WHITEPAPER

Tadpole-Cartesia:
The Complete Field Information System For Utilities

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CONTENTS

1. Executive Summary

This paper covers the Tadpole-Cartesia family of products and describes the Cartesia software and J-Slate hardware, the components of a new integrated Field Information System (FIS) from Tadpole Technology. This paper introduces a solution that is aimed at any field worker who today receives job or work instructions together with a map or schematic.

FIS requirements are discussed, and used as a basis to explore the limitations of existing paper-based and PC solutions.

The paper goes on to describe the components of the system, and shows how it addresses many of the challenges initially identified.

This is complimented by a discussion on the business drivers, the operational benefits of the system, a review of Total Cost of Ownership (TCO), and a user view of the business benefits. Future directions for product development are also addressed.

2. Why Field Systems?

2.1 The Requirements

Some 70% of all utility personnel spend at least some of their time outside of the office. In an environment where regulatory and competitive pressures are rapidly increasing, a utility's field service force is an asset which must be exploited for maximum effectiveness.

Field service business processes, although differing in detail between organisations, are essentially very similar. Field service engineers carry out jobs, which can be part of routine maintenance or installation work, or in response to emergency situations such as leaks or power failures.

Processes, therefore, usually consist of extracting information from corporate systems to provide job cards, maps, documentation etc, as well as work scheduling. Following completion of each job, information must be fed back to the same systems either in the form of alphanumeric information or, for example, “redlined “ maps.

The ability to rapidly fix a power outage or leak, and to complete routine work in a timely and cost efficient manner is very much a part of a utility’s core business competence.

Although our initial focus, and all of the discussion herein is based around utilities, the product is applicable to a wide range of other industries ranging from emergency services to domestic appliance engineers.

2.2 Traditional Solutions

Many utilities still issue paper job cards and maps, and rely on “redlined” paper documents as the medium for transmitting job completion information back to the depot. Job status is frequently fed back verbally over corporate radio systems.

This approach results in a number of inefficiencies including:

- Significantly increased travel times. Even for planned work engineers often have to pick up job documentation from depots on a daily basis. In emergency situations, special journeys may have to be made, with potentially serious implications for downtime.
- Inaccurate records. Paper-based systems are very error prone, and make it difficult to enforce good QA procedures.
- Cumbersome and inefficient business processes. Issuing and tracking paper documents is very time consuming and difficult, with a high probability of loss.

2.3 Why are Field Information Systems Difficult?

Information technology, long accepted as a vital element for office operations, has been slow to take off in the field. Given the problems discussed above, it is perhaps useful to ask why this is so.

Perhaps the biggest reason is that “the field” is a very hostile environment for IT; hardware is exposed to moisture, extremes of temperature and physical abuse. Communications is not just a question of plugging into a convenient LAN socket, but has to take place over low-bandwidth links with poor reliability and indifferent coverage.

These difficulties are compounded by user interface and usage problems. It is much easier to cope with a system reboot in warm office, than half way up a telegraph pole in the middle of a thunderstorm!

A different, but nevertheless difficult problem, relates to the architecture of corporate IT systems. Information required for fieldwork is usually resident in a number of different corporate systems, such as works management, Geographical Information Systems (GIS), parts management etc. Full integration of such systems, even at the corporate level, can be a difficult problem which has only begun to be addressed in recent years. Getting information to and from these systems into the field has proved to be even more challenging.

In view of the importance of their work, it is easy to see why systems, which do not do the job, are simply ignored by field personnel.

3. First Generation Systems

A number of attempts have been made to introduce field information systems, but, for the reasons discussed above, success has been variable. Existing systems in utility companies can be divided into limited job status-based systems and integrated solutions.

Job-status solutions automate only the job management status information, by displaying job cards as alphanumeric forms-based information to user. This has a number of advantages, since it only requires a link to one corporate system (the Job Management System) and the relatively small volumes of information are much easier to transmit over low-bandwidth connections. Also, information can often be displayed on small low-cost PDA devices. Such systems have been around for a number of years

However, while such systems are certainly useful they cannot be said to create a complete solution for all field workers. For those who need maps, or other graphics information, they do not solve the problems discussed above, and do not remove the inefficiencies of paper based systems.

As a result of this, attempts have been made to combine job status systems with GIS maps, the most widely used job documents.

However, GIS data in the field presents a number of daunting technical problems. GIS databases with the required asset information are quite large (at least 10GB) and are correspondingly difficult and expensive to store, and to transmit over low bandwidth links. One solution is to take a periodic copy of corporate GIS records, either using a hard disk or by cutting a CD.

This, however, introduces some challenging data synchronisation problems. GIS information changes frequently as assets are added or changed, and even the data model itself may change as new *asset types* are added. If a copy of GIS records is taken for mobile field workers, the question of how often to update it inevitably arises. This causes a further issue – GIS operators must track which version of the GIS an engineer has redlined, which requires sophisticated version control facilities.

The bottom line is that, whilst these problems can be solved, this can only be achieved by employing complex and expensive technologies. A fact which has deterred many companies from going forward.

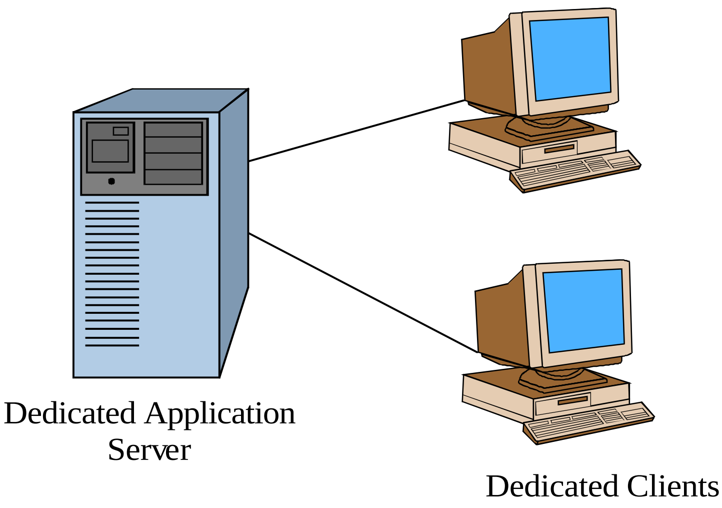
Recently, the use of web browsers has been advocated for field systems. Whilst these are extremely useful in certain limited cases, their use is problematic because they are designed to be used in a desktop system, where connectivity to the server is readily available. To be effective, field systems must work both standalone and in connected mode.

