28th Annual INCOSE international symposium

Washington, DC, USA

July 7 - 12, 2018

An Austere SoS Integration Assurance Methodology

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SHOAL™

An Austere SoS Integration Assurance Methodology

INCOSE 2018 **10 Jul 18**

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Overview

- Problem Context – Introduction of Defence Capability Programs (SoS)
- The Research Approach
- The Design of the SoSE Assurance Methodology
- Initial Application of the SoSE Assurance Methodology
- Conclusion

Impacts of Changes in Australian Defence

- First Principles Review (2015)
  - Recommended and initiated a range of reforms
  - One Defence Business Model
  - Capability Managers leading development
    - CJC, CA, CN, CAF, DEPSEC SPI
  - Created the Integrated Investment Plan
    - 10 year expenditure plan
    - Approved annually by Government
    - Managed through the Investment Committee
      - Chaired by Vice Chief of the Defence Force (VCDF)
  - Increased Focus at the Portfolio and Program Level
  - Establish effective, arms-length contestability
  - Establishment of VCDF as the Joint Force Authority

Pre-Existing Defence Enterprise Characteristics

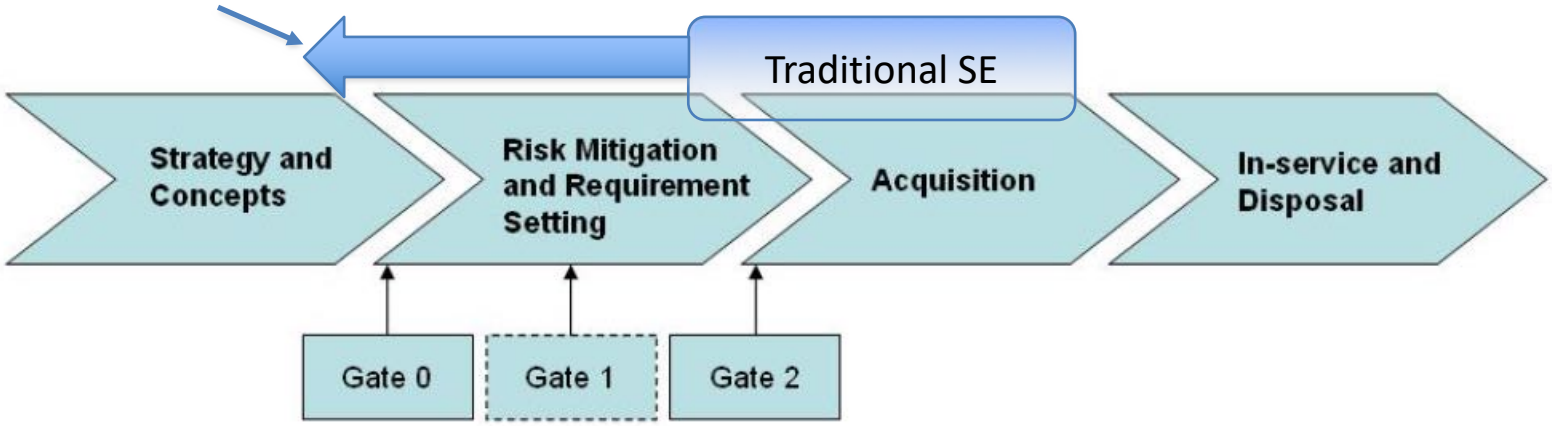
Current Characteristics	SoSE Implications
Modest Size force in 3 services, but operates as a joint force	Need for joint SoSE and Integration
Project-centric capability development and acquisition	SoSE must support project-centric acquisition
Complex capability development organisations, processes and cultures	Work within and to each culture Support Project-centric organisation
~ Off-the-shelf acquisition	Focus on system and SoS integration Defence as the SoS integrator
National SoSE capability is embryonic	Start by aiming at “Level 1”
Significant Processes Flexibility	Supports a tailorable approach to SoSE and hence assurance
Resource challenges & limitations for joint force design and realisation	Need to keep SoSE team(s) small, with lean processes and overheads

New More Flexible Capability Lifecycle (CLC)

- Four Stage CLC
  1. Strategy and Concepts
  2. Risk Mitigation and Requirement Setting
     - Gate 0, [1], 2
  3. Acquisition
  4. In-Service and Disposal

- Three Management Levels
  1. **Portfolio**: Whole-of-Defence capability consideration
  2. **Programs**: "a group of related Projects, Products, and Program activities that are managed in a coordinated way to optimize the capability outcome within allocated resources"
  3. **Projects**: Development and acquisition of new Products

Extend SE to SoSE early in the CLC



Problem Definition

- At IS 2018 Cook & Unewisse described a SoSE methodology for delivering Defence Programs that will be *"integrated-by-design".*
- The challenge:
  - How do we assess the ability of a Program to deliver the intended capability with the required level of integration and interoperability?

