

Smart City as an Innovation Engine: Case Oulu

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Abstract. This paper explains how a proactive city as an R&D&I ecosystem can achieve remarkable results in the field of innovation. The City of Oulu has an internationally recognized tradition as an innovation center. Especially, the city's track record in the field of ICT can be regarded as a great success. The secret behind this development is in a seamless collaboration between all the central players related to innovation. This includes PPPP – Private-Public-People-Partnership. All parts of the innovation support are in place, ranging all the way from the basic infrastructure and services, to the world class research and support for businesses. The paper provides an insight to the Oulu experience in introducing the technology, business models, partnership and innovation concepts of a smart city, and also the vision and strategic steps towards keeping up the top performance as a global level innovation hub.

Keywords: smart city, innovation, ecosystem

1 INTRODUCTION

The today's cities are complex ecosystems, where ensuring sustainable development and quality of life is a central concern. In such environments, people, businesses and public authorities experience specific needs and demands regarding the public and private services. Services are increasingly enabled and facilitated by ICT and Internet infrastructures. Therefore cities are facing growing challenges on how to maintain and upgrade the required infrastructures and establish efficient, effective, open and participative processes to keep up the pace with the demands of their citizens (Schaffers et al 2012).

A city can be called »Smart City« when investments in the human and social capital and traditional and ICT-based infrastructure fuel a sustainable economic growth and a high quality of life, with a wise management of natural resources, through a participatory government (Caregliu et al 2009). There are also various other definitions about the Smart Cities, such as they are places generating spatial intelligence and innovation, based on sensors, embedded devices, large data sets, and real time information and response. There are also various smart domains listed, like smart economy, smart mobility, smart environment, smart living, smart people, smart governance, smart infrastructures and smart communities.

Being a Smart City offers new and better services to city residents, as well as cost savings to the city in provision of services and operating the city. A good »Smart City« brand also attracts new key stakeholders to the city; companies, professionals, students, new business opportunities. The existing stakeholders within

the Smart City value system have different roles in making a city a smart one (Schaffers et.al. 2012):

1. *Local governments* set challenges and implement policies for development and orchestrate the planning and decision process. Policy instruments such as pre-commercial procurement contribute to pushing innovation.
2. *Citizens and businesses* have an immediate interest in shaping their living and working environment. Representing the demand side, they increasingly organize themselves in grassroots citizen interest groups or professional communities
3. *Living labs* act as generators of ideas and innovative solutions through open innovation, and as "arenas" bringing together different actors from both the demand and supply side in the relevant value networks. It is a fundamental trend of smart cities that solutions have to be defined and implemented with the involvement of citizens, as consumers and user, as well as large enterprises and SMEs both acting as advanced users and suppliers, together with researchers and policy makers.
4. *Research and technology communities* such as research institutes/laboratories offer technological know-how as well as facilities for technology testing and for the evaluation of user experience enrichment and level of engagement.

2 OULU – CAPITAL OF NORTHERN SCANDINAVIA

Oulu is the sixth largest city in Finland, the largest city in Northern Finland and the largest urban centre in

Northern Scandinavia with its 188'000 inhabitants, including 5000 foreigners representing 116 different nationalities. The city's residents are its most important asset. The drive towards the future and to create and innovate is likely due to the region having the youngest population in Finland and in Europe with an average age of 34.5 years.

Oulu has also the largest regional R&D spending per capita in Finland and the fifth largest R&D spending in Europe. The city is especially known for its ICT sector; there are 14 000 ICT jobs in the region. The city has also a good business infrastructure and a very innovation/R&D friendly central administration.

As a proof of global level performance in innovation the City of Oulu has got several acknowledgements for being innovative and smart city. Oulu made it just recently onto a Fortune magazine list of the seven best new global cities for startups¹. In 2012 Oulu was awarded for being the most intelligent community in Europe, and was ranked among the Top7 globally². The tv channel CNBC ranked Oulu as one of the »15 Surprising Global Technology Cities«³. The Oulu's international attention is not just recent; for example, the Wired Magazine ranked Oulu already in 90's as the "Silicon Valley of Finland". This success has brought Oulu a notable international media exposure, publishing also prominent articles on the Oulu-based start-ups.



Figure 1. Air Guitar World Championships have been held in Oulu since 1996 (www.airguitarworldchampionships.com/).

