

EUROPEAN COMMISSION
DG RESEARCH
SIXTH FRAMEWORK PROGRAMME
THEMATIC PRIORITY 1.6
SUSTAINABLE DEVELOPMENT, GLOBAL CHANGE & ECOSYSTEMS
INTEGRATED PROJECT – CONTRACT N. TIP5-CT-2006-031315



Towards advanced transport for the urban environment

**Fourth Yearly Report on the Progress of the Heathrow
Pilot Scheme (May 2009- April 2010)**

Deliverable no.	D 1.2.1.4
Dissemination level	PU
Work Package	1.2.1
Author(s)	Philip Bly and Charlotte Kelly
Co-author(s)	
Status (F: final, D: draft)	Draft (January 2011)
File Name	Administration and coordination of the Heathrow demonstrator
Project Start Date and Duration	01 May 2006 - 31 December 2011



Executive Summary

This Report describes the progress that has been made on the Heathrow Pilot PRT system, in its fourth year May 2009 to April 2010. 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 was essentially complete by Spring 2009, though repair of minor faults and general tidying up by the contractors continued into the summer. A fault in some of the communications cabling caused extra delay in the spring, and after the control centre was transferred from the Cardiff Test Track a series of additional problems with the control communications was found to result from the change in frequency from 2.4 to 5.1GHz which had been requested by BAA in the winter of 2008-9. The knock-on effects of this change required some changes in vehicle hardware, and all problems resulting from the change were not finally resolved until late 2009. Through the winter additional vehicles were added to the operations, and comprehensively tested, until in mid-March the full complement of 18 vehicles could be operated satisfactorily. All details of stations, information signs, destinations selectors etc were completed. First carriage of passengers, beyond the ATS staff who had been riding the system periodically over the past few months, began in late March, and BAA's schedule of passenger trials started at the beginning of April 2010 with groups of BAA staff who were fully instructed in the system and what they were required to monitor as they rode it. There were intensive periods of passenger carriage on most days. So far, these trials have been to monitor system reliability and performance, and to check every detail of the system for compliance. More extensive trials with airport staff began in May.

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	11
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 fourth year of participating in the CityMobil project (1st May 2009 to 30th of April 2010).

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 fourth 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 (www.ultraprt.com/). 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 and make fuller use of PRT's flexibility to transport passengers non-stop from any station on the network to any other.. Passengers returning from Terminal 5 will select the appropriate car-park station.

