North Korea on the Cusp of Digital Transformation

Alexandre Y. Mansourov, Ph.D.

Introduction

North Korea has an underdeveloped telecommunications sector, but its government now demonstrates increasing interest in catching up with the modern IT development trends, and its population reveals insatiable demand for more robust and extensive telecommunications services. As a laggard in the global digital revolution, Pyongyang enjoys key advantages of backwardness – dramatic savings on initial R&D costs in the IT sector, the opportunity to leap-frog from exclusive reliance on obsolete and scarce landlines (which carry traditional telephone traffic for a meager 1.1 million customers in a country of 24.5 million people) to world-class 3G mobile communications, which gained almost 700,000 users in less than three years of operation, as well as some access, albeit restricted, to the leading open source IT technologies, software, hardware, and multimedia content. Its telecommunications market is still very small, stove-piped, non-competitive, and highly regulated by the oppressive government placing a premium on regime security as opposed to consumer demand and the developing tastes of its population.

The North Korean regime, obsessed with secrecy and control, severely restricts and strictly monitors the access of its population to international TV and radio broadcasting, Internet, email, and telephone services. On the other hand, Pyongyang mobilized its limited resources to develop and push out the pro-government propaganda content via a handful of rather sophisticated official websites (see Appendix 1) and popular social networking sites (SNS) like domestic uriminzokkiri.com and foreign-based Tweeter (http://twitter.com/uriminzok), Facebook, Flickr (http://www.flickr.com/photos/uriminzokkiri), and YouTube (http://www.youtube.com/user/uriminzokkiri), in order to portray a positive image of the country and leadership and promote its political and economic interests abroad. At the same time, it deployed significant cyber warfare assets to conduct surprise hacker attacks against its enemies' military units, government organizations and pro-government private institutions, and critical national infrastructure systems in the Republic of Korea, United States, and Japan.

Although the DPRK is a developing country with a GDP per capita of only 1,800 U.S. dollars, suffering from chronic food and energy shortages, where less than 3 percent of the population currently use modern telecommunication services, it has adequately trained human capital, a rather developed industrial and technological base, and sufficient financial resources to pursue the digital revolution to the benefit of the majority, and not just the privileged few, as the market forces gain momentum, the lure of new consumer technologies becomes irresistible, the elite becomes more enlightened and the masses begin to demand higher living standards and wider access to modern amenities.

Defining Political Mandate for IT

The DPRK's modernization efforts in the telecommunication sector began in earnest on 25 August 1993, when Kim Jong Il sent a letter entitled "Let Us Go Full Speed Ahead with Modernization of Telecommunication" to the National Conference for Telecommunication Employees. The letter highlighted the importance of modern telecommunications as the principal technical instrument to guarantee the timely communication of the Great Leader's instructions and the party guidance to the people and cadres and as a way to provide more self-reliant and creative living conditions for the general population. The letter was a mighty weapon that enabled the industry officials to rapidly develop the telecommunications infrastructure in line with the demands of building a powerful state, following Kim's guidance that "the modernization of post and telecommunications is an essential demand for realistic development, in which communication means and broadcasting equipment are rapidly developing today based on leading-edge electronic technology."[1]

Sometime in 2000, Kim Jong Il remarked that computer illiterates were the worst fools in the 21st century, according to South Korea's Chosun Ilbo.[2] Kim admonished the party that "Our-style socialism has a decisive superiority in also developing the information industry." In October 2000, Kim Jong Il famously asked Madeleine Albright, then the U.S. secretary of state, for her e-mail address, revealing his awareness of Internet-based communications.

After returning from China's Silicon Valley in early 2001, Kim Jong Il instructed the WPK CC Science and Education Department to work out party guidance on launching the IT revolution and starting up mobile telecommunications service in Pyongyang before April 15, 2002, the 90th birthday of his late father and DPRK founder Kim Il Sung.[3] On March 11, 2001 the official newspaper of the WPK Central Committee published Kim Jong Il's classic work, "The New Century, The 21st Century, Is the Era of Information Industry,"[4,5] which laid out the theoretical foundations for initiating the IT revolution in the country by clarifying the nature and characteristics of the era of IT, the role of IT in making social and economic progress and the tasks and ways of developing the information industry of the country.[6] On May 6, 2001 the party central committee organized a brain-storming National Seminar on Era of Information Industry of senior government officials and functionaries in the IT sector in Pyongyang.[7] On June 18-19, 2002, the National Academy of Sciences organized an international forum on IT in Pyongyang to discuss measures the DPRK government should take to develop software and hardware, build IT infrastructure and cooperate with the international community in the IT sector. [8] North Korea's newly discovered passion for informatization also came into view during the Arirang art performance held from June 31st to July 2002. The final theme of the Arirang mass gymnastics show, "A Future with Hope," featured a "The 21st Century as the Age of Information Technology Industry" slogan against images of computers and satellites.[9]

It is interesting that originally the party thought went only as far as to stress "the inevitability of the ruin of capitalism and the advantages of Korean-style socialism in the development of science and technology through the rapid development of the information industry of the country."[10] However, within a decade, the party theorists dramatically expanded the political mandate of the IT industry and developed a much more extensive list of the main roles that the information technology must play in the DPRK's development. That is,

1. IT is a "core basic technology and central link in the country's science and technology development," according to the party's economic theory journal Kyngjae Yonggu.

"Developing this area (IT) as the direction of the main offensive has an important significance in opening breakthroughs in powerful state construction and developing the country's overall science and technology."[11]

a. "The WPK now regards science and technology (IT) as one of the three pillars of building the great prosperous powerful nation along with ideology and the army," according to the party theoretician Kim Hui-suk.[12]

2. IT is a "tool to modernize and realign industrial structure," according to Associate Professor Ri Ch'an-hwang.[13]
3. IT is an "economic growth engine," according to the party theoretician Kim Hui-suk.[14]
4. "Informatization of economy, military, government, and the whole society is a major strategy of state development and the most important affair of the state," according to Dr. Ri Kong-cho, vice president of the College of Information Science and Technology at Kim Ch'aek University of Technology.[15]
5. IT is the "seed to spur economic reform," according to Rodong Sinmun's Chon Son-ch'ol.[16,17, 18]
6. IT is a "means to raise the people's living standards (economically, socially, and culturally)," according to Dr. Cho Myong-ho[19] and Dr. Kim Song-ryong.[20]
7. IT is part and parcel of the WPK's "Toward the World" Campaign, according to Dr. Han Son-bong.[21]
8. IT is regarded as the "future key industry of the DPRK," according to Dr. Ri Sang-ch'un of the KAST Computer Technical Committee.[22]
9. IT is considered an "attractive alternative to brain drain," according to Dr. Ri Sang-ch'un of the KAST Computer Technical Committee.[23]
10. IT is a "powerful weapon in countering US psychological warfare against DPRK and mobilizing popular opposition to US-ROK alliance," according to Rodong Sinmun's Ri Kyong-su.[24]
11. IT offers "novel and much more sophisticated instruments of surveillance and control over population," according to Kim Hung-kwang, director of NK Intellectual Solidarity.

The party leadership now regards IT as so critically important that on February 3, 2010, the WPK Central Committee and WPK Central Military Commission issued an unprecedented joint call to all party members and all people to "Make a great leap forward in the development of IT."[25] Subsequently, the WPK CC Working Organizations and Capital Construction Department and Propaganda and Agitation Department mobilized the leading mass public organizations—Kim Il Sung Socialist Youth League, General Federation of Trade Unions of Korea, Korean Democratic Women's Union, Union of Agricultural Workers of Korea, General Federation of Science and Technology of Korea, and others—to fully embrace the party goals of the informatization of the whole society and economy and implement them through the field activities of their provincial and local organizations and the enterprise-based Three-Revolution groups, as well as various socialist emulation and competition movements. The only problem is that the more people learn about modern information technologies, the more they want to use them in their businesses and private lives and the more they expect and demand from the

authorities with respect to access and quality of IT services. And North Korea turns out not to be an exception.

Developing IT Policy: Principal Players, Key Considerations, Complicating Factors

In 2001, following the party center guidance, the DPRK Cabinet of Ministers established the **Third General Bureau of Industry** (later renamed as Information Industry Guidance Bureau) to oversee the IT revolution and coordinate the IT plans of DPRK Ministry of Post and Telecommunications, the DPRK Ministry of Electronics Industry, the Ministry of Electric Power Industry, the Academy of Sciences, and National Science and Technology Commission. But, very soon, the number of party and government organizations charged with driving forward the IT revolution expanded considerably, as Table One demonstrates below.

Table One. Principal Party, Government, National Security, and Corporate Players in the DPRK IT Policy-Making Field

Type of Entity	Name of Organization	Mission
Party	Section for Science and Technology Policy of WPK CC Science and Education Department	overall IT policy guidance
	Section for Censoring Publications and Section for Newspapers, Broadcasting and News of WPK CC Propaganda and Agitation Department	party guidance of content development for domestic publishing and broadcasting media and Intranet
Government (Cabinet-level)	State Planning Commission	Overall IT policy planning in accordance with party guidance
	Information Industry Guidance Bureau (previously known as Third General Bureau of Industry) under the Cabinet of Ministers	supervision of the implementation of the party IT guidance and the Cabinet-level inter-agency coordination
	DPRK Ministry of Post & Telecommunications	executive agent for IT policy execution, provision of mobile & landline telecommunication services, construction and maintenance of fiber optic cable network
	DPRK Ministry of Electronics Industry	telecommunications equipment manufacturing
	DPRK Ministry of Electric Power Industry	Laying and maintaining power wires
	DPRK Academy of Sciences	IT R&D, Intranet

	State Science and Technology Commission	development of IT standards and technical requirements
	Korean Radio and Television Broadcasting Commission	supervision and censorship of broadcasting media and Intranet content
Government (sub-Cabinet level)	International Telecommunications Bureau and Rason International Telecommunications Center	provision of international satellite and landline telecom services and maintenance of related facilities
	Central Information Communications Bureau	maintenance of telephone landlines and telegraph facilities
	Central Information Agency for Science and Technology[26]	construction and maintenance of domestic Intranet
	General Bureau of Software Industry and Software Arbitration Committee	software development, distribution, installation, and maintenance; software protection
National Security	Communications Security Bureau of State Security Department	monitoring of domestic and foreign telecommunications traffic for counter-revolutionary and anti-regime content and national security purposes; provision of communications security (COMSEC) for the party leadership and government offices; surveillance of telecommunications use by resident and visiting foreigners and foreign missions in the DPRK
	Communication Bureau of the Ministry of People's Security	detection of unknown electronic waves, management of all communication issues for the benefit of the national people's security system and local law enforcement
Military	Communications Bureau and Electronic Warfare Bureau of KPA General Staff Department	administration and operation of all communications within the KPA; monitoring of both domestic and foreign telecommunications traffic for national defense purposes; cooperation with the General Reconnaissance Bureau and State Security Department in conducting signals intelligence (SIGINT) operations; provision of communications security (COMSEC) for the KPA in cooperation with the General Staff's Classified Information Bureau
	Seventh (Technical) Department of Military Security Command	surveillance of telecom use for official and private purposes by KPA general officers and foreign military visitors

Corporate	Korea Post and Telecommunications Corporation	principal telecommunications carrier under DPRK Ministry of Post and Telecom
	Korea Computer Center	Principal state-owned entity responsible for IT software development, research and training

In determining overall IT strategy and policy, the DPRK government first takes into consideration the views of national leadership, especially Kim Jong Il's instructions and more recently his successor Kim Jong-un's views. Their authoritative guidance has paramount significance for all bureaucratic players involved in IT issues.

- It is noteworthy that the DPRK's national landline telecom network, made up of several independent parallel networks serving specific communities (Party, Military, Internal & State Security, Industries, etc.) and directly linking all units throughout their respective hierarchies, was originally built primarily for administrative purposes to deliver "political and administrative orders" from the party leadership to the management of the state-owned factories and enterprises, collective farms and governmental organizations and agencies and to connect major industrial bases, rather than to provide commercial telecom services for individuals. Hence, only 10 % of the installed telephone fixed lines were private home lines, and the rest belonged to the so-called national "industrial phone lines network" composed of approximately 400 industrial telecom networks (산업전화망), with the wiring structure closely following the road structure due to the mountain terrain.

The regime security considerations represented in the frequent reservations from the Guard Command and Ministry of People's Security and national security considerations as voiced by the State Security Department, Korean People's Army, and others still dominate the IT policy-making discussions.

