The 7th International Scientific Conference
"DEFENSE RESOURCES MANAGEMENT IN THE 21st CENTURY"
Braşov, November 15th 2012

CONSIDERATIONS ABOUT TACTICAL DATA – LINK 16 NETWORK MANAGEMENT

COLTANEL CATALIN-BOGDAN

95 th Air Flotilla /Bacau/ Romania

Abstract:
Once the Romanian decision regarding F-16 Falcon multi-role airplane aquisition was taken, a large number of other issues has to be solve in order of use them as the best manner as posible. One of these issues consist of implementation and management of tactical data link - Link 16 network. Unfortunately, there is no "gain without pain" and the benefits of Link 16 cannot be realised without complex equipment, trained personnel and good organisation. Will see the way in which Romanian army will manage this situation.

Key words: Tactical data link, network, joint, command and control, communications, computers.

1.Introduction

Link 16 is the primary Tactical Data Link used in national, NATO and coalition forces today and facilitates a high degree of interoperability between air, land and maritime based participants, sharing intelligence, surveillance, reconnaissance, engagement and weapon status in near real-time.

Basically, Link-16 is an internet in the sky, and it's revolutionizing the way jet fighters wage war.The new ability to combine off-board data with their own means the airplanes can now pinpoint the locations of radars, track them with their helmet sights, and shoot weapons accurately. [1].

The most common TDL for National, NATO and Coalition forces is the Multifunctional Information Distribution System (MIDS) Link 16, which has been at the forefront of recent NATO and coalition operations including Bosnia, Iraq, Libya and Afghanistan.

MIDS Link 16 is deployed on air, land and maritime platforms and facilitates the exchange of
information in standard message formats including:

- Situational Awareness;
- C2 (Command and Control) to C2 Battle Management;
- C2 to Fighter mission assignments;
- Fighter to Fighter information exchange;
- Imagery;
- Voice communications.

We could also say that *Link 16 provides real-time, jam-resistant secure transfer of combat data, voice and relative navigation information between widely dispersed battle elements. Participants gain situational awareness by exchanging digital data over a common communication link that is continuously and automatically updated in real time,*

reducing the chance of fratricide, duplicate assignments or missed targets. Each participant in the communication link is able to electronically see the battle space, including assigned targets or threats. The MIDS represents the latest generation of Link 16 equipment incorporating secure data and voice into a single, small, affordable and highly reliable unit.[2]

Whether the battlespace is managed from a single C2 centre or a distributed C2 environment Link 16 facilitates the exchange of sensor data to enable the C2 centre to construct and maintain the Common Operating Picture (COP) and facilitates successful mission execution by allowing the Link 16 enabled platforms to be deployed with maximum effectiveness (Fig.1).

