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Customer Success Is Our Mission

11th NDIA SE Conference: Mission Analysis Impacts on Systems Engineering Fundamentals

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Raytheon IIS
22 October 2008

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Mission Analysis Impacts on Systems Engineering Fundamentals

Raytheon Information and Intelligence Systems (IIS)

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Topics

- Disaster awaits
- Mission is the context for systems engineering
- Mission analysis – building the ‘right’ mission knowledge foundation
- Tools of the trade

Disaster Awaits

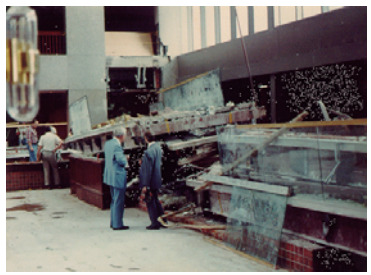
Hyatt Regency Walkway Collapse - 1981

Critical product components departed from design detail

Interface failures (connections)

Construction began before design was sufficiently mature

Moved from concept to design too quickly



117 people died

$140M cost (judgments alone)

Negative national press

Inspection for earlier significant failure limited due to scope issues

Used beyond design limitations

Communication failures

Key product 'subsystems' developed by subcontractor

Critical changes accepted via verbal approval

Mission Need Exceeded the Capability

What's Similar Between a Walkway and a Weapons System?

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- Mission should be pre-eminent in our planning and building
- Operational use will expand beyond existing design capability
- Communication too often lacks clarity, conciseness, rigor
- Prime hires others to provide piece parts for the solution
- Interfaces are high risk breakage points
- Right knowledge foundation is critical to downstream utility & quality
- Systems thinking is needed to 'rise above' limitations of scope perspectives
- Need for speed often overrides process discipline
- Disaster will strike if the foundation is not properly laid early in the game

What Impacts Are DoD Seeing Today?

- System complexity has grown dramatically since the early cold war
  - Program schedules grew from 3 - 8 years to greater than 10 years
  - Cost growth ranges from 45% to a staggering 100+%
- Of 11 major programs reviewed by the GAO, 8 had quality problems attributed to systems engineering deficiencies
- Insufficient systems engineering is applied early in the life cycle, compromising the foundation for initial requirements and architecture development
- Requirements are not always well-managed, including the effective translation from capabilities statements into executable requirements to achieve successful acquisition programs

Sources:

Pre-Milestone A and Early-Phase Systems Engineering: A Retrospective Review and Benefits of Future Air Force Acquisition, 2008 (ISBN: 0-309-11476-4)

Increased Focus on Requirements Oversight Needed to Improve DoD's Acquisition Environment and Weapon System Quality, February 2008 (GAO-08-294)

NDIA Task Report: Top 4 Systems Engineering Issues within DoD and Defense Industry, 26-27 July 2006

How Can Mission Analysis Help?