- For instance, one of the persistent concerns of the North Korean security apparatus is the availability and use of Chinese cell phones on the North Korean side along its border with China. Bloomberg Businessweek estimates around 1,000 people use such phones to keep in touch with relatives and associates in China, South Korea and elsewhere. Because the cell phones connect to Chinese cell phone towers it is difficult for the North Korean government to eavesdrop on the calls, but it does mean use is restricted to the border area.[27]

On the other hand, the Cabinet-level ministries, commissions, and general bureaus are primarily concerned with the scarcity of domestic resources, including perennial shortages of electricity and skilled labor, obsolete wired and underdeveloped wireless and satellite telecommunications infrastructure, as well as the chronic deficit of finances. They are aware that telecommunications and networking depend on electric power, and the DPRK's electrical infrastructure is both antiquated and unreliable, with frequent power outages and poor frequency control. They are also mindful of their country's very limited access to international markets and capital due to international sanctions and its poor reputation. Chinese experience in IT development over the past two decades also serves as one of the guiding lights in North Korean IT policy deliberations.

The IT policy-making process is complicated by a number of factors that are hard to avoid under current political conditions. The party guidance over IT policy tends to oscillate between more restrictive and more permissive regimes, depending on the perceived severity of domestic political challenges threatening internal stability and the ruling regime. The military-first policy and prioritization of the munitions industry skews the allocation of scarce resources towards the national defense sector at the expense of all civilian industries and prioritizes the informatization of the military and munitions industry first at the expense of civilian economy and consumer demand. State planning and control of the economy distorts the allocation of capital and labor and restricts the free flow of ideas, people, and money that can benefit IT development. In the DPRK, the main battles of the IT revolution are waged in the Cabinet's State Planning Commission and Information Industry Guidance Bureau, and not in the marketplace. Because of the excessive state regulation of the IT industry, the domestic IT market remains largely underdeveloped in the DPRK.

Notwithstanding the unified party guidance, military-first requirements, and state planning imperatives, one cannot ignore the bureaucratic politics within the Cabinet with respect to the IT policy ends and means, timelines and deadlines, etc., with competing bureaucratic agendas pursued by the Information Industry Guidance Committee, Ministry of Post and Telecommunications, Ministry of Electronics Industry, Academy of Sciences, Ministry of Electric Power Industry, State Science and Technology Commission, and other actors. Moreover, despite their apprehension of markets in general and limited experience in market regulation in particular, the North Korean authorities have already gained some expertise in using the bottom-up market pricing and marketing mechanisms, especially in the IT field (for example, dealing with Koryolink and software developers for outside clients), which complicate their top-down state planning process.

Finally, the IT policy-making process is obfuscated by the relatively unpredictable vacillations in the local foreign investment climate and fragile relations with major foreign IT investors like Egypt's Orascom, Thailand's Loxley Pacific, China's Huawei, PRC Ministry of Telecommunications, China Netcom, and others. The hostile international environment, including economic sanctions, COCOM and Wassenaar Agreement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies, national trade embargoes, and international isolation, discourage foreign capital from entering the DPRK.[28] What is further hindering the process is the fact that all DPRK IT players must keep in mind the long-standing national requirement for import substitution in dealing with foreign providers of IT hardware, software, and content.

Designing Regulatory and Financing Framework

In 2001, the DPRK government adopted a comprehensive long-term plan for developing the IT industry, including a nationwide mobile communications network and Internet Access Roadmap. At the first stage, the plan envisioned the construction of mobile communications network in Pyongyang City and Rason City by August 2002 with the assistance of NEAT&T. At the second stage, it envisaged the construction and operation of 40 mobile telecommunications base stations (70 meter-high steel towers for the installation of mobile telecommunications antennas and digital signal converters) providing mobile telecommunications in provincial capitals and along major highways nationwide by September 2003.[29] At the third stage, the goal was to establish a

nationwide mobile communications network before 2007.[30] At the fourth stage, the goal was to provide Internet service for special agencies and authorized individuals by 2009.

- As it will be demonstrated below, the construction of a nationwide mobile telecommunications network was aborted in 2004 due to security concerns, but it was resumed in 2008 on the basis of the 3G technology and Orascom service and was finally completed in 2009. In 2005, the government temporarily disabled both international internet and domestic intranet connections,[31] postponing the rollout of domestic Intranet service until February 2010.

One of the obstacles to the accelerated development of IT industry is the inadequate legal environment and opaque regulatory framework. The Presidium of the DPRK Supreme People's Assembly passed only two pieces of enabling legislation for domestic software production and distribution – the DPRK Law on Computer Software Protection on June 11, 2003 and the DPRK Law on Software Production on June 30, 2004. These laws upheld the military-first requirements, information security concerns, and the leading role of state planning organizations in national software development, production and use, while making only passing, albeit unprecedented, references to actual market realities, actual profits, and actual skills of the people and organizations involved.

Starting at the turn of the 21st century, the DPRK government began to include IT development plans in its regular five-year plans for development of science and technology. According to Ch'oe T'ae-bok, Party Secretary in charge of science and technology, during the First Five-Year Plan for Development of Science and Technology in 1998-2002, "modern IT research institutes and databases were newly established, with the result that the foundations of the IT industry had been consolidated." An added benefit of these measures was the partial alleviation of the problem of brain drain of North Korean IT specialists to China.

The Fourth Session of the 11th Supreme People's Assembly held on April 11, 2006, stressed that "in the field of hardcore basic technology, it is urgent to build a nationwide information network and develop programming technology rapidly and thus turn our country into a power in software development." Ch'oe T'ae-bok noted in his report "On Stepping up the Development of Science and Technology to Give Strong Impetus to the Building of a Great Prosperous Powerful Nation" that "state budgetary allocations for science and technology (including IT) should be sharply increased and rationally used."

At the Sixth Session of the 11th SPA held on April 9, 2008, the then DPRK Premier Kim Yong-il stated that "under the new (third) five-year plan for the development of national science and technology (beginning in 2008 and) ending in 2012, we will systematically increase the state investment in this field (IT) and will exert state efforts for the development of the IT industry." Open sources offer no credible estimates of how much money the DPRK government has actually invested in the IT industry since its inception.

Laying National Fiber Optic Cable Network

Initially, one of the priorities of the DPRK government in the telecommunications field was the development of an optical fiber cable line network together with digital communication services. As early as August 1990, the DPRK reached an agreement with the United Nations Development

Programme (UNDP) to get assistance for the installation of an optical fiber cable between Pyongyang and other major cities.

- Following the agreement with UNDP, the Pyongyang Fiber Optic Cable Factory was built in April 1992 and the country's first optical fiber cable network consisting of 480 Pulse Code Modulation (PCM) lines and 6 automatic exchange stations from Pyongyang to Hamhung (300 kilometers) was installed in September 1995.[32]
- In the Rajin-Sonbong Special Economic Zone (SEZ) a 95 km long optical fiber cable network was installed as early as 1995 to connect the SEZ with the city of Hunchun in China's Jilin Province by NEAT&T, the Thai-DPRK joint venture telecom company. Afterwards, this network was linked to Pyongyang via Chongjin and Hamhung.
- An optical fiber network was successfully completed in February 1998 between Pyongyang and Sinuiju (400 kilometers) including most cities and counties in the North Pyongan Province via Sinuiju. In March 2000, all major areas in the North Pyongan Province were completely connected, and, in 2001, the network was extended to Nampo.

As of 2000, DPRK's operational optical fiber telecom lines included: Pyongyang – Hamhung; Pyongyang - Sinuiju including all cities and counties in North Pyongan Province; Hamhung - Rajin-Sonbong; Rajin-Songbong - Hunchun (China), Pyongyang - Nampo. By 2002, the DPRK had basically established the backbone optic fiber network for connecting all cities and counties throughout the nation,[33] installed digital transmission equipment in all provinces, and completed the construction of infrastructure facilities for digital mobile communications, thereby laying the foundation for the mobile communications industry start-up and development.[34]

Key actors in this nationwide endeavor were the DPRK Ministry of Posts and Telecommunications (Central Optical Fiber Technical Management Office) and its provincial and local post and telecommunications management bureaus, KPA General Military Engineering Bureau, Pyŏngyang Optical Fiber Cable Factory (also known as March 4 Factory), Wŏnsan Communications Cable Factory, and Pyongyang Communications Equipment Factory, Kim Ch'aek University and Hamhung University of Chemical Engineering, Pyongyang office of the United Nations Development Programme (UNDP), and local staff of Loxley Pacific.

It is interesting to note that "during the "Arduous March" period, when all other sectors of the nation's economy were stagnant, investments in the communications sector alone were active," according to Mr. Hwang, a mid-ranking official of the DPRK Ministry of Post and Telecommunications.[35] Moreover, the nationwide land leveling and rezoning campaign initiated by Kim Jong Il in Kangwon province in May 1998[36] and in North Pyongan province in January 2000[37] facilitated the construction of provincial and county fiber optic lines, which were laid by tens of thousands of KPA soldier-builders and provincial shock brigade members mobilized for the large-scale public works projects designed to rehabilitate the hundreds of thousands of hectares of arable lands devastated by the natural disasters in the late 1990s.

Construction of a nationwide communications network of optical fiber cables[38] was largely completed on October 10, 2000, in time for the celebration of the 55th anniversary of the founding of WPK. At present, its backbone capacity stands at 2.5GB per second[39] between Pyongyang and nine provincial capitals.[40]

Policy Choices for Mobile Telecommunications

Facing similar policy questions, the DPRK government made very different decisions on principal issues during the first period of launching mobile telecommunications services (1998-2004) and the second period (2008-present) of re-starting them again. One wonders what may account for these differences. Major obstacles to IT development in the country remained the same (see above), while the international security situation may be even worse today than at the turn of the century. The answer may lie in specific circumstances, the state of bilateral relations with specific countries, cost considerations, and gradual learning and adaptation by North Korean authorities to new information technologies and emerging market realities.

Choosing National Industrial Standard for Mobile Telecom

In choosing the national industrial standard for mobile telecommunications services, in the 1990s and in the period from 2002 to 2004, the DPRK government opted for the GSM [global system for mobile communication] standard (which was more popular in Europe than CDMA and devised by the U.S.-based wireless technology firm Qualcomm Inc) primarily for security reasons in order to erect technical barriers between the country's mobile communications network and that of its southern rival, as well as because of international patent infringement and sanctions concerns.[41]

But, in 2008, against the background of thawing inter-Korean relations which temporarily alleviated the security concerns about the prevalence of 3G mobile standard in the South and in light of broader international mobile telephony trends revealing that the world was gradually moving towards the 3G standard ,[42] Pyongyang decided to follow China's footsteps and by and large replace the legacy GSM platform with the 3G mobile phone network based on the globally leading W-CDMA (wideband code division multiple access) standard offering higher data transmission rates and greater network security. Beijing announced in May 2008 that the telecoms sector was re-organized and three 3G networks were allocated to China's three largest mobile operators - China Mobile, China Unicom, and China Telecom - all of whom were required to retain/or relinquish their respective GSM and CDMA2000 customer bases. Soon afterwards, in December 2008, the DPRK launched its only 3G mobile network called Koryolink, preceding by nine months the official launch of 3G in China on 1 October 2009.

Choosing Exclusive Mobile Telecom Service Providers

In choosing the monopoly mobile telecom service provider for exclusive partnerships with the DPRK Ministry of Posts and Telecommunications at the turn of the century, the DPRK government decided to do business with two very different players - the more experienced and resources-rich, albeit risk averse, Loxley Public Group of Thailand to run the GSM network and the small, more opportunistic and capital-poor private venture Lancelot Holdings Ltd. registered in Bermuda and an associated company of Hong Kong-listed Pearl Oriental Cyberforce Ltd. as the monopoly operator of the CDMA network.

- The example of the DPRK Ministry of Posts and Telecommunications (MPT)' dealings with Lancelot Holdings Ltd. is very telling. In 1998, the MPT granted Lancelot an exclusive 30-year license to provide international direct dialing facilities and a five-year

license to provide a calling card service through exclusive revenue sharing agreements. Subsequently, the MPT permitted Lancelot to build a CDMA-based mobile telephone network in Pyongyang and Nampo with financing to be derived from the revenues of its two other projects in North Korea. However, Lancelot failed to raise the required capital (initially estimated at 10 million U.S. dollars), and, consequently, never built the CDMA network in North Korea.[43] It still remains a mystery why the MPT decided to do business with Lancelot to begin with.

