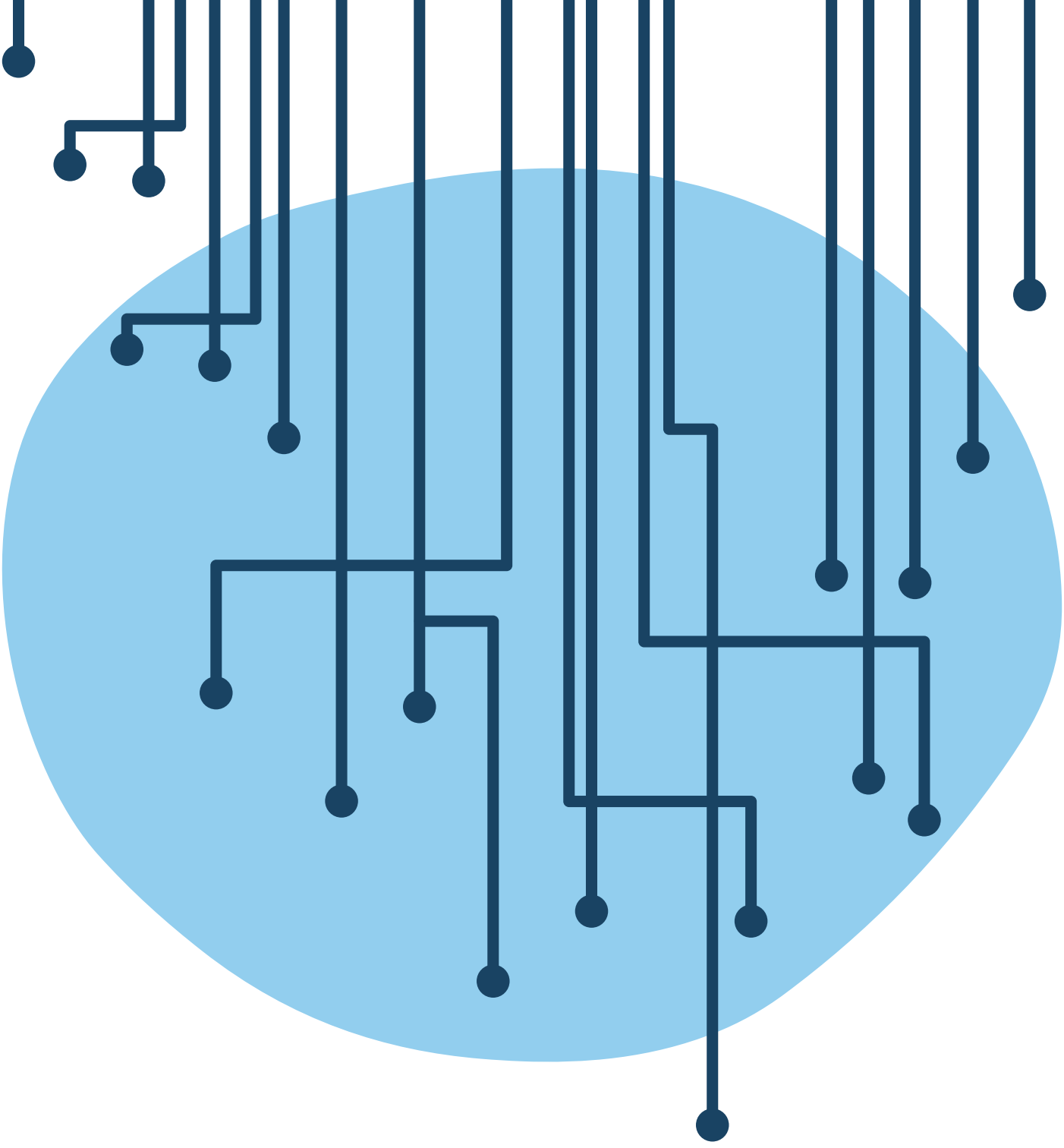
Swedish Agenda for the Future Internet

Denna agenda är framtagen inom ramen för Strategiska innovationsområden, en gemensam satsning mellan VINNOVA, Energimyndigheten och Formas. Syftet med satsningen är att skapa förutsättningar för Sveriges internationella konkurrenskraft och hållbara lösningar på globala samhällsutmaningar.



Swedish Agenda for the Future Internet

Executive Summary

THE MAIN OBJECTIVE FOR this agenda is to facilitate for the Swedish society and industry to fulfill their plans for social and economic growth as well as to support the business models and services of all companies that are already dependent on the existing internet infrastructure. This agenda contributes to this objective by ensuring continued access to an open and scalable, reliable and secure internet infrastructure. Highlighting this objective now will give the Swedish ICT-industry a window of opportunity, or rather a competitive advantage, in providing the global market new products and services to establish this new infrastructure.

The further development of the internet is a prerequisite for economic growth, by allowing innovative ways to increase the efficiency of electronic communications and electronic services.

It might also contribute to challenging common practices of production, and thus it would contribute to redesigning our established ways of providing services.

The future internet agenda describes strategy, and plans for further development of the global internet. The agenda will contribute to unleashing the potential and unused resources in several sectors of society relating to internet development: resources that have both social and economic benefits.

This agenda has evolved from five workshops with a multitude of internet infrastructure stakeholders. During the workshops, several development areas have been identified and the following six were prioritized.

1. Research, innovation and entrepreneurial development
2. Identity and access management
3. Internet access
4. Resource management in private networks
5. Personal privacy and digital trace
6. Open and de facto standards

A list of proposed actions for the selected areas has been compiled during the workshops. Proposed actions are published in unedited format at URL: https://www.iis.se/lar-dig-mer/rapporter/swedish-agenda-for-the-future-internet.

An overarching conclusion of the agenda is the need for coordination of focus areas and the proposed measures. We propose that Swedish coordination of the internet's multifaceted infrastructure could take place within a multi-stakeholder and independent entity with representatives from academia, civil society, technical community, business and government. This entity could assume the shape of an independent foundation, not for profit organization, or an independent company. It is envisaged that an independent board, consisting of representatives from such stakeholders, could be the Swedish node for such coordination. It would preferably be non-governmental and non-business-based, with a chair of the board who would be independent of the stakeholders.

As the internet infrastructure is not a specifically isolated Swedish function, the coordinating entity would need active participation in e.g. de facto and international standardization organizations, protocol development bodies, an active and continuous engagement in other governmental aspects as international internet governance and development of well-functioning business models. The coordinating entity's relation to research organizations and academia (and funding) would also need to be developed.

Summary in Swedish

DET ÖVERGRIPANDE MÅLET FÖR denna agenda är att bidra till social och ekonomisk tillväxt i Sverige. Det ska ske genom att optimera internets infrastruktur och internetanvändning, till förmån för alla och allt som är uppkopplat. Agendan bidrar till målet genom att främja allas tillgång och anslutning till en öppen, skalbar, stabil och säker internetinfrastruktur. Dessa egenskaper är förklaringen till de historiska svenska framgångarna för internetutvecklingen i Sverige och bedöms även vara ett framgångsrecept för den fortsatta utvecklingen.

En skalbar och stabil internetinfrastruktur är en avgörande förutsättning för informationssamhällets fortsatta kraftiga tillväxt i Sverige. Som ofta är fallet med infrastruktur att den bara ”syns” då den *inte* fungerar. Om infrastrukturen *inte* lyckas expandera i takt med efterfrågan hindras inte bara IT-sektorn som avgränsad näring, utan effektivisering och tjänsteutveckling i alla branscher i samhället som i en allt ökande takt blir del av informationssamhället.

