Abstracting Views of System Architecture
Exploring Perspectives of Software Intensive System Design

Raymond Jorgensen
Rockwell Collins

Objectives

- Define system architecture
- Describe traditional approach to develop systems architecture
- Discuss potential issues with traditional approach
- Discuss alternative approaches to develop system architecture
- Define architectural views necessary to capture the design of complex systems
- Discuss layering of architectural views – software views
- Demonstrate how different layers of the architecture are mapped to one another

What is System Architecture?

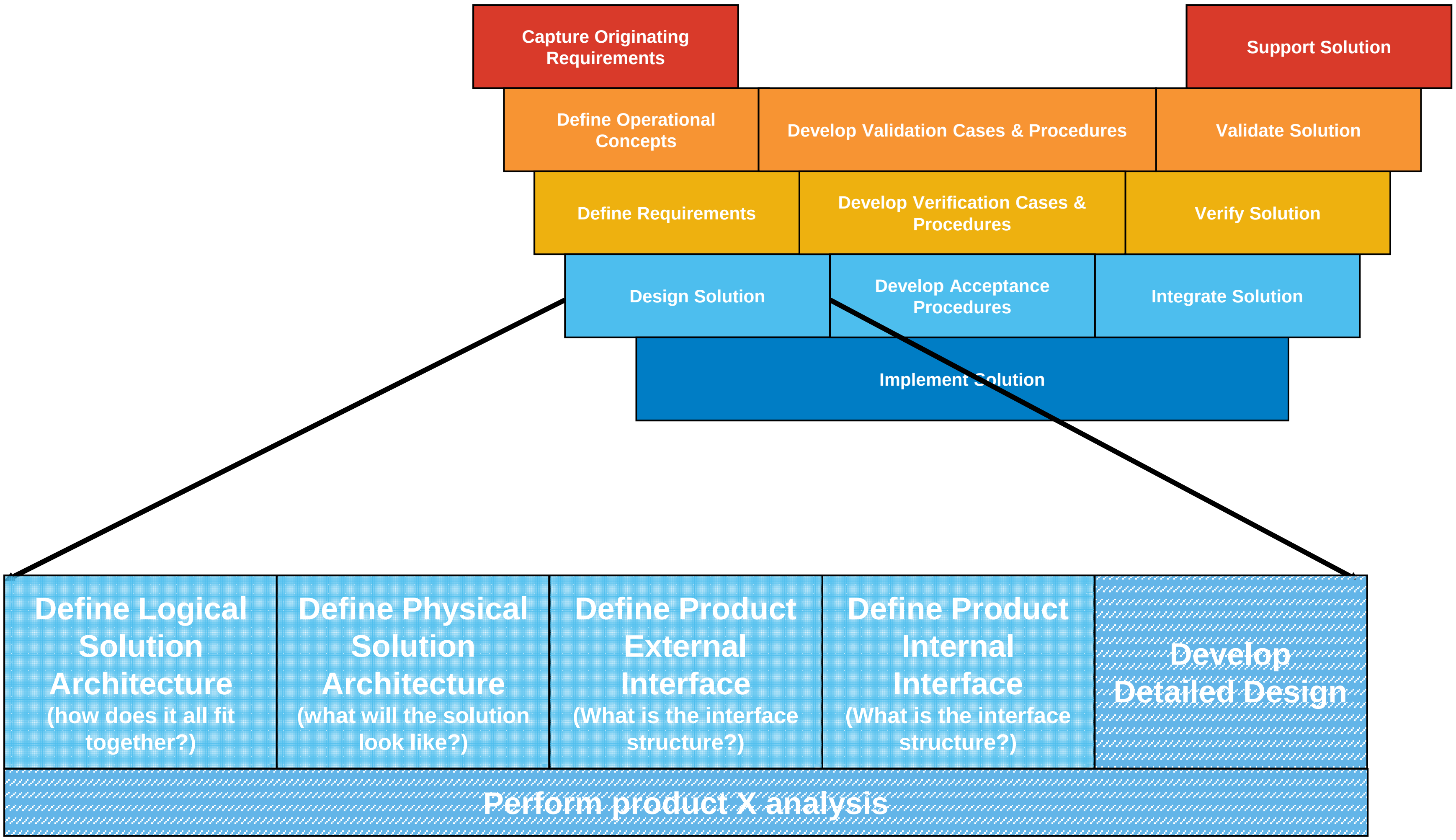
- Wikipedia:
  - A system architecture or systems architecture is the conceptual model that defines the structure, behavior, and more views of a system.
- IEEE:
  - The composite of the physical architectures for consumer products and their life-cycle processes. (P1220)
  - The organizational structure of a system or component. (STD 610.12)
  - A logical or physical representation of a product which depicts its structure, but, provides few or no implementation details. (P1220)
- DERA
  - The structure of levels and/or branches that partition a system into its constituent parts or components.
- NASA
  - How functions are grouped together and interact with each other. (MDP92)

Definition of System Architecture

- The definition adopted by Rockwell Collins Architecture Standard (RC-ENG-S-101)
  - The fundamental organization of a system embodied in its components, their relationships to each other and to the environment, and the principles guiding its design and evolution.

    ISO/IEC/IEEE 42010

Architecture in the Process



Why is Architecture important?

- Clearly defines the components of the system and how they relate to one another
  - Both logical and physical components
- Identifies dependencies between system components
- Allows for clearly allocating system non-functional requirements flow down to components
- Exposes interface points early and drives interface definition to improve independent development of components
  - As long as components conform to their interfaces, they can be developed independently
- Helps provide a map for integration of system components
- Aids in clearly communicating with all stakeholders
- Facilitates reuse of system components by clearly defining their boundaries, functions, and interactions

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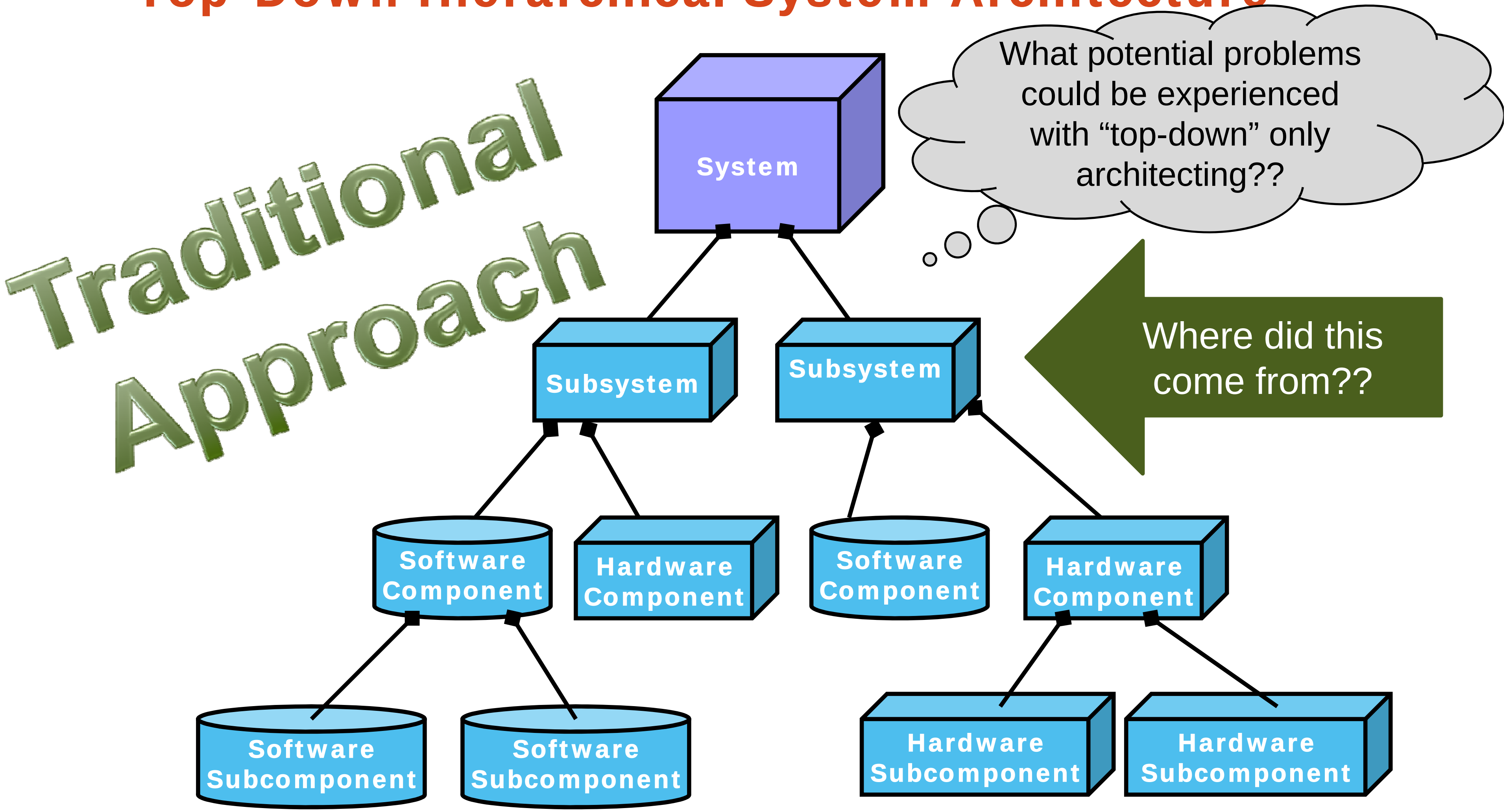
Top-Down Hierarchical System Architecture



