Defense Information Systems Agency
Department of Defense

Challenges with Testing Service Oriented Architectures in DoD

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Topics

- **Background**

- **SOA Overview**

- **SOA T&E Recommendations**

- **SOA Support Environments**

- **Summary / Way Ahead**

Background
Net-Centric Operations

- Transforming to Net-Centric Operations requires *people, processes, and technology that work together* to enable timely and trusted access to information, sharing of information, and collaboration among those involved (NII – Enabling Net-Centric Operations)

- The technological change will be significant, but the mental shift to this agile force may be even more challenging. *Becoming a Net-Centric Force requires fundamental changes in process, policy, and culture across the Department (defense operations, intelligence functions, and business processes).* Timely and dependable information will be available across the Enterprise - from higher level headquarters and command centers, to a soldier in the city tracking insurgents, or a civilian in need of a new supplier….(NII – Enabling Net Centric Operations)

National Defense Strategy and Transformation Planning Guidance Calling for Net-Centric Operations

Background
Business and Technology
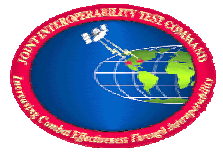
- **Business / Government Changing**
  - **Increased inter-organizational alliance**
  - **Rapid response to changes in mission and environment**
  - **Tighter coupling of customers and suppliers thru life cycle**
  - **Better asset tracking in dynamic organizational structures**
  - **Utility to all stakeholders**
  - **Identify potential issues before they impact productivity**
  - **Provide a consistent view of enterprise across all elements**

- **Enabling Technology Emerging**
  - **Ubiquitous web apps and data and communication standards**
  - **Software morphing into service versus a product in a box**
  - **Transmission speeds impacting how computers are used**
  - **Metadata registries / repositories describe data and services**
  - **An exploding array of services being built by using the software equivalent of Lego blocks … to "mash-up" capabilities in new distributed applications**

Changes in business and technology vital to DoD transformation to Net-Centric Operations and a significant challenge to T&E

Background
DISA Emphasis

- **Per Draft RFP (Encore II, 12/6/2005 contains, as Attachment 13, "Net-Centric Review Process and Strategy for DISA", Version 1.0, 3 November 2005, lists, "Net-Centric Checklist for Net-Centric Reviews:**

  - **DoD Net-centric Data Strategy -- appropriately tagged with metadata and logged in the DoD Metadata Registry, web-accessible, in XML format, understandable through well-defined taxonomies or ontologies, use of standard data (from the DoD Registry), and rigorous data models**

  - **Design Tenet -- Open, *Service-Oriented Architecture (SOA)*, documented Service Level Agreements, service interfaces expressed in WSDL, Inter-service communication is via XML-based messages, application services are accessed through public interfaces, based on public standards governed by IEEE, W3C, OASIS, etc., Services are component-based, and interfaces separated from implementations**

SOA is a the primary design tenet for DISA Enterprise Services and considered key to achieving Net-Centric Operations

