

**10TH INTERNATIONAL COMMAND AND  
CONTROL RESEARCH AND TECHNOLOGY  
SYMPOSIUM  
The Future of C2**

**“Agile Assessment Techniques for Evaluating  
Mission Capability Portfolio Ensembles in Complex  
Adaptive Architectures”**

**Topic: C4ISR Architecture**

**Date: June 2004**

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# Report Documentation Page

Form Approved  
OMB No. 0704-0188

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1. REPORT DATE <b>JUN 2005</b>		2. REPORT TYPE		3. DATES COVERED <b>00-00-2005 to 00-00-2005</b>	
4. TITLE AND SUBTITLE <b>Agile Assessment Techniques for Evaluating Mission Capability Portfolio Ensembles in Complex Adaptive Architectures (Briefing Charts)</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Space and Naval Warfare Systems Center, PO Box 19002, North Charleston, SC, 29419-9022</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES <b>The original document contains color images.</b>					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES <b>18</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

# Agenda

- **The issue addressed**
- **What are the Basic Assessment Requirements**
  - **Platforms**
  - **Architectures**
  - **Composed Capability Sets**
  - **Shared Assets**
- **What is an SOA?**
  - **Software Architecture**
    - **Highly Available (HA) Software Stack**
    - **HA + Disaster Recoverable (DR) Software Stack**
  - **Hardware Architecture- GRID**
- **What does a GRID Look Like**
- **Quality of Service Architecture Rating Scale**
- **Conclusion**
  - **What solution meets the architectural requirements?**

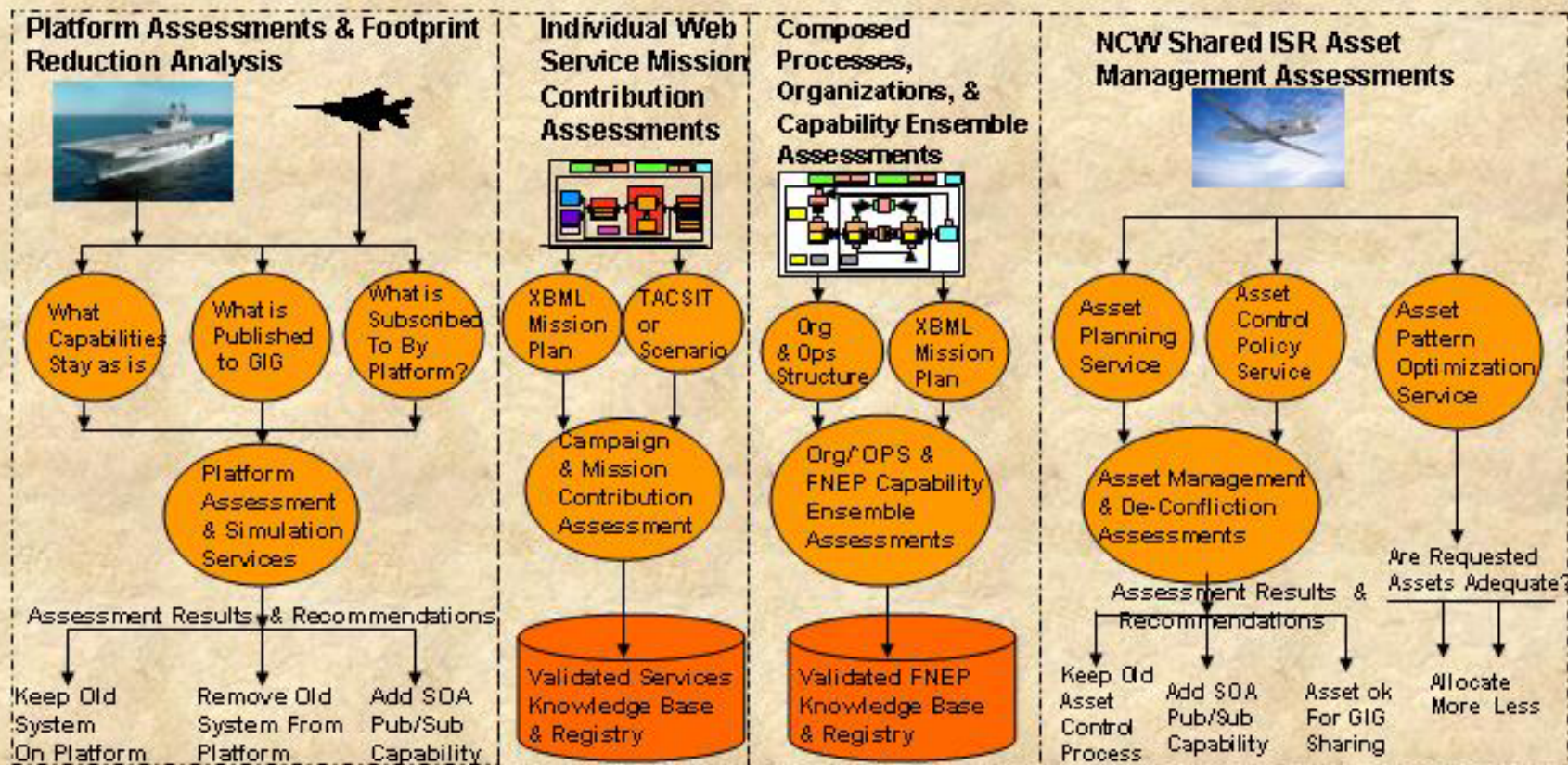
# **Issue Addressed**

Given the prototypical architectural template's demise, the purpose of this research is to begin a formulation of the "Agile Assessment Methodology" needed to evaluate the mission capability impact of using composeable web services in complex adaptive architectures

# Platforms

- What Stays and Why
- What Goes and Why
- What is replaced by Pub/Sub and Why?

