# CBRNe FORENSIC IN REMOTE: A NEW RUGGED ROBOT FOR CBRNe DETECTION

*Dr.Eng. Riccardo Quaranta, MSc*

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# PURPOSE OF THE SYSTEM

- Investigation of a potentially contaminated area in relatively safe conditions.
- Enhanced safety for responders and population.
- Easy, reliable and immediate communication and data transmission from the field to the decision makers.

# Evolution of ROVs

Goliath, 1942


tEODor Explosive Ordnance Disposal (EOD) Robot

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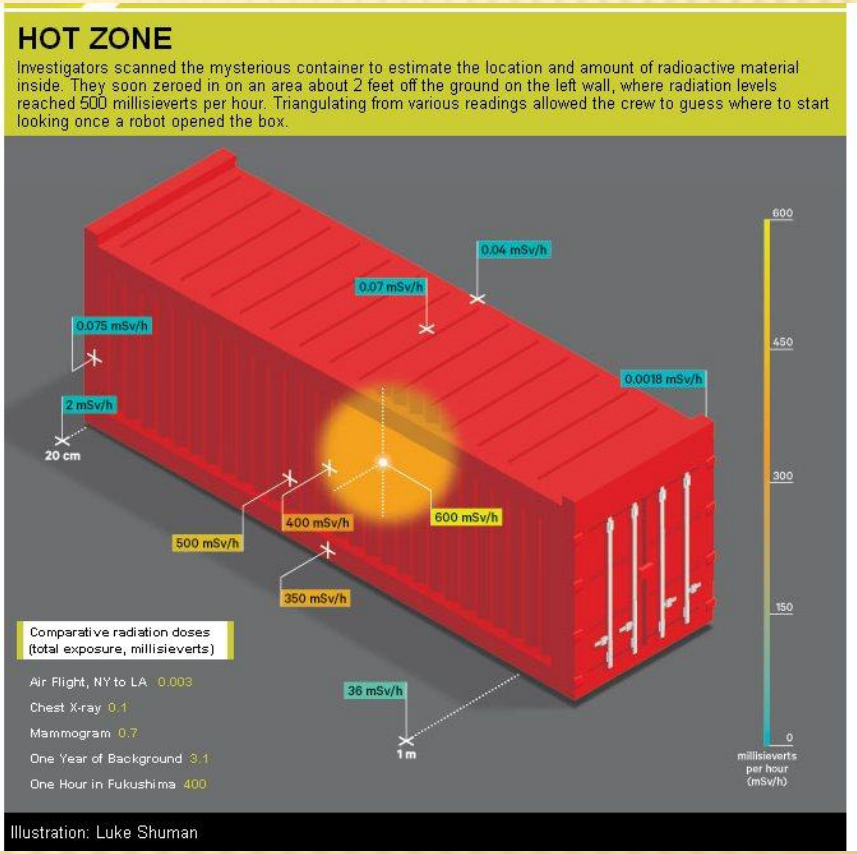
# Use of ROVs: Radioactive source in Genoa (I)




A remotely operated robot (ROV) has been used

# Use of ROVs: Radioactive source in Genoa (I)

The following short video shows the preparation before the disposal of the radioactive container

# Use of ROVs: Radioactive source in Genoa (I)

# PROPOSED ROBOTIC SYSTEM: 2 FUNCTIONAL AREAS

## Mobile system (ROV - Robot)

- Automatic detection of CBRNe agents.
- Transmission of data to the remote station.
- Collection and transport of samples (gas-water-soil) from the contaminated area to the remote station.

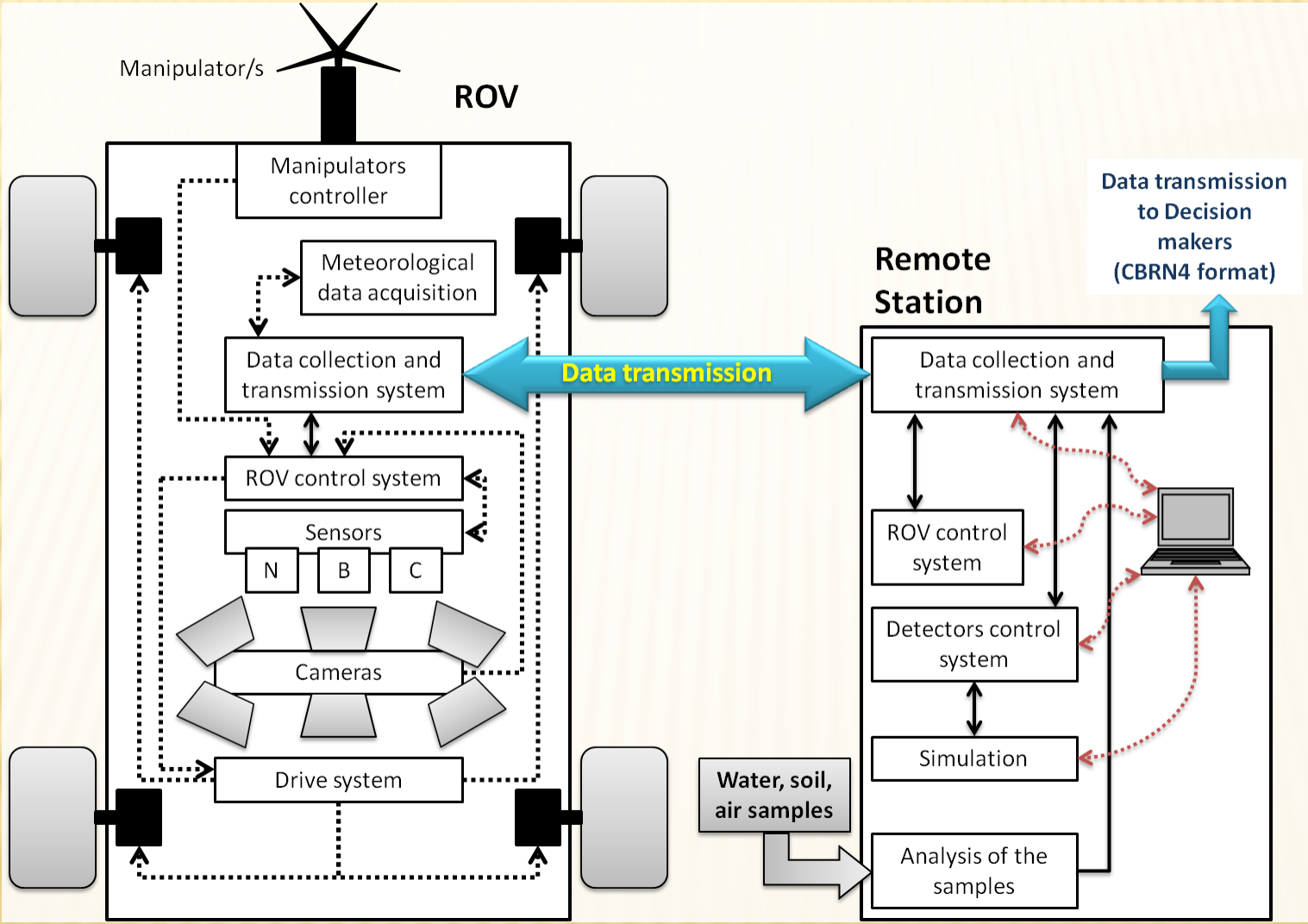
## Remote station

- Remote control of the mobile system and its on board sensors.
- Qualitative analysis of the samples collected on site by the ROV.
- Near Real-time simulation of the CBRNe agents diffusion routes in order to map the potentially contaminated area.
- Report information to the involved authorities.

