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INCOSE International Symposium

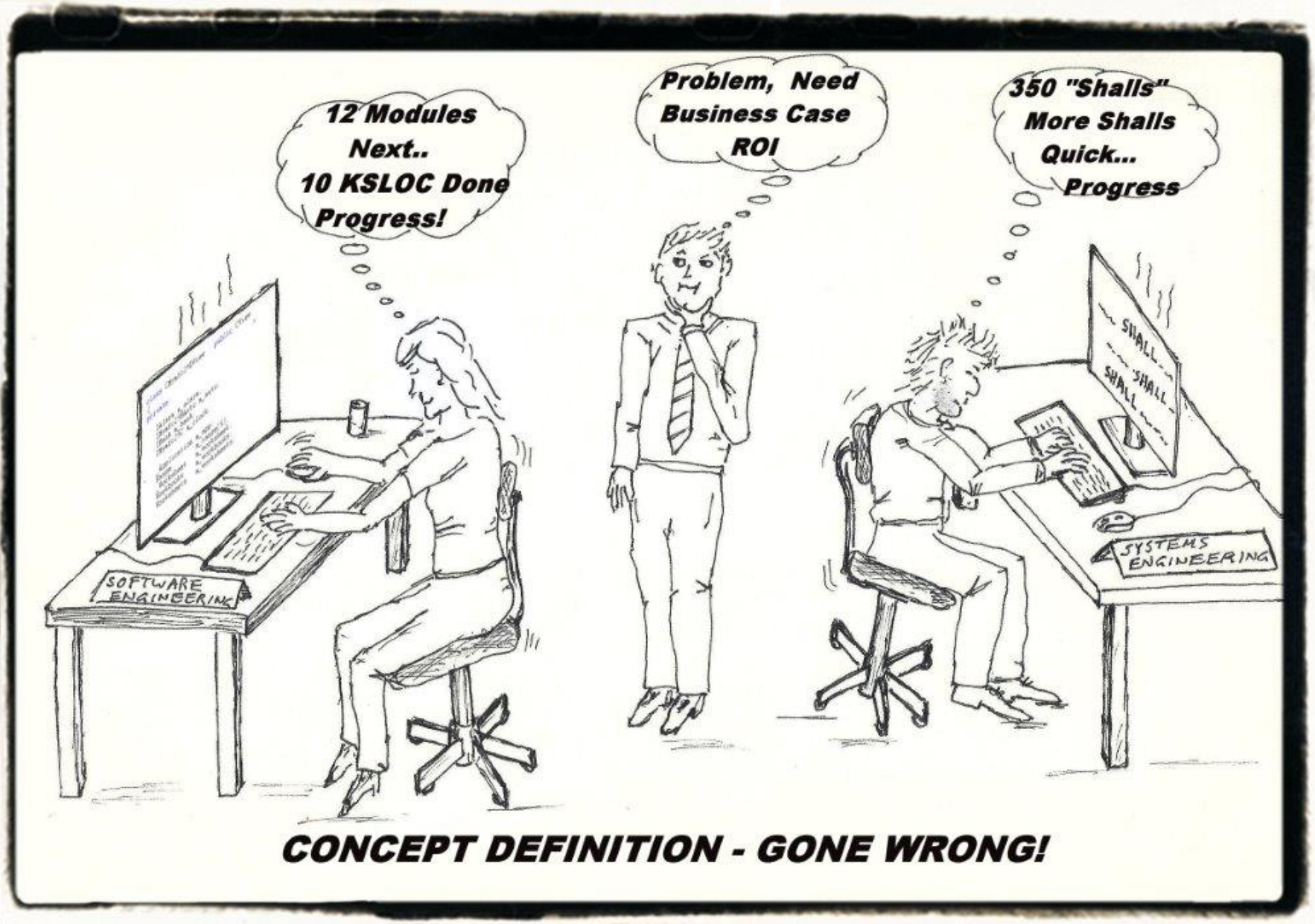
Philadelphia, PA
June 24-27, 2013

A Framework for Harmonizing Systems Engineering and Off-The-Shelf Procurement Processes

