Markets for Transport

Eliminating Congestion through Scheduling, Routing, and Real-time Pricing

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- Global congestion costs $1 trillion/year
- Los Angeles congestion costs $23 billion/year

The Boston Globe

THURSDAY, OCTOBER 19, 2017

CLOGGED STREETS, UNHAPPY TOURISTS

BARRY CHIN/GLOBE STAFF

A duck boat approached Leverett Circle on Tuesday. Boston Duck Tours is considering cutting Charlestown from its routes.

By Beth Teitell
GLOBE STAFF

Boston traffic has been driving locals berserk for years. But now it's become so toxic that it's taking aim at our guests — and threatening Boston and Cambridge's $13 billion tourism industry.

Every major sightseeing firm contacted by the Globe has made or is mulling changes to deal with paralyzing congestion that never seems to end, and frustration is so intense that even PR types aren't trying to sugarcoat the situation.

"It just stinks to tour Boston right now," said Steven Grasso, president of North American Traveler, a North Reading-based travel-planning firm. One of his groups recently spent 35 minutes in a coach traveling from Faneuil Hall to the Boston Opera House — a 0.9-mile trip, according to Google Maps. "You can't move," he said.

As Bostonians know, no app in the world is capable of outsmarting local traffic. That leaves sightseeing companies to do what little is under their control.

They're cutting major destinations from itineraries — who needs to see Harvard, Charlestown, the Seaport, or

TRAFFIC, Page A13

Ante
raise
bids
Ama

Proposals
from N.J.
the pressu

By

Transport market

- Open access
- Scheduled/routed transport
- Efficient congestion pricing

No congestion

The time is right

- Advances in mobile communications enable
  - Precise (to 1 cubic meter) location of vehicles
  - Easy communication of preferences, prices, schedules
- Advances in computers and markets enable efficient scheduling/routing and pricing of transport