4. The Cartesia Solution

4.1 Concepts

Cartesia is a new style of integrated field information system, which has been designed to leverage a number of architectural innovations within the IT industry. This innovative approach allows us to solve many of the problems outlined above in a very elegant way. The concepts behind our approach are outlined in this section.

FIG. 1: TWO-TIER ARCHITECTURE



Traditional enterprise systems have *two tier architectures* as shown in Fig.1. In this scenario client systems are very closely coupled with associated server systems. This reflects their evolution as isolated, monolithic departmental systems, which do not communicate very effectively. Building field systems with a two-tier architecture is not very easy, and requires complex interfaces to be built and managed.

Cartesia, by contrast, is based upon the *three-tier architecture* shown in Fig.2. Here server-side applications are divorced from individual backend systems (typically data repositories), allowing them to integrate information from as many different systems as required by the end user.

Cartesia is also *work-flow orientated*, recognising the fact that field business processes are not just isolated transactions, but are part of a complex network of enterprise business processes. Cartesia supports workflow for field processes, and also integrates easily to HQ and depot-based processes, which may be resident in different departmental systems.

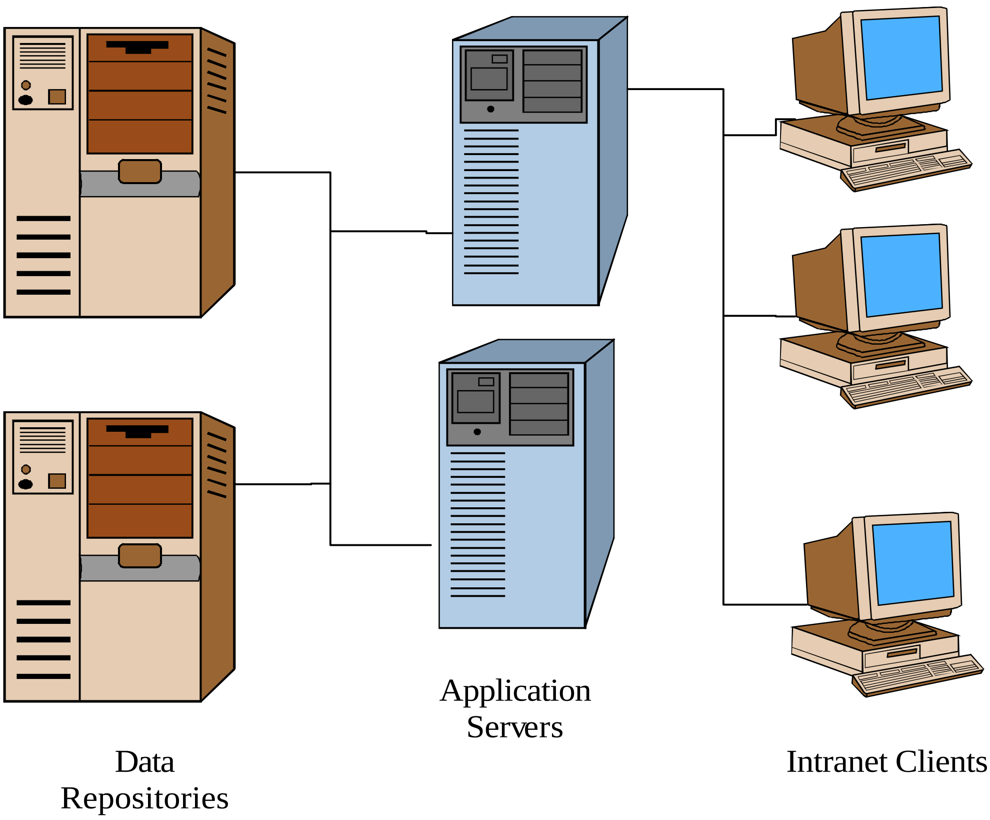


FIG.2: THREE-TIER ARCHITECTURE

Traditional PC and client systems are typically fat clients, in that they are composed of large, monolithic applications, which do not share data very effectively, and are difficult to port to different hardware platforms.

Cartesia clients are lightweight. They are composed of small, configurable software components which can be easily re-engineered to change functionality.

Cartesia is built using Java [1], a new network-centric application language which is specifically designed to be portable across different platforms, by making use of virtual machine technology.

Java also helps us to build targeted user interfaces, which are much easier to use than traditional Windows-type GUIs.

4.2 THE CARTESIA FAMILY

Fig. 3 shows a schematic diagram of the Cartesia family. It consists of three basic modules:

- The Enterprise Field Server-an office based server application which acts as an "agent" for field engineers, managing the flow of information and workflow between the field and "backend" systems.
- Cartesia Redline- the thin client software application which runs on the field engineer's machine
- Cartesia QA module-An enterprise application which performs the quality assurance function for redlined spatial data and asset data.
- Cartesia Gateway. A desktop browser for GIS information. This product is described fully in an associated paper from Tadpole. [2]

In addition Cartesia is designed to work with a Java-based hardware platform-J-slate, which is described fully in Section 5.2 below.