In 1998, the Korea Post and Telecommunications Corporation of the DPRK Ministry of Post and Telecommunications and Loxley Pacific Co., Ltd. (LOXPAC), a joint venture between Loxley Teltech of Finland, a subsidiary of Thai telecommunications giant Loxley Public Co. Ltd., and Charungthai of Taiwan, and signed a USD 28 million joint venture investment deal for 27 years of telecommunications network concessions in the North Korean free trade area of Rajin-Sŏnbong and established the Northeast Asia Telephone and Telecommunications Company (NEAT&T), a joint venture which was granted the 30-year license to operate the DPRK's first 2G GSM mobile telephone network on a build-operate-transfer basis.[44]

- All activities of NEAT&T were to be based on principles of commercial viability. During the implementation phase, the company encountered many problems including Western embargos on certain technical equipment, difficulties travelling between Rajin and Bangkok, difficulties in assigning Thai engineers to work in Rajin for an extended period, lack of international banking facilities, and shortage of power supplies and fuel. At the same time, the DPRK Committee for Promotion of External Economic Cooperation (CPEEC) and the DPRK Ministry of Posts and Telecommunications did provide the company with some assistance. According to KCNA, on January 25, 2003, the DPRK government even dispatched a telecommunications delegation led by Minister Ri Kŭm-bŏm of Post and Telecommunications to Thailand to discuss the problems facing Loxley's operations in the North.[45]

North Korea began European-style GSM service on a trial basis in August 2002, and the service was first made available in Pyongyang and the special economic zone Rason (Rajin-Sonbong) in November 2002. In the initial stages of implementation, NEAT&T invested close to 130 million Thai baht or USD 3 million.[46] But, due to very poor foreign investment turnout, in the first year NEAT&T was able to install only 1,200 mobile communications lines with access numbers starting with "193-0001," 1,500 radio pager lines,[47] and 80 pay phones in Pyongyang, as well as to finalize the inter- connectivity with China, to conduct a feasibility study for inter-connectivity with Russia, prepare the site for the Telecom Center building and complete the services buildings in Rason, in addition to training of Korean NEAT&T staff members to take over from Thai engineers.[48]

However, the DPRK government banned the use of mobile phones first in Pyongyang on May 19, 2004 and then in other cities on May 20, 2004, following the discovery of some evidence that seditious elements utilized mobile phones during the Ryongch'on explosion incident that took place on April 22, 2004 shortly after Kim Jong Il's return from his unofficial visit to China.[49] Thus, the original plan to establish a nationwide mobile communications network before 2007 was abruptly aborted in 2004. At that time, the total number of mobile phone subscribers in North Korea stood at around 40,000, leading Shanghai experts to conclude that the country had a significant potential for a strong rebound of its mobile communications industry once the ban on mobile phone use was lifted.[50]

- On April 22, 2004, an explosion rocked Ryongch'on Railway Station; the North Korean security services suspected that a mobile phone had been used to ignite the ammonium nitrate and fuel oil on the train. Meanwhile, the DPRK Government was worried that, in general, mobile phone may lead to a massive influx of foreign culture and leakage of domestic intelligence. Therefore, a government notice was issued to completely ban the use of mobile phones by its citizens. On entering the DPRK, foreigners were required to turn in their mobile phones and other communications equipment to DPRK authorites for safekeeping at the airport or railway station; they were to get their equipment back on departure from the DPRK.

The overall experience of NEAT&T was sobering. It invested more than 30 million U.S. dollars to set up a mobile phone network, but in May 2004 mobile phones were suspended by the North Korean government as part of a security crackdown following the Ryongch'on train explosion on April 22, 2004. According to the experts of Shanghai Northeast Asia Investment and Consultancy Company, one of the reasons why LOXPAC eventually folded was "the lack of good communications and cooperation with the DPRK Government." [51] Only more than a year later, in his meeting with the DPRK Minister of Post and Telecommunications Ryu Yong Sop, on August 29, 2005, Thailand's Foreign Minister Dr. Kantathi Suphamongkhon raised the problems encountered by LOXPAC resulting from the ban imposed on the use of mobile phones. He told the DPRK side that an early resolution of the issue and lifting of the ban would give confidence to other Thai companies interested in exploring business opportunities in the DPRK. He also noted that there were technologies available to address the security concerns of the DPRK side rather than resorting to an outright ban on the use of mobile phones. The DPRK side said that they would look at how the issue could be resolved as soon as possible for the mutual interest of both sides.[52] In reality, it took the North Korean and Thai authorities almost five years to reach a compromise: in the end, Loxley Pacific probably agreed to sacrifice its interest in the DPRK's mobile telephone market while Pyongyang agreed to allow the Thai telecom carrier to enter the DPRK's Internet market as a consolation prize in 2010 (see below).[53]

When the DPRK government finally decided to resume mobile telecommunications services in 2008 (despite earlier rumors that it might lift the ban on cell phones around the birthday of the North's leader Kim Jong Il on February 16 or that of the late Kim Il-sung on April 15, 2006, or in 2007 [54]) Pyongyang chose Egypt's Orascom and SunNet instead of returning the license to NEAT&T and its Loxley Pacific owner. The most plausible explanation for this controversial decision is the rapid deterioration and dismal state of the North Korean-Thai relations following the military coup in Bangkok in September 2006. LOXPAC's business in the North really took off in 2001-2002 when political relations, party-to-party ties, and economic interaction between Pyongyang and Bangkok improved significantly after Thaksin Shinawatra became Thailand's Prime Minister in January 2001. But, political crisis in Thailand in 2005-2006, culminating in the military coup in September 2006, negatively affected the leadership trust, political relations, and economic exchanges between Pyongyang and Bangkok. The Thai military junta led by the coup leader Army Commander General Sonthi Boonyaratglin subsequently reduced the level of Thai-DPRK relations in order "to eradicate" the Thaksin legacy in Thailand's foreign policy. It was no wonder that the North Korean government decided to seek a new partner in rebuilding its mobile telecommunications network in 2007-2008.

It is important to note that during the inter-Korean thaw in the early 2000s, the DPRK Ministry of Posts and Telecommunications seriously explored the possibility of opening the country's

mobile telecommunications market to South Korean companies. In June 2002, the eight-member delegation of the ROK government and mobile carriers and electronic giants made a five-day path-breaking visit to the DPRK to discuss establishing wireless services in the capital, Pyongyang, and other issues of inter-Korean cooperation in the IT sector. These preliminary talks did not really produce much, and, subsequently, the North-South telecom cooperation was limited to the fixed line phone business in the Kaesong Joint Industrial Zone and Mt. Kumgang Special Tourist District.

- In 2002, South Korea's top mobile carrier SK telecom, the largest fixed-line carrier KT Corp., the largest telecoms equipment manufacturer Samsung Electronics and LG Electronics Inc., and Hyundai Syscomm created a consortium to promote mobile services in the North on CDMA technology and prevent excessive or redundant investments in North Korea. The original project envisioned that KT would establish wire networks, SK Telecom would design and establish wireless networks, and three other companies would provide cellular handsets and other communications equipment, according to a KT spokesman. [55] However, this project and others never took off the ground because of two persistent stumbling blocks – Pyongyang's fears and refusal to award required operator licenses to ROK businesses and the U.S. refusal to allow shipment of necessary telecommunications equipment to the North.

In December 2008, North Korea announced the resumption of mobile communication services based on a new 3G standard through Egypt's Orascom Telecom,[56] which promised to lower costs, increase connectivity, diversify services, expand coverage area, and increase the customer base. North Korea's 3-G mobile network known as "Koryolink" was established by CHEO Technology Joint Venture Company, a joint venture between Egyptian company Orascom Telecom Holding (75 percent share) and the local state-owned entity, Korea Posts and Telecomm Corporation (KPTC) (25 percent share). According to Egyptian sources, "it took about a year from the initial contact to reach an agreement [with North Korea] and another nine months to get the network installed."[57] Orascom Telecom planned to invest up to $400 million in network infrastructure from 2008 to 2010, $200 million over the first year, and $100 million in each of the succeeding two years.[58]

The North Korean government first approached Orascom Group sometime in 2006 and, on January 19 2007, the Korea Post and Telecommunications Corporation signed a communique on cooperation with Orascom Telecom Holding in Pyongyang, agreeing "to realize long-term cooperation in the sector of telecommunication of the DPRK in the spirit of South-South cooperation, and the principles of mutual respect and non-interference in internal affairs."[59] On July 16 2007, Orascom Construction Industries agreed to make a large investment in the DPRK's cement industry and formed a joint venture with Pyongyang Myongdang Trading Corporation (PMTC) to modernize, renovate, upgrade, and operate the Sangwon Cement Complex, promising also to invest in the Rason SEZ, mineral production, energy sector, port facilities, and hotel business, including the renovation of the 105-floor Ryugyong Hotel in Pyongyang.[60] SPA President Kim Yong-nam's official visit to Cairo and his talks with Egypt's President Mubarak on July 27 2007 gave political support to the major investment projects under discussion between the two countries, including the Orascom's initiatives. In January 2008, the DPRK MPT awarded the 25-year license (with the first four years on an exclusive basis) to Orascom Telecom Holding to establish a 3G mobile network in the DPRK. In May 2008, Orascom announced that it

succeeded in making its first test-call and finally inaugurated Koryolink on December 15, 2008. It is still a mystery how Orascom got on Pyongyang's radar screen to begin with.

- High-level personal attention of the DPRK leadership and Orascom top management to the Orascom projects in the North was critical for successful consummation of the Koryolink deal. Naguib Sawiris, Chairman and CEO of Orascom Telecom Holding visited North Korea at least four times: on February 27- March 2 2007, to meet with SPA President Kim Yong-nam and present Orascom's proposal for the launch of a new mobile network,[61,62] on December 14-17 2008 to meet with DPRK Premier Kim Yong-il[63,64] and officially launch the DPRK's first 3G mobile communication service;[65] on September 29–October 1, 2009 to meet with SPA President Kim Yong-nam[66,67] and receive the Order of the DPRK Friendship First Class for his contribution to the development of the DPRK telecommunications industry;[68] and on January 21-25 2011 to "have a cordial talk" and dinner with Kim Jong Il and Chang Song-t'aek to discuss the future development prospects for Orascom in the DPRK.[69,70]

On the left: Chang Song-t'aek, Naguib Sawiris, and Kim Jong Il

On the right: Orascom President chats with Kim Jong Il, on 24 January 2011

- Without doubt, Kim Jong Il's dinner with Orascom President in the presence of his brother-in-law Chang Song-t'aek represented a turning point for IT in North Korea. This was only the second time that Kim Jong Il chose to receive an international tycoon of Sawiris' stature, which should be seen as a new departure for Orascom's fortunes in the North. Previously, after Kim met with the late Hyundai Group Founder Chung Ju-yung on October 30,1998, Hyundai was awarded exclusive rights to the development of the Mt. Kumgang Tourism Zone and inter-Korean cooperation in Mt. Kumgang project really took off. Moreover, WPK CC Administrative Department Director Chang Song-t'aek's participation in the dinner carried enormous symbolic weight, demonstrating that the North Korean security services had finally conquered their fear of modern telecommunications and were ready to lend "full

support" to the Orascom's operations in the DPRK. The picture of the Dear Leader and North Korea's de-facto security czar embracing the principal foreign investor in IT communications was a game changing development, sending a powerful signal to the power elites, domestic bureaucracy, and the general public that North Korea was now open for modern telecommunications which would enjoy both political support and the backing of the security apparatus. It was indeed a watershed moment for IT development and foreign investment in North Korea.

With respect to Orascom's motivations behind investing in the DPRK's telecommunications, Donald Kirk believes that Egypt's biggest tycoon has a special bond with the North Korean ruler and wants to help him out for ideological reasons.[71] But others assert that Orascom Chairman Naguib Sawiris is not an ideologue – he is a gambler of epic proportions... he is betting on the eventual reunification of the Koreas and wants to be the monopoly telecommunication company incumbent in the North when that happens. That will inflate the value of his multi-million dollar investment into a multi-billion dollar one. Still others believe that Sawiris is profiting while he can and that is all he is doing. When reunification comes, there is no way a foreign company will stay entrenched in the local telecommunications market. There are just too many players in the South already and they won't let an outsider in. He's probably charging the North prices way over market-value and is just taking advantage of the opportunity while it lasts.