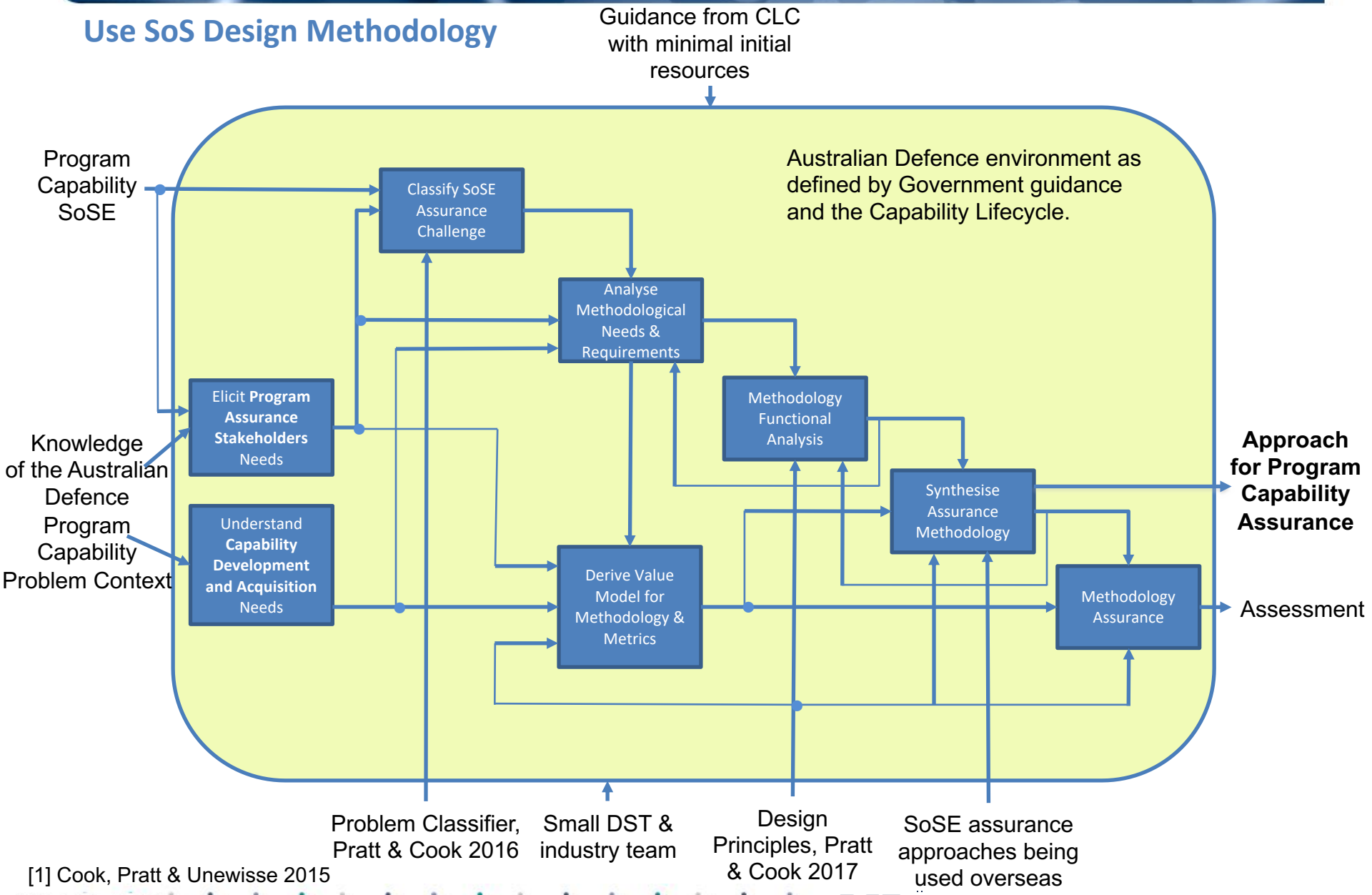
The Research Approach

- Reviewed the nature of Integration and Interoperability Assurance in Defence Organisations
- Conducted stakeholder interviews to support needs analysis
- Defined the purpose of Program I2 Assurance
- Choice of solution approach
- Defined Stakeholders needs for Program I2 Assurance
- Designed the Program I2A methodology
- Assessed methodology through use

Insights from Review of International SoSE Assurance

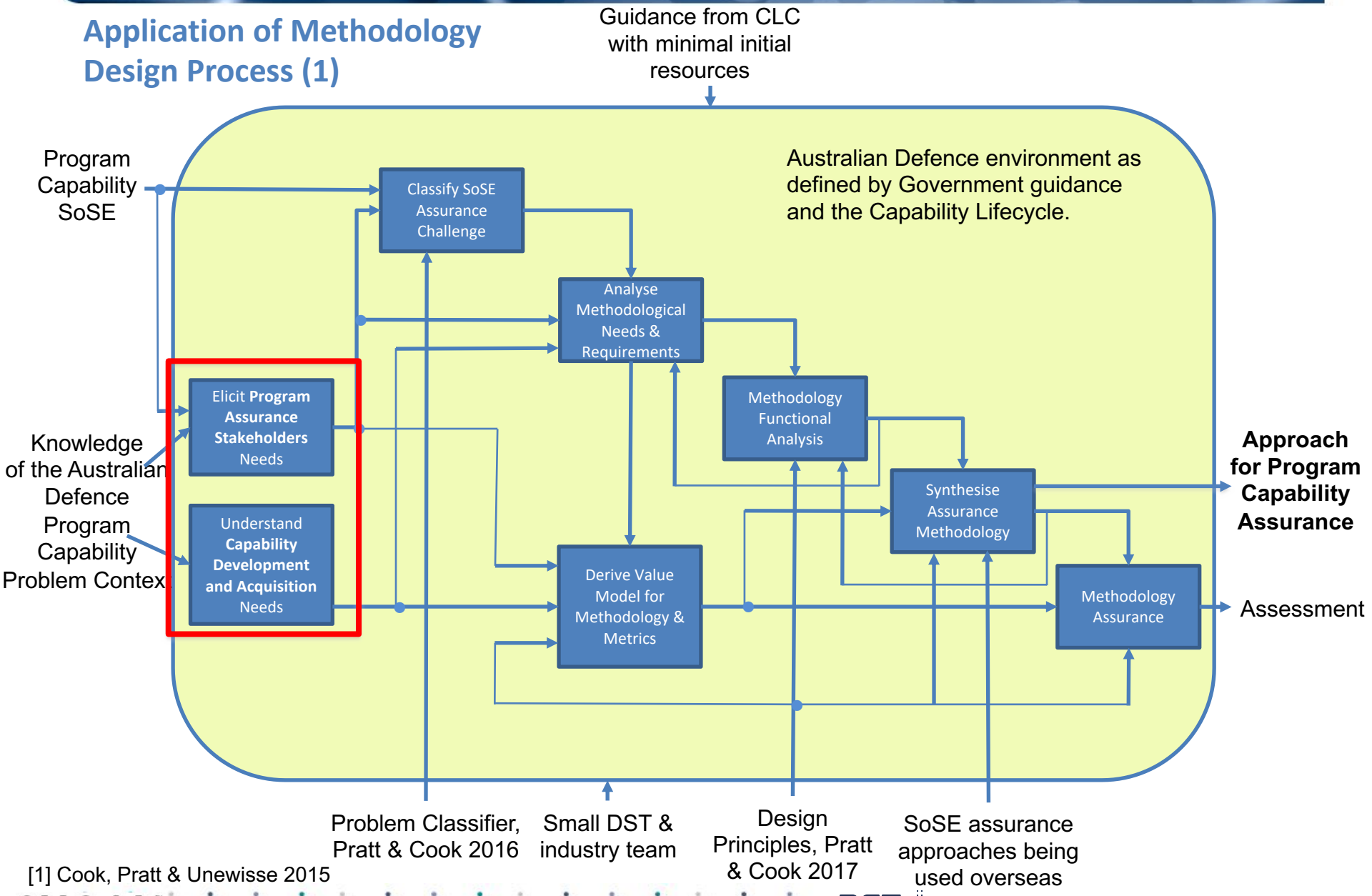
- US and UK have changed emphasis from assuring I2 per se to the assessment of the adequacy of Systems of Systems Engineering being undertaken on the SoS-of-interest
- Rationale: it became apparent, in practice, that it is the quality of the systems design and analysis work that determines the likelihood of SoS implementation and I2 success

Use SoS Design Methodology



[1] Cook, Pratt & Unewisse 2015

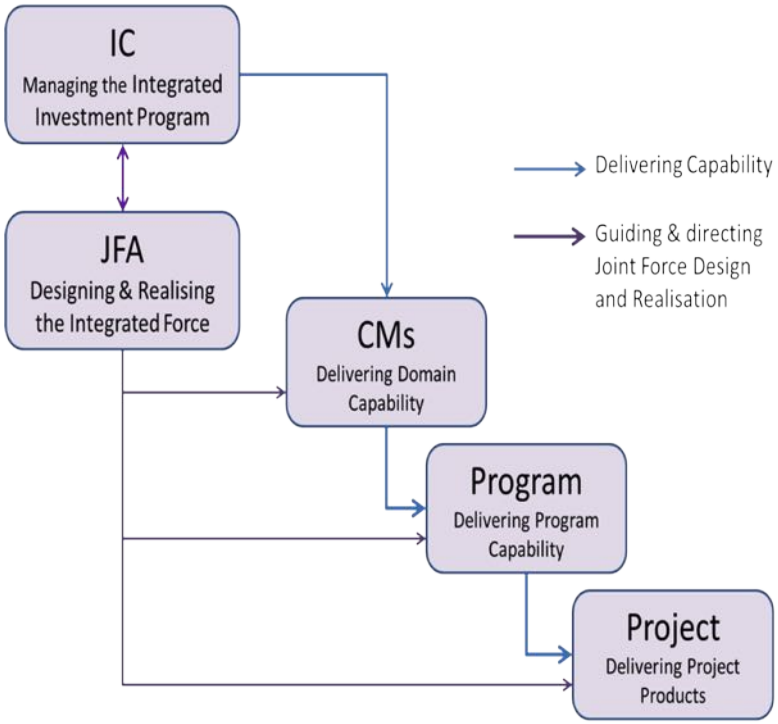
Application of Methodology Design Process (1)



