# Annex A – OPERATIONAL PERSPECTIVE FOR IST-124

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This annex provides the operational perspective and the scenario for the NATO STO Research Task Group (RTG) on "Heterogeneous Tactical Networks – Improving Connectivity and Network Efficiency" (IST-124-RTG-061). The scenario was also used as the basis for the experimentation activities of the RTG. It covers mission threads related to an attack with mechanized battalions against insurgent forces and is associated with the task of cordon and search of insurgents that threaten security of civilians and peace in the area of operation. The mission is supported by a naval task group that performs reconnaissance and surveillance requirements of the mission.

The mission-scenario was created to show the information needs and thus the challenges that appear when this information needs to flow in the heterogeneous network of the mission. The purpose of IST-124-RTG-061 is to improve connectivity and network efficiency in heterogeneous tactical networks, which are composed of a wide range of radio communications systems (HF, VHF, UHF and SATCOM), sensor networks, UAV systems, and deployed 4G or 5G cellular systems.

The operational perspective describes the task to be fulfilled, Command and Control (C2) system, collaboration among organizational units, information management, and example communications systems used for this purpose.

## A.1 OPERATIONAL CONTEXT

The scenario depicts an operation conducted by the company task forces of a mechanized battalion and a naval task group off the shore of the operational zone. They are part of the Military Contingent (MC) coordinated by the Coalition HQ (CHQ). The coalition unit's Communications and Information System (CIS) is equipped with modern CIS assets and is connected to National Operational WANs as well as the Coalition WAN (e.g., a Federated Mission Network (FMN)). The CHQ plays the reach-back role during the operation and provides Combat Support (CS) and Combat Service Support (CSS) as requested.

Analysis of the intelligence and reconnaissance information indicates that enemy forces are preparing a complex attack against the coalition base from the village located in the operational zone (Figure A-1). The enemy is well armoured and operates in an area that can be mined, so there is a chance of IED (Improvised Explosive Device) hazard. The enemy uses camouflage rules and cannot be distinguished from civilian village inhabitants in their behaviour, clothing, or activity. The enemy potential has been assessed to be approximately 20 people, including 2 people prepared for a suicide mission.

The task of the company forces is to move into the operational zone, neutralize the insurgents, and destroy the armaments they collect. It is very important to avoid civilian casualties and to prevent the insurgents from escaping.

The most important elements in this mission are communications and information system, logistics, and medical support, which are provided by the Coalition Forces.

The completion of the specified mission requires access to a wide range of systems and communication networks, i.e., radio communications systems (HF, VHF, UHF, SATCOM), sensor networks, and Unmanned Aerial Vehicle (UAV) systems. Elevated communications relays can be present at different altitudes and on platforms with varying endurance to improve connectivity in the mission network. Deployed 4G or 5G cellular systems can also be present in the field.

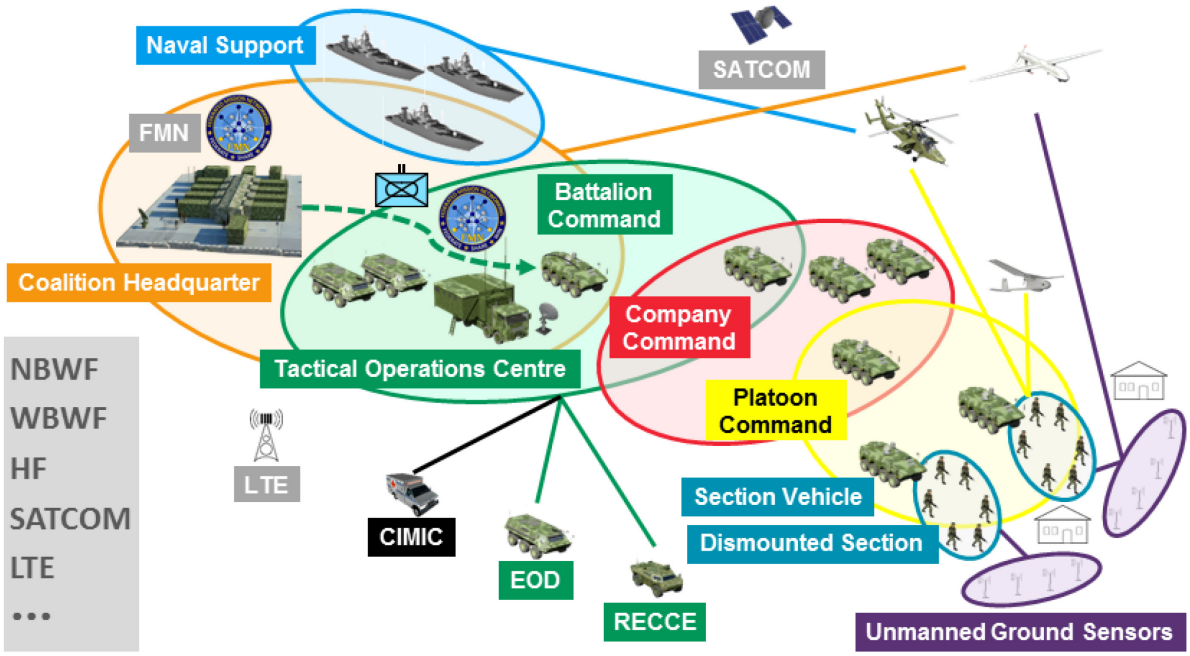


**Figure A-1: Operational Scenario for RTG-061 (General Picture). A range of possible networks and transmission technologies that might be present in the operation is listed.**

## A.2 OPERATIONAL CONCEPTS

The scenario depicts an operation conducted by the company's task forces of a mechanized battalion and a naval task group off the shore of the operational zone (Figure A-2). It shows the tactical domain located in the fictitious area of Fieldmont in Anglova, where the Coalition HQ (CHQ) of the Military Contingent (MC) is based. As part of the scenario, units, systems, and several sensor networks are deployed to the town of Wellport (also in Anglova). The operational context of the three envisaged vignettes with some example communication means is highlighted in Figure A-2. The vignettes use the installed Communications and Information System (CIS) and suitable services in order to exchange information necessary for the realization of the mission tasks.

