Software Systems Maturity Analysis

Abstract ID: #19758

For:
NDIA
20th Annual Systems Engineering Conference
23-26 October 2017

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Core Functions – INL Systems Analyses & Engineering

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- Concise Problem Definition
- Understanding Important Customer Needs
- Concise System/Project Boundaries
- Strategic Planning & Baselines
- "Concept" of Operations
- Stakeholder Buy-in
- Acquisition Strategy
- White Papers

2

- Technical, Functional, and Operational Analysis
- Requirements Elicitation, Clarification, Derivation, and Tracking
- Traceability, Change Control, and Impact Analysis
- Requirements Verification and Validation Planning

3

- Analysis of Alternatives
- Decision Metrics
- Organization Analysis & Visualization of Complex and Big Data
- Uncertainty Analysis & Probabilistic Risk Assessment
- Risk-informed Decision-making
- Integration of Viable Solutions
- Chemical Process Engineering & Analysis
- Chemical Process Control
- Computational Fluid Dynamics

4

- Risk Identification and Tracking
- Justification for Funding Contingency
- Risk Handling Strategy
- Risk Reduction Plan
- Risk-informed Path Forward

5

- Technology Maturity Analysis
- Technology Development Roadmap/Path Forward
- Roadblock Identification & Mitigation
- System Assessments (e.g., Energy Systems)

6

- Program & Project Integration
- Laboratory-wide R&D Integration
- Laboratories/Industries/ Universities Integration
- Integration of System Elements
- Systems of Systems Analyses

7

- Verification of System Performance and Functionality
- Validation of System Specification and Design Parameters
- Test Planning and Implementation

Software Systems Maturity Analysis Approach

- Customer Required Measurement of Tools / Capabilities
- ~ 10 Participating Companies Providing Tools / Capabilities
- Technology Readiness Levels (TRLs)
  - Accept criticism from participants
- Software Readiness Levels (SRLs)
  - Accept criticism from participants
- Maturity Gates (MGs)
  - Based on tailored version of generic TRL and SRL language
  - Criteria specific to products and platforms
  - Vetted with participants & gained acceptance
- Initial Rating of All Tools / Capabilities
  - Feedback discussed with participants
  - Goals outlined and road mapped for each participant

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Maturity Gate Philosophy

Element / MG	Demonstration	Environment	Risks	SSCs (systems, subsystems and components)
MG1	Idea	None		Component
MG2	Theory	Correlational & mathematical	Good correlation of performance defined	Component
MG3	Performance Of Theory	Virtual simulated	Performance validates theory	Component
MG4	Performance of components in simulated system environment	Simulated operational environment, increased scale of operations	Performance is achievable within expected environment	Subsystem (component + environment)
MG5	Performance of subsystems working at same time	All parts of system running simultaneously but not yet integrated in simulated environment	Performance of system components can work at the same time without issues	Subsystem (multiple components + environment)
MG6	Performance of integrated system working together	Parts integrated in simulated environment working together	Performance of integrated system meets ops needs in simulated environment	System (integrated components + environment)
MG7	Performance of operational staff doing simulated tasks	Operationally simulated environment and missions, live streaming of data	Performance of integrated system by actual operators (non-developers) in simulated environment meets needs	System (system + operators + simulated mission)
MG8	Performance by operational staff doing actual tasks	Actual deployed system environment and missions	Applicable to actual systems and operators and tasking	System plus operators plus actual mission

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Example Genericized MG Criteria

Maturity Gate 2
MG2 Risks to Mitigate
Data to detect threat is not available
Algorithms/analytics poor at detection/false alarm ratio
MG2 Exit Criteria
Identification of competing designs that have potential to detect threat
Performance evaluation of competing designs to detect threat
Data features that represent threat activity are defined

Maturity Gate 3
MG3 Risks to Mitigate
Access to required data is not provided for testing
Access to military network with appropriate sensor is not allowed as needed
Data interfaces & needs for analytics to run on platform are not clearly defined
Delay in platform documentation may impact development of ingest modules
No interesting data available to exchange for cross-systems communications
Different versions of platform software on remote VMs and central test system
MG3 Exit Criteria
Analytic/tool operate on the platform operating system at each participant facility
Appropriate data sets delivered to support remote development
Trial performance test in prototypical environment of selected design(s)

