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.

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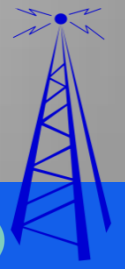
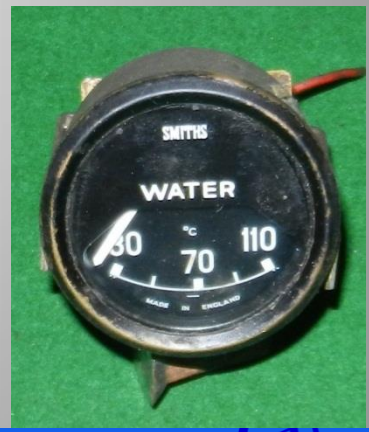
This briefing will show some of the impacts that a national DSRC deployment will have on State network operators.



Dedicated Short Range Communications (DSRC)

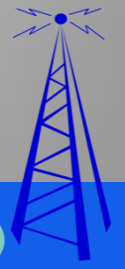
General Remarks on the Topic area of DSRC

- 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)



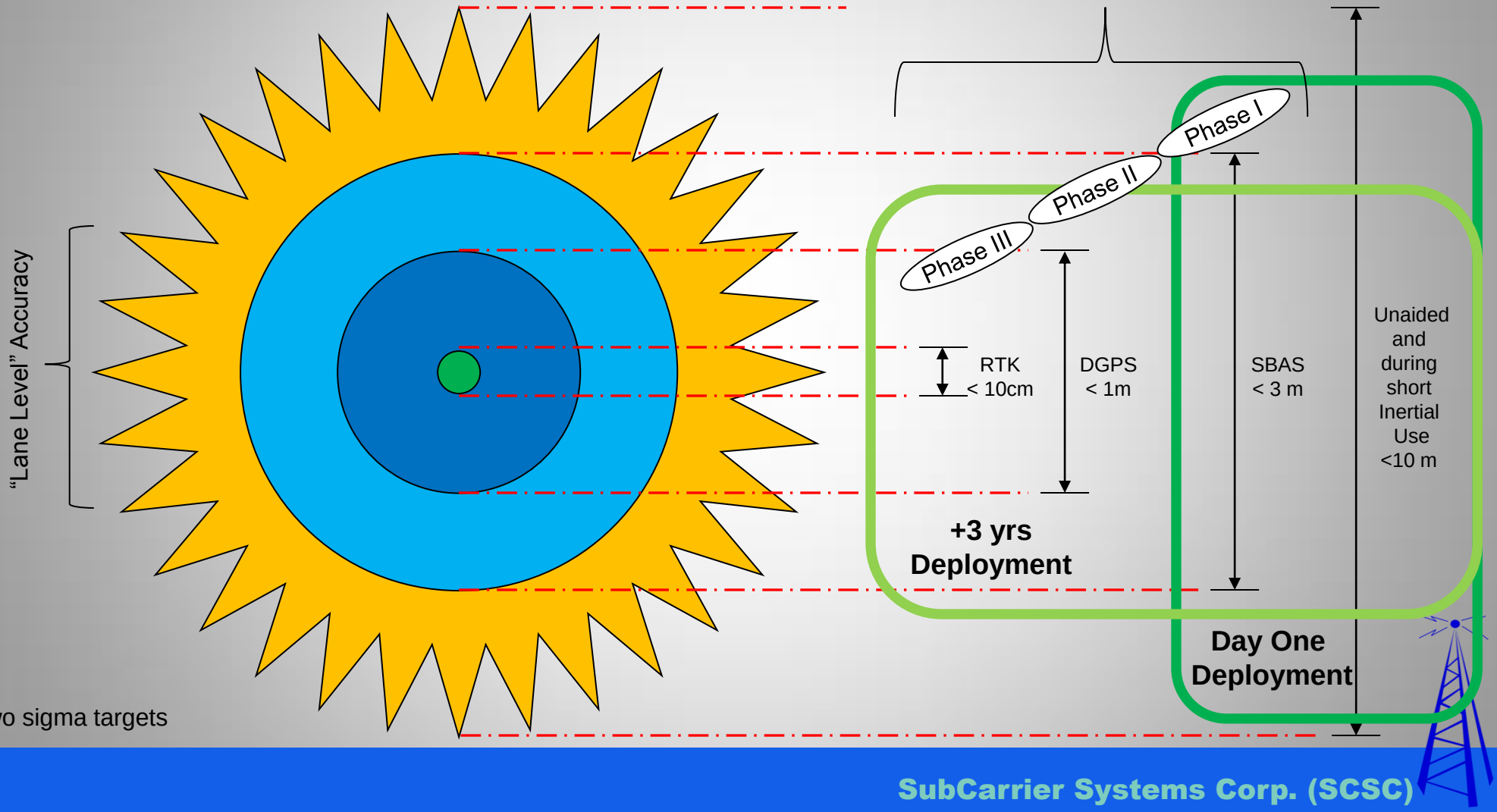
The Positioning Problem:
Today's chips with WASS Aided L1 GPS are sufficient for Day One Bur not for Day Two needs

