

Enabling Near-Term Nationwide Implementation of Distance Based Road User Fees



Presentation: Max Donath
University of Minnesota

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Presented at
Symposium on Mileage-based User Fees
April 20-21, 2010



VMT Technology Requirements

- Must be nationally deployable
- Must be interoperable across all jurisdictions
- Must ensure privacy
- Must allow for the free flow of traffic; tolling gates or physical separators are unacceptable.
- Must identify mechanisms to ensure **compliance** and facilitate **enforcement**
- Must be **auditable & transparent**; **maintain** the **trust** of the public.
- **Must be scalable**, given the context - **250 million registered vehicles in the U.S. collectively traveled 3 trillion miles in 2006.**
- Must minimize deployment of infrastructure & administrative overhead



Many approaches considered to date

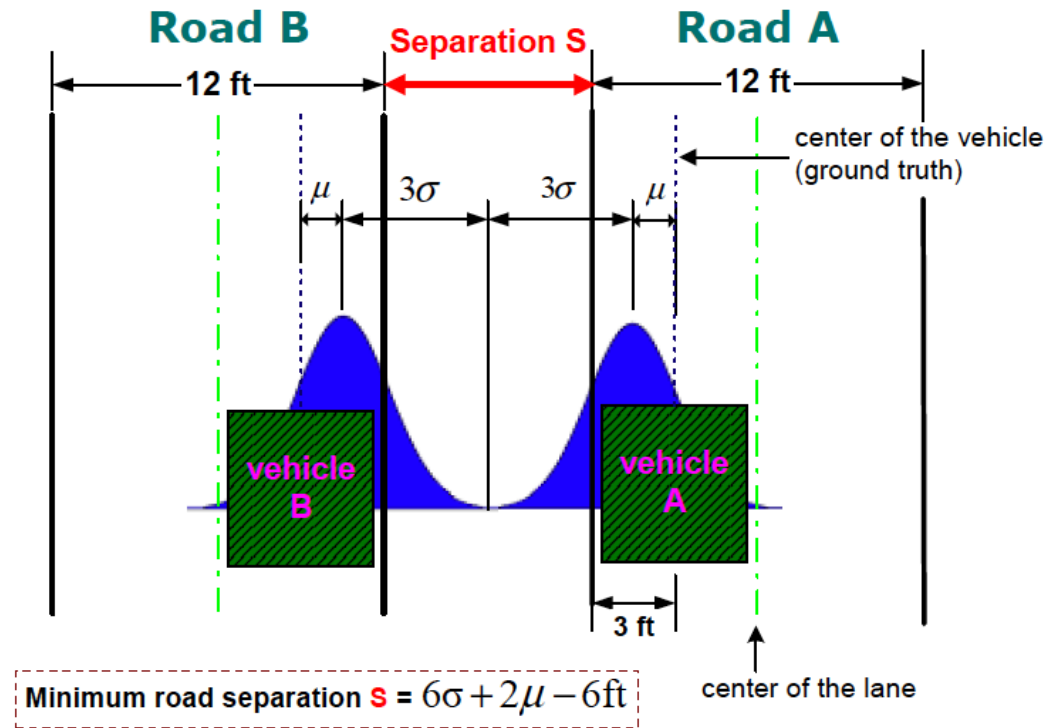
- **Weight/vehicle class**
- **Fuel consumption**
- **Miles:** Just need odometer?
- **Time of day:** Time reference
- **In/out state:** Position + Map
- **Jurisdiction:** Position + Better Map
- **Variable charge rates:**
Position + Better Map + Time + Charge schedule
- **Facility:** Accurate Position + Accurate Map
- **Parallel payment systems:** Fuel used vs VMT
Provide credit for paid motor fuel use taxes (federal & state)



Previous study developed system requirements for GPS and digital maps for future in-vehicle road user charging system.

The focus was to evaluate BOTH in the most difficult of environments

– where roads of different jurisdictions and different fee structures are located in close proximity to each other (e.g. a highway and a frontage road).



Reference: M. Donath, S. Shekhar, P. Cheng, X. Ma, “A New Approach to Assessing Road User Charges: Evaluation of Core Technologies,” MnDOT Report No. 2003-38, June 2003.

