

WHITEPAPER

IoT Ecosystem Investigation

ANALYSING THE IOT ECOSYSTEMS
2020



Nordic IoT Centre
FOUNDED BY ALEXANDRA INSTITUTE AND FORCE TECHNOLOGY

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1.1 SUM-UP

The whitepaper *Developing IoT in partnerships*¹ listed nine different challenges and some related needs that we see as important to work with in order to strengthen the Nordic IoT ecosystem. The concept of an ecosystem is not only the title of this research project, but it is also widely used in IoT, and it did seem like a concept that our informants found natural to work with. However, we have also experienced through our research, that the definition of an IoT ecosystem can mean and include/exclude very different things for the different stakeholders. How does an IoT ecosystem look like and how are the actors in the ecosystem interconnected and interdependent on one another? What is needed for all the actors in an ecosystem to thrive and to benefit from one another?

This finding has led our research to an investigation and a mapping of different ways of talking about ecosystems in the field of IoT. In the next section we will outline six definitions of ecosystems, which will help us to get closer to a description of how we find it productive to work with IoT ecosystems.

¹ Nordic IoT centre: *developing IoT in partnerships*, 2020, <https://nordiciot.dk/developing-iot-in-partnerships/>

2 DEFINITIONS OF IOT ECO-SYSTEMS

What is an ecosystem? According to the Oxford Advanced Learners Dictionary an ecosystem is:

“all the plants and living creatures in a particular area considered in relation to their physical environment”²

The ecosystem idea naturally derives biology and describes a system where everything is connected to everything and somehow is interdependent and in constant competition with one another. In an ecosystem all elements have a role to play and nothing goes to waste. Wikipedia provides a definition of a digital ecosystem:

“A digital ecosystem is a distributed, adaptive, open socio-technical system with properties of self-organisation, scalability and sustainability inspired from natural ecosystems. Digital ecosystem models are informed by knowledge of natural ecosystems, especially for aspects related to competition and collaboration among diverse entities.”³

If we zoom in on IoT ecosystems it differs widely from what is included in the definition of the ecosystem. In this chapter we will provide six somewhat different definitions of what an IoT ecosystem covers. The definitions ranges from rather narrow and technical definitions to more open definitions related to ways of doing innovation. The purpose of listing these different definitions is to firstly see how the ecosystem is used

² Oxford Advanced Learners Dictionary: https://www.oxfordlearnersdictionaries.com/definition/american_english/ecosystem

³ Wikipedia: https://en.wikipedia.org/wiki/Digital_ecosystem

differently and how it matters for how we can possibly work with ecosystems and secondly to get closer to how we, at the Nordic IoT Centre will be working with IoT ecosystems.

2.1 THE TECHNICAL SETUP

The most classical depiction of an IoT Ecosystem is something like this from sensorexpo, where we see a network of connected technical devices:

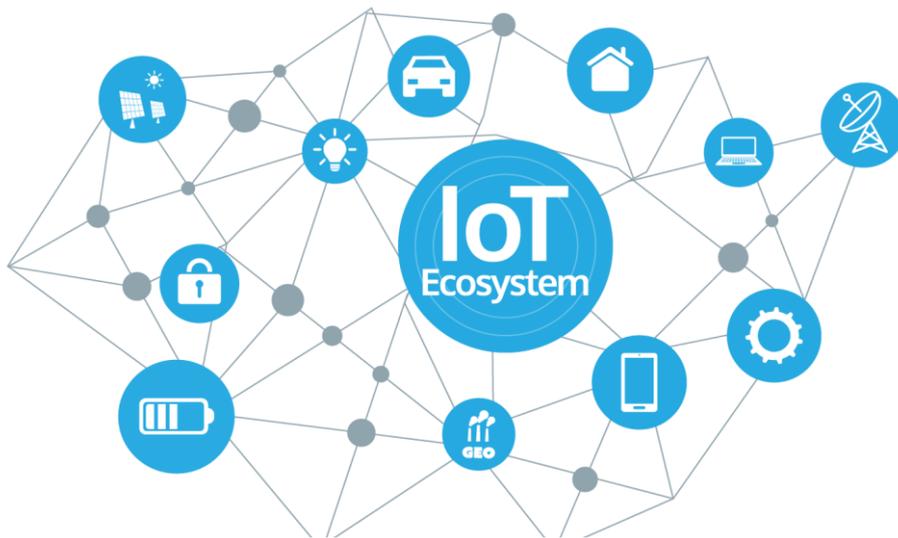


Illustration from <https://www.sensorexpo.com/iot-ecosystem>

This ecosystem is the manifestation of all the technical components needed in order to build an IoT service, including sensors and actuators, gateways, servers, network, data analytics software, user interface, security software, etc. The components included in the technical setup each perform their part of the system, which breaks down if one of the parts are not working. If we take this definition of an IoT ecosystem it does not as such include all the companies and organizations involved in designing the system, it does not include the regulations and standardization

