



Internet of the Future

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How do we see the future?

We at Telefónica I+D envision a future in which services based on communication will make up a digital world full of possibilities and improvements to people's daily life and capabilities. These services will support modern society's main challenges in addition to creating a more sustainable world.

Internet of the Future will make this digital world a reality. An Internet which over the next ten years will make people, society and the economy in general much more connected, a fact which will affect and transform all aspects of life.

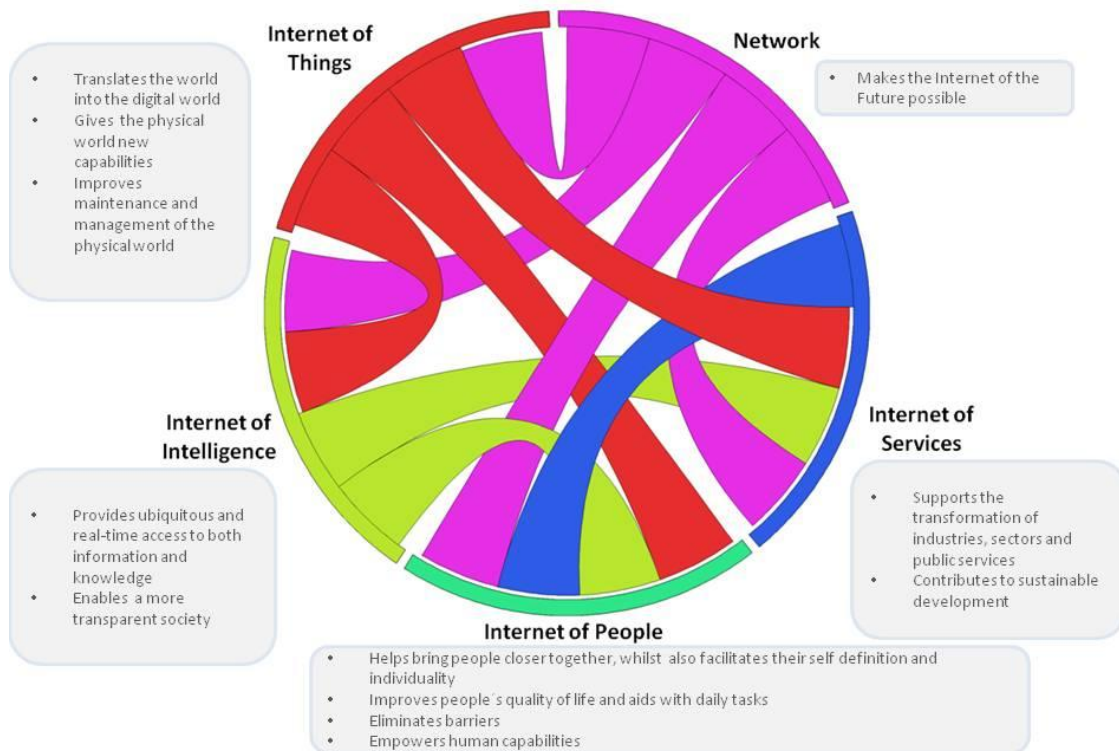
People will be closer to each other than ever, and distance and time factors will become shorter, thanks to the **Internet of People**. We will take a step toward a hyperconnected society, in which the option to communicate with others will be not only permanent and universal, but also available through different kinds of media, and by using numerous devices. Communication services will support one-to-one, one-to-many and many-to-many forms of communication, combining voice, text, images, video, telepresence, 3D video and even holograms, and allowing the above methods to complement one another.

Objects will communicate amongst themselves, and people with those things. And the things will not necessarily be digital. The evolution of Internet of the Future will lead to a digital translation of the physical world, enabling the latter to be permanently connected. This is what we call **Internet of things**.

Information, content, products and services will be more readily available. Thanks to the network, they will also be closer to people, thereby setting up a more accessible world. Its basis will be an **Internet of Intelligence** providing us with increased capabilities and placing the Internet of the Future's full potential at the service of the people.

