President's Corner
Broken Is As Broken Does
By Greg Skalka, President, Under the Computer Hood User Group, CA
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www.uchug.org
president (at) uchug.org

We have come to expect good experiences with our technology, and even demand them. A lot of things have to go right, however, to give us those good experiences. When we want to watch a cat video on YouTube, it seems there are few of us in the modern world that don't know how to do it. Most of us probably don't realize all the things that have to work correctly in order to have that experience, however. And when something goes wrong, not all of us seem equipped to effectively determine what is wrong and fix it.

Our watching that cat video depends on a great many devices and systems working perfectly and in concert. To get to that internet site we want to visit, we need to have good ac power available or a good charge on our mobile device's battery. In our computer, laptop or smart phone, a multitude of tiny things need to work perfectly. Processors need to process and access memory and peripherals correctly, memories and other components need to function, input devices (mice, keyboards, touchscreens and switches) must operate and displays and speakers must output. The BIOS or kernel in the device, as well as the operating system, need to work together produce the capabilities and functionality required to make all those components work together to perform the task. Additional browser software must send commands and interpret results correctly. In addition to the hardware and software required at our end, the device's physical connection to the internet (wired or Wi-Fi) must work. Your ISP must provide you with a good connection to the World Wide Web, and all the hardware and software connecting you to that server hosting the web page you want to see must be working. Finally, the YouTube servers themselves must be working. If even one tiny bit of that chain of components and software fails to work as expected, there'll be no cat videos for you. And if it does not work as expected, will we be given any useful information why?

With our increasing dependence on technology, knowing how to debug a tech problem seems like an essential skill to have. Yet troubleshooting does not seem like a common skill. Admittedly, as the devices and systems we use get more complex and tend to be constantly changing, it is very difficult to be an expert on all of it, or often, any of it. Maybe everyone can't be expected to repair their own computers, fix their own cars, debug their own icemakers and unclog their own toilets. But a little bit of knowledge about these devices and systems and some basic fault isolation skills can at least help point you in the right direction and allow you to deal more effectively with any service experts that must be called in.

As an engineer, I've had many personal and professional troubleshooting experiences, but a lot can be done by less experienced users thinking logically and working on the

problem methodically. Providing substitutes for suspect components and conducting controlled experiments can help isolate the fault or eliminate potential causes. In the case of the missing cat videos, using another device to successfully view them points away from a problem with your ISP, the World Wide Web or YouTube. Being able to view other video web sites on the original device probably means it and its internet connection are OK.

When only one item has failed, the odds of being able to isolate the problem to that one item are much better. When there are multiple failures in a system, however, fault isolation becomes more difficult and takes longer. What if your ISP has a failure at the same time your computer has an issue? If your second device also can't view cat videos, you might conclude your first device is good. When you fix your ISP problem and the first device still does not work (but the second one does), further debugging will be required related to that first device.

I recently had a confusing tech problem in which my fault isolation initially pointed in several directions, with a couple of false fixes and multiple issues. Fortunately, though I've still a few minor things to fix, I appear to have resolved my main issue.

All our tech devices need stable, reliable power. Unreliable power can interrupt your use in the best case and damage your devices in the worst case. Valuable devices like computers and smart TVs should at least have a transient voltage suppression device on their power inputs. For computers, where an unscheduled power outage could mean lost data, an uninterruptable power supply or UPS is advisable. This device contains a battery, which powers the device for a short time, allowing a graceful shut-down. These are typically used with desktop computers, while laptops, with their battery installed, have a built-in UPS function when plugged into ac power.

In my home office, I have a Windows 7 laptop, my primary computer, and a Windows XP desktop, which I run from a UPS. I keep the XP machine as it has a lot of software that I still need or prefer (to avoid security issues, I don't have it connected to my home network). I typically never turn off the XP computer; I generally leave the laptop on but close its lid to hibernate it.

One recent evening while working in my home office on my laptop, I noticed that the room lights occasionally flickered, as if the voltage to them was suddenly dropping a bit. I noticed it on the ceiling light and a lamp plugged into a wall outlet, so it was probably not a failing light bulb. I did not see this flickering in lights that were on in other parts of the house but did see it in the laundry room and garage lights.

Fortunately, I made a diagram of our house when we moved in 32 years ago that would be very helpful. On a floor plan of the house, I had drawn all the outlets, wall switches and ceiling lights in each room in their locations. I added information indicating which lights or outlets each switch controlled, and which circuit breaker each was on. Anyone can do this for their own home by turning off each circuit breaker individually, and then

noting which items no longer worked. From my diagram, I noticed that all the flickering lights were on the same circuit breaker.

Residential electrical circuits used to be protected from over-current and short circuit events by fuses in a fuse box, but modern electrical code specifies resettable circuit breakers. Instead of cat videos, I recommend that everyone search for videos on how circuit breakers work - they are interesting and informative.