Steven Saunders

Raytheon Australia

Motivation

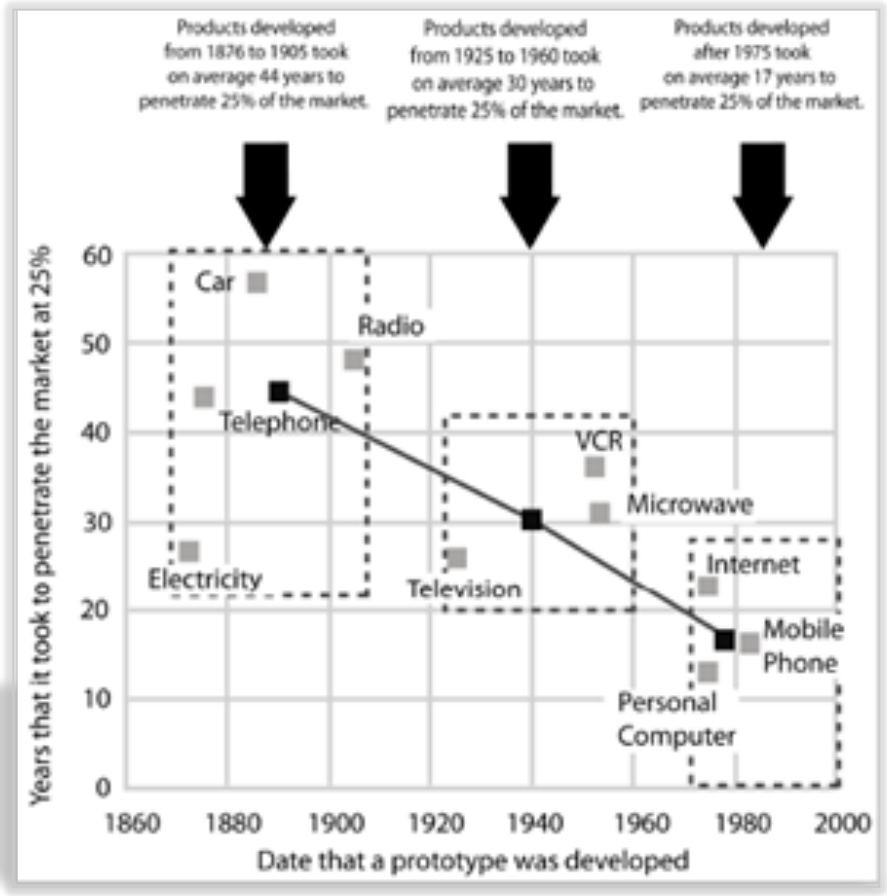

12 Modules Next.. 10 KSLOC Done Progress!
Problem, Need Business Case ROI
350 "Shalls" More Shalls Quick... Progress
SOFTWARE ENGINEERING
SHALL
SHALL
SHALL
SYSTEMS ENGINEERING
CONCEPT DEFINITION - GONE WRONG!

Topics

- The Burning Platform
- Off-The-Shelf: Achieving Lower Risk?
- Framework for Harmonizing Systems Engineering and Off-the-Shelf (OTS)
  - Case Study:
    Royal Australian Navy Air Warfare Destroyer
    - Strategy
    - Process / Framework
    - Results
- Conclusions
- Questions

The Burning Platform

- Competitive Advantage
  - Reducing Time for Market Penetration of New Technologies
- Avoiding Program Failure
  - Minimize Risk
- Is Off-The-Shelf (OTS) the Answer?



Haskins 2011

Reducing Technology Market Penetration Times

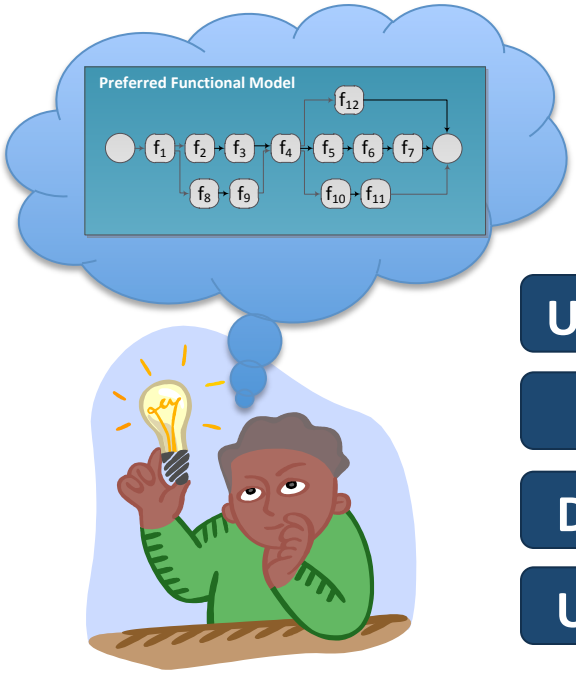
Off-The-Shelf: Achieving Lower Risk?

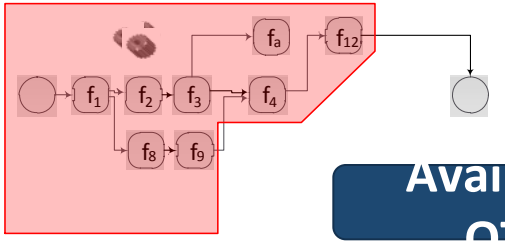
- Fallacy 1: *"OTS Means High Technical Readiness Level"*
- *Not Necessarily*

OTS May not be Intended for Required Environment

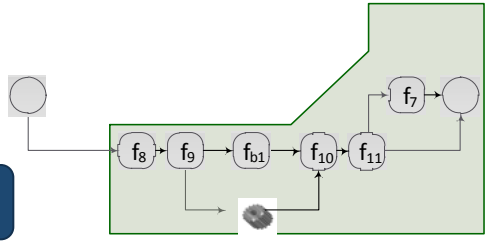
Off-The-Shelf: Achieving Lower Risk?

