Project Management by Functional Capability

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Introduction

- How many of your companies:
  - Manage projects?
    - What size ($, # people)?
    - What technical scope (new development, modification, maintenance)?
    - What domain?
  - Use a size estimation method?
  - Follow a “CMMI” Project Management process?
- How do you define your projects?
  - At what level of management is your Project Management process applied?
  - How do you aggregate projects?
- How many are in “Product Line” organizations?
  - How does this affect your Project Management process?
  - How is the wbs applied?

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Goals of this Presentation

- To introduce Functional Capabilities (FCs) as a mechanism for managing work in a complex product development environment
  - An efficient way to communicate anticipated functionality to the user, the developer, and other stakeholders
  - A structure of discrete artifacts and flows that define product development lifecycle activities
    - logical design
    - system analysis, design and implementation, and integration
    - testing
  - A scheme for planning, tasking, and tracking work
  - An effective generator of artifacts for CMMI
- To share experiences gained from initial deployment of this project management process

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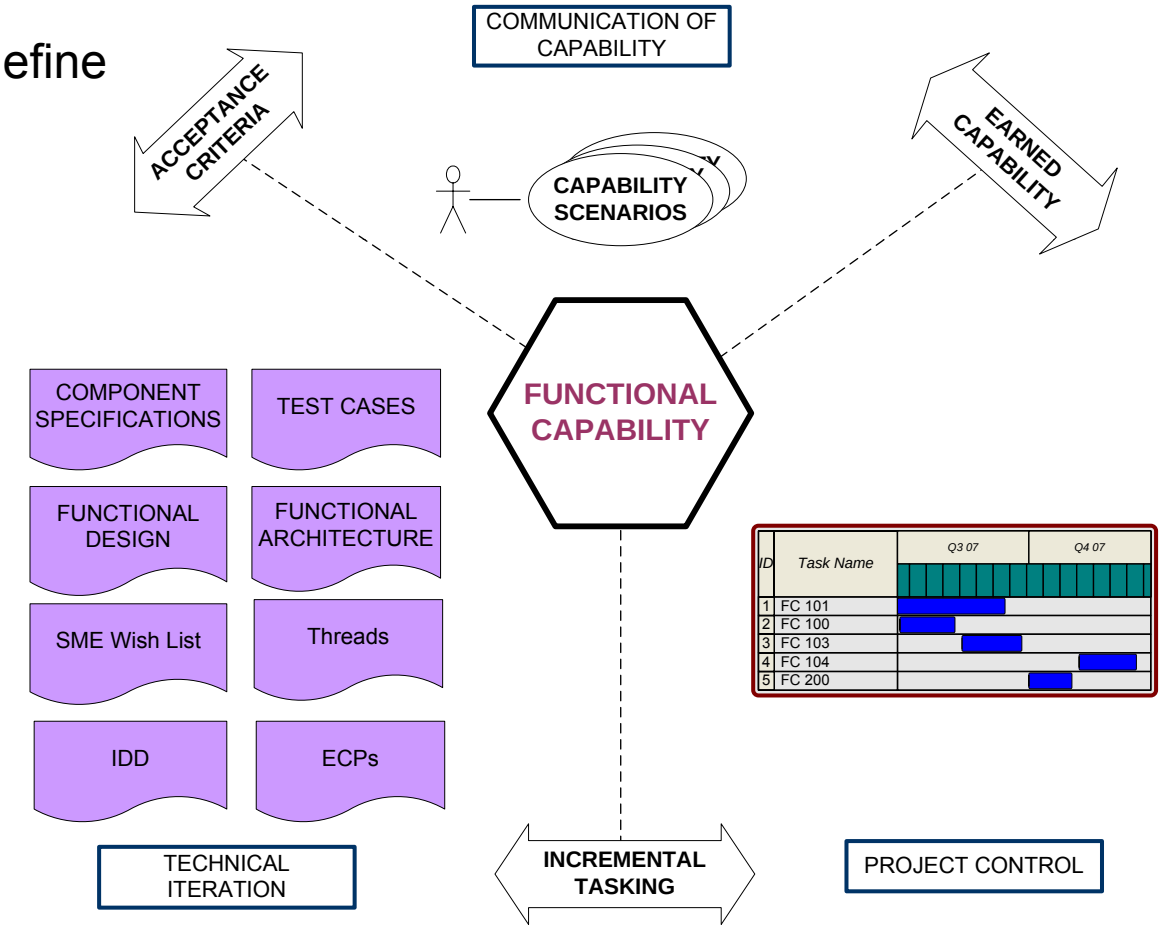
Functional Capability – Context

- Consider your *Program* to be a large amount of *functionality,* expressed as *capabilities*
- *Functional* decomposition will define increments of work to be accomplished, resulting in incremental *capability*
- We are proposing *functional capabilities* as a project management scheme to help deliver:
  - the right product
  - delivered on time and within budget



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Agenda

- Problem Statement
- SIAP
- Program Performance
- Functional Capability Overview
- Functional Capability Elaboration
- CMMI Mapping
- Summary

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Problem Statement

- Product developers routinely fail to execute their projects
  - GAO Report 05/301, 2005
  - Defense Acquisition Performance Assessment, 2006
- How do acquirers (or sponsors) gain insight into their project's performance?
  - Does developer CMMI ML significantly affect project performance? If not, why not?
- How do contractors know they are producing what their customer wants?
- Do we need a different project context for Systems of Systems (SoS)?
  - CMU/SEI-2006-TR-017, Systems of Systems: "Scaling Up the Development Process"

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Problem: Communication of Capability

- Capability must be expressed in user terms... What they want
  - Joint Capabilities Integration and Development System (JCIDS) is not sufficient
  - systems engineers need more expressive methods for requirements capture and development
- What they will get
  - “System” specifications (to drive developers) that users can relate directly to capabilities
- And how they know they are getting it
  - Earned value expressed in terms of capability, i.e., “earned capability”
    - performance-based earned value
    - assessment of functionality bow wave

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Problem: SoS Development Practices

- SoS: Collaborating systems developed by collaborating system acquisition teams
  - highly autonomous systems and teams
- Process challenges in:
  - organizational ownership, responsibilities, and technical team interactions
  - systems:
    - boundary definition
    - legacy systems and continuous technology evolution
    - continuous capability evolution
  - project definition, measurement, and reporting mechanisms
  - project execution processes
- Practical process methods are needed