The City of Oulu is an ideal example of a Smart City. It has also been successfully using the Smart approach to business and innovation development. According to the Oulu's track record, the city can be regarded as one of the forerunners of Smart Cities, having been driving the Smart City ideas already from the early 90's. Many of the activities which at the time were not called the

"smart city" were done in co-operation with the real end user, "the everyday innovator".

3 SMART OULU INNOVATION ECOSYSTEM

In association with economy or jobs, the Smart City is used to describe a city with a "smart" industry. That especially implies industries in the field of information and communication technologies (ICT) as well as other industries employing ICT in their production processes (Giffinger 2007). The term Smart City is also used regarding education of its inhabitants. Inhabitants of a Smart City are smart in terms of their educational grade. Also, good governance as an aspect of a smart administration is characteristic for the Smart City approach; this is often referred to the usage of new channels of communication for the citizens, e.g. "e-governance" or "e-democracy". A Smart City is furthermore used to discuss the use of modern technology in the everyday urban life. The Oulu's innovation ecosystem includes elements using the Smart City approach.

The Oulu's innovation engine is like the DNA in the body, being part of each cell (Bell, Robert et.al. 2012). It is based on the long tradition of co-operation between education and research institutes, companies, public sector as well as enthusiastic and innovative individuals. This means that instead of talking about the Public-Private-Partnership, the term used for it in Oulu is *Public-Private-People-Partnership*. Smart City Oulu approach to cooperation activities is strategy driven and innovation oriented; its collaboration projects are developed and executed based on a real need which means fast and easy deployment of the obtained results.

The city of Oulu has recognised the importance of innovation and its innovation ecosystem as a central tool to guarantee the success. In 2007, the city set up national level working group to evaluate the city's potential from the global perspective to draw up a regeneration proposal for the Oulu innovation ecosystem in order to better meet the challenges of business and innovation. One of the working group's proposals was to establish a strategic partnership of the Oulu Triple Helix development Alliance, called the Oulu Innovation Alliance (OIA). The alliance consists of the City of Oulu, the University of Oulu, the Oulu University of Applied Sciences, the VTT Technical Research Centre of Finland and Technopolis.

The purpose of the alliance is to carry on the Oulu's long tradition of cooperation between the education and research companies and the public sector that supported the Oulu region's high tech success story in the 1980s. The ultimate target of the OIA agreement is to maintain the Oulu's position as an internationally recognized center for innovation. The OIA agreement signed between the founding members lays out strategic objectives, the governance model, the roles and

¹ <http://money.cnn.com/gallery/technology/2012/09/19/startups-global-cities.fortune/7.html>

² <http://www.intelligentcommunity.org/index.php?src=news&refno=682&wpos=0,5000,11276>

³ <http://www.cnbc.com/id/49348509?slide=1>

responsibilities of each member as well as the practical implementation of the cooperation. The OIA founding partners have committed themselves to:

- focus their operations, education, research and development activities on agreed innovation areas
- invest in the development of agreed infrastructures
- create and develop mechanisms for mutual use.

The agreed initial focus areas were– based on a study to find the most potential sectors from the international perspective - Internet research, printed electronics, international business, environment and healthcare sectors. The activities focused on the creation of centers of excellence and on an open ubiquitous city in Oulu. The OIA has established several innovation centers that are responsible for executing the OIA strategy in their respective fields: Martti Ahtisaari Institute of Global Business and Economics (MAI, <http://www.maigbe.fi>), Center for Internet Excellence (CIE, <http://www.cie.fi>), PrintoCent (<http://www.printocent.net>), Center for Health and Technology (CHT, <http://www oulu.fi/english/CHT>) and Center for Environment and Energy (CEE).



Figure 2. Oulu Innovation Alliance structure.

3.1 Oulu City Innovation Ecosystem

The Basic idea behind the Smart City focused innovation ecosystem is that the entire system serves the common goal i.e. making the city a better place to live in and to make the global growth oriented business. From this perspective the innovation ecosystem has been developed to take into account all the layers (Fig. 3). All parts and layers are needed, and when linked together they support the common goal. How this approach is implemented in the City of Oulu is presented here especially from the ICT perspective.

