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Software Intensive Systems – The Synergy of Architecture, Life Cycle Models, and Reviews

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Agenda

- **Problem Statement**
- **The National Security Space Acquisition Policy (NSSAP 03-01) Acquisition Life Cycle Model**
- **Waterfall vs. Iterative/Incremental Development**
- **Anchor Points in The IBM/Rational Unified Process (RUP®)**
- **Risk-based Life Cycle Model (LCM) Selection**
 - ❖ Opportunities and Risks of Various LCMs
 - ❖ Simplified Hierarchy of System and Software LCMs
 - ❖ Different WBS Levels – Different LCM Choices
- **Reviews**
 - ❖ System Technical Reviews
 - ❖ System Technical Reviews and Anchor Point Reviews
- **Architecture-Centric Synergy of Elaboration, Evolution and Evaluation**
- **Conclusions**

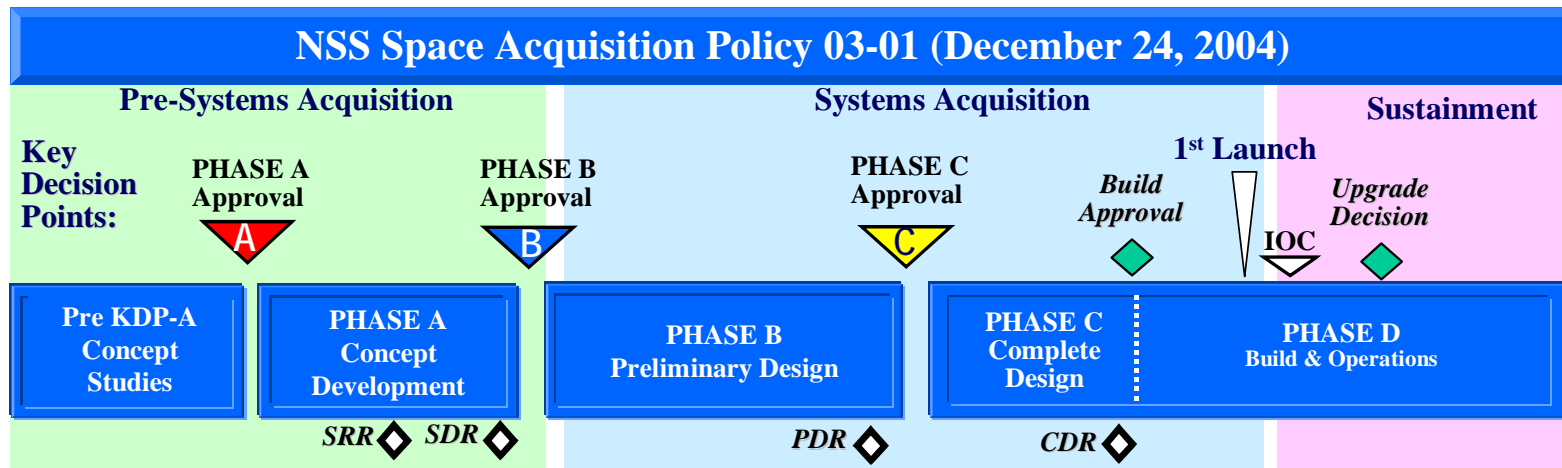
® RUP is registered in the U.S. Patent and Trademark Office by IBM/Rational Corporation

Problem Statement

- **Fundamental Lack of Understanding and Appreciation of LCMs**
 - ❖ **Current National Security Space Acquisition Policy (NSSAP 03-01)**
 - Acquisition phase-names imply a waterfall structure of development
 - Prescribes technical reviews that – in their names and their positioning – also imply waterfall development
 - **Although, with respect to review details, no specifics are given**
 - ❖ **Current Software Life Cycle Standard (J-STD-016-1995)**
 - While does not explicitly exclude iterative development, it does not really supports it either
 - **Index does not even has an “Iteration”-related entry**
 - It is not properly harmonized with systems engineering standards
 - ❖ **Technical Review Standard (MIL-STD-1521B)**
 - Although it is under revision, most likely the updated version will still
 - **Maintain the obsolete, waterfall-oriented review-names**
 - **Lack of a solid, overarching, life cycle modeling foundation**

NSSAP 03-01 Acquisition Life Cycle Model

Small Quantity System Model



Reviews:

SRR – System Requirements Review

SDR – System Design Review

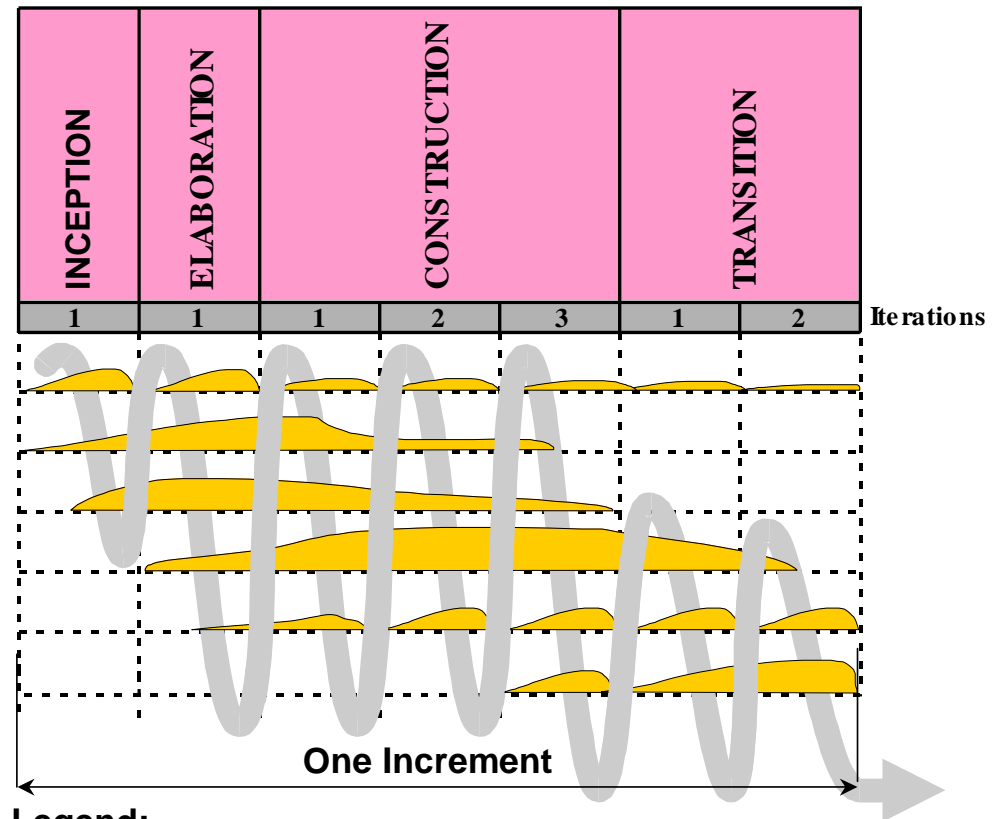
PDR – Preliminary Design Review

CDR – Critical Design Review

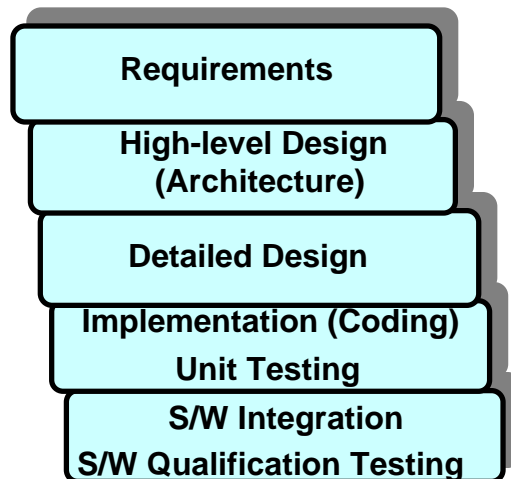
Waterfall vs. Iterative/Incremental Development

