

Siemens Electronic Tolling

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The Ascent of Satellite-Based Tolling Systems in Europe and Beyond

Norbert Schindler

Jersey City, 1st May 2012

**IBTTA Symposium on Mileage-Based User
Fees & Transportation Finance Summit**

The United States Space Program

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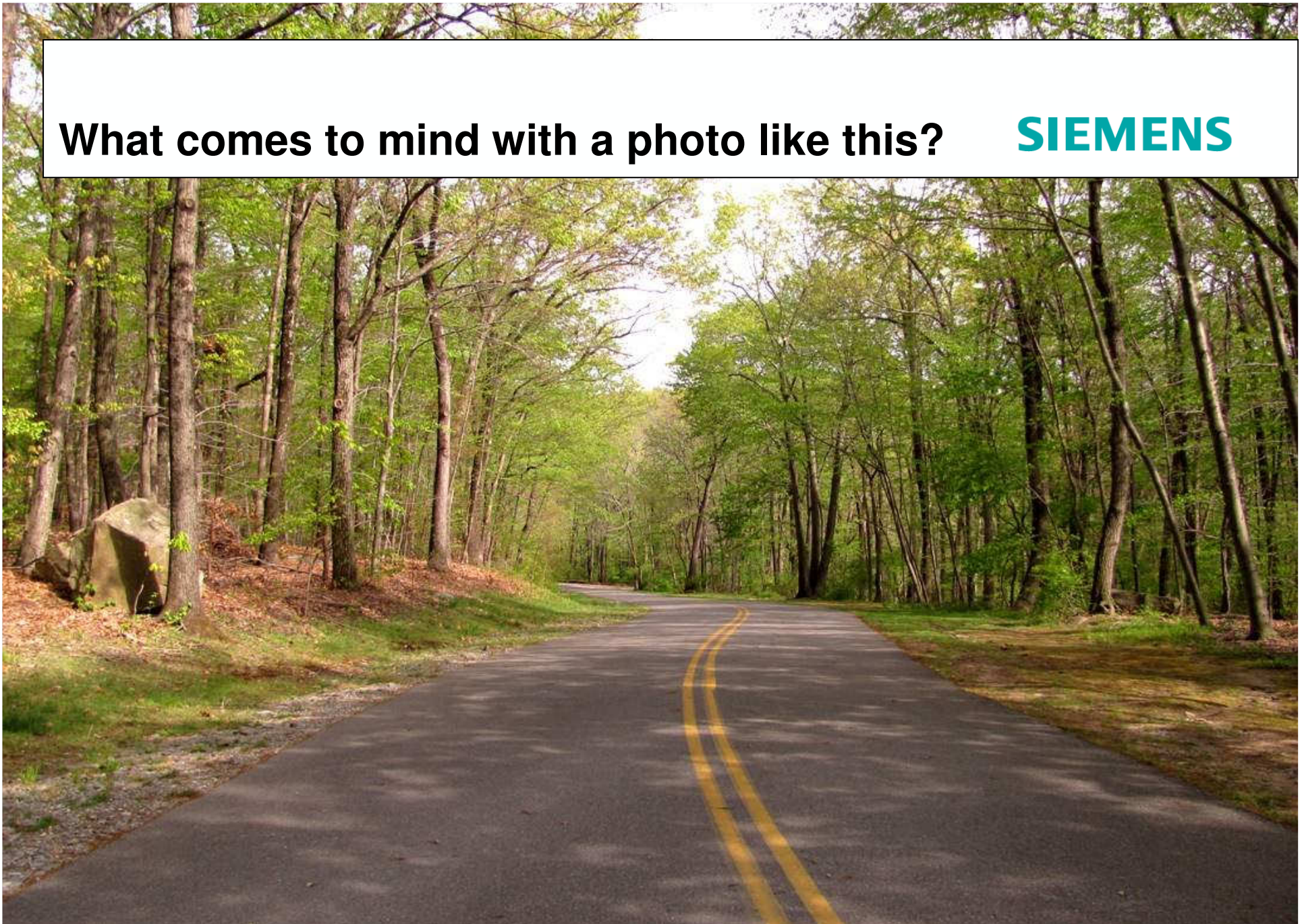
Photo taken of the Space Shuttle “Enterprise” just after its last voyage.

Is the Space Program relevant to Mileage-Based User Fees?



What comes to mind with a photo like this?

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If this a toll road, what was that rural road?

