Acquisition Research Program:
Creating Synergy for Informed Change

Dynamic Multipoint Optimization Application to Corporate Portfolio Management

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Naval Postgraduate School

Presentation Overview

1 Introduction
2 System Development Challenges
3 Need for an Integrated Environment
    3.1. What is a Lifecycle Framework?
    3.2. What are Maturity Metrics?
    3.3. Push for Portfolio Management
4. Developing a CPM Strategy
    4.1. Four Key Questions
    4.2. Portfolio Enterprise View
    4.2. Lifecycle Portfolio Management
5. Summary and Conclusion
6. List of References

Introduction

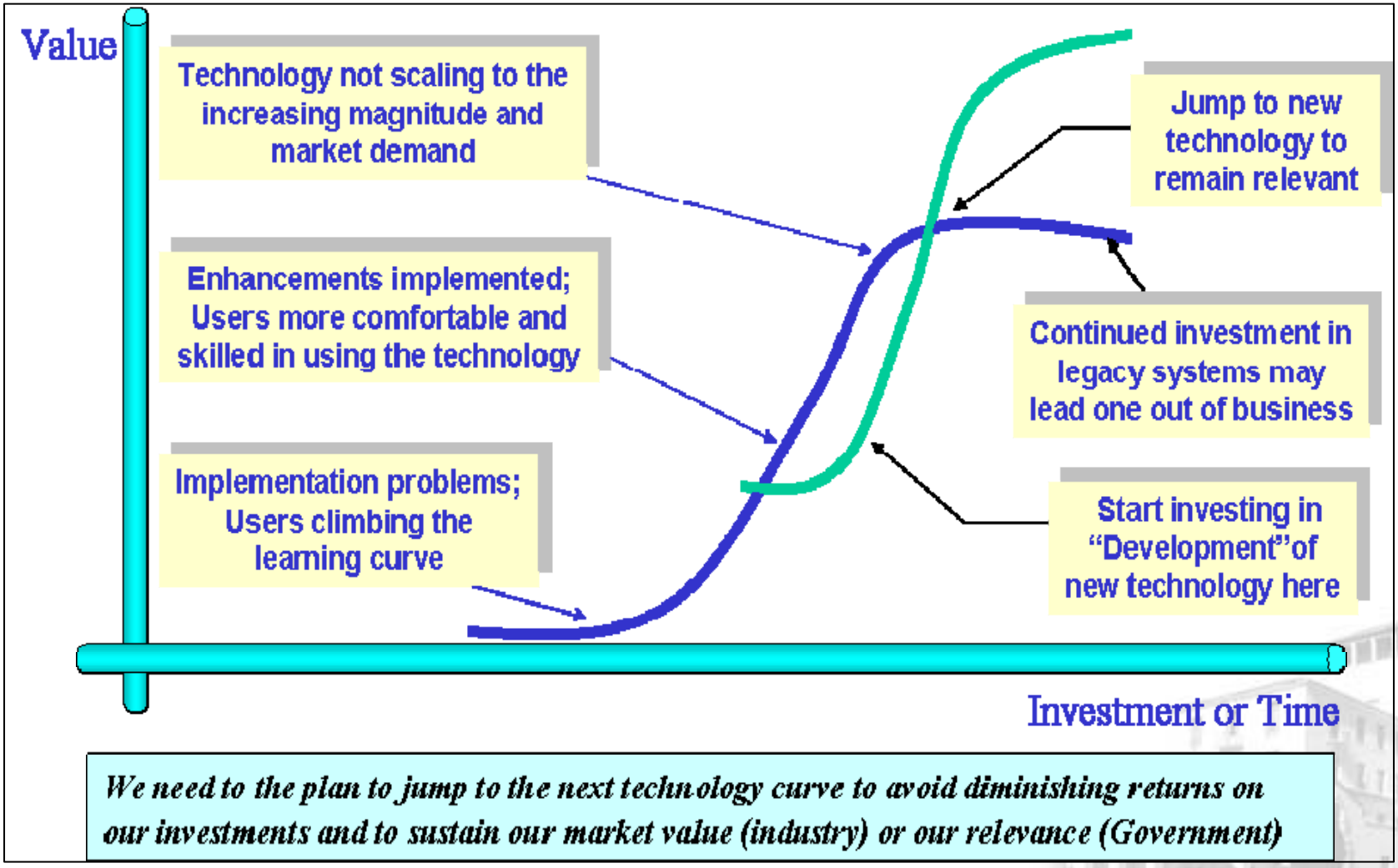
- Increasing number of major DOD system development programs experiencing difficulties and failing to achieve their intended goals successfully.

- Resulting in:
  - Cost overruns
  - Program delays
  - Program cancellations
  - Unacceptable system performance.

System Development Challenges

- Systems have become far more complex
- Increased data demand requirements
- Operating in a net-centric environment
- Increasing threats to system security
- Rapid development cycle
- Rapid technology obsolescence
- Funding constraints
- Experienced workers.

