7.3 Early development of Internet in South Korea and Asia

Kilnam Chon

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1. Introduction

Computer networks began in the 1960s [Asia 2013; Lynch 1993; Leiner 2009]. ARPANET was one of these computer networks, which started as an experimental computer network in 1969. Its successor, the Internet with the Internet Protocol (IP), was available in the 1980s. We developed the computer network in South Korea 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 history of Internet development in South Korea in the 20th century, as well as related developments in Asia and the rest of the world. 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
e-Commerce and e-Payment
High Technology Ventures
Science & Technology Parks
Remarks

2. Internet Ecosystem

An 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.

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

CSNET, along with UUCPNET/USENET and BITNET, expanded the users of computer networks beyond ARPANET both in the USA and the world in the 1980s [Asia 2013]. NSFNET

replaced ARPANET as the backbone network in the USA, and connected to the Internet Protocol version 4 (IPv4) networks in other continents, Asia, Europe, and Latin America, as well as North America, in the 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 it today.

The technologies for the Internet ecosystem include 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. Relevant conferences include International Computer Communication Conference (ICCC), INET, Interop, and many other conferences that were formed in the 20th and 21st centuries.

The Internet ecosystem activities include the following and more;

Research and Education Networks
Network Operator's Groups
Cyber Security
Commercial Internet Service Providers
The WWW and its Applications
Digital Services, including Short Message Systems, Social Media and Messaging Services
e-Commerce and e-Payment
Entertainment
Internet Governance

The Internet users in the world now exceeds five billion. [Internet 2022] They form numerous user communities, nationally, regionally, and globally. One of the significant issues for users is "the last billion Internet users" [Chon 2010]. They are disadvantaged 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 geographical disadvantages, such as remote regions, but not others.

The public and commercial sectors play essential roles in the Internet ecosystems. Governments play different roles depending on the country, in addition to their regulatory roles. Public institutions play additional roles to the government, such as standardization, research and development, among others. Telecommunication service providers provide infrastructure services, including telecommunication services and Internet services. Other commercial Internet service providers are increasingly becoming minor Internet service providers. On the other hand, digital service providers such as social media and e-commerce are becoming dominant alongside the telecommunications service providers.

To have healthy Internet ecosystems, we need good human networks nationally, regionally, and globally. The human network must be interdisciplinary, not just technical or industrial. Another

challenge we face is having good next-generation human resources with appropriate handover processes.

There are many other issues in the Internet ecosystem. First of all, the evolution of the Internet ecosystem. Evolution is not easy, even though we know that evolution is necessary because it is becoming a large-scale social infrastructure. Unfortunately, we did not realize the Internet had become so big and so fast, and we could not prepare for the formation of the large-scale social infrastructure. Some of the practices on the Internet, such as “winner take all,” “don’t fix when it works,” and “free” Internet services such as email and social media, hinder the development of a healthy Internet ecosystem. As digital ecosystems are being formed now, the Internet ecosystem, as the leading ecosystem among the ecosystems, may take the lead in creating the digital ecosystem.

In South Korea, the Internet ecosystem started with the research network community, which included universities, public research institutes, and corporate research laboratories, in the early 1980s. [Asia 2013; Korea 2015]. The research network community in South Korea has extensively cooperated with its counterparts in Asia and the world. The global conference, 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 part of the PACCOM Project involving the USA(NSF), Australia, Hong Kong, Japan, South Korea, and New Zealand. The three consortium members of the HANA/SDN (Korea Telecom, Dacom, and INET) started their commercial Internet services in 1994 [An 2015; Internet 2022b].

Internet governance began with the establishment of a research network community in the 1980s. It evolved into the HANA/SDN consortium with the establishment of the Academic Network Council (ANC) in 1991. ANC had many activities, including working groups and conferences, among others. One of the activities was the management of .kr domain names and IP addresses since 1986. The public organization, KRNET, administered these names and numbers under government supervision from the 1990s. Cybersecurity has been a problematic issue in South Korea. We handled user access uniquely with public key infrastructure (PKI) and Active X, the proprietary software by Microsoft. Later, we tried to correct shortcomings, but it was not easy once the ecosystem was widely established. These and other problems in the Internet ecosystem in South Korea hinder its development.