<http://www.its.umn.edu/Publications/ResearchReports/reportdetail.html?id=687>

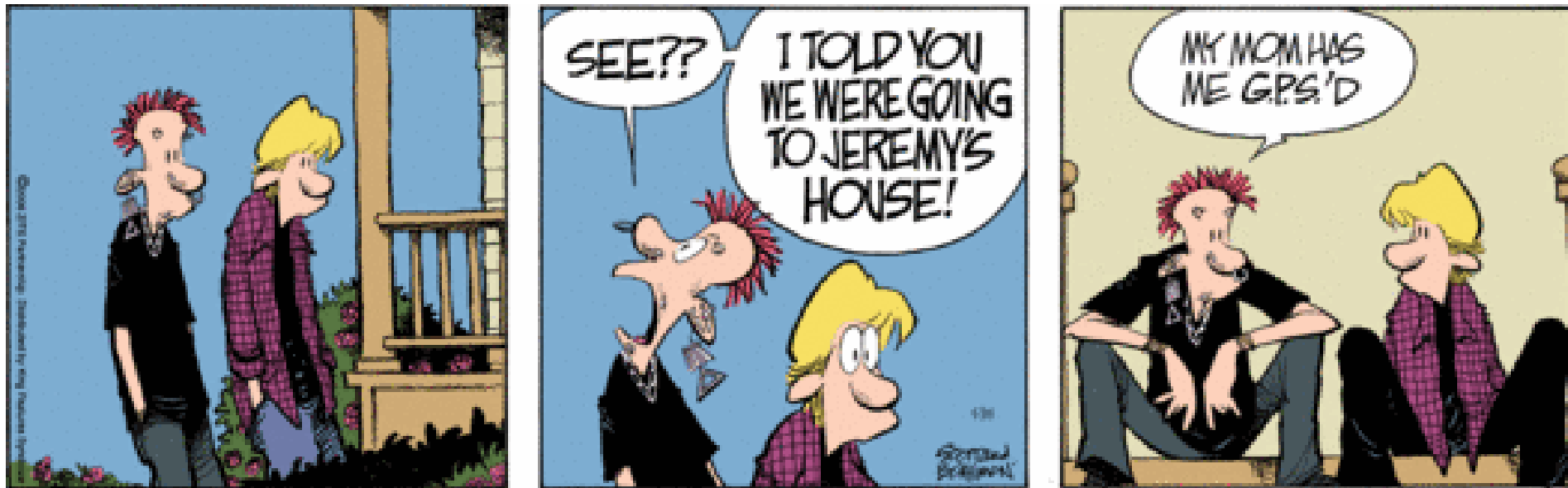


GPS + Map: Privacy Considerations

- **GPS does NOT track ! !**
- Confused by the media all the time
- GPS only provides the means with which a position can be computed.
- For others to “know” location, separate wireless communication device needed.
- Has important implications with respect to design of VMT system & data privacy.



Nevertheless, we have a problem



From Zits (May 15, 2006)
By Jerry Scott and Jim Borgman



Privacy vs. Security

- Privacy and security are not the same.
- What does the “customer” demand?
What will the customer tolerate?
- Use of **credit card can be secure**,
... but **does not preserve privacy**.
- Use of **cell phone generally secure**,
... but **does not preserve privacy**.
- Privacy and Security dictate architecture
for VMT technology.



Privacy Considerations

- Accountability
- Purpose is identified at time of collection
- Informed consent for collection
- Limited use and disclosure
- Limited retention of data
- Quality of data (accuracy, completeness, etc.)
- Security of data
- Openness about policies and practices
- Individual access to data and correction

Adapted from Collin Bennett and Charles Raab,
'The Governance of Privacy: Policy Instruments in Global
Perspective', MIT Press, 2006



