Technology to Enable and Complement Congestion Pricing

**Audio:**
- Via Computer - No action needed
- Via Telephone – Mute computer speakers, call 1-866-863-9293 passcode 57921953

**Presentations by:**
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**Audience Q&A** – addressed after each presentation, please type your questions into the chat area on the right side of the screen

**Closed captioning is available at:**

**Upcoming Webinars:**

**Recordings and Materials from Previous Webinars:**
Upcoming Webinars

July 28, 2011  Dynamic Ridesharing and Congestion Pricing
August 25, 2011  Pay-as-You-Drive Insurance
September 22, 2011  Economics of Congestion Pricing and Impacts on Business
October 27, 2011  Integrating Transit with Congestion Pricing and Increasing Congestion Pricing Acceptance
November 17, 2011  Best Practices in Parking Pricing
December 15, 2011  Results of the Urban Partnership and Congestion Reduction Demonstration Programs
Purpose

- To outline the key research and concepts in Road User Charging process and technologies;
- To present worldwide trends in Road User Charging process and technologies;
- To outline technology options for each system.
FHWA Primers

http://ops.fhwa.dot.gov/tolling_pricing/value_pricing/publications.htm
Primer Topics

Technologies that Enable Congestion Pricing
- The functional processes for tolling and congestion pricing.
- What technologies there are to consider.
- How the technologies are applied.
- Examples of how technologies have been applied.
- What technologies may make it work better in the future.

Technologies that Complement Congestion Pricing
- How technology complements congestion pricing.
- What technologies there are to consider.
- How the technologies are applied.
- Examples of how technologies were applied to retrofit congestion pricing on an existing facility.
Travel behavior - Congestion related to gasoline prices in Southern California

Pricing Works!
Revenue Collection Systems

Motorist/Vehicle Sub-System (MVS)

Collection Sub-System (RCS)

Back Office Sub-System (BOS)
Revenue Collection Process

(1) Inform

(2) Detect

(3) Classify

(4) Declare

(5) Collect

(6) Complete

(7) Enforce

(8) Back Office System

Reports

Billing Statements

Records

Record each transaction

Record exceptions & images

Record exceptions, non-payments and violations
System Design Approach

Solution Classification

- Basis of Charge
- Type of rate
- Who detects charge liability

Methods determining and declaring

Solutions from which to develop system design

---

Event Based

- User Declaration
  - User Declaration (personal)
  - User Declaration (assisted)
  - User Declaration (automatic)

- System Detection
  - System Detection (ALPR)
  - System Detection (DSRC)

All Possible Solutions

Rate Based

- Engine Run Time
- Distance Driven
- Elapsed Time

- User Declaration
  - User Declaration (assisted determination)
  - User Declaration (assisted declaration)
  - User Declaration (automatic)

- System Declaration

Event Based, personal declaration

Event Based, Assisted Detection

Event Based, System Detection (ALPR)

Event Based System Detection (DSRC)

VMT
Technology Options

1. Paper Based System;
2. Auto-License Plate Recognition (ALPR);
3. Radio Frequency Identification (RFID);
4. Dedicated Short Range Communication (DSRC);
5. Satellite Positioning System (GPS / GNSS);
and
6. Wireless “cell based” solutions and new “smart phone” approaches
Technology Options

Vehicle Detection and Classification

ETC RX/TX

Video Capture

Gantry
# Comparison of Technology Options

<table>
<thead>
<tr>
<th></th>
<th>Paper Based</th>
<th>ALPR</th>
<th>RFID/DS RC</th>
<th>GPS</th>
<th>Smart Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Business District Single Zone/Unitary Charge</td>
<td>✔️</td>
<td>✔️</td>
<td></td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td>Central Area / Multiple Zones / Multiple Routes/Variable Charges</td>
<td>✔️</td>
<td></td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Multiple Time Frames/Variable Charges by Location/Time of Day/Type of Vehicle / Environmental charges</td>
<td>✔️</td>
<td>✔️</td>
<td></td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td>Distance Based Charging in Zones/Combinations of above</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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</tbody>
</table>
Technology for Minnesota’s Managed Lanes Systems

Nick Thompson
Minnesota Department of Transportation
Agenda

- Discuss the technology and systems needed to enable successful congestion pricing system in Minnesota
Managed Lanes in MN