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**We don't toll roads, but VEHICLES.
No matter on which roads they drive on.**

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Fuel taxes alone cannot finance road infrastructure

Increasing need for additional road financing




**Cost of operation
and maintenance of
roads is growing**

**Level of fuel tax
revenue is
decreasing**

**Road users should
foot the bill based
on use (and abuse)**



Technologies for All Electronic Toll Collection

	Video (ANPR ₁)	Microwave (DSRC ₂)	Satellite (GNSS ₃)
System description	 <ul style="list-style-type: none"> ▪ Roadside infrastructure ▪ ANPR cameras (roadside) ▪ Optionally gantry servers ▪ No additional equipment in vehicles ▪ Manual post processing 	 <ul style="list-style-type: none"> ▪ Roadside infrastructure ▪ Transceivers on gantries ▪ Gantry servers ▪ On board devices in vehicles ▪ No Manual post processing 	 <ul style="list-style-type: none"> ▪ On board units with GPS, GLONASS, GALILEO ▪ GSM data connection ▪ No roadside infrastructure ▪ No manual post processing
Main characteristic	Infrastructure based		On board device necessary
examples	<ul style="list-style-type: none"> ▪ Stockholm Congestion Tax ▪ London Congestion Charge 	<ul style="list-style-type: none"> • Truck tolling schemes in A, CZ, PL • Ireland 	<ul style="list-style-type: none"> • Truck tolling schemes in D, SK, F

