WHITE PAPER - EXECUTIVE SUMMARY

Internet of Things: application areas, guidelines and potential for the development of projects for South Tyrolean companies.

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Executive summary

Through the fourth industrial revolution, the world is entering an era where millions of items are able to collect, communicate and share information through the network. The Internet of Things (IoT) is placed in this context, representing one of the technologies that will have major implications in the near future. With the IoT, physical and virtual objects can be linked to other objects and the Internet, creating relationships between things and humans. The IoT can combine the physical and virtual world creating smart environments, able to perceive, analyse and adapt to multiple applications and users. Since 1999, the year in which the term was used for the first time by Kevin Ashton, co-founder and director of a research consortium based at the Massachusetts Institute of Technology, the IoT trend has grown a lot. An indicator of this is the number of mobile objects connected, which, thanks to the Internet have seen an exponential increase. In 2018 there were 7 billion objects connected to the Internet [1]. For the year 2020 the number of mobile objects connected through the IoT is expected amount to 50 billion [2]. Other estimates are 14 billion objects connected by the end of 2019 and over 25 billion by the end of 2021 [3]. According to a study by the European Commission, the market value of the IoT in Europe is expected to exceed a trillion euros for 2020 [4]. The IoT Growth was also favoured by the reduction in the cost of sensors over the last 5 years, which is around 30 -70%, as well as by the wide availability of low-cost sensors that lend themselves to multiple uses. Relying on existing communications technologies like the Internet, the IoT allows people and objects to interconnect in different private, public and industrial contexts by facilitating the exchange of information and facilitating decision making in real time. In this way, the objects are capable of interacting with the surrounding environment, gathering data and informing the user about the state, and to the changes that the object detects in the real world. These opportunities represent a real step towards the digitization of many aspects of society, economy, the environment, public administration and industry.

The progress of the *Internet of Things* in Europe

Internet of Things (IoT) is the next economic and social innovation allowing significant flow from the Internet. Through the IoT, any physical object (such as a thermostat or a bicycle helmet) and virtual (ie a representation of a real object in a computer system) can be connected to other objects and the Internet, creating relationships between things and humans. The IoT can combine the physical and virtual world in an intelligent environment that perceives, analyses and adapts, making the lives of millions of people easier, safer, and more efficient. The strategy for the European Digital Single Market stresses the need to avoid fragmentation by promoting interoperability so that the Internet of things can express it's potential at the highest level [5].

In Europe, many countries have implemented programs and initiatives that aim to promote the dissemination of a series of enabling technologies for the industry 4.0, which constitute the foundation of the fourth industrial revolution. Enabling technologies for the industry 4.0 include several technologies, including the IoT. In Italy, in September 2016, the Ministry for Economic Development drew up the National Industry 4.0 Plan, which includes a series of specific actions in favour of business digital processing, including reference to the Industrial Internet of Things (IIoT), or the set of specific IoT applications in the context of production process management. The potential of the IoT is of increasing importance in various sectors, both in the production of goods and in the production of services, as this technology is included within the set of enabling technologies that formally establish the transition to the industry 4.0 technological model. In manufacturing the paradigm to which reference is made is that of **Smart Manufacturing**, in which the IoT can be seen as an innovative tool for increasing the efficiency of production processes and traceability in real time of production assets. However, the IoT will not only help to improve the manufacturing industry, by monitoring the most precise and reliable manufacturing processes, but will also allow the emergence of new business models, which will be based on the use of large amounts of data, collected from sensors.

The ability to connect the real world to the internet will have implications that will involve, in addition to manufacturing, more strategic sectors of South Tyrol such as agriculture, trade, construction, mobility, public administration, health and tourism. In the previous *Smart Specialization Strategy for the Autonomous Province of Bolzano Bolzano-Alto* [6] The concept of IoT was already being cited as promising in relation to innovation in the area of specialization of creative industries. In these terms, the benefits of creating a link between the electronic and the real world had already been recognised. "In conferring electronic identity to things and places through the physical environment, e.g. through the use of distributed devices such as sensors and/or radio frequency tags (RFID), you can collect data and communicate information over the network, making them accessible and usable by any user "[4]. In this way it was hoped for the development of applications, infrastructure, services and content, mainly ICT-based technologies, acquisition, monitoring, conservation, development and use e.g. the historical, artistic and cultural heritage of 'South Tyrol through the IoT concepts.