- 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*

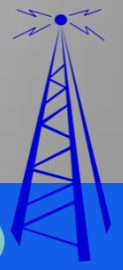
Safety Applications are Enabled by increased accuracy in the rovers



Two sigma targets

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

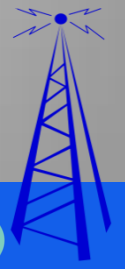
- Baselines of interest are short, <<5km, Absolute accuracy not often a factor, relative is
- There are no on-station dwell times, always moving, quickly starting, and no “do overs”
- Must have a new positional estimate every 100mS, even a bad one (10Hz updates)
- Rate aiding with odometery is expected 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

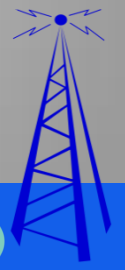
- Of the ~715 million GNSS units to be sold this year...
  - Only 0.04% (~286 k units/yr)
    Required RTCM RTK corrections data,
    chiefly from the agriculture and survey communities.
  - 12.9% (~92,000 k units/yr) or 321x bigger
    Were used in automotive devices for telematics and navigation needs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



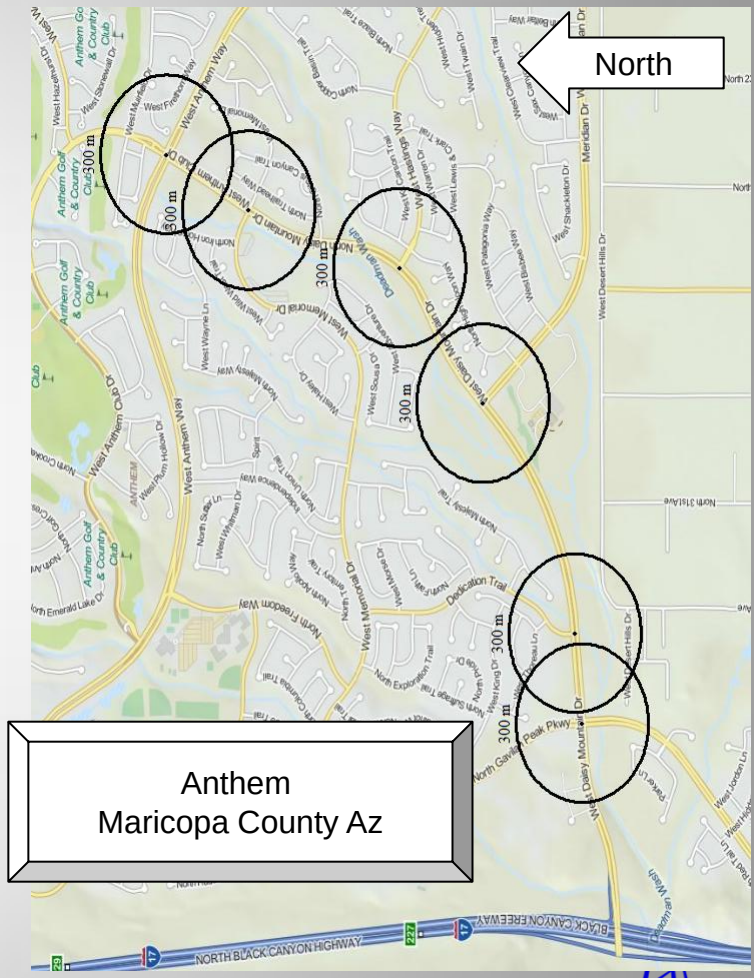
The evolution of RTK, from the high end to the mass market

- 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



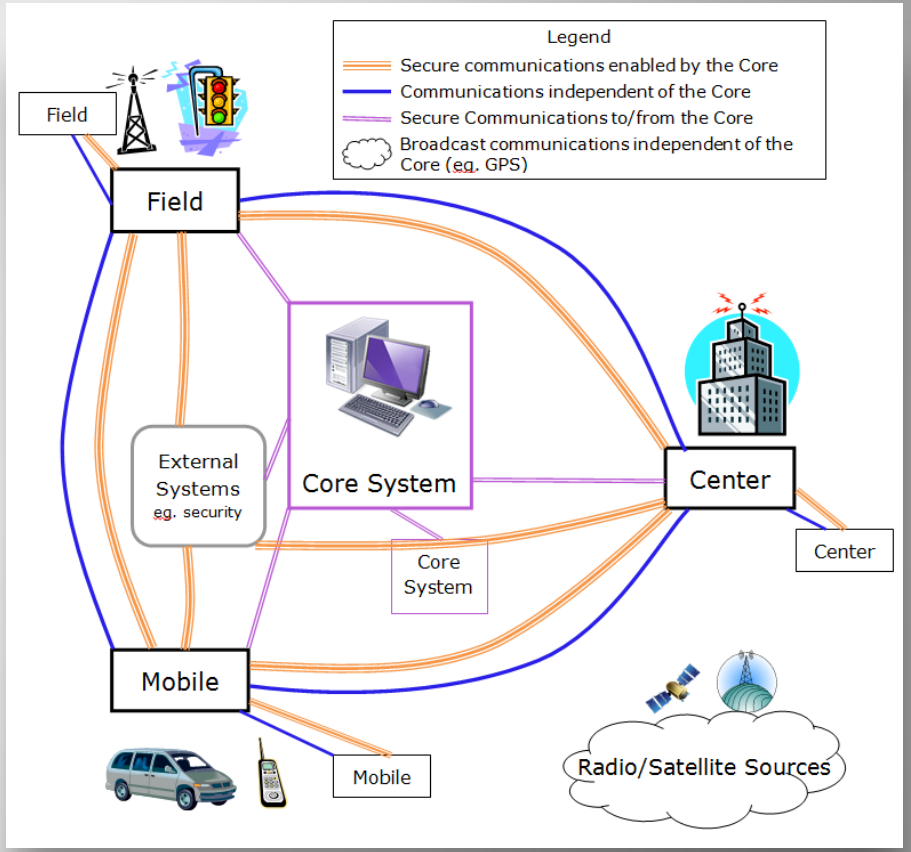
DSRC will always be a land of Islands of data in the desert

