Kapsch TrafficCom

EXPLORATORY ADVANCED RESEARCH PROGRAM

FHWA BAA DTFH61-09-R-00004

Project Kickoff

November 4-5, 2009

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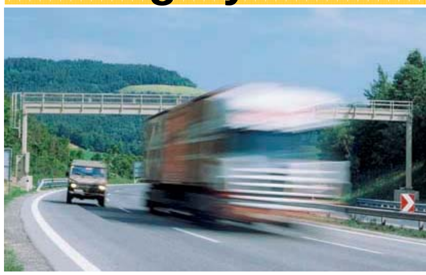
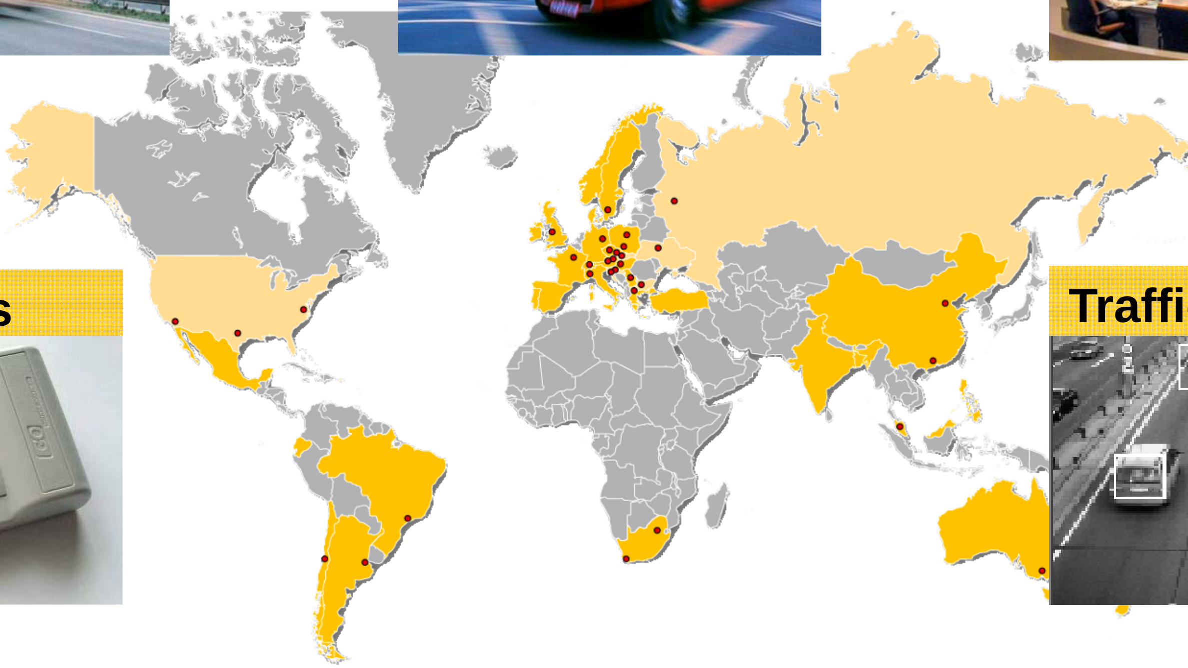
Kapsch is a global supplier of transportation and tolling systems

Tolling Systems



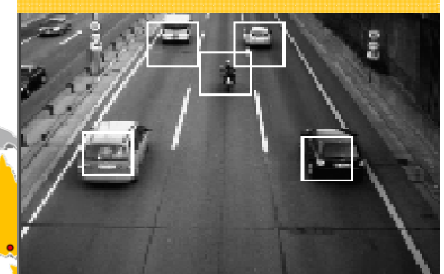
Urban Traffic Solutions

Operations



Components

Traffic



Offices References

Kapsch TrafficCom Project History

Global supply to date

- Over 140 references in over 30 countries
- 3 out of 4 contracts for nationwide systems in Europe
- 13 million On-Board Units (OBUs) worldwide
- 11,000 equipped lanes worldwide

Project Highlights

	Australia Projects	Chile Projects	Swiss Truck Tolling System	Austria Truck Tolling System	Czech Truck Tolling System
Start:	1999	2001	2001	2004	2007
Lanes:[1]	~ 250	~ 270	~ 380	~ 2,700	~ 1.200
OBUs:[1]	~ 3 m	~ 1.2 m		~ 0.8 m	~ 0.7 m
Revenues to date:[2]	€ 101.9 m	€ 92.9 m	€ 33.4 m	€ 337.0 m	€ 184.3 m
2007/08:[3]	€ 21.9 m	€ 18.0 m	€ 3.5 m	€ 27.7 m	€ 78.1 m

