Trolley Scan (Pty) Ltd

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P.O.Box 59227
Kengray
2100 South Africa
Tel (+27) 011 648-2087
Fax (+27) 011 648-2085
Email:info@trolleyscan.com
Web:http://trolleyscan.com
Vat Reg No 4310153848

BROCHURE

Your one stop UHF passive RFID technology provider.

- Long operating ranges
- Multiple Transponders
- Small transponder size
- Complete systems of readers/transponders/antennas
- Systems capable of measuring exact range also available
- Software packages for operating RFID systems

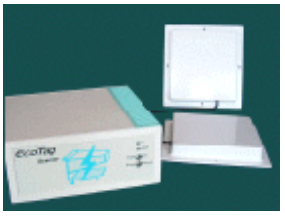
Although developed originally as a "barcode replacement" technology, this technology has application in all applications where computer systems need to have "vision".

Product range (immediately available)

Readers

Compact fixed reader - Compact fixed Reader with patch antennas, cables

Small portable system - Portable Reader with charger and cables (no PDA/notebook supplied)



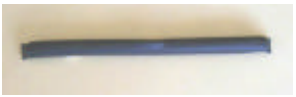
Transponders

Ecochiptags Credit card sized - 200uW sensitivity

Ecowoodtags Credit card sized for attachment to wooden items - 400uW sensitivity

Laundrytags 160mm long thin wire - waterproof - flexible -1000uW sensitivity

Long range Ecotags - Battery assisted stick type transponders with 25 to 30 meter range (5uW sensitivity) - and claymore type with ranges further than 40 meters (0.6uW sensitivity)



Lap top computer tags - 200mm long rubber passive tags for attaching to laptop and notebook computers giving detection ranges up to 13 meters

Small systems

Small fixed system - Compact Reader, 100 creditcard sized 200 uW transponders, patch antennas, cables

Small portable system (long range)- Portable Reader, 100 creditcard sized 200 uW transponders, charger and cables (10 meter range)

RFID-radar systems

Position locating system capable of tracking multiple transponders to accuracies of centimeters and ranges up to 100 meters. Supplied as a reader, antennas and 15 long range transponders with operating distances up to 40 meters, and 5 Ecochiptags. Also supplied with display software and source code. Uses the same transponder systems that are used by the RFID reader,

Software

All RFID readers and RFID-radar products do not need additional software to operate. They are supplied with interfacing details ands simple examples to allow the purchaser to just plug his new reader into a computer system and operate immediately.

Trolley Scan do supply additional software for those who want additional features such as transferring data through LANs, looking up details automatically in databases, and displaying relevant data on network computers remotely. In addition Trolley Scan will make available simple software packages for those users who want a solution to an application

and do not want to write their own software.

Application package currently available are production line management

Application packages planned are - asset control, access control, conference management, sports timing, and others.

Getting supplies

Buying from Trolley Scan	For low volumes of readers and transponders, supplies can be purchased immediately from Trolley Scan
Buying from licensees	For medium volumes of readers and transponders, supplies can be purchased from licensees of Trolley Scan
Producing it yourselves	Trolley Scan will licence your company to produce the transponders and readers in house or through sub-contractors. There is a range of options from assembling a kit of parts bought from Trolley Scan in a low technology facility to designing your own integrated circuits and high tech assembly operation. RFID-radar™ is **not available** for licensing at this time.

How do RFID passive systems operate

RFID technology makes use of two components, namely a reader and a transponder (also called a tag). The transponder is attached to the item to be identified and is programmed with a number to be broadcast when it is read by the reader. The transponder receives its operating power from an energising field that is radiated from the reader.

The reader energises the tags within its immediate vicinity and reads the identity of the transponders in the reading zone using a special protocol, converting the identity numbers to a computer format and providing that data to a computer network.

The transponder can also include anti-shop lifting (EAS) features.

A reader can be much simpler than a common cell phone.