Remark: There are more descriptions on the ecosystems, including the AI ecosystem, in Chapter 4. Digital Ecosystem.

3. Internet Routers

Internet router development was the first major technical undertaking in South Korea during the 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 the ARPANET. IMP was

developed on the Honeywell minicomputer in 1969. The next generation of Internet routers was based on microprocessors, such as those found in Sun Microsystems workstations with a Motorola 68000, in the 1980s. Then, the commercial routers based on custom VLSI chips, such as those from CISCO and Proteon, became available in the late 1980s.

In South Korea, the first Internet routers were developed on PDP11 minicomputers from Digital Equipment Corporation (DEC), since importing ARPANET IMP was not possible nor practical. Unfortunately, one of the minicomputers, the PDP 11/44, challenged our project team to modify the operating system to run IPv4. The OS modification was a new challenge in South Korea in the early 1980s. Finally, the routers were successfully developed on PDP 11/70 and 11/44 in 1981 and 1982, respectively. Later in the 1980s, the microprocessor-based routers were developed on the SSM-16, the Motorola 68000-based UNIX computer developed by Samsung in South Korea, similar to the router based on Sun Microsystems 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 Microsystems workstation between the Korean Internet called SDN and NSFNET through the University of Hawaii as part of the 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 broadband Internet, starting in the late 1990s, required low-cost routers to be used at homes and organizations. Various commercial routers were offered from many router companies, including CISCO, in the 2000s.

4. Leased-Line Internet

ARPANET had a 56 Kbps leased line network in 1969 [Leiner 2009; Youn 2021]. Other countries in Europe and Asia had both leased lines and dial-up connections domestically. Still, connections to the USA tended to be dial-up due to the high cost of international connections.

ARPANET did not allow international leased line connections with IP except for the ARPANET project member nodes in the UK and Norway. When NSFNET replaced ARPANET as the backbone network in the USA in the late 1980s, it allowed international links to foreign countries.

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

As traffic increased exponentially in the 1980s and international links with IP were allowed in 1986, 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 multi-stakeholder consortium, called HANA/SDN Consortium, in 1989. The consortium members include 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 original research and education network called SDN, which was established in the early 1980s. The consortium had an annual budget of 150 million won, about 500,000 US dollars. The HANA/SDN consortium performed various network management and administration functions such as

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

In the late 1980s, HANA/SDN joined the PACCOM Project, which NSF and research and education networks in Asia, including Australia, Hong Kong, Japan, Korea, and New Zealand operated. All networks connected to NSFNET in the USA are connected with leased lines. Some linked to Hawaii, and others connected to California in the late 1980s, including HANA/SDN in 1990 with 56 Kbps.

The Korea Institute of Science and Technology Information (KISTI) is a government research institute that operates the Korea Research Environment Open Network (KREONET), the National Supercomputer Center, and the National Science and Technology Information Center. KREONET connected to NSFNET through CERNET with a 56 kbps link in 1990, the same year as the HANA/SDN.

These networks steadily increased their link bandwidth from 56 Kbps to 256 Kbps or more, both internationally and on domestic backbone networks, to 1.5 Mbps (T1) and higher bandwidths in the 1990s to accommodate the explosive growth of network traffic. In the case of HANA/SDN, the annual traffic grew three times between 1984 and 1988, 200 times between 1988 and 1991, and 40 times between 1991 and 1993.

These efforts led to the following activities in the 1990s;

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

5. Commercial Internet Service Providers

The Internet service was provided to research and education communities worldwide until late the 1980s [Park 2021b]. The first commercial Internet service was provided by UUNET in the USA 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 South 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 worldwide in the 1980s and 1990s [Chon 2022]. 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 with the USA [Park 2022]. @Home in the USA offered the first broadband Internet service over cable TV in 1996. South Korea moved to broadband services through cable TV (Thrunet) in 1998, and ADSL (Hanaro and Korea Telecom (KT)) in 1999. Dial-up access became a minor access scheme due to slow speed and unreliable access compared with broadband services, which offer "always-on service." Please refer to the next section on Broadband Internet for details. Each of the USA and South Korea had over 10 million broadband Internet subscribers in 2002. Korea is the leading country in broadband service in terms of the number of subscribers and broadband speeds.