# Agile Assessments - NCW Assessment Methodologies Must Quickly Adapt to Enable the Composition of New Assessment Tools and Provide Web Service Based On Demand Assessment Services, On Demand Simulation Services, and Assessment Knowledgebase Access Services



# Autopilot Architecture with all system components on board in one unit

## On Board Auto Pilot Architecture

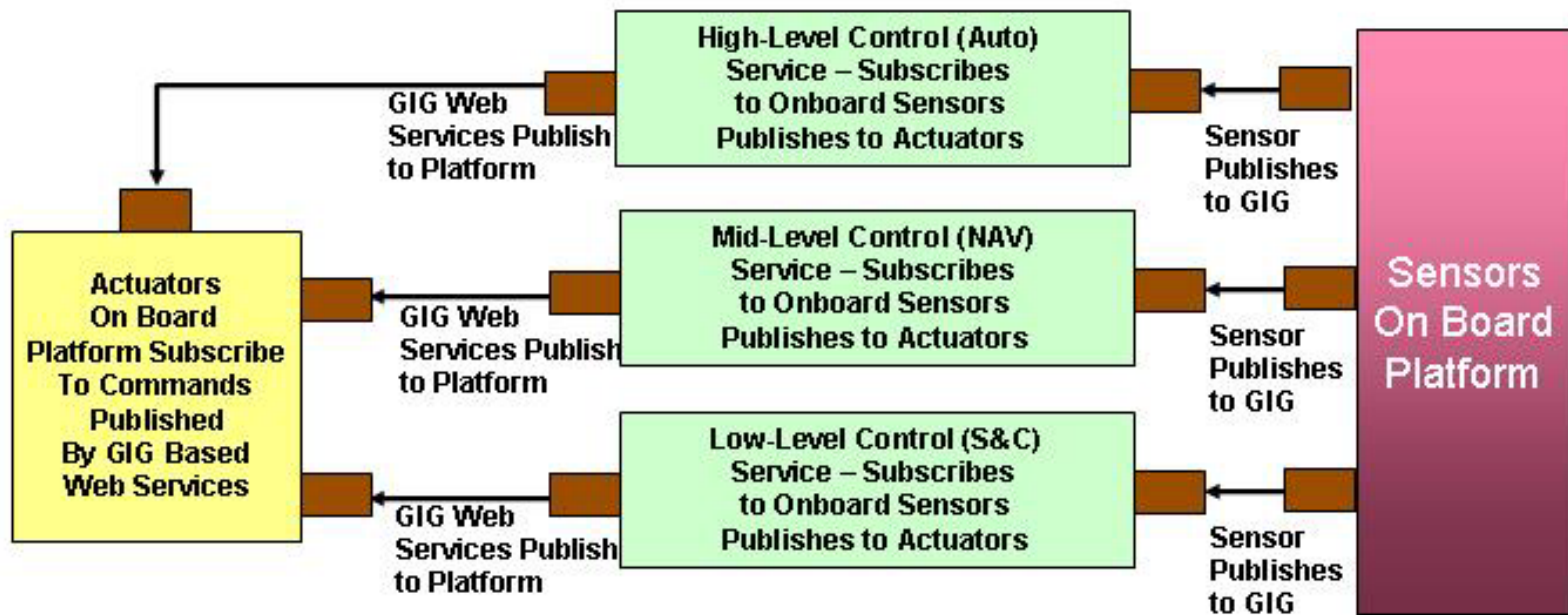


Autopilot Architecture - Source: Unmanned Dynamics, LLC  
- [http://www.u-dynamics.com/sensor\\_fusion/sensor.htm](http://www.u-dynamics.com/sensor_fusion/sensor.htm)

