Australian Government
Department of Defence
Defence Science and Technology Group

A SoS Approach for Engineering Capability Programs

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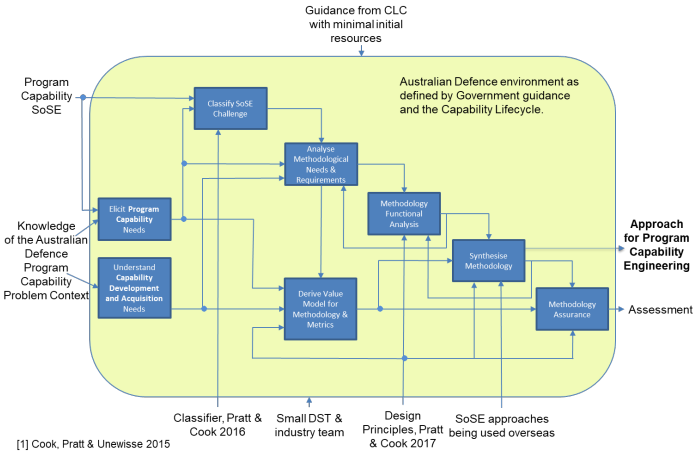
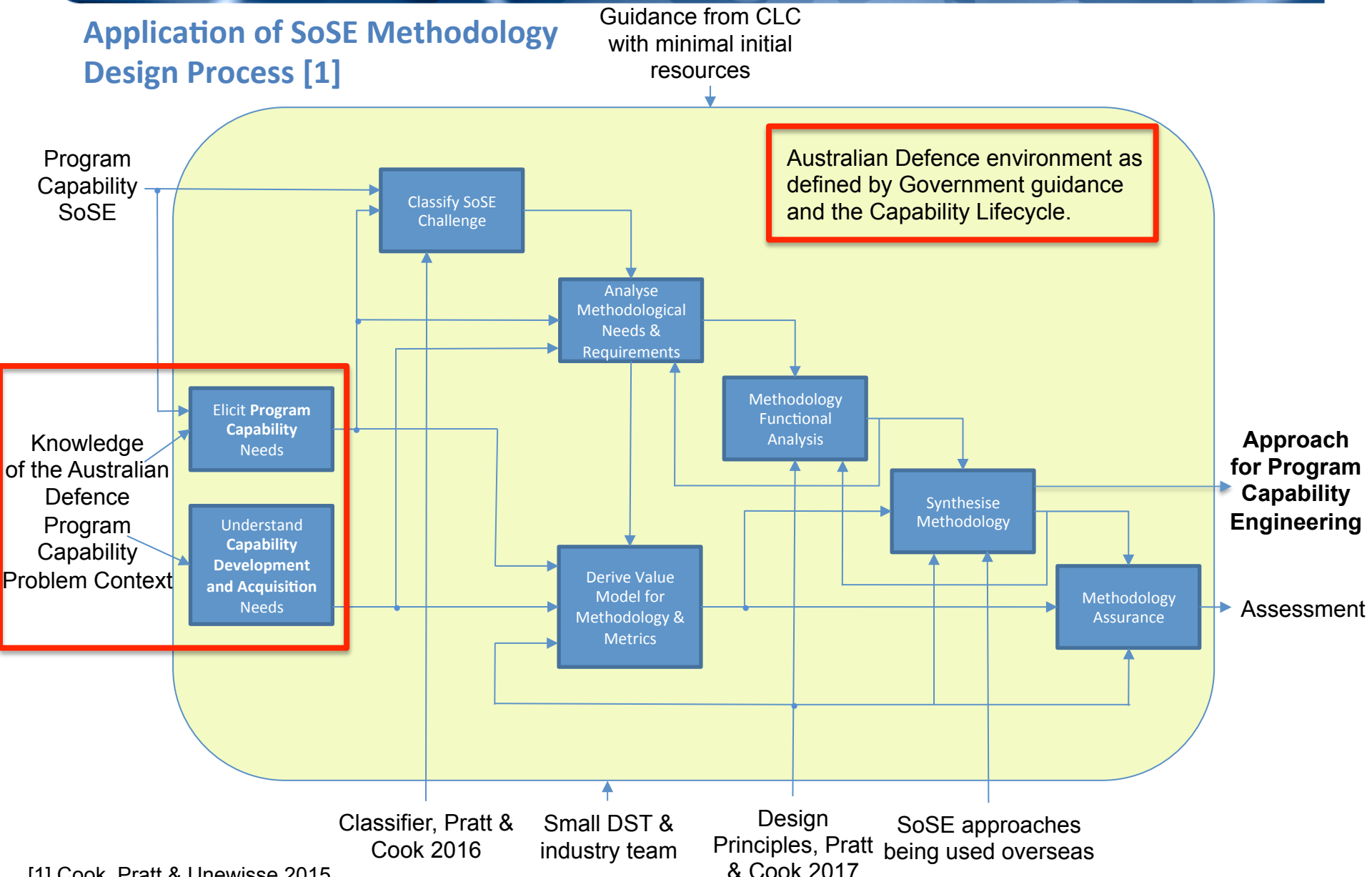
Overview

- Design Approach
- Problem Context
- SoS Challenge and Classification
- Functional Analysis
- Identification of the Needs
- Review Existing SoSE Approaches
- Generation of a Hybrid SoSE Approach
  - Needs
  - Key Recommendations
- Initial Applications and Assurance
- Conclusion



Application of SoSE Methodology Design Process [1]



[1] Cook, Pratt & Unewisse 2015

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

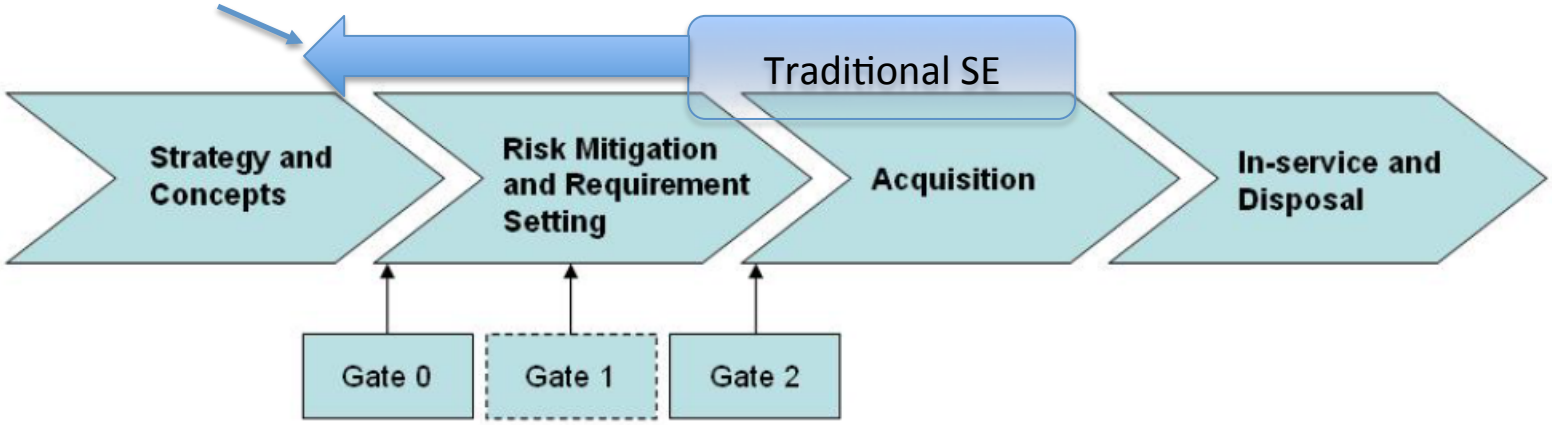
Current Characteristics	SoSE Implications
Modest Size force in 3 services, but operates as a joint force	Need for joint SoSE and Integration
Project-centric capability development and acquisition	SoSE must support project-centric acquisition
Complex capability development organisations, processes and 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
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

