

Industrial IoT Solutions for Federal Bands

High-Performance Data Links for Public Safety and Defense applications



The need for Industrial IoT solutions for Federal bands

Federal, Public Safety, and Defense applications deployed in the field are highly dependent on reliable and robust communications links. Currently, most Federal bands still use old wireless technologies and waveforms that were designed for voice and low bandwidth data traffic. However, to meet the demands of modern applications requiring huge amounts of data and high-definition video, newer technologies are needed.



At the same time the Public Safety and Defense sectors are still using dated wireless technology, the surge in popularity of the Industrial Internet of Things (Industrial IoT) has driven the development of new technologies in the private sector. While it would seem that migrating these innovations to Public Safety and Defense applications would be straightforward, that has not been the case. In practice, finding wireless communications solutions that can leverage the latest innovations from Industrial IoT and operating at licensed-band Federal frequencies is a challenge for government-focused OEMs.

Doodle Labs solves these problems by using state-of-the-art MIMO technologies, IP-based network architectures and applying them to Federal bands. As a result, OEMs can integrate modern wireless platforms at a significantly lower cost than the legacy technology. This combination of enhanced performance and lower cost comes together to drive innovation and create a compelling business case for the use of newer wireless technologies in Federal, Public

Safety, and Defense verticals.

In addition to the lack of development that existed at Federal bands, the nuanced regulatory requirements put in place by the NTIA (National Telecommunications and Information Administration) create barriers to entry and add complexity. Doodle Labs has worked extensively to meet these requirements and make compliance and integration as seamless as possible. The Doodle Labs product offering consists of several wireless building blocks that are designed with modularity and extensibility in mind. This enables OEMs to design solutions that are customized to meet the unique demands of a Federal agency or unique use-case.

Public Safety and Municipal Applications

Public safety agencies are striving to improve their effectiveness and responsiveness within their own jurisdictions as well as enhance their ability to collaborate with other agencies. This is driven by an increased focus on homeland security that demands improved inter-agency communications and deeper levels of connectivity with first responders.

More and more first responder units are transitioning away from using just simple text and voice communications in the field. More departments are adopting modern tech like UAV and UGV systems, making the need for high-performance wireless communications at Federal bands even greater.

Defense

Military applications of Industrial IoT technology have been around for some time. However, there are many areas where the benefits of modern Industrial IoT and wireless sensor technology are underutilized in the Armed Forces. To further enhance military capabilities, officials and leaders in the industry are now exploring ways to leverage IoT in ISR (Intelligence, Surveillance, and Reconnaissance) applications, such as unmanned vehicles.

The combination of IoT and ISR present several opportunities for military units across the world, by enhancing current mission-critical capabilities and enabling new innovative techniques. For example, by using state-of-the-art MIMO technology to enable [long range video streaming on unmanned aerial systems](#), military units can enhance their ISR capabilities significantly.

Another area of opportunity is the connection of private networks using wireless Ethernet extenders capable of operating at Federal bands. Operating at Federal bands helps to enhance security and privacy. Additionally, by using licensed-band frequencies, wireless connectivity becomes inherently more robust and reliable because there is less congestion on the network.

When developing solutions for Defense applications, security and encryption are of the utmost importance. Doodle Labs recognizes this and has worked extensively to ensure its wireless solutions can meet the stringent security and encryption requirements the Defense sector demands. For example, Doodle Labs products offer 256-bit AES encryption and have successfully been integrated into FIPS 140-2, Level 2 compliant systems.



Overview of Federal frequencies

The NTIA allocates specific frequency bands for Federal use that are not used in the private sector. As a result of the lack of private sector use, there are fewer new radio and wireless technologies in the tightly regulated world of wireless Public Safety and Defense applications.

When you contrast this paradigm with the widely used 802.11 global standards, you can easily understand the problem. The 802.11 standards benefit from the contributions of hardware and software vendors from around the world. On the other hand, in the Public Safety and Defense space, communication systems for licensed-band frequencies must be developed in-house. This in turn forces OEMs to engage in costly development cycles and miss out on the benefits of the developments and discoveries made by others in the ecosystem.

