Synthetic Environments Integrated with Capability Engineering – Powerful Tools to Address the Future

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Workplace/Battlespace Revolutions: Recent Past

Workplace/Battlespace Revolution of ~1990

- **Integrating rapid advances in printers, e-mail, personal computers, networks, word processing, fax, etc changed the way that DND/CF conducted its business at the office and in operations.**
- **Severe change in skill sets and how we communicate resulted. Tempo increased.**

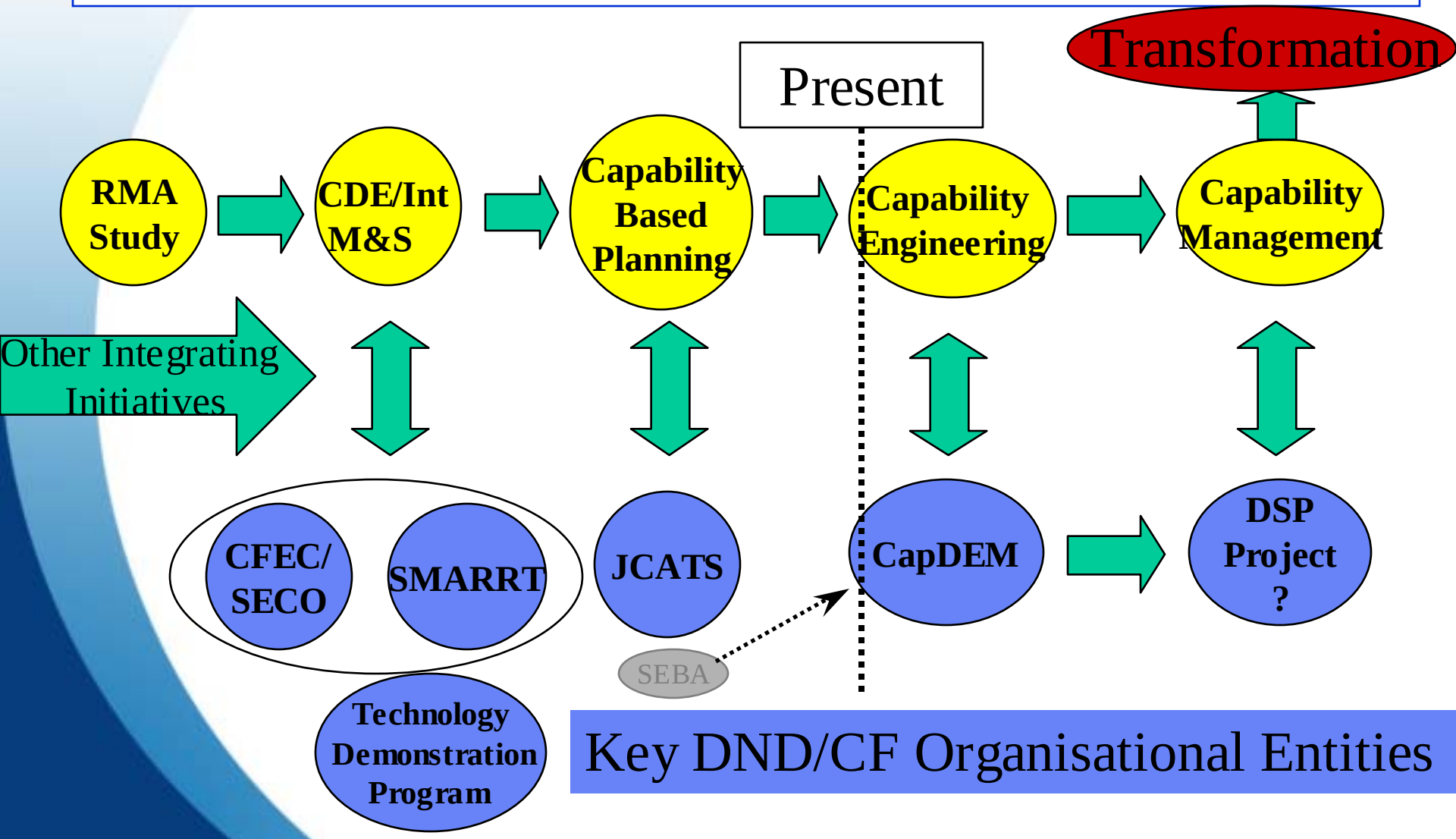
The Single Integrated Battlespace

Workplace/Battlespace Revolutions: Near Future

Current Workplace/Battlespace Revolution

- **Integrating rapid advances in synthetic environments, systems of systems engineering, collaborative tools, the dramatically increasing power of individual computers and networking technologies will change the way that DND/CF approaches the Future Single Integrated Battlespace.**
- **The way in which DND/CF conducts its business, both on and off the battlefield, will change dramatically (e.g. Network Centric Warfare).**
- **We will design, engineer, and manage DND/CF capabilities in an integrated, fused approach, and will fight and survive in the future battlespace in the same way.**
- **This will have a profound effect on the skill sets required by DND/CF staff to produce future capabilities. Tempo of operations will increase further.**

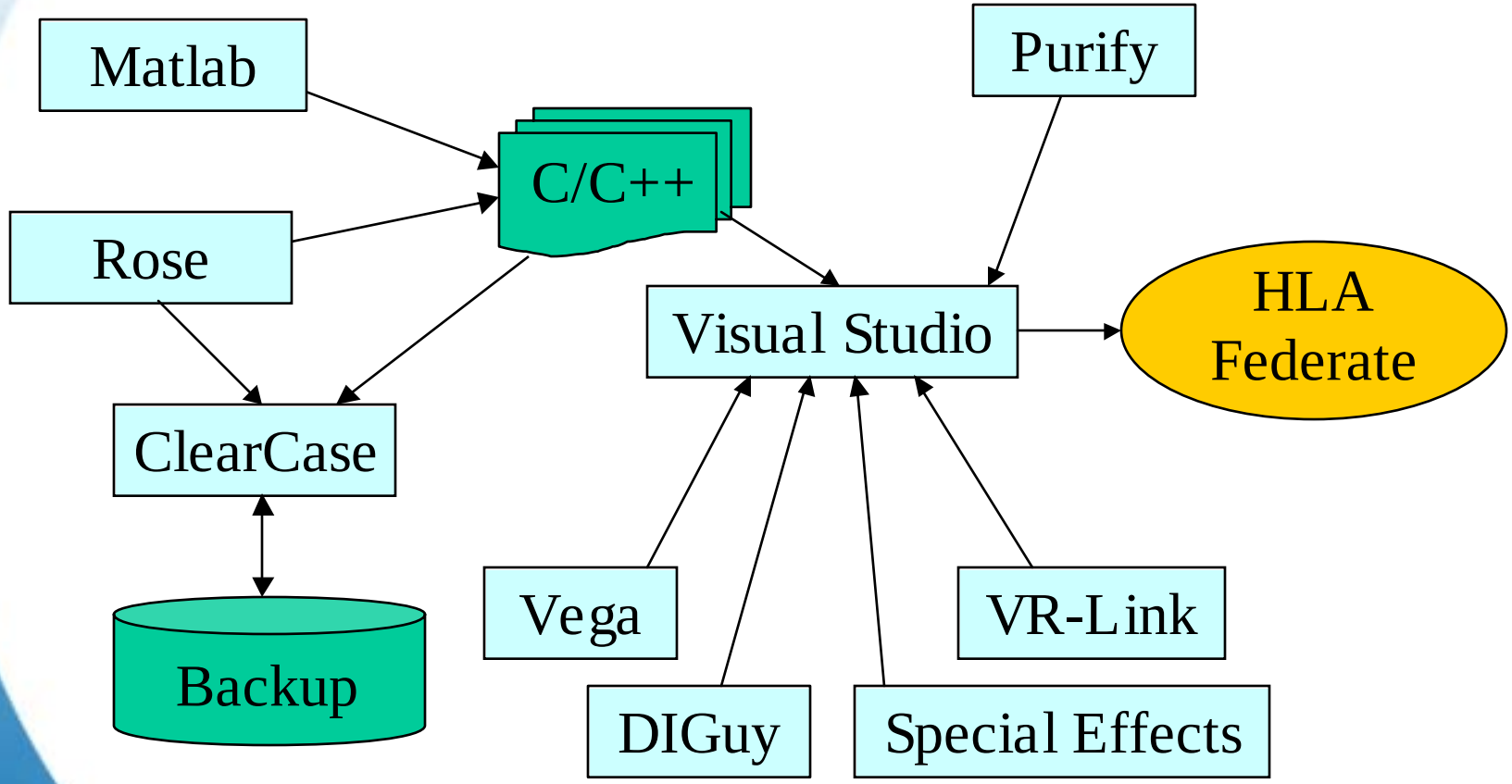
DND/CF Transformation



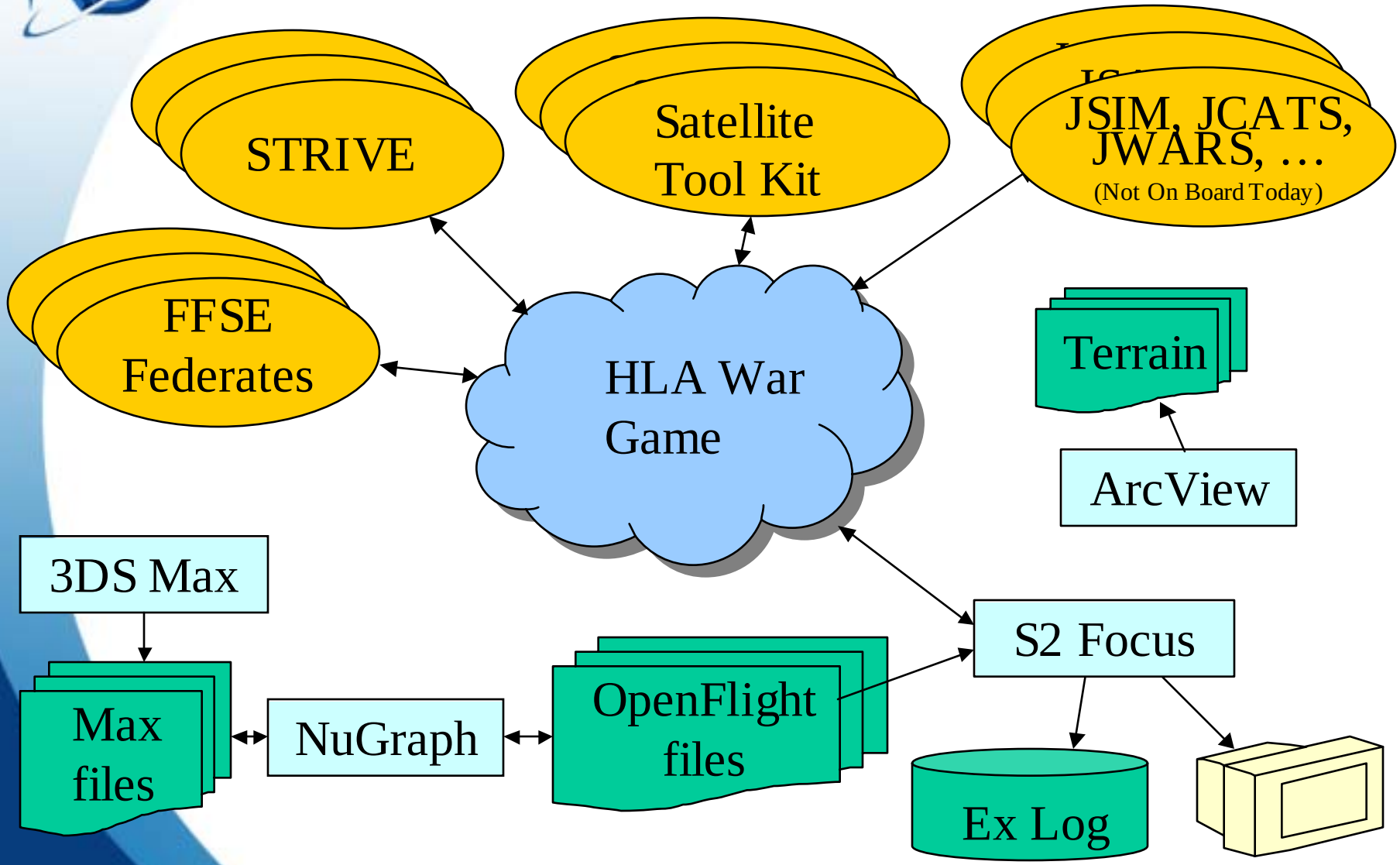
Key Missing Pieces in the DND/CF M&S/Synthetic Environment Construct:

- **Recent DND/CF Advances**
  - **Creation of CFEC/SECO/SMARRT/CFXNet & Connecting with CFBLNet**
  - **CFXNet: a specialised, classified Network using secure rooms. Will be heavily subscribed.**
- **Future DRDC/DND/CF Advances Required:**
  - **DRDC/DND/CF Federation of Models and Simulations (comparable to US RDEC Federation)**
  - **DRDC/CDE Community Distributed Simulation Network (comparable to US DREN) connected with Key DND/CF Partners and the future SECO M&S Resource Repository**

Sample Integrated Software Tools for Developing HLA Models



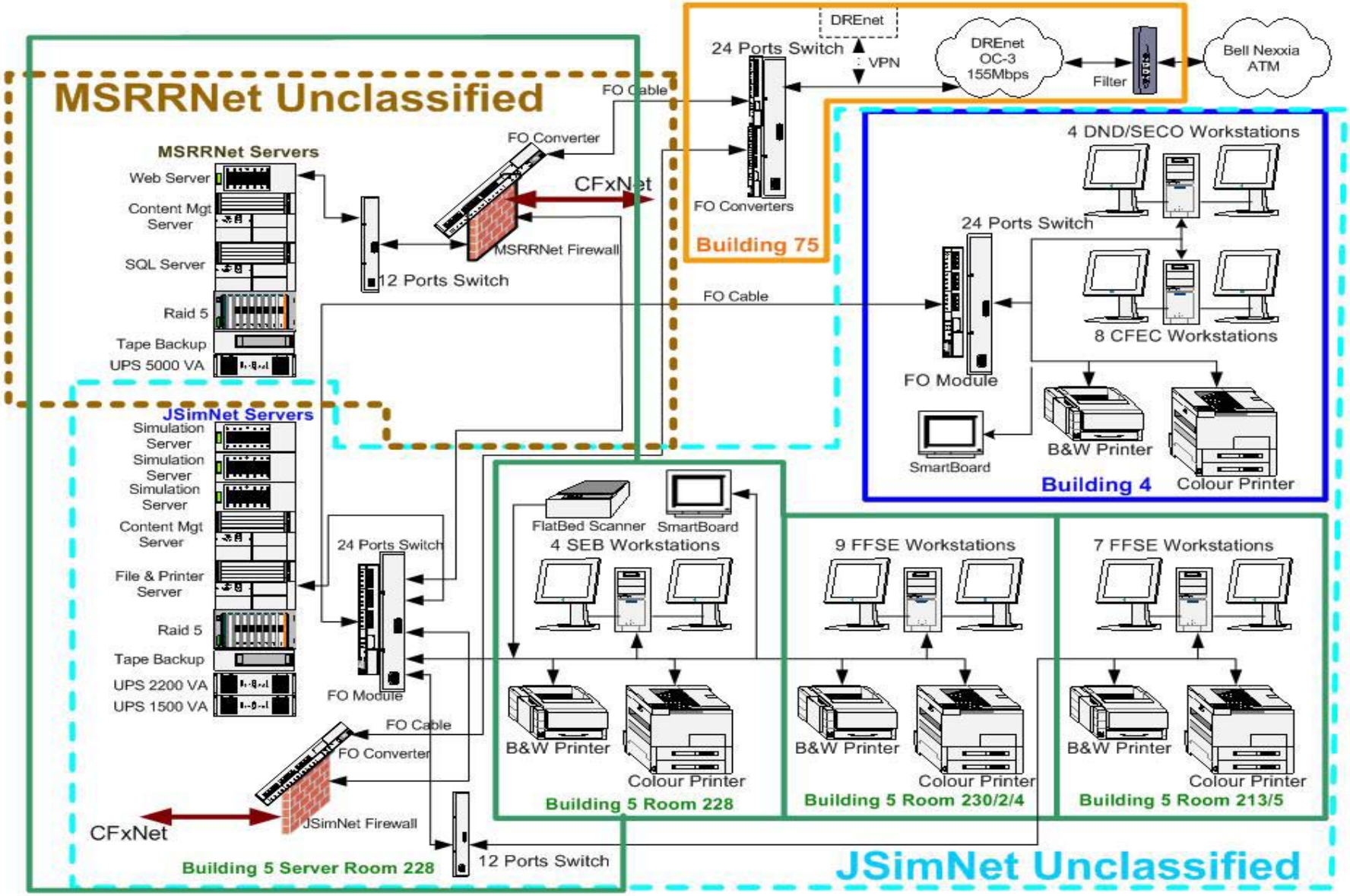
Typical Software for HLA War Gaming



Fighter and UAV Models Inserted into a Synthetic Environment

Program external FFSE federates to interact with STRIVE federates via HLA/RTI

The DRDC M&S Strategy: Joint Simulation Network (JSimNet) & M&S Resource Repository Network: Stages 1 & 2



CapDEM (Collaborative Capability Definition, Engineering and Management) TDP

Vision:

To establish a process in which DND/CF and Industry are enabled by robust, **collaborative** use of simulation and engineering technology that is **integrated across acquisition phases** and programs in order to **define, engineer, and manage future capabilities**.

Goals:

The goals of CapDEM are to define, engineer and manage key DND/CF capabilities with:

- substantially reduced time, resources, and risk associated with the entire process;
- increased quality, military worth, and supportability of fielded systems while reducing total ownership costs throughout the life cycle;
- enable Integrated Product and Process Development across the entire acquisition life cycle.

The CapDEM TDP Team

- **SRB: Co-Leaders – Dr Walker and MGen Dempster**
- **DRDC (Ottawa, Valcartier, Toronto) – SMARRT**
- **DCDS (CFEC, SECO)**
- **VCDS (DGSP, DDA)**
- **ADM(Mat)**
- **ADM(IM)**
- **DGOR**
- **PWGSC**
- **Industry Liaison Panel**
- **CA/US/UK/AS Coalition Systems Engineering Process using Coalition Integrated Air Picture**
- **CA/UK Bilateral**
- **PM for CapDEM is Jack Pagotto**

Hand over to Jack Pagotto

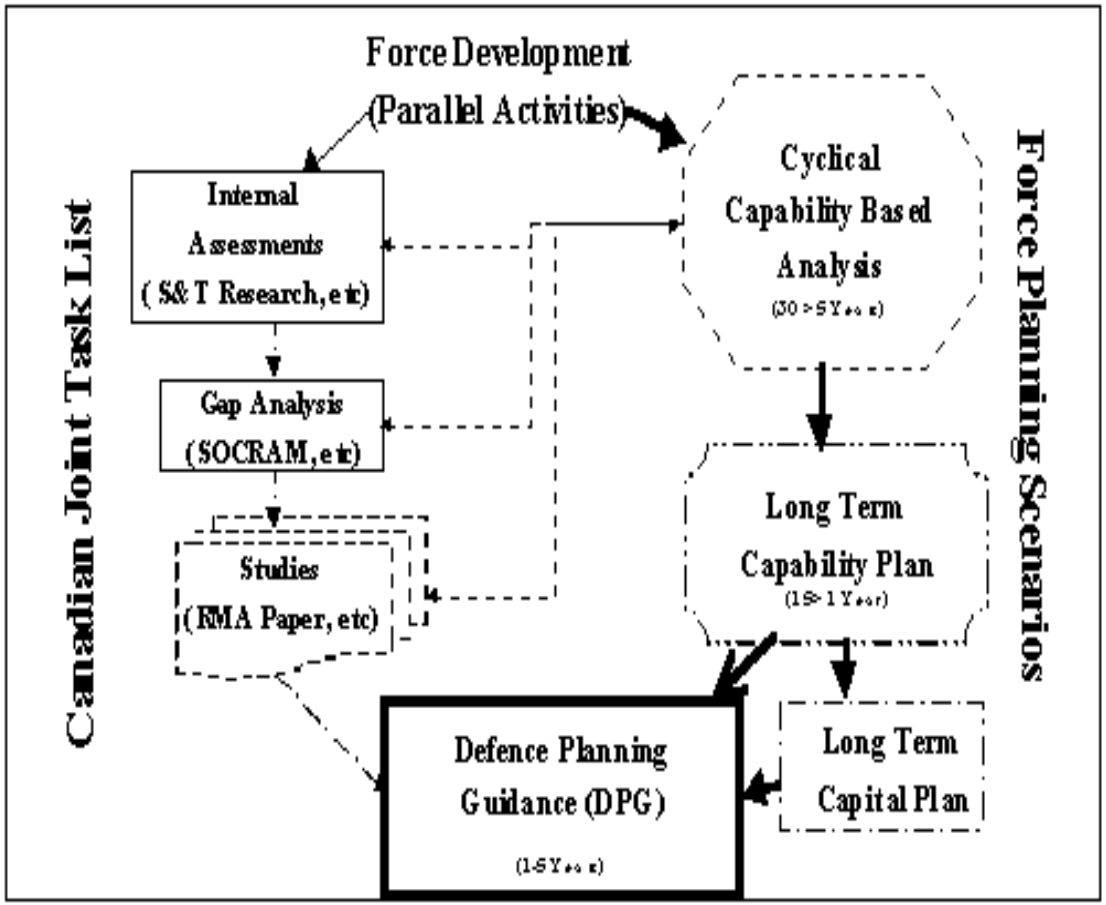
CapDEM - Project Objectives

- Define Capability Engineering Process
- Enable Capability Engineering Process
  - Integrated Collaborative Engineering Environment
- Demonstrate and Evaluate, the tools and the process (based initially on USN CHENG).
- Advise/Transition DND/CF implementation of Capability Engineering Process

