North America Activities Update
(‘Beyond Standards’)

ITS World Congress - SS16
Madrid, Spain
November 18, 2003
Dick Schnacke
Topics:

1) Open-Road Tolling
2) Multiple-Protocol Devices
3) Electronic Vehicle Registration
4) GPS Tolling (Road-Pricing) R&D
5) 5.9 GHz Developments

Standards
ISO Linkage
FCC Activities / VII
US DOT Activities
Prototype Development Project
Vehicle OEM Activities
1) Open Road Tolling

- Definite movement to ORT
- Capacity / flexibility improvements
- Everyone wants it --- Lane-based systems deemed ‘old’
- ORT acknowledged as ‘not a new idea’ --- but new technologies being explored to make it a better, more economical solution today
Open Road Tolling – What’s New

- **Fundamentals**
  - Get the integration and vehicle framing right – without overly expensive components

- **New reader hardware and firmware enhancements for higher reader performance**
  - Higher concentration of compact antenna patterns
  - New features allow maximum frequency re-use and minimal interference among AVI lanes
  - Networked reader solutions for faster and smarter TDMA across multiple lanes
  - Faster processing for higher read reliability
  - Support of low-cost and mixed mode tag technologies

- **Evolving multi-lane vehicle classification systems**
  - Incremental improvements in AVC integration
  - Signal processing approaches using neural network-based design

- **Evaluation of new video enforcement technologies**
Example of Concentrated Antenna Patterns for ORT Operations
‘All Electronic’ Open Road Tolling R&D

- Equip substantially all vehicles expected to use the toll road with AVI tags via simple, widespread distribution
- All vehicles are expected to have a tag – those without a tag are considered violators.

Goals
- Achieve the advantages of ‘all electronic’ tolling without the cost and operational complexity of video tolling
- Significantly reduce the need for VES

Technical/Operational Challenges:
- Requires low cost, high performance tag technology to allow broad distribution but provide reliable operation
- Requires an approach to broad distribution
- Requires a means to easily provide tags in proximity to the road for those ‘few exceptions’
  - e.g., “TagTeller™” by TransCore
2) Multiple-Protocol Devices

- Why?
  - U.S. ‘regions’ populated with mixed protocols - ‘regions’ now intersecting / colliding
  - Desire to ‘read every tag that comes by’
    - Improved traffic probe systems
    - e-commerce, m-commerce
  - Path to pain-free migrations / upgrades

- Two natural approaches to the problem
  - Multiple protocol tags
  - Multiple protocol readers

- Proponents of both
Multiple-Protocol Tags

- Principally oriented toward VEHICLES that must cross through or operate within a variety of ‘protocol regions’

- Proposed for long-haul, heavy trucks that cross through many regions
- Can eliminate the maze of different tags once needed by such vehicles
- Current designs offer up to three on-tag protocols
Multiple-Protocol Readers

- Principally oriented toward INFRASTRUCTURES that must (or wish to) deal with a variety of tag protocols
- Excellent migration approach for agency wishing to change protocol, support two or more different protocols, or add a low-cost tag option
Multiple-Protocol Readers (con’t)

- Readers with up to five protocols available:
  - Allegro (including SunPass)
  - Title 21
  - IAG
  - ATA
  - eGo

- High speed operation with any two protocols
- Slower speed operation with more than two protocols
3) Electronic Vehicle Registration

“How if…..”
Electronic Vehicle Registration

“…every vehicle had a tag?”
Electronic Vehicle Registration (EVR)

What is EVR?
- The use of RFID technology to electronically identify vehicles and validate the identity, status, and authenticity of vehicle data

What does it do?
- Enables *automatic detection and screening* of motor vehicles for compliance with federal, state, and municipal vehicle regulations
- Enables *automated enforcement* actions and violation processing for non-compliant vehicles
- Enables automation of current manual visual-based inspection … greatly *increasing effectiveness and efficiency*
Benefits

- Improved registration integrity and compliance
- Enhanced agency revenue & cash flow
- Potential reduction in annual registration administration and expenses
- Improved public safety and environment
- Improved use of law enforcement personnel
- Enhanced traffic management systems
How Does It Work?

