



JOINT SERVICE POWER EXPO

Greg Cipriano, VP Marketing & Military Development

Phil Robinson, VP Electronics & Power Systems

May 7, 2009

THE NEXT GENERATION OF PORTABLE POWER.™

Agenda

- **Company Overview**
- Products and Technology
- Power Managers
- Alternative Energy Harvesting
- Questions



 **PROTONEX – The Next Generation of Portable Power...**

PROTONEX Overview

- **Leading provider of 100 - 1000 watt PEM and SOFC power solutions**
 - Portable, remote and mobile power
 - Targeting applications underserved by batteries and small generators
- **Strong traction to date with US Government agencies**
 - Over \$40M in program value with Air Force, Army, Navy, SOCOM, DARPA, DOE, NASA...
- **Well positioned to deliver product for military and non-military applications**
 - Offering PEM and SOFC products to meet diverse application needs
 - Capable of high performance and low cost

- **Key commercial partnerships in place, more in discussion phase**



- **Headquartered in Southborough, Massachusetts**
 - Development facility in Broomfield, Colorado focused on SOFC products
 - Excellent and experienced management and technical team
 - Over 90 employees today and growing
- **Publicly traded on the AIM market of the LSE - symbols: PTX and PTXU**

The Value of Portable Fuel Cells



VS. ADVANCED BATTERIES

- Reduced weight
- Extended run times
- Reduced size
- Lower life cycle cost
- Less hazardous contents
- Enables new missions

VS. ICE GENERATORS

- Low noise level
- Reduced emissions, indoor operation
- Greater efficiency
- Lower heat signatures
- Longer maintenance cycles
- Lower life cycle cost

> Fuel cell based power systems provide many advantages over existing technologies

Portable Power Focus - 100 to 1000W



- **Wearable (1–2 kg, ~20-50 W)**
 - Individual soldiers
 - Direct power of soldier loads, single battery charging



- **Packable (4–8 kg, 100–200 W)**
 - Squad level
 - Battery charging for soldier batteries
 - Direct power of field gear



- **Portable (10–20 kg, 250–1,000 W)**
 - Platoon+ level
 - Forward base battery charging
 - Tent power, silent watch



- **Truckable (30–60 kg, 1,000–5,000 W)**
 - Current tactical generators
 - High power equipment
 - Fixed APU for vehicles

Agenda

- Company Overview
- **Products and Technology**
- Power Managers
- Alternative Energy Harvesting
- Questions



 **PROTONEX – The Next Generation of Portable Power...**

Two Fuel Cell Technology Platforms

■ Proton Exchange Membrane (PEM)

- Fuels
 - Methanol
 - Chemical hydride
 - Hydrogen
- Operating temperature: 50°C – 75°C
- Configuration: planar
- Readiness: now



■ Solid Oxide Fuel Cell (SOFC)

- Fuels
 - Propane
 - Gasoline, Diesel and JP-8
 - Biofuels
- Operating temperature: 700°C
- Configuration: tubular
- Readiness: 1-2 years



> Fuel flexibility to address multiple applications
Strong overlap between PEM and SOFC

Current Military Platforms

M250-CX – Battery Charger/APU



- 35 pound, methanol-fueled PEM system
- Charges up to 5 batteries or functions as portable APU
- Proceeding to full product and 810f testing in 2009.
- Ongoing program funded by OSD, CERDEC, ARO

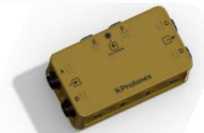
UAV and UGV Propulsion



- Demonstrated 9+ hours on Puma UAV vs. 2.5 hr on battery
- Moving to commercialize PUMA platform with Aerovironment
- Demonstrated over 3x range on FMI Talon



BPM and SPM Power Managers



- Provides soldiers with on-board power management of multiple devices
- High efficiency to reduce heat loads. Lightweight, compact and rugged
- Automatic and flexible for a wide range of applications
- Funded via RDECOM (AIDE), run by ARO/CERDEC

S125-CX – Battery Charger/APU



- 10 pound, propane or liquid fueled system
- Charges military batteries or functions as portable APU
- Early stage development, currently at TRL 5
- Ongoing initial program funded by ARO and CERDEC

➤ **Future products to follow with higher power levels and different fuel types**

Current Commercial Platforms

M250-B – Battery Tender



- Targeted mainly at recreation and renewable market
- Provides clean quiet power
- Methanol fuel
- Product introduction scheduled for December 2008

M250-U – Backup Power



- Targeted at Broadband and WiFi backup markets
- Provides extended run power for remote nodes
- Methanol fuel
- Provides compliance with Katrina Act