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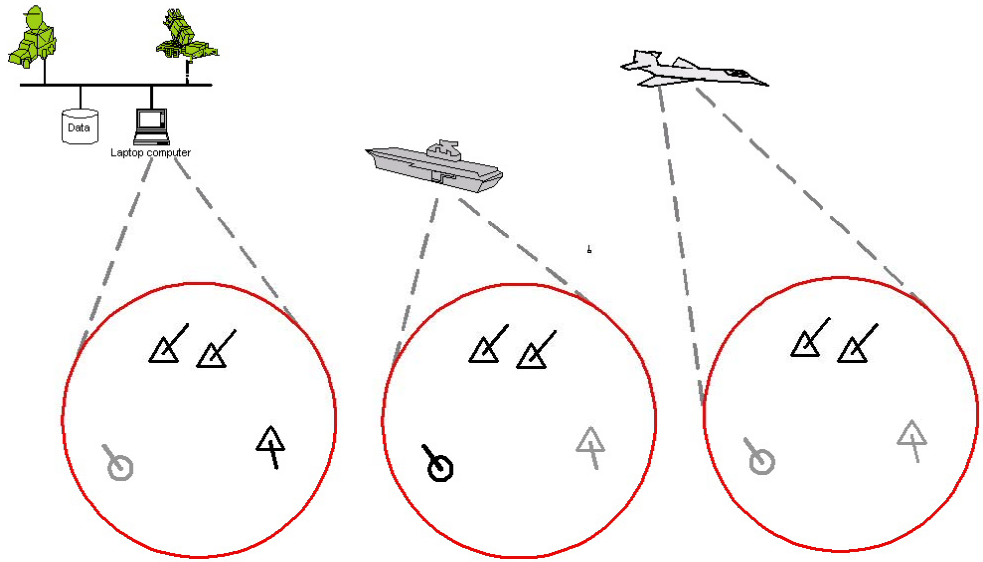
Background: Single Integrated Air Picture

- Functional Capabilities (FCs) developed from experiences in SIAP
  - SIAP is a Software Intensive System
  - FCs should apply to SoS in general



- SIAP Capability
  - **user viewpoint:** common, correct, complete, continuous, timely track situation presentation
  - **system viewpoint:** state of data consistency among distributed, replicated data stores, for objects of peer interest

DISCLAIMER: This presentation makes no statement concerning current SIAP engineering practices.

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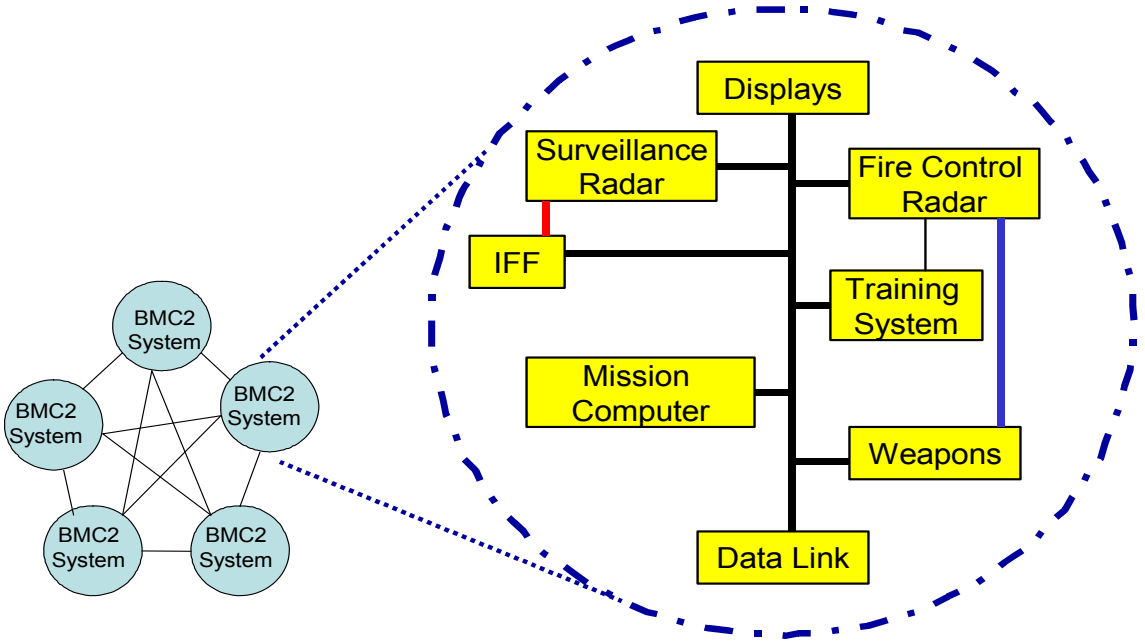
SIAP – Capability Material Challenge

- SIAP requires interactions of networked peers, each an operational node hosting multiple integrated systems
- Network connections are weak, with ad hoc, dynamic configurations



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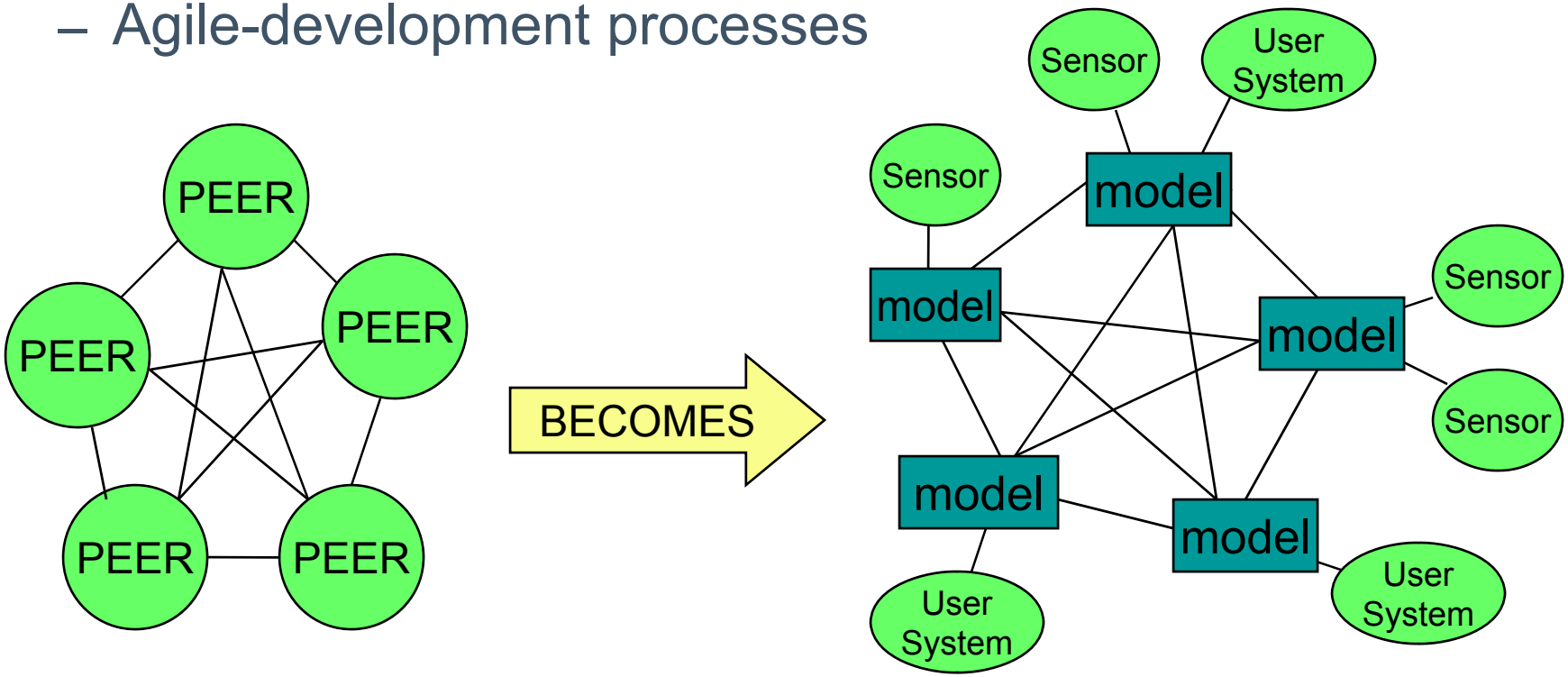
SIAP – Capability Material Solution