The mechanized battalion is a part of the MC, which plays the reach-back role during the operation and provides Combat Support (CS) and Combat Service Support (CSS) as requested. According to the operational context, it is assumed that insurgent forces have taken up positions in the town of Wellport and are preparing a complex attack against the coalition forces located in the operational zone. The most important elements in this

mission are CIS, logistics, and medical support, which are provided by Coalition Forces (CF). A functional and reliable communications infrastructure is essential to help organize the armed forces. The battalion CIS is connected to the National Operational WAN and has access to the Coalition WAN (FMN).

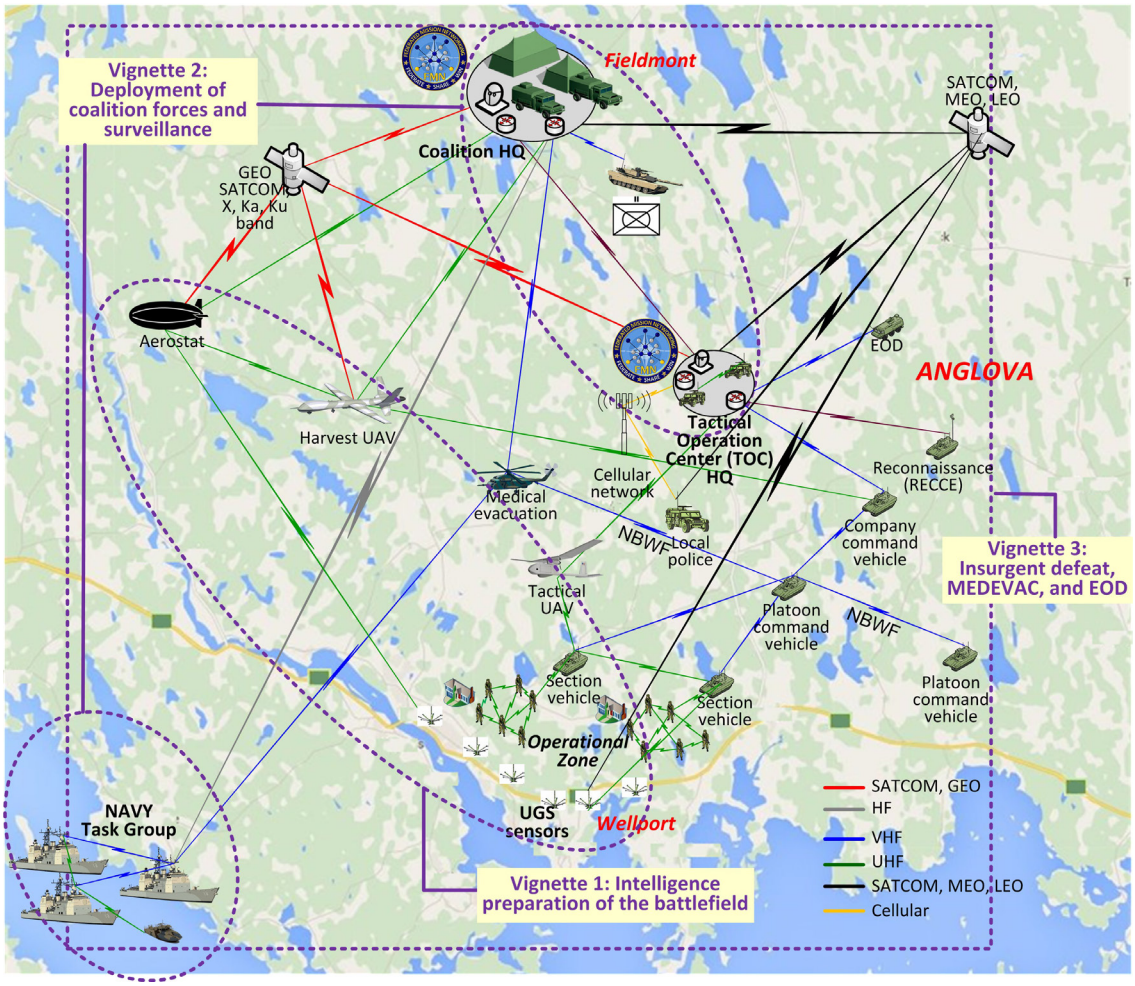


**Figure A-2: High Level Operational View of the IST-124 Scenario.**

The Naval component is present to support reconnaissance and surveillance activities, as well as provide Maritime interception and interdiction operations to control the flow of arms and goods into and out of Anglova. The individual ships have basic radar, AIS (Advanced Identification System), and ESM (Electronic Warfare Support Measure) systems connected to their C2 (Command and Control) systems. Each of the task groups performs operations within Line of Sight (LOS) of at least one other ship in order to utilize LOS connectivity with the group. But there are occasional inevitable positional displacements and, as the operational situation dictates, temporary detachment of small groups for missions like patrols, search and rescue, and reconnaissance missions. These situations require connectivity with the use of BLOS connections. Example communication means for the naval task force is show in Figure A-3.