# GIG Based Web Services Auto Pilot Hypothetical Model

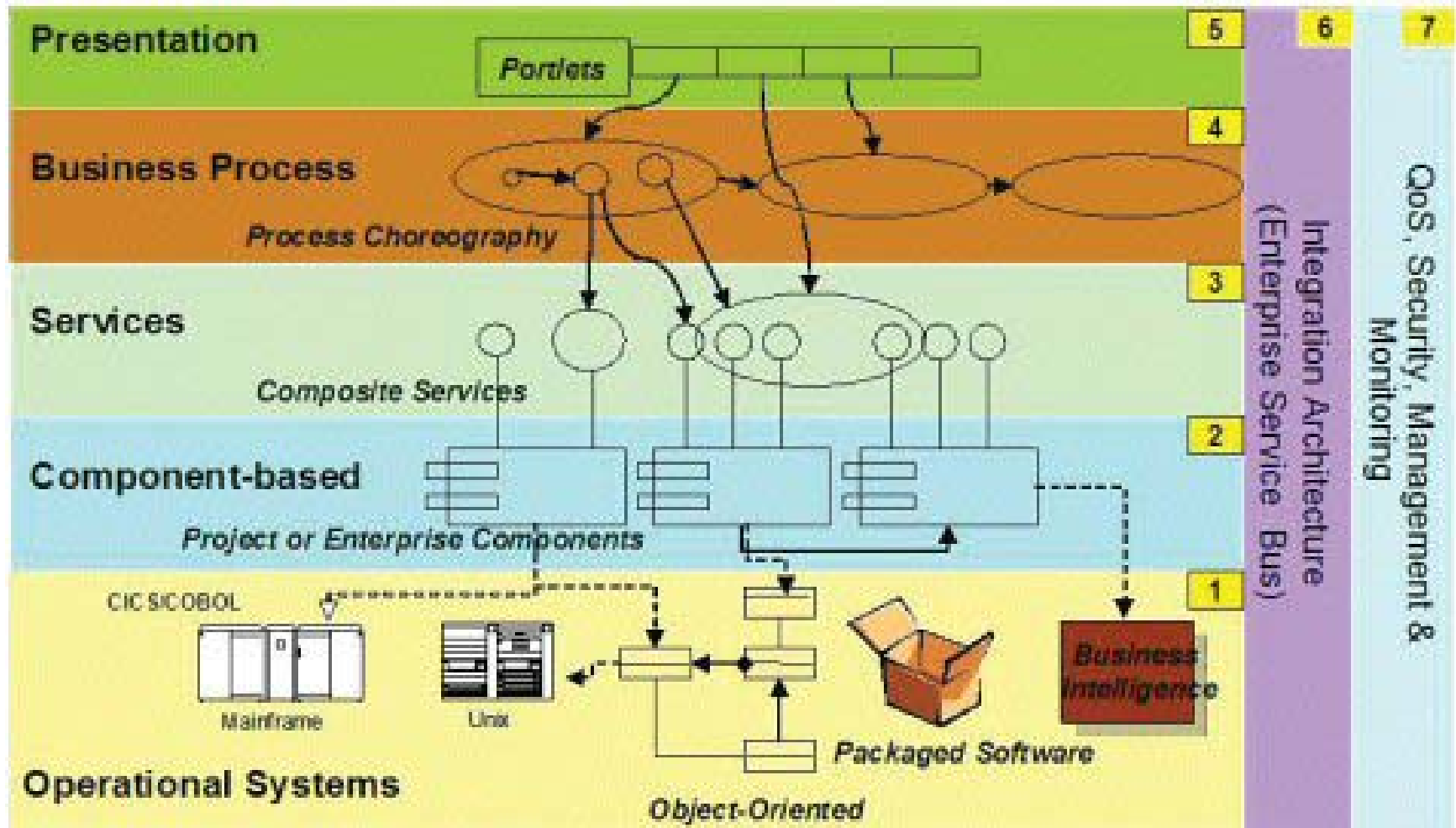
## Distributed Auto Pilot Architecture

GIG Web Services Based Auto Pilot Architecture (per Jack Lenahan not the original architects)  
On Board Auto Pilot Processing Removed in Favor of GIG Based Web Services –  
If this is silly, what are the proper boundaries for platform system footprint reduction in favor of GIG Based Services?





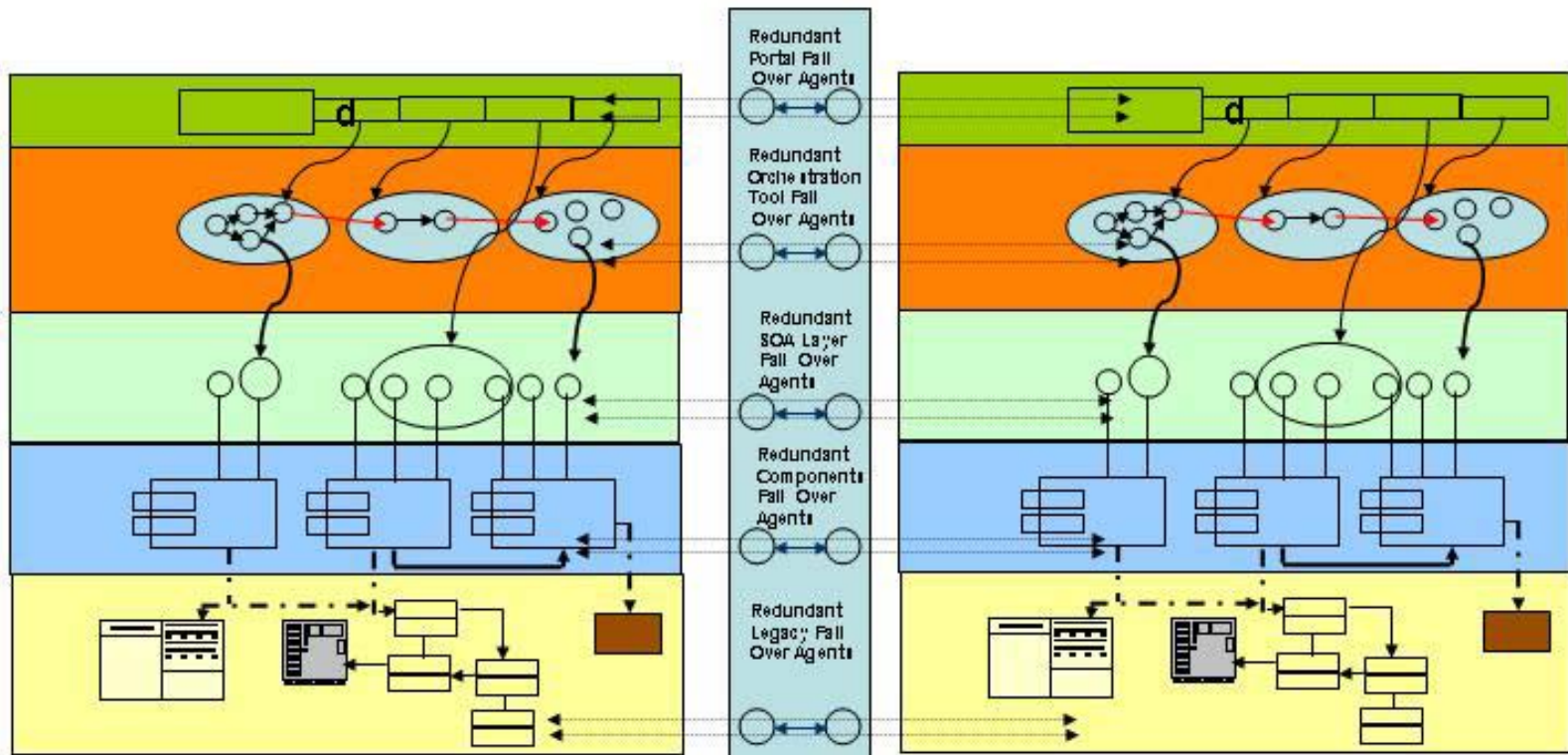
# Software Architecture Layers



From: “Delving into Service-Oriented Architecture”, By [Bernhard Borges, Kerrie Holley and Ali Arsanjani](#) , used with permission of Jupiter Media – Copyright Owners

