Ask Mr. Protocol

by Michael O'Brien

TOM BARRETT

"Then the LORD rained on Sodom and Gomorrah brimstone and fire from the LORD out of heaven"
– Genesis 19:24

"After having been around two hundred million years, it's hard to get excited about a dirty ball of ice."
– The dinosaurs

"I think this wire goes here."
– Internet emergency field repair

The Internet in Adversity

Q: *Well, I've had a wonderful month. My computer blew up and spent two weeks in the shop. You'd think that in an industry whose service is dominated by card replacement, no problem could take more than half a day of card-swapping to fix, but NoooOOoo, not a chance. Then, when I finally got the machine home I found out they'd fixed it so well that I couldn't read any of my backup tapes, or even make any new ones. Then the plumbing failed outright and my backyard became a federally-protected wetland, a sweet little 4.5 tectonic wake-me-up rearranged all my books and my cacti have all developed scale carried by an extremely robust population of ants who don't seem to be deterred by anything short of a tactical nuclear weapon.*

The only thing I've got that still works is the Internet.

Makes me sort of wish I'd kept my backups on that Datacomputer you were moaning about the other month. Just how useful is the Internet in times of disaster, anyway?

A: Mr. Protocol is glad you asked. He's glad mainly because he regards anything not on the Internet as a disaster waiting to happen, or occasionally, a disaster in progress. His peculiar species of irreality strengthens this attitude. To him, the Internet seems the most reliable thing in existence because whenever it disappears, he does too. This results in certain lacunae in his perception of time, which sometimes makes me think that Chez Protocol is actually some sort of prototype of Escher's Castrovalva. He gets me marching in enough circles, certainly.

On its face, the question of the Internet's potential in a disaster is a simple one. The Internet is so hard to get working, even at the best of times, that it seems plain silly to think of its even being in existence, let alone useful existence, in conditions which are far less than optimal. Life is contrary. When examined, the territory seems unexpectedly rich.

Jecon Gregory, a man who claimed to remember so little of his childhood that he could not even remember in what country he had been born, once wrote a fascinating volume entitled, *History Of a Nation Of One*. No man is an island, but nevertheless the smallest-scale disaster, which seems convenient to treat, is a disaster that affects a single individual.

The Bandwidth Problem

The Internet is beginning to be of real value in remote medical applications. The only problem with this is many medical indicators are pictorial: nuclear and magnetic scans of various sorts, good old X-rays, etc. Further, detail is important: the images can withstand little or no degradation before they lose critical diagnostic value.

This spells bandwidth. Wide-area Asynchronous Transfer Mode (ATM) networks–and there are getting to be a fair number of them under various rubrics–almost invariably play host to one or several remote medical telepresence experiments of one sort or another. The only problem with these

experiments is they generally permit a top medical expert in one city to view all sorts of detailed medical images in another city, which might be presumed to be stuffed with top medical experts of its own–top medical experts being primarily urban creatures. Once you get further out into the sticks–say, rural Alaska–not only do top medical experts get a little thin on the ground, so does ATM. Also scarce in such places is the money to pay for long-haul, high-speed ATM virtual circuits, which presumably cost much more than the virtual circuits on the inter-city fibers carrying the Internet packets between the two cities mentioned above.

Enter the wonderful world of satellite communications.

Mr. Protocol doesn't give a rodent's derriere about the cost of communications. He thinks "cost" is the name of a field in a routing table. Most people wouldn't care much about the cost of communications in a medical emergency, either. The notion of saving a life makes them go all noble on you. Well-known Internaut Phil Karn once remarked that "'National Security' is the root password to the Constitution." It doesn't take a lot of observation to note that "saving a life" is the root password to the public wallet. Nevertheless, there are very real costs involved with satellite communications, and they aren't going down very fast, either.

The result is an amalgam of special-purpose services and individual projects, rather than the more usual (and more effective) suite of commercial applications sharing a common infrastructure that make up the bulk of the Internet. Not every Eskimo (Inuit, Aleut, take your pick) child with a brain tumor is lucky enough to have an imager backed up by a high-speed data service.

But the infrastructure is growing, even if all of the companies involved in its expansion are taking a flyer into the economic unknown as they build their systems. Iridium is far enough along to have generated its own minor, unanticipated intrusions into everyday life. We knew it was going to support satellite telephones. We could have figured out, but didn't, that the presence of 66 satellites with large, flat, aluminized antennae in 400-mile orbits would lead to the phenomenon of the "Iridium flare," in which an Iridium satellite whose antenna panels catch the Sun at just the right angle suddenly becomes a stellar object of magnitude -7 for a few seconds, dominating the night sky.

Such services will gradually spawn special-purpose, secondary services devoted to medical, search and rescue, and other emergency, disaster-of-one applications. It is not difficult to find park rangers who believe that one's encounter with the wilderness should not be cushioned by such shock absorbers as cellular phones, transponders or other high-tech links with the rest of civilization. To which one can say, fine and dandy. As someone who lost two good friends to an avalanche in a remote part of a national park, I prefer that such aids be available. One can also remark that when one finds their friends' names in the national media, it is almost never a good thing. Bunch of storm crows.

