Supercapacitors, Applications and PROS & CONS
Technology Comparison

- Lead-acid
- NiCads
- Lithium
- Ultracapacitor
- Hybrid capacitors
- Double-layer capacitors
- Aluminum electrolytic

Dashed lines are isotherms of characteristic time constant.
Energy Storage Technology Options

- **Batteries:**
  - very high energy density
  - bad cycling stability / lifetime
  - Safety
  - Shipping restrictions
  - low peak power

- **Flywheel Storage:**
  - high energy density
  - bad cycling stability / lifetime
  - expensive
  - low peak power

- **Ultracapacitors:**
  - high power density
  - high numbers of cycles / lifetime (>1M cycles, >10yr)
  - simple technical system (reliability)
  - safety – no chemical reaction (store energy electrostatically)
  - no shipping restriction
  - low energy density
Industry Applications and Trends

- Demand for long life with wide temperature range requirements
- Frequent battery replacement
- Government regulations – reduce rapid depletion of natural resources
- Increased investments and government funding for energy efficient devices
- Demand for small high-frequency devices
- Greater focus on system level collaboration
- Pairing with various battery technologies for load leveling
- Li-Ion safety and logistic concerns
Application Classifications

- **Dynamic**
  - Rapid change of current
  - Rapid change of power in and out of ucap
  - Rapid change of voltage to ucap
  - Wide ambient temperature fluctuations over the application life
  - High current/power loads on ucap
  - High vibration environment
  - Long cycle life requirement

- **Static**
  - Steady operation vs time
  - Majority of time spent in charged state
  - Low charge current, long charge duration
  - DC life critical
  - Self discharge critical
Back up Power Applications

**Ultracapacitor Benefits:** High reliability, maintenance free, long life

Examples: Graceful Power Down, Bridge Power, Ride Through – seconds to a few minutes
Peak Power Applications

**Ultracapacitor Benefits:** High Power Charge/Discharge, Up to 1 Million Cycles, High Duty Cycle, Long Life

Markets and Applications

- **Industrial**
  - Automation
  - Scanner/POS
  - Surveillance
  - Transportation
  - UPS
  - Lighting

- **Data Storage**
  - Memory Backup
  - RAID
  - SSD
  - HDD

- **Smart Grid**
  - AMR/AMI
  - Solar
  - Wind
  - Energy Harvesting

- **Consumer**
  - GPS
  - Entertainment
  - Appliance
  - Smoke/CO Detector

- **Medical**
  - Handheld
  - Patient Monitoring
  - Ultrasound/MRI

- **Telecom**
  - Infrastructure
  - Networking
  - Wireless
  - XDSL/DSLAM

- **Military**
  - Emergency Power
  - Avionics
  - Radar
  - Munitions
  - RF
  - Vehicles