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**CSIAC TECHNICAL INQUIRY (TI) RESPONSE REPORT**

Overarching Wireless Technology Program for Flight Lines in the U.S. Air Force

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A chief service of the DoD IACs is free technical inquiry (TI) research, limited to 4 research hours per inquiry. This TI response report summarizes the research findings of one such inquiry jointly conducted by CSIAC.

# ABSTRACT

The Cybersecurity & Information Systems Information Analysis Center (CSIAC) was tasked with researching and identifying an all-encompassing wireless technology program for wireless communications on flight lines used by the United States Air Force (USAF). CSIAC identified wireless standards provided by the U.S. Department of Defense (DoD) that should be followed by all DoD programs, employees, and contractors. CSIAC also identified various modern wireless technologies used to improve wireless connection on flight lines and hangars and standard processes used to implement these wireless technologies effectively and efficiently. Wireless communication technology is especially important to supporting flight line operations and maintenance workflows. Improving these technologies could improve the productivity and efficiency of operations personnel. Throughout the USAF, implementing new wireless technologies varies base by base, as the infrastructure is designed specifically to each base’s needs.

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# 1.0 TI Request

## 1.1 Inquiry

Is there an overarching Wi-Fi program for the United States Air Force (USAF)?

## 1.2 Description

The Cybersecurity and Information Systems Information Analysis Center (CSIAC) was asked if the USAF had any specific guidance on standard, approved wireless technologies. The inquirer is working on prototyping software and tools that can help advance capabilities on the flight line; however, these devices need the correct connectivity to function properly in a flight line environment.

# 2.0 TI Response

## 2.1 Notable Wireless Standards

To have the correct wireless infrastructure and security posture, the wireless environment must comply with various standards provided by the U.S. Department of Defense (DoD). The USAF determined they need a wireless platform that could incorporate layer 2 encryption and wireless intrusion detection systems, support complex applications, and meet or exceed all DoD security standards [1]. Some notable wireless standards found are the Base Information Transport Infrastructure (BITI) wired/wireless program [2], the Federal Information Processing Standard (FIPS) 140-2 Certification [3], the Federal Information Processing Standard (FIPS) 140-3 Certification [4], the National Institute of Standards and Technology (NIST) Special Publication (SP) 800-153 [5], and the requirements outlined in DoD Directive 8100.02 [6].

### 2.1.1 BITI

In 2009, the Combat Information Transport System program was restructured into two pre-Major Automated Information System components—Information Transport System (ITS) and Air Force Intranet. In 2012, the ITS program was renamed BITI, which included the wired and wireless components [2]. BITI wired provides the core Air Force network infrastructure for 178 fixed Air Force installations and geographically separated units. BITI wired capabilities encompass optical cable systems, digital voice/data/video systems, and allied support, resulting in high-speed packet switching and circuit transport of critical information among core buildings and mission areas on a base. Additionally, BITI wireless provides a robust and secure wireless infrastructure that incorporates high-availability and multitiered network connections at facilities requiring remote access, such as flight lines, hangars, medical facilities, and large storage areas.

### 2.1.2 FIPS 140-2

The FIPS 140-2 certification identifies the security requirements that should be fulfilled by a cryptographic module implemented within a security system protecting sensitive but unclassified information. FIPS 140-2 also provides four increasing, qualitative levels of security: Level 1, Level 2, Level 3, and Level 4. These levels are intended to cover the wide range of potential applications and environments in which cryptographic modules may be employed. The security requirements cover areas related to the secure design and implementation of a cryptographic module. These areas include cryptographic module specification, cryptographic module ports and interfaces; roles, services, and authentication; finite state model; physical security; operational environment; cryptographic key management; electromagnetic interference/electromagnetic compatibility; self-tests; design assurance; and mitigation of other attacks [3].

### 2.1.3 FIPS 140-3

On 22 March 2019, the Secretary of Commerce approved [FIPS 140-3](https://csrc.nist.gov/publications/detail/fips/140/3/final), “**Security Requirements for Cryptographic Modules**,” which supersedes FIPS 140-2. This was [announced in the Federal Register](https://www.federalregister.gov/d/2019-08817) on 1 May 2019 and became effective 22 September 2019. FIPS 140-2 will run through 2026 [4].

The new standard introduces some significant changes. Rather than encompassing the module requirements directly, FIPS 140-3 references the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) 19790:2012 security requirements. The testing for these requirements will be in accordance with ISO/IEC 24759:2017 security requirements. While there are few major technical requirement changes, the use of the ISO documents requires several procedural changes in the management and execution of the validation program and process [4].

### 2.1.4 NIST SP 800-153

NIST SP 800-153 provides organizations with recommendations for improving the security configuration and monitoring of their IEEE 802.11 wireless local area networks and devices connecting to those networks [5].

