The Summer of Popping Power Supplies

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Around April 2008, Sierra College (Rocklin, California) had an unusual problem in the datacenter. Nobody remembers exactly when and how it started, but server power supplies began failing in unusual numbers and patterns. The senior system administrator remembers hearing "pop pop pop," perhaps a second apart, followed by the acrid smell of charred electronics. On investigation, the staff discovered that three power supplies in three adjacent racks had failed. Thus began a period of travail that some College staff find painful to remember.

The datacenter had been relocated to a building that had not previously housed a datacenter. Raised flooring was installed, power for a single row of racks was provisioned, and two residential air conditioners were installed. Mains power was piped in from an adjacent building. This was supplemented with a pair of Chloride UPSes, a 50 KW Wacker generator, and a manual transfer switch. As servers were added, AC power was extended underfloor with flex armored conduit. There were some server power supply failures right after the move, but nothing like when the problems started in April.

The datacenter manager recalls that the servers—there were around 35 at the time—mostly remained up during the trouble. Most equipment had redundant power supplies, and usually the failures were detected in time to swap in a replacement before the other supply failed. To decrease time to replacement, we implemented a continuous ping-sweep using Solar Winds' IP Sentry utility. This usually caught overnight server outages.

The highest estimate given for the total number of failed supplies was around 50. At that time the College's kit was mostly Dell. Dell balked at the high rate of replacements, which forced us to begin using third-party replacements. Occasionally a tier-2 server's second power supply would be shifted to make a tier-1 server's power fully redundant, shifting the risk of a total failure to lower-valued services.

The entire episode lasted a few months. The College's facilities people, who had installed the datacenter power, were not able to determine the cause. They recommended a local electrical contractor to consult on the problem.

A number of issues came to light. It was discovered that the underfloor boxes that held the electrical outlets had screws that were a tiny bit too long, which caused problems if the face plates were disturbed. The relative humidity was determined to be just 9%. This eventually resulted in replacing the residential air conditioners with a pair of substantial commercial chillers that also maintain humidity at correct levels. Apparently, the facilities people and the contractor didn't agree on the

contribution of unbalanced power draw from the legs of the 3-phase circuit, issues with power factor, or harmonics. But they did agree that grounding was a problem. The addition of 10 to 20 servers over time almost certainly was a contributing factor.

A number of changes were made that together effectively ended the problem. The AC service was upgraded to 400 amps. The generator, undersized for its job, was replaced with a 100 KW Cummins diesel unit. The transfer switch was replaced with an automatic one, and the UPSes were replaced with a much larger pair. Grounding rods were driven into the ground, the floor pedestals and racks were brazed to large-gauge ground wires, a ground buss bar was installed, and all the grounds were connected there.

That was nearly the end of the problems. But in 2011 another (possibly) related problem cropped up. Commercial power failed, the UPS began supplying the datacenter, the generator started and stabilized, and the transfer switch attempted to shift the load to the generator. But, possibly because of a floating neutral, the UPS would not "take" the generator power. Once the batteries ran out, the datacenter went dark. The ground was found to be inadequate. New grounding rods were sunk and the buss bar was replaced.

What can we learn from all this? First, I suggest careful attention to power, especially grounding, when building a datacenter. Second, even under adverse circumstances, it is possible to provide relatively reliable services with relatively unreliable parts. Which has been the story of automatic computing since its inception [1].

References

[1] Claude E. Shannon, "Von Neumann's Contributions to Automata Theory," *Bull. Amer. Math. Soc.,* 1958, pp. 123–129: http://www.ams.org/bull/1958-64-03/S0002-9904-1958-10214-1/S0002-9904-1958-10214-1.pdf (http://tinyurl.com/c2538jw).