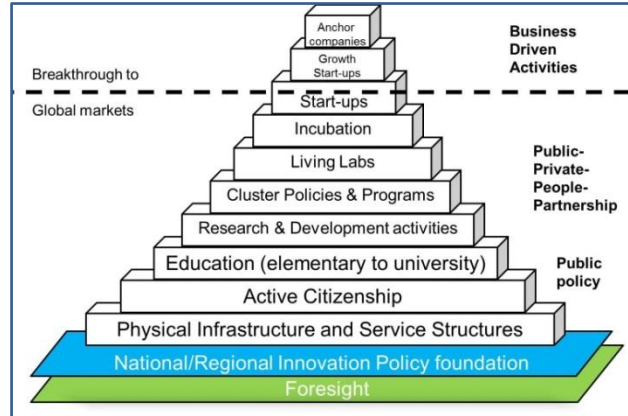


Figure 3. Innovation Ecosystem Structure.

3.2 Policy foundation, foresight perspective

The foresight and policy approach to the innovation system was mainly laid down by the Oulu Innovation Alliance. It defines the common framework for local innovation policies and activities, taking into account the global trends and the Oulu's strengths as described above. The parts of the innovation ecosystem structure are interconnected to support individual common goals. A good example of this approach is the Oulu Inspires Innovation Strategy (2007-2013)⁴. It draws attention to the importance of human enthusiasm as a source of innovation. Enthusiasm springing from a working environment of inspired individuals enables renewal as well as success in global competition. The Strategy goal is two-fold. First, make Oulu known for its growth of companies operating in the global market. Second, ensure the city to be a competitive and dynamic innovation environment for different businesses.

The City of Oulu has been a very active player at the operational level, investing its own funds and resources into joint development programs executed in collaboration with the local industry and research institutions. The primary examples of such programs are the Competence Oulu 400 Program⁵ and the Future Service Society Program that illustrate the City of Oulu's commitment to advancing the knowledge society.

3.3 Infrastructure and Service Structures

The city and all other central players take into account innovation aspects also in development of the infrastructure and service structure. One such good example is development of innovative ICT deploying schools, one of them being Ritaharju school⁶ opened in 2010. The school acts as a heart of the community center, serving pupils but also other people living in the region. From the innovation ecosystem perspective it works as a testing environment for researchers and

⁴ www.ouluinspires.fi/strategy/index.htm

⁵ <http://www.ouka.fi/taito/>

⁶ <http://www.ouka.fi/oulu/ritaharjun-koulu/in-english>

businesses, being also a very popular site to visit to see how an innovative teaching and learning environment works in practice.

Another example from innovative infrastructure is Oulu Technology Park (later Technopolis Plc.), which is the first technology park in Nordic countries, founded in 1982 to provide premises to ICT companies and act as an incubator⁷. The Technopolis Plc. nowadays operates in ten cities in Finland, as well as in Estonia, and Russia. Besides providing the premises it has been a central player in supporting the innovative SMEs.

Innovativeness means also a proactive approach to innovative infrastructures. Oulu has been in forefront in development of an open source virtual world platform called realXtend that lets anyone create 3D environments and applications⁸. The realXtend project, which was started in 2006, speeds up the development of the global standardized 3D internet of virtual worlds by making the technology available to everyone and entirely free of charge.

The latest achievement of the Oulu innovation infrastructure is a cave virtual lab which has already attracted both domestic and international attention⁹. The cave virtual lab is a joint operation in Oulu where the aim has been to build a modern 3D environment. The space has been built at the Oulu University of Applied Sciences and has been operational since beginning of October 2012. The newly opened environment makes it possible to visualize designs where people can walk around freely. This is useful for example for architects designing new buildings and environments and wanting to gather the user feedback before the building process starts. The goal is to meet the needs of the rapidly growing businesses in the Oulu region, developing business/products in the field of 3D Internet.

