Systems Architecting for a Retrofittable Subsea System Application

BE FIRST

Transocean

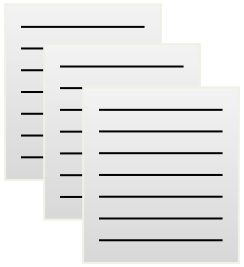
Presenters:
Jason Baker, Jason.Baker@deepwater.com
Patrick Ferraioli, Patrick.Ferraioli@deepwater.com

Overview

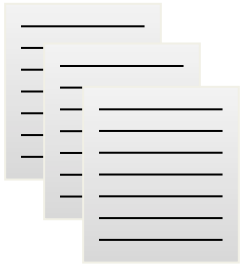
- Model Based Systems Engineering (MBSE)
- Systems Architecting
- Challenges with Offshore Operations
- Challenges with Architecting a New System
- Systems Architecting Approach with MBSE
  - Top-Down Process
  - Bottom-Up Process
- Conceptual Functional Architecture
- Conceptual Physical Architecture
- Key Findings

Model Based Systems Engineering (MBSE)

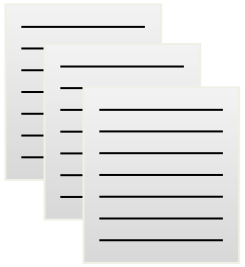
Industry Standards



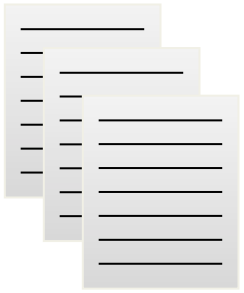
Regulations



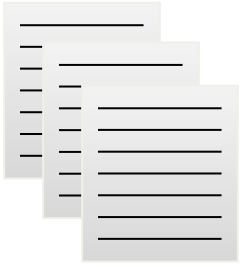
Company Standards



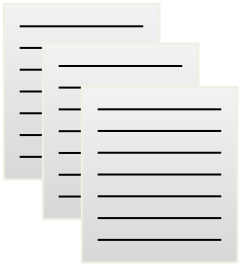
OEM Specifications



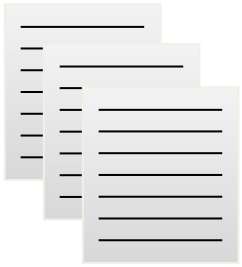
Functional Design Specifications



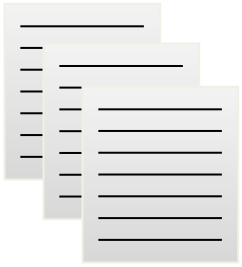
Stakeholder Needs



Operations

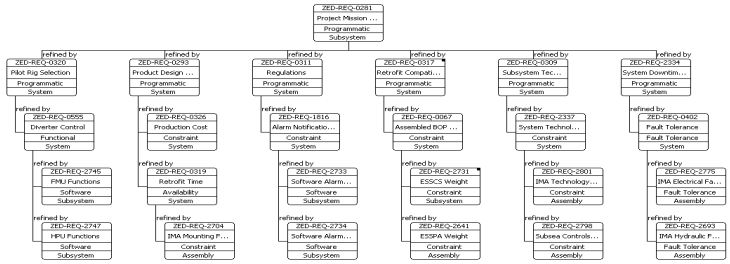


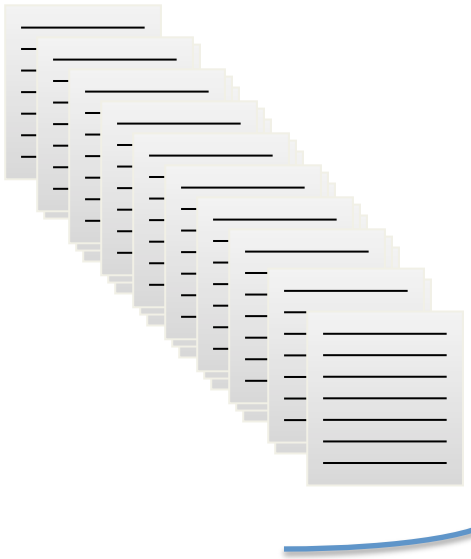
Tests/Records



Model Based Systems Engineering (MBSE)