In recent years, technological progress has greatly expanded the areas of the IoT application, providing numerous opportunities for developing new products, services and innovative business models that could also benefit the South Tyrolean economy. Relevant applications that are deemed to have positive effects on the territory of South Tyrol also concern the field of **Smart Cities,** in which case the IoT allows people to relate with the infrastructure and services to citizens, in a simple and immediate way. The objects in the case of smart cities could be traffic lights, vehicles, buildings, and monuments that are able to communicate information to users, thanks to sensors that continuously collect data, then transmit to a central network, which processes and connects them. Smart Cities are one of the most relevant areas for the IoT. According to some observers, more than a fifth of all IoT projects announced publicly relate to the theme of Smart Cities [1]. The IoT applied, specifically, to the field of **Public administration** also opens up a number of scenarios for improving the relationship between institutions and citizens. Even the theme of mobility is strongly influenced by this technological trend. In this scenario we talk about **Smart Mobility**, i.e. the set of dynamics caused, for example, by the connection of tracking systems for public transport and infrastructure, allowing various stakeholders to know various information, such as the location of the means, the state of the roads or the vehicle operating state, in real time. The Internet of Things also finds room in the field of **tourism**, a particularly important issue for South Tyrol. Monuments or places of interest can be equipped with radio transmitters, which allow the user to receive information about the object on his *smartphone*. One of the most promising sectors for development for the *IoT* regards **Health and Welfare**. Through sensors that monitor parameters such as blood pressure or the level of sugar in the blood, the health of a patient can be monitored remotely in real time. A central computer could not only collect data, but could also analyse and predict the onset of certain diseases promptly notifying the user and the medical staff. Also, the way in which it interacts with buildings and with people's homes has the potential to be revolutionized by the IoT. In this context, the IoT is an enabling technology leading to **home automation**, allowing people to save time and improve the quality of their lives by digitally managing many features and home devices. The concept of the Smart Home will continue to be one of the main areas of the IoT application, as evidenced by the high volume of sales of dedicated devices globally. The potential of the IoT can be extended to encourage innovation in the **agricultural and environmental sector** with applications which support the concept of **Smart Agriculture**. In this sector there is a great potential deriving from the systematic analysis of data that are generated by agricultural activities in support of decision making. The information derived from the data may help improve the sustainability of business through the optimization of production processes and the use of a targeted use of raw materials in the supply chain.

The transformation of Big Data in Smart Data

Through the Internet of Things (IoT) objects are connected and continuously collect data that are brought to a central system that will analyse, process and share them, so the real

and virtual worlds converge in what is called an intelligent world. These items not only collect data, but they can communicate with each other in order to make decisions based on the data collected through algorithms. The huge amount of collected data (Big Data) does not hold any meaning until it is read and transformed into information by a central computer, which assigns, via specific analysis, meaning to the data read by the sensors, giving life to what are defined as **Smart Data**.

Accessibility in terms of cost and availability of the IoT technologies also allows Small and Medium Enterprises (SMEs) to ride the wave of this technological trend. SMEs account for 99% of all businesses in European countries, and a key element in the economic and productive fabric of South Tyrol. Despite the huge potential the IoT presents, numerous studies report that SMEs are still very cautious about the introduction of new technologies in their production structure. This is due to their lack of resources, both in monetary terms and in the knowledge and of the opportunities and risks of this technology for their business. Moreover, the fact that there are still no standards and specific rules for the use does not favour a rapid deployment of the IoT in all the above areas. That said, both SMEs and start-ups have real a real possibility to seize the opportunities presented by the IoT, because their agility allows them to radically change their marketing strategy and their organizational structure. Scientific literature devotes much space to the implementation of Industry 4.0 technologies in SMEs. The research focuses on the development of methodologies and tools that enable knowledge transfer to SMEs to develop new solutions for specific contexts (use-case), services and business models that allow the connection of elements of the virtual and digital world.

For versatility of the use of the IoT, the European Commission considers this technology to be the next significant economic and social innovation permitted by the internet, stressing the need to avoid fragmentation by promoting interoperability so that the Internet of things can express potential at the highest level. The development of this trend also contributed to the emergence of several topics of discussion that relate to security, privacy and ownership of data collected. The progress of the debate related to these issues requires careful consideration, including thorough targeted research activities, that encourage responsible, safe and effective use of this technology to support the competitiveness of the territory. The emergence of this technology will also depend on local and international policies which support the IoT spread in SMEs, which represent almost all of the companies in the territory. SMEs, like other players in the area interested in exploiting the potential of the IoT, must be able to rely on instruments aimed at creating strategic partnerships between companies and research centres, that promote the transfer of highly technical knowledge and know-how for introduction in the market of new products, services and business models. The European Union recognises the importance of targeted IoT research and testing to support the development and adoption of such a strategically important technology. For the 2014-2021 period, under the European research and innovation program Horizon 2020 [7], the EU will invest nearly 500 million euros in research, innovation and diffusion of the IoT, trying to overcome the possible technological barriers and regulatory and market conditions that could hinder the spread.

