Chapter 1

How ICT and the Digital Economy Have Evolved

New services and businesses emerged and flourished over the 30 years of the Heisei Era (1989-2019), but similarly global structures, and the mindsets and behavioral patterns of people, underwent massive changes. One main factor was the advancement of ICT, especially the Internet and mobile phones. Another factor was the evolution of the digital economy i.e., the shape of the economy brought about by ICT. In Chapter 1, we trace how both ICT and the digital economy evolved, primarily looking back at the Heisei Era. This chapter also sorts out the current state of ICT and the digital economy.

Section 1 Looking Back at the History of the Digital Economy in the Heisei Era

The world's first commercial Internet service provider (ISP) was established in the United States in 1989, the first year of the Heisei Era.[2] In 1988, the previous year, Japanese university researchers and others launched the WIDE Project, which conducted Internet experiments.[3] As for mobile phones, services began in 1987 with handsets far smaller than conventional car phones. Mobile phones would become the symbolic tool of the Heisei Era.

The convergence of Internet advances and mobile communication advances, led by mobile phones, would transform people's lives and culture as well as social and economic structures.

1. How Did Mobile Communication Services Develop and Expand?

The development and expansion of mobile communications, especially mobile phones, can be divided into four major time periods: the dawn of mobile communication services up to around 1993, the initial growth period of mobile phones from about 1993 to about 1998, the golden age of feature phones from about 1998 to about 2008, and the entrance and proliferation of smartphones from about 2008 to the present. Using this frame, we look back at the development and expansion of mobile communications, including a brief synopsis how devices and services have changed as well.

a. The Dawn of Mobile Communication Services: Unidirectional Communications Led by the Pager

The sections below outline the developments from around 1970 to around 1993, the dawn of mobile communication services.

People Experienced "The Phone of The Future" at the 1970 Osaka Expo

The Nippon Telegraph and Telephone Public Corporation (today the Nippon Telegraph and Telephone Corporation (NTT)) exhibited a wireless telephone dubbed "the phone of the future" at the Japan World Exposition, Osaka in 1970.[4] The exhibition is said to have provided hints for the development of later mobile phones, such as the tendency for people to press buttons with their thumbs and not their forefingers.

The Three-Kilogram "Shoulder Phone"

The Nippon Telegraph and Telephone Public Corporation rolled out a first-generation analog car phone service in 1979 that was the world's first to use a cellular system for the private sector. The service initially only enabled people to make calls from inside cars.

A phone that strapped to a person's shoulder came out in 1985, permitting phone calls from outside a car as well. The shoulder phone was even used prior to its commercial release in the search and rescue operations after the Japan Airlines crash.[5] The shoulder phone not only weighed about three kilograms; it was incredibly expensive, requiring a deposit of about 200,000 yen, a monthly basic usage fee of over 20,000 yen, and calling charges of 100 yen per minute. The shoulder phone was used by only a very limited number of people and it never grew into a commercial success.

The "Pocket-Bell" Pager: A Social Phenomenon of the Early Heisei Years

Prior to the popularization of mobile phones, the "pocket-bell" pager was the mobile communication service of choice in the early Heisei years, beginning from the late 1980s through to the early 1990s. The pager came on the scene when telephone calls could not be made outside the home or workplace. The pager made it

[2] The world's first ISP was PSINet in the United States.

[3] The precursor to the WIDE Project, the WIDE Study Group, was launched in 1985.

[4] Strictly speaking, it was different from later mobile phones, as phone calls did not use a cellular system, which is in wide use for mobile communications today.

[5] Japan Airlines Flight 123 departing from Haneda and bound for Itami crashed into a mountain in Gunma Prefecture on August 12, 1985, claiming the lives of 520 of the 524 passengers and crew members on board.

possible to contact people outdoors or elsewhere who could not be reached by telephone.

The Nippon Telegraph and Telephone Public Corporation launched a wireless paging service, which would become the origin of the pager, in 1968. Initially, the service could only send a paging signal that sounded a ringtone on the pager. But even though messages could not be sent, the service was widely used for sales and other business purposes. A numeric display function was added to devices in 1987, which led to rapid adoption of pagers by the general public. The biggest drawback of pagers was they could only receive messages; they couldn't be used to send messages.

b. The Initial Growth Period of Mobile Phones: The Move to Bidirectional Communications

The next sections below outline the developments from around 1993 to around 1998, a period when mobile phones exploded in popularity.

System and Other Reforms Accelerated Competition Among Carriers, Driving Down Prices and Increasing Device Variety

NTT began selling the "mova" series of mobile phones, the world's smallest at the time, in 1991. The initial models featured a revolutionary folding design and weighed about 230 grams, making them significantly lighter and smaller than previous models.

Digital services (2G) started up in 1993, replacing analog services (1G). This accomplished a number of things. Phone calls were less noisy and battery life was extended, and prices also fell. In the early days, a handset deposit was about 100,000 yen, the new subscriber fee was over 40,000 yen, and the monthly usage fees, including the handset rental fee, were 17,000 yen.

The number of mobile phone subscriptions soared, amid competition between new entrants and NTT that was prompted by telecommunications liberalization in 1985. Subscriptions hit their peaks in the early 1990s.[6]

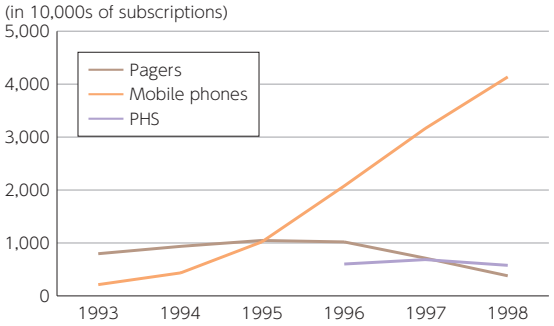
During this period, NTT Docomo[7] got rid of deposits for its mobile phones, which had been 100,000 yen, in 1993. The following year, the Ministry of Posts and Telecommunications (now MIC) introduced a system allowing people to purchase handsets outright (previously handsets were only rented). And in 1996, the fee approval system for mobile phones was scrapped. These system and other reforms accelerated competition among carriers and led to drastically lower mobile phone charges. Furthermore, multiple manufacturers competing to provide handsets that were attractive to users was a factor in driving the growth of mobile phones.

PHS: One More Mobile Communication Service

The personal handy phone (PHS) system, which started services in 1995, played an important role in the evolution of mobile communication services, alongside the pager and the mobile phone. PHS was a Japan-originated standard that functioned similarly to a cordless phone. PHS services and devices were provided more cheaply than mobile phones because the infrastructure build-out costs were low: The base stations were smaller and less expensive than mobile-phone base stations and many PHS links could be shared with fixed-line communication networks. The drawback was the communication coverage area of one base station was small, limited to a radius of 500 meters. Other advantages of PHS besides its price were better voice quality in general than mobile phones and fast data communication speeds. Because of these distinctions, the first PHS services were expected to penetrate a wider segment of the population than mobile phones. PHS services were widely accepted by younger people in place of pagers, which had hit peak subscriptions in 1995. Unfortunately, PHS subscriptions failed to grow and gradually tailed off because base-station rollouts did not progress, resulting in many out-of-service areas even in urban centers.