- By establishing an electronic identification record for each vehicle:
  - Via RFID transponder
  - Unique for each vehicle
  - Tamper-resistant

- Linking each electronic vehicle identification record to a centralized owner and vehicle-based data base
Electronic Vehicle Registration Tag

Tamper-Resistant Transponder
Read / Write

Unique ID
Read Only

Vehicle Description
VIN: 49525421544125
Plate: FAB-275
Year: 2001
Make: Honda
Model: Accord
Original Sale: 12.03.02

Other Data (emissions example)
Test cycle: 01/01
Center: 13
Type: A
Date: 091802
Test result: Passed

Write & Lock
Write & Update
Constituencies Supporting EVR

- Departments of Motor Vehicles
- Law Enforcement Officials
- Transportation Officials/Planners
- Public Policy Makers
“Old World”

Officer manually writes up the accident report.
Manual Report

- Can take hours to prepare
  - Time at the scene of the accident
  - Time cleaning up report for files
- Can be inaccurate due to human error
- Can be illegible
“New World”

Officer uses hand-held reader to record information on each vehicle in the accident to generate an electronic report.
Electronic Report

- Takes less than a second to scan per transaction
  - Driver’s license
  - eGo™ tag
- Accurate
- Legible
- Digital images can easily be placed into the report.
Monitoring Vehicles for Compliance

- Fixed readers via gantries or poles
  - Monitoring high traffic flows
  - Monitoring borders
  - Monitoring for tag and registration compliance
- Roadside transportable readers
  - Monitoring variable locations to avoid persistent “by-pass” of known reader locations
  - Special operations
- Handheld readers
  - Officer interrogation
  - Walking patrol
  - Updating tag data
If vehicles have an EVR tag.....

- What if.....

....those tags were suitable for tolling?

- They are!
  - Reading range: >6 meters
  - Vehicle speeds: >160 kph
  - Read/write
All-Electronic Toll Roads

- Substantially all vehicles equipped by mass distribution (e.g. EVR by DMV)
- Conveniently located distribution outlets for the few who don’t have tags, lost, stolen, etc.
- Multi-protocol readers allows a “mix” of technologies

TagTeller™

Booth 111
4) GPS Tolling (Road-Pricing) R&D

- Tolling every vehicle movement
  - GPS Tracking / Cellular Reporting

- The dream of every revenue raiser

- But is the dream a nightmare?
  - Testbeds include only trucks (via mandates)
  - Very complex S/W & back office
  - Problematic enforcement
GPS Tolling / Road Pricing – Why?

- Desire for ‘light’ infrastructure
  - Especially for dense networks
  - But…..
    - Enforcement requires infrastructure and/or labor-intensive mobile systems
    - Very complex back-office operation
    - Cellular airtime charges an operational cost
- Offset is very complex, expensive onboard unit
GPS Tolling / Road Pricing - Activities

- Fundamental Research in Technical Requirements
  - Low cost, high accuracy GPS technology
  - Alternate enforcement strategies to better deliver the potential for reduced infrastructure cost

- Business Model Development
  - Researching application models to find a reasonable business case that can absorb the inherently very high in-vehicle unit costs
    - Truck tolling
    - Business district toll boundaries
    - General fuel tax revenue replacement

- Exploratory activities in Washington & Oregon
5) 5.9 GHz Developments

- The next generation of DSRC (Dedicated Short-Range Communications)
- Sporadic progress has been made over past 4-5 years (mostly related to standards)
- No guiding light
- No real sponsor
- No killer business model
- No sugar daddy
5.9 GHz – What Is It?

The Next Generation

Transmission Range increases 2 orders of magnitude

From 10 meters to 1000 meters

Transmission Rate increases 2 orders of magnitude

From 0.25 Mbps to 25 Mbps

Tailored to the hi-speed mobile environment

Near-instant access
Application Types

- Vehicular Safety: 50 - 60 applications
- Public Safety: 10 - 15 applications
- Other – approximately 40 applications
  - Tolling
  - Other payment systems
  - e-commerce
  - Everything else

TOTAL: up to 125 applications presently defined
5.9 GHz - Standards

- Now moving swiftly ahead
  - Much work contracted out
- Focus on unique aspects of the mobile applications set
- Considerable attention to communications security

- Much of past work done within ASTM
- New / current work done within IEEE (802.11p?)
5.9 GHz – ISO Linkage

- Solid relationship between ASTM/IEEE work (North America) and ISO (International)
- ISO has agreed to accept the leading work done in North America and collaborate in completing all standards tasks
- Bottom line: North America and International solutions will be identical
5.9 GHz – FCC Activities

- Band allotted to ITS four years ago
- Hearings, commentings, drafting of rules – all per ‘normal’ FCC roadmap


- FCC to take unusual step (at our request) of requiring adherence to radio standards
ASTM 5.9 GHz DSRC Band Plan

US and potential Mexican DSRC allocation

Optional 20 MHz

Ch 172 Ch 174 Ch 176 Ch 178 Ch 180 Ch 182 Ch 184

Proposed Canadian DSRC Allocation

Optional 20 MHz

Ch 172 Ch 174 Ch 176 Ch 178 Ch 180 Ch 182 Ch 184

Frequency (GHz)

Control Channel
Service Channel
Vehicle to vehicle
Primarily public safety high power applications
Canadian Special license zone
5.9 GHz – U.S. DOT Activities

- U.S. Congress – 10 year plan to reduce fatalities (50%)
- DOT & automakers charged to make it happen
- Studies are done – results are in
- Answer is NOT simply to PROTECT people better in a crash
- Answer is to ELIMINATE the crash
- The key is situational awareness, and….

