NATO OTAN
Science & Technology Organization (STO)

Next Generation Communication Networks

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Military capabilities will require increasingly effective military communications from the Next Generation Communication Network (NGCN) to derive decisive advantage in future military operations, as well as in strategic influence. The integration of emerging technologies such as autonomous systems, advanced sensors, and AI-driven analytics into NGCN enhances command and control effectiveness, ensuring mission success across multi-domain environments while addressing evolving operational challenges.

Implications

Economic Implications – The importance of communication in the civilian sector will have an effect on the adoption of such dual-use technologies. The contribution of private investments in research will boost the development of technologies ready for military applications.

Military Implications – The range of deployment of autonomous systems with man in/on the loop can be significantly extended with NGCN technologies. The possibility of securing reliable communications with underwater/underground assets, represents a critical enabler across all military domains from seabed to space.

Societal Implications – The increased capabilities guaranteed within autonomous systems will be particularly useful in scenarios like natural disasters, emergency response or infrastructure inspections, where quick deployment of reliable communication networks is essential.

Key Technology Areas

5G/6G – 5G/6G technologies are characterised by low latency and high-speed data transmission capabilities that enable real-time control and communication between sensor grids, autonomous systems, and AI-driven analytics. This allows decentralised (or federated) data processing, rather than relying solely on centralised data centres. 6G, in particular, presents significant advancements in data transmission speeds and frequency bands up to 100 Gbps, 20 times faster than 5G technology. This speed and capacity can support applications such as ultra-HD video streaming and real-time control or direction in autonomous vehicles, meeting increasing communication demands.

Next-Generation Networks (NGNs) – NGNs are a modern type of network infrastructure that allows the transmission of different types of information into small units that can be fast and easily distributed. New network technologies need to face the challenges of low-probability of intercept, hiding traffic in commercial signals, integrating sensor networks, communication links, and processing to drive the need for Command, Control and Communication warfare or multi-domain battle networks. The increased reliance on data, networks, sensors, and analytics also presents significant cyber vulnerabilities.

4D Antennas – 4D antennas promise improvements in performance and enable long-range wireless communications, including underground and underwater. The antenna arrays are manipulated so that individual elements are selectively turned on and off, creating unique and useful sidebands, which are suitable for multi-channel transmission and smart beamforming.

Low-Frequency Transmission – Ultra Low Frequency (ULF, 0.3 kHz to 3 kHz) and Very Low Frequency (VLF, 3 kHz to 30 kHz) are beneficial frequencies for underground and underwater communications. Normal antennas require huge spaces that can be reduced considerably using mechanically manipulated magnetic/electrical fields.

Post-Quantum Encryption – Communications can be secured with cryptographic methods using quantum properties to provide intrusion detection. Post-quantum cryptography uses enhanced encryption algorithms that are not amenable to solutions by quantum computers.

Technology Convergence

Energy – The increasing power requirements of 5G systems and other communication technologies will require collaborative development of new exploitable energy nets/sources.

Autonomy – Given the communication opportunities offered by NGCN, a coherent development of unmanned aerial vehicles (UAVs), unmanned ground vehicles (UGVs), and maritime unmanned systems (MUS) will benefit from seamless coordination and real-time communication.