Contributions to Support Interoperable, Resilient Deployment Structures

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Vorwort

In modern conflict scenarios, attackers rely on a combination of classic military operations, economic pressure, computer attacks, and even propaganda in the media and social networks. This combination encompasses all areas of society and can very quickly take on a wide variety of forms and intensities.

In order to be able to react to this in a timely and appropriate manner, it is necessary to analyze and collate data from a wide variety of sources and distribute it to decision-makers and, accordingly, to the task forces. This requires a high degree of interoperability and a resilient management and communications structure.

Current and past conflicts show that one-dimensional communication structures quickly reach their limits when they are disrupted or completely blocked by electronic warfare measures.

One possible way to meet these challenges is through networked operations involving tactical cyber forces and increased use of unmanned land and air systems (UMS) as manned unmanned teaming (MUM-T), as well as a distribution of forces in space (deployment) and implementation of highly mobile command posts (mobility) with simultaneous redundant networking.

Under the leadership of griffity defense, renowned companies and institutes have jointly developed and prototyped a conceptual framework for mobile command posts and command centers based on military-tactical considerations and analyses.

Under the motto **"Contributions to Supporting Interoperable, Resilient Operational Structures"** we will demonstrate the networking between command posts and mobile ground- and air-based units at AFCEA 2022.

With this brochure, we would like to introduce you to this conceptual framework and present our considerations and proposed technical solutions based on various exemplary implementations.

We hope that our brochure will provide you with ideas for your work in optimizing current and developing future solutions.

Norbert Frank

griffity defense

AFCEA 2022
Joint Presentation
Stands F14/A04
by griffity defense

1. Introduction.
Battle Management Challenges

The numerous inventions, discoveries, globalization and technological developments of recent decades have made our lives, at least in the Western world, easier, more convenient and more carefree. However, the strong interconnectedness and interdependence of systems has also made the overall system very vulnerable and open to attack.
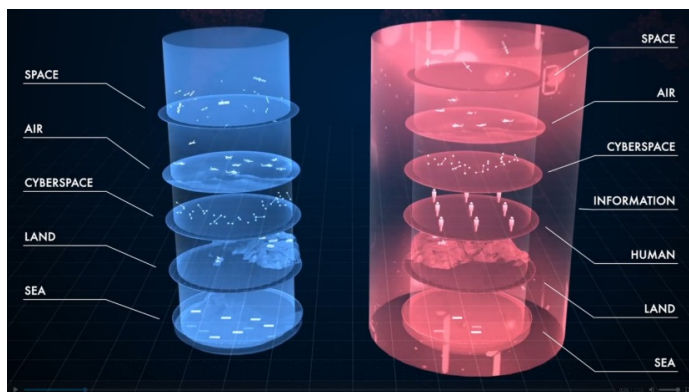
Source: US Army Future Forces Command

The consequences of the Corona pandemic have made us aware of this and also that freedom, even if it is only the freedom to meet with others, the freedom that was previously so selfevident, is a precious commodity.

The line between war and peace is blurring, eruptive events with little or no warning time are changing the environment.

The Russian attack on Ukraine has now made it clear to us, too, that it is necessary to use military means as well to defend our freedom. National and alliance defense has thus now also become the focus of the entire population.

Various analyses by NATO and research institutes clearly show that technological development in the military field is progressing steadily. Particularly

through the use of IT, systems ranging from reconnaissance to effectors have become faster, more precise and more effective, and new systems have been added whose effect is to impair (manipulate, disrupt, destroy) information systems.

Adversaries are prepared to attack in all dimensions – on land, at sea, in the air, but also in cyberspace and, in the future, probably also via outer space. To meet these complex challenges, U.S. forces have developed a new battle management concept under the term of "multi-domain operations" that addresses actions in all of these domains. The important thing is to be able to influence actions, opinions and developments in and around the theater of operations in order to put the adversary in his place.

1.1. Situational Awareness

A prerequisite for information and effectiveness superiority, and thus for successful battle management, is a situation picture that is as complete and up-to-date as possible. This makes it possible, for example, to react quickly and precisely to enemy force concentrations.

It is necessary to quickly collect information from the various data sources, evaluate it, merge it and make it available to the decision-makers and the task forces in a form appropriate to their roles. The functionality of the sensors and thus also the quality of their results has improved considerably, and further developments in the area of processors, data storage and management as

well as artificial intelligence already allow a high degree of automation and a comprehensive, level-appropriate representation of the current situation, despite the increasing volume of data.

The solutions and systems we will present at AFCEA 2022, for example, can contribute to the situation picture.

- Control of high-resolution sensors as well as evaluation and forwarding of sensor data (mobile platform)
- Automated analysis of images and videos produced by UAVs
- Detection, classification and analysis of mobile platforms and infrastructures
- Situation visualization and processing in 3D across different locations
- ATAK with various software additions for better command support/situation visualization
- Data processing and storage hardware
- Comprehensive data management (NetApp)
- Interactive navigation system

1.2. Interoperability and Standardization

The majority of current and future missions will be conducted with NATO and EU allies. For this, interoperability in technical (equipment), procedural (doctrines/procedures/logistics) and human (common understanding, training) terms is essential. And although NATO forces have already achieved a high level of interoperability through decades of joint planning, training and exercises, it is still a key issue.

"Interoperability does not necessarily require common military equipment. What is important is that the equipment can use common facilities and is able to interoperate with other equipment, establish links and communicate, and exchange data and services.

Interoperable solutions can only be achieved through the effective use of standardization, training, exercises, experience, demonstrations, testing, and trials.

By developing relationships with the defense and security industry and using open standards as much as possible, NATO seeks interoperability as a force multiplier and a streamlining factor for national efforts."

(www.nato.int/cps/en/natohq/topics _ 84112.htm)

Examples of interoperability requirements in different force configurations:
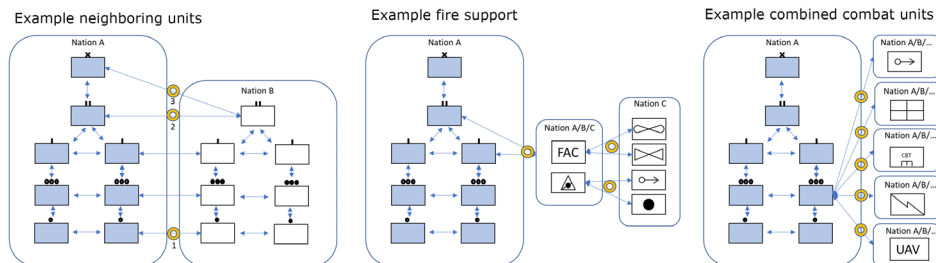
Interoperability

Neighboring units

Here are interoperability requirements between two battalions operating in close proximity to each other and sharing a common border. One battalion from nation A and one battalion from nation B. Both are under the command of a nation A brigade staff.

Fire support

Special fire support teams are often deployed at the company or battalion level to serve as a link between artillery and mortar units on the one hand and close air support from flying systems on the other. These teams also include Forward Observers (FO) and Forward Air Controllers (FAC). The composition of such units/teams may vary by country.

Combined Combat Teams

Recent operations have shown that units equipped with different military capabilities, can operate more independently on the dispersed battlefield when deployed in smaller units (such as platoons). Combined Arms Teams (CAT) are an example of this. While traditionally the brigade level has been the smallest unit integrating various types of combat and combat support, the trend is that in the near future (under certain circumstances) the platoon may function as the smallest integrated unit to conduct operations on a smaller scale.

In multinational operations, the unit tasked with the mission then draws on various force elements (e. g., reconnaissance, medical support, close air support, EloKa). Depending on the mission, different configurations of troops from different nations may be required. For this reason, a modular system must be defined from which mission-adequate units can be assembled, taking into account the respective interoperability requirements.

Technical interoperability via standardized mission modules and rack structures:

To enable equipment to use common facilities and to interact with other equipment, it is advisable, for example, to equip mobile platforms with standardized set-up mission modules and standardized rack structures with adapter panels, which then allow IT and communications equipment to be installed or exchanged easily and without major adjustments, e. g. in cable routing, according to a kind of "plug and play" system. This can save a considerable amount of time and money, including logistics, and provide flexibility in the configuration of the equipment.

