Siemens Electronic Tolling

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Trends and Experiences in Satellite-Based Tolling

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Czech Satellite Toll Day
Prague, October 25th, 2007

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Different Approaches to Road Pricing

Electronic Tolling Technologies

International Tolling Experiences

Different Approaches to Road Pricing
Main Types of Tolling Systems

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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
- ► Satellite (with GSM[1])
- ► Satellite (with SmartCard)

Congestion Charging

Typical Environment
- ► Cities
- ► Urban Areas

Characteristics
- ► Reduce City Congestion
- ► Encourage Public Transport

Technologies
- ► Video
- ► Microwave
- ► Satellite (with GSM[1])

[1]**GSM**: Global System for Mobile Communications

Different Approaches to Road Pricing
Various Categories of Tolling Schemes

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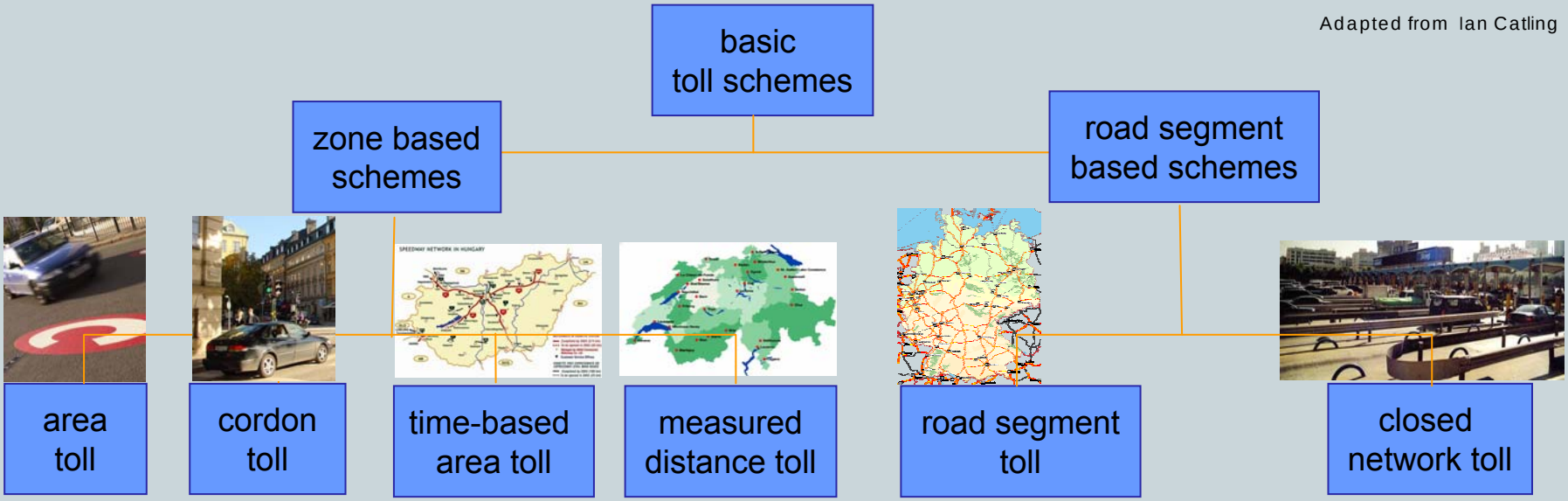
Adapted from Ian Catling



- **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

Different Approaches to Road Pricing
Examples of Different Tolling Approaches

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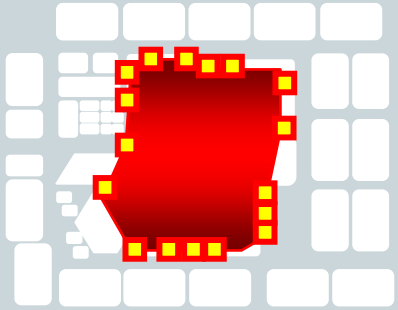
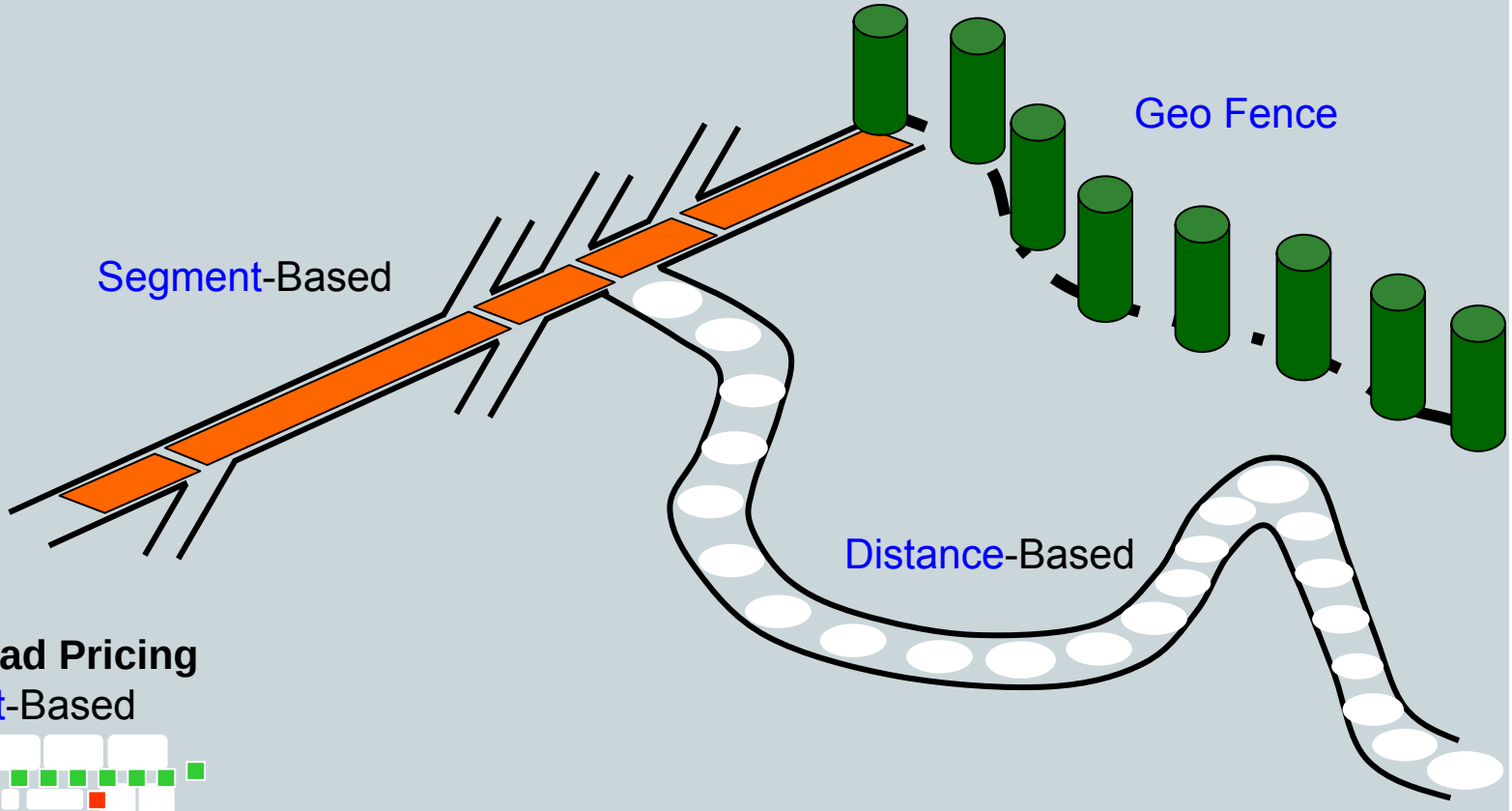
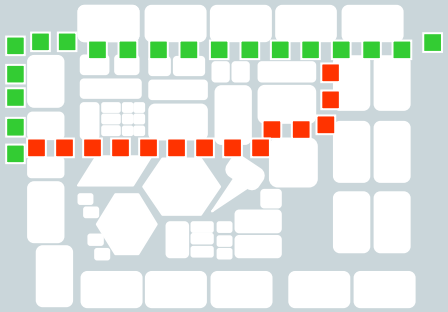


