RESEARCH and EXPLORATORY DEVELOPMENT DEPARTMENT

JOHNS HOPKINS UNIVERSITY
Applied Physics Laboratory

Advanced EOD Robotic System AEODRS

09.27.12

The AEODRS Program

DoD Top 5 Systems Engineering Award

"AEODRS is the Navy's example program for open architecture and a model for the Navy's future acquisition approach."

- Ms. Mary E. Lacey, DASN RDT&E

"AEODRS is not only the flagship program for EOD but for the entire Navy."

- CAPT James Stein, EOD/CREW Program Office

The Critical Challenge

Create the Next Generation of
Explosive Ordnance Disposal Robots

Break "Vendor Lock"

- Rapid Upgrades
- Affordable
- Modular Open Systems Approach (MOSA)

iRobot
PackBot

QNA
Talon

Remotec
F6A

The Critical Challenge

Create the next generation of EOD robots using a common architecture and open system design.

- Current systems function well.
- Valuable field experience has been gained with the existing systems.
- Deploying an open architecture will improve rapid upgrades and logistics support.

iRobot PackBot

QNA Talon

Remotec F6A

Program Evolution

2006
Revolutionizing Prosthetics Program *(2006)*

2007
Funded IRAD Human Capabilities Projection *(2007)*

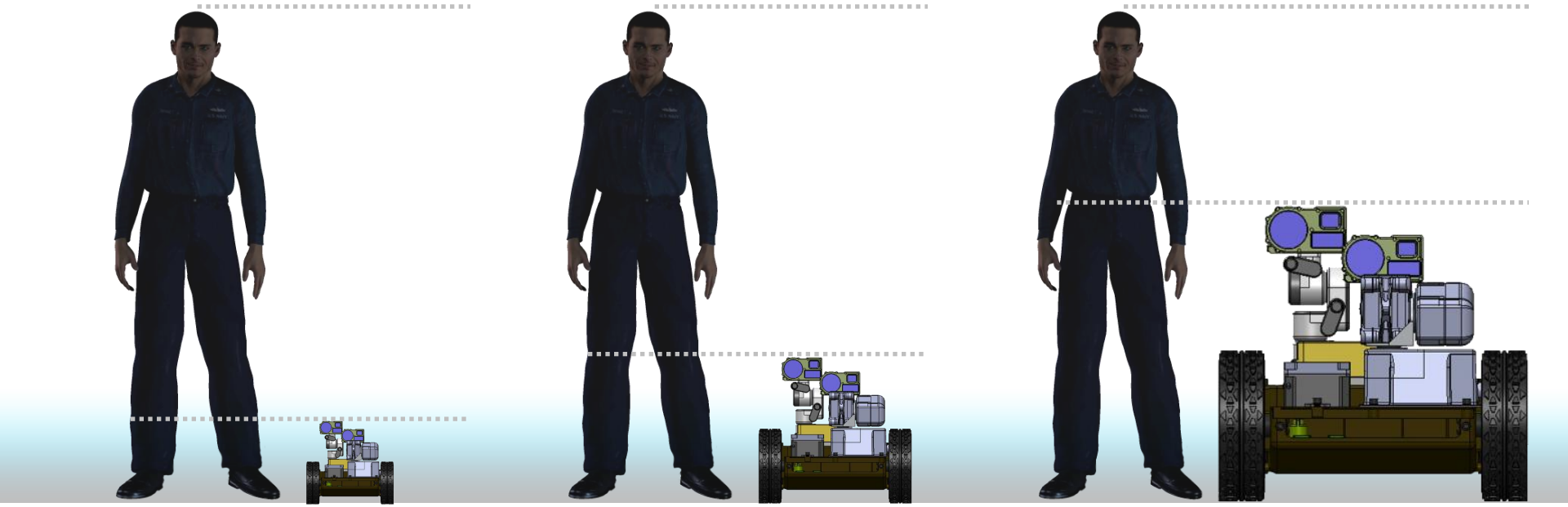
2008
Initial Sponsor Contact (Gov Industry Day) *(2008)*

2008
Critical Challenge Identified *(2008)*

2009
Open Architecture Developed *(2009)*

2010 - 2013
USN Open Architecture & Business Model Realized *(2009-2013)*

AEODRS - A Family of Systems



Increment 1:

Dismounted Operations
- Fills capability gap
- Back-packable
- Reconnaissance and threat assessment (to 100m)
- Smallest unit (<35 lbs)

Increment 2:

Tactical Operations
- 2-man portable (<165 lbs)
- Down range reconnaissance and threat prosecution (to 1000m)
- Replaces existing robot class

Increment 3:

Infrastructure Operations
- Trailer transportable
- Provides heavy lifting capability
- Largest unit size (750 lbs)
- Replaces existing robot class

APL's Five Roles

- Common System Architecture Definition
- Develop High Dexterity Manipulation and Advanced Technology
- Architecture and System Test Bed Development
- Advanced Systems Engineering
- Prime System Integrator for System Development and System Integration

The System Development and Integration Team (SDIT)

