

Intelligent Transportation Systems

Erik Vanhauwaert

PhD student

UGent IBCN

10/06/2010 Ghent

Outline

- Intelligent Transportation Systems (ITS)
- Cost modelling
- Policy & government role
- Business modelling
- Future work

ITS

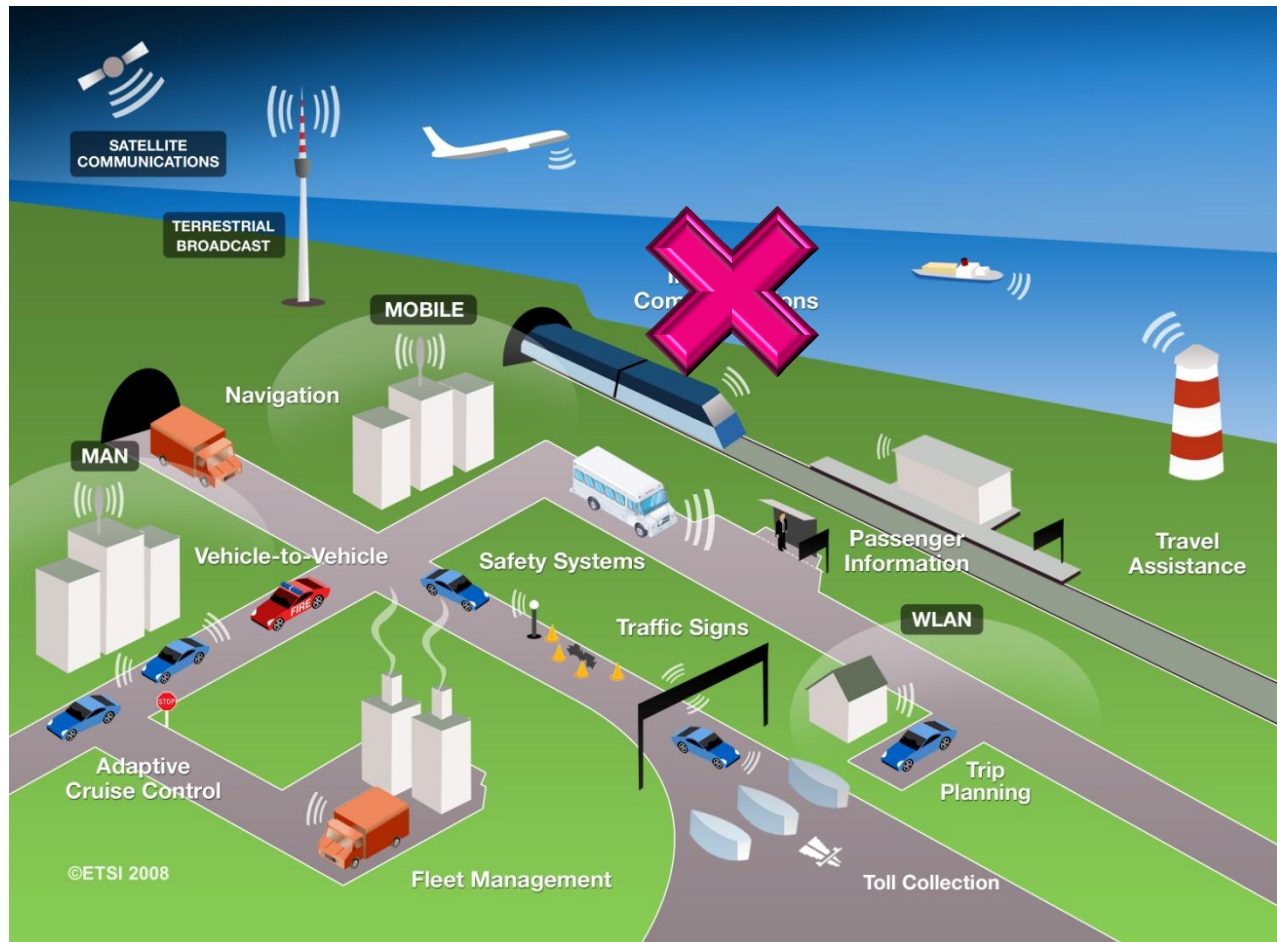
- Defining an Intelligent Transportation Systems

*“The addition of **information and telecommunication technology** to transport infrastructure and vehicles.”*

- Goal
 - Improve safety
 - Improve efficiency
 - Reduce costs
 - Fuel, vehicle damage
 - Environmental effect

