North America Activities Update

('Beyond Standards')

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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

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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

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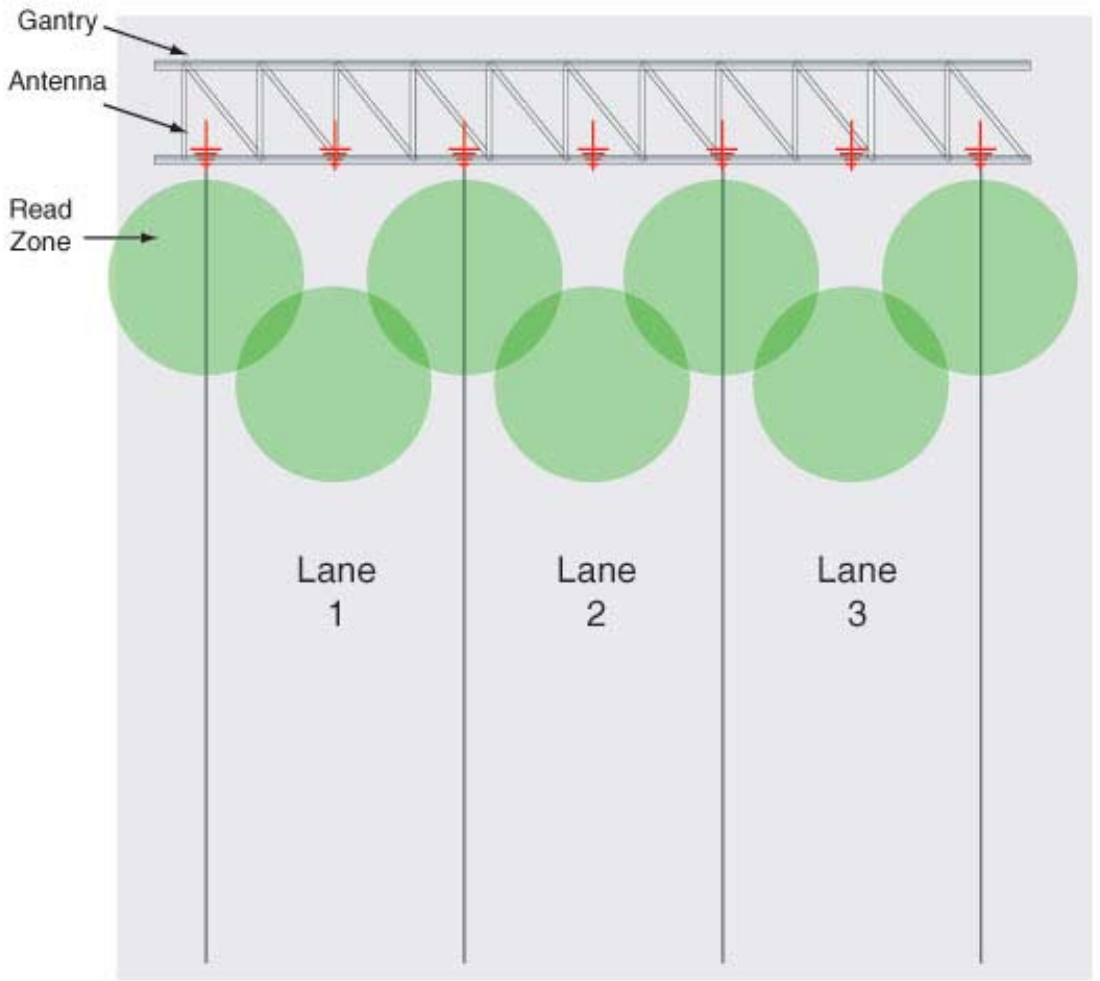
Example of Concentrated Antenna Patterns for ORT Operations



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‘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

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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

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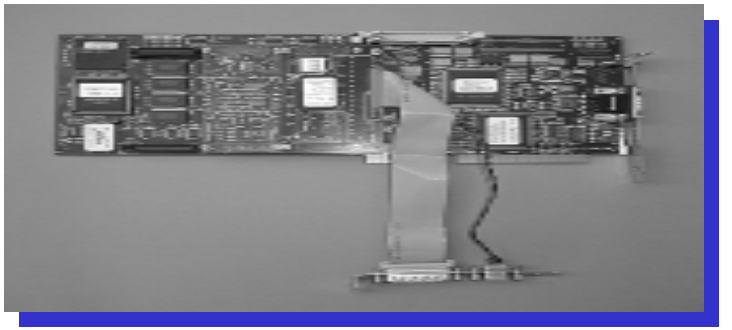
Multiple-Protocol Readers (con't)

- 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

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3) Electronic Vehicle Registration

“What if……”

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Electronic Vehicle Registration

"…every vehicle had a tag?"