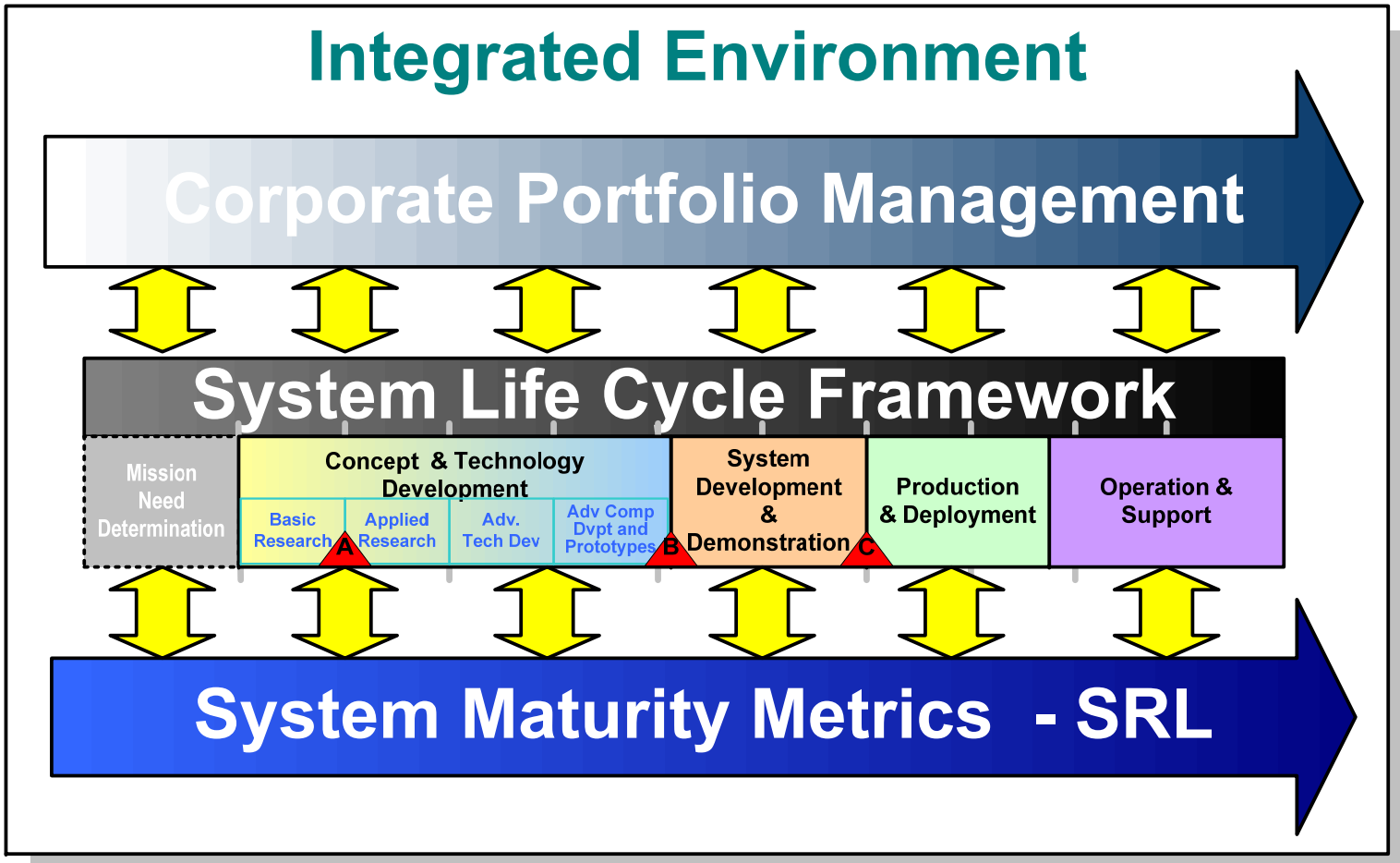
System Development Challenges - "S"Curves