Agendan har tagits fram i samarbete med en bred representation inom internetsamfundet i Sverige under fem arbetsmöten. En lång lista på möjliga åtgärder för en förbättrad internetinfrastruktur har tagits fram. Förslagen har samlats i sex fokusområden, områden som kan bidra till att strukturera åtgärder samt till att identifiera vem som är lämplig att genomföra dem. Dessa områden är:

1. Forskning, innovation och entrepreneuriell utveckling
2. Identitets- och behörighetshantering
3. Internetåtkomst
4. Resurshantering i privata nätverk
5. Integritet på nätet och elektroniska spår
6. Öppna och de facto-standarder

För vart och ett av dessa områden har en lista över föreslagna åtgärder sammanställts under arbetsmötena. Förslagen publiceras i oredigerat skick på adressen https://www.iis.se/lar-dig-mer/rapporter/swedish-agenda-for-the-future-internet.

En övergripande slutsats av agenda-arbetet är behovet av en systematisk och långsiktig koordinering av åtgärder för en stabil och säker internetinfrastruktur i Sverige. Internet är idag en infrastruktur som tillhandahålls av en mångfald av aktörer genom avtalsrelationer. En sådan koordinering bör därför ske med bred representativitet bland de intressenter som har direkt anknytning till att tillhandahålla sådana tjänster. I likhet med internationell praxis bör koordineringen ha representanter från akademi, det civila samhällets aktörer, teknikersamfundet, affärsintressen och offentlig verksamhet. En sådan koordineringsenhet bör ha en relativt stor grad av självständighet med balanserat inflytande från alla intressenter. Verksamheten skulle vägledas av ovanstående värden om ett öppet internet och koordineras och ha sin hemvist hos en icke vinstdrivande organisation.

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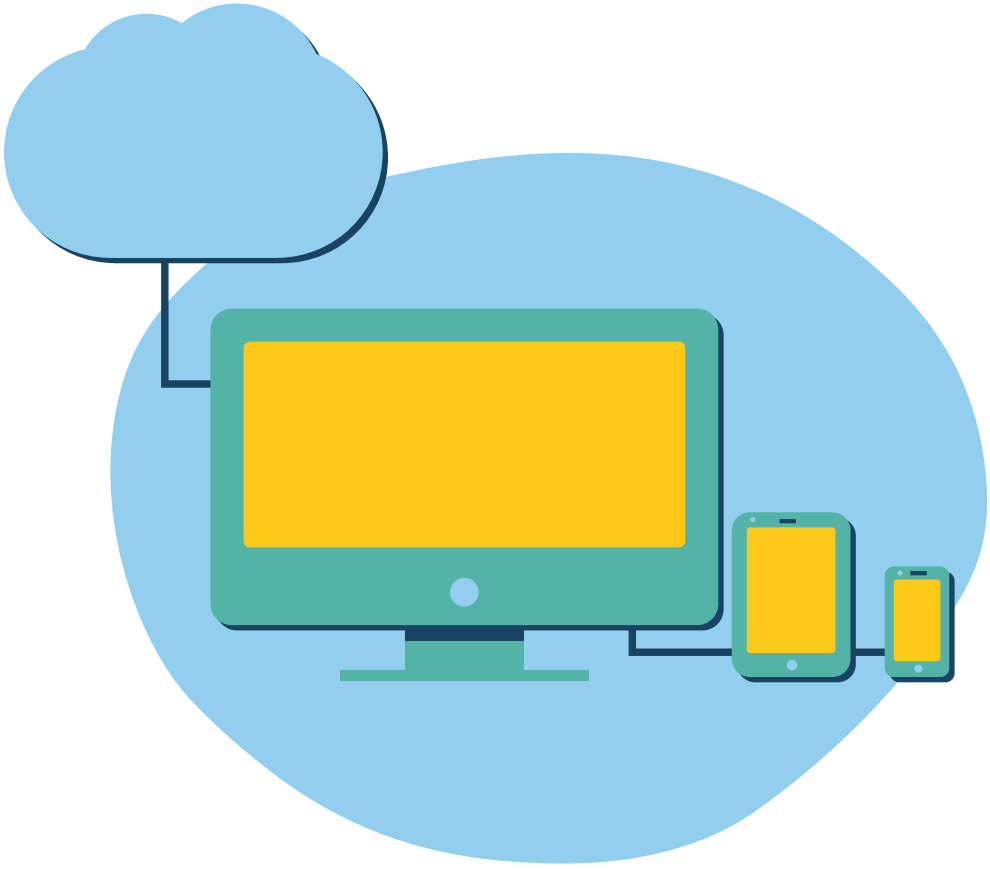

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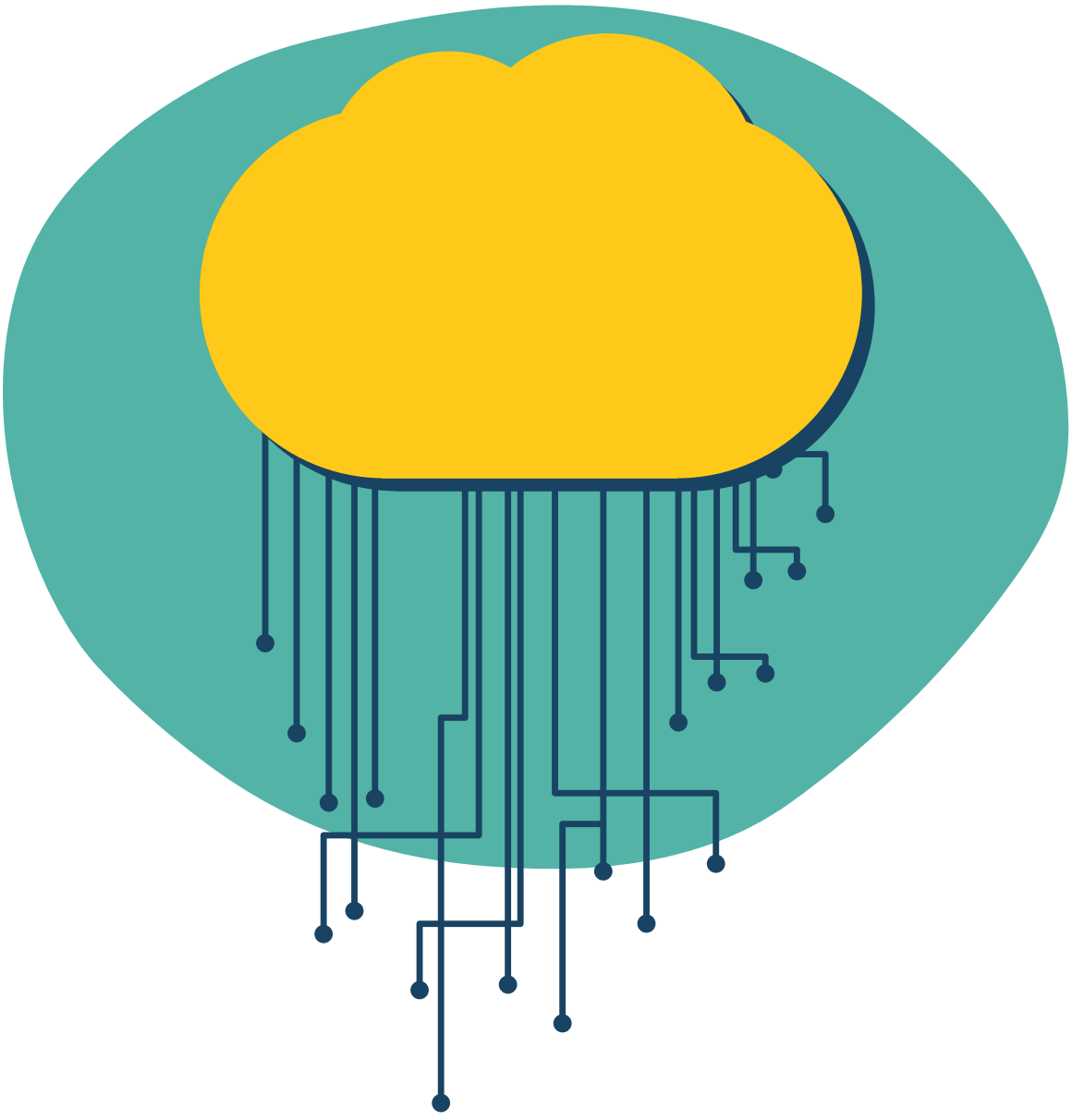
How the agenda was developed

