

Early development of the internet in Korea, Asia, and the world

2022.6.7/2023.4.8/7.27/12.06

Kilnam Chon

Introduction

Computer networks started in 1960s.[Asia 2013; Lynch 1993; Leiner 2009]. ARPANET was one of these computer networks which started as the experimental computer network in 1969. Its successor, the internet with the Internet Protocol (IP) was available in the 1980s. In South Korea, we developed the computer network with the Internet Protocol in 1980 - 1982.[Asia 2013]

There are several books on the early development of the internet in the 20th century including the following;

- C. Malamud, Exploring the Internet, 1992.[Malamud 1992]
- D. Lynch and M. Rose, Internet System Handbook,1993.[Lynch 1993]
- C. Malamud, World's fair for the global village, 1997.[Malamud 1997]
- C. Farivar, Internet of Elsewhere, 2011.[Farivar 2011]
- K. Chon, Asia Internet History, First Decade, 2013, Second Decade, 2015, Third Decade, 2018, Fourth Decade, 2021.[Chon 2021]

The following articles describe brief histories of the global internet and the Korean internet, respectively;

- B. Leiner, et al., A brief history of the internet, ACM, 2009.[Leiner 2009]
- K. Chon, et al., A history of computer networking and the internet in Korea, IEEE, 2013.[Chon 2013]

In this article, we review the South Korean internet development history in the 20th century with the related developments in Asia and the rest of the world additionally. We will cover the following topics in this article;

- Internet Ecosystem
- Internet Router
- Leased-Line internet
- Commercial Internet Service Providers
- Broadband Internet
- Cyber Security
- Users of Computer Communications
- Digital Services
- eCommerce and ePayment
- High Technology Ventures
- Science & Technology Parks
- Concluding Remarks

Internet Ecosystem

Ecosystem is defined in the Google search as follows;

- *A biological community of interacting organisms and their physical environment*
- *A complex network or interconnected system*

Internet Society defined the Internet ecosystem as follows [Internet 2017];

The organizations and communities that help the Internet work and evolve are called the Internet Ecosystem. They share common values for the open development of the Internet.

ICANN defined the Internet ecosystem as follows [ICANN 2010];

“A network of interactions among organisms, and between organisms and their environment.

The Internet is an ecosystem.

The Internet is successful and thriving because its ecosystem is open, transparent and collaborative.”

ARPANET with four nodes in the USA was developed in 1969. [Leiner 2009] The IPv4 network with two nodes in Korea was developed in 1982. These were the beginning of the internet ecosystem formations in USA and the world, and Korea respectively. [Chon 2021]

CSNET along UUCPNET/USENET and BITNET expanded users of computer networks beyond ARPANET both in USA and the world in the 1980s.[Asia 2013] NSFNET replaced ARPANET as the backbone network in USA, and connected to the various Internet Protocol version 4 (IPv4) networks in other continents; Asia, Europe and Latin America as well as North America in 1980s and 1990s. NSFNET and computer networks in many countries around the world which are based on the Internet Protocol (IPv4 and IPv6) became “the internet” as we know today.

Technologies for the internet ecosystems consist of research and development, standardization, and conferences among others. Various standardization bodies such as Internet Engineering Task Force (IETF), Institute of Electrical and Electronics Engineers (IEEE), World Wide Web Consortium (W3C), International Organization for Standardization (ISO), International Telecommunication Union (ITU) and various industry consortia. The relevant conferences include International Computer Communication Conference (ICCC), INET, Interop, and many other conferences were formed in the 20th and 21st centuries.

The activities related to the internet ecosystems include the following and more;

Research and Education Networks
Network Operator’s Groups
Cyber Security
Commercial Internet Service Providers

WWW and its Applications

Digital Services including Short Message Systems, Social Media and Messaging Services

e-Commerce and e-Payment

Entertainment

Internet Governance

Internet users in the world exceeds five billion now. [Internet 2022] They form numerous user communities; nationally, regionally, and globally. One of the major issues on the users is “the last billion internet users.”[Chon 2010] They are handicapped economically, geographically, and/or physiologically. Numerous efforts have been taking place. One of the notable efforts is the low-orbital earth satellite constellations such as Starlink. [Chon 2022e; Starlink 2022] This could solve the geographically handicapped such as remote regions, but it does not solve others.

Public and commercial sectors play important roles in the internet ecosystems. State governments play various roles depending on countries in addition to their traditional roles on the regulations. Public institutions play additional roles to the state government such as standardization, and research and development among others. Telecommunication service providers offer infrastructure services including telecommunication services and the internet services. Other commercial internet service providers are increasingly becoming minor internet service providers now. On the other hand, digital service providers such as social media and e-commerce are becoming dominant along the telecommunications service providers.

In order to have healthy internet ecosystems, we need good human networks; domestically, regionally, and globally. The human network needs to be interdisciplinary, not just technical or industrial human networks. An additional challenge we are facing is to have good next generation human resources with appropriate hand-over processes.

There are many other issues in the internet ecosystem. First of all, the evolution of the internet ecosystem. Evolution turns out to be not easy even if we know evolution is needed as it is becoming one of large-scale social infrastructures. Unfortunately, we did not know the internet has become so large and so fast, and we could not prepare for the large-scale social infrastructure formation. Some of the practices on the internet such as “winners take all,” “don’t fix if it is working,” and “free” internet services such as email and social media make the good evolution of the internet difficult. As the digital ecosystems are being formed now, the internet ecosystem as the leading ecosystem among the digital ecosystem may take a lead on the digital ecosystem formations.

