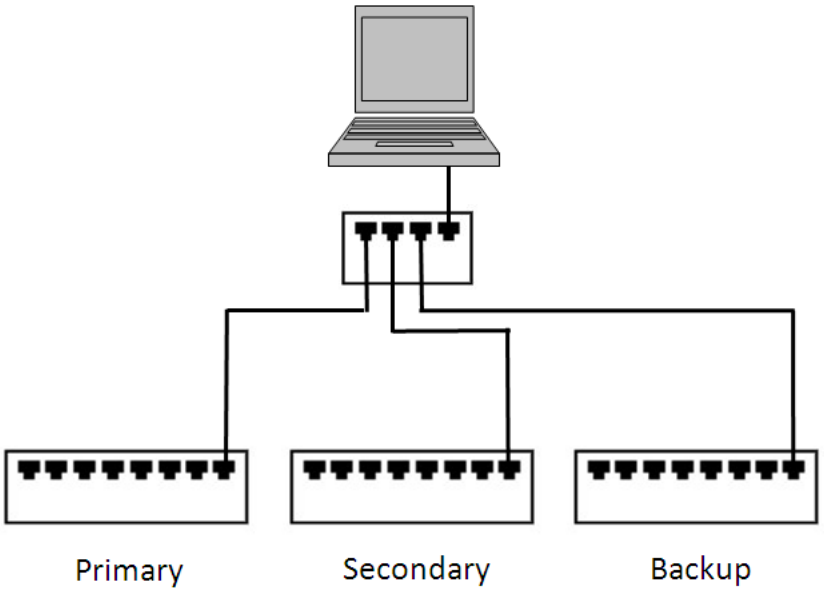
Designing a Redundant Network

March 28, 2011

What is Redundancy?

A redundant network is a system that can lose a network cable or Network Interface Card and still continue to function flawlessly.

The primary cable runs to the primary router and then to a the primary modem that goes to the ISP. The secondary cable runs to the secondary router and then to a the secondary modem that goes to the ISP. Like the first two links, the backup link goes through its own router and modem.

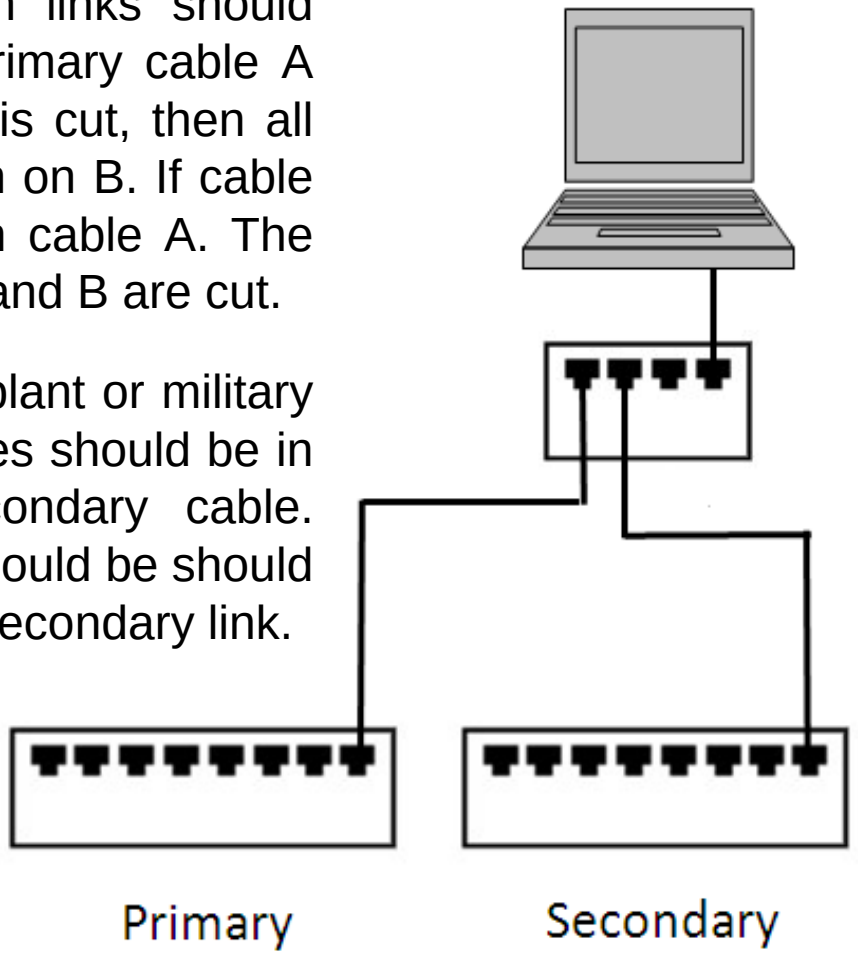


Primary and Secondary Links

Primary and secondary communication links should have the same speed. Let's call the primary cable A and the secondary cable B. If cable A is cut, then all the computers will exchange information on B. If cable B is sliced, then we would talk through cable A. The system will not function if both cables A and B are cut.

In a building, such as a nuclear power plant or military communication center, the primary cables should be in a separate cable tray than the secondary cable. Outside the building, the primary links should be should be routed in the ground differently than secondary link.

Businesses have lost their connections from construction workers who have accidently cut both cable in the same place when digging around the building.

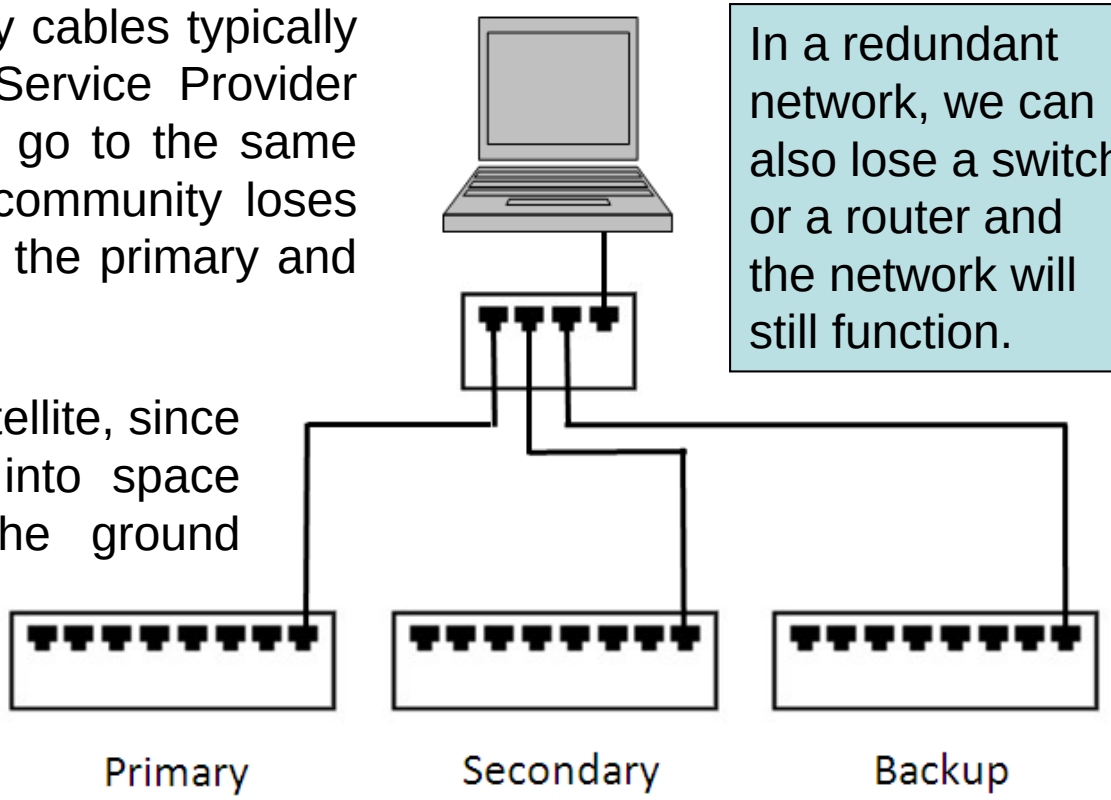


Triple Redundancy

In a triple redundancy network, we have a our primary and secondary network cables that are operating in the Gigabit per second range and then we have a third line that is communicating using a different technology.

