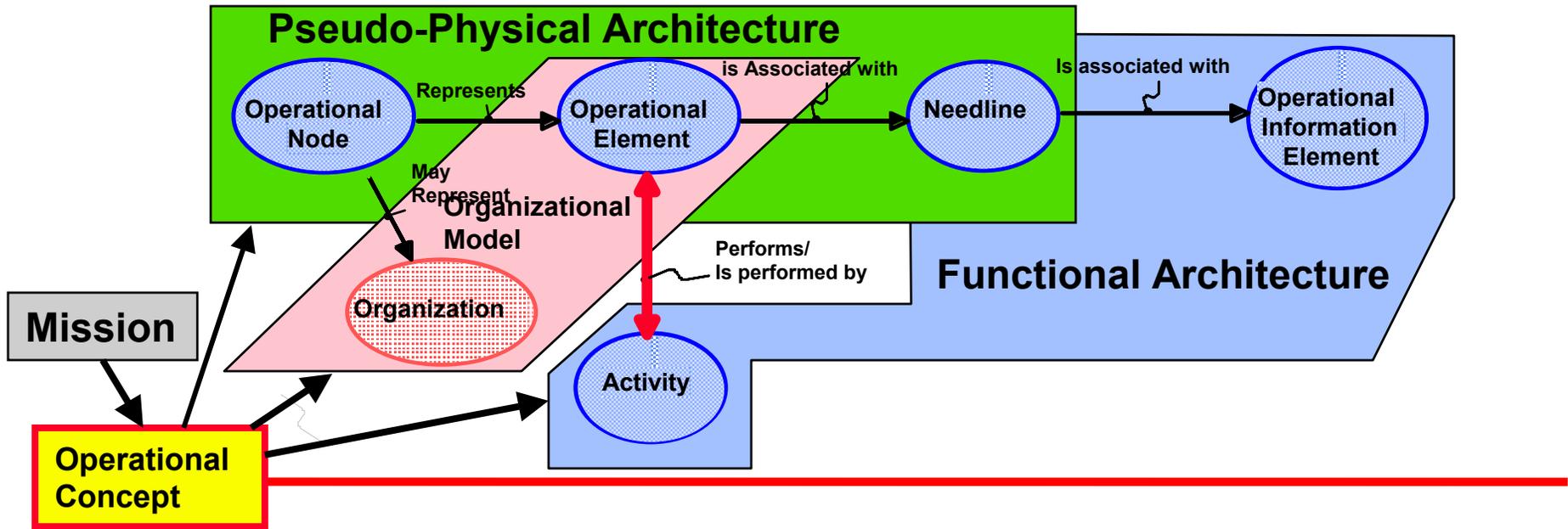


ARCHITECTURE DEVELOPMENT

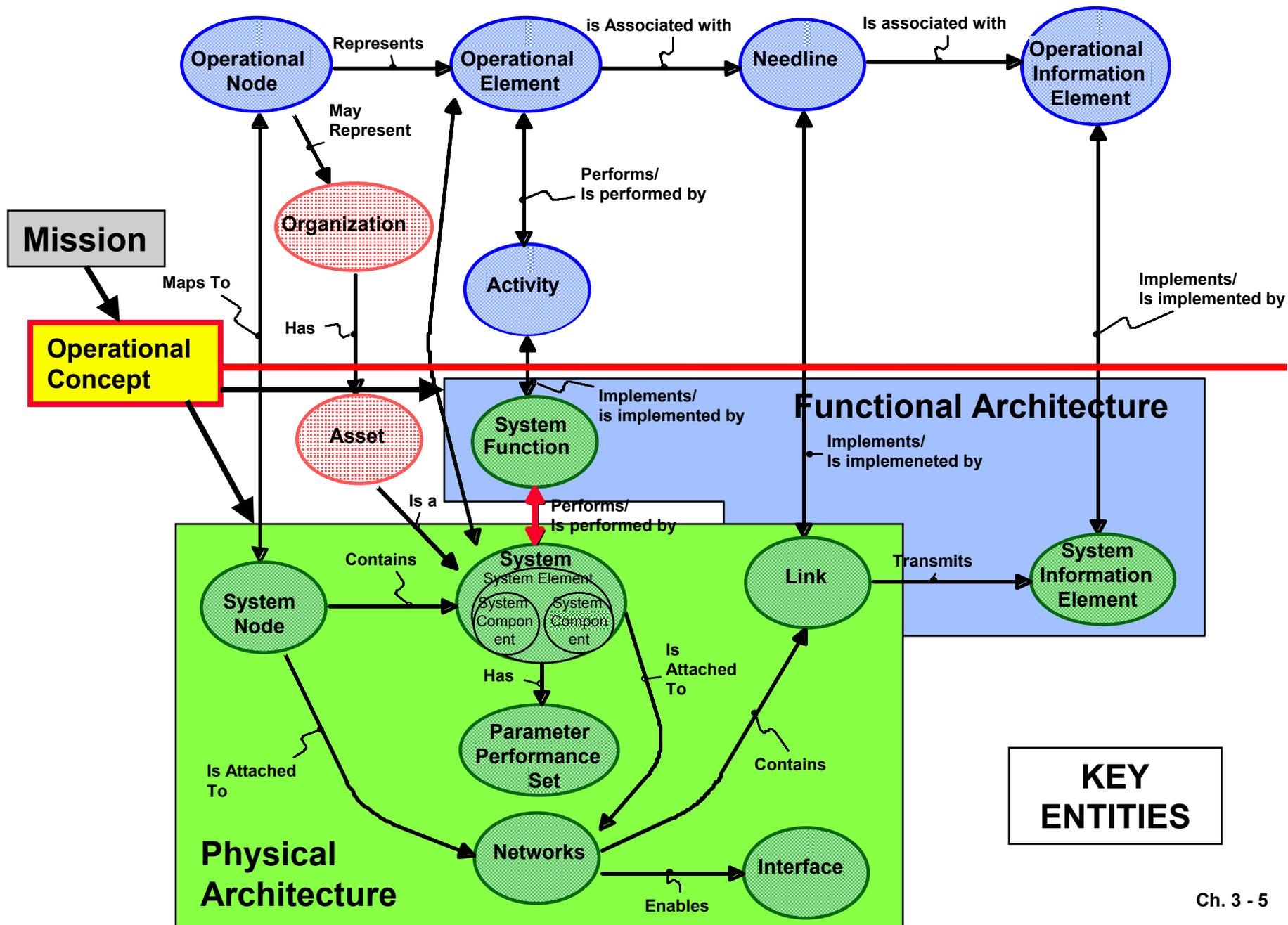
The elements of the Systems Engineering process are:

- A Functional Architecture based on activities and information flows
- Physical Architecture with System Nodes and Links
- An Organizational Model





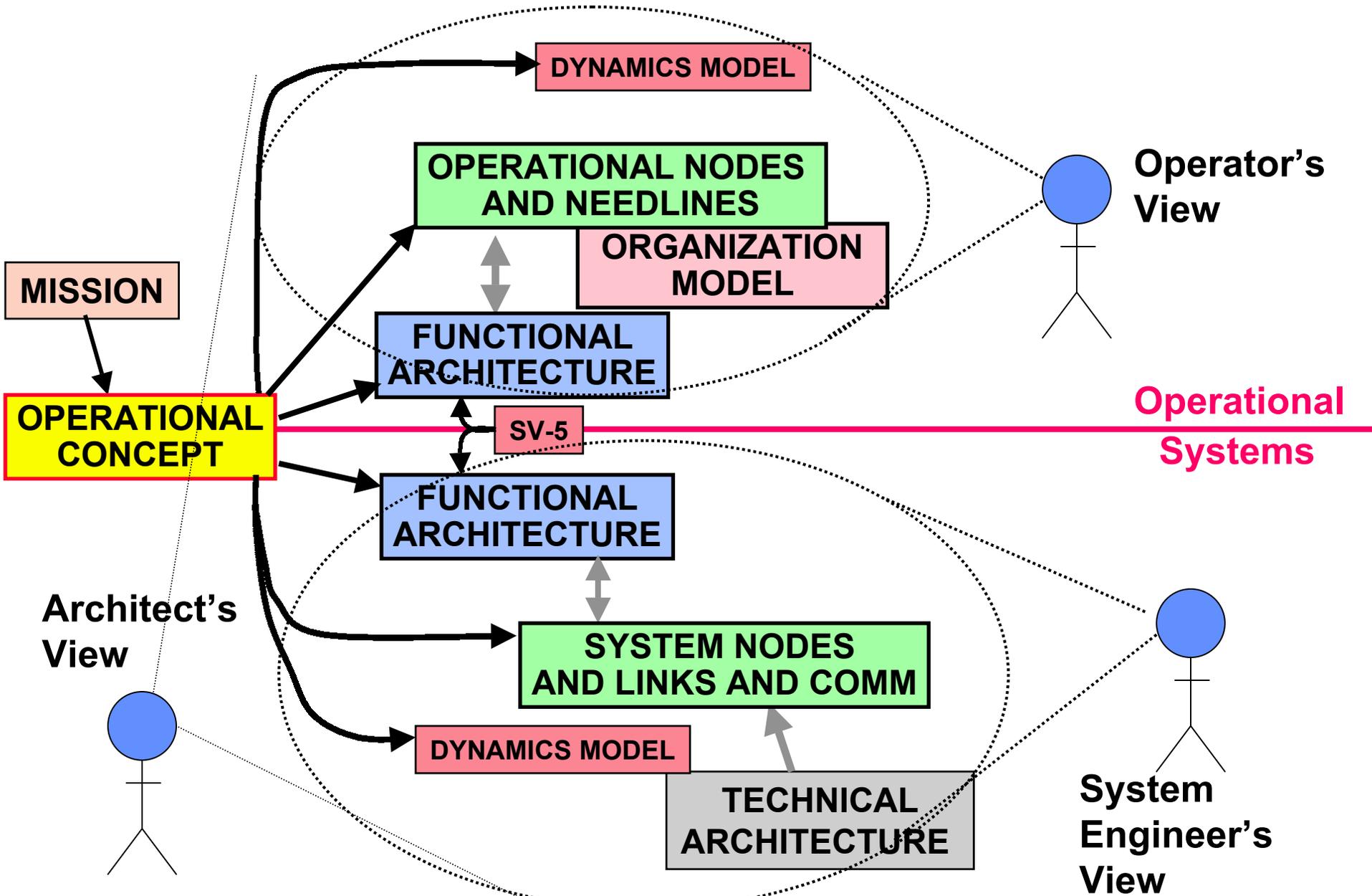
KEY ENTITIES



THE PROCESS

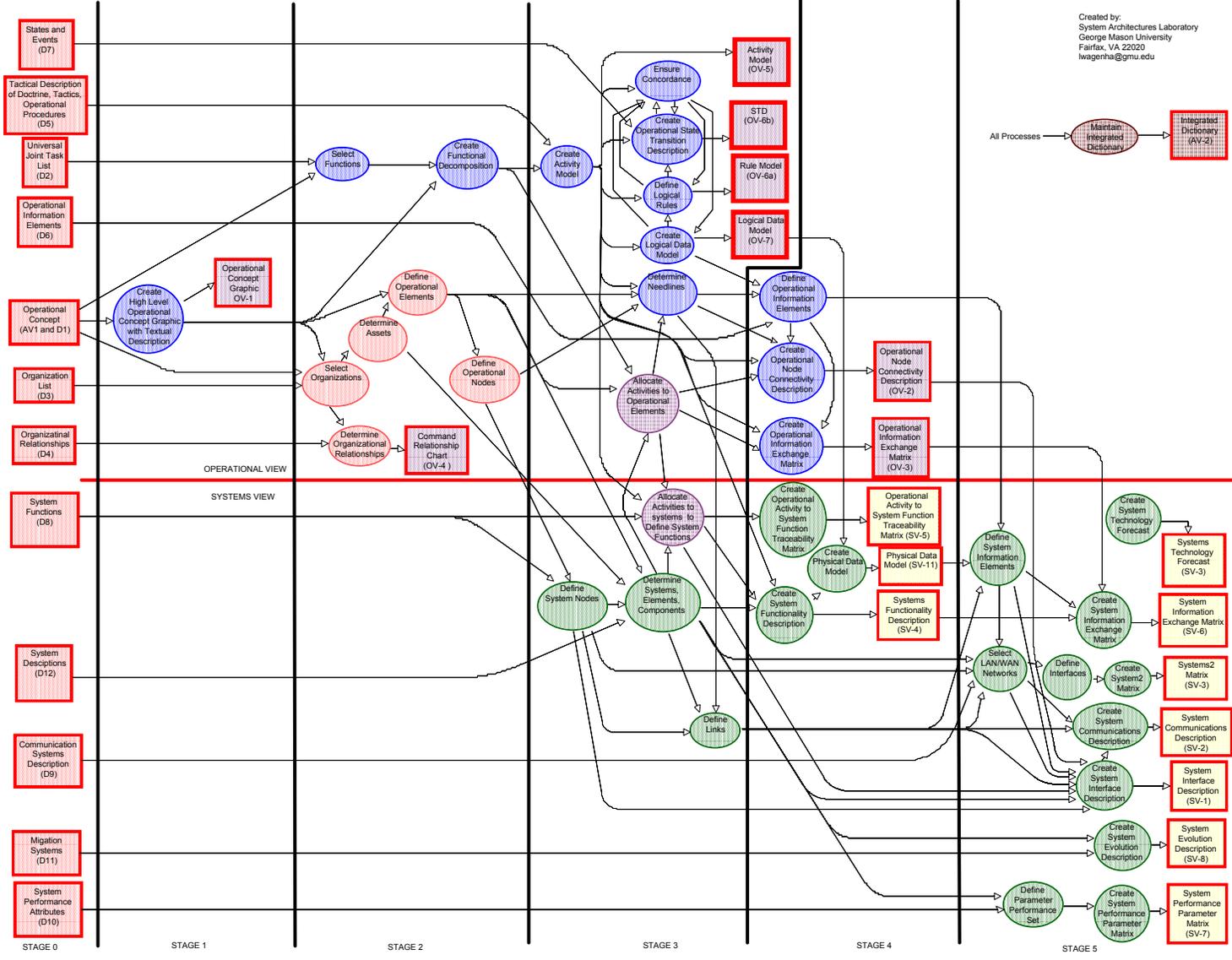
- **The architect develops a representation of the architecture by showing, through a series of diagrams, what activities and information flows will accomplish the operational concept, which organizations and systems will perform those activities.**
- **This is an iterative rather than a sequential process**
- **The key questions are: Does the Structured Analysis approach generate the information required**
 - **by the C4ISR AF products?**
 - **by the executable model?**

