Backup Power Systems

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Backup Power Systems

The RMC 7X24Exchange does not endorse any manufacturer's product and it is not our intent to do so in this presentation. Information is presented using manufacturer's names and product identification. References to specific manufacturers are not product endorsements or recommendations of one product over another.

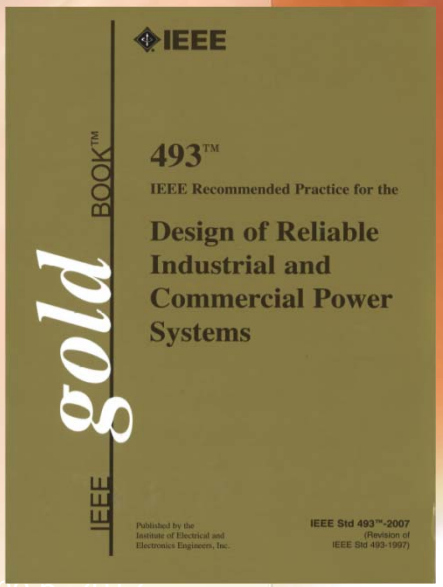
Types of Data Centers

- **Mission-critical or business-critical (enterprise data centers, military, medical records): Downtime stops business processes and organizational productivity, and revenue starts dropping immediately. Real-time transactions can be lost, and potentially not recovered, introducing major risk and liability. The financial impact could alter earnings.**
- **Batch processes (research): Seismic data reduction, drug molecule modeling, weather mapping and financial predictions, non real-time processes; the results can be replicated if interrupted. As long as the process is completed within the expected delivery window, exactly when the work is run and whether it is interrupted are not important to the user.**
- **Real-time services processing: Jobs like Web searches, services from an application services provider or software-as-a-service have little or no direct financial consequence to the service provider; if there is an interruption, the user may incur losses and frustration.**

http://www.forbes.com/2009/02/10/data-center-computing-technology-cio-network_0211_data_center.html

Reliability

- **IEEE 493-2007, Chapter 8, 7x24 Continuous Power Facilities**
- **What constitutes a failure?**
  - **"…inability… to perform a function…"**
- **The concept of "N"**
  - **"N" is the required component to achieve an operational system**
    - **If a 1000 kVA load:**
      - **1000 kVA UPS: N=1**
      - **500 kVA UPS: N=2**
      - **Two 1000 kVA UPS's: 2N**



Reliability, Availability and Maintainability

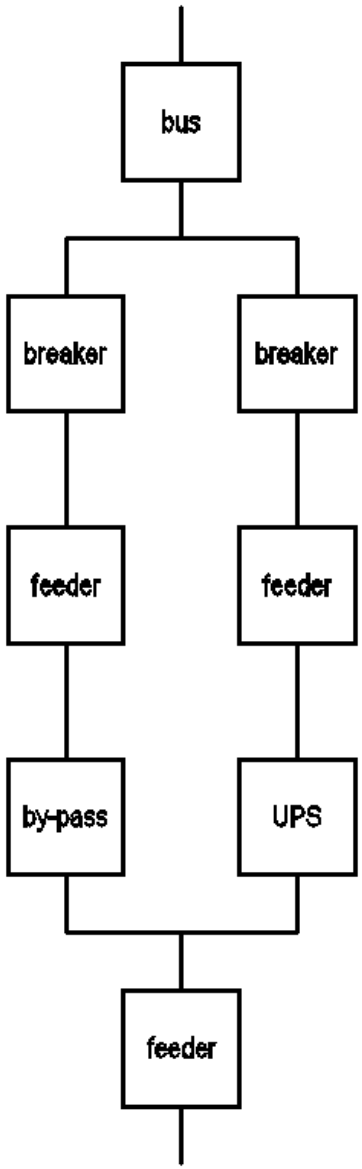
- MTBF (mean time between failure), h
- MTTR (mean time to repair), h
- Ai (inherent availability)
  - % of mission time
  - a realistic measure of reliability of critical power backup systems
  - Often expressed as "nines“
    - 99.999 – five 9’s
    - 99.9999 – six 9’s

$$\text{Availability} = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}}$$

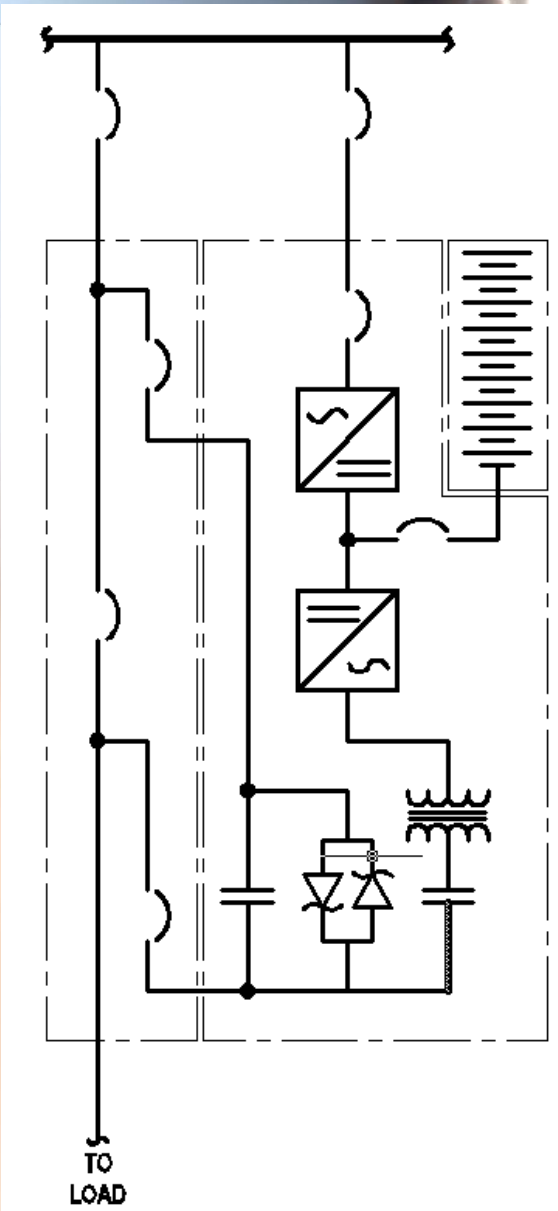
Reliability, Availability and Maintainability

- **Assumptions**
  - **No human error**
  - **Routine service**
- **Failure mode and effect analysis FMEA**
  - **The mission**
  - **The mission time frame**
  - **Reliability Block Diagram/Fault tree analysis**
  - **Single point of failure (SPOF)**

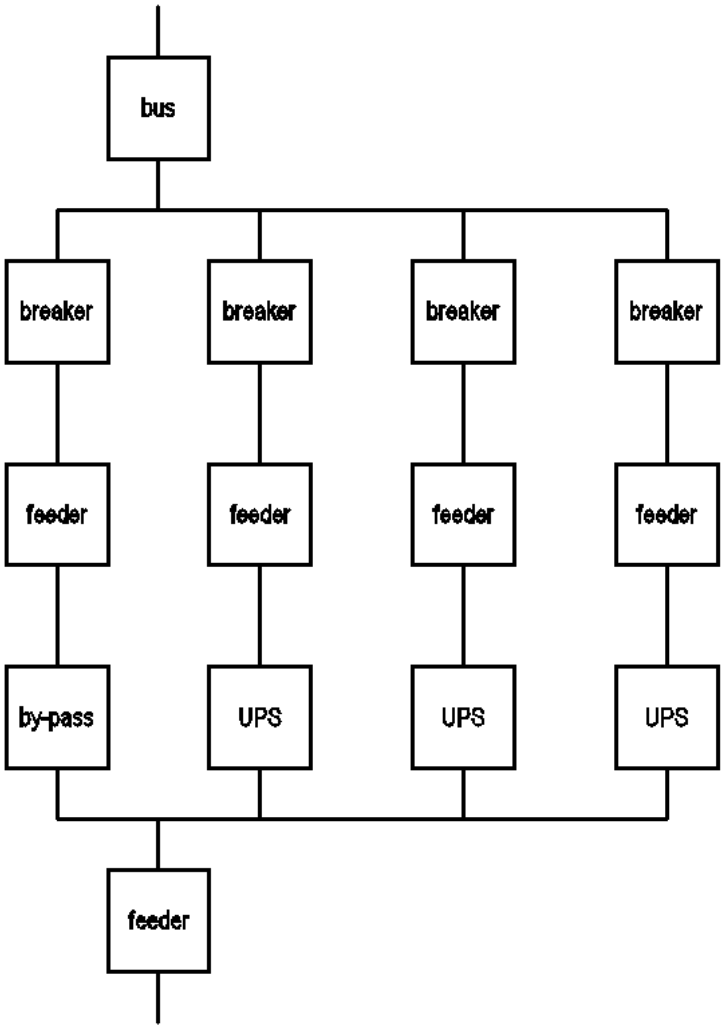
Reliability Block Diagram/Fault tree analysis

