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Towards advanced transport for the urban environment

**Third Yearly Report on the Progress of the Heathrow
Pilot Scheme (May 2008- April 2009)**

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Executive Summary

This report describes the progress that has been made on the Heathrow Pilot PRT system, in its third year May 2008 to April 2009. The key objective of the Heathrow demonstration within CityMobil is the implementation of a PRT (Personal Rapid Transport) system at the new Terminal 5 of London's Heathrow Airport and assessment of its performance and passenger satisfaction. The initial pilot scheme comprises of 18 (four seater) battery-electric vehicles running along 3.8km of guideway from the business car park to Terminal 5. The original timetable for construction and operation of the system was rescheduled after a review of BAA's commitments following the change of ownership of BAA in spring 2007. Although there had been some limited construction of the infrastructure close to Terminal 5 as the new Terminal was being built, full contracting of ATS for delivery of the system was not completed until October 2007. At this point construction began in earnest, and has proceeded without any serious problems and according to the original time schedule. By the end of April all the infrastructure was complete, apart from some finishing detail and general tidying up. Fourteen vehicles had been delivered to ATS for comprehensive testing at the Cardiff Test Track. The central control system had been constructed at Cardiff, and tested successfully in the control of multiple vehicles. During this year progress has been extremely satisfactory, and even though a decision was taken rather late in the process to double the frequency used for communications from 2.4 to 5.1 GHz, in order to avoid any possibility of interference with the communications system of terminal 5's automated baggage handling facility, the change was designed, tested and implemented without delaying the schedule. On April 21-23rd, an ATRA Conference on PRT was held at Heathrow, in conjunction with the CityMobil General Assembly, and delegates were able to inspect the system and see it in action with individual vehicles under autonomous control, though not yet with the multi-vehicle central control system. Delegates were not able to ride on the system because of licensing constraints. The final form of the system is described fully in Deliverable 1.2.2.2.

With the transfer of the central control system to Heathrow during June, this will begin 6 months of commissioning of the system to ensure reliability, before it opens to the public before the end of the year.

In March a survey was conducted of passengers using the current transfer bus system between the Business Car Park and Terminal 5. 304 valid questionnaires were obtained and analysed, and reported in Deliverable 1.2.4.1. An exactly equivalent questionnaire will be administered to PRT users in March 2010.

TABLE OF CONTENTS

Executive Summary	2
1 Introduction	4
2 Background	4
3 Heathrow Demonstration	5
3.1 Personal Rapid Transport systems	5
3.2 Heathrow Case Study	5
3.2.1 Timeline before CityMobil	8
3.3 Key CityMobil Milestones	8
3.3.1 Demonstration project Management	9
3.3.2 PRT system construction and integration	9
3.3.3 Quantify the benefits of PRT system performance	10
3.3.4 Assessment of benefits of a PRT system	10
3.3.5 Generalization of Results and Sustainability Analysis	11
3.3.6 Analysis and Demonstration of Communication Based Collision Avoidance	12
3.4 Current status and next steps	12
4 Summary	13
5 References	13
6 Useful Websites	14

Third yearly report on the progress of the Heathrow Pilot Scheme

1 Introduction

The Heathrow case study was selected as a demonstration project within CityMobil with the aim of investigating the effects of implementing a PRT (Personal Rapid Transport) system. Prior to CityMobil commencing, BAA, the airport owners, had committed to installing a PRT system at London's Heathrow airport in 2005. In addition the ULTra PRT system (discussed in more detail below) had been selected as the type of transport system that this innovative form of travel would take in the demonstration. Assessment of the Heathrow scheme became part of the CityMobil project in May 2006. This report provides a summary of the progress made in the Heathrow demonstration over the third year of participating in the CityMobil project (1st May 2008 to 30th of April 2009).

This report will firstly discuss the key aims of the CityMobil project and show how the Heathrow demonstration fits into this programme. It will then summarise the key components of PRT systems and introduce the ULTra system that is being implemented in the Heathrow demonstration. It will then describe the progress made in this third year.

2 Background

The Heathrow demonstration forms part of the European 6th Framework CityMobil project¹. This project has the goal of achieving a "more effective organisation of urban transport resulting in a more rational use of motorised traffic with less congestion and pollution, safer driving, a higher quality of living and an enhanced integration with spatial development" (CityMobil, 2006). This is being achieved in the project through developing concepts for advanced road vehicles, developing new tools for managing urban transport and investigating how to remove the key barriers that are currently preventing the large scale introduction of automated systems. The CityMobil project is building on the results of recent European and national projects involving automated vehicles including EDICT, CYBERCARS, CYBERMOVE and STARDUST.