The Internet community in South Korea has been an open, self-governing community from the beginning, and has developed rapidly. Telecommunication providers offered Internet services in 1994, and broadband services started in 1996. South Korea was also flexible in the standardization. It adopted the Internet standards along the Open System Interconnection (OSI) by the International Organization for Standards (ISO) earlier than many other countries.

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

Korea's commercial Internet service provider community had a similar structure to the research and education network community. The redundant backbone networks were built both domestically and internationally. The backbone bandwidths of the commercial service increased the bandwidth in a timely manner from 56 Kbps to 1.5 Mbps (T1), 45 Mbps (T3), and Gbps. The Internet exchanges were also developed earlier. However, Internet exchanges did not develop well in the 2000s [Chon 2022e].

There are several problems with commercial Internet services. First of all, unlike many other developed countries, Internet service providers' engineers have not had an influential voice in South Korea's Internet. A good example is the Network Operation Group (NOG). NANOG in

the USA, JANOG in Japan, and their counterparts in Europe have been active, unlike South Korea. It had SG-INET in the 1980s, but we no longer have any NOG activity in South Korea.

In the last decades, a major change has taken place worldwide in terms of commercial Internet service providers (ISPs). Commercial ISPs provided by mobile telecommunication service providers now dominate the world.

6. Broadband Internet

Al Gore delivered the “Information Superhighway" statement for US National Information Infrastructure under the High Performance Computing and Communications Act in 1991. [Gore 1991; Asia 2015] South Korea established the National High Speed Information Network Master Plan in 1994. [Park 2022] It emphasized two or more companies' nationwide optical fiber networks. The thirty-billion-dollar plan was one of the most significant projects in South 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 nationwide optical cable networks.

In 1996, @Home launched the broadband Internet service in the U.S. using the Cable TV networks. In South Korea, Thrunet launched the Cable TV-based broadband Internet service in 1998. This was followed by the ADSL-based broadband service of Hanaro in 1999 and Korea Telecom in 2000. One of the reasons for the broadband service earlier in the USA and Korea was the lack of ISDN services, which offered 64 Kbps bandwidth. South Korea did not have “unlimited dial-up service” either, unlike the USA and Japan. Therefore, it is cheaper to have the broadband service than the dial-up service for heavy Internet users in South Korea.

The broadband access can 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)

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

xDSL	57.6%
CATV	34.6%
LAN	7.3%

In the United States, Cable TV dominated broadband access with 52%, followed by xDSL with 22% in 2000.

Broadband applications for home include;

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

Broadband business applications include;

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

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

Provider perspectives;

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

User perspective;

Informed and demanding users
Parents' passion for education, and new broadband applications.

Government perspective;

Deregulation and introduction of fair competition
Allowing non-telecom companies (electricity, gas, oil) to offer services
Promoting Internet-based education

7. Cyber Security

John Shoch and Jon Hupp studied the network worm and published "The Worm Program - Early Experience on Distributed Computation" in 1982 [Shoch 1982]. This was 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 down the ARPANET. It affected the South Korean Internet by slowing down email exchange with the USA. [Asia 2018] This incident alerted the Defense Advanced Research Project Agency (DARPA), which sponsored the ARPANET Project. DRAPA asked the Software Engineering Institute of Carnegie Mellon University 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 own CERTs.

The Korea Information Security Center was established in 1996 and operates KrCERT/CC. Later, it merged with the Korea Internet Information Center (KRNIC), which had the new name Korea Internet and Security Agency (KISA).

