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INTRODUCTION

VISION AND OBJECTIVES

The vision of Enterprise Technical Reference Framework (ETRF) is to enable and accelerate the overall objective of Navy Logistics IT. ETRF provides a digital logistics IT architecture that will generate scalable, interoperable, flexible and fluid technology solutions; maximizing access to information/data via applications anywhere, on any device at any time.

The main objectives of ETRF can be articulated along four major themes:

1. **DIGITAL AGENDA** - Enable a digital enterprise and a digital workforce by adopting scalable and mobile Applications
2. **SIMPLIFICATION** - Create immersive customer experience by embracing human centred design, mobility and IoT
3. **NEW WAY TO OPERATE** - Drive cloud migration to build common enterprise infrastructure - shared cost and increased savings – Ashore & Afloat
4. **INCREASE CYBER SECURITY** - Automated governance and compliance to adhere to RMF and to enable proactive defense

ARCHITECTURE GUIDING PRINCIPLES

The ETRF guiding principles defines the foundations of the new technology platform that will fulfil the vision and objectives of the Digital Logistics IT.

1. **DIGITAL TRANSFORMATION** - Replace logistics legacy systems and consolidate into the optimal number of IT systems possible with a common access point based on human centred design.
2. **SHARED SERVICES MODEL** - Adopt a functional domain driven design and microservices architecture approach to establish a shared services operating model and to position the platform to create innovative cross-domain products and services.
3. **CLOUD, ASHORE AND AFLOAT** - Adopt a containerized cloud and edge posture and consistent technology stack to seamlessly extend logistics IT capabilities across shipyards, ships and submarines including detached operations.
4. **SECURITY & AUDIT** - Establish a robust framework for automated governance and compliance using integrated DevSecOps which strictly adheres to RMF and enables proactive monitoring and defense.
The Enterprise Technical Reference Framework will leverage the Digital Transform Plan – Services, Data, Technology, Security and Change Management strategies – to provide a framework and roadmap to transform 1600+ current Applications and 5000+ data sources to a common unified logistics IT platform. The following graphic captures the key components of this unified platform.

The left side of the diagram shows how the Digital Transformation Plan will guide the nine identified vectors to migrate the current applications and data sources to the common unified Logistics IT platform.

The focus of the graphics is on the Enterprise Technical Reference Framework which consists of three major components:

1. **USER INTERFACE** - A personalized User Interface that provides a highly immersive customer experience leveraging human centered design, business capabilities driven process orchestration and edge computing that seamlessly integrates AR, VR, Robotics, Sensors, Analytics and Applications.

2. **INTEGRATED PLATFORM AS A SERVICE** - A highly scalable PaaS that unifies Logistics Apps and data in a single platform exposing simple, intuitive domain driven APIs that not only enables rich logistics capabilities but also opens the door for innovative integration with IoT (sensors, robotics), other Navy / DoD Systems and other Federal Govt. systems.

3. **SECURED CLOUD AND DETACHED INFRASTRUCTURE** - A highly secured and governed cloud and detached infrastructure augmented with integrated DevOps, Containerization, Hybrid Integration Platform and Data Integration to enable Ashore, Afloat and Detached scenarios.

A comprehensive security architecture will encompass the Enterprise Technical Reference Framework automating governance and compliance activities to ensure strict adherence to Risk Management Framework.
USER INTERFACE

The User Dashboard is a lightweight framework that supports the use of open source technologies to create a responsive presentation layer that will conform to multiple form factors. The presentation layer will leverage data binding technologies and open APIs to combine Applications and Analytics to provide an immersive human centered user experience.

Industry leading Business Process Management products may be used to bring the services strategy to life to cater to end to end user workflows and business processes.

Robotics Process Automation tools can be plugged into this framework to automate manual processes that span across different Applications and Analytics and reduce time and increase efficiencies within business processes and user workflows.

The API Gateway serves as the common way of interacting with all the applications and analytics and AI offerings that will be part of the Ecosystem. Myriads of Internet of Things (IOT) including sensors can be plugged into the framework using open APIs and data formats.

Non-Logistics Navy systems, other DOD and United States Federal Governments can interact with this platform via open APIs that are exposed via the API Gateway.

