ELROB 2016

20 - 24 June 2016

Eggendorf, Austria

Foreword by Governor Dr. Erwin Pröll

ELROB, Robotics for Military Applications

Modern Technology for Protection and Security

In my capacity as Governor of Lower Austria, I am happy to welcome the participants of the European Land Robot Trial in Eggendorf.
I take your presence as confirmation of the fact that Lower Austria is able to provide the modern facilities required for such an event.
The objective of ELROB is to bring togewther representatives of science and industry as well as users of defense and security robots and to promote further developments in this field.

In an era of globalization and domination by technology, people feel a growing need for security. Supported by modern robot systems, the experts of the Austrian Federal Army are well equipped to fulfill their tasks and to guarantee a sufficient level of protection and security for the population.

I therefore wish to thank the engineers and soldiers involved in this effort for their commitment and dedication. I cordially welcome all participants to Lower Austria and thank all those who have made this event possible. I wish you every success and good luck for today's ELROB Trial.

At the same time, I should like to express my best wishes for a satisfactory and successful further development.

ARMAMENTS AND
DEFENCE
TECHNOLOGY
AGENCY

The Director

„Grüß Gott!“ – a very warm welcome to the 6th/9th European Land Roboters’ Trials (ELROB) at Eggendorf, Lower-Austria. A quite unique and historic place close to Wiener Neustadt awaits you: sites since longtime dedicated to innovation and research just at a stone’s throw away.

Examples are the first Austrian airfield and aircraft production where the famous Etrich II Taube was developed and had its maiden flight on April 6, 1910. Also the steam locomotive development and factory starting 1860 and the well-known Austro-Daimler car and racing car production found 1899 its place here.

Exactly 110 years ago the latter developed an all-wheel driven armored car for the military. During its field trials it performed extremely well. But during the presentation to the military leadership the loud roaring engine made the Chief-of Defence Beck- Rzikowsky horse shying away. Consequently this top-project was cancelled by the Emperor… Do we fear similar decisions concerning robots today?

No, we don’t. Events like ELROB should to the contrary provide for a clear picture about current capabilities, limitations and potentials of robotic systems. It is my firm belief that within ten to fifteen years from now on robotic systems of all different kinds will spread throughout the armed forces. They will influence many situations of military business and cover a wide range of military tasks at land, air and sea. They will increasingly assist, support and join humanoids – our soldiers – while hybrid threats challenge the military during asymmetric and conventional warfare as well as crisis management operations.

ADTA as the host will do its best to make sure that the ELROB will be conducted within the best trial environment possible. So let’s have together a challenging view into the future.

Vienna, June 2016

BG Michael B. Janisch, MA m.p.

wwwPicture: http://www.austrodaimler.at/bilder/Nutzfahrzeuge/panzer-auto.jpg

Military ELROB 2016 – Eggendorf, Austria

Welcome to the military ELROB 2016 in Austria. This year's event is already the ninth edition of the European Land Robot Trials. Over the years, the trials have established themselves as Europe's leading outdoor robotics event.

After exceedingly successful ELROB events in Hammelburg (Germany), Thun (Switzerland) and Warsaw (Poland) this sixth presentation of the military version of ELROB is kindly hosted and co-organized by the Austrian Armed Forces. Bringing together potential end-users, members of the robotics research community and industry representatives, ELROB once more demonstrates the successful cooperation between the European countries.

The purpose of the European Land Robot Trial is to provide a comparative evaluation of outdoor robotic systems across applications such as basic mobility, scouting, EOD, convoying, etc. The trials will provide important information to potential users in terms of the status of current technologies. Through a baseline comparison of systems, it is also a prominent opportunity for vendors to understand current limitations and needs of end-users. ELROB furthermore provides an important venue for academics to understand challenges of technology transfer from research to field applications and basic research problems that remain unsolved.

The military ELROB addresses the fact that it is generally difficult for companies to get access to user feedback about their systems from actual end-users in the theatre. The event offers a unique insight into possible use cases. ELROB is thus an important event for all participants including end-users, providers, research institutes, and universities.

To promote new and future-oriented innovations, European Robotics, the scientific co-organiser of the event, will award special Innovation Prizes. The purpose of these prizes is to recognize new ways of solving the challenges at hand as well as approaches with very strong potential.

We are convinced that this ELROB will again provide important insight into the state of the art regarding military use of ground robotics and will be a valuable resource in further dissemination of UGV technology.

We wish all ELROB visitors and participants a pleasant and successful stay in Austria!

With kind regards

F. Schneider

Dr. Frank E. Schneider

Deputy Head of the Cognitive Mobile Systems Department
Fraunhofer Institute for Communication, Information Processing and Ergonomics FKIE
frank.schneider@fkie.fraunhofer.de

Fraunhofer
FKIE

The Fraunhofer FKIE

The Fraunhofer Institute for Communication, Information Processing and Ergonomics FKIE carries out applied research in the area of defense and security issues. The increasingly complex global political situation is a threat to all modern societies on many different levels. FKIE puts in place innovative precautions for protection and safety and pushes the boundaries of international research in information and communication technology. More than 400 members of staff are currently working on the development of innovative technologies targeted at analyzing intelligence and the early detection and prevention of potential threats.

The institute's expertise is also being applied increasingly to the civil sector, in areas such as the protection of the environment and the prevention of natural disasters right through to business management and the protection of business-critical infrastructures.

The Cognitive Mobile Systems Department (CMS)
FKIE's Cognitive Mobile Systems Department is actively working in the area of land robotics and unmanned vehicles for more than 20 years now. Thereby, CMS is laying important foundations for the development of complex multi-robot systems which can be handled easily and more intuitively. Another focus is developing software for intelligent support functions for controlling the robots and designing tools to improve the coordination of multi-robot systems.

Whether a situation requires poisonous substances to be detected or removed from industrial plants or a temporary communications network to be built in a disaster zone, mobile robots can save people from being exposed to extreme danger. However, the demands on the control systems required for such robots are very exacting. A single robot is already equipped with a wide range of sensors and can carry out movements that must all be monitored and controlled,

a task which can quickly overwhelm even trained remote operators. If several robots are employed in the loop, the burden on the operator increases even more so as they monitor the interaction of all of the equipment being used.

The research into "Human-Multi-robot systems for defense and security related missions" meets the challenges outlined above on two levels:

(1) Assistance Functions for Controlling Robots: The operator can be relieved of many cognitively demanding control tasks by means of intelligent software. For this purpose CMS develops algorithms that continuously monitor the robots' sensor data and consolidate it into intuitively understandable situational information. Current results from our research into autonomous robots increasingly enable us to utilize this information for carrying out more complex motion and manipulation tasks automatically.

The assistance functions provide the user with an understandable representation of the environment as perceived by the robot system as well as its intended actions. Consequently, a high-level system control emerges from the development which is altogether more user-friendly.

(2) Coordinated Use of Multi-Robot Systems: Many tasks require the coordinated use of several mobile robot systems at the same time, such as for the deployment of mobile manipulators in pairs when neutralizing explosives or the application of an entire team of unmanned vehicles for constructing a communication network in a disaster zone. The additional time and effort required for coordination causes the burden of work on a multi-robot system to rise disproportionately.

CMS develops software-based coordination techniques which allow us to reduce this additional effort considerably. Therefore, planning algorithms are used to propose an efficient and coordinated course of action of the group of robots. During routine tasks the planning software can even take over the full control of the individual robot systems.

At both levels the research group continually integrates promising technical innovations into new concepts and methods and evaluates them using prototypical application systems. This is carried out in close collaboration with our clients which include the German Armed Forces (Bundeswehr) and other organizations entrusted with security assignment

Explosive Ordnance Disposal Centre of Excellence

EOD COE is one of the tools of the NATO Supreme Allied Command for Transformation aiming to improve military capabilities, value and efficiency throughout the Alliance and for the benefit of NATO partners.

With the support of five NATO nations including Slovakia, the Czech Republic, Hungary, Poland and Romania, the EOD COE provides support to operations and exercises. It helps to improve interaction and cooperation among NATO member nations, partner nations, and international organizations.

The EOD COE deals with the whole EOD/IEDD spectrum as advise, expertise, support, EOD info management and EOD tasks. Its ambition is to become a multinational hub for EOD/IEDD issues, bearing on four pillars:

- education and training,
- technology management,
- doctrine and standardization,
- lessons learned,

likewise to provide support to NATO operations and transformation efforts with the EOD expertise and assist in development of NATO wide EOD/IEDD tactics, techniques and procedures while remaining current in technology development as well as to improve relations, interoperability and a practical cooperation with partners, NATO command elements, member countries and international organization in the area of EOD

In accordance with the prominent co-operation with European Robotics and the NATO Research Task Group on "Standards Promoting Interoperability for Coalition UGVs" the EOD COE is one of the Organizers for the 9th European Land Robot Trials, the **6th Military ELROB**. The EOD COE is the responsible entity as well as the mentor for the **"Reconnaissance and Disposal of Bombs and Explosion Devices"** scenario.

Short history

ACT plays a crucial role as a member of the EOD COE and with its continuous support; the EOD COE plays an important role within EOD and C-IED community in NATO to improve military capabilities and to enhance interoperability, relevance and effectiveness of the Alliance.

The EOD COE was assessed by ACT HQ team in a period from 19-21 January 2011 and the Centre has successfully met the accreditation criteria. The North Atlantic Council approved the accreditation of the EOD COE and the Centre was activated as an International Military Organization on 28 April 2011.

Education and Training

The EOD COE Training Branch creates training products and offers specialized education with the overall aim of broadening general, as well as particular, knowledge of EOD area of expertise.

The instructors regularly deliver several types of courses and training activities whose learning objectives reflect the training requirements and educational needs of diverse audience - EOD operators, EOD staff officers, ammunition technicians, military searchers, all arms patrols, etc.

All activities organized by the Training Branch are primarily delivered on the various military premises within Slovakia; however there exists the possibility to support a requesting country by dispatching the EOD COE Mobile Training Team (MTT).

Technology Management

EOD COE is establishing the EOD equipment database. We cordially invite each producer/manufacture/company to take part in our project as a good opportunity for their advertisement.

The main aim of this project is to facilitate finding of suitable equipment for specialists as EOD personnel as well as supporting armament branches in search of the expected products. Equally important it will be to know new technology and technologically advanced EOD equipment along with a user assessment based on technical and tactical approach within a multinational environment connected to NATO experience and relevant network. Having this kind of information in one place is a real benefit for all people involved in the EOD area of interest. It is also an excellent opportunity for manufacturers to present their products to the people most interested in.

One of the most important issues regarding the COE is to collect and share information related to EOD new technology and technologically advanced EOD equipment. Technology Department as a part of the COE is responsible for establishing and updating this database consisting of several main categories like detectors, ROVs and others. Any kind of EOD equipment is kindly expected.

Concept, Doctrine and Standardization

The EOD COE is a NATO subsidiary body contributing to development, revision and update of Allied concept, doctrine and standardization publications through leverage of its expertise in the dedicated EOD sphere.

It provides an active support to respective NATO bodies in order to facilitate standardization and achieve the required level of interoperability.

Lessons Learned

The NATO LL process provides a structured framework to capture and pass on practical experiences and knowledge for the benefit of others. The process must be tracked and driven in a deliberate manner; steps of the process are relatively straightforward, yet vital to ensure a valuable outcome. The process is scalable and can be used on all levels.

Main task is to collect, store and analyse the EOD operational lessons learned and trend analyses. These tasks are aimed to support NATO and national efforts for adapting EOD capabilities in various aspects such as doctrines, techniques, tactics, procedures, training, equipment, Command and Control (C2).

Another role is to maintain a technical library, to include an accessible web-base electronic library of ordnance and related EOD procedures. Finally, the COE will act as portal seeking and establishing links to other appropriate EOD websites.

While specific EOD procedures remain a national responsibility, the COE will serve as a multi-national hub for information sharing and comparison. It will perform information management in conjunction with the proposed EOD Database.

