S06 Update

7th SHRP 2 Safety Research Symposium

Washington, DC

July 12, 2012

VTTI
Driving Transportation with Technology

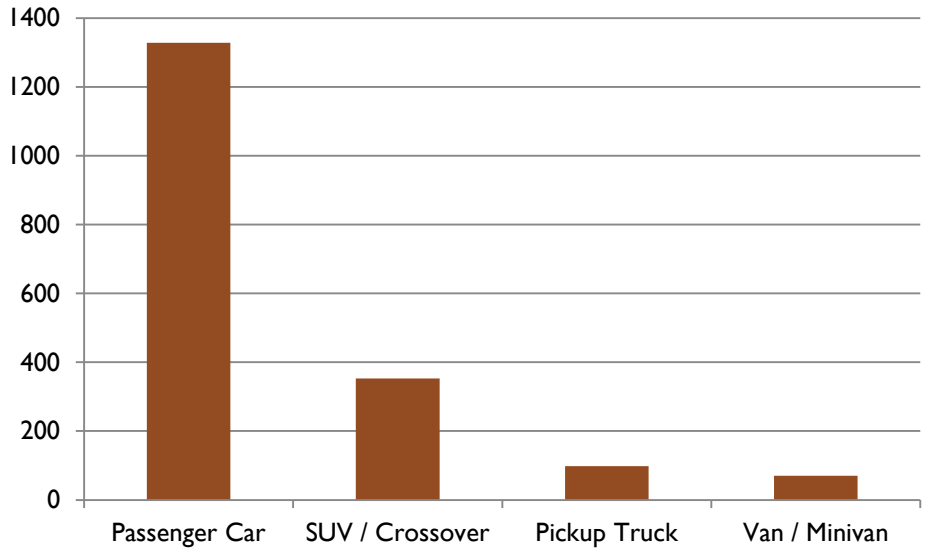
Executive Overview: Original NDS Targets

- Largest Naturalistic Driving Study Ever Undertaken
  - ca. 3,100 primary drivers, all age/gender groups.
  - ca. 3,900 data years; 2.5M trip files
  - 2 years of data collection
    - some participants for 1 year, some for 2 years
  - Vehicle Types: All light vehicles including
    - Passenger Cars
    - Minivans
    - SUVs
    - Pickup Trucks
    - Advanced technology vehicles
  - Six data collection sites

- Integration w/ detailed roadway information (S04)
- Data useful for next generation of researchers

Executive Overview: Progress Update

	Operational Sites	Vehicles on Road	Completed Participants	Data Drives Ingested	Trip Files in DB2 Database
Sum '10	0	0	0	0	0
Sum '11	6	600	0	200	60,792
Sum '12	6	1,844	278	4,564	383,775



VTTI Driving Transportation with Technology

S06 Role: Current Focus Areas

- **Study Oversight**
  - Reporting & Provision of Study Planning Support to TRB
  - Inventory Management & Reconciliation
- **Data Quality Assurance**
  - Installation Guidance
  - Shakedown Process
  - Periodic DAS Health Checks
  - Manual Quality Inspection of Ingested Data
  - Issue Management & Support
- **S07 Support**
  - Ongoing Provisioning of DAS Kits & Parts
  - RMA Triage and Manufacturer Warranty Service
  - Leading weekly S06-S07-TRB Project Meetings
  - Leading Quarterly Installer Meetings
- **Cell Data Study**
- **IRB Issue Management**
- **Dashboard Website**

Study Oversight

Recruiting Summary

Total Recruitment by Age Group								
origin		IN	PA	NC	WA	FL	NY	Total
Cold Calls	16-17	-	1	3	1	1	-	6
	18-20	5	1	6	4	4	9	29
	21-25	10	13	13	11	17	19	83
	26-35	45	47	93	56	86	94	421
	36-50	109	138	284	191	222	283	1,227
	51-65	168	208	284	243	297	370	1,570
	66-75	68	86	142	190	213	191	890
	76+	29	37	42	91	111	88	398
	Total	**434**	**531**	**867**	**787**	**951**	**1,054**	**4,624**
Calls In	16-17	4	2	19	-	15	4	44
	18-20	15	8	30	-	60	14	127
	21-25	8	3	24	5	56	17	113
	26-35	13	3	38	10	38	31	133
	36-50	16	6	65	21	85	61	254
	51-65	15	12	77	15	132	74	325
	66-75	5	8	60	7	104	45	229
	76+	9	2	46	2	44	23	126
	Total	**85**	**44**	**359**	**60**	**534**	**269**	**1,351**
WBST	16-17	22	18	104	98	167	55	464
	18-20	61	53	93	209	415	201	1,032
	21-25	112	62	168	332	294	294	1,262
	26-35	52	82	215	434	282	457	1,522
	36-50	69	97	312	455	285	366	1,584
	51-65	54	94	166	363	263	240	1,180
	66-75	23	32	83	90	135	59	422
	76+	9	15	48	53	56	17	198
	Invalid BD	-	-	2	3	5	2	12
	Total	**402**	**453**	**1,191**	**2,037**	**1,902**	**1,691**	**7,676**
Total		**921**	**1,028**	**2,417**	**2,884**	**3,387**	**3,014**	**13,651**

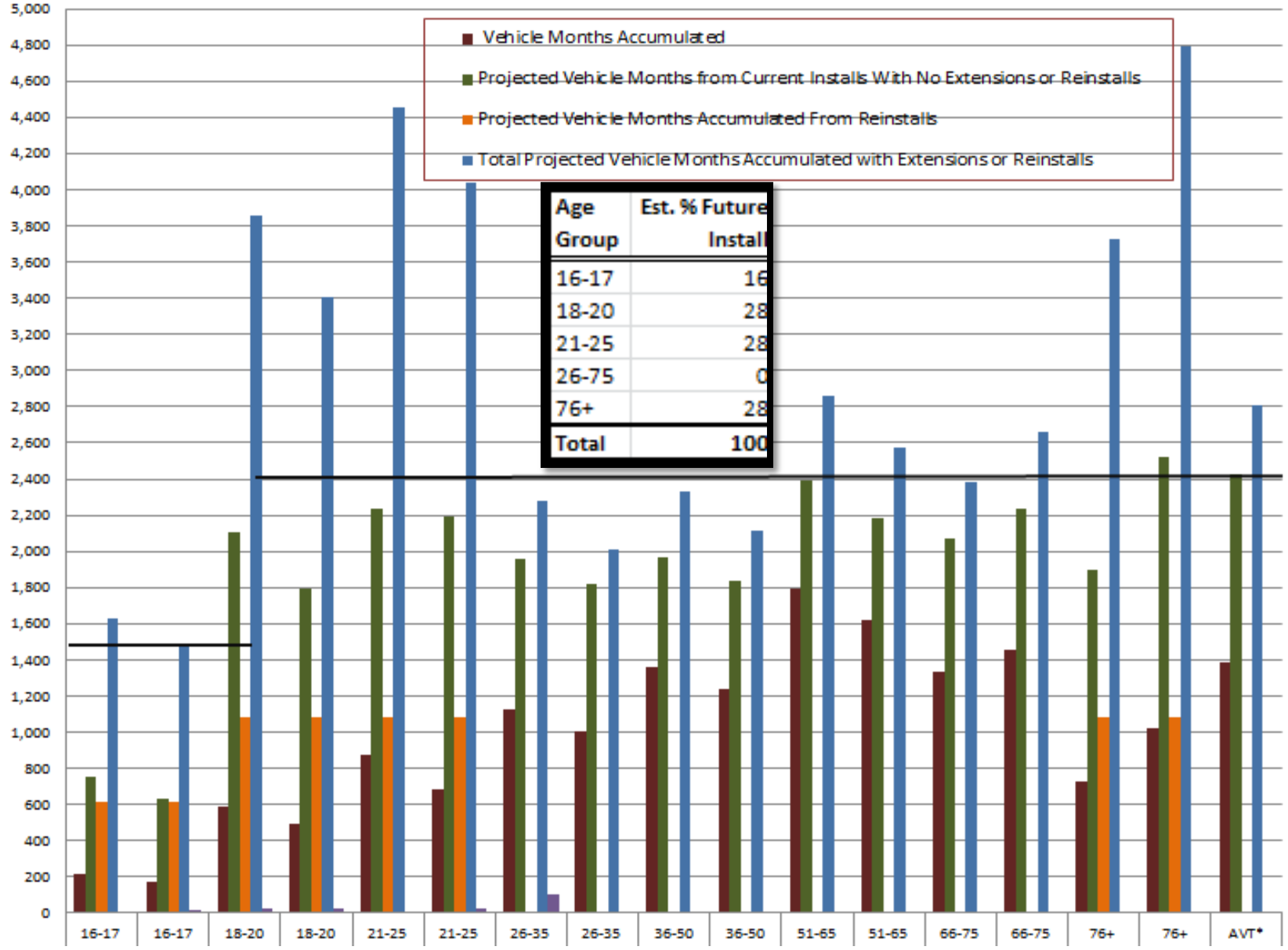
Inventory Tracking

- Protocol – Boxes scanned as they arrive / depart a location
- Parts scanned as they are installed / de-installed
- Scan data populate the database