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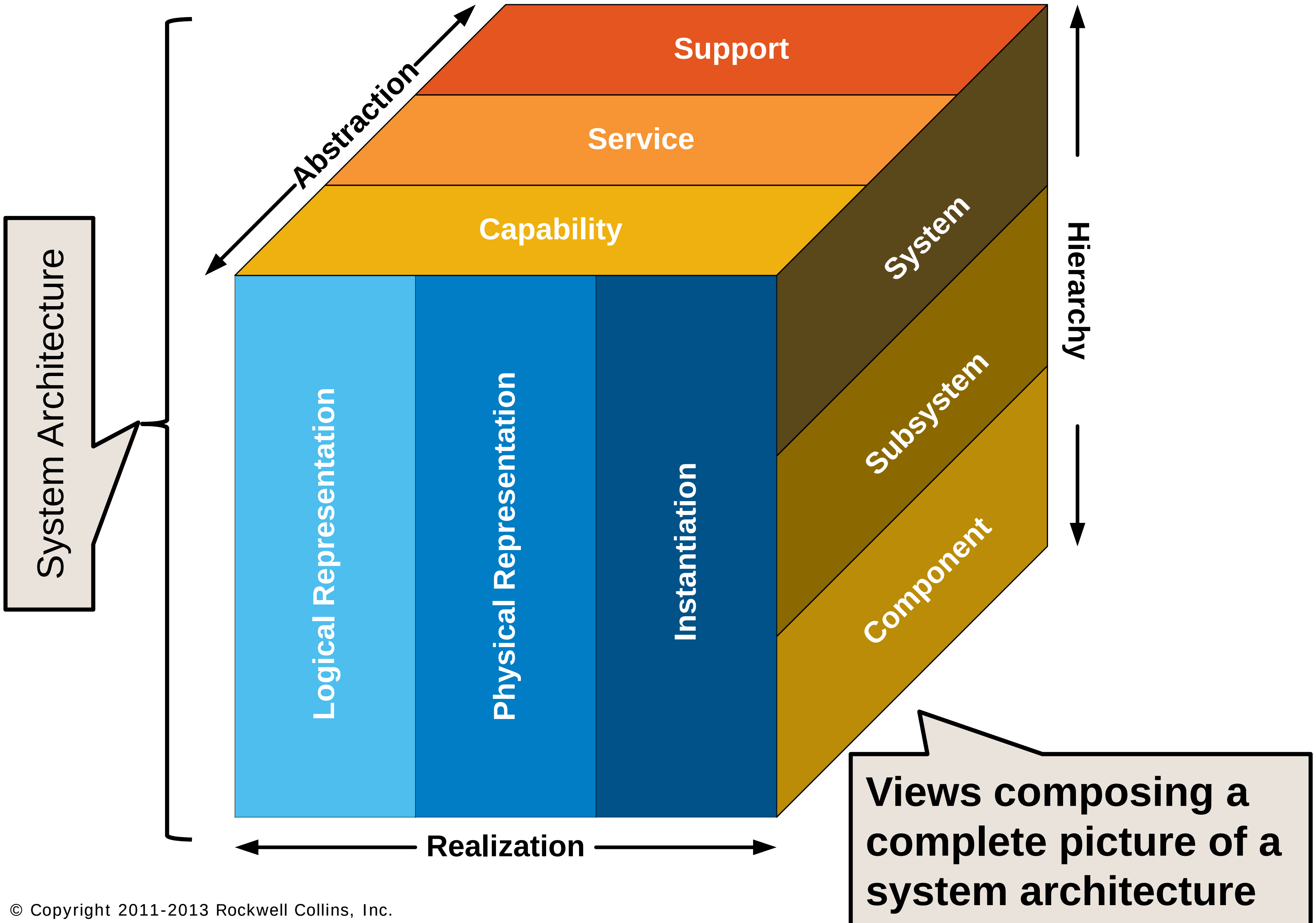
Traditional Top-Down System Approach

- What is a “subsystem”?
- How does a “system” differ from a “subsystem”?
- Can a system share components with other systems within the same hierarchy?
- What happens when the “subsystem” does not have unique components?
- How has “plug and play” and “modularity” changed the way we engineer or manage our products?

Is there a better way?


1978
1985
1990
1993
1995
2003
2010

Integrated Modular Solution Architecture (IMSA)



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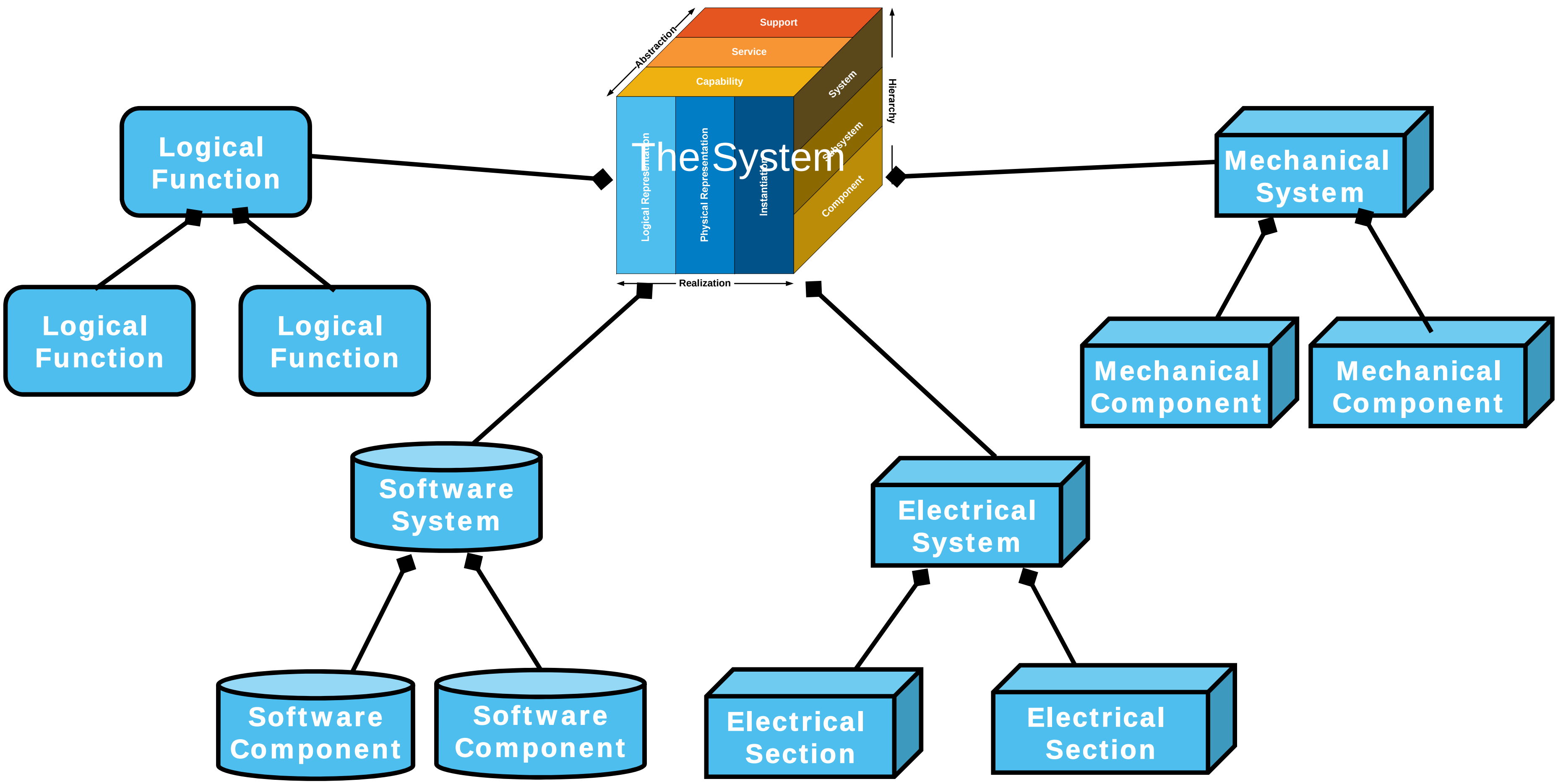
Integrated Modular Solution Architecture (IMSA)



Characteristics of IMSA

- Independent software architectures
  - Software architecture can **exist** independently from underlying physical hardware architecture!
    - Two projects with identical software architecture could have very different hardware configurations.
  - Software applications/ programs can **reside** anywhere in overall physical hardware architecture
    - Application software design abstracts out hardware interface so that it is not tied to a single box
  - Software architecture **defined** independently from the hardware
    - Allocation of application software to specific processors requires analysis to assess resource usage
    - Concerns – latency, throughput, and processor loading – can the underlying architecture handle resource usage?

Solution Architecture Views

- No one "picture" shows the full architecture of the solution
  - How is the architecture captured and managed?
  - Is a hierarchy view enough?

- Architecture contains
  - **Components** with structure and composition
  - **Behavior** showing inputs, processing, and outputs
  - **Relationships** showing interconnectivity of the solution

- Multiple perspectives result in multiple views of the architecture
  - Software, Hardware, Behavioral, etc.

- Interdependencies between views must also be captured
  - Interfaces and relationships

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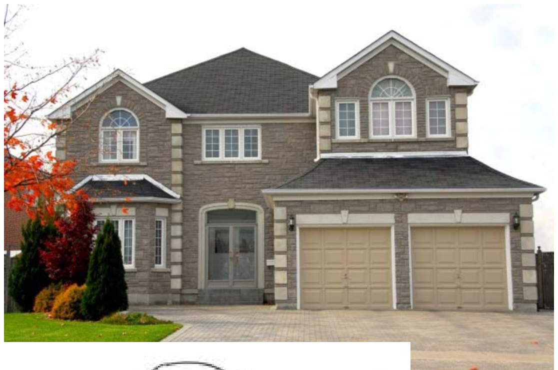
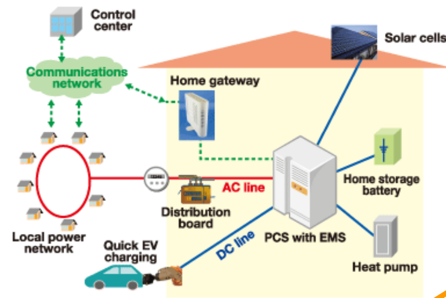
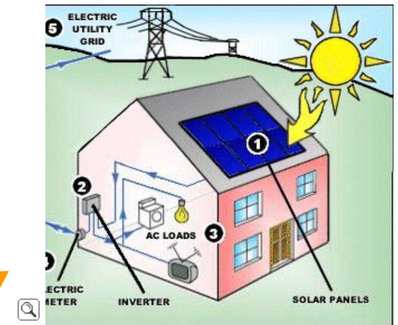
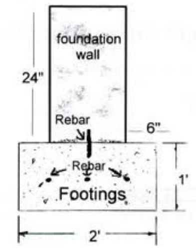
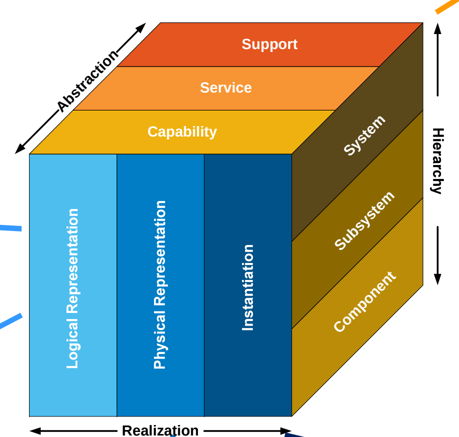
"Your House for Example"

