SIDCOM

Innovation using Tracking and Sensing Solutions

An Information Booklet for Managers

Contents

Acknowledgement

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Disclaimer:

The publication of this booklet was first undertaken in 2003. The information contained herein regarding the capability of the technologies, device availability, costs and performance were to the best of the author's knowledge accurate at that time. However, with the dynamic nature of the semiconductor devices market and the general technology developments in this area it is advised that an independent study should be conducted by individuals or companies considering the adoption of the SIDCOM non contact data transfer and sensing technologies in their products.

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1. Commercial Opportunities for Exploiting Non-contact Data Transfer Technologies

1.1 The Potential Economic Benefits

The results of the SIDCOM project, supported under through an EC IST funded Best Practice project, have demonstrated the significant economic benefits that will be derived by the innovative application of non-contact identification, data transfer and sensing technologies.

The economic impact achieved by the 14 individual company user experiments incorporated in the SIDCOM project's work programme resulted in an average payback period of 21.75 months and an average ROI (return on investment) over 3 years of in excess of 240%. These calculations of returns were based on the inclusion of all development and product industrialization costs including marketing related activities (averaging 71.5 K Euro). The return on investment on the development budget was 450%.

Whilst these quantified economic results are impressive in themselves a series of other economic benefits impacting positively on the user companies' performance were also reported. The frequency of these positive outcomes are illustrated in the following table:

Reported Economic Benefit	Percentage of Companies Deriving the Benefit
Increased Sales	100.0%
Increased Market Share	85%
New Markets Reached	46%
New Services Delivered	46%
Improved Export Potential	69%
Reduced Product Costs	23%

Reported Economic Benefits of the Adoption of SIDCOM Technologies

One of the most noteworthy aspects of the benefits reported is the impact on the innovation impact of the adoption of the SIDCOM technologies indicated by number of companies delivering new services or entry into new markets.

The SIDCOM results lead to the general conclusion that the adoption of these new technologies may deliver significant benefits to the companies incorporating the new technologies in their products or processes.

The widespread exploitation of RFID (radio frequency identification) technology in commercial applications, such as electronic article surveillance, animal tagging and high volume logistics supply, has resulted in the availability of very low cost device technology that can be exploited by companies seeking to add value to their products or operations. The latest generation of chipless RFID tags promise such low costs that the tags can be applied to permanently identify food stuffs and clothing articles.

The reducing cost trends of the devices indicates that in the future the potential to incorporate such technologies in products will offer significant commercial opportunities for companies to innovate. Indeed, in the future the reduction in costs combined with the added values delivered by the technology could result in the widespread adoption of this device technology in products, leading to a move towards a situation where “chips with everything” is a reality.

1.2 Current Applications of Non-contact Data Transfer Technologies

The most common form of non-contact data transfer technology in current application is that of RFID device technology. RFID technology delivers passive devices (devices that do not require a permanent power supply) for the storage of data, including a permanent unique identity code, to allow tracking, identification and control functions to be performed on the item ‘marked’ by the device. Typical application areas for the use of RFID technology includes:

- Animal tracking, especially in applications such as the labelling of pets so that they can be identified or to ensure vaccination, dairy cow feed and yield recording, and for livestock tracking from breeding to the supermarket. The importance of tracking has been highlighted in recent years with the outbreaks of 'mad cow' disease.
- Logistics supply. To allow the processing of high volumes of items ion application ranging from parcel services to supermarket retail supply chain management. These systems provide real time information on the status of every single item essential to fulfill customer's requirements and precise automatic stock control.
- Security applications such as electronic article surveillance (EAS). The market size already exceeds 6,000 million units per year for this application.
- Vehicle access and security applications. Around the world, more than 100 million transponder-based keys are protecting vehicles against car theft using RFID technology. In addition future transponders will hold additional information such as the drivers preferred seat and steering position, in-car temperature and entertainment requirements.
- Personal identification, security and access control. This application includes building security systems and for leisure applications such as ski passes.
- Road tolling, where window mounted transponders can be used for traffic management.
- Electronic article surveillance (EAS) where it is already reportedly reached a market size of over 6,000 million units per year, with strong continued growth.

The penetration of RFID technology into such high volume areas has reduced the unit cost significantly, making the use of this technology a viable commercial possibility in innovative application areas.

RFID implementations will add extra costs in comparison to bar-coding but significant benefits can often arise from the automation facilities it enables, for example in advanced object tracking, quality maintenance and production control.

