## Regional Prioritization of Corridors for Traffic Signal Retiming

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## Background

Signal retiming is a low cost alternative

Traffic signals need to be retimed periodically

Limited funding available

Lack of staff and other resources

Prioritization is necessary

## Research Objectives

Understand various issues in traffic signal retiming

Identify current state of the practice for retiming project selection

Propose a new and more efficient strategy for prioritizing corridors for retiming

## Traffic Signal Retiming - Benefits

Reduction in delay and number of stops

Less driver frustration -safer conditions

Reduction in fuel consumption

Improvement in air quality

Fewer diversions to local streets

## Current Strategies - Outside DFW

## Limited staff \& budget - No regular retiming

Retiming when

- Hardware upgraded
- Customer complaints
- Additional funds available
- Guidelines used in selection
- Traffic volumes
- Selection processes like CMAQ
- Time since last update
- Qualitative "congested corridor" classification


## Current DFW Strategy

## Regional programming

- Member cities submit candidate corridors

Two Approaches

- Ranking model
- More sophisticated
- Applied to travel time runs performed on corridors
- Group forum approach
- Expert group selects the projects


## NCTCOG's ranking model - Variables

- Delay

DPV =Delay/vehicle/intersection = (Travel time - Desired travel time)
(number of intersections)
Total delay/ intersection $=$ DPV x ADT

- Number of Stops

Number of stops = (Number of stops/ number of intersections) x ADT

- System Type

1: complete connection
2: partial connection
3: Isolated

## NCTCOG's ranking model - Expression

Total Score $(S)=\frac{\text { DELAY }}{\operatorname{Max}(\text { DELAY })} \times 50+\frac{\text { STOPS }}{\operatorname{Max}(\text { STOPS })} \times 30+$ SYSTEM_TYPE $\times 20$
Where SYSTEM_TYPE $=1.0 \quad$ for type 1
0.5 for type 2

0 for type 3

## NCTCOG Ranking Model Application



## Discussion on NCTCOG model

It is based on severity of existing conditions

Weighting given by expert group

Average delay/vehicle vs. Total delay

- System type plays important role
- Sensitivity analysis


## Before and after studies - Retiming projects

- Travel time studies
- Just before implementation of retiming
- After adjustment of traffic to new timing
- Conducted to
- Measure effectiveness of improvements
- Document the results
- Instrument
- Jamar TDC-12
- Software
- Jamar PC-Travel


## Great Southwest Pkwy corridor

| Number of Lanes | 4 |
| :--- | :--- |
| Length | 5.37 mi. |
| Number of signals | 15 |
| North End | E. Division Street |
| South End | Fairmont |
| Maximum Speed Limit | 45 mph |
| Average Daily Traffic | 20,328 |

## Total corridor benefits -Great Southwest Pkwy

| North Bound - Total savings in three years |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | \# of stops | Total Delay (Hours) | Fuel (gal) | HC (Tons) | CO (Tons) | NOx (Tons) |
| AM | 1,380,709 | 69,905 | 49,172 | 5.1 | 46.5 | 0.5 |
| MD | 1,458,479 | 13,005 | -5,338 | -2.8 | -42.1 | -3.6 |
| PM | 1,173,302 | 40,419 | 25,377 | 3.6 | 24.2 | 1.4 |
| South Bound - Total savings in three years |  |  |  |  |  |  |
| AM | 188,325 | -5,115 | -3,675 | -0.2 | -6.0 | 0.2 |
| MD | 1,400,873 | 16,916 | 1,063 | 1.9 | 3.9 | 1.1 |
| PM | -7,003,211 | -95,899 | -41,393 | -1.7 | 8.2 | 4.1 |
| Texite summer meeting, College Station 13 |  |  |  |  |  |  |

## Pioneer Parkway corridor

| Number of Lanes | 6 |
| :--- | :--- |
| Length | 2.33 mi |
| Number of signals | 8 |
| West End | W. Freeway |
| East End | 45 mph |
| Maximum Speed Limit | 35,351 |
| Average Daily Traffic |  |

Total corridor benefits -Pioneer Parkway

| East Bound - Total savings in three years |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |
|  | \# of stops | Total <br> Delay <br> (Hours) | Fuel (gal) | HC <br> (Tons) | CO (Tons) | NOx (Tons) |
| AM | $6,829,098$ | 75,172 | 81,744 | 15 | 127 | 12 |
| MD | $12,638,158$ | 126,248 | 112,404 | 21 | 114 | 17 |
| PM | $9,990,647$ | 103,120 | 99,136 | 20 | 119 | 16 |

West Bound - Total savings in three years

| AM | $-1,276,598$ | $-10,611$ | $-16,717$ | -2 | -17 | -2 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |
| MD | $-136,084$ | 3,651 | $-38,920$ | -6 | -99 | -6 |
| PM | $6,264,081$ | 65,305 | 24,278 | 2 | -41 | 0 |

## Total daytime corridor benefits

|  | \# of stops | Total Delay <br> (Hours) | Fuel (gal) | HC <br> (Tons) | CO <br> (Tons) | NOx <br> (Tons) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Great <br> Southwest <br> Pkwy | $-1,401,524$ | 39,231 | 25,207 | 5.9 | 34.6 | 3.6 |
| Pioneer Pkwy | $34,309,303$ | 362,886 | 261,926 | 49.3 | 204.6 | 36.2 |