The agenda has been developed in five seminars with a broad multi-stakeholder reference group. The diversity of the reference group is used to safeguard a multitude of knowledge, interests and needs. The reference group is designed specifically to draw on the experience and insights of individuals, trusted for their perspectives and their ability to contribute to the future internet. The proposals that emerged during the seminars were categorized, and prioritized by participants, into six focus areas. Since a universally accepted definition of the internet infrastructure is missing, this group initiated work by establishing a baseline describing the current infrastructure. This common understanding of the infrastructure was partly elaborated as a starting point, and partly for rallying commonly accepted terminology. Subsequently, once common ground was established, the group, with the help of different sector scenarios of a proposed future, focused on listing necessary actions or reforms. The resulting proposed measures within the six focus areas form the core part of the developed agenda.

Introduction



THE INTERNET HAS BECOME a critical infrastructure for our society. Today it is seen as the main enabling technology for globalization of the service industry and of society's grand challenges in regards to communication in general. Internet services have evolved from simple applications such as e-mail, file transfer and virtual terminals to services that support distributed information processing and storage systems, critical industrial applications, never closing public services, such as e-health, banking, e-business, as well as interactive media and streaming of live and recorded media. The internet has become the backbone of the information society. Swedish internet penetration is among the highest in the world: 90 percent of ages 16 to 74 use the internet weekly.

As internet usage has diversified, the internet has evolved from a simple IP network, providing a best-effort service, to a complex of communication technologies, such as peer-to-peer distribution, content-distribution networks, various middlebox functions, traffic shaping and most importantly, all forms of mobile communication. Today, expectations are both high and diversified, as well as demanding, regarding capacity and quality of services to a constantly lower cost.

The internet is also expected to deliver a stable and resilient infrastructure even when it is under massive denial of service attacks. Important services that are part of the infrastructure have also evolved: search services, identity federations, anonymity services, name resolution and mobility support. The internet has developed from interconnecting computers to general cloud-based services. Today, the internet is perceived rather as a system for distributed information processing, a cloud-based storage system, and services based on streaming of live and interactive media. The increased expectations on the internet also reach further than just its infrastructure. Online privacy, freedom of information and freedom of speech all coincide under the rule of law.

The original internet design was neither intended for the diverse set of applications we have today, nor the multitude of communication technologies. The internet's infrastructure could be and needs to be improved in several ways, not the least with respect to mobility, security, malicious attacks, governance and ad-hoc attachment of users. It is important to realize that the internet evolution has just begun, and it will continue. The requirements on the network infrastructure will continue to evolve, opening up for new pioneering innovations and business opportunities. Yet, not enough thoughts and efforts are spent on the infrastructure itself.

This proposal outlines an agenda for Sweden on how to contribute to the infrastructure of the Future Internet and at the same time help the Swedish society, businesses and ICT industry to stay at the forefront.

From new technology to innovation

Historically, there are several reasons for the success and rapid rollout of internet technology. These reasons relate to the inherent features of the internet technology itself.

- An early design decision to separate services from the transportation of data is often outlined as one key success factor. The separation of transport and content has made it possible from the start to relay internet traffic over virtually any carrier.
- That access to the network was not confined to separate technologies and business models, was another success factor. Low thresholds for market access and for innovation are two other common explanations. In short, it means that anyone on the internet can easily launch a new service and instantly reach a worldwide market.
- The ability to use cost and license free standards for internet access has resulted in a rapid growth of producers of internet equipment.

From innovation to societal change

In economic terms, initially low thresholds for innovation already gave the network economic rationale from the beginning. The introduction of the technology also challenged old, and soon-to-be outdated, production methods for established services and products. It introduces new production methods, and even more importantly, it allows new ways for production. For example, three-dimensional printing of physical objects might not only reshape *how* and *where* we produce, but will also have secondary systematic effects on transport and logistics.

In technological terms, the internet has developed from interconnecting computers to enabling general cloud-based services. Today, the internet is perceived rather as a system for distributed information processing, a cloud-based storage system, and services based on streaming of live and interactive media. This is also the scope of the internet assumed by this agenda.

We are now in a second or maybe third phase of technology maturation where internet technology has become a de facto standard for electronic communication. It is apparent that the internet today is a key enabler for economic and social growth. The technology already contributes to economic growth by providing new services.

The basic internet infrastructure is still a fundamental platform for development, and is of increasing importance for all other services. That is where this agenda begins.

The Agenda – and what's in it for Sweden

WRITING A SWEDISH AGENDA for the Future Internet is an ambitious and demanding endeavor. The use of information and communication technologies (ICT) has already penetrated the Swedish society, both in public and in the private sector, as well among small and medium sized companies (SMEs) as in public sector agencies and municipalities. ICT is ubiquitous in the Swedish society and all stakeholders expect the internet infrastructure to scale, i.e. to expand seamlessly at the same pace as the demand increases.

Vision

The vision for the agenda is *the internet is for all and everything*. It takes an inclusive and user-oriented approach, where everybody and everything should

be able to have internet access. The vision is operationalized by the objective presented below.

Objective

The main objective for this agenda is to facilitate for the Swedish society and industry to fulfill their plans for social and economic growth as well as for all companies' business models and services dependent on the existing internet infrastructure. This agenda contributes to this objective by promoting continued access to a ubiquitous, open and scalable internet, based on a reliable and secure internet infrastructure that invisibly fulfills the demands of all users.

Highlighting this objective now will give the Swedish ICT-industry a window of opportunity, or rather a competitive advantage, in providing the market with new products and services to establish this new infrastructure. The agenda will leverage Swedish research, development and operational expertise to build new underlying internet services and tools for everybody, to be used for future services and products. The aim of the agenda is to create innovations within internet services that enable these actors to develop highly competitive products and services.

This agenda aims at addressing implicit expectations on the growth of an open internet infrastructure. It aims at identifying hurdles and obstacles before they occur, in order to allow for continuous uninterrupted expansion. The intent of the agenda is also to pinpoint coming demands for ensuring a stable, secure and resilient internet infrastructure of tomorrow and to inspire the ICT industry to develop highly competitive products and services. This is operationalized by:

- Defining requirements and innovative solutions for the future internet infrastructure and for enabling new services and applications on top of it.
- Identifying research efforts where focus should be on open flexible and accessible architectures, on higher layer of communications protocols and on infrastructure services.
- Addressing existing needs to improve the infrastructure as well as to facilitate new usages and applications. It includes operational and management aspects, end-user needs and design and development of products.

The Swedish Agenda for the Future Internet is expected to result in new services and applications. It might entail enterprise and home solutions as well as improvements for internet service providers. It may further contribute to services, administration, operation and management systems and procedures for the infrastructure.