According to Orascom's latest quarterly report, Koryolink has successfully crossed the 600,000 subscribers mark in the first half of 2011 totaling 666,517 customers as of June 30, 2011 and representing more than a 361% increase in subscribers when compared to the H1 2010 closing base of 184,531 customers as of June 30, 2010. The network supports a variety of services in addition to voice such as video call, SMS, MMS, voice mail, WAP and HSPA.

During the first half of 2011, Koryolink capitalized on its distribution agreement with KPTC and increased its scratch card sales network in Pyongyang to reach 24 shops. Through these new shops – together with the 18 shops that previously existed inside the capital and the 8 shops covering other main cities, Koryolink has successfully become more reachable for its existing as well as potential customers.

Koryolink cellular handset


Koryolink cell phone tower


Rason Telecom Center set up by NEAT&T

It is noteworthy that the DPRK government did not object to the Koryolink management's main focus throughout 2011 on increasing subscriber growth and maximizing the foreign currency revenues through new subscriber acquisition and the introduction of innovative offerings and value-added services to the market like "Euro Pack" bundles, balance transfer service,

multimedia messaging service, and video call service – all of which proved to be a "huge success across all base sectors," resulting in tremendous growth of the subscriber base and 164 percent growth in consolidated revenues on a year to year basis, exceeding 35 million U.S. dollars in the second quarter of 2011 and over 61 million U.S. dollars in the first half of 2011, with the projected total revenues in the amount of over 134 million U.S. dollars for the entire 2011.

It remains unclear whether or not, to what extent, and how Orascom plans to repatriate its profits from North Korea.[72] But, according to a recent investment report by "Naeem Holding," an Egyptian investment bank, "Orascom is in a negotiation with the North Korean authorities over how to repatriate profits from the DPRK to Egypt. Until that issue is resolved, a large-scale direct investment by Orascom management will be difficult." Ora Bank is probably one such venue.

- To compensate for the lack of international banking facilities – the problem encountered earlier by NEAT&T – on December 16, 2008, Orascom Telecom Holding of Egypt and the DPRK's Foreign Trade Bank opened a joint venture bank in Pyongyang, Ora Bank,[73] which handles subscriptions for Koryolink and the wages paid to the North Korean construction workers employed in various overseas construction projects in the Middle East in connection with the Orascom corporate empire.

As the year of 2012 – the last year of exclusive mobile operations under Orascom's 25-year license – approaches, the DPRK government is likely to use its growing leverage to renegotiate the cost structure, profit margins, and future investment plans of the monopoly 3G service provider, insisting on further tariff reductions, profit re-investments in expansion of customer base and value added services, and possibly even on adjustments in the current profit sharing scheme as a price for keeping the North Korean mobile telecom market relatively closed and competition free for Orascom. Should Orascom bulk, one cannot exclude the possibility that the DPRK MPT may resort to the so-called Turkmen option where the local telecom authorities asked for a greater share in profits and when rejected, revoked the mobile operator's license from Russia's MTS and transferred its assets and rights to its local partner in the Turkmen-Russian joint telecom venture.

In order to accommodate the interests of its lingering GSM customer base, the DPRK government also allowed market entry for a novice Hong Kong-registered SunNet Technology Co. Ltd., probably part of China Network Communications Group Corp., which was widely seen as the number two fixed-line operator in mainland China after China Telecom, operating mostly in northern Chinese provinces and large cities such as Shanghai, Guangdong, Beijing, Tianjin, Hebei, Henan, Shandong, and Liaoning.[74] Judging by the NEAT&T reference on the SunNet calling cards, some arrangement must exist between SunNet Technology and LOXPAC, although it is unclear whether SunNet bought the LOXPAC's stake in NEAT&T or offered some other accommodations to the Thai company to share the rights to or to legitimately replace it as the exclusive operator of the legacy 2G GSM network in North Korea.

- SunNet offered the 2G technology to the legacy GSM customer base in Pyongyang, Rason, and some other large cities, despite public complaints about poor call quality, frequent disconnections, and relatively high costs of its SIM cards (30 euros per card). The SunNet network is mostly used by foreigners. The SunNet-connected cell phones can be used to make international phone calls and domestic calls to other SunNet phones, as well as to the

international phone numbers offered to Koryolink subscribers. SunNet offers no subscription service and relies only on calling cards. The SunNet does not offer SMS or any other services but voice calls.[75]

- The SunNet prices are relatively expensive: an outgoing local call costs 0.30 euro per minute, and an incoming local call costs 0.10 euro per minute; an international call to China costs 1.40 euros per minute, to Asia – 3.40 euros per minute, and to Europe and Russia - 4 euros per minute. The SunNet mobile phones have the following numbers +850 193 801 plus 4-digit number (when being called from overseas); 193 801 plus 4-digit number (when calling SUNNET to SUNNET); and 193 801 plus 4-digit number (when calling from Pyongyang "381″ landlines to SUNNET). Pyongyang "382″ landline numbers cannot reach SUNNET cell phones. SUNNET subscribers can call Koryolink "250″ numbers but not "260″ numbers.[76] Foreign visitors can lease SunNet phones for the duration of their stay in the country, paying 2.5 euros per day, 10 euros for the SIM card, and 60 euros for the calling card.[77]

SunNet SIM-cards for 50 euros (left) and 10 euros (right)

Choosing Principal Telecom Equipment Manufacturers

In choosing the principal telecommunications equipment manufacturers, the MPT opted for the well-known Western brand of Nokia in 2002-2004. At that time, it was one of the dominant handset makers with large-scale distribution channels in China and Asia-Pacific. The Loxley Teltech of Finland, one of the foreign owners of NEAT&T, strongly preferred the products made by the Finnish behemoth Nokia because of their familiarity, affordability, and reliability. Hence, in March 2003, the NEAT&T imported 30,000 high- and medium-priced Nokia mobile phones from China for its GSM customers in Pyongyang and Rason.[78]

In contrast, in 2008-2010, the MPT mostly imported the networking and telecommunications equipment manufactured by China's own Huawei Group, following Kim Jong Il's visit to Huawei's headquarters during his China tour in 2006. Later on, in April 2010, the DPRK MPT announced plans to launch the production of "hand phone terminals" within six months first by importing and assembling the parts brought from China, but eventually moving to self-reliant production.[79] In November 2010, Ch'ekom Technology JV Company built a new plant where it introduced a "flow manufacturing process of cellular handsets (a build-to-order process aimed at minimizing inventory)" and is "now producing hundreds of high-performance cellular phones each day" to meet the accelerating demand of rapidly growing number of mobile phone subscribers (which quadrupled in 2010), according to Chosun Sinbo, a pro-Pyongyang newspaper in Tokyo.[80] According to the MPT officials, "Related sectors are testing new devices and actively working on a project aimed at modifying the operating software to suit the needs of

local users," while "central engineering rooms for mobile communications are also pushing a program to develop software for their main machines to meet the domestic environment." It is reasonable to expect that in the future the MPT will strive to achieve total import substitution with respect to the production of less sophisticated parts of the telecommunications equipment, especially cellular handsets.

Other Choices in Providing Mobile Telecom Services

In choosing who may have access to mobile communications, the North Korean government set up a very restrictive regime back in 2002-2004, limiting the customer base mostly to the loyal party cadres, foreign trade functionaries engaged in earning foreign exchange, and expatriates (between 30,000 and 40,000 people as of May 2004). The scope of NEAT&T mobile phone services was limited to voice calls only.

- The NEAT&T service was very costly, charging exorbitant fees for the mobile phones, phone line access, and call time. A mobile phone cost as much as $750 (equivalent to 670,000 DPRK won), about 28 years of wages for an ordinary North Korean making between 2,000 to 3,000 DPRK won a month; individual registration fee was $750, in addition to a charge of five to 10 DPRK won for each call; mobile phones were out of reach for ordinary residents.
- At that time, the DPRK also opened up the international mobile communications business, which was mainly oriented toward the DPRK-based foreigners, as well as working personnel of foreign-funded companies, joint ventures and joint-operation companies in the DPRK, and the DPRK's import and export companies; the access fee was 980 euros, and calls were charged on both ends, with different rates depending on the countries called. The newly opened international mobile communications business was not linked with the existing landline telephone network in the DPRK, and could be used only to dial out and receive offshore, not domestic, telephone calls.[81]

In contrast, in 2008, the government adopted a much more permissive regime allowing ownership of cell phones by pretty much anyone who could afford it. The primary beneficiaries of this new policy were 90 % of the North Korean residents who did not have private home phone lines and whose main access to communications was through public phones installed on the main streets as well as in post offices and local public offices.

In less than three years of operation, the number of Koryolink subscribers has grown to almost 700,000 making up almost 3 percent of the total North Korean population, and it is expected to continue to grow exponentially in the future. As demand quadrupled in 2010, the cell phone prices began to fall, making the service more affordable and accessible to the lower income people. As of May 2011, according to Daily NK, in Pyongyang, the price of a single-piece handset went down from $280 to $250, and a clamshell design from $400 to $380 (at the exchange rate in South Pyongan Province, one dollar is presently worth 2,500 North Korean won, while a kilo of rice continues to drift in the 2,000 won range).[82] Handset prices in a remote Ryanggang province tend to be higher in the 400-450 U.S. dollar range. The registration fee went down to 100 U.S. dollars for individuals and 750 U.S. dollars for businesses. The basic monthly service charge is 2,850 Korean Won, or about US$1 according to the black market exchange rate. Subscription offers 200 free minutes and 20 free SMS messages per month, and a $10 calling card can buy up to 600 minutes of talk time.[83]

The scope of Koryolink mobile telecommunications service is almost unlimited and includes voice calls, video calls, SMS, MMS, voice mail, music, games, access to domestic Intranet and email, WAP and HSPA, and others, except access to international phone services. A wide variety of services, convenient functionality, and fashion make cell phones very popular with young North Koreans, who use the gadget to take photos, listen to songs and watch videos, according to Chosun Ilbo. It is worth noting that in Pyongyang approximately 60% of people between their 20s and 50s use cell phones. Especially for the younger generation in their 20s and 30s, as well as the merchant community, a cell phone is seen as "a must," and many youngsters "can no longer see their lives without it."

In general, according to anecdotal evidence, North Korean residents, on the positive side, believe that cell phones make their daily communications with family, friends, and colleagues easier and more convenient; make business communications faster and more efficient thereby improving their productivity; and ensure better privacy of personal and business communications. Many also consider them status symbols and fashion attributes. On the negative side, they still regard cell phones as expensive, complain about burdensome payment processing, limited geographical coverage, lack of competition because of the single service provider, limited menu of services, and limited device functionality.[84]

Furthermore, in choosing the desirable coverage area, probably because of cost considerations, the DPRK government was more selective and cautious in 2002-2004 than in the latter period. In 2003, the NEAT&T formally opened the domestic GSM mobile communications service to the North Korean citizens in Pyongyang, Namp'o, reportedly in all provincial capitals, on the Pyongyang-Myohyangsan tourist highway, and the Pyongyang-Kaesong and Wonsan-Hamhung highways.[85]

In contrast, in 2008 – 2011, following the country's economic recovery and capitalizing on the falling costs of international telecommunications equipment, the government decided to cover the entire nation with mobile telecommunications service. According to Koryolink's semi-annual report in 2011, its mobile network currently consists of 370 on air base stations covering the capital Pyongyang as well as 14 main cities and 78 smaller cities. Additionally, network coverage extends to over 22 roads and highways. Koryolink now covers 13.79% of the territory and 92.91% of the DPRK's population.

Traditionally, the State Security Department monitored most communications on a daily basis, eaves-dropping on most landline telephone calls, checking every fax and incoming email. However, due to the dramatic explosion of mobile phone use, the communications flow has recently moved beyond the SSD's ability to monitor everything.

Inability to secure total control is a big deal for the Kim regime because it fears that cell phones may be used for anti-Republic spying,[86] for hostile recruitment and blackmail of government officials,[87] for psychological warfare by hostile powers,[88] for massive influx of foreign culture,[89] to organize and execute terrorist acts by remote control, and, finally, to organize anti-government protests and uprisings. No wonder that last year, Kim Jong Il inspected the SSD and MPS-run "technical offices" (responsible for monitoring public communications) and set the revolutionary tasks "to meet the new challenges of the present day" for their staff.