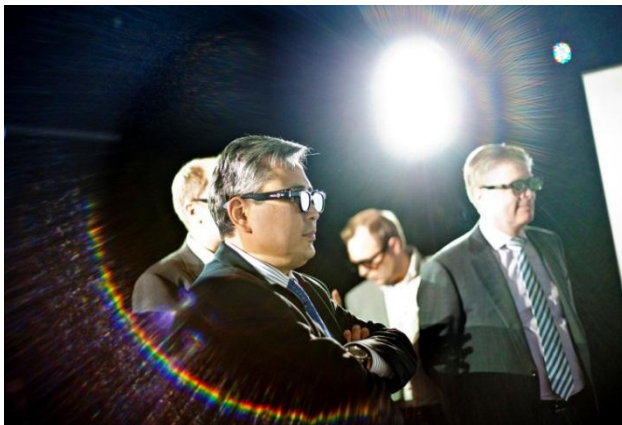


Figure 3. 3D Cave lab in Oulu was visited by the Ambassador of Kazakhstan to Finland, Mr Galymzhan Koishybayev and the Ambassador of Finland to Kazakhstan, Mr Mikko Kinnunen (Picture: Jussi Tuokkola).

3.4 Citizen perspective

From the user community's point of view – both citizens and businesses - the city appears as a smart space providing a rich interaction between the physical, virtual and social spaces. This means that citizens can enjoy about innovative service solutions, such as innovative schools, and also contribute to the development of new services.

One way of serving the citizens is to develop the communal ubiquitous technology to embed the information technology into the urban environment in an invisible manner to provide better services for citizens. A 'ubiquitous city' has been envisioned as an urban environment in which solutions and devices using the embedded information technology merge physical, virtual and social spaces into one seamless entity. The primary task of the ubiquitous technology is to facilitate the lives of citizens.

The competence Oulu 400 Program and Future Service Society Program enhance digital inclusion. Among other things the program has developed the OmaOulu Citizen Portal¹⁰ providing "one stop" access to municipal online services. The portal provides the citizens of Oulu with the access to a wide range of the City's e-services as well as to others user-friendly information society services. The portal is based on an open source architecture and employs a single sign on the (SSO) authentication mechanism so that the user can access all the services with a single login. Since May 2012, the portal has also supported mobile authentication. Every citizen of Oulu who chooses to use the portal gets a customizable personal page, access to social networking services, and easy-to-use and reliable email. Currently, the OmaOulu Citizens Portal contains 50 services and is monthly used by 21'000 users.

The Future Service Society program has developed e-services for the municipalities in the Oulu region, both transforming the existing conventional services into the web services and developing completely new online services. The Future Service Society program has also established the means for fostering user-driven open innovation. The PATIO test user community program adapted to foster user-driven open innovation¹¹ and established in Oct 2010, encourages the inclusion of citizens of all ages in the user-driven open innovation of new services and in the co-creation of services with businesses and developers. Today the PATIO is part of the OULLABS (Oulu Urban Living Labs). Every citizen is welcome to join the Patio to participate in the design and evaluation of new applications and services at different stages of their design process. Companies or organizations can easily collect the users' feedback on their products, services or ideas. Over 50 different

⁷ <http://www.technopolis.fi/en/technopolis/Pages/default.aspx>

⁸ <http://realxtend.org/>

⁹ <http://www.oamk.fi/hankkeet/cave/>

¹⁰ <http://www.omaoulu.fi>

¹¹ <http://www.patiolla.fi>

projects involving almost 500 users have been carried out at the PATIO so far. They either generate or evaluate ideas and test mobile applications, mobile device designs, 3D user interfaces or public online services. Customer experiences show that the PATIO has been useful for research projects and product and service development of companies.

The education level of the people in the City of Oulu is one of the highest in Finland; 75% of its inhabitants older than 15 years have degree education (SVT 2012). Even though the education perspective is essential as far as innovation is concerned, it is not just the university level education that matters. To ensure the high level education all the way from the pre-school stage, the city invests in development of learning environments to meet challenges of future learning. The Education Office in the City of Oulu is investing in future oriented thinking to better match the learners and their needs. One such good example is the Ritaharju school.

3.5 Research and education institutions

From the R&D institutions' point of view, the city appears as an open community test bed stimulating innovation, research and development of new services and applications. The most important research and education institutions in the City of Oulu are the University of Oulu¹², established in 1958 with its 17 000 students, the Oulu University of Applied Sciences¹³, with its 9 000 students, as well as the VTT State Technical Research Centre of Finland¹⁴ established in Oulu in 1974.