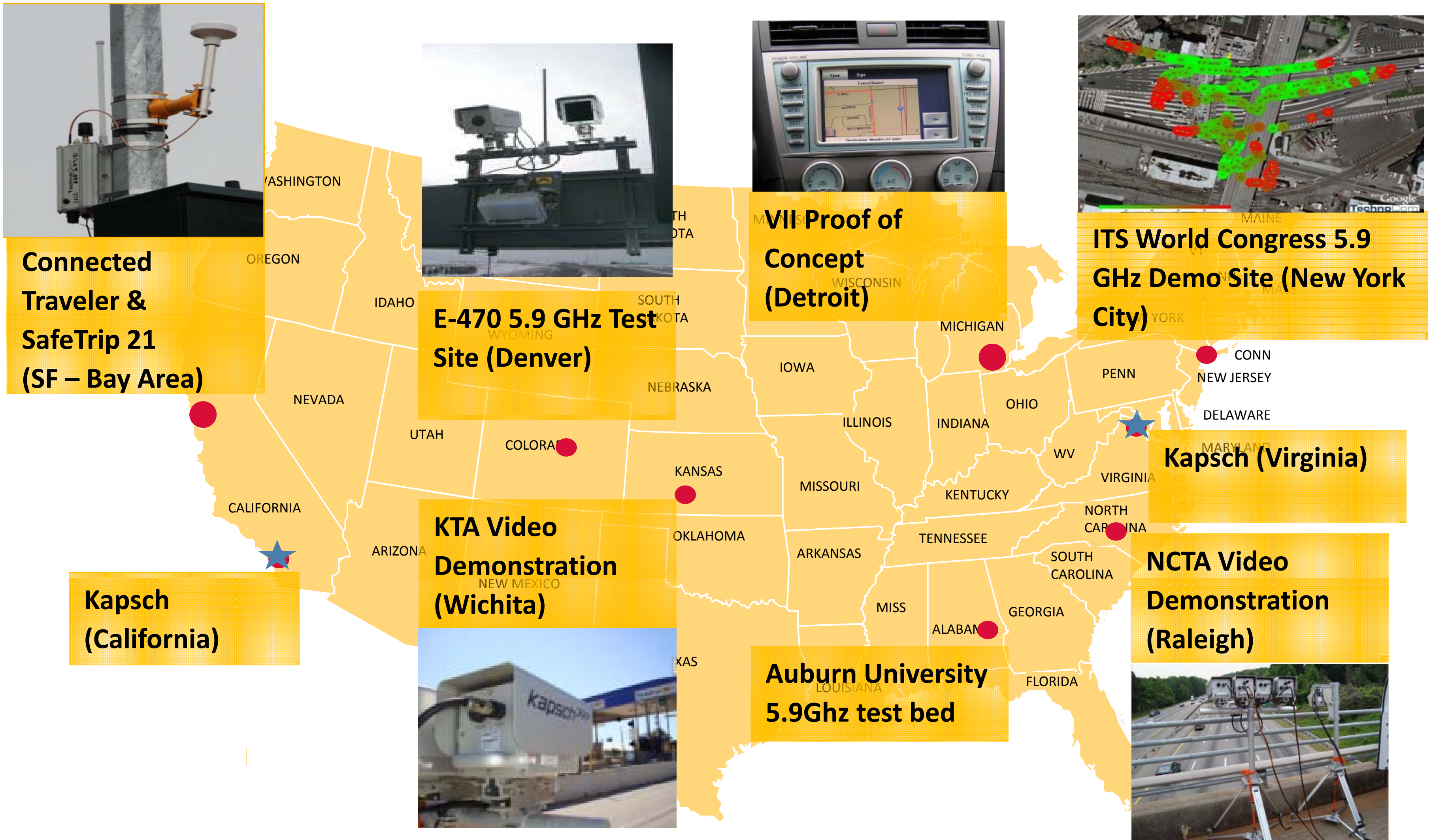
	Start:
New Zealand	2008
South Africa	2010
India	2008

1 Reference projects may include contracts awarded, system in implementation, in full operation or operation finalized.

2 Revenues as of 31 March 2008

3 1 April 2007 – 31 March 2008; Total of RSP and SEC segment

Kapsch in the USA



Connected Traveler & SafeTrip 21 (SF – Bay Area)

E-470 5.9 GHz Test Site (Denver)

VII Proof of Concept (Detroit)

ITS World Congress 5.9 GHz Demo Site (New York City)

Kapsch (California)

Kapsch (Virginia)

KTA Video Demonstration (Wichita)

Auburn University 5.9Ghz test bed

NCTA Video Demonstration (Raleigh)

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What is 5.9 GHz DSRC?

