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CASE STUDY:

Airbase and flightline operations powered by 5G

OVERVIEW

Advanced technology driving advanced operations

Flightline operations refer to the activities and processes that take place on the tarmac, or flightline, of an airbase or airfield. This area is where aircraft are parked, maintained, prepared, loaded, refueled, and inspected before flights. Key mission profiles on the flightline include:

Airframe maintenance: Conducting routine checks, diagnostics, and repairs to ensure aircraft safety and performance.

Refueling and loading: Managing fuel, cargo, and passenger logistics.

Communication and coordination: Ensuring ground crews, maintenance teams, pilots, and air traffic control communicate effectively.

Data management: Collecting and recording operational data such as fuel levels, maintenance logs, and diagnostics.

Flightline operations are critical in support of air traffic operations, being it for transport, training or actual combat missions. Therefore, flightline operations must be closely coordinated with airspace flight control operations and other command and control networks overseeing training and live missions.

The introduction of 5G on the flightline brings significant ehancements in speed, connectivity, and data capacity, enabling advanced automation, real-time data processing, and improved connectivity for both indoor and outdoor flightline and airbase operations. Additionally, 5G powers transformative technologies like artificial intelligence (AI), virtual reality (VR), and the Internet of Things (IoT), revolutionizing defense operations and logistics.

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SITUATION

Traditional flightline operations often face several challenges that impact efficiency, safety, and cost-effectiveness. Key issues related to airfield operations personnel included:

Communication delays:
Flightline operations rely on coordination among various teams (e.g., maintenance, refueling, loading, air traffic control). Traditional communication systems regularly experienced delays or miscommunication, impacting mission and flight planning, leading to operational slowdowns and, in particular, lower sortie generation rate.

Limited data access and manual processes:
The existing flightline operations lacked real-time data access, relied on manual data entry, paper logs, and radio push-to-talk communications, which were limited to a small group of users on disconnected networks. This led to slow data transfer and higher chances of human error.

Maintenance delays and unscheduled downtime:
Maintenance on operational assets was often reactive rather than predictive, leading to unexpected aircraft downtime. Without real-time or advanced diagnostics, or even better advanced diagnostics, maintenance crews were unable to detect issues early, resulting in extended repairs, last-minute training, mission cancellations, and further reduction in sortie generation rates.

Asset and inventory management challenges:
Managing tools, parts, and consumables across multiple hangars and locations was difficult without automated tracking. Misplaced or unavailable parts resulted in delayed repairs, while excessive inventory raised costs.

Environmental and safety risks:
Refueling, heavy lifting, and engine testing are hazardous without automated or remote assistance, requiring staff to be physically present in high-risk areas. This increases the potential for mishaps, raises safety concerns, and contributes to staffing challenges.

Inefficient resource allocation:
Without integrated digital systems, the flightline struggled with efficient use of resources like fuel trucks, labor, and equipment, even when available.

Higher operating costs:
The inefficient and outdated processes contributed to higher operating costs. The reliance on manual labor, limited automation, and lengthy repair times added to the operational expense of maintaining and preparing aircraft for their mission.

Lack of airfield / flightline wide communication:
Efficient communications was available around the control tower and main buildings, but not across the entire flight line and airfield premises, which spans multiple miles. As a result, communication between airfield personnel and assets was limited. In addition, personnel and pilots often had to physically go to the main building to operate their applications connected to available wired or Wi-Fi networks.

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CONTEXT

5G mobile network technology

5G is the fifth generation of mobile network technology, designed to offer faster data speeds, lower latency, and more reliable connectivity than previous generations like 4G LTE. It operates on higher frequency bands, allowing for much faster data transfer—potentially up to 100 times faster than 4G—enabling downloads, streaming, and communication in near real-time.

5G supports a higher number of connected devices, essential for IoT, UXVs, robotic systems, uncrewed systems and drones. It reduces network congestion, benefitting Command-and-Control networks, and enhances performance for VR and AR applications. With its low latency and high speed, 5G drives innovations across government and defense, from base modernization to edge mobility.

O-RAN: Open Radio Access Network refers to an open and interoperable approach to building and operating cellular networks, where network functions are decoupled from proprietary hardware and software provided by a single vendor. This enables different contractors to supply hardware and software components, promoting innovation, flexibility, and cost savings to the advantage of the government and military customers.

Private Wireless Network (PWN): A private 5G wireless network is a dedicated, high-speed cellular network that operates within a specific organization or location, such as a factory, campus, military installation or airbase. Unlike public 5G networks that are provided by telecom carriers and serve the public, private 5G networks are owned or managed by the organization using them, offering more control over data, security, frequency bands and network configurations. Military organizations, for example, can tailor private 5G networks to meet their specific needs, such as prioritizing certain types of traffic, controlling device access, network and cyber security, and integrating the network with other internal systems. Additionally, private 5G can be scaled up or down to support a growing number of devices as needs evolve.