Another under-utilised non-contact sensing and data transfer technology is that of capacitive sensing technology. One potential advantage of the application of capacitive data transfer is the low cost of the aerial, which in the ultimate design could consist of low cost foil plated packaging. One notable, example is the demonstration of data transfer from a tag device located on a cereal packet using this technology.

Capacitive sensing applications offer a wide variety of applications. These applications include:

- Flow or pressure measurement where the movement of a diaphragm with stable deflection properties can be measured
- Liquid level measurement, where the liquid level in a reservoir by measuring changes in capacitance between conducting plates which are immersed in the liquid or fixed to the outside of a non-conducting tank.
- Spacing or thickness measurement. For example, if a metal object is near a capacitor electrode the mutual capacitance is a very sensitive measure of spacing. Electrostatic measurement techniques such as this can also be applied in reversing aids for vehicles, where the distance between the vehicles bumper and an object can be sensed.
- Limit switches. The proximity of a metal machine object can be detected as an increase in capacitance, and the proximity of a plastic component by virtue of its increased dielectric constant over air.

An innovative application of capacitive sensing is in the detection of ice on aeroplane wings where ice formation can be detected using insulated metal strips in wing leading edges.

However, capacitive or electrostatic sensing solutions can also be applied in non-sensing applications. For example, many lamp dimmer switches uses 50 Hz excitation to respond to a human body.

These applications indicate that innovative control, sensing and data transfer solutions can be developed using capacitive non-contact sensing solutions.

In order to make the introduction of systems using this technology profitable, the challenge is to develop technical solutions that achieve high-performance at a low cost. Low-cost solutions usually imply the system has to be passive (that is, having no internal power supply). In addition the technology has to operate and perform well in different kinds of environments to achieve the required robustness and reliability.

These technologies will make further progress in the next five years. These developments provide an opportunity for companies to exploit high volume, low cost technologies in product ranges that otherwise could not deliver the volumes required to achieve this cost competitiveness.

The challenge facing entrepreneurs is therefore how to apply this technology to deliver innovative, new products that can deliver sales growth and improve customer satisfaction levels.

The experience of the companies partaking in the EC SIDCOM project provides some insights and exemplars of the adoption of this innovative application of technology.

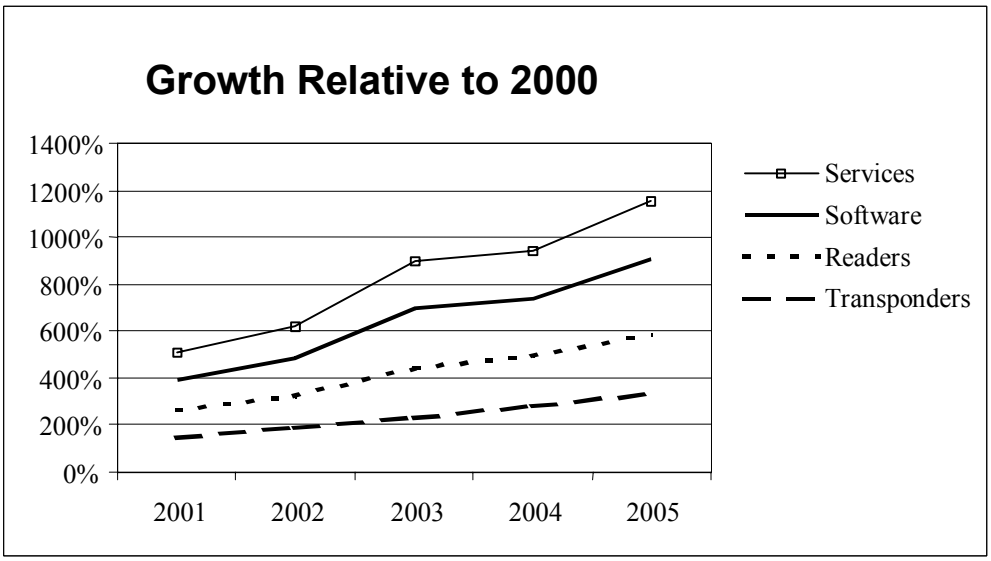
1.3 **Market Growth Projections**

The economic advantages of utilising RFID technology has resulted in a significant growth in the market for products and related services. It is this economic growth that will provide cost reductions and maturing technologies that can be applied in other innovative applications.

The global market revenue for RFID systems was $965 million in 2002[1], and is still growing. As issues of compatability and acceptance of ISO specifications to consolidate industry and application standards are increasingly adopted then new product lines and new application developments will further occur.