bodies, and it does not even seem to include the user of the system. The components are only part of the ecosystem because, and as long as, they are physically included in the technical setup.

2.2 ECOSYSTEM PLATFORM

Another definition of an ecosystem we call an ecosystem platform. Here we are dealing with a setup where one stakeholder is the platform owner, and therefore the ecosystem owner. This definition describes a relatively new business model where the platform is designed as a tool to expand a firm's reach into the market ecosystem. This is, among others, defined by InnoTribe in their whitepaper on Platform Design Toolkits:

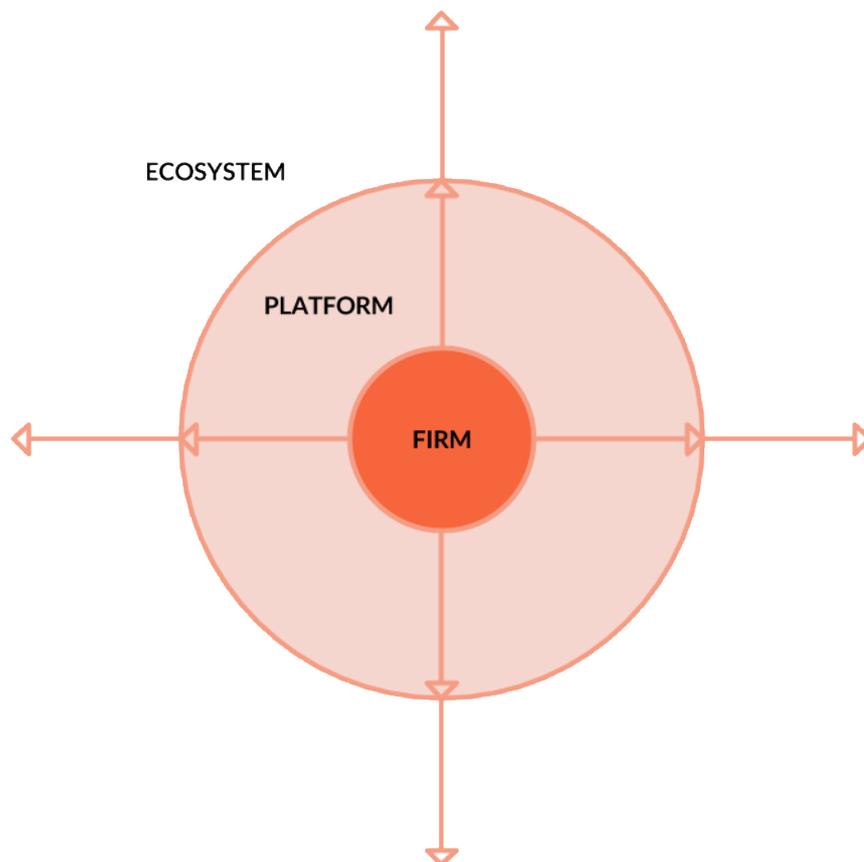


Illustration from <https://platformdesigntoolkit.com/wp-content/docs/Platform-Design-Toolkit-Whitepaper-ENG.pdf>

The best way to describe this model is through services such as Air B&B and Uber. Here enterprises are owning the software platform and take care of all transactions, but they do not own or sell any material themselves.

“The platform model is about designing for interactions that can happen in the Ecosystem”⁴

The platform aggregates actors on the platform and enables them for trade with one another. Besides peers for selling and buying, the ecosystem owner also often has partners or sub suppliers who can provide additional services such as insurances or extra components.

Another way of thinking ecosystem platform setup is through cloud computing and data analytic platforms such as Amazon AWS and Microsoft Azure. Here the companies offer data storage and data services to customers, but they are also building up an ecosystem of other enterprises that uses their platforms to offer end-customers services and maybe even develop extra functionality on top of their services.

