

**S&T Portfolio Maturity & Performance Analysis:
The Concept of Critical Research Elements (CREs)**

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Motivation: US Innovation Agenda

A Critical Need identified by the highest office in the USA

EXECUTIVE OFFICE OF THE PRESIDENT
NATIONAL ECONOMIC COUNCIL
OFFICE OF SCIENCE AND TECHNOLOGY POLICY

A STRATEGY FOR AMERICAN INNOVATION:
DRIVING TOWARDS SUSTAINABLE GROWTH AND QUALITY JOBS

History should be our guide. The United States led the world's economies in the 20th century because we led the world in innovation. Today, the competition is keener; the challenge is tougher; and that is why innovation is more important than ever. It is the key to good, new jobs for the 21st century. That's how we will ensure a high quality of life for this generation and future generations. With these investments, we're planting the seeds of progress for our country, and good-paying, private-sector jobs for the American people."

-President Barack Obama, August 5, 2009



A Strategy for American Innovation:

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US Innovation Agenda: Salient Points

Innovation Funding at an Unprecedented Scale !!

A Strategy for American Innovation: Driving toward Sustainable Growth and Quality Jobs

- Double R&D budget for key R&D agencies (inc. NSF)
- Invest 3 % of GDP in R&D (Public and Private sectors)
- Use innovation to improve government programs at all levels of government
- Harness science and technology to address the "Grand Challenges" of the 21st century.
- A number of other directions (increase in Graduate Research Fellowships, Academic funding, etc ...)

Strategic Issues: Meeting the Challenges

Innovation Management Needs Recognized

■ **Office of the President** : [A Strategy for American Innovation: Driving toward Sustainable Growth and Quality Jobs](#)

■ **Private Organizations**: Recent Gartner Group, Deloitte and IBM studies have said Innovation is the “top of the mind” for corporate and public CEOs. Recent IBM study, titled: “Expanding the Innovation Horizon” concluded that:

- Business Model Innovation Matters: Business process innovation
- External Collaboration is Indispensable: Collaboration beyond the walls
- Innovation requires Orchestration from the top: Strategic commitments, teams, rewards and technology/process integration

■ **Department of Defense**: DoD Force Transformation:

- Support the Joint Warfighting Capability of the DoD
- Enable Rapid Access to Information for Strategic Decisions
- Reduce the Cost of Defense Business Operations
- Improve Financial Stewardship to the American People

Strategic Issues: Innovation Management is Art

Call to Action: An Innovation Management model which incorporates rigor, metrics and discipline



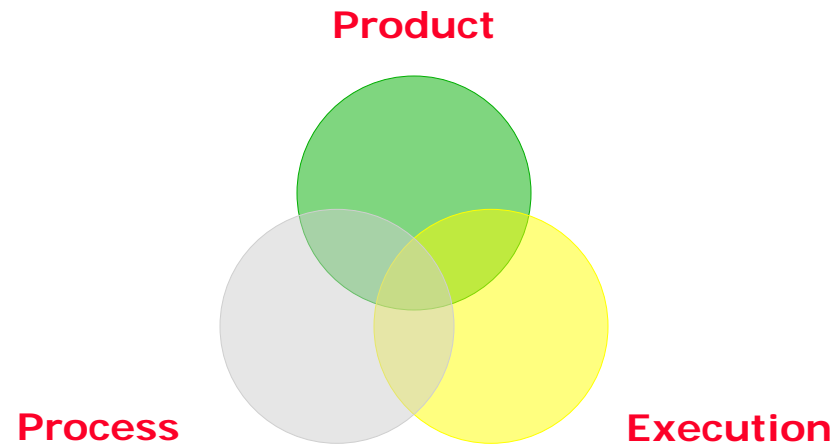
- Innovation should be held as same measurement rigor as other core functions.
- Innovation Opportunity Is About How the Process is Managed – Not Just Ideas and Creativity
- Improving Innovation is not Beyond Leaders' Control – It must be measured and controlled
- Key Innovation Mistakes: Not Emphasizing Speed, and Not Managing with Discipline and Aggressiveness



- [DoD Report to the Congress on Technology Transition, July 2007](#). Conclusion – Disconnect between S&T and Acquisition Programs
- Best Practices: Stronger Practices Needed to Improve DOD Technology Transition Processes [GAO-06-883](#) Concussion – Immature Technology insertion causes cost and time escalation