Database snapshot: NextGens as of 7/6/2012

Status	NY	FL	WA	NC	IN	PA	VTTI	ACDI	Undetermined		
Installed Equipment	418	441	408	291	152	133	6	6	0		
Out for Repair	6	6	6	7	4	1	4	0	0		
Field Inventory	19	14	19	36	8	20	5	27	17		
Missing in Action	0	0	2	0	0	0	0	0	0		
Duplicate S/N	0	1	0	0	0	0	0	1	0		
Failed Manufacturing	0	0	0	0	0	0	0	4	8		
Passed Manufacturing	0	0	0	0	0	0	1	5	3		
	443	462	435	334	164	154	16	43	28	2,079	Total

Vehicle Months Collected & Projected



Age Group	Est. % Future Install
16-17	16
18-20	28
21-25	28
26-75	0
76+	28
Total	100

VTTI Driving Transportation with Technology

Data Quality Assurance

Data Intake and Quality Control Process: Health Check

- Health Check – periodic DAS self-assessment and transmission of results via cellular M2M communication to S06 server
- Health Check Data
  - **96%** of vehicles communicating
  - Main Benefits
    - Detecting non-communicating vehicles
    - Detecting near full data drives

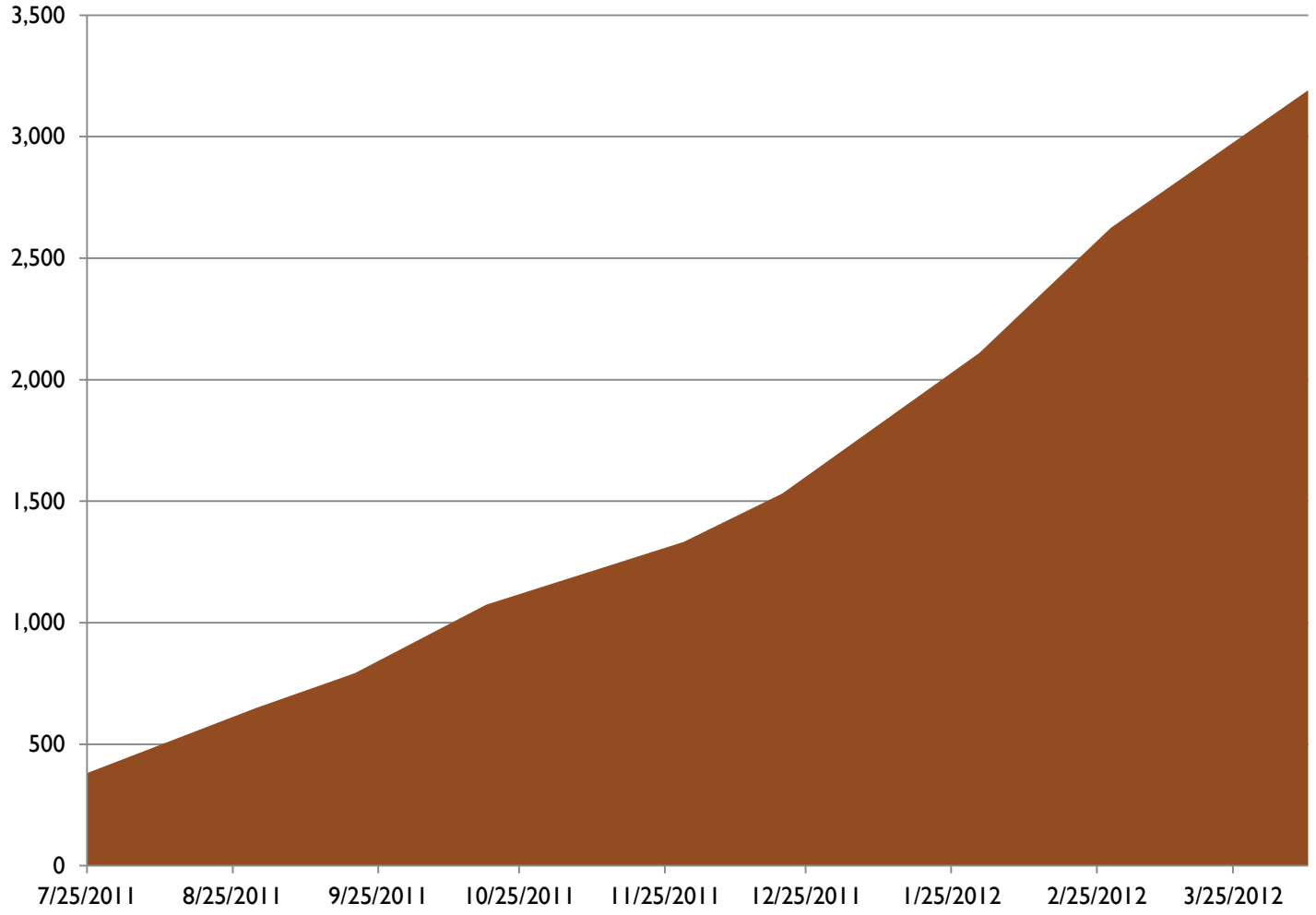
High Level Data Flow Diagram

Data Drive

S07 site
staging server
(one at each S07 site)

VTTI processing, storage &
database servers

Data Drives Ingested - Cumulative



Database Ingestion Checkpoint

- Data are brought into an S06 staging database
- Before data are transferred to a production (i.e., analysis) database, they undergo a quality control process
- "Questionable/Bad" data are stored on an "exceptions" database
  - Allows for recovery, as needed

Quality Control Checks

- Data Stream Detection – sensor problem or failure
- Boundary Exceptions –
  - Sensor malfunctions
  - Calibration problems
  - Unit conversion issue
- Variable Interdependencies - variables believed to have a problem based on their relationship to another variable

Example Quality Metrics (6/21/12)

	Data Item	Value	%
Manual Data QA	Files manually reviewed for QA	19,218	
	Vehicles reviewed using in-house data	1,326	93.84%
Data Ingestion	Sold State Drives (SSD) ingested	4,168	
	Number of sites using slurpers	6	100.00%
S06/S07 Coordination	Vehicles with SSD exceeding 70% full	251	13.13%
	SSD available for install at S07's	236	
	Vehicles with battery drainage issues	1	0.05%
	Vehicles installed last week	16	0.84%
	Vehicles scheduled for maintenance	390	20.40%
	Number of known crashes	49	
	Vehicles reached data transfer limit	0	0.00%
	Vehicles on the road	1,912	98.05%
	Primary Participants (Installed + Completed)	2,102	67.81%
	Vehicle Months Collected	17,081	

S07 Support

General Support

- Leading weekly meetings including S06, S07s, and TRB staff
- Leading quarterly installer meetings
- Support of participant management issues (e.g., crash video requests, payment requests, etc.)
- Project Wiki & Digest

SHRP2 STRATEGIC HIGHWAY RESEARCH PROGRAM

Wiki Digest- June 11, 2012

See What's New on The Wiki

Have We Got a Vehicle for You!

- We've updated the vehicle list! See more here: http://wiki.shrp2nds.us/index.php5/Main_Page . A new vehicle listing for installer use is now available at http://wiki.shrp2nds.us/index.php5/Installation_Related

Livin' On Easy Street

- S07 WA has shared templates for organizing multiple ESD files. Check them out here: http://wiki.shrp2nds.us/index.php5/Downloads or http://wiki.shrp2nds.us/index.php5/KLD_Crash_Templates

You Put the DAS Kit In, You Take the DAS Kit Out (Hey- That is Expensive- No Shaking It About!)

