



RDECOM

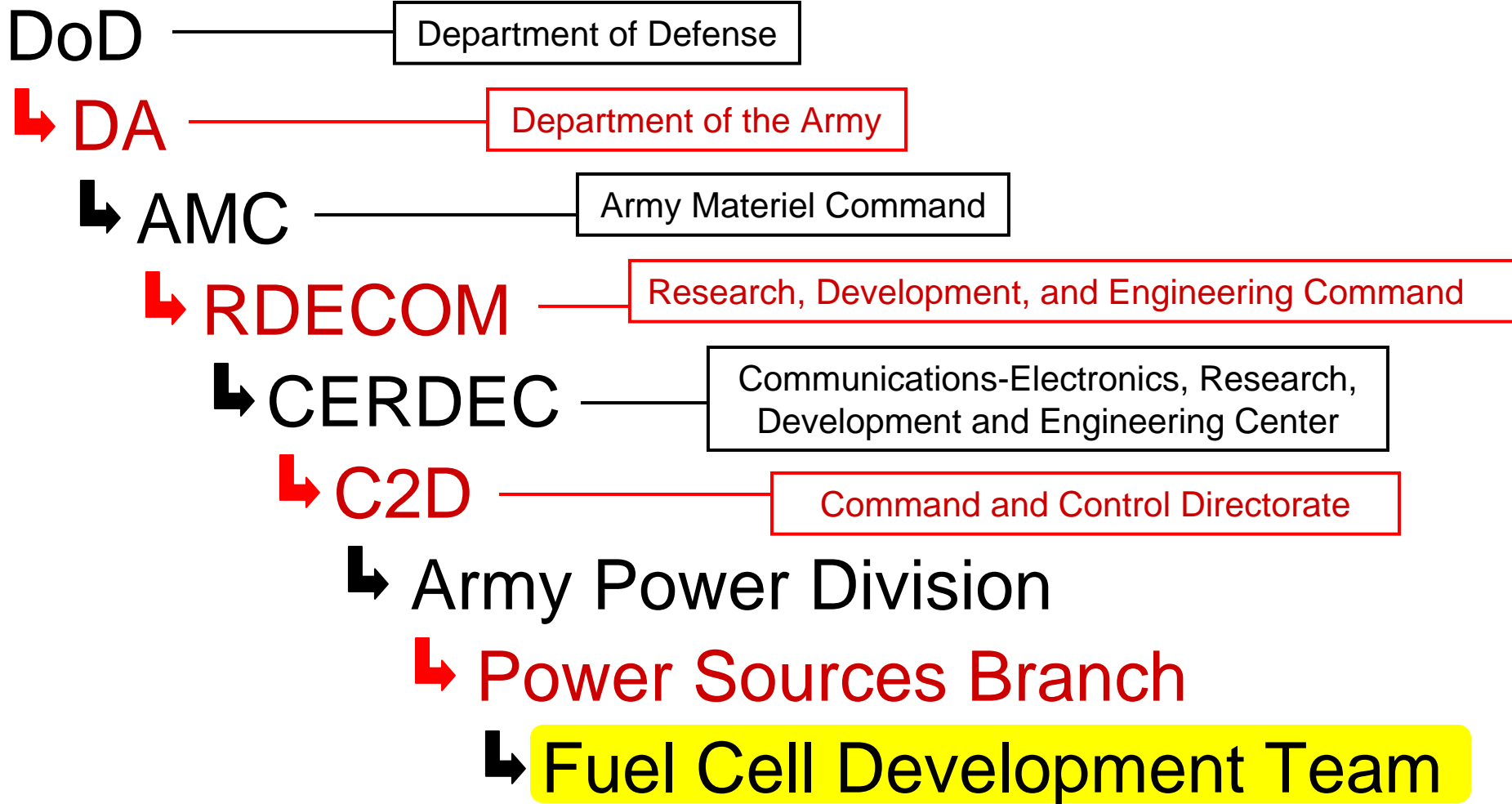
★ CERDEC
US ARMY – RDECOM

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

CERDEC Fuel Cell Team: Soldier and Man Portable Fuel Cell Evaluation and Field Testing