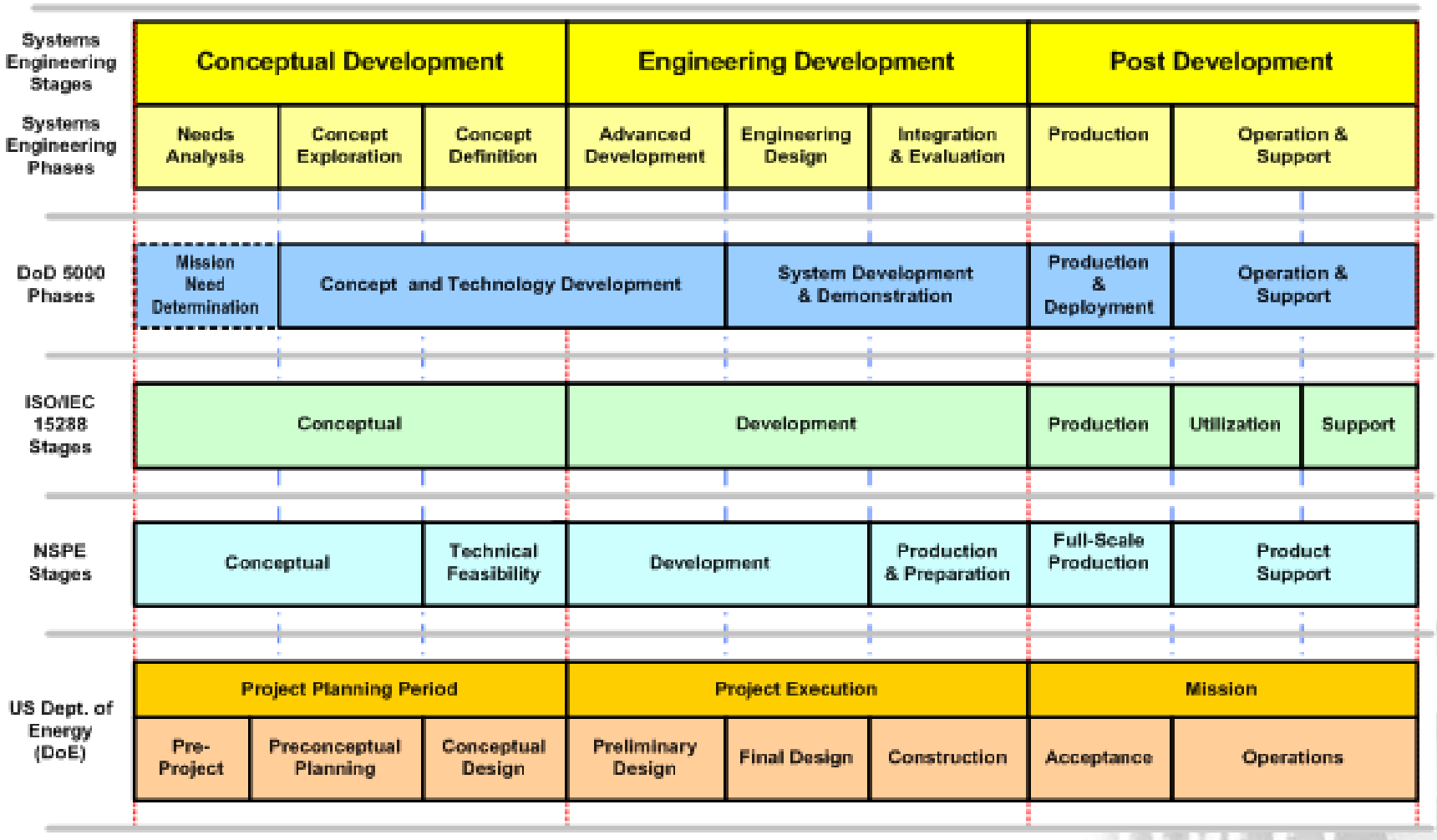
System Development Challenges

- According to various GAO studies of DOD technology development practices, reasons for these difficulties are the inability to assess technical maturity of complex systems during development
- 1999 - GAO report reviewing major defense acquisition programs and analyzing the causes and reasons for a majority of them and their failure to meet at least a TRL 7 level before entering the system development phase.
- 2008 - GAO report showed an increase from the previous year in the number of programs with immature technologies still maturing technologies late into the system development and production live cycles. (9 yrs after similar report)
- 2007 – DoD Report to Congress – Need to Establish a Process to Enable a “Systematic Approach to Product Development”

Need for an Integrated Environment



Life Cycle Frameworks



What are Maturity Metrics?

- What are Maturity Metrics? - Metrics supporting the lifecycle assessment of a system or technology's state of progress or development.

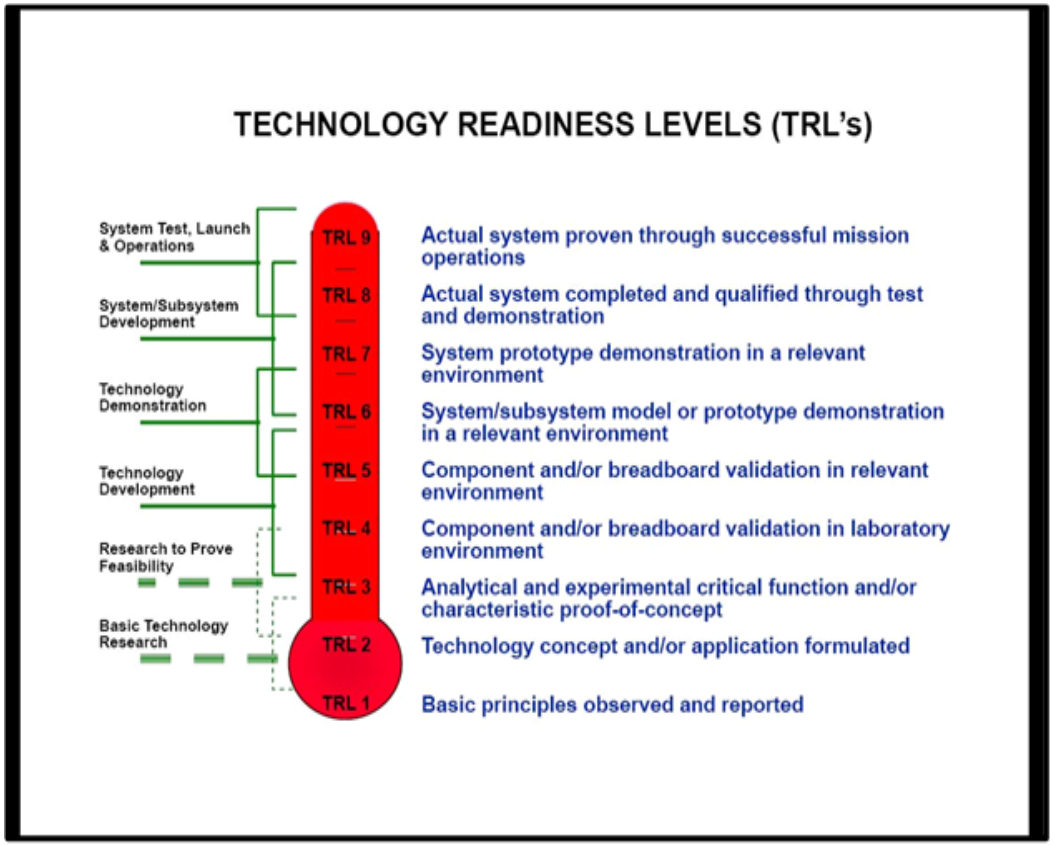
- We have made considerable improvements in the area of improved software IT systems to perform financial status tracking and monitoring metrics of system development.

- Importance? - Assessment of the maturity level of the systems and technologies are a critical factor in the decision making process throughout the system development lifecycle.

What do we have now?

- Technology Readiness Levels (TRLs)

- Describes the maturity level of a technology (9 levels)
- Introduced by NASA for their space programs
- Later adapted for use by other agencies (DoD)
- Supports the maturity assessment of individual technologies well
- Doesn't address assessment of systems involving multiple technologies.



What's New in Maturity Metrics

- System Readiness Level (SRL)

- Describes the maturity level of a system comprised of multiple technologies (9 levels)
- Proposed by Stevens Institute of Technology to address need for system maturity metrics for multi-technology based system development not address by current TRL metrics
- SRL Model – Incorporated currently used TRL index with new index, Integration Readiness Level (IRL).
- IRL describes how the system components are integrated together. (related to physical architecture of system)

What's New in Maturity Metrics -Integration Readiness Levels

STEVENS Institute of Technology

SSE School of Systems & Enterprises

Integration Readiness Level

A systematic measurement of the interfacing of compatible interactions for various technologies and the consistent comparison of the maturity between integration points.

Integration – the combining and coordinating of separate components into a seamless unit – interfacing the compatible interactions of various technologies together

	IRL	Definition
Pragmatic	9	Integration is **Mission Proven** through successful mission operations.
	8	Actual integration completed and **Mission Qualified** through test and demonstration, in the system environment.
Syntactic	7	The integration of technologies has been **Verified and Validated** with sufficient detail to be actionable.
	6	The integrating technologies can **Accept, Translate, and Structure Information** for its intended application.
	5	There is sufficient **Control** between technologies necessary to establish, manage, and terminate the integration.
	4	There is sufficient detail in the **Quality and Assurance** of the integration between technologies.
Semantic	3	There is **Compatibility** (i.e. common language) between technologies to orderly and efficiently integrate and interact.
	2	There is some level of specificity to characterize the **Interaction** (i.e. ability to influence) between technologies through their interface.
	1	An **Interface** between technologies has been identified with sufficient detail to allow characterization of the relationship.