Trends in Standardization
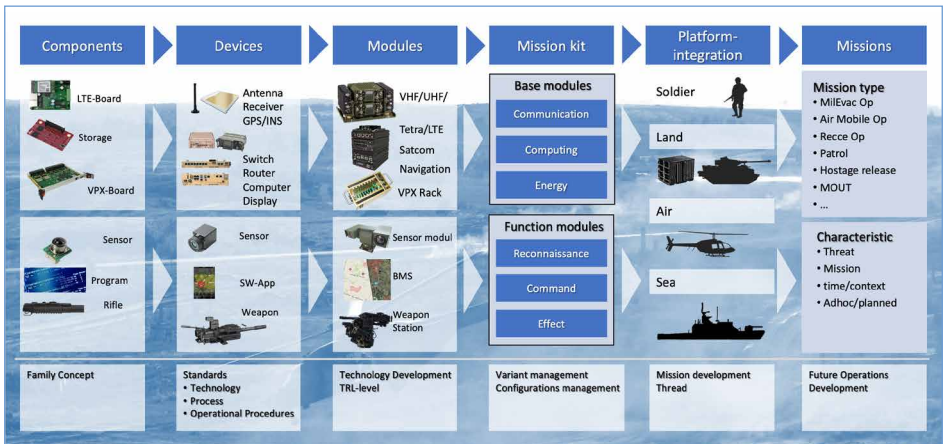
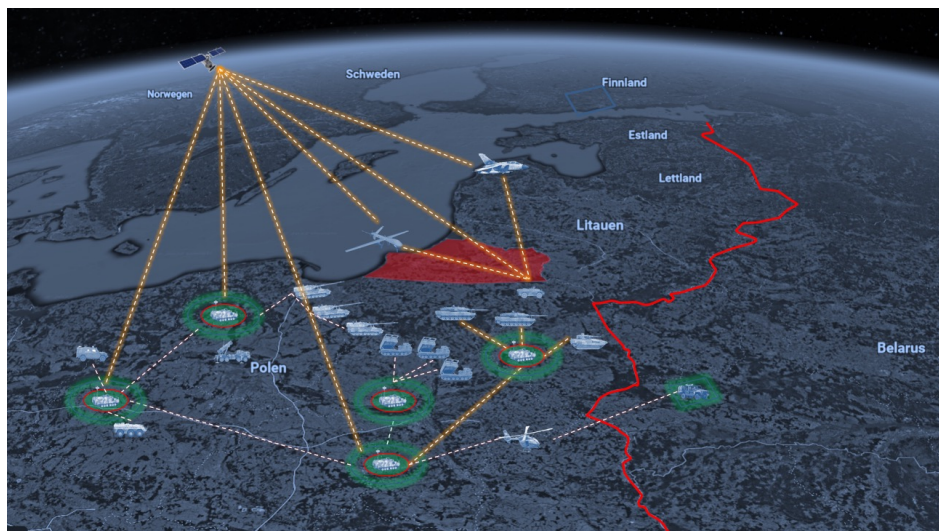## 1.3. Mobility and Dislocation

A NATO study, prepared after the occupation of Crimea, states that all units and command posts that were stationary for more than eight minutes were reconnoitered. In most cases, the reconnaissance was immediately followed by engagement by steep fire.

To counter this, highly mobile operational contingents are needed in the theater of operations that can be configured and reconfigured "on the move" and can quickly integrate capability contributions from other dimensions and partners/allies. Vehicle platforms such as the FFG PMMC (Protected Mission Module Carrier) G5, as well as container vehicles, are ideal for this purpose.

Dislocation means that, as far as possible, mission tasks are performed in the protected rear area and only the absolutely necessary resources are brought into the forward zone/combat zone. This also results in a lower potential threat to deployed forces and a smaller logistical footprint.

In order that mobility and deployment can fully develop its advantages in the Command – Control – Reconnaissance – Effect – Support Chain, comprehensive networking of all units involved in the operation and, consequently, reliable, robust communication with one another is of crucial importance.

Dislocation – Mobility – Networking

1.4. Networking/Communications

In the future, command and control of operations from distributed locations will become increasingly important in order to remain capable of command and control in the event of the loss of a command element. Thus, the

ability to network actors and platforms in a "hostile" environment and to provide a disruption-resistant, secure, flexible and resilient communication and information infrastructure becomes a key requirement.
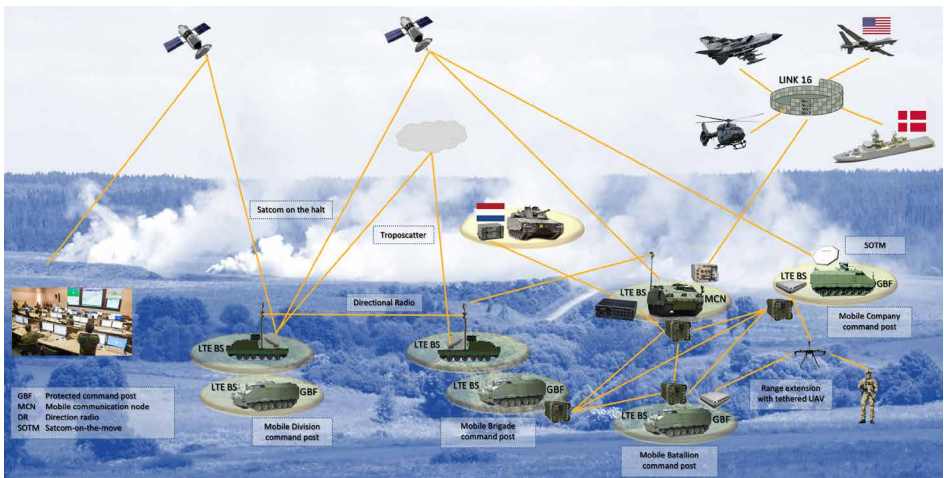
The illustration above shows, using the fictitious example of a multinational operation, the networking between home base and the respective command posts (division – brigade – battalion – company), which are designed as protected highly mobile components. The networking is done via wide area network and the tactical communication network up to the soldier using different technologies to account for range, bandwidth and interference resistance.

In order to ensure secure, resilient and flexible tactical communications that also meet operational requirements, it is necessary to use and combine communication technologies according to their specifics (range, bandwidth, frequency range, etc.).

For planning purposes, PACE, a method developed by the U.S. Armed Forces, can be used to develop resilient communication plans for all types of situations.

PACE stands for:

Primary: best method of communication between stakeholders

Alternate: common, but not so optimal method of communication

Contingency: this method of communication is not as fast/simple/cost-effective as the aforementioned, but is capable of accomplishing tasks

Emergency: last resort for emergencies

Radio	Frequency	Range [1]	Througput [1]
HF	3-30 MHz	Up to 4000 km	1,2-16 kbps
VHF	30-89 MHz	8-30 km	16-60 kbps
UHF	225-400 MHz	8-15 km	≤ 1 Mbits
LINK 16	960-1215 MHz	LOS	28.8 kbps - 1,1Mbits
LTE mil	700-750 MHz	2-5 km	15 Mbits
DR mobile	4,9-5,9 GHz	≤ 100 km	≤ 15 Mbits
DR	4,4-5,0 GHz	~45-70 km	≤ 50 Mbits
SOTM	C, Ka, Ku	2000+ km	2-6 Mbits
Troposcatter	4-5,9 GHz	50-250 km	75-20 Mbits
SOTH (2.4m)	C, Ka, Ku	2000+ km	8-32 Mbits

1) Anhaltswerte

LTE — Networks within HQ area
SOTM — Satcom-on-the-Move
SOTH — Satcom-on-the-Halt
Rifu — Directed Radio
FEBA — Forward Edge of the Battle Area
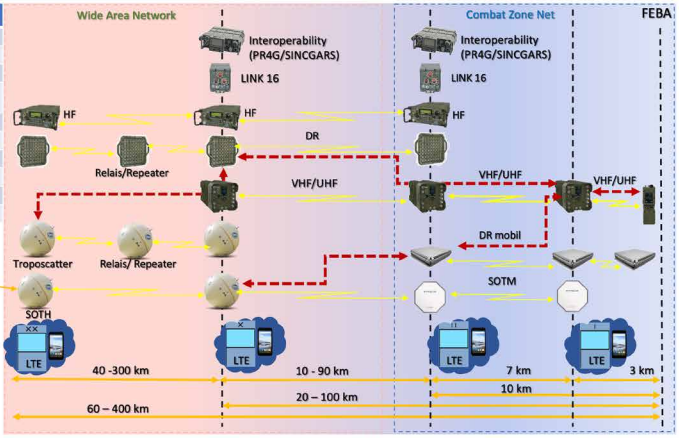
Overview Communication Technologies and Networking – The figure shows the basic networking of the command posts, taking into account range requirements.

Long-distance traffic: Satcom/HF links

Today, satellite links, with which high data rates can be realized, form the backbone for long-distance communications in many areas. In the military, they are suitable for communication from the home country to the area of operations, between distant command posts in the country of operations and for linking remote units (e. g. SOF units) to their base when tactical means of communication are insufficient.

As a backup or supplement to satcom, HF links can be considered, which can transmit only small amounts of data, but are highly resistant to interference and less expensive to use because there are no monthly airtime costs. HF can also be used for communication in polar regions where no satcom coverage exists.