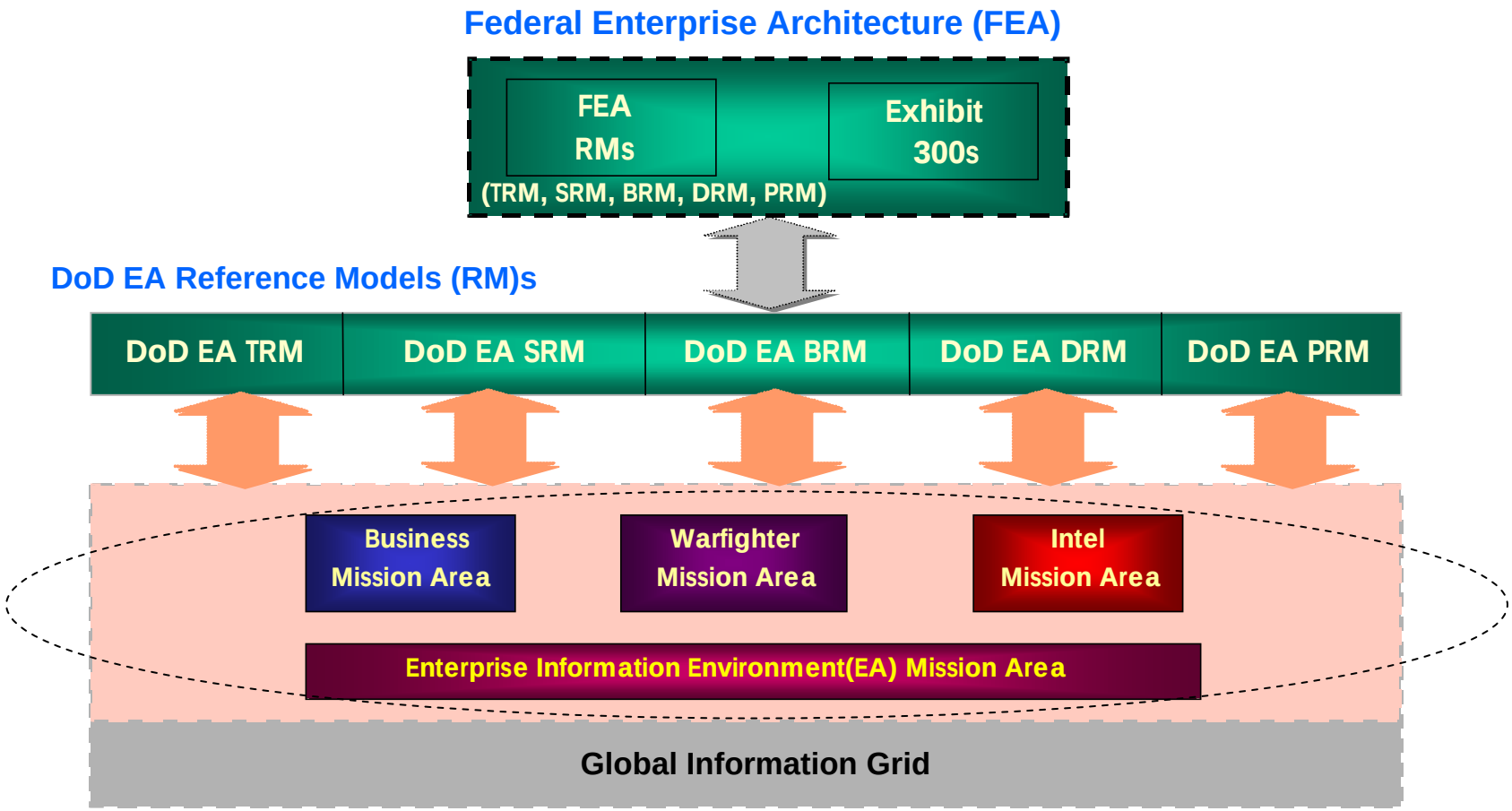
- Sound understanding of the mission is necessary for building the right mission knowledge foundation
  - For solving the right problem and close mission capability gaps
  - For creating credible operations concept and alternative solution concepts, architectures, and requirements (pre-Milestone A through system development)
  - For aligning Government-Contractor goals

- Insufficient mission analysis
  - May find contractors selling what they have in their inventories instead of what is needed to solve the problem
  - May cause us to find out too late that while we meet stated requirements, we however do not meet mission needs

Mission Needs Are 'North Star' for Systems Engineering

Mission is the Context for SE

Customer Missions and Mission Need Statements



Think Mission 1st

Mission Need Statements Address Mission Capability Shortfalls

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- ***1. Administrative Information***
- ***2. Impact on Mission Areas***
- Briefly describe the impact of the capability shortfall or technological opportunity
- ***3. Needed Capability***
- Describe the functional capability needed or technological opportunity.
- ***4. Current and Planned Capability***
- ***5. Capability Shortfall***
- ***6. Impact of Not Approving the Mission Need***
- ***7. Benefits***
- ***8. Timeframe***
- ***9. Criticality***
- ***10. Long Range Resource Planning Estimate***