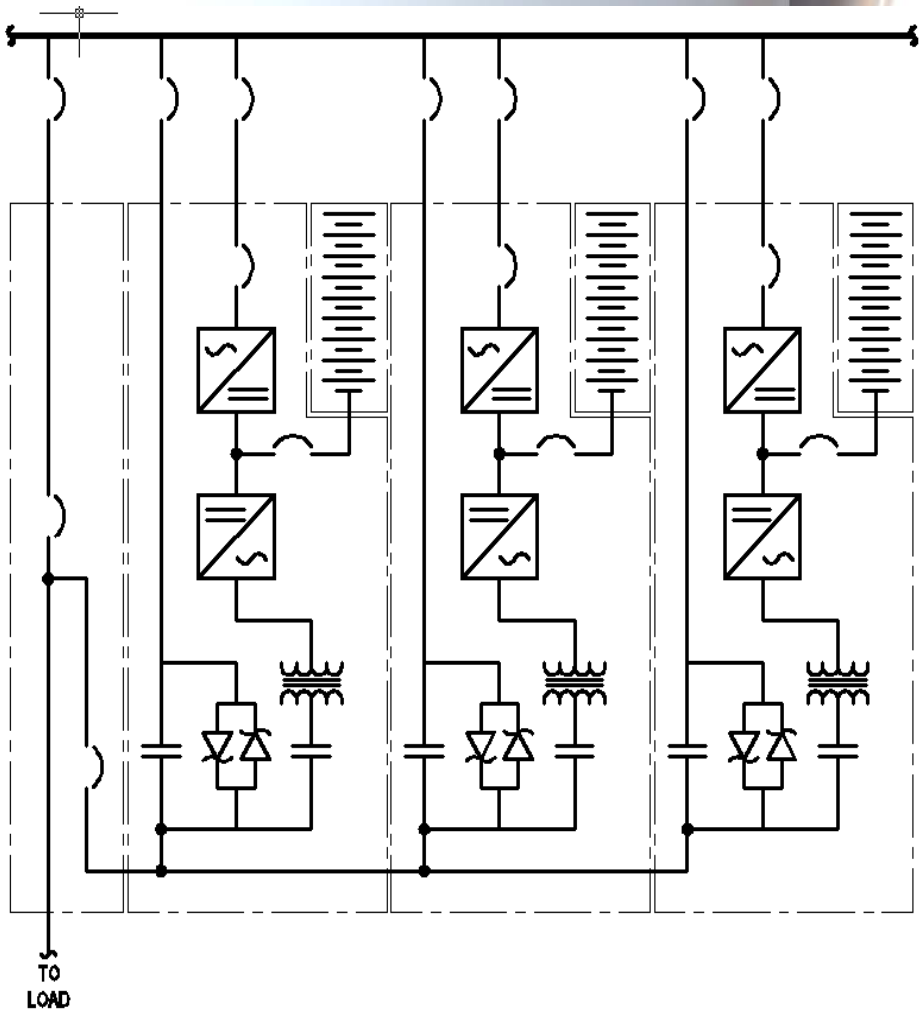


- Each component has its own MTTR and MTBF
- Analysis results in a calculated value for Ai

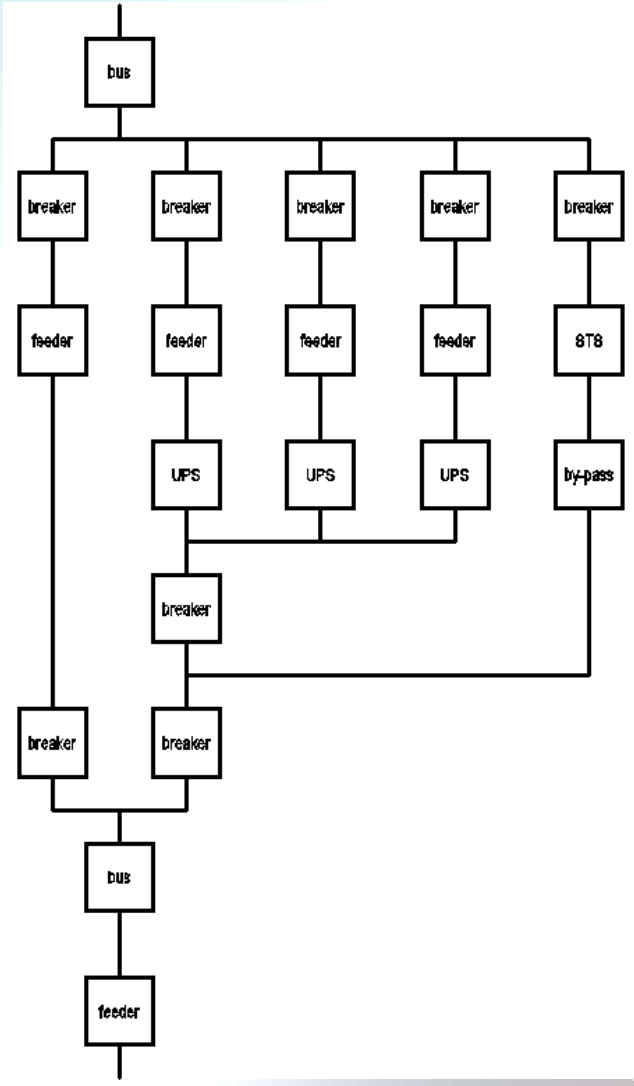


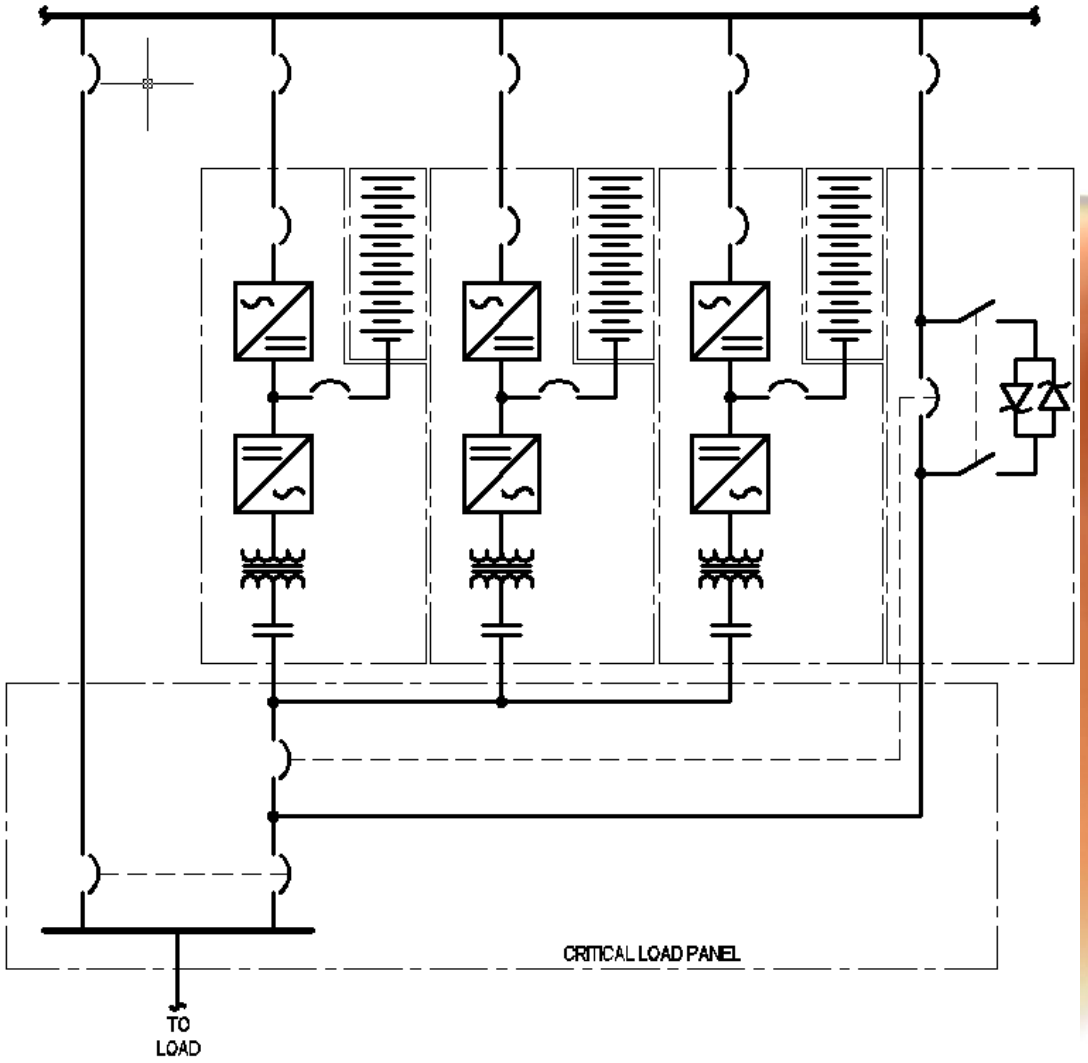
Reliability Block Diagram/Fault tree analysis