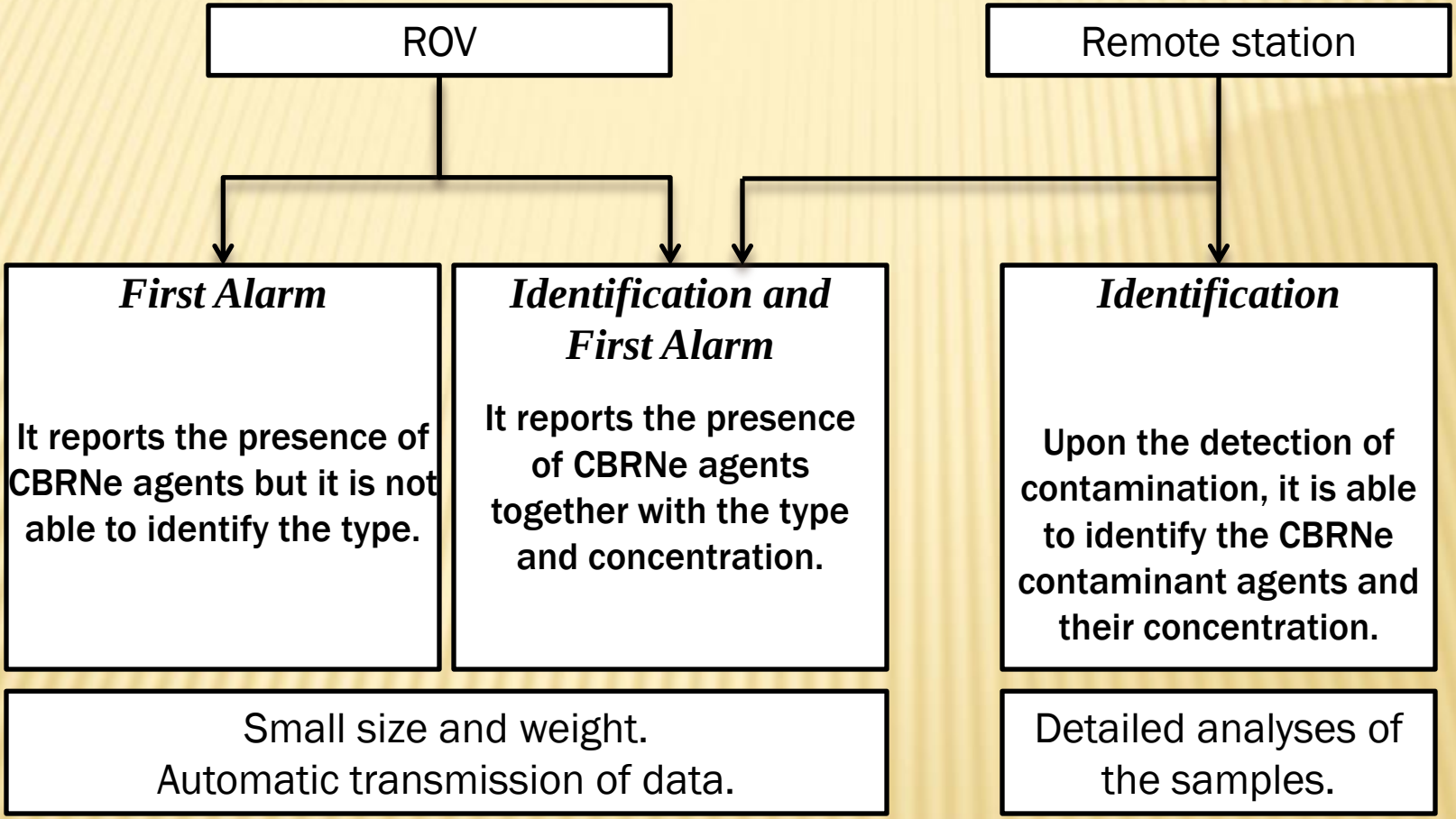
# INNOVATIVE ASPECT OF THE PROJECT

Integration into a single architecture of different components that, in case of CBRNe events, operate separately or are merged partially, but are not totally cooperating with a high degree of automation.

# FUNCTIONAL ARCHITECTURE AND MAIN COMPONENTS OF THE SYSTEM



# CBRNe Detectors



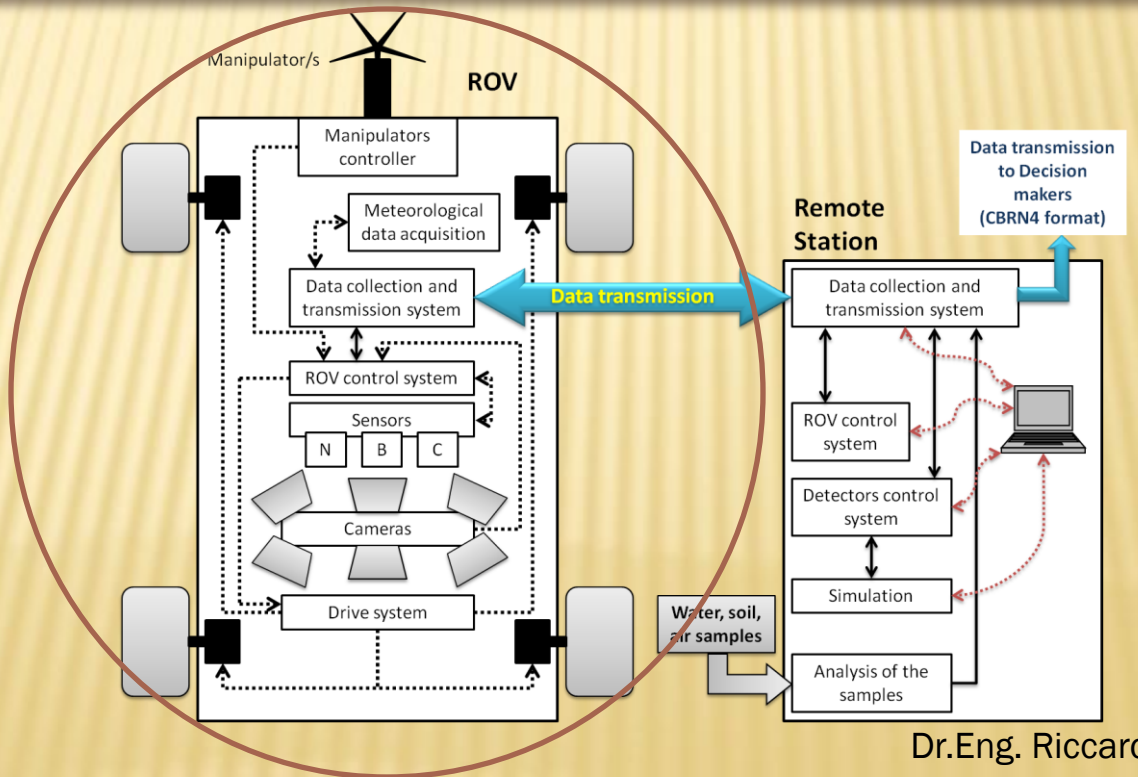
# CBRNe DETECTORS USED IN THE SYSTEM

| Detector type | ROV | Remote Station |
|---|---|---|
| R-N | Radiation dosimeter (RD). | Geiger Muller detector (GMD), equipped with an extension bar that allows to analyse the samples at safety distance. |
| C | Photo ionisation detector (PID) sensor. | Gas Chromatography - Mass Spectrometry (GC-MS) type. |
| B | Particle measuring system, Trigger detector (TD). | Polymerase chain reaction (PCR) or Real time PCR. |

# MAIN CHARACTERISTICS OF THE R-N DETECTOR FOR THE ROV

| Radiation detectable | Accuracy | Response time | Principle of work and characteristics | Implementation | Detector Category | Advantages | Disadvantages |
|---|---|---|---|---|---|---|---|
| Gamma ray, neutron | 5 cGy to 10 cGy | 10 s to 24 h | Semiconductors<br>Size range: 70-90 mm x 40-60 mm x 8-10 mm<br>Weight: 40-60 g | ROV - Remote station | First Alarm | Reduced size | Slow response time |