Trends and views

In general terms, we foresee a future internet where focus increasingly shifts from infrastructural aspects to the general task of information handling and of providing the right to access information. The right of access to information is in part an issue of immaterial ownership, and in part the means of accessing the information. But internet development is increasingly more than implementing technology. Change in technology is fast, and it is accompanied by changes in legal, regulatory and business views.

Technical view

In the Future Internet, decentralization can be anticipated in a multitude of services, all based on and dependent on a working and scalable internet access. A ubiquitous internet is the backbone for further connected technologies, and therefore necessary for future internet development. The Internet of Things (IoT) together with constant online wearables are examples of some of those connected technologies. We can also foresee a rapid increase in the deployment of sensors, and with them online services in the connected home, in health-care, in optimizing transportations and logistics, in self-driving cars, etc.

In parallel, we anticipate an opposite trend towards the centralization of data. The amount of stored and controlled data is expected to grow exponentially. Centralizing stored data (and the associated services) will make us increasingly more dependent on secure and resilient data transmission with low latency.

Sector specific services can be anticipated to continue to develop using data together with data analytics. Such services will need economies of scale, with the implicit need to simplify, rationalize, reuse and eventually standardize services. But at the same time, the internet can also be expected to contribute to the diversification of services.

Regulatory and legal views

Internet development is also intrinsically interdependent with other trends like internationalization, regional and national specialization and the internet's challenge to the nation state regulation. Internet infrastructure is today under scrutiny from several policy bodies and political aspects of society. There are international, European and Swedish processes going on in parallel.

In the arena of international internet governance, the process of finalizing a privatization of internet infrastructure is in its final stage. It is the US regulatory agency NTIA that, in 1998, started to transition the stewardship of the fundamental internet infrastructure to the multi-stakeholder community of the internet.[1] These mechanisms for global control over internet infrastructure are still challenged in the global internet community, e.g. in the United Nations, and in individual nation states. Several cross-border legislations pose a challenge to the existence of a unified and universal internet.

The European Union recently formed a Digital Single Market Strategy, where a digitalized inner market is one key enabler for economic growth and jobs in the union. The EU also relies on the regulation of the Telecoms Single Market (TSM) and regulation for the Network and Information Security (NIS) directive. Furthermore, the European Parliament will soon decide on rules for integrity online, rules that will have effect on a unified internet.

The Swedish government has recently announced its intentions to focus on internet security through development of public sector electronic communication (e-government). Public electronic services might contribute to establish de facto standards for end-user security solutions such as electronic signatures for ensuring privacy, and security of end-user data. In the spring of 2015, the Swedish government also published a report on the revision and implementation of European privacy directives.

Market and business views

Net neutrality is a multi-faceted term somewhat esoteric and elusive. Current debate on net neutrality relates to several views, such as internet traffic management, policy, regulatory and also business considerations. It is a debate on the right for internet operators to provide two-tiered internet access, i.e. differentiated internet access-quality based on payment (a 'fast lane internet' and 'slow lane internet'). Technical traffic management (prioritization of certain internet content) is central to this debate.

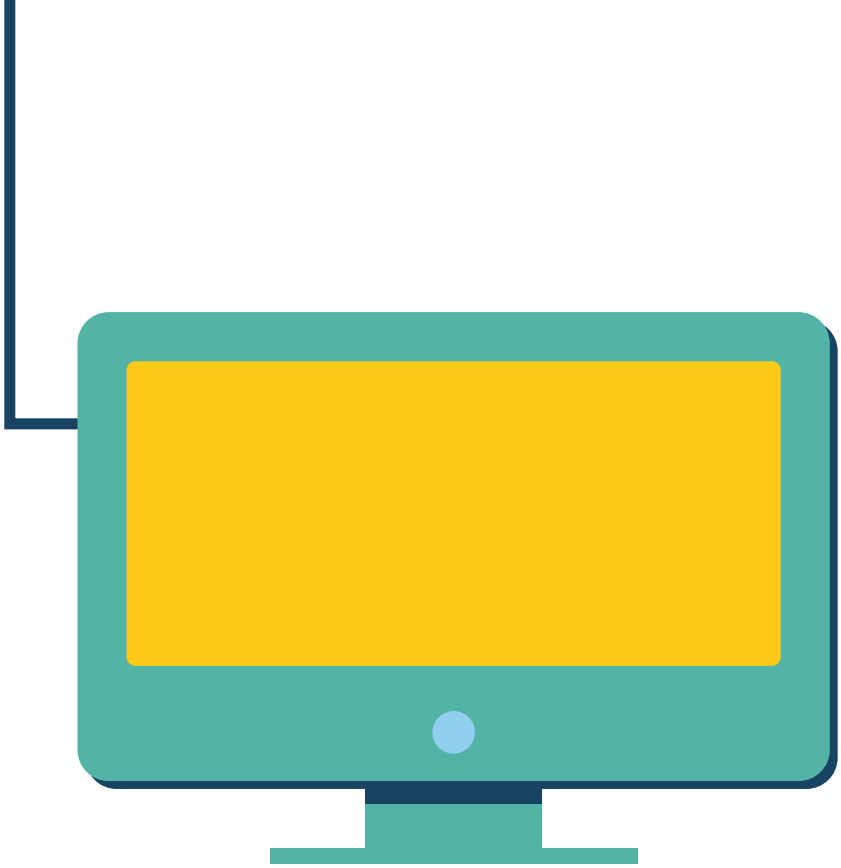
In economic terms, the future can be expected to deliver less costly internet access, but increased cost for information, i.e. a shift from value bound in capital, to value bound in information. Whereas information value increases, so will the need for secure services, ensuring exclusive access and control of stored information. One such trend is to give access to publicly gathered information (open data) available for commercial reuse and similar (e.g. European Union PSI directive).

Specifics for Sweden

The internet is a truly international artefact, developed globally and without any considerations of national borders. In this capacity, internet technology, just by its design, poses a constant challenge to nation-state policy and politics. So, what are the unique features and rationales for a specific Swedish internet agenda?

Sweden already had, during the early internet days, a broad and solid ICT maturity. Today we still find confirmation of that culture, in different ICT readiness indexes. Sweden typically tends to be amongst the top five countries in several rankings. These indexes often weigh readiness from several aspects. Internet access and delivery capacity are often starting points. But enablers for Sweden are also to be found in other aspects, like broad user skills in the population, attention to usability, and the ability to bridge

[1] In March 2014, NTIA announced that it is prepared to hand over the final control mechanisms of the internet to this global community. The NTIA has recently asked the internet community to come up with a plan, and an institutional design for ensuring the continued operations of IP-addresses, technical standards and the domain name system. Anticipated transfer date of the infrastructure stewardship is July 2016.