Maturity Gate 4
MG4 Risks to Mitigate
Access to required data is not provided for testing
Data interfaces & needs for analytics to run on platform are not clearly defined
Delay in platform documentation may impact development of ingest modules
Incompatibility of ingest language with analytic may lead to analytic failure
May not operate at scale (cannot process data at scale)
MG4 Exit Criteria
Demonstration of analytic using representative data
Demonstration of analytic using 30 days of captured data
Issues defined in MG3 corrected and confirmed
Strategy, requirements, architecture and design report for operations plan
Test Plan defined functional performance demonstrated

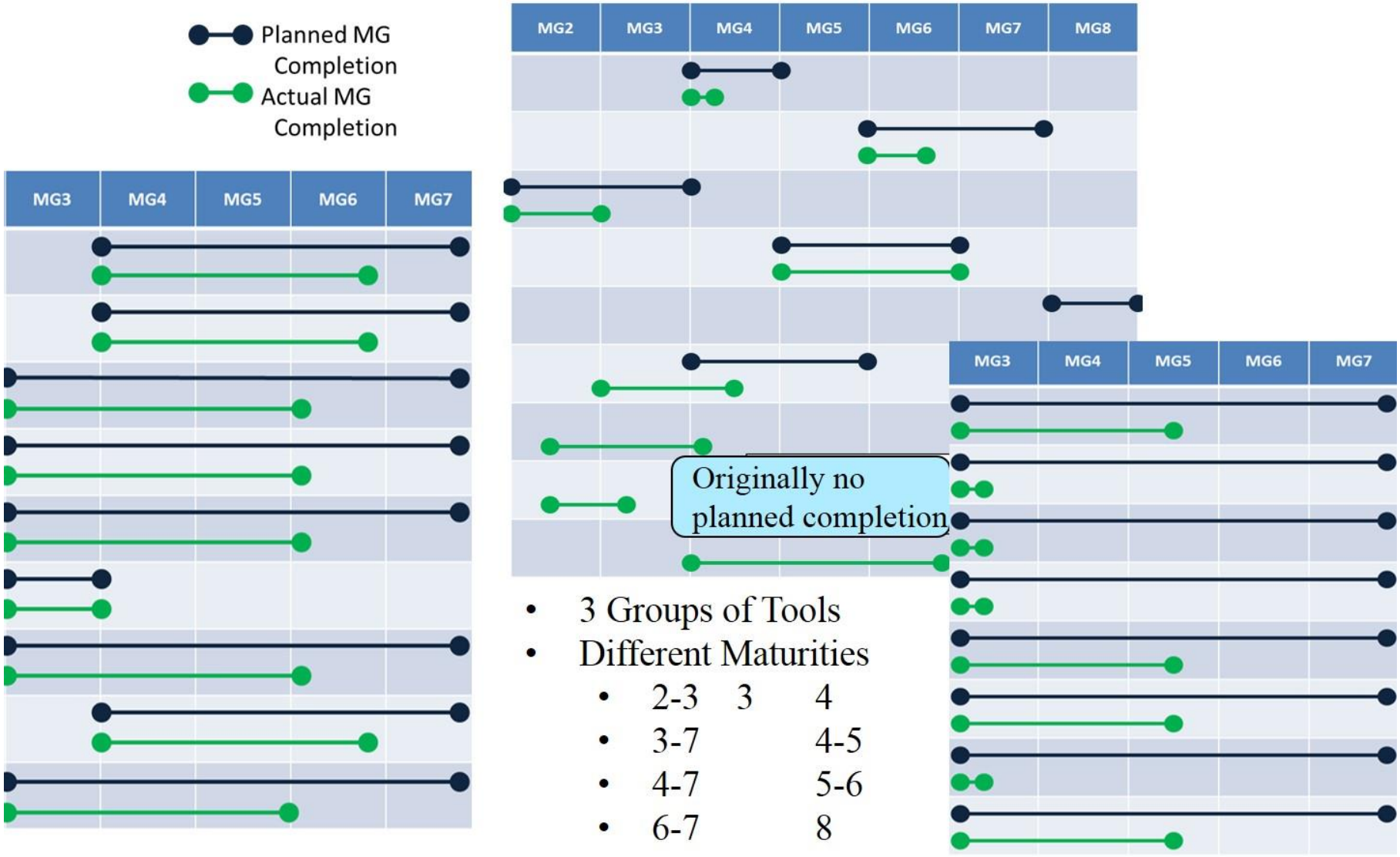
Maturity Gate Mapping

LEGEND:

RV = Resolved	Greater than 66% complete
PR = Partially Resolved	Between 33% and 66% complete
UR = Unresolved	Less than 33% complete
NA = Not Applicable	
NI = Not an Issue	

	Ktr1	Ktr1	Ktr2	Ktr2	Ktr3	Ktr4	Ktr4	Ktr5	Ktr5	Ktr6	Ktr7	Ktr7	Ktr7	Ktr7	Ktr7	Ktr8	Ktr8	Ktr9	Ktr10	Ktr10	Ktr10	Ktr10	Ktr10	Ktr10	Ktr10	Ktr10
	Tool / Capability 1	Tool / Capability 2	Tool / Capability 3	Tool / Capability 4	Tool / Capability 5	Tool / Capability 6	Tool / Capability 7	Tool / Capability 8	Tool / Capability 9	Tool / Capability 10	Tool / Capability 11	Tool / Capability 12	Tool / Capability 13	Tool / Capability 14	Tool / Capability 15	Tool / Capability 16	Tool / Capability 17	Tool / Capability 18	Tool / Capability 19	Tool / Capability 20	Tool / Capability 21	Tool / Capability 22	Tool / Capability 23	Tool / Capability 24	Tool / Capability 25	Tool / Capability 26
Maturity Gate 2	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**100%**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
MG2 Risks to Mitigate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	100%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MG2 Exit Criteria	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	100%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MG2-->MG3 Entrance Criteria	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Maturity Gate 3	**NA**	**NA**	**100%**	**100%**	**100%**	**NA**	**NA**	**100%**	**100%**	**NA**	**0%**	**NA**	**NA**	**80%**	**100%**	**100%**	**33%**	**NA**	**100%**	**29%**	**29%**	**100%**	**100%**	**100%**	**29%**	**29%**
MG3 Risks to Mitigate	NA	NA	100%	100%	100%	NA	NA	100%	100%	NA	NA	NA	NA	75%	100%	100%	100%	NA	100%	0%	0%	100%	100%	100%	0%	0%
MG3 Exit Criteria	NA	NA	100%	100%	100%	NA	NA	100%	100%	NA	0%	NA	NA	100%	100%	100%	0%	NA	100%	0%	0%	100%	100%	100%	0%	0%
MG3-->MG4 Entrance Criteria	NA	NA	100%	100%	100%	NA	NA	NA	100%	NA	0%	NA	NA	75%	100%	100%	0%	NA	100%	50%	50%	100%	100%	100%	50%	50%
Maturity Gate 4	**100%**	**100%**	**88%**	**88%**	**100%**	**0%**	**NA**	**NA**	**100%**	**100%**	**NA**	**NA**	**NA**	**50%**	**100%**	**0%**	**NA**	**100%**	**81%**	**0%**	**0%**	**81%**	**81%**	**81%**	**0%**	**0%**
MG4 Risks to Mitigate	100%	100%	50%	50%	100%	0%	NA	NA	100%	100%	NA	NA	NA	NA	100%	0%	NA	100%	100%	0%	0%	100%	100%	100%	0%	0%
MG4 Exit Criteria	100%	100%	100%	100%	100%	0%	NA	NA	100%	100%	NA	NA	NA	100%	100%	NA	NA	100%	100%	0%	0%	100%	100%	100%	0%	0%
MG4-->MG5 Entrance Criteria	100%	100%	100%	100%	100%	0%	NA	NA	100%	100%	NA	NA	NA	0%	100%	0%	NA	100%	63%	0%	0%	63%	63%	63%	0%	0%
Maturity Gate 5	**100%**	**100%**	**100%**	**100%**	**100%**	**NA**	**NA**	**NA**	**100%**	**100%**	**NA**	**100%**	**NA**	**0%**	**100%**	**NA**	**NA**	**100%**	**50%**	**0%**	**0%**	**50%**	**50%**	**50%**	**0%**	**0%**
MG5 Risks to Mitigate	100%	100%	100%	100%	100%	NA	NA	NA	100%	100%	NA	100%	NA	0%	100%	NA	NA	100%	100%	0%	0%	100%	100%	100%	0%	0%
MG5 Exit Criteria	100%	100%	100%	100%	100%	NA	NA	NA	100%	100%	NA	100%	NA	0%	100%	NA	NA	100%	50%	0%	0%	50%	50%	50%	0%	0%
MG5-->MG6 Entrance Criteria	100%	100%	100%	100%	100%	NA	NA	NA	100%	100%	NA	100%	NA	NA	100%	NA	NA	NA	40%	0%	0%	40%	40%	40%	0%	0%