Multiple Transponders

With operating ranges as far as 13 to 40 meters metres even when attached to metal, it is likely that more than one transponder will be in the reading zone at a time. In order to cater for the multiple transponder situation a “protocol” is needed to allow multiple transponders to be read at the same time.
Trolley Scan have developed the Trolleyponder® protocol specifically for the situation where RFID will be used to replace barcoding on groceries in a supermarket.
This protocol allows

- up to 1000 items to be read in a zone at a time

- all transponders can have the same identity (many boxes of 1kg Rice Krispies)
- Full 3D scanning to cater for different transponder orientations
- Controllable EAS features to allow for advanced theft protection
- Tag talks first protocol
- One time programmable transponders
- Frequency agile allowing operation worldwide

The current version of transponders from Trolley Scan use a Trolleyponder(RIST) protocol where some of these features are not yet incorporated.

EcoTag

Trolley Scan are world well-known for their EcoTag® energy enhancement features that have been included in Trolleyponder. RFID systems operate on frequencies allocated by the governments of the countries where they are in use. The European community have allocated a common operating frequency, but have set the power level to be used so low that prior to the invention of EcoTag by Trolley Scan, no passive transponders could operate on this frequency with sensible ranges. EcoTag is a breakthrough in the efficiency of the power extraction circuitry of the transponder allowing transponders to operate on the very low power levels with good range.

The EcoTag technology also allows transponders to operate over a wide dynamic range of powers and to operate almost independently of polarisation restrictions.

The technology has being patented by Trolley Scan.

In January 2006, Trolley Scan added a long range Ecotag version with an operating range of 25 to 40 meters based on battery assisted technology

RFID-radar

In 2006 Trolley Scan started to deliver a new concept in RFID reader systems: namely a RFID based system that could measure very accurately and quickly the exact range between the reader and the transponder. This will have a major impact in the future on RFID systems, as very long operating ranges become practical with the computer being given the identity and the exact location of each transponder in the zone.

Typical RFID specifications for passive transponders

Medium reading range for passive transponders	Typically 6 to 13 meter reading ranges even if attached to items such as wood or metal for passive transponders.
Multiple articles	1000 items can be read at the same time
Low cost technology	Transponders use a simple integrated circuit, using the cheap silicon technology that is widely available, have a small silicon area, simple design, wide tolerances,no tuned circuitry and are attached to a simple antenna.
Passive	The transponder receives its energy from the reader field, thereby not using a battery and so saving cost, increasing reliability and avoiding regulatory and environmental issues.

Very efficient power conversion	The EcoTag energy conversion system allows transponders to operate at good ranges on very low energising fields. Transponders needing just 200microwatts of power in its 134sq cm aperture will operate
Fast reading	One of the fastest reading rates for high volume multiple transponder systems available.
Large number range	The system allows for a very large range of possible identity numbers.
Common identity data	As the protocol does not make use of the number content to identify the transponder, either unique or common numbering can be used in the application., i.e all identical products can have the same identity and be counted at the same time.
Electronic Article Surveillance	Tags can be repeatedly neutralised or reactivated on command for use with an integrated EAS system (anti-theft) at exit points along logistics paths (loading trucks, retail checkout). EAS feature can also automatically reactivate after a predetermined time.
Simple structure	Transponders comprise only two electronic parts joined together, an integrated circuit and an antenna.
One chip fits all	As the transponders have no tuned components on board, the same transponder chip can be used for different applications by fitting the appropriate antenna to the needs of the application.
Frequency agile	The transponders contain no tuned circuits and use the backscatter modulation principle for communication, allowing the same transponder to be read by different readers operating at different frequencies, thereby making the transponder ideally suitable for International trade where different operating frequencies are used in the different regions.
Three axis reading	The limitation of RFID transponders to discrepancies in polarisation of the transponder and the reader are overcome in a unique feature that allows a three axis reader (XYZ) to read all the transponders while using only a single frequency.
Different antenna packaging	The transponder will work with a number of different antenna configurations and shapes which can be tailor made to the specific applications.