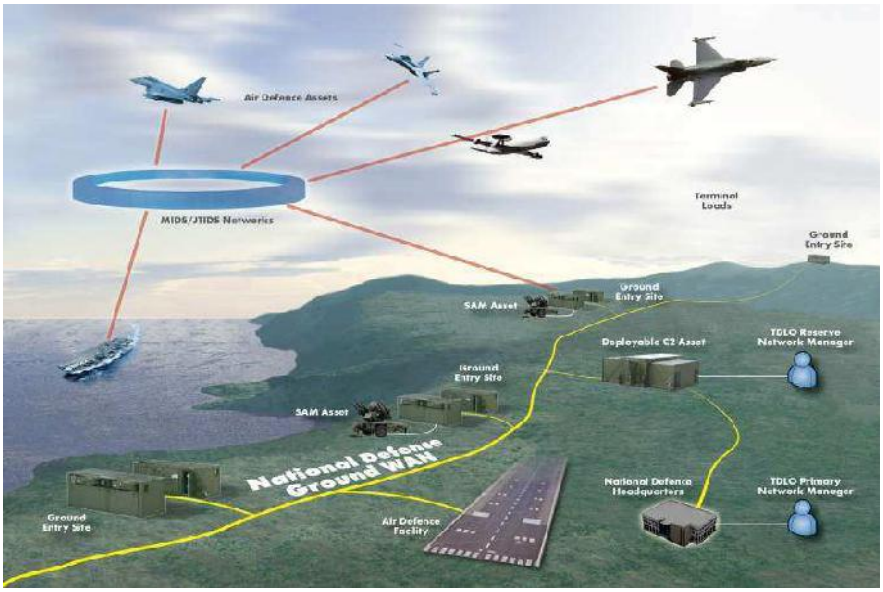


Fig.1 Link 16

Some examples of platforms currently using the Link 16 capability are:

- Aircraft:F/A-18 Hornet, F-15 Eagle, F-16 Fighting Falcon, Eurofighter Typhoon, Dassault Rafale, Dassault Mirage 2000D, Dassault Mirage 2000-5F, Saab Gripen, Panavia Tornado, E-2C Hawkeye, E-3 Sentry, MH-60S/R NavalHawk family helicopters, E-8 Joint STARS, EA-6B Prowler, EA-18G Growler, EP-3C Aries, Boeing RC-135 Rivet Joint, Saab 340 AEW&C, ATR-72MP, Greek Embraer R-99A Airborne Early Warning & Control aircraft;
- Ships:U.S. carrier battle groups, French aircraft carrier Charles de Gaulle (R91), Italian aircraft carrier Cavour (550) and Giuseppe Garibaldi (551), Royal Navy Ships, French, Italian, Spanish, Norwegian, Netherlands and German frigates;
- Ground vehicles VESTA (Verifiëren, Evalueren, Simuleren, Trainen en Analyseren); a minivan with radiotower used for training purposes;
- Missile defense systems: Arrow, Patriot ICC and Battery Command Post (BCP),THAAD, SHORAD, JTAGS, Joint Land Attack/Cruise Missile Defense Elevated Netted Sensors (JLENS), Networked Weapons, SDB II, JSOW-C1;
- Command and Control : Joint Data Network.

2.Role of Tactical Data Links

Tactical Data Links (TDLs) support the continuing requirement to exchange data within Command, Control, Communications, Computers and Intelligence (C4I) systems; they exist to support Command and Control (C2), Intelligence, Surveillance and Reconnaissance (ISR) functionality. They should be seamless, transparent exchanges of data with the primary C4I or other systems used by each platform.

C4I infrastructures are necessarily complex as shown in the figure below which maps out the TDLs that are being used by assets in current battlespace arenas. These TDLs have architectures and require careful management. An appropriate organisation is required to carry out these tasks and a Joint Data Link Operations Centre (JDLOC) or Joint Interface Control Officers Cell (JICC) is as the diagram shows, ideally suited to execute these responsibilities. The diagram shows the intricate paths TDLs' take and how joint the battlespace is in reality.

For the Joint Task Force Commander (JTFC) to fully understand his battlespace, a data link validated operating picture is essential. Today Link 16 data received from assets within operational networks as well as other sources such as Intelligence, Meteorology, EW and Imagery results in a Joint Operating Picture (JOP). This is a combination of the Recognised Air Picture (RAP), Recognised Land Picture (RLP) and Recognised Maritime Picture (RMP) contributing to Combat ID and enables the JTFC to make effective measured decisions from multiple sourced C4 architectures.

