# Uninterruptible Power Supply (UPS) - Design Guideline

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| ISSUE | AUTHOR, DATE       | REVIEWED BY / APPROVED BY, DATES               | EFFECTIVE  
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<td>1</td>
<td>Mike Peralta, 6/5/07</td>
<td>Erich Snow, 6/7/07</td>
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<td>2</td>
<td>James E. O’Connor, 2/8/16</td>
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<td>James E. O’Connor, 03/01/19</td>
<td>Gary Gutfeld 03/01/19</td>
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1. **PURPOSE**

1.1. This document describes the recommended procedures to guide the UIT Facility Engineer (UIT-FE) in the development of design requirements and specifications for the installation of Uninterruptible Power Supply (UPS) devices in telecommunication rooms serving Voice over Internet Protocol (VoIP) users.

2. **GENERAL**

2.1 Stanford’s VoIP is the next generation of communication service. With VoIP Telephone Service, a call between a Stanford telephone and Stanford’s centralized voice switching equipment is converged into a single, managed voice and data network infrastructure. The phone connection is part of the Stanford network instead of being hooked into the wiring of the traditional Stanford telephone infrastructure.

VoIP allows for the convergence of many separate systems into a single, managed voice and data infrastructure. It also dramatically lowers costs associated with moving lines and changing features. Because frequently requested functions come with the IP phone sets, VoIP eliminates the need to change service levels. A consolidated voice and data network positions Stanford to take advantage of increased network functionality in the future.

Note — at this time — VoIP service is not available for bridged extensions or for fax machines, modems, courtesy phones, or conference phones.

2.2 With VoIP telephone service, a UPS shall be installed in the telecommunications room (TR) to maintain emergency electrical power to VoIP voice switches or converged network switches.

Stanford UIT’s VoIP operational guideline is to provide a minimum of 20 minutes of UPS power to enable the completion of E911 emergency calls. This requirement includes all VoIP serving TR’s, even if the TR is on an emergency generator circuit.

2.3 Stanford’s current vendor of choice for VoIP solutions is Cisco.


3. **DEFINITIONS**

3.1 **Uninterruptible Power Supply (UPS):** A UPS, or sometimes called a battery backup, is a device which maintains a continuous supply of electric power to connected equipment by supplying power from a separate source when utility power is not available.

A UPS is inserted between the source of power (typically commercial utility power) and the load it is protecting. When a power failure or abnormality occurs, the UPS will effectively switch from utility power to its own power source almost instantaneously.

While not limited to safeguarding any particular type of equipment, a UPS is typically used to protect computers, telecommunication equipment or other electrical equipment where an unexpected power disruption could cause injuries, fatalities, serious business disruption or data loss. UPS units come in sizes ranging from units which will back up a single computer without monitor (around 200 VA) to units which will power entire data centers or buildings (several megawatts). Larger UPS units typically work in conjunction with generators.
A UPS should not be confused with a standby generator, which does not provide protection from a momentary power interruption and may result in an interruption when it is switched into service, whether manually or automatically. However, such generators are typically placed before the UPS to provide cover for lengthy outages.

3.2 **Voice over Internet Protocol (VoIP):** Stanford’s VoIP is the next generation of communication service. With VoIP Telephone Service, the signal that carries calls between a telephone and Stanford’s centralized voice switching equipment is in reality, a data network. The phone connection is part of the Stanford network instead of being hooked into the wiring of the traditional Stanford telephone infrastructure.

VoIP allows for the convergence of many separate systems into a single, managed voice and data infrastructure. It also dramatically lowers costs associated with moving lines and changing features. Because frequently requested functions come with the IP phone sets, VoIP eliminates the need to change service levels. A consolidated voice and data network positions Stanford to take advantage of increased network functionality in the future.

VoIP phones plug into a network port instead of a phone port. There is a simple log-in procedure when starting up a Stanford VoIP phone, but otherwise the equipment works very much like the multi-line speakerphones Stanford departmental users are accustomed to. VoIP Telephone Service includes most of the features currently offered with non-VoIP phone service, as well as many new functions only available with IP phones. See Stanford UIT website https://uit.stanford.edu/service/phone/voip for details.

3.3 **Net-to-Jack Program (N2J):** Stanford’s Net-to-Jack program is a centralized service model with full, end-to-end support for internal and external network infrastructure. In the past, most departments provided their own support for internal network infrastructure (connectivity and routing/switching equipment within a building) or paid for third-party support. External network support and infrastructure, (connectivity out from a building to the SUNet backbone and the Internet) was provided by IT Services. The Net-to-Jack program combines these two support functions into one service profile, providing academic and administrative departments with highly reliable network equipment and centralized, expert monitoring and support at a cost-effective price.

