Proposed Applications for 5.9 GHz DSRC in North America

ITS World Congress – SS27
Nagoya, Japan
October 21, 2004

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Topics:

1) What is 5.9 GHz DSRC ?

2) Why are we moving to DSRC ?

3) How & When Will it Come ?

4) The Applications

-- Some examples

-- Relating applications to DSRC performance

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5.9 GHz DSRC –

What is it?

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5.9 GHz DSRC – What Is It ?

The Next Generation of ‘Short Range’ Vehicular Communication

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

5.9 GHz DSRC – What Is It ?

The Next Generation of ‘Short Range’ Vehicular Communication

- Primary band allocation
- Tailored to the hi-speed mobile environment
- Near-instant access
- Application prioritization
- Dynamic frequency control
- Dynamic power control
- ‘Bulletproof’ security

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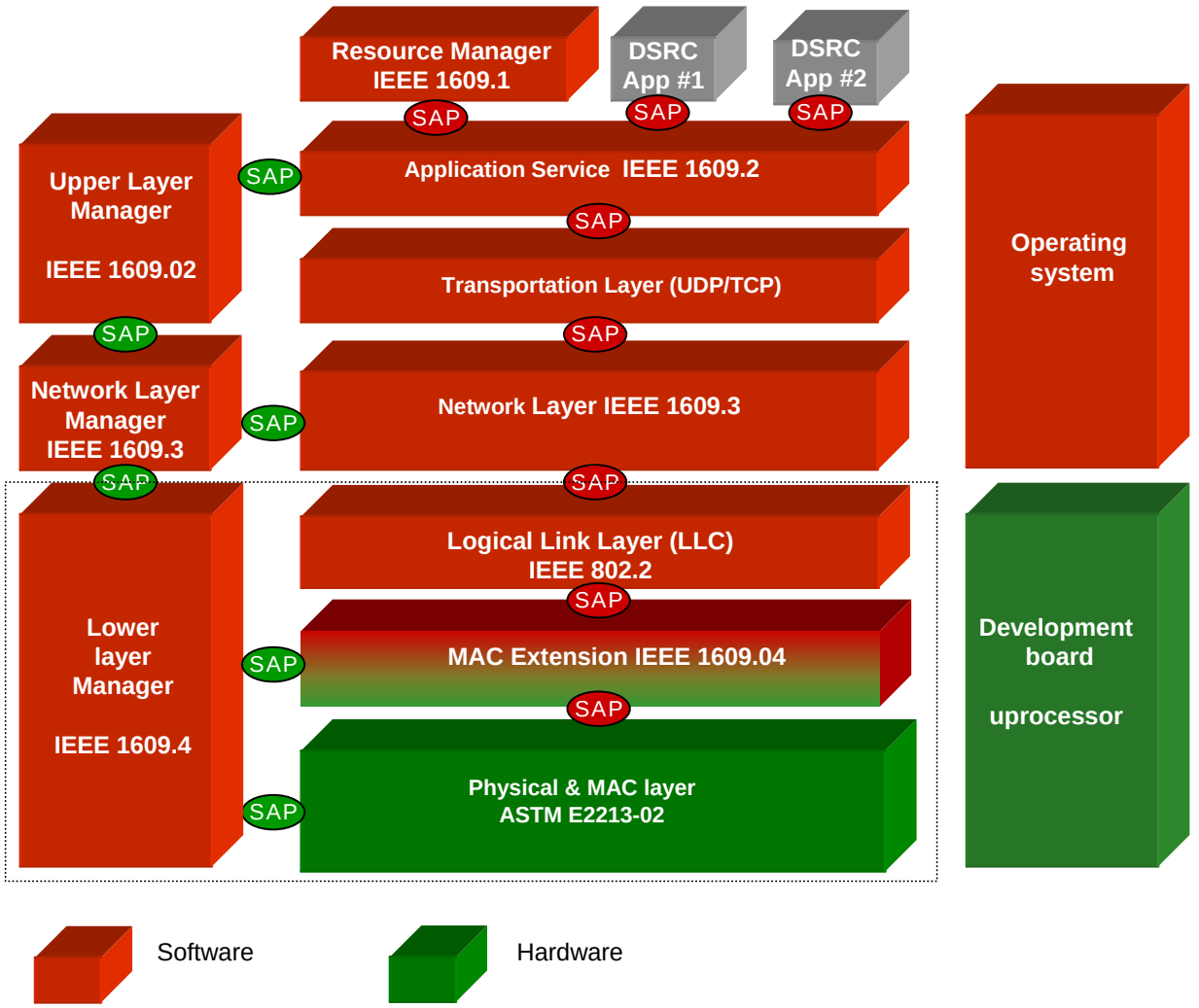
DSRC Solution Elements



5.9 GHz DSRC –

Why are we moving to it?

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5.9 GHz DSRC – The Incentive

- Safety is the primary catalyst

- 1960s – safety goal led to the seatbelt
  - Survive the crash
- 1980s – safety goal led to the airbag
  - Survive a worse crash
- 2000s – new safety goal enabled by new technology
  - Eliminate the crash

And DSRC is the heart of the technology advance

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How / When?

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A Realistic Timeframe

- Complete the standards: 1Q 2005
  - Balloted/approved: 3Q 2005
- Delivery of prototypes: 4Q 2005
  - Report on Prototypes – TP74 – Friday @ 9:00AM
- Tests & more tests: 2006-2008
  - Model deployments: 2007-2008
- Deployment decision: Mid-2008
- Vehicle decision: Mid-2008
- Vehicle implementation: 2010
  - Fast ramp-up could achieve 50 million vehicles by 2015

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The Applications?

Present-day ‘Old’ Technology Supports….

- Roughly 10 Applications:
  - Electronic tolling
  - Traffic management
  - Parking payments
  - Certain e-commerce (m-commerce)
  - Commercial vehicle weigh-station bypass
  - Electronic border clearance
  - Fleet management
  - Access control
  - A few others
- Limited by basic nature of the technology

5.9 GHz DSRC Application Types

- Vehicle Safety: 50 - 60 applications
- Public Safety: 10 - 15 applications
  - Includes Tolling & Traffic Management
- Other – approximately 40 applications
  - Numerous vehicle-centric payment systems
  - e-commerce
  - Fleet / CVO
  - Everything else

- TOTAL: up to 125 applications presently defined

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Vehicle Safety Applications - RSU -> OBU

- Enhanced route guidance and navigation
- Point of interest notification
- Map downloads and updates
- GPS correction
- Curve speed warning
- Highway/rail collision warning
- Adaptive headlight aiming
- Adaptive drivetrain management
- Merge assistant
- Pedestrian crossing information
- Pedestrian/children warning
- School zone warning
- Animal crossing zone information
- Sign information - dips, rough road
- Low parking structure warning
- 'Keep clear' warning
- Wrong-way driver warning
- Low Bridge Warning
- Work Zone Warning
- Left turn assistant
- Stop sign movement assistance
- Infrastructure Intersection Collision Warning
- Traffic Signal Warning
- Stop Sign Warning