- Fallacy 2: *"OTS Results in Low/No Development Risk"*
- *Not Necessarily*





Available OTS



Unwanted Functions

Interface Risks

Duplicate Functions

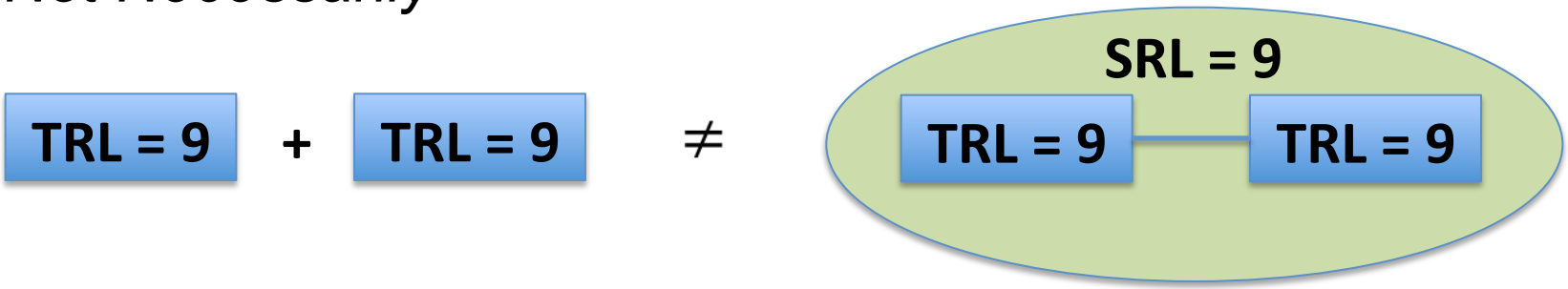
Unwanted Coupling

Missing Functions

OTS Constrains Functional Behaviors

Off-The-Shelf: Achieving Lower Risk?

- Fallacy 3: *"Systems of OTS Components are Low Risk"*
- *Not Necessarily*



- TRL not necessarily preserved in the Intended Environment
- SRL is not the MIN, AVG, or MAX of component TRL

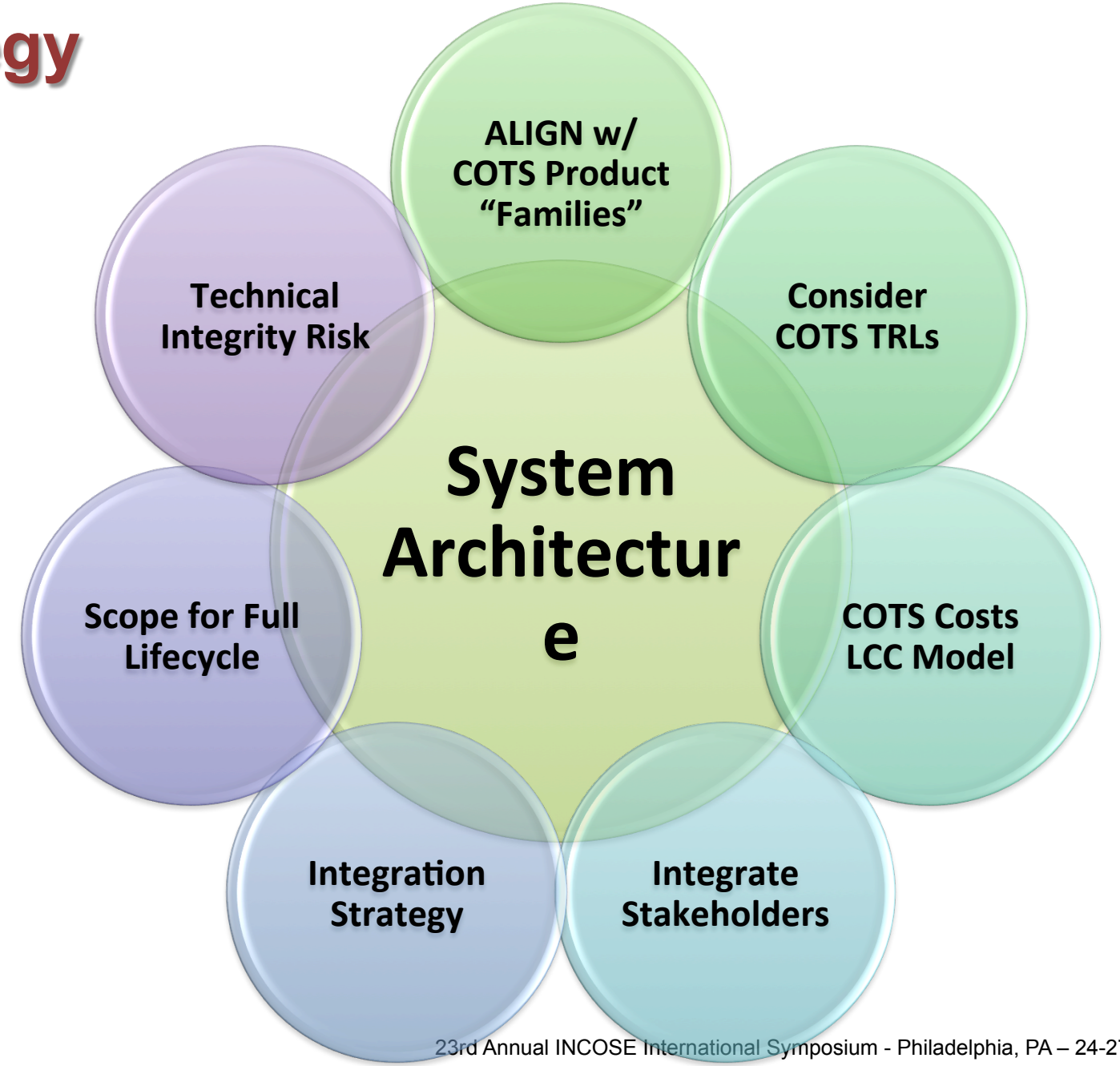
Case Study: Royal Australian Navy (RAN) Air Warfare Destroyer (AWD)