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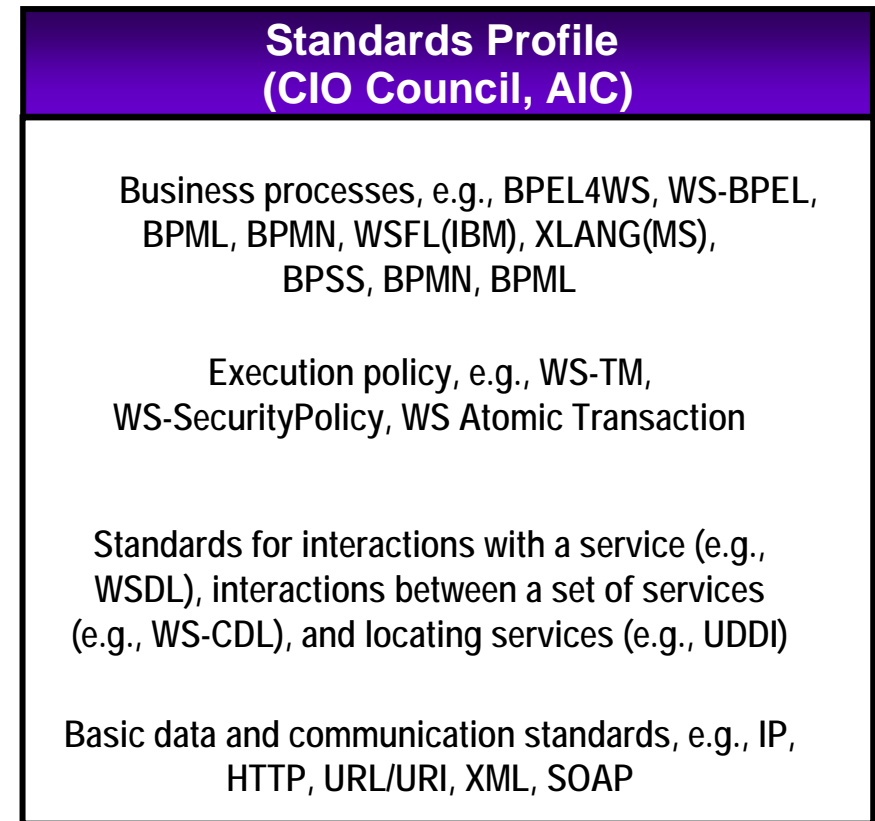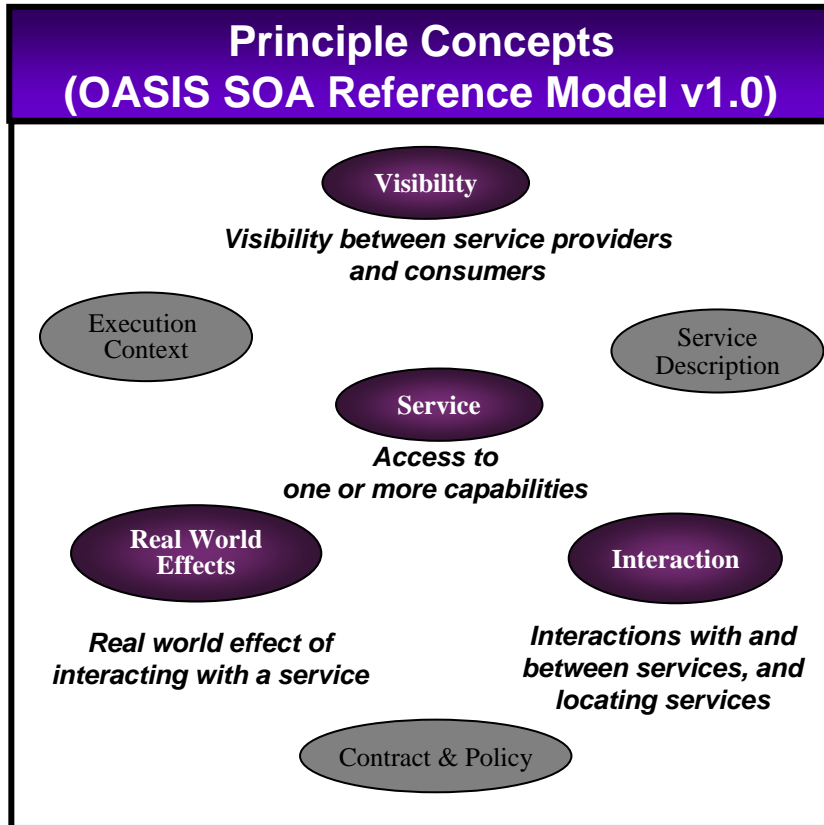
- **Summary / Way Ahead**

SOA Overview Description

SOA is a paradigm for organizing and using distributed capabilities that may be under control of different ownership domains (OASIS SOA Reference Model v1.0)

Principle Concepts
(OASIS SOA Reference Model v1.0)