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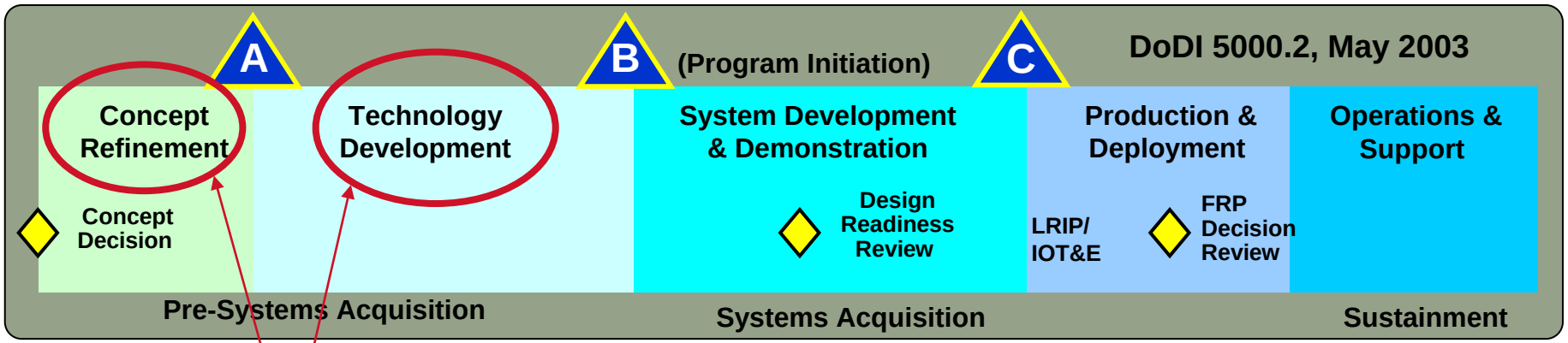
Mission Analysis – Building the ‘Right’ Mission Knowledge Foundation

JCIDS Phasing and 'Early' SE



DoD Acquisition Lifecycle

Areas of Opportunity to Lay Success-Oriented SE Foundation

- ***"Systems engineering is the overarching process that a program team applies to transition from a stated capability need to an operationally effective and suitable system" (***DoD 5000 series),
- Concept Refinement and Technology Development phases provide opportunities to work collaboratively with customers and other mission stakeholders to <u>understanding their needs and their environments</u>

Early SE is Required to Effectively Transform Capability Gaps into an Operationally Valid Mission Solution

Early Systems Engineering: Extending the Systems Engineering "V"

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Capture the Customer's Vision

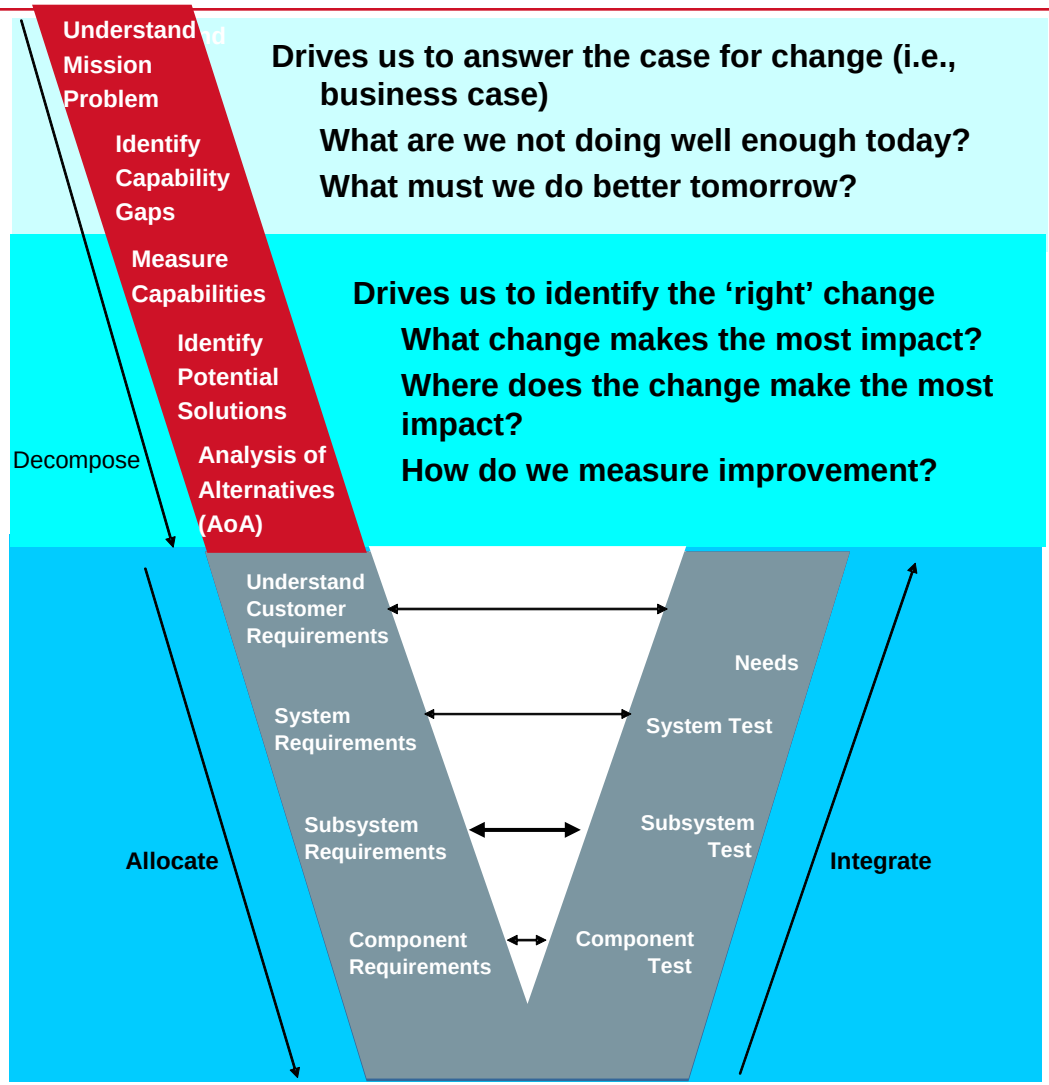
"Understand the problem"

