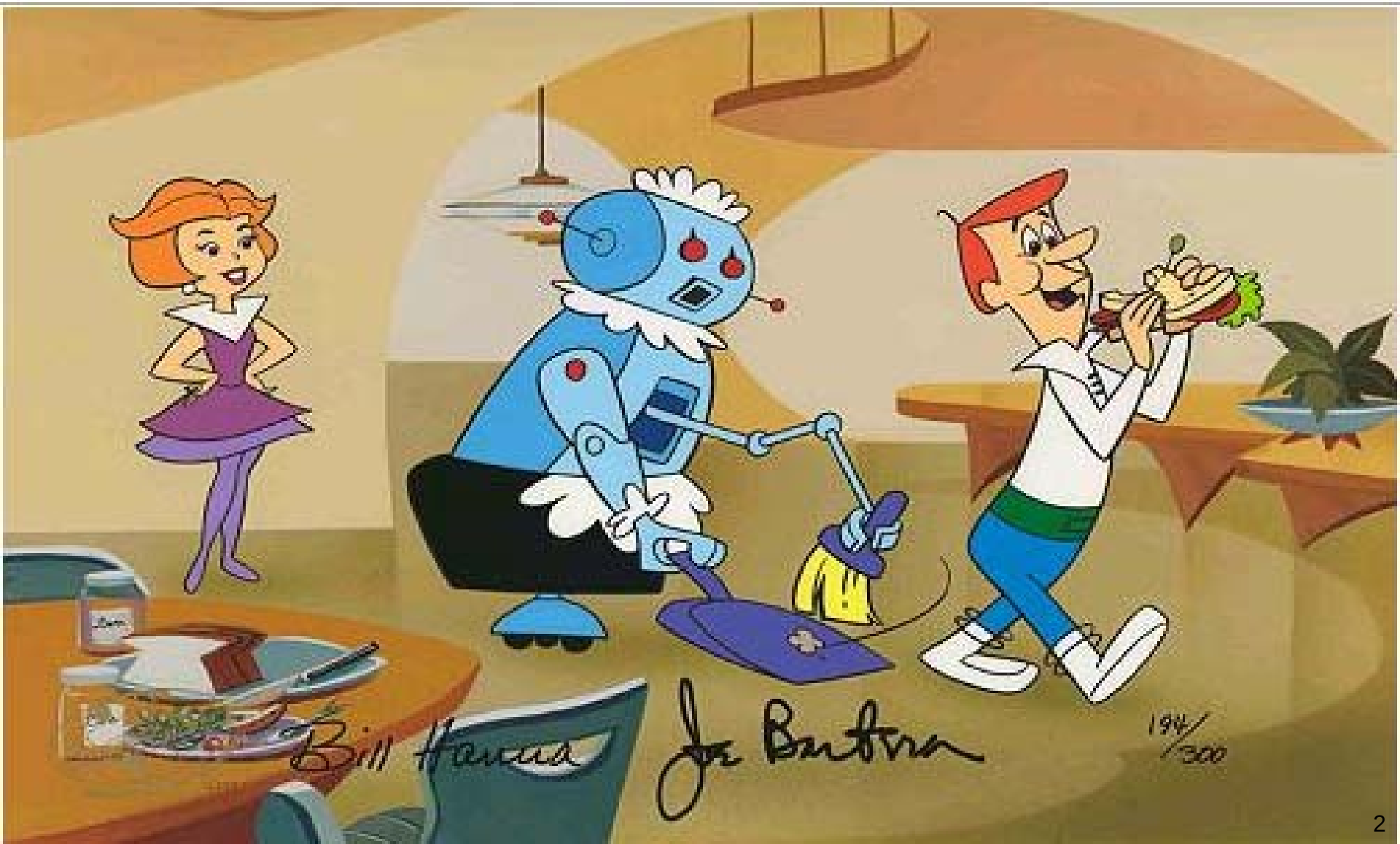
United States Army
Combined Arms Support Command

