

Second International Engineering Systems Symposium 2009

Architecting C4I Systems

Presented by Ming Chun NG

Defence Science & Technology Agency

Picture Source <http://www.saabsystems.com.au/Images/operability.jpg>

Multi-faceted and multi-dimensional security challenges



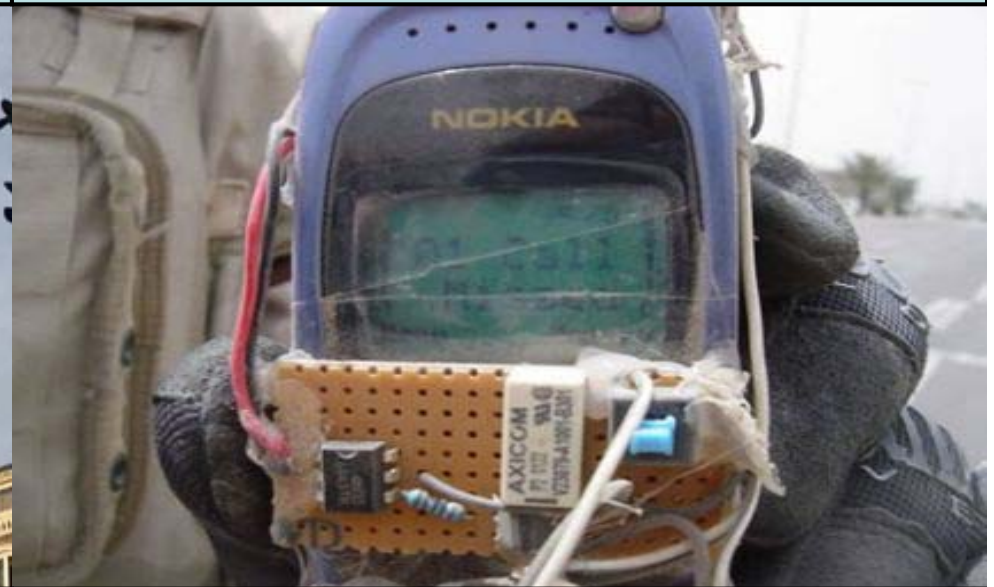
State-on-State Conflict



Pirate Attacks



Terrorism



Cellphone Bomb Detonator

Network-Centric Warfare Concept

Link up knowledge-enabled forces to create greater synergies and firepower.





How to build a coherent C4I System-of-Systems?

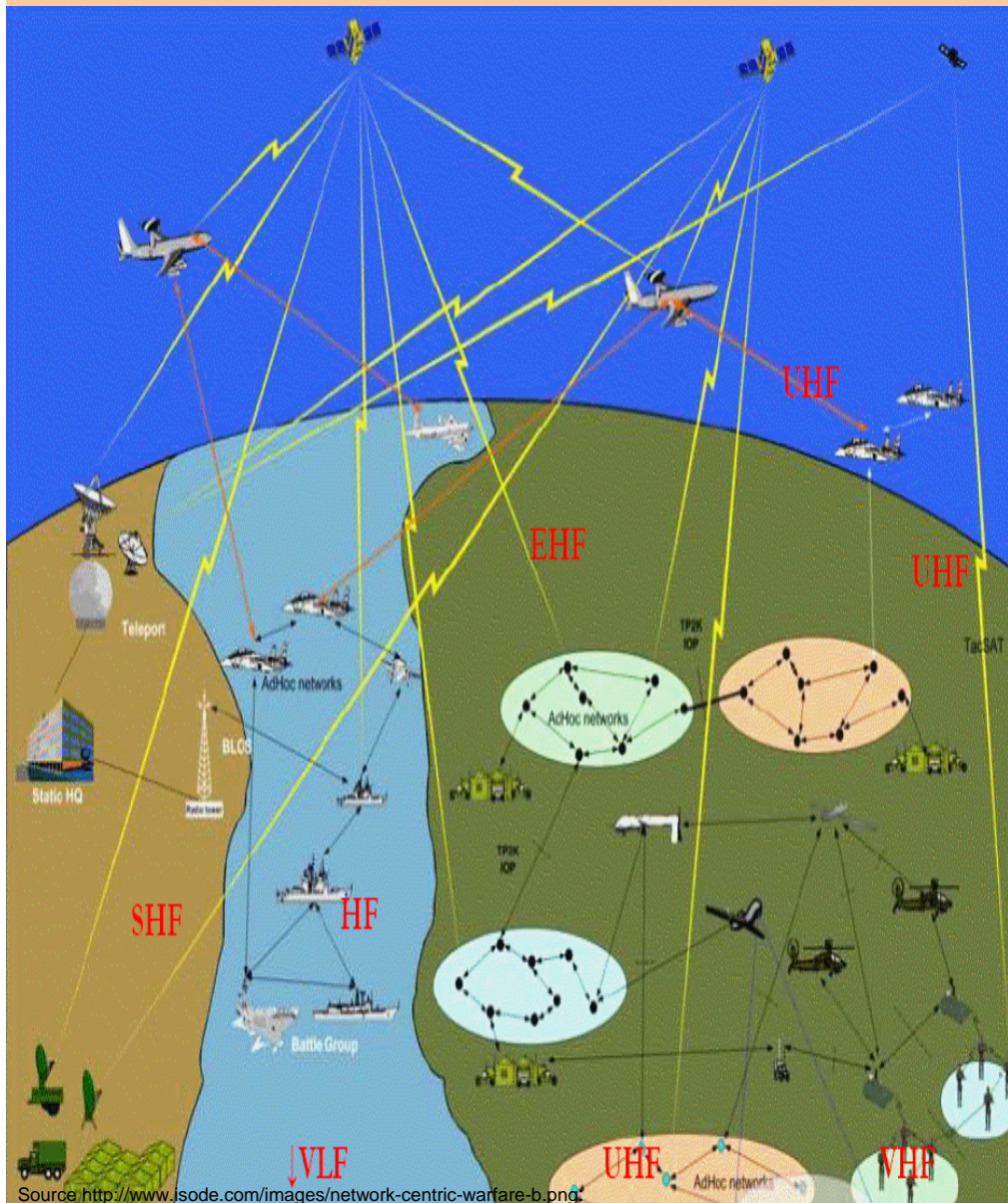


Designing a C4I System-of Systems

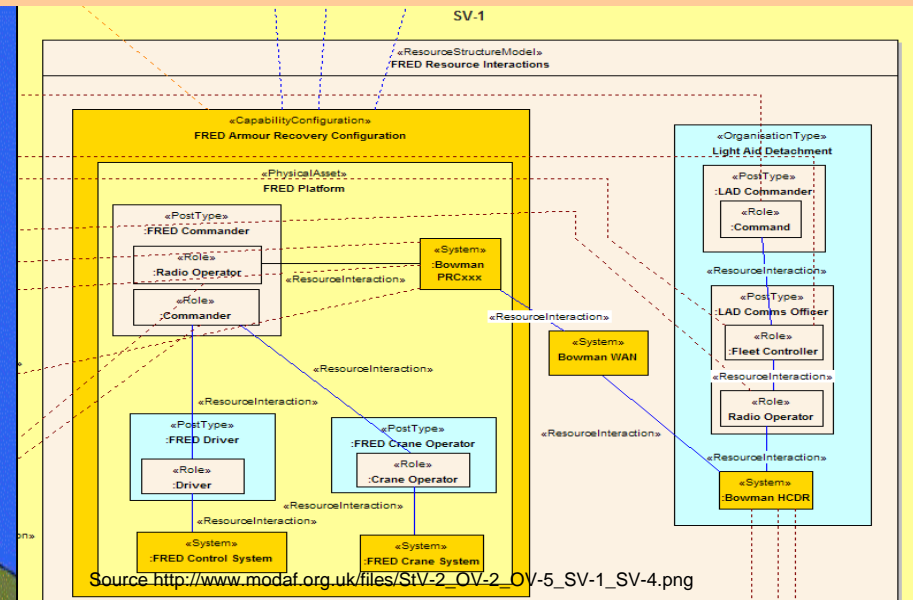
The background of the slide features a blue-tinted image of several rolled-up architectural blueprints. In the lower right corner, a portion of a green printed circuit board (PCB) is visible, showing various electronic components and traces. The overall aesthetic is technical and professional.

Systems Architecting a C4I System-of-Systems.