1) ANPR = Automatic Number Plate Recognition

2) DSRC = Dedicated Short Range Communication

3) GNSS = Global Navigation Satellite System

Cost driver

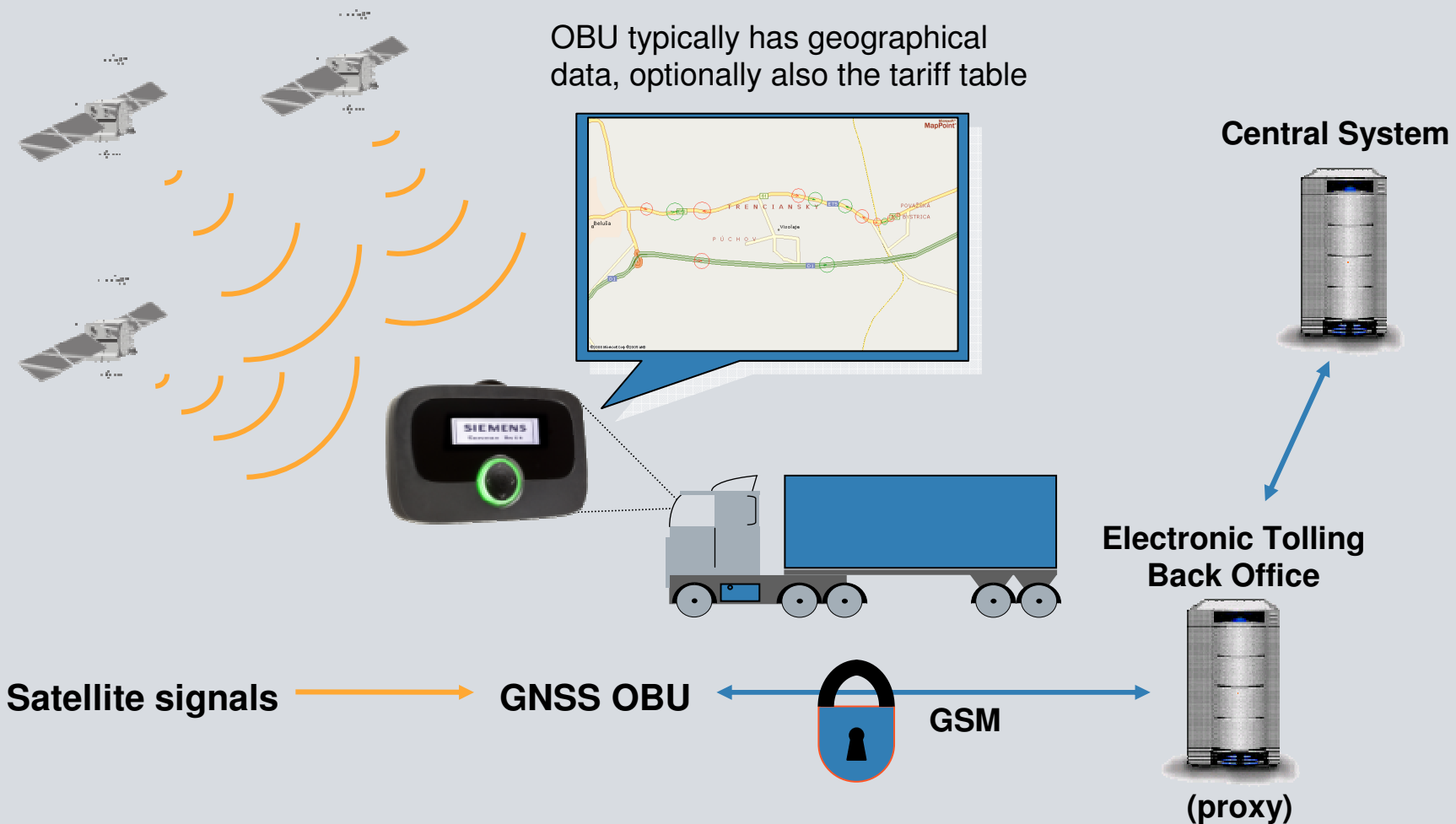
Advantage

Siemens Plug & Play GPS On Board Unit

- Robust automotive hardware
- No connection to the odometer
- All antennas built into the device
- Secure and encrypted communication
- Integrated GSM/GPRS module
- Built-in battery

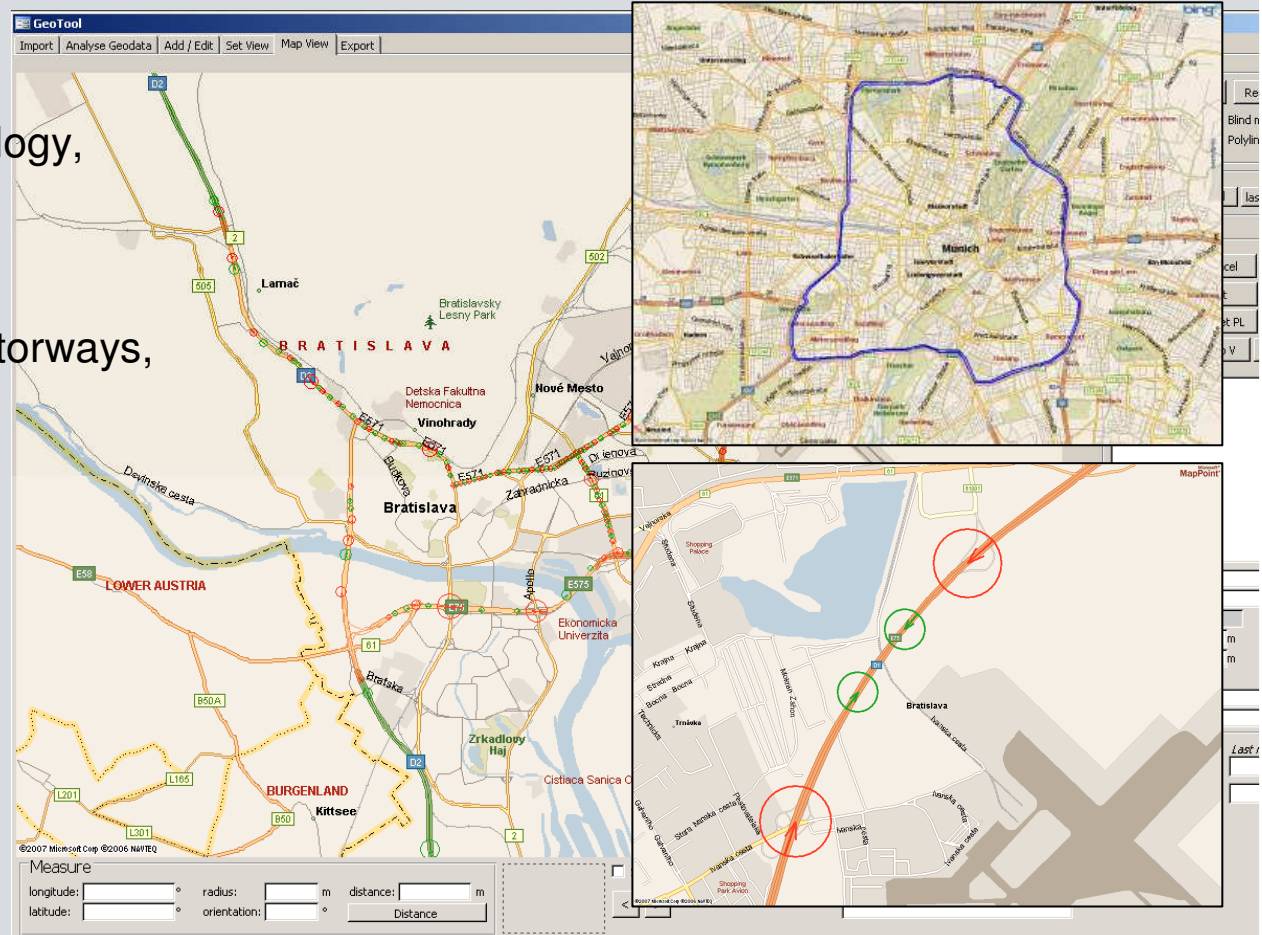


Operational Environment of the GPS On Board Unit



Flexibility of the Intelligent GPS-Based OBU

- **Zone detection:**
multiple zones, complex topology,
may overlap
- **Section detection:**
road section detection for motorways,
primary roads
- **Map matching:**
full road network detection
- **Mileage counting:**
based on GPS



A nationwide system can easily be upgraded to include zones for city tolling

Security Features of the Siemens GPS-Based OBU

User opens device

- The device is equipped with intrusion sensors.
- Intrusion alert is triggered, the event is stored in the log file and sent to the central system.
- Status will change to red - non operational - and the driver is not allowed to start the trip.
- Communication keys are destroyed.