Ground Robotics Capabilities Conference

26 March 2009

Mr. Bill Moore, SES
Deputy to the Commanding General
CASCOM

Supporting a Campaign Quality Army with Joint and Expeditionary Logistics Capabilities


Bill Hanna
Joe Barbera
194/300

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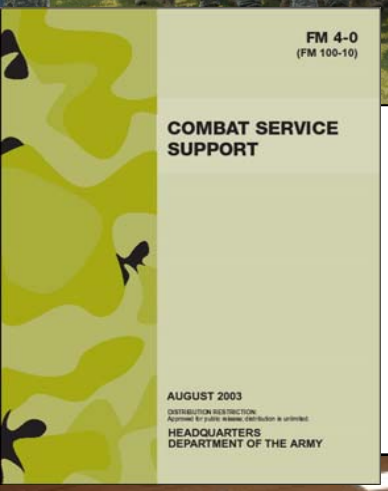
What Does CASCOM Do?

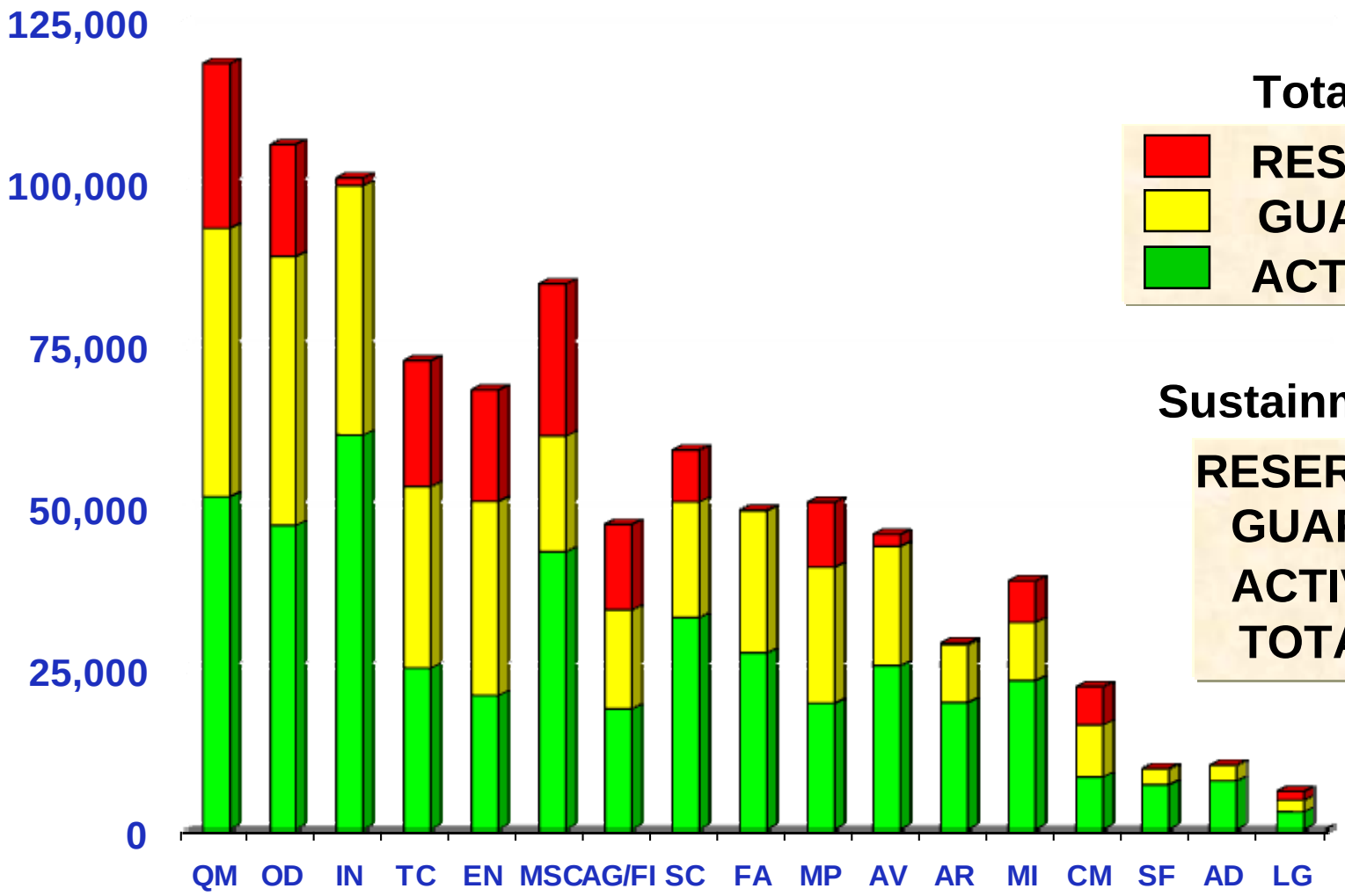


- We **train** Soldiers and **educate** Leaders
- We **organize** these Soldiers into units
- We write "how to" **doctrine** to guide them
- We **develop** state-of-the-art equipment for them