Systems Architecting



Operational View



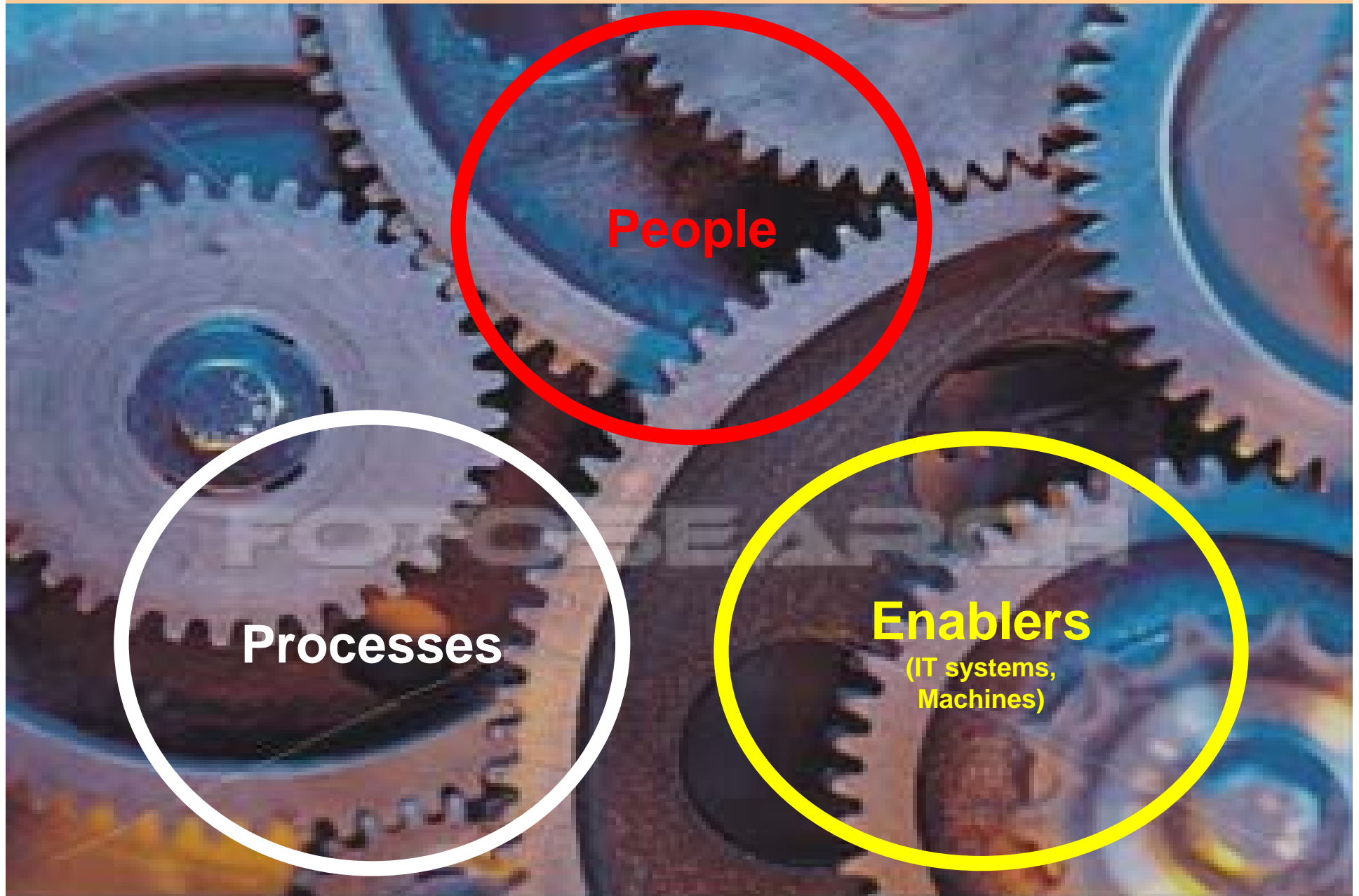
System View

JTA Service Area	Service	JTA Standard and Source Document
Information-Processing Standards	Higher Order Languages	
	Software Life-Cycle Process	
	Geospatial Data Interchange	
	Motion Imagery Data Interchange - Video	
	Distributed-Object Computing	
Information-Transfer Standards	Data Flow Network	
	Command and Control Information (C2I) Network	
	Physical Layer	
	Network Interface	
	Layer Management	
	File Transfer Standards	
	Remote Terminal Standards	
	Network Time Synchronization Standards	
	Web Services Standards	
	Connectionless Data Transfer	
Information Modeling, Metadata, and Information Exchange Standards	Transport Services Standards	
	Activity Modeling	
	Data Modeling	
Human Computer Interface	Object-Oriented Modeling	
	Mandates	
Information Security / Information Infrastructure Standards	Password Security	

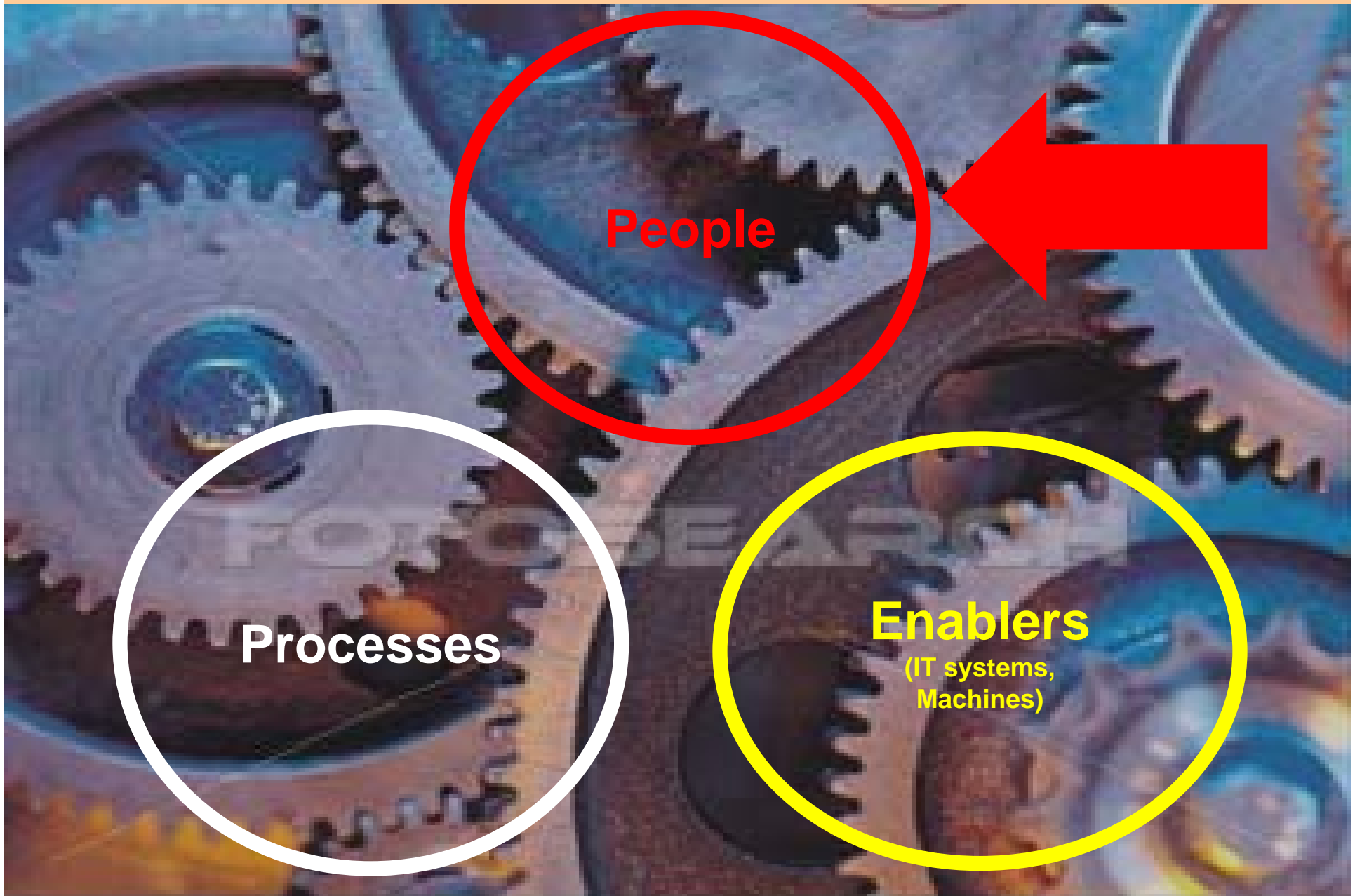
Source: <http://elamb.org/wp-content/uploads/2008/03/tv-1large.gif>

