COMICT

Connecting, Mastering complexity, and Innovating by Cooperation

Preface

In September 2008 ICTRegie was requested by the Dutch Ministry of Economic Affairs and the Ministry of Education, Culture and Science to coordinate the composition of one coherent research proposal for the theme ICT (Information and Communication Technology), to be submitted for the FES 2009 round. The research proposal should be a follow-on for succesful BSIK projects within the ICT theme, which are due to be completed in the course of this year. This request posed quite a challenge to us, because the ICT-research arena is still young and dispersed and because of the short time available to do the job. Many people have worked very hard in a consorted way, which resulted in a coherent and ambitious ICT research program, COMICT, involving 117 private companies, 34 leading non-profit organisations and 19 knowledge institutes.

The primary objective of COMICT is to create a national open ICT innovation ecosystem. This ecosystem builds on BSIK consortia as well as on ICT Innovation Platforms (IIP's). IIP's were developed under the auspices of ICTRegie and resemble European Technology Platforms: communities in which companies and researchers cooperate on specific themes. Together, these communities form the COMICT consortium, which is now emerging as the national ecosystem for ICT research and innovation.

We are proud to present herewith the public version of te proposal, which was submitted by the Ministry of Economic Affairs at March 2, 2009.

The importance of ICT can hardly be overestimated. We all experience the impact of ICT on our lives, and yet the ICT revolutions is still in its early phases, there is much more to come!

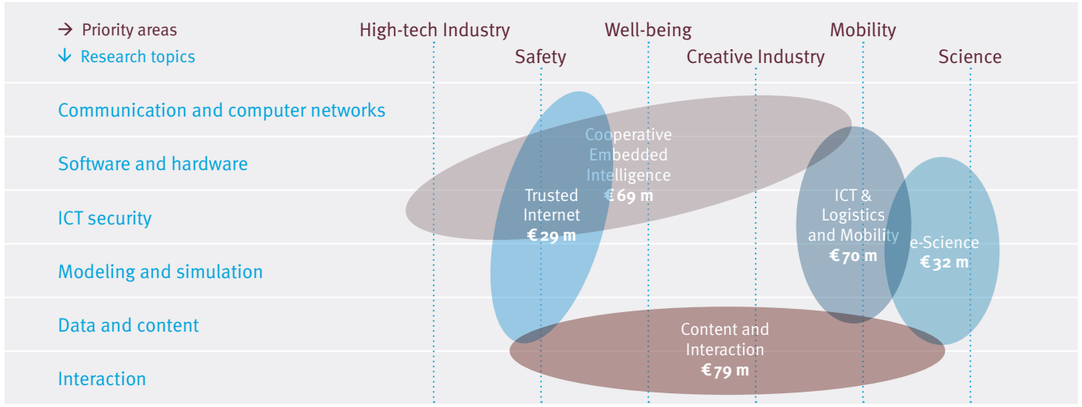
ICT is crucial for knowledge creation, sharing and diffusion; ICT boosts innovation in all sectors and has a huge potential in addressing the societal challenges we are facing. ICT helps realize productivity growth and can help us to recover from the economic crisis. It is therefor extremely important to invest in ICT research and innovation now.

Prof. Gerard van Oortmerssen
16 March 2009

Executive summary

The main goal of the COMICT program is to build the first national private-public innovation ecosystem for information and communication technology (ICT). This ecosystem will bring about solutions to increasingly complex economic and societal challenges. It supports the Dutch competitive position in strategic ICT innovations and reinforces its already world-class scientific base in an open and extendable consortium. The COMICT program selectively continues very successful ict Bsik projects and builds on the valuable private-public networks that have been built around these projects, namely *ESI*, *MultimediaN*, *VL-e*, *Freeband Communication*, *Smart Surroundings*, *BRICKS*, *Transumo* and *ICIS*. The results of these Bsik projects, now in their final stages, directly feed into the five COMICT clusters: *Content and Interaction*, *Cooperative Embedded Intelligence*, *Trusted Internet*, *ICT & Logistics* and *Mobility and e-Science*. These clusters have been selected to cover key economic and societal challenges, as well as opportunities, for the Netherlands. The figure below depicts the clusters' consonance with economic, societal, and research domains, including the clusters' budgets. The program will run from 2010 to 2013. It requires a fes contribution of € 153 million, matched by an investment of € 74 million from 117 private companies and 34 leading non-profit organizations and € 83 million from 19 knowledge institutions. The very large support is an unmistakable indicator for the effectivity of COMICT and the confidence that companies and institutions alike have in the ICT ecosystem.

Figure 1
COMICT clusters' consonance with economic, societal, and research domain, and the clusters' budgets (the program also includes a management and flexibility budget)



Trends and developments in ICT

Industry, business and society at large have come to rely on the extensive possibilities that information and communication technology (ICT) offer. ICT improves the efficiency of businesses and industry, and it enhances the quality of life. The impact of ICT is accelerating. ICT creates global markets, where ICT achievements of today have a major innovation impact tomorrow. In such markets, the continued added value of our national ICT-laden industries rests predominantly on three areas, now and after the current economic downturn: (1) ICT industries enable the design of state-of-the-art, complex systems, the integration of applications, and the creation of lifestyle and business services; (2) ICT industries help solve increasingly complex problems which society faces in mobility, security and well-being; and (3) ICT can have a long-term impact on the life sciences, chemistry and ecology by making its scientific and industrial research more effective. Innovative ICT solutions are needed as to meet these business, societal and scientific challenges. Therefore, Dutch ICT industries wields a double-edged sword; they are challenged to maintain their competitive positions, and they also face immense opportunities to expand these positions into European and global markets. Dutch industry and science can achieve a competitive edge on a global scale through focused private-public collaborations and breakthrough ICT innovations in key economic and societal areas.

This requires dynamic and open interaction between all stakeholders in selected priority areas, in a way that goes far beyond the usual linear interaction.

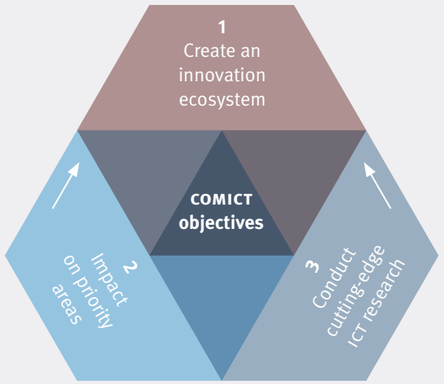
Approach and objectives of the program

The main goal of the COMICT program is to create the first national ICT innovation ecosystem. This ecosystem is positioned around the five COMICT clusters, leveraging the excellent Dutch knowledge infrastructure and the valuable private-public networks created in Bsik projects. Each cluster collects a large number of financially-committed, major Dutch ICT industrial players, innovative SMEs, leading knowledge institutes and domain-specific users in selected technology, economic and societal domains. In other words, COMICT brings together *the* key players which impact economic ICT competitiveness, which are stakeholders in solving societal challenges with ICT innovations, and which have an excellent scientific track record. To achieve this goal, the program has three coherent objectives, as illustrated in the figure.

(Main) Objective 1: Create an ICT ecosystem

In the ecosystem, stakeholders along the entire value chain will be brought together, from academic partners to industries, domain-specific ICT appliers to users. This results in a rich portfolio of activities in an open

Figure 2
COMICT objectives



innovation network, encompassing projects that span exploratory research, applied research, research consolidation and cross-sectoral collaboration for knowledge dissemination. The added value of the complete ecosystem itself is considerable. It will enable new ways of working in living and experience labs, industry as a lab and worktables. The ecosystem's impact will be maintained by structuring the program into five coherent clusters which are guided by the priorities of the ICT innovation programs of the private partners. An explicit target is the development of breakthrough interdisciplinary projects between the five COMICT clusters.

Objective 2: Impact on priority areas

In the open innovation network, R&D focuses on the needs of Dutch priority areas in society and industry, namely well-being (prevention and patient-centered care), mobility (traffic control systems and advanced routing systems), safety (physical monitoring systems, and trust technology for internet), high-tech systems (embedded and pervasive communication systems), creative industries (life and work-style services, customer information mining) and science (software tools for system-level science and simulations). The program accelerates the transfer of application-oriented research findings in academia to create a lasting impact on the competitive advantage of the Netherlands and resolving urgent societal needs (Table 1).

Objective 3: Conduct cutting-edge ICT research

Research challenges across the program address today's exploding complexity of data and systems from various scientific perspectives. Major progress in mastering complexity will be achieved by leveraging existing scientific excellence and industrial needs for solutions. ICT areas in which cutting-edge research will be carried out include communication and computer networks, software and hardware, ICT security, modeling and simulation, data and content, and interaction.

Continuing impact and excellence into the future

The program directly translates into additional economic activity in the ICT sector that deals with designing and integrating state-of-the-art complex technological systems, services and applications. COMICT uses ICT as the Motor of Innovation, enhances its competitive capabilities, and delivers patents and spin-off companies. There are many direct economic benefits that COMICT will bring. For one, research into the costs of designing complex ICT systems indicates that an improvement in design efficiency of 1% represents about € 5 million in direct costs savings in the high-tech sector. An efficiency improvement of 15% is considered feasible. Another example of COMICT's impact on the economy can be found in the introduction of advanced technical-scientific methods and tools to improve the reliability of complex systems. Costs-of-non-quality (recall, after-sales, brand damage) can amount to 2-5% of total turnover. An improvement of just 1% in the high-tech ecosystem amounts to savings of at least € 500 million per year. With the COMICT program, an improvement of 5% is achievable within its high-tech and creative industries projects. Furthermore, in the area of lifestyle, new € 2 billion markets have emerged in ambient sensing home products, which can still be expanded to innovate shopping, well-being and hospitality. Another € 1 billion market has emerged in mobility and routing services. Finally, Schiphol airport, the harbor of Rotterdam, Amsterdam-IX and SURFnet are important European mainports and infrastructures that have major economic benefits for the Netherlands. The future economic success of these mainports and infrastructures is greatly dependent on innovative ICT applications, such as those researched in the COMICT program.

The program also directly results in societal benefits. We mention two striking examples. First, ICT innovations in advanced traffic control systems, routing systems and intelligent vehicles have the potential to reduce congestion by up to 50%, and the resulting traffic-related CO_2 emissions by 10%. An added benefit is the potential to reduce the number of fatal traffic accidents by 25%. Second, enhanced hospital logistics and ICT planning systems will reduce the length of patients' hospital stays by one day per 10 admissions. The benefit of this alone is € 40-80 million in savings annually.

Table 1
Urgent problems addressed by the COMICT program

Sector	Urgent problem adresses by COMICT
Well-being	• Ageing population exhausts the existing centralized care system • Lack of ICT-based planning hamper the resolving of waiting lists in hospitals and leads to non-optimal resource usage
Mobility	• Traffic congestion negatively influence productivity, increases green house gasses, and causes fatal accidents
Safety	• Increasing feelings of insecurity in physical and on-line worlds • Identity theft increases and volume of e-transactions decreases
Creative industry	• Missed economic opportunity in product and service innovation and loss of competitive power because of broken innovation chains
High tech industry	• Embedded software design technology moves abroad, undermining an important economic pillar of Dutch industry
Science	• Increasing gap in efficiency and effectivity relative to international competition
Internet & Business	• Digital disconnect of substantial part of population must be avoided in times of economic recession • Missed opportunity for exploration of new technologies that will transform business models • Digital part of the information society will go abroad

Table 2 (page 8) shows the expected economic results of the five COMICT clusters in their respective main markets.

Finally, the program enhances the scientific excellence of key ICT research groups. Academic research, profit and non-profit organizations in ICT will establish working relationships that maximize knowledge transfer and relevance of the academic research. Even now, such relationships are emerging in networks of stakeholders, such as the joint research unit (JRU) that was recently established by the three technical universities and ESI, the embedded systems institute. COMICT stimulates research groups to embark on interdisciplinary approaches to mastering the complexity of data and systems in a range of real-world applications and economic sectors. This makes academic research more valuable to society and the economy, and at the same time strengthens the reputation of the participating research teams. COMICT also directly impacts computer science and electrical engineering curricula since the program will lead to newly developed courses, for instance in designing complex systems or mining of large volumes of data. In this way, students will be prepared for their pivotal roles in the information society of the 21st century. A total of 150 highly trained new employees will be available at the end of the program. About 300 currently already employed ICT researchers, software engineers, and end-users will have acquired state-of-the-art knowledge and skills.

The COMICT consortium includes over 170 companies that recognize the direct economic and societal impact of the program. Over 30 leading companies are committed to invest in the program (see the Letters of Intent) and to participating in research and knowledge sharing. More than 30 societal organizations ensure focus on the societal priorities. The program has succeeded in involving a large number (over 80) of SMEs; these SMEs also directly invest in the program. World-class researchers from 30 research groups in ten universities and nine institutes continue their recognized research successes in the program. Among these researchers are two Pioneer grantees, six VICI winners and more than 10 VENI/VIDI award laureates. Eight academic researchers in the program have a Hirsch impact factor of over 30.

Table 2
Expected economic results of the program

Cluster	Main market	Yearly turnover	Target sector	Expected effect (after program)	Expected result
Content and Interaction	Creative industry	€ 50 billion [1]	Lifestyle & Well being	(re)new products	10% new products
			i-Services & b-intelligence	(re)new products	5% longer home self-care
			Consumer data	Marketing data	20% new services
			Cultural heritage	Increase tourism	30% digital services
Cooperative Embedded Intelligence	High-tech industry	€ 30 billion [2]	High-tech systems	Design efficiency	15% improved efficiency
				Increase quality	5% less costs-of-non-quality
Trusted Internet	Internet commerce	€ 5 billion [3]	Internet business	Increase amount of sales	30% increase in e-sales
ICT & Logistics and Mobility	Transport	€ 53 billion [4]	Mobility	Reduce congestion costs	€ 30 million annually
				Reduce traffic related CO_2	Reduce by 10%
	Health care	€ 72 billion [5]	Health logistics	Improve bed & resource planning	10% reduction of voids Save € 40-80 million annually
e-Science	Science in industry	€ 2.7 billion	Food science	Efficiency	10% more efficient
			Genomics	Effectiveness	10% more effective
			Ecology science		
			Physics		

1 Innovatieplatform, 2008. Connecting global creative ambitions, Creativiteit als kernpropositie van Nederland.
2 High Tech systems platform, Productie High tech industrie, 2009.
3 Blauw Research, Thuiswinkel Markt Monitor, 2008; Note: Internet commerce include revenue of other industries, 2008.
4 CBS, Productie, verbruik, inkomensvorming (60, 61, 62 , 63), 2007
5 CBS, Statistisch jaarboek 2008, uitgaven gezondheids en welzijnszorg, 2006.

Reinforcing Dutch policy counts

The government's FES investment in the COMICT program is required for development of a national ICT ecosystem. No other funding possibilities exist for the creation of such ecosystem. The FES impulse will make it possible to pull together, strengthen and connect the private-public collaboration networks that have emerged from the Bsik projects. The impulse will reduce the threshold for research investments by private companies, as risks can be shared with other stakeholders. SMEs can develop their lines of business with relatively moderate investments by leveraging the ecosystem; without the government funding of this program the individual SME's investments are too small to have a significant impact. The FES impulse will help level the playing field, which is crucial in a globalized economy. Only with the government's FES impulse it will be possible to seize this great opportunity to change the Dutch ICT innovation landscape, to pull together individual (Bsik) networks that are currently fragmented and which lack focus, critical mass and efficiency.

As a new application-driven initiative, the program executes parts of the Dutch government's (ICT) agendas '*ICT Agenda 2008-2011*' and '*Maatschappelijke Innovatie Agendas (MIA) Gezondheid*', *MIA Veiligheid*', the '*Strategische Kennis- en Innovatieagenda (SKI) Mobiliteit en Water*', and is complementary to the action program '*Maatschappelijke Sectoren & ICT*'. For impulse funding of COMICT, no other funds associated with these governmental agenda's are available. The role of the government – via funding the COMICT program – is to set the stage to facilitate solutions by industry. Finally, the program increases the market values of the high-tech sector (and in particular the embedded and pervasive communications systems subsector) and of the creative industries (in particular the lifestyle, business services and well-being subsectors).

COMICT adds substantial value to national innovation ecosystems such as ESI for the embedded systems industry and academia, PointOne for the high-tech sector, e-Science for innovation of science, MultimediaN for content and IIP Create for the creative industry, IIP MAIS for ICT and mobility, and IIP '*Veilig Verbonden*' for secure internet. The program specifically contributes the perspective of application-oriented research and development of complex data and systems. By actively pursuing interaction, COMICT enriches itself and other innovation ecosystems.

Governance to meet the challenge

Program-level governance assumes responsibility for creating and enriching the national ICT ecosystem in an international context. It encourages interaction between clusters, and assures the opportunities in the ecosystem emerge bottom-up. The governance at the cluster level assumes responsibility for the deliverable-oriented execution of projects. It encourages coherent interaction between projects.

Overall, program governance is carried out by key representatives from the public and the private sectors. The composition of the governing bodies reflects the large commitment of private and public-funded organizations. The supervisory board consists of three members representing industry and societal organizations, three members representing knowledge institutes, and an independent chairperson. Executive control over the program is delegated to the Board of Executive Directors. This Board consists of six members: three directors from industrial and non-profit partners, and three scientific directors. The scientific directors oversee specific clusters, one for *Content and Interaction* (CIN), one for *Cooperative Embedded Intelligence* (CEI), and one for the cluster group including *ICT&Logistics and Mobility (ILM)*, *Trusted Internet (TIN)* and *e-Sciences*. One of the three 'cluster' directors will act as chair.

The economic, societal and scientific key performance indicators, listed in Table 3 (page 10), directly reflect the program's specific goals to impact the economy and society as a whole, and ultimately to build a national private-public ICT innovation ecosystem for the first time.

Table 3
Key performance indicators to measure the program effectiveness

Strategic oblective	Performance indicator	Targets
Create an ICT ecosystem	Number of industrial partners	80 partners
	Percentage of industry contribution to the total budget	25% industry participation
	Number of spinoff companies	10 spinoffs
	Number of established or transferred patents	50 patent applications
	Number of cross-cluster collaborations	25 collaborations
	Number of academic researchers finding employment in the eco-system	200 researchers
Impact on six priority areas	Creation of societal support for the program	10 world-novel and 40 state of the art demonstrator systems
		10 road shows
		20 appearances in national press
	Number of (new) program activities funded by stakeholders in the six priority areas	20 new partners in the program
	Number of innovations in the priority areas	10 product innovations per priority area
Conduct cutting-edge ICT research	Participation in EU programs (number of projects)	20 new joint project in EU
	Number of papers in internationally refereed journals	20 award winning papers 200 science papers published in journals
	Number of completed Ph.D.s	150 Ph.D.s

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1 Vision

ICT and the World

Industry, business and society at large have come to reply on the enormous possibilities that Information and Communication Technology (ICT) offers. Immediate access to information and communication is revolutionizing the way we do business and the way we live. It is improving our well-being, creating a fabric of new social relationships in a global village. Behind the scenes, communication technology has created global markets, and economic, societal, and scientific progress without today's ICT achievements would be unthinkable.