In addition to the migration to PHS, another factor that caused the decline in pager subscriptions was the introduction by NTT Docomo in 1997 of short message services (SMS) for mobile phones. This accelerated the switchover to mobile phones, which allowed users to reply immediately to short messages. (Figure 1-1-1-1)

Figure 1-1-1-1 Number of subscribers to pabers, PHS, and mobile phones



(Source) Prepared based on MIC, "Transitions in Mobile Phone and PHS Subscription Numbers (Simple Totals)" (as of September 30, 2018) and MIC, "Transitions in Pager Subscription Numbers"

c. The Golden Age of Feature Phones: The Development of Multi-Featured Handsets

The following sections look back at developments from 1999 to about 2008, a period that witnessed rapid evolution in feature phones.

Given the ever-lower fee prices and growing diversity in handsets due to accelerated competition among telecom carriers, mobile phone growth surged forward, causing a shortage in available phone numbers. As a result, numbers for mobile phones and PHS handsets were changed from 10 digits to 11 digits on January 1, 1999. Also that year, NTT Docomo brought out i-mode, an Internet connectivity service specialized for mobile phones.

[6] The year-on-year growth rate in subscriptions topped 100 percent in 1989, but the rates slipped to 77.2 percent in 1990, 58.5 percent in 1991, 24.5 percent in 1992, and 24.4 percent in 1993.

[7] Due to measures taken by the Ministry of Posts and Telecommunications in 1990, NTT's mobile communications business was split off from the parent company to promote fair and effective competition. NTT Mobile Communications Network, Inc. (now NTT Docomo) began operations in 1992.

Following this, mobile phone handsets began to appear with an array of built-in functions, including cameras, mobile-phone wallets, and the capability to view One Seg broadcasts. Many of these features were quite advanced and some were world firsts.

Higher Speed Networks with Greater Data Capacity Led to More Seamless Internet Use

The introduction of 3.5G mobile communication systems and services in 2006 made using the Internet on mobile phones a much fuller experience. The new 3.5G systems enabled mobile phone users to view webpages with images and watch videos without interruption.

d. The Entrance and Proliferation of Smartphones

Migration from Japanese-style "Galapagos" Feature Phones to Smartphones

As multi-featured mobile phone handsets evolved in Japan, mobile phone handsets more similar to computers were being developed overseas. These handsets came to be called smartphones. Apple's iPhone, announced in 2007, was an innovative smartphone handset for the time. The iPhone won over the public with its highly polished design and intuitive usability that didn't require reading a manual. It precipitated the global rush from feature phones to smartphones.

(2) The Rise and Growth of the Internet and Transformations in Communications

a. How did the Internet Come into Existence and Expand?

This section begins with an overview of the Internet's development and growth, as well as how the Internet has been used from a consumer's viewpoint, divided into four major periods: the dawn of the Internet continuing up to around 1994, the initial Internet growth period from 1995 to around 2000, the proliferation of always-on connectivity from 2001 to around 2010, and the migration to the smartphone from 2011 on.

(i) The Dawn of the Internet: From Computer Communications to the Internet

The Age of Computer Communications

Computers were able to communicate in the form of exchanging data using telecommunication lines prior to the Internet's emergence. These computer communications were primarily used by small groups of computing enthusiasts in Japan starting from the mid-1980s.

The number of computer communication users in Japan climbed to 5.73 million by 1996. The user population dropped off after the Internet began proliferating the market from the second half of the 1990s and businesses one by one abandoned their computer communication services.

Birth of the Internet

The origin of the Internet was the Advanced Research Agency Network (ARPAnet), a packet-based communication network whose research began in 1967 with funding from the U.S. Department of Defense. The origin of the Internet in Japan is said to be the Japan University NETwork (JUNET). JUNET started tests in October 1984 over a network that connected the University of Tokyo, the Tokyo Institute of Technology, and Keio University. The network eventually encompassed about 700 organizations.[8]

Internet Initiative Japan (IIJ), Japan's first commercial Internet service provider, was established in 1992 and started providing commercial services connecting to the Internet in 1993.[9]

(ii) The Initial Internet Growth Period

Internet First Begins to Grow Despite Various Restrictions

Windows 95, released by Microsoft in 1995, is said to have been a huge trigger in the Internet's expansion among the general public. ADSL, which was first provided commercially in 1999, also fueled the growth of the Internet by improving user convenience. ADSL permitted simultaneous voice calls and Internet connections and provided flat-rate, always-on connections.

(iii) Proliferation of Always-On Connectivity

Establishment of Rules Encourages Inter-Carrier Competition, and High-Speed, Flat-Rate, Always-On Broadband Takes Off

As the possibilities of ADSL, mentioned above, were being recognized, the Ministry of Posts and Telecommunications (now MIC) established rules in 2000 that allowed various carriers to offer ADSL services more easily. With these rules in place, competition among many carriers pushed down prices and increased speeds and ADSL service subscriptions rose. And by means of competition over higher speeds, high-speed FTTH services using optical fiber also expanded rapidly. Today, FTTH services are the primary modality of fixed-line broadband services. (Figure 1-1-1-2)

(iv) Smartphone Becomes the Main Internet Connectivity Tool

Mobile Devices Surpass Computers in Internet Use in 2010

The number of Internet users accessing from mobile devices surpassed those accessing from computers for the first time in Japan in 2010. The gap has widened every year since. The primary mode of Internet use in Japan has conclusively shifted from computers to mobile devices.

The change is even more apparent when looking at the average time spent on the Internet. Internet usage time from computers has levelled off,[10] but Internet usage time from mobile (time spent on the Internet from either feature phones or smartphones) has increased year by year. (Figure 1-1-1-3)

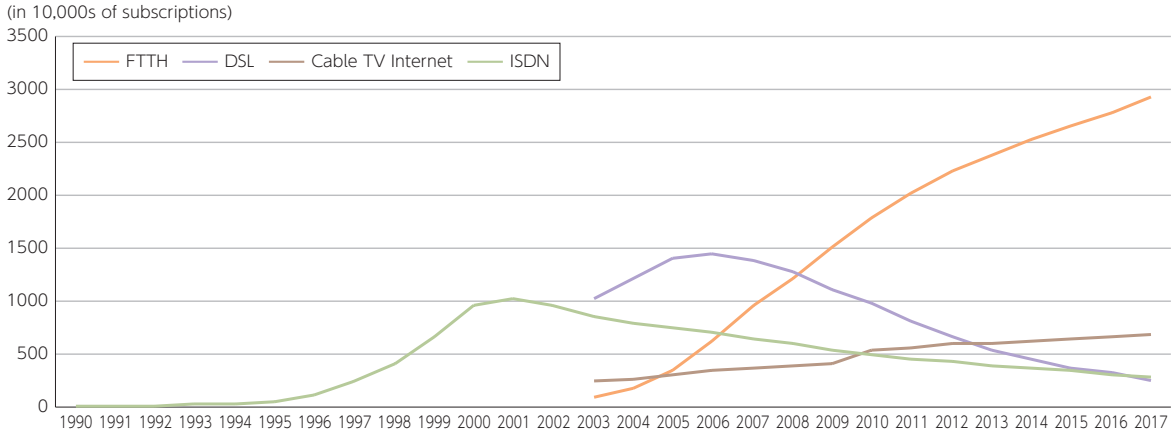
With more smartphone users, the time spent on social media, online and social games, and video sites from mobile devices has skyrocketed. The time spent on social media from mobile devices in particular has nearly qua-

[8] With the inauguration of the WIDE Project, JUNET's role as a test network ended and it was discontinued in October 1994.