- Executable Object Model transformable to code, with core required functionality
- Agile-development processes



Unpredictable Heterogeneous Set of Systems

Predictable, Logically Homogeneous Federation

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The Value of Capability

- Functional Capabilities express *functional* requirements
  - manageable abstraction level for SoS
  - meaningful to user and developer
- An FC identifies a value-chain
  - tangible artifacts
  - framework for measuring program process performance
- An FC represents value that can be earned against a planned-performance baseline
  - an example of Performance-Based Earned Value®

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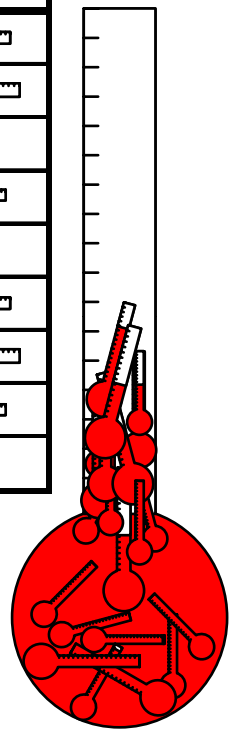
Functional Capability – Earned Capability (Value)

FC #	Description	# Req	# Use Cases	# Scenarios	# IPT Affected	Pol. Vis.	Total	Status
FC 1		5	3	1	1	Hot	26	
FC 2		49	8	3	3	Hot Hot	88	
FC 2.1		18	2	2	1	Hot	24	
FC 2.2		22	4	1	1	Hot Hot	34	
FC 2.3		9	2	3	2	Medium	14	
FC 3		13	6	2	2	Medium	39	
FC 4		45	9	4	3	Hot	81	
FC 4.1		33	6	2	2	Hot	46	
FC 4.2		12	3	2	1	Medium	22	

- Establish relative size measures for each capability
- Establish dependencies between capability projects
- Establish the approved list of capability (or value)
- Release work as appropriate and accrue “value” against the project capability “baseline” at Management reviews
- Measure project lifecycle task duration and effort to refine estimation process and establish project historical parametric data
- Capability can be “re-scoped”, but deviations from the baseline are easily recognizable as the “bow-wave” of functionality



Capabil-o-meter

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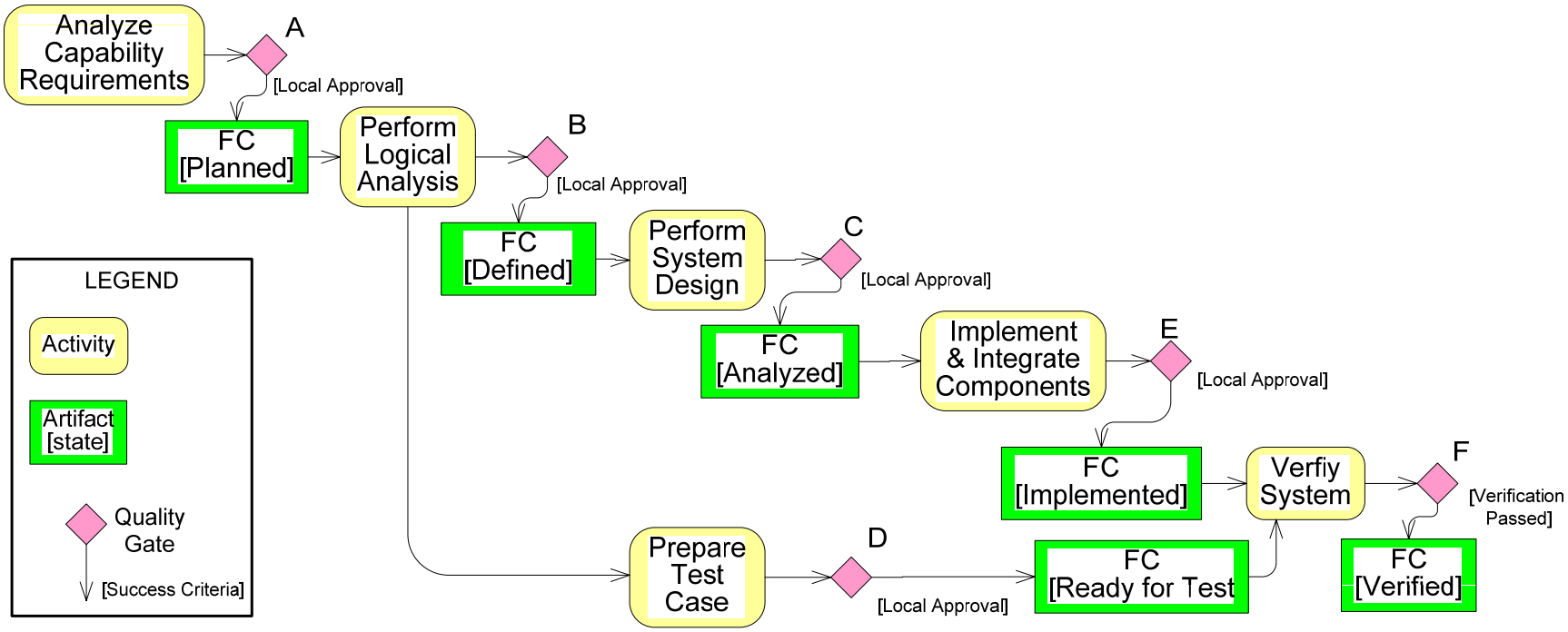
Functional Capability Life Cycle