Medium-distance: troposcatter/directional radio/VHF links

Thanks to their technological advancement, troposcatter are today again an alternative to microwave and satcom for communication links of up to 250 km and high data volumes. Troposcatter links have a low susceptibility to interference and interception and can thus close the niche between tactical and long-range communications.

Radio relay links are point-to-point connections. In addition to a certain immunity to interference, they offer high data rates and ranges of up to approx. 75 km. By using relay stations, the range can be increased over several hundred kilometers. They are available as fixed stations or mobile applications.

VHF is the classic tactical radio for military units. VHF transmissions have lower data rates than UHF, but can achieve greater geographical ranges. VHF is suitable for the transmission of voice and basic data, while the transmission of megabit data such as typically occurs in video and image transmission is reserved for the UHF band.

Short-range: UHF/LTE

UHF radio offers high data transmission rates, but is limited in its geographical range. The main military use is for networking tactical units and sensors.

In the meantime, LTE systems and smartphones specially designed for military users are also deployed, e. g., for command post networking. They offer the functionality familiar from the civilian sector, supplemented by the specific features required by the military in terms of robustness, secure communication, and applications (e. g. PTT).

Overview

| Technology	Frequency range	Distance (Indicative values)	Data rates (Indicative values)
Satcom-On-The-Move	C, Ka, Ku-band	2000+ km	2 – 6 Mbit/s
Satcom-On-The-Pause	C, Ka, Ku-band	2000+ km	8 – 32 Mbit/s
HF	3 – 30 MHz	up to 400 km	1.2 – 16 Kbit/s
Troposcatter	4 – 5.9 GHz	50 – 250 km	20 – 75 Mbit/s
VHF	30 – 300 MHz	8 – 30 km	16 – 60 Kbit/s
UHF	225 – 400 MHz	8 – 15 km	$\leq$ 1 Mbit/s
Link 16	960 – 1215 MHz	Line of Sight	28.8 Kbit/s – 1.1 Mbit/s
LTE mil	700 – 750 MHz	2 – 5 km	15 Mbit/s
Radio Relay mobile	4.9 – 5.9 GHz	$\leq$ 100 km	$\leq$ 15 Mbit/s
Radio Relay stationary	4.4 – 5.0 GHz	$\sim$ 45 – 70 km	$\leq$ 50 Mbit/s

Examples of the above technologies can be found at our AFCEA 2022 joint booth.

2. Solutions/Products

2.1. Overview

The joint presentation by griffity defense and its partners at the AFCEA 2022 technical exhibition includes contributions in support interoperable, resilient deployment structures in the areas of:

- Vehicle integration/mission modules
- Reconnaissance and command support
- Communication/Navigation
- Cross-functional IT (data processing/data management)
- Networking of dismounted forces
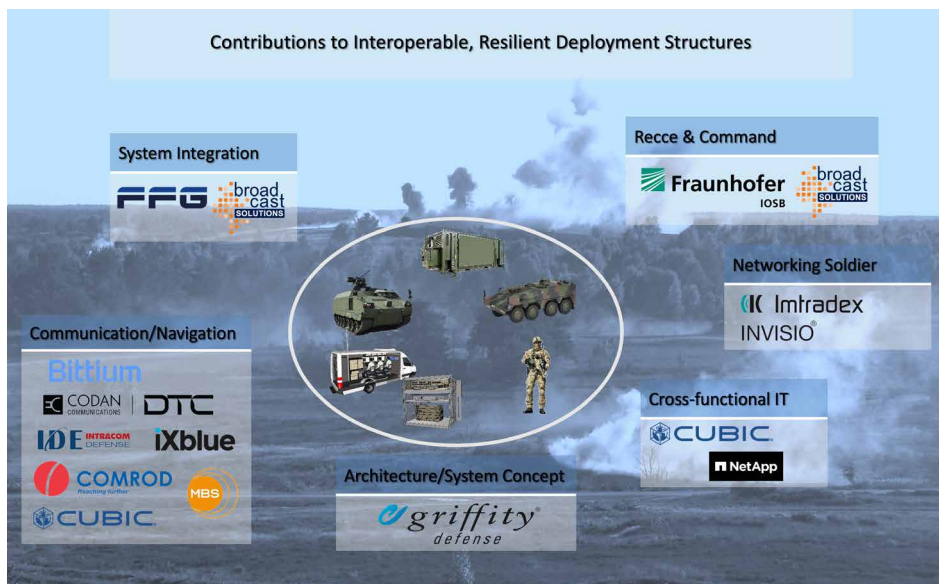
Solutions and Products

2.2. Vehicle Integration/ Mission Modules

The high level of technology, constantly growing requirements, the further development of equipment for modern protection and armed forces make it necessary to rethink the design of vehicles and the corresponding mission sets.

While the service life of vehicles lasts for several decades, the use of communication and IT components, especially those installed in mission sets, is only a few years due to the speed of technological development and continues to decrease as the development cycles of new products become shorter and shorter.

FFG's modular mission kit system uses standardized racks and standardized components that enable rapid adaptation to respective mission kit changes. It is conceived and designed with protection aspects in mind for use in military and special police vehicles, regardless of whether they are tracked or wheeled.
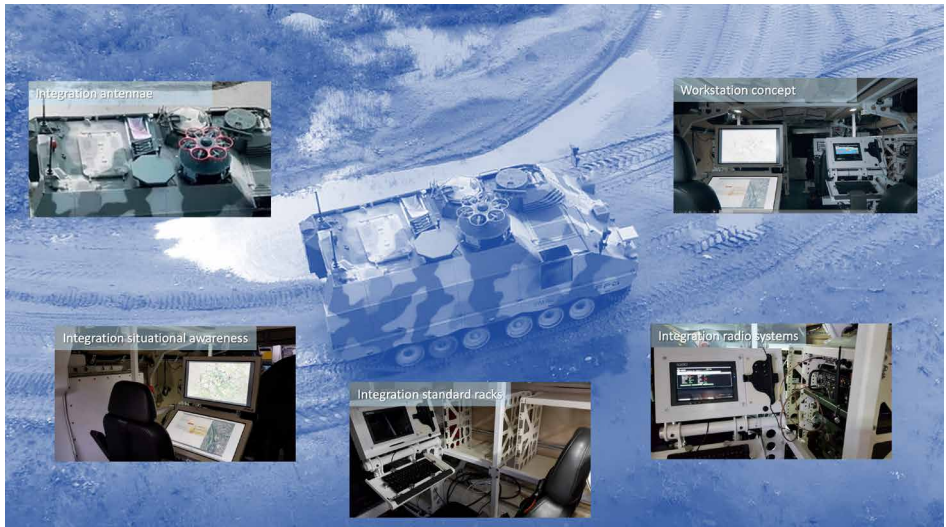
By using the modular mission kit system, the components of the mission equipment resp. mission kit can be integrated into the vehicle without extensive new developments and adaptations. Taking into account the requirements of the operating personnel, a modern, functional and ergonomic operating concept is realized for the corresponding workstations. This applies not only to the installation of complex radio and command systems, but also, for example, to the installation of extensive sanitary or other special equipment.

The robust design and consistent use of established subsystems as well as standardized components ensure a high degree of logistical uniformity. Coupled with a modern maintenance and repair concept, this leads to very low life cycle costs (LCC) and thus to maximum cost efficiency. This is the optimal way to meet the changing requirements and conditions in global operations over decades.

The use of standardized racks enables the rapid and cost-saving installation or replacement of equipment and thus adaptation to the mission to be carried out. Since equipment of different types and manufacturers can be used, this leads to a more flexible composition of the required mission configuration and less dependence on manufacturers.

The concept thus already meets standardization initiatives and agreements such as NVGA, Open VPX or MORA.

Example for vehicle integration and mission modules:

Integration antennae

Workstation concept

Integration situational awareness

Integration standard racks

Integration radio systems

Vehicle Integration and Mission Modules

2.3. Reconnaissance and Command Support

In the area of reconnaissance and command support, we show how the task forces can be automatically supported with the help of algorithms in the detection and identification of objects on the basis of video images. These reconnaissance results are then transmitted via a suitable tactical network and displayed to command and visualization systems such as the DigLT or ATAK.

Recognize – Evaluate – Visualize

2.3.1. ABUL Automated Image Exploitation for Unmanned Aircraft

ABUL is a full motion video evaluation for reconnaissance and surveillance and was developed in cooperation with aerial image evaluators.

The advantages of video-equipped unmanned aerial vehicles (UAVs) for reconnaissance, search and rescue missions are obvious. By radio transmission of the image and video data recorded by the UAVs to the ground station, the evaluator has the possibility to analyze the data in real time. In this context, Fraunhofer IOSB has developed the ABUL system, which was designed as a supporting tool in the evaluation process and to relieve the operator during critical missions.