In South Korea, the internet ecosystem started with the research network community with participation of universities, public research institutes and corporate research laboratories in the early 1980s.[Asia 2013; Korea 2015]. The research network community in Korea had very extensive cooperation with its counterparts in Asia and the world. The global conference, called Pacific Computer Communication Symposium (PCCS) was held in 1985, followed by other international and domestic conferences. [Asia 2013]

The HANA/SDN consortium connected to NSFNET with the first international leased line for the Korean internet in 1990 as the part of PACCOM Project which included the USA(NSF),

Australia, Hong Kong, Japan, Korea and New Zealand. The three consortium members, Korea Telecom, Dacom and INET started commercial internet services in 1994. [An 2015; Internet 2022b]

Internet governance really started with the establishment of a research network community in the 1980s. It evolved to the HANA/SDN consortium with the establishment of Academic Network Council (ANC) in 1991. ANC had many activities through working groups and conferences among others. One of the activities was the management of .kr domain name and IP addresses from 1986. These names and numbers were managed by the public organization, KRNET, under government supervision from the 1990s. Cyber security has been a difficult issue in South Korea. We had unique handling of the user access with public key infrastructure (PKI) with Active X, the proprietary software by Microsoft. Later, we tried to correct shortcomings, but it was not easy once the ecosystem was established widely. These and other issues on the internet ecosystem in South Korea pose the challenge of internet ecosystem evolution as one of critical social infrastructures.

Internet Routers

Internet router development is the first major technical undertaking in Korea during its early Internet development in the 1980s.[Park 2022] “*Router is a networking device that forwards data packets between computer networks*” according to Wikipedia.[Router 2022]. Interface Message Processor (IMP) is the name used for the routers in ARPANET. IMP was developed on the Honeywell minicomputer in 1969. The next generation Internet routers were based on microprocessors such as the one based on Sun Microsystem Workstation with Motorola 68000 in the 1980s. Then the commercial routers based on custom VLSI chips such as the one by CISCO and Proteon became available from the late 1980s.

In Korea, the initial Internet routers were developed on PDP11 minicomputers by Digital Equipment Corporation (DEC) as importing ARPANET IMP was not possible nor practical. Unfortunately, one of the minicomputers, PDP 11/44 challenged our project team on the OS modification to run the TCP/IPv4. The OS modification was a new challenge in Korea in the early 1980s. Eventually, the routers were successfully developed on PDP 11/70 and 11/44 in 1981 and 1982. Later in the 1980s, the microprocessor-based routers were developed on SSM-16, the Motorola 68000-based UNIX computer developed by Samsung in Korea, similarly to the router based on Sun Microsystem workstation in the USA which was the most popular Internet router in the 1980s. Then, the PC-based router was also developed in Korea in the mid-1980s. The first international IP link was made with the router based on Sun Microsystem Workstation between Korean Internet called SDN and NSFNET through the University of Hawaii as part of PACCOM Project, which enabled it to link other countries in Asia for the first time in the late 1980s. They include Australia, Hong Kong, Japan, Korea, and New Zealand.

The VLSI-based routers were developed in the USA by Proteon and CISCO in the mid-1980s. They were the first commercial Internet routers. These commercial routers dominated the global

Internet in the 1990s. The VLSI-based routers were not developed in Korea in the 1980s since the VLSI chip for the Internet router could not be developed in Korea.

The broadband Internet starting in the late 1990s required inexpensive routers to be used at homes as well as organizations. Various commercial routers used at homes and organizations became available from many router companies in addition to CISCO in the 2000s.

Leased-Line Internet

ARPANET had 56 Kbps leased line network from the beginning in 1969.[Leiner 2009; Youn 2021] Other countries in Europe and Asia had both the leased line and dialup links domestically, but connections to the USA tend to be the dialup due to the expensive international link cost. ARPANET did not allow the international leased line connection with IP until the late 1980s.

In South Korea, the first international links were dial-up links to UUCPNET in 1983 and CSNET in 1984. The dialup links do not offer good networks due to low bandwidth and low quality operation.

As the traffic increased exponentially in the 1980s and the international link with IP were allowed in 1986, the leased-line international links were seriously considered in Korea and other countries in Asia despite their prohibitive costs compared with the total budget of the domestic Internet operation.

We overcame the expensive international link cost with the multistakeholder consortium, called HANA/SDN Consortium in 1989. The consortium member includes the following;

- Telecommunication service providers (KT, Dacom),
- Industry Research Institutes (Samsung, LG),
- National Research Institute (ETRI),
- Universities (KAIST, Postech), and
- Individual Users

The consortium evolved from the initial research & education network called SDN which was formed in the early 1980s. The consortium had an annual budget of 150 million won which was around 500,00 US dollars. The HANA/SDN consortium operated various network management and administration function such as

- Academic Network Council (ANC)
- SG-INET with various technical working group
- Network Operating Group (NOG)
- Conferences including KRNET

HANA/SDN joined PACCOM Project which was operated by NSF and research & education networks in Asia including Australia, Hong Kong, Japan, Korea, and New Zealand in the late 1980s. All networks connected to NSFNET in the USA with the leased lines. Some of them

connected to Hawaii, and others connected to California in the late 1980s including HANA/SDN in 1990 with 56Kbps.

Korea Institute of Science and Technology Information (KISTI), the government research institute operates Korea Research Environment Open Network (KREONET) as well as the national supercomputer center and the national science & technology information center. KREONET connected to NSFNET through CERNET with 56 kbps link in the same year as the HANA/SDN in 1990.

These networks increased their link bandwidth constantly from 56 Kbps to 256 Kbps or more internationally, and domestic backbone networks to 1.5 Mbps (T1) and more in the 1990s in order to handle explosive growth of the network traffic. In the case of HANA/SDN, the traffic in terms of the annual traffic increased 3 times between 1984 and 1988, and 200+ times between 1988 and 1991, and 40 times between 1991 and 1993.

These efforts led to the following activities in 1990s;

- Commercial internet service providers,
- Internet governance through KRNIC and various committees
- Conferences including KRNET

Commercial Internet Service Providers

The internet service was provided to research and education communities around the world until late the 1980s. [Park 2021b] The first commercial internet service was provided by UUNET in 1987. In South Korea, the three companies, Korea Telecom, Dacom and INET provided the commercial internet service in 1994 followed by a few others in the mid-1990s. It is rather unusual that only around ten companies offered the internet service in Korea whereas 100 or 1,000 or more companies offered the commercial internet service in the USA and many other countries.

