18th ICCRTS

"C2 in Underdeveloped, Degraded and Denied Operational Environments"

Interacting with Multi-Robot Systems Using Battle Management Language (BML)

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Motivation

There are many operations in which a multi-robot system (MRS) can be deployed to support the human forces, e.g., for reconnaissance tasks.

Controlling a MRS in operations, however, is a complex and demanding task, especially if the MRS in question has to be controlled by a **single operator** in order to free her fellow soldiers for other tasks.

The operator can be disburdened by giving the robots some **autonomy**.

Motivation

robot autonomy

- give orders on a more abstract level
- let the robots handle details themselves.

However, this raises the question as to how those tasks assignments can be defined, formulated and exchanged.

Our approach: formulate orders (as well as the reports the robots send back to the controller) in **Battle Management Language**.

Communication Architecture

In our experiments and showcases, we used multi-robot systems that included aerial as well as ground vehicles.

The **aerial vehicles** were the so-called “UAV Psyche 1000”, MD4-1000 drones, developed by Micro-Drones and modified by Siegen University.

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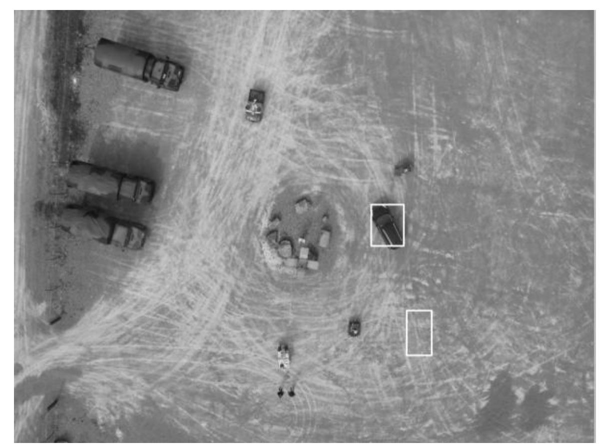

Communication Architecture

The **ground vehicles** include the so-called “RTS-HANNA”, a car like UGV based on an off-the-shelf Kawasaki Mule 3010 Diesel chassis which had been modified and adjusted by Hannover University, a quad bike based UGV called AMOR built by the university of Siegen, and two smaller UGVs modified and adjusted by Fraunhofer FKIE.