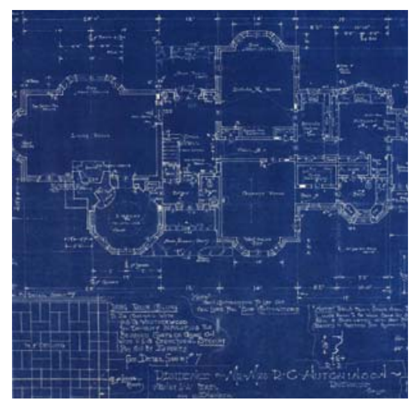






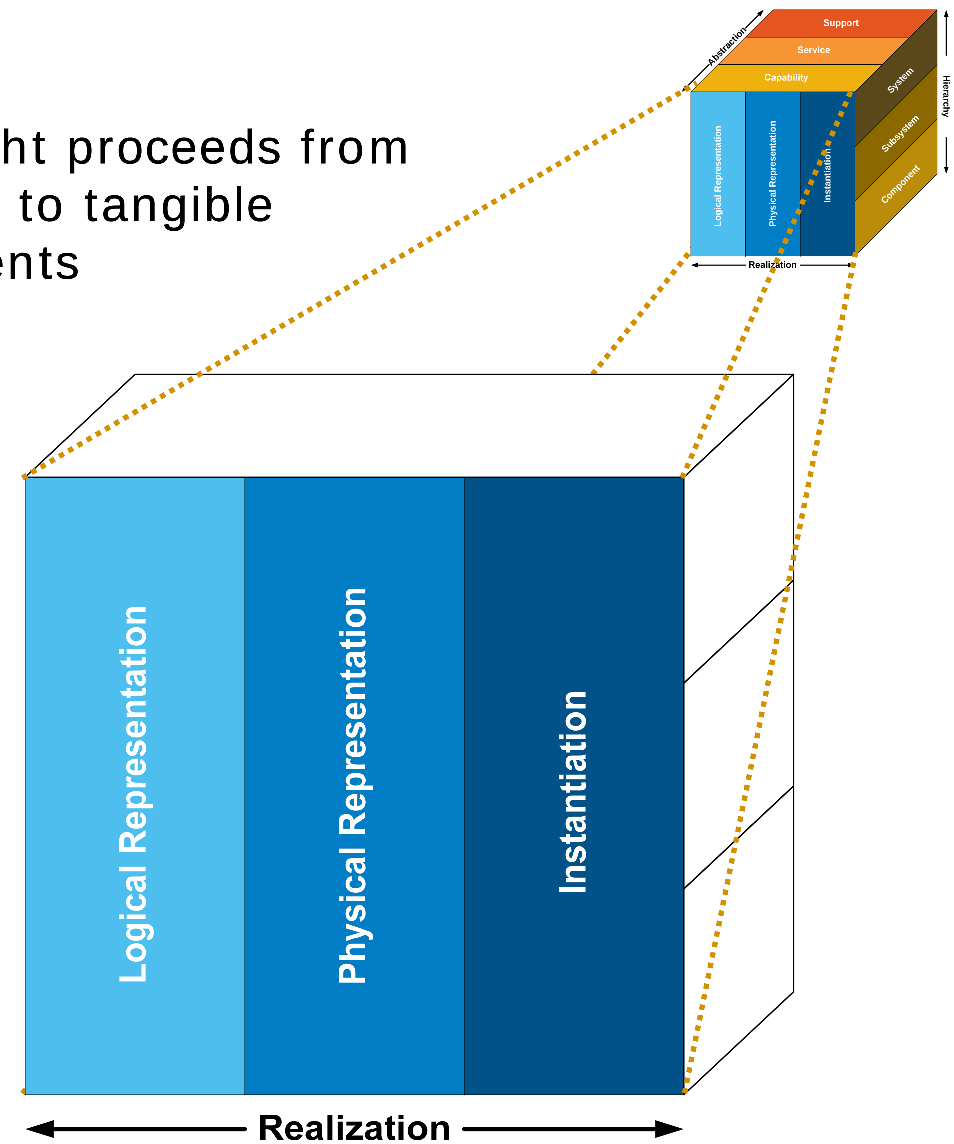


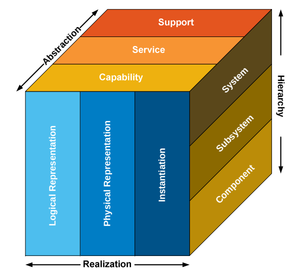




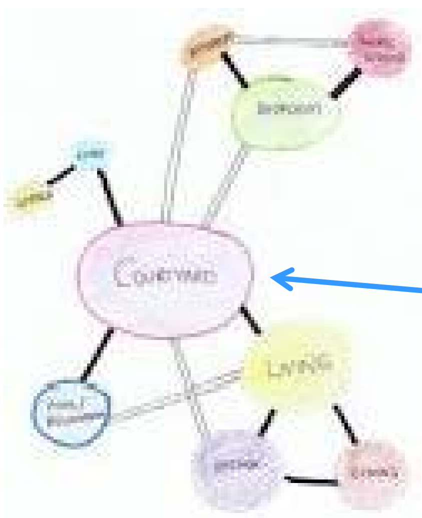
Realization Views

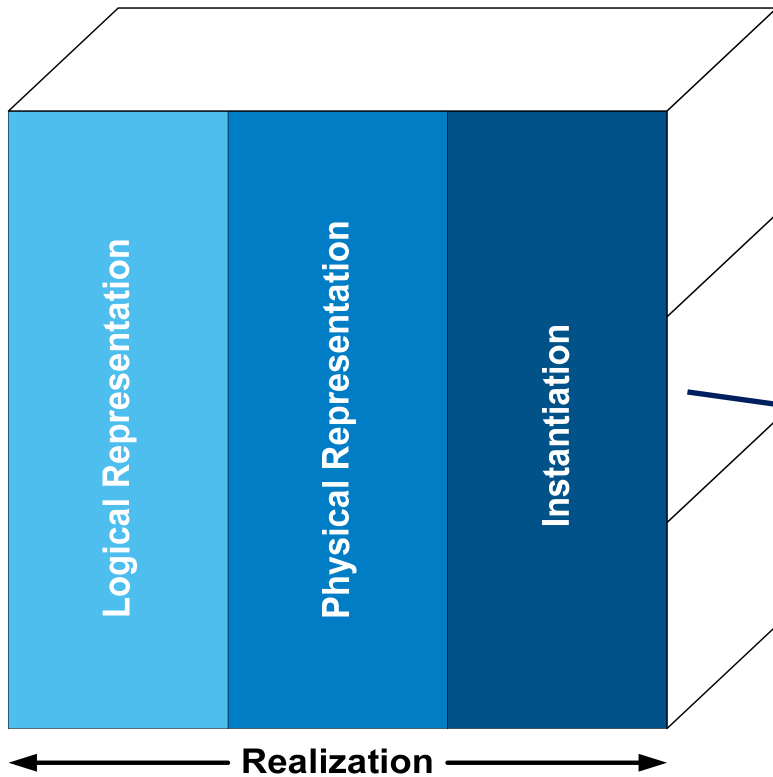
- Progression from left to right proceeds from abstract, notional concepts to tangible assets to realized components

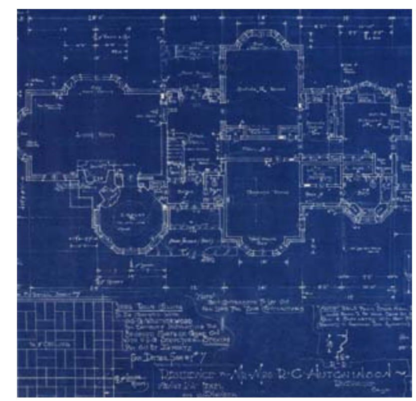




Realization Views







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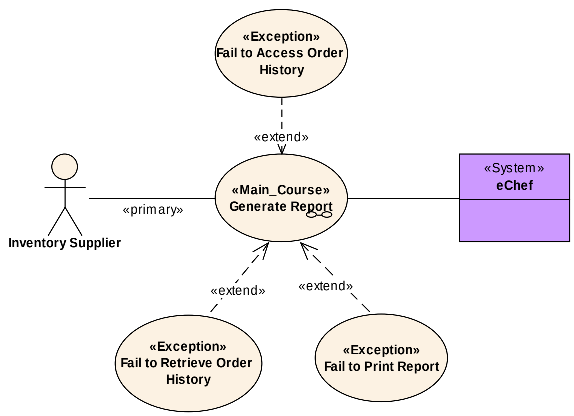
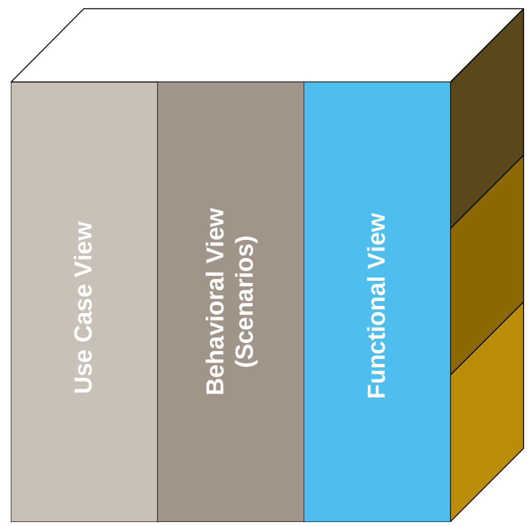
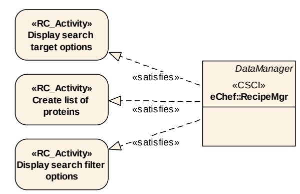
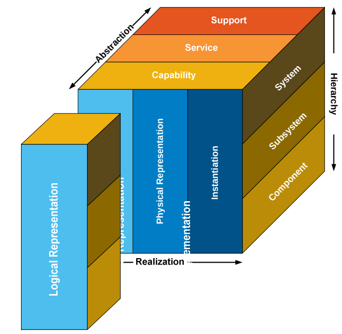
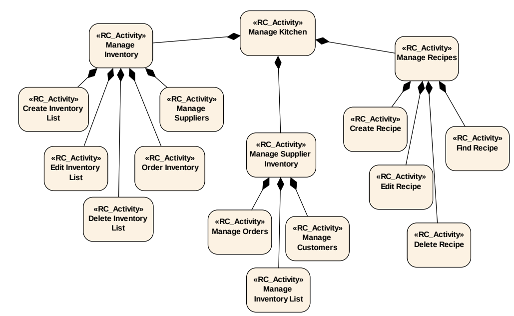
Logical Representations Summary

