Power & Sensor Solutions

The Case for Smart Power Management and Distribution for the Military

Joint Service Power Expo 2007

Introduction

- **Rick Silva**
  - At CME 6 years in military power management
  - Previous work in power automation at TeCom, a TECO Energy company, that resulted in two patents in Environmental Controls
- **PI for Shipboard Power Management**
  - Navy Phase II STTR with ONR
  - Power management for future Electric Ships
- **PE for Advanced Power Management**
  - Army Phase II SBIR that transitioned to Phase III, and resulted in a TRL 8 power system

What is Smart Power ?

- **Basic Elements of a Power System**
  - Generation
  - Distribution
  - Consumption
- **Smart Power System**
  - Where one or more elements act on information to effect a desirable change in the system
- **Examples**
  - Self-Dispatching Generators (demand based)
  - Input-Qualifying Distribution Equipment
  - Self-Shedding / Restoring Loads

Applications

- **Tactical Operations Centers (TOC)**
  - Radios, Networking Equipment, Computers
- **Forward Operating Bases / BEAR Bases**
  - Billeting, Kitchens, Showers, Medical Facilities, Satellite Communications
- **Ships**
  - Radar, Guns, Catapults, Missiles
- **Fixed Facilities – Camps, Forts, Naval Bases**
  - Admin. Buildings, Training Facilities, Housing

Tactical Operations Center

- **A TOC is one or more shelters, tents and/or containers outfitted with equipment and power with defined operational functions and arranged for efficient interaction among them.**
- **Functions in a Brigade TOC**
  - S2 – Intelligence
  - S3 – Operations
  - ENG – Engineering
  - ADA – Air Defense Artillery
  - FSE – Fire Support Element

Tactical Operations Center

- **Power Sources**
  - APU's: 10kW AC, 5kW DC
  - MIL STD
  - Tactical Quiet Generators; 3kW to 200kW
  - Non-MEP military / commercial generators
- **Issues**
  - APU limits mission equipment
  - Generators tend to be over specified/underused
  - Safety suffers from creative generator hookups
  - Phase imbalance can reduce available power
  - The need to reduce fuel consumption
  - Lack of training

Tactical Operations Center

- **Power Distribution - PDISE**
  - M200: 200A 3ph input, 100A, 60A 3ph output
  - M100: 100A 3ph input, 100A, 60A 3ph output
  - M40: 40A 3ph input, 12-20A 1ph outputs
  - M60: 60A 1ph input, 6-20A 1ph outputs
  - M46: 20A 1ph input, 12-15A 1ph outputs, 3 drop lights
  - Universal Adapter: 60A 3ph input, lugs output
- **Issues**
  - No connector for 60A 1ph shelters
  - Bulbs in the M46 break
  - M46 load can overload M40

Tactical Operations Center

- **Loads**
  - ECU, single largest load in most shelters
  - Power Supply, paralleled with vehicle battery for trickle charging and as a UPS for radios
  - Radios, SatCom, Phones, DAGR, MTS
  - Computers, Networking Equipment, Printers
- **Issues**
  - Not all loads are in the MTOE
  - Localized overloads do occur
  - Power quality may be lacking
  - SICPS shelters aren't 3ph loads

Smart Generators for TOC's

- **Smart Power Generation System**
  - Generators that can be clustered and run based on demand
- **PSI**
  - 20kW and 35kW generators
  - Auto-shed load bank to eliminate wetstacking
  - Auto-shed ECU in GET units
- **Rolls-Royce**
  - 15kW FEPS (VSIG about to go into service)
  - Prognostics / Diagnostics / Data Logging

Smart Generator Benefits for TOC's

- **Smart Power Generation System**
  - Clustered generators provide incremental power
  - Only generators that need to run are operating
  - Fuel savings
  - Higher reliability, no power disruptions
  - Smaller HMMWV towable generators
  - Prognostics / Diagnostics / Data Logging (R-R)

Smart Distribution for TOC's

- **Smart Power Distribution System**
  - Monitors and provides input status, ensures safety, balances loading across all phases
- **IPDISE is for distribution management**
  - Single and three phase AC sources and loads
  - Per phase measurements (V, A, W, Hz)
  - Passive and active load balancing across phases
  - Components; I200, I60, I46
  - Input Qualification
  - Embedded troubleshooting guide

Smart Distribution Benefits for TOC's

- **Smart Power Distribution System**
  - Safer power distribution through input qualification
  - Less training required through guided troubleshooting
  - Load balanced across phases, more available power
  - Fewer units per TOC, an I200 can accommodate 11 direct shelter connections plus daisy-chaining
  - Direct support for 60A 1ph shelters
  - Less weight, smaller size
  - Improved generator voltage regulation

Smart Loads for TOC's

- **Smart Load Management System**
  - Loads shed and restore with no mission impact, no soldier intervention
- **Intelligent Power Management System**
  - IPMS is for shelter load management
  - Total shelter and load power measurements
  - Priority based load shedding and restoral
  - AC and DC loads
  - Programmable breaker
  - TRL 8

Smart Load Benefits for TOC's

- **Smart Load Management System**
  - No soldier intervention, focus is on the mission
  - Avert overloads, loss of power
  - Priorities can be easily changed for different mission profiles
  - Power consumption and demand can be lowered

Smarter Loads for TOC's

- **Smarter Load Management**
  - Manage loads across multiple shelters
  - More sophisticated shedding and restoral
- **Distributed Power Management System**
  - DPMS is for load management across the TOC
  - Load aware shedding and restoral, load shifting, load sharing
  - AC and DC loads
  - Web-based Application
  - Embedded or Point of Load modules

