UNIVERSIDAD DE MURCIA

T-Systems

Analysis of technological alternatives in electronic toll systems

Work sponsored by CEDEX CENTRO DE ESTUDIOS Y EXPERIMENTACIÓN DE OBRAS PÚBLICAS an entity of GOBIERNO DE ESPAÑA MINISTERIO DE FOMENTO

Context

- New developments around “Eurovignette” Directive increase interest of Member State Governments to
  - apply km-based Road User Charging to increasing parts of public road networks
  - consider using Road User Charging as a means to influence traffic demand
  - include environmental and safety issues by internalising external cost
  - think about replacing existing taxes partly or fully by km-based Road User Charging

- New developments around “Interoperability Directive”
  - Limits technologies that can be chosen for local/national tolling systems
    - 5.8 GHz Microwave DSRC for short range communication vehicle to infrastructure
    - Global Navigation Satellite Systems for positioning
    - GSM/GPRS cellular networks for Wide Area Communication vehicle to infrastructure
  - Establishes new role and responsibility model (CESARE III)
  - Establishes new technical interoperability architecture (RCI / ISO17575)

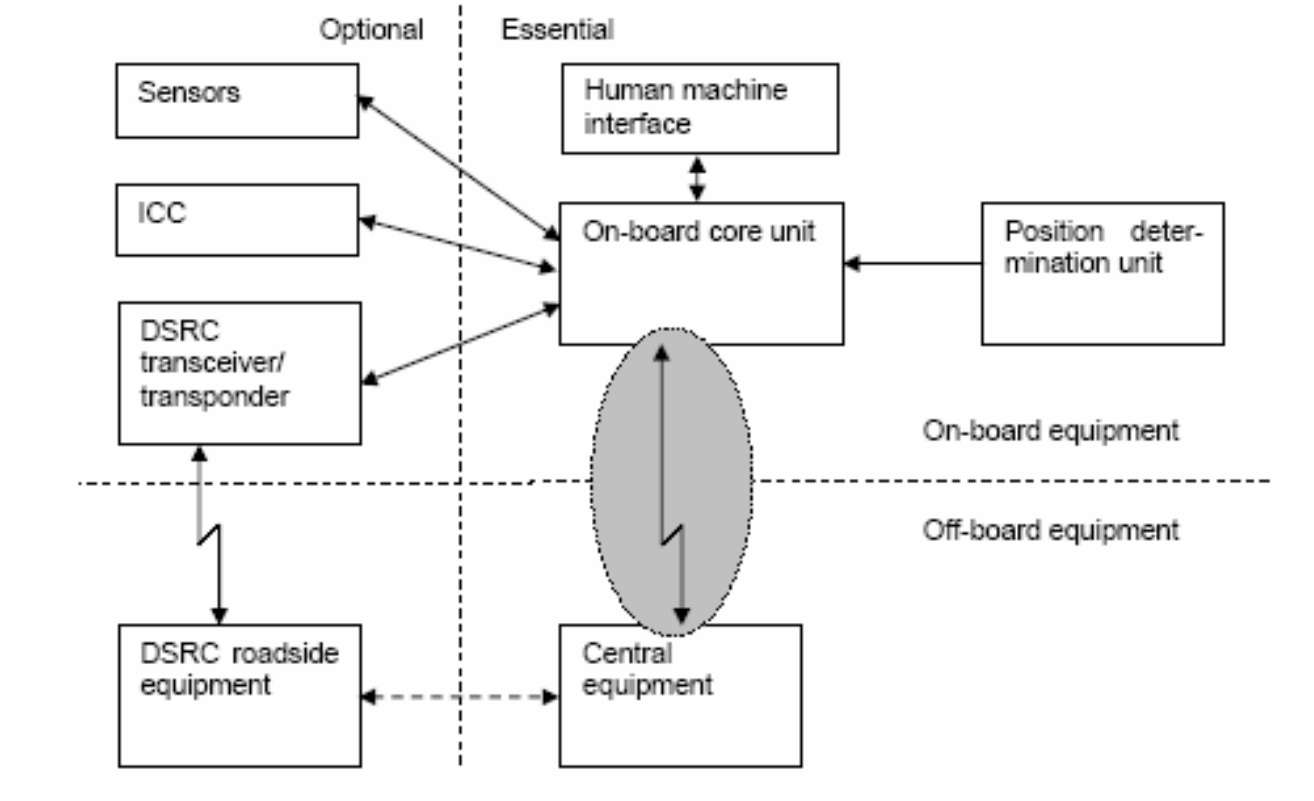
Context

- New Developments of “Eurovingette” Directive enables new road user charging objectives

- New Developments in standardisation and in EC Decision detailling Interoperability Directive set new framework for
  - participants and roles in tolling
  - tolling systems and technologies