- Each FC advances through lifecycle phases, representing states of completion, defined by artifacts
- Artifacts are reviewed at Quality gates, providing evidence of value



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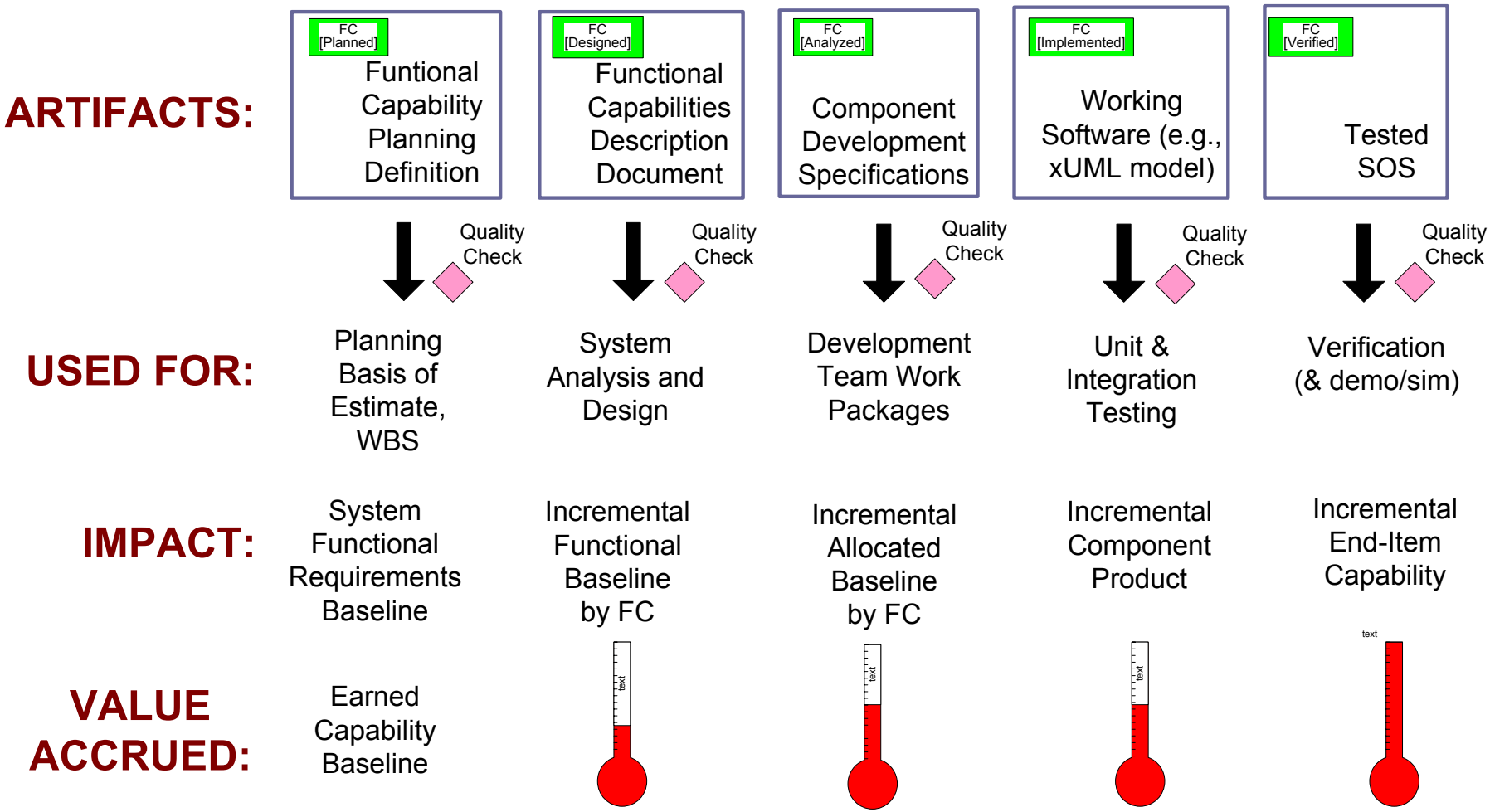
FC Artifacts and Value



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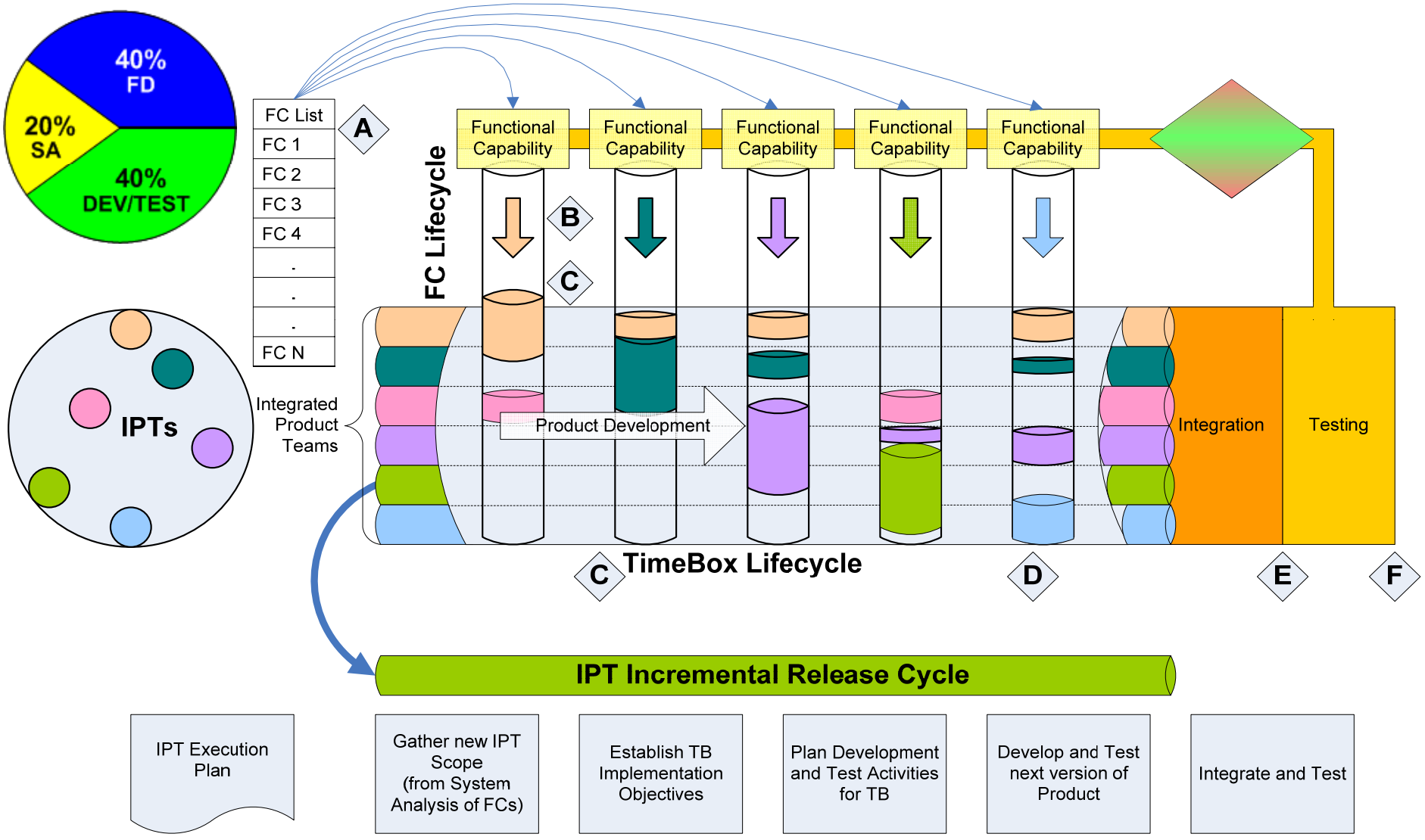
Functional Capability – Overview