Capability Planning Process

White Paper 94
Strategy 2020

Strategic Overview Military Assessment

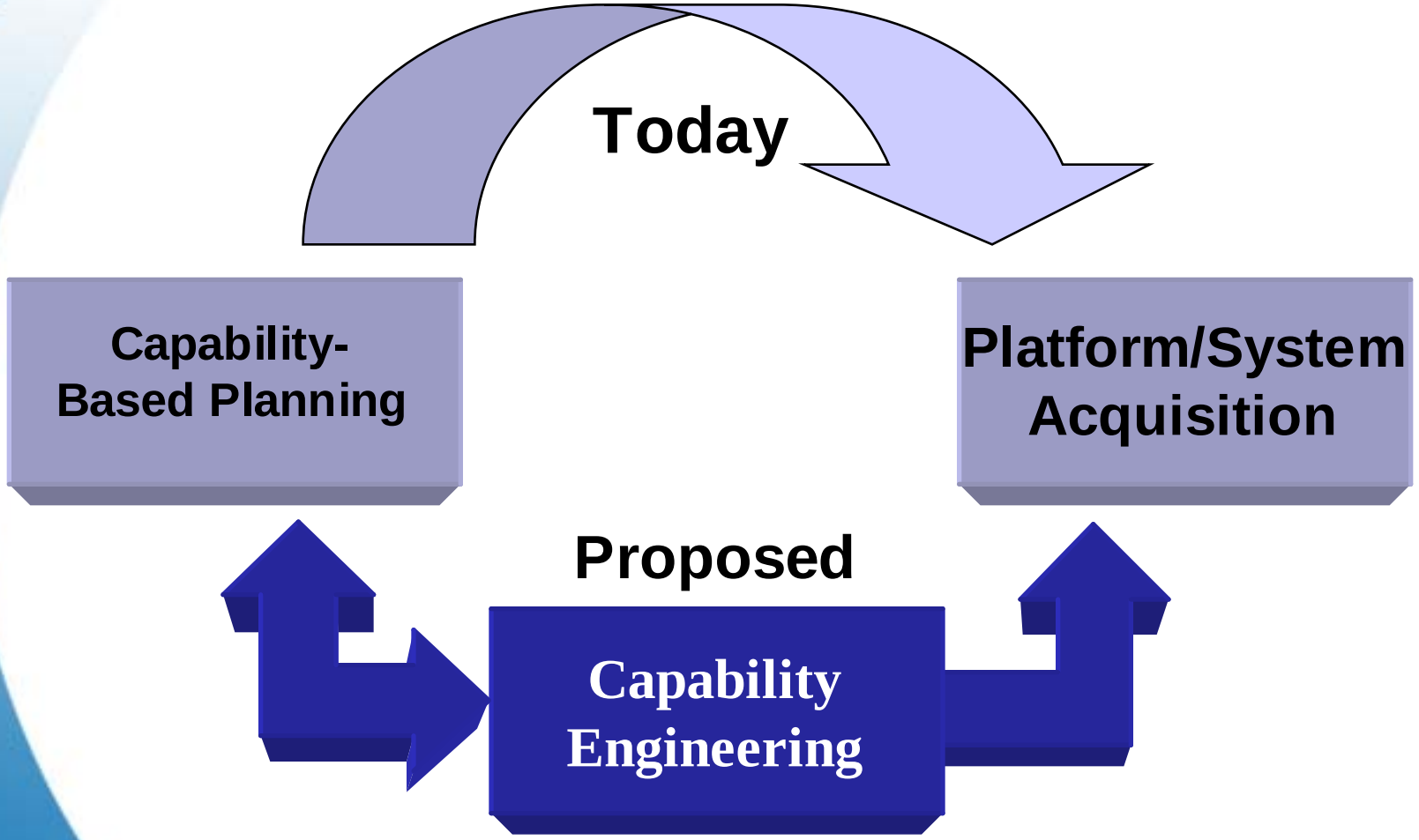


Joint Task List Capability Areas

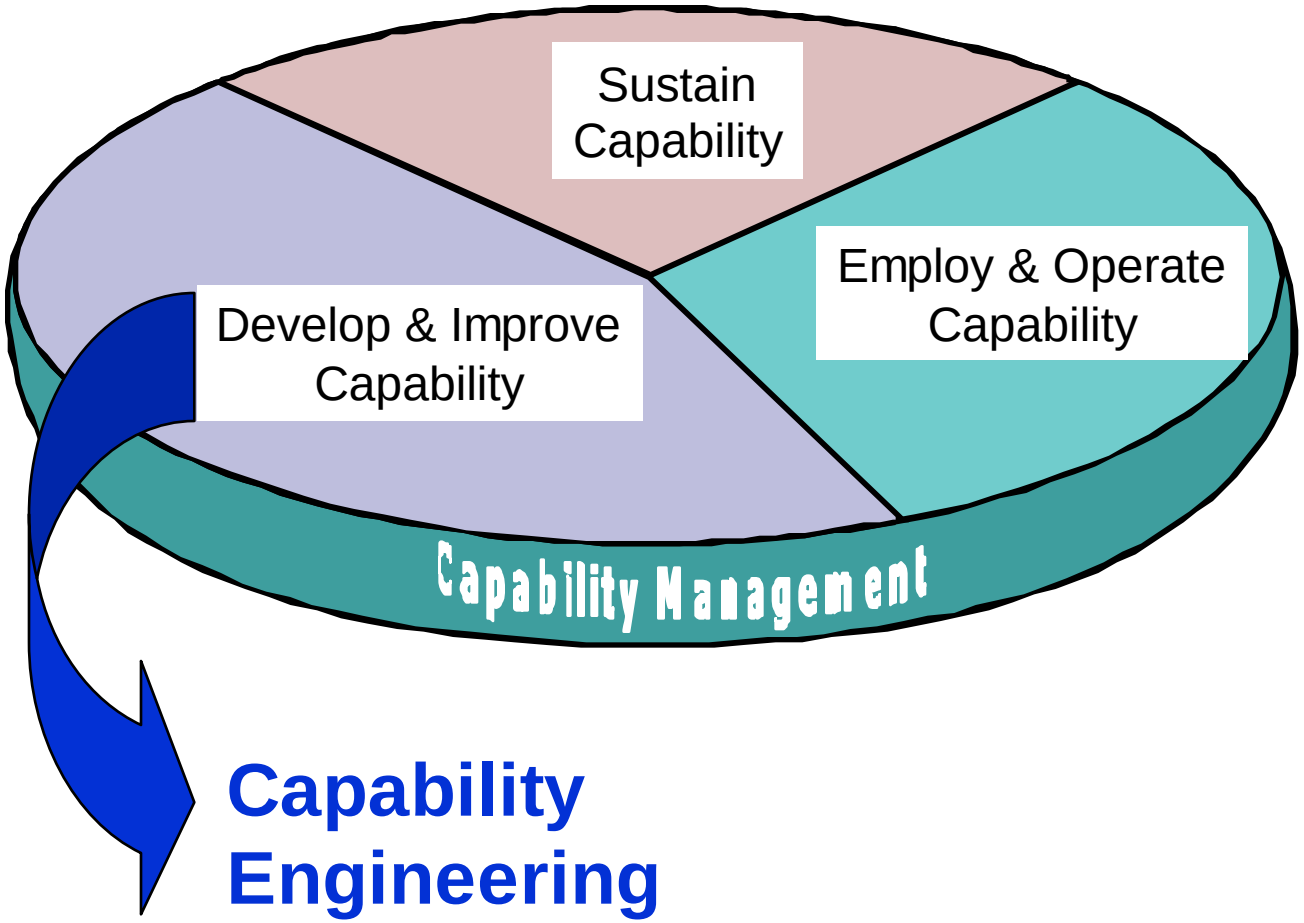
- Command
- Information & Intelligence
- Conduct Operations
- Mobility
- Protect Own Forces
- Sustain
- Generate Forces
- Co-ordinate with Other Government Initiatives

Also JCATs, etc but … need implementation process…

Capability Engineering Concept

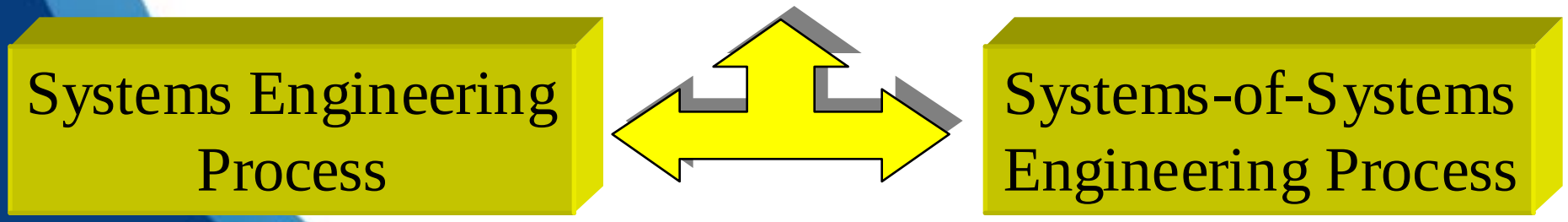


Capability Engineering: One Essential Component of Capability Management



Capability Engineering Definition:

The application of systems level engineering and management processes and tools to establish the necessary rigour for effective planning, acquisition and evolution of a capability at a system-of-systems level.



Capability as a System-of-Systems

(an assemblage of independantly operated & managed systems)

CapDEM … Potentiallly Disruptive…?