**Type: RD**





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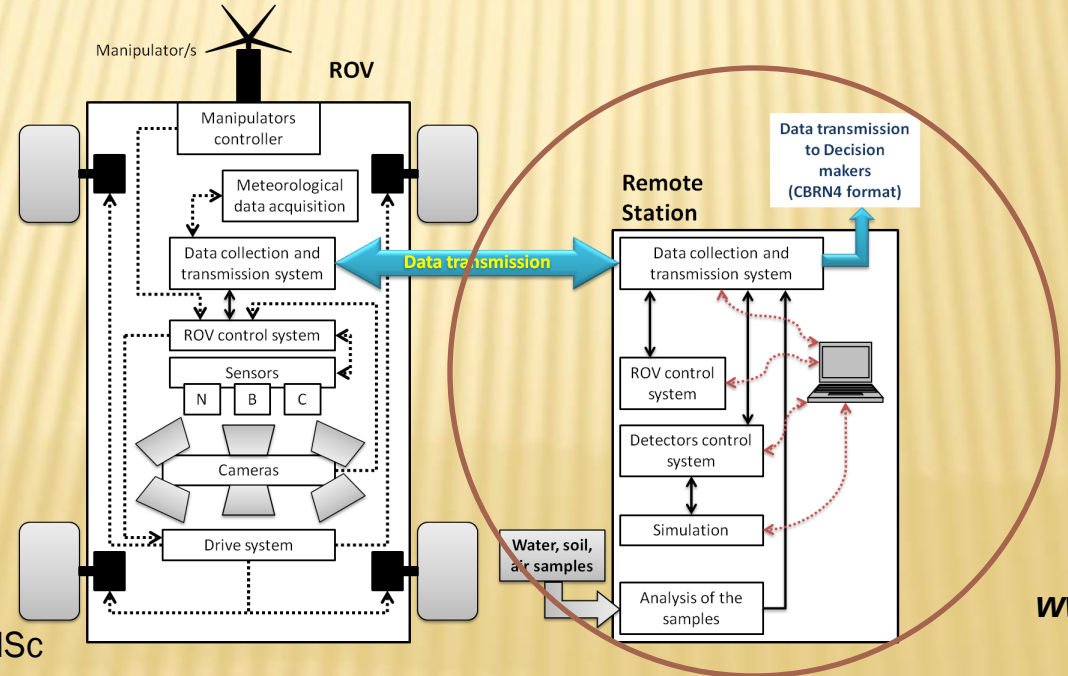
# MAIN CHARACTERISTICS OF THE R-N DETECTOR FOR THE REMOTE STATION

| Radiation detectable | Accuracy | Response time | Principle of work and characteristics | Implementation | Detector Category | Advantages | Disadvantages |
|---|---|---|---|---|---|---|---|
| Gamma and beta ray | 1 mSv to 10 Sv | < 1min | Geiger Muller<br>Size range:<br>Length: 80cm to more than 4m<br>Width: 10-20cm | Remote station | Identification and First Alarm | Allow measurements at safety distance | It is not remotely handled |

**Type: GMD**

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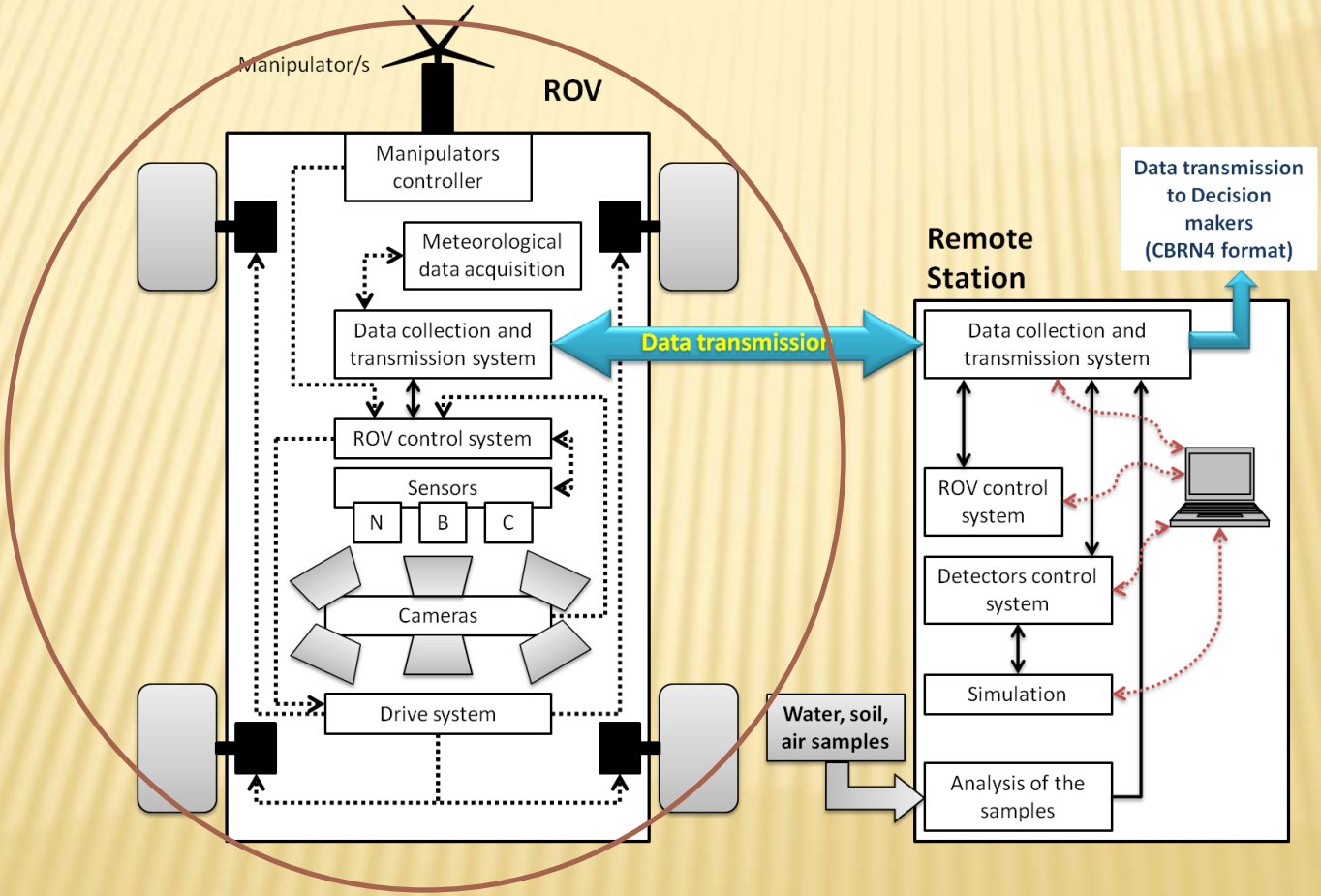
# MAIN CHARACTERISTICS OF THE C DETECTOR FOR THE ROV

