Decision Management (DM) as the engine for scalable cross domain Systems Engineering (SE)

Pradeep Mendonza

Systems Engineering Group
US Army – TARDEC , Warren, MI

John A. Fitch

Science Applications International Corporation
Sterling Heights, MI

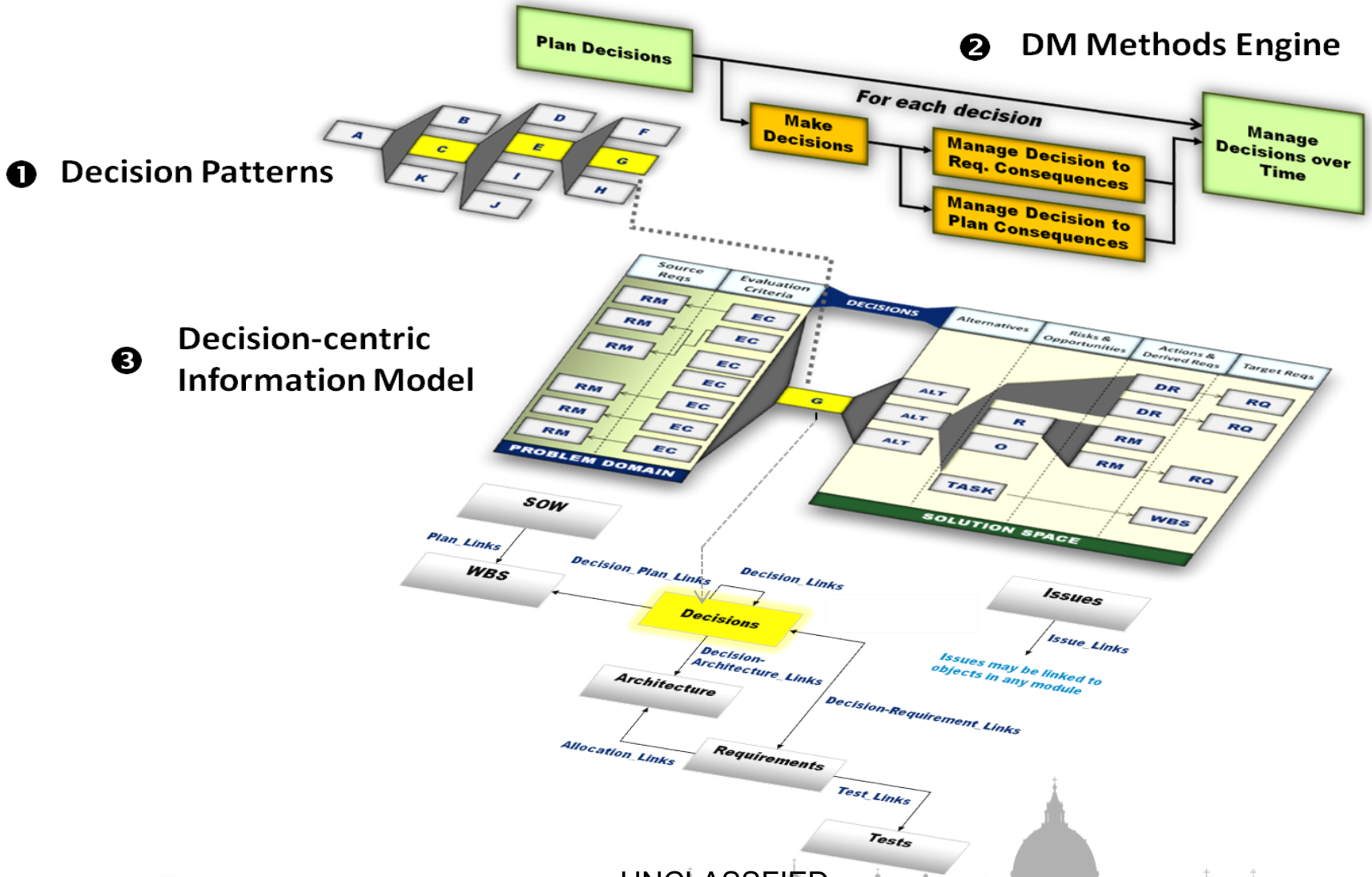
Decision Management Principles

- Decisions create the future in any industry or human endeavor
- A robust Decision Management (DM) capability is the key enabler for accelerating the benefits of Systems Engineering (SE) discipline to new domains
- Effective Decision Management is comprised of three elements
  - Decision patterns;
  - DM methods engine
  - Decision-centric information model.

