Using Geofencing to Actively Monitor, Collect, and Share Information

Transportation Management Center (TMC) Pooled-Fund Study

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Issues Faced by State Departments of Transportation (DOTs)

- Travelers need accurate and easily accessible real-time travel and road condition updates that are specific to their route.
- Traditional methods of delivering traveler information (e.g., changeable message sign (CMS), 511 services) often do not provide specific or relevant information for a traveler's route.
- Traditional intelligent transportation system devices used for collecting and disseminating traveler information can be costly and require ongoing services to manage, operate, and maintain.
- New technologies and third-party service providers can support and improve transportation management system (TMS) functions (e.g., geofencing). Integrating these new technologies and methods into a DOT's TMS requires careful planning to realize their full potential.

What Is Geofencing?

- Geofencing is the use of Global Positioning Systems (GPS) to create a virtual geographic boundary in software.
- It can be used to trigger a response in the software when a mobile device enters or leaves the geofenced area.
- It can enable an agency to collect traffic and incident data and send travel alerts or information to a specific geographic (or geofence) location.
- It can enable the sending of information to travelers through mobile apps, automated alerts, or CMS.

Geofencing Scenarios

- When a road closure occurs downstream of a motorist's travel path, the motorist's mobile device receives an automatic alert if the motorist is within an impacted geofenced area (e.g., a 10-mi radius of the closure).
- When a particular road weather information system (RWIS) station reports inclement weather (e.g., poor visibility), all CMSs within a geofenced area display a message to drivers to slow down.
- When a motorist with a mobile device approaches an upcoming slowdown due to construction activities:
  - An app on the driver's mobile device automatically provides an alert to the driver about the slowdown when the driver enters the geofenced area around the construction site.
  - Maintenance workers at the site receive a warning if the vehicle enters the geofence above a speed determined unsafe for the conditions.

Potential Benefits of Geofencing

- Drivers can make informed travel decisions before they reach a slowdown from an incident or closure.
- Drivers only receive relevant alerts that directly impact their specific route.
- Work zone area safety is improved for both construction workers and drivers.
- Agencies can save costs by leveraging third-party service providers for data collection and information dissemination.

Desired Outcomes

- Help agencies use geofencing to augment traditional methods to deliver traveler information (CMS, highway advisory radio, 511 services, etc.).
- Support agency TMS functions, including collecting data; actively monitoring travel conditions; and sharing information with agency staff, service providers, and the public.
- Leverage mobile applications and information from third-party service providers to reduce data collection and information dissemination costs.
- Deliver automatic, immediate information to travelers that is directly relevant to their specific trip.

Challenges With Implementing Geofencing

- Deciding how much information is too much so that travelers are not overloaded.
- Determining the cost-benefit ratio. Compare the cost of a third-party service versus an agency providing hardware, software, and information.
- Establishing uniformity in policies, procedures, and standards:
  - Difficulty integrating new data formats into existing TMS.
  - Uniformity of alerts and messages.
- Customizing alerts to drivers based on travel directions and specific routes.
- Sharing incident information between agencies in neighboring States.

Enabling Technologies and Methods

- Application programming interfaces enable geofencing:
  - Allow seamless data transfer between different types of software and sources.
  - Allow agencies to share information directly with service providers or travelers.
- Travelers receive relevant information when they travel through the geofenced area, including proactive, automated alerts:
  - Drivers pay closer attention.
  - Drivers do not need to search for relevant information.
- Alerts are typically provided audibly using hands-free technology:
  - Audible alerts are nondistracting and safer.
  - In-vehicle technology is required.