Driving without external power connection

- The integrated movement sensor will “wake” the device up.
- Message about the missing power connection is stored in the log file and sent to the back office.
- The device is fully operational with internal power.
- Optical and acoustic alarm is generated until the power connection is restored.

User connects the device to manipulate data

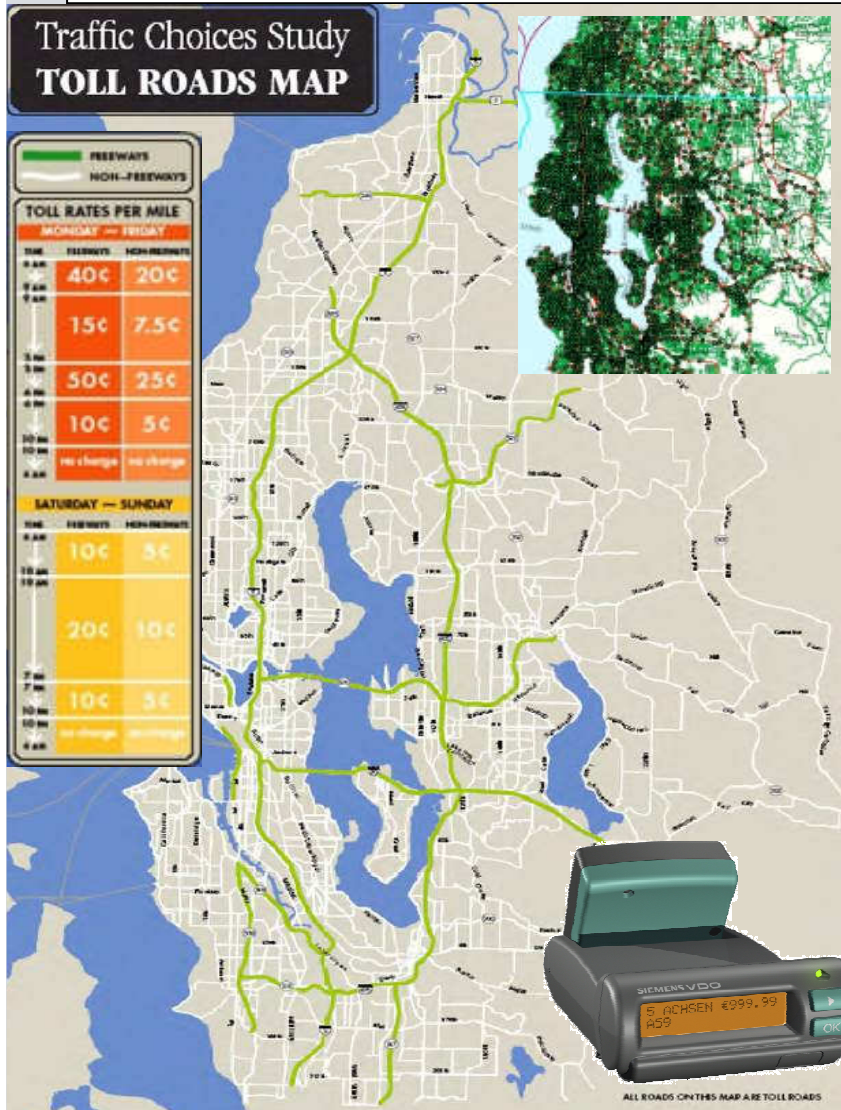
- The service port connection uses asymmetric encryption algorithms requiring a specific key file (every single device has its own key).
- Any USB connection triggers an event that is stored and sent to the central system.

Disruption of GPS signal through metal

- The integrated movement sensors will “wake” the device up.
- Device can detect disturbance or manipulation of GPS signal (e.g. GPS jammer).
- Message about the missing or manipulated GPS signal is stored in the log file and sent to the back office.
- The device will display a red operational state (as opposed to green).