Three main vignettes are defined in order to implement the actions included in the scenario. The roles and actors are the same for each vignette. The first vignette covers intelligence preparation of the battlefield by deploying sensor networks and gathering surveillance information. The sensor network gateways have a Beyond Line Of Sight (BLOS) channel for notification of events but the bulk of the data from the sensor networks is exfiltrated via a UAV that harvests the data and provides it to CHQ.

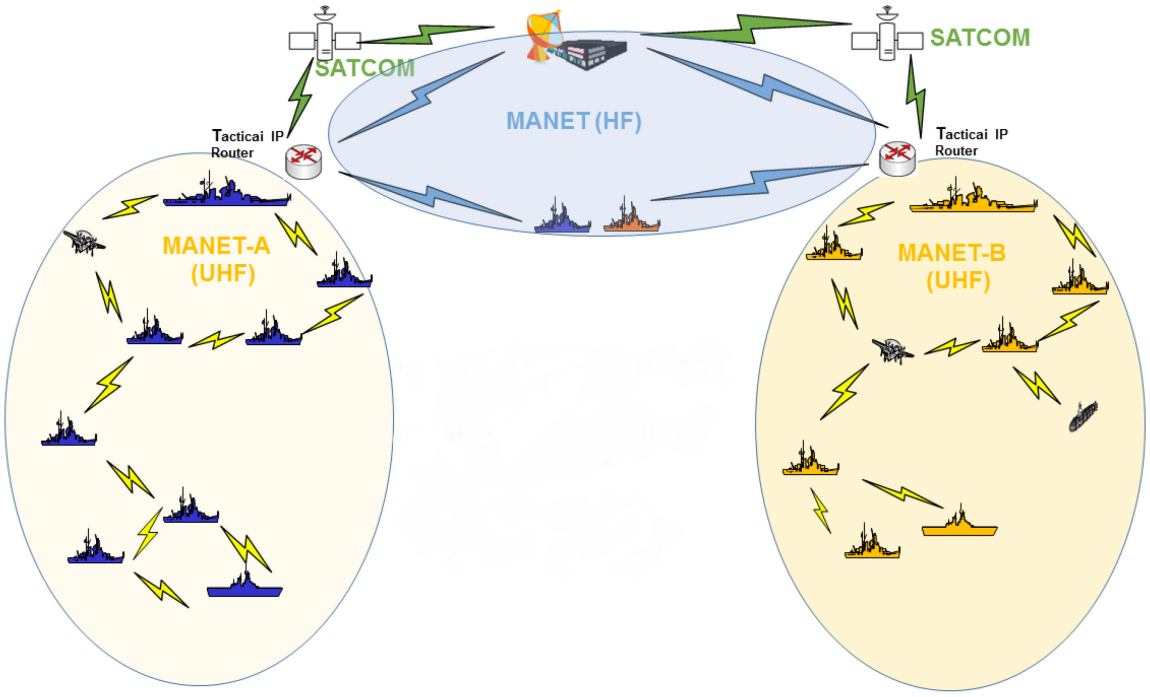


**Figure A-3: Detailed Example View of the Coalition Naval Task Group and its Shore Based Commands.**

The second vignette covers deployment of the coalition forces into the operational zone. The forces that are moving into the operational zone need local communications and connections with MC forces. It is assumed that as the forces move away from the CHQ, they need to change from local communications to some BLOS communication to reach the CHQ. Another option is to use an organic tactical UAV as a communications relay, or use deployed UAV's at higher altitudes, for the connection to the CHQ. These assets can also be used to improve communications within the deploying force. The naval component arrives and performs surveillance and reconnaissance of the Anglova port and see.

Finally, the third vignette describes neutralization of insurgents and IEDs and medical evacuation of wounded soldiers. This vignette includes an attack of the enemy positions as well as the use of Medical Evacuation (MEDEVAC) helicopter. There is also suspicion of explosives being detonated by the enemy, which requires the support of an EOD (Explosive Ordnance Disposal) team to minimize casualties and damage. The Naval component, which is deployed near the area of operations, supports the MEDEVAC tasks of the mission. Communications with the Navy can be supported with BLOS as well as long range LOS communication. A strategic (high altitude) UAV asset provides an intermittent communications relay as well.

Each vignette describes data that are expected to be exchanged between the actors and C4ISR equipment and emphasizes the challenges of connectivity and network efficiency of heterogeneous military networks.

### A.2.1 Vignette 1: Intelligence Preparation of the Battlefield

Given the threat of IEDs, persistent surveillance is deployed fourteen days prior to the operation, where the ingress and egress routes to the operational zone are monitored. This surveillance is achieved by a combination of an Aerostat with long range sensors as well as Unattended Ground Sensors (UGS) being emplaced along the routes. The Aerostat is tethered to a ground station (which is in friendly territory near Fieldmont) and equipped with visual and IR (Infrared) camera sensors. The Unattended Ground Sensors

consist of a variety of tripwire sensors, seismic sensors, and UTAMS (Unattended Transient Acoustic MASINT sensors). The deployed sensors interconnect via a sensor network. The sensor network has two gateways nodes, one of which connects to the Aerostat while the other to the BLOS connection as well as to the tactical UAV (when it is put into operation). Data gathered by these sensors is archived locally, with notifications being generated and transmitted on demand to the Coalition HQ, Tactical Operations Centre (TOC) HQ, as well as dismounted sections.

