PTOLEMUS
Consulting Group

ELECTRONIC TOLL COLLECTION

2015
EDITION

Free
abstract

The point of
reference on
electronic tolling

Transforming road charging into a connected vehicle service

ABOUT PTOLEMUS CONSULTING GROUP

PTOLEMUS is the **first strategy consulting firm entirely focused on the connected vehicle and the Internet of Things**.

We help our clients apply strategic analysis to this fast-moving ecosystem, across all its industries (Automotive, consumer electronics, insurance & assistance, transport, road charging, etc.) and on an international basis.

PTOLEMUS operates worldwide and has Partners in Boston, Brussels, Chicago, Hannover, London, Milan, New York and Paris.

It has also built a network of telematic specialists across the world to be able to analyse and address global mobility issues.

PTOLEMUS has performed more than 50 assignments in the connected vehicle domain.

For any enquiry, please contact:
contact@ptolemus.com

Our consulting services

Strategy definition
Vision creation, strategic positioning, business plan development, board coaching & support

Investment assistance
Strategic due diligence, market assessment, feasibility study, M&A, post-acquisition plan

Procurement strategy
Specification of requirements & tender documents, launch of tenders, supplier negotiation & selection

Innovation management
Value proposition definition, product & services development, architecture design, assistance to launch

Business development
Partnership strategies, detection of opportunities, ecosystem-building, response to tenders

Implementation
Deployment plans, complex / high risk project & programme management, risk analysis & mitigation strategy

Our fields of expertise

Car infotainment & navigation
Connected services (Traffic information, fuel prices, speed cameras, weather, parking, POIs, social networking), driver monitoring, maps, navigation, smartphone integration

Usage-based charging
Road charging / electronic tolling, PAYD / PHYD insurance, fleet leasing & rental, car sharing, Car As A Service, etc.

Telematics & Intelligent Transport Systems
ADAS, autonomous car, connected vehicle, fleet management, eCall, bCall, SVR, tracking, vehicle data analytics (OBD / CAN-bus), VRM, V2X, xFCD

Positioning / Location enablement

M2M & connectivity

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Thomas Hallauer has gained 12 years of research & marketing experience in the domain of connected vehicle services. He is an expert in new products and services notably in the automotive, motor insurance, navigation, road charging and positioning industries.

Before PTOLEMUS, Thomas held management responsibilities with Mobile Devices, a leading provider of telematic technology platform and devices and with TU Automotive.

Thomas is a regular speaker and blog writer. He is also often called for interviews by publications such as *GPS Business News* or *ITS International*.

Thomas led the research for this study and interviewed over 60 players in RUC globally.

Frederic Bruneteau, Managing Director, Brussels (fbruneteau@ptolemus.com)

Mr. Bruneteau founded the PTOLEMUS Consulting Group on the conviction that pervasive location and connectivity would revolutionise the business of mobility.

He has 20 years of experience in 12 countries with companies such as TomTom, SFR Vodafone, Arthur D. Little and BNP Paribas.

Mr. Bruneteau has led over 30 assignments on the connected vehicle domain for clients such as Allianz, Generali, Michelin, Octo Telematics, Thales Alenia Space, Toyota and Qualcomm. He has also assisted key players on ETC-related assignments, notably Egis Projects, SOFICO and Telit Wireless.

He has spoken at over 50 conferences on the connected car and is often quoted by publications such as *The Economist*, *The Wall Street Journal, Forbes* and *Reuters*.

Frederic reviewed and contributed to this report, holding notably discussions with over 25 stakeholders in the domain.

Matthieu Noël, Senior Consultant, Paris (mnoel@ptolemus.com)

Mr. Noël has gained 4 years of consulting experience primarily helping clients in the automotive, roadside assistance and road charging sector such as Allianz, BMW, Egis Projects, Michelin, PSA Peugeot-Citroën and Renault-Nissan.

For this report, Matthieu has notably led our market forecasting work.

OTHER CONTRIBUTORS

Sergio Tusa, Associate Partner, Milan (stusa@ptolemus.com)

Sergio Tusa has gained over 25 years of experience in the telematics, location-based services and automotive domains.

He has led a very large number of connected vehicle projects, for clients such as Cobra Automotive Technologies, Ferrari, Fiat, Magneti Marelli and Renault/Volvo Trucks.

Sergio is also the President of the Italian association of Telematic Service Providers.

Hartmut Albers, Associate Partner, Hannover (halbers@ptolemus.com)

Hartmut Albers has gained 30 years of experience in the mobility services, transport and logistics industries from firms such as Deutsche Bahn, DKV, Duisburger Container Terminal, Hannover Public Transport and Schenker.

He has gained world-class expertise in connected services, notably in RFID, e-ticketing, capacity and fleet management, process and workflow management, factoring and tax retrieval combined with the design of IT applications and solutions.

At DKV Euro Service, Europe's largest provider of fuel cards for fleets, Hartmut co-headed the creation of the business unit in charge of tax refund services for transportation fleets of Heavy Goods Vehicles.

Maria Grazia Verardi, Senior Expert, New York City (mgverardi@ptolemus.com)

Maria Grazia Verardi has gained over 15 years of experience in R&D, product design, hardware- and software development in the domain of telematics and IT.

She has gained a comprehensive understanding of telematics technologies from leading technology and service providers such as Cobra Automotive and Cesar Satellite. She has been actively involved in the CEN pan-European eCall working group, notably participating to the development of eCall requirements and associated standards.

Finally, Maria Grazia recently assisted a major European telematics supplier in its global device strategy.

OUR SINCERE THANKS

The richness of this report is largely based on the willingness of the "ecosystem" to co-operate and give its time and knowledge for the benefit of the wider society and economy

We would like to particularly thank

- Our four guest interviewees;
- Everybody who kindly accepted to respond to our questions. A list of the companies we interviewed is available on page 11;
- Our families for their patience and understanding.

Electronic tolling, road charging, road user charging, ETC, RUC, Intelligent Transport Systems, connected car, connected vehicle, traffic management, electronic fee collection, tolling, e-tolling, electronic toll collection, vehicle payment systems, vehicle-to-infrastructure, V2X, V2I, credit card payment, DSRC, RFID, ANPR, GNSS, GPRS, M2M, IoT, Internet of Things, Internet of Objects

IMPORTANT NOTICE

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Disclosure

The recommendations and opinions expressed in this study reflect PTOLEMUS' independent and objective views. However, PTOLEMUS cannot provide any guarantee as to the accuracy of the information provided or the reliability of its analyses and forecasts.

Cover photo courtesy of Toll CDM Smith

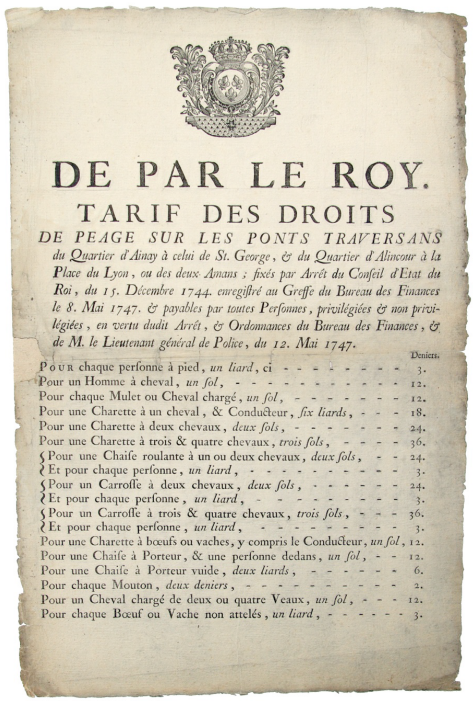
FOREWORD

From octroi to connected vehicles

In the Middle Ages, as towns in France started to assert their independence and transform into solid commercial centres, they obtained the right to establish, collect and re-invest local taxation. Numerous charters were later granted to cities, offering them the right to charge "octroi duties" on beverages, food, fuel, forage or building materials entering the city.

This right has since almost disappeared, yet when travelling throughout the world today, the government authorities' ability to charge the travellers is strangely reminiscent of this ancient tax. Recent examples include the UK's road levy (for trucks) and the German PKW-Maut (for all light vehicles) which effectively add new charges only to foreigners - which probably makes them infringe EU law.

Toll tariffs for a bridge near Lyon in 1747



DE PAR LE ROY.

TARIF DES DROITS

DE PEAGE SUR LES PONTS TRAVERSANS du Quartier d'Ainay à celui de St. George, & du Quartier d'Alincour à la Place du Lyon, ou des deux Amans ; fixés par Arrêt du Conseil d'Etat du Roi, du 15. Décembre 1744. enregistré au Greffe du Bureau des Finances le 8. Mai 1747. & payables par toutes Personnes, privilégiées & non privilégiées, en vertu dudit Arrêt, & Ordonnances du Bureau des Finances, & de M. le Lieutenant général de Police, du 12. Mai 1747.

	Deniers.
POUR chaque personne à pied, *un liard*, ci	3.
Pour un Homme à cheval, *un sol*,	12.
Pour chaque Mulet ou Cheval chargé, *un sol*,	12.
Pour une Charette à un cheval, & Conducteur, *six liards*,	18.
Pour une Charette à deux chevaux, *deux sols*,	24.
Pour une Charette à trois & quatre chevaux, *trois sols*,	36.
Pour une Chaise roulante à un ou deux chevaux, *deux sols*,	24.
Et pour chaque personne, *un liard*,	3.
Pour un Carrosse à deux chevaux, *deux sols*,	24.
Et pour chaque personne, *un liard*,	3.
Pour un Carrosse à trois & quatre chevaux, *trois sols*,	36.
Et pour chaque personne, *un liard*,	3.
Pour une Charette à bœufs ou vaches, y compris le Conducteur, *un sol*,	12.
Pour une Chaise à Porteur, & une personne dedans, *un sol*,	12.
Pour une Chaise à Porteur vuide, *deux liards*,	6.
Pour chaque Mouton, *deux deniers*,	2.
Pour un Cheval chargé de deux ou quatre Veaux, *un sol*,	12.
Pour chaque Bœuf ou Vache non attelés, *un liard*,	3.

Unlike *octroi*, tolls are not just a tax to the authorities, they are a fee to recover past or future investment in the roads. The main change is that most of these projects are now planned at a country level.

However, as in the Middle Ages, the tax is decided by the public authority and, like the *octroi* duties, there is no alternative to payment.

Even in concession models, **the road operator is a *de facto* monopoly**. For all intents and purposes, we are back to pay an *octroi* to drive on the freeway.

The very old tolling industry is however being transformed by the development of electronic payment systems and more largely, the take-off of connected car solutions.

While technologies differ between markets, Electronic Toll Collection (ETC) is gradually becoming the dominant way to do business. Obstacles to change are numerous but the laws of physics will eventually apply everywhere: the cost of charging vehicles is radically reduced by ETC, which will push both governments and operators to adopt the technology within the next 15 years.

In this report, we will evaluate how the road industry will transform due to ETC. We will also question whether it can become one of the main stakeholders of the connected car industry. By connecting to the Internet, will vehicles be charged the same way as other connected devices, based on their usage level and impact on the network?

Thomas Hallauer
Research Director

EXECUTIVE SUMMARY

1. Driven by **traffic congestion and infrastructure financing needs,** electronic tolling is taking off. Worldwide, **the market will double** from 200 million ETC subscriptions in 2016 to over 400 million in 2025, largely due to the growth in the Chinese market.
2. **Barriers are falling:** tolling is becoming connected and electronic; **63% of today's** toll sites are expected to become gate-free by 2025.
3. **The lack of EU progress on EETS interoperability is likely to make Europe fall behind**, notably in its failure to impose DSRC and GNSS. This will severely impact both the transport and the tolling sectors.
4. A possible initial step towards toll 'roaming' will be through the **effective use of database roaming enabled by video tolling / ANPR**. The US is making great steps in that direction thanks to the ATI Hub.
5. **Truck tolling is becoming pervasive** on worldwide highways and is fast becoming integrated into the connected vehicle service set. All **fleet service providers will need to integrate tolling** in their portfolio. At the same time, **toll specialists will benefit from combining their offering with fleet management systems**.
6. **The US will become the biggest market for ETC by 2018** with over 77 million subscribers, taking on Japan's long-held lead.
7. In **China**, already the country with the largest tolling infrastructure, we expect that active DSRC-based ETC will start being deployed from 2017 and generate over €40 billion by 2025.
8. **Europe is the biggest market in terms of toll revenues** and will reach over €40 billion by 2020. By 2020, the **South American** market will be generating more than the North American one, driven by Brazil.
9. GNSS and hybrid OBUs will remain a premium technology representing a maximum of **5.5% of ETC subscriptions** worldwide but **58% of the device market value by 2025.**
10. From 2017, **RFID will become the most popular device technology**, overtaking DSRC. The share of ETC subscriptions based on RFID will peak at 30% from 2017 and reach over 110 million ETC subscriptions worldwide in 2025.
11. Within 10 years, **tolling will become another wireless payment, starting with the US market.** It will use smartphones as the on board unit and ANPR as enforcement and roaming mechanism.
12. Tolling will be **integrated in the vehicle**, but only from 2020 onwards either through V2X or a converged telematics platform. The main factor will be the standardisation of technologies in the US and in Europe.

LIST OF COMPANIES INTERVIEWED AND MENTIONED IN THIS REPORT

As part of the in-depth industry research and consulting assignments conducted in the last 4 years, we have **held ETC-related discussions with 118 organisations in 19 countries** including

- 10 public authorities and industry associations,
- 15 toll chargers or concessionaires,
- 18 toll service providers,
- 9 toll operators and system integrators,
- 25 device and equipment suppliers,
- 7 vehicle manufacturers / OEMs (Original Equipment Manufacturers),
- 8 Telematics Service Providers (TSPs),
- 26 other stakeholders.

We would like to **thank these organisations** for their precious contribution to this report.

We have also indicated the **246 companies mentioned** in this report.

Company name	Country	Sector	Discussion	Profiled
3M	USA	Device and equipment supplier		
A/S Storebaelt	Denmark	Toll operator	✔	
ABCR	Brazil	Toll operator		
ABERTIS Autopistas España	Spain	Toll operator		
Accesos de Madrid	Spain	Concessionaire		
Aecom	USA	Toll services		
AETIS	EU	Association		
AGES	Germany	EETS service provider	✔	
AISCAT	Italy	Association		
Allianz	Germany	Insurance company	✔	
ARUP	Ireland	Integrator	✔	
Ascendi O&M, S.A.	Portugal	Concessionaire	✔	
ASECAP	Belgium	Association	✔	
ASETA / SEOPAN	Spain	Association	✔	
ASFA	France	Association		
ASFINAG	Austria	Toll charger	✔	
Assercar	France	Service provider		
Association of European Vehicle Logistics	Belgium	Association	✔	
Astrata	USA	Telematics service provider	✔	
ATI	USA	Association	✔	
Atlantia	Italy	Concessionaire		✔
Atos	France	Integrator		
Attica Tollway Operations Authority	Greece	Concessionaire		
Automatic	USA	OBD dongle service provider		
Autopass	Norway	Toll operator	✔	
Autostrade per l'Italia	Italy	Toll operator		✔
Autostrade Tech	Italy	Device and equipment supplier	✔	✔
Autotoll	Hong Kong	Toll operator		
Avtodor	Russia	Toll charger		
AXA	Global	Insurance company	✔	
Axxès	France	Toll service provider		
Azuga	USA	Device and equipment supplier		
BancPass	USA	Service provider		
BestPass	USA	Service provider		
BlaBlaCar	France	Mobility service provider	✔	
BNV Mobility	Netherlands	Mobility service provider		
Bosch	Germany	Device and equipment supplier	✔	✔
BP	USA	Toll service provider		
Brisa	Netherlands	Road operator		
Brisa Auto Estradas	Portugal	Concessionaire	✔	

Company name	Country	Sector	Discussion	Profiled
BroBizz	Denmark	Toll service provider	✔	
Brookfield Motorways Holdings	Brazil	Concessionaire		
Caisse des Dépôts	France	Banking / Investor		
Caltrans	California	Toll charger		
Capital One	USA	Banking / Investor		
Carlyle Group LP	USA	Banking / Investor		
Central Texas Regional Mobility Authority	USA	Toll agency		
Cintra Servicios de Infraestructuras SA	Spain	Concessionaire		
Ciralsa	Spain	Concessionaire		
Cofiroute	USA	Concessionaire		
Combitech	Norway	Integrator		
Comsan	Spain	Concessionaire		
Confidex	Finland	Device and equipment supplier		
Connect East Group	Australia	Toll operator		
Continental	Germany	Device and equipment supplier	✔	✔
Dachser	Germany	Logistics group		
DAF Trucks NV	Netherlands	Automotive OEM		
Daimler AG	Germany	Automotive OEM		
Danlaw	USA	Device and equipment supplier		
DARS	Slovenia	Toll service provider		
DBA Group	Italy	Integrator		
Denso	Japan	Device and equipment supplier		
Department for Transport, UK	UK	Toll charger	✔	
Deutsche Bank	Germany	Banking / Investor		
Deutsche Telekom	Germany	Telecommunications company		
Disruptive Capital	UK	Private equity fund	✔	
DKV	Germany	Toll service provider	✔	
DVB LogPay	France	Toll service provider	✔	
E-470 Public Highway Authority	USA	Toll agency		
E−ZPass Group	USA	Toll operator		
East Nippon Expressway Company Ltd	Japan	Toll operator		
ECOMOUV	France	Toll operator		
Edenred	France	Service provider		
EFKON AG	Austria	Device and equipment supplier	✔	✔
Egis	Global	Toll operator/ Service provider	✔	✔
EGRIMA Holding GmbH + Co. KG.	Germany	Banking / Investor		
Eiffage	France	Road construction		
Electronic Toll Committee	Europe	Public body		
Electronic Transaction Consultants Corp.	USA	Service provider		
EMC	USA	Integrator		

Company name	Country	Sector	Discussion	Profiled
Emparque	Portugal	Parking solutions		
ENI	Italy	Service provider		
eReg	Europe	Association	✔	
Ericsson	Sweden	Device and equipment supplier	✔	
EROAD	New Zealand	Device and equipment supplier	✔	✔
ERTICO	Belgium	Association		
Escota	France	Concessionaire		
Esso	Global	Service provider		
Europ Assistance	France	Assistance provider	✔	
European Automobile Manufacturers Ass.	Europe	Association		
European Commission	Europe	Governmental institution	✔	
Eurotoll	france	EETS service provider	✔	✔
Eurowag	Czech Rep.	EETS service provider		
Federal Highways Administration	USA	Governmental institution		
Federal Signal Technologies (FSTech)	USA	Device and equipment supplier		
Fela	Switzerland	Toll operator/ Service provider		
Ferrovial	Global	Toll operator/ Service provider		
Fleetboard (Daimler)	Germany	Telematics service provider	✔	
FleetCor	USA	Service provider	✔	
Ford	Global	Automotive OEM		
G.E.A	France	Device and equipment supplier	✔	✔
GALP	Portugal	Energy company		
GDDKIA (General Directorate for Motorways and National Roads)	Poland	Toll charger		
Gemalto	Global	Technology company		
Generali	Global	Insurance company	✔	
Georgia's State Road & Tollway Authority	USA	Toll charger		
GeoToll	USA	Service provider	✔	
Grundig	Germany	Device and equipment supplier		
HDI Gerling	UK	Insurance company	✔	
HELP Inc.	USA	Transport sector		
Henarsa	Spain	Concessionaire		
Highgain Telecom	Korea	Device and equipment supplier		
Hochtief	Germany	Construction		
Hoeft Wessel AG	Germany	Device and equipment supplier		
Hong Kong Productivity Council	Hong Kong	Governmental institution		
Horizon Roads Consortium	Global	Consortium		
HUKA	Croatia	Toll charger		
Hungarian Transport Administration	Hungary	Toll charger	✔	
I+D	Mexico	Toll operator		

Company name	Country	Sector	Discussion	Profiled
IAVE	Mexico	Service provider		
Iberpista	Spain	Concessionaire		
IBM	Belgium	System integrator	✔	
IBTTA	USA	Association		
iCell	Hungary	Device and equipment supplier		
IMS	Canada	Service provider		
infoblu	Italy	Service provider		
Intellic	Germany	Device and equipment supplier		
International Road Federation (IRF)	Europe	Association		
International Road Transport Union (IRU)	Europe	Association	✔	
ITS UK	UK	Association		
Iveco	Europe	OEM		
JP Morgan Chase	USA	Banking / Investor		
JSC NIS	Russia	Device and equipment supplier		
Kapsch TrafficCom AG	Global	Device and equipment supplier, system integrator and concessionaire	✔	✔
KoD	Hungary	Device and equipment supplier	✔	
Lagan	India	Construction		
Lecit consulting	Italy	Consultancy	✔	
LLC Infrastructure satellite systems	Russia	Device and equipment supplier		
LLC Optima Plus	Russia	IT solutions		
Lockheed Martin	USA	Device and equipment supplier		
LogPay	Germany	Toll service provider	✔	
Lysanda	UK	Device and equipment supplier	✔	
Macquarie Group	Global	Toll operator		
Magneti Marelli	Italy	Device and equipment supplier		
MAN SE	Germany	Automotive OEM	✔	
Mapfre	Spain	Insurance company	✔	
Masternaut	France	Telematics service provider	✔	
Mediobanca	Italy	Banking / Investor		
Microsoft	USA	Technology company		
Mobile Devices	France	Device and equipment supplier	✔	
Mobile Systems	UK	Service provider		
Mojio	USA	OBD dongle service provider		
Moreas	Greece	Concessionaire		
Národná diaľničná spoločnosť (NDS)	Slovakia	Toll charger		
National Roads Authority	Ireland	Toll charger		
Navman NZ	New Zealand	Telematics service provider		
Nedmobiel	Holland	Service provider		
Neology	San Diego US	Device and equipment supplier		

Company name	Country	Sector	Discussion	Profiled
NIS-Glonass	Russia	Device and equipment supplier	✔	
Norbit	Norway	Device and equipment supplier	✔	✔
North Texas Tollway Authority	USA	Toll agency		
Northwest Parkway LLC	USA	Toll agency		
Novacom Europe	Netherlands	Telematics service provider	✔	
OAO Gazprombank	Russia	Banking / Investor		
Octo Telematics	Italy	Service provider		
OHL Concesiones	Spain	Concessionaire		
OJSC MegaFon	Russia	Mobile phone operator		
Olympia Odos	Greece	Toll operator		
OMV	Germany	EETS service provider		
Oregon DoT	USA	Toll agency	✔	
Øresundsbro Konsortiet	Denmark	Toll charger		
Osborne Clarke	Europe	Lawyer		
Packard/DAF	USA	OEM		
Panasonic	Japan	Device and equipment supplier		
Pase Urbano	Mexico	Service provider		
Pavimental	Italy	Construction		
Payurtoll	USA	Service provider		
Perceptics	USA	Device and equipment supplier	✔	
Peugeot	France	Automobile company		
Posdata	USA	Device and equipment supplier		
Prepass	USA	Device and service provider		
Progressive Insurance	USA	Insurance		
PToll (bancpass)	USA	Service provider		
PTV	Germany	Service provider	✔	
Q-Free	Norway	Device and equipment supplier	✔	✔
Qualcomm	Global	Device and equipment supplier		
Raytheon	USA	Device and equipment supplier		
Renault Trucks	Global	OEM		
Rent A Toll	USA	Service provider		
Ressa	Italy	Energy company		
RFPI	Russia	Asset management company		
Rosavtodor	Russia	Toll charger		
RosTec	Russia	Toll operator/ Service provider	✔	✔
Routex	Global	Association		
RT-invest Transport Systems	Russia	Device and equipment supplier		
Sacyr	Spain	Construction		
SafeFleet	Hungary	Telematics service provider	✔	
Samsung SDS	South Korea	Electronics industry company		

Company name	Country	Sector	Discussion	Profiled
SANEF	France	Road operator	✔	
SANRAL	South Africa	Toll charger		
SAPN	France	Concessionaire		
Scania	Global	OEM	✔	
Schaeffler AG	Germany	Automotive & industrial supplier		
Schneider Electric	Global	Integrator		
Shell	Global	Energy company	✔	✔
Siemens	Germany	Device and equipment supplier	✔	✔
Sirit	USA	Device and equipment supplier		
Skytoll	Slovakia	Toll charger		
Sociedad Concesionaria Autopista Central	Global	Device and equipment supplier, system integrator and concessionaire		
SoftToll	Ireland	Service provider	✔	
ST Micro	Global	Technology provider	✔	
STAR Systems International	Hong Kong	Technology provider		
STATOIL	Global	Energy company		
Steria	Europe	Integrator		
Stockholm Group	Sweden	Association		
Stoneridge	Global	Device and equipment supplier		
Strabag	Global	Device and equipment supplier, system integrator	✔	
Summit Partners	USA	Investor		
Swedish Road Administration	Sweden	Toll charger		
T-Systems International GmbH	Denmark	Integrator	✔	✔
Telepass	Italy	Toll operator		
Telenor	Norway	Telecommunications company	✔	
Telit	Global	Technology provider	✔	
Thales	Global	Technology provider	✔	
The Illinois State Highway Authority	USA	Toll agency		
TIP Services	Netherlands	Leasing company	✔	
Toll Collect	Germany	Toll operator	✔	
Toll Service	Hungary	Toll operator		
TollPlus	India	Service provider	✔	
TomTom	Netherlands	Telematics service provider		
Total	Global	Energy company	✔	✔
Trafineo GmbH & Co. KG	Germany	Toll service provider	✔	✔
TransCore Inc.	USA	Device and equipment supplier	✔	✔
Transdyn	USA	System integrator		
Transics (Wabco)	Belgium	Telematics service provider	✔	
Transpass (Egis)	Europe	EETS service provider	✔	
Transurban Group	Australia	Toll operator		

Company name	Country	Sector	Discussion	Profiled
Trimble	Global	Device and equipment supplier		
UniCredit	Italy	Banking / Investor		
United Toll Systems	USA	Toll operator		
Unitronic	USA	Device and equipment supplier		
UTA	Germany	EETS service provider	✔	✔
Utah Department of Transportation	USA	Toll agency		
Vehco	Global	OEM		
Vendeka	Turkey	Device and equipment supplier, system integrator	✔	✔
Verizon Telematics	USA	Telematics service provider		
Veyance Technologies Inc.	USA	Device and equipment supplier		
Vinci	France	Road operator		
Vitronic	Germany	Device and equipment supplier	✔	✔
Vodafone	UK	Telecommunications company	✔	
Volkswagen AG	Germany	OEM	✔	
Volvo	Sweden	OEM	✔	
Washington State Department of Transportation	USA	Toll agency		
Wavecom	Global	Technology company		
WEX Fleet One	USA	Service provider		
Wilbur Smith Associates	USA	Consulting and construction		
World Bank	Global	Banking / Investor	✔	
Xerox	USA	Integrator	✔	✔
Zubie	USA	OBD dongle service provider		

LIST OF COMPANIES PROFILED IN THIS REPORT

As part of our analysis, we have built **25 profiles of all major ETC industry participants, listed below.**

System integrators	Service providers	Device and equipment suppliers
• Atlantia • Autostrade per L'Italia • Autostrade Tech • EFKON • Egis Projects • Kapsch • Q-Free • Siemens • Transcore • T-Systems • Vendeka • Xerox	• DKV • E-Road • Eurotoll/Sanef • Shell • Total • Trafineo/BP • UTA	• Bosch • Continental • G.E.A • Norbit • Rostec • Vitronic

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Cover photo courtesy of Toll Collect

INTERVIEW WITH

MARC BILLIET

HEAD OF EU GOODS TRANSPORT

INTERNATIONAL ROAD TRANSPORT UNION (IRU)

Interview performed on 6th January 2015 by Thomas Hallauer

Tolling impacts the transport sector in many different ways. One of them is the toll rate itself. We compared the toll rates across Europe and the difference between countries is staggering. Do you believe the road toll rates are always proportionate to the road investment?

