Item #4

Initial analysis of AirSage O-D cellular data for the TPB modeled area

Presentation to the Travel Forecasting Subcommittee
July 18, 2014

Ronald Milone, COG/TPB staff
National Capital Region Transportation Planning Board (TPB)
Metropolitan Washington Council of Governments (COG)

airsage
The power of where and when

Exogenous travel demand inputs were reviewed with the TFS in March

- These are special demand markets that are not modeled but rather are prepared as model inputs

- The existing exogenous markets include:
  - External and through trips (autos, trucks)
  - Visitor/tourist, taxi and school trips (auto driver)
  - Airport passenger trips (auto driver)

- About 12% of the regional trips loaded to network

Issues identified

- Surveys associated with exogenous travel are:
  - Difficult to conduct regularly
  - Expensive
  - Prone to low response rates

- Much of the observed data supporting exogenous travel markets are dated:
  - The last auto external roadside survey: 1994
  - The last visitor/tourist, taxi, school surveys: 1968

A considered solution: AirSage (AS)

- Atlanta based software development and applications firm
- Has refined the technology for converting cellular data from cell phones, tablets, and other devices into aggregate O-D flows
- Has exclusive agreement with major cellular providers to access signal data from mobile devices
- Hold 2 patents for converting cellular data into O/D data

TPB staff aggressively pursued this opportunity during June

AirSage Technology

- AirSage's Wireless Signal Extraction (WiSE) extracts data from wireless carrier networks in real time
- The signal data stream is securely captured; anonymity is ensured
- Includes access to over 100 million mobile devices
- Multiple stages of analysis are performed to monitor the location and movement of the mobile devices
- The analysis results in a highly sampled archive of O/D movements throughout the U.S.

The data is increasingly being used for planning and marketing purposes

AS Methodology: Five Steps

1. Device location processing: Time stamped locations coordinates from devices are continuously accessed and recorded. Trip movements identified by time & distance criteria.
   - Trip O-Ds must be at least 1.2-1.5 km (0.75-0.93 miles) in distance
   - If device movement stops for 5+ minutes, a destination is assumed

2. Activity pattern analysis/point generation: Assumed home and work locations are imputed based on 4 to 6 weeks of recorded data. Statistical *clustering* algorithms are used to identify home, work and intermediate stop locations.
   - Home location: where mobile user clusters between 9PM-6AM
   - Work location: where mobile user clusters between 9AM-5PM
   - "Trip Legs" are formulated around home & work locations to arrive at a daily trip pattern

AS Methodology: Five steps (cont'd)

3. Population Synthesis: Trip movements from the observed sample devices are expanded based on the ratio of observed devices to the 2010 Census population at the *Census tract level*

4. Trip Analysis: Trips are distinguished by traveler type, trip purpose, time of day and day of week

5. Data Aggregation and Packaging: Trip O/Ds are summarized by geography, typically zip codes or TAZs

O-D matrix features

- Geography
- Time frame (selected days, weeks, months, year)
- Resident class (resident vs. visitor)
- Trip purpose
- Time of day
- Day of week
- External analysis
  - the use of “external shed” areas to study external and through trips

TPB staff developments in June

- TPB staff engaged AirSage in a series of teleconferences
- TPB staff's data needs were articulated
- AirSage data product options were discussed
- Staff contacted previous AS data users in others areas
- Contract terms were negotiated
- Sole source purchase justification was drawn up
- A final cost figure was negotiated ($200K)
- Data product was delivered on June 28

AirSage data applications

- Immediate purpose:
  - To examine external and through trip patterns
  - To examine visitor/tourist trip patterns
- Additional uses
  - Special generator analysis of various locations
  - Checks on the regional model

Specifications of AirSage data purchase

Parameter	Specification	Notes / Details
# Zones	3722	Zone level
Month(s) Analyzed	1	April 2014 (a representative month)
External TAZs included	Yes	External areas to be included
Day of Week Type	Avg. Weekdays	Tuesday, Wednesday, Thursday only
Time of Day Periods	Early AM / 12mid -6AM	Time periods consistent with model conventions
	AM Peak/ 6-9AM	
	Midday/ 9AM- 3PM	
	PM Peak / 3PM-7PM	
	Night/ 7PM-12mid	

