

Data Acquisition & Field Test Data Analysis

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Eagle Crest Resort & Conference Center
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Topics

- Overview – purpose of data collection
- Data archive overview
- Requirements on data
- Data acquisition
- Fleet monitoring

Data Acquisition System



Phase I

- Support Phase I development of IVBSS.
- Provide data during Phase I testing.

Phase II

- Provide data from extended pilot FOT and from FOT itself.
- Allow remote monitoring of test fleet (IVBSS performance & health, driving behavior)



Data Uses

- UMTRI –
 - monitoring fleet
 - analysis of experimental data (performance, acceptance, safety)
 - debriefing test subjects
- Visteon/Eaton/Cognex –
 - technology performance
- Volpe Center/USDOT –
 - quality assurance
 - analysis of experimental data
- Side benefit – data archive for future research

Data Archive – “Raw” Objective Data



- Driver information
- Onboard data
 - Numerical (database)
 - Video
 - Audio
- Offboard data
 - Map & roadway feature databases
 - Weather data

Data Archive – Processed Objective Data



- Cleansed data – smoothing/fusing, managing dropouts & outliers, bias removal, validating trips, etc.
 - Driving context characterization using roadway data, weather data, time, etc.
 - Characterization of events & scenarios of interest
 - Building measures of system performance, potential safety impacts, facts possibly affecting driver acceptance
- ➔ Additional data may exceed size of original raw numerical data



Data Archive – Subjective Data

- Pre-drive questionnaire
 - Driving style and behavior questionnaires completed prior to FOT participation
- Post-drive questionnaires
 - Completed after FOT participation: on-site and take home
- Driver debriefs
 - Review of a subset of warnings to rate for usefulness
- Focus groups

Data Archive – Subjective Data: Questionnaires



- Pre-drive questionnaires
 - Driver style questionnaire (DSQ)
 - Evaluates 6 factors of drivers' style: focus, calmness, social resistance, speed, deviance, and planning
 - Driver behavior questionnaire (DBQ)
 - Examines drivers' errors, lapses, and violations
 - Drivers' scores from DSQ and DBQ will be used in statistical models as predictors of IVBSS acceptance

Data Archive – Subjective Data: Questionnaires (continued)



- Post-drive questionnaires
 - Extensive evaluation of drivers' opinions of IVBSS
 - Will evaluate safety, ease of use, comfort and convenience, and willingness to purchase
 - Two questionnaires
 - On-site: highest priority questions
 - Take home: questions of lesser priority



Requirements on Data Archive

- Complete and 'auditable' characterization of events & system performance
 - Highly robust & structured data set
 - Continuous 10 to 100 Hz logging (depending on subsystem)
 - ~400 signals on light vehicle and ~300 signals on heavy truck
- Video collection to provide analysts with situational context for FOT data, especially IVBSS-related events.
 - What was happening inside and outside the vehicle?
 - What did the IVBSS system react to?
- Secure from data loss, privacy concerns