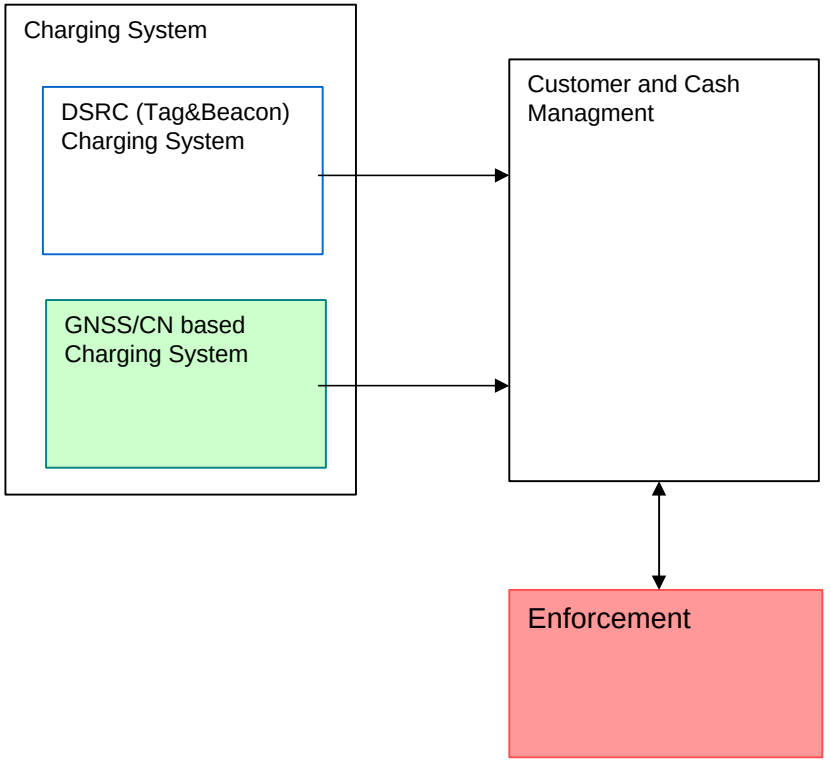
- ITS Action Plan of EU suggests a future common platform for
  - Tolling
  - Regulatory Services, e.g.
    - Road and Freight Safety
    - Security
  - Commercial Services
  - (...but this requires GNSS and GSM functionality...)