There has been an increased take-up in the use of the technology in recent years, with application areas varying from use in libraries, laboratories, manufacturing to laundries. The primary use of the technology in these application areas was that of item or material management. In addition, the co-operation of logistics and materials handling system designers with RFID technology solution suppliers has also resulted in the increased use of the technology in the areas of logistics, warehouse and asset management and industrial automation.

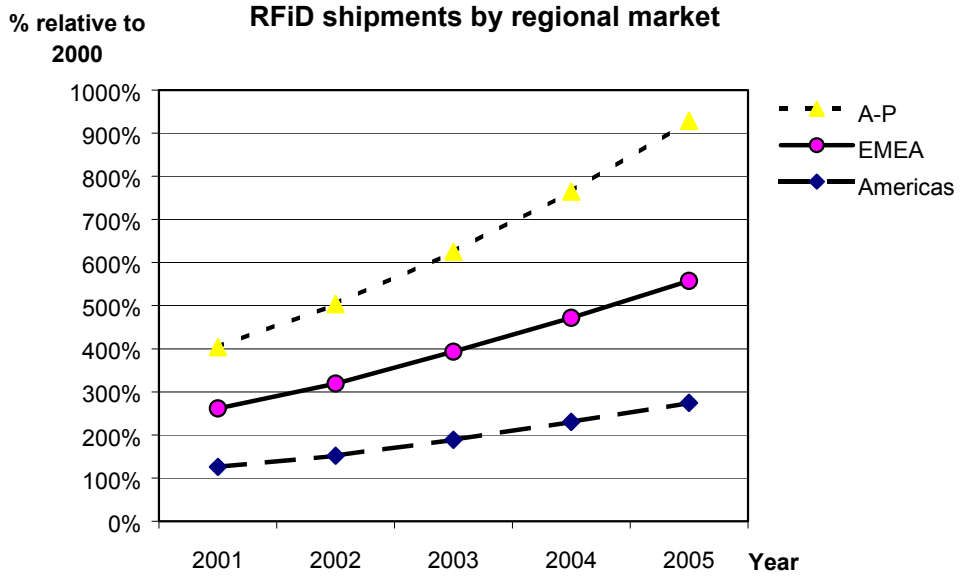
The growth in sales achieved and projected in RFID technology is indicated in the following chart. Currently there is an annual market growth of 24%, which is the highest of any automated identification technology.



This market growth is not uniform. It is anticiapted that there will be a higher increase in the level of adoption and user acceptance in Europe than any other region. This will

[1] Source: Venture Development Corporation, 2003

lead to an incerase in Europan sales of over 100% in the next 5 years, and this growth rovides a major opportunityu for companies to innovate using this technology.



Key:

EMEA – European and Middle East

A-P - Asia / Pacific

APPLICATION	Number of units estimated in 2003
Supply Ghain Management	440 million
Parcel Services	240 million
Rental applications	176 million
Re-usable media applications	120 million
Airline	83 million
Emerging and other applications	190 million

Projected Use of Smart Labels with Embedded RFID Devices

The low cost and flexibility of smart labels are gaining increased attention for applications such as baggage labeling, and is now being seen as a significant growth area for item management of various kinds.

However, the area of ”emerging and other applications” is indicated to be 19% of the total projected number of smart labels sold. This is a very high available market opportunity for exploitation.

Chipless technologies are emerging that may well influence the growth in the future. As chipless technologies gain visibility and are further developed the prospects for significant low cost, near-contact, label-based applications in, for example, the areas of small item securicy and document handling are clear.

The fusion of technolgoical development and standards, and the commercial acceptability of the technology (as indicated by market growth projections) indicate new application areas for this device technolgoy will emerge in the next few years. Innovative companies made aware of this technology can fully exploit this opportunity.

1.4 Innovative Application Opportunities for Non-contact Sensing and Data Transfer Technologies

Analysis of data communications and data handling processes is a significant key to identifying appropriate applications for the use of RFID technology, and to establishing the requirements that have to be fulfilled to realise the technical solution.

One of the main challenges is to define the value of data to the system, the data structure required to deliver this value, the system and associated technology requirements and finally the economic and people-based needs that have to be satisfied. Value can be added in several area, including:

- Introduction of mobile data bases located in the product, removing the need for complex, integrated database systems
- Reductions in manual handling through improved automation possibilities.
- Reduction in error count and quality costs as a result of improved quality control system implementations.
- Reduction in costs by removing active data transmission requirements and the introduction of passive, non-contact data transfer mechanisms.

- The development of new services based on contactless cashless card systems.

Case Study 1:

Markes International Ltd designs, manufactures and markets thermal desorption instruments to major industries, key regulatory agencies and service laboratory sectors, with applications ranging from environmental health and safety to materials testing and product quality control.