The work being conducted in CityMobil to answer these questions is split into five sub-packages:

- SP1 Demonstrations and City Studies
- SP2 Future Scenarios
- SP3 Technological Issues
- SP4 Operational Issues
- SP5 Evaluation

It is in SP1 that the concepts, methods and tools developed within the other sub-packages in CityMobil are tested in a range of European cities under different circumstances. There are three demonstrations within CityMobil (Heathrow, Rome and Castellón) which are being used

¹ See <http://www.citymobil-project.eu>

to supply proof of concept of innovative transport systems integrated in the urban environment. Rome is demonstrating the feasibility, public acceptance and performance of small automated vehicles (Cybercars). Castellón is demonstrating the implementation of an automated bus system. Heathrow, the demonstration discussed in this progress report, is demonstrating a pilot installation of Personal Rapid Transport (PRT) at the new Terminal 5 of London's Heathrow Airport.

3 Heathrow Demonstration

3.1 Personal Rapid Transport systems

PRT is a fully-automated transport system using small driverless vehicles. The vehicles are automatically navigated along a network of dedicated guideways, with merges and demerges where guideways intersect, and stations are constructed "off-line" on sections of guideway parallel to the main through route so that vehicles can stop to load or unload passengers without obstructing other vehicles. Whereas conventional public transport involves waiting, multiple intermediate stops, and interchange between different service routes, PRT offers in effect a driverless taxi, providing transport on demand non-stop to the destination selected by the passenger, which can be any station on the dedicated guideway network. PRT has also been described as a horizontal elevator. Since for most passengers an empty vehicle will already be waiting at the station, or if not one will be called up automatically from the nearest available supply, there is very little waiting.

All PRT systems under current development are electric and thus (locally) emissions free. Because the electric vehicles are quiet and emit no exhaust pollutants, they can be routed through buildings where appropriate.

The system to be installed at Heathrow is "ULTra", developed by Advanced Transport Systems Ltd of Thornbury, UK. The four-seater vehicles are the size of a small car, powered by electric motors running from lead-acid batteries, with four rubber-tyred wheels running on a 2 metre-wide concrete or metal track. Batteries are recharged in the stations. Maximum running speed is 40kph, and vehicles can climb a 10% gradient and negotiate 5m radii.

The ULTra system provided the base operating parameters used in the evaluations of PRT made in the Fifth Framework European EDICT project (www.cardiff.gov.uk/edict), where desk studies were made of PRT applied at four different sites.

3.2 Heathrow Case Study

Figure 1 shows the route of the PRT system, connecting the business car park to the new Terminal 5, which opened in March 2008. This comprises of 3.8km of mainly elevated 2m wide guideway, with two parallel tracks along most of its length between car park and Terminal, as shown in the cross-section of Figure 2. There are two two-berth stations within the Business Car Park, accessed via two loops of guideway, and passengers arriving here will call for a vehicle, which they will occupy in the same group in which they arrived by car, ie with their travelling companions or alone. For the pilot, the only destination on offer at the touch-sensitive terminal in the stations will be Terminal 5, but if the Pilot Scheme is successful BAA intend to roll PRT out to serve the whole north side of the airport, and through the access tunnel to the Central Terminal Area, where the existing Terminals 1, 2 and 3 will be redeveloped into two new Terminals. At that point, the station terminals will offer a range of destination stations. Passengers returning from Terminal 5 will select the appropriate car-park station.