### 2.1.5 DoD Directive 8100.02

The purpose of DoD Directive 8100.02 is to establish policies and assign responsibilities for the use of commercial wireless devices, services, and technologies in the DoD Global Information Grid; direct the development and use of a knowledge management process to promote the sharing of wireless technology capabilities, vulnerabilities, and vulnerability mitigation strategies throughout the DoD; and promote joint interoperability using open standards throughout the DoD for commercial wireless services, devices, and technological implementations [6].

Overall, these standards were created and put in place to ensure that wireless technologies are implemented and managed properly and can be secured properly.

## 2.2 WIRELESS Technologies and Implementation

There are four key reasons for problems that arise with wireless connectivity in hangars and flight lines:

1. There is such a large and vast amount of space in which a wireless signal must travel.
2. Many of the structures in these environments are created with metal, concrete, and other building materials which can block wireless signals.
3. There is a dynamic array of vehicles that can be present in a hangar or flight line at any given moment; these vehicles tend to also block wireless signals.
4. Enterprise/commercial-grade, wireless access points may perform well in an office setting but poor on flight lines.

When trying to advance the wireless capabilities of a wireless environment, there are very important steps that should be a part of every implementation effort. First, conduct a site survey of the wireless environment. Make sure to interview on-the-ground personnel about their daily workflows, when they access the wireless network, and where they see the most issues [7]. Then, measure the overall wireless coverage throughout the location. This includes measuring the average wireless signal strength, download speeds, upload speeds, and latency for every wireless access point. Next, based on the site-survey and measurements, create a wireless coverage model of the wireless environment needing improvement [8]. This wireless coverage model will be the roadmap to implement any new wireless technologies efficiently and cost effectively.

There are two major wireless technologies currently being implemented to improve wireless capabilities in hangars and flight lines throughout the USAF—mesh networks and citizens broadband radio service (CBRS)/private long-term evolution (LTE).

A mesh network is a network of devices or nodes connected directly and dynamically without a node taking priority over another. Each node connects to as many other nodes as possible and can dynamically change which node it connects to based on the wireless environment or scenario. For example, if a wireless access point is obstructed by a plane on the flight line while trying to connect to another node, it can redirect its connection to another unobstructed access point. Mesh networks allow organizations to efficiently route data from one user to another while maintaining a consistent connection throughout a wireless environment.

CBRS is a lightly licensed band that uses the 3550–3700-MHz band (3.5-GHz band) for shared commercial use. CBRS also features a dynamic spectrum access system which manages the allocation of frequencies in this shared range. CBRS uses a three-tiered access and authorization framework. Incumbent access users (Tier 1), which include authorized federal users within the 3550–3700-MHz range, receive protection against harmful interference from priority access licensees (PALs) and general authorized access (GAA) users. The priority access tier (Tier 2) consists of PALs that will be licensed on a county-by-county basis through competitive bidding. Each PAL consists of a 10-MHz channel within the 3550–3650-MHz band. PALs are 10-year renewable licenses and must protect and accept interference from incumbent access users but receive protection from GAA users. The GAA tier (Tier 3) is licensed by rule to permit open, flexible access to the band for the widest possible group of potential users. GAA users can operate throughout the 3550–3700-MHz band, must not cause harmful interference to incumbent access users or priority access licensees, and must accept interference from these users [9].

While the Citizens Broadband Radio Service can be used for 4G LTE, it is ideally suited to delivering fixed or mobile 5G new radio (5GNR). Specifically, CBRS can be employed by enterprise information technology providers to build out a private LTE network supporting large warehouse facilities, sports stadiums, and remote mines. CBRS can replace existing distributed antenna systems, providing high-speed data offload and in-building coverage. This will be particularly important when deploying 5GNR in the gigahertz spectrum, where CBRS can offset the significant signal degradation experienced when traversing general construction materials [9].

In the briefing provided by the Sierra Nevada Corporation, they discuss adding more access points to improve coverage and redundancy and utilizing directional antennas for access points. The briefing also mentions installing a wireless mesh network to extend connectivity range and utilizing a private LTE as a complimentary network to support backup communications. These infrastructure upgrades were critical to supporting the flight line of the future improvements at Homestead Air Reserve Base in Florida [8]. The SMS Data Products Group, Inc. (SMS) team boosted antenna strength to extend the range of the access port devices needed for better flight line coverage. They also created a network configuration designed to allow the addition of mobile access points to communicate as a mesh network. The Air Force technicians could place these mobile devices and obtain connections in previously inaccessible flight line spots, enhancing mission critical coverage [7].

The way improvements are implemented into wireless environments depends on the wireless coverage model of the environment and the information gathered from the site survey. Different wireless environments require different implementations for the varying workflows of the USAF.

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