M250-G – Generator



- Targeted at recreation and emergency responder markets
- Operates indoors or outdoors
- Methanol fuel
- Product introduction scheduled for October 2009

P125 – Generator/Tender



- Targeted at recreation and commercial battery charging market
- Compact and easy to use
- Propane fuel
- Alpha prototypes scheduled for January 2009

> Future products to follow with higher power levels and different fuel types

Non-Military Application Targets

DC Backup Power

- Telecom Wireless
- Telecom Wireline
- Traffic Systems
- Broadband / CATV
- Critical Systems
- Security Systems



Recreation

- Portable Power
- RV Power
- Marine Power
- Campsite Power
- Remote Cabins
- Expeditions



Emergency

- Homeowner Emergency
- Battery Chargers
- Communications Equipment
- Emergency Response
- Security Systems
- Traffic Control Systems



Professional

- Scientific Equipment
- Power Tools
- Battery Charging
- Communication Systems
- Security Systems
- Video Equipment



Mobile

- Electric Motorbikes
- Personal Mobility
- Vehicle APUs
- Golf / Utility Carts
- Mobile Signage
- Commercial Robots



Renewable

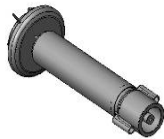
- Solar Power Systems
- Wind Power Systems
- Remote Monitoring
- Remote Signaling
- Off-Grid Homes



M250 Product Architecture

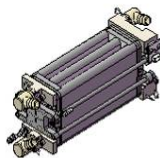
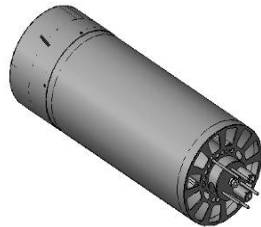
Fuel Reformer Core

- Unique patented design
- Commercial catalyst
- Designed for external fab



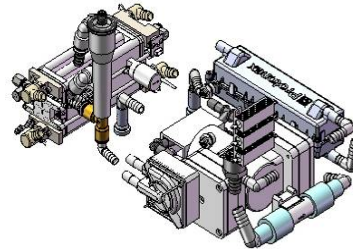
Fuel Processor Module

- Converts methanol to H₂
- Unique patented design and mfg process
- Designed for external fab



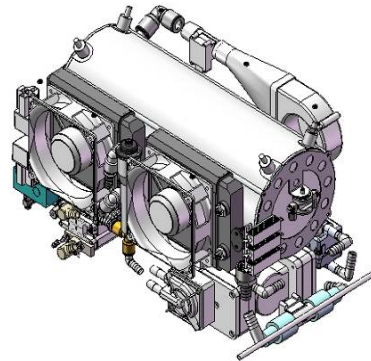
Fuel Cell Stack

- Unique patented design & mfg process
- In house manufacture
- Core of fuel cell system



Fuel Cell Module

- Feeds & controls for stack
- High performance, available balance of plant components
- Contains several proprietary PTX components

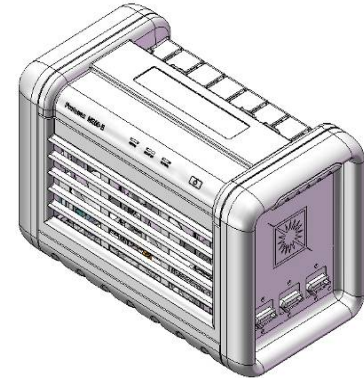


Integrated System

- Fuel reformer linked to fuel cell
- Control electronics, power management, safety systems
- Suitable for contract assembly at higher volumes

Packaged System

- Packaged specific to application
- Professional look and feel
- User interface
- All accessories and connections



M250-CX Battery Charger / APU

APPLICATIONS:

- Portable Battery Charger (Li145, LI80, BB2590)
- Primary Power Source (28 VDC, 110 AC with inverter)
- Portable Squad Power (Direct Power & Charging)
- Silent Power (Night Time, Quiet Environments)
- Vehicle Mountable (No need to run vehicle for power)
- Forward Operating Base Power (Long Endurance, Efficient)
- Long Endurance Missions
- Training Missions
- Battery Power Extension



M250-CX Battery Charger / APU

Battery Charging (250 watt continuous)

- BB 2590 3 Batteries @ Max Rate
- LI145 5 Batteries @ Max Rate
- LI80 5 Batteries @ Max Rate

APU (250 watt continuous)

