The PrivOps Matrix™ - The 1st Open Data Fabric for Multi-Domain Operations

An open data fabric for building modular, high-velocity, operationally adaptable information supply chains that convert raw data into decisions that win missions, save lives & reduce cost

The 21st century battlespace has expanded with adversaries challenging the U.S. and allies across social media, Internet of Things (IoT), business and governmental systems, and other endpoints, giving rise to an imperative for assured multi-domain operations. An overreliance on proprietary and stovepiped systems has hindered our nation's ability to Command and Control (C2) and disseminate information fast enough against peer or near-peer threats to maintain decision superiority. In a 2017 *Defense News* interview, Air Force (AF) Chief of Staff (CSAF) General David Goldfein made overhauling the service's C2 enterprise a top priority, specifically the "procurement of information technology." The AF Multi Domain Command & Control (MDC2) Capabilities Office (MCO) was tasked with developing and defining a Shadow Operations Center (Shadow OC) to adopt critical technologies like data analytics, re-purpose current C2 systems, and enable Agile Development Operations (DevSecOps) Proof of Concept (PoC). In 2018, Brig Gen Chance Saltzman, Director of Operations at Headquarters AF (HAF), said, "[Commanders] must leverage advanced technologies to increase their lethality, accuracy, and decision speed, and their units must be manned with properly trained experts in multi-domain command and control."

Artificial Intelligence (AI), Machine Learning (ML), blockchain, and other emerging technologies show great promise to help secure the 21st century battlefield, but without timely access to clean, actionable data, such solutions are no more effective than warfighters without ordinance. The number of data sources, users, and amount of data needed to establish true situational awareness and decision superiority for rapid response to threats and opportunities across the expanded battlespace has grown according to Metcalfe's law, which holds that the number of connections (or integrations) in a

> *"The advantage in today's competition will go not to those who create the best technologies, but to the ones who can integrate and adapt faster than the adversary."*
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> *- Heather Wilson, former secretary, USAF*

network grows according to the square of nodes in the network. This exponential growth and complexity has made it more difficult to Observe, Orient, Decide, and Act (OODA) with actionable data. Legacy Information Technology (IT) systems in need of modernization have proprietary data structures and communication protocols, further exacerbating the data and systems proliferation problem (data sprawl). The situation is also fluid; in addition to dealing with the data sprawl problem, Multi-Domain Operations (MDO) must also be highly adaptive.

What is needed is a modular, high-velocity, operationally agile information supply chain that converts raw data from thousands of heterogeneous sources into decisions that save lives, win missions, and reduce cost. It must scale by converting exponential growth in IT complexity to a linear relationship and by extending agile principles (beyond DevOps) to the design, deployment, and reconfiguration of information supply chains. Beginning with innovations like interchangeable parts and standard cartridges, modularity has played a central role in the development and use of firearms and weapons systems at scale; there is every reason to believe that information system modularity will provide a similar contribution to the rapid innovation and adaptability of information supply chains to support MDO, as well as data integration in general while minimizing the impact to existing systems.

Solution Description – The PrivOps Matrix data fabric

Traditional IT technology procurement works against modularity. Simply put, it is in the financial interest of large Commercial Off-the-Shelf (COTS) vendors and some technology consultants to create proprietary data structures and interfaces that make it difficult to be replaced when contracts end. For that reason, any attempt at creating a modular, agile information supply chain for MDO and IT modernization requires open source as the central element of its architecture. For that reason, we designed the PrivOps Matrix data fabric as an entirely open system that makes next generation COTS and custom software components that aggregate, validate, secure, analyze, and act on data hot pluggable as part of an information supply chain.

The data fabric has three components: Apache Cassandra is an open source distributed database that provides massive scalability and resilience with its distributed architecture; Node.js is an open source software platform that scales integration and development with
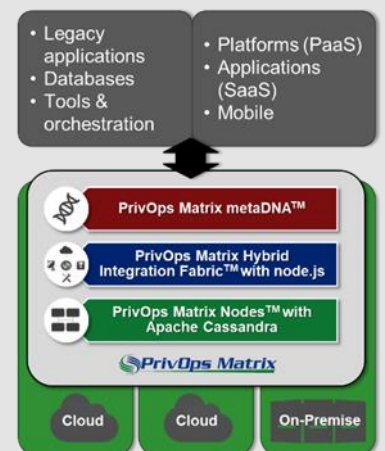
thousands of free connectors and modules; and the PrivOps Matrix software accelerates and scales the automation, protection, and control of data. Since the Matrix software is the only non-open source component, we license the source code, making the data fabric an entirely open system that serves as the foundation for a best-of-breed, agile approach to MDO platform development.
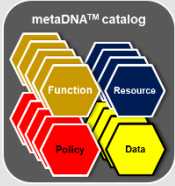
The key innovation in the Matrix data fabric is the patent-pending metaDNA™ catalog, which implements a data ontology that creates a standardized structure for data that serves as an intermediary for all data domains. Because these data objects have a standardized format, the metaDNA™ catalog becomes a library of reusable components to automate creating and updating new applications and integrations. It also automates changes in policies to automate data governance across thousands of apps and databases and billions of users and devices.

