The Joint Land Component Constructive Training Capability: An SoS Success Story

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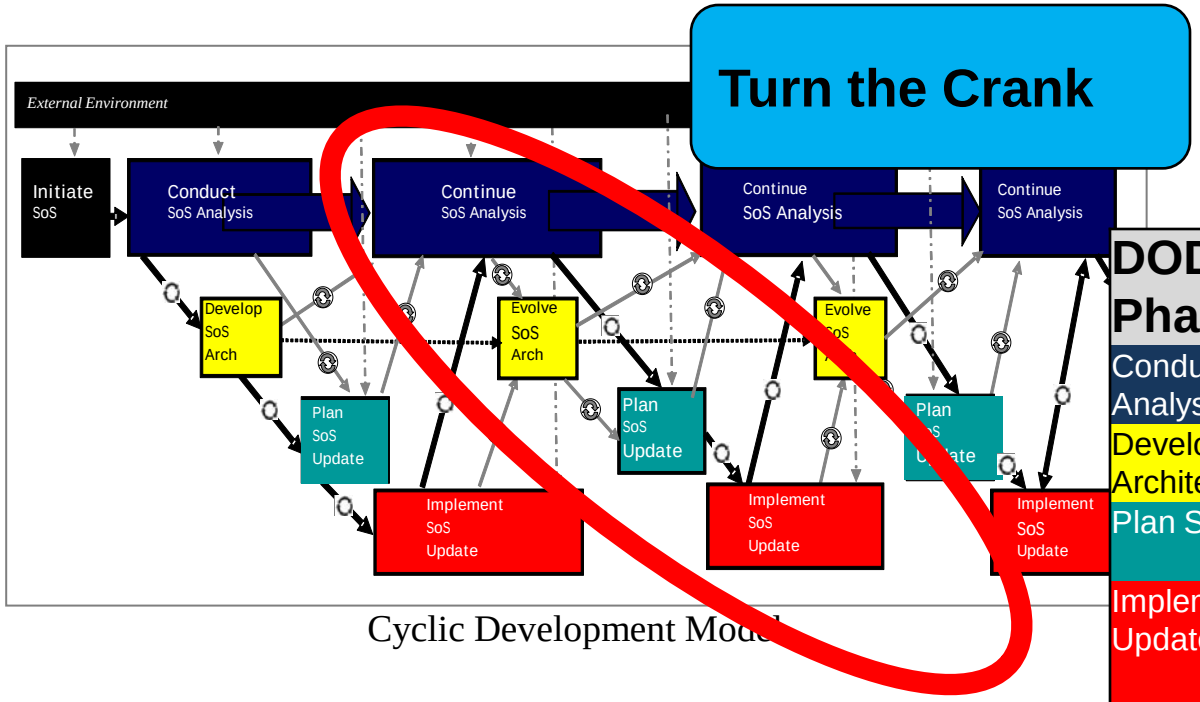
Outline

- Introduction to the Joint Land Component Constructive Training Capability (JLCCTC)
- Today's focus:
  - 'Steady State' System of Systems (SoS) operations
  - Provide overview of JLCCTC SoS process and artifacts
  - Identify key tenets of SoS SE in this example
- Topics not covered:
  - Initiating the SoS
  - Back plane planning

SoS System Engineering Process



Cyclic Development Model

- *DoD Systems Engineering Guide for Systems of Systems*, Version 1.0, August 2008

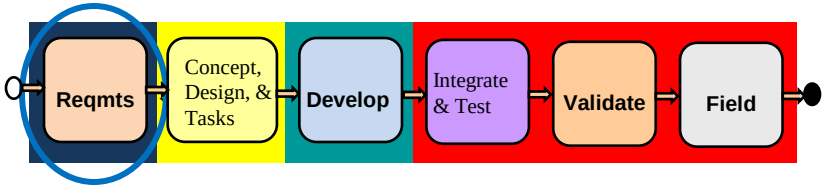
DoD SoS SE Guide Phases mapped to JLCCTC Phases

DOD SoS SE Phase	JLCCTC SoS Phase
Conduct SoS Analysis	Requirements
Develop SoS Architecture	Conceptual Development
Plan SoS Update	Design Development
Implement SoS Update	Develop Functionality
	Integrate and Test
	SoS Test
	Fielding