All faults are decision faults!

Typical Decision Faults	Consequences
• Key decisions overlooked or poorly framed	→ Inadequate analysis yields an inadequate solution
• Criteria poorly traced to upstream requirements	→ Alternatives fall short of stakeholders' threshold values
• Incomplete or biased performance, risk, & opportunity tradeoffs	→ Less-than-the-best solutions selected for implementation
• Derived requirement consequences not communicated	→ Decision conflicts (cross-constraints) not discovered until integration
• Implementation tasks not blended into project plan	→ Good decisions fail during project execution
• Decisions made with short time horizon	→ Solutions rapidly made obsolete by changes in needs/technologies
• Decision patterns and lessons learned not harvested	→ Decision faults propagated to next phase or product

Elements of Effective Decision Management

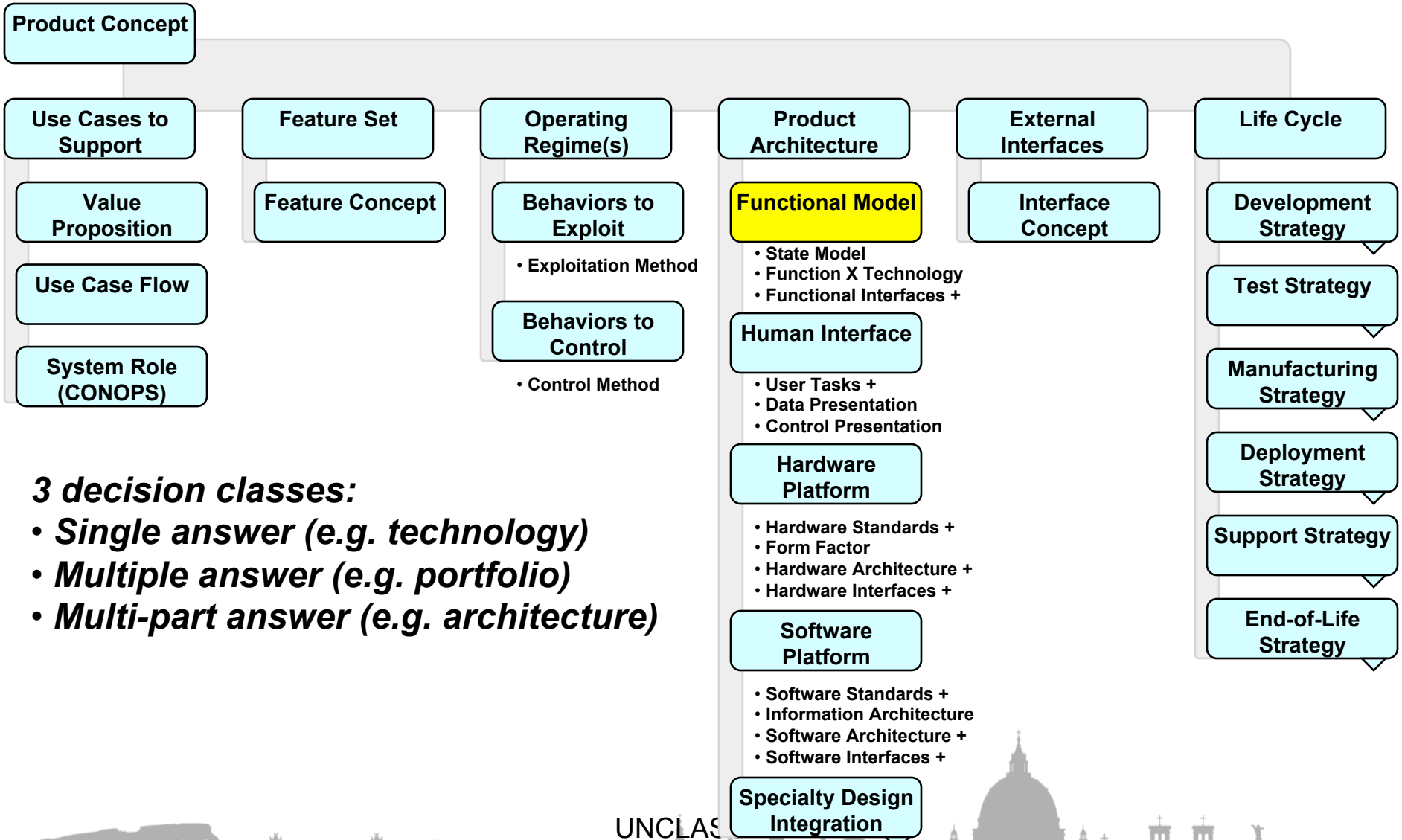


UNCLASSFIED

Elements of Effective Decision Management

- ***Decision patterns***
  - Help Systems Engineers quickly frame any project or problem as a Decision Breakdown Structure
  - Jump-start decision analysis with proven evaluation criteria.
- ***Decision Management methods engine***
  - Highlights the value-creating steps in this process.
- ***Decision-centric information model***
  - Provides the context for Systems Engineering knowledge capture, object-level traceability and proactive change management.

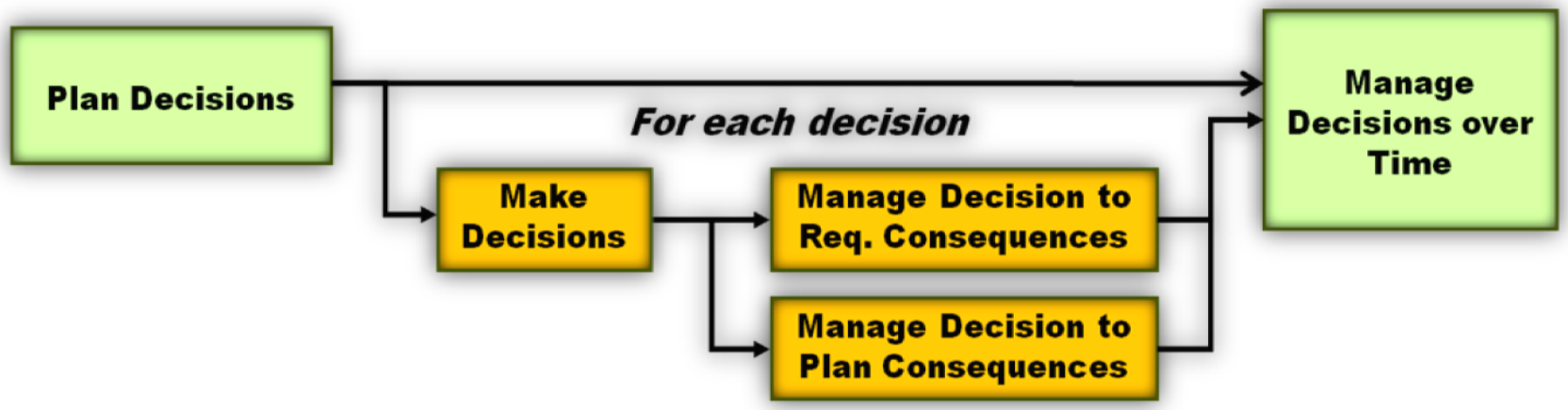
Decision Pattern – Product Design



3 decision classes:

- ***Single answer (e.g. technology)***
- ***Multiple answer (e.g. portfolio)***
- ***Multi-part answer (e.g. architecture)***