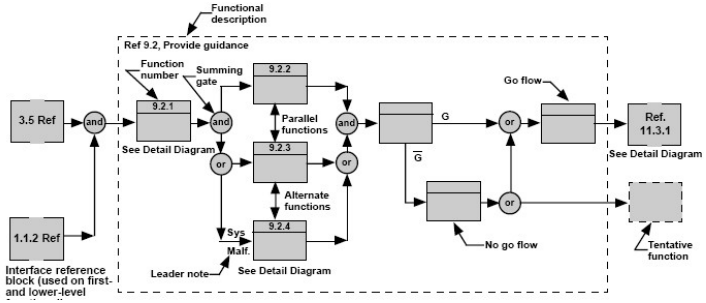
Requirements





System Model

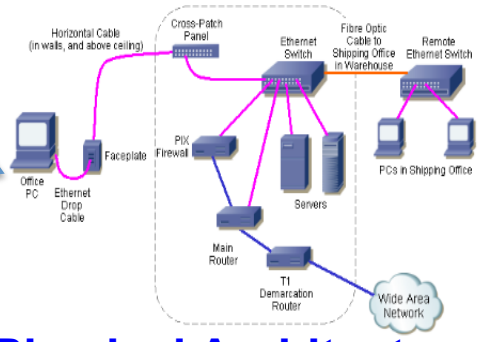
Functional Behavior



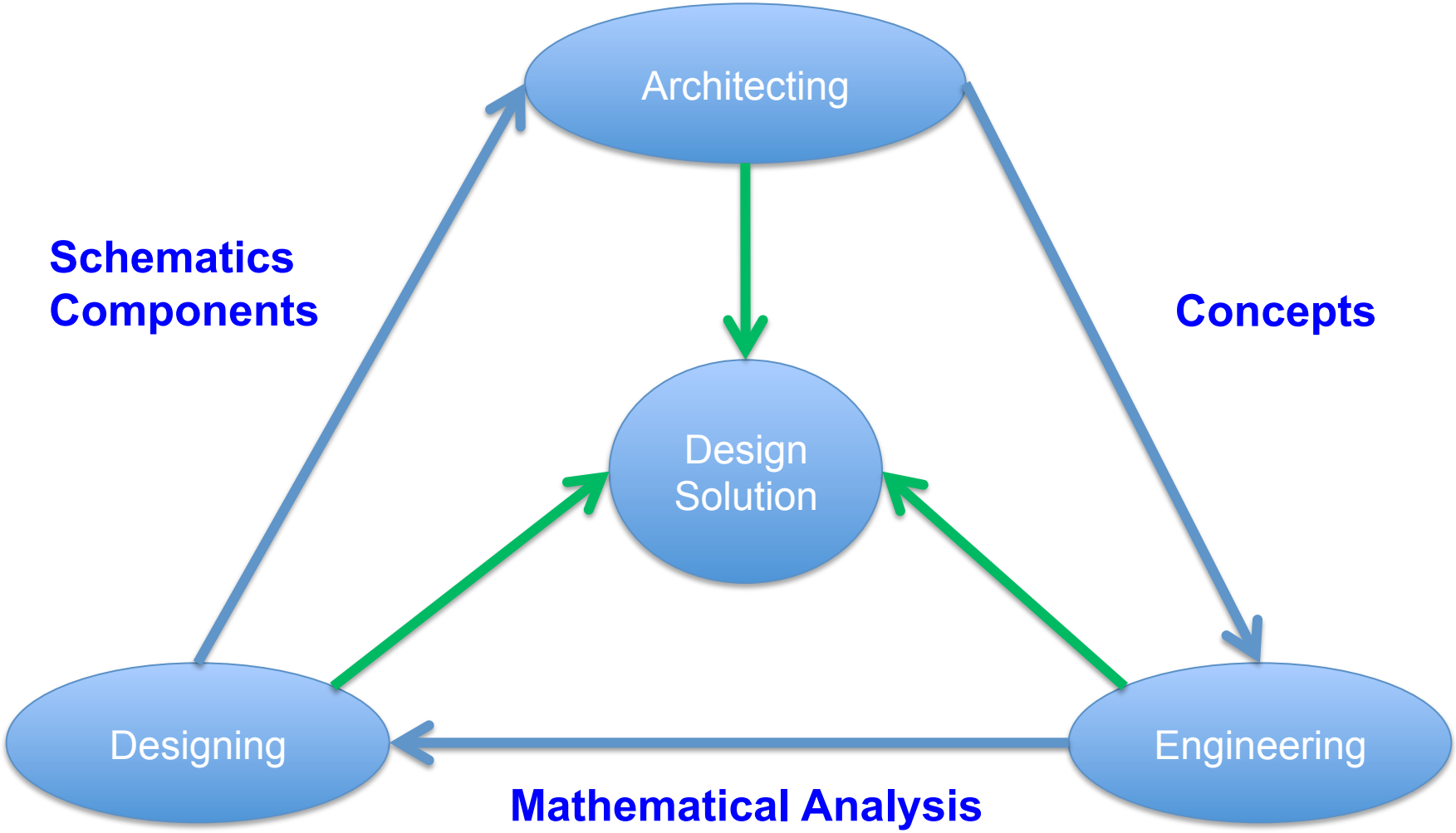
V&V

Requirement No. [a]	Document [b]	Paragraph [c]	Shall Statement [d]	Verification Success Criteria [e]	Verification Method [f]	Facility or Lab [g]	Phase [h]	Acceptance Requirement? [i]	Preflight Acceptance? [j]	Performing Organization [k]	Results [l]
P-1	xxx	3.2.1.1 Capability: Support Uplinked Data (LDR)	System X shall provide a max. ground-to-station uplink of…	1. System X locks to forward link at the min and max data rate tolerances 2. System X locks to the forward link at the min and max operating frequency tolerances	Test	xxx	5			xxx	TPS xxxx
P-i	xxx	Other paragraphs	Other "shalls" in PTRS	Other criteria	xxx	xxx	xxx			xxx	Memo xxx