PROCESS

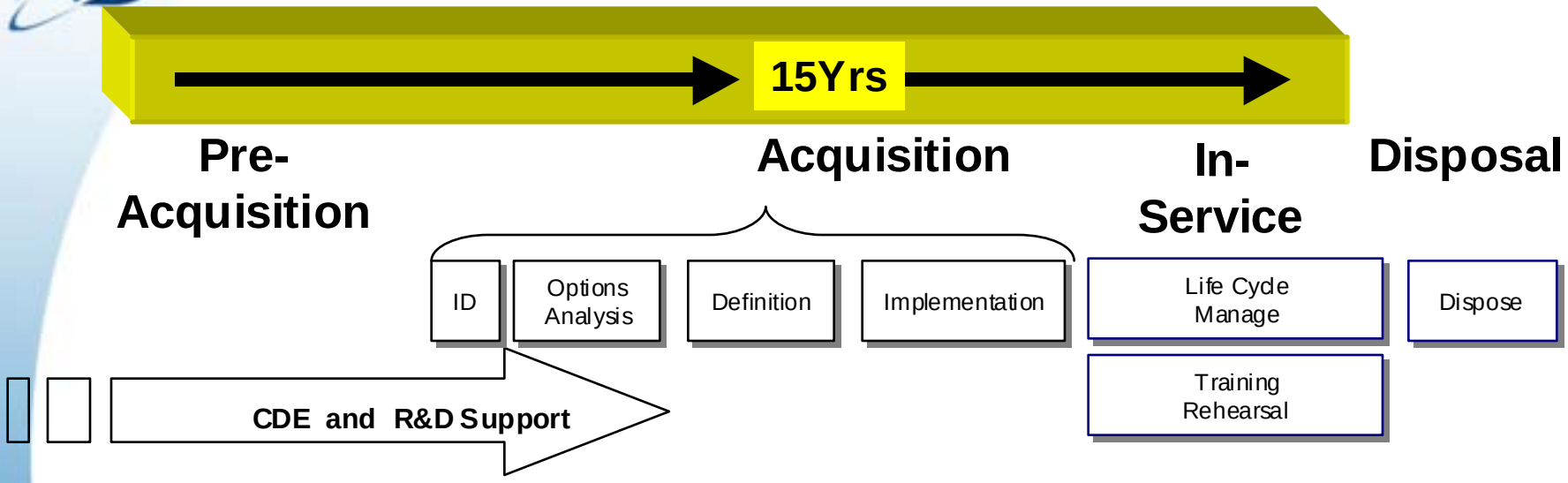
- **Capability Based Planning & Defence Management System (DMS)**
- **Capability Requirement Definition**
- **Capability Stakeholders**
- **Systems Engineering Cycle, Tools & Techniques (SoS version of IEEE1220?)**
- **Test and Evaluation Environment**
- **Project Management Process**
- **Integrated Process Teams**

Organization

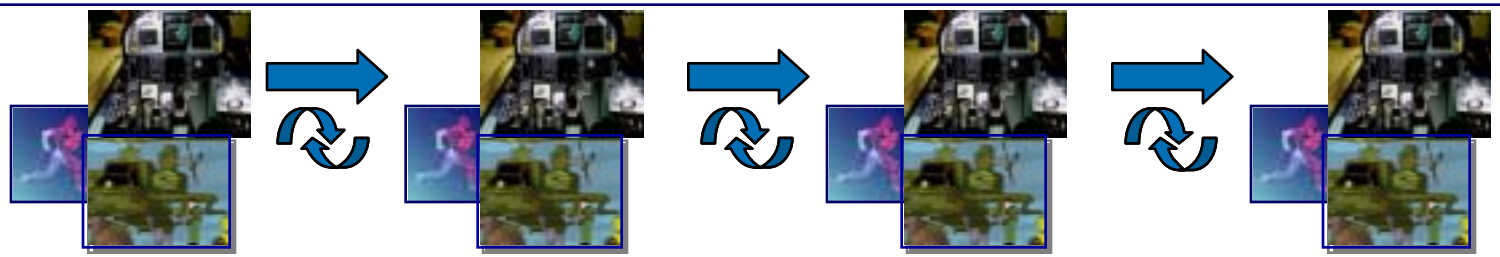
- **Capability "Portfolio" Manager ?**
- **Industry (Contracting process, IP protection, etc!)**
- **Environmental Stovepipes**

Examine some examples of this diruption…

Systems Engineering in Current Defence System Life Cycle



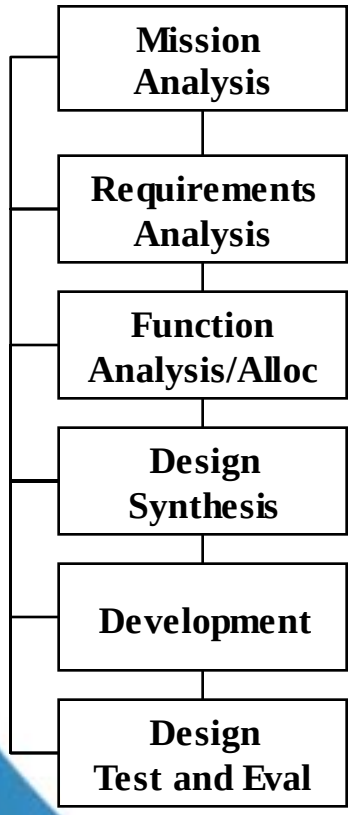
System Engineering Process Iterates Several Times Throughout Life Cycle



Shared Models & Simulations of System
- -Common system model
- -Consistent scenarios, measures
- -Increased quality of analysis
- -Decreased time of analysis

Training System

Impact of Capability Engineering on: Systems Engineering Cycle



The System	The Capability
Mission for the system	Mission for the capability
Requirements for the system	Rqmts for the capability
Allocate among the different system components	Allocate among the different systems
System design	Integration of System into a capability design
Build the system	Integrate systems, doctrine, personnel, Joint, Coallition
Test the system	Conduct capability level T&E and acceptance.

Impact of Capability Engineering on: Capability Requirements Definition

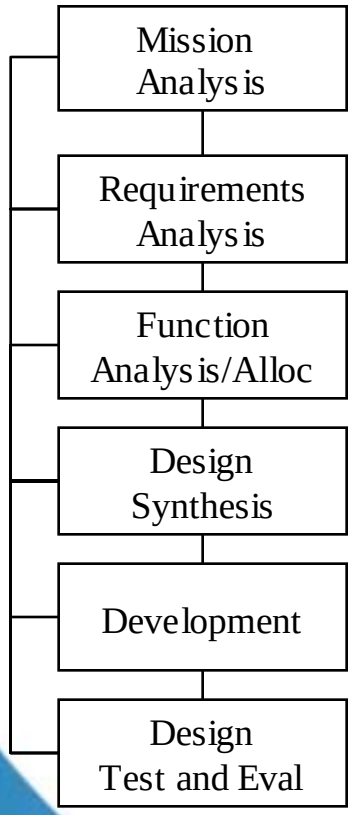
- Need to quantify the desired capability …

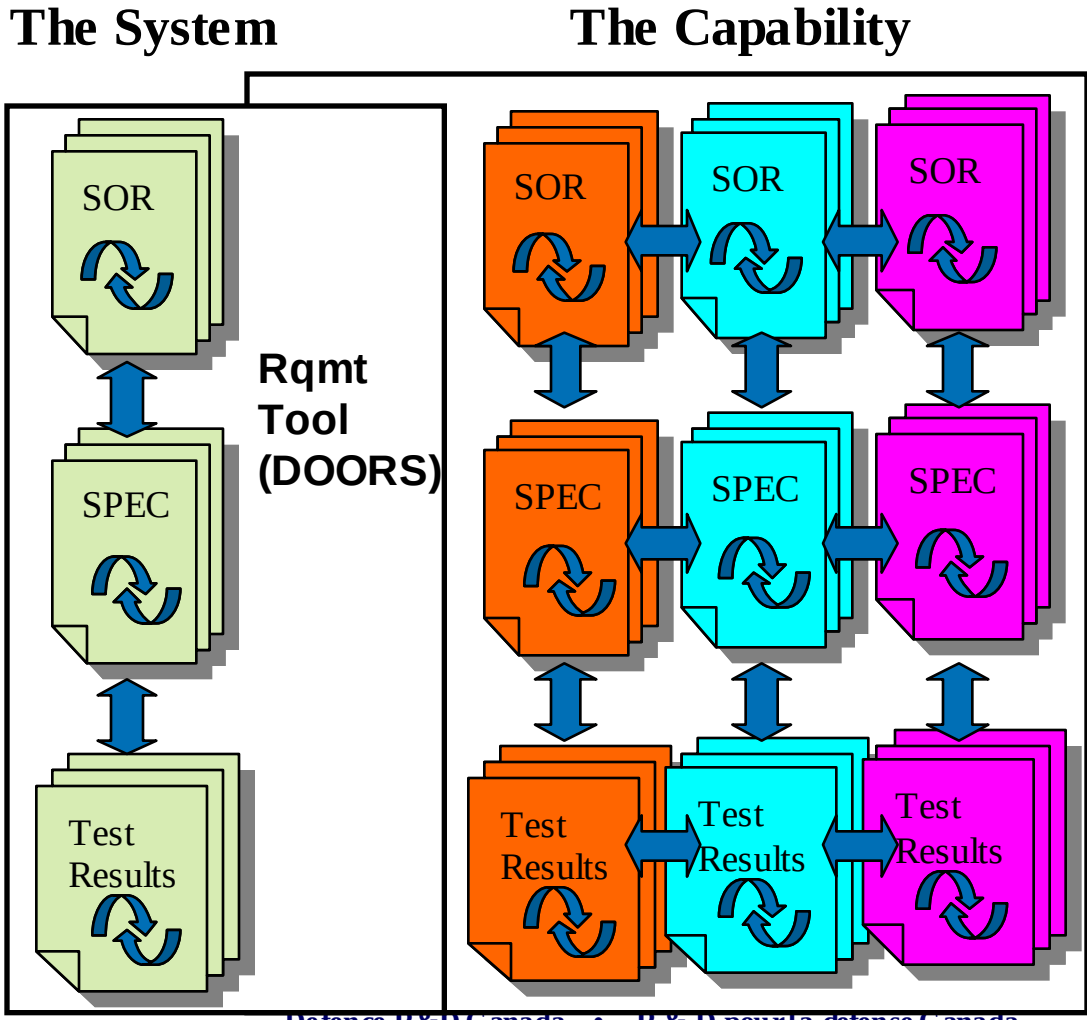
  $\int$(military effectiveness + people/materiel/doctrine)

- Need to **allocate requirements across multiple projects, systems, & platforms.**
- Must **conduct trade offs** across multiple projects and systems to meet capability requirement
- Must '**configuration manage' the capability** to ensure systematic introduction into service within the CF.
  - **Synchronize R&D/CDE requirements** with forecasted capability requirements
  - **Synchronize/Program deployment & disposal** of systems

Capability Engineering will impact: Systems Engineering Tools

eg: Requirements Management



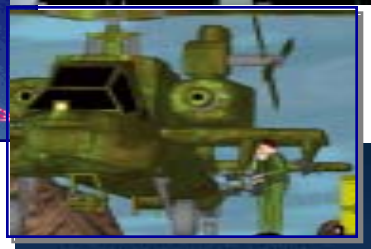


Capability Engineering Will Impact: Test and Evaluation Environments

Mission Analysis

Requirements Analysis	Requirements Studies
Function Analysis/Alloc	Functional Studies
Design Synthesis	Design Studies
Development	V&V Studies
Design Test and Eval	