Generic Tolling System Architecture

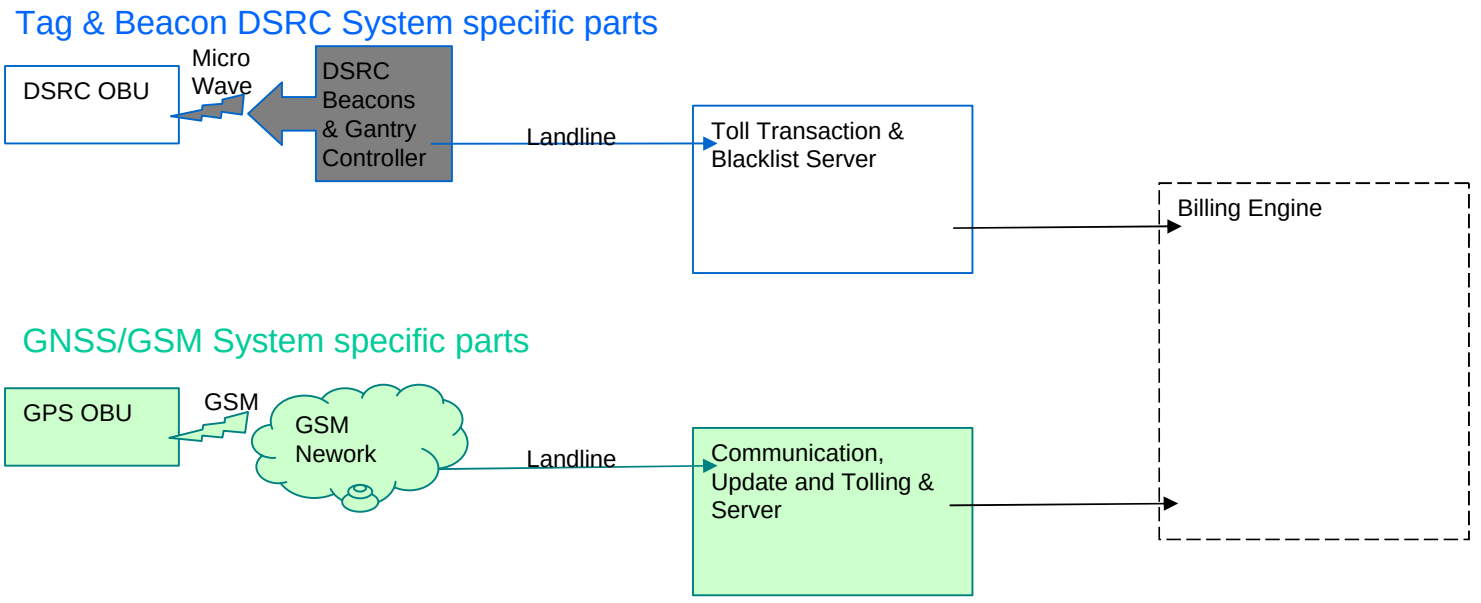


As considered in ISO 17575

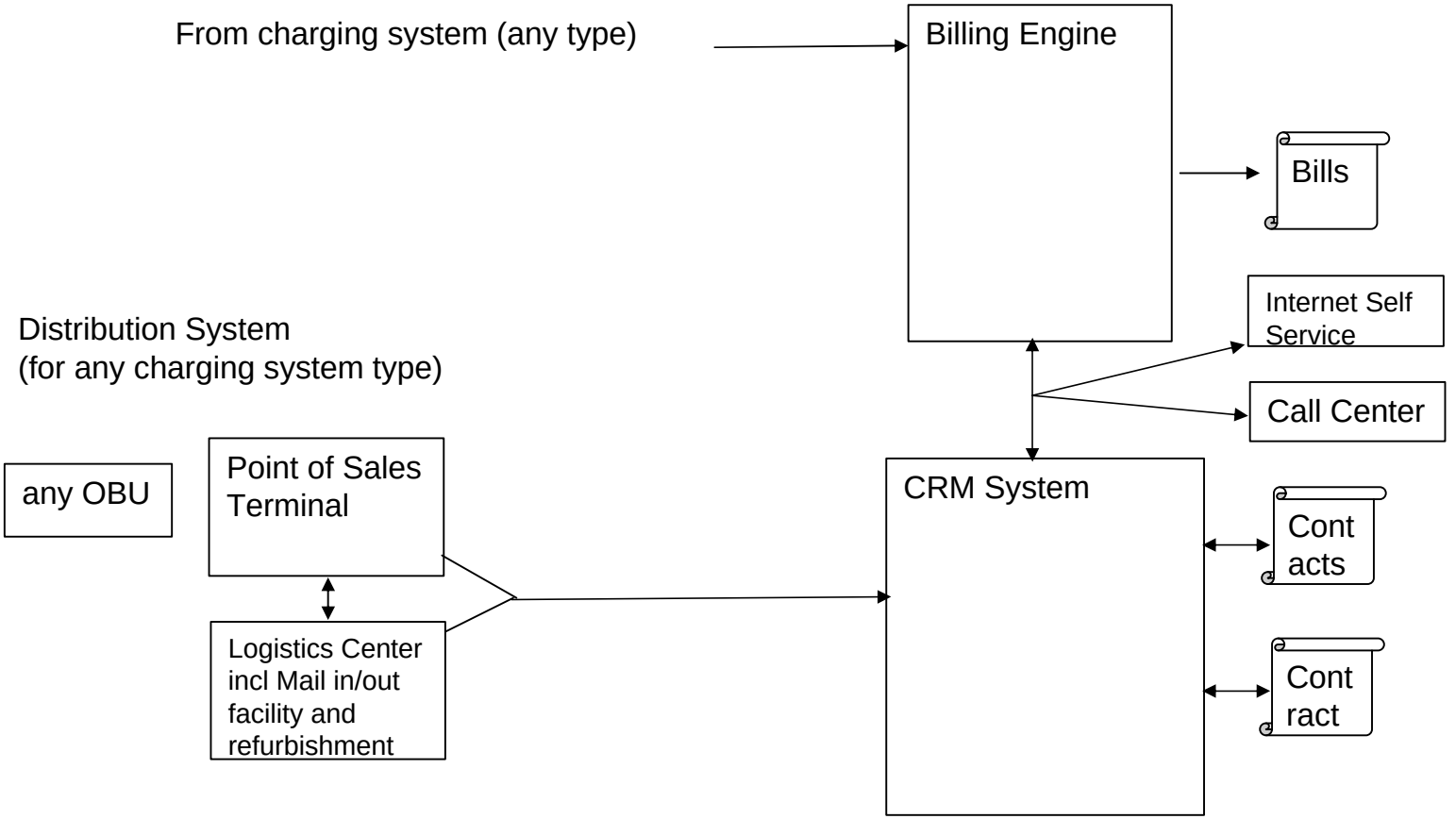
General system architecture