Doodle Labs helps solve this problem by bringing the technological benefits of 802.11 OFDM/MIMO technology and applying them to Federal frequencies. Doodle Labs' proprietary BII (Broadband for Industrial IoT) [technology](#) enables solutions that can operate at any frequency between 100 MHz – 6 GHz. (see appendix for table of frequencies). Doodle Labs also offers a variety of off-the-shelf solutions for many of the most commonly used frequency bands.

Another challenge with NTIA's method of frequency allocation is that there is some opacity in how frequency band allocation works. This is due in large part to lack of documentation and highly bureaucratic procedures in the sector. Partnering with an experienced wireless solutions provider like Doodle Labs can help overcome the knowledge gaps and rapidly identify the right solution for a given use case.

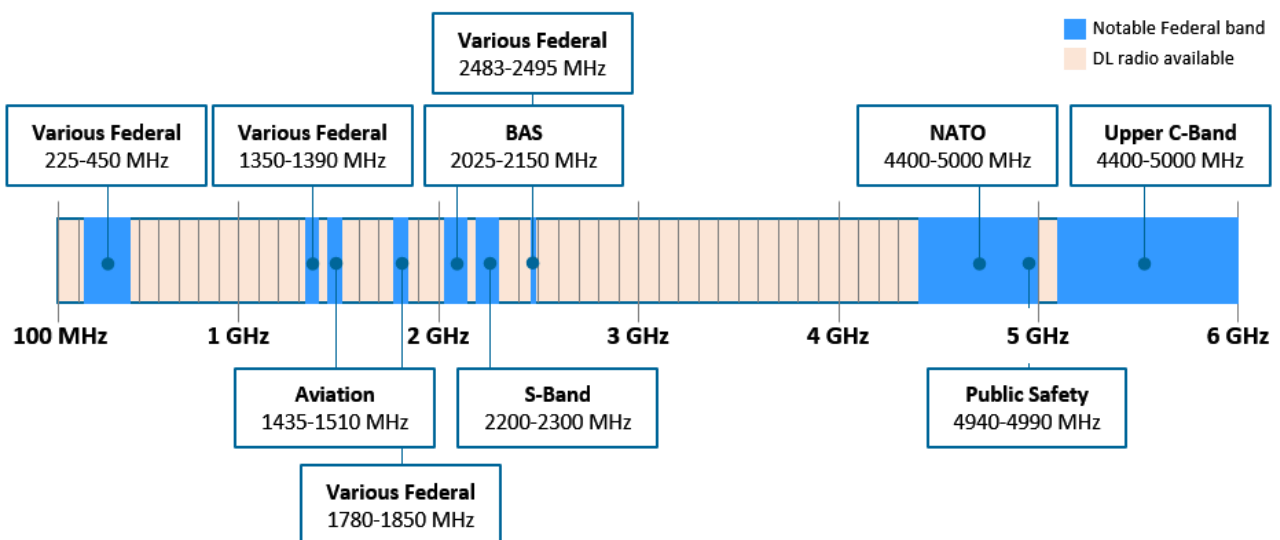


Figure 1 Federal bands that are frequently discussed.
Doodle Labs radios are available from 100 MHz – 6 GHz

Addressing Requirements of Public Safety and Defense OEMs

System developers face several common challenges when designing solutions for public safety and defense use. Doodle Labs helps solve these challenges. Below are some of the most common challenges OEMs in the space face, and how they can be addressed.

Licensed and Unlicensed-Band Operation



Public Safety and Defense end-users have access to special subset of frequency bands. Manufacturers need systems that can communicate in each of these frequencies without requiring costly system redesigns. For example, a multi-purpose UAV needs to operate at different frequencies depending on whether they are being deployed by the FBI (e.g. 1.8 GHz Federal band), military (e.g. 4.6 GHz NATO band), or a construction company (e.g. 900 MHz ISM band).

Doodle Labs' BII technology offers OEMs the extensibility needed to seamlessly integrate wireless into their systems, regardless of the application. It enables support for frequencies from 100 MHz to 6 GHz. This means that OEMs who leverage Doodle Labs' solutions can optimize their systems for a specific frequency band, without costly system overhauls. Additionally, BII technology enables users of Doodle Labs solutions to have granular control of frequency selection, including choosing channel sizes as small as 3 MHz.

Encryption and Immunity against Cyber Attacks

Public Safety, Defense, and many Commercial applications transmit highly sensitive data. Communications must be secure, and the vehicles must be protected from unintended parties gaining access. Doodle Labs solutions help OEMs ensure that their solutions meet the stringent security requirements in the space, including meeting FIPS 140-2, Level 2 compliance.