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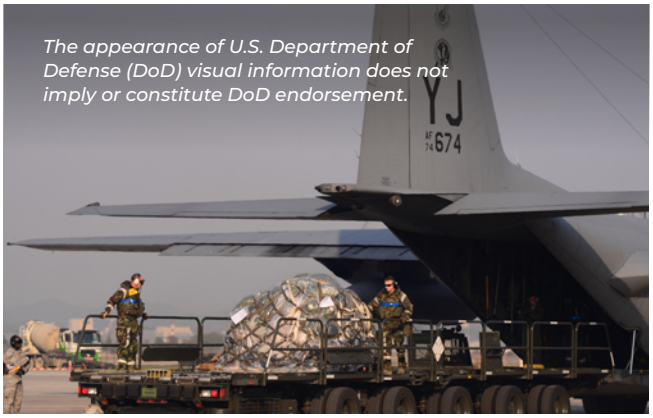
SOLUTION

Private wireless network

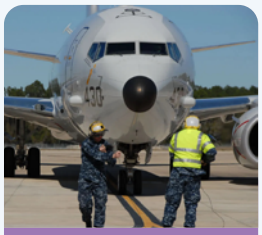
JMA provided its XRAN Private Wireless Network solution covering over 2 miles of outdoor flightline area including multiple indoor hangar / warehouse spaces. XRAN is a fully virtualized O-RAN distributed system built on software-based architecture using standard commercial-off-the-shelf (COTS) components, leveraging existing government IT infrastructure.

XRAN can work across multiple bands, supporting both 4G and 5G technologies. Devices in the warehouse environment require LTE-M support on licensed bands, while other, newer applications perform better on the 5G CBRS system.

The solution's critical components include a 4G/5G core, virtual baseband, centralized unit (CU), and distributed unit (DU), indoor and outdoor RU's covering multiple spectrum bands, edge computing platform supporting flightline and logistics applications, a distribution switch, a digital electricity system, and a Distributed Antenna System (DAS). The entire solution was integrated with the base fiber network and COTS IT data center leveraging a "Zero Trust Architecture".



After completion of the PWN solution, new flightline automation applications were activated supporting; rapid data analytics, digital inspections, smart ground support, "connected maintainer", and remote engineering support (see picture below).



Rapid data analytics

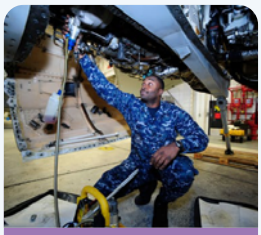
Aircraft and mission data offload

Digital inspections

Aircraft engine inspection with video and ML

Smart ground support

GSE tracking and service optimization



Connected maintainer

Maintenance process/staff mobility

Remote engineering support

AR/VR and reach back augmentation

5G connectivity is enabling technology for operational impacts to include:

- Increased sortie rates
- Efficient use of training ranges
- Flight safety
- Mission readiness
- Emergent maintenance capabilities
- Surge capacity

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RESULTS

Instant high-capacity communication infrastucture

Airbase and flightline 5G private wireless networks using unlicensed, licensed or shared spectrum, offer fiber-like speed, capacity and reliability. They enable low-latency applications, offer efficiencies, and provide frequency band flexibility, often not feasible with wired or other wireless network solutions.

Specifically:

The flightline 5G PWN enabled instant high-capacity communications to all base tenants, including large numbers of mobile users and User Equipment (UE). This allowed for quick and efficient coordination between personnel and the tracking of mobile equipment, tools, and supplies during critical events such as fueling, repairing, and retargeting air assets, leading to an increased sortie rate and more efficient use of available training ranges.

The flightline 5G PWN enabled continuous monitoring of military aircraft using IoT sensors that transmit real-time data on the condition of critical systems. Maintenance crews were able to receive instant alerts on potential issues, allowing for predictive maintenance, reducing the likelihood of aircraft downtime and improving mishap prevention.

The flightline 5G PWN enabled technicians on the tarmac, or in the hangar, to receive real-time guidance from remote experts through high-definition video calls and augmented reality (AR) overlays. This allows less experienced workers to perform complex repairs with expert assistance, reducing errors and downtime whilst increasing the sortie rate.

The flightline 5G PWN provided instant connections for all UE with minimal setup, drastically simplifying the need for training or technical support.

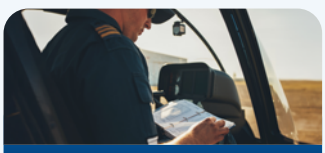
The flightline 5G PWN enabled seamless communication between the airfield warehouses and supply chain partners. Real-time data sharing allowed for better coordination of inbound and outbound logistics, reducing delays, improving supply chain efficiency and reducing costs.

Significant network cost savings due to availability of 50x unmetered capacity and throughput vs. public paid for cellular services.

The flightline 5G PWN has multiple mobile architectures deployed with an expanding set of 5G-enabled flightline logistics modernization efforts and emerging ‘Digital Depot’ MRO applications, both organic and in progress.

Emergent/Organic

AR/VR aircraft corrosion inspection



Pilot flight manuals & notices updates

Ad hoc operations center & events

Airfield security & safety

About JMA Wireless

JMA Wireless is restoring U.S. leadership in wireless technology at a critical time in the transition to 5G. JMA makes the world's most advanced software-based 5G platform, which it designs and manufactures in the United States. JMA's Open RAN platform is ushering in a new era of innovation and connectivity with leading government organizations.

The JMA Federal team is enabling modernization at scale and helping the DoD make wireless history by deploying the most advanced private 5G networks at the U.S. Army, Navy, Air Force, and Marine Corps, enabling modernization at scale for frontline military operations, smart warehouse logistics, and flightlines of the future.

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U.S. ARMY

NIWC PACIFIC

For more information: www.jmawireless.com/government

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