Reliability Block Diagram/Fault tree analysis

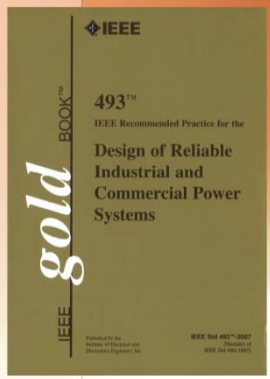




Reliability, Availability and Maintainability

- **IEEE 493-2007**

Component	Ai	failures per year	MTBF	MTTR
Cable in Conduit	0.999999938	0.00007	12895993	8.0
CB, drawout, 600v	0.999999858	0.00002	42129480	6.0
Gen 250kW - 1.5MW	0.998287624	0.58269	15033.8	25.7
DT Xfmr, <500kVA	1.000000000	0.00022	39846258	4.0
UPS, Rotary	0.999895500	0.00402	2176564	4.0
UPS	0.999951289	0.00092	9499764	4.0



Reliability

- **Design For Reliability (DFR), is an emerging discipline that refers to the process of designing reliability into designs**
- **There is no single standard for measuring how a UPS performs its mission: keeping connected loads powered.**
- **It is nearly impossible to compare one UPS manufacturer's MTBF figures to another's**

Reliability

- **Module mean time between failure (MTBF) rating will vary significantly with parts count, operating temp, component design and rating**
- **The MTBF rating of a given UPS module operating at full load and maximum rated temp (40°C), will routinely be four or five times lower than the same module operating at half load in a 25°C ambient**
- **MTBF calculations are published at full load rating, which does not apply in applications at lighter loading**
- **MTBF values can easily be misconstrued and should only be used as a relative guide**

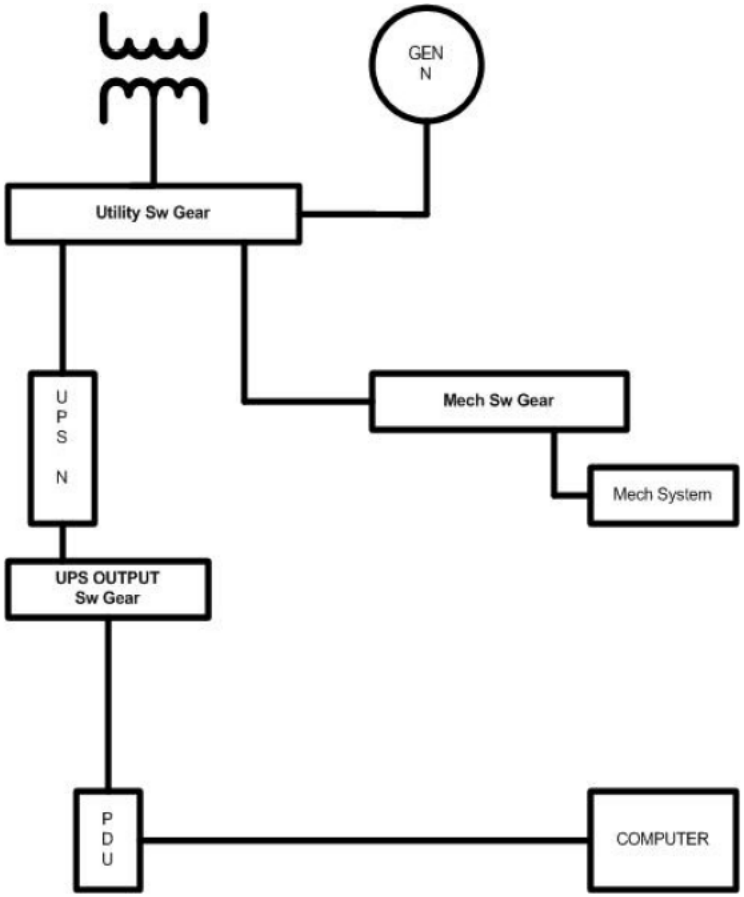
UPS Evaluation Report Released, Aug 10, 2009, EC&M Magazine

Uptime Institute™

- **Tier I – 99.67% Availability**
  - **(28.8 hour outage per year)**
- **Tier II – 99.74% Availability**
  - **(22 hour outage per year)**
- **Tier III – 99.98% Availability**
  - **(1.6 hour outage per year)**
- **Tier IV – 99.99% Availability**
  - **(0.8 hour outage per year)**

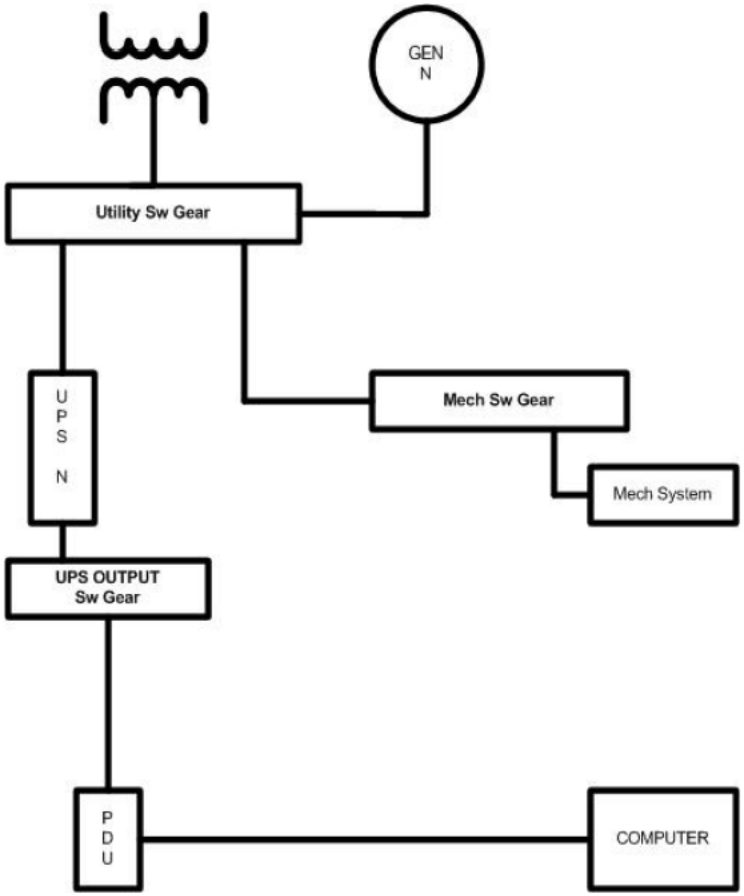
Electrical System Topology – Tier I

- **Tier I – 99.67% Availability**
  - **Single path for power and cooling**
  - **No redundant components**



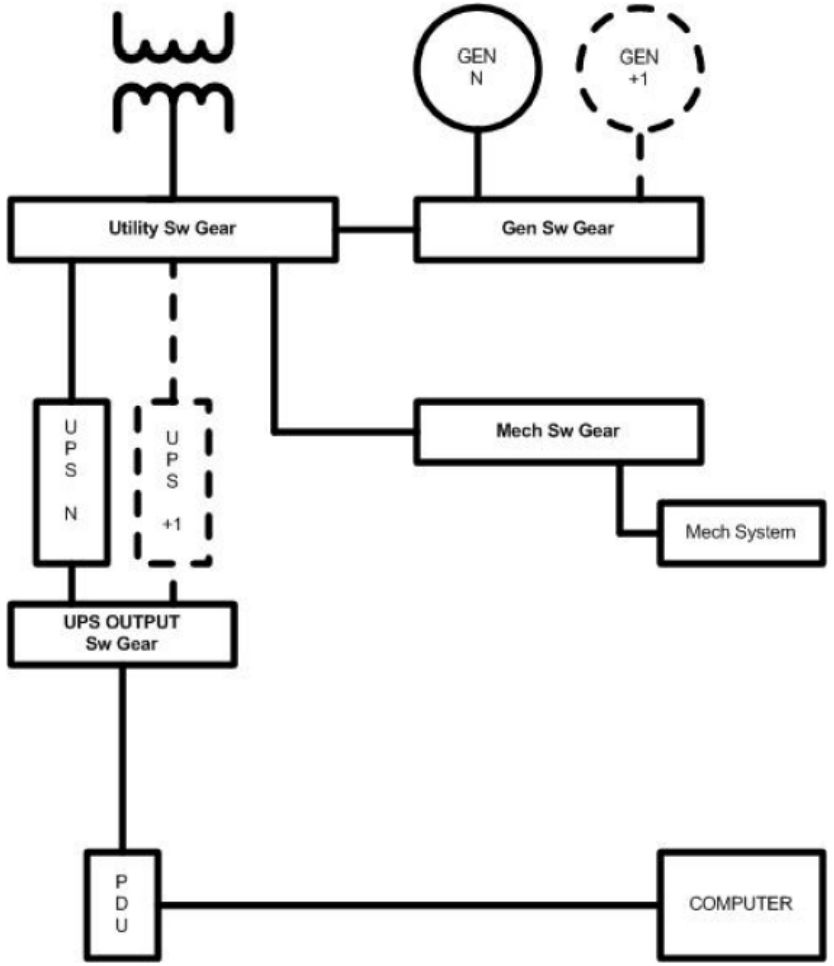
Electrical System Topology – Tier I

- **Tier I – 99.67% Availability**
  - **28.8 hour outage per year**
  - **1.2 failures per year, 4 hours per failure**
  - **Two 12-hour PMs**