Decision Management Methods Engine



Manage Decisions across Domains

Manage Decision Patterns

Manage Common Architecture Decisions

Manage Process Decisions

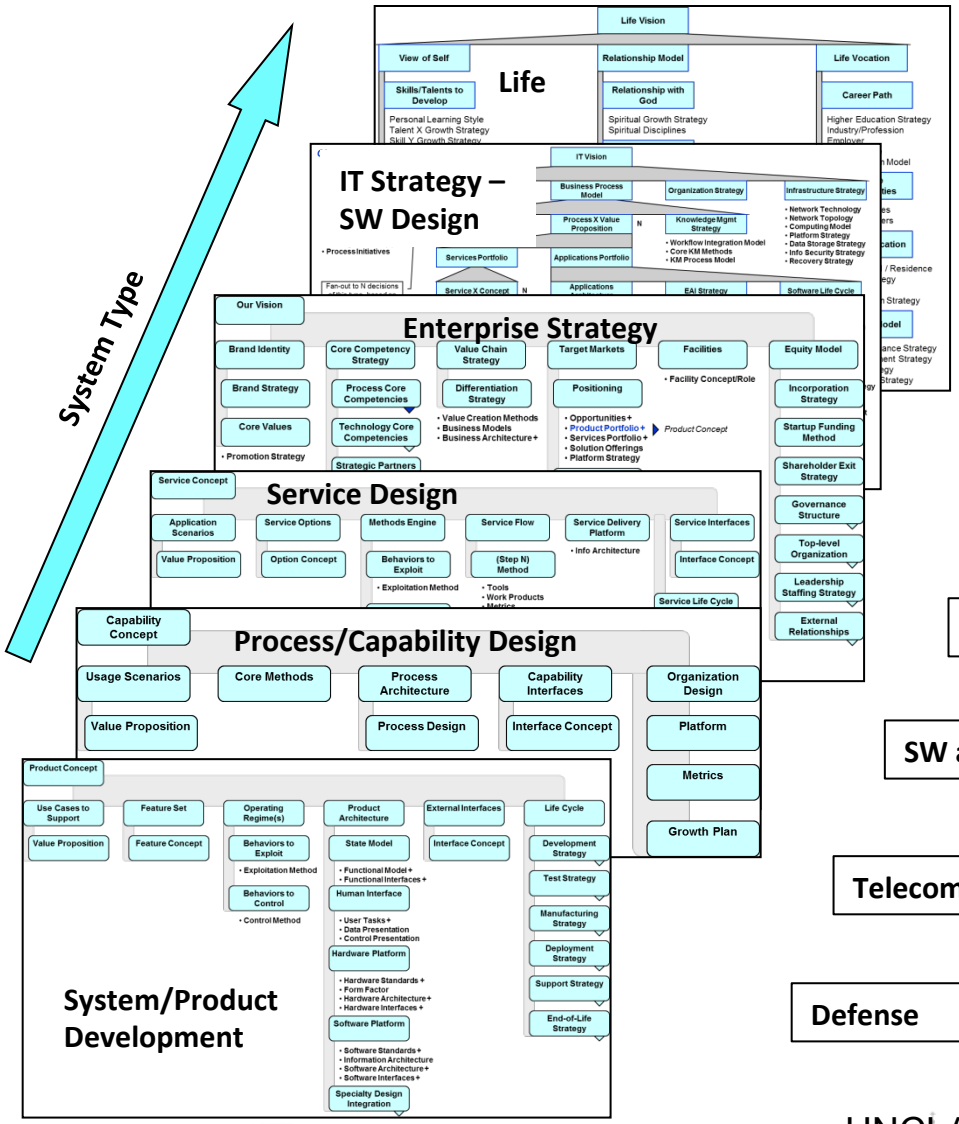
Decision-centric Information Model

- Decisions are the integrative mechanism of SE
  - Decisions create requirements, i.e. all requirements can be traced to an upstream decision
  - Decisions consume requirements. A requirement that doesn't drive a decision is at risk of being overlooked
  - Decisions define solutions architectures
    - All architecture elements can be traced to an upstream decision.
  - All tasks in a system development project plan either inform a decision or realize an alternative
  - All risks and opportunities are associated with an alternative in a decision
  - Models inform decisions
    - All models are representations of the structure/behavior of an alternative