[9] Connections were initially limited to domestic destinations only (connections over IP using dedicated lines within Japan and connections over UUCP to the U.S. UUNET with dial-up connections over international links). Once IIJ was licensed by the (former) Ministry of Posts and Telecommunications in 1994, it offered direct connections over IP using dedicated lines to overseas destinations as well.

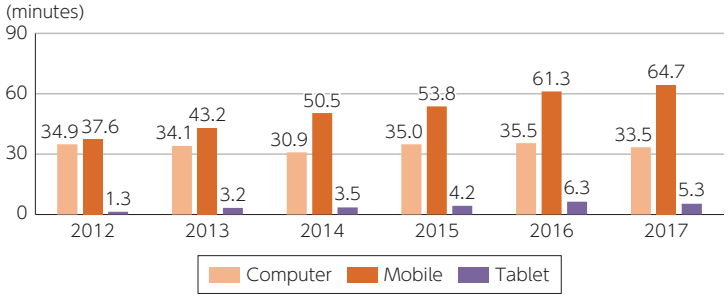
[10] When limited to use at home, Internet usage time from computers is on the downturn.

Figure 1-1-1-2 Transitions in number of subscriptions to fixed-line broadband services



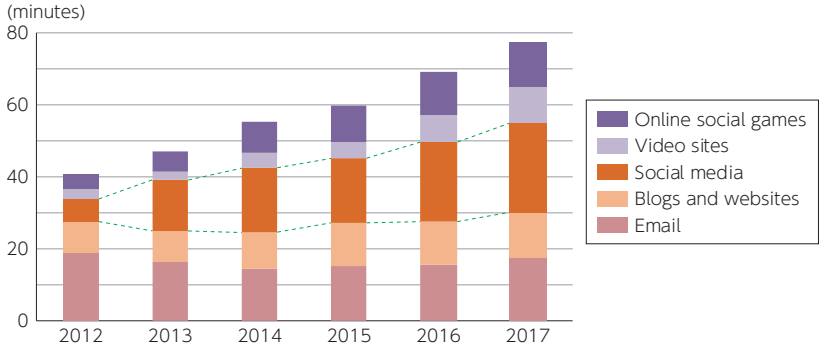
(Source) Prepared based on the respective year's "Announcement of Quarterly Data on the Number of Telecommunications Service Subscriptions and Market Share", MIC

Figure 1-1-1-3 Average Internet usage time from primary device (all age groups)



(Source) Institute for Information and Communications Policy, MIC (2018), "2017 Survey Report on Telecommunication Media Usage Times and Information Behavior"

Figure 1-1-1-4 Average time spent on different online activities from mobile devices



(Source) Prepared based on the respective year's "Survey Report on Telecommunication Media Usage Times and Information Behavior", Institute for Information and Communications Policy, MIC

drupled in the six years from 2012 to 2017. (Figure 1-1-1-4)

(3) Evolution of Communication Networks

This section traces the evolution of communication networks mostly from a technology viewpoint. The communication networks of 2019 are formed through interconnections between mobile networks and fixed-line communication networks, with a small remainder of networks, despite the widespread adoption of IP networks, mostly for fixed-line telephones using switching equipment (PSTN[11]), which had been the primary type of communication network until the mid-1990s.

a. Move from PSTN to IP Networks

The first distinctive change in communication networks over the 30 years of the Heisei Era is the transition from PSTN to IP networks. The move to IP networks also facilitated the introduction of flat-rate systems and a remarkable drop in communication fees.

PSTN today is used by fixed-line telephones. NTT East and West, however, will start to transition voice calls made on fixed-line telephones over to IP networks

[11] Public Switched Telephone Network

in January 2024 and complete the switchover in January 2025.

b. Formation and Evolution of Mobile Networks

Another distinction of network evolution over the 30 Heisei years was the formation of networks that integrated fixed-line communications and mobile networks.

For 2G and 3G mobile networks, two types of networks existed in parallel: circuit-switched networks for voice communications and packet-switched data communication networks. From LTE onward, packet switching was used for voice communications as well, making mobile networks completely IP (all-IP networks).

The move to all-IP networks accounts in large part for the introduction of flat-rate voice calls.

(4) Evolution of Information Networks

This section takes up the evolution of information systems from mainframes through client/server systems to cloud computing.

a. 1960s and 1970s: The Appearance of Mainframes

Mainframes began with IBM's System/360,[12] which came out in 1964. Some Japanese manufacturers of electronic machines and communication equipment had developed their own computers beginning in the 1950s. However, they gradually moved toward technology partnerships with IBM and other overseas companies.

b. 1980s and 1990s: Rapid Proliferation of Personal Computers and the Move to Client/Server Systems

Personal computers began to spread rapidly starting in about 1981. At the same time, companies started transitioning from mainframes to client/server systems. Moving into the 1990s, the fall in mainframe numbers versus the jump in server numbers was striking.

IBM had held a dominant share of the computer market, including mainframes. When IBM entered the personal computer market with its open production method, the effect was to standardize in the early 1980s peripheral devices and software that previously had differed from company to company. The standardization fueled competition among vendors, and compatible personal computers appeared from many vendors other than IBM. This in turn triggered new demand, which furthered supply-side competition and drove higher performance and lower prices. Mainframes, on the other hand, that used dedicated terminals and software necessitated fairly expensive installation and running costs compared to using multiple personal computers. The cost benefits, coupled with the development of LAN technology, prompted companies to migrate to client/server information systems formed using many personal-computer clients.

One more point worthy of mention is that although computer use exploded during the 1990s, the main factor was the socialization of technology innovation, more than technological advances. The elemental technologies underpinning the Internet and computers had mostly been implemented in the 1960s and 1970s. And though the performance of these elemental technologies improved obeying Moore's Law, technology evolution itself did not rapidly accelerate in the 1990s. Rather, the coupling of supply and demand expanded computer use. This tendency was especially notable in the United States.

c. 2000s: Growth of Cloud Computing

Cloud computing began growing globally in the latter half of the 2000s.

