TELEX

Radio Dispatch

# Telex Market Overview - Telex IP Radio at Denver Public Schools

In 1859, Denver was an out-of-the-way backwater of the Territory of Kansas, a supply hub for the few hundred gold-seekers panning the South Platte River and digging mines in the nearby Rocky Mountains. A century-and-a-half later, the "Mile-High City" is the capital of the State of Colorado and center of a metropolitan area that is home to more than three million people. As the city has grown, so too have its schools, from the log cabin Union School where professor Owen Goldrick taught the city's original thirteen students to the 162 campuses that now serve the nearly 80,000 students of Denver Public Schools (DPS).

Dispersed over approximately 200 square miles, DPS has long relied on two-way radio communications to keep key areas such as transportation, security, and maintenance functioning smoothly. A half-decade ago, faced with limitations inherent in operating heterogeneous terrestrial radio systems over a broad geographical area, DPS became a relatively early adopter of the Radio over Internet Protocol (RoIP) solution from Telex Radio Dispatch. With its Telex RoIP systems, DPS has been able to integrate diverse radio operations into a single communications network, to connect local on-campus systems to distant administrative offices, to cut costs by consolidating off-peak dispatch operations, and to establish communications to remote locations that were previously out of reach.

This case study looks at how Telex RoIP was implemented to enable DPS to achieve its communications objectives, how the technology has opened up new avenues of communication for DPS, and how DPS's investment in Telex RoIP solutions continues to provide lasting value.

**Diverse deployments**

Two-way radio operations at DPS fall into three general categories: transportation, security, and local campus systems. The Transportation Services Department system is comprised of approximately 420 radio-equipped school buses plus another 50 or so hand-held radios used by supervisors and mechanics to support their day-to-day functions. The transportation operations are dispatched from DPS's main dispatch center in the Hilltop Terminal Bus Garage building in central Denver, where radio base stations are installed on the roof.

Two of the center's dispatch stations handle most of the TSD's day-to-day needs. "We are predominantly using two conventional 450-MHz channels for all of our bus dispatching," says Mike Mastin, the DPS communications technician who is responsible for designing and maintaining all TSD radio systems as well as the district's RoIP systems. "We also have a third 450-MHz channel that we use for the Balarat Outdoor Education Center, which is located in a fairly remote area about 40 miles northwest of Denver."

On the east side of the city, meanwhile, is a separate SOC dispatch center that handles dispatching for the district's Department of Safety and Security, which provides protection for students, staff, and visitors to DPS schools and other facilities, and also provides for the safety and security of all district facilities and assets. 80 mobile and portable radios are deployed on this 800-MHz system, which operates as part of a larger EDACS radio network run by the Denver Police Department.

In addition to the high-power systems operated by the Transportation and Security departments, an increasing number of the individual school campuses have their own local radios. "Those are simplex radios in the 450-MHz business band that talk to each other with no base station in between," says Mastin, who allocates frequencies to the schools. "We keep these school-based radios at very low power because we are using the same few frequencies over and over throughout the district. We space the frequencies that we use at schools far enough away from each other that they don't create interference."

**Up against the limits**

By the mid-2000s, DPS was making extensive use of radio for key operations, but it was being held back on several fronts from getting the maximum benefit from its radio resources. One critical limitation was the lack of interoperability between the district's disparate networks. The response to a school bus accident, for example, would typically involve supervisors and field personnel from both the Security and Transportation departments. But with one department operating on the 800-MHz system and the other on 450-MHz radios, timely and effective communication was a challenge.

Similar constraints applied to the low power systems in use at individual schools. Each school was an island unto itself because the radios were not able to transmit across the city to an administrative office or dispatch center. It was clear that the district could improve safety and security at its campuses by facilitating easier communication with these on-campus radios, but that was beyond the capability of the existing system architecture.

DPS also wanted to add redundancy to its radio networks to keep lines of communication open in case of failure at a dispatch center. And it wanted to be able to consolidate onto a common platform the various additional communications methods employed by district personnel such as landline telephones, IDEN phones, and pagers.

One solution to all of these needs would have been to pick one radio system – for example 800-MHz for compatibility with the Denver Police Department's radios – and convert over everyone who was not already on that system. But that approach would have meant abandoning DPS's substantial investment in the other systems and finding the funds to replace those abandoned assets with new equipment. This was clearly not an option. The alternative, which could meet all of DPS's radio goals without abandoning any of its existing investment, was a Telex RoIP system.

**The RoIP solution**

The idea behind RoIP is simple: use the existing infrastructure of nearly ubiquitous data networks to extend the reach and interoperability of two-way radio systems. With radio on each end and a network in between, radio communication is liberated from the vagaries of long-distance transmission through the air and enabled from any location with access to an IP network.