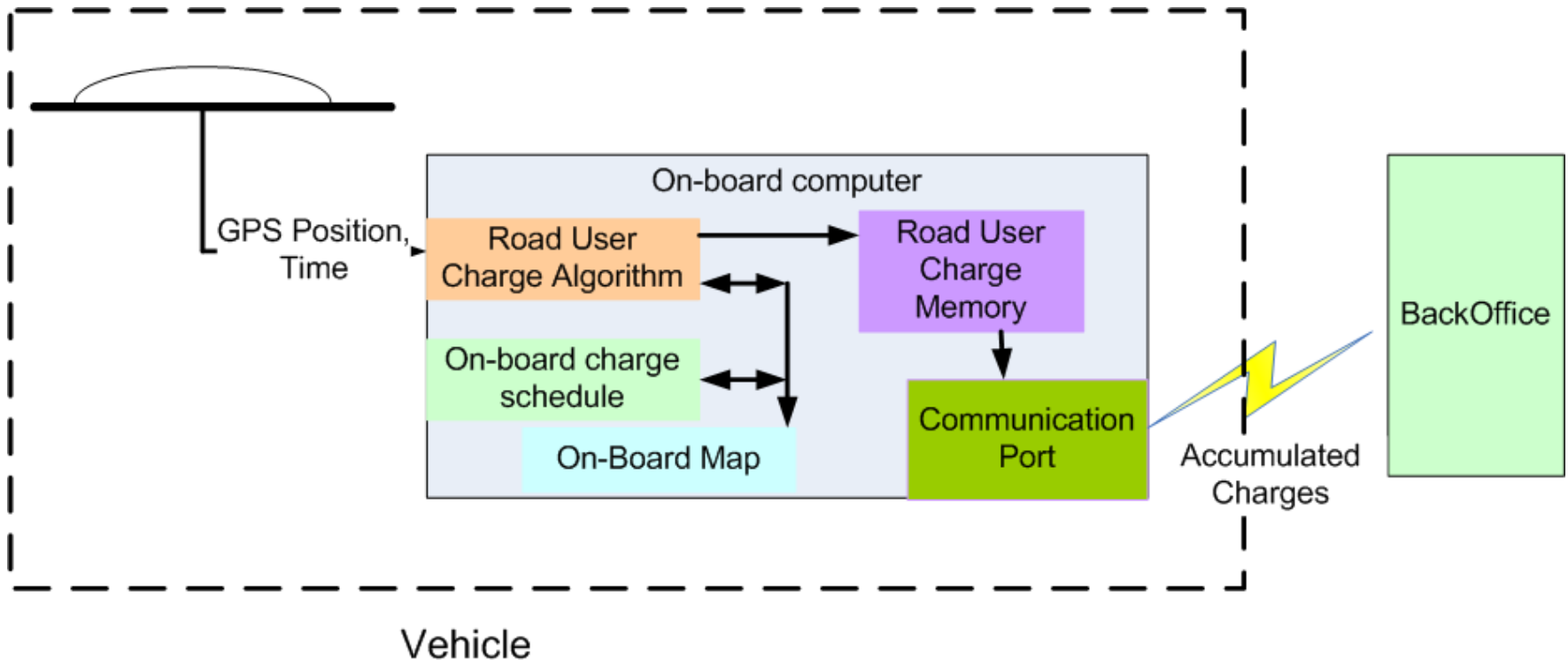
Develop Privacy Standards

- Log and report only the “minimum” amount of data “necessary”
 - Do NOT record routes traveled
 - Log and report **accumulated road user charges** for each jurisdiction, facility, etc.
 - Remove unneeded data as soon as it is verified and uploaded to collection center
 - Erase data at collection center after suitable appeal period
 - Privacy architectures: The greater the privacy, the more difficult to audit and ensure compliance.
- Use encryption to ensure data security



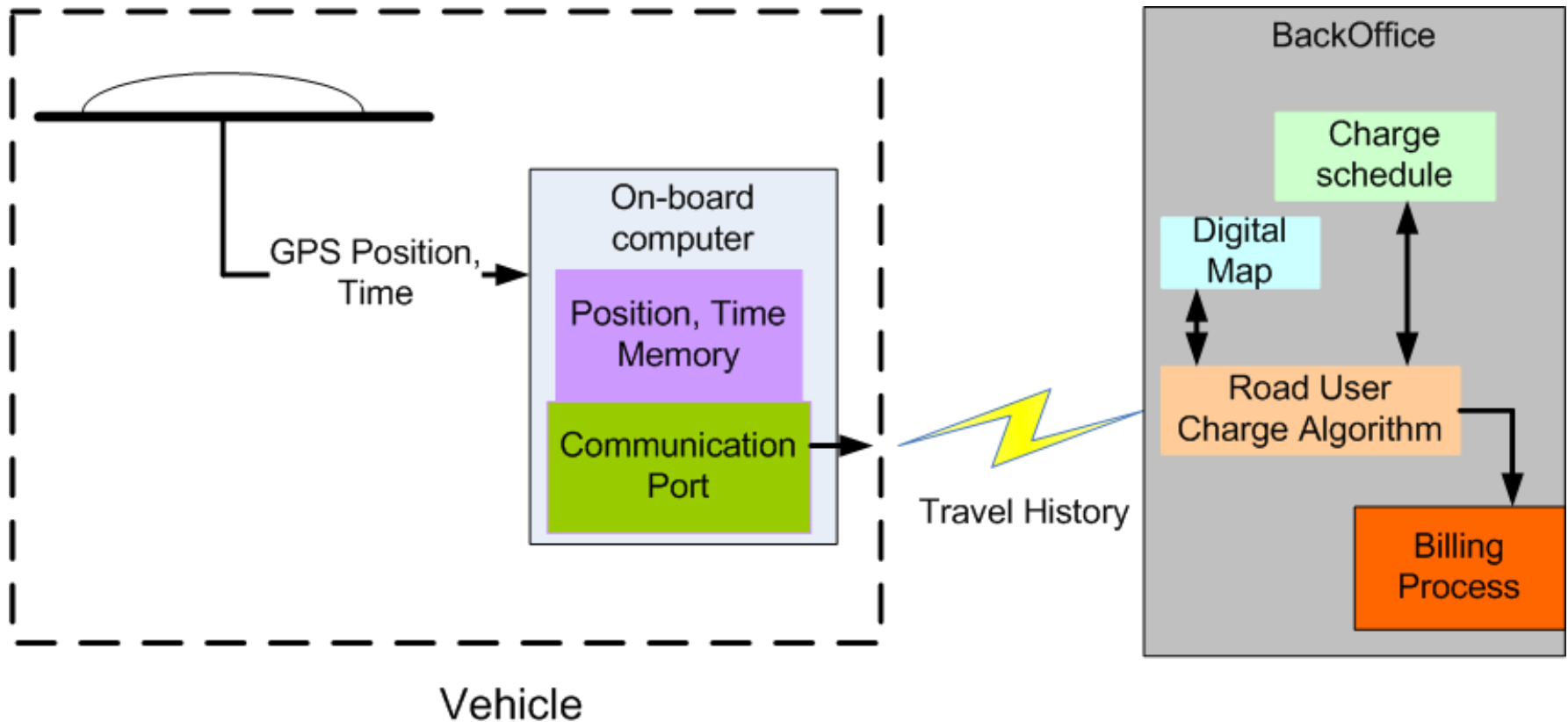
GPS + Map: Architecture which preserves privacy