Dial-up access was a common way to access the internet and other computer communications in the world in the 1980s and 1990s. [Chon 2022] The access through Integrated Service Digital Network (ISDN) was also available in some countries including Japan and many European countries in the 1990s and 2000s.

South Korea is one of the first countries to offer broadband internet services along USA. [Park 2022] @Home in the USA offered the first broadband internet service using cable TV in 1996. South Korea moved to broadband services through the cable TV (Thrunet) in 1998, and ADSL (Hanaro and Korea Telecom (KT)) in 1999. The dialup access became a minor access scheme due to slow speed and unreliable access compared with the broadband services which offer “always on service.” Please refer to the next section on Broadband Internet for detail. Both the USA and South Korea had more than 10 million broadband internet subscribers in 2002. Korea has been the leading country on the broadband service both in number of subscribers and broadband speeds.

The internet community in Korea was an open community with self-governance from the beginning, and it moved quickly. The telecommunication service companies offered the internet service in 1994, and The broadband service started in 1996. Korea was also flexible on the standardization, and embraced the internet standards along the Open System Interconnection (OSI) by International Organization on Standards (ISO) earlier than many other countries.

Human resource development on the internet was done openly through research and education network communities in the 1980s and 1990s. These open collaborations helped to expand the internet community of universities, research institutes, and industry. Much of the critical human resource moved from the research and education network community to commercial internet service companies smoothly in the 1990s.

The commercial internet service provider community in Korea had a similar structure as the research and education network community. The redundant backbone networks were constructed both domestically and internationally. The backbone bandwidths of the commercial service increased the bandwidth in a timely manner from 56K to T1(1.5 Mbps), T3 (45 Mbps), and Giga-bps bandwidth. The internet exchanges were also developed earlier. But, the internet exchanges did not evolve well in the 2000s.[Chon 2022e]

There are several issues on the commercial internet services. First of all, engineers of the internet service providers did not have influential voices in Korea internet unlike many other developed countries. A good example is network operation group (NOG). NANOG in the USA and JANOG in Japan as well as their counterparts in Europe have been active unlike Korea. It had SG-INET in the 1980s, but we don't have any NOG activity in Korea anymore.

A major change took place around the world on the commercial internet service providers in the last decades. Commercial ISPs by mobile telecommunication service providers dominate the world now.

Broadband Internet

Al Gore made the statement on "Information Superhighway" for US National Information Infrastructure under the High Performance Computing and Communication Act in 1991.[Gore 1991; Asia 2015] South Korea came up with the master plan on the national high-speed information network in 1994.[Park 2022] It emphasized the nation-wide optical fiber networks by two or more companies. The plan with the thirty billion dollars was one of the largest projects in Korean history. The initial candidate companies include Korea Telecom (KT) and Korea Electric Power Company (KEPCO). Later, other infrastructure companies such as Korea Rail joined the nation-wide optical cable networks.

In 1996, @Home started the broadband Internet service in USA using the Cable TV networks. In Korea, Thrunet also came up with the Cable TV-based broadband Internet service in 1998. This was followed by the ADSL-based broadband service by Hanaro in 1999 and Korea Telecom in 2000. One of the reasons to provide the broadband service earlier in USA and Korea was lack of ISDN services which offers 64 Kbps bandwidth. Korea did not have "unlimited dialup service"

either unlike USA and Japan. Thus, it is cheaper to have the broadband service than the dialup service for heavy internet users in Korea.

The broadband access may be classified as follows;

Cable TV	1-10 Mbps (shared)
xDSL	1-40 Mbps (dedicated)
LAN (Ethernet)	10-1,000 Mbps (dedicated)
Fiber (FTTH)	100-1,000 Mbps (dedicated)

Korea had more broadband service subscribers per capita than any other countries in the early 2000s. The total number of subscribers in Korea exceeded 10 million in 2002. Broadband access in 2002 in Korea were

xDSL	57.6%
CATV	34.6%
LAN	7.3%

In the USA, Cable TV dominates broadband access with 52%, followed by xDSL with 22% in 2000.

Broadband applications for home include the following in the 20th century;

- General Internet Access; web applications, email, messaging and internet telephony
- Entertainment; games, video and IPTV
- Others; e-commerce, financial activities, distance learning

Broadband applications for business include the following;

- e-Commerce
- telecommunication services; telephone, fax,
- knowledge management solution

Key drivers of broadband growth in the 20th century in Korea include the following;

Provider's Perspectives;

- Flat-rate, low price strategy
- High urban density and residential areas
- Well-developed physical infrastructure
- Merging of telecommunications and broadcasting services

User's Perspective;

- Informed, eager, and sophisticated users
- Parent's passion for education, and new broadband applications.

Government's Perspective;

Deregulation and introduction of fair competition
Allowing non-telecom companies (power, gas, oil) to offer services
Promotion of internet-based education

Cyber Security

John Shoch and Jon Hupp studied on network worm, and published “The Worm Program -Early Experience on Distributed Computation” in 1982. [Shoch 1982] This is the beginning of the worm, which was realized as Morris Worm on the ARPANET by Robert Morris in 1988.[Morris 1988] The Morris Worm brought ARPANET down. It impacted the Korean Internet by slowing down email exchanges with the USA severely. [Asia 2018] This incident alerted the Defense Advanced Research Project Agency (DARPA) which was sponsoring ARPANET Project. DRAPA asked the Software Engineering Institute of Carnegie Mellon University (CMU) to establish the Computer Emergency Response Team/Coordination Center (CERT/CC) in 1988. Many other organizations in the USA and other countries followed DRAPA to establish their CERTs.

Korea Information Security Center was established in 1996, and operates KrC ERT/CC. Korea Information Security Center merged with Korea Internet Information Center (KRNIC) later, and the merged organization had the new name, Korea Internet & Security Agency (KISA).