ABUL provides optimized real-time functions for online reconnaissance and tactical exploration as well as valuable functionalities for offline exploration missions.

2.3.2. RecceMan® (Fraunhofer IOSB)

It is not only in the field of military intelligence that necessary information about objects and infrastructures must be derived from imagery data. This also includes imaging reconnaissance, which is obtained by recording and analyzing aerial and satellite images.

Key issues in this regard are the detection and identification as well as analysis of land vehicles, troop move-ments and accumulations, ships and infrastructures of all kinds. To ensure and improve evaluation and analysis results, Fraunhofer IOSB developed the RecceMan® recognition assistant on behalf of the BAAINBw (German Procurement Office) which is, since years, deployed as an operational system in the Bundeswehr. The object recognition and identification assistant enables the image analyst to describe objects on the basis of characteristic features. The RecceMan® software provides comprehensive assistance, for example by providing a list-like overview of existing objects
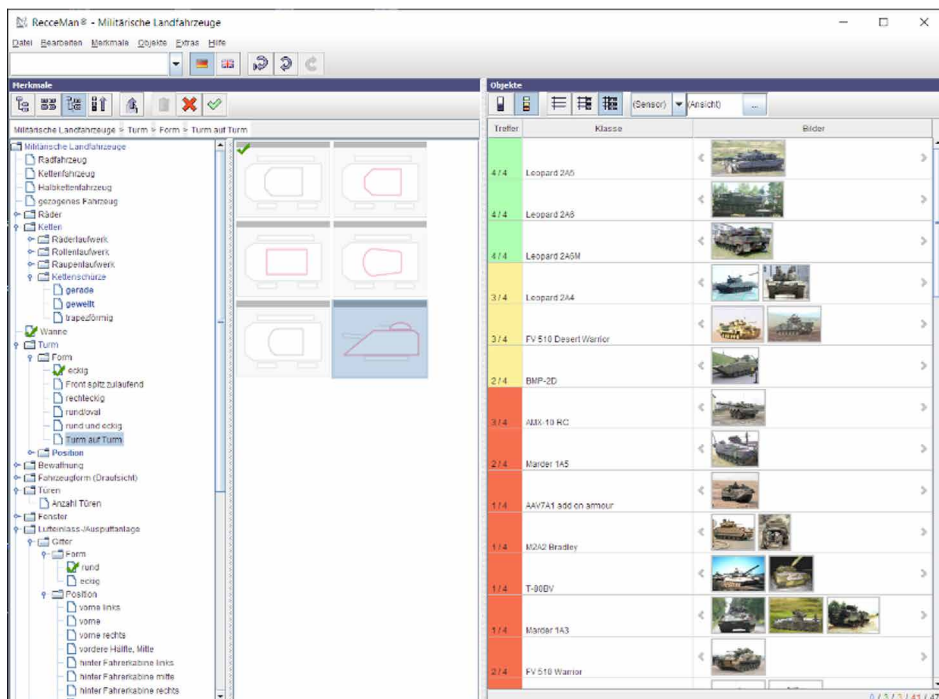
2.3.3. Situation Visualization – DigLT (Digital Map Table) (Fraunhofer IOSB)

The Digital Map Table (DigLT) is a software system for shared situation visualization and analysis. Any number of users can work independently of each other on the same situation, using personal computers and tablets alongside shared digital tables or large screens.

The underlying software is modular and can easily be custom-tailored towards specific needs and extended depending on the requirements. Its uses range from educational use to mission preparation, mission execution, and review. A diverse range of data sources and geodata can be integrated to provide the right information for each use-case. This provides the basis to correctly judge the situation and make the right decisions.

Stationary, deployable and mobile systems (existing and new technologies to be introduced) can be merged in such a way that national and international interoperability is given and the information required for command & control is available on time and as required.

The core of the Digital Map Table is the server, the DigLT^{Core}, which, in addition to geodata, also provides all layers, configurations and functions. The server can then be accessed by the web-based client DigLT^{Web} and the virtual reality client DigLT^{VR}. Due to the flexibility of a web application, this client can be used on almost all end devices, especially the high-resolution DigLT^{4k}.

- Scalable, highly mobile solution
- Interactive teaming over long distances
- Can be used flexibly in stationary, mobile command posts, command vehicles down to soldier level without media disruptions
- Simple operation by using a user interface known from the civil world (smartphone/tablet/PC)

Virtual Digital Map Table
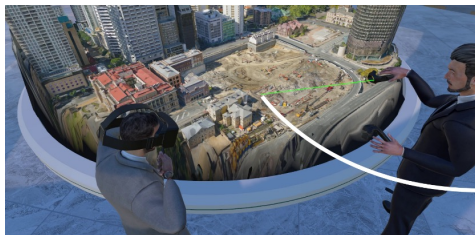
Virtual Site Survey

2.3.4. Android Team Awareness Kit ATAK

ATAK is a tactical real-time application for tablets and smartphones such as the Tough Mobile from Bittium. It provides geospatial data and enables soldiers to work collaboratively at different locations, using voice, chat, video, a shared interactive map, etc.

ATAK networks can be established using a variety of communication technologies, including cellular devices, Wi-Fi, and radio-based tactical communications.

ATAK began as a simple situation display tool and developed into a wide application. The flexibility of ATAK allows a quick integration of new technologies.


ATAK and Plug-Ins – The figure shows the integration of extensions that the manufacturers of various sensor, communication and other systems have developed for ATAK.

For example, the raw video of an unmanned system (UAS/UGS) can be processed by software on site and fed into ATAK, which enables the operator to quickly display georeferenced and other processed images.

Another example: One of the most difficult challenges on the battlefield is disrupted troop communication by the enemy. In combination with additional tools from third-party providers, ATAK can track down and detect possible interference attempts and alert soldiers.

In conjunction with the digital situation table (DigLT), it forms the front-end in the tactical area.
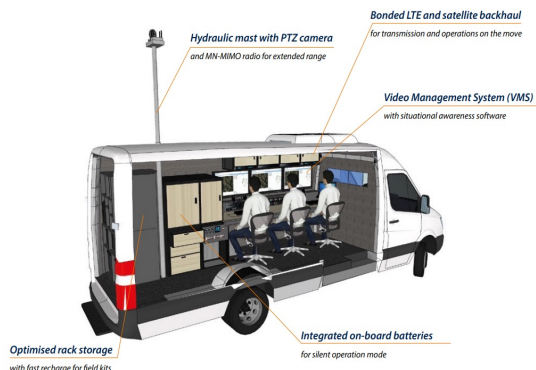
MoSA Vehicle

2.3.5. Reconnaissance Vehicle – MoSA (Broadcast Solutions Stand A04)

The MoSA (Mobile Situational Awareness) platforms developed and manufactured by Broadcast Solutions enable flexible tactical communication in mobile units of various designs and sizes.

The MoSA-M4 platform (to be seen at the outdoor stand A03) is a vehicle that facilitates command, control, communication and computer infrastructure (C4), optimized storage solutions and logistics. Additional possible equipment includes hydraulic masts, PTZ cameras, video management systems (VMS), and further sensors, with optional drone detection or drone defense systems (with selected partners).

Highlights:

- High-performance and resilient IP transmissions (ad hoc networks, MESH topology, NLOS, COFDM, MIMO, full-duplex for voice, data, video)
- High-quality, low-latency video transmission (live HD and 4K videos)
- C4 on board (3-4 operator positions, monitoring, recording and analysis of feeds from the field, can be combined with GIS system, digital intercom system for communication with units in the field)
- Drone detection and drone defense
- Mobile power supply and optimized energy management
- Mobile data backhaul (via mobile radio or SatCom)

2.4. Communication/Navigation

In the area of communications and navigation, we are showing a combination of different technologies ranging from wide-area communications and tactical communications to command post networking using LTE. The increasing threat to communication and navigation systems from jamming and spoofing is also taken into account here with appropriate technologies (e. g. INS).
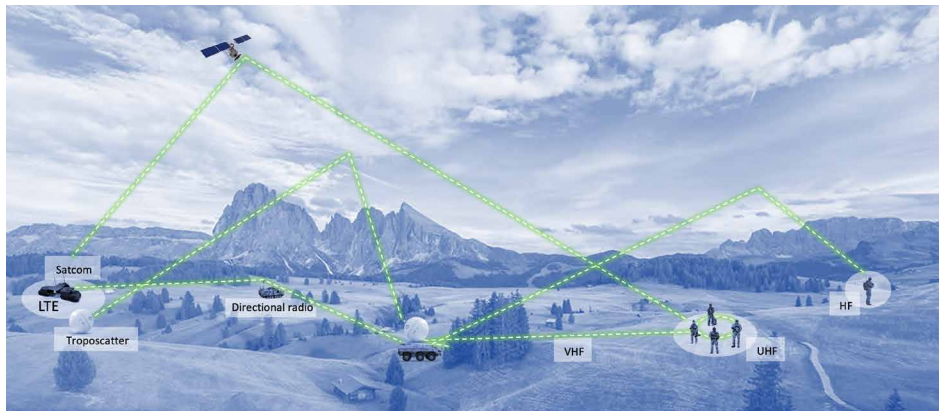
Communications in Mission

2.4.1. Satellite Communications (MBS)

As the time between reconnaissance and action becomes shorter and shorter, mobility or the rapid deployment of troop units is becoming increasingly important due to avoid presenting the enemy a static target in battle.