- We **assess** their capabilities and find ways to improve them
- We **focus** Army R&D investments on the right problems

Over 1/3 of Today's Army relies on us to enable them to remain Army Strong!

Branch Populations – Total Army Authorization Comparisons

(Source: QCCAUDB 20090130 / TAADS OOC DEC2008)



Total Army

- RESERVE (18%)
- GUARD (35%)
- ACTIVE (47%)

Sustainment Soldiers

- RESERVE (42%)
- GUARD (35%)
- ACTIVE (30%)
- TOTAL (38%)

Branch Populations – Total Army Authorization Comparisons

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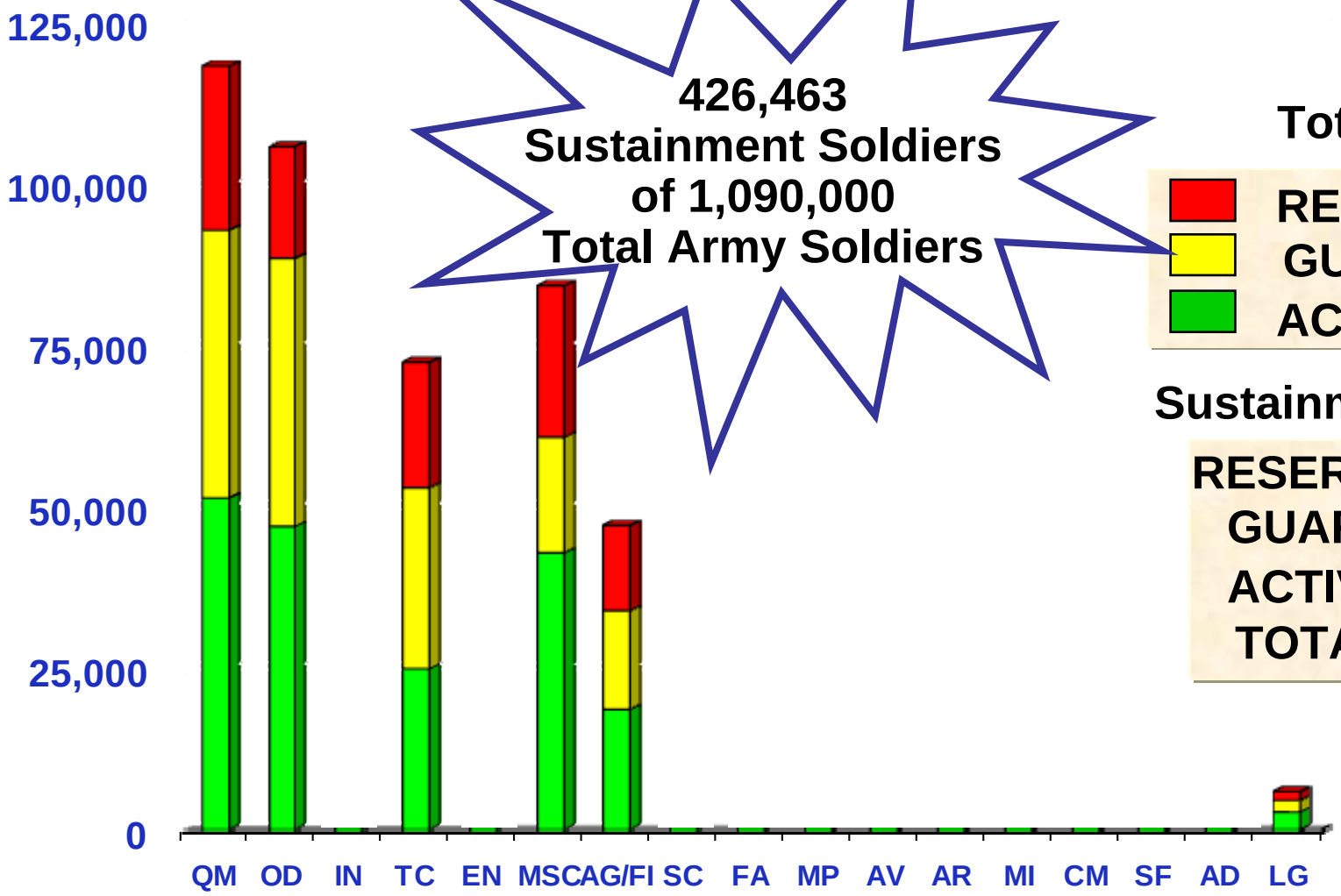


