Siemens Electronic Tolling

Road User Charging Schemes in Europe: Current Experiences and Future Trends

Warsaw
June 12th, 2007
What Road Pricing Is All About

Electronic Tolling Technologies

Nationwide Tolling Systems in Europe

City Tolling Schemes ("Congestion Charging")
What Road Pricing Is All About
Main Types of Tolling Systems

**Toll Plazas**
- **Typical Environment**
  - Motorways
  - Tunnels and bridges
- **Characteristics**
  - Closed road networks
  - Delays at payment barriers
- **Technologies**
  - Manual
  - Video
  - Microwave and infrared

**Open Road Tolling**
- **Typical Environment**
  - Motorways
  - Nationwide schemes
- **Characteristics**
  - Open, barrier-free roads
  - High traffic throughput
- **Technologies**
  - Microwave and infrared
  - Satellite (with GSM)
  - Satellite (with SmartCard)

**Congestion Charging**
- **Typical Environment**
  - Cities
  - Urban Areas
- **Characteristics**
  - Reduce City Congestion
  - Encourage Public Transport
- **Technologies**
  - Video
  - Microwave and infrared
  - Satellite (with GSM)

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What Road Pricing Is All About
Different Categories of Tolling Schemes

- **Area toll** – tolls for driving in a tolled zone, no matter how often they enter within a certain period
- **Cordon toll** – tolling for vehicles enters or leaves a zone
- **Time-based toll** – vehicles charged on the basis of time spent within a zone or on a network
- **Measured distance toll** – toll levied according to the exact distance travelled within a defined area
- **Road segment toll** – tolling charged for driving on specific segments of roads such as bridges & tunnels, or as the truck tolling scheme in Germany
- **Closed network toll** – fee depends on where network was entered and exited
What Road Pricing Is All About

Examples of Different Tolling Approaches

Congestion Charging
  Area-Based
  Toll Entry Points

Urban Area

Flexible Road Pricing
  Segment-Based

Nationwide
Open Road Tolling

Geo Fence

Segment-Based

Distance-Based
Electronic Tolling Technologies
Major Components for a Complete Tolling System

Electronic Toll System

Business Processes

Software Applications

CENTRAL DATA SYSTEM

TOLLING

- On-Board Units (OBU)
- OBU-related services
- Communication network
- Toll charging back-office

ENFORCEMENT

- Stationary Enforcement
- Mobile Enforcement
- Enforcement post processing
- Enforcement back-office

SYSTEM INTEGRATION

- Clearing
- Accounting
- Call Centre
- Customer Relations
- Billing
- OBU-related services
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Long Term Roadmap for On-Board Equipment

Stand-alone solutions

DIN Slot OBU
Dashboard OBU
Windshield OBU

Integrated Solutions

Mirror solution for cars

Integrated Toll Module

Long Term Roadmap for On-Board Equipment

1990s

2004

2005

2007

20xx
Electronic Tolling -
Comparison of the Two Most Common Technologies

**SATELLITE**
- GPS Satellites
- Satellite OBUs
- GSM network
- Tolling Back Office

**MICROWAVE**
- Microwave OBUs
- Microwave Gantries
- Gantry Server

Cost Driver
Free!

**Central System**
The “Hybrid” Approach:
Combining Satellite and Microwave Technologies

GPS Satellites → Satellite OBUs → Central System
GSM network

GPS Satellites

Central System

Tolling Back Office

Tolling Back Office

Hybrid OBUs

Hybrid OBUs

Microwave Gantries

Microwave Gantries

Gantry Server

Gantry Server

Major Cost Drivers

Major Cost Drivers

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LONDON: Satellite-based Trial
Siemens Demonstrated That Urban Canyons Aren’t a Problem

- 10,000 toll sections
- Smallest sections had a length < 5 meters
- Sections have been processed in the back office
- System robustness, also when Satellite signal is lost
- Deployment of innovative algorithms based in graph theory
- Siemens achieved an accuracy of **99.8%**


SANS also achieved > 99.7% in USA, AUS, Singapore

Checked the accuracy of GPS-based tolling algorithms in a difficult urban environment (City Center of London). Demonstrated the whole process chain: evaluation of location; recognition of toll-segments; implement a tariff-scheme.