On the other hand, the combination of extended use of information technologies and communication services in different productive sectors and public services will set up an **Internet of Services**. Rather than merely improving services themselves, it will help them to transform their own sectors and make them more productive and sustainable.

All of the above will make up the Internet of the Future, advanced Internet based on a ubiquitous, high-capacity **network**, which will provide us with communication services in a way that will be both transparent and user-focused. Its network infrastructures will provide mass services while adhering to security and privacy standards and keeping context and personalisation in mind for each case. The network will enable Internet of the Future by building the bridge we need to cross the gap separating the digital and non-digital worlds.



INTERNET OF PEOPLE

People are social creatures: we feel the need to communicate, interact with others and take part in groups, even as we need to define ourselves and differentiate ourselves from everyone else. **Communications of the future** present an arena in which it will be normal for people to use connectivity services to meet all of those needs, exactly as we do in the physical world today. In ten years, it will be normal to send out multimodal, multidirectional communications, using Internet of the Future to extend the physical experience of keeping in touch. New services will provide support for communications between groups, networks and from many to many, between stable communities, ad-hoc communities, those based on common likes, etc. They will also provide support for cooperative communications that facilitate teamwork, co-creation or putting ideas together. In addition, new types of communication will appear since technology will provide options that are unavailable to us in the physical world, such as cutting distances and times and eliminating the language barrier. It will also be easier to find networks with common likes. People will always be available, active, connected and locatable, and will have help remembering everything. It will no longer be necessary to be physically present in order to maintain and care for personal relationships. To sum up, we will all be closer.

In ten years, Internet of People will let us be closer to our loved ones.

In addition, hybrid communication models such as combinations of voice, video, telepresence, 3D video, text messages, web services, body language, thoughts and much more will evolve, and they will all be available simultaneously on a single device, or on several devices.

In ten years, it will be normal to have a conversation with each of my brothers that begins with telepresence session on the living room television set in my house, changes to a mobile phone videoconference when I go out on the street, and then becomes an audio session when I get in the car. All of this will be done transparently with no user intervention, because devices and services will ascertain a person's location in order to facilitate the task of communicating.

Concepts such as “community”, “circle of friends” or “conversation” will all evolve. Every human being's inherent need to be connected will be met by the Internet of the Future, which will also create profiles for our digital identity and therefore set us apart from other people.

Context information and personalisation data will be taken into account in order to offer this new set of services. The context refers to a person's environment and circumstances. Firstly, simple parameters such as the time, date, the person's identity, the language he/she speaks, preferences, age and sex are considered, and then others, such as location or emotional state, may be added to enrich context data. This involves applying filters in order to offer only that information or those services that the person wants or needs at each moment, and managing **personal security and privacy** along with trust, since this is what will make it truly possible to use these services in the future.

Thanks to the above, in ten years' time we will see services that are adapted to people's needs and manage their lives digitally, thus contributing to improved quality of life. For example, it will offer an enriched planner which, like a butler, tells you the best time to leave your house by car (having already checked the time it will take you to get to your destination according to the state of traffic), or what food to buy to prepare the diet you wish to follow, proposing the best recipes according to the fruits and vegetables in season, or what exercises to do during the day to improve your health. Technologies such as massive real-time data processing and context modelling, or devices such as sensors and smartphones, all play an important role in this process. However, the thing which will truly make it possible will be Internet of the Future, offering the possibility of using third-party services, gathering information in real time, and being completely connected.

In ten years, the relationship between people and information and communication technologies will come about in a more natural, nearly transparent way, and be integrated into daily life. **Usability** will be noticeably better, particularly as regards the new **multisensory interfaces**. The many devices which people will use to access communication services will have increasingly intuitive and personalised interfaces: the use of touchscreens will become widespread, and haptic technology, touchscreens and reactive technology with screens that provide tactile information to the fingers, will be present in many areas. Meanwhile, voice recognition will become very common, natural language use will increase and there will be marked improvements in translation and semantic comprehension. On the other hand, gesture-recognition interfaces, such as eye-tracking technologies and those based on emotion detection, will become popular.

