TACTICAL DATA LINK SYSTEMS; THE HEART OF NETWORK–CENTRIC WARFARE

Savaş ÖZKAYNAK¹
Erdem HEKİMHAN²
Turkish Air War College, İSTANBUL

ABSTRACT

Today, well improved technology and the knowledge ingredients of this technology has just given the name of this era. In the near future technological researches and developments will form the bases of military and civil technological developments. The foundations of civil and military technological developments depends on the information in shaping precision, speed and accuracy, high reliability, real-time information transmission speed and to maintain the information securely. In addition to land, sea and air platforms there will be space and cyber platforms when the operational environment of there future is imagined. These spaces will change the aim of the war and military operation areas will become a dynamic battlefield. To keep up with this pace, establishing common operational picture through interoperability and the real-time/near-realtme time transmission of this picture will change the course of operation. In order to increase situational awareness of performing operation platforms required to owned national use of information technology. The objective of Tactical Data Link (TDL) Systems are real-time or near real-time data transmission between friendlies, allies and the combined forces by C4ISR platforms and the systems.

This paper was written with in the framework of information and data sharing needs. Tactical Data Link Systems which was developed in the early 1950s will be considered by technological developments, use in operations, joint force dynamics improvements. In this context, Tactical Data Link Systems, will be examined under the joint operations and central command via interoperability. Tactical Data Link Systems, which is a part of Network-Centric Warfare, are considered to be successful in today’s and tomorrow’s modern operations.

INTRODUCTION

The concept of Network-Centric Warfare, evolved in early 90s, is the milestone of future operations. The aim of Network-Centric Warfare is to collect and share all operational data to improve the capability of air, surface and sub-surface forces [Alberts,Garstka,Stein, 2000]. In this concept collection of information, fast data processing and transfer, operational platform, C2 and other associated systems and finally situational awareness are supported by TDL Systems.[Truver, 2006].

In this article TDL system provides new vision on OODA(Ovserve,Orient,Decision and Action) Loop theory of Jhon Boyd in modern aviation, decision making to strategic effect of operations [Meilinger, 1997].

¹ 1st Lt , Turkish Air War College, E-mail: ozkaynaksavas@hotmail.com
² 1st Lt , Turkish Air War College, E-mail: ehekimhan@gmail.com
The effect of this TDL system in the future war, general properties, technical properties, functions, additional important aspect of operation, joint use and interoperability especially contribution to armed forces is described in this article.

**What is Link? What all are the components?**

To understand the term “Link”, the terms “linkage”, “communications” need to be understood. For the purpose of the information, data link communication is created according to predetermined standards and methods of communication media. As per Prime, followings are the other component for the Data Link.

- **Data Source**: Sensors are another link and the link will feed the data elements on the sensor.
- **Data Processing and Display System**: The data are processed and displayed through the operator console.
- **Crypto System**: Considering the reliability of the line system encryption software may be used.
- **Communication System**: Data Terminal Set(DTS)-Multifunction Information Distribution System(MIDS).
- **Message Sets**: S,M,J and F series messages.

Current technological opportunities within the framework of link, data can be transferred to the environment are as follows:

- **Cable Line**: It is possible via cable connections.
- **Satellite**: Commercial and military satellites may be used.
- **Radio Frequency Broadcasting**: Different military radio frequency band and spacing is shown in following Figure-1:

![Figure-1: Military Radio Frequency Band With and Data Communication Band With Characteristic](Quistorf, 2013).

**What is Tactical Data Link Systems and Aim?**

From the starting of the human civilization data transfer is always a primary need. In every era, human explored existing facilities and technology for this need. For example, at the Vietnam War end of 1970 USA faced some problem in tactical data transfer and lateron they improve Link-16 TDL systems which includes electronic jamming, high volume data transfer with high speed. Slowness and limited ability to transfer data in the Link-11 system has also increased this need.