Planning and Procurement

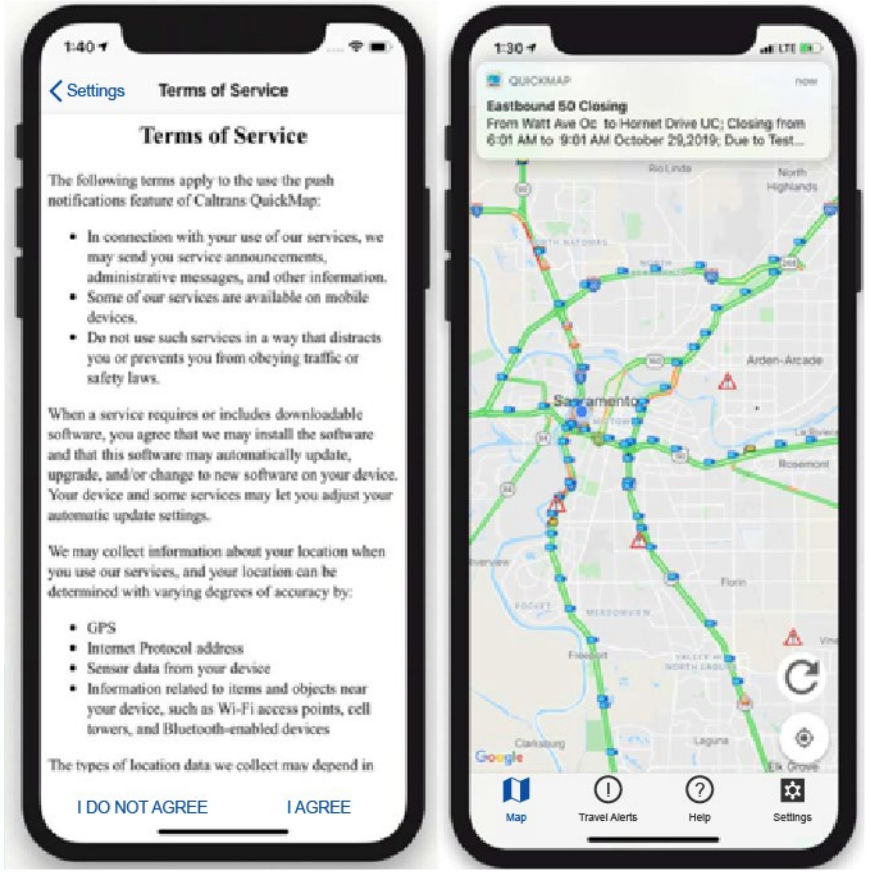
- Agencies have successfully developed geofencing tools in house or partnered with third-party service providers to develop them:
  - In-house tools require ongoing operations and maintenance staffing and resources.
  - Service providers require a contract with ongoing costs.
- It is important to know your agency's information technology (IT) policies and procurement requirements to know what information is considered sensitive and should be guarded from public domain.
- IT staff should be included in planning and procurement activities.

Examples of Agencies Using Geofencing

- California DOT (Caltrans): QuickMap.[1]
- Pennsylvania DOT (PennDOT): 511PA, Advanced Traffic Management System (ATMS) Integrated Queue Detection.[2,3]
- Colorado DOT (CDOT): COTrip Planner.[4]
- Virginia DOT (VDOT): 511, vehicle-to-everything (V2X) smart work zone.[5,6]
- New Jersey DOT (NJDOT): 511NJ.[7]
- Florida DOT (FDOT): Smart Work Zone.[8]

Caltrans QuickMap (Enabled by Geofencing)[1]

- QuickMap partners with a location services provider to determine when a driver is within the geofence. QuickMap was developed by the Caltrans IT department and is operated by TMC staff.
- Travelers may use either a website or mobile app to sign up for customized alerts.
- The TMC operator generates geofences and customized messages, which are sent to drivers within the geofence.
- QuickMap integrates with Caltrans TMS' Lane Closure System (LCS):[9]
  - QuickMap receives closure information from Caltrans LCS.
  - QuickMap automatically notifies app users within a geofenced area 30 min prior to a lane closure start as well as during the closure.
  - Quickmap sends updates to the navigation app every 5 min.