- 2005 Converted 11 miles of HOV to HOT on I-394
- 2009 Expanded HOT network to 35W
  - 8 miles HOV to HOT conversion
  - 3 miles Shoulder to HOT conversion
  - 11 miles of ATM/Managed lanes system (all lanes)
- 2010 Completed additional 4 mile HOT lane/Managed Lane system on 35W
MnPASS Innovations

• Tolling on lanes directly adjacent to non-barrier separated lanes with multiple access points
• Full dynamic pricing on multiple consecutive roadway segments
• Technology applications assist in enforcement, read/write transponders and enforcement readers
• Tolling combined with Active Traffic Mgmt
MnPASS System Layer

• MnPASS enabled by underlying systems
### Existing System and New Technology

**Existing**
- Communication network
- Traffic Sensors
- Dynamic Message Signs
- Cameras
- Gates for Reversible Road
- Traffic Management Center/Systems
- Incident Mgmt Systems

**New Technology**
- Toll Systems
  - Transponders
  - Pricing Signs
  - Toll Readers
  - Communications
- Back office
  - Transactions
  - Customer Service
  - Monitoring
- Enforcement
I-394 MnPASS Lane Design
Establishing the Toll Price

- Min: $0.25 Max $8,00
- Price based on HOT lane traffic conditions only and priced in zones
- Data from sensors in lane every ½ mi
- Price updated every 3 minutes
- Price is set off customizable rate tables
  - Existing Price, Level of Service, and Rate of Change determine New Price
- Price based on worst traffic density point downstream of entrance
- Pricing during set hours (i.e. not 24x7)
- Displayed price needs to be linked to the toll transaction for the toll reader downstream from price sign
MnPASS Enforcement Strategy

**Goal:** Violation rate <10%

1. Convert violators to paying customers
2. Measure compliance, target problems
3. Be present
4. Provide technology to enforce

Desired, but unrealized, compliance strategies
- Higher fine structure, video enforcement

**Results:** Violation rates are <10%
Enforcement

• Supplemental tools
  – Beacons
  – Enforcement transponder
  – Mobile enforcement reader
Technology Provided to Enforce MnPASS

Raytheon Mobile Enforcement Reader

Control Unit

Antenna

Reader
Toll Collection

- Pre-paid MnPASS account - Credit Card only
- User Install transponder
- Must have “off” switch
- License plate readers *not* allowed

- Antennae read transponder in vehicle
Back Office Operations

• Center to Center Communications
• Transaction Processing
  • cashless
• System Monitoring and testing
• Data
• Customer Service
  • Phone, web, walk-in
• Highly Reliable Systems
• Built with expansion in mind
Expansion to 35W Corridor

Build upon
- In place communication networks
- In place traffic management systems
- Toll Systems

Retain
- Tolling strategy
- Enforcement Technology
- Back office

New
- Active Traffic Management all lanes
- Dynamic priced shoulder lane
- Dynamic lane signs integrated with toll pricing
I-35W MnPASS: Travel Time Advisory
PDSL/Managed Lanes: Driver Views

- Rate: $1.00 TO DOWNTOWN
- Speed Limit: 45 MPH
- Exit Details:
  - 31st St: 1
  - Downtown: 2
  - Washington Ave UofM: 3
Visit www.mnpass.org
Or www.dot.state.mn.us/upa
Contact: nick.thompson@state.mn.us

Questions and More Information
Technologies That Complement Congestion Pricing

Presented by:

Morgan Balogh, P.E., PTOE
Traffic Engineer, Northwest Region Operations

Congestion Pricing Webinar
June 23, 2011
Monitor, Manage, Measure

WSDOT is a nationwide expert on using technology to keep drivers informed, move more traffic safely & efficiently, and systematically measure & report on performance.
WSDOT’s Long History of Freeway System Operations

- Reversible express lanes operations
- Variable message signs
- Variable speed limits
- Traffic management centers
- Traffic cameras
- Ramp meters
Traffic Management Centers

• Integrated Operations
• Coordinated Communication
• System Controls
  – Tunnel Operations
  – Ramp Metering
  – Active Traffic Management Systems
  – Central Control of Traffic Signal Systems
  – Integrated Corridor Management (ICM)
• Information Dissemination
How do we use high quality traffic data?
To develop strategies and assess the performance of the three-part Moving Washington strategy

