TECHNICAL ACTIVITY PROPOSAL (TAP)

<table>
<tr><td>ACTIVITY REFERENCE NUMBER</td><td>SAS-ET.BX</td><td rowspan="2">ACTIVITY TITLE
ROBOTICS UNDERPINNING FUTURE NATO OPERATIONS</td><td>TBA</td></tr>
<tr><td>TYPE AND SERIAL NUMBER</td><td>SAS-xxx/RTG</td><td>START
Jan 2012</td></tr>
<tr><td colspan="2">LOCATION(S) AND DATES</td><td>TBD by the RTG
(various locations as required)</td><td>END
Jan 2015</td></tr>
<tr><td colspan="2">COORDINATION WITH OTHER BODIES</td><td colspan="2">ACO, ACT, NC3A, IMS, IST, SCI, SET, HFM, NMSG</td></tr>
<tr><td colspan="2">NATO CLASSIFICATION OF ACTIVITY</td><td>Up to NATO Confidential</td><td>Non-NATO Invited
Case- by -Case</td></tr>
<tr><td colspan="2">PUBLICATION DATA</td><td>RTO SAS Technical Report (Spring 2015)</td><td>Inputs for ACT Concept Development WG</td></tr>
<tr><td colspan="2">KEYWORDS</td><td colspan="2">Military robots, use of robots, cognitive robotics, artificial intelligence, machine intelligence, human paradigm, mam-robot-interaction, communication with robots, algorithm, nanorobots, UAV, UGV, robotics strategy, EOD robot, EATR (Energetically Autonomous Tactical Robots), asymmetrical warfare, decision loop, UCAV (Unmanned Combat Air Vehicles), MAST (Micro Autonomous Systems and Technology), microdrones, legality of robots, humanoid, SUGV (Small Unmanned Groud Vehicle), ethical implications, hummingbird robots, self-localization and navigation, scalable robotic simulations, robotics military applications</td></tr>
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I. Background and Justification

The growing use of robotic systems in military operations entails questions such as how to reassess their advances in NATO operations and identify critical areas. Future operating environments will be more complex and uncertain and future NATO forces might look differently when applying robotics. Robotics offers enormous potential while robotics applications embrace a number of necessary interlinked subject areas. Robotic systems will redefine the way modern warfare will be conducted, and may render existing capabilities obsolete.

The challenge is the lack of system theories allowing holistic analysis of the overall systems, involved processes and their interactions. All current models of systems suffer for significant scalability problems and the problem of derivation, use and integration of representations for modeling the environment, control, and motivation. Thus, better theories are needed for conceptual evaluation of robot systems in operations.

A dialog between humans and machines, interactions between physical and emotional features that have moral, ethical, and legal aspects, have not been solved yet completely. There are needs for generating sophisticated criteria for robotic decision-making whereas human abilities are limited.

II. OBJECTIVES

- Analyze the gap between operational requirements and technical possibilities and how they relate to the innovated NATO LTCRs..
- Bridge the natural gap between cutting edge of technology and military operational needs.
- Provide analytical and technological/ operational experimentation support for the robotics concept development and testing.
- Organize a NATO supported symposium or conference to demonstrate cutting-edge robotics technologies to military users.
- Make bidirectional working links to the European Commission R&D activities in the area of robotics.
- Open possibilities for the new robotics research motivated by military needs and funded by third parties, both public bodies and industries.

III. TOPICS TO BE COVERED

1. Robots' cognitive abilities:
   Robots and other intelligent devices need to perceive their surroundings during military operations. Planning and control of robots is based on the perception-action cycle in most cases. The goal is to develop new perception algorithms applicable in the defense and embed them into the cognitive framework.

2. Self-localization and navigation:
   To achieve fully autonomous and intelligent behaviors of robot systems, their operation relies mainly on uncertain information processing from sensors. Self-localization and navigation capabilities together with building up a proper machine representation of the operating environment belong to generic functionalities of any unmanned mobile robot, and enables autonomous activity planning as well as safe and collision-free guidance of these systems. The objective is to indicate system methods for intelligent sensor data processing applied into mobile robot perception field with a specific focus on investigation of advanced data fusion methods towards real world models capable of handling uncertain and incomplete information.

3. Robotic coordination, teamwork and interaction with humans:
   Homogenously teamed unmanned robots boost capabilities and reliability of a single robotic system. Heterogeneous grouping incorporates humans as ordinary team members, sharing common knowledge with robots, and assists each other in a complementary way. The objective is to study mechanisms, design algorithms and propose a development of new technologies for coordinated operations performed by heterogeneous teams of unmanned aerial systems (UASs), unmanned ground systems (UGSs), unattended sensors and human operators. The cornerstone concept of functionality planning and coordination will be agent-based computing, and the theory of multi-agent systems.

4. Scalable robotic simulations:
   The design methods and technologies might be tested on a scalable, high-fidelity computational

simulation. The goal is to investigate the methods of agent-based simulation and modeling, and perform its validation on deployment on real hardware platforms. Besides fidelity, it is to investigate the concept of scalability, e.g. ability to perform tests on a very high number of robotic entities - scenarios that can never be executed on real hardware platforms (an experience in modeling the US national airspace in cooperation with the US FAA).

5. Robotics military applications:
   All the afore mentioned research fields are targeted on both a single or multi-robot (teamed up) setups of unmanned ground and/or aerial vehicles operating in large real indoor and outdoor environments. Application field implies major use in unmanned vehicles control area, i.e. in rescue missions, inspection and surveillance robotics, autonomous assistive systems, and many other defense/safety/security applications.

Other areas to be considered:

- Interactions, relations between humans and robots – identification of technological alternatives in communicating with intelligent systems;
- Development of artificial intelligence control tools;
- Interface discrepancies and a lack of compatibility and the absence of common standards;
- Assumptions of the accelerations of technologies and methods and development of more reliable algorithms.

IV. DELIVERABLE AND/OR END PRODUCT

- Final technical report - deliver results to better understand the natural gap between cutting edge of technology and military operational needs;
- Organize a conference or symposium to present results, conclusions, and recommendations and build up new personal relations;
- Build the network of interested academic, industrial and military subjects and institutions. (including computerized support allowing the network to work in a virtual manner);
- Test results through experimentation and concept development;
- Next RTG meeting in Prague, Feb 2012;
- RTG meetings twice per year – annual reports.

V. TECHNICAL TEAM LEADER AND LEAD NATION

- CZE is willing Lead this activity and provide the Team Leader (prof. Vaclav HLAVAC)
- CZE RTO SAS representative: Mr. Miroslav SVEJDA, CZE MOD Prague

VI. NATIONS WILLING TO PARTICIPATE

Canada, France, Italy, NATO ACT, USA, Hungary

PfP Nations: none identified yet

VII. NATIONAL AND/OR NATO RESOURCES NEEDED

National resources are required (travel, research, operational experimentation, technology experimentation, concept development, literature search etc.). Participating nations should also be prepared to provide respective unclassified/ classified data related to objectives of the study. Inputs will be needed from ACO and ACT as well as coordination framework with EDA on particular issues.

VIII. RTA RESOURCES NEEDED

SME support (operational, technological). Funds for the conference or symposium. Specialist support to prepare CD&E proposals and concept experimentation. RTO interpanel cooperation (IST. HFM, SET, SCI).