NAVIGATING THE FLOOD

DriveTexas™ and Lessons Learned During Hurricane Harvey
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Introduction & Background

DriveTexas.org is TxDOT’s official public-facing, traveler information system for real-time travel information. It allows drivers to personalize their travels in and around the state. The following services can be found on this site:

- Map legend allowing travelers to look up what type of travel conditions are along a specific route (i.e., construction, road closures, crashes, traffic levels, flooding, ice/snow, etc.)
- Emergency conditions: Contraflow and EvacuLane status
- Traffic camera icons linking to local sites with traffic cameras, congestion data, incident reports and more detailed information in select locations
- Travel Information Center and Safety Rest Area icons including the location of facility, details on amenities, phone number and hours of operation
- The site also offers a toll-free phone number (800-452-9292) that provides information 24/7
Hurricane Harvey

On August 25th, Hurricane Harvey made landfall as a category four hurricane near Rockport, TX.

With more than 500 state roadway closures during the height of Hurricane Harvey, DriveTexas.org was visited more than 5 million times as drivers searched to check road conditions, find alternate routes and see closures on state roadways.

Estimates for Texas alone...Harvey dumped an estimated 53.4 million acre-feet of water on Texas.

Gage reports in excess of 50 inches in the Houston area.

Heavy rainfall from just east of the Austin/San Antonio area to the Texas/Louisiana border.

Numerous new flood records on area rivers.
Hurricane Harvey

I-10 at San Jacinto River in Harris County.
DriveTexas During Hurricane Harvey

DriveTexas provided critical real-time updates to TxDOT’s Emergency Operations Center, first responders, and the general public

- Usage of DriveTexas spiked from an average of 1,000 sessions per day to more than 700,000 sessions per day
- A temporary direct data feed for all responding agencies was implemented in a matter of hours
- Direct sharing of camera images with Department of Public Safety was setup in a day

Saturday 8/26

Sunday 8/27
DriveTexas During Hurricane Harvey

- The usage seen during this period was significantly higher than the site had ever experienced before.
  - Under normal conditions, the site receives between 1,500-3000 daily sessions
  - Under storm conditions, the site surges to 20k to 500k daily sessions
  - During Hurricane Harvey, the site surged to 736,000 daily sessions
    - It was 29 times more than the site had ever been tested for
DriveTexas During Hurricane Harvey

Public Response

- Real-time updates provided by DriveTexas were widely praised
- Aided first responders in identifying roads that were open to direct citizens to safety and guide response personal to critical areas
- Featured on several local news broadcasts to inform general public of flooding and road closures
- Widely used by the public to determine best routes to get to loved ones and property during recovery
Keys to Success: Architecture

DriveTexas Architecture - December 2017

- Data Source
- Data Transfer
- Tile Rendering
- Application Hosting and Configuration Files
- End User

Amazon EC2
AWS Compute Engine

Mapnik
Open Source Tile Rendering for Static Map

Amazon S3
Static Map Files

Web Browser static alerts

TXDOT ArcGIS Server
future and current conditions data from on-premise TXDOT ArcGIS

Google Compute Engine
Linux / NodeJS timed data transfer app (every 5 minutes)

Google BigQuery
Conditions snapshots

Google Cloud Storage
State mask files

Google Maps API
Map control (external map loads)

Google App Engine
DriveTexas web application files

Google Compute Engine
Admin Console web app files

Google Maps API
Map control (internal map load)

Google App Engine
Contraflow web app files

Google Maps API
map control (external map loads)

File Geodatabase
Contraflow, Contraflow Access Points and Evacuation Lines

MapLarge Cloud
tile rendering and styling (dtmaster.maplarge.net, dtmapping.maplarge.net)

TXDOT Web Services
source traffic camera data

Contraflow data dissolved into a single contraflow line and two versions loaded to MapLarge for use in the applications

Contraflow application code calls "contraflow_fix", "contraflow_dissolve" and "access point" layers for display on Contraflow website

Version 3
Keys to Success: Architecture and Analytics

- Data entered by TxDOT field employees and published via ArcGIS server
- Data is then scraped from the server, converted to GeoJSON, and published by MapLarge every five minutes
- Five key process components
  - “Get data” – pull data from current or future conditions
  - “Do stuff” – run current and future conditions
  - “Sync table” – send data to MapLarge
  - “Check in” – confirm uploader has successfully completed
  - “Stay alive” – uptime monitoring, triggers email to AppGeo team if a check-in has not successfully completed within a given timeframe
- Utilize Google Maps API to integrate traffic, geocoding and routing, and provide familiar look and feel through basemaps
- Monitor usage through Google Analytics to track number of sessions, how users are accessing the site, number of new and returning users
Recovery – Server Activity

- DriveTexas was widely utilized in both evacuation and recovery
- By Tuesday August 29th as recovery was beginning, 1 billion server requests had been logged by MapLarge since the start of the storm
- Over 5 TB of web services data transfer had taken place
- Received over 200 million requests per day with consistently low error rate
Recovery

- Revealed new use cases as the site was widely utilized during recovery efforts
- Observed unusual user click behavior with significantly more users clicking events to read condition messages
  - This was not an identified use case in original planning and design, thus had not undergone proper stress testing for randomized clicks
  - The map became unresponsive due to a network bottleneck
- Resulted in 3.5 hours of downtime where the Static Map (Emergency Backup) was enabled
Recovery

- The static map was implemented by TxDOT after a previous winter storm that resulted in downtime, with no backup alternative.