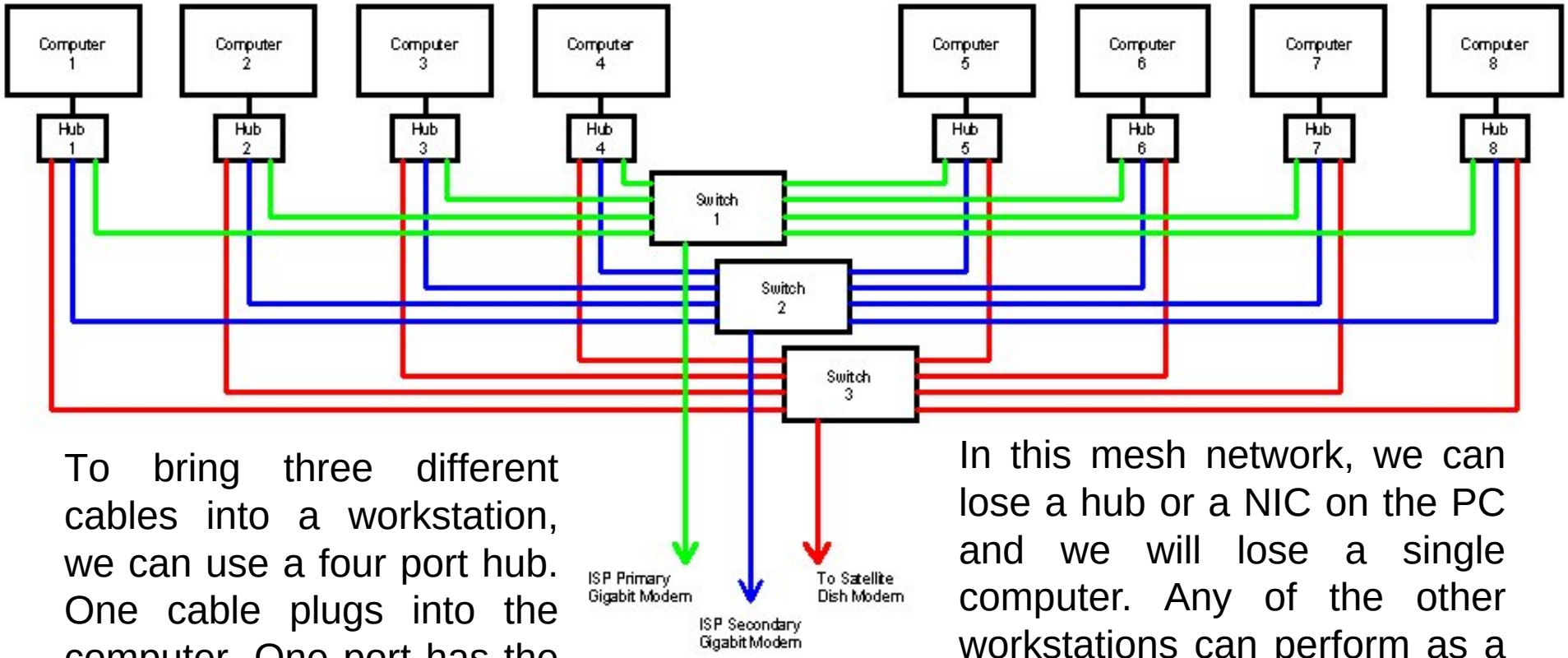
The primary and secondary cables typically go to the same Internet Service Provider (ISP) which will eventually go to the same building or station. If the community loses that connection point, both the primary and secondary links will be lost.

A good backup link is a satellite, since the connection is going into space and is not buried in the ground around the building.



In a redundant network, we can also lose a switch or a router and the network will still function.

Redundant Diagram



To bring three different cables into a workstation, we can use a four port hub. One cable plugs into the computer. One port has the primary link. One port has the secondary link. The last port has the backup link.

In this mesh network, we can lose a hub or a NIC on the PC and we will lose a single computer. Any of the other workstations can perform as a backup to any of the others, so redundancy is still functioning.

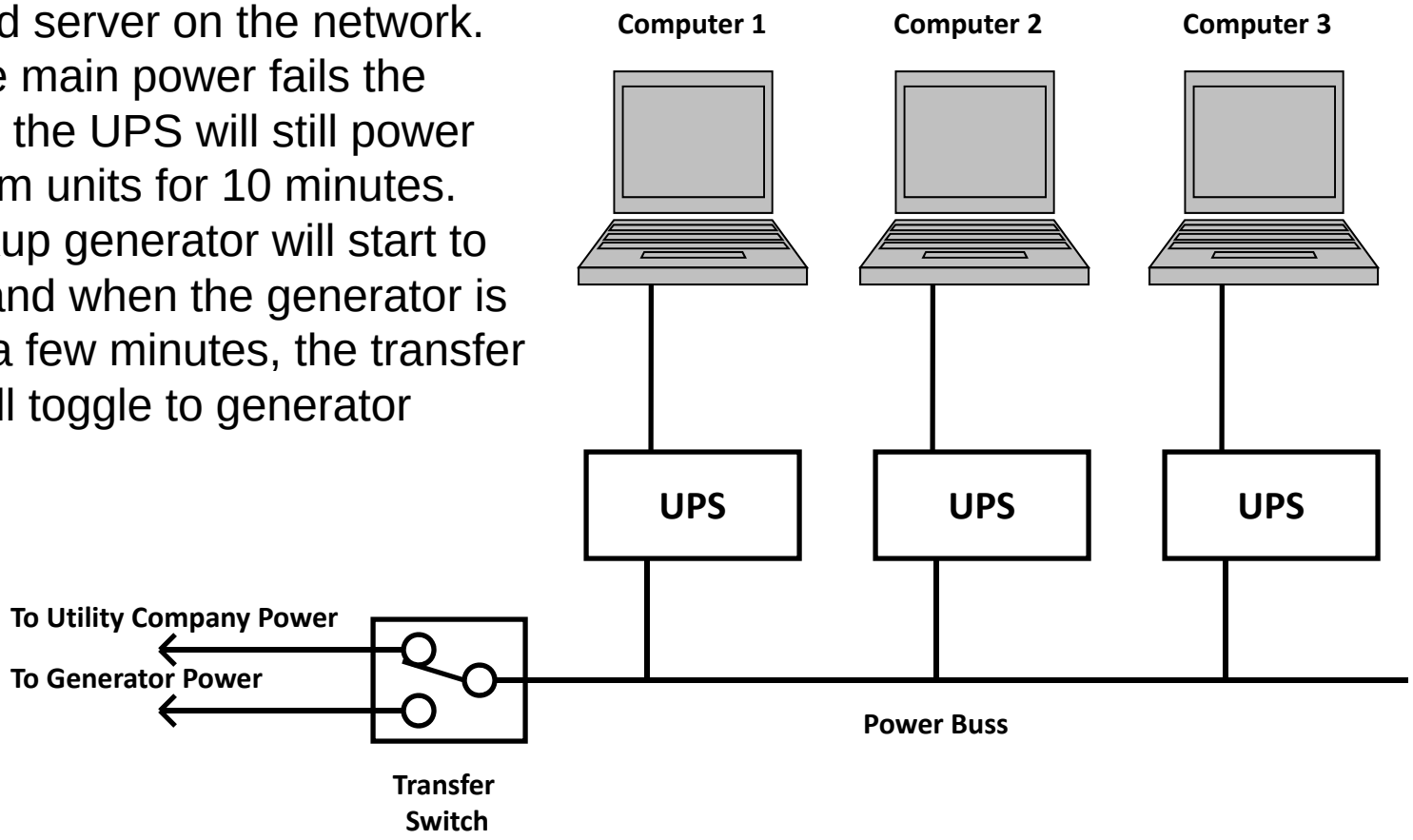
Redundant Power

We also design a redundant network to have backup power. We utilize a Uninterruptable Power Supply (UPS) to act as a buffer between our primary and standardized AC power circuit in the building and a backup system such as a generator.

Some companies are using diesel or natural gas powered generators. Others are using a greener solution such as wind or solar power to provide electricity to the system.

Backup Power System

A typical backup power system has a UPS for each computer, switch, router and server on the network. When the main power fails the battery in the UPS will still power the system units for 10 minutes. The backup generator will start to operate and when the generator is ready in a few minutes, the transfer switch will toggle to generator power.



Backup Power Items

When we design a backup power system, we will need either Uninterruptible Power Supplies (UPS) on every electrical device on the network or we will supply backup power to the entire building, so the battery backup is built into the architecture of the complex.