(Note Performance achieved is dependant on design criteria to be chosen by licensees. The current Trolleyponder(RIST) version on sale omits some of these features)

What applications can benefit from Trolleyponder RFID?

Although Trolley Scan have been developing this technology for the long term solution of scanning a shopping trolley/cart full of groceries in an un-manned checkout aisle, the same technology can be used in most other applications where it is useful to give a computer up to thirteen meter "vision" to identify goods within the presence of a low cost RFID scanner.

The following are applications that could use this universal technology packaged in the appropriate form and delivered at the right price:

Computer vision for IT systems	Information Technology systems have been built from sophisticated computer networks and application software, but still largely rely on manual or semi automatic data capture. The integration of RFID into labelling objects used with such systems allow the computer to automatically identify objects within 13 meters of the reader and process the data automatically
Laptop computer tracking	Preventing the unauthorised removal of laptop and notebook computers from business premises.
Warehousing	Tracking of containers and pallets, stocktaking
Access control	Ability to read the identity of many people at the same time passing through doorways, tube station entrances, lift access and doorways.
Identifying capital goods	Ability to read the identity of transponders mounted inside capital goods or packaging, when in the warehouse, when being transported and even when passing through doorways for an asset tracking system.
Case-lots of low value consumer items	Same system can be used for the producer, wholesaler and retailer at case lot level of consumer goods for transferring via truck, checking in and out of warehouse.
Vehicles access control	Ability to read many vehicles in different traffic lanes for parking, toll and access control.
Containers labelling	Shipping, airfreighting and rail movement.
Courier parcels and documents	Remote identity, sorting, routing and track-and-trace information
Parcels and mail bags	Remote identity, routing, track-and-trace information.

Airline baggage	Identifying, sorting and routing - not confused by the transponders that will be read from labelled goods within the luggage due to the use of RFID systems.
Compact discs and video retailing and rental	EAS, identifying and stock taking
Laundry for hospitals and hotels	Identity, sorting and routing after bulk washing
Motor vehicle tyres	Transponder embedded into tyre provides positive identification of case for identifying, wear tracking, usage tracking, anti theft.
Files and documents	Identifying, track-and-trace, locating, association with person carrying documents past doorways - suitable for insurance industry/ government records.
Passport, driver license	Anti-counterfeiting, identifying
Manufacture	Labelling components for JIT manufacture, storing, routing, warehousing, identifying
Library books	Identifying, EAS, self service checkout/check-in, book location.
Loyalty cards for retailing	Remote identification of client and association with database
Gaming chips	Identity, anti-counterfeiting
Pharmaceutical/ pathology	Tracking controlled and restricted drugs, warehousing, manufacture date, identifying high value drugs. Tracking pathological samples during processing
Farm animals	Electronically identifying herd animals for control, for documentation of milk yield, for controlled feeding and dosing and for disease control
Labelling clothes and shoes	Identifying, stocktaking, size distribution, self service, EAS. Reading clothes washing properties for an automated washing machine
Dismantling items	For green legislation requiring the dismantling and sorting of old capital items, robot identification of parts and type of material.
Marking explosives	Identity, track-and-trace, anti-theft
Sports events	Timing marathon athletes, cyclists, MotoX, fun runs

Hospitals	Tracking patients, access control, preventing baby removal, patient location and identification, computer authorisation of surgical procedures
Penal systems	House arrest - verification of presence
Marking hotel possessions	Remote identity of possessions in clients luggage
Forestry	Tracking logs and products. Inventory control of trees and plants in a nursery
Bank notes	Anti-counterfeiting, accurate counting
Grocery retailing	High speed scanning of baskets, trolleys and carts, stock-taking, EAS, goods receiving - the ultimate application

Issues in choosing a Transponder system

Comparing Active/Passive UHF transponder systems

Transponder systems are active or passive. The active versions have their own batteries on board for powering up the transponders and radiate a signal on a designated frequency, while the passive versions are usually very energy efficient and can operate on the energy received from the reader field, while operating over very wide bandwidths and reflecting some of the received energy back to the reader. Trolleyponder systems are passive.