The impact of ICT is accelerating. ICT innovations create new services and products, and thus new economic activity. As a result, ICT directly improves prosperity.[6] New and innovative ICT is particularly helpful in times of economic downturn. It can connect people who are disconnected from work. And, it can offer access to work and to innovation through the Internet. In short, Information and Communication Technology is a vital factor for sustaining economic growth, jobs and well-being.

Trends and Development in the Netherlands

The Netherlands has the ambition to be amongst the most competitive countries in Europe by 2015. Dutch excellence in the field of knowledge, skills, and use of information and communication technology is critical for accomplishing this ambition. The government's '*ICT Agenda 2008-2011*' rationalizes and puts forward the Dutch goals and ambitions in the area of ICT. The vision of COMICT in working towards this goal and ambition encompasses societal, economic, and scientific elements.

1 Society is fundamentally changing

Highly mobile citizens in a densely populated country, the aging population, and the increasing dependability on Internet are major challenges currently facing the Netherlands. Through the '*Maatschappelijke Innovatie Agendas (MIA)*'[7] and the action program '*Maatschappelijke Sectoren & ICT*' the Dutch Government underscores the importance of responding to societal challenges in mobility, safety and well-being, particularly of the aging population. ICT plays a critical role as an agent of innovation to meet these challenges.

6 R.D. Atkinson & A.A. Mackay: Digital prosperity: Understanding the Economic Benefits of the Information Technology Revolution (March 2007). Available at SSRN: http://ssrn.com/abstract=1004516.

7 http://www.ez.nl/Actueel/Kamerbrieven/Kamerbrieven_2008/Juli_2008/Aanbieding_langetermijnstrategie_Nederland_Ondernemend_Innovatieland_en_Maatschappelijke_innovatieagenda_s_veiligheid_en_gezondheid.

Focusing academia and industry on these challenges not only brings answers, but also gives Dutch companies an innovation and business edge to take the lead in these domains.

2 Using ICT: the Axis of Innovation

The Innovation Platform of the Netherlands, under the direction of the Prime Minister, has characterized ICT as the Axis of Innovation. The organization of R&D in the manufacturing industry, the emerging leadership of SMEs and international competition in the knowledge economy have changed the role of R&D. The creation of a level playing field and of open innovation networks in the high-tech and creative industries is a condition for sustaining and expanding the Dutch competitive edge.

3 Economic recovery

The current economic downturn will force companies to reduce costs. Laying off R&D employees will soon be seen as inevitable. This loss in human capital will complicate innovation uptake once the recession has passed. Reinforcing private-public collaboration between research and industry now is instrumental to the availability of sufficient capacity later.

4 Open involvement

Private-public collaboration has developed in various sectors in the Netherlands over the past decade. Thanks in part to the Bsik ICT projects, collaboration networks are emerging. These private-public partnerships have taken the first step towards improving the Dutch ICT ecosystem. Under the auspices of ICTRegie, ICT Innovation Platforms (IIP) were recently created, inspired by the European Technology Platforms. These IIPs provide a shared platform for industry, end-users and knowledge institutes to establish strategic research agendas (SRAs) in important economic and societal sectors. The IIPs will develop as important platforms to disseminate and consolidate high impact results of current and forthcoming ICT R&D programs. In most cases, the SRAs address domains that are cross-sectoral in nature, yielding an interdisciplinary approach that is open to all stakeholders essential for the Dutch competitive position.

5 Mastering complexity

Society is becoming increasingly complex. Dependencies of all sorts entangle societal and economic sectors more than ever before. An increasing amount of information is becoming available and systems are becoming more interdependent. ICT has enabled these developments, and has now also become the key factor to make information and systems more transparent. ICT can answer society's concerns about the dependability, safety and usability of such solutions. A concerted R&D effort that is focused on mastering the complexity of systems and information will be directly beneficial for vital sectors of the Dutch economy.

Outlook for the Netherlands

The outlook for realizing the COMICT vision is very optimistic. The Netherlands has strong foundations for moving forward rapidly in this field:

- the high-tech, software and the emerging creative industries hold good export positions and indicate high growth potential (see Section 4);
- the Netherlands is home to a strong knowledge base, scientific excellence in the ICT field and excellence in applied ICT research as recognized by the *Commissie van Wijzen (CvW)* in their mid-term review report on the Bsik projects;
- a digital-ready population thanks to widespread, high-bandwidth Internet access as recognized by OESO[8];
- a high-speed communication network, SURFNET-6, based on cutting-edge technology, giving our country a worldwide recognized leading position;
- the Dutch population is among the most connected populations of the world and willing to experiment with new solutions.

Dutch industry and science can achieve a competitive edge on a global scale through focused private-public collaborations and breakthrough ICT innovations in key economic and societal areas. This, however, requires dynamic and open interaction between all stakeholders in a way that goes far beyond the usual linear interaction.

8 Available from: http://www.oecd.org/document/54/0,3343,en_2649_34225_38690102_1_1_1_1,00.html.

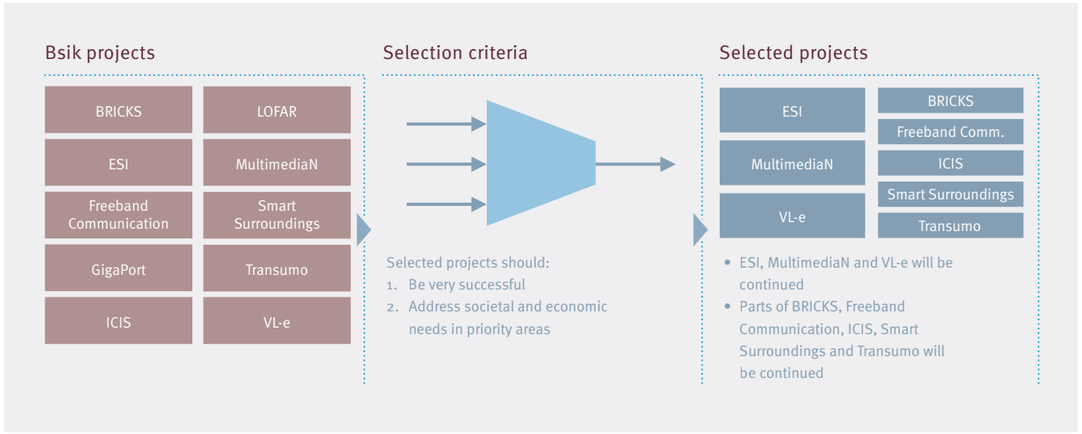
2 Strategic objectives

Selective continuity of Bsik ICT projects

The COMICT program builds on the successful Bsik ICT programs; *VL-e* in e-sciences, *MultimediaN* in the area of multimedia content, *BRICKS* in the area of logistics and *ESI* in the domain of high-tech embedded systems. The program selectively continues the most successful parts of these programs. In addition some of the excellent results and best practices of *Freeband Communication* and *Smart Surroundings* in the areas of intelligent communication and sensing systems, *Transumo* in area of mobility, and the CityLab concept of *ICIS* have been selected to be integrated in the program. Besides their successes, projects have been selected for continuation on the basis of societal and economic need.

We remark that the *Commissie van Wijzen* placed ESI in the theme HighTech Systems and Materials (HTSM) and MultimediaN in the theme Creative Industry.

Figure 3
Selectively continued Bsik projects



ESI has discussed its strategy with the Ministry of Economic Affairs and SenterNovem. As a result of these discussions, ESI has made the choice to include its proposals in the ICT FES COMICT program and thus to leverage the technology and potential in the domains of sensor systems and communication technology. The technology of MultimediaN connects well to VL-e, e-Science and Mobility. The integration of ESI and MultimediaN offers the technological basis for many applications in industrial and societal sectors. Therefore COMICT has been built upon ESI and MultimediaN as technological pillars and e-Science as scientific pillar. The link of ESI with HTSM is via PointOne, and the link of MultimediaN with Creative Industry via IIP Create.

Objectives of the program

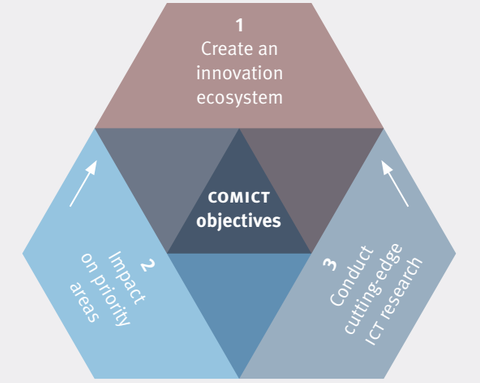
The main goal of the COMICT program is to create the first national ICT innovation ecosystem. This ecosystem leverages the excellent Dutch knowledge infrastructure and the valuable private-public networks created in Bsik projects. Each cluster collects a large number of financially-committed, major Dutch ICT industrial players, innovative SMEs, leading knowledge institutes and domain-specific users in selected technology, economic and societal domains. In other words, COMICT brings together *the* key players which impact economic ICT competitiveness, which are stakeholders in solving societal challenges with ICT innovations, and which have an excellent scientific track record. To achieve this goal, the program has three coherent objectives, as illustrated in Figure 4.

Objective 1: Create an ICT ecosystem

The innovation strategy preferred by large and small companies alike is to find high-tech knowledge, to convert it into robust know-how and to implement it into products and services. If the knowledge is rooted in cutting edge research, the chances of a competitive advantage are much better than if it is based on business model innovation alone.

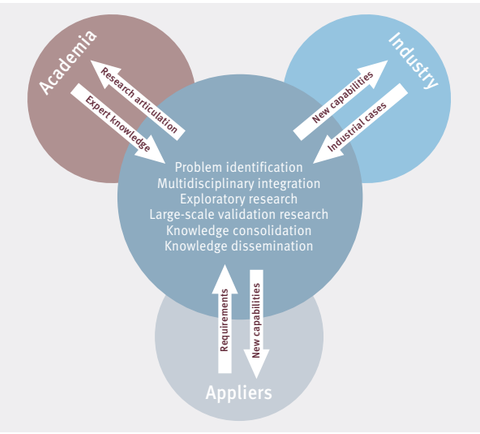
The creation of a knowledge ecosystem for open innovation is generally seen as one of the best ways to address industrial and societal challenges in the area of innovation and exploitation of new technologies, as illustrated in Figure 5.

Figure 4
The three program objectives



This is true for the Netherlands, the rest of Europe, and globally, as the complexity and costs of problems that need to be addressed are beyond the scope of individual organizations and industries. This transition towards open innovation research requires the creation of new instruments for valorization of investments in public/private funded research programs.

Figure 5
Stakeholders and activities in the ecosystem



It is essential to the successful development of an open innovation infrastructure that systematic attention is given to all elements of the knowledge chain including the hair vessels of the system, i.e. research agenda, exploratory research, applied research, knowledge consolidation & dissemination, and validation.

- *Cross-connect the successes of current Bsik consortia* to ICT Innovation Platforms (IIPs). A means towards establishing a permanent Dutch ICT innovation ecosystem in the priority areas is to conduct collaborative research, to perform joint development and to evaluate cross-sector pilots. COMICT will use road shows, awareness programs, and other means to establish a working relation between research and market sector organizations.
- *Open innovation or living labs* bring together users, producers and knowledge in an ecosystem as recognized by the national Innovation Platform. The virtual lab model (from the Bsik program VL-e), the 'work table model' (Bsik program MultimediaN), the City Lab concept (Bsik program ICIS), and the Embedded Systems Institute as a dedicated knowledge consolidation partner (Bsik program ESI), can all be seen as instruments in the ecosystem. COMICT will endorse and expand these experiences for the program as a whole.
- *The involvement of the public* brings about a novel kind of entrepreneurship and ultimately new forms of open innovation, such as open-source software and information resources (Wikipedia, blogs). The public can bring new societal and economic activity (Google, Hyves). The purpose of COMICT is to exploit just that.
- The COMICT program is supported with an *extensive consolidation and dissemination program* which will include golden videos highlighting results to the public. Consolidation focuses on the systematic capturing of research results for future re-use and deployment in the ecosystem. Dissemination encompasses activities for distribution & exchange of knowledge and education & training within and outside the ecosystem.
- *Valorization activities* must be broadly anchored into the ecosystem as an important continuous process for capturing of needs, capturing knowledge from the research projects and re-issuing of knowledge to any interested industrial, societal or academic party. This implies a clear valorization mission for the partners in the open innovation network, implying the strong need to consolidate and disseminate research findings, so that these find application for future industrial and societal use.

At the end of the COMICT program a lasting structure of collaboration will have been established with a permanent impact on society's capacity to innovate.

Objective 2: Impact on six priority areas

The COMICT program aims its efforts at six priority areas. These areas have been selected because ICT research in the Netherlands is well positioned to contribute substantially to all of these, based on the outcomes of the Bsik projects. The benefits in each of these areas are listed in Section IV. The priority areas correspond to the '*Maatschappelijke Innovatie Agenda (MIA) Gezondheid*' and '*MIA Veiligheid*', the '*Strategische Kennis- en Innovatieagenda (SKI) Mobiliteit en Wate*r', the action program '*Maatschappelijke Sectoren & ICT*', and the two '*Sleutelgebieden High Tech Systems and Creative Industries*'. However, given the power of ICT to innovate, towards the end of the program a spill-over effect can be anticipated from the priority areas to other societal and economic areas.

Well-being

Well-being and healthcare is shifting towards prevention and patient-centered care. COMICT focuses on enhancing the population's well-being, while reducing the costs of healthcare, by improved planning of operations & resources, by tracking and tracing supplies of medical equipment and medication in hospitals, and by supporting extended home care. This builds on ICT Logistics expertise from the BRICKS Bsik program. The strategic objective is to reduce the average latency for receiving care and to improve cost-effectiveness.

Mobility

Mobility of freight and individual citizens is critical to the functioning of our economy. The increase in traffic stretches the system to the limit. The next generation of traffic control and routing solutions must incorporate more information from a variety of sources such as sensors and the Internet. This builds partly on mobility expertise from the Bsik program Transumo and ICT research in the areas of architecture and data management. In accordance with the strategic agenda from VWS, '*Strategische Kennis- en Innovatieagenda Mobiliteit en Water',* the strategic objective of COMICT is to reduce traffic congestion, thus improving traffic safety, improving cost-effective resource planning for logistic chains, and reducing CO_2 emission.

Safety

Public and industrial safety is important to protect society at large against industrial disasters, crime and terrorism. The increasing dependency on the Internet calls for truly trusted transactions. Hence, it is important to reduce the vulnerability to theft of digital identity and other personal data. This builds on the security expertise from Sentinels and ICT Innovation Platform '*Veilig Verbonden*'. The objective of COMICT is to support security officers with a new trusted layer – on top of the current Internet – and situation-aware monitoring systems.

Creative industry

The content and media business is important to the Dutch economy and to society. The emerging creative sector is starting to use ICT and digital media for new products and new services in lifestyles, in work-styles, in tourism, for well-being, and in communities. This builds on ICT and media expertise from Bsik program MultimediaN and ICT Innovation Platform Creative Industries. Inspired by the agenda of the Innovation Platform '*Sleutelgebied Creative Industries*', the COMICT objective is to develop interaction, information and media technology for new digital content, lifestyle, work-style and community-based businesses.

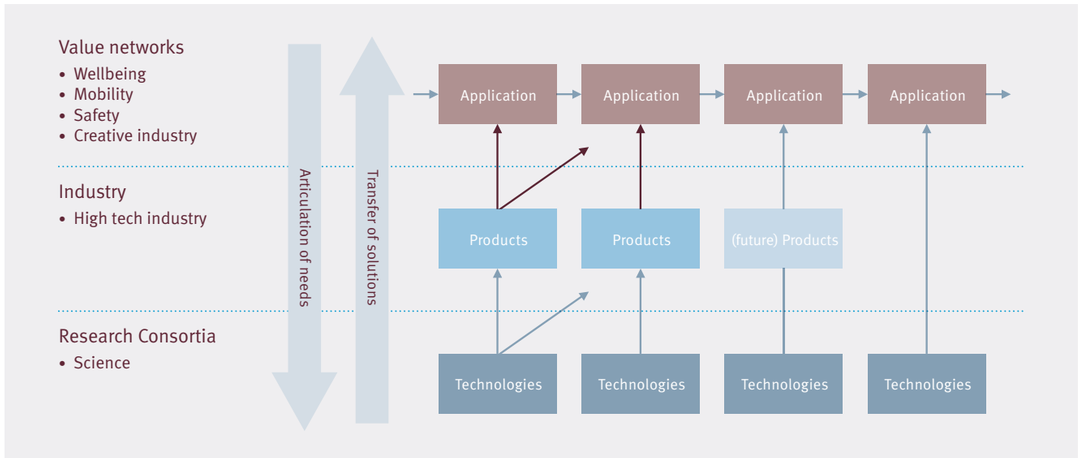
High tech industry

Another economically important sector is high-tech systems; see '*Sleutelgebied High Tech Systems (HTS)*'. The sector is increasingly challenged to provide solutions that are not only technologically advanced, but also flexible, reusable, and dependable. This builds on embedded systems expertise from ESI (both the results of the Bsik program as well as the excellent network of the ESI institute), wireless sensor network expertise from Smart Surroundings, and communication technology from Freeband. The COMICT objective is to accelerate the design cycle of high-tech embedded and pervasive communication systems.

Science

Scientific and industrial innovations are a substantial force for the innovation of society. Their progress increasingly depends on massive and computationally intensive in-silico experiments and simulations. These simulations enable virtual experiments. The research topics include the fundamentals of matter, of systems biology and of bio-diversity. This builds on the results and know-how from the Bsik program VL-e. The COMICT objective is to provide a simulation and knowledge infrastructure for experimenting across scientific and industrial sectors.

Figure 6
Innovation in market value chains



Obviously, relationships exist between impact on the market value network in (end-user) application domains and impact on the high-tech and creative industry as a provider of systems and technology for these application domains, as illustrated in Figure 6. Market value networks can be very large and diverse and involve players from entirely different fields and backgrounds. On one hand, needs in market value networks yield innovation in a pull model; on the other hand, research solutions create innovation in a push model. For instance, the future of automotive is in car-to-car communication and car-to-infrastructure communication. This will make cars an even more complex configuration of integrated systems with strong technology links to the value network of the Dutch and European road infrastructure

Objective 3: Conduct cutting edge ICT-research

To achieve a lasting impact on these six priority areas, applications need to be developed based on results from cutting edge ICT research. The topics of research are application-inspired in the sense that they follow from the choice of six priority areas. This working method creates a leading edge advantage in the priority areas as the science impulse is directly followed up into domain-specific applications.

