# Enhancing the Link Network Performance with EB Tactical Wireless IP Network (TAC WIN)

Elektrobit

*EB Tactical Wireless IP Network (TAC WIN) installed in an army vehicle. Copyright Finnish Defence Forces*

**Modern military operations require higher mobility. Will the relay link networks be able to meet the new requirements?**

In tactical communications the link networks are the critical layer that connect brigade command posts and various operational units such as artillery and combat battalions together. The Combat Net Radio (CNR) systems provide communications for the front line troops equipped with portable and vehicle installed radio equipment allowing information and command messages to be relayed between the command centers and the operational units. However, seamless connectivity between the CNR network and the link network cannot be always provided due to incombatibility and limited functionality of equipment available.

Conventionally, the link networks have been built with point-to-point links supported by fixed connections where applicable. Typical examples of such solutions are the YVI 1 and 2 networks deployed by the Finnish Defence Forces since the beginning of 1990's [1],[2]. In the YVI networks the link layer was based on independent microwave point-to-point links connected to data terminals. The connection to the mobile units was based on separate CNR and other equipment either on VHF or HF frequencies. Later, IP-routers have been deployed to provide seamless IP-data transfer over the entire network. An example of a conventional tactical network architecture is depicted in Figure 1. Although the radio link stations are typically vehicle mounted, setting up and configuring such links require manual work starting from putting up the antennas, determining correct antenna direc tions, configuring radio frequencies and establishing the connections to other networks according to a predetermined plan before the actual communications link is operational and ready to be used. Successful operation is therefore highly dependent on the operators' skills and motivation and the network configuration can be considered as fixed with little or no mobility support.

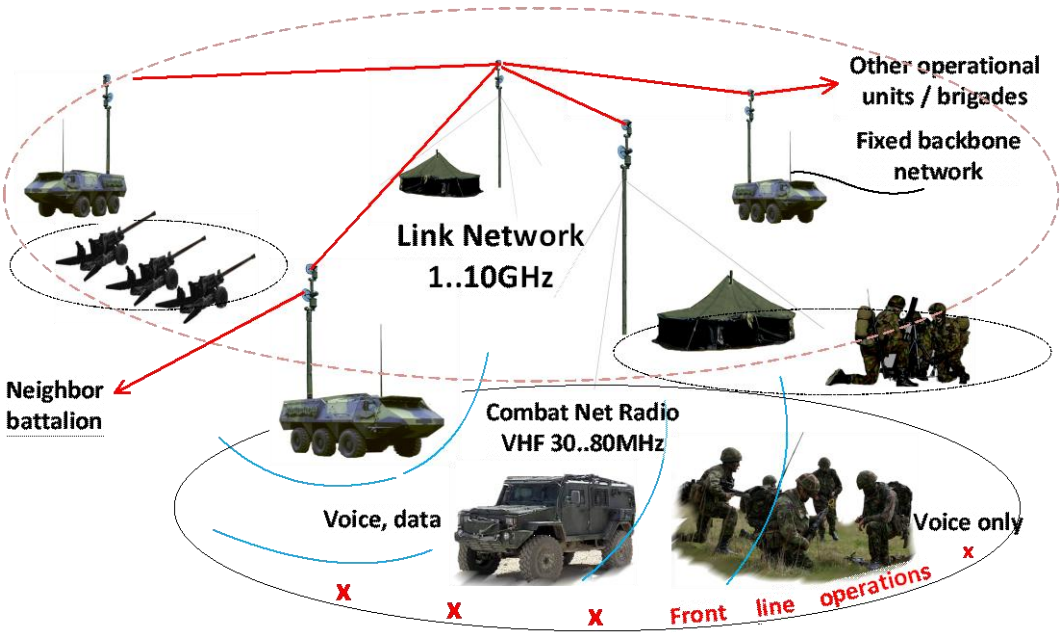


**Figure 1: Tactical communications system architecture example** *(Copyright Elektrobit)*

To reach the desired reliability level and to avoid interference between adjacent network nodes, careful planning of the operation including node positions, frequency mapping and antenna directions is required. After getting everything set up, the connections should work well as long as the conditions remain unaltered. However, if the planned frequencies become interfered, nodes disconnect from the network or if moving the nodes to new locations is required, the situation becomes quite challenging. The network must be reconfigured and this means again manual work, which is time consuming. In the worst case just a tiny human error can block the connections for hours.

From the wireless technology point of view, the link networks have deployed radio solutions similar to transmission links used in wireless backhaul networks that carry voice and data traffic for commercial operators. The transmission links have been based on microwave links and data routers connecting the individual links together. Based on mature technology, the conventional solution represents a straightforward way to provide high throughput and good reliability for fixed link applications. However, the major drawback of such a solution is its very limited ability to adapt itself to any changes and lack of mobility, which is a severe limitation considering the modern military operations.