# Highly Available Software Stacks

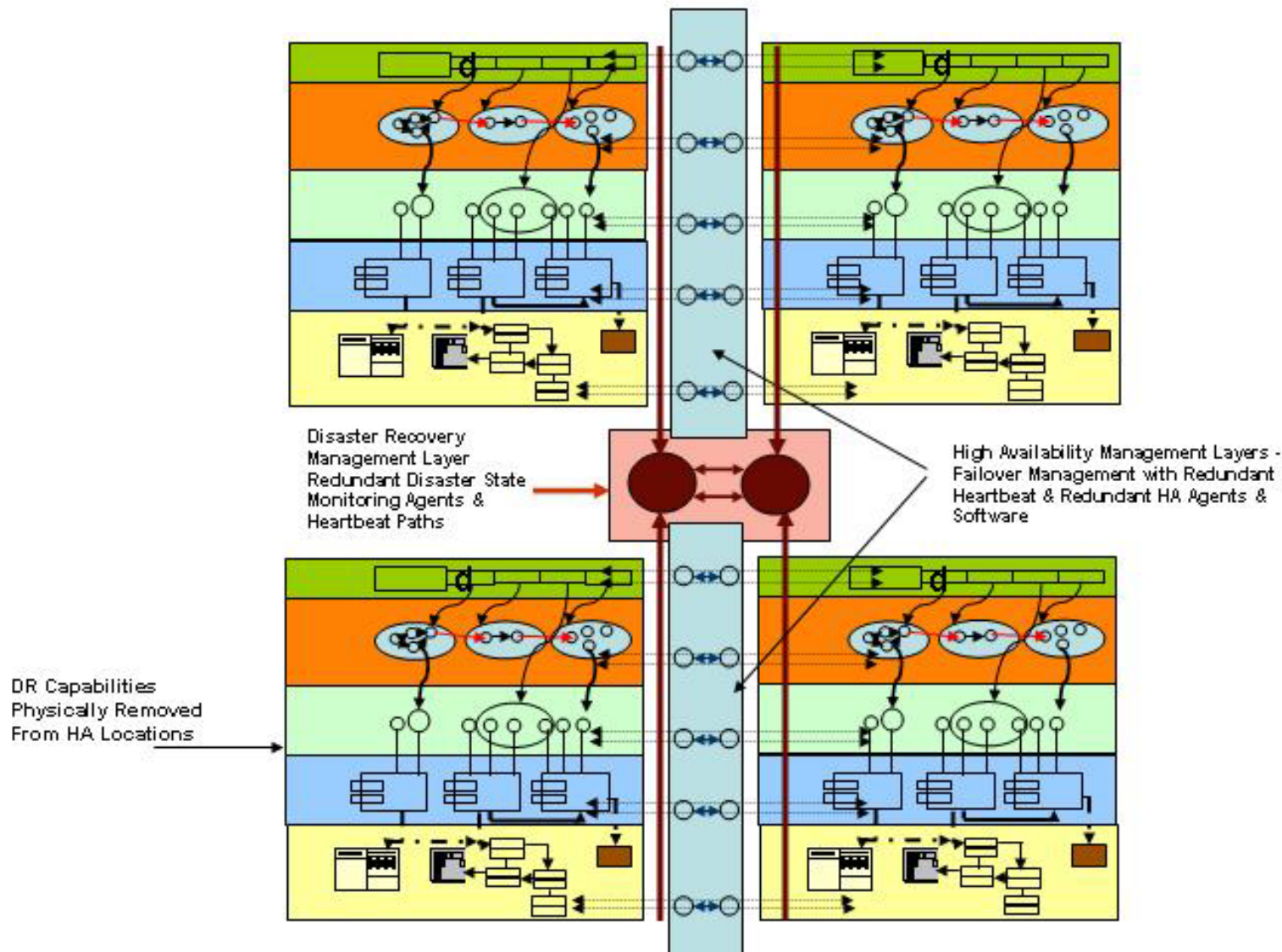
Full HA at All SW Layers – No DR



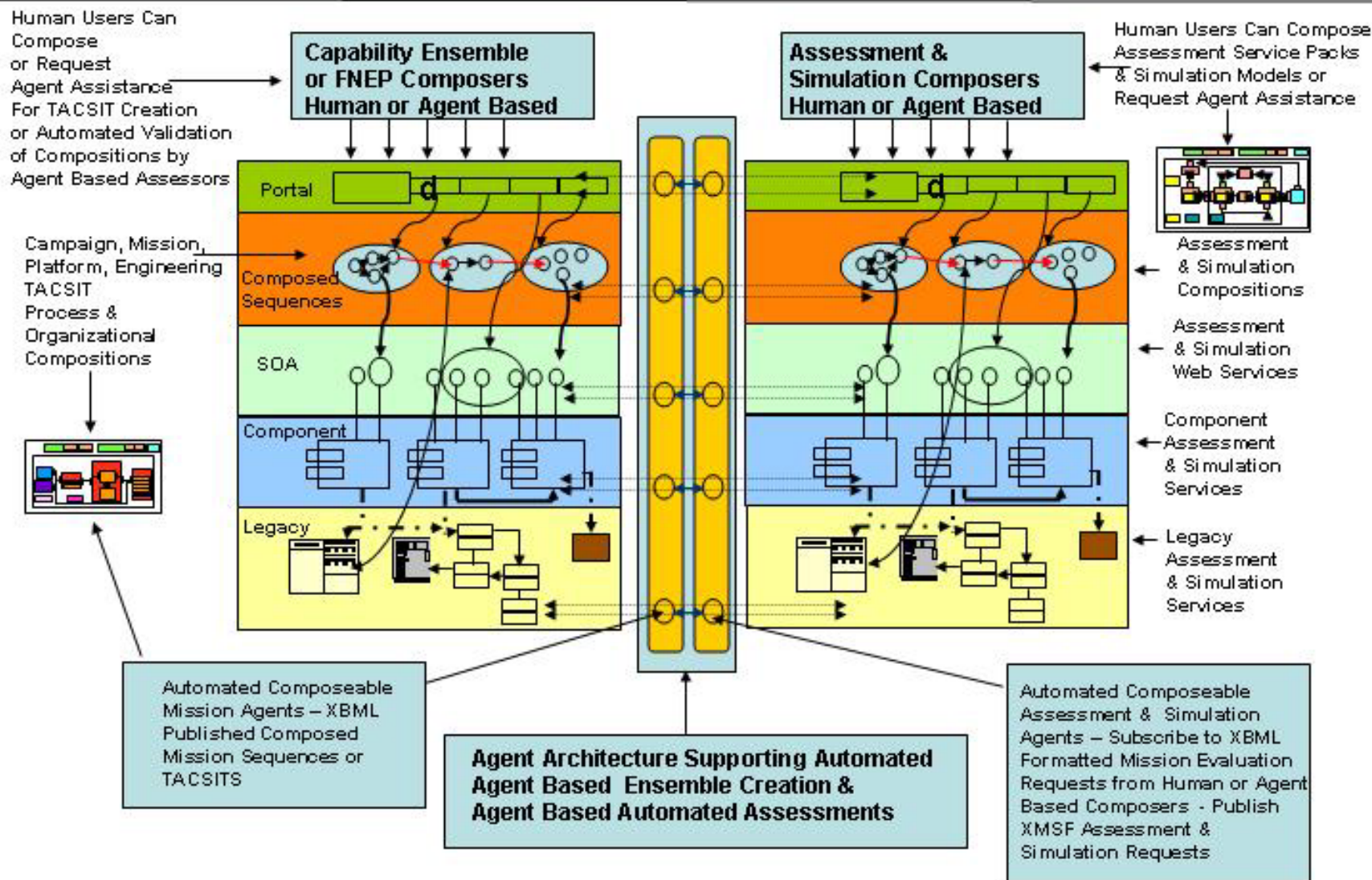
High Availability Layer Failover Management With Redundant Heartbeat, Redundant Failover Agents & Redundant HA Software