ITS

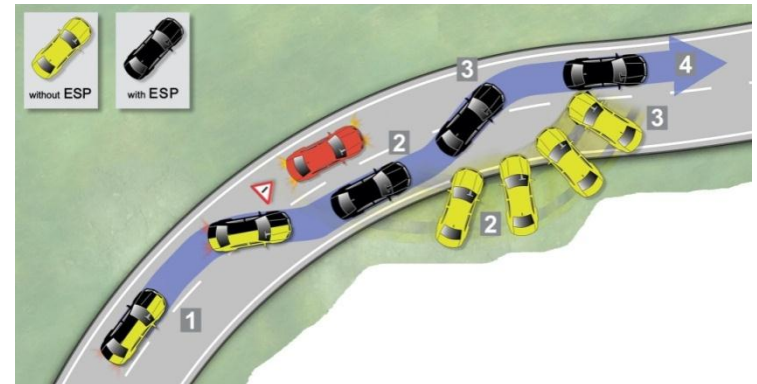
- ETSI vision



ITS

- ITS is a **collection of applications**

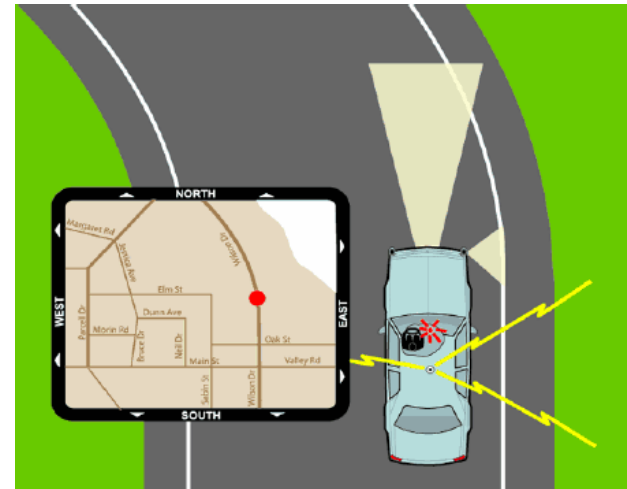
- Electronic Stability Program
 - Detect and minimize skids



- Collision hazard warning

- With cars
- With other objects

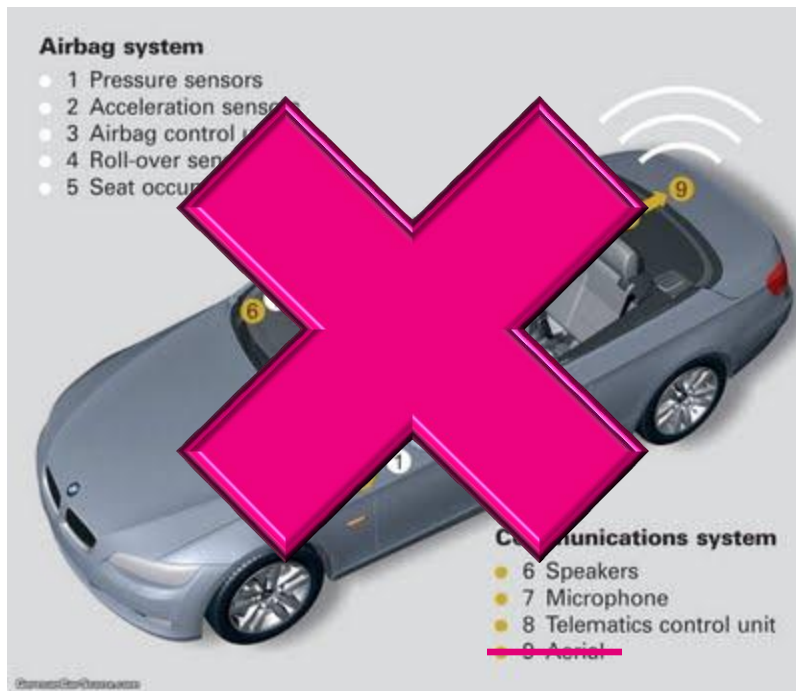
- ...



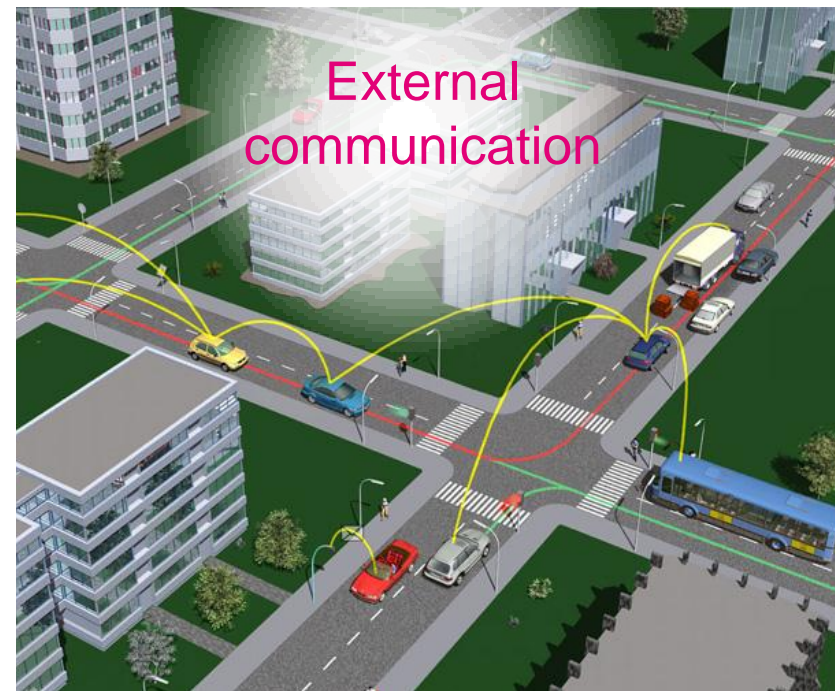
ITS

- ITS is a collection of applications
 - Two types

Autonomous



Cooperative



ITS

- ITS is a **collection of applications**
 - Several environments

Urban

Highway

Rural



ITS

- ITS elements
 - On-Board Unit (OBU)
 - PND-like: audio, screen
 - Integrated in vehicle
 - Wireless connection
 - Road-Side Unit (RSU)
 - Network
 - Traffic Management Center