The list of ICT science and technology themes is as follows:

- *Communication and computer networks:* The objectives of the COMICT program are the enlargement bandwidth, the handling of heterogeneity, the improved support of wireless and mobile systems, and the enhancement of the infrastructures. Scientific leaders in this field are profs. Ignas Niemegeers, Ton Koonen, Maarten van Steen, Inald Lagendijk;
- *ICT security, including information security:* The objectives of the COMICT program are the inclusion of trust and privacy as a separate network layer, and analysis of volumes of sensed data to detect unusual events. Scientific leaders in this field are profs. Bart Jacobs, Henk van Tilborg, Tanja Lange, Pieter Hartel, Wim Jonker, Sandro Etalle;
- *Software and hardware*, including embedded systems and sensor networks: The objective of COMICT is generic solutions to dependable functioning, a proper interaction with the physical world, the inclusion of data of pervasive systems, and techniques to handle streaming of data. Scientific leaders in this field are profs. Boudewijn Haverkort, Arie van Deursen, Gerard Smit, Koen Langendoen, Paul Havinga, Henk Corporaal, Jan van Leeuwen;
- *Modeling and simulation:* COMICT specifically aims at advances of the robustness of operations research and modeling theory suited for real-life problems; Also the high-tech systems objective requires a rethinking of software engineering in view of its software legacy. Scientific leaders in this field are profs. Bob Hertzberger, Henri Bal, Richard Boucherie, Cees Witteveen, Bart van Arem, Rob van der Mei, Joost Kok;
- *Data and content:* COMICT addresses the data explosion in many different ways deriving semantics, discover knowledge and in general access these volumes of data. Scientific leaders in this field are profs. Arnold Smeulders, Martin Kersten, Peter Apers, Maarten de Rijke, Frank van Harmelen, Mark Overmars, Arjen de Vries, Guus Schreiber;
- *Interaction:* COMICT searches for new ways and universal conditions to improve human-computer interaction and enhance its usability wherever, whenever, and whatever. Scientific leaders in this field are profs. Anton Nijholt, Mark Neerincx, Catholijn Jonker, Huib de Ridder.

For the resolution of these topics, institutes and research groups have signed in with the best scientific excellence as demonstrated by high peer-reviewed research evaluation scores of the QANU, by the high percentage of VENI, VIDI, VICI laureates participating in the program, and by ERC grants. VICI is the highest and most selective career development program based on personal excellence. The majority of all VICIs ever assigned to the ICT field participate in the program. The institutes and groups are led by internationally recognized scientists, whose resumes are attached to this proposal as an appendix. COMICT will strengthen the Dutch research position in these areas and at the same time bridge the gap to have an impact into the six selected priority areas.

The further details of the scientific themes and methods are described in the 50 project plans that have been added to the COMICT program proposal. In defining the program, the scientific research agenda has been determined on the basis of economical and societal needs; the necessary research activities have been awarded to top scientists in the Netherlands. Each project plan gives an overview of the state-of-the-art, making sure that the program will have an international orientation.

3 Urgency and role of government

The Dutch competitive position strongly depends on knowledge workers. The Dutch economy is a knowledge economy, and knowledge is an important basis for the innovative capacity. A governmental FES investment in the COMICT program is required to enable the development of the national ICT innovation ecosystem and the realization of the three objectives. External investments are needed in COMICT since its merits surpass that of individual participants. The COMICT participants are unable to invest in COMICT without governmental financial support.

Avoid fragmentation

Thanks to Bsik programs, the Dutch ICT knowledge infrastructure is well developed in the areas mentioned under Objective 3 (Section II). These areas represent the Dutch strengths in ICT. This position can and should be strengthened: doing nothing implies giving up the typical Dutch strengths. The FES impulse will make it possible to seize a big opportunity to change the Dutch ICT innovation landscape and to avoid individual (Bsik) networks and strengths to remain fragmented and lacking focus, mass and efficiency.

Urgency

The FES impulse is once only because sufficient warrants (such as consolidation, dissemination, and valorization) have been built into the program to ensure independent continuation of partners after the impulse. Furthermore, after the impulse, the ecosystem will have been built up, and it will be an independently viable system that can function without further government support. COMICT also ensures sufficient momentum for the ecosystem, again avoiding fragmentation. As a result, the effectivity and efficiency of COMICT is larger than when investments would be made in individual and independent parts of the program.

The investment needs to be made urgently. An impulse is necessary to be able to build on the results of the finishing Bsik projects. Results are becoming available. If no action is taken – and the *Commissie van Wijzen* was very adamant about this – these past investments yield no or insufficient return on investment. The education and training level of Dutch population should be maintained, not only via in-school educational program, but also via training on-the-job by participating in advanced R&D projects. External factors require urgent action: international crisis, investments in innovation by companies are under pressure, large scale investments in the knowledge infrastructure in neighboring countries. Not acting now will lead to loss of employment in industry *and* the supplying SMEs.

Sustainability

Because of the recession, investments in sustainability are under pressure. It is the government's responsibility to be alert on these undesirable effects, and to make sure sustainability is not only on its own agenda but also on the industry's. Therefore, investments are needed to replace decreasing industrial R&D investments in sustainability. Several major societal problems need to be resolved that all have a sustainability component. These problems are not only Dutch, but worldwide. If we can find answers to these challenges using ICT, then we can export not 'just' ICT solutions, but solutions that contribute to a more sustainable world.

Invest in research for healthy economic infrastructure

In times of an economic downturn it is important to invest in areas where to expect economic growth. It is well recognized that the high-tech industry and the creative industry have such a capacity. It is also important to remove obstacles for economic growth, to which the areas of safety and mobility are pivotal. In such times, it is important to be cost efficient by improving the quality of life, for example for the elderly. And finally it is important to invest in the basis of future solutions to the problems of society by investing in science. In all of these priority areas the Netherlands has a good starting position. The position will be accelerated through execution of this program by creating a stronger link to cutting edge Dutch ICT-research (as outlined under Objective 3 in Section 2). The Netherlands is already a net exporting country for software, by supporting COMICT the Netherlands aims to become a net exporter for solutions in the priority areas. Finally, the program increases the market values of the high-tech sector (and in particular the embedded and pervasive communications systems subsector) and of the creative industries (in particular the lifestyle, business services and well-being subsectors).

Level playing field in a globalized economy

Today's industry has to compete on a global level. Advanced ICT products and component are available from anywhere in the world, with low-wage countries holding a significant competitive advantage in costs. Emerging countries are strongly investing in the development of their national knowledge infrastructures. For instance, investments in search engines are in France (€ 200 million) and Germany (€ 80 million). Large scale R&D programs are executed in Ireland, Finland and France (Inria receives 400 new structural positions). The added value of our national ICT industry of the future lies in the ability to design and to integrate state-of-the-art systems. These systems are sometimes complex, at other time high-tech, and yet other times based on novel services from novel data. In any case, both the design of the system as well as the systems themselves are more and more based on ICT. This urges for highly qualified knowledge workers in strategic economical and societal ICT areas. The support of government to this proposal is needed to develop cutting edge ICT research vital in the creation of a competitive level playing field now and after the current economic crisis. Government support encourages joint research which decreases the risks of industry and SMEs relative to individually investing in cutting edge ICT research. Finally, government support provides an adequate answer to similar developments towards leveling the playing field in the countries surrounding the Netherlands.

Government central role in a functioning society

In the areas of mobility, safety, and well-being, government plays a central role. Inherent in these areas is infrastructure, physical or virtual. As new infrastructure is typically owned by the government, major ICT improvements can only be realized with the full government support. Furthermore, standardization and sometimes legislation are essential in making organizations, ICT applications, and data effective. De-facto standardization can be a valuable spinoff from collaborative research. However, full benefits will only be realized through a priori government involvement in these processes. The role of the government is to set the stage to facilitate solutions by industry. As a new application-driven initiative, the program executes parts of the Dutch government's (ICT) agendas 'ICT Agenda 2008-2011' and '*Maatschappelijke Innovatie Agendas (MIA) Gezondheid*', *MIA Veiligheid*' and the '*Strategische Kennis- en Innovatieagenda Mobiliteit en Water*'. For impulse funding of COMICT, no other funds associated with these governmental agenda's are available.

Consequence of not investing

Not investing in the Dutch ICT ecosystem leads to fragmentation of the research in knowledge institutes, and departure of ICT R&D to abroad. It will be impossible to build up this knowledge at a later stage and to re-attract R&D to the Netherlands. Table 4 summarizes a number of specific effects that will occur if the program is not funded.

Readiness of the sector for concerted action

Facing a major global economic downturn and societal challenges, the ICT sector recognizes the need for concerted action. Based on a shared vision and broad support by the stakeholders from science and industry, this COMICT program proposal moves the ICT sector to set forward a concerted plan for private-public R&D in selected areas. The industrial support for the program is 25% from more than 150 business partners. COMICT sets a remarkable milestone in the Dutch ICT sector.

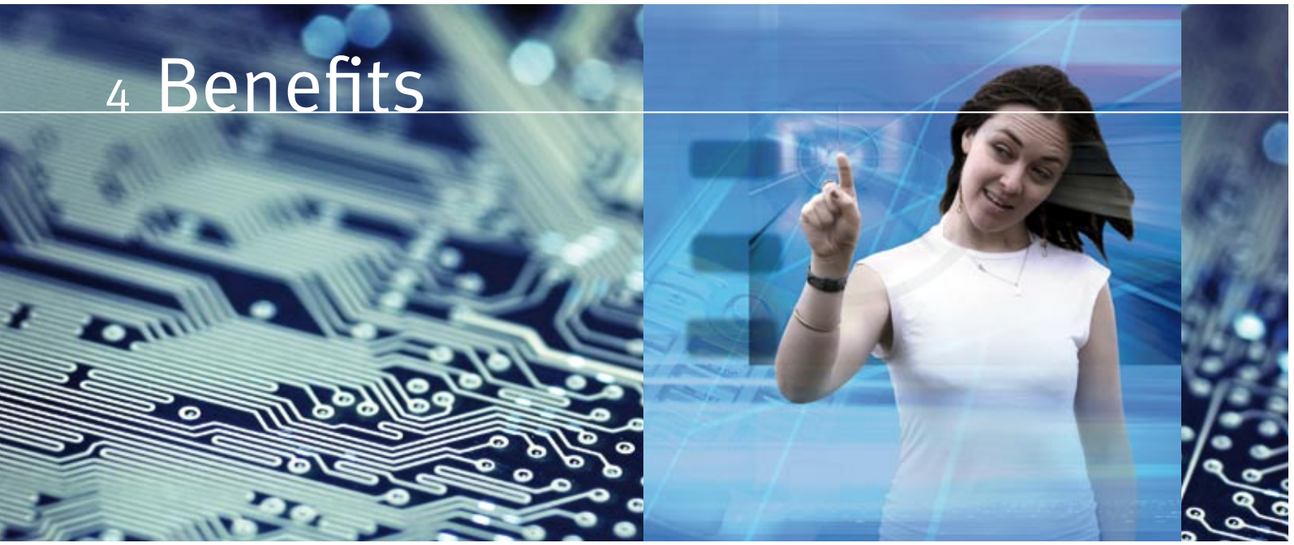
Alternative Funding

For the funding of COMICT no other sources are available. NWO funding targets scientific research. For the innovations programs, societal innovation programs, and other instruments of relevant ministries, the 4 years execution time of COMICT is too long. FES funding in particular gives the opportunity to stimulate the entire innovation chains, from academic to end-users. In the current economic climate it is very positive that industry is committed to invest in COMICT at this large scale. The total amount of private investment is € 74 million, as can be seen from the Letters of Intent added to the COMICT program proposal.

Table 4
Specific effects and urgent problems

Sector	Urgent problem addressed by COMICT
Well-being	• Ageing population exhausts the existing centralized care system; • Lack of ICT-based planning hamper the resolving of waiting lists in hospitals and leads to non-optimal resource usage;
Mobility	• Traffic congestion negatively influence productivity, increases green house gasses, and causes fatal accidents;
Safety	• Increasing feelings of insecurity in physical and on-line worlds; • Identity theft increases and volume of e-transactions decreases;
Creative industry	• Missed economic opportunity in product and service innovation and loss of competitive power because of broken innovation chains;
High tech industry	• Embedded software design technology moves abroad, undermining an important economic pillar of Dutch industry;
Science	• Increasing gap in efficiency and effectivity relative to international competition ;
Internet & Business	• Digital disconnect of substantial part of population must be avoided in times of economic recession; • Missed opportunity for exploration of new technologies that will transform business models; • Digital part of the information society will go abroad;

4 Benefits



4.A Societal benefits

The program directly results in societal benefits. At this stage of the information and communication technology explosion, it is fair to conclude that ICT has been woven into the fabric of society. This holds unique opportunities to employ ICT innovation to increase social coherence. In addition, ICT innovation can provide solutions to some of the increasingly important societal challenges in the priority areas well-being, mobility, and safety.

Social coherence

The impact of the digitization of information, communication and media on all social interactions is growing. Many people are connected to several communities at a time, in both real and virtual worlds, in which people work, do sports, are entertained, live and share emotions. COMICT innovations will create (virtual) communities that will form new social fabrics defined by shared (media) interests. This unique combination of creativity, content and technology can close the digital divide between those who are at ease with new technology and those who have little experience with it. One exemplary focal point of COMICT's endeavor is cultural heritage, by granting tourists personalized access to curated and socially-tagged collections.

Well-being benefits

Healthcare is moving more towards prevention and patient-centered care. The COMICT program proposes a number of research activities that will facilitate this trend: improved integrated information systems give patients insight into the quality and safety of the care received, while enhanced communication and telecare systems allow patients to receive care in their own homes. As a result, COMICT projects will contribute to patient's feeling of well-being and reduce their need to travel.

Mobility benefits

Traffic congestion has remained a pressing issue over the past few years. Structural solutions for mobility problems in densely populated countries like the Netherlands have to be found. COMICT proposes enhance regional and interurban traffic management by developing advanced traffic control and routing systems. Traffic safety will improve through intelligent vehicles with features such as foresighted driving. A recent study shows that in the next 10-15 years, these applications have the potential to reduce congestion by up to 50%[9] with a conservation estimated cost saving of € 30 million annually. This corresponds to enough fuel savings to reduce traffic-related CO_2 emissions, accounting for 25-30% of the total Dutch greenhouse gas emissions, by 10%. An important benefit of intelligent vehicles is improved traffic safety, which has the potential to reduce the approximately 800 fatal traffic incidents per year by 25%.

9 'Slimmer en beter: de voordelen van intelligent verkeer', TNO Report 2008-D-R0996/A, October 2008, Delft (in Dutch), Arem, B. van, B. Jansen & M. van Noort.

Safety benefits

The need for detecting threats such as accidents and terrorism in a timely and accurate manner has continued to increase. Protecting civil structures involves large amounts of data from various sensor networks such as cameras that needs to be collected and interpreted. COMICT will develop system architectures to cope with this and similar challenges in public safety. Applications such as semi-automated monitoring systems can support police and security officers in complex or harsh environments. These systems allow them to monitor a wider scope of public and industrial spaces, improving threat detection and thus contributing to public safety.

As the current financial crisis shows, trust in any system is an important value. Though the Internet has rapidly become a vital part of society, incidents have affected the general population's trust in it. This hampers, for instance, the adaption of internet education or government internet services. COMICT proposes to develop a Secure Communications Layer and a Trust and Identity Management Layer on top of the current Internet infrastructure. These layers contribute to a solid environment of security and trust for higher-level applications, aiming to reduce security incidents on the Internet by 50%.

4.B Economic benefits

The program directly translates in additional economic activity in the ICT sector that deals with designing and integrating state-of-the-art complex technological systems, services and applications. COMICT uses ICT as the Motor of innovation ('Innovatie-as'), enhances the competitive capabilities, delivering patents and spin-off companies. The COMICT stakeholders in the ecosystem will create ICT innovation that can create economic value in the priority areas well-being, mobility, safety and the creative and high-tech industries.

Lasting ecosystem of open innovation

This program creates a lasting ecosystem of open innovation that makes the Netherlands attractive for companies to deploy new activities and improves the competitive position of specific Dutch industries. A broad combination of larger companies and innovative smaller companies has committed to the program and will spearhead the developments.

COMICT reinforces the national policy on strengthening the economic structure. The program directly contributes to improving the competitive position and innovation capabilities of Dutch industry. COMICT also strengthens the knowledge infrastructure. Due to the economic crises the intensification of existing national policies is urgently needed.

Benefits for the ICT sector

The ICT sector contributed to 7.9% of Dutch GDP in 2006 and employed approximately 248,000 people, which accounts for 3.3% of the Dutch workforce.[10] The export of computer and information services of € 4.7 billion accounted for 5.7% of the total export of Dutch services in 2007.[11] From 2004 to 2006, 55% of the companies in the ICT sector are innovators, against a 25% average over all Dutch companies.[12] This demonstrates that innovation in the ICT sector is far more important compared to other sectors. The COMICT program will accelerate innovation in the 33 industrial partners and 84 SMEs involved, resulting in new applications, services and spin-offs that add economic value. As a result, the innovations proposed in this program will enhance the competitive position of the Dutch ICT industry.

High-tech industry benefits

The high-tech OEM industry and SMEs play a central role in R&D in Dutch industry as a whole. Its ability to innovate and create desirable new products is of great importance to our global competitive position. The size of the Dutch high-techs systems market is about € 30B and for the last 10 years has consistently been the fastest growing industrial sector with an annual growth of about 6%, before today's financial crisis. It is the largest export sector, which is about € 18B, one and a half times the size of the second largest export market (basic materials). In terms of added value per employee, the high-tech systems market ranks a strong number one.

The midterm evaluation '*Voortgang Sleutelgebieden*' states that the high-tech sector exhibits an increasing degree of clustering, and that enlargement of the impact should be achieved by outreach to other sectors. There are many direct economic benefits that COMICT will bring. For one, the introduction of advanced technical-scientific methods and tools improve the reliability of complex systems. For example, an improvement of 1% in the

10 'De Digitale Economie', 2008, Centraal Bureau voor de Statistiek.
11 'Internationale handel; In -en uitvoer van diensten naar land', 2009, Centraal Bureau voor de Statistiek.
12 'Innovatie bij bedrijven; 2004-2006', 2008, Centraal Bureau voor de Statistiek

high-tech ecosystem amounts to savings of at least € 500 million per year. For the COMICT program, an improvement of 5% must be achievable within its high-tech and creative industries projects. Another example of COMICT's impact on the economy can be found in the introduction of advanced technical-scientific methods and tools to improve the reliability of complex systems. Costs-of-non-quality (recall, after-sales, brand damage, legacy issues) can amount to 2-5% of total turnover. An improvement of just 1% in the high-tech ecosystem amounts to savings of at least € 500 million per year. Based on past experiences with resolving similar problems in information systems software, an improvement of 5% is achievable within the COMICT high-tech and creative industries projects.