[1] Cook, Pratt & Unewisse 2015

Key Stakeholder Groups

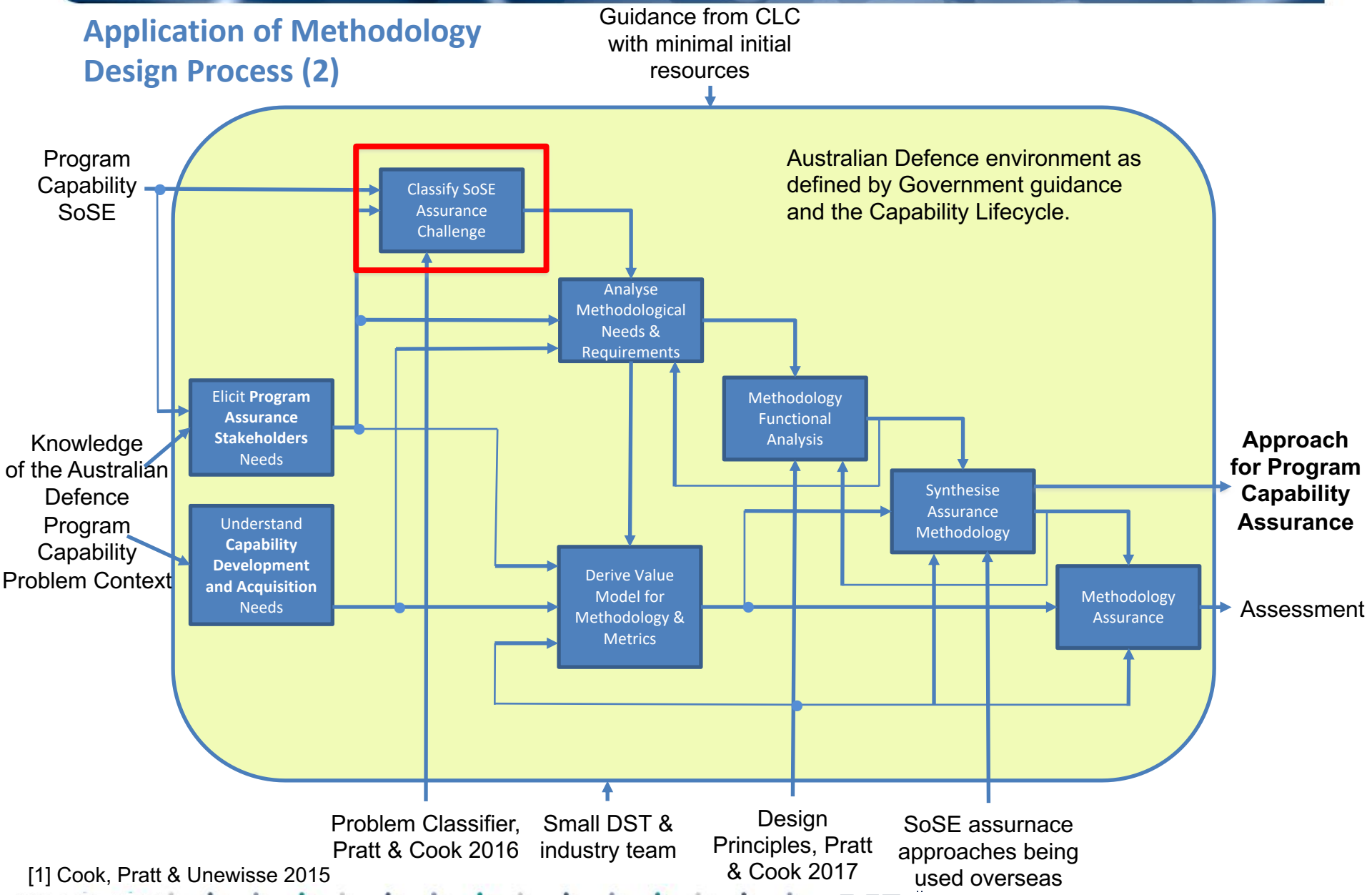
- Investment Committee (IC)
  - Managing and prioritisation of the Defence Integrated Investment Program
- Joint Force Authority (JFA)
  - Responsible for the Joint Force
    - Force Design
    - Force Integration
    - Force Validation
- Capability Managers
  - Delivering the Defence Capabilities
    - Programs and Projects
  - Chiefs of Service
- Undertook targeted stakeholder interviews to produce a set of stakeholder needs for each group



High-Level Needs

- Combined Stakeholder needs with insight from Defence guidance and literature
- Identified top-level need for a SoSE assurance approach
  - Inform Senior decision-makers
    - JFA, CMs, Program Sponsors
  - Support Program-capability design, realisation and management
  - Underpin delivering Joint Force by Design
  - Able to evolve and be tailored as required
  - Work with austere resources
  - Build on emerging SoS and SoSE awareness
  - Shape the relevant Projects and Products
  - Support cultural change

Application of Methodology Design Process (2)