Satellite-Based Tolling Pilot in Seattle: 2005-2006



Puget Sound Regional Council GPS-based Pricing Pilot Project: Evaluation of Traveler Response to Variable Road Tolling

The system was in operation from July 2005 until February 2006, with over 400 GPS-based OBUs

By the end of the study the toll system had:

- logged over 4.5 million vehicle miles traveled in trip records database
- recorded over 750,000 individual vehicle trip records on a network of 8,000 toll sections
- supported over 100,000 vehicle to central system wireless data communication transactions
- issued over 4,000 customer billing invoices

➔ **Siemens supplied the GPS Tolling Technology**

Satellite-Based Tolling Systems in Europe

Switzerland 2001: all trucks > 12 tons

Germany 2005: all trucks > 12 tons

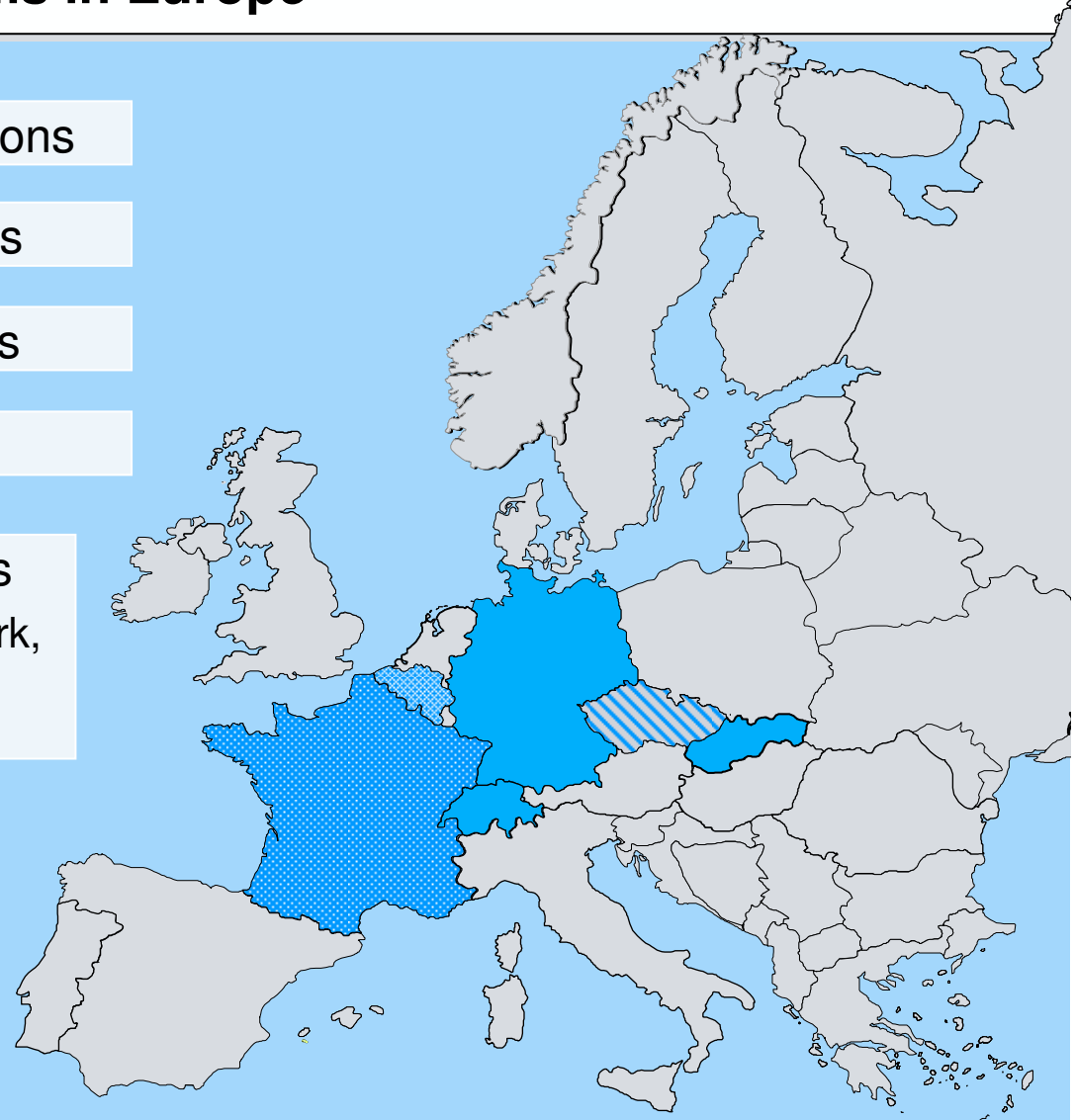
Slovakia 2010: all trucks > 3.5 tons

France 2013: all trucks > 3.5 tons

Belgium 2014: all trucks > 3.5 tons
Because of its complex road network,
Belgium is an ideal candidate for a
satellite-based tolling system

Czech Republic ?