For highly mobile and rapidly deployable units pre-integrated Communications-On-The-Move (COTM) and Communications-On-The-Pause (COTP) as well as stationary solutions for land-, sea-based & airborne operations are offered.

Example: Satcom-On-The-Move

A modern Satcom-On-The-Move (SOTM) solution makes it possible to provide high data volumes while the vehicle is moving, without having to unload and commission a communications terminal first. SOTM systems available today transmit up to several Mbps and, due to their flat shape, can be mounted in such a way that they hardly affect the contour of a vehicle.

VSAT Terminals / Antennas				
Categories	**COTM** Communications-on-the-Move	**COTP** Communications-on-the-Pause	**SATCOM**	
Types / Size	**Mobile** Up to 100 cm	**Mobile** Up to 45 cm	**Deployable** 1m - 1,8m	**Stationary** From 2,4m
Standards	MILSATCOM COMSATCOM	MILSATCOM COMSATCOM	MILSATCOM COMSATCOM	MILSATCOM COMSATCOM
Platforms				

COMSATCOM = Commercial SatCom | C-, Ku-, Ka- Band
MILSATCOM = Military SatCom | X- & MIL Ka-Band

Overview: VSAT Terminals/Antenna Categories

As an example, we show a KYMETA-SOTM antenna.

Features:

- Ku-Band

- +4 Mbps Downlink, up 2 Mbps Uplink

- Automatic pointing without moving parts

- Fully automated commissioning

- Dimensions: 82.3 x 82.3 x 7.1 cm, 15.9 kg

Example: Satcom-On-The-Pause

To enable broadband satellite communications on-the-pause (SOTP), lightweight and compact terminals are becoming increasingly important. With a weight of 8 kg and dimensions of 47 x 30 x 5.5 cm as well as data rates of up to 20 Mbps via HTS (High Throughput Satellite) the SATCUBE, for example, represents a bandwidth-enhanced alternative to previously available solutions such as BGAN.

The SATCUBE terminal contains space for 3 batteries (for 3 hours of transmission), which can be replaced without interrupting operation.

The alignment of the antenna is visually supported by a pointing system via an LCD display, so that commissioning only takes about one minute.

2.4.2. HF-Communications (Codan)

From the wide range of communication solutions, we will show some solutions from the field of RF communication at AFCEA 2022:

SENTRY-H 6120 BM Mobile

Robust Software-Defined Radio (SDR) solution for military organizations that require uncompromised, secure voice and data communications over long distances. With an RF power of 150 W, it is specifically designed for the smallest and lightest form factor to enable easy integration into base and mobile platforms.

Working closely with military customers, the 6120-BM has been optimized for ease of use and features an ergonomic, intelligent hand-set with a full-color, high-resolution, multi-language user interface and a host of other features.

3040 AUTOMATIC WHIP Vehicle Antenna

A low-profile antenna that provides a mobile antenna solution for all Codan HF radios. The 3040 offers a combination of fast tuning, compact form factor, and rugged construction, all to create a state-of-the-art mobile antenna tuner. It has an RF power capability of 125 W and can be used for voice and data operation over the entire frequency band from 2 to 30 MHz. The tuner has a tuning time of less than 200 msec with unlimited memory capacity, with new frequencies typically tuned in less than one second. The extremely fast tuning function and optimized antenna efficiency ensure maximum system readiness and are always available to the operator.

SENTRY-H 6110-MP Manpack

Rugged, portable Software-Defined Radio (SDR) solution for military organizations that require uncompromised, secure voice and data communications on the move. The 6110-MP is an integral part of the Sentry-H product family, meeting the needs of the modern battlefield while providing full backward compatibility with legacy products. The 6110-MP is one of the smallest and lightest HF crew radios available. It offers powerful 30 W RF power and up to 79 hours of battery life at a weight of less than 4.7 kg, without compromising on features.

HF-Application Software

RC-50C

Email via HF radio. In conjunction with the RM50 series RF transceivers and data modems, the software runs on a standard Windows™ PC via a single USB port and requires no special PC hardware. Once installed, the software runs in the background and requires no user interaction.

SPRINT

SprintChat and SprintNet applications take advantage of the 3G ALE waveform to provide connections quickly and securely.

RF data communications. Peer-to-peer email, file transfer and chat are supported, as well as SMS and Internet email over the SprintNet gateway. The flexibility and interoperability benefits of the Sprint solution provide a powerful extension to your RF networking capabilities.

2.4.3. Tactical Wireless – TAC WIN and Tough SDR (Bittium)

With the Software-Defined Radio (SDR) based Bittium Tactical Wireless IP Network (TAC WIN) system, combat groups can create high data rate wireless IP networks as the backbone to support command and control data transmission (C2) during military operations. The flexibility to use the Bittium solution in different frequency bands and network structures offers cost effectiveness, ease of use and efficiency compared to existing tactical data link networks.

Bittium Tough SDR™ – Newest generation of Tactical Radio

The software-defined tactical vehicle and handheld radios provide voice and data over the widest frequency range and the highest data throughput across multiple frequency bands. Together with flexible configuration options and routing networks, the radios support even thousands of radios in one network.

Bittium is a member of the ESSOR industry consortium. Porting the waveform to the national software-defined radios enables compatibility between radios used in European coalition operations, in line with the objectives of the ESSOR program.

Waveforms:

- Bittium Narrowband WaveformTM (25 kHz)
- Bittium TAC WIN WaveformTM (5/10 Mhz; data rate bis 25 Mbps)
- ESSOR High Data Rate Waveform (1.25 MHz, datarate bis 1.25 MHz/Radiolink)
- Porting of other waveforms on request

At AFCEA 2021 you will see radios and devices as folllows:

Bittium Radiohead IV™

- Point-to-point with integrated Beam-Steering
- Range LOS approx. 40 km (under ideal conditions up to 80 km)
- Frequencies: 4.400 – 5.000 MHz
- Channel width 5/10/20 Mhz
- 10 kg/385 x 520 x 67 mm

Bittium TAC WIN Tactical Router™

- Routing und Waveform Processing Unit
- 19.4 kg/223 x 356 x 400 mm
- Multiple interfaces

Bittium Tough SDR Vehicular™

- 2-Canal Radio/Manet
- Frequencies: 30 – 512 Mhz and 225 – 2.500 Mhz
- Cannel width:
  Ant 1: 25 kHz – 10 Mhz
  Ant 2: 25 kHz – 5 MHz
- <15 kg/210 x 270 x 300 mm
- Application sandbox for C2 applications such as BMS and Blue Force Tracking

Bittium Tough VoIP Field Phone™2

- Rugged VoIP phone for versatile use in shelters, vehicles or by remote squads
- Connectivity via Field Wire (SHDSL), Ethernet or WiFi (Bluetooth, USB, serial/audio)
- Interoperable with Bittium VoIP ServiceTM or 3rd Party SIP Servers
- PTT functionality
- Disables wireless connection to ensure radio silence

Bittium Tough SDR Handheld™

- Connection of TabletPCs or Smartphones through cable or air
- Frequency range: 30 – 2.500 MHz
- Cannel width: 25 KHz – 25 MHz
- 74 x 244 x 47 mm
- 70Wh chargeable lithium-ion battery

Bittium Tough Mobile 2™

- Secured hardened Android-based 4G LTE-Smartphone
- Dual SIM with Dual SIM Standby (DSDS)
- Hardware-based security platform
- Integration customer-owned and 3rd party security solutions
- 3 variants: standard, restricted, confidential
- PTT, Privacy Button, up to 4 Container
- Secure Suite VPN, MDM

Bittium Tactical Network Management™

Network management system and toolset, optimized for Bittium tactical communication networks:
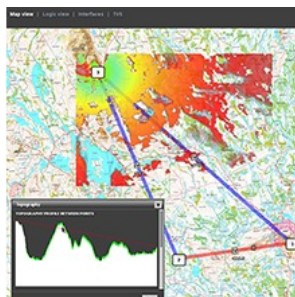
Bittium Tactical Network Planner Tool

for optimized network planning including calculation of the link quality and simulation of the coverage area

Bittium Tactical Network Manager Tool

for real-time monitoring of network status, link quality and alarms
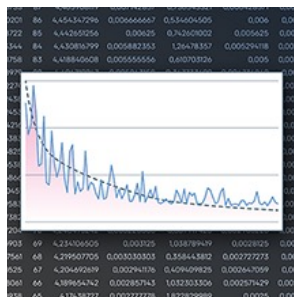
Bittium Network Analytics Tool

collects information from the network for your own evaluations/ statistics and recordings

2.4.4. LTE-Network – LTE M3C (M3-Cellular) (Cubic)

LTE M3C is a robust, 4G LTE base station with an integrated core network (EPC Evolved Packet Core) that can be used as an independent LTE network or as a backhaul to larger networks.