Physical Architecture



Systems Architecting

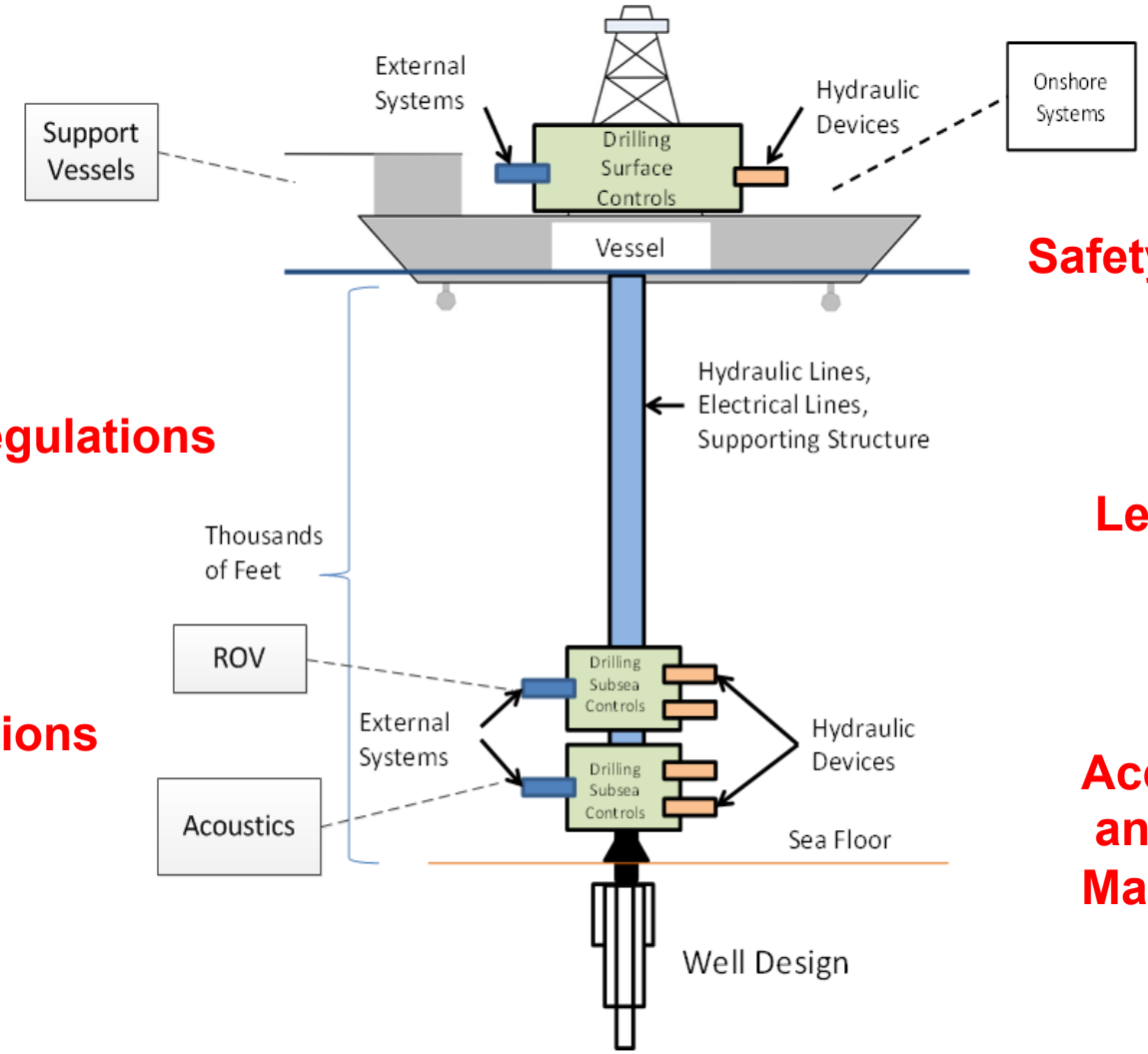


Offshore Operations Challenges

Complex SOS

Conflicting Regulations

Global Operations

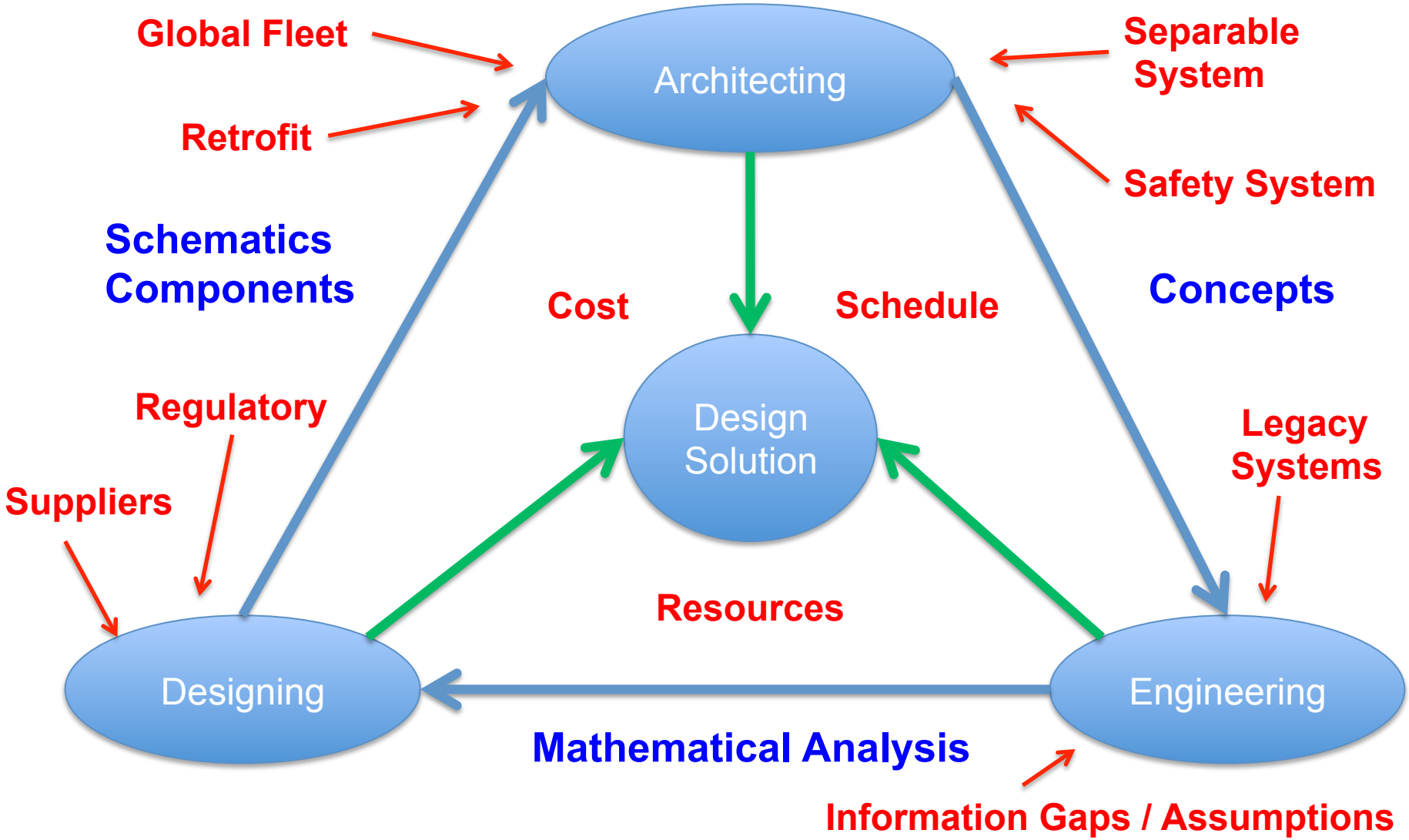


Safety and Efficiency

Legacy Systems

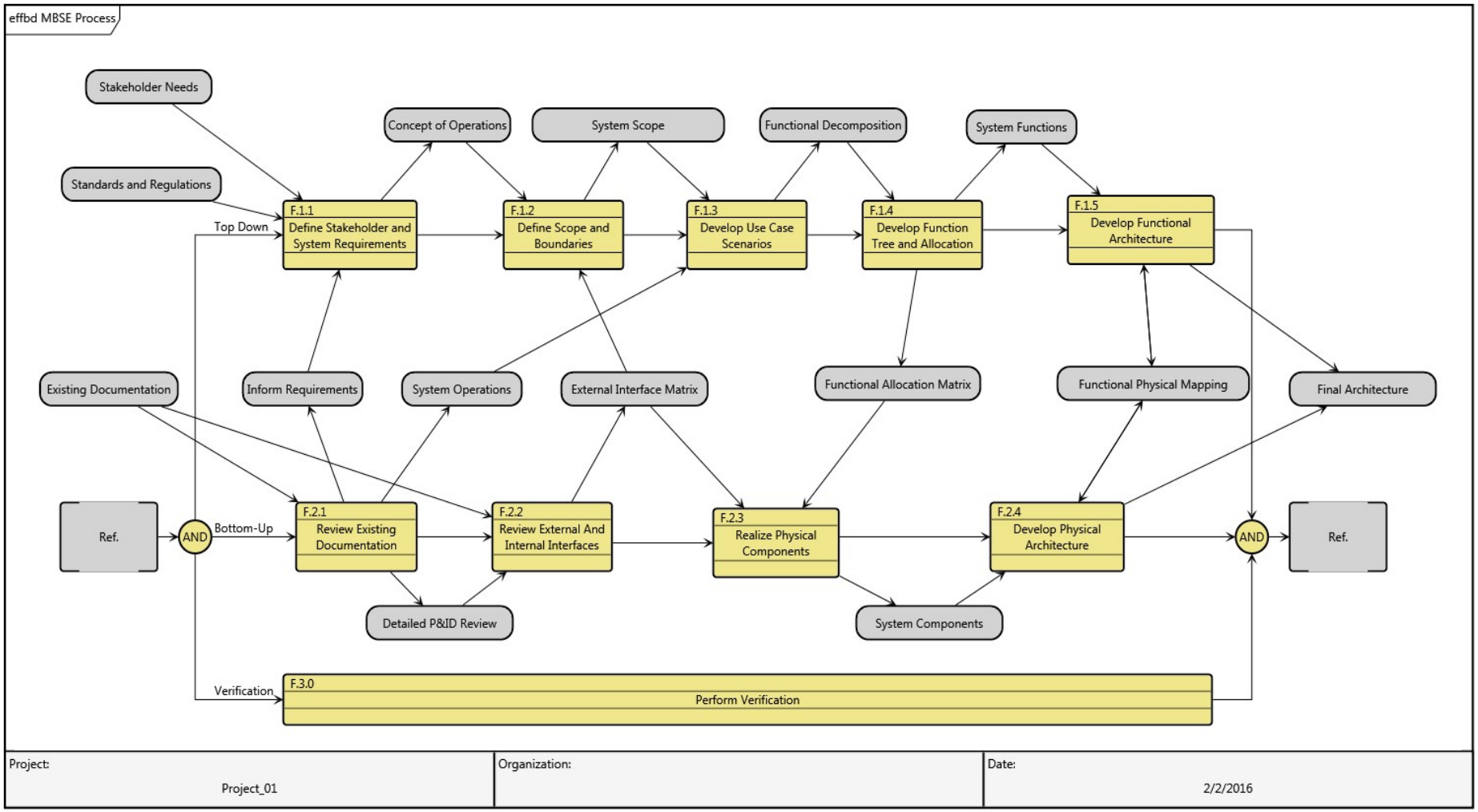
Accessibility and Maintainability

Challenges in Architecting an Offshore System



MBSE Approach

Top-Down and Bottom-up approach run in parallel each informing the other



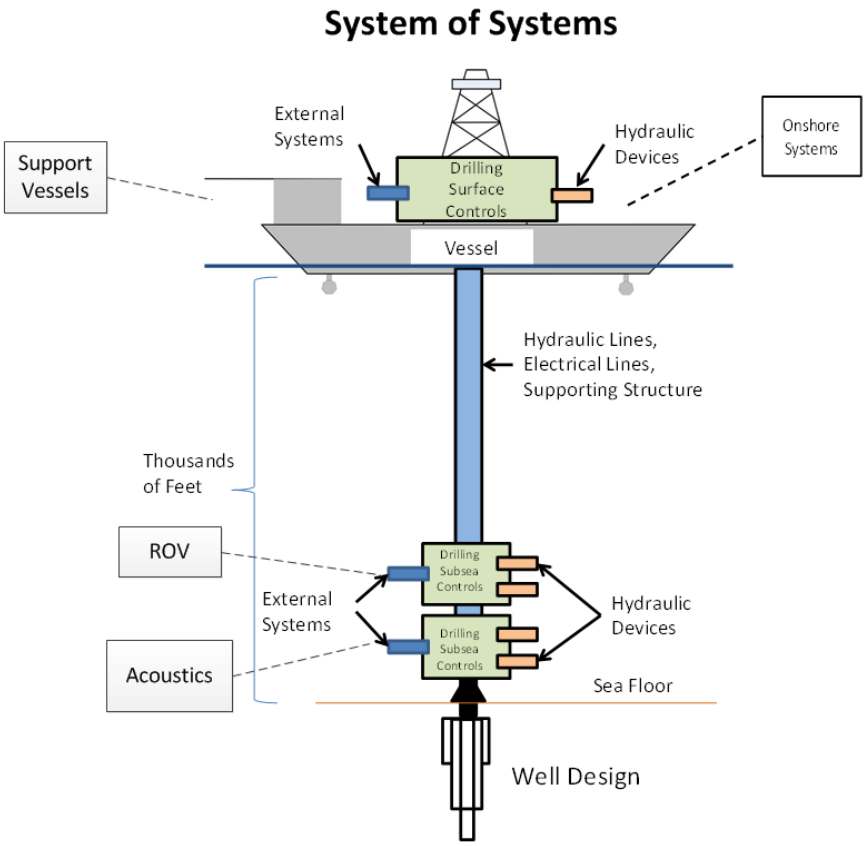
Top-Down Process

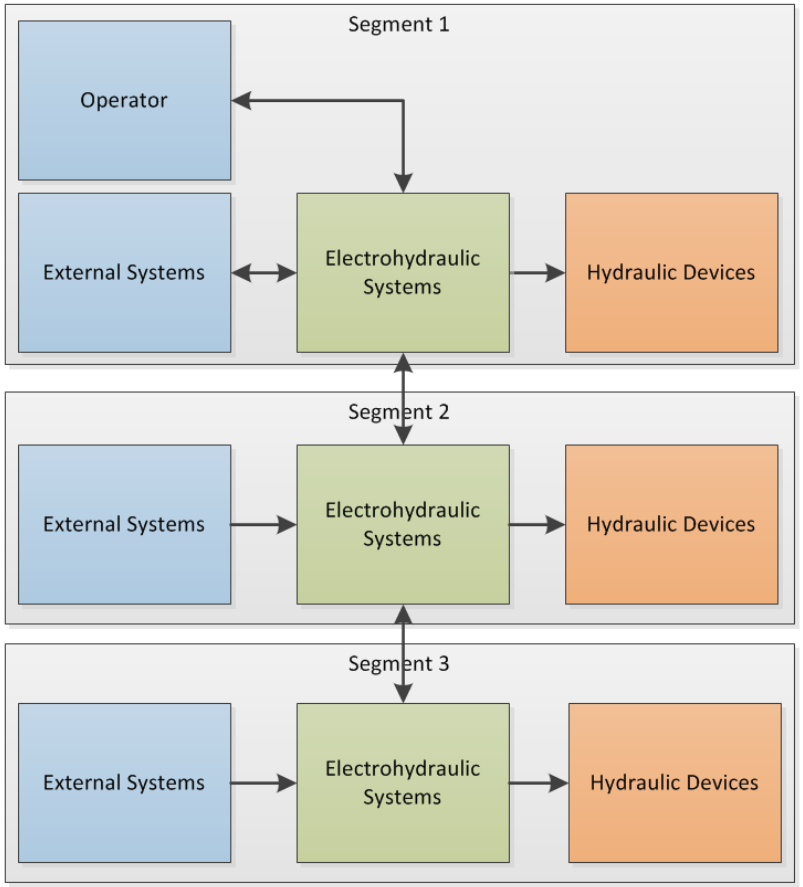
1. Define Stakeholder And System Requirements
   - An Order Of Magnitude Higher In Safety, Reliability And Availability Compared To Existing Systems
   - Retrofittability
   - Regulatory Compliance Or Prove Equivalence, If Applicable
   - Maximize Reuse Of Legacy Equipment
   - Efficient Maintenance, Servicing And Logistics