New tender of nationwide tolling
planned to extend the existing
microwave system (from 2007)
to all major roads, using GPS



SWITZERLAND

First Distance-Based Truck Tolling System – on all roads

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Distance Measurement by Tachograph

- ▶ For Trucks > 12 tons; ~ 80,000 OBUs
- ▶ OBU Mandatory for Swiss Trucks
- ▶ Manual booking system for foreign trucks

Commercial Figures

- ▶ Initial investment costs ~ € 150 million
- ▶ Operation costs ~ 5% (use of Customs Officers)
- ▶ ~ € 1 Billion revenues generated per year

Supporting Technologies: GPS & Microwave

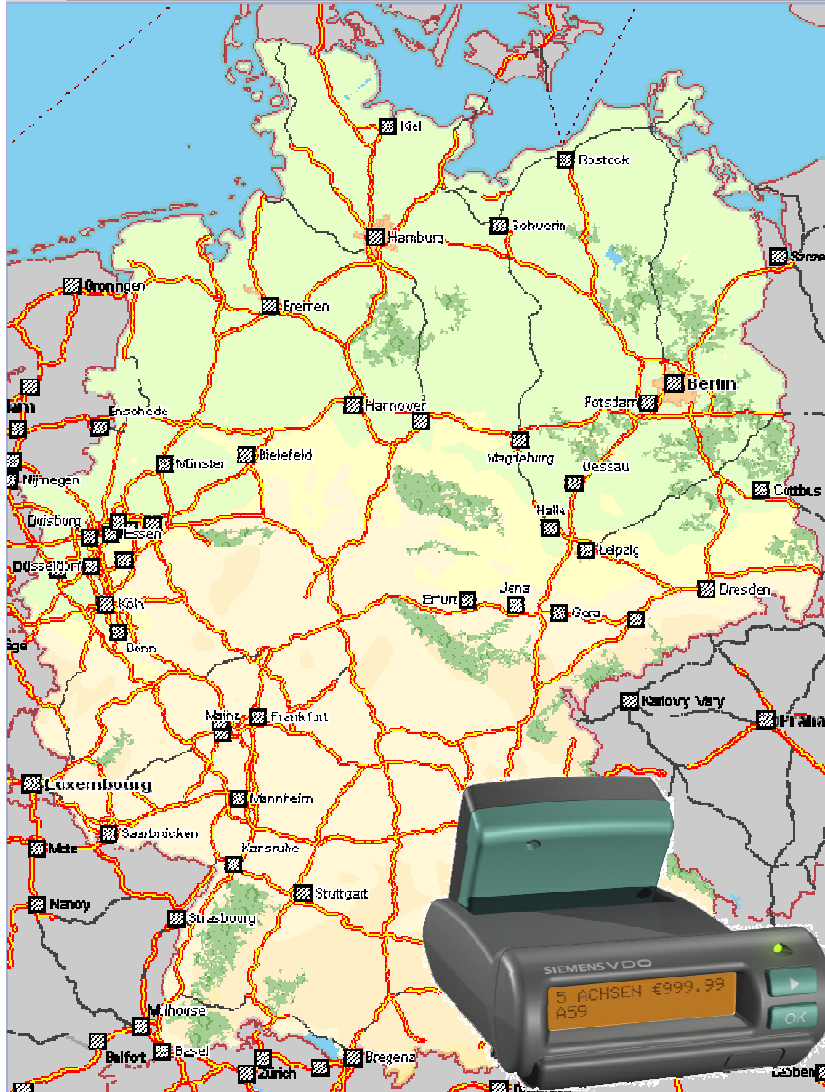
- ▶ GPS verifies distance, recorded on a chip-card
- ▶ Microwave for enforcement & border crossings
- ▶ OBU can also be used in Austria and in Italy

➡ **Siemens supplied the new generation OBUs**

GERMANY

First Nationwide Tolling System using GPS

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Section-Based Tolling System for Trucks

- ▶ Launched January 1st, 2005
- ▶ For Trucks > 12 tons; ~ 700,000 OBUs
- ▶ Entire "Autobahn" network of 12,000 km tolled

Commercial Issues

- ▶ ~ € 4 -5 Billion revenues generated per year (!)
- ▶ Operation costs ~ 15 - 20%