JLCCTC SoS Characteristics

- The SoS components:
  - Must exchange information in a coordinated fashion
  - Are largely software
  - Have a long lead time and large price tag
  - Are owned by many organizations (multi Service, Nations)
  - Include both Programs of Record and Non-Programs of Record
- The SoS architecture
  - Includes common infrastructure software
  - Loosely couples the individual components
  - Includes legacy infrastructures and protocols
  - Requires a common data model for information exchange
- Changing and critical warfighter needs demand rapid response times

Requirements Process



Understand and prioritize SoS needs.

Requirements collected from users and prioritized

- SoS SE groups Requirements by functional areas
- Contributing systems identified

SoS SE records decisions in Integrated Task List (ITL)

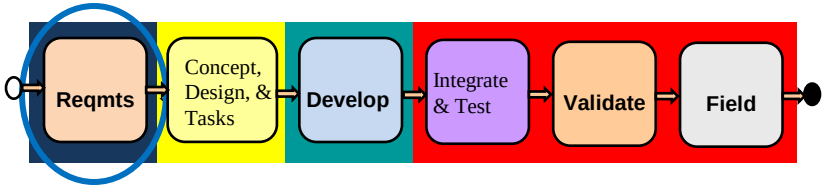
Requirements collected from component systems

SoS SE's Requirements (Master Plan, infrastructure, deferred, deficiencies)

Government only CCB

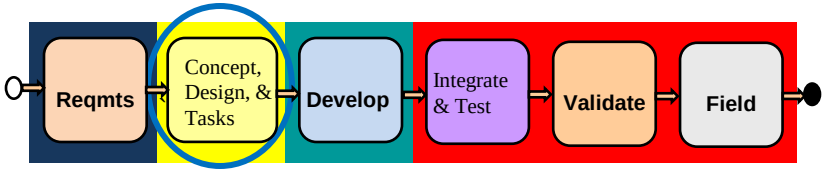
SoS SE key tenet for JLCCTC

Requirements Artifacts



Guide Artifact Title	JLCCTC Title	Producer/User Context	Format
SoS Capability Objectives	Joint Land Component Constructive Training Capability (JLCCTC) Capability Production Document (CPD)	The JLCCTC Program uses a "System of Systems" approach for development. This approach will leverage the best functional capabilities of existing and developing simulation systems. At the same time, it incorporates new capabilities in a modular fashion, all of which, the Materiel Developer integrates into the simulation environment over time and as it 'makes sense' to do so. This approach works by retiring older technologies as newer technologies demonstrate an improved capability that results in increased training effectiveness and/or relevancy.	Word
SoS Requirements Space	TRADOC, NSC User SoS Requirements	Produced by the combat developer (TRADOC National Simulation Center) based on input from all users of the system	Word
SoS Requirements Space	Fielded Sites SoS Requirements	Produced by the users at the fielded sites.	Word, email
SoS Requirements Space	Non-Army User SoS Requirements (AFAMS, JFCOM JWFC)	Produced by the non-Army users of the SoS, including AF Agency for Modeling and Simulation, and JFCOM Joint Warfighting Center.	Word, email
SoS Requirements Space	Prior cycle deficiencies and carryovers	System problem reports (deficiencies) generated in prior cycle by systems engineer and the combat developer and end users using the fielded product. Carryovers recorded in prior cycle's ITL as incomplete tasks.	SPR tracking system, ITL
SoS Requirements Space	Architecture / infrastructure improvements	SoS requirements based on SE performance and stability testing or OS / COTS / GOTS upgrades, etc.	
SoS Requirements Space	SoS Information Assurance	The SoS is required to have an Authority to Operate (ATO) signed prior to fielding. This is accomplished through incremental steps throughout the development cycle, culminating in final Information Assurance steps taken at the Validation event.	Word

