The PRT Project
Phase 1 Design & Engineering

PRT Continued – Phase Two

Title/Name of delivery:	PRT Continued - Phase Two
Document ID:	1-AB-1-11-1.0
Version:	1.0
Date:	26.04.03
Company:	daVinci Consulting AS
Author:	Jan Magnussen
Approved by:	Hanyoung Choi
Security:	Confidential

Content

PRT Continued - Phase Two

1 Executive Summary

During the 6 weeks of Phase One we have focused on all nontrivial issues related to realisation of a commercially viable, effective, safe and environmentally friendly PRT System. The conclusion is clear: it is possible to build a competitive, safe and environmentally friendly PRT System and it is furthermore possible for the PRT JV to be the first in the world to operate a fully functional test track before end of 2003.

This report describes Phase Two of the PRT Development Project. The main targets for Phase Two are 1) to have an operational test track at Fornebu, Norway before end of 2003, 2) to pre-qualify the JV PRT System for the Fornebu project, and 3) to begin the detailed design and engineering of the real JV PRT implementation - in terms of software and hardware. Phase Two ends December 31st, 2003.

The targets are achievable provided decisions are taken swiftly and in a way that secures continuity between Phase One and Phase Two. We believe for the moment that the organisational and funding challenges the PRT JV are facing may be larger threats to achieving the targets than the technical and political challenges we are facing. WGH Ltd will not take the responsibility completing the test track, the vehicles and the station before December 31st unless they can work continuously through 2003. If the PRT JV cannot demonstrate that the JV PRT System can handle snow and ice conditions during the winter of 2003/2004 it is highly unlikely that the JV PRT System will be among the alternatives the Norwegian authorities will consider.

The PRT JV has established intermediate funding for May 2003, which means that all activities on critical path for test track will commence as planned 2nd of May. From June 1st it is then necessary to accelerate the project. The project's burn rate will increase significantly from June 1s. By then the PRT JV must be established and funded in order to secure continuity on all tasks related to the test track and the preparations for pre-qualifications and eventually tendering for the Fornebu Project.

We believe that a budget of 82 MNOK for the period from May 1st until December 31st will be adequate to achieve the Phase Two goals defined in this document. This budget does not cover the pre qualification and tendering costs for the FlyBy Consortium. In short summary these goals are:

- Complete Functional Design
- Detailed design and engineering of all mechanical components going into the test track
- A 600 m test track with two switches, one station and five vehicles
- Control System with functionality to control the vehicles on the test track
- An environmental assessment that places our PRT solution among the best transportation systems in the world
- A safety assessment that proves that our PRT solutions is as safe as, or even safer, than any other public transportation system
- Find global industrial partners, establish and fund the PRT Joint Venture
- Find partners, establish and fund the FlyBy SPC
- Pre-qualify for the Fornebu Project

- Surveying the world wide business opportunities for PRT Systems, and respond adequately not to loose out to PRT business opportunities coming up, mostly in the terms of SPC or consortium initiatives

A PRT System, like the system we have described in Phase One, is no doubt an innovation. This system has not been built before, but we know basically what we have to do to build this PRT System. Most certainly there will be surprises. We shall need to improvise and find new solutions – quickly. Most likely we will succeed, but we shall also keep in mind that the risk for not achieving what we set out to do is larger than zero, and that the degree to which all decisions can possibly be prepared with detailed documentation, is inverse proportional to the degree of innovation and novelty, as well as to speed of fulfilment.

We are asking the involved professionals to do what most large businesses will say is not possible to do in such a short time. However we know what small, competent, flexible and highly motivated teams can achieve. We believe motivated, professional enthusiasts can "move mountains". Control, bureaucracy and fear for what happens if the goals are not achieved, may become major hindrances.

Recommendations:

- Establish and fund the PRT Joint Venture before June 1st. Continuity is critical. The most critcal objective is to have an operational test track by the end of 2003
- Trust the process and the professionals involved. We need to commence immediately with the work we know from long experience that is necessary to do. The specifications and milestone plans for all the work to be done in Phase Two have been elaborated to a degree reasonable for the present stage of project and timetable. As there is no time for further detailing, the choice is really between detailed plans or an operational test track by the end of 2003.
- Use negotiated purchases from the principal suppliers of Phase One. Their know-how, enthusiasm and motivation built during Phase One are important prerequisites for Phase Two. There is no time to find, negotiate with, involve and train many new partners.

2 Introduction

This document describes the content of Phase Two. Realization risk and economic risk is controllable. This document also touches on to Phase Three, the Industrialisation Phase of the JV PRT System. Detailed planning of Phase Three is part of the scope of work for Phase Two.

This document is written for executives on a summary level and for project management at the detailed level. It is intended that this document give sufficient structure to Phase Two that this phase can be started.