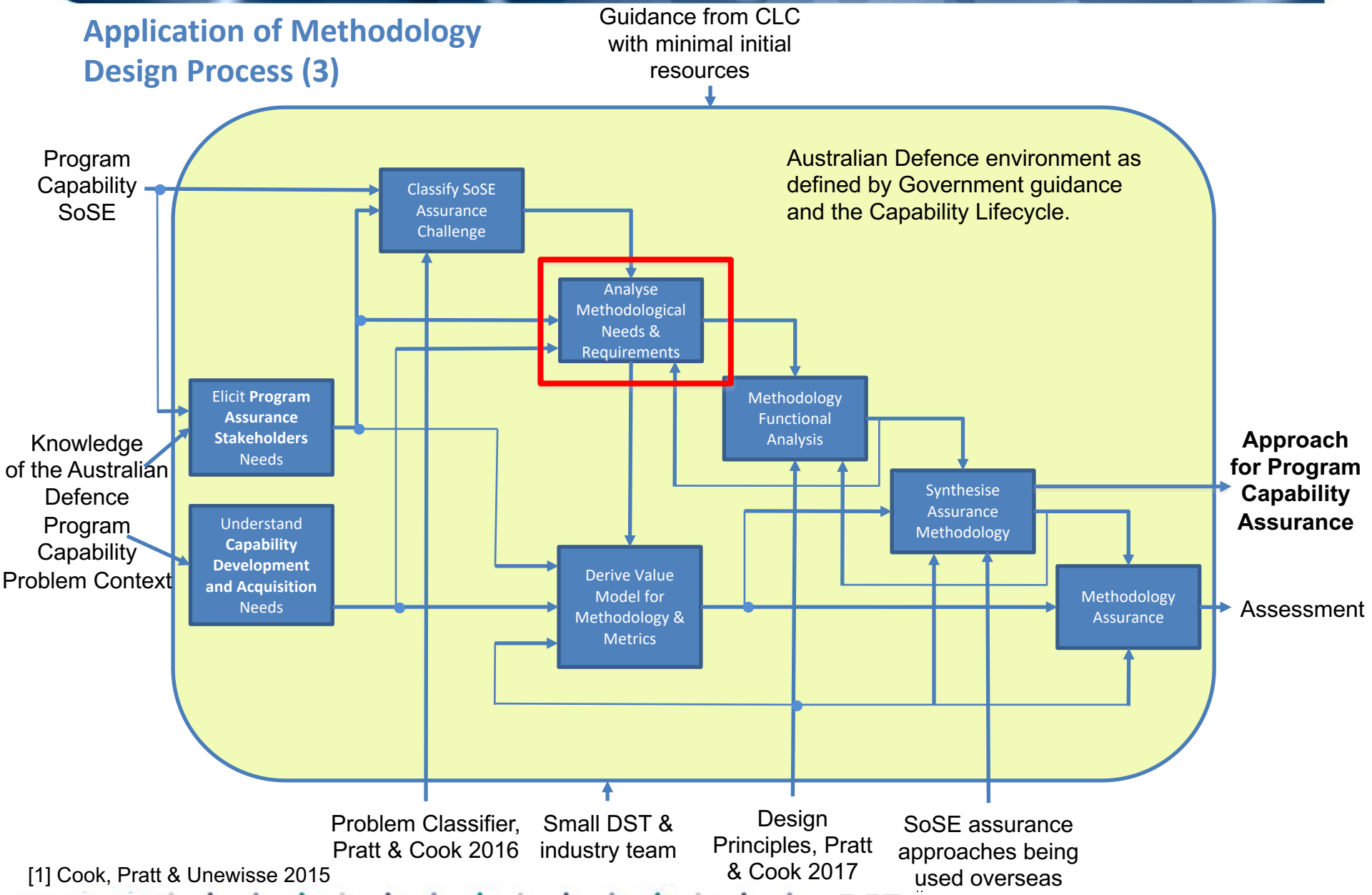
[1] Cook, Pratt & Unewisse 2015

Example Program Classification

Domain	Defence
Governance	Collaborative to Acknowledged
Complexity	High (technical and social)
Stakeholder Agreement	Pluralist - Can be convinced
Rate of change	Systems – Moderate Environment – Rapid
Level	Major Defence Capabilities
SoS Lifetime	Enduring > component systems
SoS Connectivity	High
Sociotechnical Nature	Highly complex and varied

- **Note that the Programs vary significantly requiring tailored approaches**
  - From Integrated Air and Missile Defence to Explosive Ordinance
  - From Platforms to C4ISR

Application of Methodology Design Process (3)



[1] Cook, Pratt & Unewisse 2015

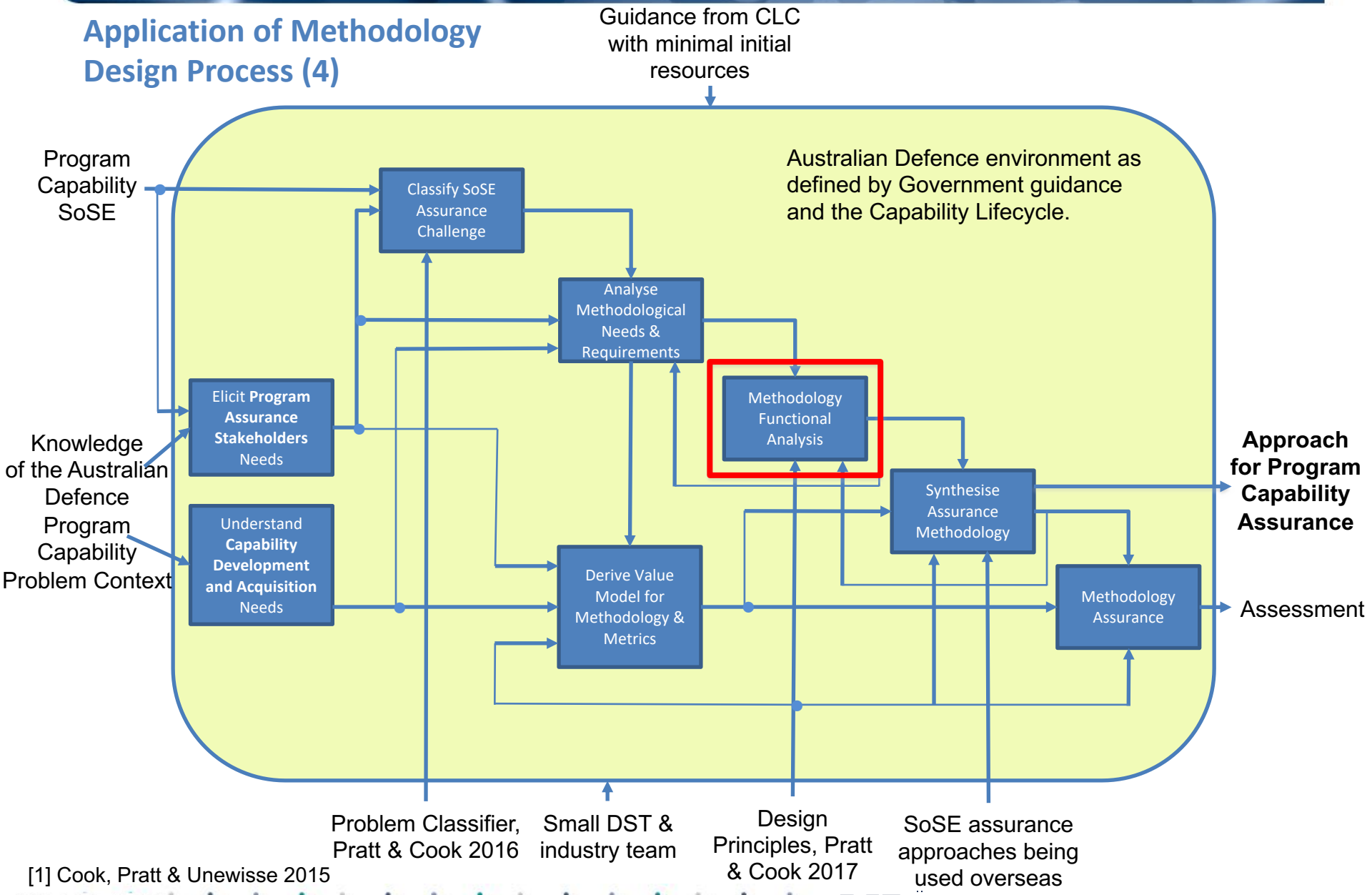
Consolidated Stakeholder Needs Analysis

- An interview-based stakeholder needs analysis elicited that a good Program I2A methodology should:
  - Be simple to use
    - Suitable for use by an Integration Officer who has limited time to produce a Program I2A
  - Capture Program-level dependencies
  - Report on the Program Capability management
    - Capture the nature of the agreements between Program stakeholders
  - Artifacts are fit for purpose
    - Achievable, Manageable, Maintainable
    - Facilitate understanding and engagement
    - Support actions to shape and enable Program goals
  - Facilitate evidence-based decision-making
  - Employ a pragmatic design approach to evolve the Program I2A