## Proposed Methodology

Based on societal benefits

Benefits modeled in terms of corridor characteristics

- Regression analysis (dependent variables)
> $S_{D}=$ Saving in delay (in sec)
$S_{F}=$ Saving in fuel consumption (in gallons)
> $S_{E}=$ Saving in NOx emissions (in Tons)


## Set of Predictors

| Physical characteristics |  |
| :--- | :--- |
| Variable | Description |
| L | Length |
| N | Number of signals per mile |
| I | Spacing between the signalized intersections |
| Z | System type |
| Traffic Characteristics |  |
| ADT | Average Daily Traffic |
| FFT | Free flow travel time |
| D | Delay |
| NS | Number of stops |
| M | Turning movements as a percentage of total <br> volumes |

## Correlation matrix for independent variables

|  | $\begin{gathered} \text { Lengt } \\ \mathrm{h} \end{gathered}$ | signal density | $\begin{aligned} & \text { st dev } \\ & \text { Sp } \end{aligned}$ | ADT | $\begin{gathered} \text { FR } \\ \text { TIME } \end{gathered}$ | $\begin{aligned} & \text { measur } \\ & \text { ed } \end{aligned}$ | $\begin{gathered} \text { Total } \\ \text { delay/veh } \end{gathered}$ | delay/veh /signal | delay/ve h/mile | \#Stops IVeh | \# Stops/ veh/signal | \#Stops/v eh/mile |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Length | 1.0 |  |  |  |  |  |  |  |  |  |  |  |
| signal density | -0.6 | 1.0 |  |  |  |  |  |  |  |  |  |  |
| st dev Sp | 0.4 | -0.6 | 1.0 |  |  |  |  |  |  |  |  |  |
| ADT | 0.3 | -0.1 | -0.1 | 1.0 |  |  |  |  |  |  |  |  |
| FRTIME | 0.9 | -0.5 | 0.3 | 0.2 | 1.0 |  |  |  |  |  |  |  |
| measured TT | 0.9 | -0.5 | 0.4 | 0.1 | 0.9 | 1.0 |  |  |  |  |  |  |
| Total delay/veh | 0.6 | -0.2 | 0.3 | -0.1 | 0.6 | 0.8 | 1.0 |  |  |  |  |  |
| delay/veh/sign al | -0.1 | 0.0 | 0.2 | -0.6 | -0.2 | 0.1 | 0.5 | 1.0 |  |  |  |  |
| delay/veh/mile | -0.5 | 0.8 | -0.4 | -0.4 | -0.5 | -0.4 | 0.1 | 0.6 | 1.0 |  |  |  |
| \# Stops/veh | 0.71 | -0.31 | -0.09 | 0.03 | 0.70 | 0.85 | 0.88 | 0.25 | -0.1 | 1.0 |  |  |
| \# Stops/veh/ signal | 0.0 | -0.1 | 0.3 | -0.5 | 0.0 | 0.2 | 0.5 | 0.8 | 0.3 | 0.55 | 1.0 |  |
| \# Stops/veh/ mile | -0.5 | 0.8 | -0.3 | -0.4 | -0.4 | -0.3 | 0.1 | 0.5 | 0.9 | 0.07 | 0.5 | 1.0 |

## Monetary Benefits

- Value of time ( $\mathrm{V}_{\mathrm{D}}$ )
- \$8.39 per hour (estimate for DFW area)
- Fuel Price $\left(\mathrm{V}_{\mathrm{F}}\right)$
- American Automobile Association
- Value of $\mathrm{NO}_{\mathrm{x}}\left(\mathrm{V}_{\mathrm{E}}\right)$
- \$4750/ton per metric ton (TCEQ)


## Overall Project Scores

- Project Benefit Score

$$
P B S=V_{D} * S_{D}+V_{F} * S_{F}+V_{E} * S_{E}
$$

- Weighted Project Benefit Score (WPBS)

$$
=W_{D} V_{D} S_{D}+W_{F} V_{F} S_{F}+W_{E} V_{E} S_{E}
$$

Where

$$
\mathrm{W}_{\mathrm{D}}, \mathrm{~W}_{\mathrm{F}} \text { and } \mathrm{W}_{\mathrm{E}} \text { are weightings }
$$

- Default value $\mathrm{W}_{\mathrm{D}}=\mathrm{W}_{\mathrm{F}}=\mathrm{W}_{\mathrm{E}}=1$
- Final order of priority is in the decreasing order of WPBS


## Application of methodology



## Conclusions and Recommendations

- Regular traffic signal retiming is recommended
- More corridors - less funds
- Prioritizing of retiming projects is necessary
- Current strategy based on severity of existing conditions is explained
- Estimation of benefits using before and after studies
- More efficient prioritization methodology using existing conditions to forecast potential benefits is proposed
- Next steps
- Estimate and validate the proposed model
- Additional research on value of the benefits


## Questions?

## Total corridor benefits

- AM, PM and OP hourly Turning movements
- Time of day

|  | AM Peak | Midday | PM Peak |
| :---: | :---: | :---: | :---: |
| Monday-Thursday | 7AM to 9:30AM | 11AM to 4 PM and <br> 7PM to 9:30PM | 4 PM to 7 PM |
| Friday | 7AM to 9:30AM | 11AM to 3 PM and <br> 7PM to 11PM | 3 PM to 7 PM |