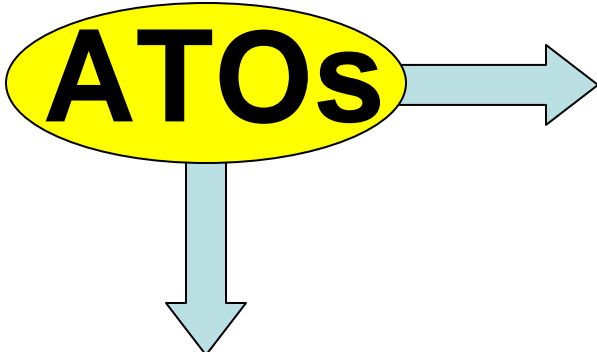
2009 Joint Services Power Expo – New Orleans, LA – 5 May, 2009

Mike Dominick, Elizabeth Ferry, JJ Kowal, Marnie de Jong, Jon Novoa



- **Army Power and CERDEC Fuel Cell Team Missions**
- **Sensor and Soldier Power**
 - **Potential Benefits**
 - **Recent Testing results (Akermin, AMI, Ultracell, Samsung)**
- **Man Portable Power**
 - **Potential Benefits**
 - **Recent Testing Results (Protonex, Idatech)**
- **Recent Exercises and Demos**
 - **Wearable Power Challenge, 2008**
 - **Medical Readiness Training Exercise, 2008**
 - **Cobra Gold, 2009**
 - **Rapid Fielding Initiative, Current**

Mission: Conduct research, development, and system engineering leading to the most cost-effective power, energy, and environmental technologies to support Army's soldier, portable, and mobile applications.



ATO R.LG.2009.01
Mobile Power
*Transitional Hybrid Power Source, Log-fueled
 Waste Heat Recovery
 Power Centric Mobility applications*

ATO D.CER.2008.08
Power for Dismounted Soldier
*Half-Sized BA5590 Li/CFx Battery
 Half-Sized BA5590 Li-Air Battery
 Soldier Conformal Rechargeable Battery
Soldier Hybrid Methanol Fuel Cell Power Source
Soldier Hybrid Fuel Cell Power Source
Portable Hybrid Power Sources & Chargers, JP-8 fueled*



Mission: Rapidly develop and transition suitable fuel cell technologies to applications where they are most needed.

