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TNO-rapport

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1 VP ICT

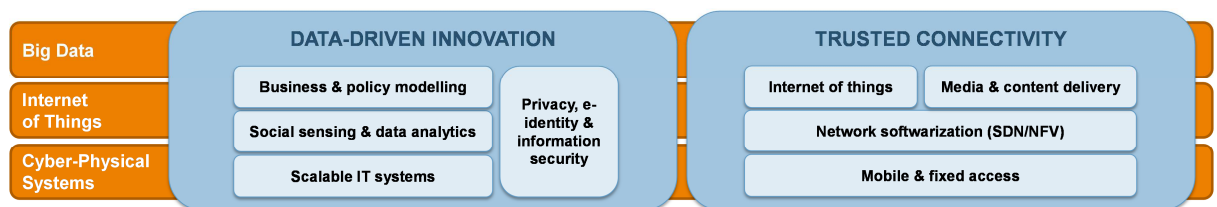
1.1 Topsector ICT

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1.1.1 Summary

TNO's Networked Information Roadmap aims to guide its industrial and societal stakeholders through the digitization of their business. This digital transformation is taking place in every sector in society as a result of technological developments such as big data, the internet of things and cyber-physical systems. ICT is thus both an area of innovation as well as a key enabler for innovation. The VP ICT focuses on delivering innovations in two areas: Data Driven Innovation and Trusted Connectivity. Within both areas the roadmap focuses on four core topics (see figure below).



Until 2018, the main goals for the VP ICT are:

- Establishing a leading position in big data, both within Europe (via the Big Data Value Association) nationally (via COMMIT2DATA and Almere's Big Data Value Centre).
- Shaping data ecosystems in specific application domains by setting up Fieldlabs, such as in the field of smart industry (e.g. Smart Dairy Farming, STOOP, Digital Factory), and using the approach of the Metropoolregio Amsterdam/Almere, which allows multiple aspects of the ICT transformation to take place in the same physical area.
- Developing information security and privacy tooling, such as the TrustTester data validation technology, the PRANAdat privacy respecting architecture, and the RESPECT4U methodology for protection of personal data.
- Expanding TNO's leading international position in the field of media and content delivery and virtual reality, also by testing media innovations in the Amsterdam Arena live experience Fieldlab.
- Consolidating our international position in the field of ICT standardization and specifically the emerging 5G standard, setting up (pre)5G Fieldlabs for 5G proof-of-concepts, and investigating the development of radar technology for 5G antennae.
- Developing a leading position in blockchain nationally, by setting up a program in collaboration with financials and academic partners, focusing on setting up experimental Fieldlabs and on the implications of introducing distributed ledger technology.

In relation to the above mentioned goals, the VP ICT is actively involved in stakeholder management on the national and the European level with main

academic partners, and within leading industrial partnerships. Furthermore, we aim to maintain our leading position in ICT standardization.

TNO is contributing to the Topsector HTSM Embedded Systems Roadmap. The related Demand Driven Program (VP ESI) was described in TNO's 'Speurwerkprogramma 2015-2018 Thema ICT'. The 2017 update of VP ESI is included in TNO's report 'Meerjarenprogramma 2015-2018 Topsector High-Tech Systemen en Materialen, Bijstelling 2017'.

1.1.2 *Short description*

TNO's *Networked Information* Roadmap aims to guide its industrial and societal stakeholders through the digitization of their business. This digital transformation is taking place in every sector in society as a result of technological developments such as big data, the internet of things and cyber-physical systems. Sectors that have the specific attention of the Roadmap are Telecom Providers with key account KPN, Government, Media, Financials and Smart Industry with a focus on Agriculture. ICT is both an area of innovation in itself as well as a key enabler for innovation in these sectors. The VP ICT focuses on delivering innovations in two key areas: Data Driven Innovation and Trusted Connectivity.

Data Driven Innovation emerges as a result from the unprecedented volume of data and interconnected devices, increasingly linking the virtual and the physical world. Main objectives in this area are to remain leading in the European and national data ecosystems, to set up Fieldlabs that develop data innovations for specific application areas, and to develop information security and privacy tooling. *Trusted Connectivity* aims to sustain these developments, for which high quality, secure and reliable access networks are essential. Its main objectives are to remain leading in digital infrastructure, media orchestration and to be a frontrunner in 5G with 5G Fieldlabs. A related objective is to remain leading in ICT standardization.

1.1.3 *Goals*

Data Driven Innovation

Big Data is seen as an enabler for solutions to societal challenges such as international economic competition, ageing society, urbanization, and global warming. It is expected to spur transformation in all sectors, including industry, mobility, health, and energy. Innovations are referred to as smart systems. TNO is recognized as one of the leading players in Europe for the valorization of the combination of technological and business innovations of data driven innovations. We are involved in agenda initiatives such as the EU digital agenda, the European Big Data Value Association (BDVA), COMMIT2DATA and the National Science Agenda.

