Traffic Data Roadmap: Where We Have Been, Where We Are Going

Scott Lee & Kevin Mizuta
Transpo Group

The Evolution of Traffic Data

The collection, processing, archiving, and dissemination of traffic data has become the norm in most metropolitan areas by their respective transportation agencies, but this wasn't the case merely 15 years ago. Traffic data and how it is collected and handled has evolved with the changes in technology and policy. One state agency that was considered an early adopter in traffic data management and real time traffic information was the Northwest Region of the Washington State Department of Transportation (WSDOT). WSDOT practiced a "sharing" philosophy when it came to traffic data. Along with developing software in-house and collaborating with the University of Washington, WSDOT shared a real-time, raw traffic data feed with the public which was driven by the interest of private enterprise. The sharing of this real-time data led to the development of hardware and software driven by the open market. The purpose of sharing WSDOT's traffic data story is to provide an example of how traffic data collection and dissemination evolved over the last few decades.

The WSDOT Traffic Data Story[i]

In the 1960s, the major commutes in and out of Seattle occurred north of the downtown core across the Ship Canal through the University District and beyond where the bedroom communities of the city resided. The corridor of I-5 serving this commute is where WSDOT historically focused its deployments in technological advancement.

WSDOT's first freeway data collection system was installed in the late 1960s in the form of permanent traffic recorders satisfying a requirement by the federal government to collect and report highway traffic volumes. At the time, the need to collect traffic data was driven by federal taxation. Tax incentives relating to the freeway system were distributed based on highway volume. The NW Region had 28 stations in the Seattle area along the I-5 corridor. These stations detected vehicle presence through induction loops and recorded data on paper punch readers in the field. Data had to be manually retrieved from each station's recorder at regular intervals for processing and reporting.

Around the same time, the first Traffic Management Center was built near the Ship Canal Bridge of I-5 to remotely manage the reversible express lanes that added directional capacity between downtown and North Seattle. This reversible system was made up of 10-15 CCTV cameras along its 7-mile corridor and included remotely operated, chain driven vertical gates for access control. Camera images were hauled on coaxial cable with several video amplifiers along the path. A tragic accident in the reversible lanes caused by the gates forced WSDOT to abandon the remote operation and switch to manual control in the field. The TMC remained operational and the camera system evolved to have multiple purposes including reversible lane operations and traffic monitoring. There was occasional contact between the TMC and media when incidents in the express lanes and mainline could be seen with the cameras.

In 1978, there was growing interest in arterial performance and Seattle's first coordinated signal system was installed on SR 522. This system was comprised of several Sonex Traffic Controllers connected along Lake City Way with the master controller residing at the TMC.

The central control concept soon migrated over to the freeway data collection system and the Central Traffic Control Master (CTCM) was implemented. The stand-alone, paper punch data stations along the freeway were replaced with Electronic Stations (ES Stations) that continued to use the existing traffic loops. Data at each station was collected by microprocessor and sent back to the CTCM residing at the TMC using a 300 Baud modem. The CTCM, a Perkin-Elmer system, recorded traffic data from the field onto magnetic reel tapes. At the time, the magnetic tapes recorded traffic data of 2200 loops.

In 1982, WSDOT saw the installation of the first 6 roadside flip disk variable message signs to assist in the reversible lane operation. A couple years later a major overlay project on the I-5 Ship Canal Bridge allowed the installation of the first 2 large overhead variable message signs on the freeway mainline. This was also when the region's first ramp meters were installed on I-5 along the same corridor, covering 18 ramps total. An expanded CTCM also controlled the ramp meters and generated a color coded congestion map that was displayed on a television screen.

Communication with local media, which included local TV and radio, became protocol. The media would call the TMC and the operator on duty would recite a traffic report on the spot referencing the cameras and TV congestion map. The media would also call for updates to ongoing traffic incidents.