"Define the need"

"Measure Capabilities"

"Assess Alternatives"

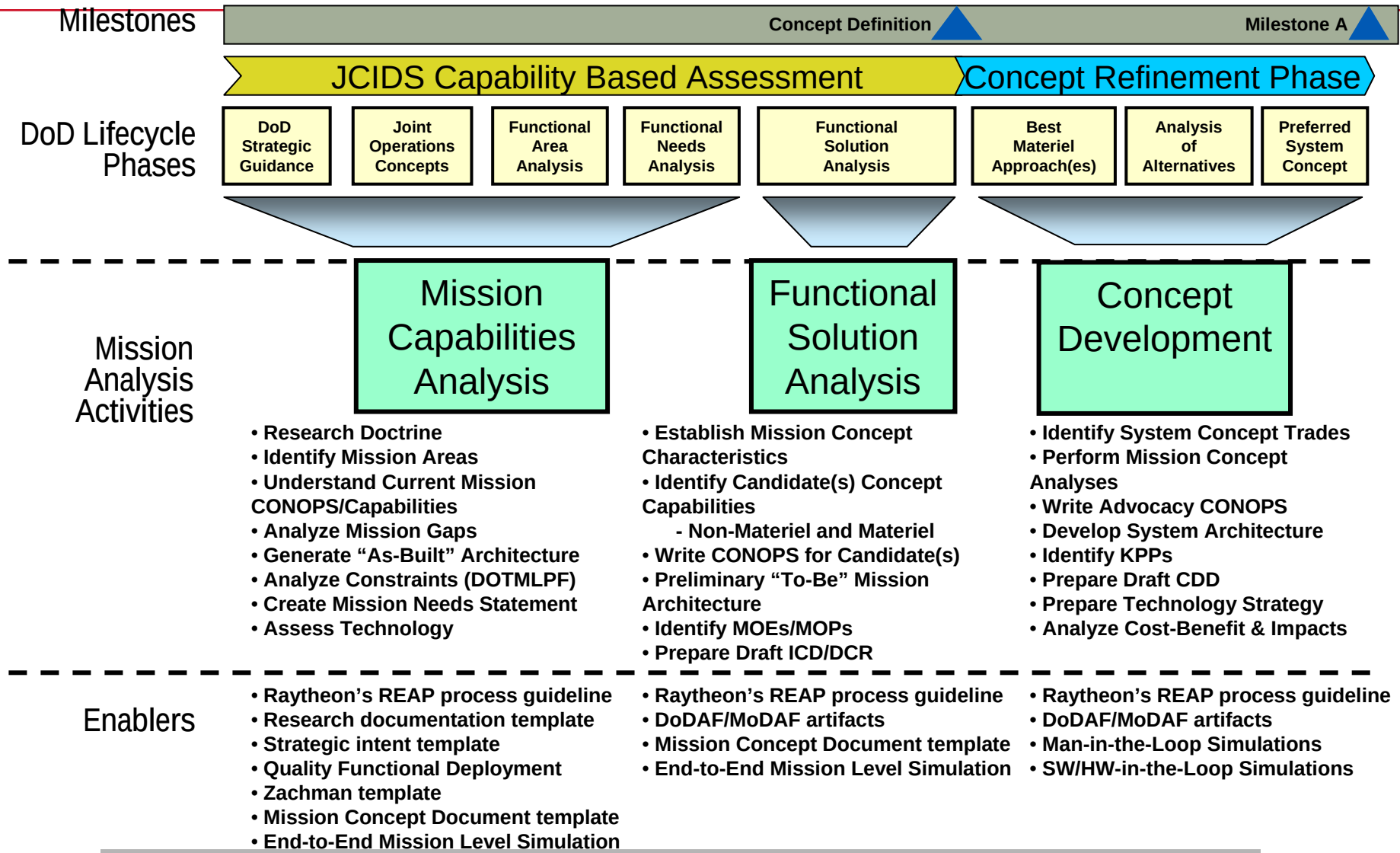
"Build this"



