INTERNET of THINGS
INTERNET of EVERYTHING

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Nowadays the information available on the Internet is, almost entirely, dependent on humans. The humans created the data found on the Internet, which is growing at high speed every second, by pressing a record button, taking a digital picture, scanning a bar code or by typing.
But a new concept has been in development for decades beginning in the early 1980s with the experiment in connection with a Coke machine at Carnegie Mellon University, a private research university in Pittsburgh, Pennsylvania, United States of America.
The experiment was performed by programmers, who could connect to the Coke machine over the Internet checking if there is a cold drink for them in case they decide to make the trip down to the machine.
The experiment led to the idea that equipping all objects in the world with minuscule electronic identifying devices or machine-readable identifiers would transform our daily life.
If all objects and people in everyday life would have tags or identifiers, they could be managed and inventoried by computers.
The *tagging* of things can be achieved electronically, using:

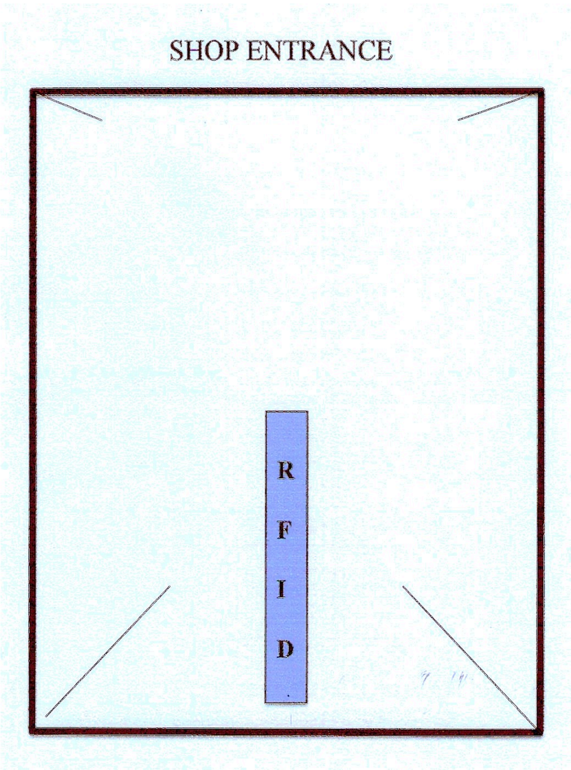
- radio-frequency identification
- near field communication
- barcodes
- quick response codes
- digital watermarking

Radio-Frequency Identification **RFID** is the wireless, non-contact use of radio-frequency electromagnetic EM fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects, not necessarily within the line of sight of the reader.
The tags containing electronically stored information use a local power source such as a battery or collect energy from the interrogating EM field and then emit microwaves or ultrahigh frequency UHF radio waves. Battery powered tags may operate at hundreds of meters.
An Electronic Product Code EPC is one common type of data stored in a tag.
When written into the tag by an RFID printer, the tag contains a 96-bit string of data:

- the first 8 bits are a header, which identifies the version of the protocol.
- the next 28 bits identify the organization that manages the data for this tag; the organization number is assigned by the EPC Global consortium.
- the next 24 bits are an object class, identifying the kind of product.
- the last 36 bits are a unique serial number for a particular tag.

The last two fields are set by the organization that issued the tag.

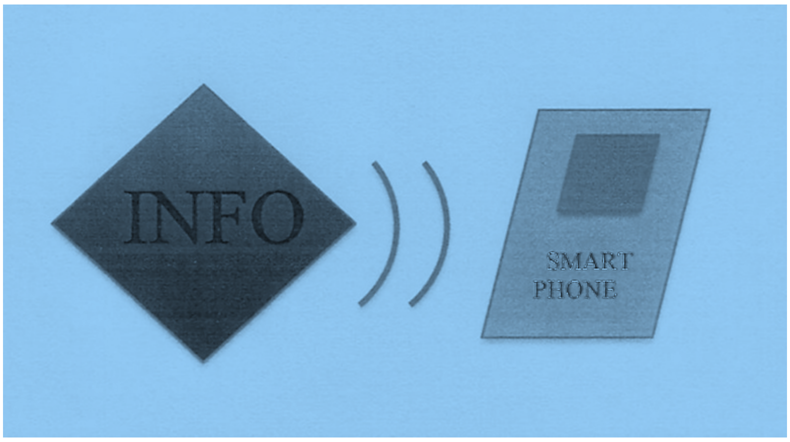
Like an URL (uniform resource locator/identifier or web address), the total electronic product code number can be used as a key into a global database to uniquely identify a particular product.