ITS

- ITS elements
 - On-Board Unit (OBU)
 - Road-Side Unit (RSU)
 - VMS
 - Beacons (e.g. toll, ...)
 - ...
 - Network
 - Traffic Management Center



ITS

- ITS elements
 - On-Board Unit (OBU)
 - Road-Side Unit (RSU)
 - Network
 - Mobile network
 - GPRS, EDGE, UMTS, HSDPA, WiMAX ...
 - Broadcast
 - DVB-T, DAB, MBMS, ...
 - Local
 - DRSC, CALM-IR, CALM-M5, ...
 - Traffic Management Center

ITS

- ITS elements
 - On-Board Unit (OBU)
 - Road-Side Unit (RSU)
 - Network
 - Traffic Management Center
 - Central application management
 - Link ITS with traffic center
 - Administration

ITS

- Issues
 - How much will it **cost**?
 - **Valuation** of benefits?
 - Benefits for society <> costs for a few companies
 - Many other questions
 - Will the system be **reliable** enough?
 - Will **privacy** be assured?
 - How will the system **interact** with the driver?
 - Who will be **responsible** in case of failure?
 - Will there be **standards** to ensure cooperation of units?
 - ...

Outline

- Intelligent Transportation Systems (ITS)
- **Cost modelling**
- Policy & government role
- Business modelling
- Future work

Cost modelling

- What?

“Costs for different roll-out scenarios for cooperative applications of an ITS on Belgian highways.”

- To what extent?
 - No detailed cost & planning tool
 - Estimation of order of size
 - Compare different scenarios

Cost modelling

- Scenarios
 - Technologies
 - Mobile network
 - HSDPA, WiMAX, LTE
 - Broadcast
 - DVB-T, DAB, MBMS
 - Local
 - DRSC, CALM-IR, CALM-M5
 - Applications
 - Adoption
 - Phases

Re-use of existing

- *base stations*
- *transceivers*
- *backhauling*

Cost modelling

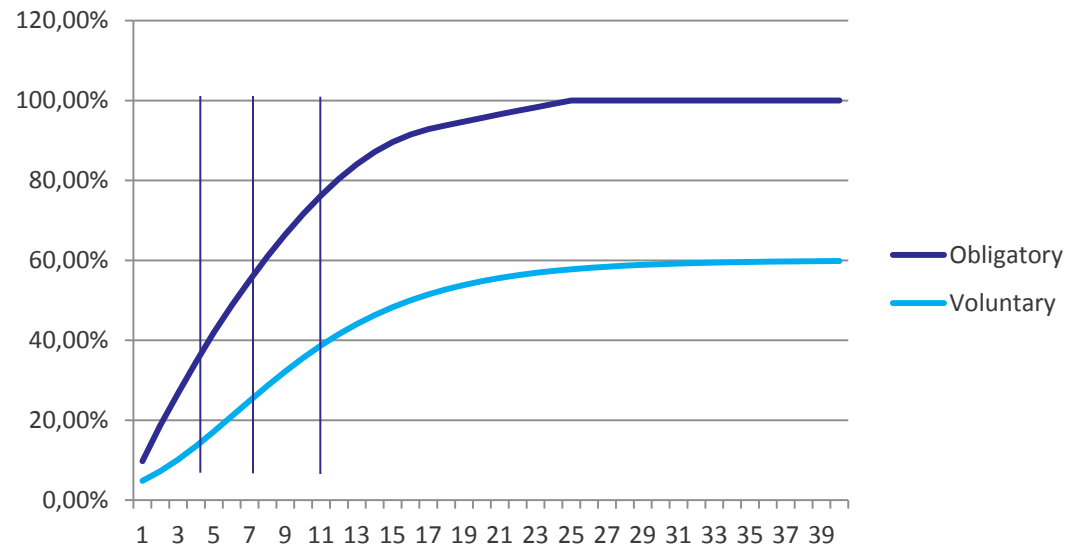
- Scenarios
 - Technologies
 - Applications
 - Safety & convenience
 - eCall
 - Frontal collision
 - Remote diagnostic
 - ...
 - Recreational
 - Internet connection
 - Audio/video
 - Adoption
 - Phases

Cost modelling

- Scenarios
 - Technologies
 - Applications
 - Adoption
 - Voluntary
 - Obligatory (only new cars)
 - Phases