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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***

EVR System Overview

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

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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

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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

Write & Lock

Other Data
(emissions example)

Test cycle: 01/01
Center: 13
Type: A
Date: 091802
Test result: Passed

Write & Update

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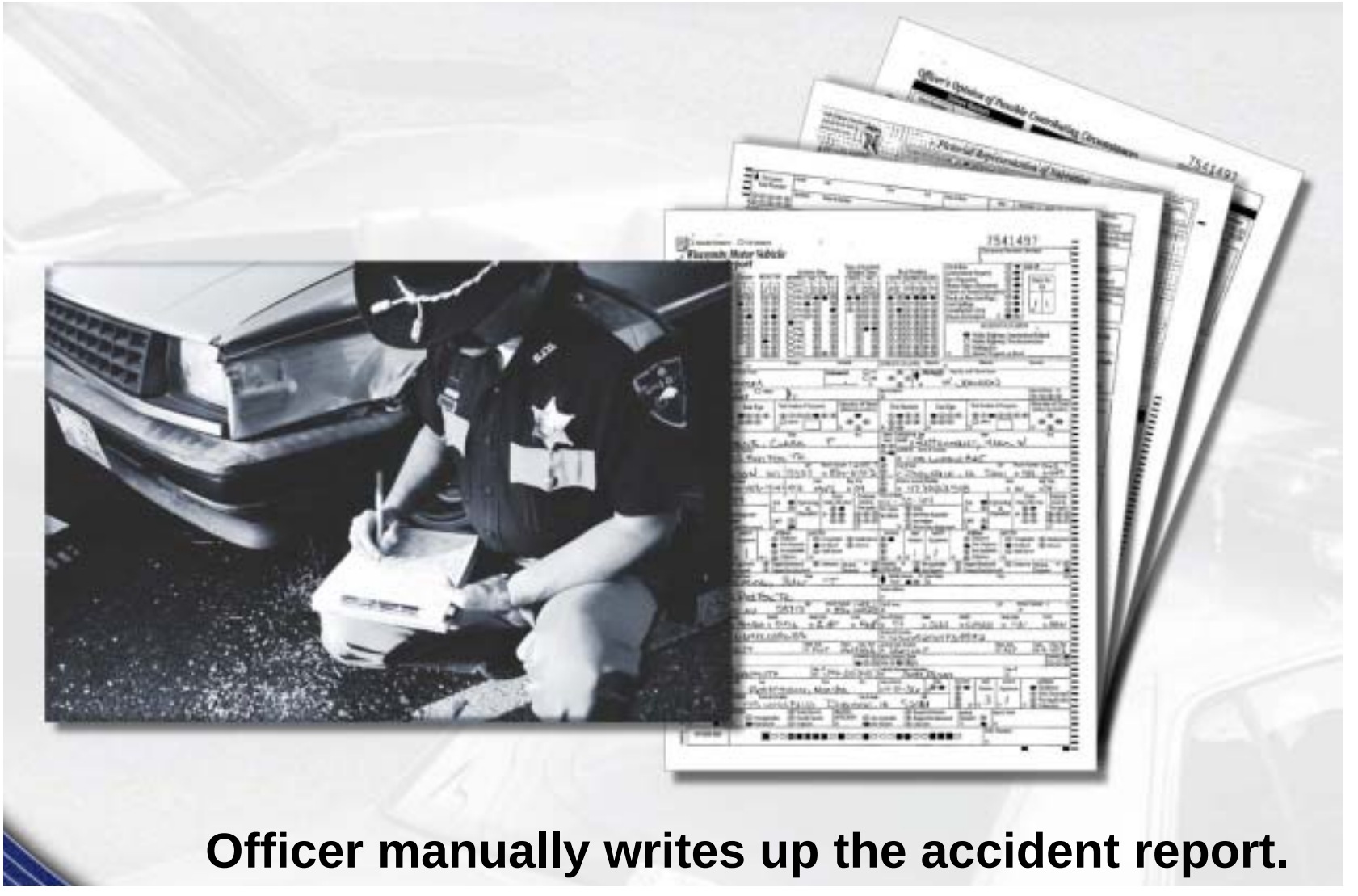
Constituencies Supporting EVR

