Robotic Vehicle Control Architecture for FCS Program Overview

Chris Mocnik
Robotic Vehicle Control Architecture for FCS ATO Manager
U.S. Army RDECOM – TARDEC
Vehicle Electronics and Architecture Office

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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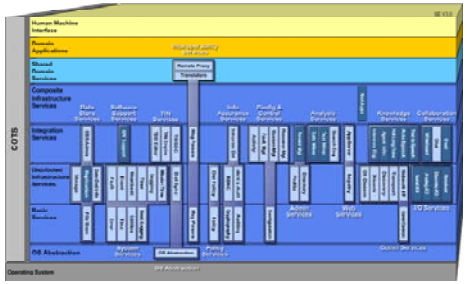
FCS Priority Matrix

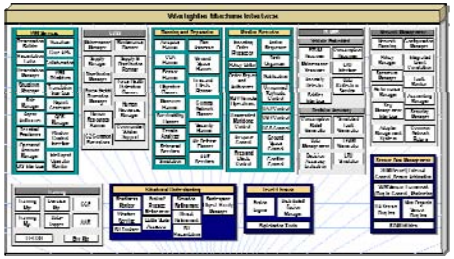
Priority	TARDEC Program	Top-Level Capability	PM FCS	Anticipated Products to FCS
1	Safe Ops program	Safe Operations in Dynamic Environments & 360º Situational Awareness	Detect, classify, track & predict human & vehicle threat trajectories - provide path planning for relative behaviors	Test data and algorithms to FCS ANS
2a	RVCA ATO	Autonomous Maneuver	Autonomous operating speeds over various terrain types and conditions	Test data and algorithms to FCS ANS
2b	RVCA ATO	UGV Control for Overall System Effectiveness	Soldier ability to operate UGV with weapons/sensors within FCS Network constraints	Pieces of end-to-end system as appropriate and negotiated
3	Autonomous Platform Demonstrator	Platform	Larger than 7 ton class wheeled platform technologies	Advanced 6x6 Hybrid Electric Platform, Integrated with FCS ANS and FCS SW architecture

TARDEC has programs addressing FCS needs!