Top-Down Process

2. Define System Scope and Boundaries

- System of Systems
- System Segments Identified

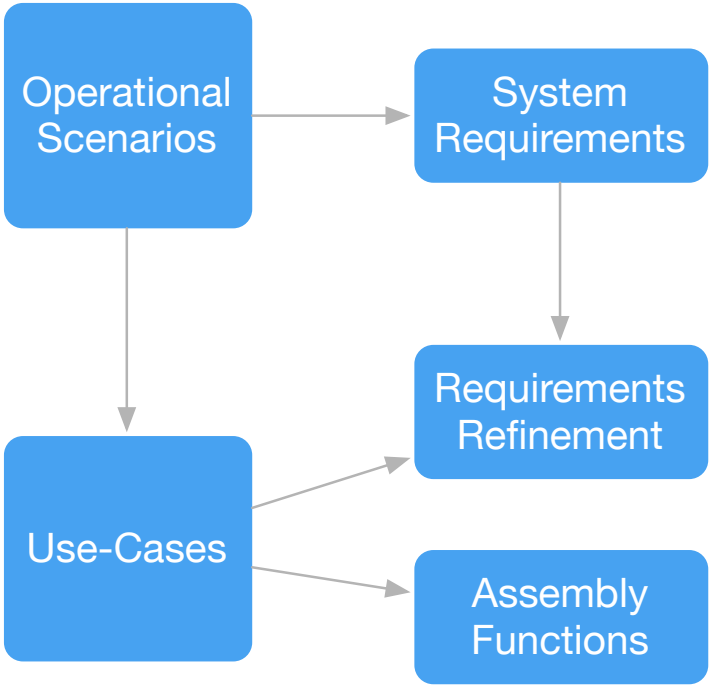




Top-Down Process

3. System Functional Defintion: Phase 1

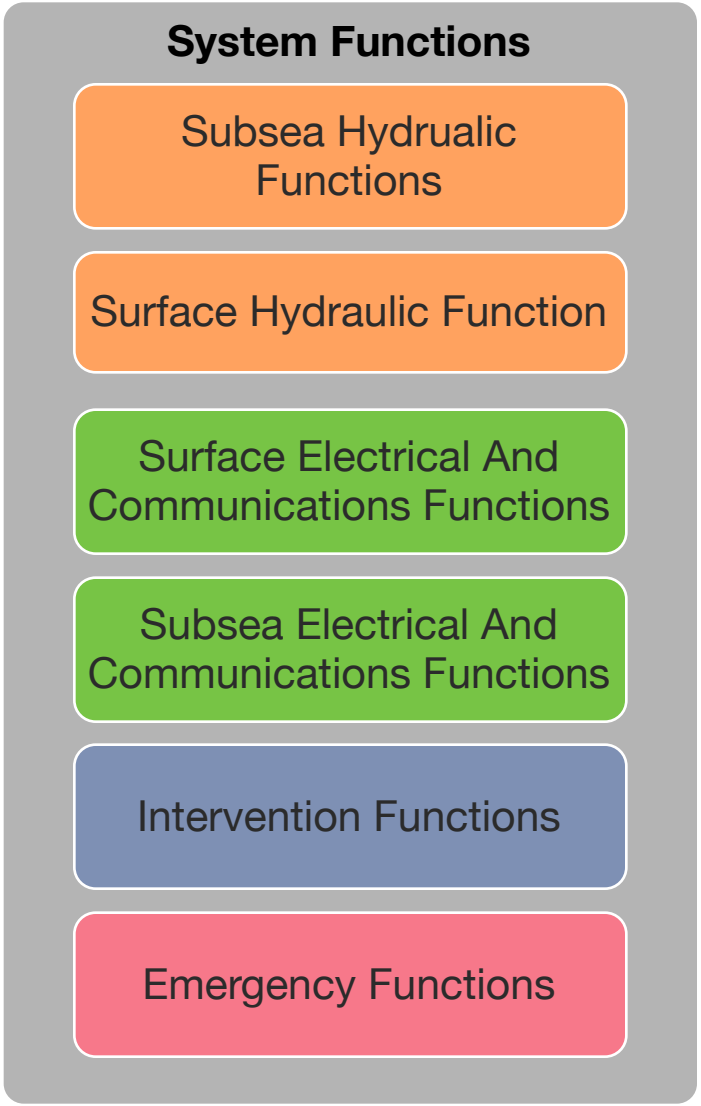
- Step 1: Operational Scenarios
  - List Derived From: Stakeholder Requirements, System External Interfaces, Legacy Operations Documentation and Data
- Step 2: Use Cases
  - Use-case developed for each scenario
  - External Actors Identified at each step followed by a System Response
- Step 3: System Requirements Refinement and Functional Architecture
  - Each Operational Scenario is captured as a System Requirement
  - Each system response is captured as a requirement refined from the scenario derived System Requirement
  - System Responses are defined as System Functions in the System Functional Architecture