In this environment of hypercommunication, **devices** will be transformed into “windows” to bring us closer to people, information and services. Smartphones will be widespread, and they will be key devices for connecting us to the services provided by the Internet of the Future. Electronic ink technology in e-readers will also change our relationship with paper. It is thought that a large majority of the population will have devices of this type, which will be able to display colour and movement (in order to include videos), and provide instant access to books. The range of devices will continue growing and becoming increasingly specialised, helping bring the tasks we would normally carry out on a physical level into the digital world. To that end, their design, interface and Internet uses will be adapted to achieve the best possible **user experience** for each case. With reading as an example, having an e-reader and its associated book sale service will make the reading experience more extensive and complete. Not only will you have a large number of books available through a single device and be able to change the text size and consult a dictionary as you read or buy a book at any time and place and have immediate access to it following the purchase, but your reading experience will be synchronised. This means you will be able to use an e-reader to read content and then continue reading the same text in the reading application on any other device just by “opening another window to your digital world” with no additional steps.

Devices will be mainly portable and ultra-portable, and all of them will of course be equipped with wireless network access technology. Increasing miniaturisation of components, the decreasing price of microchips and improved batteries will make this possible. In ten years, it will be common for people to have a large array of devices connected to the Internet, and their homes will also be equipped with multiple devices using the Internet of the Future. In addition to traditional desktop PCs, laptops and netbooks, the true revolution will come with smartphones; use of these devices will be widespread, and they will come to be the main device used to access the Internet. Connected television will be only one of the entertainment centres in the home; we will also find the e-reader and tablets which will provide multimedia content on an individual level. The connected car will also become widespread. In addition to providing an easier driving experience, it will provide the vehicle with new safety mechanisms by providing real-time traffic reports, vehicle diagnosis and automatic communications in the event of an accident, among other features. Other devices to complement the above will include digital signage systems, digital information boards or telemetric systems that will become common in different areas. To sum up, devices connected to the Internet of the Future will improve the experience of reading, watching television, driving, reading magazines, learning and finding information...while eliminating time, distance and language barriers.

On the other hand, services that combine the **real and digital worlds** will become more extended. This tendency, which we call "digi-real", allows us to complement geolocation data from the physical world with that we obtain from the digital world, providing hybrid perception. Without a doubt, this tendency will increase human capacities.

One of the means of achieving such hybridisation consists of using and integrating virtual information in the real world, for example, by using technologies such as 3D or telepresence to simulate a person or group's being present in a room or enhanced reality to show things that cannot be seen with the naked eye by combining a direct or indirect view of the real world with virtual elements. This permits a view of reality with artificial information added in real time. An example might be visiting the Puerta de Alcalá in Madrid, and at the same time receiving information about its construction, history and most important events on the screen of your mobile phone, or having a system to guide you when you have to change a tyre by indicating the steps to be carried out with a video and audio explanation. In both cases, it would be like having a tour guide, or an instructor to help you with your tasks.

The result is that people know where they are at all times and receive enriched information from their surroundings. They will have an improved view of the reality in which they find themselves and will be able to click on information in the physical world, something which up until now has only been possible in the digital world.

Another channel which will become stronger is that of using real information in the virtual world. This will be possible, for example, in metaverses, virtual spaces that model real physical spaces, or in the use of virtual worlds in training centres for different professions and spheres. Another example of this hybridisation will take place in interfaces. This is the case with virtual keyboards which will be projected onto any surface.

Internet of the Future will eliminate barriers, strengthen human capabilities and greatly improve people's quality of life.

INTERNET OF THINGS

The Internet of the Future will be a more tightly-knit network, not only because more people will be connected, but rather because in an ideal situation, everything may be connected. On the one hand, there will be more devices using connectivity as an essential element for offering services.

