

The Little Book of RFID

For Tires



RFID. Transforming the things we can do.

Radio Frequency Identification is already changing the way things can be identified and tracked. It's also allowing objects to communicate with each other. And this is just the start.

At Computype we believe that RFID stands today at the dawn of a new era of smart products, with integrated intelligence, wireless connectivity, monitoring and control. Along with other leading scientists and technologists we see a future of amazing potential and, as yet, unimagined applications and innovations...

The future of RFID is wide open, and things are about to get very interesting.

The RFID timeline

Space exploration, computing, radar, plastic surgery, jet propulsion... As with many transformational technologies which ultimately benefit humanity, RFID can trace its origins back to a time of conflict – the Second World War.



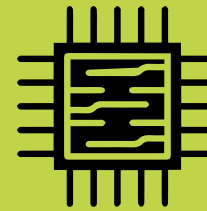
1939-45

British scientists developed a transponder-based system, using radio to distinguish between friendly and enemy aircraft.



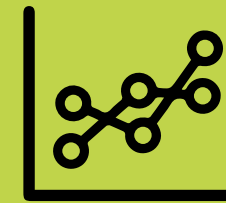
1950-60s

Scientists in the US, Europe and Japan continued research and presented papers explaining RFID's potential in remote object identification.



1971

Mario Cardullo demonstrated a transponder with 16-bit memory for use as a toll device to the New York Port Authority.



1973

Steven Depp, Alfred Koelle and Robert Frayman demonstrated modulated backscatter (a core principle of modern RFID) at the Los Alamos National Laboratory.



1980s

RFID formed the basis of automated toll systems for roads, bridges and tunnels.



1980s

RFID tags used to identify cattle, and later, domestic pets.



1990s

IBM engineers developed and patented Ultra High Frequency RFID.



1999

At the newly established Auto ID Center, David Brock and Sanjay Sarma developed RFID tags to link with the internet as part of networking technology.



2005

AIM Standard created for embedded Tire RFID.



2006

Aerospace industry required RFID asset tracking on all commercial airliners.



2008

All new vehicles sold in the U.S. required to have tire pressure monitoring systems – wireless communication method utilizing RFID tags.



2014

Apple introduces the iPhone 6 and sells 74 Million during 4Q15; every new iPhone has NFC (near field communication) that can be used for automatic payment and other benefits.



2015

10% of the world's apparel (4B items per year) now include RFID tags for inventory control.

Radio frequency – the science bit

As RFID is based on sending signals via radio waves, it's worth
overviewing a little of the physics behind the concept.

Energy in a certain form

Radio waves are a kind of
electromagnetic energy
within a specific range of
wavelengths.

The range extends
from Very Low
Frequency (VLF) at 10
to 30 kilohertz (kHz),

all the way up to
Extremely High
Frequency (EHF) at 30
to 300 gigahertz (GHz).

In nature, radio waves are
caused by lightning, stars,
galaxies - humans have simply
harnessed the same energy to
enable communication.

And like all electromagnetic
waves, radio waves travel at
the speed of light.

What RFID can do

RFID can be 'read-only' or 'read/write'.
It doesn't need contact or a line of sight
to work. RFID operates in all kinds of
environmental conditions. RFID provides
high levels of data integrity. It's also very
hard to counterfeit, and ideally suited to
security-sensitive applications.

Importantly, information can be written
to the memory on the device many
times. It is write-many, read-many
(WORM).

Currently RFID is used in systems such as:

- Railway rolling stock identification and tracking
- Identification of freight containers
- Identifying and tracking assets
- Automated toll collection
- Animal identification
- Car immobilizers
- Passports
- Ticketing
- Apparel
- Door entry systems
- Managing items in retail, healthcare and logistics
- Smart phones for automatic payment
- Racing tires

RFID. It's just radio waving

Radio Frequency Identification (RFID) simply means the use of radio waves to provide automatic identification.

