Adaptive Layer Framework

JET Systems

Introduction

- Problem
  - Proprietary, closed system flight computers on Type 1 and 2 UAS prevent easy, affordable, cross system visibility into navigation and sensor data.
  - Incompatible or proprietary representations of the same kind of data
  - Reinventing the same applications for different platforms
- Solution
  - Open Architecture Framework
  - Rapidly integrate new capabilities
  - Extensible environment, modular configurations
  - Applications are portable to any ALF enabled platform.

Demo Outline

- This technical demonstration will show ALF operating in multiple low-cost configurations:
  - Adjunct processor to a Fight Computer
  - Integrated Flight and Mission Computer
  - Ground Station
  - Roll-on / Roll-off Independent Hardware
- It will demonstrate ALF enabling data collaboration of navigation sensors and other external interfaces in real time.
- Perform a sample mission demonstrating multiple Unmanned Systems (UAS and UGV) forming a hybrid ad-hoc mesh network including broadband LTE, WiFi, and Telemetry radios.

Demo Goal

- Demonstrate the ALF middleware framework running on different hardware profiles, hosting common applications
- Aggregate data from multiple vehicles using different sensors, routed via the ALF middleware to a common backbone
- Show flexibility via dynamic ad-hoc mesh networking of nodes with drop-in / drop-out capability.

ALF UAS Hardware

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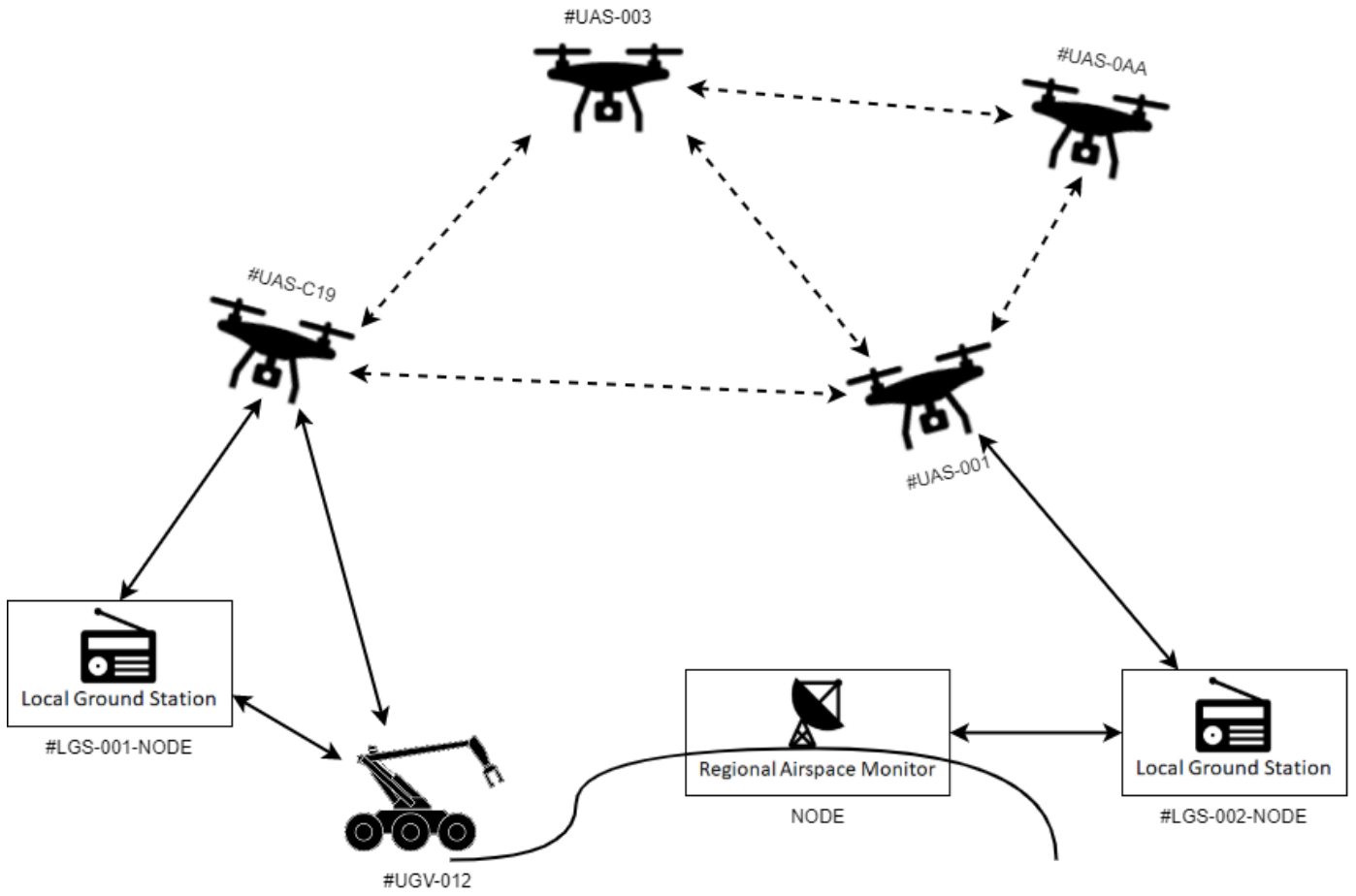
Mobile Ad-Hoc Networks (MANET)