GPS and GSM Technologies Used

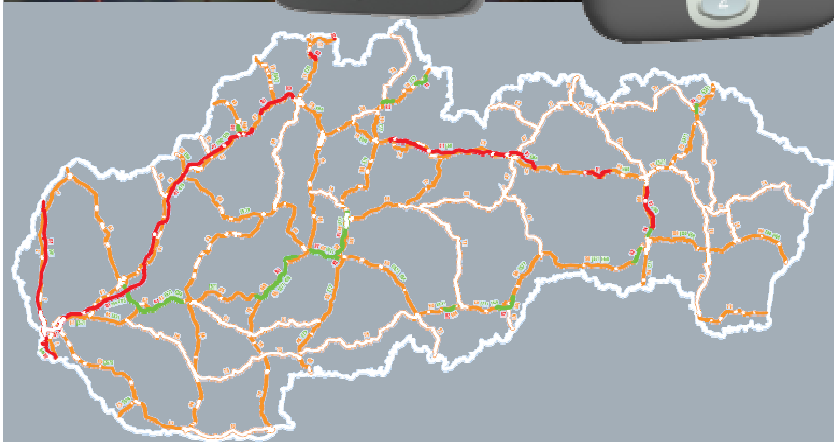
- ▶ Use of GPS proven to be highly reliable
- ▶ Dual system (manual booking) complex & costly
- ▶ > 80% of revenues generated via OBUs

➡ **Siemens supplied > 350,000 OBUs**

SLOVAKIA

First Nationwide System with Mandatory GPS OBU

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Segment-Based Truck Tolling System

- ▶ For Trucks > 3.5 tons; ~ 220,000 OBUs
- ▶ OBU Mandatory for all trucks
- ▶ Network consists of 500km of highways and 1900 km of first class roads

Commercial Figures

- ▶ Initial investment costs ~ € 200 million
- ▶ Operation costs ~ 15%
- ▶ ~ € 150 Million revenues generated per year

Plug and Play OBU using GPS/GSM

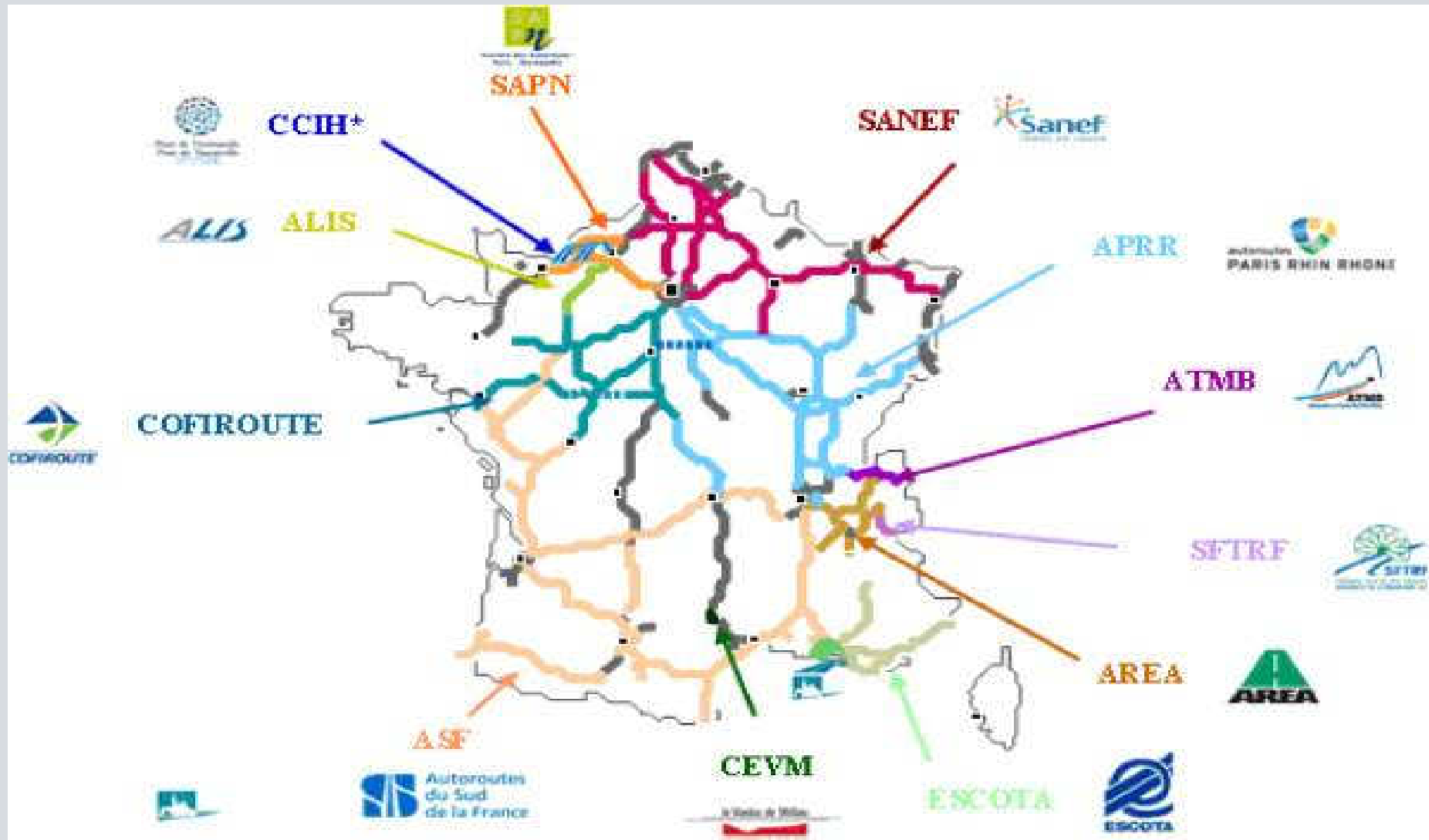
- ▶ System built up within only 11 months
- ▶ Driver can install on windshield within minutes
- ▶ > 99% accuracy from the very beginning