As Simone Cicero and the Platform Design Toolkit Team describe, an important element of most successful ecosystem platforms is a so-called ‘learning engine,’ a service through which the users can become even better at contributing and benefiting from the knowledge in the ecosystem.

The ecosystem platform idea has become very popular as a new, very difficult and very lucrative business model.⁵ In the ecosystem platform definition it is worth noticing that the ecosystem platform owner is in the center of or on the top of the ecosystem. The platform owner may be dependent on the critical mass of system users, but each individual user

⁴ Simone Cicero & The Platform Design Toolkit Team: *From Business Modeling to Platform Design*. <https://platformdesigntoolkit.com/wp-content/docs/Platform-Design-Toolkit-Whitepaper-ENG.pdf>

⁵ Weill & Woermer (2018): *What is your Digital Business Model*. Harvard Business Review Press

are not as such essential for the system to work. However, the platform owner is absolutely decisive for the working of the system; if this actor chooses to close down the ecosystem, the rest of the ecosystem will disappear.

2.3 THE ACTORS MAKING AN ECOSYSTEMS DESIGN

Another way of looking at an IoT ecosystem is to focus on the actors, stakeholders and institutional organs involved in setting up a technical IoT system. This is similar to the first ecosystem definition, but here the focus is widened from solely focusing on the technical elements to a focus on the actors behind the technical devices. This for example means that a reseller of e.g. a smart meter is part of the system rather than the company behind the meter. This changes also the points of responsibility as the reseller is responsible for the technology s/he is providing.

An illustration of this ecosystem definition could look like this:

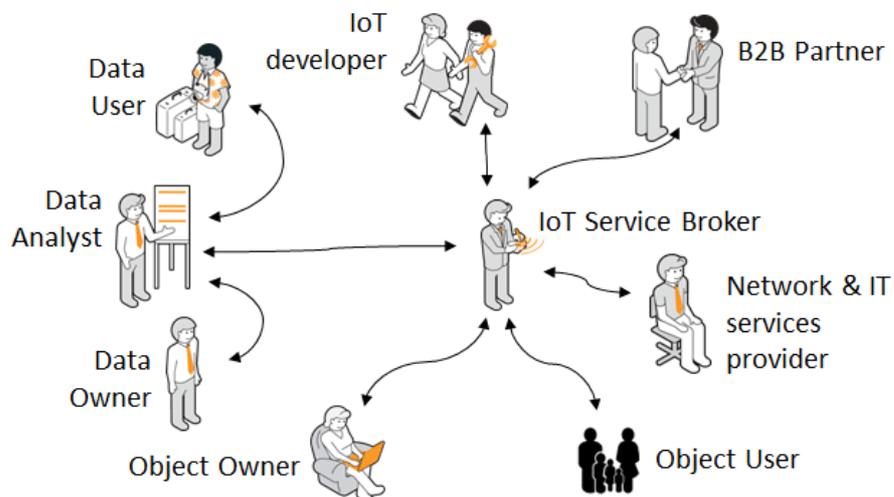


Illustration from: Omnes et al. (2015) 'A programmable and virtualized network & IT infrastructure for the internet of things: How can NFV & SDN help for facing the upcoming challenges,' IEEE. <https://ieeexplore.ieee.org/document/7073808?reload=true>

In this definition there is more space to include actors such as regulatory bodies and for example the building facility management who may be running the system. And also the end user seems to be a relevant

stakeholder to include in this ecosystem. Similar to ‘the technical setup’ definition all the entities in the ecosystem exist prior to the making of the ecosystem, but it is not until they are included in the specific ecosystem design that they become part of the ecosystem.

2.4 BUSINESS ECOSYSTEMS

Based on Tansley’s original definition of ecosystems from 1930s¹⁰, James More in 1993 coined the concept of a ‘business ecosystem’ (Moore 1993⁶). The ecosystem business models are mostly connected to the development of the internet and digitally connected systems – including IoT systems, where many actors are involved and should be sharing the revenue (see e.g. Ivori et al. 2016⁷, Leminen et al. 2015⁸, Gupta et al. 2019⁹). In a blogpost writer and lecturer Adam Hayes describes a definition of a business ecosystem, which we find very illustrative:

“A business ecosystem is the network of organizations—including suppliers, distributors, customers, competitors, government agencies, and so on—involved in the delivery of a specific product or service through both competition and cooperation. The idea is that each entity in the ecosystem affects and is affected by the others, creating a constantly evolving relationship in which each entity must be flexible and adaptable in order to survive as in a biological ecosystem.”¹⁰

⁶ Moore, J. (1993): *Predators and prey: a new ecology of competition*. Harvard Business Review, Vol. 71, pp. 75–86.