5.9 GHz DSRC is a secure wireless communication technology for point-to-point communication among Vehicles, as well as Vehicle to ITS infrastructure.

Purpose:

Provides rapid and secure exchange of information among vehicles and intelligent road infrastructure

Features:

Frequency	FCC allocated 75MHz licensed band (5.875 – 5.925GHz)
Data speed	High (3-27 Mbps)
Latency	Low (milliseconds)
Range	Short (up to 1000m, typical 50-300m)
Secure	Support message authentication and encryption
Built on open standards	IEEE 802.11p, IEEE 1609, SAE J2735

Applications:

- Vehicle collision warnings and cooperative safety systems, probe data collection
- Electronic toll payments
- Commercial vehicle e-Screening
- Travel information, Signage, Warnings

5.9GHz versatility to meet user and applications needs

User Benefits

Safety
- VII collision avoidance applications

Reduced Congestion
- Real time traffic info, including signal timing and signal priority for transit vehicles

eCommerce
- Payment applications (Parking, roadside purchases)
- Infotainment

Banking-grade Security
- Security that protects user privacy for payments and related applications,

5.9 GHz DSRC System

Agency Benefits

Maximum Tolling Revenue
- Interoperable free flow tolling & future related applications
- Variable pricing

Open Procurement
- Interoperability creates open procurement from multiple bidders in competition

Mobility
- Lane localization enabling HOT lanes & congestion management

Scalability
- Applications & systems are combined seamlessly
- Cross-border revenue sharing

Automakers interest in 5.9GHz DSRC

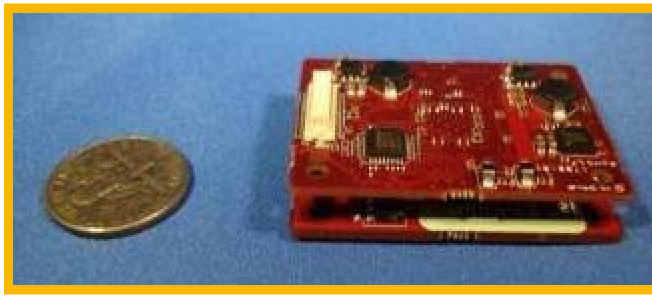
- Nine (9) light-duty vehicle manufacturers formed VIIC
- Automotive OEMs develop *pre-competitive* safety technologies
- VIIC together with US DOT developed Detroit Test Environment system
    - Kapsch provided radio technology for on-board unit and Road-Side units

Kapsch 5.9 technology and products

5.9GHz Roadside Communication Equipment

5.9GHz Vehicle Onboard Unit

Small size fits variety of devices & applications



5.9GHz DSRC embedded module

Roadway services (commercial vehicles, transit, emergency priority, parking access, parking payment)

In-vehicle safety notification (OEM and aftermarket)

Commercial vehicle services

5.9 GHz DSRC technology in use

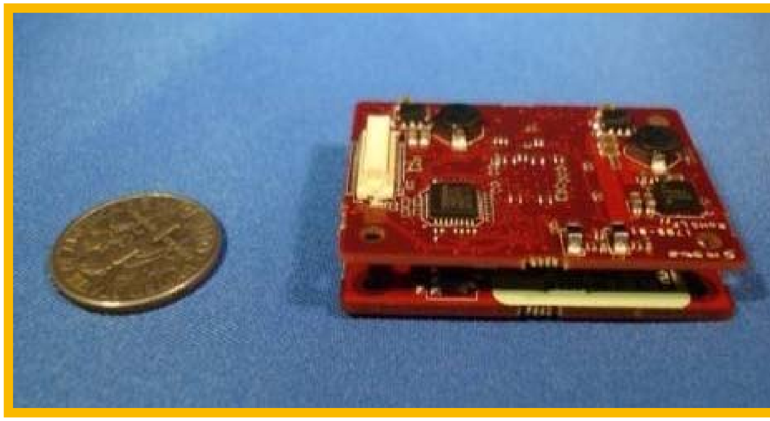
Kapsch is the only company worldwide providing 5.9 GHz DSRC technology and services for both the CVIS and VII Proof-of-Concept programs

5.9 GHz DSRC roadside equipment is installed in over 200 locations world wide

- Detroit (100 units)
- California (30 units)
- New York City (45 units) – Tolling & VII demo at ITS World Congress 2008
- New York State Thruway (18 units)