High mobility is a must as the troops move in quickly on land, sea or in the air. Alsothe "front line" changes its location continuously. In addition to new combat tactics, increased firepower and better equipment, this trend sets new requirements also to the communications systems. Although the link network can be considered less mobile than the tactical front-line radio systems operated in the battlefield, the link network must be able to adapt to the highly dynamic environment and to keep up with the moving front line troops. This is a real challenge for conventional link networks and the problem has been identified by military organizations already years ago [3].

EB Tactical Wireless IP Network (TAC WIN) is a novel solution providing outstanding performance for the link network communications among other applications. It replaces the traditional point-to-point link networks with a flexible high performance broadband network supporting quick automatic configuration and mobility. With its ability to support multiple network topologies including point-to-point (P2P), point-to-multipoint (P2mP) and more complex MANET configurations (Mobile Adhoc Network), EB TAC WIN allows more flexibility to adapt the network to the situation, which means higher tolerance to any threat that might block a link connection or disable network nodes. The ability to establish and maintain connections to multiple nodes simultaneously using a single Tactical Router simplifies the system configuration and allows quick changes in traffic routing. In addition to link network connections, the same Tactical Router supports connection to the Tactical Data Radio as well as legacy Combat Net Radio systems. For this purpose, Radio Head Units providing access on NATO I, NATO III and NATO IV frequency bands are currently provided. As a Software Defined Radio (SDR) solution (), EB TAC WIN supports running multiple waveforms simultaneously allowing optimized waveforms to be deployed with the same equipment, for example, ESSOR or WNW for Tactical Data Radio access and EB TAC WIN high data rate for the link layer access (Figure 3). In addition to supporting flexible network topologies and access to multiple network layers with the same equipment, EB TAC WIN supports IP-data transfer throughout the entire network. This forms a solid base for various end-user services including voice, data and multimedia information transfer.

In its standard configuration, each Tactical Router is able to establish three completely individual antenna beams with each beam serving multiple users within its coverage area. With the optional integrated RH-IV Radio Head Unit (Figure 4), especially designed for high-performance link applications, EB TAC WIN is able to combine the performance of a directional high-gain antenna into the ability to provide service in a wider sector with its electronically controlled antenna beams. This makes setting up the connections easier and quicker as the antennas need no longer to be pointed precisely towards the other end. In addition, with adaptive beam control it will be possible to serve multiple users in different directions by switching the beams fully synchronized to the transmission according to where the other end is located. Although the best link performance will be achieved with high-gain directional antennas, EB TAC WIN also supports using omnidirectional antennas if a single sector node covering 360 degrees is

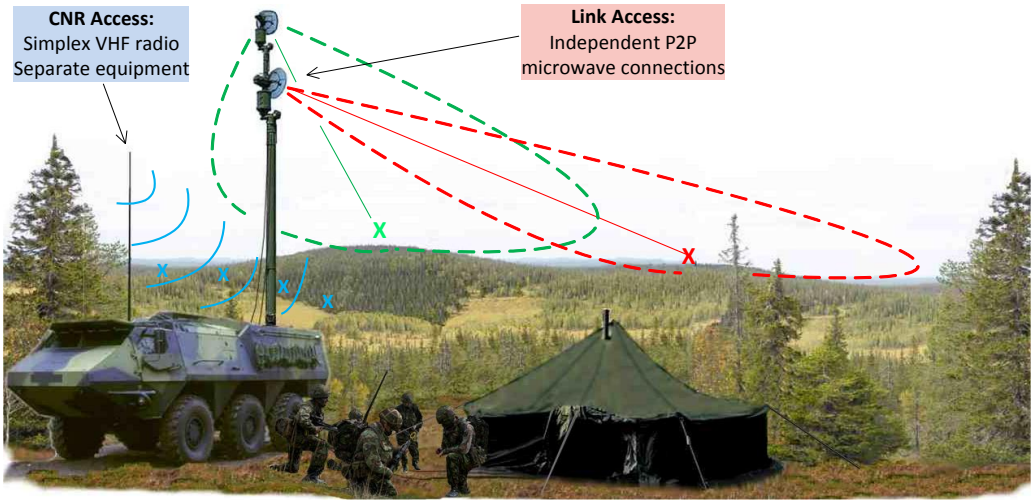


**Figure 2: The conventional point-to-point link solution** *(Copyright Elektrobit)*

required. This is typically applicable for Tactical Data Radio access operated at lower frequencies such as 225-400MHz (NATO I) requiring support to high mobility and adhoc routing.