This is the case of gadgets which, for example, allow us to access a weather station from home and obtain updated information in real time over the Internet, or devices such as e-readers that access content in a transparent way, and many more. However – and this is the novel part – objects in the physical world which previously lacked this kind of connectivity will be networked: cars, buildings, highways, appliances, urban elements and everything we need to manage or control. Without a doubt, this new “networked reality” will show us a new way to run a house and manage any infrastructure, a company, a community or even a country's economy.

The Internet of Things will bring us services that will complement information in the world and facilitate its analysis. On the one hand, it will permit us to monitor the behaviour of people and things through time and space and bring together services such as presence-based advertising or the management and follow-up on a supply chain in a company. In addition, having enriched information about the world will translate to heightened consciousness, which could even evolve to enable real-time consciousness about our physical surroundings.

The Internet of Things will increase our knowledge of our physical surroundings: reality will be complemented and enriched, evolving to improve our daily lives.

Another large sphere of application for the Internet of Things has to do with automation and control. This regards optimising processes such as resource consumption by facilitating automatic control in closed systems, as well as assembly lines, where this type of technology is going to permit more precise production.

The technology behind the Internet of things is, on the one hand, the technology that permits **object identification**, such as RFID, bidi codes and QR, in addition to sensor networks like Zigbee, based on wireless technology and next-generation sensors. These last include contactless sensors that are sensitive to context, nanosensors and actuators that also enable operations to be carried out remotely.

Sensors in this Internet of Things will be essential elements for the Internet of People, since they enable many of the services provided by the latter. For example, the Internet of Things is necessary in order to recover information about service context and personalisation. This information may include data on position or location, light and noise levels, presence, temperature or movement; combined with modelling and data mining techniques, they will help create adapted services and improve the user experience for many activities and tasks in peoples' daily lives.

Complete development of the Internet of Things goes hand in hand with the network, which supports **machine to machine communications (M2M)** and concepts such as **environmental intelligence**. All of these enable such ideas as smart cities, urban services, interaction among vehicles and between vehicles and urban fixtures and remote meter reading, to name a few. It also clearly applies to services for managing energy efficiency (to save energy by managing lights, heating and air conditioning) and in those for efficient energy management or smart energy grid (for managing an environment in which power generation and storage will be distributed in a two-way configuration).

In the future, it will be common for machines and objects to communicate amongst each other and with their surroundings spontaneously and without human intervention. Interactions will range from simple self-identification with a set of basic data up to self-evaluation of internal performance, communicating with other users or receiving external information that modifies its behaviour. Machines will become self-sufficient enough to make simple decisions, initiate communications on their own, and exchange knowledge instead of just raw data. All of this will take place in an environment of independent cooperation between objects. The goal: improve management of many tasks which currently require human intervention. In ten years, for example, we will be able to shop and pay with no need to empty the grocery cart, since your

purchases will “communicate” with the point of sale, which will also “speak” to your mobile phone and confirm the purchase. Doing inventory will no longer involve physically moving things around, since they will be digitally identified and therefore able to provide their identification data in a transparent way. There will also be complex independent systems permitting automatic control over unsecure open environments. For example, the Internet of Things may be applied to managing systems that prevent automobile collisions, or robotic systems that carry out tasks such as cleaning up areas contaminated with toxic substances and so on.

In ten years, it will also be normal to access your home remotely, using for example video surveillance applications and your own mobile, or activate the remote controls for heating, air-conditioning or opening awnings, or monitor fire detectors and water or gas leak sensors. In short, our homes will communicate with us. Cities will also be able to tell us where there are free parking spaces, or what route to follow to avoid construction and traffic jams. All in all, in ten years we will live in a world in which the Internet of Things will complement and enrich our reality, making daily life better.

The Internet of Things will provide the physical world with new capabilities and improve its maintenance and management

INTERNET OF INTELLIGENCE

If there is something that Internet has made possible, it is universal access to information that is available in real time. In the next decade, we will be witnessing yet another step. This information, which has grown exponentially, will be interrelated, have a context and make sense, and there will be an increasing number of mechanisms to make it intelligent. All of this infrastructure that will be found on the network will make up Internet of Intelligence. This will involve managing knowledge, and more precisely, managing access to this enormous amount of information in such a way that its excess will not be a problem. In ten years, it will be much easier to select the information that interests us and access all of the news, reports, advertising, opinions, conversations and blogs that have to do with what we are searching for. In conclusion, Internet of Intelligence will help people and applications find information about people, places, things, products and services, in addition to documents, images, sounds and relationships.