The PrivOps Matrix Integration Fabric is composed of appliances that are constructed in an Ubuntu Linux instance with Node.js installed as well as other modules for integration with external systems and a Cassandra Node.js driver that connects to the Cassandra cluster. The Cassandra cluster then connects to other clusters in other Matrix nodes and provides for resilience, data transmission, and other capabilities related to scaling and protection (encryption). Using Matrix libraries, the connector microservices (appliances) perform integration, automation, and Extract, Transform, Load (ETL) functions to support the appliance's assigned task.
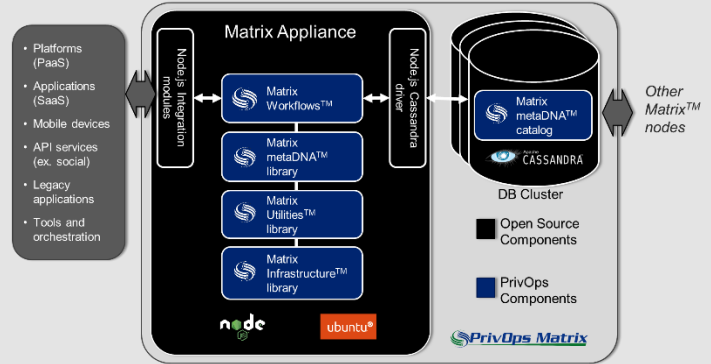

MDO Mission Scenario/Example – Response to Biological Attack

Multi-domain operations are most effective with close coordination between various public and private entities, but this requires relevant and timely information with strong controls. PrivOps' Matrix data fabric can integrate with the identity management systems of each organization and create access rights at the object level (unstructured data, like images) or data field level (structured data, like personnel lists). The policy automation capability of the data fabric makes it possible to change in real time which organization and which individuals within each organization can view data within each other's organization as the situation and players change.

In this scenario, we will combine social media activity with AF Command, Control, Communications, and Computers Intelligence, Surveillance, and Reconnaissance (C4ISR) surveillance imagery and public health data to create a biological attack response plan of action for the Federal Emergency Management Agency (FEMA), AF, and other aid organizations. Using the Matrix data fabric, we create an information supply chain by routing needed data first from public health agencies, social media, and AF C4ISR's image datastore to data-cleansing applications that validate and rationalize data, then to AI applications that aggregate and analyze the data to create heat maps showing probabilities for infection rates. These are transmitted to organizations like FEMA, aid organizations, command and control, and other permitted organizations inside and outside the U.S. government. Because the information supply chain is dynamically reconfigurable, we can quickly incorporate new data sources, users, and technologies (like AI) as they are available using Agile principles. Finally, since all components of the information supply chain are modular, there is 100% reuse of work to create new information supply chains to support additional types of operations (e.g., combat operations, support operations). Incremental work required to deploy new information supply chains decreases substantially and deploying new MDO capabilities over time becomes more efficient, not less – essentially inverting Metcalfe's law.
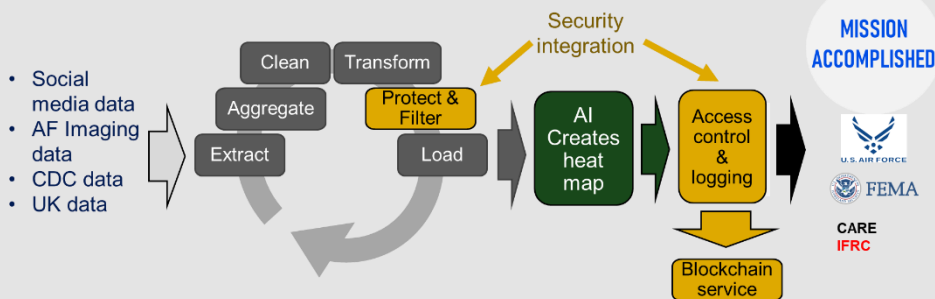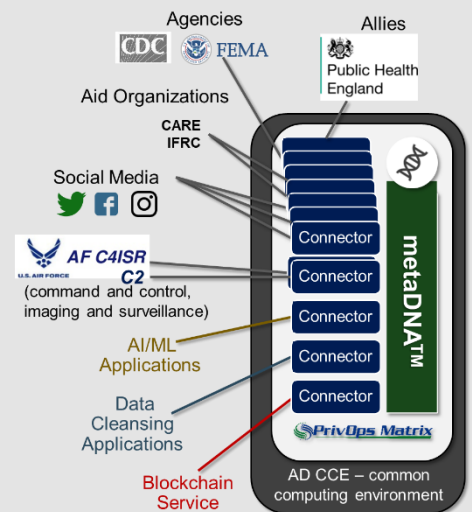
Information Supply chain built on the PrivOps Matrix™