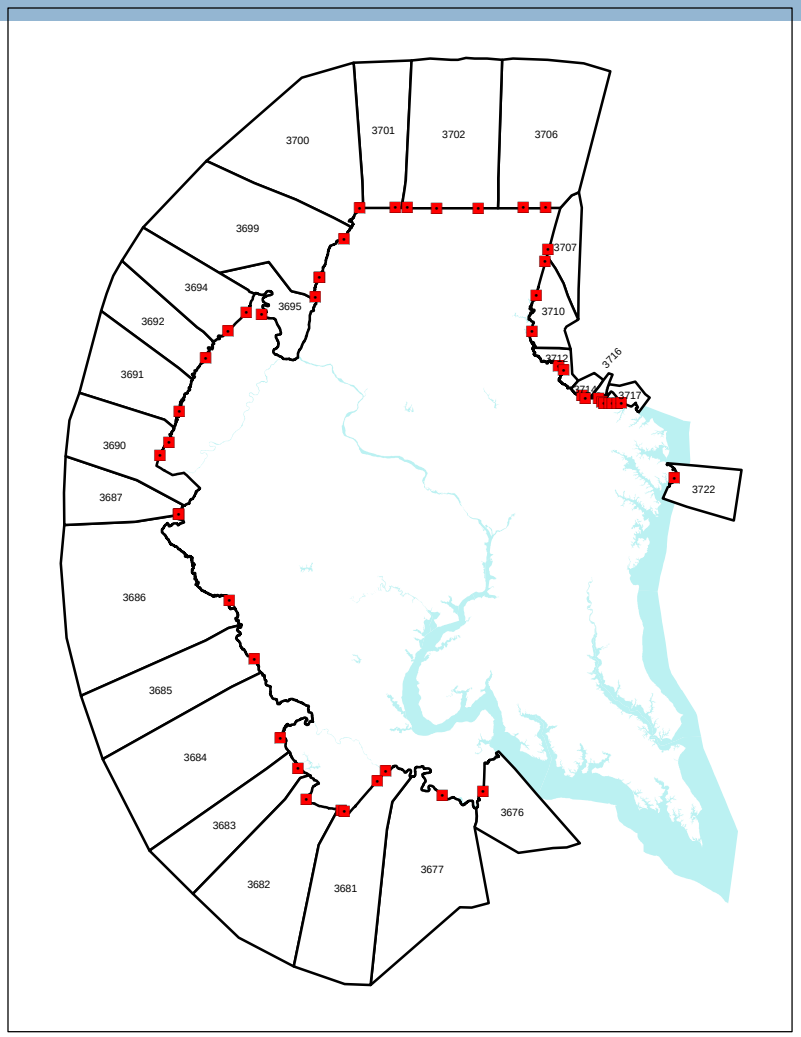
Specifications, continued

Parameter	Specification	Notes / Details
Trip Purpose Attributes	9	H-W, H-O, H-H, W-H, W-O, W-W, O-H, O-W, O-O
Resident Class Attributes	6	Resident Worker –Resident that works in study area
		Home Worker – Resident, similar day/night clusters
		Inbound Commuter- Non-Resident, works inside study area
		Outbound Commuter – Resident, works outside study area
		Short Term Visitor – Non-resident, in area 2 weeks or less
		Long Term Visitor- Non-resident, in area > 2 weeks

Level of AirSage O/D geography:

- Internal geography – Existing internal TAZs of the 3722 TAZ system (3675 TAZs)
- External geography- AirSage requires external stations to be expressed as external TAZs or "capture areas".
  - TPB staff developed 26 external TAZs
    - Developed around the existing 47 external stations
    - Numbered 3676 to 3722 (with gaps)