This is a complex issue because the Eurovignette directive mentions what toll chargers can include in their rates but at the same time gives them a certain amount of flexibility. For example, maintenance and depreciation costs can be included in the charges. So can the costs of installing an electronic system or to make a system interoperable within a larger framework. Provisions can also be included taking into account potential changes in a traffic mix, for example to compensate for a reduced use of vehicles with older Euro norms. This was recently used by Austria to justify an increase of its toll rates. And they are also allowed to make a profit. As a result, we see vast differences between those charges. In France, a recent report from the competition authorities (FCA) highlighted the fact that motorway concessionaires were making net profits of between 20 and 24% of their revenues, making the authorities reflect on whether the amount passed on to the State should not be increased or whether the concessionaires should be told to invest more. This said, notwithstanding the fact that the legislation lays down what can be included in road user charging (RUC) rates and what not, it is very difficult as a user to challenge them for being too high.

The charge level can also depend on the political decision supporting the introduction of tolling road user charge (toll or vignette). For example, in Switzerland, RUC is an important tool to force modal shift, say from road to rail or combined transport.. This country has some of the highest rates in Europe but the impact on modal shift is negligible.

What is your take on the *Ecotaxe* saga, where do you think it may go? What are the lessons from the debacle?

The IRU had a very strong reservation about this from the beginning. The concessionaires in France already have their own toll domain and equipment. So why go for a completely new solution? Why have they not looked at the examples of their neighbours and learned from them to save costs and create more interoperability? Lastly, the consortium set-up raised more questions about potential conflicts of interest: why include the national rail provider SNCF in a road tolling consortium? These first questions immediately cast doubts on the real aims of road tolling.

As said, the IRU was concerned about the new systems' interoperability from the start. Ecomouv suggested that their system was fully interoperable, but that was only at the technical level. At the commercial and effective level, they completely relied on the 6 SHTs (*sociétés habilitées au télépéage*, i.e. third party toll service providers) to negotiate commercial contracts with other toll chargers to create effective interoperability. Yet, considering that the cost of testing an OBU in one toll domain can cost €500,000 and can take around 6 months, that would have required a considerable investment.

Today, the contract with Ecomouv has been cancelled so the whole concept is now gone. How the French government is going to cover the lost revenues and the huge sums invested in setting up the architecture, the back-end and the customer service teams remains to be seen.

More important how should the road freight transport operators, French and foreign, who have invested in the preparations for the entry into force of the Ecotaxe be compensated? Because as things stand now, these are wasted investments.

As far as the contributions of the transport industry in France is concerned, scientific research shows that the contributions paid today towards infrastructure use are already far higher than the actual investments in roads. In France, this is done through the TICPE (excise duty), the axle tax and the tolls. Governments like to insist that everybody should pay for the cost they cause, but never ask whether this coverage isn't already sufficient or too high.

A new tolling system is often a great excuse to create transparency on how infrastructure is financed but it also hides the contributions already paid through other channels. **The risks of users paying double is high and is unacceptable for the IRU.**

Some countries compensate for the introduction of road user charges.

For example, in the UK, the government promised to lower the annual vehicle tax in order to give compensation for the e-vignette. This may be a partial compensation but given the fact that excise duties on fuel also cover infrastructure use in the UK and continue to be high, the question needs to be asked if the industry is actually not paying more than before.

Is that a way to comply to the regulation on toll systems in Europe? Ensuring that the system does not discriminate foreign drivers.

Many countries are indeed struggling with the positive discrimination of their own hauliers.

Many countries feel that foreign hauliers do not pay enough for the use of their infrastructure and use this as an argument to introduce a toll or vignette system. For example decision-makers in France, the UK and Belgium have made this very clear on several occasions.

The other impact of tolling on the transport sectors is the administration burden from the registration and payment procedure for example. How are your members coping?

It is often very difficult to get an account set up, register all the vehicles and also it is often very difficult to get your tolls paid.

In Hungary, for example, until recently the foreign drivers had fewer options to pay, credit card were not accepted and there was only a few terminals at the border. Also the route shown on the terminals was inefficient, sometimes longer and forcing them to pay more.

Gradually, the Hungarian system is improving.

But for hauliers, it is critical any new system works from day one since their income are directly affected by initial delays and queues as we have seen in most truck toll system introductions.

Also in France, the registration procedure for the *Ecotaxe* was a bureaucratic nightmare for transport operators.

The Hungarian system uses a fleet management OBU to process the toll. On one side, it forces the transporters to be equipped with a fleet-wide management system but on the other, it is one of the most cost efficient toll system once installed. What is your view on this toll model?

We believe that every toll systems should provide options for transport operators to comply. The haulier should never be forced to use a system requiring extra investment and it should not be punished for having chosen a particular option.

In Hungary, this is not clear. Currently, the disadvantage of the route ticketing solution is obvious.

For hauliers already equipped with a fleet management system, why should they invest in an additional system with the Hungarian toll requirements?

It should also be said that fleet management systems are to a very large extent tailor made for a company according to their needs.

This doesn't fit with the Hungarian approach.

Looking at the administration costs, do you think that the fuel card providers are benefiting the transport industry and how do you see their role in the future?

The one bill service is a first step to administrative simplification, but it does not solve the problem of having to establish contracts with different toll providers and having to use several On-Board-Units to pay your way through the EU.

The transporters are indeed relieved from paying different bills but they still have to suffer the burden of signing all the contract agreements with each system, have the vehicles registered and manage the different OBUs.

So it is a step in the right direction for now but it is far from what we need: the possibility to use one single provider, one box, one maintenance contract and one bill for all tolling in Europe.

What needs to be done today to make toll interoperability work?

You need to look at who or what is holding up progress in that matter.

First, there are legal issues with the contracts between toll providers and the competent authorities.

As an example, the contract Toll Collect has with the German government allows them to operate only on the German territory. Toll Collect can operate abroad, but only for test purposes. So the interoperability with Austria and the Toll2Go programme is limited to 50,000 vehicles only. The same contract restricts toll service provision in Germany to Toll Collect. That's why Toll2Go only works with German OBUs in Austria, not the other way around.

Second, there are technical issues. Toll2Go is possible only because Toll Collect managed to remotely upgrade the OBUs for this purpose and because the latest version of the toll collect devices included microwave DSRC. However, apparently they would not be able to make the device function in Italy, without recalling the OBUs, since Telepass uses a different DSRC standard.

Third: the competitive landscape: **today the toll operators are enjoying national monopoly status**. Looking at the EETS project, you can imagine vast numbers of service providers with different OBUs all entering the various toll domains and compete with the incumbent operators. It is obvious this will not facilitate EETS.

A fourth barrier is financial. I mentioned the large sums of money needed to certify each OBU in each toll domain. There is also the necessity for a potential EETS providers to have a financial standing in every member state. Again, this is a very heavy burden.

What would be a solution then?

Potentially, we need to look at what can the EU do. We have the CEF (Connecting Europe Facility) budget, which is supposed to support the Trans European Network (TEN-T) with road investment. Tolling as well as ITS services are included in this budget's scope. So there is a possibility for Member States to call on the EU or for Service Providers to call on the EU for help.

A very big burden is that the legislation requires the Service providers to be active in the 28 Member States in one go. It means you need to have the device checked and approved in every toll domain. A lighter version of this requirement might encourage more companies in getting involved.

For example, not every Member State has ETC, some are running vignettes. The suggestion that a service provider could manage different toll payments as well as vignettes across Europe is still very unclear.

Contractually speaking; where there are limitations clauses today, governments should break these contracts open when they are renewed not only to allow their own providers to work beyond their borders but also to allow other providers to come into their country.

Ultimately, we have to ask ourselves if there are no simple alternatives available.

INTERVIEW WITH

MARTIN STONE

GENERAL MANAGER, EGIS PROJECTS USA

Interview performed on 12th and 24th March 2015 by Frederic Bruneteau

Dear Martin, could you please introduce for us the Egis Group and its North American activities?

Egis is a worldwide company, 75% owned by Caisse des Dépôts, France's largest financial institution, with $330 billion in assets and 25% employee-owned.

Egis is involved in the design, construction, operation and maintenance of infrastructure. We are part of the group that runs 35 projects globally in Europe, Asia and the US

What is Egis' overall strategic position in the tolling value chain? How is that different from Egis' position in Europe?

In Europe, it is more focused on hard engineering, as well as the operation.

We have 3 projects here in North America: two in Canada and one in the US. The two projects in Canada are the Golden Ears Bridge and Port Mann Bridge in Vancouver, two very large toll bridges where Egis is either the prime contractor or a JV participant.

In the US, we were selected by the Alliance for Toll Interoperability, an organisation of 38 US public toll agencies across the US and Canada, to operate the ATI hub.

We are also actively pursuing many projects. The company is interested in bringing the different lines of business to the US. We have started with toll operations projects. We are interested in all types of PPPs and concessions: at-risk, PPP investments to those that are more contractual and operational. We will announce other exciting projects in the coming months.

You have been instrumental in initiating the ATI interoperability initiative. First could you please introduce the ATI Hub?

The ATI hub is a new venture to exchange and settle toll transactions across jurisdictional lines. For toll customers who are driving outside of their normal regional area, this is a method for toll agencies to exchange the transactions and settle the funds.

The hub is a first step in developing a national infrastructure to allow the US to move towards a national interoperability.

Of course there are other pieces of that. There is the roadside and in-vehicle technology. Today, in the US, we have 7 different technologies.

Five agencies have formally signed and we have additional commitments and interest from others, including agencies in California, Maryland, Texas, Oklahoma and Kansas).

Are there links between ATI and IBTTA?

The relationship is a co-operative relationship that recognises the difference between the 2 organisations.

ATI's overall mission covers more than just interoperability. It is a not-for-profit organisation of public agencies who are looking at a range of services that support interoperability. The objective is to provide combined services to their member agencies at a lower cost than this was done separately, notably thanks to greater purchasing power. This could include the creation of a national licence plate database or the sending of violations on behalf of agencies. It has a very small budget. Most people who work for ATI are volunteers. Its President is a volunteer, JJ Eden, who is a Director of AECOM as well and one of the founders of E-ZPass. Its offices are in Raleigh, North Carolina.

On the other hand, IBTTA is an industry association, which unites both public and private sector

entities. It also plays an important role because it runs the National Interoperability Committee, which I have chaired for almost 5 years. The Committee is focused on technology and business rules. It is in the last step of a process to identify one set of business rules to exchange transactions and the national toll protocol, which will be one of the 7 existing technologies. IBTTA is also busy with creating a national toll symbol, which is very important for customers to understand that their toll account works at a given place.

The main benefit of this national standard is that each agency will be able to keep its existing technology but also accommodate customers from other agencies who use different technologies. Customers who wish to have a national tag will be able to drive across the country with one device and one account.

Both associations work together but ATI provides the infrastructure for interoperability.

We understand that ATI, Egis, Sanef and all participating toll operators are involved. Could you please describe what is the role of each entity?

Egis and Sanef ITS have created a 50-50% joint venture, Secure Inter-Agency Flow (SIF). Sanef provides the back-office (computer hardware & software) systems to do the matching and exchange of the transactions. Egis manages the overall management for the ATI hub and runs the operations of the customer service.

We are not a concession but a contractor that the ATI board (11 agencies from the US and Canada) has selected.

We do not speak for ATI but we do of course communicate. Our JV operates under a 5-year contract from the effective working date, which has been extended once by 6 months due to the delayed start. The contract can be extended twice.

What have been your challenges in building the hub?

We are at the very beginning of the ATI hub project. The challenges have mainly been on ATI to get agencies to sign up for the Hub. Many of the public agencies are wrestling with how to get started or who should go first.

We understand 8 agencies have signed up and 4 more are in process. Can you tell us what response you are getting from them?

The contract originally was signed on September 2013. We anticipated that by September 2014, we would be underway. Unfortunately it took almost a year for the ATI to obtain an agreement between the agencies. Meanwhile we developed the system and went through factory acceptance testing.

ATI is responsible for signing up their member agencies and bring them to the hub. And it is our job to service the hub. ATI did not finalize their agency agreement until late summer last year. Then they started to market to their members and by September, they had signed the initial agencies so by October, we started to contact these agencies to go through the connection process.

We found out that many agencies had some technical issues that were slowing them down.

A number of agencies have signed and are interested in getting started. Those agencies include the Florida Sunpass system, which actually is 3 agencies. They will have one connection to the hub.

The Illinois State Highway Authority (ISHTA), a very large toll authority that uses the E-ZPass system, are going through the deployment of a brand new back-office right now. The North West Parkway (Denver, Colorado) also has back office development work at the moment. CTRMA (Central Texas Regional Mobility Authority) was the first to sign up and is now ready to go. The Georgia State Road Authority also signed their agreement...

And we have been talking with a number of agencies around the country. We have the commitment from 4 of the largest agencies in California: The Golden Gate Bridge, BATA, the TCA and SANDAG have committed to join.

I also expect the remainder of Texas agencies to join, but they have technical issues with their internal hub. They have to work through these before they can work with us.

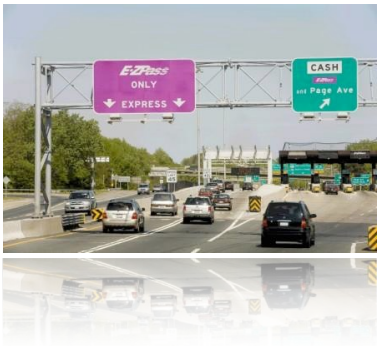
What kind of challenges are you trying to solve?

All interfaces are different, as the agencies built their systems independently a long time ago. So we are working on hooking up to each agency, providing the ICD (Interface Document Control), which defines the message that is be sent and received, the

information that is transmitted and how the acknowledgments are undertaken within the systems.

The interfaces are not a huge challenge. We can handle that. The biggest difficulty is that while the ATI hub is important, it is not as important as their existing business so we need to wait for agencies to be ready to hook up. We then have to go through a testing process. We test the connection and the software between the hub and the agencies. To do that, they have to make a commitment to invest some resources in their back office. Virtually every agency has a development or maintenance operation going on in their back office. All agencies have their own way of doing things.

I am optimistic. The hub will get started in the next few months with a small number of agencies and transactions. I think we will begin with Florida and Illinois and add new agencies slowly in the first year.



Do you expect all North American agencies to join?

Yes, I hope that **we can have all of them within 5 years.** At some point, we are going to experience much faster growth. Within 2 years, we believe that most of the agencies will be members.

In the northwest, the state of Washington and the Canadian province of British Columbia would like to use the hub as a way to exchange transactions across the border.

Of course, there could be a competing hub, as is the case in the financial industry where there are several clearing houses. Eventually, agencies will make their choice based on quality and price.

How does the hub foster interoperability concretely?

Typically, in the US, when a driver drives on an out-of-state agency without a transponder, a picture of the licence plate is taken and a bill or violation is issued.

In Florida, you must pay a $25 penalty at the first violation. If it is not paid, you get fined by the local traffic court and must pay a fine of over $200. These are little bit like the violations for truck tolling in Germany.

ATI want to create a national database of vehicle owner information so that we know who to send the information to.

ATI may send the letter or the violation. It could offer a licence plate reading service. This is particularly nice for small agencies who would benefit from the volume pricing of the Hub.

Today, if you have an agency that has mixed technology (ETC or cash without transponders), customers must pay cash or otherwise they get a violation. These violations come with a steep penalty.

With the ATI hub, we will be able to exchange transactions for those customers who have valid accounts. The receiving agency will submit the transaction to the Hub for matching with other member agencies. This is a much lower cost solution.

How does the cost of enforcement per transaction compare?

The benefit is much higher than the cost. The main benefit will be that the Hub will match and settle many transactions that today are very expensive to collect or are not collected at all.

A transaction fee is paid to ATI by the agency that is receiving the fund. This fee is only applied to matched transactions and is independent on what the toll is.

The level of the fee is based on the total volume of transactions on the hub: from 9 to 4 cts per transaction.

At the lowest volume, it costs 9 cts for ATI to clear the toll. This is the same amount for a $1-3 toll or a $8 toll such as the New York bridges and tunnels. It is not a percentage of the toll, which is a very attractive approach for agencies who are clearing transactions for which most of time they are not collecting.

Could you give a concrete example?

Yes. With the Hub, if a car from Florida with a SunPass account travels to Illinois, the Illinois Tollway will submit the transaction to the Hub which will match the trip to the valid SunPass account and later settle the funds.

This is exactly like a retail model: the customer goes into a store, pays the merchant and the merchant pays the credit card fee. The bank who is holding the credit card account is just doing the payment. But contrarily to a bank, public agencies do not make money on holding customer accounts.

If a transaction cannot be matched on an account in the hub, it is up to the Tollway to take the licence plate, find the customer and to send them a bill or a violation. They typically go to either their in-state Department of Motor Vehicles or otherwise to private information providers for out-of-state customers. This costs them $1.10-.1.25 to obtain owner information. If the customer is a New York customer, he / she gets a notice and people tend to pay immediately. For out-of-state customers, this is more expensive.

Illinois sends a violation notice in the mail, which often does not get paid. Most of our states do not have a way to enforce violations across state lines. A couple of states have started working on that. The best known example is between Massachussets, Maine and New Hampshire. They have signed an agreement to process the violations across state lines by creating a 'registration hold'. If the owner does not pay, the 'home' state can put his/her registration on hold. The next time that a customer comes in to renew their licence plate for their vehicle, the state will ask for the bill to be cleared up.

Each agency has different business rules and costs. The cost depends on whether it has its own staff or works with contractors or outsourced mailing houses. The unit cost is generally $1 or higher.

To compensate, certain agencies will ask for an administrative fee. These fees could be as much as $5. The penalty fee itself may reach $25. The DMV (Department of Motor Vehicles) may charge them to have their registration hold.

So the ATI hub is looking for a way to create a national consolidated database so as to obtain a much lower nominal cost.

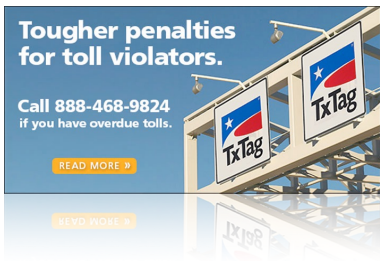
We are working with the American Association of Motor Vehicle Administrators to create a national database of out-of-state owner information.

What are the KPIs of the hub?

There aren't strictly speaking KPIs for the ATI hub.

This is not unusual for clearing houses, as agencies voluntarily sign up for the Hub. It is different from a public agency contract to a service provider.

One of the requirements is that agencies have to submit their transactions within 60 days of the transaction occurring on the roadway. We then batch-process these transactions overnight.



What are the actual mechanisms at play against fraud within the ATI hub?

First, let us say that the ATI hub is not an enforcement operation, although we could offer that. Our main objective is to reduce the number of violations and increase agency revenues by matching transactions to customers who have valid toll accounts with other agencies.

Someone could create a false transaction, either by playing with the OBU or by changing licence plate. We have not seen too much of the former because the benefit is low compared to the cost to do it.

What we do see is errors in the licence plate recognition. If an agency cannot recognise the transponder, makes a mistake and send a wrong plate number, another customer gets invoiced. If this out-of-state customer refuses to pay, saying he/she wasn't there, the transaction can be suspended through the Hub's dispute process.

This is the same as when someone stole my credit card number and made two refuellings of $400, probably a trucker. I asked my bank to block the transaction.

Today, there is no fraud investigation within the ATI hub. The ATI does the notification of the dispute, i.e. sends the message: "This transaction has been disputed". The two agencies, e.g. Florida and Illinois then talk to each other and resolve the disputed transaction.

Generally, this leads to a manual review of the licence plate to make sure it matches Florida's record. The responsibility for investigating the possible fraud lies with the agency creating the transaction. If an agency continuously makes errors because they have poor equipment, ATI can turn them off. This is the right of any clearing house.

What are your next milestones?

The hub has not started yet so our next step is to go live. We are now in the process of working with agencies' back offices and the start is a few months away. 10 agencies are in the first group and should have joined by year end. Once agencies see the hub working, we believe most of them will join.

The current ATI hub is based what we call "database roaming". Is it good enough or should we expect customers to be able to use the same device across North America?

For us, a clearing house is a way to exchange and settle transactions. But it is does not depend on whether there is only one device. It is device-independent. The

IBTTA Interoperability Committee is currently working on the identification of a national protocol for transponders.

In the long term, we would like to get to one transponder. This device has to follow an open architecture, i.e. its specifications must be published and there can't be any impediment to other manufacturers. For example, if Transcore's 6B protocol would be selected as a provider, it may charge a small royalty but should allow the manufacturing by others. We are interested in a competitive environment for both the OBUs and the roadside equipment, where most of the costs are.

IBTTA has short-listed it down to 3 protocols today: 6B, 6C and the E-Zpass / IAG, developed by Mark IV and now owned by Kapsch. Kapsch has already published specifications for that architecture and made it royalty-free so they have met the requirements. The 3 protocols will be evaluated and the Committee will make a recommendation within the next year.

Agencies won't have to adopt it immediately. They will then evolve towards it by either continue to use their own (if it is the selected protocol), sell the national protocol as a second tag in their own region or continue to use licence plate photography. **Long term, we do want one protocol from multiple manufacturers that meet certifications of interoperability** to be sold and used in the US. That will dramatically simplify the American toll market.

But behind that, **we want one account because it is really the account that is the issue.** Today if a truck has 10 OBUs in their cab, its company will have 10 accounts... With a single protocol or multi-protocol transponders, we should be able to move a single account.

There is a growing number of wireless payment services being launched. Do you think they will influence the e-tolling market and accelerate the use of smartphones as toll-capable OBUs?

We are seeing a wide number of these applications being developed for the tolling space. The smartphone is just a communications device. What is smart is the app.

There are some key hurdles, i.e. potential duplication (several phones being charged in the same car) and operational issues but I am sure smart people will figure it out. However, you must remember that agencies have spent a lot of time and money embedding their existing technologies into the tolling infrastructure.

Smartphones will need to accommodate the existing infrastructure. So it may take 10-15 years for this to happen. That said, most of us believe that the future for mobile payments will be a platform in the vehicle.

Should we expect electronic tolling to be included as a standard in new cars?

This is really the future. We have been talking about it since the mid-90s. The car companies are also talking about it. They are waiting for IBTTA to identify the national protocol. Once this is done, I believe they will start embedding it on their windshields. This is going to happen. **ATI has been in direct conversation with both automobile manufacturers and electronic suppliers.**

Overall what are your ambitions for the tolling market in North America?

Today there are 42-45 million transponders / active tolling accounts in North America, spread across 100-120 toll agencies. Maybe 40-50 agencies are medium-sized to large. Others are pretty small. Overall, the industry generates more than $10 billion in revenues annually. This already represents 1/3 of federal gas tax revenues while less than 5% of limited access highways are tolled in the US and Canada. I do not see the US Congress have the fortitude to raise the gas tax and the state DoT do not have the funds to create new projects.

We see the toll market double in the next 10 years. This growth is driven by the growth of managed lanes. High speed express lanes on inster-states are taking off in particular.

What role do you expect Egis to play into it?

Of course, as a toll operator, we are excited by this. We are now looking to do more than toll collection. For example we manage highways, bridges, tunnels and airports in Europe and should be able to bring that business to North America. We are at the beginning. In some areas, Europe is ahead for example in the provision by the private industry of services and funding, for example in concessions or PPPs at risk. It is also better at supporting VAS (Value Added Services) such as driver information or mobile commerce.