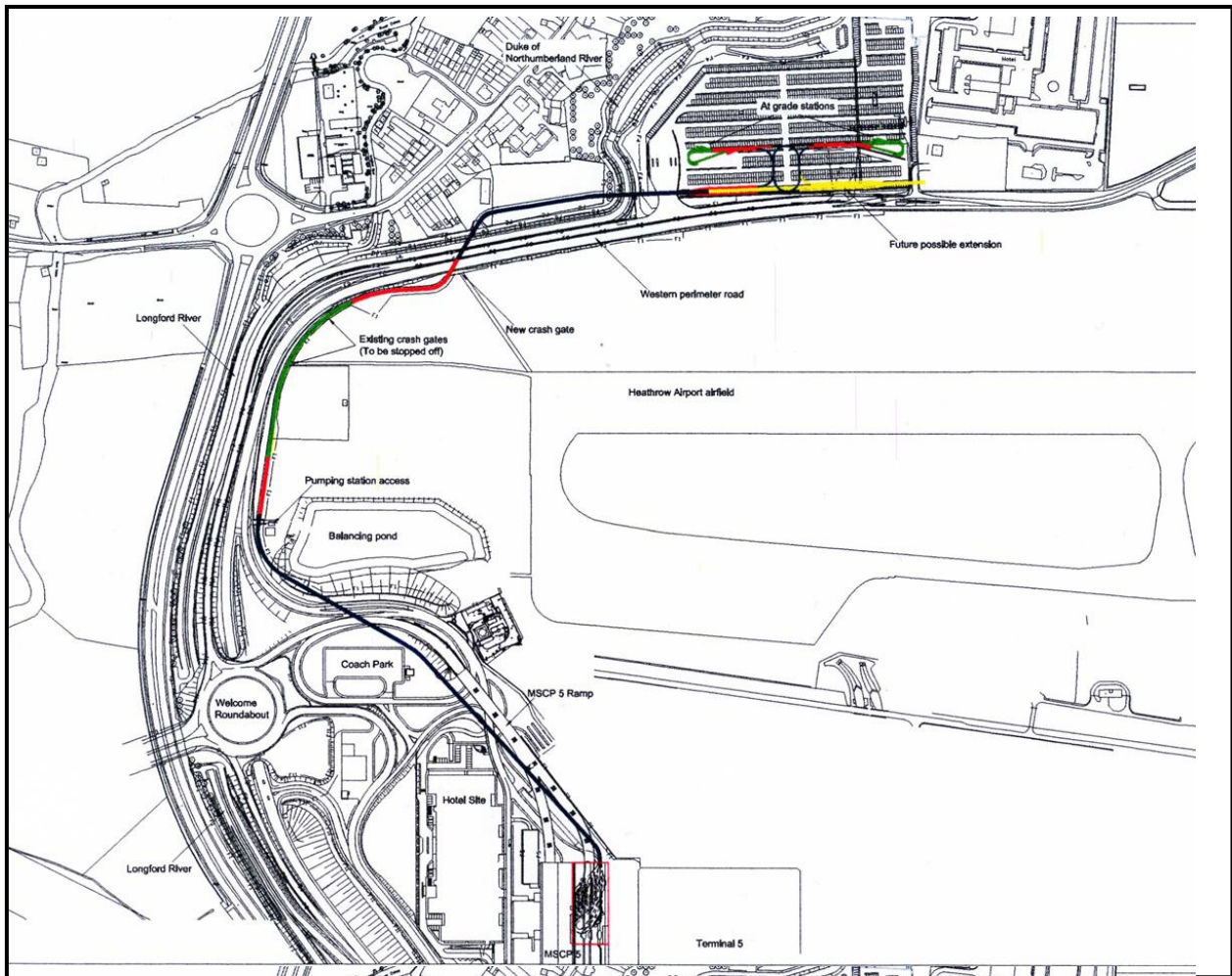


Figure 1 Route of the Heathrow PRT Pilot Scheme

Normally, there will already be a vehicle waiting in the station, and both station and vehicle doors open simultaneously to permit access to the vehicle. If not, the system will automatically call up a vacant vehicle, which will arrive within a minute or so. On board, passengers press the “start” button when ready, and the vehicle drives automatically to the station located in a multi-storey short-term car park adjacent to the Terminal building. Figure 3 shows one of the stations in the car park, with the vehicle depot alongside, while Figure 4 gives the plan of the Terminal 5 station. This contains four berths arranged in a chevron, so that vehicles travel in forwards, vehicle and station doors open simultaneously on the right-hand side, and contacts under the vehicle recharge its batteries. When loaded, the vehicle reverses automatically from its berth into the station lane, and then joins traffic in the main guideway.