426,463
Sustainment Soldiers
of 1,090,000
Total Army Soldiers

Total Army

- RESERVE (18%)
- GUARD (35%)
- ACTIVE (47%)

Sustainment Soldiers

- RESERVE (42%)
- GUARD (35%)
- ACTIVE (30%)
- TOTAL (38%)

Year of the NCO

“ Competence is my watchword. My two basic responsibilities will always be uppermost in my mind -- <u>accomplishment of my mission and the welfare of my Soldiers</u>” **- NCO Creed**

What’s this got to do with robotics?

“***accomplishment of my mission and the welfare of my Soldiers”***

Robotics

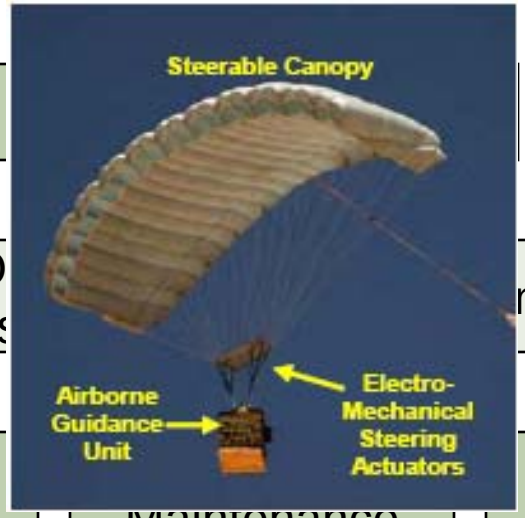
Definition: Technology dealing with the design, construction, and operation of robots in automation.

"robotics." Merriam-Webster Online Dictionary. 2009. Merriam-Webster Online. 19 March 2009 <http://www.merriam-webster.com/dictionary/robotics

Our Interpretation: A combat multiplier for the Sustainment Community that automates our capabilities and ensures the accomplishment of our mission and welfare of our Soldiers on the 21st Century battlefield and beyond.