Cloud computing gained attention in Japan starting in around 2009. In the early stages, companies were hesitant about storing valuable data on the cloud for such reasons as repeated outages and system crashes. By the mid-2010s however, the reliability of cloud computing had been dramatically improved, to the point that even Japan's financial institutions now use the public cloud.

d. Mid-2010s Onward: Emergence of Edge Computing

Several negative aspects began to surface with the growth and expanded application of cloud computing. These included communication line costs and traffic congestion as well as risks of cloud service crashes and cyber attacks. Real-time processing of information was also necessary. Consequently, in the mid-2010s and beyond, companies focused on edge computing efforts, where certain necessary information processing is performed at the edges of networks close to the client terminals.

2. How has ICT Development and Growth Changed Industry?

Tracing industry in the Heisei Era as part of the digital economy's history requires looking at two movements: the movement of the industry involved in providing ICT (the ICT industry) and the movement of ICT use in other industries. At the same time, these movements did not start in the Heisei Era. To get a complete view of the transformative changes in industry, we must look back to the Showa Era (1926-1989) and even earlier.

Japan was using what was cutting-edge ICT at the time, globally speaking, in the 1960s and 1970s. This usage helped push ahead the ICT industry. Through the 1970s and 1980s, manufacturing in the ICT industry (ICT manufacturing) developed into an industry that drove the Japanese economy on a par with the auto industry. Japan's ICT manufacturers had a large presence globally as well.

Unfortunately, since the 1990s onward, the contribution of ICT use to Japan's economic growth has trailed

[12] The System/360 name was chosen to reflect that the machines addressed all 360 degrees of client needs, from office data processing to scientific and engineering calculations. IBM's provision of a single line of products was a tremendous change from the conventional computers of the time.

that of other countries, even as ICT has generated far-reaching possibilities through the rise of the Internet and development of mobile technology. And especially since the 2000s and beyond, our ICT manufacturing has lost its former presence.

(1) Informatization of Industry in Japan

We will begin by tracing the movement in ICT use in various industries in Japan — i.e., the informatization of industry.[13] Industries that use ICT will be called ICT user industries to distinguish them from the ICT industry described above, which is the industry that provides ICT.

a. 1960 to 1970s: Construction of Pioneering Online Systems

1964 Tokyo Olympics Hinted at the Potential of Online Systems Using Data Communications

The 1964 Tokyo Olympics spurred on Japan's advances in the informatization of industry via online systems. For example, IBM Japan constructed an online system without precedent in the world at the time that used telecommunication lines to deliver event information from terminals at over 30 sports stadiums to the press center in real time. Another example from 1964 was the MARS 101 seat reservation system operated by the former Japanese National Railways. As these examples show, Japan led the world in constructing online data communication systems that used telecommunication lines.

Advances in Constructing Online Systems by Industries and Companies that Exchanged Large Amounts of Information among Multiple Sites

After the Tokyo Olympics, online system construction progressed, especially by industries and companies that needed to exchange large amounts of information among multiple sites spread all over Japan. Another development was the introduction of a mainframe (the previously mentioned IBM System/360) for production management at Nippon Steel's Kimitsu Steel Works in 1968. In this way, the informatization of industry proceeded at large companies in business fields whose operations required advanced calculations.

Development of Information Systems Departments and Creating Subsidiaries

Amid the informatization of industry, workloads connected to installing and operating information systems at companies increased. Information systems departments, which were once called mechanical calculation clerks, were raised first to departmental status and then divisional status. In particular, from the mid-1960s attention was drawn to management information systems (MIS) that made use of information in business management. This led to expectations that information systems departments would take a part in supporting business management.

A simultaneous trend was spinning off information systems departments as subsidiaries. The background to this trend was cost savings, freedom from managing information system personnel, and effective use of space.

The independence of information systems departments also led to the industrialization of information, described below.

b. 1980s and Beyond: Investment in IT Falls Off After Peaking in the 1990s In Terms of Nominal IT Investment, Informatization of Industry Draws to a Near Standstill during the Heisei Years

The informatization of industry by ICT user industries advanced throughout the 1980s and the expansion of IT investment was striking, even statistically. Moving into the 1990s however, IT investment amounts fell with the collapse of the bubble economy. Although it did recover in the middle of the decade, nominal IT investment by ICT user industries has tailed off since peaking in 1997. This is partly due to Japan's economic deflation and lower prices due to higher hardware performance.

From just the view of nominal IT investment, Japan's informatization of industry ground to a near halt during the Heisei years, although one must account for Japan's economic deflation and lower prices due to higher hardware performance.

Looking at the entire economy as well, the informatization of industry was believed to be a big contributor to labor productivity increases up to around 1990. After that point, such benefits were no longer produced in sufficient quantities.

Increased Outsourcing of Information System Construction and Operations

From the end of the 1980s through the 1990s, companies began actively outsourcing to other firms all aspects of information system construction and operations, instead of leaving such construction and operations to their own information systems departments. Some observers have indicated the motivation, in addition to pushing down information system costs, was rooted in a belief at ordinary companies that information systems development was not a core business operation and that they should focus on their main business. The outsourcing movement is believed to have produced Japan's unique ICT investment patterns, where the outsourcing model is commonplace, and the predominance of ICT personnel working at ICT companies. Increased outsourcing also depleted knowledge and skill in information system construction and operations at the information systems departments of ordinary companies. This lack of knowledge and skill has been suggested to have caused problems, such as mistakes in selecting contractors, that created large risks for the execution of business operations.

(2) Industrialization of Information in Japan

Next, we will look at the movement in Japan's ICT in-

[13] The informatization of industry refers to the increasing labor and intermediate inputs devoted to information in various industries.

[14] The industrialization of information refers to the formation and expansion of independent industries providing information-related services that has accompanied the informatization of industry. These sections primarily focus on ICT-related goods and services provided by the communications industry, the communication-related construction industry, the ICT-related manufacturing industry, and the information service industry.

dustry — i.e., the industrialization of information.[14]

a. Japan's ICT Industry Grew Out of the Communications Business

Formation of a "Family" Centered on the Nippon Telegraph and Telephone Public Corporation

State-managed monopolies started and expanded both the telegraph, from 1869, and the telephone, from 1890, in Japan. Although telephone use was very limited in scale compared to modern telecommunication businesses, the telephone network was expanded aggressively.

The Nippon Telegraph and Telephone Public Corporation (now NTT) was inaugurated after WWII, in 1952, by assuming the telegraph and telephone operations of the former Ministry of Communications and Transportation. The new public corporation had two major objectives: eliminate the backlog of subscriber telephones, and introduce automatic and instantaneous telephone services nationwide. With these two objectives, the Nippon Telegraph and Telephone Public Corporation pushed ahead with infrastructure build-out. As part of this, the public corporation established a role-sharing framework, in which it would define specifications of the communication equipment it needed and companies like NEC, Oki Electric Industry, Fujitsu, and Hitachi would design and manufacture the equipment.

