Layer 1 Switches Offer Resiliency

Jeffrey Monaco

Higher-layer technology is interesting, but to ensure uptime, you might want to look at the bottom of the OSI stack.

As a network engineer, at times I find myself obsessed with building a highly reliable, fault tolerant network. This obsession is tempered by the cost or technical difficulties associated with building reliable networks in certain situations.

In some of my consulting engagements, we've begun working with a new device, a Layer 1 switch, that allows us to extend network resilience to parts of the network that, before now, simply did not allow for a fault-tolerant design. The purpose of this article is to describe some situations where a Layer 1 switch neatly and cleanly solves some vexing design issues.

First, you need to know a little bit about exactly what a Layer 1 switch is. As the name suggests,

FIGURE 1 Layer 2 Switch Failure

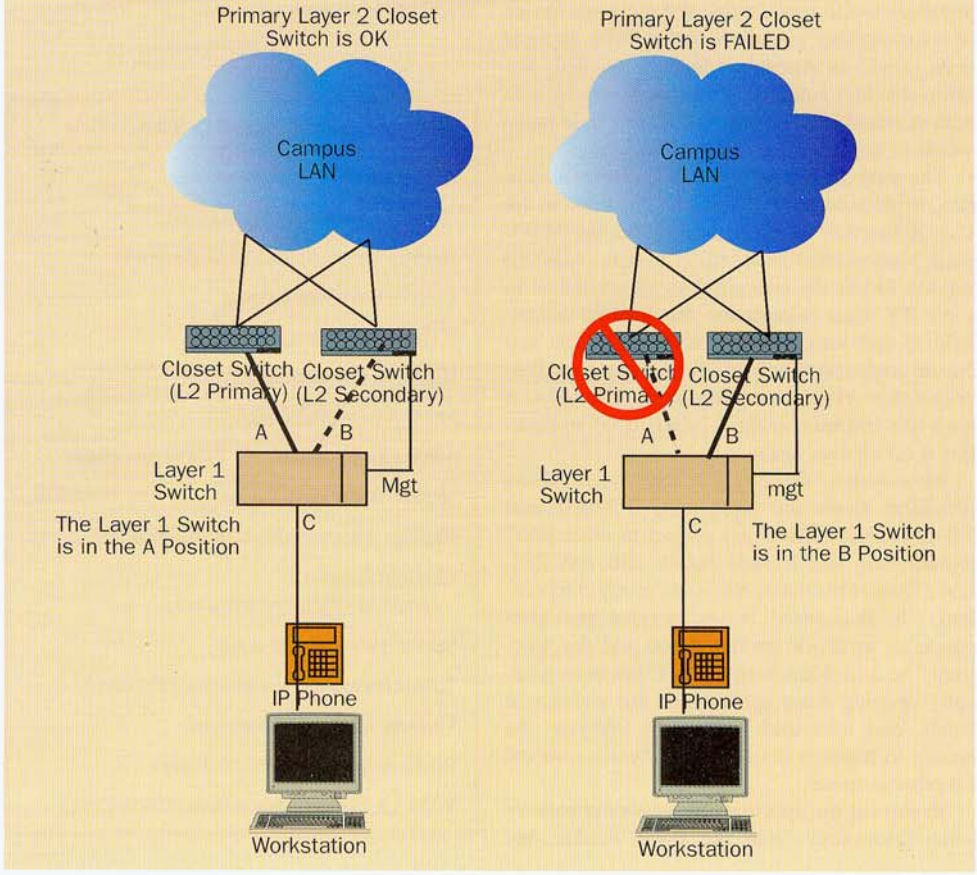

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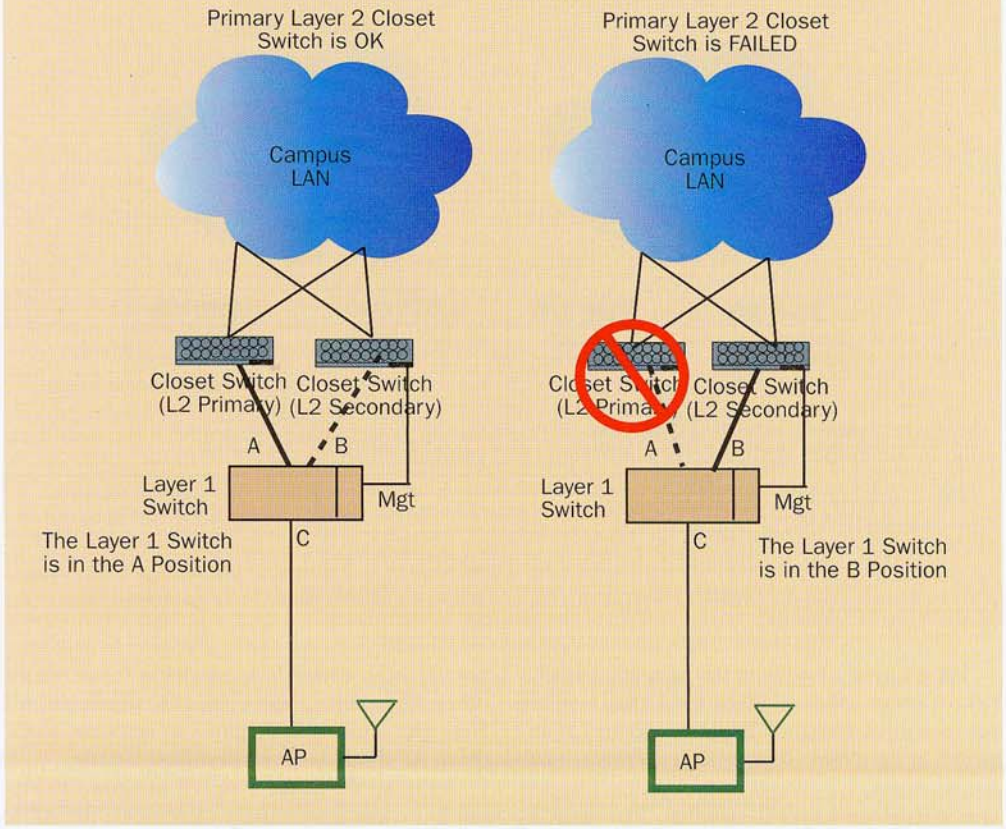
FIGURE 2 WLAN Deployment



A Layer 1 switch can pass signals even if it loses power

this is a device that operates at Layer 1 in the OSI model. The device transmits electrical or optical signals; it does not concern itself with bits, bytes or protocols. Think of an A/B switch on steroids, and you'll get an idea of what the Layer 1 switch does.

Each module in a Layer 1 switch chassis has a "common" port (referred to as C) and two other ports called "A" and "B". The signal path is either C-to-A or C-to-B. When a module is "latched" to a particular setting, either C-to-A or C-to-B, it stays in that position even if the Layer 1 switch loses power. As with higher–layer switches, a Layer 1 chassis will contain multiple modules.

Several things make Layer 1 switches attractive. First, the port settings are software–controllable. So, for example, you can toggle a connected device from the A to the B position remotely. This also allows for automation to control individual settings. It's a significant boost for building a reliable network. With automation, a failed device connected via the Layer 1 switch can be detected, and switched out of the data path, within seconds.

Second, the switches support any number of connection types, such as: RJ45, DB9, AC power, singlemode and multimode fiber with various connector types.

Third, and most important for a resilient design, the switches transmit signals even if the box is "down." That is, you can disconnect the power to the switch, or even remove the management module, and the switch will continue to let signals pass. This is because the switches use relays or mirrors that are physically latched into position. Once a position is set, it stays set. Thus, even though it might look like you are introducing a single point of failure, the switch is nearly as reliable as the cables attached to it.