And case for innovation gets stronger each year

Autonomous vehicles are here

Trade-offs in transport

University of Maryland

7860 Tysons Corner Center, Tysons, VA

Arrive by

OPTIONS

9:00 AM

Tue, Oct 10

Send directions to your phone

via I-495 W — typically 40 min - 1 h 15 min

DETAILS

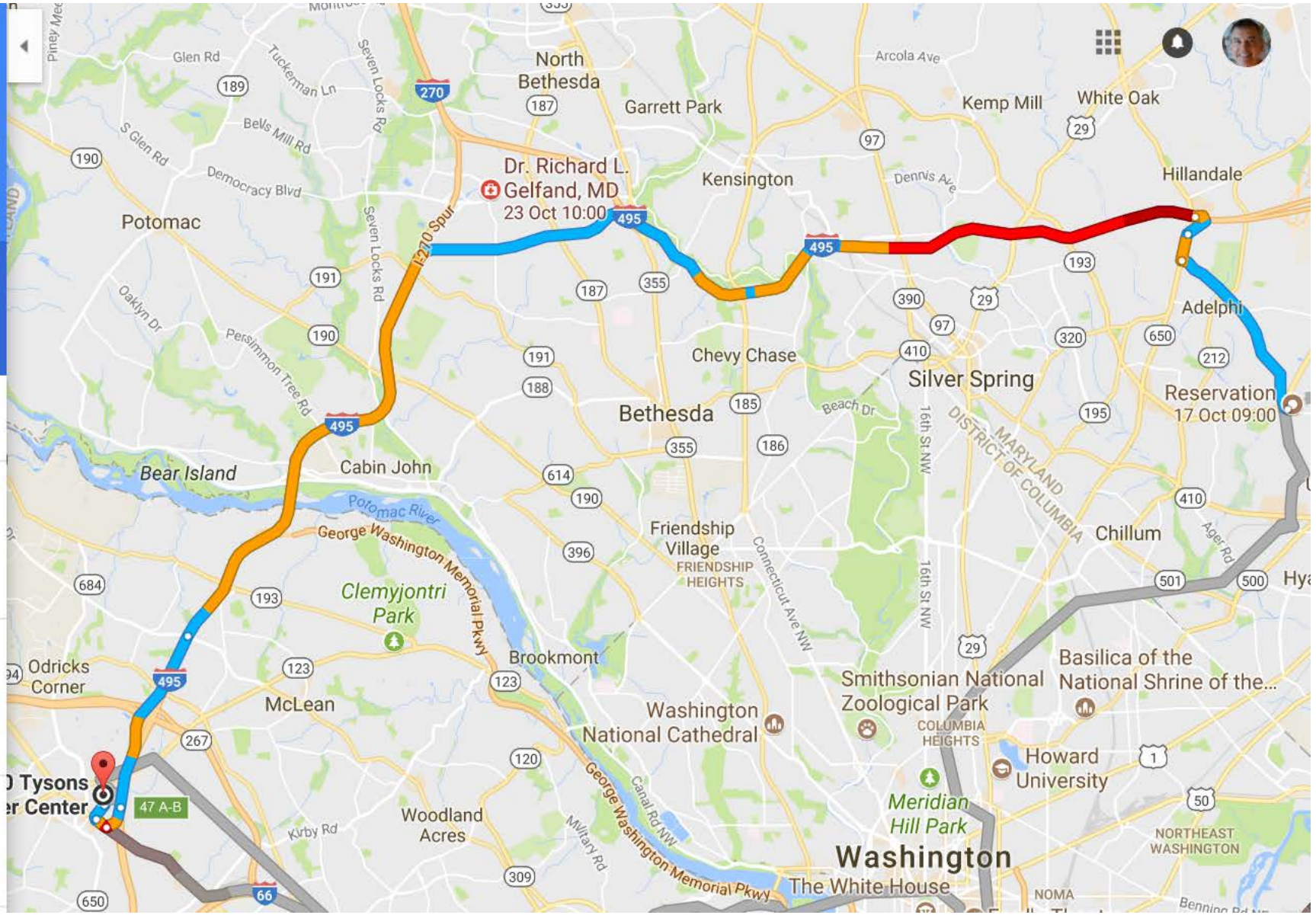
Leave around 7:45 AM
22.4 miles

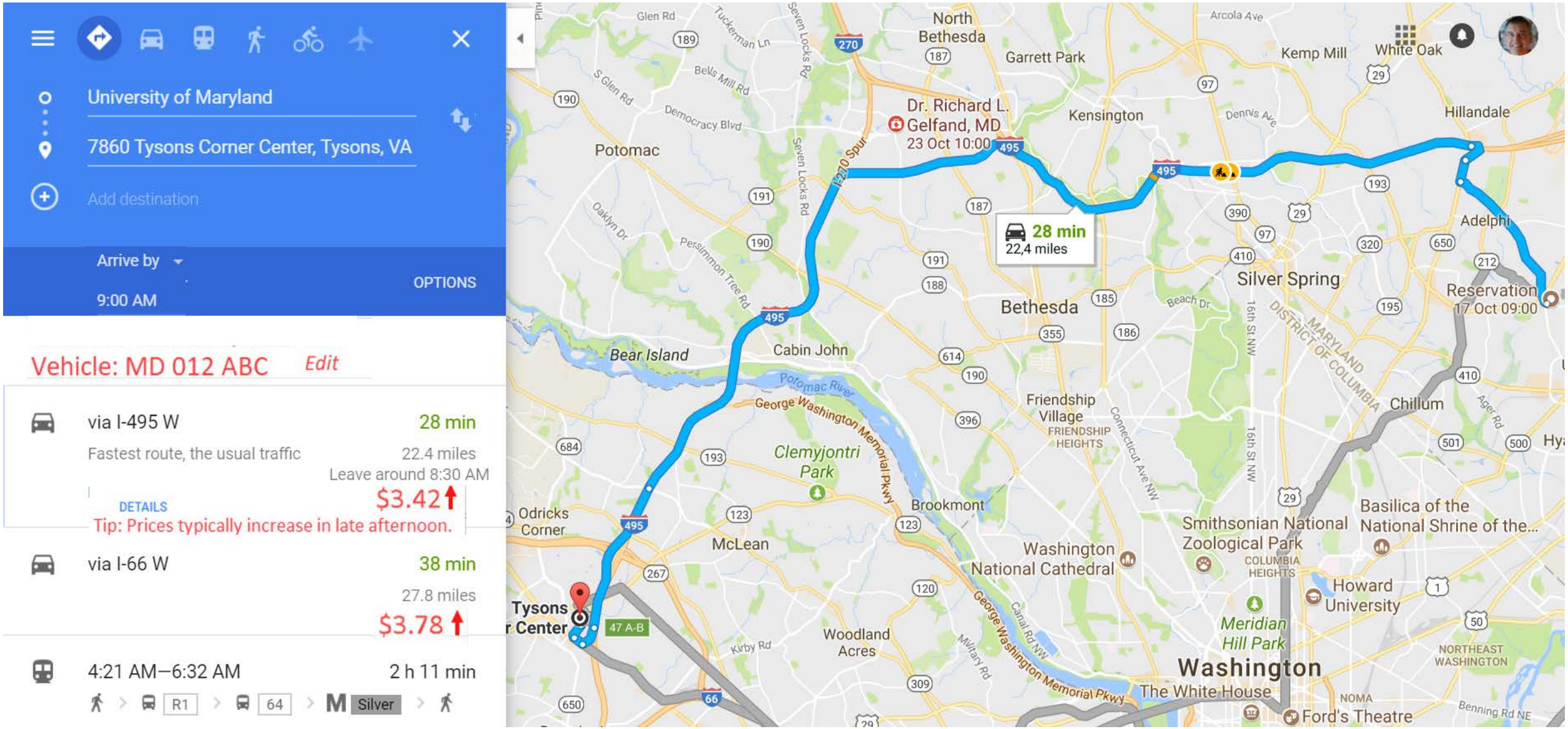
via I-66 W — typically 1 h - 1 h 50 min

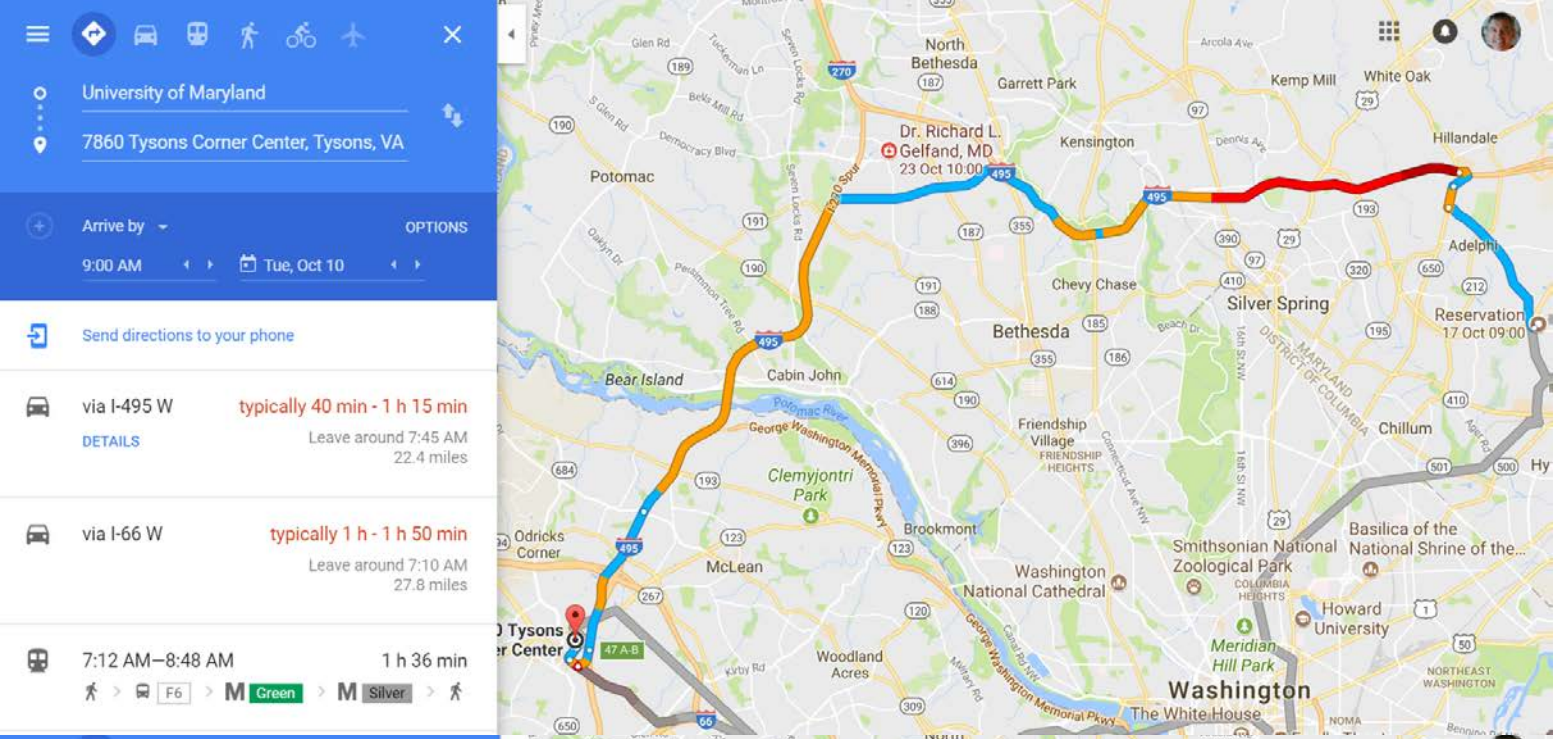
Leave around 7:10 AM
27.8 miles

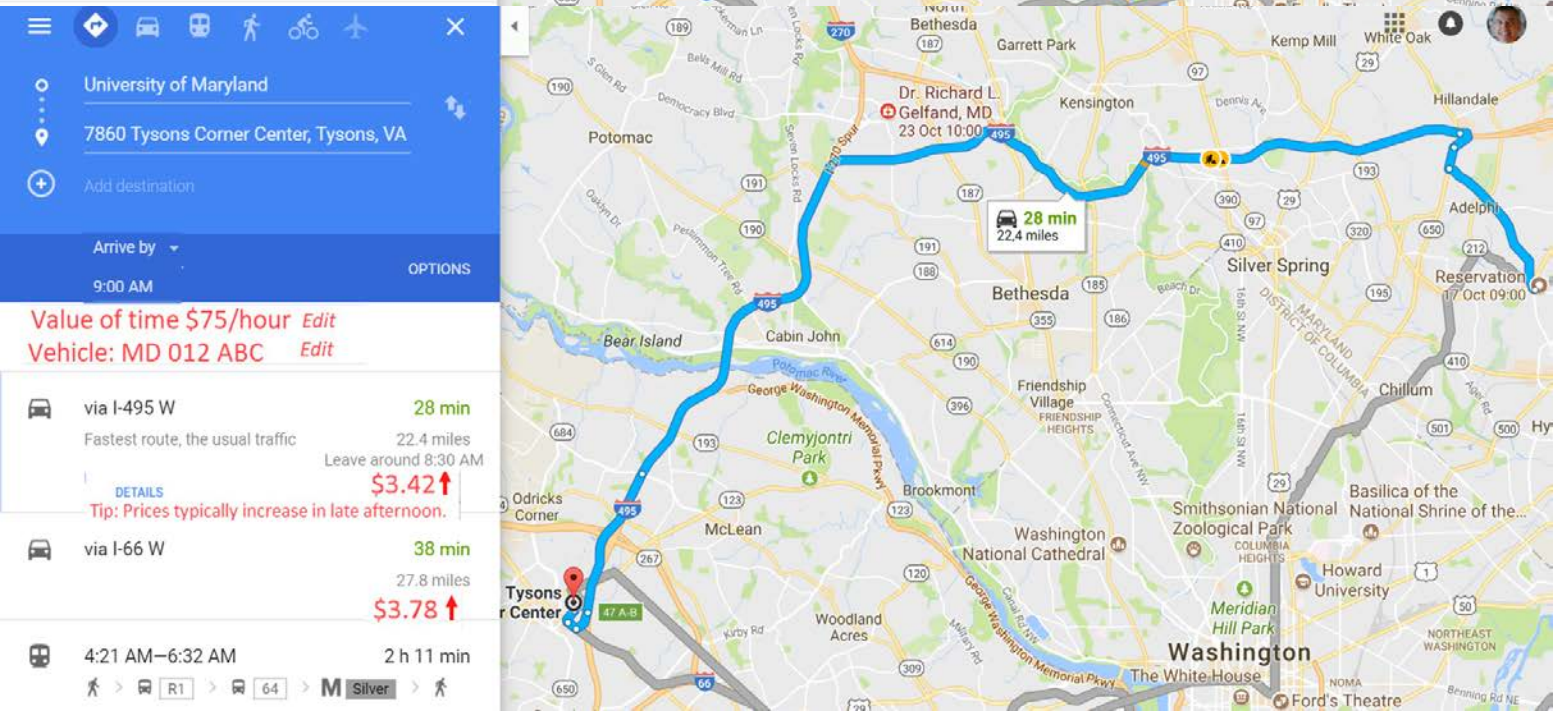
7:12 AM—8:48 AM — 1 h 36 min

F6 › Green › Silver




University of Maryland
7860 Tysons Corner Center, Tysons, VA
Add destination
Arrive by
9:00 AM
OPTIONS
Vehicle: MD 012 ABC
Edit
via I-495 W
28 min
Fastest route, the usual traffic