The Trend Points Towards Satellite-Based Tolling

- Manual Tolling (Toll Booths)
- Electronic Tolling (Microwave & IR)
- Satellite-Based Tolling

Satellite-Based Telematic Applications

We are here

Galileo will be introduced

Customer Base


time
Satellite-Based Systems Support a Variety of Advanced Telematics Services

Value Added Services for Freight Forwarder
- Pre-Trip: Toll collection and booking
- On-Trip: Information and Fleet Tracking
- Post Trip: Fleet Statistics

Value Added Services for Road Owner
- Road Status
- Road Usage
- Road Statistics
- Fuel Tax
- Travel Information
- Journey Time Data

Vehicle Centric Services
- Navigation
- E-/B-Call*
- Traffic Information
- Fleet Application
- Floating Car Data

End-User Centric Services
- Voice, Email, SMS, MMS, Internet / Wap Services
- Location Based Services
- Infotainment (News, etc)
- Entertainment (Games, etc)

Brand Specific Services
- Remote Diagnostics
- Remote Maintenance
- Remote Vehicle Control
- Software Download
- Roadside Assistance

*E-/B-Call: Emergency/Breakdown Call

Additional revenue possible for operator
Existing Nationwide Tolling Systems in Europe
Distance-Based Tolling
(LSVA = “Leistungsabhängige Schwerverkehrsabgabe”)
- Law for “LSVA” passed in 1998 for tolling on all roads
- System start: January 1st, 2001
- For Trucks > 3.5 tons; ~ 60,000 On Board Units (OBUs)
- avg. price / km: 65 Eurocents or 1.6 cents / ton / km

Commercial Issues
- Contract award (1999): Fela/Ascom; CAPEX ~ € 200 million
- Operation costs ~ 5% of revenues (€ 35 million / year)
- ~ 750 MEUR revenues generated per year
- LSVA makes for 20% of the overall transport costs

Satellite and Microwave Technologies Used
- Distance measured by odometer (tachograph) connection
- GPS verifies the distances, recorded on a “smart-card”
- Microwave used for enforcement and at the borders

New OBU generation will be launched 2009 by Siemens

SIEMENS
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A Clever Move!
Open Road Tolling on Motorways and Highways
- System start: on January 1st, 2005 (16 months delayed)
- For Trucks > 12 tons; 1.3 Million users (520,000 OBUs)
- avg. price/km: 12.4 Eurocents or 0.3 cents / ton / km
- ~ 12,000 km Road Network; ~ 5,000 Toll Segments
- ~ 90% of revenue via OBUs; 3,500 roadside terminals ~ 8%

Commercial Issues
- Contract award (2002): TollCollect; CAPEX “way over €1b”
- Operation costs ~20% (€ 600 million / year)
- approximately € 3 Billion revenues generated per year
- Penalty for delays still open, government wants € 4.5 billion

Satellite / GSM Technology
- Tolled road network is easily expandable
- Satellite Technology has proven to be very reliable
- Delays due to underestimated system integration efforts
- Dual system (manual booking) is too complex & costly

Siemens supplies over 350,000 OBUs to TollCollect
Open Road Tolling on Motorways and Highways
► System start on January 1st, 2004
► For Trucks & Buses > 3.5 tons (~ 500,000 active OBUs)
► avg. price/km: 22 Eurocents or 0.6 cents / ton / km
► ~ 2,000 km Tolled Network; ~ 800 Toll Segments
► ~ 45% of tolling revenue generated by foreigner users

Commercial Issues
► Contract award (2002): Autostrade; valued at € 747 million
► Operation costs ~15%
► ~ € 800 million revenues generated per year
► ASFiNAG purchased “Europpass” for € 208 million in 2005

Microwave Technology
► Local Austrian supplier purchased companies in Germany and Sweden with the technology, making some adaptations
► Major effort in building 800 gantries (building permits needed for digging data and power lines to all the gantries)
► Project started on time, 18 months after contract award
Open Road Tolling on Motorways (& First-Class Roads)

- System start on January 1st, 2007
- Tender for Trucks > 3.5t, but legislation passed for only > 12t
- Phase 1: 970 km Motorway Network, 350 Toll Segments
- Phase 2: 1,100 km of first-class roads, 500 Toll Segments

NEW TENDER IS NOW PLANNED FOR PHASE 2!