Consolidated Methodology Needs

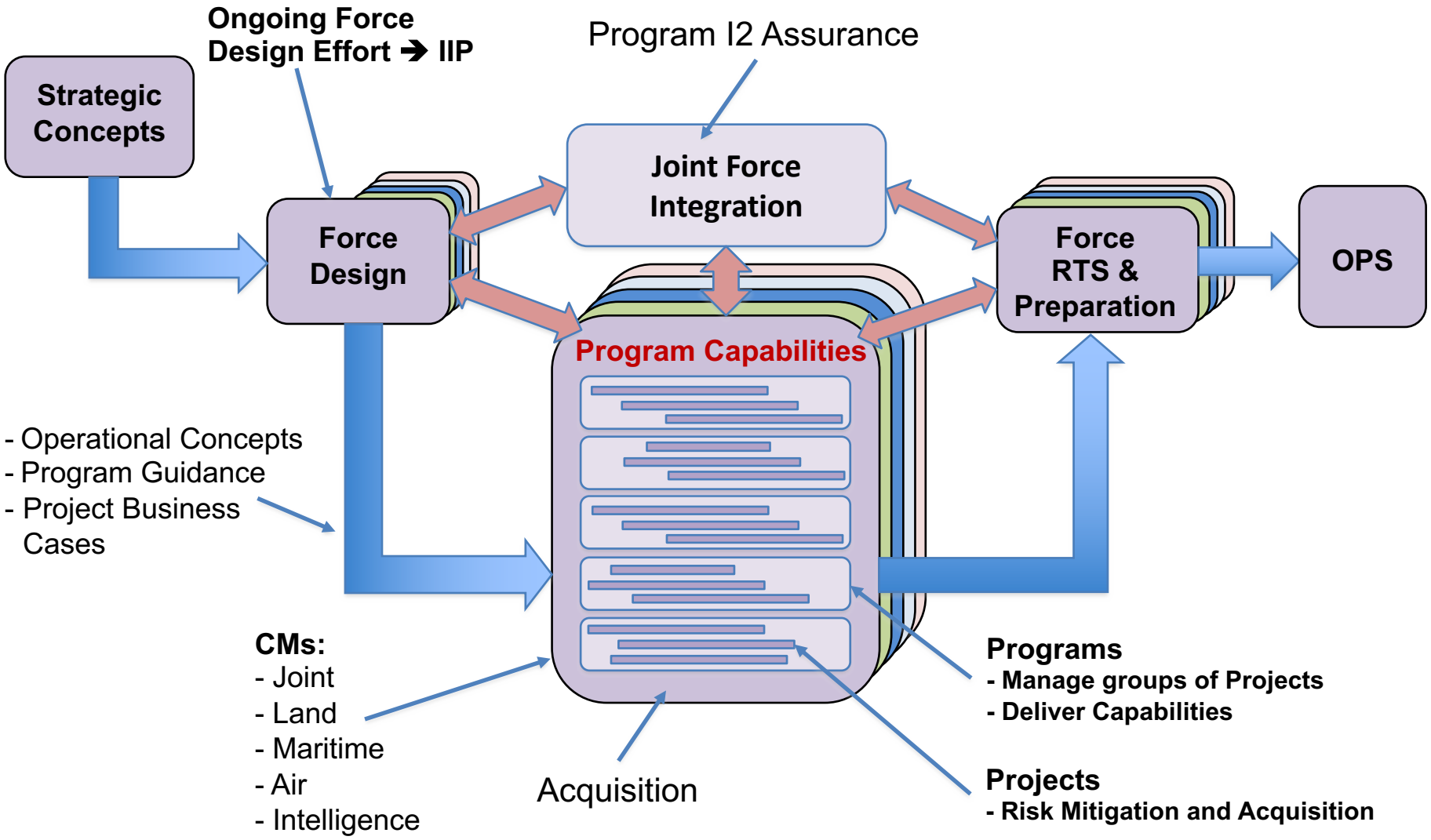
- From a SoSE perspective, the Program I2A should:
  - Draw on established systems engineering (SE) concepts and vocabulary
  - Focus on simple approaches where the value delivered is much greater than the overheads
    - Be austere
    - Seek to help manage complexity rather than add to it
  - Support early Program-level design efforts and inform timely decision-making
  - Provide an output that:
    - Facilitates implementing measureable and achievable goals
    - Encourages Program-level design
    - Uses systemic and leading indicators to enable early intervention
    - Captures risks and issues that could compromise Program outcomes
    - Provides a set of recommended actions that need to be performed to ameliorate concerns raised

Application of Methodology Design Process (4)