Thanks to Internet of Intelligence, managing access to the enormous amount of information on the Internet will grow increasingly easier.

Another element with a great deal of potential will be access to a considerable amount of data (generally corresponding to the physical world) which is currently held by numerous administrations or organisations and is for public access, but not within easy reach of society. Internet of the Future will bring these data closer to society. This tendency is known as **Open Data**, referring to information that will be connected to other “**Link Data**” in order to make sense. Information will no longer be considered plain text, but will become data with meaning. This will enable systems to have the possibility of contextualising information, making it possible for them to offer it to the user in the appropriate way at a given time. In addition, these data may be used by third parties for purposes of analysis, or by Internet services that use such analyses.

Internet of Intelligence will present all of these data in a way that is much more user-focused. For that reason, it is reasonable for us to pass from an Internet model based on text storage to a concept storage model. At present, technologies that follow this model are grouped under the name of **semantic technologies**, those that “process knowledge” through structures that define concepts and store relationships between concepts. These technologies permit the integration of knowledge sources that are both structured and unstructured (databases and other resources: documents, web pages, messages etc) and offer better system interoperability. These technologies are called upon to play a very important role in the development of information

systems and in the evolution of the Internet itself, since they will enable computer systems to "understand" the information they store in their immense databases, thereby making the users' tasks of accessing and managing the required information easier. These applications will not arrive at the end market directly; rather, they will be marketed full of traditional applications that will improve efficiency in a spectacular way. Thanks to that efficiency, it will be possible to contextualise information according to user needs, improve information search ratios and facilitate system interoperability. In short, Internet will stop being a mere data repository and become a warehouse of knowledge at the service of its users, and will also facilitate automatic interaction between systems. All of the above, combined with artificial intelligence mechanisms used for retrieving and recommending content, will improve access to information with butler-style services.

On the other hand, we must speak of **Cloud** as the enabler of many services found in the Internet of Intelligence. Thanks to this philosophy, it is possible for many service functions to be based on the network, and in some cases this will permit architecture to be cheaper and more efficient, or permit the existence of the service itself (because use of connectivity will be necessary for offering that service). This term "cloud" refers the concept of a network understood in an extended way. Applications served under this model will depend on the cooperation of networked services. Examples of the above include locating, searching, real-time traffic reporting and content storage services, to name a few. There are several approaches to cloud computing. One of the most noteworthy involves the uses of online storage capacity, processing capacity, services and platforms. In ten years, the cloud concept will be present in most services offered by the Internet of the Future.

Lastly, another two concepts will hold up the framework of the Internet of Intelligence: **virtualisation and content-oriented networks**. The first allows us to disconnect the physical characteristics of the computer or network resources, making it possible for those resources to be used by other systems, applications or end users. This means that we can use the virtual version of the resource (as opposed to the physical one: an operating system, server, storage device or network resource). Thanks to this idea, in ten years, we will have expanded the possibilities of emulating applications, operating systems, and even complete units (such as video game consoles) using much simpler devices. On the other hand, the need for adapting the network to current Internet use patterns, which focus more on accessing content than on the addresses of machines containing it, brings up another topic: **content-centric networks (CCN)**, which will improve network architecture in order to bring content to the user in a more efficient way.

INTERNET OF SERVICES

Internet of the Future will be more than an information superhighway. It will be a true platform for transforming many industries and sectors, while also contributing to sustainable development.

In ten years, we will see how the main economic sectors, in addition to incorporating new technologies and communication services on a massive scale in order to offer their products and services to society, will be using their benefits in order to improve processes, and resolve such challenges as facing dwindling resources, improving energy efficiency and environmental management. The world will be more accessible and sustainable thanks to this concept.