Extended 'V' Yields the Mission Context and Change Drivers

Adapted from Raytheon SE Symposium presentation by Adrienne Rivera

Mission Analysis Implements Early SE



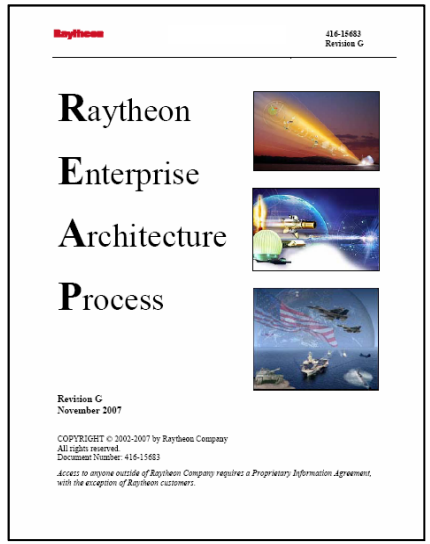
Mission Analysis is the Foundation Activity of Early SE

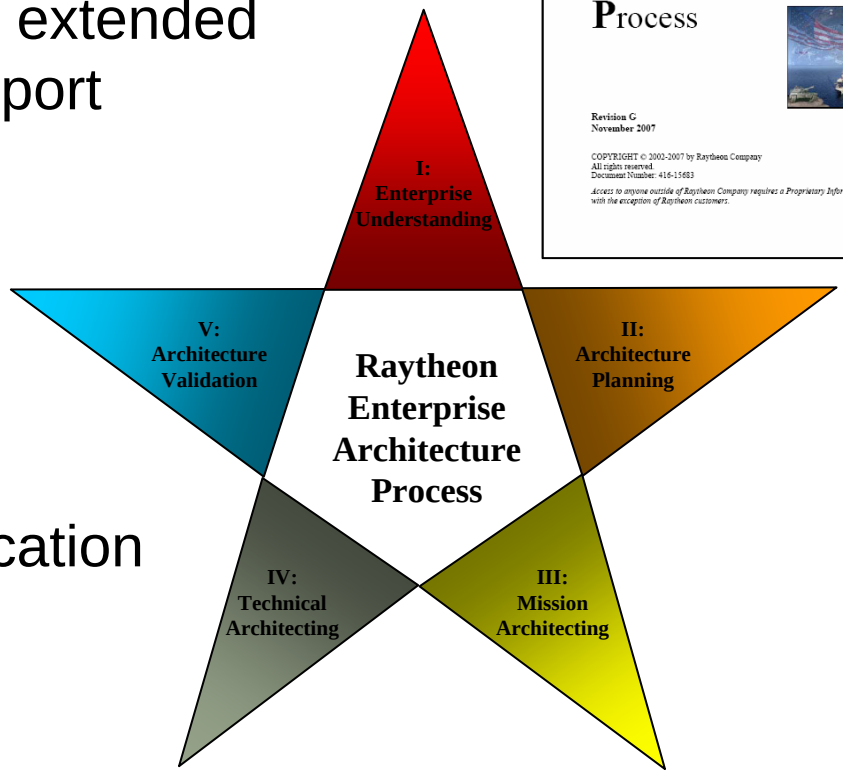
Adapted from Raytheon SE Symposium presentation by Adrienne Rivera

Tools of the Trade

Raytheon Enterprise Architecture Process (REAP) Overview

- Begins with understanding the mission and mission context
- A systems architecting process extended with enterprise architecting support
- A wrapper around established industry and government standards to "connect the dots"
- Reinforced through strict certification process