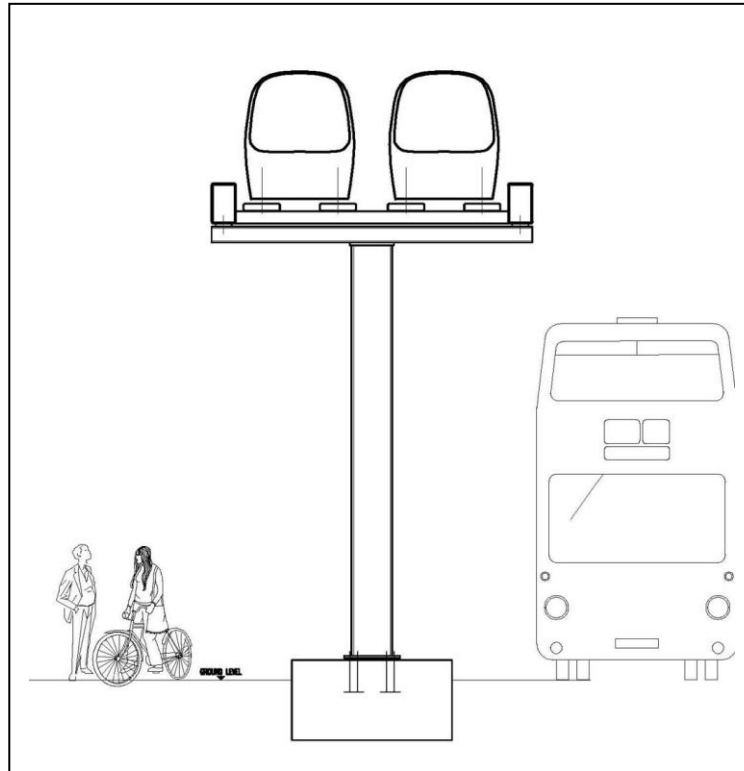


Figure 2 Cross-section of the twin-track elevated guideway



Figure 3 Station A and vehicle depot in Business Car Park

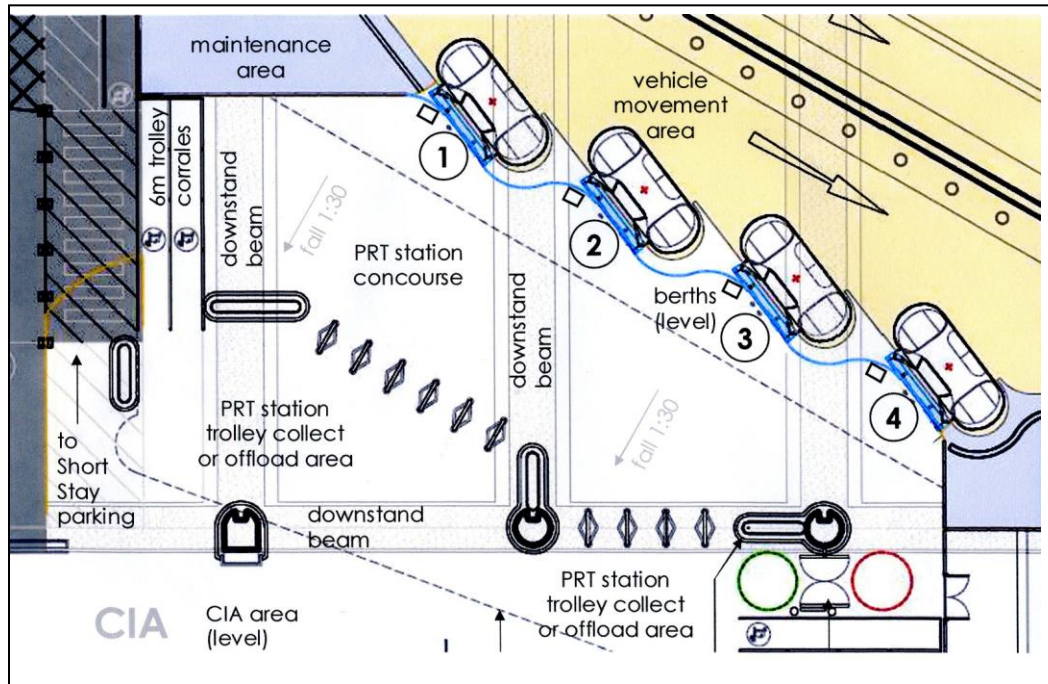


Figure 4 Station layout at in the Terminal 5 multi-storey car park

More details of the system, including the hierarchy of control systems and safety features, can be found in Deliverable D.1.2.2.2, Outline Description of the Heathrow Pilot Scheme.