Innovation Management Model

Innovation = f (Product, Process, Execution)



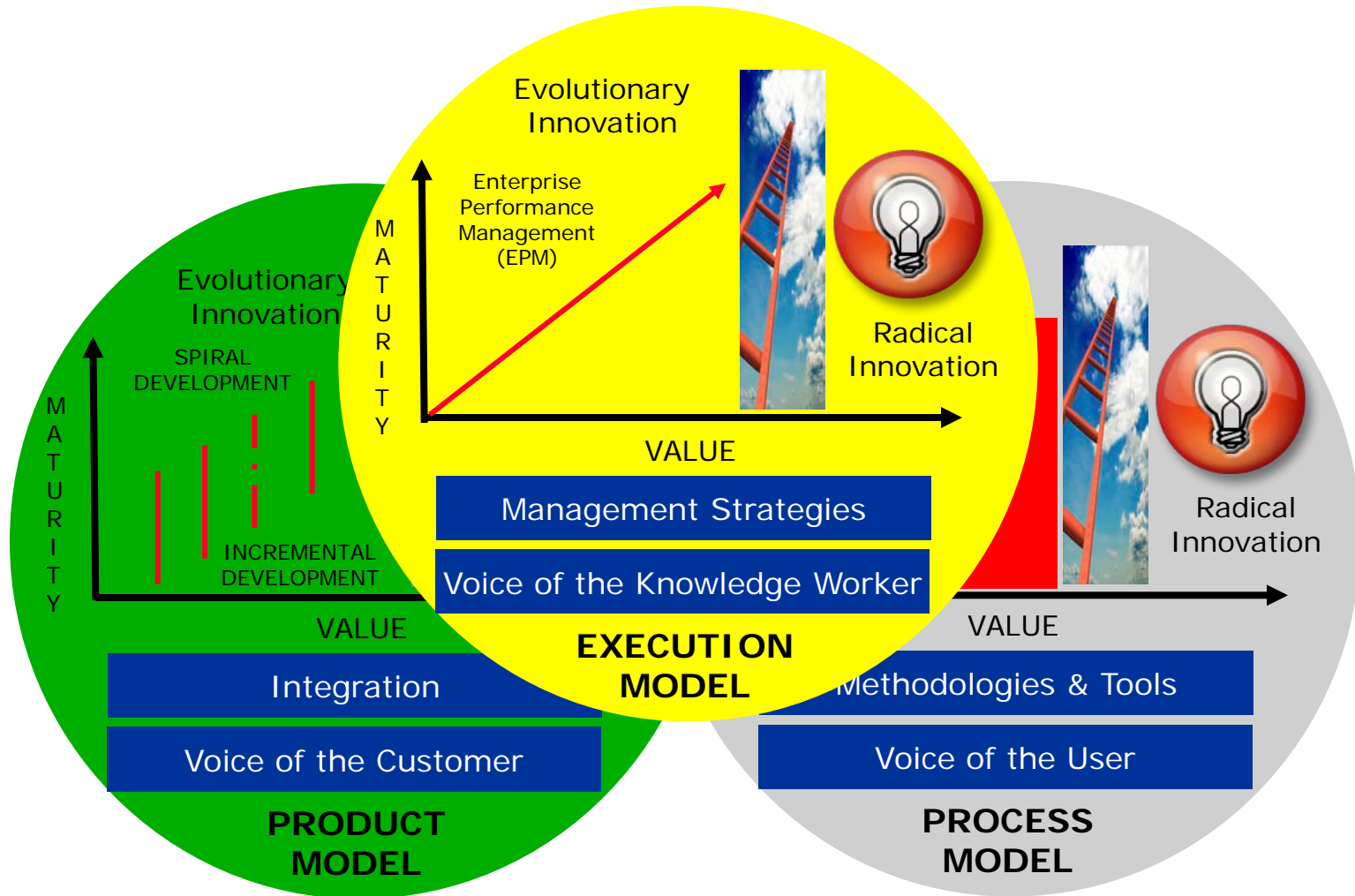
- **Product:** Technology-heavy (e.g: Airplane, iPod) OR Service-heavy (e.g: Starbucks System, eBay)
- **Process:** Any critical business process to ensure the success of product (e.g: iTunes for iPod, Marketing and Supply Chain Management)
- **Execution:** Management strategies to ensure that Innovation works! (WILL to ACT !!)

