Data Acquisition & Field Test Data Analysis

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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 to100 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 synching 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
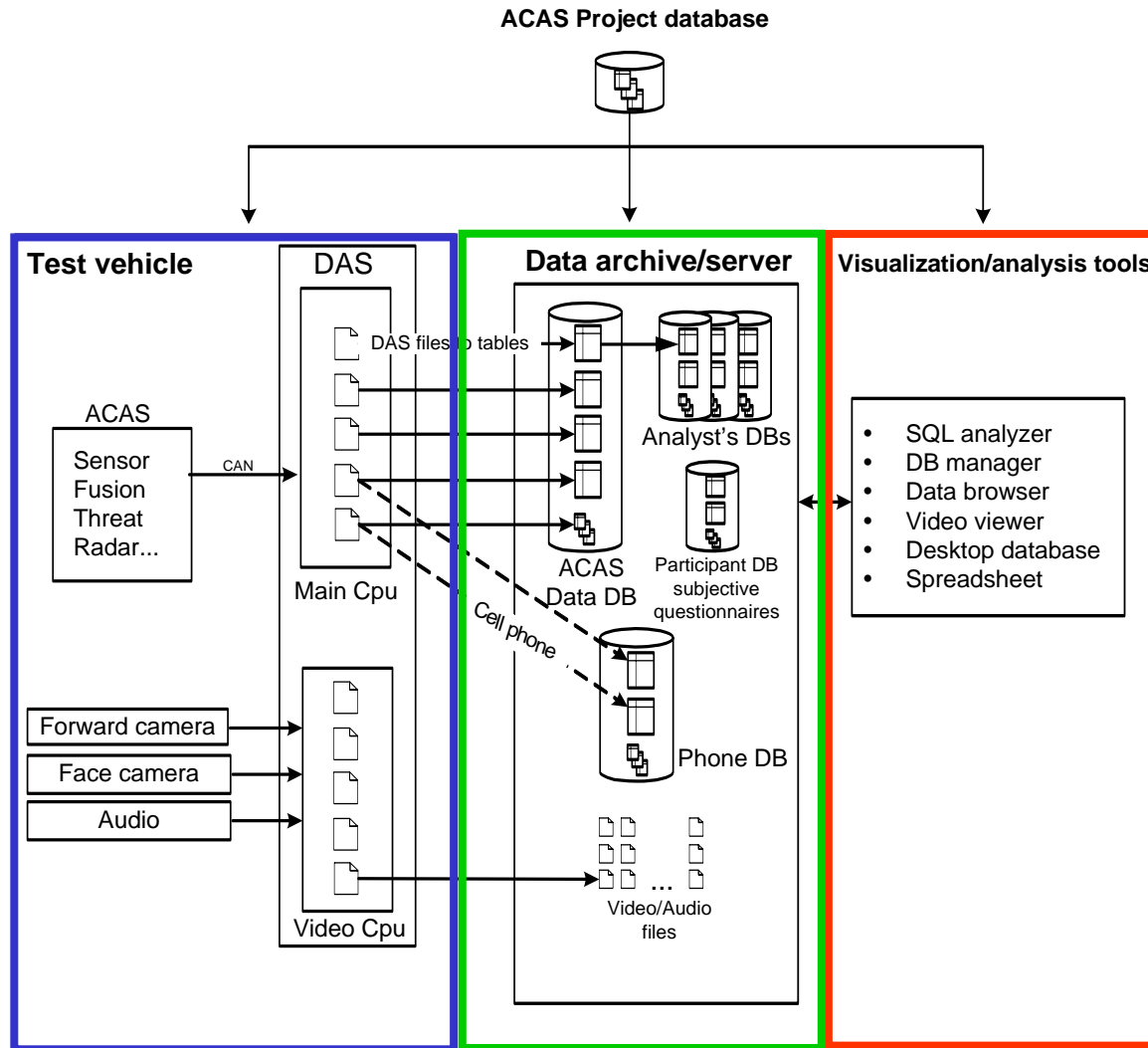
Data Acquisition System

- 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

Forward: 44270

Face Video: 13480

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

Virtual Private Network

IVBSS

Truck Fleet Location

Car Fleet – Field Operation Test

UMTRI

Local LAN
Client VPN
Site VPN
Site VPN   –
Site VPN
Client VPN

Cellular

802.11 Wireless

Server

Server

Remote Management

Network

(Assistware) Development Support Site

Cellular

Eaton/(Visteon) Site

Cable Modem

Default GW2

Existing DSL link

AssistWare LAN

GW1

802.11 Wireless

Default GW2

Server

VLAN will be connected if Cable Modem bandwidth not enough

New Link for Project data

Default GW1

GW2

Eaton Users

Server

AssistWare User

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