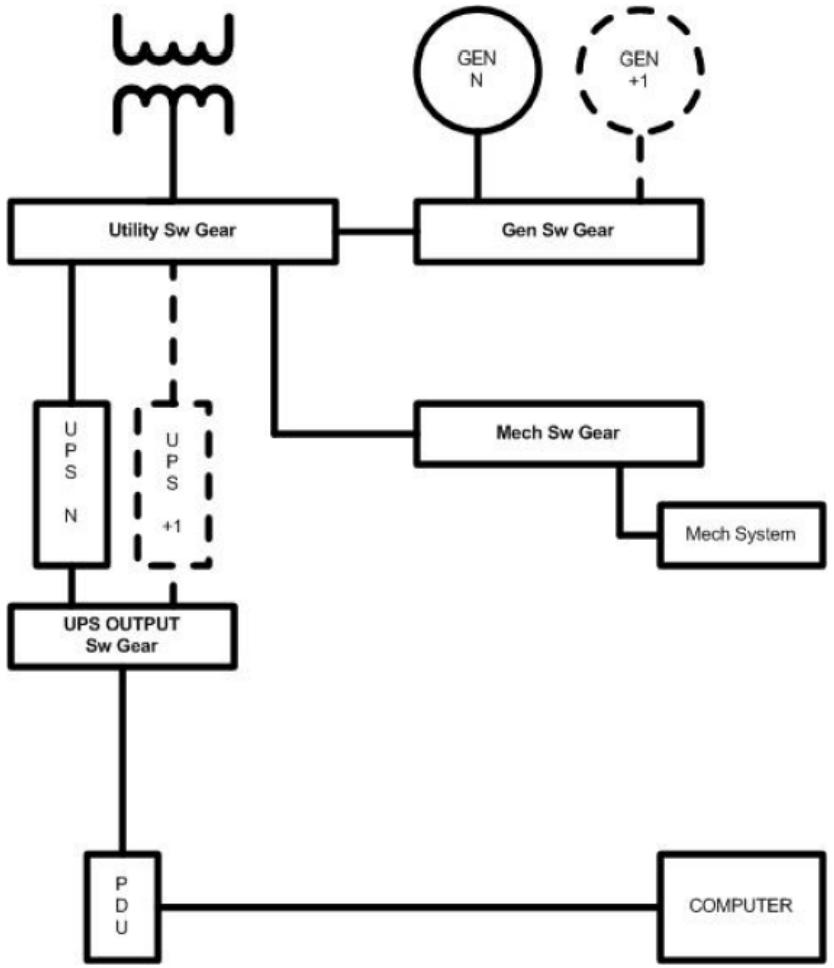
Electrical System Topology – Tier II

- **Tier II – 99.74% Availability**
  - **Single path for power and cooling**
  - **Redundant components**



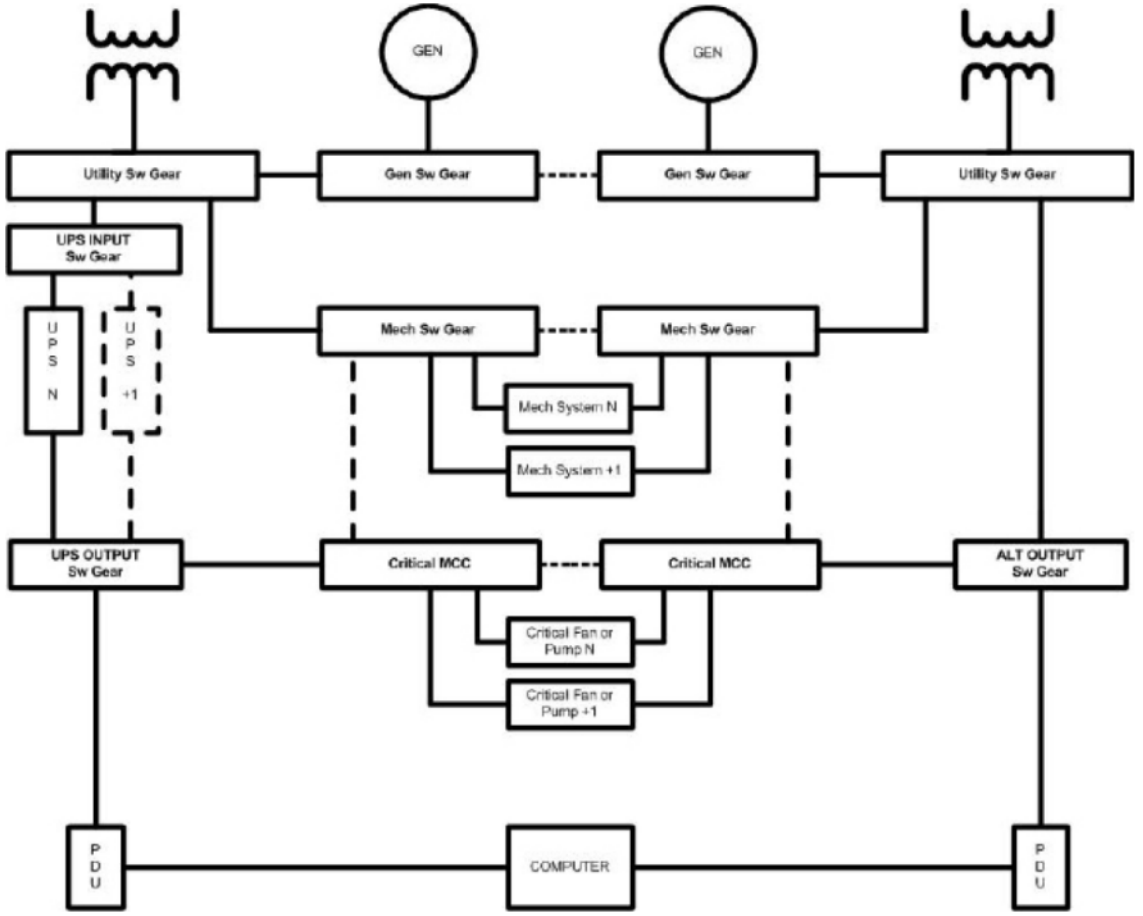
Electrical System Topology – Tier II

- **Tier II – 99.74% Availability**
  - **22 hour outage per year**
  - **1 failure per year, 4 hours per failure**
  - **One 18-hour PM**



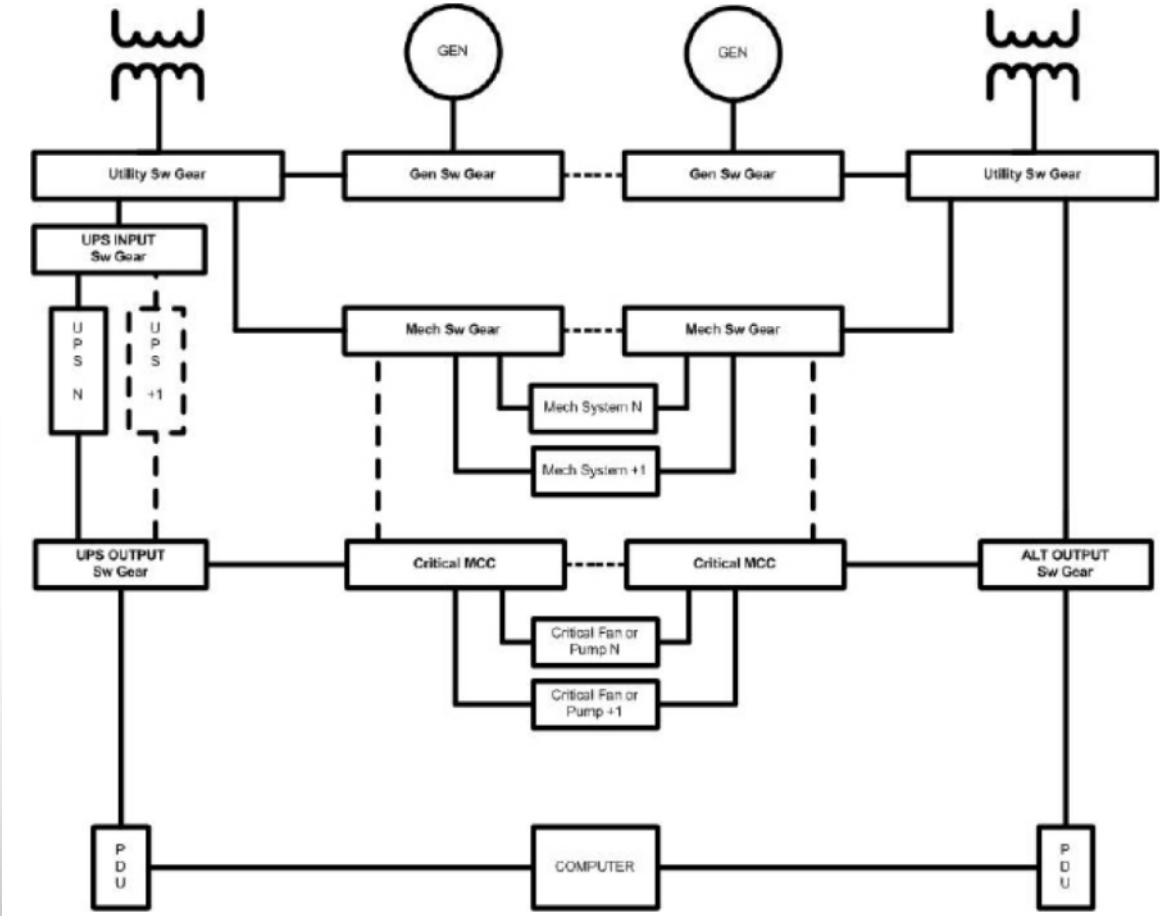
Electrical System Topology – Tier III

- **Tier III – 99.98% Availability**
  - **Multiple power and cooling paths**
  - **Concurrent maintenance**