3.2.1 Timeline before CityMobil

Assessment of the Heathrow project became part of the CityMobil programme in the early stages of planning for the Pilot Scheme. In 2005, BAA, the owners of the airport, had held a competition for provision of a pilot PRT system for Heathrow, and ATS were selected to provide the system. Indeed, BAA saw the potential of PRT to become a key transport system for the future, and invested substantially in ATS, providing funding for ATS to complete its commercialisation programme to move from prototype vehicles running on ATS's 1km test track in Cardiff towards a fully-designed and controlled commercial system. The latter stages of this programme took place during the first year of the CityMobil Project. At the same time, ATS and BAA were developing and agreeing an outline design of the Pilot PRT Scheme.

3.3 Key CityMobil Milestones

There are five workpackages that the Heathrow demonstration contributes towards:

- 1.2.1 Demonstration Project Management
- 1.2.2 PRT system construction and integration
- 1.2.3 Quantify the benefits of PRT system performance
- 1.2.4 Assessment of benefits of a PRT system
- 1.2.5 Generalization of Results and Sustainability Analysis
- 1.2.6 Analysis and Demonstration of Communication Based Collision Avoidance

The progress in each of these workpackages over the period 1st May 2008 to 30th April 2009 will now be described:

3.3.1 Demonstration project Management

The key outputs from this work package are the yearly reports on the demonstration progress of which this is the first report.

Deliverable	Month due	Achieved
D.1.2.1.1 Yearly reports on the demonstration progress	M12, M24	Yes

3.3.2 PRT system construction and integration

The key objective for this workpackage is to provide the PRT pilot system for the demonstration.

Deliverable	Month due	Achieved
D.1.2.2.1 Summary Specification for the Heathrow Pilot Scheme	M12	Yes
D.1.2.2.2 Outline description of the Heathrow Pilot Scheme	M36	Yes, M37

Milestone	Month due	Achieved
M.1.2.2.1 Detailed design completed by	M9	Yes
M.1.2.2.2 Initial Production of Vehicles available	M18	Yes
M.1.2.2.3 Pilot scheme operational in public use	M42	

Deliverable 1.2.2.2 describes the final design of the Heathrow Pilot PRT system, its route and guideways, stations, vehicles and control systems. The guideway runs between two two-berth stations in the Business Car Park to a four-berth station on level three of the multi-storey short-term car park alongside Terminal 5. There are 3.8 km of guideway, mostly elevated.

The original plan called for the system to be constructed during the latter half of 2007 and the first half of 2008, with commissioning through the summer of 2008 and public operation beginning in the autumn of 2008. However, BAA was taken into new ownership in May 2007, and this led to a general reassessment of BAA's commitments, including the PRT Pilot. The outcome of this review was favourable, but the process has unavoidably delayed the scheme. Although there was some limited construction of the infrastructure close to the construction of the new Terminal, the contract with ATS for provision of the system was not completed until October 2008. Changes were also made to the details of the interiors of the vehicles, and the total number of vehicles required has been increased to 18, plus two additional vehicles for ATS development work which could, if required, be made available to the system. Fourteen vehicles have been delivered, and the remainder are imminent. As noted above, the communications frequency has been changed from 2.4GHz to 5.1GHz. Overall, construction of the system has proceeded remarkable smoothly, with no major technical problems, and this is remarkable for what is the world's first installation of this novel concept. Nevertheless, what are largely institutional and organisational issues have pushed the opening date back on the original plan by about a year. The system will be commissioned during the next six months, and opened to public use before the end of the year.

3.3.3 Quantify the benefits of PRT system performance

The key objectives of this work package are to outline the anticipated benefits of the PRT system at Heathrow and to deliver a new PRT simulation package

Deliverable	Month due	Achieved
D.1.2.3.1 Identification of the key parameters affecting the passenger and operator satisfaction with the transport system and key benefits anticipated.	M12	Yes
D.1.2.3.2: Simulation of a representative version of the existing PRT system	M24	Yes

Milestone	Month due	Achieved
M.1.2.3.1: Definition of key parameters and benefits	M12	Yes
M.1.2.3.2: Simulation package available	M24	Yes

Deliverable 1.2.3.1 builds on the recommended Framework for Evaluation of the CityMobil Demonstrations proposed in Deliverable 5.1.1, to identify the main indicators to be used in the ex-post evaluation of the Heathrow PRT Demonstration. The Pilot system is not intended to be economically justified in its own right, and so the ex post evaluation will focus on the technical operation of the system, passenger satisfaction, and the costs. Nevertheless, additional data relevant to a wider socio-economic assessment will also be collected, to inform the financial and economic justification for expanding the Pilot system, and for applications elsewhere. The key parameters for the evaluation are listed in Table 1 of D.1.2.3.1, which lists the indicators which are considered to be most relevant, either directly or indirectly, to an ex-post evaluation. Each category of indicators is then briefly discussed.