Cybersecurity took a major turn with enacting the Electronic Signature Act in 1999. The South Korean government took an unusual step of using the Public Key Infrastructure (PKI) with the new law of 1999. This made South Korea use over 90% of the public keys in the world. The South Korean government used Active X of Internet Explorer with the PKI. Therefore, other browsers, including access to bank accounts in South Korea, cannot be used for electronic commerce. This was problematic. To make matters worse, Microsoft did not support Active X when its default web browser was changed to Microsoft Edge. The transition to technology neutrality took a lot of time and effort. Due to the cybersecurity ecosystem problems and other issues, the banking system, including credit cards, is extremely complex in South Korea.

South Korea has been one of the most attacked countries in cyberspace, with many major incidents in the government and the financial sectors, among others. Therefore, these cyberattacks and cyber warfare are causing additional major problems in the South Korean Internet ecosystem.

In recent decades, cyberspace has been included as the fifth dimension of warfare along land, sea, air, and space around the world [Fifth 2022]. Appropriate preparation for cyberspace warfare is important.

Kissinger commented on Artificial Intelligence (AI) and cybersecurity in his recent book, “The Age of AI: And Our Human Future” [Kissinger 2021]. He wrote a warning on the recent advances in AI, and their potential impact on human society, including cybersecurity and cyberwarfare.

8. Users of Computer Communications

(1) Timeline

In the 1970s, the email service was created in ARPANET [Asia 2013]. This and other services to individual users are the beginning of the users of computer communication. Bulletin board systems with messages were also created when Personal computers (PCs) 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 microcomputers were also introduced in the early 1980s, including AOL, CompuServe, and Prodigy in the USA. Similar services were launched in South Korea, such as Chollian in 1984 and Prestel in 1986 [Chon 2022; Korea 2021]. In South Korea, these computer communications services were called “PC Tongshin” (Personal Computer Communications).

Mobile phone services also began short message service through Global System for Mobile Communications (GSM), whose standards were developed by the European Telecommunications Standards Institute (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 the 1990s. [DongA 2020]

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

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

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

The WWW deployment also gave rise to many other digital services, such as short message systems and social networking services [Chon 2022b]. These 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 launched the messaging service in 2009, followed by KakaoTalk and LINE in 2010, and WeChat in 2011 [Asia 2021].

(2) User Migration

There has been substantial migration of users from some of the three tracks, particularly PC Communications users to other user tracks; the Internet, and the mobile phone since the 1990s. The migrations are still taking place today, in particular from Internet users to mobile phone users due to smartphones.

The first major migration started with the invention of World Wide Web (WWW) services based on the Internet in the 1990s. Many web-based services appeared in the 1990s, especially for end-users, including search services such as Bing and Google in the USA and Naver in Korea, and web-based email services such as Hatmail 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, were unable to develop similar services in the 1990s, and they encouraged PC communication users to migrate to the Internet/WWW. Eventually, PC communication services were phased out in the 2000s in South Korea and later in the USA and elsewhere.

Some PC Communication users migrated to mobile phone services when the 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 mobile phone services increased significantly. This is particularly true as 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 smartphones became available in the late 2000s. Improved keyboards were introduced in Northeast Asia, including China, Japan, and South Korea, encouraging further migration to mobile phone services. The details of 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 migration of users from the Internet to the mobile phone services. Many social media services such as X (Twitter) and Facebook, as well as messaging services that appeared in the 2000s and the 2010s, also accelerated the migration of users to mobile phones based on smartphones.

(3) Keyboard

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

Both the full keyboard and the 10-key keyboard have been popular for inputting Korean characters in South Korea since the early days of personal computers. [Korean 2022] The full keyboard includes both the English alphabet and Korean characters called Hangul, with the conversion key between the English alphabet and Hangul. When smartphones were introduced, their users used 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. This makes real-time dictation in Japanese almost impossible, unlike the Korean language. Then, the remarkable new scheme on Japanese input methods based on the 12-key keyboard was invented in the 2010s. They are called keitai input for mobile phones and flick input for smartphones. They made the Japanese input methods much simpler and more efficient. Keyboard users can input Japanese characters directly without using the English alphabet input. They also don’t have to learn the QWERTY keyboard layout.

