Bus Systems in a Three Tiered World

– Experiences from the ICAN Project

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1 Introduction

Disabled people have benefited greatly from the developments in technology over the last twenty years. Systems have been developed and refined to help them overcome, or cope with, difficulties they experience as a result of their disabilities. As technology has become cheaper, more powerful and easier to use, disabled people have taken to using them to an ever-increasing degree.

This is true for people suffering from a wide spectrum of disability. It has been seen that many of the solutions that have emerged as most useful find application with more than one disability type. This allows the economies of scale to be brought to bear. Unfortunately, the current situation is that the problems a disabled person has are addressed in a somewhat compartmentalised way. This means, for example, that one professional team sees the person thinking only of how to address the client's communication problems, whilst another tackles independent living needs, and yet another considers equipment required to access the curriculum or specific employment tasks.

Technologies, and technical systems, designed to help people with disabilities are called "Assistive Technologies" (AT)

2 What are Assistive Technologies?

The International Standards Organisation (ISO, 1992) defines assistive technology ("technical aids" in their terminology) as:

> *"..any product, instrument, equipment or technical system used by a disabled person, especially produced or generally available, preventing, compensating, relieving or neutralising the impairment, disability or handicap."*

The term Assistive Technology (A.T.) is applied to any device or system, technically based, that has been designed to help a disabled person overcome problems associated with their disability. At one extreme, a pair of spectacles could be referred to, as an assistive technology device. Therefore, for the purposes of this paper, the term is taken to refer to a device that is computer based. In particular, since the work is drawn largely from experiences gained with the Technical Division of the Central Remedial Clinic in Dublin; considerable emphasis is placed upon the particular problems associated with various forms of physical disability.

AT equipment can be taken to fall into one or more of the following application areas:

- Inter-personal communication systems – devices designed to assist the user communicate face to face with another individual using either written text or artificially uttered speech.
- Environmental control systems – devices designed to permit the user exercise a greater degree of control over devices and functions within their immediate vicinity
- Curriculum access systems – those devices designed to allow a person with a disability take part more fully in the conventional learning process.
- Vocational or Employment access tools – as previously, but specifically designed to interface with existing business systems, e.g. normal computer systems.
- Leisure access systems – specialised devices that allow the user access to recreational systems or artistic endeavours.

3 Advantages of Integrating Assistive Technologies

3.1 Why Integrate Systems?

The methodology proposed in this paper is that all the assistive technology needs of a disabled person should be combined, as far as possible, into one integrated unit. The end device becomes the user's 'tool for life access', customised to their needs. It follows, on an integrated, holistic assessment of those needs, by a multi-disciplinary team of clinicians. The result can be considered as follows:

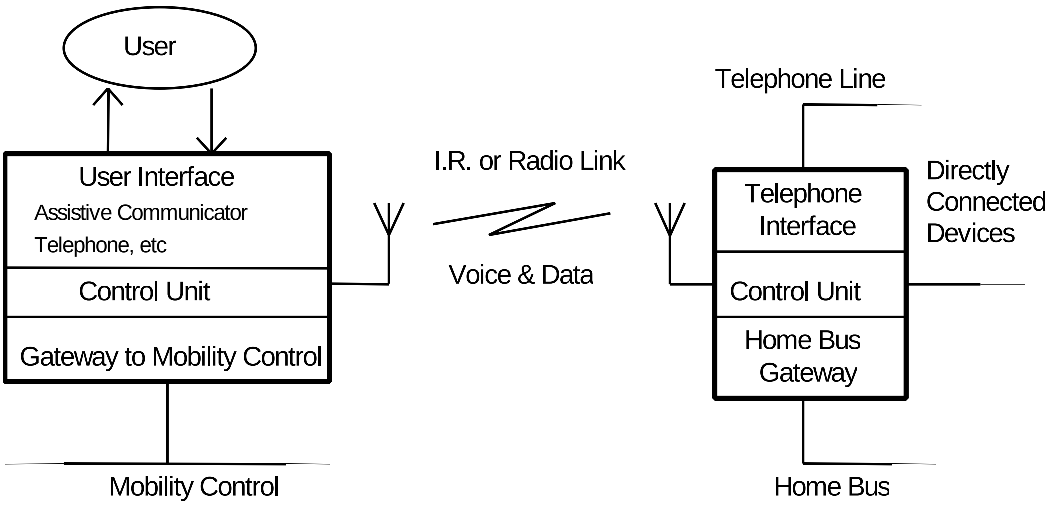

Figure 3-1 A Conceptual Model of an Integrated System

The disabled person is provided with a single platform and user friendly, consistent, interface, that allows control of functions both close to, and further away from the user. Obviously, the design of the interface and the precise functions to be controlled will be customised to the disabled client, as will the method of access to the terminal. A series of gateways are necessary to allow access to more distant functions.

It is argued that the above picture is a natural consequence of considering the disabled person as operating within three distinct spheres of operation, or 'environments'. First, the following sections overview the advantages of integrating the assistive technology devices.

(a) Economic Benefits

Integrating assistive technologies has an immediate benefit for the equipment financier. Since each item of discrete equipment requires both an input and output mechanism, there is a distinct advantage if an integrated system is employed requiring only one of each. In addition, and as stated previously, many of the individual devices are basically computers at heart and, with the power and cost of modern technology, it is perfectly feasible to have one computer carrying out a number of different functions.

If a compartmentalised approach is taken to assessment and provision, there is an additional cost incurred in the duplication of assessment time required. A single team comprising professional staff from various disciplines, removes this need whilst also making the assessment process a lot less arduous and tedious for the person being assessed.

(b) Cognitive Benefits

Many people are familiar with the problem of trying to use several software applications in which different conventions or guidelines have been adopted. This was particularly apparent ten to fifteen years ago when many people were using computer programs written by different Companies; where there was no reference or co-ordination one with another. In one program, the F1 function key may mean "Help" in others it may have an entirely different designation. Gradually, some order was imposed, resulting in software that was considerably more intuitive than previously. Few people would argue that this was the wrong approach. The resultant "standard" helped users and software developers alike.

The proposed methodology seeks to produce a single, user-friendly interface, with a single input, and a single output mechanism (appropriate to the user's needs). In this regard, however, simplicity can be the hardest thing for the designer to achieve. An ideal solution may therefore have a changing interface, altering itself to suit the situation the user is in, the time of day, or anticipated requirements. If this task is tackled properly at design stage, the software, which is the key to achieving the ideal, may require more design effort to include artificially intelligent systems. The result should be a system that is far easier for the average disabled user to understand (and the average clinician) and will be accessible to people with a degree of cognitive impairment.

(c) Aesthetic Benefits

Disabled people are already aware that they look different to others. Their disability makes them stand out, and this is not usually something they welcome. For example, a wheelchair immediately identifies a person as disabled. Adding other equipment makes the situation worse. If technology is to be accepted by the users, this fact should be considered and every attempt made to minimise equipment clutter.

It is easier to reduce obvious differences if the amount of equipment is kept to a minimum. Integrated systems allow clinicians to do this. If the above problem is placed within the context of a World in which ordinary people are using more technology (mobile telephones, notebook computers etc.), it may even be possible to imagine a situation where the disabled user merges into normal society – at least as far as appearance is concerned.

3.2 Common Platforms for Integrated Technologies

If technologies are to be truly integrated, they must be designed to operate on a common computer platform. A PC based computer, for example, can accommodate a number of separate applications to cover needs in the areas of communication, environmental control, education, work and leisure. The applications must be designed to reside on this common platform, and to co-exist with other, separate programs.

In addition to running on a common platform, programs must follow accepted guidelines so that the interface environment can be unified, and keys have the same meaning no matter where the user may be within the overall application.