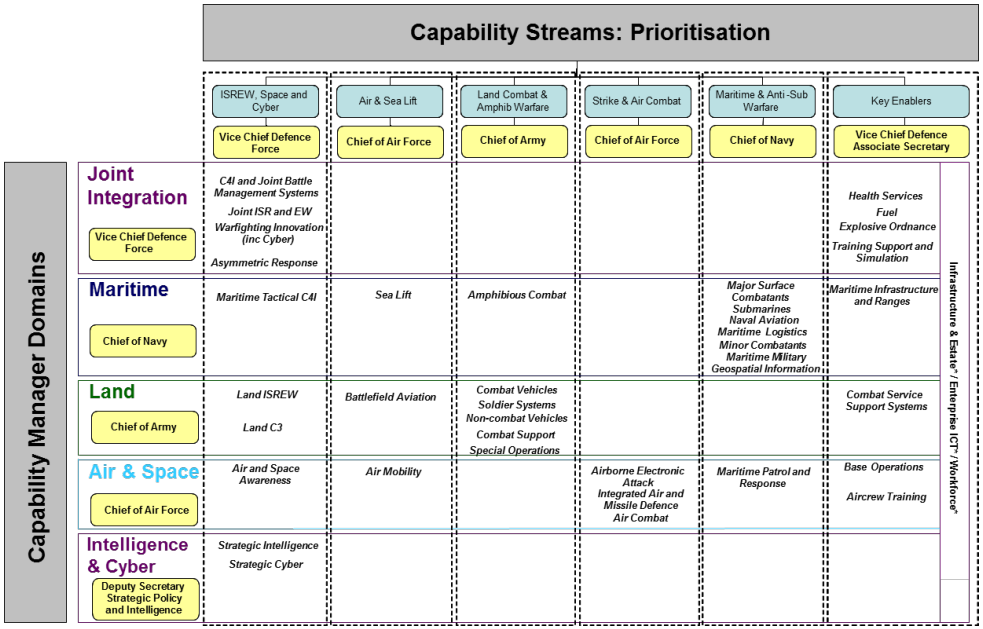
- Three Management Levels
  1. **Portfolio**: Whole-of-Defence capability consideration
  2. **Programs**: Collections of Projects and Products to deliver capability outcomes
  3. **Projects**: Development and acquisition on new Products

Extend SE to SoSE early in the CLC



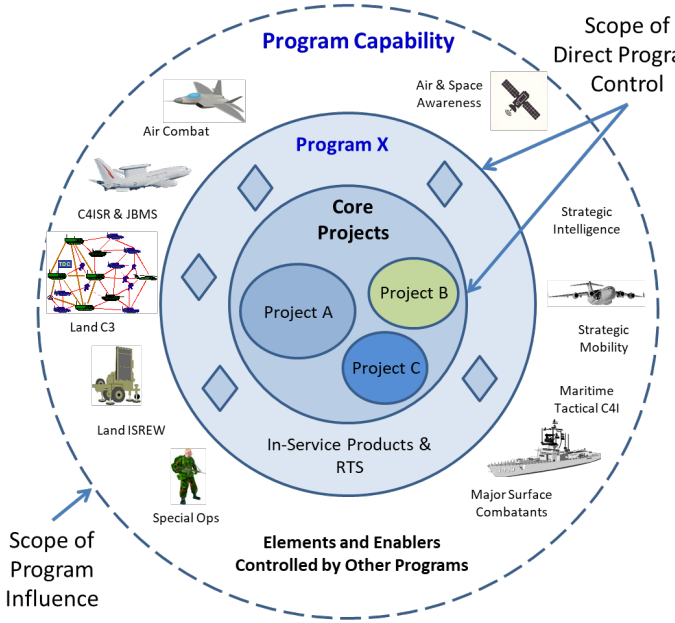
Portfolio and Program Management

- CM Domains
  - Joint, Maritime, Land, Air & Space, Intelligence &Cyber
  - Deliver capabilities
- Capability Streams:
  - Guidance from Government
  - Reporting to Government
- 40 Programs
  - Across the CM Domains and Capability Streams
  - Introduced to improve decision-making & management



Program Capabilities

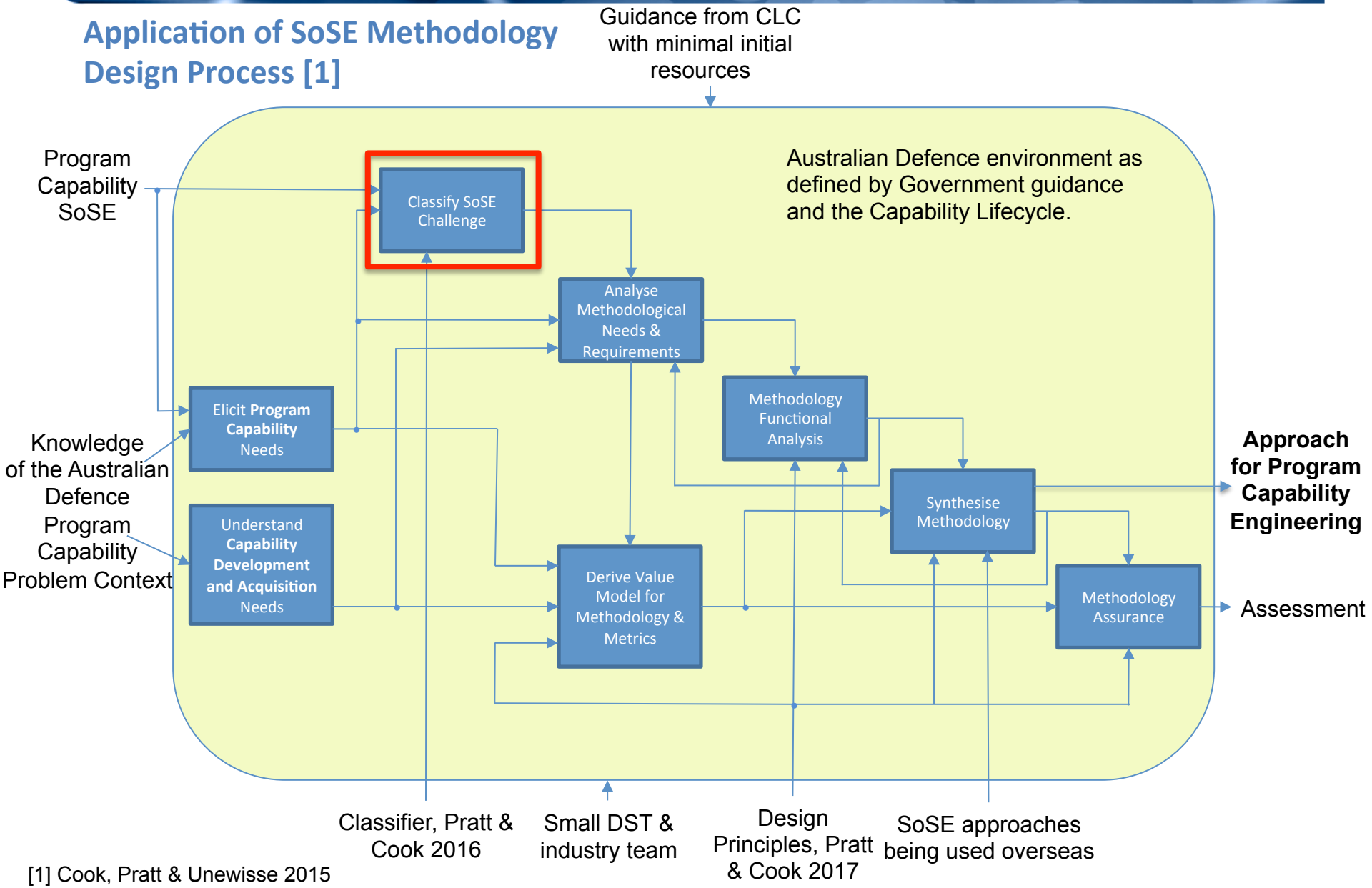
- Some of the 40 Programs can be considered as the core of broader Program Capabilities
  - Amphibious Combat, IAMD …
- Components within the Program
  - Core Projects delivering new Products
  - In-Service Products
- Components within other Programs
  - Need to shape and influence
- The Program Capabilities are SoSs



Joint Force Authority

- VCDF Identified as the JFA Responsible for:
  - Force Design:
    - Ensuring gaps, risks and issues in capability (military, enabling & enterprise) and future force structure are considered, joint, and developed upfront to allow informed, prioritised, balanced investment decisions
  - Joint Integration:
    - Shape Programs to deliver capabilities that are integrated and joint by design
    - Ensure Projects are designed to deliver required joint integration & interoperability
  - C4ISR Design:
    - Direction setting and assurance for all capability options under development to ensure they comply with the C4ISR Design Concept
  - Joint T&E:
    - Policy and direction setting with ongoing governance and direct involvement with Capability Manager Test & Evaluation organisations to ensure capability being delivered meets the required joint needs
- Shape via Programs and deliver by Projects