Congestion Charging
Area-Based
Geo-Fence/Toll-Points

Urban Area



Flexible Road Pricing
Segment-Based



Nationwide
Open Road Tolling

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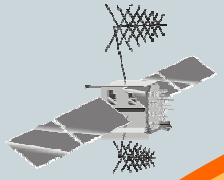
Electronic Tolling Technologies

Major Components for a Complete Tolling System



On-Board Units (OBU)

OBU-related services

Stationary Enforcement

Mobile Enforcement

TOLLING

ENFORCEMENT

Business Processes

Electronic Toll System

Software Applications

Communication network

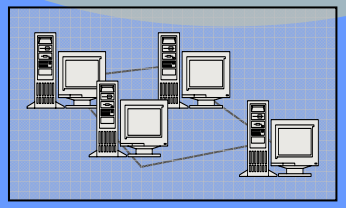
Toll charging back-office

Enforcement post processing

Enforcement back-office

Customer Relations

Billing



Call Centre

Clearing

Accounting

CENTRAL DATA SYSTEM

SYSTEM INTEGRATION

Long Term Roadmap for On-Board Equipment

Stand-alone solutions

Microwave Tags

1990s

DIN Slot Satellite OBU

2004

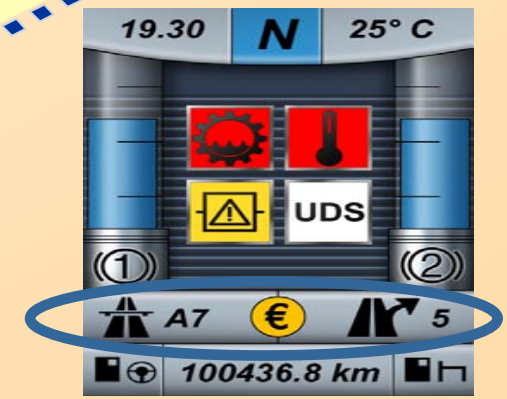
Dashboard Hybrid OBU

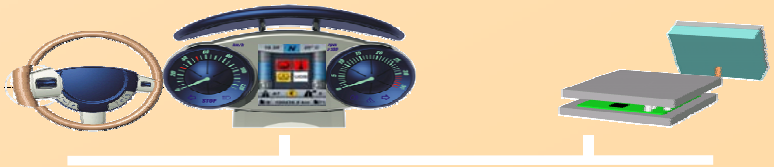
2005

Windshield Hybrid OBU

2007

20xx

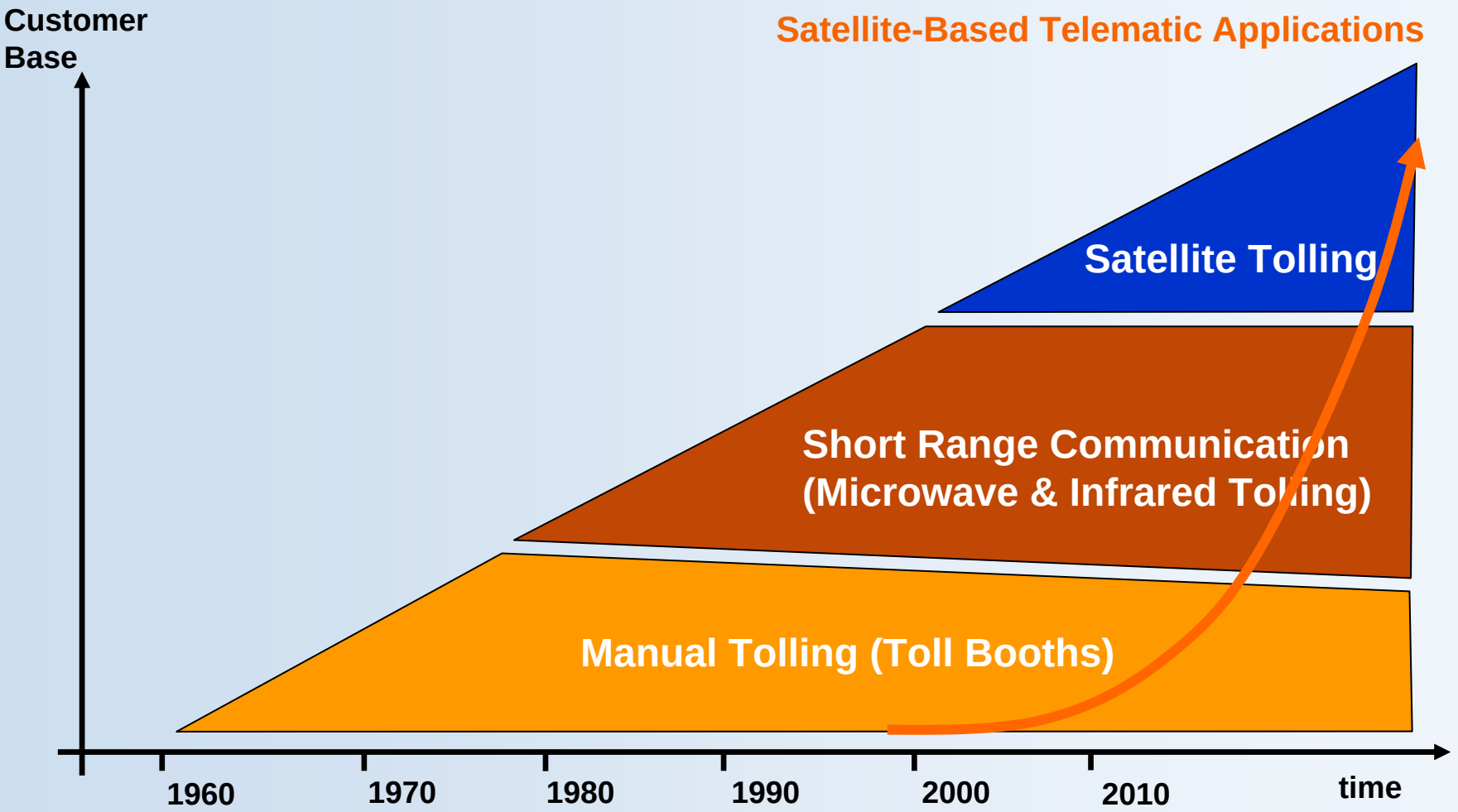




Integrated Toll Module

Integrated Solutions

The Trend Points Towards Satellite-Based Tolling



Satellite-Based Systems Support a Variety of Advanced Telematics Services

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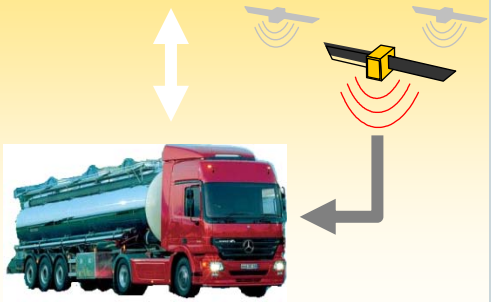
Value Added Services for Freight Forwarder

- Pre-Trip:
  Toll collection and booking
- On-Trip:
  Information and Fleet Tracking
- Post Trip:
  Fleet Statistics

Additional revenue possible for operator

Toll Centre

Dedicated GSM Link



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

Electronic Tolling - Comparison of the Two Most Common Technologies

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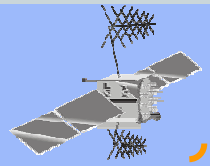
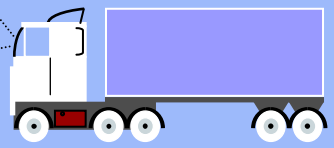
SATELLITE

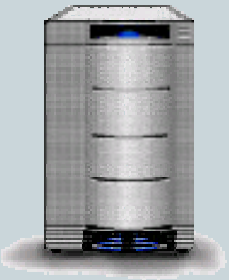


Free!

