

2. Long Term Challenges

The NIRICT Long Term Challenges are a selection of a few research topics that can be characterized by high complexity, high risk/high return, and high relevance and a horizon of at least 8 years. The first one is “3TU.Centre for Dependable ICT systems (CeDICT)”.

Dependable systems

More and more applications depend on the reliability, availability, integrity, and maintainability of ICT systems. Due to the increase of complexity at the hardware, software, and communication level, creating dependable systems has become a major scientific and engineering challenge

ICT is everywhere and in each appliance. Think of embedded systems (fly-by-wire, drive-by-wire, logistics control, mobile communications) but also of e-business systems (online auctions, online-retail, bank and stock-exchange trading systems) and medical systems (e.g. cardio/vascular X-ray machines for interventional radiology). Good and reliable functioning of these systems is essential and the increasing societal and business reliance on correct and timely operation of ICT systems asks explicitly for a high level of “dependability”. In the past, dependability was an explicit design issue only for mission-critical systems, like in aeronautics, aerospace and military applications. Nowadays, medical and business systems might not be as mission-critical as a space mission, but are still that critical that lives are threatened and high costs are incurred in case of malfunctioning of ICT components. Despite long-standing efforts, the solutions proposed in classical mission-critical systems are not directly transferable to the much broader class of ICT systems today. For one, cost is a major issue. The classical approach to achieve dependable systems often involves very expensive specialized hard- and software, that cannot be applied in the more consumer-oriented markets of today.

Moreover, there are a number of reasons why systems tend to become more un-dependable.

- ICT systems include more and more software, and software is notoriously not error-free.
- The interaction of the software and the hardware and the fact that most current ICT systems these days are distributed systems, makes designing error-free systems an illusion.
- The ever decreasing feature size of the hardware components increases the chances for hardware induced errors (bit flips, cross-over).
- Where in traditional dependable systems communication is typically based on reliable wired links (often even duplicated), nowadays communication takes often place over error-prone wireless links.
- ICT systems are not only being used by specialists; in practice this means that faults can be caused by human operators or system users.

Centre for Dependable ICT Systems (CeDICT)

Scientific leaders

prof.dr.ir. Boudewijn Haverkort,
prof.dr.ir. Wil van der Aalst, prof.dr.
Arie van Deursen

Participating chairs of NIRICT

TUD

Prof.dr. Arie van Deursen, Software Engineering
Prof.dr. Inald Lagendijk, Information and Communication Theory
Prof.dr. Stamatis Vassiliadis, Computer Engineering
Prof.dr.ir. Alle-Jan van der Veen, Circuits and Systems

TU/e

Prof.dr.ir. Wil van der Aalst, Information Systems
Prof.dr. Henk Corporaal, Embedded System Architecture
Prof.dr. Jan-Friso Groote, Design and Analysis of Systems
Prof.ir. Ton Koonen, Broadband Communication Networks

UT

Prof.dr. Ed Brinksma, dr.ir. Arend Rensink, Formal Methods and Tools for Open Systems
Prof.dr.ir. Boudewijn Haverkort, Design and Analysis of Communication Systems
Prof.dr. Pieter Hartel, Distributed and Embedded Systems
Prof.dr.ir. Bram Nauta, Integrated Circuit Design

New chairs

Next to these existing chairs, new chairs are being hired on Dependable Ad Hoc Networking (TUD), Dependable Multimedia Processing (TUD), Short-Range Radio (UT), Formal Methods and Tools (UT), Embedded System Security (TU/e) and Network Communication Protocols (TU/e).

As a result of these reasons, dependability enhancing techniques will become more and more needed, already to maintain existing levels of acceptable system dependability, let alone, to increase system dependability.

Aim and mission

Given the above problems, the aim of CeDICT is to develop and apply methods and techniques to make dependable ICT systems (commercial consumer-market systems, as well as specialized systems) a reality. Depending on the specific application area and the effective constraints, one or more of several dependability-enhancing techniques (“dependability means”) will be chosen. One of the explicit aims of CeDICT is to view dependability as a system-wide issue that has to be addressed as such, given a dependability budget, and, therefore, not to focus *a priori* on one particular dependability means.

The quality of the constructed dependable systems must be quantifiable, which is currently not possible at all. Furthermore, the quality of the systems as a whole, and this explicitly includes its software, should be guaranteed (fixed or probabilistically). System and software design methods must be developed that make sure the required quality is inherently guaranteed. In practice, this means that researchers with different background and expertise (hardware vs. software design, communication vs. computation, and so on) have to cooperate on solving system-wide dependability problems. This will also lead to new, cross-layer, dependability solutions. In summary, the mission of CeDICT is to develop the methods, techniques and tools necessary to design and implement truly dependable ICT-systems under cost and resource constraints.

Application areas

The application areas that would benefit most from our research on dependability are found in the HiTech industry, where Philips, ASML and OCE are important players, together with hundreds of SME who provide services and products to the main players and to the market. This area is explicitly addressed in our recent Smartmix proposal.

Dependability is also a key concern in the services market (7x24 availability of online services); major retailers, banks and insurance companies are important players in this field. We envisage to develop projects with partners in this field as well.

A third important area of application concerns “critical infrastructures”, more in particular, infrastructures that are “run” using ICT, such as the power grid or the international gas and oil grids. The dependability of the ICT support system in these fields is paramount to the economy of (western) societies. Here also the robustness against malicious failures (attacks) plays an important role. We envisage to develop projects in this field as well.

Economic relevance

ICT proliferates in all branches of society and supports many critical processes (business processes, but more and more technical processes in embedded systems). The smooth operation of all these processes is paramount for the growth of our economy. Stated differently, the non-operation of all these processes has a direct economical impact, and in some cases even can be life threatening.

Dissemination of results

Research results will be disseminated through the usual scientific channels, that is, international refereed conferences and journals. Ph.D. dissertations written in CeDICT projects will be made publicly available. During CeDICT projects in cooperation with industries, the CeDICT chairs will actively contribute to valorization of the research results.

Academic partners

CeDICT cooperates with partners outside of its core structure, both from within 3TU and outside of it, depending on the project needs. As an example, for the recently submitted Smartmix proposal on “Dependable Embedded Systems” partners from within 3TU were added, as well as from Free University, Amsterdam. Next to that, co-operations with CWI (Amsterdam) and the ESI (Embedded Systems Institute, Eindhoven) are foreseen; In fact, ESI and CeDICT together took the lead in the above Smartmix proposal.

Industrial partners

CeDICT does not currently have fixed industrial partners, but expects to cooperate with leading industries in the Netherlands (like Philips Research, NXP Semiconductors, Thales Communications, ASML, Oce, IBM, Devlab) and throughout the rest of the world.