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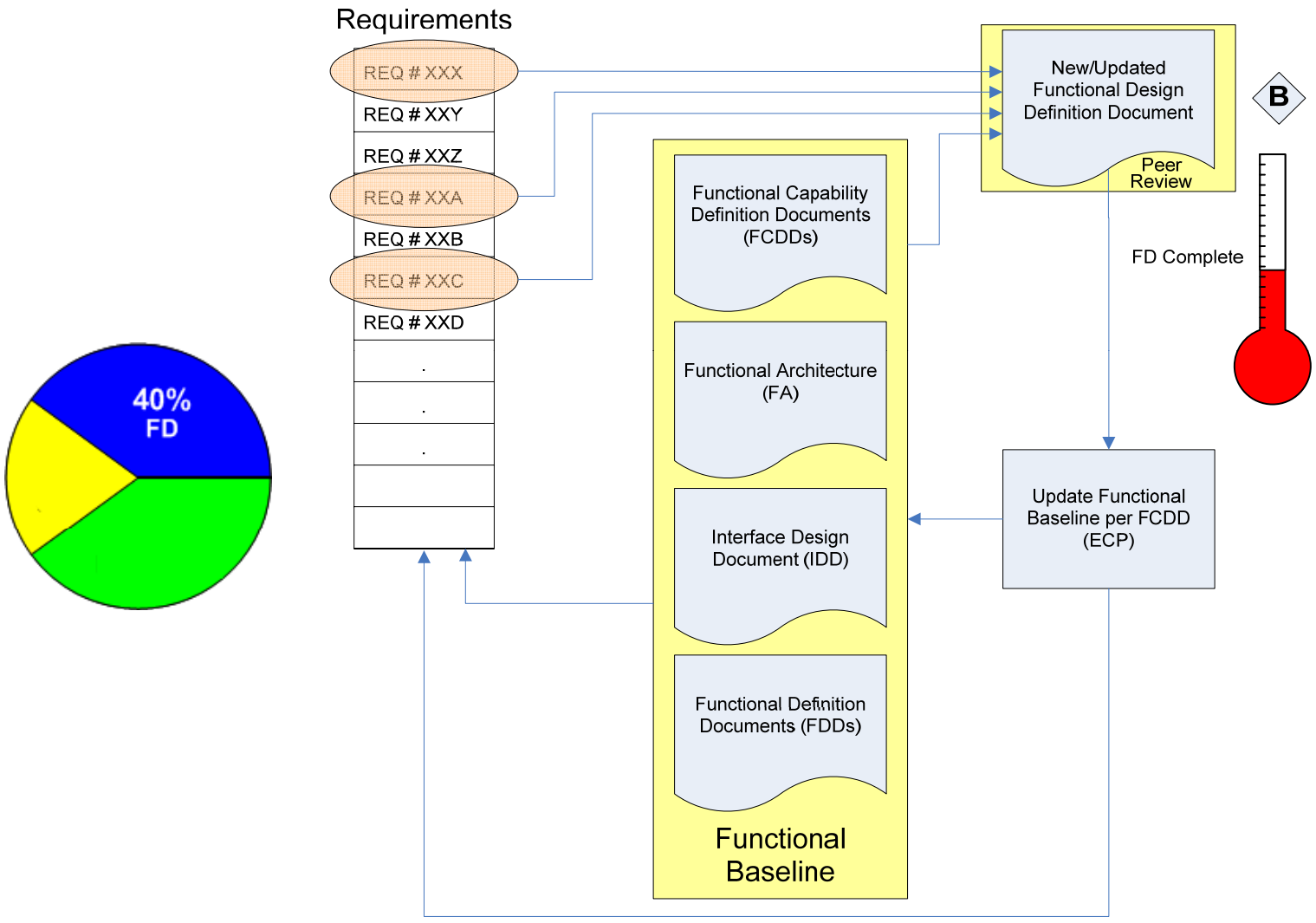
Functional Capability – Functional Definition