Top-Down Process

Develop Function Groupings and Subsystem Allocation

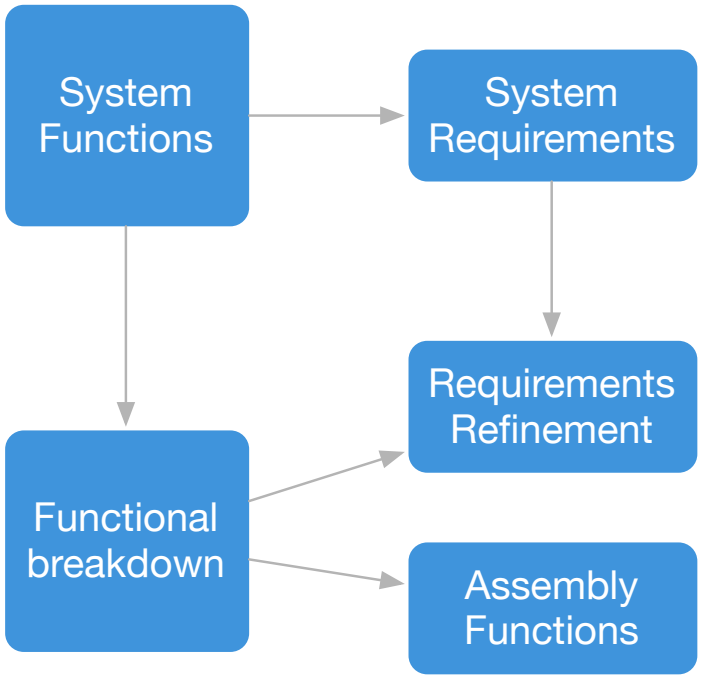
- Using Functions Identified from the Use-cases a System Function groupings Can be Developed
- Functions grouped by Like-Characteristics inform a Subsystem breakdown of the System



Top Down Process

System Functional Defintion: Phase 2

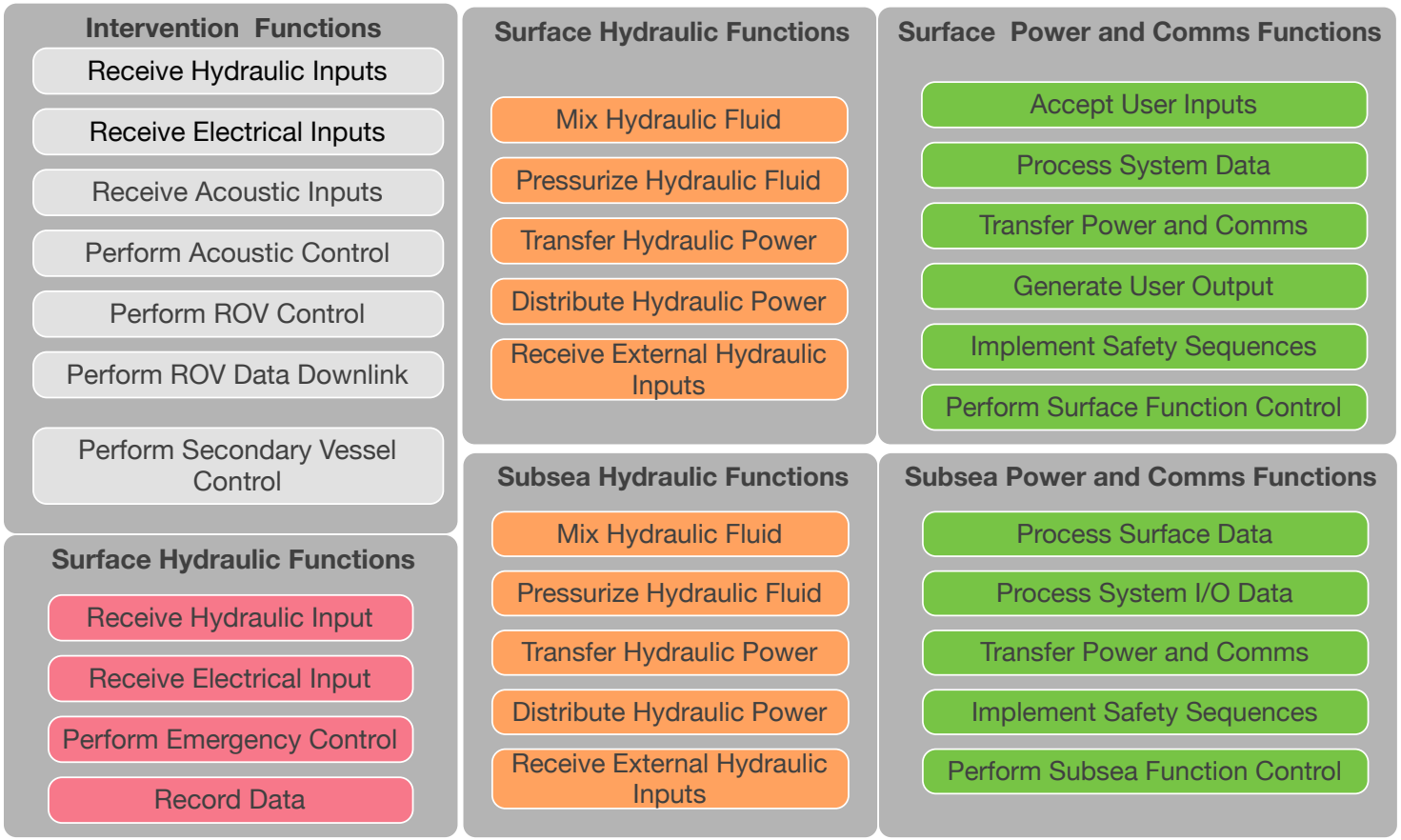
- Step 1: Detailed Design Functional Breakdown
  - Each System Function Broken into sub-functions
- Step 2: Use Cases
  - Use-case developed for each System Function
  - External Actors Identified at step followed by a decomposed functional breakdown with internal system actors identified at each step
- Step 3: System Requirements Refinement and Functional Architecture
  - Each step in the functional breakdown is captured as a lower level requirement which refines a requirement from phase 1
  - Each step of the functional breakdown is also captured as a function decomposing the system function.