The Link 16 network also provides vital exchange of Situational Awareness information between Link 16 enabled assets, making Link 16 a vital contribution for military executives to make informed decisions within the battlespace.Link 16 is normally exchanged through a Radio Frequency (RF) bearer, although can be exchanged through landlines, satellite and serial links. Data encryption and frequency hopping techniques ensure that Link 16 is both jam resistant and secure. Link 16 operates at UHF frequencies; therefore direct communications is only possible when the transmitter and receiver are in line of sight. Link 16 protocols therefore allow information to be "relayed" via other platforms, but this still requires the C2 staff to ensure assets are geographically located to maintain the communications network at all times. As an alternative, Link 16 messages can be transferred via secure landlines, satellites or other data links, using, for example, Joint Range Extension features to enhance the Link 16 infrastructure.[3]

Link 16 operates at frequencies that have the potential to interfere with the operation of Navigational Aids. Therefore, in peace time, the use of Link 16 needs to be managed to maintain compliance with national flight safety legislation. Network Management and Monitoring Systems,
enable the Link 16 Network Manager/JICO to maintain flight safety. A typical Link 16 network for a national air defence system is depicted in Figure 2, note that the ground system, has distributed MIDS Terminals (radios) which provide Line of Sight communication over the airspace being protected.

3.TDL Lifecycle

Tactical Data Links such as Link 16 play a key role in the CONOPS from threat detection to deployment of responses and in delivering full ISTAR capability. Effective management and deployment of network assets is the number one priority for Link 16 nations. The TDL lifecycle will enable the creation of a successful robust TDL network.

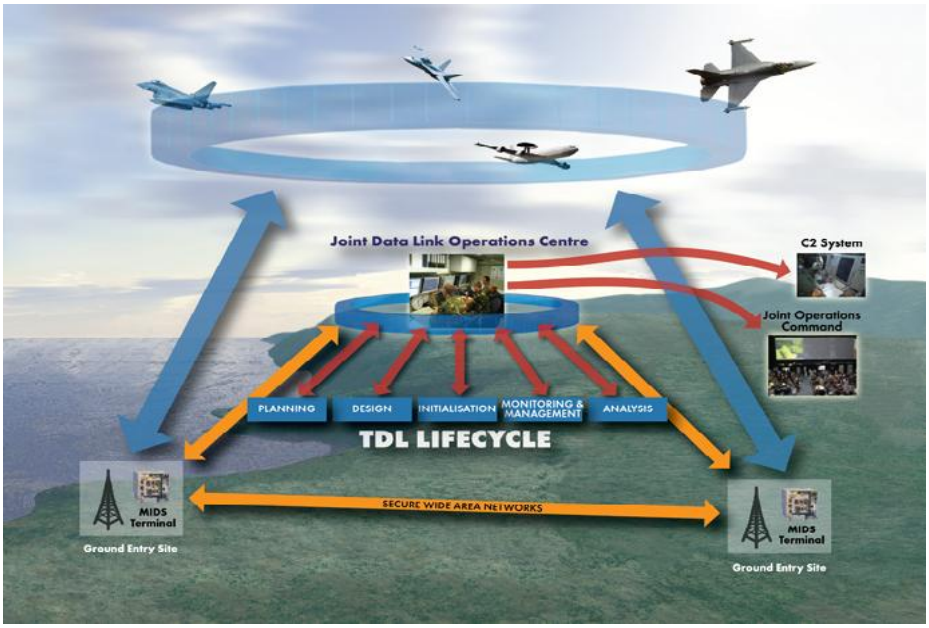
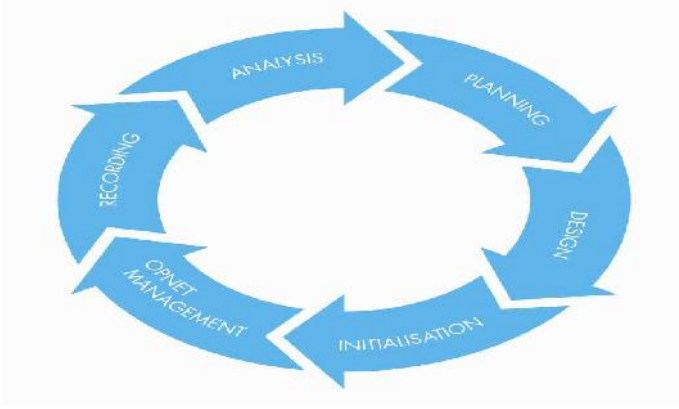


Fig.2 TDL lifecycle

The lifecycle comprises five stages as shown in the diagram, which together ensure that the TDL optimises the interoperability between participating platforms resulting in successful integration at both physical and data levels. The lifecycle involves a number of organisational entities and must be integrated into the overall Battlespace Management process. Therefore each nation may have different ways and different organisational entities performing the tasks described below.[4]



.

