A-PeMS
An Arterial Performance Measurement System

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Agenda

- Our Starting Point
  - PeMS = Freeway Performance Measurement System
  - What does PeMS do?
  - How does that influence what we’re doing?

- Motivations for expanding to arterials

- Approach

- Arterial PeMS (A-PeMS)
Background: What is PeMS?

- PeMS is a real-time Archive Data Management System (rt-ADMS)
- PeMS collects detailed freeway information
  - Fixed sensor: lane-by-lane, 20/30-second values
  - Incident: detailed reports
- Processes these values in real-time, performing:
  - Detector diagnostics
  - Imputation
  - Speed calculations
  - Aggregations
  - Performance measurement calculations
- Has a huge number of reports and tools
- Accessed via a browser
- In California:
  - Collects data from 6 districts (> 23,000 sensors)
  - Holds 5TB of data
Sample: Freeway Operations – Performance Measures

- Data collected from multiple detectors
- Plot of total delay (veh-hrs) and Q (vmt/vht) per month for a section of freeway in San Diego
- Covers six years
- Shows a clear trend that delay is increasing on this freeway and the performance is decreasing
- Provides clear, easy-to-obtain measurements of performance measures
Sample: Freeway Operations – Bottlenecks

- Bottleneck identification algorithm is based on persistent changes in speed over time and space.
- Shows the locations of bottlenecks on a map.
- We color and size the dots according to the delay caused and the number of days activated.
- For Caltrans we tie the map to other types of media.
- They have a video record of every freeway in the state (PhotoLog).
- Users can see the bottleneck through these movies.
Sample: Planners – Congestion Maps

- We compute the percentage of time spent in congestion (speeds below a certain threshold) for each shift for each detector.
- The map represents the average congestion during the weekday AM shift over a month.
- Large red dots signify more congestion.
- We can also track the duration of congestion at an individual location over time.
- Plot shows 25th, 50th and 75th percentile of congestion duration for 2004 at a single location in San Diego.
Sample: Maintenance – Diagnostics

- PeMS performs diagnostic checks on every detector in the system every night.
- This page shows detector health of all lane detectors over a section of the road on one day.
- Color represents health of the detector and suspected reason for failure.
- Can pick different days to see changes over time.
- Allows user to drill in to see actual tests failed.

PeMS performs diagnostic checks on every detector in the system every night. This page shows detector health of all lane detectors over a section of the road on one day. Color represents health of the detector and suspected reason for failure. Can pick different days to see changes over time. Allows user to drill in to see actual tests failed.
Summary:

- PeMS archives detailed traffic data, rolls it up over space and time and presents many different views.
- Maintaining and managing all of the sensors needed to properly monitor a large network is difficult.

Lessons Learned:

- Many measures or tools can be based off of archived data.
- Not all useful applications are performance measures.
- But these applications can be used by traffic engineers to improve the performance of their system.
- Hence we can also call this system an Arterial Data Archive Reporting System.

We want to apply the same concepts to A-PeMS.
Our Motivation for Arterials

Corridor Management Studies (lofty goal)
- Corridors carry a large number of people – want to capture this
- Tracking performance measures for entire corridors
- Measure effects of integrated management strategies

Multimodal version of PeMS (medium-sized goal)
- Comparing travel times across modes
- In SF Bay Area: Freeways and BART
- Currently working on a project in San Diego (transit)

Helping Poor City Traffic Engineers (achievable goal)
- Many demands on their time
- Financially (resource) poor
Our Approach for A-PeMS

Principles:
- Start off small and build up
- Help front-line guys (city traffic engineers) first
  - San Diego: 1200 count stations, 4 full-time employees, count at each station 1 day/3 years
  - Have to respond to local congestion boards, local MPOs, and 1 request/day from public/city
  - Dislike doing any travel time studies due to safety reasons

Different types of calculations/reports require different types of information:
- Starting off with detailed and long-term plots of flow
- Fold in variation over time of day and day of week
- Calculate simple performance measures first (good for trends, if not for ITS functions)
- Add in different (better?) performance measures when more configuration information is added
- But allow users to start getting something quickly

Use actual data sets:
- Leverage a detailed data set collected for Arterial Travel Time Study for SCAG
- Lincoln Blvd in Los Angeles (1.4 miles)
- Includes detailed detector measurements, signal phases, probe vehicles, manual counts of flow and pedestrians

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A-PeMS Plots: Intersections

- We’ve implemented a version of A-PeMS using this data
- Navigate via GIS or through listings of arterials and intersections
- We show the standard plots of measured quantities against time
- This plot shows flows from all approaches at this intersection
- Can also show them versus time of day and day of week
We also show various plots for each individual type of detector (ie: all through lanes) instead of just intersection values.

We compute link travel times or speeds a number of different ways (depends on the amount of configuration information available).

This shows the spot speed (g-factor based) over time for the two through lanes on Lincoln NB at Washington blvd.

Our data set allows us to compare with measured ground truth.
A-PeMS Plots: Relationship Plots

- Can plot different quantities against each other
- This shows flow versus occupancy at a particular detector
- Working on additional measures/tools, including folding in signal timing information
APeMS: Travel Time Estimation (1)

Link travel time = Running Time plus delay at the Signal

Data:

Signal status & settings (cycle, length, splits, offsets)
Counts, occupancy (and speed) from mid-block (system) detectors

TOTAL DELAY

- Delay of a single vehicle
  - Deceleration
  - Acceleration
  - Signal waiting time

- Delay because of queues
  - Shockwaves
  - Offsets
  - Platoon Dispersion

- Oversaturated delay
  - Extended red
  - Smaller service times
Model Application I (1)

M Street, Washington DC

- Eight closely spaced intersections (1.07 Km, 0.7 miles)
- Fixed-time two phase signals (C = 60)
- Microscopic simulation (CORSIM):
  - Counts and occupancy from simulated detectors
  - Arterial travel times
Model Application I (2)
Model Application II (1)

Lincoln Avenue, Los Angeles

- Seven intersections (2.3 Km, 1.4 miles)
- Traffic data (counts, occupancy) from midblock loop detectors part of the LADOT ATSAC system
- Multiphase traffic responsive signal operation (C=100-150sec)

Data Collection:
- Turning movement counts (6-10 am)
- Probe vehicle travel times (at 7 min headways)
Model Application II (2)

Lincoln Avenue: Manual vs. Loop Detector Counts
Model Application II (3)

Lincoln Avenue: Travel Times NB Direction
Model Application II (4)

Lincoln Avenue: Travel Times SB Direction

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