<table>
<thead>
<tr>
<th>Operating Roadways Efficiently</th>
<th>Managing Demand</th>
<th>Adding Capacity Strategically</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Support variable pricing for HOT lanes</td>
<td>• Monitor results of various efforts to reduce VMT (for GHG and congestion)</td>
<td>• Assess the impacts of past strategies</td>
</tr>
<tr>
<td>• Facilitate electronic tolling</td>
<td>• Track HOV usage</td>
<td>• Customize solutions for congested corridors</td>
</tr>
<tr>
<td>• Implement Active Traffic Management – Smarter Highways</td>
<td>• Validate the modeling analysis of TDM strategy impacts</td>
<td>• Plan, prioritize, and program capital improvement projects</td>
</tr>
<tr>
<td>• Provide real-time traveler information</td>
<td></td>
<td>• Assist legislature and governor in making investment decisions</td>
</tr>
<tr>
<td>• Apply other technologies in operations to enhance safety and system efficiency</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SR 167 High Occupancy Toll (HOT) Lanes

General Purpose drivers save time:
• GP lane speeds increased by 11 percent
• Volume has increased two to three percent

HOT lane drivers save time:
• HOT lane drivers save up to eight minutes during rush hour
• Volumes increased 12 percent

Usage and Revenue is growing:
• HOT lane usage doubled during the second year of the pilot
• Revenue covers O&M costs
What are Smarter Highways?

Build upon current traffic technology
   Use the successes we have to build smarter roadways for the future

Install overhead electronic signs
   Alerts drivers to slow down or change lanes due to blocking incidents. Also improves emergency access.

Allow drivers to use shoulders
   Open shoulders as a travel lane during peak commute hours where safe to do so

Build in emergency pull off areas
   Gives space for vehicles to pull over in emergencies and helps keep traffic moving

Give drivers more real-time information
   Electronic signs allow drivers to make better reroute decisions
Smarter Highways

- Traffic accidents are responsible for at least 25% of all congestion
- Anticipate a 30% reduction in injury collisions
- Give drivers information to make better travel decisions

- Variable speed limits
- Lane control
- Real time traffic information
1st Sign Bridge: A collision ahead causes speed limit to drop to 50 mph.

2nd Sign Bridge: Signs display lane status. And direct drivers to begin to start moving over.

3rd Sign Bridge: At the incident, two right lanes closed.

4th Sign Bridge: After the incident, the speed limit automatically returns to the posted 60 mph.
Smarter Highways Segments Under Way

**Northbound I-5**
*August 2010*
Boeing Access Road to I-90 in Seattle

**SR 520**
*November 2010*
I-5 to 130th Avenue NE in Bellevue

**I-90**
*June 2011*
I-5 to 150th Avenue SE in Bellevue
WSDOT engineers conducted a feasibility study to see where in the Central Puget Sound Region Smarter Highways might be effective in improving safety.

Future expansions of the system are currently unfunded.

What other highways might get smarter?
Lake Washington Urban Partnership Agreement

$154.5 million federal grant to apply these innovative approaches to reduce congestion in the SR 520 corridor

- **Tolling** – encourages travel at off-peak hours and reduces trips
- **Technology** – variable speed limits and real time driver info
- **Transit** – added over 130 new daily bus trips to the 600 already in the corridor
- **Telecommuting** – educational efforts with employers, van/carpools

**Partners:**
- Puget Sound Regional Council
- Washington State Department of Transportation
- King County
Lake Washington Travel Time Signs

3 new dedicated travel time signs
– WB SR 520 just east of I-405
– SB I-405 at NE 72nd Place
– SR 522 at SR 202
Seattle Integrated Management Corridor

- Freeway - I-5
- Commuter Rail
- Light Rail
- Transit Corridor
Corridor Dynamics

• Regionally critical corridor
• Geographically constrained
• Complex right-of-way network
• Significant freight traffic – Port of Seattle
• Over 90 major events annually
• Major highway construction over several years - Alaskan Viaduct Replacement
Web, 511, & Other Media Comparison

• Web: Average about 1 Million page views per day. (~85% is for travel information)
• Web: Routinely see over 2 million daily page views during winter weather
• Comparatives
  – 511 calls vary from 70K to 500K per month
    • Reached our 10M 511 call after year 6
  – Blog views are 10K per month
  – YouTube views 20k per month
  – Flickr sees up to 200K views per month (although had 1 million views last month due to north cascades!)
  – Twitter has about 16,000 followers
  – Email alert pushes, minimum 400K per month
  – 2500 Facebook fans
# Seattle Area Travel Times