Visibility

Visibility between service providers and consumers

Execution Context

Service Description

Service

Access to one or more capabilities

Real World Effects

Interaction

Real world effect of interacting with a service

Interactions with and between services, and locating services

Contract & Policy

Standards Profile
(CIO Council, AIC)

Business processes, e.g., BPEL4WS, WS-BPEL, BPML, BPMN, WSFL(IBM), XLANG(MS), BPSS, BPMN, BPML

Execution policy, e.g., WS-TM, WS-SecurityPolicy, WS Atomic Transaction

Standards for interactions with a service (e.g., WSDL), interactions between a set of services (e.g., WS-CDL), and locating services (e.g., UDDI)

Basic data and communication standards, e.g., IP, HTTP, URL/URI, XML, SOAP

SOA acknowledges ownership boundaries are motivating consideration in the architecture / design of systems (OASIS SOA Reference Model v1.0)

SOA Overview
Benefits / Challenges

- **Benefits of SOA**

  – **Abstracts development from underlying complexity**

  – **Facilitates manageable growth of large enterprise systems**

  – **Reduces development costs through reuse of services**

  – **Allows for rapid change by enabling composable services**

  – **Supports business versus technical orientation**

- **Challenges with SOA**

  – **Complexity, flexibility, and management**

  – **Maturity of enabling standards**

  – **Interoperability of different implementations**

  – **System design and analysis methods**

  – **Policy specification and enforcement**

  – **System performance, behavior, reliability and availability**

Source: Towards Service Oriented Architectures: Bridging the Gaps among Theories, Technologies, and Standards Presentation, CIO Council, 15 Sep 2006

SOAs benefits are significant, but challenges unprecedented barriers to T&E across life-cycles and programs

SOA Overview
SOA T&E Premises

- **Features that most distinguish SOA testing from other types of system testing:**
  - Role of standards, complexity of standards, and need for centralized responsibility for system development and maintenance

- **Recommended practices derive from these three elements, and should be implemented on top of sound testing discipline**
  - Recommendation is to extend best practices for "traditional" software system testing into the arena of service oriented systems
  - Caveat is that "system level" testing is tremendously challenging due to the rapid and relatively uncontrolled, requires new approach

- **Types of SOA testing regularly conducted in industry includes**
  - Conformance, performance and robustness, behavior and effects

- **Centralized responsibility for distributed environment essential**
  - Challenges with evolution of SOAs and Web Services makes integrated development and test environments critical…a must
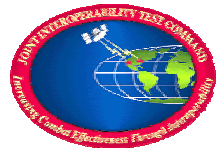
Source: Recommended Practices for SOA Testing, Dr. James Nutaro, Oak Ridge National Laboratory

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- **SOA T&E Recommendations**

- **SOA Support Environments**

- **Summary / Way Ahead**

SOA T&E Recommendations Standards Conformance

- **Verifies compliance to underlying policy, interaction, and comm standards (business process standards testing adds little value)**
  - Makes low-level service interoperability possible and is essential to the fielding of working services
- **Interaction and communications standards are straight forward, well defined and mature**
  - Testing is relatively simple, automated tools commercially available
- **Execution Policy standards are complex and less mature**
  - Reusable test suites are applicable, but not currently commercially available, and development is extremely labor intensive and costly
- **Recommendation:**
  - Partner with industry to ensure tools support DoD implementations
  - Test execution policy and lower level interaction, data, and communications standards using commercially available test tools
  - Also use available test tools to monitor for low-level failures that might occur during application execution

SOA T&E Recommendations
Performance and Robustness

- **Determines if a Web service operates correctly under the expected load of service requests**
  - Especially critical when a Web service will be highly visible and provides access to critical business functions

- **Performance testing addresses response latency and request throughput**
  - If these are found to be inadequate, then more computing power or further software development may be needed prior to deployment

- **Robustness testing addresses availability, reliability, and data integrity**
  - Failure requires additional development, additional hardware resources, and/or suitable upgrades to other Web services