Current Capabilities Using Robotics

Packbot-EOD



Joint Precision Airdrop System (JPADS)

RONS-EOD

TALON-EOD

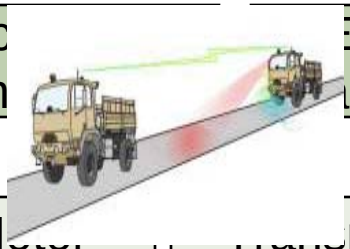
BomBot-EOD

Army Capabilities We Manage / Integrate

Unmanned Surface Vehicle

MULE

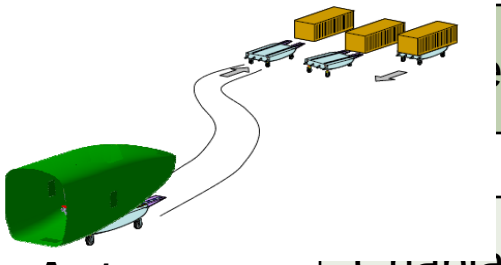
UAS Supply



CAST

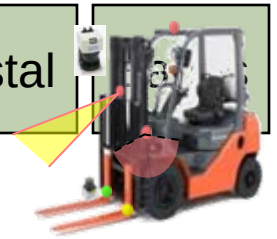
Sea Truck

BEAR



Autonomous Cargo Handler

Exoskeleton



Agile Robotic Forklift

The Challenge…

"Help us find ways to automate capabilities to accomplish our mission and to ensure the well-being of our Soldiers"

The possibilities are endless!

11

CASCOM POCs

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Year of the NCO

Thank you for helping us remain Army Strong!

Questions?

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Back-up Slides

Ground Robotics in Sustainment

Importance of Robotics

National Defense Authorization Acts goals for unmanned systems and preference over manned systems

Army Campaign Plan Logistics Transformation Annex

Autonomous Systems identified in the 26th Army Science Conference as a transformational/disruptive capability

Army Science and Technology Master Plan indentifies unmanned systems as a future force technology area

Several Warfighter Outcomes focused on robotics: Improved Inter-modal Platforms, Technologies, and Techniques; UGV Autonomous Movement; Increase Control of Unmanned Systems

Robotics identified as part of TRADOC Pamphlet 525-66,Force Operating Capabilities (FOC), functional concept for sustain, and Army Distribution Operations for the Future Modular Force

Agile Robotic

iRobot Pack Bot

MULE

Exoskeleton

JPADS

- Many of the current robotics applications grew out of CENTCOM operational need statements
- Robotics technologies can lead to paradigm shifts by introduction of many game changing technologies
- Various plans, roadmaps, alliances and robotics organizations have been established to synchronize development efforts

Sustainment Strategy

- Many emerging robotics capabilities can improve sustainment with respect to needed warfighter outcomes
- Factors to consider
  - Pressing operational needs that can minimize soldier exposure to dangerous operations (example: man-portable EOD Robots)
  - Broad applicability of technology across logistics functional domains, technology maturity, process improvement/ROI potential
  - Reliability, communications, security, interfaces, cultural acceptance, safety, and maintainability
- Approach
  - Conduct studies as necessary and incorporate expected robotics technologies into future concepts (ex. Maintenance strategy study)
- Consider robotics capabilities as part of DOTMLPF gap analysis
  - Support research, development and test of needed capabilities such as improvements to perception and human-machine interfaces
  - Continue to partner/form collaborative relationships
  - Identify and pursue development of needed capabilities

Ground Robotics in Sustainment

- **Transportation of Cargo**
  - Surface Transportation - transport cargo, equipment, and personnel by waterways, railroads, highways, oceans, and through joint logistics over the shore
  - Aerial Transport - Transport of cargo using three primary modes: airland, where the aircraft touches down to unload; sling load and air drop

- **Supply**
  - Encompasses all classes of supply necessary to equip, maintain, and operate military units
  - Includes warehousing, storage, inventory control, pick, pack and material movement

- **Maintenance**
  - Encompasses repair and maintenance of weapons systems and equipment
  - Includes diagnosis, repair, inspection, test adjustment, part replacement, and recovery of disabled equipment

Logistics Support

- Program managers can resolve most logistics issues using DOD Directive 5000.1 and the JCIDS process
- Additional standards and architecture work is required
- Remote operation of robots may stress secure communications capabilities
- Potential Robotics policy implications:
  - Autonomous operation will require new software and creative solutions
  - Maintenance actions could invalidate the platform security accreditation and present some unique operations security challenges