“Thick client” model



Limited Privacy Architecture

“Thin client” model



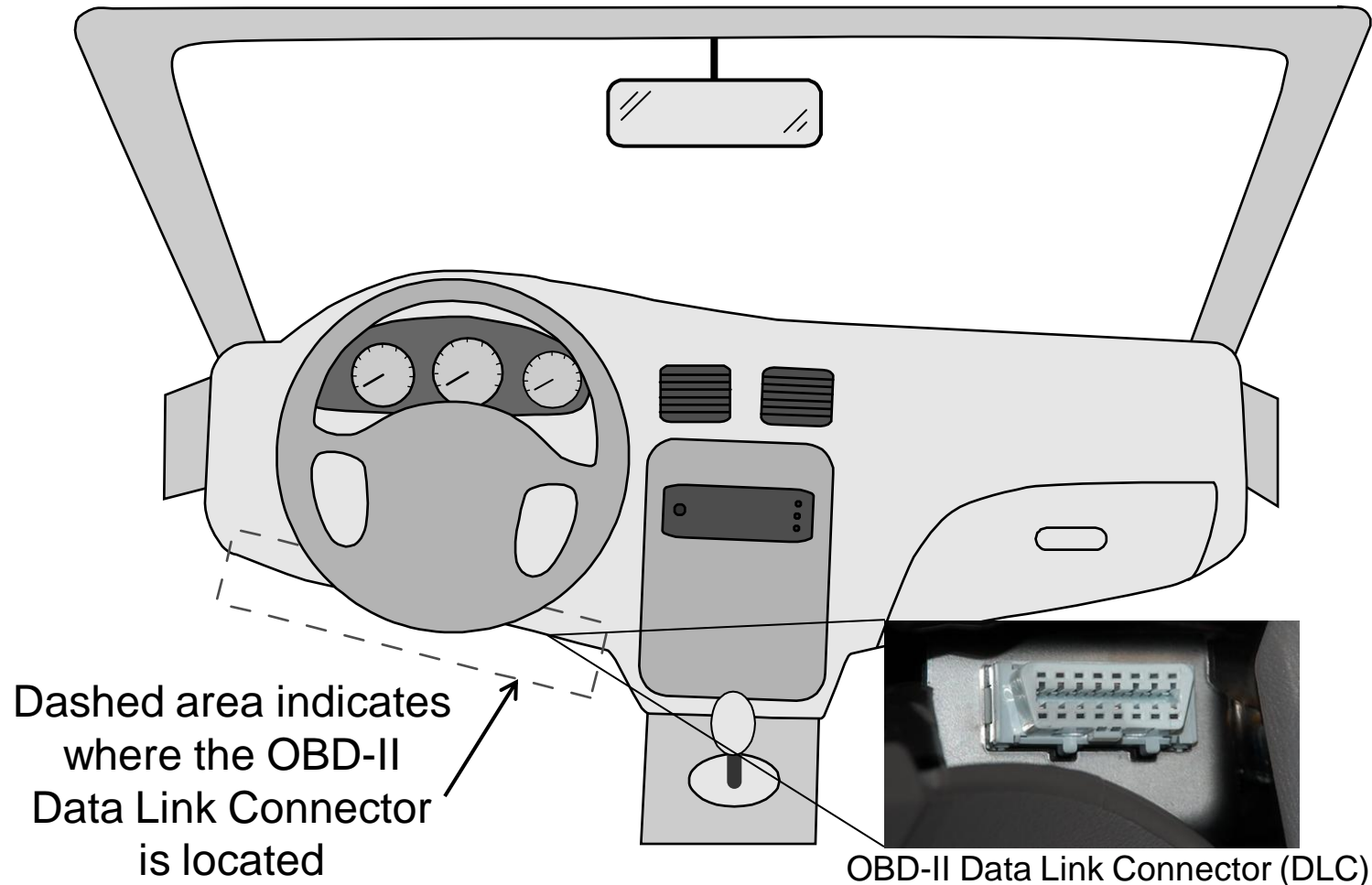
Privacy and Architecture

- If Privacy is to be fully maintained, ALL travel records and cost calculations should be performed on board the vehicle
 - Technical burden is on the vehicle
 - Increases the in-vehicle cost
 - Increases the complexity of the deployment
- Question: How does one get this technology into the **present** vehicle fleet?



The OBD-II Data Link Connector (DLC)

The OBD-II is available as a standard interface to the vehicle data bus on ALL passenger car models since 1996



The OBD-II Data Link Connector (DLC)