To measure the success of Innovation in an organization, maturity analyses should be conducted for all THREE components:

Product, Process and Execution

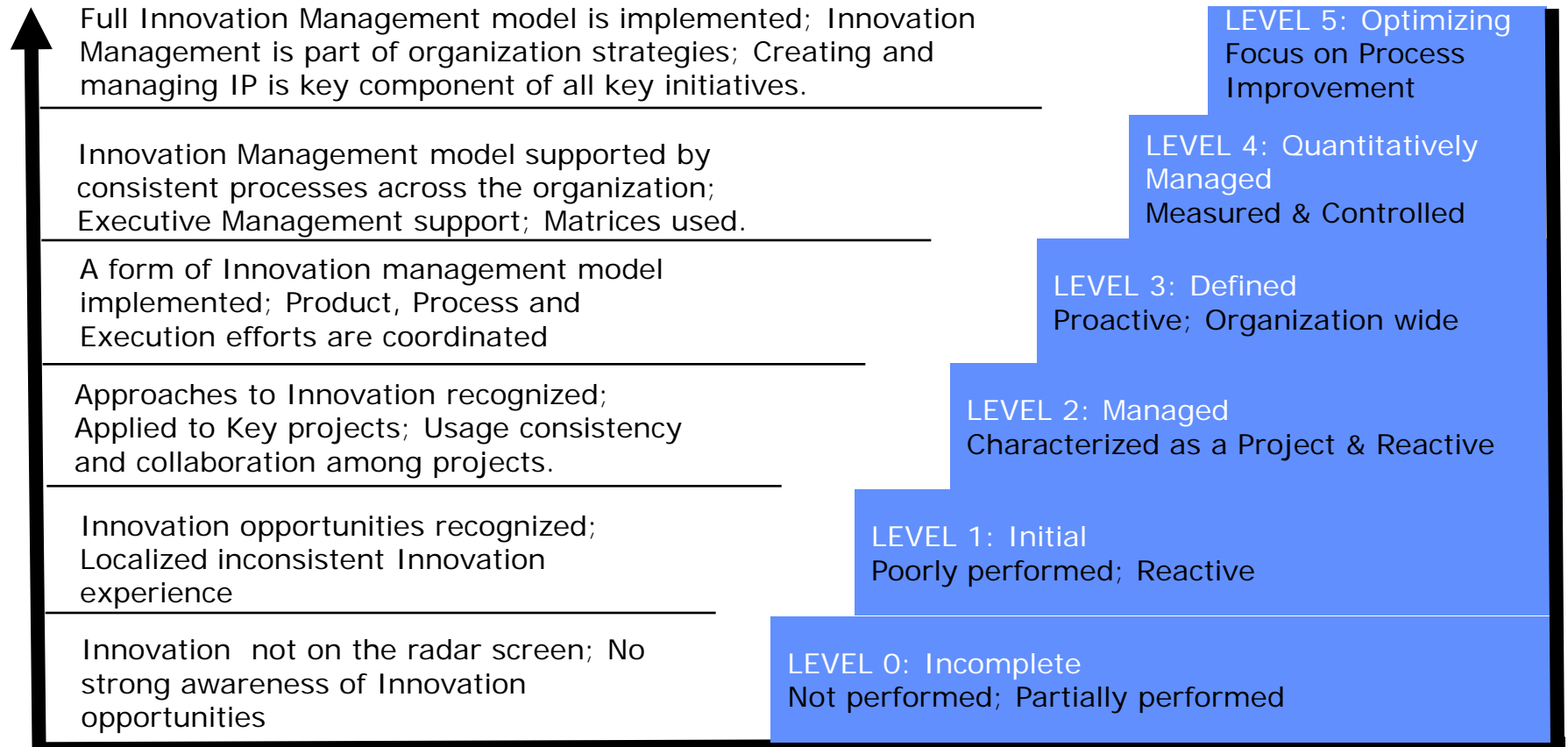
Innovation Management Model: Components

Innovation Management Components



Innovation Management Model: Maturity

Innovation Management is a Process and should be matured using the CMMI methodology



Innovation Model: Implementation

An Innovation Model can be applied to varied functions of an Organization

■ Private Organizations

- Organization wide Innovation maturity – measure and control the whole organization's current level of maturity in adopting Innovation
- Product specific – measure and control Innovation in a given product (e.g: Idea to market for a given widget.)
- Process specific - measure and control Innovation in a given Process (e.g: Human Resource Management)

■ Public Organizations (DoD)

- Program Specific – measure the maturity of technologies and processes for a given Program through its life cycle (e.g: FCS)
- **Sector Specific – measure the Innovation maturity of an organization (e.g: R&D and Technology Management)**
- Initiative specific – measure the Innovation maturity for an Initiative (e.g: eGov)

Challenges & Issues: DoD R&D and Technology Management

Valley of Death Phenomena !!

