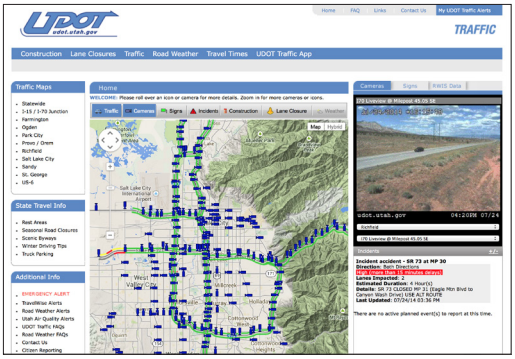
UDOT Uses IoE Capabilities to Improve Traffic Flow and Road Safety, Reduce Fuel Costs and Emissions



EXECUTIVE SUMMARY

Objectives

- Preserve infrastructure
- Optimize mobility
- Strengthen economy
- Reduce road fatalities

Strategy

- Established network of partnerships with municipalities, state agencies, and private companies to enable innovation and ability to serve citizens more effectively
- Developed app that especially targets rural residents, encouraging them to crowdsource updates regarding conditions on roads that UDOT does not electronically monitor

Solutions

- Fiber-optic network infrastructure
- Advanced traffic management system, including traffic cameras, variable message signs, traffic detectors, weather stations, and the UDOT traffic website and mobile app

Impact

- Better visibility into Utah's transportation systems
- Faster, more efficient traffic management
- More timely infrastructure repair
- Improved traffic flow and road safety; reduced fuel costs and CO2 emissions; faster commutes

Background

In January 2014, Cisco released the results of an in-depth analysis of the economic benefits of the Internet of Everything (IoE) for the public sector. Cisco's model revealed that some $4.6 trillion in "Value at Stake" would result from the adoption of IoE capabilities across 40 key public sector use cases over the next 10 years, including smart water, smart buildings, smart energy, smart parking, and more (http://bit.ly/1aSGlzn).

As a next phase of its analysis, Cisco engaged Cicero Group, a leading data-driven strategy consulting and research firm, to undertake a global study of IoE capabilities across these 40 use cases – how the best public sector organizations are "connecting the unconnected," as Cisco terms it. To that end, Cicero Group conducted interviews with dozens of leading public sector jurisdictions – federal, state, and local governments; healthcare organizations; educational institutions; and non-governmental organizations (NGOs) – to explore how these global leaders are leveraging IoE today.

The research examined real-world projects that are operational today, are being delivered at scale (or through pilots with obvious potential to scale), and that represent the cutting edge of public sector IoE readiness and maturity. The aim of the research was to understand what has changed in terms of the jurisdictions' people, processes, data, and things, and how other public sector organizations can learn from (and replicate) the trail blazed by these global IoE leaders. In many cases, these jurisdictions are Cisco customers; in others, they are not. The focus of these jurisdictional profiles, therefore, is not to tout Cisco's role in these organizations' success, but rather to document IoE excellence, how public sector entities are putting IoE into practice today, and to inform a roadmap for change that will enable the public sector to address pressing challenges on multiple fronts by drawing on best practices from around the globe.

About UDOT

The Utah Department of Transportation (UDOT) combines connectivity, technology, and data analytics to increase efficiency and lower costs. Programs include road and traffic-flow monitoring; regional traffic-information sharing and traffic-flow coordination; development of a software interface that maps and organizes layers of GIS data; and the use of Lidar to collect real-time 3D data of roads and highways.

Carlos Braceras was appointed executive director of UDOT following stints as UDOT's deputy director, chief engineer, and region director. He has served as the state's chief geotechnical engineer, chief value engineer, and roadway design engineer. In 1998, he was named "State of Utah Governor's Manager of the Year" and received the "UDOT Leader of the Year" award.

David Burton is UDOT's information technology director; Robert Clayton is UDOT's traffic management director; John Thomas serves as UDOT's planning manager; and John Gleason is UDOT's public information officer.

The Utah Department of Transportation (UDOT) combines connectivity, technology, and data analytics to increase efficinecy and lower costs.

Objectives

Four strategic goals guide UDOT's planning strategies: 1) preservation of infrastructure, 2) optimization of mobility, 3) strengthening the economy, and 4) zero road fatalities.

