Ministry of Economic Affairs

ICT 2020_4 Scenario Stories

Hidden Assumptions and Future Challenges

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Foreword by Maria van der Hoeven, Minister of Economic Affairs of the Netherlands

Thoughts on the road to 2020

Hypes and bubbles notwithstanding, ICT has developed into a factor of utmost importance for economic recovery, innovation and productivity. The ICT sector currently accounts for 20% of our economic growth and 30% of productivity increases in Europe. As the digital gateway to Europe, the Netherlands has found that strong ICT infrastructure attracts foreign investors. In order to reap the full benefit of ICT, governments need to assist in solving teething problems in ICT and foster trust in new technologies. We all need to work hard to ensure that ICT can fulfil its potential.

In order to keep one step ahead of new developments and to ensure we steer a steady course, we need to keep an eye on new developments on the horizon, such as cloud computing, the internet of things, and augumented reality. Although these concepts have been around for quite some time, only now are we beginning to see what they might mean for society and the economy. That is why we embarked on a *tour d'horizon*, to explore the future prospects of ICT and the role the government could or should play in these.

We set out with a set of questions and after dozens of interviews we returned with hundreds of answers from experts around the world. Using their invaluable input we then identified driving forces for change. Thanks to the co-operation of numerous representatives from business, civil society and research institutions, we then distilled four scenarios from this wealth of information. These are presented in this publication. The scenarios are intended for application during the following phases of ICT policy development in the Netherlands and they will also serve as a starting point for a dialogue. I hope this dialogue will start with you.

I hope you will find this publication not only useful, but also enjoyable. I am looking forward to the discussions this publication will undoubtedly give rise to.

Maria van der Hoeven
Minister of Economic Affairs of the Netherlands

Contents

1. Introduction

"Yesterday is not ours to recover, but tomorrow is ours to win or lose"
(Lyndon B. Johnson)

Our thinking about the future is driven by the global crises of today. Economic recovery, global warming and the need for sustainability determine our present actions and shape our perspectives on the future. New developments in fields like ICT and the internet, nanotechnology and genetics, provide us with exciting new insights and possible solutions. In reaction to these crises, people, companies, civil society and government share a sense of urgency that may lead to a change for the better. There is almost unanimous consensus that ICT and the internet will play a decisive role in this process in many different ways: by enabling communication between each and every one of us, by making huge amounts of data manageable, by serving as a tool for analysis and control, and by enhancing or augmenting the reality that surrounds us. This is not a utopian vision, but a mere starting point for reflection. What should be done to win tomorrow, or at least to prevent its loss? And how can ICT be instrumental in this great ambition? The first step would be to shift our focus from 'the world of the digital' to the digitised world we all live in.

The Directorate General for Energy, Telecoms and Markets of the Dutch Ministry of Economic Affairs has set out to gather answers to questions about the development of ICT in the next 10 years (2010-2020), such as: how can ICT contribute to sustainable economic growth and societal improvement? Which insights should guide our discussions on this topic?

The Digital Thinking Network (DTN) was contracted to design and facilitate a scenario process for the future of ICT in 2020. Einstein is often quoted as having said "you cannot solve problems within the same consciousness that created them". The challenge for the DTN was to overcome 20th century thinking in order to be able to tackle the problems of the 21st Century. The focal question was: what will the world look like in 2020 and what is the role of ICT?

A huge amount of food for thought was generated during an extensive round of interviews with people from all over the world that shape the present and future of ICT and the Internet. A thorough analysis of the material led to the identification of a number of 'driving forces'. These are forces which we cannot control or influence, but which we can anticipate and prepare for. On the basis of this material, the actual scenarios emerged during a number of quick-fire sessions. They each represent 'a possible future' and can help us to make more informed decisions today. They consist of narratives that are relevant, plausible, coherent and surprising and they are focused on the developments that we cannot control. The scenarios challenge our thinking and reframe the strategic context for policy, innovation and corporate decision making. They are intended to fuel debate with civil society, entrepreneurs, CIO's and policy makers on the implications of these changes. This publication does not contain predictions or policy. The use of company names is only meant to illustrate the narratives and does not imply any evaluation whatsoever. This study does not represent the opinion of the Ministry of Economic Affairs.

The World Congress on Information Technology (**WCIT**) in Amsterdam in May 2010 provides the perfect stage for the presentation and discussion of these scenarios, during the congress and the workshop 'ICT

scenarios 2020'. In the structure of this publication, the present stage of the scenario process is being reflected. First, you get a short introduction to the aims and limits of scenario thinking. Then, the four scenarios will be presented in the form of concise narratives intertwined with quotes from the interviewed experts. The analytical part of the process that leads up to the scenarios is presented in the form of driving forces. These will provide you with insights and facts behind the scenarios and the future of ICT in 2020 in general. An overview of all the interviewees and participants in the sessions is also given.

This publication is only the tip of the iceberg. If you would like to read or hear more, a large number of documents and hours of video are available in the Wiki at www.futureofict.com. Do come back for updates!

Acknowledgements

We would like to thank all the experts, entrepreneurs, visionaries and professionals who so generously shared their insights into the future of ICT with us. All names are listed towards the end of this publication. Special acknowledgements to the many persons who provided input and insight, late night sparring and challenging questioning throughout this project, including; Paul de Ruijter, Per Espen Stoknes, Peter Leyden, Nalini P. Kotamraju, Judith Zissman, Benjamin Gross. The scenario interviews were done over a 6 week period in Washington, San Francisco, Tokyo, Hong Kong and Mumbai with the help, scheduling insights and network of Vint Cerf, John Seely Brown, Tim O'Reilly, Izumi Aizu, Teruyasu Murakami, Masu Masuyama, Christine Loh, Craig Erhlich, Charles Mok, Dave Evans, Rishab Ghosh, Jeremy Godfrey, John Hagel, Brewster Kahle, Mary Austin, Jaron Lanier, Tom Gruber, Mitra Ardron, Hal Varian, Marc Smith, Krish Murali Eswar, Rajeev Shrivastava; the accurate and timely transcription of Barbara Morgan; the logistical support of Karlien van Bunningen, Sam Hamady and Jeetendra Chudasama; and the key economic insights learnt from the many profound thinkers at the inaugural conference of the Institute for New Economic Thinking at Kings College in Cambridge.
We would like to thank our many colleagues for their continuous contributions, remarks and criticism. If we were ever under the illusion that the future would be easy, we now know better…
Last but not least we would like to thank the Digital Thinking Network (DTN) - especially Daniel Erasmus, Jeff Ubois, Wendy van Wilgenburg and Gabriella Ng - for their unfaltering enthusiasm during the many versions and revisions.

The project team

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2. Scenario Thinking: Assume Nothing

In this scenario set we address a set of uncertainties that will determine how ICT and the Internet will be a driver of economic activity in the next 10 years. The uncertainties were selected through the process of 33 expert interviews on 3 continents, a set of expert workshops, and innumerable internal discussions at the Ministry of Economic Affairs and at the DTN.

There are thousands of possible futures to explore, the purpose of scenario thinking is to select three to four stories through quantitative and qualitative methods that challenge existing assumptions, and reflect plausible timelines into the future. The scenario space that we have selected here, challenge four key ICT assumptions that we found across the globe.

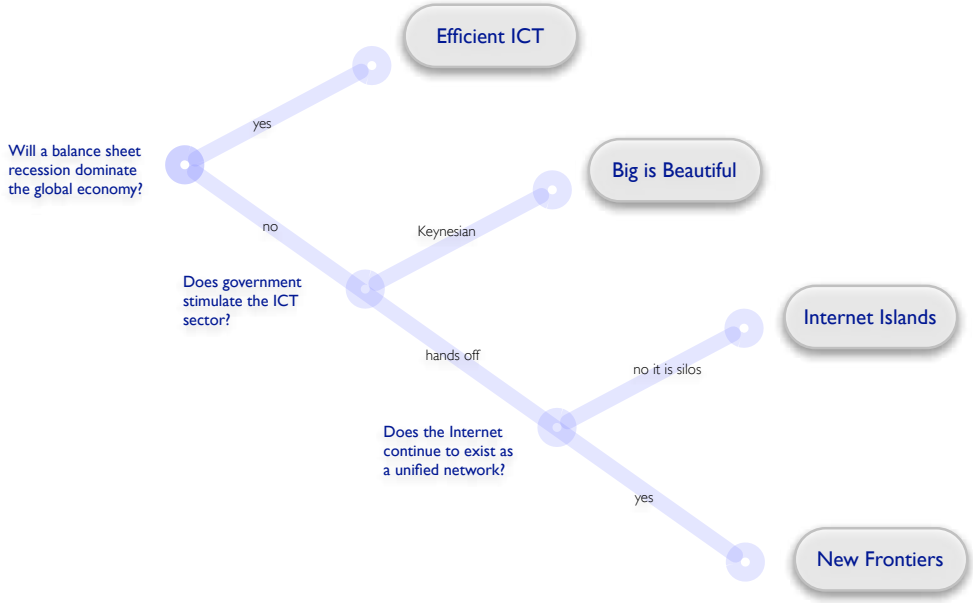
Firstly it is often assumed that ICT and the use of the Internet equal innovation. Though there are many areas of innovation, ICT is as often used to make existing systems resistant to change as to make them innovative and adaptive to change. In the *Efficient ICT* scenario we explore a future where cost cutting leads to less investment in innovation and ICT is implemented merely as a cost cutting measure.

Secondly it is often assumed that ICT innovation can only come from the current paradigm of distributed innovation, based on a predominantly Silicon Valley based venture capital system. In the *Big is Beautiful* scenario we explore a future where ICT innovation is driven by large known corporate entities.

Thirdly it is often assumed that the Internet is an open unified network, with its own set of implicit and explicit rules, that operates relatively independently from national and in commercial boundaries. In the *Internet Islands* scenario we explore the fragmentation of the Internet in commercial ecosystems and along geographical boundaries.

Lastly it is often assumed that technologies and approaches of ICT and the Internet are maturing and that the landscape will be dominated by the current parties. In the *New Frontiers* scenario we explore a new wave of openness that will create new players, opportunities and challenges.

The system shown on the following page describes the uncertainties and tensions that could lead to each of the four scenarios. It is important to remember that this uncertainty scheme is not unique, and that there are many possible uncertainties that could lead into a particular scenario. This is a guide to understand *one* possible way in which we can arrive at these scenarios. What is important about the guide is that it stipulates a system, through which we can understand the differences between the scenarios.



Recession

The first question: Will a balance sheet recession define the economic landscape in the next 10 years?
The post crisis situation is clearly a space in which there will be less capital to invest in the next ten years in new technologies and new approaches because debt reduction is thought to be crucial. The economist Richard Koo compares the current economic crisis with the crisis in Japan in the 1990's and the great depression of the 1930's. He states that the lesson learned is that many companies realised that their balance sheet was under water. They still had a positive cash flow and devoted a significant part of their profits to debt reduction in order to repair their balance sheets. Because this reduces the total debt it effectively shrinks the economy, and importantly it reduces the ability of companies to invest in new technologies. If this *balance sheet recession* dominates the global economic environment, then companies will only invest in ICT and new Internet approaches if it leads to cost reduction. Hence we have the scenario: *Efficient IT*.

Intervention

The second question: Does the government stimulate the ICT sector?
In the 1930s Keynes argued that the government should stimulate the economy at a time of recession/ depression through investment in large-scale public works (and other) programs. The second scenario question therefore reflects the possibility that governments around the world will continue to stimulate the economy in sectors that are seen to be possible drivers of future economic growth. ICT is understood to be one of these sectors. Therefore governments will partner with larger ICT organisations to develop large-scale next generation ICT infrastructure projects. These projects will be used to transform government services into Government 2.0 services but according to a different route than currently debated. Governments will select partners of equal size, to implement these large projects, which will lead to consolidation of the ICT sector into large cloud based companies and services. Hence we have the scenario: *Big is Beautiful*

Break-Up

The third question: Does the Internet continue to exist as a unified network?
TCP/IP protocol and the Internet built on top of it ingeniously separate the content from the communication layer. This was the intention of the original design and it allowed for a network architecture that could sustain exponential growth. The emergence of the commercial Internet and the rapid growth of the user base with mobile and broadband was predominantly the result of a "hands off" approach by law makers to allow this new space to emerge. This changes now the Internet and ICT is seen as crucial for many economic and societal sectors. There are more and more examples of new legislation that seeks to modify or legislate *existing* behaviour on the Internet. This includes country level firewalls that limit content; most notably China, but also to a lesser extent Australia and other territories; and new copyright enforcement legislation. Clearly the nature of the debate on the ownership or not of ideas, the evolution of the digital commons and practices of co-creation will play a significant role over the next decade. Different areas of the world might have different approaches to resolve these tensions. Hence we have the two scenarios *Internet Islands* and *New Frontiers*.

Secondly the emergence of a mobile Internet has the potential to change the dominant paradigm of access to the Internet of the last two decades. Over the last 20 years people mostly "got online" through general-purpose devices, computers that allow for unlimited user configuration, in contrast to mobile telephones that allow for limited user configuration. Which paradigm will dominate the devices that increasingly access the mobile Internet is uncertain. Therefore we layered this uncertainty onto the previously stated two scenarios, *Internet Islands* having closed geographical and commercial Islands on the Internet, and *New Frontiers* lead by open approaches to access, content and collaboration.