- For mission critical applications, having an emergency backup ensures that travelers can always access roadway conditions.

- AppGeo and MapLarge worked to identify and resolve the issue.

- A simple update to the API calls being made through the application made it so that network usage of click events was 100X more efficient.
**Recovery - System Performance During Network Issue**

**Drive Texas 8/28/2017 After Action Report:** Load increased by over 60,000% from August 23rd to August 27th when over 600 million requests were served in a single day without significant errors. On the Morning of August 28th requests hit an all time high and the system began to experience an unexpected bottleneck with unusual user click behavior which AppGeo and MapLarge worked to quickly understand and resolve in real time.

**Load and Error Statistics for Past 24 Hours**

- **Monday Morning Over Load**
- **Static Maps Enabled for 3.5 hours**
- **Upgraded System:** deployed and handles highest load seen yet with no errors

**Solution:** Errors with on click popups occurred on Monday morning in a fashion that had never been seen before because many more users were clicking to read condition messages. AppGeo and MapLarge worked to identify changes to API usage for Clicks that made the network usage of those clicks over 100x more efficient and deployed the fix with static maps providing coverage for 3.5 hours in the interim.
Recovery – Design and Planning

- Service oriented architecture to provide flexibility to change a particular component without changing the architecture of the entire system
- Two Hosting environments

1. TxDOT Employees enter conditions
2. Esri web services publishing current road conditions
3. Custom component accesses Esri service to ID conditions changes and pushes to MapLarge
4. Public use at Google scale

Note: there is no DriveTexas server; several cloud components are utilized instead
Overall Success Story

- Real-time updates provided by DriveTexas were widely praised
- Widely used in evacuation and recovery as it was originally designed for emergency response
- Aided first responders and the general public in identifying roads that were open or flooded
- Technical infrastructure robust enough to handle unprecedented usage with one minor glitch that utilized back up plan
- Confirmed the value and need for data sharing among agencies
- Validated data approach: A single source of truth for real-time travel information (including road condition and traffic levels).
Lessons Learned

Lessons

▪ Behaviors and use cases can be learned when disaster strikes

▪ Some performance improvements were identified by the unprecedented use
  – For approximately 3.5 hours, DriveTexas operated in backup mode
  – Event caused by software code that processed requests inefficiently (has now been fixed)

▪ Regular and robust surge testing should be performed – know when it breaks

▪ Automation of data sharing is critical during emergencies

▪ Live video is a significant tool for managing emergency response
Improvement Plans

- Make the direct data feed permanent and expand the number of formats
  - More surge testing needed, randomized mouse clicks
  - Better monitoring of usage on MapLarge server
- Integrate additional internal and external data sources
  - City/County roads added with road condition information
  - TxDOT road sensor data, Waze, weather conditions, DMS signs
- TxDOT cameras great resource, need video sharing
  - Received requests for sharing video from TxDOT cameras
  - Working on a pilot video sharing effort, including sharing between coastal districts and Emergency Operations Center (EOC)
- Improve ease of mobile entry of road conditions directly into DriveTexas
- Replicate Static map in Google Cloud Platform (GCP) to provide backup should AWS encounter issues
- Improve visual granularity for road conditions
Conclusion

- TxDOT’s mission: Through collaboration and leadership, we deliver a safe, reliable, and integrated transportation system that enables the movement of people and goods.

- DriveTexas achieves that mission by providing a single point of trusted information regarding the transportation system to the public and other agencies in emergencies and everyday.

- “We’ve always been proud of DriveTexas.org as a resource for guiding drivers across Texas, but we had never relied on it more than we did in the days following Hurricane Harvey.” TxDOT Executive Director James Bass

- “During the storm, DriveTexas.org was visited by a record number of people trying to safely navigate to their destinations. The real-time updates, which are made by TxDOT team members in the field, kept pace with fast-moving conditions and were invaluable to thousands of travelers and emergency responders who otherwise may not have known where to turn for accurate information.” TxDOT Executive Director James Bass
Questions?

Cassie Jordan  
Director – Strategy & Portfolio Management  
TxDOT - Information Management Division  
Cassie.Jordan@txdot.gov

Jenn Sylvester  
Project Manager  
Applied Geographics, Inc.  
jsylvester@appgeo.com