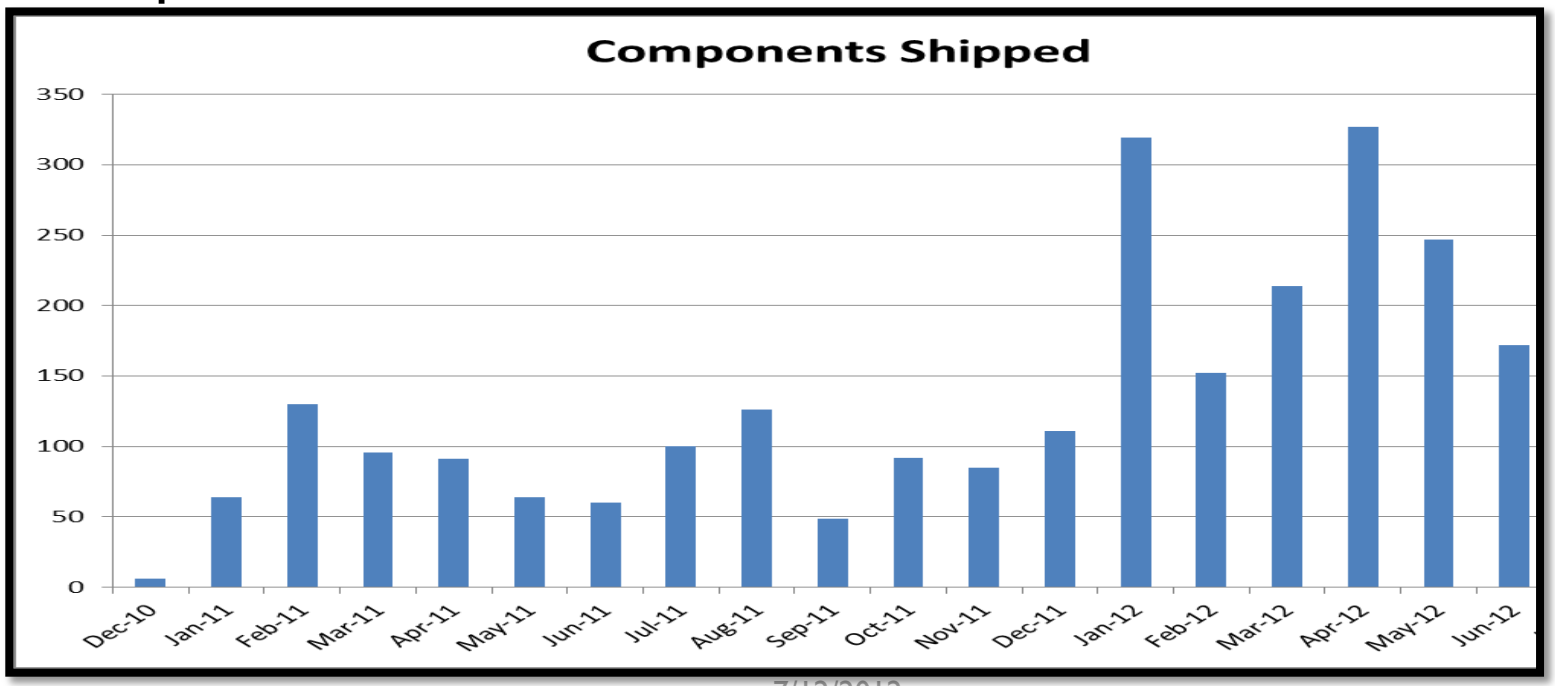
- Deinstalls are what it's all about! Read all the ins and outs in our deinstallation guide: http://wiki.shrp2nds.us/index.php5/Installation_Related

The Turn of The Screw

- NC has enjoyed success with this radar screw: http://wiki.shrp2nds.us/index.php5/Radar_Screw_Part_No.

RMA & Provisioning

- Managing DAS kit repair process
  - triage at VTTI → repair at VTTI or at ACDI, as appropriate
- Provisioning of parts to S07s based on a weekly update of:
  - Current and expected shelf inventory
  - Reported install & maintenance schedules

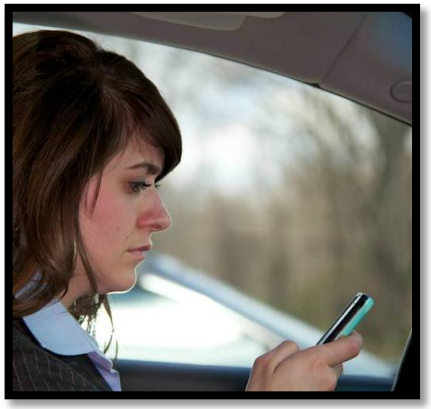


Issue Tracking Summary

	Queue	Tickets Created	Tickets Resolved /Closed
S06	Admin / General / Intake	1,067	877
	Data Ingestion	442	431
	ACN	2,060	1,577
	Automated Mismatch Detection	10,997	10,991
	DBA	527	454
	Development	146	120
	Hardware Repairs	436	296
	Automated Health Check	6,740	6,490
	Network Tech Support	607	591
	DAS Install / Maintenance Support	668	524
	Subtotal	**23,690**	**22,351**
S07	NY	707	583
	FL	791	636
	WA	500	402
	NC	497	454
	IN	269	234
	PA	252	196
	Subtotal	**3,016**	**2,505**
	Grand Total	**27,475**	**24,666**

Cellphone Usage Follow On Study

- VTTI working with key stakeholders to establish processes:
  - TRB & NHTSA
  - FCC & CTIA
  - Top 4 carriers (AT&T, Sprint, T-Mobile, Verizon)



- Establishing Study Documents
  - Informed Consent (between VTTI & Participants)
  - Permission to Access Records (between Participants & Carriers)
  - NDA / Memo of Understanding (between VTTI & Carriers)
- Have secured VT & NAS IRB protocol approvals
- Working with each carrier to establish secure information & data transmission practices

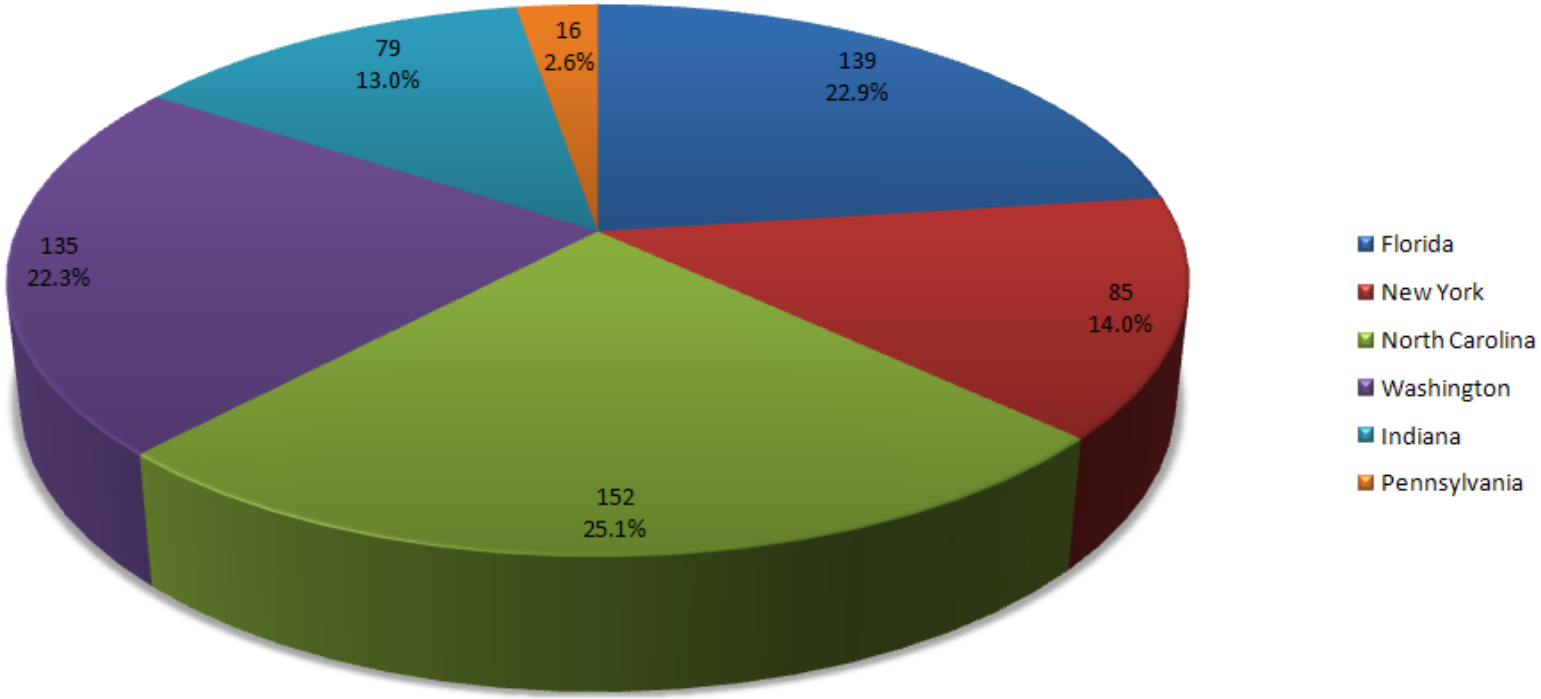
Institutional Review Board (IRB) & Related Overview