⁷ Ivori et al. (2016): *Toward Ecosystemic Business Models in the Context of Industrial Internet*, Journal of Business Models (2016), Vol. 4, No. 2, pp. 42 -59

⁸ Leminen et al. (2015): *ECOSYSTEM BUSINESS MODELS FOR THE INTERNET OF THINGS. INTERNET OF THINGS Finland / 1 • 2015*

⁹ Gupta et al. (2019): *Business, innovation and digital ecosystems landscape survey and knowledge cross sharing*. Technological Forecasting & Social Change 147 pp. 100-109

¹⁰ Adam Hayes (2019): *Business Ecosystem* <https://www.investopedia.com/terms/b/business-ecosystem.asp>

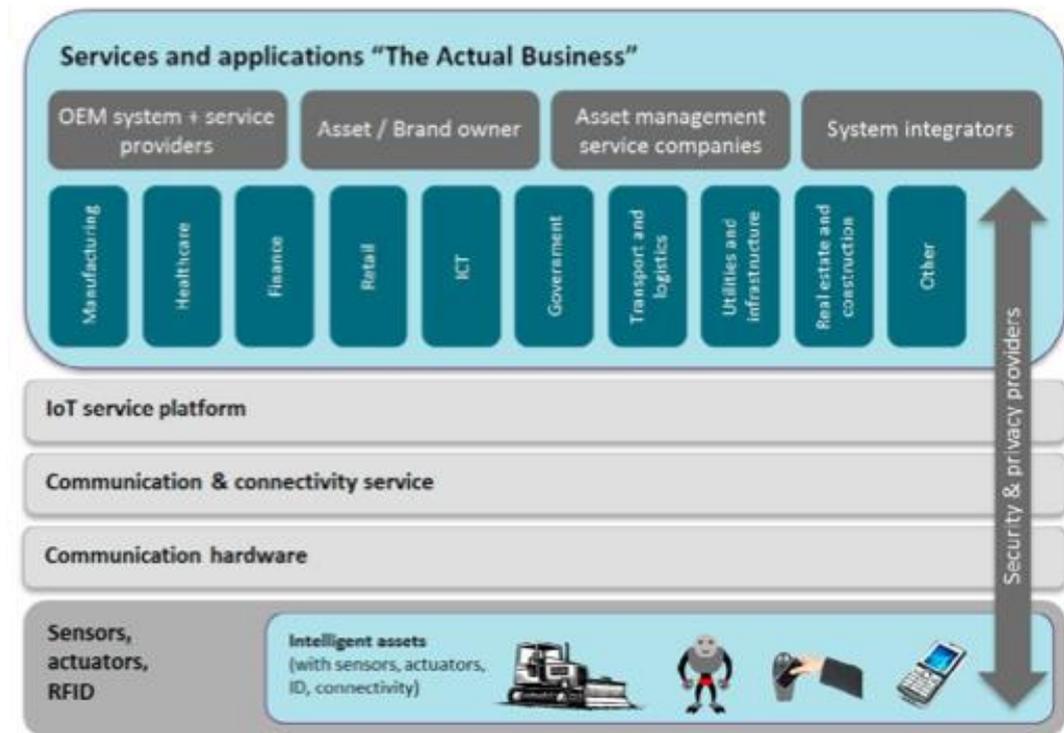


Figure 2. The IoT as a business ecosystem (adapted from Ailisto, 2015)

Illustration from Gupta et al. (2019): *Business, innovation and digital ecosystems landscape survey and knowledge cross sharing. Technological Forecasting & Social Change* 147 pp. 100-109
 1 Adam Hayes (2019): *Business Ecosystem*

The purpose of talking about business models in terms of ecosystems is to move away from linear, hierarchical, horizontal and vertical business models. Rather than having one actor who is buying of services from sub-suppliers, the business ecosystem functions as a network of co-dependent actors, for whom the shared purpose is to capture as much value as possible across the different segments of the system. When the whole system thrives, each actor is gaining value. Ivari et al. (2016) describes the ecosystem business model as a co-dependent process for value co-creation and co-capture. Enterprises engaging in business ecosystems have to let go of the in-house, linear business model and instead think about how their collaborators can all possibly thrive from the ecosystem. Thus, for the system to work, also over longer time, it is necessary for all actors involved to continue gaining a share of the co-created value.