Conclusion

The IoT is one of the necessary components needed for the new industrial revolution. The possibility to connect each object to a network, uniquely accessible and integrated in a context of centralized or distributed information systems, will allow the development of technologies, products, services and business models. The creation of an IoT *community* on a local level which intends to cooperate in the development of innovative ideas, can promote the further development and use of such technologies, increasing regional capacity to generate positive effects on the territory. In addition to *stakeholders* which include representatives of industry, research and public administration it is desirable to involve civil society, in order to drive the development of innovative products and services

in terms of expectations and needs both shared and real. In South Tyrol there are numerous opportunities for the application of the IoT technologies in the most strategic sectors and areas of the territory such as agriculture, tourism, mobility, citizen services and public administration, smart-cities, healthcare, manufacturing and construction. These applications will provide new growth opportunities for local businesses as well as offer innovative services with high technical content and *know-how* on the territory.

The potential of IoT businesses in South Tyrol

The systematic collection of companies and other types of stakeholders has allowed the definition of the characteristics of the IoT network and the main fields and strategic areas of knowledge for the development of innovative projects at a local level. This community is composed of stakeholders in the area that can benefit directly or indirectly in the development of projects in the IoT. The study shows the presence of a network composed of many stakeholders classified in companies, start-up and research centres operating in various sectors and areas of strategic application to the territory. Figure 1 illustrates the distribution of stakeholders by sector and scope of application at a local level. The results of the survey aimed at defining active South Tyrolean stakeholders or those that can benefit, even indirectly, from the introduction of innovative IoT services, shows the existence of a very heterogeneous and synergetic network composed of companies, research centres, start-ups up and public administrations..

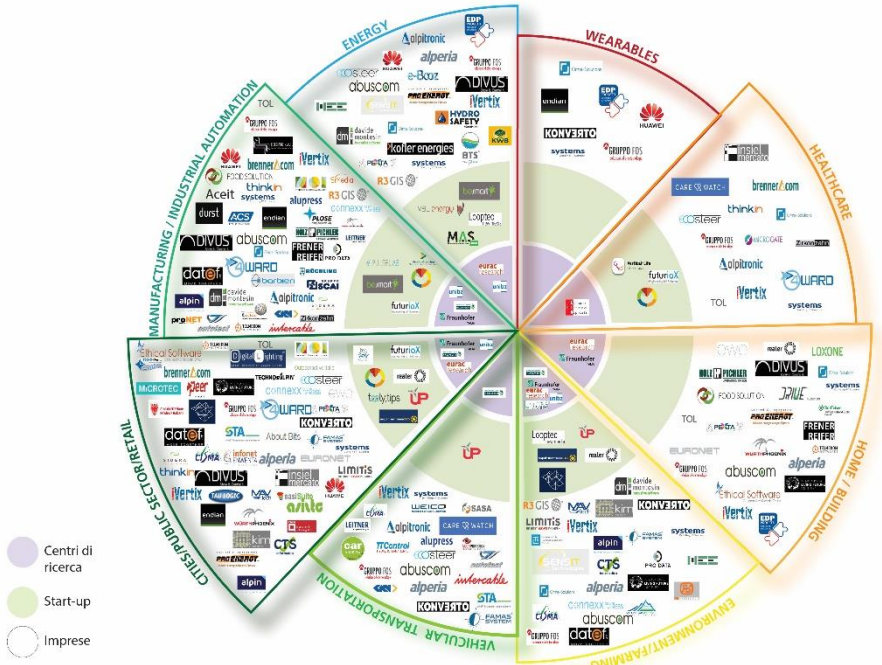

Figure 1: Stakeholder IoT network in South Tyrol

The division of the stakeholders was conducted on the basis of the references provided by the Internet of Things Alliance for Innovation (AIOTI) within the report "IoT LSP Standard Framework Concepts" [8] which identifies the following areas of application for this technology:

- Home/Building
- Manufacturing/Industrial Automation
- Vehicle/Transportation
- Healthcare
- Energy
- Wearables
- Environment / Farming

