Incident-Management in Central Arkansas: An ITS Application
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In this project, we are working toward building a Traffic Incident Management Center. It provides not only a shared database but an Incident Command Center (ICC) to motorists and operators alike. All interested agencies can use the center, enhancing mutual cooperation and coordination. Similar to other communities, incident-management activities in Central Arkansas consists of Motorist Assistance Patrol, Towing and Wrecker Service, Emergency Medical Services, Traffic Management at Work Zones, and Traveler Information System.

We have four goals in our study. The first is to investigate advanced incident-detection techniques. The second is to model the distribution of incidents. The third is to choose the appropriate incident-response strategies. And the fourth is to perform benefit/cost analysis.

Working toward real-time monitoring of traffic conditions, we are developing routing algorithms to assist incident managers in decreasing response time and motorists in re-routing around incidents. Here are some salient features of our incident-management model:

- Provide a good tactic to allocate available response vehicles to serve reported incidents.
- Pay attention to potential incidents in ensuring a certain level of reliability in delivering quality service overall.
- Reduce the negative impact of incidents as much as possible.

In order to cater for potential incidents, available resources may not be committed to the closest-by reported incidents—a somewhat counterintuitive finding. The simulation result for Central Arkansas shows that the delay cost & work time are reduced by about 20%, while the workload is also decreased. The public is served better with less expenditure from the Arkansas State Police, assuming the towing contractors are paid by their work time, instead of by the number of dispatches.

In an Advanced Traveler Information System (ATIS), we study how to map a driver’s interests to real-time routing decisions. Accounting for en-route delays and alternate routing, we found counter-intuitively that ATIS networks exhibit non-FIFO behavior—drivers who depart earlier may not arrive ahead of those who depart later. Given a time-dependent network, we consider waiting en-route for an incident to clear. Viewed as an advance in computational efficiency, we are able to model accurate arc travel-times yet using coarse simulation time-intervals. Accordingly, the algorithm has been shown to be operationally viable for real-time applications.

As a prototype, the proposed ICC serves three functions as follows.

- Publish public information on 511, variable message signs, or the website to announce current incidents and dynamic travel time.
- Provide motorists with re-routing paths to go around incidents.
- Assist incident operators to arrive at incident scenes as quickly as possible, and advice managers in the judicious allocation of resources.
Part of ITS architecture
-- (Animation) --

It is an integrated and shared system – a **Traffic Management Center**. (Dorothy Rhoder)

It provides not only a shared database but also as a **command Center** to provide suggestion to motorists and operators.

All interested agencies can use the system, enhancing mutual cooperation and coordination.
Incident Management Activities

- **Motorist Assistance Patrol**
  - *Proposed* to provide some coverage of both US 67/167 and I-530, from I-30 to Dixon Road
- **Towing and Wrecker Service**
  - A rotation list of qualified towing and wrecker services.
  - Current procedures do not specify a minimum response time.
- **Emergency Medical Services (EMS)**
  - 911 calls
  - Communications upgrades are needed.
- **Traffic Management at Work Zones**
  - Queue detectors
  - Variable message signs (VMS) and highway advisory radio (HAR)
- **Traveler Information System**
  - 511 calls

The slide shows the current and proposed activities for incident management in Central Arkansas.
• Working toward real time monitoring of traffic conditions

• We will give the statistical results according to the datasets (2000~2003) of the state police office. From the results, we will know about incidents under the different situations, such as weather, area, road system and so on.

• We are developing routing algorithms to assist incident managers in decreasing response time and motorists in optimizing re-routing paths.

• Another kind of model is on incident management, which assists an Incident Command Center to dispatch response vehicles.

• Using response time and clearance time from response-vehicle operators such as towing truck companies about of incidents, we can plan for better response strategies
Our research objective focuses on the highway network in Central Arkansas, including:

-- (pointer) --

• I-630
• I-30
• I-430
• I-40
• US 67/167

As an example, the map shows the incident data for January 2003 using Routh Towing and Arkansas Highway Police incident tables.

Incidents are identified by mile markers along affected highways.

Frequency of accidents are color coded – Red being most severe and Yellow the least.
Incident Management Model

1. Provide a good tactic to allocate available response vehicles to serve reported incidents.
2. Pay attention to potential incidents in ensuring a certain level of reliability in delivering quality service.
3. The model helps to reduce the negative impact of incidents as much as possible.

Read this

• Let us now put ourselves in the shoe of an incident manager. An algorithm is developed to help him reduce the negative impact of incidents.

• The model does not only allocate the available response vehicles to serve the reported incidents, but also accounts for the potential reported incidents.

• Most importantly, the manager wishes to ensure a certain reliability (say 90%) in delivering quality service.

• We use stochastic non-linear programming to build the model.
We will show a simple example with travel times shown.