2.1 Outline of this document

- Main tasks and overall schedule for Phase Two
- The Phase Two Organisation
- The PRT generic specification work
- The FlyBy specific specification work

2.2 Phase Two Ambitions

The purpose of Phase Two is to build a test track that is as close to the envisaged appearance and operation as possible. The purpose is furthermore to reduce uncertainty in terms of choice of control strategy, vehicle and guideway designs. We want to convince decision makers in the Fornebu Project – and elsewhere - that the JV PRT System is one option they need to consider seriously, and that it is highly feasible and essentially proven. During Phase Two we shall:

- Design and build a test track - start 2nd of May 2003 and end 31st of December 2003
- Design and build one vehicle prototype and 4 vehicle mock-ups which look like the real vehicles but have no interior
- Prototype the basic and necessary components of the control system in such a way that the vehicles will travel safely on the track with specified headways before 31st of December
- Establish necessary documentation for FlyBy pre-qualification and the following tendering process
- Recalculate important cost parameters, both for the generic PRT System and for the FlyBy realisation
- Begin documenting the life cycle environmental profile of the generic PRT system and its performance in relation to comparable transit systems
- Establish the safety organisation and begin working according to standards which are mandatory for organisations designing and manufacturing public transportation systems
- Plan the Phase Three, as we envisage as the beginning of the industrialisation phase and the bidding phase for the FlyBy project

Phase Two is a natural continuation of Phase One. Consequently discontinuities should be avoided in order not to loose momentum or project staffing - both administrative and experts.

In parallel with the development of the PRT System in Phase Two it is critical to complete the establishment and funding of the PRT Joint Venture. It is furthermore very important to immediately find the right partners to the FlyBy SPC and agree its shareholding and funding.

2.2.1 Functional Design

We shall provide documentation that describes on a functional level how all the main components in the PRT system will work separately and as a part of the complete PRT system. This document is a detailed follow up of the Overall System Design Report from Phase One. The functional design is the basis document for all detailed technical specifications.

The functional design will be focused as follows:

For passengers

One axis of the functional design will follow the logistics in moving people from station entrance, to platforms, to embarking, to selection of destination, travel, disembarking and finally leaving a station. All variances and options for passengers will be described.

For operators

Another axis in the functional design will follow the operator's challenge regarding maintenance of stations, guideways and vehicles - hence providing a very flexible on-demand service with virtually no waiting for passengers.

For Supervisory Control

The third axis we shall follow is that of the Control Room Operator. There will be a centralised control room where Control Room Operators survey and control the automatic operation of the PRT system. The Control Room Operators monitor flow of vehicles and intercepts if for some reason vehicles stop or queue up. The Control Room Operators also survey all the security systems, admission control systems, CCTV and on board video from vehicles if passengers have pressed the alarm button.

2.2.2 Mechanical Design

Mechanical design is concerned with guideways, rails, switches, stations, vehicles, bogies and motors. First for the test track, which will be used for verification of all important design criteria, then afterwards for the Generic PRT System.

The mechanical design is already at a fairly advanced stage. It has been achieved only through high degrees of trust, and informal and creative ways of cooperation.

2.2.3 Control Systems Design

During Phase Two we will use an Extreme Programming Technique (Prototyping) for the basic levels of the control system in order to achieve the main goal for Phase Two. In parallel with the prototyping of the control system the functional design, the architecture and the technical specifications will be developed. It is likely that the early versions of the basic levels of the control system will be completely redesigned and rewritten in later development phases. The Control System Requirement documentation shall contain the functionality required on higher control levels, levels which will not be implemented for the test track during 2003.

We have identified and are in contact with a possible supplier for the test track control software, working worldwide with software development for automation and mechatronics – at fixed price. It may also be highly instrumental for the setting up of an SPC in a second country, Sweden.

2.2.4 Protect IPR

Along the development of the JV PRT specifications, Intellectual Property issues will appear. It is critical to the JV that such values are protected, as they are an essential part of the business model.

This work must start immediately, as IP that should be protected, has already been developed in Phase One, and more will come.

A separate report on IP has been set up as part of Phase One. It recommends measures that will have consequences also for the staffing of Phase Two.

2.2.5 Build a test track

We shall build in total 600 meters of guideway and one station. The test track shall contain all curve-lengths discussed so far in the project in addition to up hill /down hill slopes where the climbing and breaking capabilities can be tested. We will build 5 vehicles and a control system. The test track is described in a separate report, ref document no. 1-BCD-5-10-1.0 Test Track.

We have identified and are in contact with possible suppliers for the physical test track. The choices of partners must be based on a mix of established relations, flexibility, speed of delivery, price, and expectancies as to future partnership in the SPC.