Backup Power Items

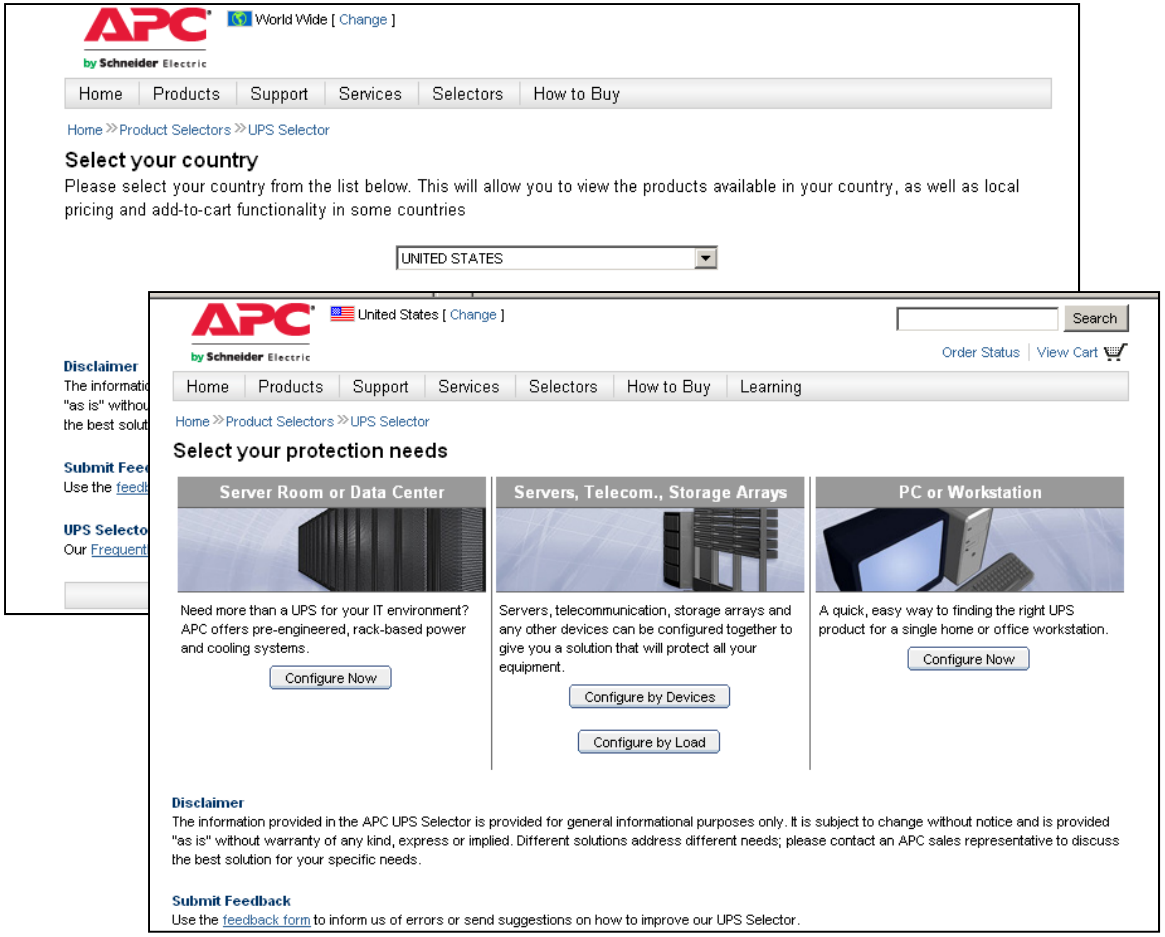
Uninterruptible Power Supply (UPS)
Generator
Generator Pad or Room
Transfer Switch

Many companies choose to just put an individual UPS on each device that will be backed up. So, we will learn how to choose a UPS. Network designers will also pick a generator and transfer switch. The largest cost of the project is the installation of the equipment, so we want to size the generator adequately, so we can utilize the backup system for many years. If we choose a power rating close to our existing power load, we will have to replace the generator or install a second one.

Another consideration is where to put the generator pad on the outside of the building or we can have a room in our building for the generating unit.

UPS Selector Program

We will use a computer program to pick our UPS that was made by the American Power Conversion Corp (APC). Open their web site at http://www.apc.com/tools/ups_selector/index.cfm and we selected the United States in the list box and press Next. At the second web page, we will pick the Configure Now command button under PC or Workstation.

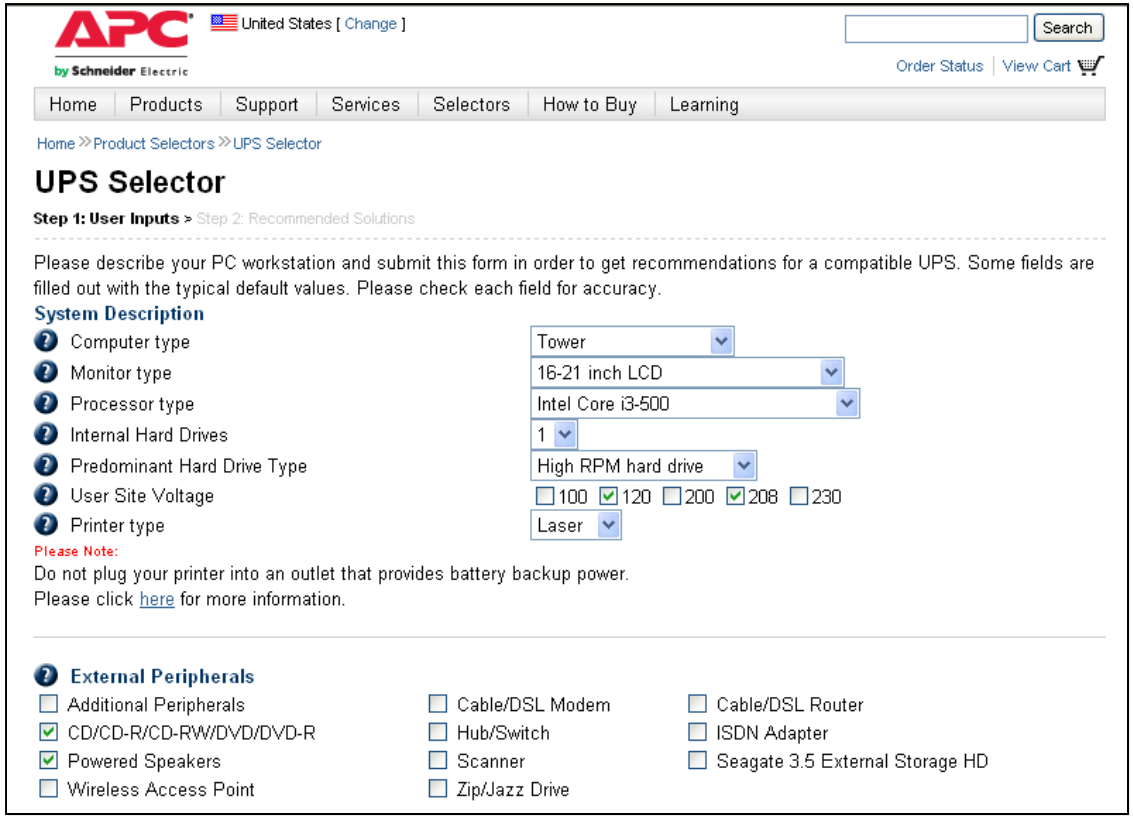


UPS Selector, 2011, American Power Conversion Corp, March 31, 2011, <http://www.apc.com/tools/ups_selector/index.cfm>

UPS Selector Program

We will answer the prompts in the program from our list in the table. Then, we will scroll down and answer more questions. In this exercise, all the computers are the same. In some installations, we can have multiple UPS based upon the power ratings.

Computer Type	Tower
Monitor Type	16-21 inch LCD
Processor Type	Intel Core I3-500
Internal Hard Drive	1
Predominant Hard Drive Type	High RPM hard drive
User Voltage	120V
Printer Type	Laser
External Peripherals	CD/CD-R/CD-RW/DVD/DVD-R
	Power Speakers

