Private 5G networks are expected to play a huge role in Defense and Tactical networks in the future to enable secure and resilient information exchange, command and control, and situational awareness for military operations at both strategic and tactical levels.

Introduction

Wireless networks have served as part of the defense and tactical networks for a very long time. Due to many different limitations, these wireless networks were proprietary in nature with custom-made network equipment and devices. This resulted in huge challenges when additional infrastructure or devices were needed at short notice.

With the hardware and technological advances that 5G brings, many countries, regions, and security services have started to explore the use of private 5G (P5G) networks for defense and tactical purposes.

Defense networks are wide-area communication infrastructures that serve as the backbone for military operations which are typically designed to provide long-range, high-capacity connectivity across large geographic areas. Defense networks are responsible for connecting military bases,

command centers, intelligence agencies, logistics units, and other military entities. These networks facilitate secure and reliable communication, information sharing, and coordination at strategic, operational, and tactical levels.

Tactical networks, on the other hand, are more localized networks that are designed for use in the field during military operations. They provide communication capabilities to troops, vehicles, and other assets in the immediate operational area. Tactical networks are characterized by their mobility, flexibility, and ability to be rapidly deployed. They enable real-time situational awareness, command and control, and coordination among individual soldiers, small units, and commanders in dynamic and often challenging environments.

It is important to remember that the main objective of these defense and tactical networks is to establish secure, robust, and resilient communication channels that enable military forces to effectively carry out their missions. These networks support voice, data, video, group communications, and various other applications that are critical to, and the lifeblood of military operations. These networks must be designed to meet the highest standards and needs of the military, such as ensuring security, privacy, low latency, high reliability, and interoperability with other military systems and equipment.

Due to these multi-faceted requirements, 5G and specifically P5G will have a huge role to play in the future of these defense and tactical networks.

Benefits of P5G Networks in Defense and Tactical Networks

P5G networks are expected to be used in Defense and Tactical networks to provide secure and reliable communication capabilities. Here are some of the ways in which these networks may be used:

- **Network Segmentation and Prioritization:** Defense networks require strict segmentation and prioritization to ensure critical operations receive optimal network resources. P5G networks can be configured with dedicated network slices, allowing different applications and user groups to operate independently while maintaining security and quality of service.

- **Localized Coverage:** In certain defense scenarios, it may be necessary to establish communication networks in remote or isolated areas where public infrastructure is limited or nonexistent. P5G networks can be deployed as a standalone network-in-a-box (NIB) system, providing localized coverage and ensuring reliable connectivity in such environments.

- **Mobility and Flexibility:** Military operations often involve rapid deployment and the need for quick network setup. P5G networks can be deployed quickly, providing on-demand connectivity in the field, offering mobility and flexibility, and enabling seamless communication even during movement, which is crucial for tactical networks.

- **Resilience and Redundancy**: P5G networks can be designed with redundancy features to ensure resilience in the face of network failures or hostile actions. Multiple network access points, redundant backhaul connections, and distributed architecture can enhance network survivability and maintain communication capabilities in challenging conditions.

- **Secure Communications:** P5G networks can establish encrypted and secure communication channels for military personnel, allowing them to transmit sensitive information, voice, and video data without the risk of interception or unauthorized access. The advanced encryption protocols used in these networks enhance the overall security posture.

In short, P5G networks have a lot to offer which is what is making them a valuable option for defense and tactical networks.

Applications of P5G in Defense and Tactical Networks

P5G networks offer numerous applications and benefits in defense and tactical networks. Some of the key applications include:

- **Command and Control:** P5G networks can enhance command and control operations by providing seamless communication between commanders, field units, and headquarters. Real-time situational awareness, voice and video conferencing, and data sharing become more efficient and effective, improving decision-making processes in dynamic environments.

- **Real-time Situational Awareness: P5G** networks support the transmission of real-time data, including video streams, sensor data, and geolocation information. This enables military personnel to have a comprehensive and up-to-date understanding of the operational environment, enhancing situational awareness and informed decision-making.

- **Mission-Critical Applications: Defense** and tactical networks often require real-time data transmission and low-latency communication for mission-critical applications. P5G networks offer high-speed connectivity and low latency, enabling applications such as real-time video streaming, remote monitoring, unmanned systems, and augmented reality/virtual reality (AR/VR) training.

- **Augmented Reality (AR) and Virtual Reality (VR):** P5G networks support AR/VR applications in defense and tactical networks. Soldiers can use AR/VR headsets to receive real-time visual information, overlay digital maps, access training simulations, and receive remote guidance, enhancing situational awareness and training effectiveness.

- **Unmanned Systems and Autonomous Robots:** Defense and tactical networks can benefit from P5G connectivity for Uncrewed Aircraft Systems (UASs), including unmanned aerial vehicles (UAVs), unmanned ground vehicles (UGVs), and autonomous robots. P5G networks are able to provide low latency and high bandwidth, which is a must for real-time control, remote monitoring, and data transmission for these unmanned systems.