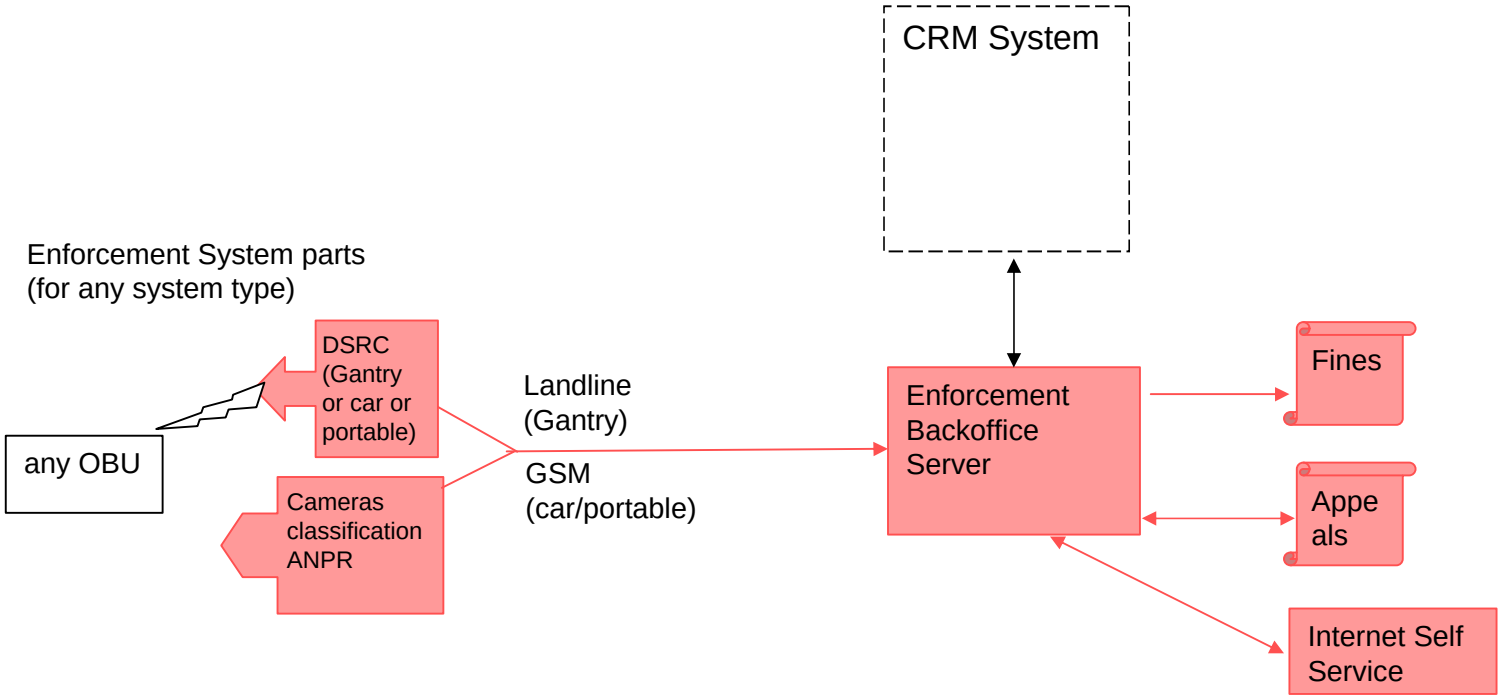
Breakdown of general system architecture: Charging System



Breakdown of general system architecture: Customer and Cash Management