➡ **Siemens supplies 2 generations of OBUs**

FRANCE

Existing Toll Road Concessions

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Nationwide Scheme for Trucks on all National Roads

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— Réseau National taxable (10 500 km)
— Réseau Local pouvant être concerné (2 000 km)
Réseau déjà soumis à péage à l'horizon 2012
— Concessions
Modulation de -25%

French National “écotaxe”

- ▶ 15,000 kilometers of national roads which are not yet tolled
- ▶ Approximately 800,000 Satellite-based OBUs will be needed
- ▶ New operator (écomouv’) provides the GPS-service and the infrastructure
- ▶ All 5 existing toll service providers can provide the GPS-service as well
- ▶ New Hybrid-OBU must work on all existing toll-plazas (electronic lanes)
- ▶ Major challenge is the integration of the new GPS-system into the existing network of 20 tolled road network concessions (having different technologies) - INTEROPERABILITY

➔ **Siemens supplies new Hybrid OBUs to existing toll service providers**

RUSSIA

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The world's largest tolling system should launch 2014

Federal Law was adopted in Russia in April 2011 that all trucks > 12 tons should pay for Federal Roads usage starting January, 1st 2013.

This applies to approximately 50,000 km of Federal Roads.

Regional roads will probably be added: another 500,000km of roads!

There are about 1.5 million trucks > 12 tons registered in Russia; considering foreign transit trucks, about 2 million trucks will use satellite-based OBUs.

The use of GLONASS positioning technology will be mandatory – it is anticipated that a combination of GPS and GLONASS will be used.

Tender will be issued in 2012, the system could be launched by mid 2014.

Use of Three Satellite Systems for Satellite Tolling

Global Positioning System (USA)



Uses Code-Division Multiple Access (CDMA) on 1 frequency

Accuracy approximately 10m

Less accurate in far north and south, in mountains, and in urban canyons

GLONASS* (Russian Federation)



Uses Frequency Division Multiple Access (FDMA), multiple frequencies

Accuracy approximately 10m

Orbits at higher angle, thus much higher accuracy in the far north

GALILEO (European Union)



Uses Code-Division Multiple Access (CDMA), on 2 frequencies

Accuracy approximately 5m, but not until about 2016

With combined GPS/GLONASS, higher reliability and greater accuracy possible – TODAY!

* GLObal NAVigation Satellite System, ГЛОбальная НАвигационная Спутниковая Система (ГЛОНАСС)

GPS and GLONASS Integrated into the Siemens OBU

A trip through Vienna's Historical Center (urban canyons)

OBU Seriennummer	07760005113114230000000518
Trip Id	1320594583032 (49549)
Beginn	So, 6 Nov 2011 16:49:43
Ende	So, 6 Nov 2011 17:52:30
Summe Distanz	27.428,000



with a GPS-only OBU

OBU Seriennummer	07760004112819490000000342
Trip Id	1320594675834 (49541)
Beginn	So, 6 Nov 2011 16:51:16
Ende	So, 6 Nov 2011 17:54:02
Summe Distanz	28.749,000



with a GPS/GLONASS OBU

GPS: A Success Story of the Space Program **SIEMENS**

Many other countries now use GPS for tolling, why not the United States?

Russia's milestones with the first Sputnik and Yuri Gargarin's trip into space caused the US to increase its efforts in its own space program.

Now Russia is about to launch the world's largest tolling system, using satellite technology – the toll industry in the United States should also!





**Hope to see you at the ITS
World Congress in Vienna**

Siemens Infrastructure and Cities
Electronic Tolling

Norbert Schindler
Siemensstrasse 90
1210 Vienna, Austria
+43 664 8011735671
norbert.m.schindler@siemens.com