- 28 VDC output, hybridized with logistic batteries (BB 2590)
- Luggable weight – 30 lbs
- Replaces 3,600 BA 5590 batteries over lifetime
- Strong value prop – better than 80% savings in weight and cost
- Operates for > 10 hours / gallon of fuel
- Low emissions (indoor operable)
- Low noise (<55 dBa @ 1 meter)
- Hardened to pass mil-std-810f
Previous generation passed
810f drop, shock & vibration

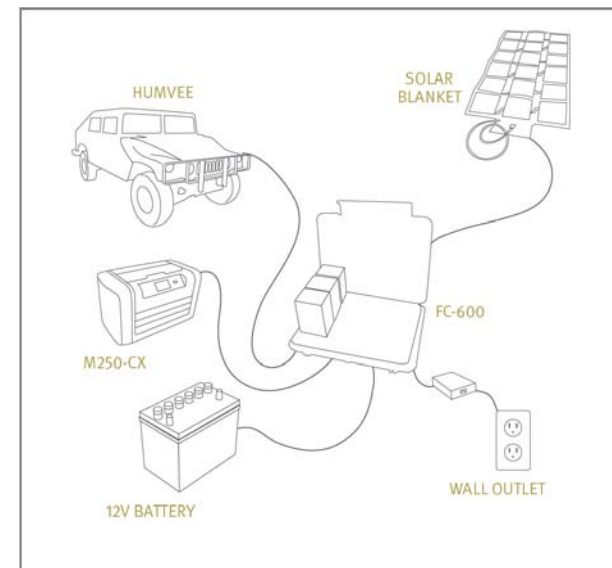


FC-600 Lightweight Battery Charger



- BB-2590 - all variants
- 1-6 batteries
- 3 hour fast recharge
- Fuel cell & solar power sources
- Military & civilian vehicle power
- Worldwide AC power

- **Compact reduced weight and bulk**
- **Runs cool even while charging multiple batteries with 96—99% ultra high efficiency chargers**
- **Uses SMBus protocol, aka smart batteries**
- **Minimizes fuel use by negotiating optimal power rate with fuel cells**
- **Automatically recognizes solar input and applies Peak Power Point Tracking algorithm to maximize usable solar energy**



UAV Activities *\$6.5M Funding to Date*



**United States
Special Operations
Command**

- AECV – 6 hour, Hand Launch



**United States
Naval Research
Laboratory**

- Ion Tiger – 24 Hour Demo



**United States
Air Force Research
Laboratory**

- Puma – 10 Hour, Hand Launch
- Raven B – range extension, 2-3x

UxV Key Value Proposition



- Longer Electric Endurance
- Quiet Propulsion
- Low Thermal Signature
- High Efficiency
- Reliable Electric Start
- Silent Hybrid Mode