RUP

Phases




Waterfall



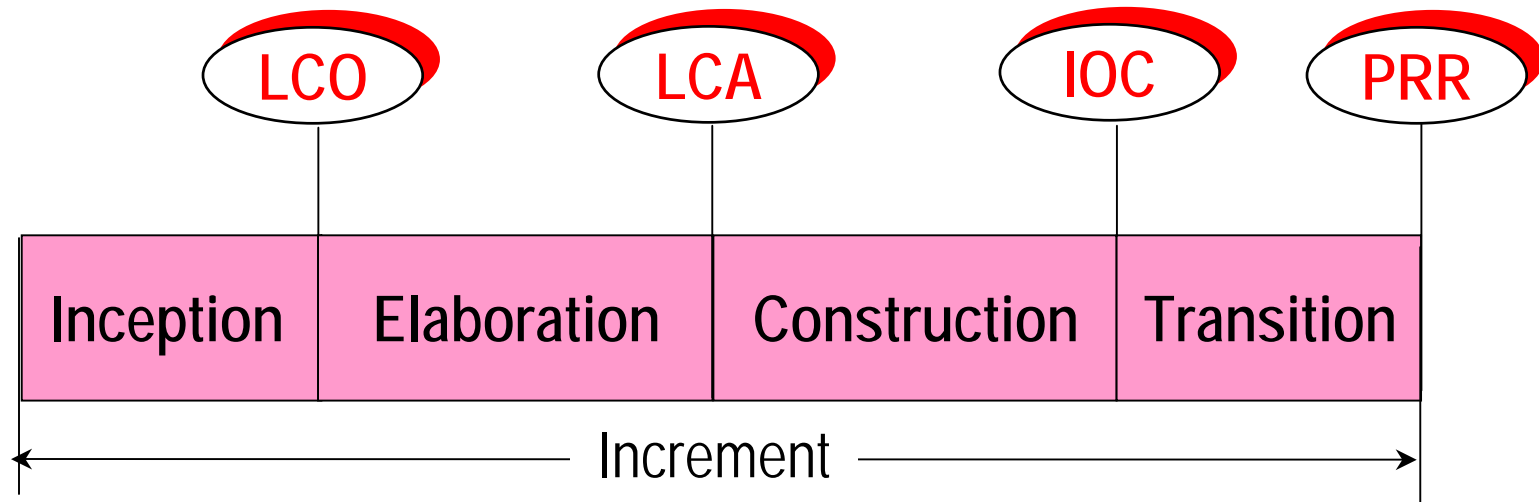
Disciplines

Business Modeling
Requirements
Analysis and Design
Implementation
Test
Deployment

Legend:

 Approximate Effort (Notional)
 Flow of Execution (Mini-Waterfalls)