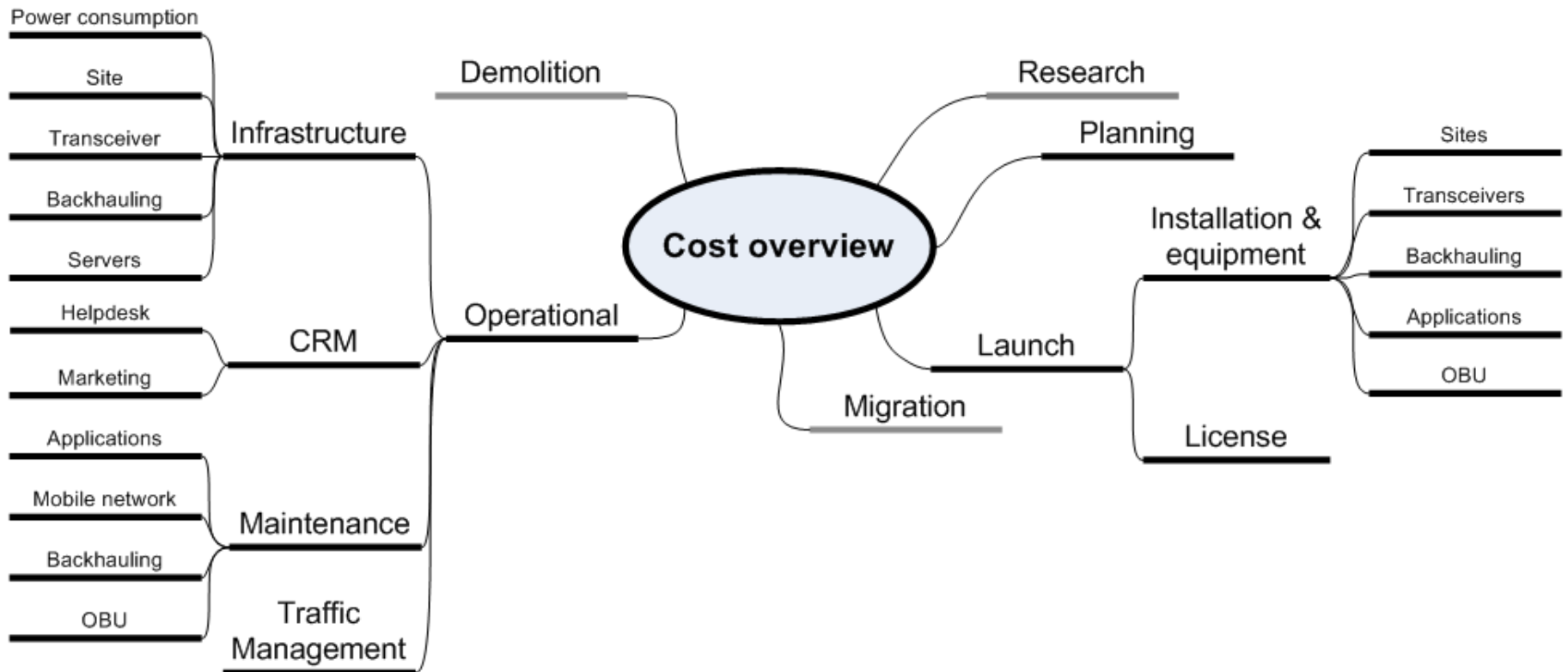
Cost modelling

- Scenarios
 - Technologies
 - Applications
 - Adoption
 - Phases



Cost modelling

- Costs



Cost modelling

- Results – adoption obligated

Applications		Technologies						Unicast
		HSDPA		WiMAX		LTE		
Safety	Recr.	No	Yes	No	Yes	No	Yes	Broadcast
Yes	No	991,23	991,23	1.124,85	1.902,18	1.316,78	2.094,12	Cost (10 yr) €1M
		--	MBMS	--	DVB-T	--	DVB-T	Broadcast techn.
No	Yes	1.012,22	--	1.083,63	--	1.275,50	--	Cost (10 yr) €1M
		--	--	--	--	--	--	Broadcast techn.
Yes	Yes	1.063,22	1.055,06	1.126,41	1.903,75	1.318,35	2.095,68	Cost (10 yr) €1M
		--	MBMS	--	DVB-T	--	DVB-T	Broadcast techn.
Yes	Yes++	1.291,21	1.281,17	1.126,55	1903,87	1.318,40	2.095,73	Cost (10 yr) €1M
		--	MBMS	--	DVB-T	--	DVB-T	Broadcast techn.

Cost modelling

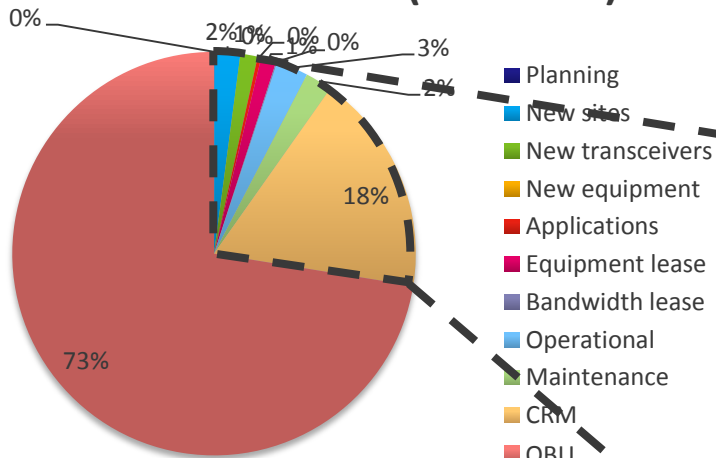
- Results – adoption voluntary

Applications		Technologies							
		HSDPA		WiMAX		LTE		Unicast	Broadcast
Safety	Recr.	No	Yes	No	Yes	No	Yes		
Yes	No	446,5	446,5	492,9	793,8	562,9	863,8	Cost (10 yr) €1M	
		--	MBMS	--	DVB-T	--	DVB-T	Broadcasttechn.	
No	Yes	435,8	--	451,7	--	521,7	--	Cost (10 yr) €1M	
		--	--	--	--	--	--	Broadcasttechn.	
Yes	Yes	484,2	478,6	494,5	795,3	564,4	865,3	Cost (10 yr) €1M	
		--	MBMS	--	DVB-T	--	DVB-T	Broadcasttechn.	
Yes	Yes++	607,9	602,2	494,5	795,3	564,4	865,3	Cost (10 yr) €1M	
		--	MBMS	--	DVB-T	--	DVB-T	Broadcasttechn.	