Unmanned Vehicles and Fuel Cells

UAV



- Tier I Planes
- Tier II Planes

UGV



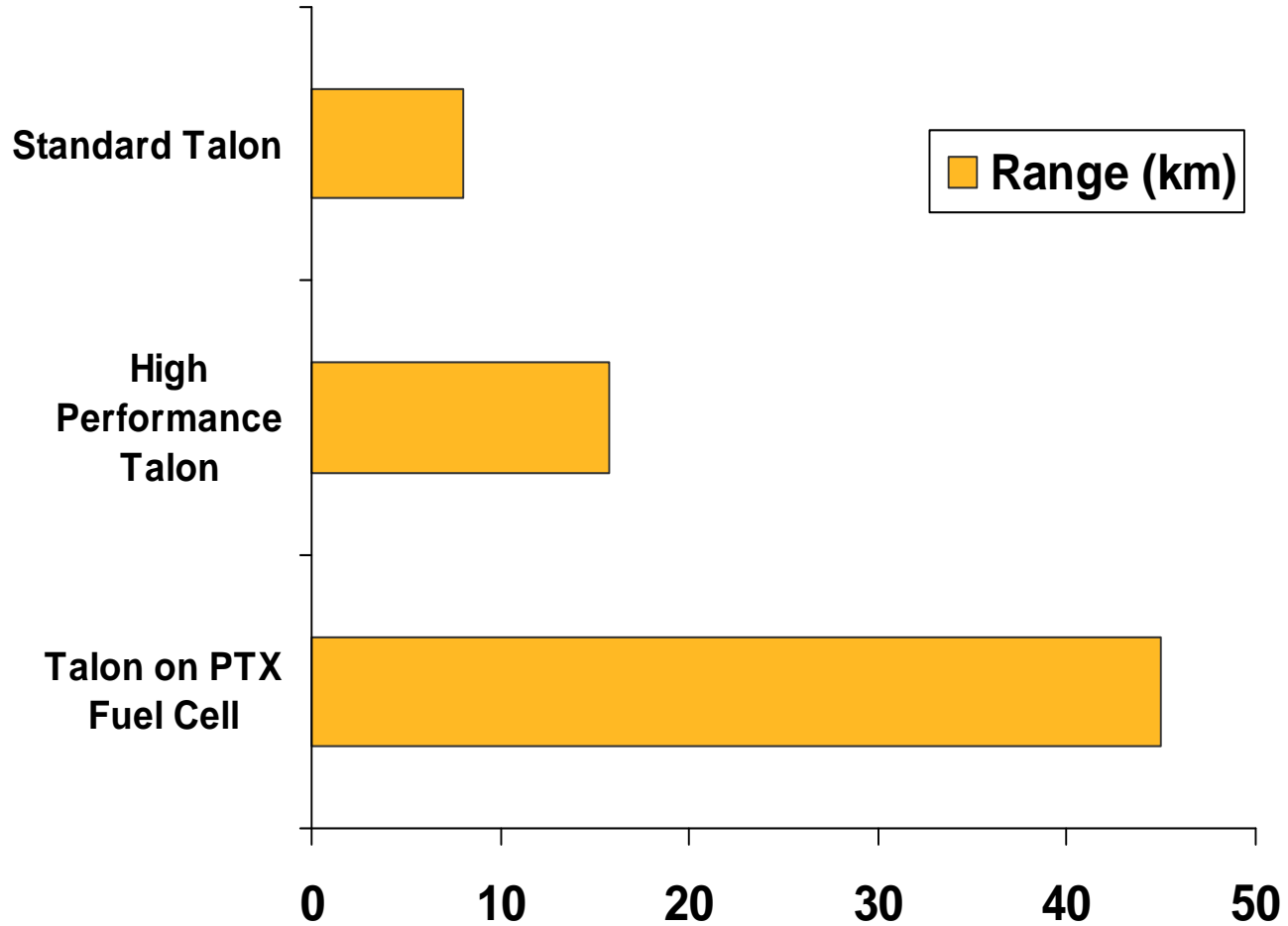
- Talon
- Others in discussion

UUV



- Evaluating opportunity with the Naval Undersea Warfare Center (NUWC)

UGV Energy Storage Comparison



Greater than 2X more energy storage compared to advanced batteries

UxV Power Spectrum

Vehicle	Power [watts]			Hybrid	Fuel	FC Weight [kg]
	Nominal Power	Max Power Continuous	Peak Power			
Plane A	80	120	400	Y	NaBH4	0.6
Plane B	120	150	700	Y	NaBH4	0.78
Plane C	140	220	500	Y	NaBH4	1.2
Talon	250	300	1000	Y	NaBH4	2.5
Plane D	200	300	300	N	Hydrogen	1
Ion Tiger	300	500	500	N	Hydrogen	1
Next Gen	800	1500	2500	Y	H2 via JP8	1.5

UAV Product Development Status



- Hand, Tube, & Rail Launch
- Deep Stall Autoland
- MIL-810F Qualification
- Altitude: 15000 ft
- Temperature: -10 - 50 °C
- Waterproof Designs
- Today: TRL 6-7
- One Year: TRL 7-8

Agenda

- Company Overview
- Products and Technology
- **Power Managers**
- Alternative Energy Harvesting
- Questions