If the common platform approach is adopted, the disabled user can move their A.T. from one machine to another as technology develops. Currently, many users are migrating to the new hand held computers, which use an operating system very similar to that of larger machines.

4 The Three-Environment Model

This approach can best be summarised by the following two diagrams:

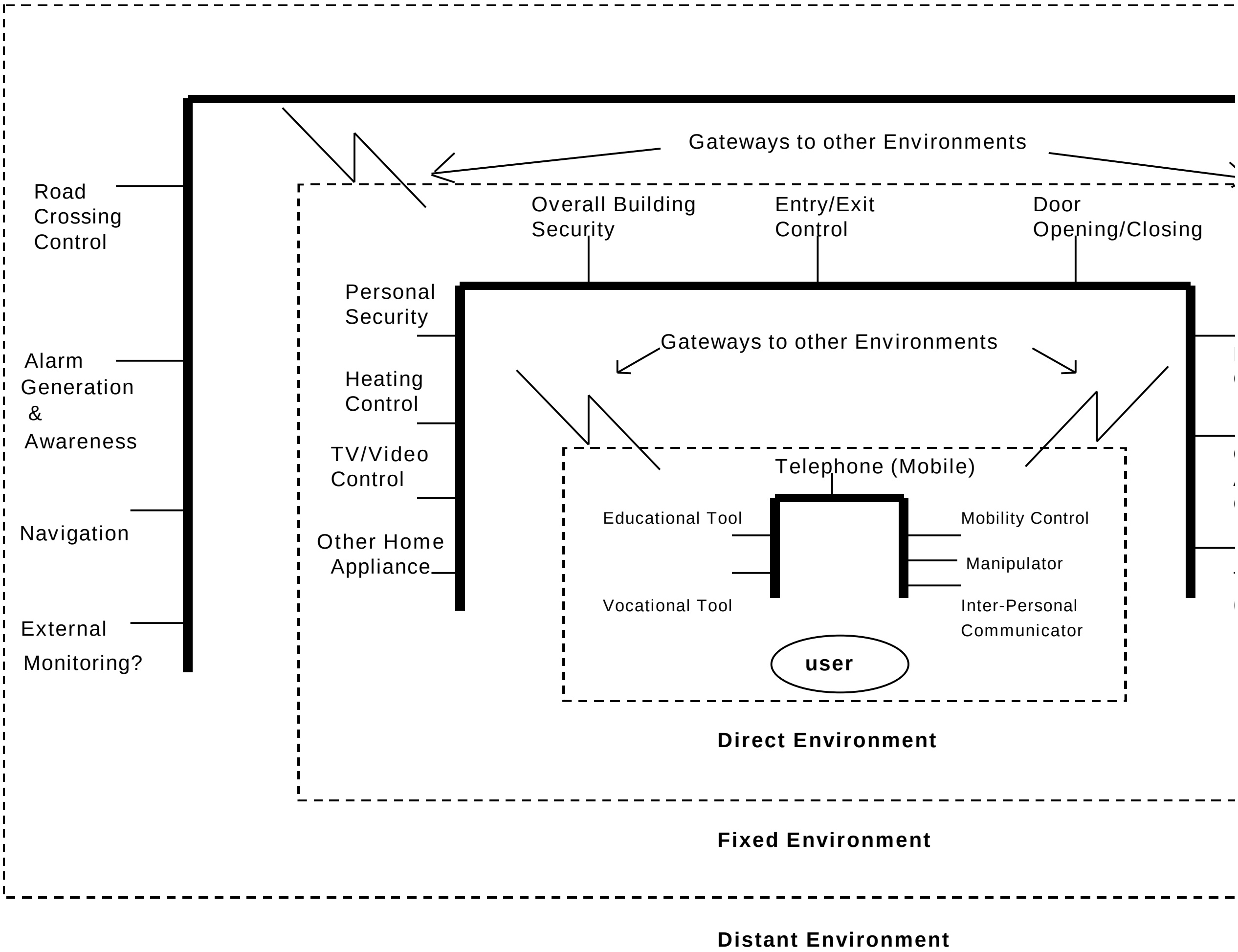

Figure 4-1 Typical User Environments

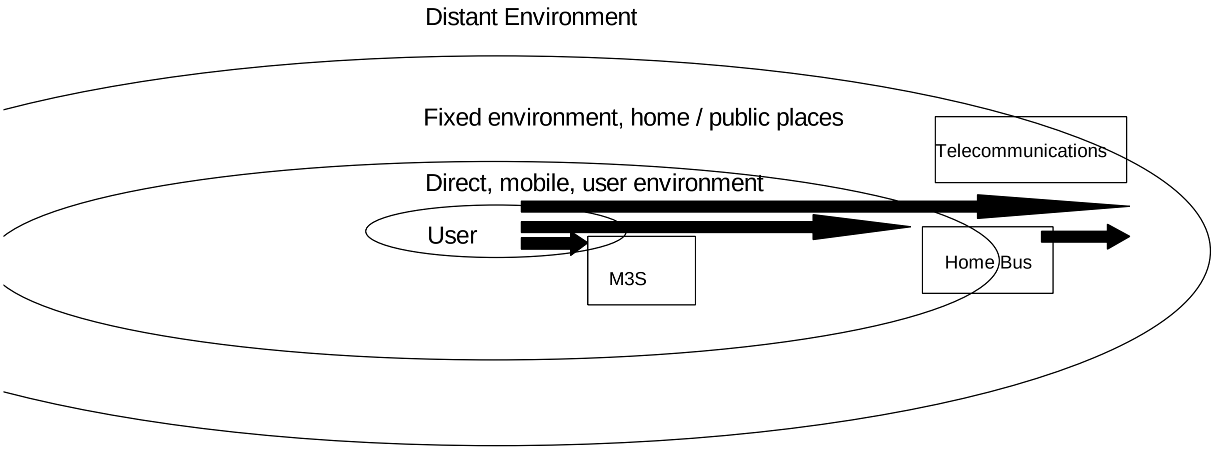

Figure 4-2 Gateways between User Environments

The disabled person is portrayed as being at the centre of a three-tiered world of control functions. Within each of these separate environments, attempts are made to establish a common platform for equipment, allowing for easy construction of an overall system following assessment. As well as allowing for a logical development of the system, tools are required to allow clinical staff to move from a plan of needs on paper to a real system. Such tools are partly available, some having been developed at CRC.

In an ideal world, the user's needs are assessed, then the integrated system is realised from "off the shelf" components designed to interface with each other through agreed protocols. In others words a communication bus is required. Establishing a standard of this type is not easy and requires considerable support from equipment designers. Market pressures can often determine the eventual de-facto standard, so consideration of the current support picture is important to allow for a clearer view of where the general industry is likely to be in this regard, in the near future.

CRC have carried out an examination of the degree of acceptance currently in place for bus systems proposed for the inner two environments.

4.1 The Direct Environment

The Direct Environment is the term chosen to represent all devices and systems within the immediate vicinity of the user. This would include control of their mobility, inter-personal communication, telecommunication, manipulative control, and the use of a computer as a working or learning tool.

In practice, this is likely to include computer technology designed to provide the user with an artificial voice, control of complex wheelchair functions, access to a telephone and the ability to operate a robotic manipulator if necessary. All these functions were implemented on a pilot basis as part of the work of the M3S project, the SPRINT – IMMEDIATE project, and the MECCS project. It is anticipated that work at CRC in developing this idea further, will continue through a new transnational activity called ICAN (Integrated Control of All Needs) which began in 1998 and is planned to run for 36 months.

The MECCS project (Modular Environmental Control and Communications) constructed a mobile platform incorporating a cordless telephone and infrared device controller. The platform used a specially produced and evaluated interface, running under Microsoft Windows 3.11. The platform contained a radio transmitter and receiver that allowed commands to be carried beyond the users immediate location when necessary. This last process of bridging between environments is inevitable, and is shown in the diagram as a “gateway”.