NATO EOD Demonstrations and Trials 2016

6 - 7 September 2016

INCHEBA EXPO
Bratislava, Slovakia

The NATO sponsored biennial event is organized in close cooperation between the NATO Explosive Ordnance Disposal (Slovakia) and Counter- Improvised Explosive Devices (Spain) Centres of Excellence within the framework of the NATO Defense against Terrorism Programme of Work.

The primary aim of this event is to exchange information on new developments and trends in the EOD and C-IED areas, where your contributions are valuable and highly welcome, and to discuss the overall partnership programmes in years ahead.

Due to close links with EOD area, the C-IED and CBRN oriented companies are also invited to present and demonstrate their newly developed equipment and its application procedures.

The main idea of the NATO EOD Demonstrations and Trials 2016 is **"Protection as complex and composite responses to terrorist threat"**, a challenge for EOD/IEDD experts, scientists, producers, industry and SMEs involved in the fight against terrorism.

The event is held under the sponsorship of the NATO ESC (Emerging Security Challenging) Division and is organized by the NATO EOD Centre of Excellence with the close cooperation with the NATO C-IED Centre of Excellence, Madrid, Spain, with the full support of the Ministry of Defense of the Slovak Republic.

Registration

Registration in advance is mandatory and must be done online at the EOD COE web site www.eodcoe.org where you will find more detailed information.

The ELROB 2016 organizing team wants to express their sincere gratitude to the following generous sponsors of the event:

ELP GmbH
European Logistic Partners

Wuppertal, Germany

www.elp-gmbh.de

Platinum Sponsor

Foresight Operations GmbH
Querfurt, Germany

www.foresight-operations.com

Platinum Sponsor

Cobham Mission Systems
Unmanned Systems

Ostfildern, Germany

www.cobham.com/unmannedsystems

Silver Sponsor

Robotnik Automation
Paterna, Valencia, Spain

www.robotnik.eu

Bronze Sponsor

1. Team Information activeROBOTICX

Picture of vehicle:

SAFIR

Name of vehicle:

Picture of team leader:

Name of team leader:	Trattler Andreas
Team Name:	activeROBOTICX
Team E-mail:	office@activeroboticx.com
Logo:	--
Website:	https://www.activeroboticx.com
Location:	Freilassing, Berchtesgadener Land
Institution/Company:	activeROBOTICX – Trattler Andreas
Address:	Sägewerkstraße 3, 83395 Freilassing, Deutschland
Telephone:	+49 (0)8654 4804387
Fax:	+49 (0)8654 4804388
Team Description:	--
Sponsors:	--

Selection of scenario:	x and	Reconnoitring of structures (focus on radiological nuclear measuring and mapping)
	x	Mule (shuttle between two locations)
	--	Movements / Convoying (transport with two vehicles)
	x	Search & Rescue (SAR) / MedEvac (find and drag a dummy body)
	--	Reconnaissance and disposal of bombs and explosive devices (EOD/IED; for professionals only!)

1.1 Vehicle Specification Sheet Team activeROBOTICX

Pictures of vehicle:

Name of vehicle: SAFIR

1.1.1 Basic data about vehicle

Length:		
Width:		
Height w/o antennas:		
Height with antennas:		
Weight:		
Ground clearance:		
Average noise level:		
Climbing performance:		
Wheel or track driven:		
Propulsion:		
Endurance:		
Max. speed:		
Payload:		

1.1.2 Communication equipment

Function:		
Type:		
Frequency:		
Possible frequency range:		
Power:		
Modulation:		
Number of channels:		

Function:		

Type:		
Frequency:		
Possible frequency range:		
Power:		
Modulation:		
Number of channels:		

1.1.3 Sensors equipment

Laser:	
Vision:	
GPS:	
Radar:	
Inertial measurement unit:	

1.1.4 Computing equipment on vehicle

Number of computers:	
Number of CPUs:	
Type of CPU:	
Operating system(s):	

1.1.5 Basic data about control station

Pictures of the control station:		
Number of mandatory operators		
Number of optional operators:		
Number of computers:		
Number of CPUs:		
Type of CPU:		
Operating system:		
Space needed for control station (LWH):		cm
Weight of control station:		kg
Power source needed:		

2. Team Information ARTOR

Picture of vehicle:

Name of vehicle: ARTOR (Autonomous Rough Terrain Outdoor Robot)

Picture of team leader:

Name of team leader:	Philipp Krüsi
Team Name:	ARTOR
Team E-mail:	philipp.kruesi@mavt.ethz.ch
Logo:	--
Website:	http://www.asl.ethz.ch
Location:	Switzerland
Institution/Company:	ETH Zurich, Autonomous Systems Lab Institute of Robotics and Intelligent Systems
Address:	Leonhardstrasse 21, LEE J 201 8092 Zürich
Telephone: +	+41 44 632 06 98
Fax:	+41 44 632 11 81

Team Description: Team ARTOR is a collaboration between the Autonomous Systems Lab (ASL) at ETH Zurich, RUAG Defence, and armasuisse W+T, under the leadership of Philipp Krüsi (ETH/ASL).

Our robot ARTOR is a 6-wheeled, skid-steered electric vehicle. An array of onboard sensors is used for monitoring the robot's state and gathering information about the environment for online mapping, localization and obstacle avoidance. The equipment includes a rotating 3D laser scanner, two 2D laser scanners, a stereo camera, a GPS receiver and an inertial measurement unit. Furthermore, a pan-tilt-zoom unit containing both a visual and a thermal camera is installed. All data processing for autonomous navigation, including mapping, localization, path planning, obstacle avoidance and motion control, is performed on the onboard computer, using the robot operating system ROS.

Sponsors: --

Selection of scenario:

-- and Reconnoitring of structures (focus on radiological nuclear measuring and mapping)

x Mule (shuttle between two locations)

-- Movements / Convoying (transport with two vehicles)

-- Search & Rescue (SAR) / MedEvac (find and drag a dummy body)

-- Reconnaissance and disposal of bombs and explosive devices (EOD/IED; for professionals only!)

2.1 Vehicle Specification Sheet Team ARTOR

Pictures of vehicle:

Name of vehicle: ARTOR

2.1.1 Basic data about vehicle

Length:	140	cm
Width:	75	cm
Height w/o antennas:	125	cm
Height with antennas:	125	cm
Weight:	330	kg
Ground clearance:	14	cm

Average noise level:	60 (approx..)	dB(A)
Climbing performance:	30	degree
Wheel or track driven:	Wheels	--
Propulsion:	Batteries	--
Endurance:	2	hrs
Max. speed:	10	km/h
Payload:	50	kg

2.1.2 Communication equipment

Function:	Data connection between base station and robot	--
Type:	WLAN 802.11 b/g/n	--
Frequency:	2432	MHz
Possible frequency range:	From 2412 to 2472	MHz
Power:	0.1	W
Modulation:	BQSK, QPSK, 16-QAM, 64-QAM	--
Number of channels:	13	--

Function:	Emergency Stop	
Type:	--	
Frequency:	434	MHz
Possible frequency range:	434	MHz
Power:	<0.01	W
Modulation:	FM – narrow bandwidth	--
Number of channels:	--	--

2.1.3 Sensors equipment

Laser:	1x Velodyne HDL-32E 2x Sick LMS-151
Vision:	1x Point Grey Bumblebee2 (stereo, front) 1x AVT Stingray (mono, back) 2x color camera (1 front, 1 back) 1x pan-tilt-zoom unit with thermal and visual camera
GPS:	Trimble Pathfinder ProXH
Radar:	--
Inertial measurement unit:	Xsens MTi

2.1.4 Computing equipment on vehicle

Number of computers:	2 (low level/high level control)
Number of CPUs:	1 (low level), 4 (high level)

Type of CPU:	Intel Core i7 1.7 GHz (high level)
Operating system(s):	Linux

2.1.5 Basic data about control station

Pictures of the control station:		
Number of mandatory operators	1	
Number of optional operators	--	
Number of computers:	1	
Number of CPUs:	4	
Type of CPU:	Intel Core i7 1.7 GHz	
Operating system:	Linux	
Space needed for control station (LWH):	100x100x100	cm
Weight of control station:	10	kg
Power source needed:	230 V, 300 W	

3. Team Information Austrian Technology

Picture of vehicle:	
Name of vehicle:	Truck MAN X58, Autonomous Tractor, Taurob
Picture of team leader:	
Name of team leader:	Dipl.-Ing. Bernhard PESCHAK, COL
Team Name:	Team Austrian Technology
Team E-mail:	arwt.fgt@bmlvs.gv.at
Logo:	TAT
Website:	--
Location:	Vienna
Institution/Company:	Armament and Defence Technology Agency, University of applied sciences Technikum Wien, TAUROB
Address:	1090 WIEN, Rossauer Lände 1
Telephone: +	+43 (0)50201 1030700; mobil +49 (0)664 622 1663
Fax:	+43 (0)50201 103017135
Team Description:	The Team consists of the Austrian Armament and Defence Technology Agency representing the user approach, the University of applied sciences Technikum Wien representing the scientific approach and the company TAUROB representing the commercial approach and supplier of the platform;
Sponsors:	--

Selection of scenario:

x Reconnoitring of structures (focus on radiological and nuclear measuring and mapping)

x Mule (shuttle between two locations)

x Movements / Convoying (transport with two vehicles)

x Search & Rescue (SAR) / MedEvac (find and drag a dummy body)

x Reconnaissance and disposal of bombs and explosive devices (EOD/IED; for professionals only!)

3.1 Vehicle Specification Sheet Team Austrian Technology

Pictures of vehicle:

Name of vehicle: MAN HX58

3.1.1 Basic data about vehicle

Length:	935	cm
Width:	255	cm
Height w/o antennas:	3200	cm
Height with antennas:	t. b. d. max. ca. 4 m	cm
Weight:	14100	kg
Ground clearance:	46	cm
Average noise level:	(approx.) 82	db(A)
Climbing performance:	60	degree
Wheel or track driven:	Wheel	--
Propulsion:	fuel	--
Endurance:	Up to 48	hrs
Max. speed:	90	km/h
Payload:	11900	kg

3.1.2 Communication equipment

Function:	Data Link	--
Type:	Digital	--
Frequency:	2400	MHz
Possible frequency range:	2412-2472	MHz
Power:	0.1mW	W
Modulation:	OFDM	--
Number of channels:	2-13	--

Function:	Video Link	--
Type:	SRD	--
Frequency:	5800	MHz
Possible frequency range:	5740-5860	MHz
Power:	0.025	W
Modulation:	FM, Audio and Video	--
Number of channels:	7	--

3.1.3 Sensors equipment

Laser:	--
Vision:	Analogue HD Streaming Camera
GPS:	--
Radar:	--
Inertial measurement unit:	--

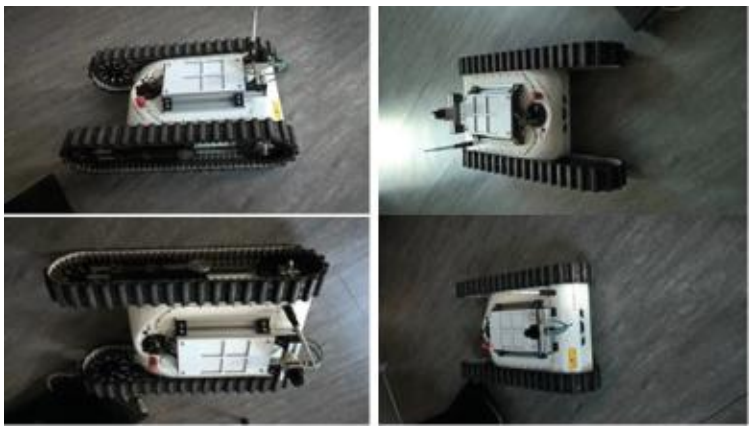
3.1.4 Computing equipment on vehicle

Number of computers:	1 Microcontroller
Number of CPUs:	1
Type of CPU:	Atmel SAM3X8E ARM Cortex-M3 CPU
Operating system(s):	None