”We claim, that simultaneous value co-creation and co-capture within IoT ecosystems rises through “oblique” business models. In the context of IoT, the relationship among partners is no longer based on customer-sub-supplier–relationship but organizations are now dependent on each other, interact in order to achieve common strategic objectives and eventually share a common fate. [...] Therefore, organizations cannot build their business models in silos, but a synergic view requires them to consider the stage of life cycle of clients and partners as well, as the stage determines how firms should build their own business models.”¹¹

In the business ecosystem there is a shift of focus away from the technologies as enabling the ecosystem – the technological ecosystem is still there, but the way the business model is create is equally important for holding together the ecosystem and for its sustainability as a system.

¹¹ Ivari et al. (2016): *Toward Ecosystemic Business Models in the Context of Industrial Internet*, Journal of Business Models (2016), Vol. 4, No. 2, pp. 50

2.5 A NETWORK OF IOT STAKEHOLDERS

This is different in this fourth definition of an ecosystem, where we include all the actors and stakeholders who work with IoT some way or the other in the overall IoT ecosystem. An illustration of this could look like this:

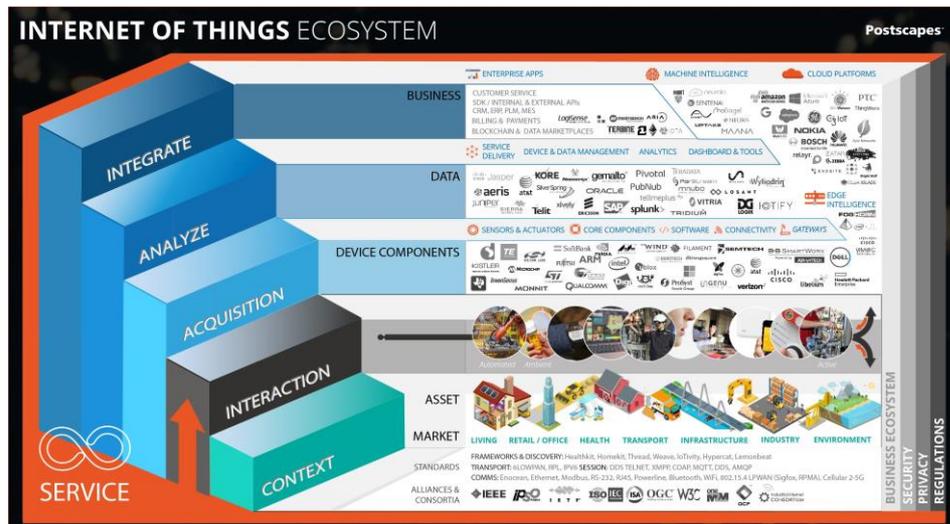


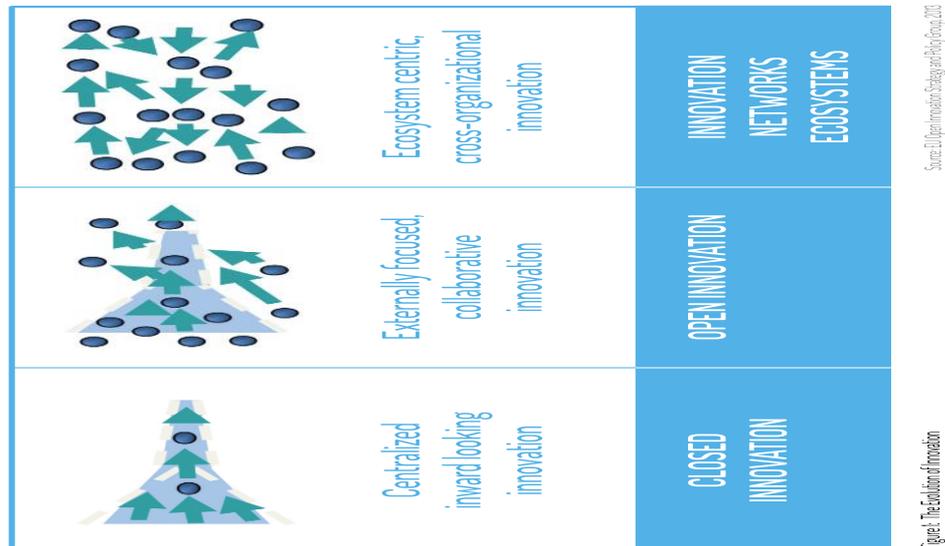
Illustration from: ThingLink <https://www.thinglink.com/scene/891050305024688128>