- The RAN AWD Program will deliver a new major surface combatant to the RAN within an aggressive timeframe
- OTS Approach to achieve risk profile & delivery timeframe

- 2 Years for Concept Definition
- 8 Years to…
  - Select Equipment & Complete the Design
  - Build Integration and Training Facilities
  - Build the Shipyard
  - Build the Lead Ship
  - Integrate the System
  - Verify installed Performance

Courtesy AWD Alliance

RAN AWD Off-The-Shelf Procurement Strategy



RAN AWD Off-The-Shelf Procurement Strategy

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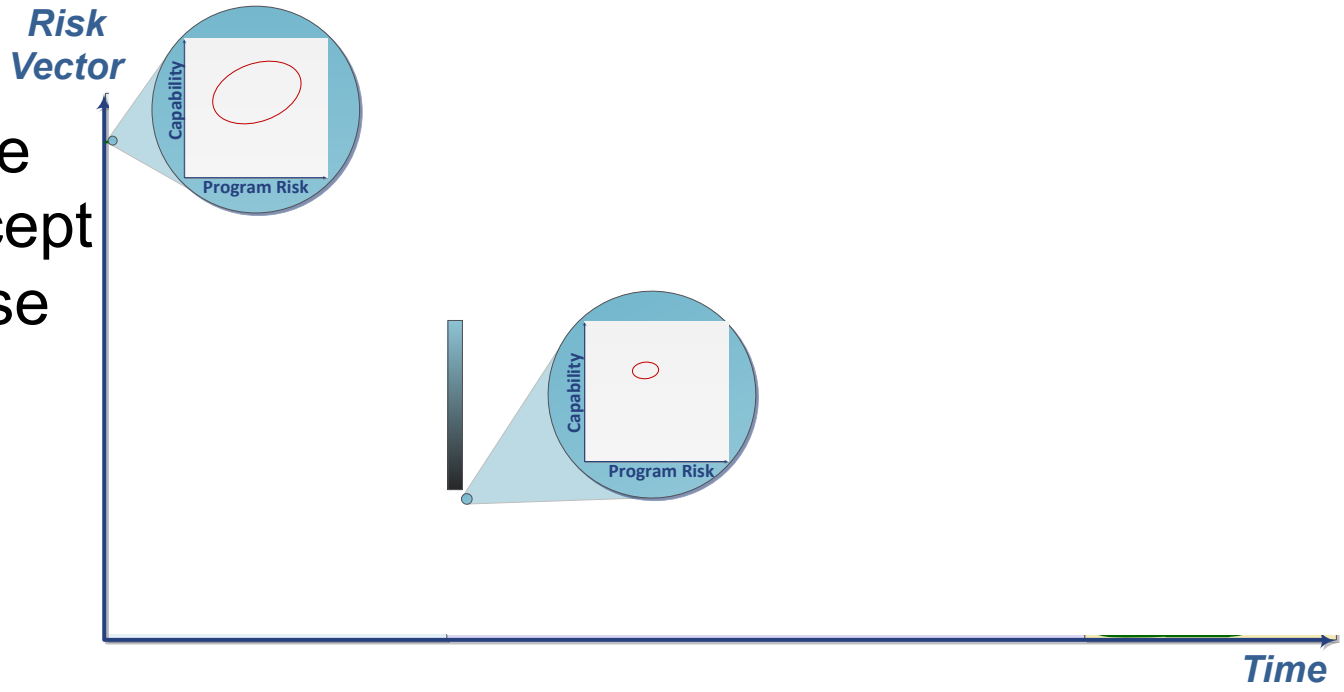
- Maximize Value Added in Concept Definition Phase
- Aggressively Pursue Risk Reduction
  - Consider all Risk Contributors Concurrently
  - Collaborate with Key Stakeholders



Aggressively Pursue Risk Mitigation during Concept Definition – Consider the Complete "Risk Vector"