- 8 IRBs involved (6 for ongoing reviews)
  - NAS + VT + Each of the data collection contractors (S07s)
    - Two S07s have opted to rely on VT IRB
- Two submission packets:
  - Overall Study – 14 amendments, so far… (1 in process)
  - Recruitment – 14 amendments, so far… (1 in process)
- Why so many amendments? Continual efforts to:
  - Maximize collection of desired data & crashes (i.e., by extending certain participants)
  - Dealing with issues (e.g., video requests)

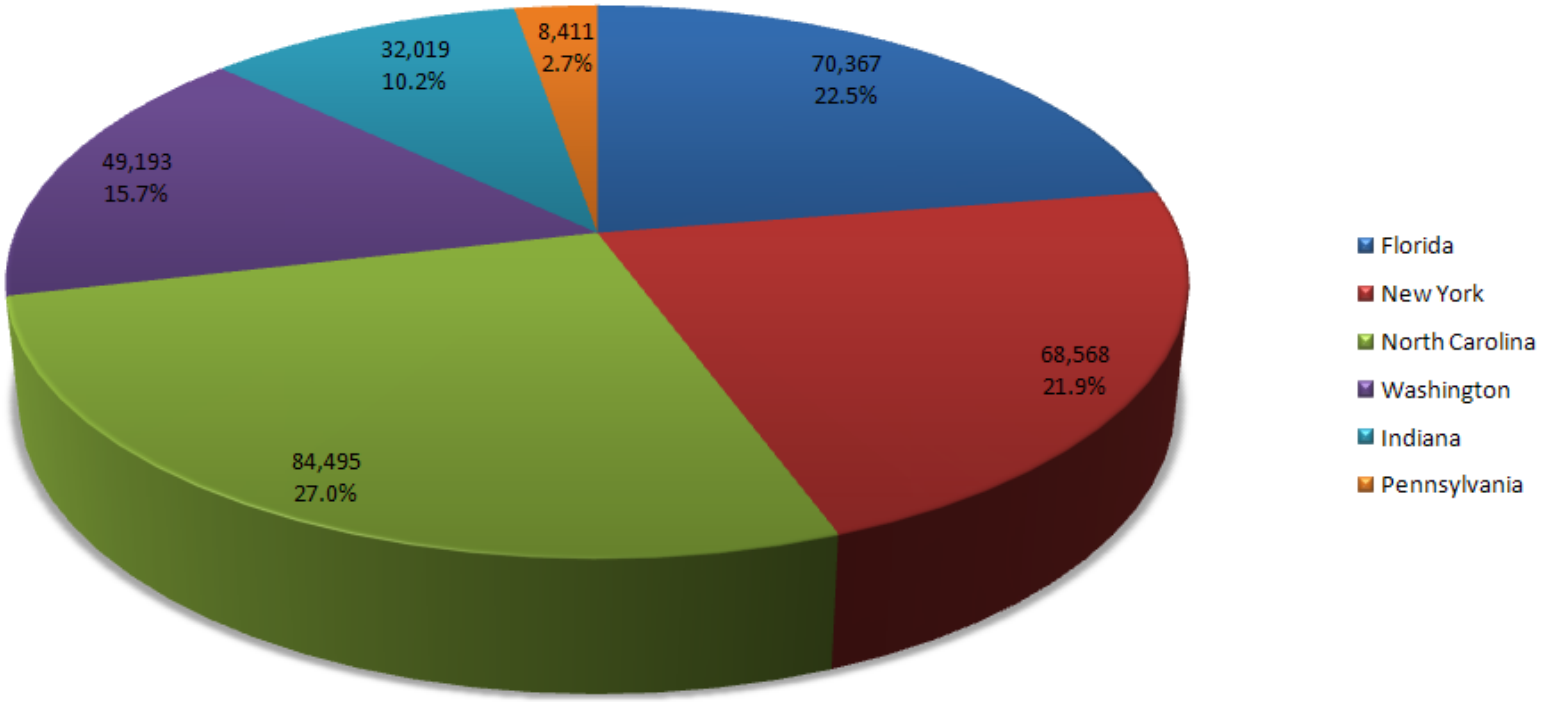
SHRP 2 NDS Dashboard Website

- Goal: Provide high level snapshot of key data for stakeholders and researchers for status & study planning
- Update
  1. Develop automated code to generate data summaries.
     - This is fairly within reach and underway.
  2. Develop website framework that would receive the output in a standard format (e.g., JPEGs).
  3. Establish a development website and confirm populating it is feasible each week without large labor effort
  4. Obtain feedback from key stakeholders
     - Incorporate improvements
  5. Migrate to production