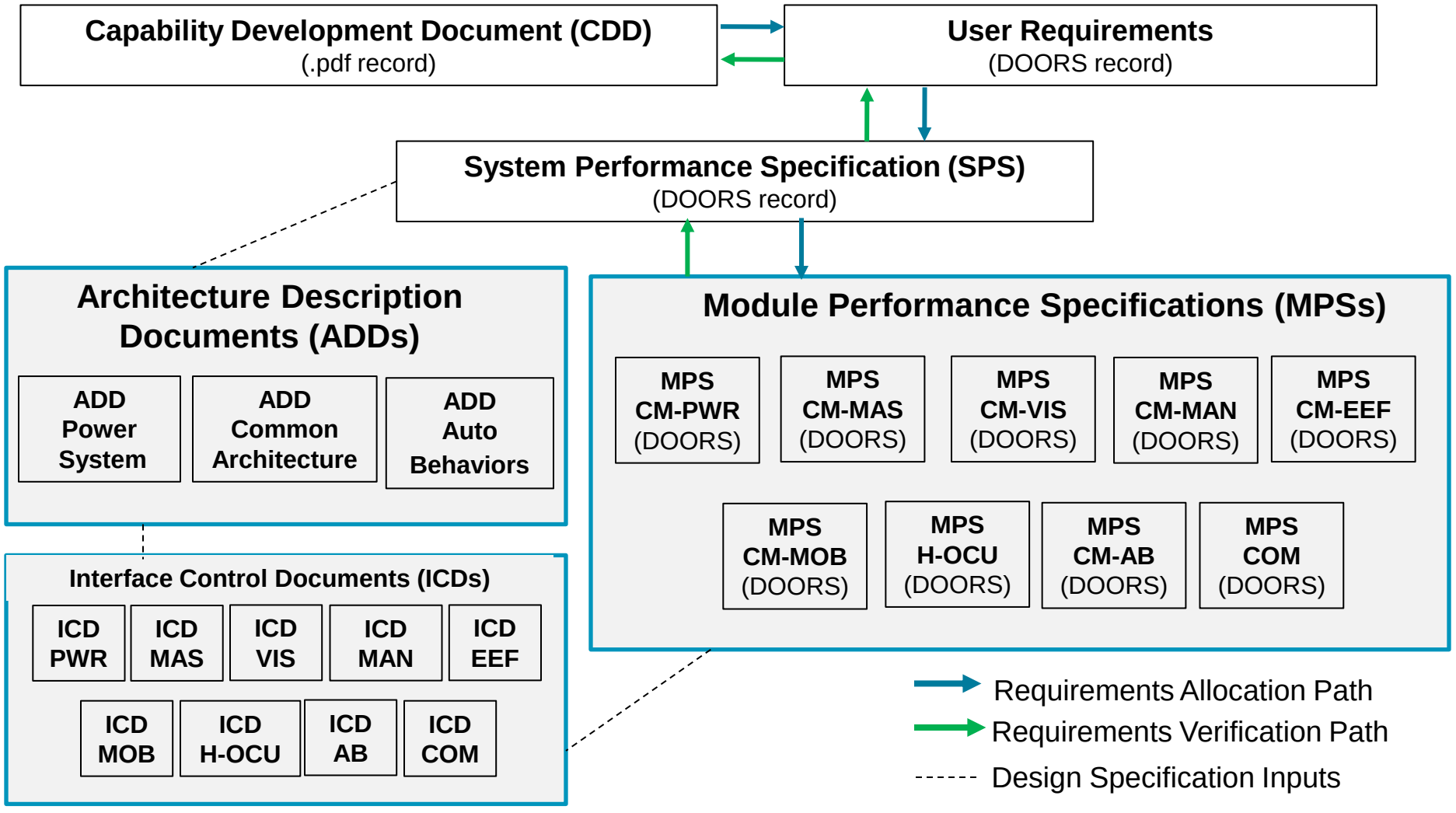
The System Development and Integration Team is equivalent to an integrated product team (IPT) for Milestone B activities. It consists of five members. Each member provides specific subject matter expertise to the program.

The SDIT Members and specific roles:

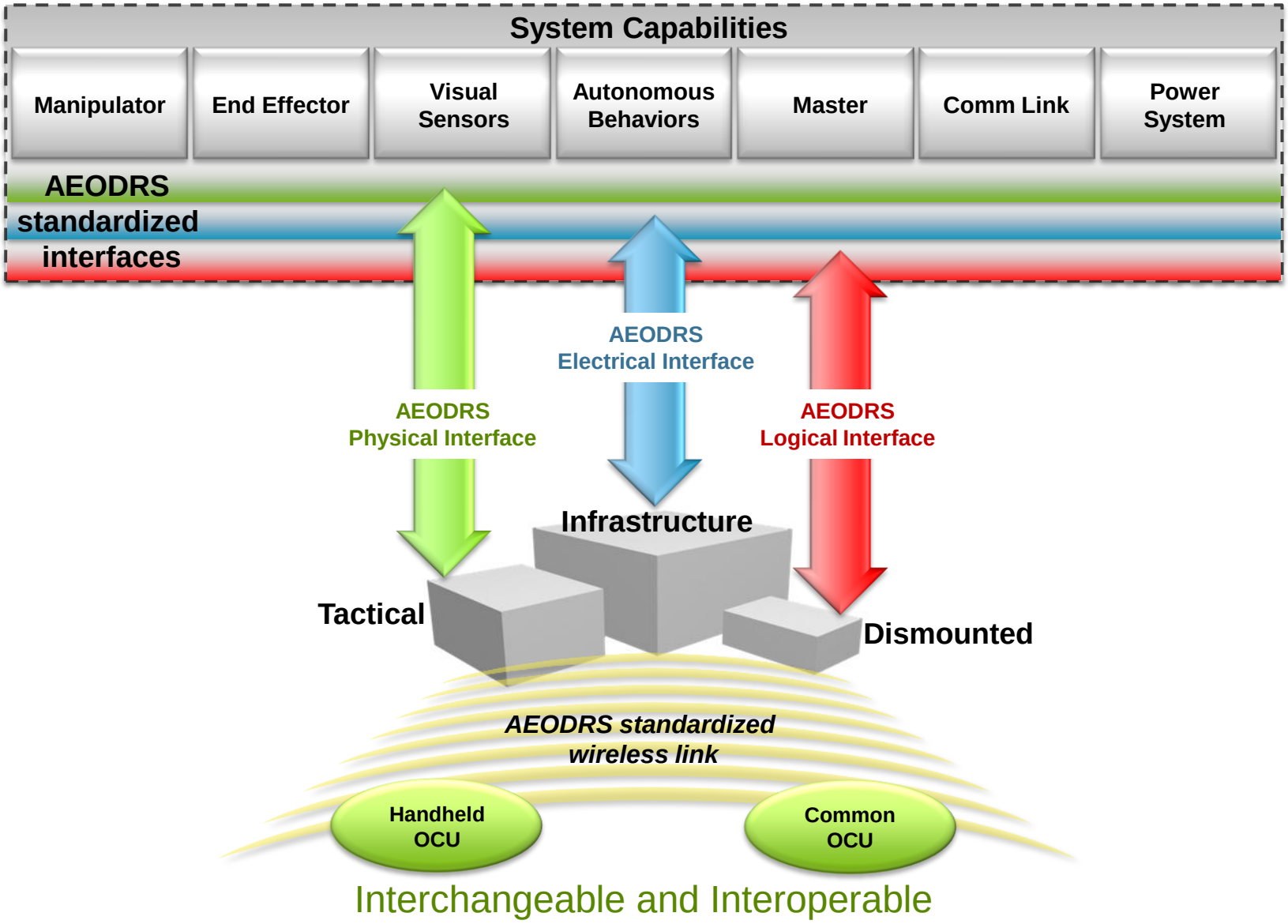
- NAVEODTECHDIV - Program Management, User Requirements and Testing
- APL – Prime System Integrator and Requirements Management
- SPAWAR – Software for Autonomous Behaviors and Operator Control Unit
- PSU/ARL – Power Systems
- Battelle Memorial Institute – Risk Management and Test Bed Simulatior

The SDIT is a highly collaborative team that tackles all technical aspects of the program.

