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Future Internet: Challenge And Research Trend

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Abstract
This article first presents the Challenges of the current Internet and concept of Future Internet Research, motivation for future Internet. Challenges and limitations of Current Internet are reason of Future Internet Researches. In order to provide Future Internet's service, the Future Internet testbed must be deployed as foundation, and many countries such as USA, Europe and Asia are striving research of Future Internet and deployment of the Future Internet. This paper describe countries which are active on Future Internet research and summarizes the Trends of the Future Internet.
Keywords: future Internet, Internet Engineering, Internet Science, Internet Trend

I. INTRODUCTION

This The term "Future Internet" (FI) represents worldwide research activities for reinventing the Internet with better performance, reliability, scalability, security and privacy while keeping its key neutral principle as constantly recommended by Tim Beemer's-Lee, the famous inventor of the Web. There is a great diversity of research streams and related topics for designing alternatives of the Internet networking of tomorrow. For example, the Internet of Things (IoT) is considered as a major research and innovation stream leading to create plenty of service opportunities in interconnecting physical and virtual worlds with a huge amount of electronic devices (e.g. sensors, actuators) distributed in houses, vehicles, streets, buildings and many other public environments (e.g. airports, train, metro and bus stations, social spaces). Hence, a massive amount of data will be flowing over the Internet that should not decrease the overall service performance and user satisfaction [2, 9].

Future Internet is a new infrastructure to support new services not provided by the existing Internet. Today the most important information, service and networking infrastructure providing the mechanisms for the digital society at large to function as an integrated entity. This infrastructure is evolving rapidly with the transition from "sharing" in Web 1.0 (Web) to "contributing" in Web 2.0 (user generated content) to "co-creating" in Web 3.0 (collaborative production, semantic Web) [7, 9].

Our challenge nowadays is to prepare a similar trip into the future: what will be the Internet in ten-twenty years from now and what more amazing things will it offer to people? But before trying to see how the future will look like, we need to consider some important challenges that the Internet faces today. The Internet today is a complex agglomerate of protocols that inherits the grown legacies of decades of patchwork solutions. Network management costs explode. Security problems are more pressing than ever, as organized crime discovers its value. The application and user demands on the Internet are increasing with mobile technologies and media content on the rise, all the while the number of participating nodes is equally boosting. As a direct consequence the recently triggered research on concepts for the future Internet has to cope with a high complexity at network layer and significance in mission critical service infrastructures of society [7].

Paper contents:

- Challenges of the current Internet
- Concept of Future Internet Research
- Motivation for the Future Internet
- Future Internet Trends
- Conclusion

II. CHALLENGES OF THE CURRENT INTERNET

The Internet concept was born with different conditions and goals by "the fathers of the Internet", Vinton G. Cerf and Robert E. Kahn [13] in the seventies. Since then Internet became a huge global network and we are speaking on Internet age. The original concept of Internet (TCP/IPv4) has limitations and there are new societal requirements (mobility, security), while the technological development provides new opportunities and solutions for the challenges. Limitations of Current Internet are [1, 7, 8, 9, 11]:

- The limited identification capacity, the lack of IPv4 domain names;
- The essentially private wireline network concept, the lack of a scalable efficient network and mobility management, an inherent mobile centric network architecture;

- The best effort solutions, the lack of guaranteed and differentiable quality of services and security;
- Energy efficiency: energy awareness is critical due to the network size and usage;
- Application development is inflexible, etc.

New technological opportunities are for managing limitations [7, 8, 9, 10, 11]:

- Advanced wireless/mobile technologies;
- Broadband optical solutions;
- Huge storage capacity, storage efficiency;
- Innovations in material and manufacturing technology, especially in the technology of sensors, CPUs, memories, energy sources;
- Potential opportunities from nanotechnology and biotechnology.

Growth of societal role of the Internet gives rise demands as [1, 6, 7, 8, 9, 10]:

- Anywhere, anytime access (always on);
- Interconnection of objects, devices, sensors (networked 20…100 billion things);
- Expansion of content space with 3D and cognitive contents (gestures, emotion);
- Scalable and customized data and knowledge engineering;
- A lot of human-centric, secure smart applications.

We can conclude that we were witnesses of the radical increase of Internet in size and complexity; there is a great technical potential and societal need for significant expansion of applications; and the penetration of Internet has fundamental impact on lifestyle and human relations.

Those challenges and capabilities envisaged for the Future Internet are addressed by several research areas as depicted in Figure 2.