LTE M3C can serve up to 64 active users at a download data rate of up to 150 Mb/s and a distance of up to 15 km.

Technical data

	Vehicle variant	UAV-variant
Dimensions (WxHxD)	23.03 W x 19.30 H x 9.39 D (cm)	23.03 W x 19.30 H x 6.0 D (cm)
Weight	1.7 kg	1.0 kg
Frequency band	B1, B5, B28, B40 (further bands on request)	
Channel space (MHz)	5, 10, 15, 20	
Power	35 W	
Operational temperature	-20º C to +50º C	
Protection code	IP67	

There are also pure base stations (without EPC) with capacity for 64 or 128 users available.

SOLUTIONS AND PRODUCTS

2.4.5. WiSPRevo – Information & Communication System (Intracom Defense)

The WiSPRevo is an advanced information and communication system for military applications and digitalization of battlefield operations. WiSPRevo is designed based on the latest open architecture and technology standards, providing a wide range of hardware and software interfaces in order to fulfill any interoperability and integration requirements of the end user and integrator.

WiSPRevo complies with all related military standards and is highly modular and expandable solution for use in various platforms such as wheeled and tracked vehicles, rapidly deployable military structures and rigid inflatable boats.

WiSPRevo CCU user terminals are modern IP-based communication devices with PoE capabilities and provide a wide range of tactical voice and data services including Intercom and Tactical VoIP communication channels, RoIP, Messaging, Radio Remote Control. Moreover, CCU terminals support advanced Dynamic Noise Reduction (DNR) features, providing unmatched performance in very noisy environments, remarkable speech intelligibility, improved crew hearing safety, increased situational awareness.

Tactical Mission Node (TMN) is a state-of-the-art WiSPRevo component for building complete C4I solutions. TMN provides advanced IP networking and routing capabilities, multimedia services, Local Area Network, data processing and storage, voice and data recording as well as interfaces and services for connections to platform's subsystems, sensors and actuators.

In addition, TMN can embed optional modules for last-mile wireless comms, a Generic MOTS Processing Unit to support third-party customer's applications, real-time video streaming and distribution, extended data storage etc.

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2.4.6. Deployable Networknode RIOS (Codan/DTC)

Radio interoperability system – any to any voice device

Codan's RIOS (Radio Interoperability System) is a set of devices that enable end-to-end secure radio-to-radio-to-IP voice communications. Encrypted and unencrypted radios from any band (e. g. HF, VHF, UHF, satellite) can be bridged and distributed to IP links (e. g. LTE Internet, fiber, microwave, Ethernet), allowing "software" users on Windows computers, iOS/Android smartphone apps or VoIP phones to talk directly to radios on the ground.

RIOS is hardware compatible with any device that has a microphone and a speaker. This means that GSM or POTS phone networks can also be easily integrated into the same RoIP talk groups. RIOS works transparently for all encryption standards – communication channels remain "red" between radios, are decrypted by the connected radio going into the RIOS, and then re-encrypted by another outgoing radio connected to the RIOS.

Control: Daylight readable Windows gateway controller.*

Network: Integrated router with LAN, Wi-Fi, and USB cellular data connection access.*

Enclosure: Pelican iM2500 roller case: Water resistant, pressure release valve, telescoping handle.

High-Density Radio Interface: Eight (8) D-Sub 26-pin connectors for standard and/or remote radio control interface for two-way radios.

Power: DC input or AC with power supply provided. DC output for auxiliary devices, 12 Volts at 1.5 amps. Integrated Lind for integrated laptop charging.

*Items subject to change. Contact Codan for latest component specifications.

2.4.7. Antennae and Masts (Comrod)

Every radio transmitter and receiver requires an antenna. With the increasing number of radios and the increasing use of multi-channel radios, the number of antennae on vehicles and shelters has risen continuously.

The integration of antennae onto limited platform space, while achieving antenna separation to maintain pattern performance, is the largest challenge of modern communication. Comrod offers multi-band antenna solutions together with passive or active antenna

combiners for connecting multiple transceivers to a reduced number of antennae. Sharing antennae reduces the pattern distortion associated with co-site antenna interference.

Typical Configuration

Two antennae VHF302700TB-WBE and GNSS Puck 30-88/118-480/700-2700 MHz/GNSS Puck

- two antenna configuration using VHF302700TB-WBE and GNSS Puck

- small visual profile

- extended VHF/UHF band coverage 118-480 MHz

- full LTE frequency band coverage of 700-2700 MHz

- low-profile GNSS antenna
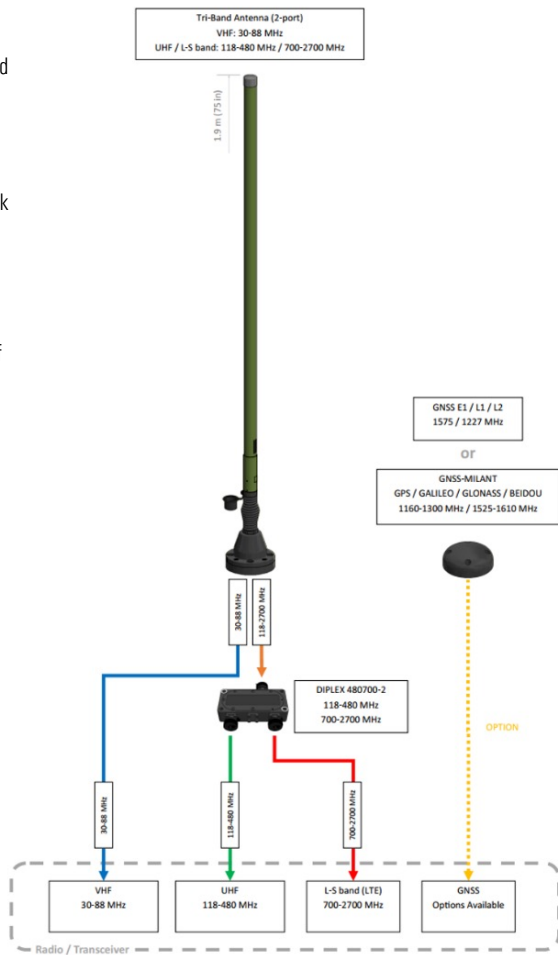
2.4.8. Navigation (iXblue)

iXblue is a leading global provider of innovative solutions and services for navigation, positioning and imaging on land, air and sea.

In the area of land systems, iXblue has developed a wide range of inertial navigation systems for blue force tracking and light weapon systems through to the navigation and route guidance of tactical artillery and armored vehicles. From this iXblue will present Advans Ursa at AFCEA 2022.

Advans Ursa

an INS (Inertial Navigation System) based on FOG (Fiber Optic Gyroscopes) technology that continuously supplies position, direction and altitude information for tactical navigation, blue force tracking, in combat missions and the use of light weapon systems, even if no GNSS/GPS signals are available.

Advans Ursa 5 connected to a TabletPC

2.5. Cross-Sectional IT (Data Processing & Data Management)

2.5.1. Micro-Router, Switch, Power Supply – M3X (Cubic)

Mobile. Micro. Modular if there is no space for 19"

The M3X product family from CUBIC Mission Solutions (DTECH LABS) is the ultimate powerhouse for small, secure, portable communication systems. A "cuboid" consisting of a computer, router, switch and power module weighs $\sim$ 8 kg and is just $\sim$ 21 cm long/deep and $\sim$ 26cm high.

The patent-pending design transmits power and data between the modules via Ethernet without the need for cabling via plugs, which significantly reduces set-up time and complexity.

An interlocking rail system enables the modules to be pushed together horizontally and vertically. A special lever construction enables quick release and reconfiguration.

M3X Modules
in Stack

M3X Context

M3X Rack Square

Modules from the M3X-family.