Three days prior to operation execution, the sensor network is queried for any anomalies that have been detected. The query results indicate that some anomalous behaviour may have been captured and archived by the sensors, and it is determined that the data should be harvested for further analysis.

Two days prior to operation execution, a Harvest UAV is deployed by CHQ to harvest and send data that has been gathered by the Aerostat and the UGS sensors. This data is then delivered to Intelligence Analysts at CHQ to prepare for the upcoming operation.

## A.2.2 Vignette 2: Deployment of Coalition Forces and Surveillance

### A.2.2.1 Deployment of the Battalion

The example battalion consists of six companies: four tank companies each with 24 vehicles, one command and artillery company with 22 vehicles, and one support and supply company with 39 vehicles. Altogether, there are 157 vehicles, with each one being a network node. The task for the battalion is to stage an attack against a hostile force that is advancing into the area of the battalion. The area selected for the troop deployment consists of hilly terrain covered by forests. The deployment is characterized by movements mainly on large and small roads over a rather large area, a 13 km by 29 km rectangle. The battalion starts out by moving in a single column on one main road from the CHQ. After about 10 km, the battalion splits up over two main roads and after about 25 km splits up further onto many roads grouped in companies. Towards the end, the battalion finally splits up to the level of platoons (Figure A-4). Altogether, the battalion deploys for two hours.

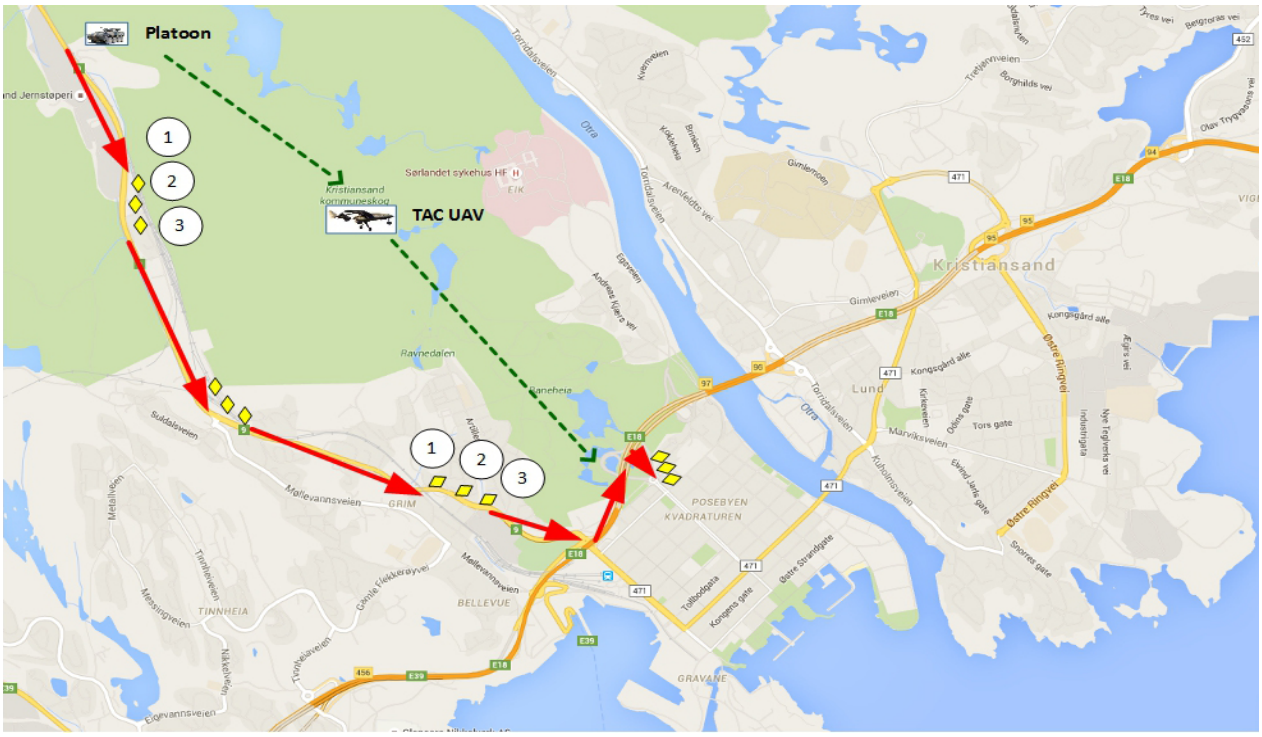


**Figure A-4: The Final Part of the Battalion Deployment into Operational Zone.**

Deployment of the mechanized battalion is achieved with the simultaneous transfer of voice and data shared between all participants of communication, BFT and intelligence from sensors in Wellport, as well as data gathered by UAV.

#### A.2.2.2 Maritime Deployment and Surveillance

The Task Group sailed away under the command of OTC (Officer in Tactical Command) from the shore to conduct a Surveillance and Reconnaissance mission. This operation lasts for the duration of both Vignette 2 and Vignette 3. A LOS network among each unit in the Task Group and a BLOS network with the capable units are automatically established.