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Vehicle Safety Applications - OBU -> RSU

- Emergency Vehicle Signal Preemption
- Intelligent on-ramp metering
- Intelligent traffic lights
- Infrastructure based traffic management - probes
- SOS services
- Post-crash warning
- Just-in-time repair notification
- Blind merge warning

Vehicle Safety Applications - OBU -> OBU

- Merge assistant
- Blind merge warning
- Highway/rail collision warning
- Pre-crash sensing
- Cooperative glare reduction
- Instant problem messaging
- Vehicle-based road condition warning
- Vehicle-to-vehicle road feature notification
- Curve speed warning
- Electronic brake lights
- Enhanced differential GPS corrections
- Vehicle-to-vehicle intersection collision warning
- Lane change assistant
- Blind spot warning
- Post-crash warning
- Visibility Enhancer
- Cooperative collision warning
- Cooperative vehicle-highway automation system (platooning)
- Approaching emergency vehicle warning
- Cooperative adaptive cruise control
- Approaching emergency vehicle warning
- Hybrid intersection collision warning
- Left turn assistant
- Stop sign movement assistance

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Public Safety Applications

- Electronic Tolling
- Electronic Traffic Management
- Emergency Vehicle Signal Preemption
- Vehicle-to-Vehicle Data Transfer
- Approaching Ambulance, Police Car, Fire Truck
- Video Links
- Safety Warnings (numerous)

And many more

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‘Everything Else’ Applications

- Most of the ‘old’ applications
- Congestion alert – perhaps in time to exit
- Distance to next exit or toll point
- Toll amount at next toll point
- Account balance
- Distance to rest area / service area
- Services available at service area
- Map databases
- News, music, etc.
- Mobile internet
- Traveler Information
- Rental car operations
- Repair service records
- Diagnostic data transfer
- Vehicle software updates
- Safety inspections
- Drivers daily logs
- Tractor-trailer communications
- Tractor-trailer matching
- Transit vehicle data transfer
- Transit vehicle fuel management

And many more

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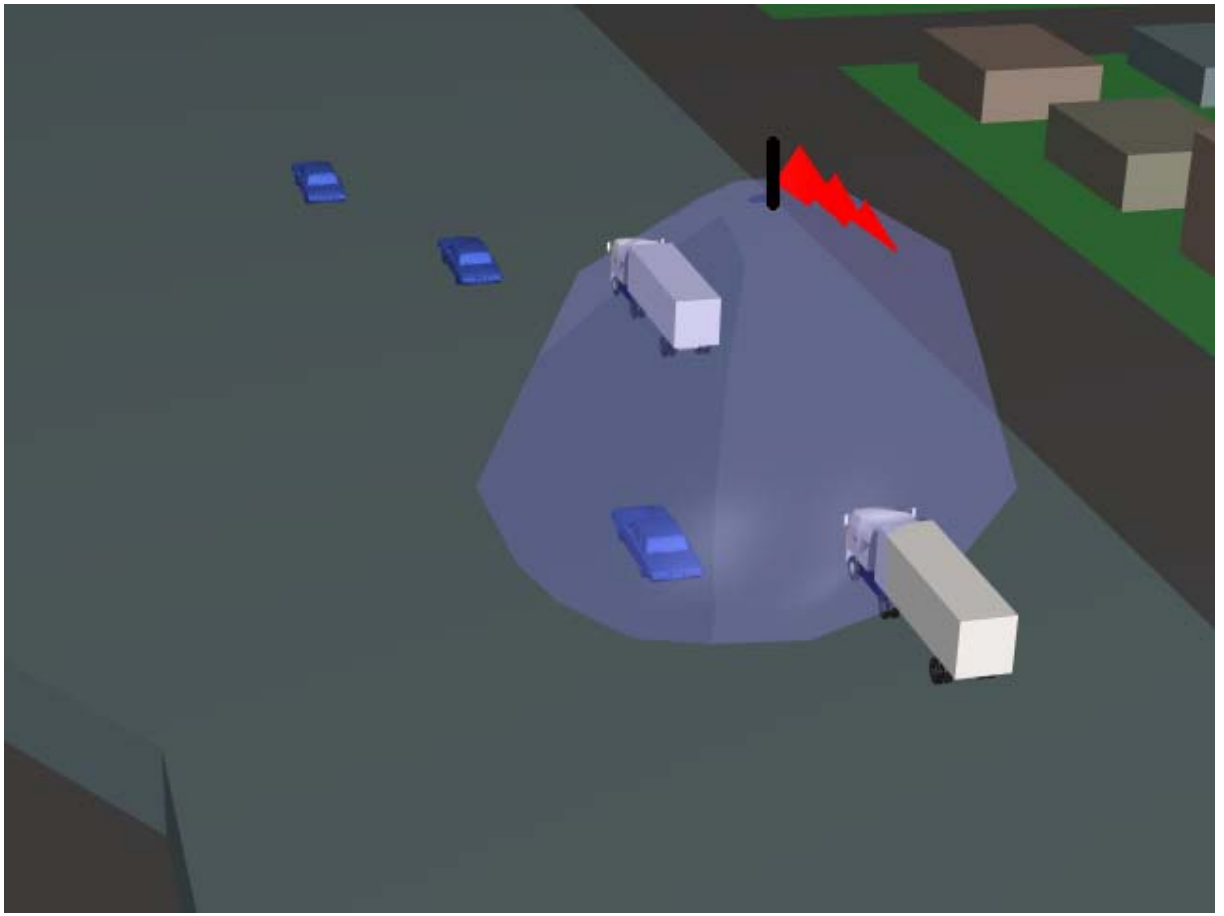
Many Safety Applications are Warnings



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Today – Everything is signage