I looked in my home's breaker box for the circuit breaker in question, but it appeared normal and had not tripped. I considered if something on this circuit were drawing high current intermittently, but there was not much on this circuit but lights, my computers and the garage door opener, and besides, the circuit breaker should trip if overloaded to the point that the voltage drops enough to be visible as flickering. I cycled the circuit breaker switch for good measure, and then found the flickering had stopped.

A few days later, again in the evening, the flickering lights were back, and this time my XP computer's UPS was making occasional clicking sounds. This seemed to indicate that the UPS was protecting the computer, but then my XP computer went off. The UPS did not protect the computer, which probably meant the internal battery in the UPS was bad. I left the XP computer off and also unplugged the UPS. I'd need to look into buying a replacement battery.

For the next few evenings, it appeared that the flickering had gone away. It is hard to troubleshoot a problem that no longer manifests itself. Though still without a UPS battery, I needed to use the XP computer, and so used an ordinary power strip to plug all the XP computer components into the wall outlet. When I tried to start it, however, the computer would not turn on. Sometimes it seemed like the fans would spin momentarily when I pressed the front panel power button, but it otherwise remained dark and dead. Had the power glitching killed my computer?

I pulled the XP computer out and set it on a table. It was obvious it had been running in its place for a long time, as the air inlets were covered in dust. I opened up the case and cleaned out all the accumulated dirt and dust. I also disconnected and reconnected all of the internal connections I could reach, in case any had corrosion or dust on the contacts. While still open, I plugged a power cord into it and hit the power switch. This time it started up! I switched it off, and then on. This time it did not start. I repeated this a number of times and found it would

start about one time in five. I looked like maybe the power supply needed to be replaced, but once it got running, it seemed OK.

Since I needed to use it, I plugged the XP computer back into the power strip and got it running. That evening I noticed the flickering lights again. Then while I was sitting there, the power in the room went out completely for about a second, and then came back on. This was obviously not something shorting the power as the circuit breaker had not tripped - it must be an interruption or "open" in the circuit somewhere.

I told my story to a friend the next day, and he said the very same thing had happened to him a few months before. He eventually found that a staple used to fasten his house wiring to a 2x4 in a wall had apparently been hammered in too hard when his house was built. This had deformed the copper wire it was holding, putting a sharp bend in it. Over time, the weakness in that spot in the wire increased until it opened intermittently under heavy loads. He found where it was by determining that outlets between the circuit breaker and the staple still worked, while those past the staple had problems.

In my case, it seemed all the devices on that electrical circuit were affected, but it would be hard to tell for sure with just flickering. Fortunately, my troubleshooting was about to get easier, as that evening, while using the computer, the power in that room went off and stayed off.

I immediately went down to the circuit breaker box on the outside of the garage and saw that the breaker in question was not tripped. I carefully removed the metal cover from inside the box, exposing the wiring and the power distribution bus bars in the box. I measured the voltage on the output of the suspect circuit breaker (the screw terminal, where a wire attaches) with my digital multimeter to the ground wire in the box. It read zero volts, indicating the problem was not in the house wiring (thank goodness!), but was in the breaker.

I purchased a new circuit breaker from Home Depot the next day and went home right after work to be able to change it out while it was still daylight. To be safe, I shut off the main breakers, cutting all house power (of course my wife just loved that). I disconnected the output wire and pulled the breaker up and out (the breaker has a plastic tab that hooks into the breaker panel on the output side, and metal contacts that slide over the power bus bar in the box on the breaker's input side). I looked at my new breaker and realized it was not the same as my old one. My breaker box has bus bars that run horizontally; the new breaker I'd bought was for a box with vertical bus bars.

While I had it out, I noticed that the contacts on my old circuit breaker and the bus bar where they connected were discolored and pitted. Just like within my XP computer, perhaps cleaning the contacts would help. I used fine sandpaper to clean off both contact points and put the old breaker back in. After putting everything back together, I switched on the main breakers and checked the light in the garage - it was on! I then set about resetting all the clocks in the house and restarting all the other devices. Perhaps my power problem was fixed.

Everything worked fine for another few days, and then one evening the flickering started again. Late that evening the power on that circuit went out completely again. I switched the breaker on and off and wiggled it to try to make better contact, but it appeared that this time it was the breaker itself. It is likely its internal contacts had become pitted and corroded. It was too late to run to the store, so I removed the breaker so that I could take it with me to Home Depot the next day. Unfortunately, having this circuit disconnected disabled our garage door opener and our home internet access (the main Ethernet distribution switches are located in my office, so with no power to them, all wired and Wi-Fi Ethernet would be interrupted). I pulled out extension cords and powered the Ethernet switches and the garage door opener from other unaffected outlets.

With the existing breaker in hand, I was able to purchase the correct replacement and get my home fully powered again. I've had no problems with it since, though I still need to buy a new UPS battery and look into changing the XP computer's power supply. And quickly, before something else breaks!