- Departments of Motor Vehicles
- Law Enforcement Officials
- Transportation Officials/Planners
- Public Policy Makers

“Old World”

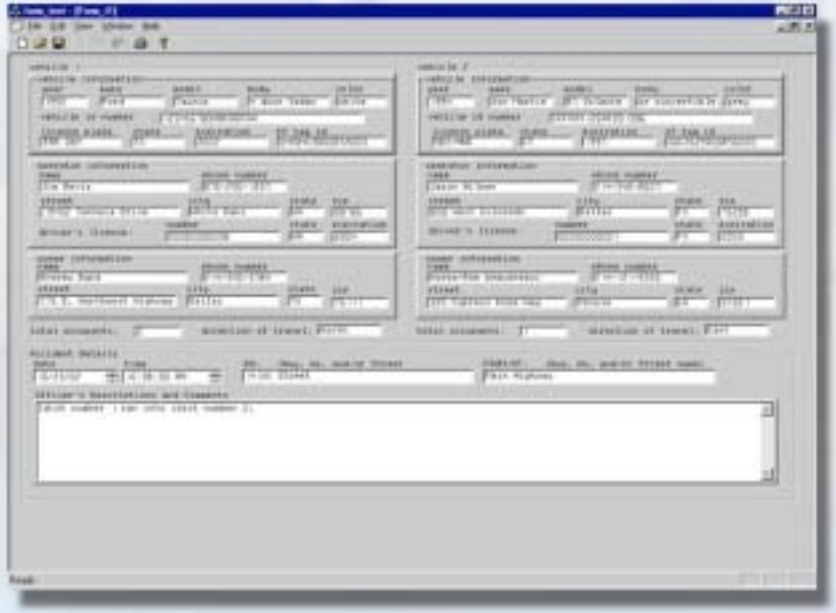


Officer manually writes up the accident report.

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

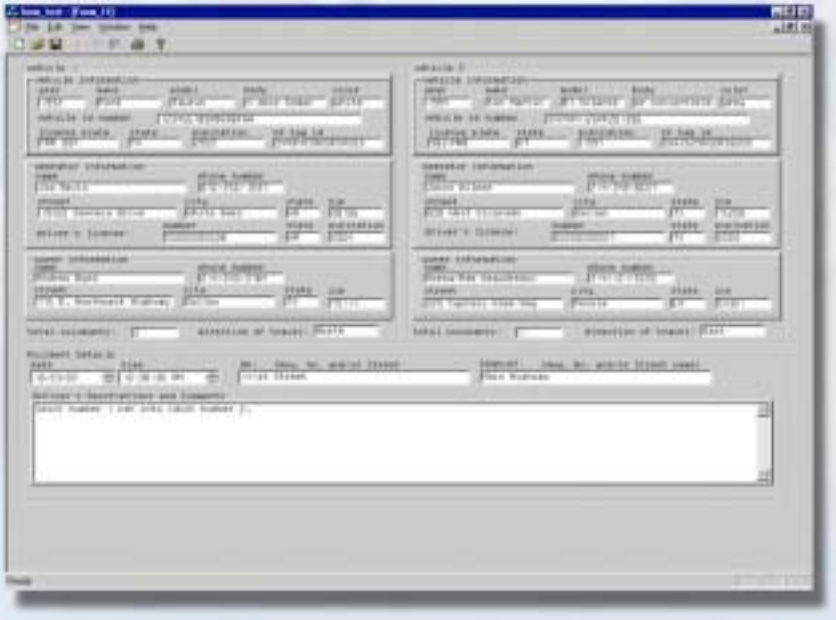
“New World”