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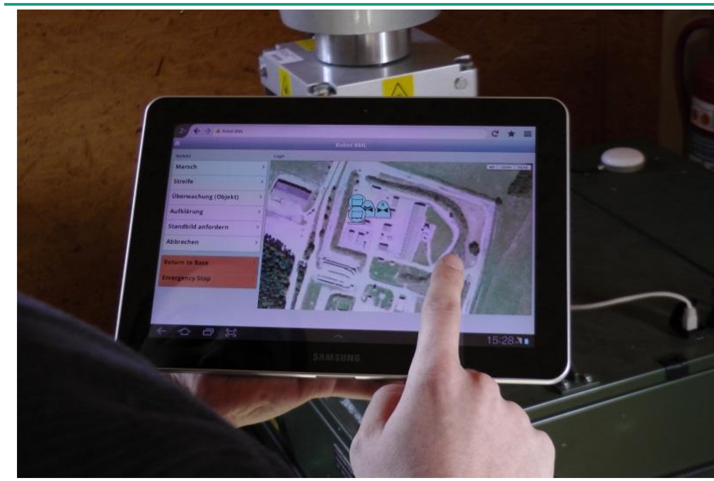
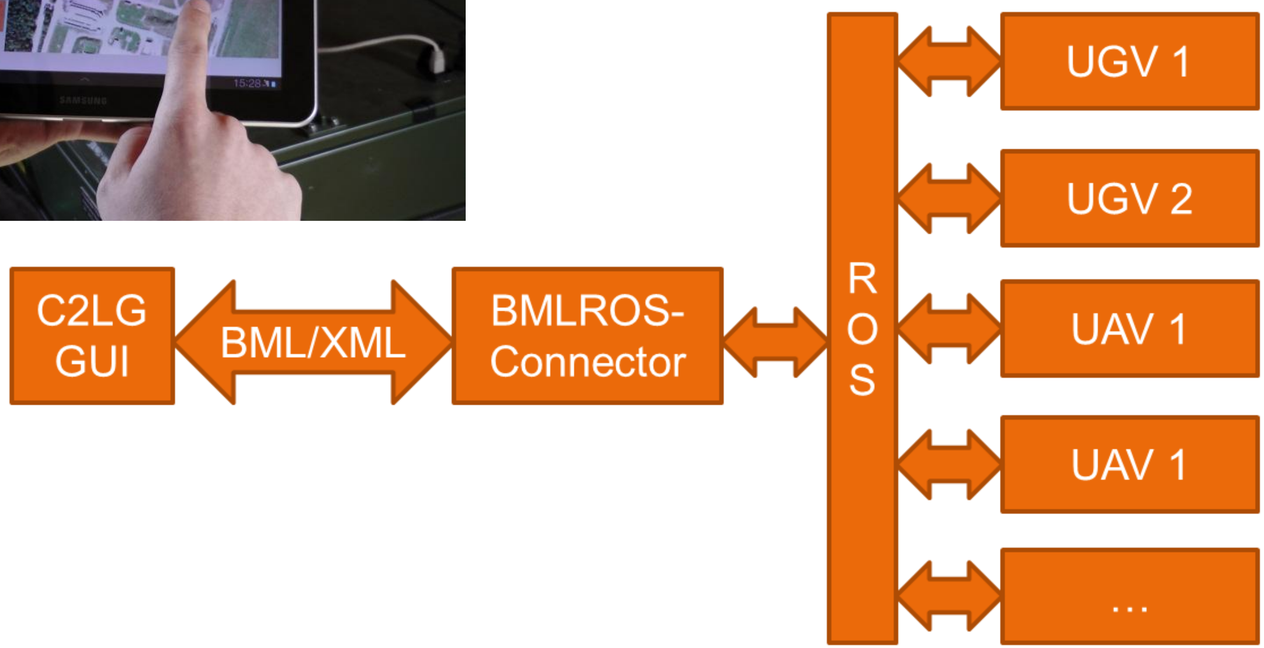
Communication Architecture

As the different types of vehicles use different operating systems, middlewares, and communication protocols, we use the **Robot Operating System (ROS)** developed and maintained by Willow Garage, as communication standard among the vehicles. ROS offers well-defined data types for most kinds of data. It is open source and hence free available, and it has a constantly growing community contributing to the software repository.

In short, the operator communicates with the MRS and its robots via two standards, BML and ROS, which allows to change the robots within the MRS easily.

Communication Architecture





Battle Mangement Language

BML has been developed within NATO MSG-048 and NATO MSG-085 (and is discussed by the SISO in order to provide a SISO standard).