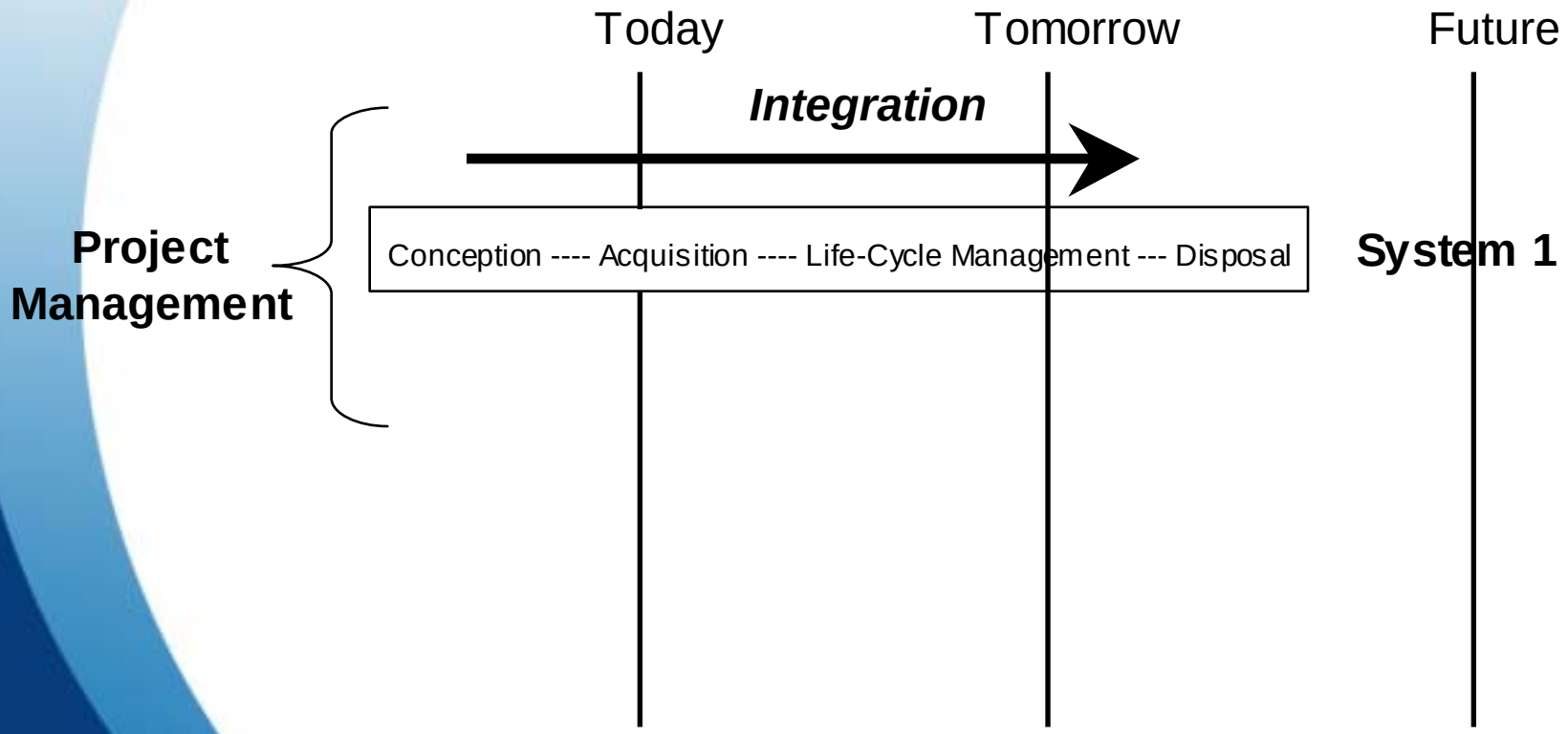
The System **The Capability**



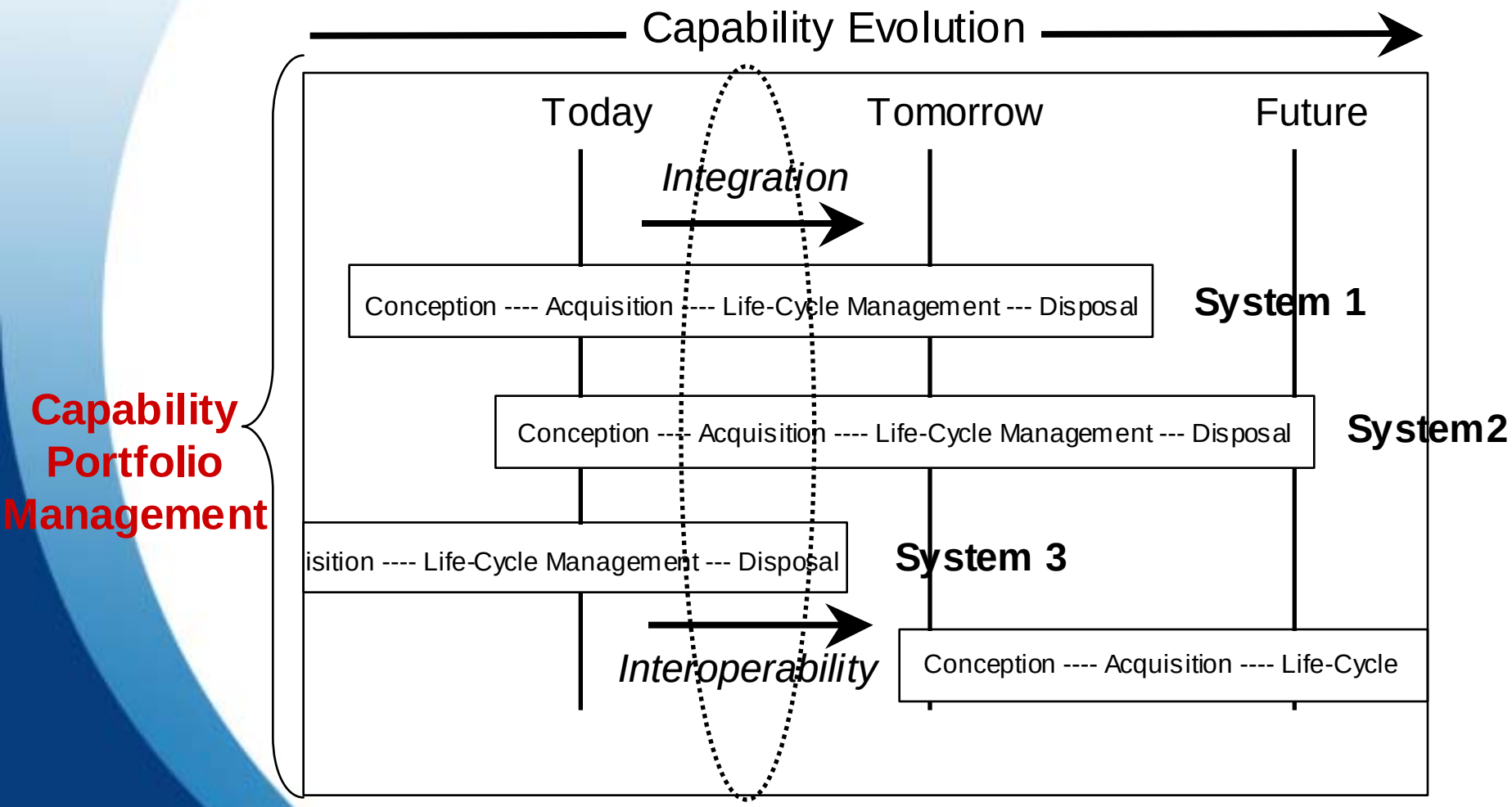
CapDEM will Impact Stakeholders and Organizations

- **Multiple Project Directors, Managers, Sponsors, …**
- **Multiple Military Environments – Joint Ops, air, land, sea, space**
- **Multiple Nations (Coalition Ops)**
- **Multiple Participating Industrial Performers**

CapDEM will impact classical Project Management process:



CapDEM will impact classical processes: Project Management



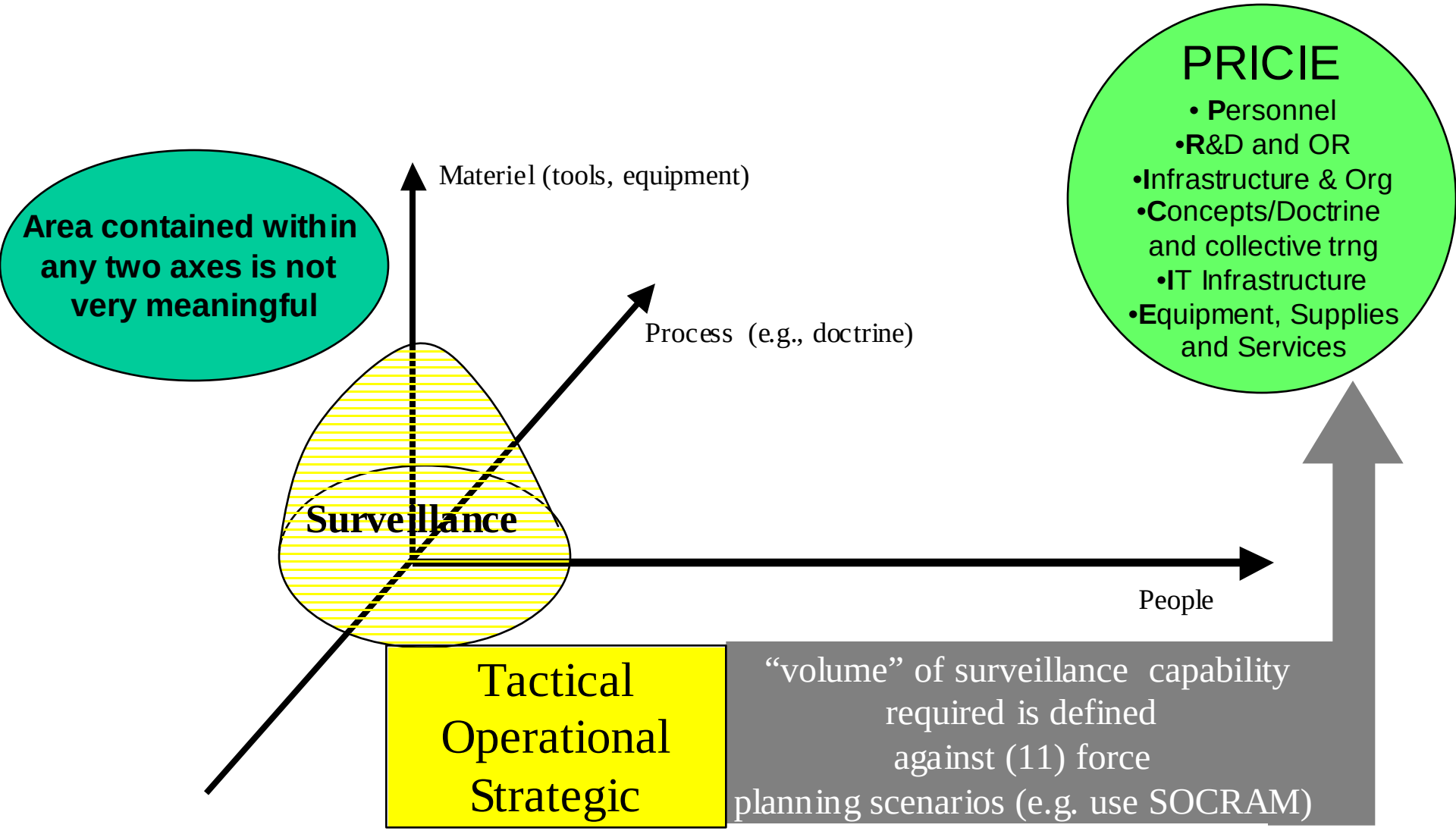
But how will Capability Manager quantify capability gap?