RFID at shop entrance

Near Field Communication **NFC** is a set of standards for smartphones and similar devices to establish radio communication with each other by touching them together or bringing them into close proximity, usually no more than a few inches. Communication is also possible between an NFC device and an unpowered NFC chip, called a "tag".

Present and anticipated applications include contactless transactions, data exchange and simplified setup of more complex communications such as Wi-Fi, a popular technology that allows an electronic device to exchange data or connect to the Internet wirelessly using radio waves.



Transmission of information from an
Info-point to a mobile phone by NFC

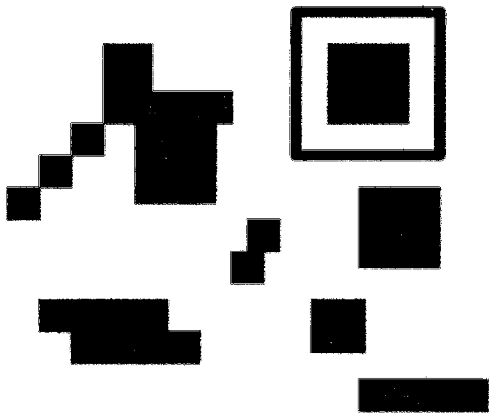
Barcode is an optical, machine-readable representation of data in connection to the object to which it is attached, representing the data by varying the widths and spacing of parallel lines, one dimension patterns. Later they evolved into rectangles, dots, hexagons and other geometric patterns in two dimensions. Used in supermarket checkout systems the barcodes became very successful.

Barcode with parallel lines

The barcodes are scanned by barcode readers. Scanners and interpretive software are available on devices like desktop printers and smartphones.

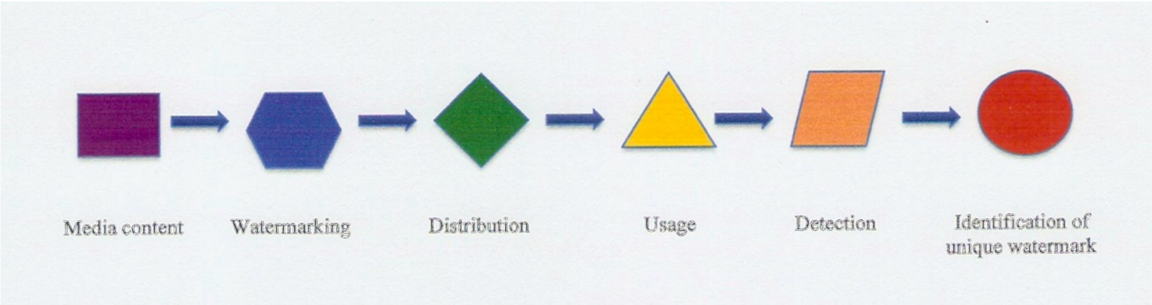
Quick Response Code, first time designed for the automotive industry in Japan, is a type of matrix barcode or two-dimensional barcode that can contain up to 4000 characters, used to encode URLs, contact information, GPS coordinates or any free text.

A quick response code consists of black modules (square dots) arranged in a square grid on a white background, which can be read by an imaging device (such as a camera) and processed using Reed–Solomon error correction until the image can be appropriately interpreted; data is then extracted from patterns present in both horizontal and vertical components of the image. Applications include item identification, product tracking, time tracking, document management, general marketing. Originally designed for industrial uses, the quick response codes have become common in consumer advertising. Typically, a smartphone is used as a quick response code scanner, displaying the code and converting it to some useful form such as a standard URL for a website, avoiding to type it into a web browser.



Black modules used in quick response matrix barcode

Digital Watermarking is a kind of marker covertly embedded in a noise-tolerant signal. Also called *forensic watermark* is a sequence of characters or code embedded in a digital document, sound, image, video signal or computer program to uniquely identify its originator and authorized user. Forensic watermarks can be repeated at random locations within the content to make them difficult to detect and remove. Digital watermarks may be used to verify the authenticity or integrity of the carrier signal or to show the identity of its owners. It is prominently used for tracing copyright infringements and for banknote authentication. With a digital photo, a watermark is a faint logo or word(s) superimposed over the top of the photo.