Gove, R. (2007) *Development of an Integration Ontology for Systems Operational Effectiveness.* M.S. Thesis. Stevens Institute of Technology. Hoboken, NJ
Gove, R., B. Sauser, J. Ramirez-Marquez. (2007). "Integration Maturity Metrics: Development of an Integration Readiness Level." *International Journal of Technology Management* (under review)

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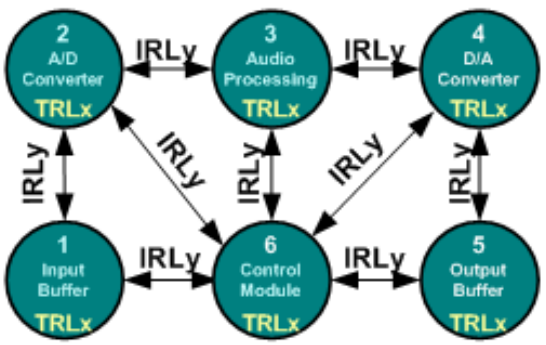
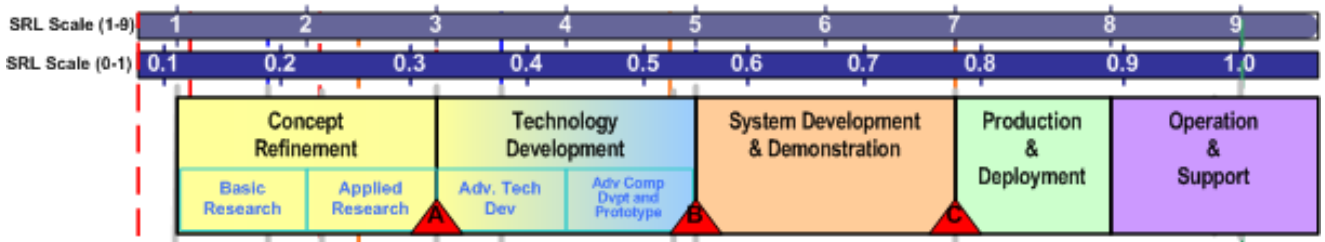
Applying the SRL - Example 1



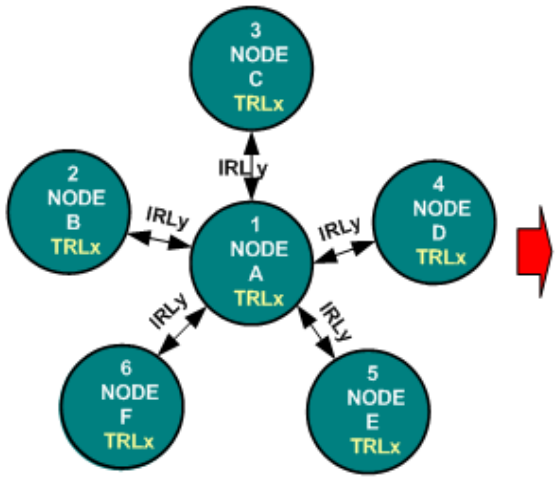
IRL Matrix

TRL	Tech	1	2	3	4	5	6
x	1	9	y	0	0	0	y
x	2	y	9	y	0	0	y
x	3	0	y	9	y	0	y
x	4	0	0	y	9	y	y
x	5	0	0	0	y	9	y
x	6	y	y	y	9	y	9



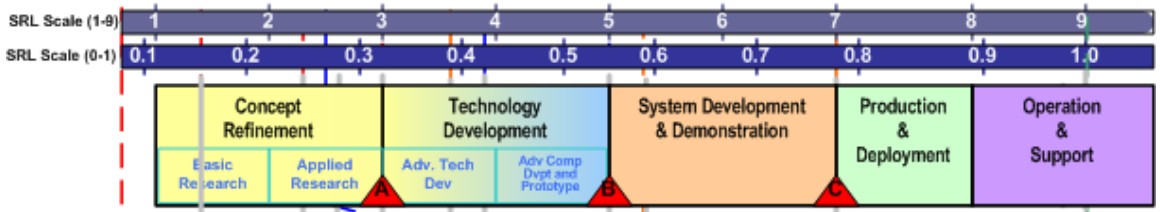
SRL Composite	0.038	0.115	0.224	0.333	0.192	0.370	0.555	0.268	0.523	0.777	1.000
SRL1	0.045	0.136	0.234	0.333	0.226	0.390	0.555	0.316	0.546	0.777	1.000
SRL2	0.037	0.111	0.222	0.333	0.185	0.370	0.555	0.259	0.518	0.777	1.000
SRL3	0.037	0.111	0.222	0.333	0.185	0.370	0.555	0.259	0.518	0.777	1.000
SRL4	0.037	0.111	0.222	0.333	0.185	0.370	0.555	0.259	0.518	0.777	1.000
SRL5	0.045	0.136	0.234	0.333	0.226	0.370	0.555	0.316	0.546	0.777	1.000
SRL6	0.029	0.086	0.210	0.333	0.144	0.349	0.555	0.201	0.489	0.777	1.000
TRLs,IRLs	1,1	3,1	3,5	3,9	5,1	5,5	5,9	7,1	7,5	7,9	9,9
Step	1	2	3	4	5	6	7	8	9	10	11

Applying the SRL - Example 2



IRL Matrix

TRL	Tech	1	2	3	4	5	6
x	1	9	y	y	y	y	y
x	2	y	9	0	0	0	0
x	3	y	0	9	0	0	0
x	4	y	0	0	9	0	0
x	5	y	0	0	0	9	0
x	6	y	0	0	0	0	9



