Automated Transport Systems

Francesco Filippi
Centre for Transport and Logistics
Sapienza University
Role of Technology Exploitation

Innovative uses
Influence new business thinking
Manage technology trials – make it real
Educate, promote and disseminate
Provide personal support for stakeholders
Deliver tactical projects
Technology Exploitation Process

First evaluation
Second evaluation
Initiation
Trials
Implement
The beginning
Business Park Rivium (NL)

Operational period from 1999
Patronage 3,500 passengers daily
Peak Capacity: 500 p/h, headway of 2.5 minutes
6 Vehicles electric drive
Track Length: 1800 m with 8 stations
6 Crossings for Traffic/Pedestrians
ULTra Test Track Cardiff (UK)

Operational period from 2002

1 km test track with 2 electrical vehicles

$4M funding for the test track came from various United Kingdom governmental source.
## EC projects on ATS since year 2000

<table>
<thead>
<tr>
<th>FP</th>
<th>Projects</th>
<th>Permanent implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>VII</td>
<td>CityMobil2, CATS, CityNetMobil</td>
<td>PRT Masdar</td>
</tr>
<tr>
<td>VI</td>
<td>CityMobil, CyberC3, CyberCars2</td>
<td>PRT Heathrow</td>
</tr>
</tbody>
</table>
| V  | NetMobil, EDICT, CyberMove, CyberCars | Business Park Rivium (NL)  
ULTra Test Track Cardiff (UK)  
Floriade PRT (NL)  
Schiphol GRT (NL) |
PRT Ultra at Heathrow

ULTra system is now servicing a 1.9-km point-to-point guided track between Terminal 5 and the N3 Business Car Park.
PRT viaduct
PRT station
PRT views
Heathrow PRT is up, running, and since opening in May 2011 system of only 21 vehicles has carried 700,000 passengers with 99.7% system availability.

Heathrow PRT takes over 70,000 bus journeys off the road per year, saving over 200 tonnes of CO2 per year.

Heathrow PRT is currently completing over 5000 journeys per week.
Personal Service, Low space, High capacity

PRT takes up far less space than other forms of transit.

PRT carries as many people as a 50 seat bus every 75 s.

The lighter infrastructure means that PRT capital costs are much lower than for other systems.

<table>
<thead>
<tr>
<th>Light Rail</th>
<th>Ultra</th>
<th>APM</th>
</tr>
</thead>
<tbody>
<tr>
<td>£9-14M/km</td>
<td>£4-8M/km</td>
<td>£11-40M/km</td>
</tr>
</tbody>
</table>
The European project CityMobil

Development and demonstrations of innovative transport technologies for Automated Transport Systems (ATS):

- Cybercars (CC)
- High-tech Buses (HTB)
- Dual-mode Vehicles (DMV)
- Personal Rapid Transit (PRT)

Tests, evaluations, and comparisons performed in several cities.
ATS in CityMobil

- Cybercar
- High-Tech Bus
- Automated city car
- PRT
The evaluation objectives

What kind of transport services are ATS best suited to?
What advantages do ATS offer over conventional systems?
How would users react to ATS?
What are the drawbacks?
Will ATS be more sustainable than conventional systems?
How much do they cost?
The evaluation steps

1. Definition of the evaluative framework
2. Demonstration evaluation
3. Ex-ante evaluation of other case studies
4. Evaluation of advanced transport contribution to sustainability
Types of evaluations

**Demonstrators** are real implementations of the ATS.

**Showcases** are pilot projects aimed at disseminating ATS through dedicated events in different cities.

**Case studies** use simulations to reproduce the behaviour and performance of ATS over different urban areas.
Evaluation techniques

Implementation and measurements

City simulation and scenario evaluation

Technology testing

Survey on acceptance and quality of service
The evaluation categories

- Acceptance
- Quality of service
- Transport patterns
- Social Impacts
- Environment
- Financial Impacts
- Economic
- Legal impacts
- Technological success

Showcases
Demonstrators
Case studies
Passenger Application Matrix

PAM rows and columns are the origin-destination (OD) considered in the cities.

All the evaluations are in the PAM cells.

The cells contain the ATS studied in the CityMobil cities according to the origin-destination of the trips they cover.