M3X-RTR2: Based on the trusted Cisco ESR-6300, the M3X-RTR2 modules are full Gigabit Ethernet routers featuring 2 x GE PoE or 2 x SFP layer 3 routed WAN ports and 4 x PoE GE layer 2 switch ports. Both modules support Cisco Command Line Interface and up to 32 GB of removal storage. Available in SFP and none SFP Variants.

M3X-SW24: Powered by an embedded Cisco ESS-3300 switch, the M3X-S24G provides a 24 x GE port switch plus 2 x 10 GE SFP+ ports.

M3X-APP: High performance Xeon D server with 128 GB RAM and a single 7 mm/2.5" SSD solid-state drive ensures the M3X-APP is more than capable of running server applications, virtual machines and wireless LAN controllers at the tactical edge.

M3X-BPS: Battery power supply and backup in case of power failure with programmable LED screen, which allows the user to see various functions, status and battery life.

Smart Battery Power Supply supplying over 96 watt-hours of power to a vertical stack of equipment. Multiple M3X-BPS modules can be placed anywhere in a stack providing additional reserve battery power to support mission requirements.

2.5.2. Rugged Mobile IT-Solutions (roda)

roda offers a wide range of hardware (tablets, handhelds, notebooks, displays, power supplies) in various versions for mobile use and vehicle integration under the toughest conditions, of which we show the

roda Common Crewstation (roCCs) a (N)GVA compliant (smart) display solution with touchscreen, Intel Core-processor, Video-over-Ethernet and a large number of interfaces and individually programmable keys.

2.5.3.Data Management – Data Fabric (NetApp)

Data Fabric is the data layer architecture and offers consistent and integrated data management services with a focus on data access, protection and security, as well as applications for data visualization.

The provision of resilient and equal data in the EDGE, CORE & CLOUD layers is ensured by the mission-dependent selection of the relevant NetApp product. The products are part of the Data Fabric architecture, are modularly scalable and can be deployed in both stationary and mobile environments.

Maximizing data benefit thus contributes to information superiority true to the motto: "Data @ Machine Speed enables Fight @ Machine Speed."
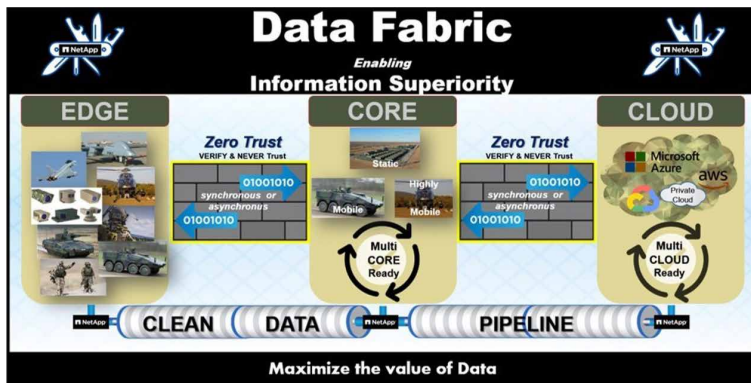
FlexPod – Converged Infrastructure Platform

The FlexPod solution with hardware from NetApp and Cisco is an IT infrastructure platform for the hybrid cloud that consists of pre-validated storage, network, and server technologies. FlexPod increases IT responsiveness to customer needs while reducing computing and storage costs through maximum uptime and minimal risk.

FlexPod can accelerate any application deployment or transition to public cloud, hybrid cloud or multi-cloud use cases. The converged infrastructure solution integrates management, compute, storage and networking components in a simple architecture that can be scaled to support a variety of virtualized and non-virtualized, enterprise and hybrid cloud environments.

Further products of the Data Fabric architecture:

- ONTAP (data management software)
- StorageGRID (scalable, software and object-based storage solution for large archives, data stores and media repositories.

Dismounted Soldier

2.6. Interconnection Dismounted Soldier

The soldier can also be seen as a platform for the integration of personally worn sensors, effectors and command and control means. In addition to networking these components, networking with his team and vehicle also plays a role.

2.6.1. Over-the-Ear-Active Hearing Protection Headset – Invision T7 (Imtradex)

The INVISIO T7 Over-The-Ear headset combines latest technology. Without battery it is light-weight and available in different wearing styles, headband, neckband and helmet mounted. Interchangeable in less than 2 minutes. The 28 dB SNR hearing protection secures the hearing. The market leading 360° siturational awareness provides directional knowledge of your surroundings. In combination with the In-Ear Headset X5 – certified as Dual Hearing Protection – it increases the hearing protection to 42 dB SNR. The headset can be used at heights of 12,000 meters+ or down to 10 m under water. Immediate situational awareness after emerging due to the innovative drainage technology.

2.6.2. RACAL 4000 Headset (Imtradex)

The RA4000 is based on a fully digital architecture with advanced digital signal processing (DSP) and a software-defined feature set that provides a high level of performance for demanding applications. The headset can be reconfigured for use with future communication devices, as the software can be easily updated via the USB interface. An optional 3D engine supports up to 8 audio channels in a virtual 3D environment.

Exceptional passive and active noise reduction (ANR) features protect the hearing of users exposed to high levels of continuous noise. The headset achieves a noise attenuation of 36 dB SNR.

The integrated AA battery compartment powers the active noise reduction (ANR) and talk-through functions, so users benefit from maximum hearing protection even when not connected to a communication system.

Users can activate talk-through to hear local ambient noise at safe levels (<85 dBA) to maintain situational awareness of hazards or enable face-to-face conversations without destroying hearing protection.

The headset is IP68 certified and can be immersed in water.

2.6.3. Control Units of the Latest Generation INVISIO (Imtradex)

The latest GENII of the control units get an innovative software-driven step ahead for the communication equipment. The system is highly flexible. With support of AI technology, it allows a better hearing and transmission. The patented IntelliCable™ auto-sensing technology is providing plug&play capabilities. All comports are dual-net-ready and can be used with different radios and intercom systems straight-forward. The voice prompts provide the enhanced user experience. The control units are available with single comms versions V10 and V20, dual comms version V50 with internal power supply and the triple comms version V60.


V10 II

V20 II

V50 II

V60 II

2.6.4. Intercom – INVISIO (Imtradex)

The INVISIO intercom systems allows a seamless flow between mounted and dismounted soldiers. The combat proven INVISIO soldier system can easily be adapted to the intercom providing enhanced features. Whether the intercom is fixed installed or flexible fitted as a bag pack solution, it provides state-of-the-art functionality. It does not matter if you are on a air, to sea or on land.
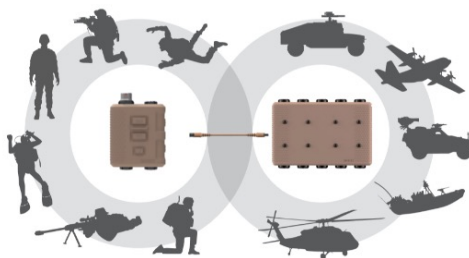
2.6.5. Data and Power Distribution Multiport-STAR-PAN™-USB-Hub (Glenair)

The Glenair Multiport STAR-PAN™ USB hub is a lightweight, compact data and power distributor for use under extreme conditions. Thanks to the integrated STAR-PAN™ USB hub, soldiers can use their personal communication and command systems (Personal Area Network) optimally through simultaneous energy monitoring and distribution and thus improve situational awareness, information gathering and reconnaissance.

All STAR-PAN™ technologies, from proven Glenair connectors and cables to low-profile hub housings, are designed for optimal size, weight and robust mil-spec performance and plug into any open USB 2.0 and Molle West system to be integrated.

3. Overview Participating Companies

3.1. Bittium

Bittium is a Finnish company with over 35 years of experience in radio communication technologies. For the defense and security market, Bittium offers a future-oriented portfolio. The products and solutions for tactical communications bring broadband data and voice to all units on the battlefield. For secure communications, Bittium has developed proven mobile devices and cyber security solutions certified to the CONFIDENTIAL level. Bittium is listed on the Nasdaq Helsinki Exchange.

3.2. Broadcast Solutions GmbH

Broadcast Solutions GmbH is one of Europe's largest system integrators for mobile and fixed communication platforms. Securing, providing or implementing infrastructures for communication are our specialty. We consult, plan and implement projects in Europe, Asia and the Middle East for public authorities, first responders, disaster control and BOS. Broadcast Solutions offers key technologies, from bodyworn systems to tactical wireless voice and data communications. With our mobile ad-hoc networks, we offer an independent system structure that provides data flow from the top (strategic) to the bottom (tactical) level.

3.3. Codan/DTC

Codan Communications/Domo Tactical Communications (DTC) is a global technology company that develops robust technology solutions to solve customers' communications, security and productivity problems in the world's harshest environments.

