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Application of US Military Data Link in Typical Weapon and Equipment

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Abstract: Data link, always known as the bond of information warfare, is also a multiplier for enhancing military combat effectiveness, thus playing a vital role in information warfare. This paper analyzes the current data link usage in US military weapon platform, as well as the advanced weapon and equipment data link technology developed by the US army. On this basis, this paper summarizes the development trend of the US military equipment data link to provide a theoretical reference for the development and construction of the future weapon and equipment data link.

1. Introduction

In order to meet the needs for various data exchanges in military operations, data link has been deployed and used in the US army since the 1950s. The name "data link" is mainly used in NATO forces, while the US army refers to data link as "tactical digital information link". At first, data link was primarily used to transmit tactical information data in various types of electronic equipment, including conventional voice, text information, ordinary images, etc. [1]. With the continuous progress of information technology, data link equipment gains great development, with various types of data links successively introduced, such as Link-4, Link-11, Link-22, Link-16, TTNT and so on. The loading platform has also developed from land-based to sea-based, air-based, space-based equipment, etc. It is very important to thoroughly study the application of US military data link in typical weapon and equipment [2].

2. The Development of Typical US Military Weapon and Equipment Data Link

2.1. Missile Data Link

The main functions of the missile weapon data link are as follows. ① After the warfighters launch the missile, it is possible to continuously transmit and update the target information to the missile through the data link; ② Through the intelligence reconnaissance equipment loaded on the missile, it is possible to detect the enemy's situation and transmit it back to the combat command center via data link [3-4].

(1) "AN/AXQ-14" data link system developed by Hughes. The weapon data link operates in the

L-band (the frequency band can be selected as 1.71GHz-1.75GHz or 1.75GHz-1.85GHz), which is loaded on the combat aircraft platform such as the F-15E fighter aircraft through various pods. Its main function is to control various precision-guided weapons, aerial bombs, etc., typically AGM-130, GBU-15 aviation weapons [5].

(2) "AN/AWW-13" advanced data link system developed by Raytheon. The weapon data link operates in the 1.427-1.435GHz frequency band, which is also loaded on the combat aircraft platform through various pods. It is mainly used to control various precision-guided weapons, typically AGM-62 missiles, which can implement the functions of command, control and communication. In addition, it can also ensure that the fighter pilots can establish a two-way information transmission link with the weapons after launching the airborne weapons, thereby achieving the goals of "launch first, then aim", "rough launch and precise hit" [6].

(3) By loading the data link to the cruise missile, Lockheed Martin developed the "Surveillance Micro Attack Cruise Missile (SMACM)". In 2015, the US Navy successfully tested the use of weapon data links in control of Tomahawk cruise missile. In addition, Rockwell Collins loads data links to missiles, guided bombs and other weapons, typically "harpoons" and "JDAM", thus precisely attacking various moving targets on land and sea[7].

2.2. UAV Data Link

UAV data link is an essential and critical component of the UAV system. Its main function is to enable remote control, positioning and tracking of the UAV by the operator, or allow information transmission with the ground control station, air command center, relay platform and various weapon platforms [8].

Table 1: US UAV data link

Data link type	Working frequency band	Main purpose	Loading platform
Common Data Link (CDL)	X-band Ku-band	Allow information transmission between intelligence, surveillance, reconnaissance (ISR) platforms, ground command and control stations, and various combat nodes	Global Hawk, Predator and other UAVs
Tactical Common Data Link (TCDL)	Ku-band	Allow broadband data transmission between unmanned aircraft platforms and manned aircraft, and between ground stations	Predator, Precursor, Hunter, Pioneer, Shadow-200, E-8 and other UAVs
Tactical Digital Data Link (TDDL)	S-band, C-band, X-band, Ku-band	Implement code modulation to provide digital microwave communication link between the platform and the control terminal	Some types of tactical UAVs
High Integrity Data Link (HIDL)	UHF band	Allow digital information transmission between surface ships and UAVs, featuring full duplex, narrowband, anti-jamming, confidentiality, etc.	Some types of fire reconnaissance UAVs
STARLINK micro data link	C-band, L/S-band, Ku-band	Used for real-time transmission and display of images, videos and other information collected by small/micro UAVs	Some handheld launch UAVs, Pioneer UAVs

UAV data link can be divided into four categories, namely Common Data Link (CDL), Tactical

Common Data Link (TCDL), Tactical Digital Data Link (TDDL), High Integrity Data Link (HIDL), as shown in Table 1 [9-10].

2.3. Helicopter Data Link

Helicopter is an important non-negligible combat force in local area military operations and special operations under high-tech conditions in the future. In order to further enhance the helicopter's situational awareness, intelligence reconnaissance, and collaborative combat capabilities, the US army has loaded different types of data link systems according to the different scenarios, tasks, and needs of helicopter combat use, thus increasing the combat range, strike capability of helicopter combat platforms. Its main types include: tactical data link Link-16, broadband data link (CDL, TCDL), dedicated data link (automatic target handoff system ATHS), etc., as shown in Table 2 [11-13].