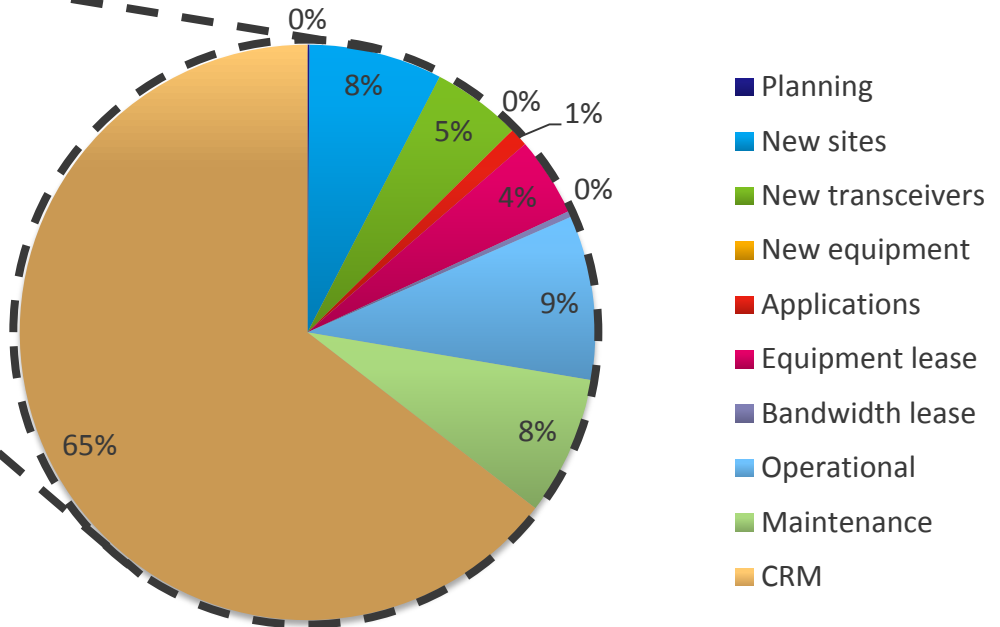
Cost modelling

- Detailed results – cost breakdown (10 years)

Cost breakdown (incl. OBU)



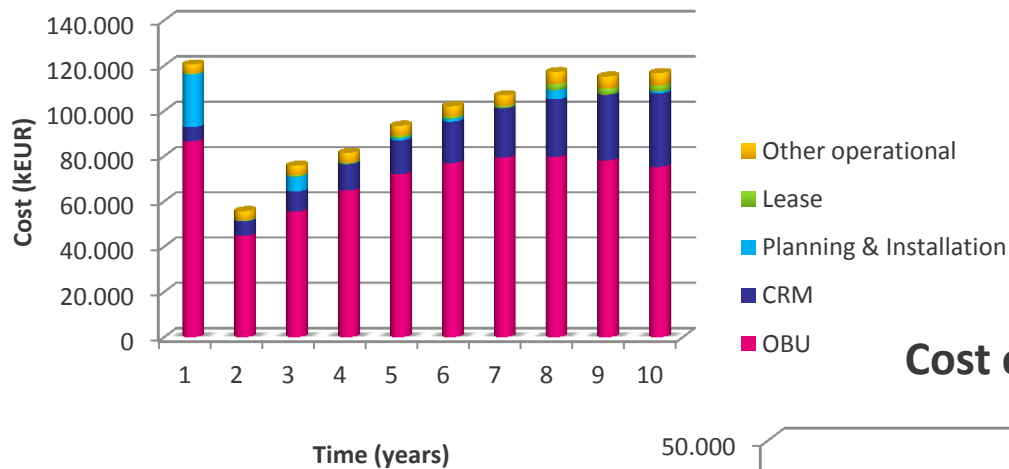
Cost breakdown (excl. OBU)



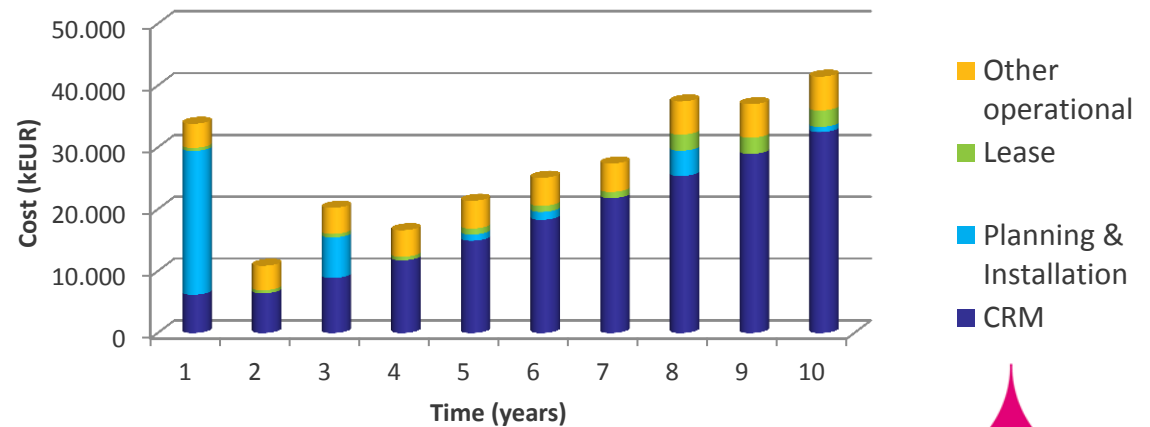
Cost modelling

- Detailed results – cost evolution

Cost evolution



Cost evolution (excl. OBU)