2.2.6 Convince local authorities

By using the test track as our demonstration facility, we shall convince the local deciding authorities for the Fornebu project, and other potential sites around the world, that the JV PRT System is the best alternative transport system when it comes to:

- Functionality
- Capacity
- Comfort
- Availability
- Safety
- Energy
- Aesthetics
- Environment
- Economy

2.2.7 Assist the FlyBy team

Interested partners for the Fornebu Project need be signed up at LOI level prior to handing in the pre-qualification documents. The FlyBy Consortium, eventually the SPC, must be established and the funding arrangement cleared before returning the tendering documents to the authorities. The Phase Two team will assist the FlyBy team in the sales process aimed at potential new partners. The Phase Two team will furthermore provide all technical documentation necessary for pre-qualification and eventually tendering for the Fornebu project.

However, it is the aim of the Phase Two that the FlyBy stream, through the more formal establishment of the full-fledged FlyBy Consortium, shall finance its own process. Nonetheless, it is clear that there will be close interrelations between the JV and the work at the SPC level, as this is necessary to open the PRT market.

2.2.8 Assist the PRT JV with the funding challenges

Establishment and funding of the PRT Joint Venture is critical for progress. Phase Two will not "take off" before the PRT JV is established and adequate funding is provided. The Phase Two team will assist the management of the PRT JV with documentation and actively during presentations to potential partners.

However, the establishment of a management for the PRT JV is not considered a part of the Phase Two and consequently not further described in this document.

2.2.9 Detailed planning of Phase Three

Phase Three commences January 2nd 2004 and is for all practical purposes a natural continuation of Phase Two. Phase Three will be planned in more detail during Phase Two.

Main objectives in Phase Three are basically:

- Win the Fornebu Project
- Complete all generic functional and technical specifications for the PRT System
- Commence industrialisation of the critical generic PRT components such as vehicles, propulsion system, guideways, control systems etc.
- Utilize the test track for experiments on control strategy, control systems, guideway design, LIM design, vehicle design and station design in order to achieve higher capacity without reducing safety.
- Seek and find significant global industrial partners for the PRT JV
- Position the PRT JV and new SPCs in other transportation project around the world

2.3 Phase Two Procurement strategy

For continuity we propose to engage for Phase Two most of the resources that were working on the project during Phase One. In addition we will selectively invite specialists in the fields where more in depth knowledge is required and where manpower need be added in order to achieve the targets. The test track we envisage as a negotiated purchase from WGH Ltd in UK. The LIMs and LIM controllers will be a negotiated purchase from Force Engineering Ltd also in UK. For these deliverables, there is no time for traditional tendering processes where one first establishes a delivery specification and then issues a request for proposals from relevant suppliers. For other deliverables, there is a little slack still for direct, fairly informal and fast negotiations.

We therefore recommend that the PRT project should be developed using the partners that already have build in depth knowledge about the technical and practical solutions.

3 Main objectives and tasks in Phase Two

3.1 Main Objectives

- Test Track operational 31st of December 2003
- Establish Competitive Position on the Fornebu Project
- Show to potential customers that we have "proven technology"and a safe, environmentally friendly and efficient solution
- Design and Engineering documentation ready in time for the FlyBy tendering process
- Find Global Industrial Partners for the PRT Joint Venture
- Establish and fund the PRT Joint Venture

3.2 Main Tasks

We assume that all tasks in the FlyBy stream, which does not involve technology, are handled in a separate project, as intended. The main tasks in Phase Two Detailed Design and Engineering are then as follows:

- Design Review – Business Opportunities, Overall System Design, Competitive Position
- Complete specification of test track
- Build a test jig in order test bogies, tyres and LIMs
- Construction of a test track
- Design and build the PRT control system
- Complete the functional description of the PRT Concept
- Begin the detailed design and engineering of all generic PRT components and PRT related systems which will be necessary for the Fornebu tendering process
- Safety Assessment
- Life Cycle Assessment (Environmental) - EPD - Ecodesign guidance
- FlyBy specific design and engineering
- Detailed planning of Phase Three
- Business proposal for the FlyBy SPC
- Business proposal for the PRT Joint Venture
- Find and convince potential global industrial partners
- Find and convince potential FlyBy partners

The objectives and tasks ahead represent significant challenges for the people involved, who are actually going to do the work, and for the investors who are actually going to provide funding for the project.

4 Phase Two Organisation

Phase Two is a large development project, probably close to 11 MUSD (82 MNOK). Phase Two will in periods probably engage as many as 100 persons, if we count key personnel in the project staff and all personnel out in the sub suppliers and their sub contractors. We need an extremely professional project management, with the necessary delegated discretional power, to secure timely deliveries of high quality products and at the same time avoid cost overruns.