Smarter Load Benefits for TOC's

- **Smarter Load Management**
  - TOC level load management provides more options for control of consumption
  - No soldier intervention, focus is on the mission
  - Avert overloads, loss of power
  - Load aware load management allows for virtually no programming
  - Web-based access to shelter load information
  - Point of Load modules simplify installation

Issues for TOC's

- **Smart Power Systems**
  - Implementation of Smart Power crosses boundaries of responsibility
  - No one owns the whole Power System
  - Historic and philosophical practices hinder advances
- **Future Possibilities**
  - The drive to reduce fuel consumption, weight, size and logistics tail could bring change
  - The Greening of the Military could be the start

Forward Operating/BEAR Bases

- **BEAR Base**
  - Air Force Mobile Base
  - Supports 550 airman increments
  - Basic Expeditionary Airfield Resources
- **Forward Operating Base**
  - Army version of BEAR
  - Supports 3300 soldiers

FOB / BEAR Bases

- **Power Sources & Distribution**
  - MEP-12, MIL-STD 750kW
  - DPGDS, Deployable Power Generation & Distribution System, 920kW
  - Prime Power output is 2400/4160 VAC
  - Prime Power requires Primary and Secondary Distribution Centers
- **Issues**
  - MEP-12 are old
  - DPGDS is Smart Generation but may have problems

FOB / BEAR Bases

- **Loads**
  - 60kBTU ECU's are used for cooling
  - Shelters are tents of various sizes from small barracks to large hangars
  - Billeting, Kitchens, Showers, Maintenance Facilities, Communications,

- **Issues**
  - The fuel needed by the base (4000 gal/day)
  - The directive to reduce the foot print and to go green

Smart Power For Bases

- **Smart Power Sources & Distribution**
  - Exists in DPGDS, assuming it works
  - Prognostics, diagnostics and data logging with Web-based access
  - Primary and secondary distribution monitoring
- **Smart Load Management**
  - Coordinated ECU control
  - Occupancy detection or scheduled operation

Smart Power For Bases

- **Micro Grid System**
  - The use of multiple generating sources
  - The inclusion of green sources (solar, wind)
  - The inclusion of less conventional sources (fuel cells, hybrid vehicles)
  - Overall system monitoring and control system (SCADA)
- **Prior Work**
  - Tyndal Air Force Base has done work in shelter based hybrid power generation

Smart Power For Bases

- **Micro Grid System Implementation**
  - DPMS could be used for distributed measurements and Point of Load controls
  - Larger generators of the PSI and R-R variety
  - Energy storage could be considered if there was sufficient green power overcapacity.
- **Issues**
  - Impermanence
  - Mobility
  - No commercial grid

Smart Power For Bases

- **Micro Grid System Questions**
  - Can green power be effective harnessed in this environment?
  - Can “Plug-n-Play” technology overcome the need to engineer the system?
  - Can this technology deliver the reduction in fuel and air lift footprint the military wants?

  There is much work to do to answer these questions.

Ships

- **Ship Power is in transition**
  - The Navy Electric Ship is at hand
  - Crew size reduction mandates automation
  - Electric weapons push for controlled high power
  - The Integrated Power System (IPS) will rely on Smart Power technology
- **Implementations**
  - PEBB / PCM units are Smart Loads
  - Smart Distribution Systems will control power distribution to provide reconfiguration for recovery from battle damage or faults as well as direct power to systems as required

Advanced Electrical Power System, Office of Naval Research

- Phase II STTR project to develop an advanced electrical power management system for future Navy warships
- Teamed with Texas A&M University Power Center
- Developing software application for power system reconfiguration

Benefits for Ships

- **Reduced crew size**
- **Enhanced survivability and fight through**
- **Electric Weapons support**
  - Rail Gun
  - High Energy Laser
- **High Power Sensor Systems support**
  - Radar

Variations on Smart Power

- **Energy Scavenging Autonomous Surface Vehicle**
  - Green Self-Navigating Surface Vehicle
  - Wind and solar energy for locomotion
  - Solar power stored and consumed by an electric outboard motor
  - Wind power is used for long distance travel

Energy Scavenging ASV, Office of Naval Research

- Phase II STTR to develop an autonomous surface vehicle (ASV) with self-sustaining energy scavenging and energy harvesting capabilities
- Provides energy harvesting technology development to support persistent, on-station surface platform
- Project includes the development of control algorithms and storage technologies.
- FSU Center for Advanced Power Systems (CAPS) on our team

Summary

- **A variety of military applications can benefit from Smart Power Systems**
  - Smart Generators
  - Smart Distribution
  - Smart Loads
- **The technology is available**
  - The application needs to be defined
  - The goals articulated
  - The benefits understood
- **With the right combination of technologies we can have a smarter future**

About Us

- Founded by Dr. Nancy Crews in 1997
- ISO9001:2000; 36,000 square foot Development & Manufacturing Center in Tampa Bay area
- Top Secret facility
- ~120 employees with 60 in Engineering
- 40% of technical staff possess graduate degrees
- Over 15 years average technical experience
- Technically diverse capabilities and products
- Proven electronics fab and assembly operation
- Leading SBIR/STTR transition company: 13 Phase I, 9 Phase II, and 5 Phase III projects
- Multiple Awards & Recognition
- Customers: Government and prime contractors

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