UDOT's innovations in transportation and infrastructure management include the following:

- **Traffic Signal Monitoring System:** allows remote access for monitoring and adjusting timing of 80 percent of the traffic signals throughout Utah
- **Traffic Signal Automated Performance Measures Program:** provides real-time measurement and analysis of traffic signal performance to inform signal adjustment and improve traffic flow
- **UPLAN:** incorporates GIS mapping with thousands of layers of information for planning purposes
- **Traffic camera system:** informs UDOT, public safety agencies, and the public about traffic congestion and incidents
- **Lidar imaging:** enables remote viewing of entire road and environmental structures to educate planning and pinpoint maintenance needs
- **Public crowdsourcing system:** gathers road condition reports in rural areas
- **Fiber-optic network:** used by the agency and leased to private and municipal entities
- **Freeway electronic message signs**
- **Partnerships with technology firms and municipalities:** enable optimization of technology and integrated systems for efficient planning and upkeep

Strategy

The core of UDOT's strategy is a network of partnerships with municipalities, state agencies, and private companies. UDOT believes that leveraging partners allows the organization to innovate and serve the citizens of Utah more effectively. "As a public agency, our focus is on the outcomes we are trying to achieve," Mr. Braceras explained. "The more we can leave the 'how' to our partners in private industry – even just leaving the how-to with our employees within the department – it's amazing the type of innovation that occurs."

UDOT has opened up its real-time traffic and road monitoring data through a free mobile app and website. The app has been particularly popular, with 250,000 downloads in a state of about 3 million residents.

For example, handing analytics work to technology companies has yielded more creative, insightful models than would have been possible if they were developed in-house. Partnering with tech companies has also allowed UDOT to beta-test new technologies within the tech company before they are rolled out for public use. According to Mr. Braceras, opening public processes to private competition reduces costs, inspires innovation, and accomplishes the goals of the state in a far more effective way than public resources alone. "Our job is truly about safety, mobility, preservation of the infrastructure, and helping the economy," he said. "I prefer private sector to come in, because I want to see competition and innovation. Competition brings innovation. As soon as you get down and you start thinking you know how to do something, you start losing the ability to take advantage of what other private sector competition can bring. I think as a public agency, it's about keeping yourself focused on what you're trying to achieve."

Partnering with other public sector agencies such as municipalities on projects like the Traffic Signal Monitoring System allows both entities to retain ownership over infrastructure, but with an agreement to cede operation during special circumstances. According to Mr. Burton, the public has been receptive to the improved operations because of the joint ownership.

Finally, UDOT also works directly with the public, providing and collecting data to improve the driving experience. First, UDOT has opened up its real-time traffic and road monitoring data through a free mobile app and website. The app has been particularly popular, with 250,000 downloads in a state of about 3 million residents. "We've got pretty good penetration," says Mr. Clayton. "People really like the app. It's a good way for us to communicate."

UDOT also developed an app that especially targets rural residents, encouraging them to crowdsource updates on road and travel conditions on mountainous roads that UDOT does not electronically monitor. Utah experiences heavy snows in the winter, especially in mountainous areas of the state. In these areas, UDOT cameras are not installed with the same density that they are in urban areas. Through the app, rural residents can share with one another and the department important information about road conditions and safety. In its first year, more than 500 users participated, providing a vital link between the agency and the public.

UDOT also conducts statewide public service campaigns promoting safe and smart travel habits.

UDOT relies on the state's Transportation Commission and state legislature for its annual budget. Some of the software collaborations, however, have come at no cost to UDOT, such as cases where software companies own and test their own products.

UDOT owns its fiber-optic system, but allows use of its installed ducts by private companies, while private companies have also allowed UDOT to expand its network on private fiber-optic lines. UDOT also owns its traffic cameras, but has allowed media companies to tap into the live footage for traffic-related and other media broadcasts.

UDOT's advanced traffic management system (ATMS) includes traffic cameras, variable message signs, traffic detectors, weather stations, and the UDOT traffic website and mobile app, which provide data to UDOT, emergency officials, media organizations, and the public on the Internet.

Solution

Fiber-Optic Network

The core of UDOT's system is its fiber-optic network. After laying the first cables 15 years ago, the department built up capacity piecemeal on an as-needed basis for various projects, and coverage was spotty. Ten years ago, UDOT realized a better long-term approach would be to dedicate a project to networking Salt Lake County (the most populous county in the state and home of the state capital and county seat, Salt Lake City). UDOT did not know how much capacity it would need in the future, so a portion of empty ducts were installed during a major rebuild of I-15, the primary north-south roadway through the county.