5.9 GHz DSRC OBUs are installed in over 400 trials globally

- VII Consortium 5.9 GHz DSRC supplier
- New York ITS World Congress
- New York Commercial VII trial
- CVIS program in Europe (ERTICO)

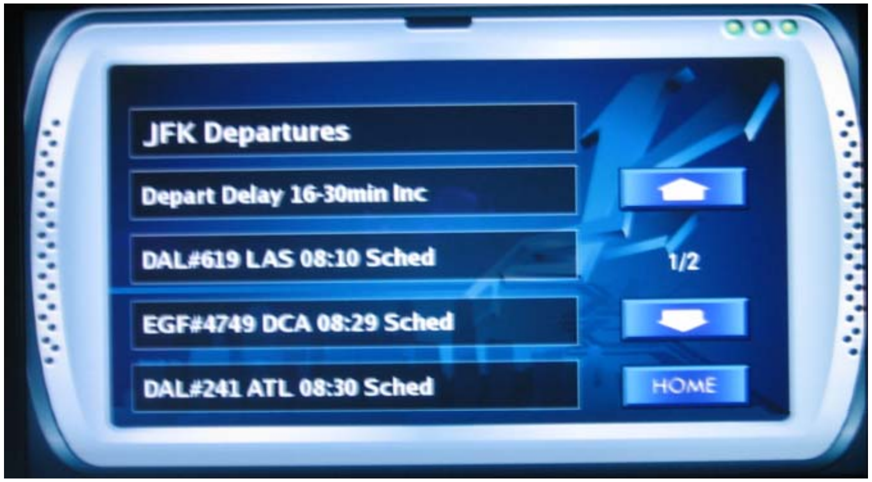


New York 5.9GHz test bed at the 2008 ITS World Congress

- 40+ RSEs installed in New York City and Long Island for demonstration
- Demonstrated 20+ applications in New York city and Long Island
- Installation managed from a traffic management center in LIE
- All DSRC radios are synchronized by GPS accurate clock.
  - Select RSEs were used to broadcast D-GPS augmentation messages to vehicles

RSE sites in NY city and Long Island

Examples of 5.9GHz applications (infrastructure enabled)