On the other hand, the US is now taking the lead on interoperability, as EETS has not taken off yet in Europe.

INTERVIEW WITH KAPSCH TRAFFICCOM

PETER UMMENHOFER

VP, SOLUTION MANAGEMENT DIVISION

MARCUS HANDL

INVESTOR RELATIONS & STRATEGY OFFICER

Interview with Peter Ummenhoffer and Marcus Handl on 8th April 2015 conducted by Frederic Bruneteau

Dear Sirs, most of our readers know Kapsch but could you please sum up what is Kapsch' value proposition to the electronic tolling market?

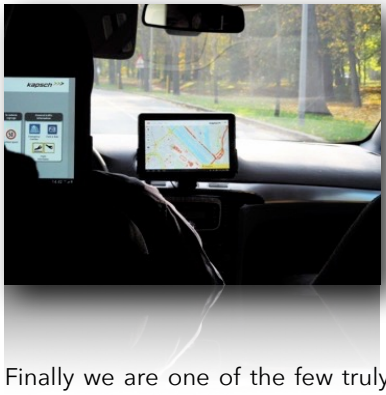
I would sum it up in 4 points. First, we provide solutions that work. While some projects have failed or been delayed, we have considerable experience deploying large scale ETC projects on time, which guarantees our customers to generate their income from the beginning.

Second, our solutions are 100% fit for purpose. We are technology-agnostic. Historically, we come from the microwave 5.8 GHz CEN DSRC world but today we support all the major tolling technologies around the world. Already 7-8 years ago, we started to develop a solution for GNSS, which is in operation, e.g. in France.

We also have a video tolling solution, and the 915 MHz RFID standard and technology we support since the acquisition of Mark IV in North America.

And finally **we have started to invest in future technologies** such as 5.9 GHz DSRC (WAVE and ITS G5). Thus we can choose the appropriate future-oriented technology that has the best business case. I believe that there is no other company in the world with a broader technology spectrum than we have today.

Third, we are not only a vendor of solution but also an operator of toll systems, for example in the Czech Republic, South Africa, Poland and Belarus. So one could say that we are our own customers. This experience gained in operations provides insight that we incorporate in our solutions.



Finally we are one of the few truly global ETC vendors. As a result, our customers benefit from solutions which reflect ideas and best practices from all over the world.

In addition, we have started expanding our activities towards Intelligent Transport Systems (ITS). We recently acquired Transdyn, an ATMS (Advanced Traffic Management Software) system vendor. We have developed multi-purpose solutions combining ITS and ETC that are in line with the trend we see in some markets e.g. North America. Here they use so called HOT lanes solutions that integrate traffic management and tolling functionalities.

Thus we can broaden step-by-step our portfolio and offer an out-of-the-box packaged solution.

What is Kapsch' Unique Selling Point?

Our track record with some impressive references is one. We are also **a true end-to-end provider of solutions**.

We offer our own products, from the OBU to the transceivers / readers, ANPR cameras to the roadside software, the back-office systems and add-on products like the mobile enforcement units. Sometimes we even operate and pre-finance our solutions.

Kapsch has chosen to position itself both as a system integrator and as a road operator, for example in Poland. Aren't there risks for Kapsch to compete against its toll charger customers?

It is important to understand that **we are not a road operator** but we operate toll systems on behalf of road operators. We provide to them both technical operations support (i.e. the monitoring, maintenance and the ongoing optimisation of tolling infrastructure) and commercial operations support (the planning implementation and operation of Point of Sales, call centre services, web portals, payment services including the invoice).

We provide these services to road operators who can be either public (road authorities or toll authorities), or private, for example concessionaires.

So we are not competing against them, we serve them.

Thus it is true that we sometimes compete with 4 private companies, namely Abertis / Sanef, Autostrade, Strabag and Vinci. For example, we are one of the largest suppliers to Vinci in France.

They may be competitors but only in those cases when they leave their core business and on a case-by-case basis.

But this is not the case with most road operators.

Kapsch acquired Mark IV Industries a few years ago. What advantage did it give to Kapsch in North America? How strong is Kapsch there now?

We acquired Mark IV AVHS in November 2010, which was our entry ticket to the US market. Before we had a small operation but with hardly any commercial success. Thanks to the acquisition, we obtained a customer base, a large local presence and the qualifications to migrate their business from a pure component provider to a systems solutions provider. Mark IV was concentrated on manufacturing tags and the corresponding roadside equipment (RSE), actually the largest seller of transponders in the US. Our objective from the beginning was to develop them from a component provider to become a systems provider and increasingly an end-to-end solutions provider including the operation.

Meanwhile we have delivered our first end-to-end system in Texas for Cintra, a subsidiary of the Spanish construction company Ferrovial.

We have also been awarded an end-to-end electronic tolling and customer operations contract in Ohio (River Bridge).

It means that we have successfully developed Mark IV to a comparable position in the US to the position we have in the rest of the world.

In addition, we acquired in 2014 **Transdyn**, a specialist in traffic management systems, which allows us to propose a broader portfolio of solutions including ITS in North America and globally.

Today, besides North America, we have a high market share in Europe and even e a higher market share in Australia and in South Africa. Africa, outside South Africa and some minor activities in North Africa, is still not really an ETC region yet. In South America, we are strong in Chile.

In the US, 3M, Transcore, Xerox / ACS and Schneider Electric (formerly Telvent) are our main competitors. Transcore and Xerox are certainly stronger than we are there.

What are the chances of the US moving the Interstate Highway System to the tolled model? What are the best reasons for the US Federal Government to make this happen?

First of all, there are 2900 miles of tolled roads already in the Interstate Highway System. They have been introduced prior to a Federal Government ban on interstate toll.

On the other hand, we know that the Federal gas tax is the main resource to maintain the interstate highway system and the taxes have not been increased since 1993! We see that the tax income is declining due to modern cars with better combustion engines and electric or hybrid vehicles. So the federal Government is searching for alternative funding means.

Tolling is a feasible option to both finance new infrastructure and maintain and renew existing roads. Only to maintain the infrastructure in place, a multi-billion dollar amounts would be required each year and is missing today. Someone has to pay for the roads eventually! It is only the question of whether all should pay for these or only those who use these roads. When you take an airplane, you don't expect it to be free!

Why tolling? Because it is fairer, as it is follows the *user pays* principle. Moreover, tolling brings another benefit: it is a powerful traffic policy tool. For example, in Germany, Austria and the Czech Republic, the implementation of an emissions-dependent tariff scheme system led to the extinction of old, highly polluting trucks. So tolling has had a very positive impact on the environment.

In your view, what lessons should the industry bring from the failure of the *Ecotaxe* project in France?

The first thing we can learn and actually the same has happened in South Africa: a growing political instability has disturbed an ETC project. We see that the economic

downturn has put political pressure from the users of the roads on governments. Political opinions can change and that situation, the government has to redesign or even stop the project.

Our constant recommendation to governments in that respect is that **excellent communication around the introduction of toll is key.** In France, only these enforcement gantries with their cameras ("Big Brother" watching you") were visible in the media. But these gantries are only used for those who do not pay! Communication should have focused on the fairness of toll to fund road infrastructure. Road enforcement is a key part of the fairness of the system, as not everybody can decide whether they should pay or not, which is not in the interest of the overall community!

On the other hand, the UK has implemented a very light HGV toll system, a vignette within a few months. Doesn't this play against device/mileage-based schemes?

The introduction of the UK road levy went smoothly because it was made free to UK hauliers! The vehicle tax was diminished in the same proportion as the new revenues generated from the vignette.

Only foreign lorries actually pay. The same discussion exists in Germany for the PkW Maut (the German vignette for passenger cars). It will be interesting to see how these systems that make only foreign vehicles pay will be perceived in front of a European court...

Of course the disadvantages of vignette schemes are obvious: they bring very limited new revenue. In some cases, they tax only foreign vehicles.

As time-based systems, they are unfair to low mileage drivers: you pay once and then you can drive as much as you want.

And finally they cannot really be used for the traffic policy, contrarily to variable pricing models.

What are the chances now that EETS will be effectively implemented? Will the REETS project move things forward?

The chances for EETS to happen are higher than ever.

Based on our own calculations, we can say that today **the business case for EETS providers is weak**, particularly if it is requested from them to offer access to the 28 EU countries from the start. That said, the European Commission is now willing to allow regional schemes - REETS - and we see a clear movement in the market. Toll chargers are now seriously considering a remuneration model for the service providers.

On the other side, some service providers are becoming active. Numerous fleet / fuel card providers are starting to offer a European tolling service. So REETS will happen from our perspective.

That said, it is true that **the business case for EETS providers is not favourable**. They often must cross-subsidise ETC with other services (Stolen vehicle tracking, fleet management, eCall, etc.). However, we also see a number of hauliers being ready to pay a supplementary fee for tolling.

Would you recommend the European Commission to issue a new Directive on tolling to solve the inefficiencies of the market that are preventing interoperability between different countries?

It will not work if the European Commission insists that all 28 countries should be covered from the start. They should impose the legal framework but let commercial providers decide on what markets they should cover.

Numerous European trucks carry up to 10 OBUs on their windscreens. Wouldn't interoperability threaten your device business?

We do not see EETS and inter-operability as a threat to our device business. **The move towards EETS will mean that the market will need more complex OBUs, which will also be much more costly than the DSRC tags** we typically sell.

We believe there is a chance for our services business to compensate that decrease in the number of devices per vehicle. In the long run, this fall in our hardware revenues will come anyway, as other telematics devices and smartphones are gradually being used. In addition, cars will in the long run provide these functionalities too. We have to prepare to this situation by working with the automotive industry in that respect.

Would you expect Russia to eventually implement GNSS-enabled road tolling (maybe using Glonass)?

The original tender was cancelled last year but they still plan to introduce a system for HGVs beyond 12 tons by November 2015.

The State Highway Agency, Rosavtodor, has introduced a concession holder, RT-Invest

Transport Systems (partly owned by Rostec Corporation) to implement the system. We are of course willing to support them.

The expected income for the Russian government would amount to €800 million per year, for trucks above 12 tons. We understand they are still considering to reduce the weight limit to 3.5 tons, which would dramatically increase revenues. But we have not heard statements related to that yet.

Our global report highlights the fragmentation of the industry between numerous technologies & standards. Would you expect a number of global standards to emerge?

We do not expect to see one global tolling standard emerge soon. We do expect to see a co-existence of different technologies that meets diverse customer requirements, namely DSRC (915 MHz, 5.8 and increasingly 5.9 GHz), GNSS, ANPR and RFID.

ANPR is an integral part of both DSRC and GNSS enforcement systems. And RFID will also be used for other applications, for example in the electronic registration space.

Kapsch has deployed numerous tolling projects worldwide. Based on this experience, what can governments do to make ETC more acceptable among both private and fleet vehicle users?

In our view, tolling is a fair system: It follows the pay-per-use principle and foreigners must pay as well, contrarily to vehicle tax. An ETC system can also be used to manage the traffic, for example by running variable or dynamic pricing schemes, high occupancy lanes, congestion charging like Stockholm or Singapore or even by promoting vehicles with low emission rates.

Tolling systems are in themselves a way to avoid or reduce traffic. It is also possible to combine tolling with other mobility services such as parking or provisioning of real-time traffic data.

Finally, governments can use tolling income to improve the traffic situation by building road infrastructure or public transport.

Would you see smartphone-based payment systems such as Apple Pay emerge as a valid toll payment system? If no, what are the real barriers to that happening?

Absolutely, smartphones will be introduced for tolling in various steps.

Initially - and that is what we are doing in our own operations - it can be used a customer relation management tool. Toll operators are able to contact users more easily.

Secondly, it can be used in a plaza toll context, for example with a NFC/RFID tag attached to the handset or simply by putting your account balance to a certain threshold.

Finally the future is open. It is an efficient tool for payment but less so for enforcement. There are challenges ahead of course. Toll operators / road authorities have to support multiple mobile phones. Of course we could support them in that respect but for them, a dedicated onboard unit represents a lower risk today. Smartphones enable a small reduction of the costs but on the other side, there is a risk of lost income become something is not working properly. In the long run, we will find solutions to these challenges.

Do you expect ETC technologies to be embedded in new cars anytime soon, as currently envisaged in Singapore?

In Singapore, the device is not truly embedded but retro-fitted in the aftermarket. It will be most likely be a very sophisticated OBU equipped with the latest technology such as LTE, GNSS, 5.9 GHz DSRC and offer lots of additional services.

In general, we are closely following what is happening in the connected car world and are talking to automotive suppliers. There will be so-called Telematics Control Units in cars shortly. Some cars have them already. You can't find 5.9 GHz yet but GM has announced V2X in 2017 for a first model (cf. figure below).

We expect an increasing number of vehicles to embed technology, which can be used for various telematics/ITS applications including tolling. Toll operators will see the benefit of getting rid of the OBU. If that happens, these embedded in-vehicle platforms may be a game changer for the tolling industry.

Autonomous cars are coming, sooner than later. What would it change for the tolling industry?

Certain governments want to support autonomous driving to push their local car industry. These cars could be subsidised in the short-term. However, in the long run, autonomous cars will not remove the need to build an maintain roads.

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I. The concept of road charging and its global implementations

A. What is road user charging (RUC)?

The aim of road tolling and charging is to charge the user for the direct use of the road infrastructure. The purposes are multiple and can include road building and maintenance financing, other fund raising, to reduce congestion or/and pollution, or to manage transport demand and traffic flow.

Road user charging (RUC) refers to all direct charges levied on road users to use a defined area of road. The definition of RUC includes **tolling**, which in general refers to a charge as a **financing mechanism for new roads**, but also includes all other types of charges such as distance-based charges for purposes such as **traffic management** on existing roads.

The RUC terminology can depend on who is writing rather than any objective distinction. For example, **road pricing** is usually used by transport economists and **value pricing** can be used in the US mainly in the context of High Occupancy Toll (HOT) lanes.

RUC can become complex because it may involve multiple stakeholders with changing roles and interactions. Three of these are

- the **toll charger**, responsible for the infrastructure whether as the owner or the concessionaire,
- the **service provider**, in charge of collecting and clearing revenues as well as the toll system operational management,
- the **driver**, subject to the toll or charge by contract or regulation.

As well as the different types of charging classified under RUC such as distance-based charges, vehicle-classified charges or time-based charges that will be discussed throughout the study, different **toll types** are used.

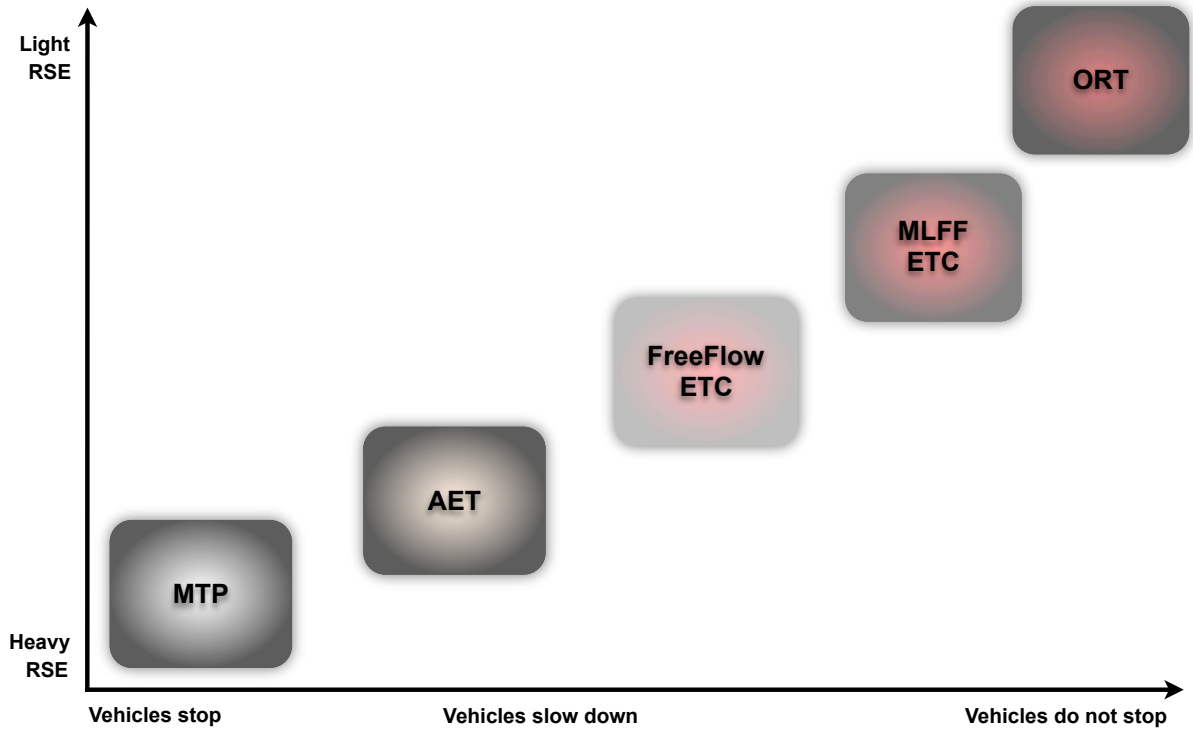
In this report, we will define the 4 different tolling types as such:

- **Motorway Toll Plaza (MTP):** the original tolling system with barriers. Toll booths can take cash, card or ETC but cars have to stop, as the barrier only rises once the payment is processed. Motorway toll booth can include dedicated free flow lanes.
- **All Electronic Tolling (AET)**: toll booths equipped with multiple dedicated ETC lanes allowing vehicles equipped with a transponder to pass through at lower speed. A barrier might still be in place for enforcement.
- **Free Flow Electronic Toll Collection (FF ETC)**: tolling without booth or barriers but with Road Side Equipment (RSE) such as gantries over the road. The traffic does not need to slow down and tolling and enforcement is done by the gantries. Free Flow ETC can be done on a single

dedicated lane or over **Multiple Lanes** (MLFF ETC) over the motorway itself. It can be based on technologies such as DSRC (Dedicated Short Range Communications) or RFID (Radio-Frequency Identification).

- **Open Road Tolling (ORT)**: On-Board Unit (OBU) based tolling using GNSS technology to charge the vehicle based on miles driven and types of road. ORT can be applied on all roads or a wide variety of road types. Some gantries are used but only for enforcement.

Fig. 1.1: The matrix of the 4 toll system types



Source: PTOLEMUS. Note: RSE= Road Side Equipment

Tolling and payment are separate events. **Tolling relies on capturing evidence** of a vehicle's presence at a specific location and a specific time whether through customer action or through the enforcement system.

Payment relates to transferring the funds from the driver to the operator. Payment can be done in advance (pre-pay) or after the use of the road (post-pay).

We can summarise the **main reasons** for tolling:

- **Access** to a single infrastructure such as a highway, tunnel, bridge, etc.
- **Time-based charging**: the road network can be used for a given period of time,
- **Distance-based charging**: the vehicles are charged as a function of the total distance driven in a defined area. One specific version is **mileage-based charging** where the toll is charged based the estimated number of kilometres driven.

Most countries have used these different road charging systems over time.

For example, the cordoned toll area in Singapore, which was a first, was implemented in 1975 and originally involved a paper licence for driving into central Singapore, which was a time-based charge. It was upgraded to Free Flow ETC, which is a distance-based charge, using DSRC tags in 1998. The Singapore Land Transport Authority charges the vehicles using on-board units (OBUs) that use prepaid smart cards. Money is deducted from the smart cards inserted in the OBU when vehicles pass under the gantries.

Fig. 1.2: Singapore's toll booth in 1975 and today's free flow system

Source: Singapore Land Transport Authority

The price of a toll charge is generally based on mileage, maintenance requirements or congestion levels, but we will see that the criteria vary widely.

In the US and many other countries, the Gas Tax serves as a proxy for the road usage charge. Thus tolling is an additional charge for the usage of dedicated roads. Many countries such as the Netherlands, Finland or the US are now looking at different ways to charge the drivers for road usage.

There are many terminologies around the concept of electronic tolling. Many are simply interchangeable and depend purely on who is writing, while others have objective distinction. We attempted below to group and differentiate them.

Interchangeable terminologies with ETC:

- Road tolling (usually used for bridges, tunnels, and charges on motorways),
- Road pricing (used by transport economists),
- Road user charging (used in the US and by the European Commission),
- Electronic fee collection (used by the European Commission),
- Electronic road pricing (ERP, only used in Singapore).

Terminologies distinct from ETC:

- Congestion charging (used specifically for zone access such as in Stockholm),
- Value pricing (US – mainly in the context of high occupancy toll (HOT) lanes),
- Congestion pricing (US – especially for HOV lanes),
- Road user charging (often used for mileage-based, truck-only schemes).

B. Road charging around the world

1. European market overview

The European Union (EU) is the world's largest market for tolling and ETC.

However, its tolling landscape is a **patchwork of programmes, models and technologies**.

Germany has Europe's largest toll domain, with 14,064 kilometres being submitted to the *LKW-Maut* road pricing scheme. This domain is even being extended by another 1,100 km from October 2015.

More than 1 million trucks are registered to the system, more than half from outside Germany. 776,000 trucks from 44 countries are equipped with a Toll Collect OBU.

France is Europe's largest tolling market in terms of tolled revenues. It generated €9.17 billion in revenues for the French government and concessionaires. Yet its ETC system, *Liber-t,* represents only 5.4 million vehicles. 685,700 trucks are registered to TIS-PL, the motorway toll scheme applied to Heavy Goods Vehicles (HGVs), which means that 85% of trucks use ETC at the moment.

Italy has the highest number of ETC subscribers, with 8.2 million vehicles subscribed to Autostrade's *Telepass* scheme.

As shown in these 3 examples, Europe is a mosaic of different tolling systems.

Southern Europe, which has generated the largest tolling revenues for the longest time, is largely using physical gates and DSRC (Dedicated Short Range Communications) electronic tolling to implement **distance-based** charging.

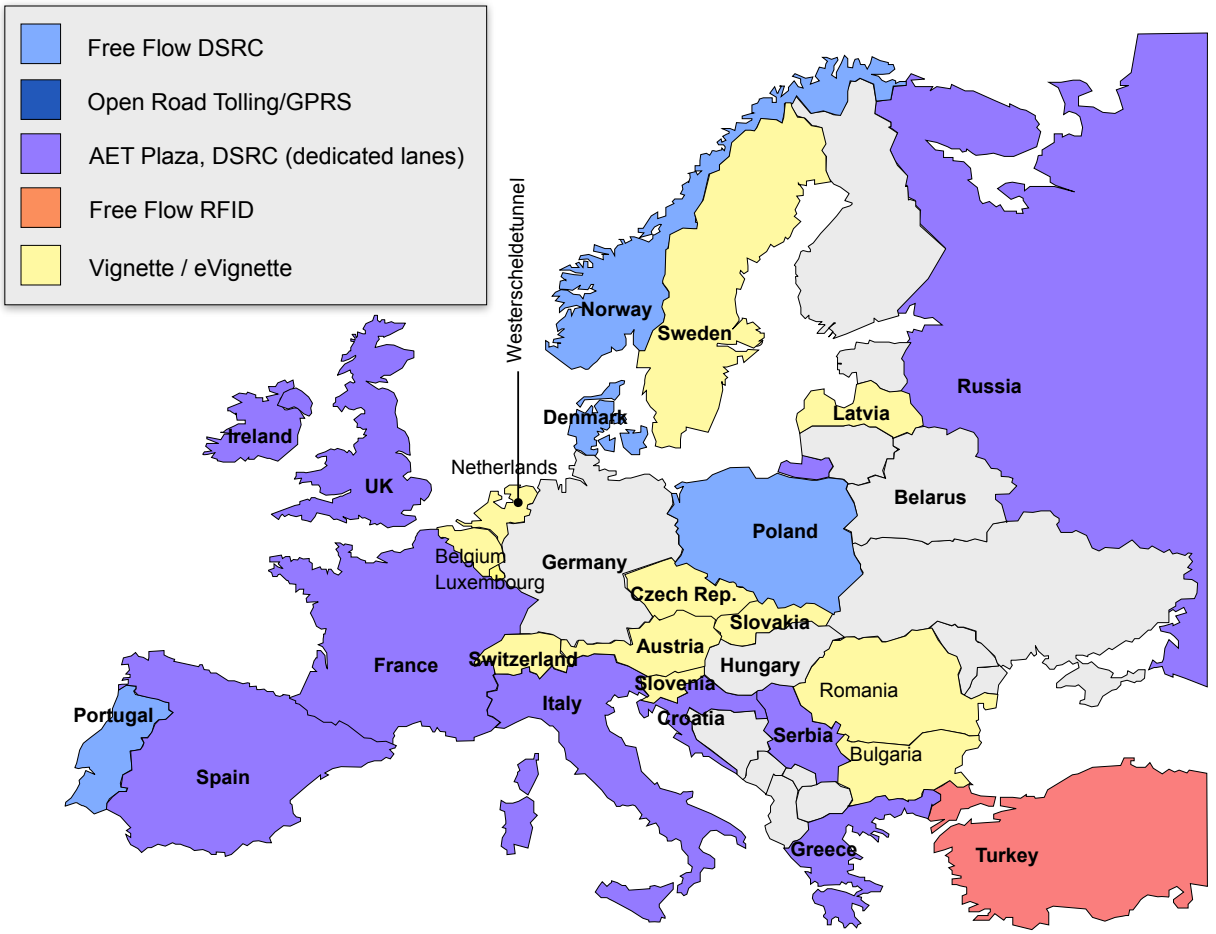
Germany and a number of Central European countries use GNSS (Global Navigation Satellite System) electronic technology to implement **mileage-based** charging.