Cost modelling

- Technology conclusions
 - Combining many technologies is not efficient
 - No combination of broadcast and mobile
 - WiMAX appears best suited
 - HSDPA not future-proof
 - LTE still too expensive

Cost modelling

- Cost conclusions
 - Total cost is very high
 - OBU is biggest cost
 - +/- 300 EUR per user
 - Up-front cost!
 - Difficult to estimate
 - Installation/integration in cars?
 - Cfr GPS in cars: handheld vs. integrated
 - Application set & flexibility influence requirements
 - CRM also has heavy impact
 - Could be lowered considerably

Cost modelling

- Approach conclusions
 - Re-use of existing equipment
 - Positive, but very limited impact on total cost
 - About 1% of total cost, due to
 - Infrastructure only small part of total cost
 - Conservative lease prices
 - Combination of applications
 - Huge positive impact

Outline

- Intelligent Transportation Systems (ITS)
- Cost modelling
- Policy & government role
- Business modelling
- Future work

Policy & government role

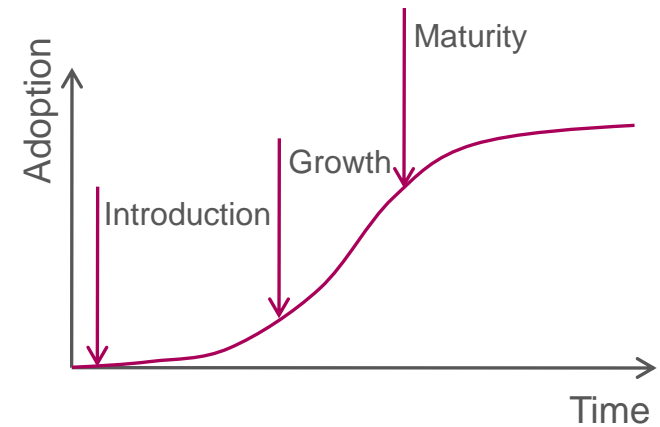
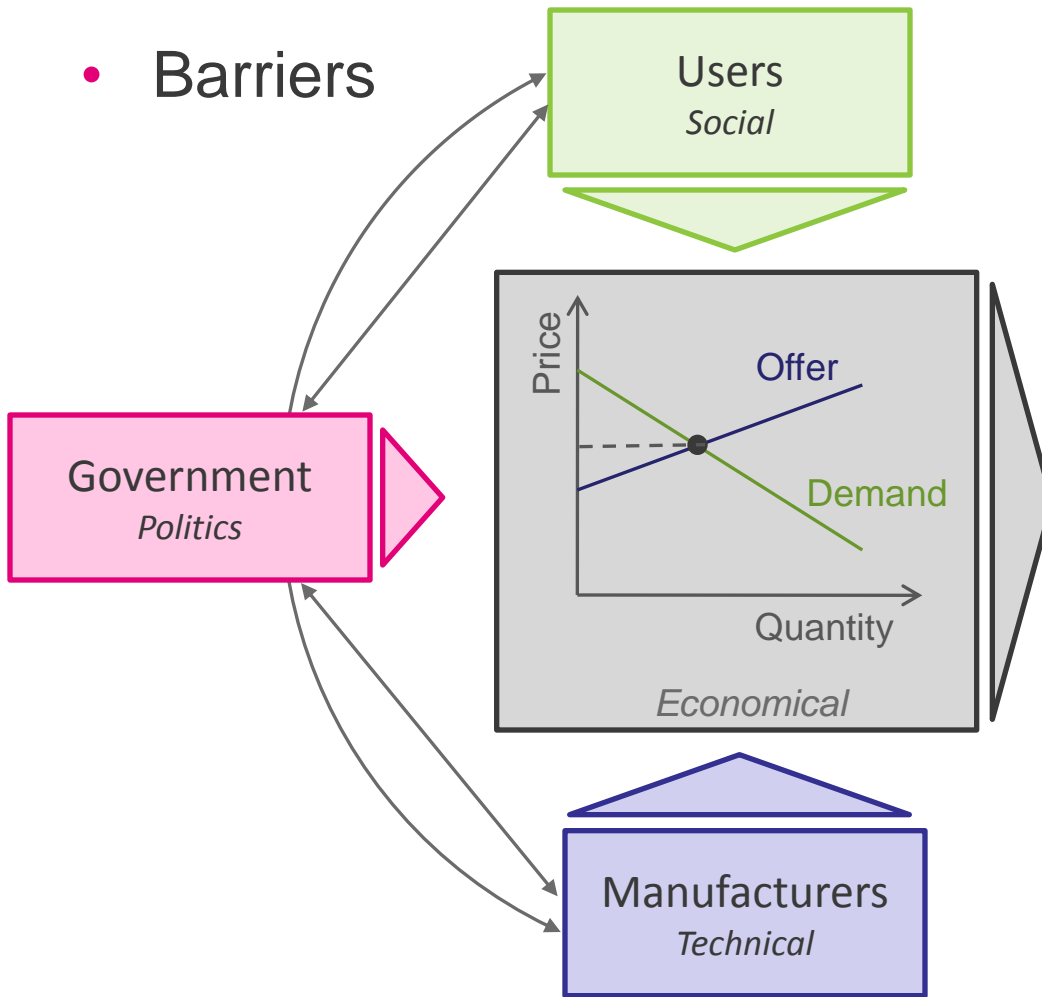
- Government goals aligned with ITS goals
→ **supportive** attitude
- Costly **investment required**
→ cost-benefit, total cost, multi-criteria analyses
 1. *Valuation is difficult and uncertain*
 2. *Other research shows (barely) positive result*
- Our vision: government will not yet invest directly