Sensors
<5W

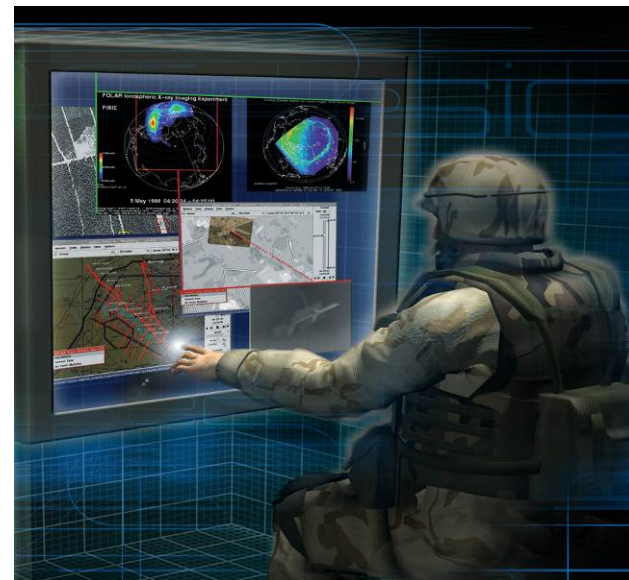
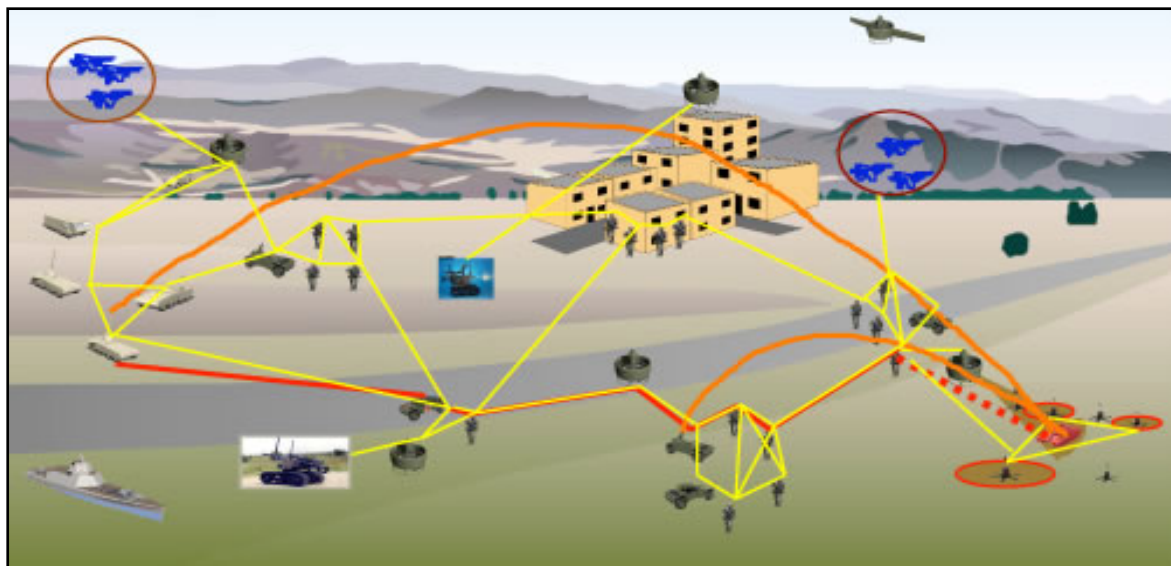


