ICTRegie
Netherlands ICT Research and Innovation Authority

Synopsis of ICT2030.nl

ICT agenda for the future of the Netherlands

Version 1.0

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Acknowledgements

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Realisation	The ICT2030.nl agenda has been realised in collaboration with a large number of parties: the ICT Research Platform Nederland (IPN), the ICT industry association ICT~Office, the CIO Platform Nederland, ECP-EPN, the Confederation of Netherlands Industry and Employers (VNO-NCW; committee technology and innovation) and the ICT Innovation Platforms (IIPs) at ICTRegie. Surveys were taken among the backers of ICTRegie, ICT~Office and CIO Platform Nederland, and a number of major decision-makers were interviewed. Finally, the ICTRegie advisory groups also played a major part here (the advisory council and also the advisory group on social questions).	

1. The role and significance of ICT for a sustainable society

The Netherlands has ambitious objectives: it wants to be competitive, innovative and pioneering, with an international influence, and also wants to find solutions to issues such as climate change, ageing of the population, depletion of raw materials and traffic gridlock. This all requires a joint approach, with a view to achieving innovative solutions in a number of different sectors. The accent has to shift from continuous growth to sustainable development. Not just more, but rather smarter and better; better for us, for succeeding generations and for our planet. Information and Communications Technology (ICT) has a vital role to play in achieving this. The proper performance of that role demands intensive collaboration among all of the players concerned, so that we can achieve cross-sectoral innovations of a sustainable nature. This is what we describe as an ICT innovation ecosystem.

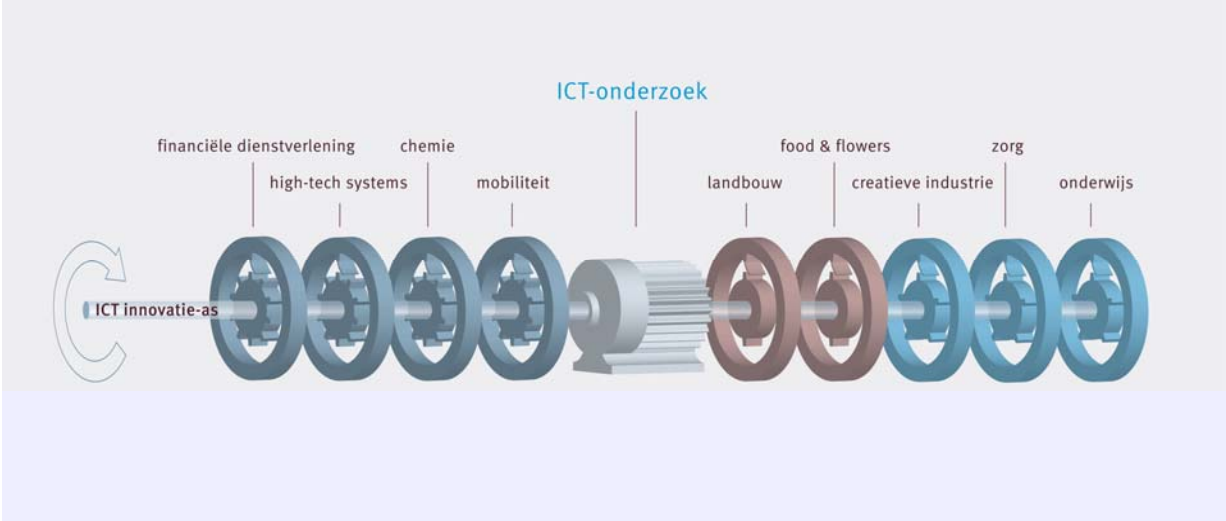
1.1. Government vision

In June 2008, the Dutch government provided its vision of the future, up to 2030, in the paper entitled ‘Towards an agenda for sustainable productivity growth’. The report outlines a prosperous, internationally competitive, healthy and safe Netherlands, fully prepared for the changing climate and doing everything possible to secure the sustainable development of the living and working environment; a country where it is both attractive and safe to live for young and old alike, where there are no mobility problems and where there is good social cohesion.

Every faction, industry and discipline within society will have to set its own agenda and harmonise its own contribution with the national objectives. In the present ICT2030.nl agenda, this is realised from the ICT perspective. The accent here is not primarily on applications, as was the case in the ICT Agenda 2008, but on boosting innovative potential and on the sustainable development of ICT itself. Sustained efforts in the development of ICT will contribute to the realisation of the objectives set, so that ICT2030.nl shall ultimately facilitate the implementation of part of the government’s strategy.