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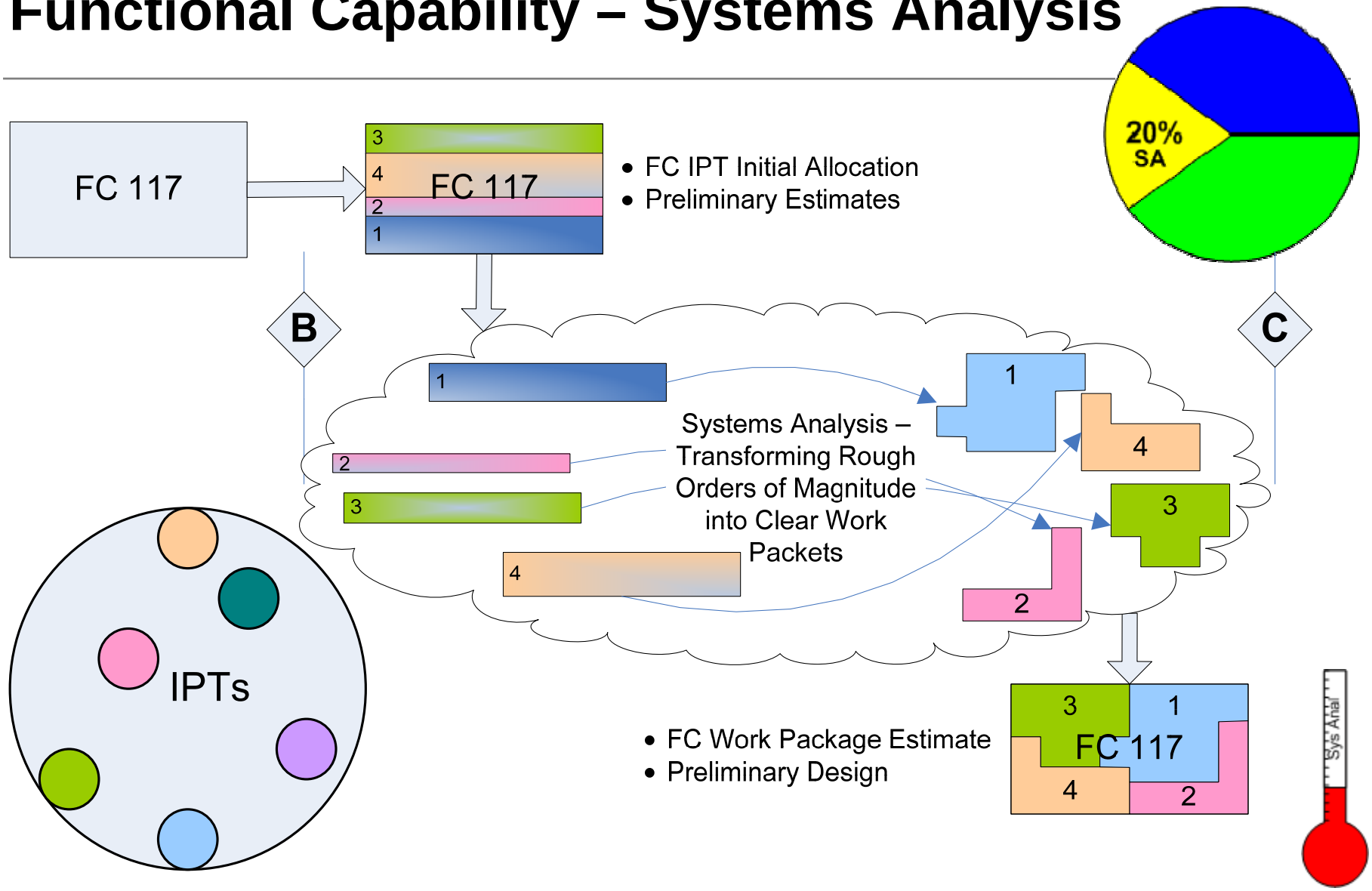
Functional Capability – Systems Analysis



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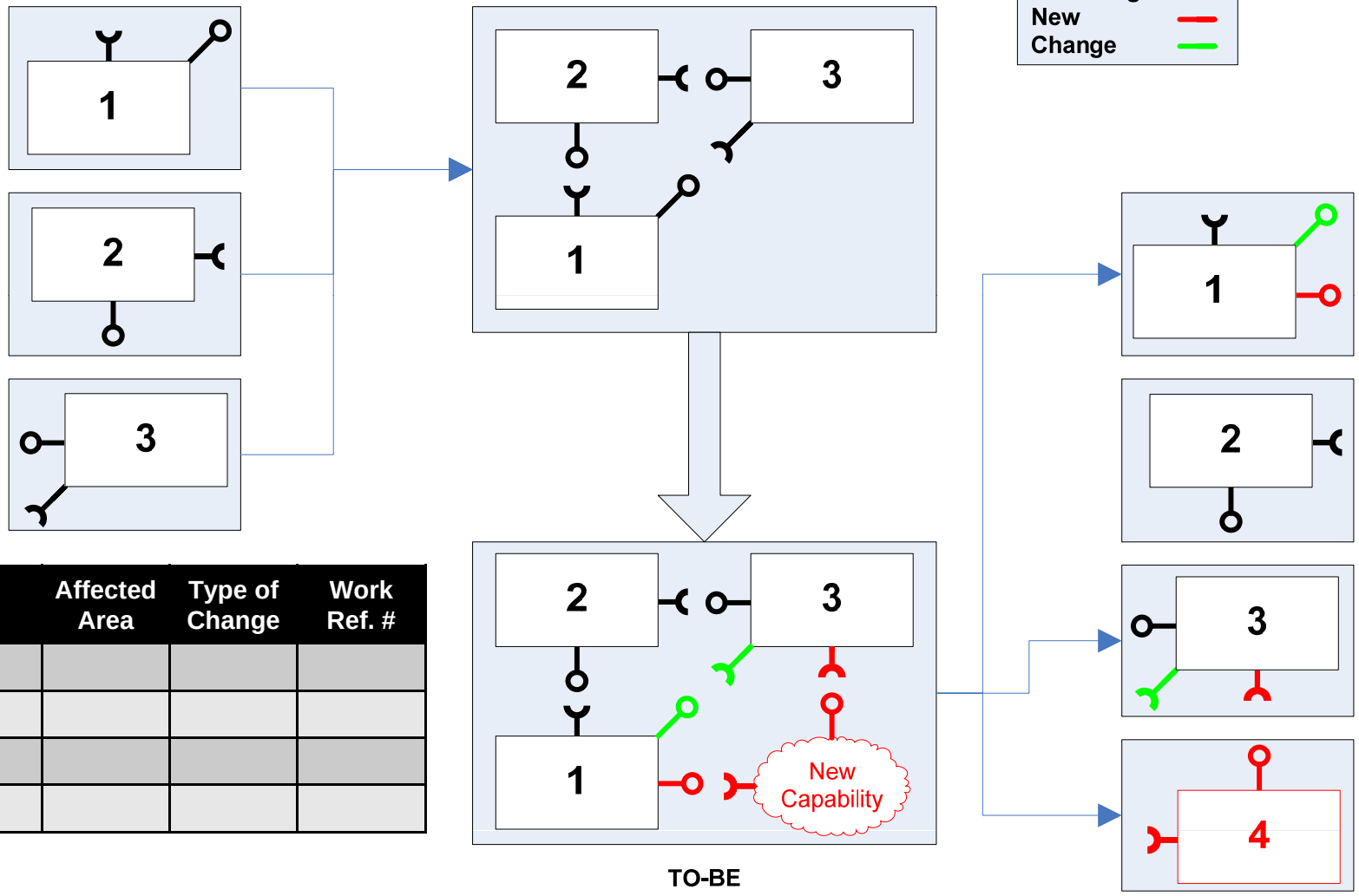
Functional Capability – Systems Analysis



Para. #	Title	Affected Area	Type of Change	Work Ref. #
1.1				
1.2				
1.3				
2.1				