Policy & government role

- No **private initiatives** to organize an ITS
 - Government should
 - identify the barriers
 - investigate the barriers
 - remove those barriers
- **Investment** could be limited/avoided by
 - limiting costs (international cooperation & economies of scale)
 - sound business model (increase value or value perception)

Policy & government role

- Barriers



Policy & government role

- Barriers
 - Manufacturers: cars, OBU, RSU, ...
 - Alignment
 - Benefits (e.g. insurance companies)
 - Costs (e.g. network operators)
 - Organization
 - Standards (lower risks and costs)
 - User interaction & requirements
 - Installation & integration of OBU?
 - Legal framework
 - Pricing model?
 - Users
 - Economical factors

Policy & government role

- Barriers
 - Manufacturers
 - Users: drivers of vehicles
 - Awareness
 - Reliability, durability & effectiveness
 - Privacy
 - Human interface & interaction
 - Little administration
 - Flexibility?
 - Economical factors

Policy & government role

- Barriers
 - Manufacturers
 - Users
 - Economical factors
 - Price, costs, value
 - Costs vs benefits
 - Critical user mass: chicken & egg
 - Mixed good: free riders
 - Macro-economical and social benefits

Policy & government role

- Conclusions on government policy
 - Support research
 - Create awareness
 - Initiate and organize
 - Promote international cooperation & standardization
 - Define responsibilities and regulations
 - Influence adoption
 - Retribute of benefits to cost carriers

Outline

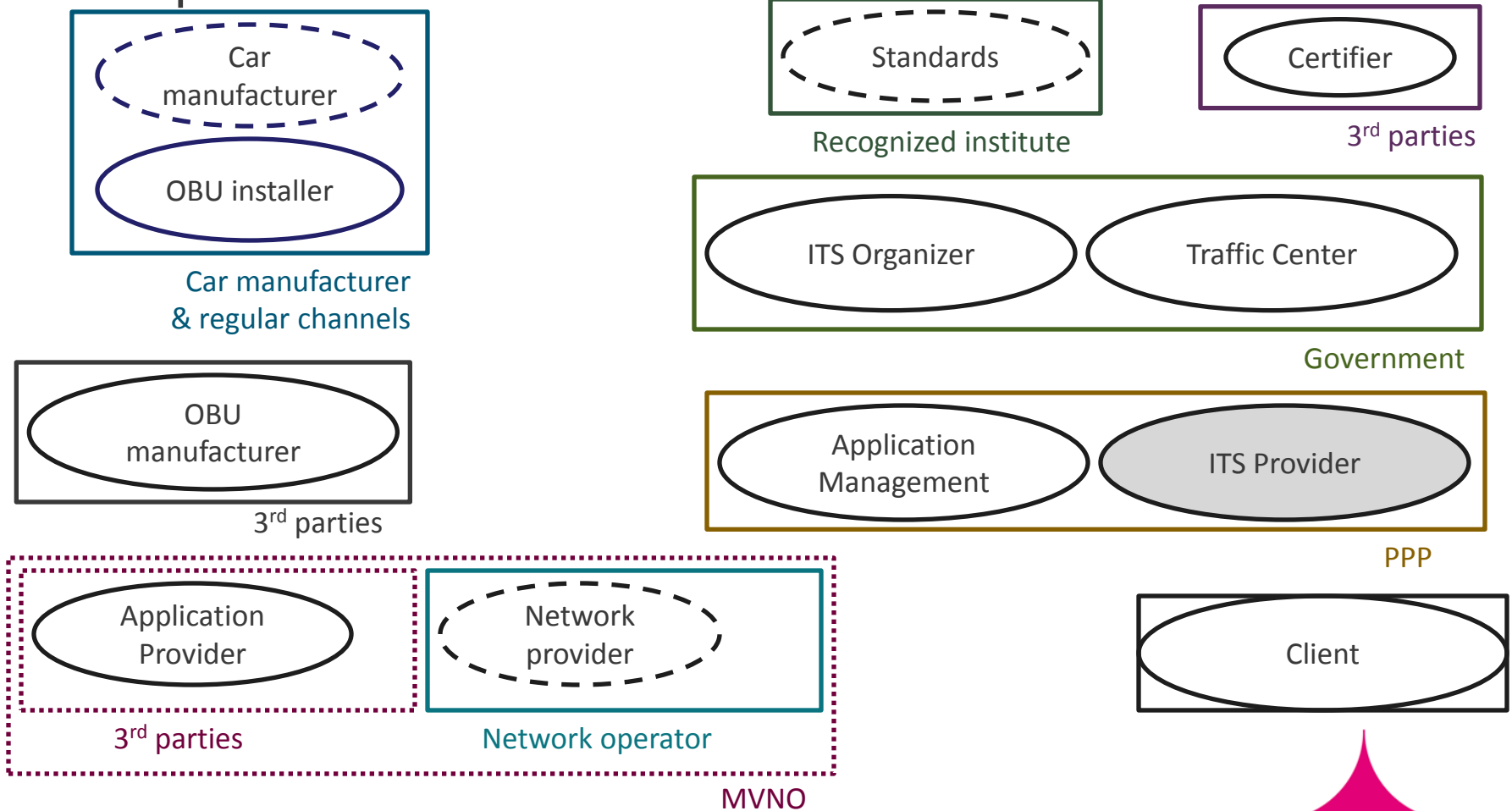
- Intelligent Transportation Systems (ITS)
- Cost modelling
- Policy & government role
- **Business modelling**
- Future work