■ DoD Report to the Congress on Technology Transition, July 2007

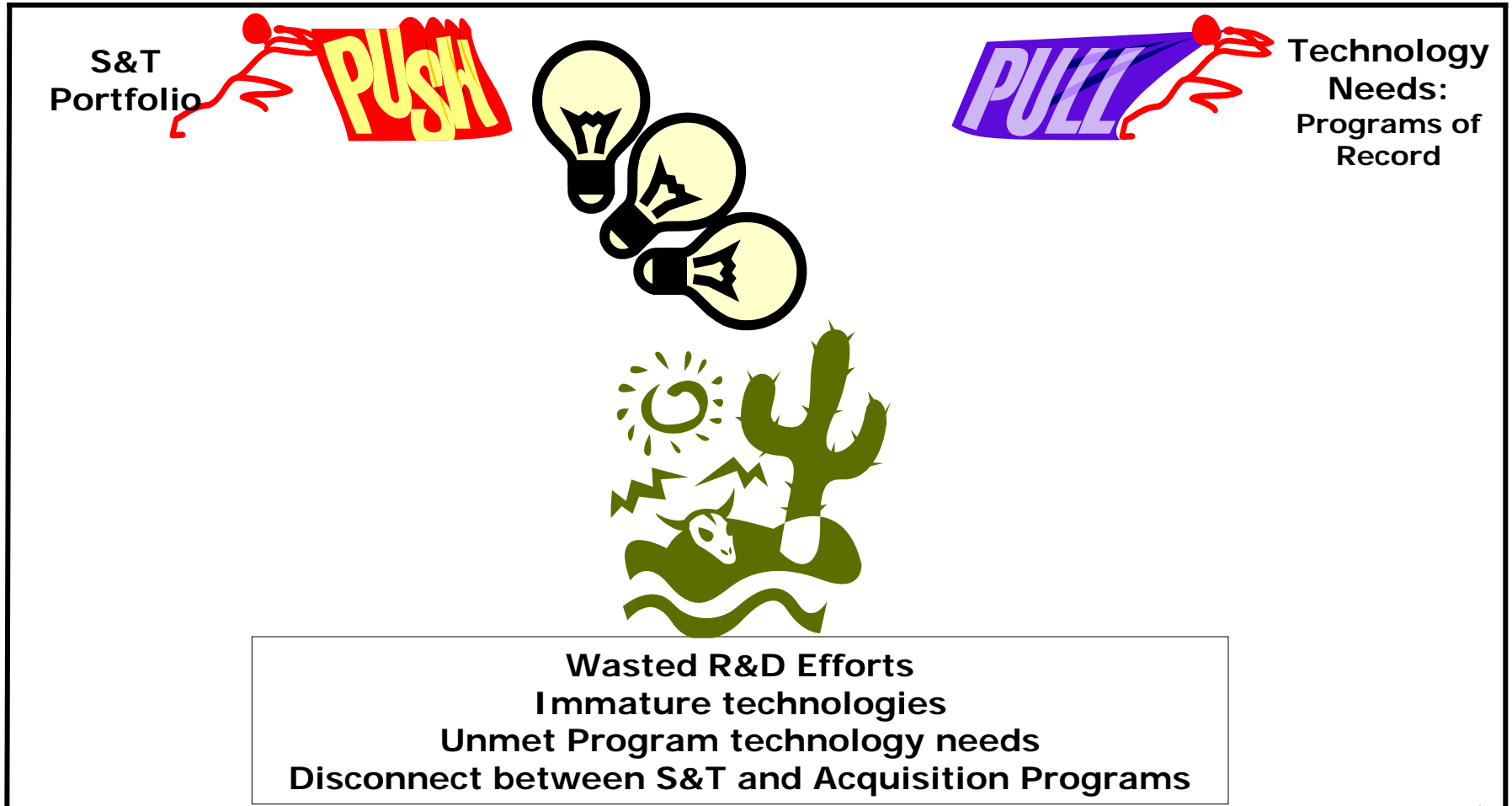
- **Author** - John J. Kubricky, Deputy Under Secretary of Defense, Advanced Systems & Concepts and Kathleen L. Harger, Assistant Deputy Under Secretary of Defense, Innovation & Technology Transition.
- **Conclusion** – Disconnect between S&T and Acquisition Programs
- **Recommendations** – (1) Improve Technology Push, (2) Improve Technology Pull, (3) Remove technical, cultural and business barriers to integrate new suppliers and technologies into defense system architectures, and (4) Focused governance and oversight at the Enterprise level