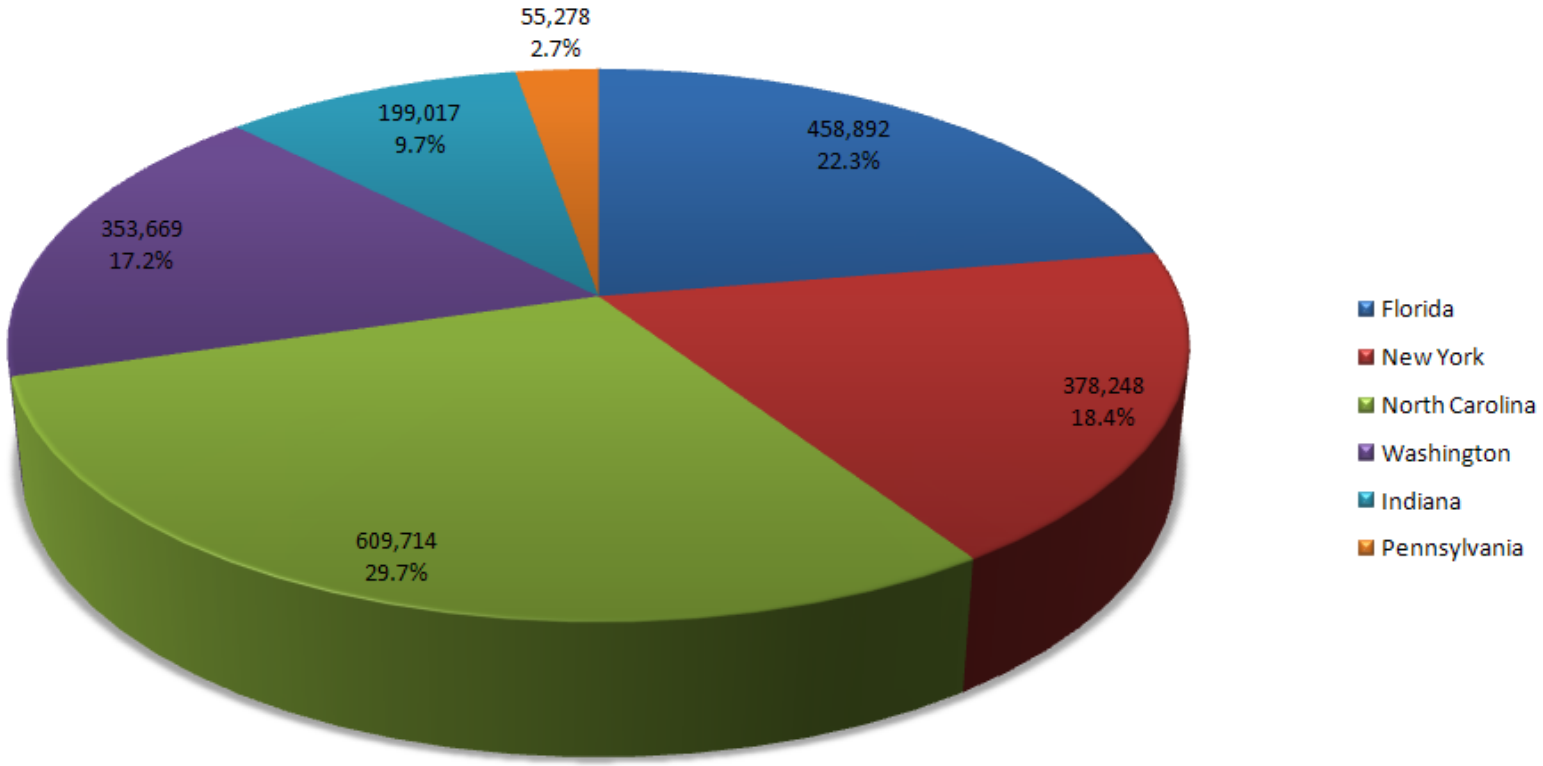
Number of Vehicles



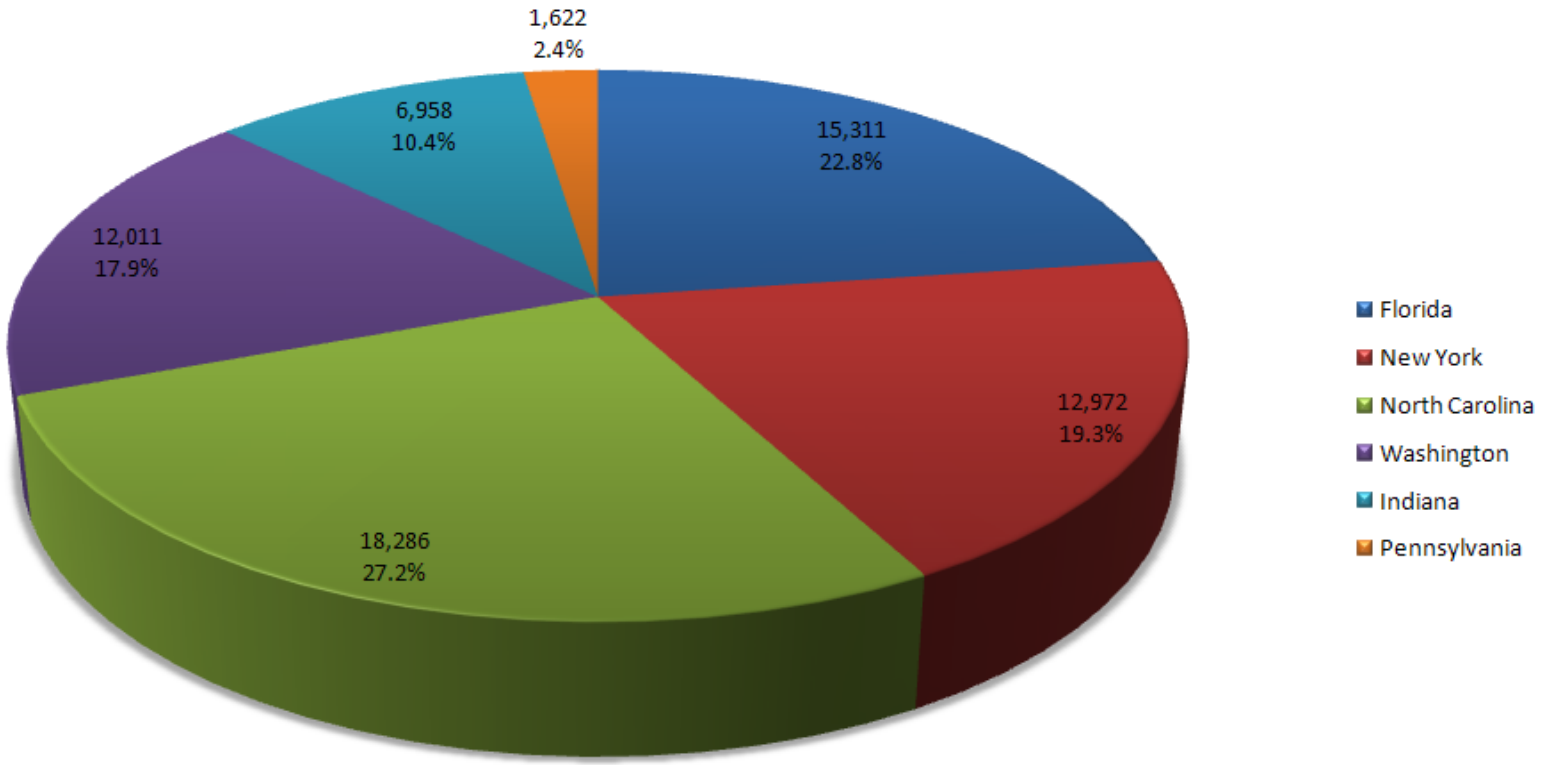
Number of Trips



Mileage

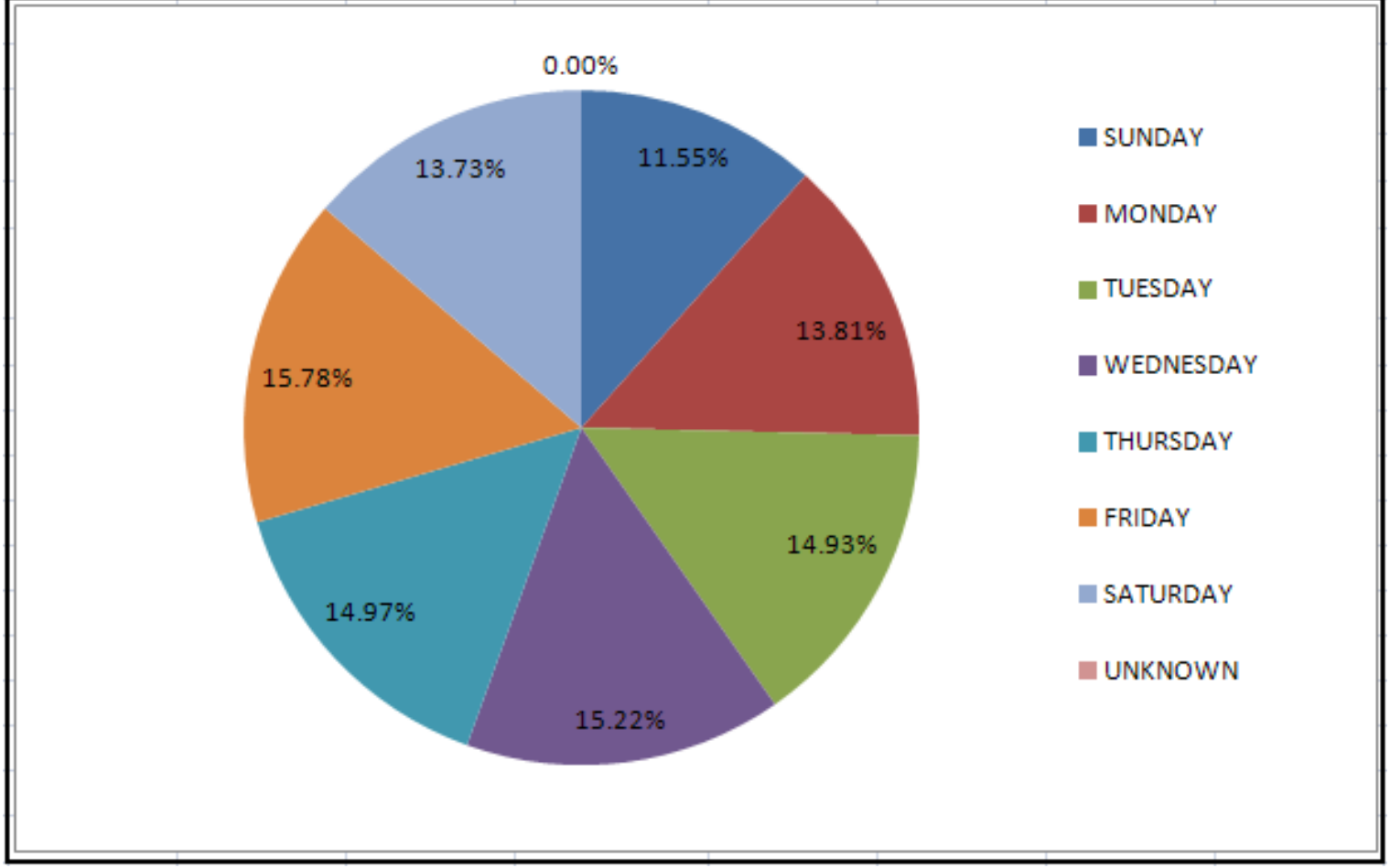

55,278
2.7%
199,017
9.7%
458,892
22.3%
353,669
17.2%
378,248
18.4%
609,714
29.7%
Florida
New York
North Carolina
Washington
Indiana
Pennsylvania