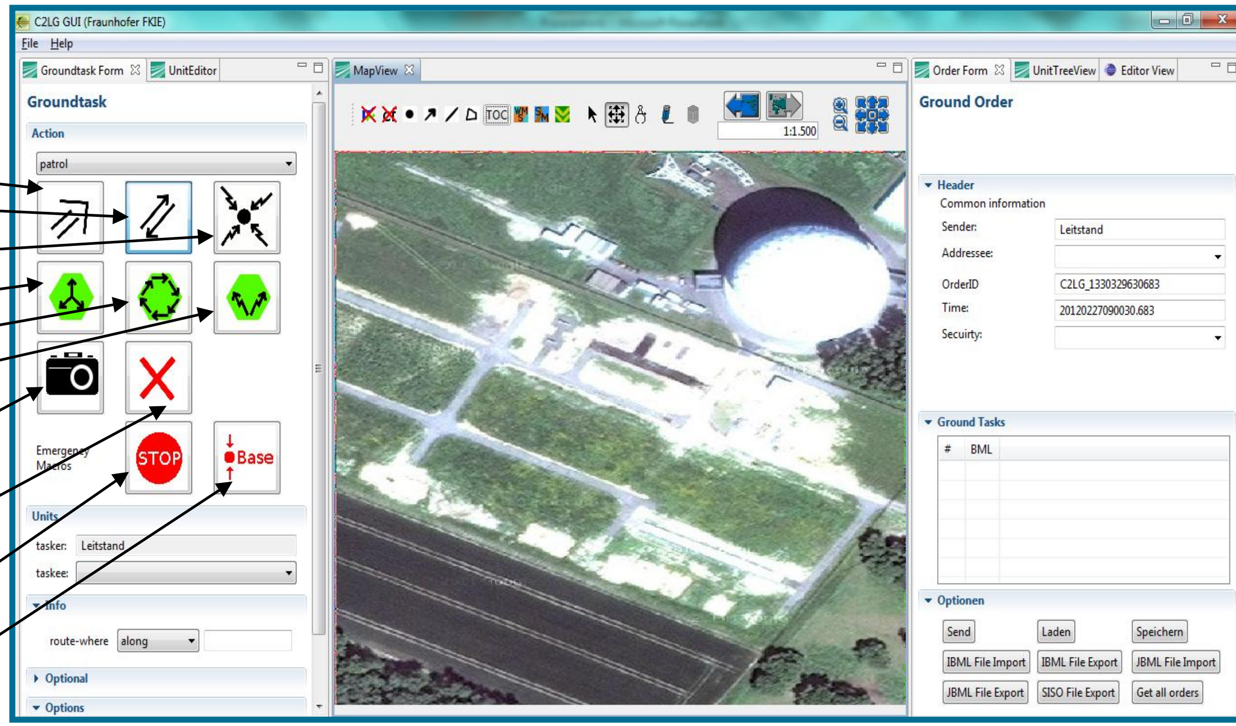
BML normally is used to command simulated units in simulation systems in order to improve training, after action analysis, and decision support.

The BML for C2 system – simulation system interaction has been applied for our purposes, commanding multi robot systems, without changes to the syntax of the language.

Battle Mangement Language
Orders

Orders

move
patrol
observe
distribute
guard
recce
imagery intelligence
gathering
disengage
emergency stop
return to base