Tolling and Enforcement Station – Enforcement Sequence

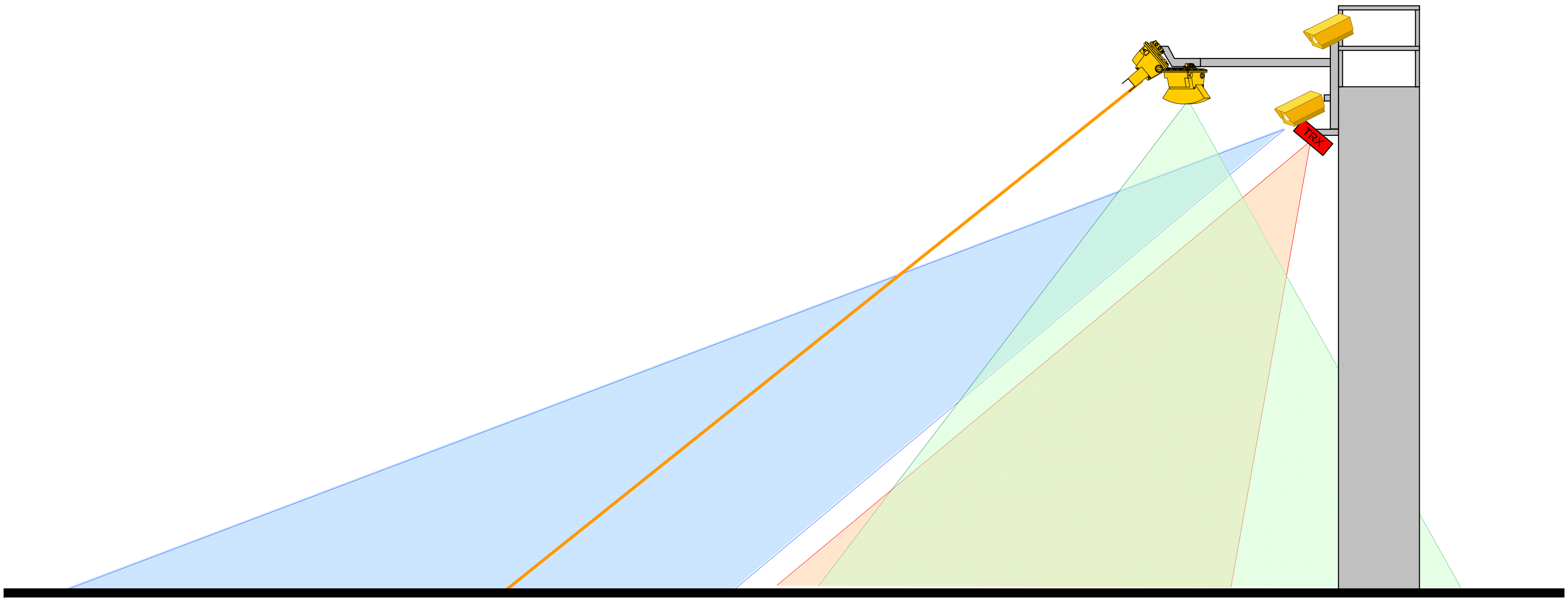
Detection

Image generation

DSRC communication

Classification

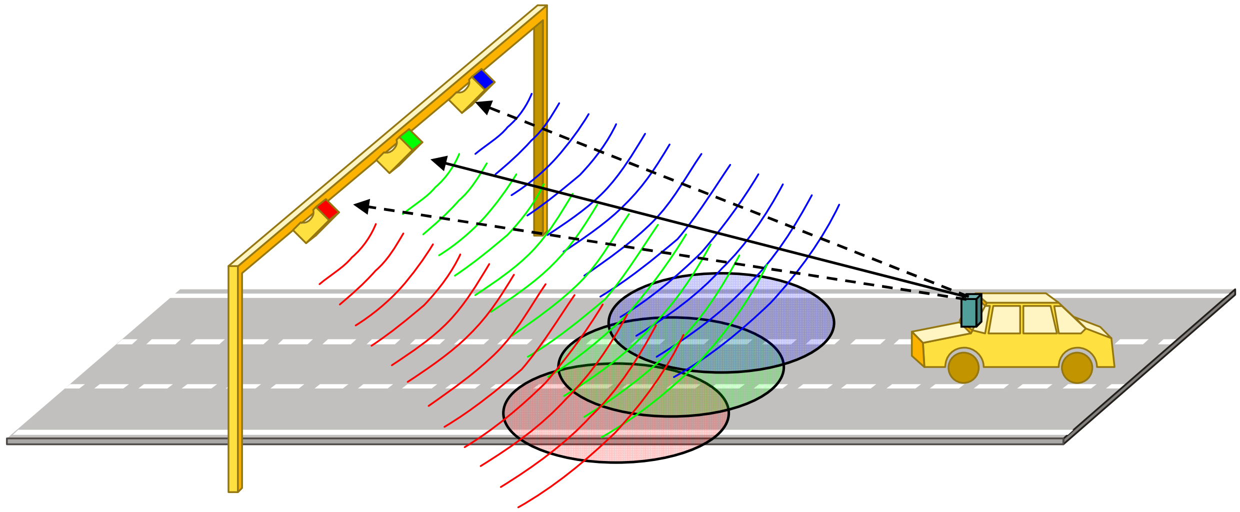
Enforcement decission and transfer to Central System



Vehicle localization using tolling transcievers

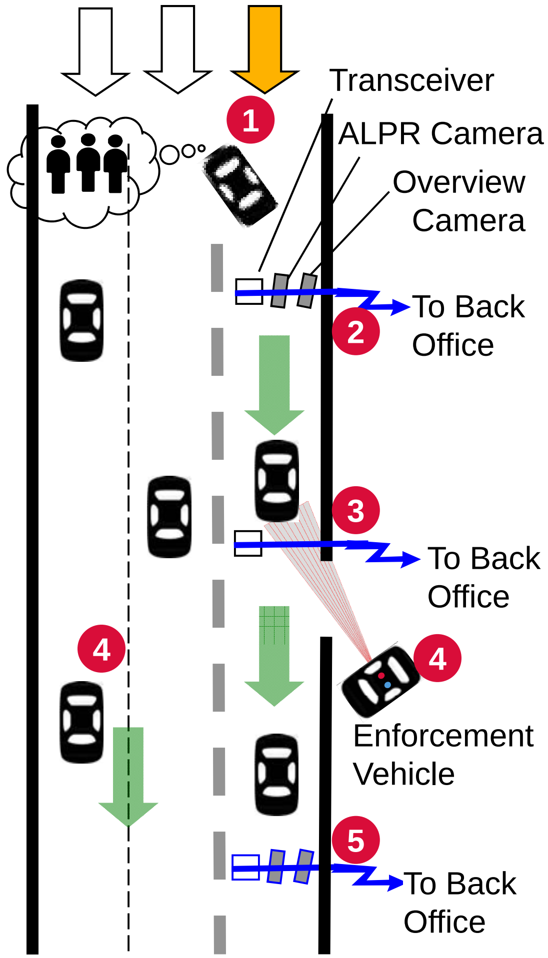
Determine vehicle lane localization

- RSE sends focused RF beams to communication with OBEs
- OBE exchanges toll transaction data with the RSE
- RSE triangulates OBE location
  - OBE signal strength ~ rough location determination
  - Signal phase (angle of arrival)