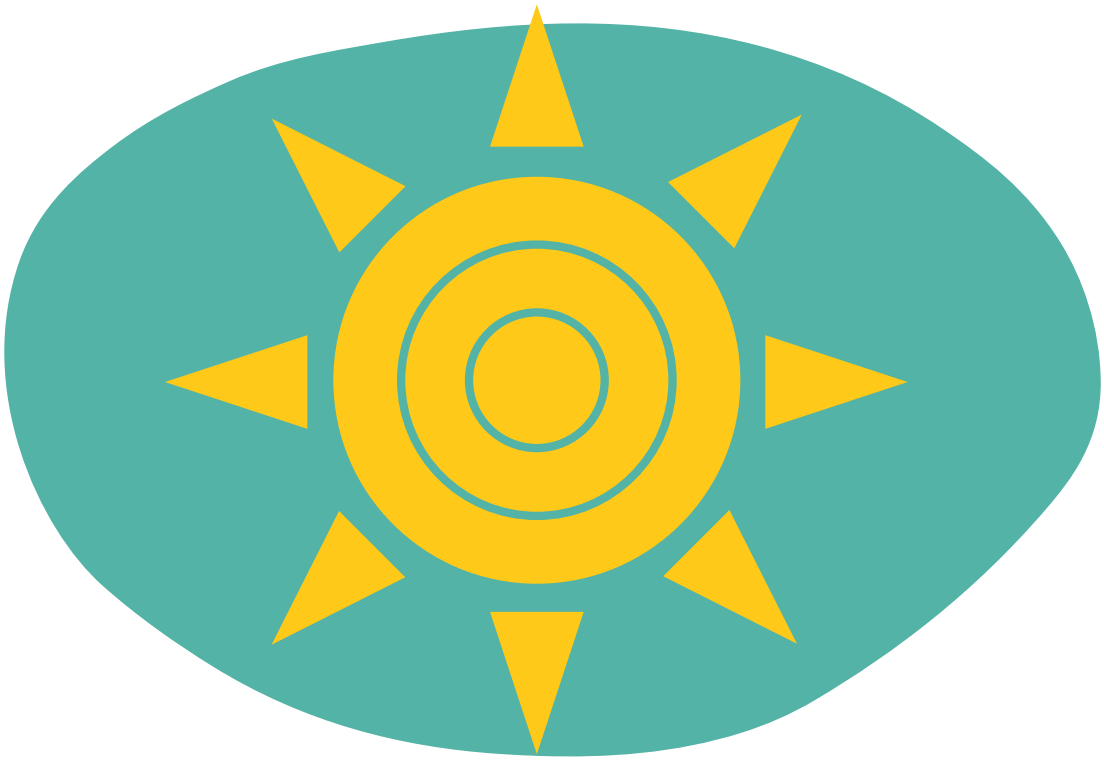
technical and administrative aspects of development. Sweden has been described as eager to adopt new technology, and it is a small enough country to serve as a test market for new services. Sweden is also home to several multinational companies that today deliver infrastructure for basic fixed and mobile internet access, as well as a multitude of smaller start-ups delivering innovative internet based services.

Swedish actors will, with the output of this agenda, have the advantage of influencing internet development. With actors, we mean not only providers of internet technologies but also users that formulate requirements on the Future Internet, e.g.:

- Internet companies that push for a wireless and mobile internet.
- Internet operators interested in providing new value-added services and who push for scalable and flexible technologies.
- ICT consultancy firms developing leading-edge knowledge of internet technologies and designing internet services.
- Process industry concerned with reliability and maintenance of internet-based control and information systems.
- Media and gaming companies that expect scalable data-distribution systems with high and predictable performance.
- E-health sector demands for personal integrity, security, reliability and usability of the network.
- Law enforcement agencies demanding technology for legal monitoring of internet usage while protecting sensitive information.
- Defense industry for which redundancy and resiliency is of primary concern.

The Swedish ICT industry can contribute to a continued open and international internet and may remain in position in the high end of providing for the Future Internet by exploiting ideas in this agenda together with academia and innovation clusters. There is much knowledge of using the internet in both the public and private sector in Sweden. It needs to be reused and extrapolated into designing new, better and even more user-friendly solutions. The actors addressed in the agenda are Swedish but the solutions will be international. The internet should remain open, which means that de facto and open accessible standards should be used to no fee or at a nominal fee.

Definition of internet infrastructure and scope



AS A COMMON UNIVERSALLY accepted definition of internet infrastructure is missing, and as the field is wide and involves many aspects, we choose to define internet infrastructure by using a model.

The model outlined in this agenda is based on the underlying assumption that the internet infrastructure is, and should be, one common denominator for several sectors of society. In other words, sector specific solutions such as e.g. specific technical standards, are not addressed herein. Instead everything outside the common denominator represent diversification of the internet, with the ensuing risk of making it fall apart.

The task of ensuring future scalability of the internet is based on the assumption of a universal and open network, with low thresholds for innovation, and cost-efficient use for anyone.

The common ground for universal use in this model is represented by a metaphor depicted as the sun, where sector specific infrastructure solutions and applications are confined to the beams of the sun and the body of the sun represents the infrastructure, or the common ground for internet services, independently of sector.

In our model we divide the internet infrastructure into four layers for which we apply three different views of analysis.

LAYER 1 – *Finite resources and public goods* are typically represented by externalities in the conceptual and dominant OSI model.[2] Finite resources are e.g. national spectrum for internet traffic or public goods, for example, societal infrastructure, the presence of electricity and land allocated for antennas, cables, etc. This category also includes artificially constructed finite resources such as national competition regulations.

LAYER 2 – *Hardware* encompasses a range of hardware equipment such as routers, switches, fixed and mobile access equipment, and actuators.

LAYER 3 – *Service infrastructure* contains typical protocols, such as TCP/IP, BGP, routing, and federated security.

LAYER 4 – *Services* contain web and application-access, API catalogues, configuration, monitoring, database services, home network management, and data storage.

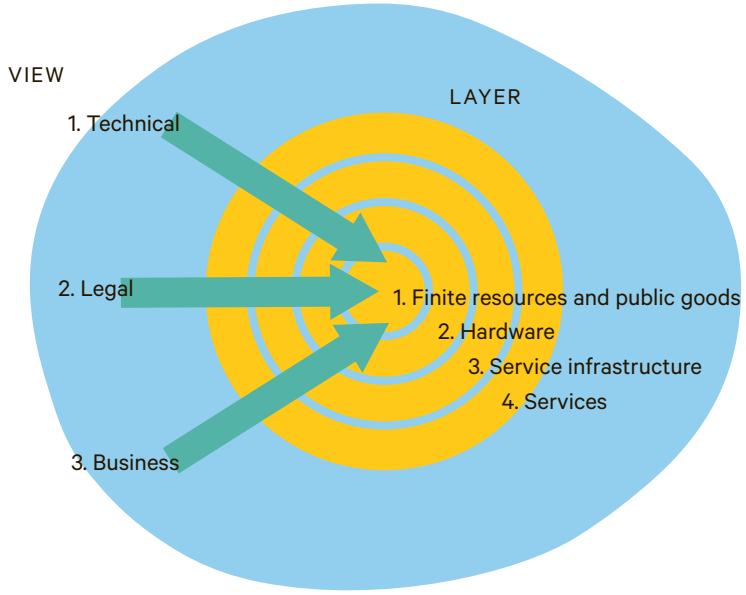
VIEW 1 – *Technical view* represents parts of the internet infrastructure such as security, identity, integrity, traffic monitoring.

VIEW 2 – *Legal view* includes *soft law* and public policy regulations that directly affect internet infrastructure operations. This could be regulations for competition, privacy rules, etc.

VIEW 3 – *Business view* represents company policies and strategies that directly affect internet infrastructure operations. This could be business decisions based on revenue, profitability for a service, or specific business tactics.

VIEWS ONE, TWO AND THREE are of a general nature and cut across all four layers. The three views also contribute specifically to define national aspects of internet infrastructure in the same way as the beams of the sun represent *sector* specific infrastructure components and applications.

[2] https://en.wikipedia.org/wiki/OSI_model



Innovation areas and potential

Today the internet infrastructure covers many topics with great potential for innovation and development, such as: improvement of the infrastructure's reliability and resilience, more efficient content distribution, solutions for privacy, user identification and security, as well as wireless connection of billions of devices. In Western Europe and the US, over 20% of national GDP growth is claimed to be deriving from the internet.