Cyber Security took a major turn by the new law on electronic signature in 1999. The Korean government made an unusual move to use the Public Key Infrastructure (PKI) with the new law in 1999. This made Korea use over 90% of the public keys in the world. The Korean Government also decided to use Active X of Internet Explorer along with the PKI. Therefore, other browsers cannot be used for electronic commerce including any bank account access in Korea. This was problematic. To make it worse, Active X was not supported by Microsoft when its default web browser was changed to Microsoft Edge. The transition to technology neutrality has been taking much time and effort. Due to the cyber security ecosystem problems and other problems, the banking system including credit cards is extremely complex in Korea.

Korea has been one of the most attacked countries in cyber space with many major incidents in the government offices and the financial sector among others. Thus, these cyber attacks as well as cyber warfare cause additional major problems in the Korean internet ecosystem.

Cyber space has been included as the fifth dimension of the warfare along land, sea, air, and space since the last decades around the world. [Fifth 2022] It is important to have appropriate preparation on the cyberspace warfare.

Kissinger commented on Artificial Intelligence (AI) and cyber security among others in his recent book, The Age of AI: And Our Human Future. [Kissinger 2021] He wrote the warning on the recent progress on AI, and possible impact to human society including cyber security and cyber warfare.

Users of Computer Communications

Timeline: In the 1970s, the email service was created in ARPANET. [Asia 2013]. This and other services to individual users are the beginning of “users” of the computer communications. Bulletin board systems with messages were also created as soon as Personal computers (PC) from IBM and other microcomputer systems were developed in the 1970s. UUCPNET with email services and USENET news were also created in the same time period, and they are compatible with ARPANET. [Asia 2013]. They were also introduced in South Korea in 1982.

Commercial computer communications services based on the microcomputers were also introduced in early 1980s including AOL, CompuServe and Prodigy in the USA. Similar services started in South Korea such as Chollian in 1984 and Prestel in 1986. [Chon 2022; Korea 2021] These computer communications services were called “PC Tongshin” (Personal Computer Communications) in South Korea.

Mobile phone services also started short message service through Global System for Mobile Communications (GSM), whose standards were developed by the European Telecommunications Standards (ETSI) for the second generation (2G) mobile phone networks [GSM 2022]. Korea chose the CDMA technology for the second generation (2G) mobile phone service. The 2G service including the messaging service was deployed much later in 1990s. [DongA 2020]

These three tracks; the internet, PC communications, and mobile phones accommodated users on the computer communications. Migrations of some tracks to other tracks evolved to the current status of the computer communications with well over half of the world population use the computer communications. [Internet 2022] This will be described in the next section, User migration.

Commercial internet services started in the late 1980s starting from the USA, followed by many other countries in the 1980s and the 1990s. The commercial internet services in South Korea started in 1994 by the three companies independently; Korea Telecom (KT), Dacom, and INET in South Korea.

The deployment of World Wide Web (WWW) in the early 1990s encouraged many web-based applications including web-based email services and search services. [WWW 2022] In South Korea, Hanmail, the web-based email service by Daum and the web-based search service by Naver started in 1997. [Korea 2021]

The WWW deployment also created many other digital services such as short message systems, social networking services. [Chon 2022b] They tend to be called social media as the term was developed in this century.

The next major user service deployments called the messaging services appeared in the late 2000s and the early 2010s. WhatsApp started the messaging service in 2009, followed by KakaoTalk and LINE in 2010, and WeChat in 2011. [Asia 2021].

User Migration: There have been substantial user migrations from some of the three tracks, in particular PC Communications users track to other user tracks; the internet, and the Mobile Phone from the 1990s. The migrations are still taking place now, in particular from the internet users to the mobile phone users due to smartphones.

The first major migration started with the invention of the World Wide Web (WWW) services based on the internet in the 1990s. Many web-based services appeared in the 1990s, in particular for the end-users such as search services of and Bing and Google in USA, and Naver in Korea, and web-based email services such as Hotmail from Microsoft and Gmail from Google in USA, and Hanmail from Daum in Korea. [Asia 2013; Korea 2021].

The PC communications communities in the USA and South Korea among others could not come up with similar services in the 1990s, and encouraged the PC communication users to migrate to the internet/WWW. Eventually, the PC communication services were phased out in the 2000s in South Korea, and later in the USA and elsewhere.

Some of the PC Communication users migrated to the Mobile Phone services when Short Message Service by GSM was introduced in 1993. When smartphones are introduced in the late 2000s starting with the iPhone in 2007, the migration to the Mobile Phone services increased substantially. This is particularly true when the mobile telecommunication services migrated from analog service in 1G to digital services in 2G and beyond. Even the internet users started to migrate to mobile phone services when the smartphones became available in the late 2000s. Improved keyboards were deployed in northeast Asia including China, Japan and South Korea, and they encouraged further migration to the Mobile phone services. The detail on the improved keyboards are described in the next section.

Messaging services such as WhatsApp, KakaoTalk, LINE, and WeChat were introduced in the late 2000s and early 2010s. They further accelerated the user migration from the internet to the Mobile Phone services. Many social media services such as Twitter and Facebook as well as messaging services which appeared in the 2000s and the 2010s also accelerated the user migration to the Mobile Phone based on smartphones..

Keyboard: Keyboards play some important roles on users including their migrations in particular in Asia. We will focus on three cases; South Korea, Japan, and China.

Both the full keyboard and the 10 keys keyboard have been popular to input Korean characters in South Korea from the beginning of personal computers. [Korean 2022] The full keyboard includes both English alphabet and Korean characters called Hangul with the conversion key between English alphabet and Hangul. When smartphones were introduced, their users use the full keyboard or the 10-key keyboard, depending on their preferences. Some people use both.

The situation is very different in Japan where the input method is somewhat complex. [Japanese 2022] Firstly, users need to input the Romanized Japanese characters in the English alphabet, called Romaji, followed by conversion to Japanese characters; Hiragana (or Katakana). Then, Chinese character conversions shall be done. Thus, real-time dictation in Japanese is nearly impossible unlike Korean language. Then, the remarkable new schemes on Japanese input methods based on the 12-key keyboard were invented in the 2010s. They are called Keitai input for mobile phones and Flick input for smartphones. They made the Japanese input methods far simpler and efficient. The keyboard users can input Japanese characters directly without going through the English alphabet input. Thus, they don't have to learn Qwerty keyboard layout, either.