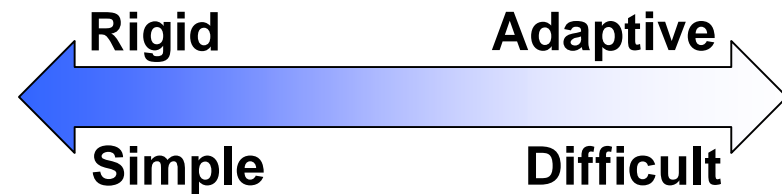
Anchor Points in RUP



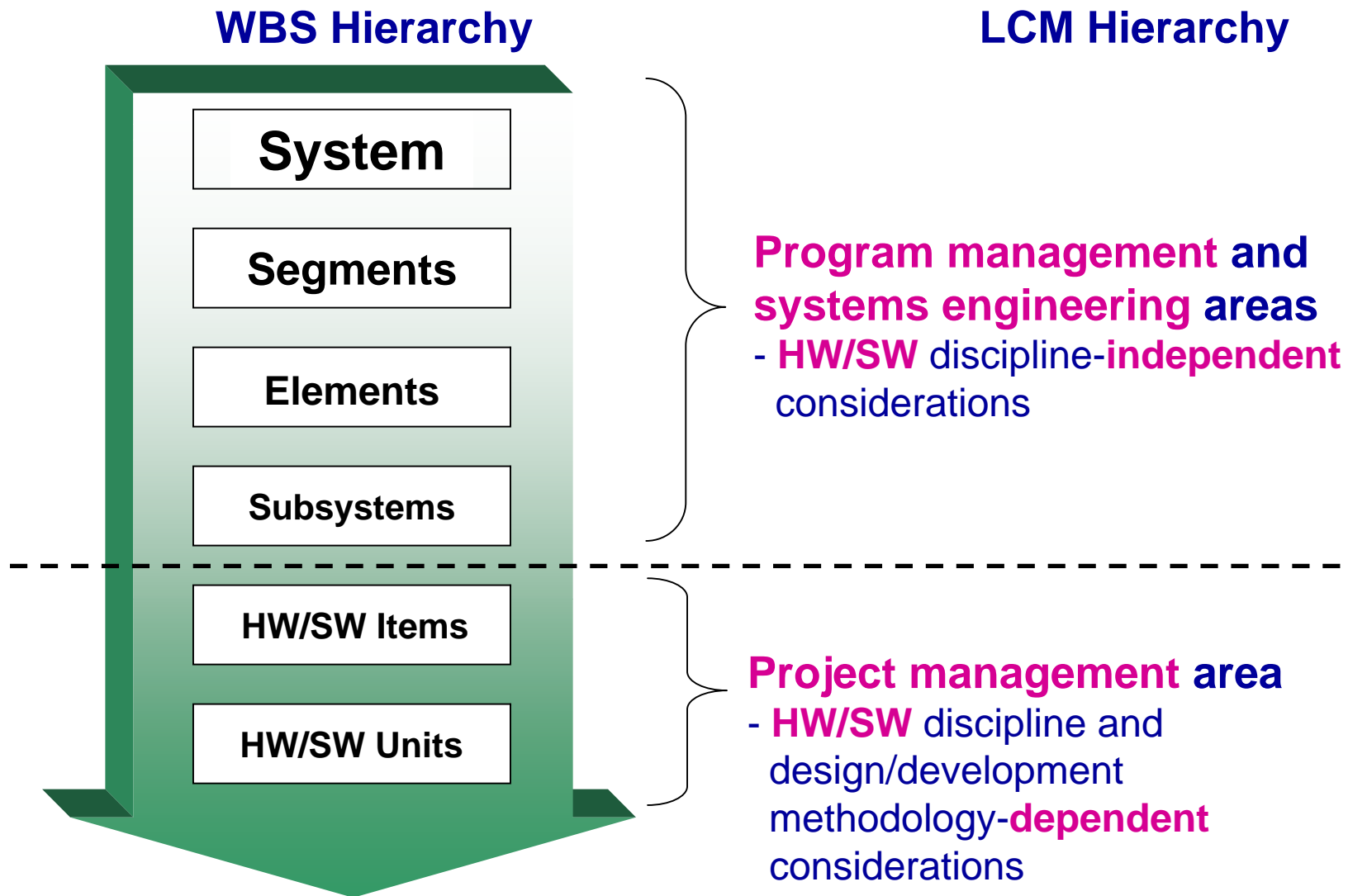
- **Definition:**
 - ❖ Anchor points are a set of project planning milestones with specific objectives
 - **LCO** (Life Cycle Objectives)
 - **LCA** (Life Cycle Architecture)
 - **IOC** (Initial Operational Capability)
 - **PRR** (Product Release Review)
- **Anchor Points bring architecture focus into the life cycle**
 - ❖ **Explicitly address architecture option-exploration and evolution**