While anyone can launch a new service, the success of companies like Skype and Spotify are not only due to their innovative services and business models but also to highly skilled technical implementations and operation. For Sweden to maintain its strong international position in the internet sector, access to skilled people and new research results are of crucial importance as well as cross-fertilization between various actors within the internet domain.

A second wave of internet innovation is expected when sensors and "things" interact with our physical world. The Internet of Things (IoT) poses new requirements on the infrastructure. It is of strategic importance for Swedish industry and society to embrace this new concept. Further potential innovative areas are networked homes, convergence across heterogeneous fixed and mobile networks (e.g. het-nets, 5G). Networking in adjacent critical infrastructures such as healthcare and well-being, transportation, electricity grids, emergency services, monitoring of built and natural environments and financial services are also potential areas. Reduced delay, increased reliability and better end-user security are issues common to all of these areas that require research and development to be properly solved.

A STRATEGIC RESEARCH AND INNOVATION AGENDA

The Swedish Agenda for the Future Internet identifies measures that are expected to result in new services and applications. The Future Internet infrastructure might entail enterprise and home solutions as well as improvements for internet service providers. It may further contribute to services for the infrastructure, as well as administration, operation and management systems and procedures.

EU-PROGRAMS AND INTERNATIONAL EFFORTS

Future Internet architectures and services constitute a key research area within the EU, as represented by the challenge on "Pervasive and Trusted Network and Service Infrastructures" within the EU's 7th Framework programme (FP7) and the "Future Internet" theme within the EU Research and Innovation programme Horizon 2020. Within such EU efforts, the ongoing large scale program on "Future Internet Research and Experimentation (FIRE)" needs highlighting.

Focus areas and proposed actions

THESE SIX AREAS HAVE been identified for further development and prioritized in the analysis.

1. Research, innovation and entrepreneurial development
2. Identity and access management
3. Internet access
4. Resource management in private networks
5. Personal privacy and digital trace
6. Open and de facto standards

In this chapter, further rationales for the areas are outlined. The focus areas represent various aspects; however, they are not necessary mutually exclusive. In other words, actions may be present in two or more focus areas.

Research, innovation and entrepreneurial development

In an international context, Swedish status and knowledge legacy in ICT in general and regarding the internet in particular are very strong due to historical contributions to internet development. However, while research on the Future Internet is prioritized in the European and US research agendas, the interest from Swedish funding agencies for research on internet technologies has dropped in recent years. In Sweden, the internet is becoming an infrastructural commodity taken for granted.

In order to recapitalize on Sweden's role as a frontrunner, further investments are needed. In order for the future Swedish internet community to provide an open, scalable, stable and secure in-

ternet infrastructure, active R&D measures are already required today.

A renewed interest in funding core internet research is needed in Sweden. This is needed to maintain Sweden's strong position in the internet area and foster new high-tech internet companies, While research within the various application domains for the internet are important, further research on the technical underpinnings of the internet are still required to drive development within these areas, and as exemplified below many open problems still exist that are vital for the continual development of the internet.

A Future Internet will need to meet challenges from a wider set of services than are provided today.

Further R&D is required accordingly.

- Scaling to billions of connected devices stresses addressing and management.
- The unabating growth in traffic stresses routing capacity and opens up for in-network content caching.
- The further we approach the information society, ultra-high reliability and security become increasingly important, both for personal information and for payment methods.
- Since the infrastructure needs to evolve, there is increased interest in architectures that permit upgrading by software (software-defined networking).

There are not any readily applicable solutions for these areas.

In addition to lists of concrete measures, this agenda promotes activities in three areas.

Research programs on internet technology. The first area is the responsibility of the public agencies for funding of research and innovation: the Swedish Science Council, Vinnova and the Foundation for Strategic Research (SSF).

Establishing meeting venues. The second area relates to establishing new meeting areas in Sweden. This is especially needed between academic research and development for medium and small enterprises.

Innovative procurement. There is thirdly a need for establishing standardized building blocks for performing good procurements and framework agreements. It is perceived that public sector actors have a central role to contribute to the establishment of such blocks, by coordination, and via their public procurement agreements.

The public sector can also assume a role as frontrunner relating to the development of innovation and new services. A requirement on open standards and interfaces means vendor lock-in can be minimized by means of having competition in implementation and interaction with existing and new systems. Central cooperation and framework agreements may give cost benefits that local entities cannot achieve in relation to larger commercial entities.

Identity and access management

Identity and access management, IAM, is a fundamental element for robust IT and internet security. Many of the current problems in handling people, roles and things on the internet necessitate better IAM solutions.

The need for secure and efficient solutions will increase dramatically as new application areas evolve, such as, The Internet of Things (IoT), Bring Your Own Device (BYOD) in the workplace, cloud computing, mobility etc. The need for online security will further increase at the same pace as more end users and businesses go online for further services. This will in turn spark the need for further coordination of protection from organized crime, industrial espionage, foreign government sponsored cyber-attacks and a commercial interest to profit from collection of behavioral meta-data.

Identity and access management services will enable further development of the internet. Services are needed to make it more difficult to have unauthorized access and to committing identity fraud and privacy breach. New services will have to provide security, robustness, traceability, personal integrity, and usability in an even more cost-efficient way. These services also need to be developed within a viable business-model applicable for the context, and to allow for a functioning market to emerge.

Federated identity management solutions have the potential to be the common generic solution for identity and access management services. The implementation of federated identity management for a specific community consists of a common set of policies, practices, definition of the attribute used by applications for granting access, and protocols to manage identity information across otherwise autonomous security domains. The goal for identity management must be to enable users of one do-

main to securely access data and devices of another domain seamlessly (single sign-on), without the need for redundant user administration.

Our conclusion is that there exist good examples and knowledge in the field, mature standards and methods for implementations. The challenges for a broad adoption are then the following:

- limited use for the first movers, as the member value first arises when the federation has several users (high initial costs);
- specific attributes, policies and practices have to be specified and agreed on between the members before launching a federation for a community;
- legacy systems need to be adapted to federated use;
- financing of the federation's joint operations and infrastructure; as well as
- few suppliers of electronic identification and a market characterized by absence of competition.

Internet access

When it comes to internet access, there is a mismatch today between the needs and expectations of users, and what is actually provided by internet service providers. There is a diverse need for quality, functionality and price, but this diversity is not met by market supply. There are few options when you are a buyer of internet access. Factors like robustness, availability, and security are rarely part of the service description. Furthermore, buyers cannot easily compare products offered from competing providers. As a result, internet access is often sold as a best-effort service without guarantees on its performance. Consequently, the market does not supply what buyers need. Hence, there is a need for better information and education of end-user consumers. There is specifically a need for a clear and widely accepted terminology for specifying internet access characteristics, also understood by end users. Also organizational purchasers need good examples of how to plan, build and manage access networks, to help them make informed demands on their suppliers.

There is also a need for a uniform language as well as methods for establishing detailed service level agreements (SLAs) that match the evolution of the network neutrality debate. All of this may lead to better buyer demands, which in turn leads to increased service diversity and in the end better services for the user.

The public sector (including local municipalities) has the ability to act as forerunners in the coordination of the aspects above. Public sector demands in the area represent vast values, and are thereby the key actor for establishing de facto standards. Demand for measurements, such as quality, is easiest to coordinate in and by the public sector. By establishing a clear terminology, it should be possible to change primarily the behavior of the public sector in purchasing internet access.

The public sector could also create good examples such as "standardized building blocks", i.e. establishing widely spread and accepted specifications for internet access. Such blocks would standardize how to plan, build and manage access networks. To this extent, municipalities and fiber owners could be aided by shared experiences, information and by best current practices, in their broadband deployment.