Problem: If you cannot cost Equipment Personnel, Process elements of a Capability..

- **You cannot manage it**
- **You cannot trade it off**
- **You cannot allocate resources to it**

Answer: Capability Metrics

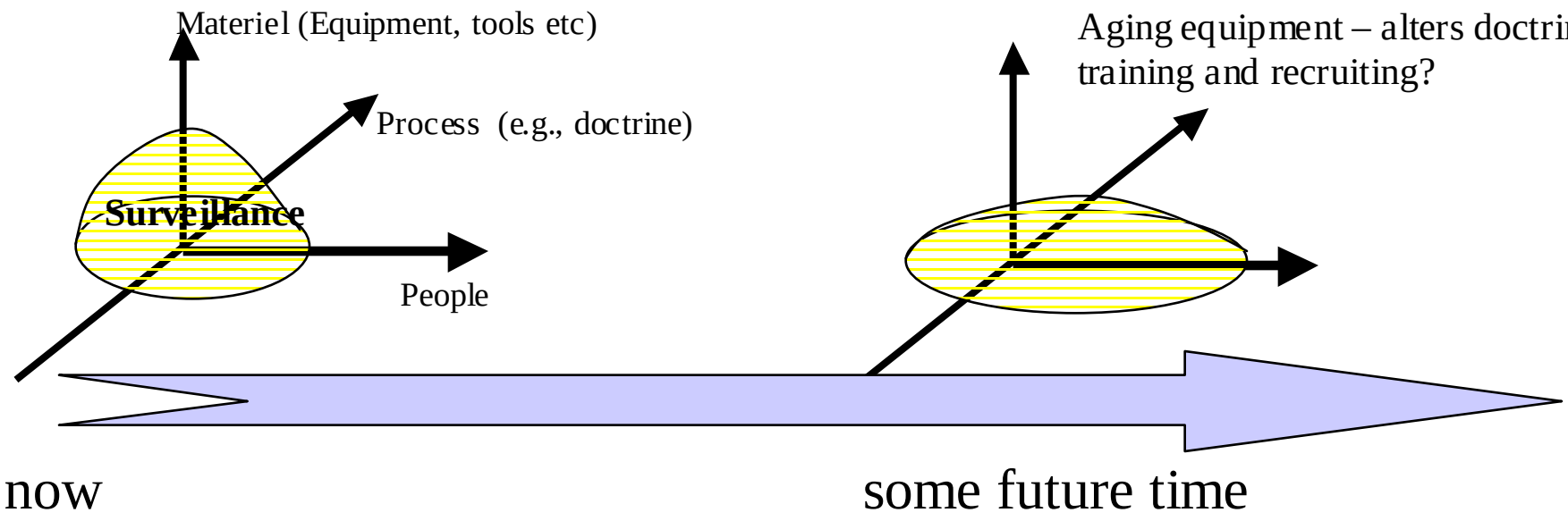
Quantifying a Capability (e.g. Surveillance)



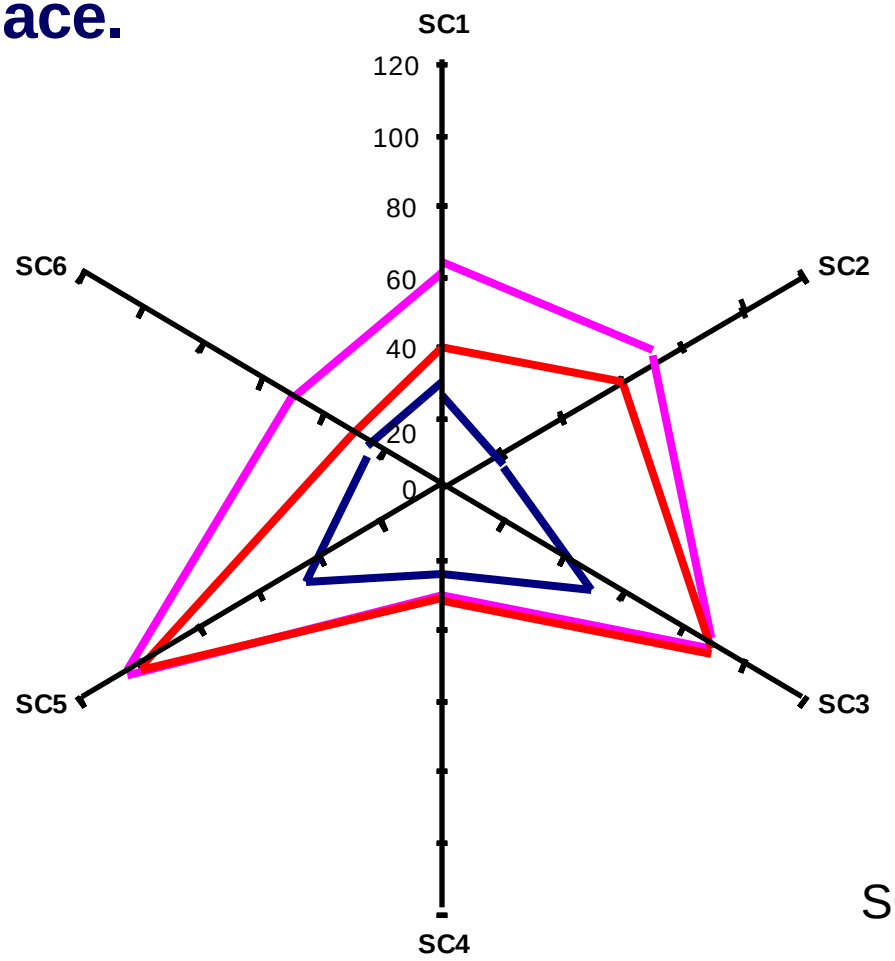
The "shape" of the 'Capability Heap' changes under the influence of people, process and materiel over time

SEC

- **Capability "heap" changes over time**



Rigorous Systems Engineering process analyses and develops integrated system of systems capability. Key is to present complex solution space to decision makers coherently… need to "Visualise" the Capability Solution Space.