Here everything is included from technical alliances to regulatory and standardization bodies and component developers, data analysis, business layer, and even the different sectors in which IoT are typically employed. Since all the different more or less formalized IoT networks such as members of alliances, innovation networks, clusters and innovation projects would also be included one could say that this definition of an IoT ecosystem is also a network of networks. Thus, in this definition it becomes difficult to define the difference between a network of actors and an ecosystem. Is it productive to have the two definitions as separated? Or is an ecosystem simply a network of stakeholders?

2.6 OPEN INNOVATION ECO-SYSTEMS THINKING

The last definition we will include here is yet a step wider, as this is not specific for IoT, but it is rather a way of thinking about innovation – a

definition which comes out of academia. We include it because we believe that it can provide productive contributions to ways of working with working with the Nordic IoT ecosystem.



The idea of open innovation ecosystems or open innovation 2.0, as it is also often called, has, among others been described by Professor Martin Curley at Intel Labs:

“Open Innovation 2.0 (OI2) is a new paradigm based on principles of integrated collaboration, co-created shared value, cultivated innovation ecosystems, unleashed exponential technologies, and extraordinarily rapid adoption.”¹²

He describes the ecosystem centric innovation as the third paradigm of innovation. The first paradigm is a conventional closed innovation which is happening solely inside a company and no actors from outside are involved. In the second paradigm, famously coined by Henry Chesbrough

¹² Curley & Salmelin (??) Open Innovation 2.0: a new paradigm. https://ec.europa.eu/news-room/dae/document.cfm?doc_id=2182

(2003) as open innovation, companies are opening up their innovation processes by either inviting external innovators in or by collaborating with other companies, university or even the users. The innovation process is still anchored inside the company, but the process is opened up. In the third paradigm, Open Innovation 2.0, the innovation process is moved out into the ecosystem of relevant stakeholders and partners. The innovation process is a co-creation process and does not necessarily belong to one of the partners but is owned by the partnership. The Open Innovation 2.0 project is also closely linked to the quadruple helix model where innovation is happening in a partnership between industry, governance, academia and the public, however these four instances are not necessary in order to call it Open Innovation 2.0.

“Innovation has moved out of the lab and into an ecosystem that crosses organizational boundaries. Innovation networks are the driving force. An innovation network is an informal or formal grouping based on trust, shared resources, shared vision, and shared value. Ecosystems are most effective when they are explicitly orchestrated and managed.”¹²

As we hear from this quote, Curley subscribes to our fourth definition of ecosystem as ‘a network of IoT stakeholders’ from which innovation can be made by gathering selected stakeholders in innovative partnerships.

Curley sees open innovation 2.0 or open innovation ecosystem as enabled by three megatrends: digitization, mass collaboration and complex issues around sustainability and social injustice. The challenges are so huge, and the solutions need to be so complex that they are not possible for one actor to solve alone. At the same time new ways of collaborating through digital technologies have made it easier innovate together. If we look at IoT and some of the challenges IoT is foreseen to solve, such as issues around energy consumption, transportation, resource reduction in the building sector, aging populations and much more, Curleys analysis of complex innovation processes seem to be very relevant.

2.7 HOW TO WORK WITH THE ECOSYSTEM IDEA?

Summing up these different definitions of ecosystems we see that the way we define the ecosystem depends firstly on whether we focus more on the technical aspects, the business aspects, or on the innovation systems aspects. These different aspects are not necessarily contradictory or mutually exclusive, but they very often exist simultaneously. The purpose here is not to evaluate one over the other, but rather to emphasize that when we talk about IoT ecosystems we may not necessarily be talking about the same content. It matters how we define ecosystems and which perspective we talk from. Furthermore, the chapter shows that there are unclear boundaries between what is defines as a network, what is a platform and what is an ecosystem. We will not reach a clearer definition of this in the present whitepaper but consider it an important task for further work.