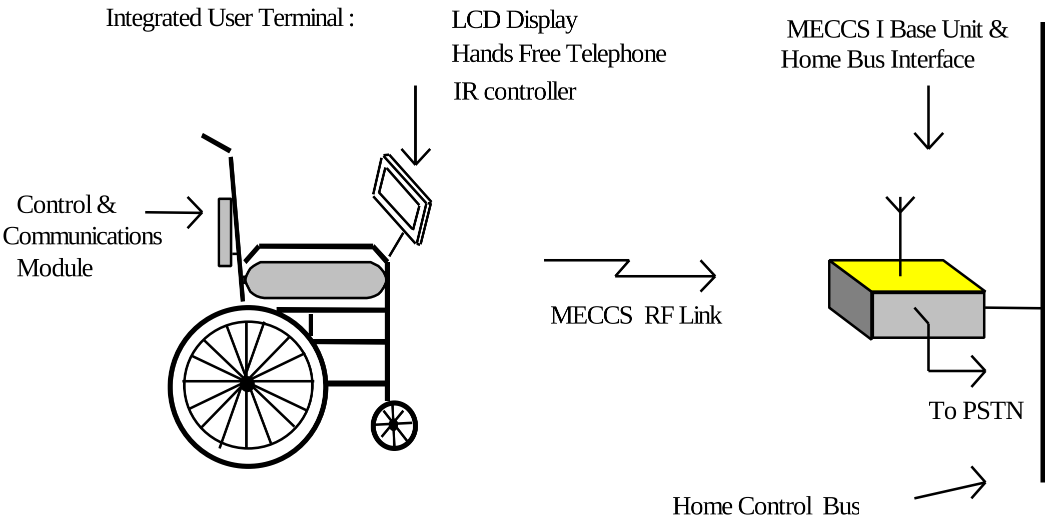

Figure 4-3 The MECCS System

The M3S project comprised 13 partners from across Europe. Since the object was to try to establish a wheelchair bus standard, it was felt that a large number of transnational partners could best accomplish this. The M3S Bus wheelchair bus “standard” was developed under .the M3S project which was supported by the European Union TIDE initiative, which addresses a wide range of technical development needs for disabled people. The work of the M3S consortium, along with new partners, was continued in the SPRINT – IMMEDIATE project. In this case, the emphasis was on dissemination of ideas, and evaluation of prototype platforms. This project finished in February 1997.

4.2 The Fixed Environment

The Fixed Environment is the term applied to represent functions within the user’s living or working space, but not mounted upon their wheelchairs. Obviously, someone with reduced mobility or communication, by virtue of a physical handicap, would stand to benefit more from systems allowing home automation than would many others.

The journey from one room to another is a great obstacle to a person with a disability. Equally, in other Countries, due to severe weather conditions, there is a greater need to ensure disabled people can live independently due to the difficulties experienced by carers in visiting them.

The following diagram shows a model system adopted for the Finnish ASHoRED project,] which set out to produce guidelines and a prototype model for an Adaptable Smarter Home.