RAN AWD Off-The-Shelf Procurement Process – Summary

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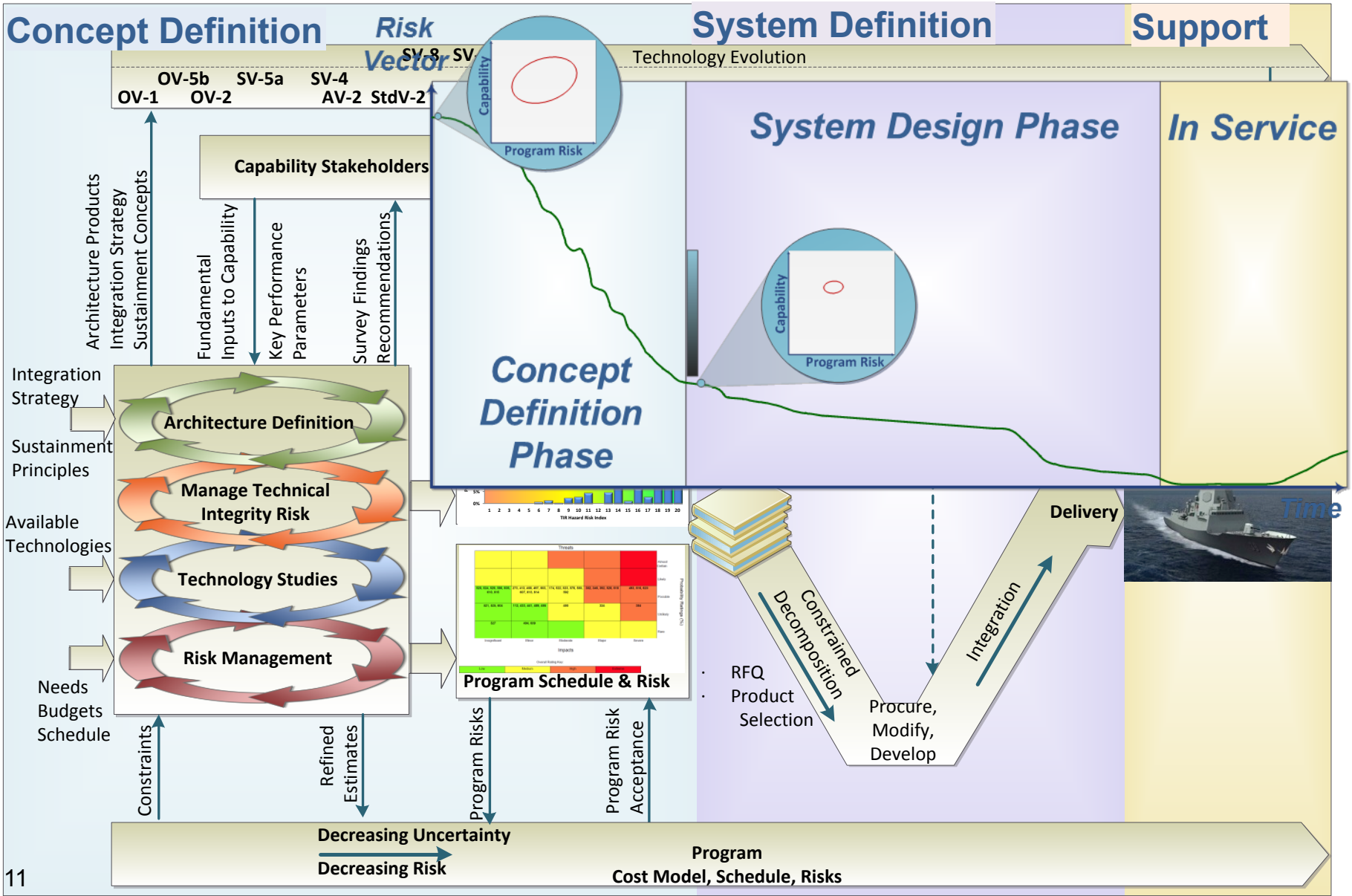

RAN AWD Off-The-Shelf Procurement Process – Architecture Definition

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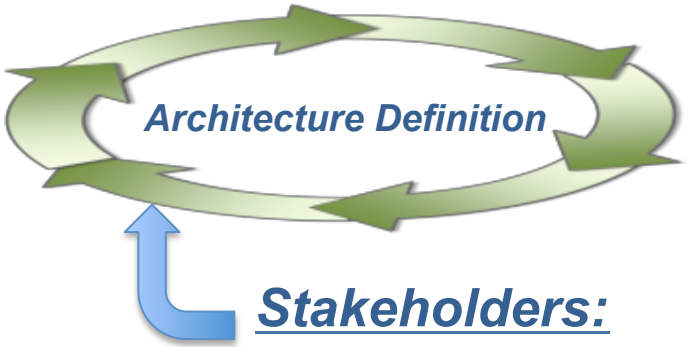