Fig.3 Organizational tasks

3.1 Stage 1- Planning

Link 16 is a highly structured network which utilises information about the mission and mission participants to optimise the network and maintain security. With the line of sight limitations of Link 16 it is clearly essential to configure the network so that communications can be maintained at all times.

To plan the architecture, long range planning processes need to take place at least 6 months in advance of training. On the other hand, short range planning addresses the

weekly/daily requirements of the Link 16 network and the platforms participating within it events/operations .

3.2 Stage 2 - Design

Network Designs contain information about the Link 16 Network and are used to initialise each of the Terminals associated with each network participant.

Network Designers build the Link 16 networks. They are driven by requirements laid down in national Frequency Clearance Agreements (FCA), Individual Equipment Requirements (IER), crypto and platform types and numbers. This information is taken from the long range planning information received by the DLOC. The Link 16 Designer key considerations are based on idea that The Link 16 Design Cell:

- is part of the DLOC and is the only authority with the remit to design, validate Link 16 networks using a Network Design Tool.
- is the only team of designers who have the authority and remit to convert foreign designs using a Network Design Tool
- is the sole authority for the dissemination of Link 16 designs to the user community
- routinely provides support to the user community on Link 16 network and platform load issues.

The design cells often have locally created tools which collate and record IERs for the user community. This can enable smart, efficient designs to be disseminated at short notice for real world operations. The Link 16 designer carries out the above responsibilities using a specific tool. There are only three tools presently used. The Tactical Network Design Station (TNDS) is predominantly used by European DLOCS. The JTIDS Network Design Application (JNDA) is predominantly used by the US forces and foreign nations using US companies. ACCOR is a French Network Design tool. All these tools create the designs and individual platform loads which are then distributed

3.3 Stage 3 - Initialisation

The ground based infrastructure to monitor and control the L16 Network is connected together with ground terminals via interfaces and national WANs. The establishment of a Link 16 network is initiated by a Link 16 Network Management System (NMS) commanding their own ground terminals to enter the network, either by operating as the Network Time Reference or by synchronising with an External Network Time Reference. A Link 16 Network Management System controls and synchronises the ground terminals. It performs the IDPF role for their own ground terminals by constructing terminal Initialisation Data Loads from Network Design Parameters and Mission Specific Parameters resulting in the TDL terminals being synchronised into the Link 16 network. This can only be successful if the terminal is loaded with correct crypto. The terminals on the platforms will gain the crypto and a terminal Initialisation Data Load via platform specific IDPF tools.

Experienced Link 16 nations have DLOCs which have a deployed capability. The Deployed or Out of Area (OOA) cells will execute the complete TDL cycle in support of a training event /operation. Those who are small or new emerging nations with Link 16 assets will rely on large countries such as the US to support their Link 16 requirements.

3.4 Stage 4 - Monitor and manage network

Active Link 16 networks need to be fully monitored and managed. This requirement is fulfilled by NMS operated by network managers as part of national Data Link authorities. Active monitoring and dynamic management ensures the platforms high quality data exchanges to support their mission objectives during training and operations.

3.4.1 Monitoring

The FCA often requires the Network Manager to monitor a variety of parameters, such as the monitoring of platform proximity to navigational aids, the monitoring of platform timeslot allocations to ensure that platforms have the correct ID loads. Network Management Systems will provide these functions

Monitoring the connectivity of platforms within the network is key to the robustness of the network. If platforms cannot see each other due Line-of site or cannot be seen by a ground features, this will contravene FCA's and prevent platforms exchanging tactical information.