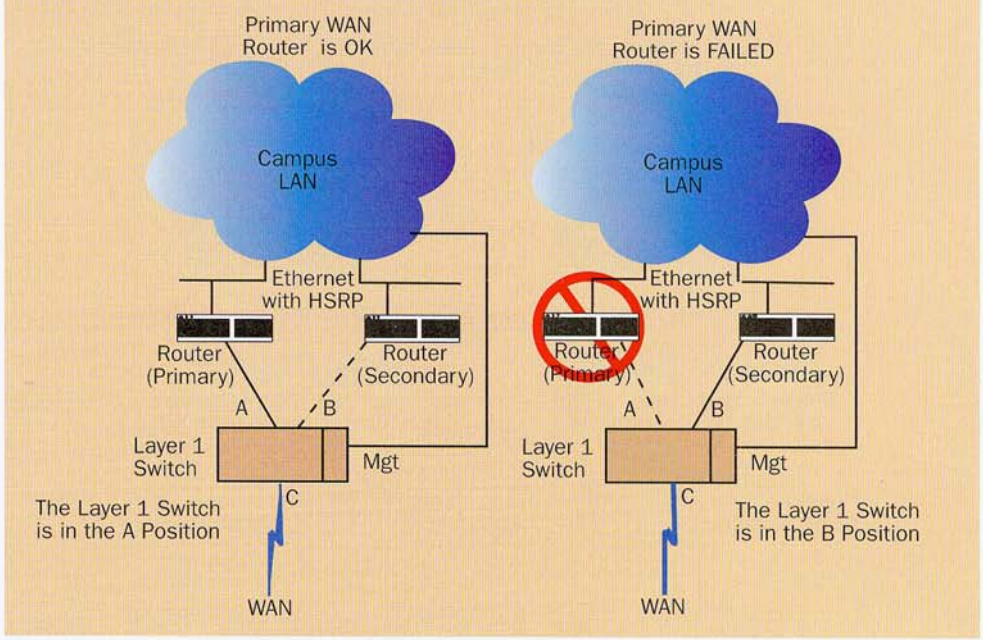
How It's Useful

Now that you know a little about a Layer 1 switch, let's take a look at a scenario where such a device is useful. Consider a call center where IP phones and user workstations are connected to a data closet. In this instance, I want to provide some resilience in case the Layer 2 switch in the data closet goes down. But I don't want to dual-attach every call center device—i.e., attach each device to two L2 switches. That's too expensive. Also, it is impractical if there are IP phones, since IP phones are not typically built to support two separate connections to the closet L2 switch.

Until now, my only option was a chassis-based Layer 2 switch with dual power supplies and dual supervisors. This option is expensive, and still leaves an exposure: If the blade in the chassis fails, my workstations and IP phones still become unavailable.

A Layer 1 switch can keep users from associating with a WLAN access point that's lost its data connection

FIGURE 3 WAN Deployment



Put a Layer 1 switch in the mix, and I readily have a better solution. Place the Layer 1 switch between the workstation/IP phone and the Layer 2 switch in the closet. Replace the expensive, mostly–redundant, L2 chassis with separate inexpensive standalone Layer 2 switches. The resulting design looks like Figure 1. Notice that management access to the Layer 1 switch is via a normal Ethernet port on the secondary Layer 2 closet switch.

By using the Layer 1 switch, the Layer 2 switches in the closets do not have to be dual–supervisor and dual–power–supply flavor. This makes for a more cost effective solution. It neatly solves the problem of a failed chassis blade. As discussed earlier, the hardware "latching" of the A/B position keeps electrical signals moving, even if the Layer 1 switch is down. I don't have to worry about a failure in the Layer 1 switch.

An interesting variant of this has to do with Layer 2 switches that support wireless LAN access points. There are different flavors of this variant, depending on how the APs get their power. I'll illustrate one variant where Power over Ethernet (PoE) is used.

Consider the case where an AP is attached to a Layer 2 switch supplying both power and data connectivity. Aside from the possibility of a blade failure, as described above, you might also have a data traffic failure on the Layer 2 switch. This can result from a problem in the supervisor OS code, problems with the uplink or something similar.

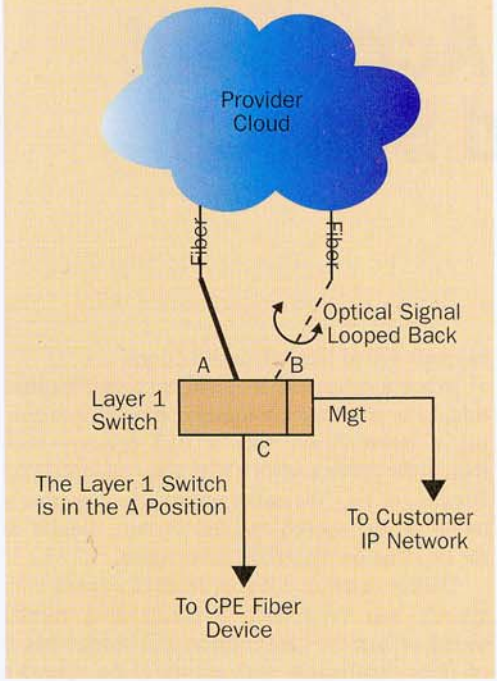
When this happens, power will probably still be supplied to the AP, even though the data connection is down. And since the AP still has power, users who have associated with that AP will remain there, unable to access the network via the down AP or change associations to a different AP. New users, too, will continue to associate to the down AP if that is the nearest, best signal.