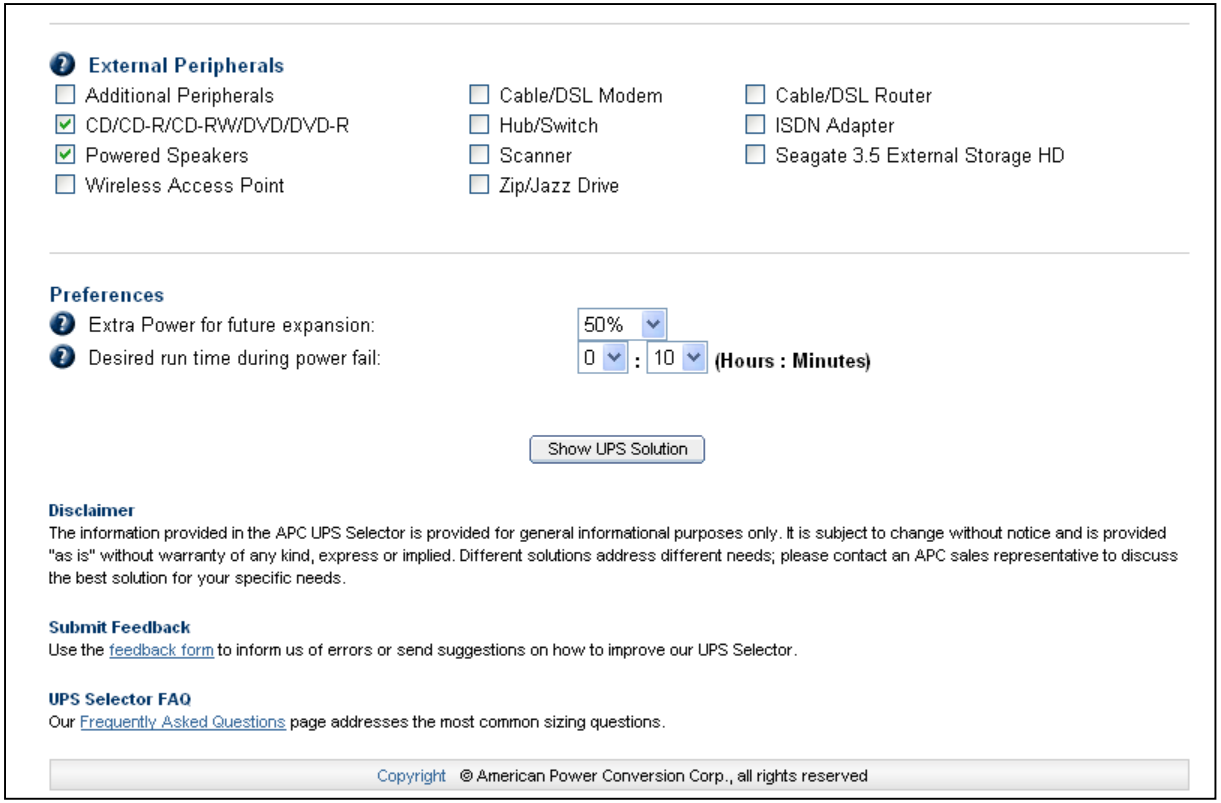


UPS Selector, 2011, American Power Conversion Corp, March 31, 2011, <http://www.apc.com/tools/ups_selector/index.cfm>

Peripherals and Performance

We will plan the UPS to have 50% more capacity and that it will supply power for 10 minutes in battery backup power before the generator will start.

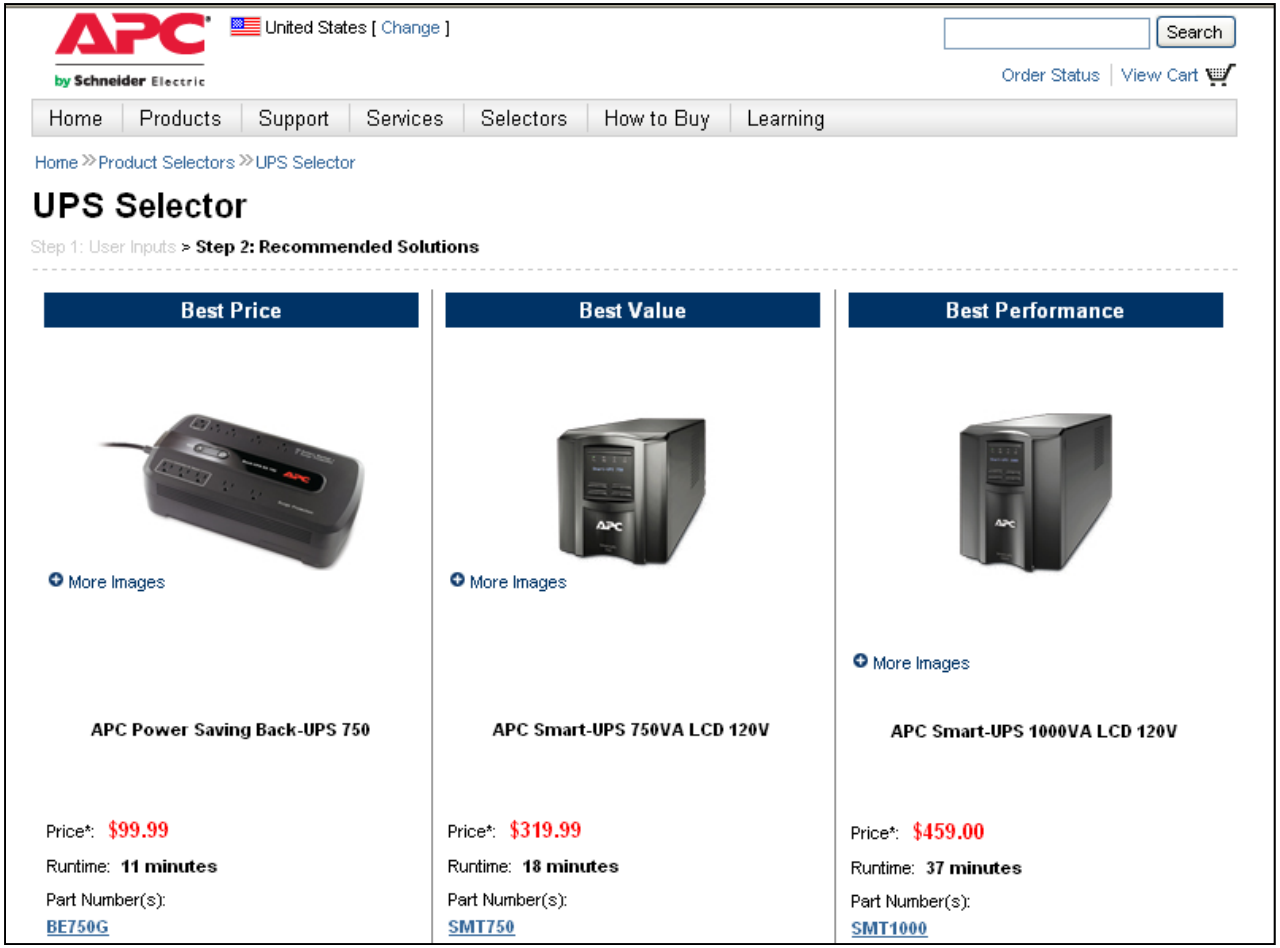
We will pick the Show UPS Solution button.



UPS Selector, 2011, American Power Conversion Corp, March 31, 2011, <http://www.apc.com/tools/ups_selector/index.cfm>

Summary of Choices

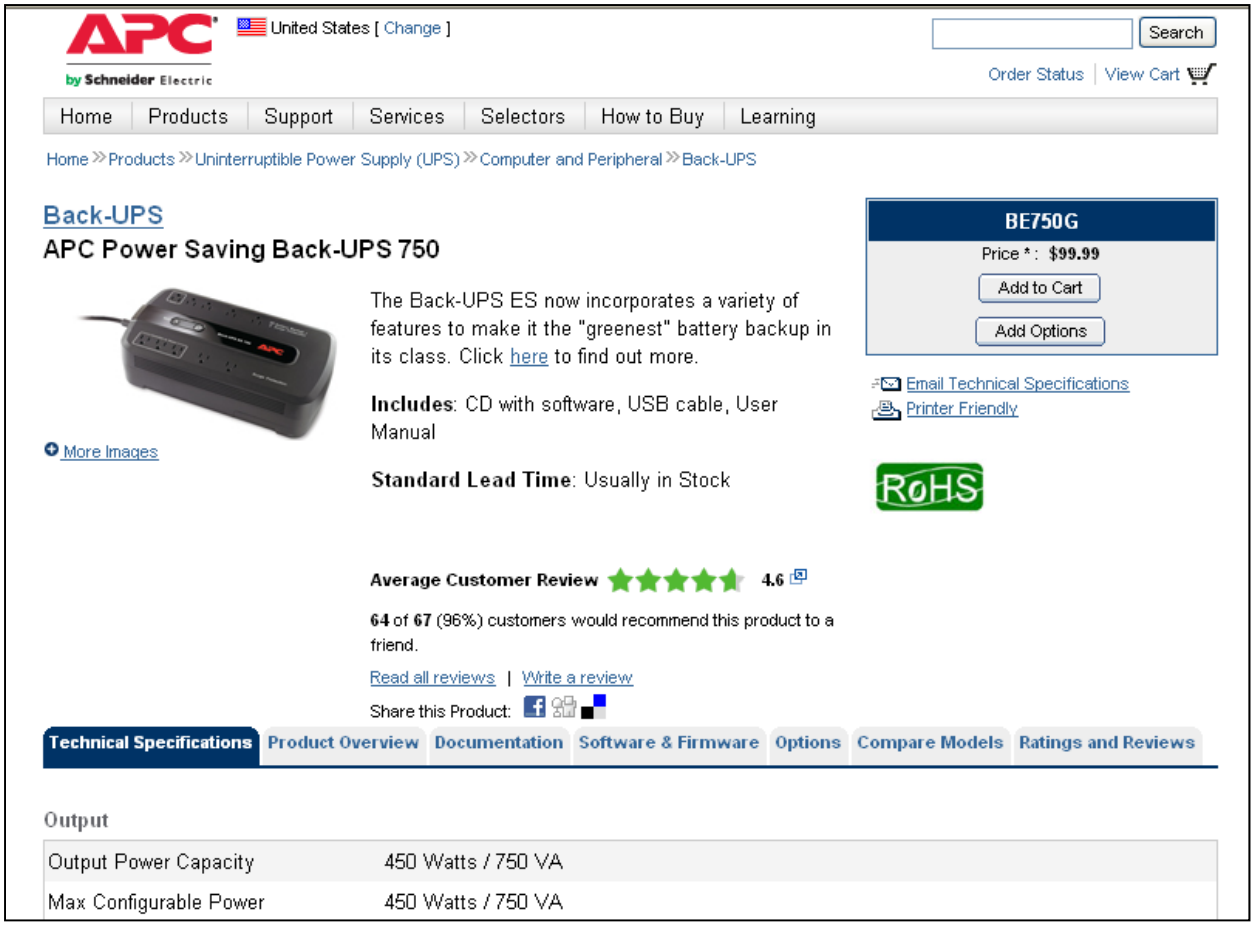
We can see three choices that are either 750 or 1000 VA. We will pick the APC BE750G, so we click on the BE750G hyperlink to investigate the unit's capabilities.



