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REPORT

Communications Networks to Support Integrated Intelligence, Surveillance, Reconnaissance, and Strike Operations

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Prepared for the United States Air Force

Approved for public release; distribution unlimited

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Summary

U.S. military operations in the 21st century rely heavily on receiving and distributing information to and from the field of operation. Immense amounts of data must be collected, processed, and fused into knowledge via high-capacity networks. The required high capacity in a hostile environment introduces significant challenges and conflicting requirements to the communications network for a variety of reasons.

The research in this report focuses on combat systems operating at medium and low altitudes, which pose different challenges from the challenges of intelligence, surveillance, and reconnaissance (ISR) platforms operating at high altitudes:

- Medium- and low-altitude airborne platforms, such as fighters and bombers, are closer to jammers and signals intelligence (SIGINT) receivers. Hence, the adversary systems may require less sensitivity to intercept those signals and less power to jam them.
- The low observability of the platforms can potentially be compromised by transmitting large amounts of data.
- During transmission of large amounts of data, platforms at lower altitudes are at a higher risk of being detected.

To fully understand the issues and challenges, we considered two types of threats: mobile jammers and SIGINT receivers able to detect and locate user transmitters. Such jammers and SIGINT receivers are hard to locate and engage. (See p. 5.)

We first discuss data requirements and threats and examine the current communications programs and shortfalls. We then analyze a variety of options in terms of frequencies, waveforms, and antenna types, and make suggestions for improving the current communications program based on altitude, range, data rate, and threat. (See pp. 11–15.)

The following are some of the main findings:

- The Joint Tactical Information Distribution System (JTIDS) and the future Joint Tactical Radio System (JTRS) do not have the required capacity to support a high-data-rate connectivity requirement. (See p. 6.)

- Common Data Link (CDL) family programs can provide a sufficient data rate for the fighter/bomber with Advanced Synthetic Aperture Radar System—Improved Program (AIP) capability. However, these systems need further improvement to survive a more severe threat environment. (See p. 21.)

- A near-term solution for improving jam resistance is the addition of nulling capability to CDL families (including Multiple Platform Common Data Link, MP-CDL). However, although nulling techniques are effective for jammers, they are not effective against SIGINT receivers that detect communications emissions. (See p. 22.)

- Agile, multibeam, low-sidelobe directional antennae are required to achieve more protection against jamming and intercept receivers. These techniques increase the size and weight of the antenna. (See p. 23.)

- The following communications options are effective against jamming and SIGINT detection but are not appropriate for medium- and low-altitude platforms. These options can be used for high-altitude platforms, such as ISR platforms, communications nodes, and satellites: (See pp. 21–29.)
  - Absorption band (55–60 GHz) is a viable option for links above 55 km (60 kft) because signals at absorption band get absorbed through the atmosphere. Absorption band is inherently effective against *ground* threats, but is not effective against *airborne* jammers and *airborne* SIGINT receivers.
  - Laser is the most robust option for links above 12 km (40 kft) because laser beams get absorbed through clouds.
  - Workarounds such as proliferated platforms, compression, alternative concepts of operation, and system augmentation (e.g., airborne relays) may be appropriate, but further analysis is needed to examine their effectiveness. In particular, proliferated platforms with multiple beams may form a more robust, reliable network.

In summary, there is no one solution for all situations and platforms. A combination of options will be needed for a reliable and robust communications link; these options may change depending on altitude, range, data rate, and threat. (See pp. 33–35.)

Thus, communications does not appear to be a major limiting factor, at least not technically, in developing future ISR forces. However, programmatic action will be required to develop the necessary systems, and the costs could be significant.

The communications problems posed by future ISR forces appear to be solvable, but at a cost.

The development of new systems, together with required platform modifications and new designs, raise technology and cost issues that are not addressed here but that need to be carefully examined.