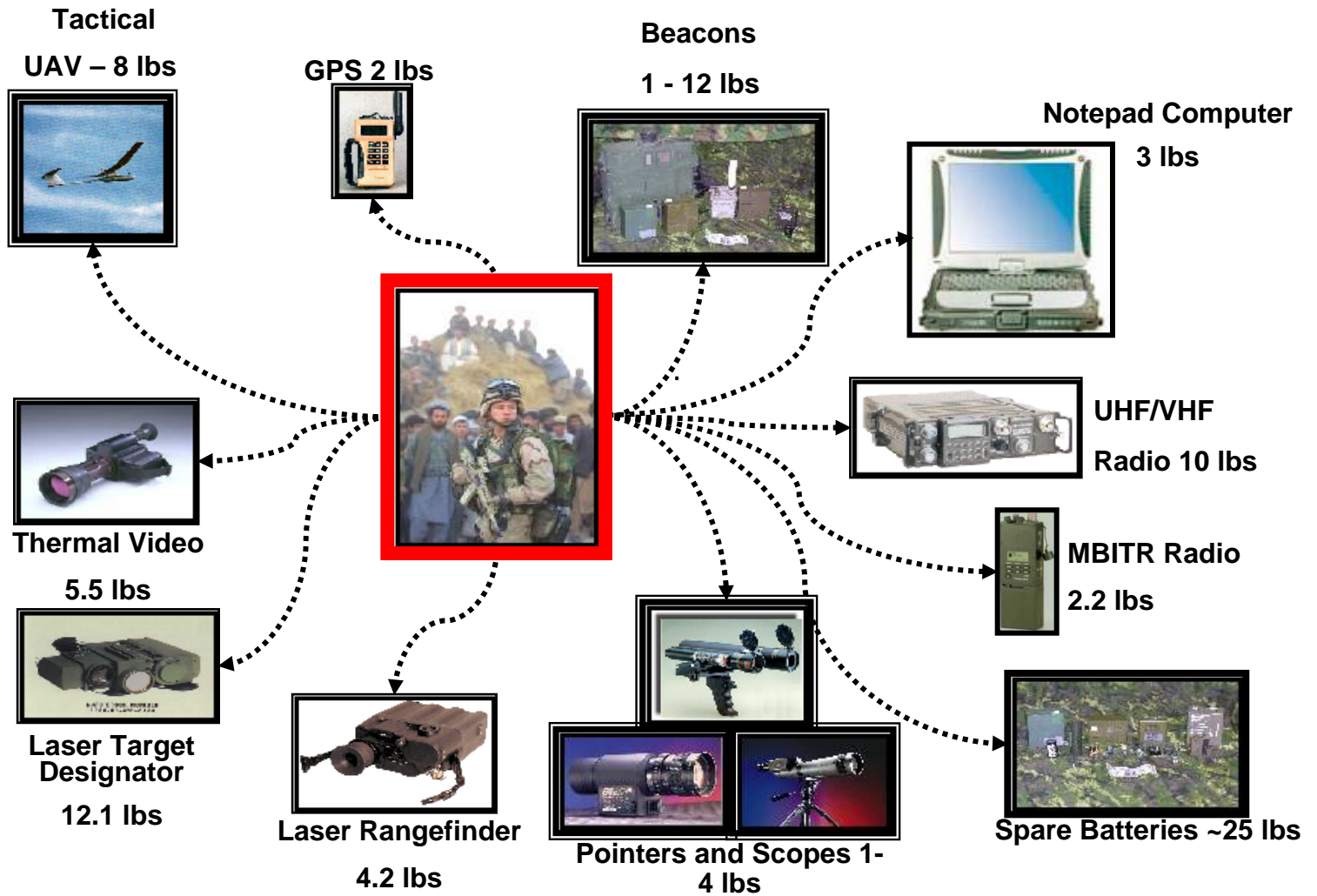


 **PROTONEX – The Next Generation of Portable Power...**

Why A Power Manager?



Today's Warfighter

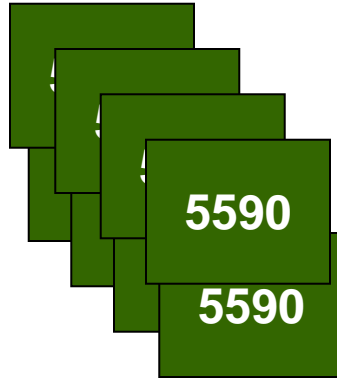


> All these devices use **DIFFERENT** batteries...

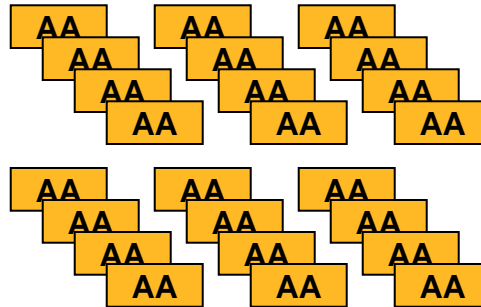
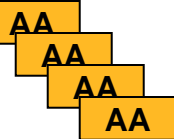
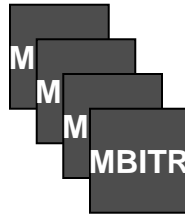
The Cost Of Battery Variety



5590



MBITR



The weight of the batteries in use is dwarfed by the weight of the spares!!

So What Is A Power Manager?