External TAZ Sheds used in AS analysis



- Devices moving outside of the study area are “detected” in these external sheds so that E-I, I-E and E-E trips are developed
- AirSage detects E-E trip movements that are irrelevant to the TPB study area, such as:
  - Trips within external sheds
  - E-E trips that likely do not pass through the modeled region
- These types of trips **must be removed**

Cell phone movements vs. modeled trips

- We assume AS trips are equivalent to person trips in any mode (walk, bike, autos, trucks, buses, rail, skateboard,…)
- AS trips may not be “linked” as they would be for modeling
- AS flows are not distinguished by vehicle class
- AS flows are not distinguished by mode
- O/D locations are *inferred* based on statistical location clusters of device, not *reported* purposes
- Some trips will not be germane to the scale of regional travel model (dog-walking around the neighborhood, for example)

Direct comparisons with modeled outputs will therefore likely be a challenge.

Data delivered: Two text files

- Daily File
  - Total O/D records: 4,695,825
  - Initial weighted trips: 23,075,600 (“raw” file total)
  - Final weighted trips: 21,304,800 (irrelevant E-E trips removed)
- Period File
  - Total O/D records: 6,710,419
  - Total weighted trips: 23,075,500
- Variables:
  - O-Zone/ D-Zone/ Start date/ End date, Aggregation Code/ Subscriber class/ Trip purpose/ Time of Day/ Count

Cross-tabulations of AirSage Trips are under examination

Observations:

- 86% of I-I trips made by internal residents working in the region or working at home (reasonable)
- 6% of all I-I travel made by long-term visitors (reasonable)
- 28% of I-I trips are HBW trips (appears too high)

Weighted Trips by Subscriber Class and Movement Type					
	I-I	I-E	E-I	E-E	Total
Res_Work:	13,001,829	71,342	69,061	190	13,142,422
Hom_Work:	5,239,680	52,880	51,920	126	5,344,606
Inb_Comm:	17,778	32,485	33,006	456	83,725
Oub_Comm:	860,869	61,138	59,663	355	982,025
Sht_Visi:	246,696	99,292	100,731	16,247	462,966
Lng_Visi:	1,205,325	41,568	39,648	2,555	1,289,096
SUM	20,572,177	358,705	354,029	19,929	21,304,840

Weighted Trips by Purpose and Movement Type					
	I-I	I-E	E-I	E-E	Total
H_H:	3,879,416	5,050	4,875	11	3,889,352
H_O:	3,082,152	92,662	57,847	2,204	3,234,865
H_W:	3,086,652	43,514	26,368	1,641	3,158,175
W_W:	423,593	537	483	0	424,613
W_H:	2,584,718	21,975	37,736	1,453	2,645,882
W_O:	793,376	17,025	10,973	392	821,766
O_O:	2,915,326	113,196	107,333	11,727	3,147,582
O_H:	3,462,345	58,531	101,810	2,266	3,624,952
O_W:	344,599	6,215	6,604	235	357,653
SUM	20,572,177	358,705	354,029	19,929	21,304,840

Initial comparison with regional model

Comparison of trips by movement type: AirSage vs. TPB Modeled Person Trips

(Modeled trips include motorized and non-motorized modes)

	Internal	External	Through	Total
2014 AirSage Trips	20,572,177	712,734	19,929	21,304,840
2015 TPB Modeled Person Trips	21,601,746	1,434,969	45,321	23,082,036
Ratio: AirSage to TPB Model	0.95	0.50	0.44	0.92