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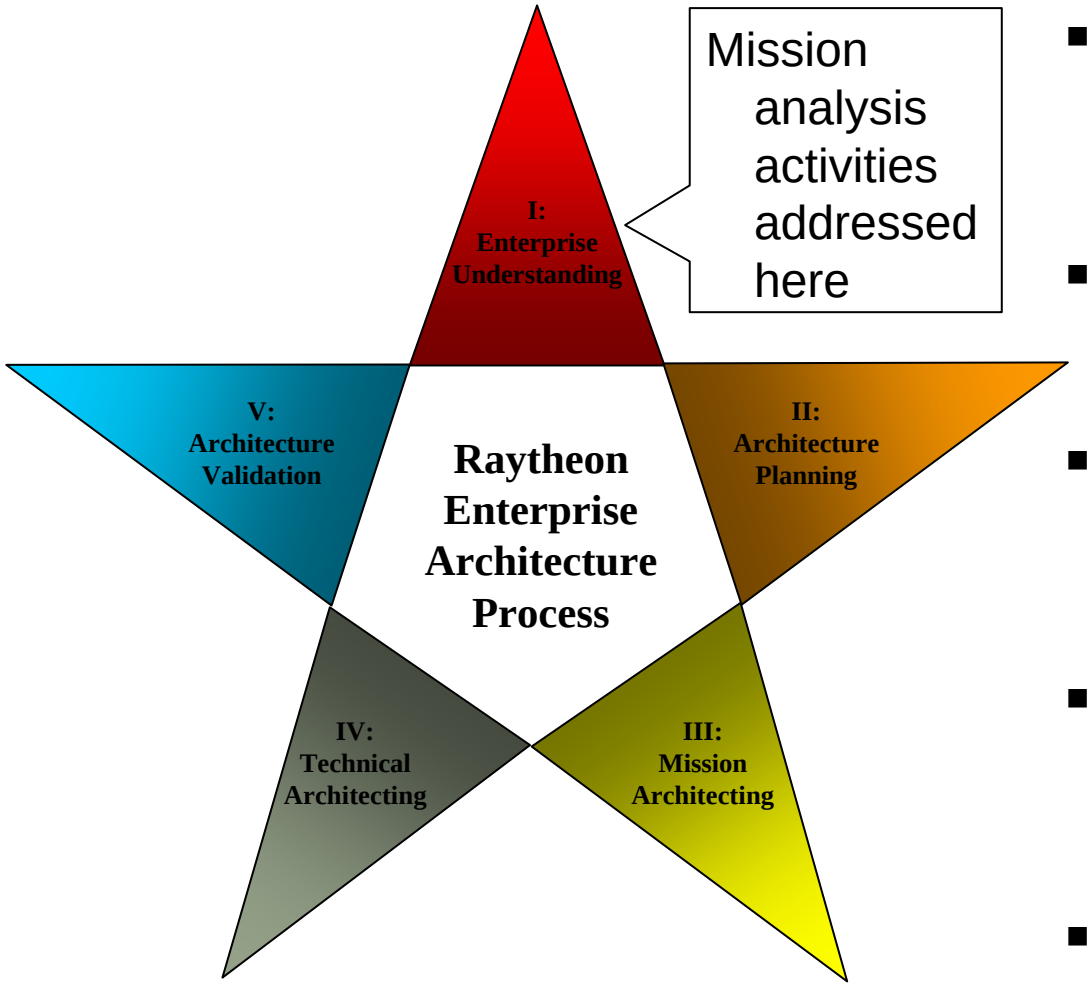
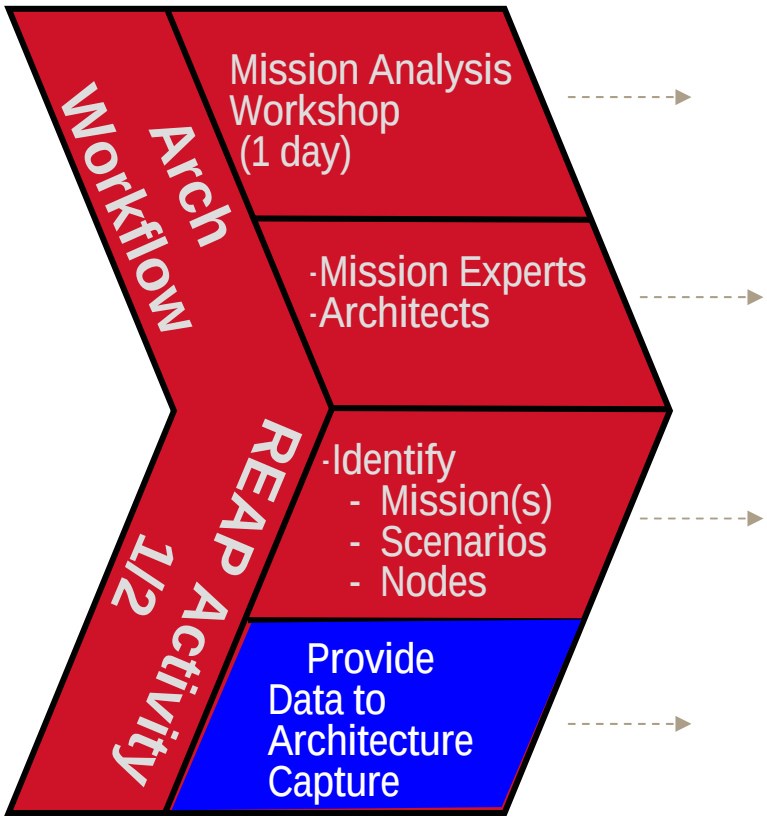
REAP Activities