Develop Concepts, Design, and Task Definition Process

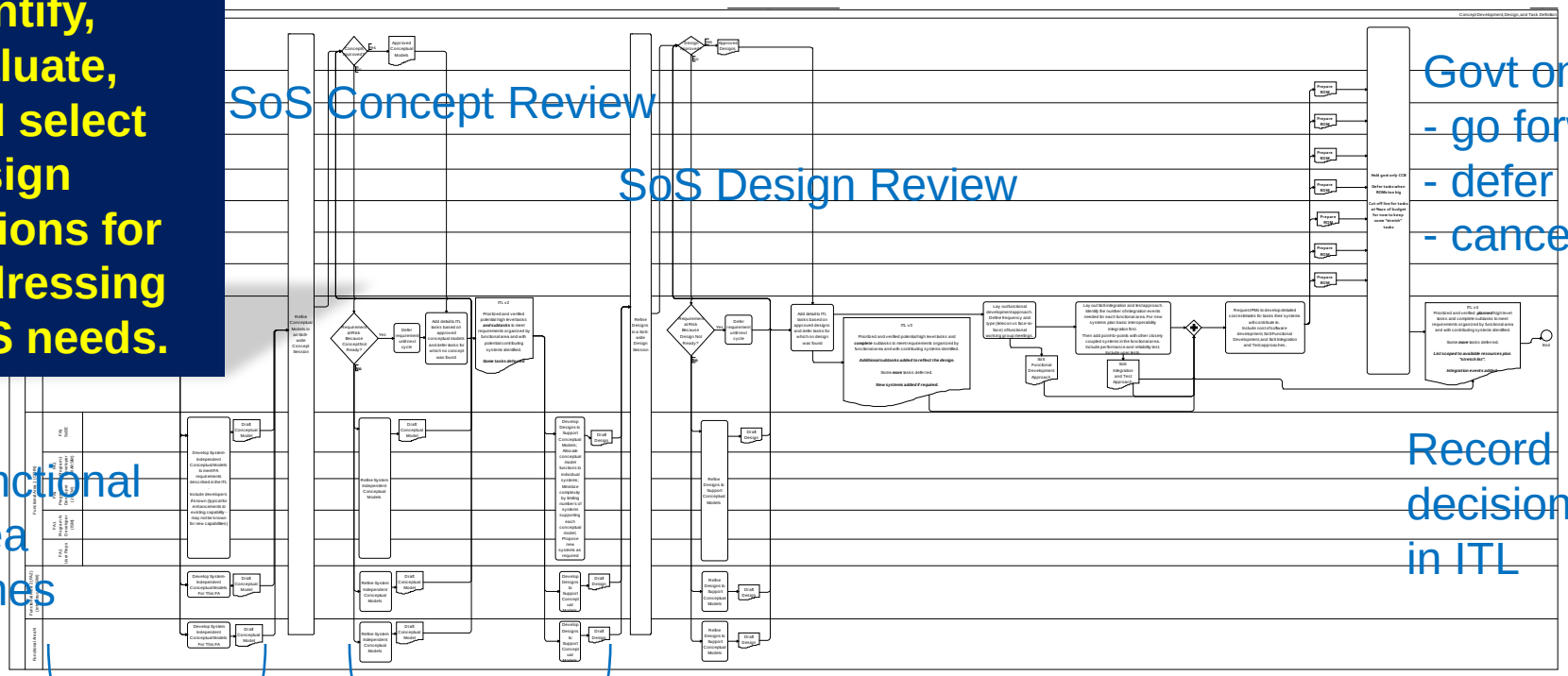


Identify, evaluate, and select design options for addressing SoS needs.