3.1.5 Basic data about control station

Pictures of the control station:	No pictures available Off the shelf RC Controller + video goggles or TFT Display	
Number of mandatory operators	1	
Number of optional operators:	0	
Number of computers:	0	
Number of CPUs:	0	
Type of CPU:	none	
Operating system:	none	
Space needed for control station (LWH):	500x500x2000	cm
Weight of control station:	est. ~3 kg	kg
Power source needed:	Battery	

Pictures of vehicle:



Name of vehicle: Taurob

3.1.6 Basic data about vehicle

Length:	99	cm
Width:	59	cm
Height w/o antennas:	120	cm
Height with antennas:	180	cm
Weight:	65	kg
Ground clearance:	9	cm
Average noise level:	(approx.) 45	db(A)
Climbing performance:	30	degree
Wheel or track driven:	Track	--
Propulsion:	batteries	--
Endurance:	3	hrs
Max. speed:	5	km/h
Payload:	20	kg

3.1.7 Communication equipment

Function:	Data link	--
Type:	DSSS, OFDM	--
Frequency:	2357	MHz
Possible frequency range:	2312 - 2397	MHz
Power:	1	W
Modulation:	DSSS, OFDM	--
Number of channels:	17	--

3.1.8 Sensors equipment

Laser:	Hokuyo LIDAR, Sick LIDAR
Vision:	Mono cameras (color), Stereo cameras (b/w)
GPS:	Standard GPS

Radar:	none
Inertial measurement unit:	Standard IMU

3.1.9 Computing equipment on vehicle

Number of computers:	2
Number of CPUs:	1 each
Type of CPU:	Intel Core i7
Operating system(s):	Linux

3.1.10 Basic data about control station

Pictures of the control station:	 	
Number of mandatory operators	1	
Number of optional operators:	0	
Number of computers:	1	
Number of CPUs:	1	
Type of CPU:	Intel	
Operating system:	Windows 7	
Space needed for control station (LWH):	22 x 42 x 7	cm
Weight of control station:	3,5	kg
Power source needed:	Optional but preferable	

Pictures of vehicle:

Name of vehicle: Autonomous Tractor

3.1.11 Basic data about vehicle

Length:	5017	cm
Width:	2682	cm
Height w/o antennas:	3150	cm
Height with antennas:	4100	cm
Weight:	7300	kg
Ground clearance:	~0,5	cm
Average noise level:	69	db(A)
Climbing performance:	30	degree
Wheel or track driven:	Wheel	--
Propulsion:	Diesel (390L)	--
Endurance:	Up to 48	hrs
Max. speed:	50	km/h
Payload:	~7000	kg

3.1.12 Communication equipment

Function:	Base Station Video and Data Link	--
Type:	WLAN	--
Frequency:	2400	MHz
Possible frequency range:	2412-2472	MHz
Power:	0.1mW (up to 10W)	W
Modulation:	OFDM	--
Number of channels:	2-13	--

Function:	Base Station Data Backup Link	--

Type:	SRD	--
Frequency:	868 ISM	MHz
Possible frequency range:		MHz
Power:	0.315	W
Modulation:	FSK	--
Number of channels:	1	--

3.1.13 Sensors equipment

Laser:	Velodye HDL32
Vision:	AIT Multi-Baseline Stereo Camera System
GPS:	Ublox M8N
Radar:	--
Inertial measurement unit:	MicroStrain 3DM-GX3-35

3.1.14 Computing equipment on vehicle

Number of computers:	3
Number of CPUs:	3
Type of CPU:	Intel i7 Quad Core Ivy-Bridge
Operating system(s):	Linux

3.1.15 Basic data about control station

Pictures of the control station:	No pictures available	
Number of mandatory operators	1	
Number of optional operators:	2	
Number of computers:	2	
Number of CPUs:	2	
Type of CPU:	Intel i3-i7	
Operating system:	Linux	
Space needed for control station (LWH):	Desk, 2 Laptops, Joysticks, POE Switch, tripod with antennas , Additional Monitor (~180x60x2500)	cm
Weight of control station:	est. ~25 kg	kg
Power source needed:	230V AC Power	

4. Team Information Avrora

Picture of vehicle:

Name of vehicle: MARS A-800

Picture of vehicle:

Name of vehicle: Avrora Z-1

Picture of team leader:

Name of team leader:	GOL STANISLAV
Team Name:	AVRORA
Team E-mail:	likvon@list.ru, pe4alj@mail.ru
Logo:	AVRORA ROBOTICS LAB

Website:	www.kb-avrora.ru, www.rsreu.ru/en
Location:	Russia
Institution/Company:	Ryazan State Radio Engineering University (RSREU)
Address:	390005, Russia, Ryazan, Gagarina Str. 59/1
Telephone:	+7 (4912) 46-03-03 / +7(910)579-30-13
Fax:	+7 (4912) 92-22-15
Team Description:	"AVRORA" team (AV - autonomous, RO - robots, RA – radio engineering university) unites Ryazan State Radio Engineering University students and engineers of various technical specialties, who discovered a new area of their talents application - robotics. The team had developed several wheeled mobile robots (www.kb-avrora.ru), which are the winners of the nationwide robotics competitions "Mobile Robots - 2010" named after Professor Devyanin, "Robofest - 2010, 2014", "Robokross – 2013, 2014, 2015"
Sponsors:	«VOLNOE DELO» OLEG DERIPASKA FOUNDATION, The Robotics Program, Skolkovo Innovation Center.
Selection of scenario:	x and Reconnoitring of structures (focus on radiological nuclear measuring and mapping) x Mule (shuttle between two locations) x Movements / Convoying (transport with two vehicles) x Search & Rescue (SAR) / MedEvac (find and drag a dummy body) -- Reconnaissance and disposal of bombs and explosive devices (EOD/IED; for professionals only!)

4.1 Vehicle Specification Sheet Team Avrora

Pictures of vehicle:

Name of vehicle: MARS A-800

4.1.1 Basic data about vehicle

Length:	3360	cm
Width:	1800	cm
Height w/o antennas:	1680	cm
Height with antennas:	1860	cm
Weight:	950	kg
Ground clearance:	28	cm
Average noise level:	60	db(A)
Climbing performance:	30	degree
Wheel or track driven:	Track driven, 2 tracks	--
Propulsion:	storage batteries (2), gasoline internal combustion engine	--
Endurance:	5	hrs
Max. speed:	25	km/H
Payload:	400	kg

4.1.2 Communication equipment

Function:	Remote control vehicle	--
Type:	Active vehicle control	--
Frequency:	2400	MHz
Possible frequency range:	2400÷2483	MHz
Power:	0,1	W
Modulation:	DSMR	--
Number of channels:	4	--

Function:	Video Downlink	--
Type:	Video Transmission Module	--
Frequency:	1200	MHz
Possible frequency range:	1075÷1250	MHz
Power:	1,5	W
Modulation:	--	--
Number of channels:	8	--

Function:	Remote vehicle control, Emergency Stop	--
Type:	Wireless Hi Power Radio Modem	--
Frequency:	430	MHz
Possible frequency range:	387÷464	MHz
Power:	0,01	W
Modulation:	2-FSK, 4-FSK, GFSK, MSK	--
Number of channels:	256	--

Function:	Telemetry	--
Type:	Dual-band point of access	--
Frequency:	2400; 5000	MHz
Possible frequency range:	2400÷2483,5 5150÷5350 5470÷5850	MHz
Power:	20	W
Modulation:	BPSK, QPSK, 16QAM, 64QAM, OFDM, DQPSK, DBPSK, DSSS, CCK	--
Number of channels:	16	--

4.1.3 Sensors equipment

Lidar:	3D lidar Velodyne HDL-32E. Laser Class 1 (eye safe), 905 nm wavelength. Measurement range 1m to typically 80–100m	1x
Laser:	Sick LMS511: Field of view - 190 °, Scanning frequency - 100 Hz max, Operating range - 0 m ... 80 m	2x
Vision:	Beward BD2570-K12. Color, IP67, 5 MP, Ethernet	2x
GPS:	XSENS MTi-G-700, GEOS-3M Module. L1 GPS C/A, L1	4x

	ГЛОНАСС СТ, WAAS, EGNOS Signals	
Inertial Measurement unit:	MTi-G-700. Measurement range: ± 450 °/s (gyro), 50 m/s2 (accelerometer), 3 axes: pitch (x), roll (y), and yaw (z)	1x
Encoder:	Rotate encoder Autonics EP50S8-1024-2F-P-24, E40S6-	5x
Guiding system	Self-manufactured device. Operating range - 0 m ... 12 m.	1x

4.1.4 Computing equipment on vehicle

Number of computers:	2
Number of CPUs:	3
Type of CPU:	Intel Core i7-4770S
Operating system(s):	Linux

4.1.5 Basic data about control station

Pictures of the control station:	

		
Number of mandatory operators	1	
Number of optional operators	2	
Number of computers:	1	
Number of CPUs:	1	
Type of CPU:	Intel Core i5-3230M	
Operating system:	Linux/Windows 7	
Space needed for control station (LWH):	38x25x3.4	cm
Weight of control station:	2.5	kg
Power source needed:	Adapter Lenovo ADLX90NCT3A	

Pictures of vehicle:

Name of vehicle: AVRORA Z-1

4.1.6 Basic data about vehicle

Length:	120	cm
Width:	77	cm
Height w/o antennas:	80	cm
Height with antennas:	100	cm
Weight:	100	kg
Ground clearance:	10	cm
Average noise level:	40	db(A)
Climbing performance:	30	degree
Wheel or track driven:	Track driven, 2 tracks	--
Propulsion:	Storage batteries (2)	--
Endurance:	2	hrs
Max. speed:	20	km/H
Payload:	50	kg

4.1.7 Communication equipment

Function:	Remote control vehicle	--
Type:	Active vehicle control	--
Frequency:	2400	MHz
Possible frequency range:	2400÷2483	MHz
Power:	0,1	W
Modulation:	DSSMR	--
Number of channels:	4	--

Function:	Video Downlink	--
Type:	Video Transmission Module	--
Frequency:	1200	MHz
Possible frequency range:	1075÷1250	MHz
Power:	1,5	W
Modulation:	--	--
Number of channels:	8	--

Function:	Remote vehicle control, Emergency Stop	--
Type:	Wireless Hi Power Radio Modem	--
Frequency:	430	MHz
Possible frequency range:	387÷464	MHz
Power:	0,01	W
Modulation:	2-FSK, 4-FSK, GFSK, MSK	--
Number of channels:	256	--

Function:	Telemetry	--
Type:	Point of access	--
Frequency:	2400	MHz
Possible frequency range:	2412÷2462	MHz
Power:	0,6	W
Modulation:	BPSK, QPSK, 16QAM, 64QAM, OFDM	--
Number of channels:	16	--

4.1.8 Sensors equipment

Vision:	Beward BD2570-K12. Color, IP67, 5 MP, Ethernet	2x
Lidar:	3D lidar Velodyne HDL-32E. Laser Class 1 (eye safe), 905 nm wavelength. Measurement range 1m to typically 80–100m	1x
Guiding system:	Self-manufactured device. Operating range - 0 m ... 12 m.	1x

4.1.9 Computing equipment on vehicle

Number of computers:	1
Number of CPUs:	1
Type of CPU:	Intel® Core™ i7 6820HK / 6700HQ
Operating system(s):	Linux

4.1.10 Basic data about control station

Pictures of the control station:	   	
Number of mandatory operators	1	
Number of optional operators	2	
Number of computers:	1	
Number of CPUs:	1	
Type of CPU:	Intel Core i5-3230M	
Operating system:	Linux/Windows 7	
Space needed for control station (LWH):	38x25x3.4	cm

Weight of control station:	2.5	kg
Power source needed:	Adapter Lenovo ADLX90NCT3A	

5. Team Information bebot

Picture of vehicle:

Name of vehicle: bebot

Picture of team leader:

Name of team leader:	Björn Jensen
Team Name:	bebot-team
Team E-mail:	bebot.team@gmail.com
Logo:	BEBOT robotics
Website:	http://www.roboticslab.ti.bfh.ch/elrob2016
Location:	2501 Biel, Switzerland
Institution/Company:	Berner Fachhochschule Technik und Informatik
Address:	Quellgasse 21
Telephone:	+41 32 32 16 414
Fax:	+41 32 32 16 500
Team Description:	Team bebot comprises of 6 members of the robotics lab of the Berner Fachhochschule, students and a packbot robot.