PROCESS



THE SIX STAGE PROCESS

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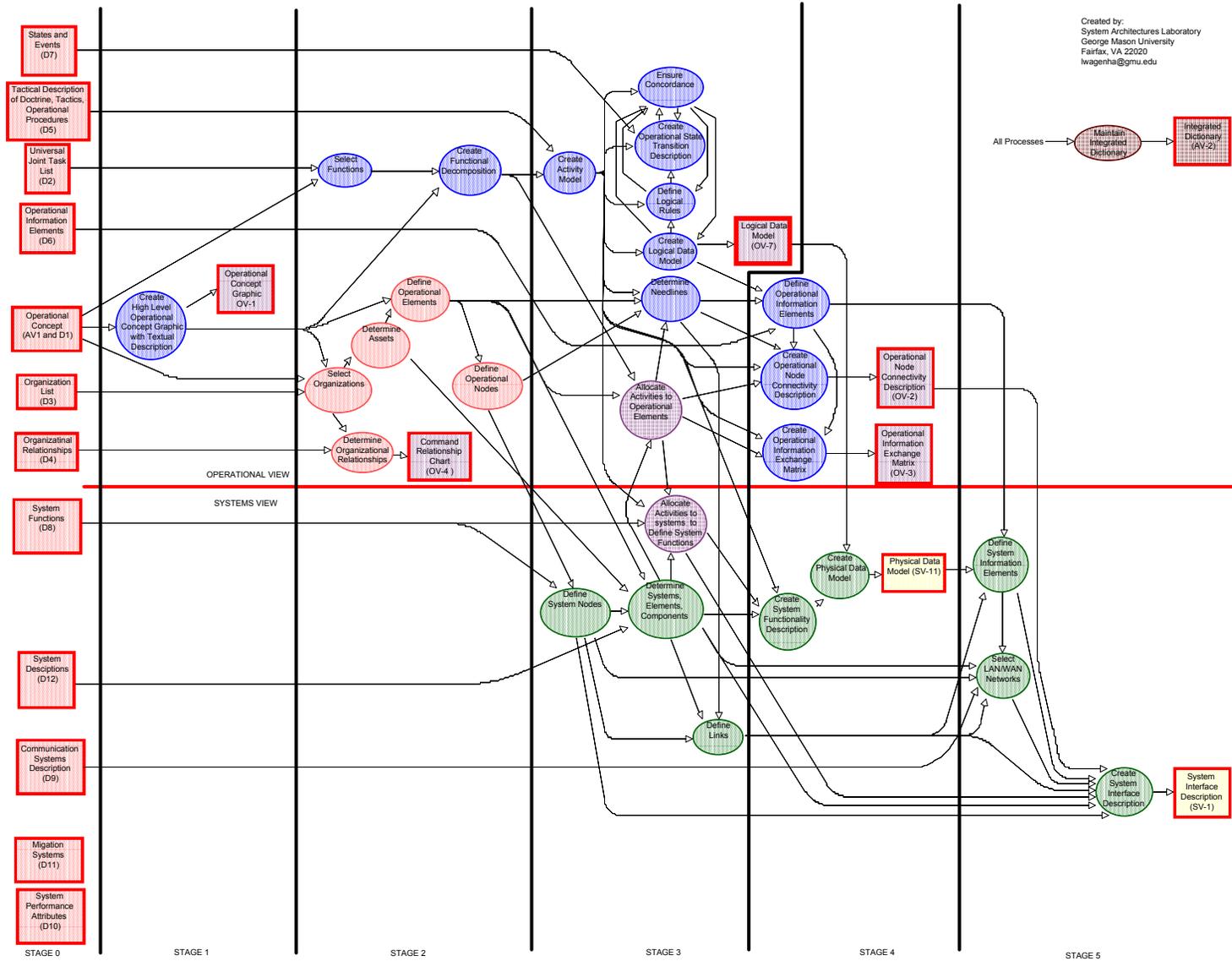
REMARKS

- **This is a Data Flow Diagram of the Six Stage Process. It starts with the needed inputs (terminators/sources) on the left (Stage 0) and ends with the last products (terminators/sinks) on the right.**
- **The top half contains activities or transformations related to the Operational Architecture view; the bottom half to the Systems Architecture View**
- **Note that the two views are crosslinked several times. This was the first lesson learned by those who tried to do C4ISR Architectures: The OA view and the SA View cannot be developed independently from each other**
- **The crosslinking is in both directions: system information is needed in the OA view and activity information in the SA view**
- **The OA view can be done independently, but only at a high level of abstraction (Domain level). The SA view cannot be done independently of the OA view.**

REMARKS

- **C4ISR Architecture products are obtained at every step of the process. This means that, if concordance is not maintained rigorously from the start, there will be continuous need to revise and update already developed products**
- **Development of such a Data Flow Diagram and the associated Data Model of the products that will be needed for a particular architectural effort is a key responsibility of the Architect.**
 - **The Data Model specifies the dependencies among models and determined the selection of supporting products that must be developed**
 - **The Data Flow Diagram indicates the sequence in which products can be developed and specifies the data needed to construct them**