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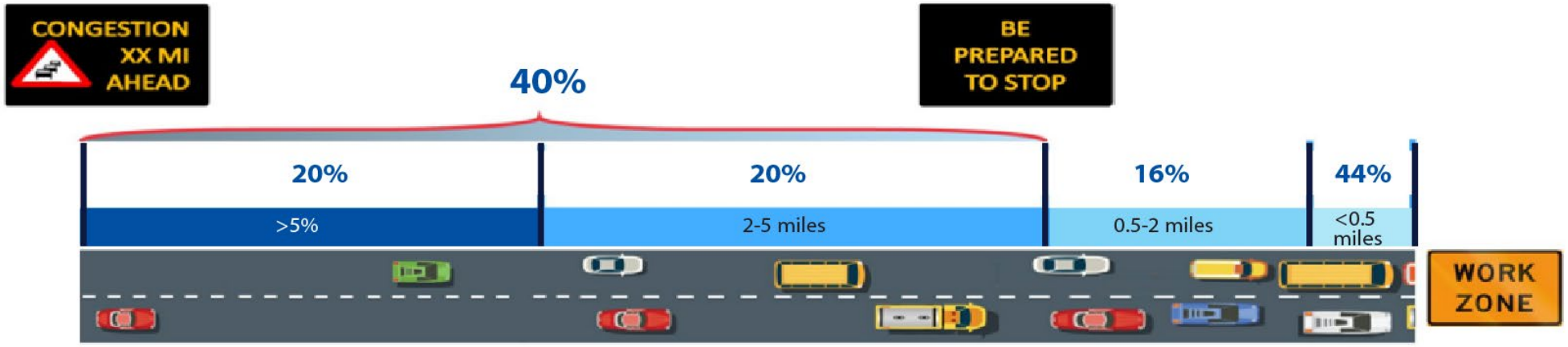
PennDOT—511PA (Enabled by Geofencing)(2)

- Developed by a third-party service provider.
- Sends travelers alerts based on GPS data from their mobile phones:
  - Travelers can elect to receive alerts within a 1- to 500-mi radius in all directions or just the direction of travel.
  - The system is unique because it allows travelers to tailor the alerts based on geolocation.
- Includes major roadways in neighboring States of New Jersey and West Virginia.

IVR = interactive voice response.

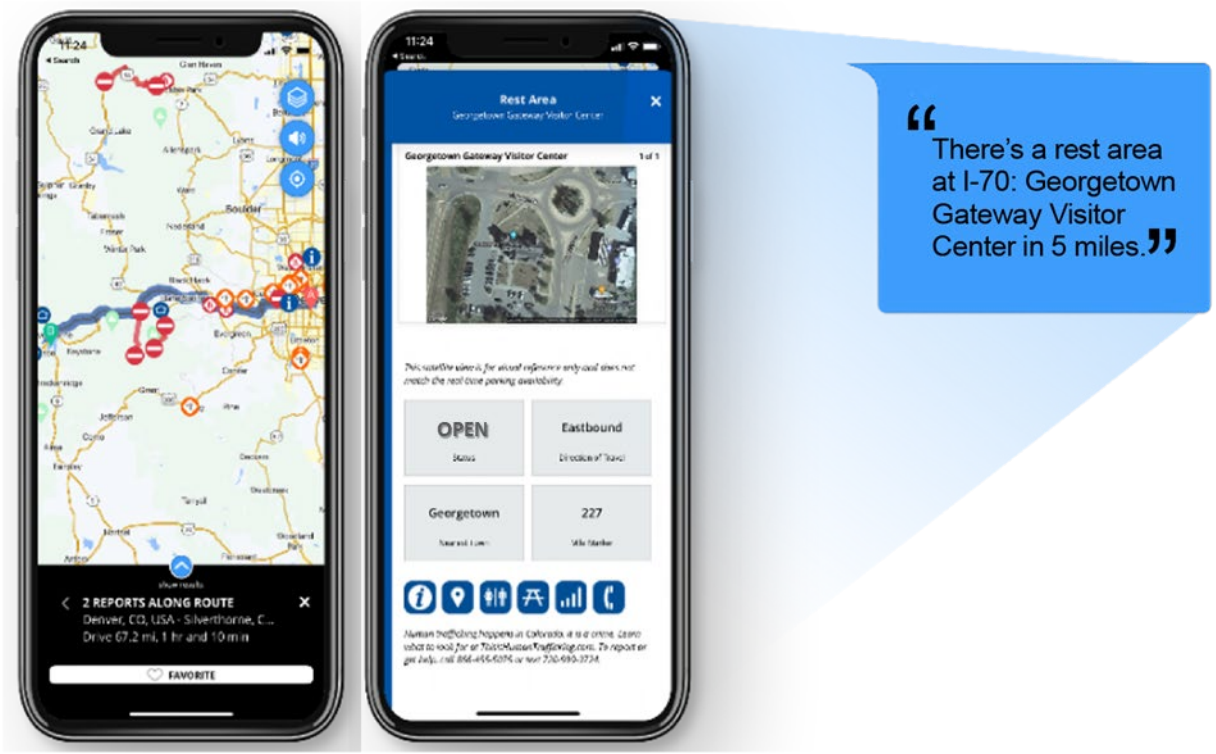
PennDOT—ATMS Integrated Queue Detection System (Enabled by Geofencing)[3]