Breakdown of general system architecture: Enforcement System



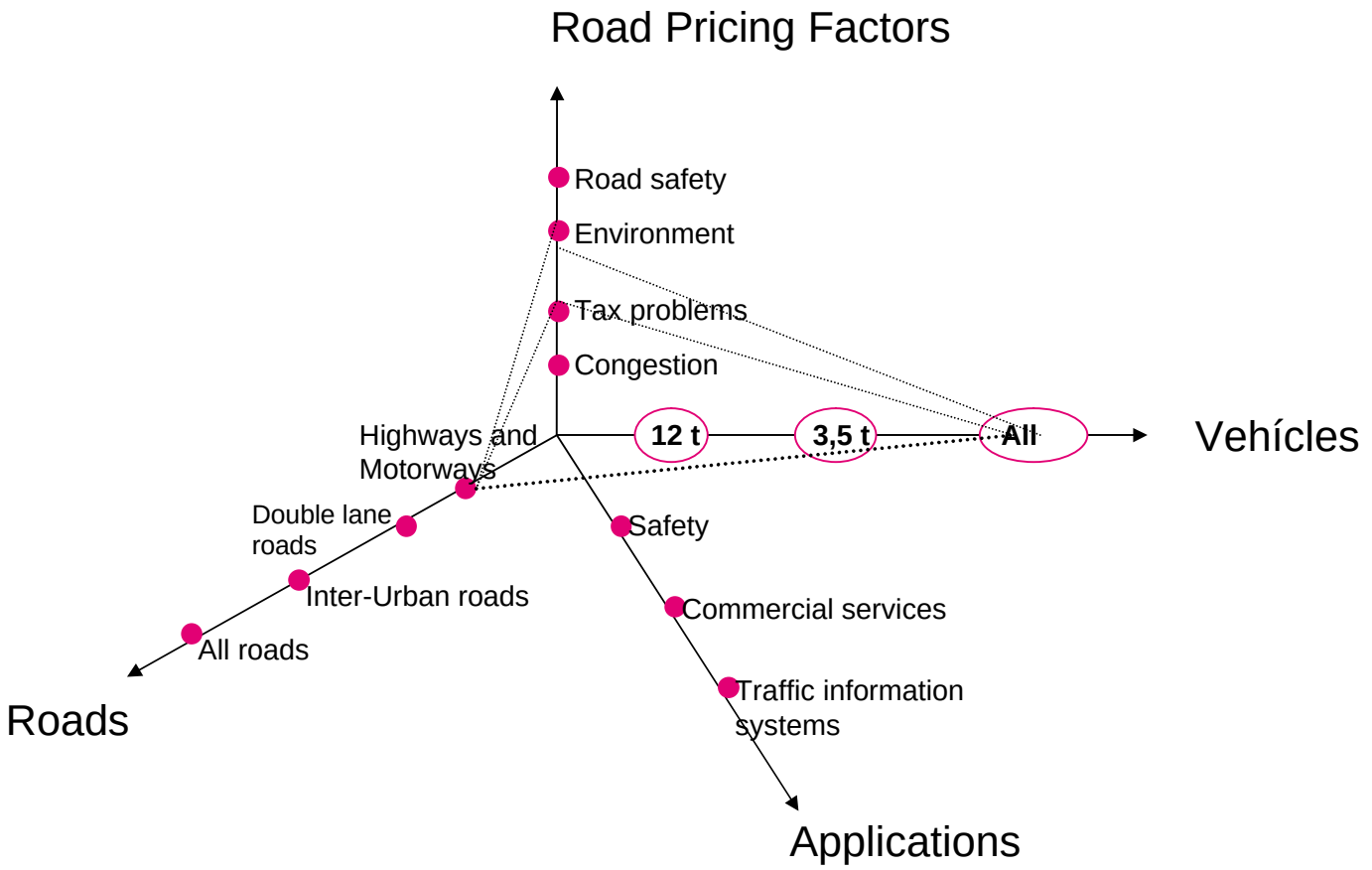
Parameters for Cost of Ownership and Operation