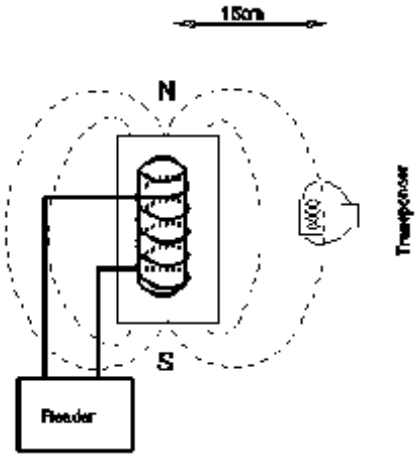
	Passive(Trolleyponder)	**Active**
Energy source	efficient conversion of RF energy radiated from reader	On Board battery
Transponder life	Infinite	Typically a 6 months to a few years
Cost	Cheap	Up to US$25
Multiple transponders	Up to 1000	Up to 50
Frequency agile	Operate on frequencies from 860Mhz to 930Mhz allowing international trade	Operate on fixed single frequency
Range	Within reader beam of a few metres (13 metres)	Varies depending on height above ground (up to 100 metres)

Interference	Responds only when in energising field	Can be detected by any system operating within range on same frequency
Reader	Complex technology	Simple technology

Comparing frequencies for passive transponders

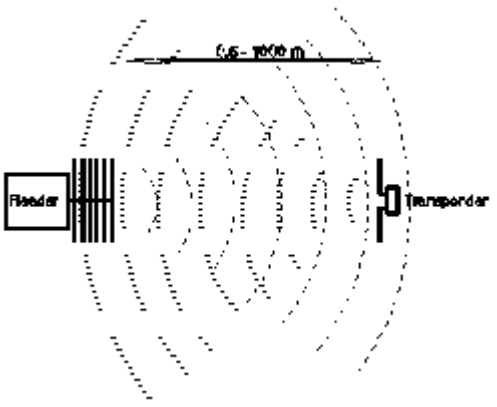
The operating performance of a passive transponder is firstly dependant on the operating frequency of the system.

Transferring radio energy to a transponder happens via magnetic and electric propagation fields. At frequencies below 100MHz, the magnetic field propagation is dominant, indicated by the use of coils for antennas. Above 100 Mhz, the electric field becomes dominant, usually using antenna systems such as dipoles, Yagis and patch antennas.



The transponders systems operating at 125Khz and 13.56Mhz use Magnetic propagation. As shown in experiments at school with iron filings on a piece of paper over a magnet to show the lines of force, it is difficult to increase the distance of the lines from the central magnet except by increasing the separation of the magnets North and South poles.

The transponders operating on the 860-930MHz UHF frequencies and the 2,45GHz frequencies use electric field propagation. In electric field propagation the energy radiates away from the source at the speed of light, spreading out over the surface area of a sphere centred on the source and of radius of the distance travelled This energy travels forever, even as far as the moon. The energy density decreases as the square of the distance, - that is for every doubling of distance the energy density is quartered.



The energy arriving at the transponder is collected in the antenna aperture which for a dipole has the dimensions

Frequency	Aperture(sq cms)
869Mhz	149
915Mhz	134
2450Mhz	18

The collected energy is converted to power to operate the transponder. The amount of power needed to operate is the sensitivity of the transponder. Trolley Scan provide transponders with sensitivities as low as 200uWatts.