A blue picture is formed automatically since the unit reports their position frequently through the network. Units exchange their tracks and inform the Navy HQ with summary reports. Units also use text chat / free text messages for coordination purposes. The following activities are carried out by the maritime component during the operation:

- Units in the force detect targets with its primary radar. With the help of AIS and ESM information, the targets are classified, and contact information is reported to the other units.
- One eastbound unit locates a group of targets far away from the friendly task group, moving together as a convoy with suspicious appearance, course, speed, and AIS information. The observation is reported to the OTC. The contacts are initially reported with suspect vessel identity.
- OTC orders a small task group consisting of one command ship with helicopter capability and four fast patrol boats to form a MIF (Maritime Interdiction Force) group to investigate and if required, board and search targets.
- The commander on the departing command ship, now called On Scene Commander (OSC), departs eastwards with his MIF group from the rest of the task force to investigate, while keeping in contact with the OTC and the remaining ships through the BLOS network.
- The OTC also tasks the MEDEVAC helicopter to take off from one of the westbound ships and sail to the MIF Command Ship to be prepared for any emergency call from the land forces and improve communication connectivity between the two separate groups.
- The task group arrives near suspect targets and positively identifies the tracks as Contact Of Interest (COI) tracks and reports this message to headquarters, OTC, and the rest of the fleet with a priority message. The OSC also takes a photograph of the convoy using a daylight camera and e-mails this photo to the OTC in order to give a positive indication to their identification. The e-mail goes through the network with a lower priority.
- The OTC/headquarters then takes necessary actions against the COI tracks and sends their orders with a guaranteed delivery to OSC. The Coalition HQ is informed of the incident and the result.
- The MEDEVAC helicopter lands on deck of the MIF Command ship, and the MIF group enters the harbour of Anglova, while the rest of the task group continues on the Surveillance Task.
- The MEDEVAC helicopter takes off again to answer an emergency call from the Land Forces and lands in the designated landing zone in Wellport.

### A.2.3 Vignette 3: Insurgent Defeat, MEDEVAC, and EOD

The start of the operation is scheduled for one hour after Sunrise due to lack of helicopter crews that has training with the use of night vision goggles. The ground troops achieved their position at 5 AM. The route march was secured after a check by the local police and due to the IED hazard, the route was subsequently

monitored by the CHQ. Moreover, continuous intelligence and surveillance are ongoing with the Naval components, UGS sensors and tactical UAVs.

At 5 AM, two platoons cordoned the operation zone creating the fire system to contain the enemy in a few buildings. The third Platoon is ready to support the other two (but is in reserve). Possible support is foreseen in the case of strong resistance. The first Platoon of the Second Company is prepared for action.

The following activities take place as part of this vignette.

### A.2.3.1 Neutralization of Insurgents

- Intelligence reports are provided to the platoon commander, which, based on information gathered form UGS sensors and Navy AIS and ESM, indicate an increase in enemy radio traffic. The insurgents have likely become aware of the coalition operation.
- Using RF triangulation between multiple UGS sensors, the base stations providing cell phone coverage to the area are identified. This information is reported to the TOC HQ. The base stations are temporarily disabled to prevent the insurgents from calling for reinforcements or notifying other insurgents about the operation.
- The local Police proceed to remove all residents from the buildings located next to Insurgents' positions and report their progress to the TOC HQ. The Insurgents are called upon to surrender to the Police. Two suicide bombers attempt to attack the blue troops but are neutralized by the sniper. At the same time a few insurgents try to capture a few kids and women as hostages. This action is blocked by the APC's gun fire. The enemies are forced to return to the occupied buildings.
- A tactical UAV is deployed to provide overhead video surveillance of the buildings occupied by the insurgents. The video feed from the UAV is downlinked to the operator on the ground, who monitors any movement around the buildings of interest. He reports the actual situation to dismounted soldiers.
- The UGS that were previously deployed are re-tasked to provide perimeter monitoring for force protection. They will notify the platoons about any detected movement through the ingress and egress routes (i.e., the sensor network must now directly communicate with dismounted troops).
- The rebels indicate that they will fight and are ready to die. The blue troops receive SAF and mortal fire. The company commander – to avoid losses – orders to keep the positions and respond with fire.
- The commander of the Navy support informs Coalition HQ using available radio equipment that the naval task group has prevented unwanted goods to be transferred to the enemy harbour.
- The company commander orders attack on enemy positions by the first Platoon. At the same time the second Platoon covers the first one, and blocks enemy on their positions. Both voice and data must be supported.
- The first Platoon starts the attack. The soldiers take two buildings and neutralize the enemy. Two soldiers are wounded – cat. A and B. The condition of the first one is serious. They must be evacuated. The Platoon Commander reports the situation to the TOC HQ. A MEDEVAC helicopter is needed.

### A.2.3.2 Medical Evacuation

- The two wounded soldiers are instrumented with telemetry, which allows the MEDEVAC crew and the Navy hospital to monitor their condition in real-time. This allows the hospital to direct administration of emergency care to the soldier who is seriously wounded to stabilize his/her vital signs.

- The MEDEVAC helicopter is ready for operation.
- The Commanding Officer orders that a field helipad must be secured and prepared. The reserve Platoon is ordered to prepare the landing place and secure it as well as to establish communication directly with the helicopter. The CHQ Duty officer orders the helicopter crew to take off.
- The Navy hospital is informed about the wounded soldiers' condition. The wounded soldiers are evacuated.