Opportunities and Risks of Various Life Cycle Models

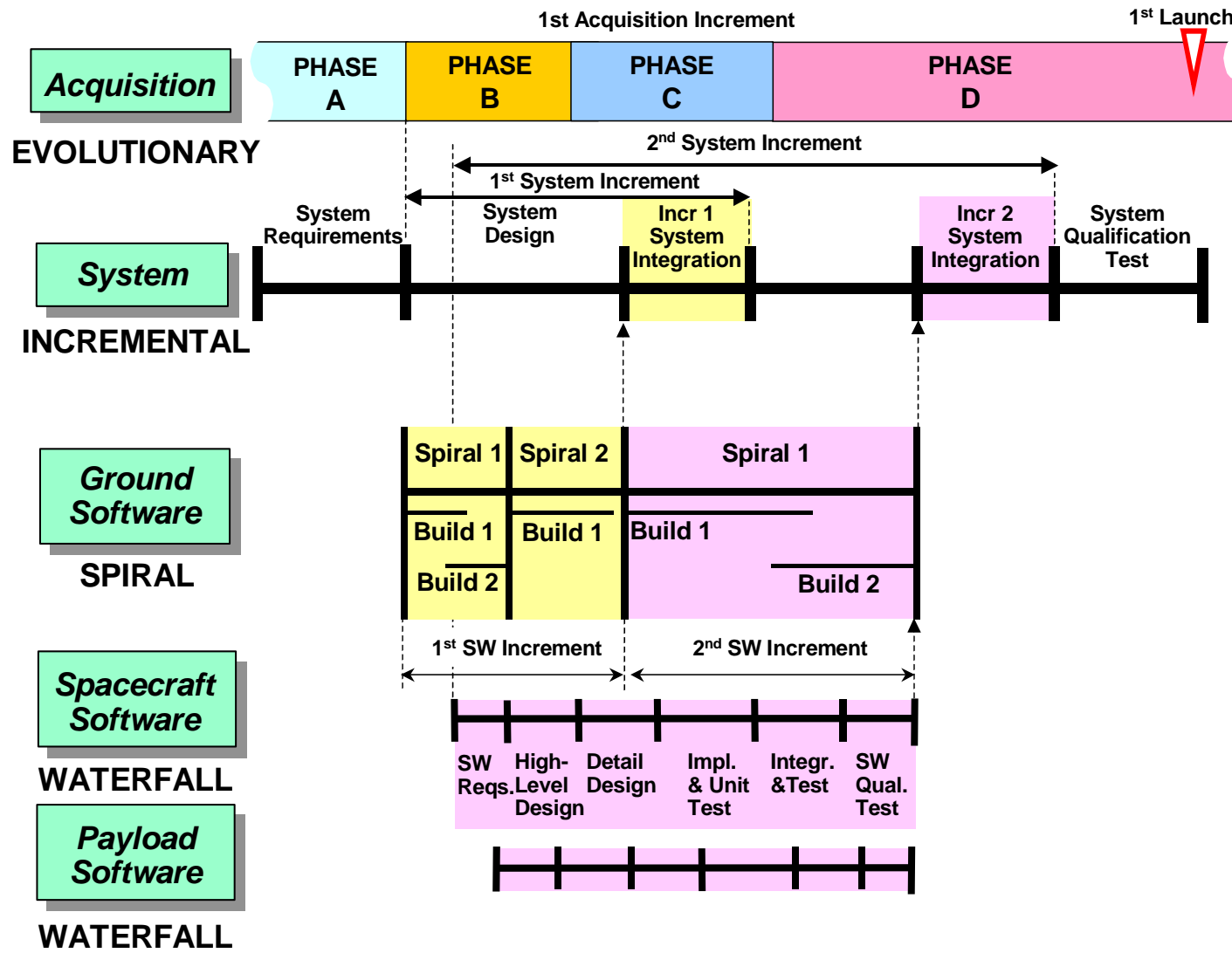
Risk Factor		Basic Life Cycle Models							
Category	Item	Once-Through		Incremental		Evolutionary		Iterative	
		O	R	O	R	O	R	O	R
Requirements	High Requirements Volatility is expected due to user feedback		X		X	X		X	
	System is not precededented		X		X	X		X	
	Requirements are not well understood		X		X	X		X	
	User needs some capabilities delivered early		X	X		X		X	
Technology	New technology is being incorporated		X		X	X		X	
	Rapid changes of critical technologies are anticipated		X		X		X	X	
Complexity	Size (SLOC, function points, etc.) is a concern		X	X		X		X	
	High level of inter-dependencies amongst different disciplines		X		X		X	X	
	The system naturally breaks into increments		X	X		X		X	
Personnel	Concerns about responsiveness to funding/staffing needs		X	X		X		X	
Politics	Concerns about securing funding for a large project		X		X	X		X	
	Difficult stakeholder conflicts are expected		X		X	X		X	