When examining Figure 2, we see that after World War II in about every 20 years military technology data links have been demonstrated incredible increase in data transfer speed.
All levels military headquarters require complex and precise information for present and future operational area. Also this operational area is getting more dynamic. Operational planning in this environment and need to make an unprecedented increase in the amount of information needed to support decision factor in communication occurred. The need to ensuring uninterrupted information flow between practitioners and decision makers has increased. In this context, one of the most important operational elements that will allow interoperability between C4ISR systems have developed their TDL system. Data links for the purpose of management and administration of the war, are military systems for now composed of components that enables real-time transmission of information needed about the state of theater. The decision of the authorities to assist in the decision-making is considered to contribute towards the success of the operation.

Now, by examining the development of the existing TDL System;

**Link-1 Tactical Data Link System:**

Link-1 is the first NATO’s air defence TDL system which had started to develope in beggining of 1950’s. Also this data transmission link is still in use. Includes “S” series of message sets.

**Link-11 Tactical Data Link System:**

Link-11 TDL system, as principal NATO/USA has been developed with the aim of meeting the needs of the marine element data link. It is a system with 1960s technology. It includes “M” series of message sets. For the communication infrastructure, it uses HF (2-30 MHz) / UHF (225-400 MHz) communications environment.

**Link-11A:** This protocol is also used as the US TADIL-A, the information they collect from the sensor unit reporting the message M series is available. This protocol is usually use by naval forces to repor land, sea and submarine targets (Figure-3). If you use the UHF band (225-400 MHz) Line of Sight rules used if available and range surface to surface 25 nm range is used up in the air capability of the system can reach up to 150 nm.
Link-11 protocol will go out of use after 2015 and will be replaced on the Link-16 and Link-22 protocol. This will be resolved deficiencies for military operation [Deakin, 2010].

Link-11B: Also known as TADIL-B in the United States. Link-11 is used by Navy but Link-11B has terrestrial lines and point-to-point version of Link-11. Considering the message set the difference from Link-11 is, Link-11B does not have Anti Submarine Warfare (ASW) option. Considering the transmission the difference from Link-11A is, Link 11B uses terrestrial lines insted of UHF/VHF.

Figure 4: Link-11A/B TDL Picture[Prime, 2013].

Other than the TDL system mentioned above, there are some other systems used in short and long-range air defence systems, different communication systems or different aerial platforms. Some of them are technologically obsolete, some have alternate systems. These systems are as follows:

Link-14 Tactical Data Link System,
Link-6 Tactical Data Link System,
Army Tactical Data Link-1 (ATDL-1) Taktik Data Linki,
PLOT Link System,
Link-4 Tactical Data Link System,
Interim JTIDS Message Specification (IJMS) and VMF(Variable Message Format) systems.

Within the existing TDL technology, the most powerful data structure developed to support the C4ISR (tactical, operational and strategic level) tactical data link is Link-16 TDL System. The operations of Link-16 in different platforms is described below.

Link-16 Tactical Data Link:

For the first time in 1994 Link-16 is used in the United States Navy for operational tasks. Presently it is assigned to the platform of NATO Tactical Data Communication protocol and used by 40 countries. From 2015, Link-16 is planned to be used in NATO as the main link for common operations.NATO's work continues in this direction[Prime, 2013].

In the TDL systems, Link-16 which is working in the upper part of the UHF band, includes high capacity and digital audio transmission, characterized with a multi-network capability. Link-16 system, in the cycle structure uses Time Division Multiple Access (TDMA) protocol [Asenstorfer,Cox, Wilksch, 2003]. In this protocol, the center of the stations participating in the cycle, without being tied to a control station, offers a flexible use. It enables them to broadcast within their allocated time frame.
In the middle of the 1990s, the US Air Force revealed the advantages of Link-16 through a scientific project named "Joint Tactical Information Distribution System Operational Special Project". In this project, in the day and night operational environment, the effectiveness of only voice communication system and Voice communication System with Link-16 (capable of data communication systems) were compared.

Collecting the Data over 19,000 flight hours and 12,000 sorties, during daytime operations, it was observed that the average hit rate increased to 2.61 times. In night operations this rate also increased to 2.59 times. Both in day and night operations, it is concluded that there is an increase of hit rate over 150 percent.