Sponsors:	The team is supported by Dr. Thomas Nussbaumer (armasuisse S+T / Swiss MOD UGV research program / RUAG Defence).
Selection of scenario:	x and Reconnoitring of structures (focus on radiological nuclear measuring and mapping)
	x Mule (shuttle between two locations)
	x Movements / Convoying (transport with two vehicles)
	x Search & Rescue (SAR) / MedEvac (find and drag a dummy body)
	-- Reconnaissance and disposal of bombs and explosive devices (EOD/IED; for professionals only!)

5.1 Vehicle Specification Sheet Team bebot

Pictures of vehicle:

Name of vehicle: bebot

5.1.1 Basic data about vehicle

Length:	88.9	cm
Width:	52.1	cm
Height w/o antennas:	17.8	cm
Height with antennas:	50	cm
Weight:	22	kg
Ground clearance:	4	cm
Average noise level:	(approx.) 70	db(A)
Climbing performance:	60	degree
Wheel or track driven:	Track driven	--
Propulsion:	batteries	--
Endurance:	4	hrs
Max. speed:	9.3	km/h
Payload:	< 40	kg

5.1.2 Communication equipment

Function:	Communication Link	--
Type:	Pineapple Mark V Standard	--
Frequency:	2’412 (1), 2’431 (5), 2’452 (9), 2’472(13)	MHz
Possible frequency range:	2’412 - 2'484	MHz
Power:	< 0.1	W
Modulation:	half-duplex	--

Number of channels:	13	--

Function:	Emergency Stop	--
Type:		--
Frequency:		MHz
Possible frequency range:		MHz
Power:		W
Modulation:		--
Number of channels:		--

5.1.3 Sensors equipment

Laser:	Velodyne Puck
Vision:	Swissranger SR4000 and packbot on-board camera
GPS:	yes
Radar:	no
Inertial measurement unit:	yes

5.1.4 Computing equipment on vehicle

Number of computers:	1 + (packbot on-board PC)
Number of CPUs:	1
Type of CPU:	Intel Core i7 3517UE
Operating system(s):	Linux (Ubuntu 14.04 LTS)

5.1.5 Basic data about control station

Pictures of the control station:		
Number of mandatory operators	1	
Number of optional operators	0	
Number of computers:	1 (HP Elitebook 850 G1)	
Number of CPUs:	1	
Type of CPU:	Intel Core i7	
Operating system:	Linux (Ubuntu 14.04 LTS)	
Space needed for control station (LWH):	Laptop (37.55 x 25.36 x 2.14)	
Weight of control station:	2	
Power source needed:	no	

6. Team Information Cobham

Picture of vehicle:

Name of vehicle: telemax tEODor

Picture of team leader:

Name of team leader:	Dr. Andreas Ciossek
Team Name:	Cobham
Team E-mail:	andreas.ciossek@cobham.com
Logo:	COBHAM
Website:	www.cobham.com/missionequipment
Location:	Germany
Institution/Company:	telerob Gesellschaft für Fernhantierungstechnik mbH doing business as Cobham Mission Equipment – Unmanned Systems
Address:	Vogelsangstrasse 8, 73760 Ostfildern
Telephone:	++49-711-34102-115, Mobil: ++49-172-7498689
Fax:	++49-711-34102-555
Team Description:	To develop machines, equipment and systems that protect or replace human beings in situations where their presence would be either impossible or place them at great risk.

This is the motto, motivation and mission of Cobham – Unmanned Systems. Whether it's one of our Master- Slave Manipulators being used to dismantle a nuclear facility or an EOD robot being used to disarm a dangerous explosive device, protecting people and their surroundings is always our paramount concern anytime one of our products is deployed. Our engineers and specialists in the fields of electrical engineering, electronics and precision mechanical engineering combine creativity and competence in the quest for advanced solutions in the worlds of bomb disposal and remote handling technology. The Cobham range of products encompasses EOD robots (tEODor and teleMAX), completely equipped bomb disposal vehicles (TEL600), bomb disposal equipment, nonmagnetic special tools (NOMATOOLS), as well as manipulators for servicing, maintaining and dismantling nuclear facilities (EMSM).
A highly qualified, highly motivated staff provides our worldwide client base not merely with innovative products developed and manufactured in accordance with the very highest standards but also with the training and instruction needed to ensure their effective use. telerob is an official NATO supplier and development partner (NATO supplier code: C 5152). Furthermore we conform to the requirements of AQAP 2130.

Sponsors: --

Selection of scenario:

x and Reconnoitring of structures (focus on radiological nuclear measuring and mapping)

-- Mule (shuttle between two locations)

-- Movements / Convoying (transport with two vehicles)

x Search & Rescue (SAR) / MedEvac (find and drag a dummy body)

x Reconnaissance and disposal of bombs and explosive devices (EOD/IED; for professionals only!)

6.1 Vehicle Specification Sheet Team Cobham

Pictures of vehicle:

Name of vehicle: tEODor

6.1.1 Basic data about vehicle

Length:	130	cm
Width:	69	cm
Height w/o antennas:	124	cm
Height with antennas:	124	cm
Weight:	375	kg
Ground clearance:	10	cm
Average noise level:	(approx.)	db(A)
Climbing performance:	45	degree
Wheel or track driven:	2 tracks	--
Propulsion:	battery	--
Endurance:	Up to 4 hours	hrs
Max. speed:	3	km/h
Payload:	350	kg

6.1.2 Communication equipment

Function:	Data link	--
Type:	Radio	--
Frequency:	434	MHz
Possible frequency range:	433 to 435	MHz
Power:	0,5	W
Modulation:	F1D	--
Number of channels:	80	--

Function:	Video link	--
Type:	Radio	--
Frequency:	2353	MHz
Possible frequency range:	2353 to 2381	MHz
3	F3F	W
Modulation:	F3F	--
Number of channels:	5	--

6.1.3 Sensors equipment

Vision:	1 x colour camera with 10 x optical zoom, auto focus and integrated LED illumination. 3 x fixed focus colour camera with LED illumination Further optional cameras
GPS:	Garmin 16-HVS. Average accuracy 15m.
Rdiation:	Thermo Electron RadEye-PRD or other.
Gas:	Dräger Xam7000 or other

6.1.4 Computing equipment on vehicle

Number of computers:	1
Operating system(s):	(Example: Linux, Windows XP etc.)

6.1.5 Basic data about control station

Pictures of the control station:		
Number of mandatory operators	1	
Number of optional operators	3	
Operating system:	(Example: Linux, Windows XP etc.)	
Space needed for control station (LWH):	Size of the Sprinter: 7500 x 2500 x 3200	cm

Weight of control station:	5000	kg
Power source needed:	not necessary - optional 230Volts with 1600Watts	

Pictures of vehicle:

Name of vehicle: telemax

6.1.6 Basic data about vehicle

Length:	80	cm
Width:	40	cm
Height w/o antennas:	75	cm
Height with antennas:	75	cm
Weight:	80	kg
Ground clearance:	10	cm
Average noise level:	(approx.)	db(A)
Climbing performance:	45	degree
Wheel or track driven:	4 tracks	--
Propulsion:	battery	--
Endurance:	Up to 4 hours	hrs
Max. speed:	10	km/h
Payload:	10	kg

6.1.7 Communication equipment

Function:	Data link	--
Type:	Radio	--
Frequency:	434	MHz
Possible frequency range:	433 to 435	MHz
Power:	0,5	W
Modulation:	F1D	--
Number of channels:	80	--

Function:	Video link	--
Type:	Radio	--
Frequency:	2353	MHz

Possible frequency range:	2353 to 2381	MHz
Power:	3	W
Modulation:	F3F	--
Number of channels:	5	--

6.1.8 Sensors equipment

Vision:	1 x colour camera with 10 x optical zoom, auto focus and integrated LED illumination. 3 x fixed focus colour camera with LED illumination 1 x fixed focus colour camera Further optional cameras
GPS:	Garmin 16-HVS. Average accuracy 15m.
Radiation:	Thermo Electron RadEye-PRD or other.
Inertial measurement unit:	Dräger Xam7000 or other

6.1.9 Computing equipment on vehicle

Number of computers:	1
Operating system(s):	(Example: Linux, Windows XP etc.)

6.1.10 Basic data about control station

Pictures of the control station:		
Number of mandatory operators	1	
Number of optional operators	3	
Operating system:	(Example: Linux, Windows XP etc.)	
Space needed for control station (LWH):	Size of the Sprinter: 7500 x 2500 x 3200	cm
Weight of control station:	5000	kg
Power source needed:	not necessary - optional 230Volts with 1600Watts	

7. Team Information ELP

Picture of vehicle:

Name of vehicle: iRobot PackBot 510 EOD

Picture of team leader:

Name of team leader: Colin Weiss

Team Name: ELP

Team E-mail: cweiss@elp-gmbh.de

Logo:

Website: http://www.elp-gmbh.de

Location: Wuppertal, Germany

Institution/Company: ELP GmbH, European Logistic Partners

Address: Nützenberger Str. 359, 42115 Wuppertal, Germany

Telephone: +49 202 698940

Fax: +49 202 69894-10

Team Description: ELP GmbH is distributing iRobot's range of robotic systems within German-speaking Europe and provides Service and Training for these systems within all of Europe.

	In addition, ELP is developing accessories and additional capabilities for the iRobot equipment.
Sponsors:	--
Selection of scenario:	x Reconnoitring of structures (focus on radiological and nuclear measuring and mapping) -- Mule (shuttle between two locations) -- Movements / Convoying (transport with two vehicles) x Search & Rescue (SAR) / MedEvac (find and drag a dummy body) x Reconnaissance and disposal of bombs and explosive devices (EOD/IED; for professionals only!)