The company utilised RFiD technology to improve their thermal desorption auto-sampler product, Ultra TD. The improved product provides the security and traceability required to accurately track a sample tube from the sampling site and through out the analysis process. This will result in increased sales of both the Ultra TD and of the new tagged sample tube, increasing the company's market share.

Details of examples of such innovative commercial applications can be located on the SIDCOM web site (www.euro-sidcom.com).

Other illustrative examples of the use of these technologies include:

i. The integration of a capacitive sensor solution in an aid for the disabled to prevent the acciental trapping of fingers in the moving mechanisms.

ii. The application of an active tag with integral memory, microcontroller, sensors and RFID communications interfaces that allow the tag to monitor at regular intervals the environmental conditions experienced by the tag and its associated cargo whilst in transit. This product allows the verification that shipping requirements of critical items (for example, vaccines or frozen food) were adhered to.

iii. Innovative vending machine applications for controlling the dispensing and return of rental items such as videos or DVDs.

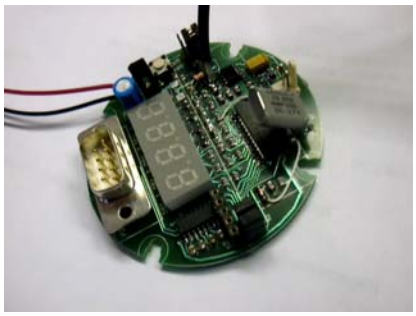
iv. Pumping controllers with integrated RFID technology that check a tank is only filled from the correct nozzle in order to prevent contamination of the product. For example, a recent patent applies this principle in petrol stations where a small transponder fitted alongside the filler cap of motor vehicle's fuel tank enables the pump to sense the vehicle's fuel requirements automatically so as to dispense the correct grade of fuel.

Case Study 2:

Sensitron s.r.l. is a leading manufacturer of industrial gas sensor products for use in a range of industrial applications.

Using electrostatic non-contacting sensor technologies the company has developed a product that allows fluid level sensing in fuel tanks (GPL, diesel and gas oils.

This will results in significant economical benefits to the company based on increased sales. The improved features of the fluid level sensor enabled through the use of the new technology adoption allow the product to be used in the home supply or industrial market places.



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v. Document protection. By using RFID technologies to indicate specific data, documents can be given a signature that can be used for verification of the documents. Systems can then be developed to prevent the photocopying of certain documents depending on their signature.

vi. Safety and personnel tracking systems, which use RFID solutions to detect the presence of individuals in a critical area and to take appropriate safety actions following this detection.

vii. Power tool use control using RFID technology to limit the application of equipment to only authorised users issued with an appropriate transponder device.

Case Study 3:

Assulub AB, a supplier of lubrication systems and lubricants, utlised RFID technology to ensure that its customers' preventative maintenance schedules were adhered to. This innovation delivered a major marketing advantage for the

viii. Condition monitoring systems, where data can be stored in a tag mounted for example on a moving shaft during normal operation for later evaluation. A variation on this them is the logging of operational hours of a product.

ix. The prevention of forgery of critical components, for example as used in the aerospace industry, by attachment of an RFID tag with encoded data to enabling receiver verification. One application involves the integration of tags within fire doors to validate the product and to verify the production methods employed.

x. Non-invasive sensing for medical applications, including the development of systems for sensing the fluid levels in plastic bags, or for detecting bubbles or droplets in drug and other dispensing products.

xi. Home automation systems that apply capacitive sensing solutions to enable controls to be embedded into furniture.

xii. Innovative proximity sensing solutions based on capacitive sensing solutions for door annunciation system or lighting controls.

xiii. Plumbing controls using capacitive sensing technology for level sensing in spas or pools, or leak sensing.

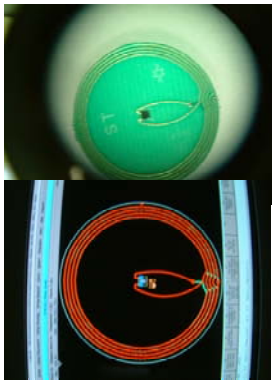
xiv. Electronic controls in disability aids using capacitive sensors to sense small body movements or to reduce the need for pressure or pull strength.

xv. Automotive product solutions, such as rear bumper parking aids or windscreen rain detection systems.

xvi. Location systems for recovering items. For example, a recently granted patent proposes a RFID technology solution to finding lost golf balls on a golf course.

xvii. Laundry control systems. A recent patent details the concept of embedding transponders into clothing so that laundry appliances can then interrogate the garment and set up the correct washing cycle, water temperature and spin cycles for the garments.