1.2. The importance of ICT

ICT is successfully applied in economic key areas and also in social sectors, such as care and mobility. This range of applications creates the possibility of strong increases in productivity. ICT creates new markets for established operators and opens up existing markets to new players. In this context, ICT operates as an axis of innovation; a pivot running through the sectors, prompting innovation.



ICT as an axis of innovation driven by ICT research

An axis of innovation is, however, of little value without an engine to drive that axis. Another indispensable element is the transfer between the axis and those parts (sectors) it transects and that must be set in motion. Hence, to gain maximum benefit from the opportunities afforded by ICT, we not only need smarter applications of available ICT, but also good research, as well as the development of new opportunities. This is the only way to keep the axis turning. The connection between ICT and the application fields is essential, and leads to new challenges and ideas. This requires intensive interaction among all of those involved in the innovation process: researchers, end-users, ICT companies, businesses and social institutions using ICT. This sort of ecosystem forms the basis for successful, ICT-driven innovations in products, services and processes.

1.3. The role of ICT

ICT transforms society. It facilitates new working methods, allowing us to do more with less. ICT has now permeated the bloodstream of society as we know it. Nowadays, no government department could function properly without ICT, no hospital or factory could operate effectively, transport would regress a hundred years, no one would be able to use the telephone and no one would be paid a salary. We no longer live *with* networks and *with* digital media, but *in* networks and *in* media.

Sustainable society. Although ICT is becoming a major energy consumer, it can also be applied to achieve energy savings, for example by using a 'smart grid' to more accurately harmonise the demand for and supply of energy so that sources and users of power are linked up more intelligently. Needless to say, progress towards a more energy-efficient ICT is still vital.

Efficient mobility systems. The influence of ICT on logistical processes and patterns of activity (teleworking, virtual offices, mobile working) is radically changing the patterns of traffic and transportation. ICT is used to manage and direct traffic and transportation flows (e.g. traffic management, vehicle and accident tracking). In the area of road traffic, ongoing, centrally directed developments are underway (panels beside and above the carriageways). There are also increasing numbers of personal information services (e.g. navigation and traffic jam reports), and progress is being made towards vehicles which communicate with each other and with the highway. ICT continues to make progress inside cars. Automatic distance warning is already available, and applications to enable mileage charges will be introduced in the near future. Communication between users, vehicles, businesses and highways managers will be distilled into cooperative systems, with prospects of safer, smoother and cleaner traffic and transportation.

Secure society. Security services operate within chains of information where ICT plays a crucial role: threats, scenarios and incidents are linked with information about risks, priorities and preventive local measures. Also, modern military activity requires connections between a wide range of weapons systems, sensors and command systems. Information files are linked in order to identify individuals and verify documents. ICT is used for observation, supervision and detection, allowing a proactive stance for the prevention of incidents. ICT is playing an increasing role during personnel training (e.g. the use of simulated environments and events). Provided that the privacy of those involved is preserved, and the ICT systems and information are or can be made secure, ICT offers a profusion of possibilities for making Dutch society more secure.
In addition to the many advantages, the application of ICT also throws up some hazards. Dependence on ICT systems renders us vulnerable, and people of evil intent can abuse the same systems to gain access to sensitive information. The concomitant risks must be thoroughly analysed and discussed. At the end of the day, this revolves around citizens having faith in the government and in the systems.

Efficient care systems. Within the network of a patient's carers, ICT is crucial for improving the efficiency and effectiveness of medical treatment. This might involve the sharing of knowledge, access to the relevant knowledge, decision-support systems and intelligent equipment. Furthermore, ICT enhances quality of life by allowing the option of telecare (at the patient's bedside), which uses advanced communication technology in combination with sensor technology. In the future, robots might even be able to help people with getting in and out of bed and washing (home care services).

Water management and quality. The use of real-time sensors and satellite data contributes to the reliability of predictions in the field of water management, so that the correct steps can be taken at the right time. ICT can also enable effective decisions to be taken in such circumstances. For example, in the Netherlands dyke and flood models have been developed with this in mind. These are used in either entirely computerised situations (e.g. a virtual exercise environment for dyke watchers), or in field experiments (e.g. at the IJkdijk in Groningen where sensors monitor dyke conditions).
There is increasing global demand for better solutions to water production, purification, recycling, distribution, and monitoring and, in more general terms, for sustainable water management. ICT has an important role to play here, in a number of ways, for instance using sensors and lab-on-a-chip technology to monitor water quality. Remote sensors, advanced online measurement methods and geoinformation systems are being applied to monitor the underground infrastructure in cities, and to carefully harmonise that infrastructure with the demands placed on it. Fast, online technology is needed to measure toxic materials and pathogens in water, or to establish the origins of pollution rapidly, so that measures can be adopted in good time.