- **Enterprise Understanding**
  - Understand the Customer's problem, mission gaps, constraints, and context
- **Architecture Planning**
  - Define the REAP-guided work to the appropriate level
- **Mission Architecting**
  - Document the Mission and Operational Architecture…not the Technical Architecture
- **Technical Architecting**
  - Define the Technical Architecture solution from the Mission Architecture context
- **Architecture Validation**
  - Validate the content and utility of the architecture

Workshops, Mission Analysis, and Mission Experts



- Formalizes Mission Analysis phase for large, complex programs
- Pilots have shown that workshops are good approach
- Ensures strong alignment with Mission Experts
- Uses template for Data Capture (AV-2s, AV-1, QFDs, etc.)
- Captures mission definition, gaps, challenges, timeframe for target architecture
- Stakeholders may desire to validate output and identify any actions before proceeding to downstream activities

Mission Area Quality Functional Deployment (QFD) Template

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PACOM Fires Mission)	Relative importance to mission	Capability 1	Capability 2	Capability 3	Capability 4	Capability 5	Capability 6	Capability 7	Capability 8	Capability 9	Average Opportunity score	Weighted Score			
Scenario 1 (Use Case) - as is state											0	0			
Desire State															
Scenario 2 (Use Case) - as is state											0	0			
Desire State															
Scenario 3 (Use Case) - as is state											0	0			
Desire State															
Scenario 4 (Use Case) - as is state											0	0			
Desire State															
Scenario 5 (Use Case) - as is state											0	0			
Desire State															
Scenario 6 (Use Case) - as is state											0	0			
Desire State															
Scenario 7 (Use Case) - as is state											0	0			
Desire State															
Scenario 8 (Use Case) - as is state											0	0			
Desire State															
Scenario 9 (Use Case) - as is state											0	0			
Desire State											0	0			

1 is low correlation
10 is high correlation

Simple Tool to Correlate Mission Needs & Capabilities

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Applied Mission Area QFD Example

	Find, Fix, Track Individuals of Interest - As Is State Locating "JFC's Most Wanted People"	Relative importance to mission	SIGINT	IMINT	Video	HUMINT	MASINT	Multiple Intel Source Aggregation	KM/KD	Open Source Exploitation	Cyberspace Exploitation	Biometrics	Resource Management	Average Opportunity score	Weighted Score				
	Get Tip from Sources (Forces in Contact, Other Govt Agencies, LE, SOF, Open Source, Alliance Partners)	6	5	5	5	5	5	5	5	5	5	5	5	5	30				
	Desire State	6	8	8	8	8	8	8	8	8	8	8	8	8	48				
	Identify Target	9	4	4	4	4	4	4	4	4	4	4	4	4	36				
	Desire State	9	6	6	6	6	6	6	6	6	6	6	6	6	54				
	Confirm Target (in Probability Terms)	7	7	7	7	7	7	7	4	4	4	4	4	6	39				
	Desire State	7	7	7	7	7	7	7	7	7	7	7	7	7	49				
	Fix	6	4	4	4	4	4	4	0	0	0	0	0	2	13				
	Desire State	6	6	6	6	6	6	6	3	3	3	6	3	5	29				
	Track	7	8	8	8	8	8	8	8	8	8	8	8	8	56				
	Desire State	7	7	8	8	8	8	8	8	8	8	8	8	8	55				
	Gather Additional Situation Awareness Info As Needed	4	6	6	6	6	6	6	6	6	6	6	6	6	24				
	Desire State	4	6	6	6	6	6	6	6	6	6	6	6	6	24				
	Discern Intent	7	2	2	2	2	2	2	2	2	2	2	2	2	14				
	Desire State	7	8	8	8	8	8	8	8	8	8	8	8	8	56				
	Tag	5	3	3	3	3	3	3	3	3	3	3	3	3	15				
	Desire State	5	7	7	7	7	7	7	7	7	7	7	7	7	35				

