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Emerging technology snapshot

Beyond line-of-sight communications and applications

Modern wireless communications systems normally require a transmitter and receiver to be within 'line-of-sight' of each other. For example, smartphones switch between base stations to stay connected and enable voice and data transmission while on the move. Beyond line-of-sight (BLOS) refers to technologies or systems that extend the range of wireless communications systems beyond this limit. Applications include BLOS control of Unmanned Aerial Vehicles (UAVs), radars able to see targets over-the-horizon and ad-hoc communications networks used for natural disaster relief.

Enabling Science and Technology

Skywave-based communications

Skywave-based communications use one of the layers in the atmosphere (usually the ionosphere) to 'bounce' radio waves to extend their range. The range depends on the surrounding atmospheric conditions, as well as state of the ionosphere, but it can reach hundreds or even thousands of kilometers.

Multiple-input-multiple-output (MIMO) systems

MIMO systems use a single radio channel to transmit more than one type of data signal, which is particularly important for smartphones and other wireless devices. Although current MIMO-enabled devices tend to require line-of-sight to a base station or antenna, recent research is investigating ways to extend their range to BLOS.

Space weather

Space weather refers to solar weather events like flares or coronal mass ejections (CMEs) and their effect on the ionosphere, and by extension BLOS communications. The ability to detect and estimate the magnitude of such events can help predict their impact on BLOS communication networks and related applications, like over-the-horizon radar or UAVs.

Signal processing

Signal processing relates to the processing of received signals, often to extract certain data or information or convert them from one form to another (e.g., digital-to-analogue). BLOS communications and applications increasingly use artificial intelligence and machine-learning techniques like convolutional neural networks to perform signal processing tasks.

Terahertz (THz) frequencies

Terahertz frequencies (0.1-10 THz) are likely to be used in future wireless standards (like 6G) to support data transmission rates of about 1 TB, which is significantly faster than what 4G or 5G can currently provide.

"Survivable, resilient, enduring, and effective communications, both domestic and international, are essential … such communications must be possible under all circumstances to ensure national security, effectively manage emergencies, and improve national resilience."

The White House. Executive Order - Assignment of National Security and Emergency Preparedness Communications Functions. July 6, 2012.

Signals

Academic

China-based academic institutions have high publication counts in BLOS-related research. However, research from US- and European-based organizations generally tend to be cited more often, suggesting they have higher research impact.

Government

National governments support BLOS-related research either directly through military-funded projects (e.g., USA) or indirectly via government-sponsored research and development (R&D) funding (e.g., Canada, Europe).

Collaboration

Major players in BLOS-related research do not tend to collaborate often, preferring their own collaboration sub-networks instead. Canadian organizations tend to collaborate internationally rather than with other Canadian institutions.

Defence

Chinese and US military organizations are active in BLOS-related research. Defence Research and Development Canada (DRDC) ranks sixth among these organizations by publication count. Military organizations' research is largely focused on antennas, receivers and signal-to-noise ratio.

Corporate

Major players in BLOS-related research include mobile wireless firms like Huawei (China) and Nokia (Finland). The research focus of industry players tends to be related to 5G networks.

"In communications, the commercial sector has been moving at a faster pace than the military. Open architectures are being increasingly adopted to make way for inclusion of … protocols such as 4G and 5G in tactical communications, albeit with adequate security layering for defense applications."

Frost & Sullivan. Global Land Tactical Communications Market, Forecast to 2028. January 2020.

Impact

Social

Access to BLOS communication networks can be critical for first responders in major emergencies or natural disasters to coordinate and conduct their operations when regular radio or cellular communications networks are offline or overwhelmed.

Policy

National rules and policies for operating Unmanned Aerial Vehicles (or drones) beyond a pilot's or operator's visual line of sight (BVLOS) differ between countries and regions.

Economic

According to a 2020 Frost & Sullivan report, the military land tactical communications market (which includes both line-of-sight and BLOS) will be worth USD 48.3 billion by 2028.

Environmental

Improving the energy efficiency of BLOS communications networks is of interest to researchers world-wide. Methods include reducing or managing the power consumption of devices and individual components (e.g., antennas).

Defence

Emerging research into BLOS imaging may allow soldiers to 'see' people/objects behind a closed door or around a corner.

"Beyond visual line-of-sight (BVLOS) operations … allows operators to explore new drone applications that can take advantage of Canada's vast geography. Drones have the potential to serve isolated regions, lower population densities, and large pockets of uncontrolled airspace with minimal airspace traffic."

Transport Canada. Fly your drone beyond visual line-of-sight. June 2022.

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