**Type: (PID) sensor**



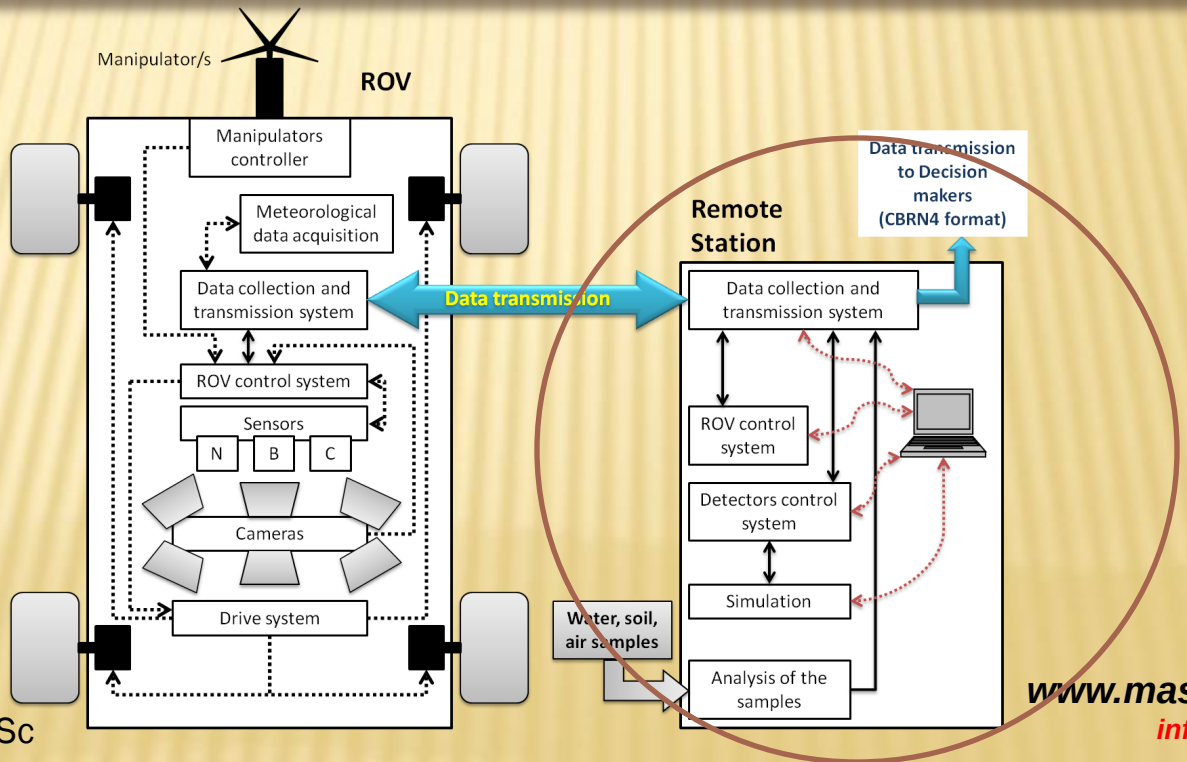
# MAIN CHARACTERISTICS OF THE C DETECTOR FOR THE ROV

| C detectable agents | Accuracy | Response time | Principle of work and characteristics | Implementation | Detector Category | Advantages | Disadvantages |
|---|---|---|---|---|---|---|---|
| Oxygen | 0-30% | 30 s – 1 min | PID sensor<br><br>Size range: 10-20cm x 7-10cm x 4-6cm<br><br>Weight: few hundred grams with battery | ROV | Identification-First Alarm | Many agents detectable<br><br>High accuracy | Slow response time |
| Combustible Gas | 0-100% LEL | | | | | | |
| VOCs | 0-200 ppm 200-2000 ppm | | | | | | |
| CO | 0-500 ppm | | | | | | |
| Hydrogen Sulfide | 0-100 ppm | | | | | | |
| Sulfur Dioxide | 0-20 ppm | | | | | | |
| Nitric Oxide | 0-250 ppm | | | | | | |
| Nitrogen Dioxide | 0-20 ppm | | | | | | |
| Chlorine | 0-10 ppm | | | | | | |
| Hydrogen Cianide | 0-100 ppm | | | | | | |

# MAIN CHARACTERISTICS OF THE C DETECTOR FOR THE REMOTE STATION

| C agents detectable | Accuracy | Response time | Principle of work and characteristics | Implementation | Detector Category | Advantages | Disadvantages |
|---|---|---|---|---|---|---|---|
| All | Few ppb | 20s - 1 min | GC-MS<br><br>Weight: Several Kg<br><br>Size range: 40-50 cm x 40-50 cm x 15-25 cm | ROV- Remote station | Identification-First Alarm | Many agents detectable | Database preparation |

**Type: GC-MS**

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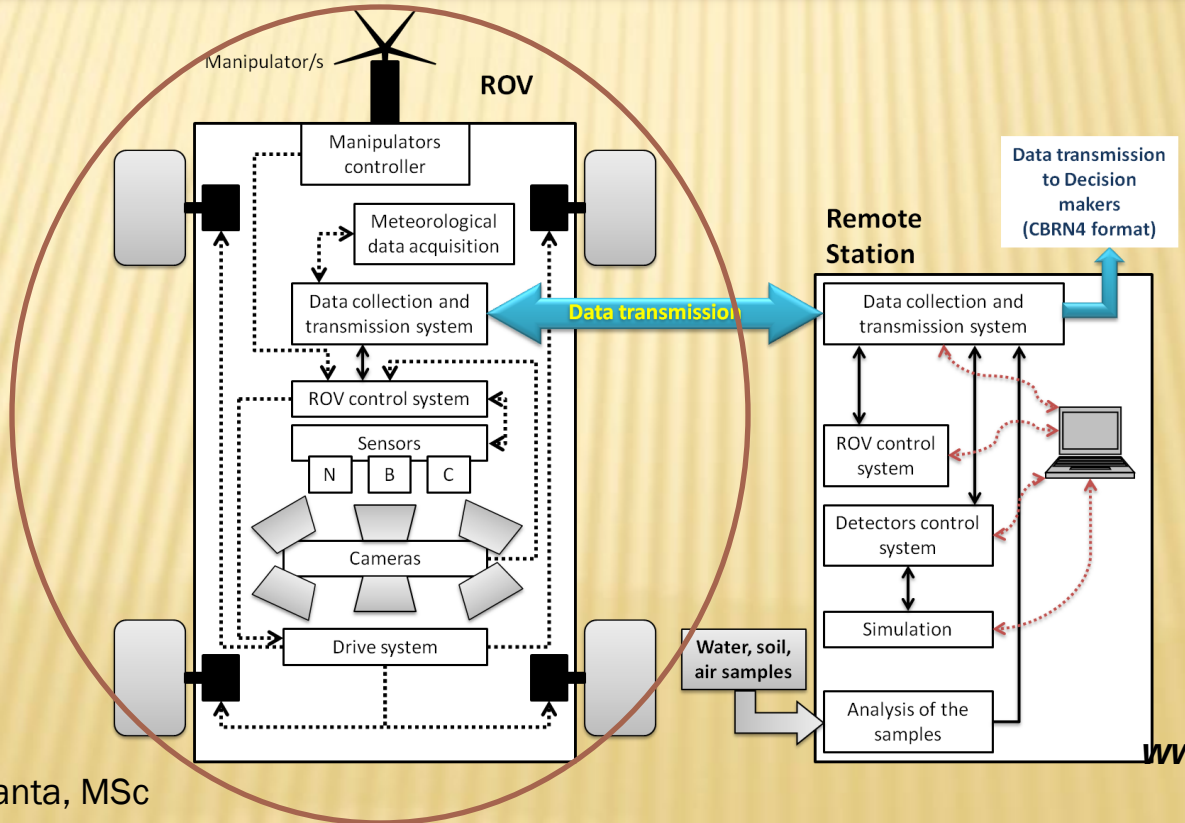
# MAIN CHARACTERISTICS OF THE B DETECTOR FOR THE ROV

| B agents detectable | Accuracy | Response time | Principle of work and characteristics | Implementation | Detector Category | Advantages | Disadvantages |
|---|---|---|---|---|---|---|---|
| Theoretically everything | Few ppb | 0-5 min | BIO-LIDAR Laser-induced fluorescence (LIF)<br><br>(Feasibility currently under investigation) | Remote station | First Alarm | Many agents detectable and high accuracy | False alarms and slow response time |