Cost Driver



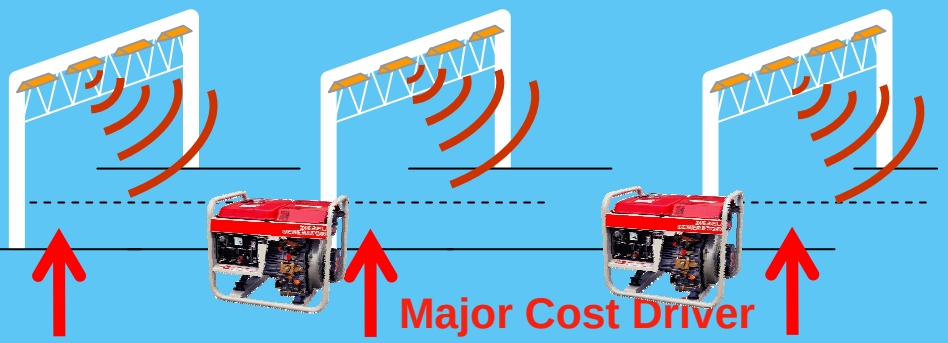
Central System



GPS Satellites → Satellite OBUs ↔ GSM network → Tolling Back Office

MICROWAVE

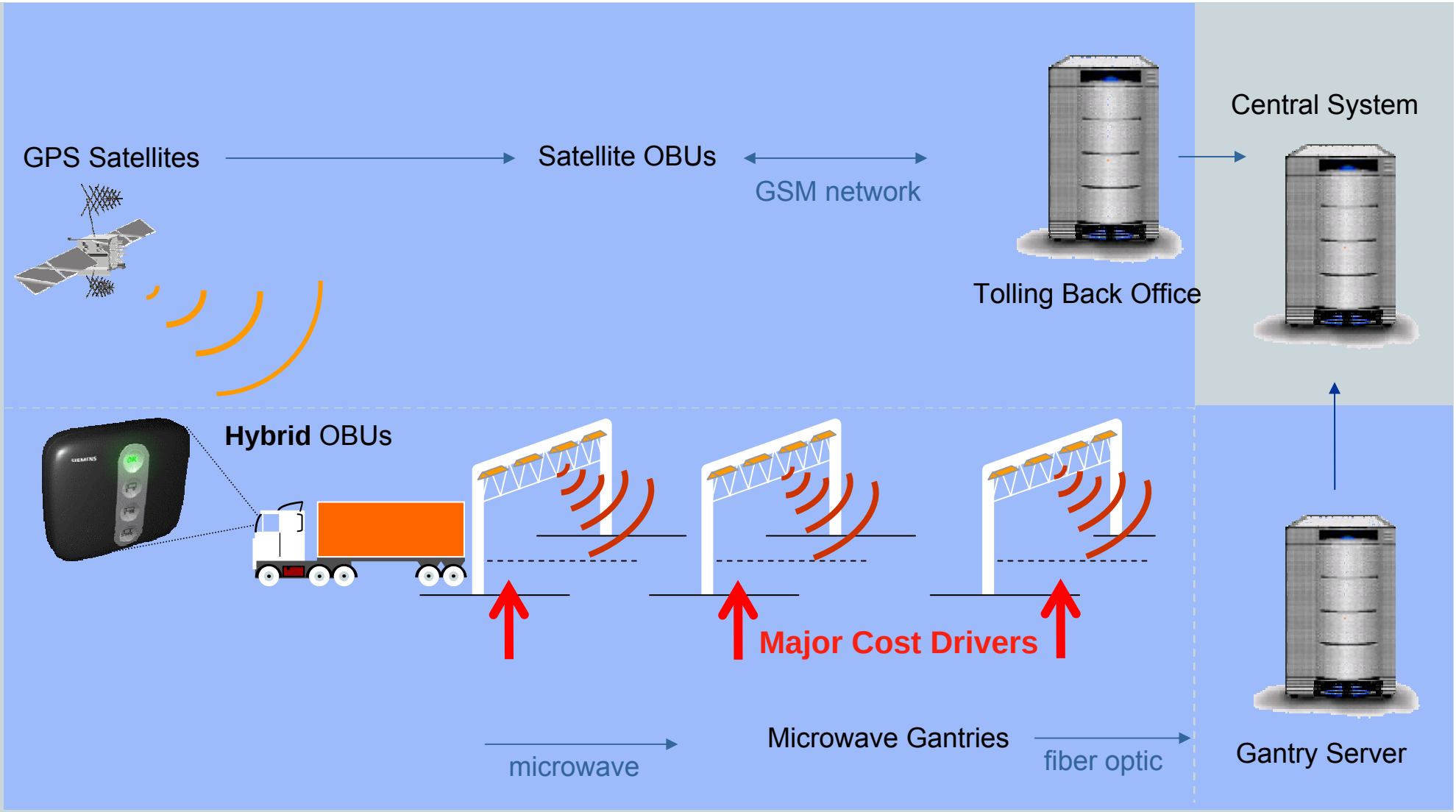
Microwave OBUs → microwave communication → Microwave Gantries → fiber optic → Gantry Server



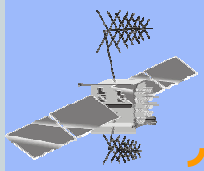
Cost Driver

Major Cost Driver

The “Hybrid” Technology Approach



The “Thick” and “Thin” Client Satellite Approaches



OBU Data

GSM network

Tolling Back Office

Thin Client: Geographical Data and Tariff Table stored in Back Office

Section 1
Section 2
Area 1
.....

An “intelligent” thick OBU can display recognized sections and charged tolls, supports a wide variety of telematic services, and protects user privacy.
A thin OBU constantly transmits its position, even when not on a tolled road.

Satellite OBUs

$X_1\ Y_1\ Z_1$;
$X_2\ Y_2\ Z_2$;
$X_3\ Y_3\ Z_3$;
$X_n\ Y_n\ Z_n$

Section 1
Section 2
Area 1
.....

Thick Client: Geographical Data and Tariff Table are stored on the OBU

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International Tolling Experiences

HUNGARY 1996-2004
Toll Plazas Constructed, only to be torn down later…

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SWITZERLAND 1998-2001