2000 Dodge Caravan

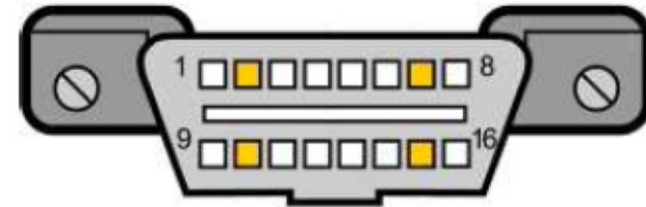


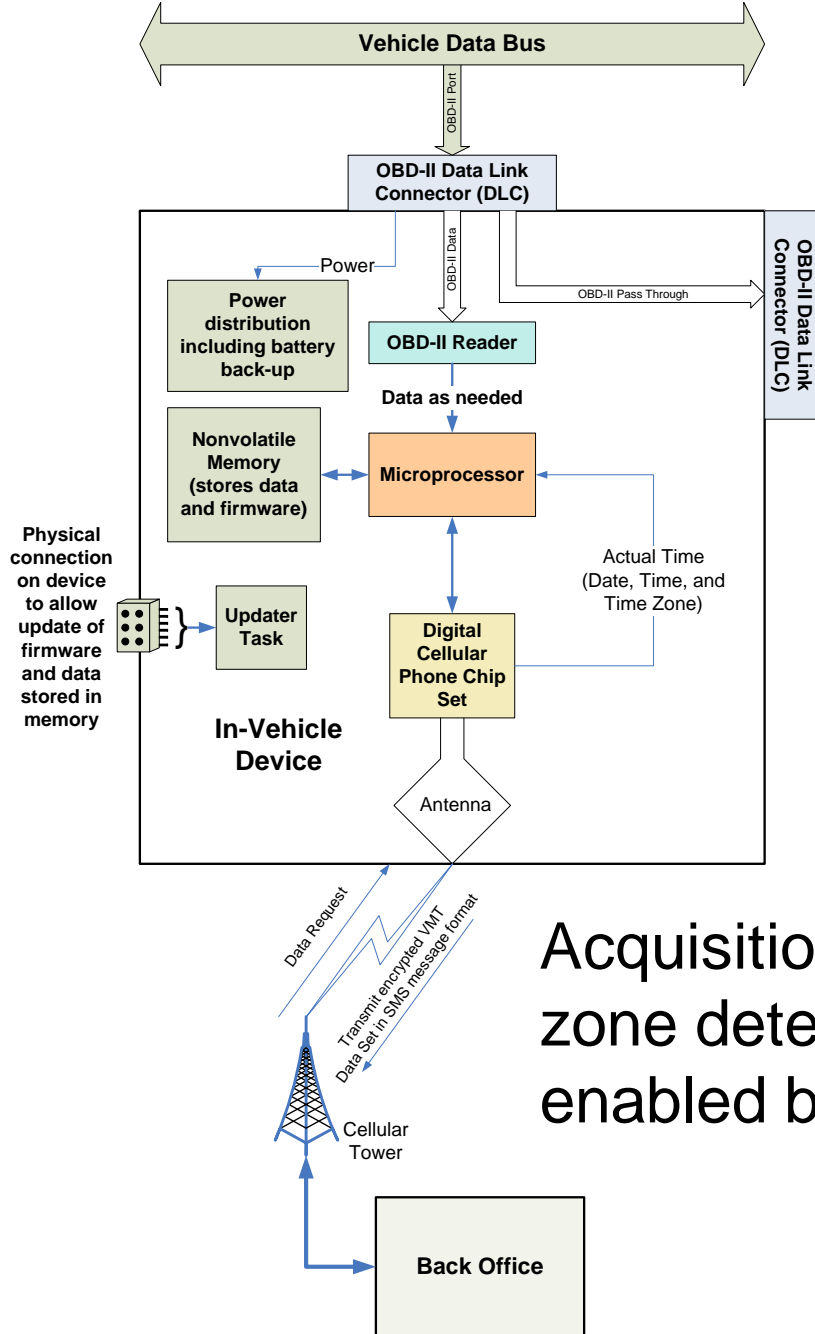
2005 Nissan Titan Pickup



2006 Toyota Prius

- ◆ Power and ground are available on the DLC.
- ◆ The OBD-II connector pinout has Ground on #5 and Power on #16
- ◆ Vehicle data bus access turned on/off by ignition; power is always on (if battery connected & charged)
- ◆ Speed signal from vehicle bus can be read directly and numerically integrated to calculate distance traveled





Access by automotive service personnel still available

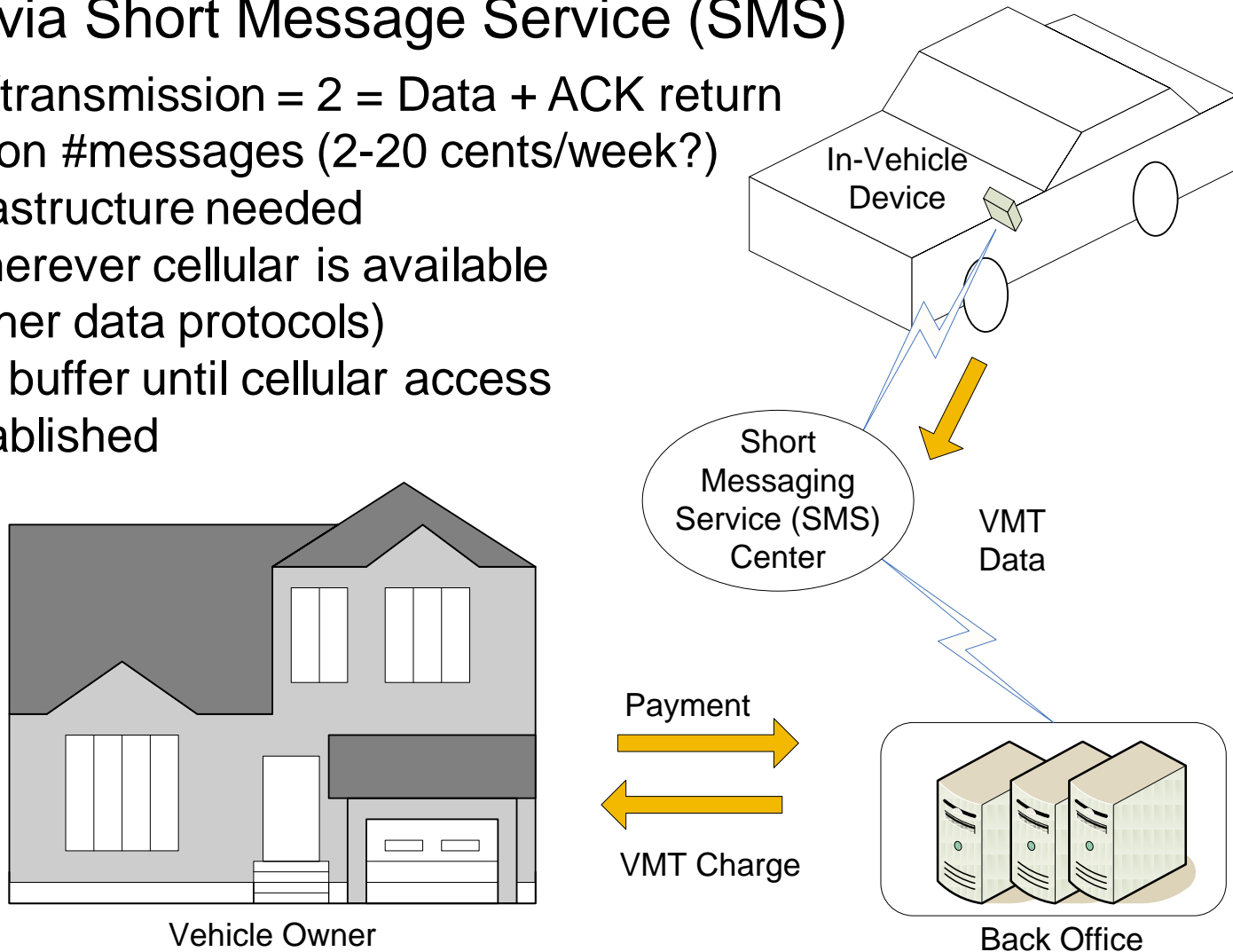
Communicate via encrypted Short Message Service (SMS)