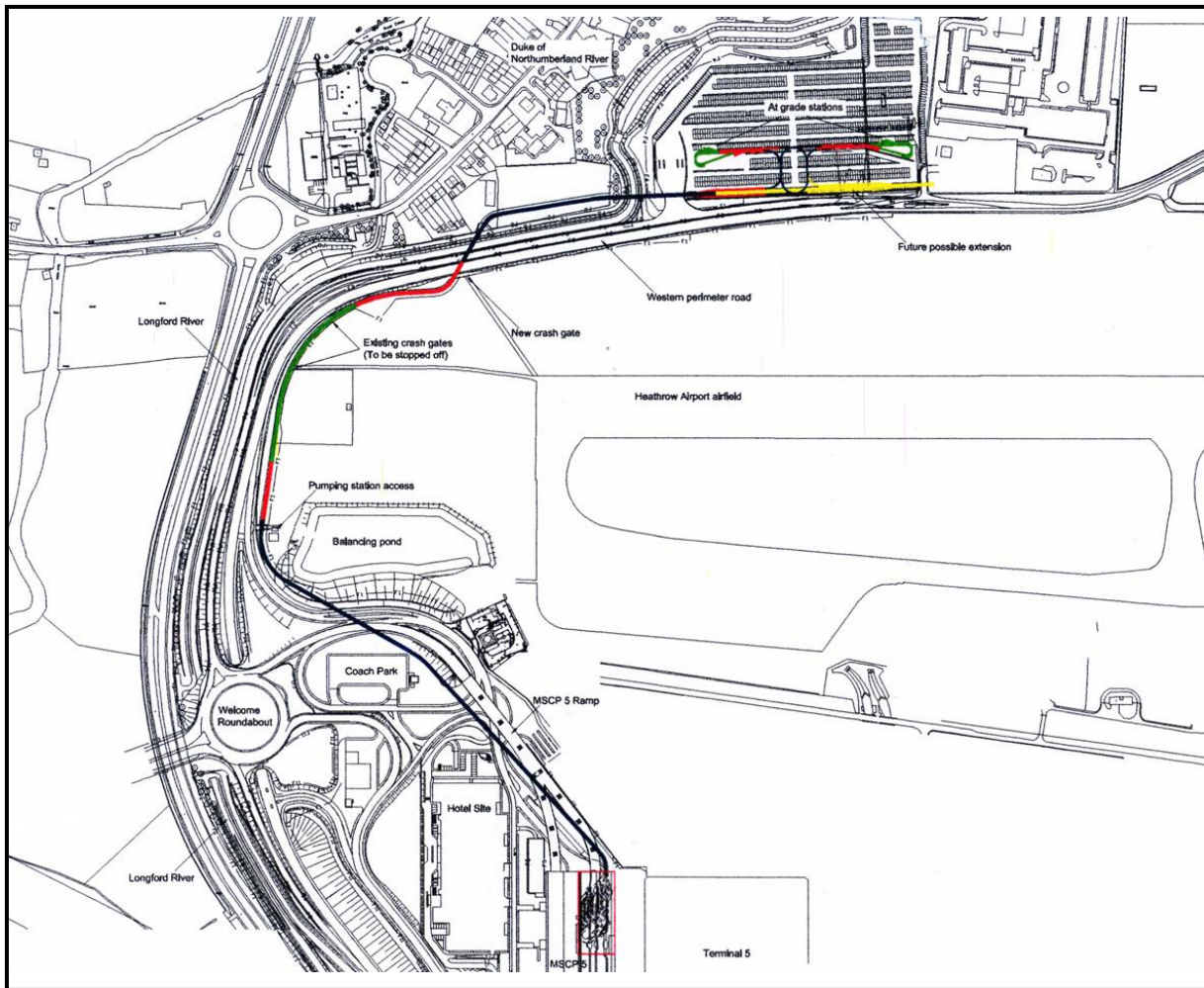


Figure 1 Route of the Heathrow PRT Pilot Scheme

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. In all of the stations vehicles travel forwards into their berth, 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 moves forward to join traffic in the main guideway