The Good, the Bad and the Ugly

None of the scenarios are preferred above the other scenarios. They all contain positive and negative aspects. Their intent is not to be prescriptive, but to challenge us by questioning the assumptions we have going forward. Scenarios are thinking tools to be used to make our strategies robust, and allow companies and policy makers to consider contingencies rather than ignore uncertainty. The following section will describe possible scenario stories resulting from the above scenario space. These storylines are the 9th draft in this series. We look forward to using the WCIT conference to improve the scenarios and update them as part of an ongoing discussion, to explore the commercial, investment and economic consequences of these possible futures.

3. The scenario stories

I. EFFICIENT ICT

The world had been struggling to get back to the "old" normal after the global recession hit rock bottom back in 2009. In the years following, the global economy fluctuated wildly at the slightest hints of instability. The United States, as a direct result of being unable to control their ballooning deficit, was unable to fully drag itself out of the prolonged period of recession. Not many could have predicted that the appreciation of the Chinese yuan, which the U.S. had pressured China into doing, would only have a minimal effect on the creation of domestic U.S. jobs. In fact, the appreciation of the yuan so adversely affected the Chinese manufacturing sector, and the rest of the Chinese economy, that U.S. exports to China also fell. The sluggish trade synergy between two of the world's leading economies had an impact on the rest of the world. Furthermore, the Chinese property bubble finally burst early in 2012, slowing the Chinese economy. Since China had effectively become "the world's engine", global markets also declined, particularly other emerging markets that were heavily dependent on business with China.

However, past experiences during the 1997 Asian Financial Crisis helped developing economies to rebound relatively quickly. Within a few years, these countries were back on track for growth. China ceased to peg its yuan to the dollar, choosing to peg its currency to a basket of currencies; other Asian nations followed suit. The economies of the United States and the EU declined in comparison with the rest of the world.

In fact, what was going on in the developed world was a "balance sheet recession", whereby companies were de-leveraging and paying off the debts on their balance sheets. The only way they could do this was by severely cutting their budgets and not making any new investments in order to avoid the creation of anymore debt. This drove the reversal of ICT development from being innovation-driven to being efficiency-driven. In other words, nothing much came out of ICT in terms of innovation; ICT was all about saving money and making things more efficient. The Netherlands, in contrast, did fairly well as Dutch companies were comparatively profitable and had a much lower debt-to-earnings ratio than many companies in other countries.

The question is: how are we going to get out of this debt hole that we've all put ourselves in?" What will move us to an economically sustainable development? We've overspent, and now we're in this period of de-leveraging, and how are we going to get through that hurdle? There's this old line from a cartoon, "Pogo," where it said, "We've met the enemy and he is us," because we all have some responsibility here. We all have to contribute to resolving it.
Hal Varian, Chief Economist at Google and UC Berkely

This opened up the acceptance of cloud computing services for companies. Cloud services removed the need for companies to invest and maintain their own servers and other technologies needed to run their business, allowing them to move from a capital-expenditure heavy model to an operations-expenditure model. For under 5 million euros, a company the size of Rabobank (approx. 60.000 people) could subscribe to an entire online suite of word-processing services for their entire workforce. As this figure was a fraction of what companies had been spending before, the surplus saved from capital expenditure was used to continue paying off the debt on their balance sheets.

As a result, liquidity in the markets dried up, leading governments to introduce large stimulus packages in order to prevent GDP from declining. A major component of the stimulus packages was to inject new life into ICT development in order to address efficacy and efficiency issues, such as optimization of operations management systems for government and corporate entities; introduction of intra-European contingency transportation systems so that travelers would not be stranded en masse due to weather phenomena; and early warning systems for flu/pandemic trends so that citizens could be forewarned and pharmaceuticals could prepare a sufficient supply.

2010-2013

Nobody thought 2010 was going to be the best year of the decade. The green sprouts of recovery would not survive a second dip. In the United States, real estate, unemployment, insufficient consumer demand, currency problems with the US dollar, and an attempt at devaluing the dollar to bring debt under control were all factors that increased the move of economic activity to Asia. However, Asian consumption wasn't sufficient, given the imbalance of those economies, to completely match up with excess production capacity. Thus, Asia did not become a driver as anticipated.

The EU was under increasing pressure because it was clear that Greece was going to default. In countries like Greece, Italy, and then Ireland, the GDP dropped 15 percent in the space of two years. The rolling series of deep economic problems, compounded by an aging population that not only did not provide new sources of growth but the expectation of significant burden, put intense pressure on northern economies.

High unemployment, reduced life savings, and a growing sense of social disconnect caused global crime rates to rise. From piracy to drug wars to civil unrest, social insecurity was a burgeoning problem that governments sought to alleviate. Government budgets, already stretched beyond their means, could not justify adding more officers to existing police forces. As an alternative, existing city-wide closed-circuit television systems were expanded and improved as a way of ensuring security. The improvements allowed for real-time around-the-clock monitoring, and allowed existing police forces to mobilize more quickly and effectively. Citizens felt more secure because they felt that their concerns were being addressed by the government as their well-being was monitored and recorded on camera 24/7.

2014-2017

ICT expenditures decreased as lifecycle replacement doubled from 18 months to 36 months or longer at the consumer level. Several different factors contributed to this development. For one thing, new methods of recycling electronic waste made it an extremely lucrative business. As more and more ICT hardware components were recycled, the use of raw materials was cut down, leading to much more sustainable use of technology. In turn, this also diminished the amount of energy needed in ICT production. Hence, the entire cost of lifetime operations was reduced. Consumers liked this, not only as a sustainable practice, but also because it cost them less money per year. Their demand for energy reduction and cost savings paved the way for ICT companies to reframe products as long-lasting green and sustainable to increase margins. Within corporations, this move was thought of as a new efficiency of getting more out of the ICT infrastructure in a difficult business climate.

Silicon Valley's venture system, built over decades, did not survive the demand for less innovative ICT, not only because their businesses depended on fast, disruptive innovation, but also because venture capital dried up due to the closure of the IPO market. The few funds that survived were focused on efficiency-driven ICT by investing in companies with existing products and revenues. Efficient ICT forced a focus on the real economy as opposed to the symbolic economy. ICT was applied to smart grids to save gigawatts; to agriculture to save water and labor; and to transportation to save oil and reduce carbon waste. The youngest and brightest minds went into other sectors, such as green tech, bio, and energy. The business-efficiency drive gathered steam, and there were opportunities of using ICT infrastructure for less. This huge downward pricing spiral put pressure on ICT, which was good for Open Source companies. It was understood that the licensing model of the past, which was a cornerstone of corporate ICT, was coming to an end. The few pockets of innovation that were global were not reachable by Silicon Valley, and thus they missed the wins between 2010-2015.

There was a strong push for cheap robust cloud services with the added concern of business data repository. For 2 euros per month, companies subscribed to office services on Salesforce for their entire workforce, but also had to bear the consequences of insecurity. Infrastructures became thin and the focus was not on managing large deployments but on service fees. Corporations focused on cheap and cheerful solutions. ICT was more reliable but also less innovative, and focused on clear, predictable economic returns. As there

was little internal corporate ICT left, the CIO lost his seat at the board table, and was lumped together with facilities planning, a vastly diminished role comparable to the printshop or building maintenance. Without an internal corporate ICT infrastructure, it was deemed unnecessary to innovate or migrate to new in-house ICT systems.

By the middle of the decade, corporate customers were willing to experiment with low-cost suppliers from new global regions, having found the products of equal or better in quality. New names appeared to take the place of old. Huawei, HTC, Baidu, QQ replaced the American and European household names of the 90's and the 00's.

2018-2020

By the end of the decade, there were still some opportunities for efficiency, but ICT ceased to hold the imagination, to draw in the best and brightest, or to offer the greatest promise to investors.

> *We should monetise what people do with their brains. Essentially, what the Internet does is it helps people do things with their brains more effectively, and gets the fruits of their brains out into the world in a more effective manner. The challenge is to capitalise brain activity.*
> ***Jaron Lanier, computer scientist***

Despite this situation, there was some kind of reversal in terms of the players in the field. The decade's frugality did, in part, create some pent-up demand. Microsoft, which came out of the brutal business as a survivor with new, open standards-based services, became a much tougher competitor than ever before. Microsoft was not alone. Towards the end of the decade, a number of new businesses arrived that thrived on open standards, and low-cost publicly-accessible infrastructure. These emerged out of the previous seven lean years as brutally competitive innovative challengers to the existing enterprises who had not invested in significant innovation during this period of time.

Secondly, the transition of economic focus from the West to the East, and North to South seemed unstoppable. New innovative enterprises, capable of approaching ICT in new and frugal ways because they didn't have legacy issues to hold them back, were emerging in places like India and China, countries which were accustomed to low capital. Silicon Valley was no longer at the center of ICT software or hardware. Europe, knowing that with their aging population it would be difficult to keep up, chose a model of assimilating these new innovations. For example, large European enterprises, like Nokia and Telefonica, began buying out small Chinese green tech start-ups or entering into joint ventures with Indian ICT vendors.

> *There is need for balanced development - ICT and manufacturing - for India to go forward. India sees IT and communications and the Internet as a way to satisfy its hunger. If we want it to be that way, India clearly needs to educate the masses.*
> ***Dr. Lalit Kanodia, Chairman and founder Datamatics Global Services (New York)***

Though people were copying books and other forms of IP and sharing it widely at the same rates, it was clear that public dissemination of what some considered intellectual property was no longer a key concern. There was little public stomach to prosecute this because attention was focused on the basic questions of how to create economic growth. Since economic survival was the overriding concern, personal and sectoral issues were pushed to the background.

Because of lower revenues, governments either downsized into limited and specific functions, or added even more government positions to be filled in order to keep employment numbers up and prevent large unemployment benefits from being claimed. In direct contrast to the US model of massive layoffs, European countries weighed the cost of part-time or under-employment against the social cost of unemployment benefits, and decided that it was better to expand their workforces and re-open offline service branches. Not only did it help to keep many people at least partially employed, but it also helped a large of number of citizens, particularly elderly ones, who were relieved that they again had somewhere to go for information relating to their local government without having to learn to use a computer.

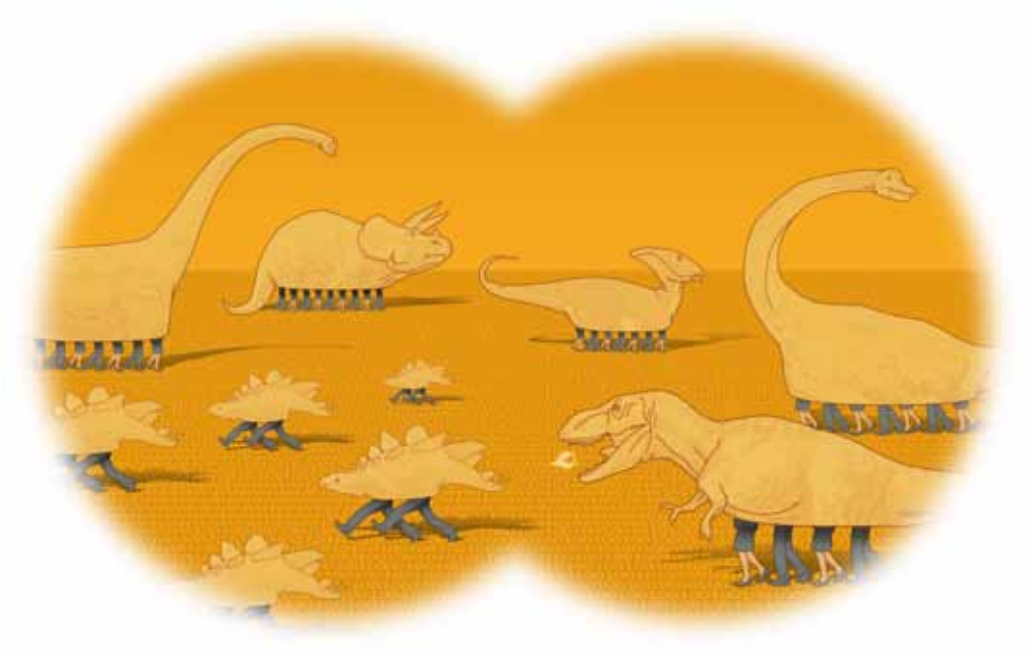
Information technology was only used where clear costs could be saved, and the appetite for large-scale Government 2.0 types of projects was significantly reduced because of slow but widespread growth of general public distrust in government, compounded by growing concerns over increasing mass surveillance, privacy data retention, and litigation against bloggers. Healthcare and education, on the other hand, were areas that were invested heavily in to develop large-scale ICT in an attempt to improve standards of education and quality and longevity of life.

In our hospitals any doctor can find your medical history, can look at the films, the radiographic images and so forth. It's led to a very high degree of productivity in the hospital authority, to reductions in medical accidents as well as unnecessary duplicated medical tests. One of the first decisions we made was that the data belongs to the patient. So the patient must be in control of authorising which doctors should be allowed to see the data.
Jeremy Godfrey, Hong Kong SAR Government, Government Chief Information Officer

Governments decided that developing large-scale ICT systems to detect illnesses earlier through lifestyle monitoring, or even to prevent them before signs could be exhibited, would lower the government's healthcare burden. Philips and Siemens, already giants in the area of healthcare ICT and consumer goods, were poised for success. Regarding education, for example, in Europe with its shrinking young demographic, investing in the young and improving educational standards across the region was thought to be the best long-term strategy to keep the European region competitive with the rest of the world. Education Europe 2.0 was launched, based upon tried-and-true, post-Industrial methods of teaching and learning.