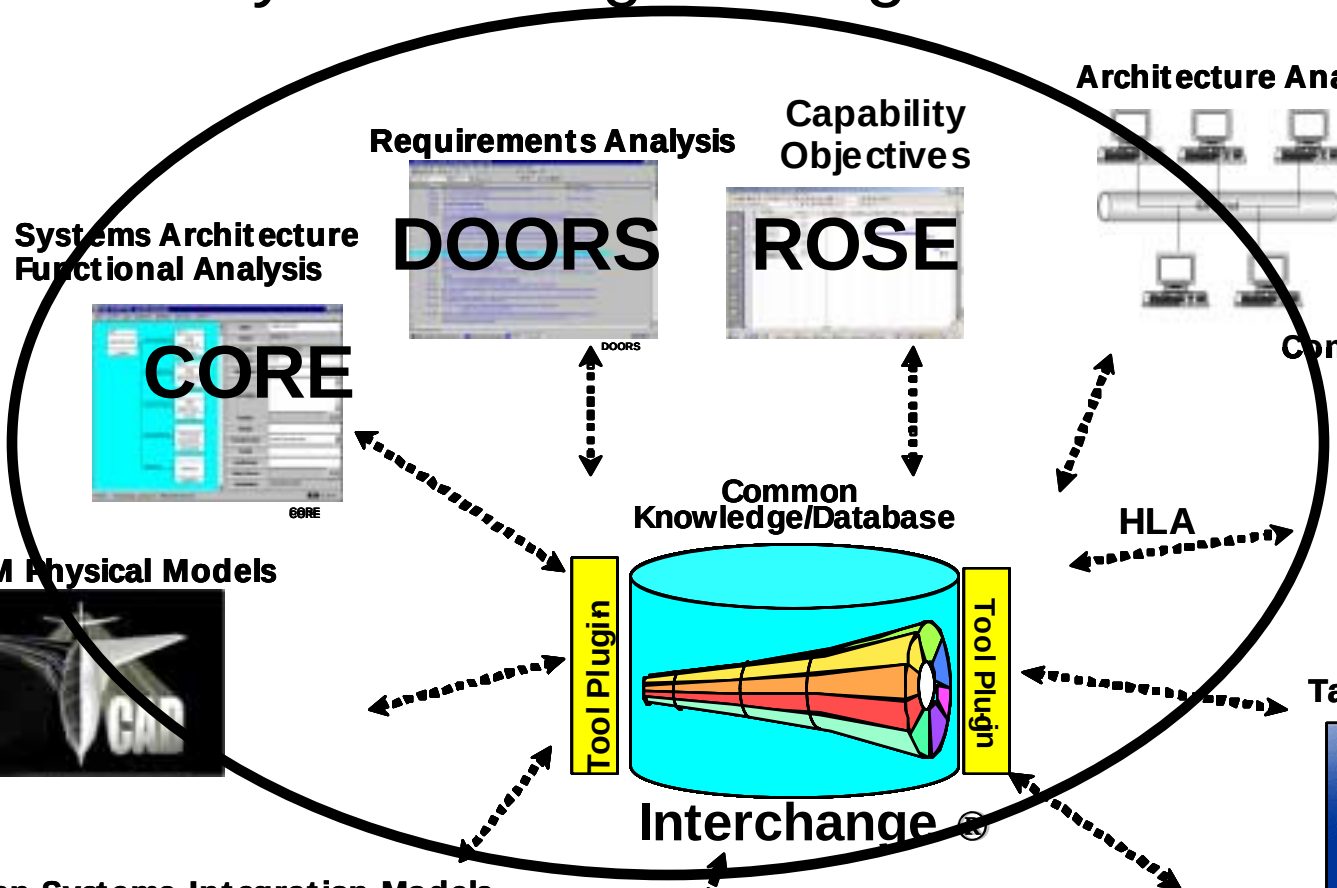


SC = Subsystem Capability

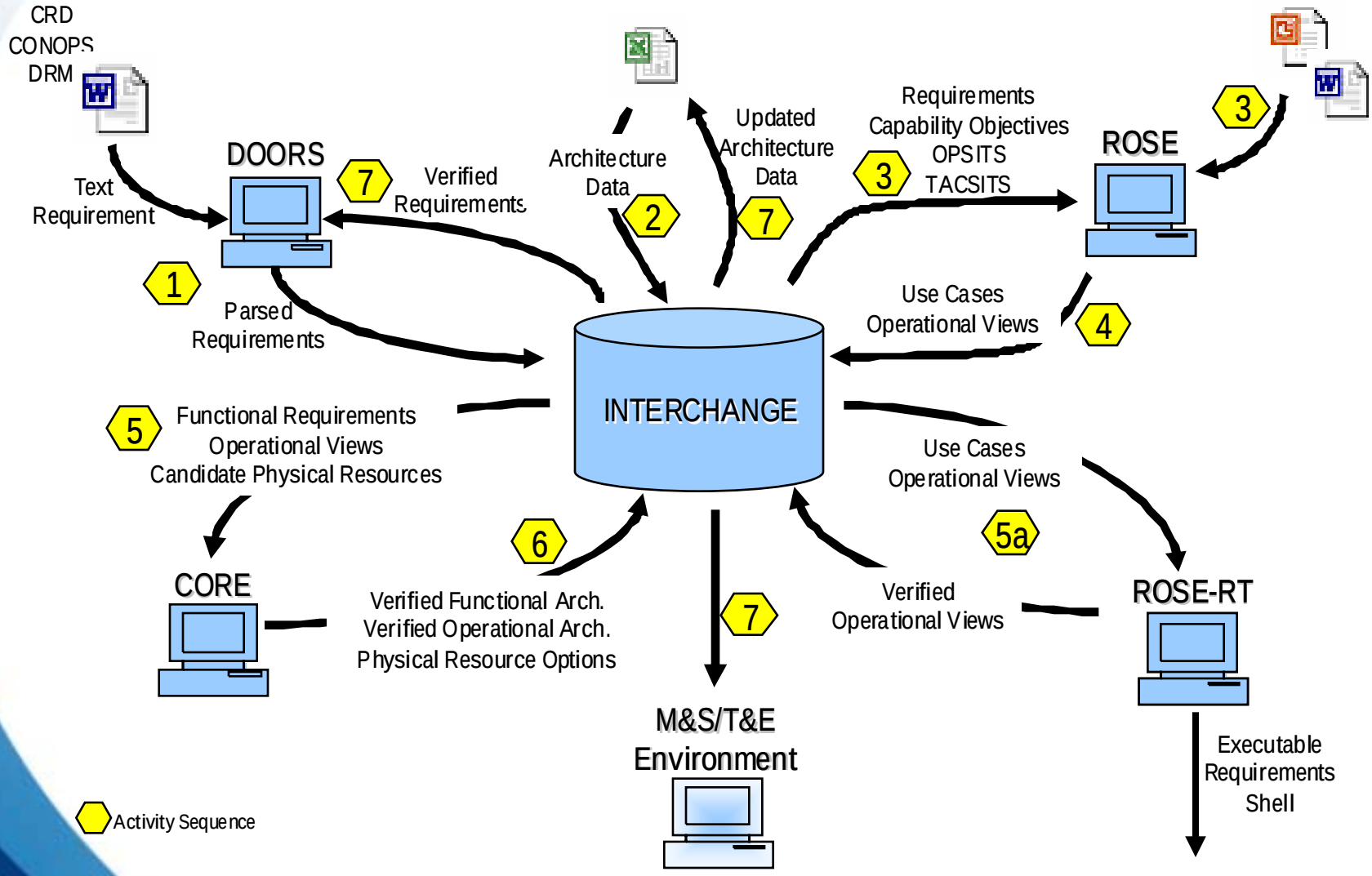
CapDEM - Project Objectives

- Define Capability Engineering Process
- Enable Capability Engineering Process
  - Integrated Collaborative Engineering Environment
- Demonstrate and Evaluate, the tools and the process.
- Advise/Transition DND/CF implementation of CapEng Process

Integrated Collaborative Engineering Environment
"Linked Systems Engineering Tools"



US Navy (CHENG) System-of-Systems Engineering Process



Capability Engineering Summary

- **Capability Engineering**
  - **Is Collaborative**
  - **Is Defined by a Capability Requirement**
  - **Integrates Multiple Systems**
  - **Requires Linked Engineering Analysis**
  - **Requires Shared Experimental Environments**
  - **Leads to Capability Portfolio Management Principles**
  - **WILL be disruptive to DND/CF Organizations and Processes… CapDEM TDP will assess "how disruptive".**

IS IT WORTH IT…?