First Nationwide Toll System for Trucks (on *all* roads)

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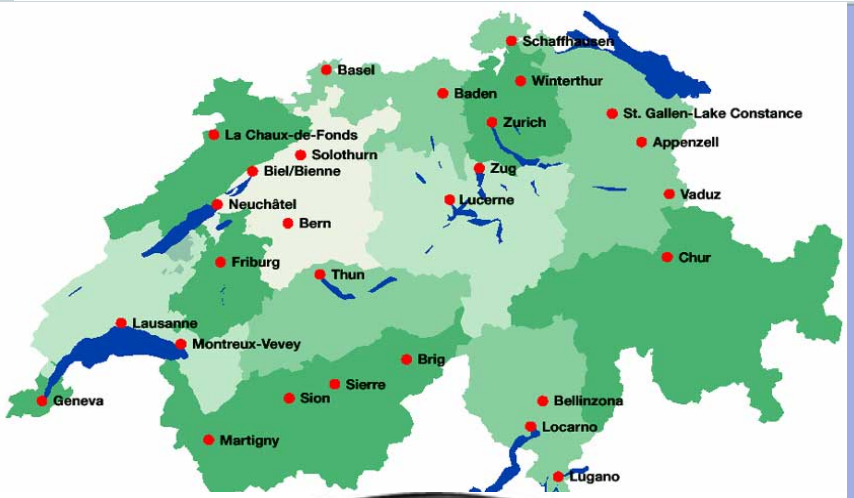

Distance-Based Tolling

- System start: January 1st, 2001
- For Trucks > 3.5 tons; ~ 60,000 On Board Units
- avg. price / km: 65 Eurocents or 1.6 cents/ton/km

Commercial Issues

- CAPEX ~ € 200 million, Operation costs ~ 5%
- ~ € 750 Million revenues generated per year
- LSVA makes for 20% of the overall transport costs

Satellite and Microwave Technologies Used

- Distance measured by odometer connection
- GPS verifies distance, recorded on a “smart-card”
- Microwave used for enforcement and at the borders

New OBU generation from Siemens for 2009

GERMANY 2002-2005
First Nationwide Toll System for Trucks with GNSS/GSM

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Distance-Based Tolling

- System start: January 1st, 2005
- For Trucks > 12 tons; ~ 550,000 On Board Units
- avg. price / km: 12.4 Eurocents or 0.3 cents/ton/km

Commercial Issues

- CAPEX “way over €1Billion”
- Operation costs ~ 20%
- ~ € 3 Billion revenues generated per year

Satellite and GSM Technologies Used

- Tolled road network is easily expandable
- Satellite Technology has proven to be very reliable
- Dual system (manual booking) is complex & costly