So, if you send a radio signal to an RFID tag, it will respond by sending a signal back.

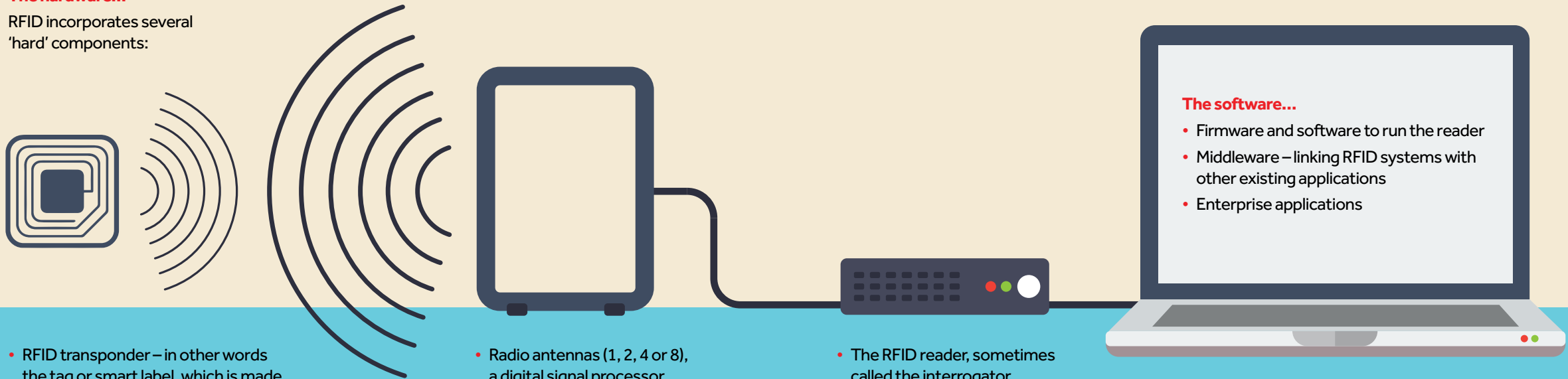
For instance, a car with a tag onboard drives through a toll gate equipped with a radio transmitter. The tag picks up the radio wave, is activated by it, and sends a signal back.

That's how the car is automatically identified and a toll charge attributed to it.

Things get a little more complicated when we think about the various types of tag, but only slightly!

The hardware...

RFID incorporates several 'hard' components:



- RFID transponder – in other words the tag or smart label, which is made up of chip, antenna, substrate, and in some cases a battery

- Radio antennas (1, 2, 4 or 8), a digital signal processor, network port, input/output ports and a power source

- The RFID reader, sometimes called the interrogator

- ### The software...
- Firmware and software to run the reader
 - Middleware – linking RFID systems with other existing applications
 - Enterprise applications
- An edge server to run the filtering middleware
 - Network appliances to manage the reader/data flow

Tags, tagged

There are several kinds of RFID tag, to perform different jobs in different applications:

- **Binary** – the simplest form of RFID. If a binary tag is present the system spots it. No data is held on the tag. Binary is an ideal, economic way to security mark items in shops or libraries, for instance
- **Active** – the tag has its own power source, usually a battery, to receive and transmit data. Active tags are often used to track non-disposable items

- **Passive** – the tag takes its power from the signal it receives, and has the ability to modify the signal. Battery Assisted Passive (BAP) increases range, with a power chip for data logging and sensors
- **Near Field Communication (NFC)** – the reader and tag communicate through a magnetic field. NFC allows the use of smart devices

How a passive tag system works

This is a representation of how the simple passive tag version of RFID operates.



The reader creates an electromagnetic field, and transmits information to the tag.

The tag 'back scatters' the reader's signal, to transmit information back to the reader.

Why RFID is a game-changer

The really significant fact here is that the chip on the passive tag receives its energy from the radio waves, and that's enough power to drive its read/write capabilities.

This is basically an extremely inexpensive form of wireless communication, combined with an equally low cost computer – the chip itself.