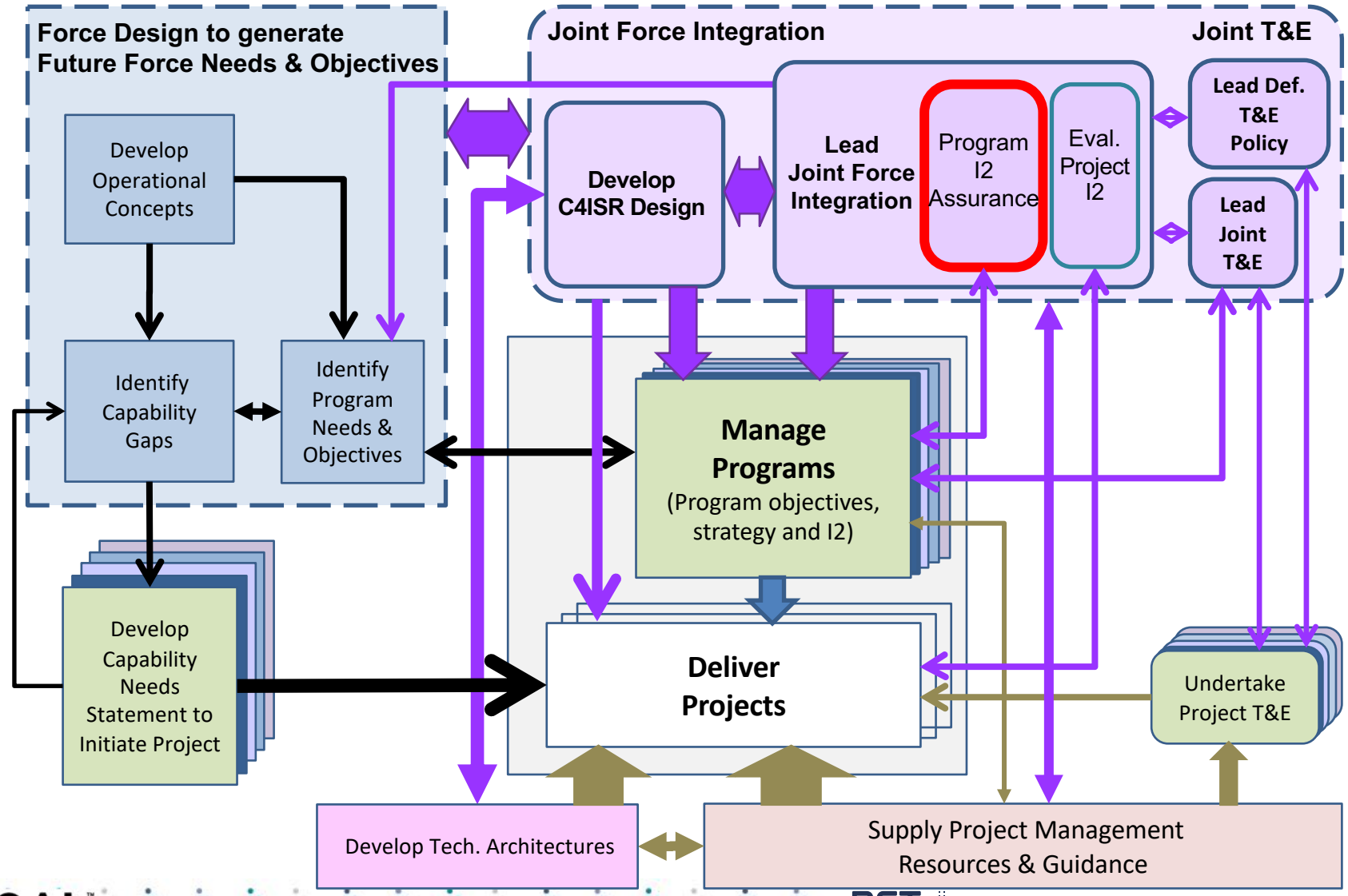


[1] Cook, Pratt & Unewisse 2015

Functional Flow of Capability Lifecycle

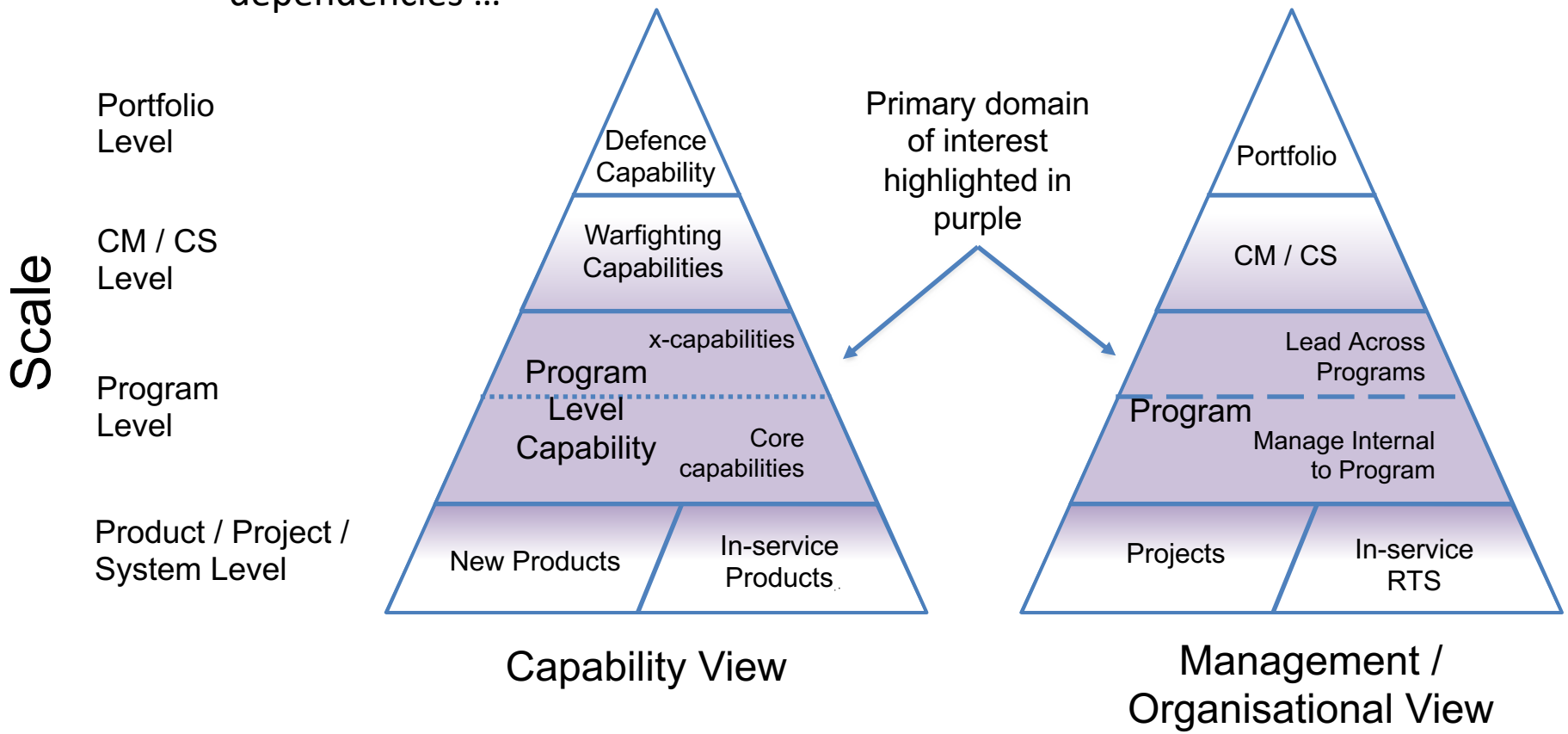


Capability Lifecycle: Functional View

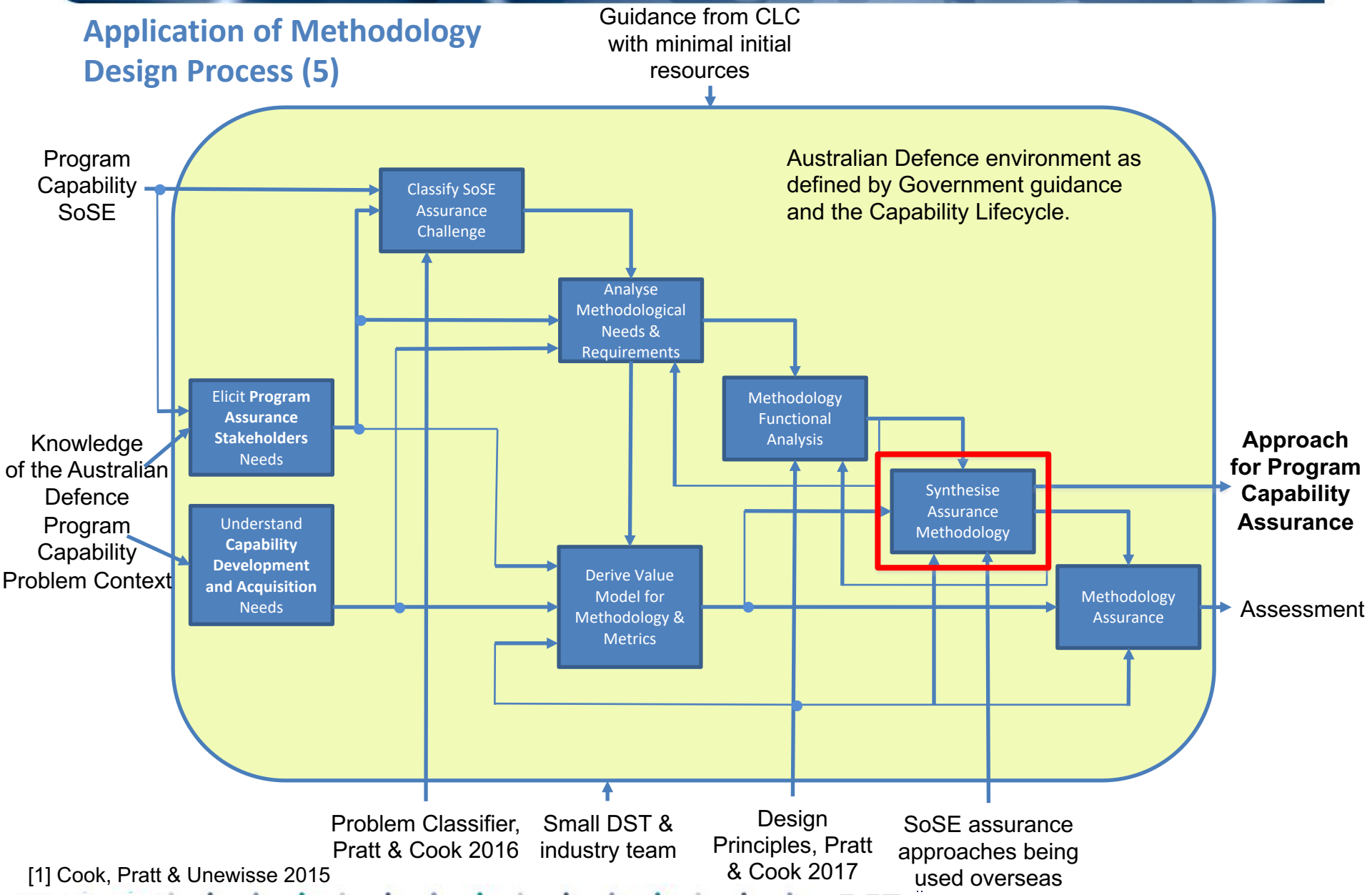


Supporting Capability and Management Views

- Need to address both:
  - I2 capability challenges – architectures, systems dependencies …
  - Management / organisational challenges – implementation, management dependencies …