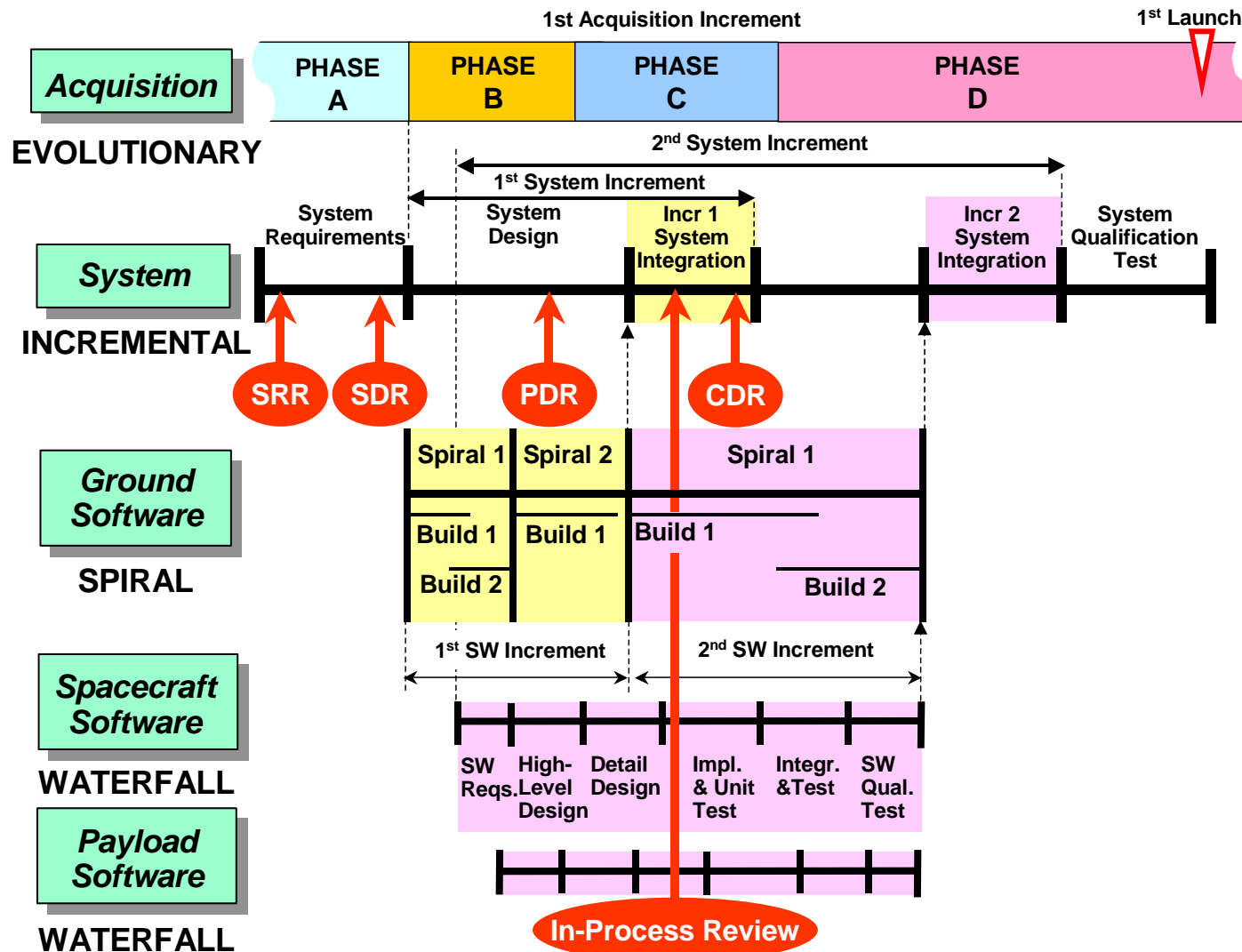
Different WBS Levels – Different LCM Choices