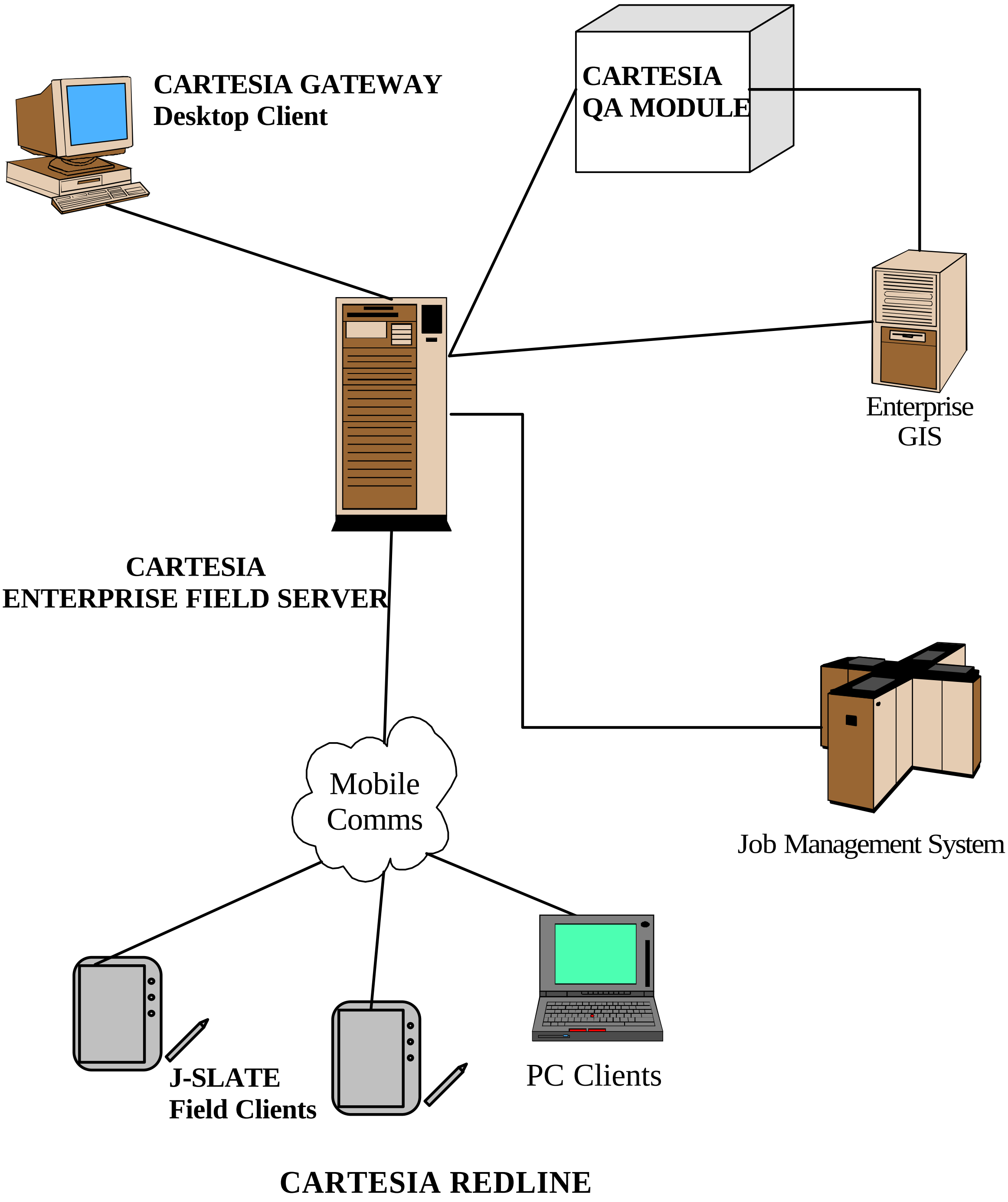


FIG. 3: CARTESIA FAMILY

4.3 THE CARTESIA ENTERPRISE FIELD SERVER

The Enterprise Field Server (EFS) is the heart of the Cartesia system, and, as discussed above, essentially acts as a server "agent" whose primary function is to manage the flow of information between enterprise systems and the field. Key features are:

- Enterprise quality infrastructure. Cartesia is built on the Forte application server. It provides 24x7 levels of reliability, as well as an architecture which is scalable to thousands of users. Features to support this include replication (the ability to allocate server software to multiple redundant hardware platforms), load balancing (the ability to distribute server requests amongst multiple hardware platforms) and failover (the ability to recover from hardware failures.)

- Rich connectivity options. The EFS has a wide range of options for connecting to backend systems, these include CORBA (Common Object Request Broker Architecture) and RMI (Remote Method Invocation) for applications and JDBC(Java Data Base Connectivity) for databases. XML (Extensible Markup Language) adapters will also be supported in a future release.

The EFS could also be called the "Electronic Field Stapler", by analogy with paper-based systems, since it assembles electronic folders of job information (including the relevant map), in the same way as is done with paper-based systems.

The EFS is designed to be part of a truly integrated FIS, which provides support not just for job cards, but also for GIS maps, and, in the longer term other multi-media documents. It provides a flexible architecture that allows for integration with existing systems.

One of the most important features of the EFS is its support for spatial data. Unlike conventional field GIS systems described in Section 3 above, Cartesia does not require replication of GIS data, but instead produces a targeted map extract, specifically for each job. Size and shape of the extract can be programmed against job type within the EFS, mirroring the way it is done for printed maps.

A typical job workflow would be as follows:

1. Job management system (JMS) schedules a job.

2. The EFS extracts information from the JMS for the job card, and also extracts an appropriate map from the GIS.

3. A "job folder" consisting of both sets of information is placed in a queue for retrieval by each mobile unit (See Section 4.4 below).

4. As jobs are completed, the job information, and GIS redline data is fed back to the EFS.

5. Job card information is automatically fed back into the JMS, whilst spatial information is routed to the QA module in the enterprise GIS system.

Also of note is the fact that only difference information is fed back to the EFS, after which the map is discarded. Since job maps are only extracted for specific jobs, the need for complex version control is completely removed.

In addition to the automated extraction function described above, the EFS can also support an interactive "on demand" extraction for emergency jobs, this is described in the next section.

4.4 Cartesia Redline

Cartesia Redline is the Java-based client of the Cartesia family. Redline is a 100% Java application, and will run on any hardware platform that supports a Java Virtual Machine(JVM). It is not an applet, and does not require a web browser such as Netscape or Explorer (Cartesia Gateway performs this function); it has been optimised to run in the disconnected field environment.

It has been designed from the ground up as a field application, and will operate standalone during normal operations. Connection is only made to the server when transporting job folders to and from the EFS, and when performing online browsing of GIS information. (See below).

Communication can be via any medium which supports the TCP/IP protocol. A typical arrangement is to use PSTN for planned work (at the engineers home), and GSM or other mobile technology for emergency work in the field.

The engineer would normally start by viewing an job overview, as shown in Fig. 4. This gives an overview of outstanding jobs, and allows the engineer to initiate a communications session to update the job list. This results in new jobs being downloaded, and redlining information being uploaded back to the EFS. He can also mark each job as complete, when he finishes it.