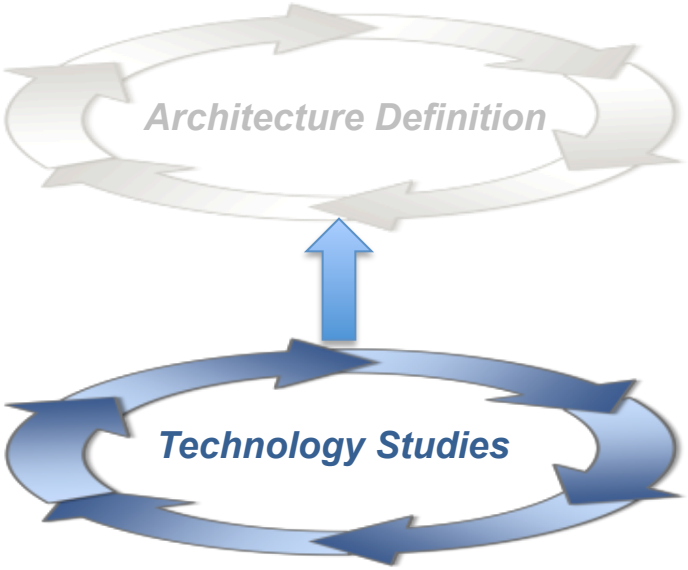
Stakeholders:

- ***Capability***
- ***Regulatory***
- ***Integration***
- ***Technologists***

- Define Reference Architecture
- Cognizant of OTS Solution Classes
- Cognizant of Technology Readiness
- Align with Integration Strategy
- Align with Certification Strategy
- Consider Evolution Paths
- Simplify Complexity

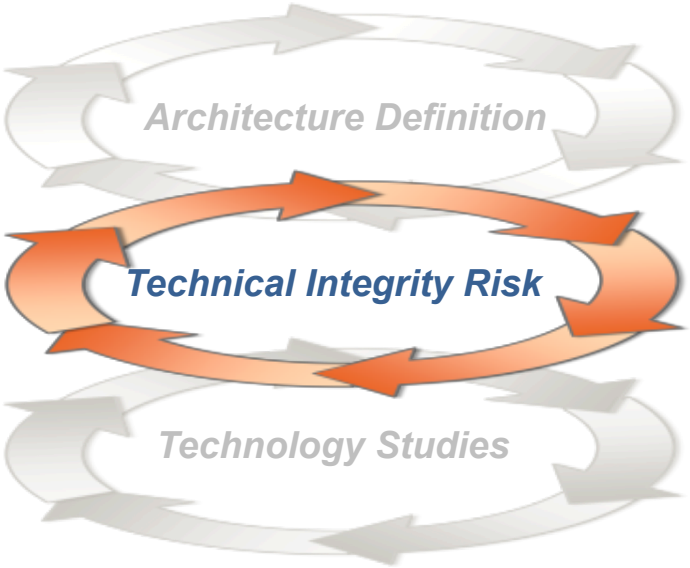
Definition of a Suitable Architecture Essential Hide Complexity to Support Decisions

RAN AWD Off-The-Shelf Procurement Process – Technology Studies



- Trade Studies
- Understand Available COTS
- Understand Technology Roadmaps
- Validate TRL
- Validate Cost Budgets

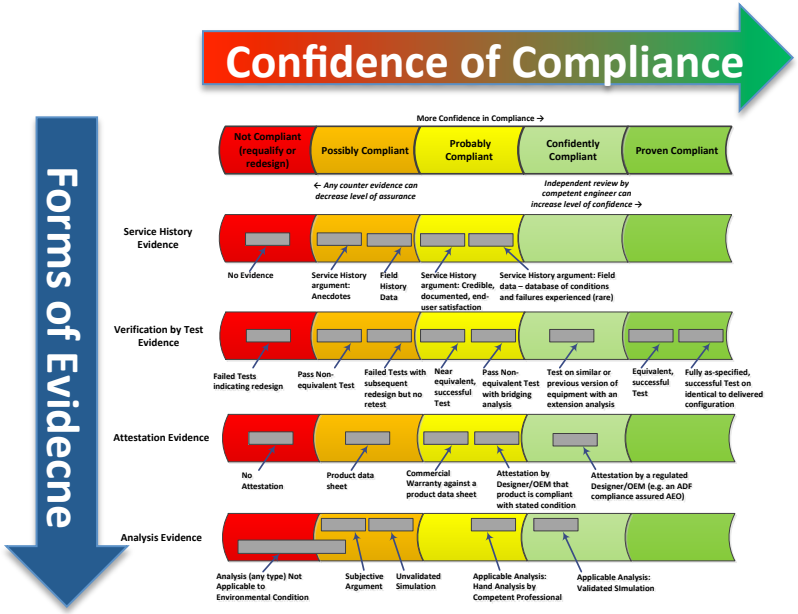
RAN AWD Off-The-Shelf Procurement Process – Technical Integrity Risk



- Assess Risk to:
  - Mission, Environment, Safety
- Quantify and Mitigate Intolerable Risks
  - Iterate Architecture
  - Iterate Technologies
- Gain Stakeholder Buy-In

RAN AWD Off-The-Shelf Procurement Process – Technical Integrity Risk

- But there is a Problem
  - Off the Shelf comes with less objective compliance evidence
  - Establish a Scheme to assess compliance risk and uncertainty