• An incident is reported at node f. In addition, Nodes v and f are both potential incident sites.

• We have two vehicles at depots 1 & 2.

• For a particular risk threshold, or a reliability level 80% as shown, we can compute the expected delays

• -- (Animation) --

• A counter intuitive results is obtained when vehicles are dispatched from a distant depot for the reported incident, while the fleet at depot 2 is reserved for potential incidents, resulting in the minimal delay to motorists and overall work time for the study area.

• While one would expect the worst, the delay to motorists at f is only 80 min, due to “asymmetric” workload.

• When incident management is performed with inadequate resources, not all the required response-vehicles are available. The solution becomes infeasible if the requirements are set too high, as is the case when Risk = 0.05. The model serves to trade off reliability against committed resources.

• A case study in Central Arkansas, a study areas with rare incident occurrences, validates the usefulness of this model.
The simulation result shows that the delay cost & work time are reduced by about 20% while the workload is decreased, the total number of vehicle dispatches is equal the public is served better with less expenditure from the ARState Police, assuming the towing contractors are paid by their work time, instead of by the number of dispatches.
For destination D, the driver who starts at node j has both the best departure time and wait time, in comparison with the driver who starts at node k.

For origin node k, the dashed line shows a risk-avoidance trajectory. The comparable non-FIFO solid line simply waited longer than warranted at node i.
A case study of Central AR:
-- (Pointer) --
I-30, I-40, I-430, I-440, I-630 and US Hwys 67/167 are the main features
Numerous incidents are reported on I-630, I-30, I-40, I-430 and US Hwy 67/167, while I-440 and US HWY 65/167 are much safer.
We present a case study concentrating on the green circled area, enclosing I-630, I-30, and US Hwy 167 representing the most congested area in Little Rock.
Major bottleneck is arc (1, 3)
We focus on the origin node 10 to destination node 5 during morning rush hours.
The non-FIFO routing policy would advice him to wait one time unit (5 mins) before departing and he would achieve a travel-time of \((5.57 - 4.98) \times 5 = \text{approx. 3 mins faster than FIFO counterpart who would not wait, but would take a longer route via node 9.}\)
To Impute the Value of Safety

- Should s/he be more interested in arriving at the destination the fastest way, his/her regular non-FIFO travel time (4.98 time units) is the expected value of taking the risk, with the concomitant savings in travel time.
- As a risk-adverse person, the non-FIFO/Risk-Avoiding driver is willing to pay the difference between the certainty equivalent and this expected value to ensure safety, or \((5.56 - 4.98) = 0.58\) units or 2.9 min.

Value of safety is the *risk premium* to insure against being in “harm’s way.”
-- (Read from slide) --
randomly generated network of 100 nodes and 165 arcs
varying the total time period $T$ from 10 to 50
not having to search beyond max cap significantly help in avoiding the quadratic $O(M^2)$ part of the run-time complexity
We propose a computerized system consisting of Public switching Telephone Network (PSTN), SS7 protocol for load balancing, Cable Television, and TCP/IP Internet Protocol.

**Traffic Management Center**

- As a product, we will deliver a prototype software, which is a real-time internet information system. Here we show the basic architecture of the software.
- From outside, we collect real-time information from sensors, such as GPS, Camera, Floating Cellular Data (FCD), Interactive Voice Relay? (IVR) and so on.
- After processing these data, we feed them to routing and incident management models to provide motorists and incident managers with the relevant information. VISSUM/TransCAD GIS transforms these data into maps, which are posted on our web site.
- Advisories can also be sent to variable message signs to guide motorists through an incident. This system actively communicates with users with Script or ASP programming technology.

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(in alphabetical order)

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Thanks. Any Question?

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Brief Biography

YUPO CHAN

Yupo Chan received his PhD from Massachusetts Institute of Technology in 1972. After 28 years of post-doctoral experience in industry, universities and government, he became the Founding Chair of the Department of Systems Engineering at the University of Arkansas at Little Rock (UALR) Donaghey College of Engineering and Information Technology (EIT College) in 2000.

Before coming to the UALR CyberCollege, Chan worked at The Air Force Institute of Technology, Washington State University, the State University of New York at Stony Brook, Pennsylvania State University, and Kates, Peat Marwick. Additionally, he was a Congressional Fellow in the Office of Technology Assessment in Washington, DC.

Chan’s training and research focus on transportation systems, telecommunications, networks and combinatorial optimization, multi-criteria decision-making and spatial-temporal information. Chan has published numerous books and monographs, including Location Theory and Decision Analysis (Thomson/South-Western); Location, Transportation, and Land-Use: Modeling Spatial-temporal Information (Springer); Urban Planning and Development Applications of GIS (ASCE Press).

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