UPS Selector, 2011, American Power Conversion Corp, March 31, 2011, <http://www.apc.com/products/resource/include/techspec_index.cfm?base_sku=BE750G&tab=models>

APC Power Saving UPS 750

The APC Power Saving UPS 750 has an output capacity of 450 watts (750VA). The program was able to take the major components that we will plug into the UPS and it computed the amount of power needed. This unit has a 50% expansion capability in our design.



UPS Selector, 2011, American Power Conversion Corp, March 31, 2011, <http://www.apc.com/products/resource/include/techspec_index.cfm?base_sku=BE750G&tab=models>

Output and Input

The nominal input voltage is 120 volts (88 to 139 volts) and the unit will autosense for whether it is running on 50 or 60 hertz. The power cord is 6 feet long. The wide range in input voltage is okay since the output to our computer is 120 volts from the battery.

Output

Output Power Capacity	450 Watts / 750 VA
Max Configurable Power	450 Watts / 750 VA
Nominal Output Voltage	120V
Output Frequency (sync to mains)	60Hz +/- 3 Hz
Waveform Type	Stepped approximation to a sinewave
Output Connections	(5) NEMA 5-15R (Battery Backup) 
	(5) NEMA 5-15R (Surge Protection) 

Input

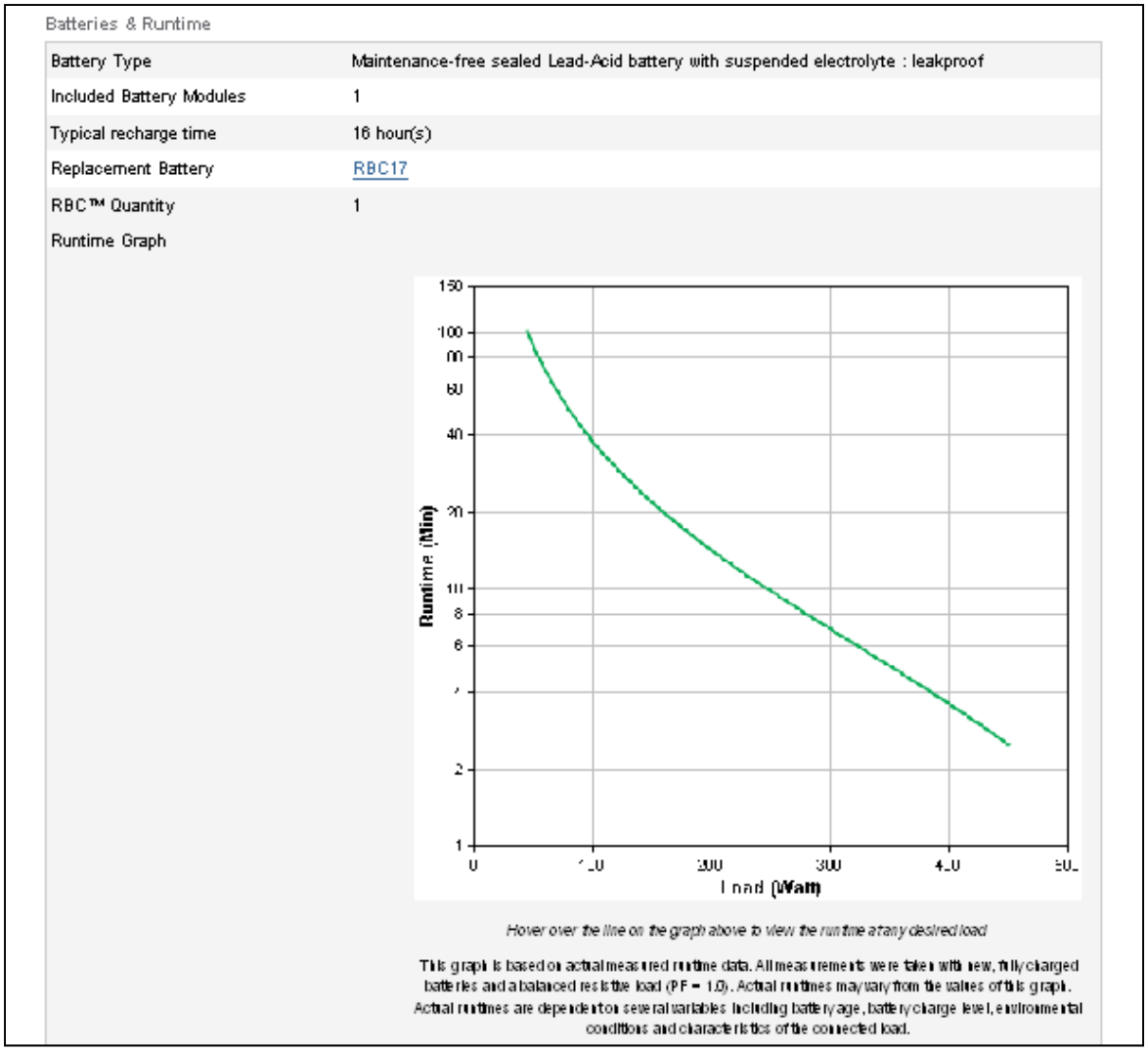
Nominal Input Voltage	120V
Input Frequency	50/60 Hz +/- 3 Hz (auto sensing)
Input Connections	NEMA 5-15P 
Cord Length	6 feet (1.83 meters)
Input voltage range for main operations	88 - 139V

UPS Selector, 2011, American Power Conversion Corp, March 31, 2011, <http://www.apc.com/products/resource/include/techspec_index.cfm?base_sku=BE750G&tab=models>

Battery Runtime

The battery is a maintenance free sealed lead acid with suspended electrolyte. The recharge time is 16 hours

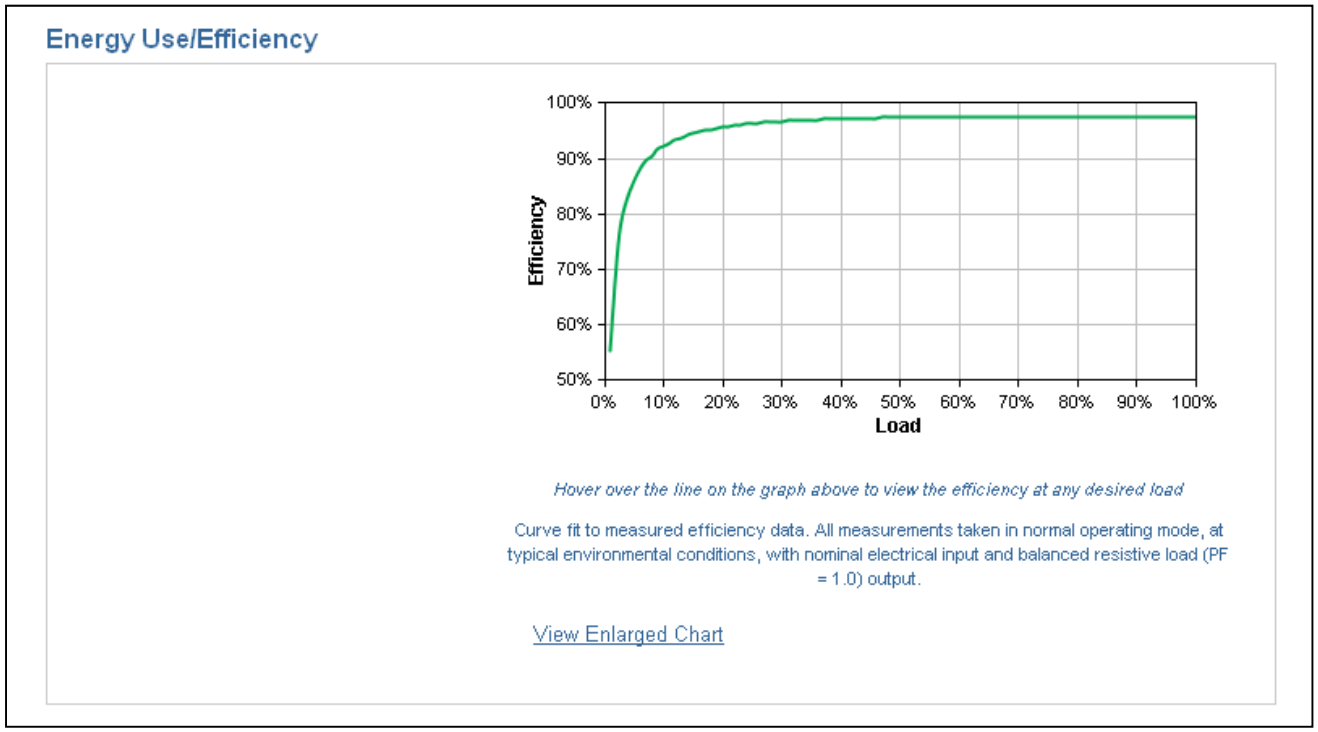
In the graph, we see the runtime on the left and the load across the bottom. The 250 watt load can run for 10 minutes when the battery is fully charges and relatively new. As the unit ages, the performance can degrade.