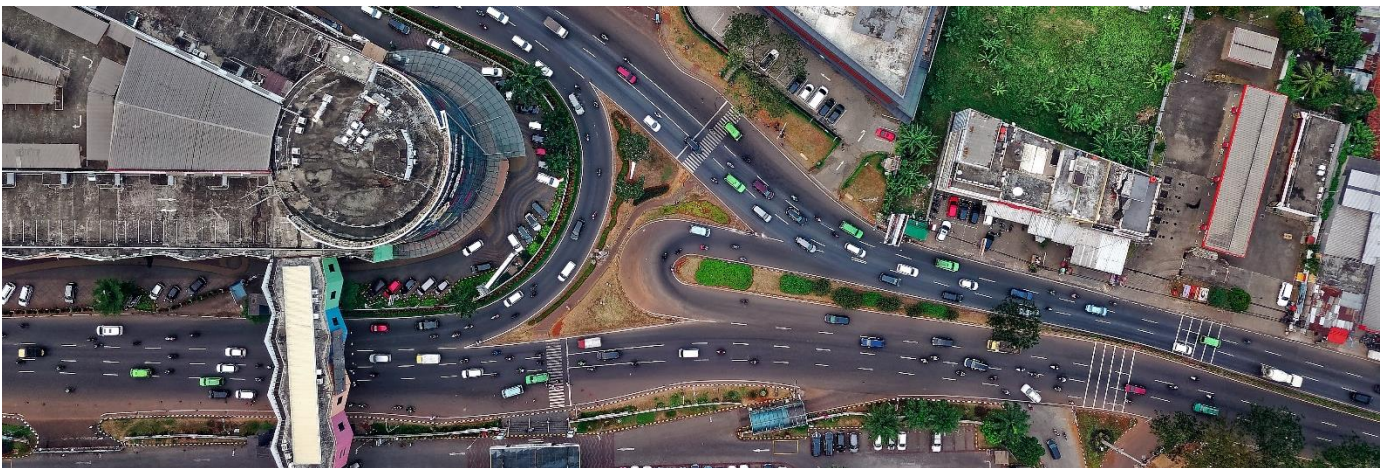
The Smart Radio, for example, deploys 256-bit and 128-bit AES encryption, protection against DoS (Denial of Service) attacks, firewall & VPN capabilities, protection against noise and jamming attacks. Other solutions, like Special Band Transceivers, can operate as a transparent link to leverage a system's pre-existing encryption technologies.

Reliable Links

Robust and reliable communications are of the utmost importance to first responders. Whether responding to an emergency or communicating under “normal” operating conditions, first responders rely upon a variety of communication tools to do their jobs effectively.

It is naïve to expect interference-free environments in the field. Real world applications tend to be noisy with many competing devices operating on the same frequency bands. Products from Doodle Labs help account for this as they are finely tuned with precise, customized filters on their front-ends. They also have a receive sensitivity of up to -100 dBm, which is superior to any comparable product on the market. This allows the radios to detect weak signals, and dramatically increase operating range.

Additionally, as communications devices move around and change direction, often at very fast speeds, issues can emerge from the shifting orientation of the link. BII software mitigates these risks through a host of advanced networking features like Convolutional Coding, Forward Error Correction, ACK-retransmits, Maximal Ratio Combining, Spatial Multiplexing, Beam Forming, and Space Time Block Coding. The mesh networking capabilities built into select Doodle Labs products further enhance network resilience and communications reliability.



Long-Range Communications

When dealing with long-distance communications and video streaming, for example in a military ISR application, line of sight problems can have a significant negative impact on operations. It can be frustrating to have developed a system that has the potential to complete missions over many kilometers, only to be limited by the communications link. Doodle Labs solutions have been deployed in numerous systems where high-definition sensor data, including 4K video, is streamed to the ground station from over 10 kilometers away. Doodle Labs Smart Radios combine 33 dBm of transmit power with the networking features of BII technology to maintain a stable, secure link.