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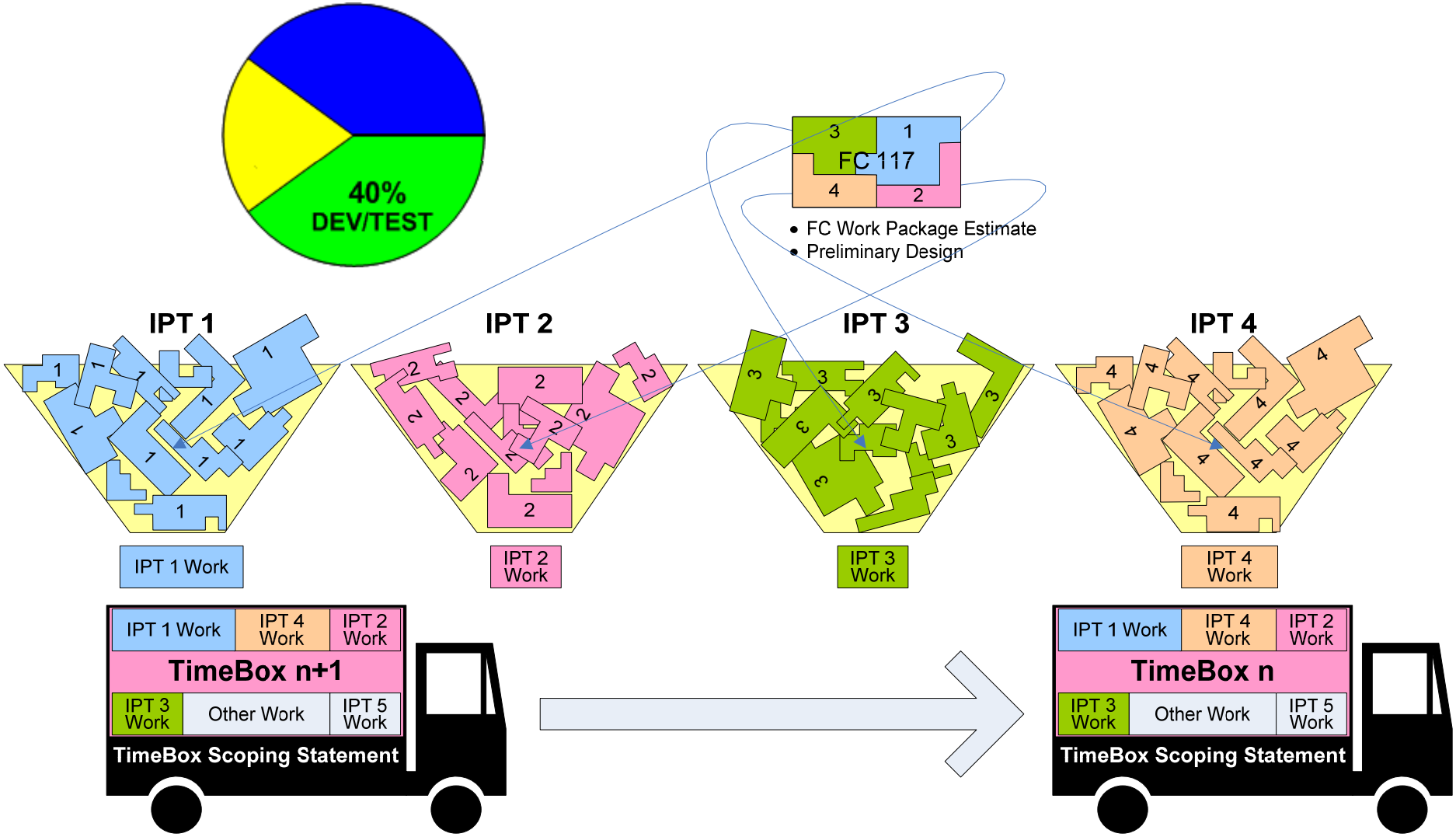
Functional Capability – Dev. & Int.



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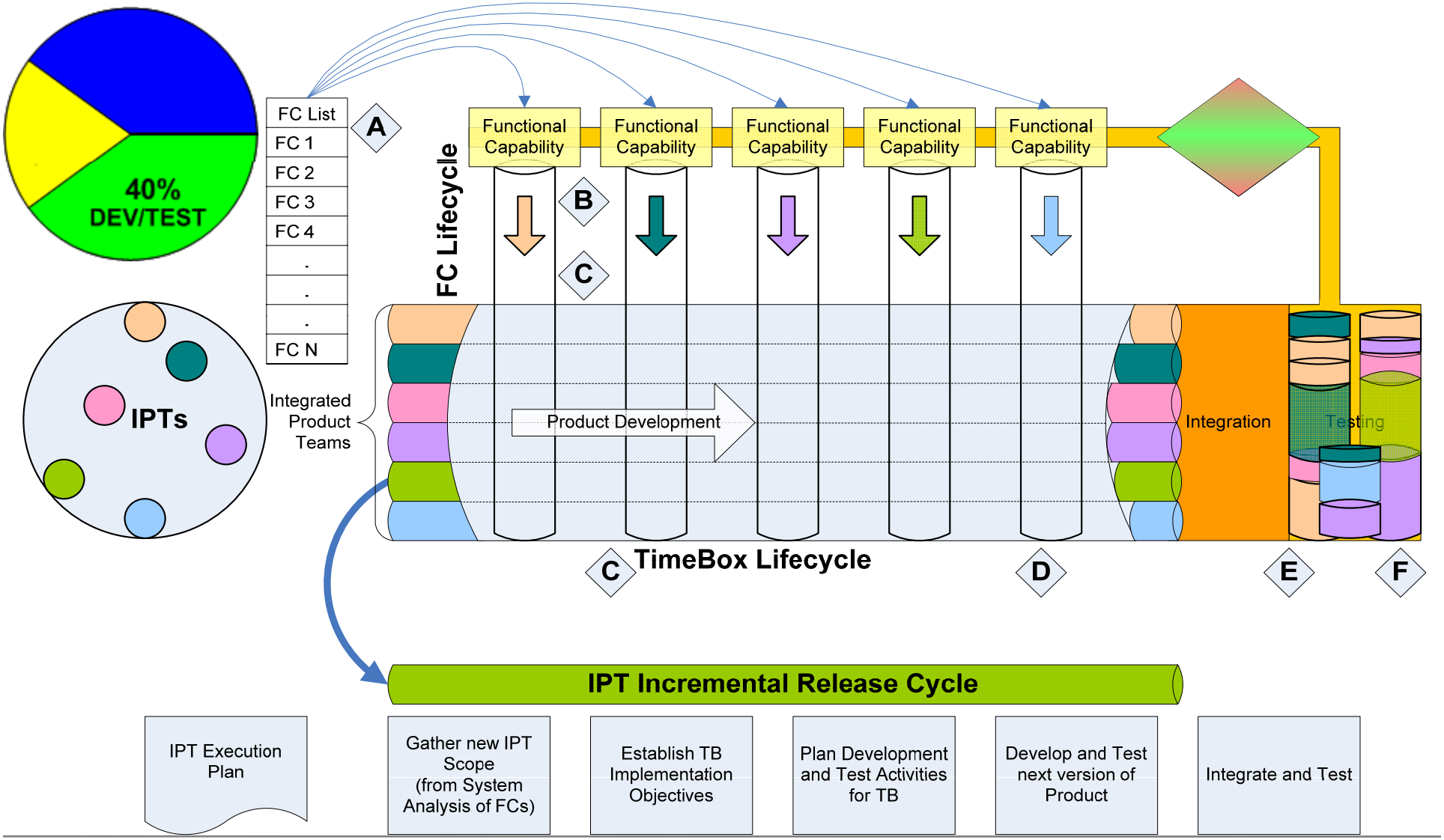
Functional Capability – System Test



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Connection to CMMI

Q: So what does this have to with CMMI anyway?