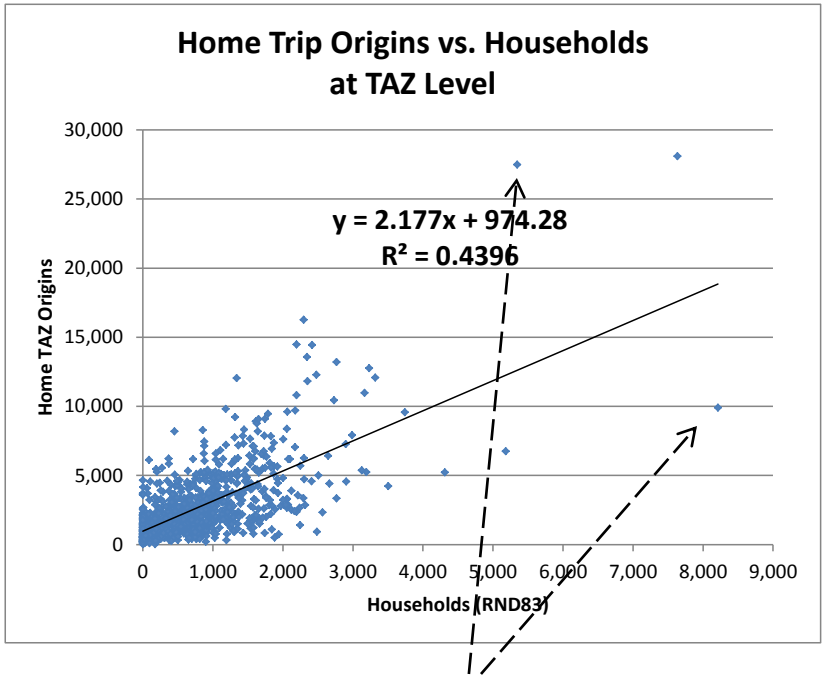
Comparison of trip purpose distribution: AirSage vs. TPB Modeled Person Trips

(Internal / motorized and non-motorized)

	AirSage	TPB Model
HBW	27.6%	19.2%
HBS/O	50.7%	53.7%
NHW	7.6%	10.0%
NHO	14.2%	17.2%
All	100.0%	100.0%

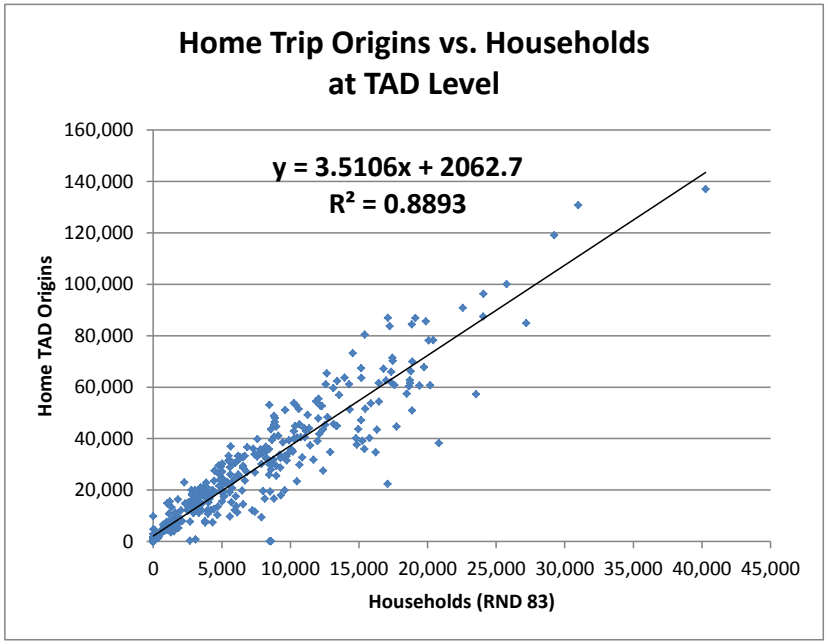
Correlation between AS "home" trip origins and Round 8.3 HHs

Zone Level of Analysis



Leisure World (Mont. Co.)