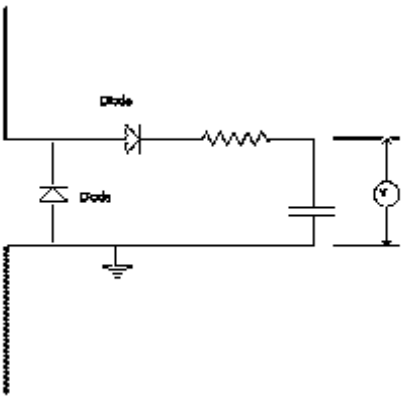
From the above the operating range versus frequency of operation is as shown in the following table

Frequency	Typical range	Propagation	Comments
125kHz	5cms	Magnetic	1000 turn coils
13.56Mhz	50cms	Magnetic	5 turn coils on credit card sized former
860-930Mhz	4-13meters	Electric	Simple dipole
2450Mhz	1 meter	Electric	Simple dipole

A white paper of the performance of the different frequencies is available from Trolley Scan on request

The importance of EcoTag®

The Patented EcoTag technology allows Trolley Scan to produce much more energy efficient transponder systems than previously available, as well as allowing different antenna shapes to be used with smaller footprints without losing sensitivity.



A conventional dipole type antenna would have a power circuit as shown in this circuit diagram. The impedance of the dipole antenna is 72 ohms. RF energy collected in the aperture of the dipole is converted to an AC voltage which is then doubled and peak detected to give a voltage on the capacitor that can be used to power up the transponder circuit.

The following table shows the relationship between the power needed to be collected in the aperture and the operating voltage of the transponder

Transponder voltage	Antenna voltage	RF Power
5 volts	2 volts	54milliwatts
3 volts	1.3 volts	23 milliwatts
Ecotag transponder		0.2 milliwatts (200uwatts)

The benefits achieved with EcoTag in the design currently supplied by Trolley Scan give a 260 times improvement in power consumption compared to the standard 5 volt transponder. This means that

- < 260 times lower transmitter power is needed for the same operating range
- < 260 times smaller reader transmitter
- < 260 times longer battery life
- < Or a 16 times operating range increase

In addition the use of EcoTag technology allow antenna shapes and footprints to be altered meaning that instead of using 160mm long dipoles, credit card sized antennas can deliver similar efficiencies as well as designs can be adapted to suit the needs of transponders for attaching to wooden items (Ecowoodtag) or moulded in plastic for farm animals (Ecofarmtag). These benefits are realised while still having a transponder that will operate over a wide frequency range (860-930Mhz) allowing for international trade.

How much range should a RFID reader have? Before the arrival of Trolley Scan's new RFID-radar product, a reader that can report range information to 0.5 meter accuracy, there has been little interest in extending the range of the transponders beyond 10 meters. In January 2006 Trolley Scan have developed a new long range tag, compatible with both its reader and radar, that has been operated at distances as far as 49 (forty nine) meters.

Tag talks first protocol

In order to communicate between many simple transponders and a reader, a set of instructions(rules) implemented in the transponders and readers is needed. This set of instructions is known as the protocol. Trolley Scan invented and use the Trolleyponder protocol which allows up to 1000 transponders to communicate reliably with the reader, even if the all have the same identity, and yet preserve their properties of frequency agility and simple design.

There are basically two types of protocols for implementing multi-transponder situations, namely "Tag-talks-first" and "Reader-talks-first".

In a "tag-talks-first" situation, the reader puts out an energising field which is generally a carrier wave signal with no modulation at the operating frequency of the system. Tags entering the field, collect this energy in their transponder aperture, convert it to operating energy, and communicate their identity to the reader. In some cases the reader communicates the successful receipt of the message back to the transponder by a short burst of modulation on the energising field. Trolleyponder is this type of system.

In a "reader-talks-first" situation the reader puts out an energising field which is modulated ith call messages to the transponders. Tags entering the field, collect this energy in their transponder aperture, convert it to operating energy, and listen for messages from the reader which is modulated on the energising field. The reader polls for transponders in its reading field by asking"Transponder number 1, are you there?" If transponder number 1 is there, then it replies "Yes" and its identity is known to the reader. This is repeated for all the possible numbers of transponders present, or a more compact "treeing" method is used. The disadvantage of this system is that the reader has to be continually calling for transponders, modulating its high power signal and causing widespread interference around the reader, even if no transponders are in the field at the time. Also this interrogation has to be repeated faster than the time it would take for a transponder to pass through its field so as not to possibly miss a transponder in transit through the field. This requires high bandwidth and widespread interference to other radio users.