7.1 Vehicle Specification Sheet Team ELP

Pictures of vehicle:

Name of vehicle: Kobra 710

7.1.1 Basic data about vehicle

Length:	91,4 cm for the chassis 108 cm with 2-link manipulator arm	cm
Width:	54,1 cm with flippers removed 76,7 cm with flippers installed	cm
Height w/o antennas:	45,7 cm stowed (for the chassis only) 73 cm stowed (with 2-link manipulator arm)	cm
Height with antennas:	757 mm (with 2 Link-arm mounted)	cm
Weight:	166,5 kg 228 kg with arm installed (both figures are inclusive of battery and flipper weight)	kg
Ground clearance:	7.6	cm
Average noise level:	not determined	db(A)
Climbing performance:	Stair Climbing: 45° Slope: 45°	degree
Wheel or track driven:	Track	--
Propulsion:	(12) BB-2590/U Batteries in a battery box	--
Endurance:	8 – 10 h	hrs
Max. speed:	12,9 km/h	km/h
Payload:	68 kg	kg

7.1.2 Communication equipment

Function:	Telemetry (Video, Data, Brake)	--
Type:	WLAN with small patch antenna (300m LOS), Max. radio output 630 mW	--

Frequency:	Digital radio: 4.9 GHz, Alternative: 2.4 GHz	MHz
Possible frequency range:	4.9 GHz, 2.4 GHz	MHz
Power:	398	W
Modulation:	OFDM	--
Number of channels:	7 possible channels – 4.9, 3 possible channels – 2.4	--

7.1.3 Sensors equipment

Laser:	Class 3R lasers for disruptor aiming. Not permanently installed
Vision:	2 wide FOV cameras in chassis, 1 312x zoom camera in turret, optional external cameras for gripper and/or high-back view
GPS:	No on-board GPS
Radar:	No on-board radar
Inertial measurement unit:	3 axis, full 360 all axis, 180Hz refresh rate

7.1.4 Computing equipment on vehicle

Number of computers:	1
Number of CPUs:	1 each
Type of CPU:	Intel Core i7 1.5GHz processor
Operating system(s):	Linux

7.1.5 Basic data about control station

Pictures of the control station:	
Number of mandatory operators	1
Number of optional operators	1

Number of computers:	2	
Number of CPUs:	1 each	
Type of CPU:	Intel Core2 Duo	
Operating system:	Linux	
Space needed for control station (LWH):	2 Laptops, approx.. 352 x 284 x 64 cm LxWxH	cm
Weight of control station:	Approx. 6-10	kg
Power source needed:	110/230V @ 150W when operating on mains power	

Pictures of vehicle:

Name of vehicle: PackBot 510 EOD

7.1.6 Basic data about vehicle

Length:	69 cm (Flippers stowed), 88,9 cm (Flippers extended)	cm
Width:	40,6 cm without Flippers, 52 cm with Flippers	cm
Height w/o antennas:	40,7 cm (Total height from ground to top of the vehicle, Arm stowed, including flexible Antennas)	cm
Height with antennas:	2.210 cm (Total height from ground to top, arm extended)	cm
Weight:	33,3 kg including batteries and optional F/O Spooler	kg
Ground clearance:	7,62 cm	cm
Average noise level:	-/- (approx.)	db(A)
Climbing performance:	Stairs (with 5 kg additional) payload: 43° on wood, 38° on carpet, 40° on metal	degree
Wheel or track driven:	Track	--
Propulsion:	Rechargeable Li-Ion Batteries, BB-2590 or similar	--

Endurance:	12 – 15	hrs
Max. speed:	9,3	km/h
Payload:	35 kg	kg

7.1.7 Communication equipment

Function:	Telemetry (Video, Data, Brake/E-Stop)	--
Type:	WLAN 802.11a MESH-Networking, Alternative: WLAN 802.11b/g or uPoint MESH-Radio (MANET)	--
Frequency:	4.9 GHz, Alternative: 2.4 GHz, uPoint: TBC	MHz
Possible frequency range:	4.9 GHz, 2.4 GHz	MHz
Power:	0,4W (max, 4,9 GHz; uPoint: TBC)	W
Modulation:	OFDM (uPoint: TBC)	--
Number of channels:	4.9 GHz: 3; 2.4 GHz: 11, fixed to channel 6; uPoint: TBC	--

7.1.8 Sensors equipment

Laser:	Not yet decided
Vision:	4 Colour Cameras, 1 with 312x zoom and low light mode, one input for an auxiliary camera (FLIR or Wide-Angle as per mission requirements)
Radar:	--
Inertial measurement unit:	Self-protection IMU in Chassis, uBlox 11 DOF IMU in UAP-Module

7.1.9 Computing equipment on vehicle

Number of computers:	2: 1 fixed (main Computer in chassis), 1 optional (ELP-Payload)
Number of CPUs:	1 each
Type of CPU:	Intel Core2 (main Computer in Chassis), Intel Core i5 (ELP-Payload)
Operating system(s):	All: Linux, MRC Controller: Android

7.1.10 Basic data about control station

Pictures of the control station:		
Number of mandatory operators	1	
Number of optional operators	1	
Number of computers:	2	
Number of CPUs:	1 each	
Type of CPU:	Intel Core2 Duo Mobile T5500, 2 x 1.66 GHz, Intel Core i7	
Operating system:	Linux	
Space needed for control station (LWH):	2 Laptops, approx.. 352 x 284 x 64 cm LxWxH	cm
Weight of control station:	Approx.. 6 – 10	kg
Power source needed:	110/230V @ 150W when operating on mains power	

8. Team Information FKIE

Picture of vehicle:

Name of vehicle: Garm PackBot

Picture of team leader:

Name of team leader:	Illing, Boris
Team Name:	Team FKIE
Team E-mail:	boris.illing@fkie.fraunhofer.de
Logo:	Fraunhofer FKIE
Website:	www.fkie.fraunhofer.de
Location:	Wachtberg, Germany
Institution/Company:	Fraunhofer Institute for Communication, Information Processing and Ergonomics FKIE
Address:	Fraunhoferstr. 20, 53343 Wachtberg
Telephone:	+49-228-9435-495
Fax:	+49-228-9435-210
Team Description:	Company Description: The Fraunhofer-Institute for Communication, Information Processing and Ergonomics (FKIE) employs currently more than 300 staff members, who perform studies in computer science and ergonomics with application to the diverse research areas of command & control, communications, intelligence, surveillance, and reconnaissance (C3ISR). A distinctive aspect of the FKIE methodology is the fact that

we are as accomplished in technology as we are in the so called “human factor”. As experts in ergonomics we know how to equip technologies with user interfaces that are easy to operate and control. Also unique to us is the fact that we handle the entire data processing chain from acquisition to display allowing us to work in highly specialized units or interdisciplinary teams according to project requirements.
The Cognitive Mobile Systems (CMS) department as part of the FKIE develops innovative techniques for efficient guidance of human-multi-robot systems with an emphasis on military applications. Remote-controlled mobile systems have high demands on an operator’s concentration and cognitive abilities, especially if control has to be maintained over long periods of time. In order to increase efficiency and available deployment options, CMS develops assistance functions which enable an operator to guide mobile systems on a high level of abstraction while the robots execute required low-level commands autonomously. New developments are constantly integrated in experimental systems and evaluated in cooperation with security authorities, organizations, and the German army.

Sponsors: The team is supported by Dr. Thomas Nussbaumer (armasuisse S+T / RUAG Defence).

Selection of scenario and:

x Reconnoitring of structures (focus on radiological nuclear measuring and mapping)

x Mule (shuttle between two locations)

-- Movements / Convoying (transport with two vehicles)

x Search & Rescue (SAR) / MedEvac (find and drag a dummy body)

-- Reconnaissance and disposal of bombs and explosive devices (EOD/IED; for professionals only!)

8.1 Vehicle Specification Sheet Team FKIE

Pictures of vehicle:

Name of vehicle: Garm

8.1.1 Basic data about vehicle

Length:	178	cm
Width:	74	cm
Height w/o antennas:	141	cm
Height with antennas:	141	cm
Weight:	400	kg
Ground clearance:	10	cm
Average noise level:	60	db(A)
Climbing performance:	40	degree
Wheel or track driven:	Track	--
Propulsion:	Batteries	--
Endurance:	4	hrs
Max. speed:	13	km/h
Payload:	250	kg

8.1.2 Communication equipment

Function:	Data Network	--
Type:	WLAN 802.11b	--
Frequency:	2400	MHz
Possible frequency range:	2400 to 2500	MHz
Power:	0.1	W
Modulation:	GMSK/8PSK/QPSK/16QAM	--
Number of channels:	13	--

Function:	Emergency Halt	--
Type:	Radiosafe Link	--

Frequency:	433	MHz
Possible frequency range:	433 to 435	MHz
Power:	0.01	W
Modulation:	FM	--
Number of channels:	64	--

8.1.3 Sensors equipment

Laser:	2x Sick LMS 511
Vision:	2x Telemax Manipulator Cameras, 1x PanTilt Camera
GPS:	XSens MTi-G
Inertial measurement unit:	XSens MTi-G

8.1.4 Computing equipment on vehicle

Number of computers:	1
Number of CPUs:	4
Type of CPU:	Intel Core i7
Operating system(s):	Linux

8.1.5 Basic data about control station

Pictures of the control station:	 	
Number of mandatory operators	1	
Number of optional operators	1	
Number of computers:	1	
Number of CPUs:	4	
Type of CPU:	Intel Core i7	
Operating system:	Linux	
Space needed for control station (LWH):	200x200x250	cm
Weight of control station:	10	kg
Power source needed:	None, 230V optional	

Pictures of vehicle:

Name of vehicle: Packbot

8.1.6 Basic data about vehicle

Length:	89	cm
Width:	53	cm
Height w/o antennas:	60	cm
Height with antennas:	60	cm
Weight:	14	kg
Ground clearance:	4	cm
Average noise level:	20	db(A)
Climbing performance:	60	degree
Wheel or track driven:	Track	--
Propulsion:	Batteries	--
Endurance:	2	hrs
Max. speed:	9	km/h
Payload:	<1	kg

8.1.7 Communication equipment

Function:	Data Network	--
Type:	WLAN 802.11b	--
Frequency:	2400	MHz
Possible frequency range:	2400 to 2500	MHz
Power:	0.1	W
Modulation:	GMSK/8PSK/QPSK/16QAM	--
Number of channels:	13	--

8.1.8 Sensors equipment

Laser:	2x Hokuyo UTM-30
Vision:	1x PanTilt Cam, 1x PanTilt IR Cam, 555x Manipulator Cams
GPS:	Packbot internal INS
Inertial measurement unit:	Packbot internal

8.1.9 Computing equipment on vehicle

Number of computers:	1
Number of CPUs:	1 CPU, 2 threads
Type of CPU:	Intel i5
Operating system(s):	Linux

8.1.10 Basic data about control station

Pictures of the control station:		
Number of mandatory operators	1	
Number of optional operators	1	
Number of computers:	2	
Number of CPUs:	2 CPUs total, each 2 threads	
Type of CPU:	Intel	
Operating system:	Linux	
Space needed for control station (LWH):		cm
Weight of control station:		kg
Power source needed:	None, 230V optional	

9. Team Information IMM

Picture of vehicle:

Name of vehicle: MSAS

Picture of team leader:

Name of team leader:	Janusz Będkowski
Team Name:	IMM-MSAS
Team E-mail:	januszbedkowski@gmail.com
Logo:	
Website:	http://lider.zms.imm.org.pl
Location:	Warsaw
Institution/Company:	Institute of Mathematical Machines
Address:	02-078 Warszawa, ul. Ludwika Krzywickiego 34
Telephone:	+48 22 621 78 17
Fax:	+48 22 629 92 70
Team Description:	Our team is working on autonomous mobile mapping system. Our goal is to provide accurate 3D maps in real time. We are focused on parallel implementation of 6DSLAM

integrated with ROS (Robot Operating System). Our platform is Husky from ClearPath robotics equipped with 3D measurement unit provided by MANDALA.

Sponsors: MANDALA (www.mandalarobotics.com)

Selection of scenario:

x and Reconnoitring of structures (focus on radiological nuclear measuring and mapping)

-- Mule (shuttle between two locations)

-- Movements / Convoying (transport with two vehicles)

-- Search & Rescue (SAR) / MedEvac (find and drag a dummy body)

-- Reconnaissance and disposal of bombs and explosive devices (EOD/IED; for professionals only!)