SRL Composite	0.057	0.169	0.251	0.333	0.282	0.418	0.555	0.394	0.585	0.777	1.000
SRL1	0.029	0.086	0.210	0.333	0.144	0.349	0.555	0.201	0.489	0.777	1.000
SRL2	0.062	0.185	0.259	0.333	0.309	0.432	0.555	0.432	0.604	0.777	1.000
SRL3	0.062	0.185	0.259	0.333	0.309	0.432	0.555	0.432	0.604	0.777	1.000
SRL4	0.062	0.185	0.259	0.333	0.309	0.432	0.555	0.432	0.604	0.777	1.000
SRL5	0.062	0.185	0.259	0.333	0.309	0.432	0.555	0.432	0.604	0.777	1.000
SRL6	0.062	0.185	0.259	0.333	0.309	0.432	0.555	0.432	0.604	0.777	1.000
TRLs,IRLs	1,1	3,1	3,5	3,9	5,1	5,5	5,9	7,1	7,5	7,9	9,9
Step	1	2	3	4	5	6	7	8	9	10	11

Push for Portfolio Management

- **DoD:** Joint Net-Centric Operations (JNO) group adopted a capability portfolio management process to ensure that the portfolio is aligned with strategic objectives, and the capability mix synchronized, integrated, and optimized to meet warfighter needs, rapidly and efficiently. (JNO. 2007, April).
- **CPM Highlights:**
  - Ideal for large programs (multiple projects)
  - Focuses on Project Selection, Prioritization, Resource Allocation, Strengths/Weakness of each project
  - Identifies Gaps/future development opportunities
  - Determines/manages optimal mix of development projects to achieve capability goals and objectives

Developing a CPM Strategy

Four Key Questions:

1. What are we Trying to Accomplish?

   (Euphoria)

2. What can we do now?

   (Herd the Cats)

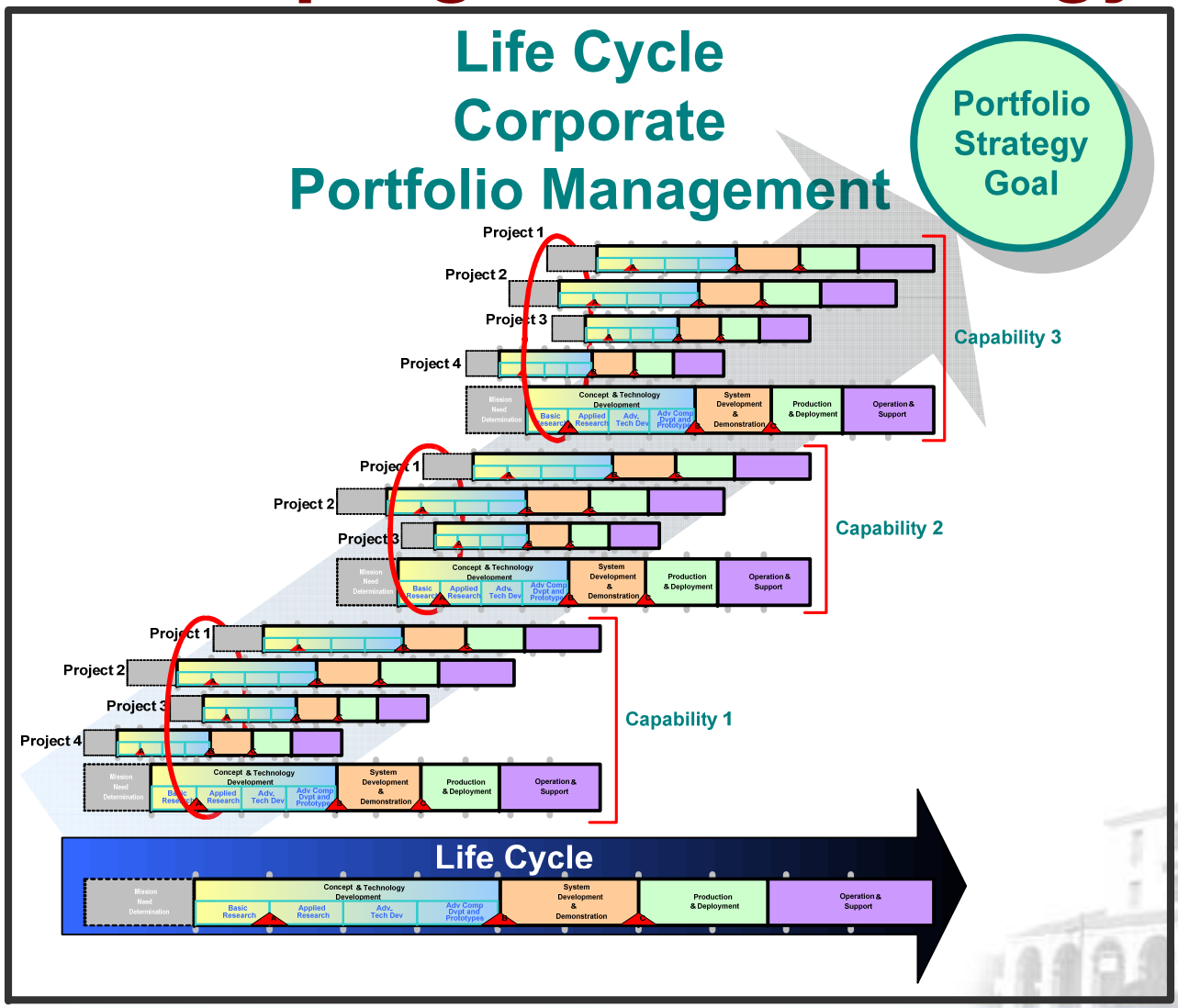
3. What is our Plan to get There?

   (Road to Euphoria)