SIX STAGE PROCESS – ESSENTIAL ONLY



THE SIX-STAGE PROCESS

STAGE 0: Problem Definition and Collection of Domain Information

STAGE 1; Operational Concept and Requirements

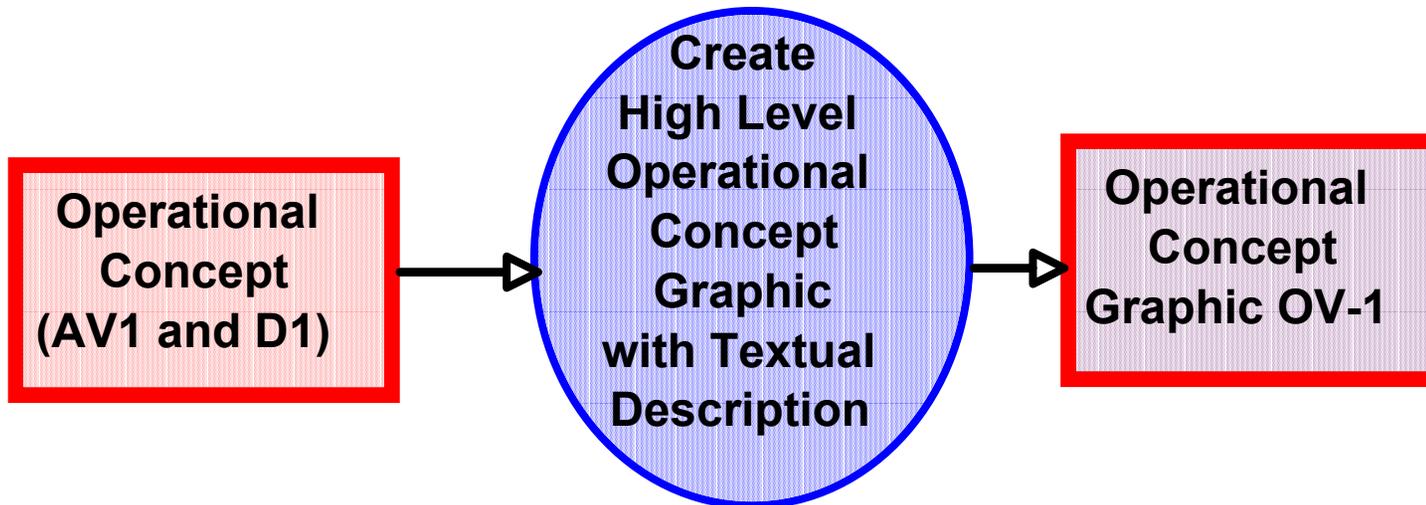
STAGE 2: Functions and Organizations

STAGE 3: Activity Model, Logical Data Model, Needlines, System Nodes, System Elements and Functions, and Task Allocation

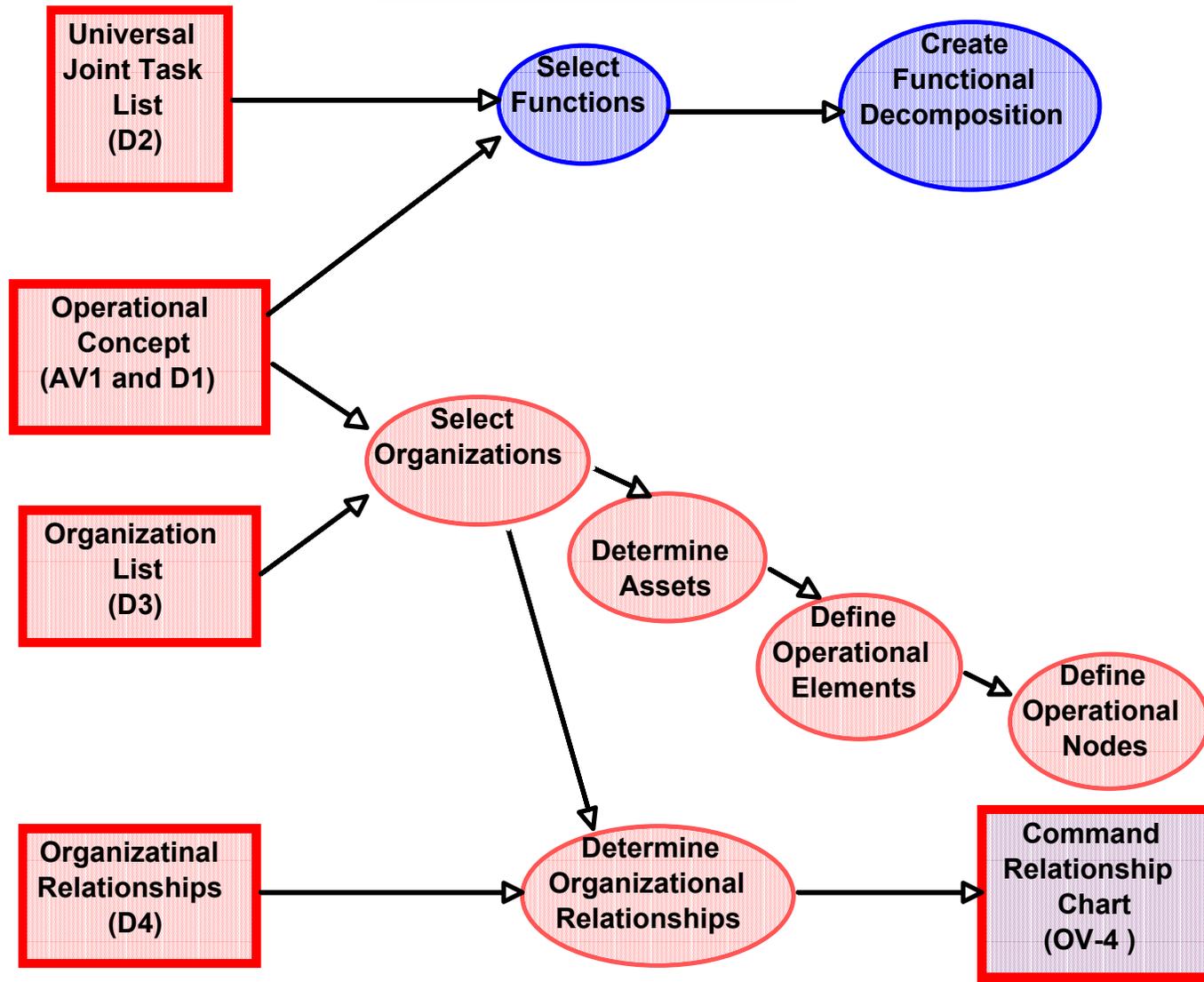
STAGE 4: Operational Information Elements and Exchanges, System Functionality Description, Physical Data Model

STAGE 5: System Information Elements and Exchanges, LAN/WANs, System Interface Descriptions, System Performance