Developer Portal will be used by the developer community - Navy Logistics IT and beyond – to explore APIs and metadata to develop new and innovative products and services. IT Portal will be used to maintain and operate the entire ecosystem including containerization and cloud provisioning.
INTEGRATED PLATFORM-AS-A-SERVICE

The user interface will be powered by an integrated Application and Data platform which will reside just below the API Gateway. The top tier of this platform is represented by the core Logistics APIs that captures the business capabilities that Logistics IT provides such as Supply, Ordering, Planning, etc. These APIs are derived based on Services strategy and domain driven design.

The API Gateway will route requests to appropriate core Logistics APIs. These APIs are registered with the API Gateway and the Gateway knows how to discover, load balance and route the appropriate requests to them. It is important to note that the API Gateway will be used for incoming traffic from the User Interface, IoT sensors, external systems (Non Navy Logistics), and IT and Developer Portal.

The core Logistics APIs will be provided by COTS (Custom Off the Shelf) products, legacy Applications’ APIs and refactored microservices based applications. The internal communication between these microservices will happen over an event bus using publisher-subscriber (Pub-Sub) Architectural pattern. Each service that exposes an API will be stateless and they will rely on the Event Hub to provide asynchronous communication.

The inner microservices architecture will be based on the notion of bounded context and domain driven model. The outer architecture will be based on containerization. The microservices along with their dependencies and data requirements will be containerized and deployed together in a cloud agnostic posture.

The bounded context and asynchronous communication paradigm that the reactive microservices based inner architecture provides in combination with containerization will enable the platform to be scalable and deployable to the enterprise cloud and edges.

A single trunk of code along with sound API versioning strategy will enable the platform to remain flexible to changes and ensure that the interfaces within Logistics and with external systems is easily maintained.

A Hybrid Integration Platform can be leveraged to integrate the disparate APIs from Applications, IOT devices, COTS, EDIs and data sources to transform this tier into an integrated platform-as-a-service and data-as-a-service.
DATA-AS-A-SERVICE

Data-as-a-service will integrate COTS data, Microservices App data into a Master Data Management cluster and help facilitate data ingestion into the data lake. Further reference to the Data Integration and Management will be articulated in the Data Strategy document.

The following architecture will be used to enable Analytics and AI:

Data Analytics guiding principles:

1. Build a decoupled system with clear separation of concern along data, storage, compute and consumers
2. Employ the right tools and technologies at each tier based on functional use cases, data structures, non-functional requirements such as latency, throughput and security and data access requirements
3. Leverage cloud native and best-in-breed open source technologies and a server less posture with the end goal of creating a highly scalable, resilient System with low maintenance overhead
4. Build a state-of-the-art Data lake that houses data ready for use to improve latency and real-time compute requirements.
5. Achieve cost efficiency by choosing the right technologies and by closely monitoring cost as part of the overall data governance.
6. Apply AI and Machine Learning to continually optimize the data pipeline and computational algorithms of the System.
SECURED CLOUD AND DETACHED INFRASTRUCTURE

The integrated platform-as-a-service architecture will be hosted in a central cloud and distributed edge posture. An integrated Dev-Sec-Ops and containerization will ensure that the IT capabilities are easily coordinated, deployed and maintained between the central enterprise cloud and the cloud nodes on board ships and submarines and also in Navy Shipyards.

A consistent technology stack across cloud and edges and the principles of communicating information and syncing data only via APIs will ensure that the cloud and edges remain consistent and complement each others capabilities. The same principles can be applied to Shipyards where consistent edges can be leveraged for business continuity.

To enable detached capability four things are imperative:

1. A traditional hyperconverged infrastructure (HCI) solution bringing the agility and innovation of public cloud to micro data centers on Submarines and Ships.
2. Ability to run big data analysis on Cloud native technologies which can be seamlessly synced with enterprise cloud.
3. Implement serverless posture at the edge, minimizing memory and processing foot print on-board submarines and ships.
4. Ability to prioritize data interchange between Enterprise Cloud and Edge.
The Enterprise Technical Reference Framework is a framework that enables a common unified platform while separating the operating concerns into four distinct tiers as indicated above. This separation of concern will allow Navy Logistics IT to focus on delivering business value to their end users while leveraging best-in-breed advancements in technology in UI, API, PaaS and DaaS.

Emerging technologies such as Blockchain can be easily integrated to this platform using open API standards, Change Data Captures via DaaS and leveraging distributed computing across Enterprise Cloud and distributed edges.