At the end of the decade, although there was some lingering uneasiness and distrust of new government ICT initiatives, citizens did observe and appreciate the efficacy of the healthcare and education ICT programs. New regulatory frameworks to improve transparency and to open communication channels between government and the public by means of enhanced ICT systems went a long way towards restoring trust in ICT. The original role of CIO, for both governments and corporations, as a key strategic player in ICT implementation, was restored.

II. BIG IS BEAUTIFUL



"Don't laugh at dinosaurs, some can run real fast and bite the hell out of you."

The government stimulus programs introduced during the Great Recession worked so well to pull global markets out of the economic downturn that individual governments decided to proceed with the same strategy to continue powering growth. Governments entered into more active partnerships with large companies, which were understood to hold a central and legitimate role.

After bailing out the financial and property sectors, governments turned to ICT as the next phase of economic focus. To support growth, large investment sums were funneled into a big national healthcare system, ICT infrastructure, and the green economy. The reasoning was to build large-scale ICT systems to make the government work better for the people. The perception that the appetite for creative destruction was reduced, and that stability and predictability were the solution. These government actions drove the market towards large-scale ICT solutions where innovation was driven from the top.

However, instead of placing significant investments in a few projects, the government set up an ICT venture fund to invest smaller amounts in many different projects. This "sell-or-shoot" strategy directly influenced the emergence of small start-ups that effectively created distributed R&D for existing major market players. More of the mobile Internet was owned by monopolistic carriers. The logic of vertical integration of services was based around limited devices as opposed to general purpose devices. This in turn led to vertical silos that were used to extract economic value. Clouds, special purpose devices, healthcare - all needed accelerants.

2010-2013

No one could have anticipated that the freedom presented by the Internet would not last into the following decade. With the demise of many newspapers in the years leading up to 2010, it was clear that the Internet had damaged the basic business model of printed media. The combination of weak global growth and lackluster performance resulting in lower advertising budgets, plus the shift to digital media, made it evident that newspapers would not be the only industry to struggle to survive similar dynamics.

In their fight to stay in the game, these companies increased their lobbying efforts. This time politicians were willing to listen, and the promise of creative destruction through new media did not weigh as heavily as the concern for protection of existing jobs. Several treaties, such as the Anti-Counterfeiting Trade Agreement (ACTA), helped incumbents re-establish power lost in the 2000s. Increasingly, the Internet was seen to be governed by local laws and judges.

Central question is: who pays for the Internet? We have to enable people, who produce high-quality web content, to get compensated, without having to go through advertising or through selling information about the users.
Christine L. Peterson, founder and Vice President Foresight Institute

Italy's conviction of Google's executives heralded a new approach to Internet governance that reflected the needs of large content providers, phone companies, etc. Organizations like the Electronic Privacy Information Centre (EPIC) and the Electronic Frontier Foundation (EFF) that had long championed an open Internet were now associated with chaos. The Internet was viewed as something that needed to be controlled for the greater social good, a move that echoed a practice China had been following for many years. Logging of user activity at every level in the technical infrastructure turned the Internet into a monitoring system for social control.

There is a gradual change of the relationship between governments and other entities, especially when it comes to Internet governance. Even evolved countries such as China, India, others, have accepted at least in theory that multi-stakeholders and civil society play much larger roles than it used to be in other sectors.
Izumi Aizu, Tama University

Protocols such as BitTorrent, which in many cases dominated actual Internet traffic, were effectively shut down. Governments required ISPs to act as their agent. This did not stop all file sharing, but it made it much more difficult. Certain closed network communities for dedicated file sharers still remained, such as Tor, which was an anonymous file sharing platform, but they were not on the scale of earlier P2P networks.

Surprisingly this was not seen by consumers as a significant problem; they relied on the convenience and simplicity of closed devices like the iPad to deliver their media content. This resulted in a significant reduction of sharing. It was realized by the studios that their key problem was their pricing model. They

could either price content at a lower level, or package it for free with advertising, which would create sufficient new revenue opportunities to replace existing sources and increase their audience. Consumers also continued to give up their privacy and anonymity. Facebook was just the beginning.

Everybody had expected that large companies would be doomed to oblivion by small-scale companies and micro-multinationals. Surprisingly competition also came from ordinary people moving along on the Internet, who choose to produce or add value as a hobby or avocation, to gain sympathy or just for good old money. However, they were wrong. Large companies thrived and grew bigger, aided in part by government initiatives to support the economy. A limited number of companies dominated their respective markets: content, software, hardware, journalism or news, even high culture – the mass culture part – was dominated by one company, others by a few. So the Disneys, the Microsofts, the Bertelmanns and the SAPs survived. The reason they did was simple: economies of scope and scale. The Internet and ICT continued to be technologies par excellence for large-scale production, reproduction, repackaging and distribution at minimal cost.

This didn't mean these companies could avoid change; in fact, they had to undergo huge changes. It was the economic crisis of 2008 – 2012 that drove the message home and got them to take action because, in fact, many large companies were collapsing during that time. Big companies learned they had to build trust, and they had to step away from reducing their fellowmen and women to advertising targets or even mere consumers.

> *The image comes to mind of the Red Queen, running faster and faster just to stay in the same place. Research shows that at least in the United States, public companies are running faster and faster and falling farther and farther behind.*
> ***John Hagel, Co-chairman Deloitte Center for the Edge***

Energy consumption was on the rise, and in the face of heightened environmental concerns, they had to take responsibility for their business and the entire supply chain, for the impact on the natural environment and sustainable usage of scarce resources, and for the way they were accountable to their social environment. The Internet turned out to be the technology par excellence to unveil evil behavior of companies. Google was one of the first that changed its business model as a consequence of that.

2014-2017

Governments found energy and legitimacy in a new role where it had to work with known and trusted parties. The Internet, although technically one global network, was in fact operating differently in different vertical segments. The integration of these vertical silos, and their limited functionality, blocked certain URLs. It became common to block certain domains or activities on these specific purpose devices. There was no such concept as net neutrality. China adopted its own subtly different flavor of IPv6, which ensured greater control over the content on the China network and the flow of content in and out of China.

As the whole of the Internet split into vertical silos, the question was one of device approach. In this climate, closed special-purpose devices rather than general-purpose open computers were more successful. In an apps world with vertical dominance and integration, software was seen as a consumable. The success of Apple's

model led to competition framed around vertically integrated systems, including end-to-end services and control of the application layer. The confluence of these factors led to the development of emotionally evocative media. User interfaces were extended so that other senses - touch, taste, feel - were added to traditional senses of sight and sound. The promise of virtual reality and haptic devices was finally realised as more and more consumers demanded these features to be built into their devices. Enterprises that were able to meet this demand enjoyed big gains; those that were too slow to catch on suffered huge losses.

It was very hard for customers to switch from one provider to another, especially since their data was kept in convenient but closed environments by the service providers. Different silos operated by different rule sets; some driven by small purchases, others by advertising - consumers found it hard to understand the real implications of choosing between these different models. Towards the end of the decade, as tensions increased regarding this matter, data portability once again became a legitimate consumer issue. Consumer groups began to lobby at a local and transnational level for cross-platform data portability.

The Internet was such an important part of the economy, that governments took on new responsibilities in determining the rules of the market space. The disruptive innovation of the 90s and 00s had not slowed, but took on a more predictable shape. It was less about which industry might be destroyed, as in the case of newspapers, but more about which industries would be enabled through incremental innovation. The role of government was broadly understood as a driver of new economy through government investment in order to ensure a stable environment for incumbent parties to innovate on existing business models and services, rather than create new ones. Intellectual property was protected insofar as it was evident that it would give the bearer a definite competitive edge. It was thought that protection of intellectual property would force competitors to come up with new and challenging ideas on their own versus building upon someone else's idea. The time when governments refused to intervene, e.g. with sales taxes, was over.

The reshaping of the global economic order foresaw a much more active role for government in the economic market space. This more interventionist approach, reflected also in increasing intervention in the financial markets, in health care, and traditional telecoms, moved into the Internet and ICT. As with other socially transformative media of the 20th century (i.e. telephone, radio, television), governments opted to create carefully regulated monopolies, sharing power with large companies, but also actively controlling the disruptive effects new media can have. Restrictions were placed on sensors - the installation of them, the transmission and storage of data, and the ways this data could be used. Information was power, and the government felt that unless carefully regulated, this power could be abused.

2018-2020

There was a real request for innovation in healthcare. The healthcare systems and the future requirements of baby boomers led to a rationalization and to the perception that health care systems would be severely taxed by aging boomers. As a result, existing health care systems were digitized, where ICT was used to drive top-down efficiency and more rational expenditures. Patient files were fully digitized and stored in a large-scale data repository. Some control was lost by the patients, but it was understood and perceived to be attractive because it was now possible to get healthcare without having to go into the doctor's office via "tele-health". The infrastructure required to implement this new approach to healthcare meant large-scale capital expenditures, but these were understood to be an investment in the future and thus worth doing.

The nature of mobile provision of digital services through having a few large providers with frequency licenses created an oligopolistic, or sometimes even monopolistic, environment. The goals of a free and open Internet, although technically possible and occasionally used, were less important. In this space, the government saw its role as one to facilitate the inclusion of all in this truly digital age. In this respect, the Millennials proved far more trusting of government than Boomers.

The consumer disappeared. This was inevitable as the focus of a majority of people moved from consumption to participation, from burning to co-creating and co-producing, thus enabling mass customization and individual expression. Everybody had to develop a far more entrepreneurial attitude, something which Europe struggled with for quite a long time. Europe had to learn some lessons from the US there, but the US also needed to learn something from Europe in terms of taking the raw edges of competition and turning transactions into something different versus a simple money swap with inevitably a winner and a loser as a result. That was a precondition for any type of co-creation or other form of user-participation, and heralded a move from shareholder to reviewee. All these aspects were only possible on the basis of a certain level of trust.

Doc Searles is working on a vendor relationship management system, which is flipping around the customer relationship management to say "I want to be in control of my data and I want to be the one who is giving others permission to come to me and to collect data of me, or only if I say yes, this is OK." And I think that is also something that we have to really work hard on to make sure that we get the rights to our own data.
Mark Finnern, Chief Community Evangelist SAP Labs, head Future Salon

The triumph of large companies was really not the defeat of small ones. A large competitive and innovative fringe of small companies flourished and became successful. Some were absorbed by large companies. Still others even became a large company themselves, although this happened very rarely. Here trust also played a critical role because, in an interconnected world, the vulnerability of one small part in the network can mean catastrophic failure to the entire network, like falling domino pieces. However, by cooperating and trusting each other, in a symbiotic relationship, this approach allowed smaller companies to take the risk of innovation while larger companies took the risk of failure. In this manner, widespread system failures were warded off. This was another lesson they learned from the financial and economic disaster. By erecting walls and gates, the consumer was protected and companies were able to consolidate gains. Furthermore, governments relaxed immigration to allow ease of entry for highly educated experts, who would contribute most to meeting the corporate needs of any given country. These experts were able to move across borders with ease, provided that they had a corporate sponsor in the country to which they were emigrating. However, to make it more "fair" to the average immigration applicant, countries began adopting a lottery model for approving cross-border immigration, subject to certain conditions, such as age, education, financial assets, etc.

III. INTERNET ISLANDS

The global economy recovered slowly and painfully from the Great Recession. Instead of open collaboration between countries working in concert to help the rest of the world bounce back, populist protectionist sentiment prevailed. The tension between national boundaries translated into a disconnect of network boundaries, which resulted in the breakup of the whole network into individual "Islands". It could no longer be said that there was a single global Internet network. It had evolved into a collection of Islands, centered around a commercial brand, a national entity or a common interest-based 'tribe' of many different, closed networks.

The days of the Internet as a single global communication system were over. Lawmakers around the world increasingly saw the network as an area of lawlessness and chaos (e.g. piracy, counterfeiting, intellectual property) that required legislative limitations. Each Island was subject to regional laws.

As more and more closed platforms emerged, many separate versions of the Internet appeared. Some were open, while others were not. Some were more permissible, while others carried more restrictions. The success of Apple's closed "iAnything" platform and a range of products served as a model for other companies to create similar platforms whereby only approved services and applications could be accessed by users. However, while most of the Islands operated within a regulatory framework, the Islands also included powerful and thriving black markets. Efforts to fence out economic predators, the continued inability of computing vendors to provide systems that were both open and secure - all of these factors accelerated the enclosure of open spaces into walled gardens.

It is not at all clear just how all the different cloud based systems interact with each other. You can't say, "Hi, I'm on the Amazon cloud and I want to move my data over to the Microsoft cloud or the Google cloud." There's no technology, no identification system for that, nor protocols for moving stuff back and forth.
Vinton Cerf, Vice President and Chief Internet Evangelist of Google Inc. Former participant ARPANET.