Specification of building blocks would be made in two parts: a) a terminology defining relevant terms that explain the parameter space for access and how to measure them, and b) a matrix where there are specified (minimum) values that should be met for each kind of connection.

Development of service measurements systems could be another way of assessing real internet access delivery. Various variables defined in category a) and b) above would be needed. The measurements should be objective and irrefutable and hence usable for resolving disputes between customers and their access-service providers.

A central actor could host a series of round table meetings with consumer-rights organizations, access providers and regulators with the goal of having a definition and terms for internet access widely accepted and used for a) and b) above.

Resource management in private networks

Management of users, devices and services in private networks has for many years been a costly task in large organizations. Typically, a dedicated IT support organization with skilled personal and highly developed procedures and tools has been established for each and every network. There is however a further need for increased effectiveness in management of private networks.

EXAMPLES OF RESOURCE MANAGEMENT

This agenda provides two examples where resource management in private networks can be developed.

FIRST EXAMPLE: The digitization of Swedish schools is currently a big challenge. In order to take advantage of the possibilities that the pupils' own IT equipment provide, pedagogy, learning materials, administration systems and network support need to be developed. The vision is that students should seamlessly access all needed pedagogic and administrative systems to be able to acquire knowledge wherever they are.

Schools provide a good example of additional features demanded in privately managed networks. The networks should:

- provide instant access to schedules with updates and alerts, and other student administrative issues;
- prioritize network capacity for streaming media to different educational activities, independent of the user's specific equipment and location;
- filter illegal and inappropriate contents and inform students about challenged contents;
- monitor the presence of equipment with malicious code, and
- log activities in order to be able to troubleshoot and manage incidents.

For the school sector, a general specification of needs for resource management must be provided. Pre-established building blocks for purchasing internet access, as proposed above, could be used by schools in cooperation. To this extent, it would be beneficial to specify the protocols and interfaces needed to obtain efficient competition in providing such building blocks.

THE SECOND EXAMPLE includes the end-users' homes. An increased presence of intelligent devices in our homes indicates an increased need for configuration and compatibility.

It is already unclear where the responsibility lies for the configuration of appliances and services in our homes. A multitude of service providers in each and every home will blur the line of responsibility for the functionality of the private network. The exercise of carrying out accountability for lack of quality and failures therefore risks becoming impossible. Furthermore, individual end-users will desire to protect their privacy, and especially so in home networks. Privacy concerns are in conflict with incentives for service providers to log and collect end user behavioral data.

For home networking, a proof of concept prototype could be developed for management systems with practical applications. The concept could demonstrate how an end-user can smoothly interact with the policy and controls of his or her home network and its devices through an application on their connected devices without compromising privacy.

The internet-edge private networks pose increasing demand for management of a growing end-user flora of standards and equipment. This is becoming an increasingly complicated issue, when the number of wireless devices increases it challenges current management systems for configurations in homes. Thus, there is a need for developing a de-facto-standard for different private network management systems. As initially assumed in this agenda, such a standard needs to be based on low thresholds for innovation, and low costs for use, i.e. established open and universal standards.

The wide demands posed by home networking challenge several other areas for the Future Internet. Home networking is increasingly becoming a merging point for end-user privacy (security), end-user control of behavioral data, the need for identity management, and more. Such a merging point also needs to allow for competition on several levels of internet delivery.

There are several standardization initiatives in this area.

- One group is the Internet Engineering Task Force (IETF) and newly initiated Working Group

Homenet. This working group focuses on the evolving networking technology for an increasingly broad range and number of devices among relatively small residential home networks.

- Another group is *Continua*, a non-profit, open industry organization whose vision is to establish a system of interoperable personnel e-health solutions that fosters independence and empowers people and organizations to better manage their health and wellness.

However, there is still a lack of efforts for the development of standards for management of resources in private networks. Neither are there any management systems for home networking that include both identity and access management, service and device management, in conjunction with policy and administration.

Resource management in private networks can be improved by investigating the possibility for cross-sector standardization.

Personal privacy and digital tracing

The issue of personal privacy and digital tracing reaches across several sections of this agenda, and it is closely related to internet security. The earlier section on identity and access management also includes the need for privacy. Personal privacy also has a central role in the implementation of home networking.

Personal privacy online is still poorly defined for the information society. There is a rapidly increasing market for end-users digital traces, or meta-data behaviour. As noticed in the public debate for several years, there is a difficult balance between the pros and cons of the collection of end-user information. Furthermore, some electronic services demand a higher level of information security, e.g. online banking, health services, etc. One way of ensuring such increased security is by having a standardized way of ensuring security[3] so that as few proprietary clients as possible have to be installed on devices.

These standardized protocols could be freely available, providing high quality free implementations so that all application developers can use them. The

EXAMPLES OF MEASURES FOR PRIVACY

Today there are several mechanisms for targeting end-user behavior. On the current internet, cookies are placed for profiling end-user behavior. Users may have a conflicting interest in constantly having their behavior traceable. A way to solve this conflict would be to have a standardized way of making it visible for end-users to see what information is collected. By establishing a mandatory clearing house, companies could be required to report what data are registered.

In this context, current legislation (the 'cookie law') only addresses a fraction of the problem. Further development in this area and requirements on advertisers and information brokers would be beneficial because it would increase consumer confidence in the whole internet ecosystem.

THE IMPORTANCE OF ADEQUATE STANDARDS

Open and ideally global standards are a prerequisite for the development of the Future Internet. It is therefore important that the agenda for the Future Internet clearly identifies and promotes standards that will nurture and foster this development. Standards enable competition and interoperability between systems, which in turn lowers the threshold for innovation. Lowered thresholds enable users to implement innovative solutions since they are not locked into systems that do not develop. Open standards are one of the key success – factors for internet development.

[3] Authorization and authentication and transfer of information.

[4] According to European Interoperability framework for Pan-European e-government Services.

APIs used should be standardized and openly documented. Preferably the operating system manufacturers would provide this functionality. Centralizing this codebase could contribute to maintaining security and ensuring high quality of this software.

Open and de facto standards

Today, the internet is being defined in standardization and industrial forums such as IETF, W3C and 3GPP. There are also a plethora of standards and Standards Development Organizations (SDOs) and ways these support their businesses through fees, patents, etc. The underlying internet technology is becoming less and less visible, and the technology is assumed to scale up with demand, security, integrity, reliability, mobility at continually decreasing cost.

The following are the minimal characteristics that a specification and its attendant documents must have in order to be considered an open standard[4]:

- The standard is adopted and will be maintained by a not-for-profit organization, and its ongoing development occurs on the basis of an open decision-making procedure available to all interested parties (consensus or majority decision).
- The standard has been published and the specification document is available either freely or at a nominal charge. It must be permissible for everyone to copy, distribute and use it at no or nominal fee.
- The intellectual property - i.e. patents possibly present - of (parts of) the standard is made irrevocably available on a royalty free basis.
- There are no constraints on the re-use of the standard.

However, such definitions may be – and often are – challenged. Standards are a too general term, and bear within them very different meanings. Standards can also mean huge commercial possibilities for natural monopolies. Hence, a definition of standardization needs to be carefully crafted in order to be competitively neutral. Research is needed into the value of freely and publically available open standards as a driver for innovation and removal of barriers for new entrants.

Internet supports public, private and not-for-profit sectors on equal terms. However, interoperability between the sectors is needed. It is therefore a shared responsibility to develop generic standards since most actors have something to gain from it.