- A type of network where each device can change locations and reconfigure themselves automatically.
- Increases the operational range of unmanned vehicles by routing through other unmanned vehicles
- Resiliency through saturation: Network self-heals when routes are damaged if there is an available pathway

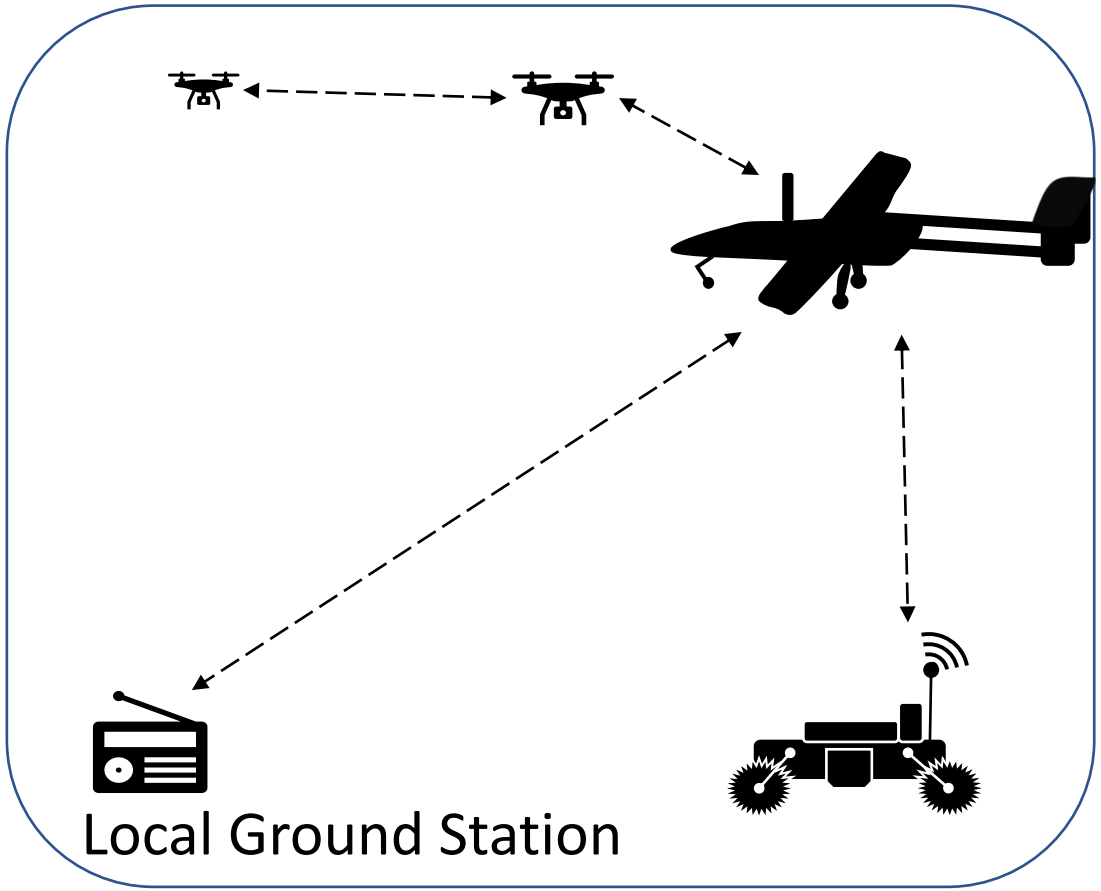
Notional Network Topology



Alternative Network Views

Map View

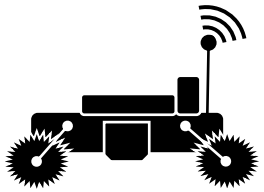
Mesh Routing Network View



ALF Demonstration Nodes

1. Fixed Wing UAS
(Roll-on / Roll-off Independent Hardware)
- ALF Flight Computer
  - GPS / IMU
  - Telemetry Radio

2. Demo UAS Payload
(Adjunct Processor to Flight Computer)
- ALF Computer
  - Mesh Networking
  - GPS / IMU
  - Telemetry Radio
- Pixhawk Cube Flight Controller



3. Autonomous Rover
(Integrated Flight and Mission Computer)
- ALF Computer
  - Mesh Networking
  - GPS / IMU
  - Telemetry Radio

4. Ground Station (Mesh Network Bridge)
(Ground Station for connection to Mesh Network)
- ALF Computer
  - Mesh Networking
  - GPS Receiver
  - Telemetry Radio Receivers

5. Ground Station (Mesh Network Gateway)
(Ground Station for connection to Remote Networks)
- ALF Computer
  - Mesh Networking
  - GPS Receiver