Travel times as of 6:35 A.M. Thursday, June 23, 2011

<table>
<thead>
<tr>
<th>State Route/Interstate</th>
<th>Route Description</th>
<th>Distance (miles)</th>
<th>Average Travel Time (minutes)</th>
<th>Current Travel Time (minutes)</th>
<th>Via HOV (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>167</td>
<td>Auburn to Renton</td>
<td>9.8</td>
<td>14</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>405</td>
<td>Bellevue to Bothell</td>
<td>9.7</td>
<td>10</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>405</td>
<td>Bellevue to Everett</td>
<td>26.1</td>
<td>27</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>405</td>
<td>Bellevue to Federal Way</td>
<td>24.6</td>
<td>29</td>
<td>28</td>
<td>27</td>
</tr>
<tr>
<td>405</td>
<td>Bellevue to Issaquah</td>
<td>9.6</td>
<td>9</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>405</td>
<td>Bellevue to Lynnwood</td>
<td>14.9</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>405</td>
<td>Bellevue to Redmond</td>
<td>7.0</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>405</td>
<td>Bellevue to Renton</td>
<td>11.2</td>
<td>14</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>405</td>
<td>Bellevue to Seattle</td>
<td>10.6</td>
<td>11</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>405</td>
<td>Via Westbound</td>
<td>10.6</td>
<td>11</td>
<td>13</td>
<td>13</td>
</tr>
</tbody>
</table>
Canadian Border Traffic

Traffic Conditions as of: Aug 19, 2009 8:07 AM PDT

**Northbound Border Wait Times**
8:15 A.M. Wednesday, August 19, 2009

- I-5 General Purpose: 35 Min
- I-5 Nexus Lane: Less than 5 Min
- SR 543 General Purpose: 10 Min
- SR 543 Nexus Lane: Less than 5 Min
- SR 543 Trucks: 15 Min
- SR 543 Trucks FAST LANE: Less than 5 Min
- SR 539 General Purpose: 20 Min
- SR 5 General Purpose: Less than 5 Min

**Southbound Wall Times and Cameras**

- **I-5**
- **SR 543**
- **SR 539**
- **SR 5**

** reigning State Travel**
- Travel Alerts & Slowdowns
- Mountain Pass
- Weather
- Construction
- Cross State Travel
- Route
- Winter Driving Tips
- Safety Rest Areas
- State Highway Map
- Interstate Exits
- Featured Services

**More Border Information**
- Average Travel Delays
- Local Weather and Forecast
- Nexus Information
- FAST Application Information (Commercial Shipment)
- Archive Border Wait Times
- Questions about crossing the border
- Other Points of Entry

**Travel Info**
- Parking State Travel
- Driver & Vehicle Licensing
- Washington State Tourism
- Contact Us
- Disclaimer

**News**
- The hottest housing deals in Western Washington will be on display Saturday on Wednesdays in Seattle.
- Roundabout to open Sunday night at SR 539/Pedestrian Centennial Trail intersection near Lindsli.
- Second Anemone sets train to Vancouver, B.C. begins service August 19.
- More News...
Travel Alerts Puget Sound Area

**State View**
- Seattle Area
- Tacoma
- Hood Canal
- Olympia
- Centralia & Chehalis
- Vancouver Area
- Mount Vernon & Stanwood
- Bellingham
- Monroe & Sultan
- Canadian Border
- Spokane
- US 97 Border
- Wenatchee

**State Travel Info**
- Travel Alerts
- Mountain Passes
- Weather
- Construction

**Travel Alerts**

**HIGH IMPACT**

- SR 18 Westbound - Until further notice, the ramp from Weyerhaeuser Way to westbound SR 18 is closed around the clock. The closure will allow crews to rebuild and elevate the ramp 20 feet to make room for a new flyover. A detour is available. Last Updated: 6/3/2011 10:49 AM At milepost 1

**MODERATE IMPACT**

- I-90 Both Directions - Blasting Thursday through Sunday will begin at 8 p.m. Crews will be blasting rock closer to I-90, which could result in a closure longer than one hour. Drivers need to plan for more than an hour of added travel time. Traffic will be stopped milepost 56 to milepost 61. Tuesday through Friday, delays possible for rolling slowdowns to move construction equipment in the work zone. Monday night through Saturday morning, 8 p.m. to 9 a.m. Traffic restricted to one lane each direction on loads over 12 feet wide are prohibited. Last Updated: 6/23/2011 12:16 AM From milepost 56 to milepost 61

