



view, the older technologies are usually long passed before a sunset event would force a phone upgrade. In parallel to the explosive cell phone market growth is the industrial usage of the cellular communication networks. The presence of a cellular network removes the necessity for wired connections and makes mobile monitoring possible for a number of industries. Use cases include alarm systems, asset tracking, cold chain monitoring, environmental sensors, and a variety of light industrial monitors where a remote data collection is beneficial. Many industrial uses are low data and do not need a real-time connection which is in complete contrast with the needs of a typical personal cell phone connection. While the cellular industry has been addressing the needs of the consumer phone market with faster speeds, better connectivity, better phones and higher functionality, the industrial use cases have remained consistently mundane in comparison. As the cell phone experience gets much better, the industrial market struggles to utilize the networks following the rules built for phone use.

The progression of the cellular industry has been defined by a series of 'generations'. Loosely based around speeds, the actual definition is far more complex and manifests in differing hardware connecting to specific cellular network availabilities. Whether it is 2G, 3G, 4G, or now 5G, each defines a type of technology used to accomplish and manage the cellular connection. The actual part of the frequency spectrum on which each generation resides is a function of the carrier that own the rights to use that spectrum space. When the population of a generation of devices decreases to a point where the spectrum space is better purposed for a new technology, then the older generation is 'sunset' to free up the spectrum space. If spectrum space were available a new technology could be brought on line and the older generation could languish, but that is not the case as depicted in Figure 1.

The migration to 4G LTE (long term evolution) technologies is mostly complete for consumer cell phones. The technology advantages of LTE for cell phones are many. Internet access with streaming video, connectivity for the myriad applications, and the ability to have a voice conversation while purchasing the newest gadget off the internet have been made possible by the speed and connectivity that LTE has afforded. The spectrum space where the 2G and 3G technologies still exist are now being planned for implementation for additional LTE capacity and newer 5G generation technologies. This migration requires the existing technology be sunset to free the space.

The nearest sunset involves the Verizon 2G/3G CDMA/EV-DO network. This network began the sunset process in June of 2018 by disallowing activations of any new devices. The actual shutdown date was pushed out to December 31, 2020 as user's migration to new technologies was slower than expected. As this technology was useful for industrial applications, there are still many devices working perfectly well. The cost for users to migrate involves the new hardware and a truck roll to remove the old device and install its replacement. Assuming the supplier of the hardware has redesigned devices, upgraded server systems and are able to produce the product, then customers can follow a migration path. A major migration of technology creates an opportunity for customers to evaluate their business needs and opens the door for the market to competitively bid new solutions.

The next looming sunset will be the AT&T's 3G GSM/HSPA network. The process is well underway as new device activations were discontinued in June 2019, and the sunset date has been published as December 31, 2021. Sprint has also published a sunset date of December 31, 2022. T-Mobile has not

yet published a 3G sunset date as of the end of 2019. The three major Canadian carriers have all pushed a 3G sunset to the end of 2025.

The future is promising for industrial IoT applications. In 4G, LTE is defined with a series of releases with new features and improved connectivity for all types of cellular devices. The M1 and NB-IoT technologies are specifically designed for IoT applications with lower power consumption, better noise tolerance, and lower cost while benefitting from the LTE network coverage and availability. The past generations of cellular technologies were mostly exclusive, meaning that they could not coexist on the same spectrum space. The 4G LTE and the new 5G technologies are defined to be a continuum and while older implementations of LTE technologies will not be forward compatible with the new releases, the LTE network is intended to maintain compatibility with all LTE releases. Major LTE carriers have promised the 4G network will be available through at least 2027, and as there are releases planned throughout the 2020 decade, likely the network will be available well into the 2030s.

The sunsetting of the 2G and 3G networks requires some action over the course of 2020 in order to prevent a disruption in industrial IoT services. Devices destined to go offline need to be identified, procured, physically replaced and have the data management systems updated. Scheduling the implementation of such a migration is dependent on the resources available for the activities and should not be put off until the approach of the sunset date. A smooth transition is the goal for all parties involved.