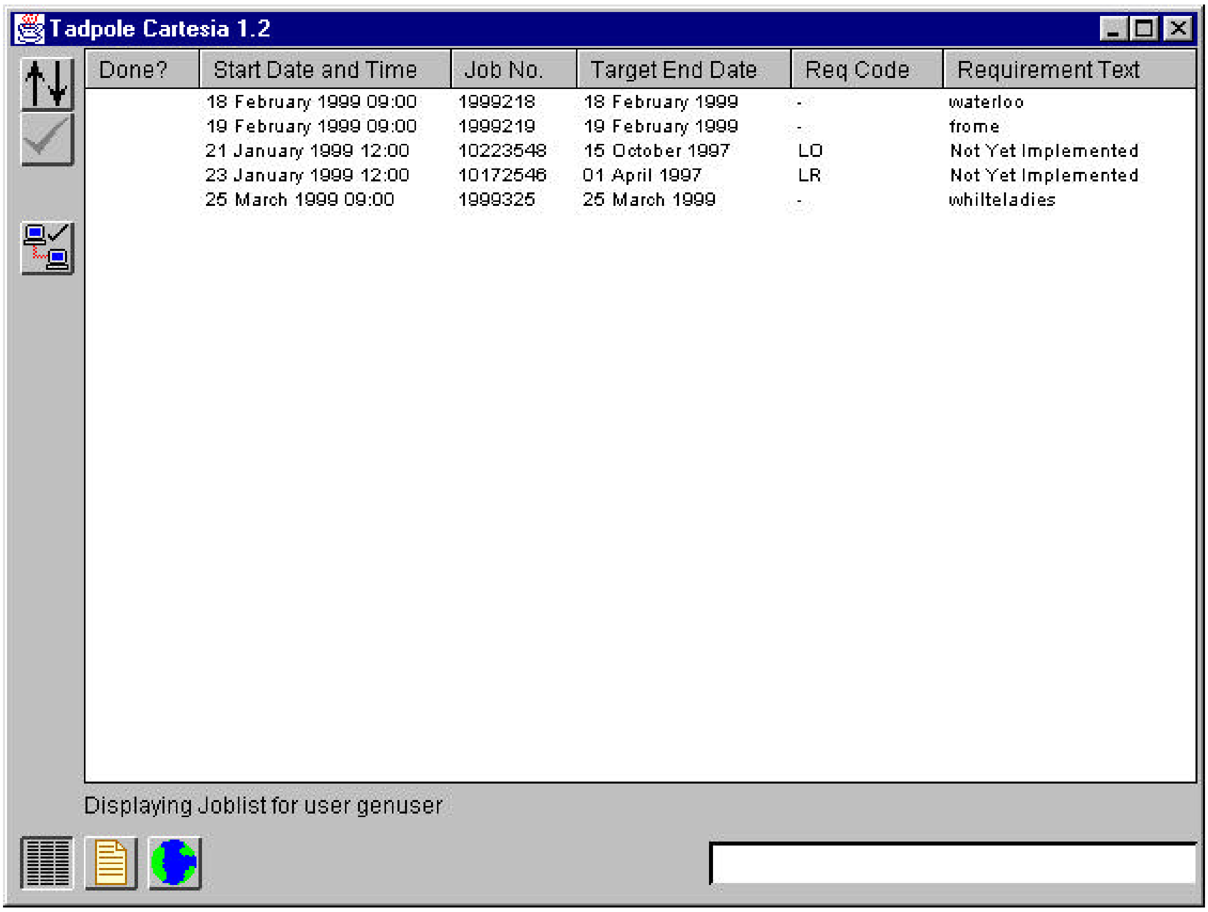


FIG. 4: REDLINE JOBLIST

The engineer can also select different views of the job, such as a map view (Fig. 5) or a job card view (Fig. 6). Other views may be added in future releases (See Section 7 below)

4.4.1 Redline Spatial Module

The Redline spatial module allows field engineers to view and redline the spatial information associated with specific jobs. As can be seen from Fig. 6, the application is controlled by buttons arranged in two columns down the left hand side of the screen. The leftmost column is the "navigation bar"; this controls the generic features of the module. These include such as panning, zooming, distance measuring tool etc. The right-hand bar is the "task bar", each button here corresponds to a specific task.

It is likely the navigation functions will be the same for most users, whilst the task bar will be customised to support specific user groups. Each task program will normally lead the user through each step of the task; users can be compelled to complete a step completely and correctly before being allowed to proceed to the next. This approach allows the module to be configured to precisely match the process and QA requirements of the organisation.

The spatial module operates on object-oriented vector data (e.g. company assets such as pipes, poles,etc), which includes appropriate attributes for the job. This is available at all times, by means of an Inspector button. Redlining capability includes a freehand sketch tool, and full vector editing with embedded forms. However, these functions are normally tied in to a particular task, and are not normally available as a discrete function. (Although this is not mandatory.)