# Highly Available – Disaster Recoverable Software Stacks

Full HA – With DR

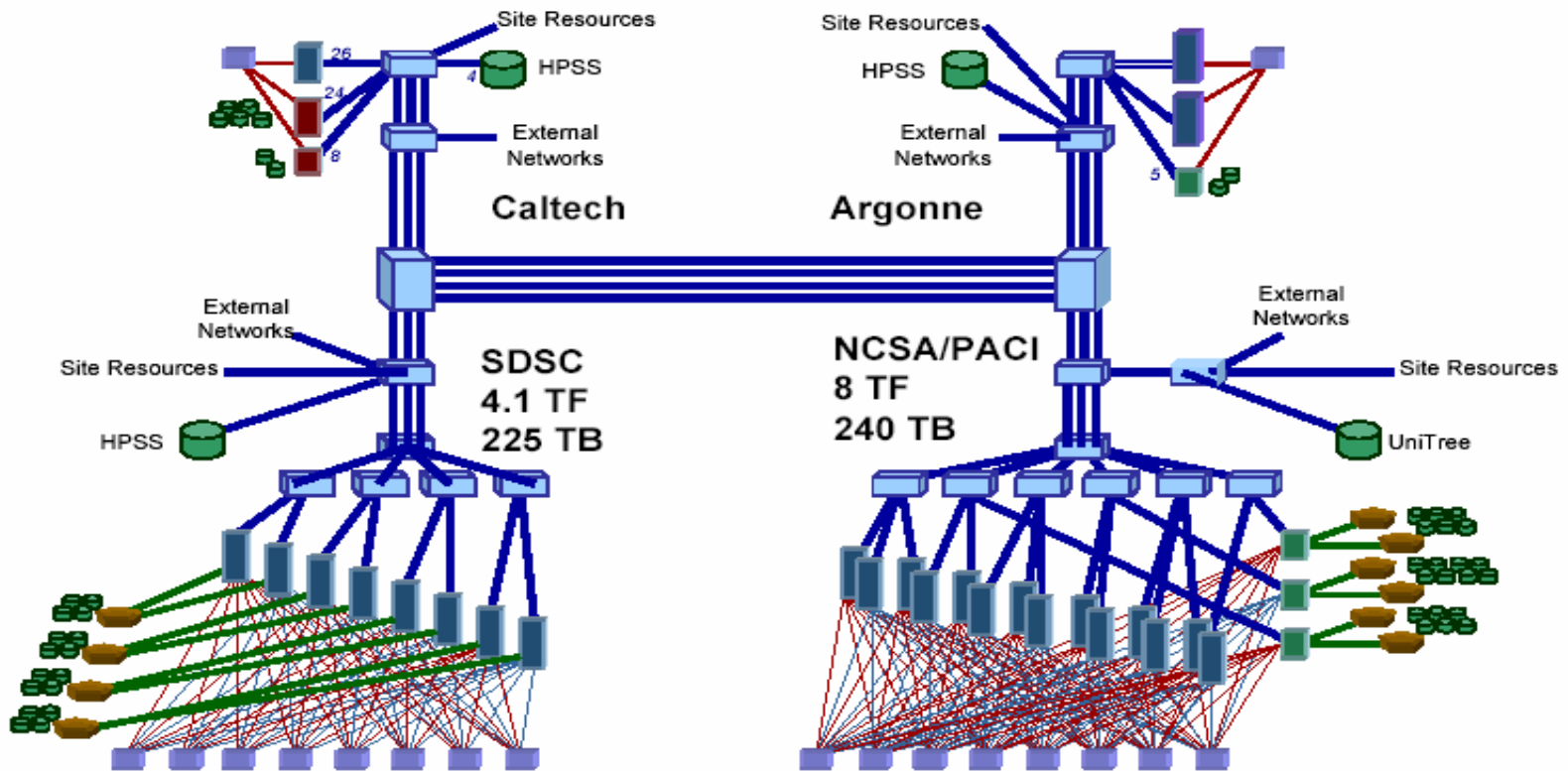


# Agile Assessment & Simulation Toolkit Architecture Which Will Enable Composable Assessments and Simulations for The Purpose of Validating Mixed Architecture Capability Ensembles or FORCENET Engagement Packs



# Hardware