Creative industry benefits

The Netherlands has a strong position in the creative industry. The creative sector is the fastest growing economic sector; in combination with ICT, the sector has the potential to soar. According to the 2006 survey of UNCTAD, the Netherlands ranked sixth in global export value of new media, with a total value of € 250 million in 2005 and a 15% growth over a five-year period. However, France, the UK and Germany have recognized this sector's potential, and have initiated large-scale investments According to the midterm evaluation *'Voortgang Sleutelgebieden'*[13], the creative industry remains receptive to active support to extend its market position. COMICT will directly benefit this growing industry and help it to retain its competitive edge through a number of innovations: life and work-style services such as the Intelligent Workplace for nomadic workers; new commerce services, business information supply and customer marketing research through individual data mining.

Well-being benefits

In 2007, the costs of healthcare in the Netherlands amounted to 13% of GDP[14]. If no action is taken, the ageing population will cause this share to increase to an expected 15-20% by 2020[15]. To keep these costs under control, the healthcare sector needs to make significant efficiency improvements. COMICT will develop systems to optimize medical equipment logistics and in- and outbound patient flows, and systems that ensure patients' medical data are readily available at the right location. As a result, the healthcare chain will become more efficient and accurate, shortening patients' healthcare pathways.

In 2007, a patient's average hospital stay was 6.3 days.[16] As a result of the shortened healthcare pathways through COMICT innovations, hospital stays can be reduced by one day for every ten admissions, reducing patients' average hospital stay to 6.2 days. With 11.7 million nursing days in 2007 at a price of € 225-450 per nursing day, this amounts to € 40-80 million that will be saved annually. Furthermore, the improved availability of patients' medical data will reduce the number of medical errors and the corresponding costs.

Mobility benefits

The Dutch transport sector, with the Rotterdam harbor and the Schiphol mainport, accounted for 4.1% of Dutch GDP in 2007.[17] The sector employs approximately 350,000 people, or 4.5% of the Dutch work force.[18] However, due to the expected 40–80% increase by 2020 in the volume of goods transported[19] and due to increasing travel, the Dutch infrastructure is suffering from growing congestion. Traffic congestion alone costs Dutch society approximately € 3 billion annually.[20] The advanced traffic control systems and routing systems proposed by COMICT have the potential to reduce congestion, with each percentage improvement saving Dutch society € 30 million annually.

Due to the high population density in the Netherlands, finding solutions to the resulting mobility issues has historically had a higher priority than in most other countries. The intelligent systems developed in this program give the Dutch transport industry the opportunity to further streng-then the competitive edge it already has in mobility solutions.

13 Voortgang Sleutelgebieden en tussentijdse evaluatie Sleutelgebieden-aanpak, Innovatieplatform, January 2009.
14 'Raming van uitgaven aan en financiering van de gezondheid- en welzijnszorg', 2009, Centraal Bureau voor de Statistiek.
15 'Niet van Later Zorg', p. 100, 2007, Min VWS, http://www.ggzbeleid.nl/2007/1322.pdf.
16 Analysis of Dutch hospitals' annual reports on 2007, Roland Berger, 2008.
17 'Productie, verbruik, inkomensvorming', 2009, Centraal Bureau voor de Statistiek.
18 'Arbeidsrekeningen', 2009, Centraal Bureau voor de Statistiek.
19 'Maatschappelijke Sectoren & ICT' (www.m-ict.nl).
20 Mobility Policy Document, Part IV, Officially Adopted Policy Document, June 2006, V&W.

Safety benefits

In 2008, 7.7 million Dutch people shopped online[21], spending a total € 5 billion.[22] The share of e-commerce turnover in the total turnover of Dutch companies has increased from just over 3% in 1999 to nearly 15% in 2007. However, rampant identity theft threatens further e-commerce growth and introduction of new online services. Lack of trust in internet security causes 3-4 million people in the Netherlands to hesitate while processing online transactions, putting over € 2 billion in sales at risk. The environment of security and trust resulting from the COMICT innovations described earlier will improve people's trust in e-commerce, decreasing the amount of sales at risk and allowing e-commerce to continue its steady growth. Given the autonomous growth of electronic payment by 25% per year, an increase of 30% in e-sales thanks to the solutions developed in COMICT is feasible.

The trust issues described above are not unique for the Netherlands, but are observed on a global scale. The same holds for the increasing need to improve detection of threats such as accidents and terrorism. Therefore, the solutions that are provided by COMICT innovations can be applied on a global scale; this holds great opportunities to enhance the competitive position of the Dutch industry in the area of safety.

Expected economic results

The expected long term economic results of the program are given in Table 5 (page 28).

Follow-up investments

Investments in COMICT will lead to additional, continued or new investments to valorize the results of the program and to achieve the above mentioned economic effects. COMICT leads to new applications and new products. After – or even during the program – these must be made market-ready, and next, taken into production. Even if mass production takes place abroad, additional investments in the Netherlands will be needed to achieve these long term economic effects. This will require investments that need to be made outside – and most likely after – the COMICT program.

Expected contribution to sustainability

The COMICT program will have a number of positive effects on various aspects of sustainability.

- Less commuter-related traffic: thanks to working at home using a trusted internet;
- Less production of greenhouse gasses: thanks to less congestion because of new mobility solutions;
- Less printing: due to further use of digital technology;
- Energy saving: more accurate and faster sensing enables optimized climate control in office buildings and homes;
- Support sustainability developments: thanks to the e-Science tools and methodologies for a variety of fields;
- Improved production processes: thanks to intelligence embedded in production processes, sustainability of these processes can be improved;
- Software compatibility: thanks to dependable and evolvable software development, existing solutions can migrate to further generation systems;
- Self-care: thanks to ambient intelligence elderly can remain to live longer independently;
- Cultural heritage: thanks to access to archives, sustainable maintenance of our national cultural heritage is improved.

4.C Science Benefits

The program enhances the scientific excellence of key ICT research groups. Academic research, profit and non-profit organizations in ICT will establish a working relationship that maximizes knowledge transfer and relevance of the academic research. Even now, such relationships are emerging in networks of stakeholders, for instance the joint research unit (JRU) that the three technical universities and ESI have recently established. COMICT stimulates research groups to embark on interdisciplinary approaches to master the complexity of data and systems in a range of real-world applications and economic sectors. This makes academic research more valuable to society and economy, and at the same time strengthens the reputation of the participating research teams. COMICT also directly impacts computer science and electrical engineering curricula since the program will lead to newly developed courses, for instance in designing complex systems or mining of large volumes of data. In this way, students will be prepared

21 'De digitale economie', 2008, Centraal Bureau voor de Statistiek.
22 Innovatieplatform, 2008. Connecting global creative ambitions, Creativiteit als kernpropositie van Nederland.

Table 5
Expected economic results of the program

Cluster	Main market	Yearly turnover	Target sector	Expected effect (after program)	Expected result
Content and Interaction	Creative industry	€ 50 billion [23]	Lifestyle & Well being	(re)new products	10% new products
			i-Services & b-intelligence	(re)new products	5% longer home self-care
			Consumer data	Marketing data	20% new services
			Cultural heritage	Increase tourism	30% digital services
Cooperative Embedded Intelligence	High-tech industry	€ 30 billion [24]	High-tech systems	Design efficiency	15% improved efficiency
				Increase quality	5% less costs-of-non-quality
Trusted Internet	Internet commerce	€ 5 billion [25]	Internet business	Increase amount of sales	30% increase in e-sales
ICT & Logistics and Mobility	Transport	€ 53 billion [26]	Mobility	Reduce congestion costs	€ 30 million annually
				Reduce traffic related CO_2	Reduce by 10%
	Health care	€ 72 billion [27]	Health logistics	Improve bed & resource planning	10% reduction of voids Save € 40-80 million annually
e-Science	Science in industry	€ 2.7 billion	Food science	Efficiency	10% more efficient
			Genomics	Effectiveness	10% more effective
			Ecology science		
			Physics		

23 Innovatieplatform, 2008. Connecting global creative ambitions, Creativiteit als kernpropositie van Nederland.
24 High Tech systems platform, Productie High tech industrie, 2009.
25 Blauw Research, Thuiswinkel Markt Monitor, 2008; Note: Internet commerce include revenue of other industries, 2008.
26 CBS, Productie, verbruik, inkomensvorming (60, 61, 62 , 63), 2007
27 CBS, Statistisch jaarboek 2008, uitgaven gezondheids en welzijnszorg, 2006.

for their pivotal role in the information society of the 21st century. A total of 150 highly trained new employees will be available at the end of the program. About 300 currently already employed ICT researchers, software engineers, and end-users will have acquired state-of-the-art knowledge and skills.

Direct contribution to Science

ICT is not only a motor of innovation for the economy, but is also a critical driver for science at large. Many of the scientific challenges relevant to climate change, energy, water, healthcare, food safety and so forth have become increasingly multidisciplinary. As a result, the complexity of mining and visualizing large volumes of data has become much higher, and can only be adequately addressed through a system-level research approach.

COMICT proposes to develop applications on top of the current knowledge and tool infrastructure that will host multidisciplinary virtual experiments. These applications will accelerate turnaround times between simulations and analysis, providing scientific and industrial stakeholders the means to find the answers to the urgent challenges of our time.

Benefits of the open innovation ecosystem

Experience has shown that the working model of academia is adverse to knowledge transfer. In academia, basic science is traditionally separated from application-oriented science and this in turn from applied science. With its objective to establish an innovative Dutch eco-system, COMICT combines theory and practice of a small scientific domain into a single working group or even a single person. Theory and practice thus learn to accept each others' proximity and interaction, steering science around the spokes of the concentric science wheel. Academic research and profit and non-profit organizations in ICT will establish a working relationship that maximizes knowledge transfer, as experience in Bsik ICT projects has shown. The expected outcome of the COMICT program, science aside, includes golden demos, entrepreneurial scientists, open-source products, tools and knowledge networks and spin-off companies.

The COMICT proposal lays the foundations for the Dutch contribution to a ICT - Knowledge Innovation Community (KIC) of the European Institute of Innovation and Technology. Detail can be found in Section IV.B (Coherence). By participating in the COMICT program, the knowledge partners also participate in a European-wide open innovation network, which strengthens both the national and European ecosystems and knowledge partners.

Benefits of interdisciplinary approaches to mastering the complexity of data & systems

The program stimulates individual Dutch ICT researchers and groups to embark on interdisciplinary challenges and approaches to mastering the complexity of data and systems in a range of real-world societal and economic sectors. Hence, COMICT creates more value for society and economy, while at the same time strengthening the researchers' and groups' international academic reputation.

Education benefits

The program will permanently impact computer science and electrical engineering curricula at the participating universities. Students will participate in COMICT related studies and projects as part of their curriculum, for instance in their thesis project. In this way, students will be trained to recognize value but also the complexity of data and information processing systems. This focus brings education at par with technological needs of today's society, and it prepares computer science and electrical engineering students for their pivotal roles in the information society of the 21st century. In the longer run, spillover to other academic domains can be expected, such as to engineering, sciences, arts, economy and law. In these academic domains and curricula, the results of the COMICT program will be studied for their beneficial effects in solving societal problems.

Embedding in knowledge infrastructure

The embedding of the COMICT results in the knowledge infrastructure takes place via the aspiration of establishing 3 new full professor chairs, as well as new faculty and senior research staff resulting from the 150 Ph.D. students trained in the national ICT ecosystem.

5 Approach

5.A Program design in five clusters

The five COMICT clusters

The COMICT program selectively continues very successful ICT Bsik projects and builds on the valuable private-public networks that have been built around these projects, namely *ESI*, *MultimediaN, VL-e, Freeband Communication, Smart Surroundings, BRICKS, Transumo* and *ICIS*. The results of these Bsik projects, now in their final stages, directly feed into five COMICT clusters: *Content and Interaction, Cooperative Embedded Intelligence, Trusted Internet, ICT & Logistics* and *Mobility and e-Science*. These clusters have been selected to cover key economic and societal challenges, as well as opportunities, for the Netherlands. Figure 7 visualizes the formation process of the five COMICT clusters.

The five clusters are related to socio-economic agendas, as detailed here:

- *Content and Interaction (CIN)*, the continuation of the Bsik program MultimediaN, and parts of Freeband Communication and ICIS. This cluster connects to IIP/Create, implementing part of this IIP's strategic research agenda for developing the *sleutelgebied* Creative Industry;
- *Cooperative Embedded Intelligence (CEI)*, the continuation of the Bsik projects ESI, Smart Surroundings and Freeband Communication. This cluster is connected to the IIPs Sensor Networks and Intelligent Communication, implementing part of these IIPs' strategic research agendas for developing the sleutelgebied high-tech systems;
- *Trusted Internet (TIN)* implements a major part of the strategic research agenda of the IIP '*Veilig Verbonden*', developing the priority area *Veiligheid*;
- *ICT & Logistics and Mobility (ILM)*, is the selective continuation of parts of the Bsik project BRICKS and Transumo. This cluster implements part of the strategic research agenda of the IIP MAIS for developing this priority area, and IIP Health Support;
- *e-Science* is the continuation of the applications component of the Bsik project VL-e. The multidisciplinary approach of VL-e is leveraged to expand further the relation-network and to strengthen e-Science.

Figure 8 depicts the clusters' consonance with economic & societal (COMICT Objective 2), and research domains (COMICT Objective 3), including the clusters' budgets.

Figure 7
Formation of the COMICT clusters

Selected Bsik projects	Adjusting and grouping	COMICT research clusters
ESI MultimediaN VL-e *BRICKS* *Freeband Communication* *ICIS* *Smart Surroundings* *Transumo*	**Adjust based on priority areas** Projects are adjusted to match societal and econimic needs **Groups based on research topics** Projects are grouped based on similar research topic	1. Content and Interaction (CIN) 2. Cooperative Embedded Intelligence (CEI) 3. ICT & Logistics and Mobility (ILM) 4. Trusted Internet (TIN) 5. e-Science

- ESI, MultimediaN and VL-e will be continued
- *Parts of BRICKS, Freeband Communiation, ICIS, Smart Surroundings and Transumo will be continued*

Figure 8
COMICT clusters' consonance with economic, societal, and research domain, and the clusters' budgets (the program also includes a management and flexibility budget)

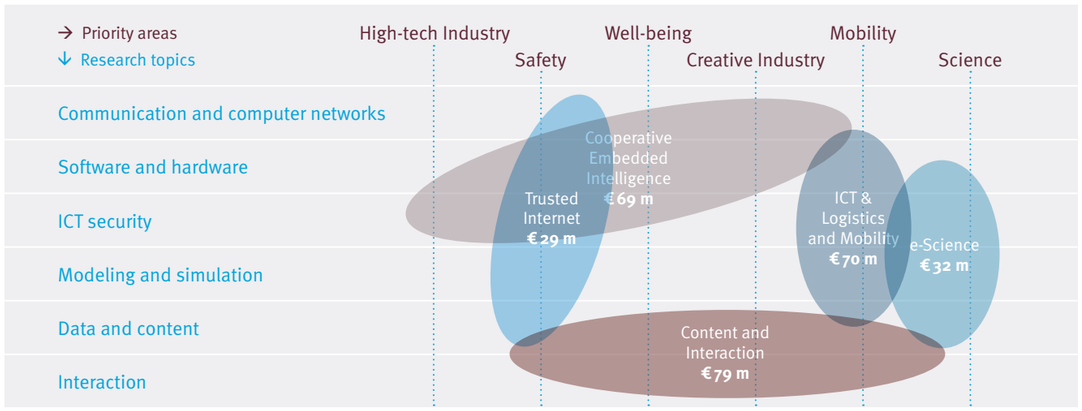
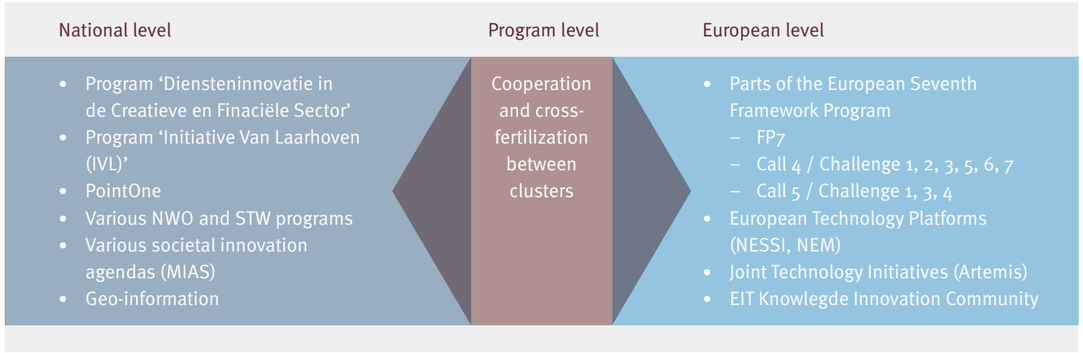


Figure 9
Internal and external coherence



5.B Coherence

Internal coherence: the COMICT cluster matrix

The matrix in Figure 8 shows that the COMICT program comprehensively covers priority areas, and science and technology themes. It is clear that the clusters are largely complementary in nature. The clusters have focused, yet partially overlapping, technological and societal objectives derived from the program's overall objectives. Thus, they form a coherent set of activities that leaves ample opportunities for synergy. The matrix also reveals opportunities for activities that bridge two or more clusters. There is funding reserved in the program budget for activities of this type which will be actively encouraged and pursued by the program management.
Themes and technology developments enhance one another. Specifically for ICT significant spill over effects over can be expected. The technology items as listed under Objective 3 are each repeated in many of the themes. Data handling is in all themes, interaction is all themes and projects, and infrastructure is also important to all themes. In addition, the entire theme of security is a supplier to other themes such as mobility and well-being. Likewise, the entire theme of content is a basic tool to many of the other themes. Cross-fertilization will happen at the personal level, through the same institute participating in more than one theme, and at the program level by distributing the projects of one priority areas to several clusters. Cooperation between clusters is built in into the program.

Relationship to the program 'Diensteninnovatie in de Creatieve en Financiele Sector'

The focal point of the '*Diensteninnovatie in de Creatieve en Financiele Sector*' program is on strengthening the economic infrastructure with ICT-driven innovation and business models in the creative industries (media sector), whereas the activities in the COMICT program are substantially more focused on strengthening the knowledge infrastructure. The '*Strategische Advies Commissie*', led by A. Rinnooy Kan, has requested that several projects be shifted from the '*Diensteninnovatie'* program to the COMICT program to ensure an optimal connection between the two. These projects have been well received by the COMICT consortium and are now being integrated and elaborated. These '*Diensteninnovatie'* projects have been added as appendices to three projects in the clusters *Content and Interaction* and *Cooperative Embedded Intelligence*. COMICT will actively push its research findings towards the '*Diensteninnovatie'* program to ensure support for investments in the economic infrastructure by the knowledge-oriented ICT innovation ecosystem. In this way the COMICT program serves as a lever for the '*Diensteninnovatie'* program.