A number of countries still use vignettes and **electronic vignettes (e-vignettes)** for time-based charging, notably in the Benelux, Scandinavia and South Eastern Europe.

Finally, a very few countries still do not charge the use of roads, notably Finland and Sweden, except for a limited number of tunnels and bridges. Hereafter is a map of the tolling models and

technologies used in Europe today, specifically for passenger cars and LCVs (Light Commercial Vehicles).

Fig. 1.3: Europe's electronic tolling programmes and models for light vehicles in Europe



Source: PTOLEMUS

Ten countries have put in place barrier-free tolling systems; four use satellite positioning (Germany, Slovakia, Switzerland and Hungary) and six use DSRC (Austria, the Czech Republic, Poland, Portugal, Norway and Belarus).

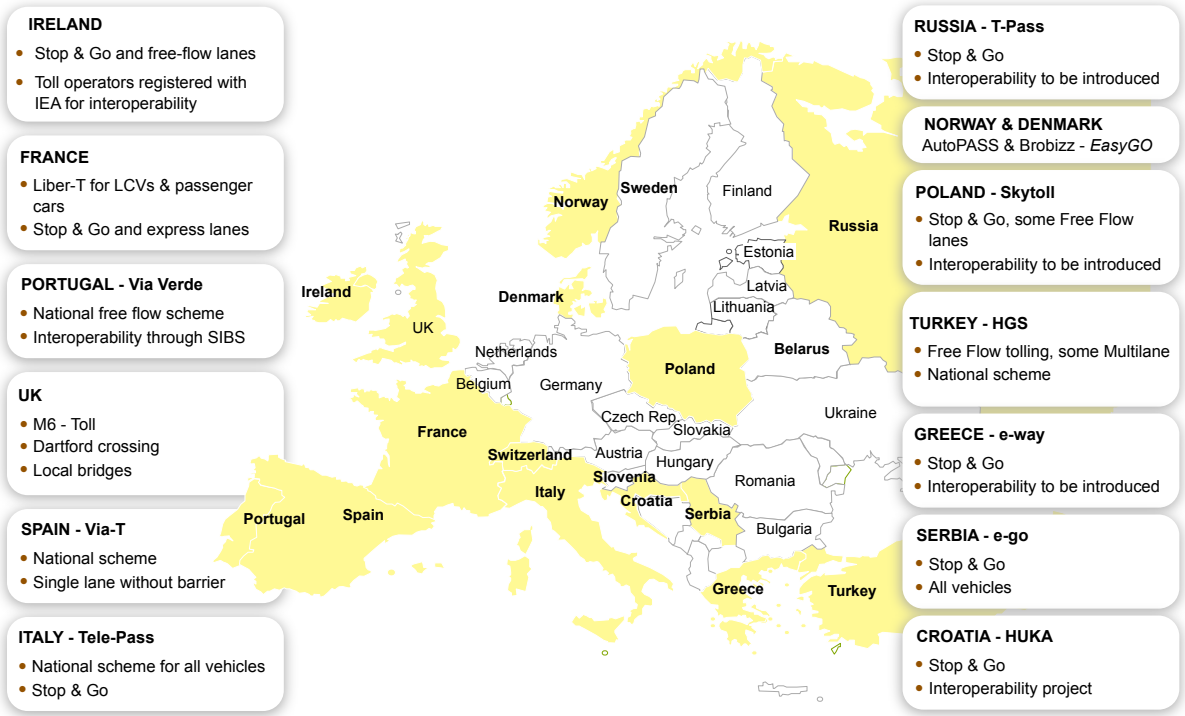
A further six countries have tolls with barriers but dedicated lanes for ETC (France, Croatia, Slovenia, UK - M6 toll - Italy and Spain).

Four other countries offer the possibility of electronic tolling on motorways with barriers (Ireland, Greece, Turkey and Serbia). Inside these countries, there are isolated roads or bridges using free flow such as the M50 in Ireland and the Bosphorus bridge in Turkey.

In addition, some countries are running vignette systems for trucks (in the UK and Hungary) or for all vehicles such as the Eurovignette countries (Belgium, Denmark, Luxembourg, the Netherlands and Sweden), as well as Bulgaria and Romania who run their own vignette systems. These schemes are not always shown on the map for simplification purposes.

The programmes and their particularities are analysed in the next figures, focusing on the car- and LCV-related programmes and excluding vignettes.

Fig. 1.4: Europe's passenger car electronic tolling programmes



Source: PTOLEMUS

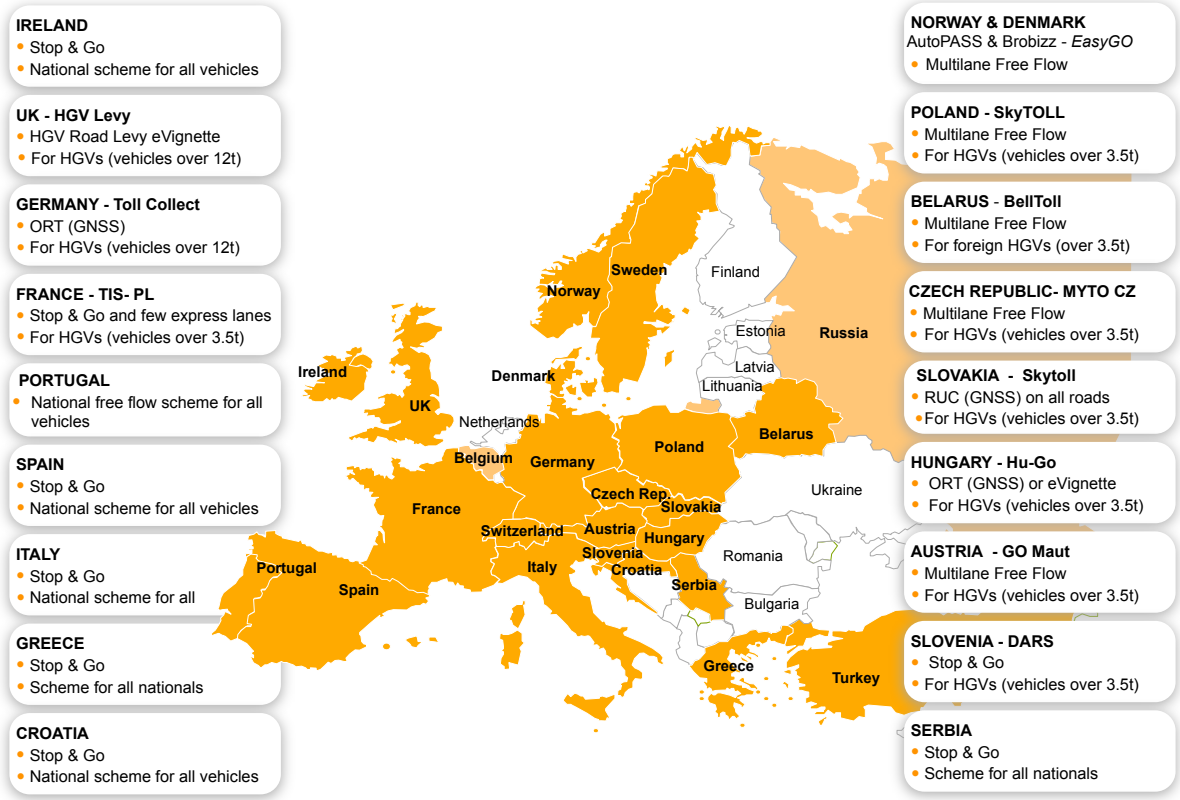
E-tolling systems that apply to all vehicles are primarily found in countries with pre-existing DSRC infrastructures based on motorway concessions.

The technology they use has slowly evolved in the last two decades with the exceptions of Norway - switching to Free Flow ETC - and Turkey - switching first to smart cards and then to RFID stickers.

Partly thanks to the success of the German Toll Collect model, a growing number of countries have implemented specific schemes to charge heavy vehicles. Initially, they used the same tolling systems as for light vehicles, but they are now increasingly deploying dedicated truck road user charging schemes.

The map thereafter lays out the various schemes and toll programmes that trucks have to submit to. Some of those are dedicated to trucks. Others are for all vehicles but the trucks pay a different rate related to their class. When relevant, the name of the truck-specific programme is mentioned next to the country.

Fig. 1.5: Electronic toll collection schemes for trucks in Europe



Source: PTOLEMUS - Note: Upcoming schemes are in lighter orange

As the map above shows, **HGV tolling is rapidly becoming universal.** The technology used, however, is far from universal. The map of the toll styles and technologies applied in truck-specific programmes is again showing a wide variety of choices made.

In fact, most available technologies are on offer in Europe alone. It does not include the back-up technology (often a ticketing or vignette system), nor does it show the enforcement technology,

(1) Price-based policies

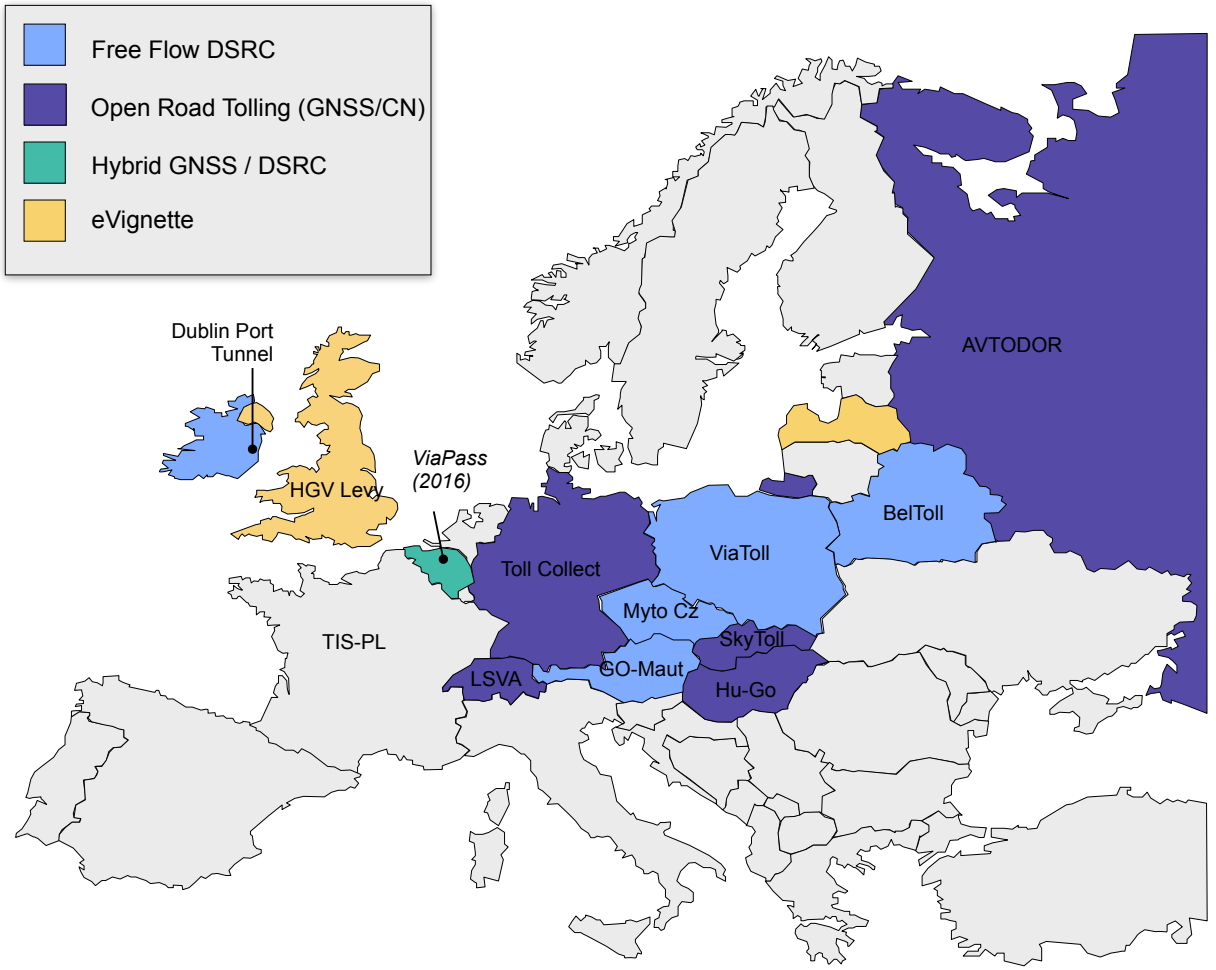
These policies include both traditional toll lanes and those that use ***congestion pricing***, where the toll price depend on various factors in order to manage demand such as peak-period surcharge or off-peak discount.

which is typically Automatic Number Plate Recognition (ANPR). We considered the Russian upcoming RUC programme in this map although it has not been confirmed exactly when it will start.

We also listed the schemes and their toll chargers with the duration of the concession or contract. With several of those schemes due to be re-tendered, it serves to highlight how rapidly changing this area is.

The truck-specific toll systems need to comply with the free trade rules of the European Union, which guarantee the freedom of transport inside the 28-country area. Due the development of heterogeneous technologies and charging models, the European Commission, as "guardian of the treaties", decided to pass regulation to ensure that **these systems would not become obstacles to trade**.

Fig. 1.6: Europe's truck-specific toll styles and technologies



Source: PTOLEMUS

The **2009 EETS directive** stipulates that a European Electronic Tolling Service shall be provided by each Member State for vehicles exceeding 3.5 tonnes and vehicles that are allowed to carry more than 9 passengers.

The initial deadline for the implementation of the directive to truck tolling was 3 years afterwards (i.e. by October 2012); and 5 years afterwards for all other vehicles (i.e. by October 2014).

Finally most Member States aspire to mobility pricing, whereby the full cost of transport (including so-called external costs, which are created by vehicles but primarily impact third parties) is included in all the different modes.

Fig. 1.7: HGV-only charging schemes and toll chargers

Country	Programme	Toll charger	Start	End
Austria	*GoMaut*	ASFINAG	2007	2018
Belarus	*BellToll*	Ministry of Transport and Communication	2013	2033
Belgium	*ViaPass*	Belgian government	2016	2027
Czech Republic	*MytoCZ*	Ministerstvo dopravy České republiky / Ředitelství silnic a dálnic (Czech Roads and Motorways Authority)	2007	2016
Germany	*LKW Maut*	BMVI (German Transport Ministry)	2005	2018
Hungary	*Hu-Go*	Állami Autópálya Kezelő Zártkörűen Működő Részvénytársaság "ÁAK Zrt."	2013	2033
Poland	*viaTOLL*	GDDKiA	2011	2017
Slovak Republic	*Myto*	Národná diaľničná spoločnosť (NDS)	2010	2022
Switzerland	*LSVA*	Federal Customs Administration (FCA)	2004	n/a
UK	*HGV Road Levy*	Department for Transport (DfT)	2014	2019

Source: PTOLEMUS

Mobility pricing is expected to tackle the key issues affecting the transport industry today:

- Increased congestion in and around cities due to both growing urbanisation and mobility of the population and goods,
- Air and noise pollution, often reaching alarming levels in many cities, particularly in emerging countries,
- The combined development of alternative energies and the improved fuel efficiency, which undermine governments' tax revenues everywhere in the world.

Despite the EETS directive, the road towards the harmonisation of the EU transport systems and the solving of these financial and environmental issues is, however, yet to be built.

a. Interoperability in Europe today

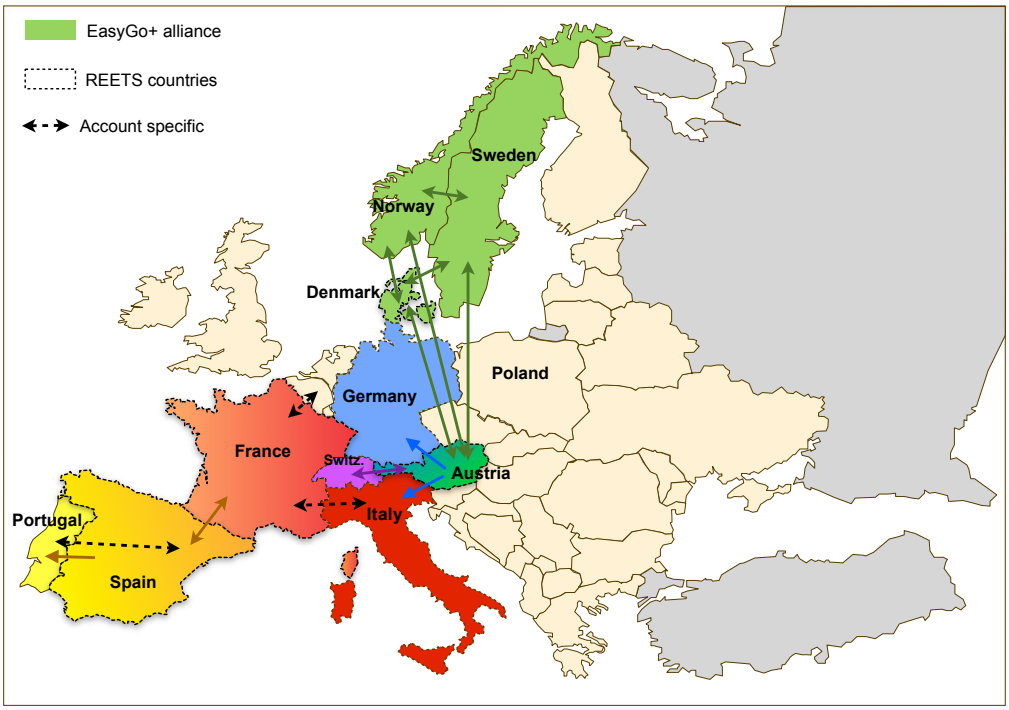
Interoperability between the road networks in Europe is unusual at present. For a start, let us distinguish between **3 types of interoperability.**

The first is the ***network interoperability*** agreed between two toll chargers or two groups of toll chargers. It is the ability for a vehicle to be recognised and accepted by a toll charger without the assistance of a third party. This method generally uses the identification of vehicle number plates using ANPR systems.

The second is the ***device interoperability***, i.e. the ability of a device to be used on other networks than its home network. We name it "account specific" in the map below. We will analyse in detail the services offered and their network coverage in **Section IV.** There is also technical interoperability between some devices that are not yet used, for example between Switzerland and Italy. The Swiss device is technically able to function on the Italian network.

Finally, we also consider ***contractual interoperability*** as the ability to use different tolling networks with a single service contract. This is a functionality provided by toll service providers or other service providers such as fuel card providers. Companies such as DKV, LogPay or Eurotoll propose their transport customers to have their truck equipped with the necessary device for it to drive everywhere in Europe, while the transporter will receive only one invoice for the tolls, the fuel and associated services.

Fig. 1.8: Tolling network interoperability in Europe today



Source: PTOLEMUS

Interoperability is not always by-directional. The German and Italian devices can be made to work and bill on the Austrian network but not vice versa. The Spanish ViaT devices now function on the whole of the ViaVerde network.

Today, interoperability in Europe has been initiated between toll chargers on a **bilateral basis** and is always based on the DSRC technology:

- France - Spain: TisPL devices and ViaT devices work in Spain and France. The market for LiberT tags is not open and there is no interoperability with Spain;
- Spain - Portugal: In progress, today the ViaT devices function on the ViaVerde network. A trial is taking place in Galicia for ViaVerde tags to be used there;
- Italy - France: Only with the ***Telepass*** EU devices;
- Austria - Switzerland: ***EmotaCH*** can be used in Austria (Two user contracts);
- Germany - Austria: ***Toll2Go*** the Toll Collect device can be used in Austria (Two user contracts);
- Norway - Denmark - Sweden: ***EasyGo*** the Brobizz (Denmark) device can be used in Norway;
- Norway - Denmark - Sweden - Austria: ***EasyGo+*** device can be used in the whole area (One contract solution). The Norwegian device (AutoPass) cannot be used elsewhere.

b. The main stakeholders in Europe

Multiple stakeholders are involved in the ETC decision-making process for Europe.

As mentioned earlier, the **European Commission** (EC) is the guardian of European treaties, notably the Treaty of Rome. It aims at maintaining and deepening the commercial union between the 28 EU members. As such, it is the overall co-ordinator of European interoperability and issues the relevant directives. More information on the different directives impacting the industry can be found in section II/A/1.

The **Electronic Toll Committee** is formed by representatives of the Member States and chaired by the EC.

The **Stockholm Group** is an informal group set up by a number of EU Member States that cooperate with a view to facilitate the deployment of the European Electronic Toll Service and the exchange of best practices. The 14 countries represented in the group are Austria, Denmark, Finland, France, Germany, Hungary, Ireland, the Netherlands, Norway, Poland, Slovenia, Sweden, Switzerland and the UK.

ASECAP is the association of the European Associations of motorway concessionaires and toll chargers.

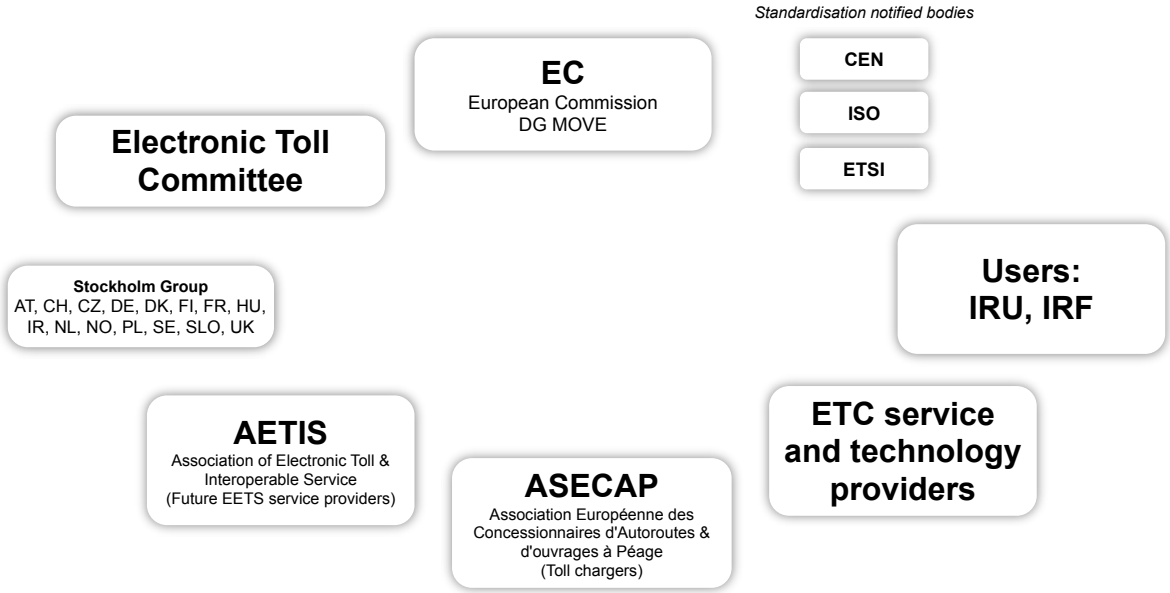
The **IRU,** the International Road Transport Union, represents transport users, and it is the world road transport organisation, promoting the interests of bus, coach, taxi and truck operators.

The **IRF** (International Road Federation) is a global organisation supporting the development and maintenance of better, safer and more sustainable roads and road networks around the world.

AETIS, the Association of Electronic Toll and Interoperable Services, is a non-profit-making association with the goal of representing EETS providers, as defined within the EU legal framework. AETIS members are specialist toll service providers, oil companies or independent fuel card providers: Axxès, DKV, Eurotoll, LogPay, OMV, RESSA, Shell, Telepass, Total, Trafineo, UTA and WAG Payment Solutions.

CEN, ISO and **ETSI** are the three technical standard definition bodies used by Europe for the standardisation of tolling technologies.

Fig. 1.9: Main stakeholders of European tolling



Source: PTOLEMUS

2. US market overview

The US model has a comparatively homogenous base from which to evolve. All the tolling programmes are based on RFID transponders, which are the same for all vehicles. Each state has its own particularities and while many do not have any sort of tolling as of now, there are signs that the tolling market in the US could grow rapidly.

a. The insufficiency of the Federal Gas Tax

In the last 20 years, the total number of vehicle miles travelled in the US has increased by more than 70%, whilst highway capacity has grown by only 0.3%.

The Federal Gas Tax in the US is earmarked by law for the maintenance and construction of roads via the **Highway Trust Fund**. Drivers now pay 18.4 cents per gallon in Federal Gas Tax. Heavy duty trucks average about 5.8 miles per gallon.

Since 1999, gas tax revenues have been decreasing rapidly whilst infrastructure costs have continued to grow. This is especially true in the North East, where tunnels and bridges are nearly 100 years old. It is a very delicate political issue and the US government has not shown any plans to raise fuel taxes.

The ability of the gas tax to finance the road infrastructure has receded for 3 main reasons:

- Unlike most taxes that are levied on a percentage basis, the gas tax is levied as a **fixed amount per gallon,** currently 18.4 cents. The problem with writing fixed dollar amounts into the tax law is that, in the long term, inflation erodes their "real" value. Unfortunately, "inflation indexing" has not been implemented with respect to the Federal Gas Tax. The **growth in the cost of construction, materials** and **labour** therefore directly impacts the cost of building new highways and maintaining the existing network. This **represents the largest part of the current gas tax shortfall.**
- **Behavioural changes also play an important role**. Car driving is not as popular as it used to be. Many young Americans do not drive yet and are not yet interested in driving, and this is reflected in car sales. In 1999, 37% of 16-year-olds had a driver licence; a decade later, that had dropped to 31%. The ever-increasing urbanisation of the population is accentuating that trend and further reduces the time spent driving.
- **Improved fuel efficiency** also had a big impact. The recent improvements are, in no small part, the result of the standard mandated by President Obama in 2010 that the average gas mileage for passenger vehicles must reach an unadjusted fuel-economy rating of 54.5 miles per gallon by 2025.