■ GAO Report on Assessments of Select Weapon Programs, March 2008

- **Author** - Gene L. Dodaro, Acting Comptroller General of the United States
- **Conclusion** – Immature technology causes cost and time escalation (other – software development difficulties, contractor usage, staff turnover)
- **Recommendations** – Employ Knowledge-based approach (Technology Maturity, Design Maturity and Production Maturity)

Valley of Death ?

Disconnect between S&T and Acquisition Programs



Valley of Death: Why?

The Issues to be resolved and Best Practices to be implemented

S&T
Portfolio



Technology
Needs:
Programs of
Record

S&T and Program Management Issues

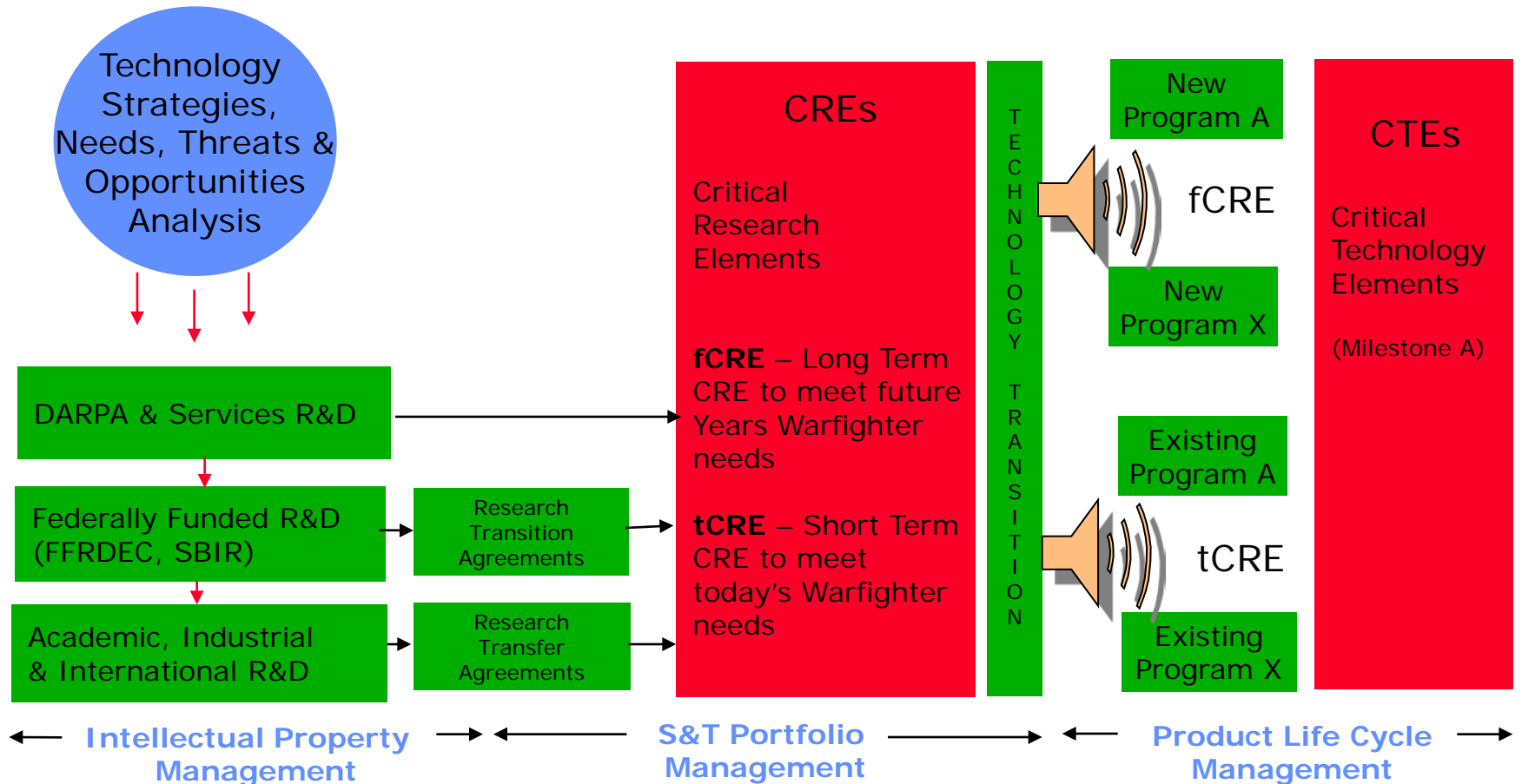
Enterprise Guidelines and Issues

Lack of Industry Best Practices



Critical Research Elements (CREs)

Linking IP, S&T Portfolio and Product Lifecycle Management



Multi-Dimension Maturity Analysis: CREs (to be developed) and CTES (TRLs & MRLs)

What are CREs?

Linking CREs to International Standards and CTEs

Critical Research Elements (CREs)	Critical Technology Elements (CTEs)
<p>Proposition: A CRE is a <i>manageable</i> and/or <i>patentable</i> component of a S&T Program. A Program may be composed of one or more CRE. The following definitions apply:</p> <p>(a) <i>Manageable:</i> The Project Manager has determined that this research element represents one of the major areas of the S&T Program, and the program can not succeed without tracking its progress through the life cycle of the program.</p> <p>(b) <i>Patentable:</i> World Intellectual Property Organization (WIPO), an agency of the United Nations Definition:.