UPS Selector, 2011, American Power Conversion Corp, March 31, 2011, <http://www.apc.com/products/resource/include/techspec_index.cfm?base_sku=BE750G&tab=models>

Energy Efficiency

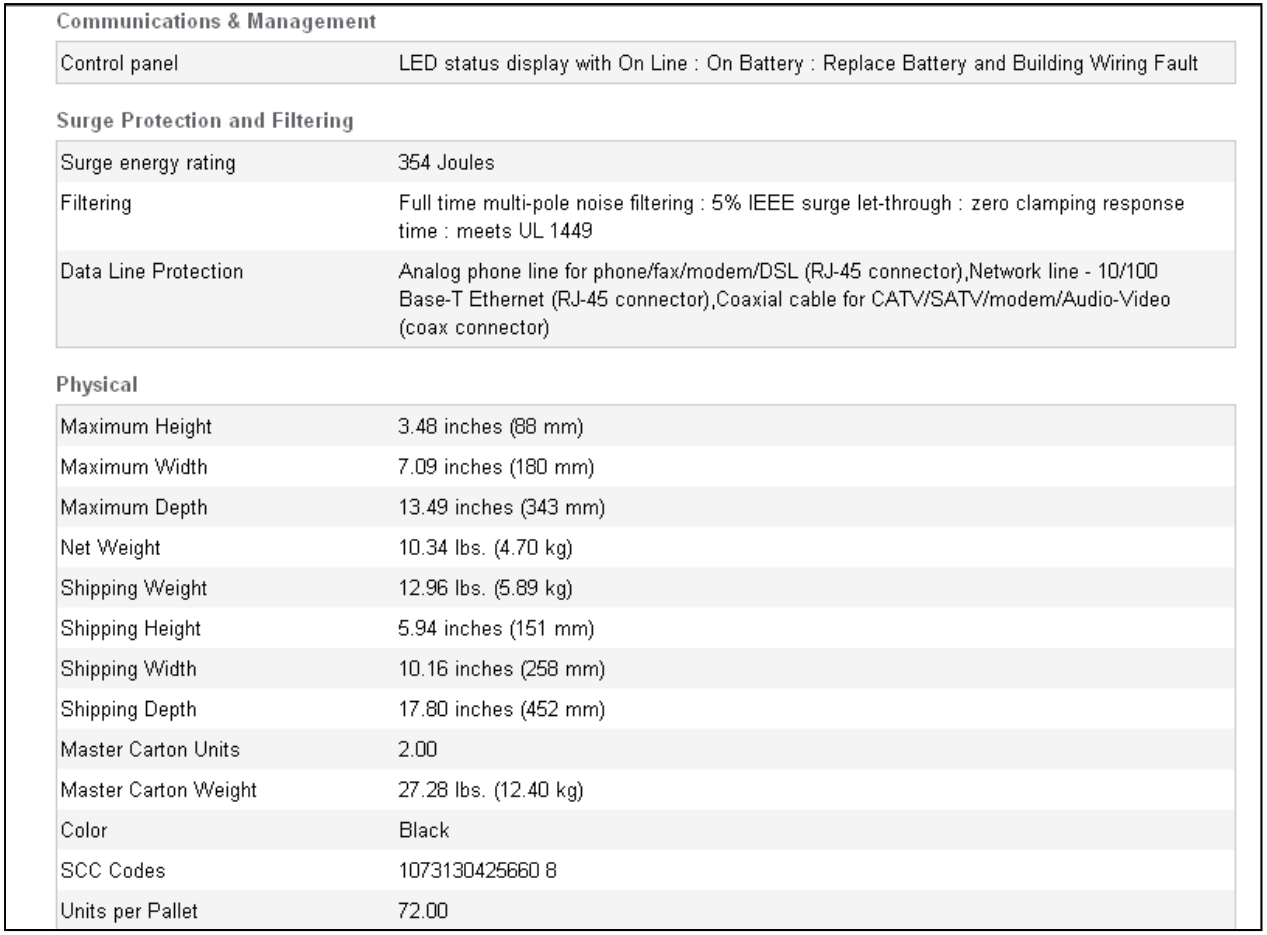
The UPS's efficiency is below 90% when the unit is supporting very small loads such as a single switch or router. The efficiency is above 90% when the load is around or above 10%.



UPS Selector, 2011, American Power Conversion Corp, March 31, 2011, <http://www.apc.com/products/resource/include/techspec_index.cfm?base_sku=BE750G&tab=models>

Physical Size and Weight

The control panel will display that the unit is online, that the battery is on, or that we should replace the battery. UPS units are heavy since they have a battery, so most network technicians place the units on the ground next to a computer tower. This small unit weighs almost 30 pounds (12.4 kg).



Communications & Management

Control panel	LED status display with On Line : On Battery : Replace Battery and Building Wiring Fault

Surge Protection and Filtering

Surge energy rating	354 Joules
Filtering	Full time multi-pole noise filtering : 5% IEEE surge let-through : zero clamping response time : meets UL 1449
Data Line Protection	Analog phone line for phone/fax/modem/DSL (RJ-45 connector),Network line - 10/100 Base-T Ethernet (RJ-45 connector),Coaxial cable for CATV/SATV/modem/Audio-Video (coax connector)