Soldier
Power
20 to 55W

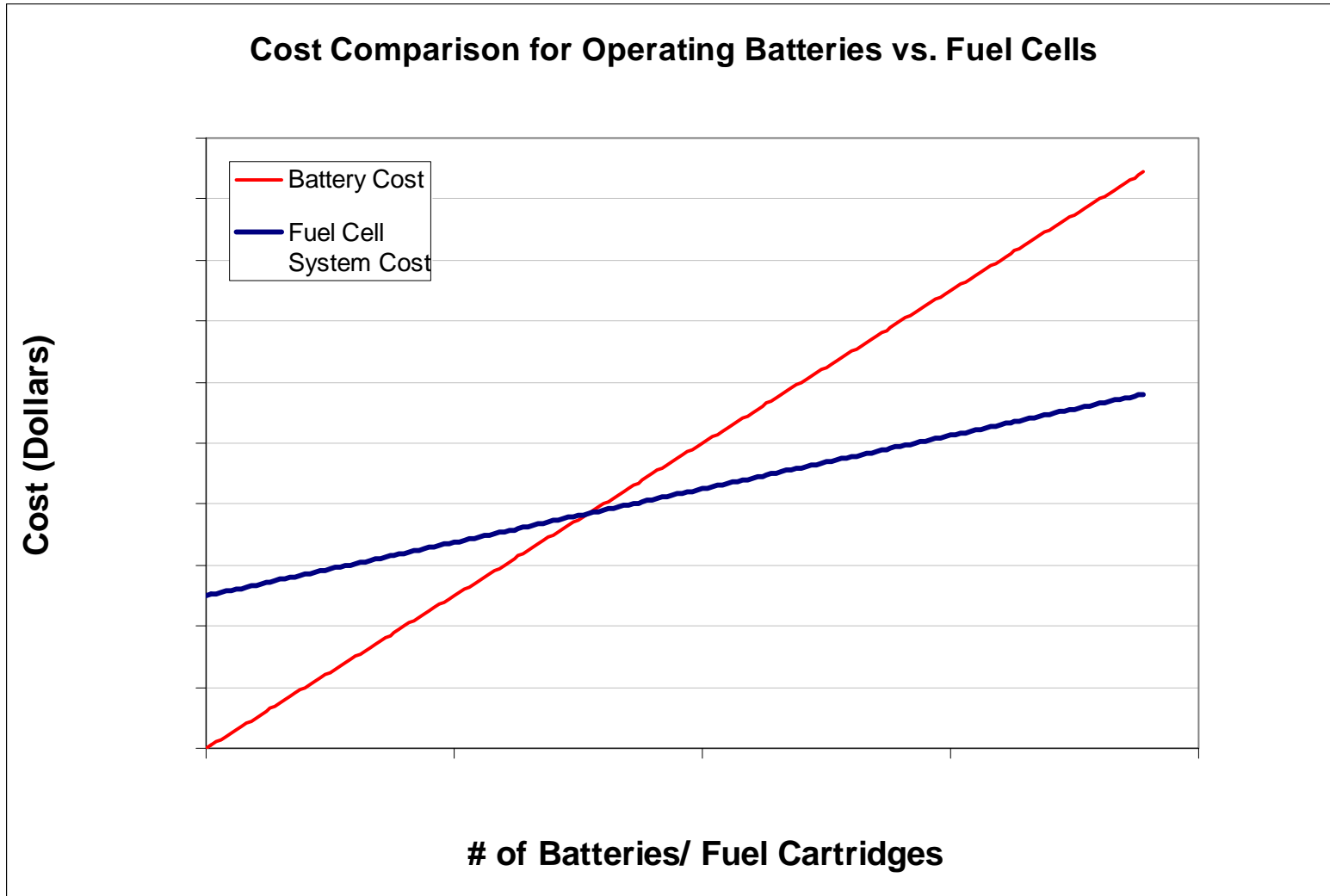
Man Portable
Power
150 to 500 W



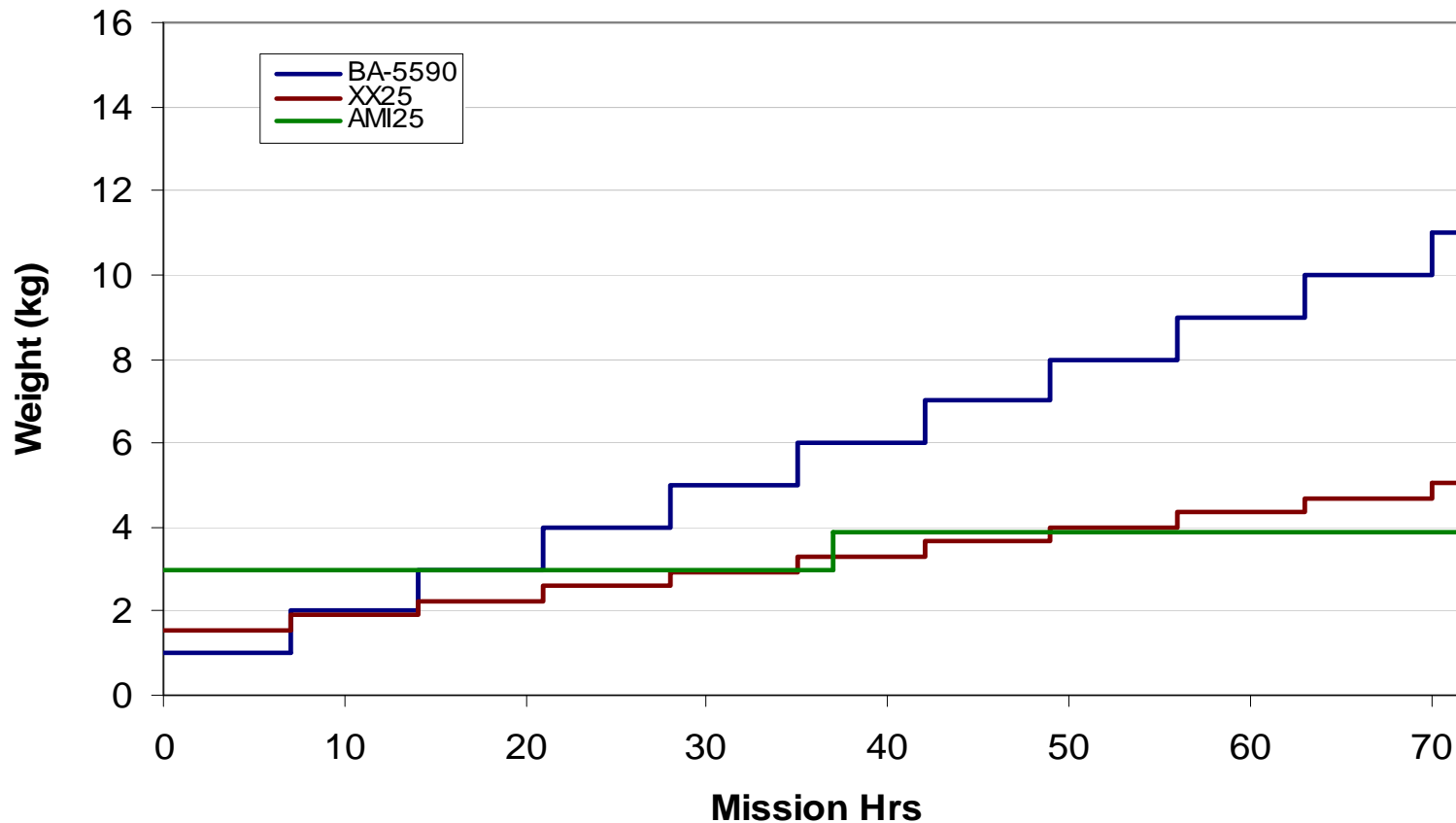
Fuel Cells for Sensors and Soldier Power