In 1988, the CCTV system was upgraded, which included the implementation of an additional network known as the Video Distribution System (VDS). This system included color monitors and a software interface to control cameras rather than a push-button panel. At this point, the TMC operator station was made up of a large 19" black and white CRT for ramp meter monitoring, a 12" color TV for the congestion map, a PC with the camera GUI, and another PC for VMS control. An additional PC existed to access the archived traffic data from the magnetic tapes.

By 1990, a symbiotic relationship existed between the TMC and the local media. From the media perspective, the TMC was an invaluable resource for the most up to date traffic information, and from the TMC perspective, the media was a powerful tool to disseminate information to motorists in the context of incident response and demand management. Although this relationship was essential, the constant phone calls from the media were becoming a distraction and were affecting the performance of regular operations.

In an attempt to mitigate the number of phone calls to the TMC, a solution was developed that allowed each media outlet to have their own real-time congestion map. This was accomplished by developing and distributing a program called FLOW and providing access to a private network. FLOW, which was a Microsoft C program, ran on MS-DOS based computers with VGA 16 color displays. The bandwidth and data packet size allowed for up to 400 stations to be colored on the congestion map. WSDOT provided each interested party with the client software and a modem to dial into the server at the TMC to produce a real time congestion map. One of the factors that suddenly made this possible was the substantial price drop in modems from industrial level to consumer level. The FLOW program also allowed the use of instant messaging to send and update incident information to the users within the network.

In 1991, a DOS PC-based program was used to extract the volume & occupancy data from the magnetic tape system and write it to disk. This was the first time the traffic data was archived on disk at the TMC. A companion program was used to process the archived data and generate reports.

In 1993, the Perkin-Elmer system was replaced by a VAX computer, which was a giant leap forward because it combined multiple functions (VMS, cameras, ramp meters, and data) into one PC. The VAX still continued to write volume, occupancy, and speed data to magnetic tape and a supplemental program still archived this data to disk.

In January of 1995, the NW Region started publishing screenshots (GIFs) of the FLOW congestion map on the WSDOT website at regular intervals, creating the first version of the Seattle Traffic web page. Later in 1995, the FLOW software was moved to a Windows based system and became known as WINFLOW, improving performance and information capacity. This system was connected to a gateway computer and several large businesses, kiosks in shopping malls, and the media were sharing the same congestion map and incident updates as the internet web page. The gateway computer had 7 modems with limited capacity so dial up access was restricted to those (approximately 40 entities) that would distribute to a wider audience.

A Windows version of the archived data retrieval and reporting program known as CDR was developed in 1996-97 that processed the VAX volume, occupancy, and speed data that was copied to disk.

In 1996, a File Transfer Protocol (FTP) routine was added to the client software and become known as WEBFLOW. WEBFLOW allowed clients to receive raw traffic data directly from the web via FTP transfers rather than dialing in. This step opened up the potential to share traffic data directly to a wider audience.

Developers at Palm Computing, the makers of Personal Digital Assistants (PDAs), saw the value in real-time traffic data and approached WSDOT to acquire a direct feed to the traffic data in a usable format. They were interested in developing an interface for real time traffic data for their upcoming Palm 7 PDA. WSDOT agreed to provide the feed they requested as long as Palm understood there would be no exclusivity and the same feed would be available to the general public. This data was soon received by multiple interested parties and various software and devices in many form factors started to appear.

WSDOT's current version of WEBFLOW which allows access to all data traffic data produced in Western Washington is available for download at:
http://www.wsdot.com/traffic/seattle/products/webflow.aspx.

Traffic Data Content

Since the installation of induction loops on I-5 in the 1960s, traffic data has been collected and stored in one format or another- first, on punch cards in the field, then to other formats such as magnetic tape and disks centrally located at the TMC. In the earlier formats there was less flexibility with the proprietary systems outputting data in text based reports. These reports were sent to WSDOT Headquarters in Olympia to be transferred to microfiche. Retrieving archived data was a significantly tedious exercise.