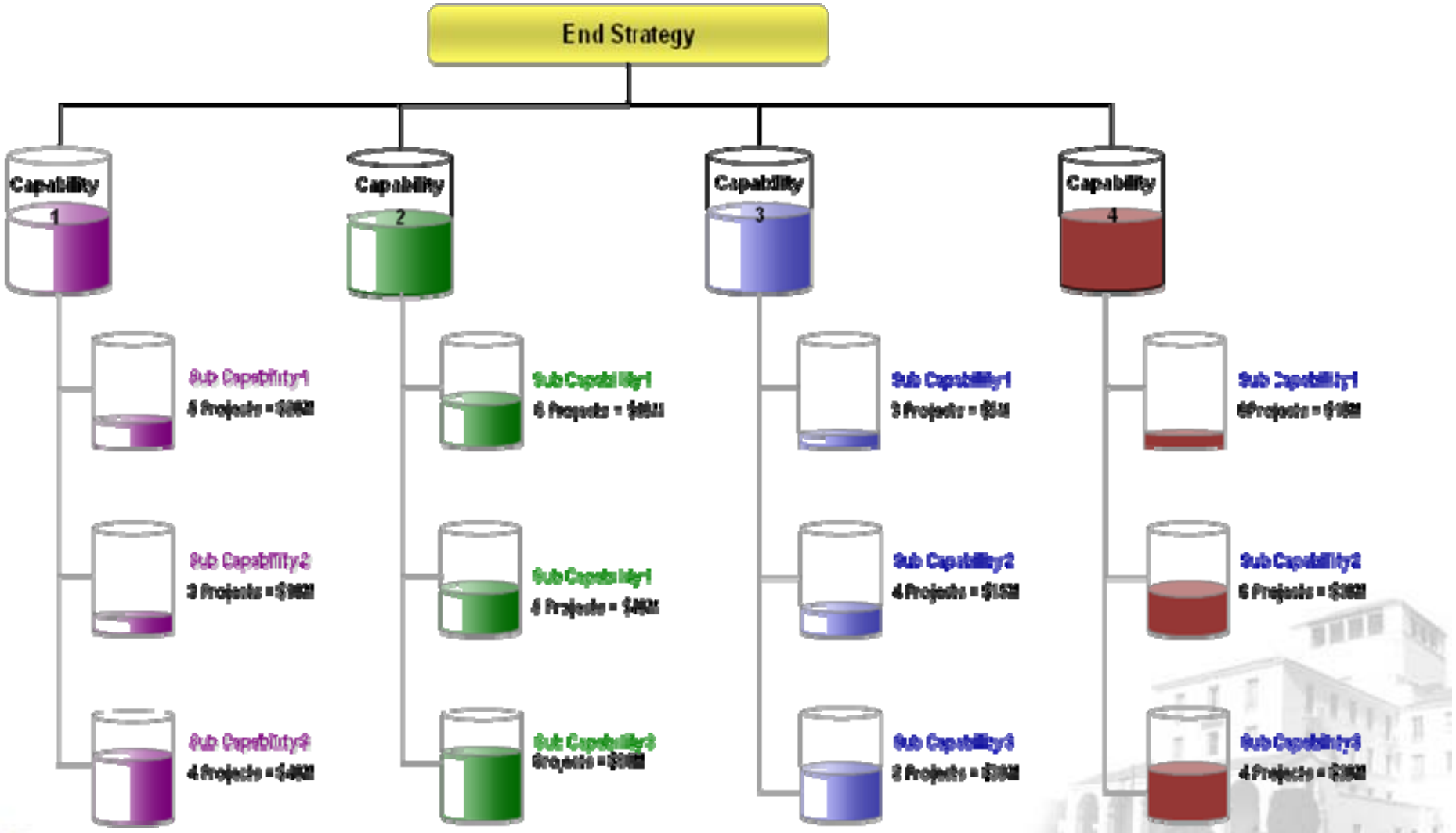
4. How are we Doing?

   (Metrics)

Developing a CPM Strategy



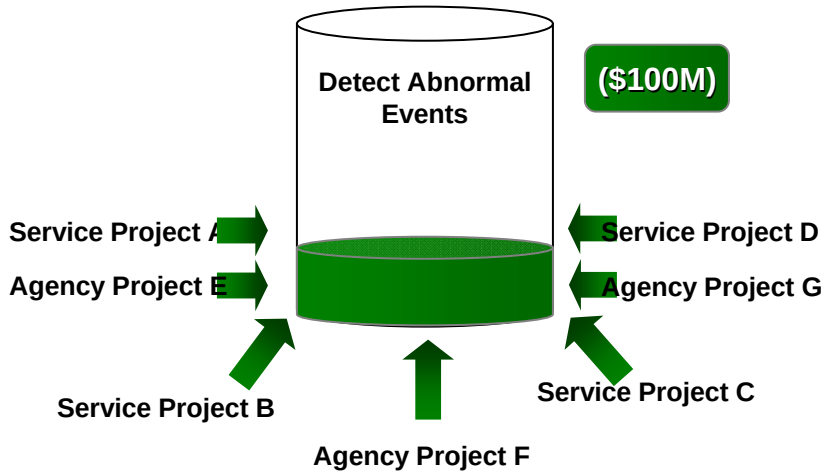
Developing a CPM Strategy - Enterprise View



Developing a CPM Strategy - Approaches

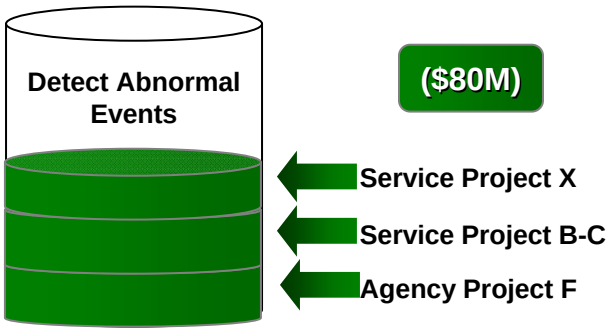
Non-Enterprise Approach:

Multiple concurrent, stove-piped projects without consistent focus reduces effectiveness of capability



Enterprise Approach:

Analysis of all projects with future objectives reduces redundancy and increases capability