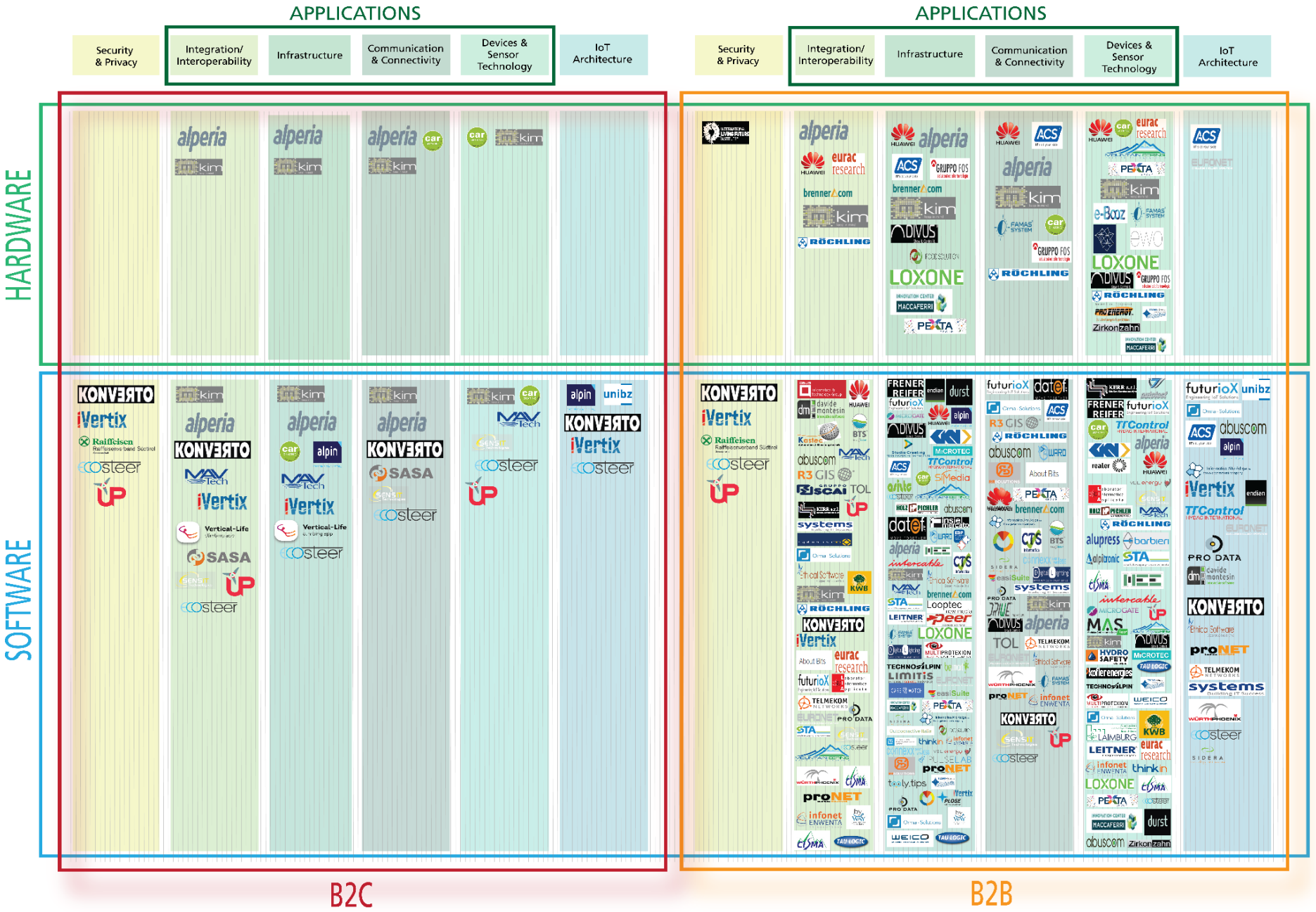
APPLICATIONS
Security & Privacy
Integration/ Interoperability
Infrastructure
Communication & Connectivity
Devices & Sensor Technology
IoT Architecture
HARDWARE
SOFTWARE
B2C
B2B

Figure 2 Applications and market positionin

The analysis, indicates that the majority of stakeholders in the area in relation to the IoT field is primarily active in the manufacturing sector and in the application areas related to the Smart Cities theme. Further sectors characterized by the presence of numerous stakeholders concern agriculture and the environment, Smart Home and construction, and energy and mobility. The sectors in which a relatively low level of participation is found include healthcare and wearables.