Hunter

Marcbot

Throwbot

Packbot

TELEMEDICINE VISION:

"Take the very best of Army Medicine to the Front"
--General Max Thurman, Former Deputy Chief of Staff, US Army

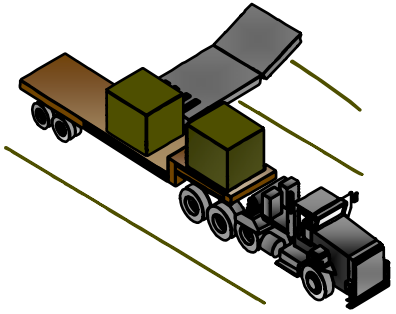
Military Medical Center

- Ubiquitous Electronic Medical Record to include diagnostic imaging throughout Continuum of Care
- Rapidly deployable Net-centric Global Grid enabled Telehealth care
- Teleconsultation to & from Role 3 & to 2+
- Telementoring to Roles 1/2 & direct to medic
- Robotic enhanced casualty extraction & care

CONFLICT

Boeing Cargo Handling Technologies

Advanced Cargo Ramp



- Articulated self aligning ramp
- Automated auxiliary loading ramps
- Automated cantilevered ramp toes

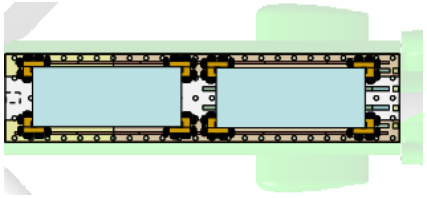
Cargo Handling Robots

iRobot

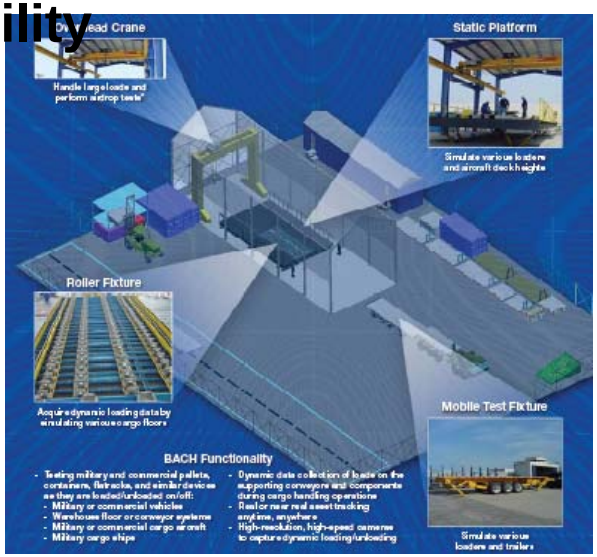
- Replicate legacy systems
- Reduce transport crew workload
- Replace current ground based MHE

Advanced Cargo Compartment

- Eliminate need for interface pallets and load pushers
- Rapid combat offload of platforms and containers
- Handled by a single loadmaster or crew chief
- Remote rapid reconfiguration



Boeing Advanced Cargo Handling facility



Develop and test new cargo handling technologies

Autonomous Cargo Handling Concepts
Basic Concept Description

- **Autonomous Cargo Handling Concepts**
  - **Military Cargo Robots (MiCaBots)**
    - MiCaBots are small robots that combine into teams to lift and move large, heavy payloads
    - One location being considered for storage of the MiCaBots is on the upper (inner) surface of the ramp door