Development of collaboration between the organisations has resulted in new innovation centers, such as the Center for Internet Excellence (CIE), where all the central bodies in the field of future Internet/3D Internet collaborate. The CIE research and innovation activities are multi-disciplinary with their main focus on technology but closely linked with application development, usability, social sciences and businesses. CIE also uses the Living Lab approach to enable user-driven innovations by involving individuals outside the traditional product and service creation professions. This empowers the ordinary people to experiment and contribute to the Future Internet. According to the multidisciplinary approach also CIE's activity themes vary, from technology oriented cooperation with Intel and Nokia related to 3D Internet in mobile devices, all the way to how to exploit 3D Internet in education as well as how to develop equality in ICT sector.

3.6 Cluster policies and programs

In the 1980s, the City of Oulu, together with the local industry and research institutions, established the first regional business development strategy with a conscious

decision to focus on ICT and electronics. These organizational and strategic developments laid the foundation for the subsequent evolution of the Oulu region into one of the leading "silicon valleys" in the world.

Oulu has systematically updated its master strategy to address the changes in the economic climate. In the 1990s, the "Oulu Centre of Expertise Program"¹⁵ laid down the strategic objectives to increase the development of ICT in different areas of society, to accelerate the commercialization of the ICT-based ideas and products in the global business arena and to support the development of new technologies that tolerate risks for business. In time the program has been extended to the national level by the Ministry of Employment and the Economy. The Centre of the Expertise Program is still a tool for the innovation policy in Finland and in Oulu.

In the next stage, the "Oulu Growth Agreement" continued the strategic approach to the cluster policies and programs with the objective to improve Oulu's position as an international competence cluster and increase the competitiveness of growth sectors (OECD 2005). The agreement was signed by a large number of local public entities committing themselves to 300 MEUR of joint R&D activities during five years on five competence clusters: information technology, content and media, wellness, biotech and environmental technology. In the last phase the Oulu Innovation Alliance has been coordinating the innovation policy work with focus on internationally competitive sectors.

3.7 Living Labs

The Oulu's unique Living Lab infrastructure is coordinated under the OULLabs (Oulu Urban Living Labs) brand¹⁶. The OULLabs, coordinated by the Center for Internet Excellence, aims to provide a diverse environment for innovation, research, development and testing of new applications and services in an authentic environment with real users and thus to improve competitiveness of the companies. The OULLabs is a network-like Living Lab which is based on the infrastructures of the founding members of the Oulu Innovation Alliance.

The OULLabs aims to enlarge utilization of the common infrastructures by gathering them into a one stop shop-based entity from where a customer company can easily order a comprehensive user test for a new application. The OULLabs infrastructure includes among other things a free wi-fi network panOULU, which covers large parts of the city and the online test user forum PATIO which provides companies and organizations an opportunity to easily collect users' feedback on their products, services or ideas. The

¹² <http://www oulu.fi/english/>

¹³ <http://www.oamk.fi/english/>

¹⁴ <http://www.vtt.fi/?lang=en>

¹⁵ http://www.oske.net/en/contacts/centres_of_expertise/oulu_region/

¹⁶ <http://www.oullabs.fi/en/front-page.html.html>

testing infrastructure includes also other types of the testing environments, such as sensor networks and innovative schools and hospitals.

The panOULU¹⁷ wifi network, established in 2003, is an excellent example of the Oulu approach to the Living Lab activities. Developed in collaboration the network works as a testing environment, but also provides an open and free Internet access to all. Today, the panOULU is a regional municipal WiFi network comprising 1300 access points around the City of Oulu and 8 nearby townships. The City of Oulu provides the largest zone of 580 access points covering the downtown of Oulu and all municipal facilities. The 1300 access points provide an open (no authentication or registration) and free (no payment) Internet access to the general public. The network is used monthly by over 40'000 unique devices, of which a large proportion belongs to visitors. The network is also a valuable asset for numerous R&D projects. The usage of the network has grown so much that the City of Oulu and the University of Oulu have just decided to sponsor the tripling of the capacity of the Internet gateway of the network.



Figure 4. UBI-screens, which are part of OULLabs infrastructure, are large, public, interactive displays installed in several locations in downtown Oulu.

3.8 Incubation environments

The City of Oulu has organised its business development and support activities to the development company »Business Oulu«¹⁸. BusinessOulu aims at creating a business climate that supports entrepreneurship and boosts the creation, operation, growth and competitiveness of businesses, which will enhance the employment situation. BusinessOulu promotes the internationalisation of local companies and handles the international business marketing of Oulu.