Acquisition of actual time (time stamp), zone determination **and** communication enabled by same communication device

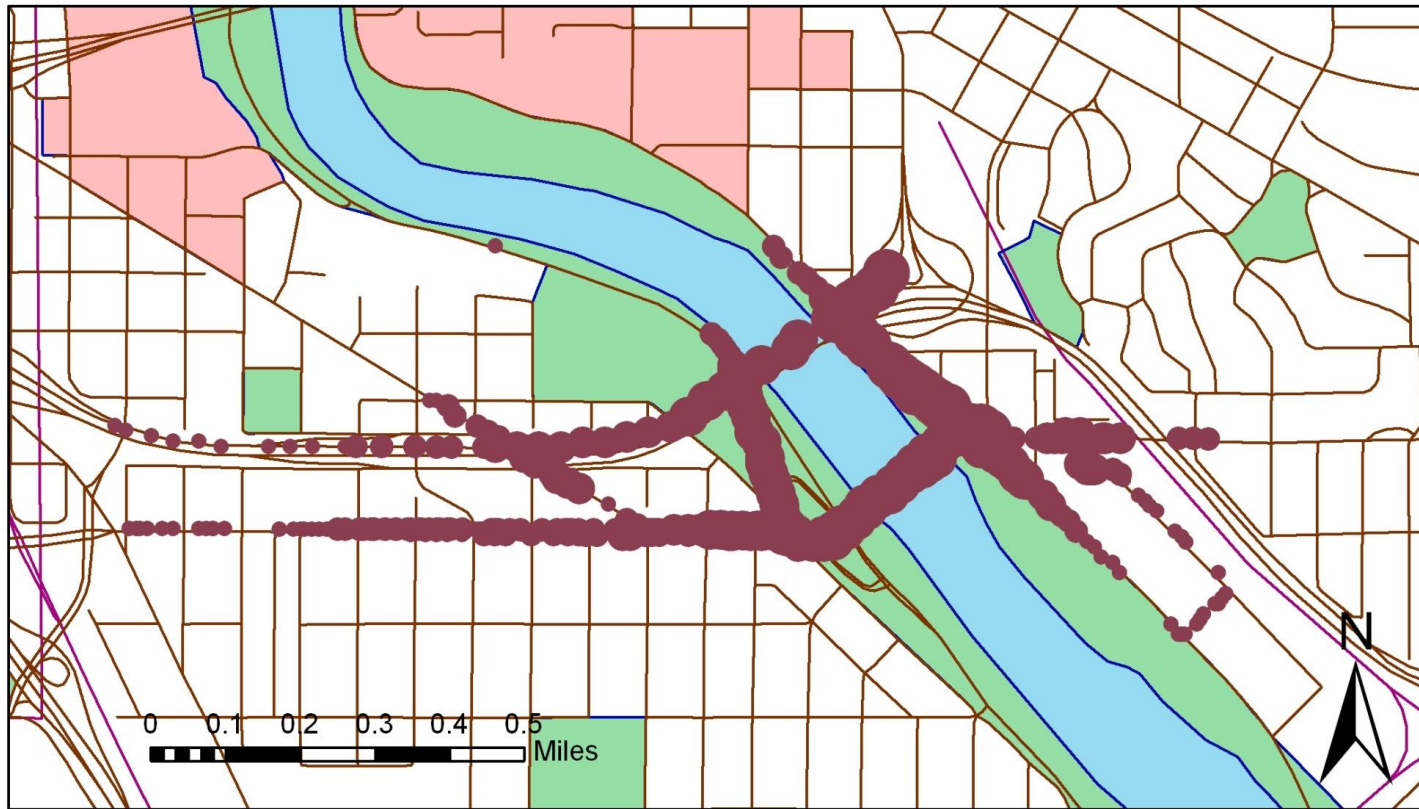
Paying the VMT Road User Fee

Communicate via Short Message Service (SMS)

- #messages/transmission = 2 = Data + ACK return
- Cost based on #messages (2-20 cents/week?)
- No new infrastructure needed
- Available wherever cellular is available (unlike other data protocols)
- Data held in buffer until cellular access is re-established