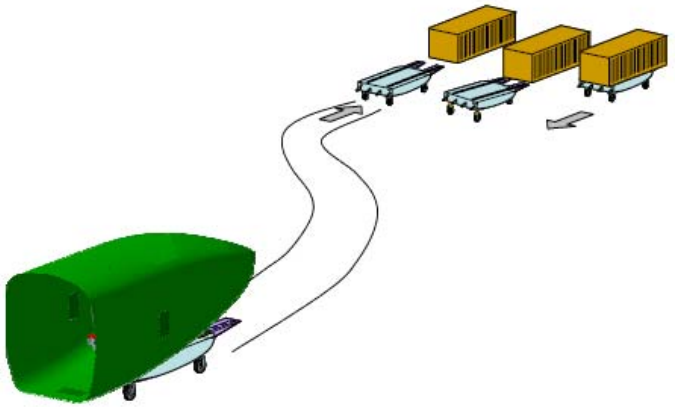


Figure 8: Autonomous Cargo Ramp

  - **Autonomous Cargo Ramp (ACR)**
    - ACR can detach from the aircraft
    - Senses location of a payload
    - Plans and executes a route to the payload
    - Retrieves the payload
    - Plans and executes a route back to the aircraft
    - Positions itself on the aircraft
    - Moves the cargo into the cargo bay

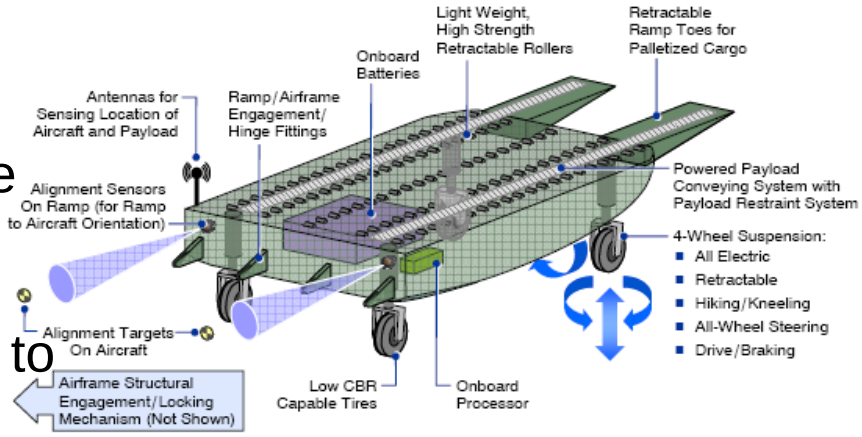
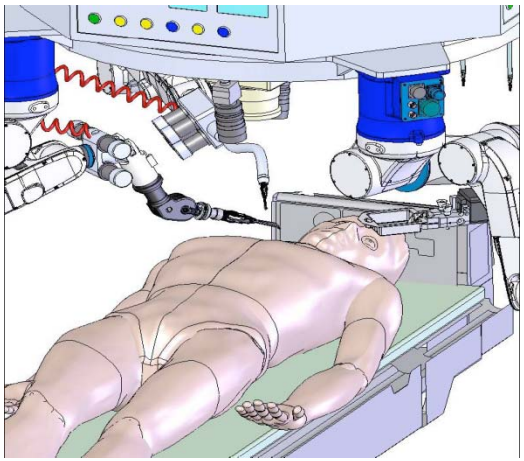


Figure 9: Autonomous Cargo Ramp Features

Telemedicine, BEAR, and the Future

Tele-operated Trauma Pod inside vehicle



- **Future Soldiers will utilize unmanned vehicles, robotics, and advanced standoff equipment to recover wounded and injured Soldiers from high-risk areas with minimal exposure.**
- **These systems will facilitate immediate evacuation and transport, under even the harshest combat or environmental hazard conditions.**
- **The MRMC and TATRC have teamed up to do research on telemedicine and robotics on the battlefield. Two items include the Trauma Pod and the Battlefield Extraction Assist Robot.**

Battlefield Extraction-Assist Robot (BEAR)

Future Combat Systems

The Mule, includes three variants:

Transport (MULE-T), Armed Robotic Vehicle – Assault (Light) (ARV-A-L)) and Countermine.

The XM1217 Transport MULE Vehicle (MULE-T)

•The Multifunctional Utility/Logistics and Equipment (MULE) Vehicle is a 2.5-ton Unmanned Ground Vehicle (UGV) that will support dismounted and air assault operations.