In addition, the public sector does, by its size as public procurer, have the best possibility to contribute to open de facto standards. By coordinating public procurement, contribution to open de facto standards could reach far. Public entities could by default require systems and devices that use publicly and freely available standards for system and device interaction. There is a need to define requirements and definitions for such public procurement. In a next step, standards are developed, and then there is a further need to implement them. A continual participation and coordination in international standardization is necessary.

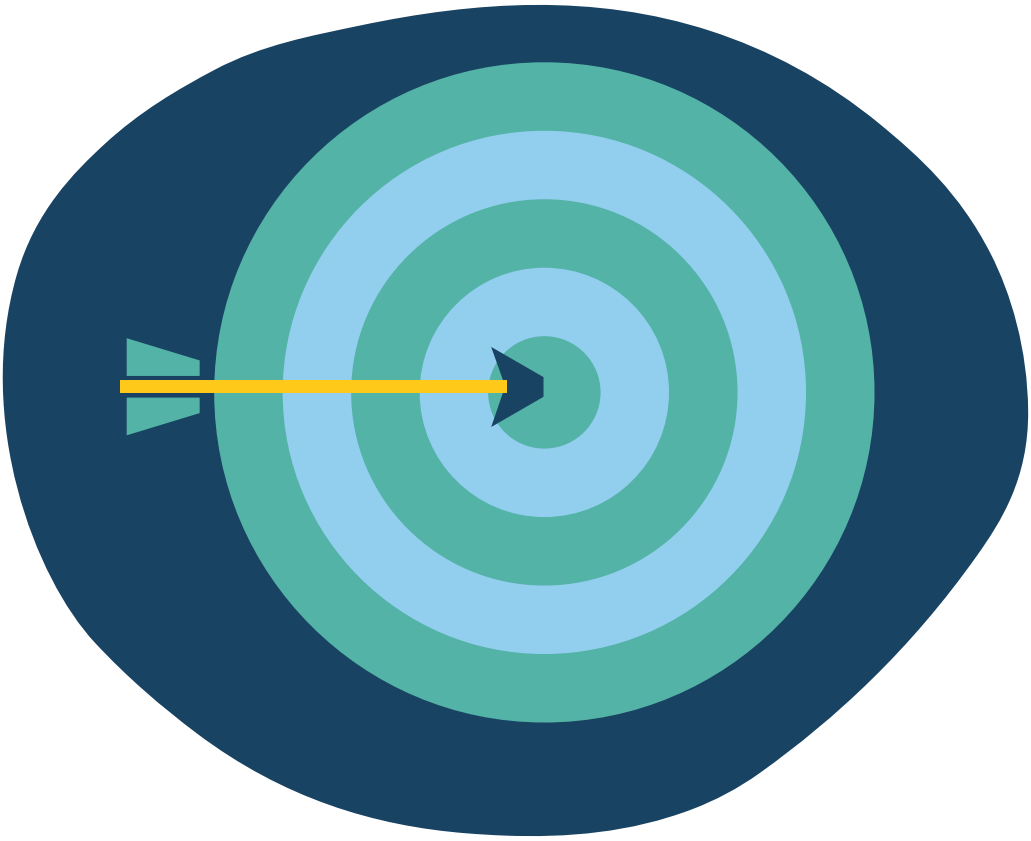
An internet agenda for Sweden needs to define a strategy that will lead to adoption of standards both in the public and private sector. In doing this, it is necessary to identify existing open standards that meet agreed requirements, and where such standards do not exist or are not openly available to set up a plan to engage in standardization work to develop new or open standards. It is also suggested that public entities should require systems and devices that use publicly and freely available standards for system and device interaction both internally and externally.

THE CROSS-SECTOR REACH OF STANDARDS

The borders between sectors are disappearing. For example, a company producing engineering tools will supply them to different industries such as construction, mining, energy, automotive and defense. Likewise, a hospital buys office supplies, food, medication, medical devices and service. If each of these sectors uses its own standard, then standards become a major problem.

Lack of cross-sector standards leads to a need to convert between the standards, which in turn leads to higher costs and difficulties for companies such as SMEs and startups to enter certain sectors. Hence, we conclude that broad cross-sector standards are vital for interoperability of systems and for providing opportunity also for smaller companies to compete in the internet systems and services market.

Conclusions



THE MAIN OBJECTIVE FOR this agenda is to facilitate for Swedish society and industry to fulfill their plans for social and economic growth as well as to support the business models and services of all companies that are already dependent on the existing internet infrastructure. This agenda contributes to the objective by promoting a continued access to an open, scalable, reliable and secure internet infrastructure. Highlighting this objective now will give the Swedish ICT-industry a window of opportunity, or rather a competitive advantage, in providing the market with new products and services to establish this new infrastructure.

This agenda has evolved from five workshops with a multitude of internet infrastructure stakeholders. During the workshops, several development areas were identified and the following six were prioritized.

1. Research, innovation and entrepreneurial development
2. Identity and access management
3. Internet access
4. Resource management in private networks
5. Personal privacy and digital trace
6. Open and de facto standards

A list of identified proposed actions has been compiled during the workshops and is available in unedited form at https://www.iis.se/lar-dig-mer/rapporter/swedish-agenda-for-the-future-internet.

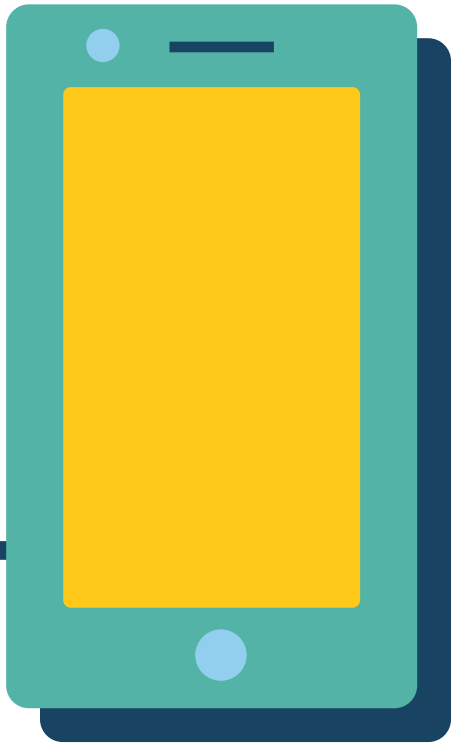
An overarching conclusion in the agenda is the need for coordination of focus areas and measures proposed. Traditionally, the nation state has ensured coordination of infrastructural developments e.g. for roads, airport transportations, railways, telephony, electricity and gas. In an international outlook, inter-

net infrastructure is mainly provided by a multitude of stakeholders, often by private, or semi-private development. This is especially true for Sweden, and it is arguably true that this is one explanation for the success for Sweden in ICT.

A consequence of the main conclusion is the need for a Swedish coordination of such multifaceted infrastructure design and maintenance. It could take place within a similarly multi-stakeholder and independent entity.[5] Its operations could be hosted in the remit of a non-for-profit environment, like e.g. a research institute or The Internet Infrastructure Foundation in Sweden (iis).

Such a node would require a multi-stakeholder financing, with complementary funding from public means, e.g. the European Union or national funds. The six focus areas identified are heterogeneous, and would therefore need individual programs for separate attention and fulfillment.

Providing internet infrastructure is however not a specifically isolated Swedish function. With the aim of ensuring a continued open and accessible internet, outreach measures would be necessary for such a node. This would include active participation in e.g. de facto and international standardization organizations, protocol development, and also active and continuous engagement in other governmental aspects, such as international internet governance and development of well-functioning business models. The coordinating entity's relation to research organizations and academia (and funding), would also need to be developed.



5 The entity could assume the shape of an independent foundation, not-for-profit organization or an independent company.