Case Study 4:
KFI TRADING (Kitting For Industries) is an Italian company specialising in delivering products and services to the continually expanding and highly competitive market of electronic systems for automation and identification. It developed a complete solution for garment traceability and process quality control using RFID techniques and state of the art microelectronic technologies. The company will now be able to deliver higher added value products to their customers.



xviii. Tyre pressure sensors using capacitive non-contact data transfer have been proposed.

A brief consideration of the potential for the application of non contact sensing and data transfer technologies indicated by these innovative proposals clearly indicates the innovation opportunities available to companies.

1.5 **The Cost Benefit Equation**

The incremental increase in product cost resulting from the inclusion of the RDID transponder is usually less than 2 Euro if volumes of 10,000 units per annum are achieved. Whislt detailed cost estimates for the additional part costs can be obtained, the major economic decision to be made is the product development cost and the analysis of the expected payback benefits that this can produce.

The economic payback is most easily calculated where the technology is to be applied in a product to be marketed through existing channels. Here, traditional market demand estimation methods can be used to project annual sales volumes, sales revenues and margins.

However, the economic benefits are often less clear when the benfits of applying RFID technology is considered by the end user. Here the benefits can be described in terms of such factors as:

- Improved security of items with the RFID tag fitted
- Improved capacity to track and locate items
- Reductions in transportation costs through improved distribution control
- Reduced sorting times, using automation techniques
- Increased reliability of item data.

A cost –benefit analysis for the customer

Consider as an example the case of a company considering the installation of a warehouse system which would reduce the need for manual work sheets to be produced.

A typical anlyses is in the area of error reduction cost saving analysis through the introduction of RFID technology. Consider the cost of retesting a sample that has been misplaced or incorrectly processed in chamical laboratory. The cost of this error could include the following terms:

Management time to re-arrange second sample correction - cost 20 Euro

Collection costs for the sample:- cost 30 Euro

Additional administrative costs (maintenance of records etc.) – cost 10 Euro

Customer complaint management –cost 30 euro

Therefore an error may lead to a cost of 110 Euro. If one such error was to occur every day then the annual cost would be of the order of 23,000 Euro.

Similar exercises can be done to calculate the cost of errors in other areas of a company's activities. For example, errors in data entry mistakes or in issuing incompatible work tools to operators can be estimated. In many cases the true cost of correcting mistakes or the price of non-conformance is much higher than most end users realise. In the worst cases, it may involve a total recall of product from the market; a very expensive proposition.

The realisation of this potential saving to clients has resulted in one company integrating RFID technology in its laboratory processing machinery to prevent incorrect processing. The introduction of the technology also allowed additional improvements in record traceability and improved database systems. The use of RFID technology therefore reduced user costs whilst delivering improved performance – a notable success for the company!

1.6 Applying the Technology to Deliver Innovative and Profitable Products and Services

The identification of new business opportunities suitable for the application of RFID and non-contact sensing technologies requires an identification first of the commercial needs faced by the customer of the products. This might include an assessment of the following factors:

i. Could the product or process be improved by the adoption of the technology. For example, can any of the following improvements be delivered:

- Reduced product / process cost by the removal of unnecessay contact based connectors.
- Improve technical performance through the sharing of data between moving units at appropriate stages in the process cycle.
- Improved process control through the application of control systems that react to data stored in the tagged item.

- Lower cost, non-invasive sensing solutions.

ii. Can the use of the technology deliver improved customer satisfaction by, for example, the delivery of:

- Stored information which can be applied to improve the process or to predict maintenance needs.
- Reduced errors in the distribution process thereby reducing product return or recall costs.

iii. Can the technology allow the company or its customer to become more effective in its operations by, for example:

- More effectively managing its processses by the provision of more accurate information.
- Managing its stores levels better, through the use of improved information supplied via the use of RFID technology.

iv. Can the technology allow the company to enter new markets.

Case Study 5.

BESTEL S.a.s. is small Italian company based in Florence, Italy. The company's traditional business was in the supply of "turn key" solutions for system integration in IT-Information Technologies.

The adotption of the innovative use of RFID technology ahs allowed the company to enter anew market for the supply of refectory pre-pay cards for schools.

These, and similar, opportunity identification processes can lead the company towards new business opportunities and improved growth prospects.

It is clear that RFID technology markets are maturing, rapidly growing and increasingly being accepted in general use. This background provides a major opportunity for companies aware of the technologies' capabilities to develop innovative products.