Chinese input methods could be complex since they have to deal with around 10,000 Chinese characters to be inputted. [Chinese 2022] Eventually, the pinyin method and other methods were invented. The pinyin method uses the English alphabet to input. Many users started to input Chinese characters using smartphones rather than personal computers as the personal computers and the smartphones were introduced at similar time. Recent development on handwritten Chinese has been remarkable. This makes handwritten Chinese input methods possible, and this method started gaining popularity.

High Technology Ventures

High technology ventures played important roles to progress internet development around the world. [Jeon 2022] In the San Francisco Bay Area called Silicon Valley was the birthplace of many multinational high technology ventures in semiconductor, computer, internet, and other information technologies. They include Intel, Apple, and Oracle among others in the 1980s, followed by Google, Yahoo, Netscape and others in the 1990s.

In South Korea, we had similar developments at a similar time. It started at Trigem Computer in Seoul in 1980. Yongtae Lee and his colleagues started producing Apple II compatible computers followed by personal computers as one of the first companies to produce them in Korea. The company focused on education and government markets initially. Yongtae Lee also funded many ventures including Qnix, Human and INET in the 1980s and the 1990s.

Many high technology ventures started at Korea Advanced Institute of Science and Technology (KAIST) in Seoul in the 1980s. Qnix was formed by Bomcheon Lee, a professor of Computer Science Department of KAIST with his students in 1981. Qnix focused on desktop printing. Qnix also worked on the MSX personal computer with Microsoft.

Medison led by Minhwa Lee was the first venture from the Electrical Engineering Department of KAIST on diagnostic ultrasound systems for medical applications in 1985. Medison founded around thirty companies in the medical field in the 1990s. Minhwa Lee also founded Venture Company Association in 1995.

Human was founded by Chul Chung upon his completion of the Ph.D degree in Computer Science at KAIST in 1989. The company focused on desk top publishing including English, Korean and Chinese characters. The company was located in Gangnam (Teheran Valley) in Seoul.

Serom Technology was founded by KAIST Computer Science Department graduates in 1993. Serom started Dialpad as an internet telephony service in California in 1999 before Skype started a similar service in Europe in 2003. This is the first time a Korean has started a high technology venture company in the USA. Unfortunately, Dialpad did not succeed unlike Skype.

In 1995, non-KAIST graduates led by Jaewoon Lee, a Yonsei University graduate started the high technology venture which succeeded well in the 1990s. Daum's initial product was Hanmail, the web-based email service in 1997. Its service in Korea was very successful and

became the dominant email service in Korea in the 1990s. Later Daum merged with Kakao in the 2000s.

Naver was founded in 1997 by Haejin Lee, another KAIST graduate to offer the web-based search service. It spun off Kakao which offers the messaging service in 2010. Naver also offers the messaging service, LINE, which has dominated the Japanese market.

In the 1990s and 2000s, several online game companies were founded including Nexon, NCsoft and HanGame. In the 2000s, they dominated the online game market globally, but Chinese companies including Tencent dominated the global market from the 2010s.

In the 2000s, several social media companies such as CyWorld and SayClub in similar times as their counterparts in the USA. But, none of them have become major companies.

Science and Technology Parks

“A science and technology parks is defined as being a property-based development that accommodates and fosters the growth of tenant firms and that is affiliated with a university (or a government and private research bodies) based on Proximity, ownership, and/or governance.”[Wikipedia 2022; Jeon 2022b]

Science and technology parks started in the San Francisco Bay Area in the 1950s. It was named “Silicon Valley.” Many high technology ventures in information technologies starting from semiconductor companies and electronics companies in the 1950s-1970s. Silicon Valley was followed by Route 128 in Massachusetts, Sophia Antipolis in France, and Cambridge Science Park in the UK.

In Asia, Tsukuba Science City in Japan was developed from 1963 followed by Daedeok Science Town in Korea from 1975, and Hsinchu Science Park in 1980s. Many government research laboratories moved to Tsukuba. Several universities also moved to Tsukuba. But, we don’t find many companies nor high technology ventures in Tsukuba. Daedeok Science Park is similar without major companies nor high technology ventures. Hsinchu in Taiwan is different. It is more like Silicon Valley with an eventual population of more than one million with several major semiconductor companies such as TSMC and UMC. There are also universities and national research laboratories in Hsinchu. Taiwan government also founded Nankang Software Park in Taipei later in the 2000s.

China also came up with its own Science and Technology Parks. The first park is Zhongguancun which is located between Peking University, Tsinghua University and Academia Sinica in Beijing from 1988. This was followed by Shenzhen, Shanghai and many other science and technology parks in China. Shenzhen became the major metropolitan city with a population of more than 10 million focusing more on hardware whereas Silicon Valley focused more than software and semiconductor.

Daedeok Science Town accommodates most national research laboratories initially with two universities; Chungnam University and Korea Advanced Institute of Science and Technology (KAIST). Daedeok Science Town started to facilitate high technology ventures in the 21st century.

Many of the private high technology ventures started at KAIST in Seoul. Then, Teheran Valley in Gangnam District of Seoul had many high technology ventures. Bundang, 15 km south of Gangnam is one of the first spill-over of Tehran Valley with Naver among others. Later in the 2010s, Pangyo in Kyonggi Prefecture which are around 15 km south of Gangnam District of Seoul City facilitated buildings to the well established information technology companies by the Korean government, but not high technology ventures. Universities are not involved in Pangyo, either. Most venture capitals concentrate in Gangnam.

Several science and technology parks in biotechnology were established in many parts of Korea including Songdo, Daeduk, Osong, and Biocluster in Kyunggi Prefecture. [Jeon 2022b] Korean Government developed the Startup Valley Project to deploy science and technology parks outside of the Seoul-Gyeonggi Metropolitan area since the most high technology venture and the major information technology companies are concentrated in Seoul-Gyeonggi Metropolitan Area. The Startup Valley Projects include Daejeon, Gwangju, Gangneung, Daegu, Busan and Jeju. [Jeon 2022b]

Ro Khanna discussed the concentrations of the high technology startups and major information technology companies in his recent book, *Dignity in a Digital Age; Making Tech Work for All of Us*. We need to pay good attention to the concentration in Korea, USA and elsewhere.