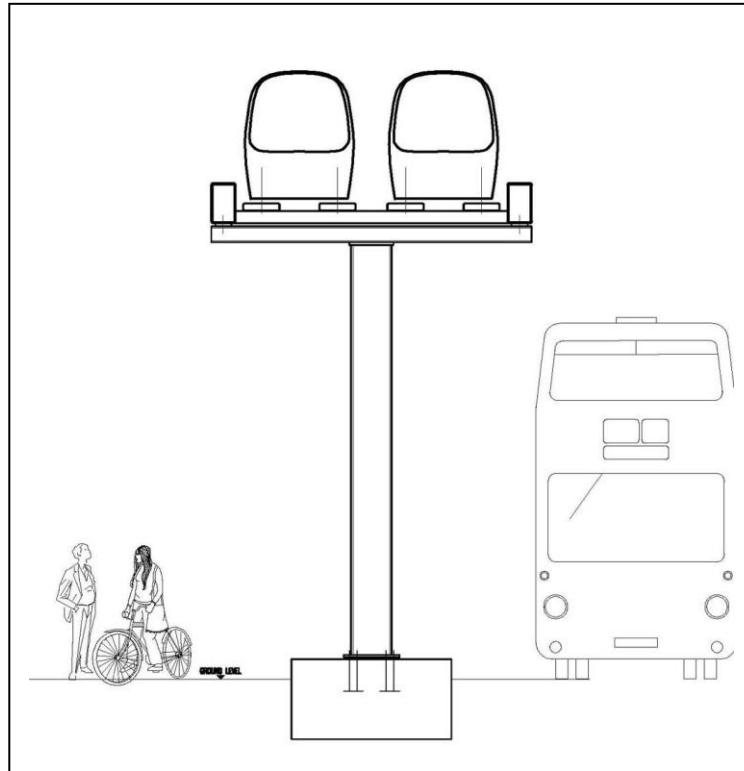


Figure 2 Cross-section of the twin-track elevated guideway



Figure 3 Station A and vehicle depot in Business Car Park

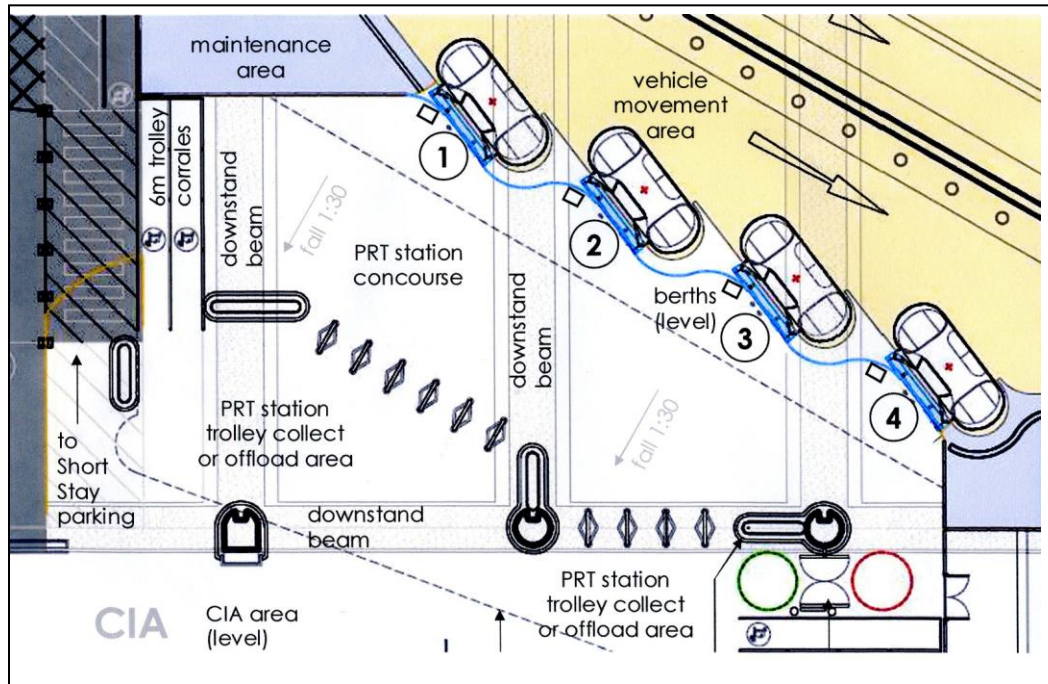


Figure 4 Station layout at in the Terminal 5 multi-storey car park

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 2009 to 30th April 2010 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 fourth report.

Deliverable	Month due	Achieved
D1.2.1.1 - D1.2.1.4 Yearly reports on the demonstration progress	M12, M24, M48	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	M58	

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 kms 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 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. Overall, construction of the system has proceeded remarkable smoothly, with none of the technical problems which might reasonably be expected in what is the world's first installation of this novel concept. Nevertheless, what were largely institutional and organisational issues pushed the opening date back on the original plan by at least eighteen months. In addition, rather late in the development work, in the autumn of 2008, BAA required that the communications frequency be changed from 2.4GHz to 5.1GHz, because it was concerned that the system might interfere with the automated baggage handling system at T5 which operated on the lower frequency. The control system was redesigned and tested on the Cardiff Test track through the winter of 2008-9, but it was not possible to test it in full multi-vehicle operation. Consequently, once the control centre was transferred from Cardiff to