6. Quadcopter UAS
(Integrated Flight and Mission Computer)
- ALF Computer
  - Mesh Networking
  - GPS / IMU

7. Remote UAS
(Simulated UAS Sensor)
- ALF Computer
  - Mesh Networking
  - GPS Receiver
  - ADS-B Receiver

Configurations Overview

Roll-on / Roll-off Independent Hardware

- Fixed-Wing UAS Stand-alone configuration:
  - Mission Processor / Flight Controller
    - ALF Computer with integrated IMU
      - Sensors: Accelerometers, gyros, compass, barometer, temperature
      - External GPS Input: 5V DC Active (SMA)
  - Data Link
    - Telemetry Radio (900 MHz)
  - Enclosure
    - ABS with active cooling
    - 12V DC Power Input Jack

Configurations Overview

Adjunct Mission Computer

- Demo UAS Payload
  - Mission Processor
    - ALF Computer with serial connection to Flight Controller
  - Flight Controller
    - Pixhawk Cube 2.1 Flight Controller
      - Sensors: Accelerometers, gyros, compass, barometer
      - Internal Integrated GPS / Compass
  - Data Links
    - Wi-Fi (2.4 GHz)
    - Telemetry Radio (900 MHz)
  - Enclosure
    - ABS with active cooling
    - 12V DC Power Input Jack

Configurations Overview

Integrated Flight and Mission Computer

- Autonomous Rover
  - Mission Processor / Vehicle Controller
    - ALF Computer with integrated IMU
      - Sensors: Accelerometers, gyros, compass, barometer, temperature
      - GPS
  - Data Links
    - Wi-Fi (2.4 GHz)
    - Telemetry Radio (900 MHz)
  - Controller
    - 2.4 GHz FHSS
  - Enclosure
    - Lightweight, passive cooling
    - 12V DC Power Input Jack

Configurations Overview

Simulated UAS Sensor

- UAS (Providing ADS-B IN)
- ALF Computer
  - Sensors
    - ADS-B IN via Software Defined Radio (SDR), temperature
    - GPS
  - Data Link
    - Wi-Fi (2.4GHz)
  - Enclosure
    - Lightweight, passive cooling

Configurations Overview

Ground Station (Bridge)

- Ground Station (Provides Mesh Network Interface)
- Mission Computer
  - ALF Computer
    - Raspberry Pi 4 running ALF UAS
    - GPS
  - Data Link
    - Wi-Fi (2.4GHz)
    - Telemetry Radio (900MHz)
  - Enclosure
    - Lightweight, passive cooling

Configurations Overview

Ground Station (Gateway)

- Ground Station (Provides Wide Area Network Interface)
- Mission Computer
  - ALF Computer
    - Raspberry Pi 4 running ALF UAS
    - Sensors: Accelerometers, gyros, compass, barometer, temperature
    - GPS (Navio or LTE GNSS)
  - Data Link
    - Wi-Fi (2.4GHz)
  - Enclosure
    - Lightweight, passive cooling

ALF

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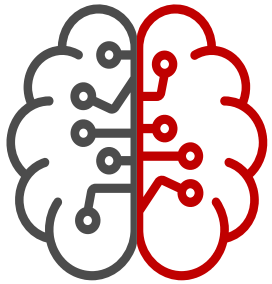
The Need: Smart Solutions

Problem:
Slow Integration and Vendor Lock
Currently, capability developmental approaches are based on proprietary Data Rights making changes to OEM systems and integrations costly, requiring significant and unnecessary cost and schedule for development and testing.

Solution:
Smart Aircraft Environment
The Adaptive Layer Framework (ALF) is an Open Architecture framework that bridges the disconnect between legacy systems and enables truly “Smart Aircraft” environment based on government-owned data rights, modularity, extensibility, and software re-use.

The Way Forward

Challenges



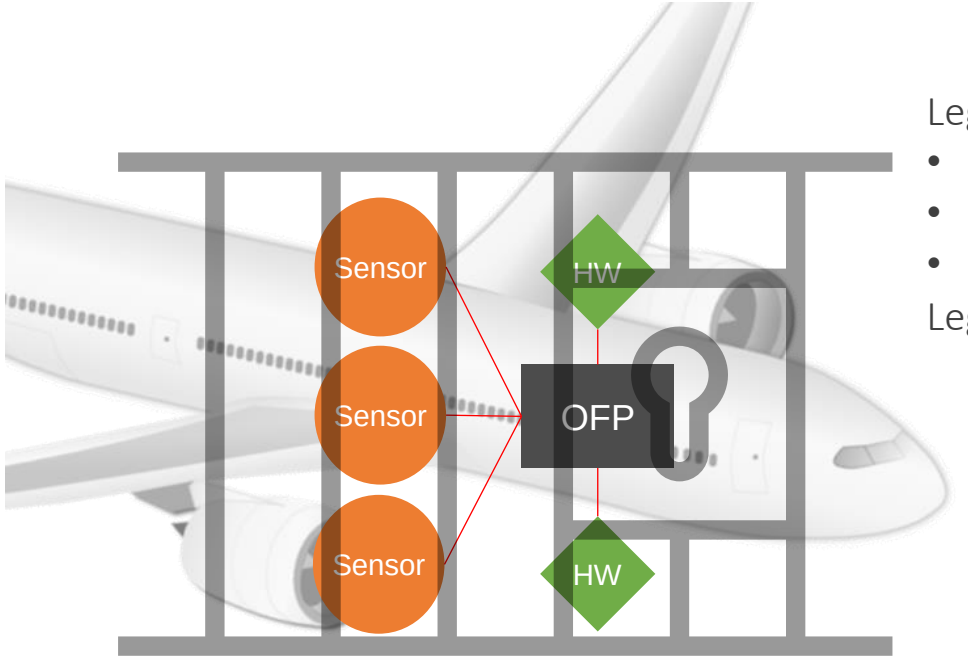
- Inter/Intra Service Communication
- Vendor Lock
- Duplication of Efforts
- Speed-to-fleet