Concluding Remark

The initial internet development in South Korea in the 20th century was very tough, or we were very ambitious. [Asia 2013; An 2015] Fortunately, we managed to deliver the initial internet with the two nodes in South Korea successfully in 1982. This was one of the first IPv4 networks in the world. We had very extensive international collaboration in Asia and the world, and progressed similarly to our counterparts in the USA and elsewhere as many countries in the world did.

The internet users in South Korea is over 96% of the population now. [Internet 2022] The broadband internet service in South Korea is almost universal with one of the highest bandwidths in the world. The internet is convenient and one of the “must have” for various applications including data access, e-Commerce and e-Payment, and social media. Without the internet our economy and society do not function anymore. Since we don’t have any other choice but to live with the internet, we need to put our effort for the internet to serve us, but not the other way around like what we are observing on cyber security among others.

We did not anticipate the internet became a critical social infrastructure so soon. The internet impacted the whole society, but we did not pay proper attention to the internet ecosystems. We stumbled in several areas including cyber security and social media. their ecosystems did not

develop properly, and they did not evolve properly. It is not easy to change ecosystems once they become large-scale systems. We could not redesign many systems once they are deployed in society as we are finding out on cyber security and social media among others. Even though these problems are not unusual among many social infrastructures, we should have paid better consideration when we designed these social infrastructures.

References

- [An 2015] Jungbae An, Korea Internet Development, 2015.(in Korean)
- [Asia 2021] Asia Internet History, Fourth Decade (2010s), 2021.
- [Asia 2018] Asia Internet History, Third Decade (2000s), 2018.
- [Asia 2015] Asia Internet History, Second Decade (1990s), 2015.
- [Asia 2013] Asia Internet History, First Decade, 2013.
- [Chon 2010] Future Internet for the Other Billion, 2010.
- [Chon 2013] Kilnam Chon, et.al., A history of computer networking and the internet in Korea, IEEE, 2013.
- [Chon 2021] Kilnam Chon, Internet Ecosystem, KR4050 Workshop, 2021.
- [Chon 2022] Kilnam Chon, Users of Computer Communications, KR4050 Workshop, 2022.
- [Chon 2022b] Kilnam Chon, Digital Services – Overview, KR4050 Workshop, 2022.
- [Chon 2022c] Kilnam Chon, e-Commerce and e-Payment, KR4050 Workshop, 2022.
- [Chon 2022d] Kilnam Chon, Internet Exchange and Peering (draft ppt), 2022.
- [Chon 2022e] Kilnam Chon, Internet Access (draft ppt), 2022.
- [DongA 2020] DongA Science, Mobile era for all people, 2020.[in Korean]
- [Farivar 2011] Cyrus Farivar, 2011.
- [Fifth 2022] Fifth Dimension Operation, Wikipedia, 2022.
- [Gore 2022] Al Gore, Information Superhighway, Wikipedia, 2022.
- [ICANN 2010] ICANN, 2010.
- [Internet 2017] Internet Society, 2017.
- [Internet 2022] Internet World Stats, 2022.
- [Internet 2022b] InternetHistory.kr, 2022.
- [Jeon 2022] SM Jeon, High Technology Ventures, KR4050 Workshop, 2022.
- [Jeon 2022b] SM Jeon, Science & Technology Parks, KR4050 Workshop, 2022.
- [Kim 2022] Myun Chul Kim, Cyber security ecosystem, KR4050 Workshop, 2022
- [Kissinger 2021] Henry Kissinger, et al., The Age of AI: And Our Human Future, 2021.
- [Khanna 2022] Ro Khanna, Dignity in a digital age; Making tech work for all of us, 2022.
- [Leiner 2009] Barry Leiner, A brief history of the internet, ACM, 2009.
- [Lewis 2016] James Lewis, Advanced Experience in Cybersecurity Policies and Practice, Inter-American Development Bank, 2016.
- [Lynch 1993] Daniel Lynch and Marshall Rose, Internet System Handbook, 1993.
- [Malamud 1992] Exploring the Internet, 1992.
- [Malamud 1997] World's fair for the global village, 1997.
- [Park 2021] Hyun Jae Park, Routers, KR4050 Workshop, 2021.

[Park 2022] Hyun Jae Park, Broadband Internet, KR4050 Workshop, 2022.
[Park 2021b] Taeha Park, Commercial Internet Service Providers, KR4050 Workshop, 2021.
[Wired 2016] Wired, Shenzhen: The Silicon Valley of Hardware, YouTube,.2016.
[Youn 2021] JY Youn, Leased-Line Internet, KR4050 Workshop, 2021.

Appendix A Timelines

Appendix A1 Internet
Appendix A2 PC Communications
Appendix A3 Mobile Phone/Smartphone

Appendix A1 Timeline – Internet

1969 (Internet with NCP)
1971 (Email with @)
1980 (USENET News)
1982 IPv4 Network in South Korea
1983 USENET News in South Korea
1990 (WWW)
1993 Website in South Korea
1994 Commercial Internet Service Provider (ISP) in South Korea
1997 1 million Internet users in South Korea
1997 Hanmail – web-based email in South Korea
1997 Search service (Naver) – web-based service in South Korea
2000 21 million Internet users in South Korea

Remark: () indicates the global development such as in North America and Europe.

Appendix A2 Timeline – PC Communications

1983 AOL (CompuServe, Prodigy and others in 1980s)
1984 Chollian (천리안)
1997 3 million users in South Korea
1988 Chollian (천리안) – Commercial service
2000s Phase out of PC Communications

Remark: Need data on PC Communications user's migration to the internet and mobile phones and smartphones.