Capability Evolution Will Enable Transformation

THE TECHNICAL COOPERATION PROGRAM

SUBCOMMITTEE ON NON-ATOMIC MILITARY RESEARCH AND DEVELOPMENT

Capability increment #1

Capability increment #2

Capability increment #3

Strike

C4ISR

USW

etc

2002

2004

2007

2010

2015

04

06

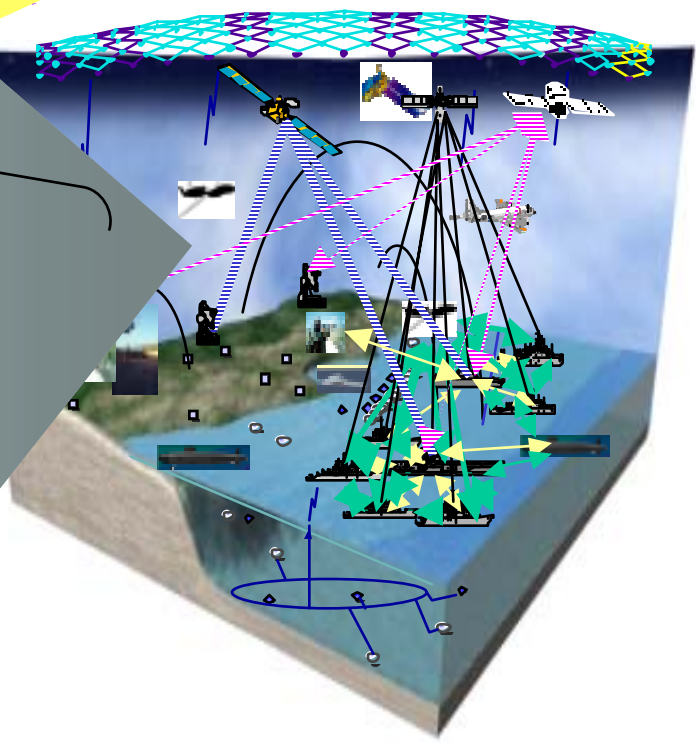
08

10

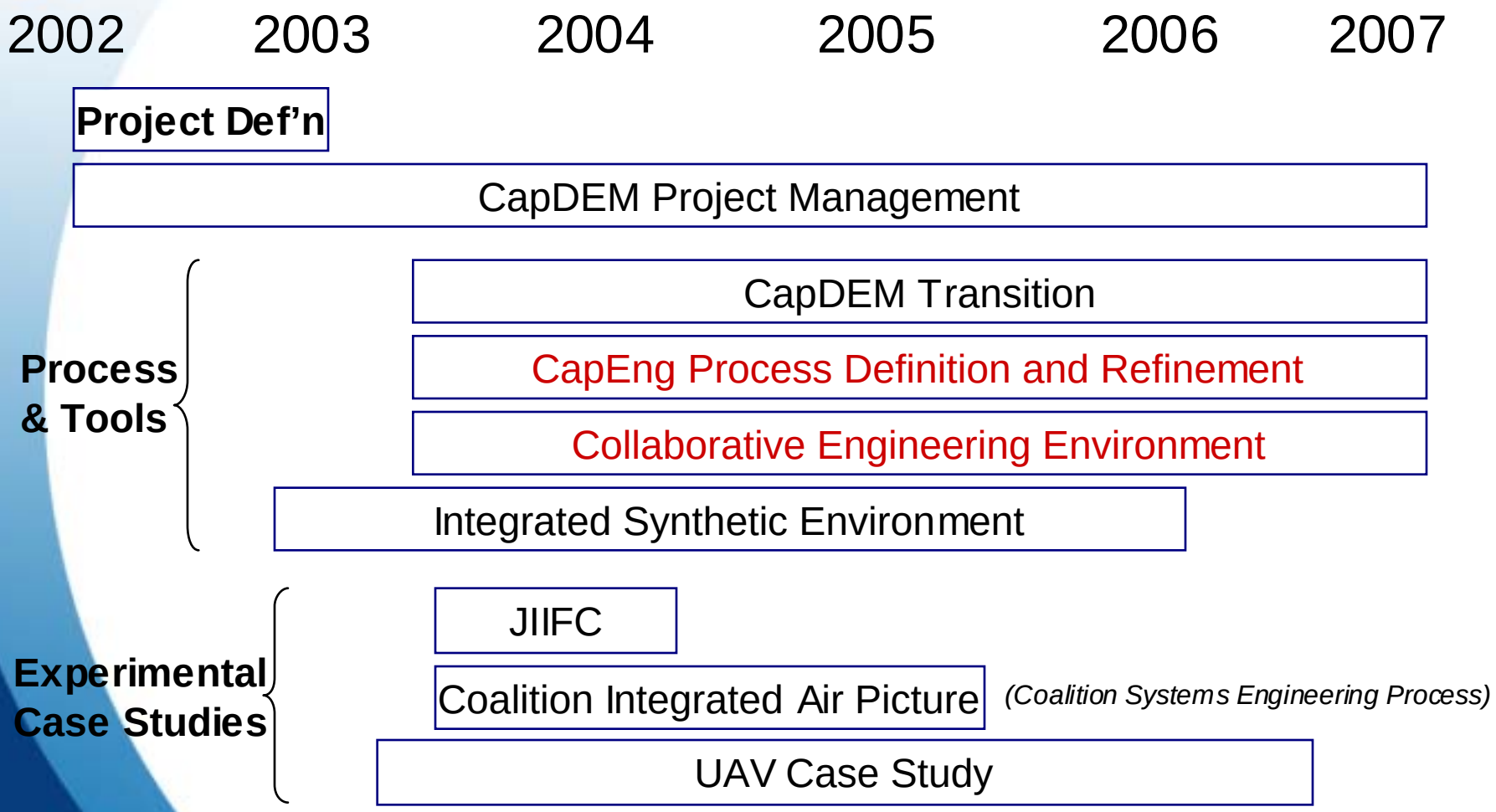
12

Integrated Warfare Capabilities

Future Forces

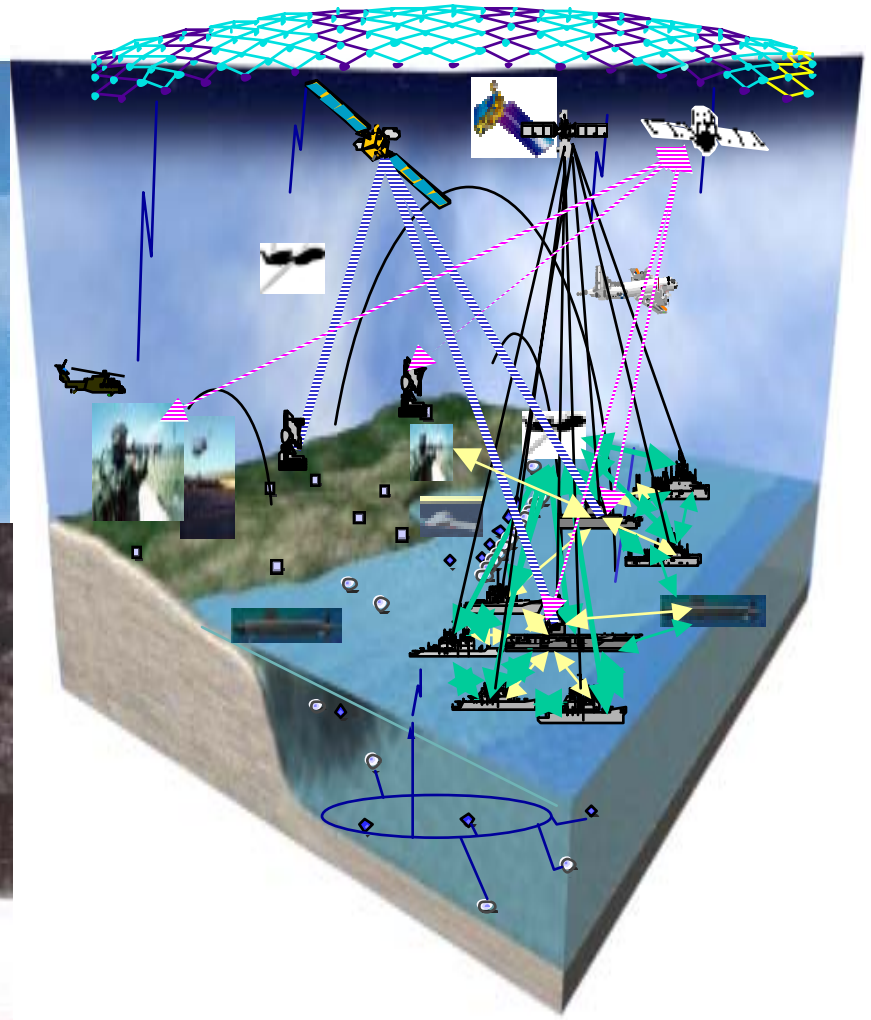


CapDEM Tech Demo Project – Work Plan:



Summary

- **A "Workplace/Battlespace revolution" is underway involving integrating, rapidly advancing technologies (synthetic environments, systems of systems engineering, increasingly powerful computers, networking technologies, etc)**
- **The DND/CF CapDEM TDP team, in collaboration with our closest Allies, is examining these integrating technologies for the definition, engineering and management of future DND/CF capabilities**
- **Capability Engineering is the key missing piece that will allow DND/CF to establish Capability Management and plan the roadmap to the transformation required to fight and survive in the future Single Integrated Battlespace**



Questions? Comments?

Additional Slides follow

A 'System-of-systems' is an assemblage of components which Individually may be regarded as systems and which possess two additional properties:

1) ***Operational Independence of the Components**: If the system-of-systems is disassembled into its component systems, the component systems must be able to operate independently. That is, the component systems fulfil customer or operator purposes on their own.*

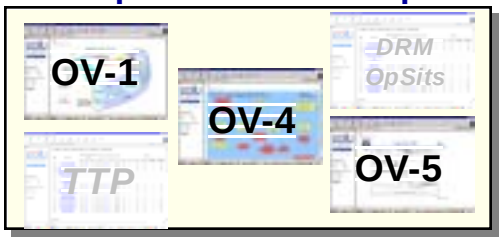
2) ***Managerial Independence of the Components:** The component systems not only can operate independently, they do operate independently. Component systems are separately acquired and integrated, and maintain a continuing operating existence independent of the system-of-systems.*

System of Systems Section, DRDC-Valcartier

Systems Engineering Process Applied to System-of-Systems Architectures & Acquisition

Rev 4 (1)
22 Apr 02

Operational Concept



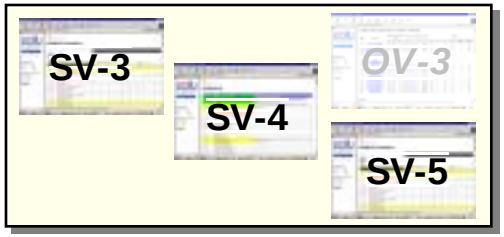
Lesser

The Role of Engineering and Technology

Greater

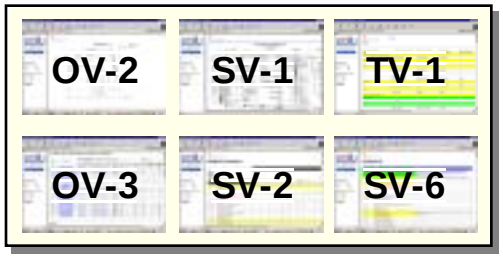
CV-6	Capabilities Evolution Description
OV-1	High-level Operational Concept Graphic
OV-2	Operational Node Connectivity Description
OV-3	Operational Information Exchange Matrix
OV-4	Command Relationships Chart
OV-5	Activity Model
OV-6C	Operational Event/Trace Description
SV-1	System Interface Description
SV-2	Systems Communication Description
SV-3	Systems Matrix
SV-4	System Functionality Description
SV-5	Operational Activity to System Function Traceability Matrix
SV-6	System Information Exchange Matrix
SV-7	System Performance Parameters Matrix
SV-8	System Evolution Description
SV-9	System Technology Forecast
SV-10	System Activity Sequence & Timing
TV-1	Technical Architecture Profile
TV-2	Standards Technology Forecast

System Functional Mapping



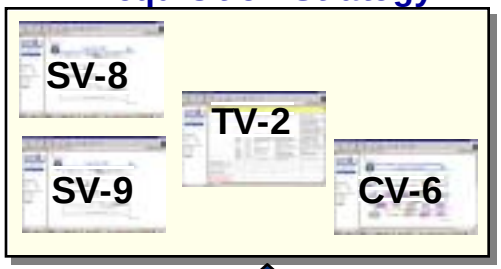
1st Order Analysis:
Functionality--

System Interface Mapping



2nd Order Analysis:
Static Interoperability

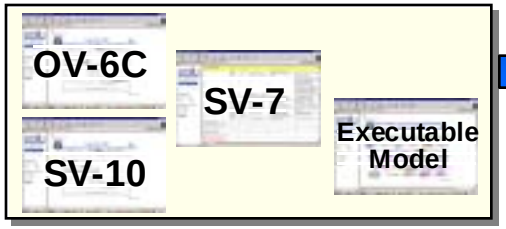
Acquisition Strategy



DRM: Design Reference Mission
OpSit: Operational Situation
TTP: Tactics, Techniques, Procedures

Note: There are dependencies between the Architecture products that are not shown in the System Engineering flow. Many of the products are developed concurrently.

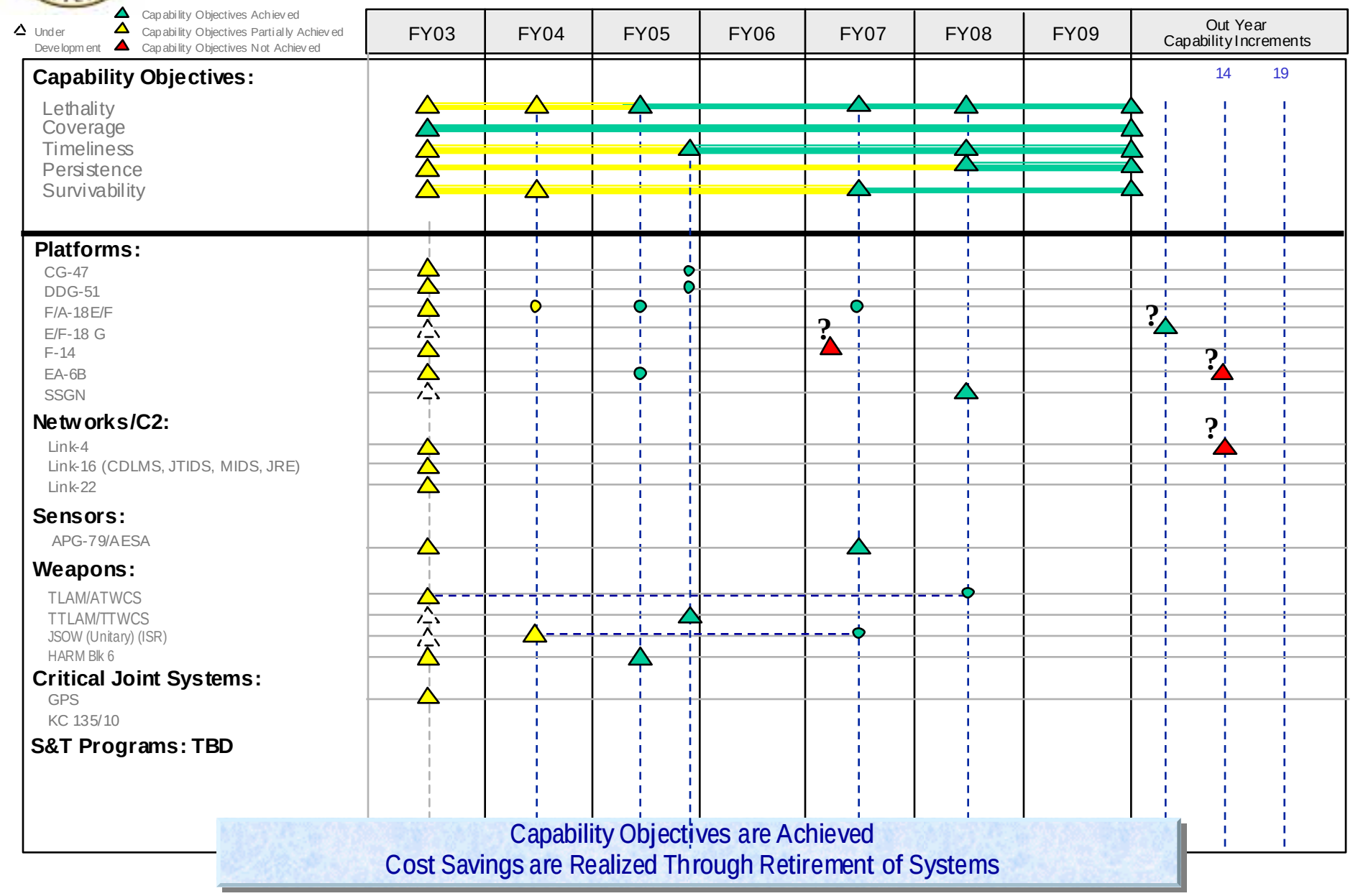
Architecture Performance and Behavior



3rd Order Analysis:
Dynamic Interoperability

Architectures Provide the Framework for FoS/SoS Systems Engineering & Acquisition

US Strike Capability Investment Plan



Capability Objectives are Achieved
Cost Savings are Realized Through Retirement of Systems