**Zoom Out** [1] [2] [3] **Zoom In**

Impact Level/Type

**View All Alerts For Area (Printer friendly version)**

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**Email updates**

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**Inbox - Microsoft Outlook**

**RE: Need some Pow...**

**RE: Need some Pow...**

**Technologies That C...**

**C:\Documents and S...**

**Microsoft Word**

**WSDOT - Travel Alerts**
Performance Measurement

- Accountability
- Optimization
- Investment Decisions
## Travel time performance for July-December in 2007-2010 on a sample of 18 high demand commute routes

Morning (am) peak is between 6 am and 9 am; evening (pm) peak is between 3 pm and 7 pm; length of route in miles; all travel times in minutes

<table>
<thead>
<tr>
<th>Route name (route length)</th>
<th>Direction of travel</th>
<th>Average travel time in minutes during peak period</th>
<th>Peak average travel time change in minutes</th>
<th>Peak volume change</th>
<th>Daily volume change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Morning commutes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-5 Federal Way to Seattle (22)</td>
<td>NB</td>
<td>42</td>
<td>35</td>
<td>31</td>
<td>34</td>
</tr>
<tr>
<td>I-5 Everett to Seattle (24)</td>
<td>SB</td>
<td>41</td>
<td>36</td>
<td>35</td>
<td>37</td>
</tr>
<tr>
<td>I-5/I-405 Everett to Bellevue (23)</td>
<td>SB</td>
<td>42</td>
<td>37</td>
<td>36</td>
<td>40</td>
</tr>
<tr>
<td>I-405 Tukwila to Bellevue (13)</td>
<td>NB</td>
<td>35</td>
<td>33</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>SR 167 Auburn to Renton (10)</td>
<td>NB</td>
<td>17</td>
<td>14</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>I-405/I-90/I-5 Bellevue to Seattle (11)</td>
<td>SB/WB/NB</td>
<td>14</td>
<td>-</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>I-405/SR 520/I-5 Bellevue to Seattle (10)</td>
<td>NB/WB/SB</td>
<td>14</td>
<td>13</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>I-5/I-90/I-405 Seattle to Bellevue (11)</td>
<td>SB/EB/NB</td>
<td>14</td>
<td>14</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>I-5/SR 520/I-405 Seattle to Bellevue (10)</td>
<td>NB/EB/SB</td>
<td>16</td>
<td>15</td>
<td>15</td>
<td>16</td>
</tr>
</tbody>
</table>

### Evening commutes

<table>
<thead>
<tr>
<th>Route name (route length)</th>
<th>Direction of travel</th>
<th>Average travel time in minutes during peak period</th>
<th>Peak average travel time change in minutes</th>
<th>Peak volume change</th>
<th>Daily volume change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Evening commutes</strong></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
For more information

Morgan Balogh, P.E., PTOE
Traffic Engineer, Northwest Region Operations
206-440-4487
baloghm@wsdot.wa.gov
FHWA ETC Rule

- Published October 8, 2009
- In response to SAFETEA-LU requirement in §1604 to issue rule on req'ts, standards, or performance specs for automated toll collection
- NPRM issued September 2007, included questions about need for & timing of standard
FHWA ETC Rule

- **Headlines of Comments to NPRM**
  - Sunk costs of installed base must be considered
  - Long phase-in period or grandfathering
  - Back-office is major aspect of interoperability; toll tag is only a part
  - Significant cost difference between DSRC/5.9Ghz & toll-only devices
  - Question related to timing of std: General response was “too soon” & DSRC considered when it's ready
FHWA ETC Rule

- Only applies to 3 tolling programs: Interstate Construction Pilot (1), Express Lanes Demonstration (2) and Value Pricing Pilot Program
  - Not applicable to HOV-HOT, 23 USC §129 or Interstate Reconstruction Pilot
- Requires ETC for all these programs
  - ETC defined as “ability for vehicle operators to pay tolls automatically without slowing down from normal highway speeds”
FHWA ETC Rule

- Requires FHWA concurrence of selected ETC method
  - Consider likely users, how interoperability is addressed, consider future (5-year) techniques
  - Intent is not to be a barrier or hindrance, but to ensure a collaboration between industry/deployers and Government as technologies & techniques advance

- About $\frac{1}{2}$ of responders stated that any national toll collection std be pursued as an integral part of connected vehicle research (formerly known as the IntelliDrive$^{SM}$ program)