Chinese input methods can be complex since they have to deal with around 10,000 Chinese characters [Chinese 2022; Mullaney 2024]. Eventually, the Pinyin method and other methods were invented. The Pinyin method uses the English alphabet to enter Chinese characters. Many users started to input Chinese characters using smartphones rather than personal computers, as both were introduced at similar times. The recent development on handwritten Chinese input is remarkable. This makes handwritten Chinese input methods possible, and this method started to gain popularity.

Remark: One may refer Section 2.2 Users for additional descriptions on users.

9. High Technology Ventures

High-technology companies have played an essential role in the development of the Internet around the world [Jeon 2022]. The San Francisco Bay Area, known as Silicon Valley, was the birthplace of many multinational high-technology companies in semiconductor, computer, Internet, and other information technologies. These include HP, 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 an identical time. It started at Trigem Computer in Seoul in 1980. Yongtae Lee and his colleagues began producing Apple II-compatible computers, followed by personal computers, as one of the first companies to make them in South Korea. The company initially focused on education and government markets. Yongtae Lee also funded many companies, including Qnix, Human, and INET, in the 1980s and 1990s.

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

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

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

Serom Technology was founded by graduates of KAIST Computer Science Department in 1993. Serom started Dialpad as an Internet telephony service in California in 1999 before Skype began to a similar service in Europe in 2003. This is the first time a Korean high-tech venture in the USA. Unfortunately, Dialpad did not succeed like Skype.

In 1995, Jaewoon Lee, a Yonsei University graduate, started the high-tech company Daum, which succeeded well in the 1990s. In 1997, Daum's first product was Hanmail, a web-based email service. Hanmail was very successful and became the dominant email service in South Korea in the 1990s. Daum later merged with Kakao in the 2000s.

Naver was founded in 1997 by Haejin Lee, another KAIST graduate, to provide a web-based search service. In 2010, it spun off Kakao, which offers a messaging service. Naver also offers the messaging service LINE, which dominates the Japanese market.

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

In the 2000s, several social media companies, such as CyWorld and SayClub, were founded at similar times to their counterparts in the USA. But none of them has become a major company.

10. Science and Technology Parks

"*A science and technology park 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 began in the San Francisco Bay Area in the 1950s, and it was called "Silicon Valley." From the 1950s to the 1970s, many high-tech ventures in information technologies started from semiconductor and electronics companies. 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 in 1963, followed by Daedeok Science Town in South Korea in 1975, and Hsinchu Science Park in Taiwan in the 1980s. Many government research laboratories moved to Tsukuba. Some universities moved to Tsukuba. But, we don't find many companies or high technology ventures in Tsukuba. Daedeok Science Park is similar, with no large companies or high technology ventures. Hsinchu in Taiwan is different. It is more like Silicon Valley, with an eventual population of over one million and several major semiconductor companies such as TSMC and UMC. There are also universities and national research laboratories in Hsinchu. The Taiwan government also established Nankang Software Park in Taipei in the 2000s.

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

Daedeok Science Town houses most national research laboratories. It initially had two universities: Chungnam University and Korea Advanced Institute of Science and Technology (KAIST). In the 21st century, Daedeok Science Town began to facilitate high-tech ventures.

Many 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 outposts of Tehran Valley with Naver and others. Later in the 2010s, Pangyo in Kyonggi Prefecture, which is around 15 km south of the Gangnam District of Seoul City, was developed by the South Korean government for well-established information technology companies, 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 South Korea, including Songdo, Daeduk, Osong, and Biocluster in Kyunggi Prefecture. [Jeon 2022b] The South Korean Government developed the Startup Valley Project to establish science and

technology parks outside the Seoul-Gyeonggi Metropolitan area, where the most high-tech ventures and the major information technology companies are concentrated. The Startup Valley Projects include Daejeon, Gwangju, Gangnoon, Daegu, Busan, and Jeju [Jeon 2022b].

Ro Khanna discussed the concentrations of high-tech 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 close attention to the concentrations in South Korea, the USA, and elsewhere.