AI technologies today are laser focused on specific areas of innovation. We can easily integrate the cutting edge AI tools and technologies in this platform to clean and standardize data, enrich user experience through Natural Language Processing and Deep Learning while optimizing the Data Analytics and generating actionable intelligence in real time.

The shared resource utilization model can be applied to both Applications and Analytics. The separation of concerns of Big Data Analytics into storage, compute and presentation will allow stakeholders to bring their own compute and AI tools to derive new insights while operating under the strict confines of data governance and Security.

By integrating data and applications into a common unified platform, by representing Logistics IT with intuitive APIs and by leveraging the best in breed cloud native and edge computing technologies the Enterprise technical Reference Framework provides Navy Logistics a platform for innovation and opportunities.
### GLOSSARY

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<th>Terms</th>
<th>Definitions</th>
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| Edge Computing                | Edge computing reduces latency and enables immersive customer experience by performing data processing at the edge of the network, near the source of the data generated by IoT and sailor/end user interactions. This reduces the communications bandwidth needed between distributed locations (afloat scenario) and the central Cloud.  

*Integrated Dev Ops will enable deployment of edge computing resources and event driven microservices will decide at runtime what to process at the edge versus central cloud.*  |
| Serverless Compute            | Serverless compute uses events and functions to dynamically manage the allocation of machine resources.  

*This minimizes the runtime footprint at both the Cloud and Edge where server computing resources are only spun up as needed.*  |
<p>| Hybrid Integration Platform (HIP) | HIP integrates end user apps, COTS products, on-premise systems, IoT, B2B applications and Data-as-a-service (DaaS) on Cloud and Edges. E.g. Informatica and Mulesoft.  |
| Dev Ops                       | DevOps unifies software development (Dev) and software operation (Ops) for Logistics applications. It is strongly reliant on automation and monitoring at all steps of software construction, from integration, testing, releasing to deployment and infrastructure management.  |
| Domain Driven Microservices   | Expresses domain in simple named resource driven API posture. This architectural style structures an application as a collection of loosely coupled services. Services should be fine grained and the protocols should be lightweight.  |
| Reactive Microservices        | An event driven architecture where Microservices are stateless and communicate with each other via an event hub. This allows the System to scale automatically to handle concurrent processing under load.  |
| PaaS                          | A cloud computing service that provides a platform allowing Logistics application developers to develop, run, and manage applications without the complexity of building and maintaining the infrastructure typically associated with developing and launching an app.  |
| IaaS                          | Refers to online services that provide high-level APIs used to de-reference various low-level details of underlying network infrastructure like physical computing resources, location, data partitioning, scaling, security, backup.  |
| Data-as-a-Service             | On-demand Data for Sailors, Suppliers, Maintainers and other users to access regardless of the geographic or organizational separation of provider and consumer.  |</p>
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<th>Terms</th>
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<tr>
<td>Metadata Store</td>
<td>Metadata describes the structure and context of any data, of any subject, stored in any format.</td>
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<td>Data Lake</td>
<td>To accomplish the Logistics Integrated Data Environment and to facilitate innovative Analytics capability, a Data lake can be used to store all data in the enterprise ranging from raw data (which implies exact copy of source system data) to transformed data which is used for various tasks including reporting, visualization, analytics and machine learning to make better supply chain decisions.</td>
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<tr>
<td>Decoupled System</td>
<td>A system that enables a IT Logistics programmer or agile team to make changes to their Logistics IT system without influencing any other system.</td>
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<td>Cloud Platform-as-a-Service</td>
<td>Extends the basic Infrastructure-as-a-service model of Cloud to provide platform capabilities via Databases, Application servers and DevOps automation and other services to simplify building, running and maintaining applications on the Cloud. E.g. Amazon RDS.</td>
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ARCHITECTURE GUIDING PRINCIPLES (DETAILED)

DIGITAL TRANSFORMATION
Replace logistics legacy systems and consolidate into the optimal number of IT systems possible

SIMPIMLIFICATION & SELF-SERVICE
A common access and entry point across all acquisition programs for shore & afloat

FUNCTIONAL DOMAIN DRIVEN APPROACH
Adopt a functional domain driven design simplify service definition and position the platform to create innovative cross domain products and services

SHARED SERVICES MODEL
Establish a shared services operating model for ease of adaptation for other programs and to track utilization of resources by program areas

CLOUD FIRST POSTURE
All new applications and services architected, designed, built and optimized for hosting in the cloud and compatible edges