2010-2013

Nobody could have foreseen that 2010 would see the beginning of the deterioration of ICT and the Internet. The original promise in the final decades of the previous century of a single global network, which would bring the world together, evolved. Gradually and subtly, the Internet fragmented, built upon the framework of France's "three-strikes-and-you're-out" system and layered with aspects of the Australian firewall and the Great Firewall of China. ICT stagnated because these firewalls and a failure of standardisation efforts effectively made it next to impossible for any single device to be used across different platforms, much less across borders. Computers became general purpose devices and mobile phones became specific purpose ones. This development also had the unintended effect of stifling innovation. Each "Island" had its own technological innovations and unique communication devices. Since each Island had to abide by a different set of regulations, in that sense, legislation was the end determinant of ICT development and content on the Internet. Globalisation as a dogma for development continued around different sets of rules in different places, having far-reaching consequences for healthcare, education, and environment.

As a result of such direct government intervention, new structures around user behaviour emerged, whereby users had to play by the rules or risk forfeiting their right to connectivity. On the other hand, governments took a much more hands-free approach to businesses. Still fresh from a long battle with economic stimulation, governments around the world were nervous about damaging the economic viability of large commercial players, which had begun to close off their devices and products. The reduction of production and manufacturing costs led Silicon Valley enterprises to pursue vertical integration strategies, which locked users into these proprietary "vertical ecosystems" and "walled gardens".

Old business models were vertically integrated. Recently, new vertically integrated business models have been emerging. Maybe with the proliferation of open standards and open source applications, mobile will be moving to a more open business model where interfaces between different layers will become open.
Yasuhiko Taniwaki, division director ICT Strategy Policy Division, Global ICT Strategy Bureau, MIC (Ministry of Internal affairs and Communications, Japan)

2014-2017

Some movie studios and intellectual property champions saw these vertical ecosystems as a prime opportunity to buy into a business model that locked-in their market. A model of downstream, convenient, cheap, consumer-based video- and content-viewing channels gradually replaced the YouTube model of interactive,

bottom-up, collaborative environment that had been envisioned in the 90s. Because these pioneers in the Internet-Island race were so profitable, governments thought that their hands-off approach to the commercial side of the Islands was a successful strategy. Users themselves, tired of past experiences with computers that required constant care and maintenance, chose to forgo privacy and freedom of abundant choice for these new closed systems that offered greater simplicity, usability and customer support.

The boundaries between Internet Islands solidified, supported by the emergence of unicode-based high-level domains. Japanese could now list domains in kanji, katakana, or hiragana. Similarly, the Chinese used Chinese calligraphy, the Indians used Hindi script, etc. This use of other systems of writing effectively precluded international collaboration by large segments of the world's population. Software developers needed to decide beforehand which Island to be a part of. Although some Islands did overlap and there was limited interaction among the Islands, it was obviously an exclusive environment whereby it was difficult to move from one Island to another. For example, Facebook users that wanted to transfer their contacts to LinkedIn had to pay a penalty for the service. However, within social networks itself, members of the community could easily conduct commercial transactions through the integrated phone bank payment system.

That the output of America in entrepreneurial or tech culture is so great has not much to do with technical prowess. The universities in China produce more engineers than America and Europe put together, probably. It has to do with the sort of start-up culture. Also compare China, Hong Kong and Taiwan. You can say they're all Chinese, but the appetite is different, because in China, you're still building wealth. But in Hong Kong, you're protecting wealth.
Yat Siu, CEO Outblaze

The same situation was true for healthcare and education. Sensors were everywhere, built into clothing and devices. People within the same Island shared data with each other; however, there were arguments against sharing information with other Islands. Any scientific discoveries or breakthroughs were kept within the Island. Knowledge and information was not shared outside of the community. While this was decidedly in opposition to the idea of the Internet as a space of open collaboration, it also helped the profit margins of companies, thereby quickly leading the global economy back into an upswing in the economic cycle.

While boundaries were being erected around brands and on the Internet, political boundaries were being lowered. Government used the data it owned to enact policies to encourage greater inclusion and integration of immigrant populations. They did so amongst other things as a way to address the kind of internal social conflict that had given rise to the emergence of homegrown terrorists. Education was de-institutionalized, which meant more flexible programs to cater to a wide range of learning curves and abilities. New technologies and methodologies were developed to help students with learning difficulties, such as dyslexia. Social media did not only benefit education, but also healthcare. Social media were used as a way of organizing special rates and services from insurance companies, so that people could be matched up to the best healthcare package for their particular circumstances.

2018-2020

The original bet of AOL of closed-space communities became a reality. There were countermovements, headed by open source communities; however, these counter movements did not gain much traction. Although the open source community created open devices that were technically advanced, they did not have the same ease of integration that closed devices offered. As with Linux, these open devices were adopted primarily by the technology community, but to a much lesser extent by the general public.

> *Those kinds of "targeted", those highly relevant, highly personalised results are, in fact, the most valuable pieces of attention in the whole web, in the whole ecosystem of this attention-based economy.*
> ***Tom Gruber, co-founder, CTO, and VP Design at Siri (mobile VPA's)***

Ubiquitous sensors collected data that was sent to the government, which was the trusted authority to hold this information. The government was the ultimate owner of this data, which it then used to institute changes in healthcare, education, and taxation. When it felt that it would benefit public interests, the government pressured different Islands within her realm to share healthcare and education information with each other to provide a common solution. The accuracy of sensors and the storage of data led to new income streams for government in terms of taxation. In the face of mounting evidence of climate change and human contribution to it, governments began taxing citizens and companies on their carbon footprint and waste generation with the help of sensor-collected data. The reasoning behind this was to fundamentally alter human behaviour, which would ultimately help to reverse the negative impact of global warming and climate change. This would in turn, theoretically, normalize the frequency and violence of weather patterns, thereby saving the government money. In terms of intellectual property, despite pressure from a consortium of media enterprises led by Bertelsmann and News Corporation the government decided that too many boundaries would ultimately stifle any innovation, which would hurt the economy.

IV. NEW FRONTIERS

After the initial government stimulus packages of the Great Recession were withdrawn, global markets suffered a period of sporadic and unsteady growth as they gingerly found their balance in the "new" normal. Despite recovery difficulties and a prolonged credit crunch, governments chose not to intervene excessively, becoming an avenue of final resort versus a panacea to heal an ailing economy.
Having run out of options, small pockets of innovation emerged, built upon the existing Internet architecture. The reign of Moore's Law continued unabated. This was in part due to innovative and startling new developments of ICT services and technologies and underlying core technology improvement.
There was also a new sense of optimism fueled by high tech non-profits that an open commons way of approaching 21st century challenges was the best way forward. The combination of open software, open standards, open content and global contribution not only saved money it also produced very innovative software and services. It was understood that to use the commons, one had to contribute to the commons.

Maker Fairs were really the crystalisation of a global "can do" attitude to problem solving, and self reliance. People were less inclined to rely on governments or companies, both who were cost cutting, but relied more and more on each other, in small scale local solutions.
These solutions were shared via social media to gain global prominence. Technologies such as sophisticated search engines, social media, semantic approaches, and maturing Artificial Intelligence systems made it much easier to get "just in time" context to your actions.

Open innovation is the most simple example of moving from push to pull. Instead of large organizations, we may see new kinds of organizations that are based on clusters of companies that have come together in loosely coupled ways. But how do we build new innovation networks, where we can commit to long-term beliefs about the world we want to build?
John Seely Brown, Independent co-chairman Deloitte Center for the Edge / Visiting scholar USC

Education itself was going through significant changes where it depended less on accreditation, and more on a person's ability to learn the task at hand, and focus the expertise of a social network on aiding or enabling activities. In other words, a global network and an ability to learn quickly was seen as superior to a Harvard MBA. What you can do was more important than where you come from. This open meritocracy, however, was not without its dark side. As people were considered only as good as their latest project, failures were very public on social media, and people had to constantly contribute to the network to be found. You were not considered an expert if you did not constantly update and amplify your latest great idea for free on the open web.

Paradoxically the best expertise had to be given away; and at the center of this world stood search engines and social media, which facilitated this traffic. The old saying that in a gold rush you either prospect or sell pigs and shovels held true - ideas were the new gold, while search engines and social networks made money of advertising irrespective of the "guru de jour".

The role of Silicon Valley as a bed of innovation remained unchanged, but not unchallenged. India, Egypt and Kenya, with their comparatively young populations were also becoming innovation hot spots. Unfortunately, areas with rapidly graying populations, such as Europe, Japan, and China found themselves lagging behind their younger neighbors in many areas. Out of necessity, some new initiatives were born. Tele-consultations between doctor and patients were commonplace, for instance, in the Netherlands, while in 'younger' countries, waiting rooms were still severely congested. Physicians also used augmented vision aids in their glasses to see patient records. Consultation was even possible across borders. In case of an emergency abroad, consultations were made much more effective through the use of real-time translation services that were offered on most mobile phones.

A flood of second-generation mashups came to the forefront of ICT development as developers took full advantage of open Application Programming Interface software and permissive architectures due to the government's non-involvement. Layer upon layer, everything was integrated with everything else. As a result, the disappearance or failure of any single service provider did not rock the markets very much because there were enough similar providers to fill the void.

The confluence of mashup applications and mobile devices contributed significantly to the rising trend of global nomadism. From students to professionals, everyone owned a smartphone, loaded with applications. ICT infrastructure for mobile devices was so widespread and highly developed that costs for supporting this trend went down, becoming significantly cheaper. While this meant that people were more connected than ever, it also meant changing social norms. For professionals, work-life balance became a thing of the past.

2010-2013

In 2010, nobody thought ICT and the Internet could have much more to offer in terms of new developments beyond the continued proliferation of connectivity to the bottom billion through mass adoption of the mobile. It was widely viewed that there would be no more real massive innovation because ICT seemed to be maturing. The traditional ICT world consolidated, abetted in part by the increased acceptance of cloud computing as the preferred operations model by more and more companies. This move was inevitable as governments withdrew stimulus packages after the Great Recession. In that period of uncertain growth and volatility, after already cutting their workforce and squeezing higher productivity out of their remaining employees, companies had no other alternative than to cut capital expenditure costs by minimizing overhead.

As the cloud garnered wider acceptance, net neutrality once again came to the forefront of debate. Proponents of net neutrality won the argument that governments and companies should not apply any restrictions that would remove competition or hinder development. They argued that putting limitations on open spaces would mean less opportunities for all.

> *Openness is the best thing for capitalism. Closed is the best thing for monopolies, and monopolies are a starved desert of information and innovation.*
> ***Brewster Kahle, co-founder and director the Internet Archive, former MIT/Thinking Machine***

One of the areas that benefited most was mobile devices and associated vendors. Since its release in 2007, the iPhone became one of the most popular mobile devices on the market. Due to increasing demand and perceived long-term trends in mobility, its competitors, namely Taiwan's HTC and the Android phone, made a huge push to give Apple a run for its money, playing off consumer desire for more product choices in the market. The popularity of these devices led to the decline of laptops and desktop computers, such that by 2011, there were more smart phones in use than laptops. By 2013, 80% of the global working population had a smart phone of some sort. This made it difficult for those who were less tech-savvy to keep up.

While there were clear benefits to the open market, there were also drawbacks. Although there were more opportunities for mobile application vendors, the climate was such that what they produced had to be given away for free, or at such a low price that it could not begin to cover development or maintenance costs. Instead, vendors had to find other ways to generate income, such as tacking on "premier" features for an additional fee, with an added incentive of donating a portion of that fee to a charity, which appealed to the philanthropist feelings of subscribers.

2014-2017

ICT, in the form of mesh wifi and open standards, had finally reached a phase to fully support global nomadism. Towards the middle of the decade, the resurgence of second-generation mashups, resulting in part by the need for applications designed especially for a growing mobile workforce and bottom-up innovation supported by a permissive Internet architecture, led to an explosion of mobile device applications. By the end of 2017, there were 3 billion mobile applications available in the cloud. Although many applications came and went, users were not left without necessary resources as there were many similar

applications available should any single one cease to exist. Interoperability, when not taken care of by large companies themselves, was solved by the thriving open source community.

The confluence of cloud computing and the widespread use of mobile devices inevitably made the need to maintain large physical office spaces obsolete. Aside from core administrative functions that remained at a fixed address, most employees were mobile, accessing the cloud on the go. This mode of operations did not completely negate the need for mobile office space or equipment. It became popular to set up a business in a formerly empty office space, providing Internet access, conference rooms, copiers, etc., and rent the space out for a small hourly fee to employees of any company, provided that they run their own applications from their own devices. In this manner, it could be said that the model of mobile computing triumphed decisively over the model of mobile telephony.

Mobile devices became very sophisticated. More and more features were built in to create a much richer user interface that appealed to senses beyond sight and hearing. For professionals, presentations could be uploaded to their smart devices, and then through a mini built-in projector they could present anywhere, anytime. Although the projection technology for smart devices was still 2-D, prototypes for 3-D mini projectors were already being released towards the end of the decade.

I'm fascinated by augmented reality, the idea that we carry around a device that provides us with additional layers of information on top of the reality we can see and hear. Before long, we'll actually have a heads-up display in our eyeball, or on a pair of glasses, that allows us to walk around, look at something, and get additional information about it.
Tim O'Reilly, founder and CEO O'Reilly Media, Inc.