Technical View

Systems Architecting

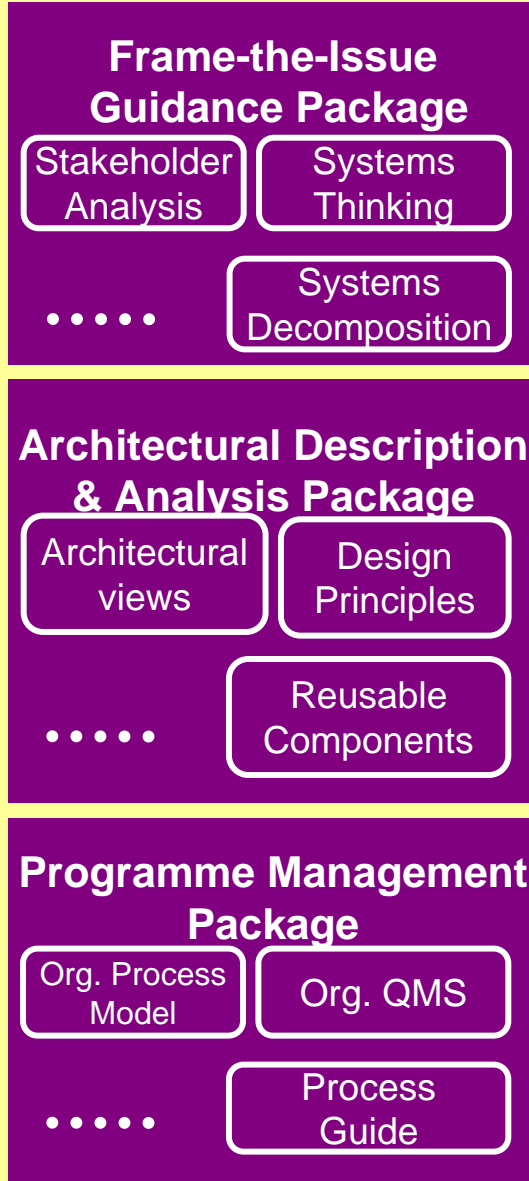


Systems Architecting – Both a Science & an Art



C4I Systems Architecting Framework

Systems Architecting Process



Governance



Knowledge Book of Architecting



Competency Development Guidebook



Consultation Environment



Body of Knowledge

C4I Systems Architecting Framework

Systems Architecting Process



Governance



Knowledge Book of Architecting



Competency Development Guidebook

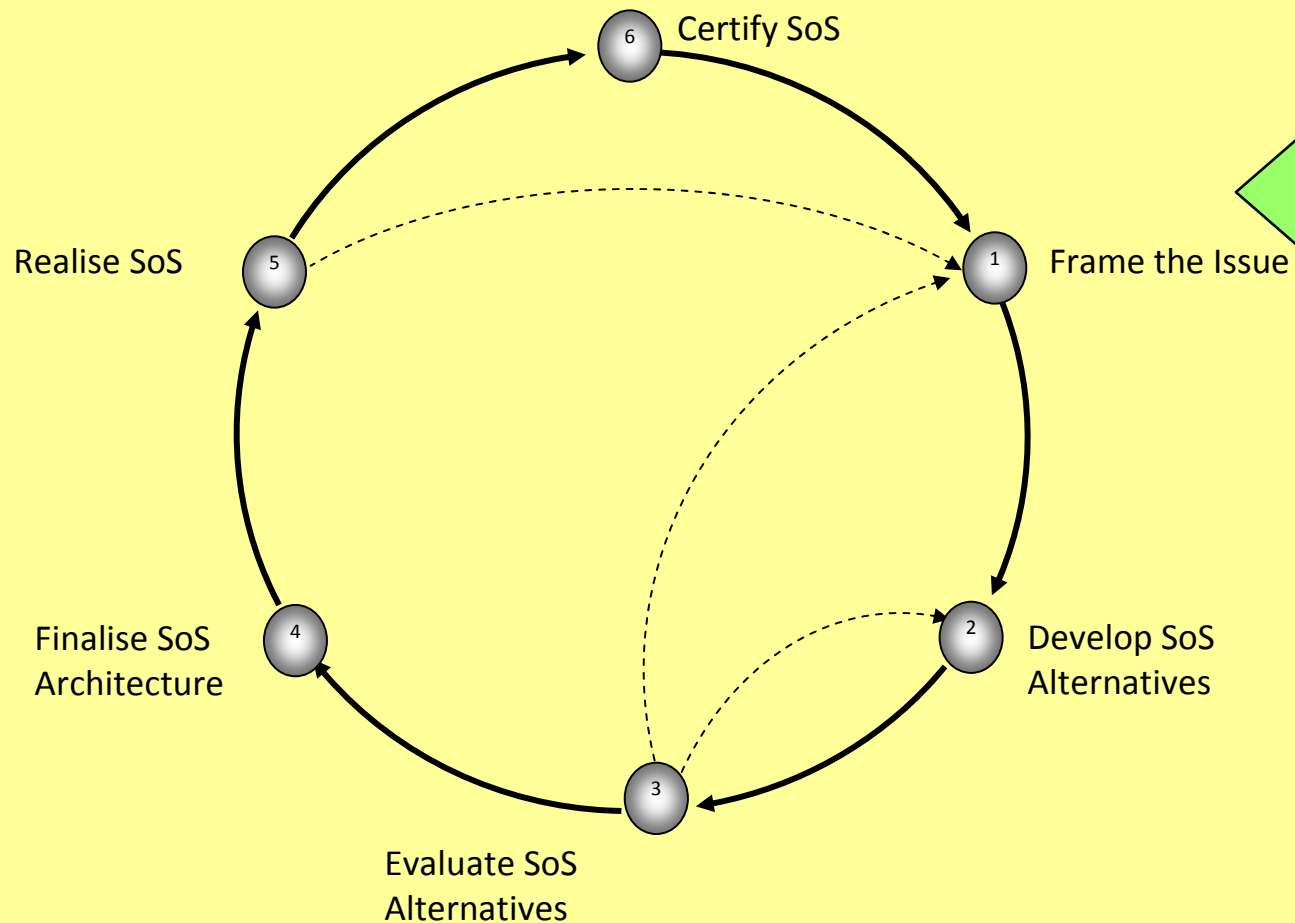


Consultation Environment



Body of Knowledge