22.4 miles
Leave around 8:30 AM
$3.42
DETAILS
Tip: Prices typically increase in late afternoon.
via I-66 W
38 min
27.8 miles
$3.78
4:21 AM—6:32 AM
2 h 11 min
R1
64
Silver
28 min
22,4 miles
Dr. Richard L. Gelfand, MD
23 Oct 10:00
Reservation
17 Oct 09:00
North Bethesda
Garrett Park
Kensington
Potomac
Bethesda
Silver Spring
Adelphi
Hillandale
Kemp Mill
White Oak
Cabin John
Bear Island
Clemyjontri Park
Brookmont
Friendship Village
Chillum
Odricks Corner
McLean
Tysons Corner
Woodland Acres
Washington National Cathedral
Smithsonian National Zoological Park
Basilica of the National Shrine of the...
Howard University
Meridian Hill Park
Washington
The White House
Ford's Theatre
NOMA
NORTHEAST WASHINGTON
Potomac River
George Washington Memorial Pkwy
I-270 Spur
Seven Locks Rd
Democracy Blvd
Bells Mill Rd
Tuckerman Ln
Glen Rd
S Glen Rd
Oaklyn Dr
Persimmon Tree Rd
Beach Dr
16th St NW
Connecticut Ave NW
Military Rd
Canal Rd NW
Kirby Rd
Dennis Ave
Arcola Ave
Ager Rd
Benning Rd NE
MARYLAND
DISTRICT OF COLUMBIA
COLUMBIA HEIGHTS
FRIENDSHIP HEIGHTS

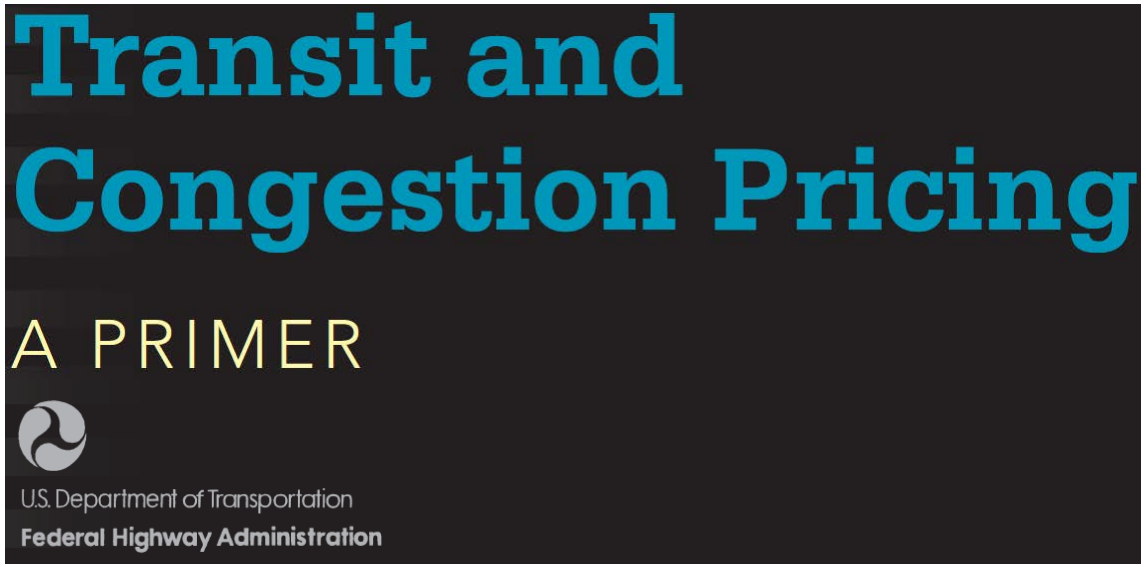




Today's transport is mostly free, but comes at the cost of uncertain congestion delays

Our **market** puts a price on transport, but avoids delays (and improves throughput)

Both regimes cause some drivers to leave early, late, or not at all,
or to switch roads …



"The number of vehicles that get through per hour can drop by as much as 50 percent when severe congestion sets in. At high-traffic levels, the freeway is kept in this condition of 'collapse' for several hours after the rush of commuters has stopped."