Application of SoSE Methodology Design Process [1]



[1] Cook, Pratt & Unewisse 2015

SoSE Challenge

- Develop a SoSE approach that can 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

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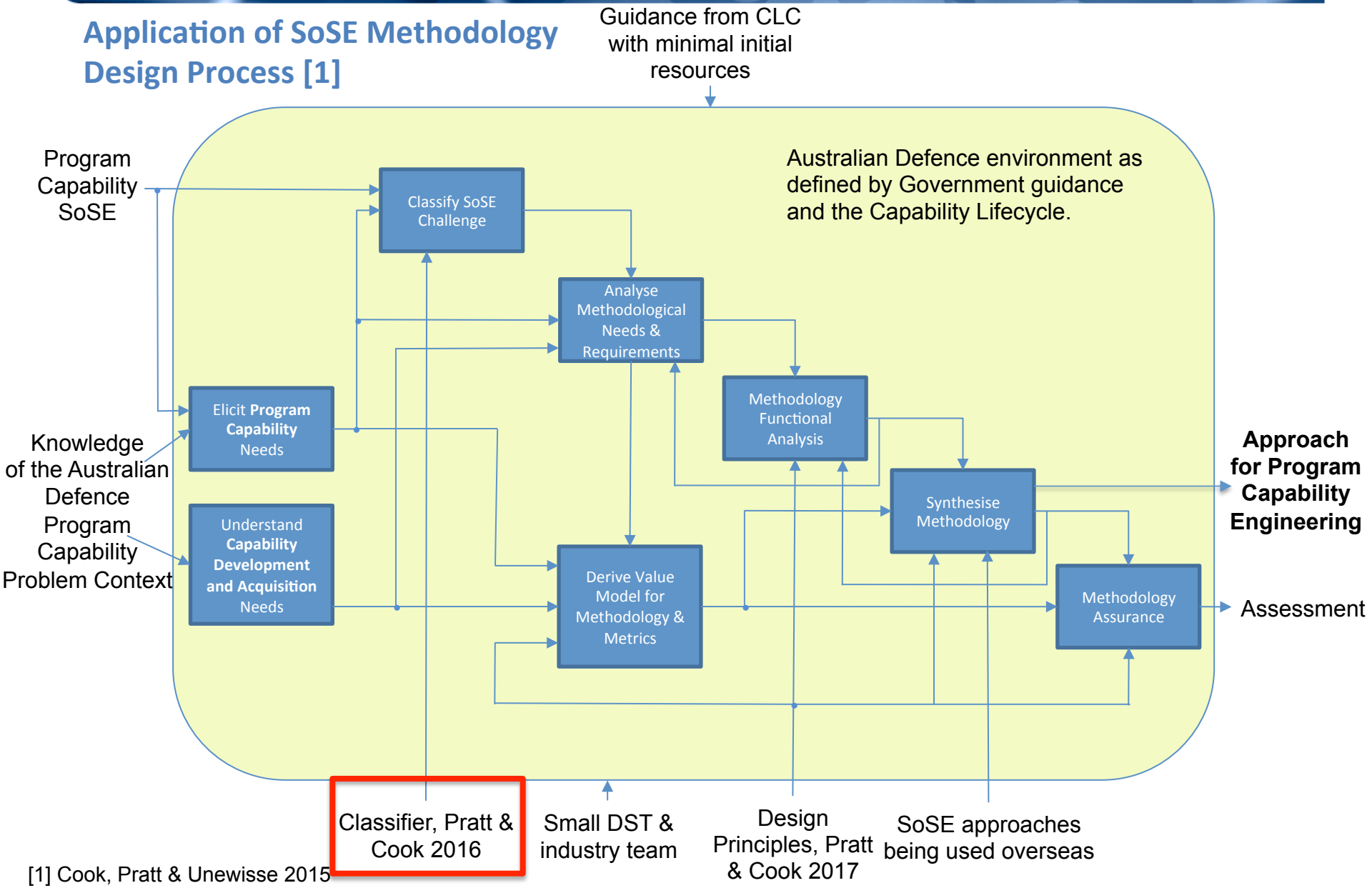

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SoS Classification

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

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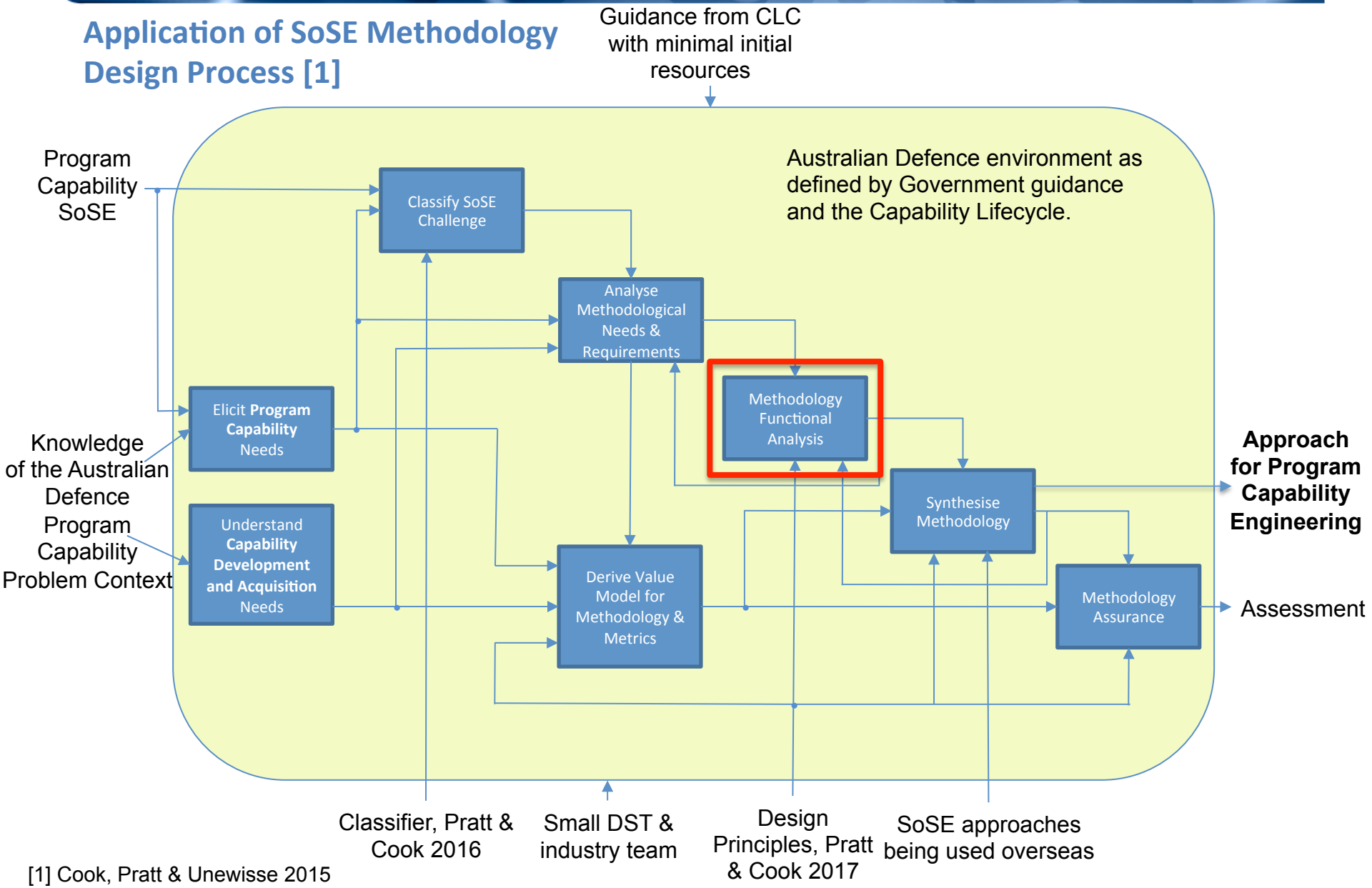