STAGE 1



STAGE 2



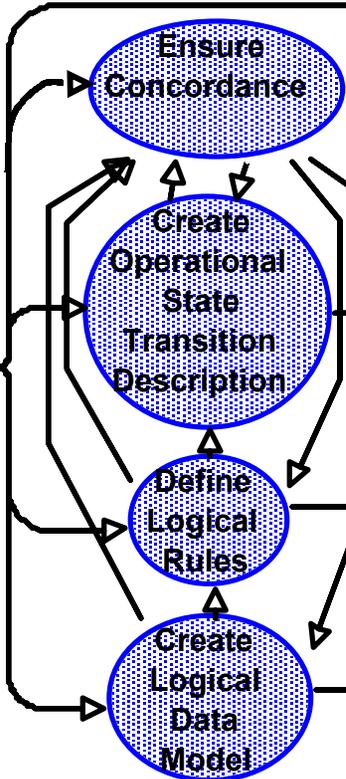
STAGE 3a

Tactical Description of Doctrine, Tactics, Operational Procedures (D5)

Create Functional Decomposition

From Stage 2

Create Activity Model



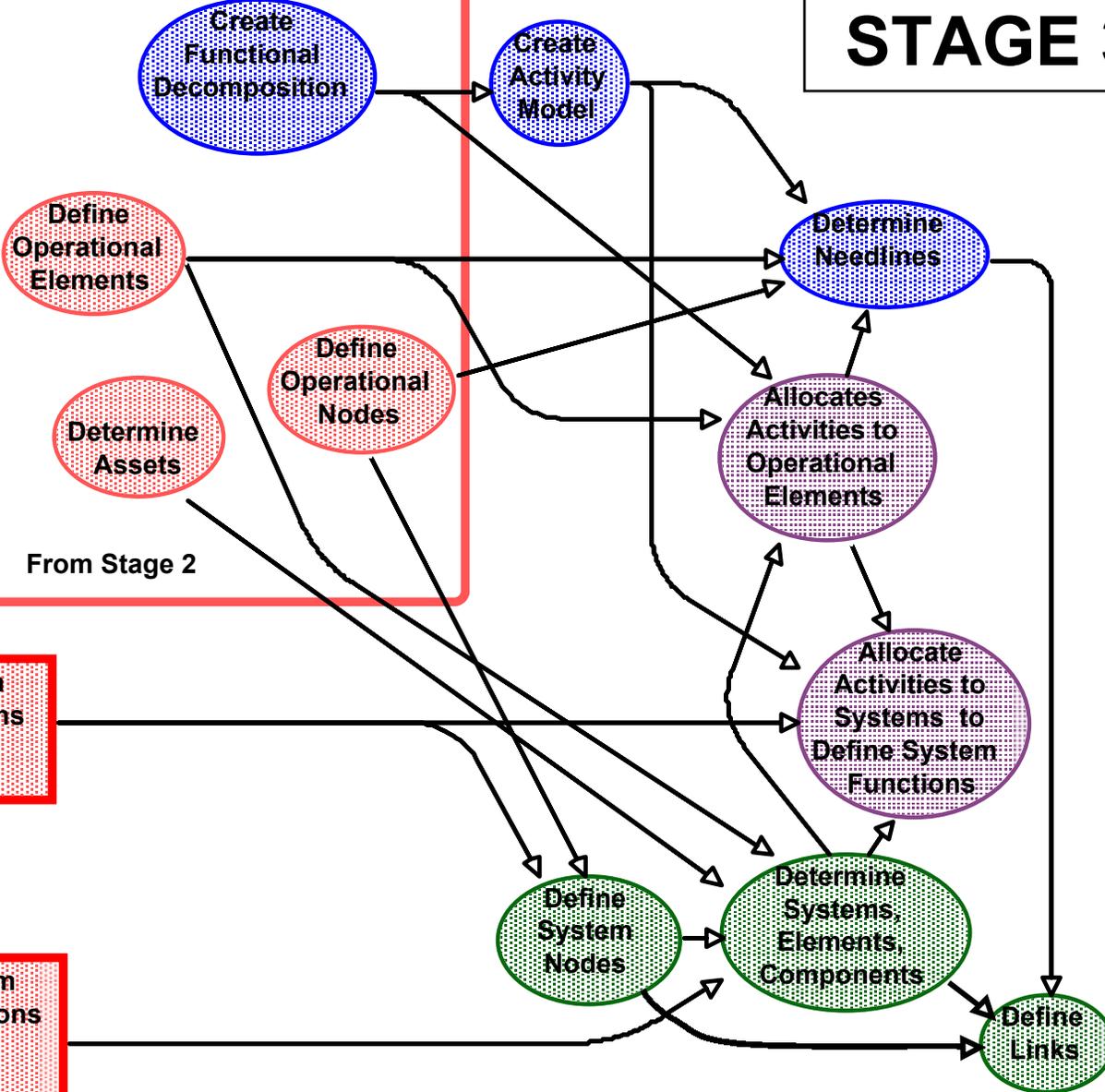
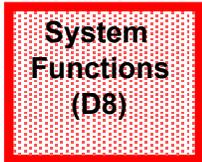
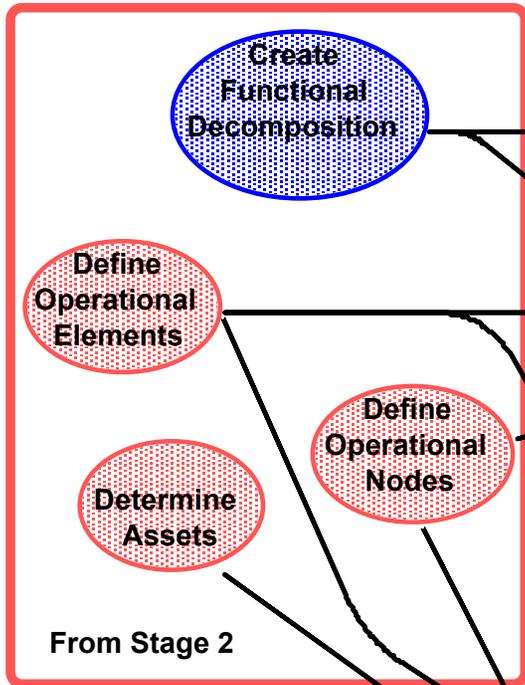
Activity Model (OV-5)

