U.S. Army Research, Development and Engineering Command

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Global Energy Grid (GEG)

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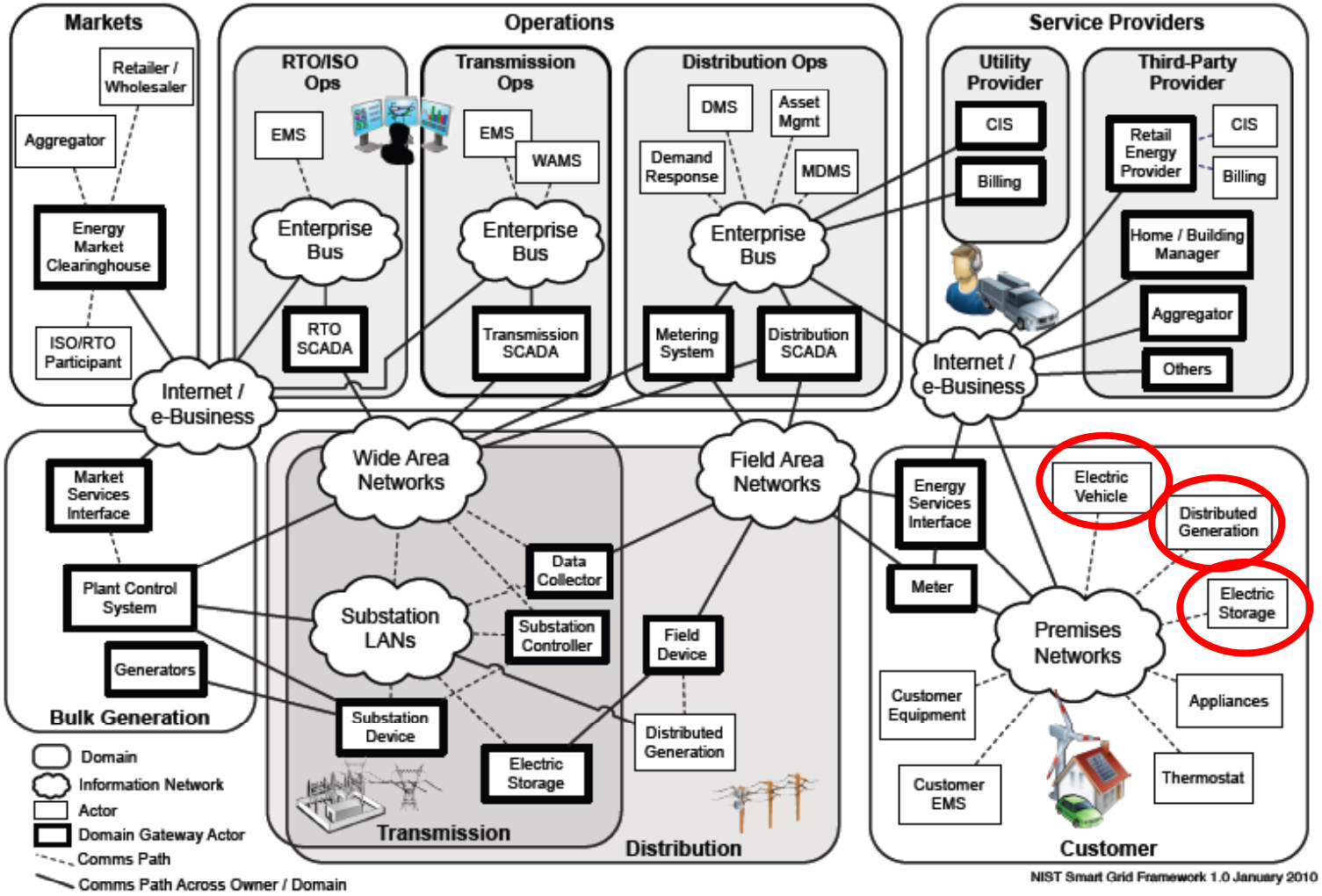
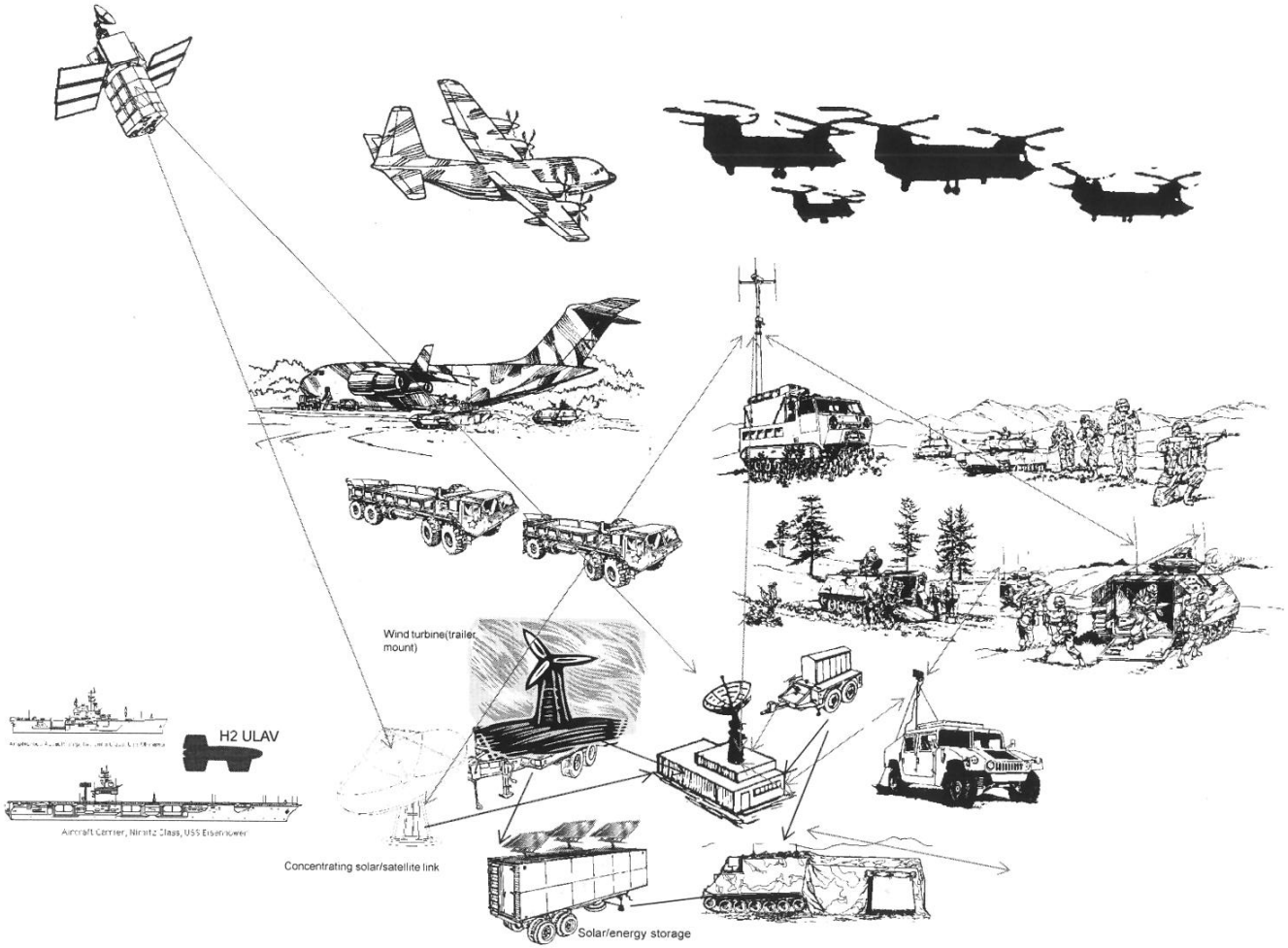
Smart Grid Structure