Table 2: US military helicopter data link

Data link type	Main purpose	Loading platform
Link-16	Tactical information transfer between combat units	UH-60 "Black Hawk"
Broadband data link CDL, TCDL	Information exchange between helicopters and ground combat command center	MH-60R, SH-60 "Seahawk", AH-64D, UH-60 "Blackhawk"
Situational Awareness Data Link SADL	Air-to-air, air-to-ground combat target indication and coordination	"Little Bird", MH-47, "Chinook"
Dedicated data link ATHS	Coordinated fire strike information transmission with artillery fire control systems	OH-58D, AH-64, "Apachi"
Ship-based data link LAMPS	Anti-submarine information transfer between helicopter and mother ship	“Siren”

3. Advanced Technology of US Military Weapon and Equipment Data Link

Weapon platforms in modern warfare move faster with stronger stealth capabilities. In order to effectively deal with such agile and rapid targets, Rockwell Collins of the United States developed TTNT, whose full name is Tactical Targeting Network Technology. Using this technology, the US army can effectively connect information nodes such as manned fighters, large (medium) UAVs, various types of reconnaissance and surveillance platforms, and ground command hubs to form a sensitive self-organizing, high-speed and stable coordination, command and control data link network with strong anti-disturbance, invulnerability, and seamless communication. Under normal circumstances, TTNT system has a capacity of tens of megabytes, and within a range of nearly 100 kilometers, it can simultaneously transmit tactical information data and reconnaissance intelligence information for more than 200 information transmission nodes and weapon platforms. The TTNT system is perfectly compatible with the Link-16 data link widely used in the US army. Moreover, the network throughput of the TTNT system is nearly 20 times higher compared to Link-16, with the information transmission speed increased by nearly 50 times. The TTNT system was first applied to combat aircraft. In response to the increasingly complex situation in the informationized battlefield environment, the US army gradually popularizes this technical system to missile weapons and platforms of other military services, such as airborne troops, air force ground troops, and marine corps. In addition, the US army has also developed small, simplified, and portable device, i.e. the QNT (only 20 cubic inches in size and 5 pounds in weight). Through QNT equipment, missile weapons, small

tactical UAVs, and ground fighters can interact with combat aircraft, medium and large UAVs, and US command and control networks by communicating command control and intelligence information [14].

4. Development Trend of US Military Weapon and Equipment Data Link

(1) Networking of weapon and equipment data link. By making full use of the security, high-speed, broadband, anti-jamming, anti-destruction performance characteristics of weapon and equipment data links, it is possible to gradually develop "point-to-point" communication into "multi-point connectivity" and then "network interconnection". The ultimate goal is to integrate into the "Global Information Grid (GIG)" proposed and implemented by the US army for many years, so that every platform (or node) loaded with a weapon and equipment data link becomes a part of "network-centric warfare" information intelligence.

(2) High-speed weapon and equipment data link. With the continuous progress of photoelectric sensing technology, the information such as pictures and videos accessed by various reconnaissance and surveillance platforms has become increasingly refined with increasingly higher resolution. As a result, an exponential increase occurs in the amount of data demanding transmission. In order to meet the information transmission requirements of photoelectric sensing technology, as well as the future coordination command, information distribution and other operational needs in joint operations of multiple military services, high-speed data transmission bandwidth is required. The main research and development direction is to combine new adaptive modulation and coding technology to further increase the information transmission capacity and speed of weapon and equipment data link [15].

(3) Generalization of weapon and equipment data link. In the future, the battlefield will be filled with a large number of weapon and equipment data link devices. If these data link devices are not generalized, information infusion between different platforms is impossible. At present, most of the data links already loaded on the US military weapon and equipment platforms are typical dedicated data links with a narrow scope of use, which cannot be fully compatible with each other. In order to address this issue, the US army has begun to gradually unify the standards of various types of data links, and a single terminal is adopted to integrate the original UAV data link systems independently developed by different military services.

(4) Miniaturization of weapon and equipment data link. The traditional weapon and equipment data link equipment mainly consists of modules such as codec, encryption, modulation and demodulation, up/down converter. Each module is formed by hardware with certain functional characteristics. The equipment has big size and weight in overall, which is difficult to load on a small-scale weapon and equipment platform and difficult to use in individual soldier and unit equipment. In addition, it is more difficult to implement hardware transformation, or software upgrade and maintenance of such large-scale equipment, and the scalability is relatively poor. To this end, the US army applies new software radio technique to the design and development of weapon and equipment data link, and uses software to implement some equipment functions, which effectively reduces the equipment size and weight to render greater flexibility and adaptability. This also helps to reduce costs of weapon and equipment data link system.

5. Conclusion

The application of data link in typical US military weapon and equipment fully reflects the important role of data link technology in competing for the "right to control information" and winning the war. It will certainly be the core content of equipment informatization construction in the future. At the same time, with the continuous evolution of cutting-edge technologies such as big data, cloud computing, artificial intelligence, etc., data link technology will gradually integrate with them to

develop systematic and more intelligent equipment, thereby meeting the needs for efficient, real-time, and safe transmission and sharing of information in joint operations between multiple military services and multiple platforms.

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