Identifies the Best 'Focus Area' Opportunities

Mission Analysis Feeds Back to the Mission

- ***1. Administrative Information***
- ***2. Impact on Mission Areas***
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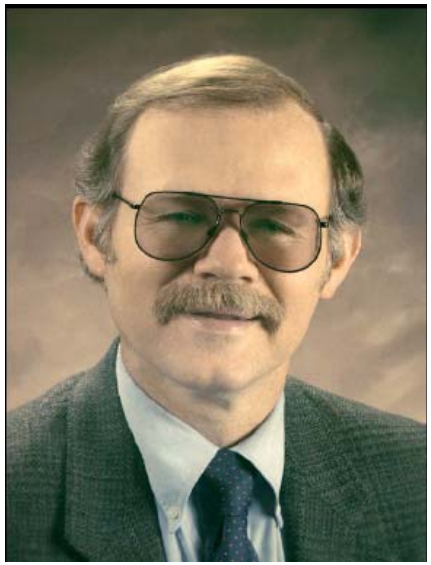
- ***10. Long Range Resource Planning Estimate***

Mission analysis activities and artifacts address items 2 thru 5

Acronyms

1) BRM – Business Reference Model
2) DOTMLPF – Doctrine, Organization, Training, Materiel, Leadership & education, Personnel, Facilities
3) DRM – Data Reference Model
4) FEA (Federal Enterprise Architecture)
5) PRM – Performance Reference Model
6) SRM – Service Component Reference Model,
7) TRM – Technical Reference Model
8) UJTL – Unified Joint Task List

Bio – John T McDonald



John T McDonald

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- BS in Mathematics
- BS in Computer Science
- MS in Physics
- MS in Computer Science

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- RTN Six Sigma Expert
- Raytheon Certified Architect
- Chief Engineer /Chief Architect IIS
- RTN Garland Site Council
- RTN IIS Technology Team
- University of Texas At Dallas Industry Advisory Board

Summary of Experience

John has close to 25 years of experience in Intelligence Community and DoD Software and Systems Engineering. John has served as lead and chief engineer on numerous systems and led an organization of aprox 100 SW Systems Engineers for over 7 years. John also lead the Object Technology Center at Garland for 5 years in the early and mid 90s.

John is currently the Chief Engineer and Chief Architect of IIS. John was a founding member of the RTN Architecture Review Board and formed a team that planned and realized the initial REAP (Raytheon Enterprise Architecture Process) which is the RTN wide architecture process and methodology.

Bio – David W Rhodes

David W Rhodes

(dwrhodes@raytheon.com)

- BS in Computer Science
- MS in Systems Management
- DMSC/DAU Advance Program Managers Course
- PMI™ Project Management Professional

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- RTN Six Sigma Expert
- RTN IIS SE Council Co-chair
- Colorado State University Industry Advisory Council (ISTeC-IAC)

Summary of Experience

David Rhodes has worked at Raytheon Space Systems in Aurora, CO since 2001 and is currently the IIS Systems Engineering Council Co-chair and a member of the Raytheon corporate Systems Engineering & Technology Council. David has over 20 additional years in the aerospace industry performing in a variety of mission analysis, systems engineering, program management, and business development roles. David is a graduate of the DSMC Advanced Program Manager's Course and Systems Engineering Management course. David has an MS in Systems Management from the University of Southern California and a BS in Computer Science from the University of Maryland. David is also a member of the Industry Advisory Council for Colorado State University's Information Systems and Technology Center.