Business Modelling

- Value Network
 - Identifying roles & actors
 - Mapping?
 - Barriers
 - Competition possibilities (lowering price)
 - Existing companies

Business Modelling

- Proposed Value Network

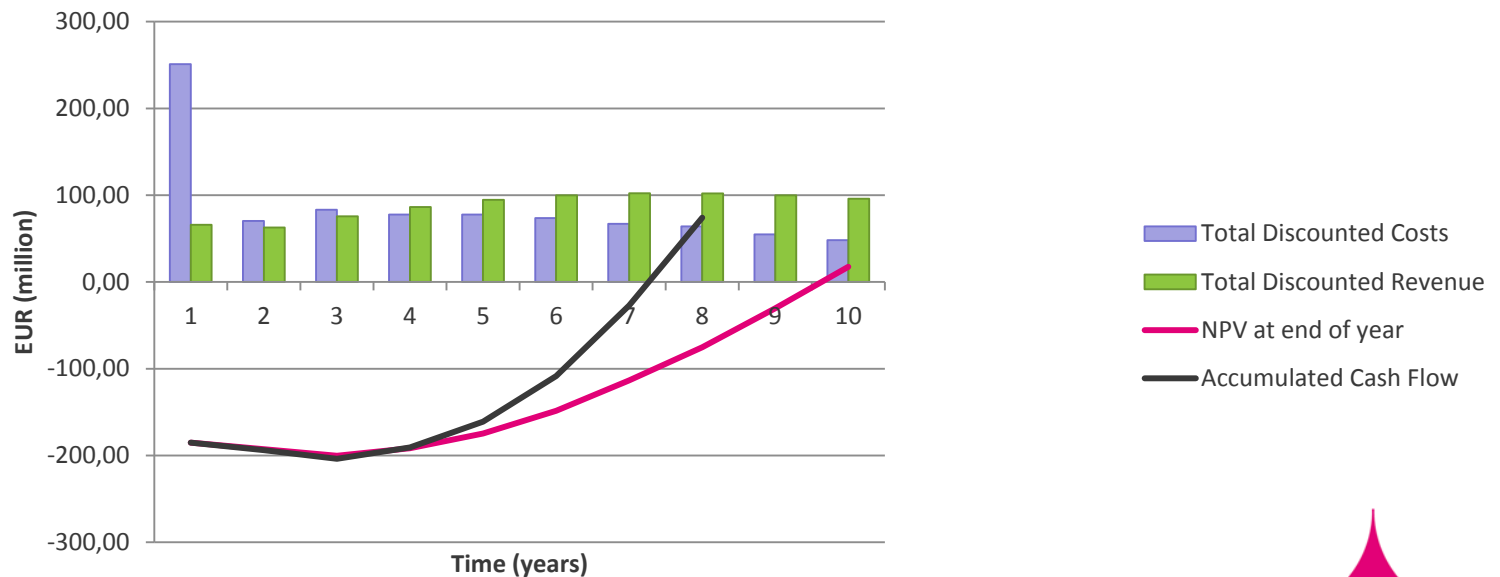


Business Modelling

- Costs
 - Calculated before
 - Distributed according to roles
- Revenues
 - Customer payments
 - Subscription fee or one-time purchase?
 - Retributions of benefits
 - E.g. lower insurance premium
 - Government subsidy
 - Distributed according to
 - Cost coverage
 - Market power

Business Modelling

- Preliminary example case
 - Purchase: 100 EUR, subscription 150 EUR / year (excl. VAT)
 - Recreational applications for 200 EUR / year (excl. VAT)
 - 20% of users subscribe to recreational applications
 - 45% company cost overhead



Business Modelling

- Preliminary conclusions
 - A valid business case may be made
 - Government should be in strong control position

Outline

- Intelligent Transportation Systems (ITS)
- Cost modelling
- Policy & government role
- Business modelling
- **Future work**

Future work

- Complete & link each part
 - Input data
 - Adoption
 - OBU price
 - Calculations
 - *Theoretical vs realistic connection possibilities*
 - Methodology
 - *Value Network configuration*
- Social cost/benefit analysis
- From highways to other environments
- Integrate with autonomous applications
 - Car manufacturer point of view

Thank you!

Thank you!