The mission-critical solutions secure, share, and communicate real-time video, voice, and data to enable Shared Situational Awareness (SSA) on land, at sea, in the water, and in the air. DTC's state-of-the-art mesh radio solutions for mobile ad hoc networks (MANET) offer ultra-low latency and end-to-end encryption and are deployed worldwide aboard UPS, UAV and UGV platforms, to support long-range mobile, semi-autonomous and autonomous operations.

DTC's innovative waveform combines Coded Orthogonal Frequency Division Multiplexing (COFDM), Multiple Input Multiple Output (MiMo) and Mobile Ad Hoc Networking (MANET) to deliver video, data and voice communications with superior performance.

3.4. Comrod

Comrod Communication AS is headquartered in Stavanger, Norway, and has facilities in Norway, France, Hungary, and the USA. The group develops and manufactures antennae, antenna combination and control systems, telescopic and section masts, power supplies and battery chargers for the tactical communications market. Comrod also designs and manufactures marine antennae for the commercial marine market.

Comrod antenna products cover all frequency bands in the HF, VHF, UHF and SHF spectrum and include broadband, multiband and multiport products. These products can solve problems with co-site interference or availability of platform space. In addition to the extensive range of vehicle and manpack antennae, Comrod has a wide range of remote antennae for use with wide area networks and to expand the range of tactical networks.

3.5. Cubic Mission and Performance Solutions MC2

Cubic Mission & Performance Solutions develops network and communication technologies for the military sector that offer extreme modularity,
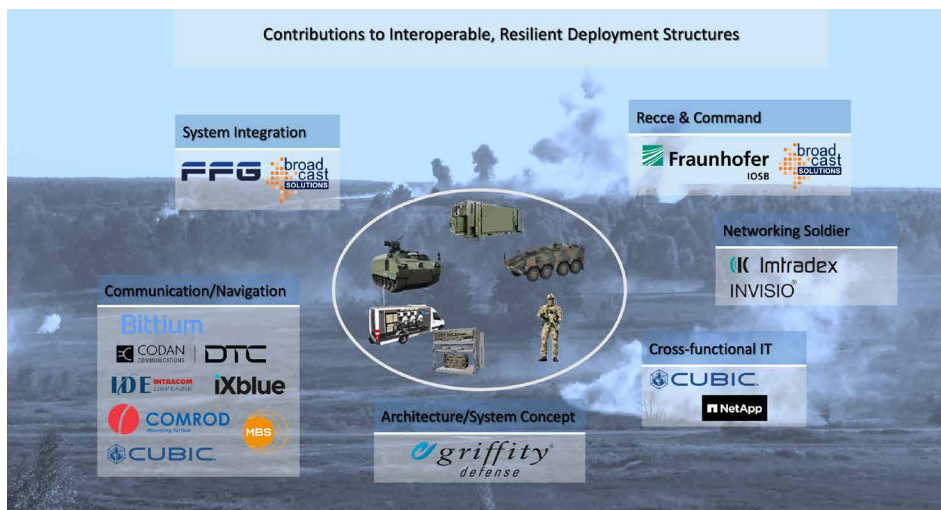
Overview Participating Companies

redundancy, reliability and high performance at the edge of the battlefield. Cubic has extensive experience in delivering capabilities that are developed in collaboration with end users and industry partners worldwide.

The product range includes high-speed servers, routers, switches, radio gateways and solutions that enable the transmission of voice, data and video over a variety of technologies (e. g. PTT radios, mobile networks, WLAN, SatCom).

Cubic aims to provide the smallest package with industry-leading performance so our customers can address capability needs with flexible, open platforms.

3.6. FFG – Flensburger Fahrzeugbau Gesellschaft mbH

In addition to modernization, conversion and repair of military vehicles, FFG also offers in-house developments such as the PMMC G5. Taking into account current requirements for standardized armament sets, also in existing vehicles, FFG has worked out a number of concepts with partners and will be showing a prototype of a PMMC G5 equipped as a command vehicle (outdoor stand A06) at AFCEA 2021.

Over the past fifty years, FFG (Flensburger Fahrzeugbau Gesellschaft mbH) has consistently developed from a repairer for the German armed forces and armies of friendly nations via upgrade specialization into a vehicle manufacturer and system provider.

These activities have led, among other things, to extensive further developments, such as for vehicles of the Leopard 1 family, M113 and the current development of the NDV Wiesel 1. Within the last few years, FFG has invested in its own developments and has since been represented on the market with its own vehicle systems.

The highly protected vehicle platforms ACSV, G5 and WiSENT 2 with their modularity offer customers a wide range of possible applications and pave the way for FFG to establish itself as a system house on the world market. The focus on maximum flexibility of in-house developments and low life cycle costs form the cornerstone for future-oriented and economical emergency vehicles with a long service life.

3.7. Fraunhofer Institute of Optronics, System Technologies and Image Exploitation (IOSB)

The core competencies of the IOSB are the generation of images and related sensor signals, the associated signal processing and the use of images in systems.

With RecceMan®, an interactive recognition assistance for imaging reconnaissance, and ABUL, an automated image analysis for unmanned aerial vehicles, as well as the Digital Situation Table DigLT/DigLTVR, IOSB offers essential contributions to reconnaissance and command support.

3.8. Glenair GmbH

Glenair is a leading manufacturer of the latest connector technologies, including both mil-spec qualified and commercial round and rectangular connectors. All interconnect designs are available in environmental, filter, hermetic, and fiber optic configurations. Interconnect technologies may be supplied as either discrete components or integrated into turnkey assemblies. In addition to electrical and fiber optic interconnects, Glenair produces and supplies backshells, dummy stowage receptangles, protective covers and shield termination designs in a variety of materials and is a leader in composite accessories. Glenair is also a market leader in cabling systems and lightweight EMI/RFI braids for the military/aerospace market.

3.9. griffity defense GmbH

offers comprehensive services around the development of complex technical and application-related scenarios, from concept development to support during implementation, e. g. by finding the right partners. One focus is system design and the development of cross-platform architectures and concepts including tactical scenarios.

3.10. Imtradex

supports its customers under the motto "command & control" in security-critical applications. IMTRADEX sells the world's leading INVISIO hearing/speaking system exclusively in the German market. The system is already being used reliably and accepted by users in over 50 nations. Over 230,000 systems have been delivered and are used by the military and special forces in a wide variety of operational areas and climatic zones around the world. Whether the connection of different headsets or different radio devices, cell phones, intercom systems in vehicles, airplanes or helicopters, the simplicity is leading.

3.11. Intracom Defense (IDE)

INTRACOM DEFENSE (IDE) is a highly acclaimed Defense Systems Company in Greece, with an outstanding record of participation in domestic programs and exports to quality-driven international customers including Finland, France, Germany, Israel, UK and the USA.

IDE utilizes high-end technologies in the design and development of advanced products in the areas of Tactical IP Communications Systems, Integrated C4I Systems, Missile Electronics, Surveillance, Hybrid Electric Power Systems, and Unmanned Systems. The Company retains its international recognition through the long-standing participation in European and NATO new technology development programs.

3.12. iXblue

iXblue is a world leader in the development and manufacture of innovative solutions for navigation. With its unique technology, the company offers its defense customers turnkey solutions with optimal efficiency and reliability.

iXblue is industry-recognized for pioneering Fiber Optic Gyroscope (FOG) design. In all these areas, the group works to ensure that their products offer high accuracy and unmatched performance and reliability. iXblue produces all relevant parts by its own in France and the products are 100 % ITAR free. Due to the production depth, there is a high precision and performance.

3.13. Media Broadcast Satellite (MBS)

MBS is the operator of Germany's largest teleport and long-standing service provider of tailor-made communication solutions for government organizations and the military.

We offer pre-integrated solutions for agile and robust networking of temporary and/or fixed sites, and especially for highly mobile and rapidly deployable units.

Our highly available communication solutions are hardware-independent and can be integrated into existing systems and adapted flexibly and cost-effectively to changing requirements. For secure, worldwide and broadband communication, MBS provides dedicated and highly available satellite connections in the X, C, Ku, Ka and MIL Ka bands – including optional hardware.

MBS works EU/US/NATO security-compliant and operates an ISO 27001 certified infrastructure. The services range from standardized to fully managed solutions.

To ensure mission critical availability of our services, MBS operates a 24/7/365 available NOC (Network Operations Center) that both monitors all connections and is available as a point of contact at all times.

3.14. NetApp

NetApp is a cloud and data management software provider, specializes in the secure and efficient storage, encryption, backup and replication of data. In addition to the storage itself, this includes the management, backup, storage and provision of data. The hardware and software available on the market from NetApp offers a broad portfolio of hybrid cloud data services that simplify the management of applications and data across cloud and on-premises environments. On the basis of the wide range of competencies, innovative and low-risk NetApp technologies – for both civil and military use cases – can be put together in a modular manner in order to generate maximum data benefit.

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