It's amazing to think that today the computing power of this tag costs pennies; a generation ago it would have cost thousands of dollars.



Now a whole new generation of applications is emerging using wireless communication and computing power, because RFID can be implemented for a very low cost.

Today's tags

RFID tags have been developed to suit different applications. They're commonplace these days, and fit into three main types.



Hang tags – inlays set into labels to identify items via RFID for stock management.



Cards – credit and debit cards, ID cards and entry systems can all utilize RFID.



Passports – Because RFID tags are extremely hard to counterfeit, they're an ideal added security feature for passports.

Checking tire pressure on the move: RFID in a safety-critical role

In the US, it's now mandatory for new cars to incorporate a system which shows the pressure in all four tires in real time, in a dashboard display. It's a safety measure that's bound to be adopted soon by automobile manufacturers around the world.

But how do you measure the pressure in a rotating tire?

RFID tags are attached to the base of the valve stem in each tire, so the pressure levels can be constantly monitored whilst the car is moving. The reader/tag system integrates with the car's engine management controls, feeding the real time tire pressure data to the dashboard.



So goodbye barcodes? Not just yet...



Most experts agree that the barcode in its many guises still has an important role to play in identification and tracking. In fact, RFID and barcodes are starting to work together in complementary ways.

Combining the barcode with RFID offers the safety of two data carriers – if one can't be read

for whatever reason, the other provides back up.

In fact a new form of labeling product is emerging, one that offers three communication channels: data stored in the tag's chip, a barcode, and printed human-readable information.

This three-way combination satisfies several requirements:



Branding can be color-correct and reproduced to a high standard



The product name, important safety information or other information required by law or regulation can be visibly presented



The barcode identifier will provide data if RFID is not available, and the same information will be replicated on the RFID tag



The RFID component also allows the label to be updated to record any processes the labeled product passes through.



How Barcodes and RFID compare

Evaluate barcodes and RFID and their respective strengths are clear. It's also apparent that when used together, the overall benefits are compelling:

Parameter	Barcode	RFID
Data management	Write Once, read many (WORM)	Write many read many (WORM)
Data density	1-100 Bytes; static	1K – 64 Kbytes; configurable (dynamic R/W)
Machine readability	Good; line of sight needed	Good; no line of sight needed
Human readability	Limited	Impossible
Influence of optical covering	High; impossible to read	Low to non-existent
Influence of materials	No influence	High; can cause functional failure (metal, some liquids)
Influence of position or direction	Noticeable as a function of distance	Limited; dependent on dipole orientation
Investment and operational costs	Low investment; multiple sourcing options	Relatively high hw and sw; limited sources
Unauthorized modification	Easy	Impossible
Reading speed	Low; single read cycles	High, 'multiple read' cycle
Maximum communication distance	0-50 cm	0-500 cm

How RFID fits with tire production

RFID is proving invaluable in helping manufacturers identify, track, and manage tires and other assets all through their production and distribution processes...

It's a key component in increasing productivity, reducing waste and bringing down costs.

Small tags, big wins

Total automation saves on labor.

The chip-held data is accessed or managed automatically – no need for hand scanning or any kind of human intervention.

No line of sight required.

Unlike barcode labels, RFID tags can be read when they're obscured by other objects, or when they are embedded in the tire itself.

Assets can report their status.

Dynamic data combined with sensed information allows objects to communicate their status - providing real time condition monitoring and supporting predictive maintenance, for example.

Real time tracking.

Assets can be tracked inside the tire plant, reducing the time required to locate materials used in the production process. Many plants use this system, based on active battery powered RFID tags.

Higher read rates could reduce waste

It's a testimony to the efficiency of modern barcode systems that read rates can be as high as 99.8% - that's a remarkable statistic, drawn from a real tire plant.

The problem for the plant in question is that due to the high volume of tires produced, even this read rate results in around 40 tires being removed daily from the line for costly rework.