- **IoT-enabled Applications:** The Internet of Things (IoT) plays a significant role in defense and tactical networks. With cellular IoT technologies like LTE-M, NB-IoT, and RedCap maturing in 3GPP standards, P5G networks are expected to enable the deployment of a multitude of connected devices, including sensors, surveillance systems, wearable devices, and smart assets. These devices collect and transmit valuable data for monitoring, asset tracking, logistics, and decision-making support.

These are just a few examples of how private 4G/5G networks can be applied in defense and tactical networks. The advanced capabilities of these networks contribute to improved communication, situational awareness, command and control, and the overall effectiveness of military operations.

Network Infrastructure Requirements

It is generally accepted that three layers of networks would be necessary for military and defense personnel. They can be classified as:

1. Dedicated slice of public network for nationwide coverage.

2. Wide-area coverage in the field using a dedicated spectrum.

3. Opportunistic localized coverage in any available spectrum during operations.

While the nationwide public network would be deployed by a mobile network operator, P5G networks will be required in the other two scenarios. The wide-area defense network would typically be implemented as a hybrid network if access to personal devices is provided as well. The network infrastructure requirements for both the defense and tactical networks is slightly different as follows:

- **Defense Network:** High-power radio with antennas mounted on top of a post or tower, baseband units that are needed in high-capacity solutions, core network in case of standalone network but not required in case of hybrid networks, power generator or a source of power, and, devices with provisioned SIM cards. Defense networks have lots of parts and even though they are movable, they often require two or more people.

- **Tactical Networks**: Network in a box with antennas, small cell radios, core network, backhaul connectivity equipment if the connection to the base is needed, battery or other powering equipment, and, devices with provisioned SIM cards. Tactical networks are light as they have to be mobile and easy to carry, either in a backpack or in a small box.

In addition to the above, any applications that need to be run on the devices will also require a corresponding application server that can be a standalone server or could be on the same server as the core.

These infrastructure requirements lay the foundation for robust, secure, and agile P5G networks in defense and tactical environments. Each deployment is unique and as a result, the network design needs to be adapted to the specific needs and operational constraints specific to deployment. This ensures a reliable and effective network, capable of secure communication for military forces.

Implementation Challenges

Implementing P5G networks in defense and tactical networks can have several challenges. Here are some of the common ones to consider:

- **Spectrum:** Defense and Tactical networks need multiple bands of spectrum to cater for different situations and scenarios. Acquisition and use of these frequency bands can be a challenge as these bands are often limited and tightly regulated. It is also important to ensure that these bands are not disclosed to anyone otherwise jammers can be deployed in real-life situations making the network unusable.

- **Handsets and other Devices**: As each Defense and Tactical network uses its own set of spectrum, it may become challenging to obtain end-user devices easily. They may often have to be designed specifically, not just from the security point of view but also for the specific set of frequencies that will be in use within the network.

- **Backhaul:** Defense and Tactical networks operate in diverse and challenging environments, including remote areas, urban environments, and complex terrains. It is important for them to be able to communicate with the base and headquarters. This requires multiple secure and resilient backhauls to ensure the communication channel is always available.

- **Security:** Security is a paramount concern in defense and tactical networks. Implementing robust security measures to protect against cyber threats, unauthorized access, and data breaches is crucial. Establishing secure authentication protocols, encryption mechanisms, and intrusion detection systems requires careful planning and expertise.

- **Interoperability with Legacy Systems:** Defense organizations still often rely on a wide range of legacy communication systems and equipment. Ensuring interoperability between P5G networks and the existing legacy systems cannot only be challenging but may require careful planning and coordination to avoid compatibility issues as well as compromise in security.

- **Mobility and Rapid Deployment**: Defense and tactical operations demand quick deployment and mobility of communication networks. Designing agile P5G networks that can be rapidly deployed, reconfigured, and relocated is essential. Overcoming logistical challenges, ensuring portable infrastructure, and addressing power and connectivity requirements in different operational scenarios can be complex.