Telex RoIP works by converting the audio and control signals from analog or digital radios to Ethernet packets that can be transported via existing data networks including LAN, WAN, 802.11 (Wi-FI), satellite, and the Internet. This piggybacking on existing infrastructure makes only modest demands on network bandwidth but has profound implications in terms of cost-effectiveness, allowing big benefits to be realized from a small investment.

One of the chief benefits is interoperability. Interfacing is available for all common types of two-way radios. Each radio is assigned an IP address to identify it on the network and connect it to designated ports and addresses. Once the signals from a given source radio are converted to packets the content can be delivered to any other connected radio regardless of the radio type of the source or destination. In fact, interoperability is not limited to two-way radios: telephone systems, iDEN phones, satellite phones, and intercom systems can all be interlinked.

Another plus of RoIP is that networks can be easily expanded as user needs grow. As long as IT resources are available to maintain a data network, assign IP addresses, and program routers and other network equipment, the total number of networked users is virtually unlimited. And because IP is by nature a distributed network, systems can be designed with built-in redundancy to ensure that no single point of failure can bring the network down.

Most of the advantages of RoIP were directly applicable to the radio challenges faced by DPS. DPS already had an Ethernet WAN in place, and several months of testing by DPS's Department of Technology Services confirmed that the bandwidth requirements for a Telex RoIP system could be accommodated without added investment in the district's network infrastructure.

Since the Telex system can easily interface with all major radio types, the system would function with all of the district's already deployed equipment, and systems from different manufacturers and using different frequencies could be easily cross-patched by dispatchers. If a dispatch center were to lose power or a connection to the data network, dispatchers at another location could access the radio system via the data network and take over radio control. On all counts, Telex RoIP appeared to be a win-win for the district.

**C-Soft and IP-223**

Once the benefits of Telex RoIP were understood at DPS, the district embraced the system with enthusiasm, starting with the Transportation department dispatch center. "Our first step was to install three dispatch stations running the Telex system," Mastin says. Provided by local radio dealer Triple C Communications, the stations were built around C-Soft software-based radio dispatch consoles and IP-223 IP network remote adapters.

The Telex IP-223 bridges two-way radios and other communications devices onto the IP dispatch network. Featuring built-in or optional support for multiple interface types — IP, two-wire, four-wire, iDEN (Nextel), local control, and TDI with phone — each IP-223 connects up to two base radios or other devices and allows control of those devices from a network-connected hardware or software dispatch console.

In the DPS system, the dispatch workhorse is the C-Soft console, which runs on a Windows PC with a full-duplex sound card. C-Soft enables dispatchers to monitor and control all two-way radios on the network. And it's compatible with popular touch-screen monitors, offering dispatchers a simple user interface for the creation of talk groups and the cross-patching of other communications networks and equipment to the system.

As a software solution, C-Soft supports the full range of dispatch console functionality but with greater flexibility and at lesser expense. Those cost savings allowed the Transportation department to broaden the deployment of dispatching capabilities by running C-Soft on existing computers in the terminal manager's office, the program routing office, the radio room, and the IT department, all of which would have been far too expensive without software-based RoIP.

In addition to C-Soft, each of the three Transportation dispatch stations is also equipped with a Telex C-6200 radio dispatch console. Able to function in either IP or analog mode, the 18-line C-6200 is a full-featured desktop control console that enables the use of RoIP with conventional radio systems. The C-6200 console offers two-tone paging, three concurrent cross-patches, and other standard analog console features.

"The C-6200s were intended as backup for the C-Soft stations in case we ever have a situation where there is an issue with the computers running C-Soft," Mastin says. "At the time we just didn't know how reliable the C-Soft systems would be. They've turned out to be very reliable, so we haven't done much with the C-6200s."

With its C-Soft/IP-223 positions in place at the Transportation dispatch center, DPS moved on to deployment of a similar three-seat system for Security dispatch, which was taking up residence in a new home within the district's Northeast bus terminal near the old Stapleton Airport. "We integrated the base stations that we use for our Security radio traffic, which interface with the Denver Police system, with IP-223s, which are operated from C-soft systems," Mastin says. "Between the call-in technical support and the service bulletins that detailed all the wiring we needed to tie the systems together, Telex made the integration process very easy."

**Consolidation and interoperability**

Because either of DPS's dispatch centers can access the base stations of the other via the district's WAN, establishing two RoIP dispatch centers achieved the important goal of system redundancy. It has also gained the district major ongoing cost savings through a dispatching consolidation that greatly reduced overtime for the Transportation department. "Depending on what events are going on, Transportation sometimes runs buses on weekends or late evenings," Mastin explains. "The standard shift for Transportation dispatchers runs from early morning to late afternoon, so the department was paying overtime for dispatchers to cover these evening and weekend events."