Solutions

- Common ALF middleware integration allows for easily-shared capabilities
- Programming to a common ALF opens all components up to competition in the free market
- Government will be able to search for pre-developed apps from the DoD Store
- Vendors will be able to develop capabilities to the common ALF ahead of the need

Breaking vendor lock does not BLOCK vendors; it frees the Government to have options, and increases speed of integration

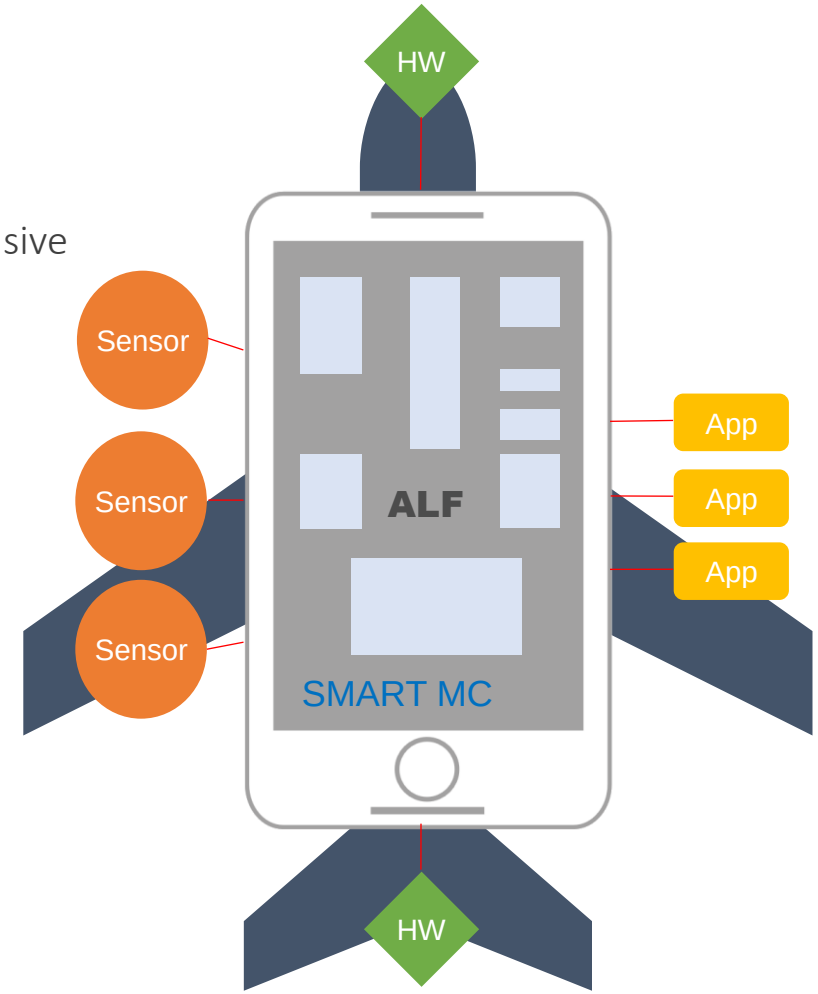
What is ALF?



Legacy System Development

- Built Uniquely – (Stove-piped)
- Not Modular
- Not Re-usable

Legacy System upgrades are slow and expensive



ALF is Modular

- Maximizes speed of capability to the end-user
- Maximizes commonality
- Minimizes schedule of development through software re-use

ALF hosts applications that can access common software components

ALF communicates with sensors and hardware using standard data formats

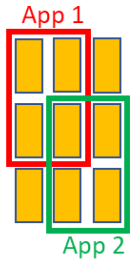
- *All ALF-compatible Applications, Services, and Data are shared with all ALF-enabled Platforms*
- *Changes to a single ALF-compatible component benefits ALL ALF-enabled Platforms*

Software Re-use

Faster Capability Integration

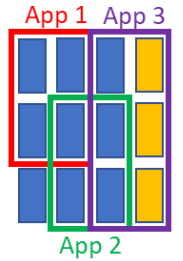
- ALF promotes **Software Re-use** via Apps that interface using **Common Services**
- Software re-use correlates directly with **reduced development cost** (resource and schedule) when integrating capabilities onto platforms

Base services to host App 1 & 2



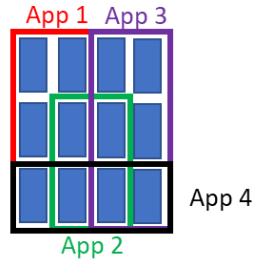
- **Initial** effort to build an OA environment
- Create new services for everything