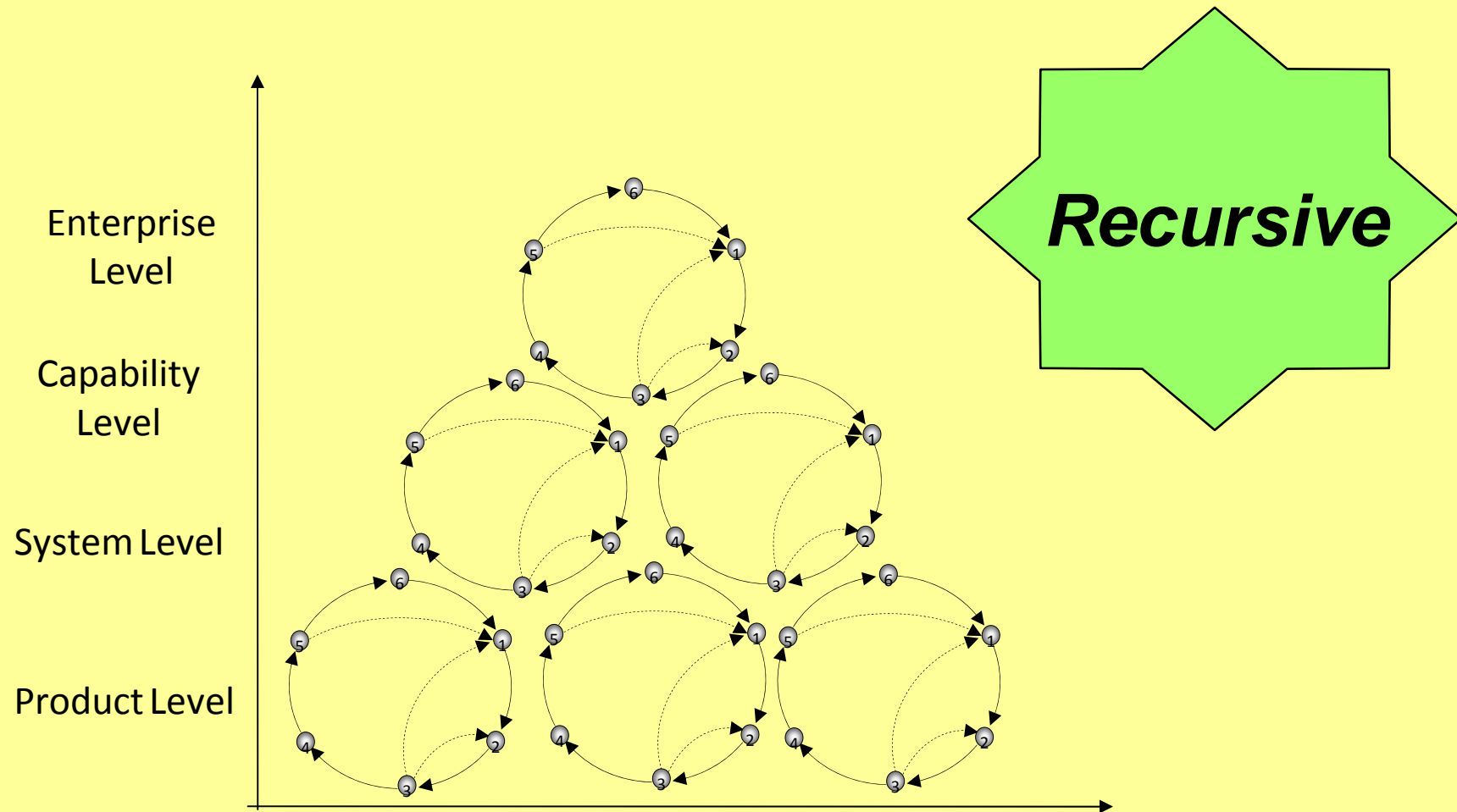
Systems Architecting Process



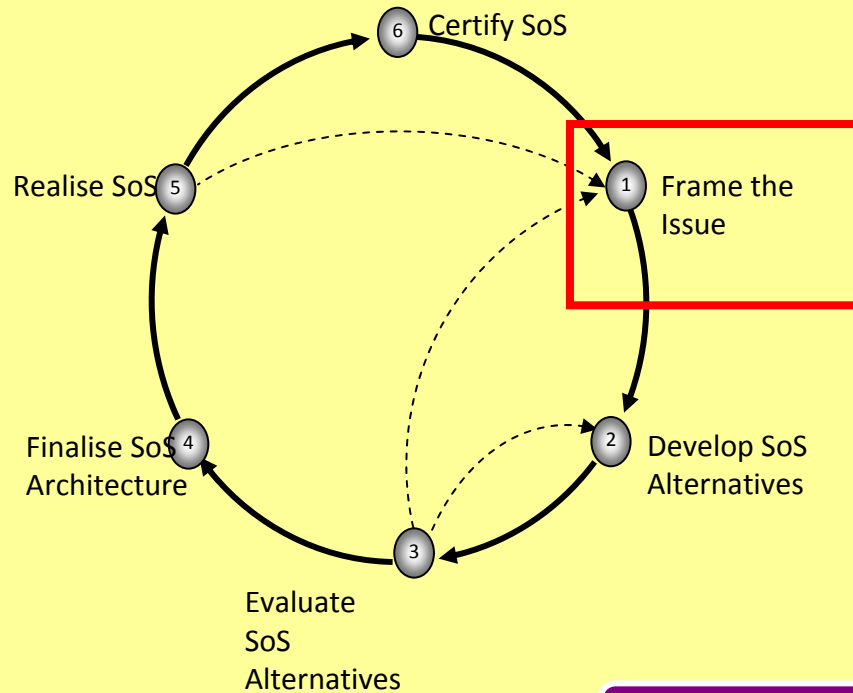
Iterative

A Six-step Systems Architecting Process

Systems Architecting Process ...



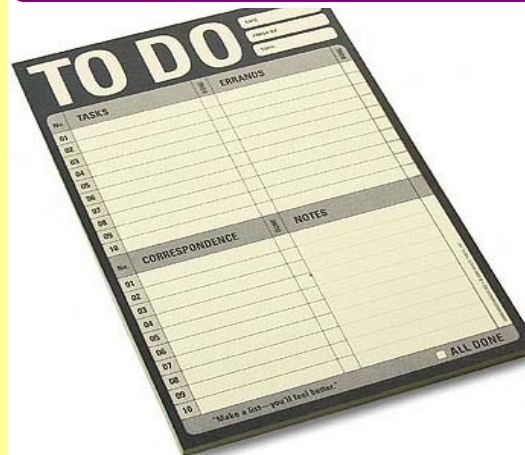
Understanding the Capability Gap



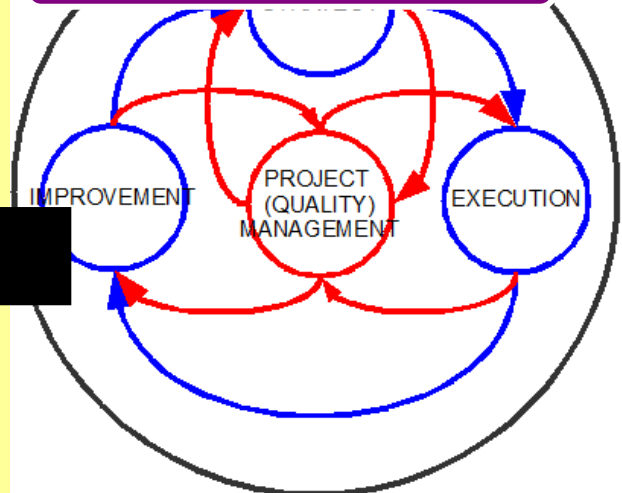
Stakeholder engagement



Capability Gap List



Problem Analysis



Frame-the-Issue Guidance Package

Stakeholder Analysis

Systems Thinking

Systems Decomposition

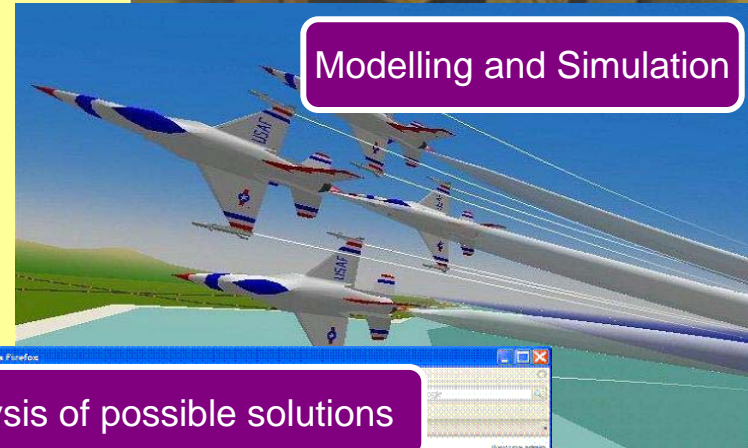
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Devising the SoS Solution