Total Time (Hrs)

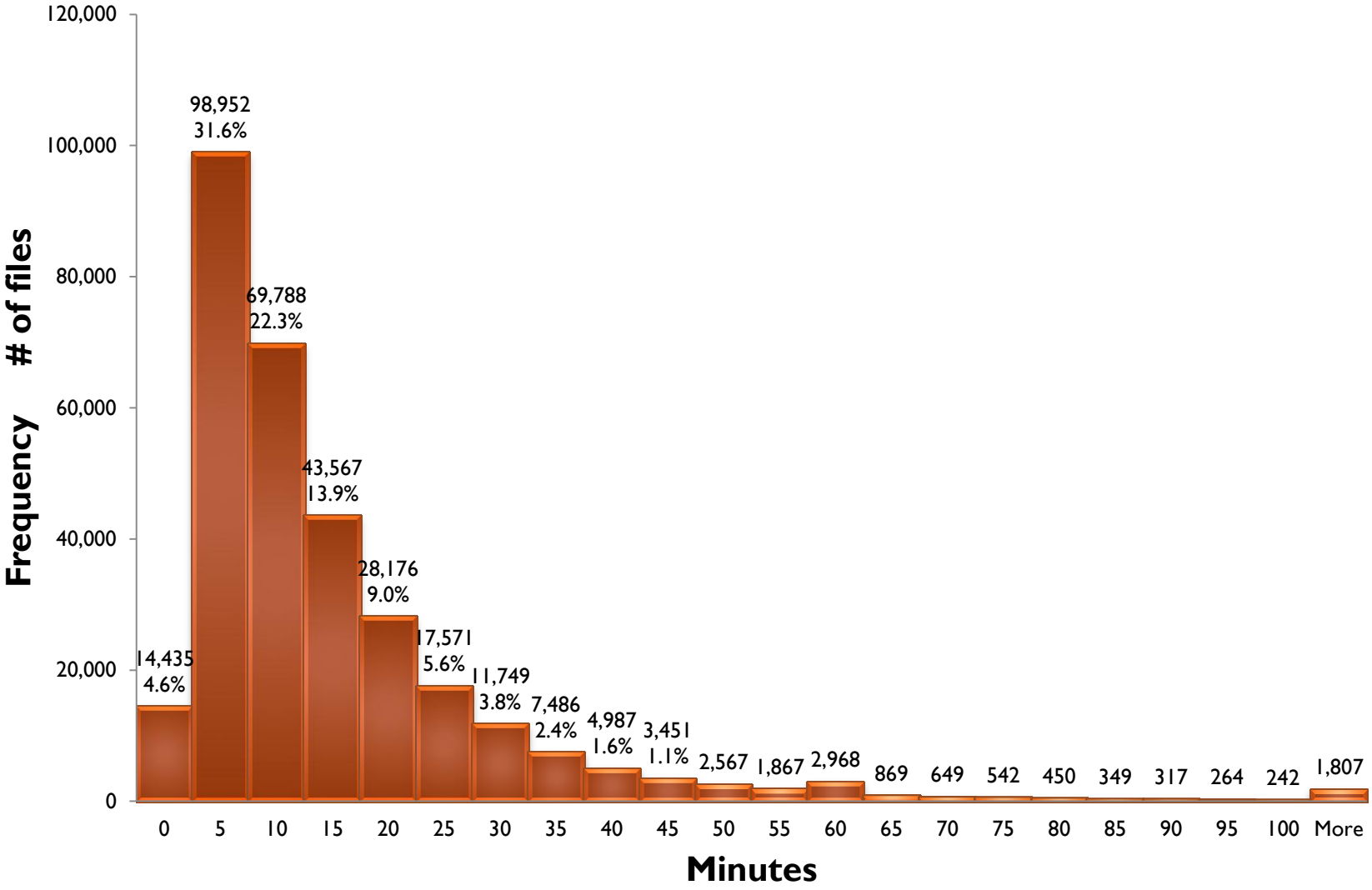


Trips Day of the Week

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	UNKNOWN
36172	43220	46738	47649	46878	49392	42997	7



Driving Time per Trip Histogram



What Questions Do You Have?

Supplemental Slides if/as Needed

Original Experimental Design

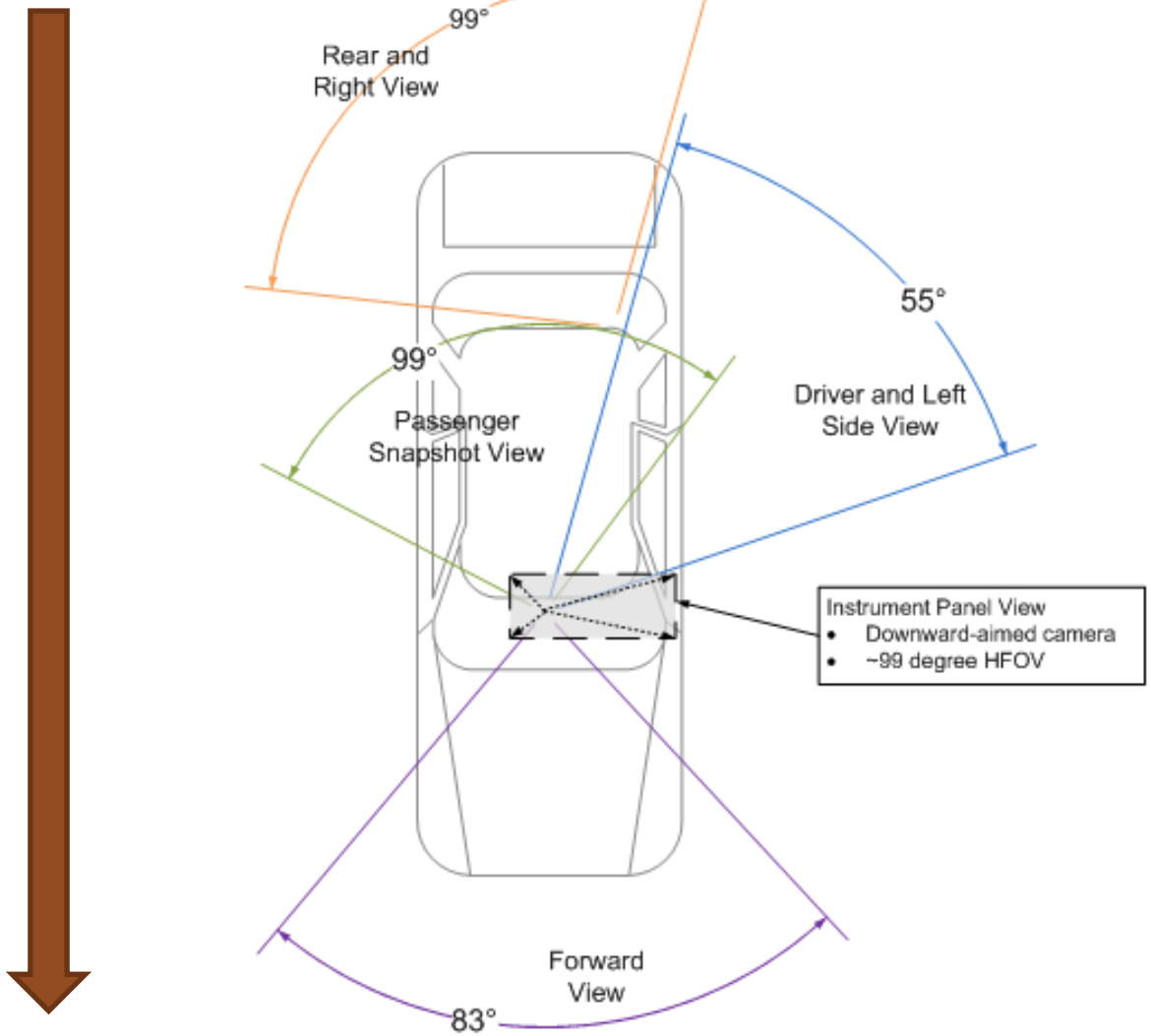
Gender: Age Range	Age Range Description	One Year	Two Years	DAS units	Primary Participants	Data-Years
M 16-17	Minor Teen	72	28	100	172	200
M 18-20	Adult Teen	72	28	100	172	200
M 21-25	Young Adult	72	28	100	172	200
M 26-35	Adult	72	28	100	172	200
M 36-50	Middle Adult	72	28	100	172	200
M 51-65	Mature Adult	72	28	100	172	200
M 66-75	Younger Older Driver	72	28	100	172	200
M 76+	Older Older Driver	72	28	100	172	200
F 16-17	Minor Teen	72	28	100	172	200
F 18-20	Adult Teen	72	28	100	172	200
F 21-25	Young Adult	72	28	100	172	200
F 26-35	Adult	72	28	100	172	200
F 36-50	Middle Adult	72	28	100	172	200
F 51-65	Mature Adult	72	28	100	172	200
F 66-75	Younger Older Driver	72	28	100	172	200
F 76+	Older Older Driver	72	28	100	172	200
Any	Advanced Vehicle Technology	0	350	350	350	700
Totals:	new totals	**1,152**	**798**	**1,950**	**3,102**	**3,900**
	original totals	**1,152**	**798**	**1,950**	**3,102**	**3,900**