The time slots for which Transportation was paying overtime are typically off-peak hours for Security dispatch, which is staffed on a 24-hour, 7-day basis. So the two departments made an arrangement that Security dispatchers would handle the after-hours Transportation dispatching, saving the district much-needed funds. "Security now has full capability for dispatching Transportation," Mastin says. "And with the Telex system it was easy to implement. We didn't have to install additional base stations or antennas, cabling, or anything else, because the system allows Security dispatch to access the Transportation department's base stations from across town through the network. It was a simple matter of programming the Transportation channels into the Security C-Soft positions."

Integrating Security and Transportation onto the same network was also a huge step forward for interoperability, easing the obstacles to communication between Security's 800-MHz radios, Transportation's 450-MHz system, and the low-power handhelds used by the schools. In the unfortunate event of a school bus accident, for example, dispatchers are now able to connect simultaneously to the bus driver and Security officials. Similarly, in case of an incident at a RoIP-enabled school campus, supervision by Security or district administration can be established more quickly and easily than ever before. In an ongoing effort to fully enable that capability, DPS has so far placed IP-223s at about 50 schools.

"The magic of the Telex RoIP system," Mastin says, "is that we can now take radio traffic that was once available only in a local area and transmit it over great distances. A school radio that is capable of transmitting maybe a mile at best is now able to have a two-way conversation with a Security dispatcher that might be 20 miles away. Before, it was physically impossible for dispatch to speak to people on the low-power 450-MHz systems at the individual schools. Now the schools that have IP-223s can contact Security dispatchers with their portable radios, and the dispatchers can speak to Security officers on their 800-MHz system."

Mastin points out that, because many Security officers were already used to carrying two types of radios, there has not so far been a pressing need to connect directly without a dispatcher in between. "But it's great to know that the cross-patching capability is already built in if and when we decide that we need to enable it. Without the Telex system, it would be nearly impossible for us to interconnect our dissimilar radio systems. So that's a great advantage."

**Going the distance**

In addition to spanning the distance between school campuses and Security, the RoIP system also helps DPS cope more efficiently with the distance between the Balarat Outdoor Education Center site and the program's in-town offices. "There's little to no cell coverage in the mountain canyons that the buses travel through to get the kids to the Balarat site, or at the site itself, where we have a number of people that the central office needs to stay in contact with. So we maintain a solar-powered repeater on a remote mountaintop that gives us radio coverage for one of our channels up into that area."

The problem was that the Balarat office in Denver has no permanent home; it's given a classroom to use for a year or two, and then moved as that classroom is needed for something else. "Over the years I've had to relocate their office eight or ten times," Mastin says. When the temporary office was well-positioned to reach the mountaintop repeater, the arrangement worked fine, but otherwise communication could be problematic. "Rather than trying to find workable spots for the base station every time they moved, we set them up with C-Soft instead. Now no matter where they put the office, they just have to plug into the network to get clear communications with the remote site."

The latest improvement enabled by Telex RoIP has been the transition to a better way of identifying buses when they call in to the dispatcher. "We have been using DTMF ANI coding to display the bus number on the C-Soft screen," Mastin says. "But DTMF is not that reliable, and every time the driver keys their microphone it takes a bit of time for that four-digit code to be transmitted. During peak hours, when we have a lot of radio traffic, that becomes very inefficient."

The solution has been to activate the IP-223's optional FleetSync capabilities. "FleetSync uses a much shorter data burst and is a lot more reliable than DTMF," Mastin says. "It also allows dispatchers to send messages to individual buses, so if a driver doesn't respond to a call, dispatch can leave a message with that driver on their radio. We think that will be very useful. We just installed FleetSync on the IP-223s and are in the process of adding the feature to all of our bus radios. The C-Soft environment makes it very easy to implement the FleetSync functionality."

With several years of constant use to prove its worth, DPS's Telex RoIP system has delivered on its promise, freeing the district's two-way radio systems from the limitations of strictly terrestrial transmission. Along the way Telex RoIP has managed to save the district money while simultaneously extending the system's reach, bridging gaps in both physical distance and radio compatibility.

"Telex has allowed us to greatly increase the capabilities of our system relatively easily, without having to add a lot of infrastructure at our dispatch sites," Mastin says. "And the system has been very reliable. I've yet to have to replace a single piece of Telex equipment. So the Telex system has proven to be an extremely good fit for our needs. It's worked out really well."