Data Archive Formats & Size

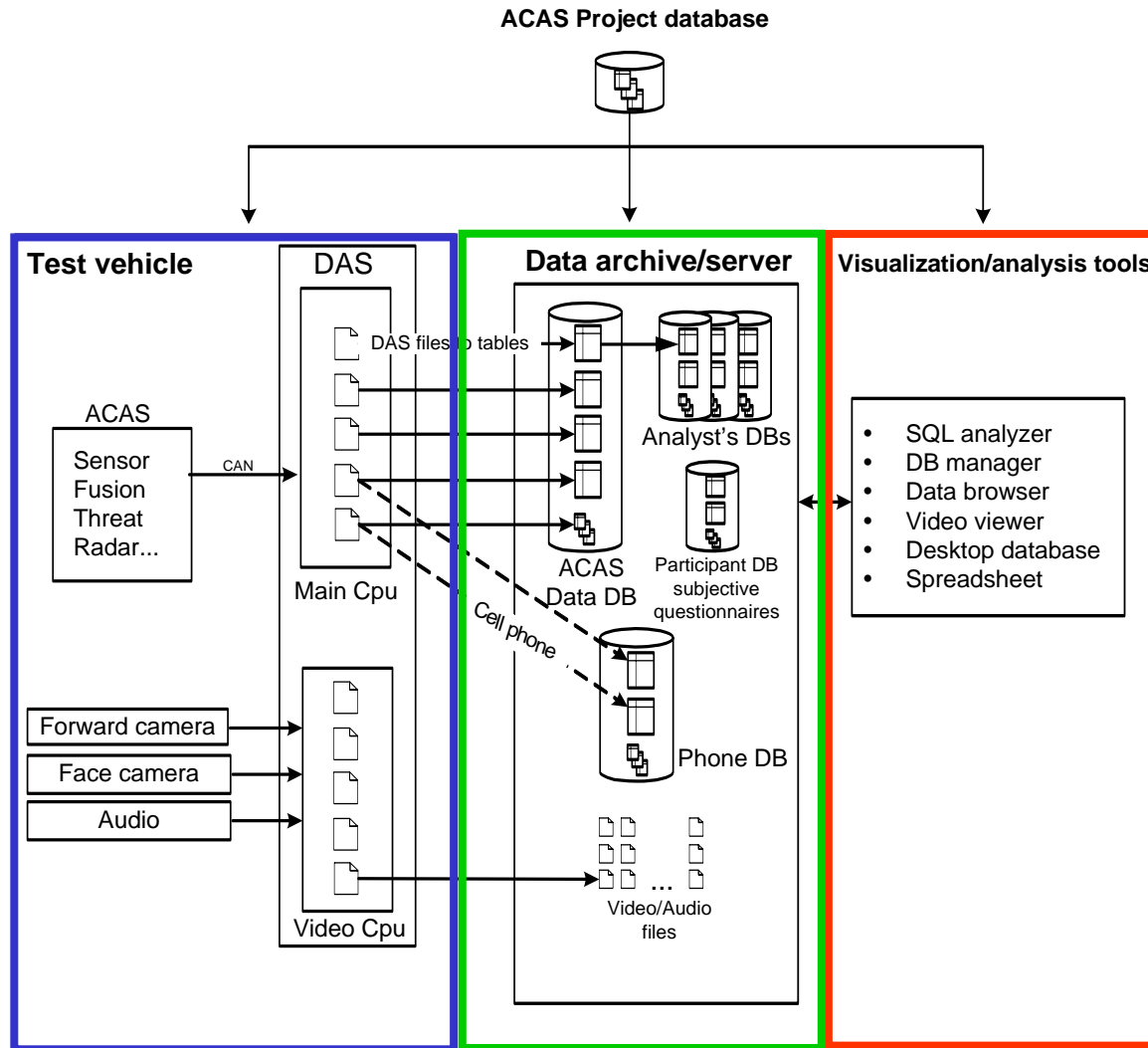
- Format when archived:
 - Numerical: enterprise-level relational database
 - Video: MPEG-4 compressed video with indexing for syncing with numerical data
 - Compression & frame rates vary by video stream
 - Audio: Compressed 64 kbps with indexing
- Size estimates are preliminary
 - Numerical – depends on radar – 1-2 terrabyte (TB) order of magnitude
 - Video – depends on compression levels – 10 TB?



Requirements on Data Archive

- Highly usable:
 - Analyst access to all data within seconds, including video
 - Analysis tools
- Sharing information between project team & independent evaluator

UMTRI integrated data collection and analysis



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Data Acquisition System

- Two CPU system (CAN/radar + vision/audio)
- Automotive-grade hard disks
- CAN and J1939 buses – primary data sources
- Second GPS for analysis (differential)
- 5 cameras with video capture & compression
- Up to 7 radars
- Vehicle motion sensors
- GPRS/Edge cellular modem
- DAS power management system

Video Scenes – Representative Images



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Monitoring the fleet



Track:

- health of IVBSS & data system
- usage of vehicle
- driver experience with IVBSS (alert types & experience)

Cellular modem:

- Trip characteristics, IVBSS actions, health information including histograms

Web-based interface for monitoring fleet



Phone Data: TRI-ACAS

File Edit View Insert Format Records Tools Window Help

driver Arial 10 B I U

System Health

Car 1

driver	trip	Shutdo	Malfuncio	DirtyRa	DasTempMin	DasTempMax	DasTempAve	EnclosureTem	EnclosureT	EnclosureT	BatteryVMin	BatteryVMax	BatteryV	Target	TargetsN	Targets
87	68	0	0	0	0	10	4.4	-5	10	4	13	14	14	0	13	
87	67	0	0	0	0	5	5	5	4	13.5	14	13.9	0	12		
87	66	0	0	0	-15	5	-2.6	-15	10	-1	13	14	14	0	11	
87	65	0	0	0	0	0	0	-5	-5	-5	13.5	14	13.9	0	3	
87	64	0	0	0	-5	0	0	-5	0	-5	13.5	14	13.7	0	10	
87	63	0	0	0	0	0	0	-5	0	-2	13.5	14	14	0	14	
87	62	0	0	0	0	10	6.5	0	10	6	13.5	14	14	0	15	
87	61	0	0	0	0	5	3.1	0	5	0	13.5	14	14	0	10	
87	60	0	0	0	-10	5	-1.8	-10	5	-1	12.5	14	14	0	15	
87	59	0	0	0	-10	-10	-10	-10	-5	-9	14	14	14	0	12	
87	58	0	0	0	-20	-15	-17.8	-15	-10	-15	13.5	14	14	0	15	
87	57	0	1	0	10	10	10	5	5	5	10.8	10.8				
87	56	0	0	0	15	15	15	15	15	15	13.5	13.5	13.5	0	0	
07	55	0	0	0	10	15	11.5	5	15	10	12.5	14	13.5	0	12	
87	54	0	0	0	-5	15	5.8	-5	15	7	13	14	13.8	0	15	

driver	trip	miles	minutes	StartTime	CriticalOK	NonCriticalOH	Target	Threat	Vision	YawRate	DVI	Accel	Class2	Fusion	GPS	MapData	MapMatch	Radar	Scene	AtoD	LaneC
87	68	9.1	14.0	01-29 16:06	100.0	3.0	100.0	100.0	98.3	100.0	91.0	100.0	100.0	100.0	100.0	3.6	5.3	100.0	98.4	100.0	
87	67	2.1	8.0	01-29 14:10	100.0	96.0	100.0	100.0	97.1	100.0	91.0	100.0	100.0	100.0	100.0	66.8	100.0	100.0	97.2	100.0	
87	66	18.7	37.0	01-29 12:21	100.0	94.0	100.0	100.0	99.6	100.0	91.0	100.0	100.0	100.0	100.0	93.0	67.3	100.0	99.6	100.0	
87	65	0.0	0.0	01-28 21:33	100.0	0.0	100.0	100.0	0.0	100.0	90.0	100.0	100.0	100.0	100.0	70.4	100.0	100.0	0.0	100.0	
87	64	0.7	3.0	01-28 20:51	100.0	94.0	100.0	100.0	94.1	100.0	91.0	100.0	100.0	100.0	100.0	69.3	100.0	100.0	94.5	100.0	
87	63	1.1	5.0	01-28 19:01	100.0	95.0	100.0	100.0	95.9	100.0	91.0	100.0	100.0	100.0	100.0	67.8	100.0	100.0	96.2	100.0	
87	62	3.8	11.0	01-28 13:51	100.0	97.0	100.0	100.0	97.1	100.0	91.0	100.0	100.0	100.0	100.0	67.5	100.0	100.0	97.2	100.0	
87	61	0.3	2.0	01-28 13:06	100.0	87.0	100.0	100.0	87.6	100.0	91.0	100.0	100.0	100.0	100.0	68.1	100.0	100.0	88.1	100.0	
87	60	3.8	27.0	01-28 11:43	100.0	99.0	100.0	100.0	99.3	100.0	91.0	100.0	100.0	100.0	100.0	67.9	100.0	100.0	99.4	100.0	
87	59	0.7	2.0	01-25 14:30	100.0	0.0	100.0	100.0	0.0	100.0	90.0	100.0	100.0	100.0	100.0	67.5	100.0	100.0	0.0	100.0	
87	58	0.5	2.0	01-25 11:28	100.0	78.0	100.0	100.0	78.1	100.0	90.0	100.0	100.0	100.0	100.0	69.5	100.0	100.0	78.4	100.0	
87	57	0.0	0.0	01-23 17:33	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
87	56	0.0	0.0	01-23 16:47	100.0	100.0	100.0	100.0	100.0	100.0	90.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	100.0	100.0	100.0
87	55	1.1	12.0	01-23 16:35	100.0	97.0	100.0	100.0	97.6	100.0	91.0	100.0	100.0	100.0	100.0	67.8	100.0	100.0	97.7	100.0	
87	54	7.9	33.0	01-23 15:18	100.0	88.0	100.0	100.0	99.4	100.0	91.0	100.0	100.0	100.0	100.0	87.6	67.7	100.0	100.0	99.4	100.0

Record: 1 of 13

Form View

Summary



- Data archive – several types of data
- Extensions from previous FOT analyses:
 - More advanced data collection
 - Power through joining diverse types of data: onboard, offboard, driver information.
 - Driving treated as more ‘holistic’ than previous studies – context considered in more detail