- The virtual queue detection function is integrated as a standalone subsystem within the PennDOT TMS.
- The system has been implemented in more than 10 corridors to detect slowdowns (i.e., speeds <30 mph).
- TMC operators assign CMSs to geofences within the TMS software.
- The TMS sends a message to be displayed on all CMSs within that geofence when it detects a slowdown.



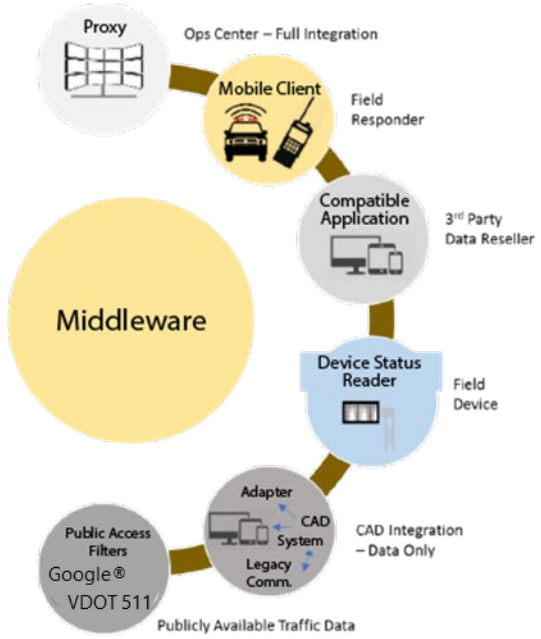
CDOT—COtrip Planner (Enabled by Geofencing)[4]

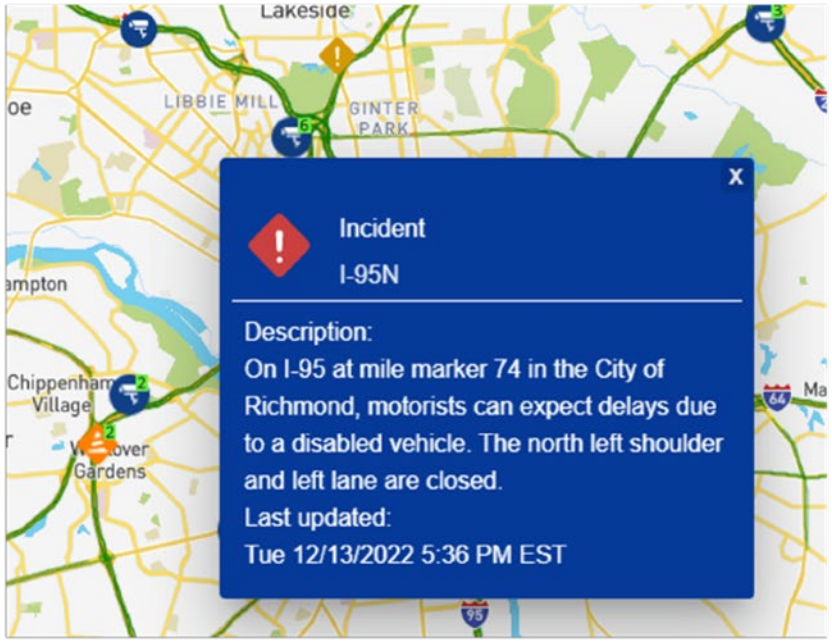
- Developed by a third-party service provider and operated by CDOT TMC operators.
- Includes a feature that detects a user's location and immediately provides a summary of relevant traffic incidents from TMS.
- Identifies a traveler's direction and speed from the mobile phone's GPS and sends alerts specific to the vehicle's travel path within a 5-mi radius.
- Integrated into the State's TMS. TMC operators generate customized messages sent out to all travelers in a geofenced area.