The Nippon Telegraph and Telephone Corporation (NTT) was formed with the privatization of the Nippon Telegraph and Telephone Public Corporation in 1985. Concurrent to this, telecommunications liberalization created the basis for multiple carriers, including NTT, to compete in the telecommunications market. The active competition among multiple carriers made huge advances to Japan's telecommunications business while creating services that boosted the convenience of customers.

From Communication Equipment to Computers

Manufacturers of communication equipment in particular began to move toward computer development. The Nippon Telegraph and Telephone Public Corporation also got involved in computer research in 1953, with an eye to using computers for switching equipment, calculating telephone charges, and other applications. Observers have noted that it was communication equipment and switching equipment that motivated many Japanese manufacturers to develop transistor computers.

Rise of System Integrators and the Progress of Their Independence

As mentioned earlier, a movement was seen in the ICT user industries in the 1960s and 1970s to spin off information systems departments into subsidiaries. Manufacturers of computers also entered the business of constructing and operating information systems. Furthermore, the Nippon Telegraph and Telephone Public Corporation partnered with Fujitsu and others starting in 1966 to develop an online system for the Regional Banks Association of Japan. The public corporation also set up a data communications division (today NTT Data) in 1967 for a full-fledged entry into this business field. Trading companies also started setting up information system subsidiaries, as they gradually transitioned from just selling telecommunications equipment imported from abroad to getting involved in hourly rentals of computers, software development, maintenance, and other operations. The movement to create subsidiaries from information systems departments persisted and grew in the 1980s and 1990s, as companies increasingly turned to outsourcing their information system operations.

These moves formed the system integration business field, which consisted primarily of constructing and operating information systems. This industry structure was internationally unique to Japan. This is evidenced by the coining of the term "SIer" (meaning "system integrator") in Japanese to describe the technicians and engineers involved in the industry.

b. Changes in Japan's ICT Manufacturing Industry

Once an "Electronics-based Nation" in the Showa Era, Japan's ICT Manufacturing Industry Dwindles in the Heisei Years

Viewing the value of production, the value of exports, the value of imports, and other statistics[15] of Japan's ICT manufacturing industry shows a long-running upward trend in the value of production and value of exports until around 1985. So enduring was the run that Japan was dubbed an "Electronics-based Nation".

After the so-called Plaza agreement in 1985, the increase in exports slowed on the back of a rapid appreciation in the yen, even as production, apart from a brief downturn, continued to climb. Moving into the 2000s, the value of production reversed course and began to contract, and in the latter half of the decade, the value of exports also started to slump. On the other hand, the value of imports increased significantly from the late-1990s onward, when the Internet started to grow. In 2013, the value of imports overtook the value of exports turning the trade balance surplus into a deficit.

Looking at just communication equipment, the industry appears to have been always led by domestic demand, as the value of exports has never been large in comparison to the value of production. The value of production of communication equipment, apart from a brief downturn, rose until the mid-1990s. This value began to slide in the second half of the 1990s as the Internet grew in popularity, and by the 2000s production had plummeted. Imports soared from the mid-2000s onward due to the rise of the smartphone.

[15] Specifically, the tabulation of the value of production and other statistics from consumer electronics, industrial electronics, and electronic parts and devices.

3. How has ICT Development and Growth Changed the Global Economy?

(1) Changes in Advanced Nations: Controversy over Productivity

a. Productivity Arguments in the United States in the 1980s and 1990s

The Solow Paradox: Productivity Initially Failed to Rise in the United States Despite Computerization Advances

U.S. productivity growth remained stagnant for a long period in the 1970s and 1980s, despite steadily advancement in computerization investments. The U.S. economist and Nobel laureate Robert Solow wrote in a 1987 book review: "You can see the computer age everywhere but in the productivity statistics." This paradox that real productivity does not increase despite advancements in computer and information technology was called the "Solow Paradox". It led to arguments over experimental studies that tried to show whether productivity gains due to computerization investments could be confirmed statistically.

Looking at Japan's ICT investments, nothing like the Solow Paradox that appeared in the United States in the 1980s was observed in the computerization investments and their benefits in Japan from the 1970s through to the 1990s.

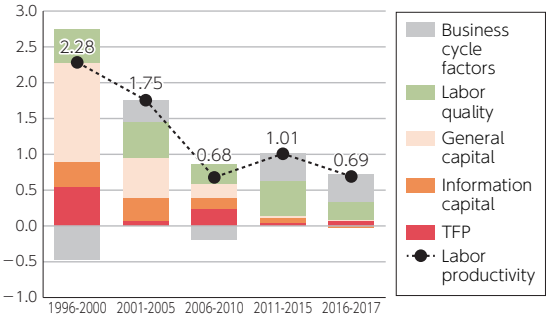
b. After Productivity Arguments in Advanced Countries and the New Economy Theory

Comparing the changes in real GDP per capita in Japan and the United States from 1980 to 2017, Japan's GDP shows a clear slowdown in growth in about 1990, whereas the U.S. GDP growth in the 1990s and early 2000s was remarkable.

Comparing the labor productivity growth factors,[16] including for business cycle factors, since 2000 between Japan and the United States, in Japan, labor quality is a relatively large contributor, but the contribution from total factors in productivity (TFP) is small. (Figure 1-1-3-1) In the United States, TFP's contribution was large until 2010 but has diminished since 2011. (Figure 1-1-3-2)

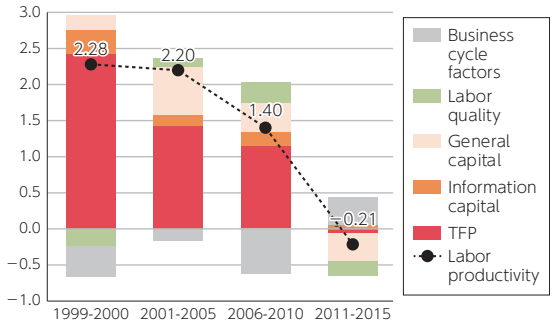
The waning TFP growth is thought to be symptomatic of sluggish GDP growth in advanced countries, which is discussed in Section 2 of Chapter 2.

Figure 1-1-3-1 Breakdown of labor productivity growth in Japan



(Source) MIC (2019), "Research Study on Informatization in the Heisei Era"

Figure 1-1-3-2 Breakdown of labor productivity growth in the United States



(Source) MIC (2019), "Research Study on Informatization in the Heisei Era"

Section 2 Trends in ICT Supporting the Digital Economy

1. Current ICT Investment in Japan and the United States

(1) Changes in ICT Investment Amounts in Japan and the United States

The ICT investment amounts in Japan and the United States were surveyed from 1989 to 2017. The nominal ICT investment value in 1989 was 14.3 trillion yen in Japan versus 147.6 billion dollars in the United States.

ICT investment has declined in Japan since hitting a peak of 20.0 trillion yen in 1997, slumping to 16.3 trillion yen in 2017. In the United States, although downturns were seen in the early 2000s and again in around 2008, ICT investment has risen overall, reaching 655.1 billion dollars in 2017, a more than four-times increase in a 30-year span.