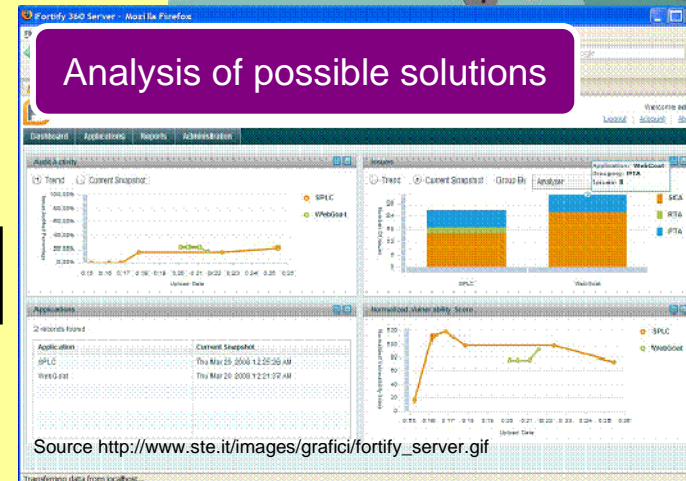
Solution Space Exploration



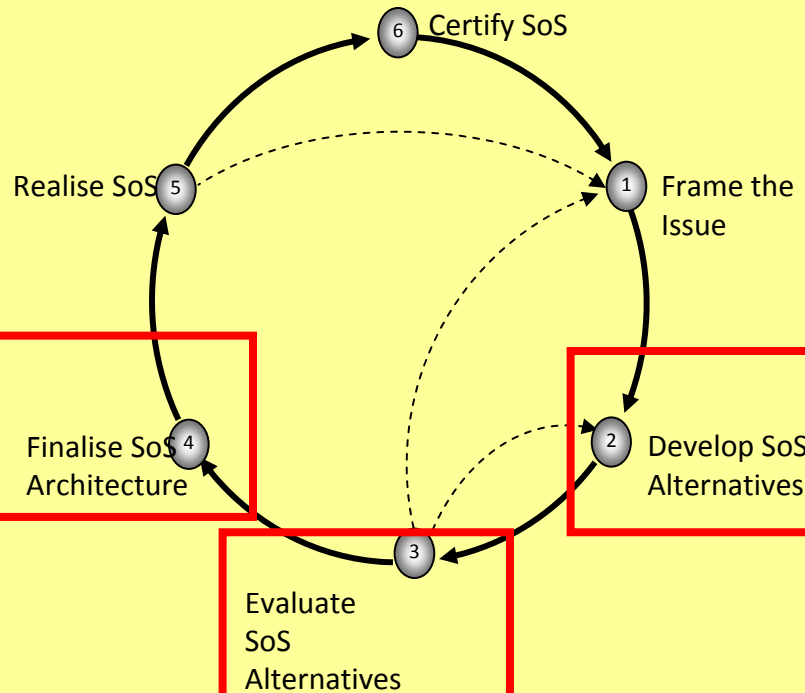
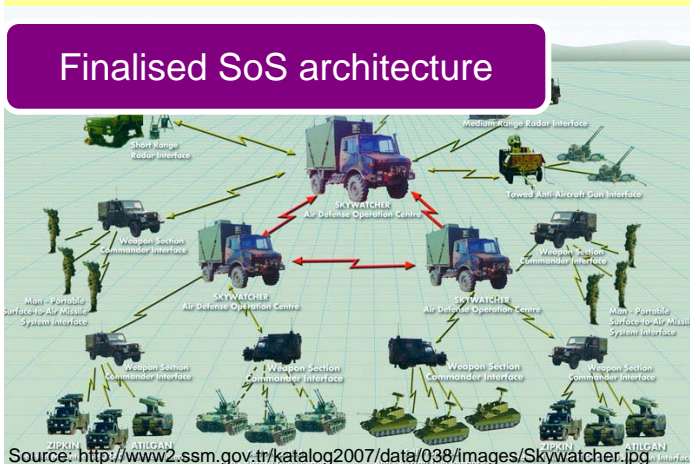
Modelling and Simulation



Analysis of possible solutions



Finalised SoS architecture



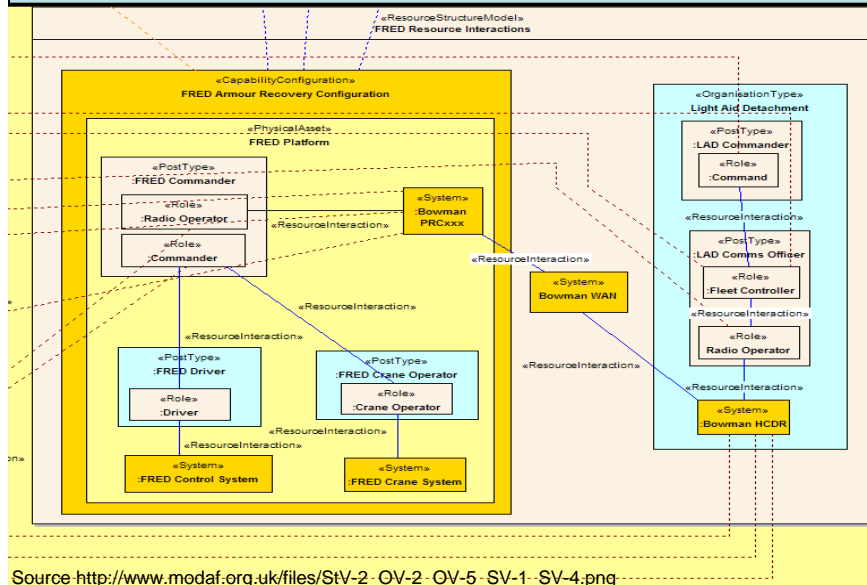
Examples of SoS Architectural Views



JTA Service Area	Service	JTA Standard and Source Document
Information-Processing Standards	Higher Order Languages	
	Software Life-Cycle Process	
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	Motion Imagery Data Interchange - Video	
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Information Modeling, Metadata, and Information Exchange Standards	Activity Modeling	
	Data Modeling	
Human Computer Interface	Object-Oriented Modeling	
	Mandates	
Information Security / Information Infrastructure Standards	Password Security	
	Application Software Entity Security Standards	
Information Security / Information Infrastructure Standards	Virtual Private Network Service	
	Intrusion Detection Service	
	Human-Computer Interface Security Standards	

Source <http://elamb.org/wp-content/uploads/2009/05/1img991>

Operational View



System View

Technical View

Architectural Description & Analysis Package

Architectural views

Design Principles

Reusable Components

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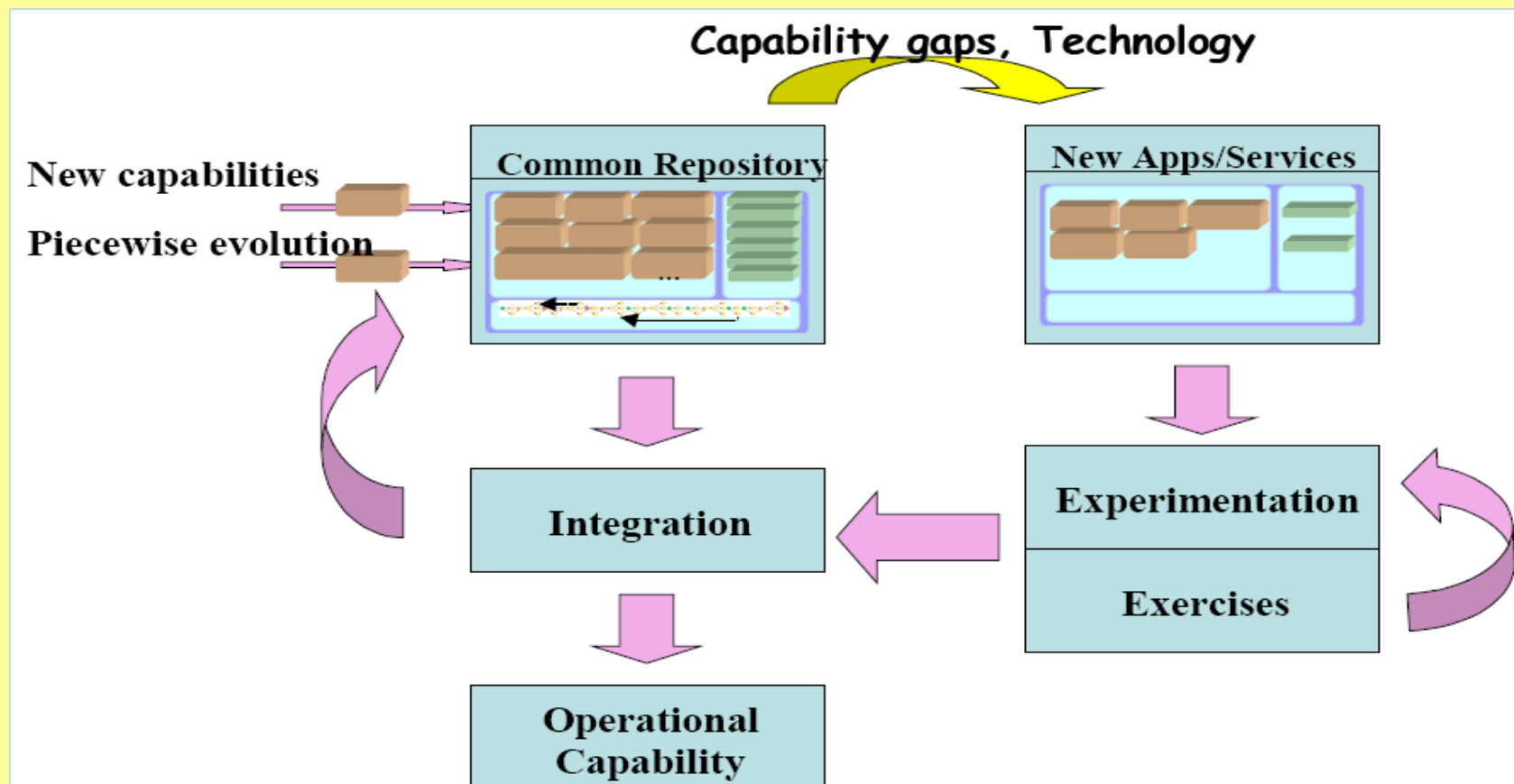
Devising the SoS Solution ...