Innovative education. Increasing numbers of ICT-based resources are being deployed in education, such as learning with the aid of simulation models, serious gaming, interactive intelligent learning modules, virtual instructors, interactive whiteboards at school, and distance learning. But the most important development facilitated by ICT is that of personalised learning, fully customised to the abilities, needs, aims and learning strategies of the individual student.

More efficient contacts between citizens and government. An improved disclosure of information allows the citizen to become more directly involved in the political decision-making process. For example, citizens can personally participate in and follow national debates via the Internet. One specific development is that of 'e-communities'. These new forms of interaction between citizens and government departments are changing the democratic process. The transition to various forms of e-government or public services goes hand-in-hand with organisational changes, and demands new knowledge and skills on the part of all those involved. Significant

factors to be dealt with here include transparency, participation, the tempo of change, effectiveness, cohesion and a multidisciplinary approach.

A healthy economy

ICT also plays an important role in the Dutch knowledge economy and the success of the key areas identified by the Innovation Platform. According to Statistics Netherlands, the ICT sector is making an important contribution to the Dutch economy. This relates not only to size (€31 billion turnover, 250,000 jobs, and more than 2750 ICT businesses), but also to growth: between 2001 and 2006, ICT was responsible for roughly 30% of the average annual growth in GDP. Turnover within the Dutch ICT market is increasing. Among companies who do their business electronically, the percentage of turnover from this source has increased to 15% of total turnover, whereas that figure stood at only 3% in 1999. However over the period 1996 to 2006, the contribution of the ICT sector to gross added value in the Dutch commercial sector lagged behind that of other countries.

2. SWOT analysis of ICT in the Netherlands

Strengths and weaknesses

Broadband (ADSL and cable) penetration in the Netherlands is very high, as is the domestic presence and use of computers and the Internet. The Netherlands is an important hub for the Internet (AMS-IX) and major fibre-optic routes (NetherLight). The commercial sector also uses ICT intensively. Internet banks and Internet payment systems are export products as far as the Netherlands is concerned. The research network SURFnet is regarded as the most advanced in the world. Public ICT research is tightly formulated and can be measured against the best in the world in terms of quality. We also enjoy a strong position in the field of high-tech systems, and more software is exported from the Netherlands than is imported. The government devotes specific attention to the use of ICT and acknowledges the technology as an axis of innovation.

The relatively small scope of public research is a weakness, certainly in comparison with other countries. The recognised importance of ICT is not being translated into an increase in the use of public resources. Industry spends a lot of money on ICT research and development, but the services sector is lagging behind in this. Implementation of research results (from knowledge to skills to cash) is not sufficiently well developed. The Netherlands is battling with a too small – and shrinking – supply of qualified ICT graduates at every level. The Dutch government is making active use of ICT (Tax & Customs Authority, government portal), although sometimes the steps it wants to take are too large (Electronic Patient File, mileage charges). Confidence in ICT diminishes as a result. Finally, willingness on the part of Dutch financiers to support small-scale ICT start-ups is limited in comparison with other countries.

Opportunities and threats

The advanced Dutch ICT research infrastructure and high penetration of broadband facilities, mentioned among the strengths, afford a wealth of opportunities. They make the Netherlands the perfect breeding ground for new forms of service provision. Not only can these lead to new models for exploitation, but also the desired improvement in labour productivity sought in the services sector. Moreover, this breeding ground increases the attractiveness of the Netherlands as a base for the knowledge-intensive activities of innovative foreign businesses.

The development of the European Union and the Netherlands into a knowledge economy offers considerable opportunities for the Netherlands, provided that the investment in ICT continues to be enhanced. The European Commission also recognises this; on 13 March 2009, it called on all Member States to double their investment in ICT research and innovation. Note this investment is not for ICT, but for the indispensable ICT innovation which contributes towards finding solutions to major social challenges.

The threats to ICT in the Netherlands arise from the difference in pace between Dutch developments and those occurring abroad. ICT initiatives are rapidly increasing in the United States and Asia in particular, but also in European countries such as Scandinavia, France, Germany, Great Britain and Spain. The current crisis also poses a threat if it results in a deferral of investments in the ICT innovation cycle. The shortage of high-quality graduates, caused partly by low influx numbers, must be addressed. Finally, the image of ICT and lack of faith in it can also be regarded as threats.