**Type: TD**

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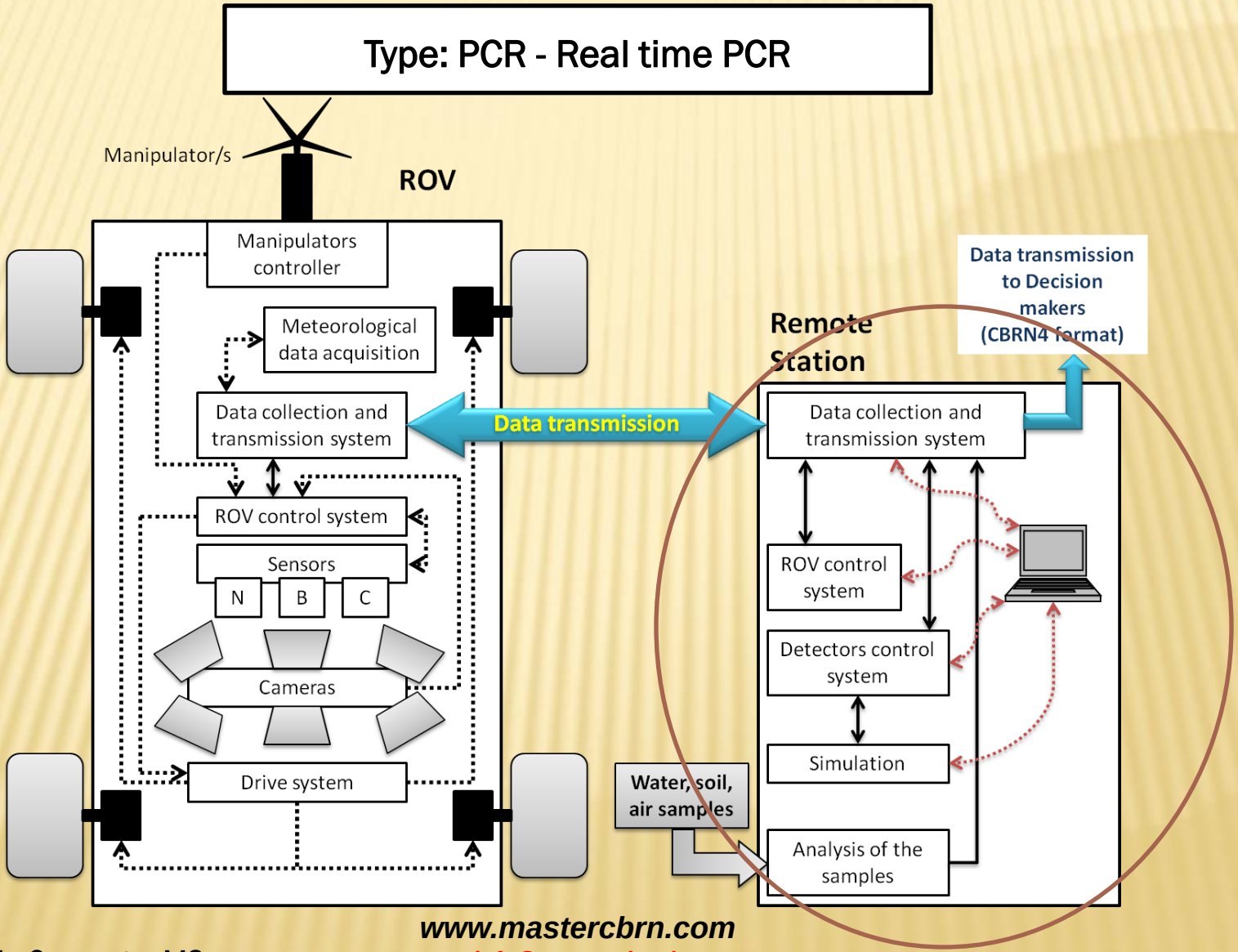
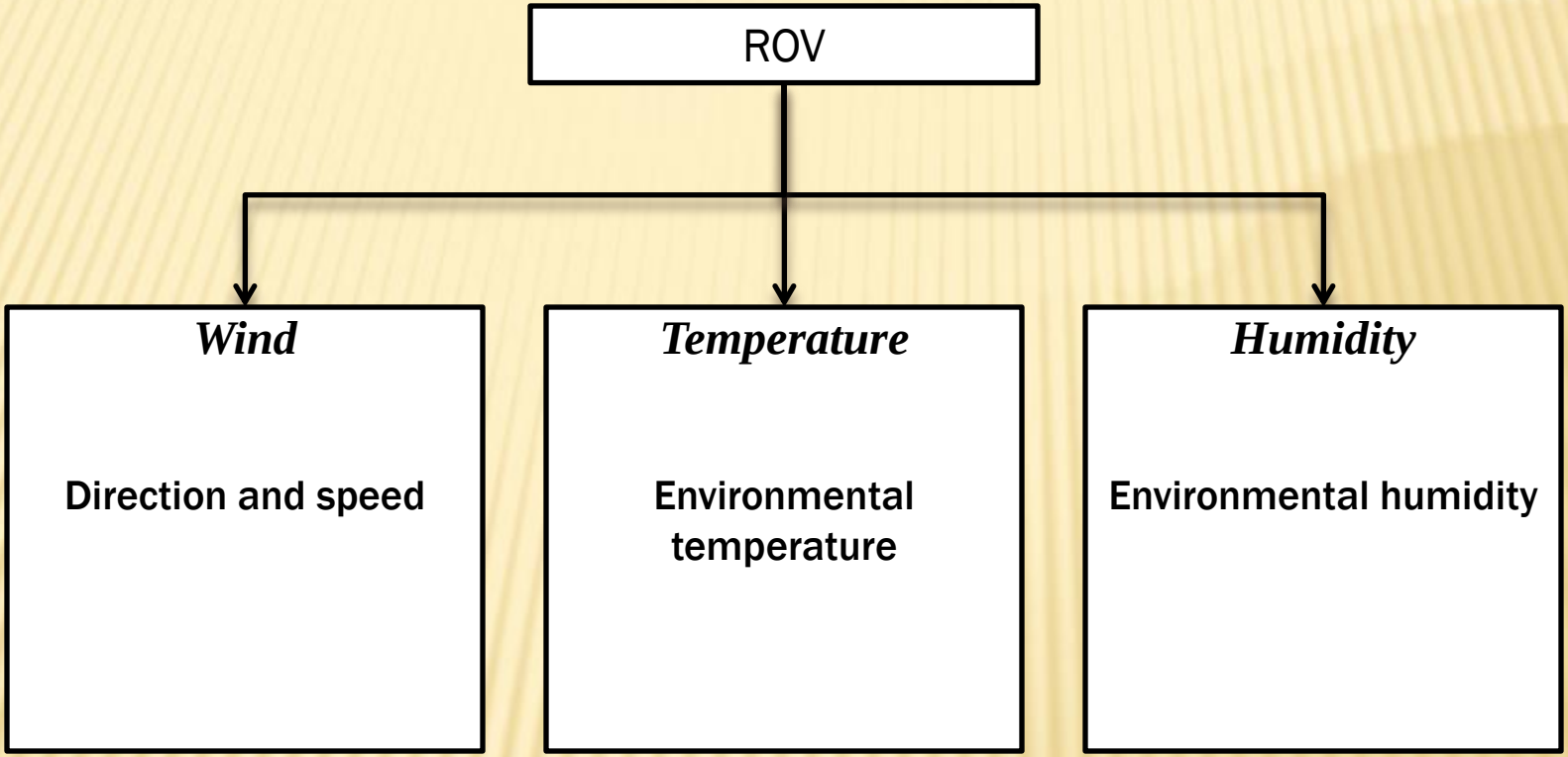
# MAIN CHARACTERISTICS OF THE B DETECTOR FOR THE REMOTE STATION



# MAIN CHARACTERISTICS OF THE B DETECTOR FOR THE REMOTE STATION

| B agents detectable | Accuracy | Renponse time | Principle of work and characteristics | Implementation | Detector Category | Advantages | Disadvantages |
|---|---|---|---|---|---|---|---|
| Bacillus anthracis | ppb | 30 min | PCR<br><br>Real Time PCR (Preferable) | ROV | Identification | Accuracy | Slow response time<br><br>Not all agents are detectable |
| Brucella species | | | | | | | |
| F. tularensis | | | | | | | |
| Y. pestis | | | | | | | |
| C. botulinum Type A | | | | | | | |
| Listeria monocytogenes | | | | | | | |
| E. coli | | | | | | | |

# Meteorological Detectors




These environmental parameters are necessary to perform a diffusion simulation using a predictive software (such as CBRN-Analysis), that increases the survey about CBRNe situation on a field, in order to provide potentially safe routes for the responders and the population.