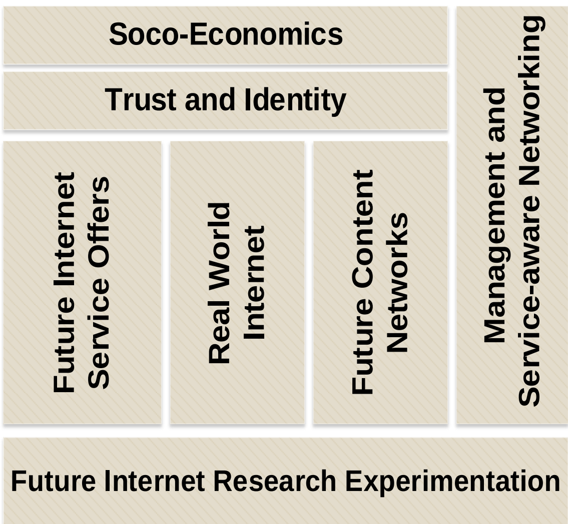

Figure 2. Future Internet Research Area

III. CONCEPT OF FUTURE INTERNET RESEARCH

The challenges of the Current Internet, the tangible and potential demands, and the technical opportunities determine the critical research issues, research goals and spheres, and need the reconsideration of the classic Internet concept. Figure 1 shows the Future Internet vision based on the scheme of Japan's National Institute of Information and Communications Technology (NICT), and the achievements of the FIA 2011 in Budapest and Poznan, FIA 2012 in Aalborg and FIA 2013 in Dublin.

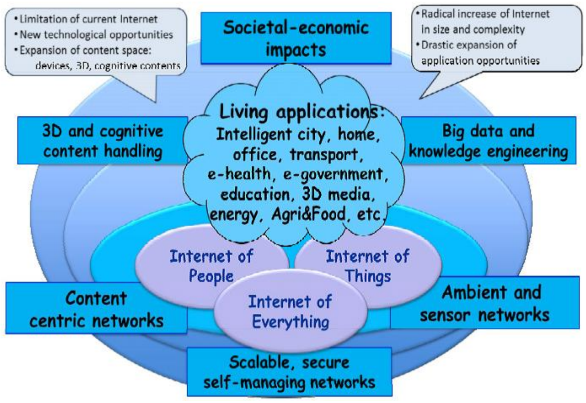

Figure 1. Concept of Future Internet research, based on Japan NICT's Future Internet vision, FIA2011 in Budapest and Poznan, FIA2012 in Aalborg and FIA2013 in Dublin [1]

The classic Internet aimed at interconnection of persons and contents, the Future Internet is aiming at the interconnection of devices, too, resulting in a two-pillar concept: Internet of People (Media Internet) and Internet of Things (IoT). (On the latest FIA, the comprehensive concept of Internet of Everything was emerged.) Therefore Future Internet research activities primarily focus on network architecture issues to solve challenges in scalability, security, manageability and sustainability, both for ambient and sensor networks (IoT) and for efficient media networks (content centric networks). Big data and knowledge engineering (acquisition, management, storage, etc.), 3D and cognitive content handling became also significant research issues [1].

Drastic expansion of application opportunities and recently the societal-economic impacts are also intensively investigated.

The research goals and spheres can be combined into the usual three levels. The Internet is considered a complex network system; its common attributes are heavily researched in the frame of Network Science. In general, basic research topics related to the fundamentals of Future Internet, embracing mathematical modelling of large scale networks, cryptography as theory of security, human, socio-economic and environmental aspects, legislation and governance principles, etc. are collected in Internet Science [1, 5]. Engineering research issues - as creation and elaboration of Future Internet technologies, network architectures and protocols, data and content management methods and design procedures - represent the backbone of the Internet applied research, called Internet Engineering. Finally Future Internet experimental research and innovation actions aim at the development of FI based solutions, smart industrial and community applications, customizable content services, involving their experimentation, demonstration and standardization issues, shortly referred to as Internet application development [1, 7, 8, 9, 10].

IV. MOTIVATION FOR THE FUTURE INTERNET

The Internet was initially developed for a limited number of trusted nodes interconnected by copper based transmission technology implemented supporting applications like file transfer and message exchange. The initial architecture developed for this purpose was essentially simple but open for new applications. Its evolution has led to a tremendous success – the Internet as we know it today. It is however far from clear that it is still the optimally evolvable solution, able to meet the challenges of fibre optics and radio transmission technology, realtime multimedia and file-sharing applications and exposure to an untrustworthy world. Furthermore the Internet, starting as a simple set of protocols and rules, has over the decades reached a state of high complexity with regard to interoperability, routing, configuration and management [7].

Within the research community the need for change is largely acknowledged although there is not yet agreement on how this change should take place. Some propose a clean slate approach, which aims at investigating new architectural concepts with new requirements in mind and which initially doesn't need to consider legacy, while others are advocating an evolutionary approach, introducing new solutions incrementally. It seems likely that both approaches will migrate current Internet technologies towards a Future Internet [7].

V. FUTURE INTERNET TRENDS

Future Internet research is supported by several programs in Europe, US and Asia. In the US research on future Internet and the provisioning of facilities for large scale experiments is funded by the Global Environment for Network Innovations (GENI) and the Future Internet Design (FIND) program.

The European Union also funds several projects on future Internet research and has recently started projects for the establishment of federated testdbeds to support experimental research. Several governments support such activities with national funding. In Japan and Korea similar activities can be observed. The common differentiation between revolutionary and evolutionary paradigms is followed in these programs [7, 12].