Increased situational awareness could not be measured quantitively. But the reported findings (less tactical radio usage, joint maneuvers are made of discussion) shows a significant increase in the area of situational awareness. In analog voice communication, aircrafts get data and picture from one radio by control element. The data detected and analysed by aircrafts´ radar and other sensors are transmitted to each other. This create a 3D image in pilots´ minds with required conditions, enhancing situational awareness. On the other hand AWACS and the other platform transmit their target informations through Link-16. This gives near realtime picture to the users. This enhances the situational awareness to the pilots and reduces the workload especially during the large extent engagements. This is shown in Figure-6. As shown in Figure-5, Blue-1(B-1) F-15 aircraft leader make clear decisions via Network Centric structure data link. By this way the situational awareness is increased for decision-making speed and the reaction. The leader can design, share and distribute the tasks more effectively.

![Figure-5: Platform-Centric and Network Centric Operations](Image)

During air to air exercise it was found that the hit rate of aircraft with Link-16 is 2.6 times more than that of aircraft without link system both day and night operations. [Daniel, 2005].
In light of this information Link-16 capable of transmitting encrypted data / voice, high speed data transmission information, transmission of message from a wide spectrum in an electronic warfare resistant environment. Due to its small equipment size land, air and naval elements can easily use it for very accurate location and identification information of TDL (Figure-7).

Royal Navy overcame the limitations of LOS by linking Link-16 of JTIDS to satellite. Feasibility study started in 1991. Royal Navy combined both Satellite Tactical Data Link(STDL) and JTIDS/Link 16 in the same time in their platforms and using it since then. Both JTIDS and satellite communications use TDMA. Figure-9 shows the satellite transmission of message in Link-16. According to Demir(2007), there are 3 ways for the satellite communications. In the ‘broadcasting’ mode one ship transmits signal the other one recieves. ‘Network’ mode is used to transmit data to allocated ship and ‘Intergroup’ mode is used to communicate within the group.
Technical and operational functions of the Link-16 system, which supports context of interoperability, are described as follows:

System Information
Exchange and Network Management
Precise Location and Identification-PPLI
Air Surveillance
Surface-Maritime Surveillance
SubSurface-Maritime Surveillance
Ground Surveillance
Space Surveillance
Electronic Surveillance
Electronic Warfare (EW) Intelligence
Mission
Management
Weapons Coordination and Management
Control
Information Management

SubSurface-Maritime Surveillance function of these items gives out a research encountered when examined. This survey searched by G. Richard Thompson, Hans P. Widmer, Kurt A. Rice, Robert E. Ball, and John H. Sweeney. Submarines are using Link-11 in common, on the other hand Link-16 capability is not available as of now. Without leaving the submarine periscope depth, in case of the need to establish a UHF antenna communications, submarine may participate in the Link-16 network.

In a study of 1999, Link-16 participation in the submarines shown in the Figure-9.
Figure-9: The Submarine Joining into the Link by Fiberoptic Technology [Thompson, Widmer, Rice, Ball, Sweeney, 2007].

**Link-22 Tactical Data Link:**

Link-22 is a TDL system which is currently being developed under the name of “NATO Improved Link Eleven (NILE)” to eliminate the weaknesses of Link-11. Link-22 design and development program within the framework of NILE has been continuing with the participation of 7 countries. (Canada, Germany, France, Italy, Nederlands, England and USA)

With NILE project, Link-16 system of the horizon will be beyond extension, which can operate in military UHF and HF frequency bands. It is Electronic Protection (EP) capable, secure, and in the long run will completely change the Link-11 system to a new system [Asenstorfer, Cox, Wilksch, 2003].

In the Link-22 system “F” series of message formats are used. Link-22 and Link-16 both use "J-series" messages. They are compatible with each other. Thus, each data transfer between two links may be provided without any loss. It is expected that the maximum number of users in the cycle would be 32,764. As such Link-22 system is intended to be used in place of Link-11. It is planned to use fixed or frequency-hopping HF (2-30 MHz) with fixed or frequency-hopping UHF (225-400 MHz) frequency band.