The infrastructure was then made available for private businesses to lay cable to bring Internet service to the community, while UDOT maintained control of the cable system. "We never would have that reach if we didn't just adopt this philosophy that we are going to partner with private industry and realize that it is OK to have a private company with their own fiber right away," said Mr. Braceras. "There are a lot of DOTs [Departments of Transportation] that do not want that. They do not want anyone in their road. But it's not our road, it is the public's road, and we are going to leverage the public's value here." The private partnership trading led UDOT to now control more fiber than it installed itself, so the UDOT system has more than doubled.

Advanced Traffic Management System

UDOT's advanced traffic management system (ATMS) includes traffic cameras, variable message signs, traffic detectors, weather stations, and the UDOT traffic website and mobile app, which provide data to UDOT, emergency officials, media organizations, and the public on the Internet. Cameras show traffic conditions on major roadways, as well as weather conditions and incident information.

Traffic Signal Monitoring and Measuring

UDOT has connected nearly 80 percent of the state's 1,900 traffic signals on its fiber-optic network; four out of five of these signals are owned by UDOT, and the remainder by individual localities. A single software application manages all of the signals, which allows for seamless communication and coordination across all of the signal owners. "We invested. We bought the controllers, the computers, the chips, and basically upgraded the local signals so we could be all talking together," said Mr. Braceras. Having signals coordinated across jurisdictional boundaries is especially

useful to move traffic efficiently during big-event situations such as college football games, in which UDOT is given authority over localities to manage signal changes.

UDOT's Traffic Signal Monitoring System gives the department unprecedented control to dynamically manage traffic. First, a controller housed in a roadside cabinet – one for each traffic light – dictates when the light should change based on traffic conditions in and around the intersection. In addition, each signal feeds real-time data to UDOT regarding arrival times of vehicles when the light is green and red, the wait times at red lights, and equipment functionality, such as if a pedestrian-crossing light is broken.

Signal timings require human adjustments, but rather than doing them in the field, engineers can make the improvements to traffic patterns from their desks or even in the field – anywhere they have Internet access.

UDOT also uses radar to monitor traffic on roadways. Data from the radar system feeds into the system, telling lights when a car is waiting. Previously, UDOT heavily utilized "loops" embedded in the roadway to sense traffic, but recent innovations led UDOT to transition to the radar devices on poles because the loops were less flexible and invasive to the pavement (installation of the embedded loops required cutting into the roadway, where water could easily damage the pavement around the loops). Pole-mounted radar is easier to maintain, and the system provides more accurate data because bicycles, motorcycles, and pedestrians are now detectable.

This data from the traffic signals is then analyzed by UDOT's Traffic Signal Automated Performance Measures Program to understand the effectiveness of signal timing. Signal timings require human adjustments, but rather than doing them in the field, engineers can make the improvements to traffic patterns from their desks or even in the field – anywhere they have Internet access. According to Mr. Burton, "It used to be that independent boxes would gather statistics, and that information would be processed over weeks or months. Then, data was fed back into the timing changes of the signals, meaning possibly weeks of delay before traffic flow could be improved. Now, improvement occurs in real time. If they see an issue, they can literally change the timing in real time."

Traffic Camera System and Lidar

UDOT also has more than 900 cameras on its fiber-optic system statewide to monitor traffic and road conditions. These cameras feed traffic flow and other data to UDOT, public safety, and emergency officials so dispatchers and first responders can quickly access and relay accurate information to emergency responders. A mobile traffic application provides general access to the traffic camera data feeds, as well as weather forecast information, road temperatures, and lane-closure information. The information is available to the public on udottraffic.utah.gov.

UDOT also uses Lidar 3D images to aid in planning and infrastructure maintenance. In order to gather the data, a Lidar-equipped vehicle will drive down the roadway with a unit that sends 64 lasers out and collects 2,000 points of data per second. This provides an incredibly detailed 3D image of the surrounding natural and built environment, all seen with design-level accuracy.

UDOT is additionally working on utilizing Lidar to further improve its ability to plan and manage Utah's roads. This includes the ability to see 3D road images that pinpoint maintenance needs and give precise geographical data for planning and development purposes.