Behavioral research questions

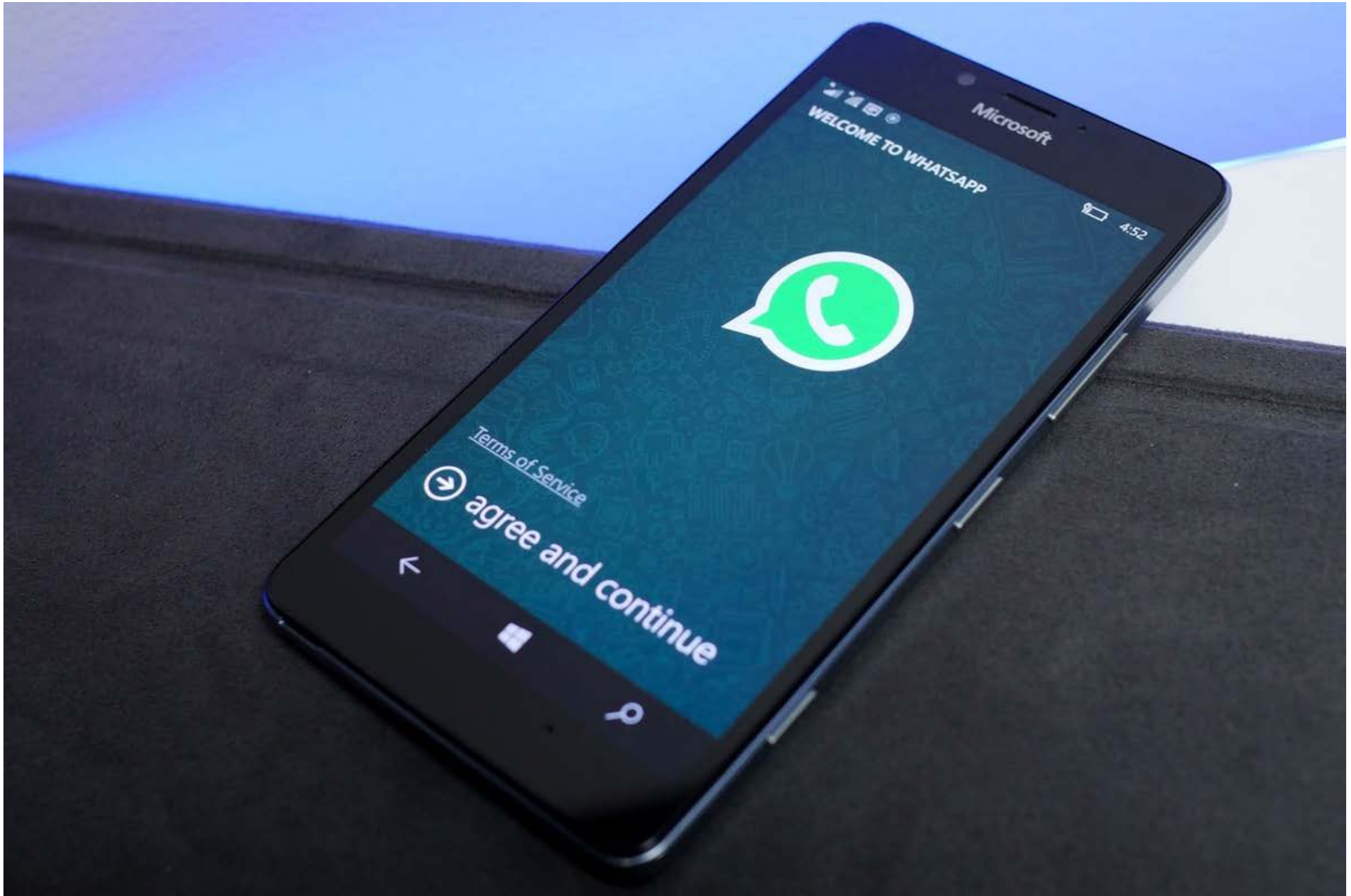
Do *individuals* pick departure time and roads rationally?

- Simple competitive markets are known to work well (e.g., Smith 1962), but few lab studies look at behavior along different dimensions in competitive markets, such as time and space
- Economic traffic experiments focus on simple, repeated coordination games without prices (Selten et al. 2007, Chmura/Pitz 2004a,b, Schneider/Weimann 2004, Rapoport et al. 2004), or include a simple toll (Gabuthy et al. 2006, Hartman 2009); almost all experiments induce identical driver preferences, inelastic demand and deterministic supply (but see Lopez 2017)

Are *markets* more efficient and acceptable than the status quo?

Which market design effectively promotes participation & acceptance?

Privacy


Microsoft
WELCOME TO WHATSAPP
4:52
Terms of Service
agree and continue

Equity

vs

Market objectives

- Efficiency
- Transparency
- Simplicity
- Fairness

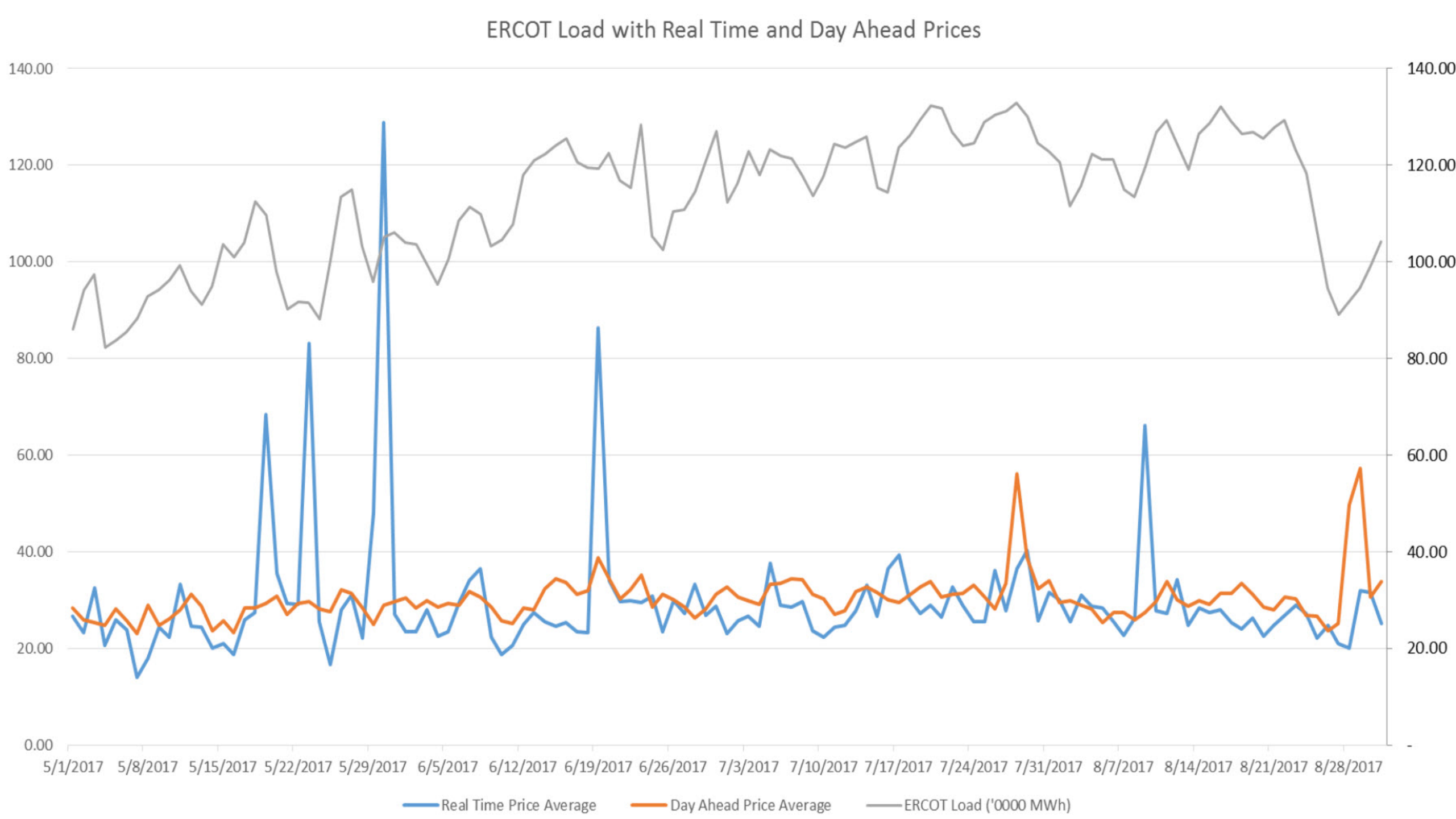
Draw on best practice from existing time and locational markets