SoS Concept Review

SoS Design Review

Govt only:
- go forward
- defer
- cancel



Functional Area Lanes

Record decisions in ITL

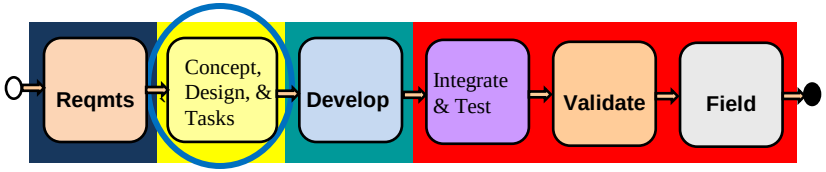
System Independent Conceptual Models

System Specific High Level Designs

Integration & Functional Development Plans & Tasks
==> ROM

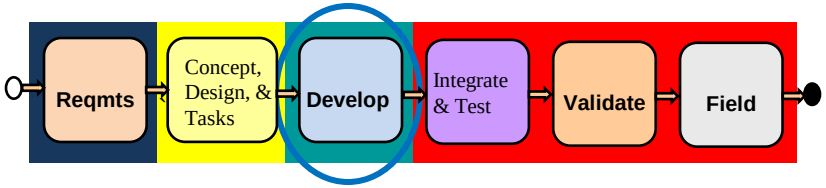
SoS SE key tenet for JLCCTC

Concepts, Design, Task Definition Artifacts



Guide Artifact Title	Title	Producer/User context	Format
	Concept Session functional area briefings	Concept briefings are developed by SE, Users, and Developers to further describe the version requirements. These briefings are conceptual and do NOT identify specific systems.	PPT
SoS Architecture	SoS Architectures	SoS SE prepares a depiction of what systems are in the SoS for the current version, including information exchange architecture and security enclave. Prepared for each cycle during the Concept Development and Design phase.	PPT
SoS Architecture	SoS Data Exchange Model	SoS SE leads working groups in functional areas to develop the data exchanges between the systems. Candidate changes are reviewed by a technical board that assesses cost and performance impact to the individual systems and to the SoS, and are then entered into a database once approved. The SoS Data Exchange model modification process is led by the SE for each cycle during the Concept Development and Design phase. The model may evolve through later phases as the interface matures through system implementation and SoS integration activities.	OMT, FED files, and Word. Doc includes FOM and Federation Agreement info. HTML version of FOM.
SoS Architecture	SoS Data Exchange Vignettes	SoS SE leads working groups in functional areas to develop the patterns of interactions between the systems. These are documented as event trace diagrams and are called vignettes. Prepared by the SE for each cycle during the Concept Development and Design phase. These evolve through later phases as the interface matures through system implementation and SoS integration activities.	pdf, in Word docs (EMF).
SoS Architecture	C2 Spider Charts	These charts identify each SoS system that stimulates a C2 system or receives messages / direction from a C2 system, and the message format used.	

Develop Functionality Process



Develop and manage the SoS architecture.