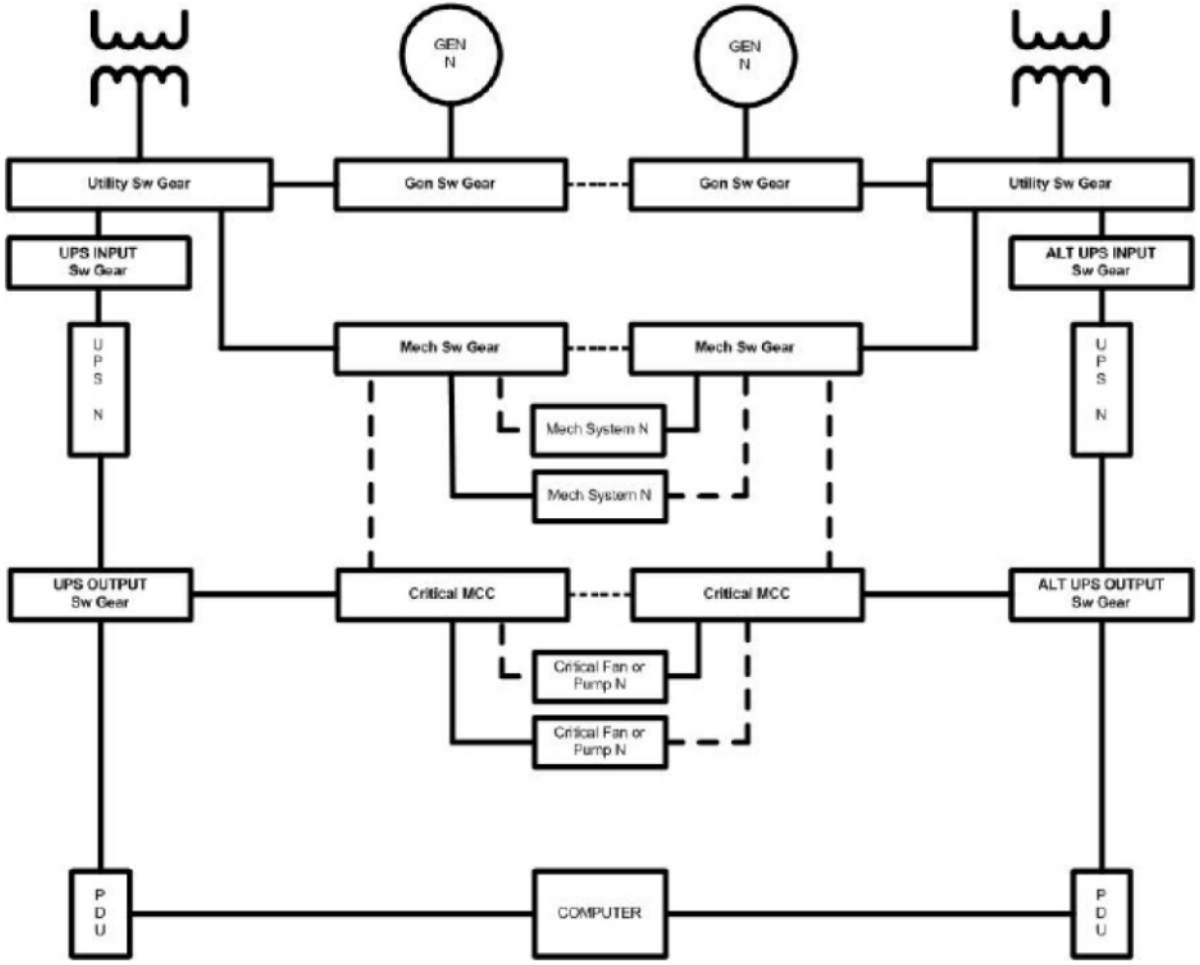
Electrical System Topology – Tier III

- **Tier III – 99.98% Availability**
  - **1.6 hour outage per year**
  - **1 failure per 2.5 years, 4 hours per failure**



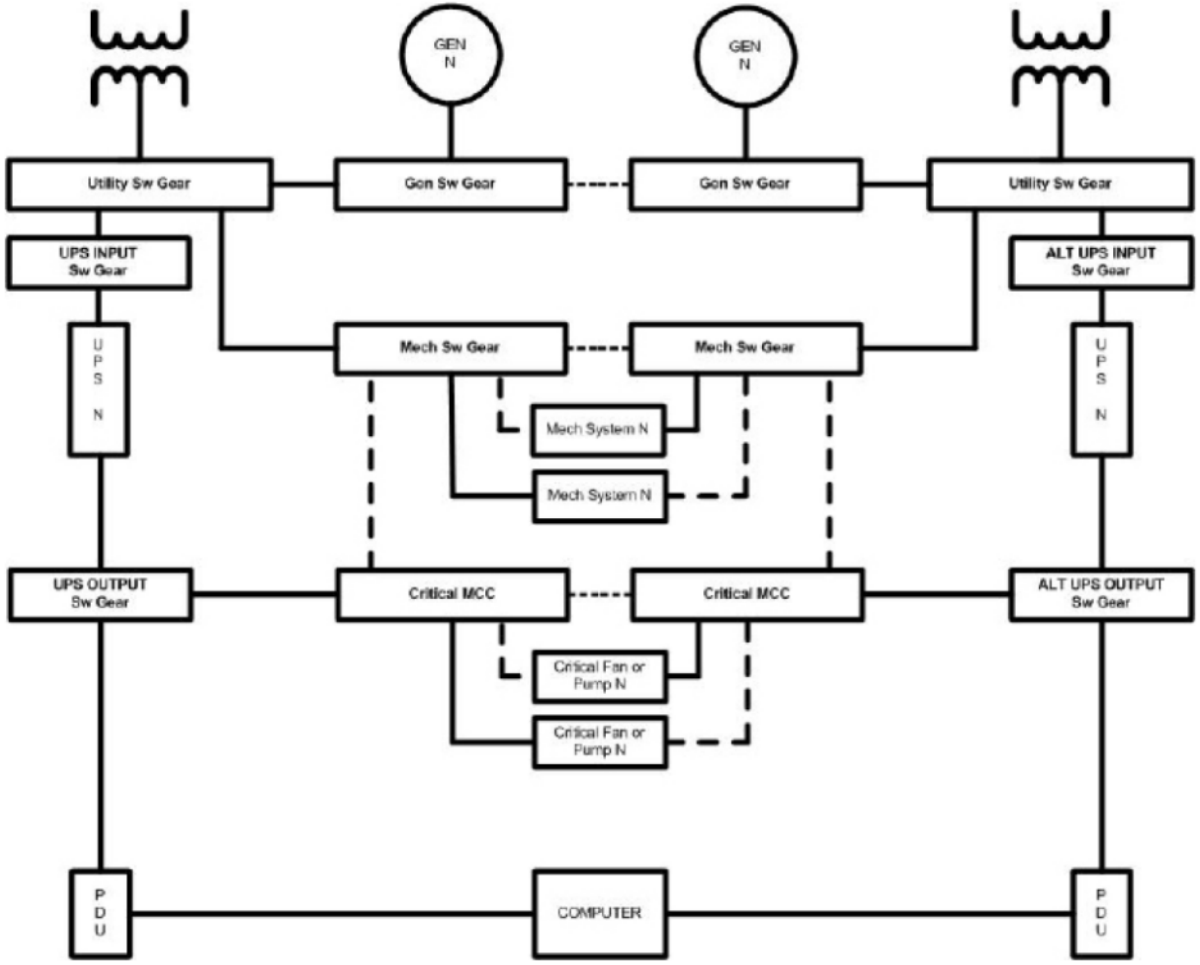
Electrical System Topology – Tier IV

- **Tier IV – 99.99% Availability**
  - **Multiple active power and cooling paths**
  - **Fault tolerant**