RFID has the potential for even higher read rates, as no line of sight is necessary for the system to operate effectively.

With RFID, the implications for waste minimization are hard to ignore.

RFID adds safety and value

Tires are clearly the crucial element in automotive safety. ABS, traction control, intelligent suspension – such systems are essentially 100% dependent on the tires they work through.

Factors affecting tires such as force, pressure, temperature, tread depth and wet grip are constantly changing, and critically influencing

how the vehicle performs in motion. RFID can monitor all this, supply the data to the driver in real time, and raise an alarm when necessary.

For consumers, RFID will offer striking benefits. Having second-by-second insight into the condition of their tires and stresses upon them will help people drive far more safely and economically.

Smarter design

At the earliest opportunity design can be optimized through finite elements modeling. The RFID tag can be modeled at the same time as the tire, in some cases using the same tools.

Aesthetics can also be improved, as the tag can be invisible - embedded in or integrated into the product design.

Counterfeiting countered

Producers of fake goods are highly unlikely to be able to counterfeit product that's authenticated by an RFID tag. As a brand and sales protection measure, RFID is pretty much unbeatable.

More insight gained

RFID enables the monitoring of critical operating information, and the storage of condition history. The technology can simplify and improve capabilities in monitoring and diagnostics.

A product lifetime of performance

Currently, barcode labels are used only until the tire is shipped to the distribution center. In fact in most cases, once the tread label is applied the barcode bead label becomes redundant.

In contrast, one RFID label can remain in use throughout a tire's life. It can contain original unique ID information, and dynamic data can be added and stored at different points, available for reading until the tire is finally discarded.

Real time retail advantages

As Walmart is already discovering, RFID labels offer exceptional benefits in inventory tracking. Knowing where everything is, what it is, where it's been and its current status in an instant delivers powerful management and cost control benefits.

Computype is enabling RFID in difficult applications

In some markets RFID can be considered a 'mature' technology. It's been proving its worth and reliability in a variety of applications over the last couple of decades and more.

The challenge now is to engineer RFID products that can deliver more functionality, and do so in the most exacting roles and environments. Product design is moving towards RFID which

is embedded within the product itself. These are innovations in which Computype is taking a leading, specialist role...

The world can be a demanding place - we're making the products to match

Clearly, it's relatively easy to design and attach a label for a carton which is not expected to handle extreme conditions.

But what about the forces, temperatures and pressures exerted through manufacturing processes? What if you need a label not just attached but integrated in a glass vial subject to the deep freeze of cryo storage, and the heat of an autoclave? Or a transfusion blood bag, where there can be no margin for error?

Computype has the specialist materials and science expertise to meet these kinds of challenges.

Experienced materials specialists

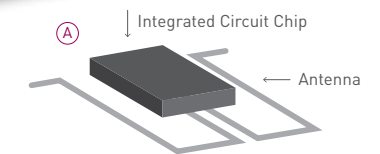
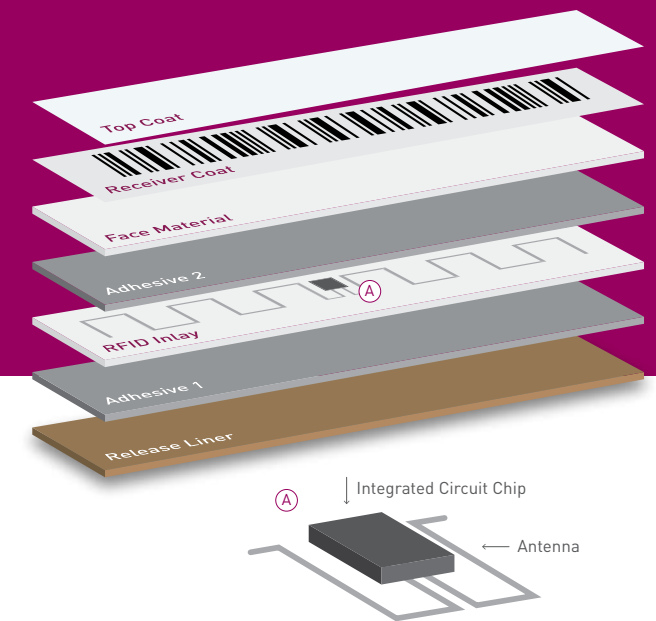
For many years Computype has been working closely with certain specialized sectors within Tire & Rubber, Life Sciences and Industrial – to design and refine identification products which meet demanding specifications.