As well as USA, developed countries are investing much budget and human resources to preoccupy Future Internet areas. In this chapter, we would like to describe the active Future Internet project of each country [12].

A. USA

National Science Foundation (USF) plays a key role in researching the Future Internet project in USA. NSF is investing since 2004 by performing GENI and FIND projects. Especially GENI is focusing on Virtualization, Programmability, Resource Sharing, Federation and so on [4].

The goal of GENI is to construct the Future Internet testbed which is totally different with the current Internet. To do this, GENI uses Internet2 and NLR (National Lambda Rail) as a backbone network.

GENI is intended to support two general kinds of activities [14]:

- Running controlled experiments to evaluate design, implementation, and engineering choices.
- Deploying prototype systems and learning from observations of how they behave under real usage.

B. Europe

Europe countries are performing FP7 (7th Framework Programme) and FIRE (Future Internet Research and Experimentation) for the Future Internet testbed. These two projects are based on optical network technology and are developing federation technology to unify other Europe countries. For this, Europe uses GEANT (1, 2, 3), PanLan and OneLab as a testbed. Also Europe is investing to Future Internet projects and the goal of Europe is to construct large-scale experiment environment across Europe [1, 4].

FIRE has two interrelated dimensions:

- Experimentally-driven long-term, visionary research on new paradigms and networking concepts and architectures for the future internet.
- Building large-scale experimentation facilities to support both medium- and long- term research on networks and services by gradually federating existing and new testbeds for emerging or future internet technologies.

C. Japan

AKARI which is led by NICT (National Institute of Information and Communications Technology) is a representative Future Internet project in Japan. AKARI concentrates on ubiquitous, mobility and service convergence.

For this Japan uses JGN2plus as a testbed. Furthermore Japan performs CORE project to do research of the Future Internet and tries to expand CORE project toward national research network. Representative research fields are federation, network architecture, mobile communications and bio/nano technology [4].

D. China

China is striving to research the Future Internet by CNGI (China Next Generation Internet) project. Major research is to increase scalability by IPv6 and uses CERNET2/6iX as a testbed. Figure 3 is coexistence of IPv6 with IPv4 [3].

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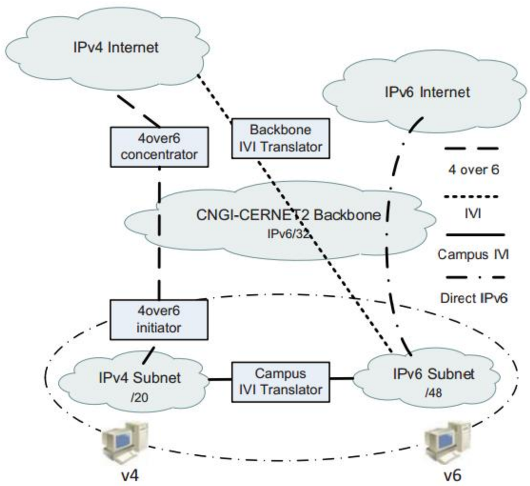

Figure 3. The Coexistence and Communication of IPv6 Users with IPv4 Users [3]

E. Korea

FIF and KREONET Projects of Korea researchers. The FIF (Future Internet Forum) aims to provide an opportunity to review the forefront information and knowledge on the timely subject of new Internet architecture and related issues. A direction for the future R&D in Internet is expected to be shaped as a result of the presentations and discussion among the experts [15].

KREONET (Korea Research Environment Open NETwork) is a national R&D network supported by MEST (Ministry of Education, Science and Technology), and has been managed and operated by KISTI (Korea Institute of Science and Technology Information) since 1988.

KREONET is comprised of 16 areas and 16 local network centers (GigaPoP), inclding Kyungpook National University, GwangJu KAIST, and Jeju National University. A network infrastructure supporting a range of location-independent R&D activity has been established based on the local network center. KREONET is providing a vital element of the national R&D network infrastructure, facilitating cooperative state-of-the-art R&D activity.

The international R&D network service of KREONET provides a 10Gbps high performance network infrastructure, similar to the global science and technology cooperation R&D network GLORIAD, through close cooperation with various advanced countries including the USA, China, Russia, Canada, and the Netherlands, among others, for the purpose of promoting international-level R&D cooperation and state-of-the-art technological R&D [16].

VI. CONCLUSION

In the Future Internet there are high demands for information interoperability and Linked Data to enable automated service composition. This Paper present here a vision for the Challenges, Concepts, Motivation and Trends of Future Internet. The movement towards the Future Internet is based on the belief that the current Internet has reached his limits. The FI represents the evolving need for infrastructures at the level of innovation infrastructure (networks of collaboration, experimental facilities, research and test centres etc), and broadband Internet infrastructure (networks, services) and this paper present several testbeds.

We hope that this paper landscape of Future Network (Internet) Trends will motivate enough other researchers for contributing to Future Internet.

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