Synchronize and develop SoS updates

SoS Architecture evolves

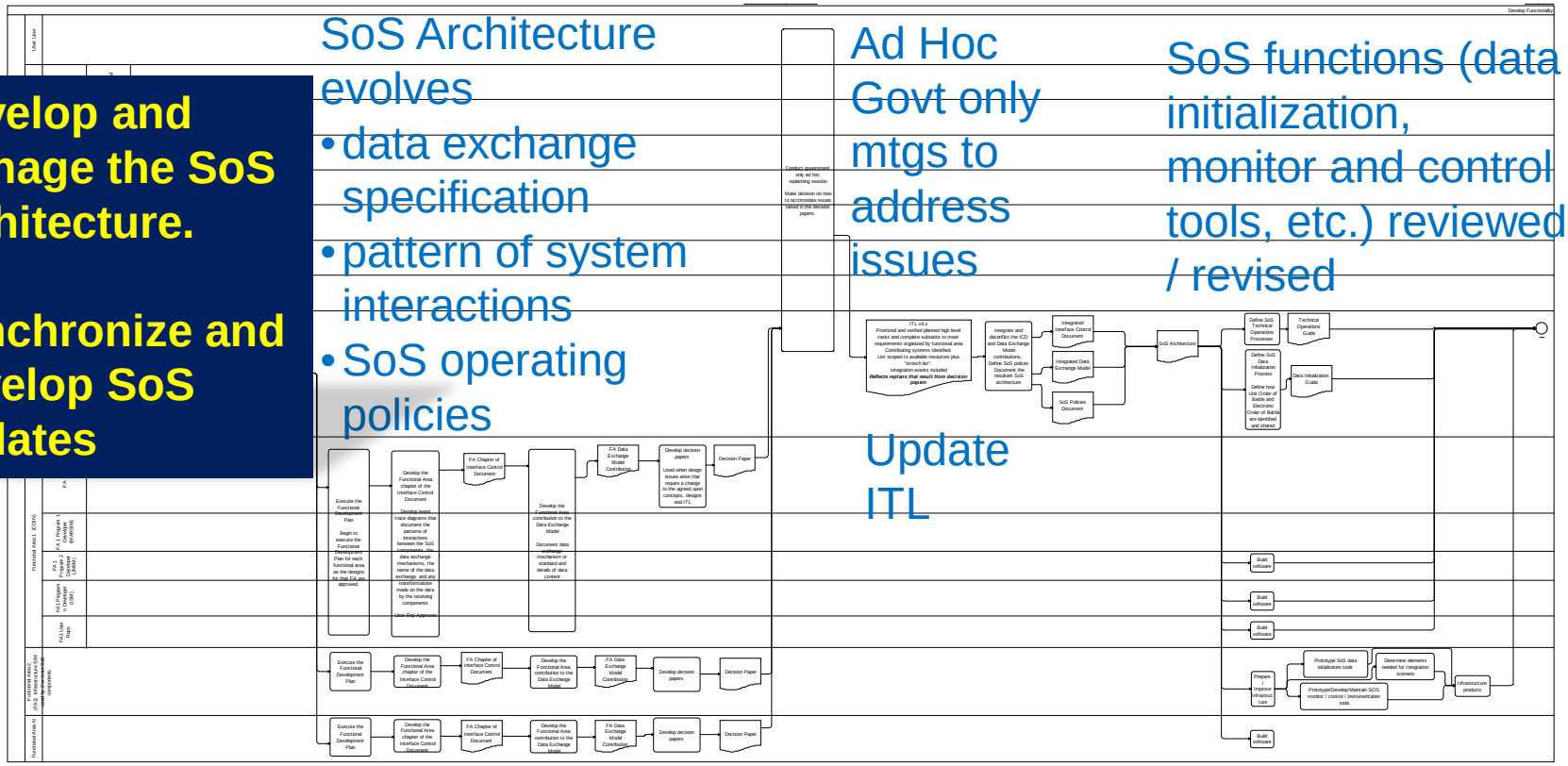
- data exchange specification
- pattern of system interactions
- SoS operating policies

Ad Hoc Govt only mtgs to address issues

Update ITL

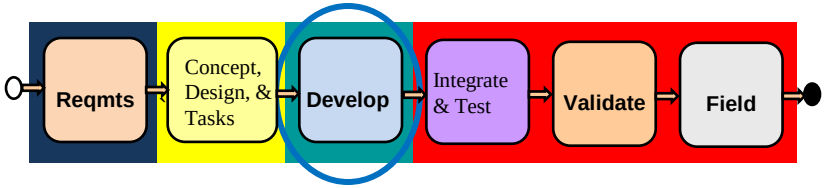
SoS functions (data initialization, monitor and control tools, etc.) reviewed / revised