3. An ecosystem for ICT innovation

Successfully addressing the complex social issues and realising the ambitions set, demands intensive collaboration between the government, commerce, social organisations, educational establishments and research centres, and private citizens. This sort of ecosystem forms the basis for successful innovations in products, services and processes in view of the fact that innovation is a cyclical process rather than a linear one. Ideas and discoveries are continually being tested, opportunities are linked to questions, and desires lead to new challenges and ideas. Interaction among all the participants in the innovation cycle results in inspiration, which in turn generates further innovation. The ability of such an ecosystem to succeed depends on a number of factors, namely:

1. **Good and varied types of collaboration**. Collaboration must not be restricted to obvious collaborative links among researchers, businesses (whether they are ICT companies or businesses and organisations using ICT) and users. There is also a growing need for multidisciplinary collaboration on the research front, for example ICT and law, ICT and management studies, ICT and business studies, and ICT for the sciences. Also, the links between the application areas or sectors must be firmly established to ensure that lessons and developments in one sector will be utilised in other sectors (trans-sectoral collaboration).
2. **The correct players**. The Dutch participants in the ICT innovation ecosystem include educational establishments and research centres, intermediary institutions (such as the Netherlands Organisation for Scientific Research (NWO), Technology Foundation STW and SenterNovem), ICT businesses (software, hardware, services), non-ICT businesses and other professional users of ICT (such as social institutions and government departments), end-users/consumers of products and services, and finally the government in its roles as mentor, executive producer, legislator, inspirer, financier and launching customer.
3. **Dynamism**. A vital and dynamic ICT ecosystem is not served by top-down organisation, but flourishes through stimulation, protection, sustenance and support. The players must recognise each other as such within the system, which must also properly accommodate the various mechanisms and processes. The ICT innovation platforms, formed with assistance from ICTRegie, are actually sub-ecosystems in which researchers, ICT businesses and users work alongside each other on Strategic Research Agendas (SRAs) for an application area or technology, and then set up and implement innovation programmes. Fertile ecosystems, comprising developers, suppliers and 'users' of knowledge, along with government departments and intermediary organisations, have developed around research centres such as the Center for Mathematics and Computer Science (CWI), Novay, Holst Centre, Embedded Systems Institute (ESI), TNO and Netherlands Institute for Research on ICT (NIRICT). Many forms of public-private partnership have shown that such collaborative efforts result in both a better harmonisation of the supply and demand of knowledge and also a larger financial support base for public research. One significant challenge here is the active involvement of smaller businesses in the ecosystem. It is also important for non-technical (social, economic, administrative) disciplines to be actively involved in the development and implementation of agendas and programmes. Support and direction both help to resolve these challenges.
4. **Global harmonisation**. The development of knowledge and innovation are global processes. Taking part in the global ecosystem requires a recognisable and respected position.

The full flowering of the innovation ecosystem we are contemplating consists primarily of bringing together *people* who have a joint resolve to produce something, and who will ultimately share the returns and celebrate successes. Processes and institutions are resources for creating and maintaining a living *community*.

4. Conditions for success

Several challenges must be overcome and various conditions must be satisfied for ICT to make a maximum contribution towards the Netherlands becoming a leading knowledge economy. The most important conditions for a properly functioning ICT innovation ecosystem are:

- **Education and training in ICT**. Basic knowledge of ICT, particularly information sciences, is essential for everyone, and should therefore be given a place at every stage of the education system, from primary school to university, even in courses where ICT is not a principal element. ICT can only flourish properly if there is a ready perception of what it has to offer to other disciplines, and how much more it involves than just programming. We need sufficient numbers of people qualified in ICT. Both of these objectives require good ICT education at advanced secondary education levels, and a satisfactory transition from higher professional education to university courses.
- **Social acceptance**. Failures and delays in major ICT projects cannot always be attributed to technical reasons. Change engenders resistance, while complexity and inadequate or unavailable information merely serve to strengthen that response. Right from the start, users must be central to large-scale projects whose results are expected to have a direct impact on them.
  Multidisciplinary and trans-sectoral collaboration is needed to achieve working solutions, and people must be able to speak each other's language for this to happen. Researchers must also have the opportunity to valorise the results of their scientific research in a realistic context, and there must be an incentive for them to do this. Testing both the results and impact of scaling-up applications within a limited territory, such as a city or neighbourhood, increase the prospects for success when the product is launched.
- **A good climate for entrepreneurs**. Starting up a new business should be attractive in the Netherlands, and there should be opportunities for established ICT businesses to grow into major players. This precondition is not confined to the ICT sector. However, the number of small enterprises in the ICT sector is relatively high in the Netherlands, where there is also a high percentage of ICT companies among start-up and innovation businesses. This means that the Dutch ICT sector is disproportionately dependent on a good entrepreneurial climate for small businesses. Under schemes such as the Technology Foundation STW's Valorisation Grant or SenterNovem's Small Business Innovation Research (SBIR) programme, the supply of excellent proposals outstrips the available financial resources, so that many good proposals cannot be supported. In areas where the Netherlands has already achieved a good position, this must be exploited to make the country more attractive for foreign businesses or their offshoots.
- **ICT infrastructure**. The Netherlands plays a pioneering role in the field of ICT facilities. To retain this, we need to be in a position to continue offering Dutch science the best possible infrastructure, now and in the future. In December 2008, ICTRegie issued an advisory report on this topic, where it argued for the creation of a single entity for the entire ICT research infrastructure, in order to ensure a coherent, user-driven strategy. This ought to be achieved as quickly as possible. The developments that have been outlined offer the Netherlands an opportunity to retain a key position in the development, innovation and operation of a Europe-wide ICT infrastructure.

5. Challenges

To get the best possible results from ICT research and innovation, we need to focus on the most important practical challenges and bottlenecks. This also involves considering the position of the Netherlands in relation to other

countries. We cannot do everything ourselves; choices will have to be made. Through an individual, focused contribution, we can utilise our characteristic Dutch position and play our full part in the international system of knowledge and innovation. Focus should also help to limit the fragmentation across different topics and organisational entities, and thus maximise the efficacy of our efforts. The ICT2030.nl agenda argues for a focus of ICT research and innovation on the following five research challenges:

1. **Managing complexity**. There is an ever-increasing need for methods and techniques to render large and continuously growing quantities of information accessible, comparable, traceable and interpretable. Combining, processing and comparing data, and taking note of the context from which it is obtained, are increasingly important matters. At the same time, the growing number of interconnected systems (with their software packages) must remain manageable. Focusing on issues of complexity enhances the good position secured in this area by the Netherlands and at the same time provides the best possible contribution to the resolution of social issues. It also makes ICT use by end-users more natural and intuitive.
2. **Increasing confidence**. Users (people and machines) need to know where information has come from and whether the information received is the same as the information sent. This requires effective online identification, its management, the facility for verification and the prevention of abuse. Technical solutions will only succeed, however, if users have sufficient confidence in these. Therefore, ICT applications should not solely be addressed from technical and legal perspectives. The organisational and ethical aspects must also be considered.
   The degree to which ICT is intertwined within products and services has elevated risk management and planning into something of a challenging discipline. The degree of dependency is not the same for every ICT system or application area, and this results in different aspirations for availability, usability, integrity, predictability, validation and ease of maintenance. However, a general framework that allows solutions to be found is needed. The Netherlands has secured a strong position in this area, which needs to be expanded even further.
3. **Integration in commercial processes and models**. Integration of ICT in commercial processes and models requires a process-defined design approach, for which new design tools and methods of simulation and verification are indispensable. Sequential computerisation needs an umbrella architecture, within which software functionalities can be positioned and related to each other. The fact that the new systems have to work seamlessly alongside previous generations is an extra challenge in this context.
4. **ICT for scientific research (e-science)**. The use of advanced ICT for scientific research creates new forms of national and international collaboration. Researchers share expensive equipment, and make joint use of large-scale distributed computer and data facilities. Fast hardware and software, along with new algorithms, make experiments based on mathematical and simulation models both possible and sensible. For instance, new genome analysis techniques demand advanced processing methods to be able to deal with the enormous data streams. The term "e-science" covers all of the knowledge and method developments, processes, architectures, workflow, hardware and software required for this.
5. **Revolutionary innovation**. Many of the breakthroughs which have radically changed our way of life and the way we work have resulted from curiosity-driven rather than demand-led research. We need revolutionary, non-conventional ICT principles if we are to continually improve our commercial processes and render these more efficient. This is a practical challenge, and the Netherlands will have to continue undertaking three types of ICT research: curiosity-driven, research based on indirect demand and direct demand-led research (applied research).