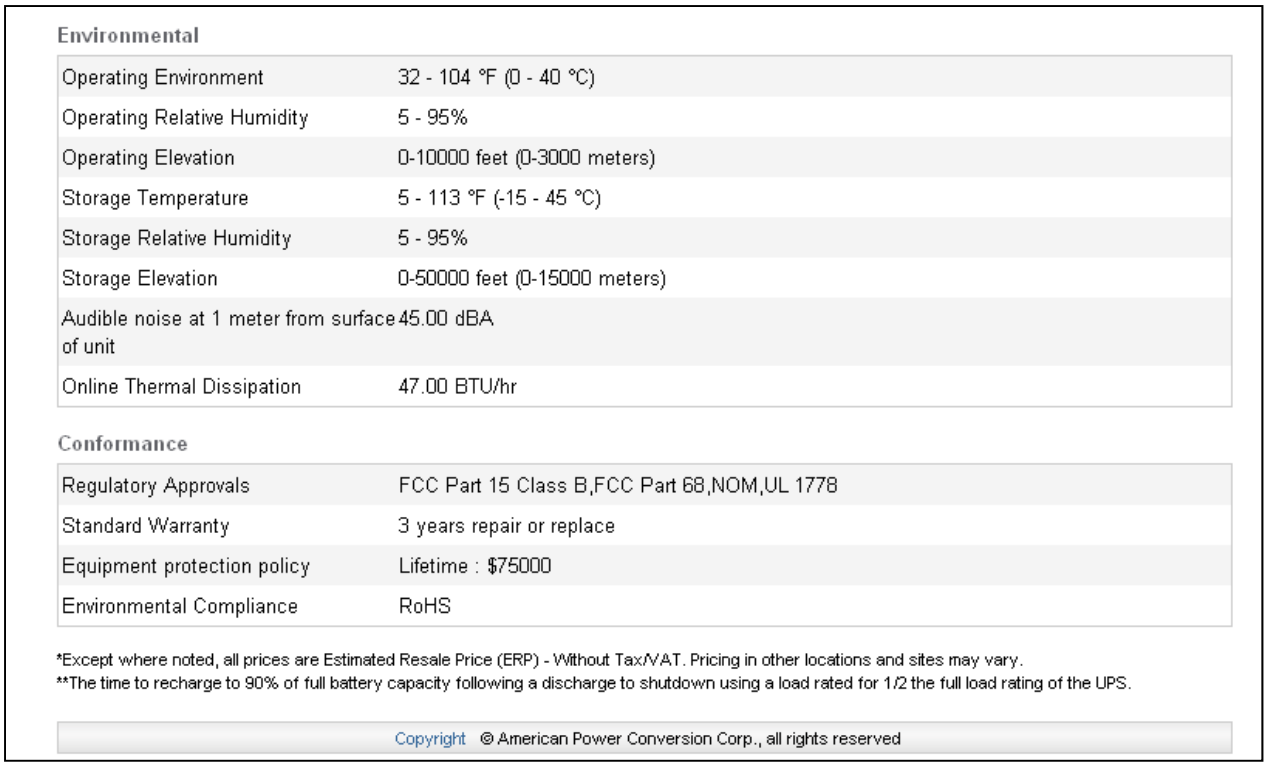
Physical

Maximum Height	3.48 inches (88 mm)
Maximum Width	7.09 inches (180 mm)
Maximum Depth	13.49 inches (343 mm)
Net Weight	10.34 lbs. (4.70 kg)
Shipping Weight	12.96 lbs. (5.89 kg)
Shipping Height	5.94 inches (151 mm)
Shipping Width	10.16 inches (258 mm)
Shipping Depth	17.80 inches (452 mm)
Master Carton Units	2.00
Master Carton Weight	27.28 lbs. (12.40 kg)
Color	Black
SCC Codes	1073130425660 8
Units per Pallet	72.00

UPS Selector, 2011, American Power Conversion Corp, March 31, 2011, <http://www.apc.com/products/resource/include/techspec_index.cfm?base_sku=BE750G&tab=models>

Environmental Conditions

The unit is able to perform its functions from 32 degrees to 104 degrees Fahrenheit and between 5 to 95% humidity. This units is made to run in normal office conditions.



Environmental

Operating Environment	32 - 104 °F (0 - 40 °C)
Operating Relative Humidity	5 - 95%
Operating Elevation	0-10000 feet (0-3000 meters)
Storage Temperature	5 - 113 °F (-15 - 45 °C)
Storage Relative Humidity	5 - 95%
Storage Elevation	0-50000 feet (0-15000 meters)
Audible noise at 1 meter from surface of unit	45.00 dBA
Online Thermal Dissipation	47.00 BTU/hr

Conformance

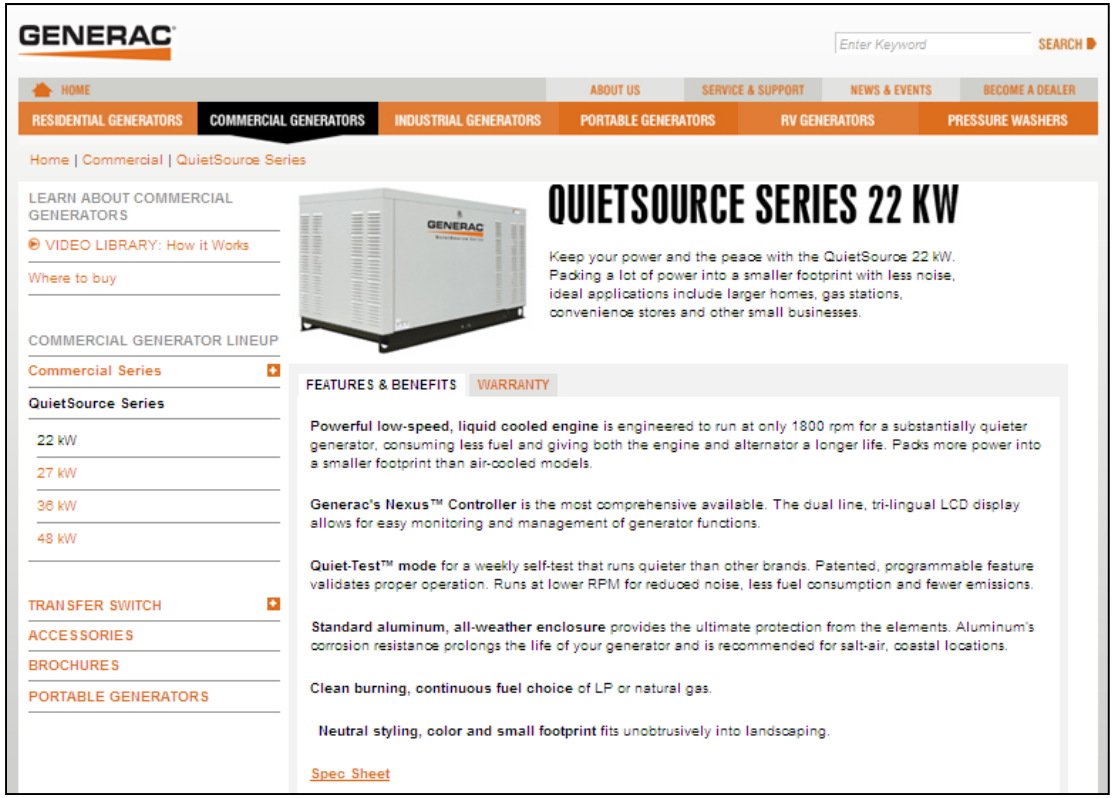
Regulatory Approvals	FCC Part 15 Class B,FCC Part 68,NOM,UL 1778
Standard Warranty	3 years repair or replace
Equipment protection policy	Lifetime : $75000
Environmental Compliance	RoHS

*Except where noted, all prices are Estimated Resale Price (ERP) - Without Tax/VAT. Pricing in other locations and sites may vary.
**The time to recharge to 90% of full battery capacity following a discharge to shutdown using a load rated for 1/2 the full load rating of the UPS.

UPS Selector, 2011, American Power Conversion Corp, March 31, 2011, <http://www.apc.com/products/resource/include/techspec_index.cfm?base_sku=BE750G&tab=models>

Backup Generator

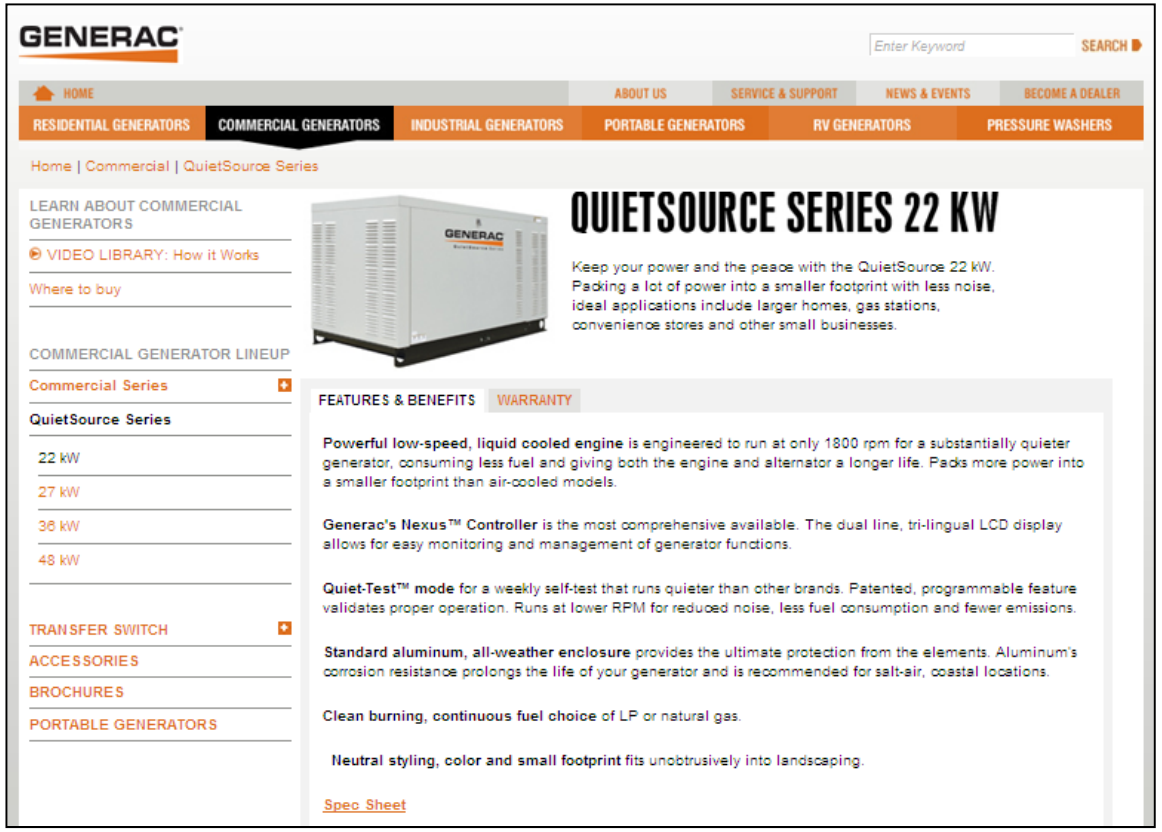
If we have 24 computers, 3 switches, 24 hubs, a network printer, and 3 routers, we would look at the entire power budget to run the system. If we multiply the 450 watts of the UPS times 24, we get 10800 watts. The switches, hubs, and routers might account for another 200 watts, and if we want 50% expansion, we will estimate that we need just over 20,000 watts of power. The Generac generator is rated at 22 kilowatts.