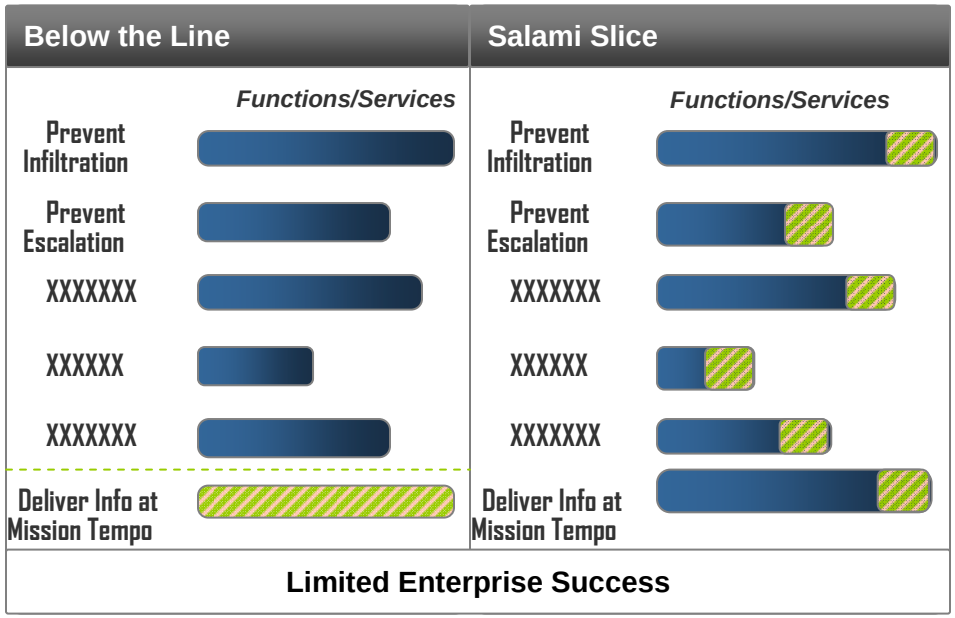


Recommendations:

- Keep Agency Project F
- Combine Service Project B&C
- Add new Service Project X
- Reallocate $20M savings to other investments
- Disinvest in redundant Projects (A,D,E and G)

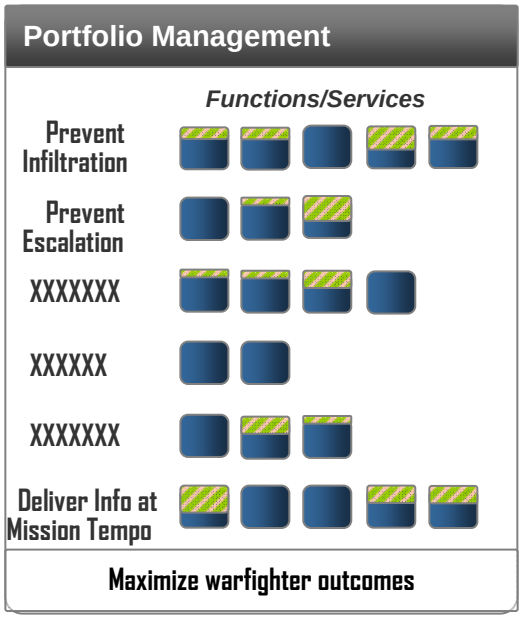
Developing a CPM Strategy - Approaches

Service/Agency Historical Approach



- Duplication
- Capabilities lost
- Are investments funding the high priority projects?

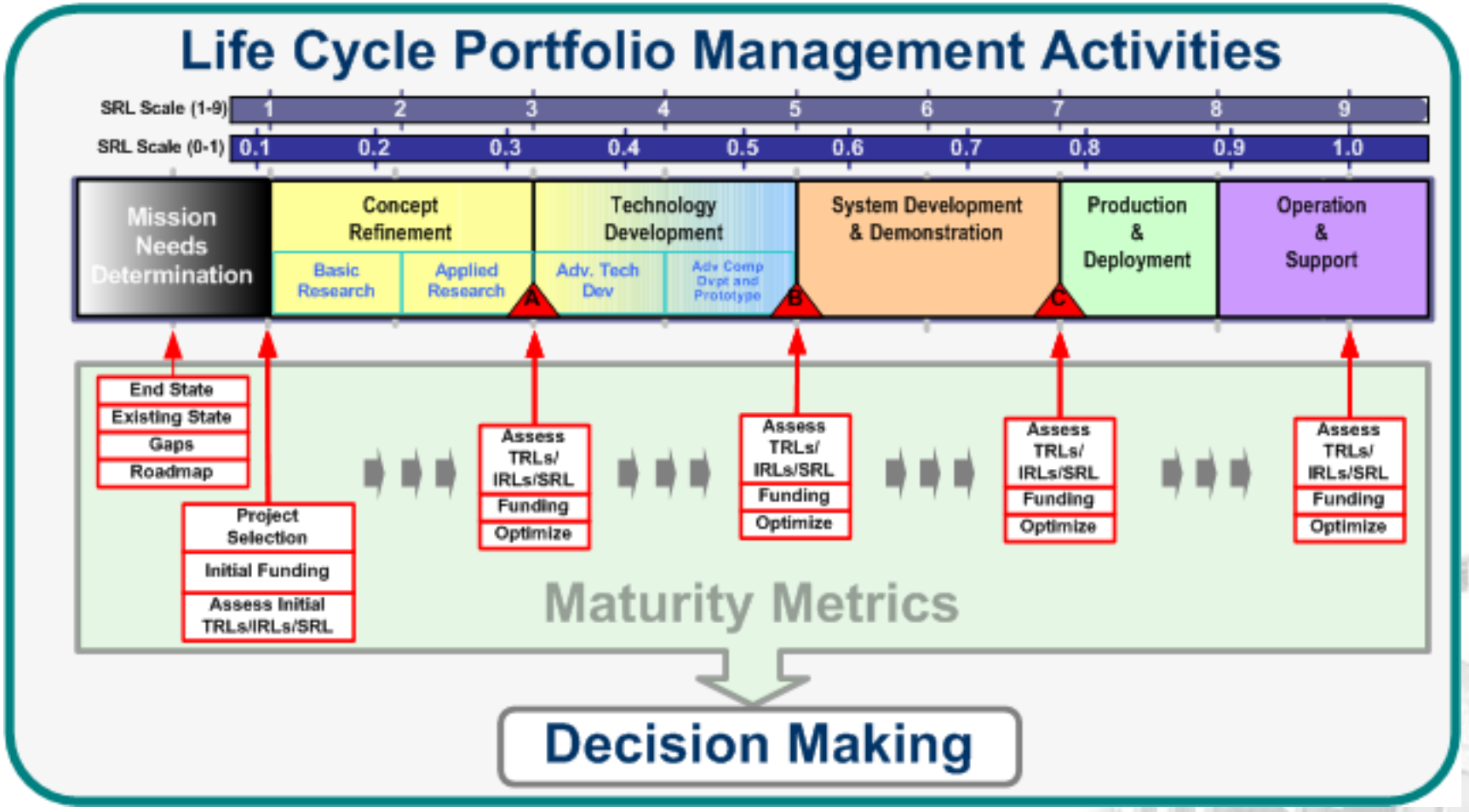
Enterprise Approach



- Justify investments in enterprise environment
- Synchronize investments to deliver maximum capabilities
- Protect investments from “below the line”/ “salami slice” budget cuts
- Identify/Address Gaps

Developing a CPM Strategy

Lifecycle CPM Metrics



Developing a CPM Strategy

Optimization Models

Provide great insight and support to trade-off analysis and decision making throughout the system development lifecycle.