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Mobile GUI

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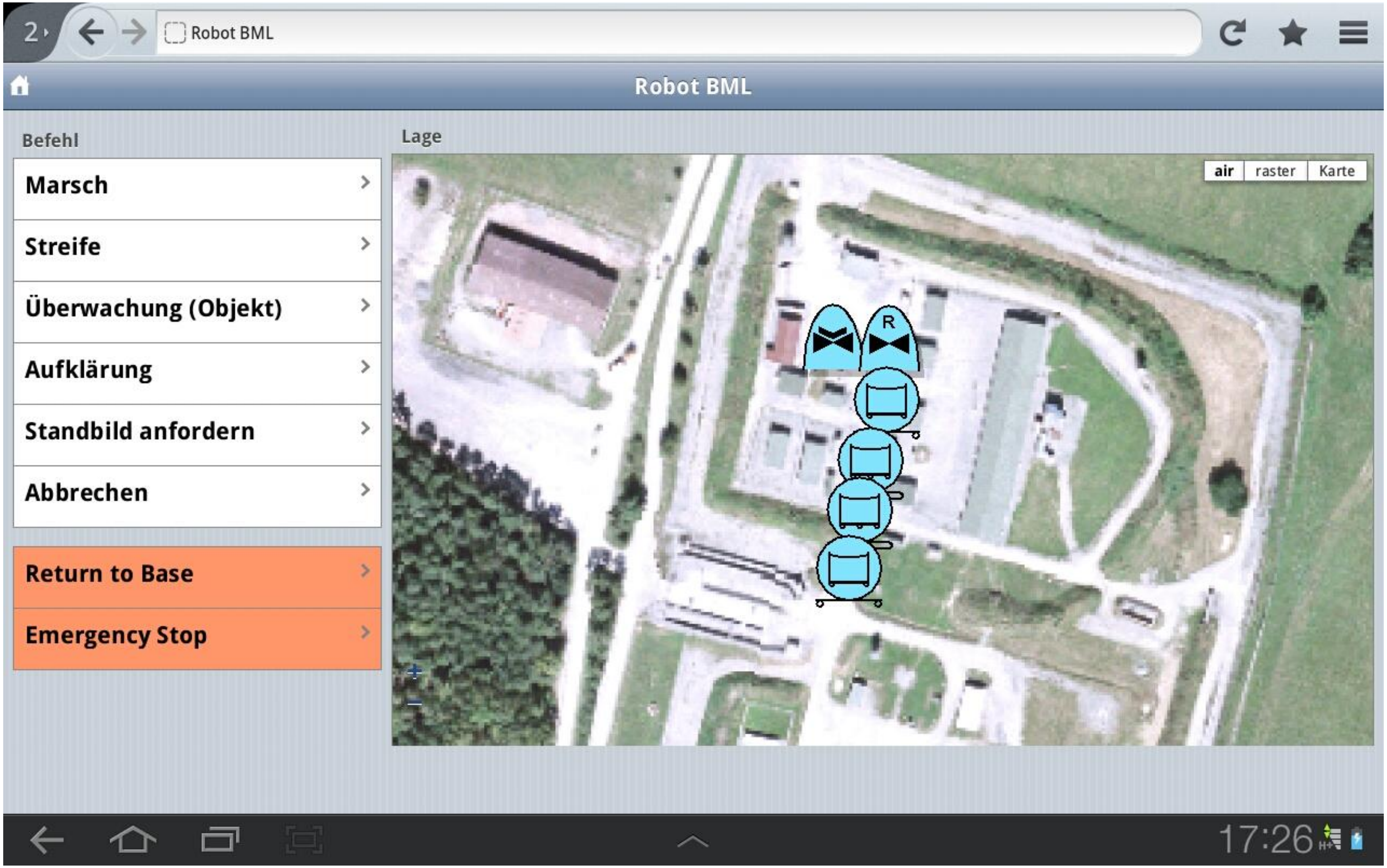
Mobile GUI – Lagekarte und Befehlsauswahl