STD (OV-6b)

Rule Model (OV-6a)

Logical Data Model (OV-7)

STAGE 3b

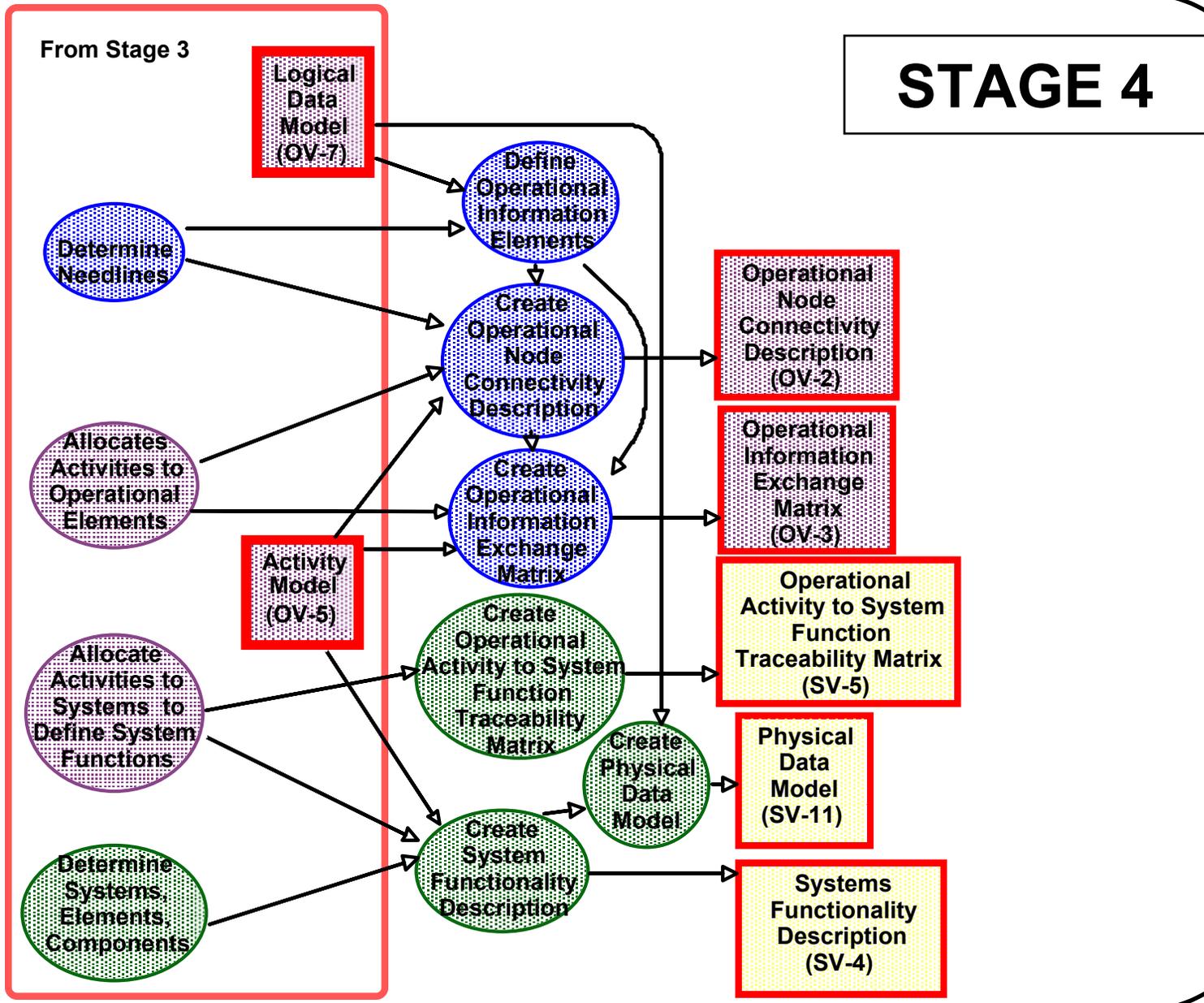


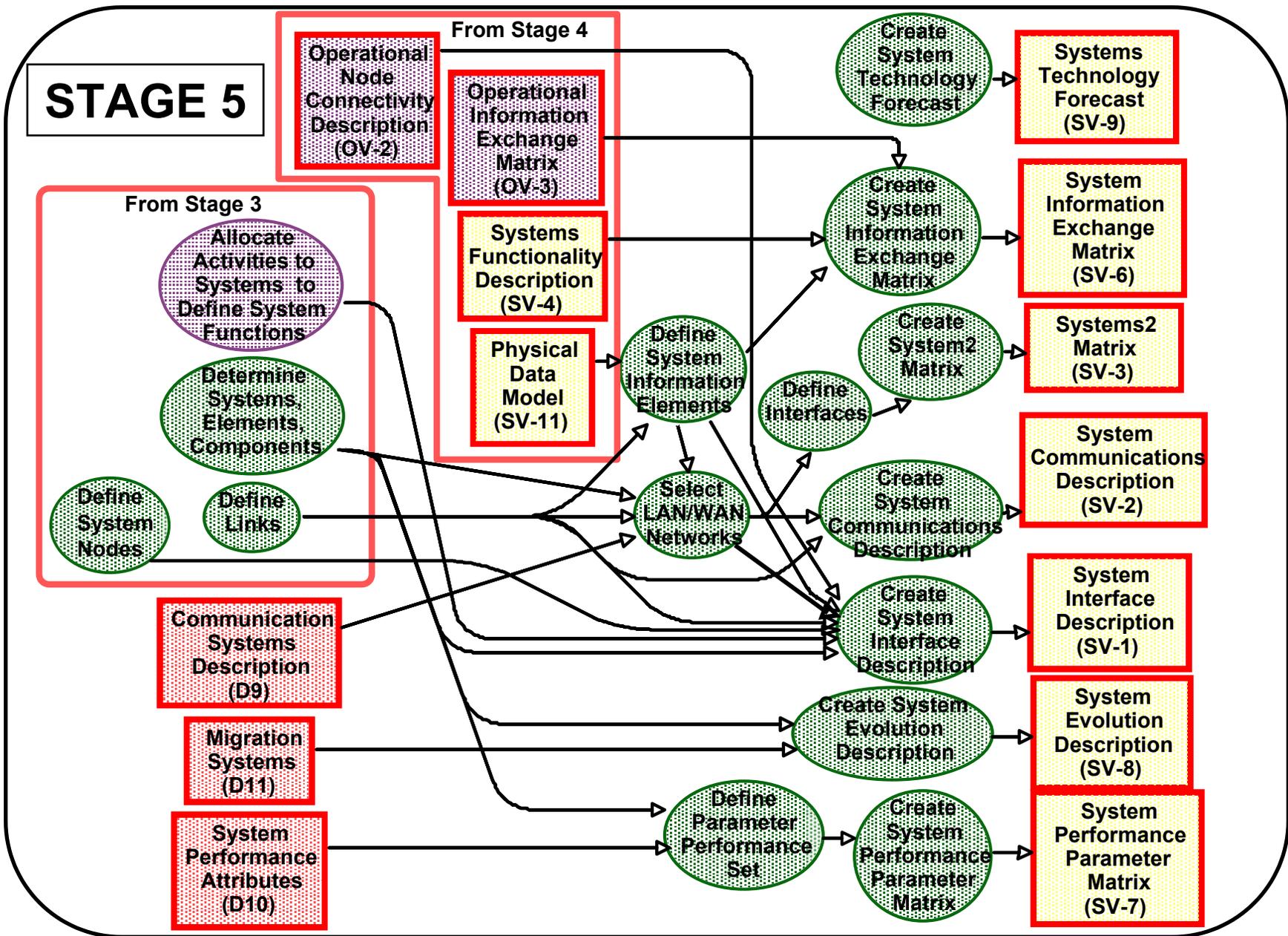
PROCESS STAGES

- 1** Once the basic information has been assembled in Stage 0, the process starts by converting the operational concept that implies or includes organizations and actions or tasks into the operational concept graphic with a textual description
- 2** The organizations implied in the operational concept have assets that are the basis for systems in the physical architecture and operational nodes and elements. The relationships between organizations imply communications requirements. The actions or tasks help in the selection of activities from the Uniform Joint Task List to form the functional decomposition.
- 3** A full functional architecture with activity model, data model, and rule model is created along with a dynamics model. Concurrently the initial physical architecture is defined using systems, elements, components and links. The activities are allocated to both organizational elements and to system functions.

From Stage 3

STAGE 4





PROCESS STAGES

- 4 Based on the analysis of the functional architecture models, the Operational Node Connectivity Description and the Operational Information Exchange Matrix are finalized. The implementation of the functional architecture is formulated and evaluated by creating the Systems Functionality Description and supporting Physical Data Model.**
- 5 From the previous analysis, the System Information Elements and the LAN/WANs are specified. The remaining products of the Systems Architecture view are created including the System Information Exchange Matrix, the System Communication Description, the System Interface Description and the System Evolution Description.**

OBSERVATIONS

- **The process appears to be complex; this is due to the tight coupling among products**
(This tight coupling is to be expected: all views and products describe aspects **of a single architecture**)
- **The process requires concurrent, but coordinated activities to take place**
(It is the architect's role to plan and direct these activities)
- **Products are produced in all six stages**
(This allows for continuous review and evaluation of the architecture description process)
- **The process diagram (flow chart) indicates what supporting products are needed in each case; the choice is not arbitrary because of interdependencies**

CONCLUSION

- **The six stage process is one approach to developing the architecture products specified by the C4ISR Architecture Framework**
- **Alternative approaches are possible; the six stage process can serve as a template to ensure that the alternative approaches cover all needed steps and produce a complete architecture description**