Further analysis allowed us to conduct an initial identification of companies depending on the area of specialization (Hardware/Software), market positioning (B2B/B2C), and type of applications provided. Figure 2 shows the distribution of the companies identified as potentially eligible for the IoT technologies, in general terms relative to the kind of applications they offer and their market positioning.

Specifically, the lower horizontal axis of the matrix represents the type of market, the vertical axis the orientation to hardware or software solutions, while the upper horizontal axis includes the set of technologies, solutions and applications that the company offers. For a correct reading of the graph we must consider that the right part of the graph indicates the presence of the company in the B2B market and the left-hand part B2C. Following the same logic, the quandrants at the bottom identify the offer of software solutions, while above are the offers of products/services in the hardware field. The combination of these dimensions with the columns relating to technologies/solutions/applications allows the identification of the specific positioning of each company.

Conclusion
The profile of the community that the research has enabled us to delineate, can be considered the initial context of competences necessary to foster collaborations for the development of innovative ideas between companies, research centres and start-ups. Encouraging and promoting the creation of such collaborations in the area can contribute to the development and market introduction of innovative products and services.

IoT projects in EU funding programs

The analysis of initiatives and projects active in South Tyrol in the IoT sector involved the systematic collection of projects co-funded by the European Commission in a number of significant financing programs for the area at different levels, by expanding the search from the local level (e.g. ERDF) to the international level (e.g. H2020). The presentation of these projects provides an overview of the thematic areas and the contents subject to research and development, to be considered to establish synergies for any possible future research developments in the area. Table 1 summarizes the main funding programs at a European level in which projects related to the IoT were carried out.

Programs	Level	project selection
ERDF Autonomous Province of Bolzano	Regional	12
Interreg Italy-Austria	Transnational	1
Interreg Alpine Space	Transnational	1
Horizon 2020	International	49
Europe Interreg	International	1
LIFE	International	3
Chist-era	International	6
Other programs	International	10
Total		**83**

Table 1: Overview EU programs in the IoT area

Most projects in the IoT have been identified within the funding program Horizon 2020. Considering only the projects financed at a local level, we can see that in South Tyrol, most of the projects fall within the concept of creating networks and knowledge transfers to the territorial players on the potential of the adoption of technologies and IoT systems, as well as services coaching on the theme of digital transformation to support businesses. The ERDF projects have mainly been concerned with the creation of an ecosystem favourable to the use of IoT technologies. The table shows that most of the projects analysed dealt mainly with the development of software or hardware platforms linked to the IoT area. This phenomenon is also reflected in the literature on the topic of industry 4.0 and more specifically with regard to the IoT.

Some of the identified projects foresee the use of Beacon, mainly for proximity marketing and location purposes. Again, some projects are dedicated to improving the capabilities of the Beacon technology, such as improving the accuracy of position identification. The number of projects that are applied within the health and construction sector has been smaller.

Preliminary research has allowed us to identify general thematic areas in which projects and initiatives in the IoT area have been developed. This reference made it possible to classify the various projects by macro-theme, providing useful information to determine which thematic areas are mostly dealt with in the respective EU Financing Programs. Subsequent analyses at program and comparison level will use this information, also combining more specific elements related to the type of activity performed, showing the main evidences that derive from it.

Conclusion
The systematic collection of projects highlights the vastness of contents and sectors subject to research and development in the IoT area, potentially transferable according to the needs within the context of South Tyrol. The knowledge of previous experiences carried out at a local and international level in the IoT field - and in particular of the methodologies used, identified success factors, as well as technological limits - representing information that can facilitate the stakeholders interested in defining innovative projects in the sectors defined as strategic at a local level

Guidelines for the development of innovative ideas in IoT

One objective of this document concerns the definition of guidelines that support the innovation community subjects in the future development of innovative projects and ideas in the IoT area. In this sense, we intend to provide NOI Spa with concrete tools to support innovation processes within collaborations between companies, research centres and start-ups.

This section presents the inclusive guidelines of the different phases of interaction between NOI Spa and the interested parties to evaluate the potential of innovative ideas and to develop projects (Figure 3).

Figure 3: Phases of interaction in the development of innovative projects and ideas

For each of the phases, specific objectives, methods, tools, expected results and required participants are indicated to support the creation of a favourable context for collaboration between companies, research centres and start-ups.