- **Charging system**
  - Investment in and distribution of OBU (On-Board Units).
  - Investment in and installation of infrastructure and Central system.
  - Mantenance of components and operation cost.
    - **GNSS/CN based system**
      - OBU cost.
      - Communications costs GSM/GPRS, and central system management.
    - **DSRC (Tag&Beacon) based system**
      - OBU cost
      - Installation, maintenance and operation of beacon, gantries and power/communication links
      - Installation, maintenance and operation of central system
- **Customer&Cash Management Cost Drivers**
  - Customer Management Processes: handling of client contacts, management of contracts, billing etc
  - Cost of financial services including e.g. payment guarantees, liquidity, deprication,...
- **Enforcement cost drivers**
  - Cost of Enforcement on the road: Automatic Gantries, Portable and Mobile Equipment
  - Investment, Installation, Maintenance and Operation of Equipment
  - “back-office” personel for validation of automatic evidence records and administration of fines and penalties as well as other legal action (appeals, objections,...)
  - Costs of Neforcement on the roads: Invest and operation cost for vehicles and personel cost for enforcement officers

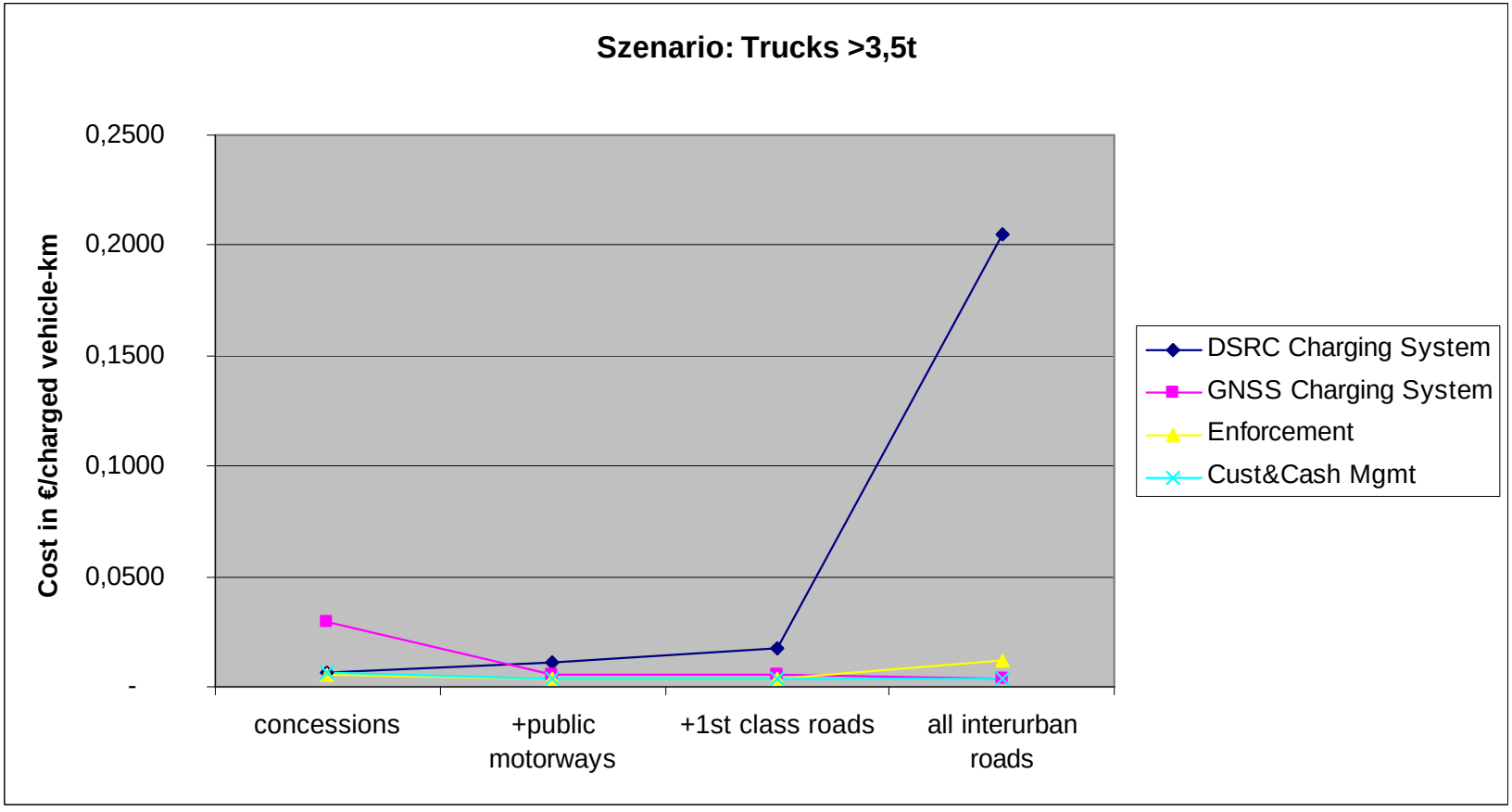
General cost parameters

- There is a range of generic cost drivers for all components that stem from the traffic scenarios to be tolled, such as
- Vehicle classes and number of vehicles per class
- Road network to be tolled and it's main characteristics like road types, average number of lanes and average length of road segments
- Traffic numbers like vehicle-km driven by the different classes of vehicles on the various road types
- The toll tariffs for various vehicle classes on the different road types
- The means of payment and allocation of charge collection risk between toll operator and toll charger (here. possibly Road Concessionaires for concession roads and National or regional Governments for public roads). Here we assume that the toll operator will carry these risks and thus a large part of payments is done by credit or fuel cards or pre-paid.
- Capital Cost, i.e. the interest rates to be paid for an investment.