Cross-domain scalability

- DM methods engine is domain-independent
- Scalable by design - built-in tailoring points
  - Decision patterns enable problem decomposition into relatively loosely-coupled decisions
  - Tailor analysis investment/rigor to match decision priorities
  - Tailor level of criteria traceability and number of criteria per decision
  - Tailor number/range of alternatives to evaluate
  - Trace most demanding derived requirements

Cross-Domain Application of Decision patterns



Life coaching

New business incubation

Non-profits

R&D and S&T Management

Medical devices

Common Arch. – Platform Eng'g

Nanoelectronics

Innovation Framework

Space

Roadmaps

SW applications

Technology Insertion

Industries

Telecom

Technical Proposals

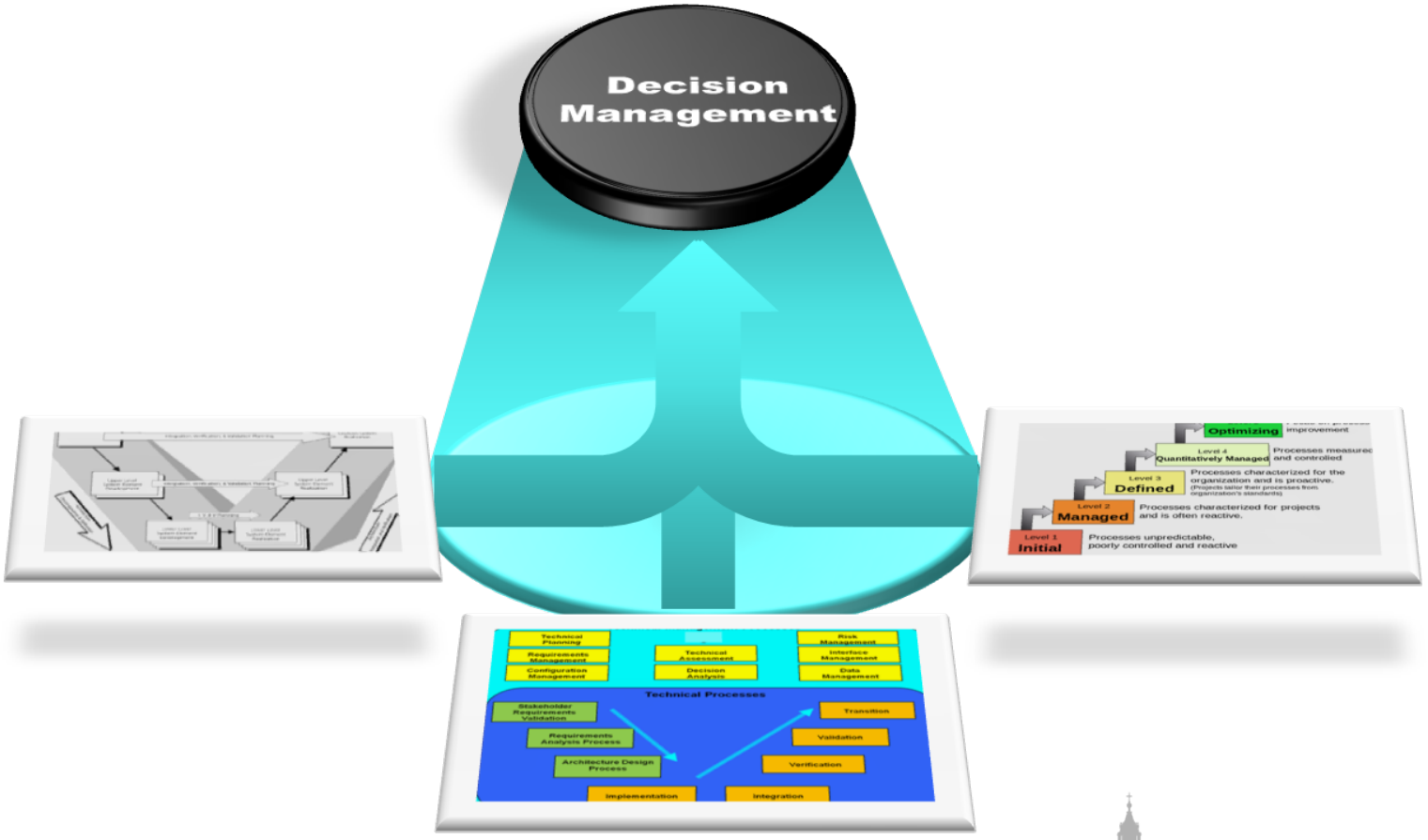
Use cases

Defense

New Product Development

UNCLASSFIED

Decision Management as the GLUE for any process framework



Decision Control Panel

DECISION CONTROL PANEL

What-if Analysis
Combine alternatives across multiple decisions to forecast change/impact.