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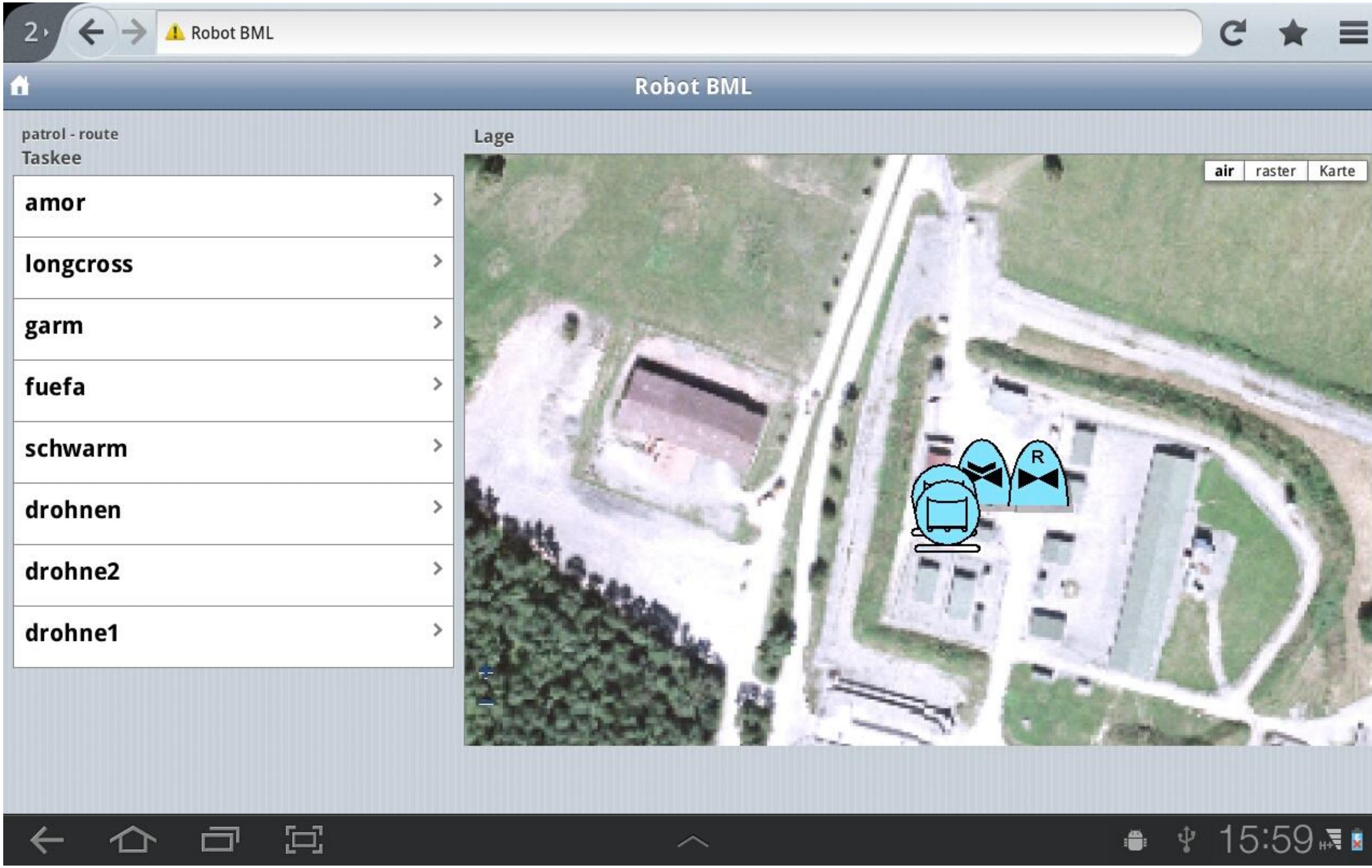