The PAM provides a brief account of all evaluations and the first step for the selection of the most appropriate ATS in an OD.
<table>
<thead>
<tr>
<th>O↓</th>
<th>D</th>
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<th>3</th>
<th>4</th>
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<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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</thead>
<tbody>
<tr>
<td>1. City centre</td>
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<td>2. Inner suburbs</td>
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<td>3. Outer suburbs</td>
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<td>4. Suburban centre</td>
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<td>5. Transport node</td>
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<td>6. Parking lot</td>
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<td>7. Service facility</td>
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<td>8. Shopping facility</td>
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<td>9. Leisure facility</td>
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<td>10. Corridor</td>
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</tbody>
</table>

- with eval.
- without eval.
Demonstrator sites

Castellon (ES) with HT Bus
Heathrow (UK) with PRT
Rome (IT) with CC
La Rochelle (FR)
Showcase sites

Daventry (UK)
La Rochelle (FR)
Orta San Giulio (IT)
Trondheim (NO)
Vantaa (FI)
Case studies

Gateshead (UK)
Madrid (ES)
Sophie-Antipolis (FR)
Trondheim (NO)
Uppsala (SE)
Wien (AT)
# Example of PAM cells

<table>
<thead>
<tr>
<th>O</th>
<th>D</th>
<th>City centre</th>
<th>Inner suburbs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>City centre</td>
<td>CC (Gateshead, Madrid, Trondheim, Wien)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PRT (Gateshead, Madrid, Trondheim, Wien, Uppsala)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>DMV (La Rochelle, Orta San Giulio)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inner suburbs</td>
<td>CC (Gateshead, Trondheim)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PRT (Gateshead, Trondheim, Uppsala)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>HTB (Gateshead, Madrid, Trondheim, Wien)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CC (Gateshead, Madrid, Trondheim, Wien)</td>
<td>PRT (Gateshead, Trondheim, Daventry, Uppsala)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HTB (Gateshead, Madrid, Trondheim, Wien)</td>
</tr>
</tbody>
</table>
City centre → City centre

Case studies:
CC     Gateshead, Madrid, Trondheim, Wien;
PRT    Gateshead, Madrid, Trondheim, Wien, Uppsala;
DMV    Gateshead, Madrid, Trondheim, Wien.

Showcases:
DMV    La Rochelle, Orta San Giulio.
Indicators collected

Case studies
- Transport patterns
- Social
- Environmental
- Financial

Showcases
- Acceptance
- Quality of service
The techniques

A dynamic Land Use and Transport Interaction model MARS (Metropolitan Activity Relocation Simulator) for analysis in Gateshead, Madrid, Trondheim, and Wien.

A simulator for Personal Rapid Transit (PRT) systems PRTsim for analysis in Uppsala. Its main purpose is to serve as a testbed for PRT control systems.
Business Case Result

(B–C)/C

Scenarios
- Base + CC
- Base + PRT

Gateshead
Madrid
Trondheim
Wien
Modal share simulations

<table>
<thead>
<tr>
<th>Modes</th>
<th>Uppsala with PRT %</th>
<th>Δ %</th>
<th>Trondheim with PRT %</th>
<th>Δ %</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRT</td>
<td>20</td>
<td>+20</td>
<td>27</td>
<td>+27</td>
</tr>
<tr>
<td>Car</td>
<td>55</td>
<td>-10</td>
<td>30</td>
<td>-10</td>
</tr>
<tr>
<td>Slow modes</td>
<td>25</td>
<td>-5</td>
<td>38</td>
<td>-15</td>
</tr>
<tr>
<td>Bus</td>
<td>0</td>
<td>-5</td>
<td>5</td>
<td>-2</td>
</tr>
</tbody>
</table>
ACC at La Rochelle and Orta

Acceptance and quality-of-service indicators:

• Each indicator scored in questionnaire from 5 (completely satisfied) to 1 (completely dissatisfied).

• Indicator performance is average value of all scores provided by the interviewees.
La Rochelle and Orta

<table>
<thead>
<tr>
<th>Feature</th>
<th>Usefulness</th>
<th>Ease of use</th>
<th>Comfort</th>
<th>Safety</th>
<th>Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACC</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
Main results:

• ATS perform best in small/medium cities (e.g. Gateshead and Trondheim), with better benefits and advantageous BCR.