#### A.2.3.3 IED Neutralization

The area surrounding the enemy's buildings is mined by anti-personnel and anti-tanks mines. There is a possibility of unmanned detonation of the mine field:

- The insurgents had constructed a bomb as part of their terror. It can be defused. The commanding officer asks for EOD (Explosive Ordnance Disposal) support to neutralize the mine field.
- The commander ordered to secure and mark the site.
- EOD (from 2 mechanized battalion) arrives. There is suspicion that one or more of the insurgents will try to detonate all enemy explosives to cause as much damage as possible. To prevent this, the EOD deploys wide-area RF jamming.
- The RF jamming interferes with blue force communications as well, causing them to switch to non-affected networks or Electronic Warfare (EW)-resistant transmission technologies.
- After reconnaissance the mine field is cleaned, at the same time the sniper neutralizes the insurgent who was trying to detonate all enemy explosives.
- The operation is completed.
- The detachment returns to the Base.

## A.3 ACTORS AND ROLES

### A.3.1 Equipment for the Operation

The vignettes describe activities related to three defined mission threads; thus the roles and actors are the same for each vignette.

Each battalion consists of six companies as it was mentioned in Section A.2.2.1. Each vehicle carries one or more radios primarily using VHF and UHF bands.

All endpoint devices are equipped with GPS.

Table A-1 lists examples of network equipment for the operational scenario key players.

It is assumed that the terminal is not a capacity bottleneck for any of the services that are needed in the mission.

**Table A-1: Example Equipment of the Operational Scenario Key Players.**
**NB = Narrow Band, MB = Medium Band, WB = Wide Band.**

| Military Platform | Radio(s) |
|---|---|
| **Section Command Vehicle** | • Soldier radio (MB, WB)<br>• Company radio (NB, MB, WB)<br>• Sensor network gateway radio (WB) |
| **Platoon Command Vehicle** | • Soldier radio (MB, WB)<br>• Company radio (NB, MB, WB)<br>• Interoperable Coalition radio (NB, MB, WB) |
| **Company Command Vehicle** | • Soldier radio (MB, WB)<br>• Company radio (NB, MB, WB)<br>• Interoperable Coalition radio (NB, MB, WB)<br>• Military BLOS radio (NB, MB, WB)<br>• Cellular network |
| **Tactical UAV** | • Company radio (NB, MB, WB) |
| **Tactical Operations Centre HQ** | • Soldier radio (MB, WB)<br>• Company radio (NB, MB, WB)<br>• Interoperable Coalition radio (NB, MB, WB)<br>• Sensor network gateway radio (WB)<br>• Military BLOS radio (NB, MB, WB)<br>• Civilian BLOS radio (NB, MB, WB)<br>• Cellular network<br>• Connection to deployed backbone (FMN) |
| **Coalition HQ** | • Company radio (NB, MB, WB)<br>• Interoperable Coalition radio (NB, MB, WB)<br>• Military BLOS radio (NB, MB, WB)<br>• Civilian BLOS radio (NB, MB, WB)<br>• Cellular network<br>• Connection to deployed backbone (FMN) |
| **EOD Command Vehicle** | • Company radio (BN, MB)<br>• Interoperable Coalition radio (NB, MB, WB)<br>• BLOS radio (NB, MB, WB) |

| Military Platform | Radio(s) |
|---|---|
| **RECCE Platoon Radio** | • Company radio (BN, MB)<br>• Interoperable Coalition radio (NB, MB, WB)<br>• BLOS radio (NB, MB, WB) |
| **MEDEVAC Helicopter** | • Interoperable Coalition radio (NB, MB, WB)<br>• Naval task group radio (NB, MB, WB) |
| **Navy Ship** | • Naval task group radio (NB, MB, WB)<br>• BLOS Naval radio (NB, MB, WB) |
| **Aerostat Platform** | • Sensor network gateway radio (WB)<br>• Military BLOS radio (WB) |
| **Harvest UAV** | • Sensor network gateway radio (WB) |
| **UGS** | • Sensor network gateway radio (WB) |
| **Local Police / CIMIC** | • Cellular network<br>• Civilian BLOS radio (NB, MB, WB) |

### A.3.2 The Radio Characteristics

During the operation different communication terminals are used. Example characteristics of some of them are given in Table A-2, Table A-3,Table A-4, Table A-5, Table A-6, Table A-7, Table A-8 and Table A-9.

**Table A-2: Basic Parameters of Vehicular and Man-Pack VHF Radios.**

| | |
|---|---|
| **Bandwidth** | 25 kHz |
| **Transmit Power** | Max. 50 W (man-pack 5 W, 10 W with booster) |
| **Type of Transmission** | Half-duplex |
| **Range** | Up to 30 km |
| **Data Transmission Speed** | Up to 64 kbs in dedicated packet data network. Substantially less in combined voice and data modes. |
| **Additional Equipment** | GPS receiver |

**Table A-3: Basic Parameters of UHF Radios.**

| | |
|---|---|
| **Bandwidth** | 1 MHz or 5 MHz |
| **Transmit Power** | Max. 50 W |
| **Range** | Up to 5 km |
| **Data Transmission Speed** | Up to several Mbs but typically several hundred kbs. |
| **Additional Equipment** | GPS receiver |