Data Acquisition System Overview

DAS Data Captured

- Multiple Videos
- Machine Vision
  - Eyes Forward Monitor
  - Lane Tracker
- Accelerometer Data (3 axis)
- Rate Sensors (3 axis)
- GPS
  - Latitude, Longitude, Elevation, Time, Velocity
- Forward Radar
  - X and Y positions
  - X and Y Velocities
- Cellular M2M Communications
  - ACN, health checks, location notification
  - Remote upgrades
- Illuminance sensor
- Infrared illumination
- Passive alcohol sensor
- Incident push button
  - Audio (only on incident push button)
- Turn signals
- Vehicle network data
  - Accelerator
  - Brake pedal activation
  - ABS
  - Gear position
  - Steering wheel angle
  - Speed
  - Seat Belt Information
  - Airbag deployment

Camera Views



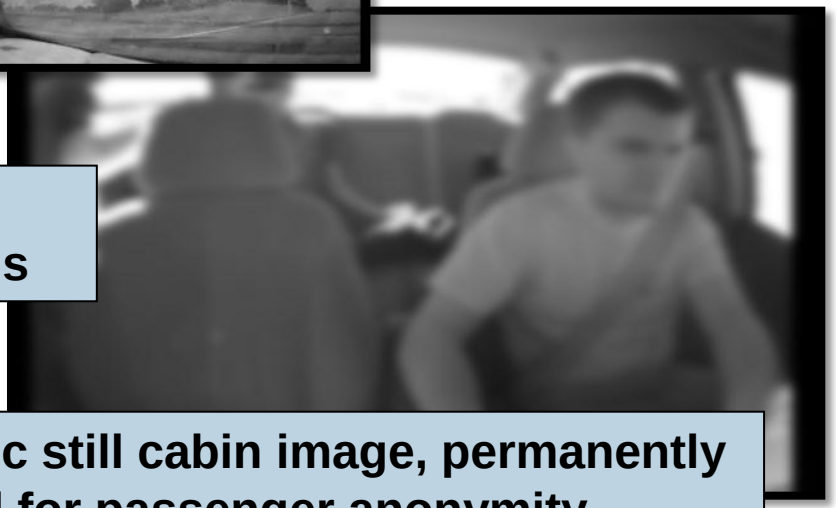
Camera Image Samples

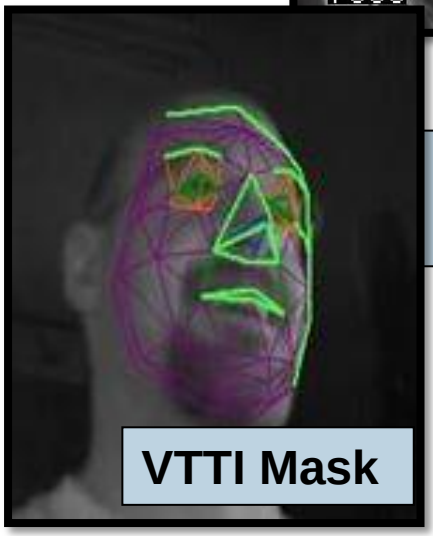
Forward View - color

- 15 Hz continuous video
- 640x320 pixels

Driver Face – Rotated for max pixel efficiency

Right-Rear View





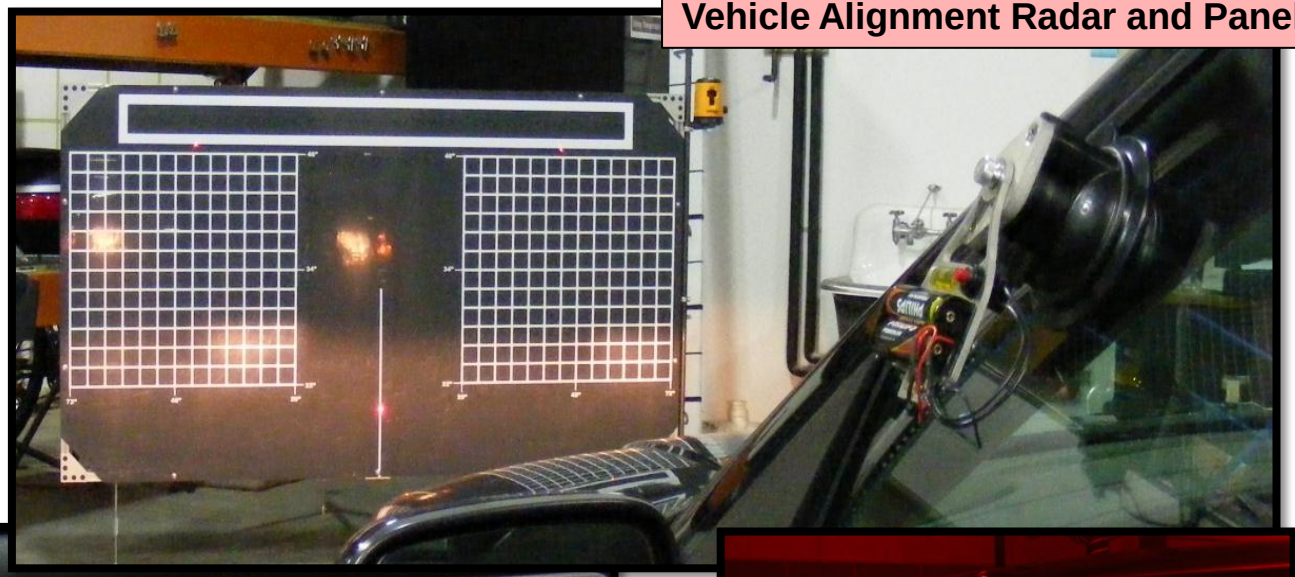
VTTI Mask

Center stack – Pedal Interactions

Periodic still cabin image, permanently blurred for passenger anonymity