Appendix A3 Timeline – Mobile Phone

1982 Pager (무선호출기, 삐삐)

1983 (Motorola phone)

1983 (Short Messaging Service - GSM)

1984 Korea Mobile Communications Service (한국이동통신서비스) 1994 SK Telecom

2000 27 million Mobile Phone Users in South Korea

2007 (iPhone)

2008 Smartphones in South Korea

2010 5 Million Smartphone users in South Korea

2010 Kakao Talk in South Korea

Appendix A4 Internet User Population in South Korea

	Internet Users (% of Population)	Population	Internet Users
1990	0.023	42,869,283	9,860
1995	0.82	45,092,991	369,763
2000	44,700	47,008,111	21,012,626

[Source: World Bank, 2021; Individual using Internet Population]

Appendix A5 Mobile Phone Subscribers, and Internet Users in South Korea

	Mobile Phone Subscriptions (in million)	Internet Users (in million)
2000	27	19
2001	29	N/A
2002	32	26
2003	34	26
2004	37	31

2005	38	33
2006	40	34
2007	44	34
2008	46	35
2009	48	39
2010	51	39
2011	53	39
2012	54	40
2013	55	42
2014	57	42
2015	59	45
2016	61	45
2017	64	47
2018	66	47
2019	69	49
2020	70	49

[Source: Mobile Phone Subscriptions, ITU; Internet Users, Internet World Stats]

Appendix B Users of Computer Communications in the 20th Century

Introduction

Computer communications started among mainframe computers and minicomputers in the 1960s. [Asia 2013; Computer 2022]. We had the landmark demonstration of ARPANET at the First International Conference on Computer Communications (ICCC) in Washington, D.C., 1971. [ICCC 1971]. This was the landmark demonstration of computer communications. One of the applications is email which created “users” of the computer communications. When personal computers became popular in the 1980s, we started to have various applications which created their users including emails, messaging systems, and bulletin board systems among others.

In this article, we plan to review the history of users on computer communications including their migrations among the three computer communications systems; the internet, personal computer (PC) communications, and mobile phones which have a microprocessor internally. We cover primarily South Korea, but we also cover other Asian countries as well as other continents additionally.

ARPANET had around 5,000 users with over 66 nodes in 1980. [Asia 2013] Computer communications networks which are compatible with ARPANET through email started their operations in the 1970s and 1980s such as UUCPNET/Usenet, Bitnet and CSNET. The internet consists of NSFNET, the successor of the ARPANET and these networks in the 1980s.

PC communication networks such as bulletin board systems and message systems including FidoNet globally, and AOL and CompuServe in the USA as well as similar services among many other countries including South Korea and Japan became available in the 1970s and 1980s. [Asia 2013]

Mobile phone services offered by telecommunication service providers around the world had messaging services in the 1990s. They were eventually standardized by the Global system for Mobile Communications (GSM) as the short message service in 1992. [GSM 2022] GSM made message services very popular globally due to global compatibility of their services. In Korea, 2G Service based on CDMA started in 1996, and SMS over CDMA started in 1997.[Donga 2020]

In this article, we will elaborate on developments of the users of computer communications in the above three areas. Additionally, we will elaborate on migration of users from each area to other areas. We analyze South Korea as the case study with additional coverage of neighboring countries including China and Japan in addition to North America and Europe where the computer communications started.

Timelines – South Korea and the World

In the 1970s, the email service was created in ARPANET. [Asia 2013]. This is the beginning of “users” of computer communications. Bulletin board systems with messages were also created as soon as Personal Computers from IBM and other microcomputer systems were invented in the 1970s. UUCPNET with email services and USENET news were also created in the same time period, and they are compatible with ARPANET. [Asia 2013]. They were also introduced in South Korea in 1983.

Commercial computer communications services based on the microcomputers were also introduced in early 1980s including AOL, CompuServe and Prodigy in the USA. Similar services started in South Korea such as Chollian in 1984 and Prestel in 1986. [PC 2021; Korea 2021] These computer communications services were called “PC Tongshin” (Personal Computer Communications) in South Korea.

Mobile phone services also started short message service through Global System for Mobile Communications (GSM), whose standards were developed by the European Telecommunications Standards (ETSI) for the second generation (2G) mobile phone networks [GSM 2022]. Korea decided to use CDMA technology for 2G, and its service was deployed in 1996 followed by SMS based on CDMA in 1997.[Donga 2020]

These three tracks; the internet, PC communications, and mobile phones accommodated users of the computer communications. Migrations of some tracks to other tracks evolved to the current status of computer communications with well over half of the world population use the computer communications. This will be described in the next section, User migration.

Commercial internet services started in the late 1980s starting from the USA, followed by many other countries in the 1980s and the 1990s. The commercial internet services in South Korea started in 1994 by the three companies independently; Korea Telecom, Dacom, and INET in South Korea.

The deployment of World Wide Web (WWW) in the early 1990s encouraged many web-based applications including web-based email services and search services. [WWW 2022] In South Korea, Hanmail, the web-based email service by Daum and the search service by Naver started in 1997. [Korea 2021]

The next major user service deployments called the messaging services appeared in the late 2000s and the early 2010s. Whatsapp started the messaging service in 2009, followed by KakaoTalk and LINE in 2010, and WeChat in 2011. [Asia 2021].

User Migration

There have been substantial user migrations from some of the three tracks, in particular PC Communications users track to other user tracks; the internet, and the Mobile Phone from the 1990s. The migrations are still taking place now.

The first major migration started with the invention of the World Wide Web (WWW) services based on the internet in the 1990s. Many web-based services appeared in the 1990s, in particular for the end-users such as search services of Bing and Google in the USA, and Naver in Korea, and web-based email services such as Hotmail from Microsoft and Gmail from Google in the USA, and Hanmail from Daum in Korea. [Asia 2013; Korea 2021].

The PC communications communities in the USA and South Korea among others could not come up with similar services in the 1990s, and encouraged the PC communication users to migrate to the internet/WWW. Eventually, the PC communication services were phased out in the 2000s in South Korea, and later in the USA and elsewhere.