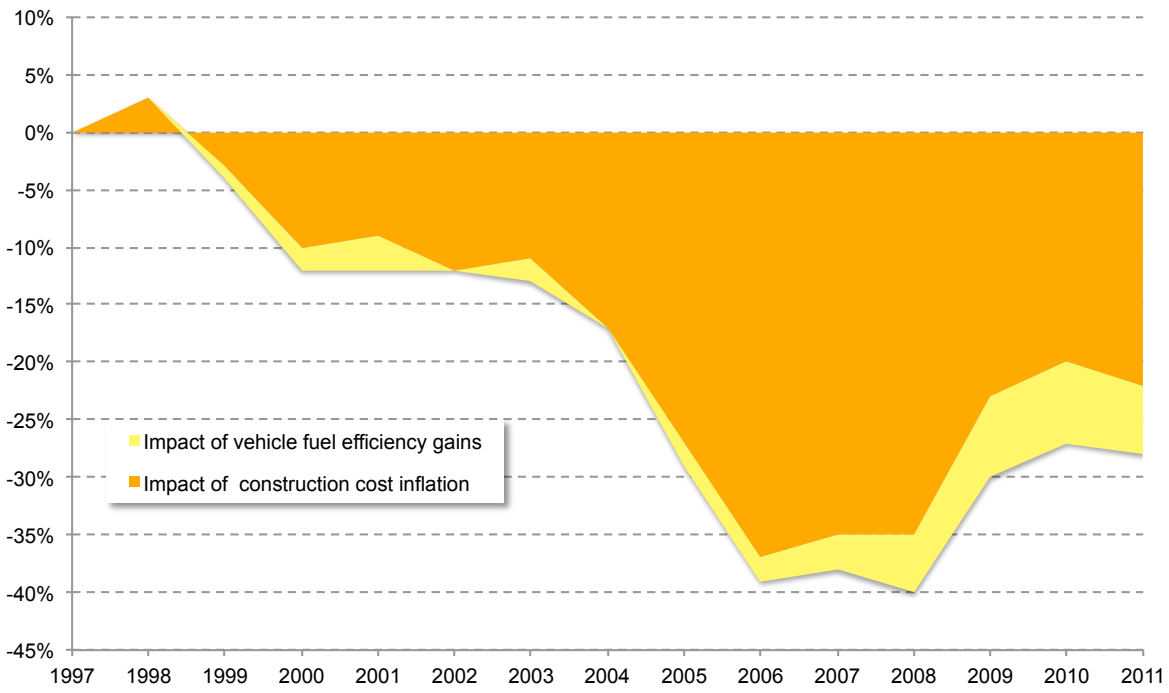
The fuel efficiency of diesel-powered vehicles has remained basically unchanged since 1997, according to FHWA (Federal Highway Administration) data. Overall the impact of fuel efficiency on total motor fuel tax revenues (including both gasoline and diesel) is less than 22%. The next figure does not include diesel tax, but rather focuses solely on the gasoline tax.

Together, **taxes** on gasoline and diesel fuel raise **more than $30 billion per year, or 85% of the revenue flowing into the nation's transportation spending account**.

All these factors have made the fuel tax budget insufficient to cover the infrastructure costs.

In fact, in the last five years, the US Congress has transferred more than $53 billion from the general fund to the transportation fund in order to compensate for lagging gas tax revenues. This unsustainable situation has led the American government to evaluate the opportunity of using tolling to generate new revenues.

Fig. 1.10: Purchasing power of the gas tax has dropped 28% since 1997



Source: ITEP

The impact of this situation is slow to come but considerable. According the US Department of Transportation, **65% of major roads are rated in less than good condition**, while one in four bridges require significant repair or cannot handle today's traffic.

One of the major **obstacles** to road funding is the fact that not all roads can be tolled. The **Federal Road Act** of 1916 prohibited existing federal roads from being tolled. Several changes in the legislation have removed this for most roads but the toll prohibition remains for most of the Interstate Highway System. Built from 1956, the Interstate Highway System network already includes 2900 miles of tolled roads.

The US government is now proposing to change that to allow each state to turn already built roads into toll roads. The proposal to reverse this long standing prohibition was made in the White House Transportation Bill in April 2014. It is now part of the plan outlined in the $478 billion **Grow America Act.**

The act includes two main road-related aspects.

First, the Federal Government will invest $29.4 billion over 6 years in support of the President's "Fix-it-First" initiative to focus on the reconstruction, restoration, and preservation or safety improvements of existing highway assets. It aims at reducing the number of structurally deficient Interstate Highway System bridges, targeting safety improvements and supporting a state of good repair on the National Highway System.

Second, it is expected to authorise the extension of two existing pilot tolling programmes, giving States additional flexibility to apply for authority to toll existing Interstate highways in order to make

improvements or to manage congestion. These requests will be subject to approval by the Secretary based on specific criteria that will be published for comment in the Federal Register.

In addition, the Act would expand the eligible uses of toll revenues collected on Federally-funded toll facilities to include the costs associated with improving public transit service located within the same transportation corridor as the toll facility or would otherwise help improve the operation of the toll facility or the highway on which the toll facility is located.

It remains to be seen whether the Act is eventually passed by a bi-partisan Congress. To warn of the possible effects of inaction, U.S. Transportation Secretary Anthony Foxx notified state transportation leaders that all federal participation in transportation infrastructure construction will stop if the current funding legislation expires at the end of May 2015.

b. Tolling without building

As many states did not have the legal framework or the budget to build new roads, instead they implemented **managed lanes** to improve traffic flow and generate income.

Four examples are presented hereafter.

(2) Policies based on vehicle eligibility

In these policies, certain vehicles are allowed while others are restricted.

This includes **High Occupancy Vehicle** (**HOV**) lanes restricted to vehicles with two or three occupants.

HOV lanes are generally free to use and are enforced by police and/or cameras.

(3) Policies based on access control

These are exclusive or special use lanes, e.g. express lanes where **all** vehicles are allowed, but access is limited during long stretches of the road, minimising turbulence in the flow of vehicles.

(4) HOT Lanes

Many HOV lanes have been ignored by drivers and left unused. Thus some agencies have turned them into **High Occupancy Toll (HOT)** lanes whereby **solo** drivers can now use the lanes for a fee that depends on the traffic conditions. HOT lanes have therefore emerged in the US as an **additional price-based management strategy,** becoming increasingly popular. The fee can be for the length of the lane, by segment or mileage-based.

Managed lanes can be defined as highway facilities or a set of lanes where operational strategies are proactively implemented and managed in response to changing conditions.

The managed lane concept is typically a "freeway-within-a-freeway" where a set of lanes within the freeway cross section is separated from the general-purpose lanes. The facility incorporates a high degree of operational flexibility so that, over time, operations can be actively managed to respond to growth and changing needs.

Some social advocates have complained that HOT lanes are unfair since they allow richer drivers to go faster. While this is partly true, the rates are not very high (they can vary from ¢50 to $5) and it is the drivers' choice to pay or not depending on his / her own level of urgency.

In addition, HOT lane users are taken out of the main traffic, which frees up to 10% more capacity in some networks, while costing proportionally little. Hence the gain is shared by everyone.

Fig. 1.11: Three examples of managed lanes in the US

Project	Goal	Description	Revenue ($ million, 2014)	Use of the revenues
State Route 91 Express Lanes – Orange County, California	Alleviate congestion and bring revenues	• 2 Toll Express Lanes • Requires account and tag • Tolls vary by time of day	42.61	60% debt service, 40% operations
QuickRide – Houston, Texas	Generate capacity with HOV lanes without slowing down buses	• HOT lanes • Requires account and tag • Allows 2 occupant vehicles access during 3+ restriction during peak hours • $2.00 per trip flat fee	0.11 (0.16 in 2010)	100% operations
New Jersey Turnpike: Dual Section – New Jersey	Enhance safety and improve flow	• 31 mile section • Trucks and cars split • HOV lane during peak • Requires account and tag • Variable pricing to discourage peak driving	200	45% debt service, 45% operations, 10% other

Source: US DoT, PTOLEMUS

HOT lanes have provided agencies and the local government a way to extend their network capacity without necessarily building new lanes. At the same time, they bring revenues, while allowing for the HOV lane to stay in place.

Enforcement can be applied by ANPR-based video tolling or using an RFID transponder. In Los Angeles, ***Fastrak*** provides a switchable device (pictured) that allows the driver to switch between HOV and HOT.

c. Interoperability in the US today

Toll networks in the US are being expanded rapidly, bringing both an increased use of ETC and an evolution towards free flow systems. **In July 2012, President Obama signed a legislation that mandated National Interoperability (NIOP) by July 2016.** The legislation did not however provide funding or direction to reach NIOP.

In response, the International Bridge Tunnel & Turnpike Association (**IBTTA**), which groups all toll road operators, formed an **Interoperability Steering Committee**. This group comprises representatives from the toll agencies and the private sector with 5 sub-committees: Roadside Operations, Back Office Operations, Communications, Governance and Cost Sharing.

The US counts 7 different protocols for RFID but 4 large pockets of interoperability. Inside these pockets, the drivers only receive one bill. There is no differentiation between truck and car tolling other than the rate per mile.

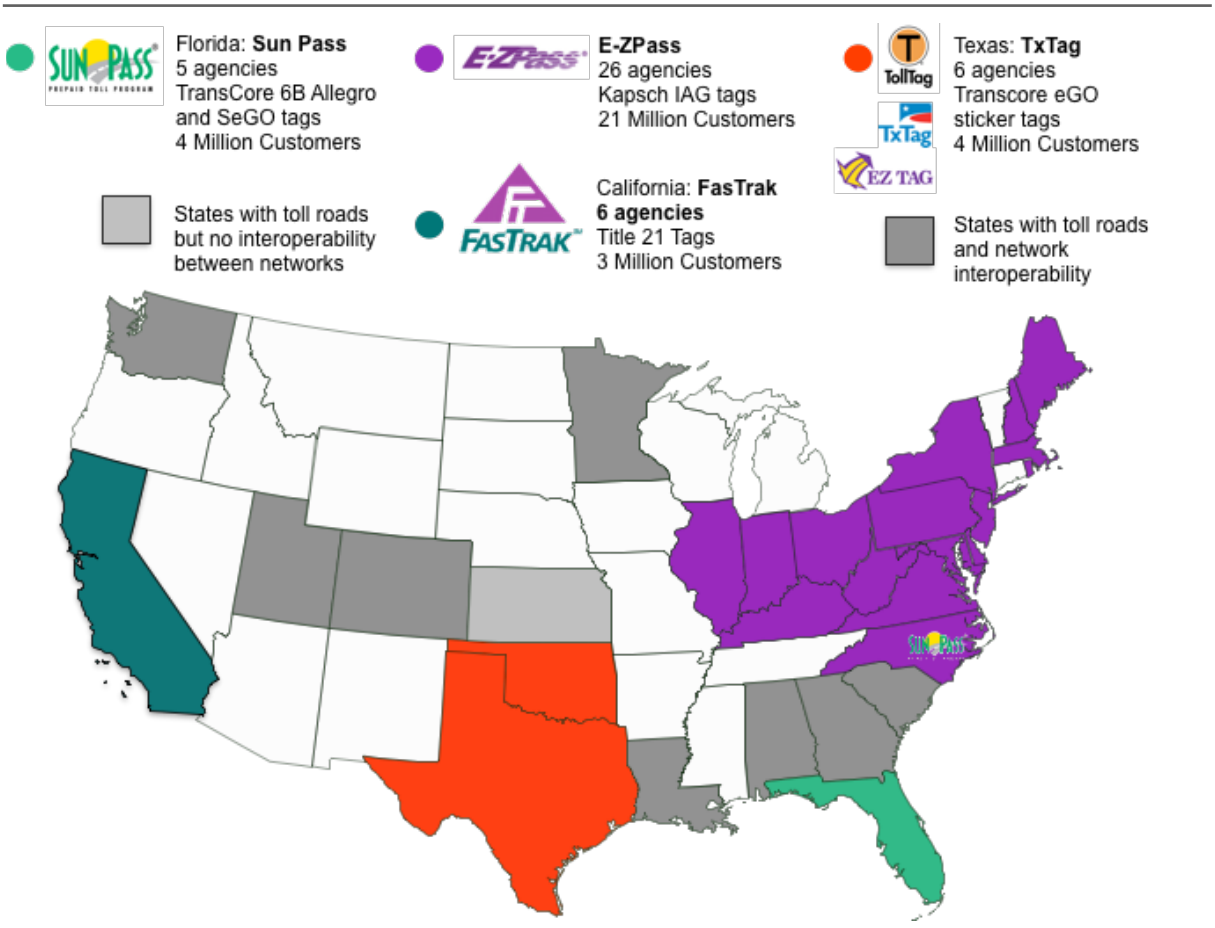
The ***current approach to interoperability*** involves:

- Deploying a clearing house (hub or peer-to-peer) for toll agencies within a regional and/or a national toll network,
- Planning interoperable systems and equipment (readers, not transponders),
- Facilitating image-based transaction processing for drivers not registered on the networks.

So far, interoperability is established at state-level. The 4 key regions are highlighted in the map below, but it does not represent the full picture of the situation.

For example, North Carolina's QuickPass is now accepted in the E-ZPass domain as well as the SunPass Domain. Both E-ZPass and SunPass also work in North Carolina. Oklahoma's PikePass works in the North Texas Tollway Authority (NTTA) domain since August 2014. NTTA TollTags also work on the PikePass lanes. Since December 2014, Georgia's Peach Pass system is interoperable with Florida's Turnpike network (SunPass, LeeWay and E-PASS).

Fig. 1.12: The 4 key tolling domains in the United States



Source: PTOLEMUS

The picture is, in fact, more complex because many transponder technologies are used - sometimes in the same state - and none are interoperable. Since the standards are patented, the states cannot easily set up multi-protocol readers.

In the following table, we can see the **domination of a few companies providing those individual RFID standards**. Kapsch, through the acquisition of Mark IV in 2010 has control over the biggest toll region. Transcore has control over 8 states. We highlighted below the tag standards grouped together to show the main technology groups and the States that use them.

Fig. 1.13: The rainbow of RFID protocols in US transponders

Toll programme	State	Technology provider	Tag standard(s)
K-Tag	Kansas	TransCore	6B Allegro
PikePass	Oklahoma	TransCore	6B
Sun Pass	Florida	TransCore	6B Allegro and SeGO tags; full IOP statewide
Lee County	Florida	Kapsch	5.9 GHz tags
EXpress Toll	Colorado	Sirit (3M) and Confidex	6C
ExpressPass	Utah	3M and Neology	6C
Good To Go!	Washington	TransCore and 3M	6C
PeachPass	Georgia	TransCore	6C tags and 6B eGO sticker tags
QuickPass	North Carolina	TransCore	6B SeGO tags and IAG/ SeGO tags
E-ZPass	Illinois, Indiana, Maine, Maryland, New Jersey, New York, Ohio, Pennsylvania,, Virginia, West Virginia	Kapsch	IAG tag
PalPass	South Carolina	Kapsch	IAG tag
Tx Tag	Texas	TransCore	ATA/eGo: Passive technology tag with multiple protocols and eGO sticker tags; full IOP statewide
GeauxPass	Louisiana	TransCore	6B ATA/ SEGO
FasTrack	California	Sirit (3M)	Title 21
MnPass	Minnesota	ASTM V6	TDMA

Source: IBTTA, PTOLEMUS

d. Principal trends in the North American market

Road freight in the US is by far the main mode of goods transport and this is will not change. However, due to its ageing infrastructure and a lack of investment, **traffic issues** lead to substantial losses of productivity for the commercial sector and time for all drivers.

Thus toll agencies are looking to find new ways to dynamically manage traffic. For example, the travel time of vehicles using HOV lanes decreased from 25 minutes to 8 minutes when introduced on the **95 Expressways** used in California.

The general trend is first to **do away with the cash collection at toll booths**. A great example is an old facility such as the Golden Gate bridge in San Francisco which recently converted to free flow. Customers now need to open a *FasTrak* account.

More generally, **no new toll booth** lanes are being built in the US.

Fig. 1.14: The Golden Gate Bridge recently moved to free flow electronic tolling

Source: Caltrans

Eight US toll agencies have converted to or implemented AET in the past two years:

- Denver's E-470 (first to convert),
- Northwest Parkway in Denver,
- All North Texas Tollway Authority facilities,
- Central Texas Regional Mobility Authority's 183A Expressway,
- Miami-Dade Expressway Authority's State Route 874, 878 and 924,
- Tampa-Hillsborough Expressway Authority's Selmon Crosstown Expressway,
- The Homestead Extension of Florida's Turnpike,
- Texas Turnpike Authority's State Highways 130 and 45 as well as Loop 1 have all AET options now but also continue to accept cash for now.

New ways to manage the lanes and increase traffic as well as revenues are also appearing. **Managed** lanes, **HOV** and **HOT** lanes are spreading rapidly instead after their initial success in Florida, California and Texas.

Toll data analysis is also now starting to be seen as a potential profit centre. The analysis can be used for traffic but also to find out where new roads are actually needed, how people really travel and what their real needs are. Ultimately this is data that can be used to manage and plan the road infrastructure better.

Furthermore, as with interoperability between networks and regions is going forward, so is the concept of **using the transponder across various vertical markets,** such as parking and transit payment. The single account for transportation cost would enable cross promotion between modes such as a free HOT lane for a day after transit has been used for a week. Tolling and transit are often seen as the first two applications to merge in the near future. The current RFQ for a new fare collection system for the city of New York transit already includes the requirement for such **cross-vertical interoperability.** Interoperability would be only on the accounting side, the toll devices would not have to be the same, at least initially.

Lastly, the **mileage-based usage fee** is now getting traction, starting with Oregon (see our case study in Section IV/B/5) and California. All the key integrators and technology providers in the US are evaluating the model very seriously to prepare a possible wider deployment. The next federal budget is expected to include funds for trials and deployment of distance-based charging schemes.

3. Overview of other major tolling markets globally

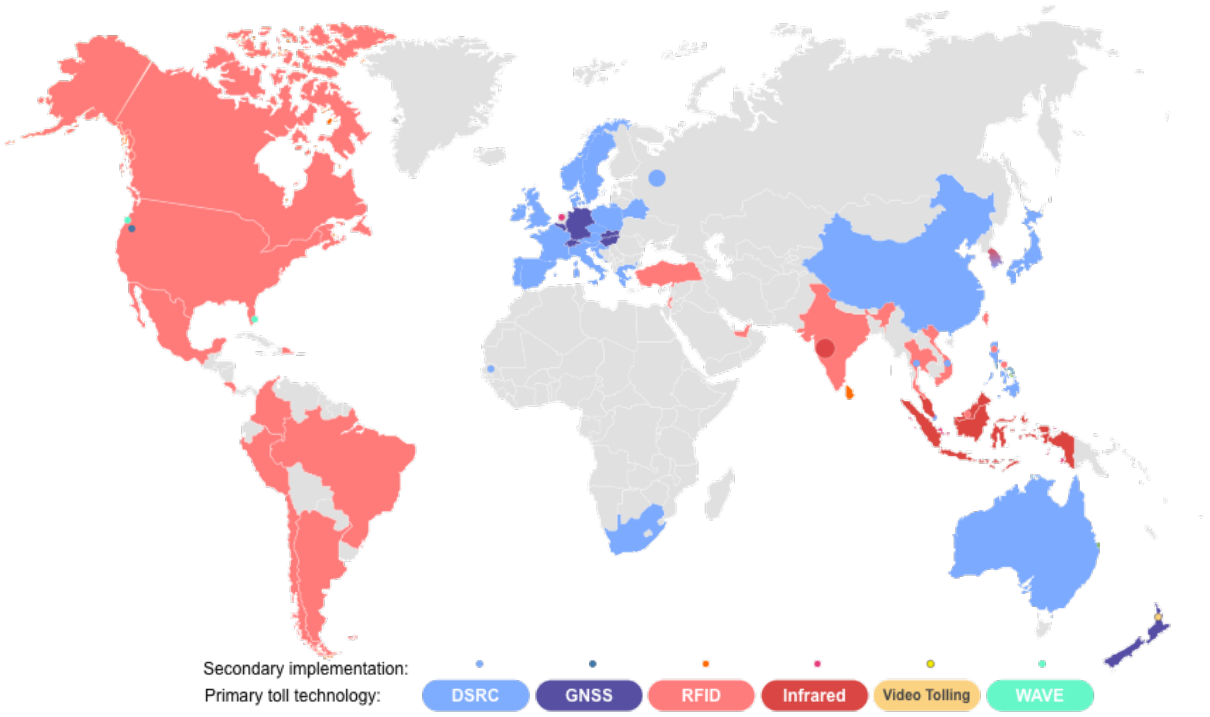
Electronic tolling has become a truly global market, as shown in the map of the most predominant toll technologies used in each countries shown below. ETC has already been implemented on the 5 continents and is gaining ground in emerging markets.

The 2 predominant technologies globally are RFID and DSRC. They split between the east and Australia where DSRC started since the onset of the millennium from the influence of the European technology providers and spread rapidly.

RFID is predominant in the Americas today, Brazil having switched recently away from DSRC. The advantages of RFID will be identified in details in the following sections but it is clear that the maturity of the technology, its ability to develop different communication protocols and the low price of its transponders are some of the few reasons why RFID is now appearing in Asia.

It is noticeable that dual systems are operated in various countries such as South Korea, India, New Zealand and the Philippines. Generally this is due to slow obsolescence, the lack of ca ohesive national toll policy or simply different policies applied to different vehicle segments.

Fig. 1.15: The toll technology world is split into 2 camps



Source: PTOLEMUS

In South Korea, active DSRC is slowly taking over infrared, which only represents 40% of the ETC transactions today. In the Philippines, RFID was introduced in 2014 on a first toll domain and is expected to be rolled out nationally. In India, infrared lanes still remain and run in parallel with the RFID lanes.

Globally, there is a growing trend away from infrared. Countries such as Indonesia, India and even South Korea are slowly moving away. Others have made the step already such as the Philippines and Taiwan, which both switched to RFID.

We organise below the main ETC markets outside the USA and Europe by how large their toll network size is and **the year of their most recent ETC project introduction**:

Fig. 1.16: Other major tolling markets' ETC network details

Country	Programme	Toll network size (km)	First ETC project	Latest ETC project
Taiwan	eTAG	383	2004	2012
Canada	407 ETR	107,272	1997	2012
Brazil	SemParar	22,040	1994	2012
New Zealand	E-Road	7.5 km toll road, and all roads for RUC scheme	2009	2013
South Africa	e-toll	3,120	2001	2013
Philippines	easytrip	320	2000	2014
Indonesia	e-Toll	649	2009	2014
Australia	CityLink	3,120	1998	2015
India	FASTag	1,263	2012	2015
Mexico	IAVE	8,000	2010	2015
South Korea	Hi-Pass	3,762	1999	2015
China	AutoToll	100,100	2000	Ongoing
Japan	ETC	9,267	2001	Ongoing

Source: PTOLEMUS

We can see that all of the most recent projects - implemented by India, Taiwan, Philippines and Indonesia - have been RFID projects. South Africa attempted to implement a new DSRC project, but currently, the future of the project is questioned and debates are underway.

Globally, the table above illustrates the flurry of activity around the world. From the more mature to the newcomers, most of the countries analysed show constant activity and rapid evolution, if not always growth.

Canada for example has seen very few projects in the last 10 years while in China the growth in toll lanes has reached 1000% in 2012 and now still at 120%. It is also worth noting that most recent projects, for instance in India, Taiwan, Philippines and Indonesia, have been RFID-based implementations.

Korea also started to deploy multi lane free flow tolling in January 2015 but based on active DSRC and infrared.

C. Why road pricing?

The purposes of introducing road pricing are multiple.

From a transport economist's perspective, it is to charge drivers for the usage of the infrastructure and for the costs they impose on other road users as well as non-road users through the generation of greenhouse gases, pollution and noise.

From the transport planner's perspective, it is a tool to **encourage people not to use certain roads** at certain times of day (not generally to price people off the roads), or to promote public transport.

From a political perspective, internalising the external costs, reducing emissions and improving the traffic flow are the key goals of road pricing. We examine each of these factors hereafter.

1. Internalising the external costs

The principle of internalisation of external costs is very dear to many European governments. It suggests that the price of transport should reflect its real costs to society. These costs should include infrastructure as well as the external costs of emissions, accidents, congestion, noise and land use. In theory, this could **motivate users to choose** the most appropriate vehicles, routes and transport modes based on all actual, fully accounted costs; and to use the infrastructure capacity more efficiently.

Road traffic is by far the most important cause of external costs. Whereas rail has a share of about 3.1%, road transport is responsible for 96% of all external costs. For example, in 2004 the Danish Ministry of Transport estimated that external costs per kilometre driven were 4.5, 2.4 and 3.4 € cents for congestion, accidents and noise respectively. A recent study by INFRAS also claimed that in Germany in 2005, the general transport sector caused macro-economic costs of more than €80 billion.