As said in the beginning of this chapter, the purpose of listing different ways of defining ecosystems is to get closer to a definition of how the Nordic IoT Center can productively work with the concept of an ecosystem. The exact definition and the specifics of *how* to work with ecosystems we will not get to at this white paper, but in order to sum up, we can reveal that the Nordic IoT Centre has no intention of building a technological IoT platform, which could go into competition with partners in our network (2.2). Rather, our purpose is to work with the entire network of stakeholders working with IoT in the Nordic region (2.4). We intend to make it easier and more seamless for all the actors developing IoT components (both hardware, software, products and business models) and for all the clients requesting IoT solutions (3.3) to get together to establish actual IoT solutions (3.1) which can provide value for the end users and society.

We believe that a good way to approach this innovation work is through ecosystem innovations. Let's return one last time to Martin Curley, when he writes:

Cultivating and orchestrating innovation ecosystems are important parts of OI2. It is increasingly clear to us that innovation ecosystems can be created and transformed by creating a shared vision and reinforcing the vision with active social network management and orchestration.¹³

The Nordic IoT center sees itself as having an important orchestrator role for the ecosystem. The remaining year of the research project will be used on figuring out exactly how to orchestrate in the best possible way; what tools, methods and services that we can develop in order to strengthen the IoT ecosystem in the Nordic region.

¹³ Curley & Salmelin (??) Open Innovation 2.0: a new paradigm. https://ec.europa.eu/news-room/dae/document.cfm?doc_id=2182 pp. 7.

3 SUM UP – WHERE TO GO NEXT

In the whitepaper: developing IoT in partnerships¹ we have analyzed the knowledge gathered through 2 stakeholder workshops and 11 interviews with relevant actors within the IoT development and performed a literature study. This work has resulted in the description of nine challenges and related needs for services and tools which can help strengthening the development of IoT in the Nordic region as described in:

Challenges and needs:

1. **Challenge:** Make it real
Needs: to educate the public and clients and engagement of industry associations
2. **Challenges:** Problem of plenty
Needs: actor mapping and independent and technology agnostic advisors
3. **Challenges:** From technology-driven to user needs-driven approaches to IoT
Needs: analyzing and visualizing actual user needs and value creation
4. **Challenge:** Matchmaking
Needs: a need for a marketplace for matching demand and supply
5. **Challenge:** Collaboration, partnerships and trust
Needs: a 'new Nordic code of conduct,' providing shared guiding principles
6. **Challenge:** Business models
Needs: business cases for inspiration, price models built for revenue sharing models in the ecosystem and value chain
7. **Challenge:** Interoperability
Needs: generalized framework for the IoT interoperability
8. **Challenge:** Standards and policy
Needs: an independent actor providing knowledge on policy and standardization
9. **Challenges:** Knowledge sharing
Needs: sharing of knowledge and experiences across the Nordic region

In the present whitepaper we have investigated models used for understanding, forming and engaging ecosystems, but when comparing to the 9 challenges above it is evident that in order to advance with ecosystem based development and possibly construct a platform for collaboration, there is a need to develop an ecosystem model, where all actors can identify their own role and identify potential partners for collaboration. This has been performed as is described in the whitepaper:

The role-based IoT Ecosystem model¹⁴.

Based on this model we will reiterate on the findings in this paper and construct new ways of facilitating collaboration for the advancement of IoT in the Nordic region.

¹⁴ Nordic IoT centre, *The role-based IoT Ecosystem model*, 2020 <https://nordiciot.dk/the-role-based-iot-ecosystem-model/>

4 APPENDIX: INTERVIEW QUESTIONNAIRE

Ref	Question
1.	What is the brief description of what your organisation does?
2.	What is your interest in IoT eco systems?
3.	What should be main focus in developing a Danish/Nordic IoT ecosystem?
4.	What kind of services and content would make it attractive for your company support/use an IoT ecosystem platform?
5.	What are the main benefits of developing IoT with partners?
6.	What are the barriers for developing IoT with partners
7.	What type of partners would for you be usefull to find in an IoT ecosystem?
8.	Do you have a need for collaboration models for developing IoT with partners?
9.	Would you like to contribute develop new/better collaboration models for the IoT ecosystem (based on your exp.)
10.	What competences does your current IoT development rely on?
11.	Do you have contractual models between you and your partners? Are you willing to share them (as inspiration in our development of IoT-platform)



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