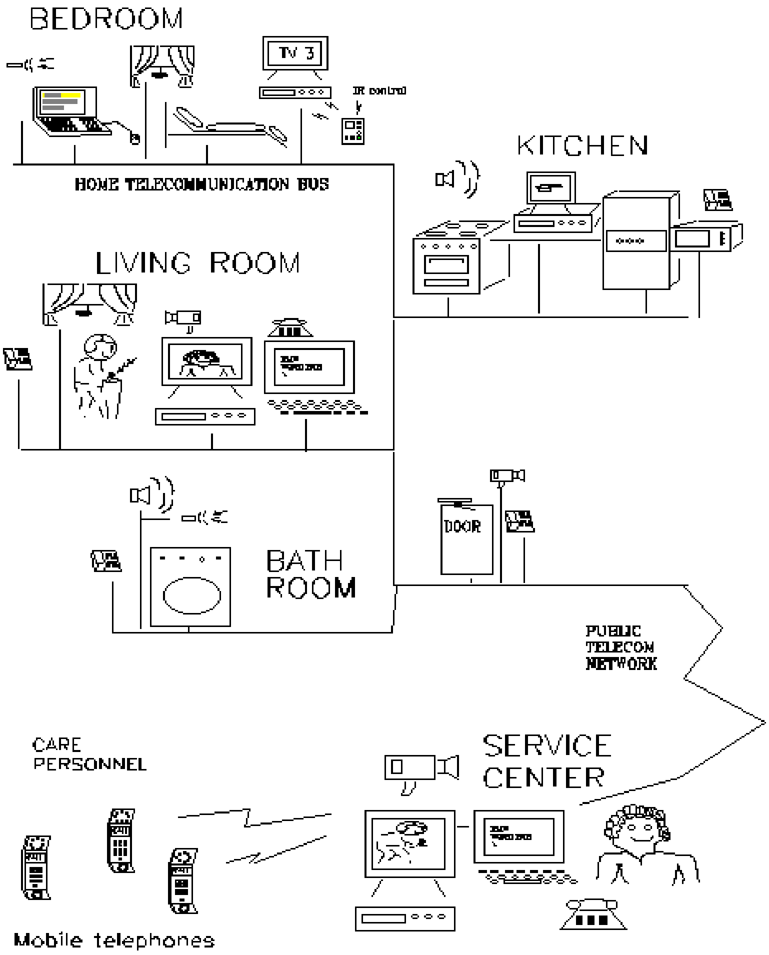

Figure 4-4 ASHoRED Model of a Smart Home.

Whilst reference is continually made to Smarter homes, the same idea can be extended to a disabled person's place of work or learning. It can be seen that control of devices within the Fixed Environment depends greatly upon the use of a Fieldbus or Home automation bus. At CRC, examination has been made of the current state of implementation and development of such systems within Europe, and consideration given to the suitability of different systems for application within the rehabilitation area.

Chapter six will also consider home bus systems in more detail and will examine the issues surrounding their adoption by disabled users and those working on their behalf.

4.3 The Distant Environment

The Distant Environment is the least well defined of the three. It implies the adoption of a common interface standard for much of the I.T. equipment finding its way into the modern High Street. Since these systems are so diverse, including such things as Automatic Teller Machines, Public Information Terminals, and the awareness of public alarms, the total co-ordination of the technical standards employed is a massive, International task.

At this time, very few attempts have been made to produce such a public bus interface "standard". This remains a task for the future, and one that can only realistically be accomplished with International will and approval. In a future ideal, situation, a disabled person would be able to move about their local community and interface with a variety of equipment. They would, for example, be able to pull up to an Automatic Teller Machine (ATM) and communicate with it through their own, individual assistive technology device. The medium of communication, or Gateway, has not been defined. An infrared link would be one possibility, as would a localised radio communication system. Whilst an infrared solution may present problems in its use outdoors, it remains a possibility, and is under consideration by bodies such as the Trace Center, in Wisconsin, USA, as part of their proposed Universal Auxiliary Interface Protocol. The second option – a radio link, could be implemented separately, or be realised through existing public radio systems such as the GSM network. The later option, gives the user an extra capability to extend their "gateway" to the Fixed Environment a considerable distance away from their homes or workplaces.

5 The ICAN Project

5.1 Overview

ICAN is an acronym for **I**ntegrated **C**ontrol of **A**ll **N**eeds. The rationale of the project is to work toward producing commercial realisations that would allow the three-environment model to be implemented. This involved producing a series of special tools, gateways and specifications that would allow clinicians use commonly available products and be able to interface them to each other.