- Longer runtimes than current batteries for comparable form factors
- Logistic advantages related to handling and lifecycle costs
- Cheaper than current batteries for comparable power needs



25W Mission Weight vs Mission Hours



Current Programs and Recent Lab Test Results

Fuel Technology

Current Efforts

Direct Methanol



Reformed Methanol



Chemical Hydrides



Propane



Bio Fuel



In Development with CERDEC

Rated 100 mW continuous
Direct Methanol Fuel Cell (DMFC)
Fuel: Methanol/ Potassium Hydroxide Mix

Dimensions: 3.63" x 2.5" x 1.5"
Start Up Time: Instant (hybridized)

System Dry Weight: 160 g
Fuel Weight: 28 g (25 mL)

100mW Mission Energy Density:
Testing In Progress



Unattended
Ground Sensor

In Development with CERDEC and DARPA

**Rated 25W continuous
Solid Oxide Fuel Cell (SOFC)
Fuel: Commercial Propane Canisters**

Dimensions: 9.75" x 3.625" x 4.75"
Start Up Time: 9 min.

System Dry Weight: 2.1 kg
Fuel Cartridge Weight: 0.8-0.9 kg

25W Mission Energy Density:
24 hr 210 W-hours/kg
72-hr 460 W-hours/kg

Orientation independent

Operated from -20 to 55 °C



In Development with CERDEC and DARPA

**Rated 25W continuous
Reformed Methanol Fuel Cell (RMFC)
Fuel: 67% Methanol / 33% Water**

Dimensions: 9.30" X 5.38" X 1.80"
Start Up Time: 20 min.

System Dry Weight: 1.2 kg
Fuel Cartridge Weight: 0.35 kg (250 mL)

25W Mission Energy Density:
24 hr 230 W-hours/kg
72-hr 360 W-hours/kg

Orientation independent except upside down

Operated from -20 to 55 °C



In Development with CERDEC CRADA

**Rated 25W continuous
Direct Methanol Fuel Cell (DMFC)
Fuel: 100% Methanol**

Dimensions: 9" X 6.25" X 3.75"
Start Up Time: Instant (hybridized)

System Dry Weight: 1.895 kg
Fuel Cartridge Weight: 0.25 kg (250 mL)