NARROW BRIDGE - WARNING SIGN

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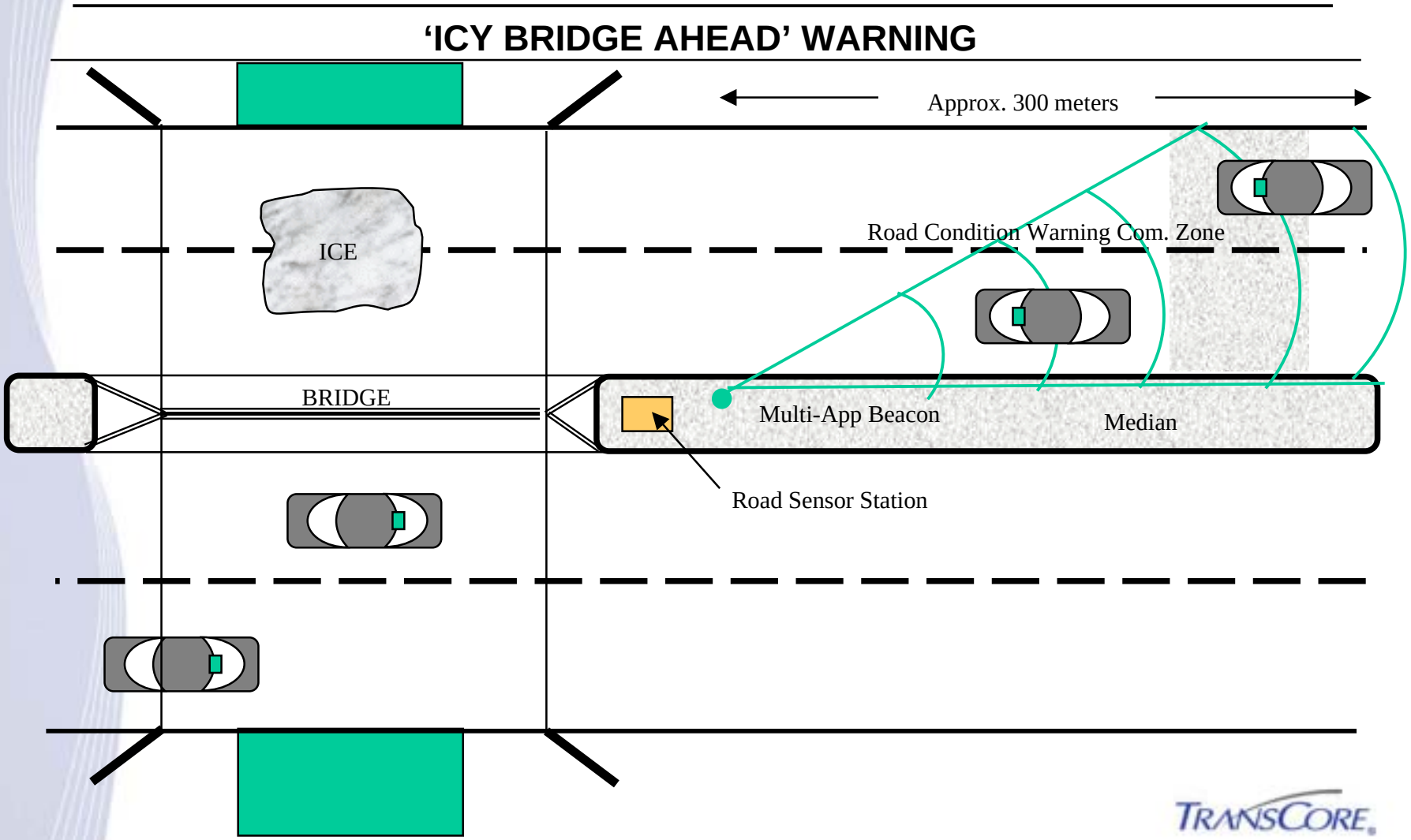
Tomorrow – In-car warnings via DSRC



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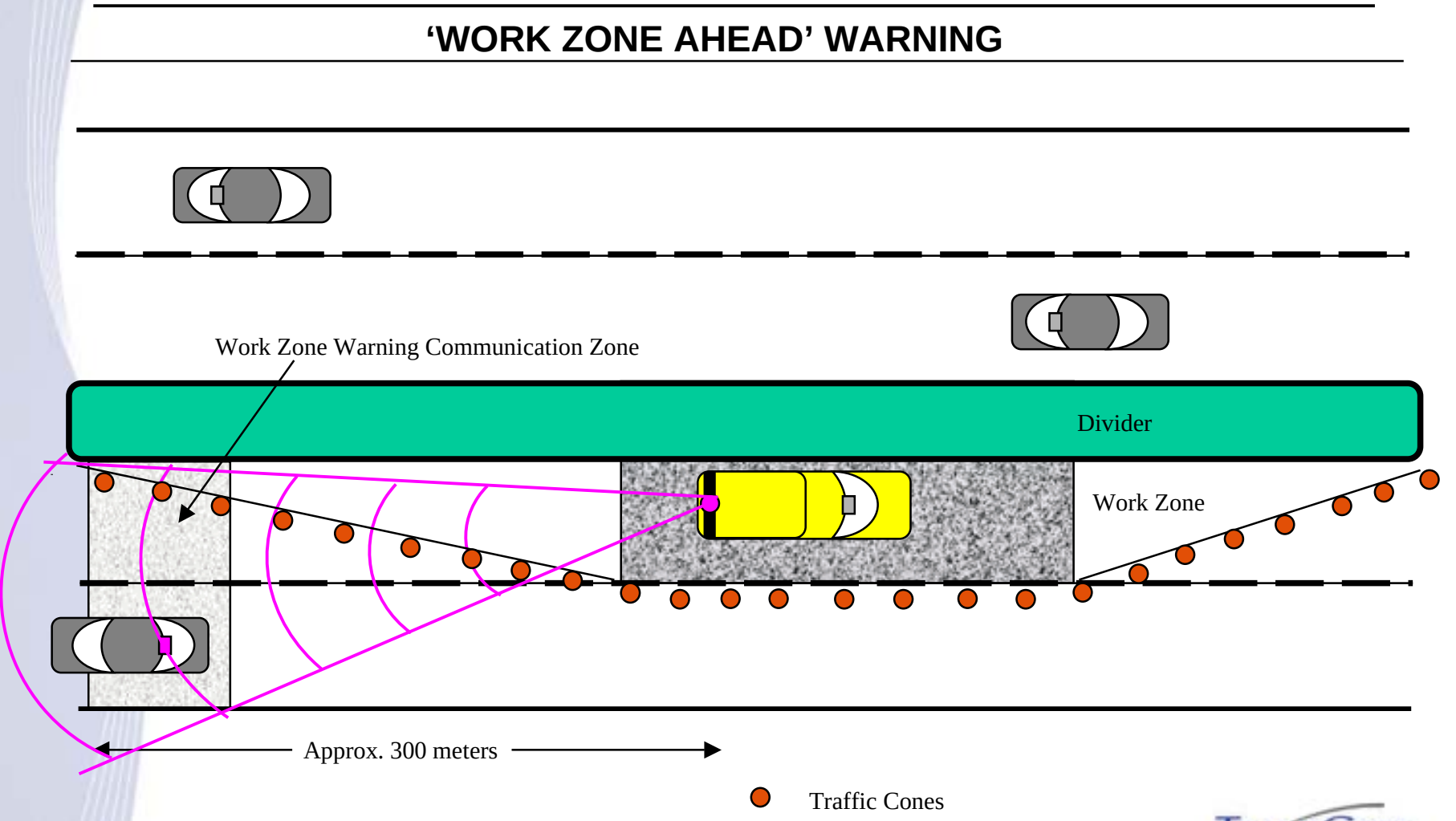
Work Zone Safety