Definition of scenarios for cost analysis



Results: Toll System Operation Cost for various roads included



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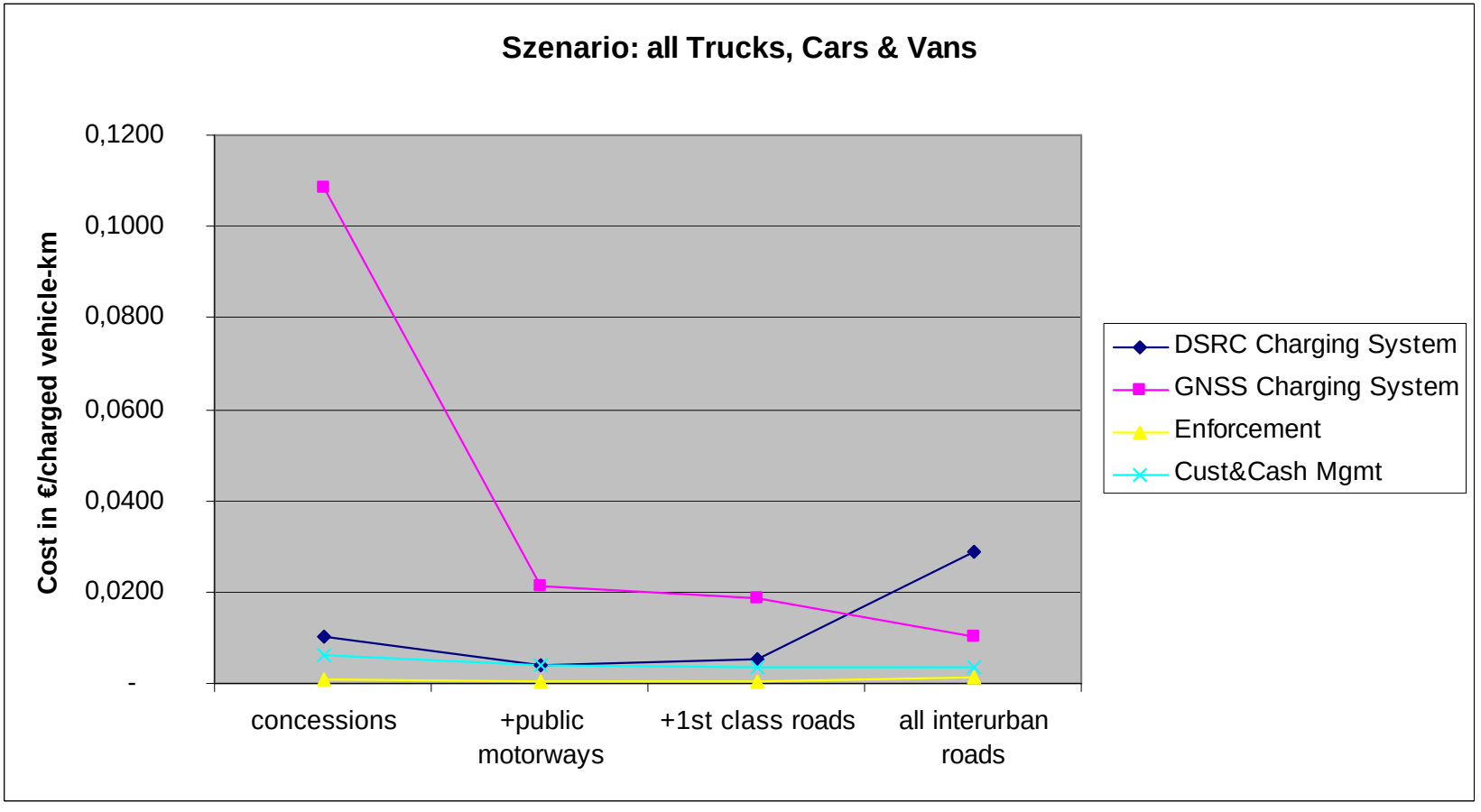
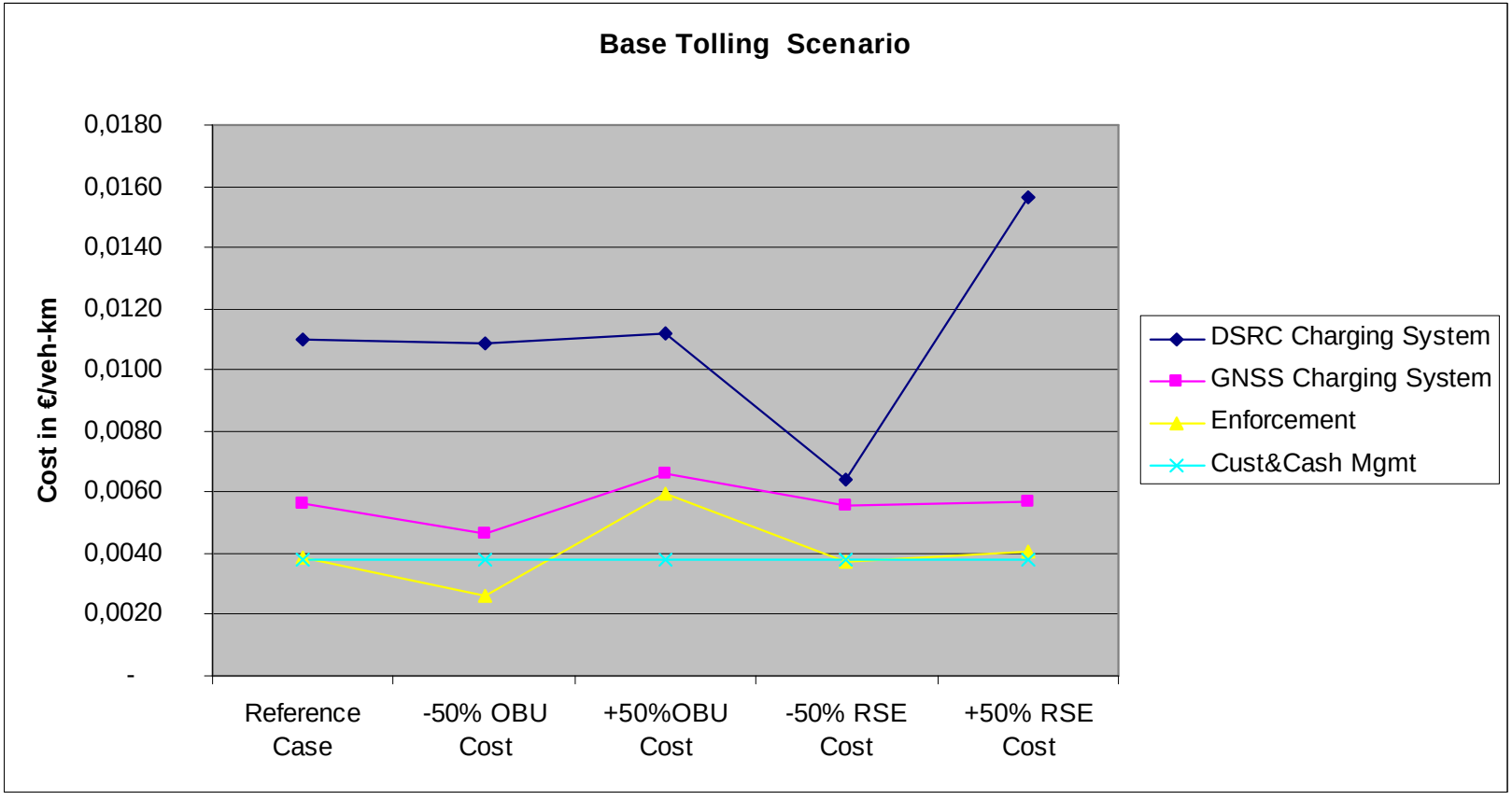