Kapsch 5.9 GHz DSRC HOT Lanes Solution

HOT lanes require sub-lane vehicle localization and discrimination for payment processing and enforcement

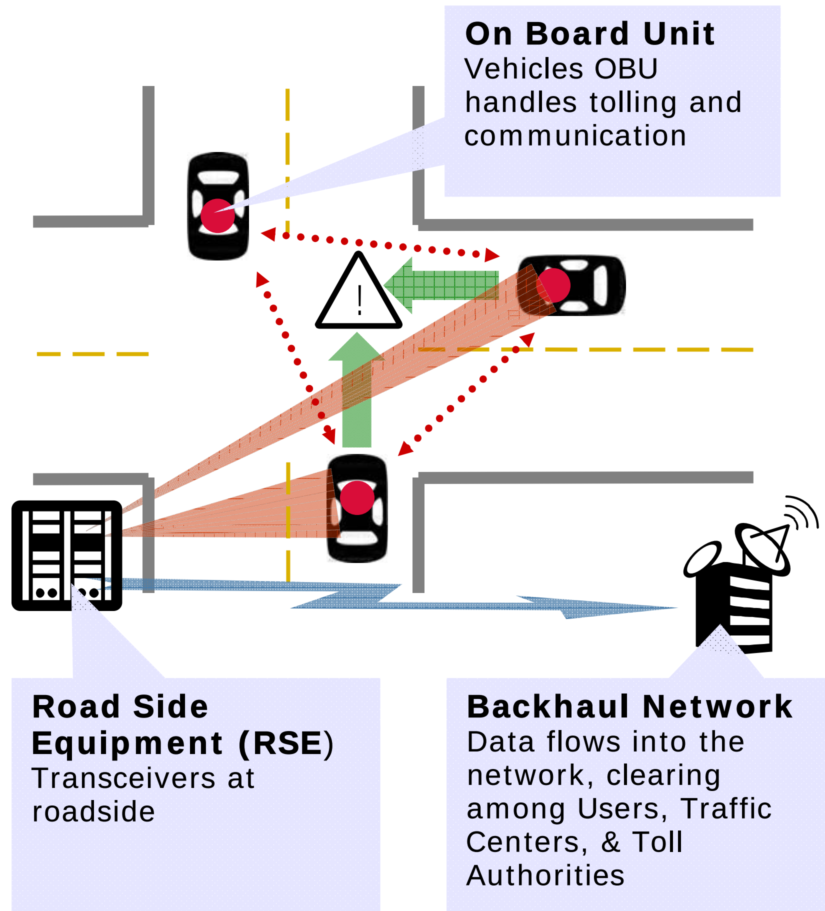


1. Prior to entering the HOT lane, the driver designates the vehicle passenger occupancy on self declaration tag
2. As the vehicle passes the first gantry, the transceiver reads the declared occupancy and processes the correct toll via back office
3. Alternate gantries use transceivers to only write location data to the tag to limit the number of back office connections, increasing coverage of vehicles weaving in and out of lanes
4. Mobile enforcement vehicles verify declared occupancy against observable passengers, using vehicles in adjacent lanes or at roadside to ensure compliance and maximize revenue