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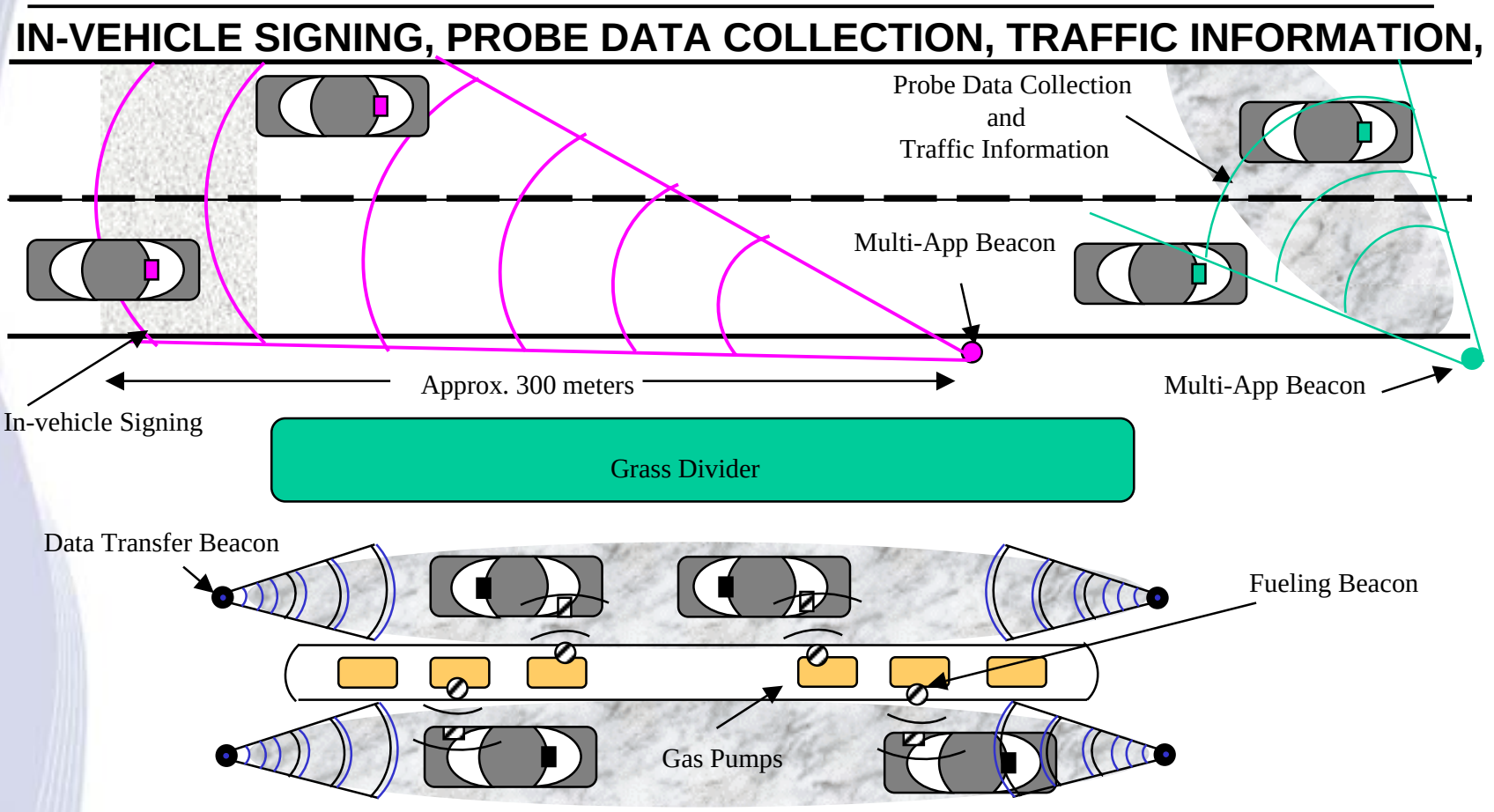
Fueling & Info-Fueling Near the Road



GAS PAYMENT and Data Transfer

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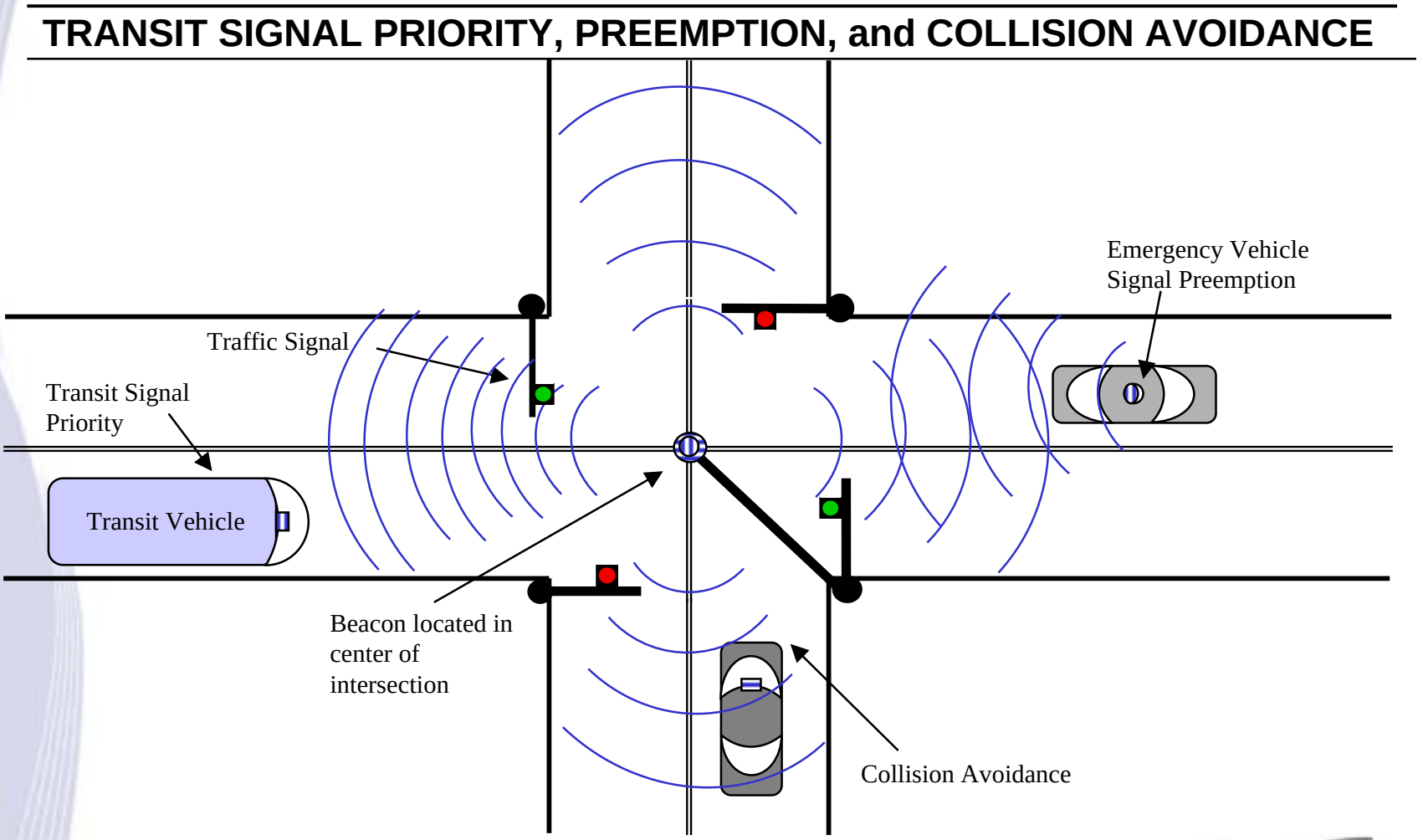
The Intelligent Intersection