The PRT micro-simulation package D1.2.3.2 was successfully developed by ATS during 2007, and made publicly available in the spring of 2008. It enables the user to build a network of guideways and stations against a map or aerial view, making one-way loops and intersections as required, and indicating the general level of demand at each station. The simulation checks that the planned network is functional, warning or advising the user where alterations should be made to overcome functional faults. The simulation then runs for a two-hour period, at a speed which can be made much faster than real time, and full and empty vehicles are seen moving around the network, off-loading passengers at their required stations, waiting empty at station berths until a new passenger group arrives, loading and then moving off to the requested station, while empty vehicles may be called up to fill vacant berths or to serve waiting passengers. The action is controlled by realistic control mechanisms and vehicle management algorithms, though these are necessarily less sophisticated than the mechanisms which would be used in ATS's own systems. The simulation has generated a good level of interest, though feedback to ATS has been rather ad hoc. There has been little effort required to support this output during the past year, but queries from users have been answered.

3.3.4 Assessment of benefits of a PRT system

The key objectives of this workpackage are :

- To assess passenger satisfaction with the Heathrow Pilot Scheme, and to identify and quantify its costs and benefits

- To assess passenger satisfaction with the alternative bus shuttle, and to identify and quantify its costs and benefits
- To compare the costs and benefits of the two transport systems, and to consider the implications for extension of the system more widely across the airport

At present the car park is connected to the Terminal by a fleet of shuttle buses. Passengers using these were surveyed in March 2009, and an exactly comparable survey will be made of PRT passengers in March 2010. Staff from BAA's own Quality of Service Monitoring team, which routinely surveys all aspects of airport services, administered a questionnaire containing 22 questions dealing with all aspects of the transfer, and obtained 304 valid replies. The survey was made over several days, encompassing a representative set of days of the week and times of day. The results were internally consistent, and the analysis was reported as Deliverable 1.2.4.1.

Deliverable	Month due	Achieved
D.1.2.4.1: Evaluation of the passenger and operator satisfaction levels for existing bus services between passenger car parks and terminals	M36	Yes, M37
D.1.2.4.2: Evaluation of passenger and operator satisfaction with the PRT system using similar metrics	M48	
D.1.2.4.3: Comparison of the ULTra PRT system with the existing bus service from the passenger and operator viewpoints	M52	

Milestone	Month due	Achieved
M.1.2.4.1: Comparative evaluation of PRT system	M54	

3.3.5 Generalization of Results and Sustainability Analysis

The key objective of this workpackage is to assess the extent to which the results may be generalised to other applications. The outputs for this workpackage are due near the end of the project but are listed below for information. No work was required on this WP in the reporting period.

Deliverable	Month due	Achieved
D.1.2.4.4: Generalization of the evaluation results of trials and studies and transfer to other applications.	M54	

3.3.6 Analysis and Demonstration of Communication Based Collision Avoidance

This work package builds on earlier work in the City Mobil project on communication based collision avoidance. The concepts developed during the earlier part of the study will be used to produce a system applicable to PRT and tested using the full scale ULTra system. Although this WP required a watching brief to be kept on the development of the communication based collision-avoidance work within the project, any substantial work is not scheduled to begin until M37.

Deliverable	Month due	Achieved
D 1.2.6.1: Specification for a communication based collision avoidance system (CBCAS) for application on the ULTra system based on the outputs of earlier tasks in the project.	M48	
D 1.2.6.2 Test and report of CBCAS using the ULTra vehicles at the Cardiff trials site.	M48	

3.4 Current status and next steps

The current status of the Heathrow demonstration in month 36 of the project is as follows:

- The guideway and stations are complete, and will be handed over to BAA and ATS formally during June. Fourteen vehicles have been delivered by ARRK Ltd, and tested at ATS's Cardiff Test track, and the remaining 6 vehicles (including two for ATS's own development work) will be available before August. See Figures 6, 7 and 8.