Be that as it may, let us scale up some in disaster size. In particular, let us consider the Loma Prieta earthquake of October 1989, perhaps better known as the Santa Cruz (or San Francisco) quake. Now, this quake was large enough to rewrite the map of San Francisco as San Franciscans took advantage of the inadvertent urban renewal to eliminate for good certain broken freeways, which had lost a critical mass of political support. San Franciscans have never been big on freeways–at least, not freeways leading downtown.

Santa Cruz itself lost a good portion of its downtown. People now tell stories of having walked out of a store just before the quake hit and, after picking themselves up off the ground, turning around and seeing only a pile of rubble behind them where the store used to be. So great was the damage that some of those rubble piles lasted for months.

Telephone service was interrupted. Some of the loss was due to phones being knocked off the hook and tying up central offices, some to damage to switching equipment, some to downed lines and some was deliberate, as some lines were reserved for emergency services.

The Internet, most of which was carried by leased lines at that time, continued uninterrupted, because the leased lines did not share most of the vulnerabilities of the switched telephone network. They did not happen to run through any of the switching centers that were damaged by the quake and they were immune to the other vulnerabilities.

The result was an ad hoc messaging service centered at the University of California at Santa Cruz and supported by the network operations centers of the other UC campuses. Students and others in and around the university were able to exchange electronic mail with people throughout the state and the rest of the world, even though no other communications services were available except for the ubiquitous ham radio. Network operations centers at the other campuses acted as human-powered relays, accepting incoming email sent by network administrators in Santa Cruz on behalf of local residents. These messages contained information on how to contact friends and relatives of the Santa Cruz residents, allowing the operations staff at the remote campuses to phone those people and pass health and welfare information back and forth. This operation was ad hoc and certainly not preplanned, but it fell together very quickly and worked very well.

As a result of this and other similar scenarios, which have played out at small and mid-level disaster sites, some efforts are now underway to formalize the use of the Internet in emergency management. It, like the phone system, is becoming an infrastructure that is heavily used in the aftermath of a disaster–at least in those cases where enough of the communications infrastructure is left to route packets.

And this is interesting. The telephone system uses a sort of hybrid of static and dynamic routing, which does not adapt very readily to severe outages. The designers of the Internet routing architecture, on the other hand, have gone to ridiculous lengths to allow the Internet to reconfigure itself dynamically and route around damaged areas. Of course, in a disaster, routing around the damage is secondary to actually moving packets into the heart of the damaged area, but as long as one router and one wire are left alive to provide routing updates, the packets will flow.

Of course, the infrastructure may not survive at all. There are

cases where people have made some startling design decisions. The state of California, for instance, just installed a fiber-optic network specifically for emergency management. The fibers are mostly underground and are made of glass. They can't stand much sideways shearing force at all. California's most common natural disaster is the earthquake, which moves the ground with sideways shearing force. Go figure. The Internet can withstand almost anything except silly planning.

This leaves the really big disasters. Well, surprise surprise, we haven't had one since the Internet was invented, at least, not in any area already served by the Internet.

P. J. O'Rourke has been claiming loudly of late that these are the best of times, and he's pretty much right. Certainly, it's guaranteed better than most of the previous centuries, because large parts of the world's population can go from day's end to day's end without seeing pustules. Such parts of the world that are undergoing misery are undergoing that misery for local, not global reasons and, in most cases, not even for regional reasons. It's not hard to find populations in extremis, but there are not nearly as many populations in imminent danger of being decreased by the million as there have been during any other period of history. All the really big bad guys have gone away. If the worst thing we have to worry about is being barked at by an Internal Revenue Service gone amuck, we're definitely not living in evil times.

The result, as far as our survey is concerned, is gratifying in a rueful sort of way: There is no theater likely to test the behavior of the Internet in dealing with a truly large-scale disaster in the immediate future. We are left to do what survey types do in such situations: We get to make stuff up.

In terms of disrupting and ending the lives of people who would prefer to have nothing to do with the goings-on, by far the biggest potential disaster is war. This disaster goes on for long stretches, instead of being a sudden one-shot like most natural disasters, and noncombatants always get the short end of the stick no matter who's in charge.

Relief efforts become most noticeable after the cessation of hostilities. During the actual campaign, people more or less get by however they can. All resources are of uncertain availability, including most especially communications, which are generally under the tight control of whoever's in charge of the territory on that particular day. At the end of war, relief efforts go to rebuilding infrastructure, the Internet, presumably, along with the rest. This makes it difficult to predict what would happen in wartime, except for one special case: insurrection.

Periods of insurrection in high-tech countries are rare. The only one in modern times surrounded the dissolution of the Soviet Union. Almost everyone who was on the Net in the early '90s will remember the gripping postings to the Usenet from the Soviet research center, describing hour-by-hour the activities surrounding Boris Yeltsin's White House. For all the garbage that has moved over the Usenet throughout the years, that shining hour made it all worthwhile. The Internet proved that it could, in such conditions, provide a degree of visibility and access to the rest of the world previously available only through news media.