In addition to the integrated RH-IV unit, further development is on-going. A novel antenna concept for NATO III band deploying rapid beam steering technology capable of covering the entire 360 sector with each beam is currently under development. The concept consists of a compact antenna unit supporting connections to 1-3 Radio Head Units and the control logic required to control the beam directions and to establish and track connections between nodes. In addition to the 360 degree coverage, the antenna unit is able to switch its beam from one direction to another within a fraction of a second allowing the same beam to provide real-time communications virtually to all directions like an omnidirectional antenna but with the advantages of the directional high-gain antenna including enhanced interference suppression. With the new antenna solution the advantages of EB TAC WIN can be fully deployed providing significant performance gain over the traditional link solutions. In addition to the communications performance, the concept allows quick set-up of the system. The operators will only have to park their vehicle, put up the antenna mast, switch on the equipment and the network connections will be established automatically, which is also a great improvement compared to the traditional link systems.

Currently, Elektrobit is leading one of the main activities in the Finnish Defence Forces Technology Programme 2013. The aim of this activity is to develop solutions improving the performance of the tactical communication networks. The activity comprises multiple work packages with focus on the wireless network performance. One of the workpackages aims at developing a cost efficient antenna concept such as the one described in this article. Together with cognitive control algorithms, significant gain in the link network performance can expected. In addition to concept development, the goal is to demonstrate the concept with real EB TAC WIN network in the near future.

**Figure 3: The integrated RH-IV Radio Head Unit**

**References:**


[1] Kosola, Jyri & Solante, Tero: Digitaalinen taistelukenttä, informaatioajan sotakoneen tekniikka. Maanpuolustuskorkeakoulu, Tekniikan laitos, Julkaisusarja 1 n:o 13 (2003).

[2] Puolustusvoimien Koulutuksen Kehittämiskeskus: Kenttäviestijärjestelmä 4, Yhtymän Viestijärjestelmä YVI 2 (2003).

[3] Karsikas, Jarkko: Maavoimien verkostokeskeisen tiedonsiirtojärjestelmän arkkitehtuuri ja sen toteuttaminen Maanpuolustuskorkeakoulu, Tekniikan laitos, Julkaisusarja 1 n:o 28 (2007).


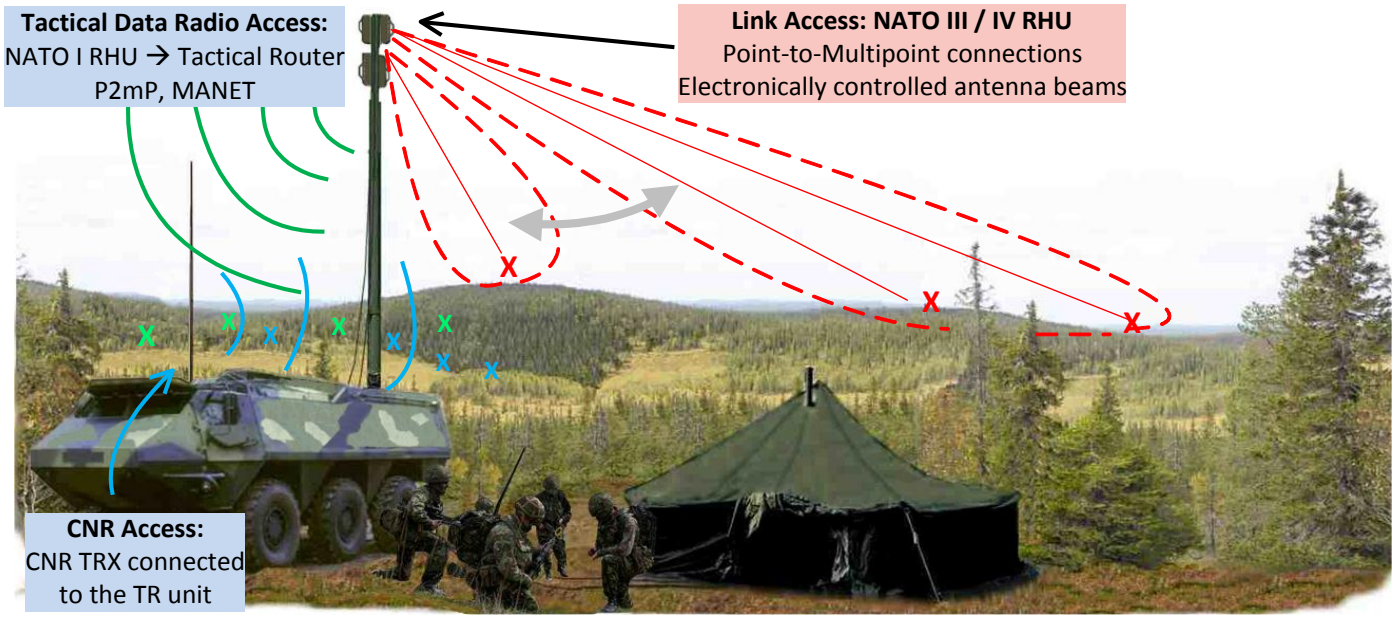


**Figure 4: An example of the connectivity provided by a single EB TAC WIN node equipped with two Radio Head Units and an interface to a legacy CNR system.** *(Copyright Elektrobit)*