25W Mission Energy Density:
Testing in progress

Orientation independent except upside down



Fuel Cells for Man Portable Power



Auxiliary Power/ Battery Charging

- Bridge power gap between batteries and generators
- Greater efficiencies than TQGs and vehicle power
- Reduced noise and heat signatures
- Enables remote, portable battery charging capability where other power sources are not practical
- Low emissions

Current Programs and Recent Lab Testing Results

Fuel Technology

Current Efforts

Reformed Methanol →



Ammonia Borane →



Sodium Borohydride →





Make (Type)	Nominal Power (W)	Dim. (in.)	System Weight (kg)*	Startup Time (min)	Fuel Cons. (g/hr @ 250W)
Protonex (RMFC)	250	10x14x20	22.8	25	360
Idatech (RMFC)	250	12x8x14	11.3	12	345

* Not including fuel weight

Recent Exercises and Demonstrations

WPP Challenge Goals:

Capable of providing 96 hours of operation

20W average power with 200W peaks

Weigh 4kgs or less

Attach to vest (wearable)



Winning Companies- all received previous CERDEC support:

- (1) Dupont/Smart Fuel Cell: *M-25 Fuel Cell System*
- (2) Adaptive Materials Inc.
- (3) Capitol Connections/Smart Fuel Cell: *Jenny 600S*

***CERDEC invested in all five of top placing companies
(4 – Ultralife, 5 - Ultracell)**



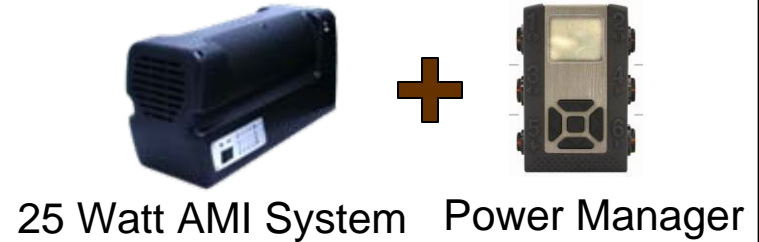
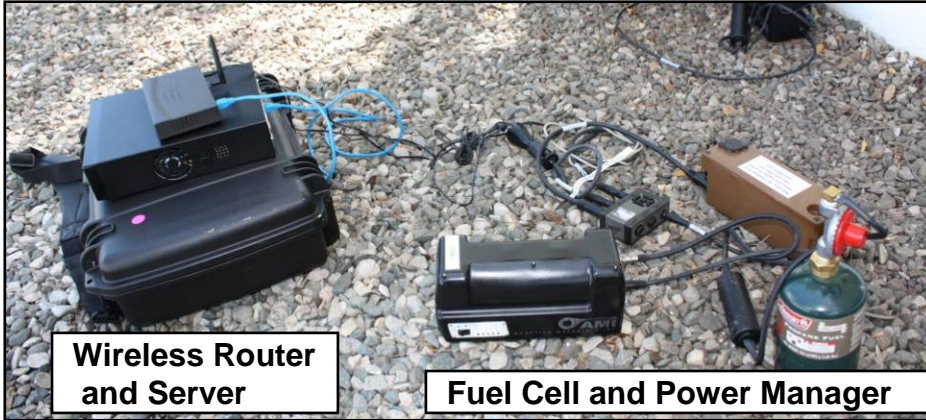


Las Calderas, Dominican Republic



What is it?

- Two week deployment
- Underdeveloped areas
- Medical and veterinary services
- Power grid not always reliable



Three fuel cell systems and power manager provided power for MUGR Mobile Recognition Terminal (MRT), laptop computers & local wireless network.



Two fuel cell systems and CLA adaptor provided power for laptop computers for validating and keeping medical records.



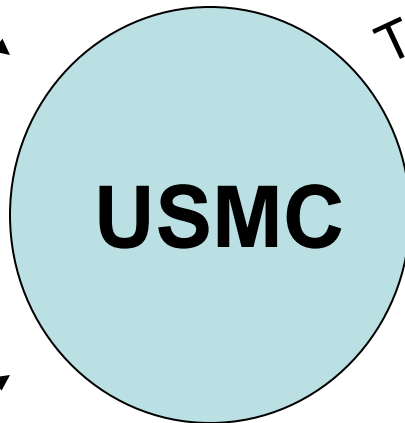
Sukhothai, Thailand

What is it?