The watermarking process

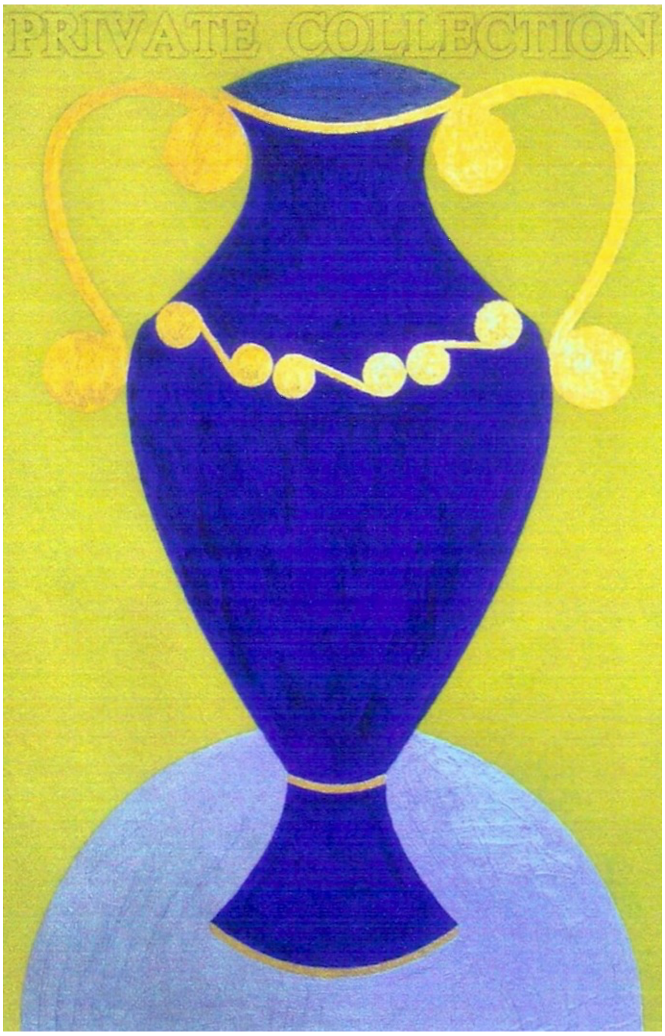


Image with upper watermark “PRIVATE COLLECTION”

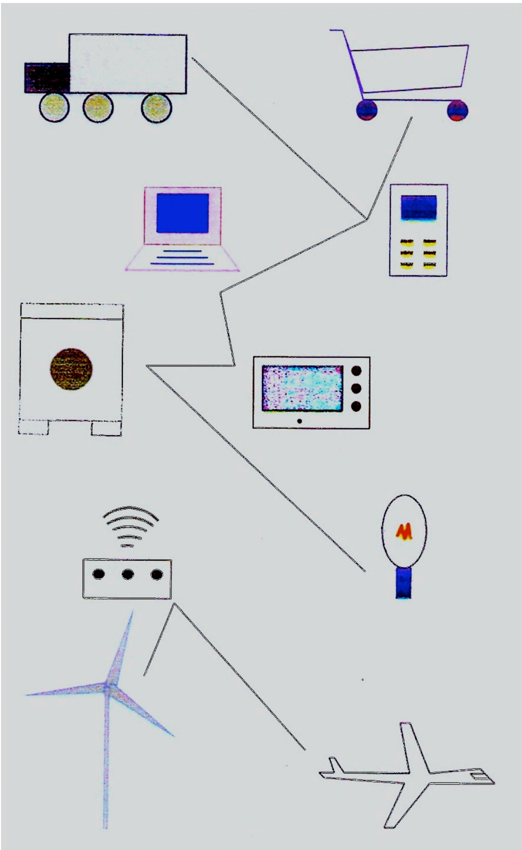
Wireless Sensors are a very spread RFID companion technology.