4.1 Partner Philosophy

The basic philosophy is always to use "fewer and better people" - the best we have found when decisions must be made - regardless of where we can find them. We advise as little as possible political influence from the PRT Joint Venture partners in order to ensure that we always have the best people for the tasks at hand. Phase Two is a challenging project that needs 100% dedication and focus from all its participants.

In summary, for Phase Two we envisage the following partners to work in the teams with responsibility area as indicated:

- LogistikCentrum AB on control strategy
- Kitron AS and/or possible Noventus AB on control systems development. The team is likely to be supplied with experts from other companies
- WHG Ltd on test track infrastructure and vehicles
- Force Engineering Ltd on LIMs and LIM controllers
- Kitron AS, together with TDI Ltd or similar on vehicle cabin design. To be decided during May
- Expert staff - not decided, must to some degree be continued from Phase one. To be decided during May
- Safety assessment from Veritas together with experts from the Norwegian Railroad Authorities and Korean Railroad Research Institute
- Environmental Assessment - LCA, EPD and Ecodesign guidance from Østfold Research Foundation
- Information, communication, ticketing, ERP, CRM systems from Posdata, Telenor Connect or similar, to be decided in May
- Project management basically to be continued with PM from POSCO and Jan Magnussen as Deputy Project Manager
- Project staff - document control, QA, procurement, contracts etc, to be recruited, decided in May
- Interconsult AS will be engaged for the detailed engineering of the site-specific details for the Fornebu test track.
- Interconsult AS will be engaged for the detailed engineering of the site-specific details for the Fornebu project, i.e. belonging to the FlyBy stream.
- BBU will be engaged for tender work and lobby, i.e. belonging to the FlyBy stream. BBU will also be involved in the search for partners to the FlyBy SPC.

Again it is important to note that there is absolutely no time to introduce new partners on activities along the critical path for most important milestones.

4.2 Steering Committee

We assume that the Steering Committee consists of top executives from the PRT Joint Venture partner companies. We assume furthermore that the Steering Committee meets regularly and decides swiftly on issues of importance for progress in the project.

4.3 Project Management

We propose little changes in the project management from Phase One. We do however propose that a resource for Business Development is added. We envisage the need for improved business organisation and documentation, a Business Prospectus, in order to attract global industrial partners.

- Project Manager from Korea, Mr. Hanyoung Choi
- Business development and liaison for bridging cultures in a true global environment, Mr. Einar Flydal
- Deputy Project Manager from Norway, Mr. Jan Magnussen
- Business Development for the PRT Joint Venture, to be decided in May
- Sub Project managers
    - Mr. Erik Hardeng, control and information system
    - Mr. Andrew Howarth, test track

4.4 Project staff

Project staff needs be increased in order to ensure the tight management and control a project of this magnitude needs and deserves. The staff must be strengthened in the areas of contract handling, document control and quality assurance. We believe tight management and strict project routines are necessary to secure progress and budget control.

- Accounting
- Progress reporting
- Administrative Issues
- Contract handling
- Managing Intellectual Property Rights (IPR)
- Negotiations
- Change order handling
- Invoice Control & Payments
- Quality Assurance
- Delivery Control
- Document Control
- LAN, WAN, Co-operation tools

Probably the most important resource to join the team immediately will be a person dedicated to contracts. We shall probably during May and June negotiate some 20 contracts. It is of utmost importance that the annexes precisely define terms and deliverables.

Some contracts will be multi million NOK contracts. The negotiations and delivery specifications will be a tough challenge.

4.5 Sub Contractors for test track

In general we shall use "negotiated purchases" from the partners who was working on the project in Phase One.

4.5.1 Mechanical

We believe that it is important that those companies and persons that so far have been responsible for design of the solutions we are presenting after Phase One, also continues in Phase Two.

Guideways

- Design and engineering, WGH Ltd
- Construction at site, to be decided in May, a clear candidate is Kvaerner Heureka
- Site preparations, to be decided in May
- Foundation, to be decided in May
- Mounting, to be decided in June, a clear candidate is Kvaerner Heureka
- Electrical, to be decided in June, a candidate could be Telenor owned Bravida

LIMs

- LIMs, Force Engineering Ltd, UK
- LIM controllers, UK sub suppliers or maybe POSCON, to be decided in May

Station

- Station will be a part of the delivery from WGH Ltd.

Vehicles

During Phase Two we shall build one vehicle prototype that shall appear as close to the real vehicle as possible and have the on board functionality we expect in the finished product. In addition we shall build 4 Mock-Ups. The Mock-Ups will probably be built in fibreglass and only be hollow shells on real bogies.