VDOT—511 (Enabled by Geofencing)[5]

- Mobile app developed in partnership with a third-party service provider.
- The app detects a user's location and provides an alert when the user is in a geofenced area:
  - Pulls incident data from TMS.
  - Alerts drivers of upcoming reduced speeds, incidents, and toll booths.
- VDOT is enhancing the data available through partnerships and website and app improvements.
- The goal is to improve incident management and provide relevant data to the public.





Source: VDOT.

Comm = communications; CAD = computer-aided dispatch; Ops = operations.

VDOT—V2X Smart Work Zone Pilot (Enabled by Geofencing)[6]

- VDOT partnered with Virginia Tech Transportation Institute and a third-party service provider.
- A cellular-V2X base station generates the geofences and serves as the primary processing unit.
- Workers can update work zone location data in realtime simply by moving connected cones.
- Workers receive audible and tactile alerts when they approach the edge of a geofence or if a vehicle is approaching.
- Connected vehicles receive advanced travel information when they enter the work zone geofence.

NJDOT—511NJ (Enabled by Geofencing)[7]

- Emergency alert system created by a third-party service provider and developed in coordination with the New Jersey State Police.
- Agencies send out a Wireless Emergency Alert message (like an AMBER Alert) during prolonged roadway closures to all drivers within a geofence location defined by a radial distance from the incident:
  - Message is broadcast to all cellphones.
  - The user does not need to download an app or register.
- Drivers can also download an app and opt to provide their location to the system, providing NJDOT more data on traffic speeds and lengths of traffic queues.

FDOT—Smart Work Zones (Enabled by Geofencing)[8]

- Developed in partnership with a third-party service provider.
- Deployed an app that shares work zone travel condition information:
  - Information includes the specific roadway, number of lanes open to traffic, temporary speed limit, and whether the work zone is active.
  - Data follows the standard Work Zone Data Exchange format.[10]
- Creates and updates geofence locations using GPS-enabled devices installed in the field (e.g., connected cones).
- Validates the status of the work zone by the presence of connected field devices.
- Sends information to navigation apps to disseminate back to the traveler.

Summary of Geofencing Benefits

- Travelers receive proactive, accurate, relevant, and continuous updates.
- Travelers can make informed decisions and stay informed during incidents.
- Geofencing enables automated TMS processes that result in faster incident response times.
- Users of location-based apps can become mobile data sources:
  - Users must agree to allow their location information to be shared.
  - Systems enable traffic information to be collected in a wide area without installing and maintaining sensors.
- Geofenced construction work zones help both drivers and workers:
  - Information generated by GPS-enabled field devices and geofencing allows agencies to provide accurate work zone information to motorists.
  - The time required for agencies to provide real-time work zone data to the public is reduced.
  - Automated alerts to workers of motorists entering geofence improve worker safety.

Lessons Learned

- Geofencing has proven to be a cost-effective option for agencies to improve the quality and relevance of their traveler information.
- Agencies that have used geofencing have given positive feedback so far.
- Agencies are in the very early stages of exploring how to use geofencing technology to support other TMS functions.

Future Direction (Currently in Planning or Testing Phase)

- Traffic detection:
  - Utilize crowdsourced or third-party data to supplement or replace traffic-monitoring devices.
  - Reduce an agency's need to deploy, manage, and maintain physical infrastructure.
  - Allow the public to report incidents and incident locations using GPS from mobile devices.
- Winter hazard notifications:
  - Create geofences around RWIS stations to detect adverse weather conditions.
  - Send an operator-defined message automatically to nearby CMSs within the same geofence when weather conditions near the RWIS exceed a threshold (e.g., visibility less than 1 mi).
- Snowplow data sharing:
  - Use location data from snowplows to collect and share road-condition information.
  - Share photos or live video from snowplows equipped with dashcams when they are within a geofenced area.
  - Send alerts from TMSs to vehicles within the geofenced area.

Additional Information on Other TMS Practices

- TMS portal.[11]
- TMC PFS website.[12]

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