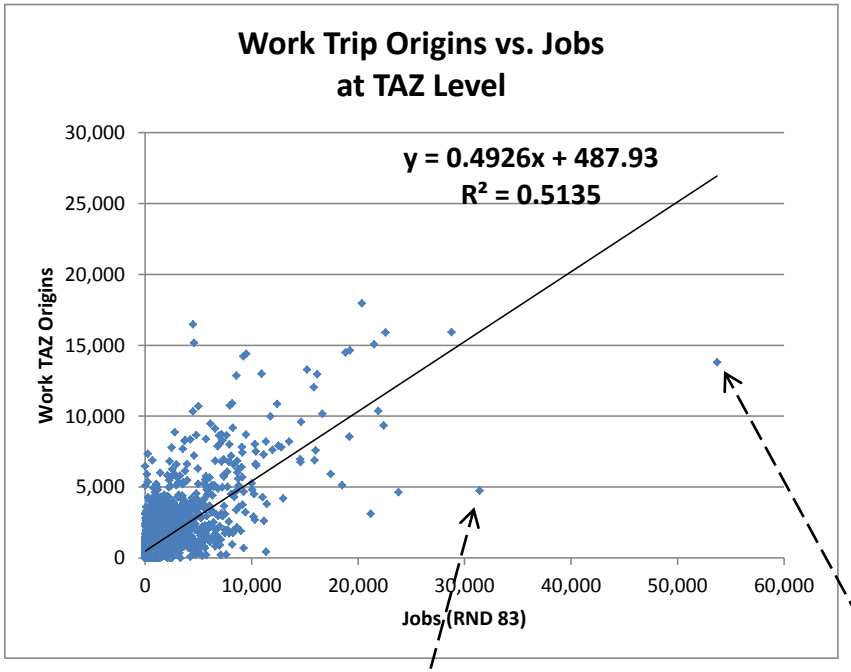
District Level of Analysis



Observation: Location "noise" in the travel data is reduced at higher levels of aggregation

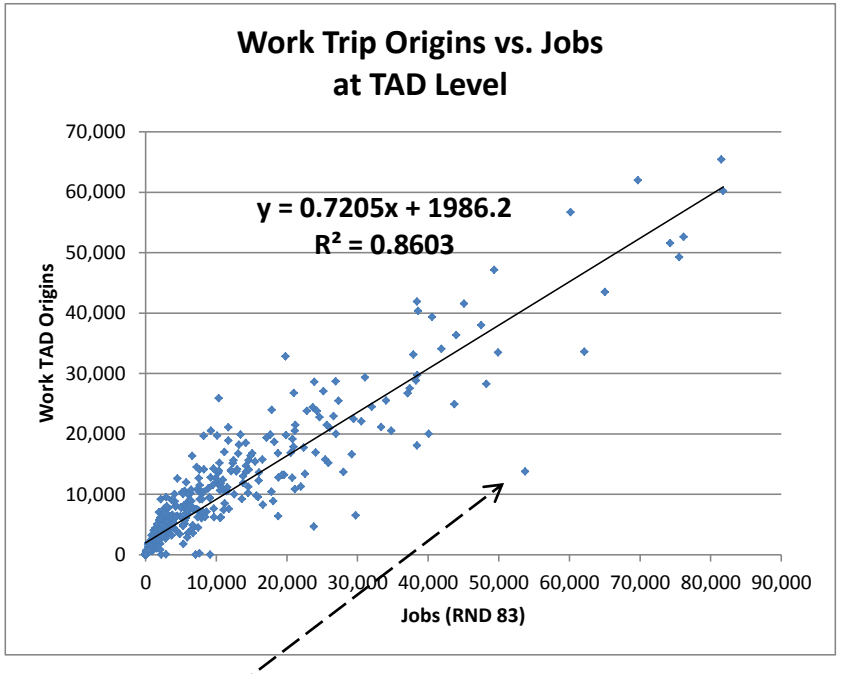
Correlation between AS "work" trip origins and Round 8.3 jobs

Zone Level of Analysis



Washington Hospital Center (DC)

District Level of Analysis



Fort Meade (Anne Arundel Co.)