Maturity Gate 6	**79%**	**79%**	**17%**	**17%**	**17%**	**NA**	**29%**	**NA**	**17%**	**71%**	**NA**	**100%**	**NA**	**NA**	**0%**	**NA**	**NA**	**67%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
MG6 Risks to Mitigate	100%	100%	0%	0%	0%	NA	100%	NA	0%	100%	NA	100%	NA	NA	0%	NA	NA	100%	0%	0%	0%	0%	0%	0%	0%	0%
MG6 Exit Criteria	100%	100%	17%	17%	33%	NA	50%	NA	33%	75%	NA	100%	NA	NA	0%	NA	NA	NA	0%	0%	0%	0%	0%	0%	0%	0%
MG6-->MG7 Entrance Criteria	63%	63%	25%	25%	0%	NA	0%	NA	0%	50%	NA	NA	NA	NA	0%	NA	NA	50%	0%	0%	0%	0%	0%	0%	0%	0%
Maturity Gate 7	**13%**	**13%**	**14%**	**14%**	**14%**	**NA**	**0%**	**NA**	**14%**	**14%**	**NA**	**NA**	**NA**	**NA**	**14%**	**NA**	**NA**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
MG7 Risks to Mitigate	0%	0%	NA	NA	NA	NA	0%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0%	NA	NA	NA	NA	NA	NA	NA	NA
MG7 Exit Criteria	13%	13%	13%	13%	13%	NA	0%	NA	13%	13%	NA	NA	NA	NA	13%	NA	NA	0%	0%	0%	0%	0%	0%	0%	0%	0%
MG7-->MG8 Entrance Criteria	0%	0%	0%	0%	0%	NA	NA	NA	0%	0%	NA	NA	NA	NA	0%	NA	NA	NA	0%	0%	0%	0%	0%	0%	0%	0%
Maturity Gate 8	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0%**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
MG7 Risks to Mitigate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MG7 Exit Criteria	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MG7-->MG8 Entrance Criteria	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0%	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Planned and Actual MG Assessments



- 3 Groups of Tools
- Different Maturities
  - 2-3 3 4
  - 3-7 4-5
  - 4-7 5-6
  - 6-7 8

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Conclusions

- TRLs / SRLs have been criticized for being not applicable – Solved by tailored MGs.
- Evaluate product status and progress against objective evidence – Proof / Plan to Prove.
- Pressure to field products vs risks from unresolved criteria in an earlier MG.
  - *Open risk items carried forward must have a coordinated risk mitigation plan.*
- When platforms change, readdress already completed maturity criteria.
  - *Risks carried forward with block releases must have a coordinated risk mitigation plan.*
- Block-released products need regular, planned releases with known capabilities.
- When changing directions to resolve issues, know where you are going before changing.
- Create accurate product documentation so capabilities & limitations are understood.
- Frequent discussions, shared portals, and remote test system access improved progress.
- Develop a plan for integrating products and assign a knowledgeable lead system integrator.
- Ensure participants understand the “big picture” and how they contribute.
- Understand users’ needs & develop information products whose displays match the needs.
- Plan for delays in getting approvals to operate on military networks.
- Ensure participants know whose comments and criticism require actions and whose do not.
- Ensure training is timely and audience has proper skills and knowledge to receive it.

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Questions?

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