Hello, and greetings from the Central Office! I'm at a toll center downtown today, overseeing the installation of some new equipment. As I have mentioned before, my employer operates both POTS and wireless service. And today is a particularly special day, one that is likely to give me a lot of future headaches. The equipment we're installing involves a feature that has been the utter bane of my existence: Voice over LTE, or VoLTE. Nothing has worked according to plan, and as we install the equipment today, I know that things are going to get worse before they get better. I'm already dreading my upcoming performance review. But all of this is a topic for a future column.

LTE was sold to network operators as a convergence solution to essentially every technology problem they had in the mid-2000s. This should have been a giant red flag, but network operators were almost willing to believe anything that could get them out of the bind they were in. At the time, the wireless landscape in the U.S. was a messy mishmash of technologies, at least relative to the rest of the world. And the technologies in place were being rapidly outgrown. Carriers and the FCC had to figure out a way to address the fragmented market in the U.S. And in the mid-2000s wireless market, there was plenty of divergence. Five different and entirely incompatible technologies were in wide use across the country, and even when there was technology parity with other parts of the world, there wasn't frequency parity. And the end result was that American mobile networks were falling rapidly behind the rest of the world.

As is often the case in technology, early decisions result in technical debt that can carry forward for a very long time. The problems in North America started with a technology mismatch that had its roots in AMPS, the legacy analog cellular network. Mobile phones were more or less invented in the U.S. at Bell Labs, and the first standard to be widely deployed was Bell Labs' Analog Mobile Phone System, or AMPS. Licenses in 850 MHz frequency ranges were granted nationwide, and duopolies were established in each market area. One license set, also known as the "A" carrier, was made available for companies that didn't operate land line phone service in the market area. McCaw Cellular, Dobson Cellular, and many other companies that evolved to operate under the "Cellular One" umbrella bid for these licenses. The second license set, known as the "B" carrier, was made available to companies that operated land line phone service in the market area. Most of these licenses were snapped up by the Regional Bell Operating Companies (RBOCs) that served the given market areas, such as US West and Ameritech, but some licenses (such as the one in Portland, Oregon) were won by independents such as GTE.

As digital technology became available, carriers wanted to switch to it. It was more efficient than AMPS, allowed more calls to be handled per cell site, and it offered value-added features such as data service and text messaging that weren't available on AMPS. However, the FCC had other plans. The licenses they'd granted specified AMPS. People with analog phones didn't want to be forced to buy new ones, and AMPS offered usable (although highly insecure - anyone with a modified scanner could listen) service over a longer distance than digital technologies. So although carriers decided to switch to digital technology, they had to continue supporting AMPS. In fact, the FCC held fast to its requirement to support AMPS all the way through February 18, 2008, long after the technology was considered obsolete!

Faced with a mandate to continue supporting AMPS, carriers looked for technologies that could work on both digital and analog networks. The first such technology to become available was called IS-54, marketed as TDMA, which launched in 1993. Later, Qualcomm released a superior technology called IS-95, marketed as CDMA, which launched in 1995. Both standards were backwards compatible with AMPS, so your phone would keep working if you traveled into an analog-only area (albeit without digital
features). Digital handsets used the same, old, familiar programming as AMPS handsets. The cellular companies that became Verizon, along with US Cellular and several other smaller network operators, chose the CDMA system for their digital evolution, roughly following the lines of the former “wireline” B-side AMPS licenses. Meanwhile, AT&T, Dobson Cellular, and most other A-side carriers chose TDMA (which were the first digital networks deployed in the U.S.). This was the first real technology split in North America, because the two digital technologies were incompatible. CDMA phones could roam on a TDMA network, but only by using the older (and insecure) AMPS system. The same was also true in reverse.

Europe and most other countries in the world, meanwhile, settled on the GSM standard, which launched in 1991. This system wasn’t compatible with older analog networks, but these hadn’t been widely deployed there in the first place; the U.K. had the largest deployment with only two such networks. Spectrum licensing in Europe also didn’t depend on maintaining compatibility with older networks. In the U.K., carriers forced their users to upgrade handsets and abruptly switched off the analog system shortly after the launch of GSM.

Europe also wasn’t hamstrung by congested spectrum, as was the case in the U.S. For its deployment, two frequency bands around 900 MHz were initially chosen (additional bands around 1800 MHz were subsequently deployed). These bands were also adopted in most places outside of the Americas. Unfortunately, the 900 MHz and 1800 MHz bands were already in use in the U.S. An FCC working group explored the possibility of a frequency swap, but the exploration didn’t last long. The U.S. Department of Defense lodged a formal objection, and the recommendation was made to maintain the status quo.

Meanwhile, the FCC, recognizing the demand for additional wireless services at lower prices than afforded by a duopoly, made additional wireless spectrum available. These were called “PCS” bands, and were earmarked for digital-only networks. However, the frequencies available were in the 1900 MHz bands, meaning there was no overlap with any of the digital frequencies deployed throughout the rest of the world. The CRTC closely followed in Canada with essentially the same spectrum allocations, as had been done previously with the deployment of AMPS in Canada.

Sprint and VoiceStream were the first “PCS” networks to deploy in the U.S. While VoiceStream chose GSM, the same technology in use in Europe, and its handsets worked only where VoiceStream had (poor and spotty) coverage, Sprint deployed CDMA. Through roaming agreements (initially AMPS, later both AMPS and CDMA) with the legacy cellular carriers, Sprint was able to offer coverage outside of its “native” coverage area. Meanwhile, AT&T got in on the fun a few years later, deploying its own GSM network, bringing to three the number of technologies supported on its network (AMPS and TDMA were also still supported). And to introduce an element of randomness into the equation, Nextel patched together a network by buying taxi dispatch companies and deploying, through a loophole in the licenses, idEN technology. While Nextel handsets operated like phones, they could also operate as half duplex two-way radios, meeting the licensing requirement.

Got all that? By 2007, the U.S. cellular airwaves were crowded with AMPS, TDMA, CDMA, GSM, and idEN technologies deployed on three separate and distinct sets of wireless licenses and frequencies, none of which were (with a few exceptions) compatible with anywhere else in the world outside of North America. What’s more, 3G had been deployed by many networks, but the 3G technologies weren’t compatible with one another either! UMTS and HSDPA had been deployed by AT&T, T-Mobile (which had since acquired VoiceStream) hadn’t deployed any 3G technology, and Sprint and Verizon were operating 1XEv-DO. So, when the 3GPP - a working group dedicated to standardizing mobile phone technology - promised a unifying standard in 2008, carriers leaped at the opportunity. LTE would treat everything as packet data. Voice and data would all run on the same carrier. Everything would magically become interoperable. The mess would become untangled. It’d be called 4G.

Well, it didn’t quite work out that way. 4G is currently the bane of my existence. But that’s a topic for my next column, where we’ll talk about the future. For now, if you’re calling relatives for the holidays, enjoy the call quality. If you’re moving while you talk, be happy that the call doesn’t drop. I’m going to do my best, but no guarantee that either of these will be the case when this awful cursed VoLTE equipment goes live!