9.1 Vehicle Specification Sheet Team IMM

Pictures of vehicle:

Name of vehicle: MSAS

9.1.1 Basic data about vehicle

Length:	99	cm
Width:	67	cm
Height w/o antennas:	(height from ground to top of the vehicle) 120	cm
Height with antennas:	(Total height from ground to top, including antennas etc.) 120	cm
Weight:	60	kg
Ground clearance:	12	cm
Average noise level:	(approx.) 80	db(A)
Climbing performance:	20	degree
Wheel or track driven:	wheel	--
Propulsion:	(Examples: batteries, fuel, solar, nuclear etc.) batteries	--
Endurance:	2	hrs
Max. speed:	4	km/h
Payload:	10	kg

9.1.2 Communication equipment

Function:	(e.g. Video Downlink, Emergency Stop etc.)	--
Type:	WLAN	--
Frequency:	5000	MHz
Possible frequency range:	2400 - 5000	MHz
Power:	No info (it is standard indoor router for personal usage)	W

Modulation:	No info (it is standard indoor router for personal usage)	--
Number of channels:	13	--

Function:	(e.g. Video Downlink, Emergency Stop etc.)	--
Type:		--
Frequency:		MHz
Possible frequency range:		MHz
Power:		W
Modulation:		--
Number of channels:		--

9.1.3 Sensors equipment

Laser:	Rotated LMS 500
Vision:	Ladybug 3
GPS:	Low cost with USB interface (NMEA compatible)
Radar:	none
Inertial measurement unit:	XSENS MTi30

9.1.4 Computing equipment on vehicle

Number of computers:	1
Number of CPUs:	4
Type of CPU:	I5
Operating system(s):	(Example: Linux, Windows XP etc.) Linux

9.1.5 Basic data about control station

Pictures of the control station:		
Number of optional operators	1	
Number of mandatory operators	1	
Number of computers:	1	
Number of CPUs:	8	
Type of CPU:	I7	
Operating system:	(Example: Linux, Windows XP etc.) Linux	
Space needed for control station (LWH):	(Example: Container, laptop etc.) 50x50x50	cm
Weight of control station:	3	kg
Power source needed:	no	

10. Team Information MuCAR

Picture of vehicle:

Name of vehicle: MuCAR-3 (right) and MuCAR-4 (left)

Picture of team leader:

Name of team leader:	Thorsten Luettel
Team Name:	MuCAR
Team E-mail:	elrob@mucar3.de
Logo:	
Website:	http://www.unibw.de/tas
Location:	Neubiberg, Germany
Institution/Company:	University of the Bundeswehr Munich
Address:	Autonomous Systems Technology (LRT 8 TAS) Werner-Heisenberg-Weg 39 85579 Neubiberg Germany
Telephone:	+49 89 6004 4637, +49 170 5566266
Fax:	+49 89 6004 3074
Team Description:	Our Team MuCAR consists of 15 team members under the

leadership of Dipl.-Ing. Thorsten Luettel. All team members work as research assistants at “Autonomous Systems Technology” institute, which is headed by Prof. Dr.-Ing. Hans-Joachim Wuensche.

Our team developes and operates the two robot vehicles “MuCAR-3” and “MuCAR-4”, the third rsp. fourth generation of our Munich Cognitive, Autonomous Robot Cars. The first two vehicle generations drove on German Autobahns under the leadership of Prof. E.-D. Dickmanns as far back as 1987. Both vehicles already have retired to museums.

MuCAR-3 is based on a stock VW Touareg with a V6 TDI engine, modified to allow computer control of steering, brake, throttle and automatic gearbox. Full body skid plates allow testing in rough terrain.

MuCAR-4 is based on a stock VW Tiguan with a TSI engine, modified to allow computer control of steering, brake, throttle and automatic gearbox.

Apart from inertial sensors, we continue to focus on vision as a main sensor for perception, as this sensor provides most of the information humans need for driving. In addition, we use a high definition 360 degree Laser Scanner mounted on the roof of the vehicle. It is advantageous in special applications such as off-road driving, until our vision systems can fully cope with those scenarios as well.

The main vision sensors are forward looking color cameras placed on a two-axis platform inside the vehicle. The arrangement resembles the human vision system, with a telecamera as “fovea” and 2 slightly outward pointed wide angle cameras for peripheral vision, which can also be used for stereo vision. All cameras are mounted on a yaw axis platform to allow for active control of the horizontal viewing direction, while the view of the tele-camera with its narrow field of view is inertially stabilized. Some more cameras working in different spectral regions (SWIR, NIR) complete the camera setup.

Our robust and fast 4D-approach to perception has been augmented by an innovative fusion of vision and LiDAR data and excels in offroad environments featuring poor GPS conditions. Team MuCAR participated at the ELROB 2007, 2008, 2009, 2010, 2012, Eurathlon 2013 and – together with TU Karlsruhe and TU Munich through Team AnnieWAY – at the DARPA Urban Challenge 2007, where this team was one of only 11 teams which made it into the finals on 3 Nov. 2007.

Sponsors: --

Selection of scenario: -- Reconnoitring of structures (focus on radiological
and nuclear measuring and mapping)

x Mule (shuttle between two locations)

x Movements / Convoying (transport with two vehicles)

-- Search & Rescue (SAR) / MedEvac (find and drag a dummy body)

-- Reconnaissance and disposal of bombs and explosive devices (EOD/IED; for professionals only!)

We consider participating in one of the two selected scenarios with two different approaches (e.g. different robot vehicle, different sensor setup, …). Details will be given as soon as available!

10.1 Vehicle Specification Sheet Team MuCAR

Pictures of vehicle:

Name of vehicle: MuCAR-3
(Munich Cognitive Autonomous Robot Car, 3rd generation)

10.1.1 Basic data about vehicle

Length:	480	cm
Width:	193	cm
Height w/o antennas:	205	cm
Height with antennas:	240	cm
Weight:	280	kg
Ground clearance:	~30	cm
Average noise level:	81 (approx.)	db(A)
Climbing performance:	45	degree
Wheel or track driven:	4 wheel drive	--
Propulsion:	fuel (Diesel) (Volkswagen 3.0 ltr. V6 TDI engine)	--
Endurance:	8	hrs
Max. speed:	205	km/h
Payload:	>250	kg

10.1.2 Communication equipment

Function:	Vehicle-to-Vehicle-Communication (optional)	--
Type:	Amber Wireless AMB8355	--
Frequency:	868	MHz

Possible frequency range:	869.40 – 869.65	MHz
Power:	0.5	W
Modulation:	2-GFSK	--
Number of channels:	up to 8	--

Function:	Vehicle-to-Vehicle-Communication (optional)	--
Type:	Satel Satelline-Easy Pro	--
Frequency:	433	MHz
Possible frequency range:	403 -473	MHz
Power:	Up to 35	W
Modulation:		--
Number of channels:	Spacing 12.5 / 20 / 25 kHz	--

Function:	Telemetry to visitors' area (optional)	--
Type:	Ubiquity Bullet M2	--
Frequency:	2400	MHz
Possible frequency range:	2412-2462	MHz
Power:	Normally 0.1	W
Modulation:	WLAN	--
Number of channels:	13 (only 3 can be used without disturbances)	--

10.1.3 Sensors equipment

Laser:	Velodyne HDL64E-S2 3D LiDAR System Ibeo LUX 8L LiDAR System
Vision:	custom-build 2 axis platform inside the vehicle, equipped with: 2x color cameras (stereo) with wide-angle lenses 1x color camera with tele-lens 2x NIR camera with wide-angle lenses FLIR LWIR Camera
Radar:	Smart Micro System UMRR
Inertial navigation system:	OxTS RT3003: Full 6 DOF IMU system with integrated RTK-capable GPS system (operated without RTK correction during ELROB)

10.1.4 Computing equipment on vehicle

Number of computers:	1 high-level computer for all sensor data processing, mapping, planning and control
Number of CPUs:	2

Type of CPU:	Octa Core Intel Xeon E5-2667v3
Operating system(s):	Arch Linux

Number of computers:	real-time capable subsystems for - low-level control - analog/digital hardware I/O
Number of CPUs:	1
Type of CPU:	PowerPC integrated in dSPACE (Micro)AutoBox

10.1.5 Basic data about control station

Control station is mounted inside the vehicle. No external control station.

Pictures of vehicle:

Name of vehicle: MuCAR-4
(Munich Cognitive Autonomous Robot Car, 4rd generation)

10.1.6 Basic data about vehicle

Length:	443	cm
Width:	181	cm
Height w/o antennas:	170	cm
Height with antennas:	215	cm
Weight:	2000	kg
Ground clearance:	<20	cm
Average noise level:	75 (approx.)	db(A)
Climbing performance:	40	degree
Wheel or track driven:	4 wheel drive	--
Propulsion:	fuel (Super) (Volkswagen 2.0 ltr. TSI engine)	--
Endurance:	8	hrs
Max. speed:	200	km/h
Payload:	>250	kg

10.1.7 Communication equipment

Function:	Vehicle-to-Vehicle-Communication (optional)	--
Type:	Amber Wireless AMB8355	--
Frequency:	868	MHz
Possible frequency range:	869.40 – 869.65	MHz

Power:	0.5	W
Modulation:	2-GFSK	--
Number of channels:	up to 8	--

Function:	Vehicle-to-Vehicle-Communication (optional)	--
Type:	Satel Satelline-Easy Pro	--
Frequency:	433	MHz
Possible frequency range:	403 - 473	MHz
Power:	up to 35	W
Modulation:		--
Number of channels:	Spacing 12.5 / 20 / 25 kHz	--

Function:	Telemetry to visitors' area (optional)	--
Type:	Ubiquity Bullet M2	--
Frequency:	2400	MHz
Possible frequency range:	2412-2462	MHz
Power:	Normally 0.1	W
Modulation:	WLAN	--
Number of channels:	13 (only 3 can be used without disturbances)	--

10.1.8 Sensors equipment

Laser:	Velodyne HDL64E-S1 3D LiDAR System Ibeo LUX 8L LiDAR System
Vision:	custom-build 2 axis platform inside the vehicle, equipped with: 2x color cameras (stereo) with wide-angle lenses 1x color camera with tele-lens
Inertial navigation system:	OxTS RT3003: Full 6 DOF IMU system with integrated RTK-capable GPS system (operated without RTK correction during ELROB)

10.1.9 Computing equipment on vehicle

Number of computers:	1 high-level computer for all sensor data processing, mapping, planning and control
Number of CPUs:	2
Type of CPU:	Octa Core Intel Xeon E5-2667v1
Operating system(s):	Arch Linux

Number of computers:	1 real-time capable subsystems for

	- low-level control - analog/digital hardware I/O
Number of CPUs:	1
Type of CPU:	PowerPC integrated in dSPACE MicroAutoBox

10.1.10 Basic data about control station

Control station is mounted inside the vehicle. No external control station.

11. Team Information NIC Instruments

Picture of vehicle:

Name of vehicle: First Responder

Picture of team leader:

Name of team leader: Steve Wisbey
Team Name: NIC Instruments LTD
Team E-mail: steve@nicltd.co.uk
Logo:

NIC
INSTRUMENTS
LIMITED
www.nicltd.co.uk

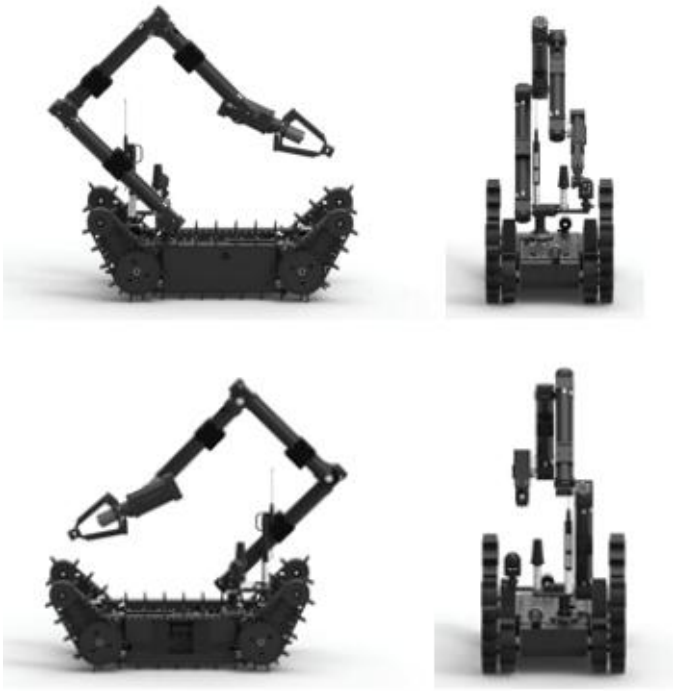
Website: www.nicltd.co.uk
Location: UK

Institution/Company: Company
Address: Gladstone Road, Folkestone, Kent, CT19 5NF
Telephone: 01303851022
Fax:

Team Description:	UGV R&D Team for NIC Instrumemts Ltd
Sponsors:	NIC Instruments
Selection of scenario:	-- and Reconnoitring of structures (focus on radiological nuclear measuring and mapping)
	-- Mule (shuttle between two locations)
	-- Movements / Convoying (transport with two vehicles)
	-- Search & Rescue (SAR) / MedEvac (find and drag a dummy body)
	x Reconnaissance and disposal of bombs and explosive devices (EOD/IED; for professionals only!)