UGV Technology Development and Integration



Demonstrating UGV Control Utilizing SOSCOE and Battle Command Software



Autonomous Navigation System (ANS) and RSTA

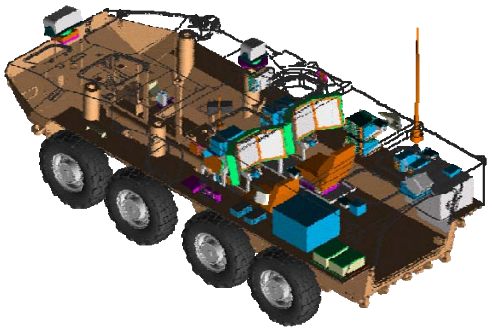
Hardware and Software Integration

Integrated Computer System and Vehicle Management System

UGV Platform

FCS Like Comms Network

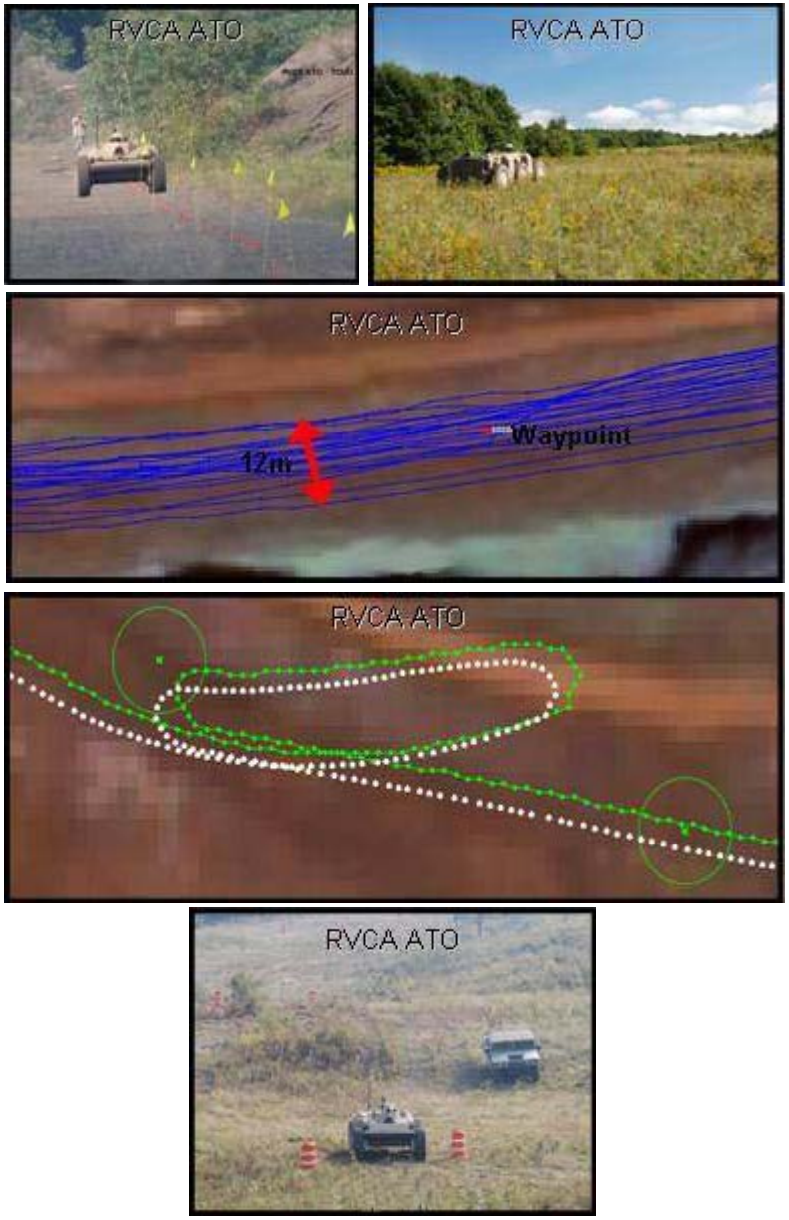
JTRS-GMR ***JTRS-GMR***



MGV With Embedded UGV Control

Engineering Evaluation 1.0

- **Title: RVCA Engineering Evaluation 1.0**
- What: Blind way-point following and tele-operation test of Crusher UGV with brass board ANS (no LADAR), and base BC architecture.
- Why: Conducted to evaluate Crusher performance and collect data concerning position accuracy, average speeds, system latencies.
- Who: TARDEC, NREC, DCS, PM FCS BCT, GDRS, BAE, Boeing, SAIC
- When: 5 – 28 Sep 2007
- Where: Gascola/Somerset, PA
- TRL Demoed: 4
- Visuals/Depictions of event: See videos
- Results: Logged 87 test runs totaling 130km of travel at speeds between 3m/s and 12.5m/s. Way-point plans contained from 29-390 way-points with spacings between 5m and 60m.



Engineering Evaluation 1.1

- **Title: RVCA Engineering Evaluation 1.1**
- What: Way-point following with ODOA through man-made obstacle courses with brass board ANS (w/ LADAR), and base BC architecture.
- Why: Conducted to evaluate Crusher performance in the avoidance of obstacles during the execution of a way-point plan.
- Who: TARDEC, NREC, DCS, PM FCS BCT, GDRS, BAE, Boeing, SAIC
- When: 10 – 20 Dec 2007
- Where: Gascola, PA
- TRL Demoed: 4
- Visuals/Depictions of event: See video
- Results: The vehicle successfully negotiated 7 unique courses. A total of 63 test runs were conducted on day 1 at speeds between 2 – 5 m/s. Days 2-3 saw a series of exploratory tests designed to collect data useful for further ANS software development activities.