Architecture

## The 13.6 TF TeraGrid: Computing at 40 Gb/s



NCSA, SDSC, Caltech, Argonne

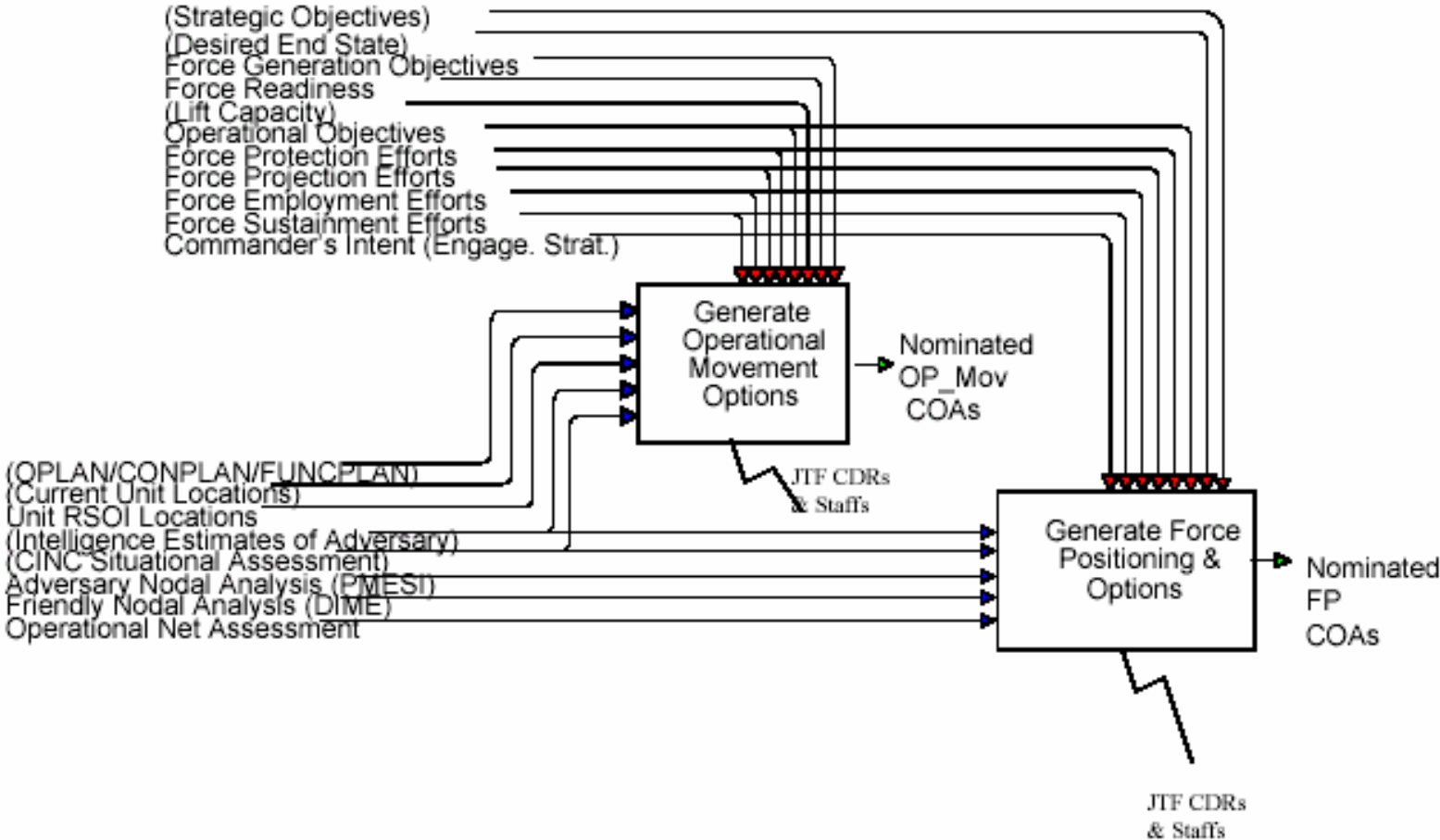
[www.teragrid.org](http://www.teragrid.org)

**GRID Architecture – A Complex Adaptive System which is scalable, highly available, disaster recoverable, and capable of dynamic program execution resource re-assignment.**