Relationship to the program 'Initiative Van Laarhoven' (IVL)

The '*Initiative Van Laarhoven*' (IVL) research program focuses on the management of international supply chains, both for large-scale multinationals and for collaboration of companies in cross-chain control centers. The IVL also focuses on managing the role of our main ports, exploring new business opportunities that are created by the increasing complexity of global-scale service supply chains. The IVL program has a focus on creating new business by means of management functions. It does not deal with the actual transport of goods, which is the focus of the COMICT *ICT & Logistics and Mobility* (ILM) cluster. Therefore, the research into supply chains in the IVL program and in the ILM cluster is related yet complementary initiatives. COMICT, and especially the ILM cluster, will coordinate its activities with connecting IVL activities, and connect relevant IVL partners to the ICT ecosystem.

Relationship to PointOne

The COMICT program has also synchronized with *PointOne*, the research program focused on embedded systems and the high-tech systems sector. There, the main focus is on the area of nano-electronics and mechatronics. R&D activities that strengthen the knowledge infrastructure in embedded systems, is part of the COMICT program and in particular the *Cooperative Embedded Intelligence (CEI)* cluster. Again, COMICT, and especially the CEI cluster, will coordinate its activities with connecting PointOne activities, and connect relevant PointOne partners to the ICT ecosystem.

NWO and STW programs

The program builds on scientific results reached in the national programs: NWO/Catch, STW/Sentinels, STW/Progress, STW/Assist, NWO/Glance, NWO/Jacquard, NWO/Focus, STW/Autonomous Sensor Systems, and the IOPs MMI and GenCom. Research groups in the COMICT program all participate in one or more of these NWO/STW projects. These programs have much smaller budgets, and industrial participation is usually limited to providing co-supervision, internships or memberships of user committees. The COMICT program specifically aims to establish a private-public R&D community in the form of an open innovation network. Hence the program serves as a lever for the transfer of the scientific findings in these NWO/STW programs into their use.

Societal innovation agendas

In the 2007-2011 policy program, the Dutch government set its priorities for the period up to 2011. Four societal innovation agendas (*MIAs*) were developed, aimed at the main societal bottlenecks and challenges of our times in the areas health, security, energy and water. Objective 1 of the COMICT program includes health and security in its focus and efforts.

Geo-information

ICT plays an important enabling role for geo-information systems. The COMICT program links to the Bsik program RGI (Room for Geo-information). The relationship between COMICT and geo-information lies in the areas of sensor networks, visualization, grid computing, and semantic web. The form of collaboration with RGI is currently under discussion.

European coherence

Though the core of this program is based in the Netherlands, research and technology development is not just a national issue. The program is well connected to the themes of the EU ICT Seventh Framework Program (FP7). We estimate that the knowledge institutes in the Netherlands are currently involved in more than 50 European projects in the economic, societal and science domains that the COMICT program covers, with an estimated project budget of over 100 M€.

The ICT community in the program incorporates the most prominent ICT researchers and innovators in the Netherlands. These ICT partners are very familiar with the FP7 themes and terms, and they will seize opportunities for optimal alignment of their work at national and European levels. The COMICT program ensures connection with state-of-the-art European knowledge and prepares the Dutch ICT community for responding to forthcoming calls in FP7.

ETPs

The European Commission is encouraging the formation of industry-driven European Technology Platforms (ETPs) and Joint Technology Initiatives (JTIs). ETPs play a major role in the development of the agendas within the FP7 Work Programs. Several of the COMICT partners are members of ICT ETP boards. Representatives include Logica for the ETP Networked European Software & Services (NESSI), the UvA and TU Delft for the ETP NEM (Networked and Electronic Media) and Philips for the JTI Artemis on Embedded

Systems. Dutch representation in the ETP and JTI boards contributes to the synchronization of the COMICT program with topics within FP7 and ETP/JTI developments.

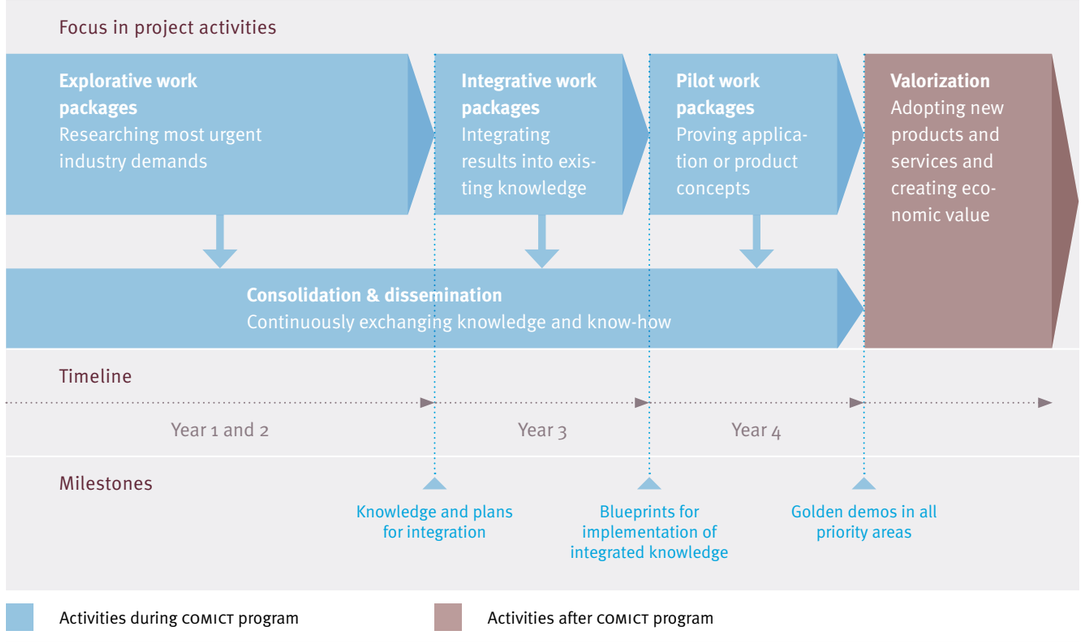
EIT

The European Institute of Innovation and Technology (EIT) is a new instrument of the Commission for strengthening innovation in Europe. The EIT will issue its first call for Knowledge Innovation Communities (KIC) in the spring of 2009. The COMICT program is strongly linked to the KIC proposal Mobi.Europe (working title) that is currently being shaped by a number of major European players representing innovation clusters. Mobi.Europe will be a network of hubs of innovation ecosystems. In the Netherlands, the ecosystem is based on the high-tech campus at Philips, with partners from all over the Netherlands including ESI, TNO-ICT and the Telematica Instituut. Academic partners are based on 3 TU.NIRICT; through the COMICT program, participation can be effectively extended to more industrial and academic partners.

5.C From explorative to dissemination activities

All clusters are divided into explorative or explorative projects, multidisciplinary integrative projects and pilots, though historically terminology may vary per cluster. Explorative projects are at the core of the cluster. They are motivated by the most urgent questions from the market. The explorative projects feed into multidisciplinary integrative projects, which add that knowledge to their own sources of knowledge. The integrative projects feed into pilot projects. All projects are steered directly by profit or non-profit parties. Therefore, all projects participate

Figure 10
COMICT's explorative, integrative and pilot projects involve continuous dissemination, resulting in valorization of the activities



in continuous consolidation and dissemination, finally resulting in valorization of the activities of the cluster and the COMICT program.

The program is built around market leaders. In the program, most of the partners are high-tech or data-intensive. Data-intensive partners are in the midst of adjusting to the information explosion with tools to manage and analyze data. The COMICT program brings knowledge institutes and these market leaders together to ensure an optimal path from explorative projects to dissemination, pushing and pulling.

Dissemination and transfer of knowledge

Knowledge consolidation refers to the collection of activities in which research findings are generalized and made reusable for application beyond the (limited) scope and timeline of a project and project consortium. Knowledge consolidation provides the basis for sustainable exploitation of research investments. It should lead to significant improvement in the multiplier for the investments of the original research project(s). Knowledge consolidation requires close interaction with the particular research project, research teams, industry and other stakeholders. The optimal added value lies in between the project level and the overall program level, COMICT will consolidate knowledge at the cluster level.

Dissemination of knowledge and know-how is a major target of the program. The aim is to infuse the ICT industry with high-tech, and thus give rise to many products and services for profit and non-profit institutes. Dissemination in combination with exploitation is primarily based on close interaction processes developed during the Bsik ICT projects. Three parties meet in such processes: the researcher funded by subsidy, the knowledge institute matching the research, and the participating profit or non-profit partner which evaluates potential and invests in the process. In the COMICT program, dissemination is the basis for the success of the open innovation network.

Dissemination in the COMICT program takes many different forms. Results will be broadcasted in the scientific community through papers in journals, conferences and workshops. *Transfer of technological and domain knowledge* is concentrated in human-human interaction in the COMICT cluster projects. *Golden demonstrators* will enhance the public and industry awareness of these projects. Experience has shown that at the core of *software* lies concepts, know-how, experience and methods. Therefore, an *open source* policy is encouraged to enhance innovation and the growth of local services and exploitation around this core. *Industry awareness and scouting* is pursued on the basis of tangible results made visible through road shows in conjunction with the various ICT Innovation Platforms connected to the COMICT clusters. *Public awareness* requires papers and presentations, press awareness and Internet appearances. Such public awareness efforts will take place at the COMICT program level.

Exploitation will take place via dedicated knowledge transfer concepts. *Business creation* will be pursued through startups and spinoffs, and/or products where possible. A substantial number of academic partners in the clusters have track records for creating spinoffs or downstream follow-up to create value from research. The COMICT program will encourage knowledge exploitation in different ways, and has reserved part of the budget (7%) for funding activities that specifically target potential exploitation of research findings through startups and spinoffs.

6 Partners

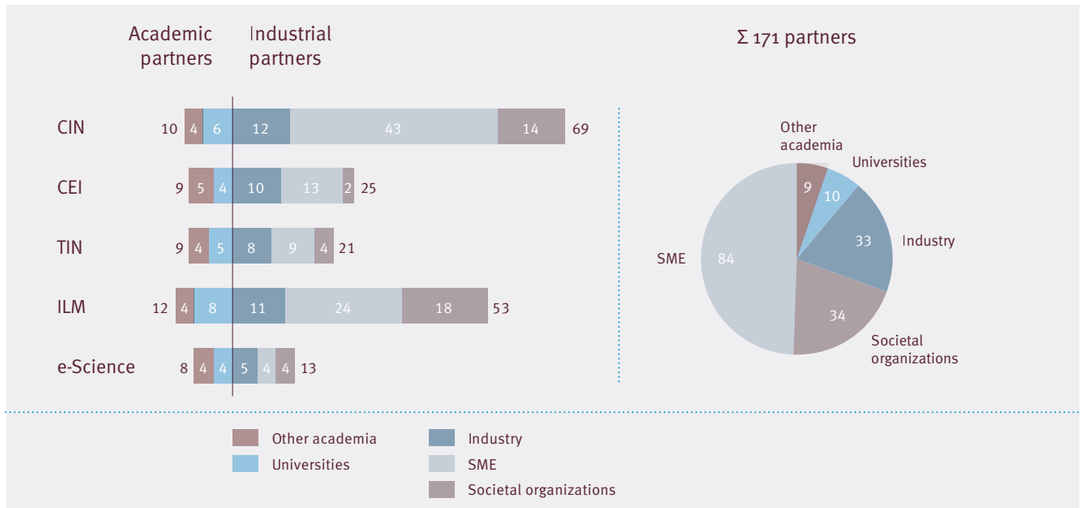
6.A Consortium

The COMICT consortium comprises industrial players, both in ICT as in other sectors, many innovative SMEs, non-profit organizations focusing on societal issues and prominent academic and research institutions. Leading industrial players, SMEs and start-ups bring market expertise and commercial knowledge to the program, focusing the research projects on commercially attractive areas.

Academia and research institutes bring extensive multidisciplinary and cross-sectoral knowledge to the program that is essential for breakthrough innovations and application across application areas. In total, there are over 170 participants, all of which contribute financially or in kind to the program.

Figure 11 gives an overview of the partners involved in the program. We emphasize that a substantial number of

Figure 11
The COMICT program involves a total of 171 academic and industrial partners



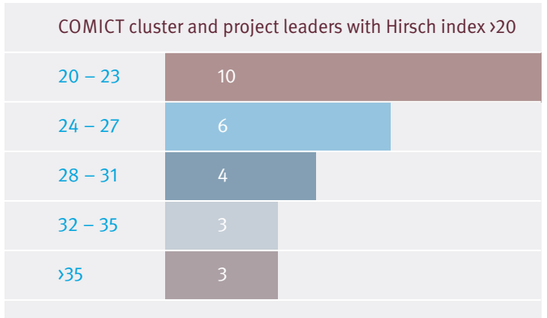
partners are involved in two or more clusters, enhancing the synergy and cross-over between the five clusters.

Most major ICT companies and leading companies working in the areas the program focuses on support the program. The COMICT program is unique in its large number of small and medium sized companies, which are actively participating to realize ICT-innovation. They contribute specific knowledge and often spearhead the application of new innovative technologies and unforeseen new applications. A part of the participants are specifically involved to ensure the program results in solutions for societal challenges. Therefore, important players working on improving mobility, wellbeing and safety in the Netherlands are participating.

6.B Scientific excellence of participating scientific institutes and researchers

The COMICT program builds on core ICT research groups at 8 universities. These academic research groups are among the international world class. Eighty percent of the participating groups were rated 18+ (out of 20) points in the last QANU research assessment, ranking them among the top computer science and electrical engineering groups. The academic research groups have all been involved in successful BISK ICT-projects three of which have been praised by the *Commissie van Wijzen* for their leadership. Their group leaders have proven to have the competencies needed to carry out excellent research and to apply their results to key societal and economic challenges. The participating research groups continue the research in their specialism within the COMICT program.

Figure 12
Hirsch-index of cluster and project leaders



Researchers of the program have been selected on the basis of their proven excellence in science, entrepreneurial activities and on their ambition to seize this opportunity to add impact to their science. The cluster leaders and the projects leaders are internationally recognized experts in their fields, as proven by their editorships of influential IEEE and ACM journals, and chairing positions of prestigious conferences. Cluster and project leaders are Fellow of the ACM, the IAPR or the IEEE, or they have received various other recognitions of scientific excellence. The Hirsh index of more than 25 scientific cluster and project leaders is above 20, based on http://www.harzing.com.

Frank van Harmelen is professor in knowledge representation in the AI department at VU Amsterdam. He is Fellow of the European AI Society (reserved for 3% of European AI researchers), and ranks consistently among the top of the country in citation impact with a Hirsh indices of 45. *Prof. Henri Bal*, also of VU Amsterdam, is a well-known professor in computer systems with specialization in parallel computers and applications. He was awarded for the NWO Pioneer award and his H-index is 39. *Prof. Mark Overmars,* who was the first one to receive a Pioneer award, leads the Center for Advanced Gaming and Simulation at University of Utrecht. His H-index is 39. *Prof. Arnold Smeulders* heads the Intelligent Systems Lab at the University of Amsterdam. He is internationally reputed for his work in multimedia analysis and access, and he scores an H-index of 34. The scientific track records (curriculum vitae) of these and other key scientists are attached to the COMICT program proposal.

More than half of all VICI laureates ever awarded in the field of computer science continue their research in the COMICT program. The program has three Pioneer grantee, five VICI winners, and more than 10 VENI and VIDI award laureates. The laureates see this program as an opportunity to have a high-science to high-tech impact on the profit or non-profit sector. *Catholijn Jonker* of Delft University of Technology received a VICI award for her work in intelligent agents in human-computer interaction. *Maarten de Rijke* at the University of Amsterdam, received a Pioneer Grant, the precursor of the VICI grants, for inexact reasoning, *Antal van den Bosch*, University of Tilburg, received a VICI for natural language processing, and *Theo Gevers* of the University of Amsterdam received a VICI award for his research on Color in computer vision. And, finally, Claes de Vreese, University of Amsterdam, has been awarded a VICI and an ERC on the impact news has on political decision making. He participates here to connect communication to digital information processing.

7 Program implementation: the clusters

7.A Cluster Content and Interaction (CIN)

Motivation and domain

Media, papers, data, news and communication are all converging into one technology and one market. This new market offers opportunities and halts others, forming the substrate of our societal and economic prosperity. It will be driven by technology that is deeply rooted in content and interaction.

With a single click, a user opens a world of information, either for acquiring business intelligence, for consuming entertainment, for extending knowledge, or for social interaction. The cluster Content and Interaction (CIN) brings together stakeholders from (multi-)nationals, companies owning data collections, ICT-integrators, and many high-tech SMEs with entrepreneurial researchers to unlock the potential of the new markets. The cluster focuses on new ways to access content, new devices and new contexts for interaction using geo-location, usability and experience. The aim is to demonstrate economically- and socially-viable solutions for media, business intelligence, mobility, security and well-being.

Coherence and rationale

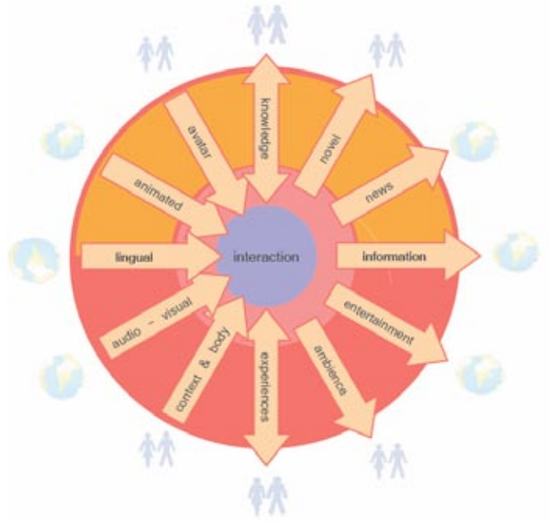
The CIN cluster is a selective continuation of the MultimediaN project technology, organization of activities, and selective results of the Freeband, ICIS and GATE Bsik projects. The CIN cluster continues on the challenges directed to the economic sectors of consumer lifestyle and well-being, i-services for business and customers, security, mobility, and cultural heritage.

These sectors have been chosen for a high-tech impulse absorbed by profit/non-profit parties because the societal and economic impact is largest here.

Key questions

Digital information is ubiquitous and pervasive, and it is exploding. This avalanche of digital content provides a wealth of economic opportunity: entertainment, travel, health, well-being and social participation.

Figure 13



Question 1: Can we address the explosion of information and steer it towards societal and economic wealth?

Interaction with digital content is quickly evolving from search-and-find in large archives into continuous interaction worldwide with people and their digital counterparts in (serious) games.

Question 2: Can we make interaction natural for all to participate everywhere?