Engineering Evaluation 1.2

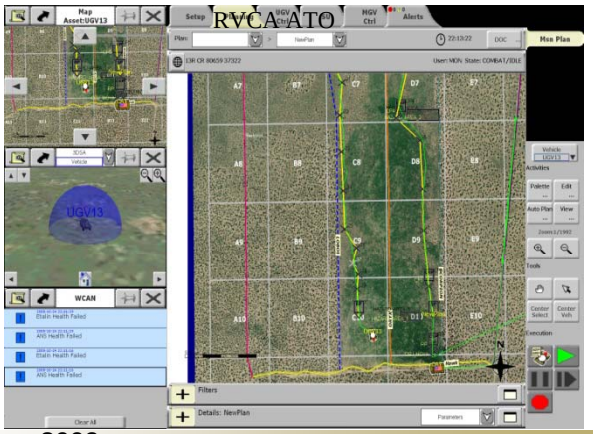
- **Title: RVCA Engineering Evaluation 1.2**
- What: Way-point following with ODOA over longer distance natural terrain courses with brass board ANS, and base BC architecture. Tele-operation over same terrain.
- Why: Conducted to evaluate Crusher performance during autonomous maneuvering and tele-operation over long distance natural terrain courses. Evaluate performance of new communications and ICS hardware.
- Who: TARDEC, NREC, DCS, PM FCS BCT, GDRS, BAE, Boeing, SAIC
- When: 31 March – 18 April 2008
- Where: Gascola, PA
- TRL Demoed: 4
- Visuals/Depictions of event: Photos and Video are available
- Results: 54 total runs with 114 km of distance traveled, at an average speed of 4.16 m/s. Some difficulty in avoiding obstacles with new ANS software. Some difficulty in tele-operation due to poor radio communications links. ICS box operates very well.

Engineering Evaluation 1.3

- **Title: RVCA Engineering Evaluation 1.3**
- What: Way-point following with ODOA and tele-operation over natural terrain courses with brass board ANS, B2F BC architecture, MWS (in Stryker), dismounted controller, and RSTA. Latency measurements.
- Why: Conducted to evaluate Crusher performance during RSTA based autonomous maneuver and tele-operations with multiple controllers in preparation for SOE 1.0.
- Who: TARDEC, NREC, DCS, PM FCS BCT, GDRS, BAE, Boeing, SAIC
- When: 7 – 25 July, 2008
- Where: Somerset, PA
- TRL Demoed: 4
- Visuals/Depictions of event: Photos and Video are available
- Results: Logged 67 test runs totaling 86 km of travel at average speeds of 4.12 m/s teleop and 3.92 m/s autonomous. Autonomous and tele-op runs with dedicated controllers went well.