Commercial Issues

- Contract award (2006): Kapsch; valued at 22 Billion CZK
- 4.2 Billion CZK income expected first year (ČTK 21-03-2007)
- Operation costs not clear, but 22/10 = 2.2 Billion, i.e. > 50%

Tender Process

- Highly opaque tender, legal investigation all of last year
- Only 4 offers made, none evaluated, 3 disqualified
- Second most expensive offer selected
THE CZECH REPUBLIC
First Nationwide Scheme with Technology Preference

Microwave Preference Reflected in Tender

- 2-Phase approach allowed time to build microwave gantries
- More than double the number of needed OBUs requested
- Less than half the number of gantries requested for Phase 2
- Value-added services & easy extendibility of network were also requested, but such features were not in total offer price

<table>
<thead>
<tr>
<th>TECHNICAL REQUIREMENTS</th>
<th>Phase I</th>
<th>Phase II</th>
<th>TOTAL</th>
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</thead>
<tbody>
<tr>
<td>Number of requested OBU in tender</td>
<td>250 000</td>
<td>80 000</td>
<td>330 000</td>
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<tr>
<td>Number of crossings (intersections)</td>
<td>352</td>
<td>1 011</td>
<td></td>
</tr>
<tr>
<td>Number of paid toll sections</td>
<td>352</td>
<td>500</td>
<td>852</td>
</tr>
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</table>

33. ... every OBU must have a DSRC (microwave) interface answering to terms CEN TC 278 for enforcement use

Problems with Microwave Technology

- Construction problems, diesel generators needed at gantries
- Czech Expert Group found microwave technology too cost-intensive for phase 2, satellite system will now be tendered
THE NETHERLANDS 2005-2012
First Nationwide Scheme for All Vehicles on All Roads

“ Anders Betalen voor Mobiliteit” (Paying Differently for Mobility, based on existing € 7 billion tax revenues)
► In 2005, legislation passed for evaluating the introduction of road-usage fees for all vehicles on all roads in Holland
► 51 Companies pre-qualified for “market consultations” from which 11 were selected for “cost monitor” evaluation
► In 2006, four Companies were chosen to evaluate overall costs of system development, supply, & organization
► In 2007, feasibility trials will be conducted to make sure, once again, that satellite technology actually works.

The goal of meeting the limit of 2,2 Billion EUR for the system supply and annual operation costs of 5% of revenue was met by Siemens.
City Tolling Schemes (“Congestion Charging”)

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A Clever Move!
Highly Innovative (and Controversial) City Charge
► Introduced 17 February 2003, extended 19 February 2007
► Daily fee set at £5, raised to £8 on 4 July 2005
► Payment online, per phone, SMS, or at special outlets
► Fines start at £50, after 2 weeks £100, after 1 month £150
► Special discounts for those living within the zone

Results
► Traffic delays reduced by 30%
► Reduction of traffic by 15% (60,000 less vehicles)
► Average speed in zone increased from 13 km/h to 18 km/h
► 50-60% of car drivers moved to public transportation

Commercial Issues
► annual operating costs £64 million
► £160 million revenues (£138 million for charges, £22 million for penalties) which are re-invested into the transportation system
► Transport for London: “congestion charging was contributing the equivalent of £50 million of net transport benefits to London’s economy per year”
Contract Awarded in October 2005 to Siemens

- 850 high-accuracy license plate recognition cameras
- 1 million plates per day (evidential records encrypted)
- Innovative system architecture to reduce data traffic
- No CCTV connections required as in original scheme

LONDON
The Success Continues With the Western Extension

Ken Livingston, Mayor of London

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STOCKHOLM
City Center Congestion Charge Successfully Tested in 2006

Trial Operation
► Trial period was from January 3rd to July 31, 2006
► 450,000 vehicles equipped with microwave tags
► Charge from 6:30 - 18:30 on Weekdays
► Fee of € 1.1, 1.6, 2.2, depending on time zone
► 25km² area, with 18 bi-directional payment portals

Results
► Reduction of traffic by 20-25%
► Queue times down 30-50%
► 14% decreased emissions
► Generally well-accepted by the public

Commercial Issues
► In 2003, Congestion charge trial proposed by city council
► Contract award (July 2004): IBM; CAPEX ~ € 400 million
► ~ € 150 million revenues expected per year

Referendum passed in September 2006 by 51%
STOCKHOLM
Roadside Infrastructure

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Background
► First concepts for city charging were developed in 1994
► Legislation passed for a tax-based scheme (not a charge)
► 200 new busses were added at the introduction of the scheme
► More park and ride facilities were provided on access roads
► 80% of the public was informed prior to launch of the scheme

Statistics
► ~300,000 passages per day (34 Million in the total 6 months)
► 99% of all vehicles correctly identified
► Up to 10,000 calls to call center per day at the peak, settling down to only 2000 calls a day (only 5% the forecasted figure)

Consequences
► ANPR worked successfully, in spite of snow and bad weather
► The scheme will be installed permanently in August 2007
► Microwave tags and infrastructure will be removed!
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