Speeding up the Development of Operational Capabilities

- Common Repository
- Service Oriented Architecture (SOA)
- Business Process Management Systems (BPMS)

Devising the SoS Solution ...

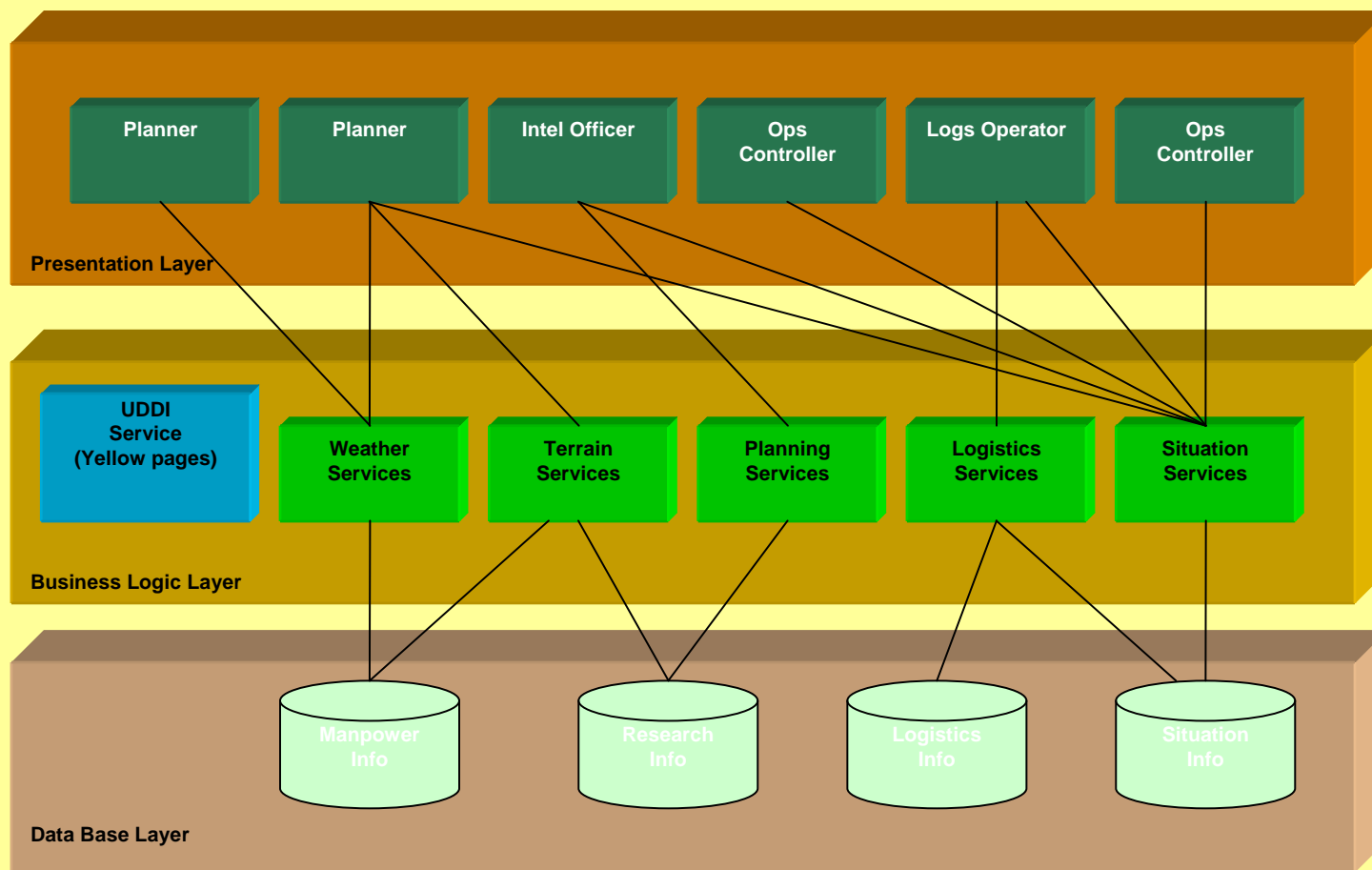
Common Repository



Process for Maintenance of Common Repository

Devising the SoS Solution ...

Service Oriented Architecture (SOA)



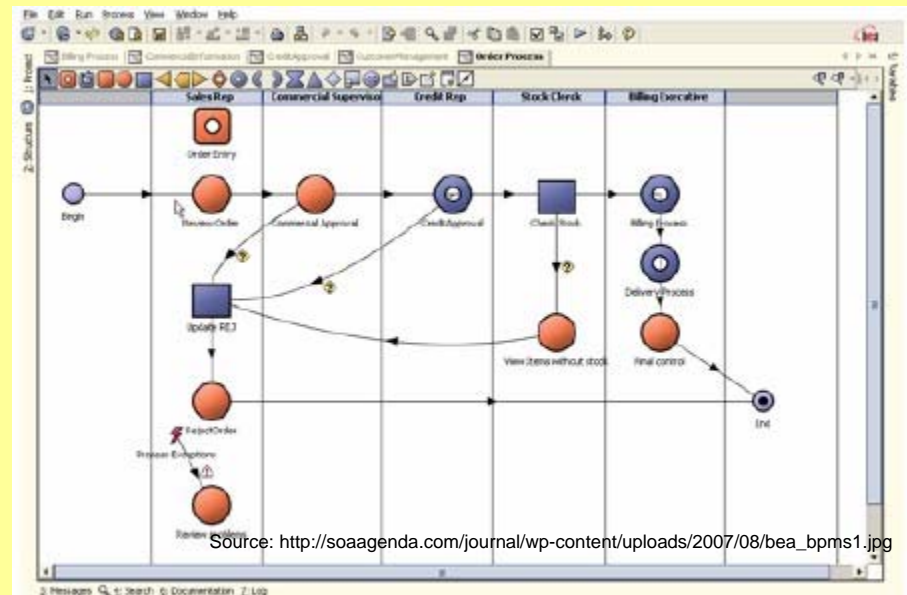
Devising the SoS Solution ...