- **Recommendation:**
  - Use commercially available testing tools and apply before any major software or hardware change is deployed

SOA T&E Recommendations Behavior and Effects

- **Encompasses what is traditionally considered software testing**
  - **Can be examined at component level (unit testing), at level of component compositions (integration testing), and at the system level (application testing)**
  - **Well established strategies should be applied but traditionally labor intensive - Business Process Modeling (BPM) providing some relief**
  - **Configuration management challenges motivates use of developmental (off-line) and operational (on-line) test frameworks**
  - **Cross-organization execution can hamper the diagnosis and removal of faults from an application**
- **Recommendations:**
  - **Coordinate with providers of services that are crucial to application to ensure requirements**
  - **Use both development and operational test frameworks, and BPM and other M&S solutions to effectively mitigate risk**
  - **Ensure simulations of required services are on-hand for those times when the actual service is unavailable but required for test**
  - **Continuously test and then monitor your application and required services to detect problems early and facilitate rapid corrections**

SOA T&E Recommendations Behavior and Effects (Cont)

- **COTS support of converging BPM standard providing DoD an excellent opportunity to improve T&E throughout acquisition life-cycle**

  - **Mission threads identified as a effective method to capture acquisition requirements**

  - **Mission threads modeled in a machine-executable form can be used to Validate and verify (V&V) behavior and effects early in the acquisition life-cycle process**

  - **Modeled mission threads can improve development and integration in a SOA environment providing agility and speed throughout acquisition life-cycle process**
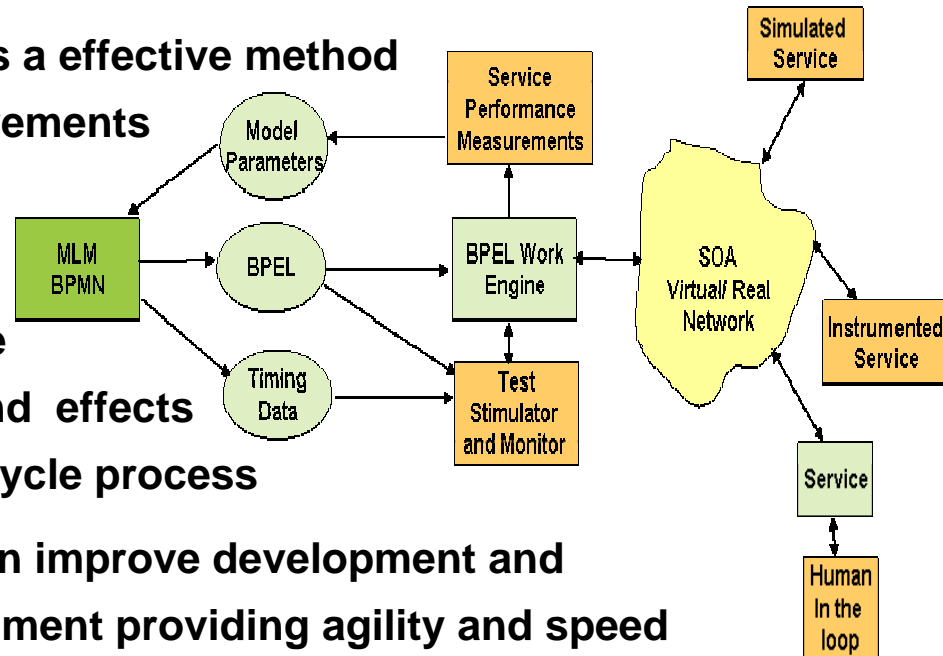
- **Approach extendable to Joint Mission Environments and formal modeling methods (e.g., Discrete Event Simulations)**

Source: Mission –Model Driven Process: Test and Evaluate Net-Centric Capabilities, Dr. Prem Jain, MITRE