Top-Down Process

4. Develop Function Groupings and Assembly Allocation

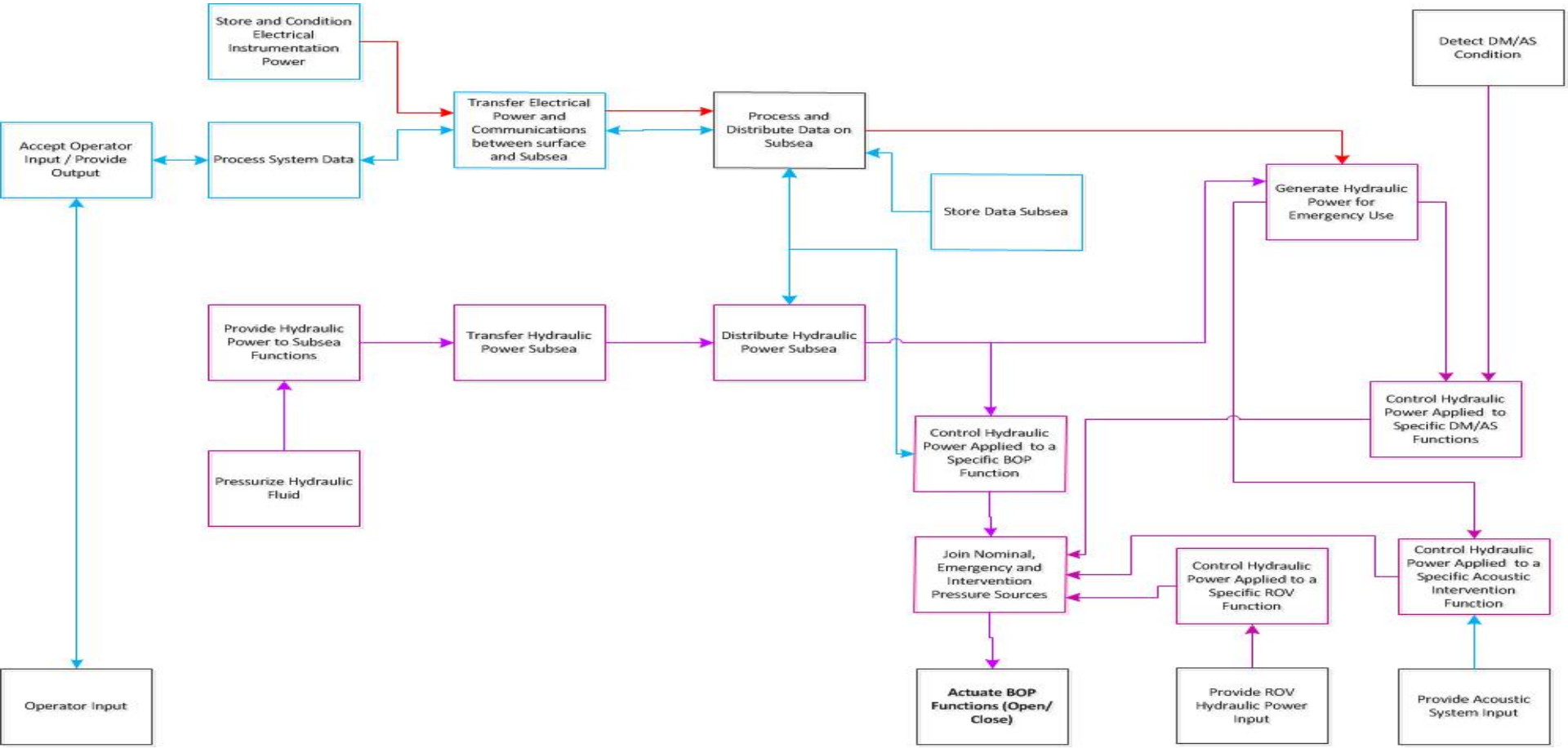
- Using Functions Identified from the functional breakdown a System Function Tree Can be Developed
- Functions grouped by Like-Characteristics inform an Assembly breakdown of the System



Top-Down Process

Integrated System Function Tree with Allocations

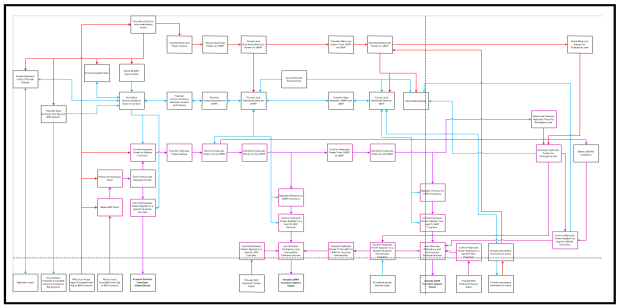
– Using these Functions Identified from the Use-cases and Function breakdown a function tree can be developed



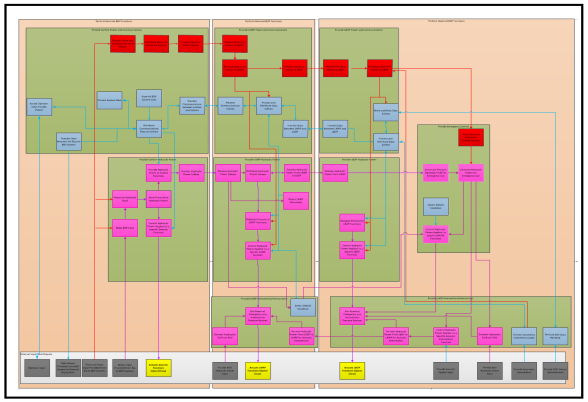
Top-Down Process

5. Develop Functional Architecture

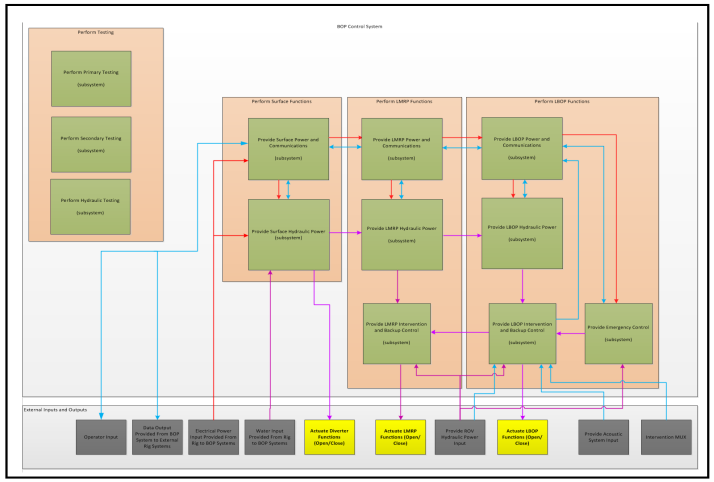
Step 1. Integrated System Functional Threads



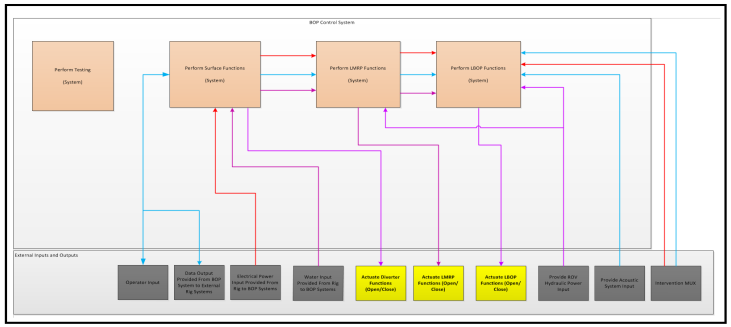
Step 2. Composed at Functional Unit Level of Abstraction



Step 3. Composed at Subsystem Level of Abstraction



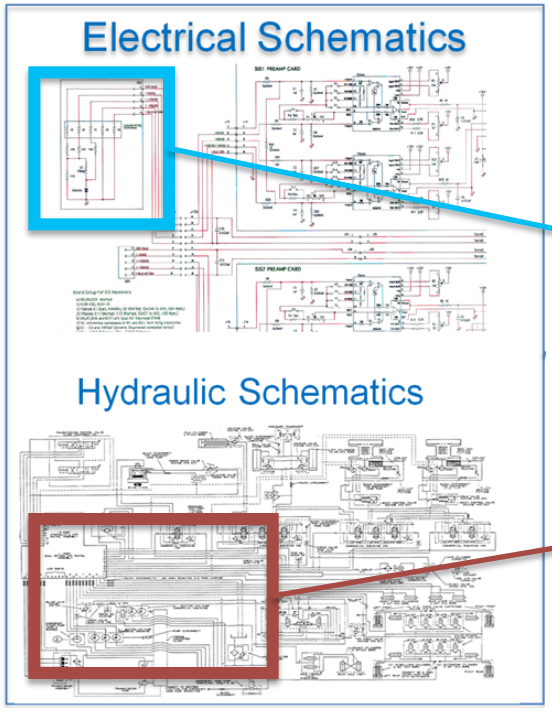
Step 4. Composed at Segment Level of Abstraction