Vehicle exterior

- Design, Kitron and others
- Prototype construction, part of delivery from WGH Ltd
- Mock-Ups, part of delivery from WGH Ltd

Vehicle interior

- Prototype will be part of delivery from WGH Ltd

Bogies

- Prototype will be part of delivery from WGH Ltd

4.5.2 Control Systems

- Probably an expert group with Kitron in lead position or a turnkey fixed price delivery from Noventus or similar organisation. Experts could come from POSCON, Kongsberg Defence, Siemens, SAAB, Sintef or similar. **NB: For reasons to do with a possible establishment of a PRT Consortium at Kungens Kurva, Stockholm, this must be decided in late April!**
- Control Systems Group shall be located and organised tightly close to the Fornebu test site
- Sub suppliers on sensors are not yet chosen and will be selected after detailed engineering of important control system aspects during May.

4.5.3 Expert Group

An expert advisory group will still be needed in order to heed the business landscape and solutions to the technical challenges we still will be facing, and – not the least – to overview the interconnections between the various sub-projects. We propose basically to continue with the same experts that were involved in Phase One. These experts now have their strengths in over viewing the general system specifications, and are needed to bind together the specialists' works and in depth expertise.

- Jin S. Lee
- Ingmar Andreasson
- Jan Even Evensen
- Nils Jacob Berland
- Representatives from POSDATA, POSMECH and POSCON

4.5.4 Information Systems

Information Systems comprises systems like:

- Public Information
- Ticketing
- Security & Surveillance
- Maintenance
- ERP
- CRM
- Back Office
- Management Information
- Data Warehouse

In May we need to appoint a consulting company to take responsibility for functional descriptions, architectural design and establishment of RFPs (Request for proposals) to potential software companies. There are several are possible choices.

4.5.5 Life Cycle Assessment - EPD - Ecodesign

We shall continue the work we started in Phase One on the assessment of Life Cycle environmental impacts of the proposed PRT system. A full Life Cycle Assessment of the PRT system shall be performed according to ISO 14040-43 and an Environmental Product Declaration shall be published for the PRT system. The PRT system shall also be compared, from an environmental point of view, to the competition from other light-rail and monorail systems as well as to trains, trams buses and cars.

This research – as well as assuring the attention to environmental related questions in the design and development process - will be conducted by Østfold Research Foundation and be an ongoing activity for as long as the PRT system is under development. This research can for evident reasons not reach its final conclusion before the first real PRT system is put into operation. We also believe that this research shall be conducted in a way that attracts interest at significant scientific conferences in 2004.

4.5.6 Safety Assessment

Safety planning and assessment is critical for the authorities' acceptance of the PRT System. We propose to continue together with Det Norske Veritas, but we will supply the team with experts with high credibility from the Norwegian Railroad Authorities as well as consult the KRRI (Korean Railroad Research Institute). We believe that this proposed organisation will prevent the wrong attitudes from building within the organisations that finally shall approve the PRT system for commercial operation. We also believe that their practical experience will be invaluable to the design of safe systems. We must consider if we shall engage our own safety staff and have Veritas and KRRI in the independent assessor role, or if we shall outsource the complete safety assessment to Veritas and find another independent safety assessor like the KRRI or other.

5 PRT Generic Specifications

The PRT Generic Specifications to be made in Phase Two, comprise all specifications that make up the IPR (Intellectual Property Rights) of the PRT Joint Venture, together with specifications not part of the JV IPR. The set of PRT generic Specifications is what will be licensed to SPCs all over the world, as well as be specifications for suppliers. The PRT generic specifications shall, eventually, contain all designs, design parameters, options etc that an SPC needs to configure a complete PRT system for a specific application.

The PRT Generic Specifications shall also contain price information and advise as to what sub contractors are recommended for the various parts of the system. These specifications will consist of the sections described below.

5.1 Overall System Design

The Overall System Design Specification introduces the reader to the totality of the PRT system. The overall system design comprises overviews, high level functional descriptions, descriptions of all mechanical components like guideways, vehicle, motors, stations etc.

In Phase Two, the Overall System Design delivered in Phase One will be expanded to a more detailed document than the present.

5.2 Information, Communication and Control Systems (ICCS)

The ICCS Generic Specifications will begin with basic principles and guidelines for the development, deployment and maintenance philosophy. The introduction will touch on topics like:

- System Architecture
- Development Methodology
- Tools
- Standards to adhere to
- Quality Control
- Quality Assurance
- Revision Control
- Testing
- Deployment

The introduction will clearly point out what degrees of freedom there is in design, development, procurement, deployment and testing of ICCS.