Sensor is a converter that measures a physical quantity and converts it into a signal, which can be read by an observer or by an instrument. For example:

- a mercury-in-glass thermometer converts the temperature into the expansion and the contraction of a liquid, which can be read on a calibrated glass tube.
- a thermocouple converts the temperature to an output voltage (electrical force), which can be read by a voltmeter.

For accuracy, most sensors are calibrated against known standards.

At present many objects are becoming embedded with sensors and so they gain the ability to communicate. Sensors and actuators embedded in physical objects - from streets to pacemakers -are linked through wired and wireless networks, often using the same Internet Protocol IP that connects the Internet. So appear novel sensor networks and from there novel applications are going to play a starring role. Huge volumes of data flow to computers for analysis from the networks created by sensors.



Objects communicating - M2M

When objects can both sense the environment and communicate, they become tools for understanding complexity and responding to it swiftly. We are now witnessing an explosion in these connected devices, both wired and wireless. Connected intelligent machines are a rapidly growing technology that embeds logic in devices to harness machine data and drive value for businesses. The result is an increase in the relevance of Machine-to-Machine M2M data, opening up a huge arena of potential opportunities spanning diverse industries and applications.

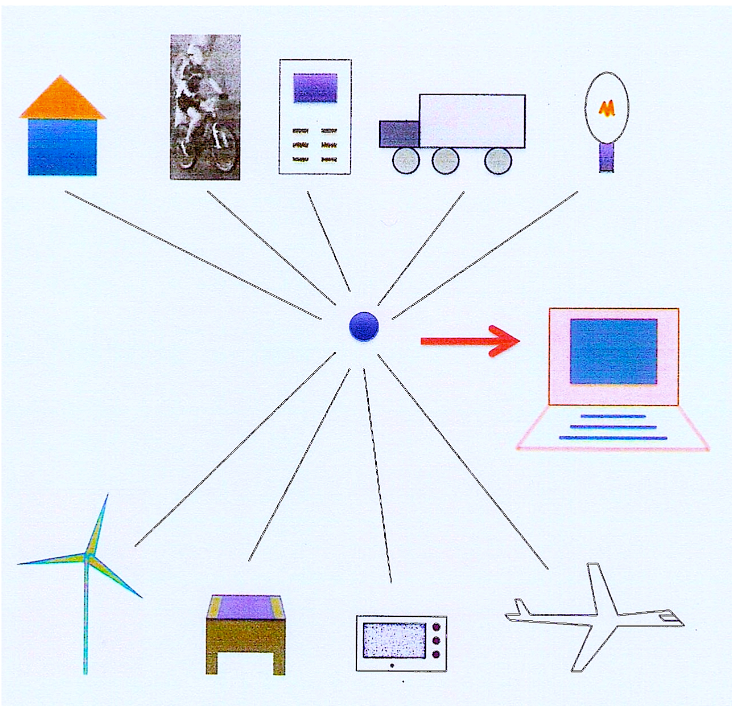
Products built with M2M communication capabilities are often referred to as being *smart.*

M2M refers to technologies that allow, both wireless and wired systems, to communicate with other devices of the same type and do not pinpoint specific networking or technology.

What's revolutionary in all the above is that these physical information systems are now beginning to be deployed and some of them even work largely without human intervention.

A scenario in which objects, animals or people are provided with unique identifiers and the ability to automatically transfer data over a network without requiring human-to-human or human-to-computer interaction is called **Internet of Things-IoT** *or* **Internet of Everything-IoE**.

The Internet of Things is a catch-all phrase used to describe the growing array of networked devices that are connected using the same protocols that power the Internet.



Things connected to Internet – IoT

A **thing***, in the Internet of Things, or* **everything***, in the Internet of Everything, can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an IP address and provided with the ability to transfer data over a network.*
IoT / IoE has evolved from the convergence of the *wireless technologies,* the *micro-electromechanical systems* MEMS and the *Internet.* It has been the most associated with machine-to-machine communication in manufacturing and power, oil and gas utilities.
In the next future this novel paradigm will play a leading role in logistics, intelligent transportation systems, business/process management, assisted living, e-health, to cite only a few examples.