In the future, the SSD will probably concentrate its limited technical capabilities on close surveillance of all communications by the party, government, and military cadres, as well as foreigners, while encouraging self-censorship amongst ordinary cell phone users by promoting

the general belief that the authorities may observe and tap all of the contents of communications (calls, SMS, MMS, etc.) made on mobile phones, even if they actually do not do so. Interestingly, the general population thinks that this is a due measure that the state can take in order to protect the socialist system. In addition, to moderate the public desire to own cell phones, the government uses various propaganda tools to caution the population that cell phones may cause brain tumors,[90] increase traffic accidents,[91] and help criminals and prisoners violate the law.[92]

The DPRK mobile communications industry crossed the Rubicon, and the North Korean government can no longer roll it back like it did in 2004 without paying a severe political price. The most the authorities can do now is probably to manage its rapid expansion in such a way that will ensure that the interests of the political regime and state security are taken care of first. As Scott Bruce from the Nautilus Institute observed, "The implication is that communication in North Korea has transitioned from a panopticon of total control to a voluntary compliance system where the government makes an example of a select group to try and force the rest of the country to stay in line (like the Chinese do)." Indeed, this is an important change in how the government seeks to control the information flow and behavior of ordinary citizens.

Policy Choices for Domestic Intranet

The DPRK is no longer the hermit kingdom that had the dubious honor of being one of the last countries in the world without Internet penetration. The country is slowly coming out of its pre-digital age, having secured the .kp top-level domain and six assigned Class C Internet protocol (IP) address blocks with 131,072 addresses, and begun to populate it with some of its most prominent propaganda and fund-raising websites. It has long had a nationwide Intranet with a rather sophisticated architecture and the backbone capacity of 2.5 GB per second. The day when the government decides to open the sluice and authorize the wholesale transfer of domestic websites to the national servers connected to the world-wide web, the floodgates will be swung widely open and the Internet boom is certain to unleash.

The DPRK government pioneered the IT field in the period from 1982 to 1990 when it started research and education in computer science at several newly established research institutes under the National Academy of Sciences, Second Academy, and mainline ministries (see Appendix 3), as well as leading national universities including Kim Il Sung University, Kim Ch'aek University of Technology, Pyongyang University of Science, and Pyongyang and Hamhung Colleges of Computer Technology, relying heavily on foreign experts primarily from Japan and the former Soviet Union, as well as built the original manufacturing base in its electronic and automation industries.

From 1990 to 2000, the government stepped up its efforts to upgrade the nation's information infrastructure, train local IT specialists, and develop a localized operational system ("Red Star") and applied software. It inaugurated the Korea Computer Center (KCC) and Pyongyang Informatics Center (PIC) in 1990-1991 as two leading IT bases with the support of the General Association of Korean Residents in Japan (GAKRJ).[93] Since its inception, the KCC, the DPRK government agency designated for the administration and development of information technology in the DPRK, has functioned as one of the general bureaus of the ministry of post and telecommunications, sponsoring computer hardware and software development, doctoral research and training, as well as acting as a trading outpost for IT products and services. Throughout the 1990s, the KCC, PIC, and other advanced research institutes and educational

establishments used the limited resources at their disposal to design the architecture and build private LANs (local area networks), establishing inter-LAN links by dial-up connections using telephone circuits (ppp [point-to-point protocol]). They also resolved the letter code issue in 1997 with the introduction of the "information-exchange-purpose two-byte code for the Korean letters" (National Industrial Standard 9566-97).

Finally, in 1996, the Central Information Agency for Science and Technology (CIAST) of the National Academy of Sciences was authorized to act as the nation's Internet Service Provider (ISP) and stood up a countrywide intranet network called "Kwangmyong"[94] (also known as "Kwangmyong Technology Service Station") connecting all government institutions at the national, provincial, and county levels with industrial factories, banks, transportation units, agricultural cooperatives, institutions of art and culture, S&T and educational institutions, trading companies, and a handful of foreign joint investment ventures.

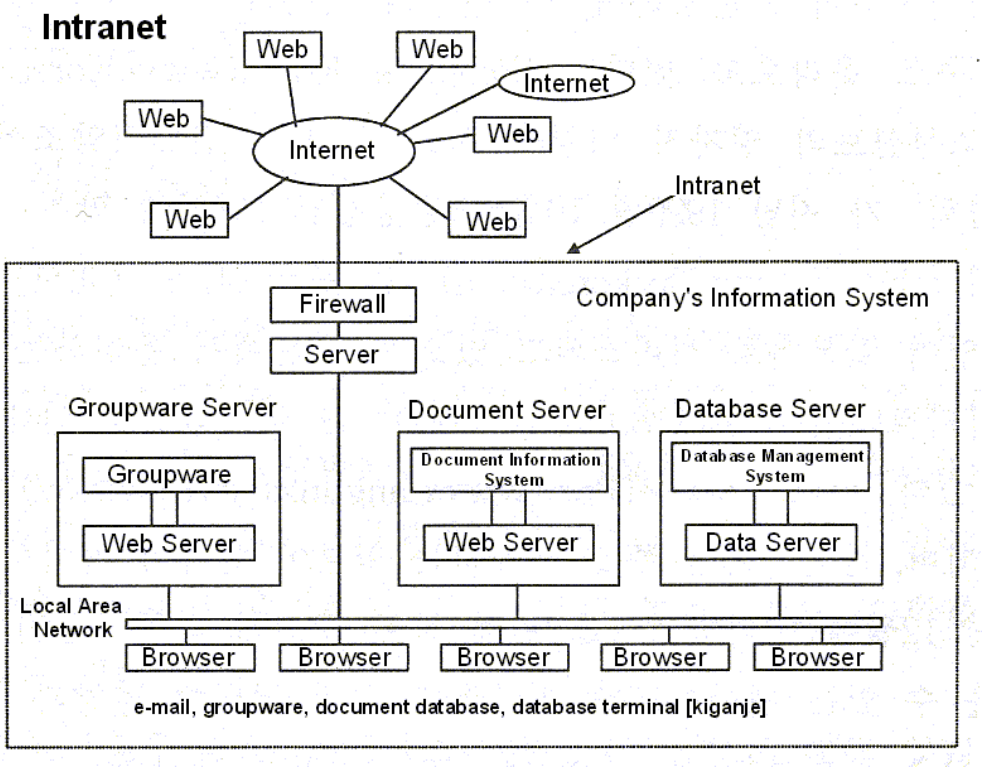

Fig1.North Korea's Intranet[95]

CIAST hosts a composite website complete with such functions as database search, e-mail, electronic news, website search, an electronic library, real-time dialogue in chat rooms, an electronic market, advertising space, and entertainment center streaming movies over a 100 megabit-per-second fiber-optic link to the national intranet.[96] Until recently, "Kwangmyong Technology Service Station" was connected to DPRK-owned servers (silibank.com, chesin.com, kcckp.net) located in the North Korean Ch'ilbosan Hotel in the northeastern Chinese city of Shenyang via the MPT international circuits connecting Pyongyang with Dandong, China, via Sinuiju. The "Kwangmyong" network hosting somewhere from 1,300 to 5,500 homepages of various governmental, corporate, educational, and other entities is still inaccessible to foreigners

and is not connected to the world-wide web yet. Local residents can access it at public e-libraries, internet cafes, and their places of employment on a need to know basis.

On the left: A screenshot of the CIAST website dated 2 September 2002

In the center: A screenshot of the Catalogue of the Ri Dynasty Chronicles digitally stored at the E-Library of Kim Il Sung University

On the right: A screenshot of the official website of Teadonggang Tile Factory hosted on CIAST (with a note from Kaspersky Anti-virus software)

- The Kwangmyong network's data is transmitted via fiber optic cable with a backbone capacity of 2.5 GB per second between the CIAST and all nine provinces. Domestic intranet networks are connected via landlines operated by local telephone bureaus under the MPT. For example, the Pyongyang Telephone Bureau would make a connection with Hamhung Telephone Bureau in Hamhung, and then with a respective local area network. Enterprises and people who subscribe to the "Kwangmyong" network use the method of private-line connection by optical fiber cable (100MB per second), or ADSL (asymmetric digital subscriber line at 8MB), while private households in general use the dial-up ppp (point-to-point protocol) connection method, utilizing the telephone modem. Most of the organizations are satisfied with ADSL. The sign-up fee is free in order to promote the spread of computer networks. ADSL modems are sold at the technical service centers of the MPT International Information Office.
- Pyongyang has the highest concentration of organizations subscribing to the Intranet services, thanks to its modernized network infrastructure. After fiber optic cable networks had been constructed between Pyongyang, provincial capitals, and other major cities by the early 2000s, the wide and local area networks infrastructure in the provinces was modernized, too, opening the possibility for moving beyond the intranet connectivity supported by the ppp (point-to-point protocol) connection using obsolete telephone circuits at best. For instance, South Hamgyong province has about 35,000 organizations, groups, and individuals that subscribed to the "Kwangmyo'ng" network as of around October 2010, according to NKIS reporting.[97]

Starting from 2001, the DPRK entered a period of steady IT growth, which saw its ups and downs, affecting the development of domestic intranet, too. The DPRK government and corporate entities have been building up and upgrading their computer hardware inventories, training thousands of IT specialists, and developing numerous software applications. In mid-2001, the MPT authorized the Korea International Insurance Group (KIIG) to arrange for the international email service between the DPRK and the rest of the world. In September 2001, the KIIG's Science and Technical Service (STS), also known as Technical Service Station 626 and manned by the technicians who had earlier worked at the U'nbyo'l Research Institute, registered

the domain name "silibank.com" in Shenyang, China, and, in December 2001, they started up an international e-mail service "Silibank," which began to serve as an Internet service provider (ISP) for the DPRK's domestic networks and became one of the leading players in the development of the North Korean Internet business and earning foreign exchange for the regime.[98] In addition to providing email exchange services between North Korea and overseas, Silibank servers using Windows 2000 as the operating system and Microsoft-IIS/5.0 as the web server hosted a dozen North Korean websites, including the famous mouthpiece of the WPK CC United Front Department for the anti-South propaganda - http://www.uriminzokkiri.com/ (since 2003).

- Silibank was designed as a cyber post office in charge of providing e-mail relay service in 30-minute intervals using two servers. This was the first time that the DPRK recognized e-mail exchanges, albeit limited, with foreigners. However, a $100 registration fee and expected communication expenses for three months had to be sent in advance and the communication fee was $1.5 (less than 10kb capacity) to $49.5 (more than 1600 kb capacity) per transmission, which was relatively expensive. Therefore, those who are doing business with North Korea, South Korean separated families, who have family members in North Korea, or Koreans living overseas are more likely to use the service than the general public. Since this website can be used in English, Japanese, and Chinese, along with Korean, it is designed to be easily accessed from places where there are many Koreans living abroad such as the United States, China, and Japan.

It goes without saying that the world-wide web access is still severely restricted in North Korea. With a few exceptions, including possibly several hundred elite families, individuals are not allowed yet to have private access to the global Internet. Regardless, the general population does not feel disadvantaged or deprived at not being able to use the Internet because it has very little knowledge of it, and it has never actively used even the intranet. It is safe to say that only the central party, national security units, and some Cabinet-level government organizations, as well as foreign diplomatic missions, joint ventures, and foreign individuals staying in Pyongyang can have "full but monitored" access to the Internet at their workplaces and such international hotels as Koryo, Ryanggakdo, and others.

North Korea's first Internet café, restricted to foreigners, was opened in Pyongyang in May 2002 by Hoonnet, a South Korean firm. Reportedly another such café in Pyongyang was opened by an ethnic Korean Chinese in 2003. In April 2004, the first local Internet café called "High-Tech Service Station" opened its doors in Pyongyang.[99]

- The café reportedly uses 100 Mbps optic cable and telephone lines for transmission. There are conflicting reports as to the price, possibly due to the ongoing inflation and repeated devaluations of the North Korean won. However, an article in South Korea's semi-official news agency Yonhap put the price at 500 won per hour at the time, about one-quarter of the monthly salary of the average worker.

North Korean citizens officially working and living abroad may have Internet access, too. At work – whether it is the DPRK embassy or trade mission or a DPRK-run hotel or restaurant or any other entity - Internet access is obviously limited to official use only, whatever it may be: data mining in foreign open sources, local news monitoring, marketing and advertising of DPRK products and services, hacking, propaganda of DPRK materials, etc. These Internet activities are strictly monitored by in-house information security staff. However, it is reasonable to expect that

when these people leave their workplaces and their residential compounds and go out - especially when and if they can get away on their own - they can theoretically visit public Internet cafes where they would have uninhibited Internet access, depending on the host country's Internet access policy. In this case, their Internet activities will be subject to monitoring only if these people are already followed by the North Korean or local security agents.