Such developments in mobile devices and ICT led to the eventual disintegration of the traditional model of education. The cost of education went down as ICT facilitated the distribution and presentation of educational material. Learning via virtual reality platforms anytime anywhere was not only fun for many students, but it also served to help cater to individual needs. The availability and accessibility of educational resources, and the de-institutionalization and personalization of education, shaped the trend towards accelerated, and life-long, learning. Despite the innovative and useful aspects of ICT in education, there were also detrimental side effects. A new social disease called "screen addiction" was spreading. Students were spending more and more time behind the screen: in social networks, in massive multiplayer online games, texting on average 100 to 200 messages a day, etc.

In China, for example, the government had a huge role in institutionalizing screen addiction. Media censorship, limits on foreign films allowed to be shown in China, and restricted programming on television – these factors all served to push the younger population to surf the Web for alternative entertainment. The Chinese government was caught in a vicious circle as it refused to relax restrictions and prohibitions, but was unable to control its citizens' need for something to do. However, in developed markets, especially in Europe, the government saw its role in terms of education as one of containing the problem of screen addiction. While it was impossible to turn the clock backward and eliminate the existence of smart devices or to forbid the use of them, governments overhauled their educational system so that students could

spend more time in the "real" world so that they could interact with each other and their environment without the intervention of a screen, keyboard or mouse.

2018-2020

The Great Recession did more than disrupt global markets; it had a significant impact on accelerating the shift from West to East and North to South. The rising influence of China and India and other emerging markets had great implications for all areas on the global agenda: from trade to foreign policy, from education to healthcare, from demographics to migration patterns. By 2018, the United States' role as the world's peacemaker was tempered by ever greater voices from across the Pacific. India and China, along with a handful of other emerging markets, asserted themselves as world powers in their own right.

The most innovative and revolutionary ideas came from countries with the youngest populations, such as India and Turkey. Because of continued strength in immigration, the United States, specifically Silicon Valley, managed to keep its position as a centre of innovation, but Japan and Europe found it difficult to keep up with its younger and more vibrant neighbors retracting their economies into steadily decreasing niches. China, realizing the barrier as an impediment to future growth, reversed its one-child policy for its citizens so long as they met certain conditions that served to distribute China's domestic population more evenly. However, the decision came too late, and its once impressive growth that used to come so easily was sorely tested by a shrinking working population that had to support the country's burgeoning aging demographic.

When designing for openness and a collaborative environment, there is always someone who says, "This won't work. What about privacy or permissions? We've really got to lock all this down, or it becomes anarchy and madness." Well, norms are changing. It will take time before the social contract figures out how to deal with that.
Ame Elliot, Researcher human/computer interaction at IDEO, Palo Alto, California

To counter the increasing burden of healthcare for the elderly, countries with a rapidly growing aging demographic sought ICT to facilitate the establishment of a comprehensive preventative healthcare system. This system monitored healthcare trends to detect and identify the onset of illnesses, such as influenza; to help contain outbreaks; and to act as an early warning system for possible pandemic. The system affected the entire supply chain, from pharmaceutical company to doctors and pharmacies to end users. In this manner, governments were better prepared to address both long-term healthcare trends and unexpected phenomena.

By the end of the decade, a functioning preventative healthcare system was fully in place in most developed countries. Because the system focused on preventing illnesses or containing illnesses before they spread, fewer people got sick, which lowered the cost burden on governments. Funds were then redirected to research and development in such areas as genomics, commonly regarded as the next scientific breakthrough for healthcare.

4. Driving forces for ICT

From 2010 tot 2020

Driving forces are the engines of change. These are long term, persistent trends, often relatively predictable in operation over the next ten years, but usually with associated uncertainties, particularly in how they might interact. These forces are not controllable, but by examining them, preparatory and anticipatory measures can be taken.

Following are discussions of twelve driving forces that emerged from discussions with almost three dozen leaders in computing and communications technologies on three continents. These driving forces are themselves composed of multiple dynamics and provide organizational structure to the scenario process. The twelve forces are:

I. Exponential Improvements in Price/Performance
II. Cloud Computing: Networked Intelligence at Scale
III. Changing Times: Atemporality, the Long Now, Deep Time, and Total Recall
IV. Big Data, Analytics, Intelligent Interfaces, and The Transformations of Media
V. Integrating Virtual and Real: Sensors and the Internet of Things
VI. Sustainability, Energy and Green Computing
VII. Business Communications: Beyond Telephone Calls and Email
VIII. Sociality and Digital Lifestyles
IX. Opening Up: Property, Markets, & Modes of Production
X. Mobile, Wearable, and Implantable Computing
XI. Globalization
XII. New Economic Models, and Approaches to Capital and Investment

This publication will take a survey approach to each of these driving forces and examines why these should be considered significant engines of change.

I. Exponential Improvements in Price/Performance

> *"In 1961, a gigaflop of computing cost $1.1 trillion dollars. Today, the same amount of computing power costs about $0.13."*
> ***Dave Evans, Cisco Systems***

For the last forty years, the price/performance ratio of computing systems has doubled every 18 to 24 months. This continuous increase in price/performance, broadly defined as Moore's Law, is now a given, and drives investment decisions in the ICT industry, among users, and in world markets. Three factors sustain this driving force:

1. Elastic demand. Since Moore's Law was first articulated, the market demand for processing, bandwidth, and storage has only increased. This makes it possible to finance continued research and investment necessary to ensure organizations keep pace.
2. Social consensus. Moore's Law is self-fulfilling; it's a clock signal for the entire computer industry. Every vendor knows it must keep pace, and knows it can count on other vendors (e.g. their component suppliers), to keep pace.
3. Separability and parallelization. Moore's Law works in the aggregate: not every aspect of system performance doubles regularly. Delays in one area can be offset by faster performance gains in another.

This continuous doubling of price/performance may violate our intuitions, and various observers have been predicting an end to Moore's Law since the 1970s.

"It's very hard for us to grasp some of those concepts," says Cicso's Dave Evans. "What does the decade after 2020 bring when we're past petaflop computing and we're doing zettaflop computing, where a desktop computer 20 years from now is equivalent to all the supercomputers on the planet today?" Evans and others suggest that by 2020, quantum computing and/or DNA-based computing could increase computing power many of orders of magnitude beyond what is predicted by Moore's Law.

But just as there is a flow of new inventions that sustain Moore's law, there is also an evolving set of impediments and resistances to it. In the coming ten years, software complexity is certain to be an issue. Another issue will be network performance: very fast computers on comparatively slow networks may not provide the kind of platform on which new applications can thrive.

Other impediments to Moore's Law are economic. Each new generation of chip manufacturing facility costs more than the previous one. For some incumbents, Moore's law undercuts profitability. The cost of providing SMS-texting and voice services has dropped, but by and large, prices have not. Ensuring a continued divergence between prices and costs of data transmission is at the core of telephone company business.

Still, to get some idea of what everyone will be doing a few years hence, it's helpful to look at what is available and attractive today to those enormous budgets and critical needs. Terabytes of storage in the average home would have seemed absurd to anyone in the 1980s who wasn't versed in Moore's Law. Petaflops in our pockets in the 2020s may be similarly hard to comprehend today, but are if anything more likely to arrive.

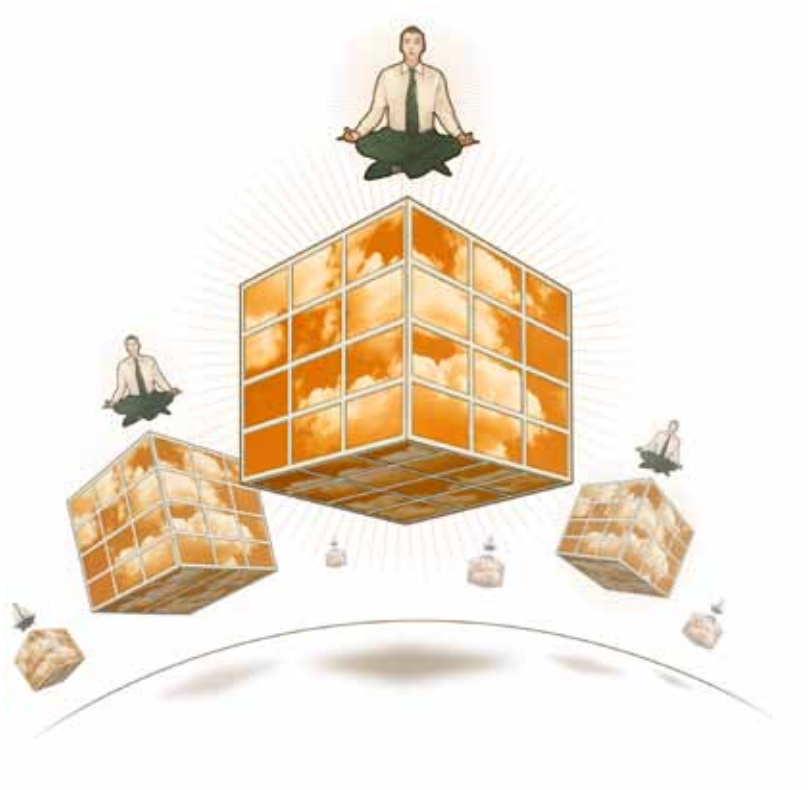
By itself, Moore's Law will not provide the kind of leaps in imagination that lead to genuinely new applications, but it will make them possible.

II. Cloud Computing: Networked Intelligence at Scale

> *"I see cloud computing as, roughly speaking, timesharing on steroids"*
> ***Vint Cerf***

Since the 1950s, there has been a cycle in ICT between architectures that put intelligence at the center of the network and architectures that put intelligence at the edge or end point. Two major driving forces of the late 20th century - the rise of personal computing and the growth of the internet - enabled the distribution of processing power and data storage to millions of network nodes, and then the consolidation of that power and storage back at the center of a massively-scalable and highly-redundant network, but with a key paradigm shift: cloud computing allows the webitself to act as the primary computing interface.

Users are no longer relying on single-point access for information. In the age of mobile phones (expected to reach 5 billion worldwide in 2010) always-on persistent connectivity is a given. In a larger sense, the mobile computing platform is a cloud device. Information must be securely and easily accessible from multiple physical locations, multiple hardware and software configurations, and often, to multiple users.



As browsers mature, they start to function as robust operating systems. Software functionality that used to be distributed across multiple programs, such as email, instant messaging, word processing and rich media players are more and more likely to be run directly in a browser window (and in the cases of both Apple and Google, with the browser itself tightly integrated with these component software pieces). This has led to the concept of Software-as-a-Service (SaaS).

Companies are increasingly moving to a service model for software and content delivery. Consumers increasingly subscribe to – rather than purchase – everything from feature films to blog content management. The economies of scale inherent in these shared services, as well as the ease of software version control, bug fixes and easily-managed tiered service offerings, make SaaS compelling to home and business customers alike.

As John Hagel explains, "At one level, you can think about the cloud as a movement back to the centre. At another level, the adoption of cloud-based services in the enterprise is actually being driven by the edge. It's the desire, as in the early days of the personal computer, for the people on the fringe of the enterprise to actually have more autonomy and capability at their hands and get independence from the IT organisation."

Yet the cloud is not a panacea; it presents new problems, perhaps most obviously, security and privacy. Because cloud computing providers centralize and manage access to customer data, the risk that this data will be compromised, monitored and/or otherwise accessed, legally or illegally, is significant and of concern to privacy advocates. It will be difficult to resolve jurisdictional issues. As Brewster Kahle explains, "the metaphor of a cloud, I think, is deeply deceiving, the idea that it's sort of everywhere and it belongs to everybody is absolutely not true."

Some developments in cloud computing seem almost inevitable. Deployment of 4G and other wireless broadband networks will support new cloud services, and demand for cloud services will drive network deployment. Additional utility services, e.g. voice recognition and other intelligent interfaces will become a part of cloud service platforms. And standards for cloud interoperability will develop so that data, applications, and environments can be ported between different cloud services. As always, standardization may be resisted by some vendors, but it's worth noting the Internet Archive recently cloned Amazon's S3 interface, and has stated that it now offers "S3 for free."