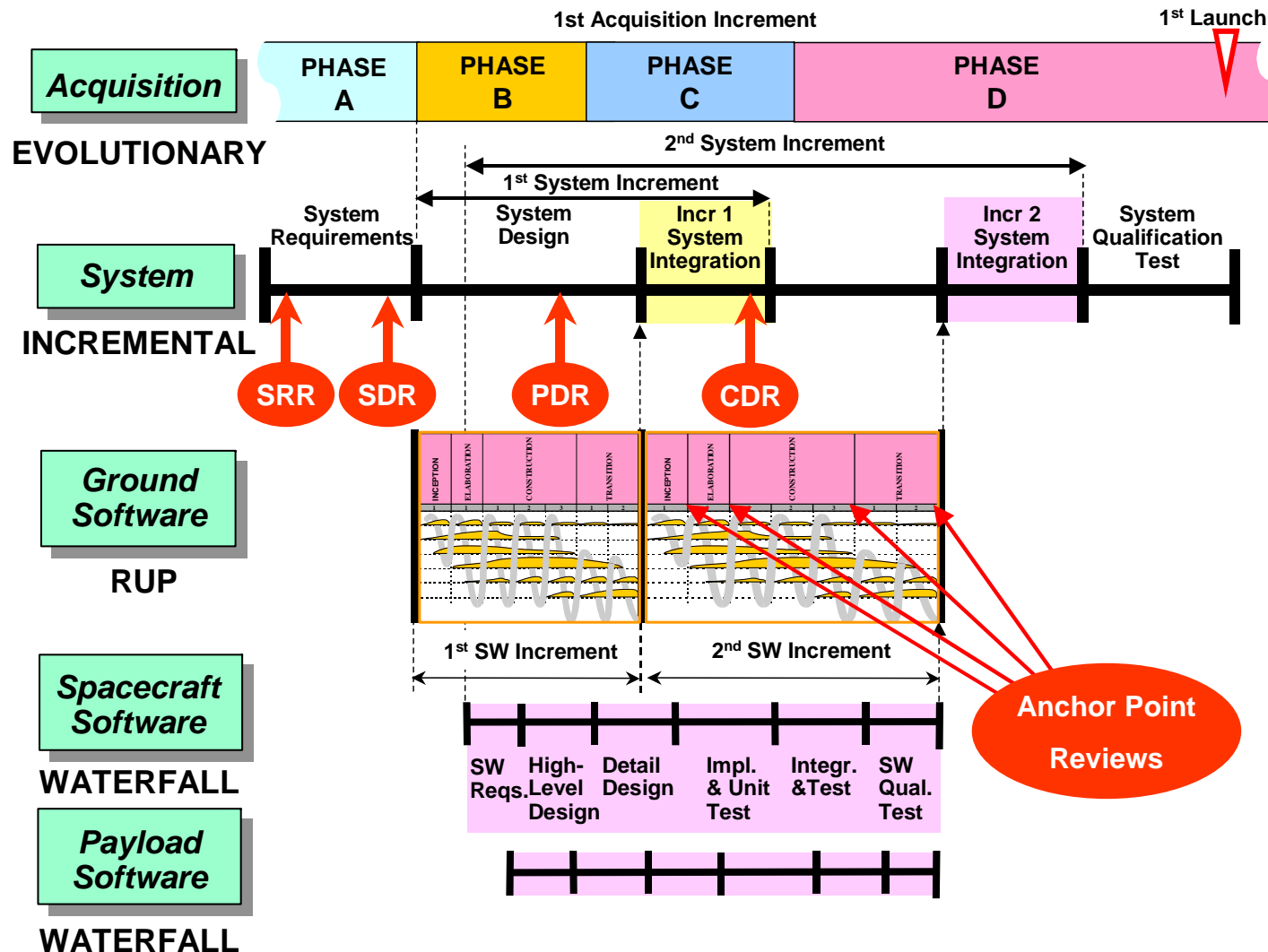
Simplified Hierarchy of System and Software LCMs



System Technical Reviews



System Technical Reviews and Anchor Point Reviews



Architecture-Centric Synergy of Elaboration, Evolution and Evaluation

	Objective	Process Domain	Product Domain
Elaboration	Understanding Internals (Refining Implementation)	LCM Hierarchy and Synchronization	Architectural Views (UML Diagrams)
Evolution	Understanding and Refining Changing Requirements	LCM Choices	Use Case Hierarchy
Evaluation (Reviews)	Progress Against Objectives Integrity of Artifacts	Validation of LCM Choices LCM-based Determination of Review Content	Verification of Artifacts Verification of Consistency with LCMs

Conclusions

- **Life Cycle Models are key in ensuring the synergy across Evolution, Elaboration, and Evaluation**
 - ❖ Paraphrasing P. Kruchten, this is a high-level, “3+1 View Model” of Software-Intensive System development
- **Due to the dynamic nature of system development, state-of-the-art review standards would have to be structured around more meta-level definitions, e.g.,**
 - ❖ “Architectural views are consistent with the appropriate LCMs”
 - ❖ “... design has been defined to the level of completeness that is based on the selected LCM.”
- **Using such standards requires a higher level of sophistication from both the Contractor and the SPO**
 - ❖ Unfortunately, we don’t have a choice here
 - **The sophistication of Evaluation must match the rapidly evolving sophistication of system Evolution and Elaboration**

Acronyms

ACE3	Architecture-Centric Evolution, Evaluation, and Elaboration
CDR	Critical Design Review
HW	Hardware
IOC	Initial Operational Capability
J	Joint
KDP	Key Decision Point
LCA	Life Cycle Architecture
LCM	Life Cycle Model
LCO	Life Cycle Objectives
MIL	Military
MOIE	Mission-Oriented Investigation and Experimentation
NSSAP	National Security Space Acquisition Policy
O	Opportunity
PDR	Preliminary Design Review
PRR	Product Release Review
R	Risk
RUP	IBM/Rational Unified Process
SLOC	Source Lines Of Code
S/W	Software
SDR	System Design Review
SPO	System Program Office
STD	Standard
SW	Software
USAF	United States Air Force
WBS	Work Breakdown Structure