Key market principle: open access

- Transport network is open to all
- Nondiscriminatory terms
- Network capacity cannot be withheld

$\Rightarrow$Efficient congestion pricing

- Basis for restructured electricity markets in US, Europe, …


ERCOT Load with Real Time and Day Ahead Prices
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
-
5/1/2017
5/8/2017
5/15/2017
5/22/2017
5/29/2017
6/5/2017
6/12/2017
6/19/2017
6/26/2017
7/3/2017
7/10/2017
7/17/2017
7/24/2017
7/31/2017
8/7/2017
8/14/2017
8/21/2017
8/28/2017
Real Time Price Average
Day Ahead Price Average
ERCOT Load ('0000 MWh)

STP-to-Whitepoint 345-kV transmission structures

Tatton Substation

Transmission Damage

- **52 inches** of rainfall in southeast Texas
- Harvey made landfall **multiple times**
  - **Category 4** near Port Aransas, Texas
  - **Tropical storm** in Cameron, Louisiana
- More than **42,000** lightning strikes
- Record number of tornado warnings in southeast Texas

Players

- Independent System Operator (ISO)
  - Runs market
- ISO or service providers
  - Develop user app for expression of demand
  - Aggregate user demand
  - Guide user (scheduling/routing)
  - Establish user plans and settle payment
- Users
  - Provide fundamental demand for road use