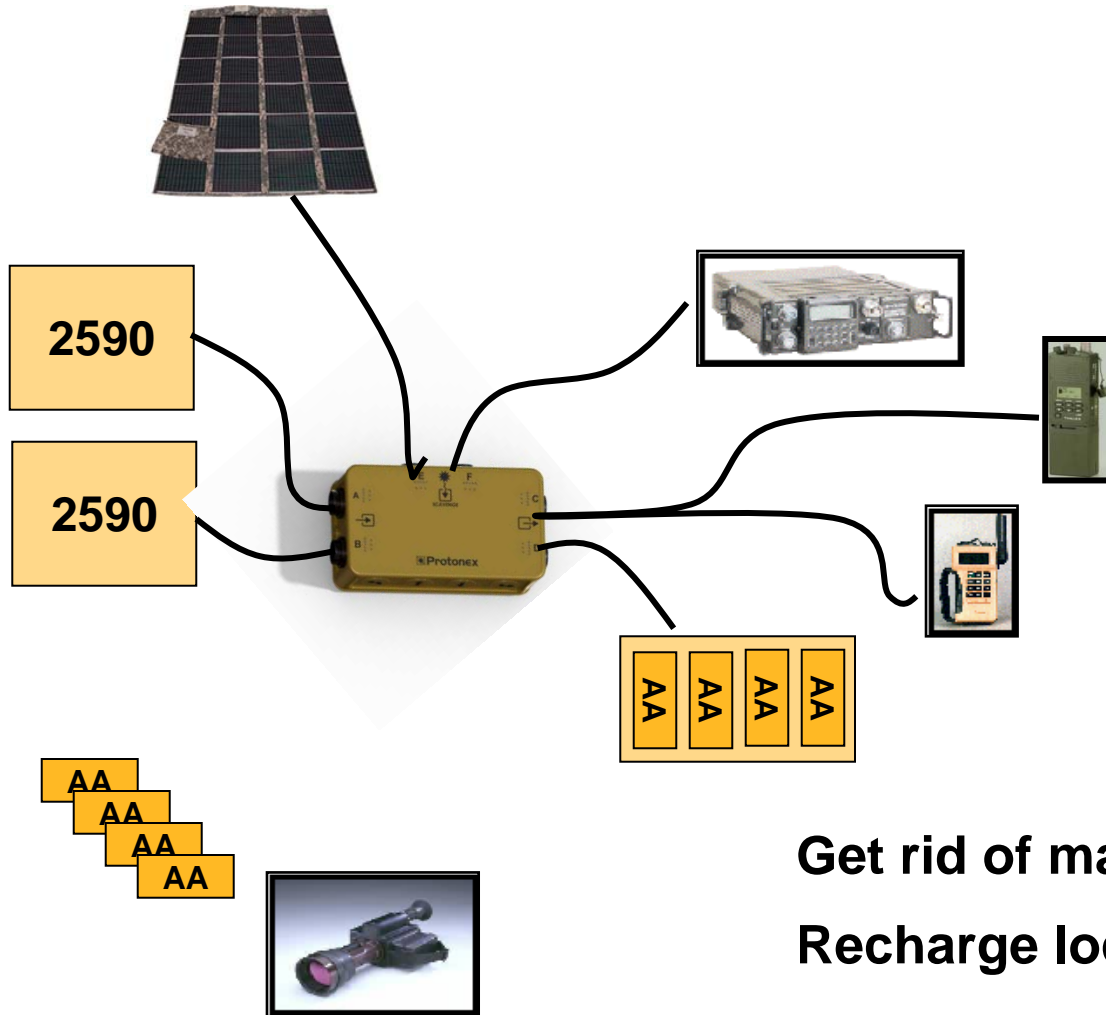
- **A Power “Universalizer”**
 - Take energy from any military or commercial battery
 - Power virtually any combination of portable military equipment

- **A Universal Recharger**
 - Pull energy from solar, wind, fuel cell, garrison power
 - Harvest energy from primary batteries
 - Recharge virtually any military rechargeable battery

- **An Active Power Monitor**
 - Gives instant at-a-glance status to the whole power system
 - Warns of impending power failure
 - Can proactively power down non-critical gear



Same Gear...



**Get rid of many spares...
Recharge locally....**

A Little History



- **Air Force Research Labs – BRITES**

- Fielded initial power manager concepts several years ago.
- Very specific for Battlefield Air Operations (BAO) Kit.
- Used with fuel cells and zinc-air batteries to reduce battery weight by 30-50%.

- **Army Research Office**

- Recognized need for more general power managers.
- Focus on warfighter simplicity – soldier not a power expert.