The evolution of data archive and retrieval was enabled through the cooperative efforts of WSDOT and the University of Washington. A program called CDR was developed in 1997 to retrieve archived data from CDs. The volume and occupancy data from the loops were stored in 5-minute intervals until 2009 when it started storing at 20-second intervals (this matched the interval at which the ramp meter algorithms operated). Some additional information beyond loop volume and occupancy are also aggregated and archived including speed calculations, station averaging, data validity, and loop conditions. The data was, and still is, used for various purposes including traffic studies, federal reporting, performance measures, traffic management, and planning.

Private Industry Traffic Data Collection

From a private industry perspective, agency level data feeds are informative, but often need to be supplemented by location specific data collection efforts to obtain necessary information. The methods and technologies used to collect location specific data has evolved over time, with significant changes in recent years.

Early data collection efforts were largely performed by transportation professionals themselves with the primary method of collection done manually. With growing metropolitan areas and increased concurrency requirements, the need for more data collection led to the use of more tools to improve the efficiency of collection efforts, including roadway tubes and intersection count boards. With increasing demands and less time for engineers to collect data, the formation of private data collection companies emerged to collect and deliver information to transportation professionals. These companies collected various types of transportation studies, primarily using manual methods, including: volume and classification counts, travel times, origin-destination, and parking surveys among others.

As technologies continued to evolve and the cost of emerging technologies, such as video equipment, were reduced, the use of new technologies has become a popular way to capture traffic data and allow data collection companies to collect a large amount of data with smaller field crews. Traffic counts were then reduced manually within an office setting and delivered to transportation professionals. This method improved the accuracy of the data since the video could be used as a reference, rather than the one-time observation provided with manual collection. Continued technological advances brought forth the introduction of video analytics, allowing video recordings to be reduced analytically, pushing the efficiencies and accuracies of data collection even further.

New technologies have pushed the evolution of data collection efforts. Some of these include GPS for travel time surveys, license plate readers (LPRs) for travel time and origin destination, and radar for volume, classification, and speed among others. More recently the use of Bluetooth and Wi-Fi has been used to collect travel time and origin-destination surveys as well.

Moving forward, many of the data collection efforts will continue to focus on location specific collection, although how that data will be derived is changing rapidly. The ability to track a roadway network user's location via Bluetooth, Wi-Fi, GPS, or cellular signal has brought forth an immense amount of information, often referred to as big data, which can be used to deliver information to transportation professionals. The way in which this data is collected and delivered continues to evolve as many of the organizations that are collecting this data have not traditionally done so with the consideration of a transportation professional as the end user. Data collection companies will need to evolve as well to find ways to bring the data to transportation professionals. This will require an increased number of skillsets to understand how the data is obtained and how to deliver a value added product to the end users.

Shifting of Data Source: Infrastructure to Individual

The ownership of transportation data is rapidly shifting. He, who collects the data, owns the data, and the source of transportation data is moving from the infrastructure to the users. The shift that is occurring is not related to transportation data per se, but rather the collection of big data as a whole. In order to understand this concept, we need to grasp what is happening in the bigger picture.

Each individual user, outfitted with a broadband mobile phone, has become a comprehensive data collection point. Information related to transportation including position, speed, trajectory, mode choice, travel time, and routing can be derived from this collected data. All of the data is provided by the user moving on the infrastructure rather than from fixed points on the infrastructure. Each individual data point has little value by itself, but as crowdsourcing of data occurs, a very valuable picture gets painted. The development and growth of this data collection is pushing the infrastructure owner out of the loop, at least for the purpose of public consumption. As this data collection network grows, more detailed, more reliable, and higher resolution data becomes available. But will the growth continue? According to what today's statistics tell us there seems to be no end in sight for the growth of the wireless broadband market and the resulting data gathering capability in the US.