Coordination Board

Companies that intend to implement innovative ideas in the IoT field and need support, for example, technological research partners, idea content improvements and evaluation of possible financing opportunities will be able to involve NOI Spa - *TechTransfer Digital Technologies*. The objective of this meeting (Coordination Board) allows the company to receive feedback on the contents of the idea and to network with other partners of the IoT community for the further development and realization of the idea (Figure 4)

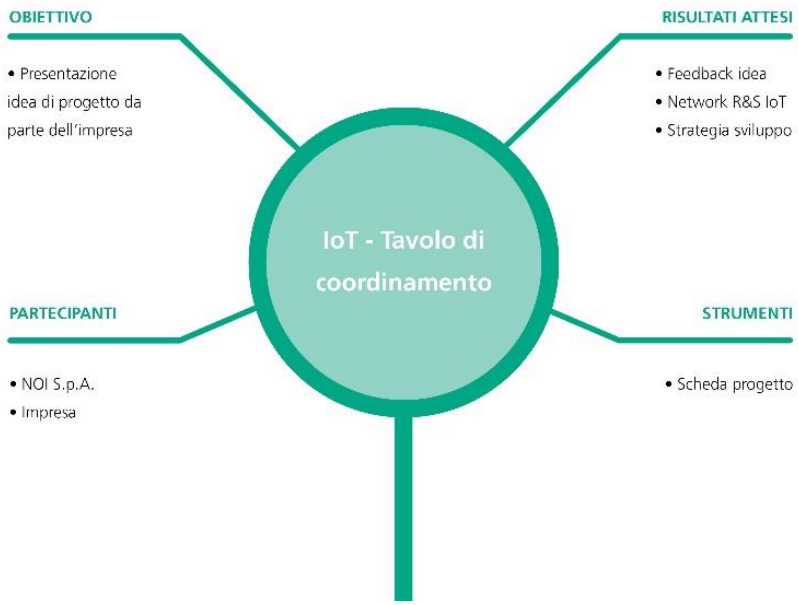

Figure 4**:** Overview of the coordination Board

Support development of the idea

If the company should be interested in drawing on the expertise, products and services of the IoT community subjects, a second meeting (Figure 5) will be aimed at:

- Networking the company with the most suitable IoT community partners for the development and implementation of the project idea
- Further developing the content of the idea according to the objectives laid down by the proposer
- Consolidating the timing and organizational aspects of the project

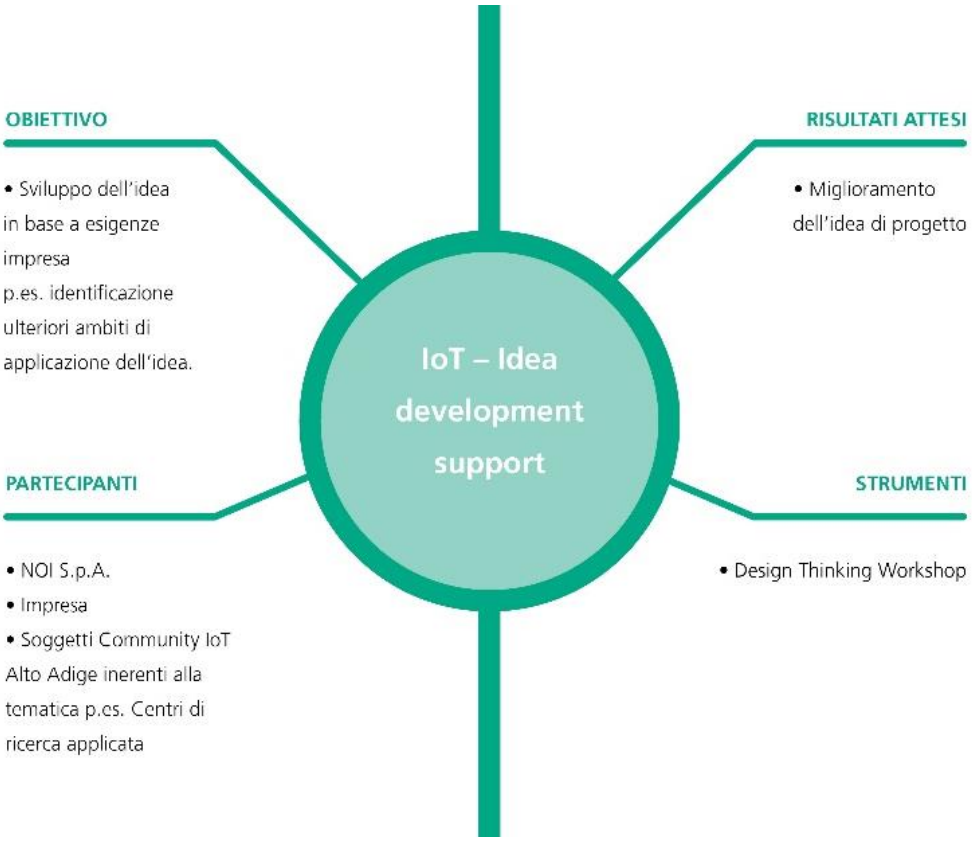

Figure 5: Idea development support Overview

Project Development

A further phase, at the end of the previous ones, provides for the launch of the project itself or the request for facilitation through participation in regional tenders for Research and Development (R&D) or projects co-financed by the European Commission (Figure 6).