Figure 6: Guideway approaching T5



Figure 7: Station in car park



Figure 8 : Vehicles at Heathrow

- The control centre has been operated on test at the Cardiff Test Track, controlling several vehicles at once on the 1km figure of eight track and overseeing their entering and leaving the prototype station, with the same chevron berths as at Heathrow. This control centre, with its banks of CTV screens, has now been transferred to a location alongside the vehicle depot at station A in the Terminal 5 Business Car Park.
- The passenger survey on the transfer bus service has proved to be very satisfactory, and the same methodology will be used to survey PRT users in March next year.
- Over the next six months the operation of the system will be tested and closely monitored in all aspects. Passenger trials will begin, first with BAA staff but then with groups of the general public to ensure that the system operates satisfactorily and reliably in all situations.
- Public operations, carrying car park users to and from Terminal 5, will begin before the end of the year.
- A comparative survey of PRT users will be made in March 2010.
- A comparative analysis of PRT and bus transport will be made in spring and summer of 2010, and this will be generalised to a socio-economic evaluation of PRT.
- The collision avoidance system designed in WP12.6 will be constructed and tested during the second half of 2009 and reported in spring 2010.

4 Summary

The Pilot scheme is complete, and entering operational commissioning. Eighteen four seater battery-electric vehicles operate along 3.8km of guideway from the Business Car Park to Heathrow Airport's Terminal 5. To date fourteen vehicles had been delivered to ATS for comprehensive testing at the Cardiff Test Track, and the central control system has been constructed at Cardiff, and tested successfully in the control of multiple vehicles. During this year progress has been extremely satisfactory, and the central control system is presently being transferred to Heathrow for full operations to begin a six month's commissioning period. On April 21-23rd, an ATRA Conference on PRT was held at Heathrow, in conjunction with the CityMobil General Assembly, and delegates were able to inspect the system and see it in action with individual vehicles under autonomous control, though not yet with the multi-vehicle central control system. Delegates were not able to ride on the system because of licensing constraints. The final form of the system is described fully in Deliverable 1.2.2.2. The system will open to the public before the end of the year.

In March a survey was conducted of passengers using the current transfer bus system between the Business Car Park and Terminal 5. 304 valid questionnaires were obtained and analysed, and reported in Deliverable 1.2.4.1. An exactly equivalent questionnaire will be administered to PRT users in March 2010.

5 References

Bly P and Lawson M (2007a) Summary specification for the Heathrow Pilot Scheme. Citymobil deliverable D1.2.2.1

Bly P and Lawson M (2007b) Identification of the key parameters affecting passenger and operator satisfaction with the Heathrow Pilot PRT scheme and the key benefits anticipated. CityMobil deliverable D.1.2.3.1

Bly P and Lawson M (2009) Outline description of the Heathrow Pilot Scheme. Citymobil deliverable D1.2.2.2

Bly P and ATS M (2009) Evaluation of passenger satisfaction levels for the existing bus service between the Business Car Park and Terminal 5 in Heathrow Airport Citymobil deliverable D1.2.4.1

CityMobil (2006) Annex 1 Thematic Priority 1.6: Sustainable Development, Global Change and Ecosystems Sub-Priority 1.6.2: Sustainable Surface transport Objective 1.6.2.1:

New technologies and concepts for all surface transport modes Call identifier:

FP6-2005-Transport-4

Zlocki A (2006) 1st 6 month progress report concerning the demonstrations. Deliverable D.1.1.1

Zlocki A (2007a) 2nd 6 month progress report concerning the demonstrations Deliverable D.1.1.1

Zlochi A (2007b) 3RD 6 monthly progress report concerning the demonstrations Deliverable D1.1.1

Zlochi A (2008a) 4TH 6 monthly progress report concerning the demonstrations Deliverable D.1.1.1

Zlochi A (2008b) 5th 6 monthly progress report concerning the demonstrations Deliverable D.1.1.1

Zlochi A (2009) 6TH 6 monthly progress report concerning the demonstration Deliverable D.1.1.1

6 Useful Websites

The ATS website at www.atsltd.co.uk contains a library of documents, pictures and videos for further information.

The EDICT website at www.Cardiff.gov.uk/EDICT

CityMobil website at www.citymobil-project.eu