By using the Layer 1 switch as shown in Figure 2, we can immediately reterminate the AP to another closet Layer 2 switch, to supply both power and data connectivity. Alternatively, you may also decide to have the "B" position of the port unterminated, in order to remove power to the AP and thereby stop users from continuing to associate with this data–down AP. That is, if the "A"-connected data connection goes down, toggling to the unconnected B side will cut off power to the AP, which will also serve to terminate all client connections with the data–down AP.

You'll notice the same problem can occur if the Access Point receives its power from a separate AC receptacle (i.e., not via PoE). Since the AC outlet isn't affected by an event on the data network, it will continue to supply power to an access point that can't communicate with the rest of the network. If you had a Layer 1 switch behind that AP, the AP would continue to draw power from the AC receptacle and would toggle over to the backup Layer 2 switch for data connectivity.

Layer 1 switching can be useful in the WAN environment as well. I've worked with sites that have only one WAN connection, and can't afford a second. These sites will have a backup WAN router either sitting on a shelf or in warm standby. Currently, when the primary WAN router fails, they manually switch the WAN, and possibly LAN, connection to the backup router. However, Layer 1 switching makes it possible to simplify and automate this failover. As before, there are dif-

FIGURE 4 Fiber Connection



ferent flavors of a solution. Figure 3 shows one way.

Use Virtual Routing Redundancy Protocol (VRRP) on the LAN side (or something like Cisco's HSRP—Hot Standby Routing Protocol—as shown in Figure 3) to provide LAN-side failover. The Layer 1 switch takes care of the WAN side. With suitable automation, the outage can be reduced to seconds, and won't rely on a person being present.

I've added one last example because it is markedly different from the first three, and gives you a feel for the wide variety of ways that a Layer 1 switch can be deployed. In this particular case, we have an OC-12 connection from the provider's central office. The provider ran a second OC-12 for migration purposes (Figure 4).

The challenge for this design was to give the provider a way to test the non-active fiber connection. Market Central, the vendor of the Layer 1 switch, modified the switch so whichever side of the switch was non-active would loop back the optical signal. Now, the provider can do whatever is necessary to ensure the optical signal reaches the customer site. More importantly for this implementation, the customer could switch back and forth between the two fiber connections during the migration period and have a high degree of certainty the other fiber connection was viable.

While this is not the type of thing you see in everyday data networking, it demonstrates the flexible use of the Layer 1 switch. Since it is passing a signal instead of a frame, it can apply to just about anything that has a signal.

Conclusion

A number of different vendors make these Layer 1 devices. We work with Market Central and their line of R5000 and R6000 switches. These are robust, cost effective switches that are widely deployed in industry. Also, they are readily controllable via automation, which makes them quite suitable for the rapid failover situations discussed above and/or disaster recovery network designs. Market Central has also demonstrated the willingness to custom-build Layer 1 switches based on individual customer requirements. Layer 1 switches are also offered by Dataprobe and WTI.

There are many different ways to apply Layer 1 switching technology. The examples described in this article are oriented toward Layer 2/3, switch and router, networking. However, since the Layer 1 switch really is just controlling electrical or optical signals instead of frames or packets, it can apply to other technologies besides IP and Ethernet; for example, Fibre Channel, ESCON, AC power source, RS232 serial connections, 3270 coax, etc. Because of its ability to transmit signal even when down, the Layer 1 switch is a good fit for process control environments.

Try thinking of all the network design problems you've had, and how Layer 1 switching might be applied to deal with them. You'll be surprised at the number of ways you'll find to apply Layer 1 switching in your network□

Layer 1 switches can also work with Fibre Channel, ESCON and other technologies

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Dataprobe (www.dataprobe.com)
Market Central (www.mctech.com)
WTI (www.wti.com)