**Table A-4: Basic Parameters of SATCOM on the Move Terminal.**

| | |
|---|---|
| **Satellite Orbit** | Geostationary |
| **Frequency Band** | X-band or Ka-band |
| **Transmit Power (EIRP)** | Approx. 40 dBW |
| **Transmit Delay** | Star 500 ms, mesh 250 ms |
| **Data Transmission Speed** | Up to several Mbs when much of the capacity in the satellite is dedicated to this channel but typically a few tenths to several hundred kbs. |

**Table A-5: Basic Parameters of LEO Satellite Terminal.**

| | |
|---|---|
| **Iridium Satellite Orbit** | LEO |
| **Orbit Altitude** | 780 km |
| **Iridium Applications** | Voice (2.4 kbps) and data (128 – 512 kbps) |
| **Satellites in Constellation** | 66 |
| **User Satellite Link Band** | 1616 – 1626.5 MHz<br>L band |
| **Gateway -> Satellite Up-Link** | 29.1 – 29.3 GHz |
| **Satellite -> Gateway Downlink** | 19.1 – 19.6 GHz |
| **Inter-Satellite Link** | 22.55 – 23.55 GHz |
| **Satellite Relative Velocity** | 26 804 km/hr |
| **Access Scheme** | FDMA / TDMA |

**Table A-6: Basic Parameters of HF Radios.**

| | |
|---|---|
| **Bandwidth** | 3 kHz (or 8 bands combined to 24 kHz) |
| **Transmit Power** | Max. 400 W |
| **Type of Transmission** | Half-duplex |
| **Range** | Up to 400 km in ground wave propagation over the ocean, unlimited range (depending on the cannel quality) in sky wave channel |
| **Data Transmission Speed** | 75 bps (3 kHz) up 120 kbs (in ground wave on 24 kHz band) |

**Table A-7: Basic Parameters of Naval V\UHF Radios.**

| | |
|---|---|
| **Bandwidth** | 25 kHz, 12.5 kHz, 8.33 kHz |
| **Operational Frequency Range** | 30 – 512 MHz |

| | |
|---|---|
| **Maximum Transmit Power** | 100 W FM, 30 W AM |
| **Transmission Mode** | Fixed Frequency, Frequency Hopping (FH) (have Quick-I/II, SATURN) |
| **Range** | 20 km |
| **Data Transmission Speed** | Up to 96000 bps |
| **Type of Security** | TRANSEC and COMSEC key |
| **Additional Equipment** | GPS receiver |

**Table A-8: Basic Parameters of Naval HF Radios.**

| | |
|---|---|
| **Bandwidth** | 3 kHz (USB), 6 kHz (ISB) |
| **Operational Frequency Range** | 2 – 30 MHz |
| **Maximum Transmit Power** | 100 W, 400 W, 1 KW |
| **Transmission Mode** | SSB, ISB |
| **Range** | 1000 km |
| **Data Transmission Speed** | Up to 9600 bps (can be as low as a few hundred bps, but typically 2.4 kbps) |
| **Type of Security** | COMSEC key |
| **Additional Equipment** | GPS receiver |

**Table A-9: Basic Parameters of Tactical LTE.**

| | |
|---|---|
| **Bandwidth** | 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 20 MHz, (assumed 10 MHz) |
| **Operational Frequency Range** | 450 MHz – 6 GHz (assumed 700 MHz) |
| **Maximum Transmit Power** | UL: 200 mW, DL: 2 x 10 W |
| **Transmission Mode** | DL: OFDM, UP: SC-FDMA |
| **Range** | For mobile base stations with assumed parameters (0.5 km – 10 km (LOS)) |
| **Data Transmission Speed** | UL: 50 kbps – 20 Mbps, DL: 1 Mbps – 30 Mbps |
| **Type of Security** | COMSEC and NETSEC |
| **Additional Equipment** | GPS receiver both for base station and mobile node |

### A.3.3 Traffic Flow

Example traffic flows in different parts of the network are described below.

The communication between battalion units is handled as voice/data communications. According to these the following data properties should be reflected:

- VHF radio 2400 bps (throughput is shared among all members of the network).
- UHF radio 500 kbps (throughput is shared among all members of the network).
- All vehicles within the TOC HQ are connected via a common LAN and each vehicle will have a VHF radio.
- The satellite capability has a duplex capacity of 512 kbps, which is shared by all users due to the use of a hub located at TOC HQ with a delay of 250 ms.
- The interoperability radio on the company level can be either VHF, e.g., NATO Narrowband Waveform (NBWF), or satellite link (SATCOM on the move).

The units have access to an UAV in the UHF band and can steer UAV's sensors to suitable positions. Moreover, some units use UAV to transmit video from the area of operation.

The sensor network and different types of UAVs provide added situational awareness for the platoon. They are used to exchange the following types of information:

- Sensor Network: Network configuration commands, sensor event notifications, seismic signatures, acoustic signatures, low and medium resolution still images (triggered and on command).
- Aerostat: Control commands, on command high resolution visual and IR still images (dedicated communication channel to ground control unit), sensor data processing and relaying, communications relay.
- Harvesting UAV: Control commands, on command high resolution visual and IR full motion video images (dedicated communication channel to ground control unit), sensor data harvesting and relaying, communications relay.
- Tactical UAV: Control commands, on command medium resolution visual and IR full motion video images (dedicated communication channel to ground control unit), real-time sensor data relaying, communications relay.