Application of Methodology Design Process (5)

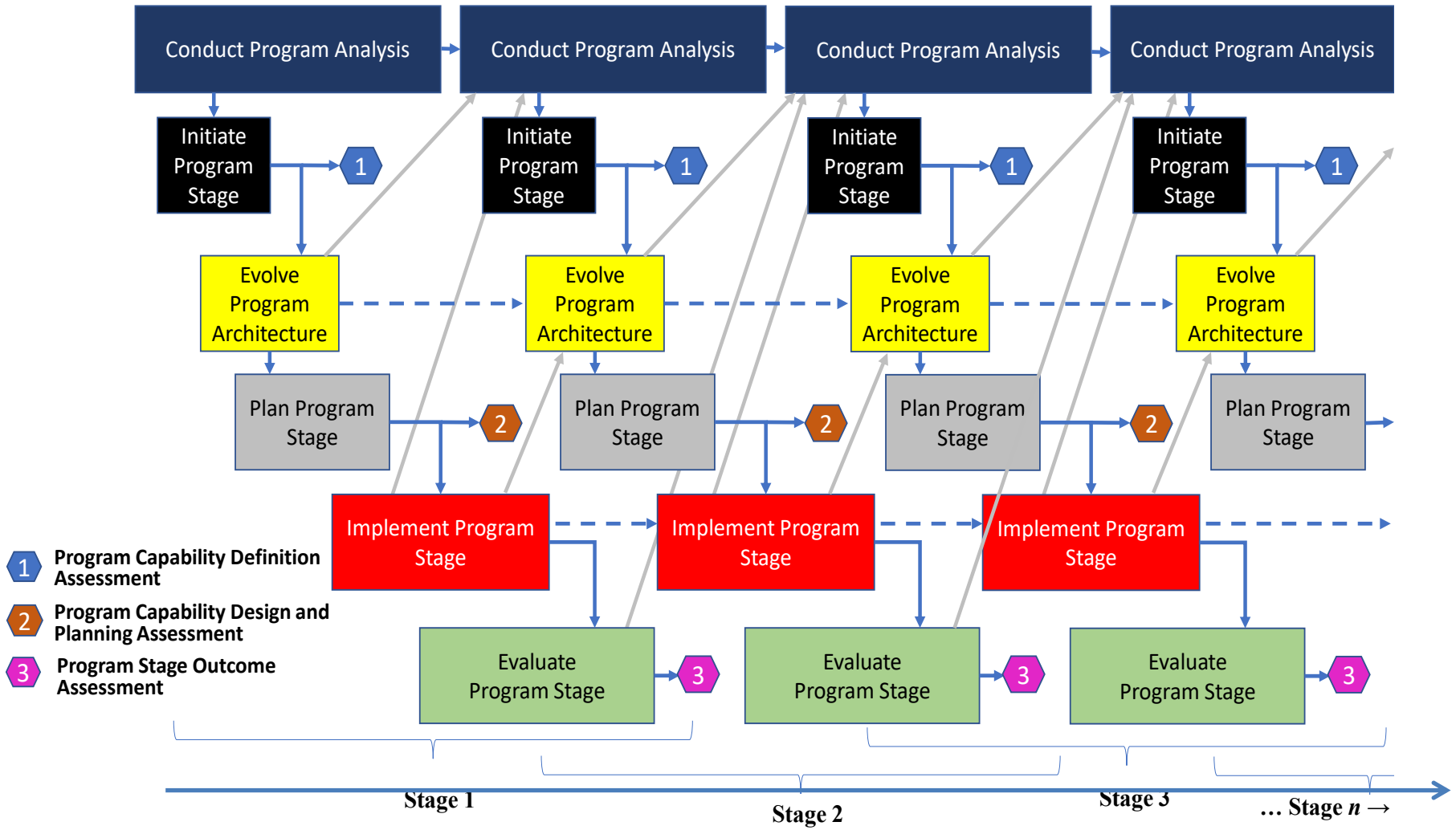


[1] Cook, Pratt & Unewisse 2015

SoSE Assurance Methodology Design - Process

- Decide the Assessment Type
- Gather Program Capability Information
- Undertake Program I2 Assessment
- Generate Program I2A Products

Program Wave Model Showing Assessment Points



Example Information for Initial Assessment

- Program SoSE management construct
- Program capability purpose and goals
- Program concept of operations
- Information about identified constituent systems (Product or Projects)
- Program risks and mitigations
- Draft agreements between the Program and the constituent Projects and Product teams, as well as between the key constituent Projects and Product teams
- Key design and implementation constraints (allied interoperability, standards, use of certain constituent systems, legacy issues, etc.)

SoSE Assurance Methodology Design - Assessment Approach

- Levels of Information System Interoperability and Mission Engineering approaches considered overly sophisticated for initial roll-out
- Selected a score-card approach

i.	Green	Element has been addressed to an appropriate level
ii.	Amber – Green	Much of the element has been addressed
iii.	Amber	Some of the element has been addressed
vi.	Red – Amber	Limited effort has been undertaken to address the element
v.	Red	The element has not been addressed

Top-Level Program I2 Assurance Structure

1. Program Governance
2. Strategic Guidance
3. Program Capability Design
4. Capability Dependencies and Interfaces
5. Program Capability Technical and Risk Analysis
6. Program Capability Evaluation
7. Capability Stages and Scheduling
8. Program Management and Analysis
9. Agreements for Program Capability
10. People and Competencies
11. Information management and Tools
12. Culture

Elements of Program I2A - 2nd Level Detail (1)

	Program I2A Element	Program I2A sub-Element
1	**Program Governance**	
1.1		Overall governance approach
1.2		Stakeholder roles, authorities and responsibilities
1.3		Program capability resources
2	**Strategic Guidance**	
2.1		Purpose, scope, and scale of the Program Capability
2.2		Program capability goals & drivers
2.3		Program gaps and timelines
2.4		Operational concept and key scenarios
2.5		Key design and implementation constraints
3.	**Program Capability Design**	
3.1		Current capability baseline
3.2		Program needs
3.3		Program measures
3.4		Functional architecture
3.5		Capability architecture
4	**Capability Dependencies and Interfaces**	
4.1		Key cross-Product capability dependencies
4.2		Nature of dependencies understood
4.3		Information Exchange Requirements (IERs)
4.4		Interface requirements
4.5		Dependencies timescales
5	**Program Capability Technical and Risk Analysis**	
5.1		Technical analysis and management
5.2		Program capability risk analysis
6	**Program Capability Evaluation**	
6.1		Evidence providing confidence in meeting Program objectives
6.2		Evidence that the key enablers will support the objectives
6.3		Value being delivered to component Projects/Products
6.4		Developmental enablers (models, SILs …)