Generac Quietsource Series 22 KW, 2011, Generac Corp, April 3, 2011, <http://www.generac.com/Commercial/QuietSource/Products/QuietSource_Series_22_kW/>

Backup Generator

Some of the considerations we will mull over is the enclosure material such as aluminum, the type of fuel, which we selected natural gas and that the unit will run quietly. We need to have a contractor quote a concrete pad to put the 3 ft by 3 ft by 5 ft long unit on.

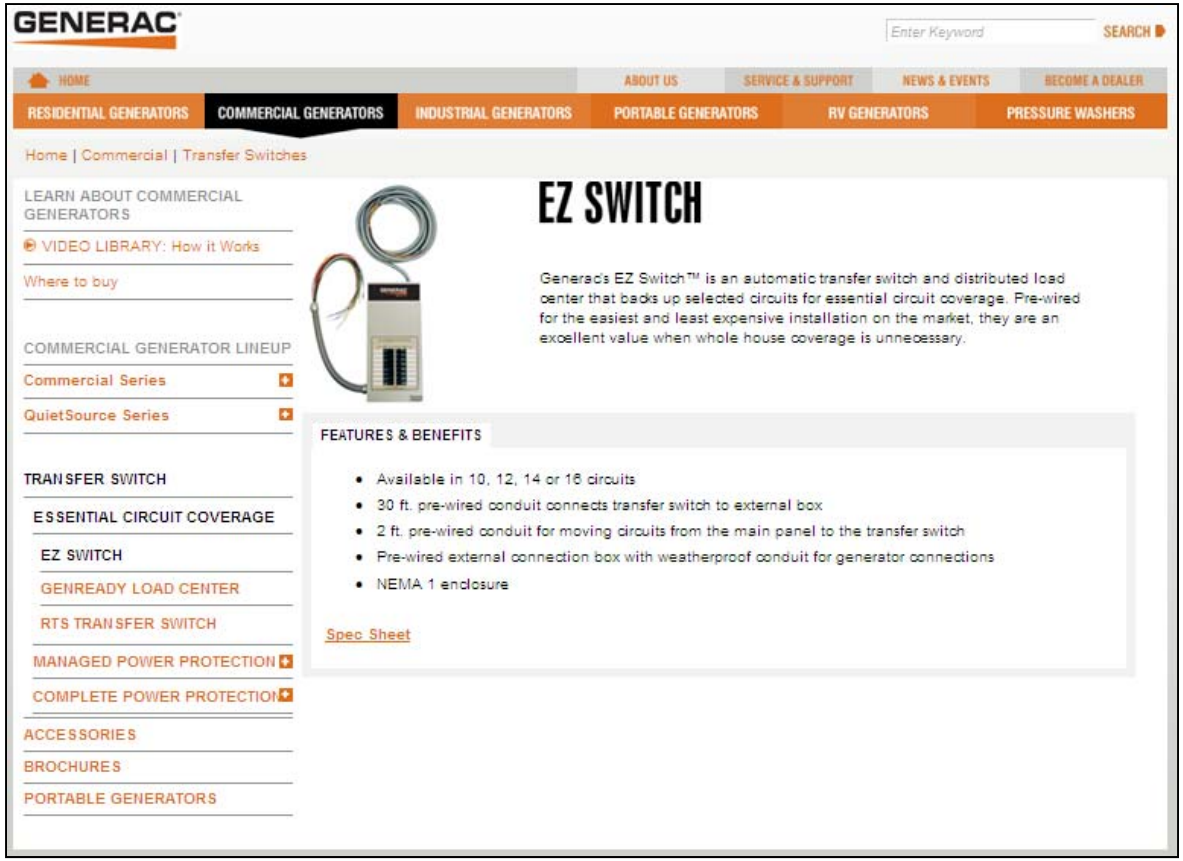


Generac Quietsource Series 22 KW, 2011, Generac Corp, April 3, 2011, <http://www.generac.com/Commercial/QuietSource/Products/QuietSource_Series_22_kW/>

Transfer Switch

To switch from regular commercial power to backup power, we need a transfer switch. The switch will be installed by an electrician.

We should schedule a test each month to check the functionality of the transfer switch.

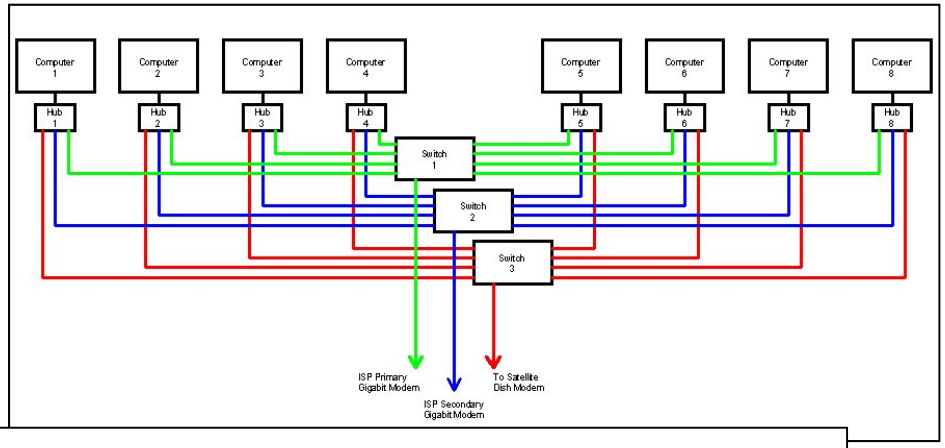


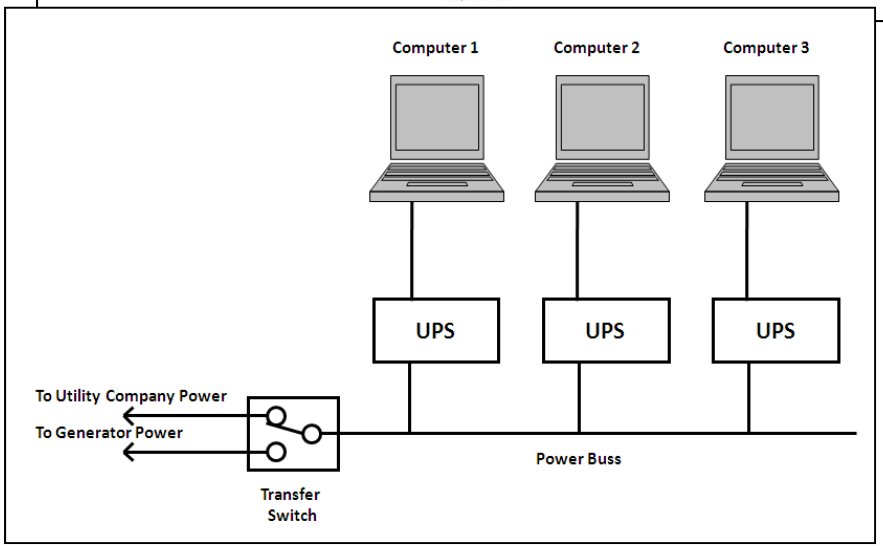
Generac EZ Switch, 2011, Generac Corp, April 3, 2011,
< http://www.generac.com/Commercial/Transfer_Switches/Essential_Circuit/EZ_Switch/ >

Design a Redundant Network

Design a wired network to have 24 computer, 24 hubs, 3 switches , a network printer, and 3 routers. The primary and secondary link will connect to 1 Gigabit lines to the ISP and the backup link will connect to a satellite link to another ISP. We will have a backup generator with 50% expansion.

Create a diagram, spreadsheet quote and cover letter for the job and send the documents to your instructor with attachments. Make an informative PowerPoint presentation highlighting the features of the redundant network you designed.





Review Questions

1. What is an Uninterruptible Power Supply (UPS)?
2. Why is a UPS heavy? How does the device work?
3. What size UPS do we need for a Core I-7 tower with a 17 inch LCD, a printer, and speakers?
4. In a critical network installation such as military command post, how many links do we have to the larger network? Describe each one?
5. What is a backup generator? How long should we take to turn the unit on?
6. What types of fuel can we use when we pick a backup generator?
7. Describe how to use a small multiple port hub to split signals to the different links?
8. What happens if both the primary and secondary links are broken? Why would we have a contractor bury the primary and secondary links on different sides of a building?
9. How often should we test the backup system? How do we do this?
10. Who will install the transfer switch for the backup generator? Who install the concrete pad for the backup generator?