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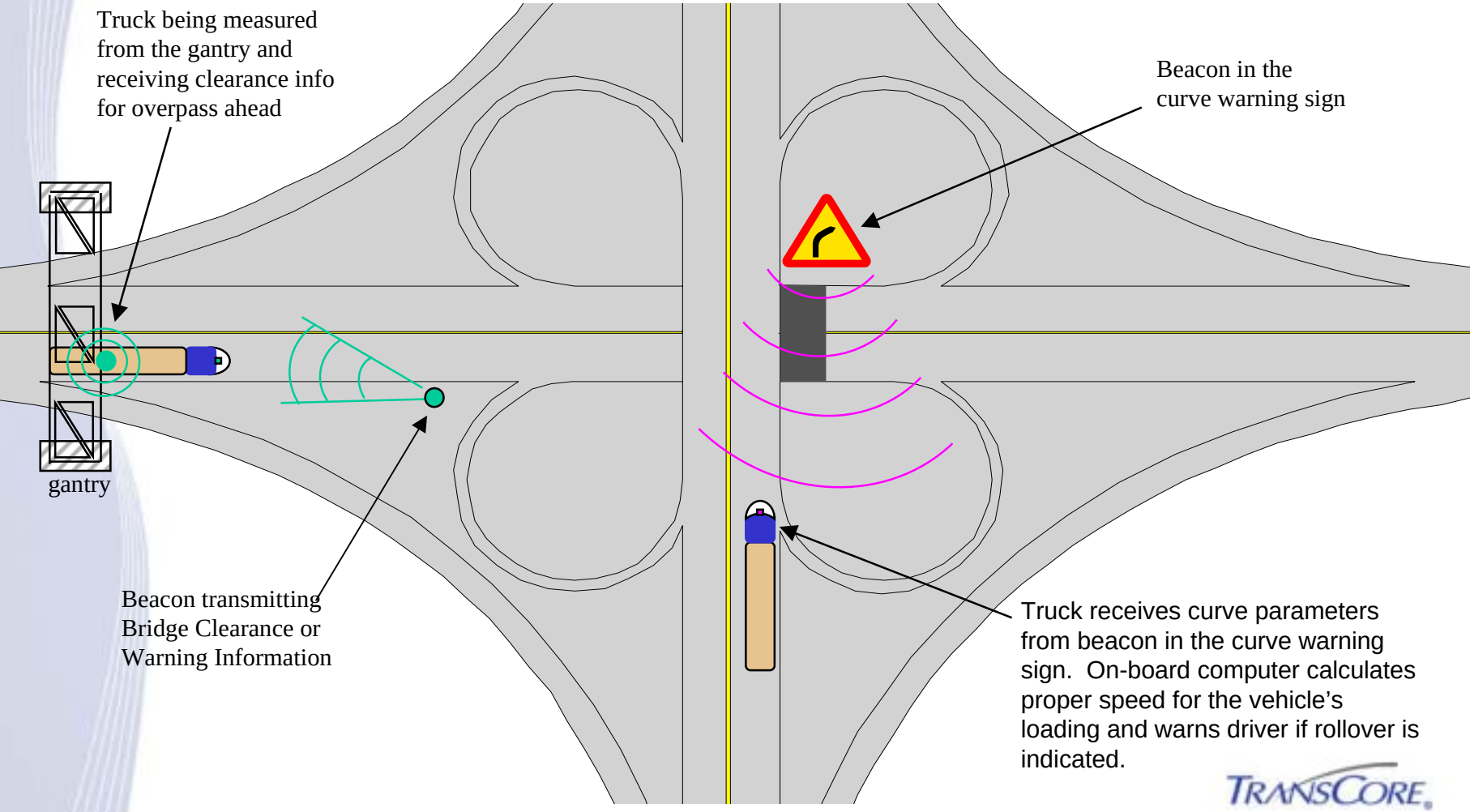
CVO - Centric Applications

LOW BRIDGE WARNING and ROLL OVER WARNING



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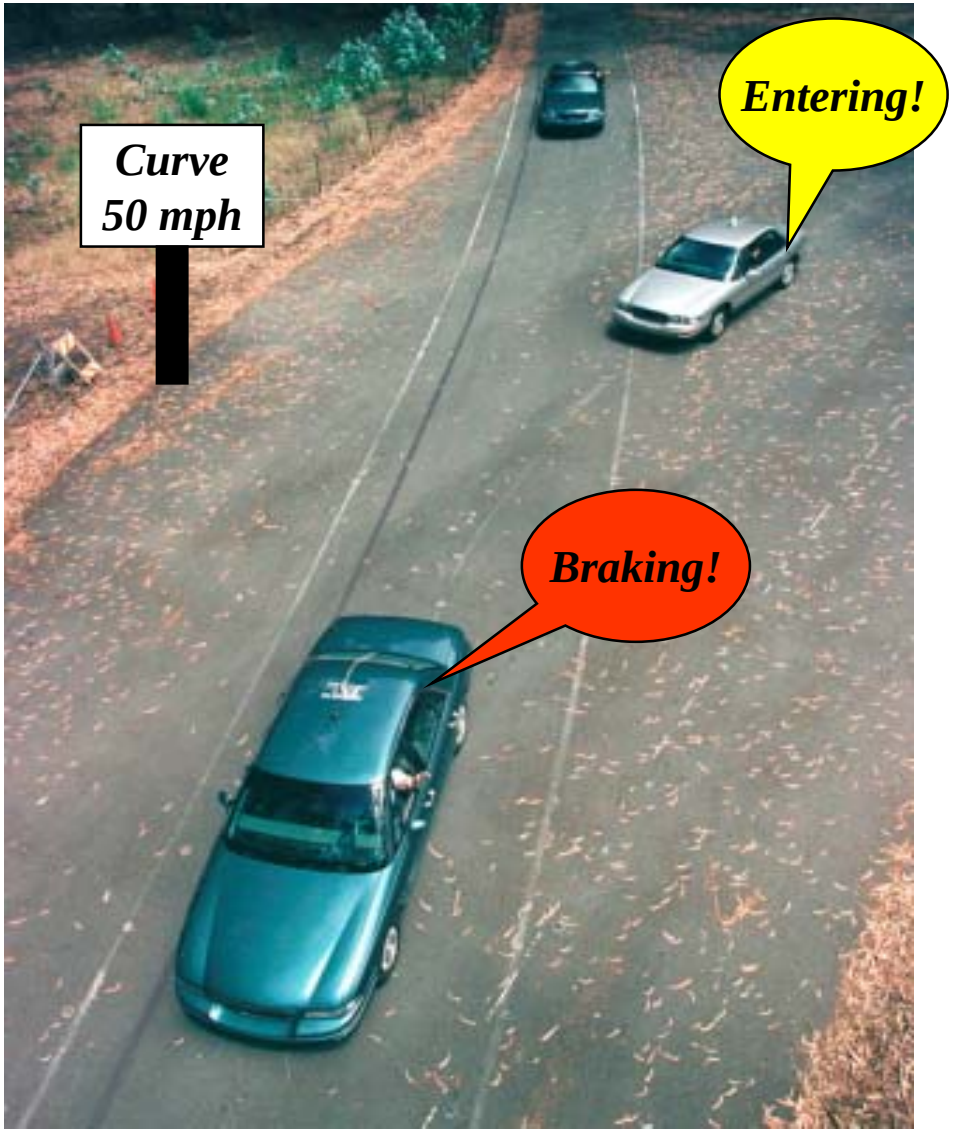
Cooperative Vehicle Operations