11.1 Vehicle Specification Sheet Team NIC Instruments

Pictures of vehicle:



Name of vehicle: First Responder

11.1.1 Basic data about vehicle

Length:	77	cm
Width:	46.5	cm
Height w/o antennas:	36.5	cm
Height with antennas:	65.1	cm
Weight:	43	kg
Ground clearance:	5.6	cm
Average noise level:	50	db(A)
Climbing performance:	45	degree
Wheel or track driven:	Track	--
Propulsion:	batteries	--
Endurance:	1-4 hours, mission dependant	hrs
Max. speed:	3	km/h
Payload:	30	kg

11.1.2 Communication equipment

Function:	Radio link and COFDM video link	--
Type:	Radio link and COFDM video link	--
Frequency:	Radio: 458.5MHz, Video 2400MHz	MHz
Possible frequency range:	Radio: 458.5MHz – 458.95MHz Video: 2.28GHz to 2.485GHz	MHz
Power:	Radio 0.5W – 5W Video 0.1W	W
Modulation:	Radio: 4-level FSK, Video: COFDM QPSK	--
Number of channels:	Radio: 37, Video 16	--

11.1.3 Sensors equipment

Laser:	<5mW
Vision:	Front, rear, nomad, claw and pan tilt cameras
GPS:	Optional
Radar:	N/A
Inertial measurement unit:	N/A

11.1.4 Computing equipment on vehicle

Number of computers:	1
Number of CPUs:	2
Type of CPU:	Collibri Tegra
Operating system(s):	Linux

11.1.5 Basic data about control station

Pictures of the control station:	

Number of mandatory operators	1	
Number of optional operators	0	
Number of computers:	1	
Number of CPUs:	Quad core single processor	
Type of CPU:	Intel i5	
Operating system:	Windows 8.1	
Space needed for control station (LWH):	47x35.7x17.6	cm
Weight of control station:	12.5	kg
Power source needed:	Battery	

12. Team Information Smart Military Vehicles

Picture of vehicle:

Name of vehicle: TULF / StrAsRob

Picture of team leader:

Name of team leader:	Dr. Thomas Kopfstedt
Team Name:	Smart Military Vehicles
Team E-mail:	Thomas.kopfstedt@diehl-bgt-defence.de
Logo:	--
Website:	http://www.diehl.com/de/diehl-defence.html
Location:	Germany
Institution/Company:	Diehl BGT Defence GmbH & Co. KG
Address:	Alte Nussdorfer Straße 13, 88662 Überlingen
Telephone:	+49 7551 89 2875
Fax:	+49 7551 89 2351

Team Description: The team consists of some contractors and sub-contractors regarding the German R&D systems TULF (Technologieträger unbemanntes Landfahrzeug) and

	StrAsRob (Straßentransport mit Assistenzfunktionen von Robotern). The idea is to present the current capabilities of these modified military trucks to a wide audience in a competition which is designed based on military requirements.
Sponsors:	BAAINBw (Bundesamt für Ausrüstung, Informationstechnik und Nutzung der Bundeswehr)
Selection of scenario:	-- and Reconnoitring of structures (focus on radiological nuclear measuring and mapping) x Mule (shuttle between two locations) x Movements / Convoying (transport with two vehicles) -- Search & Rescue (SAR) / MedEvac (find and drag a dummy body) -- Reconnaissance and disposal of bombs and explosive devices (EOD/IED; for professionals only!)

12.1 Vehicle Specification Sheet Team Smart Military Vehicles

Pictures of vehicle:

Name of vehicle: StrAsRob

12.1.1 Basic data about vehicle

Length:	946	cm
Width:	255	cm
Height w/o antennas:	332	cm
Height with antennas:	399	cm
Weight:	12860 (empty)	kg
Ground clearance:	34 cm (front) 29cm (rear)	cm
Average noise level:	82db(A)	db(A)
Climbing performance:	60 degree	degree
Wheel or track driven:	Wheel (6x6)	--
Propulsion:	Fuel (diesel engine)	--
Endurance:	750	hrs
Max. speed:	90	km/h
Payload:	12140	kg

12.1.2 Communication equipment

Function:	LTE Based military communication	--
Type:	Mobilicom MCU-100, Mobilicom HPA-20MI	--
Frequency:	2410	MHz
Possible frequency range:	2400-2450	MHz
Power:	2 x 20W peak, 2 x 4W average	W
Modulation:	QPSK / 16QAM	--
Number of channels:	1	--

Function:	WLAN	--
Type:	BULLET TITANUM M5HP	--
Frequency:	5170	MHz
Possible frequency range:	5170 - 5875	MHz
Power:	0.32	W
Modulation:	OFDM	--
Number of channels:	9	--

Function:	Remote Emergency Stop	--
Type:	JAY electronique	--
Frequency:	433.1	MHz
Possible frequency range:	433.1 – 434.674	MHz
Power:	<0.01	W
Modulation:	FM	--
Number of channels:	64	--

Function:	RF Ranging System	--
Type:	TimeDomain PulsON 440	--
Frequency:	4300	MHz
Possible frequency range:	3100 - 4800	MHz
Power:	<0.001	W
Modulation:	--	--
Number of channels:	--	--

12.1.3 Sensors equipment

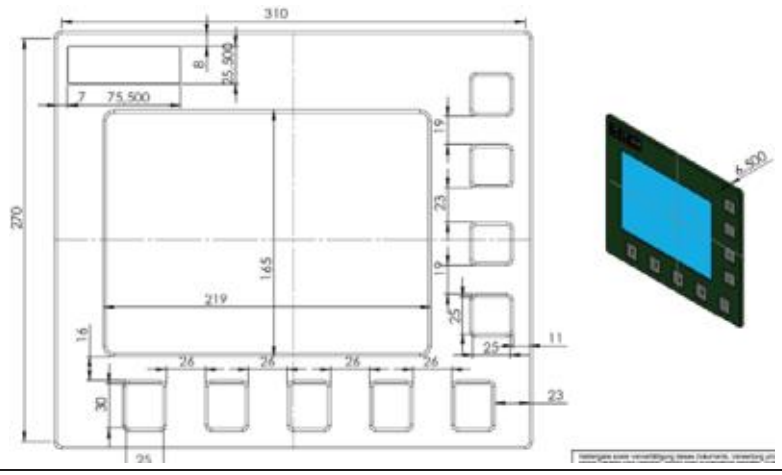
Laser:	IBEO LUX 8L

Vision:	1x Xenics Gobi 640-GigE (infrared camera) 3x Basler acA1300-30gc 1x Basler acA2000-50gc
GPS:	As part of IMU Xsens MTi-G
Radar:	Continental ARS 308T
Inertial measurement unit:	Xsens-MTi-G KVH DSP 3000 (optical gyro)
Ground Movement:	Dickey John, radar based sensor

12.1.4 Computing equipment on vehicle

Number of computers:	7
Number of CPUs:	7
Type of CPU:	Intel (i7-2715QE)
Operating system(s):	Ubuntu 12.04 LTS 64bit

12.1.5 Basic data about control station

Pictures of the control station:		
Number of mandatory operators	1	
Number of optional operators	0	
Number of computers:	1	
Number of CPUs:	1	
Type of CPU:	Intel® Core i7-2610UETM, Sandy Bridge, 1.5GHz (Turbo Frequenz max. 2.4GHz)	
Operating system:	Ubuntu 12.04 LTS 64bit	
Space needed for control station (LWH):	None (in StrAsRob integrated)	cm
Weight of control station:	6.5	kg
Power source needed:	None (in StrAsRob integrated)	

Pictures of vehicle:

Name of vehicle: TULF (Technologieträger Unbemanntes Landfahrzeug)

12.1.6 Basic data about vehicle

Length:	946	cm
Width:	255	cm
Height w/o antennas:	332	cm
Height with antennas:	399	cm
Weight:	12860 (empty)	kg
Ground clearance:	34 cm (front) 29cm (rear)	cm
Average noise level:	82db(A)	db(A)
Climbing performance:	60 degree	degree
Wheel or track driven:	Wheel (6x6)	--

Propulsion:	Fuel (diesel engine)	--
Endurance:	750	hrs
Max. speed:	90	km/h
Payload:	12140	kg

12.1.7 Communication equipment

Function:	Vehicle Control	--
Type:	Cobham RMDigi-086087	--
Frequency:	869.4	MHz
Possible frequency range:	869.4 – 869.65	MHz
Power:	0.1	W
Modulation:	COFDM 20KHz 16QAM FEC 1/2	--
Number of channels:	9	--

Function:	Video Transmission	--
Type:	Cobham RMDigi-560600	--
Frequency:	5660	MHz
Possible frequency range:	5660 - 5820	MHz
Power:	0.1	W
Modulation:	COFDM 8MHz QPSK FEC 2/3	--
Number of channels:	9	--

Function:	LTE Based military communication	--
Type:	Mobilicom MCU-100, Mobilicom HPA-20MI	--

Frequency:	2410	MHz
Possible frequency range:	2400-2450	MHz
Power:	2 x 20W peak, 2 x 4W average	W
Modulation:	QPSK / 16QAM	--
Number of channels:	1	--

Function:	Remote Emergency Stop	--
Type:	JAY electronique	--
Frequency:	433.1	MHz
Possible frequency range:	433.1 – 434.674	MHz
Power:	<0.01	W
Modulation:	FM	--
Number of channels:	64	--

Function:	RF Ranging System	--
Type:	TimeDomain PulsON 440	--
Frequency:	4300	MHz
Possible frequency range:	3100 – 4800	MHz
Power:	<0.001	W
Modulation:	--	--
Number of channels:	--	--

12.1.8 Sensors equipment

Laser:	2x Velodyne HDL 32

Vision:	1x Xenics Gobi 640-GigE (infrared camera) 2x Jenoptik IR-TCM HD 1024 (infrared camera) 10x Basler acA1300-30gc 1x Basler acA2040-25gc
GPS:	As part of IMU Xsens MTi-G
Radar:	2x Continental ARS 308T 9x UMRR Smart Micro Radar
Inertial measurement unit:	Xsens-MTi-G KVH DSP 3000 (optical gyro)
Ground Movement:	Dickey John, radar based sensor

12.1.9 Computing equipment on vehicle

Number of computers:	10
Number of CPUs:	11
Type of CPU:	9x Intel (i7-2715QE) + 2x Intel Xeon E5-2640 v3 Prozessor (2,6GHz, 8C/16T, 20MB Cache, 8GT/s QPI, 90W, Turbo, HT)
Operating system(s):	Ubuntu 14.04 LTS 64bit

12.1.10 Basic data about control station

Pictures of the control station:	Container is shown on the TULF vehicle on top of this document.	
Number of mandatory operators	1	
Number of optional operators	1	
Number of computers:	2	
Number of CPUs:	2	
Type of CPU:	Intel Core i7, Intel Atom N450	
Operating system:	Ubuntu Linux, Windows	
Space needed for control station (LWH):	400 x 265 x 240	cm
Weight of control station:	approximately 4000	kg

Power source needed:	400V DC or stand alone with power generator

13. Team Information TNO – NLD EODD

Picture of vehicle:

Name of vehicle: Telepresence@tEODor

Picture of team leader:

Name of team leader: Ing. E.P.H. (Eduard) Winckers
Team Name: TNO – NLD EODD
Team E-mail: eduard.winckers@tno.nl
Logo:

Website: www.tno.nl
Location: Soesterberg, The Netherlands
Institution/Company: TNO
Address: PO Box 23, 3769 ZG Soesterberg, The Netherlands
Telephone: +31 8886 65918
Fax: --

Team Description:	The “TNO – NLD EODD” team will participate with a telepresence system developed for use on Explosive Ordnance Disposal robots. This telepresence system was developed by TNO, in collaboration with the companies ARVOO, Embedded Acoustics, and Egripment and funded by the Dutch MoD. It has been designed and optimized for use on Explosive Ordnance Disposal robots. It consists of two main components, one positioned at the vehicle, with a Pan-Tilt-Roll servosystem (PTR) with 3D audio sensors and (stereo) cameras, and the other at the operator control station with a headtracker, stereo audio and video head mounted displays. Information between these components is exchanged by wireless communication with minimal delay. The viewing direction of the operator, recorded by the headtracker, is ‘copied’ to the PTR viewing direction, and the audio and video recorded is presented on the HMD. This provides the operator with the feeling of actually looking and hearing around at the remote location where the robot is while actually being at a (safe) remote location. The operator can be further supported with video overlays on, for example, vehicle manoeuvring options and restrictions.
Sponsors:	sponsored by the Dutch Ministery of Defence / Directorate for R&D
Selection of scenario:	x and Reconnoitring of structures (focus on radiological nuclear measuring and mapping) -- Mule (shuttle between two locations) -- Movements / Convoying (transport with two vehicles) -- Search & Rescue (SAR) / MedEvac (find and drag a dummy body) x Reconnaissance and disposal of bombs and explosive devices (EOD/IED; for professionals only!)

