The Automotive Sector:

Extending State Networks to support Vehicle Safety Requirements

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The author wishes to note the support provided to SCSC in developing differential corrections delivery methods and uses for use in the DSRC safety area by the US FHWA over a number of prior and on-going research projects in this general topic area.

Table Of Contents

- Unique Vehicle Safety Needs
  - The vehicle safety problem statement
  - Some market numbers and anticipated growth issues
- Network Considerations
  - Feeding the rover population data products when conditions allow
- Issues for State Network Operators

This briefing will show some of the impacts that a national DSRC deployment will have on State network operators.
Dedicated Short Range Communications (DSRC)
General Remarks on the Topic area of DSRC

- It has become clear that DSRC deployment will happen, a prior presentation gave a US FHWA perspective on this.

- DSRC has grown to become an international effort with strong backing by multiple sectors:
  - FHWA and DOT support in the US, is joined by the EU, Japan, and other locations
  - Multiple Automotive consortiums involved including CAMP, CAR-2-CAR, and others
  - Strong international standards community addressing interoperability needs

- But deployment itself will be slow for several reasons
  - While the benefits are easy to measure once critical mass is reached.
  - The infrastructure investment will require decades,
  - Older Vehicles cannot be retrofitted (well a few can), (e.g. the Smith gauge at right does not come with a CAN bus)
The Positioning Problem: Today’s chips with WASS Aided L1 GPS are sufficient for Day One but not for Day Two needs

- The Initial Deployment applications are designed to allow growth as conditions of market penetration, as well as various performance limits increase with time.

- As mentioned in the prior presentation, the first deployments will likely be limited to:
  - Car to Car autonomous cautions and alerting (V2V using BSMs)
  - Intersection Adaptive Signal Control (V2I using BSMs/MAP/SPAT)
  - Simplistic Traveler Advisory Alerts for work zones and incident conditions (TIM)

- However, as we all know, Accuracy is addictive, and hence the need for corrections;
  - The ill-defined “lane level accuracy” remains the current mantra, a decimeter is the next
  - Cost is an overwhelming concern in the automotive sector, an L1 RTK mode of operation “with only some software” remains the “next big thing” to many people

- State GNSS Networks will play a vital role in this future, becoming a critical link for increasing the daily safety of millions of people in the transportation network.
DSRC Automotive DGPS Accuracy Needs, today and tomorrow

Safety Applications are Enabled by increased accuracy in the rovers

Two sigma targets

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DGPS (and RTK) for Automotive Use is considerably different than traditional survey or agricultural use

- Baselines of interest are short, <<5km, Absolute accuracy not often a factor, relative is
- There are no on-station dwell times, always moving, quickly starting, and no “do overs”
- Must have a new positional estimate every 100mS, even a bad one (10Hz updates)
- Rate aiding with odometry is expected to be common, plus some inertial devices
- For the foreseeable future these are L1 only devices, hence no ionospheric measurement
- Inexpensive Patch antennas on a calibrated rooftop present other issues
- These devices expect content filtering and rapid data delivery in the DGPS stream
- Safety margins require rapid cold start up and 0.3/3.0/30 second RAIM detection thresholds
- Such systems must degrade smoothly when corrections and other data products are removed (and must often operate with no corrections at all ! - reverting the WAAS if possible).
A few market size numbers, Automotive vs core RTK users

- Of the ~715 million GNSS units to be sold this year...
  - Only 0.04% (~286 k units/yr) Required RTCM RTK corrections data, chiefly from the agriculture and survey communities.
  - 12.9% (~92,000 k units/yr) or 321x bigger Were used in automotive devices for telematics and navigation needs
  - And 87.1% (~623,000 k units/yr) Were used in various cellular phone / pda / etc. type products

The high end RTK user community remains a core, if small, segment of the overall user base.

The required RTK data products are provided by both public and private sources of corrections data using vastly different business models.

Data taken in part from the GSA GNSS Market Report – Issue 2, May 2012 published by the European GNSS Agency (GSA)
The evolution of RTK, from the high end to the mass market

- Today the worldwide sales of RTK type equipment are under 24k units per month
  - Sold to agriculture and survey users, <300k/yr, just 0.04% of all GNSS sales
  - Hence, new users for all of today's network represent under 1000 users per each day

- Tomorrow, as RTK starts to becomes a commodity used by the automotive community
  - Sales of automotive devices for navigation will shift to the DSRC safety roles
  - Various international government regulations will in time triple automotive consumption
  - **Consumption likely will be 12~15 million units a month needing corrections**
    - In the early deployment days these will by DGPS users, then becoming RTK users
    - In a few years, new user growth will be over 500,000 users per each day

- To Achieve low cost vehicle RTK, one first needs the supporting data products....
  - Local corrections, rapid orbits, clock corrections, and ionospheric models, etc.
  - Delivered to each rover in an effective way
DSRC will always be a land of Islands of data in the desert

- Deployment Coverage footprints will remain spotty for the foreseeable future (i.e. decades)
  - Initial deployments will be very intersection centric
  - Portable units will be used for work zones, incident management, as well as public sector vehicles.
  - Typical Coverage is 300 meters from the Road Side Unit (RSU), But blockage, skip, and multipath are and will remain common problems for coverage.
  - Early deployment gaps will span miles, but even mature deployments will still have notable gaps (such as shown at right)

- Higher End users may selectively cover this with G3/4 links

- The basic optical backbone remains lacking in many places

- The State DOT has the normal problems of a complex network with dynamic content management issues to cope with as well.

- In this, DGPS distribution is a fairly simple process of messages repeating the normal RTCM corrections contents.
Key Network Elements, Using the prior presentation as a departure point

- Three major Elements
  - The centers or “back office”
  - The Roadside Unit Infrastructure (RSUs)
  - The On Board Unit in vehicles (OBUs)

- The business models remain in flux.

- The path for corrections is:
  - From the state NTRIP caster
  - To an NTRIP repeater
  - Over the DOT backbone to the roadside
  - Out over an RSU when scheduled
  - In the OBU for use by the GNSS unit

- We now examine that flow in greater detail
Elements of an DSRC system to deliver DGPS to vehicles

- The normal RTCM SC104 data products are separated and packaged into SAE J2735 for this media and its standards.

- These are broadcast from the roadside unit in a UDP-like format to local rovers

- No operational change in the network is needed

- Load on the network is not significant

- Each device contains unique RAIM logic to detect and freewheel on failures.
For the State Network these trends mean...

- Key increased visibility of the local network by both citizen and other public sector users.
  - Budget ramifications
  - Network densification
  - Data sharing Agreements

- The expectation of 24x7 up time and minimum quality creates its own demands

- Issues of liability concerns remain to be worked out
  - Both to the Network operators and the DOTs and Automotive Suppliers

For better or for worse, all State networks will soon become a major critical element in the overall safety of the traveling public.

This briefing has attempted to show some of the impacts that a national DSRC deployment will have on State network operators.
Questions and Comments

Thank You!

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