Results: Operation Cost Sensitivity Analysis for base case:

Highways&Motorways, vehicles >3.5t



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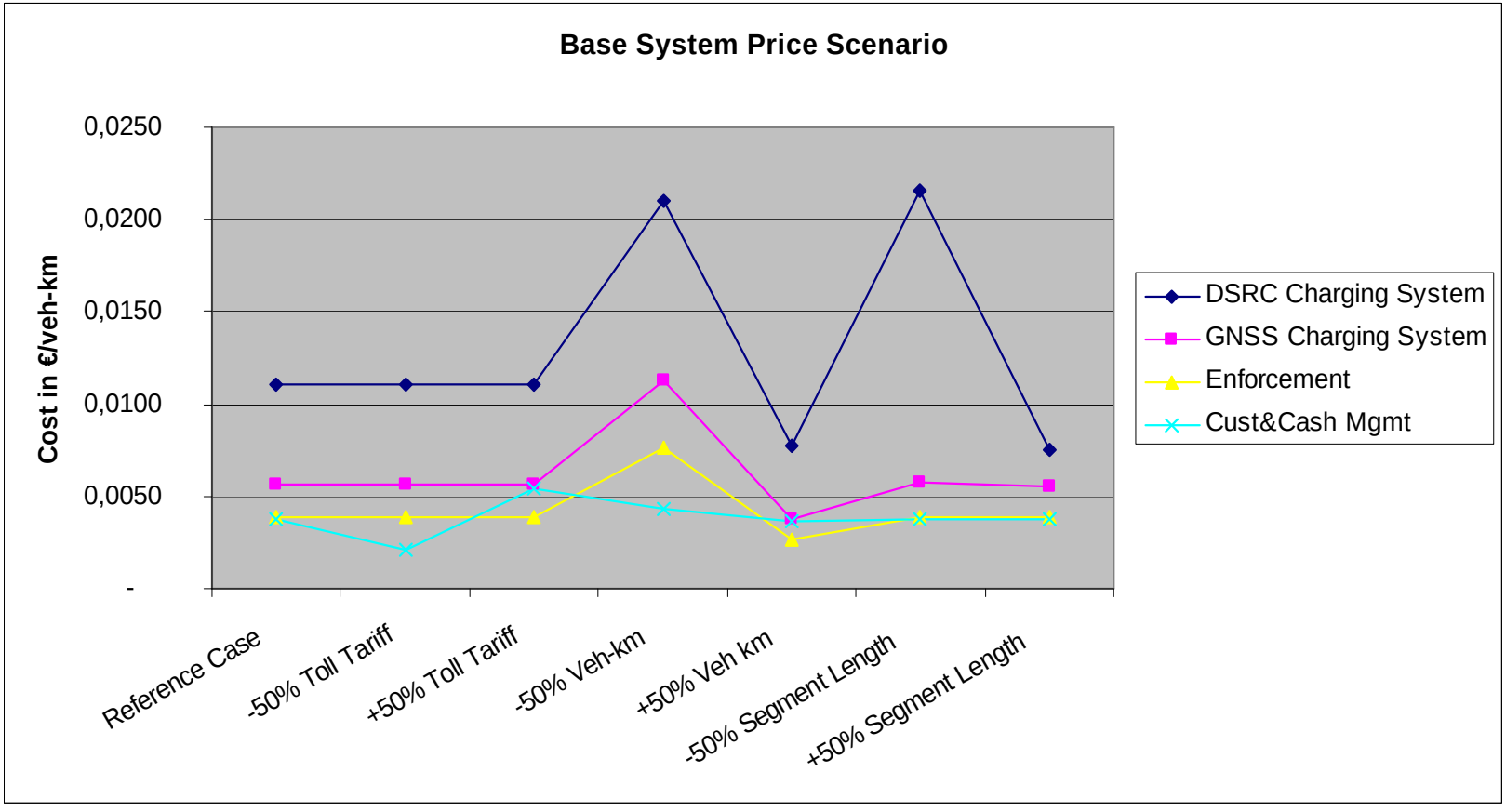

Conclusions

- For all scenarios involving public road networks in Spain, a charging system based on autonomous GNSS/GSM OnBoard-Units for trucks is more economic than a DSRC system

- Main cost drivers for the technological alternatives are
  - GNSS/GSM system: price of OBU and number of vehicles
  - DSRC system: price of gantry and beacons and number of road segments (= entry &exit possibilities) that need to be covered

- Dependency of system cost on toll tariff is low, mainly coming from financial services for both alternatives

- Interoperability of GNSS/GSM system with existing DSRC system due to use of DSRC used also for enforcement

- Only GNSS/GSM system can be platform for wide range of other regulatory and commercial applications and services

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Thank you for your Attention!

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