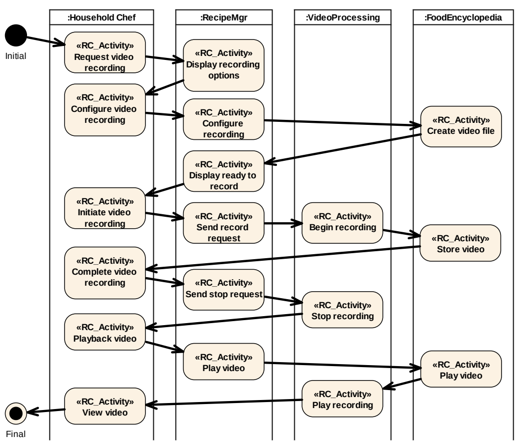










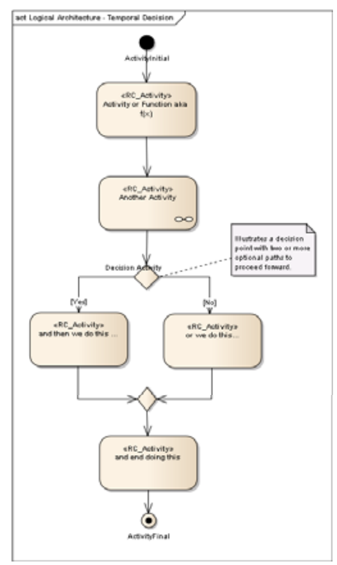


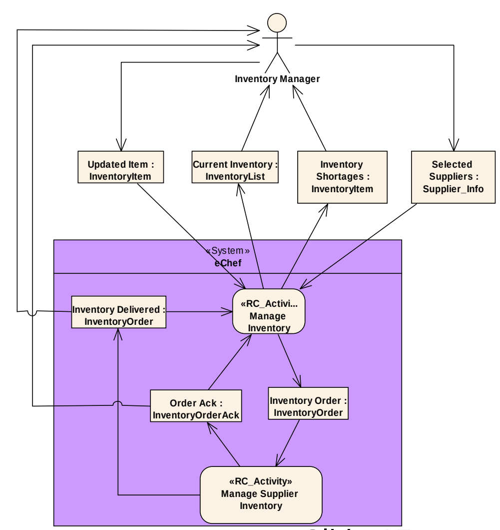
Hierarchical Perspective

Sequential Perspective

Transactional Perspective

Allocation Perspective





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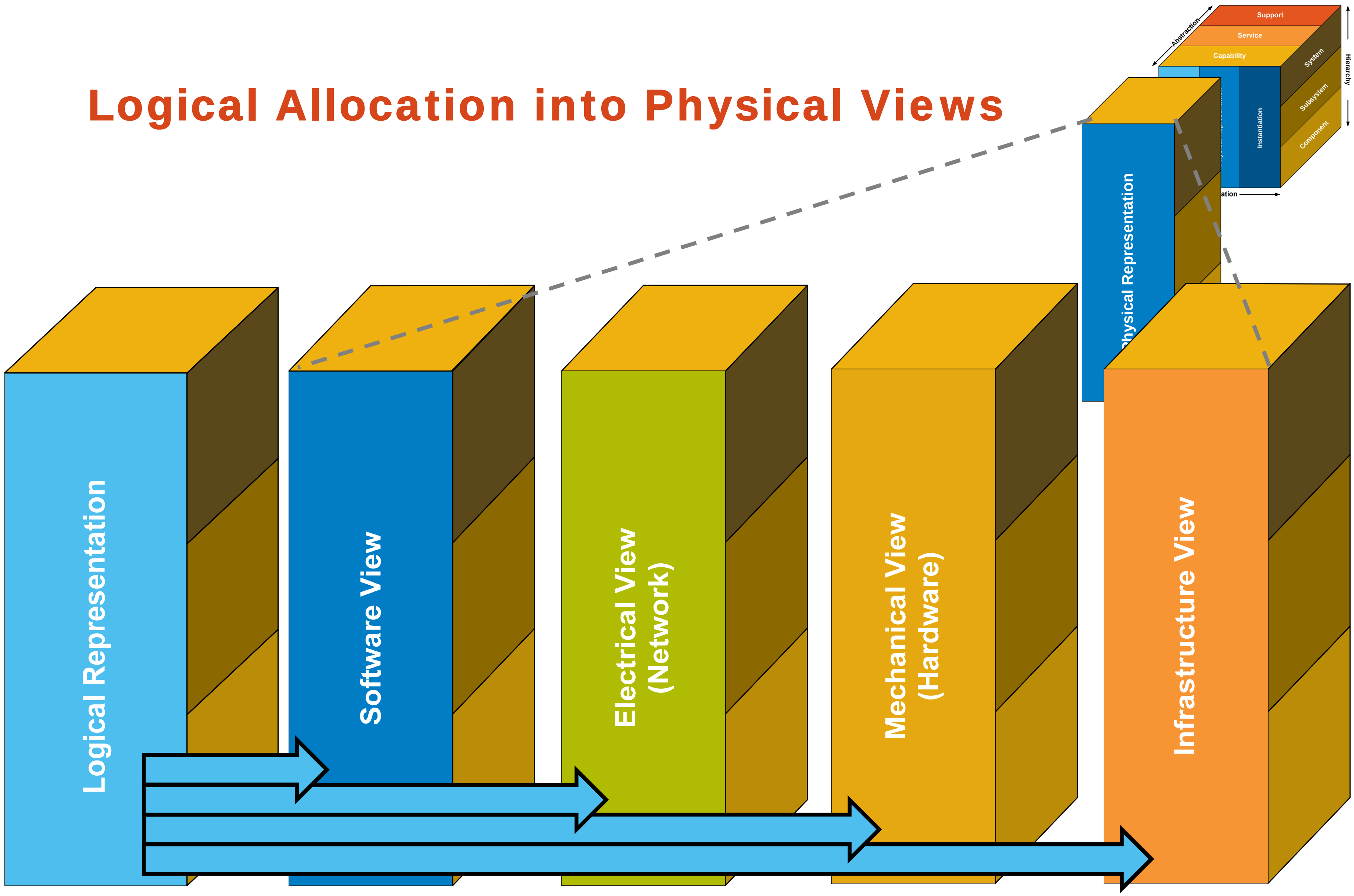
Logical Allocation into Physical Views



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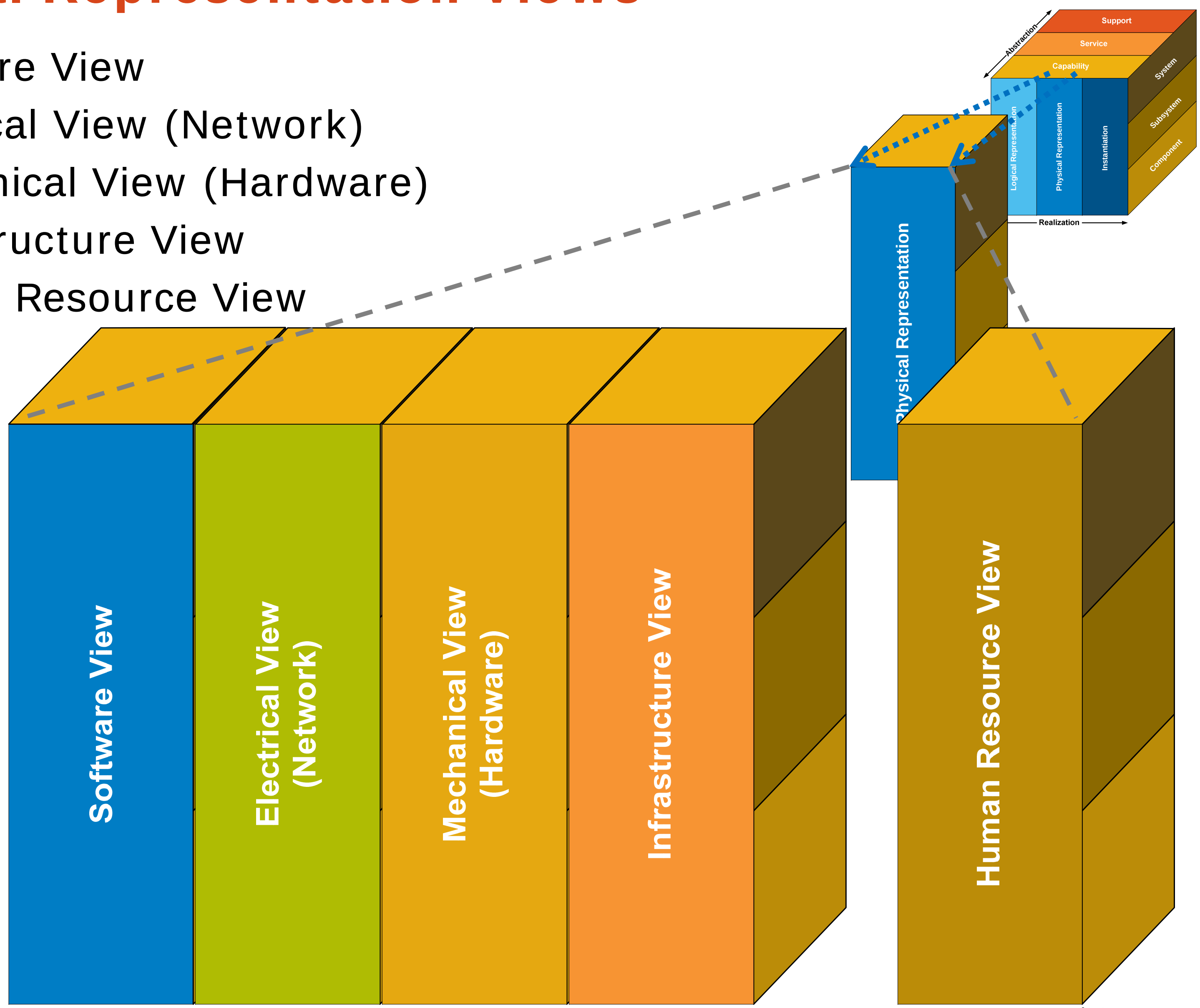
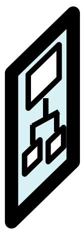
Physical Representation Views

- Software View
- Electrical View (Network)
- Mechanical View (Hardware)
- Infrastructure View
- Human Resource View