Military-Grade Construction

Communications units that will see use in the field must be designed to stand up to rough treatment and harsh environmental conditions. Many Doodle Labs products have been constructed using ruggedized, vibration-resistant components, and tamper-evident casings. They can operate within the industrial temperature range of -40°C to +85°C. Further, Doodle Labs conducts thorough performance tests on every individual unit to ensure that each product meets the highest quality standards.

Ease of Integration

For OEMs in the Public Safety and Defense sector, extensibility and ease of integration are important design aspects. The ability to use a solution in more than one application enables economies of scale, optimized workflows, and minimizes complexity.

To help enable OEMs to design solutions that can integrate into a variety of applications with minimal complexity, Doodle Labs wireless solutions are designed to be plug-and-play. In addition to offering several commonly supported interfaces (e.g. Ethernet, UART, USB, GPIO, miniPCIe), Doodle Labs wireless radios are form-factor compatible so that they can easily be switched.



Further, [Front End Subsystems \(FES\)](#) allow OEMs to simply swap a single module to enable compatibility with a given set of customer frequency requirements.

Conclusion

As we have seen, dated wireless technology has bottlenecked innovation in the Public Safety and Defense sectors for years. The inability to leverage the same solutions available to the private sector has hamstrung OEMs and prevented Public Safety and Defense agencies from optimizing their field operations. By bringing secure, modular, wireless building blocks to Federal frequencies, Doodle Labs enables OEMs bring the power of Industrial IoT to the space and help drive modernization and innovation.

If you're interested in learning more about how to best design a wireless solution for Public Safety and Defense applications, [contact us](#) today.

Appendix – Selected Available Frequencies

Frequency Range (MHz)	Description	Availability/ Model No.
902-928	<p>License Free ISM Band – USA, Canada, Mexico, Central, South and Latin Americas, Australia, New Zealand and China</p> <p>The 900 MHz band is license free for use in many countries around the world. At lower frequencies, the radio signals can travel farther and penetrate through the walls and vegetation, providing better NLOS operation. The 900 MHz band provides an excellent alternative to the crowded 2.4 GHz Wi-Fi band. The Smart Radio is used by many UAS and Ground Robotic Systems.</p> <p>Several models are available with 2x2 MIMO and features to match the project budget, Ethernet and UART interfaces, Longer than 20 Km range, up to 80 Mbps TCP/IP throughput, Up to 30 dBm RF power, FCC and IC Certification</p>	<p>View 915 MHz Smart Radio Datasheet</p>
1350-1390	<p>Federal L-Band</p> <p>L-Band Smart Radios were designed for use by Military (1350 – 1390 MHz) and Overseas customers. The longer wavelength of the L-Band allows to reach further distances with omnidirectional antennas, which is ideal for UAS applications. Available in 2x2 MIMO Streams, Ethernet and UART interfaces, Software defined 3/5/10/20 MHz channel BW, up to 80 Mbps TCP/IP throughput, Up to 30 dBm RF power</p>	<p>View L-Band Smart Radio Datasheet</p>
1435-1510	<p>Federal Band</p> <p>This frequency range usually requires special configuration to match the project specifications. Please contact us and we can explore how best we can support your requirements. Available in 2x2 MIMO Streams, Ethernet and UART interfaces, Software defined 3/5/10/20 MHz channel BW, up to 80 Mbps TCP/IP throughput, Up to 30 dBm RF power</p>	<p>Contact US</p>
1670-1710	<p>Federal Band</p> <p>Available in 2x2 MIMO Streams, Ethernet and UART interfaces, 3/5/10/20 MHz channel BW, up to 80 Mbps TCP/IP throughput, Up to 30 dBm RF power</p>	<p>RM-1690 Datasheet</p>