With the help of Internet of Services, the world will be more accessible and sustainable

This will involve using Internet in productive sectors, with a multi- and intersectoral approach to services.

Sectors such as the **health** sector stand to benefit the most. In this case, in addition to hospital management systems, electronic health records and electronic prescriptions gradually becoming

widespread, the health sector will also have incorporated technologies and services to help it manage its resources better. These may include telepresence, real-time communication between patient and doctor using mobile cameras or devices that enable remote follow-up during the postoperative period or for the chronically ill (with sensors that monitor vital signs).

Along the same lines, there will be significant advances in ten years as refers to wellbeing and health care. Contributing to these advances, we will find technologies such as smartphones, which will act as tiny personal trainers, or devices with sensors integrated into clothing in order to monitor vital signs; in conjunction with a system communicating with a follow-up centre, this will provide major benefits.

Utility companies will also use these communication-based services in order to improve the relationship with the client, for example, with telemeasuring devices in aspects such as energy efficiency, or to manage their own infrastructures by controlling electricity and the water and gas networks, and by managing quotas and tolls, car parks, etc.

Transport, moving and logistics companies, which have already incorporated such technologies, will continue to advance by contemplating increasingly complex services that help them make decisions in real time, provide real-time communications between vehicles, and monitor highway traffic or public transport.

In ten years' time, the **education** field will not only have increased use of online services, but will also have devised new ways of learning with devices such as tablets. Most of all, new technologies will be integrated into all levels of education. Without a doubt, Internet of Intelligence will be a major advance for all of the above, permitting easy access to knowledge.

In ten years, **cash** will be an increasingly obsolete concept. Financial services by Internet and mobile phones have led to a silent revolution among consumers worldwide as they complete easier, more accessible and more transparent transactions, which above all provide a tangible sense of control regardless of the city or country in which the buyer is located. For that reason, payment by mobile phone will be more popular, and become the normal solution for paying bills. This device will be able to be used in different areas such as banks, supermarkets, malls, etc. Here, in addition to spending money, consumers will be able to withdraw cash or add credit to their mobile phones. Furthermore, we will find digital receipts permitting the purchase of concert, sporting event and even train tickets with no need for a printed ticket, which will make transactions much more accessible.

On the other hand, the way that people manage and occupy their free time will continue to change, reshaping the **leisure sector**. In ten years, Internet will be the largest entertainment centre, and today's concept of television will no longer be the same. Entertainment will be more interactive and social networks will play an important role in it, with smartphones as key players in the entire process. We therefore find ourselves in a time of transition between a stage characterised by types of entertainment that depend on physical limitations and are not very personalised, and a stage in which we will find a much wider range of leisure activities. At that time, physical location will not be a barrier to interacting with others, and the dividing line between the real and the virtual will not be so evident.

In **public administration**, electronic public services will have reached a high degree of development, but the fundamental step forward will be in the area of interoperability. Thanks to communication services, it will be possible to connect with different levels of public administration in order to improve efficiency, reduce administrative burdens and offer better service to the public as a result.

THE NETWORK

However, none of these advances will be possible without a network to run them. This network will evolve toward **advanced connectivity**: from the user's point of view, this will make it possible

to access services without worrying about what type of connection is available, and without even knowing when the device is connecting to or disconnecting from the Internet. These networks will have to **interconnect and be interoperable**. This will involve providing ubiquitous, transparent broadband that will bring together various technologies and carrying out all tasks necessary in order for this connection to be transparent and apparently simple. These networks will be **self-organising and self-repairing (Autonomic and Zero-touch)** and require little or no human intervention. Networks will need to provide large-scale access, as well as additional characteristics in order to support the new services run on them. To this end, it is thought that they will evolve toward **all-optical networks**. The end product will be a network that supports everything connected to the Internet of the Future, a system that will be set up with **open service platforms** permitting agents from the real economy to build mass services for society on the network, services which evolve through a philosophy of open innovation to add value to our ways of living and working.

The network is the key to making Internet of the Future become reality