Electronic Messaging System

According to Mr. Clayton, UDOT has 150 variable message signs across the state, and more than 530 traffic-monitoring stations. The monitoring stations are mostly radar devices attached to poles that measure speed and vehicle counts along the roadways, with the ability to classify the types of vehicles using Utah's roads. The monitoring stations allow travel time to be reported via UDOTs website, mobile app, and variable message signs.

The UPLAN platform is made available online, allowing UDOT to easily share data with contractors and other interested parties. Since being made public, the platform has been adopted or modified by 37 states.

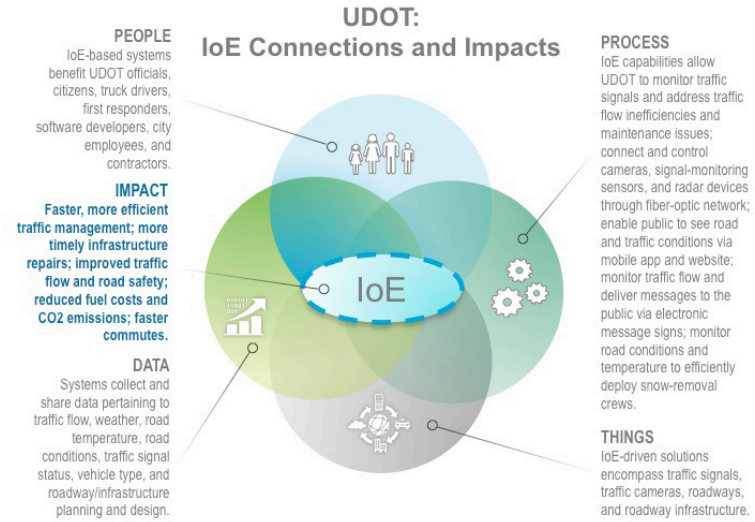
Weather Stations

UDOT owns 85 road weather stations statewide that deliver critical information during storms and allow UDOT officials to see road conditions in real time. These stations also assist UDOT in creating weather forecasts to help plan for maintenance crew deployment to clear snow or lay salt. The weather stations measure the temperature of the roads so UDOT knows which treatments to apply. This weather information is also made available to emergency responders so that they can anticipate possible accidents or other emergencies.

UPLAN

UPLAN is an interface system that merges thousands of layers of shared GIS-based information, which UDOT consults for planning purposes. It was developed in collaboration with more than 30 software companies and technology vendors. The collaboration began several years ago when UDOT invited its software vendors to a meeting to discuss problems UDOT was having in trying to get the various software systems to communicate with each other. According to Mr. Braceras, this meeting immediately resulted in some of these vendors starting to work together to figure out how to make an interoperable platform for the various GIS data feeds. The UPLAN platform is made available online, allowing UDOT to easily share data with contractors and other interested parties. Since being made public, the platform has been adopted or modified by 37 states.

Figure 1. UDOT: New and Better Connections.



Source: Cisco Consulting Services, 2014

Impact

According to Mr. Braceras, UDOT's technological initiatives create a highly granular understanding of Utah's transportation systems. This data is of extreme benefit in both the daily management of the roadways and in the infrastructure planning process. Making this information accessible both publicly and remotely adds an even greater level of usability, which has helped the agency achieve its goals of preservation of infrastructure, optimization of mobility, strengthening the economy, and reducing road fatalities.

Just-in-Time Road Maintenance

Specifically, improved understanding of the condition of infrastructure assists in making timely repairs. This supports the organization's goals of increased mobility and safety by reducing the time required for road and lane closures, which increases traffic flow, contributes to road safety, reduces fuel costs through decreased idling, and speeds up commutes.

UDOT's technological initiatives have contributed to fast and efficient traffic management as well. Sudden changes in traffic patterns due to landslides, accidents, storms, and large events can be monitored and managed remotely from any device with Internet access and credentials.

Improved Traffic Flow

UDOT's technological initiatives have contributed to fast and efficient traffic management as well. Sudden changes in traffic patterns due to landslides, accidents, storms, and large events can be monitored and managed remotely from any device with Internet access and credentials. If UDOT sees an obstruction on a freeway, information is fed to Ports of Entry so that long-haul trucks can be rerouted, saving time and money for the shipping companies and businesses waiting for deliveries. Commuters also have quick access to real-time traffic and road conditions via the UDOT mobile app and website for more efficient travel and contingency planning.