We're very experienced in creating custom solutions, and working in close partnership with customers to ensure the smartest, most

RFID is our passion

It's important to keep in mind that an RFID product is essentially a small computer – albeit a very low cost one.

The tag's ability to receive, store, update, and manipulate data – and to communicate – is the essence of what's so exciting to us at Computype about RFID.



reliable answer is quickly developed and implemented.

So while specific Computype solutions will vary, the diagram here shows the kind of complexity and materials know-how RFID products can often require.

This is a hybrid RFID barcode label, or 'smart label.' It incorporates human-readable information such as alphanumeric characters corresponding to the barcode, and has the ability to present color-correct branding.

Embedded RFID. Computype's specialist inside track

Our passion for moving RFID forward fuels Computype's work in embedded RFID.

With our materials know-how it's possible to build a tag into the fabric of a tire, and fine-tune the RFID technology to work with the various materials and layers which comprise a modern tire.

In the near future, a tire (and many other products) will be able to tell its life history and report on its current condition through its own integral RFID tag.

Computype is working right now to make it happen.

RFID in future

We're at the dawning of a new era of communication and control. Objects now have the potential to exist with a certain amount of 'intelligence'; they can identify themselves, reveal their history and status, and communicate with each other and different systems...

The Internet of Things

The IoT is basically a network of physical objects, each embedded with the technology to store data. The fact that the 'things' are also enabled for communication means a refrigerator can 'talk' to a supermarket. Trucks can 'talk' to traffic lights. A paint spray gun can 'talk' to a paint inventory. And it's perfectly

possible for the refrigerator to 'talk' to the paint inventory – which may or may not be a useful interaction!

RFID and the Internet of Things

RFID is the primary connection in the IoT. Through it, labeled items can communicate with other systems, and through them access the wider internet.

Some likely moves for RFID?

As adoption increases and costs fall, RFID technology is expected to diffuse into many more aspects of life. Here are just a very few indicators of how RFID may be applied in the near future...



Visiting a shopping mall, you'll be able to find a parking slot before you arrive.



Emergency crews at an accident scene can identify casualties, be alerted to special medical needs, and establish real time availability of hospital beds and equipment.



Your smart washing machine will select wash programs based on data read from garment labels.



Looking for ideas for dinner on the web, your refrigerator will inform the search with details of the ingredients it has available.



An aircraft maintenance technician will be able to access the service history of specific parts, detailed technical drawings, and data immediately in the service bay.



In a bar, you will serve yourself draft beer thanks to your RFID beer card.



Buildings, tunnels, bridges and other structures will monitor their own condition and create alerts if issues develop.



You will buy your groceries as you place them in your cart - queuing at the checkout will be a thing of the past.



Your socks will tell you that you're running low on clean pairs. And locate missing singles.



RFID will help locate tumors prior to surgery, increasing precision and reducing infection risk.



Find out how Computype can make RFID work for you

It's clearly important to make sure the RFID you adopt is an ideal fit for your organization.

Our 40 years in working with tire manufacturers in labeling solutions worldwide mean we know your processes in detail. Our leadership in RFID technology is therefore very much attuned to applications in tire manufacturing.

We can help establish precisely how the technology will add the most value to your specific situation. Working in partnership with your teams, Computype can handle the entire process, from producing a business case justification for your RFID adoption, right through to design, sourcing, installation, and commissioning.

To find out more, contact us at:
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