If information and interaction are so abundant, and if they are so important to society and the economy, then many countries in the world will seek to deliver an impulse.

Question 3: Can we permanently affect the high-tech drive in content and interaction?

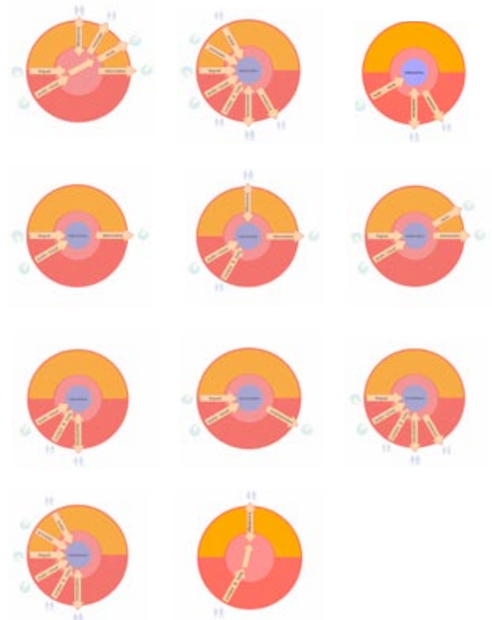
State-of-the-art

Important streams of information of the real world are lingual and audio-visual, or animated for the virtual world. They serve as input for interaction by analyzing their semantic content.[28] New devices to sense body and contextual still expand the amount of information available to monitor and to serve the user.[29] In the virtual world, avatars are being explored as an efficient way to conduct interaction.[30] The aim of content is to produce knowledge with (social tagging, annotation)[31] or without interaction (data mining)[32]. The aim of interaction is primarily to evoke experiences[33] to enhance the ambience or the entertainment value. The processing of information primarily leads to the selection and condensation of facts[34] as news and novel relations in the data personalized for the user. We aim to take the results in these areas, to expand on them, and most of all to combine them into new know-how.

Key research questions

What are proper ways for ordering very large amounts of data and knowledge and what are principles and solutions to understand the semantics and relevance hidden in digital data? Can we provide natural, universal and hardly present interaction tailored to the type of information, context, time and place? Can we make the computer access to large volumes of data and knowledge more natural and universal?

Figure 14



Main technological topics

These questions lead to 11 projects, as displayed in the figure above, with five knowledge partners and 50 profit and non-profit organizations. These projects will focus on the following technological topics:

- Databases to order large amounts of multimedia (text, audio, visual) data [projects 7 & 9]
- Ontologies to provide interoperable access to large amounts of knowledge [project 6]

28 Thomas Landauer. 'A Solution to Plato's Problem: The Latent Semantic Analysis Theory of Acquisition, Induction, and Representation of Knowledge'. http://www.welchco.com/02/14/01/60/96/02/2901.HTM.
29 A. Schmidt: Implicit human computer interaction through context, Springer Verlag 2000.
30 A. Treuille, S. Cooper, Z. Popovic, Continuum crowds, Proc. SIGGRAPH 2006.
31 T. Crecelius et al.: Making SENSE: Socially Enhanced Search and Exploration, Proceedings of VLDB, 1-2, 2008.
32 A. Hauptmann, R. Yan, W.-H. Lin, M. Christel, and H. Wactlar: Can High-Level Concepts Fill the Semantic Gap in Video Retrieval? A Case Study with Broadcast News, IEEE Transactions on Multimedia, Vol. 9, 5-2007.
33 Emile Aarts, Rick Harwig and Maarten Schuurmans, chapter Ambient Intelligence in The Invisible Future: The Seamless Integration Of Technology Into Everyday Life, McGraw-Hill Companies, 2001.
34 J. Turmo, A. Ageno, and N. Català. Adaptive information extraction. ACM Comput. Surv. 38(2), 4, 2006.

- Robust computational methods to provide semantic search in multimedia [projects 1 & 9]
- Tools to gather information and to reveal relevance of hidden relationships [projects 3 & 10]
- Natural interaction to a computer for the task at hand [projects 2 & 5]
- Universal, location and context-specific access to a computer [projects 2 & 3]
- The information and devices needed to achieve natural and universal interaction [project 4]

Societal relevance

The societal need and economic drive for digital information following the technological developments of the last decade are enormous. Within months of an essentially new way of production, communication channel or interaction manner, products and services related to the innovation abound. In forensics, media or research, it is hard to ignore the role of information. Creation of (virtual) communities forms new groups defined by their (media) interests.

Value for society originates from the right combination of creativity, content and technology (information, communication and media by mobile, Internet and interactive television) closes the digital divide between those who are at ease with new technology and those who have little experience with it. New devices will bring real inclusion to the elderly and the handicapped. As an example, consider the 60 Story Tables now in use in homes for the elderly. Sitting together they share their memories, triggered by historical photographs or video images from Beeld&Geluid, working against depression and loneliness.[35] Closing the digital divide pays off in social values. And in times when cultural heritage institutions are digitizing their collections to prevent loosing contact with a new society, it results in vast collections of digital data. Cultural heritage, surely the media, has become a high-IT endeavor. Access by content, just-in-time and just-in-context are inevitable assets for the future: heritage through ubiquitous content, access and technology.

Economic relevance

The economic impact of this cluster comes from information-intensive, ICT-driven, major economic sectors: creative industries, mobility, well-being and business intelligence. The creative sector is widely recognized as the motor for innovation.[36] So is ICT. Hence, the combination of the two drives innovation. ICT and the creative sector combined have a wide and long-lasting effect on the life and work styles of everyone. Where the current turnover of the creative sector was € 52 billion in 2004, with an added value of € 24 billion, it is expected to grow fastest of all sectors. The Netherlands has an excellent reputation in research in ICT in combination with information exploration, interaction and media. Compared to the innovation and research in this area in the EU, the Netherlands is well-positioned to take the lead. The network infrastructure is excellent. A 2006 survey by UNCTAD indicates that the Netherlands ranks 6th in export value of new media with a growth of 15% in the last five years – much higher than the US or the UK which are both under 5%, but lower than Germany with 30%. In the mobility sector, TomTom holds a significant percentage of the global market in navigation systems. Its revenue stream is $ 1.5 billion per year. The importance of the field can be seen from the revenue stream in licensing software products in this field, which amounted to $ 20 billion in 2007 with an expected growth rate of 5% annually.

Consortium

The cluster is divided into two explorative projects, one on content and one on interaction, five multidisciplinary integrative projects and four pilot projects. They cooperate along the knowledge chain. 60 profit and non-profit partners cooperate in the cluster. They are grouped around market leaders. Regional hotspots are Amsterdam (with partners mostly focused on i-services), Utrecht (SMEs focused on games and virtual worlds), Eindhoven, Twente (databases SMEs) and Delft (SMEs). Most partners are high-tech or data-intensive. And, the cluster includes successful private-public innovation interaction with MultimediaN and other Bsik projects (via UvA, CWI, TU Delft, UTwente, UUtrecht, VU, TNO, Telin), supplemented with new partners (UvTilburg, TU/e, EUR). Researchers have been selected on the basis of their proven excellence in science, entrepreneurial activities and on their ambition to seize this opportunity to impact their science. The research institutes involved have received high honors both personally and institutionally. The cluster is also connected to the EZ program for Service Innovation by incorporating, upon request of the SAC[37], two of its projects on lifestyle and real & virtual worlds, where a third is integrated in the cluster CEI on the embedding of the workplace.

35 As demonstrated in recent research by the VU.
36 Connecting global creative ambitions Creativiteit als kernpositie van Nederland Versterken van de Nederlandse creatieve industrie. Innovatie Platform 30 September 2008.
37 The Strategische Advies Commissie chaired by A. Rinnooy Kan.

Budget and projects

The budget is € 79 million for a total of 60 partners. The (non-)profit partners invest € 19 million and the knowledge institutions invest € 21 million. There are 11 projects with 100 work packages and hundreds of deliverables in science, dissemination and exploitation. See the cluster plan for more details.

7.B Cluster Cooperative Embedded Intelligence (CEI)

Motivation and domain

Almost any economic and societal innovation deploys, either directly or indirectly, systems or applications that are based on high-tech embedded and pervasive communication technology. This makes the high-tech industry an important economic factor in the Netherlands, which needs to innovate continuously. The complexity of the design of these systems has increased tremendously because such cooperative embedded intelligence (CEI) systems need to offer integrated functionality. Software and hardware (sub)systems must be flexible, robust, dependable, safe, understandable, evolvable and cost-effective. CEI systems should also be able to function collaboratively in a composite system under varying operational conditions. The CEI cluster brings together leading Dutch high-tech OEM industries, SMEs and knowledge institutes including 3TU.NIRICT, ESI and the Telematica Instituut. Together, they aim to find new approaches and solutions for cooperating systems and components, intelligent information fusion and reasoning, and integration of embedded platforms and software.

Coherence and rationale

The complexity of systems and information has become a bottleneck for innovation in important economic and societal sectors. The CEI cluster concentrates on the sectors care and lifestyle, public and industrial safety, mobility and high-tech industry because of the existing absorption potential by Dutch industrial and SME partners. The CEI cluster is a selective continuation and integration of the successful Bsik project at the Embedded Systems Institute (ESI), Smart Surroundings and Freeband Communication.

Key questions

Complex systems consisting of many distributed components, including sensors and actuators, require autonomous coordination, flexible communication and intelligent analysis and abstraction of sensory data flowing back and forth.

Question 1: How can such systems consisting of largely autonomous platforms be designed for high-quality cooperation through wireless networks?

Question 2: How can we fuse in real-time the information obtained from thousands of sensors and neighboring platforms? How can we select relevant event information in order to take appropriate automatic or human action?

Question 3: Which model-based system and software architectures and integration tools are suited for the development and evolution of distributed complex platforms?

State-of-the-art

The design of CEI systems relies on solid fundamental computer science, mathematics and electrical engineering theories and models. However, the state-of-the-art falls short for the challenges in next generation of CEI systems: their heterogeneity, their multi-disciplinary character, their scale in the number of cooperating components[38], and the required inherent system properties such as robustness, scalability and transparency. At the same time, the users of CEI systems expect flawless dependable operation.[39] Mekid writes[40]: 'more integration of current and future technology development is required to build a strong platform for various applications featured with interoperability, trust, security and protection. An immediate action is required on smart strategies for the design patterns. This will allow rapid configuration and adaptation to new manufacturing tasks with highly improved machine learning'. According to the Embedded WiSeNts Research Roadmap[41], gaps [in knowledge and methodology] that need to be considered include algorithms and extra-functional properties. Gaps related to algorithms include 'functional properties of cooperating objects, that is, specific protocols, procedures, and so

38 Ultra-Large-Scale Systems, Software Engineering Institute, Carnegie Mellon University, 2006.
39 ESI Research Agenda, http://www.esi.nl/institute/ESI_Research_Agenda_V7_11.pdf.
40 Mekid, T. Schlegel, N. Aspragathos, R. Teti, Foresight formulation in innovative production, automation and control systems, Journal of Foresight, Vol. 9, Issue 5, pp. 35-47, 2007.
41 Embedded WiSeNts Research Roadmap, Pedro José Marron, Daniel Minder [Eds.], ISBN 978-3-8325-1424-2, 2006.

forth, such as localization, context-aware media access control and routing, clustering techniques, and data storage'. Gaps related to extra-functional properties 'deal with quality-of-service-type characteristics, such as scalability, quality-of-service, robustness, performance, mobility, security, heterogeneity, and real-time properties'.

Key research questions

What are the proper ways of semi-autonomously configuring and programming a distributed wireless (sensor) network? How can these solutions be made scalable and robust without controlling and checking each and every individual node continuously? How can these large-scale systems be made power efficient? Can we integrate sensory information in a real-time fashion by reasoning or pattern recognition strategies such that applications only have to deal with higher-level event information and not with the raw data? And what methodologies and architectures are appropriate to design evolvable systems of a large number of heterogeneous subsystems or components and yet satisfy properties such as dependability, security and scalability?

Main technological topics

These research questions lead to projects that search for knowledge, know-how and experience in the following fields:

- Model-based design for a variety of embedded systems [projects 2, 4, 5]
- Programming tools and middleware for self-configuring (large scale) distributed sensor/actuator systems 3, 6, 8]
- Real-time reasoning techniques over incomplete, unreliable, heterogeneous (sensory) information [1, 5, 7]
- Physical layer and protocol designs for hybrid, self-configuring and dynamic ad-hoc networks [9] Consolidation of cluster-wide applicable methods, techniques and tools, as well as dissemination [10, 11]

Societal relevance

We have become a technology-dependent society; the effectiveness of societal innovation has become coupled to successful deployment of sensors, actuator, communication devices, embedded systems, and systems that rely on these components. In well-being, CEI technology allows for vitals monitoring when a patient is at home, thus giving patients control of their own health situation. In securing public and private spaces, automatic monitoring using advanced CEI systems assists police or security forces in detecting unusual events, which makes society more safe. In mobility, transport and logistics, advanced traffic control, and car, truck and freight routing solutions are based on measuring, communicating and integrating a range of real-time information sources, yielding reduced road congestion, increased road safety, reduced freight transportation costs and reduced CO_2 emissions.

Economic relevance

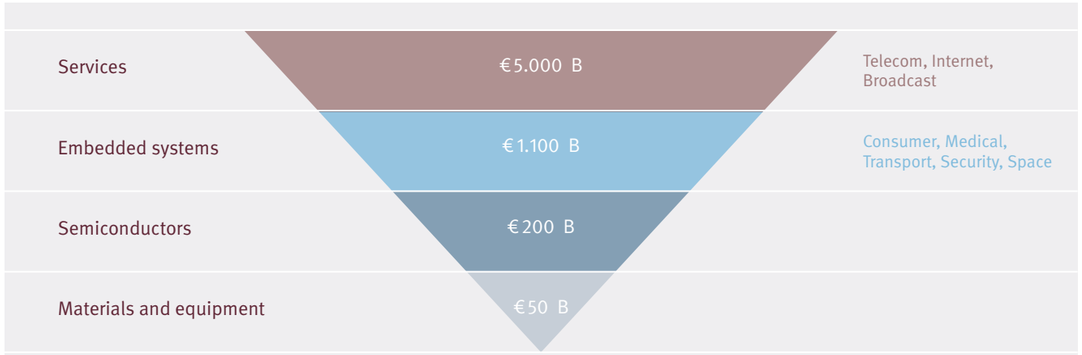
The Economic relevance results from OEM industry and SME companies in high-tech embedded and pervasive communication systems greatly impact the economy. For these companies, CEI technology is a key differentiator for growth in a global competitive market. Industry players such as ASML, FEI, NXP, Océ, Philips Healthcare, Thales, VanDerLande and many more, are positioned at the heart of technology innovation and are market leaders in their fields. This places the Dutch high-tech industry at the forefront of the embedded and pervasive systems industrial sector, with enormous potential in applied technologies such as robotics, care equipment, front-end and back-end semiconductor manufacturing, printing equipment, domotics and automotive. High-tech SMEs are well represented in the Netherlands, including Centric, Technolution, Verum, DevLab and TI-WMC. These companies play an important role in providing third-party components or partial solutions to high-tech industry, act as system integrators and sometimes even provide products to the end-user markets. The size of the Dutch high-techs systems market is about € 24 billion, and for the last 10 years has consistently been the fastest growing industrial sector, with annual growth of about 6%, before today's financial crisis.[42] It is the largest export sector, similar in size as the market for pharmacological and chemical industry combined. Also in terms of added value per employee, it ranks a strong number one. It is clear that investing in innovation in this sector will benefit the economy at large.

Consortium

The CEI cluster includes 25 companies, eight of which are multinationals with their own (large) research labs and 17 are SMEs. Researchers in the consortium have been selected on the basis of their proven track record in academic research as well as their experience with private-public funded research in the Bsik projects Freeband Communications, Smart Surroundings and ESI. Research groups of the 3TU.NIRICT (Netherlands Institute on Research in ICT) and the 3TU.Cedict (the Center of Excellence

42 Figures by Berenschot.

Figure 15



for Dependable ICT Systems) contribute to CEI. This aligns CEI well with the research agenda in the three technical universities. Other knowledge institutes present in the CEI cluster are VU Amsterdam, CWI, the Embedded Systems Institute, TNO-ICT and the Telematica Instituut. ESI has been a major proponent of open innovation in the high-tech sector in the past few years. ESI and the Telematica Institute not only contribute to the research agenda, but are also responsible for the intra-cluster consolidation of generic results and extra-cluster dissemination to societal and economic sectors at large. The CEI consortium is well-connected to the national NOAG-ICT agenda, the European agenda via JTI Artemis and a range of FP6 and FP7 projects. The cluster is also connected to the EZ program for Service Innovation by incorporating, upon request of the SAC[43], two of its projects on lifestyle and collaborative design in the CEI project VII (Smart systems for well-being and well-working).

Budget and projects

The budget is € 69 million for a total of 25 partners. The (non-)profit partners invest € 13 million and the knowledge institutions invest € 22 million. There are 11 projects with 50 work packages and hundreds of deliverables in the dimensions science, dissemination and exploitation. See the cluster plan for more details.

7.C Cluster Trusted Internet (TIN)

Motivation and domain

'The Internet is broken' was the cover story in the December 2005 issue of MIT's Technology Review[44]. The essence of this and many other articles is that the Internet lacks necessary security and privacy mechanisms. Newspapers are full of stories about Internet thieves stealing millions of credit card numbers. Identity theft is the fastest-growing crime[45], and phishing attacks, spyware, spam, hackers and viruses are rampant. Even with security protocols and privacy measures, the evolution of digital identities, poor security and its effects on trust are ill understood. Internet security cannot be seen as an individual consumer problem, but needs to be addressed on a larger scale if the full potential of the Internet as an engine of economic growth and societal development is to be realized. The Trusted Internet (TIN) cluster brings together leading Dutch industrial stakeholders in security technology and internationally renowned academic research teams. Together, they aim to find new approaches and solutions for fixing Internet security holes and for managing identity and trust. Their efforts will encourage R&D of solutions tailored to the stakeholders sectors.

43 The Strategische Advies Commissie chaired by A. Rinnooy Kan.
44 D. Talbot. The Internet is broken. MIT Technology review, Dec 2005. http://www.technologyreview.com/InfoTech-Networks/wtr_16051,258,p1.html
45 Federal Trade Commission. Consumer Fraud and Identity Theft Complaint Data January-December 2005. Consumer Sentinel Project Team, Washington, DC, Jan 2006. http://www.consumer.gov/sentinel/pubs/Top10Fraud2005.pdf.

Coherence and rationale

The TIN cluster implements part of the strategic research agenda of the ICT Innovation Platform '*Veilig Verbonden*'. The TIN cluster addresses challenges to creating 'trusted Internet environments' where security and privacy in all societal and economic activities are secured. This cluster specifically focuses its efforts on the areas well-being and safety.