Electrical System Topology – Tier IV

- **Tier IV – 99.99% Availability**
  - **0.8 hour outage per year**
  - **1 failure per 5 years, 4 hours per failure**



Uptime Institute™

- **Steve Fairfax of MTechnology, Inc.**
  - **7X24 Conference Nov 2010**

Tier-Like Fault Tree Analysis	UTI Ai	Mtech Ai
Tier I - Like	99.67	99.922
Tier II - Like	99.74	99.998
Tier III - Like	99.98	99.9999
Tier IV - Like	99.99	99.9999

UPS Systems - Types

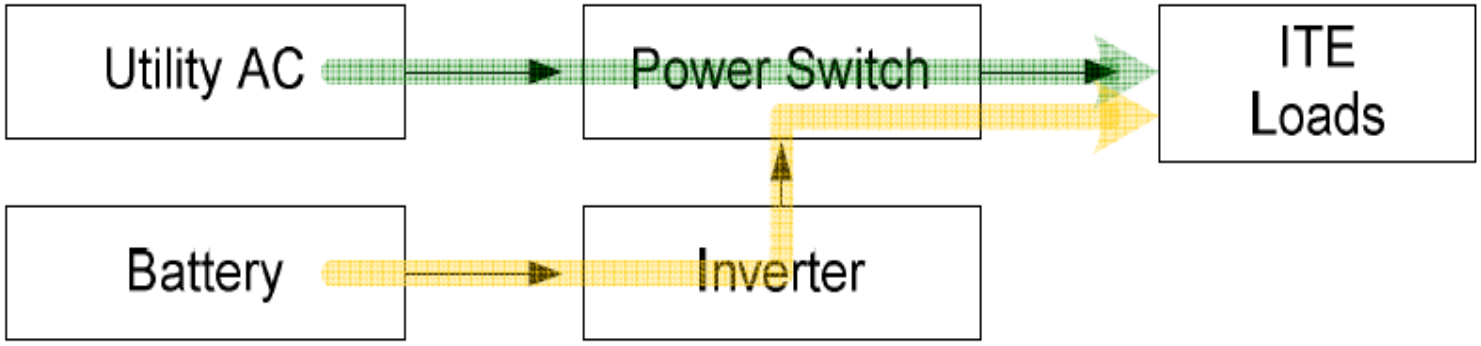
June 5, 2012

UPS Systems - Types

- Standby UPSs
- Line-interactive UPSs
- Double-conversion UPSs
- Double-conversion UPSs with multi-mode operation

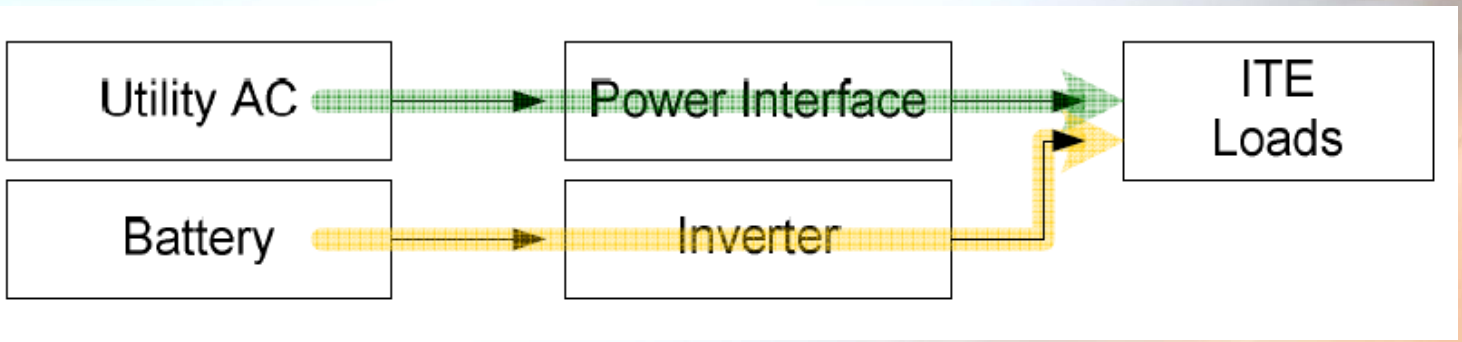
UPS Systems - Types

- **Standby UPSs** allow the load to run off of normal utility power until the UPS detects a problem, at which point the system provides protection against power outages.



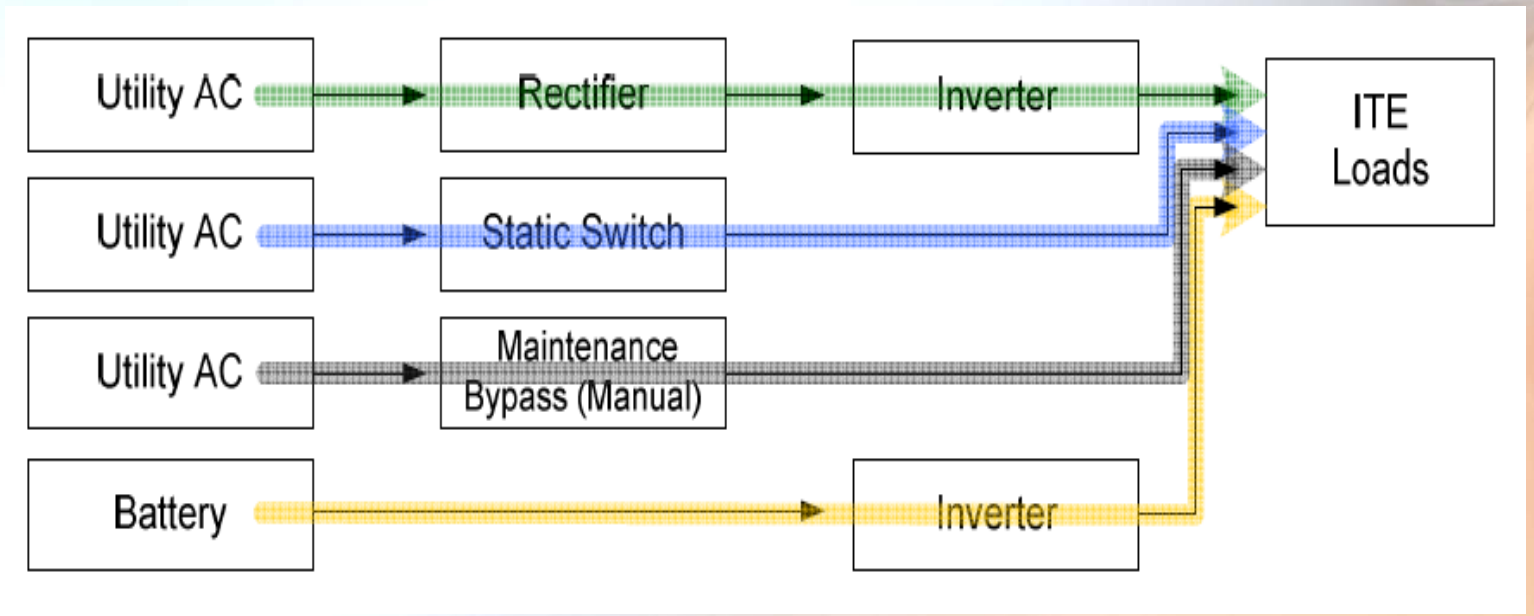
UPS Systems - Types

- **Line-interactive UPSs** typically regulate utility voltage before allowing it to pass through to protected equipment.