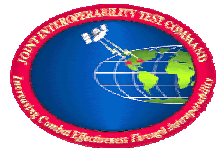# Topics

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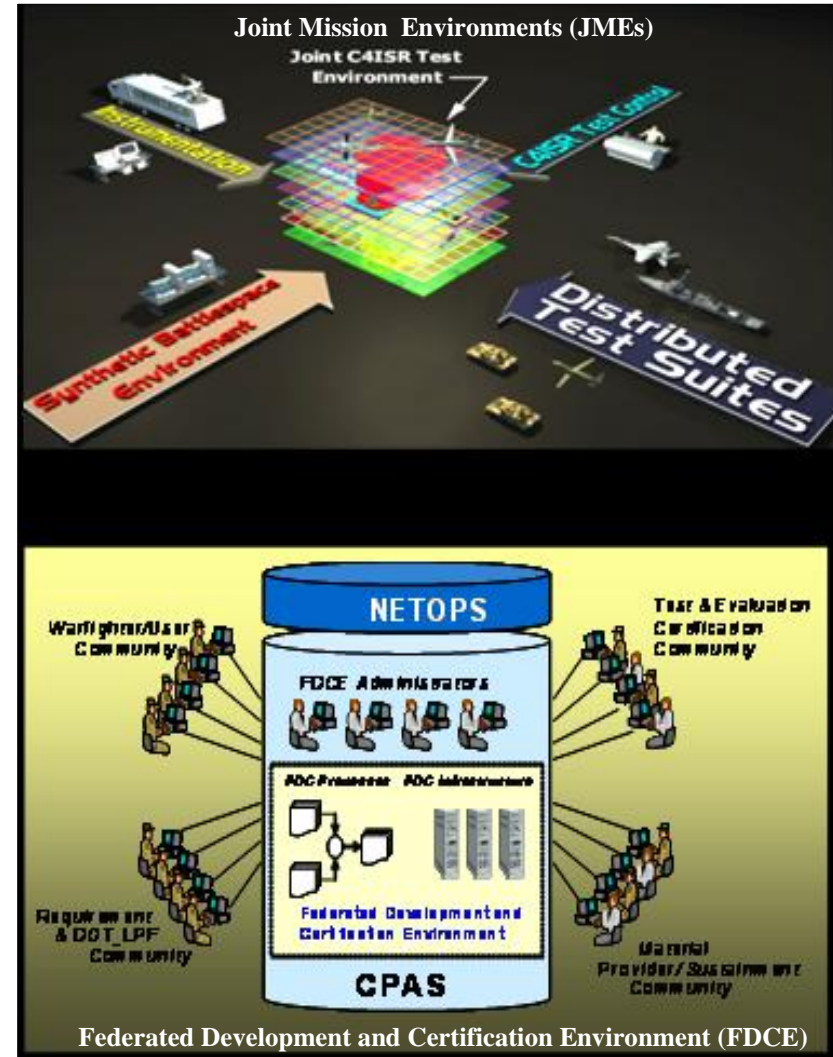
SOA Support Environments Overview

- **Joint Mission Environments (JME)**
  - Evolves from Joint Mission Area functional analysis and T&E
  - Supports behavioral and effects testing of composed services
  - Uses live, virtual, and constructive capabilities located at DoD facilities

- **Integrated Development and Test Environments (e.g., GIG FDCE)**
  - Provides collaborative development, test, and certification services
  - Operated at GIG enterprise level
  - Supports all types of SOA testing
  - Uses DISN with access to NCES
  - Extendable to COIs and JMEs

Joint Mission Environments (JMEs)

Federated Development and Certification Environment (FDCE)

SOA Support Environments
GIG FDCE Goals

- **Provide standard, approved, and reusable processes to promote both effectiveness and efficiency in DoD IT acquisition, development, and evolution**

- **Provide a standardized development, testing, assessment, and certification process supported by tools and services that supports the needs of all GIG stakeholders**

- **Provide users with visibility into operational GIG FDCE resources which includes, but is not limited to, existing and emerging capabilities**

- **Improve process transparency, synchronization, and collaboration among stakeholder communities**