- Control network, and the security of that network, are key

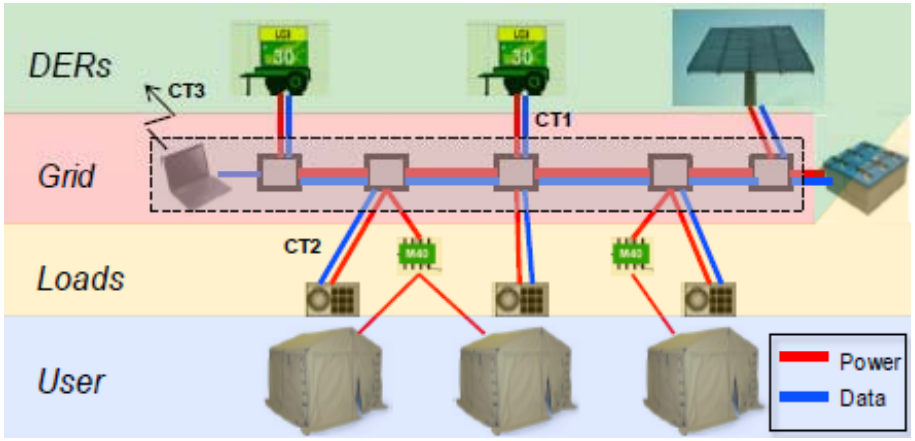
Global Energy Grid Structure



- Connected via the Global Information Grid (GIG)

Develop Standardization for Tactical microgrids:

- Interfaces for power sources (generator sets, renewables) and loads (environmental control units) must be defined
  - Enables an open architecture for any and all sources and Environmental Control Units (ECU's) and other loads to connect and communicate with the grid
  - Contractor agnostic
  - Enables future expansion and incorporation of additional sources and loads
  - Government owns the Interface Control Document (ICD) and Performance Specification for generator and ECU mod kits to enable source and load communication to the microgrid
  - ICD's can be implemented into future procurement of generator sets and ECU's to ensure communication with the wider grid



MIT study analyzed CT1 and CT2 and recommended MODBUS (industrial automation bus) to Ethernet TCP/IP. Also need to include:

- CANbus (Vehicles)
- DNP3 and IEC 61850(utility grid)
- Others(USB, SMAbus)

Over "wired" (copper and fiber optic)

Equivalent Local Marginal Pricing (Work in Progress)

- Energy [E]= Storage(Eff.) + Fueled Generation + Renewables
- Energy/ Integrated Power = Runtime [T]
  - Fuel Generation = $\sum$ Installed Capacity X Fuel Available X Efficiency
  - Renewables= $\sum$ A X Installed Capacity
    - $A \leq 0.5$ for solar
    - $0 \leq A \leq 1.0$ for wind
    - $A = 1$ for Fueled Generation
- For a given runtime T, there is a required mission dependent energy requirement E_R
  - $E > E_r$ sell energy
  - $E < E_r$ buy energy, for given T, but at what price?

Pricing (cont'd)

- Price per Unit energy (kWh?)
  - Fueled Generation = Fuel units (Eff)/ Unit Energy
  - Price Fuel units = Base fuel price + Price of delivery

    = Base fuel price + (Distance X Danger)
  - Renewables = $\sum$ Availability X Installed Capacity X (Distance X Danger)
  - Extra Fueled Generation = "

•Need: Price of Distance and Price of Danger

•And other terms (maintenance, probability of battle damage, redundancy, etc.)

Summary and Conclusion

- Opportunities exist to extend and leverage civilian Smart Grid research and development to the military
- Military is in a unique position to advance Smart Grid technology which is predicated on Informational Assurance (IA) due to the development of the Global Information Grid (GIG)
- Global Information Grid may be symbiotically augmented by a Global Energy Grid (GEG)
  - GIG enables GEG
  - GEG powers GIG
- Technologies not only enable GEG but are enabled by it i.e. Alternative Energy
- CERDEC welcomes the opportunity to partner with DISA and other services to advance these goals
  - Establish formal agreement
  - Designate POCs in each organization
  - Expand original concept to better meet DISA needs