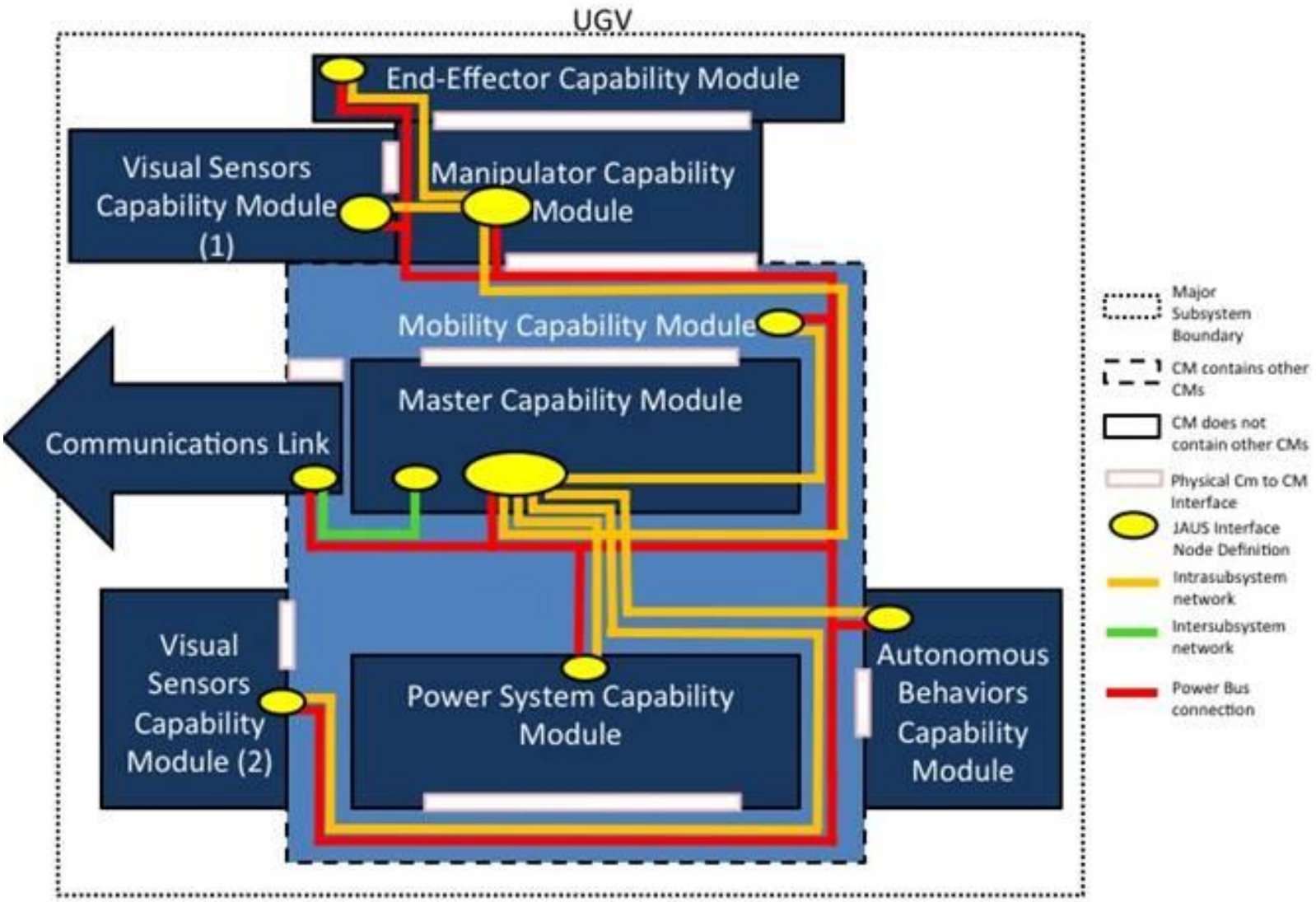
Requirements Development and Management



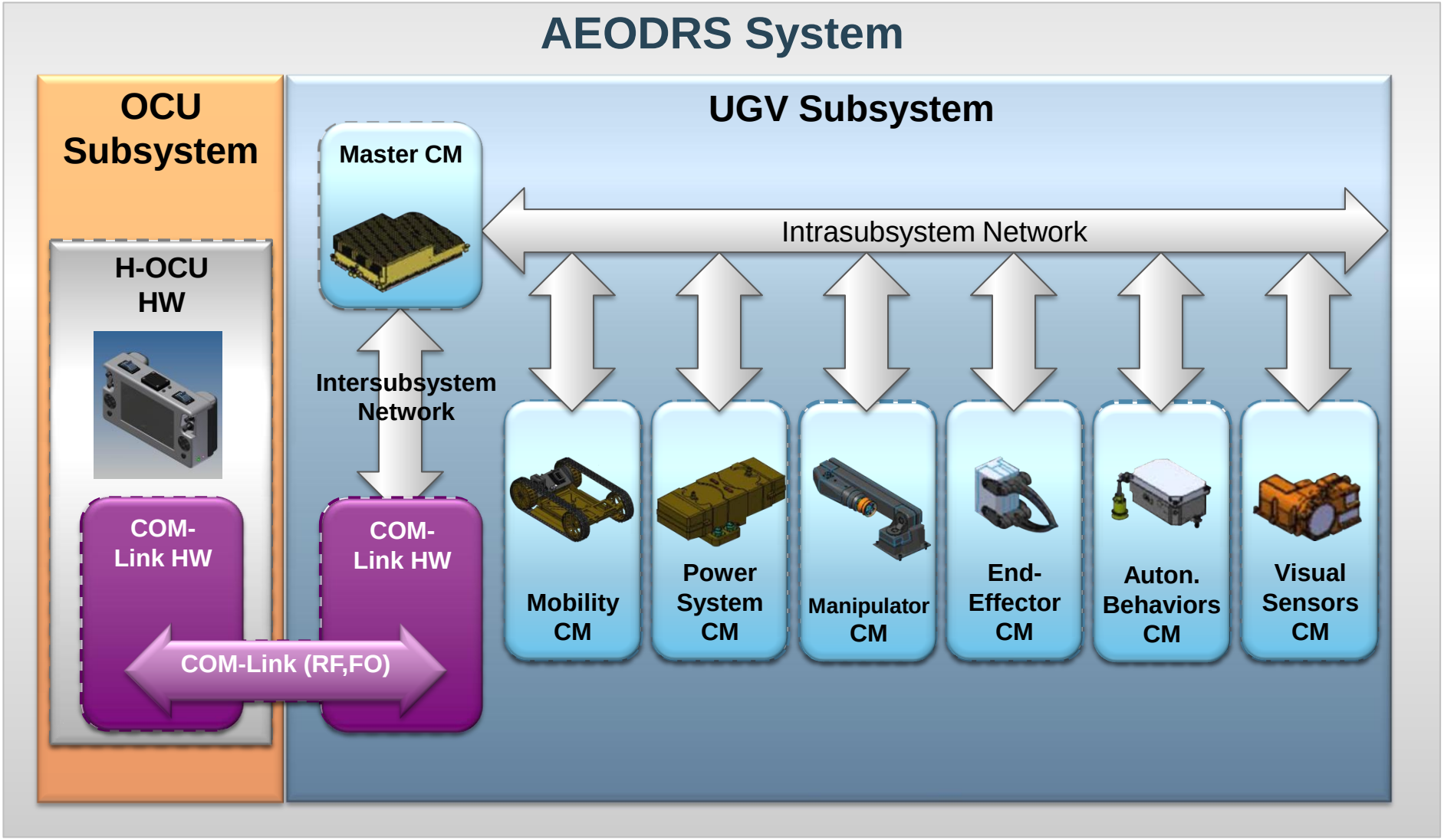
Common System Architecture Definition



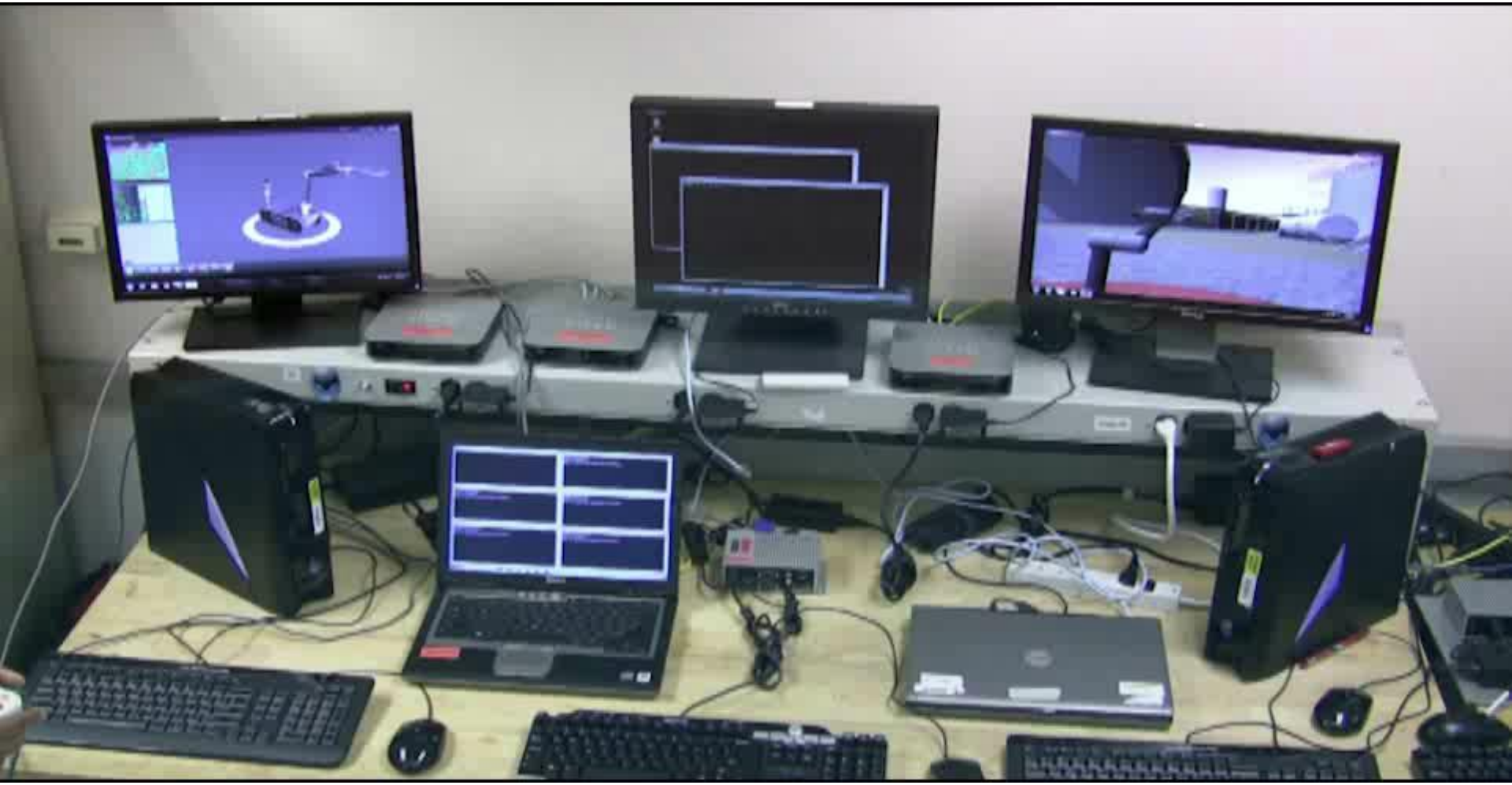
The Reference Architecture



System Test Bed Development



System Test Bed



System Development and Integration

- Manage Industry Suppliers
  - CM-MOB supplier is Remotec/MacroUSA
  - CM-VIS supplier is Chatten Associates
  - CM-MAS, CM-MAN, CM-EEF supplier is RE2
  - CM-PWR supplier is PSU/ARL
  - COM-Link supplier is NAVEODTECHDIV
  - CM-AB supplier is a collaboration of APL and SPAWAR
  - Handheld OCU supplier is a collaboration of SPAWAR and AmRel
- Manage Design to Requirements
- Manage System Test Bed Development and Implementation
- Support NAVEODTECHDIV Testing
- Perform Final System Integration
- Transition Prime System Integration role to Industry