1780-1850	<p>Federal Band</p> <p>Available in 2x2 MIMO Streams, Ethernet and UART interfaces, 3/5/10/20 MHz channel BW, up to 80 Mbps TCP/IP throughput, Up to 30 dBm RF power</p>	<p>RM-1815 Datasheet</p>
2025-2105	<p>Broadcast Auxiliary Stations Band (BAS Band)</p> <p>BAS Band Smart Radio is designed for use by TV and radio stations in applications such as live event video streaming and electronic news gathering. The BAS Band Smart Radio allows broadcasters to use their licensed spectrum without monthly fees. Verified for FCC Part 74 compliance.</p> <p>Available in 2x2 MIMO Streams, Ethernet and UART interfaces, 6/12 MHz channel BW, up to 50 Mbps TCP/IP throughput for multiple 4k video streams, Up to 33 dBm RF power for long range</p>	<p>View BAS band Smart Radio Datasheet</p>
2200-2300	<p>Federal S-Band</p> <p>Smart Radio for S-Band is ideal for use by Federal agency in (2200 – 2300 MHz) frequency range. This radio is ideal for cities, where users can take advantage of the S-Band wavelength for superior RF reflections and penetration in urban environments.</p> <p>Available in 2x2 MIMO Streams, Ethernet and UART interfaces, Software defined 3/5/10 and 20 MHz channel BW, up to 80 Mbps TCP/IP throughput, Up to 33 dBm RF power for long range</p>	<p>View S-Band Smart Radio Datasheet</p>
2400-2482	<p>License free ISM Wi-Fi band (Worldwide)</p> <p>Wi-Fi Smart Radio is fully compatible with all the Smartphone and mobile devices. These Smart Radios are used for long range and deployments in the harsh environments. Several models with 2x2 MIMO Streams and features to match the project budget, Ethernet and UART interfaces, 3/5/10/20/40 MHz channel BW, up to 100 Mbps TCP/IP throughput, Up to 33 dBm RF power, FCC, CE and IC certified</p>	<p>View Wi-Fi Smart Radio Datasheet</p>
2483-2495	<p>Federal Band</p> <p>Available in 2x2 MIMO Streams, Ethernet and UART interfaces, 3/6/12 MHz channel BW, up to 50 Mbps TCP/IP throughput, Up to 33 dBm RF power</p>	<p>Contact US</p>
3300-3400	<p>Communication Band, Europe</p>	<p>Contact US</p>

	Available in 2x2 MIMO Streams, Ethernet interface, 3/5/10/20 MHz channel BW, up to 80 Mbps TCP/IP throughput, Up to 27 dBm RF power	
3400-3600	Communication Band, Europe Available in 2x2 MIMO Streams, Ethernet and UART interfaces, 3/5/10/20 MHz channel BW, up to 80 Mbps TCP/IP throughput, Up to 27 dBm RF power	RM-3500 Datasheet
3600-3800	Communication Band, Europe Available in 2x2 MIMO Streams, Ethernet and UART interfaces, 3/5/10/20 MHz channel BW, up to 80 Mbps TCP/IP throughput, Up to 27 dBm RF power	RM-3700 Datasheet
4400-4800	Federal Band, NATO Band, Broadband Disaster Recovery (BBDR) Band 1 or 2 MIMO Streams, 5/10/20 MHz channel BW, up to 31 dBm RF power, frequency shifted 802.11n, ath9k driver, miniPCIe interface, Rugged, -40C to +85C. Compliant to NTIA channel plan	NM-4600 Datasheet
4700-5200	Military Band 1 or 2 MIMO Streams, 5/10/20 MHz channel BW, up to 31 dBm RF power, frequency shifted 802.11n, ath9k driver, miniPCIe interface, Rugged, -40C to +85C. Compliant to NTIA channel plan	NM-4950 Datasheet
4800-5000	NATO Band 1 or 2 MIMO Streams, 5/10/20 MHz channel BW, up to 31 dBm RF power, frequency shifted 802.11n, ath9k driver, miniPCIe interface, Rugged, -40C to +85C. Compliant to NTIA channel plan	NM-4900 Datasheet
4940-4990	Public Safety Band, 802.11n/y, Compliant with FCC Docket #00-32 on 4.9 GHz ruling 1 or 2 MIMO Streams, 5/10/20 MHz channel BW, up to 32 dBm RF power, miniPCIe interface, Rugged, -40C to +85C	NM-4965 Datasheet
5150-5850 (5 GHz WiFi)	License Free ISM and UNII Bands	NM-5500 Datasheet

	1 or 2 MIMO Streams, 5/10/20/40 MHz channel BW, Up to 30 dBm RF power, 802.11n, ath9k driver, miniPCle interface, Rugged, -40C to +85C.	
5650-5925	Federal Band, ITS band 1 or 2 MIMO Streams, 5/10/20 MHz channel BW, up to 30 dBm RF power, frequency shifted 802.11n, ath9k driver, miniPCle interface, Rugged, -40C to +85C.	<u>NM-5790 Datasheet</u>