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

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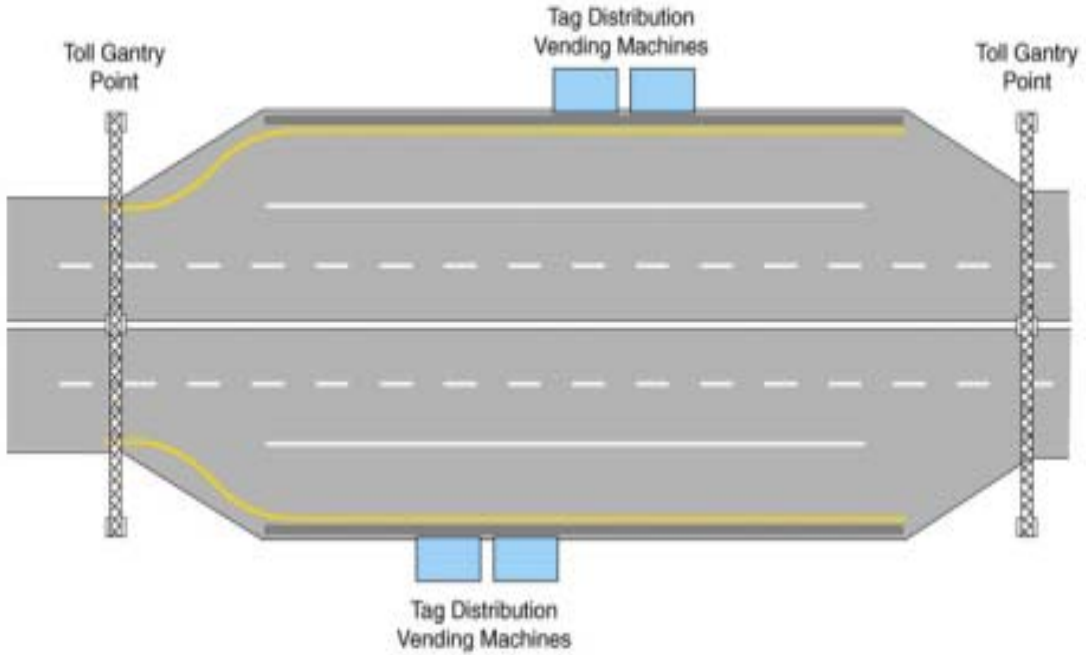
All-Electronic Toll Roads

- 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™

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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

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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

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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?)