- *Service History*
- *Attestation Evidence*
- *Analysis Evidence*
- *Test Evidence*

– Assess Risk to Mission, Environment and Safety

	Hazard Consequence			
Likelihood	**Catastrophic**	**Critical**	**Major**	**Minor**
Frequent	1	3	7	13
Probable	2	5	9	16
Occasional	4	6	11	18
Remote	8	10	14	19
Improbable	12	15	17	20
Not Credible	Not Credible			
Key	Extreme	High	Med	Low

– And Quantize

RAN AWD Off-The-Shelf Procurement Process – Program Risk Management

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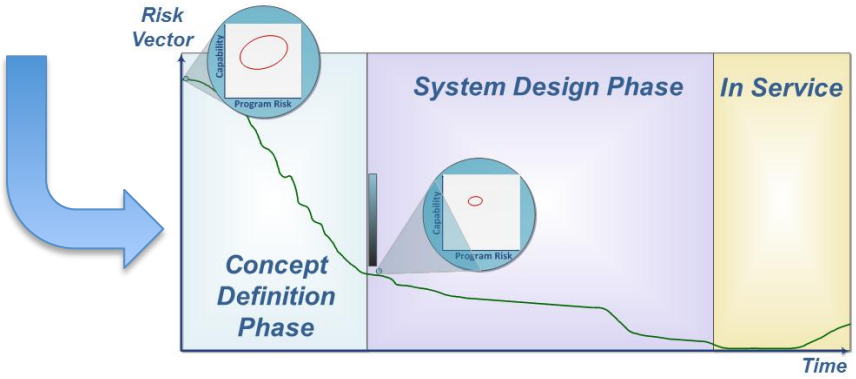
- Assess / Mitigate Risk
  - Cost, Schedule, Technical
- Aggressively Mitigate Overall Risk
- Manage risk at the Aggregate Level



RAN AWD Off-The-Shelf Procurement Process – Output of Concept Definition

- Reference Architecture Defined
- Architecture Aligned to OTS Classes
- Technology Risks Factored in
- In-Tolerable Risks Mitigated
- Budget Allocations Validated
- Overall Risk has been Minimized

RAN AWD Off-The-Shelf Procurement Process – Summary

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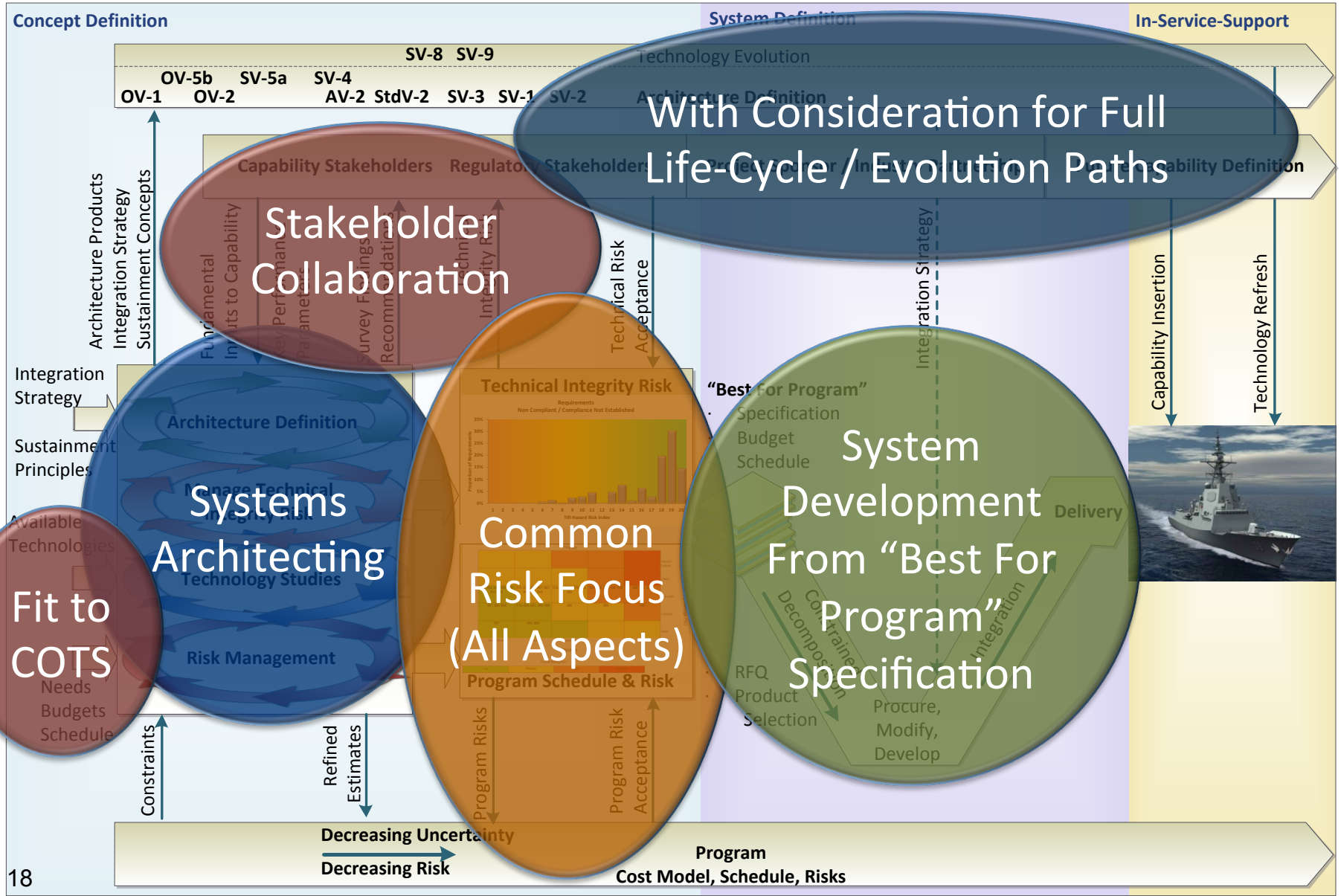