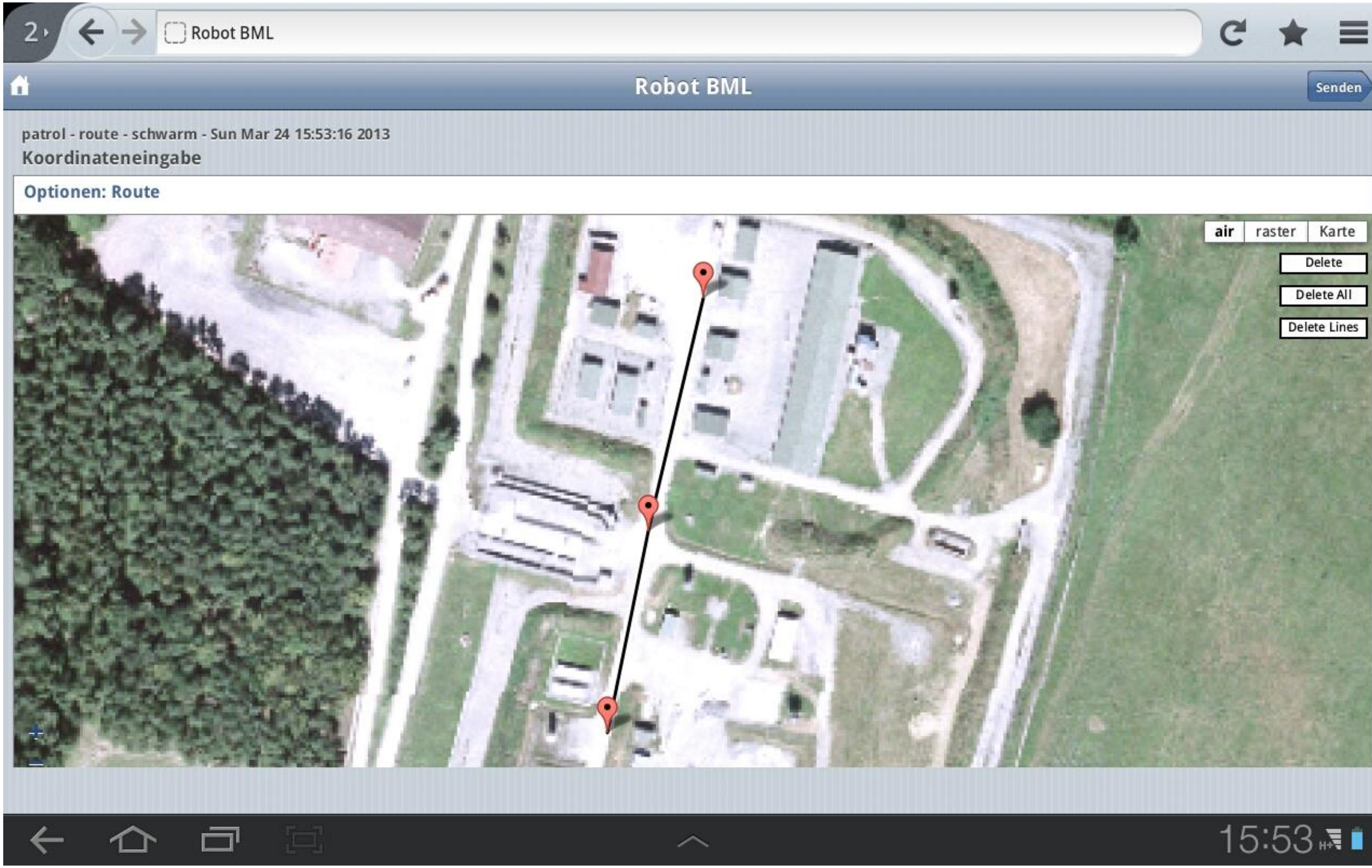
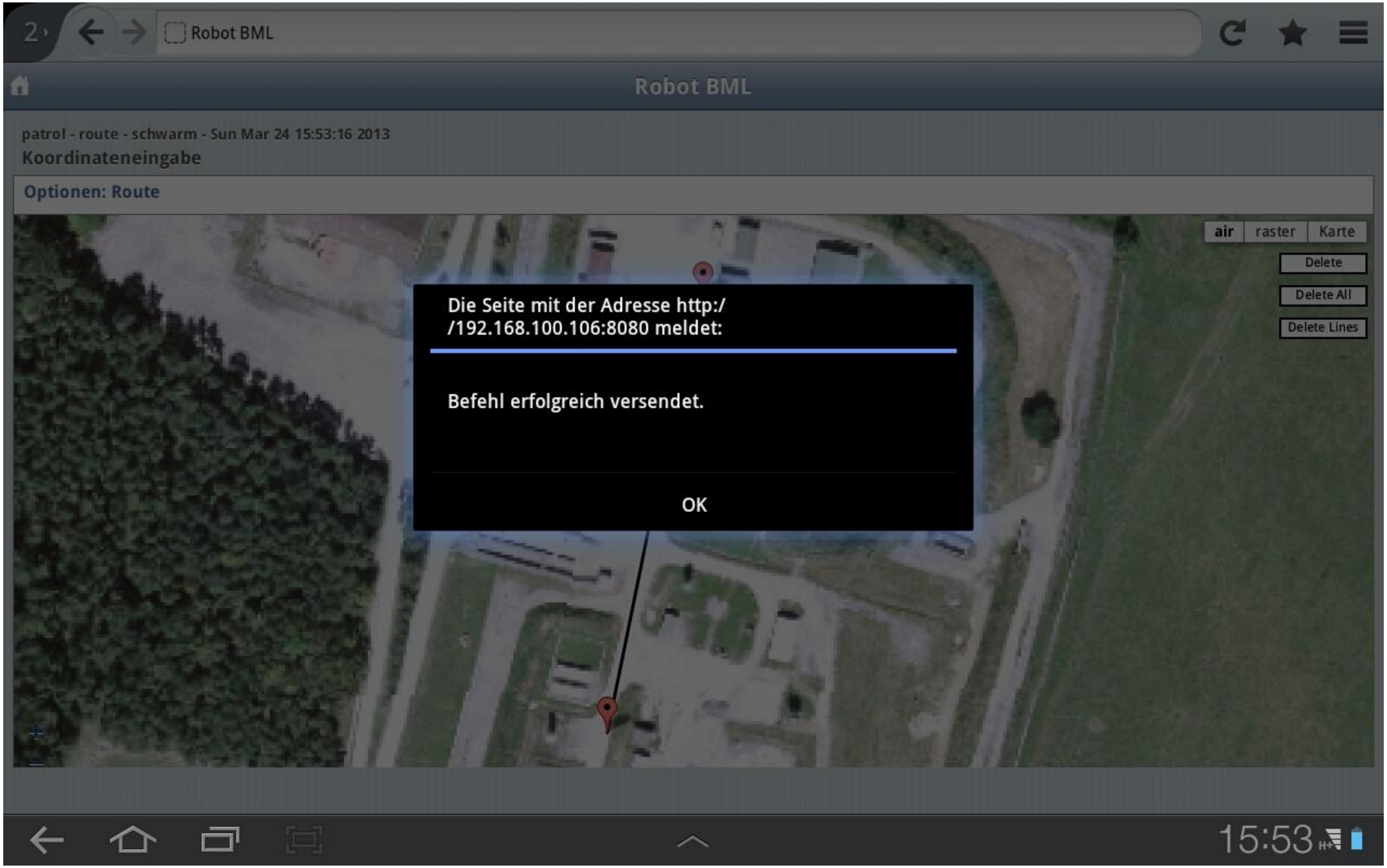
Mobile GUI - Auswahl des Roboters