- **Natick Soldier Center**

- Early parallel power manager development
- Converging towards Soldier Power Manager

- **USMC Expeditionary Power**

- Early evaluator of BRITES system applied to USMC Forward Air Controllers

Protonex Power Managers – BPM

- **BPM-602: Battlefield Airmen Power Manager**

- Active power conversion and management for full BAO equipment suite, including laser designator (very high power)
- Designed with AFRL / AFSOC / ARO
- Positive field results at Ft. Dix, Hurlburt Field, and Ft. Polk
- Deployed in Iraq and Afghanistan for non-BA missions.



- **Ongoing Activities:**

- Invited by JRTC at Ft. Polk for testing at the Brigade level, followed by deployment.
- Packaging of Portable Combat Outpost Power system (deployed in Iraq).
- Weight / Cube reduction – Apply advances made in SPM development to the BPM platform.



Protonex Power Managers - SPM

- **SPM-611/612: Soldier Power Managers**

- Smaller and lighter follow-on to the BPM
- All battery conversion, recharge and management functions needed for a squad
- Designed with PEO Soldier / ARO / CERDEC / USMC / AFRL / Natick



- **Summer 2009 Activities:**

- Field trials at JRTC (Ft. Polk)
- Field Trials at AEWE (Ft. Benning)
- PM-SWAR Field Test

- **Enhancement Opportunities:**

- Enhanced Squad Battery Chargers:
 - MBITR Battery
 - Multi-Bay BB-2557



SPM Details

- **Six bidirectional power ports**
- **Three battery chargers / device converters**
- **Solar Peak Power Point Tracker**
- **System Intelligence – Zero Configuration**
- **Set n' Forget Charging**
- **Squad Charge**
- **Power Usage Management**



Rechargeable Batteries: Need For A New Paradigm

■ Today's Concept

- Batteries are recharged in bulk at a “depot”
- They are then used by soldier in the field
- When mission is over, passed back to depot for recharge

■ Why It Doesn't Work

- Batteries are treated like bullets: small bulk commodity item
- Model works well for disposable (primary) batteries
- How many times would you want to reuse a bullet?
- A matter of TRUST – just like with equipment

■ The New Paradigm

- Treat rechargeable batteries like **equipment**, not like **supplies**
- Soldier maintains his own equipment – builds TRUST
- Moves battery charging from the depot to the squad and soldier

Agenda

- Company Overview
- Products and Technology
- Power Managers
- **Alternative Energy Harvesting**
- Questions



> PROTONEX – The Next Generation of Portable Power...

Solar Power: Limits and Solutions

- **New Solar Panels: Lighter, More Robust, More Efficient**

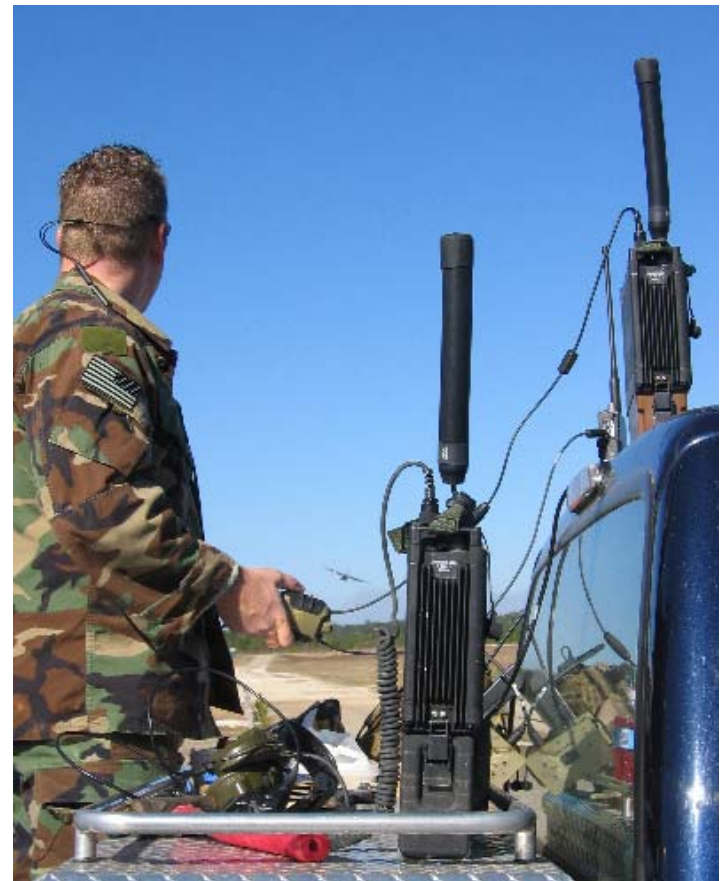


- **Solar + Power Management: Flexible Power**



Solar + Fuel Cell: 24 x 7 Power

- Active power management needed to minimize fuel usage and maximize availability.
- Efficient operation requires ballast battery system.