This is the SEPG North America conference, right?

A1: If you adopt the Functional Capability lifecycle, you get a lot of CMMI credit…

A2: If you managed your projects this way you could use CMMI practices (esp. M&A) to help you

- Produce what your customers want
- Make sure your contractor is performing

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Functional Capabilities – CMMI Mapping 1

- Project Planning (SG 1, SG 2, SG 3)
  - Estimation of FC scope (size, complexity, effort, priority)
  - Standard FC WBS
  - Defined FC lifecycle
  - FC implementation risks
  - Stakeholder identification and involvement (FC prioritization)
  - FC Implementation Budget and Schedule (FC Owners ≈ CAMs)
  - Summation of FC Planning Definitions (Baseline Plan)
  - Commitments established between IPTs
- Project Monitoring and Control (SG 1)
  - Defined project milestones (Q-Gates)
  - "Earned" Capability to calibrate program performance

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Functional Capabilities – CMMI Mapping 2

- Requirements Development (SG 1, SG 2, SG 3)
  - Stakeholder “needs” documented (or referenced) in FCDD, and validated via peer review
  - Context for requirement implementation and acceptance criteria provided in FCDD
    - Basis for product component and interface requirements
    - Definition of required functionality
    - Basis for requirements validation
  - Use cases documented in the FCDD (Operational concepts and scenarios)
- Technical Solution (SG 1, SG 2, SG 3)
  - Alternative solutions documented in FCDD and propagated through System Analysis of FC
  - FCDD represents documentation of Functional design

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Functional Capabilities – CMMI Mapping 3

- Requirements Management (SG 1)
  - FCDD helps to develop an understanding of requirements
  - FCDD to Requirements trace useful for identifying impact of changes
- Verification (SG 1, SG 2, SG 3)
  - Requirements Verification acceptance criteria defined in FCDD
  - Defined artifacts represent obvious opportunities for Peer Review
- Validation (SG 1, SG 2)
  - Defined artifacts are used to interpret, communicate and validate product design
  - Product lifecycle defines artifacts, essential for planning validation activities

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Functional Capabilities – CMMI Mapping 4

- Integrated Project Management (SG 2)
  - FC Definition Document provides basis for management of stakeholder involvement, dependencies, and identification (and resolution) of coordination issues
- Measurement and Analysis (SG 1, SG 2)
  - FC baseline represents program commitment
  - Tracking of FC progress connects tasks execution to management information needs
- Quantitative Project Management (SG 1, SG 2)
  - FC baseline represents the program's performance objective
  - Tracking of FC progress helps to determine whether the program's objectives for performance are being satisfied, and are used to identify appropriate corrective actions

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Summary

- Functional Capability provides a useful framework for managing projects
  - In a complex environment (SoS)
  - As a significant contributor of value-adding artifacts
  - As a starting point for introducing quantitative methods into the project management process
  - As a means of communicating capability, both desired and earned
  - As an effective means to deliver relevant technical and project management content to external stakeholders
  - As a method of assessing the “bow-wave” on a project, and calibrating the reported earned value

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Thank You!

Thank you for your attention!!

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Questions

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- Back-up

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Functional Capability – Planning Definition

- Early in the Program Lifecycle, Functional Capability planning definitions are needed:
  - Based on End-to-End mission scenarios
  - No more than one or two pages per FC
  - Preliminary allocation of requirements
  - High-level textual description
  - Basis of estimates for effort, resource, and schedule planning (use cases, complexity, requirements, etc.)
  - Use historical data where possible (and practical)
  - Establish FC priority and FC-FC dependencies
- Use the planning definitions to establish Earned Capability baseline and to scope project deliverables and dates

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Functional Capability – Functional Definition

- Refine the scenarios to specify the capabilities
- Finalize allocation of functional requirements to the notional FC
- Elaborate the FC
  - Create a contextual description of the functionality
  - Create sequence diagrams, use cases, behavior diagrams
  - Ensure the allocated requirements are explained adequately in the context of the functionality
  - Provide criteria for FC acceptance
- Validate the FC
  - Peer review
  - Customer review
  - Management review (Q-Gate)

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Functional Capability – Systems Analysis

- Start with validated functional design
- Allocate functionality to legacy components
  - Identify and analyze design alternatives as necessary, especially for risk mitigation
  - Update existing / create new design documentation, component specifications
  - Create work packages to implement the new designs
  - Update previous estimates of effort and schedule
  - Identify task dependencies, establish need for commitments for inter-component deliverables
- Validate the Analysis
  - Peer review
  - Customer review
  - Management review (Q-Gate)

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Functional Capability – Test Preparation

- Start with Functional Capability Definition Document requirements acceptance criteria
  - Review the acceptance criteria
    - New scenarios that need to be instantiated
    - New requirements that need to be verified
    - Legacy requirements that have been further clarified
  - Develop/modify test cases based on the criteria
  - If necessary, create new scenario (data set)
  - Identify need for additional test tools, and develop those tools
- Validate the Test Preparation
  - Peer review test cases and scenarios
  - Management review (Q-Gate)

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Functional Capability – Dev. & Int.

- Start with validated System Analysis
- Coordinate the tasks so that the Functional Capability is achieved
  - Identify and negotiate commitments between development teams
  - Establish development goals for the next increment of production (TimeBox)
  - Execute tasks in accordance with the plan
  - Perform verification tasks and pass on to integration
- Integrate the new products
  - Check interfaces, build new integrated product
  - Verify new build (smoke test)
- Validate the Development and Integration
  - Management Review (Q-Gate)

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Functional Capability – System Test

- Start with stable production build
  - Regression test (with new test cases)
  - Log bugs/defects
  - Perform SoS simulated testing (if possible)
  - Evaluate performance bottlenecks; potential SoS issues
  - Produce test report
- Validate the results
  - Management review (Q-gate)

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