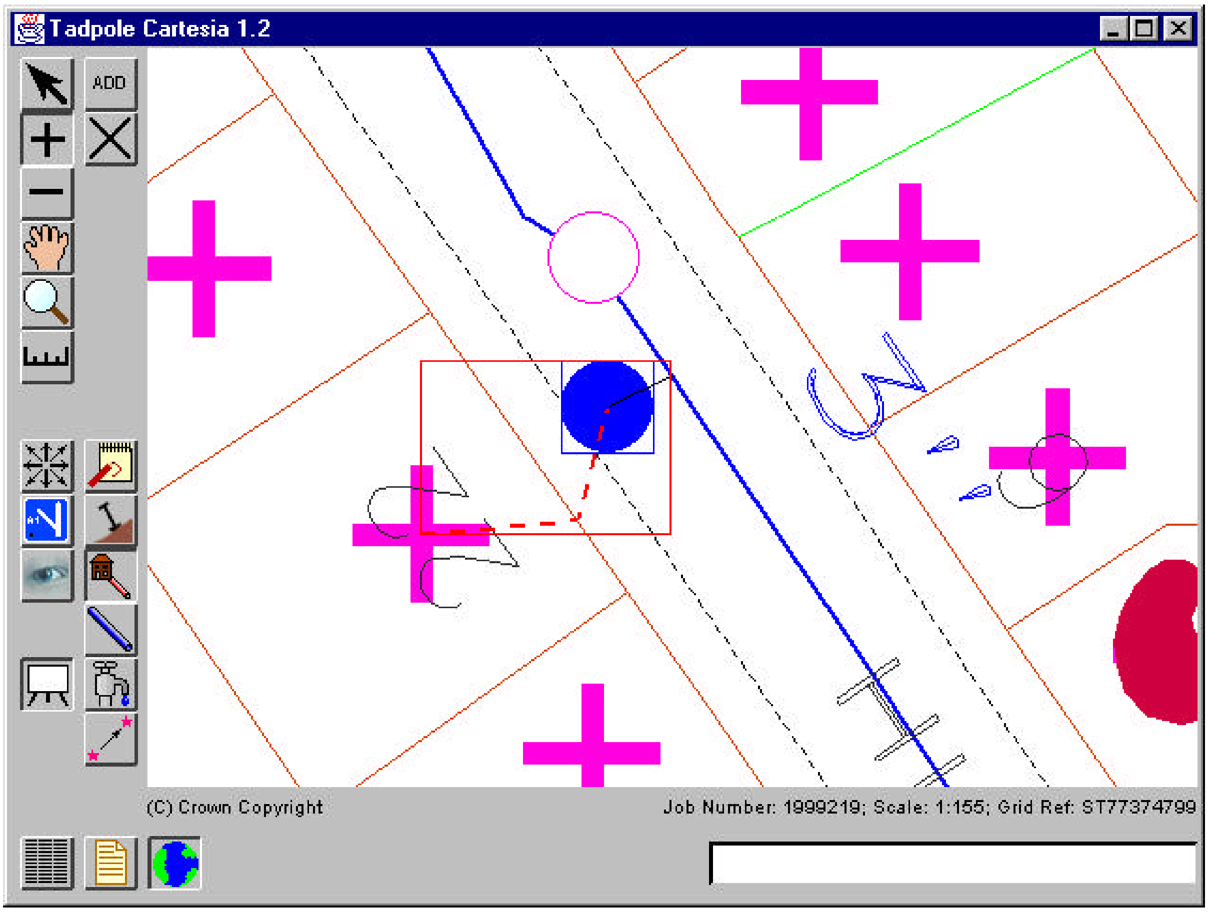


FIG. 5: CARTESIA SPATIAL MODULE

Embedded forms allow, for example, collection of information on corporate assets. Forms can incorporate dynamic validation, which prevents entry of invalid field combinations.

Redlined changes are stored ready for upload to the QA application (See next section.)

The module includes a gazetteer function, which enables users to rapidly pan or zoom to specific location based on street name or some specific asset, such as a sub-station or reservoir.

If the information is not held locally, as would normally be the case in emergency situations, the product offers the use two choices. He may elect to automatically “order” an extraction, based on a gazetteer entry, or the online preview function may be utilised.

In the former case, the EFS will carry out an extraction, and make it available via his job queue in the same way as for planned work. In the latter case, a browsing function is automatically selected.

In this mode, the user sees exactly the same display and controls as before, but does not actually view a downloaded vector map-Instead they see a raster image derived directly from the corporate GIS, using Web technology. When satisfied that they have selected the correct area, the user then selects, and “orders” the new map in the same way as before. A message warns the user that she is in pre-view mode.

Using the approach gives the user access to the complete enterprise database, whilst still realising the advantages of thin client technology. The pre-view mode facilitates interactive selection of map area, without the overhead of downloading full vector information. This is clearly quite important on a low-bandwidth channel, such as GSM.

4.4.2 Redline Job Module

The Redline Job module allows entry of job card information into the system. This is obviously much easier than spatial information. Completed information is stored in the completed folder, together with redlined spatial information.

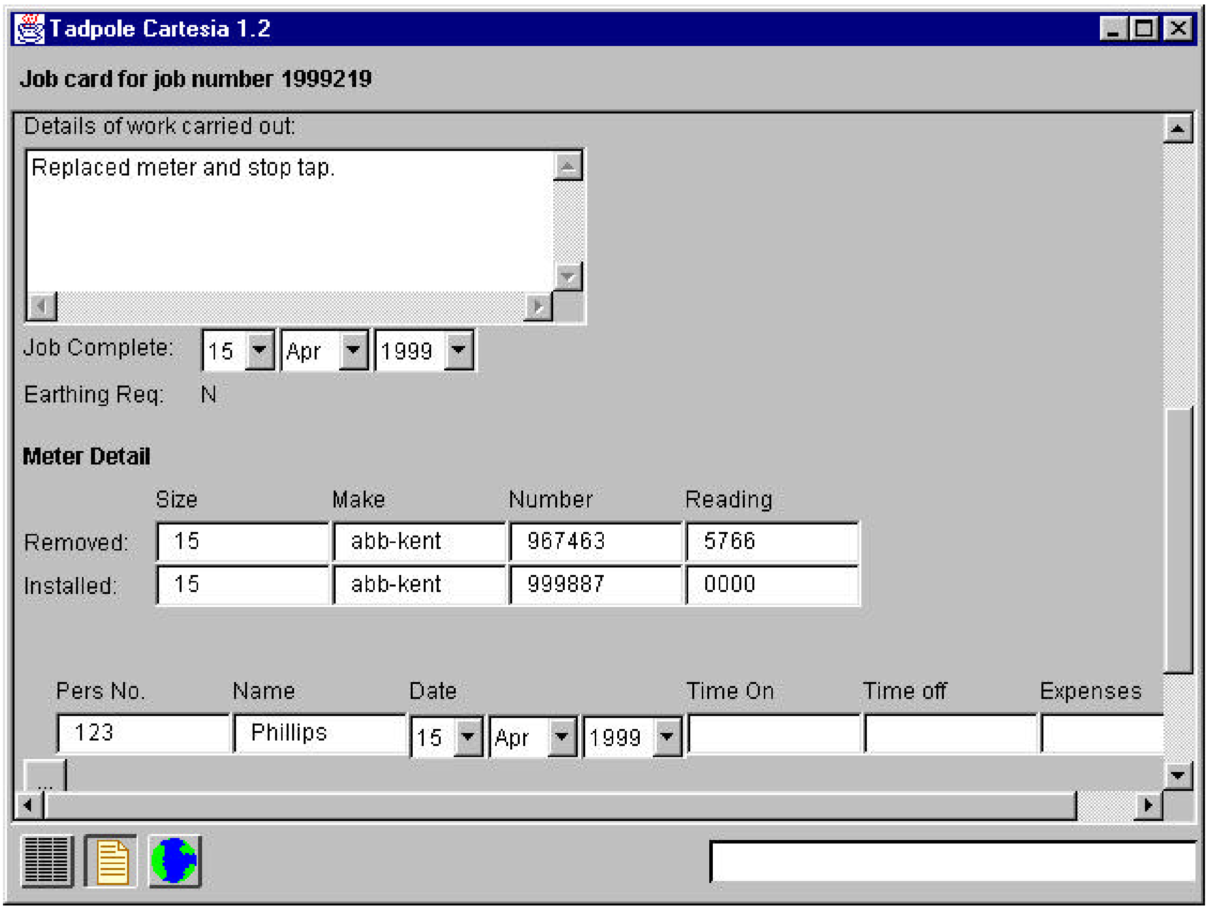


FIG. 6: CARTESIA JOB MODULE

This information does not require any further QA checking, and is normally fed back directly into the JMS via the EFS.