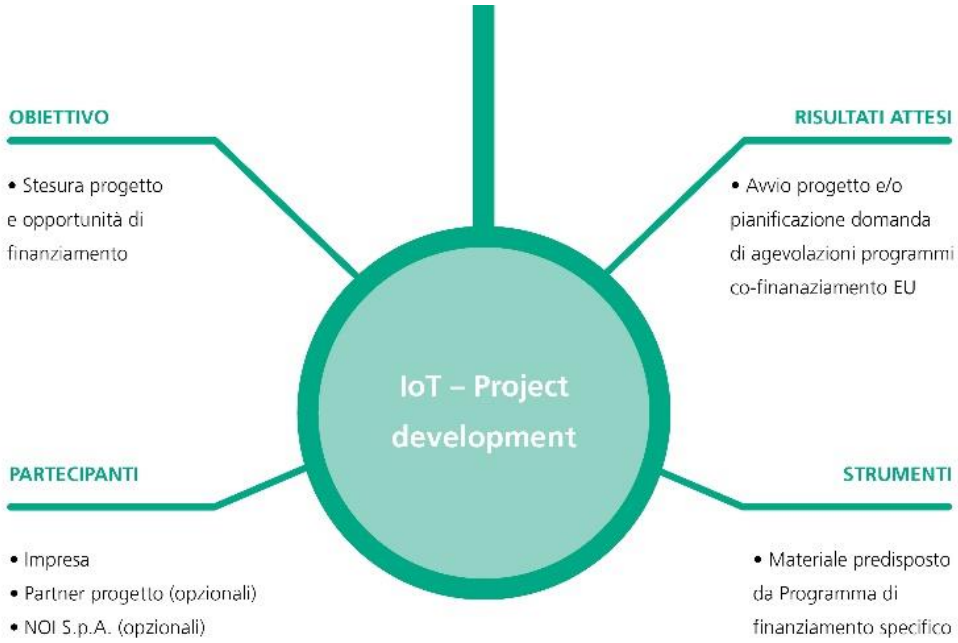

Figure 6: Project development Overview

At this stage no specific tools are provided to support the collaboration but reference will be made to the material prepared by the specific funding program or to the project material made available between the partners.

Conclusion
In support of innovation processes and defining new ideas, guidelines have been drawn up that indicate the type of interaction between the subjects of the IoT community and NOI Techpark. In this sense, we also intend to inform interested parties about the development of collaborations in the field of the IoT regarding the type of support offered by NOI Techpark in the development of the idea, in the search for potential cooperation partners, in the definition of concrete projects and in the evaluation of funding opportunities.

Technological state of the art analysis of the IoT industry

This chapter contains an introduction and a summary of the work carried out by the FOS Group and reported in the document entitled " Realization of an analysis of the state of technological art in order to identify current and future technologies and platforms regarding the IoT sector". The document contains all the results obtained in the development of the analysis of the state of technological art in order to identify the technologies and platforms, in particular, current and possibly future for the IoT sector. The first difficulty to consider in dealing with an analysis of this type is given by the reality that the IoT is a concept, a paradigm and not a technology; the IoT is embodied in the technology of things, in fact it arises from important insights that saw a maturation which started with the telegraph, perceived with research on Wireless Power Transfer (WPT) by Tesla, unconsciously applied to solve some student problems at Carnegie University and finally defined and summarized with the idiomatic phrase "Internet of Things" by Ashton. Today, 20 years after the awareness of the existence of the Internet of Things - as well as the coining of its name - we can affirm that the expansion of this paradigm has allowed the technologies related to it to have become so important that they are changing our lives socially and industrially, both in habits and in the management of business processes. Developing IoT applications does not just mean creating systems to connect devices in a network, but more complex activities are expected. We are at the peak of development activities and relative expectations for the IoT. It is therefore necessary to first understand the technological structure involved in an IoT application. In fact, to be applied, the IoT paradigm must be considered as a set of different systems including objects, communication systems and combinations of various software solutions, as well as the data itself, the related analysis activities and the actions arising from them. In the present study, the technological world of the IoT was analysed considering its fundamental aspects: device, communication and application framework.