(2) Investments by Type of Software Development

Japan Concentrates on Outsourced Software Development; the United States Uses More In-House Developed Software and Packaged Software

There was no significant difference between Japan and the United States in the percentage of ICT investment that went to software in 2017. But investment ratios by software development type reveals different investment tendencies.

It is not possible to ascertain statistics for the breakdown of software investment in Japan due to a number of constraints.[17] However, we can compare packaged software to software developed by outside contractors from statistics from software providers: 11.7 percent for packaged software versus 88.3 percent for outsourced-devel-

[16] Excludes added value by labor input amounts.

[17] Japan's national economy statistics do tally software investment amounts in packaged software, custom-ordered software, and in-house developed software, but the figures are not released to the public.

oped software. The figures for U.S. software investment are 33.8 percent for software developed through outsourcing (categorized as "custom" in U.S. statistics), the largest share going to in-house developed software, and 29.0 percent for packaged software.

Direct comparisons are not possible because the Japan statistics do not include in-house developed software. The statistics do indicate, however, there is a concentration of user companies outsourcing information system development from scratch or through customization[18] to ICT companies, a distinctive characteristic of Japan's software investments.

One factor for this concentration on outsourcing is that ordinary companies do not regard information systems development to be a core business operation. It is also possibly related to the "quality" of ICT investments.

(3) Objectives of ICT Investments

Japan Focuses on "Defensive" ICT Investments

As we saw in Section 1, ICT was originally introduced for the primary objectives of automating business processes and making them more efficient. ICT investment and construction has continued ever since as corporate system platforms. But today, in addition to those objectives, there is strong demand for ICT to assist in creating new businesses. Japan's ICT deployments, however, are still focused on making business processes efficient.

Section 3 New Trends in ICT

1. Directions for Digital Platform Operators

For many people living today, looking up things they want to know using search services, chatting on social media and using other forms of online communication, and consuming videos and music online have become part of their everyday routines.

Life has also become more convenient with the ability to buy things online as well as to make online reservations for trips, accommodations, and meals. Furthermore, the shape of society and the economy has changed dramatically. The ICT companies that provide these spaces are called digital platform operators. As the digital economy evolves, their presence will be magnified.

2. Directions for AI

AI's Positive Effect on Productivity

The application of AI is hoped to make business processes more efficient and lead to the development of new products and business models. It is also hoped to liberate people from mundane work operations, leaving people to focus on creative work that only people can do. The concentration on creative work is expected to generate more innovation.

Several survey organizations have been analyzing the productivity gains caused by AI. One example is an analysis by Accenture,[19] which predicts that AI will raise labor productivity in Japan by 34 percent from the baseline by 2035.

3. Directions for Cybersecurity

Combatting cybersecurity risks has grown in importance with the evolution of the digital economy. The World Economic Forum published The Global Risks Report 2019 in January 2019. The report identifies, as global risks, large-scale phenomena with the potential to cause large-scale damage worldwide in the next 10 years. The report organizes these risks by their potential likelihood, their impact, and their interconnections.[20]

According to the report, among the global risks that affect multiple domains such as economics, society, the environment, and technology, cyber attacks, critical information infrastructure breakdowns, data fraud or theft, and security threats are ranked among the highest in likelihood and impact.

Examining the interconnections among risks shows that cyber attacks are related not only to data fraud and critical information infrastructure breakdowns, but also to profound social instability, interstate conflict, and failure of national governance.

(1) Current State of Cybersecurity and New Threats

a. The IoT is a New Platform for Cybersecurity Threats

Cybersecurity vulnerabilities and impacts are anticipated to spill out of cyber spaces and affect the real world, as the IoT becomes more prevalent. The IoT and related matters have been moving up in the ranks of cybersecurity trends mentioned above.

The NICTER Analysis Report 2018, released by the National Institute of Information and Communications Technology (NICT) in February 2019, listed the top 10

[18] Developed from scratch means developing an information system starting from zero, whereas customization means developing custom software by modifying packaged software or other existing software.

[19] Accenture (2016). "Why Artificial Intelligence is the Future of Growth."

[20] https://www.weforum.org/reports/the-global-risks-report-2019

destination port numbers targeted in major cyber attacks measures by NICTER. Eight of the 10 ports were associated with IoT devices such as web cameras and home routers. Even the category of Other Ports contains many ports used by IoT devices, such as ports used by online management interfaces for equipment and machines.

Therefore, addressing IoT device vulnerabilities has become increasingly important, as IoT turns into a new platform for cybersecurity threats.

b. Current State of Cybersecurity Personnel

Cybersecurity's importance is mounting as digitalization progresses. As a result, demand for cybersecurity personnel in Japan is expected to outpace the supply in 2020 by 193,000 people.

NRI Secure Insight 2018, a fact-finding survey into corporate information security conducted by NRI SecureTechnologies, Ltd., compared five countries: Japan, the United States, the United Kingdom, Singapore, and Australia. The report signaled that, compared to the other four countries, Japan has a severe security personnel shortage.

Another distinctive trait in Japan was that the most significant problem related to personnel development and training was a "lack of career paths". The report mentioned that the average length of time security personnel stay at one company in Japan was longer than in the other countries. In the other countries, security personnel move from company to company to hone their specialties and build their careers. This difference is suggested as one factor for Japan's security personnel shortfall.

(2) Economic Losses from Cyber Attacks and Other Malicious Activities

Many surveys and analyses are conducted in Japan and abroad seeking to quantify cybersecurity problems in terms of economic losses.

Japan Cybersecurity Innovation Committee (JCIC), for example, after surveying companies in Japan that made timely disclosures about cybersecurity breaches and other incidents,[21] found that their stock prices fell by an average of 10 percent and net profits dropped by 21 percent on average.[22]

Given the extraordinary economic losses caused by cybersecurity problems, upper management should be tackling information security issues rather than leaving them to ICT divisions. The NRI survey report, given above, however indicates a low percentage of companies in Japan have set up and appointed a Chief Information Security Officer (CISO) as part of their corporate management team. Establishing security action plans is another weakness of Japanese companies.

The Japan Users Association of Information Systems (JUAS), on the other hand, sees a rising trend in the degree to which senior management is involved in information security. In particular, 80 percent of companies in the financial field view information security as a management issue. Frameworks in which senior management personnel take proper responsibility for cybersecurity must go hand-in-hand with obtaining the cybersecurity personnel to support the frameworks. But moving ahead with these two components in tandem is considered very hard, given the current state of worker mobility in Japan. Nevertheless, as digital continues to consolidate in all industries, this is an existential issue that we cannot ignore if we are to avoid damaging the sustainable development of companies and industries.

Section 4 Communications and Media in the Digital Economy

Online communities, thanks to the ubiquity of the Internet and social media, have turned into open communication spaces that anyone, regardless of age, gender, technical skills, or preferences, can easily use. This has granted individuals the ability to post information that motivates communities. It has also brought to the forefront problems such as flaming and fake news.