System Development and Integration

Example: Technical Performance Metric for Weight

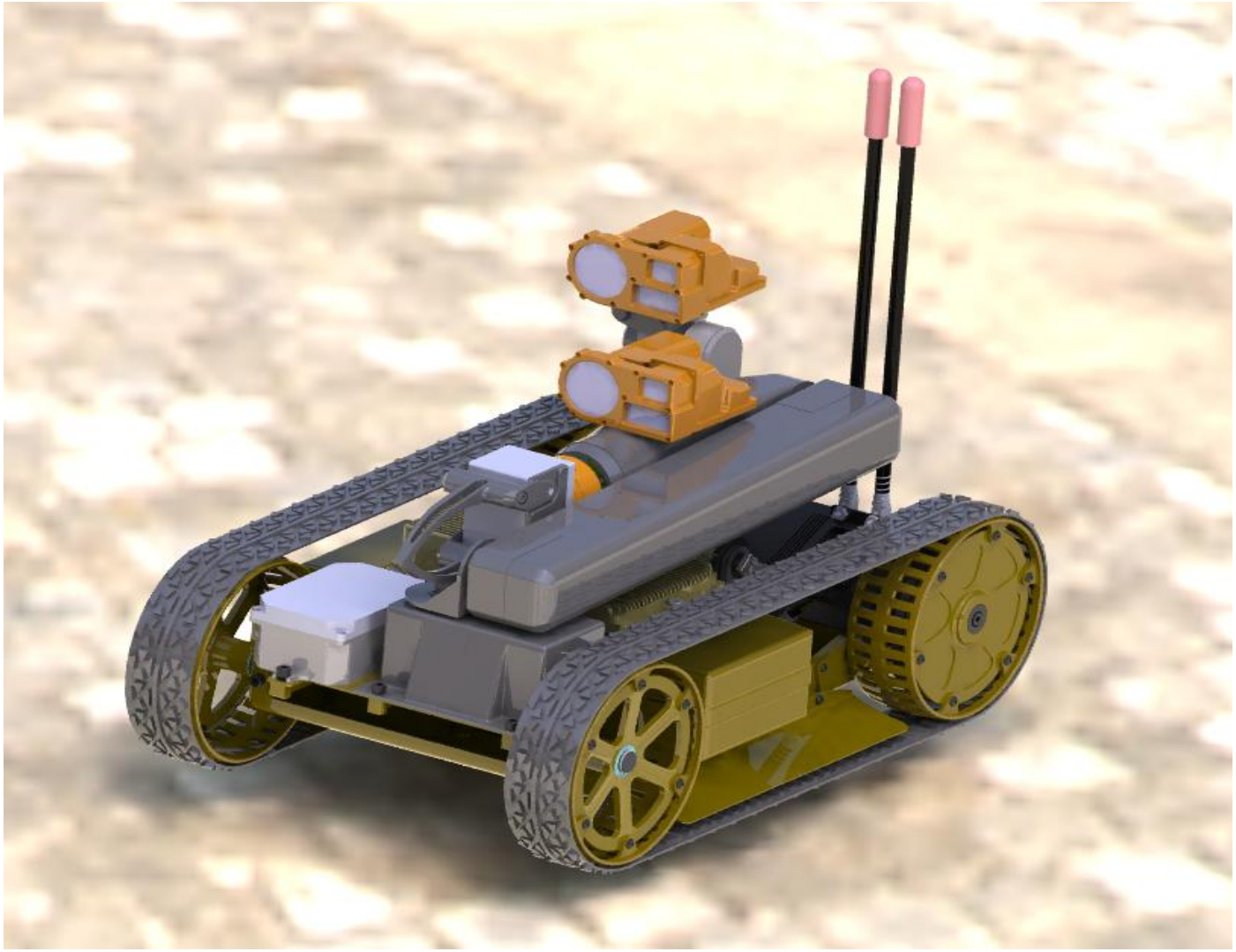
Last update: 25 Jan 2012

Milestones	Total	CM-MOB	Harness	CM-PWR	BB2590 x 2	CM-MAS	CM-VIS (1)	CM-VIS(2)	CM-EEF	CM-MAN	CM-AB	OCU	COMM	Description
Threshold Spec	**35.00**	12.90	0.00	2.00	6.20	1.10	1.75	0.75	1.50	4.00	1.30	2.50	1.00	Baseline weight allocations
Proposal	**42.03**	20.67	0.00	2.00	6.20	1.00	1.73	0.73	1.10	3.80	1.30	2.50	1.00	Accepted CM-MOB weight challenge
Post Kickoff (July 2011)	**38.13**	16.77	0.00	2.00	6.20	1.00	1.73	0.73	1.10	3.80	1.30	2.50	1.00	Eliminated right angle gear drives (increase CM-MOB width by 1/2 inch), replaced metal tracks with belts.
EEIF updates (3 Aug 11)	**38.43**	16.77	0.00	2.00	6.20	1.00	1.73	0.73	1.20	4.00	1.30	2.50	1.00	EEIF adds additional weight and length to the CM-MAN, CM-EEF pair.
Initial Trade (19 Aug 11)	**35.16**	13.50	0.00	2.00	6.20	1.00	1.73	0.73	1.20	4.00	1.30	2.50	1.00	Reference the weight trade study.
Connector trade (15 Sept)	**35.96**	13.50	1.00	2.00	6.20	1.00	1.73	0.73	1.20	4.00	1.10	2.50	1.00	Preliminary results of the connector/harness study have provided initial harness weight validation of 1 lbs.
TIM for CM-MOB (28 Sept)	**35.66**	13.50	0.00	2.00	6.20	1.00	1.73	0.73	1.20	4.00	1.10	3.20	1.00	Integrated logical wiring harness into CM-PWR with a net zero weight gain for the harness. Updated H-OCU based on estimates from Amrel.
CM-MOB and CM-PWR design summit (24-25 Oct.) at APL	**36.30**	13.50	0.00	2.50	6.40	1.00	1.70	0.70	1.20	4.00	1.10	3.20	1.00	Updated high side CM-PWR mass after two day design summit with Remotec/Macro and PSU ARL at APL
System Design Reivew (10 Nov 2011)	**35.60**	12.90	0.00	2.20	6.40	1.20	1.80	0.80	1.30	4.20	1.10	3.00	0.70	System configuration is stable. All CMs in preliminary design. Anticipate incremental improvements as CM development proceeds.
CM-AB CDR (16 Nov 2011)	**35.50**	12.90	0.00	2.20	6.40	1.20	1.80	0.80	1.30	4.20	1.00	3.00	0.70	CM-AB will meet Objective weigth.
CM-PWR PDR (15 Dec 2011)	**36.80**	12.90	0.00	3.50	6.40	1.20	1.80	0.80	1.30	4.20	1.00	3.00	0.70	CM-PWR is missing the threshold weight significantly. This PDR estimate is conservative
CM-PWR Tiger Team (22 Dec 2011)	**36.70**	12.90	0.00	3.50	6.30	1.20	1.80	0.80	1.30	4.20	1.00	3.00	0.70	Used a sample set of BB2590s to establish an accurate battery weight.
CDRs: CM-VIS, CM-MAS, CM-EEF, CM-MAN, (13 Jan 2012)	**36.40**	12.90	0.00	3.50	6.30	1.10	1.70	0.70	1.30	4.20	1.00	3.00	0.70	Factors in the EEIF weight on EEF and MAN.
CDRs: H-OCU, CM-PWR (20 Jan 2012)	**36.22**	12.90	0.00	3.12	6.30	1.10	1.70	0.70	1.30	4.20	1.00	3.20	0.70	CM-PWR and H-OCU have some potential for reduced weight.
CDR for CM-MOB (26 Jan 2012)	**34.63**	11.31	0.00	3.12	6.30	1.10	1.70	0.70	1.30	4.20	1.00	3.20	0.70	Use of carbon fiber in CM-MOB design.