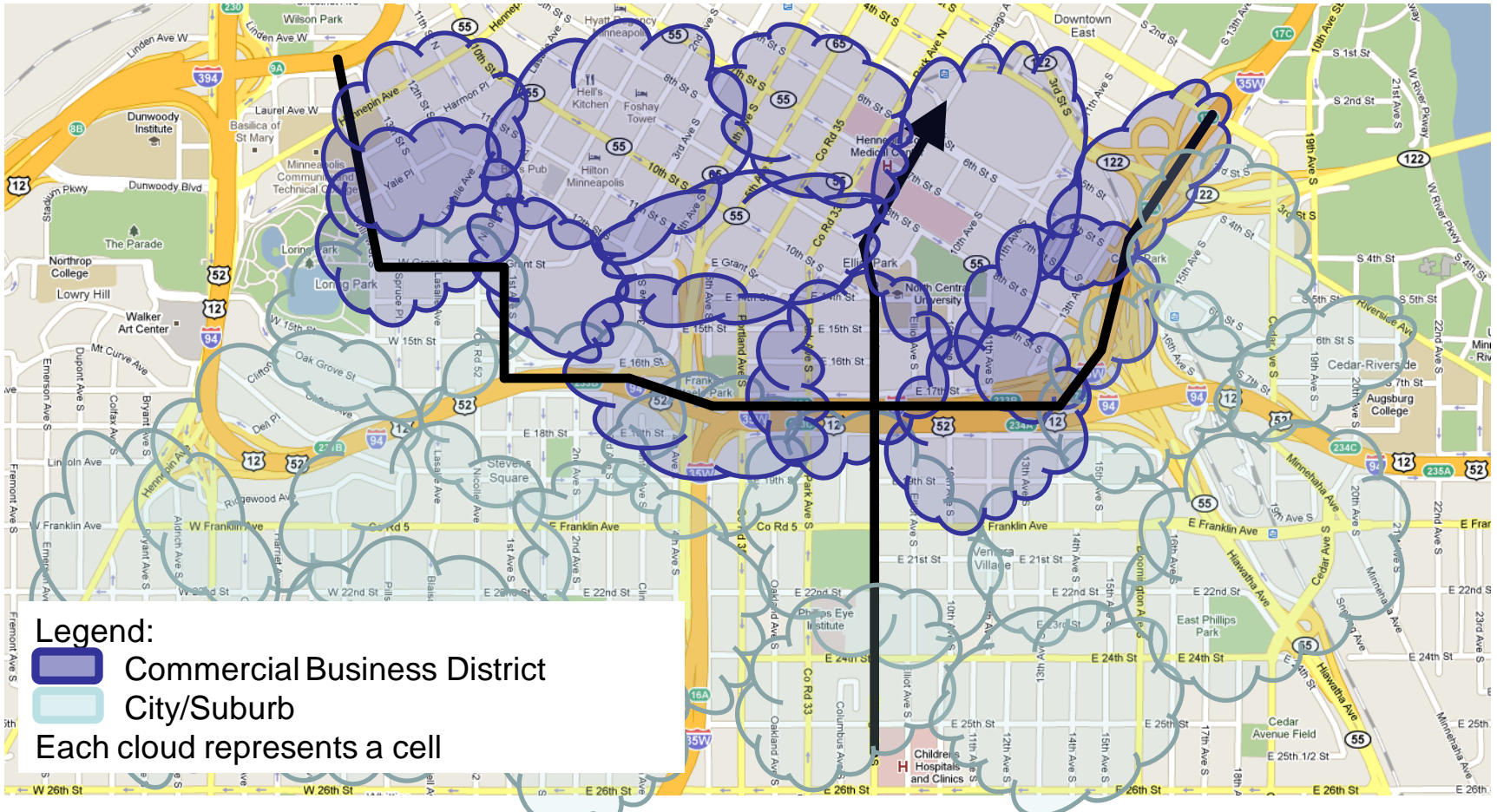
Signal Strength of a Single Tower



- Strength increases with proximity to tower
- Shows partial footprint of a single tower



VMT aggregated by zone using Cell-ID

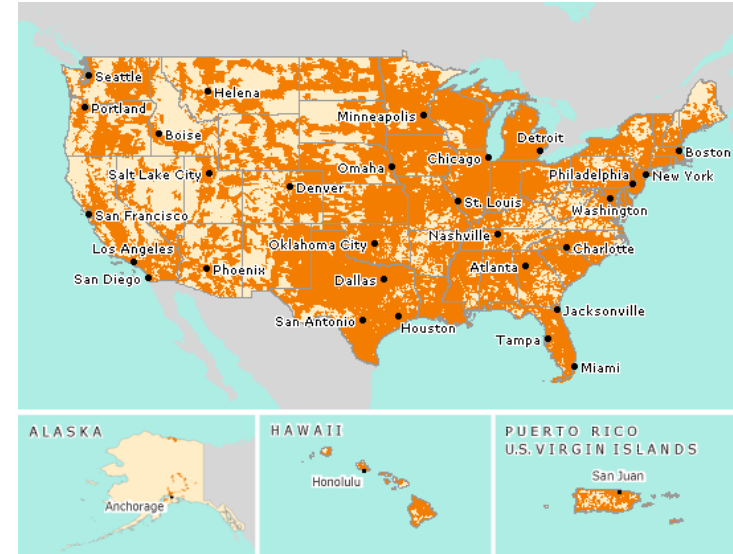


Identify travel zone based on one or more cell-ID's in zone, but requires knowledge of all cell towers in a travel zone. Better method being tested.