According to an interview with Ham Sun-ch'ol, external guidance worker at the Korea Computer Center in February 2001, North Korea had already developed a Korean language input program and translation program, which operated in the Windows 2000 environment, and had completed projects such as large-scale company information structure including the establishment of the Internet and mobile communications, network management machines and Internet service. A 2001 report indicated that North Korea had begun testing a firewall between the "Kwangmyong" Network and the Internet in order to screen and restrict information flows in both directions. According to Ham, "North Korea has already completed all technological preparations for accessing the Internet and is only waiting for an order from the General."

But the General's order has not arrived in almost a decade. Moreover, in the wake of the Ryongch'on train explosion in April 2004, the government at least temporarily disabled both access to the world-wide web via the Silibank and domestic intranet connections centered on the Kwangmyong network. Its initial encounter with ICANN on October 22, 2004 - a letter from the Permanent Mission of the DPRK to the United Nations, signed by Ambassador Han Song-ryol and informing ICANN that the "Korea Computer Center is assigned as the national network center and authorized to manage "KP" state domain by the government of the DPRK" - was not supported by any further documentation and died on arrival.[100]

- On May 22, 2006, ICANN received a letter from Jan Holtermann of the Korea Computer Center Europe (KCCE) in Berlin, Germany. The letter indicated that the DPRK government would be requesting the delegation of the .KP top-level domain. The letter went on to explain that the KCCE is an affiliate of the Korea Computer Center (KCC) in Pyongyang, DPRK, and that the KCCE will act as their official representative in the delegation matter "due to the difficult communication situation between North Korea and other countries."
- On July 31, 2006, ICANN received a letter from the Permanent Mission of the DPRK to the United Nations. The letter stated that the DPRK government has designated the KCC to manage the .KP country code top-level domain. On August 22, 2006, ICANN received a letter from the KCC, signed by Director Kim Chang Ryop. The letter requested that ICANN pursue the next step in the delegation process and referenced the government letter authorizing KCC as the administrator of the .KP top-level domain. On August 30, 2006, ICANN received the same delegation request lodged via the IANA ticketing system. Upon initial review of the request, IANA staff provided the requestors with detailed instructions on the delegation process and requested additional supporting documentation. In accordance with standard procedure, the request was administratively closed on December 1, 2006 after the requestors did not provide the necessary documentation within the specified timeframe.
- The DPRK government resubmitted the request for the delegation of the .KP top-level domain to ICANN on January 26, 2007. Initially, there was a misunderstanding about why the previous request was closed. IANA staff explained that it was following its normal process for closing the request after 30 calendar days if the requested information

had not been tendered. The supporting documentation for the current request was submitted on February 15, 2007. A delegation from KCCE, the proposed technical contact, visited the ICANN Offices on May 13, 2007. They were informed of the delegation process, and that the materials submitted in connection with the previous application were currently under staff review. The delegation was advised that if further documentation or information were needed from the applicant, they would be advised. The request sought the delegation of .KP top-level domain to the Government of the DPRK represented by the Korea Computer Center in Pyongyang, DPRK. It was proposed that Kim Chang Ryop, Vice President of Korea Computer Center, fill the administrative contact role, and that Jan Holtermann of KCC Europe GmbH fill the technical contact role. The documentation provided in support of the delegation request included an endorsement letter from the Permanent Mission of the DPRK to the United Nations, detailed information about the proposed sponsoring organization (KCC), policy and rules that have been established for managing the .KP top-level domain, and a description of the technical structure for operating the domain. On September 11, 2007, the Board of ICANN passed the resolution approving of the delegation of the .KP domain to Korea Computer Center. Prior to that, the .KP country code had never been delegated in the DNS root zone.

By 2008, North Korea had succeeded in consolidating security solutions for the prevention of online leaks of data to foreign countries and for the prevention of online intrusions, as well as made significant progress in enhancing service stability.

In 2009-2010, the North Korean IT-related trading companies procured dual-use equipment for the Internet-based servers, routers, and relay systems (Internet-enabling gear), evading US export administration regulations, by relying mostly on China's Huawei Group to the chagrin of the South's Korea Telecom.

For many years, North Korea worked with China to develop firewall systems that would permit less-restricted access to the world-wide web while allowing officials to proscribe content in order to prevent spiritual pollution. It appears that in 2010, the government overcame its inhibition: "After watching how effectively China and Vietnam could control the Internet for many years despite the fact that they opened up Internet wireless networks long time ago, the North has concluded that it can now introduce the Internet service without much threat to its internal security," according to Kim Sang-myung, Director of the North Korea Intellectuals Solidarity, a group of former North Korean professionals.[101]

- In 2010, the DPRK Post and Telecommunications Company reportedly signed a memorandum of understanding with China Telecom on expanding Internet connectivity between the two countries and bilateral cooperation in monitoring and providing security solutions for the Internet services.[102]

This notwithstanding, in 2010, the authoritative name servers for the .KP became completely lame, effectively stopping the top-level domain from operating.[103] Korea Computer Center reached out to KCC Europe (KCCE), its Germany-based technical registry provider, to have service reinstated. After several months without response, Korea Computer Center terminated KCCE's agreement to operate the .KP domain. KCC Europe was dissolved on January 31, 2011.

In the meantime, the Korean Post and Telecommunications Corporation of the DPRK Ministry of Post and Telecommunications and Thailand's Loxley Pacific Company Ltd. established the

Star Joint Venture Company in late 2010 with a charter to establish modern Internet services and to develop the requisite infrastructure in the DPRK to support operation of the .KP top-level domain. In December 2010, both the DPRK MPT and KCC endorsed the transfer of operation of the domain and a change of the nameserver records for the .KP from Korea Computer Center to Star Joint Venture Company, thereby restoring the functionality of the .KP top-level domain and designating Kang Yong Su, the President of Star Joint Venture Company, as the administrative and technical contact for the .kp domain, in a letter of authorization transmitted to ICANN jointly by Ryu Yong-sop, the Minister of Posts and Telecommunications, and Han U-ch'ol, the Director-General of the Korea Computer Center. The address and contact details of Star JV Company are the same as those of the international relations department of the DPRK's Ministry of Posts and Telecommunications residing in Potonggang2-dong, Potonggang District, Pyongyang.

ICANN Staff assessed the request, and the ICANN Board of Directors passed the resolution deciding to redelegate the .KP domain, a country-code top-level domain (ccTLD) representing the DPRK, to Star Joint Venture Company. The dot-kp domain was officially transferred on May 2, 2011to Star Joint Venture, which has been in de-facto control of the domain name since December 2010. The first websites (kcna.kp) began using North Korean domain names on January 3, 2011, when the main record for all the .kp names was updated.

This means administrative control for the KP domain now rests with Star JV. Star took control of North Korea's Internet address space in 2010 and has been building up the North Korean Internet ever since. It uses the IPv4 Internet layer protocol. Star JV has also been designated as the provider of the national Internet technical registry.

So far, Star JV has registered seven .kp top-level domains, including net.kp, gov.kp, rep.kp, co.kp, com.kp, edu.kp, org.kp, and prepared one unregistered domain tra.kp, with each of them having at least two nameservers.

The DPRK has been assigned several Class C Internet protocol (IP) address blocks with 131,072 addresses: 46.36.196.71 - 46.36.196.80; 67.43.236.32 - 67.43.236.39; 175.45.176.0 - 175.45.179.255; 193.220.157.32 - 193.220.157.47; 209.28.38.0 - 209.28.38.7; 1.11.0.0 - 1.11.255.255.

One can enter the first three sets of numbers into the robtex site, and see what is registered on that block. http://www.robtex.com/cnet/67.43.236.html shows virtualife.com.br at 67.43.236.34 to be the only registered site in the Korean part of that address block. Notice this isn't a .kp domain name. http://www.robtex.com/cnet/175.45.176.html has a lot more registered domain names, most of them .kp names. Of particular interest are the new websites registered by Star JV in the .kp domain, including kcna.kp, kptc.kp, kcce.kp; rodong.rep.kp, vok.rep.kp; naenara.com.kp, friend.com.kp, korfilm.com.kp; star.co.kp; silibank.net.kp, star-co.net.kp; korelcfund.org.kp, koredufund.org.kp; star.edu.kp, lib.ms.edu.kp; and so on.

The Internet monopoly concession for Loxley in the form of Star JV with the MPT is the North Korean payoff to the Thais (resurgent Thaksin, to be more specific) for the abandoned mobile phone network and Loxley's lost investments in the DPRK in 1998-2004. The bigger picture is that Orascon won the cell phone network monopoly, whereas Loxley belatedly was awarded with the Internet access monopoly as a consolation prize. Running the North Korean Internet can become a very lucrative business once the top political leadership decides to make a leap of faith

and authorize the wholesale transfer of the CIAST-hosted websites to the Star JV network connected to the world-wide web, and this day is rapidly approaching.

Role of Foreign Partnerships in DPRK's IT Revolution

Despite its policy and rhetoric of self-reliance, North Korea learned and borrowed a lot from the IT developments in foreign countries, exploiting the expertise and resources of foreign IT specialists and companies. Skillfully crafted selective foreign partnerships, especially with Japan and China, helped the DPRK by-pass the IT-related restrictions imposed by various international embargoes and significantly undermined the long-term effectiveness of international sanctions.

The Korean-Japanese IT businesses left lasting legacy in the original introduction of IT products and concepts in North Korea in the 1980s – early 1990s. According to Ri Sang-ch'un of the Computer Technical Committee of the KAST, in its early days, the Korean Computer Center (KCC) received all-out support from the General Association of Korean Residents in Japan (GAKRJ) in acquiring its original facilities, computer equipment, and most of the technical data. The key technical personnel at Korean Computer Center and Pyongyang Informatics Center (PIC) were returnees from Japan and their children, and their relatives and friends in Japan provided them with up-to-date materials in active support of their work. Ch'oe Yo'ng-pan, a Korean-Japanese computer scientist from Tokyo played a leading role in the establishment of PIC. In addition, all GAKRJ-affiliated organizations were required to purchase the PIC-developed Korean-language, thereby financing its initial operations, and such jobs as *karaoke* program and business system developments were outsourced to Koreans in Japan. Also, Korean residents in Japan provided significant assistance for the maintenance and operation of the newly opened computer short-course facilities.[104]

As shown above, the telecommunications companies from several newly industrializing countries like Thailand and Egypt helped the DPRK learn from global IT market experiences and gain exposure to their competitive telecom management practices in the late 1990s-2010s.

More recently, some North Korean academic institutions and economic organizations have sought to learn U.S. best practices in design, development, security assurance, and integration of various complex IT systems. For instance, Kim Ch'aek University of Technology has a number of joint collaborative projects in the IT field with the Syracuse University of New York. Last March, a 12-member economic delegation from the DPRK toured Qualcomm (whose technology is widely used in the South) and the Google headquarters in Mountain View, CA, revealing considerable interest in Google's search engine technology, and held an instructional seminar with staffers from several IT companies in Silicon Valley.[105] Obviously, U.S.-DPRK IT cooperation is severely hampered by U.S. sanctions and embargoes and is unlikely to expand any time soon.

One can no longer ignore the fact that South Korea rapidly loses its language-based competitive advantage in North Korea, as Pyongyang seeks to replace the digital divide between the two Koreas with the digital firewall based on advanced information control and monitoring technologies. Seoul still possesses the capital and technological edge, but Pyongyang is beginning to mount a comeback, threatening not to collapse but to bandwagon with China's digital juggernaut and catch up with the digital revolution in the South one day.

But, it was China that made the most significant contribution to the DPRK's IT development. China offered the "role model" of successful IT development and played the role of the leading foreign supplier of the telecommunications hardware and software matching the North's specifications and requirements during the early growth phase of the DPRK's IT sector.

Learning From China How to Build Hardware and Develop Software

Kim Jong Il's three visits to China – in January 2001, January 2006, and May 2011 - led to major advances in the DPRK's IT hardware production and software development. Following Kim's guidance, the North Korean government adopted the "Chinese model" of IT development to some extent and imported some key Chinese information technologies and products for over a decade.

In January 2001, Kim Jong Il toured Chinese Silicon valley in Pudong (Shanghai), familiarizing himself with some leading Chinese IT enterprises and their state regulators, and discussed opportunities for Chinese foreign direct investment in the DPRK's IT sector, reportedly hoping to learn Chinese experience in how to build a high-tech city. Subsequently, after he returned home, Kim instructed his government to redouble its efforts to advance the IT sector by importing more advanced Chinese technology.