Some of the PC Communication users migrated to the Mobile Phone services when Short Message Service by GSM was introduced in 1993. When smartphones were introduced in the late 2000s starting with the iPhone in 2007, the migration to the Mobile Phone services increased substantially. This is particularly true when the mobile telecommunication services migrated

from analog service in 1G to digital services in 2G and beyond. Even the internet users started to migrate to mobile phone services when the smartphones became available in the late 2000s. Improved keyboards were deployed in northeast Asia including China, Japan and South Korea, and they encouraged further migration to the Mobile phone services. The details on the improved keyboards are described in the next section.

Messaging services such as Whatsapp, KakaoTalk, LINE, and WeChat were introduced in the late 2000s and early 2010s. They further accelerated the user migration from the internet to the Mobile Phone services. Many social networking services such as Twitter and Facebook which appeared in the 2000s also accelerated the user migration in addition to the messaging services.

Keyboards

Keyboards play some important roles on users including their migrations. We will focus on three cases; South Korea, Japan, and China.

Both the full keyboard and the 10 keys keyboard have been popular to input Korean characters in South Korea from the beginning of personal computers and mobile phones. [Korean 2022] The full keyboard includes both English alphabet and Korean characters called Hangul with the conversion key. When smartphones were introduced, their users use the full keyboard or the 10 key keyboard, depending on their preferences. Some people use both.

The situation is very different in Japan where the input method is somewhat complex. [Japanese 2022] Firstly, users need to input the Romanized Japanese characters in the English alphabet, called Romaji, followed by conversion to Japanese characters; Hiragana (or Katakana). Then, Chinese character conversions shall be done. Thus, real-time dictation in Japanese is nearly impossible unlike Korean language. Then, the remarkable new schemes on Japanese input methods based on the 10 key keyboard were invented in the 2010s. They are called Keitai input for mobile phones and Flick input for smartphones. They made the Japanese input methods far simpler and efficient. The keyboard users can input Japanese characters directly without going through the English alphabet input. Thus, they don't have to learn Qwerty keyboard layout, either.

Chinese input methods could be complex since they have to deal with 10,000 Chinese characters to be inputted. [Chinese 2022] Eventually, the pinyin method and other methods were invented. The pinyin method uses the English alphabet to input. Many users started to input Chinese characters using smartphones rather than personal computers as the personal computers and the smartphones were introduced at similar time. Recent development on handwritten Chinese has been remarkable. This makes handwritten Chinese input methods possible, and this method started gaining popularity.

Remarks

Korean language support

The internet did not support the Korean language well initially in the 1980s until commercial internet service providers started to provide their services in the 1990s. USENET news as well as UUCPNET mail did not support Korean either. [Korea 2021; Asia 2013] Their users are in academic and research communities, and the local language support is not their primary interest as long as English is supported properly. On the other hand, PC communications supported the Korean language from the beginning in the 1980s since their interest is to use the PC communications for their domestic activities in Korea. Moreover, the PC communications service providers have to support the Korean language in order to keep their customers, i.e., the PC communications users. This is similar in the case of mobile phone services. It was necessary for the short message services to support the Korean language when they were deployed in the 1990s. It is similar to PC communications.

Need good statistics

We need good statistics on the 20th century as well as on the 21st century with respect to mobile phones, PC communications, and the internet, including their populations. The population data we could obtain from the World Bank and National Information Society Agency (NIA) in South Korea are substantially different. [Chon 2022]

User Populations in Korea, Internet and PC Communications

1994

140,000: Total Internet Users in South Korea [World Bank 2022]

10,000: Commercial Internet Users in South Korea [NIA 2021]

1997

1.7 million: Total Internet Users in South Korea [World Bank 2022]

1 million: Total Internet Users in South Korea [NIA 2021]

3 million: PC Communications Users in South Korea [NIA 2021]

2000

19,040,000 Internet Users in South Korea [Internet 2000]

27 million Mobile Phone Users in South Korea [ITU 2022]

Migration of PC Communication Users

Did PC Communications users migrate more to the internet, or mobile phones? We don't have good data on this matter. We guess most of the PC communications users migrated to the internet due to availability of the web-based services such as Hanmail and the search service by Naver.

They are not available under the PC communications. Some users of the PC communications migrated to the mobile phone services due to availability of short message services. Once the popular web-based services became available under smartphones, many PC communications users as well as a substantial number of the internet users migrated to mobile phone/smartphone services in the 2010s.

References

- [Asia 2013] Asia Internet History, Chapters 3 and 4, First Decade (1980s), 2013.
- [Chinese 2022] Chinese input method, Wikipedia, 2022.
- [Chon 2022] Kilnam Chon, Users of Computer Communications, KR4050 Workshop, 2022.
- [Chon 2023] Kilnam Chon, Early Internet development in Korea, Asia and the world, in Shared Vision for the Digital World, 2023.[in Chinese.
- [Computer 2022] Computer Networks, Wikipedia, 2022.
- [Donga 2020] Donga Science, Mobile ear for all people, 2020. (in Korean)
- [GSM 2022] Global Systems for Mobile Communications, Wikipedia, 2022.06.12.
- [ICCC 1971] International Conference on Computer Communications, 1971.
- [Internet 2000] Internet World Stats, Internet Statistics and Country Data, 2000.
- [ITU 2022] ITU, Mobile Phone Subscriptions, 2022.
- [Japanese 2022] Japanese input method, Wikipedia, 2022.
- [Korea 2021] Korea Internet History, Year Table, 2021.
- [Korean 2022] Korean language and computers, Wikipedia, 2022.
- [Mobile 2021] Mobile Phone (휴대전화), Wikipedia, 2021.
- [NIA 2021] NIA, Internet and PC Communications Population, Korea Internet History, 2021.
- [Pager 2021] Pager (무선호출기), Wikipedia, 2021.
- [PC 2021] PC Communications (PC통신), Wikipedia, 2021.
- [Short 2021] Short Message Service, Instant Messaging, and BBS, Wikipedia, 2021.
- [World 2021] World Bank, Internet population, 2021.
- [WWW 2022] World Wide Web, Wikipedia, 2022.