Software is built



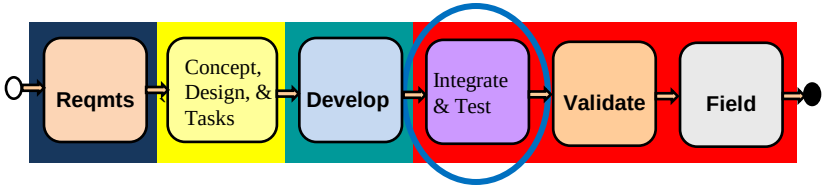
SoS SE key tenet for JLCCTC

Develop Functionality Artifacts



Guide Artifact Title	Title	Producer / User Context	Format
SoS Baseline	Design Session functional area briefs	Functional Area (FA) design briefings evolve the concepts discussed for each requirement and begin to allocate functionality to systems. These are reviewed by the SE, System Developers and Proponents, and User. As information evolves it is captured in the ITL.	PPT
SoS Baseline	Integrated Task List	The ITL contains the planned enhancements and bug fixes for the version in development.	excel
SoS Baseline	SoS Architectures	Visio diagrams showing the SoS components, security levels, and interface protocols are revised to reflect current development plans.	Visio
SoS Baseline	SoS Data Exchange Model (FOM)	As each new interface is designed and allocated to components, the data exchange model is assessed for changes (generally additions) needed to deliver requested functionality. Changes to the data model are considered, reviewed by all SoS participants, including the SE, with a goal of minimal impact to all participants and the infrastructure while delivering new functionality.	OMT, FED files, published form: Word, pdf, HTML
SoS Baseline	Functional Vignettes	Each development cycle is broken into several integration events which are focused on one or more functional areas. Functional area improvements are decomposed by interfacing systems as well as the functionality each system can bring to a specific integration event. This information is captured in the ITL. Additional interface information is captured in object model and interface event trace diagrams. System developers and the FA SoS SE keep each other informed on progress, perceived impact to other Systems, SoS hw and SoS supporting sw (i.e.., MS SQL).	pdf, word
SoS Baseline	SoS Policies	Standards for interoperating as an SoS, e.g., data encoding, heart-beating, initialization procedures, system, network protocol and SoS continuity of operations procedures. Prepared by the SE for each cycle during the Concept Development and Design phase.	Word