•The MULE is sling-loadable under military rotorcraft

•Configuration is designed to support Future Force Soldiers by providing a volume and payload capacity to carry the equipment and supplies to support two dismounted Infantry Squad.

•Multiple tie down points and removable/foldable side railings will support virtually any payload variation .

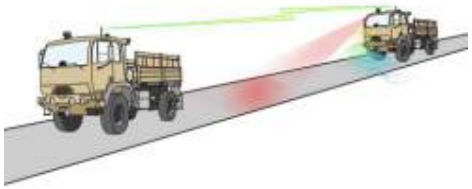
•It is suited to support casualty evacuations needs as well. It carries 1,900-2,400 pounds of equipment and rucksacks for dismounted infantry squads.

•The rugged vehicle relieves Soldiers of heavy equipment and packs while following them through complex terrain.

Future Robotics Technologies

- Military application of robotics technologies are centered primarily on tactical needs
  - Only one unmanned logistics platform is planned as part of the Future Combat System (FCS), the MULE-T
- Current research and development efforts are focused on advanced perception capabilities, intelligent control architectures, tactical behaviors, micro autonomous systems and improved human-robot interfaces
- Logistics focused Robotics efforts include
  - Robotics technology that can enhance convoy safety (CAST)
  - Enhanced strength and endurance capabilities using Exoskeleton
  - Agile Robotics material handling capabilities for movement of sustainment commodities in an unstructured environment

The FCS MULE's Three Variants: Assault, Countermine, and Transport



TARDEC CAST Technology Development

DARPA Urban Challenge

ARL XUV

EOD Robotics…where are we going

- The Army EOD units have had robotic platforms at the response team level since the late 1980's. We are presently using the 5th generation EOD robotic system.
- MK 3 Mod 0 RONS – Legacy system, limited capability.
- MK 4 Mod 0 BomBot – DARPA developed, sacrificial, small lightweight.
- MK 1 Mod 0 Packbot – MTRS platform deployed to CENTCOM.
- MK 2 Mod 0 TALON – MTRS platform also deployed to CENTCOM.
- GMAV – Small ducted fan form factor based on JUONS, in CENTCOM.
- AEODRS – Joint Service EOD next generation robotic system.
- EXOSKELETON (XOS) – Wearable Robot, PEO-Soldier NSRDEC.
- Robots save EOD Soldiers lives, (2) MTRS per (3) man response team (3) response teams to a Platoon (3) Platoons per CO, 18 MTRS per CO.

Ground Robotics for Sustainment Strategy

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Potential Advances

- Near to mid term
  - Improvements to transportation capabilities (convoy safety enhancements, unmanned aerial transport of cargo)
  - Human strength/endurance improvements for maintenance and other selected tasks that require frequent lifting/movement of heavy loads
  - Improvements to material handling, inventory and packaging capabilities supporting supply and transportation functions
- Mid to Longer term
  - Near autonomous logistics convoys
  - Fully Immersive training capabilities
  - Multi-task optimization using teams of robots to collectively meet goals
  - Unmanned Arial and JLOTS transport of cargo
  - Vehicle recovery and automated maintenance functions
  - Near autonomous warehousing
  - Micro and nano size robots

Potential Advances and Considerations

- Longer term
  - Transformer like robots with the ability to make on-the-fly changes to terrestrial mobility characteristics (legs, wheels and tracks)
  - Mechanical arms/hands that meet/exceed human performance….enabling human-like robots to perform high dexterity tasks using common tools and methods to seamlessly needed functions
  - Successful reverse engineering of the human brain to improve artificial intelligence techniques
  - Greatly improved robotics perception capabilities, allowing for near fully autonomous operations
  - Fully immersive environments with capabilities to control teams of remote robots
- Considerations moving forward
  - Effects of unmanned technologies on doctrine
  - Policy for human robot interactions
  - Liability and safety concerns
- Many great possibilities….