The focus of the VP ICT is on setting up *scalable IT systems*, such as smart dairy farming (see inset) and, based on *business and policy modelling*, new concepts of valorization with big data and ecosystems. Furthermore, people are increasingly willing and able to measure themselves and they often like to share (quantified self, wearables, social media). Therefore, this proposition includes elements of *social sensing*, developing services and platforms based on people's intent and actions by

Smart Dairy Farming develops a system for customized information on cattle nutrition and insemination in collaboration between TNO, Wageningen University, Agrifirm, CRV, and FrieslandCampina. It results in more milk production, by providing farmers with tailored information for each cow.

combining different sources using sophisticated data analytics, including personalization and recommendation features. Finally, as these innovations need to be secure and reliable, data driven innovation also encompasses system design innovations in *privacy*, *e-identity*, and *information security*.

Big data applications are not only about producing a model that fits the data, but also about sense making – this involves domain knowledge and expertise on user interaction. Therefore, the boundaries between ICT and these domains are expected to blur.

Until 2018, the main goals for the VP ICT are:

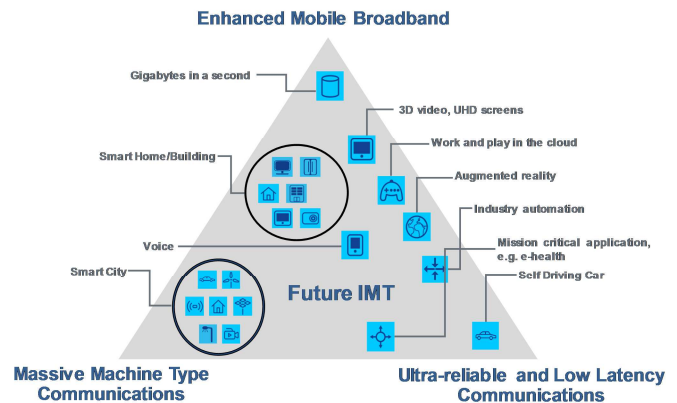
- Establishing a leading position in big data, both within Europe (via the Big Data Value Association) nationally (via COMMIT2DATA and Almere's Big Data Value Centre). In 2017, the H2020 Coordination and Support Action *Big Data Value education* (BVDe) will start, allowing TNO to coordinate and shape the European big data activities.
- Shaping data ecosystems in specific application domains via setting up Fieldlabs, such as Smart Industry Fieldlabs, and using the approach of the Metropoolregio Amsterdam/Almere, which allows multiple aspects of the ICT transformation to take place in the same physical area. In 2017, work continues on Smart Dairy Farming and the STOOP project on scaling processing facilities calculating subsidence.
- Developing information security and privacy respecting tooling, policies and technologies where the end user is in control of his own attributes, such as the TrustTester data validation technology, the PRANAdat privacy respecting architecture, and the RESPECT4U methodology for protection of personal data.
- Contribute to better policy making using new technologies, such as the Once Only policy guideline that establishes interoperability between building blocks, thereby creating seamless service delivery between EU governments, and the development of big data based policy making methodologies within the PolicyLab.
- Developing innovation and valorization strategies and business models, sometimes as a joint development with other Industry Roadmaps, such as Flexible and Freeform Products, and Semiconductor Equipment. Specifically, in the MAKE-IT project the maker movement is investigated to explore its impact on traditional industry and in the I4MS project the development of digital innovation hubs across Europe is coordinated.

Trusted Connectivity

The emergence of the Internet of Things, connecting almost every device imaginable to the internet, and the ever increasing consumption of video content, which takes up a large part (up to 80%) of the existing bandwidth for telecommunications, give rise to the Trusted Connectivity proposition.

TNO has an outstanding international position in *media content delivery* with a leading role in international standardization and a substantial IP portfolio (with our partner KPN). Technological innovations in the field of media content delivery include the development of TNO's tiled streaming technology for virtual reality devices. The increasing number of connected devices (*internet of things*) challenges our current and future networks, both external and in home. TNO has an extensive track record in optimizing and standardizing in home solutions for operators and other stakeholders.

The core of the Trusted Connectivity proposition is operating and managing secure and reliable *mobile and fixed access* to networks, to ensure the manageability of the increased complexity of these networks that need to work across operators (domains) and vendors (platforms). Our main focus is optimization of current, heterogeneous, networks (DSL, 4G, WiFi) and being at the forefront of future networks (5G). 5G is the next generation standard for mobile communication. It will reconcile contrasting design parameters such as high bandwidth, ultralow latency and massive-machine type communication (see figure¹). It offers opportunities for different sectors, such as self-driving vehicles, precision farming, more mobile and immersive media consumption, and Smart Industry. TNO is leading in standardization and active in early experiments in 5G Fieldlabs.



An important development is the increasing *softwarization* and *virtualization* (SDN/NFV)² of these networks to manage complexity and flexibility. An example is the development of the *Operator 3.0*

Mobile Virtual Network Operator (MVNO) for research purposes in TNO's ICT cluster. This is a hybrid Virtual Network Function/Physical Network Function-testbed and development platform with the purpose of obtaining operator and business user expertise, and gaining experience with innovations (IPR and tools) and third party developments.