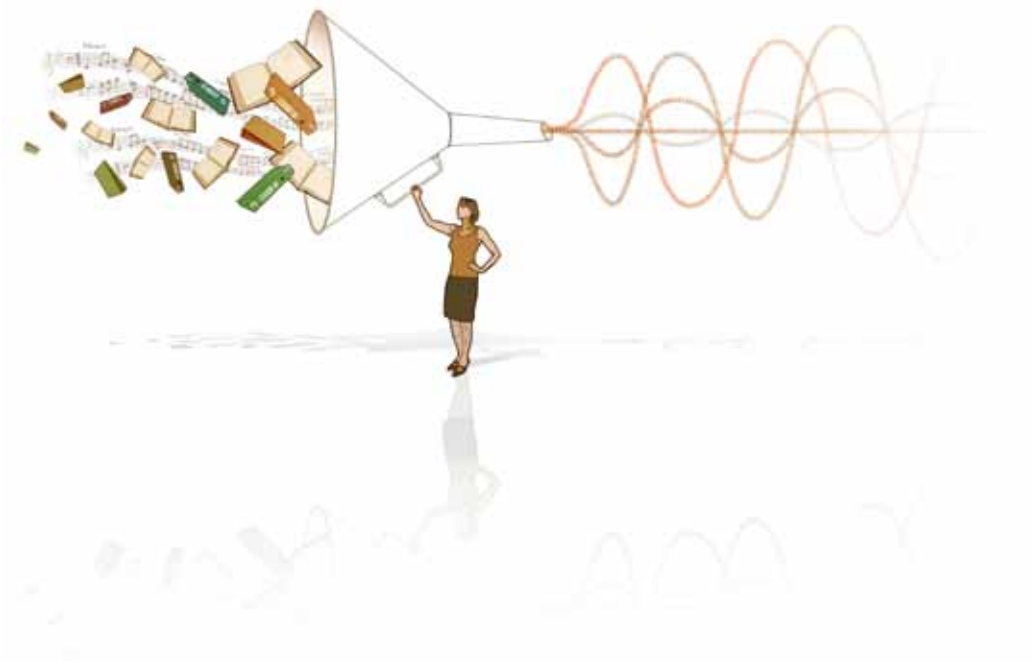
III. Changing Times: Atemporality, the Long Now, Deep Time, and Total Recall

> *"We're still in the transition of putting everything online, not just this organization but the whole world, and starting to put it together in such a way that anybody can have access to anything at any time forever "*
> ***Brewster Kahle***

As in the agrarian revolution, when astronomical calendars became important, and in the industrial revolution, when the clock became important, our relationship to time - to memory, the past, present, and future - is changing profoundly as a result of Internet technologies.

Clearly, there is a societal necessity to think longer term to handle issues such as climate change, nuclear waste, critical software infrastructure. And projecting forward into time has been a deeply held, universal human desire; the capabilities to do this, to send ever more detailed messages forward in time are rapidly improving.

But until now, time considerations on the Internet have mostly been about immediacy and real time information.



Noted computer scientist David Gelernter argues that "Internet culture is a culture of nowness. The Internet tells you what your friends are doing and the world news now, the state of the shops and markets and weather now, public opinion, trends and fashions now. … Once we understand the inherent bias in an instrument, we can correct it. The Internet has a large bias in favor of now."[1]

While our awareness of what is happening right now can be enhanced by remote sensing and by persistent connectivity, we can also gain nearly instant access to the history of persons, places, things, ideas, and organizations. Already, we can look at the world around us and see traces of the past.[2] Our casual actions are becoming a part of a searchable, accessible history. We are laying down traces that will be readable in the future, often with surprising consequences.

And there is a growing need to connect with the past via digital media. Memory prosthetics for an aging population are one example. The digitization of all the books, sound recordings, and films (see Big Data), are another.

Real time information and streams are creating a new historical record, and changing the way we interact with information. Rather than interacting with discrete pieces of information, increasingly, we will be interacting with streams of information that reach us continuously, wherever we are.

Changing our relationship to time changes our thinking about a broad range of problems. Our ability to participate in the future changes as technologies make it cheap and easy to send messages into the future. Perhaps our concepts of responsibility to the future will change as well.

But this also opens up the possibility of self-censorship: if casual, sometimes poorly thought out comments are certain to persist, why risk making a public utterance that can come back in some other context, re-interpreted to our disadvantage? Why not stick to bland and obvious truths, or simply remain silent, and leave the risk of saying what should be said to others?

[1] See http://www.edge.org/documents/archive/edge313.html

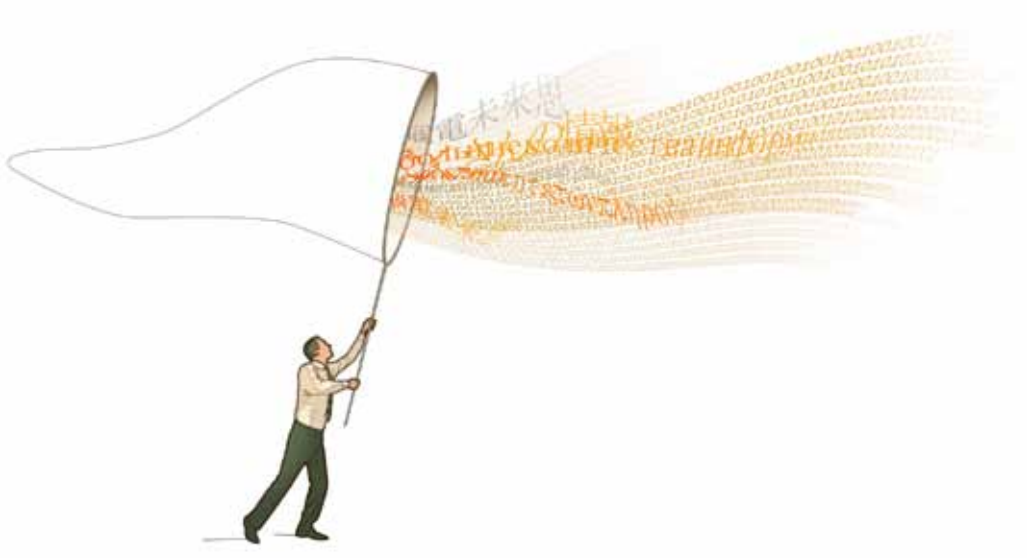
[2] See, for example, http://www.wired.com/beyond_the_beyond/2009/08/augmented-reality-and-atemporality

IV. Big Data, Analytics, Intelligent Interfaces, and the Transformations of Media

> *"It took 200 years to fill the Library of Congress with all of its content. Today, we create the equivalent of that every five minutes."*
> ***Dave Evans***

The term "Big Data" has come to mean not only the largest collections of digital information, but also the systems used to collect it, the analytics and interfaces to it, and ultimately, the ability to identify underlying causes for complex phenomena, and develop a range of systems with far greater predictive power.

Underlying these developments is continual redefinition of "Big Data" -- in 1990, that meant gigabytes. In 2000, it meant terabytes. In 2010 it means petabytes, and in 2020, it will mean exabytes. Successful Big Data applications tend to become ubiquitous as the cost of transmission, storage, and processing falls. In other instances, Big Data simply provides a progressively higher resolution of a complex model. Weather patterns, genomic data, and fluid dynamics have been staple applications for supercomputing centers for 25 years or more, but Big Data will bring ever higher degrees of resolution.



Big Data is closely tied to the evolution of media. The digitization of sound recordings in the 1980s and 1990s, the digitization of millions of books in the last five years, and the coming wave of digitization of newspapers, films, videotapes and microfilm are all manifestations of new capacities to manage Big Data. So too is the digitization and collection of new mapping data and street views.

The most startling implications of Big Data arise from the combination of large data sets with advanced interfaces and analytics. The promise is that underlying causes for complex phenomena can be uncovered, and the hope that Big Data will provide greater predictive power. For example, Google Flu Trends monitors search queries, and notes when and where users are seeking information about "flu" and other health symptoms. These query requests provide an early indication of the spread of the disease, and match data reported much later by the Centers for Disease Control.

Big Data requires and helps to create more intelligent interfaces that connect to something powerful and meaningful. Machine translation is one example. The availability of millions of books and documents carefully translated by hand is what powers the most effective machine translation services. Speech recognition, facial recognition and navigation systems are similarly aided by the availability of Big Data sets.

Restraints on the growth of Big Data, and Big Data applications happen throughout the information lifecycle, and at the level of analytic systems and interfaces. It will take time to move beyond old database paradigms. "NoSQL" approaches are gaining credibility, but are not yet mainstream.

For privacy and other reasons, certain data may not be collected or retained. The ability of companies like Wal-Mart, Amazon, and American Express to mine consumer data for early indicators of changes in buying (and bankruptcy) patterns continues to evolve and improve. American Express, for example, analyzes home prices, mortgages, and address changes to identify accounts likely to become delinquent.

This is where new tensions around Big Data will come to the fore. If Big Data creates valuable systems of prediction, then the payoff from manipulating those systems increases. The ability to predict whether a user would like a web page has created Google's value, but it has also spawned an entire industry of "search engine optimizers" intent on corrupting the integrity of that system.

V. Integrating Virtual and Real: Sensors and the Internet of Things

> *"The next billion users of the Internet won't be human."*
> ***Ame Elliott***

By 2020, trillions of networked sensors will be deployed around the planet, in the spaces we inhabit, the systems we use, the devices we carry, and inside our bodies. Sensors are a key enabling technology; with detection, measurement, computation, and communication, they can make passive systems active. Just as the addition of CCDs (Charge-Coupled Devices), GPS, accelerometers and the like have changed our interactions with devices and the network, new sensors will be better able to capture data about the environment and our intentions.

Sensors will be used to measure everything from acceleration and location to temperature, energy use, soil chemistry, air pollution, and health conditions. They will help ensure the structural integrity of airplanes, bridges, buildings and other critical infrastructure, and make our living environments more responsive to us.

The streams of data they generate will support better management of resources and provide early warnings of significant events, from impending heart attacks to climate change. They will smooth transactions, and increase the visibility and transparency of previously obscure relationships and hidden economies. The information they provide will be actionable, and ultimately, provide us with greater foreknowledge and awareness of things to come.

The old boundaries between the "real" and "virtual" worlds will therefore become ever more porous. Fully instrumented humans, environments equipped with sensors, fully annotated landscapes, views of the "real" and "virtual" worlds will evolve to meet an ever widening set of needs.

As costs decline, the variety of applications will expand. "When the price of something drops below a certain point, suddenly it becomes ubiquitous, and so, we should be thinking that storage and computation in network communication are going to be insanely cheap, and insanely ubiquitous - the fork with WiFi is not a ridiculous concept," says Marc Smith.

Perhaps the biggest barrier to this future is political: aside from the obvious privacy concerns, sensors can shift the balance between citizens and governments in uncomfortable ways. One interesting possibility is the use of sensors for taxation. "What if we could get all of our government income from taxing pollution?" asks Christine Peterson of the Foresight Institute

Sensor data will be used to inform and modify human behavior on a personal level ("hey, you need more water, more exercise, more sleep") as well a collective level ("tax policies need to be adjusted to discourage or encourage X"). Some of those modifications will flow naturally from increased transparency and improved accountability. But others will be less predictable: what will we learn as new data about human behavior becomes available?

Just as the invention of other new scientific instruments, from the microscope to the particle accelerator, expanded our understanding of the world and ourselves, sensor networks will provide unprecedented and unexpected insights into how things really work.

VI. Sustainability, Energy and Green Computing

> *"Green technology will generate more jobs than the existing industry – green tech is good for the economy, not bad."*
> ***Mitra Ardron***

The progress of computing has long been tied to electric power and environmental concerns. Even in the early 1960s, DEC's revolutionary computing designs depended in part on Ken Olsen's deep understanding of power supplies.

Today, electricity is the greater part of the ownership cost of modern servers, and for all the talk of "Green Computing" the real issue is cost of operations – the capacity of new data centers isn't measured just in petabytes, or tens of gigabits per second of network connectivity, but in megawatts.

ICT has the potential to vastly improve energy efficiency in may different domains. While the ICT sector's energy consumption and environmental impact are significant, it is also important to look beyond the obvious patterns of consumption.

The trend towards smart grids, which allow for communications between power producers and consumers to turn devices on and off to fit better with electric capacity, demand, and pricing, is a prime example of this, and an enormous market in its own right. The market research firm Zpryme predicts the global market for smart grids will grow to $171.4 billion in 2014, up from $69.3 billion in 2009.

Electric power usage also sheds light on the nature of devices in use (lower power means higher portability), and cloud computing. Researchers have noted that power consumption patterns have traditionally reflected a 50-50 balance between the edge and the core of the network. Today, power consumption is moving back towards the core, not just because of cloud computing, but because of the growing use of laptops (which consume less power at the edge).

There is also a growing amount of legislation and enforcement, and it is often the enforcement of strong policy and legislation that effects the most change. Computer manufacturers and leading technology providers such as Google, Microsoft, Apple, Dell, IBM, Intel, and others are cooperating in areas of policy, legislation, and innovation to dictate best practices for sustainability.

Achieving a greener ICT industry will involve overcoming a number of barriers, including greenwashing, over-emphasizing individual choices, toxic trade, and costs. As consumer awareness of sustainability grows, companies often use the language of sustainability in marketing their products, often without disclosing aspects of the products that are not as environmentally friendly.

Cost is often a perceived barrier to implementing sustainability policy, though in the long-term it is more likely to enable than inhibit adoption of these technologies. Initially, high-efficiency systems cost more than standard systems (the cost premium today for Energy Star desktops appears to be about $20). Better accounting, which accurately compares the increased upfront costs to power costs over the life of the device, is perhaps the most effective way increasing the adoption of green technologies.

Finally, it's worth noting that green approaches can compensate for areas in which power infrastructure is poor. For example, Vint Cerf notes that "There are places in the world where reliable power is not available. And the question is well, do you give up or do you look for ways of implementing Internet using, for example, solar energy?"

VII. Business Communications: Beyond Telephone Calls and Email

Communication, collaboration, and group formation have been central to the development of ICT, Internet technologies, and new companies since the 1970s. Though the tools, services, and companies involved in business collaboration change all the time, most successful services spring from common needs that have proven to be enduring over multiple decades.

Two of the most important business communications media – email and the telephone – seem ripe for transformation.

Email grew from simple text to support an incredible variety of functions, including file transfer, mailing lists, address books, contact management, directories, document sharing, workflow, calendaring, task management, storage, and instant messaging. It serves as both a filing cabinet and a communications medium. Yet email is showing signs of age. Email evolved when connections were not always on, and today it strains to hold our attention.