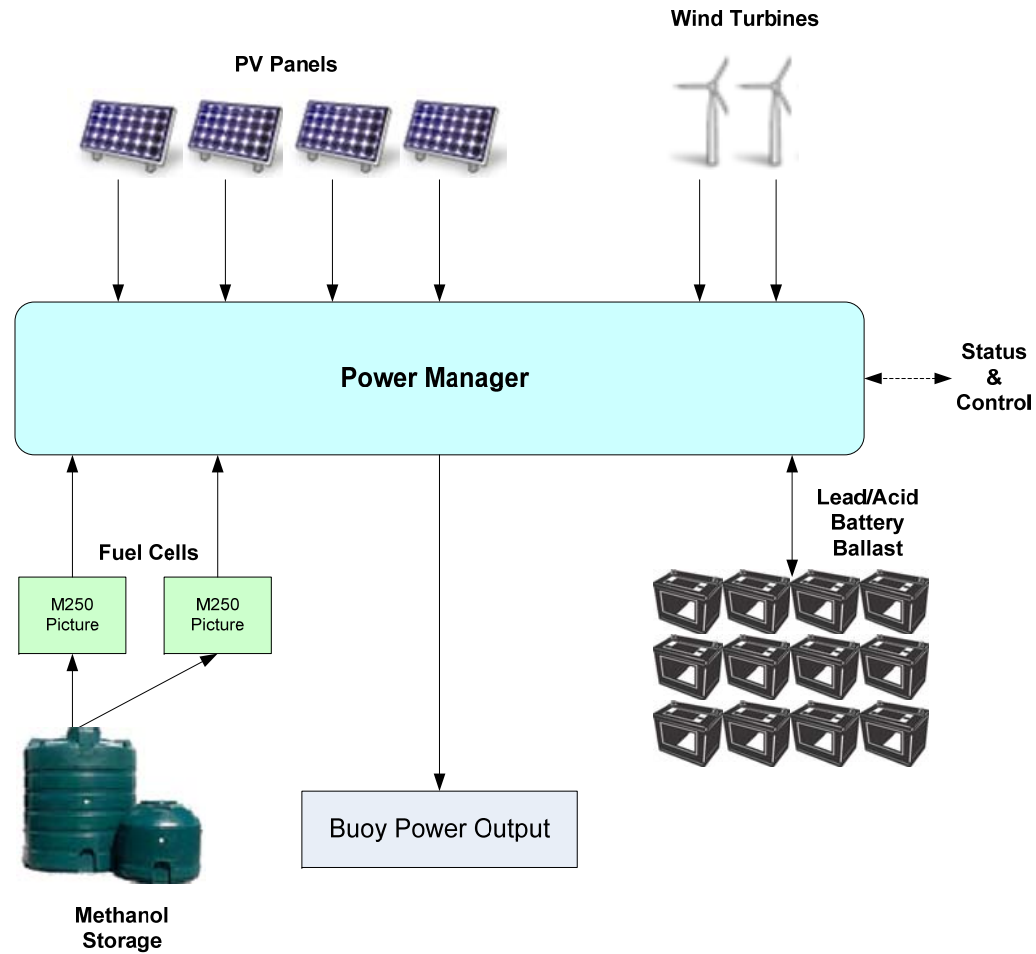


Afghanistan Deployment

- **UltraCell XX25, Global Solar and PowerFilm Panels, BPM-602**
 - Toughbook
 - PRD-13 SigInt Radio
 - Adding PRC-117F SatCom and PRC-4148 MBITR
- **Deployed late 2008 – Positive Feedback**



Alternative Energy Power Manager



Wrap-Up

- **Protonex is the Portable Power company**
 - Multiple fuel cell technologies and fuels
 - Full power management suite
 - Military and commercial battery charging

- **Power manager product line delivers:**
 - Less weight and bulk for the warfighter
 - More control and visibility
 - Significantly decreased logistics tail

- **Intelligent power management enables alternative energy use**
 - Enables combination of multiple energy sources – automatically
 - Applies this energy to many uses simultaneously



Questions?

Greg Cipriano
VP, Marketing & Military Development
greg.cipriano@protonex.com
508-490-9960 x208

Phil Robinson
VP, Electronics and Power Systems
phil.robinson@protonex.com
508-490-9960 x229

www.protonex.com

THE NEXT GENERATION OF PORTABLE POWER.™