## Lenahan Levels of NCW Architectural QoS for Web Services Implementations

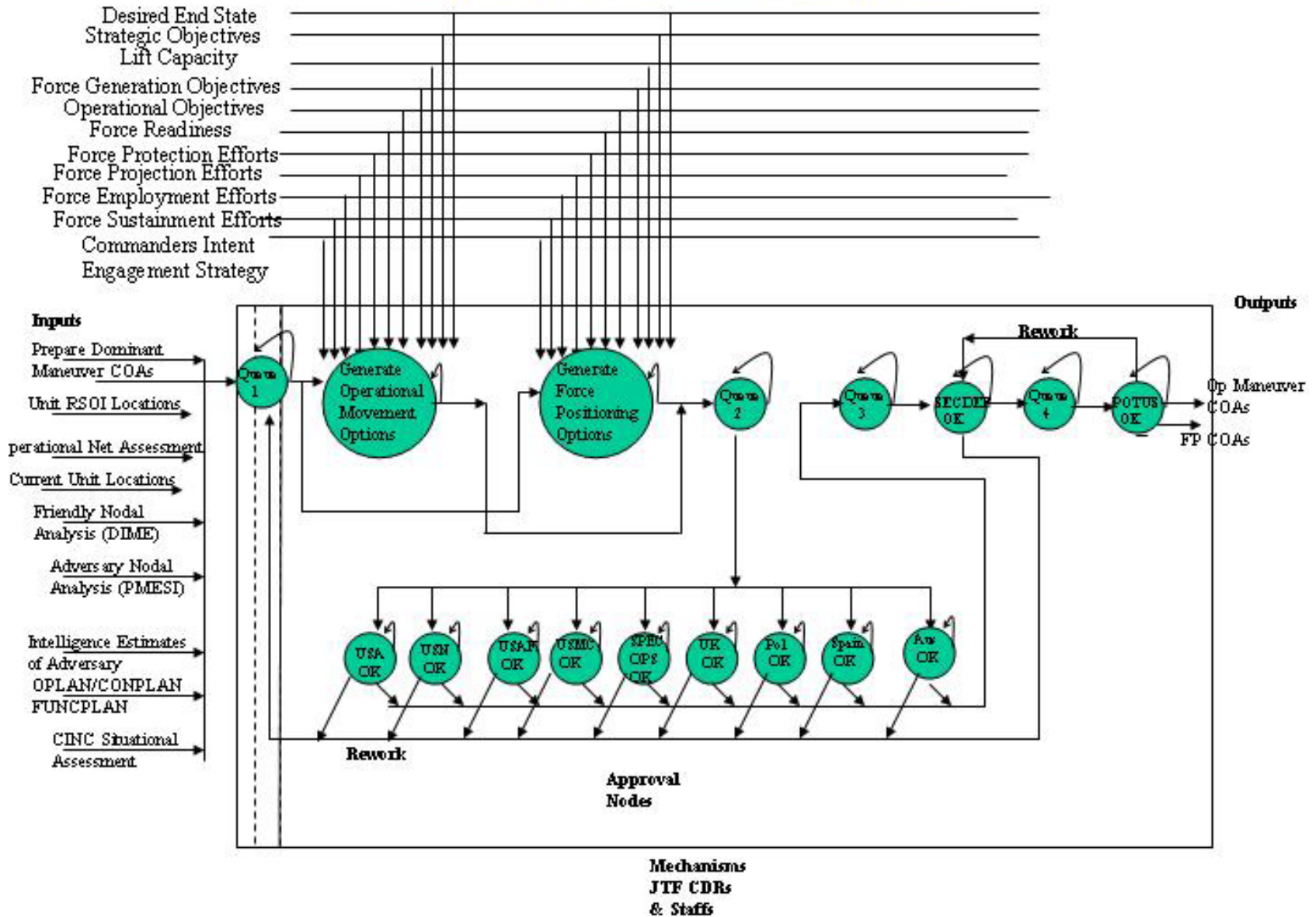
QoS Level	Capability or Capability Sets exposed as Web Services	State Recording	Simple State Recording with graceful fail over management by simple agents	Agent Monitoring of All Web Services in given C4ISR Architectural Orchestration or Choreography for Graceful Recovery of Services (Also applies to each service and its orchestration tool in a given FNEP being fully Stateful and agent monitored	HA (All enabling software / hardware infrastructure layers (Listeners, Authentication SW, Firewalls, Single Sign-on Software, Directory and Naming Management, MOMS, Database Software, Redundant Directories, Redundant data, SAN, NIC, etc) for the entire orchestration set)	HA with Full DR - Clone Of HA Suites	HA/DR with guaranteed performance management (GRIDS Only with all 7 ISO Layers HA/DR)
1	Y	N	N	N	N	N	N
2	Y	Y	N	N	N	N	N
3	Y	Y	Y	N	N	N	N
4	Y	Y	Y	Y	N	N	N
5	Y	Y	Y	Y	Y	N	N
6	Y	Y	Y	Y	Y	Y	N
7	Y	Y	Y	Y	Y	Y	Y