Business Process Management System



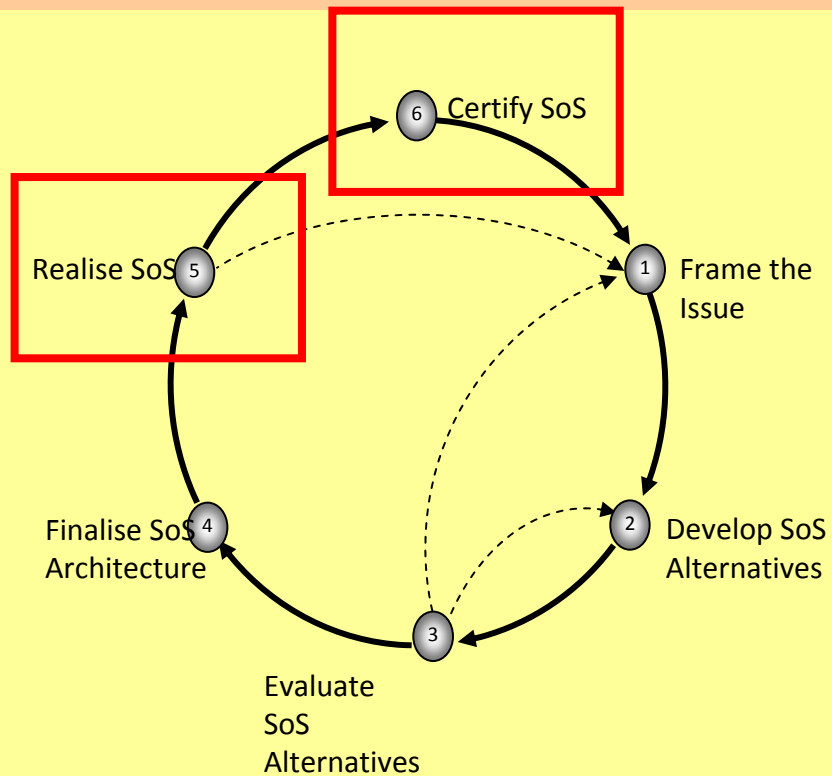
GARTNER's 10 components of BPMS

Source: GARTNER BPMS Summit 2008



Commercial BPMS: BEA Aqualogic

Developing and Certifying the SoS Solution



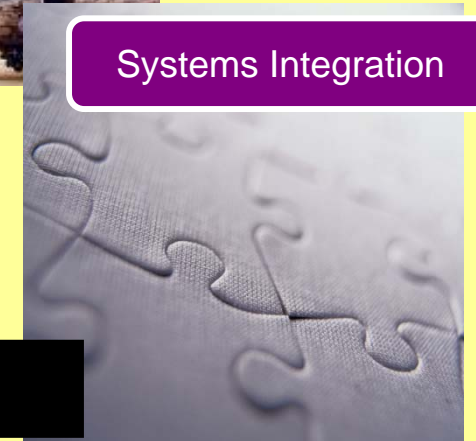
Solution Development



Solution Acquisition



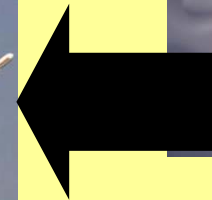
Systems Integration



Programme Management Package

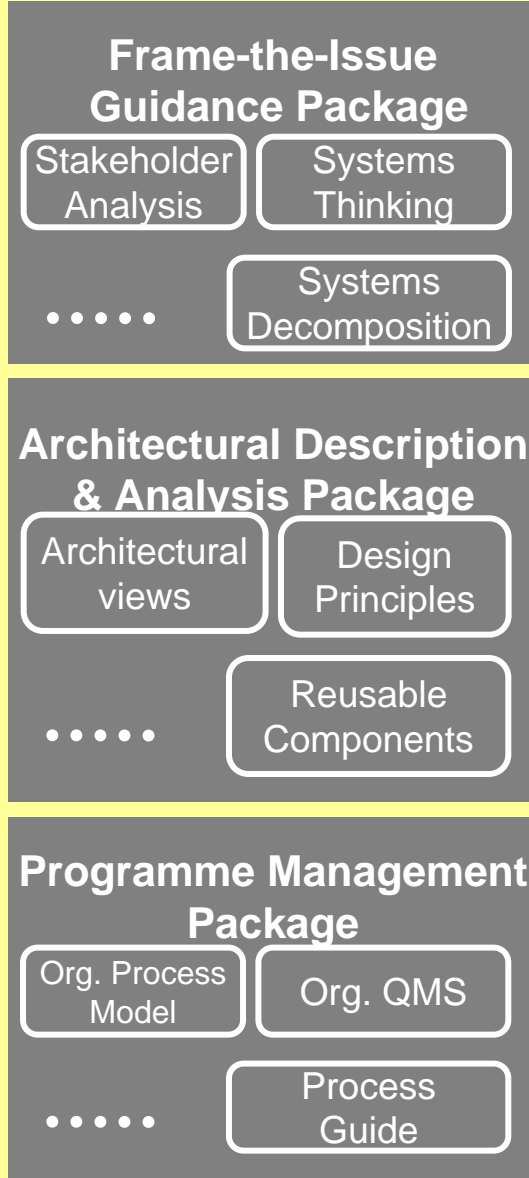
Governance

Field Test and Ops Validation



C4I Competency Development

Systems Architecting Process



Governance



Knowledge Book of Architecting



Competency Development Guidebook



Consultation Environment



Body of Knowledge

C4I Competency Development ...

Annual Learning Plan for each individual

- systems design
- systems thinking
- business analysis

MY LEARNING HUB [Learner e-Application](#) [Learner Access](#) [Supervisor Access](#) [FAQs](#) [Glossary](#) [Contact Us](#)

Learning Application
Approval Setup

Learning Application (Funded by DSTA Training Vote)

Quarterly Learning Schedule

Annual Learning Schedule

Learner Self-Update (LSU)

LSU Assisted (new)

LSU Non-Assisted (new)

Tips/Notes

» [Dav](#)

» [Fee](#)

» [Resource Misc Cost](#)

» [Misc Cost](#)

» [Cost Center](#)

» [Learning Objectives](#)

Quarterly Learning Schedule

Next 3 months Schedule starting from :

Title :

Category :

Type :

All Category

Title	Learning Providers	Rating	# of Staff Attended & Evaluated	Fees	May 2009	June 2009
1 DAY COURSE ON BUILDING INFORMATION MODELLING (BIM) SUBMISSION REQUIREMENTS	BCA ACADEMY	3.33 (Out of 4)	3	SOD \$288.90	12 (1 day)	-
1 DAY SEMINAR ON INNOVATIONS IN THE DESIGN AND CONSTRUCTION OF STEEL AND COMPOSITE STRUCTURES	BCA ACADEMY	-	-	SOD \$181.90	29 (1 day)	-
10 DAY COURSE ON GREEN AND SUSTAINABLE CONSTRUCTION PRACTICES FOR BUILDERS	BCA ACADEMY	3 (Out of 4)	3	SOD \$96.30	22 (0.5 day)	-
10 DAY WORKSHOP ON BUILDING PLAN SUBMISSION GUIDELINES (PART 1) PROCEDURES AND COMMON ERRORS	BCA ACADEMY	2 (Out of 4)	2	SOD \$58.85	27 (0.5 day)	-

Learning Plan Activities:

☐ Learning Activity (Max 1000 Chars)

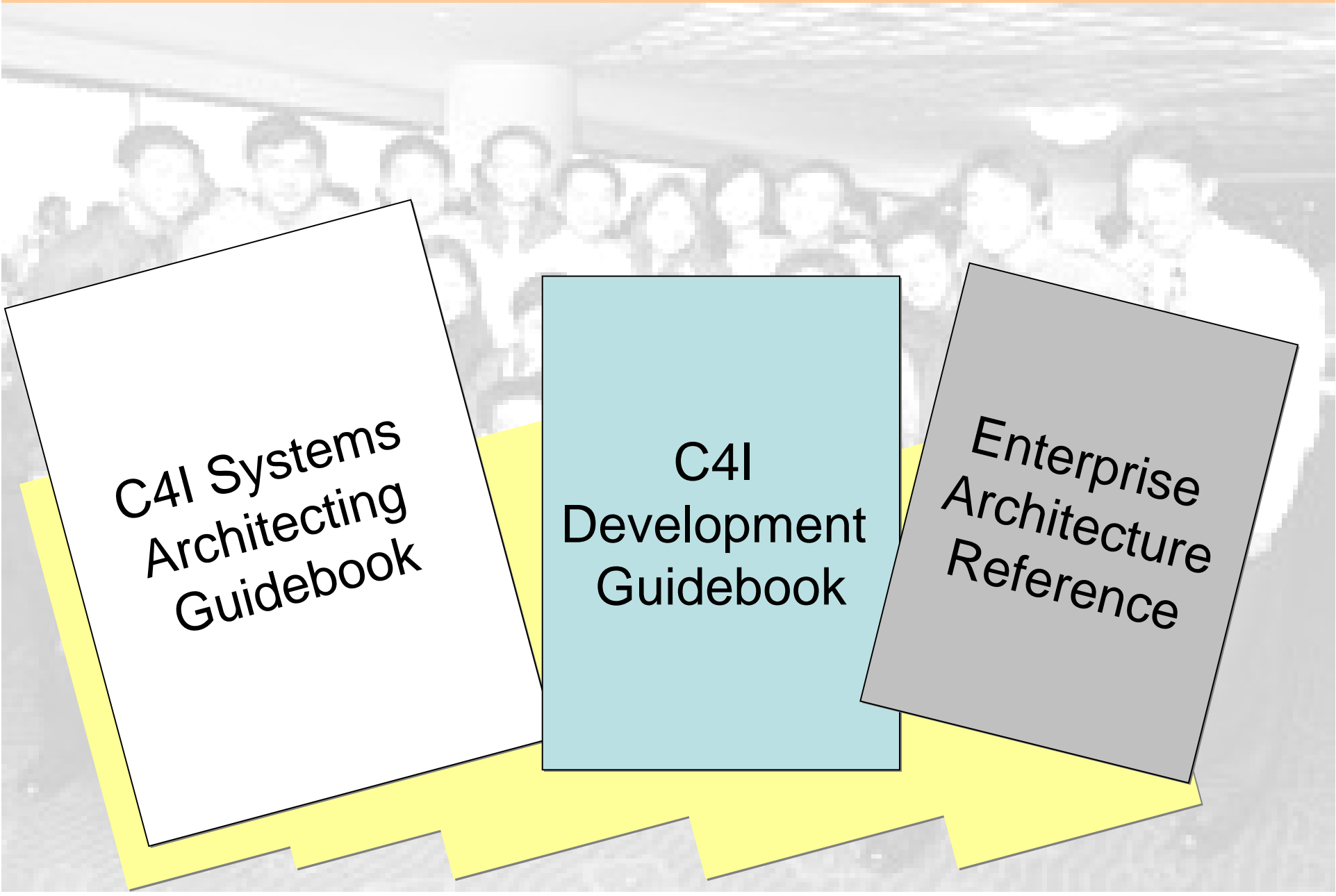
Learning Activities Completion Summary:

I have completed of learning activities

MLH Courses Attended FY2008

S/N	Learning Activity	Start Date	End Date	Day(s)
1.	SHARING OF ANNUAL BIZ PLAN WITH ALL PCO MEMBERS	29/04/2008	29/04/2008	0.50
2.	PCO QMS UPDATE BRIEFING CUP SHARING OF FY07 QA FINDINGS & QSC RESULTS	30/04/2008	30/04/2008	0.10
3.	BASIC SYSTEMS ENGINEERING & MANAGEMENT COURSE (SEMA)	05/05/2008	15/05/2008	9.00
4.	PCO STRATEGY TEAM BUILDING	03/10/2008	03/10/2008	1.00
5.	ISS CERTIFIED SYSTEMS ENGINEERING PROFESSIONAL COURSE (CSEPP) (FOR NOMINATED OFFICERS ONLY)	06/11/2008	17/11/2008	5.25
6.	SEA ALUMNI & 2 MODELLING (BY NOMINATION ONLY)	19/11/2008	21/11/2008	3.00
7.	SEA ALUMNI & 2 POLYMERIZATION & A.T. HYDROLYSIS & NITRIFICATION (BY NOMINATION ONLY)	24/11/2008	28/11/2008	5.00

Books of Knowledge



**C4I Systems
Architecting
Guidebook**

**C4I
Development
Guidebook**

**Enterprise
Architecture
Reference**

C4I Competency Development ...

- Consultation Environment

The screenshot displays the eHabitat C4I Development Portal. The top navigation bar includes links for Home, Org Directory, Staff, and Apps. The main header reads "C4I Development Portal" with the tagline "Delivering You the Knowledge Power". Below this, a "Director Says" section features a portrait of a man. The left sidebar contains a "Programme Hub" and a list of various development and support topics. The main content area is titled "Software System Development" and includes sections for Objectives, Key Performance Indicators, Process, Work Instructions and Supporting Procedures, and Forms and Templates.

Software System Development

Objectives

- The C4I System Development process is a highly structured and iterative process, commencing with the C4I System Requirements and Analysis, followed by the C4I System Design and Development, and finally the C4I System Implementation and Support. The process is supported by the C4I System Development Framework (C4I-SDF) and the C4I System Development Handbook (C4I-SDH).

Key Performance Indicators

- Programme Completion Rate
- Completion of Projects on Schedule
- Programme Process Maturity
- % of Annual Project Portfolio on Budget Allocation

Process

The process flow is represented by a sequence of stages connected by a line:

```

graph LR
    A[Front-End Planning] --> B[System Requirements Development]
    B --> C[Implementation]
    C --> D[Project Handing & Taking Over]
    D --> E[Operations & Support]
    E --> F[System Retirement]
  
```

Below the main process flow, there are sub-steps for each stage:

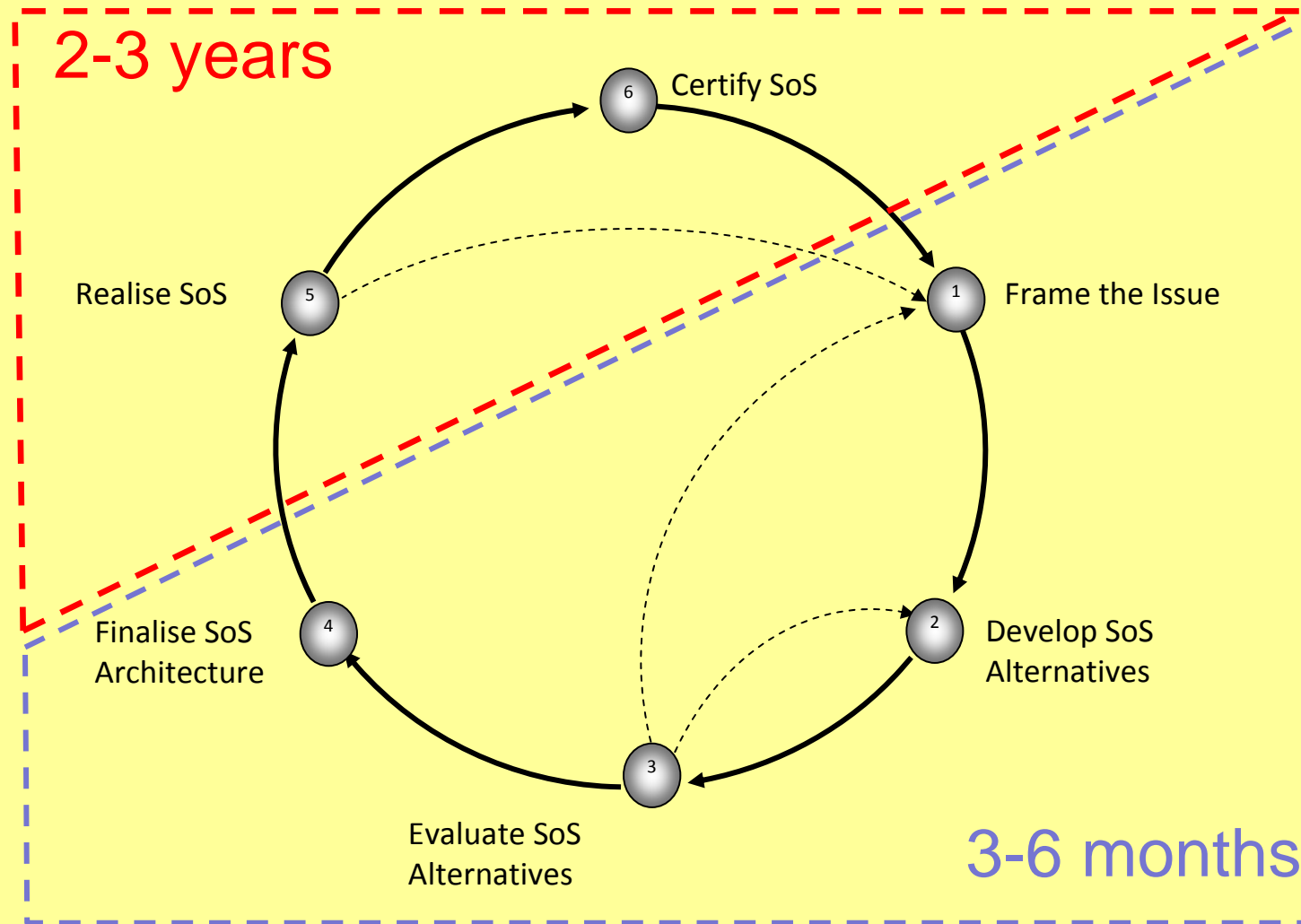
- Front-End Planning: Project Planning
- System Requirements Development: Analysis & Design
- Implementation: Deployment & Run-In
- Project Handing & Taking Over: End-of-Project Review
- Operations & Support: System Retirement

Please click at the various stages of the process flow for the pertaining procedures.

Work Instructions and Supporting Procedures

Forms and Templates
(Please refer to the respective procedure and/or work instruction for more details)

The Values of the Systems Architecting Framework



The search for alternatives to harness state-of-the-art technologies for rapid development and fielding of new operational capabilities is a never ending business for C4I systems architects...