App 3 needs FEW new services



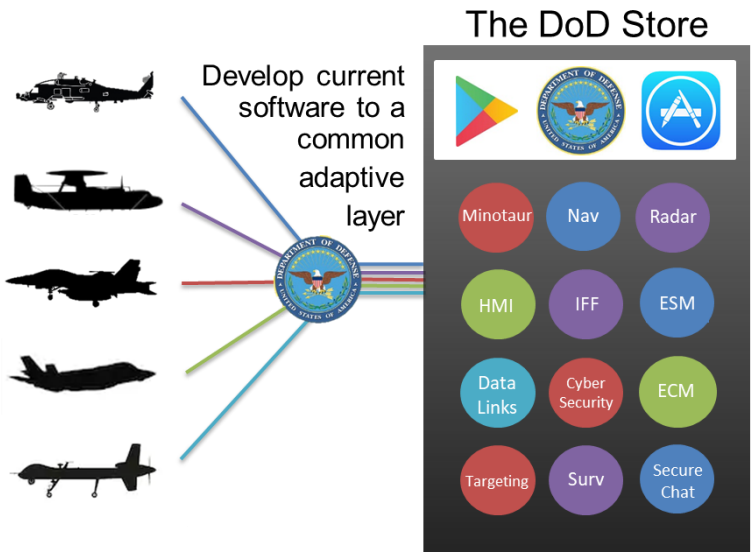
- 50% service development
- 50% service re-use for App3
- **Only** yellow is new

App 4 needs NO new services



- Make use of existing integrated services
- Effort is only to call existing/re-used services

ALF Baseline and Beyond



When developed to a common adaptive layer, integration into future platforms is simplified

ALF Baseline

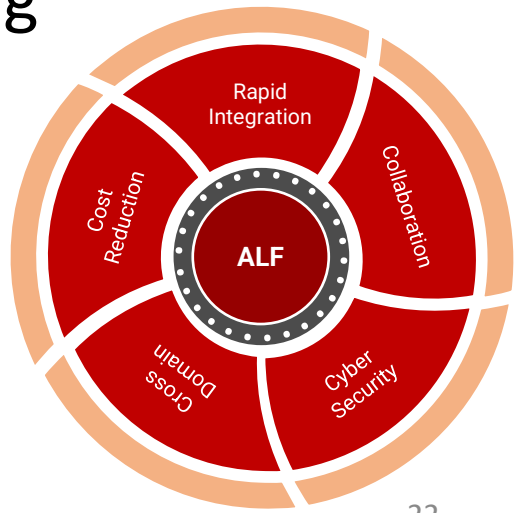
- Framework and **Common Services**
  - Governs system operation and memory management
- ALF Enabled Interfaces
  - Provides common external communications protocol support
    - Ethernet, Serial, Discrete I/O, USB, etc.
- Application Layer
  - Software Development Kit (SDK) for ALF Developers
  - Supports rapid prototyping and deployment
- Application Repository (Store)
- Collaborative development