The coverage for continues HF is uninterrupted 300 NM and UHF coverage would be within the visual range. However, these areas can be expanded by transfer capability located in the system architecture. Link-22 has a medium speed for data transfer. A typical conversion rate of HF is 1200-3600 bits/sec, while the UHF loop speed is expected to be between 2400-10000 bits/sec. The main topics of this system is determined within the framework of the development program.

**ANALYSIS**

John Boyd, the strategist and the war theorist of US Air Force, proponent of OODA loop theory in the 1980s (Figure-10) gave direction to the air battle. According to Boyd who observes enemy speedily and accurately, orient them quickly, decides and act correctly win the war. The key to achieve the desired speed and accuracy in the OODA loop is efficient and effective orientation.
TDL can highly contribute in orientation step by enhancing situational awareness which would help in decision making of person or user and command elements. It would allow all concerns to take initiative and more time to react. Tactical Data Link systems make Observation, Orientation and Decision phases shorter. Accelerates the OODA loop, shortens the phase of decision-making cycles. Increases the situational awareness of friendly elements against the enemies. (Figure-11).

In this paper, we have investigated the importance of the interoperability of tactical communications systems of network-centric structure and the near and medium future data link systems. At the strategic level, interoperability allows the basic commonality coalition. Allows for significant subsidiaries with coalition partners. US National Security Strategy identified in four levels of commonality. At the fourth level which is known as technological level, Digital Data Links are centered (Figure-12).
Today, we must have a modern air force that will examine the five key capabilities;
First it must be able to provide equipped air and space superiority,
Second, very good intelligence, surveillance and reconnaissance elements should have gotten,
Third, it should have an independent force structure,
Fourth, strategic attack should be carried out,
Finally, it should have the operational level of command and control features[Gorenc, 2014].

It is important that real-time situational picture sharing under the wide range of threats in tactical environments and it has been an increasing need to be evaluated in the future for this purpose. Also its important that futures technologies are needed TDL systems that will allow the sharing of knowledge in the development and implementation process, with the goals of reliability and interoperability. These systems should allow the provision of command and control.

By generating current and accurate operational picture, its possible to reduce fratricide (shooting of friendly forces). On the other hand it can be achieved with improved ability to control the operation area easily(Figure-13).
CONCLUSION

Future technological developments will continue to gain a tempo without losing the dynamics in the light of increasing speed. All countries and the armed forces in this race should compete with themselves for the improvement. It becomes more important for the nations to make national researches and development activities with all national elements. Nations never stay behind the pace of development.

With these words of our Great Leader said in 1918, the Turkish Armed Forces never got behind the technology and will be aimed at better targeting. Mustafa Kemal said that "meaning a strong army that has to be understood when called; every person, especially the officer, commander; understand the need of technology and civilization, and implementing a community high business ethics and act accordingly" with the words has been our polar star.

Tactical environment in real-time situational picture sharing under the wide range of threat platforms is a growing need. Towards this goal, for shaping the future of the operational environment, Tactical Data Link (TDL) systems will shape the course of the operation, information transmission and situational awareness at the top level. In addition to increasing the agility and flexibility, it will provide the capability of the forces.

The concept of interoperability of various or unique organization of the world's armed forces also constitutes the center of gravity. During the development of this context, the TDL systems are intended to study reliable and fast by interoperability. In this process, according to the principles applied in need of information sharing system can provide would need to be evaluated.

Every armed forces in the world, has its own or plans to own tactical communication infrastructure. TDL increases the efficiency of armed forces in national and multinational operations. As future operations will be based on network centric operation. All the armed forces should be in the same platform to achieve the most effective operational power. For this purposes, armed forces should be able to speak the same language by tactical data links.

Resources


Nakagami, F., Kao, C.-H., 2008. JTIDS/LINK-16-Type Waveform Transmitted Over Slow (R.C.Robertson, Hazırlayan) Fading Channels In The Presence of Narrow Band Interference, Monterey, California, USA. s. 4-6.