1. Media Landscape Changes Caused by Internet Growth

(1) Media Use Changes Seen in Usage Times

TV Viewing Has Contracted while Internet Use Has Risen for 15 Years

The number of hours of TV watched per day on average has gradually declined overall from 2000 to 2015. The number of hours watched has stayed constant for people in their 60s, but it has fallen for those under 60. The drop has been striking for those in their 10s and 20s.

The number of hours spent on the Internet has climbed. People in their 10s and 20s used the Internet over 100 minutes per day in 2015, surpassing the time spent watching TV.

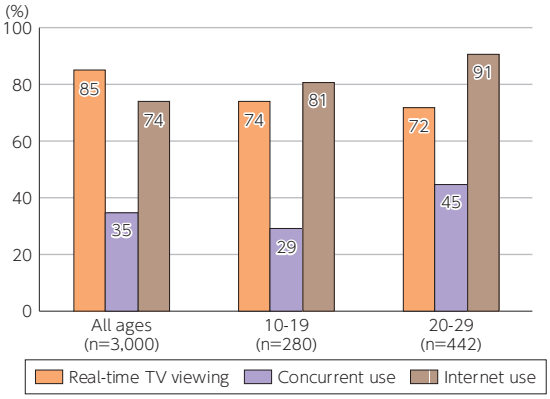
Concurrent Use of TV and the Internet

The situation, however, is not as simple as people switching to the Internet in place of TV and other forms of mass media. One example is concurrent use, where people use the Internet while watching TV at the same time. (Figure 1-4-1-1 and Figure 1-4-1-2)

[21] The regulations of financial instruments exchanges (such as the Tokyo Stock Exchange) oblige listed companies to make timely disclosures. Companies are required to communicate to investors in a timely fashion information material to the company.

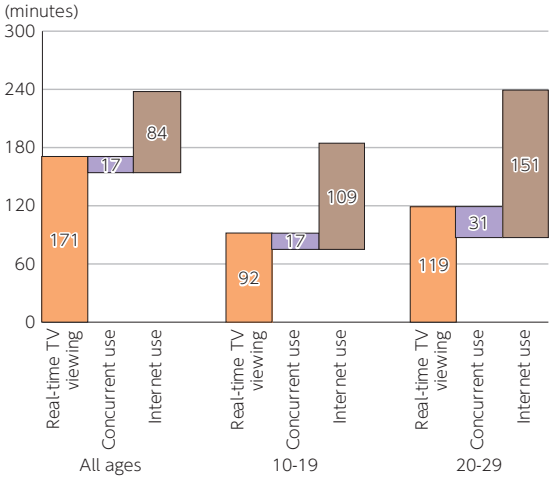
[22] JCIC (2018). "Quantifying Cyber Risk Survey." (https://www.j-cic.com/pdf/report/QuantifyingCyberRiskSurvey-20180919(EN).pdf)

Figure 1-4-1-1 Percentage of people using the Internet and watching (real-time) TV concurrently (weekdays, all age groups and by age group)



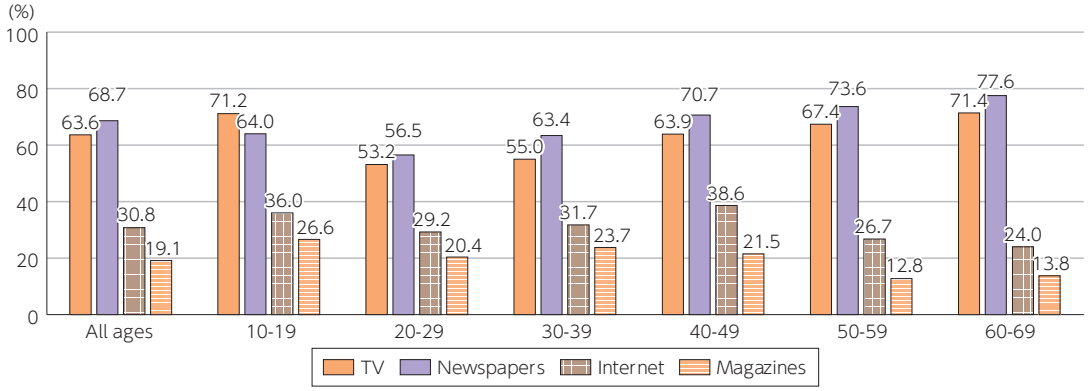
(Source) Prepared based on MIC (2015), "2014 Survey Report on Telecommunication Media Usage Times and Information Behavior"

Figure 1-4-1-2 Time spent using the Internet and watching (real-time) TV concurrently (weekdays, all age groups and by age group)



(Source) Prepared based on MIC (2015), "2014 Survey Report on Telecommunication Media Usage Times and Information Behavior"

Figure 1-4-1-3 Degree of trust by media form (all age groups and by age group)



(Source) Prepared based on MIC (2018), "2017 Survey Report on Telecommunication Media Usage Times and Information Behavior"

(2) State of Trust in Different Media Forms

Even Young People Trust Mass Media More than the Internet

It is claimed that young people in particular are moving away from mass media and consequently social media use is increasing. However, a survey by age group of the degree of trust in various media forms in Japan found that trust levels in the Internet were relatively low compared to mass media, even among young people. (Figure 1-4-1-3)

(3) The Multilayered and Integrated Existence of Mass Media and Social Media

A behavior pattern has arisen in which people use TV and the Internet concurrently. Along these lines, some say attention should be paid to the multilayered and integrated coexistence of in-person media, mass media, and social media.

Since many people routinely use in-person media, mass media, and social media in a multilayered fashion, information on mass media is retold on online and online information is retold on mass media. This makes it impossible to untangle them and discuss them individually.

2. Is Internet Use Polarizing Public Opinion?

The Internet is essentially a structure that allows all people to share information and knowledge. This positive aspect of the Internet is likely one of the reasons why it is used on a global scale in living and in business. Conversely, arguments have surfaced that Internet use is polarizing public opinion and provoking the fragmentation of society.

(1) Phenomena Said to be Characteristics of Online Information Circulation

The U.S. legal scholar Sunstein (2001)[23] identified a phenomenon called cyberbalkanization regarding the

[23] Cass R. Sunstein (2001). "Republic.com." Princeton University Press.

gathering of information online. Because of the Internet's characteristics that make it easy for people with the same ideology or beliefs to connect together, polarized and isolated groups can readily form.

Other similar phenomena said to be the result of the interaction of people's inherent inclinations and the nature of online media include echo chambers and filter bubbles.

(2) Quantitative Research Results on Public Opinion Polarization Due to the Internet

Research in the United States indicates that polarization in that country has been progressing over the past 10 years.[24] There are few examples of experimental research in Japan on the same topic, so it is not possible to determine whether public opinion is polarizing in this country. Nevertheless, there is research showing that close to 30 percent of people sense that the views expressed in public have become more extreme.