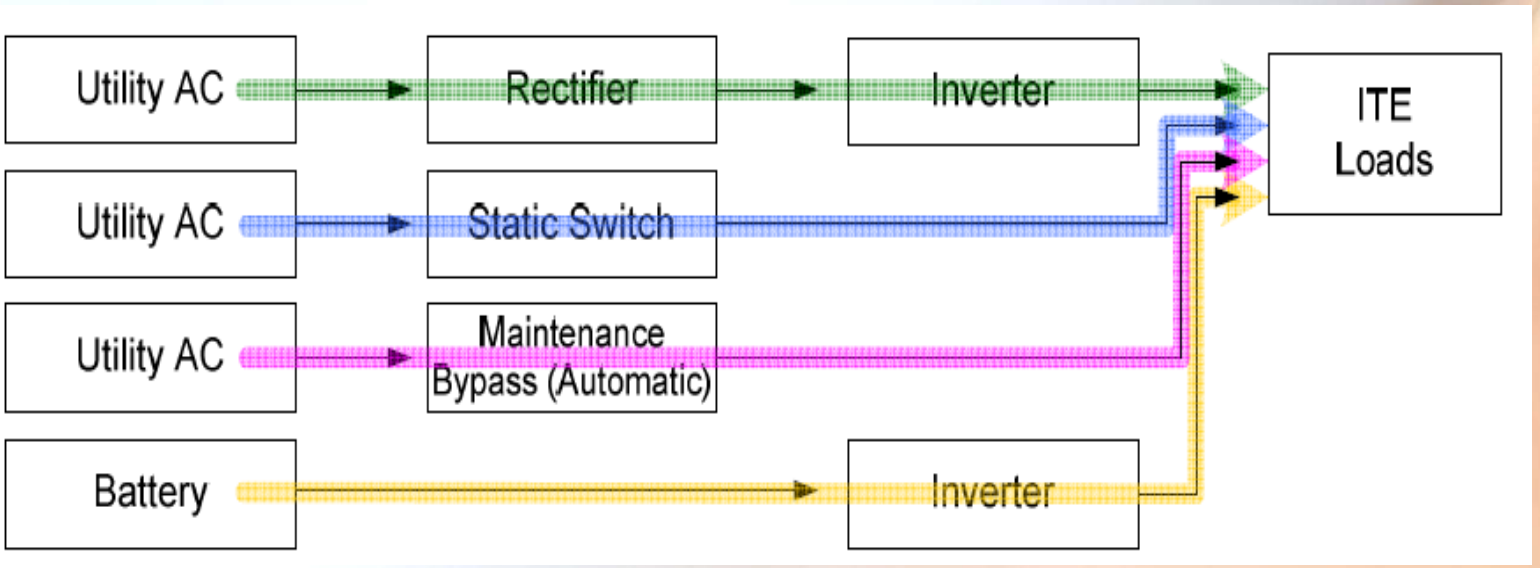
UPS Systems - Types

- .
- **Double-conversion UPSs** isolate the load from utility completely, provides clean, reliable power.



UPS Systems - Types

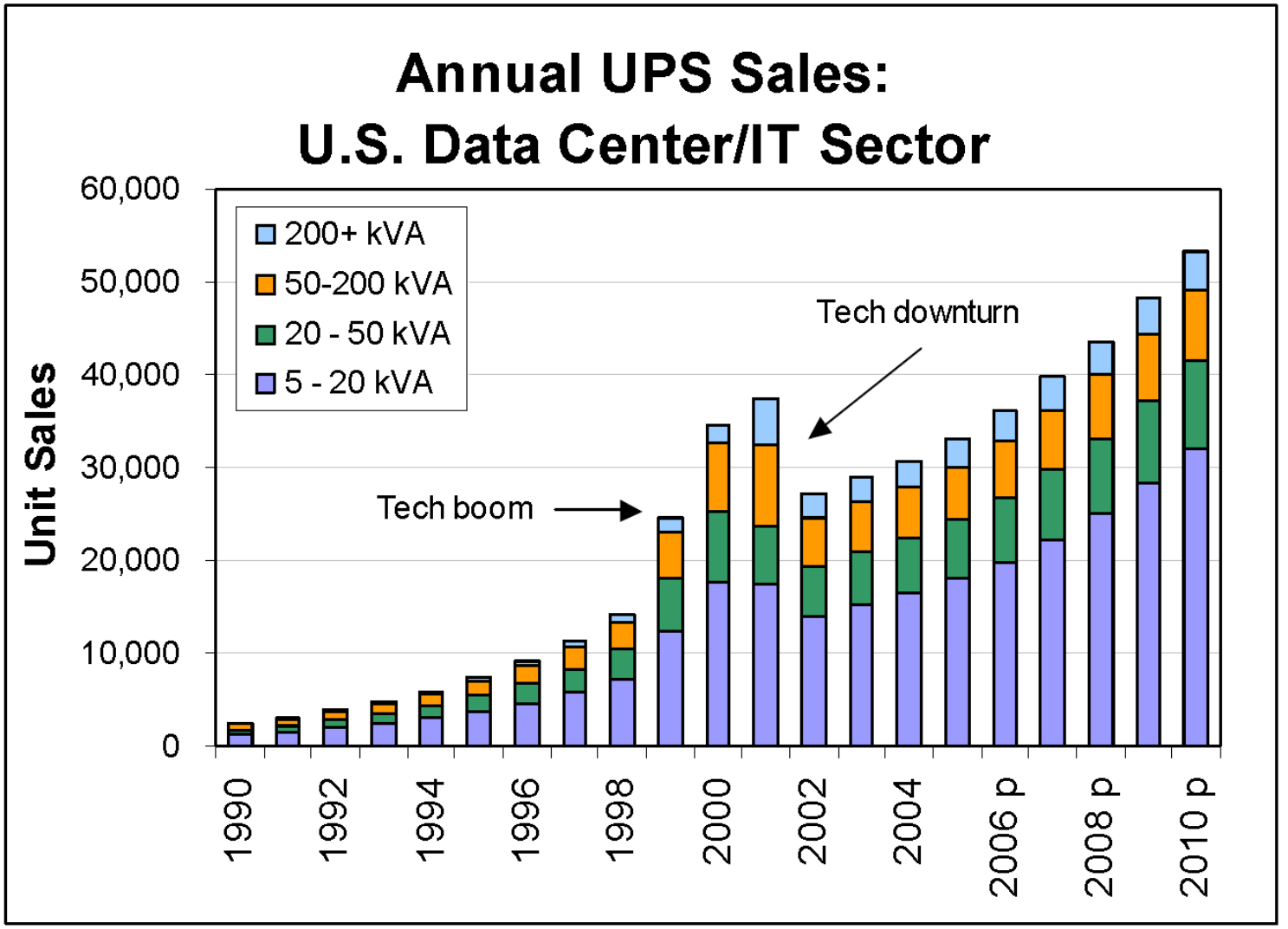
- **Double-conversion UPSs with multi-mode operation** normally operate in line-interactive mode; when power conditions warrant, they switch to double-conversion mode.



- This configuration is currently being used as an energy saving measure

Current Trends in UPS Technology

Current Trends in UPS Technology

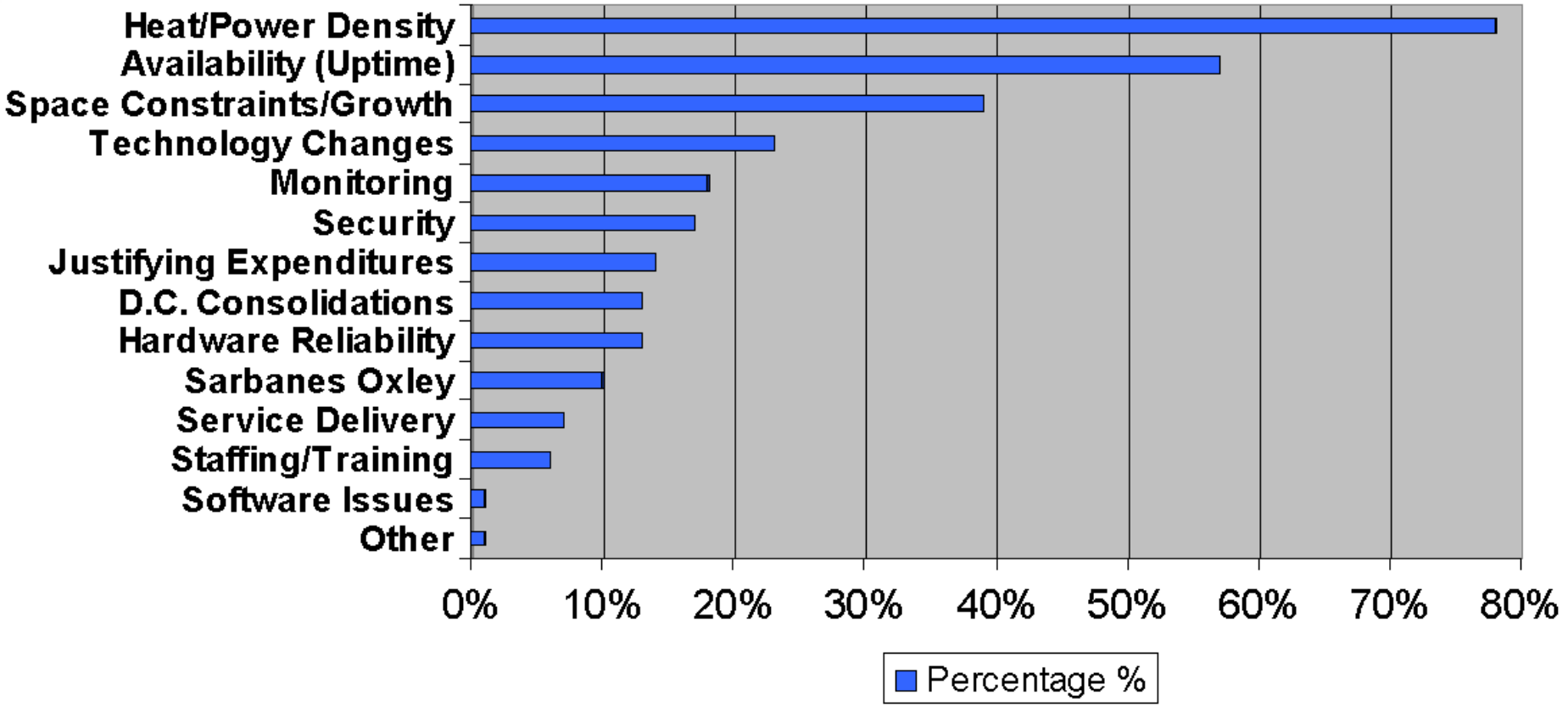


http://hightech.lbl.gov/documents/UPS/Final_UPS_Report.pdf

Current Trends in UPS Technology

Heat/Power Density is the number one concern of Data Center Management

Top 3 Concerns...