- First, he visited Shanghai Huahong NEC Electronic Co., one of Mainland China's leaders in the field of semiconductor manufacturing and IC foundry service.[106,107,108] It is noteworthy that in 2006, the DPRK government announced that during the Second Five-Year Plan for Development of Science and Technology in 2003-2007, "the IC (integrated circuit) designing technology was put on a high level, the Korean-style computer-operating system and nanotechnology-based equipment developed." Reportedly, the North Korean IC designing technology reflects considerable Chinese influence.
- Second, Kim also inspected Shanghai Bell Co.,[109] 50% owned by the Chinese government, one of Mainland China's leaders in the field covering switching networks, mobile telecommunication networks, data communication networks, transmission networks, network applications, and multi-media terminals.[110] It is noteworthy that in the following two years, the DPRK introduced S-1240 switchboards produced by Shanghai Bell Co., and the "Pyongyang Telecommunications Equipment Plant began producing automatic switching gear in August 2003," according to Marcus Noland.[111] Subsequently, automated exchanges assembled with the Shanghai Bell cooperation replaced manual switching systems in almost all 180 plus cities and counties and at over 2,200 lower-level telephone branch stations.
- Finally, Kim toured Zhangjiang Hi-Tech Park,[112, 113] the PRC's integrated circuit industry base, national software development base, and biomedicine base, where he inspected a Software Development Institute (likely Huawei Shanghai Research Institute) and Human Genome Research Institute.[114] Following the visit, Kim Jong Il gave guidance, while inspecting Kim Ch'aek University of Technology on September 20, 2001, "to set up program development centers for new operating system (OS) of Korean style at Kim Il Sung University, Kim Chaek University of Technology, the University of Science, Pyongyang University of Computer Technology and program education centers under the ministry of education, as well as to establish research rooms and research groups, if

necessary, at some universities and scientific research institutions participating in the development of applied program to be used in OS."[115]

In January 2006, Kim Jong Il toured Chinese IT hubs in Hubei and Guangdong provinces, including China's Optical Valley in Wuhan, and inspected half a dozen Chinese IT enterprises.

- First, Kim visited Changfei Optical Fiber and Optical Cable Company, the No.1 company in the China optical fiber and cable market and now among the top 3 suppliers globally, where he was briefed by company executives on "the history, state of production, and prospect of development of the company." Carefully looking around the production processes one by one, Kim scrupulously acquainted himself with the state of facilities, number of products, and even the production capacity of the company.[116] Soon afterwards, the DPRK began to upgrade its optical fiber cable network with more advanced Changfei cables.[117]
- Second, he inspected Fenghuo Communications Co., Ltd., one of the largest Chinese state enterprises focused on communication equipment for government use, including tactical military communications satellites, and one of the leading providers of mobile phones in China.[118,119] Three years later, the DPRK's Ministry of Post and Telecommunications began to produce communication equipment for government use with the technical assistance from Fenghuo Communications Co., and North Korea's Chek'om Technology JV Co. began to produce cellular phones in 2010, using the Fenghuo technology.
- Third, Kim visited Guangdong Weichuang Rixin Electronics Company, China's premier manufacturer of consumer electronics, including screen projection wall panel systems; signal processors; projection signal control software; LCD TVs, LED TVs, display shells, and CRT monitors.[120] That visit led to a major overhaul of the Chosen Soren-built Taedonggang TV Factory in Pyongyang, which was reconstructed on an expansion basis in 2009-2010 and now produces LCD TVs and other electronic goods, using Chinese technology.
- Fourth, Kim inspected the Software Development Centre of Industrial and Commercial Bank of China, one of the leading developers of software for payment settlement agency services, including All-functional Banking System, Centralized Data Center Mode, Real-time Clearing System, Electronic Exchange service, Internet banking, SWIFT-PCC System, etc.[121] This visit revealed North Korea's interest in computerizing its national banking system, developing its own electronic payment settlement system and electronic commerce in its domestic Intranet.
- Fifth, Kim's visit to Eastcompeace Smart Card Co., Ltd., a leading developer, manufacturer, and supplier of smart card products, read and write terminals, application tools and system solutions for Telecommunications, Payment, Identity, Transportation, Security and other application sectors, as well as manufacturer of SIM cards of different sizes for GSM, CDMA, CDMA2000, TD-SCDMA, WCDMA and other mobile telecommunications network operators, turned out to be the harbinger of the development of SIM card technology for Koryolink by the DPRK's mobile telecommunications network operator three years later.[122,123]
- Finally, Kim toured Huawei Technologies, the largest networking and telecommunications equipment supplier in China headquartered in Shenzhen and the second-largest supplier of mobile telecommunications infrastructure equipment in the world.[124] In 2008, the DPRK Ministry of Posts and Telecommunications and Orascom used the Huawei equipment to build mobile telecommunications towers for the nationwide launch of Koryolink.

In May 2011, Kim Jong Il's tour of several Chinese IT manufacturers reflected the growing sophistication and changing priorities of the DPRK's IT sector, namely IT systems integration and re-orientation of IT hardware production from industrial focus towards consumer demand.

- First, Kim inspected Beijing Shenzhou Digital Company,[125] a leading integrated IT services provider in China focusing on eight major business segments in the Chinese market, including IT Planning, Business Process Outsourcing, Application Development, System Integration, and so on.[126,127] This visit in particular highlighted the DPRK's new interest in integration of IT services across different platforms and systems and in hardware infrastructure services and maintenance, hardware installation, distribution, and retail.
- Second, Kim's visit to Shenzhou Shuma, an IT services provider, an affiliate of Lenovo, China's largest computer equipment producer, in the Shangdi District of the Zhongguancun science park, China's Silicon Valley, in Beijing, demonstrated "Kim's keen interest in Internet equipment," according to the company's employees.[128]
- Finally, Kim toured Nanjing Panda Electronics, a large state-owned comprehensive electronics enterprise manufacturing LCD TVs, color TVs, washing machines, water dispensers, digital photo frames, as well as mobile phones and datacards, digital A/V, set top boxes, administrative software and electronic instruments, etc.[129] In May 2002, China's Nanjing Panda Electronics Co. and Electronic Products Development Company of the DPRK Ministry of Electronics Industry entered into partnership, an investment totaling USD 1.3m, and established a joint venture Morning-Panda Computer Co. to assemble tens of thousands of computers per year for local distribution.[130] Kim's goal was to see how the successful model of Panda Electronics operations in assembling personal computers in Pyongyang could be extended to other types of consumer electronics.

Implications of DPRK's IT Growth for International Cooperation

Bearing in mind multi-layered restrictions imposed by national trade embargoes and international sanctions against Pyongyang, Western businesses and governments can try to cautiously exploit the emerging opportunities and reduce the risks in dealing with the DPRK's IT sector.

1. Western software firms can outsource software development (corporate database management, video games, cartoons, etc.) to the DPRK firms, taking into account the past experiences of the EU (Nosotek) and ROK firms operating in China (Hanabiz.com and Samsung).
2. International organizations focused on IT (IANA, APNIC, ITU, etc.) and academic institutions (Syracuse University) can try to extend the international standards and share best practices with their North Korean counterparts in order to influence the DPRK's IT developments and policy-making process.
3. Western IT hardware manufacturers can participate in the modernization of the DPRK's landline and satellite telecommunications networks by providing technical assistance in upgrading the obsolete equipment and improving connectivity and the quality of voice signal and data transmission countrywide.
4. Western governments and non-governmental organizations concerned can try to reach out directly to the growing number of the North Korean IT users and broadcast desirable content by penetrating or circumventing the DPRK's IT firewalls.

- In the past, short-wave radio broadcasts and leaflets were used to deliver the anti-regime content directly to the DPRK population as part of the psychological warfare waged against Pyongyang, but with little practical effect.
- Today, thanks to the digital transformation taking root in the North, foreign civil society organizations and NGOs interested in reaching out to the North Korean people can deliver a wide range of multimedia content including movies, documentaries, electronic books and journals, animation, study programs, games, electronic dictionaries, albums, electronic maps, etc., using various voice and visual information carriers ranging from radio broadcasts, to CDs, DVDs, tapes, USBs, MP3s, flash drives, and PMPs. For details, one can read a recent study on official media and Western media influence in the DPRK prepared by North Korean Intellectuals Solidarity, a Seoul-based research organization founded by North Korean defectors with university degrees.[131] These efforts have the potential to affect popular tastes, attitudes, beliefs, and even values, causing some changes in the day-to-day lives of the North Korean people. But, their possible impact on political behavior remains uncertain: they have failed so far to produce any observable elite or public pressure on the political regime to change.
- With respect to the North Korean users who do have full access to the Internet, Chinese experience may be very instructive: by definition, such users can search and retrieve any public information of their choice from the world-wide web, while any attempts to push the desired content into their inboxes and homepages are likely to be futile because of self-censorship and the built-in filters and firewalls.
- The use of satellite television broadcasting to beam the desired programming inside North Korea is highly problematic at present because satellite TV is still very rare and limited mostly to a few international hotels where guests can watch BBC, Japan's NHK, China's CCTV-2, CCTV-4, CCTV-9, Russia's NTV, DTV, and Zvezda channels, as well as to diplomatic compounds, and a small number of elite residences. But, even if one day it does become widely spread and easily accessible, the experience of other authoritarian regimes like China, Vietnam, Turkmenistan, Belarus, and others, demonstrates that host governments can easily adopt a wide range of rather productive counter-measures through technical innovation, education and propaganda, cultural entertainment, peer pressure and law enforcement to dampen, mitigate, and resist its subversive influence.

5. The DPRK government has a long history of engaging in varied and illicit commerce. Some Western observers have expressed concerns that as its Internet capability expands, the DPRK may become a location for servers hosting child pornography and/or gambling websites as a way of making money, as well as increasing its capabilities in cyber warfare.

Appendix 1. The North Korean Website List[132]

Websites based in North Korea:

Site[133]	Name	Server[134]	Blocked[135]	Description
 http://www.star.co.kp/	Star JV		No	Star JV is the DPRK-Thai joint venture that runs North Korea's Internet connection.
 http://www.kcna.kp/	Korea Central News Agency		Yes	Korean, English, Spanish and Japanese-language news from North Korea's state-run news agency.
 http://www.naenara.com.kp/	Naenara		Yes	Multi-lingual website from Pyongyang's Korea Computer Center.
 http://www.rodong.rep.kp/	Rodong Sinmun		Yes	Home page of the newspaper of the Central Committee of the Worker's Party of Korea.
 http://www.vok.rep.kp/	Voice of Korea		Yes	International shortwave broadcaster
	Friend		Yes	Website of North Korea's Committee for Cultural Relations with Foreign Countries

http://www.friend.com.kp/ email: dmw@star-co.net.kp				
 http://www.koredufund.org.kp email: kef@star-co.net.kp	Korea Education Fund		Yes	Website of North Korea's Korea Education Fund
 http://www.korelcfund.org.kp/ email: k-elderlyfund@star-co.net.kp	Korea Elderly Care Fund		Yes	Website of North Korea's Elderly Care Fund
 http://www.ksf.org.kp Email: ksf@star-co.net.kp	Faster Korea		Yes	Information on sports in the DPRK from the Korea Sports Fund
	Chosun Expo		No	Online mall with many North Korean products
	Pyongyang International Trade Fair		Yes	Pyongyang International Trade Fair website. Not updated since 2009
	Cholsan Patent and Trademark Agency		Yes	One of Pyongyang's several patent and trademark agencies

	Koryo PAT Rainbow		Yes	One of Pyongyang's several patent and trademark agencies
http://www.korfilm.com.kp/ email: korfilm@star-co.net.kp	Korea International Film Festival		Yes	Official Site of the Korean International Film Festival and the DPRK's Movie Industry

Major websites based outside of North Korea:

Site	Name	Server	Blocked	Description
	Uriminzokkiri		Yes	Korean-language web site carrying news and information from Pyongyang. Included are domestic KCNA and newspaper articles from Pyongyang. The site is hosted in China.
	Our Nation School ("Kim Il Sung Open University")		Yes	Juche teachings from the same group responsible for Uriminzokkiri.com (see above)
	Ryugyong Clip		Yes	Video and still images from Pyongyang
	Ryomyong		Yes	Books and music from North Korea
	Korea Publication		Yes	Books, DVDs and stamps from North Korea

	Chongryon		Yes	General Association of Korean Residents in Japan
	Korea News Service		Yes	Korean, English and Spanish language news from Korea's state-run news agency. This site is run by the General Association of Korean Residents in Japan and is better organized than the DPRK-based site listed above.
	Korea Photo Service		No	KCNA's photo news service, made available to publishers via Tokyo. Run by the General Association of Korean Residents in Japan
	Choson Sinbo		Yes	Korean-language newspaper published in Japan by the General Association of Korean Residents in Japan. Back issues of the discontinued English-language Korea News are also available.
	Elufa		Yes	Korean-language video portal notable for carrying the evening KRT News bulletin most days. Provided by the General Association of Korean Residents in Japan
	Pyongyang News		Yes	Korean-language news site with bulletins from DPRK-based sources. Provided by the General Association of Korean Residents in Japan

	League of Korean Youth Living in Japan		Yes	Group homepage
	Minjok Tongshin		Yes	Korean and English-language news about North Korea. English articles are mostly culled from other media.
	Tong Il Han Ma Eum		Yes	Korean-language site with news from Tokyo's Association of Peaceful Reunification of the Motherland.
	National Democratic Front of South Korea		Yes	Korean-language news from the Tokyo branch of the National Democratic Front of South Korea.
	Anti-Imperialist National Democratic Front		Yes	Anti-Imperialist National Democratic Front, banned in South Korea. Supposedly from Tokyo.