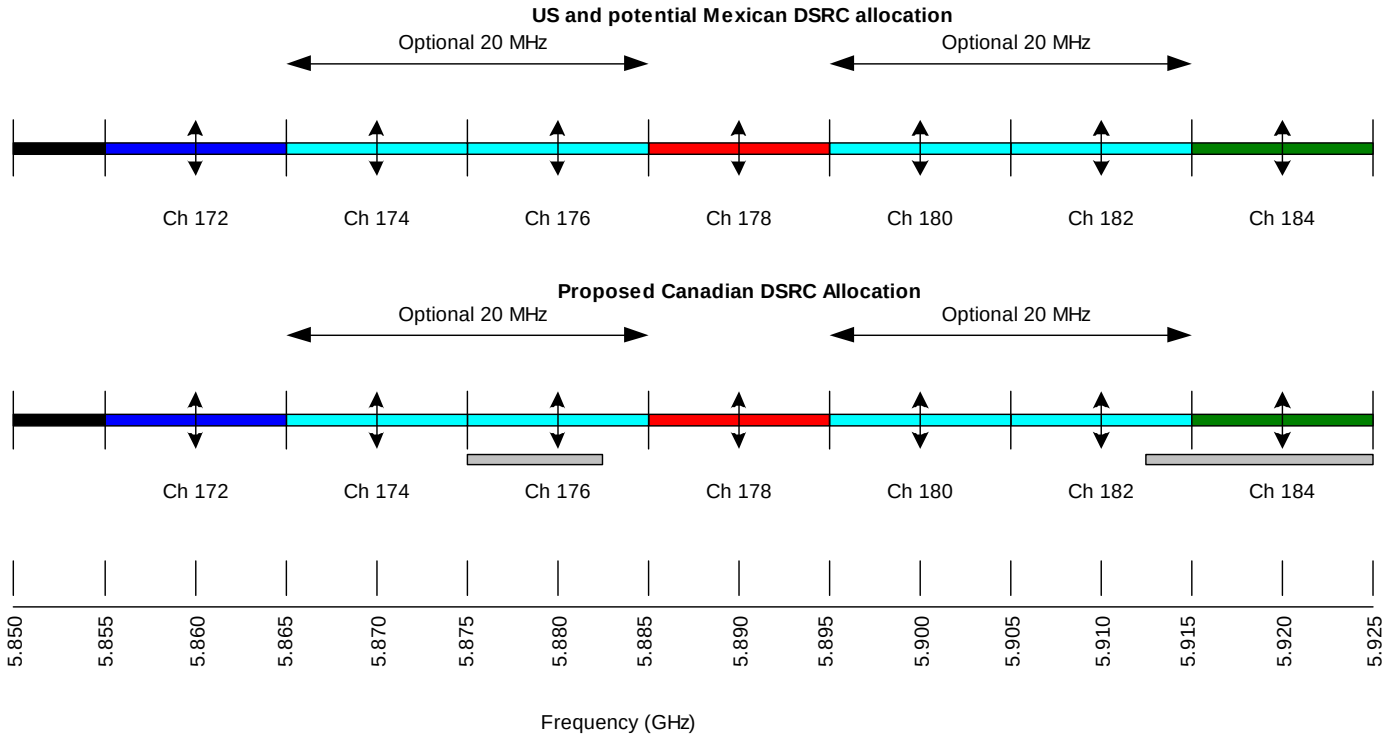
5.9 GHz – ISO Linkage

- 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 Report & Order expected in Dec. 2003
- FCC to take unusual step (at our request) of requiring adherence to radio standards

ASTM 5.9 GHz DSRC Band Plan



- Control Channel
- Service Channel
- Vehicle to vehicle
- Primarily public safety high power applications
- Canadian Special license zone

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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 ???

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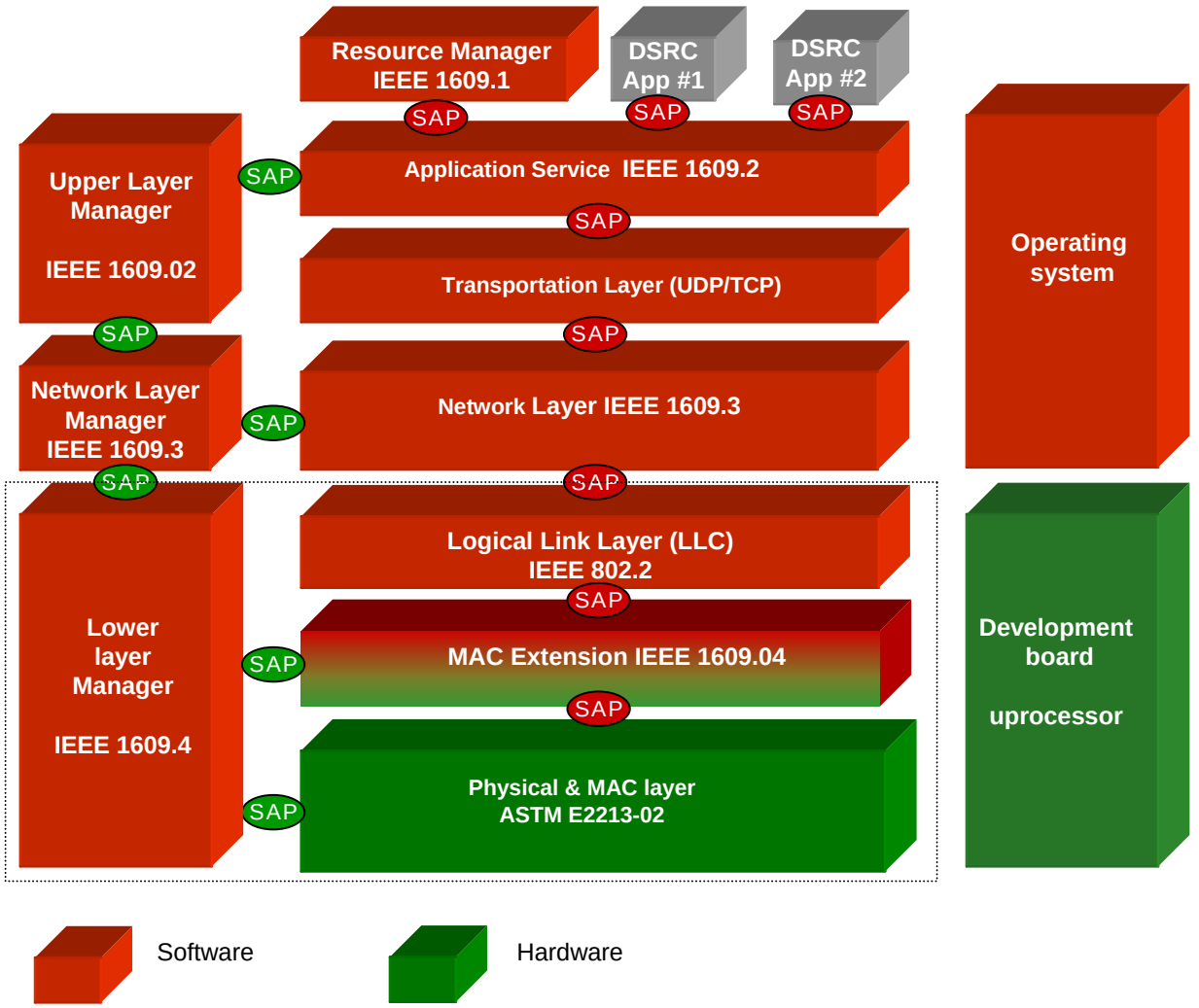
Software & Hardware development