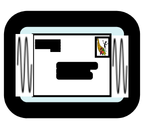
Physical Representation – Software View

- Software Views

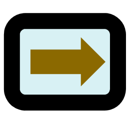


Hierarchical Perspective

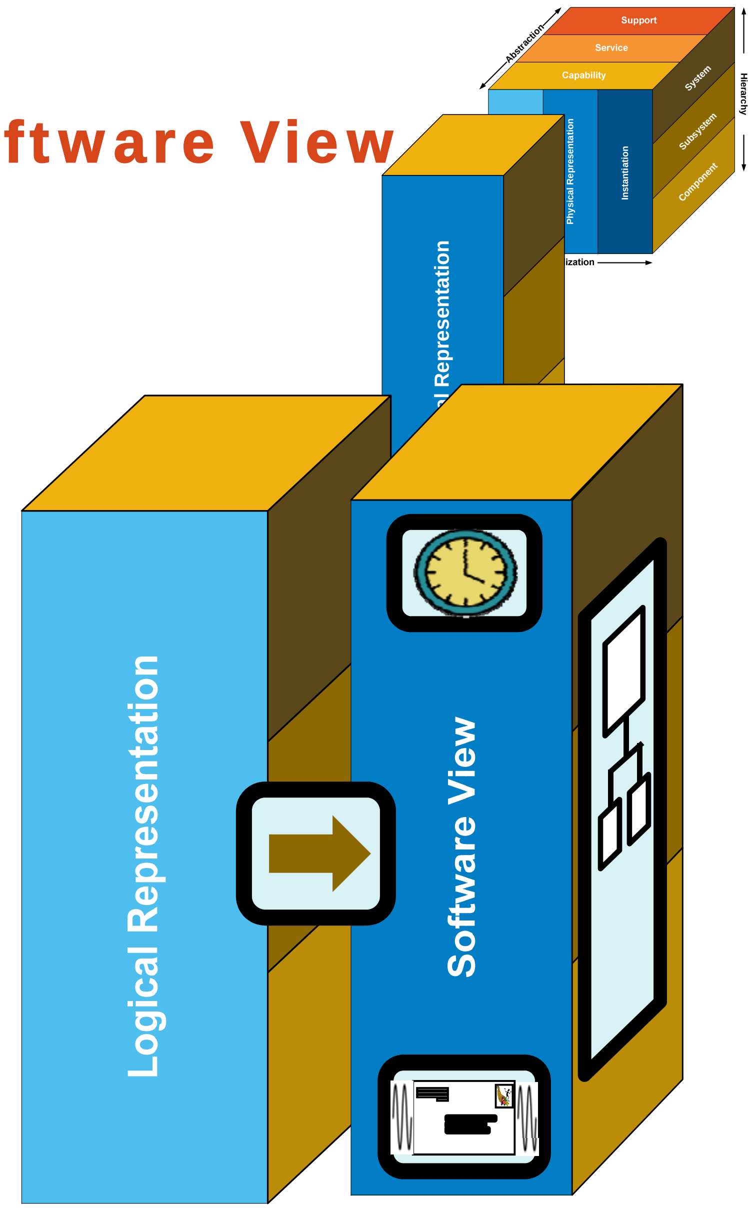
Sequential Perspective



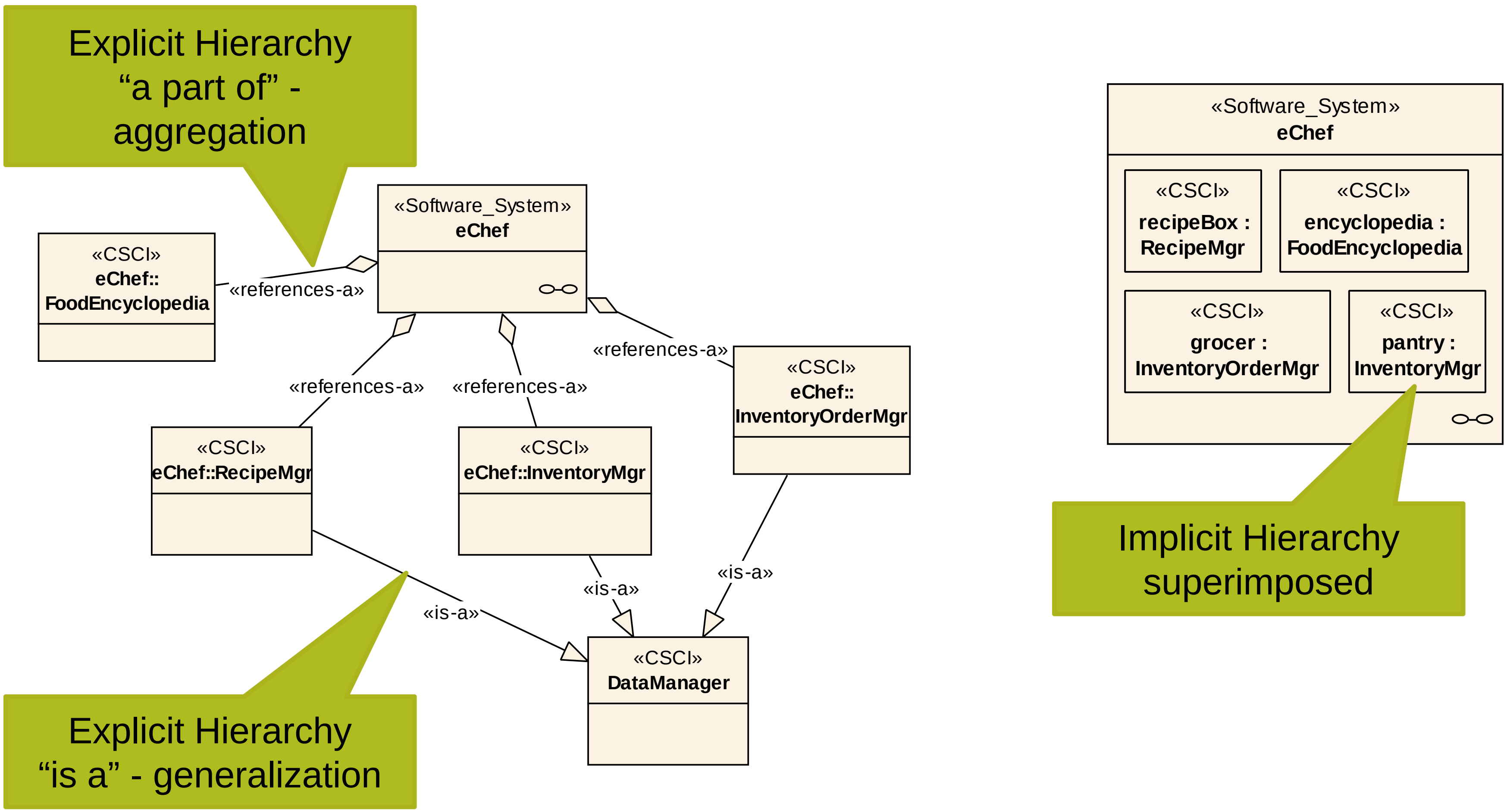
Transactional Perspective (Messaging)



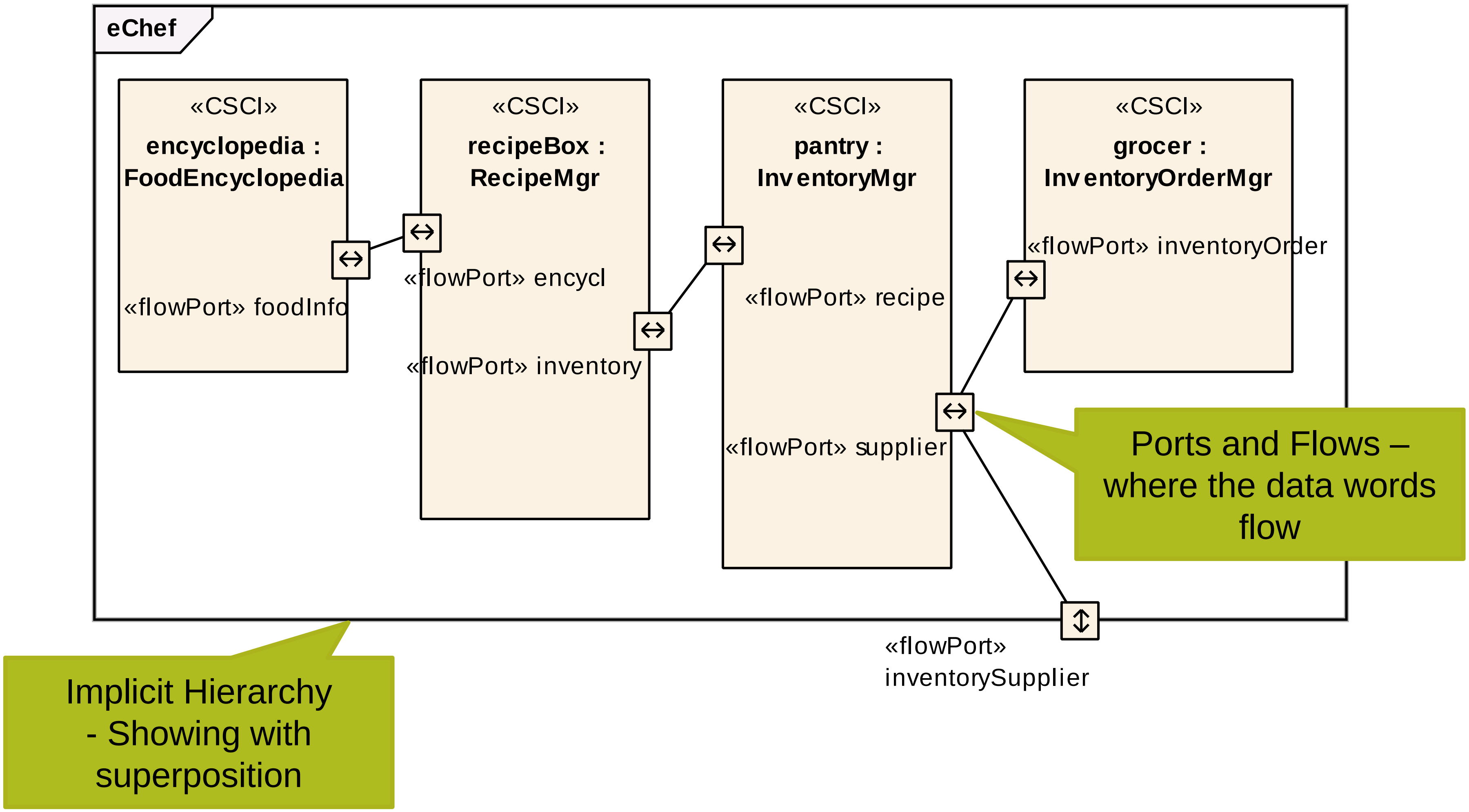
Allocation Perspective (from logical)