Crossings at External Stations

Initial analysis of AS trips with highway person counts

AirSage Station	Facility (or Facilities)	TPBTAZ	AirSage Trips (a)	Vehicle counts (2012)	(assuming 1.3 auto occ.)	Difference (a - c)	Ratio (a / c)
3676	VA 3	3676	17,539	5,000	6,500	11,039	2.70
3677	US 301	3677	12,457	11,000	14,300	-1,843	0.87
3681	US 17, VA 2, I-95, and US 1	3678-3681	65,169	104,600	135,980	-70,811	0.48
3682	VA 208/606	3682	21,134	3,500	4,550	16,584	4.64
3683	VA 612	3683	6,350	3,500	4,550	1,800	1.40
3684	VA 3	3684	36,217	23,400	30,420	5,797	1.19
3685	US 15/29	3685	32,601	26,600	34,580	-1,979	0.94
3686	US 211	3686	14,444	16,000	20,800	-6,356	0.69
3687	I-66 and VA 55	3687-3688	24,395	38,500	50,050	-25,655	0.49
3690	US 340 and US 17/50	3689-3690	22,247	28,400	36,920	-14,673	0.60
3691	VA 7	3691	28,556	26,500	34,450	-5,894	0.83
3692	WVA 51	3692	993	8,500	11,050	-10,057	0.09
3694	WVA 9 and WVA 45	3693-3694	59	26,800	34,840	-34,781	0.00
3695	WVA 480 (MD 34)	3695	6,804	5,800	7,540	-736	0.90
3699	US 40 (Alt), I-70, US 40, and MD 77	3696-3699	855	85,400	111,020	-110,165	0.01
3700	MD 550	3700	11,913	2,000	2,600	9,313	4.58
3701	PA 16/MD 140	3701	7,292	8,700	11,310	-4,018	0.64
3702	US 15, MD 194, and MD 97	3702-3704	28,972	35,100	45,630	-16,658	0.63
3706	MD 30 and MD 86	3705-3706	37,523	18,800	24,440	13,083	1.54
3707	MD 88/833	3707	9,956	4,400	5,720	4,236	1.74
3710	MD 30, MD 140 /91, and MD 26	3708-3710	86,066	95,000	123,500	-37,434	0.70
3712	I-70 East and US 40 East/MD144	3711-3712	66,211	157,300	204,490	-138,279	0.32
3714	I-95 and US 1/I-195	3713-3714	92,689	274,600	356,980	-264,291	0.26
3716	MD-295 /BWPkwy and MD 170	3715-3716	52,356	112,800	146,640	-94,284	0.36
3717	MD 648, MD 3/I-97, MD 2, and MD 710	3717-3721	30,006	263,700	342,810	-312,804	0.09
3722	US 50/301	3722	39,783	73,400	95,420	-55,637	0.42
			752,585	1,459,300	**1,897,090**	**-1,144,505**	**0.40**

Potomac River Crossings
Initial analysis of AS trips with highway/Metrorail person trips

(a)	2014 AirSage Person Trips		1,817,100	
(b)	2013 Highway Person& 2012 Metrorail Trips		1,507,870	
(a) - (b)			309,230	
(a)/(b)			1.21	
2013 Ground Counts: on bridges (MD 340 to MD 301): 973,900				
2013 Computed hwy. psn. trips (1.30 avg. occ. Assumed):				1,266,070
Metrorail trips from the 2012 Metrorail Survey:				241,800
2012/2013 Total Highway Metrorail Person Trips Counts:				1,507,870

Note: AirSage data likely includes bike/walk trips and commuter rail trips that are not accounted for in the above comparison.

What's next?

- Analysis of AirSage data is underway and is being investigated as a basis for updating exogenous trip inputs
- Direct comparisons with modeled data are problematic, given that AirSage trips reflect cellular movements, not linked trips
- There is clearly geographic noise associated with AirSage data at the TAZ level based on a comparison of trip origins and land activity
- Initial analysis indicates some inconsistencies between AirSage trips and observed data.
  - AirSage person trips at the external cordon are **lower** than the traffic counts would suggest.
  - AirSage person trips crossing the Potomac River are **higher** than the observed highway and transit counts would suggest
- Staff will convey these findings to AirSage for their input
- Staff analysis will continue