Key questions

ICT security is a very broad domain. TIN focuses on a limited number of critical issues which underpin trust in virtual worlds such as the Internet.

Question 1: How can design protocols and secure platforms be designed for managing identity trust and accountability in the virtual world?

This involves issues such as partial identities, attributes, portability and (un)linkability.

Question 2: How can (dedicated) security be built into the system right from the start, rather than as an afterthought?

Question 3: How can new high-impact ambient applications be developed that allow the user to remain in control as a sovereign individual?

This concerns transforming the answers to Question 1 and 2 into platforms for developing Internet-based and pervasive applications which allow the user to remain in control as a sovereign individual. In addition to the technical aspects, usability, legal compliance, societal acceptance and economic viability are key issues.

State-of-the-art

Unique identification numbers (e.g. credit cards, social security numbers) and storage of sensitive data are everywhere. With the explosion of Internet-based services (e-services), privacy, accountability and identity management have therefore become urgent problems. Identity fraud and leakage of private data are the fastest growing crimes. For instance, Karin Spaink et al. were successful in capturing (with permission) the data of more than a million patients, which underlines the importance of ICT security in general and Internet security in particular. Current solutions to these problems are rudimentary in nature. EU initiatives such as PRIME and TAS3 address privacy, identity, trust and accountability management,

Figure 16

but mostly just patch the problem without fundamentally solving it. The open issue is how to integrally approach the problem – e.g. join identity and trust management – and the trustworthiness of the infrastructure.

Key research questions

How can we develop an Internet-based infrastructure which supports fixed, nomadic and mobile access that relieves users from the headaches of today's security management? Which overlay architectures are needed to provide flexible yet secure solutions? What are the generic properties of the middleware for application (in the areas of well-being and public safety) that build on such overlay architecture?

Main technological topics

These research questions lead to projects that search for knowledge, know-how and experience in the following fields:

- Design of trusted gateways and overlay networks (see figure) on top op the regular Internet [project 1]
- Design of trust and identity management layer [2]
- Security and privacy of sensitive data in remote health monitoring and care [3]
- Privacy protected matching and membership in virtual communities [4]
- Strengthening the trustworthiness of public camera monitoring systems [5]

Societal relevance

The right to respect for private and family life, home and correspondence are deeply rooted in the European Convention on Human Rights, and has found its way into privacy and data protection legislation. Trust and protection of privacy on the Internet is an enormous societal issue. Significant numbers of individuals refrain from engaging in online worlds, social networks, education and transactions for fear of misuse of their personal data.

At the same time, potential social services such as those related to healthcare are not offered because of lack of security. Instead, services are often developed that require individuals to disclose abundant amounts of personal data. This only aggravates user unease. This cluster will seek to close the digital divide and empower users by building systems that are secure and trustworthy.

Economic relevance

In 2008, 7.5 million Dutch people between 16 and 74 years old shopped on the Internet. Together with Denmark and the UK, the Netherlands leads Europe in online shopping[46]. This makes the Internet an attractive platform for crime. While initially attackers where lone individuals, modern attackers are professional criminals, increasingly tied to organized crime. The 'quality' of attacks is growing sharply. The 2007 Enisa report[47] shows that the average annual loss per enterprise due to computer crime was USD 300,000. A recent report from the European statistics office states that 'nearly a quarter of Internet users had had a computer virus in the preceding 12 months, which resulted in a loss of information or time. In the Netherlands, 20% of the Internet users suffered from virus attacks and lost time yielding a productivity loss of a staggering 2 million hours per year. According to the Ponemon Institute (2007), the loss of customer records costs € 47 per record in the UK (€ 1.4 million per incident) and $ 197 per record in the US. Main costs are related to loss of customers. The costs are higher for financial services companies, namely € 55 and $ 239. Records are mostly lost through lost or stolen laptops and memory sticks.[48]

Insufficient attention to consumer privacy jeopardizes the success of large IT projects and may even lead to the failure of a project. Recent examples in the Netherlands are abandoning of the system of electronic voting in national and regional elections; delay of the national system for electronic health records; criticism on the security of the DigID system; the Dutch OV-Chipkaart has been severely criticized for its security and privacy weaknesses. Industrial participants to the TIN cluster are among the world leaders in ambient and Internet-based applications. Security and privacy issues threaten acceptance of new technologies in which companies, such as those involved in this cluster, invest. The TIN cluster will lay the basis for safer and more trustworthy Internet-based personal applications, thus encouraging more widespread adoption of new services and technologies. It is in the interest of the Dutch economy that the adoption of these services progresses quickly and that an open market is developed where service providers can compete on fair and equal terms.

Consortium

The TIN consortium joins several major Dutch industries and SMEs active in the area of security and privacy. Academia in TIN includes leading researchers from the 3TU.NIRICT, Radboud Universiteit, UvA, VU Amsterdam and University of Tilburg, including an NWO pioneer laureate. Most academic research groups in the consortium were rated 18+ (out of 20) points in the last QANU research assessment. TIN also includes influential organizations such as the Waag Society, TNO-ICT and Roessingh Research and Development. TIN partners are leading participants in relevant European and international projects, including EU FP6 PRIME, FP6 SPEED, INSPIRED, FIDIS, NESSIE, 3D-FACE, EU FP7 Turbine, EU FP7 TAS3, PrimeLife; standardization activities like the Liberty Alliance, Continua Alliance and Health Level 7; and ENISA and several IFIP working groups.

Budget and projects

The budget is € 29 million for a total of 21 partners. The (non-)profit partners invest € 4.3 million and the knowledge institutions invest € 10.4 million. The cluster encompasses five projects with 30 work packages and hundreds of deliverables in the dimensions science, dissemination and exploitation. See the cluster plan for more details.

7.D Cluster ICT & Logistics and Mobility (ILM)

Motivation and domain

In the years to come, we will witness a dramatic growth in the demand for mobility, transportation and healthcare. In the Netherlands, this enormous growth of traffic (cars, trucks, trains, patients, containers, airplanes) has already started to create congestion and accompanying societal problems (pollution, global warming, traffic jams on our highways, congestion at railway stations, waiting lists in healthcare). These problems will continue to grow dramatically and will strongly affect the Dutch economy

46 De Digitale Economie, 2008, Centraal Bureau voor de Statistiek
47 Security Economics and the internal market, ENISA 2008, http://www.enisa.europa.eu/doc/pdf/report_sec_econ_&_int_mark_20080131.pdf
48 'New Ponemon Study Reveals the True Cost of a Data Breach in the U.K', http://www.symantec.com/about/news/release/ article.jsp?prid=20080225_02

in many respects unless action is undertaken. However, despite the recent successes of TomTom and despite the potential of ICT to solve mobility problems, the market for ICT systems and services for mobility in the Netherlands is growing slowly. Corvette and Dynamite will lead the way in a break truth in mobility solutions using ground-breaking R&D in ICT technology. Cooperative road vehicle systems are a key factor to improve the utilization of the road network. ICT promises solutions that can face these challenges successfully, but groundbreaking R&D is needed, based on intensive cross-fertilization of expertise and experience between academia, government and industry. Only in this way, the enormous logistic challenges can be faced in the years to come.

Coherence and rationale

The Netherlands holds strong academic positions in Operations Research, Operations Management, traffic and transport research and the ICT sector. It is a leading technology developer and has a world-class ICT infrastructure. The cluster includes the IIPs E-Quality and MAIS, and builds upon the expertise of BRICKS. Furthermore, the cluster joins leading research groups in the fields of transportation and distribution, and four flourishing research centers in the area of healthcare logistics that jointly cover all efforts in this sector based on hospitals as partners in this program. This puts the Netherlands in the unique position to face the large logistic challenges in the years to come by working together with the other clusters in the program: e-Science for modeling resources, CIN for content disclosure and consumer route mining, and CEI for integration. The partners in the cluster are the core of the Dutch mobility and logistics branch.

Key questions

The cluster concentrates on flow of goods, persons or vehicles alike, invoking ICT to alleviate the congestion in transportation and in healthcare. To achieve a breakthrough, integrated solutions are needed.

Question 1: How can ICT solutions be exploited and integrated in such a way as to reduce congestion and energy use, and improve local air quality and traffic safety?

Question 2: How can ICT be exploited to enhance the efficiency of logistic processes in the transport and distribution sector?

Question 3: Can congestion in the healthcare chain be reduced by efficiently planning the logistics process for patients and available resources, providing high-quality healthcare at affordable costs?

State-of-the-art

The main research programs that are addressing the application of cooperative road vehicles systems are SAFESPOT (focused on traffic safety), CVIS (focused on traffic efficiency) and COOPERS (focused on motorways). The Dutch contribute significantly to these projects (TNO, Vialis, Peektraffic, Logica, Technolution, ARS, Province of Brabant and Rijkswaterstaat) and there are many test-sites in the Netherlands.

Container transport is the lifeline of global supply chains. The Netherlands mainports (Rotterdam harbor, Amsterdam Airport Schiphol) play a crucial important role in the global supply chains, and provide the basis for much of the commercial activity in the Netherlands. Currently, the main research programs that are addressing the application of cooperative road vehicles systems are SAFESPOT (focused on traffic safety), CVIS (focused on traffic efficiency) and COOPERS (focused on motorways). These projects have a significant contribution by Dutch partners (TNO, Vialis, Peektraffic, Logica, Technolution, ARS, Province of Brabant and Rijkswaterstaat) and test-sites in the Netherlands. Container transport is the lifeline of global supply chains. The Netherlands mainports (Rotterdam harbor, Amsterdam Airport Schiphol) play a crucial important role in the global supply chains, and provide the basis for much of the commercial activity in the Netherlands.

Key research questions

The main barrier in ICT for mobility, transportation and healthcare is the absence of 'orchestration' of the multitude of individual service providers of ICT systems, and the lack of systems to facilitate this coordination. How can we exploit and integrate ICT solutions to improve efficiency so as to reduce congestion, energy use and use of resources, to improve local air quality and traffic safety, to reduce delay in transportation, and to improve planning to provide high-quality healthcare at affordable costs?

Main technological topics

These research questions lead to projects that search for knowledge, know-how, and experience in the following fields:

- Develop and implement tools for efficient and cost-optimal traffic management, and development of roadmap for mobility
- Develop models to determine the optimal role of the Dutch main ports in global supply chains, and development of methods to realize reliable transport and distribution services
- Develop techniques for efficient realization of sustainable healthcare by enhancing efficiency of health logistics and optimizing care/cure pathways

Societal relevance

The Mobility Policy document[49] assumes a 35% increase in passenger car kilometers, 75% in freight traffic and 100% in travel delays from 2000 to 2020. The current societal cost of congestion amounts € 3 billion per year, or 1% of GDP. In the Netherlands, there are 800 fatal accidents per year, costing society € 9 billion annually. In the EU, 200,000 people die prematurely because of bad air-quality. A recent study[50] has shown that in the coming 10-15 years, new ICT systems and services in traffic management, traffic information and intelligent vehicles can lead to a 50% reduction in congestion, 25% reduction in traffic fatalities, 10% reduction in CO_2 and 20% reduction in air pollution. This is equivalent to € 2-3 billion per year. The Netherlands is seeing five major trends in healthcare[51]: (1) introduction of competition; (2) aging population; (3) increased chronic illness; (4) patient-centered care; (5) innovations. The sector is moving from supply-driven to demand-driven. At the same time, induced by the introduction of competition, care providers increasingly tend to specialize. Technological and treatment innovations are continuously being developed and introduced, further increasing expenditures. Cost-effectiveness analyses are often lacking, as well as analyses of the impact on the entire care pathways of patients.

Economic relevance

The European Road Telematics Implementation Coordination Organization (ERTICO) estimates the potential annual market volume of ICT systems and service for mobility in the EU in 2010 at € 21 billion, compared to € 1 billion in 2000. In the EU, 18 million cars were registered in 2007. Equipping 10 million cars with an ICT system that combines personal travel guidance and foresighted driving at a cost of € 1000 each, yields an annual turnover of € 10 billion. Given the strong position of the Dutch industry in the field of navigation and traffic, an annual turnover of € 1 billion is a realistic estimate. In the rail sector, ProRail has invested € 20 million per year on the design of new interlocking systems in the Netherlands. ProRail expects to invest € 200 million per year over the coming 25 years in the development of new systems and replacement of new equipment.

The transport and distribution sector (including Amsterdam Airport Schiphol and Rotterdam harbor) is responsible for 6% of GDP, employing 450,000 or over 11% of the total employment in the Netherlands. Rotterdam harbor alone contributes 12% to the Netherlands' export added value, and Schiphol has been recognized as the world's most innovative airport. Growth predictions suggest an increase in air transport (number of aircraft, number of passengers) in 2020 by a factor of three compared to 2002. Despite these strengths, however, the sector will face strong competition from Eastern European countries in the future. Staying at the front-end of competition in this industry will boost the Dutch economy and create a massive source of employment in the Netherlands in the years to come.

Healthcare expenditures amount to 11% of GDP and are expected to grow to 15-20% of the GDP by 2020[52]. In addition to the costs, the anticipated lack of resources (including staff) and increased waiting lists as a result prompt the healthcare sector to improve its efficiency. More efficient medical treatment may alleviate part of this problem, but will not remove the waiting lists. It is the efficient planning of care that reduces waiting times; healthcare logistics balances the request for and availability of resources.

Consortium

The ILM consortium is a well-balanced mix of academic and (non-)profit partners, including major Dutch companies and SMEs active in the area of logistics and mobility. The consortium also includes major healthcare institutes such as VUmc, LUMC, RIVAS, CZ, MST and MaximaMC. Academia in ILM includes leading researchers from UT,

49 V&W (2006), Mobility Policy Document, Part IV, Officially Adopted Policy Document, June 2006.
50 Arem, B. van, B. Jansen & M. van Noort (2008), Slimmer en beter: de voordelen van intelligent verkeer, TNO Report 2008-D-R0996/A, October 2008, Delft (in Dutch).
51 Werkdocument Innovatieplatform, 2007.
52 Brochure 'Niet van Later Zorg', p. 100, Min VWS 2007, http://www.ggzbeleid.nl/2007/1322.pdf.

TUE, TUD, CWI and VU. The consortium also includes influential organizations such as TNO, the National Aerospace Laboratory and Roessingh Research and Development. Consortium partners are leading participants in relevant European and international projects.

Budget and projects

The budget is € 70 million for a total of 53 partners. The (non-)profit partners invest € 27.5 million (of which € 10.5 million from the ministry of V&W), and the knowledge institutions invest € 14.5 million. The cluster encompasses 10 projects with 70 work packages and hundreds of deliverables in the dimensions science, dissemination and exploitation. See the cluster plan for more details.

7.E Cluster e-Science

Motivation and Domain

Our society – business, science and industry alike – is rapidly and progressively becoming more complex. Our world has developed into a networked society offering anyone access to any information resource. The main motivation behind the e-Science cluster is to harness the complexity arising from the abundance of data and information resources in order to elevate the electronic infrastructure to the next level. Science has always been at the forefront of networked electronic developments, because restrictive boundaries in understanding have to be shifted to make new discoveries possible (like the World Wide Web at CERN). In this e-Science cluster, we intend to continue creating a competitive environment for R&D in science and industry based on VL-e.

Coherence and rationale

We intend to develop software-based concepts to be integrated in the e-Science research infrastructure. Existing collaborations with SURFnet, innovation push on optical networking and the Netherlands Bioinformatics Center NBIC and innovation pull on high-throughput DNA-sequencing will help bridge the gap between the network infrastructure in the Netherlands and innovative applications in biology, biomedicine and pharmacology. We intend to realize two experimentation environments for e-Food and e-Biobanking, among other applications with the Top Institute Food and Nutrition and the Top Institute Green Genetics, as part of their Food and Flowers theme. The e-Biobanking environment will be set up in collaboration with the Pearl String Initiative, the Biobanking and Bio-molecular Resources Research Infrastructure (BBMRI-NL) and NBIC under the umbrella of the Netherlands Genomics Initiative (NGI) FES application. To secure the knowledge infrastructure further, we intend to make the research work in this cluster part of an e-Science Research Center (e-SRC).

Key questions

In modern science, engineering and society, we are increasingly faced with complex problems that cannot be studied independently. They can only be understood in the context of the entire system to which they belong. The study of these types of problems is often called system-level science, as best described by Ian Foster: '*the integration of diverse resources of knowledge about the constituent parts of a complex system with the goal of obtaining an understanding of the system's properties as a whole*'. Examples of system-level science include study into the origin of the universe, the study of the fundamentals of matter in physics, cell function, biobanking and environmental studies. e-Science is in fact the computer-driven innovation of instrumental and experimental sciences. It ensures progress in governmental and industrial R&D and thus has an enormous socio-economic impact. As system-level science and its enabler e-Science are multidisciplinary activities, the key success factor is to define application-driven problems.

Question 1: How can we design, develop and build an adaptive e-Science environment that enables global collaboration in key areas of science in a flexible way?

Modern science accelerates the explosion of data now in many sectors of science due to instrumental developments (fMRI, PET, MEG, in medicine, mass spectroscopy and DNA sequencing in genomics, digital libraries in humanities). By nature, data is distributed. Today, the complexity of this data is increasingly higher and consequently semantically richer.

Question 2: How can we establish an e-Science environment that is capable of handling the data explosion, its distributed character, abundance and complexity?

In addition, e-Science has to develop computer techniques to handle and harness the complexity arising from system-level studies. Distributed data and information resources have to be integrated.

Question 3: How can we manage complexity via integration, both at the application level and at the generic e-Science level?

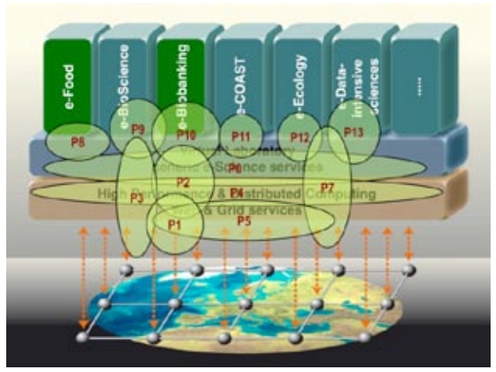
State-of-the-art

Current e-Science systems lack the flexibility and adaptation needed for multidisciplinary research. Added to this, the amount and complexity of the (distributed) data that scientific instruments and simulations generate is becoming unmanageable. In the VL-e project, we learned that focusing on generic methods and tools resulting in reusable software components helped accelerate multi-disciplinary e-Science research. Based on these concepts, the Rapid Prototyping environment for experimentation with generic e-Science tools and the Proof of Concept environment to experiment with new e-Science applications were created.