Monitoring the utilisation of assigned transmit capacity on individual participant and NPGs, highlights to the Network Manager where additional capacity is required or is under-utilised and could potentially be re-assigned. This serves to inform the decision-making process when considering potential dynamic network management actions. The information can also be fed back to the Network Design Cell for the purposes of improving future Network designs.

Network Monitoring systems provides a number of functions to help monitor the health of the Link 16 network(s) and aid the decision-making process when corrective action is required. This includes looking at individual participant and overall network statistics for parameters such as Time Quality, Position Quality, Initial Entry Messages reception or high error rate indication

TSDF is a ratio of the Time Slot usage compared with the permitted value and can be viewed in a number of ways, by participant, by NPG or for the whole Network. Expected TSDF can provide a projected view of what the TSDF would look like if all time slots are fully utilised. In addition Geographic and Area TSDF provides the TSDF for all participants within a spatial region.

3.4.2 Managing

A network design is typically created weeks or months in advance of the actual operation.Whilst a design attempts to accommodate the full set of expected participants and attempts tosatisfy their data exchange requirements, everything that happens during real-world operation of the network cannot be predicted. Therefore the dynamic management of a network in response enables the network manager to initiate transmission of network management messages over the air to update the timeslot and relay assignments of the live network participants.

Platforms will often during live operations be re-tasked by the Battlespace executive in the CAOC. This may require the platform to be allocated additional capacity e.g. additional surveillance capacity to cope with increased enemy air activity. This function will ensure timely, transparent secure over-the-air assignment or de-assignment of timeslots.

The requirement of platforms to have relay is essential due to the Beyond Line-of-site challenges Link 16 gives. The relay assignments over-the-air will enable platforms and the terminal ground infrastructure to receive/transmit data to/from participants who are beyond line-of-site of the main Network Time Reference.

Platforms are often loaded the incorrect Initialisation Data Load (IDL) by support personnel prior to going on task. Therefore the ability to transmit a brand new updated IDL is a key benefit to the platform executing a mission. This avoids the need for that platform to return to base to receive a correct Load.

The allocation of Network functionary roles, such as NTR, to participants within the network is key to maintaining a network that will always be robust ensuring that the NTR is always allocated to the most appropriate platform.

3.5 Stage 5 - Analysis

The post mission analysis of Link 16 network data enables the Battle space Executives through the Network Manager to improve, update and address lessons that have been identified during a period of operations. Quite often there is interoperability issues that prevent platforms operating in Link 16 networks and therefore limit the platforms use during a mission. This can affect the overall mission aims. The recording of FCA and JTIDS Activity Reports ensure that nations have evidence to support incident investigations by CAA. The recording and replay functions support the overall network data analysis and can additionally support operator training/feedback and briefings.

4.Conclusion

The paper tries to explain the different set of operations that need to be preformed to maximise effectiveness of Link 16. TDLs, especially Link 16, must be Planned, Designed, Monitored and Managed effectively and thorough post mission analysis must be carried out. It is important that the physical infrastructure is established and ready to support the TDL network architectures that are covered in the lifecycle process. If the appropriate requirements are not met and the lifecycle is not followed the network and exchange of data between platforms will be ineffective and the mission will be severely restricted and maybe unsuccessful.

It is therefore important that the roles performed by the organisations and operators assigned control of the functions are well coordinated, that the staffs are well trained and that the staffs are supported by equipment designed to sustain their mission. For Romanian Army will be a challenge to achieve this goal.

References:

[1] http://defensetech.org/2005/11/15/riding-the-waveform/#ixzz29jFwYOcc
[2] http://defense-update.com/products/l/link-16.htm, *Defence Update* - international online magazine, 2006, issue 2
[3] Air land sea application center, *Introduction to tactical digital information link J and quick reference guid*, 2000.
[4] http://electronicstechnician.tpub.com/14088/css/14088_142.htm