# REAL-TIME SIMULATION OF THE CBRNe AGENTS DIFFUSION

The simulation can be used to:

- Map the potentially contaminated area;
- Predict the diffusion and dispersion of the contaminants in the environment;
- Elaborate the safest routes for the responders and the escape routes for the population.

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# MAIN CHARACTERISTICS OF THE ROV

Beside all the sensors previously mentioned, the ROV must be equipped with:

- Wheels or continuous tracks, or even a combination of both, to ensure mobility on any terrains and urban areas.
- Electric motor and rechargeable batteries for all the systems.
- CCD camera/s for the transmission of images even in poor visibility conditions (i.e. darkness, rain, fog, smoke, etc.). The cameras must be remotely controlled in order to carry out 360 degree images if needed.
- IR/Thermal camera.
- GPS satellite receiver to track the movements of the ROV when out of sight.
- Different types of manipulators able to collect samples of air, water or soil to be analysed in the remote station.
- Special containers for the different samples.

# MAIN CHARACTERISTICS OF THE REMOTE STATION

The remote station must be:

- Equipped with a guidance system for the ROV (i.e. a controller);
- It must have all the necessary ports and connectors to interface the different devices;
- Prepared for internet connection and data transmission;
- Compatible with specific software to control both the ROV and the equipments.

The remote station must be located in a mobile laboratory equipped with:

- Laboratory equipment for the analysis of air, water and soil samples.
- Simulation software able to quickly elaborate weather data, first measurement of the ROV and its position in order to provide safe routes for both the responders and the population.
- Personal Protective Equipment for the responders.
- Decontamination systems for both the responders and the hardware.

# MAIN CHARACTERISTICS OF THE REMOTE STATION

Based on the previous requirements, a vehicle suitable to be used as the remote station is the Iveco One Firetruck, that is currently used by the Italian National Police (Polizia di Stato Italiana, Dipartimento di Pubblica Sicurezza) and Italian Fire Brigade (Corpo Nazionale dei Vigili del Fuoco).

# PROPOSED PROJECT

The proposed project has a conceptual work scheme divided in three phases:

1. Deployment of the ROV.

2. Data detection and transmission.

3. Retrieval of the ROV and analysis of the samples collected.

# PHASE 1: DEPLOYMENT OF THE ROV

The mobile laboratory approaches the contaminated area and, while remaining at a safe distance, the ROV is deployed.


The ROV is then remotely handled, through the contaminated area, to the target.

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# PHASE 2: DATA DETECTION AND TRANSMISSION

Collection of air, water and soil samples

Phase 3

Safety Zone


Contaminated Zone

Data elaboration

Data transmission

CBRNe detection

Simulation output Safety routes

Meteorological data collection

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# PHASE 3: RETRIEVAL OF THE ROV AND ANALYSIS OF THE SAMPLES COLLECTED

Contaminated ROV

Retrieval of the ROV

Safety Zone


Analysis of the samples

Decontamination of the ROV

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# FUTURE EVOLUTION OF ROVS


This 750g device can carry a audio/video sensor and GPS tracker

**The next step: Quadrotors are currently being studied to work as sensor carriers and video/audio transmitters.**

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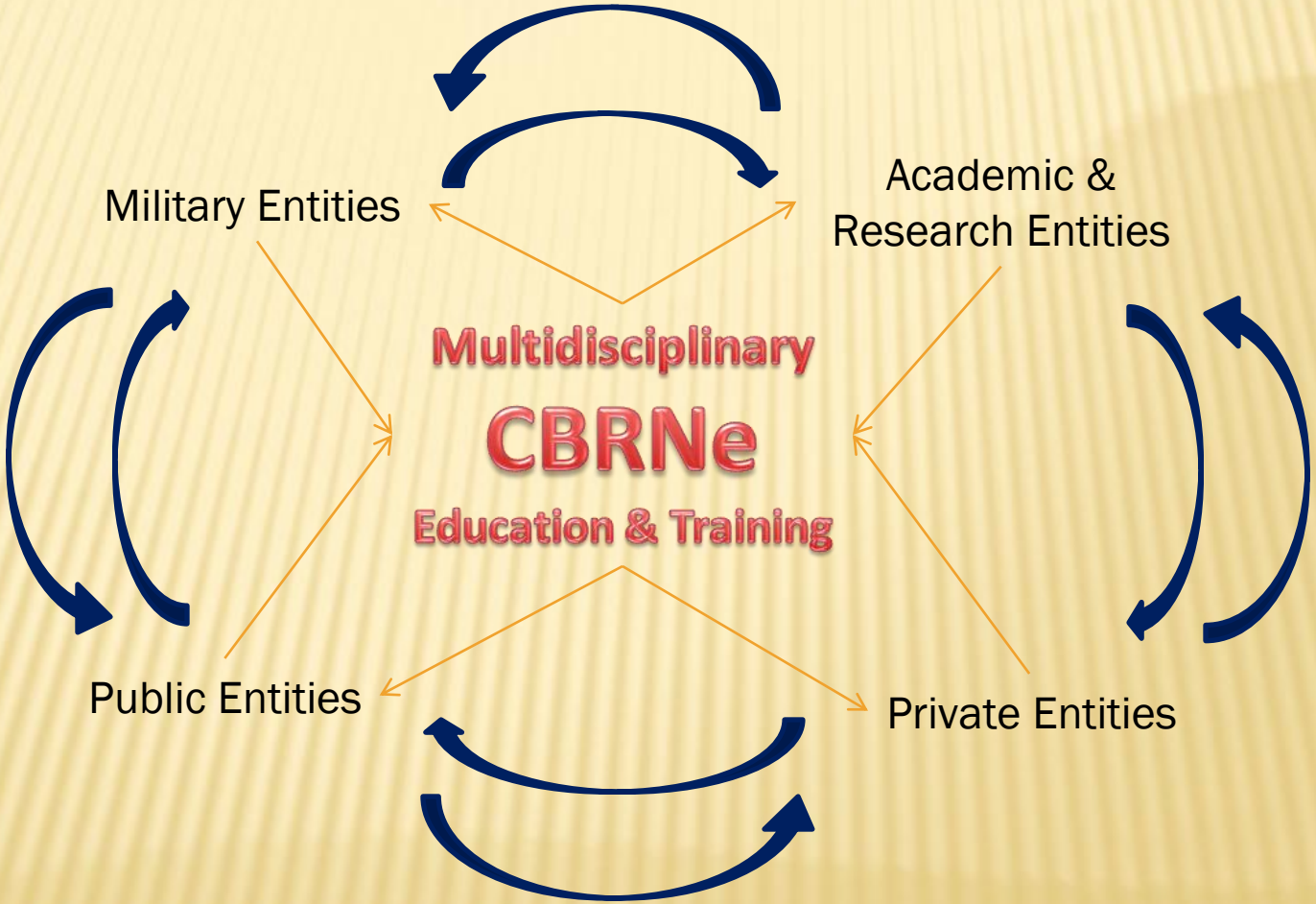
# MISSION