Siemens supplies > 350,000 OBUs to TollCollect

UNITED KINGDOM 2005-2006
Siemens Satellite Technology Receives Highest Marks

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Lorry Road User Charging – Proof of Solution

- Siemens was one of three companies selected in **2005** for system performance demonstrations for Charging Data Services and Central Services, over 30 formal tests conducted over several months
- Customer: "**Siemens scored 100%** on the test metrics"
- Motorway section recognition rate: **99.57%**
- **GPS-based distance calculation** had an accuracy **significantly better than odometer** (< 1% vs. 4%)

Transport for London – Distance-Based Charging

- Siemens was among 14 technology suppliers invited in **2006** for performance evaluations in the City Center
- **4,000 sections** defined, some as short as 5 meters
- Siemens implemented innovative algorithms to calculate sections to achieve an accuracy of **99.8%**
- In spite of "urban canyons," **all sections recognized**

AUSTRALIA 2005-2006
Siemens Demonstrates Hybrid Solution

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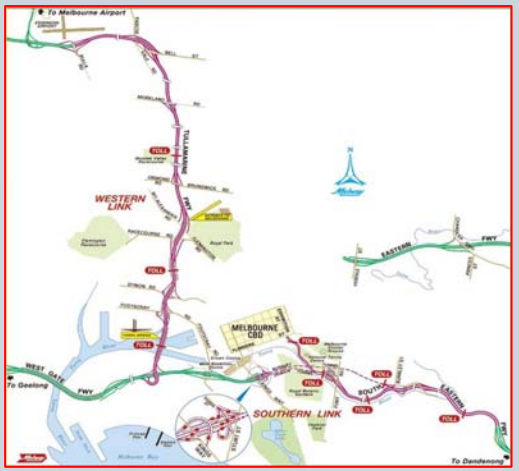
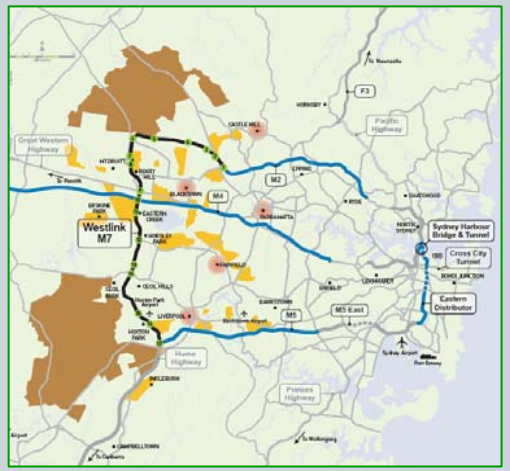


Melbourne City Link



Sydney Cordon

Melbourne City Link: - December 2005
Aim: Test Fat and Thin Client and Hybrid Solution

Sydney - January 2006:
Aim: Show feasibility of GPS tolling in urban and interurban environment

Features Demonstrated:

- **Complete hybrid solution**, supporting satellite-based and microwave-based toll calculation
- Integration into existing microwave environment
- **Fully flexible tariffs**, based on time of day, class of road, and vehicle category
- **Distance-based tracking** is also implemented
- **99.74% recognition rate** (without infrastructure)
- Tolled road network **can be modified overnight**

THE NETHERLANDS 2006-2007
Nationwide Scheme for all Vehicles on all Roads

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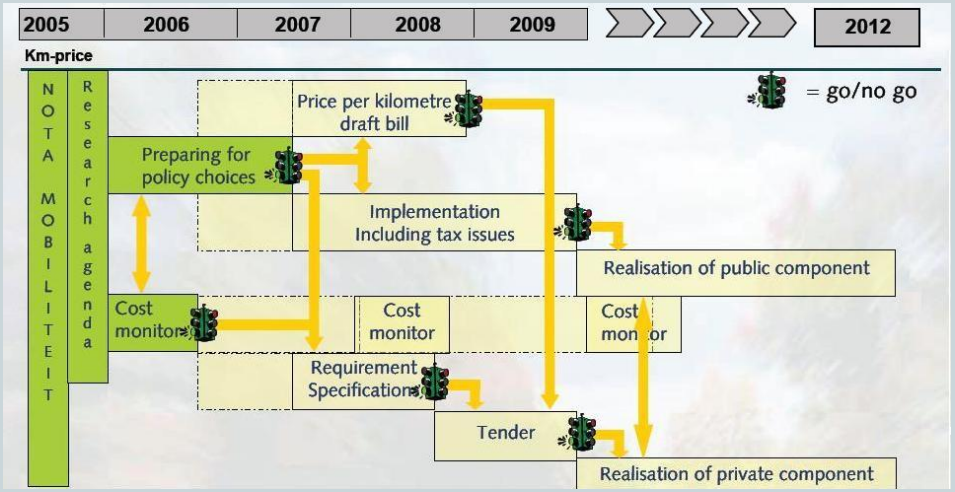
Siemens can meet goal of 2,2 Billion EUR for CAPEX as well as annual OPEX of 5%

"Anders Betalen voor Mobiliteit"

- "Paying differently for mobility" where the annual € 7 billion tax revenues will be based on distance travelled, rather than vehicle ownership, by 2012
- Ministry initiated "market consultation" in 2005
- Siemens one of 4 selected to evaluate costs of system development, supply, & organization
- Siemens participates in feasibility trials of 2007 to demonstrate satellite functionality & accuracy