- **Training and Expertise:** Deploying and managing P5G networks require specialized technical knowledge and expertise. Ensuring the availability of trained personnel who can design, deploy, operate, and maintain these networks is essential. Providing appropriate training and expertise to military personnel and contractors can be a challenge.
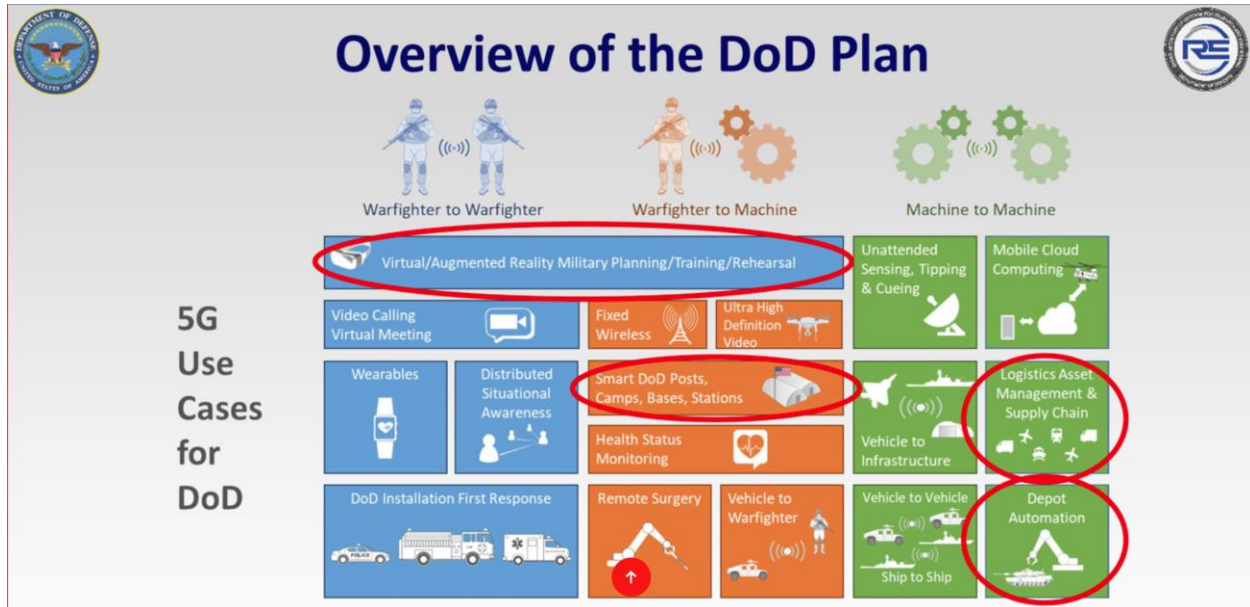
Addressing these implementation challenges requires close collaboration between defense organizations, solution providers, regulatory bodies, and other industry experts. Careful planning, risk assessment, and technical expertise are necessary to overcome these challenges and ensure the successful implementation of P5G networks in defense and tactical environments.

Real-world Case Studies

In recent years, there have been many announcements about the use of P5G networks for Defense and Tactical purposes. Here are some high-profile announcements:

- **US Department of Defense (DoD):** The US DoD has publicly listed many different use cases where they envisage P5G networks playing a huge role. Various announcements have highlighted how P5G networks can support AR/VR applications, providing soldiers with enhanced training experiences and situational simulations. Other announcements have highlighted how P5G networks can connect and manage a wide range of IoT devices and sensors, facilitating data gathering and analysis for better situational awareness and decision-making. P5G networks are also being looked upon to support communication between autonomous vehicles, drones, and unmanned systems, enhancing their

coordination and control. The following slide was shared by DoD way back in 2019, when they started looking at how 5G connectivity can support their operations.

Overview of the DoD Plan

Warfighter to Warfighter   Warfighter to Machine   Machine to Machine

5G Use Cases for DoD

- Virtual/Augmented Reality Military Planning/Training/Rehearsal
- Video Calling Virtual Meeting
- Fixed Wireless
- Ultra High Definition Video
- Unattended Sensing, Tipping & Cueing
- Mobile Cloud Computing
- Wearables
- Distributed Situational Awareness
- Smart DoD Posts, Camps, Bases, Stations
- Health Status Monitoring
- Vehicle to Infrastructure
- Logistics Asset Management & Supply Chain
- DoD Installation First Response
- Remote Surgery
- Vehicle to Warfighter
- Vehicle to Vehicle
- Ship to Ship
- Depot Automation

- *Accelerate* – Hasten DoD's adoption of 5G
  - At-scale test facilities that enable rapid experimentation & dual-use application prototyping
- *Operate Through* – Ensure that US forces can operate through wherever and whenever we deploy
  - Dynamic spectrum utilization; "Zero Trust" architectures
- *Innovate* – Enhance 5G technology and invest in future "Next G" technologies
  - There is no finish line.

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- The Latvian operator LMT in close collaboration with the Latvian National Armed Forces was responsible for the launch of the first 5G military testbed in Europe. The site is open to NATO allies to jointly develop, test, and demonstrate 5G applications in the defense industry. Recently the 5G military test site at Camp Ādaži has deployed two additional standalone P5G networks to allow for the centralized testing of relevant innovations on various networks, checking compatibility. Future testing plans include remote AR/VR defense personnel training, command and control, and various maintenance activities with remote specialist participation.

- The Norwegian Defense Materiel Agency is working with Telia Norway to develop tactical, private 5G networks that can be combined with the public national 5G network. By combining existing infrastructure and a separate tactical network the objective is to build a

communication solution that is both secure, resilient, and flexible. The public network used network slicing to ensure that the data from the Armed Forces can be kept separate from other traffic in the public mobile network and be given priority if needed.

- The Spanish Ministry of Defence has recently issued tenders to install private 5G networks for the military. One of the tenders requires the launch of two private 5G standalone networks for two military facilities in Madrid. The goal of these two P5G networks is to provide service, among other facilities, to the battleship and helicopter maintenance centers that are within the facilities.

Conclusion

Private 5G networks are already showing potential for Defense and Tactical networks and their role will expand further as the technology and use cases mature. While there are many challenges that need to be worked out to overcome the deficiencies in technology and solutions, there are many benefits that outweigh the limitations. P5G networks are undergoing limited trials and deployments now but in the next few years, they will gain a lot more acceptance once the benefits are evident. Get in touch with us to learn more about how we can help you.