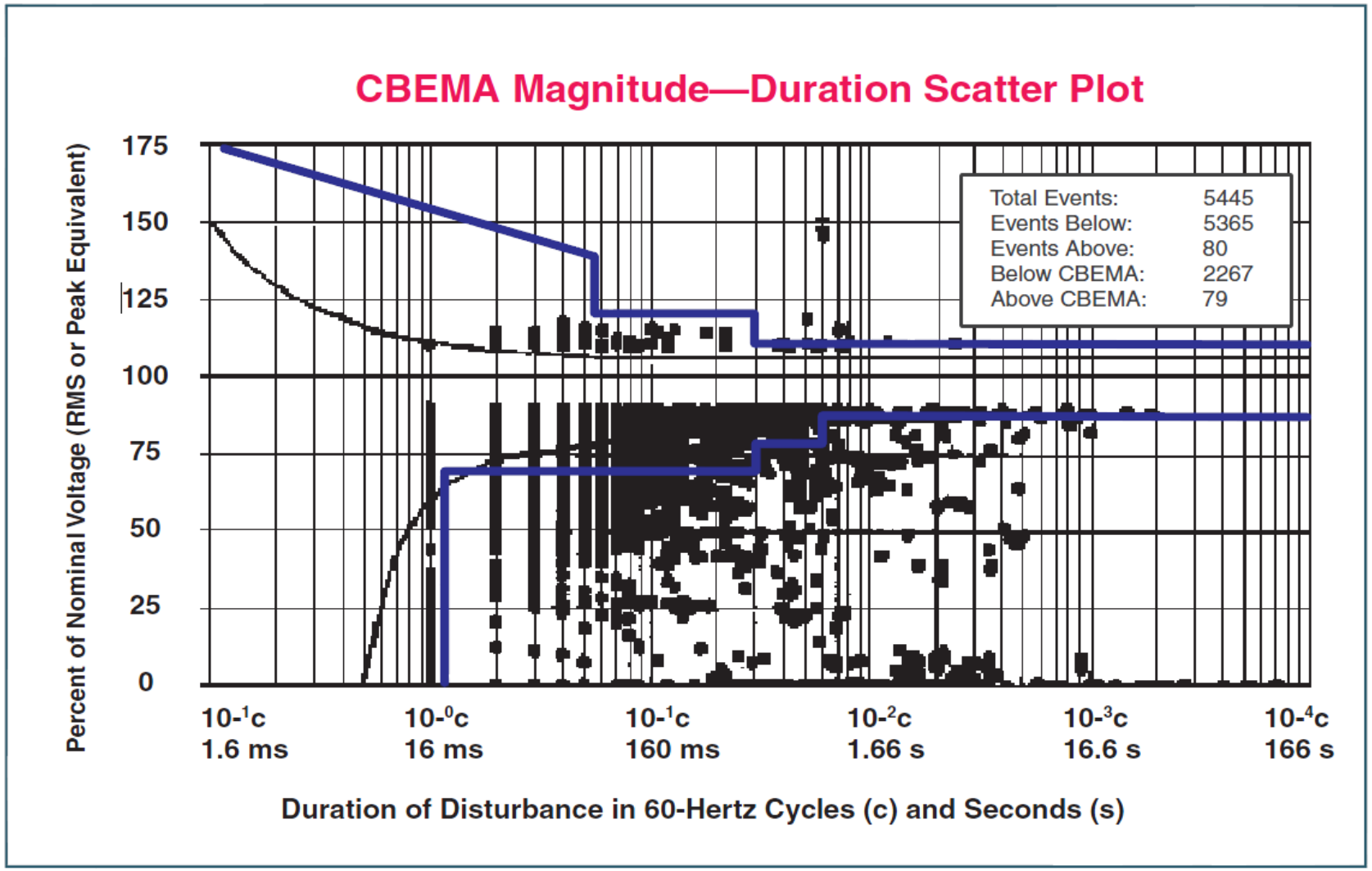
Blade Server Power Solutions: Cabinet Level Power Distribution Solutions for High Density Cabinets, High Density Cabinet Power Solutions, February 22, 2006

Current Trends in UPS Technology

- **Surveys show that Information Technology equipment is typically replaced every 2 to 5 years depending on the individual organization and its needs**

Blade Server Power Solutions: Cabinet Level Power Distribution Solutions for High Density Cabinets, High Density Cabinet Power Solutions, February 22, 2006

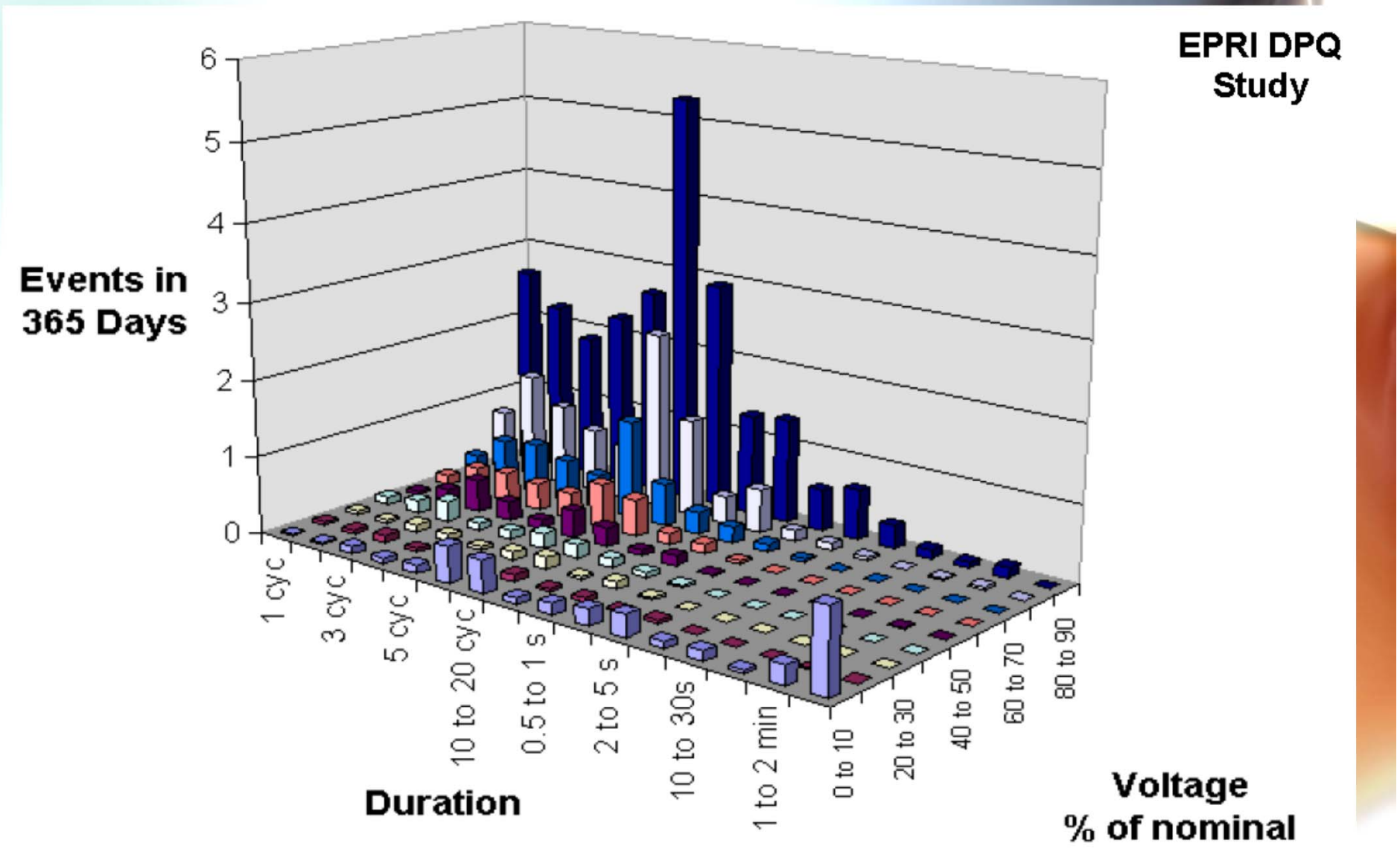
Current Trends in UPS Technology



Results of EPRI study on distribution-system voltage disturbances. (EPRI Commissioned Report RP 3098-1.)

EPRI Distribution Power Quality Report RP 3098-1, April 1995

Current Trends in UPS Technology



EPRI Distribution Power Quality Report RP 3098-1, April 1995