Mobile GUI - Eingabe der Route



Mobile GUI - Bestätigung der Übertragung



Battle Mangement Language
Reports

We use BML reports to send information from the robots to the GUI: position information, the operational status, the task status and information about detected units are directly transformed into BML reports.

The robots also report binary data such as images, video, or lidar data. These data cannot be translated into BML, instead, the data are converted into an XML format. After conversion, it is sent to the GUI, and can be stored in a central data base so that other (superordinate) C2 systems can make use of it. Since we would like to report about this data in a BML we defined a BML message which reports the link to the data in the database to the user of the MRS. This message is sent to the GUI. The operator then can call the link so that the data is displayed in side panels of the GUI.

Battle Mangement Language Reports – Examples

report own position Robot_1 at [Point A] at now eyeball completely reliable RPTFCT positionreport-12345;

report own status-gen Robot_1 OPR at now eyeball completely reliable RPTFCT statusreport-13456;

task-report OPR ongoing at now eyeball completely reliable RPTFCT label-report123;

report unit unknown_001 vehicle at now eyeball completely reliable RPTFCT positionreport-12345;

Conclusion

Our work has demonstrates that BML can be used for communicating with robots in the intended way. This is at least in part to be credited to ROS for allowing inter-service communication.

From the military point of view, many missions can profit from using multi robot systems. For example, the robots can scout the area a convoy has to pass through for enemy forces or IEDs.

Using BML allows commanding the MRS by one single controller using a mobile devise, e.g., a tablet. Thus, the MRS can be commanded directly from the convoy itself which helps to facilitate the information flow and the reaction time in the case the robots run into the enemy. Besides, loosing robots is preferable to human casualties.

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