The following table compares the two technologies

	"Tag-talks-first"	"Reader-talks-first"
Energising signal	Carrier wave	Modulated energising signal
Modulation bandwidth	10kHz	Up to 1 Mhz
RF power of modulated signal	20uWatts	0.5 to 4 watts
Interference zone for other readers	4 meters	1 km
Speed of transit of zone to detect tag	300kph	3kph
Interference when no tags present	Carrier wave only	Modulated energising signal
Transponder receiver complexity	Very simple	Needs to have good dynamic range

The choice of protocol impacts many decisions regarding the use of multiple RFID reader systems in close proximity. Trolley Scan are able top operate two readers within only four metres of each other due to the very small bandwidth(10kHz) used and the stable transmitted signals.

A white paper of the measured radio spectrum of the different protocols is available from Trolley Scan on request

Frequency agility

Radio spectrum planning is done for each country by its own committees. Due to different technologies such as GSM and CDMA cellphones, the available spectrum in many countries is slightly different from other countries. Generally transponders that can operate efficiently on frequencies between 860Mhz and 930Mhz(plus 956Mhz for Japan) would be able to be used for international trade in all countries in the world. Most passive transponders use a backscatter modulation method of communicating from the transponder to the reader, where the transponder answers on the same frequency as the

energising field. By not having tuned receiving circuits on the transponder, it is simpler to make a transponder that will be frequency agile and have a wide operating bandwidth.

What is Trolley Scan doing in retail to make RFID technology a barcode replacement technology?

Although Trolley Scan have been developing this technology for the long term solution of scanning a shopping trolley/cart full of groceries in an un-manned checkout aisle, the same technology can be used in most other applications where it is useful to give a computer a thirteen meter "vision" to identify goods within the presence of a low cost RFID scanner.

Trolleyponder technology has been optimised to be used in the retail environment eventually, as a cost effective replacement to barcode technology.

It contains special features that have been developed for this application, namely:

- low cost
- long reading ranges
- EAS features built in
- up to 1000 items in a reading zone at a time
- fast scanning
- scanning on all polarisations at the same time
- low power operation for Eco sensitive environments
- frequency agile to allow operation in different regulatory environments
- easy to attach to goods
- suitable for mass manufacture
- a numbering system that allows identical goods to have the same identity data
- accurate recording

To demonstrate how this could be used in a retail environment, Trolley Scan have worked with a student from the University of New South Wales in Australia to develop a concept called the Branders system. In this concept model the customer places their trolley in a booth, the trolley is scanned, their credit/debit card is debited, the trolley is re-scanned and the EAS features activated, the booms are opened and as the customer leaves from the roof the entire trolley and customer is rechecked for EAS detection. In this manner the customer and the store owner are happy with an unmanned self service operation.
Another project with a student from the Philippines has developed equipment called *Waverider*, an automatic scanning system used for small shops where there is not enough aisle space to allow for the use of trolleys - hence the automated scanning of shopping baskets.

Reducing the barriers to entry for companies that wish to become manufacturers of RFID?

Transponder systems with the price/performance of Trolleyponder meet the requirements of applications worldwide. It is estimated that the annual requirement for transponders of this type can reach 10^{14}. It is impossible for any single

company to meet the world's requirements. Trolley Scan have developed the technology so that it could be produced by many companies, both big and small, with limited investment and using the services of specialist consultants and subcontractors, services that are freely available from many sources. Trolley Scan can also provide kits of parts for companies wanting to start producing instantaneously.

Licensed manufacturers set their own pricing policies and set up their own VAR network to support their product.

Potential licensees initially buy a datapack from Trolley Scan which provides them with the technical and business information to get quotations for the production, and to prepare their business plans before making further financial commitments. Trolley Scan have reduced the profile of financial commitment of potential licensees to a minimum by charging low fees for acquiring the datapack and rights and also charging low production royalties. RFID-radar™ is **not available** for licensing a this time.