Furthermore, with the Traffic Signal Automated Performance Measures Program, UDOT can remotely view signal reports and make adjustments to the signals, helping to decrease time spent accelerating and idling at intersections, increase traffic flow, and reduce the chances of rear-end crashes and the running of red lights. According to Mr. Clayton, most agencies retime signals every three to five years, but UDOT's program allows it to easily identify the locations that need signal timing adjustments first. Time and fuel savings for drivers are another benefit of the SPM Program. According to Mr. Clayton, a recent implementation on Bangerter Highway and Foothill Drive allowed UDOT to upgrade the signal timing plans, allowing it to achieve improvements of between 15 percent and 25 percent for "arrivals on a green [light]." According to Mr. Braceras, well-managed traffic flow contributes to the local economy and has an environmental impact as well through reduced carbon emissions.

Effective Data Sharing and Reporting

UPLAN has revolutionized UDOT's data-sharing capabilities, both for the general public and for outside jurisdictional use and agency projects. Rather than relying on old methods such as emailing data and trading flash drives, the agency can now make data available with the click of a mouse. "If Carlos [Braceras] has some data, he publishes it and makes it available to the world or to one person. He has the

ability to structure that," said Mr. Thomas. "I can search for 'Carlos's data' and it will respond with all of Carlos's data, all with one click."

Lidar's ability – like that of UPLAN – to organize and access data simplifies and speeds up required reporting, such as environmental impact reports. A recently produced environmental impact statement was completed in three weeks rather than the several months previously required for the task.

In addition, feeding detailed data into the planning of transportation construction projects allows contractors to make more accurate bids, decreasing both financial risk for the contractors and, consequently, their bid prices. This, as Mr. Thomas noted, saves taxpayer money.

Utah has also found success in partnering not just with the private sector and other local agencies, but with individual citizens as well: its crowdsourcing app allowed rural residents to report on road conditions in places not reached by the fiber-optic network.

Public-Private Cooperation

Due to UDOT's forward thinking in laying empty ducts during the reconstruction of the I-15 interstate highway, the infrastructure was available for private businesses to bring Internet service to unserved communities.

According to Mr. Burton, innovation through technology also broadened the field of potential contractors and lowered project costs. "The competition's going up, too, with the way that we bid out our projects. It used to be more of a local bidding process, but now that's pushed out beyond even the state boundaries due to the Internet accessibility of bid information, so a greater number of competitors can bid on UDOT projects."

Lessons Learned / Next Steps

According to Mr. Braceras, the most important lesson learned is the importance of trusting in cooperative relationships with developmental partners. This has been crucial to meeting department goals, whether planning fiber networks, partnering with municipalities over traffic signal control, or bringing software companies together to find solutions to problems. "When you see successful organizations working together it's about relationships," he said. "It's the difference between relationships between people versus the relationships between data. It's the same thing. The better your personal relationships, the better your data will be shared among many different people, many different organizations, for better outcomes."

Utah's size – large enough for a sufficient development budget but small enough for limited bureaucracy – and its reputation as a sound development partner make the state ideal for private sector development and testing. "Utah is a perfect petri dish for companies that want to innovate and try out technologies because of that unique mix," said Mr. Burton.

Utah has also found success in partnering not just with the private sector and other local agencies, but with individual citizens as well: its crowdsourcing app allowed rural residents to report on road conditions in places not reached by the fiber-optic network. "Collaboration is truly the solution in solving the problems that we deal with today," he said. "Solution crowdsourcing draws on that knowledge base to solve these problems."

UDOT is leveraging its current technologies with newer developments like Lidar to link planning and design more closely to operational data. “The evolution that’s taking place is that data for planning can be data for design,” Mr. Burton said. “We’re now working towards doing 3D design, not just 2D design. We’ve had projects where contractors will take the design information, create a digital training 3D model, and feed it into their equipment. Where we’re going is the 3D design will now be taken directly. The contractor will use that, feed that into their equipment. We do not have to go out and gather our own data for each functional unit; we’re all using the same data throughout the workforce.”

According to Mr. Burton, embracing innovation and leveraging partnerships will allow UDOT to improve efficiency and delivery in the future. “Right now, we’re again on the cusp of being able to take another innovative leap. We have this information, and now we’re starting to analyze it and see what it tells us so we can understand how we can improve our decision-making processes to make the next one.”

More Information

For more information, visit http://www.udot.utah.gov/