Cisco IT Data Center and Operations Control Center Tour

Data Center Power

7. Data Center Power

Electrical Power and Power Protection

Figure 1. Power Cabinets

Dick: "Running a data center takes a lot of electricity, and we have to worry about and plan for power outages. We have UPS batteries in all our data centers, and generator backup in all our major data centers. At first we just had them for production data centers, but we started to realize that engineering data centers can be just as critical to Cisco as business data centers."

Ian: "The business data center gets a single electrical power drop from the local San Jose power grid. There's no redundancy there, we don't get two power drops; which leaves it up to us to provide good power backup. First, the power runs through an uninterruptible power supply (UPS) system so our systems in the data center are always running on filtered power. More importantly, if we lose power our system doesn't lose a beat, since it's running on the UPS all the time anyway. We have 3 UPS battery main systems downstairs in this building, part of our "N-plus-1" design, since we only need two UPS battery systems to support the full design load of the data center, command center and build room. The two UPS systems can support the full design load for about 15-20 minutes.

"During that time, two equal diesel generators behind the building, kept in separate bunkers with separate fuel supplies, spin up and then synchronize their power frequency. It takes about 15 or 20 seconds for the two generators spin up and synchronize, and once they have, then the power from both generators is transferred into the UPS system in the building. Either generator could supply enough power for the data center, but we run on both generators; that way, in case one generator has a mechanical failure, the other one is already running and could easily take up the rest of the load. So they share the load. Meanwhile they two generators are recharging the UPS battery banks from the generator as well. Now, when the power comes back on we don't automatically transfer that back to the public power grid; instead, we wait until we're satisfied by the utility. We call the power utility and wait until they assure us that the power is on for good, and that there'll be no more power outages or testing. At that point we decide it's all clear then we'll manually switch the power back to the grid power."

Q: Have we ever gone to diesel generator backup?

Ian: "Yes, we have. During the rolling blackouts in California in 2001, there were frequent power outages without much warning; so we learned to know proactively. When we did have warning – when the blackout was scheduled for one of our data centers, we would switch to our generators in advance. We get alerted when this happens, since we have a controller system that pages the plant's team and lets us know that power is lost in a location, and that the generator is up to speed, and that power is transferred over to the generator.

Dick: "You'll notice that we've got lights – one to tell us whether or not we are on batteries, and the other to tell us whether or not we are on generator power A couple of years ago we had rolling blackouts in California, and we encountered a little problem that, theoretically, shouldn't have happened. We had a blackout and we went automatically onto battery backup, then switched onto generator power and everything went smoothly. When the power came back on and our data center started up, it automatically came off the generators and went back to the UPS -- and got a ground fault. One of our two UPS backup battery systems, which isn't in use normally, had been wired badly, and the protection circuits took us right back off the backup power and immediately everything in the data center lost power. We lost a few machines because of that. We didn't lose any Cisco gear, but it took us awhile for us to get www.cisco.com back on the air, and that means millions of dollars in revenue lost or at least delayed."

Figure 2. Red and Blue Generator lights

Ian: "We had a major power problem in another data center, which we traced to an error with the power controller system. We had a power outage, and went to generator power. About 15 minutes after the system reported that we were on generator, all our data center systems failed. It turned out that the generators had not been on at all, and the data center had really been on backup battery power until it was exhausted.

"Since then we've installed red and blue lights in all the data centers, directly connected to the circuitry for the generator and for UPS. The red light tells us when we're using UPS, and the blue light tells us when we're on the generator."

Dick: "We learned some expensive lessons that day. We learned to hold our vendors a little more accountable to their standards. We worked with our Workplace Resources organization a lot more closely in the days following that event, to make sure the grounding everywhere is entirely up to standard.

Ian: "Now, we can look at the light to see when we're using UPS. But we only have staff on two or three sites on a 24-hour basis, so we can't be there to see what the light is telling us. So we've installed IP Web cams pointing at the lights, and our command center team can go online and look at the lights at any data center to see what's happening. That costs a few thousand dollars per location, and does a whole lot of good."