13.1 Vehicle Specification Sheet Team TNO – NLD EODD

Pictures of vehicle:

Name of vehicle: EOD Robot tEODor

13.1.1 Basic data about vehicle

Length:	130	cm
Width:	685	cm
Height w/o antennas:	(height from ground to top of the vehicle)124	cm
Height with antennas:	(Total height from ground to top, including antennas etc.)175	cm
Weight:	375	kg
Ground clearance:	10	cm
Average noise level:	(approx.) 70	db(A)
Climbing performance:	45	degree
Wheel or track driven:	Tracks	--

Propulsion:	(Examples: batteries, fuel, solar, nuclear etc.)	--
Endurance:	3-4	hrs
Max. speed:	3	km/h
Payload:	350	kg

13.1.2 Communication equipment

Function:		--
Type:		--
Frequency:	CLASSIFIED INFORMATION MILITARY RESTRICTED *	MHz
Possible frequency range:		MHz
Power:		W
Modulation:		--
Number of channels:		--

Function:		--
Type:		--
Frequency:	CLASSIFIED INFORMATION MILITARY RESTRICTED *	MHz
Possible frequency range:		MHz
Power:		W
Modulation:		--
Number of channels:		--

*) Due to security regulations the Dutch Ministry of Defence cannot publish or disclose details of communication links and frequencies – this is Classified Information.

If necessary, the Dutch EODD operators may be able to disclose specific details to official with sufficient clearance.

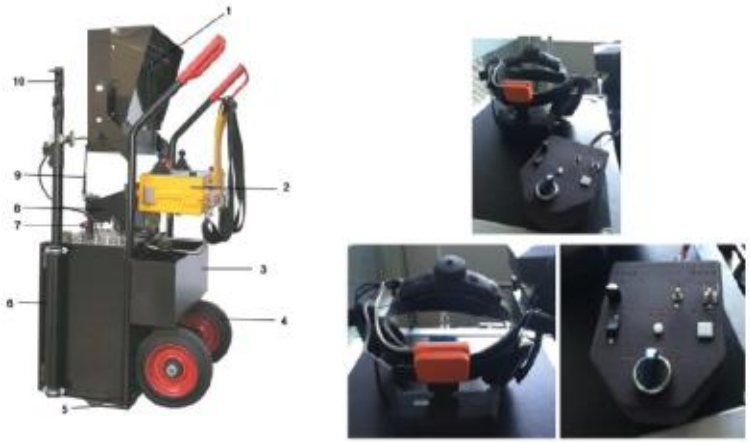
13.1.3 Sensors equipment

Laser:	NA
Vision:	6 camera´s
GPS:	NA
Radar:	NA
Inertial measurement unit:	

13.1.4 Computing equipment on vehicle

Number of computers:	
Number of CPUs:	
Type of CPU:	
Operating system(s):	

13.1.5 Basic data about control station

Pictures of the control station:		
Number of mandatory operators	1	
Number of optional operators	1	
Number of computers:	1	
Number of CPUs:	1	
Type of CPU:		
Operating system:	(Example: Linux, Windows XP etc.)	
Space needed for control station (LWH):	(Example: Container, laptop etc.)	cm
Weight of control station:	86	kg
Power source needed:	Gel-type lead-acid battery; 2 x 12 V, 85 Ah	

Company Name:	Cobham Mission Systems – Unmanned Systems
Country:	Germany
Address:	Vogelsangstrasse 8, 73760 Ostfildern
Telephone:	+49 (0) 711 34102 0
E-mail:	cms.ostfildern@cobham.com
Website:	www.cobham.com/unmannedsystems

Company Profile

Cobham Unmanned Systems is a leading provider of integrated homeland security solutions and unmanned platforms, utilizing over 30 years of expertise in this highly specialized field.

Our mission is:

"To develop machines, equipment and systems that protect or replace human beings in situations where their presence would be either impossible or place them at great risk".

More than 600 robotic systems support customer world wide

Customers all over the world are convinced about the versatile functionality of our robotic systems offering now for more than 10 years tool change capability and easy to use manipulator control. The robotic systems tEODor and telemax are now in service in more than 50 countries around the world totaling to more than 600 robotic systems. This includes more than 20 countries in the EU and also more than 20 NATO countries.

More than 150 Service Vehicles support customer world wide

The TEL600 series is a family of vehicles which deal with the demanding tasks associated with the location, identification and removal of explosive and incendiary devices, especially in the event that there is suspicion of a dirty bomb. Today more than 150 TEL600 Service vehicles support customers around the world. These Systems are made-to-order based on individual customer specifications thus perfectly fit to their demanding tasks.

Protecting People and their surroundings

Whether the task at hand is disarming an Improvised Explosive Device (IED) with a remote controlled robot; investigating CBRN hazards with an unmanned sensor platform; or deploying mobile, fully networked measurement, monitoring and intervention systems to ensure the safety and security of critical infrastructure:

Cobham's Unmanned Systems top priority is always the protection of people and their surroundings.

Company Name:	Diehl Defence Holding
Country:	Germany
Address:	Alte Nussdorfer Str. 13, 88662 Ueberlingen
Telephone:	+49 7551 89-01
Fax:	+49 7551 89-2822
E-mail:	pr@diehl-defence.de
Website:	www.diehl.com

Company Profile

Diehl Defence combines the Diehl Group´s activities in defence and security. Diehl companies are important partners of the German and international armed forces. Diehl Defence is among the global technology leaders regarding the development and production of advanced missiles and ammunition for armies, air forces and navies as well as system solutions for reconnaissance, surveillance, training and protection. Development and production of high-performance infrared modules, fuses as well as special batteries ensure independence in key components.

In the field of assistant functions and autonomous capabilities in military vehicle construction, Diehl has been refining the concept of a modular, autonomous vehicle kit since 2009. The driving assistance systems and/or autonomous capabilities are designed to be employed both as a retrofit kit and for integration new vehicles. The retrofit solution involving a modular kit offers two indisputable advantages: First, it can be employed in different available platforms. Second, vehicles can be operated independently by the driver regardless of their autonomous capabilities.

Diehl´s “Technology Platform for Unmanned Land Vehicles (TULF)” as well as the “Road Transport Platform with Robotic Assistant Functions (StrAsRob)” performed three successful test campaigns with different trial vehicles in 2014. For its unmanned vehicle concept, Diehl Defence was nominated by the Federal Association of German Industry in 2013 for the German Future Prize.

Company Name:	ELP GmbH European Logistic Partners
Country:	Germany
Address:	Nützenberger Straße 359, 42115 Wuppertal
Telephone:	+49 (0)202 69894-0
Fax:	+49 (0)202 69894-10
E-mail:	elp@elp-gmbh.de
Website:	www.elp-gmbh.de

Company Profile

Since establishment in 1989, ELP GmbH European Logistic Partners has been involved with the needs of military and police bomb disposal units and their required equipment. Initially focused on remote manipulation equipment, such as hook and line sets and remote controlled vehicles only, the range of products of the company has subsequently been expanded to include portable X-ray equipment, ballistic protection devices, exploders, disruptors as well as Narcotics- and Explosives detection devices.

All technologies, offered by ELP GmbH European Logistic Partners are from renowned manufactures: Endeavor Robotics (formerly iRobot), Med-Eng, Golden Engineering, LOGOS Imaging, Morpho Detection, Nammo LIAB AB and ChemRing Technology Solutions.

ELP GmbH European Logistic Partner is exclusive distribution partner of Endeavor Robotics (former iRobot)

Due to its intensive communication with users, ELP GmbH European Logistic Partners also works on the development of their offered products. The company thus supports its partners in optimizing their devices and develops its own technologies to expand the areas of application. The ELP GmbH European Logistic Partners accompanies its clients throughout the entire product life cycle, including procurement consulting, user training, consumables- and spares-supply, technical support, maintenance and repair, thus offering a wide range of services.

NIC INSTRUMENTS LIMITED
www.nicltd.co.uk

Company Name:	NIC Instruments LTD
Country:	UK
Address:	Gladstone Road, Folkestone, Kent, CT19 5NF
Telephone:	+44 (0)1303 851022
Fax:	+44 (0)1303 850155
E-mail:	sales@nicltd.co.uk
Website:	www.nicltd.co.uk

Company Profile

First Responder has been designed for the EOD and SWAT community to deal with a range of scenarios from simple reconnaissance to full scale EOD render safe procedures. The highly modular design allows the UGV to be configured from a lightweight simple UGV to a fully capable EOD UGV. This ability to configure 'in field' gives maximum capability with minimum equipment.

No longer will teams use multiple UGVs, now all those roles can be fulfilled with 1 platform. Now they have the strength and capability of heavier UGV, but with all the advantages of a lightweight UGV.

The modular design also allows operators to repair 'in field'. Should part of the UGV be damaged in action, there is no longer any need to send the entire unit back to a workshop for repair. By simply replacing the damaged part via the quick release modular construction, the UGV can be back up and running in minutes.

A third benefit of the modular design is the ability to strip down the unit within minutes into 2 smaller backpack packages. This ease of transportation brings a whole new capability to dismounted teams. High quality – designed, manufactured and tested in the UK.

NIC Instruments designs and manufactures all of its equipment in the UK and is globally recognised as a world leader in C-IED systems.

Company Name:	ROBOTNIK
Country:	Spain
Address:	Carrer Ciutat de Barcelona 3-A, 46988 Paterna, Valencia
Telephone:	+ 34 96.147.54.00
Fax:	+ 34 96.147.54.00
E-mail:	info@robotnik.es
Website:	www.robotnik.eu

Company Profile

Robotnik is a company specialized in robot product development and robotics R&D projects.

We offer high-quality services for national and international reach and are certified in:

- ISO 9001:08 - Design, manufacturing and commercialization of products and systems based on robotics technology.
- UNE 166002:06 - R&D management in the development of projects in the field of robotics.

Robotnik has a multidisciplinary engineering team, which is qualified in several fields, amongst others, computers, manufacturing, industrial, telecommunications and mechanics.

Our main specialties are:

- Autonomous indoor/outdoor transport robots and field service robotics applications.
- Robotics products (mobile robots, mobile manipulators, robotic torsos).
- R&D Robotics projects and special robot systems design.

We have obtained the EIBT (Innovative and High-Tech Enterprise) qualification, by the ANCES National Network, which recognizes Robotnik as a high tech company, with an innovative environment and high professional and technological formation.