Soldier Operational Exercise 1.0

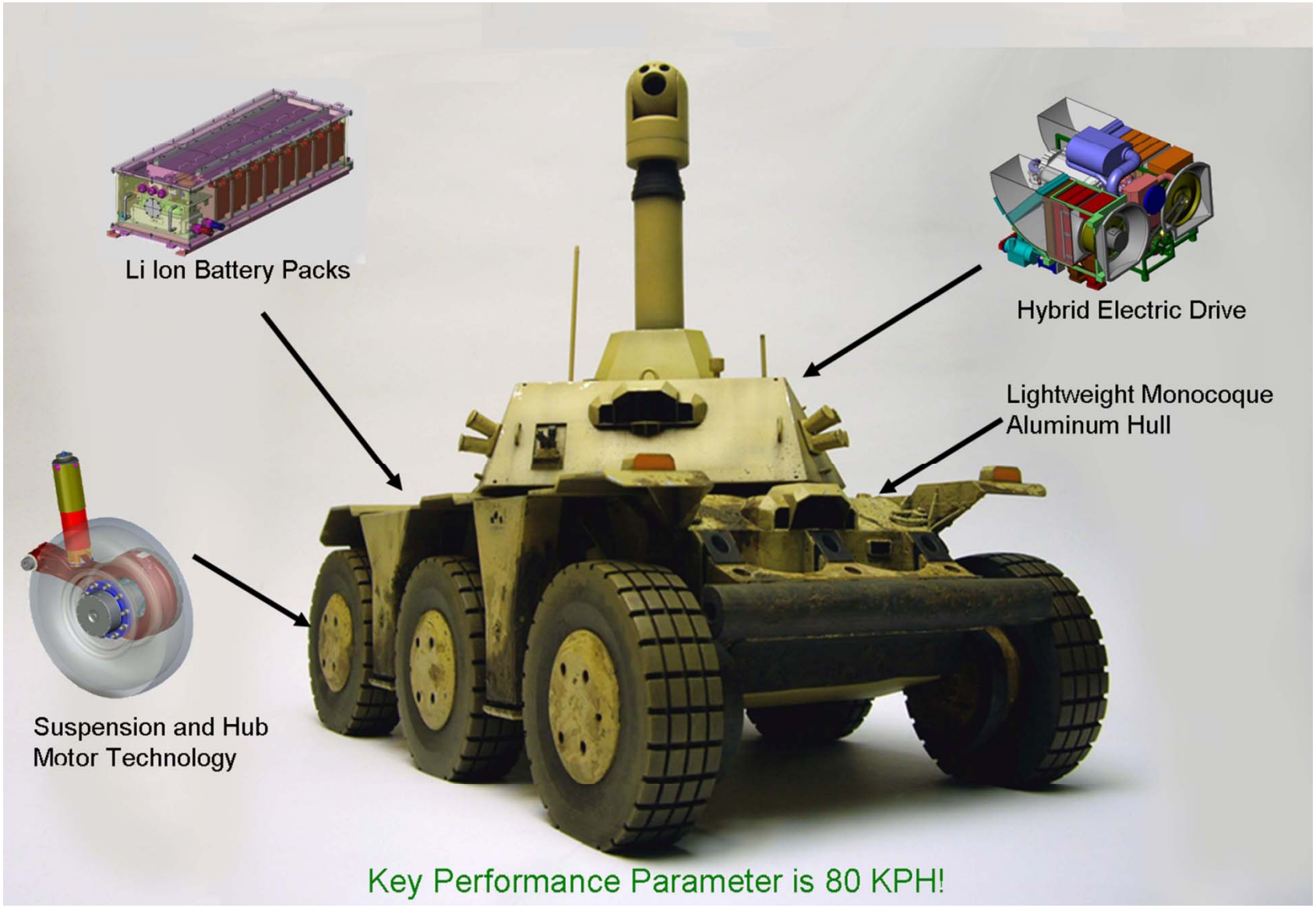
- **Title: RVCA Soldier Operating Experiment SOE 1.0**
- What: Way-point following with OD/OA and tele-operation over dessert like terrain courses with brass board ANS, B2F BC architecture, MWS (in Stryker), Dismounted Controller, and RSTA/RSTA simulation.
- Why: Conducted to evaluate Crusher performance during RSTA based autonomous maneuver and tele-operations with multiple controllers in desert terrain. US Army Soldiers were used to conduct all experiments and provide feedback.
- Who: TARDEC, NREC, DCS, PM FCS BCT, GDRS, BAE, Boeing, SAIC
- When: 29 Sept – 31 Oct, 2008
- Where: Ft. Bliss Test Range 1A/2A. El Paso, TX
- TRL Demoed: 5
- Visuals/Depictions of event: Photos and Video are available
- Results: A total of 27 Runs for Record covering 152 km of travel with an average speed of 3.92 m/s (both autonomous and tele-op runs). Soldier feedback was very positive.