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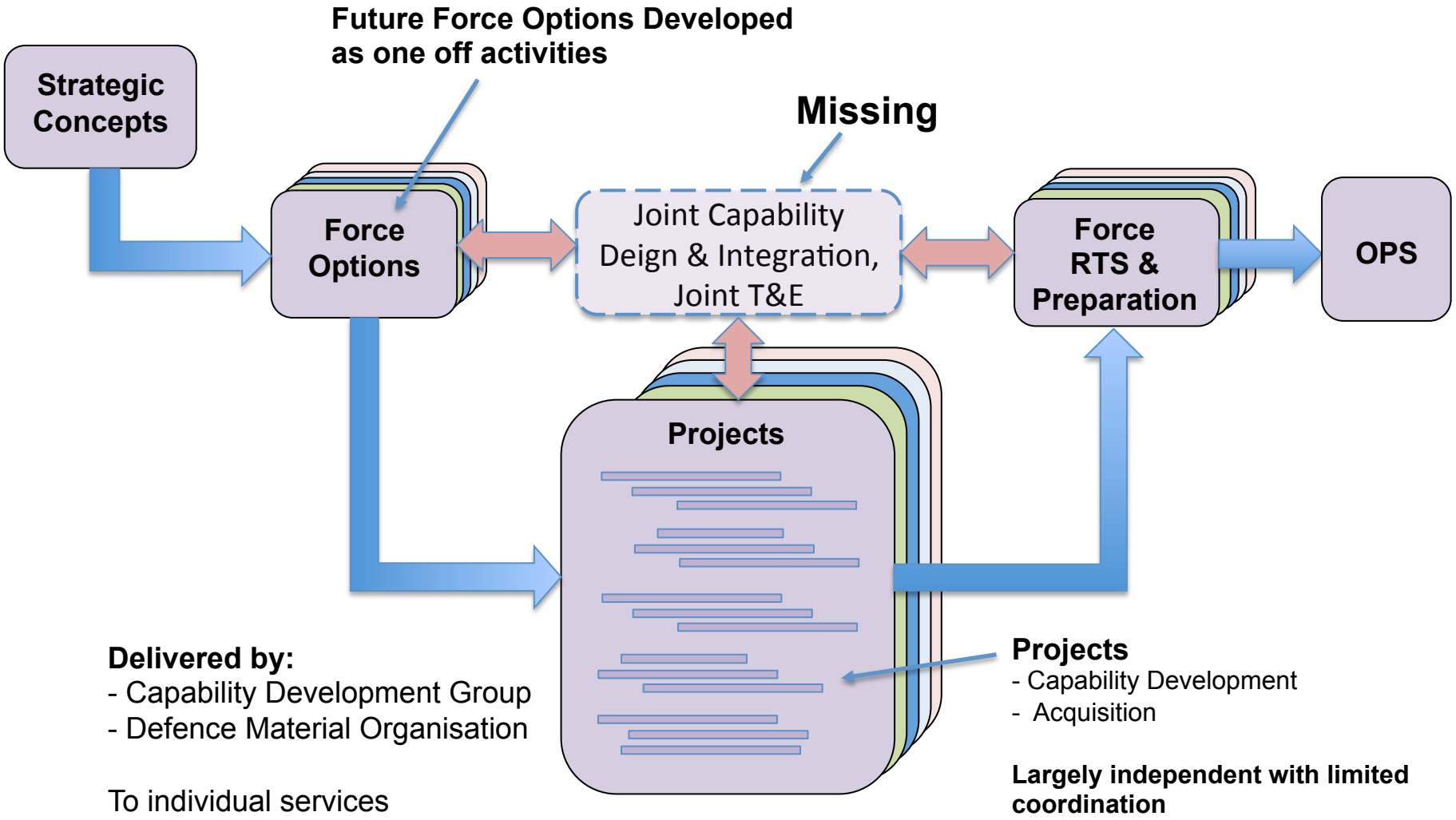
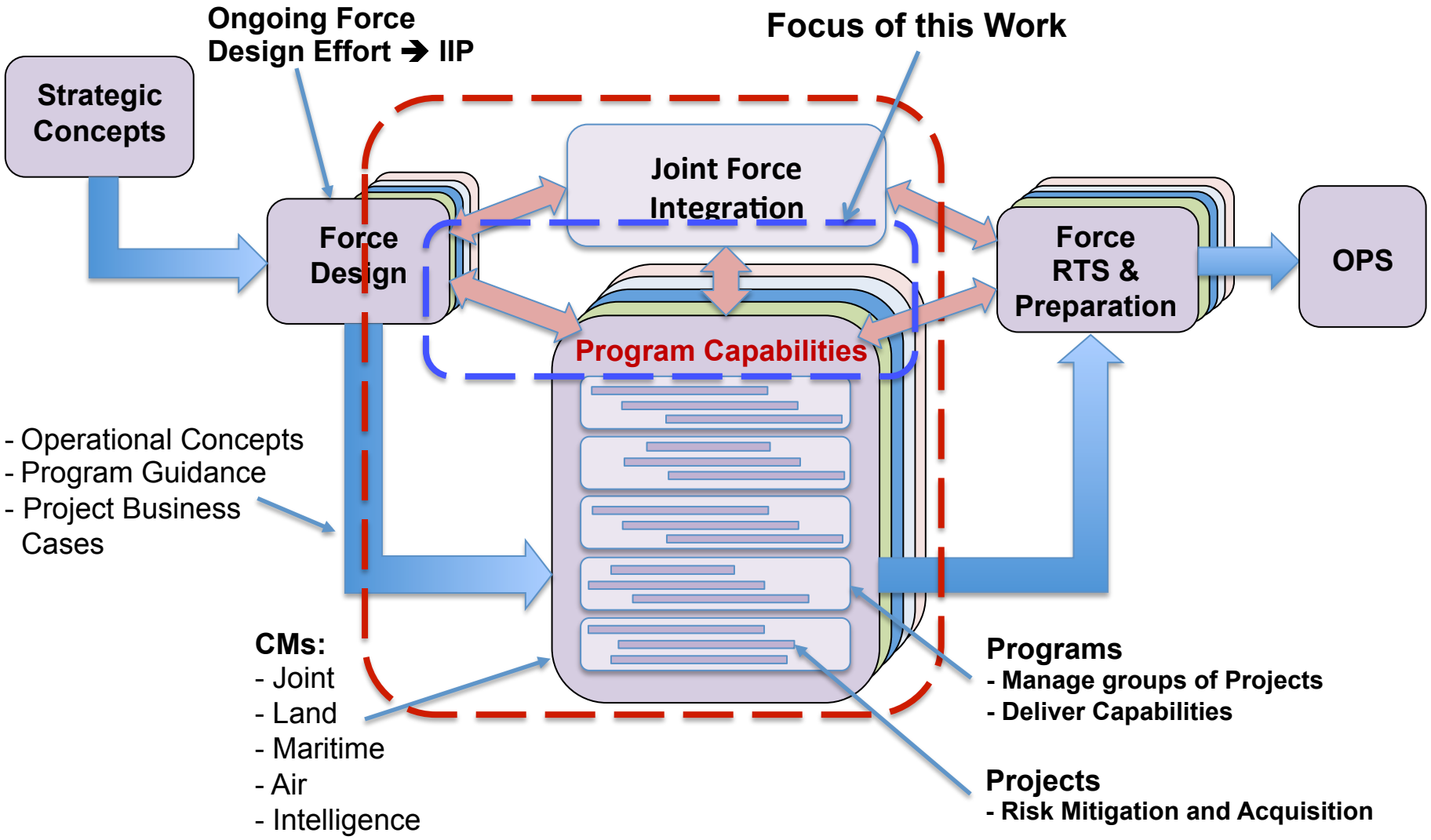
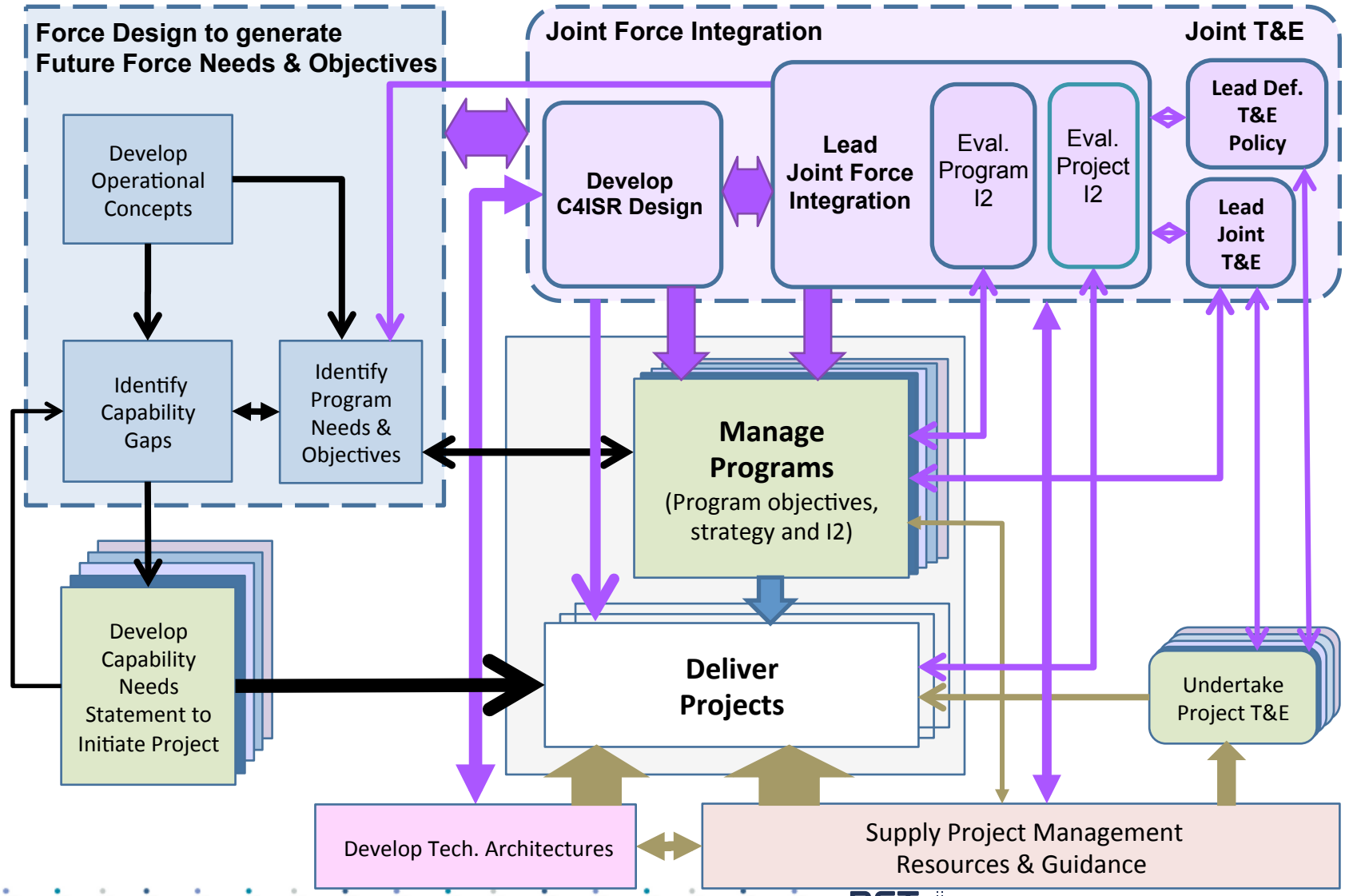
Functional Flow of Previous CLC