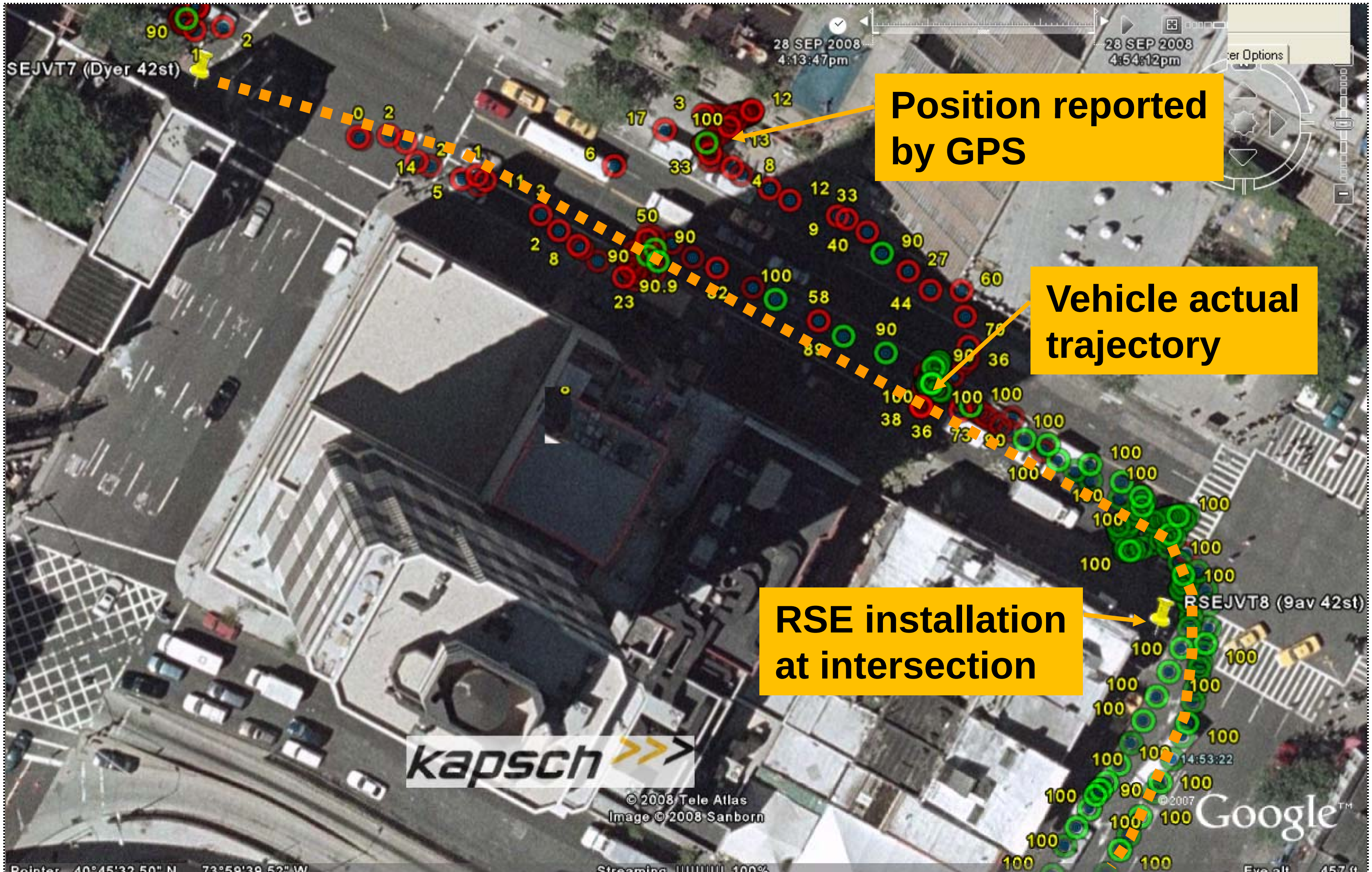
   Enforcement varies based on type of lane barrier (hard vs soft)
5. Subsequent gantries read passenger occupancy data and prior location data from the tag to process the correct toll

5.9GHz DSRC enabling Vehicle-to-Infrastructure and Vehicle-to-Vehicle safety applications at an intersection

- Vehicle-to-vehicle and vehicle-to-infrastructure communication delivering:
  - Increased safety through collision avoidance and accident prevention
- Traffic management through applications including signal optimization and in-vehicle signage
- VII depends on a 5.9GHz interoperable standard to enable communication among different system applications, users, and vendors
- Requires high accuracy vehicle positioning



GPS fluctuations in New York city (Manhattan 9th avenue & 42 street)