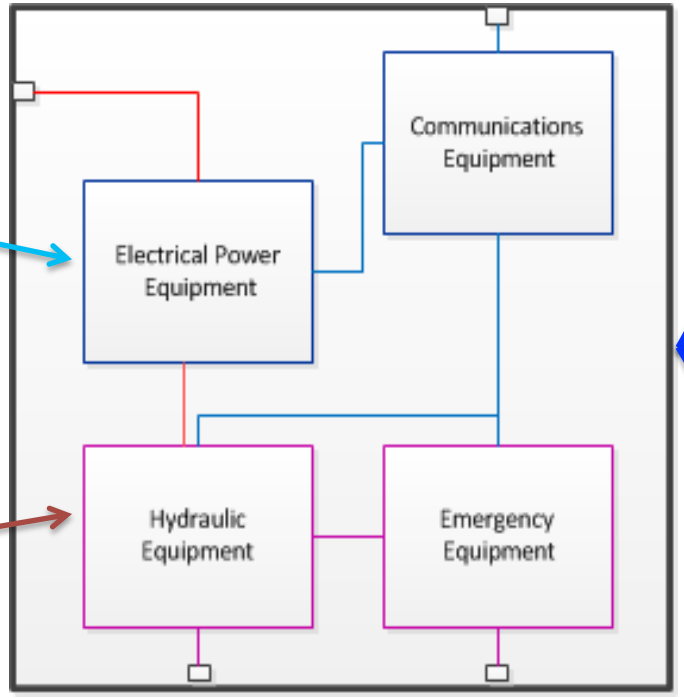
Bottom-Up Approach

1. Review Existing System Documentation
2. Review Component Internal and External Interfaces

Existing Documentation



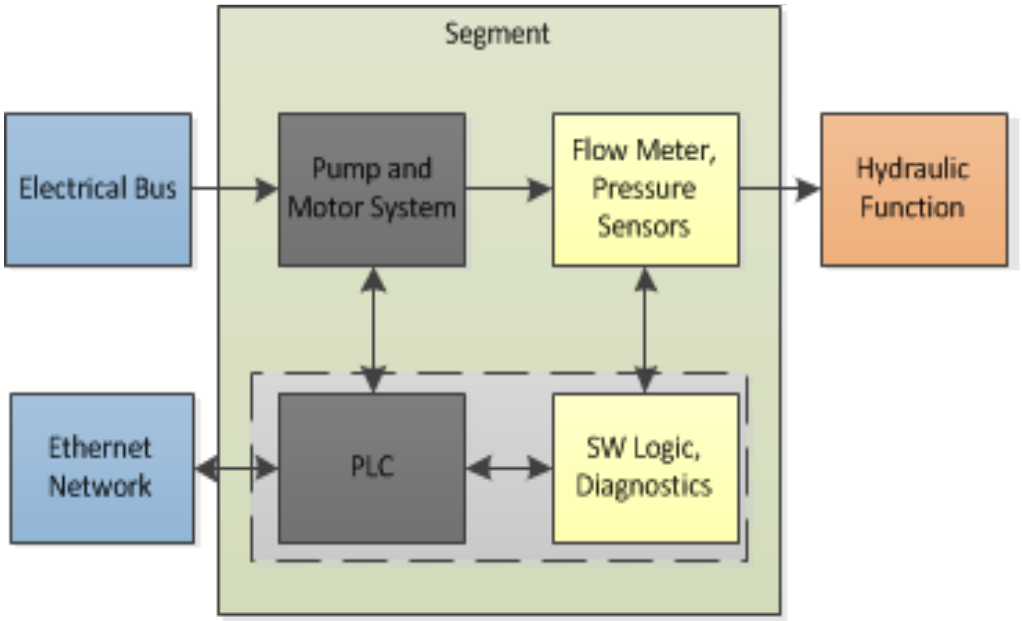
Internal Block Diagrams



- **Requirements**
- **Functionality**
- **Interfaces**
- **Physical Constraints**

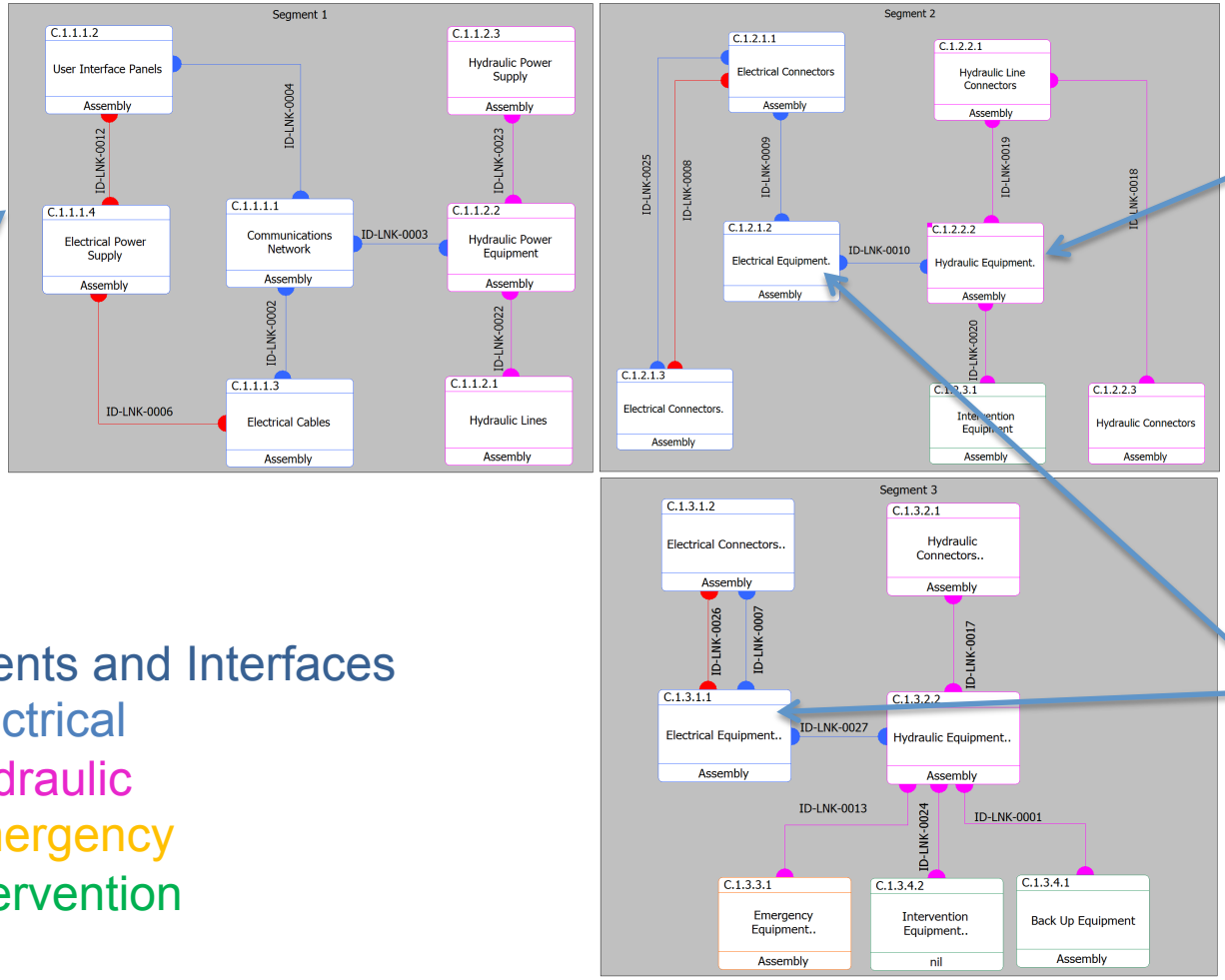
Bottom-Up Approach

3. Realize Physical Components
   - New Equipment
   - Reused Equipment
   - Removed Equipment
   - Software Modification Only