Until 2018, the main goals for the VP ICT in the field of Trusted Connectivity are:

- Expanding TNO's leading international position in the field of media and content delivery, virtual reality, also by testing media innovations in the Amsterdam Arena live experience Fieldlab. The MOS2S project will develop and test audiovisual smart city technologies and solutions in the context of citizen needs and test them in a smart city environment.
- The Autopilot largescale pilot on automatic driving in the field of the internet of things will start. Furthermore, based on the work TNO has carried out on the SAREF ontology, TNO has been invited to contribute to Google's SCHEMA.org ontology for the internet of things.
- Consolidating our international position in the field of ICT standardization and specifically the emerging 5G standard, and participate in 5G Fieldlabs with industry stakeholders (e.g. KPN, other telco's, Huawei, Ericsson) developing proof of concepts and pilots in different sectors with innovations on mobile access, SDN/NFV and IoT, for example:
 - o 5G Fieldlab Indoor: once the Hi5 platform is operational in early 2016, this will be expanded to a TNO MVNO for research purposes (Operator 3.0) in 2018.

¹ Source: Langtry, C., ITU Radiocommunication Bureau, 'Standards development for wireless broadband access', https://www.itu.int/net4/wsis/forum/2016/Content/AgendaFiles/document/9d6c7b67-33a7-4ac6-96c7-ebf2231d83c2/ITU-BR_Colin_Langtry.pdf.

² Network Function Virtualization (NFV): virtualization of networks by using common IT infrastructure, architectures and (virtualization) functionalities for telecom networks. Software Defined Networking (SDN): network functionalities become programmable and open for other (third) party applications, which provides both innovation opportunities and security threats.

- o 5G Fieldlab Rural areas: the 5Groningen agricultural pilot in 2018 develops fully automated agricultural machinery that knows where to operate by using a connected dense sensor network.
- o 5G Fieldlab Automated Driving: piloting automatic driving with 5G technology in 2018.
- o 5G Fieldlab for live events/media in Amsterdam Arena, first proof of concept in 2018.

Stakeholder management and standardization

Important objectives of the VP ICT are to support these developments via stakeholder management and standardization, to maintain connections with national and international ecosystems, such as R&D&I programs (Horizon 2020, EIT Digital, COMMIT2DATA) and standardization groups and industry fora (e.g. ETSI, 3GPP, ISO, IETF, HbbTV, Broadband forum). Several part time professors are associated with the program, connecting to relevant Dutch universities (Rijksuniversiteit Groningen, Universiteit Twente, Universiteit van Amsterdam, Technische Universiteit Delft, Universiteit Leiden, CWI). TNO is also represented on a board-level in advisory fora, including the BVDA, 5GPPP, ECP, EIT ICT Labs, PI.lab, DG CONNECT Advisory Forum. Furthermore, TNO has a long track record in contributing to the development of standards. The standardization efforts are increasingly presented as an integral part of the program.

1.1.4 Dynamics

Within the Topteam ICT TNO is involved in setting up the national Blockchain Competence Centre (BC4). Simultaneously, the VP ICT has supported the development of a research agenda for TNO in this area, which will allow us to contribute to BC4. This research agenda combines the development of technical competencies such as in the field of security, and developing strategic capabilities related to the wider societal impact of distributed ledger technologies, for instance on government and on social innovation. Based on this research agenda we also help shaping national ecosystems, such as the APG initiative in Heerlen, and Fieldlabs that allow for experimentation and development of blockchain applications, for example in the field of Smart Industry.

Together with TNO's Radar research group the VP ICT is investigating the opportunity to develop IP in the field of antennae (beamforming) for 5G, aimed at telecom vendors, as part of the Long Term Research program carried out with KPN. Simultaneously, we investigate whether we can also develop a position in front end design (antennae and chipset).

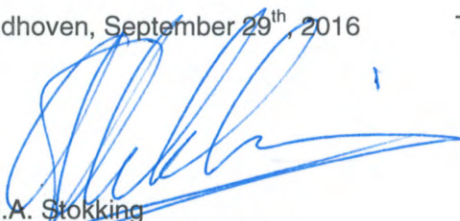
Starting in 2017, the VP ICT will contribute to the QuTech research centre on quantum technology, starting with three areas, with its central research questions:

- Quantum software and algorithms: which machine language is necessary for using a quantum computer?
- Quantum connections: what is necessary to set up a stable broadband connection?
- (post) Quantum Cryptography: what is the effect of quantum computing on existing cryptography and can we develop cryptography that is also reliable in the quantum era?

2 Signature

Eindhoven, September 29th, 2016

TNO

A handwritten signature in blue ink, consisting of several loops and a long horizontal stroke at the end.

A.J.A. Stokking
Managing Director Industry