# Sub Process to Generate Dominant Maneuver Operational Movement and Force Positioning COA Options



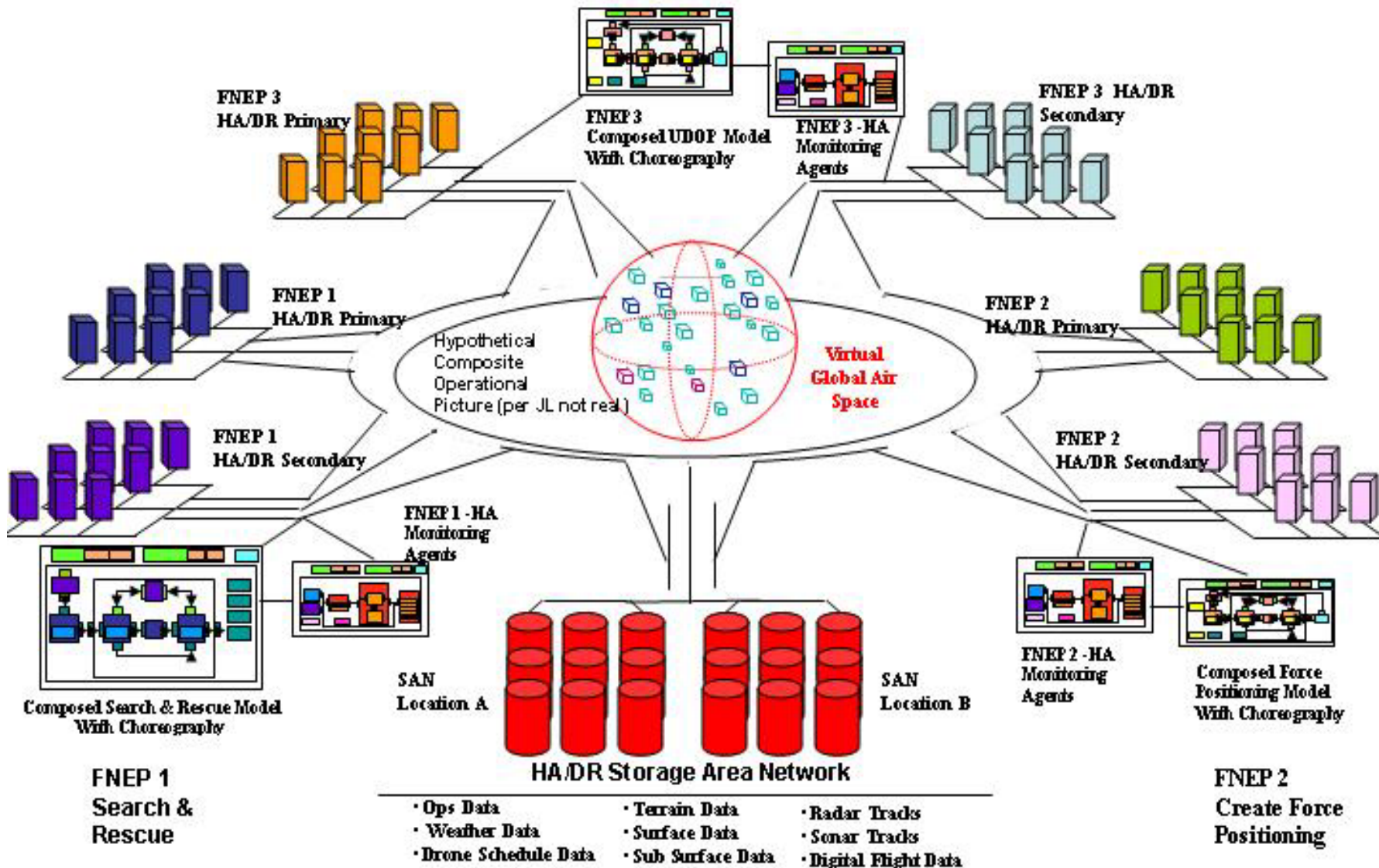
# Web Services required for a Force Positioning Publication Service in an SOA based model

## Sub Process 2 – Create Dominant Maneuver COAs





**GRID Model of Multiple Executing FNEPs with Agent Monitors - Each FNEP Representing a Lenahan QoS Scale Value of 7 – Which means that all selected services in all architecture levels must be tagged as to HA/DR & GRID Compliance  
(Modified from Original NASA Graphic)**



# Conclusion

- **The NCW architectural constructs which will appear in the near future have not been subjected to formal rigorous engineering analysis. The underlying assumptions of NCW indicate that novel architectural formations, as yet defined, will appear as a major result of architectural composeability, particularly with respect to the use of so called “composeable web services”. To quote Dr. Alberts: “No one .... can speak with final authority on NCW orthodoxy. NCW is, and will continue to be, the product of many fathers...”<sup>9</sup>**
- **Besides the novel architectural constructs, the NCW architectural boundaries for platform system reductions have yet to be formalized. This author does not accept the notion that a radical reduction of platform system footprint can occur in the near (15 years) future. A total “pub/sub” platform design has yet to emerge in the NCW literature. Replacing platform centric mission critical systems (such as terrain avoidance radar processing, autopilot, flight stabilization, etc.) in favor of subscriptions to “stabilization services” published by compute agents somewhere on the GIG which have subscribed to pubs from the very platform that they are attempting to stabilize, is simply “mythological”. OSD/OFT owe the services deeply considered guidance covering which aspects of on-board platform processing it considers to be “on the table” for removal from the platforms in favor of a pub/sub sequence.**

# Conclusion (continued)

- **In order to reduce risk, arbitrarily orchestrated or choreographed web service ensembles will require near real time, self service assessment of the composed “mission capability threads” hosted by complex adaptive architectures. This research concludes that a dynamic and composeable set of mission capability evaluation services, based upon XBML and XMSF can be used as the basis of an evolutionary and revolutionary capability. This author concurs with and embellishes other researcher’s efforts; particularly the analysis<sup>10</sup> developed by Tolk, Hieb, et al. Composeable NCW “Self Service Assessment” services should follow the following guidance:**
- **Develop Modeling and Simulation Web services that can be distributed via the Web**
- **Transform and tag existing data representations to international Joint standards (by using standardized Coalition data models such as the Command and Control Information Exchange Data Model (C2IEDM))**
- **Evaluate the applicability of XBML for Global Information Grid (GIG) Enterprise Services (GES) and Warfighter Services.**
- **Create Self Service Composeable Assessment Services which will provide Rigorous Pre-Mission Validation of the Composed Mission Capability Ensembles as hosted in Agent Monitored GRID Architectures**