System of Systems

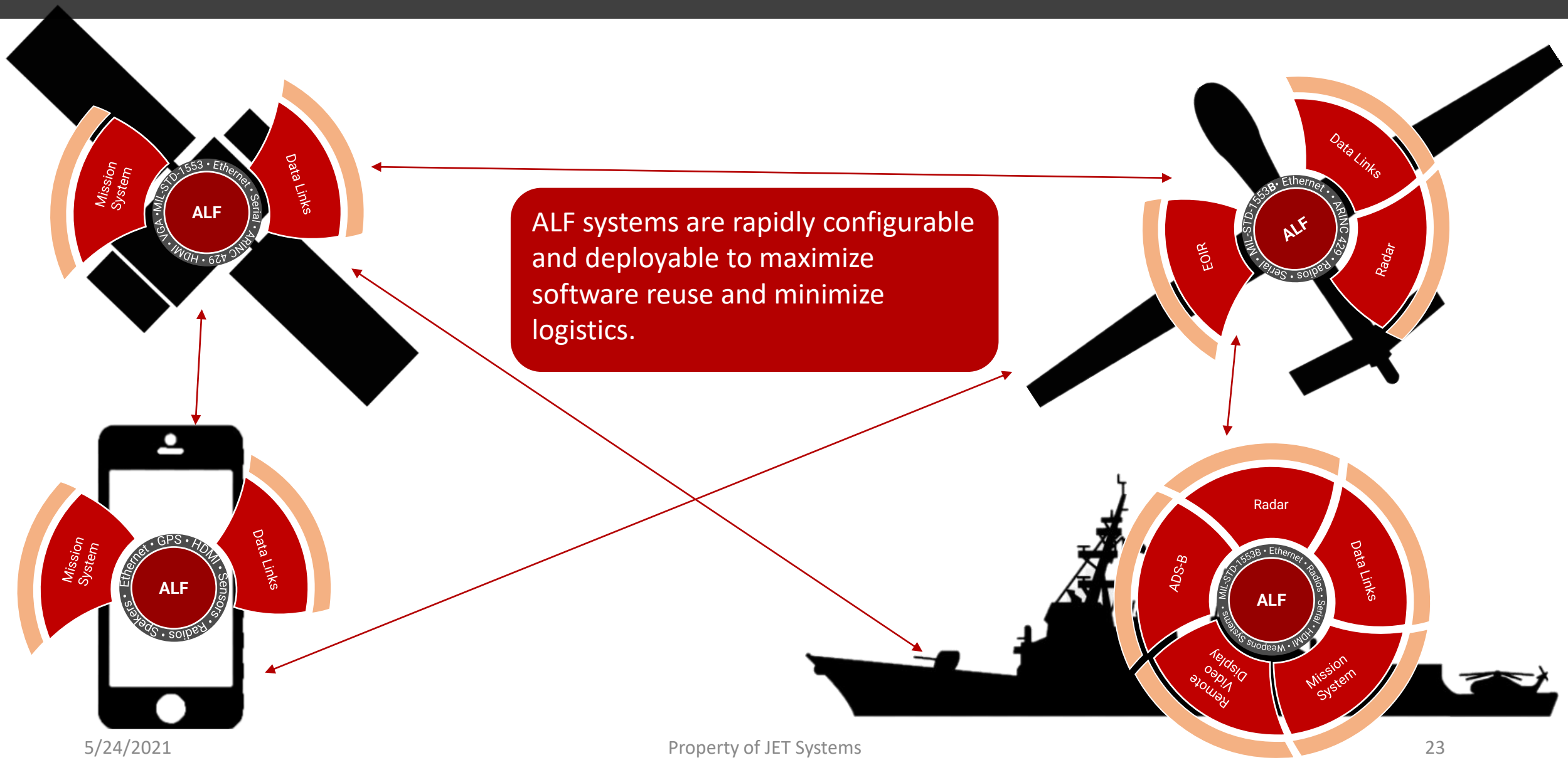
The ALF middleware is just part of the larger vision that enables:

- **Rapid Capability Integration** through **shared** Services and Applications
- **Collaborative** development across DOD and Industry
- Stronger response to current and emerging **Cyber** threats
- Common and secure communication and data **sharing across Domains**
- Significantly **reduced** and more modular regression testing

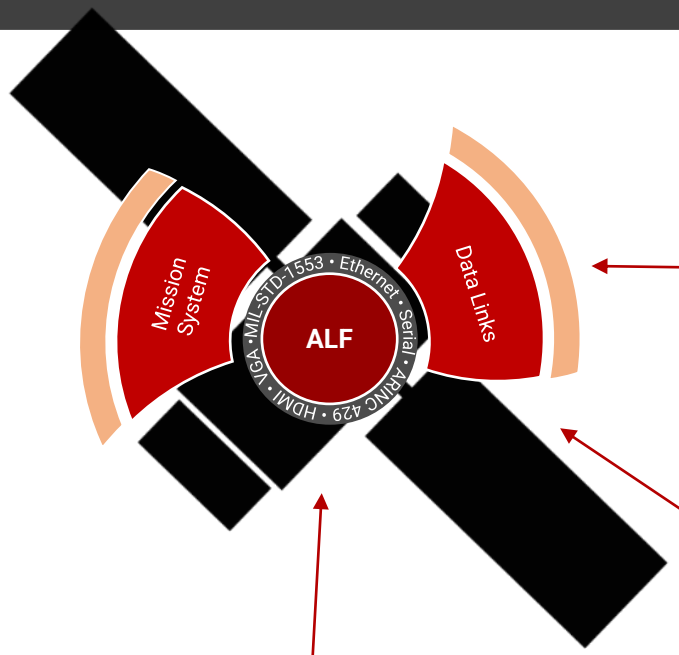
Faster and more common integrations allow for greater innovation of ideas and capabilities