Options for in-house production of Transponders and readers

Assembly from kit	Trolley Scan can provide a kit of parts which can be assembled using a minimal amount of equipment. Trolley Scan can provide OEM readers, transponder chips, antennas and packaging
Local production	Trolley Scan can provide your needs of critical parts such as transponder chips, mixers for readers etc, with you providing your own antennas and reader boards based on information provided by Trolley Scan.
High tech design	You design your own integrated circuits and readers based on the information provided by Trolley Scan via its datapack.

Potential licensees can evaluate the technology by buying one of the small systems listed on the front page of this document.

Track Record - Who are Trolley Scan?

Trolley Scan are a South African based company operating from the city of Johannesburg. Our development team is regarded as one of the world's leaders and pioneers in the development of low cost UHF RFID.

In January 1991 Mike Marsh filed a world shattering patent called *An Electronic Identification System* while working for a major South African Government Research Laboratory. This technology was built into a demonstration system that was launched to the world in January 1994 showing a supermarket trolley (cart) with 38 items being scanned remotely in a couple of seconds. This technology was made available for licensing around the world.

In May 1994 Mike Marsh left the employ of the South African Government and in November 1995 started the company Trolley Scan with Trevor Hodson, aimed at developing more advanced technologies for very low cost universal transponder systems. Trolley Scan have the long term goal of developing a US$0-05 cost RFID transponder suitable for mass consumption.

In March 1998 Trolley Scan filed provisional patents protecting the first of their developments known as the Trolleyponder transponder protocol, a revolutionary development by Mike Marsh and Trevor Hodson. The protocol achieves many of the benefits of the original 1991 developments, but adds many new features. The Trolleyponder protocol advances the low cost RFID scanning technology using a new method and intellectual property, to give a system with vastly increased performance and benefits, while being simpler in design, smaller in chip area, and with reduced production costs.

Mike Marsh started in 1995 and is still editor of the Transponder News Internet newspaper which reports on developments and trends in transponder systems throughout the world. This newspaper is highly regarded by users and currently has a readership of some 33000 pages of information per month to readers all over the world.

In May 1999 Mike Marsh invented an energy extraction system for transponders which has been trademarked as EcoTag®. This allows passive transponders to operate at good ranges in very weak energising fields (0.5 watts ERP).

In March 2001 Trolley Scan announce the development of an RFIDmodule form of EcoTag/ Trolleyponder needing less than 1 milliwatt to operate and made from off the shelf commercial parts, allowing users to immediately test and apply the technology in medium size applications.

In December 2003, Trolley Scan started delivering single chip credit card sized 200uW transponders which were soon followed by Ecowoodtag transponders, laundry tags, compact fixed readers and a portable reader.

In September 2005, Trolley Scan invented RFID-radar™, a system where identity and location could be reported for multiple transponders in a reading zone, while only using very limited bandwidth. This is another world first for South African technology.

In November 2005, Trolley Scan developed the long range portable reader, capable of reading multiple transponders in a zone at ranges up to 10 meters.

In January 2006, Trolley Scan developed a long range tag with an operating range up to 49 meters.

In May 2006, Trolley Scan started delivering commercial versions of its RFID-radar

In April 2007 Trolley Scan started focussing on developing software packages that could be used with its RFID products to deliver complete solutions to applications.

In April 2008 Trolley Scan developed a rubber based tag for attaching to laptop computers to monitor their movement.

Trolley Scan has provided approx 400 systems of its equipment already to users in 50 countries, ranging from governments, universities, major industrial companies and even small users.

Trolley Scan will continue to improve their products and work with their licensees to ensure the growth of mass usage of RFID transponder technology.

Contact information

Trolley Scan (Pty) Ltd
P.O. Box 59227,
Kengray
2100
South Africa
email: info@trolleyscan.com
Fax (+27)(11)648-2085
Tel (+27)(11)648-2087 or 648-1657
http://www.trolleyscan.com

Information on RFID-radar is at www.rfid-radar.com

TO RECEIVE FURTHER INFORMATION

complete electronic form at

http://trolleyscan.com/formbroc.html