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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

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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

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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

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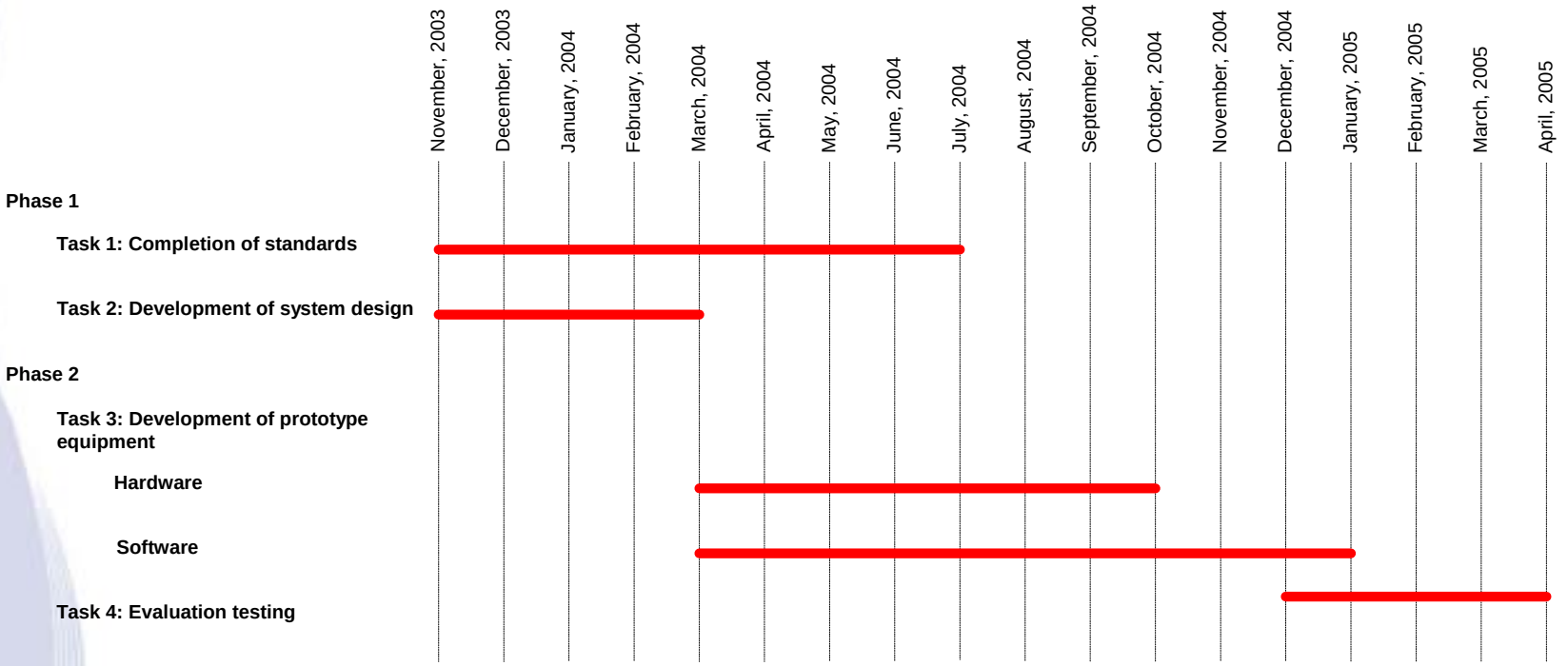
Schedule



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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:

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