Information available to units is given in form of data packets described by the following properties:

- **Size of Data Packet:**
  - **Sensor Event Notifications:** 512 bytes every 10~15 seconds max. per sensor (frequency of event trigger varies greatly but should be upper bounded to some number of seconds apart to avoid multiple notifications from the same event).
  - **Non-image Data:** 2 kB per event.
  - **Image Data:** QVGA (15 kB) to VGA (60 kB) images per event.
- **Data Stale Time:**
  - 30 seconds (event notifications).
  - 180 seconds (non-image data).
  - 180 seconds (image data).

The communication between elements of the Navy task group is handled as voice/data communications. The following data properties should be reflected:

- **Number of Tracks within the Surveillance Area:** 250.
- **Number of Tracks Per Network:** 50 (to be updated every 60 seconds).
- **Size of Track Data:** 18 bytes every 12 seconds, 27 bytes over each 96 seconds.

- **Size of Drop Track:** 9 bytes (expected roughly 5 drop tracks per minute).
- **Size of Free Text:** 250 characters long (10 messages per minute per network can be considered).
- **Track Stale Time:** 60 seconds.

On all networks, track with COI statuses and initial report of suspect vessels are first priority. Periodic reports of suspect vessels, blue force information and OTC/Fleet Commander orders are second priority.

COIs and initial report of suspect vessels and command orders along their acknowledgements are serviced with guaranteed delivery. Also, operators may specify the delivery method for e-mails while preparing them. The rest of the information is best effort.

Tactical track data for real-time tracks has a life span of 60 seconds.

### A.3.4 Services Implementation – General Network Requirements

The list of proposed services is given Table A-10, with some general requirements.

**Table A-10: List of Proposed Services.**

| Service | General Network Requirements, QoS target | Precedence / Conn. Type |
|---|---|---|
| Management of events and occurrences (e.g., the intelligence reports about increase of the enemy radio traffic). | • Med-low availability<br>• Low-med throughput<br>• Elastic | Routine – priority / CL |
| Planning and Decision Support Tools (e.g., the Navy support inform that prevent unwanted goods to be transferred to enemy forces). | • Med-low availability<br>• Low-med throughput Elastic | Routine – priority / CL |
| Allocate resources and know their status at all times (e.g., the MEDEVAC helicopter, which is waiting next to the operation spot, due to technical problems is not ready to take off, amphibious crew is ready for taking wounded soldiers). | • High-availability<br>• Med-high throughput (depending on the number of assets)<br>Assured Elastic | Priority – immediate / CL |
| Up-to-date maps – ability to present information on a map over time (e.g., the first Platoon starts attack, the soldiers take two buildings and neutralize the enemy). | • High throughput<br>Elastic | Routine – priority / CL |

| Service | General Network Requirements, QoS target | Precedence / Conn. Type |
|---|---|---|
| Bi-directional links between operational people: Voice communications (Radio). | • HF/UHF radio<br>Real-Time (1 – 2) | Routine – flash / CO |
| Bi-directional links between operational people: Short messages (Data). | • Low throughput<br>Near-real-time – Elastic | Routine – flash / CL |
| Bi-directional links between operational people: Reports (Data). | • Med throughput (non-real-time)<br>[Assured] Elastic | Routine – priority / CL |
| Bi-directional links between operational people: Images and video (Data). | • High throughput<br>Near-real-time, Elastic | Routine – priority / CO+CL |
| Information sharing with local authorities / forces (e.g., local Police removed all local residents from the buildings located next to Insurgences positions). | • High throughput<br>• Interface with public(local) networks<br>Real-time (2) – Elastic | Routine / CO+CL |

Precedence indicates military precedence level applicable for the communication (routine, priority, immediate, flash). Connection type is either Connection Oriented (CO) or Connectionless (CL). For the first one, resources are allocated by call (or equivalent) and call admission control should be enforced. For connectionless traffic DiffServ type priority and rate enforcement are applied.

QoS target indicates the required quality that the application needs from the network in terms of delay, jitter, loss and Mean Opinion Score (MOS) for voice communications.

For the Navy task group, the following services should be taken into account:

- Blue force tracking picture;
- Local Tracks / (Contacts of merchant vessels, or aircrafts);
- Common Tactical Picture / Recognized Maritime Picture (with suspect vessels, Contacts of Interest (COIs);
- Text chat for coordination issues;
- E-mail and file transfer to exchange pictures, plans etc.; and
- Limited Web Browsing access to reach out command portals to view mainly text based OPGENs, OPTASKs, orders etc.

From that the following network requirements can be derived:

- Each OTC Task Group shall work on his/her own MANET preferably with UHF frequency in order to utilize UHF frequencies advantages.
- There shall be at least one HF MANET in order to perform data exchange amongst navy headquarter and OTCs. Also, individuals that has no connection otherwise may use this MANET to communicate.

- Since the topology changes frequently, a layer 2 routing/relay capability inside the MANETs is required.
- Tactical Information routing between HF and UHF MANETs and/or SATCOM requires a layer 3 Intelligent Tactical IP routing capability.
- These MANETs should be automatically organize themselves to adhere frequent topology changes.
- End-to-end IP connectivity shall be an effective way of communications even when the detachment group switch over HF MANET, still paths exists with the same addressing schema to send their information to their destinations independent of network or frequency band they are in.