CLOUD AND EDGE
Centralized Cloud posture for coordination, aggregation, archiving and big data analytics while moving real time compute to the edge for immersive customer experience

ASHORE AND AFLOAT
Event driven posture with integrated Dev-Sec-Ops to support seamless ashore and afloat orchestration

PORTABILITY
Microservices, common services and containerization to ensure the solution is platform agnostic and to facilitate shore and afloat orchestration to include DDIL Operations

SECURITY & COMPLIANCE
Security, automated compliance and control policies and principles are strictly enforced, including continuous monitoring and automated governance

TECHNOLOGY STRATEGY DRIVERS

A comprehensive approach along seven critical areas is essential to build and shape a successful technology strategy

SERVICE STRATEGY
Develop the business case to determine how cloud can be implemented and realized to deliver greater value to our business.

APPLICATION STRATEGY
Examines readiness of existing applications and their target platform. Creates the strategy to achieve the transition where there is value. Integrates closely with Cloud Service Strategy.

INFRASTRUCTURE STRATEGY
Defines a to-be infrastructure architecture that supports the guiding principles of cloud optimization, increased savings and to position the overall enterprise architecture for innovation

OPERATING MODEL STRATEGY
Defines a to-be operating model for an IT organization to function smoothly after transitioning to cloud-enabled suite.

SECURITY STRATEGY
Employs best practices to ensure secure usage of resources from cloud and adherence to governance, risk and cyber compliance framework

CLOUD SERVICE STRATEGY
Define how services will be operationally consumed and integrated into the support pipelines. Architect application design principles with public cloud services.

DEVOPS STRATEGY
Identifies impact on tools, processes and interaction between development and operations teams as a result of shift to cloud adoption. Allows faster deployment of business capabilities.
SCALABLE PLATFORM-AS-A-SERVICE (PAAS)

A highly scalable PaaS unifies Logistics Apps and data in a single platform exposing simple, intuitive domain driven APIs that not only enables rich logistics capabilities but also opens the door for innovative integration with IoT (sensors, robotics), other Navy / DoD Systems and Federal Govt. systems.

HYBRID API INTEGRATION

- Ability to integrate a wide range of APIs – Microservices, COTS, legacy App APIs, IOT and data APIs
- Enable Business Process via an integrated Platform as a Service
- Cloud agnostic
- Able to extend PaaS between Ashore and Afloat – Cloud, Fog and Edge

CONTAINERIZED ORCHESTRATION

- Package domain microservices, legacy Apps and COTS applications in containers for deployment – ashore and afloat
- Scale resources dynamically based on workload
- Remain cloud agnostic

MICROSERVICES VALUE PROPOSITION
Stateless Microservices should minimize synchronous invocations (for example, through REST) for intra-microservices communications to ensure the best possible isolation and scalability. Consider using asynchronous communication between the services via event hub in a pub-sub model.

SERVERLESS COMPUTE

Big data analytics should leverage serverless compute where possible. Much of the intelligent actions based on streaming sensor data are also prime candidates for serverless posture.

Serverless compute is a multi-tenant event-driven compute platform that facilitates the development, deployment, and execution of function-based microservices. Serverless computing is also known as Function as a Service (FaaS/fPaaS).

FUNCTIONS THAT RUN IN STATELESS COMPUTE CONTAINERS THAT ARE EVENT-TRIGGERED, EPHEMERAL, AND FULLY MANAGED BY A 3RD PARTY
# CLOUD ADOPTION STRATEGY

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<th>ENABLEMENT</th>
<th>Consolidated, end-to-end automated, service based self-service providing a single pane of glass view</th>
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<td>TRANSFORMATION</td>
<td>Tools-based, integrated, simple governance and processes</td>
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<td>OPTIMIZATION</td>
<td>Leverage commercially supported open source technologies; facilitate a shared services cost model</td>
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<td>ARCHITECTURE</td>
<td>Strategically adopt IaaS, PaaS and SaaS capabilities while considering central cloud and distributed edge posture</td>
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<tr>
<td>ENTERPRISE INFRASTRUCTURE</td>
<td>Enterprise-grade fortified, secure, scalable, flexible cloud infrastructure</td>
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<tr>
<td>ADOPTION</td>
<td>Adopt Containerized Cloud orchestration to remain vendor agnostic and to support ashore and afloat orchestration</td>
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