- In 2013, US wireless carriers invested $34 billion, or $104 per subscriber, in their networks, which is four times more than the global average of $26 per subscriber.[ii]
- It is estimated that every $1 invested in wireless broadband creates an additional $7-$10 for the US GDP.[iii]
- As of December 2012, more than 89% of US inhabitants have mobile broadband subscriptions compared to 62% in all OECD countries.[iv]
- Increasing by nearly 50% from 2013, Americans will have 34 million mobile broadband devices by the end of 2015.[v]
- Although US consumers represent only 5% of the world's wireless connections, we comprise 50% of the world's 4G/LTE connections; double that of Japan in second place and almost three times that of South Korea.[vi]
- The US wireless industry is valued at $195.5 billion, which is larger than the industries of publishing, agriculture, hotels and lodging, air transportation, motion picture and recording, and motor vehicle manufacturing.[vii]

The collection of mobile phone data and global positioning is a subset of a much larger data collection effort. Private entities are rapidly collecting data to better understand the needs of the consumer. The collected data has endless applications from commercial marketing to medicine. The world's technical per capita capacity to store information has doubled every 40 months since 1980.[viii]

In the current state of awareness, the average consumer doesn't realize how much of their personal information is being collected for strategic gain or profit. According to the *Beyond the NSA* series by Politico, a Senate report has revealed, "Private companies already collect, mine and sell as many as 75,000 individual data points on each consumer…"

With the world of big data growing with no end in sight, transportation professionals will not have a place in raw traffic data collection. We will simply become another consumer of processed traffic information at the other end. Transportation engineers and planners will rely solely on third party data providers for traffic information. There currently is little room for transportation professionals in the collection and dissemination of traffic information for public consumption. Transportation experts were needed to implement specialized ways to collect traffic data, but now, traffic data can simply be sliced out of the bigger data pie.

As public agencies get pushed out of the traveler information business, traffic data collected by infrastructure will only serve asset management and traffic operations, but how long will this last? Third party, crowd-sourced traffic data will evolve to a point where it is completely reliable for real-time traffic management and operations. This is when we will reach our next major crossroad: will transportation systems be most efficiently managed by the owners of the data or the owners of the infrastructure?

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[i] Co-author, Kevin Mizuta, PE, PTOE, was a Transportation Engineer at the Washington State Department of Transportation for 13 years before joining the Transpo Group. The WSDOT Traffic Data Story was put together through interviews with two Engineering Managers at the WSDOT NW Region Traffic Group: Michael Forbis, PE and Mark Morse, PE. Both Michael and Mark have worked 26 and 30 years, respectively, at WSDOT and have played key roles in the development of the NW Region Traffic Management Center and ITS program as it exists today.

[ii] See Didier Scemama, et al., 2014 wireless capex: BRICs & Europe to pick up the slack, Bank of America Merrill Lynch, Global Telecom Equipment, Jan. 13, 2014, at Table 2. See also Glen Campbell, 2014: The year ahead, Bank of America Merrill Lynch, Global Wireless Matrix 4Q13, Jan. 8, 2014, at Tables 1 and 2.

[iii] Larry Summers, Speaking at the New America Foundation, Technology Opportunities, Job Creation, and Economic Growth, 2010, available athttp://www.whitehouse.gov/administration/eop/nec/speeches/technological-opportunities-job-creation-economic-growth

[iv] OECD Broadband Portal, 1C, http://www.oecd.org/internet/broadband/oecdbroadbandportal.htm.

[v] NPD Group, Mobile Broadband Market Share & Forecast, April 2013,http://www.connected-intelligence.com/our-research/connect/mobile-broadband-market-share-forecast

[vi] Informa Telecoms & Media Group, WCIS database

[vii] Entner, The Wireless Industry: The Essential Engine, op cit. http://reconanalytics.com/wp-content/uploads/2012/04/Wireless-The-Ubiquitous-Engine-by-Recon-Analytics-1.pdf

[viii] Hilbert, Martin; López, Priscila (2011). "The World's Technological Capacity to Store, Communicate, and Compute Information". Science 332 (6025): 60–65. doi:10.1126/science.1200970. PMID 21310967.