On the Internet the method or protocol by which data is sent from one computer to another is the Internet Protocol IP.
Each host computer on the Internet has at least one IP address that uniquely identifies it from all other computers on the Internet.
The today most widely used version of the Internet Protocol IP, Internet Protocol Version 4 / IPv4 which uses a 32-bit address, allows approximately 4.3 billion addresses (2^{32}=4,294,967,296).
However, Internet Protocol Version 6 / IPv6 is also beginning to be supported, providing much longer addresses and therefore the possibility for many more Internet users.
IPv6's huge increase in address space is an important factor in the development of the IoT.
IPv6 uses the 128-bit address, allowing approximately 3.4×10^{38} addresses,

(2^{128} = 340,282,366,920,938,463,463,374,607,431,768,211,456)

a huge number having in view that the number of atoms on surface of Earth is estimated to be 10^{36} atoms, the number of atoms contained in Earth is estimated to be 10^{50} atoms and the number of atoms in the entire observable universe is estimated to be within the range of 10^{78}-10^{82} atoms.
In other words, humans could easily assign an IP address to every *thing* or to *everything* on Earth.
Internet of Things is a world where physical objects are seamlessly integrated into the information network and can become active participants in business processes.
The connectivity to Internet in general is "wirelessly," but there's been a rapid evolution in existing technologies like cellular and WiFi, as well as an introduction of entirely new technologies dedicated to IoT. Wireless technology for IoT will be diverse.
Communication technologies would be: WiFi, Bluetooth, ZigBee, Z-wave, 6LowPAN, Thread, Celular, NFC, Sigfog, Neul, LoRaWan.
The term *Internet of Things* was proposed by the British technology pioneer Kevin Ashton
in 1999 year. He is known for inventing the term to describe a system where the Internet is connected to the physical world via ubiquitous sensors.
The term is evolving as the technology and implementation of the ideas move forward.

The term Internet of Things generally refers to scenarios where network connectivity and computing capability extends to objects, sensors and everyday items not normally considered computers, allowing these devices to generate, exchange and consume data with minimal intervention.
In attempting to define the Internet of Things we should keep in mind that it is fundamentally about communication, computation, sensing and actuation.
The emergence of the IoT has been described heralding a new wave of Internet connectivity and in that world, it is not longer about computers, it is not longer about people, it is about people and the world around them connecting.
Human beings in surveyed urban environments are each surrounded by 1000 to 5000 track-able objects. The Internet of objects would encode 50-100 trillion objects and be able to follow the movement of those objects.
Internet of things can be defined as a vision to connect everyday objects and devices to large databases and networks, using a simple, unobtrusive and cost-effective system of item identification and in the process, make them more intelligent and programmable.
IoT links uniquely identifiable things to their virtual representations in the Internet so IoT appears to move objects from the physical world to a virtual one.
By-products of this virtual continuum will be new services, functionality, applications.
Areas of applications include urban planning, sustainable urban environment, continuous care, emergency response, intelligent shopping, smart product management, smart meters, waste management, home automation and smart events.
The applications can be classified in six distinct types of two broad categories:

1. Information & analysis
    - tracking behaviour
    - enhanced situational awareness
    - sensor-driven decision analytics
2. Automation & control
    - process optimisation
    - optimised resource consumption
    - complex autonomous systems

The Internet of Things will be based on massive parallel IT systems (parallel computing) and the precise geographic location of a thing as its precise geographic dimensions will be critical.
Just as standards play a key role in the Internet and the Web, geospatial standards will play a key role in the Internet of Things.
The tremendous opportunities afforded by the IoT and driven by the rapid development in sensor technologies, like micro computing systems and wireless communication standards, mean that sensor device platforms will become a key element in enabling the connected world.

Some researchers argue that sensor networks are the most essential components of the IoT / IoE.
The IoT era brings new opportunities to traditional industries and drives business evolution for the next generation of products and services. To enable a diverse range of IoT applications, more efficient IoT development and to standardize different platforms and technologies, an open platform for IoT sensors and sensor nodes was established by sensor makers and module makers.
Thai Advantech Corporation, along with British company ARM, German company Bosch Sensortec, Swiss company Sensirion and American company Texas Instruments, started a collaboration of a new Internet of Things (IoT) sensor platform called M2COM.
The Low Power Wi-Fi IoT Node WISE-1520 is the first module supporting M2COM.

The use of IoT technologies in manufacturing is called the *Industrial Internet of Things IIoT* or *Industrial Internet*.
By IIoT isolated programmable devices are transformed in networks of connected machines.