Cross-Platform Deployment

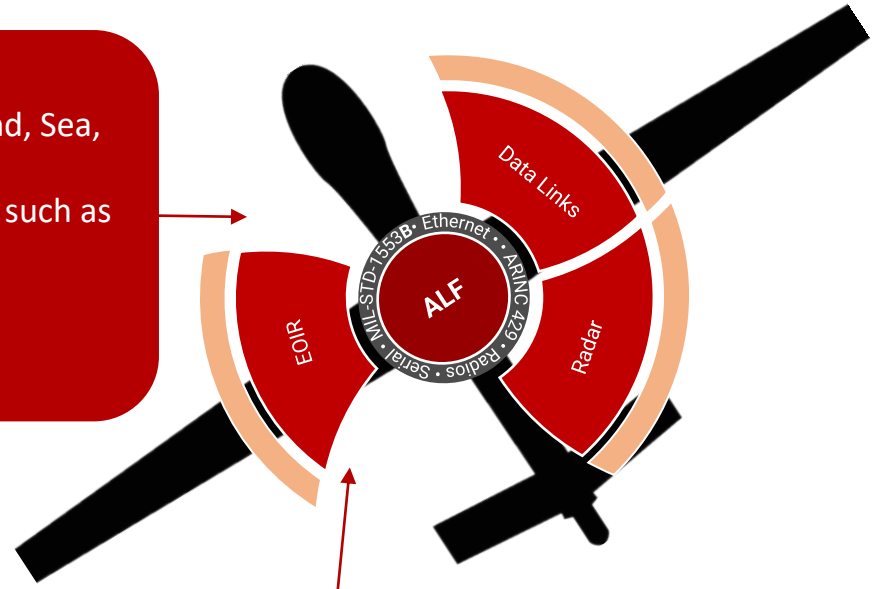


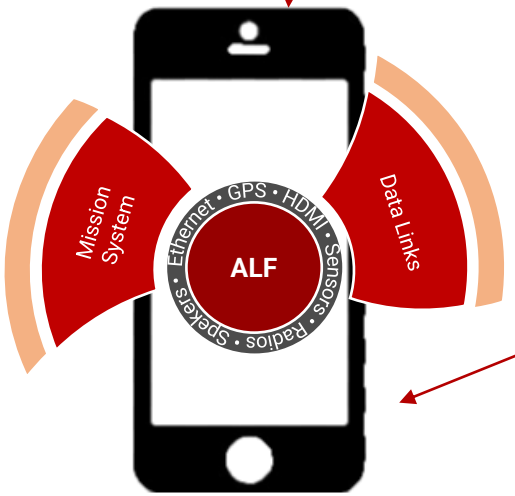
Multi-Domain Operations



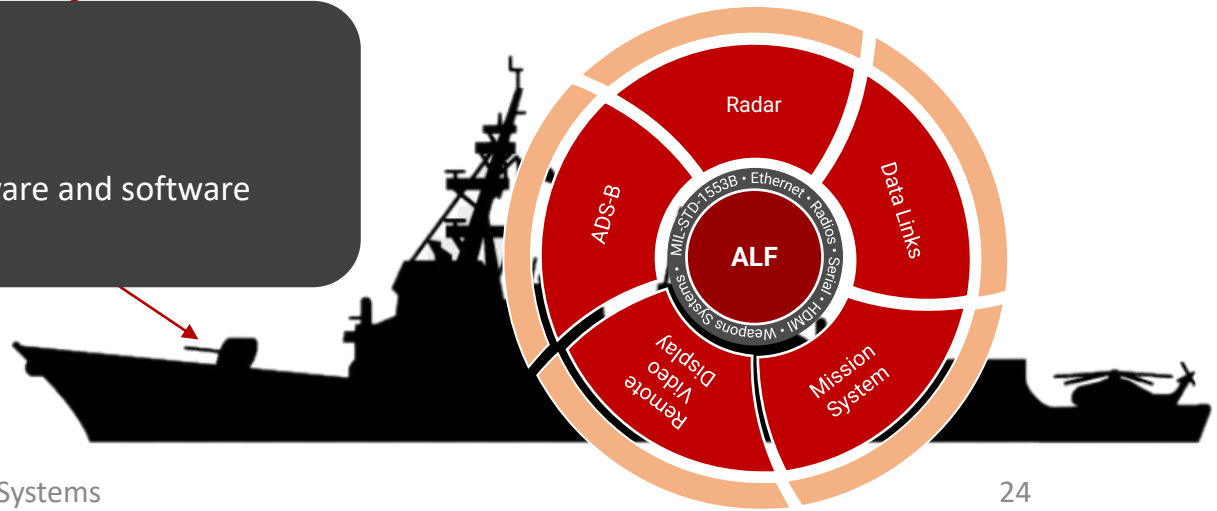
Multi-Domain Warfare enables:

- Communication and data sharing across Space, Air, Land, Sea, and Cyber
- Communication and data sharing across major entities such as our military branches and coalition forces