Following the **"polluter pays" principle**, pricing transportation based on its environmental cost aims at making the transport sector economically, environmentally and socially more efficient and fiscally fair.

a. Calculating the external costs

Congestion

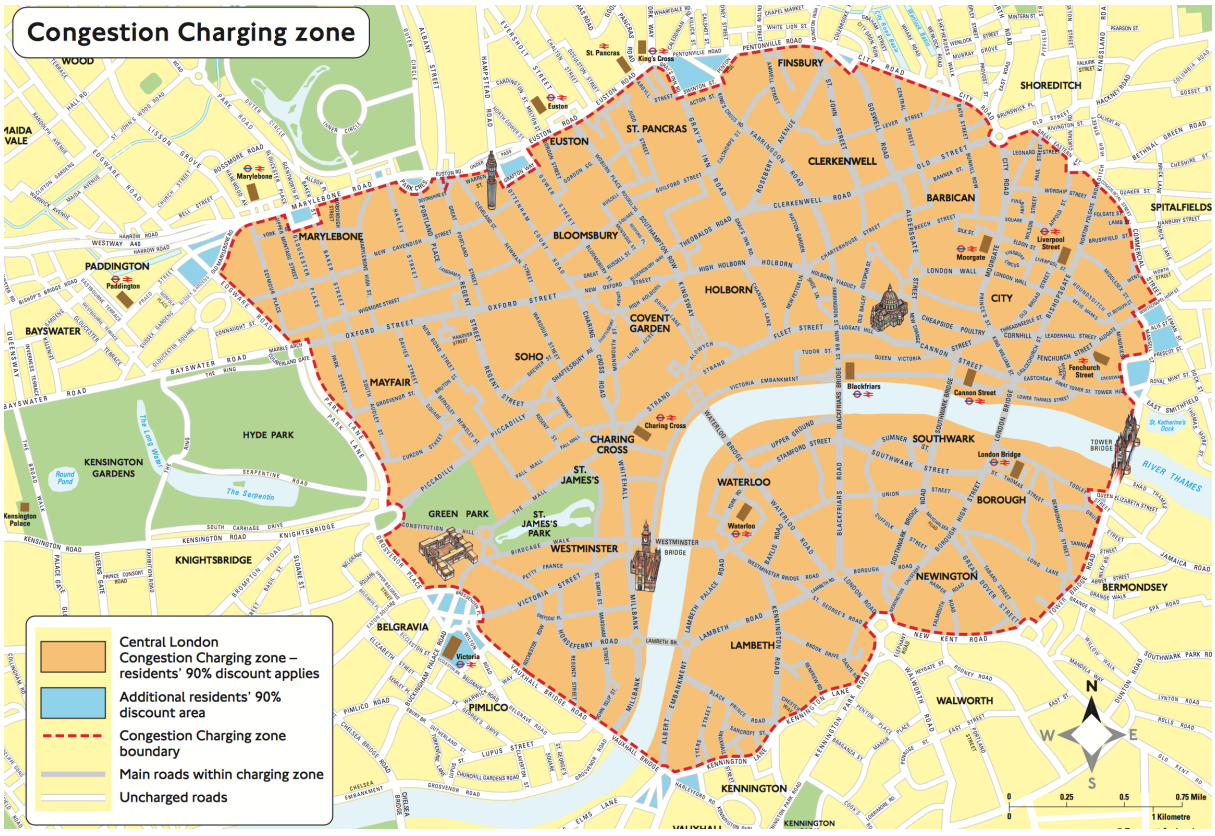
The London and Stockholm urban tolls offer useful data, as they have meaningfully contributed to reduce congestion. The gain in time created by the toll is a measure of the cost of congestion in these city centres.

In these two cities (or more precisely, the specific zones of these cities), tolls have been introduced. For example, in London, all drivers must pay an £11.50 daily charge if they enter the Congestion Charge zone between 7am and 6pm from Monday to Friday.

The effect of these local tolls was not to eliminate congestion, but to reduce it to a lower level.

In **London**, this gain amounts to around €70 million per year, according to Transport for London. Relative to the GDP of the congestion charge zone, this is 0.1%.

Fig. 1.17: London's congestion charging zone



Source: Transport for London

In **Stockholm**, the gains amount to €56 million per year according to the toll operator but other estimates put that figure at €14 million. Relative to the GDP of the toll zone, this is between 0.14% and 0.035%.

In both cases, the estimate of congestion costs in the two city centres is around **0.1% of GDP**.

Pollution

It is very difficult to evaluate whether road users effectively pay the costs they engender. Most road users (at least those who do not drive a fleet vehicle) pay the capital cost of their vehicles, insurance and the fuel they use. They also pay the cost of infrastructure they use in the form of taxes specific to road transport, for example in the UK the vehicle excise duty on car ownership and fuel duty.

These specific taxes are supposed to fully cover infrastructure construction and maintenance. It suffices then to compare the specific taxation with the cost of infrastructure. Specific taxes in France, for example, amounted to €34 billion in 2013, greatly superior to the €16 billion of public spending for roads maintenance and the creation of new road infrastructures.

Here we can see that users are paying considerably more than what is spent on infrastructure, and this is due to the **large amount of other intangible external costs** that toll charges aim to cover, some of which summarised as follows:

Fig. 1.18: Estimation of marginal costs and contribution associated with road usage in France in 2013
(€ cents per motor vehicle*km)

Marginal contributions	Without highway tolls [a]	4.88
	Including highway tolls [aa]	6.00
	CO_2 [b]	0.57
Marginal costs	Congestion costs [c]	0.10
	Operation and maintenance costs [d]	1.94
	Air pollution [f]	0.17
	Noise [g]	0.04
	Accidents [e]	0.02
	Total	**2.84**
Marginal contributions – marginal costs	**Excluding highway tolls**	**2.04**
	Including highway tolls	**3.16**

Source: ACEA

Notes: Specific fuel taxes (€27.1 billion) divided by the total number of vehicle*km on French roads (556 billion); one could argue that non-specific taxes, which are a function of road usage, such as VAT on types or lubricant or vehicle repairs, should be included.

(aa) Specific fuel taxes as above, plus tolls paid (6.3 billion €), divided as above by the total number of vehicle*km on French roads.

(b) CO_2 emissions of road transport (128 million t) x unit price of CO_2 (25€/t), divided by the total number of vehicle*km.

(c) Generous estimates of costs ranging from 0 in rural roads to 0.30 in downtown Stockholm and 0.81 in downtown London.

(d) Calculated from data on French tolled highways. Share of labour costs + operation costs + repairs (23%) in total receipts multiplied by total receipts (6.3 billion €), divided by number of vehicle*km on such highways (77 billion). This is a gross overestimate, since a number of these highway expenditures e.g. wages) are independent from road usage.

(e) Casualties (5,318) x unit cost of casualty (1 million €) – taxes on insurance and taxes on insurance for social security (3.1 billion €) divided by total number of vehicle*km. As argued in the text, counting accidents as a road externality is highly questionable.

(f) Official French government number for 2000; air pollution levels have declined by about 40% since 2000; air pollution costs by even more because of the non-linear dose-effect relationship; the data given here overestimate marginal costs of air pollution by a large margin.

(g) Motor vehicle noise damage is estimated to be about 1/4 of air pollution damage.

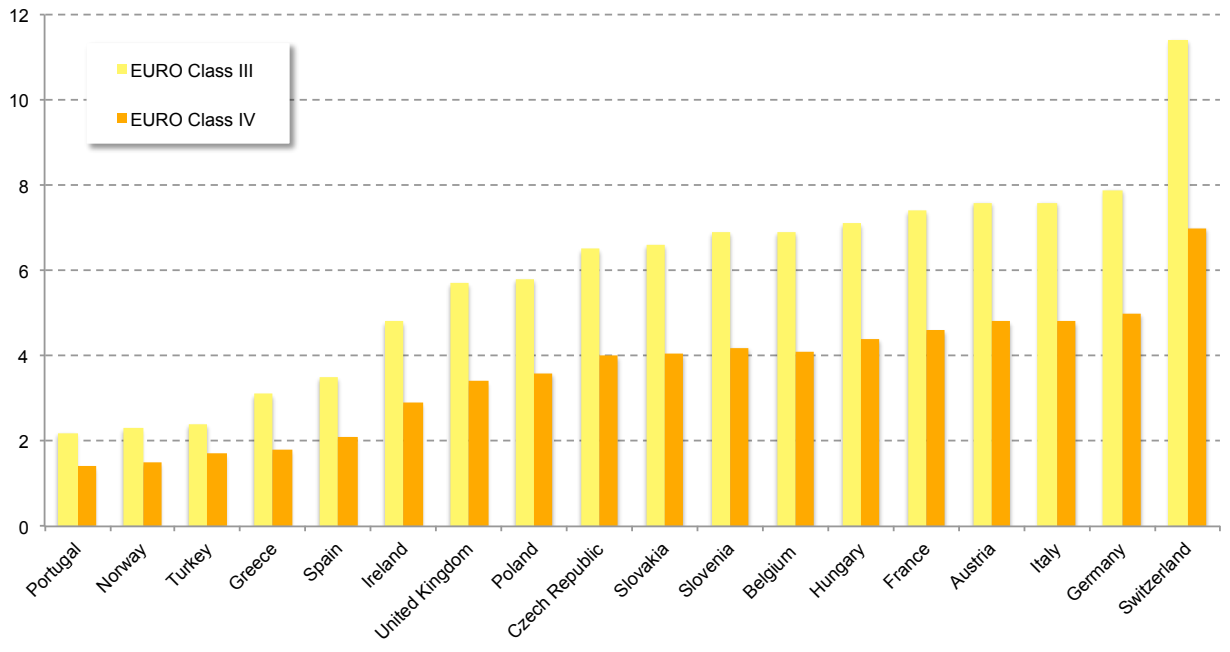
We can see estimates of the external costs that users create, most of which are difficult to measure such as the cost of noise or air pollution. Many believe that the costs to the environment is so problematic that much more should be charged, while others question how the excess money governments would receive would actually change these types of externalities e.g. how will the government compensate for noise pollution?

The graph below illustrates for one vehicle category, how the external costs of HGVs vary among countries.

It represents two of the 6 Euro classes used in Europe. Within the Euro class categories, heavy vehicles are ranked in terms of emission categories, Euro class I being the most polluting and Euro class VI being the least. The emission standards apply to all motor vehicles with a technically permissible maximum laden mass over 3,500 kg.

What is noticeable is that higher external costs are found in **landlocked countries** with **high population densities** or in **mountainous areas** where air pollution will frequently be trapped and cause extended exposure. Lower costs are observed in countries with low population densities or countries where some emission dilution over maritime areas can take place.

Fig. 1.19: Air pollution externalities of 12–14 tonnes HGVs on highways in Europe in 2013



Source: European Environment Agency

Interestingly, **all 10 countries with the highest externalities except Belgium have chosen to charge higher tolls from Heavy Goods Vehicles.** And Belgium is expected to launch its mileage-based tolling for trucks above 3.5 tonnes in April 2016. According to the Belgian Transport & Logistics Association (UPTR), the cost will be 5-8 times higher than the former vignette.

That said, EU Member States are not obliged to charge the full costs of air pollution that follow on from the formula detailed in the directive. Furthermore, Annex IIIb of the Eurovignette Directive **establishes maximum limits for the charging of air pollution** costs, and the estimates published here exceed these limits in some cases. For example, charges for road sections in mountainous areas may exceed the maximum ceiling.

The limits of the internalisation of external costs

A number of papers and modelling exercises trying to identify the impacts of internalising externalities from HGVs across Europe through RUC, showed considerable variations across regions.

Many argue that charging transport companies for their external cost impacted not only the regional economy, but also created an **imbalance between peripheral and central regions**. The peripheral areas would be hurt much more even if their accessibility was increased at an accelerated rate by a European mandate.

On the other hand, RUC can also **increase the efficiency of freight operations**, through better logistics management, shortened journey length and better utilisation of capacities. Indeed, the longer the distances are, the higher the average load factor appears to be. Thus, hauliers from peripheral countries such as Spain, Cyprus, Finland and Greece appear to have the highest load factors in international transport operations.

That said, the increase in efficiency resulting from higher operational costs is not strictly limited to road user charging, as fuel prices and competition have a similar effect.

2. Emissions reduction from traffic smoothing

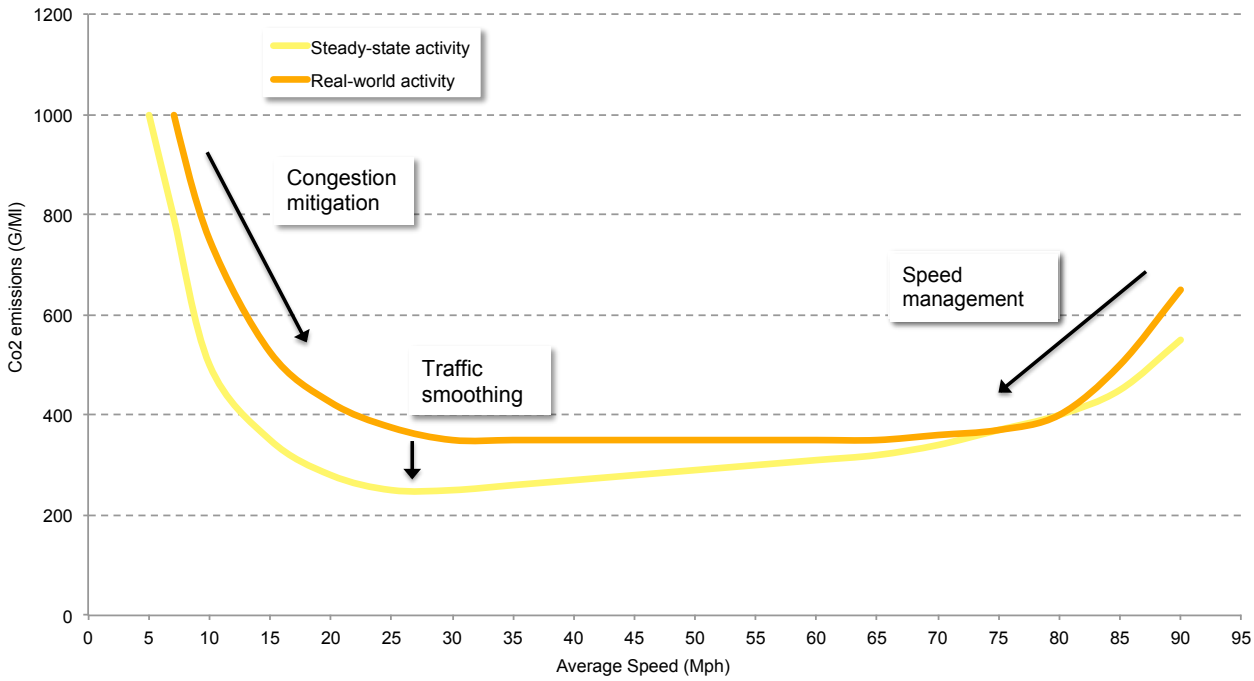
One thing that a **fuel tax cannot do** and the key reason why it is not at the heart of European road infrastructure policies is that it does not offer the potential to target congestion and environmental impacts by **location and time of day**. According to the Texas A&M Transportation Institute, the cost of congestion in the US was $121 billion in 2011.

In 2009, Barth & Boriboonsomsin have plotted CO_2 vehicle emissions versus speed, as presented in the following chart. The orange curve represents the link between emissions and speed for typical traffic conditions. The yellow curve shows the approximate lower bound of emission for vehicles travelling steadily without being affected by the traffic.

From their work, a number of results can be derived:

- At speeds below 25 mph, the vehicle is at its most polluting with emissions ranging from 1,000 to 400 g/mile. Also, if congestion reduces the average vehicle speed below 45 mph, emissions will increase since the vehicle spends more time on the road in traffic jams.
- From 30 mph to 65 mph, emissions are at their lowest at around 350 g/mile. In those speed conditions, moderate congestion will reduce emissions. Accelerating the traffic above 65 mph will increase CO_2 emissions – and make the road more dangerous.
- Above 70 mph, emissions rise more rapidly, but even at 80 mph, emissions are only 400 g/mile – **significantly less than when the vehicles are in stop-go traffic.** Also, speed reduction initiatives only have a marginal effect on CO_2 emissions.
- Overall, smoothing the stop-and-go traffic pattern and allowing cars to drive at more constant speeds will reduce emissions.

Fig. 1.20: Evolution of traffic CO_2 emissions in function of average speed



Source: Transport research at the University of California. Note: CO_2 emissions in gramme / mile.

The authors propose various techniques for reducing CO_2 emissions:

- ***At lower speeds***: **congestion mitigation** will increase average speed using congestion pricing, ramp metreing, and incident management;
- ***At mid-range speeds***: **traffic smoothing** can reduce the number and intensity of accelerations and decelerations using congestion pricing and variable speed limits;
- ***At higher speeds***: better **enforcement of speed limits** and Intelligent Speed Adaptation can be used.

Each of these strategies alone is estimated to reduce CO_2 emissions by 7–12%. All three combined could reduce them by 30%.

And, of course, road operators would need to measure and calculate the traffic's average speed.

3. National differences in introducing RUC

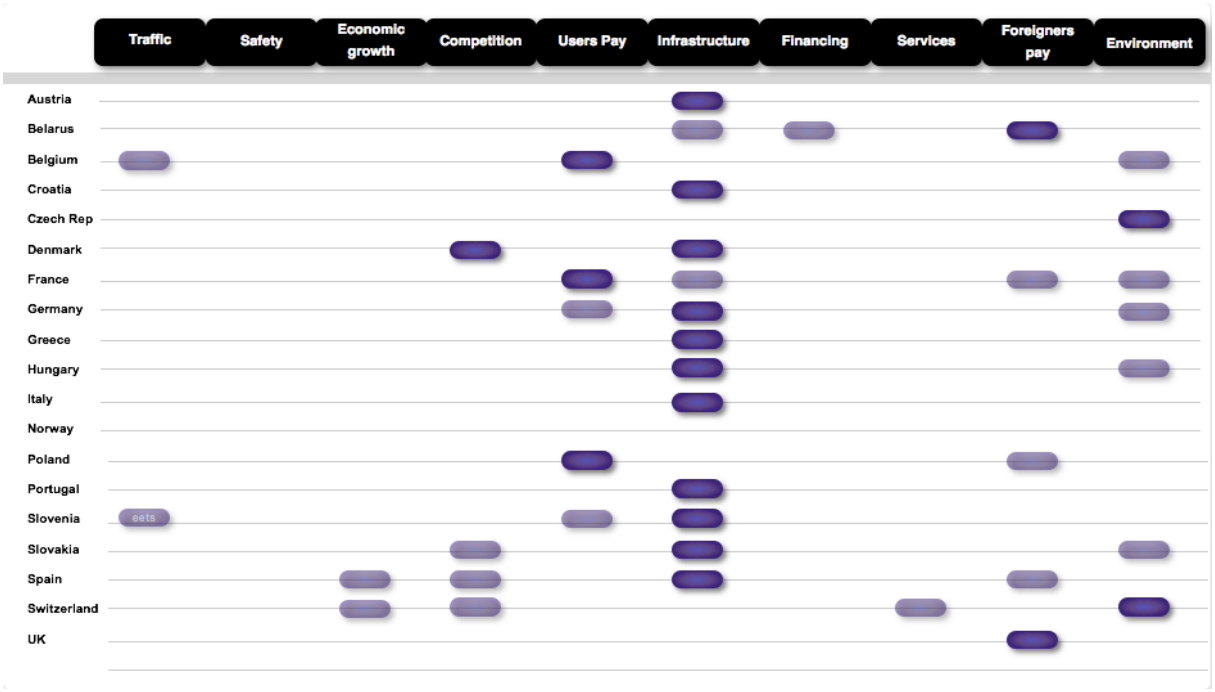
Unofficially, technology and service providers express a wide range of reasons and objectives for the introduction of new toll roads or the tolling of existing roads.

We gather hereafter the most common factors and evaluate their impact:

- **Traffic**: Improving the fluidity of the traffic and managing traffic jams;
- **Safety**: Reducing road accident rates by making roads safer;
- **Economic growth**: Creating an infrastructure that supports the growth of the logistics industry;
- **Competition**: Promoting fairness between transport modes (road, air, rail and ferries);
- **Users Pay**: Applying the "User Pays" concept promoted by the European Parliament, i.e. to change the time-based taxation to a fairer performance-based one where a user pays for the number of kilometres actually driven;
- **Infrastructure**: Financing the cost of road building and maintenance. This is supported by the public funding gaps in road maintenance, as the examples below show:
  - **In Germany**, the Daehre Kommission in 2012 highlighted a €2.5 billion funding gap per year in road maintenance;
  - **In France**, Le Cercle des Transports projected in 2012 a transport infrastructure deficit growing to €130 billion in 20 years;
  - **In the UK**, McKinsey projected a road deficit of €5 billion per year in 2011;
  - **In Poland**, a report from EY in 2012 suggested the maintenance expenditures on national roads was covering only 62% of its needs.
- **Financing**: Bringing much needed funds into the government's finances;
- **Services**: Creating a platform to introduce other services such as fleet tracking, traffic information or automatic crash notification;
- **Foreigners pay**: Making foreign traffic pay for road usage and not only the tax payer;
- **Environment**: Protecting the environment by considering the external cost of road transport;
- **Health and quality of life:** Unmanaged traffic directly reduces the quality of life and undermines the health of inhabitants. For instance, according to Greenpeace, Beijing experienced over 2,500 deaths and a loss of $328 million in 2012 as a result of pollution from fine particles pollution (PM2.5) - Without even taking into account other health effects of noise and air pollution.

Using the official documentation created by the concessions and the governmental agencies, PTOLEMUS has mapped the main arguments provided for tolling in a number of EU countries.

Fig. 1.21: National priorities in introducing RUC



Source: PTOLEMUS

Clearly in most European countries, **the financing of the infrastructure has become the most critical priority**. However, in several countries, notably in France and the UK, preserving the environment and making sure that foreigners also pay have become significant objectives.

At the other end of the spectrum, despite the fact that e-tolling has a direct effect on traffic management and congestion, these arguments have almost never been cited as primary reasons behind road charging.

D. The challenges to universal road pricing

Implementation problems in new toll programmes have become the norm worldwide. Several projects have been blocked at various stages of advancement and there are often remaining issues with projects implemented more than 3 years ago.

In many deployments, **user acceptance is an afterthought**, and it is revealing to hear countless European toll operators admitting their insufficient communication before launch was the source of many of their problems.

Besides communication, we have identified a number of **critical failure points** leading to the cancellation of e-tolling projects:

- **Public concerns** about personal data protection and disproportionate enforcement,
- **Political resilience**, i.e. the strength of the government's (and other political parties') buy-in, its mid-term stability, etc.
- **The total cost of operating the system**, especially for nationwide tolling programmes,
- **The complexity of the project**, i.e. its set up, implementation and effect on the transport industry.

Fig. 1.22: Why did a number of major lorry road charging schemes fail?

Year	State	Name	Major reasons for failure
2003	**Germany**	*LKW-Maut*	• Technical problems during the first implementation. Was delayed for 2 years
2005	**UK**	*Lorry-RUC*	• "Very expensive and overly-sophisticated system" DfT • Lack of public acceptance (several negative comments in the press)
2008	**Hungary**	*Hu-Go*	• Government internal matters
2008	**Slovenia**	*FF HGV ETC*	• Government internal matters – general elections. Re-tendered in 2011, then cancelled the tender
2010	**Netherlands**	*Anders Betalen voor Mobiliteit*	• General elections leading to a lack of government stability • Very large scope of the project leading to a high level of complexity and costs
2013	**France**	*Ecotaxe*	• Transporters' protest due to lack of communication and support by a weak government • Local protest in Brittany, one of France's peripheral regions, against the creation of numerous new taxes by the government
2014	**South Africa**	*E-toll*	• Public outcry over Gauteng's toll roads forced the government to slash toll prices

Source: PTOLEMUS

1. Clearly stating the purpose of the tolling project

The reasoning behind road charging is often unclear, or includes too many - sometimes contradictory - arguments.

They have included:

- In Portugal: "**to cover a funding shortfall**" and "change individual travel behaviour" were two unrelated arguments.
- In Germany: "**because road infrastructure needs to be efficiently used**, adequately funded and maintained by public authorities to avoid bottlenecks or missing links and control its environmental cost". This may have included too many apparently opposing concepts; how could more roads pay for their environmental damages?
- In the Netherlands: "**the need to deter non-commercial users from non-essential journeys**, especially at peak times". This resonated wrongly with anybody commuting to work.
- In the UK, the message "**make the foreign drivers pay too!**" was clear but perhaps insensitive.

These snapshots indicate too clearly how the press and all public influencers need to be briefed consistently and unequivocally about new tolling projects.

Who will pay and how the money will be used is also a message that has been mixed; appeasing public opinion by announcing no double taxation or no overall increase in the current tax burden on road transport operators suggests that only foreign transporters will pay.

But it is then impossible to claim that revenues from road tolls and usage charges should be earmarked for road transport projects, and that all modes should pay their true costs. As the UK's 2014 HGV Levy shows, the toll revenue is so low – estimated at €42.55 million per year – that it is just enough to pay for the tolling system itself (according to the UK Department for Transport)!

As most taxes, tolls bring more funds when they apply to a larger base. Thus a "niche toll" cannot be more than a temporary funding solution.

2. Privacy fears can destroy a project early

Started in 2007, the ***Anders Betalen voor Mobiliteit*** project (paying differently for mobility) in the **Netherlands** was primarily an **environmental programme**. Prepared for 4 years, its ultimate aim was to change transportation: drivers would no longer pay for owning a vehicle, but for using it.

The plan was to involve all vehicles, national and foreign. All Dutch vehicles would be fitted by a secure agent with a tracking device collecting the distance driven, the location and the time of day. The **fee calculation would be made off-board** by the agency and the payment processed by invoice. Fuel duty was not to be changed but it would replace the existing annual lump tax on vehicles. The satellite-based scheme was scheduled to have been introduced for the freight sector in 2012 and gradually extended to passenger cars by 2017.