Software View – Hierarchical Perspective

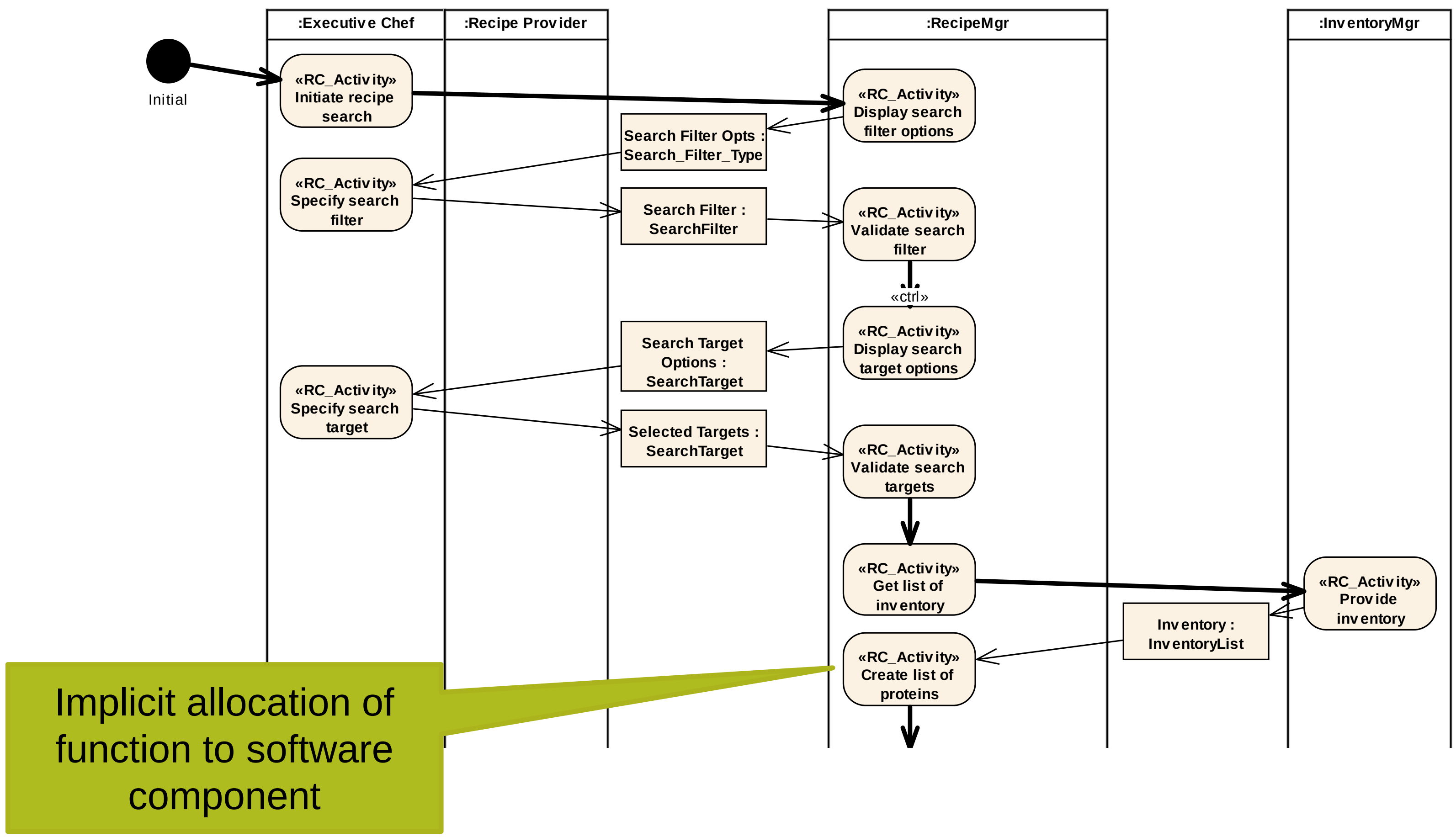


Software View – Transactional Perspective



Software View – Allocation Perspective

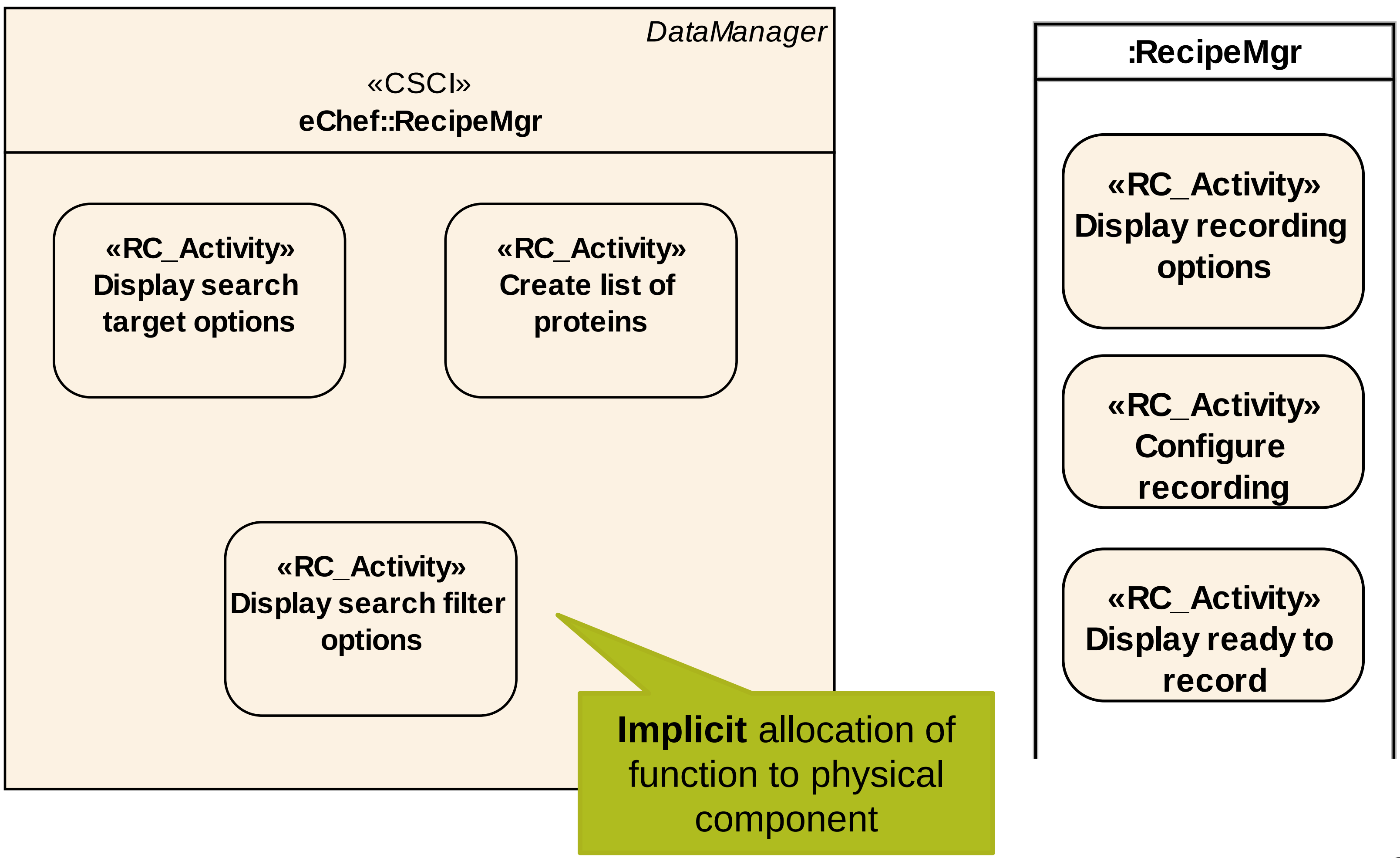
Logical Elements to Software Partitions



Functional View - Allocation Perspectives

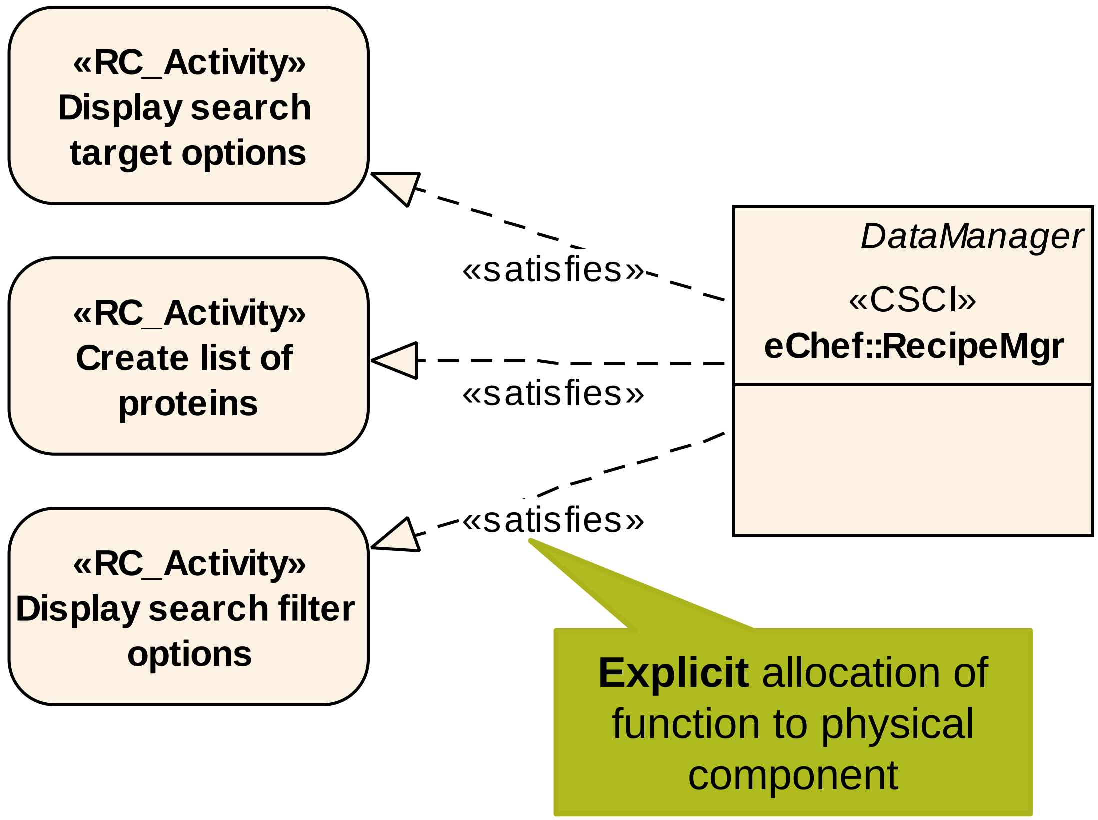
Activity Overlay on Physical Element

Activity in Partition/Swimlane

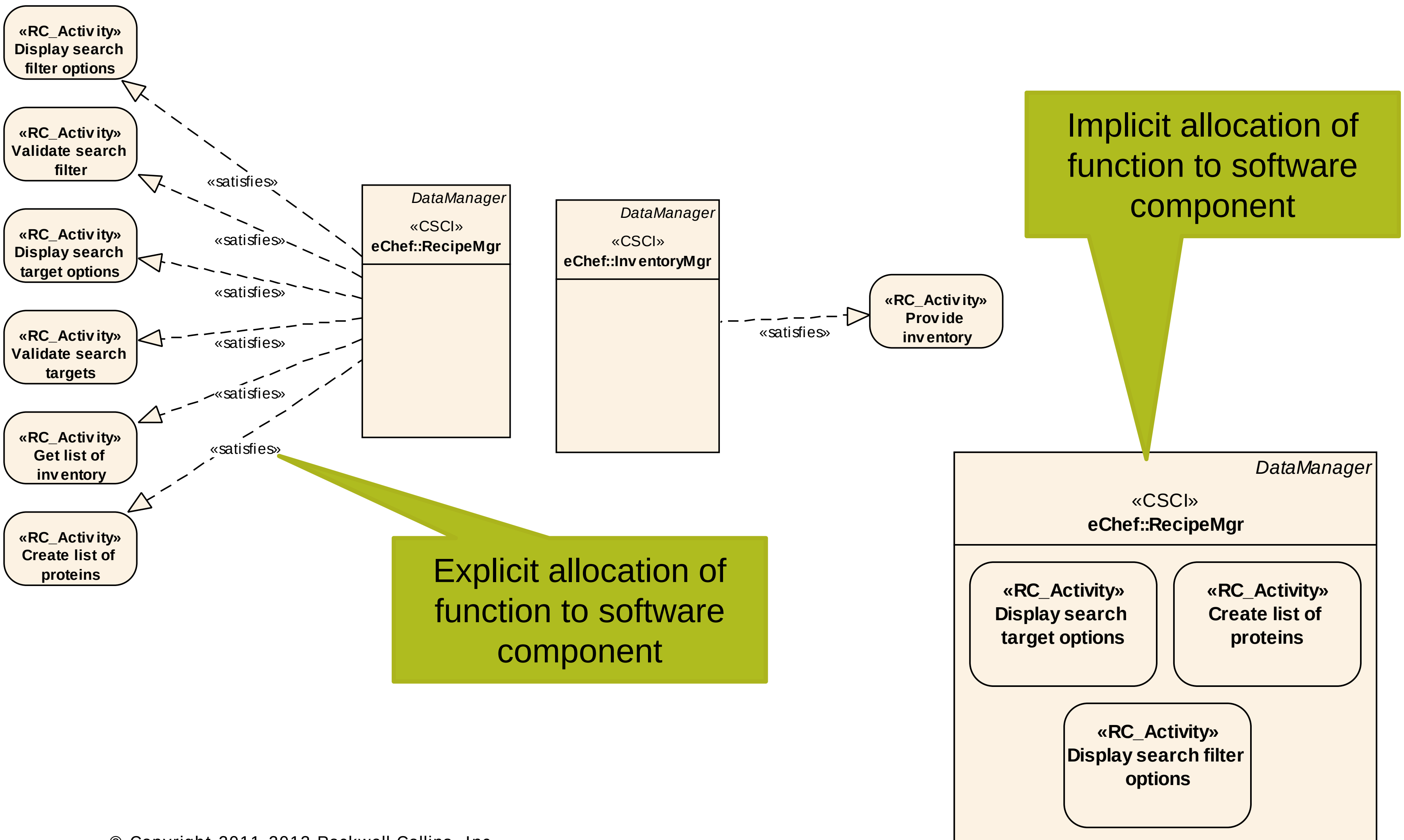


Functional View - Allocation Perspectives

Realization relationship between logical and physical elements

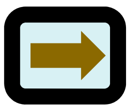


Software View – Allocation Perspective
Logical Elements to Software Elements

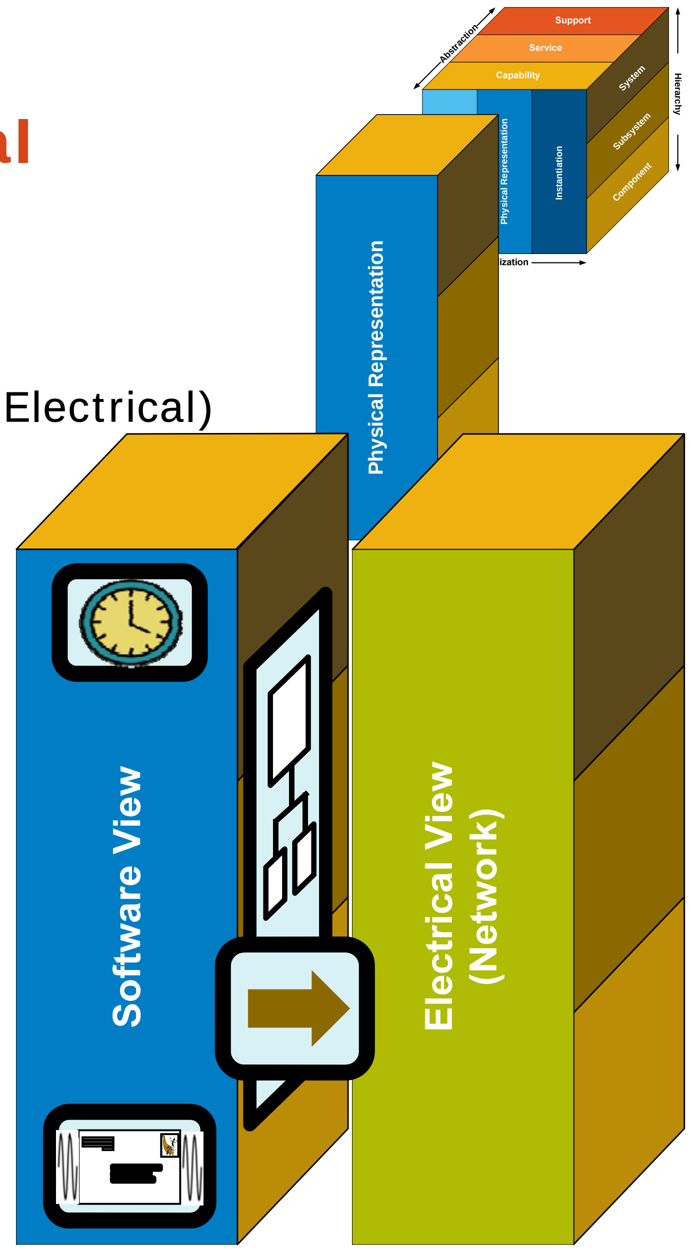


Software Allocation to Electrical