The project focused on the two, innermost environments, and looked at ways they could be produced. The direct environment, being essentially a wheelchair bus, was envisaged as being implemented through either an M3S or DX interconnection strategy. Whilst much of the effort of the consortium had focused on the M3S standard, it was recognised that the DX bus had a sizeable market share, and as such, should be provided with appropriate interfaces. The fixed, or centre most environment, would be realised using Smart Home technology. This, in turn, would use a commonly agreed bus standard such as E.I.B., BatiBus, or European Home Systems.

The ICAN system architecture has been designed to reflect these considerations. Overall it can be represented as:

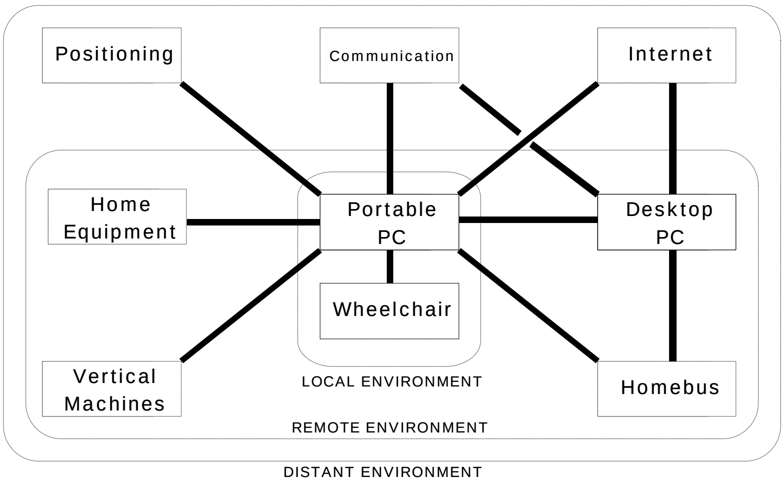

Figure 5-1 Overall ICAN Design

At the heart of the system is the user's "tool for life access" as mentioned previously . The consortium refers to this as the function carrier. This will follow an architecture in which building blocks (like interfaces to DECT, GSM, BatiBus, Home Systems, PC and Wheelchair) can be combined into a solution appropriate to the user. The function carrier itself will be based on a computer, but several approaches are envisaged.

1. One scenario will be based on a Handheld or Palmtop PC running the Windows CE operating system. This will result in a very small and lightweight function carrier, which is excellent for applications where the unit can be carried directly by the user.
2. Another approach will be based on a portable PC running the Windows 95 operating system. This will result in a unit, which is better suited for applications, where the function carrier can be mounted, for example on a wheelchair.
3. A third approach uses a more conventional modular structure in which the function carrier is an embedded PC and the building blocks are the separate devices. This will result in a less integrated function carrier but will be easier and cheaper to implement.

The building blocks can be implemented in hardware and/or software. Hardware modules can be connected to the function carrier or physically integrated within it. Software modules can be programmes running as parallel applications within a multi-tasking environment, like Windows. The following list of units are planned:

- Speech input unit,
- Dynamic keyboard unit,
- Control and configuration unit,
- Graphical user interface,
- PC emulator unit,
- Serial keys unit(interface to desktop PC),
- Infra-red environmental controller unit,
- Interface to GSM telephone,
- Interface to wheelchair control (to Control Dynamics DX bus),
- Interface to Homebus (BatiBus, Home Systems),
- Interface to wheelchair control (to M3S bus via "PC-CARD").

5.2 Detailed ICAN Architecture

The ICAN project set itself the goal of making the three-environment model a commercial reality. Examination was made of the current A.T. market in both Europe and the U.S. and considered alongside the system specification that resulted from a User Requirements workpackage. The result was the following system plan:

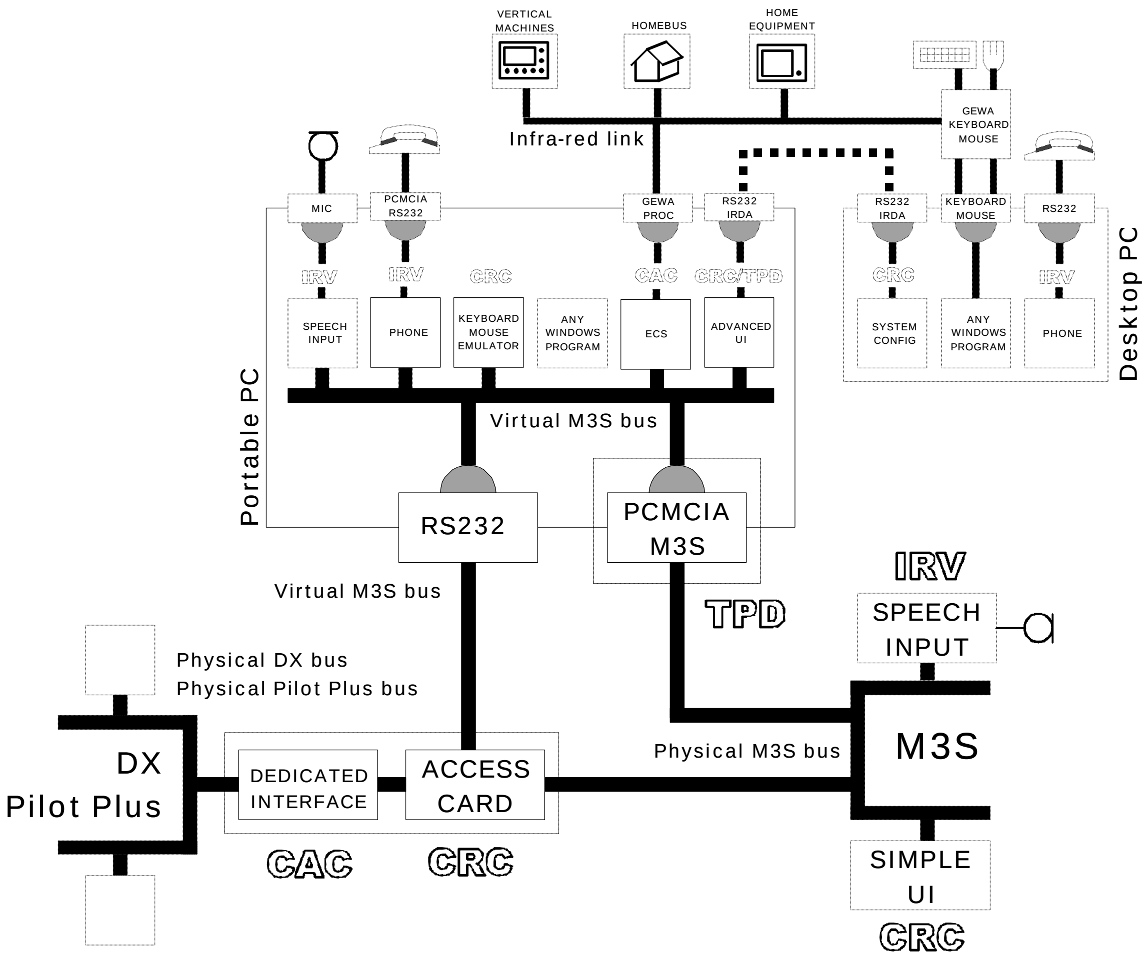

Figure 5-2 Specific ICAN Architecture

Work will now continue to produce and test the various component blocks.

5.3 The ICAN Consortium

ICAN is supported by the Telematics Applications Programme of the European Commission, DGXIII C/E. The partners in the project (TIDE DE2404) are Cambridge Adaptive Communication (CAC-Cambridge UK), Central remedial Clinic (CRC-Dublin Ireland), Institute for rehabilitation research (iRv-Hoensbroek the Netherlands) and TNO Institute of Applied Physics (TNO-TPD-Delft, the Netherlands) (Consortium leaders).

5.4 Further Information

The work of the group can be monitored by visiting the web site www.crc.ie/ican or by contacting the partners directly.