Functional Flow of New CLC

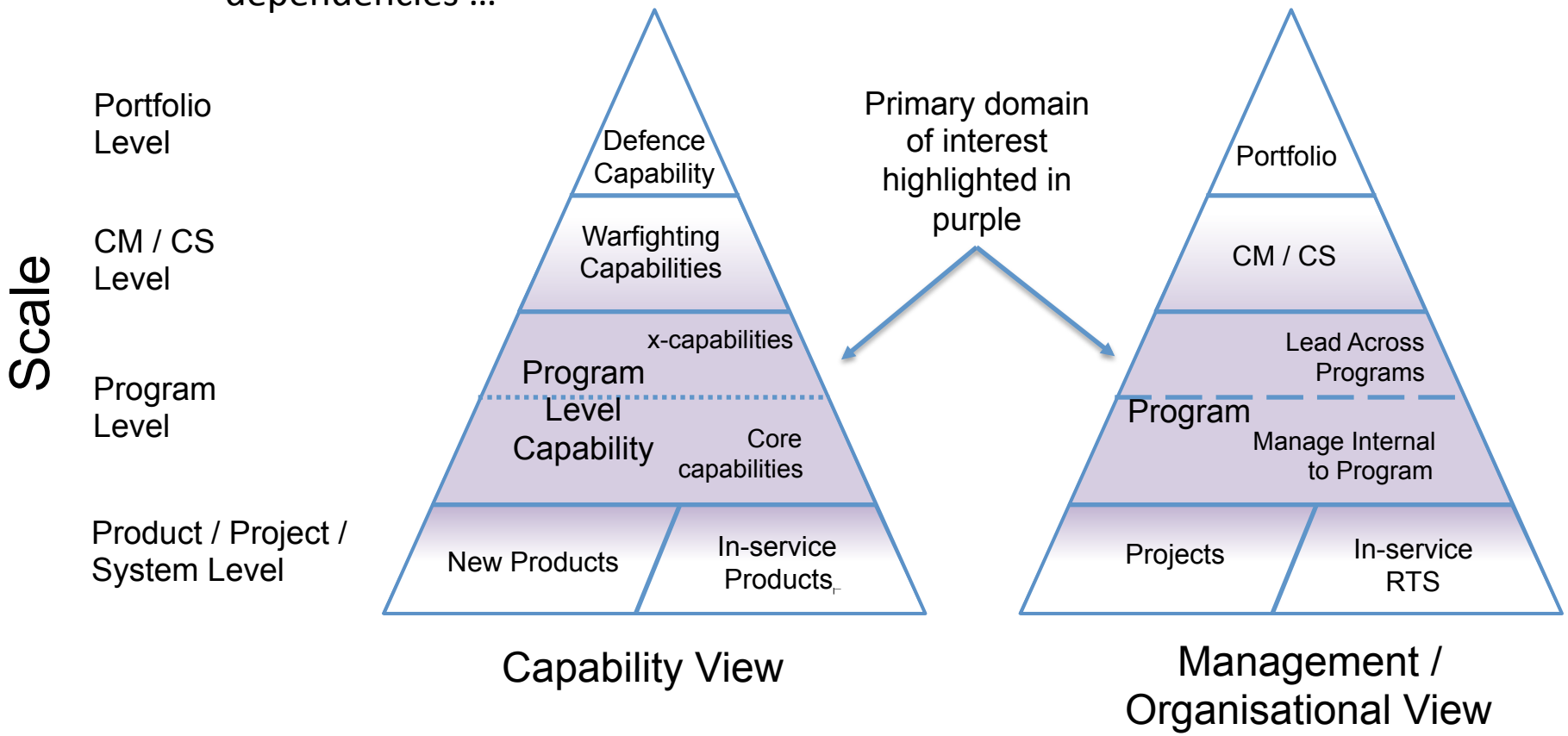


New CLC : More Detailed Functional View



Capability and Management Views

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



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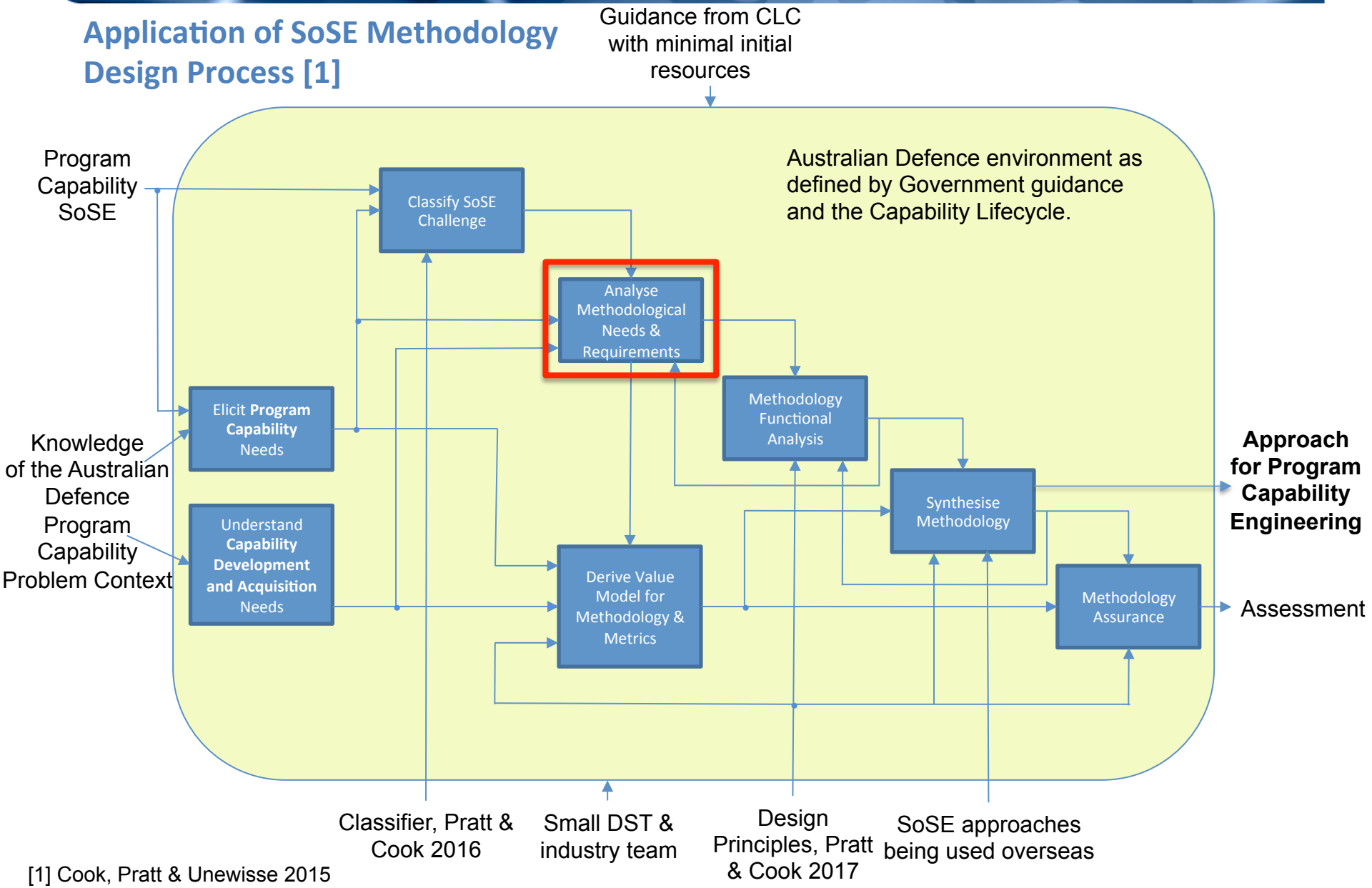

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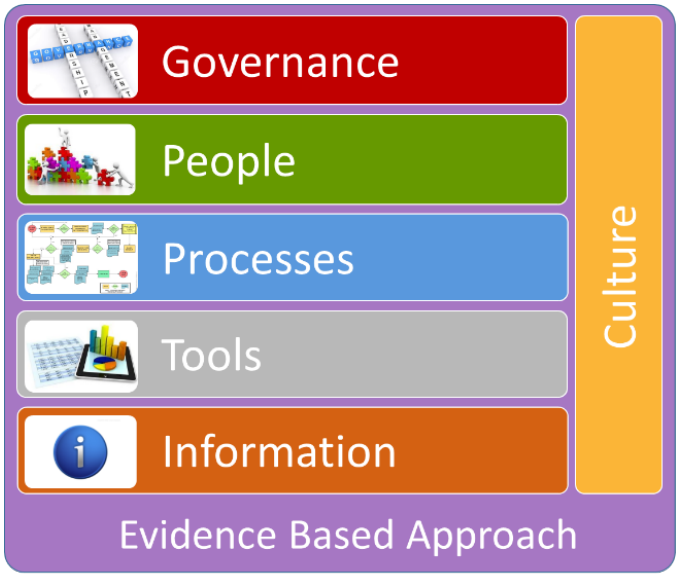
Analysis and Solution Space Using SoSE Elements

- Use a simple decomposition to capture Australian Defence SoSE
- SoSE Elements:
  1. Governance
  2. People
  3. Processes (Design)
  4. Tools
  5. Information
  6. Culture
  7. Evidence Based Approach



- Total of 35 Needs Identified across the 7 elements

Capture of Needs – e.g. Governance

	Governance Needs
G1	Implement high-level governance recommendations from FPR, including: - government to focus on activities that either only government can do - eliminate