5.2.1 Control System

The control system will be described in the following manner and be a continued development of the ICCS report delivered during Phase One:

- Control Strategy
    - Position Control
    - Speed Control
    - Separation Control
- Control System Architecture
- Critical System Requirements
- Central Control
    - Empty Vehicle Management
    - Statistics
- Local Control
    - Merge Control
    - Diverge Control
    - Station Control
- Safety
    - Automatic Vehicle Protection
    - Anti Collision Systems
    - Station Safety
    - Emergency braking
- Sensor technology
    - Position
    - Speed

5.2.2 Communication System

The communication system shall serve many purposes and must be redundant and robust. The generic specifications shall at least comprise:

- Communication System Architecture
- Communications System Requirements like
  - Up time requirements
  - Redundancy requirements
  - Speed requirements
- Control Data Requirements
- Station Data
- Passenger Data Requirements
- Data from external sources
- Sensor System Requirements
- Public Communication
- In Vehicle Communication Systems – entertainment & safety

5.2.3 Information and Security Systems

The generic information and security systems specifications shall at least contain functional requirements for the following sub systems

- Ticketing
- Safety – stations and vehicles
- CCTV – stations and vehicles
- Maintenance Systems
- ERP
- CRM
- Back Office

5.3 Mechanical

The Generic PRT specifications shall include design details and design options, which allow the:

- SPCs to design and calculate their respective project at tender level
- SPCs and their sub suppliers to build and adapt the generic PRT system to the needs of the location

5.3.1 Guideways

The rail system is standard and will be specified to great detail. The interface between the guideway and rails will be detailed defined. The guideway themselves, however, may take on may shapes and forms depending on where and through what kind of area they shall run. We hope to be able to meet a variety of needs when it comes to aesthetical demands. We will consider materials like steel, pre-stressed concrete, carbon fibre and laminated wood. Through the FlyBy stream as well as for the generic D&E, it is pivotal to consult architects and bridge designers in order to achieve optimal solutions; i.e. cover both functional and aesthetical needs. Such contacts have been established in Phase One.

5.3.2 Vehicles

The vehicles need further development. We hope to find a design where customization of the cabins is possible at a reasonable cost. We also hope to find a way to produce the vehicles locally in order to satisfy needs for local content as a competitive factor in the PPP contracts.

We shall strive for an attractive aero dynamical shape on the vehicles, which will allow for higher speeds and less energy consumption, strengthening the environment friendly profile. In the future we envisage that the transport sections of the guideways may be several times longer, and the capacities demanded higher. Hence, the vehicles should be designed for speeds up to at least the double of our present design.

The interface between vehicle body and bogie will be highly standardised to suit a wide range of possible vehicle bodies. One can imagine special purpose vehicles for goods, rescue vehicles, maintenance vehicles and so on.

5.3.3 Propulsion

Propulsion is provided by Linear Induction Motors (LIMs) in the guideway. The LIMs are simple and very robust constructions with no moving parts. The generic specifications will contain design parameters for dimensioning the LIM system according to topology, speed, stations, etc.

5.3.4 Stations

The generic specifications shall contain a station concept with all the variance needed to design stations for most standard capacities and situations. We will have one-vehicle single-side station as the minimum capacity station and maybe a 5-vehicle two-side station for max capacity, ref the Overall System Design Report.

In summary we envisage that the complete Generic System Specifications eventually will comprise all the technical details, options, prices and procurement strategy needed to plan an application of the PRT system at any specific site, as well as for helping a local consortium with tendering and building a complete PRT System.

We do not plan to complete the Generic System Specifications by the end of 2003. The level of completeness will depend heavily on at what time we start and the number, motivation and competence of the people involved in the specification process.

6 FlyBy Specific Specifications

The FlyBy specific specification stream of the project will not be initiated until we have received positive answers on the pre-qualification. A positive decision to proceed with the tendering process implies that the partners in the FlyBy Consortium are organised, a complete Flyby Consortium is formally established, and the funding for the FlyBy project is also cleared.

Below are mentioned central tasks for the FlyBy project stream in relation to JV D&E project Phase Two.

6.1 Track Configuration

This task involves drawing the exact track configuration for Fornebu and placing the track in a terrain model. The track must be designed to meet both the short term and long term objectives when it comes to capacity, and designed in such a way that there nowhere on Snarøya will be more than 500 meters to a station. Track configuration also involves designing optional tracks to the stations Stabekk and Bjørnsletta, as well as to the traffic hub Skøyen.

It is extremely important that the flexibility provided by our PRT system becomes visible for those who will make the final decisions.

6.2 Station Configurations

Station configuration and design should involve selecting from a number of possible design configurations, provided in the Generic PRT specifications, and adapting these designs to the actual situation at Fornebu. In particular will Lysaker station be a challenge with its expected up to 4500 passengers an hour in peak rush hour (recently adjusted up 50% by the local authorities). Note however that the capacity figures are estimates for 2015, not 2008!