**Prepare highly specialized FIRST RESPONDERS & CBRNe ADVISORS for Decision Makers**

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# The Courses are organised in cooperation with the following International Entities, that have signed formal Agreements with the University

## Italian Public Entities

- Prime Minister's Office
- Ministry of Defence:
  - ✓ Italian Army
  - ✓ Italian Navy
  - ✓ Italian Aereonautica
  - ✓ Carabinieri
- Ministry of Interior
  - ✓ Fire Brigades
  - ✓ Police
- ENEA
- INGV
- ISS
- COPIT
- CRATI
- MARIS
- SCIRE

## International Entities:

- OPCW
- JCBRNe COE NATO (Czech Republic)
- NATO SCHOOL of Oberammergau (DE)
- HotZone Solutions (Holland)
- VVU-026 Sternberk (Czech Republic)
- Seibersdorf Labor GmbH (Austria)
- Chornobyl Centre (Ukraine)

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Both Master Courses have been granted the **NATO SELECTED** status by the **NATO HQ SACT** (Supreme Allied Commander Transformation – Norfolk, Virginia, USA).

The Tor Vergata University has signed a **Cooperation Agreement** with the **OPCW** (Organization for the prohibition of Chemical Weapons), which will support the **Master Courses.**

As it is stated in the **OPCW Press Release,**

**"It is the first such agreement the OPCW has made with a university in this field"**

(https://www.opcw.org/index.php?id=242&tx_ttnews%5Btt_news%5D=1719&cHash=a51e455b9203696a4d17771ae5282b11)

# 65 STUDENTS OF THE ITALIAN EDITIONS OF THE COURSES (2009-2012) ; 20 students in the Edition 2012/2013 (will close January 2013)

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MATRONE GAETANO, MALUCCIO MARIA (**ITALIAN NAVY**)
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PEDEMONTE MASSIMO, LUTTAZZI EMILIANO, RICCIO ROBERTO, BARLETTA TIZIANA, PIOLETTI SIMONE(**POLIZIA DI STATO**)

CASSANI IVANO- MALIZIA ANDREA - MARCOCCI FRANCESCO - MASTROIANNI MARCO - QUARANTA RICCARDO - ORLANDO CENCIARELLI - IVAN LUPELLI – CARESTIA MARIACHIARA – CIANFANELLI FRANCESCA ROMANA, ANTONELLI LUCA, CONETTA FABIANA, CACCIOTTI ILARIA, DI GIOVANNI DANIELE, MAZZEI FEDERICO, PAGANNONE SIMONA (**UNIV. TOR VERGATA**), NUCIFORA CLAUDIO (**UNIV. CATANIA**), PRESCIUTTI FEDERICA (**UNIV. L'AQUILA**), ALESSIA AMODIO (**UNIV. CALABRIA**), SALUCCI LUIGI - FRANCESCO UNALI – ROTONDI LUCA (**UNIV. SAPIENZA**), ANTONIETTA D'AVANZO - VINCENZO PASTORINI – (**UNIV. NAPOLI**).


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ALESSANDRO GATTUSO (**INGV**)
FONTANA CLAUDIA (**Italian Red Cross**)
SOAVE PAOLO MAURIZIO (Gemelli **Hospital**)

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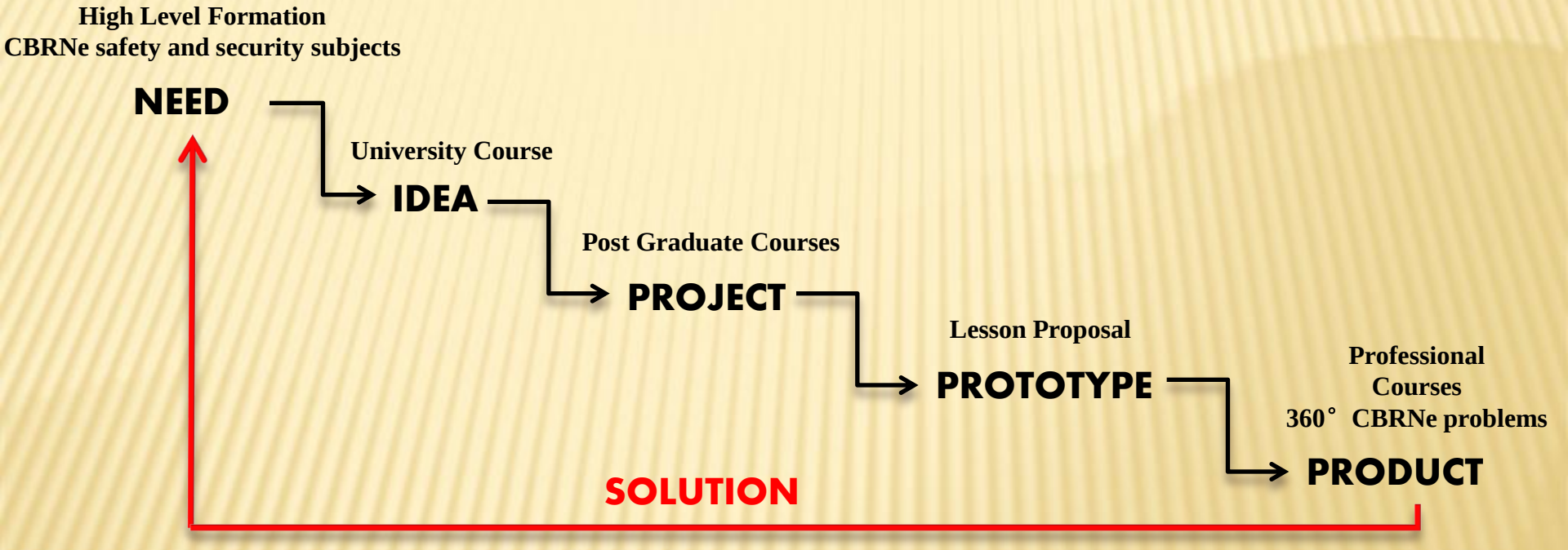
# Vision: International Training

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# Need

**All around the world**

**CBRNe First Responders** | **CBRNe Advisors for Decision Makers**

**IDEA : 2 POST GRADUATE COURSES IN CBRNe**

**PROJECT**
**SINERGY BETWEEN ENTITIES**

**PRODUCTS**
**2 MASTER COURSES IN "PROTECTION AGAINST CBRNe EVENTS"**
**BEGINNING JANUARY 2014**

SOLUTION

SOLUTION

**1st Level Course**
- ***120 ECTS → 2 Academic Years***
- Practical Preparation
- Training activities:
  - ✓ Scuola NBC di Rieti (Italy)
  - ✓ VVU (Czech Rep.))
  - ✓ Seiesdoorf Laboratories (Austria)
  - ✓ Chornobyl Center (Ukraine)

**2nd Level Course**
- ***60 ECTS → 1 Academic Year***
- Theoretical Preparation - Management
- Training activities:
  - ✓ JCBRNE COE NATO (Vyskov)
  - ✓NATO SCHOOL (Oberammergau)