Power Distribution

Figure 3. Power Distribution Cabinets

Ian: "Power distribution is important, and we've learned some lessons over time. The power distribution in the newer side of the building 12 data center is different from that in the older side. In the older side we used our standard practice of running power cables under the floor to power distribution units – they look like large circuit-breaker boxes – and then directly to the system racks.

"These power distribution units (PDUs) are more than circuit breakers though, they also condition the power like a large surge suppressor, to make sure that there are no spikes or power variations coming from individual systems. As we kept adding new units requiring new power, it strained our power distribution system. So in the new side of the data center we took more of the floor space and created multiple power zones. We take large power runs from three different PDUs down in these cabinets, with each circuit marked by identifying numbers, and then run the physical circuits under the floor to each frame."

Dick: "This new power distribution architecture makes sure that power drops are spread throughout the room, rather than in one or a few locations. When we add a new box we plug it in just under the floor to cables connecting to one or more of the nearby power cabinets. We have three power cabinets for each row. It takes up more room, but we really need it. And because much of equipment requires dual power sources, we make sure that we plug the backup power supply into a completely separate cabinet. We don't

plug directly into the cabinet, but into cabled power outlets under the floor. They're clearly labeled so that we know what circuit each one is connected to."

Ian: "This new power distribution system allowed us address two problems. One problem was the need for more power drops in less space. We've started migrating from larger servers to smaller servers; now we're getting servers in smaller form factors—in 1-rack-unit systems, or in larger units with 42 server blades in a rack, so power density needs have increased. The second problem is that more systems seem to have redundant power supplies, duplex power supplies for some servers, or N+1 power supplies for some multiserver systems. This increased the need for more power drops, and also required us to provide separate isolated power drops to the same server.

"What's the point of having backup power sources to the same server if they are all plugged into the same power bar? So now we have at least two power sources from two separate PDUs to each system, so if we get a circuit failure or a PDU failure, the system's redundant power will still support it."

Under the Floor

Cabling Standards

Figure 4. Cabling Under the Floor

Dick: "When I lift the floor tiles you can see the network. In this environment we have the network connections cabled out to one side, unlike the more distributed network in the Build room. It's still a somewhat distributed network approach, except that all the network connections are distributed by plugging them into labeled jacks underneath the floor.

"On the minus side you have to plan very carefully in advance and you have to bring enough cable drops under the floor to meet all your future requirements for network connections. On the plus side you don't have to pull cable from the racks all the way to the back to the data center distribution frames on the side of the room. So that means that we have our network connections all underneath these floor tiles and it's not all over the room."

Ian: "The cabling under the floor has gone from complex to kind of boring, which is just the way we like it. We've standardized the cabling at different levels under the floor. The network cabling tray will be up on raised trays closest to the top. Power will be down on the floor so there is vertical separation from the network cabling. In addition, network cabling will go down one row of tiles and power is pulled down another row, so there's more separation. That way if you're adding a new run of network cabling or power cables by pulling the cables under the tile, you don't end up pulling on or snagging other cables.

Power Grounding Grid

Figure 5. Close View of Power Grounding Grid

Dick: "There's a signal reference grid here, this copper grounding grid. It is a 2-foot by 2-foot grid, and the cable which is maybe ¼ inch or ½ inch in diameter throughout this entire data center. We did that because a vendor was having a signal reference problem on the floor and telling us that the subfloor is a discontinuous entity and it's not a very good place to ground. So we built this grounding grid. Unfortunately, it didn't fix the problems we were having. That vendor's equipment is still having problems. We got a very good grounding system out of it though.

“Also you’ll notice a shine on the concrete floor underneath. Over time the concrete slab will degrade and get dusty because it’s got lime in it, so we sealed all the floors with a nice lacquer finish.”

End
Data Center Power

You can go back to the Data Center Storage and Servers section, move ahead to learn how the IT data center is protected against heat, fire, and earthquakes, or you can go to any other part of the tour.

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