Another challenge we shall face is the ticketing system. The customer at Fornebu, i.e. the county administration, will provide the ticketing system themselves in order to have complete control over cash flow and travel statistics. Station design will vary depending on the ticketing strategy that the customer has. We shall strive for making the ticketing system, with some interface to permit the necessary coordination with the regional transport authorities, part of the delivery from the FlyBy SPC.

6.3 Vehicles

The vehicles too are of course based on the standard configuration provided in the Generic PRT specifications. However, there may be specific requirements from the customers that need be incorporated in the vehicle design. It could be colour, interior design, seats, materials and so on. Such requirements will emerge during negotiations.

6.4 Guideways

Hopefully, by the time the tender shall be handed in, we have a number of possible designs for guideways. The guideways will vary in style, aesthetics, material and price. What probably will intrigue our customer is the possibility to have fancy and aesthetic designs in areas where design is important, like along the seashore. Whereas through industrial areas, where maybe price is more important than design, the customer can choose cheaper designs, or design with less dampening of noise.

This activity also involves design of fundaments and struts, i.e. complete adoption to the terrain in which the guideways will be mounted.

6.5 Safety

Safety is going to be a tough issue: We have to prove that our PRT system is safer than all the other transport alternatives for Fornebu. We shall have to face local authorities that are well known for their competence on trains.

However, we fear that the authorities that finally shall approve our PRT system for public transportation, might consider our proposal more suitable for amusement parks, conventions and airports than for safe travel of ordinary people going to and from work. The necessary lobby work need be taken very seriously from the start of Phase Two. Check our comments on how we intend to staff this activity in section 4.5.6

6.6 Environment

We consider our PRT solution to be better for the environment than all competing alternatives, also in the case of Fornebu, where much importance is attributed to environment. The ambition is to make the Fornebu area, together with its public transportation system, a showcase for environmental attentions. We need serious research and assessments, however, to prove that this hypothesis is true. As long as we are sure that our solution is the best, it is important that we promote environmental issues as competitive factors. This activity involves both research work and preparation of an international scientific paper as well as detailed work together with the design crew to ensure that the environmental issues are considered in every design decision that is made in the project.

7 Test Track

Three separate reports describe what goes into the Test Track. The report 1-BCD-5-10-1.0 Test Track describes the purpose, scope, delivery and price of the Test Track. We suggest that this report is read to get an overview of scope and delivery.

The report 1-BCD-2-6-1.0 Mechanical Design describes the mechanical concepts on which the test track will be based and built.

The Report 1-BCD-5-13-1.0 LIMs for PRT describe the propulsion system that will go into the test track.

8 Schedule for Phase Two

Please observe the attached Gantt Diagram in appendix I.

8.1 Critical Path

8.1.1 Test Track

The test track is on critical path for the PRT JV as well as for the FlyBy SPC in order to be able to convince local authorities that our technology is proven, safe and runs on snow and ice. We shall furthermore convince decision makers that the PRT system has the necessary capacity. So far the target date for an operational test track is set to 31st of December 2003. In order to achieve this target, there is absolutely not a minute to spare. Detailed design and engineering of the test track must commence immediately following Phase One. Construction must be started no later than 1st of July. Time is extremely short for building a test track, and we should ideally have started this activity long time ago.

The FlyBy stream of the project has since some weeks started to secure land area at Fornebu where the test track can be built. This work is close to conclusion as to the real estate owners, and there is contact between the FlyBy project group and the local authorities as to demands from public authorities.

8.1.2 Control System

Development of the control system is also on the critical path. The control system will not be developed to full functionality by the end of 2003. We shall have to prioritise the functions that are necessary to run vehicles safely at headways close to our design criteria. These will be low-level control functions for running the vehicles on the track, station functionality, merging and diverging. Furthermore all safety related systems; Automatic Vehicle Protection System and Anti Collision System must be ready for demonstrations Spring 2004.

We believe we have found possible suppliers for both the Supervisory Control System as well as the Local Control systems.

8.2 FlyBy Path

Based on a positive decision by the Akershus County Council on April 29th, the schedule is now as follows:

June 03	Release of pre qualification documents
15 sep 03	Delivery of request for pre qualification
15 nov 03	Pre qualification decided
1Q 04	Request for proposal
3Q 04	Delivery of proposal
YE 04	Signing of contract
Autumn 08	First passenger ride

8.2.1 Design and Engineering of PRT Generic Components

We must commence design and engineering of the generic PRT Components and Systems as soon as possible after the FlyBy Prequalification request is issued. For all practical purposes this means mid August since the prequalification issue is right at the start of the summer holiday season in Norway. However, we do not envisage that the complete Generic PRT Specifications will be finished during Phase Two, which is set to close at 31st of December. The Generic specification work will continue into 2004.