Based on DISA Draft GIG Federated Development and Certification Environment (FDCE) Concept of Operations

SOA Support Environments GIG FDCE Services

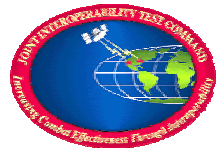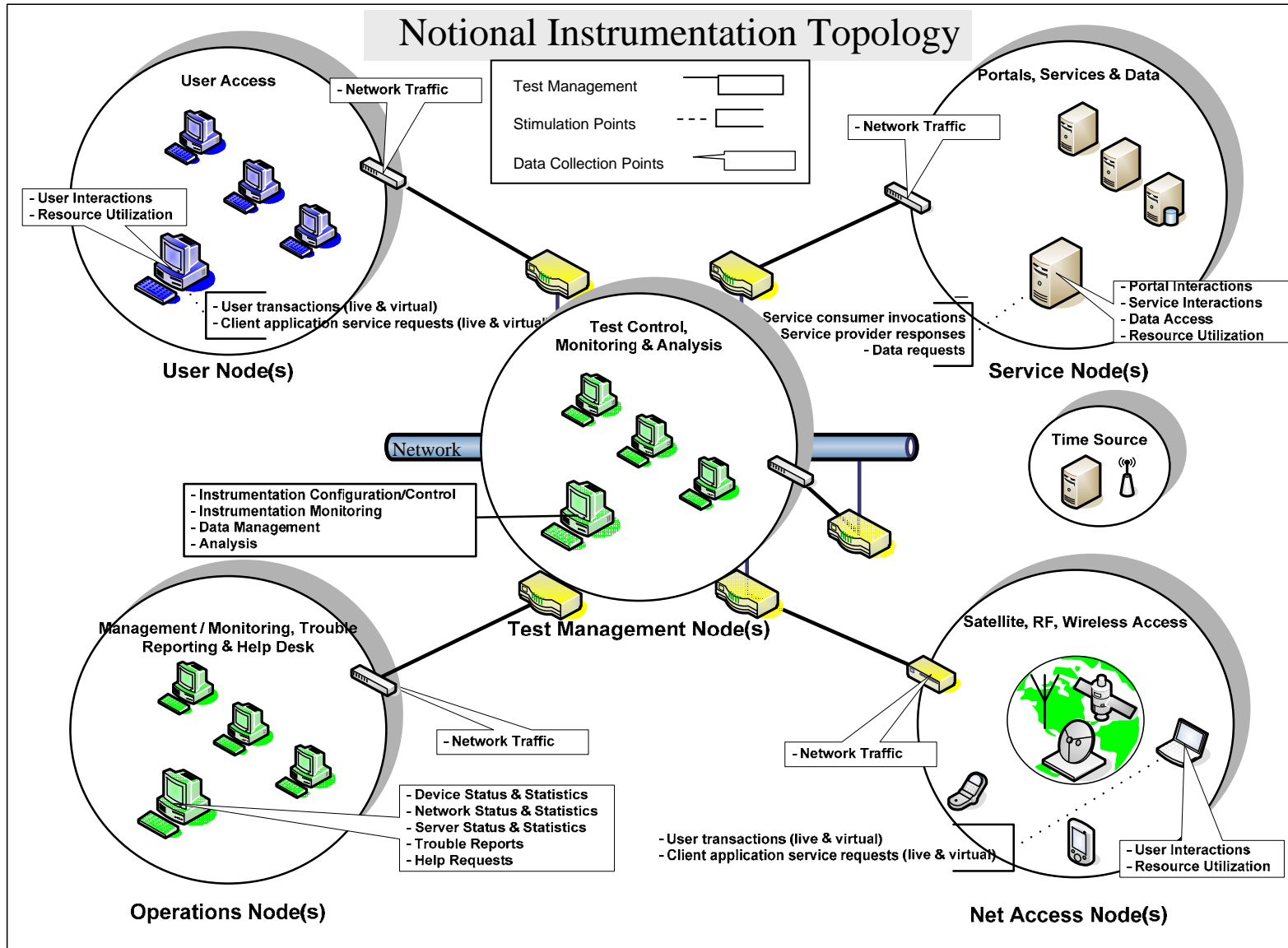## Registration and Collaborative SW Development Services