The post-email world is now taking shape, and it looks like a mix of different media. For one to one communications, short message services have taken the place of email for many people under 30, and social network services have taken over some of the function of postings to group email lists. Commercial efforts to replace email (especially in corporate settings), such as Microsoft Sharepoint and Google Wave, will receive enormous investments in marketing and R&D.

Voice communications are changing at least as quickly. Not only has the underlying infrastructure moved from copper wire and circuit switching, to fiber, IP, and wireless, but voice is becoming a service blended with other communications media, and available for free, or nearly so, to people with Internet connections. Skype, for example, includes not just voice, but video, instant messaging, and file transfer. Functional integration helped email succeed; a similar integration for real time communications seems plausible, and new capabilities, such as working voice recognition, may have an even bigger impact on voice communication.

More intelligent interfaces (such as Siri) that communicate with users, and assist in communications between humans, especially with real time translation, will further change both written and spoken interactions. "Machines are about to step into a venue, into an environment that honestly they've never been before. And that is between humans, in the synapse of society, inside the spark gap of human association. They're going to listen. They're going to notice, and they're going to be part of the interaction," says Marc Smith.

But even when new communications and collaboration technologies are clearly superior to old media, they typically face tremendous resistance, as well as collective action dilemmas: it doesn't make sense to start using a collaboration tool until there is a critical mass of other users. Adoption of new collaboration technologies typically means changes in human behavior, and those are hard to engineer.

"If you want to do something that's going to change the world, build software that people want to use instead of software that managers want to buy," writes Jamie Zawinsky in Groupware Bad.[3] "When words like "groupware" and "enterprise" start getting tossed around, you're doing the latter....The trick you want to accomplish is that when one person is using your software, it suddenly provides value to that person and their entire circle of friends, without the friends having had to do anything at all."

[3] See http://www.jwz.org/doc/groupware.html.

VIII. Sociality and Digital Lifestyles

> *"Facebook for the first time had more traffic than Google on a weekly basis in the United States."*
> ***Sue McAllister, San Jose Mercury News, 03/18/2010***

How we interact with each other and with whom we choose to associate – our sociality – will continue to drive technological change. And vice versa: not long ago, multitasking during a discussion was considered extremely rude, but today, it's a new norm.

As more of the world's population (literate and not) can access a mobile phone, they will demand services that allow for the initiation and maintenance of social relationships, though nuclear and extended families still serve as the organizing core of all societies and will continue drive sociality.

People's desire to seek out people like them (interest-based affiliations) will continue to provide a demand for systems that can satisfy that desire. "Today, I assure you that within 15 clicks, no matter what, no matter how obscure your interests are, you will find another person who shares your interest, and with that, the first opportunity obstacle to cooperation, to collective action, is removed: finding the other person," says Marc Smith. "I like to say that if you are one in a million, there's now 1,700 of you on the Internet."

This ability to connect is furthered by deliberate and inadvertent sharing of personal information. Increasingly sophisticated sensors that can detect people's relationships and their contexts (moods, location, etc.) will refine how sociality appears (see Integrating Virtual and Real).

And yet because sociality embodies enduring human qualities, many aspects will remain constant, or insulated from technological progress. Events that emphasize traditional sources of identity (geography, nationality, religion, ethnicity) will limit what new forms of sociality emerge and will slow demand for technology-supported sociality beyond the traditional ones.

ICT will create new norms between people as well. Notification norms, "social rules that govern the passing along of information," will increasingly be codified into technological systems. Technologies will have to develop context sensitivity, reacting to multiple sources of information. For example, a mobile phone should know the user is in the classroom and vibrate instead of ring, but only if it's one's mother calling, but not one's best friend. Similarly, the technological systems will increasingly respond to our moods and sensed physical states.

Technology will increasingly be applied to core life events that were previously distant from technological intervention (e.g., marriages, funerals, births, deaths), transforming notification norms.

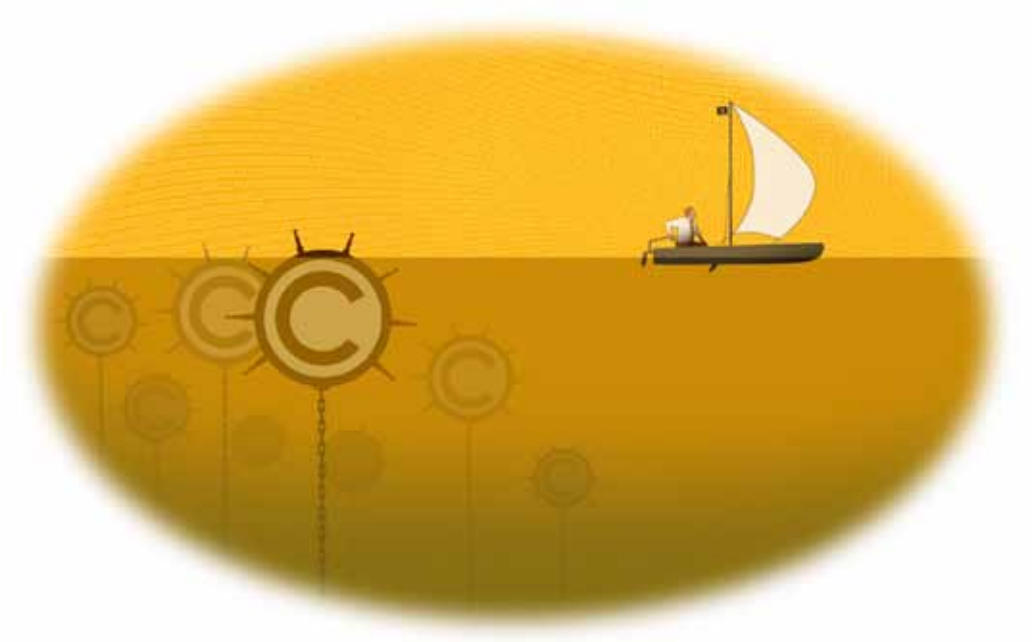
So systems will need to recognize a person's role in your social network, as well as the context of when and where they regularly contact you. Technology will need to respond to people's need to keep social relations secret for personal or professional reasons. Filtering this information is not at all about "technological" privacy (data, information, crypto, technologists talk about privacy): as Chris Nippert-Eng explains, "Privacy is about controlled accessibility to private things. 'Private things' might include anything from an aspect of the self (including one's body), a thought, a behavior, a relationship, a piece of information, a chunk of time, a certain space, or an object."

IX. Opening Up: Property, Markets, & Modes of Production

> *"The declining prices of computation, communication, and storage have, as a practical matter, placed the material means of information and cultural production in the hands of a significant fraction of the world's population—on the order of a billion people around the globe."*
> ***Yochai Benkler, The Wealth of Networks How Social Production Transforms Markets and Freedom***

The methods and measures of value creation in ICT are contested as never before. Our concepts of wealth and property, still rooted in tangibility, real property, and materiality, explain less and less about the true sources of wealth in the world. Competition is not simply between companies, technologies, or regions, but between different economic systems, business models, systems of property rights, and values.

The relationship between these systems of property ranges from cooperative engagement (e.g. IBM's adoption of open source software) to competition (Oracle vs Hadoop, Firefox vs Internet Explorer) to conflict (Hollywood vs BitTorrent networks). The effects on innovation and ICT will be complex, yet most public dialogue is highly polarized, and most predicted outcomes tend towards extremes.



The new forms of social organization enabled by ICT (see Sociality, and Digital Lifestyles) are potent enablers of open production and open standards. New approaches to realizing economic gains from open production are evolving. For example, in January 2008, Sun Microsystems paid US$1 billion for MySQL, an open source software company whose product was available for free, and most of whose developers worked in their homes.

Openness – or a controlled facsimile of it – has become a competitive strategy, especially for the second player in a market dominated by a near monopoly. This is reflected in the tension between proprietary technologies and open standards, and in specific ecosystems, e.g. in Apple's relationships with developers and with Hollywood. "Near openness" or "walled gardens" are a competitive strategy. Buyers of the iPhone and iPad are in effect trading the convenience of a well-managed environment for openness and freedom to tinker.

Another similar trade off exists around advertising. As Jaron Lanier notes, "if you make advertising the center of civilisation, there's a kind of a degradation of everybody and everything."

In other domains, openness or free content, is fast becoming a cultural expectation. Newspaper subscribers don't expect to pay for news online. Increasingly, academics, scientists, and the organizations that fund them (ranging from universities, to government ministries, to foundations) insist that scientific research be published without copyright restrictions. Open Educational Resources – free instructional materials available online – are another example of a changing cultural norm.

A common and incorrect assumption that has emerged in every information industry when threatened by open competitors is that traditionally produced material will always be of superior quality. Open source products typically improve in scale and quality very quickly, often in ways that are astonishing to incumbents.

Yet openness is not inevitable. Endeavors that require high upfront investments – chipmaking, pharmaceuticals, blockbuster movies, fiber infrastructure – are harder to support than widely distributed, capital efficient, relatively low cost activities such as software development. Media companies have tremendous political power, and they are particularly threatened by the emergence of open modes of production. The response of many publishers has been to fight for special legal protections of various kinds.

But the greatest resistance to this force remains in the imaginations of the people involved. In 1995 it was inconceivable that companies such as Microsoft might lose markets to loosely affiliated groups of programmers (like the Apache Foundation). In 2005, it was inconceivable to executives at Encyclopedia Britannica that the public might prefer Wikipedia, or that the amateur editors of Wikipedia could approach the quality of the experts writing for Britannica.

X. Mobile, Wearable, and Implantable Computing

More than five billion cell phones are in use, and the range of functions, processing power, communications, storage, and sensing provided by each one is climbing every year. In 2010, nearly 1.3 billion mobile phones will ship globally, and 250 million of them will be smartphones, according to Frost & Sullivan. Between 2010 and 2020, we will demand more of and from the mobile devices that we carry with, on or inside us. We will expect mobile devices to "know" more things, to work with other devices/systems, and to respond more intelligently to our wishes and to the environment.

As these devices become more useful, continuous interaction with ICT will be a part of life for most of the world's population. Mobility will also highlight tensions between special purpose and general purpose computing, and the growing range of mobile computing, wearable, and implantable technologies will support a range of new applications.

Decreasing cost, size, and power consumption, increasing utility, available wireless infrastructure, generational acceptance of new technologies are obvious drivers for all of this; advances in augmented reality will encourage the adoption and use of these devices, and push forward additional capabilities such as sensing, and services, such as location based information.

The assumption that everyone will have such access will affect the services provided by all institutions. The increase in services available via sms/texting (mobile boarding passes for air flights, authentication of e-government transaction in northern Europe) is an early example of this. Inclusion of mobile phones into other non-mobile technological systems to ensure interoperability is another.

Several factors could limit the potential of mobile and wearable devices. Chief among them is the monopolistic environment enjoyed by carriers and service providers who have insufficient incentives in many parts of the world to keep pace with the rate of improvement in other parts of the tech sector. On the device side, limited screen size is a barrier to certain applications. Worldwide, the typical mobile interface's reliance on text will slow adoption and use among the most recent batch of adopters, many of whom have low or no literacy.

Increased agency - independent action - on the part of these devices can be expected, and mobile devices will become even more intrinsic to people's sense of who they are. The loss or theft of a mobile device, for example, used to mean the loss of the telephony. With the proliferation of smartphones, the loss or theft of a mobile device will come to mean the loss of one's entertainment, reminders, contacts, calendar, navigation system – basically everything that people use to maintain their personal and work lives.

Implanting mobile devices that have network capacity inside of bodies will become commonplace. Devices like the three million pacemakers already implanted in people worldwide (and the 600,000 additional ones implanted each year) will be configured to allow invested parties (doctors, insurance companies, etc.) to access patient information and alerts via the Internet.

Gaming applications will merge with other activities such as education and healthcare. Games are intrinsically motivating learning environments, which share common characteristics: challenge, curiosity, fantasy, and control. The intrinsic motivations felt by participants in games are also reflected in the mode of open production, and in efforts by organizations to harness the power of the play instinct.

XI. Globalization

> *"We shouldn't be thinking what's the future for IT, we should be asking how does IT contribute to the big problems facing the world."*
> ***Jeremy Godfrey***

Nearly 500 years ago, Ferdinand Magellan led the first expedition to circumnavigate the globe, and ever since, various information technologies have driven an ever-increasing rate and volume of communication, connection, and integration between people worldwide. Internet technologies have accelerated the rise in the interdependence of economic, political and increasingly, technological systems, and from any of the most common conceptual frameworks for understanding it, globalization is rich with implications for ICT, and vice versa.

As a force for the homogenization of cultures, globalization creates a growing single market, and is fostering the exchange of values and ideas between North and South, East and West. As a trend towards widely distributed systems of design and production, it makes it possible for the ICT industry to incorporate more sources of innovation and to lower costs. As a force creating new demand for ICT, it accelerates free telecommunications, automated translation, and integration of the virtual and real worlds.

A key driver for globalization is the trend of global migration and associated job creation: humans move towards economic opportunities. Managing investment of capital and human resources properly and responsibly is a critical factor for success of ICT in the global market, and the increasing political power of multinationals means that political decisions about trade have tended towards opening up, the elimination of trade barriers, and reduction in the protection of domestic companies by national governments.