3.4 **Net-to-Switch Program (N2S):** Stanford’s Net-to-Switch program is a centralized service model with support for internal and external network infrastructure. In the past, most departments provided their own support for internal network infrastructure (connectivity and routing/switching equipment within a building) or paid for third-party support. External network support and infrastructure, (connectivity out from a building to the SUNet backbone and the Internet) was provided by IT Services.

The Net-to-Switch program combines these two support functions into one service profile, providing academic and administrative departments with highly reliable network equipment and centralized, expert monitoring and support at a cost-effective price. See Stanford UIT website: https://uit.stanford.edu/service/net2switch for details.
3.5 **UPS Topology:** The two UPS topologies most suitable for Cisco mission-critical VoIP applications are “line-interactive” and “double conversion online” (“online”). The importance of choosing one over the other to provide mission-critical VoIP networks with reliable power is highly overrated. The pros and cons of both are covered in great detail in APC’s White Paper 79 “Technical comparison of On-line vs. Line-interactive UPS designs”.

In brief, in the power range above 5kVA the double conversion online topology and its variations prevail over line-interactive. Above 5kVA line-interactive design becomes bulky and expensive which makes it impractical to build.

In the power range below 5kVA however, either rivaling UPS topology is quite competitive and may be used with confidence in regards to reliability and availability. The line-interactive UPS is usually less expensive than its online counterpart, more efficient, consists of fewer components and thus is somewhat more reliable, but, at the same time, lacks the bypass, the alternative power path in case the very unlikely failure still does happen.

The online UPS, on the other hand, is more expensive, less efficient, contains more components, but is equipped with bypass to sustain the load in case an alternative power path is required.

For further details & discussions on these and other AC UPS Topologies please see APC White Papers # 1 and # 79.

For Cisco VoIP and IP Telephony networks power protection APC offers both types of UPS topology.


4 **RESPONSIBILITIES**

4.1 New Buildings and/or Major Building Renovation Projects:

- The UIT Service Consultant (UIT-SC) and UIT-FE will work with the building client(s) to determine the voice and data TSO requirements and locations.
- The UIT-SC and UIT Network Specialist (UIT-NS) will work with the building client(s) and/or their departmental Local Network Administrator to determine the voice and data network architecture.
  - Determine if the building be on the Net-to-Jack Program (N2J) or Net-to-Switch program (N2S)?
  - Determine the voice/data network convergence location, e.g. TSO, TR, MTR, other?
    - If the voice/data network convergence location is the TSO, all switches in the serving TR shall be connected to the UPS.
    - If separate voice and network switches are located in the MTR/TR, the voice switches shall be connected to the UPS.
    - If the client requests that the data switches also be connected to UPS, the project must approve and fund the incremental UPS requirements.
Determine the total number of voice ports and percent of voice port activations. The result will determine the number voice/data or voice only switches at a UPS location?

Determine the total number of data ports and the percent of data port activations. The result will determine the number and type of voice/data or network only switches at a UPS location?

Determine the percent extra power growth factor. The result will determine the size and scalability of the initial UPS devices.

- The UIT Network Specialist shall determine the make and model number of all switches to be connected to the UPS in each applicable MTR/TR location. The information is provided to the UIT-FE.

- The UIT-FE shall
  - Design the UPS requirements in each MTR/TR location to meet the client(s) requirements,
  - Select an appropriate UPS model,
  - Provide electrical power requirements (load, circuits, wiring, outlets) to the Project’s Electrical Contractor,
  - Engage and project manage the work of the UIT contractor awarded the work of providing, installing and jointly activating the UPS.

- The UIT Installation & Maintenance (UIT-I&M) Team is responsible for:
  - Joint conformance and acceptance testing of the UPS devices with the UIT contractor.
  - Installing, activating and testing the APC Network Management Card.
  - Ongoing maintenance and performance monitoring of the UPS Device (post acceptance).

4.2 Existing Buildings:
- The UIT Installation & Maintenance (UIT-I&M) Team is responsible for the design, installation, ongoing maintenance, and performance monitoring of all UPS devices in existing buildings.

5 UIT-FE PROCEDURES (New Buildings and/or Major Building Renovation Projects):

5.1 The UIT-SC, UIT-FE, and UIT Network Specialist (UIT-NS) work with the building client(s) and/or their departmental Local Network Administrator to:
  - Determine the network architecture (see Paragraph 4.0 Responsibilities),
  - Determine the voice and data TSO requirements and locations,
  - Determine the voice and data port count activation requirements.