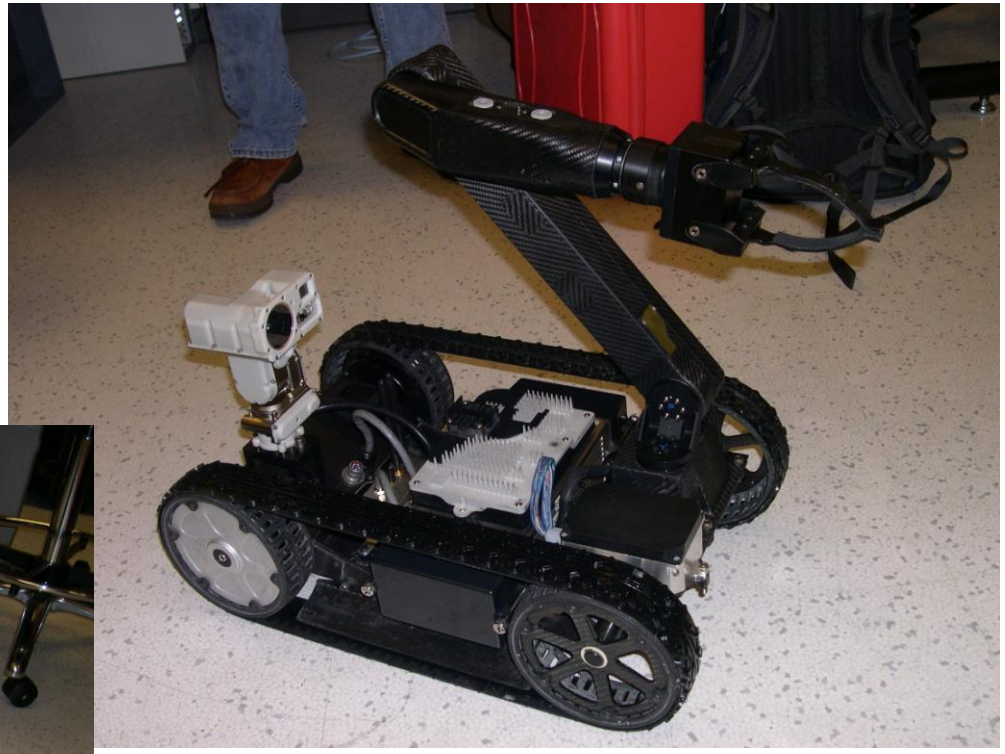
Example - Weight Reduction Options

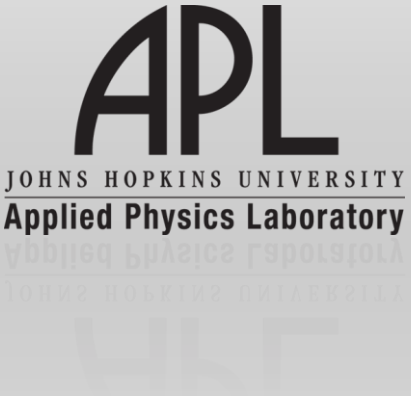
ID	Savings (lbs)	Description
1	0.1	CM-MAS 6 Port Configuration (minimal thermal fins)
2	0.3	CM-AB KVH Gyro removal
3	N/A	H-OCU Single Battery Operation
4	0.3	CM-MAN to CM-EEF interface simplification
5	0.7	CM-MOB COTS Motors and Drivers
6	N/A	Battery straps vs. Battery covers
7	0.7	Remove CM-VIS Secondary (CM-MAN)
Total	**2.1**	