Master Decision

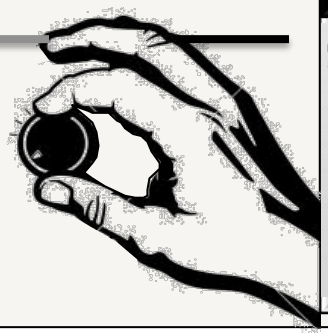
Decision

Decision

Decision

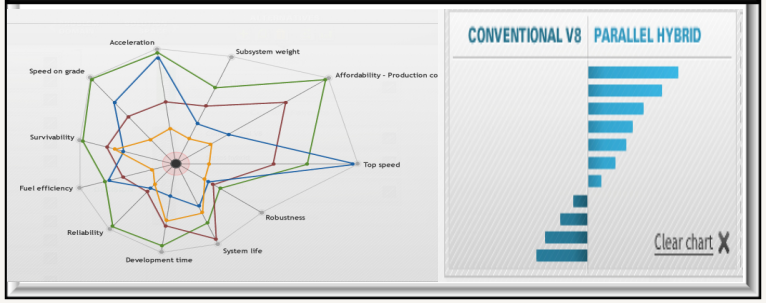
Decision

Decision



Current Performance

Forecasted Performance



Actual Performance

UNCLASSFIED

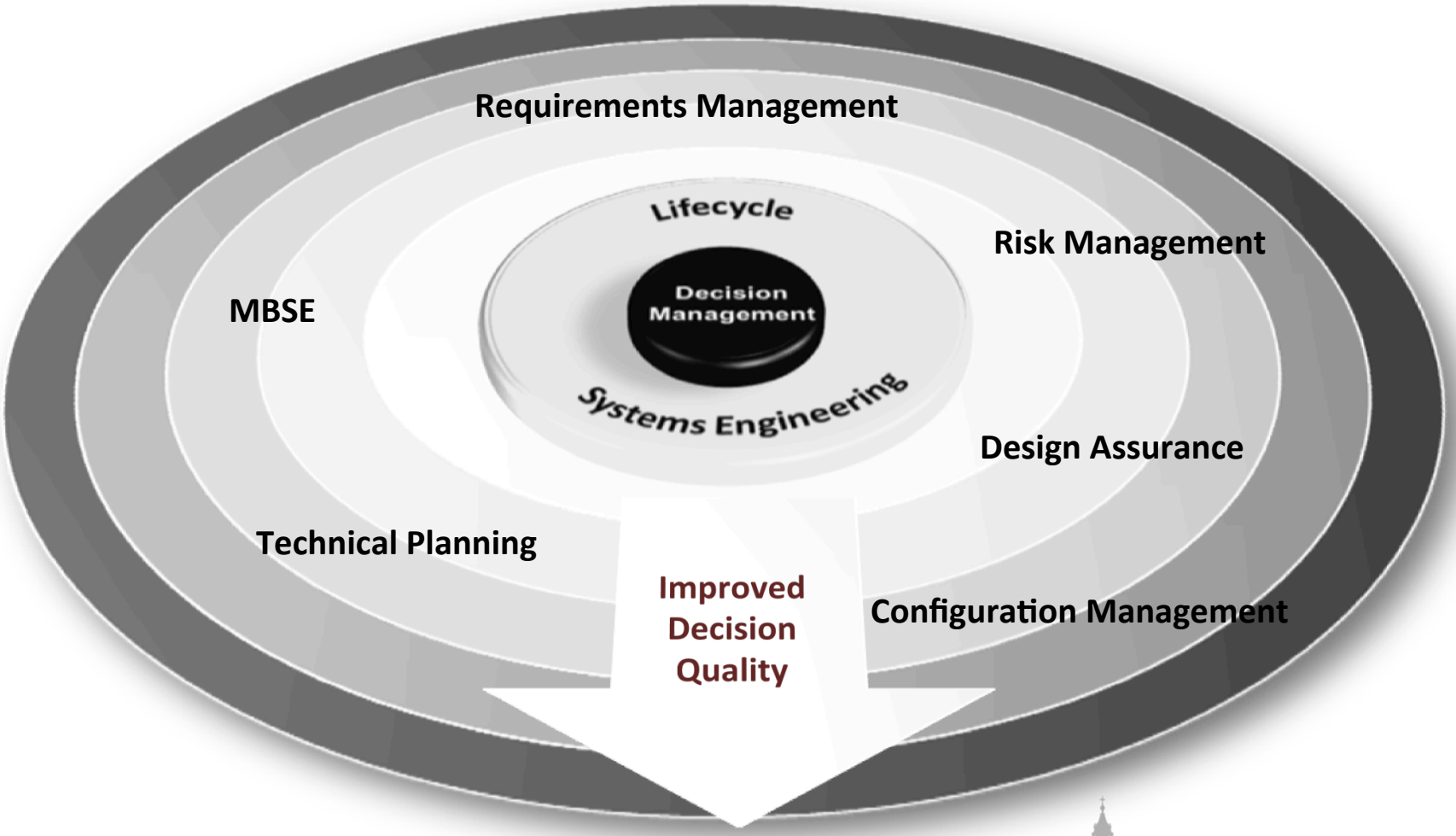
Cross-domain Outreach Strategy

- "Lead with decisions" INCOSE outreach strategy
  - Bring benefits of SE to new industries and domains.
  - Clear and compelling SE value proposition to the key stakeholders in new domains.
  - Avoid limitations and high entry barriers associated with alternative cross-domain adoption schemes
- Target the individuals who currently control (understand, frame, analyze/inform, make, implement) the decisions that drive system success.
- DM provides a new set of "control knobs" that provide rapid payback to decision-makers and domain SMEs.

Competing cross-domain outreach strategies

- Process framework driven outreach
  - Comprehensive SE frameworks are complex = very high entry barrier to a new SE audience
  - Works best when a powerful customer mandates SE discipline/certification
- MBSE driven outreach
  - Complex set of "foreign" system views/diagrams
  - Significant upfront investment in tools, training and consulting
  - Captures system model, not thinking behind it
  - Works best in industries with high software content
- Tool-driven outreach
  - Vendors have mixed motives; tools have excess baggage
  - Works best when built around a tool that has traction
- Champion-driven outreach
  - Ad hoc and spotty SE adoption
  - Accelerator of other strategies (hybrids)

Decision-centric SE outreach



Decisions create the pull for better SE

- Create demand for complementary parts of a full SE discipline to improve decision quality, speed and execution
  - Better requirements to drive decisions.
  - Better architectural models and design assurance capabilities to improve decision precision/confidence.
  - Better technical plans to inform and realize decisions
  - Better downstream traceability of derived requirements and risk mitigation plans
  - Better Configuration Management for other types of SE knowledge.

Next steps to Realize a Decision-Centric Outreach Strategy

- Most of the cross-domain benefits of DM can be demonstrated through rapid-payback pilots without commitment to wholesale adoption of more comprehensive, complex and costly SE frameworks.
- The authors propose to start a DM working group or engage INCOSE's Decision Analysis working group as the forum for investigating the cross-domain applicability of DM.

Questions

Pradeep Mendonza

Systems Engineering Group
US Army – TARDEC , Warren, MI

John A. Fitch

Science Applications International Corporation
Sterling Heights, MI