</p> <p>“... A patent is an exclusive right granted for an <i>invention</i>, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem. In order to be patentable, the invention must fulfill certain conditions. An invention must, in general, fulfill the following conditions to be protected by a patent - practical use; novelty, new characteristic, inventive step)... “</p>	<p>DOD TRA Desk book Definition:</p> <p>“A technology element is “critical” if the system being acquired depends on this technology element to meet operational requirements (with acceptable development, cost, and schedule and with acceptable production and operation costs) <i>and</i> if the technology element or its application is either new or novel. Said another way, an element that is new or novel or is being used in a new or novel way is critical if it is necessary to achieve the successful development of a system, its acquisition, or its operational utility.”</p>

Relationship between CREs and CTEs

Comparing CREs to CTEs

Critical Research Elements (CREs)	Critical Technology Elements (CTEs)
CRE has one-to-one or one-to-many relationship with a CTE	A CTE is derived from one or more CRE
Frontend of Innovation	Backend of Innovation
Measurement Indices: “Performance & Maturity” (to be developed)	Measurement Indices: TRA/TRLs (evolving to SMA)
Independent from the Acquisition Programs and managed by the S&T Community	Related to Acquisition Programs and managed by the Acquisition Community

CREs: What are the real questions?

Exploring CREs

- How to identify and define the CRE?
- Which criteria should be used to measure the performance and maturity of CRE?
- How is CRE related to the innovation metrics used by Industry?
- As SMA is conducted on CTEs, how does SMA relate to CREs
- How will the CRE link with the
 - CTE, and
 - the DOD Acquisition Management Framework?