It has been pointed out that selective contact with information is far easier with the Internet than in the era of mass media. But given the quantitative research results introduced below, there is still room for debate over whether the Internet itself is driving polarization.

Research Results from Tsuji and Kitamura (2018): Online Use has the Potential to Increase the Number of People Holding Extreme Views on Either Side

In Tsuji and Kitamura (2018),[25] the authors analyzed quantitative data to see whether online use strengthened anti-foreigner sentiment or whether anti-foreigner sentiment stimulated more online use. A further hypothesis tested by the pair was whether both anti-foreigner sentiment and online use mutually bolstered the other (a bidirectional cause and effect). His results held out the possibility that Internet use could increase the number of people holding extreme views on either side.

Research Results from Tanaka and Hamaya (2018): Net Media May Actually Moderate People's Views

In Tanaka and Hamaya (2018),[26] the authors set out to clarify whether Internet use has an effect on the polarization of society. They surveyed the same group of respondents twice separated by a period of time. The first survey noted that people who use the Internet more are more likely to hold extreme views, which agreed with the survey mentioned above that concluded Internet use fostered polarization. Nevertheless, the cause and effect was unclear, since it may be that people who have long held extreme political views are more inclined to use the Internet. To confirm this, the authors conducted the second survey.

The survey looked at consistent users of the Internet and found the change in political views due to the consistent use of media overall was insignificant. In other words, there is scant evidence that Internet use is pushing polarization. If anything, online media users trend toward moderate views. Or it may be that the polarization is occurring because of middle-age and older people who use the Internet comparatively infrequently. These facts cast doubt on the hypothesis that online use encourages polarization. If society is indeed polarizing, then the primary factor must exist somewhere else than Internet use.

3. Discussions on Internet Flaming

Flaming has been defined variously as "a seemingly uncontrollable deluge of harsh criticism toward a specific target on the Internet" and "the swelling of debate on a particular topic that turns into over-the-top bashing on multiple blogs and forums". The number of flaming incidents in Japan shot up in 2011, the year when mobile and social media started becoming prevalent. Both individuals and companies are targets of flaming incidents.

(1) Who Joins in Flaming Attacks?

What sort of people participate in flaming incidents? Research shows that the people who directly participate in posting flaming attacks are an extremely small percentage of Internet users. While the precise numbers vary from study to study, what is common to all is that less than a few percent of Internet users participate in flaming.

Furthermore, the studies say that online public sentiment forms around the comments of only a fraction of the few flaming participants.

(2) How Do People Find Out about Flaming Incidents?

In Yoshino (2016),[27] the author investigated the routes by which people find out about flaming incidents and discovered that just over half of the respondents said from TV variety programs. The percentage who mentioned TV news programs was also high, showing that much of the awareness of flaming comes via mass media.

The author pointed out that the exponential growth of flaming was due to interactions in an inter-media space — i.e., many people find out about flaming incidents through mass media reports, which then spreads once again on social media.

[24] Pew Research Center (2014). "Political Polarization in the American Public: How Increasing Ideological Uniformity and Partisan Antipathy Affect Politics, Compromise and Everyday Life."

[25] Daisuke Tsuji (2018). "Does Use of the Internet Make People More Racist? A Causal Analysis Based on a Synchronous Effects Model Using the Instrumental Variable Method." Soshioroji, Vol. 63, No. 1, pp. 3-20.

[26] Tatsuo Tanaka and Satoshi Hamaya (2018). "Does the Internet Polarize Society? An Empirical Study based on Panel Data." August 2018, FRI Research Report No. 462.

[27] Hiroko Yoshino (2016). "Development and current state of the 'blog flaming' phenomenon in Japan: Based on the results of an opinion survey." Corporate Communication Studies (20).

4. The Fake News Trend

In the 2016 U.S. presidential election, fake news was spread extensively on social media. Attention was drawn to the term "fake news" when fake news stories garnered more engagement (the total number of comments and reactions, such as shares and likes) than articles from major media outlets in the final stages of the election campaign.

An example of fake news occurred in Japan in the wake of the Kumamoto earthquake in April 2016. False stories and photos that a lion had escaped from a local zoo were posted on social media, resulting in a flood of inquiries to the zoo and police.

5. Taking Action on Problems Surrounding Online Communications

Observers have pointed out that combatting flaming, fake news, and other online problems is extremely difficult, as it is related to human cognition tendencies in selecting information. Nevertheless, some actions among users, private companies, and governments are starting to show a way forward.

(1) Raising User Literacy Levels

There are signs that literacy among the public at large about online flaming is rising gradually. Concerns, however, remain that lessons learned from watching problems associated with flaming will not be carried over across generations. If this does occur, continuing education initiatives will be important at schools and other institutions to raise literacy levels across generations.

(2) Actions by Digital Platform Operators and Other Private Companies

The idea of brand safety has taken root out of concern that companies or products will lose brand value if they appear on inappropriate sites or next to unsuitable content. In view of brand safety, some companies have pulled their ads from Facebook, Google, and other digital platform operators. In Japan, since 2018 Epson and other companies, as well as A8.net, Japan's largest affiliate service, canceled ad runs and rescinded partnerships with aggregate sites considered to publish discriminatory articles. As this shows, the private section has started to take action to cut off funding to sites considered to be breeding grounds for hate speech and fake news.

Furthermore, digital platform operators themselves appear to be devising action plans, as they bear a certain amount of social responsibility regarding the nature of information published on their platforms. But even as digital platform operators begin to take action, there are fears concerning digital platform operators' ability to control information, since they already store massive amounts of personal data on users.

(3) Rule Establishment and Other Actions by Government

Government regulation is not appropriate in this area, some say, from the point of view of preserving freedom of expression and online democracy. Other observers have noted, however, increasingly strident calls from users, exhausted by online communications in recent years that have become infested with extreme speech and fake news, for legal regulations and actions by platform operators.

In Japan, one example of government rule-making and other actions is the MIC's Study Group on Platform Services, which has been discussing measures to counter fake news and false information. In its interim report, the study group stated: "It is appropriate for the government to examine raising user literacy together with corresponding assistance policies as well as self-correcting mechanisms, such as fact-checking structures and partnerships between platform operators and fact-checking organizations, in order to have an appropriate and trustworthy Internet usage environment in which correct information is communicated, founded on independent and voluntary initiatives by the private sector."

Japan also launched the Trust Services Examination Working Group under the Study Group on Platform Services to examine trust services as a mechanism to ensure data credibility from the standpoint of free, safe, and secure data movement in cyber space. The working group is examining the current state of trust services and systematic issues with trust services in five areas: (i) structures that verify the legitimacy of people (user authentication and remote signatures); (ii) structures that verify the legitimacy of organizations (authentication for organizations and website certification); (iii) structures that verify the legitimacy of IoT devices and other things; (iv) structures that verify the existence of data and guarantee data has not been altered or tampered with (timestamps); and (v) structures that guarantee the delivery of data (e-delivery).