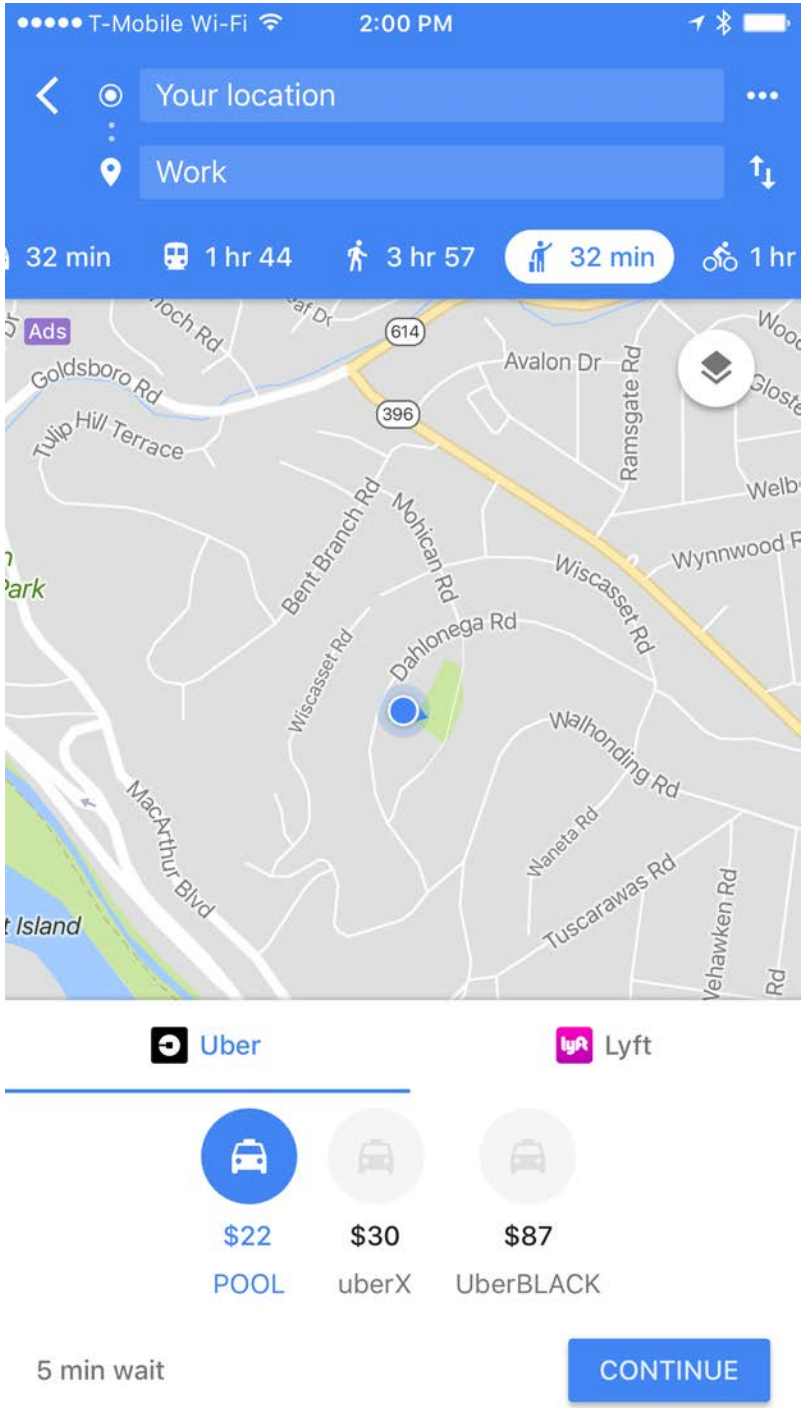
Product design

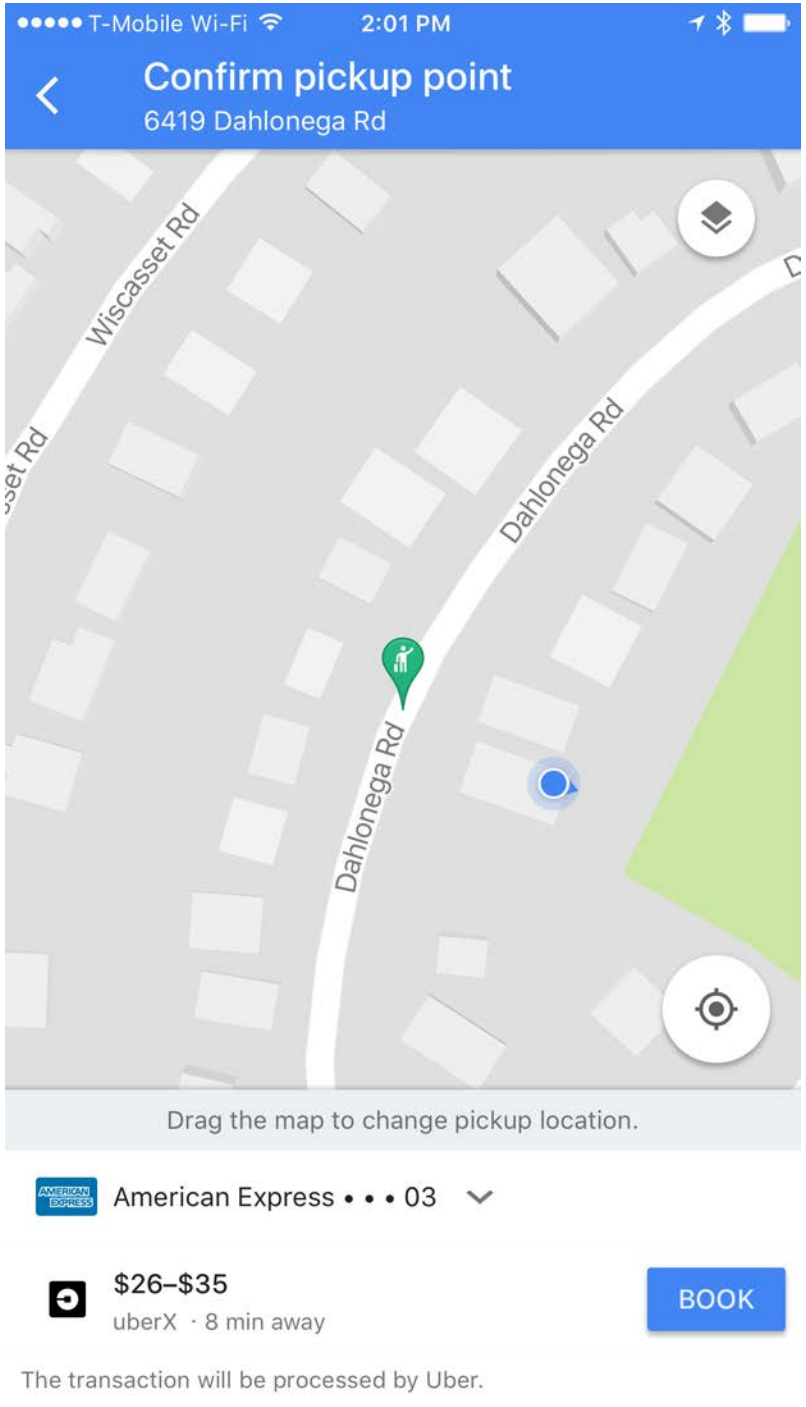
- Slot on congested road segment at particular time (e.g. 10 minute time interval)

Important features of setting

- Limited number of congested road segments
  - Bridges, tunnels, and other bottlenecks
- Congested segments are highly predictable
- Demand *does* respond to price even close to real time
  - Time shifters: shift transport to less congested time
  - Route shifters: shift route to less congested route
  - Mode shifters: take train, bus, bike or work-at-home

How today’s apps would change


T-Mobile Wi-Fi
2:00 PM
Your location
Work
32 min
1 hr 44
3 hr 57
32 min
1 hr
Ads
Goldsboro Rd
Tulip Hill Terrace
Avalon Dr
Ramsgate Rd
Bent Branch Rd
Mohican Rd
Wiscasset Rd
Dahlonega Rd
Wynnwood
Walhonding Rd
Naneta Rd
Tuscarawas Rd
MacArthur Blvd
Island
614
396
Uber
Lyft
$22
POOL
$30
uberX
$87
UberBLACK
5 min wait
CONTINUE


T-Mobile Wi-Fi
2:01 PM
Confirm pickup point
6419 Dahlonega Rd
Wiscasset Rd
Dahlonega Rd
Drag the map to change pickup location.
American Express • • • 03
$26–$35
uberX · 8 min away
BOOK
The transaction will be processed by Uber.