- **SCOD Min -** Minimizes development cost (a function of TRL and IRL development) to some predefined user level, λ, under constraints associated with schedule and required SRL value (Magnaye, Ramirez-Marquez, & Tan, 2008).
- **SRL Max -** Maximizes the SRL (a function of TRL and IRL) under constraints associated with optimal allocation of resources. (Sauser & Ramirez-Marquez, 2009).

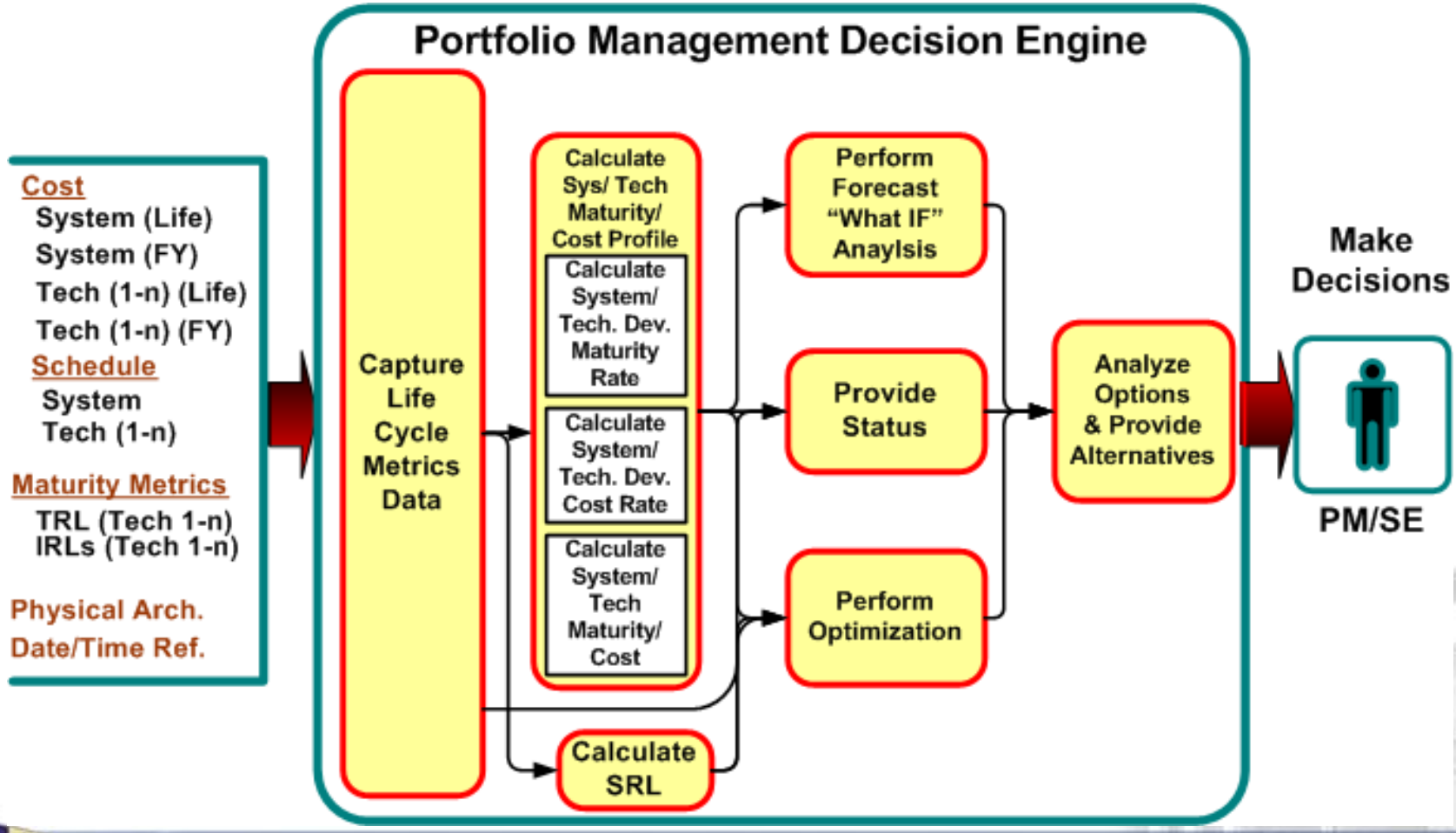
Developing a CPM Strategy

Decision Making - Complex due to many elements and events that need to be understood, analyzed, in a real-time manner.

- Pressures of schedule, cost and performance still hold true with added real-time element.
- Allocation of Resources to investments (Funding/Manpower)
- Corrections to mix of research investments in reaction to introduction of new technologies
- Optimal mix of research development investments to achieve capability goals

Developing a CPM Strategy

Decision Making



Summary and Conclusion

Introduction of the following:

- Integrated approach to ensure the CPM process and system maturity assessment process are synchronized to a lifecycle framework.
- Application of a SRL methodology to multi-technology based system development in a CPM environment
- CPM strategy and decision making process

Summary and Conclusion

Future Research

- System maturity metrics to benefit and improve performance of existing DOD system development programs.
- Application of SRL metrics to support CPM environment.
- Development of integrated S/W tools to support SE, CPM and Road Mapping capabilities.
- Identification of additional maturity metric variables needed to support the decision making process?
- Application of SRL model to other life cycles outside DoD.
- Robustness of SRL model to variety of differing physical architectures.
- Impacts of disruptive technologies on systems maturity forecasting.
- SRL applications to COTS environment and lifecycle development
- Addition of other variables to SRL model – security readiness

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