HUNGARY 2007
Tender for Nationwide Tolling of Trucks

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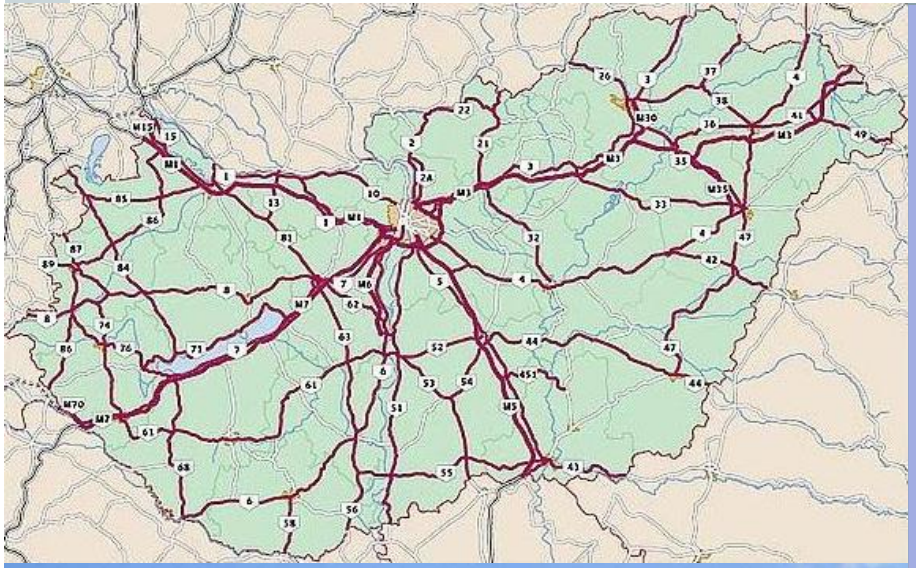

Introduction of Electronic Tolling by 2009

- Prequalification issued April 2006, but cancelled
- Vignette obligation extended to trucks > 12 tons on certain first-class roads in April 2007
- New prequalification completed in October 2007, eight consortia have entered the competition
- Electronic tolling by 2009 for buses & trucks > 3.5t
- Tolled network to start with 3,500 km (< 900 km of which are Motorways) and expand to 4,000 km
- Operation period planned only for 5 years
- Total system costs should not exceed €276 Million
- Enforcement will be tendered separately
- Heaviest vehicles are to pay same fee on first-class roads as on motorways
- Preference for satellite-based technology has been indicated, due to parallel roads and transit roads

SLOVAKIA 2007
Tender for Nationwide Tolling for Trucks

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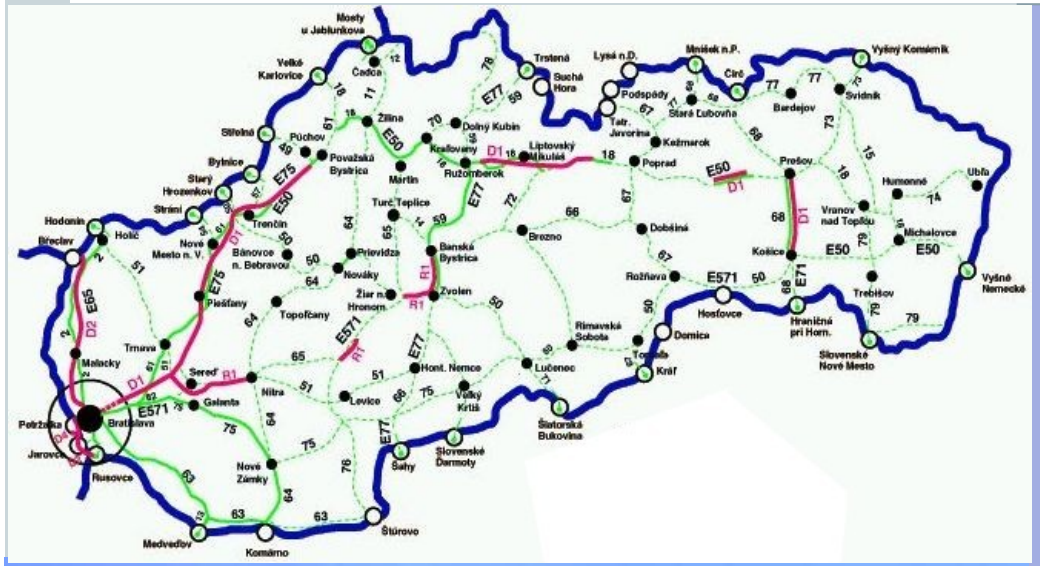

Introduction of Electronic Tolling in 2009

- Prequalification tender issued in September
- Prequalification procedure interrupted twice
- Electronic tolling to start January 2009 for trucks and buses > 3.5 tons
- Tolled network to start with 2,400 km (less than 400 km of which are Motorways)
- Operation period planned for 13 years
- Total system costs planned at €570 Million
- Annual income projected at €150 Million
- Obligatory On Board Unit is planned
- Anticipated fees 3 SKK/km for trucks > 3.5 tons and 7 SKK/km for trucks > 12 tons
- Preference for satellite-based technology has been indicated, since tolled network consists primarily of first-class roads

SLOVAKIA
Example of Road Pricing in Slovakia with “Virtual Gantries”

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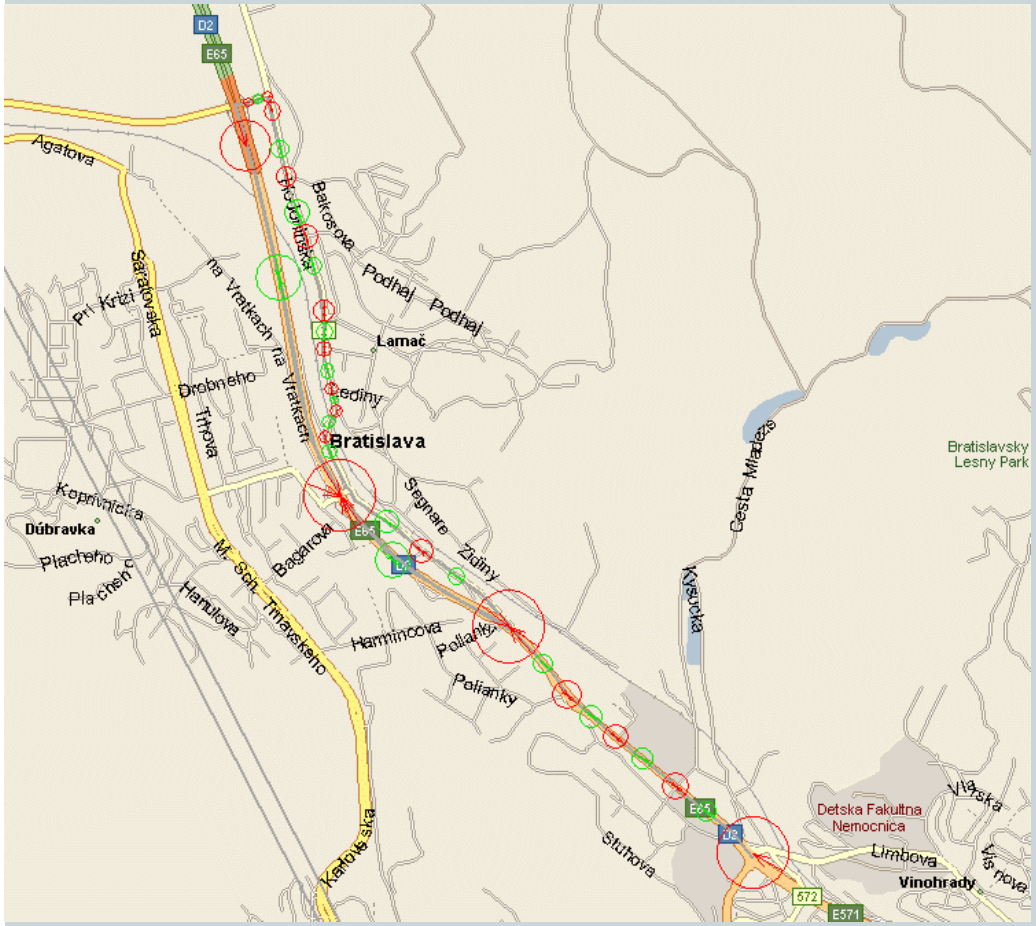