In the present technological study, there is no clear distinction between the concept of IoT and IIoT. Therefore, the vision of the IoT can be oriented both to the consumer and to the industry. In the consumer-oriented concept, the focal points are people, domestic applications, consumer electronic devices, cars, computers and many other commonly used objects. Industry 4.0 (IIoT) instead creates opportunities for companies, production plants or entire sensor networks. The examination of the various protocols and technologies present at the Network Access Layer level in the IoT panorama has shown a first settlement at least for the LWPAN/Cellular like. In fact, the 3GPP has already released all the LTE and NB-IOT specifications, only the EC-GSM-IoT remains which is at version 13. On the other hand, companies and research centres do not expect GSM operators and thanks to the various associations and consortia they are increasingly giving life to various valid alternatives, first of all noting Sigfox and LoRaWAN. In the world of WLAN, PAN, ULPW LAN, highly targeted and application-related technologies are emerging, such as the ANT/ANT + devices on the market for personal fitness and health-care gadgets, and technologies with BLE and ZigBee that are linked to more broad-spectrum activities. ZigBee is more oriented towards the industrial and domestic side, where even in these cases there are convergences, as is happening between the ZigBee Alliance and the Thread group. The latter products are now becoming part of our homes, in fact there are many Google NEST Thread products. In the Session Communication Layer, the situation is in the process of stabilization, the most used protocol is the MQTT which is seeing an evolution from a protocol designed for telemetry to the IoT-oriented protocol. Not forgetting the classic protocols of the WEB, among which the

adaptation of the XMPP, born for the exchange of messages, stands out but which is also proving to be an excellent protocol for the IoT. Finally, the way data is managed and analysed can boast the presence of a myriad of different systems and platforms. In this analysis, only a few that are not always the most used in the IoT world have been considered, but they are very interesting from a technological point of view.

The situation in South Tyrol shows a diversity of applications linked both to technologies that require a gateway to access the Internet, and to technologies directly connected to the Internet. Considering only the latter we notice a major launch of technologies related to 5G, but at the moment we are reporting the presence of specific projects or the creation of backbone connection. Furthermore, as it is also being structured at a national level, 5G will cover the areas of greatest voracity of data, such as large cities and vast industrial areas. The peripheral areas - and in particular - the rural areas, which represent a strong point for South Tyrol, will not be the focus of attention. From this point of view the business ecosystem linked to the South Tyrolean IoT is being organized both with PAN-related technologies and with LPWAN. These allow, through gateways, access to Internet networks maintaining transparency with very high connectivity (as opposed to the use of wireless and wired, and cellular or cellular-like technologies) and to take advantage of the technological developments of connectivity that will gradually arrive over the territory.

Conclusion
In technological terms, in South Tyrol there is a potential of several applications that refer to both technologies that require a gateway to access the Internet and directly connect to the Internet. Initiatives reported locally that Wireless, Wired and LoRaWan use can be evaluated for further local applications. In this context, the interested parties will be able to benefit from the Long Range Wide Area Network made available to local companies by a network of sensors capable of transmitting information in real time, to conduct research aimed at introducing products, services and models to the innovative business market based on the potential of the IoT for the benefit of competitiveness and as a factor in the attraction of skills (e.g. innovative start-ups) for the territory.

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Fraunhofer Italy is a partner of the Fraunhofer-Gesellschaft, the largest applied research organization in Europe. Thanks to its multidisciplinary team it guides businesses towards digital transformation, assisting them from the first ideas of development to prototyping. In IoT it is involved in the conceptual development of areas of application, distributed systems for data acquisition and sensors, as well as consulting on enabling technologies such as 4G / 5G, LoRaWAN, NFC, Bluetooth, embedded platforms and advanced sensors.

The FOS is a high-tech company involved in IT, the Internet of Things and electronic design, leader of the FOS Group, a group of companies focused on ICT and Technology Transfer. In particular, the FOS Group is very active in the development of high value-added technologies and provides a wide range of services in Information Technology and Telecommunications, Engineering and fast prototyping.

The Digital Technology Sector at US Techpark AIMS to turn into a smart green South Tyrol region. Together with strategic partners, as well as with start-ups and companies, it is setting up a Free Software Lab and an Open Data Hub. Moreover, promotion and networking of software developers and R & D projects are a key factor in the development of South Tyrol as a pilot region in digitalization and future issues: such as the Internet of Things and Big Data.