complicated and unnecessary structures & systems - enable arm-length contestability - enable responsibilities and facilitate accountabilities - default to fastest and simplest decision making processes
G2	Need to clearly identify Program scope and associated lines of authority and responsibility.
G3	Must ensure that organizational and management elements are working together.
G4	Resources (people, funding and facilities) and governance structures must be agile, collaborative, flexible and innovative and address the challenges of implementing SoS capabilities.
G5	Senior decision-makers should consider making decisions at the Program level rather than on disconnected individual Project proposals.
G6	Need to ensure that there is a common understanding of the nature and scope of the SoS capability.

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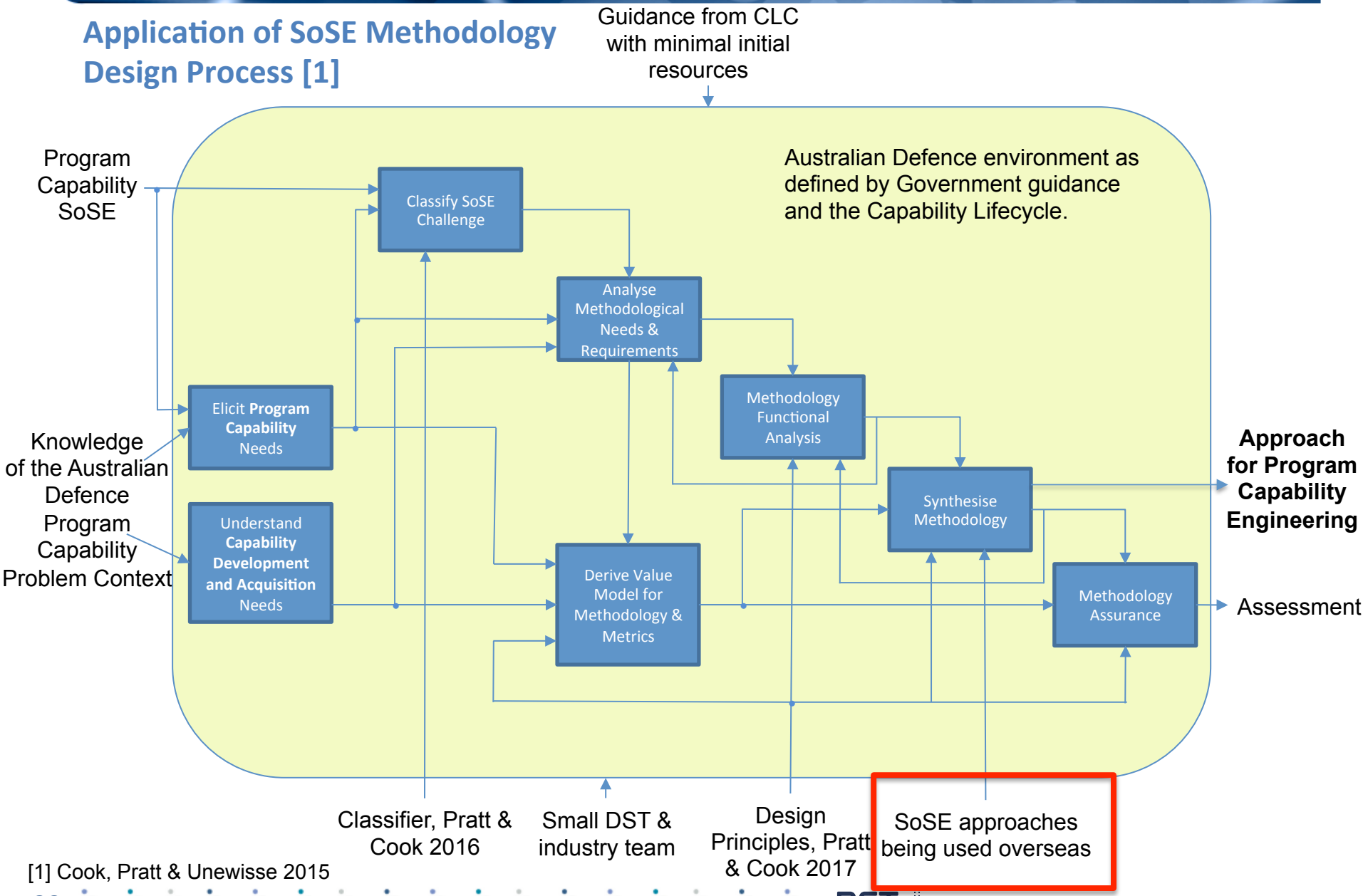