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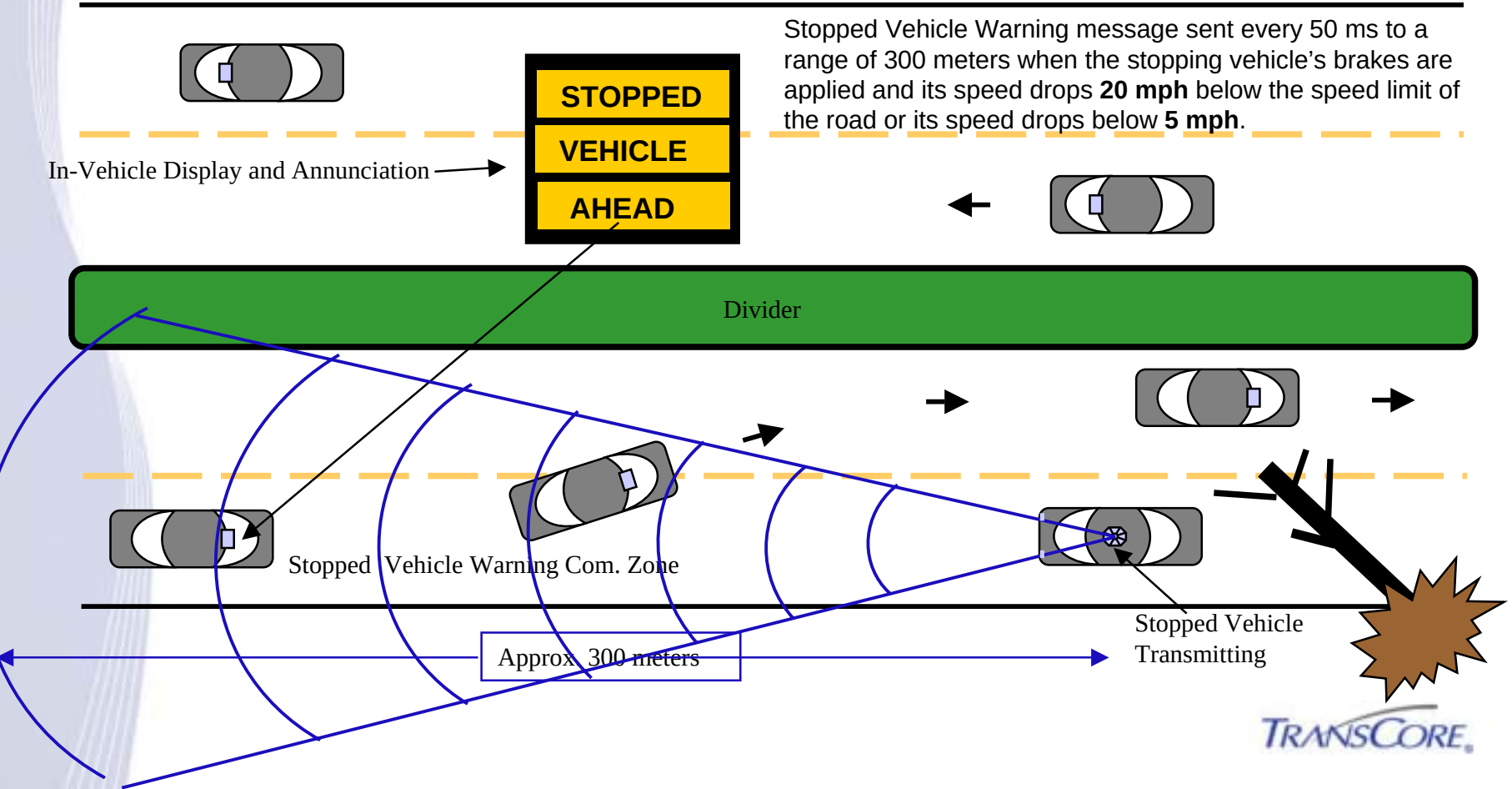
Vehicles Talking to Vehicles

VEHICLE TO VEHICLE COLLISION AVOIDANCE - STOPPED VEH. WARNING



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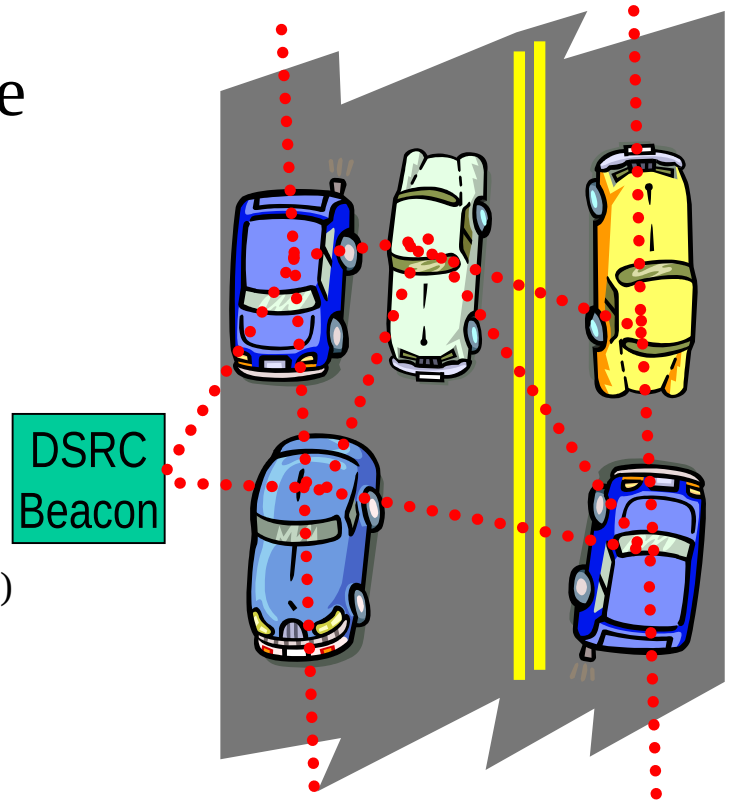
Mobile Networks Include the Roadside