Throughout the Netherlands, levies would be **charged by the kilometres** driven at a variable rate depending on the place and the time of the day.

The road charging scheme was to apply also to foreign HGVs, whether using the same tracking device or a secondary EETS device.

After the economic crisis and the elections in March 2010, the political context changed and there was no longer any support for such a pricing system on the national scale. Also, as the devices were **sending location at regular intervals**, people worried about the ability of the system to identify individual movements and misuse the information.

In the case of the Netherlands, it is fair to say that the complexity of the scheme, which led to a very long implementation timeline, was exposing it to political instability and the resulting loss of public support. Further, a system built on a **compulsory, unique**, "**thin client"** device should be expected to meet resistance.

3. Managing acceptance and postpay billing issues

In 2012, Portugal's roads agency failed to collect a total of €30.6 million from non-paying drivers, many of whom were repeat offenders. António Ramalho, the CEO of Estrada de Portugal, was quoted saying cars travelling without an electronic tagging device were costing as much to bill as the amount the motorists were paying for using the country's toll roads.

Currently, 29% of all fees collected from these motorways are channelled towards administrative fees, which rose from €17 million in 2011 to €42 million last year. In 2012, the overall revenue from the Portuguese Autoestrada SCUT toll concessions, plummeted by 74% from the previous year, with traffic figures dropping even further in 2013, as more and more motorists opted for secondary roads to avoid paying the toll.

Following the rescue package from the IMF/Central bank and the European Commission, Portugal was asked to finance all roads following the ***User pays*** principle.

As a consequence of the financial crisis, the Portuguese government decided to convert in 2010 and 2011 the 7 shadow-toll concessions into a real toll system, renegotiating all the existing contracts. Ascendi, one of the 4 concessionaires, switched to multi-lane free flow, triggering a public backlash over the change. Up to now, the motorways had been free and financed through a shadow toll, i.e. a variable scheme effectively financed by the tax payer. The concessionaire had imagined that the OBU would need to be mandatory, but **politically this was not possible**, firstly because of the need to give drivers a choice, and secondly to observe the right of drivers' privacy. For these reasons, the concessionaires had to offer an option for manual/post-pay.

But the problem really started with the **anonymous post-pay system**. It allowed people to pay 5 days after the trip, with payment made at a post office or a corner shop with their licence plate as a reference number. There is an additional 25 cents administration cost per trip. If the bill is not paid, it is sent to the vehicle owner's address according to the vehicle registration details, with an extra administration cost. If still unpaid, it becomes a fiscal offence (not penal), but only since 2010.

Clearly, the model was not functioning. People did not pay and it still costs more to process the first level of payment than the toll charged, because of the complexity of managing the systems' back-ends and the many stakeholders involved. The situation is better today thanks to a large number of OBUs installed and a wider acceptance.

We analyse the problems faced by early drivers on the ViaVerde network below.

ViaVerde's method of post payment is the source of many of its problems, particularly with foreign-registered cars.

Because there are no other options than automatic payment via the transponder, visitors need to rent a device linked to a **Portuguese bank account** that will debit the toll within a day or two of every passage.

If the visitor does not have a bank account in Portugal, the payment needs to be done at the Post Office or Pay Shop **within 5 days**, but no sooner than **48 hours** after each trip.

Post-pay is, however, not available for vehicles with foreign number plates. In effect, the foreign driver is asked to wait until he receives the invoice in the mail, which seemingly never happens. The solution is therefore to somehow pay before arriving in Portugal.

There are now 3 options to do this.

ViaVerde's pre-pay vending machine

The foreign driver can purchase a 3-day pre-paid pass at Post offices. It costs €20 for unlimited tolls along the whole network.

The second option is to purchase a 5-day pass where the driver needs to choose how much he pays in with a minimum of €10. The OBU is not refunded.

Since July 2012, a third option exists. Called ***EASYToll***, it enables drivers of foreign-registered vehicles to associate their number plate with a bank card for a period of up to one month, with toll charges being debited directly against their account.

In addition, ***TOLLCard*** allows users to buy a card that is prepaid with €5, €10, €20 or €40, and can be activated and linked to a vehicle licence number by sending a text message. Toll cards can be bought online, or at post offices and motorway services stations.

4. The French Ecotaxe saga

The *Ecotaxe* was a project of environmental tax levied on trucks that travel on French roads (excluding most motorways, which are already tolled under a concession regime). It was **agreed by all political parties** and major stakeholders in 2009 under the *Grenelle de l'Environment* plan.

The plan aimed at taxing the traffic of HGVs, empty or loaded, with a weight exceeding 3.5 tonnes on 15,000 km of French national (10,000 km) and local (5,000 km) road network.

Its aim was to create "a virtuous ecological circle to encourage behavioural change in favour of more sustainable modes of transport". It is also **earmarked to pay for transport infrastructure**, including rail and river transport. A third proclaimed aim was to deter empty runs and encourage carriers to rationalise their journeys since they also pay the tax.

While the environmental levy was to be paid by hauliers, the government expected that the costs would be passed on to the shippers through increases in their freight rates. This mechanism of flat-rate increase in the price of the transport service was presented to parliament in February 2013. It was then **made into law** and applied to all transport fleets. Certain French transport companies perceived this as a risk for their competitiveness, maybe because they feared that a number of foreign hauliers would not apply it - As is often the case of several social laws.

Ecomouv was the selected Toll Service Provider for the *Ecotaxe* project in a Public-Private-Partnership (PPP), after winning the tender against four other consortia:

- Alvia (led by Sanef and involving Siemens Project Ventures GmbH, Egis Projects and Atos Worldline),
- France Telecom, CS Systèmes d'Information, ETDE, Kapsch TrafficCom AG, FIDEPPP, SEIEF and DIF Infrastructure II BV,
- Vinci SA, Deutsche Telekom AG and Soc 29 and
- Billoo Development BV.

Ecomouv was 70% controlled by Autostrade per l'Italia and its other shareholders were Thales (11%), SNCF (10%), SFR (6%) and Steria (3%).

The contract was signed in 2011, **based on a 13-year and 3-month duration**, with an initial 21-month design and construction phase, followed by an operation and maintenance phase of 11 and a half years.

The awarded contract was **based on a fixed annual fee** of an estimated 20% running cost of €250 million per year, with an annual estimated yield of €1.2 billion.

This share of running costs was later seen as **very high compared to other PPPs**, where the operator's remuneration averages 2-3% of generated revenues.

In the details, the contract provided for an average annual weighted payment of €210 million at constant value – based on 2011 – excluding taxes, part of which was indexed annually, to be paid from the date of availability of the system. It was split as follows:

- €70 million, or 33.3%, for repayment of the initial investment, including the financial expenses requested by the creditors;
- €65 million, or 31%, for operating expenses;
- €51 million, or 24.3%, to compensate the Toll Service Providers (TSPs or SHTs in French) involved in the collection of *Ecotaxe*;
- €24 million, or 11.4%, for taxes and to pay equity.

As most large scale projects, the *Ecotaxe* project was affected by delays. In 2011, it was estimated that **800,000 vehicles had to be equipped** with the *Ecotaxe* OBU, including 200,000 foreign trucks. Yet in August 2013, only 20,000 had begun the registration process, necessary for the installation of the device.

By the end of 2014, Ecomouv and the SHTs had distributed several hundreds of thousands of OBUs, installed 250 mobile enforcement terminals and 180 enforcement gantries costing an estimated €500,000 each.

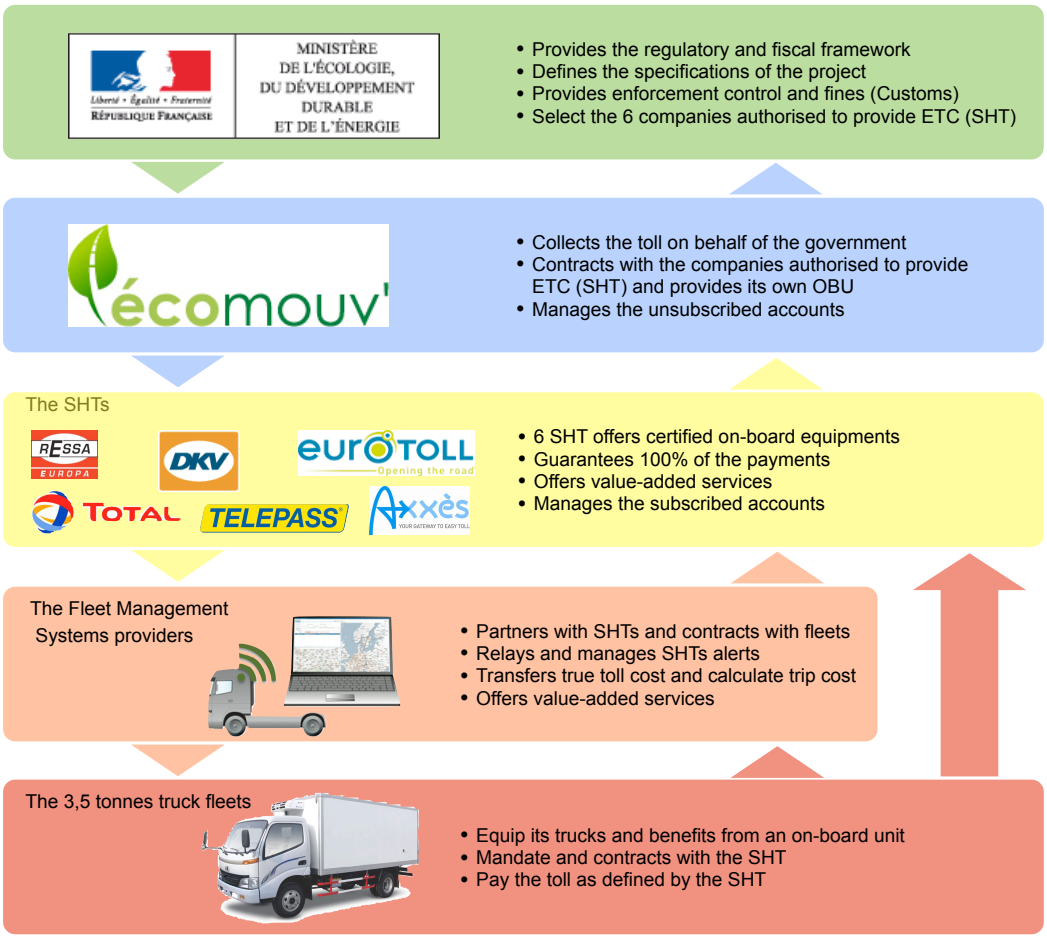
The biggest part of the installation cost – €500 million out of an estimated €600 – was financed by a banking consortium comprising Deutsche Bank, UniCredit, Banca Intesa, Mediobanca, Calyon and CDC; the rest being supported directly by Autostrade and its partners.

The price of the toll charge consisted of the distance travelled on the network chosen, a base rate depending on truck category, its Euro emission class as well as the congestion level on the regional area. Every route was split into pricing sections controlled by about **3 000 pricing points**.

By passing a pricing point, users incur by law the Ecotax for the full length of the corresponding section. Thus, the pricing involved complex RUC calculation with costs ranging from €0.088/km to €0.154/km. A number of discounts targeting certain industries and peripheral regions were also eventually included.

This was perceived by some fleets as very difficult to predict and account for their toll expenses.

Fig. 1.23: *Ecotaxe*'s complex partnership's chain



Source: PTOLEMUS

Ecomouv chose 6 companies to provide the devices, relay the information on miles driven and calculate the toll. These **Sociétés Habilitées au Télépéage** (SHTs) were the only companies allowed to provide the service. Their role was to be the first EETS providers in Europe:

- They managed the relation between the fleet and the toll chargers by providing devices and contracts.
- They were responsible for interoperability inside France but with no clear mandate or business model to provide it abroad. In fact Ecomouv had clearly stated it had mandated technical interoperability as part of its requirements but was leaving it to the SHT to negotiate with each toll chargers in Europe, as is described in the EETS model.
- They could provide the various discounts on the tolls, yet those were compensated by the **subscription the fleet had to pay to use the SHT** services.
- The subscription was offering the fleet better control over its toll expenditures, which on motorways were **comparable to the fuel cost**.
- In turn, the toll charger benefited from a guarantee of payment by the SHTs as well as an **ETC penetration rate of over 80%**.

From the start, 3 regions benefited from a reduction of the tax due to their "**remoteness from the rest of the European space**": 50% for the roads of Brittany and 30% for those of Aquitaine and Midi-Pyrénées. Subscribers using an OBU would also receive an additional 10% discount.

Nationwide, voluntary trials of the system began on 29th July 2013, involving over 10,000 vehicles and more than 15 million verified transactions.

The Brittany region was suffering from the economic slowdown, and had historically been very sensitive to changes in taxes. The **lack of clear communication** and positive reinforcement from the government led to violent protests with farmers and transporters blocking the motorways and destroying the gantries.

Brittany's transporters reaction to *Ecotaxe*: cabbages and burned tyres!

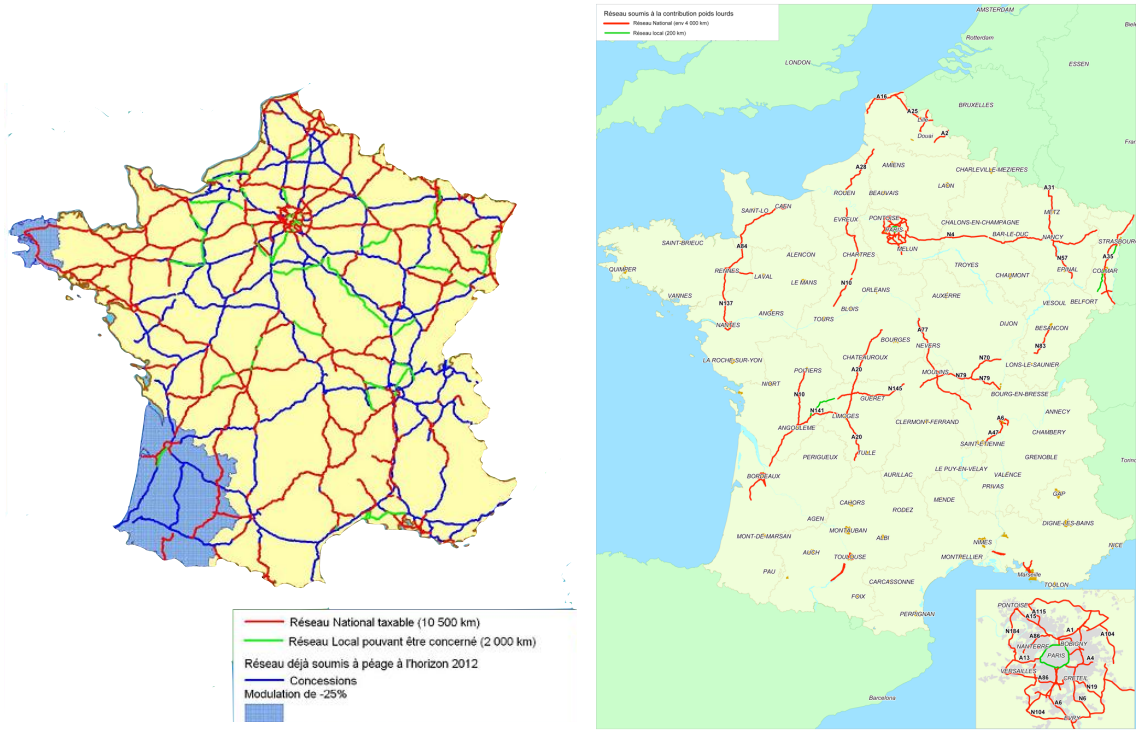
On 5th September 2013, the Ministry of Transport announced that there would be a delay in the application of the tax, previously scheduled for 1st October 2013, in order to **correct a number of peripheral aspects of the device**. Some say however it was due to the low number of contracts registered in the period from 19th July to 31st August, numbering around 20,000 and thus insufficient to permit the deployment which was then re-scheduled for 1st January 2014.

Just weeks after the announcement of this delay, France's Minister for Ecology, Sustainable Development and Energy, Philippe Martin, stated that the project would remain on hold **until the country's entire tax system had been overhauled,** and it looked like the delay would last until 2015. The minister explained that it was better to take time over introducing the tax rather than imposing it during the tough economic period France was experiencing.

In June 2014, Ecotaxe was **redrawn and rebranded** as *Eco-redevance,* replacing Ecotaxe with a much smaller programme covering only 4,000 km of national roads. The new network was aiming mainly at the highest traffic volume roads: parallel roads to motorways and the Paris regional network.

The gross income for the new project was expected to reach €550 million, compared with the previously expected €800 million.

Fig. 1.24: The taxable network for the *Ecotaxe* (left) and its scaled-down version, the *Transit Toll* (right)



Source: French Transport Ministry

However, due to more demonstrations and the risk of having most transport trade unions against the renewed scheme, another debate surfaced in the government and the parliament. After considering several options, **the French government eventually decided to cancel the tolling scheme completely in October 2014,** terminating the agreement with Ecomouv.

The effects of this decision have been significant. To compensate Ecomouv, a **€839 million indemnity package** in 10 instalments was set up over over 10 years. €403 million of this is to be paid to the consortium directly and up to 40 million euros annually will be paid back to banks. The French state was also due to pay rent of €18 million per month to Ecomouv from January 2014, which it will still need to pay. This is a heavy burden on France, which already has one of the highest public debt ratios in Europe at over 90% of GDP.

As far as the SHTs involved in the project, the consequence of the cancellation is worse for some than for others. There was a choice for service providers to either buy devices in bulk at a lower rate, or buy the devices in instalments. A number of SHTs waited to purchase the devices in instalments. A number of other service providers such as Axxès however bought the devices early on in bulk at the lower average rate. They are now **left with hundreds of thousands of devices** that they paid for and are unable to use.

SHTs could also **choose to use the Ecomouv back office**. When the project stopped, those that had bought the Ecomouv OBUs linked to its back office found that there was no option to use it. Those SHTs that invested in their own back office and OBUs can still go to market with them. They can

provide light fleet management services and tolling services on the TIS-PL network in France but also in Spain and in some cases, Portugal.

For road users, motorway tolls have since been coming under increased scrutiny, to avoid any further protesting by road users. At the end of 2014, the Transport Minister, Ségolène Royal, stated that any proposed toll increase is "unfair and inconceivable", while Finance Minister Emmanuel Macron stated that, where possible tolls must even be reduced. This is because every year toll prices have increased by around 5% to 6%, and therefore in February 2015 toll prices were frozen.

We discuss the full role of the SHTs in Section IV, as they represented the most evolved example of future EETS providers.

5. The effect of the economic downturn: the Spanish roads example

The Spanish case that we describe below emphasises another major challenge of ETC, and tolling in general: making reliable and prudent traffic forecasts or at least ensuring that the economic model can resist significant changes in the conditions.

The Spanish toll network is moribund and faces nationalisation. The economic boom that preceded the 2009 crash is mostly to blame. At the time, the economy drove Spain to break records: it had more kilometres of motorways and more commercial international airports than any other country in Europe, and was second only to China in the world for the length of its high-speed train lines.

Today, **years of low traffic volumes have forced 9 of the concessionaires to enter into bankruptcy** proceedings.

For example, **Accesos de Madrid,** who built two of the radial roads around the capital, now owes €660 million to the bank, €340 million to the builders and €400 million to residents evicted to build it. The key causal factor is the **lack of traffic**.

Between 2007 and 2013, the average daily traffic on the government tolled network decreased by 31%.

The government chose to upgrade un-tolled roads at the same time as the new tolled roads were being built. As a result, there are far too many free roads running in parallel with tolled ones, and consequently the Accesos de Madrid roads that were built to carry 35,000 vehicles a day only see 10,000 today.

In addition, the cost of displacing land owners and buying land was initially undervalued, and a number of court cases re-evaluated the cost of expropriation, in some cases, to 40 times the initial value.

The 9 concessions together own 748 kilometres of toll roads – more than a fifth of the country's entire turnpike network.

Fig. 1.25: The nine Spanish concessions that have entered bankruptcy proceedings

Domains	Concessionaire
Radial 2	Autopista del Henares (Henarsa)
Radial 3	Accesos de Madrid (Sacyr, Iberpista)
Radial 4	Accesos de Madrid (Sacyr, Iberpista)
Radial 5	Accesos de Madrid (Sacyr, Iberpista)
Madrid-Barajas, Airport, M-12	Autopista eje aeropuerto (OHL Concesiones)
Madrid-Toledo (AP-41)	Autopista Madrid Toledo (Isolux, Comsan, …)
Ocaña-La Roda (AP-36)	Autopista Madrid Levante (Cintra, Sacyr…)
Beltway around Alicante	Ciralsa
Alicante-Cartagena-Vera motorways AP 7	Aucosta

Source: PTOLEMUS

What happens with these concessions will affect the whole tolling market in Spain and abroad, because each concession is backed by the same banks and many are part of larger holding companies with international activities. If a solution is not found for them, the banks will not want to place new money in future tolling projects.

As of July 2014, the proposed solution was to agree on a way out together with the creditors and the authorities. There was a proposal on the table to create a national public concession company that will absorb the 9 concessions. The proposal would see 50% of concession holders' debt cancelled, of which more than €3.9 billion is owed to banks and another €500 million to construction companies. The state would take responsibility for €2.4 billion in debt, which includes the cost of extending the maturities. The state highway corporation would also be burdened with the debt owed to the owners of expropriated land, which could be anywhere between €1.2 and €1.8 billion.

In March 2015, the plans were confirmed and uniting these concessionaires under one publicly-owned company was decided. Obviously foreign banks do not like the proposed 50% loss, and are seeking better terms to recoup the money they lent out to the 9 toll roads.

Some toll management companies are also currently seeking compensation for the lack of vehicles using the toll roads. The Supreme Court has rejected the pleas however, ruling that traffic levels fall into the category of acceptable risk.

For road users, at the start of 2015 the **Spanish toll fees were frozen for the first time in 5 years**, as a plan to encourage more drivers to use the toll motorways and increase money for toll companies.

The example of Spain suggests that road toll projects should be motivated purely by economics and market demand, with a very stern long term view of the economy as a basis. It would have been more prudent to start by re-using, extending and upgrading the existing network using tolls, rather than build another network in parallel.

There is no bright side to the Spanish case. In both cases, the government will have to nationalise most of the roads and force out the private sector. The unused roads cannot be un-built; the cost of expropriation and the burden on the environment will only grow, and so will the cost to maintain them.

6. What can we learn from failed ETC projects?

When establishing tolling for all vehicles, the first failure points in Europe have been the feelings of unfairness and perceived loss of privacy. This has been observed in countries such as Finland, the Netherlands and the UK.

In the **UK**, the British government proposed a GNSS-based all-vehicle road user charging system in 2005. At the time, tracking technology was still **expensive and immature**, but the suggestion of a common device for all and no choice on the matter was felt as a sudden violation of privacy. The system also could not differentiate between types of cars, so SUVs would have been charged the same as city cars, generating the feelings of unfairness amongst drivers of smaller vehicles that create fewer social costs. The devices were also enormous, further fuelling drivers' **resentment at being tracked**.

In **Finland**, a similar proposal received a similar response from the drivers and ultimately from the government. The first failure of the Finish "**Fair and Intelligent Transport Working Group"** was probably to have started something that had failed dramatically already twice in Europe. Tolling has failed in many different ways but somehow the same mistakes have also been done more than twice.

High prices of toll charges can also be another issue, and this will not only affect the feedback of general users, but it can also cause the European Commission to investigate that the price charged reflects the costs incurred. In fact, in September 2013, the European Commission expressed concerns over the Hungarian authorities' launch of a new toll system. Specifically that it did not meet EU rules outlined in the Eurovignette Directive. The Commission found that the charges were disproportionate to the costs of the infrastructure, which is set as the guideline for pricing and shortly after took infringement proceedings against Hungary.

Under the directive, revenues from tolling must be spent exclusively on financing the costs of the toll collection system and the infrastructure. According to the Commission, the toll was set overly high and the model for the calculation of the toll was **not sufficiently transparent**.

Many of the programmes were described as an **additional tax**. In New Zealand, where a truck-only GNSS-based RUC programme was set up in 2012, **the charge is replacing the fuel tax**.

Success factors for RUC implementation

Based on our in-depth analysis of dozens of different ETC programmes, we would like to propose the following **12 best practices** to implement a new RUC plan.

Fig. 1.26: The 12 best practices to implement a new road charging scheme

1. **Before any decision, create a common ground of agreement by all parties** by fostering debates on the subject and ensure that a sufficient number of deep and objective economic analyses are available. This step might take years but is likely to enable a progress in the public opinion.
2. Clearly **define the aims** of the RUC programme and **communicate** them in the right way at the right time to the right people.
3. Clearly **spell out the benefits** to users: better roads, fewer traffic jams, improved road safety, fairness of charges for using the roads. External cost internalisation is not well understood, yet quite sensitive. Communicate those benefits early and widely.
4. Carefully **design the tax system structure**: balance RUC with other vehicle-related taxes and ensure the legal framework provides enough support for the enforcement to be effective.
5. **Preferably replace an existing tax** (for example, the vehicle registration tax or the vignette) than create a new one.
6. Preferably **choose the term of 'toll' rather than 'tax'**, particularly if the political situation makes it difficult to add new taxation, however sound they may be.
7. Choose the right **calculation basis**: the criteria used to calculate the toll will affect the scheme at various levels.
8. **Make the charging criteria public at an early stage** can demonstrate the purpose and value of the tolling scheme - in the case of **ViaPass** in Belgium, true GNSS mileage calculation was required from the bidders to answer the primary purpose of "charging fairly the vehicle for the road usage".
9. **Differentiate between truck and car schemes**: For example, kilometre-based charging is highly adapted to HGVs, whilst time-based charging is easier to implement for cars or wide-scale deployments initially.
10. **Keep it simple**: Adding multiple criteria might in the future allow for congestion pricing, but right now it makes the project more expensive and more difficult to interact with neighbouring toll systems.
11. **Build privacy protection** in the system from the start: allow for anonymous payment and avoid collecting superfluous data.
12. **Start small**, as road charging is a long journey and it will be better to have all parties agree on a smallest common multiple than disagree on a perfect scheme.