Integrate and Test Process

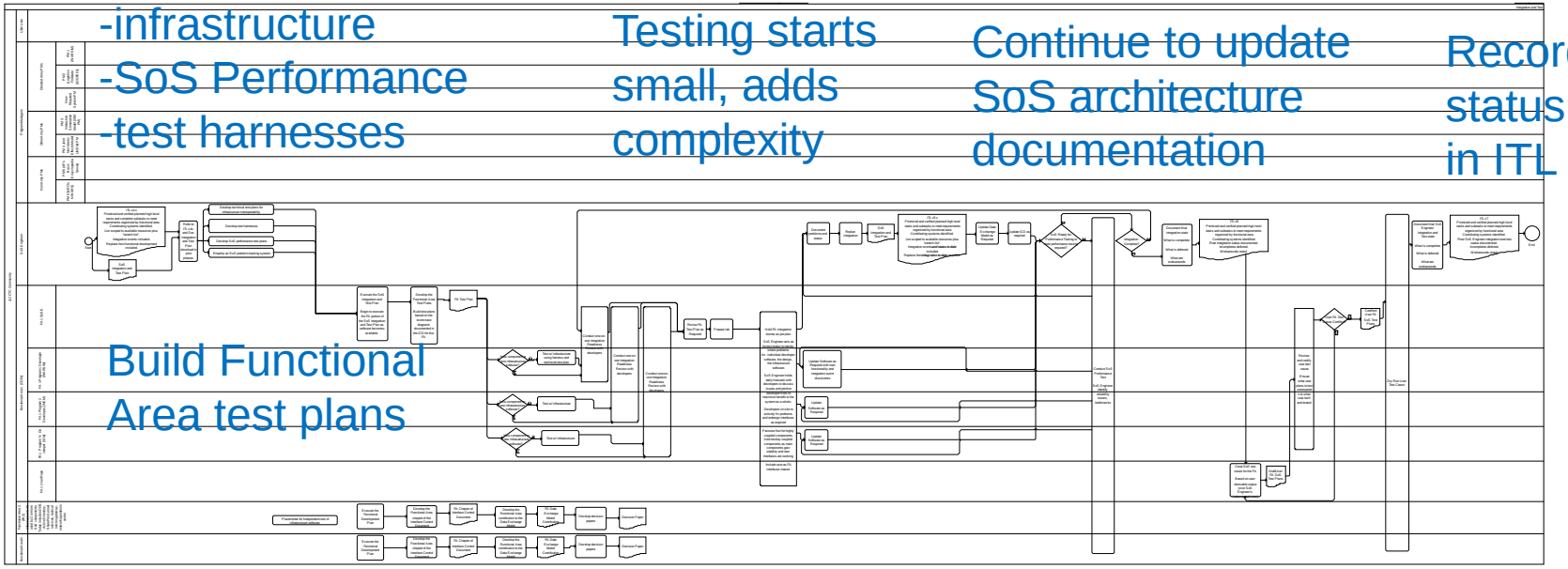


Prepare Test Plans/tools:
-infrastructure
-SoS Performance
-test harnesses

Testing starts small, adds complexity

Continue to update SoS architecture documentation

Record status in ITL



Build Functional Area test plans

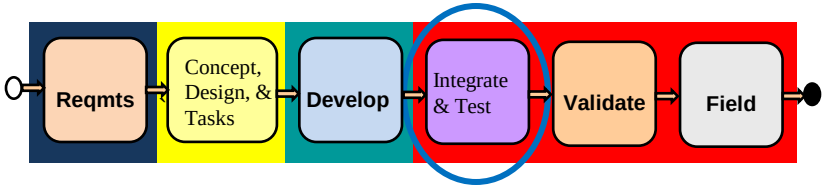
Integrate and test SoS updates

Conduct SoS performance test, IA tests, assess SoS completion

Review and dry run User Validation tests

SoS SE key tenet for JLCCTC

Integrate and Test Artifacts



Guide Artifact Title	Title	Producer / User Context	Format
Tech Plans	Integration and Test Plans	For each Integration Event: the SE publishes a list of objectives for the event, the functional areas to be tested, the FOM data exchange model to be used, and the infrastructure (including information assurance plan) to be used at the event.	excel, word, ppt
Tech Plans	Integration Readiness Review Checklist	Based on Integration Event Plan and includes objectives for next integration event; hardware, software, and staffing expectations, Information Assurance (IA) lockdown testing and anticipated modifications, systems tested ability to run with current infrastructure and SoS inputs (data exchange model, databases, etc.) These are conducted by the SE with each anticipated System for the next integration event. This allows System developer to alert SE to current status (and any known issues) in private.	PPT
Tech Plans	Integration Readiness Reviews	SE conducts an Integration Event Readiness Review with each component developer participating in the integration event. The review includes the plans for each functional area scheduled to be integrated at the event, the status of that components contribution, the hw and software required by that component, and the ability of the component to execute in the integration event environment. The IRR provides an opportunity for the component developer to assure the SE of their readiness and/or alert the SE of any issues or concerns with the development of their component.	PPT, excel
Tech Plans	Integration Event HW, SW, IA, reqmts for lab	Prior to each event, the architecture of the event is drafted and updated as the IRRs are conducted. This product describes the hardware allocated to each component, the additional software products required by the component (e.g., MS SQL), the Information Assurance lockdown version, and any specific set up reqmts by each component.	excel
Tech Plans	Integration Event Results	The SE assesses the results obtained at the Integration Event and determines the impact to subsequent events, or if the cycle is concluding, identifies which requirements will not be met by the SoS test, and therefore will not be part of the released version.	

Key Tenets of the JLCCTC SoS SE Process

- Understand and prioritize SoS needs.
- Identify, evaluate, and select design options for addressing SoS needs.
- Develop and manage the SoS architecture. Understand the breadth, significance, and power of proper architecture management.
- Synchronize and develop SoS updates.
- Integrate and test SoS updates.

JLCCTC SoS SE Principles

- Focus on SoS capabilities beyond those of any single system's area of responsibility or expertise. Keep out of the rice bowl fights between systems.
- Focus on interfaces between systems, SoS infrastructure, and common services. These things cannot be addressed by a single system, each system is likely to have an opinion, some of them quite astute.
- Focus on technically feasible solutions and remain system agnostic.
- Rely on the expertise resident in a system's organization. Stay out of any single system's internal affairs unless invited.
- Be the scribe when everyone else is talking. Nuggets of truth are often buried in the noise.
- Make sure there is common access by all system developers to all critical documents. There should be no mysteries about the state of the SoS SE process.

Features of the SoS Process

- Governance process addresses:
  - Intersection between components systems
  - Functionality within systems needed to address SoS capabilities
- Decomposition of the SoS into *functional areas*
  - As decoupled as possible in order to maximize parallel activities within a cycle
- Updated SoS design at each cycle
  - System independent conceptual models elaborating SoS requirements
  - Updated SoS *composition*
  - Updated SoS *infrastructure*
  - Updated SoS *data exchange model*
  - SoS vignettes describing the patterns of interactions between the systems in the new *composition*, using the updated *infrastructure*, and *data exchange model* to meet the requirements expressed in the conceptual models

Demonstrated SoS Transition Success

Transitioned architecture

Replaced legacy with new systems

Accommodated new systems

Integrated new capabilities in response to changing world