AEODRS Dismounted UGV…Arriving Summer 2012



AEODRS Dismounted UGV…Arriving Summer 2012

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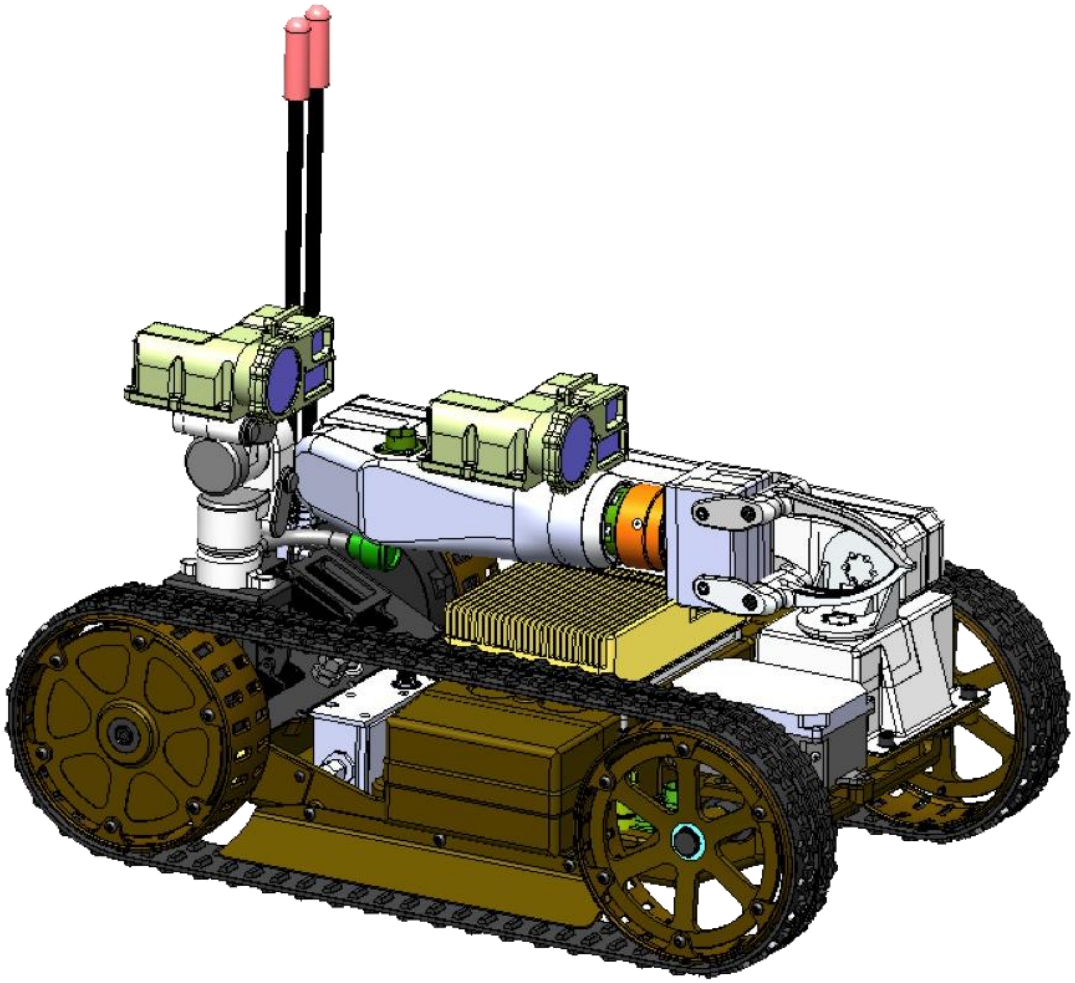
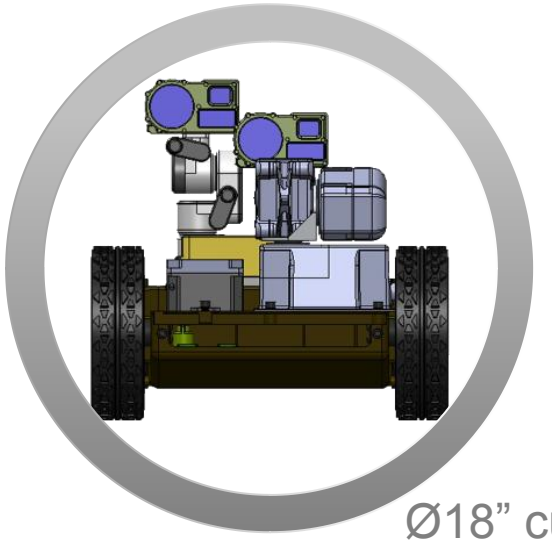
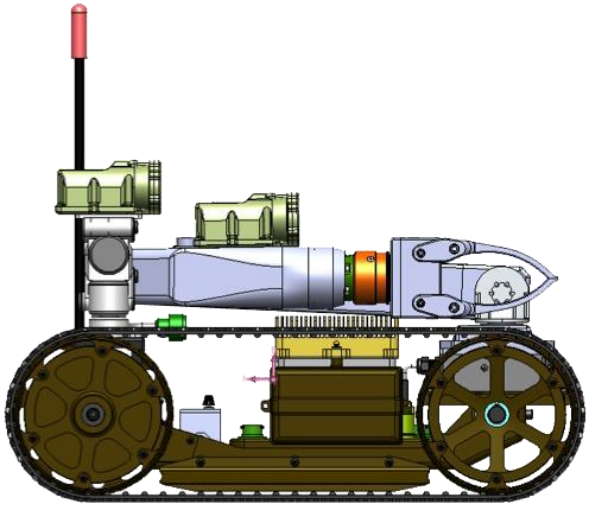
AEODRS Dismounted Design





Ø18” culvert



Common System Architecture