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Review of Current SoSE Approaches

- Reviewed a range of SoSE approaches that have been successfully applied:
  - Enhanced Traditional Systems Engineering (ETSE)
  - Complex Systems Engineering (CSE)
  - Dynamic Optimization of SoS using Value Measurement (DOSVM)
  - SoS Governance (SoSG)
  - US Department of Defence SE for SoS: The Wave Model
  - US Navy Mission Engineering Approach
  - The British Systems Thinking Approach (BSTA)
  - Systemic Strategic Planning and Execution (SSPE)
  - The United Kingdom Ministry of Defence (MOD) System of Systems Approach (SOSA)
- All have strengths and weaknesses
- None by themselves are suitable for Australian Defence

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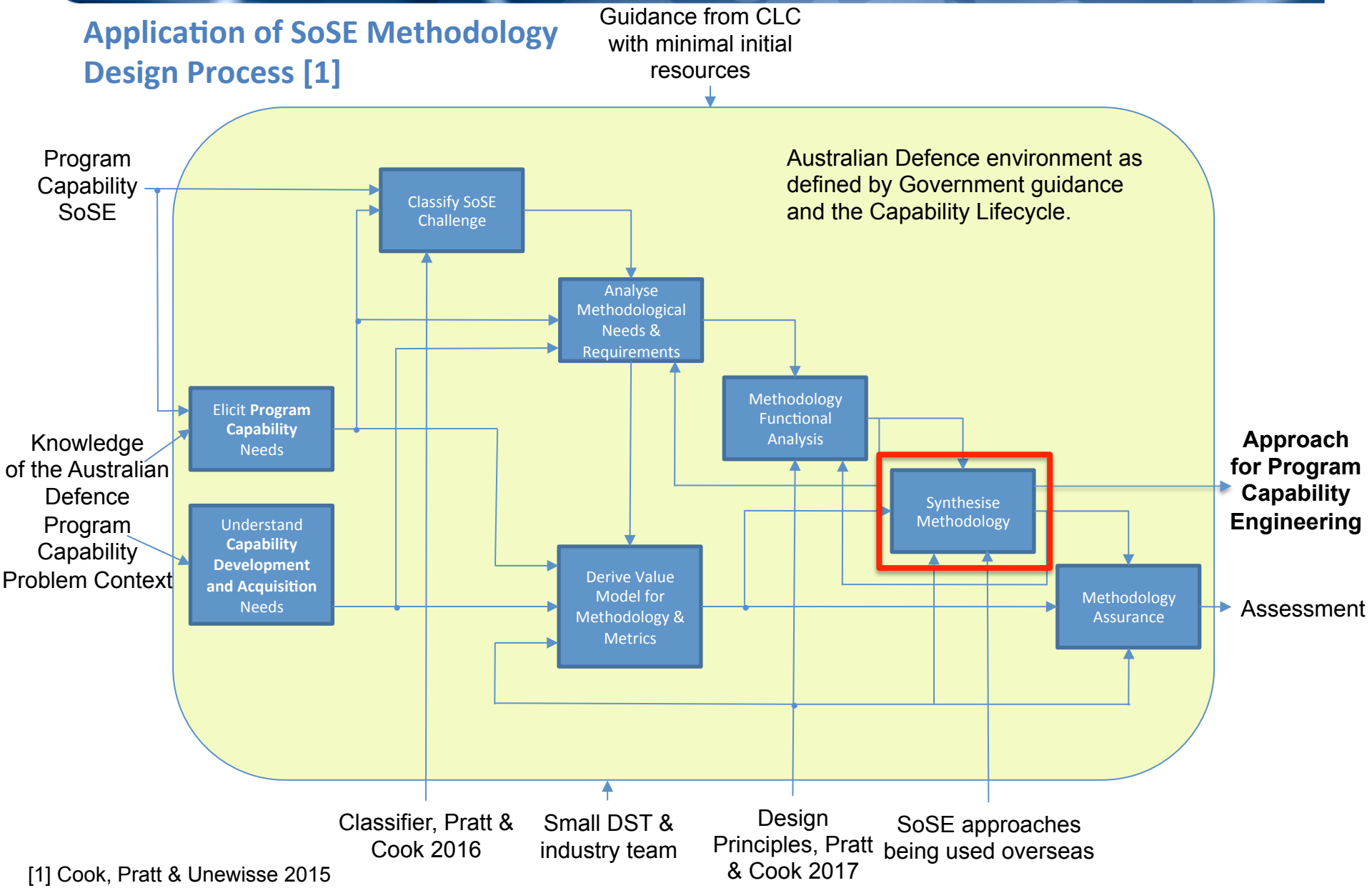

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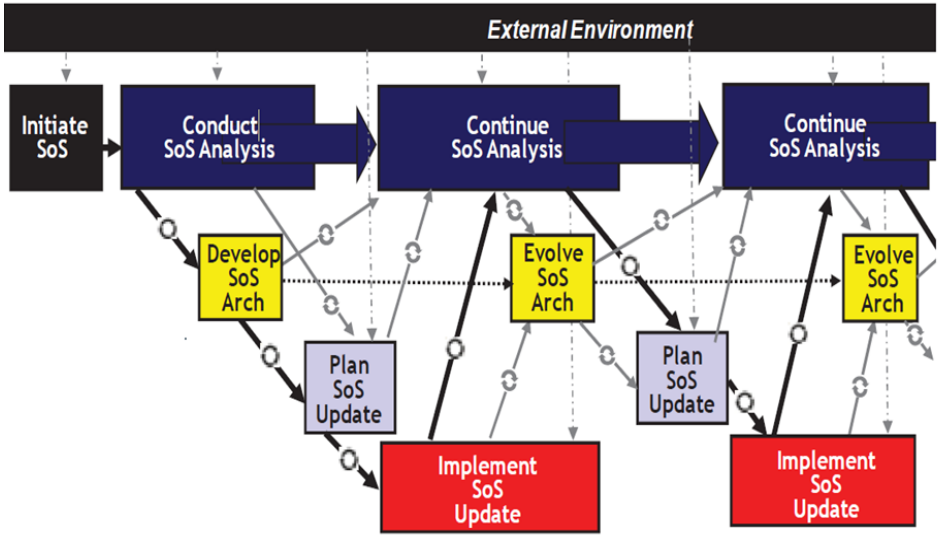
Proposed Hybrid SoSE Approach

- Hybrid SoSE Approach for Program Capabilities
  - Broadly based on US Wave-Model
    - Cyclic model for enduring Program capabilities
    - Drawing on CSE, ESTA, DOSVM and ME approaches
  - Significant elements of US Mission Engineering approach
  - Plus drawing elements from most of the SoSE approach reviewed



Wave Model

Conduct SoS Analysis	**Define the Mission** including mission threads and mission context
	Identify current systems supporting the mission and how they are employed
	Assess mission performance to assess how well current systems work together to meet mission objectives
	Identify gaps from a mission effectiveness perspective and fault isolate the source of gaps
Develop SoS Architecture	**Identify and assess option** for improving the mission effectiveness
Plan SoS Update	**Guide systems acquisition**, from requirements through implementation to test and maintenance to assure effective mission execution
Implement SoS Updates	Conduct mission level **integration and test**
	Monitor mission effectiveness with changes in mission context, scenarios and threat capabilities

Wave Model Mission Engineering

Features of the Hybrid Approach

- Austere hybrid with elements from most of the approached reviewed
- Designed for enduring Program Capabilities
  - Delivered in defined development stages
- Use Wave-Model steps modified for hybrid approach
  - Initial SoS
  - Conduct SoS Analysis
  - Develop and Evolve SoS Architecture
  - Plan SoS Update
- Tailorable to address diverse Program Capabilities
- Use methodology guidance rather than prescription
- Incorporates Program-level T&E
- Able to address a mix of collaborative and acknowledged SoS
- Use a minimal set of artefacts