Unlike GIS information, job status information is often very time critical; it will often be fed back to the EFS as soon as the job is finished.

4.5 Cartesia QA Module

Most utilities are unwilling to allow redlined information to be entered directly into the corporate systems. In the old paper-based approach utilities typically employ a operator to take the redlined paper maps and other input from the field workers, and update the corporate data.

The QA module essentially emulates this approach, but imports the information electronically, merely requiring the operator to check it. Cartesia can also handle the case where multiple operators are used to check information hierarchically.

Fig. 7 shows a screenshot of a QA module implemented for the Smallworld GIS.

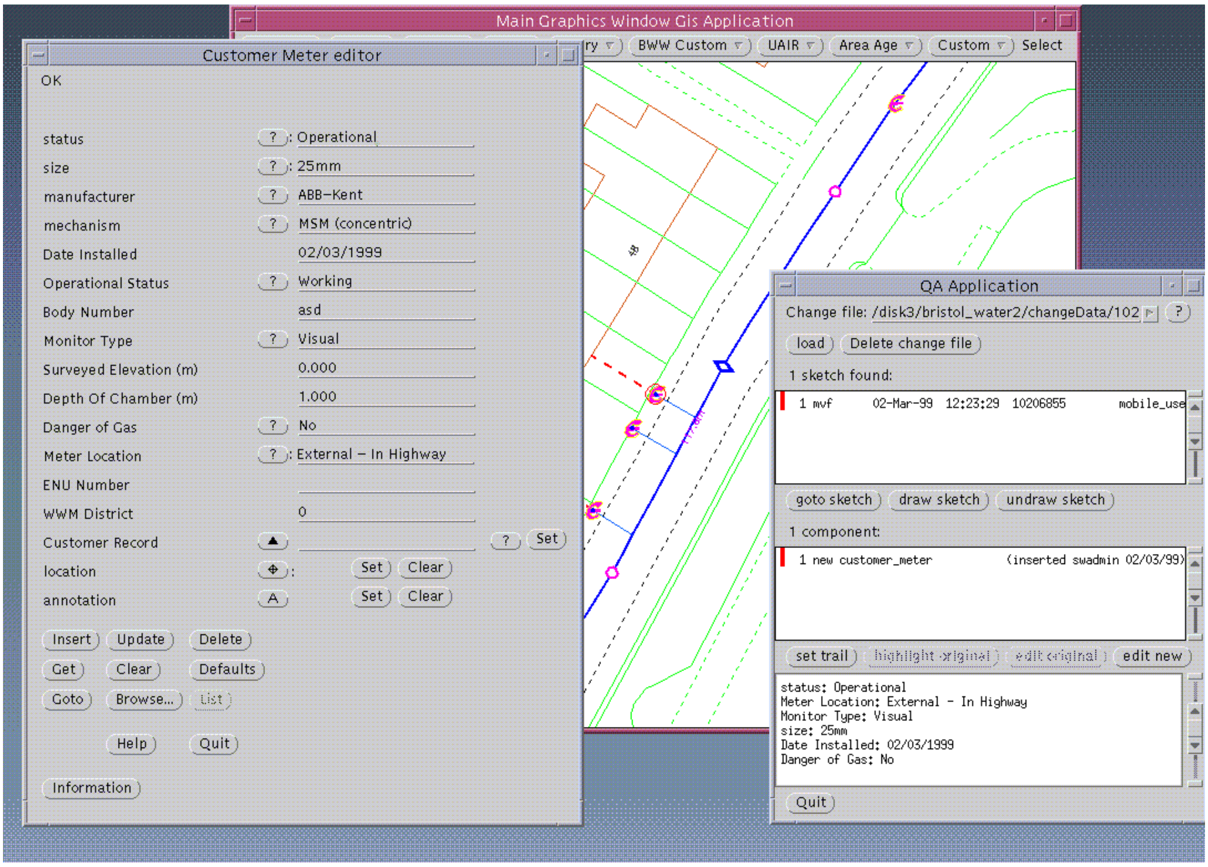


FIG. 7: SMALLWORLD-BASED QA MODULE

5. HARDWARE ISSUES

5.1 TRADITIONAL HARDWARE SOLUTIONS

Whilst Cartesia solves many of the problems of field information systems, there is still a need to consider hardware platforms. Traditionally, field systems have utilised three types of machine- the PDA, the Laptop and the pen-based PC.

PDAs, as mentioned above are really only suitable for displaying job cards, since their graphics performance is not good enough for displaying maps.

Laptop computers, whilst they have been used for field systems, are not really ergonomically suitable.- It is difficult to use a laptop standing up in a field! Full keyboards are not necessary in this context.

Pen-based computers are the optimal solution in this regard, in that they are much easier to use in a field context, and for this reason have been the solution most often adopted. However, *PC-based* pen computers still suffer from a number of deficiencies, engendered by the Windows platform on which they are based.

Windows platforms are often said to suffer from the “bloatware syndrome”, whereby OS and applications demand more and more memory and disk space to support features that are rarely if ever used. Whilst, this may be acceptable on the desktop, in a ruggedised machine it has important cost implications.

An even bigger issue is related to usage. PCs are designed to be used on the desktop, by workers running personal productivity applications such as word processing and spreadsheets. Even so, many have difficulty in using and configuring the platform. IT departments often spend significant amounts of time supporting their PC populations. Users often suffer from relatively frequent errors that give rise to a re-boot.

These issues cause significant problems in the field. Field engineers do not generally have the skill or the inclination to solve IT problems; the difficulty of supporting them remotely compounds these problems.

Other difficulties with PCs relate to battery life. Rugged pen PCs can usually only operate for approximately three hours, without recharging. This can make it difficult for engineers operating for extended periods away from their vehicles.

There is also a related problem of screen brightness. Colour screens are difficult to use in sunlight if they are not sufficiently bright. Achieving high levels of brightness is dependent on allocating sufficient power, which is a big challenge in the PC context.