Heathrow in the spring of 2009 a continuing series of problems caused by the frequency change was discovered. These proved difficult and time-consuming to resolve, necessitating changes of hardware on the vehicles, and the problem was compounded by faults in installation of some of the communications cabling. These issues were not fully resolved until the end of 2009, but through the winter of 2009-10 it was possible to add vehicles sequentially to the system until by March 2010 all 18 vehicles were operating.

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 once the system opens to the normal car park users. 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	M58	
D.1.2.4.3: Comparison of the ULTra PRT system with the existing bus service from the passenger and operator viewpoints	M58	

Milestone	Month due	Achieved
M.1.2.4.1: Comparative evaluation of PRT system	M58	

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. This assessment will incorporate the results of the Heathrow Project assessment, but it will also include relevant information on the application of PRT from other sources.

Deliverable	Month due	Achieved
D.1.2.4.4: Generalization of the evaluation results of trials and studies and transfer to other applications.	M58	

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 was not scheduled to begin until M37. Primary collision avoidance is already achieved by the way the vehicle location and control systems are designed, since they do not permit two vehicles to occupy the same time slot, but there is also a separate automatic vehicle protection system to act as a backup safety system, using sensors on the track which operate rather like railway signals. The intention of this WP is to identify ways of using the communications system itself to provide adequate secondary safety, without the need for separate sensors. D1.2.6.1 reviewed possible approaches to this technology, and recommended strategies which are currently being tested on the Heathrow system.

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	Yes
D 1.2.6.2 Test and report of CBCAS using the ULTra vehicles at the Cardiff trials site.	M58	

3.4 Current status and next steps

The current status of the Heathrow demonstration in month 48 of the project is that the system is complete in all aspects, and operating with its full complement of 18 vehicles. Vehicles are running on the system for considerable periods, and although most run empty they are frequently ridden by BAA staff and ULTra personnel. See Figures 6, 7 and 8. Various technical problems have introduced further delays of several months, for which ULTra Ltd apologises, but it should be noted that none of the problems arise from the design of the PRT system itself. It now passes into a period of close monitoring by BAA to identify any recurring faults and its reliability of operation, as part of an extended commissioning period, during which it will operate in all aspects as if it were in public operation. Airport staff will use the system regularly, and will be surveyed and asked to report on faults. BAA is very keen to ensure that the system is fault-free and absolutely reliable before it opens to the public. Only when BAA is confident of this will it permit public use. Once it has been operating for a month or so in public use we will administer the passenger survey. This will have exactly the same format and required sample size as the survey of transfer bus passengers in March 2009.



Figure 6: Guideway approaching T5



Figure 7: Station in car park



Figure 8 : Vehicles at Heathrow

4 Summary

The change in communications frequency from 2.4 to 5.1GHz, and other problems with some of the communications cabling, have delayed the project by several months. Nevertheless, as at spring 2009, the system is operating with all 18 vehicles on an almost daily basis and is regularly carrying passengers. It now enters an extended commissioning phase, in which a team of monitors from BAA will closely examine all aspects of operation, and log, and require corrections for, faults. BAA will not give permission for the system to open for public use until it is confident that it will operate reliably and without fault. Only then can we survey the passengers and compare their assessment of PRT with an exactly similar assessment of the transfer buses, as measured in the survey of March 2009. Following that the remaining evaluation Deliverables will be completed.

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

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

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

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

Zlocki A (2009) 6th 6 monthly progress report concerning the demonstration Deliverable D.1.1.1

Zlocki A (2009b) 7th 6 monthly progress report concerning the demonstration Deliverable D.1.1.1

Zlocki A (2010) 8th 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