**Enrollments accepted until the end of January 2014.**

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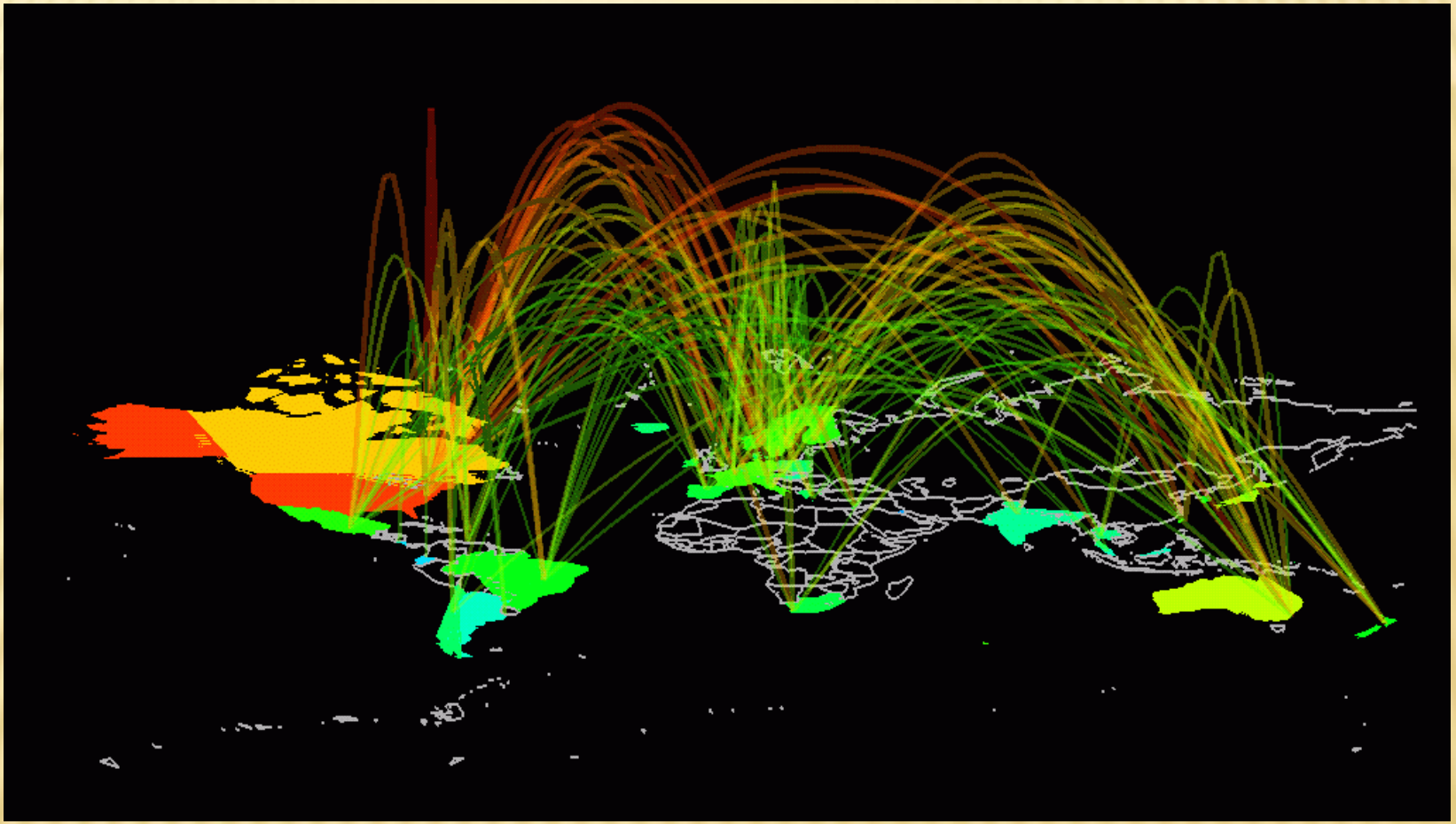
## 1st-Level Master Course - Tentative Schedule

| Module | Title | Period | Venue | ECTS |
|---|---|---|---|---|
| 0 | INTRODUCTION TO CBRNE RISKS | January 2014 | Rome | 4 |
| 1 | CRBNE AGENTS AND THEIR EFFECTS | February 2014 | Rome | 10 |
| 2 | FIRST RESPONDER TRAINING | March 2014 | Czech Republic | 5 |
| 3 | DETECTION OF CBRNE AGENTS | April, 2014 | Rome | 4 |
| 4 | PROTECTION AND DECONTAMINATION OF PERSONNEL/ENVIRONMENT, EQUIPMENT AND INFRASTRUCTURE | May 2014 | Rome | 5 |
| 5 | SOFTWARE APPLICATIONS | June 2014 | Rome | 4 |
| 6 | PRACTICAL ACTIVITIES AT THE NBC SCHOOL OF RIETI | July 2014 | Rieti | 5 |
| | | | | |
| | **August Summer Break** | | | |
| | | | | |
| | **September Test for Modules 0 to 6** | | | |
| | | | | |
| 7 | THE INTERNATIONAL RESPONSE SYSTEM TO CBRNE EVENTS | October 2014 | Rome | 4 |
| 8 | CRITICAL INFRASTRUCTURE, INTELLIGENCE AND COMMUNICATION IN CASE OF CBRNE EVENTS | November 2014 | Rome | 4 |
| 9 | MEDICAL FIRST AID | December 2014 | Rome | 5 |
| 10 | Tests Modules 7,8,9 | January 2015 | Rome | |
| 11 | Internship | February-June 2015 | | 40 |
| 12 | VVU | apr-15 | Czech Republic | 5 |
| 13 | Chornobyl | May 2015 | Ukraine | 5 |
| 14 | End of the Internship | June 2015 | | |
| 15 | Master Theses | July- November 2015 | | 20 |
| 16 | Presentation/Discussion of the Master Theses | December 2015 | Rome | |
| 17 | Degree Cerimony | December 2015 | Rome | |
| | | | | |
| | | | **Total ECTS** | **120** |

# 2nd-Level Master Course - Tentative Schedule

| Module | Title | Period | Venue | ECTS |
|---|---|---|---|---|
| 0 | CRBNE INTERNATIONAL SAFETY AND SECURITY POLICY | January 2014 | Rome | 4 |
| 1 | CBRNE AGENTS : HOW TO RECOGNISE THEM, THEIR PRODUCTION AND USE HISTORY | February 2014 | Rome | 5 |
| 2 | CBRNE PROTECTION AND MEDICAL MANAGMENT | March 2014 | Rome | 4 |
| 3 | PLANNING OPERATIONS FOR DECONTAMINATION AND RESTORATION OF NORMAL LIFE | April, 2014 | Rome | 4 |
| 4 | Seibersdorf Lab : AN OVERWIEV OF CBRNE DETECTION TECNHIQUES | May 2014 | Austria | 5 |
| 5 | DSS (DECISIONAL SUPPORT SYSTEM) FOR ADVISORS | June 2014 | Rome | 5 |
| | REMEDIAL SESSION - JUNE | | | |
| 6 | NATO SCHOOL: NATO CBRN Defence Orientation Course | July2014 | Germany | 5 |
| | | | | |
| | **August Summer Break** | | | |
| | | | | |
| | Tests at the beginning of each module | | | |
| | | | | |
| 7 | DIFFERENT WAYS TO MANAGE CBRNE EVENTS IN DIFFERENT COUNTRIES | September 2014 | | 5 |
| 8 | CRITICAL INFRASTRUCTURE AND COMUNICATION TECNHIQUES | October2014 | | 4 |
| 9 | Internship and Master Theses | November-December 2014 | | 19 |
| | REMEDIAL SESSION - November December | | | |
| 10 | Discussion/Presenation of the Master Theses | January 2015 | | |
| 11 | Degree Cerimony | January 2015 | | |
| | | | | |
| | | | **Total ECTS** | **60** |

# Conclusion:
# International Cooperation Network



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# CBRNe FORENSIC IN REMOTE: A NEW RUGGED ROBOT FOR CBRNe DETECTION

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