We shall during 2003 prioritise the components and safety aspects that are specific to the Generic PRT system. The more general challenges like ticketing systems, safety systems, maintenance systems, public information systems, operational procedures etc will have to wait until 2004.

8.2.2 Design and Engineering of FlyBy Specifics

The JV D&E stream shall commence design and engineering of FlyBy specifics when the FlyBy Consortium is pre-qualified for Fornebu. Again our guess is that this event will not occur before end of November 2003

The FlyBy specifics involve choosing particular guideway elements from the possible guideway designs we have proposed. It is furthermore to design track and station configuration and specifics for the vehicles, like number of vehicles, on board installations, security systems, etc, etc.

8.3 Gantt Diagram

See appendix 1.

8.4 Critical activities to get ready for Phase Two

Phase Two is a large project with challenging objectives that requires tight steering. If not, both development and cost may get out of control.

Among the really critical items are the activities necessary to enable a swift and controlled escalation of the project without loosing control. We mention a few of these critical activities:

- Finish contract standard for Phase Two – *at the speed the contract process is progressing now, the contract standard itself poses a real threat to the agreed objectives.*
- Decide on which sub suppliers and sub contractors to use in Phase Two. May be as many as 20 separate contracts need to be prepared.
- Negotiate terms with all sub suppliers and sub contractors, in particular with supplier of the control system and the test track
- Write up delivery specifications for all contracts
- Gear up the project secretariat to handle a large project – costing, contracts, document control etc
- Arrange a kick off meeting with all participants – two days with design reviews and team building. This activity is absolutely necessary to build the kind of pioneering spirit and enthusiasm necessary to achieve the objectives in a multi cultural setting

We believe that the Project Staff now working need to continue full speed into May if it shall at all be possible to realise the targets of an operational Test Track and a successful FlyBy pre-qualification.

It is also obvious that the PRT JV will not be established at the beginning of May, which means that the funding situation will be unclear at the time we need to start up.

9 Commercial

9.1 Budget Interim Phase (1B) May 2003

Assumptions:

- Continuity is crucial for progress and will be given high priority
- We shall commence Generic PRT Specification work when pre-qualification request is received for the Fornebu Project, i.e. mid May
- We shall not commence any FlyBy Specific specification work until the FlyBy Consortium is pre-qualified, i.e. November 2003.

For the interim period in May, 2003 we envisage the following staffing:

- Project manager, Hanyoung Choi, 100% at no cost
- Business Development and liaison, Einar Flydal, 100% at no cost
- Deputy Project Manager Jan Magnussen, 100% at NOK 50.000 pr week
- Sub Project Manager SW Erik Hardeng, 100% at NOK 40.000 pr week
- Sub Project Manager HW Andrew Howarth, including his design team at £6.000 pr week
- Contract and IP Officer, 100% to be appointed
- Provisions to use the following experts on an hourly basis (minimum NOK 250.000 during May) for advising, issue management, and coordination of the various specialist task forces:
    - Ingmar Andreasson
    - Jan Even Evensen
    - Nils Jacob Berland
    - Erik Hardeng, Kitron Design
    - Project staff secretary 100% at NOK 15.000 pr week

In addition we shall need on the order of 100.000 NOK in operation expenses for offices, phones, broadband communication, licenses, cleaning etc.

In total the budget for the interim phase between Phase One and Phase Two should be no less than 1,7 MNOK (0,5 MNOK remains of the budget for Phase One), in order to maintain sufficient speed on the critical activities. A lower sum will imply reduced speed. At the end of May the burn rate will increase significantly.

.

A more detailed version of the Phase 1B project (May 2003) is available for the steering committee and the project management.

9.2 Budget for Phase Two

A gross outline of the budget (ex. VAT in 1000 NOK) for Phase Two is as follows:

1.	Project Management	KNOK	2750
2.	Project staff	KNOK	3750
3.	Project related expenses	KNOK	1750
4.	Business Development	KNOK	3000
5.	Expert Group	KNOK	2300
6.	Control System	KNOK	7080
7.	Test Track – guideways, stations, vehicles, LIMs, installation	KNOK	37700
8.	Foundations for guideway	KNOK	3000
9.	Land lease at Fornebu, guards, visitors centre, fences etc	KNOK	1500
10.	Generic PTR Specifications	KNOK	4300
11.	FlyBy Specific design and engineering (FlyBy stream)	KNOK	0
12.	Safety Assessment Phase Two	KNOK	350
13.	Environmental Considerations – LCA, EPD and Ecodesign	KNOK	850
	Total	KNOK	68330
	Uncertainty – 20% (for the moment)	KNOK	13670
	Grand total	KNOK	82000

A more detailed version of the complete Phase Two budget is available for the steering committee and the project management.

Appendix I Gannt Diagram