VTTI Driving Transportation with Technology

Custom Hardware: Installation, Calibration & Ingestion



Vehicle Alignment Radar and Panel

Radar Alignment Fixture

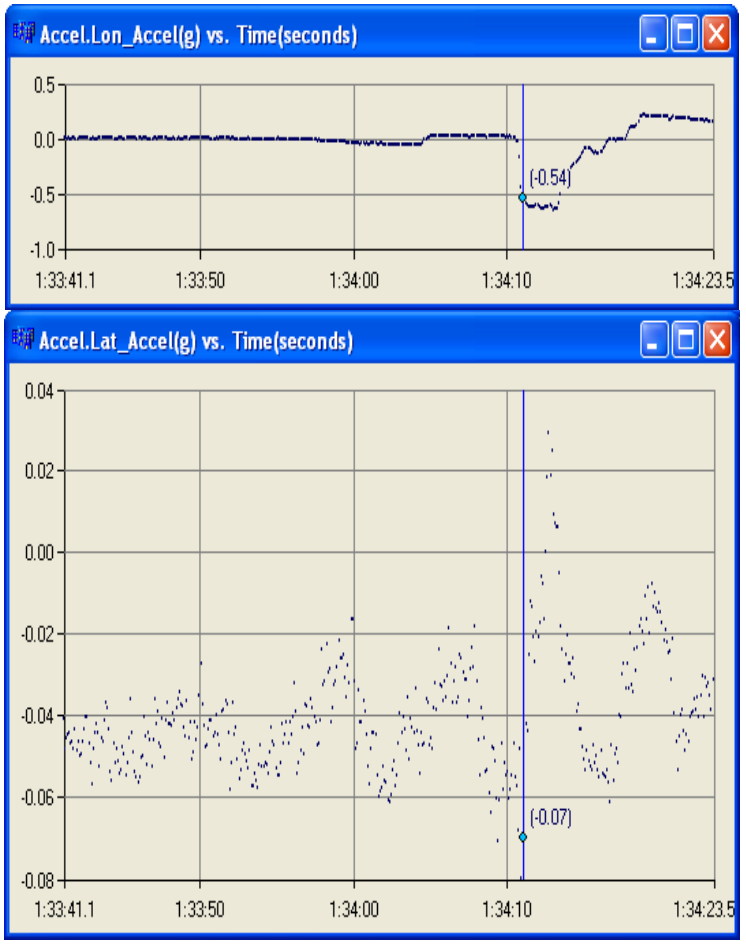
Head Unit Alignment Fixture

Hands-on Installer Training at VTTI

VTTI
Driving Transportation with Technology

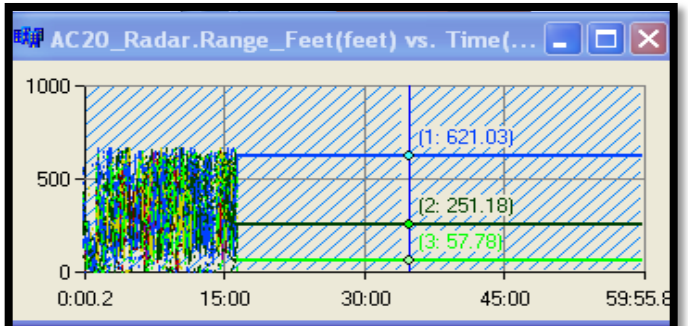
Accelerometer & Rate Sensors

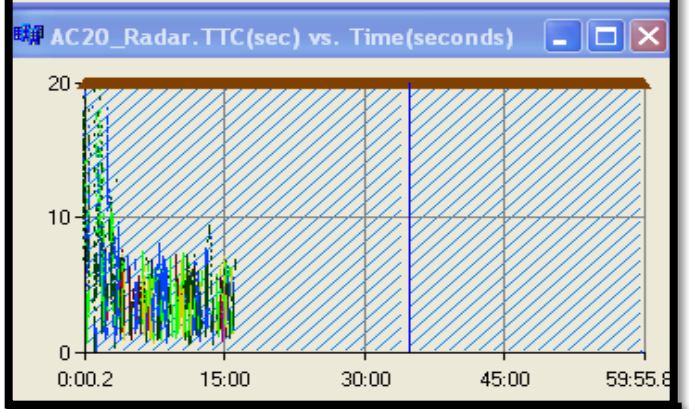
- Acceleration (buffered @ 500 Hz for incident recording; 10 Hz continuous)
  - Lateral
  - Longitudinal
  - Vertical
- Gyro yaw rate (buffered @ 100 Hz for incident recording; 10 Hz continuous)

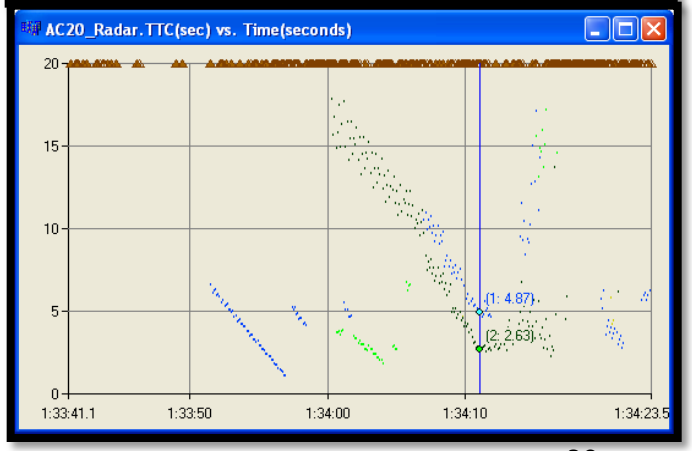


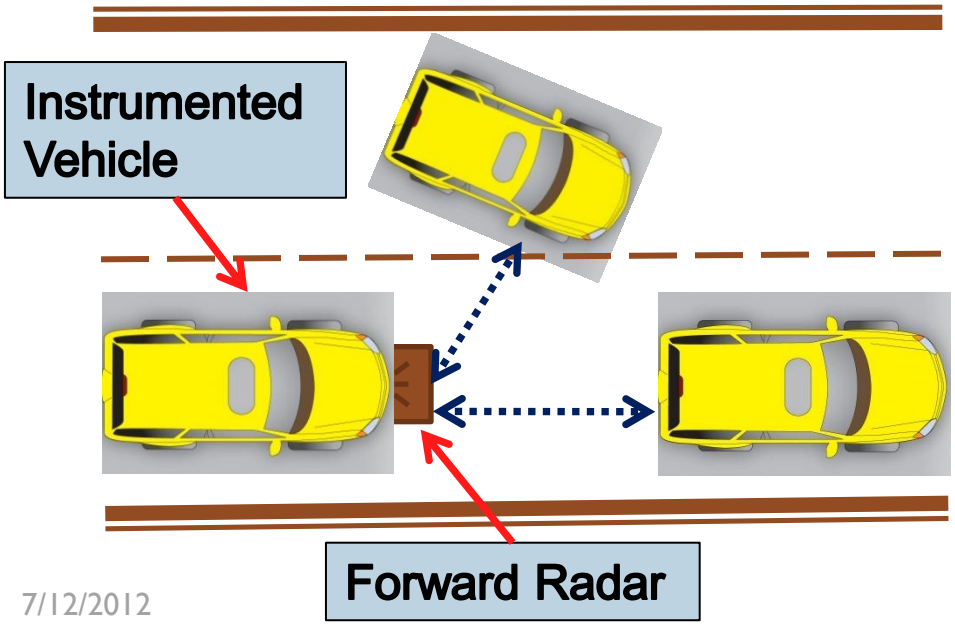
Forward Radar (10 – 20 Hz)

- Minimum of 5 objects tracked
  - Target vehicle range
  - Target vehicle range rate
  - Target vehicle orientation relative to participating vehicle
  - Track type



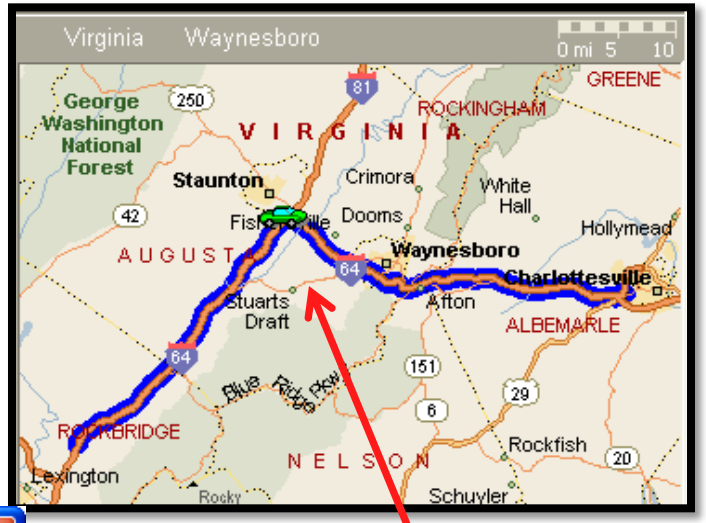




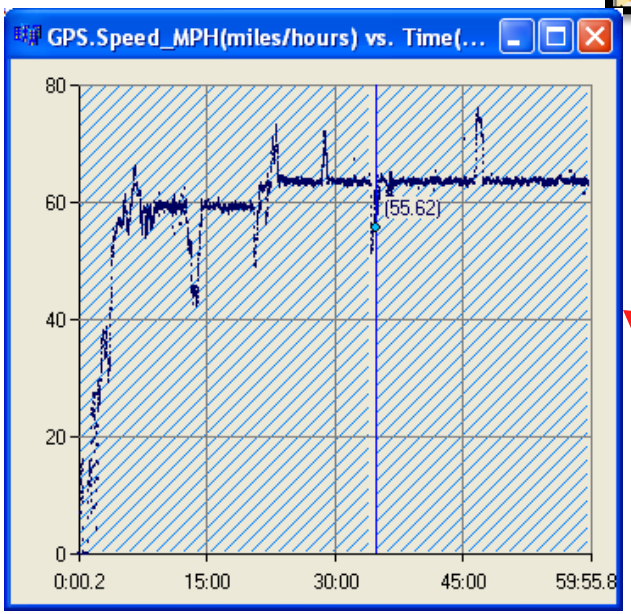


GPS (1 Hz)

- GPS time
- Latitude
- Longitude
- Altitude
- Velocity (X, Y, Z)
- Status (number of satellites being tracked)



Subject Vehicle and Route Driven



GPS Speed