Training exercise designed to provide training in a real world environment and work on logistics, operations, and interoperability with ally countries in southeast Asia.



AMI
Adaptive Materials Inc.



Toughbooks



Radios



Charging



UltraCell
HIGH POWER MICRO FUEL CELLS





Environmental Conditions

Temp: 25° to 35° C
Humidity: 60% to 80%
Environment: Dusty

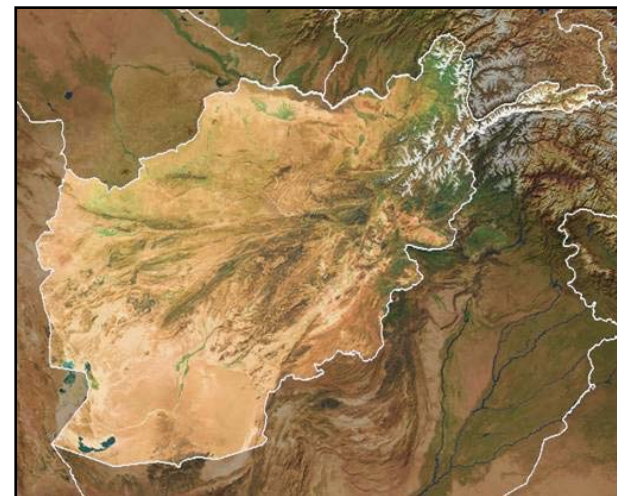
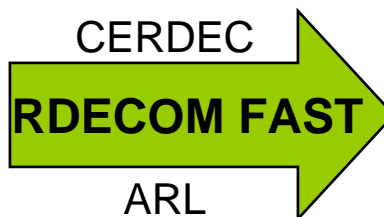
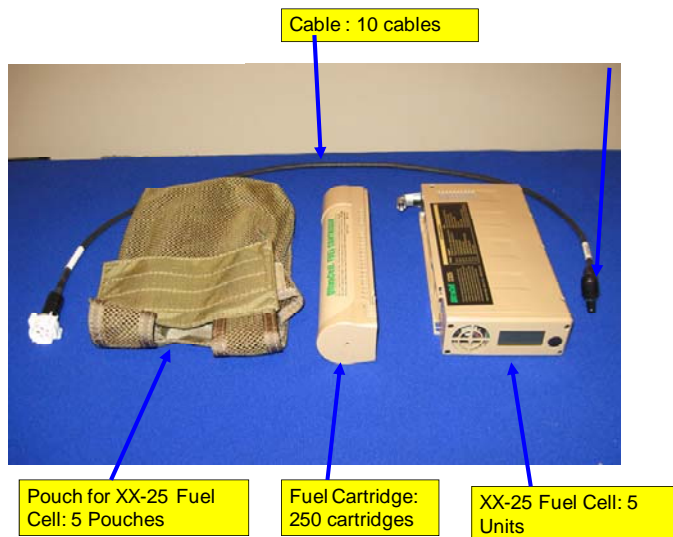


Successes

- Marines liked the portability, lightweight power sources.
- Reduced battery change-outs
- Reduced vehicle idle time

Shortcomings

- Some issues with reliability
- Heat and awkward connectors



- Need for lightweight, continuous, reliable power
- Five XX25s delivered to Afghanistan by CERDEC/ARL, November 2008
- XX25s are currently being used by different units in need of lightweight, long runtime power sources

- **Fuel Cells have shown great potential for military applications**
- **Many current systems have increased reliability and ruggedness**
- **No one technology has shown it will be the sole solution for the military**
- **Test and evaluation of fuel cell power systems plays a vital role in assessing the state of technology**

Michael Dominick, Mechanical Engineer
US Army CERDEC, Army Power
Division, Fuel Cell Development Team

Phone: (410) 278-8950, DSN: 298-8950

E-mail: michael.dominick1 @us.army.mil



Questions?