5.2 J-SLATE- A COMPUTING APPLIANCE FOR FIELD WORKERS

In order to solve these problems, and to compliment the Cartesia software, Tadpole have introduced J-Slate.   J-Slate is completely different from PCs, indeed, it is more of a “computing appliance”, than a traditional PC. Fig. 8 shows the product, whilst the Appendix provides a summary of its key features. The following section provides an overview of the product, and how it overcomes the issues identified in the last section.

J-Slate is a diskless, pen-based computing appliance. It uses the low-power, highly integrated StrongARM processor, and this, plus the fact does not have a disk means that it can support a bright screen, and achieve at least 8 hours battery life – enough for a complete shift.

The product does not use the Windows operations, but instead runs a Java Virtual Machine on top of VxWorks – a highly successful embedded operating system.

For the user this creates a different experience – "You just turn it on and use it!" It is more like a mobile phone, or a scientific instrument than a PC. Users only need to learn how to perform quite simple operations, all of which are closely connected to their job roles; they do not need to learn the details of the OS, which is completely hidden from them.

The Java environment of J-Slate also brings some significant advantages for systems administrators. Applications do not need to be "installed" instead, they merely need to be published over the network. Resident data can be similarly updated.

Because of the relatively small footprint of the maps which Cartesia produces, J-Slate can typically store up to a weeks worth of job information without connecting to the EFS - more than enough to support most users.

Whilst J-Slate will not meet everyone's needs, it will not be suitable for manager who need to run personal productivity applications, for example, it provides a very effective solution for field engineers.

The portable nature of Cartesia means that utilities can "mix and match" hardware to meet the needs of their users.

6. Business Benefits

6.1 Business Drivers for Utilities

A major consequence of utility deregulation has been to accelerate the drive to achieve substantial overall productivity improvements, whilst simultaneously delivering higher levels of customer service through faster response times and improved network performance.

Since more than 60% of a utility's workforce spend at least some of their time in the field, improvements in field performance can have a marked impact on both corporate productivity and customer service.

As discussed earlier, field systems have mostly remained paper-based . Where traditional PC-based mobile systems have been employed , benefits have been limited because of high acquisition and operating costs and uncertain information synchronisation.

When compared to either of the above field system solutions, Tadpole-Cartesia delivers much improved levels of business benefit by achieving higher levels of operational performance and lower Total Cost of Ownership (TCO)

6.2 OPERATIONAL BENEFITS

By providing the ability to extract and update data from the Corporate Geographic Information System (GIS), Tadpole-Cartesia enables the utility to improve the return on the considerable investment in GIS. Through efficient capture of data from the field , accurate data update and ready accommodation of Data Model changes the FIS operates very much as an integrated system.

The three tier architecture frees the field staff from “wrestling” with operating systems, dealing with new software versions, manipulating data held on disks or waiting for the computer to “boot or re-boot”. Additionally, the worker-specific user interface enables the user to interact with the system as he would with any familiar tool or device. The ease of use ensures that the system is not only used but is used with enthusiasm and productivity gains are achieved.

The productivity gains will vary depending on the role or task being undertaken, but improvements of 15-20% are demonstrable. Section 6.4 below illustrates some real world business benefits, which have been identified.

6.3 TOTAL COST OF OWNERSHIP(TCO)

Tadpole-Cartesia minimises TCO in four ways:

- The use of highly ruggedised hardware, without the need for disks or keyboards, promotes high levels of system reliability. Maintenance and support costs are thereby reduced.
- Operational and administrative costs are minimised by managing software, data and data models centrally, as well as simplifying field operations through role-based user interfaces.
- Hardware acquisition and maintenance costs are lower than systems will similar features that are PC-based.
- The three tier design means that Tadpole-Cartesia can be introduced without replacing corporate legacy systems.

Gartner Group have conducted studies into the total cost of ownership (TCO) of mobile systems and believe that , on average, around 25% of costs are expended on capital acquisition , just above 25% on technical support and administration services and just below 50% on end user operations. **Their research into network computer architectures, have shown savings of over 33%, compared to traditional PC-based approaches.**

Tadpole-Cartesia addresses all elements of the Gartner TCO model and, compared with PC-based mobile solutions, achieves reductions in capital costs, support costs, system administration costs and system operating costs.

Whilst TCO savings will vary from company to company, we anticipate that savings in line with those found in the Gartner Group research should be realisable.

6.4 A USER VIEW

Cartesia has proved to be a very useful tool for managers and operational field workers, replacing paper with electronic maps and job cards. Overall the following benefits have been identified by Cartesia users:
:

Shortened job completion time cycles
Speeded up job scheduling, despatching, actioning and closing
Returns to base/Depot greatly reduced
Enables "Home start" to be considered
Savings on vehicle wear and tear, mileage, fuel
Response time to customer improved
Removed the need to print maps and no need to carry maps
No need to carry line diagrams
Reduced all paperwork
Created accurate data by "forcing" input and validating all entries
Improved accuracy of field worker data and central/HQ data
Accurate job information
GIS Asset management information much improved
Increased data capture accuracy
Provided up to the minute information
Achieved high reliability
Reduced data transfer times
Accommodated data model changes
Integrated with other corporate systems

There are additional benefits of improving the productivity of Field Workers. For example, fewer Depot visits and "Home Start" also reduces travel costs and vehicle wear and tear. Overall the case for Field Information Systems can be justified and we believe that Tadpole-Cartesiia provides a flexible solution that has a lead over anything else available .

7. FUTURE DIRECTIONS

The initial product release of Cartesia and J-Slate has achieved a significant advance in field information systems. The following sections give a flavour of some of the development strategies, which we are pursuing.

Tadpole are committed to developing these products, and aggressively exploiting Java and web technologies. Our goal in all of this is to address all of the elements of the TCO equation, in order to achieve greater levels of effectiveness and performance for our customers.

7.1 DEVELOPMENT

Large projects, such as Field Systems, have traditionally been difficult and expensive to implement. Typically, the choice has tended to be between a totally custom solution (an expensive option) or a standard product, which often means that business processes have to be modified to fit the product.

Utilities core expertise is in management of their businesses- essentially the business processes they employ. Ideally, they would like to take a standard product, and configure it to fit in with their processes, with a minimum of programming effort.

Future releases of Cartesia will include a sophisticated toolkit to enable specific projects to be rapidly developed with a minimum of coding effort. The tools will de designed to compliment IDE (independent development environments) and will address workflow, user interface and enterprise integration challenges.

7.2 MANAGEMENT

Another focus of Tadpole development is in the area of system management. As mentioned above, managing field users is a difficult challenge for corporate IT departments, and is another potential source of inefficiency.