Cellular Network Based VMT

- Uses existing infrastructure
 - Wide coverage
- Coverage in urban canyons
- Will not ‘burden’ cell network
- Location “privacy”
 - Lower resolution than GPS
- Independent of cellular providers
 - Doesn’t require carrier approval
 - Doesn’t require knowledge of cell tower locations
- Determines vehicle’s current travel zone, not exact location



Coverage Map for
AT&T

Source: AT&T



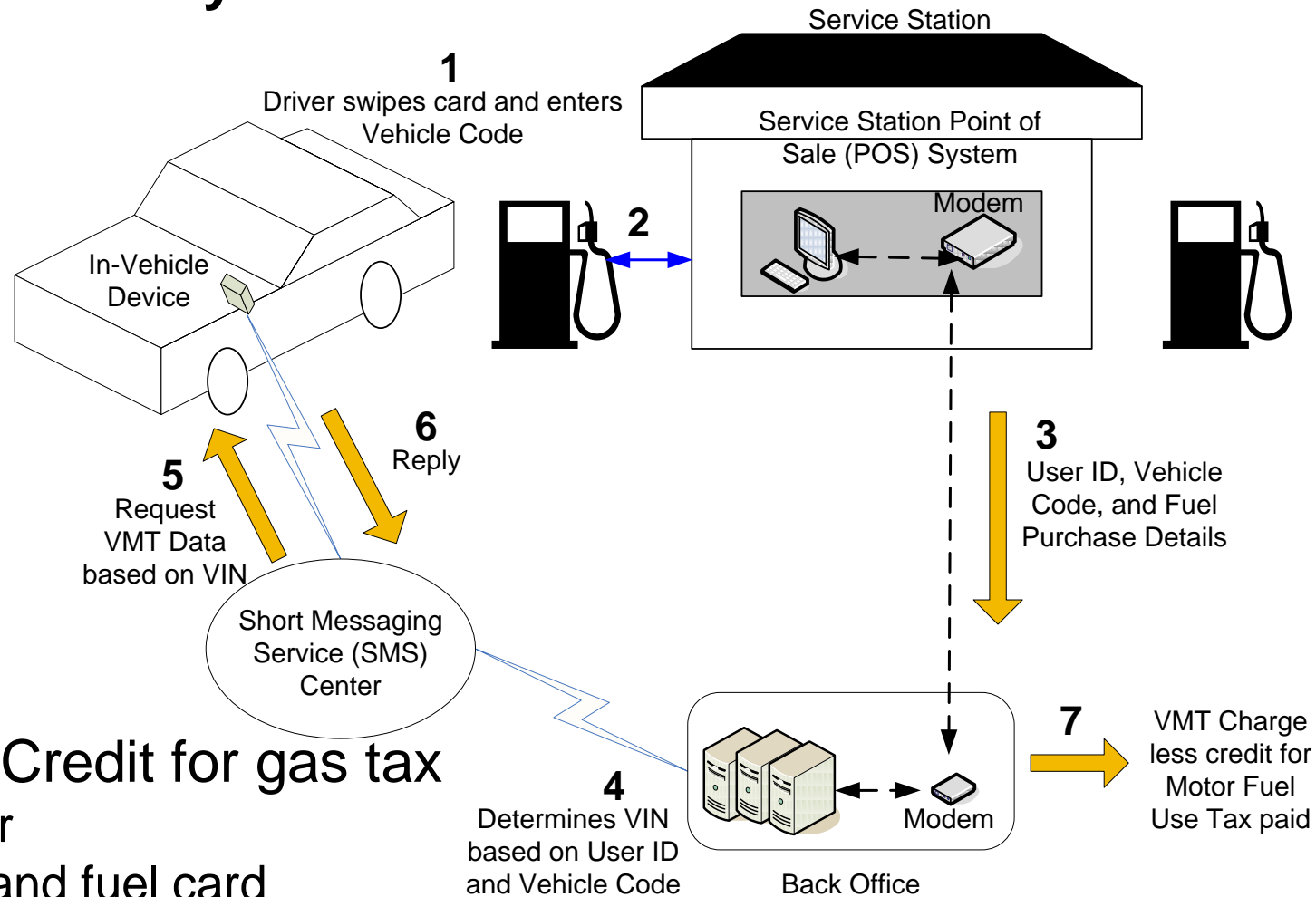
Other Cellular Network Location Methods

- Multilateration
 - Most common method for Locating vehicle
 - Requires knowledge of cell tower locations
 - Used in E911
 - Automatic Number Identification (ANI)
 - Automatic Location Identification (ALI): provided by carrier



VMT User Fee Payment: Reconciling for Paid Gas Tax

No financial stake by fuel stations



Dual system: Credit for gas tax

- Charge card, or
- Can use cash and fuel card

For further information:

See report “**Technology Enabling Near-Term Nationwide Implementation of Distance Based Road User Fees**”, by M. Donath, A. Gorjestani, C. Shankwitz, R. Hoglund, E Arpin, P.M. Cheng, A. Menon, and B. Newstrom

Download from:

<http://www.its.umn.edu/Publications/ResearchReports/reportdetail.html?id=1790>

Max Donath

Intelligent Transportation Systems Institute
University of Minnesota

P: 612-625-2304

E: donath@umn.edu

<http://www.its.umn.edu>