- 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.



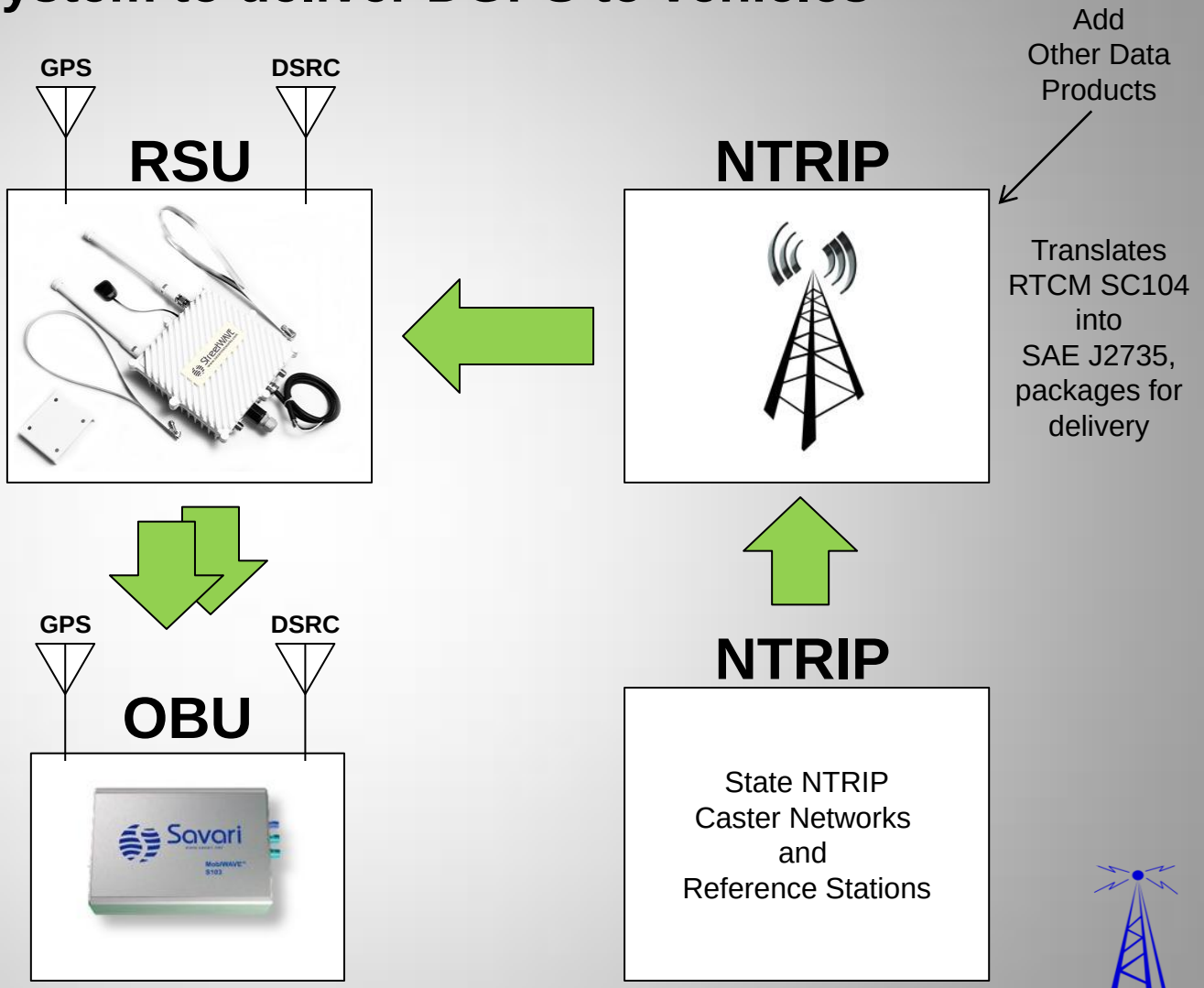
Key Network Elements,
Using the prior presentation as a departure point

- 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.

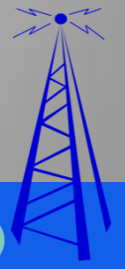


For the State Network these trends mean...

- 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 minumum quality creates it 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!