Main technological topics

The key research questions are addressed in projects which represent both the technology push and the application pull. On 'generic e-Science services', seven projects (I to VII) are formulated, led by computer scientists in collaboration with application scientists, aiming to develop generically useful methods and tools. These tools focus on data, information and knowledge, visualization and high-performance distributed processing techniques, and on the workflow tools needed for integration as well as for security and system engineering. On the application level six projects are defined (8 to 13), which address aspects that drive the specifications for an e-Science environment. All domains rely on and suffer from the data explosion, complex computational requirements, information management, security needs and the need for advanced collaboration tools. The figure shows how the projects are mapped on the components that form the e-Science environment. We intend to demonstrate efficiency enhancement in research.

Figure 17



Key research questions

Discovering and sharing knowledge in the form of experimental data, theory-rich vocabularies and reusable services is essential in e-Science. Fundamental research on knowledge systems and services is needed to allow us to move to a semantic grid. We will address the demands on an e-Science environment along the full technology chain. This means distinguishing a new abstraction level, which we define as domain (or application) generic. We will not restrict ourselves to research prototypes only, but in selected cases, we will build a full-scale application environment.

Societal relevance

For many of the topics relevant to climate change, energy, water, healthcare and security, e-Science research acts as an enabler. Together with projects like full genome sequencing, e-Science impacts the diagnosis and treatment of many illnesses, including cancer. Other examples include flight safety, a portal for biodiversity and an early warning system for food quality. The prototype knowledge-discovery system that was developed in VL-e formed the basis of a decision of Unilever to adapt and standardize their knowledge-discovering research methodology. Moreover, the application domains as represented in the work plan (notably health care, food, ecology and chemistry) are of great socio-economic importance.

Economic relevance

Industry and public R&D are moving towards the necessary networked research model. To achieve this, the concept of e-Science is quintessential. According to the 'Wetenschaps- en Technologie-indicatoren 2008' of NOWT, Dutch national spending of R&D in 2005 was € 8.8 billion, of which 60% was spent by the business community. Almost 75% of this budget comes from Philips, ASML, Akzo Nobel, NXP, Shell, DSM, Océ and Unilever – spending more than € 2.7 billion on R&D. An excellent state-of-the-art national ICT infrastructure with related e-Science tools, concepts and applications enables not only academia, but also companies to improve the results of their R&D endeavors. The sheer size of R&D spending indicates that any increase in efficiency and effectiveness justifies investments in e-Science research. Current world-wide developments convincingly point towards the growing importance of ICT applications

in real life and towards the creation of a global networked economy. These developments imply an increase in the knowledge intensity of economic processes. Strengthening productivity growth in the Netherlands requires improved access to resources and an increase in the knowledge intensity of economic processes. e-Science can enable the Netherlands to play a leading role in ICT-based research and development and to be at the forefront of international developments. It provides a means for knowledge import which is essential to speed up the R&D cycle. The main reason for a government grant is to prevent knowledge to 'leak away', and to create positive knowledge spill-over.

Achieving a top position as a knowledge economy means competing on scientific and economic markets. This can only be achieved when the scientific community in the Netherlands has the best ICT research infrastructure at its disposal. e-Science will enhance the research ICT infrastructure and can tackle a major bottleneck in the sector: limited transfer of research into the business world, caused by the low volume of ICT research in the knowledge infrastructure relative to its economic importance. This program will address these issues simultaneously. It will increase research with high pay-off potential, and ensure interplay between various market parties and dissemination of knowledge.

Consortium

This cluster increases research on knowledge infrastructure with high pay-off potential, and ensures interplay between various market parties and dissemination of knowledge. The e-Science research consortium consists of 10 scientific partners, nine profit and five non-profit organizations. The profit organizations vary from very large companies to very small high-tech companies. The consortium is a well-balanced representation of organizations that all need e-Science tools and methodologies for (system-level) research and/or for coping with the data explosion. Some of the partners represent a complete sector of industrial activity, such as Top Institute Food and Nutrition (food and nutrition industry) and Top Institute Green Genetics (flower industry) TI-COAST (Analytical Chemistry).

Budget and projects

The e-Science budget is € 32 million for a total of 13 partners. The (non-)profit partners invest € 5.5 million and the knowledge institutions invest € 10.5 million. The cluster comprises 13 projects. See the cluster plan for more details.

8 Overview of COMICT projects

Project	Title	Objectives	Deliverables
Cluster Content and Interaction (CIN)			
CIN I	Interactive exploration in forensics	Dashboard to extract and manage by intuitive interactive exploration large volumes of forensic data	Software and demonstrators for storing, exploring and visualizing digital multimedia traces and intelligence data
CIN II	Multiple worlds	Create a multiple virtual and real world for enhanced interaction and exploring business opportunities	Technology, demonstrators and user evaluation of affective cr3owded virtual worlds evaluated in business innovations
CIN III	Signaling events for business i-services	Develop support of business information services by signaling events in large textual and multimedia files	A web-based demonstrator for business intelligence techniques using both news- and video-feeds
CIN IV	Lifestyle for consumer well-being	Develop novel ways for ambient sensing for body and context signals to create quality of life experiences	Demonstrators for care and well-being, immersion and relaxation, unobtrusive sensing of emotions
CIN V	Interaction and universal access	Interaction for natural and universal access evaluated in education and cross-cultural settings to engage all	Demonstrators for natural and context-specific interaction evaluated in a variety of public places
CIN VI	Linked content for cultural heritage	Develop access to curated and socially-tagged collections aimed at personalized access (for tourism)	Web-based infrastructure to demonstrate non-curated content management and object identity resolution
CIN VII	Spatiotemporal spaces for mobile societal networks	Monitoring of virtual social networks and real world mobility for quick response and planning	A reference architecture for monitoring and mining geospatial events for dynamic routing and viral computer infection
CIN VIII	Sensor data management for well-being	Wellness in home environments through serious toys and sensor data technology	An open-source sensor data system with evaluation using prototypes for wellness and cognition development

Continued
Cluster Content and Interaction (CIN)

Project	Title	Objectives	Deliverables
CIN IX	Social enrichment for the media business	Access to large digitized archives of media by machine and collaborative labeling	A community-driven search engine for consumer and professional use
CIN X	The intelligent workplace	A context-sensitive workplace for nomadic knowledge workers fed by intelligent document retrieval	A workplace demonstrator for data enrichment; evaluation of the techniques using empirical evaluation in concrete business settings
CIN XI	Citylabs for safety, security and care	To combine intelligent systems with an innovation of the research process itself	Knowledge tools for security in the city of Tilburg; systems for healthcare decision-making ; digital life applications
Cluster Cooperative Embedded Intelligence (CEI)			
CEI I	*SmaRTEr* Sensor Networks for Real-Time Enterprise in Transportation	Exploit and integrate wireless sensor networks technology as a key ICT technology in the business processes of transportation companies to enhance their performance and to reduce their operational costs	Integrated solution for distributed real-time planning in transportation companies using sensor network technology and advanced tools for real-time enterprise
CEI II	*Allegio* Alter Lego for Evolvability and Guaranteed Inter-Operability of Complex Medical Systems	Design and (formally) verify complex medical systems (cardiovascular X-ray) that are highly evolvable and incorporate (reusable, legacy) third party subsystems	Replaceable components in a cardiovascular X-ray system
CEI III	*Cosinus* Embedded Cognitive Systems for Industrial Safety	Development of industrial monitoring and inspection platform consisting of sensing devices attached to human operators, machines, inspection robots and their environment, aiming at safety of the industrial system, and of the workers in that system	Gas pipe inspection which combines environment sensing and event detection
CEI IV	*Wings* Predictable and adaptable embedded control for high-tech systems	Develop multidisciplinary model-based design approach for embedded control systems of high-tech mechatronic systems	Prototype implementation of the embedded control system of the ASML wafer stage subsystem outperforming the current design by at least 50%
CEI V	*Metis* Cooperative Systems-of-Systems for Situational Awareness in Public Safety and Security	Reliable, compatible (architectures) and intelligent reasoning in inevitable cooperation with standalone security systems for specific application areas	Crisis situation handling in critical infrastructure (harbor)
CEI VI	*ParSec* Hierarchical and Self-configuring Sensor Networks for Public Safety and security	Processing and fusion of information in hierarchical and heterogeneous sensor networks to detect unexpected events in public spaces	Intelligent cameras and lighting for roads and public transport

Continued
Cluster Cooperative Embedded Intelligence (CEI)

Project	Title	Objectives	Deliverables
CEI VII	*Swell* Smart Reasoning Systems for Well-being and Well-working	Support adaptive and intuitive behavior in person-centric applications by providing distributed reasoning capabilities and easy personalization of the application behavior in a privacy-sensitive way	Pilots in real-life settings and evaluation of the well-being and mobile office applications' adaptability and intuitiveness capabilities for personalization and privacy control
CEI VIII	*EWIDS* Extreme Wireless Distributed Systems	Develops algorithms, designs and implementations to bridge the gap between low-level extremely large (sensor/actuator) networks and applications	Proof-of-concept in field of lighting atmosphere or social networks
CEI IX	*CCNP* Cooperative and Cognitive Network Platforms	Create a secure, dependable and performant communication infrastructure which is a hybrid ad-hoc and infrastructure-based network that is self-configuring and dynamically adapts to the context in which it operates	Integrated CCNP platform and proof-of-concept prototypes including extended physical network interfaces that embrace local and global sensory and context data
CEI X	*Knowledge Consolidation*	Establish and compose the basis for the successful reuse of knowledge, with the aim to create a significant research investment multiplier	Empirical studies on generalization methodologies; generalization of specific software tools and re-application in different domains; knowledge and tools packages
CEI XI	*Knowledge Dissemination*	Underpinning of open innovation ecosystem by disseminating cluster knowledge to market sectors via articulation of needs and transfer of solutions	Yearly CEI symposium, sector workshops and technology scans

Cluster Trusted Internet (TIN)

TIN I	Privacy Aware Trust and Identity Management	To lay the basis for realizing identity management and trust management systems that strike the right balance between trust and authentication	A revocable privacy mechanism in the architecture, allowing users to be sure that their data is secured, together with a fine-grained distributed trust management system that allows users to be in control, and manage not only their own identity-related data, but also their personal policies that govern the use of such data by other parties
TIN II	Secure Communications for Trusted Interactions	To design, implement and test methods for creating a secure communications layer on which higher-level security applications, mechanisms and policies can be built	Open-source software which realizes a secure overlay on top of the existing Internet. The software consists of a specially designed high-integrity Security Gateway (SG) called the Nymbus which manages security issues related to Internet access

Continued
Cluster Trusted Internet (TIN)

Project	Title	Objectives	Deliverables
TIN III	Security and Privacy for Home Healthcare	To provide tools for users to trust home healthcare services dealing with very personal and private information	A system which helps automatically measure the trustworthiness of a service in a provable way, and to enforce the use of information according to user-approved policies Also, contributions to standards in the area of healthcare and ambient assisted living (eg, Continua or HL7)
TIN IV	Privacy and Trustworthiness Protection in Virtual Communities	An open standard implementation and demonstration of generic privacy-protection protocol for virtual community building and maintenance	Specialized applications of the virtual community protocol for particular scenarios of the industrial partners, namely: self-help communities, content recommender engines and connecting virtual and physical communities using RFID devices
TIN V	Security for Public Safety	Increasing public safety by reducing the operational cost of camera surveillance and strengthening the trustworthiness and public acceptance of such a system	Technologies that allow for better recognition and observation of people and potential risks or dangers that can be integrated in Internet-based camera surveillance systems These technologies are protected against malicious attacks and are designed to protect the privacy of individuals in the areas under surveillance as much as possible

Cluster ICT & Logistics and Mobility (ILM)

ILM I	*Dynamite* Dynamic cooperative traffic management	Development of overall architecture and roadmap for the use of ICT mobility, and development and evaluation of innovative applications for advanced routing algorithms, personal travel assistance, traffic management and foresighted driving	Overall architecture and roadmap for the use of ICT mobility, and demonstration of innovative applications for advanced routing algorithms, personal travel assistance, traffic management and foresighted driving
ILM II	*Corvette* Cooperative Road vehicle tools, testing and evaluation	Development and evaluation with respect to technical and non-technical aspects of large scale applications of cooperative vehicle systems and in-car systems, based on Field Operational Tests	Field Operational Tests and facilities for Cooperative Adaptive Cruise Control (Helmond/Eindhoven), Regional traffic management (Delft) and Interurban traffic management (Rotterdam-Antwerpen)
ILM III	*ConLog* Logistics of the global container supply chain	Development of coordination models and software to model the integrated container supply chain, development of coordination mechanisms across the partners in container supply chains	Performance measurement system for container supply chain, supply chain software, implementation of agent-based algorithms for container supply chains
ILM IV	*Pluto* Planning of last-minute and uncertain transportation orders	Development of methods for forecasting transportation orders, and for allocation and reallocation, development of methods for adaptive replanning of orders	Simulation-driven system for prediction-based adaptive planning of transportation orders

Continued
Cluster ICT & Logistics and Mobility (ILM)

Project	Title	Objectives	Deliverables
ILM V	*INPACT* Integrated Planning of Airports and Cargo Revenue Management	Development of models for integrated Total Airport Management, development of models and methods for robust gate assignment, development of models for optimal location of regional airports, development of decision models for cargo Revenue Management	Prototype tool for integrated Total Airport Management; prototype tool for robust gate assignment; DSS for optimal location of regional airports; DSS for cargo Revenue Management
ILM VI	*LogNets* Dependable large-scale ad-hoc networking techniques for logistics	Development of techniques for exchanging information in logistic networks to increase efficiency, development and analysis of models for flows of goods, and to optimize the handling of goods; models and methods for efficient message dissemination; models for efficiency of distributed random access protocols with many low-power nodes	Scenarios, use cases and prototype implementations of the models and techniques developed
ILM VII	*Choirmaster* Health pathways optimized for all providers	Optimization of inbound patient flows, optimization of outbound patient flows between hospitals and different types of care organizations, realization of transmural health pathways throughout organizations	Inventories of organizational problems regarding transmural patient logistics; prototype decision support systems for logistical performances; optimization tools for optimal capacity dimensioning within care networks; inventories of organizational bottlenecks for implementation of tools; various dashboard applications for tracking patients; web demos, and many others
ILM VIII	*PICA* Logistics for hospital and emergency care chains	Identification of organization problems in emergency care chains, performance evaluation of current organization structures for emergency care chains, development of models for clinical pathways in the operating theatre, identification of optimal hospital-wide case-mix, development of methods for efficient planning of ambulance services	Overview of organization problems in emergency care chains; models for current organizational structures for emergency care chains models for clinical pathways in the operating theatre; DSS for optimal hospital-wide case-mix; DSS for efficient planning of ambulance services
ILM IX	*T&T* Tracking and tracing of medical supplies in hospitals	Development of models for advanced asset management of medical supplies in hospitals, development of models for assessing the value of information of medical supplies	Four golden case studies of the models based on practical implementation
ILM X	*AALAP* Automated appointment logistics and admission control for in- and outpatients	Models for patient appointment planning, both for inpatients and outpatients, development of multi-agent systems for decentralized adaptive planning based on forecasts	Agent-based simulation systems for appointment planning; DDS for dynamic planning and admission control

Cluster e-Science

Project	Title	Objectives	Deliverables
e-Science I	Scientific data management	To develop novel data access, management techniques and database architectures to cope with data volumes, the necessary algorithms, and the required response mechanisms to the analytical questions set by end-users, in particular using the MonetDB platform	Improvement of the MonetDB platform for dissemination in the open-source community, evaluated against real-life science cases drawn from astronomy
e-Science II	Information and knowledge management	To move from a data-centric view to a semantic grid with a powerful set of knowledge services, providing support for different steps in the e-Science cycle: how to provide and use data on the web and how to provide results	An efficient, cost-effective, trusted and low-entry barrier infrastructure that can be used by working scientists in a large variety of disciplines
e-Science III	Visualization	To visualize large data sets, both user-driven and through knowledge assisted automation, such that only semantically meaningful data is presented	A visualization facility that can incorporate remote computational and graphical resources, made available through interactive displays that provide low-threshold, efficient and user-friendly access to these resources, including high-resolution tiled-panel displays and multi-touch surfaces
e-Science IV	Computing and resource management	Study fundamental problems for running data-intensive e-Science applications on large-scale hybrid systems (consisting of different types of novel processor architectures), taking performance and energy-consumption into account	Tools with which data-intensive applications can run efficiently on a wide variety of possibly inter-operating emerging grid and cloud systems that use various modern processor types
e-Science V	e-Science infrastructure engineering	To engineer a collection of e-Science infrastructures that can be programmed and tuned to provide a deterministic performance to the applications	A programmable e-Science architecture consisting of a framework that is able to describe the infrastructure components; algorithms that optimize the ICT for typical usage scenarios; programming interfaces to configure the ICT services; a distributed system supporting modern hybrid processor architectures and an advanced optical wide-area interconnect
e-Science VI	Workflow management and application integration	To address key issues in workflow management: semantic support, reproducibility and interoperability	Improvement of workflow services and their enhanced reusability
e-Science VII	Reliability and security	To improve the reliability, stability, availability and security of the e-Science infrastructure by collecting failure modes, monitoring data and log information and by applying software techniques to analyze and correlate data	A coherent reliability framework aiding the production-level e-Science infrastructure in the Netherlands, with intermediate results benefitting end-user scientists
e-Science VIII	e-Food & Flowers	To remove the thresholds that exist in providing and reusing knowledge fragments in (agri)food research, and to improve the quality of this information	A set of ontology construction and vocabulary services, assisting researchers in the context of (agri)food research

Continued
Cluster e-Science

Project	Title	Objectives	Deliverables
e-Science IX	e-BioScience & life sciences	To translate current e-Science know-how (infrastructure, methods, tools and expertise) into a functional e-bioscience environment for transcriptomics	A problem-solving environment (PSE) for transcriptomics
e-Science X	e-Biobanks: from Storage to Knowledge	To establish an e-Science application platform with a high degree of transparency and dissemination within different collaborations in the Life Sciences, showing the versatility for imaging in healthcare research, ranging from efficient organization of presentation logistics to in-depth scientific analysis of experimental data	A Dutch virtual tissue bank, accessible to healthcare researchers, bringing together MRI imaging at the organism level, tissue microarray proteomics data, proteomics data on patient material and molecular histological datasets obtained with imaging mass spectrometry (IMS)
e-Science XI	e-COAST & analytical science	To develop in the context of analytical sciences tools for real-time remote control of high-end instrumentation and tools for data processing and high-level data interpretation	A prototype remote experimentation environment that will be employed to assess usefulness, user convenience and user acceptance in practical situations
e-Science XII	e-Ecology	To deal with the massive amounts of and heterogeneous character of ecological data originating from a variety of sources and geographically distributed information systems	Virtual laboratories for ecology, in particular a contribution to the design of the European ESFRI-LifeWatch infrastructure for biodiversity information
e-Science XIII	e-Data-intensive sciences	To improve management of large distributed datasets from a user point of view and to provide optimum access to petabyte-scale data sets	Efficient data management and data access in large scientific datasets