YritysTAKOMO¹⁹ is an open innovation environment where experts and new ideas meet. With a pre-defined support process YritysTAKOMO employs

expert teams to assess if there is a market for new ideas. The main objectives of YritysTAKOMO include the creation of new startup companies in the Oulu region, keeping unemployed experts active and connecting them with open positions in the existing companies. Since May 2010, the program has created 60 new startups employing currently 140 people in a broad range of different business segments. Matchmaking events and seminars organized by the program have attracted over 1000 people, helping 150 people to get employed by the existing companies.

Business Kitchen²⁰ is the Oulu Innovation Alliance, University of Oulu and Oulu University of Applied Sciences common growth entrepreneurship center. The goal of Business Kitchen is to create a new collaborative approach to entrepreneurship to promote growth and internationalisation. Business Kitchen acts as an open innovation environment, bringing together organisations which supports new business development. The activity provides a channel for making better use of the academic skills and research results for the benefit of vitality of the region. In the premises of the co-location center there are i.a. incubator, business development and student brokerage services, some Business Oulu functions, students' entrepreneurship community OuluSES as well as several start-up companies. There is also close cooperation with other incubation services.

3.9 Companies and company collaboration

The City of Oulu, the Capital of Northern Scandinavia, is the place to be, especially if you are interested in a real growth in Finland. This was one of the CNBC's findings in last October when they were listing 15 Surprising Global Technology Cities. This kind of the acknowledgement is a result of collaboration where businesses are at the core.

There are plenty of ICT related achievements which are a result of collaboration where Oulu is said to be number one in the world, such as:

- The first phone call over a cognitive radio network in 2010
- The world's first OS 3D Internet platform in 2007
- The world's first WCDMA (3GPP) telephone call in 2002
- The world's first WCDMA telephone call in 1996
- The first contactless fare collection system for public bus transportation in 1992
- The world's first GSM telephone call in 1991
- The world's first GSM base station early in 1991
- The world's first NMT network early in 1981
- The world's first wrist watch heart rate monitor 1980

¹⁷ <http://www.panoulu.net>

¹⁸ <http://www.businessoulu.com/en/home.html>

¹⁹ <http://www.yritystakomo.fi>

²⁰ <http://www.businesskitchen.fi/>

- The Northern Finland Birth Cohort, a unique global and comprehensive database of information on people born in Northern Finland in 1966, available also for the business use.

3D Internet is a prime example of an emerging sector with a huge potential for the growth and global impact to achieve similar results, based on a local innovation in companies and research institutions. The rapidly growing 3D Internet innovation cluster includes 15 companies employing currently 250 people, including the Intel-Nokia Joint Innovation Center Oulu focusing on 3D Internet R&D. Expertise areas include 3D mobile interfaces, 3D leisure and serious games, 3D virtual modelling, 3D virtual learning environments, 3D architectural design and urban planning, mixed reality applications and immersive digital environments.

The sector has formed a business oriented collaboration network 3D Internet Alliance²¹, bringing together the experts of 3D Internet and representatives from other fields of business. Their members are 3D specialists, content providers, research organizations, public institutes, media, venture capitalists and end customers from several fields of business.

4 NEXT STEPS IN SMART OULU

Several structural changes have taken place in the local ICT industry in the 2000s. Globalization has had an impact on the ICT business, affecting also Oulu. At the same time the costs of public services, particularly in the social and healthcare sector, are increasing. These challenges call for solutions to set up new businesses and more cost-effective services.

The City of Oulu together with other central players are prepared for the upcoming structural change of the local ICT industry by active participation in the knowledge workforce and business development programs. Structural Change program comprises four types of activities:

1. Support for establishing new companies in Oulu
2. Education programs for ICT professionals and youth employment
3. Large-scale projects to stimulate new businesses and employments;
4. Activation of new businesses and capital financing.

One essential action point for Oulu is to make its expertise more visible globally. This will be done with the help of active global networking and marketing campaigns.

5 CONCLUSIONS

The City of Oulu is a forerunner Smart City. It has been able to use this competitive advantage to develop new innovations, businesses and services for the benefit of the whole society. The Oulu's citizens have been playing a central role in the development work. The innovative approach and capability to react fast to the changes will be securing Oulu's role on the top of the global technology cities also in the future.

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