- Project Registration Services
- Developer Collaboration Services
- Software Artifact Repositories
- Developer Support Tools
- Software Accreditation Tools
- Software and Software Artifact Discovery and Distribution
- COI Governance and Certification Services
- COI Registration Service
- DoD Metadata Registry
- Configuration Management
- Enterprise Standards Defense IT Standards Registry (DISR)

Test and Certification and SOA Governance Services

- Milestone Decision Authority (MDA) Support
- Test, Assessment, and Certification Support
- Follow-on Coordination Activities
- Service Provider / Registration and Credentialing
- Design Time Governance
- Service Registries
- SOA Change Management and Planning Tools
- SOA Policies Management Tools
- Service Contract and Service-Level Agreement Tools
- Consuming COI Certification

Based on DISA Draft GIG Federated Development and Certification Environment (FDCE) Concept of Operations

SOA Support Environments
FDCE Instrumentation Topology

DISA

Notional Instrumentation Topology

User Access

- Network Traffic

Test Management

Stimulation Points

Data Collection Points

- User Interactions
- Resource Utilization

- User transactions (live & virtual)
- Client application service requests (live & virtual)

User Node(s)

Portals, Services & Data

- Network Traffic

- Portal Interactions
- Service Interactions
- Data Access
- Resource Utilization

Service Node(s)

Test Control, Monitoring & Analysis

Service consumer invocations
Service provider responses
- Data requests

Network

- Instrumentation Configuration/Control
- Instrumentation Monitoring
- Data Management
- Analysis

Time Source

Management / Monitoring, Trouble Reporting & Help Desk

- Network Traffic

- Device Status & Statistics
- Network Status & Statistics
- Server Status & Statistics
- Trouble Reports
- Help Requests

Operations Node(s)

Test Management Node(s)

Satellite, RF, Wireless Access

- Network Traffic

- User transactions (live & virtual)
- Client application service requests (live & virtual)

- User Interactions
- Resource Utilization

Net Access Node(s)

SOA Support Environments
JME Objectives

- **Provide capabilities to conduct T&E in a joint operational context**
  - Institutionalize the evaluation of joint system effectiveness as part of capabilities-based processes
  - Focused weapons, sensors, and operational C2

- **Leverage persistent off-line DoD networks for M&S components**
  - Link live systems with virtual and constructive representations
  - Includes C4ISR test control, instrumentation, and synthetic battle space environment

- **Generate a truly realistic mission test environment for systems undergoing testing**

Based on AT&L/TRMC Testing in a Joint Environment and InterTEC Documentation

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Summary / Way Ahead

- **SOA is an important design tenet for NCES and considered key to achieving Net-Centric Operations**

  - Paradigm for organizing and using distributed capabilities that may be under control of different ownership domains

  - Benefits are significant, but challenges may be more significant to T&E with respect to effectiveness across life-cycle and programs

- **T&E community needs to partner with industry to ensure commercial tools support DoD implementations**

  - Testing policy execution and lower level interaction, data and communications standards

  - Testing performance and robustness before major changes are deployed

  - Monitoring for related failures that might occur during application execution

Summary / Way Ahead (Cont)

- **T&E community coordinate with providers of services crucial to application to ensure requirements for behavior and effects**

  – **Leverage both development and operational test frameworks, and BPM and other M&S solutions to effectively mitigate risk**

  – **Ensure simulations of required services are on hand for those times when the actual service is unavailable but required for test**

  – **Continuously test and then monitor your application and required services to detect problems early and facilitate rapid corrections**

- **T&E community needs to be vested in GIG Federated Development and Certification Environment (and extensions)**

  – **Ensure environments are instrumented, and test, assessment, and certification services are provisioned as required**