Source: PTOLEMUS

We also describe a set of best practices and pitfall avoidance techniques in our recommendations.

E. Impact of the transportation market landscape on tolling

TIR (Transport International Routier), i.e. international road freight is generally a low margin, volatile, and fraud-ridden industry. Its evolution affects the tolling market directly, even more so than new tolling domains affect the transporters.

In this chapter, we analyse the interactions between the two sectors, first from the perspective of the Western European countries, and then the other stakeholders.

1. Key factors affecting the transport industry

a. The advance of the CEE transporters

On 1st May 2004, the European Union experienced its largest single expansion both in terms of territory and population. It enlarged to 10 new countries, which for most of them formerly belong to the former Eastern Bloc, notably Poland, the Czech Republic, Slovakia and Hungary.

Three years later, Romania and Bulgaria also joined the EU.

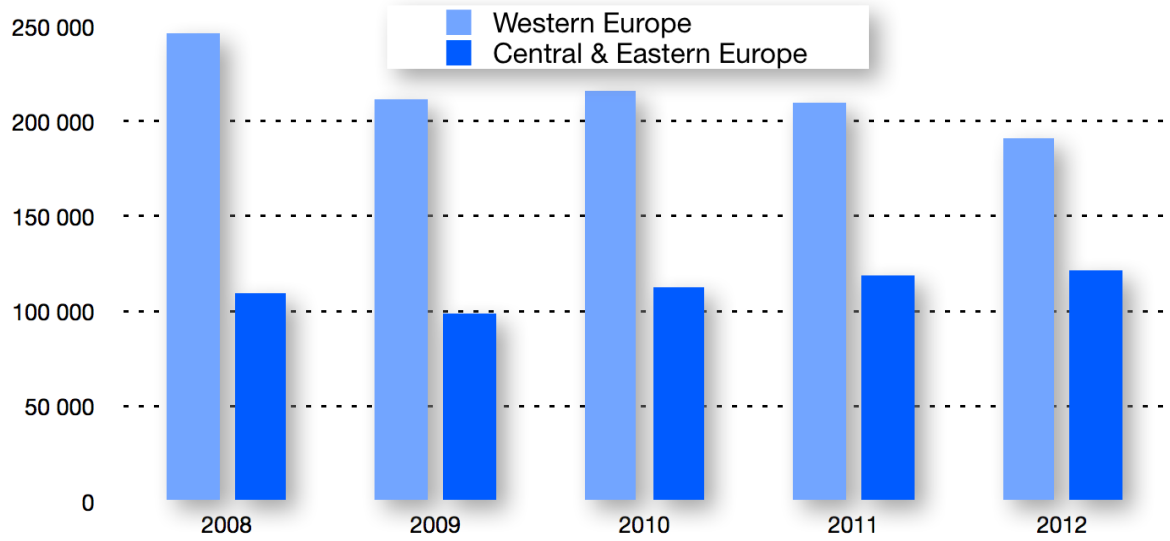
The expansion of the EU towards Central & Eastern Europe (CEE) played a fundamental role in offsetting the balance of the European international transport market.

Faced with weak demand in the domestic market, **Polish transporters** became more active on the export front from 2004. They turned first to their traditional trading partners, especially in Western Europe – already the destination for three-quarters of Poland's exports. As the demand declined in these economies, Poland began to explore new markets, particularly the emerging economies in which the middle classes were booming. The share of Polish exports to these emerging countries increased from 6.1% in 2007 to 8.7% in 2013.

In the wake of export growth to these emerging markets, Polish entrepreneurs seized opportunities presented by lower labour costs, and were able to offer competitive freight services to these markets. Poland also has a large transport fleet; at the end of 2013, there was 340 000 trucks under 16 tonnes and 460 000 over 16 tonnes in use. Road tractors dating back 10 years or less accounted for 54% of the total and we expect the park to upgrade slowly sustaining the growth in the commercial vehicle used in Poland (cf. next graph). In the transport sector, the average monthly **gross wage in 2012** was 3,134 zlotys or **€749, 11% lower than the national average**. The average cost of labour in Poland is €7.40 or more than 4 times less than in France (€34.20 per hour).

Similarly, the growth of **Romanian exports**, combined with the gradual economic recovery in the Western European countries, benefited its road transport sector and allowed the country to compete internationally, thanks to the second largest fleet of trucks in the CEE region.

Fig. 1.27: International road freight transport (in thousand tonnes)



Source: Eurostat - Note: International freight transport measured based on goods unloaded in the reporting countries

Romania has the most **attractive hourly cost in the European Union, at € 4.40**. Its production labour costs are lower than those of its neighbours, and the increase in exports mentioned earlier is directly linked to the building of new car plants locally by Dacia, Renault and Ford.

The expected recovery could favour CEE transporters in two ways: CEE countries not only supply their consumers, but they also take advantage of outsourcing opportunities and supply components and intermediary goods to other manufacturers.

In addition, Germany is experiencing strong demand for its premium-priced products from the new middle classes that are on the increase in emerging countries, **mainly in Asia**. Several of its car makers such as Volkswagen, Opel and even Porsche, which suffer from high manpower costs, have built manufacturing plants in Poland and other CEE countries.

Italy however is suffering form the economic situation and its truck park is expected to shrink further.

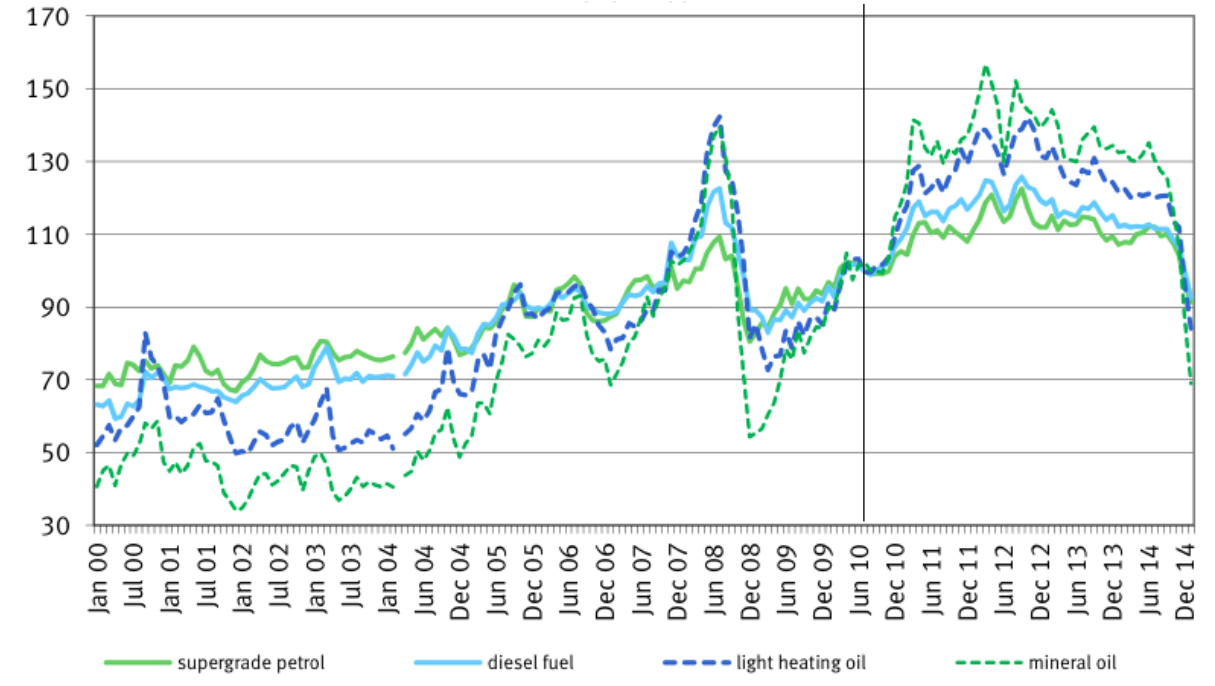
b. The economic landscape

Changing costs levels

The biggest factor affecting transport companies' margins is the cost of fuel. In fact, according to the French National Transporter Committee (CNR), **fuel represents 28% of the transporters' costs**. Between 2000 and 2012, the cost of diesel rose by an average of 4.5% year-on-year. Over the whole period, the cost of one litre of diesel has rocketed by 77%.

The recent trend has however been beneficial to the transport sector with the price of crude oil halving between June 2014 to March 2015.

Fig. 1.28: Consumer price indices for fuel since 2000 (2010 = 100)



Source: Statistisches Bundesamt, Wiesbaden 2015

Looking ahead it is also unlikely that the price of oil will rise back to $70 a barrel before the end of the year. The **US domestic oil production has nearly doubled** in the last 6 years scuppering imports from Saudi Arabia, Nigeria or Algeria who now have to compete on Asian markets. This has led to price cuts accentuated by the slow demand from the European economy. So, a positive outlook for the transporters on this cost centre.

The second highest cost for transport companies is **drivers' wages**, which account for 27.8% of the overall costs. These costs have been increasing steadily. Between 2000 and 2012, the average annual increase in remuneration for drivers in France was 2%. However the average inflation rate over the same period was 1.9%, indicating that the increase in real terms is quite low and needs to be looked at in perspective.

The proportion of tolling in total operating costs varies between countries.

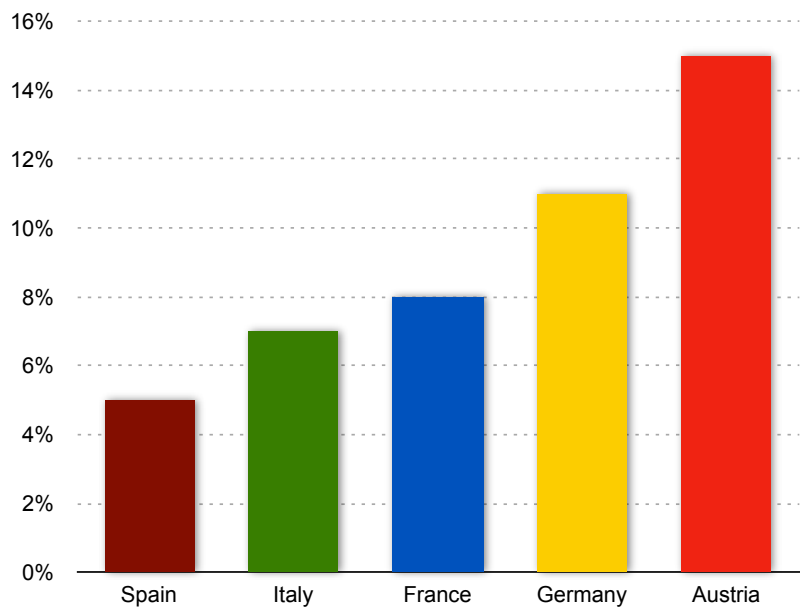
In **Austria**, crossed mostly by foreign drivers from Eastern Europe, the average toll price of €0.3 per kilometre for a Euro III 12 tonne truck is **one of the highest in Europe** and affects the fleet the most.

Fleets on German and French roads are also heavily affected.

These costs are increasingly managed and reduced by the use of **fleet management systems**, specifically affecting the fuel consumption through improvement in driving behaviour and idle time.

These systems include telematics tracking systems, fleet scheduling and dispatch systems and routing systems.

Fig. 1.29: Share of road user charges in total truck operating costs (%)



Source: B.T. Bayliss (2012)

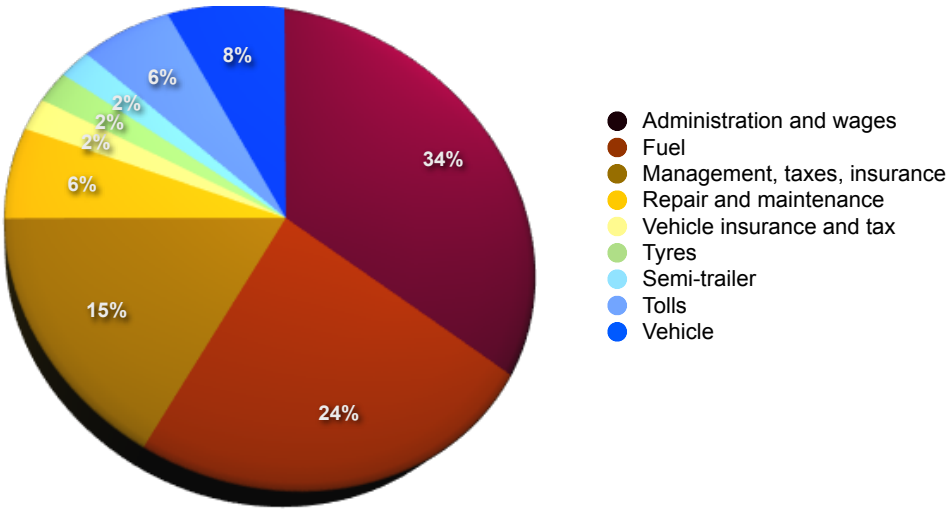
In addition, administration costs from specific service providers and maintenance costs can also be controlled by dedicated services.

For example, Waberer, the largest Hungarian transporter indicated in 2014 that it had cut fuel costs by 2-3 percent annually over the past few years, helped by a software system it developed. Thank to this tool, it has reduced the ratio of trucks running empty to below 8%, lower than the 23% average for HGVs in Europe in 2012.

On average, fuel costs have been estimated to represent 25.1% of total transport fleet costs. Vehicle costs including repair and insurance amount to 20% and the **tolls to 6.9%** although the registration process and purchase of the device will have been accounted in the overall administration costs.

A more detailed cost breakdown is shown in the pie chart hereafter for a 40 tonne truck driven 113,000 km a year on international routes. The cost of the vehicle includes depreciation and financing.

Fig. 1.30: Cost structure for a long haul 40 tonnes truck used 228 days a year



Source: Comité National Routier - April 2015

Deindustrialisation

In most Western European countries, the services sector generates more than 80% of GDP, far above industry and agriculture.

As an exception, in Germany, manufacturing still represented 30% of the GDP in 2013. The country has managed to retain a world-class industrial base that provides some activity to its subcontracting sectors, notably the road freight transport.

Services have a lower impact on transport than industry, because industrial exchanges allow physical goods to move and thus provide orders to carriers.

Thus the decline of Europe's manufacturing sector has had a negative impact on the European freight market. Less transport is required if finished products are directly imported from China, as opposed to all steps of the value chain being performed locally.

Changing demand

From the shippers' side, it is important to look at how the economy has affected the sectors that demand transport the most.

Over Europe, in 2013, the largest segment using road freight transport (by weight) was the **mining industry** with 37.9% of the weight carried by road, then was food and tobacco with 20.6%. When considering the number of kilometres driven, the first demand sector was the **food industry**, accounting for 27.9% (including agriculture and fishery), followed by the construction industry with 11%, vehicle and equipment transportation with 10%, and petrochemicals with 9.4%.

The **food industry has a very low profitability**, accompanied by a fairly high debt. This has pushed food companies to restructure, especially in the meat sector adding to the precocity of the transport sector which relies on it so much.

A general resurgence of the European economy will, of course, affect the transport sector, albeit indirectly and less visibly than a reorganisation of the vertical sector. This recovery is however uncertain and most predictions suspect it will take many years. The average growth rate prediction for Europe is 1.2% to 2018 but disparities between the Member States will directly affect the transport sector.

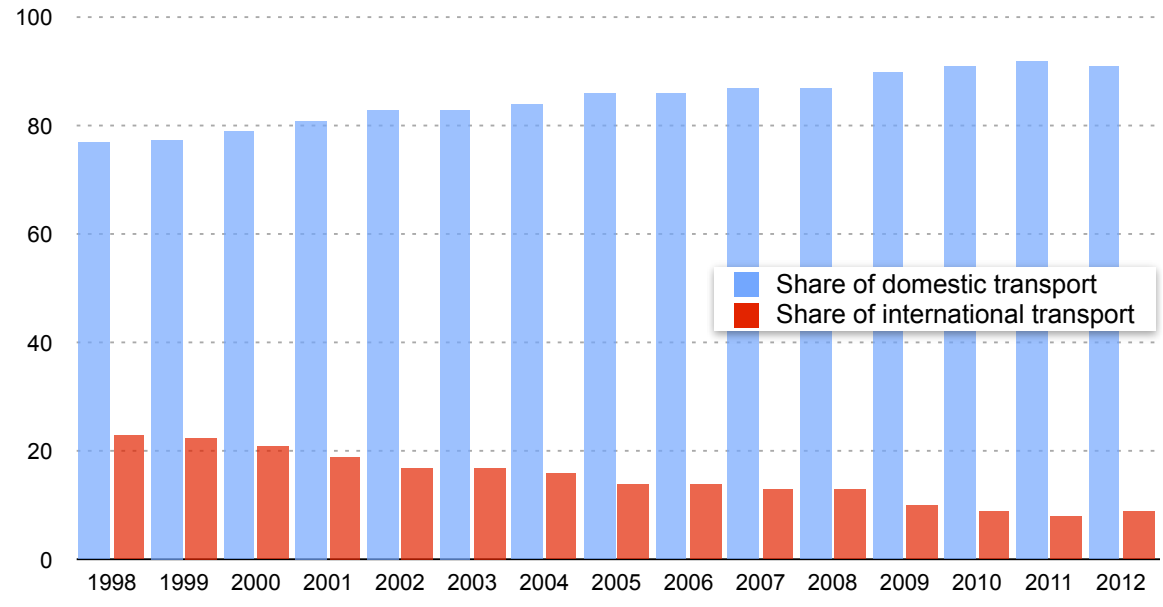
Case study: Economic background to the French transport woes

One of the characteristics of the French road transport industry is its growing **dependence on the domestic market**.

For more than a decade, the volume of international transport work of French fleets has decreased, from 23% of total transport volumes in 1998 to 9% in 2012. This trend is also evident if we consider the distance travelled during trips; nearly three quarters of trips in 2012 were shorter than 500 km. The Europe average is that only 8% of the trips are short distances.

This is largely due to the **competition from international transporters**, notably from Central and Eastern Europe. There, 56% of freight volumes are carried on distances over 300 km.

Fig. 1.31: Domestic and international activity shares of the French transport industry



Source: SOeS

This growing dependance on the domestic market has had adverse consequences in a sector that has historically always suffered from low profitability. This explains the drop in the sector's share of the French GDP from 1% in 2000 down to 0.7% in 2012. The **gross margin** of the sector has also dropped abruptly since 2008. It decreased from 16% in 2000 to **below 10% in 2011**.

Fig. 1.32: The French transport industry's focus on short-distance freight

Distance	2004	2012
Less than 150 km	27%	31%
From 150 km to less than 500 km	42%	43%
Trips under 500 km	**68%**	**74%**
500 km or more	**32%**	**26%**

Source: SOeS

It is important that the gross margin is high so that the industry is able to finance and protect itself in times of under-activity. However, **investment depreciation** is a large cost to the transport sector since trucks are expensive to finance and maintain – the National Transporter Committee (CNR) suggests that it is nearly **19% of the return cost** and rapidly increasing.

Finally the French transport sector has seen a constant rate of business creation, with 3,527 transport companies created between 2011 and 2013. Yet, while capacity has grown and the number of vehicles dropped only by 1%, activity decreased by 21% between 2007 and 2012, with the immediate effect of pushing prices down.

2. The consequences of social dumping

In Western Europe, the transport sector is affected by an unusually high level of fraud and driver abuse. The social cost of the transportation industry downturn is often hidden, but it highlights fundamental issues in the European transport regulations that do not seem to be addressed properly and which could be made worse by road charging.

We highlighted below **3 core problems from the drivers' perspective.**

Working hours

This is the biggest issue for transporters and drivers. On one side, drivers that are paid based on the number of kilometres driven or the number of loads delivered will always be tempted to work as many hours as they can in order to earn more; on the other hand, trade unions argue that the number of working hours other than those spent driving are increasing and difficult to control.

As a result, workers are unable to drive more and may not get paid for the additional work they are doing outside of driving.

The **tachograph is not solving this problem** because of tachograph fraud led by certain transporters. This has become a widespread issue, especially in Central Europe, and is undermining the safety and fairness grounds the tachograph was meant to protect.

Highly heterogeneous salary levels

The average gross monthly salary for an Eastern European driver operating in and from an EU15 country ranges between €250 and €450 (to which a fixed daily subsistence allowance varying from €40 to €45 is added). This gross salary is **7 to 8 times lower** than the salary levels paid to Western European drivers.

According to the European Transport Workers' Federation, 95% of drivers have employment contracts that entitle them to paid holidays, but in fact they are not paid for the weeks spent at home. This particularly occurs when drivers are recruited under **work organisation schemes** involving 3 to 12 weeks of work alternating with 1 to 3 weeks of time off.

Finally, employment contracts sometimes oblige drivers to pay out of their pocket for the sanctions in case of infringements of driving time and rest rules…

Disloyal employment practices

There are multiple examples of malpractices involving fraudulent companies exploiting low-paid Eastern European drivers.

For example, numerous cases of **illegal cabotage** operations were reported by the Italian trade union, FILT-CGIL, in the Marche region. A number of international transport companies based there employ drivers from Bulgaria, Poland and Ukraine who are formerly employed by "letter-box" subsidiaries set up in these countries. These drivers operate either nationally or from Italy to other European countries (but never to their countries of origin) and drive trucks that are registered in Bulgaria or Poland.

Fig. 1.33: Freight drivers' working conditions highlighted by the European Transport Workers' Federation

Source: ETF "Modern slavery in modern Europe?"

According to the trade union, through such unfair practices, these companies can offer **prices that are up to 25% lower than the minimum tariff set by the national legislation**, with subsequent disruptive effects on the market, mainly to other transport companies.

In Eastern Europe, the situation is also very difficult

It is clear that the principle of a flat rate increase of prices to compensate a new tolling charge like the French *Ecotaxe* - as seen earlier - may sometimes be difficult to apply in practice. Many transporters are not in a position to raise their prices, as the competition is too fierce. Thus any toll rate increase could be absorbed by the transporters eventually, which could lead some companies to bankruptcy.

For the transporters working in Romania, the working conditions are extremely hard. They are forced to accept the ever increasing cost of tolls. The economic situation and the competition do not allow them any leverage with their customers, and they are forced to internalise that extra cost.

We interviewed a number of fleet owners in Romania and Hungary as well as the transport association in **Romania**. They confirmed that the margins are so low that transporters had to cut on everything, **including truck maintenance and insurance**. In this climate, high risks must be taken on a daily basis. For example, a leased truck must be driven at all times to amortise its cost.

This situation has many impacts on the way they must comply with tolling schemes.

For example, **Hungary** is very important to Romanian trucks because it is the entry point to most North and West European countries. Thus the introduction of the *Hu-Go* ETC scheme has had a major impact: the **cost of driving across Hungary went from €12 to €120** when the new system was put in place.

If the truck is equipped with a telematics-enabled Fleet Management System (FMS) certified for *Hu-Go* such as those of **SafeFleet** or **Astrata**, the calculation is done by the device and the payment is made easily.

The other payment methods are altogether less practical and the risk of being penalised is high. The first way is to pay at the border, except that is not possible everywhere, depending on the route. The second way is to prepay online for a chosen route, but if traffic or an accident divert the driver off the prepaid route, there is a risk of incurring a fine.

Romanian fleets do not have the necessary solvency status for fuel cards to provide them with post-pay services. Further they need to pay in advance for fuel, which makes their cash flow problems worse.

The calculation of the **total cost of the trip** is made by the transporter. The choice of the route is, as we have seen, particularly important. In many fleets, by and large, the driver is still the one who chooses the route.

However, this is changing, and mandated routes are starting to appear, as access to cheaper and more efficient routing calculation tools becomes more prevalent.

Yet they almost never take all costs into consideration, and only the most sophisticated fleet management systems take into account most factors. As an illustration, a 2-tonne truck needs 28 litres of fuel every 100 kilometres; a 20-tonne truck requires 35 litres every 100 kilometres.

A level playing field in Europe?

Overall it seems that the **prevalence of social dumping seems to have grown in Europe**, which often threatens the sustainability of law-abiding companies.

In July 2014, Belgium's transport workers' union BTB-UBOT handed the authorities the names of 85 companies hiring drivers at rates far below the Belgian minimum wage rates.

Typically, a Belgian haulage firm would open a subsidiary in an Eastern European country which hires local temporary agency workers. They would be posted to Belgium to transport goods between Belgium and neighbouring countries for the Belgian haulage firm at rates far below those of their Belgian colleagues (€6/hour vs. €11.5). Worse, the drivers would be pushed not to observe the mandatory rest times. As they are employed under the laws of the country they come from, no social security contributions are generated to the Belgian government.

As has been observed in the resistance against *Ecotaxe*, **transporters are increasingly doubting European governments' ability to uniformly apply social and economic rules**. **The lack of a level playing field in the European international haulage market could become an additional challenge to new road pricing plans.**

But maybe the European Commission should tackle all problems at once and handle tolling, social regulations and working time regulations in a single directive that is entirely designed with the transport sector in mind.