Speaking realistically, it seems highly unlikely the world will ever see another ground war of the size and scope of the two World Wars. This is not due to lack of interested parties, but rather due to the deterrent effect of nuclear weaponry. Again speaking realistically, it seems likely that the next century will probably see a bush-league war sprout a nuclear element.

Playing that card seems likely, at least for the foreseeable future, to force the world powers to take whatever steps may be necessary to prevent that war, with its nuclear element, from spreading to planetary destruction. The Internet will work till it glows (along with everything else) but not past that point.

That being the case, it seems difficult to assess the impact, or even the continued existence, of any part of the Internet in the arena of a continental war. What we can say, though, is the TCP/IP suite was originally designed with attention to its performance in battlefield situations, where any given station can disappear at any time. This is peachy for the soldiers, who have the right routing protocols and the right radios to allow the packets to move without all the wires that have been blown up, burned, bulldozed or just plain lost. However, the military tactical Internets, though they may use the same network protocol as the Internet at large, might as well be nonexistent where the noncombatant is concerned. Ordinary folk would do as they have always done in wartime: make do. Luckily, the Internet protocol suite is robust enough to survive a large amount of "making do."

The Big One

However, there are, at least occasionally, truly large-scale natural disasters, perhaps once in a thousand years. The eruption of Krakatoa would have been one such disaster, had it occurred within shouting distance of Europe. Another example, to pick one at random, is the Yellowstone caldera. This hot spot, which sort of wanders along under the continental plate, last cut loose about 600,000 years ago. The geologic record shows that it typically blows up with some regularity every 600,000 years, so we're due. We can expect to see a volcanic explosion from a crater 20 miles in diameter, resulting in an ash plume that extends to the Atlantic.

Another current favorite, at least in movie theaters, is cometary impact. This one crossed the horizon of our collective attention so recently that we're still making hefty guesses as to the distribution of impacts according to severity and frequency. The problem is the erosive forces at work are so great that even gigantic meteor craters are invisible–unless you're six years old and look at a map, in which case the Gulf of Mexico and Santa Monica Bay get pretty obvious.

Then again there's the massive solar flare scenario, viz., Larry Niven's *Inconstant Moon*.

The notion of a disaster relief effort that must encompass recovery from the complete destruction of several states boggles the mind. One imagines that a successful effort would require the complete reworking of the political and economic foundation of the country. A mild case of the strains involved may be seen in today's united Germany, in which the highly industrialized and successful (read: rich) western half is being forced to

rebuild the entire infrastructure of the economically ruined (read: poor) eastern half. The strain is telling, and besides, all those people aren't dead.

In the wake of a truly large-scale disaster where the activities amount to recovery as opposed to resettlement, the Internet would be sure to play a part, as it is a natural medium not only for organizing the relief effort but also for allowing the remainder of the country to experience, at a personal level, conditions in the affected area. This reminder must be continuous and continual if the immense cost of relief efforts are to be borne by the remaining population.

Such an "emergency Internet" could not be carried by wires and fiber alone. In any large area whose infrastructure has been destroyed, the demands on the Net would be greater than could be borne by satellite resources alone. The Internet would have to be at least partially based on terrestrial wireless technology.

Such wireless technology comes in two flavors. The first, with which we are all familiar, cellular technology, does well in urban environments and supports arbitrary roaming. However, cellular technology depends on an installed infrastructure of interconnected cell sites.

The other flavor is point-to-point. This architecture resembles the regular wired Internet, in that connections run from one node to another. There is no "umpire node" in such an architecture, as there is with cellular technology. Packets are passed on a store-and-forward basis and the network topology is established by means of routing protocols somewhat different from those used in the hardwired Internet. These routing protocols are better able to keep up with changing topology in the network, and can also deal with unidirectional routes, because it is not at all uncommon in wireless applications to have a one-way communications path between stations. Point-to-point wireless Internet systems are not at all common, but both Metricom Inc. and Rooftop Systems Inc., for two examples, are doing work in this area.

It seems strange to think of the Internet as a lifesaver, or a front-line emergency communications medium. It depends on so much high-tech hardware working correctly. What is startling is how often the hardware does continue to work and how robust the protocols are at routing around damaged segments. It seems the Internet may be with us in adversity after all. ⊷

***Mike O'Brien** has been noodling around the UNIX world for far too long a time. He knows he started out with UNIX Research Version 5 (not System V, he hastens to point out), but forgets the year. He thinks it was around 1975 or so.*

He founded and ran the first nationwide UNIX Users Group Software Distribution Center. He worked at Rand during the glory days of the Rand editor and the MH mail system, helped build CSNET (first at Rand and later at BBN Labs Inc.) and is now working at an aerospace research corporation.

***Mr. Protocol** refuses to divulge his qualifications and may, in fact, have none whatsoever. His email address is* amp@cpg.com.