- Cooperative route planning
- Cooperative accident avoidance
- Propagation of data
  - Weather
  - Traffic
  - News
  - Entertainment (audio, MP3 file download)



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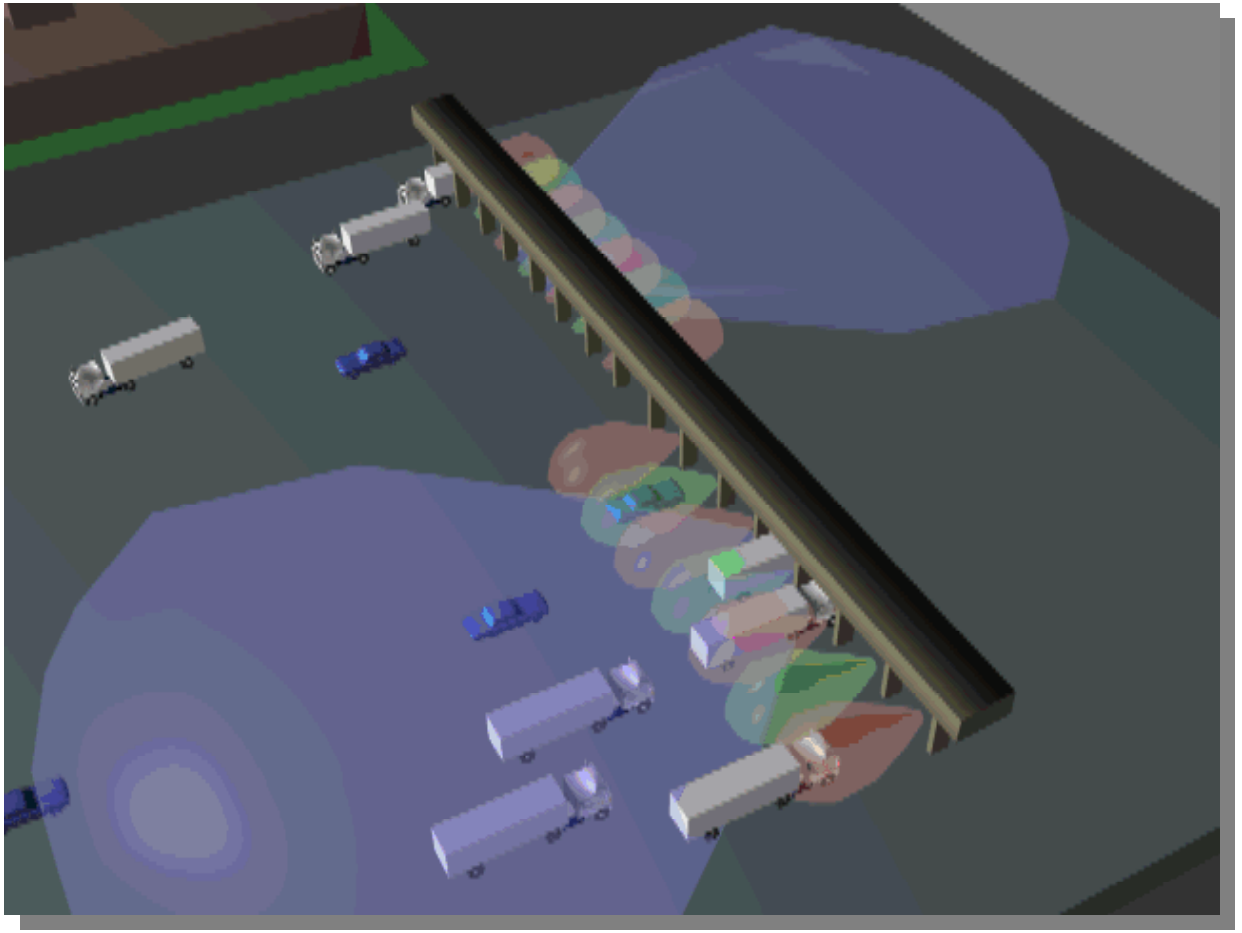
Toll Collection – Plaza Zones



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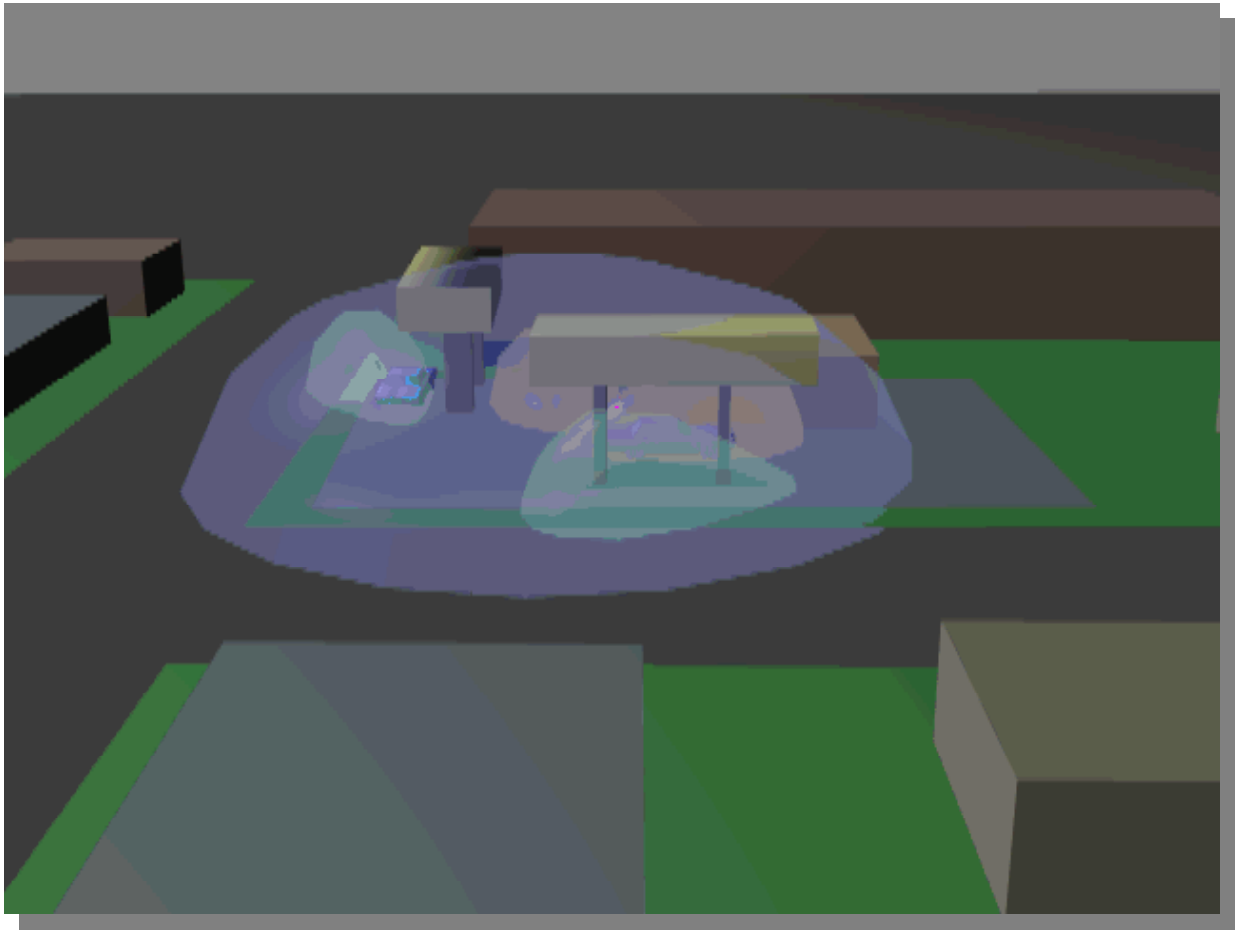
Zones Within Zones