The driving philosophy behind the IIoT is that "smart machines" (intelligent devices using M2M technology like robots, self-driving cars and other cognitive computing systems that are able to make decisions and solve problems without human intervention) are better than humans at accurately, consistently capturing and communicating data.

Instead to send data from these devices to a data center, the compute comes to those devices. That is called "fog computing".
Fog computing will bring intelligence and autonomy to industrial landscape.

The new term "**smart city**" has been emerging describing too broad numbers of technologies and applications. A *smart city* is an urban development vision to combine well information and communication technologies ICT and Internet of Things IoT solutions for managing a city's assets like schools, libraries, hospitals, transportation systems, power plants, water supply networks, waste management.
Busan is the second largest city in Republic of *Korea,* the 6th busiest container port in the world, with developed logistics, transportation and tourism. It is the first IoT-based *smart city* in Korea. It has well-equipped ICT infrastructure and strong IT technology. Using a cloud computing platform-as-a-service, the city connected the Busan Metropolitan Government, five local universities and the Busan Mobile Application Centre, which provides a setting for application development including workspace, offices, test equipment, APIs for public data and other tools. API is a software intermediary making possible for application programs to interact & share data.
South Korea also has built, at 65 Km SE of the capital Seul, the *smart city* ***Songdo*** from scratch. Nearly everything in this digital metropolis of smart homes is wired, connected and turned into a constant stream of data that is monitored and analysed by an array of computers with little or no

human intervention. That proved that the Internet of Things or embedded intelligence in things with "smart systems that are able to take over complex human perceptive/cognitive functions, frequently acting unnoticeably in the background" can be a reality.

***Amsterdam**, capital of *Netherlands*, in 2013 year began to consider a huge opportunity, the benefits of a *smart city lighting system*, because the existing infrastructure, consuming 19% of all electricity used, was decades old and a more efficient lighting could save $13.1 billion. Amsterdam had early initiatives geared toward public spaces, mobility and sustainability beginning in 2006 year.

Nice, the fifth most populous city of *France*, has developed a *smart city project* covering services as smart circulation, smart lightning, smart waste management and smart environmental monitoring.

The goal of the smart city project in Nice was to "test and validate an IP-enabled technology architecture and economic model, as well as to determine the social benefits of IoE".

The results can be used to help other cities accelerate smart city projects.

According to Juniper Research, Nice is the fourth smartest city in the world.

Nice hosts the annual TM Forum Live event, which includes smart city-related competitions.

TM Forum (TeleManagement Forum) is a non-profit industry association, for service providers and their suppliers in the telecommunications and entertainment industries.

The theme of the 2015 TM Forum "Hackathon" was *smart citizens in a smart city*.

"Hackathon" is an event typically lasting several days in which a large number of people meet to engage in collaborative computer programming. Occasionally, there is a hardware component as well. Groups compete with their results, which are sometimes selected and prizes are given.

Internet of Parks, which uses IoT applications to service parks and municipal green spaces, won a Hackathon in year 2015, for its automated robot that cleans parks in Nice. The robots can pick up trash from trashcans, automatically order new trash bags and send an alert to operators if the device is experiencing a problem.

India in 2016 year, has launched the *government's smart city program*. It will implement 83 smart city initiatives in 20 cities, in an initial phase of the nationwide program.

The initial 83 projects require a total investment of INR 17.7 billion ($262.5 million).

According to ABI market research/intelligence firm based in New York, by 2020 year more than 30 billions devices will be wirelessly connected to the Internet of Things IoT or Internet of Everything IoE, the other term used.

According to Gartner Research, the demand for connected devices will go to one trillion by 2040.

The research further indicated that there will be US $166 billion invested in the IoT industry by 2020 year especially in the transportation, retail, warehousing, medical, and manufacturing sectors.

No matter what industry sector is as health, insurance, safety, government, or consumer related, the Internet of Things IoT has become their market's latest must-have.

American technology company Microsoft believes that the businesses can start with a few changes that make a big impact. It's about using your existing things in new ways and innovating and optimizing so everything works better together.
For this new, vast IoT ecosystem, Dutch international digital security company Gemalto proposes a solid *Foundation of Trust* around the three trusted pillars: trusted connectivity, trusted security, trusted monetization.

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