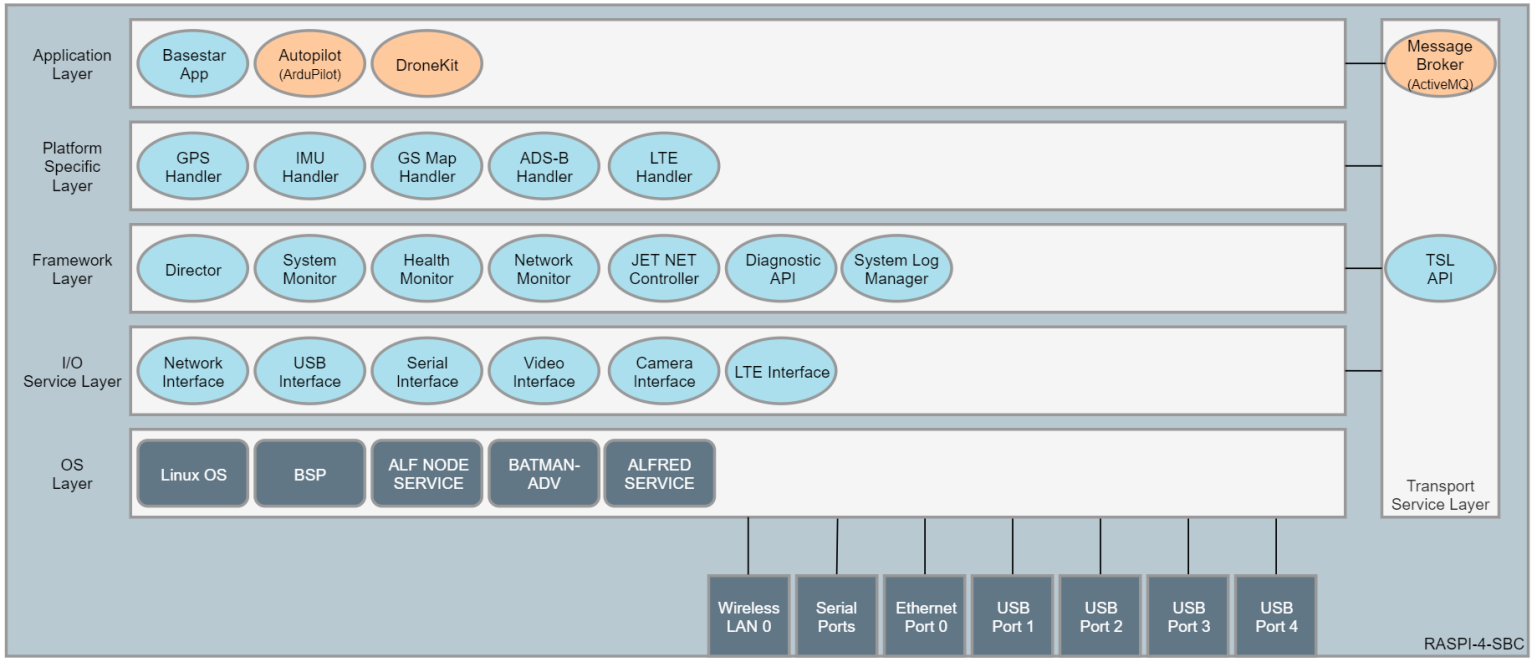


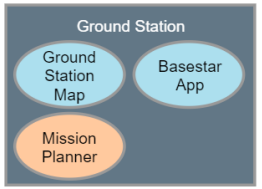
Enabling Multi-Domain Warfare requires:
Common capabilities across platforms
Common capability interfaces for both hardware and software



Sample ALF UAS Architecture

- Each circle represents an encapsulated, modular software unit.





ALF – What isn't it?

- ALF is not a standard.
  - It is a framework that implements multiple standards, from communication standards (i.e., IEEE 802.3) to architectural (FACE or OMS), to business (ISO).
  - It can be extended and configured to implement new or other standards based on requirement.
- ALF is not a data model.
  - ALF supports data model usage and standardization of data elements but does not enforce one of its own.
  - The ALF philosophy is to leverage existing Navy, DOD, and industry data modeling efforts and integrate them into the framework, instead of creating another competing model.
- ALF is not a specific hardware implementation
  - ALF as a framework is adaptable to a wide arrange of hardware and operating environments.

ALF – Purpose in the demo

- ALF provides hosting and life cycle management for GPS/IMU data collection and processing applications.
- The ALF TSL provides a common API to route data between UAVs and GSs, across different communication types.
- The ALF Framework handles the set up and management of the mesh networking.
- ALF's data backbone provides data quality of service and redundancy.

Today and Tomorrow

- Today we see a solution to tracking proprietary and disparate unmanned systems into a common operational profile, which can be extended to communicate with ATC or a local white cell, or other forces and services.

- Tomorrow we can extend this technology to enable systems to work collaborate in a way they can’t today.

Backup Slides

JET Systems

JET Systems
Adaptive Layer Framework (ALF)

System/Technology Description

- JET Systems' Adaptive Layer Framework (ALF) is a platform-agnostic, modular software and hardware system leveraging open architecture design creating common operating environments enabling ad-hoc networking and data collaboration across multiple unmanned system types and ground stations.
- Internally, ALF provides abstracted software modules for connections to individual sensors, data storage devices, and communication technologies, and enables applications (Apps) that allows for re-use of sensor integrations and tactical applications across any ALF-enabled system.

Operational Utilization

- ALF is a middleware software environment that enables scalable and extensible capability in manned/unmanned flight/mission computers and promotes cross-domain operations through data-centric collaboration.
- ALF implemented as an unmanned mission processor can functions as a stand-alone system, can be integrated into existing systems, or could be configured to operate as a combined flight controller and mission processor for Group 1/2 UAS or UGV.

Warfighter Benefits

- ALF enables modular, reusable software components that rapidly increases the rate of development and integration resulting in reduced cost and schedules in delivering capability to the fleet.

Demonstration Description

- This technical demonstration will show ALF operating in a low-cost UAS/UGV Flight/Mission Computer. It will demonstrate ALF enabling data collaboration of navigation sensors and other sensors during execution a sample mission involving multiple Unmanned Systems (UAS and UGV) forming a hybrid network including broadband LTE, the Internet, and other radios forming adaptive, ad-hoc and mesh networks to relay real-time sensor and position data to a local or remote Ground Station(s) for display.