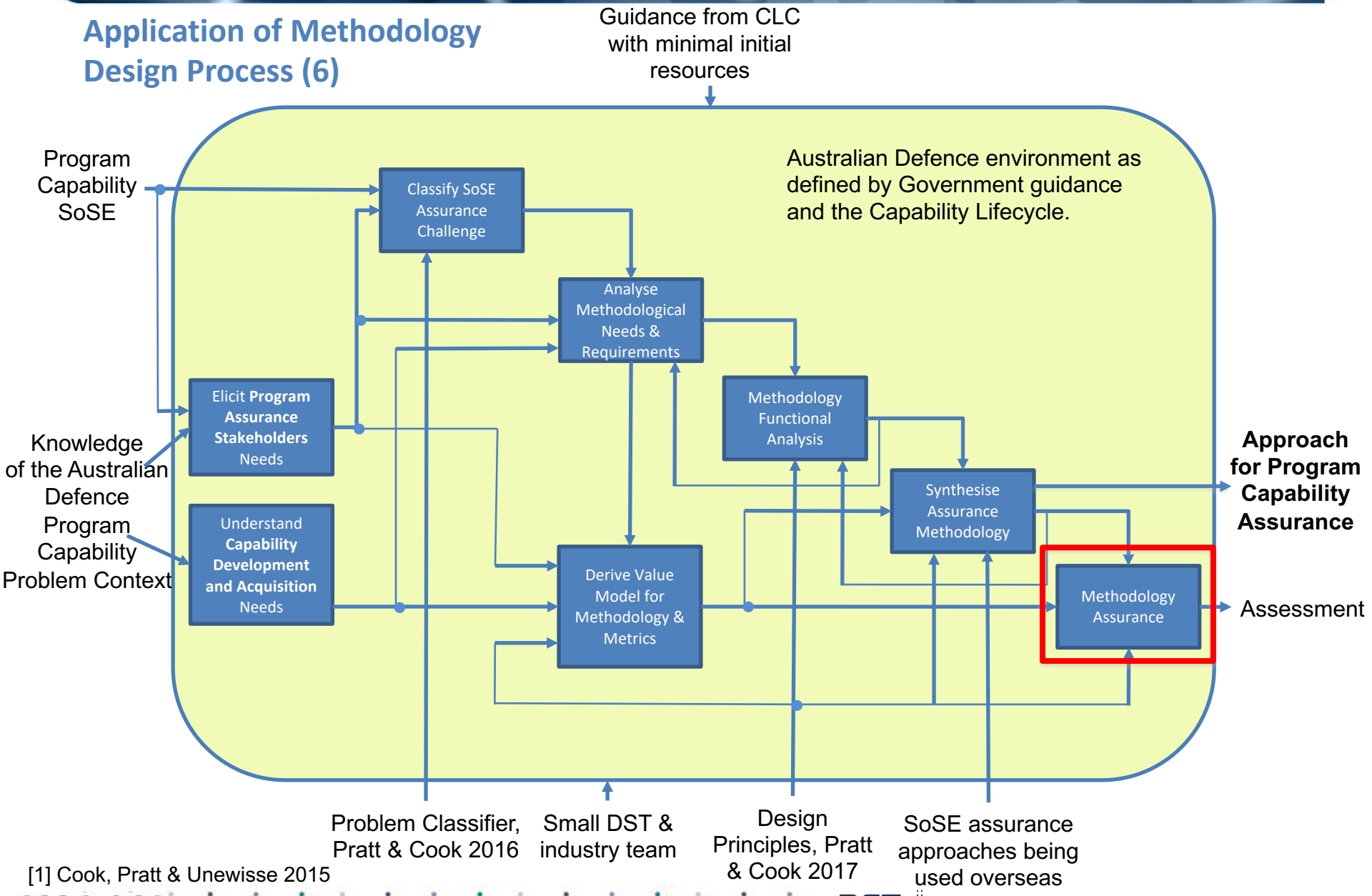
Elements of Program I2A – 2nd Level Detail (2)

7	**Capability Stages and Scheduling**	
7.1		Capability stages
7.2		Roadmap
7.3		Ability to explore scheduling change impacts
7.4		Implementation Plan
8	**Program Management Analysis**	
8.1		Program Strategy
8.2		Resources for Program capability design and realisation
8.3		Management processes
8.4		Management dependencies (cross Program and Project)
8.5		Management risks
9	**Agreements for Program Capability**	
9.1		Capability dependency agreements
9.2		Capability management agreements
10	**People and Competencies**	
10.1		SoSE Team
10.2		People and skills to support Program capability
10.3		People and skills to build tools for the Program capability
11	**Information Management and Tools**	
11.1		Information management
11.2		Program-level tools
12	**Culture**	
12.1		Culture for capability design and realization
12.2		Value is perceived to be delivered to Projects
12.3		Suitable stakeholder training

Generate Program I2A Products

- It is intended that the outcomes of the Program I2A be provided at three levels:
  - Concise overview targeted at informing briefings to senior decision-makers that would be focused on the overall Program I2 status and the key issues
  - A summary of the Program I2A assessments and recommendations against the 12 key Program I2A elements and 41 sub-elements. This would be targeted at JFA staff and the Program Sponsor/Manager.
  - A detailed Program I2A, including: a detailed hierarchy of questions, description of the I2 approach taken, the assessments, recommendations, and overall rating.

Application of Methodology Design Process (6)



[1] Cook, Pratt & Unewisse 2015

Methodology Validation through Application

- The Integrated Air and Missile Defence (IAMD) Program capability was used as a test case for the initial application of the Program I2A methodology.
- Assessment performed using the instruments and report templates generated
- Covered review of Program management, documentation, models, and constituent system materials
- An early version of the Program I2A was tested against the IAMD Program capability. The lessons and insights from this first application resulted in a restructure and refinement of the scorecard approach to produce the methodology described. Trial took < 3 weeks.
- The outcomes of this trial review were back briefed to key stakeholders, including the contractor (Shoal Engineering) who was developing the model-based tool for the PIOC

Indicative Example of Program I2A
(at highest level)

Program I2A Element	
Program Governance	
Strategic Guidance	
Program Capability Design	
Capability Dependencies and Interfaces	
Program Capability Technical and Risk Analysis	
Program Capability Evaluation	
Capability Stages and Scheduling	
Program Management and Analysis	
Agreements for Program Capability	
People and Competencies	
Information management and Tools	
Culture	

Conclusion

- Program I2A approach presented considers I2 as the outcome of effective Program capability design, realization and management.
- The methodology developed takes into account:
  - Level of maturity of Program SoS engineering
  - Nature of the information available to assessors
  - Resources allocated to the assessment effort
- Program I2A identifies 12 key assurance elements
  - Each element and sub-element has an associated guiding question to support the assessor in determining the ratings within the Program I2A
- Simple five-level (Red to Green) scorecard approach used
- Provides an austere approach to providing the feedback essential for the realization of an integrated and interoperable force at multiple levels of decision-making
- Can be quickly implemented < 3 weeks
- Approach could be adapted to provide SoS assurance to a range of SoS
- Currently being refined to a 6 element structure to facilitate application

QUESTIONS