5.2 The UIT-FE obtains from the UIT Network Specialist, the make and model number of all switches to be connected to the UPS in each applicable MTR/TR location.
5.3 UIT-FE accesses the American Power American Power Conversion (APC) website at http://www.apcc.com/products/ . The UIT-FE then uses the UPS Product Selector Tool to determine the appropriate UPS model options.

- An APC Network Management and Environmental Card (APC Part Number AP9619) shall be provisioned with each UPS unit for remote monitoring.
- An APC Power Distribution Unit(s) may be required depending on the type UPS specified, the number of devices to be protected, and/or the location of the UPS relative to the location of the protected devices.

5.4 The UIT-FE selects an appropriate recommended UPS model UPS from APC’s UPS Product Selector Tool and finalizes the detail electrical support requirements.

5.5 UIT-FE provides electrical power requirements (load, circuits, wiring, outlets) to the Project’s Electrical Contractor.

5.6 UIT-FE engages and project manages the work of a qualified UIT contractor who will provide and install the UPS. The UIT Contractor will work with the UIT Installation & Maintenance (UIT-I&M) Team to jointly activate the UPS.

6 NEW BUILDING EXAMPLE:

6.1 The Environment and Energy Building (Quad & Building No. 04-070) was the first Stanford Building selected for full deployment of the Voice over Internet Protocol (VoIP) technology. The following are the key process steps used to select the appropriate UPS devices.

6.2 Based on the client’s communication requirements available in August 2006, the OAC and UIT Project Team’s came to the following design assumptions:

- The typical VoIP phone will be installed on a voice port at the TSO that is connected to a VoIP voice switch in the serving TR.
- The VoIP voice switch will be powered by a UPS in the serving TR. No other devices in the TR shall be connected to the UPS.

  The UIT Network Specialist determined the following voice and data equipment requirements: A maximum of 75% of the total voice ports and 60% of the data ports would be activated at any one time).

  - Cisco Model 3750-48PS would be used for the VoIP Switches. In each TR, one or more Cisco Model 3750-48PS VoIP Switches would be required.
  - The VoIP switches will be connected to a dedicated Cisco 3750-12G fiber distribution switch in the MTR.

6.3 The UIT-FE accessed the American Power American Power Conversion (APC) website at http://www.apcc.com/products/ and used the UPS Product Selector Tool to select an appropriate UPS model option, e.g. Best Price, Best Value, Best Performance.

- The Electrical and Cooling Calculations were needed by the Architect, in August 2006, for inclusion in the overall building design requirements.
- As communications requirements were still preliminary, it was determined by the UIT-FE and UIT-FE Engineering Manager to specify one “Best Performance” model that met the highest load requirements in all TR’s.
6.4 In November 2006, the UIT-FE began preparation of competitive bid documents for a January 2007 Invitation for Bid meeting with cabling contractors. The number of voice ports was significantly increased to approximately double the number assumed in August 2006. As such, the UIT-FE elected to double the number of voice switches in all TR’s except TR U0.2. In addition to the doubling of voice switches, the UIT-FE Engineering Manager recommended that a 75% extra growth factor be applied to the UPS Selector Tool calculations to ensure extra power for future expansion.

The UIT-FE re-ran the APC UPS Selector Tool and appropriate UPC models were selected for each TR based on runtime performance as follows:

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<th>TR LOCATION(S)</th>
<th>MODEL DESCRIPTION</th>
<th>PART NUMBER</th>
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<tr>
<td>U0.2</td>
<td>Smart-UPS 2200VA USB &amp; SERIAL RM 2U *120V</td>
<td>SUA2200RM2U</td>
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<tr>
<td>U0.3, U1.1, U2.1, U3.1</td>
<td>Smart UPS XL 3000VA RM 3U 120V</td>
<td>SUA3000RMXL3</td>
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<td>Symmetra RM 4kVA Scalable to 6kVA N+1 208V/240V + (1) SYPT2 Battery Unit</td>
<td>SYH4K6RMT + SYBT2</td>
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<tr>
<td>U3.2</td>
<td>Smart-UPS 5000VA RM 5U 208V</td>
<td>SU5000RSTX120</td>
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Five of the UPS selections resulted in input voltage changes from the planned 208VAC/30A specification to 120VAC/20A and 120VAC/30A requirements. The Environment and Energy Building’s DPM Project Manager and the Electrical Contractor were advised of the changes in electrical requirements resulting in TR electrical circuit changes.