FUELING STATIONS



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The Applications Define the System

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Applications Analyzed

Type	# of Appls	RSU-to-OBU	OBU-to-OBU
Vehicle Safety	55	32	23
Traveler Information (TI)	13		
CVO	10		
Payment	7		
Public Safety	3		
Other	2		
Totals	90		

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Communications Range

Range (meters)	Number of Applications	Veh. Saf.	Traveler Info	CVO	Pay	Public Safety	Other
1000	2	1	1	0	0	0	0
300	38	33	2	0	0	3	0
100	28	21	4	3	0	0	0
50	12	0	1	6	4	0	1
10	10	0	5	1	3	0	1
Totals	90	55	13	10	7	3	2

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Communications Range Requirement

- **Decision: Use 300 meters as basic communications range requirement**
  - RSU
    - Power 20 dBm with 15 dB antenna gain
    - Downlink Margin 14.6 dB
  - OBU
    - Power 20 dBm with 3 dB antenna gain
    - Uplink Margin 14.6 dB
  - OBU/OBU
    - Power 20 dBm with 3 dB antenna gains
    - Link Margin 3dB

- Unsupported Applications:
  - Emergency Vehicle Signal Preemption (VS): Needs 1000 meters
  - Video Data – Streaming (TI): Needs 1000 meters

Data Rate

Data Rate	Number of Applications	Veh. Saf.	Trav. Info	CVO	Pay	Public Safety	Other
12 Mbps	5	2	2	1	0	0	0
6 Mbps	7	2	4	1	0	0	0
3 Mbps	6	5	0	0	0	1	0
1 Mbps	72	46	7	8	7	2	2
Totals	90	55	13	10	7	3	2

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Data Rate Requirement

- **Decision: Use 6 Mbps as basic data rate requirement.**
  - Does not require higher alphabet modulation schemes.
  - Increases performance comm. range because lower S/N is required at receiving unit.
  - Eliminates higher data rate performance issues in fading channel conditions.

- Unsupported applications:
  - Platooning (VS): Needs 12 Mbps
  - Cooperative Collision Warning (VS): Needs 12 Mbps
  - Tractor-trailer Interface (CVO): Needs 12 Mbps

Vehicle Speed

Speed (kph)	Number of Applications	Veh Saf.	Trav. Info	CVO	Pay	Public Safety	Other
320	11	10	0	0	0	1	0
200	39	24	6	5	2	1	1
100	22	18	1	1	1	1	0
50	7	3	1	2	0	0	1
30	7	0	4	0	3	0	0
0	4	0	1	2	1	0	0
Totals	90	55	13	10	7	3	2

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Vehicle Speed Requirement

- **Decision: Use 320 kph as basic speed requirement**
  - Speed has been a DSRC benchmark for decades and limitation of speed will generate ‘bad press’.
  - Issue is not processing or RF performance but rather testing issue.
    - Analyze performance but do not include in verification testing.
- No applications are unsupported

Latency Time

Latency	Number of Applications	Veh. Saf.	Trav Info	CVO	Pay	Public Safety	Other
50 msec	6	3	0	1	2	0	0
100 msec	34	21	5	5	1	2	0
200 msec	38	30	3	2	1	1	1
500 msec	12	1	5	2	3	0	1
Totals	90	55	13	10	7	3	2

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Latency Time Requirement

- **Decision: Use 50 ms as basic latency requirement**
  - Supports high speed transaction vehicle payment transactions.
  - Prototypes could be used to demonstrate toll collection operation.
  - Prototype could be used where OBU to Vehicle correlation is required.
- No applications are unsupported

Transaction Size

Trans Size	Number of Applications	Veh. Saf.	Trav. Info	CVO	Pay	Public Safety	Other
Unlimited	5	0	3	2	0	0	0
100K	4	1	3	0	0	0	0
20K	5	1	3	0	0	1	0
5K	10	7	2	1	0	0	0
2K	59	46	2	6	1	2	2
1K	7	0	0	1	6	0	0
Totals	90	55	13	10	7	3	2

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Transaction Size Requirement

- **Decision: Use 20K bytes as basic size requirement**
  - Transaction can be executed in one Service Channel Time.
  - Minimize the processing complexity required to suspend an application and return to the Control Channel.
  - When Service Channel Time is disabled, then unlimited data transfer should be possible.

- Unsupported applications:
  - Audio Transfer – Block (TI): Needs 100K bytes
  - Map Updates (TI): Needs 100K bytes
  - Mobile Internet (TI): Needs 100K bytes
  - Audio Transfer – Streaming (TI): Needs unlimited bytes
  - Video Transfer – Block (TI): Needs unlimited bytes
  - Map Downloads/Updates (VS): Needs 100K bytes
  - Transit Vehicle Data Xfer (CVO): Needs unlimited bytes

Response Required

- **Decision: Implement Response-required function**
  - It is a baseline capability for almost all applications.
  - Only 3 of the 90 applications do not require a response.

- No applications are unsupported

Summary

Interest is growing in DSRC-enabled applications

- Both safety initiatives and business opportunities are providing incentive to proceed rapidly
- 5.9 GHz DSRC developments are accelerating
- Money is flowing into development projects
- Automakers are supporting the program
- Planning for large-scale tests (MDIs) is underway
- 2005-2006 will be pivotal years in these developments

Remember: TP74

Friday, 9:00-10:30AM

Report on 'USA's 5.9 GHz DSRC Prototype Development Program

- For more information:

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