- DSRC is a key enabling technology to achieve it
U.S. DOT (Recently) Requested....

- Fast-paced prototype development program for 5.9 GHz DSRC
  - Industry driven
  - Shared-cost, but heavily funded up front by DOT

- Goals:
  - Prove the standards
  - Provide standard-compliant operational hardware for the vehicle OEMs
  - Perform testing to confirm vitality of the hardware, reasonableness of certain safety applications, and system acceptance by vehicle users
  - Provide a launching pad for industry
5.9 GHz – Prototype Development Project

- Substantial funding committed
- Sole source to DSRC Industry Consortium (thru ARINC)

- Participating members:
  - TransCore
  - Mark IV
  - Raytheon
  - Sirit

Four competitors working together ???
Software & Hardware development

- **Upper Layer Manager**
  - IEEE 1609.02
  - SAP

- **Network Layer Manager**
  - IEEE 1609.3
  - SAP

- **Lower Layer Manager**
  - IEEE 1609.4
  - SAP

- **Resource Manager**
  - IEEE 1609.1
  - SAP

- **Application Service**
  - IEEE 1609.2
  - SAP

- **Transportation Layer (UDP/TCP)**
  - SAP

- **Network Layer**
  - IEEE 1609.3
  - SAP

- **Logical Link Layer (LLC)**
  - IEEE 802.2
  - SAP

- **MAC Extension**
  - IEEE 1609.04
  - SAP

- **Physical & MAC layer**
  - ASTM E2213-02
  - SAP

- **DSRC App #1**
  - SAP

- **DSRC App #2**
  - SAP

- **Operating system**

- **Development board uprocessor**

- **Software**

- **Hardware**
Task 1: Completion of standards

Content
- Oversight standardization activity
- Communication Security
- Testing of the standard

Deliverables
- Security solution design document
- Standards test plan development
- Standards testing results
Task 2: Development of system design

Content
- Selection of applications
- Requirements (Functional, Performance, Testing)
- Architecture and network topology
- Prototype development plan

Deliverables
- Demonstration applications selection
- Prototype requirements
- Architecture & Design specifications
- Prototype development plan
Task 3: Development of prototype equipment
- Hardware -

Content
- Development board
- Operating system
- Network layer
- Application services
- Upper layer manager

Deliverables (Joined effort with software development)
- PDR, DR, FDR
- Prototype boards
- Source code
- Interface description
Task 3: Development of prototype equipment
- Software -

Content
- RF module
- IEEE 802.11a chip set
- MAC extension
- Lower layer manager

Deliverables (Joined effort with hardware development)
- PDR, DR, FDR
- Prototype boards
- Source code
- Interface description
Task 4: Evaluation testing

Content

- Preliminary testing
  - RF, functional interactions, Unit performance, channel operation
- Intermediate testing
  - Testing to limits
  - Application testing support
  - Pre-testing of planned demonstrations

Deliverables

- Test plan
- Test results
Schedule

Phase 1
- Task 1: Completion of standards
- Task 2: Development of system design

Phase 2
- Task 3: Development of prototype equipment
  - Hardware
  - Software
- Task 4: Evaluation testing
5.9 GHz – Vehicle OEM Activities

- Application evaluations have proven need for 5.9 GHz
- Technology evaluations have proven worth of 5.9 GHz
- Vehicle Safety Communications Consortium (VSCC) formed to further interests of vehicular safety applications
  - GM, BMW, DaimlerChrysler, Toyota, Ford, Nissan, VW
- Alliance of Automotive Manufacturers (AAM) watching developments at a higher level

- Key enabling technology now determined to be 5.9 GHz DSRC
Current Vehicle OEM Activities

- Continued application testing
- Buildup of ‘improved’ (but not fully compliant) test units to gain confidence and improve test results
  - Needed by May 2004
  - Prototype development units coming ‘too late’
- Working toward ‘livable antenna configurations’
- Trying to marry implementation needs with typical OEM product implementation timelines

- Best guess now: 2008/2009 model year
Conclusion(s)

- Many ongoing and new initiative activities in North America
- You’ve seen here the tip of an iceberg
- For more information on any topic touched:
  Dick Schnacke
  TransCore
  +1-972-874-9266
dick.schnacke@transcore.com