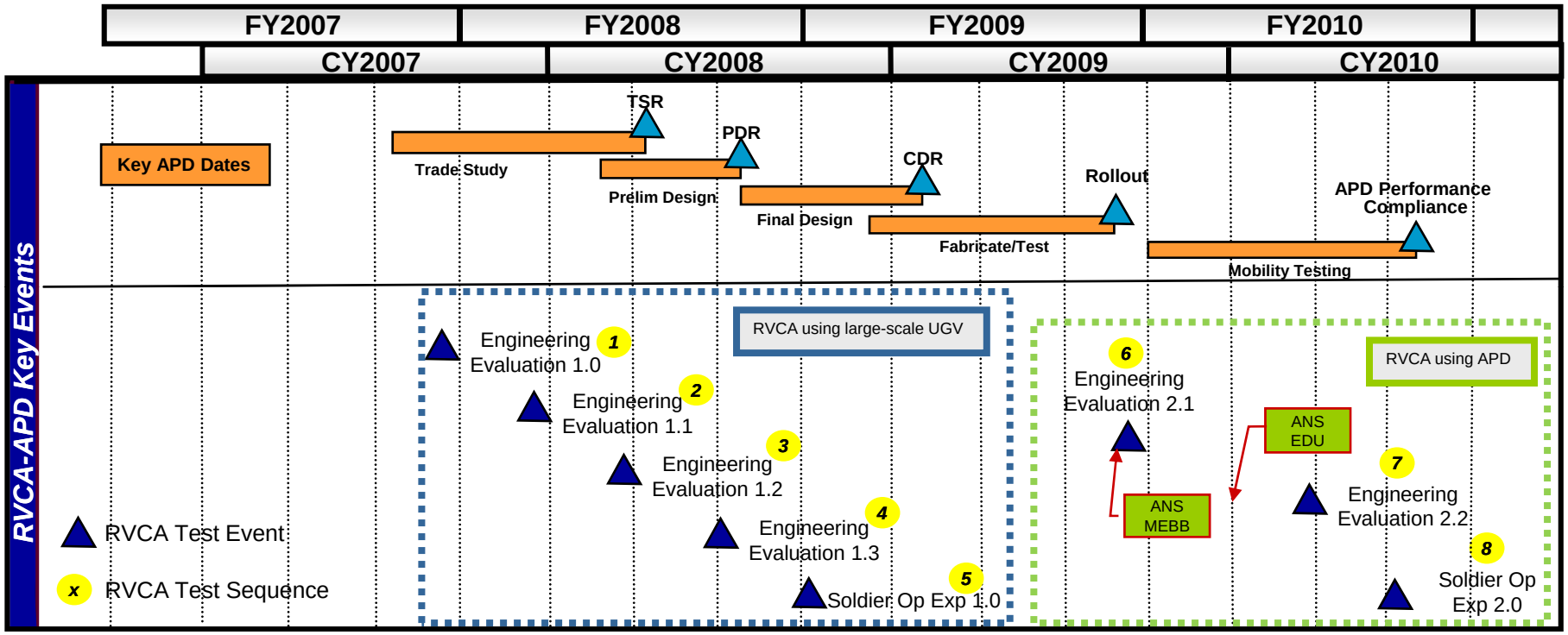
Primary Follow-on Activities

- **Working with the PM, LSI, and GDRS on obtaining latest release of ANS hardware and software for continued integration and field test.**
- **Continued battle command architecture development**
  - Improve stability and add features to existing services
  - Incorporate latest B2F specs
  - Re-use existing battle command software
- **JTRS-GMR integration**
  - Bench and vehicle integration and test
- **Obtain and integrate latest release of SOSCOE for integration and test**
- **Advance RSTA system control and features**
  - Consider other RSTA options with more capability
- **Port all hardware/software components to the Autonomous Platform Demonstrator**
- **Conduct two more Engineering Evaluations**
- **Conduct final Soldier Operational Exercise**

Autonomous Platform Demonstrator (APD)



RVCA and APD Schedule



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Conclusion

- **TARDEC put programs in place to support PM FCS BCT - UGV needs**
- **TARDEC has agreements with PM FCS BCT and DARPA for the platform and major subsystem components that enable integration and field testing with relevant hardware and software.**
- **TARDEC has developed and will continue to refine battle command software in accordance with build 2 final specifications.**
- **RVCA is working jointly with sister TARDEC programs for leveraging of WMI components and transition of architecture to follow on programs.**
- **Conducted four incremental engineering evaluations to characterize and measure system performance.**
- **Conducted a soldier operational exercise to gain valuable user feedback on system performance during mission scenarios conducted on relevant terrain.**
- **RVCA hardware/software will migrate to the APD platform for remaining field engineering evaluations and final soldier operational exercise.**