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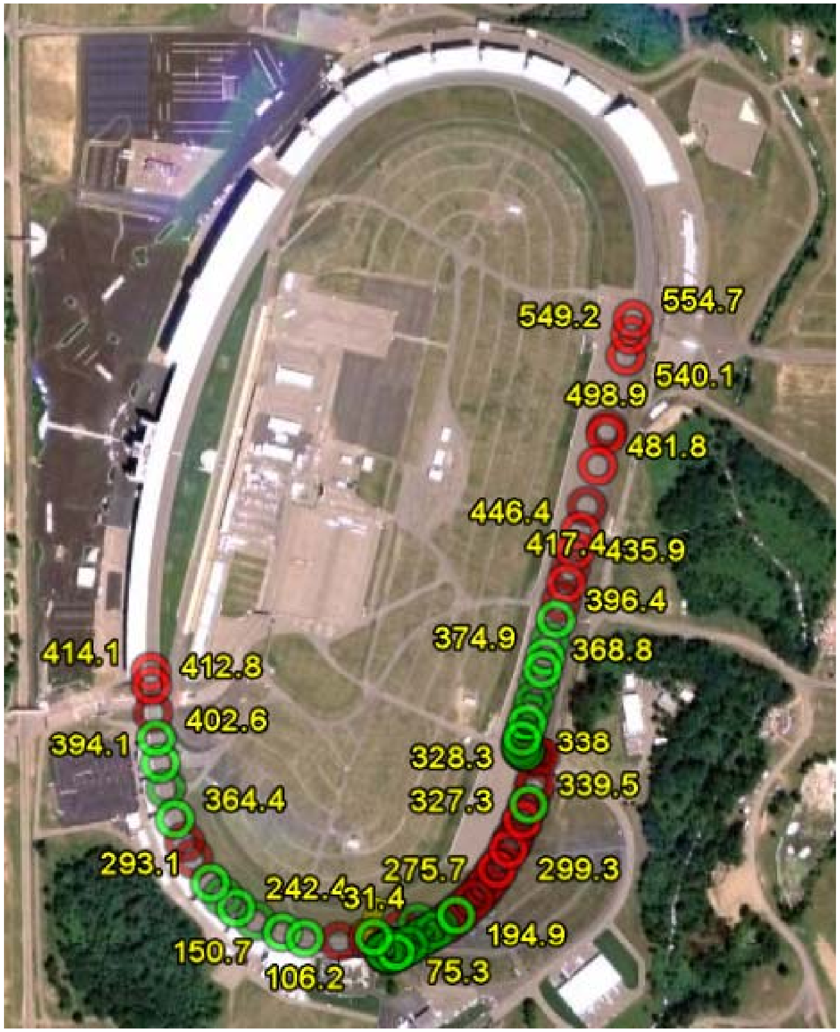
DSRC-Based RF ranging (Phase I)

- Use RF signal ranging for more precise location determination
- Evaluate number of DSRC ranging solutions combining GPS signals and RF ranging information
- Combine location information from other mobile sources, i.e. other vehicles



Kapsch participation in Phase I

- Deploy Kapsch DSRC Roadside units (MCNU) at Auburn Test Track
  - 2 MCNU radio units are included
- Conduct Site Survey for DSRC radio placement
- Equip Auburn Test vehicle with Kapsch DSRC On-Board Unit (MCNU)
- Develop test protocols and framework to collect and analyze DSRC range information
- Work with the Auburn team to collect data
- Report findings to team

Task I Schedule

- Month 1:
  - Preliminary project setup
  - Develop system requirements and testing scenarios
- Month 2:
  - Auburn-Kapsch Equipment Acquisition
- Month 3:
  - Develop RSSI data collection script and regionalization algorithm
  - Conduct lab testing
- Month 4:
  - Conduct site survey.
  - Deploy DSRC Equipment
  - Execute test scenarios
  - Provide report to Auburn
- Month 5:
  - Phase II planning

DSRC-Based RF ranging (Phase II)

- Validate advanced localization system which utilizes next-generation 5.9GHz roadside transceivers and 5.9GHz on-board units.
- Integrate 5.9GHz localization system into IPS.
- Evaluate IPS in roadway scenarios with urban canyons

Kapsch participation in Phase II

- Deploy Kapsch next generation DSRC roadside units with localization capabilities at Auburn Test Track
- Equip Auburn test vehicle with Kapsch DSRC On-Board Unit (MCNU)
- Develop test protocols to validate RSE localization capabilities
- Support testing of the IPS localization in roadway conditions

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Installation of Kapsch DSRC tolling and video enforcement system in a city

5.9 GHz DSRC comparison with 915 MHz

- 5.9GHz delivers superior technical performance due to greater bandwidth, range, bi-directional communication, and security

	5.9 GHz	915 MHz
Protocols	IEEE, open standard (802.11p)	Multiple versions, many proprietary
Largest Data Rate	3 MBit/s to 27 Mbit/s & 54 MBit/s (w/ 2 channels)	In the range of 500 Kbits/s
Range	Up to 1,000 meters	Approximately 10 meters
Max. Transmit Power (EIRP)	+ 33 dBm (2 W)	+ 33 dBm (2 W), + 36 dBm (4 W)
Competitive multi-vendor market	Expected: Standard open to all vendors	Limited to Title 21 suppliers
Reliability of bi-directional data	High. Designed to meet these requirements	Weak
Capabilities to shape communication zones	Very good	Limited
Size of antennae	Smaller	Larger
“Built-in” localization capabilities	Very good	N/A
Security & Encryption	Up to 256 bit AES encryption	Weak or not implemented