Recommendations to Implement Approach

- Total of 48 recommendation
- General - 5
- Governance – 8
- Personnel – 4
- Processes – 10
- Tools – 5
- Information – 5
- Culture – 4
- Evidence-Based - 6

Recommendations – e.g. Governance

	Governance	Need
GR1	Establish a set of agreements to underpin delivery of the Program capability, between: - Program and its constituent System Project Offices - System Project Offices within the Program - Program & other Programs delivering Products to the Program capability	
GR2	Distil SoSE artefacts and insights to inform senior decision-makers	G1
GR3	Clarify Program-level roles and responsibilities through the implementation of the initial test case, including the lines of authority and influence over and between the constituent Projects.	G1, G2
GR4	Facilitate collaboration between key Program stakeholders.	G3
GR5	Inform senior decision-makers of the value delivered by SoSE.	
GR6	Plan to deliver much of the SoSE mission though the agency of the constituent System Project Offices.	G4
GR7	Encourage the use of collaborative, flexible and innovative governance and approaches to support Program implementation.	G4
GR8	Encourage senior decision-makers to make decisions at the Program level, placing individual Projects within the Program context.	G5
GR8	Identify operational contexts for the SoS capability and key capability instantiations to shape the capability goals and assessment criteria for each development stage.	G6

Additional Research & Development Required

- Some of the recommendations require additional research and development, including:
  - Development of a clear SoSE value proposition
  - High-level artefacts to support senior decision-making
  - Design and Implement of a SoSE Team
  - How to migrate to a more Mission Engineering approach within the austere resources available?
  - Build and evolve Program Capability SoSE tools – model-based
  - Integration with existing databases
  - Information configuration control across multiple Programs
  - Design and implementation of incentives for good SoSE behaviours
  - Identification of key leading indicators
  - Establishment of Program-level OT&E

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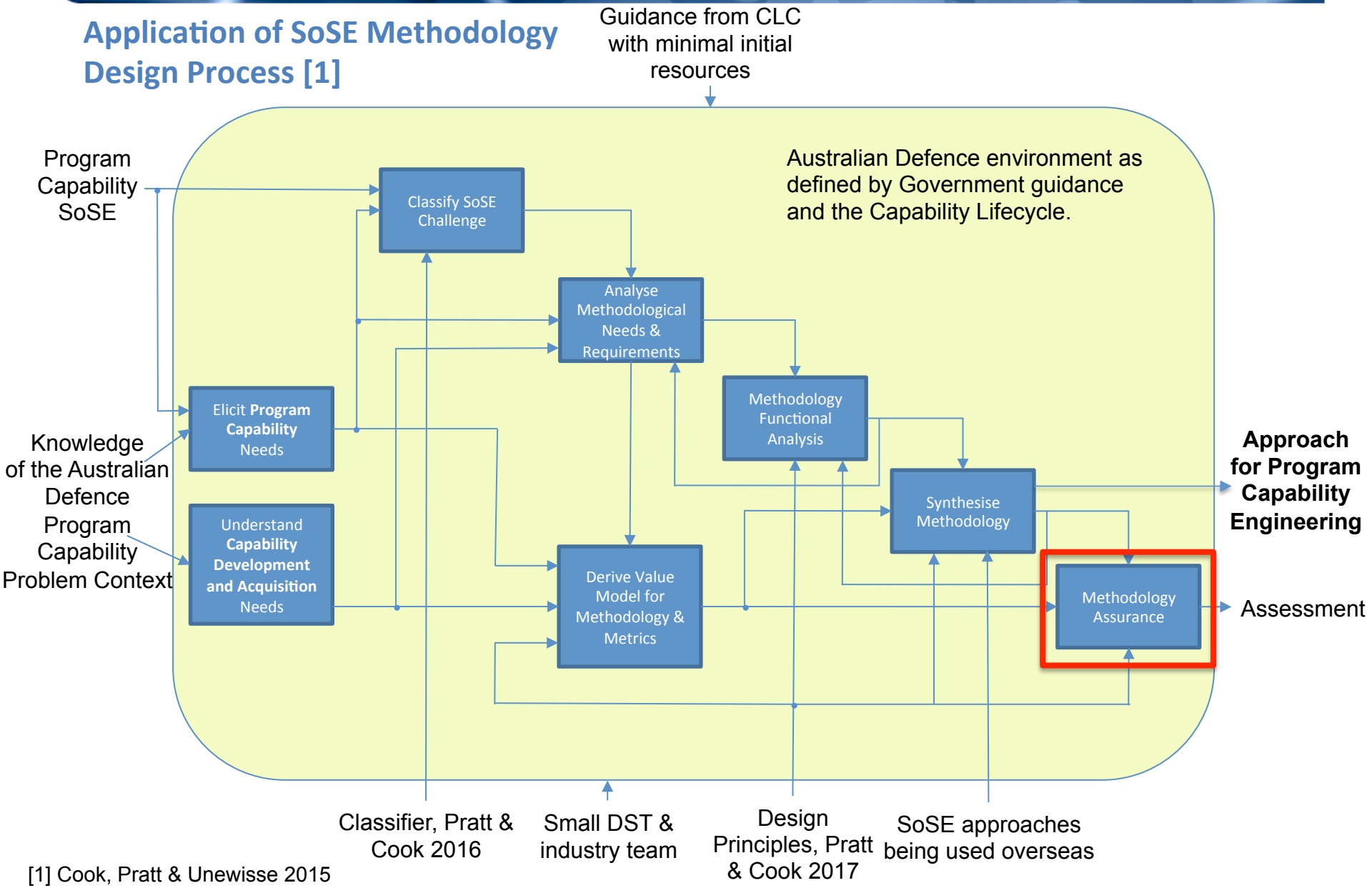

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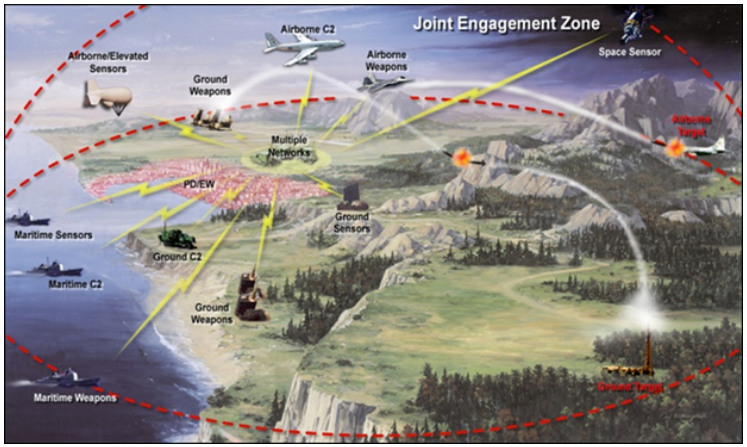
Methodology Assessment via Initial Applications

1. Used as the basis for a SoSE review of current Program Capability Design, Realisation and Management
   - Successfully used to gain insight into and provide recommendations on Program Capability Design, Realisation and Management

2. Used as the basis of a Program Capability Integration and Interoperability (I2A) Methodology
3. Applied Program I2A Methodology to IAMD
   - Successfully applied to IAMD
   - At 'Initiate SoS' point of development
   - Provided feedback on the development of Program-level tools

Use IAMD Program Capability as a Test-Case

- Apply proposed approach to a major information centric SoS
- Integrated Air and Missile Defence as Test- Case
  - Protect from Air Threats
  - Joint/Coalition
  - Distributed Capability
  - Enhanced ISR and C2 capabilities
- IAMD Program
  - A few core Projects
  - Currently collaborative
  - Migrating towards acknowledged
- Elements from multiple other Program



Conclusion

- Australian Defence is Implementing a New CLC
- Program-level a key innovation
  - Programs of a better way to manage elements of Portfolio
  - Deliver via Project
  - Shape and deliver Program-level Capabilities
- A hybrid SoSE approach developed for Program Capabilities
  - Broadly based on the 'Wave-Model'
  - Drawing an many other existing approaches
  - Austere and tailorable approach
- A range of recommendations to implement proposed approach
- Successfully being used as the basis for SoSE developments in Australian Defence

QUESTIONS