As individuals and businesses develop more global thinking, there is an increasing trend towards "glocalization", where individuals and non-global businesses consider global implications of their sourcing, purchasing and other key behaviors. As ICT globalizes, it is critical that organizations understand issues of cultural sensitivity in both the workplace and the marketplace.

In 2010, the world has passed out of a short unipolar period of disproportionate American influence, and back into a multi-polar world in which Europe is the world's largest economy, but power is distributed among a wider group of actors. This is reflected not only in political terms, but also in investment flows and comparative rates of innovation.

Globalization poses radical challenges to any local worldview. For example, European nations and the United States tend to see the increasing prominence of the Indian and Chinese economies as a new phenomenon that is surprising, while India and China see their growing economic power as a return to the natural order of things – both economies were larger than the Europe or North America until roughly 200 years ago.

Other conflicts over appropriate labor laws, environmental standards, approaches to intellectual property, and government control of information – censorship, filtering, or "protection of community standards" – highlight the tensions between local and global views.

Communication technologies and the rise of the 24 hour news cycle foregrounds the injustices and inequities of the world's populations like never before, and the tools created with those technologies (as well as the profits from those technologies) are being harnessed to fight those challenges.
In the end, there are many uncertainties about globalization, its causes, effects, and how best governments, NGOs, and commercial organizations can shape it, adapt to, and benefit from it.

XII. New Economic Models, and Approaches to Capital and Investment

In 2010, the issue that is top of mind is the continuing economic crisis.

"How are we going to get out of this debt hole that we've all put ourselves in?" asks Google Chief Economist, Hall Varian. "What's going to happen over the next five or ten years that will move us to an economically sustainable development? We've overspent, and now we're in this period of de-leveraging, and how are we going to get through that hurdle?"

The effects of debt, lowered venture capital availability, a reduced Initial Public Offering pipeline, and reduced corporate ICT spending, combined with a worldwide shift in investment priorities by pension funds, mutual funds, and institutional investors all suggest that more limited access to capital will characterize the next several years in the ICT sector.

The economic models that arise from and support new ICT applications often come as a surprise. Ten years ago, online ad revenue was negligible. Today, it supports a $200B market capitalization for Google. Similarly, texting and ringtones, major lines of business for mobile providers were a surprise.

But other aspects of new economic models are clear. Tensions over flat-rate versus usage-based pricing will take new forms for both content and services, as will the conflict over open versus closed production. A decentralized world in which commons based peer production accounts for a huge fraction of the value in the world's base of installed software would be very different. Yet high tech markets tend towards monopoly – 'winner takes all' is the norm. Apple, Google, Amazon, Microsoft, Oracle, and IBM hold the lion's share of their respective markets. This tendency towards 'winner takes all' what has made investments in ICT companies so attractive, and the fortunes of the computer industry will be tied as much to worldwide investment priorities as technological innovation.

Richard C. Koo, Chief Economist of Nomura Research Institute suggests that western economies must learn from the experience of Japan, where a "balance sheet recession," created by "bursting of a debt- financed asset price bubble that leaves many private-sector balance sheets with more liabilities than assets." Koo explains that "to repair their balance sheets, private sector moves away from profit maximization to debt minimization."

While employment levels in the high tech sector have not dropped as severely following the dot-com crash in 2001, venture funding levels are still only about 20 percent of what they were at their peak of $27.3 billion in 2000, according to statistics from PricewaterhouseCoopers and the National Venture Capital Association (NVCA). In a survey of members, NVCA found that "An overwhelming percentage of VCs (90 percent) predict that the number of venture capital firms will decline over the next five years."

At the other end of the venture pipeline, Initial Public Offerings are still relatively rare, at least in the U.S. Entrepreneurs have responded by building "lean startups" that are smaller, faster, more capital efficient, and more engineering focused, often with the goal of being acquired, rather than taken public.

In the end, corporate, government, and consumer spending for ICT is effectively a competition with other spending priorities set in part by the level of returns. While Moore's Law creates a kind of push, it's the elastic demand for storage, processing, and bandwidth that will continue to drive ICT through 2020.

Afterword: a disclaimer and an open invitation

Do we now know what the world will look like in 2020? Well, in a word: no. But we do have a better idea of what we should be looking for, and how to prepare for it. Are these the only scenarios that could have resulted from this process? Of course not, the future is far too complex to capture in four scenarios. And no, this not a formal policy document of the Dutch Ministry of Economic Affairs. And – again – no, the ministry will not base all of its future policies on it. But yes, this is an important starting point for many discussions. The scenarios are not complete or even finalised, but they do provide valuable insights into what the world might look like in 2020 and what the role of ICT could be by then. Then again, the purpose of the scenario process is not to predict the future, but to explore the implications of the possible futures of our present actions. We expect there is a lot about the scenarios you would like to challenge, change or comment on. Please do!

Once the decision was taken to embark on a journey to the future of ICT as it will be in 2020, we opted for scenario thinking because it allows us to identify uncertainties and to look at the future from different perspectives. Scenarios help us to work towards a robust strategy that still allows for flexibility – which is crucial given the turbulence of the world and the dynamics of our core subject: ICT. During the process many assumptions were reviewed and challenged. It has been a fascinating journey so far, but the hardest part is probably yet to come: sharing and discussing the results, and arriving at a shared vision on how to proceed from here. For the next few years we hope that the issues raised in these scenarios will be thought about and discussed time and again. Your participation in this is most welcome!

Appendix 1 List of Experts

Interviewees in order of being interviewed:

Vincent Cerf	Vice President & Chief Internet Evangelist Google Inc.
Robert Kahn	Chairman, CEO and President of the Corporation for National Research Initiatives (CNRI)
Marc Smith	Chief Social Scientist Connected Action Consulting Group
Christine Peterson	Co-founder and Vice President Foresight Institute
Mark Finnern	Chief Community Evangelist SAP Labs, head Future Salon
Ame Elliot	Senior Human Factors Specialist, IDEO
Jaron Lanier	Computer Scientist
Tom Gruber	Co-founder and CTO SIRI
John Seely Brown	Independent Co-Chairman Deloitte Center for the Edge, Visiting Scholar and Advisor to the Provost USC
Rishab Aiyer Gosh	Co-founder and VP Research Topsy Labs
Brewster Kahle	Co-founder and Director Internet Archive
Hal Varian	Chief Economist Google
Tim O'Reilly	Founder and CEO O'Reilly Media Inc.
John Hagel	Director Deloitte Consulting LLP
Dave Evans	Chief Technologist Cisco Internet Business Solutions Group
Mitra Ardon	Consultant Mitra Technology Consulting
Peter Leyden	Co-Founder Next Agenda
Teruyasu Murakami	Chief Counsellor Nomura Research Institute
Jun Murai	COO of DMC Institute, Vice President Keio University
Izumi Aizu	Kumon Centrer, Tama University
Shumpei Kumon	Professor and Director Institute of Infosocionomics, Tama University
Yasu Taniwaki	Division Director ITC Strategy Global ICT Strategy Bureau, MIC
Isaac Mao	Co-founder Social Brain Foundation
Yat Siu	Founder and CEO Outblaze
Charles Mok	Chairman Internet Society Hong Kong
Jeremy Godfrey	Hong Kong SAR Government Chief Information Officer
Sourav Mukherjee	President and CEO Netscribes
Munwar Shariff	CTO Cignex
Alok Pathak	CEO Idhasoft
Sudhakar Ram	Chairman and Managing Director Mastek
Dr. Kanodia	Chairman and Founder Datamatics Group
Rahul Kanodia	Vice Chairman and CEO Datamatics
Yochai Benkler	Co-director of the Berkman Center for Internet and Society, Harvard

Participants workshop 29th of January 2010

Philip Balakirsky (BZK/VRD), Eric van Cappelleveen (BZK/VRD), Roy Keesenberg (OCW), Mariska Zwinkels (OCW), Dorien van Gastel (ECP-EPN), Herman van Bolhuis (CIOnet), Frans Panken (ICT Regie), Dirk van Roode (ICT Office), Brigitte Zonneveld (EZ), Jurrian Meeter (EZ), Richard Blad (EZ), Marian Sanders (EZ), Claire Wannee (EZ), Patrick Schelvis (EZ), Lousian Pot (EZ), Krispijn Beek (EZ), Sjef Ederveen (EZ), Wolf Tostman (EZ).

Participants workshop 30th of March 2010

Patrick Aerts (NCF), Pallas Agterberg (Alliander), Hans Appel (formerly SUN), Arie van Bellen (ECP-EPN), Davied van Berlo (LNV), Erwin Bleumink (SURFnet), Herman van Bolhuis (CIOnet), Hans Bos (Microsoft), Bas van de Haterd (Van Haterd Consultancy), Tonnie van der Horst (Rabobank), Nicole Kroon (EZ), Toine Maes (Kennisnet), Leo Smits (Het Exertise Centrum), Lineke Sneller (Tele2/Nyenrode), Andrew Sordam (Oracle), Coks Stoffer (Cisco), Arjen Pieter Vriens (Motorola), Jan de Waal (Internet Branch Vereniging Nederland), Kees Rijsenbrij (Hogeschool van Amsterdam), Dirk van Roode (ICT Office), Olaf Andersen (BZK), Justiene Marseille (Trendwatcher), Peter Retera (Siemens), Frits Bussemaker (Program Director WCIT 2010), Marleen Stikker (De Waegh Society).

Appendix 2 The Structure and Elements of Scenario Thinking

The scenario process over the three-month period of creating the scenarios followed five steps. This gave structure and punctuation to the process, without which it would be, a loose set of conversations about possible futures. They were conducted in workshops, and in internal and external consultations with experts. The final outcome of the process is scenarios suggesting different possibilities and challenges. Herewith a short outline of the process that we used to create the scenarios.

Determining the focal question
In order to determine the focal question we had a workshop at the Ministry of Economic Affairs with internal policy makers and external experts.

Based upon this understanding we asked ourselves what key question we would like to have answered about the future that would enable a new level of strategic conversation. Scenarios are most relevant when they address a particular aspect of the future. That aspect should be a major issue or decision that faces organisations in the ICT Sector. Our focal scenario question is: What is the role of the ICT and how will it drive economic activity in 2020?

External Consultations (Interviews)
Scenario thinking stresses the importance of hearing new voices, from external experts who are outside the organisation's sphere of influence; individuals which have no interest in the ministry but are engaged, instead, by the ideas that are being explored in the scenario process. These interviews are a necessary part of the process to identify the driving forces that form the bases of the scenarios. Simultaneously, their ideas, insights and perspectives are expected to broaden the thinking of the scenario participants and to prompt them to think in new directions and uncommon ways.

The interviewees all are prominent in their respective fields. They are selected not only for their experience in their specific sector or field; but also for their trenchant perspectives, their critical and unorthodox views, and creative insights they bring to the discussion. For the Ministry of Economic Affairs process, 33 experts from around the world were interviewed. We conducted interviews in Washington, San Francisco, Tokyo, Hong Kong, Mumbai and Brussels. These interviews were videoed and are described as quotes throughout the scenarios and driving forces and will be made available on the associated web site www. futureofict.com

The scenarios would never have been possible without the gift of the time of the thirty three people we interviewed. In almost all of the cases the interviewees committed to a lengthy two hour interview out of their schedules, in order to get "below the surface" and allow us to address the long term assumptions and uncertainties.

Understanding the Driving Forces
Expert interviews give us a broad and multidisciplinary understanding of the scenario topic. Based on these consultations and broader desk research, the group identified a number of critical influences or driving forces behind the uncertainties that are in the landscape. Driving forces give us a sense of the deeper forces that are shaping our strategic space. It is the forces that interact with each other to create patterns of events that are often called trends. In scenario thinking these driving forces are recognized as factors beyond our control or influence, but for which we can anticipate and prepare.

Determining the key uncertainties
In our second workshop together with industry experts we reviewed the interviews, desk research and driving forces to decide which scenario stories about the future we are going to tell. If we want to describe the role of ICT and the Internet in 2020, what stories are important to know? Or stated slightly differently: how can we create stories that challenge our strategic context best?

It is important to note that this is a messy process, and that the neat decision tree that describes the scenarios in the scenario chapter was determined after the fact. It is a communication tool that help us explain how the scenarios could emerge rather than a thinking tool as it is often presented.

Crafting the scenario stories
Based on the uncertainties and the driving forces that were identified, the participants, Ministry of Economic Affairs and the DTN with external consultation developed a set of 4 scenarios, each describing a possible future and its environment. Developing the scenarios is itself a journey of thinking through the causality of possible scenarios themselves, a process of recognizing different situations that might happen, instead of one specific set of things happening in the world. As different possibilities, the scenarios are not options from which the ministry will choose one as the most likely, or one as its preferred future in which it can choose to operate. All are plausible, all are situations that can happen and all are outside the influence of a ministry or a company to control.

Scenario stories are not written in a single session, but are written and re-written. In this case we re-wrote the scenarios nine times each time changing a causal sequence here, bringing in an insight from the interviews there, etc. A good scenario set strikes the difficult balance between being surprising yet plausible. Only if a scenario is surprising will it introduce new elements into the strategic space and only if it is plausible will executives and policy makers respond strategically to the new challenge.

Colophon

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