6. Action points

The ICT2030.nl agenda is intended to provide continued momentum for the development and application of ICT. For this objective to be realised, certain preconditions have to be satisfied and significant progress must be made with respect to the aforementioned ICT challenges. Six action points have been formulated in this regard, which

focus on consolidating strengths and utilising the opportunities available in the Netherlands; they form the actual agenda for all of those involved in the ICT innovation ecosystem:

1. **Supporting and enhancing the ICT innovation ecosystem**. As with any ecosystem in nature, the ICT innovation ecosystem must also be self-regulating. A tender ecosystem like this must be nourished, protected and strengthened so that it can operate as effectively as possible. Players with various backgrounds and qualities will enter into dialogue with a view to organising an application area within ICT. This means further support and enhancement of the ICT innovation platforms and harmonisation with their European counterparts, the European Technology Platforms (ETPs).
2. **Implementing innovation programmes and research projects**. Public-private partnerships will set up and implement innovation programmes. This type of demand-led programme will be based on the strategic research agendas of the ICT innovation platforms and focus on concrete products, services and applications. They will have to coincide with the social and technological challenges outlined above. There is also a need for increased groundbreaking research, which is not – or barely – compatible with consortia and commercial participation: the horizon is too far away and the result is often highly uncertain. This type of research contributes to the attraction and education of talent, provides the Netherlands with its place in the international context and provides access to the best available knowledge in the world.
3. **Profiling the Netherlands as a worldwide breeding ground**. The advanced Dutch infrastructure lends itself pre-eminently to the 'living labs' concept. Living labs are test and development environments in a realistic context, often within a confined area such as a city or neighbourhood. Businesses, educational establishments and research centres, government departments and end-users jointly develop new products, services and business models and then test these in practice. This type of breeding ground is an effective environment for assessing the value of new innovations and testing the impact of scaling them up, thus increasing the prospects of success when the product is brought to market.
4. **Developing ICT for science**. In December 2008, ICTRegie submitted an advisory report about the route towards a competitive ICT infrastructure for Dutch scientific research to the Minister of Education, Culture & Science and the Secretary of State for Economic Affairs. It proposed bringing the national ICT infrastructure for scientific research under a single umbrella (SURF). Another recommendation is the further development of that infrastructure (networks, supercomputers, data storage and software). By doing this, the Netherlands can secure a key position in the development of a pan-European ICT infrastructure for scientific research.
5. **Improvement of education**. The action points by which education and training can be improved – leading to larger numbers of qualified ICT specialists and the promotion of ICT being adopted in non-ICT educational courses – have been prepared in close collaboration with IPN. The action points can be summarised as an improvement in the image of ICT professions and increasing the attractiveness of ICT studies. The first of these would result in better professional prospects, transparency in the differences between educational courses at vocational education, higher professional education or university level, as well as improved harmonisation of short-term and long-term requirements through the introduction of a nationally supported set of ICT key qualifications, which would have to be met by ICT courses at the different levels. The second action point would result in a substantive modernisation of information technology education at every level, with improved harmonisation of advanced studies in ICT.
6. **Strengthening the dynamism with short-term action points**. The FES-ICT 'COMICT' proposal and the services innovation programme will give the proposed innovation ecosystem a flying start. In order to maintain this momentum, increase the dynamism in the ecosystem and forge a visible link between long-term objectives and the results that are necessary and desirable in the short term, ICTRegie shall shortly formulate a programme, in conjunction with ICT~Office and the CIO Platform Nederland, to address specific and urgent bottlenecks.

The action points described above require an additional financial impulse for the Dutch ICT arena. For the desired level to be attained, this funding must be acquired within a period of five years. This is detailed in the following table.

Action point #	Description	Annually, from 2011[1] (M€)	Annually, from 2014 (M€)	Sourced from	Related measures in IPN's ICT Masterplan
1	ICT innovation ecosystem	5	5	Government	n/a
2.1	Demand-led research programmes	10	100	Government, industry, educational establishments and research centres	1.2,2.2,2.3
2.2	Groundbreaking research programmes	7	25	Government	1.1
3	Breeding grounds	3	10	Government, industry, educational establishments and research centres	n/a
4	ICT for science	71.5	79.5	Government, NWO, SURF, educational establishments and research centres	3
5.1	Improving the image of ICT professions	4	6	Government	4.1, 4.2, 4.5, 4.6
5.2	Increasing the attractiveness of ICT studies	3	4		4.3, 4.4
6	Reinforcement of the dynamism	0	0		n/a
	Total	108	234		

[1] 2010, for ICT for science