Whilst this problem can never be solved completely (if a hardware unit is completely broken it has to be returned to the depot for repair), the flexibility of Java, its ability to download code, and configure hardware remotely can go a long way in mitigating its effects. Future releases of Cartesia will support tools to help in this area.

Finally, we are also looking to addressing real time or incident management. We envisage integration of Cartesia, J-Slate and advanced GPS technology to manage field engineers more effectively, especially in emergency situations.

7.3 Document Views

Cartesia currently supports spatial and job card views. These are the most popular types of information which our customers normally require. We are also considering the implementation of other views. The most obvious example is a "documentation viewer", which would allow engineers to view extracts from, for example, equipment maintenance manuals.

Extensive use of emerging web technologies such as XML, JINI and JES (Java Embedded Server) will be utilised to achieve these goals.

8. Conclusions

The requirements for field systems in Utility and Telco organisations are clear. In response Tadpole has developed an integrated family of software products that meets the requirements of Field Workers. The software has been designed from the ground up, not only to provide the needed functionality, but also to be useable by Field Workers. The user reaction to the software has been one of the most pleasing aspects of product introduction.

The software will run on any Java equipped hardware, including all windows platforms, however, because we believe that these are not always appropriate in the field environment Tadpole provides the J-Slate hardware as a cost effective alternative that removes the need for the Field Worker to have any computer knowledge. J-Slate is a new breed of Field Appliance that lives up to the phrase "You simply turn it on and use it".

The business benefits are clear and can be quantified in real operational situations. The solution is all about putting useable technology into the hands of the workers who can deliver productivity improvements and consequently improved profitability and enhanced customer service for. The Tadpole-Cartesia solution delivers the benefits at a lower Total Cost of Ownership than alternative solutions, and we look forward to working with you.

For more information:

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Website: http://www.tadpole.com

9. REFERENCES

(1) For information on Java: http://www.javasoft.com
(2) Cartesia Gateway Technical Whitepaper Part No. 980701 Tadpole Technology PLC

APPENDIX:
J-SLATE DATA SHEET

J-Slate hardware is a rugged "thin client" pen computer with a 10.4"(outdoor readable) colour display. J-Slate uses the low cost, high performance StrongARM RISC processor. It is designed to operate as a diskless product, which delivers increased reliability, robustness and low cost.

The StrongARM processor is widely supported by Java enabled operating systems and offers some of the highest Java benchmark results. Its architecture is ideally suited to a pen computer running graphics intensive applications due to its high performance, high levels of integration, low power consumption and low cost.

An internal Type II/III PCMCIA socket can be factory configured with either modem Ethernet, or wireless communication options. The customer-specified option is internally wired to docking and external connectors for ease of connection. This gives a great deal of flexibility to support a large range of options without unnecessarily burdening the unit with the cost of unwanted interfaces.

An external (customer useable) PCMCIA socket (Type II/III) is also provided for increased flexibility.

Memory storage capacity can be increased through use of industry standard Compact Flash cards. This will allow the user to cache more data on the product if required.

J-Slate Technical Specifications

Mechanical	Ruggedised Magnesium Alloy Case
	Specified for 1metre drop test onto concrete
	Water resistant
Processor	StrongARM (SA1100) 190MHz
Memory	16-64MB DRAM 16 or 32MB on Motherboard
	DRAM Expansion Connector for 16 or 32MB DRAM Module
	Sleep mode preserve DRAM content when powered off
	8-20MB FLASH with 8MB on Motherboard and

	FLASH Expansion Connector for 4/8/12MB FLASH Module
Display	10.4" VGA or SVGA outdoor viewable 16-bit colour TFT. Adjustable brightness control Resistive Touch Panel with 10-bit x,y digitisation
Audio	12-bit audio can mix internal audio with PCMCIA audio and GSM phone audio to speaker & microphone 14-bit modem front end connects to optional DAA for soft modem feature
PCMCIA	Two Type I, II or III PCMCIA 2.1 sockets - one internal for factory configured options - one user accessible - Audio mixed with internal audio to speaker & mic.
Compact Flash	Two Rev 1.2 compliant sockets (configured to work in True IDE mode) - 3.3v modules only
IrDA	4Mbits/s IrDA interface
USB	USB Host controller
Controls	Front Panel Pushbuttons for: - On/Off - Right Mouse - Function - Backlight On/Off - Increase Brightness - Decrease Brightness Front Panel (LED) Indicators for: - Radio activity - Battery charging - Status indicator - Low battery warning - Spare Hidden Reset Pushbutton
Interfaces	RJ-11 connector (connects to internal PCMCIA modem or DAA for softmodem) - soft modem

	User accessible PCMCIA socket
	
	IrdA port
	
	Serial Port (9-way D-type)
	
	Host USB connector
	
	Keyboard/Vehicle Docking Connector Docking I/F
	- 3 x RS232 Serial Ports (2 via docking connector)
	- TTL Serial Port
	- Ethernet (if internal PCMCIA ethernet card fitted)
	- VGA port
	- PS/2 Keyboard
	- PS/2 Mouse
	- IEEE1284 compatible port (via docking connector) with support for:
	    - Compatibility mode
	    - Nibble mode
	    - Byte mode
	    - Enhanced Parallel Port (EPP)
	    - Extended Compatibility Port (ECP)
	
	Soft modem output to connect to external DAA
	
	External Power Input (+15VDC @ 2.7A)

Audio	Sources for speaker are: - Motherboard generated audio - PCMCIA Card - Internal GSM phone module Microphone
Batteries	Option of the following Li-ion "clip in" battery packs: - 6 cell 2400mAh Battery pack - 9 cell 3900mAh Battery pack Internal 5 cell Ni-cd bridge battery to support swapping of Li-ion battery packs
Optional internal peripherals	GSM telephone module and antenna 900MHz RIM Radio module and antenna

	GPS module and antenna
	PCMCIA card for PSTN/Ethernet/GSM
	2 x Compact FLASH cards configured in True IDE mode
Optional external peripherals	Keyboard/Port Replicator
	Vehicle Docking Cradle
	Carry Case
	Antenna
	Optional Antenna when internal Radio or GSM phone fitted
Environmental Specification	Operating temperature. 0 to 50 deg C
	Storage temperature -25 to 70 deg C
	Operating humidity 0 to 95% non-condensing
	Vibration MIL-STD-810e Basic transportation
	Water resistance - rain drip
	Operating altitude to 4500m