Bottom-Up Approach

4. Develop Physical Architecture



Segment Level

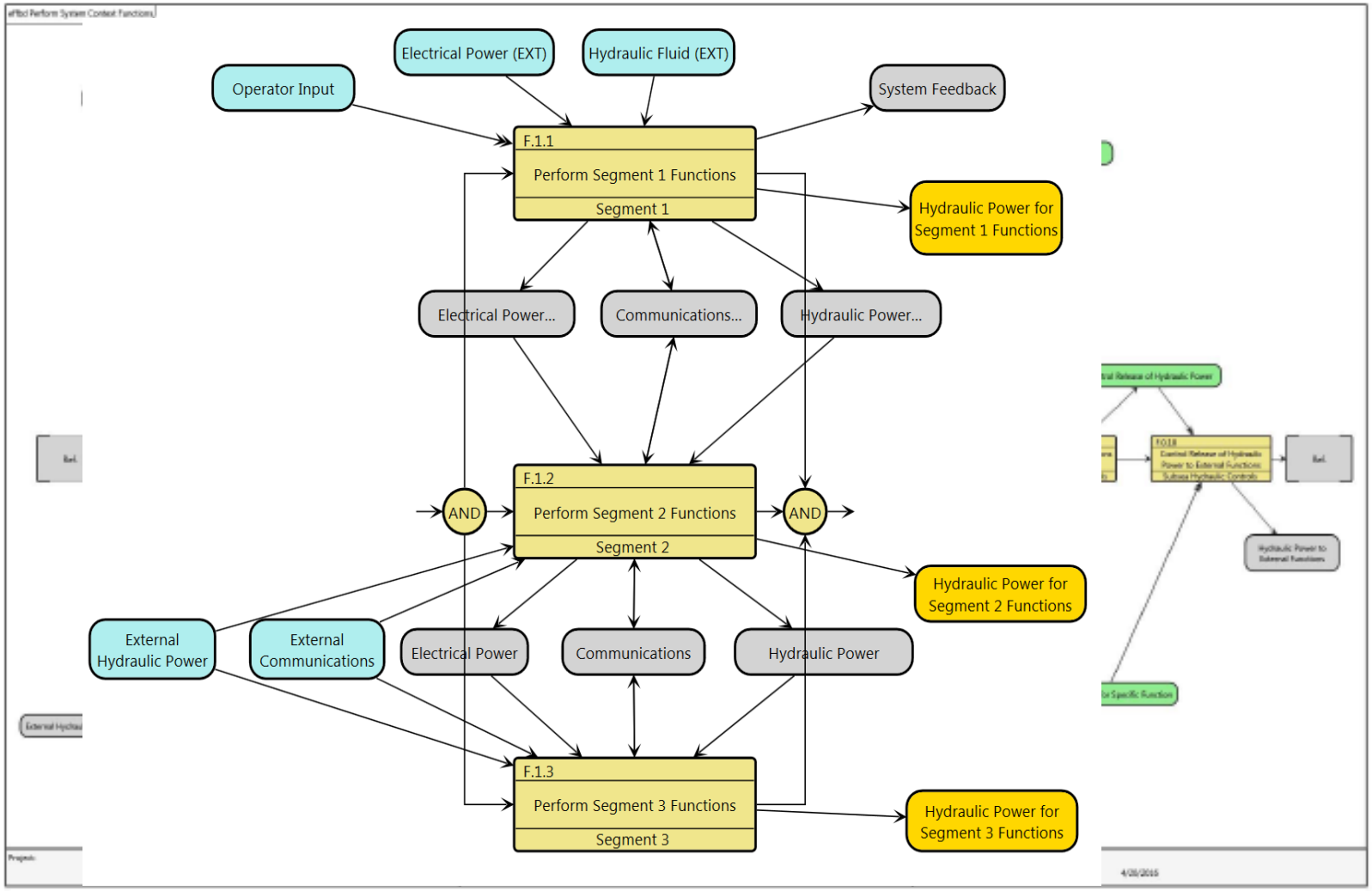
Assembly Level

Replicated Components

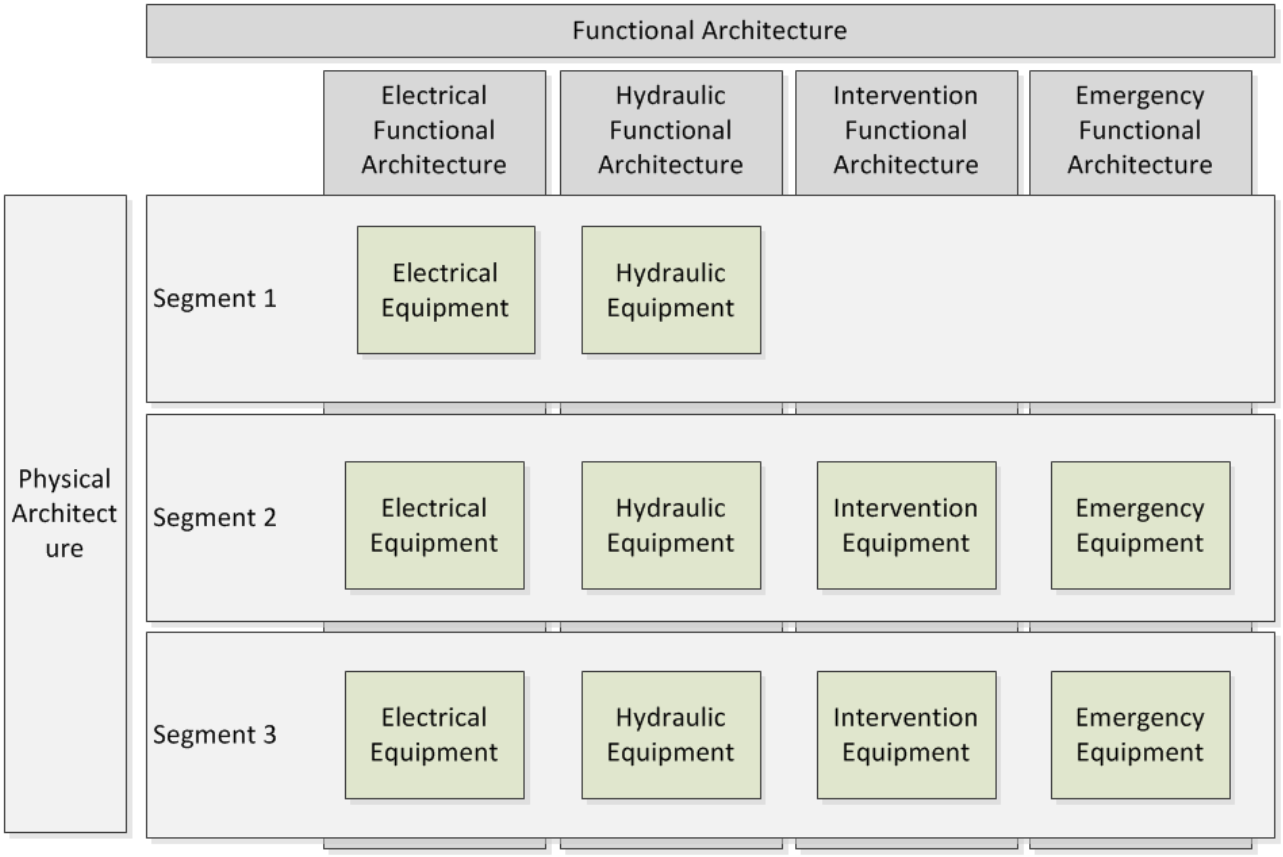
Components and Interfaces

- Electrical
- Hydraulic
- Emergency
- Intervention

Conceptual Functional Architecture



Conceptual Physical and Functional Architecture Mapping



Key Findings

- Top Down Bottom Up approach was necessary to address new stakeholder requirements as well as leverage the existing equipment.
- Performing the system functional threading, integration and composition process was necessary to characterize the complete functionality of the system and identified interacting and overlapping functions.
- A separable system is a unique type of system with complex modes of operations
- Retrofit application requires an explicit definition of equipment for reuse versus new equipment for retrofit.

Systems Architecting for a Retrofittable Subsea System Application

BE FIRST

Transocean

Presenters:
Jason Baker, Jason.Baker@deepwater.com
Patrick Ferraioli, Patrick.Ferraioli@deepwater.com