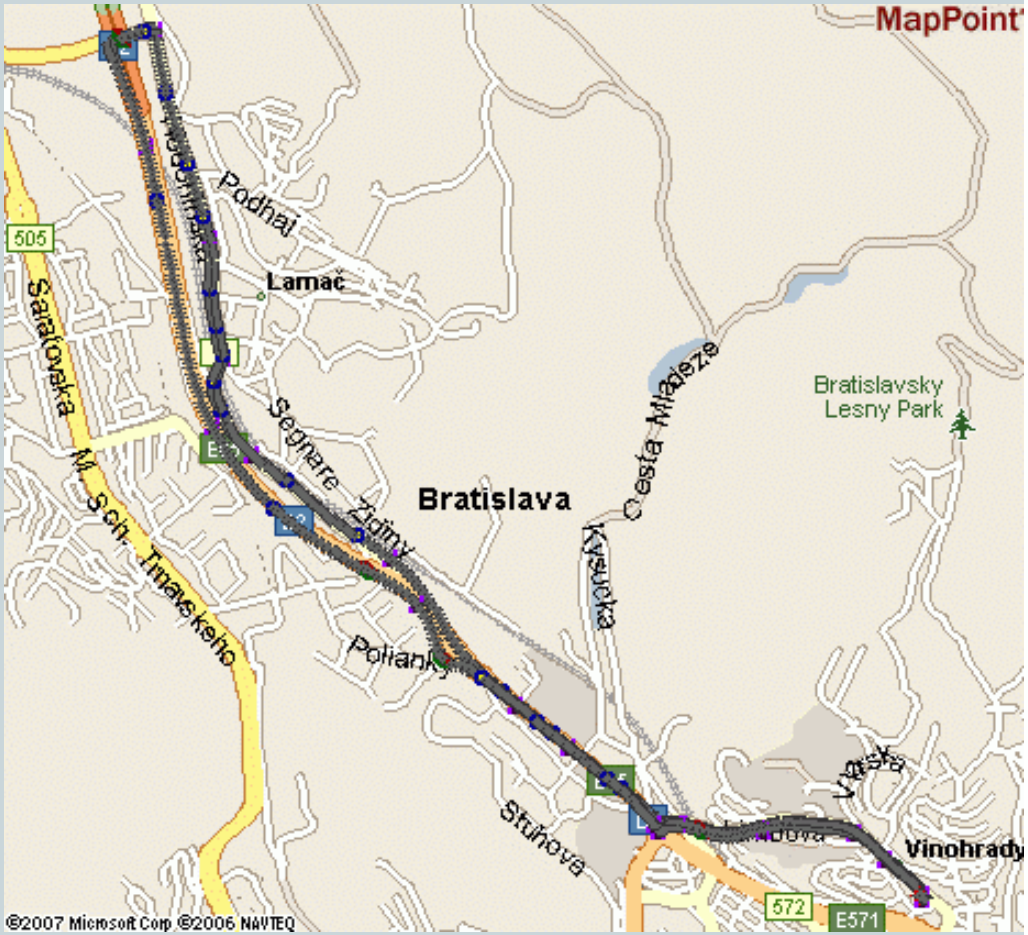

THE CZECH REPUBLIC 2007

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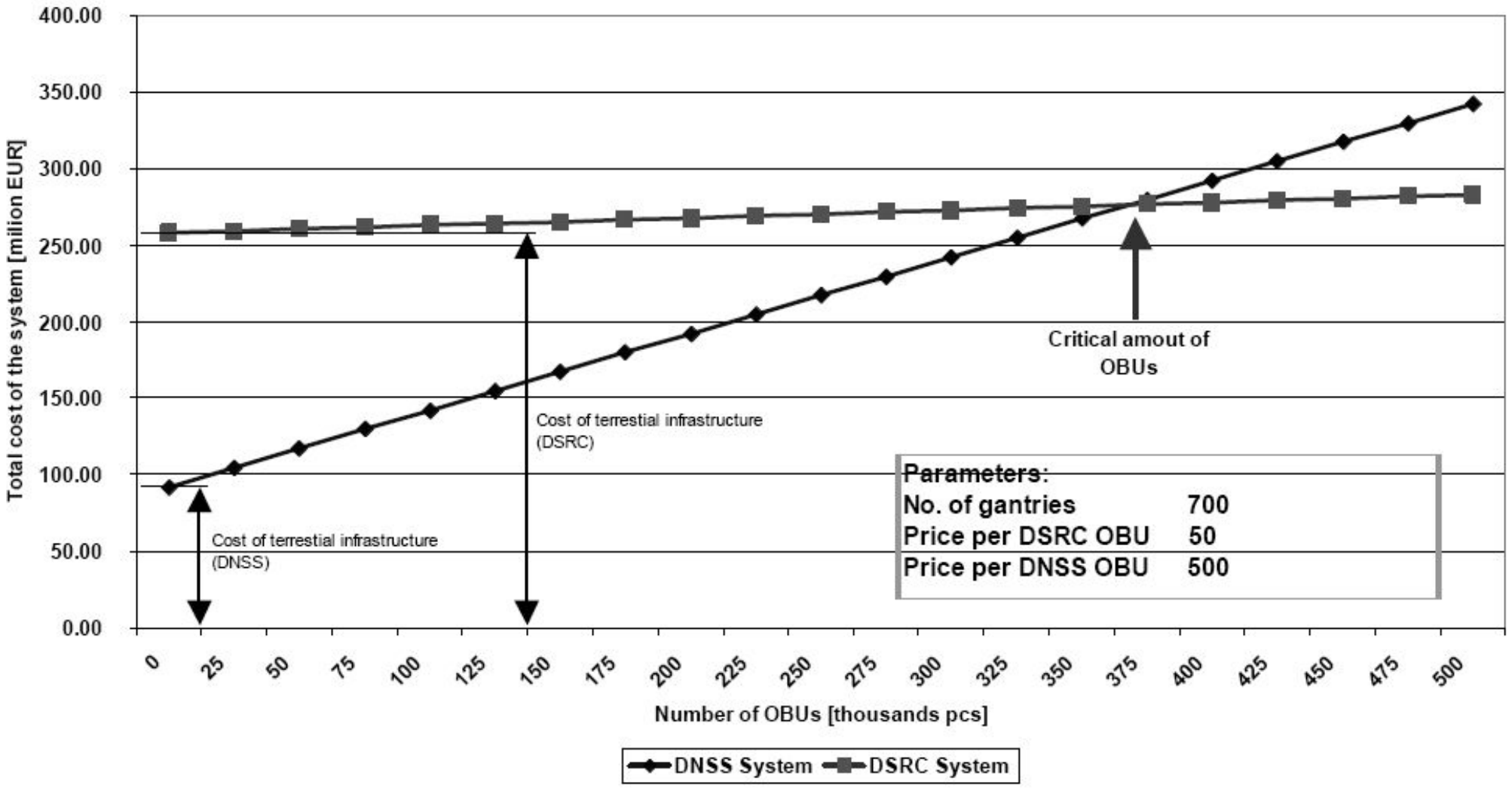
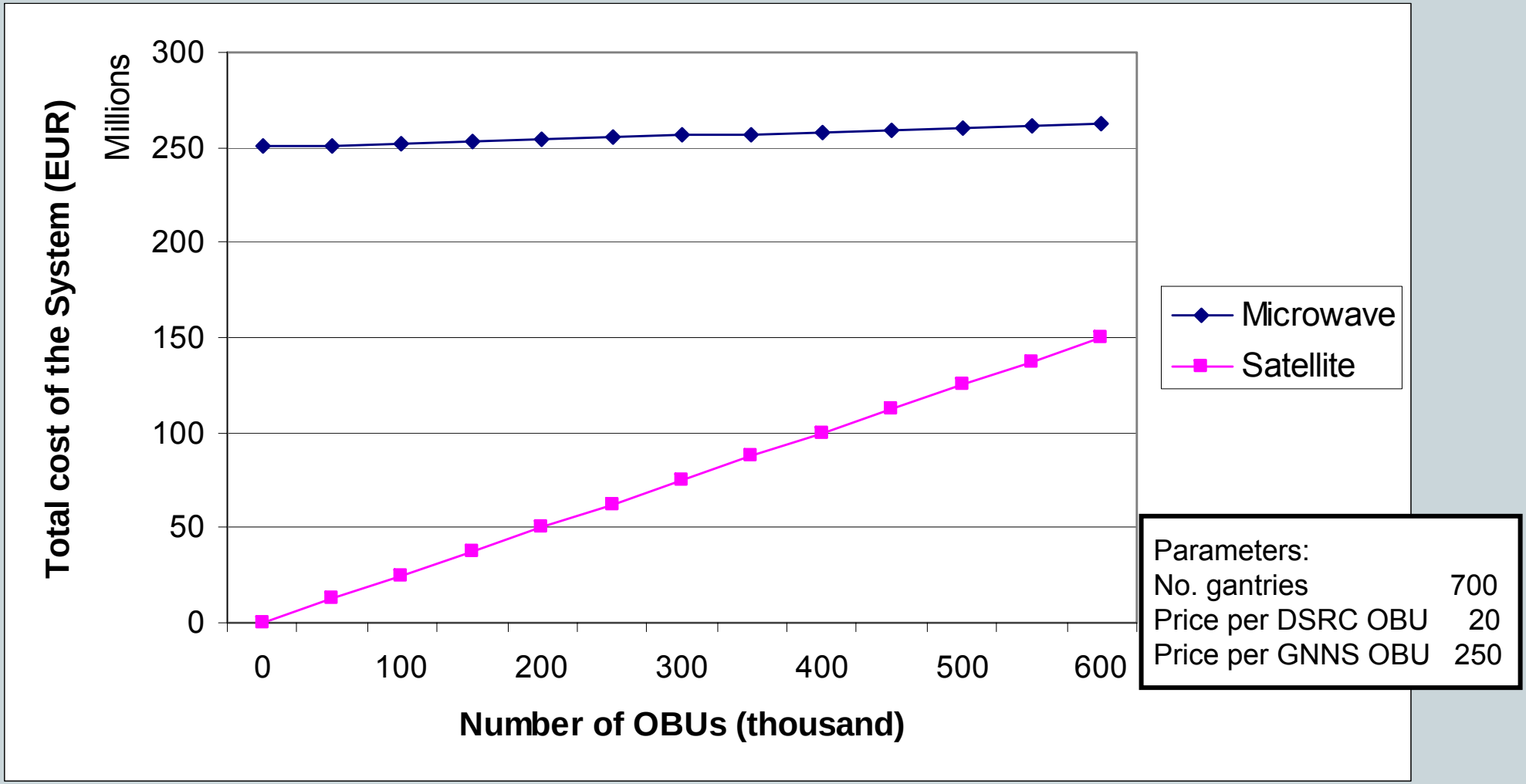
Cost Calculation from Prof. Jirovsky – Satellite is Cheaper



THE CZECH REPUBLIC 2008

Calculation Much More Optimistic Based on Current Figures



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