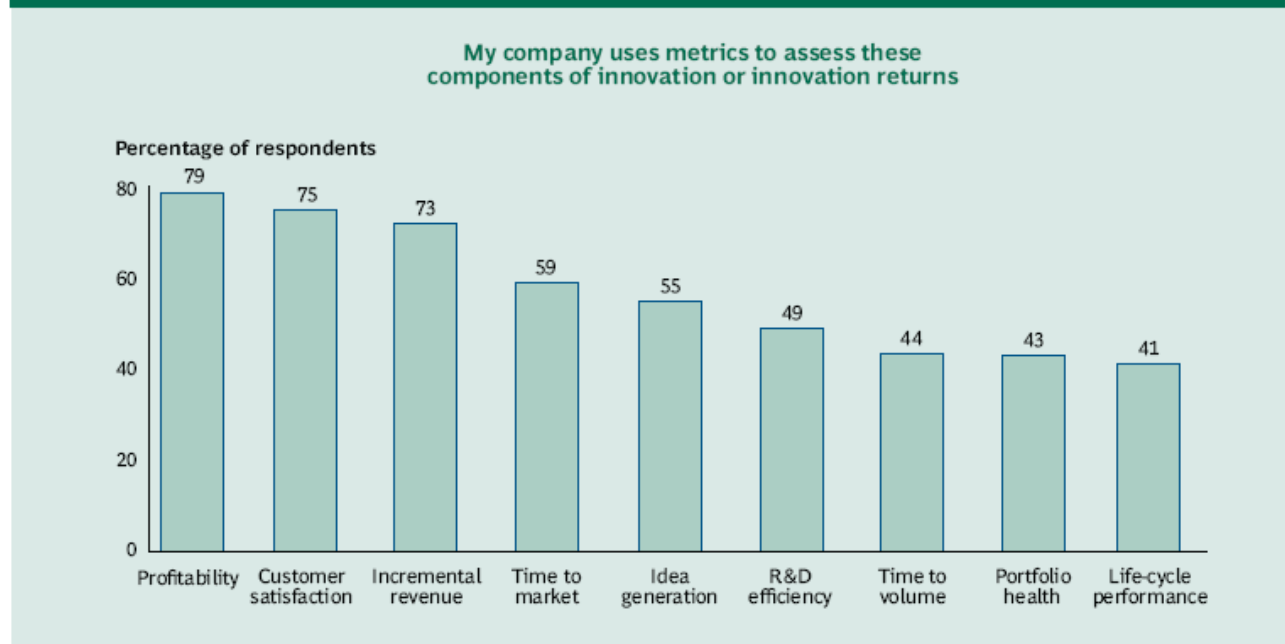
CREs: What do we know?

- Industry Innovation Management Metrics (source: Boston Consulting Group Survey – Measuring Innovation , 2009)

- Industry metrics are part of Stage/Gate Process to manage product lifecycle

- Industry Metrics should be used as a guideline ONLY to develop DoD S&T Program management metrics

Exhibit 6. Profitability, Customer Satisfaction, and Incremental Revenue Are the Most Closely Tracked Components of Innovation



CREs: What do we need to know?

Linking IP, S&T Portfolio and Product Lifecycle Management

- Industry Metrics are based on the commercial management criteria, such as profit, patents generated and new products introduced (discussed in previous slide).

- For the DOD community, the management criteria are warfare superiority, and delivering capabilities to the war fighters within the planned cost, schedule, risk/vulnerability, intelligence collection/dissemination accuracy, detection, assessment of preparedness, maintenance of situation awareness, and performance outcomes. Questions:
 - Are there any other management criteria (in addition to the above referenced criteria that should be used to develop CREs?
 - What are the desired or optimized research management practices?
 - What are the gaps between the current practices and the optimized practices?
 - What are the main challenges encountered in measuring the S&T program performance?
 - Which tools should be used?
 - How are the project selected for S&T portfolio?

CREs:

What could we do to learn that?

Linking IP, S&T Portfolio and Product Lifecycle Management

- Develop a list of research management criteria after analyzing DoD and commercial best practices for S&T and Acquisition program management.
- Prepare and conduct a market survey
- Develop a list of research performance measurement and maturity criteria and qualifications
- Research and analyze the differences between the CRE and CTE
- Develop and analyze the parameters which are essential to develop an effective communication link between the S&T and Acquisition Programs.
- Develop a link between the CRE, CTE and the Acquisition Management Framework, based on a Knowledge-based Gate Process.
- Develop a link between the OMB's Program Assessment Rating Tool (PART) and the CRE concept.
- Analyze and verify the components of the proposed multi-dimension maturity model.
- Develop a prototype software tool, using Government-off-the-shelves (GOTS) or Commercial off-the Shelves (COTS) products which will help the Defense community to link CRE to CTE.
- Develop a prototype management dash board, based on a COTS product, which will show performance and maturity health of a S&T Program using the CRE methodology and Multi-Dimension Maturity model

CREs – A part of the solution

- Innovation is a top National priority; However, Innovation Management is an ART and should be converted to a SCIENCE by developing concepts, methodologies and tools
- Department of Defense Innovation Management : Valley of Death is caused by disconnect between S&T and Acquisition Programs.
- Current DOD Community discussions on the Valley of Death mainly address the funding mechanism... however, there is a need to develop a comprehensive solution (new or improved methodologies, processes and tools) by analyzing:
 - S&T and Program Management Issues
 - Enterprise Guidelines and Issues
 - Industry Best Practices
- CREs – One of the proposed methodologies
 - Proposed a CRE definition
 - Suggested links to CTEs

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Any Questions ?

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