11. Remarks

(1) General

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

Internet users in South Korea now account for over 96% of the population. [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-haves" for various applications, including data access, e-commerce, e-payment, and social media. Without the Internet, our economy and society would not function. Since we don't have any other choice but to live with the Internet, we must strive to make the Internet serve us, but not the other way around, as we see in cybersecurity, among other areas.

We did not anticipate the Internet would become a critical social infrastructure so soon. The Internet has affected society substantially, but we have not paid proper attention to the Internet ecosystems. We stumbled in several areas, including cybersecurity 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 systems. We have not been able to redesign many systems once they are deployed in society, as we are seeing with cybersecurity and social media, among others. While these problems are not uncommon in many social infrastructures, we should have taken them into account when designing them.

(2) Korean language support

The Internet did not initially support the Korean language until commercial Internet service providers began offering their services in the 1990s. USENET news and 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 concern as long as English is adequately supported. On the other hand, PC communications supported the Korean language in the 1980s, as their interest is to use PC communications for their domestic activities in South

Korea. In addition, the PC communications service providers must support the Korean language to retain their customers, i.e., the PC communications users. This is similar to mobile phone services. The short message services needed to support the Korean language when they were deployed in the 1990s.

(3) Need good statistics

We need good statistics for the 20th and 21st centuries regarding mobile phones, PC communications, and the Internet, including their populations. The population data we obtained from the World Bank and the 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].

(4) Migration of PC Communication Users

Have PC Communications users migrated more to the Internet or mobile phones? We don't have good data on this matter. We suspect most of the PC communications users migrated to the Internet due to the availability of web-based services such as Daum's Hanmail and Naver's search service. These were not available under the PC communications. Some users of PC communications migrated to mobile phone services due to the availability of short message services. Once the popular web-based services became available on smartphones, many PC communications users, as well as a significant number of Internet users, migrated to mobile phone/smartphone services in the 2010s.

(5) KR4050 Workshop, 2021-2022

This article was developed based on the following presentations at the KR4050 Workshop in 2021 and 2022;

2021 KR4050 Workshop;

Kilnam Chon	Internet Ecosystem
Hyunje Park	Routers
Taeha Park	Commercial Internet Service Providers
Jin Hyoun Youn	Leased Line Internet

2022 KR4050 Workshop

Kilnam Chon	Users
Kilnam Chon	Internet Access
Seong Min Jeon	High Technology Ventures
Seong Min Jeon	Science and Technology Parks
Hyunje Park	Broadband Internet

(6) Financial Aspects

ARPANET was financed by the Advanced Research Projects Agency of the Department of Defense in the USA from the 1960s along with other advanced research projects in information technology. It was funded for over 20 years until the ARPANET was phased out in the 1980s [ARPANET 2024]. Donald Davies in the UK invented the packet switching network in the mid-1960s. [Davies 2024] Then, he led the project at National Physical Laboratory (NPL) to develop the NPL Network in 1968-1969, the local area network at the laboratory, as he could not obtain the government funding to establish the wide area network in the UK, unlike the ARPANET in the USA. Louis Pouzen invented the datagram service and developed the CYCLADES based on the datagram service in the early 1970s. This later influenced the packet switching of the ARPANET. Unfortunately, CYCLADES was terminated due to a lack of funding from the French Government, which preferred the Minitel service based on X.25.

In South Korea, the computer network project proposal was rejected by the South Korean government in 1981. Still, the same project as a subproject under the national computer development project was approved the following year in 1982 [Asia 2013]. The two-node IPv4 network was developed in the spring of 1982. Unfortunately, the project evaluation by the government was not positive, and recommended concentrating on the main project, the computer development. The network sub-project was not continued in the following year, 1983. But, the IPv4 network project was continued as System Development Network (SDN) in the following years with multiple funding, but without government funding.

Please refer Asia Internet History, First Decade, 2013 for further information on these and other networks. [Asia 2013]

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Appendix Timelines

Appendix 1 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 2 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 3 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 4 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 5 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]

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