• PRT is more convenient than the other technological solutions for the centres of small/medium cities.
Ease of use evaluation

Average evaluation: 3.8 (results of 3 demonstrators and 5 showcases)

Heathrow PRT demonstrator evaluation: 4.6 → Highest value, good result concerning the ease of using a new PRT system

Daventry PRT showcase: 3.1 → Lowest value, due to the vehicles used in the showcase
Evaluation of PRT and CC

PRT and CC are best-performing ATS:
  • in small/medium cities as autonomous public transport in the city centre
  • as feeders for public transport where demand is spread around urban periphery

If segregated, high installation costs but high mobility benefits
If not segregated, low installation costs, but legal aspects of vehicle certification to be considered
Evaluation of HTB and ACC

HTB:
• best-performing ATS in medium/large cities on high demand corridors
• require high investment costs
• provide high social benefits and are socially viable

ACC:
• show same CC benefit as public transport feeder
• allow advanced car-sharing through innovative capabilities as automatic parking and platooning
ATS technology is mature

CityMobil has demonstrated that current technology is enough for reliable and useful applications.

But there is room for further improvement:

- Navigation can gain in precision and speed
- Obstacle avoidance in the dark and in severe weather conditions
Diffusion

Most local transport planner and politicians do not know about ATS and their advantages

CityMobil and CityNetMobil organised showcases and events to show to citizens, politicians and stakeholders that ATS is no longer science fiction
Legal aspects

Automated systems are not allowed on normal roads because a specific legal framework is missing.

In La Rochelle the vehicles circulate with an “arrêté” of the mayor.

In Rome a long certification process had to be followed.

The EC will need sooner or later to issue a Directive regulating automated driving.
Cost

ATS (though can be designed for higher capacity) are normally in the capacity range of a bus network.

But have a much higher investment costs.

A perspective of lower costs over the time but an higher initial investments nevertheless.
Implementation

Any ATS has a niche where it performs
City center of large cities: cybercars, ACC
Radial connections in large cities: HT bus
Feeder in inner suburbs and in outer suburbs: cybercars, PRT
PT service for an entire small city: PRT

They need to be part of a wide and integrated strategy with clear objectives (e.g. car-use reduction) and a variety of policy measures.

However where correctly used they can help making urban transport more sustainable even with high BCR.
Implementation barriers

Many actors decide upon city mobility and it is very unlikely they all agree upon the installation of ATS.

The success of these system often should be accompanied with strong push and pull measures.

Few want to be the first.

The success requires a change.
Masdar city
The transport vision

In its search for appropriate and sustainable transport solutions, Masdar City is piloting a Personal Rapid Transit (PRT) and Freight Rapid Transit (FRT) system of electric-powered, automated, single-cabin vehicles that offer the privacy, comfort and non-stop travel of a taxi service, and the reliability and sustainability of a public transport system.
The PRT

A shuttle 800 m long is transporting with 13 vehicles mainly students between a station and the post-graduate university, the Masdar Institute of Science and Technology.

The electrical air-conditioned vehicles have a maximum speed of 40 km/h and run on a lithium-phosphate battery, which can last up to 60 km on a 1.5-hour charge, or between 30 to 40 trips, before making quick stops at a terminal for recharge or parking overnight for a full recharge.
Main characteristics

Operational period: 2nd half 2009
Peak Capacity: 500 p/ph
Service Frequency: On-demand
Times of Operation: 24 hrs p/d, 7 days p/w
Connections: Direct (Non-stop)
Size: 10 (+ 3 Freight Rapid Transit vehicles)
Capacity: 4 adults + 2 children
Drive: Electric
PRT Masdar city
A new project – CityMobil2

45 partners

- 12 cities (Brussels, CERN, La Rochelle, León, Milano, Oristano, Reggio Calabria, San Sebastian, Saint-Sulpice, Sophia Antipolis, Trikala and Vantaa)
- 5 manufacturers (Induct, Movemile, Robosoft, ToGetThere, Yamaha),

15 M€ budget,

9.5 M€ EC funding,

48 months durations
CityMobil2 – Main activities

Implementation of 5 ground breaking demonstrations: selected out of 12 cities after completion of feasibility studies

Providing the 5 cities with 2 fleets of cybercars manufactured by 2 companies selected between 5.

Implementation of 5 showcases in 5 other cities.

Definition of the European legal framework to certify automated transport systems (EU directive proposal).

Socio-economic assessment of the wider economic effect of automated transport uptake.