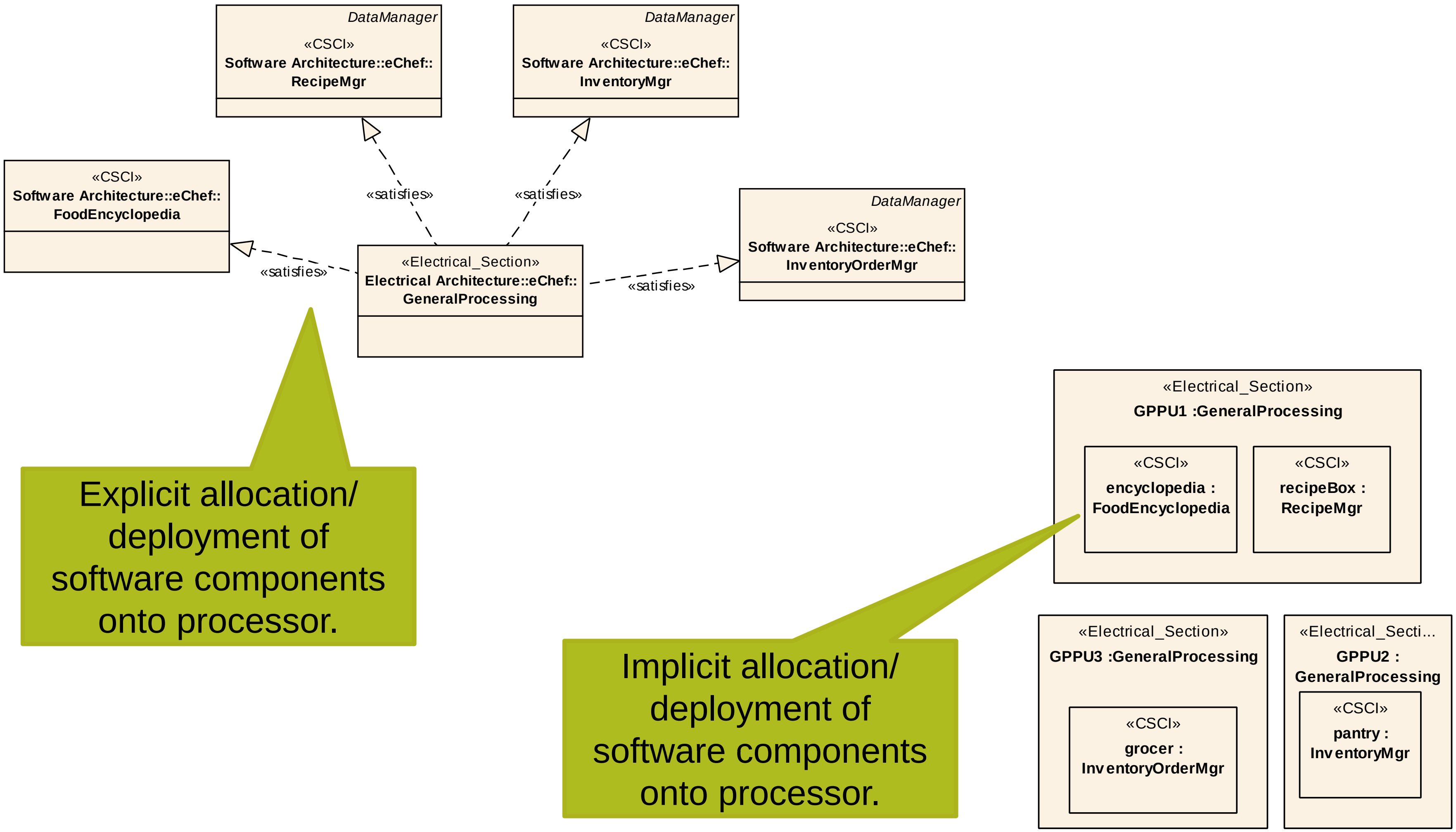
- Software View



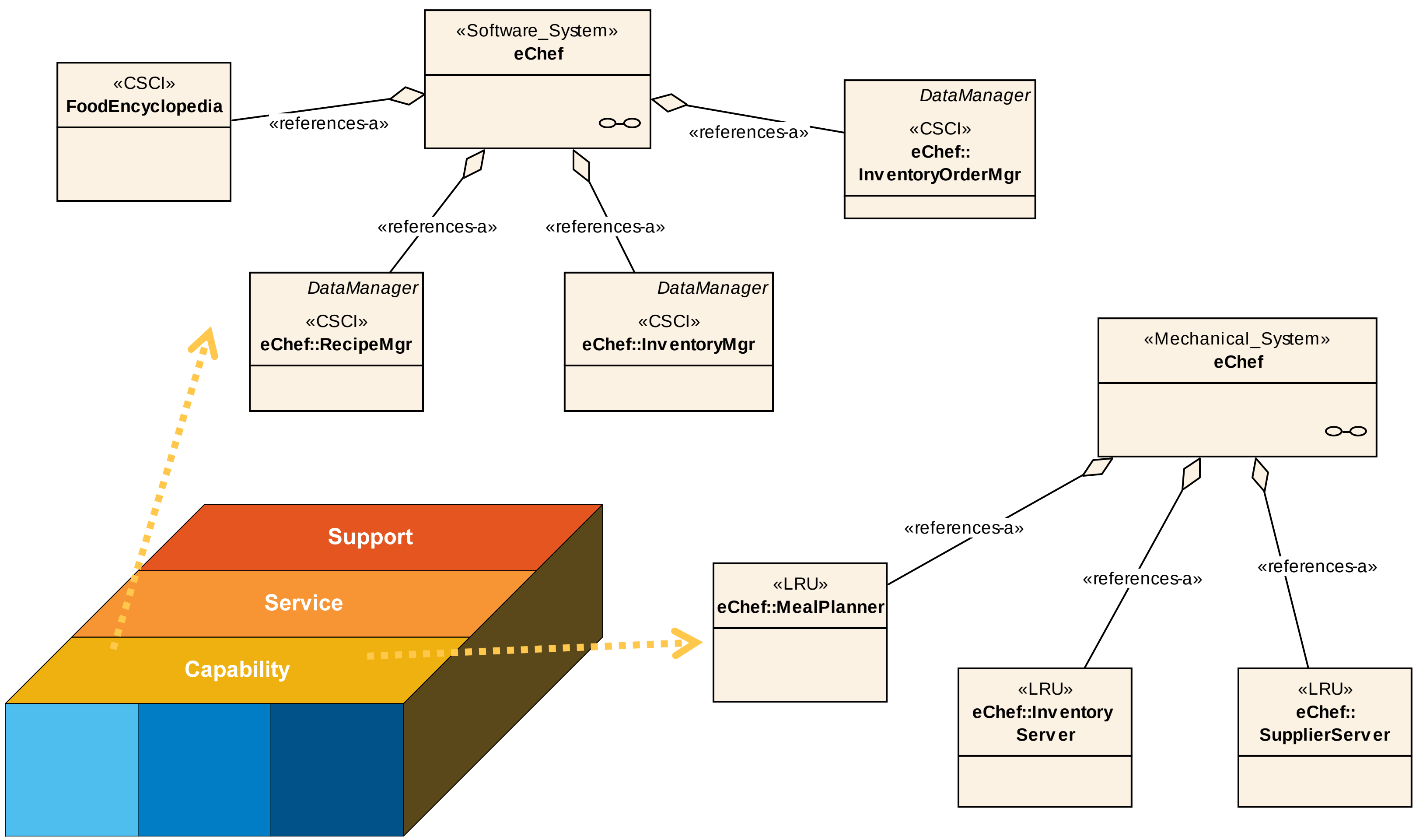
Allocation (or Deployment) Perspective (to Electrical)



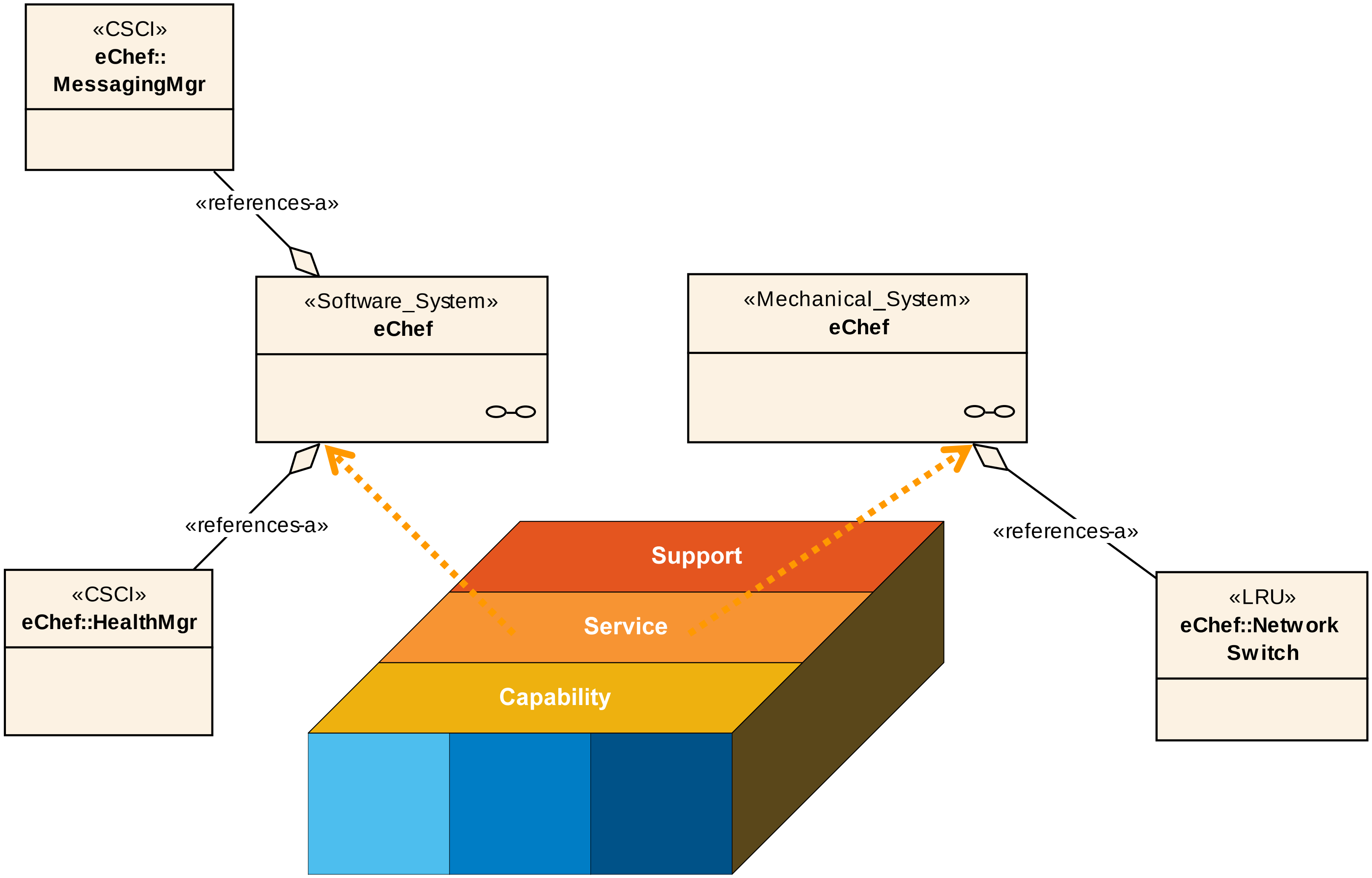
Software View –
Allocation (or Deployment) Perspective



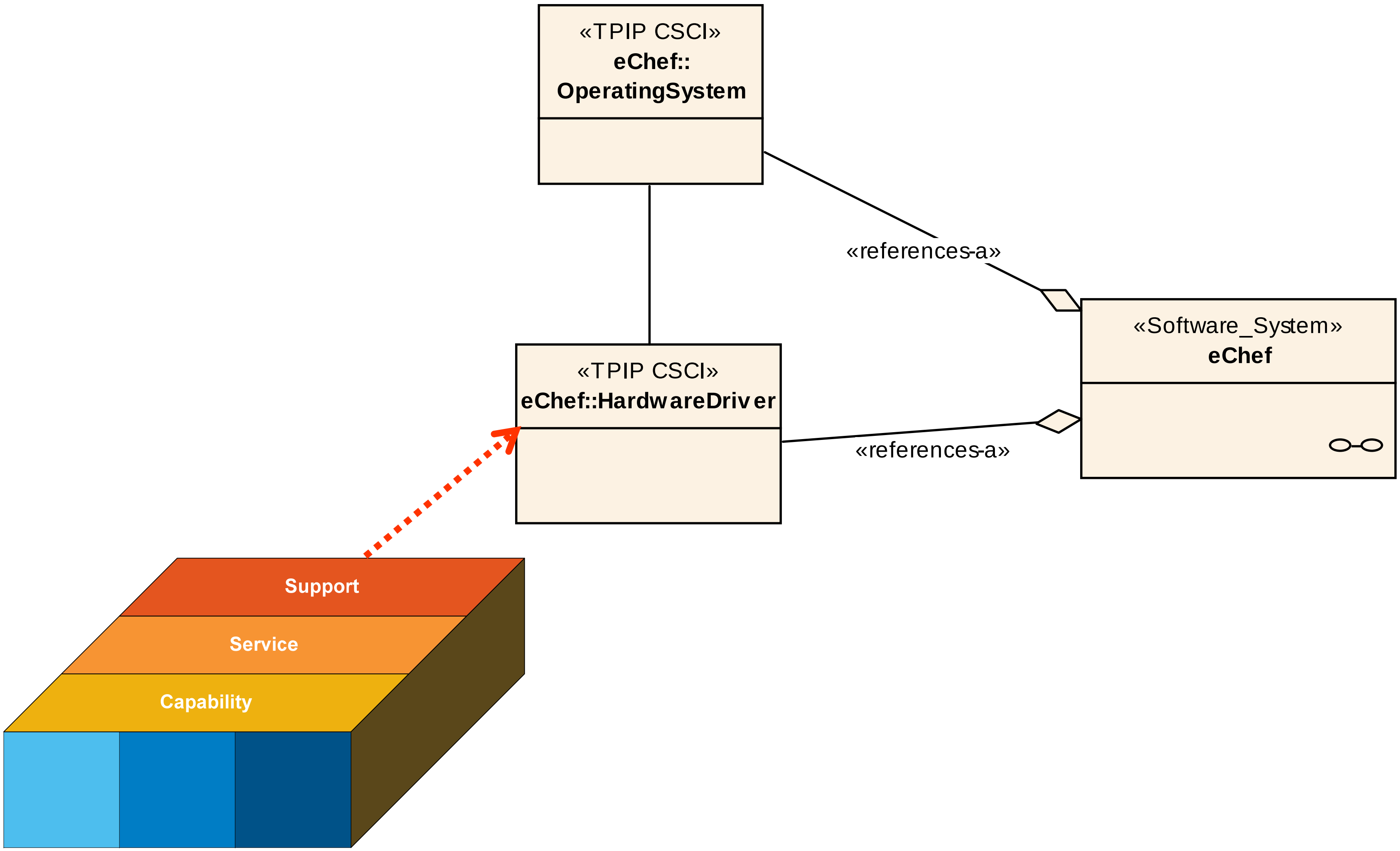
Abstraction Views - Capability



Abstraction Views – Service



Abstraction Views - Support



Summary

- Define system architecture
- Differentiate architectural design from detailed design
- Describe traditional approach to develop systems architecture
- Discuss potential issues with traditional approach
- Discuss alternative approaches to develop system architecture
- Define architectural views necessary to capture the design of complex systems
- Discuss layering of architectural views – software views
- Demonstrate how different layers of the architecture are mapped to one another

Conclusions

- Today's integrated modular solution architectures preclude a "top-down" only, traditional decomposition view
- The "software system" is a unique view that our complex systems must address
  – The interactions between software components has become one of the most complex facets of today's systems
- Four primary relationships to explore between objects
  – Hierarchical – composition, "kind of"
  – Transactional – information and object/material flows
  – Chronological – sequential/parallel timing
  – Allocation – aka deployment

Presenter Information

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