References

- **NII Enabling Net-Centric Operations, http://www.defenselink.mil/cio-nii/pubs/index.shtml**

- **Towards Service Oriented Architectures: Bridging the Gaps among Theories, Technologies, and Standards Presentation, Chief Information Officers (CIO) Council, Architecture and Infrastructure Committee (AIC)**

- **OASIS Reference Model for Service Oriented Architecture v1.0, http://www.oasisopen.org/committees/download.php/19679/soa-rm-cs.pdf**

- **Mission – Model Driven Process: Test and Evaluate Net-Centric Capabilities, Dr. Prem Jain, MITRE**

- **Recommended Practices for SOA Testing, Dr. James Nutaro, Oak Ridge National Laboratory**

- **Draft GIG Federated Development and Certification Environment (FDCE) Concept of Operations, DISA**

Questions?

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Backup Slides

SOA Support Environments GIG FDCE Services

- **Registration Services and Information**

    – **GIG FDCE Information Portal is gateway for registering for provider, user, and tester access and includes both labs and tool providers**

- **Collaborative Software Development**

    – **Project Registration Service provides software developer access to portal to create and manage a new software development project.**

    – **Developer Communication Service enables systematic collaboration to development community and to those seeking components.**

    – **Software Artifact Repositories provide software version control for check in / out of source code and related artifacts via the GIG**

    – **Developer Support Tools provides developers with a integrated development environment which supports all stages of the life-cycle**

    – **Software Accreditation Tools necessary to certify and accredit a software component for use within the GIG**

    – **Software and Software Artifact Discovery and Distribution provides a distribution service for tested software components onto the GIG**

Based on DISA Draft GIG Federated Development and Certification Environment (FDCE) Concept of Operations

DISA
SOA Support Environments
GIG FDCE Services

- **Data and Service Specification Development**
  - **COI Governance and Certification Services facilitate creation of COIs responsible for data sharing and service specifications**
  - **COI Registration Service enables COI registration and the advertisement of the COI to other GIG FDCE participants**
  - **DoD Metadata Registry and Clearinghouse supports integration of common data, packaging database servers, implementing transformation media and using Enterprise data services**
  - **Configuration Management enables the long-term maintenance, distribution, and compliance checking of various COI artifacts**
  - **Enterprise Standards Defense IT Standards Registry (DISR) includes commercial standards used in the GIG FDCE**

- **GIG FDCE Services for System Development and Certification**
  - **Milestone Decision Authority's (MDA) activities support governance decisions with regard to graduating a capability through the GIG FDCE**
  - **Test, Assessment and Certification activities for MP and/or appropriate T&E and user community testing and provisioning of related artifacts to include risk assessments and tailored test and evaluation criteria to assist provider**
  - **Follow-on Coordination Activities between the PMO, MP and Net Ops during sustainment and operations to ensure a service is meeting its obligations**

Based on DISA Draft GIG Federated Development and Certification Environment (FDCE) Concept of Operations

SOA Support Environments
GIG FDCE Services

- **GIG FDCE SOA Governance Services**

  – **Service Provider / Service Consumer Registration and Credentialing supports service providers and consumers identification, authentication and authorization of one another**

  – **Design Time Governance ensures MPs comply with design time policies defined by the DoD CIO Executive Board and administered by the operations and maintenance organization.**

  – **Service Registries facilitates provisioning of Information that either should be supplied to effectively describe a service on the GIG.**

  – **SOA Change Management and Planning Tools model and report on dependencies between service providers and consumers**

  – **SOA Policies Management Tools enable DoD service providers to implement SOA policies, and certifiers to validate their services' conformance to policies before they are advertised to consumers**

  – **Service Contract and Service-Level Agreement Tools requires that consumers and providers can agree and commit to service level expectations and escalation procedures**

  – **Consuming COI Certification enables consumers to evaluate and certify the service for use within their realm of authority**

Based on DISA Draft GIG Federated Development and Certification Environment (FDCE) Concept of Operations