RAN AWD Off-The-Shelf Procurement
Combat System Results

Courtesy AWD Alliance

RAN AWD Off-The-Shelf Procurement
Combat System Results

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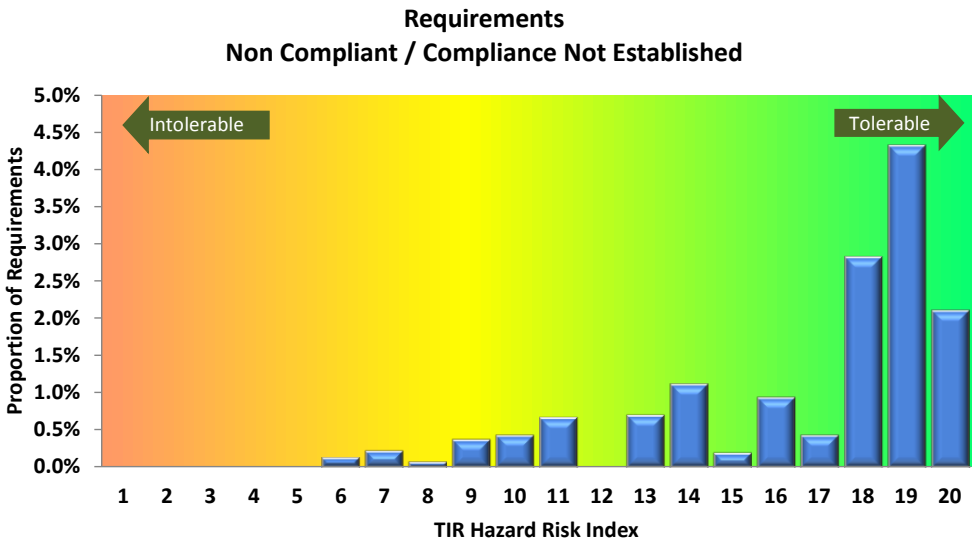
- Reference Architecture Stable for 6 years
- Major Equipment Procured
- Integration on plan
- Operational Software Complete / Baselined
- Combat System Program on schedule/cost
- No intolerable Technical Integrity Risks



COTS / MOTS Approach Has Worked

Conclusions

- Off-The-Shelf Can Result in Lower Risk – but…
  - Tailor the Process to this Strategy

- Maximize Benefit in Concept Definition Phase
  - Align the Architecture with OTS Classes and Integration Strategy
  - Architect to Hide Complexity – Support Value Decisions
  - Early Collaboration with Stakeholders
  - Concurrently Perform Technology Trades
  - Concurrently Validate Budget Allocations
  - Architect for Future System Evolution
  - Capture the Reference Architecture
  - **BALANCE** the Solution rather than **OPTIMIZE** few Parameters

Employ System Architecting EARLY, Seek a BALANCED Solution
Aggressively Mitigate the Overall Risk Vector in the Concept Definition Phase

Questions?

Steve Saunders
Raytheon Australia

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About the Author

Steve Saunders is an Engineering Fellow of Engineers Australia and for Raytheon Australia. He received his Bachelor of Electrical Engineering, from the University of Technology Sydney (UTS) with first class Honors in 1990. He has worked with Rockwell International, Boeing Australia and now Raytheon Australia on Australian Defense projects in various Systems Engineering Management, Requirements Development, Architecture, Design and Test roles. He is a Raytheon certified architect having completed the Raytheon Certified Architect Program in 2005.

Steve has been involved in the Royal Australian Navy's Air Warfare Destroyer Program since 2005 as the Combat System Chief Architect working in phase 2 of the Program to establish the Combat System architecture. He is now the AWD Combat System Chief Engineer and Combat System design authority for the AWD.

Acronyms

- AWD Air Warfare Destroyer
- CAIV Cost as an Independent Variable
- COTS Commercial Off The Shelf
- MOTS Military Off The Shelf
- OTS Off The Shelf (generalization for COTS and MOTS)
- RAN Royal Australian Navy
- SRL System Readiness Level
- TRL Technology Readiness Level