Sequence of auctions

- Multiple opportunities to trade
  - Reduces risk of service provider
  - Facilitates planning of service provider
  - Provides price transparency
  - Mitigates market power

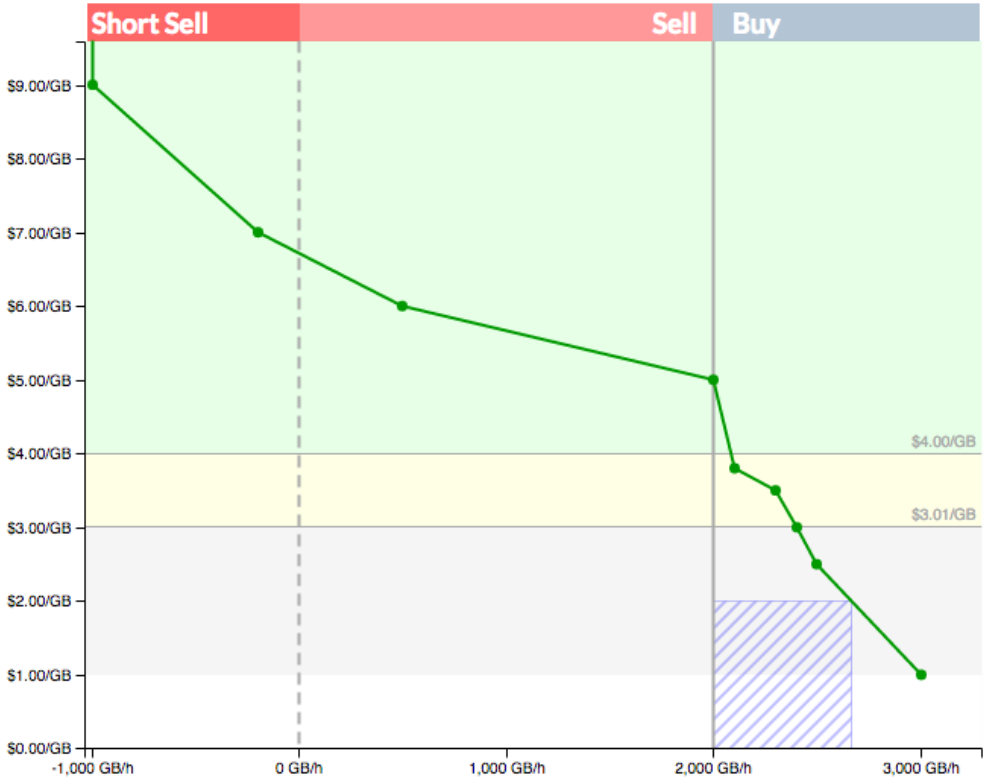
Sample demand for bidder

Manhattan (peak) monthly

Manhattan (Peak) At $ | /GB hold GB/h Add Cancel

Your Forward Position: 2,000.000 GB/h **Published Maximum Supply:** 10,000.000 GB/h

	Price	Quantity	Change in Quantity	Commitment (180 hours)
Future Rounds				
	$9.00/GB	-1,000.000 GB/h	-3,000.000 GB/h	-$4,860,000
	$7.00/GB	-200.000 GB/h	-2,200.000 GB/h	-$2,772,000
	$6.00/GB	500.000 GB/h	-1,500.000 GB/h	-$1,620,000
	$5.00/GB	2,000.000 GB/h	0.000 GB/h	$0
Current Round				
	$4.00/GB	***2,083.333 GB/h***	***83.333 GB/h***	***$60,000***
	$3.80/GB	2,100.000 GB/h	100.000 GB/h	$68,400
	$3.50/GB	2,300.000 GB/h	300.000 GB/h	$189,000
Past Rounds				
	$3.00/GB	***2,400.000 GB/h***	***400.000 GB/h***	***$216,000***
	$2.50/GB	2,500.000 GB/h	500.000 GB/h	$225,000
	$2.00/GB	***2,666.667 GB/h***	***666.667 GB/h***	***$240,000***
Price Floor				
	$1.00/GB	3,000.000 GB/h	1,000.000 GB/h	$180,000



ForwardTransport, Inc. … *lock in prices and drive with confidence!*

Type	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Daily trip	●	●	●	●	●		

Round trip	One way	Multi-stop	Vehicle
Home		Work	MD 0123

Begin	End
Wed, 1 Nov 2017	Thu, 30 Nov 2017

	Depart	Arrive
Home to Work	8:00am	8:28am
Work to Home	5:00pm	5:28pm

Cost per trip

$ 3.76

Add to Cart

Alternatives and Price Change

Later		Earlier	
+10 min	$ 0.45	-10 min	$ 0.32
+20 min	$ (0.20)	-20 min	$ (0.33)
+30 min	$ (0.46)	-30 min	$ (0.59)
+40 min	$ (1.11)	-40 min	$ (1.24)
+50 min	$ (1.21)	-50 min	$ (1.34)
+60 min	$ (1.40)	-60 min	$ (1.53)
+70 min	$ (1.56)	-70 min	$ (1.69)
+80 min	$ (1.82)	-80 min	$ (1.95)
+90 min	$ (2.01)	-90 min	$ (2.14)

Investment

- Transparent pricing provides detailed information for network investment
- Revenues provide essential funds for investment

Conclusion

- Assures transport network is used efficiently
- Eliminates congestion through scheduling/routing and congestion pricing
- Transparent pricing motivates network investment and provides much needed funds