North Korean companies

Site	Name	Server	Blocked	Description
	Nosotek		No	DPRK/German software outsourcing joint venture
	Oun Patent Attorneys		No	Pyongyang-based patent attorneys
	Taedonggang Patent & Trademark Law Office		No	Pyongyang-based patent attorneys

	PyongSu Pharma		No	Joint venture pharmaceutical manufacturing company
	Air Koryo		No	Air Koryo home page hosted by the Korean Friendship Association.
	Pyeonghwa Motors		No	South Korean / North Korean joint-venture auto company
	Phoenix Commercial Ventures		No	Pyongyang-based business consultancy
	Daedong Credit Bank		No	Pyongyang-based bank
	Korea Computer Center Europe		No	European outpost of Pyongyang's Korea Computer Center. Possibly defunct.

North Korean business-related

Site	Name	Server	Blocked	Description
	European Business Association in Pyongyang		No	Member listing of the European Business Association in Pyongyang
	Korea Business Consultants		No	Beijing-based business consulting company specializing in DPRK

	GPI Consultancy		No	Rotterdam-based outsourcing consultancy with specialist knowledge on DPRK

North Korean education

Site	Name	Server	Blocked	Description
	Pyongyang University of Science and Technology		No	Pyongyang University of Science and Technology
	Pyongyang Business School		No	Pyongyang-based international business school

Other websites based outside of North Korea:

Site	Name	Server	Blocked	Description
	Koryo Tours		No	Experts on travel to the DPRK
	Pyongyang Painters		No	Paintings from North Korea
	DPRK Expo		No	DPRK Expo online shopping site
	Mansudae Art Studio Gallery		No	Italian-based international agents for the Mansudae Art Studio. Art works can be bought online and shipped worldwide from Italy.

	Korean Friendship Association		No	Website of Spain-based Korean Friendship Association (KFA)
	North Korea Books		No	Online bookstore carrying North Korean books and magazines

Discontinued or unavailable websites

Site	Name	Server	Blocked	Description
	LRIT Data Center			Maritime Long Range Identification and Tracking system data center website. Possibly test site.
	Air Koryo		No	Air Koryo home page, Neglected, broken and unused.
	Pyongyang International Film Festival		No	Pyongyang International Film Festival. Last updated in 2008

Appendix 2. Table of Operational Joint Ventures in the DPRK's IT Sector

JV Company	DPRK Partner	Foreign Partner	Products & Services	Ownership Stakes[1]	Date Established
Ch'ek'om Technology JV Co.[136]	Ministry of Posts and Telecom	Orascom	3G Mobile telecom network	75/25	Jan 2008
Star JV Co	Ministry of Posts and Telecom	Loxley Pacific	Internet infrastructure		Sep 2010
NEAT&T JV Co	Ministry of Posts and Telecom	Loxley Pacific	Legacy mobile phone network in Rason	70/30	1995
Achim-Panda JV Co	Ministry of Electronics Industry	China's Panda Electronics Group Co., Ltd	Computers & accessories	unknown	Sep 2002
Korea Hana Electronics JV Co	Ministry of Culture	Phoenix Commercial Ventures Co.	VCD and DVD players, VCD and DVD disks, TV sets and amplifiers	50/50	March 2003
Nosotek JV Co	General Federation of Science and Technology of DPRK	Next Generation Entertainment N.V.	Software development for overseas customers	unknown	Aug 2009

[1] The first percentage belongs to the foreign partner, the second – to the DPRK side.

Appendix 3. List of Research Institutes in the DPRK's IT Field

Institution Name	Main Functions
DPRK Automation Institute	specializes in developing robots and numerical control devices and realizing CAD/CAE/CAM
DPRK Electronic Materials Institute	application of magnetization processing technology to on-site production, research on development of world-standard compound semiconductor crystals, thin-layer development that can produce laser semiconductors and microwave devices, and studies how to intensify the integrated circuit industry
DPRK Electronics Institute	R&D on semiconductors, optical materials, and LCDs
DPRK Integrated Circuits Institute	R&D on integrated circuit technology and industry
DPRK Information & Communications Institute	R&D of telecommunications technologies and equipment (for instance, multifunctional internal switchboards, application of synchronous digital transmission method, etc.)
DPRK Institute of Computer Science	R&D of computer systems, such as parallel adder, and OS [operating system]
DPRK Institute of Information Communication	R&D of telecommunications and broadcasting equipment
DPRK Weak Current Engineering Institute	R&D on weak current issues
DPRK Research Institute No. 110	R&D of cyber warfare capabilities
Kusŏng Electronic Warfare Institute	R&D of EW concepts, methods, and equipment
DPRK Mathematics Institute	Applied software research

Appendix 4. List of DPRK IT Enterprises

IT Sector	Company Name	Main Line of Business	Subordination
IT Hardware Manufacturing	Pyongyang Optical Fiber Cable Factory	Optical fiber cable manufacturing	Ministry of Post & Telecom
	Wŏnsan Communication Cable Factory	Communication cable manufacturing	Ministry of Post & Telecom
	DPRK Electronic Goods Development Company	IT products development & manufacturing	Ministry of Electronics Industry
	Pyongyang Semiconductor Factory	Semiconductor manufacturing	Ministry of Electronics Industry
	Pyongyang Integrated Circuit Factory		
	Hamhung Semiconductor Materials Factory		
	Haeju Semiconductor Factory		
	Pyongyang Communication Machinery Factory	Communication machinery manufacturing	Ministry of Post & Telecom
	Kanggye First Communication Machinery Factory		
	Anju Communication Machinery Factory		
	Kaesŏng Communication Machinery Factory		
	Namp'o Communication Machinery Factory		
	Kilchu Disabled Solders Communication Machinery Factory		
	Pakch'ŏn Communication		

	Machinery Factory		
	Sŏnggan Communication Machinery Factory		
	Pongsan Automation Instrument Factory	Automation instrument manufacturing	Ministry of Electronics Industry
	Okryu Automation Instrument Factory		
	October 5 Automation Instrument Factory		
	Moranbong Automation Instrument Factory		
	Madong Hamhŭng Automation Instrument Factory		
	Hamhŭng Veterans Automation Instrument Factory		
	Taean Automation Parts Factory		
	Teadonggang TV Factory (May 11 Factory)	TV manufacturing	Ministry of Electronics Industry
	Wonsan Television Assembly Factory		Ministry of Electronics Industry
	Aeguk Television Assembly Plant		Ministry of Electronics Industry
	Meari Company Limited	Audio-visual equipment manufacturing	Ministry of Culture
	Mokran Video Company	DVDs, CDs	
	Computer Factory of DPRK Ministry of Railways	PC assembly	Ministry of Railways
IT Service Enterprises	Korea Computer Center	Software development	Ministry of Post & Telecom
	Pyongyang Informatics Center	Software development	Ministry of Post & Telecom

	Pyongyang High-Tech Service Station	electronic goods sales, internet cafe management, software development	
	Miraetech Company	Software development	
	Pyongyang June 15 Information Technology Company	Ryŏmyŏng website management	National Reconciliation Council
	Pyongyang Kwangmyŏng Technology Service Station	Kwangmyong network management	CIAST of National Academy of Sciences
	Silver Star Laboratories	Software development	Korea Ŭnbyŏl General Trading Corporation
	Taehung Information Center	Software development	Korea Taehŭng General Corporation
	Uriminzokkkiri Computer Company	Uriminzokkkiri website management; software development	Committee for Peaceful Reunification of Fatherland
	Technical Service Station 626	ISP for Silibank	Korea Insternational Insurance Group
	Chagang Provincial E-Business Institute	Business systems software development	
	South P'yŏngan Provincial E-Library		
	Koryolink	Mobile telecom carrier	JV of KPTC & Orascom
	SEK Company	Animation software	
IT Trading Companies	Korea Post and Telecommunications Trading Company	imports Communication Equipment, Switching & Transmission Equipment, Equipment for Relay Stations, Materials for the Production of Optical Fibers	Ministry of Post & Telecom
	Korea General Information Technology Industry Corporation	IT Products (Equipment, Software)	Ministry of Post & Telecom
	Korea Jinŭng Trading	Exports computer	

	Corporation	software; Imports electronic products	
	Korea Namsanjae Trading Corporation	Exports: Multimedia programs, programs for the retrieval of databases, programs for computer network, communication and security Imports: Computer accessories, office supplies	
	Korea Saenal Technology Trading Corporation	Outsources IT Programming & Services	
	Korea Ch'olsan Technology Trading Corporation	imports Computer Equipment & Accessories	
	Korea Paekho Trading Corporation	Exports Audio & Video Cassettes, CDs. DVDs, Equipment for film-making	
	Korea Paekma Trading Corporation	imports Printers & Spare Parts, Printing Paper	
	Korea Samkwang Trading Corporation	imports and exports TV Sets, Computers & Parts	
	Sinhung Company	imports Computers & Accessories, Software, Network Equipment	Korea Computer Center

Appendix 5. List of DPRK Universities and Specialized Colleges Offering IT Training

Name of Educational Institution
Kim Ch'aek University of Technology
Pyongyang College of Computer Science at Kim Il Sung University
Pyongyang University of Automation (former Mirim College)
Pyongyang University of Science and Technology
Pyongyang University of Computer Technology
Hŭich'ŏn University of Communications
Hamhŭng University of Computer Technology
Hamhŭng College of Electronics and Automation
Ch'ŏngjin College of Information Technology
Sariwŏn Specialized School of Electronic Automation
Kim Hyŏng-gwŏn Military Academy of Communications Men

[1] P'yongyang *Rodong Sinmun* in Korean 25 Aug 03 p 2
[2] "Kim Jong-il Thinks Computer Illiterates Fools: Weekly," Digital Chosun Ilbo, Seoul, 5 February 2007, http://english.chosun.com/w21data/html/news/200702/200702050019.html
[3] Jong-Heon Lee, S. Korea Eyes North's Mobile Market, UPI, Seoul, 6 June 2002, http://www.upi.com/Business_News/2002/06/06/SKorea-eyes-Norths-mobile-market/UPI-64361023372857/
[4] Pyongyang Rodong Sinmun (Electronic Edition) in Korean 12 Mar 11; Special article by Kim So'ng-ryong: "Superiority of Socialism of Our Style and the Development of the Information Industry"; Description of Source: Pyongyang Rodong Sinmun (Electronic Edition) in Korean -- Daily of the Central Committee of the Workers Party of Korea; posted on the Korean Press Media (KPM) website run by the pro-Pyongyang General Association of Korean Residents in Japan; URL: http://dprkmedia.com
[5] Pyongyang *Korean Central Broadcasting Station via Satellite* in Korean 10 Mar 11 - 11 Mar 11
[6] KCNA, 11 March 2006
[7] National seminar on era of information industry, KCNA, May 6, 2001
[8] Jong-Heon Lee, S. Korea Eyes North's Mobile Market, UPI, Seoul, 6 June 2002, http://www.upi.com/Business_News/2002/06/06/SKorea-eyes-Norths-mobile-market/UPI-64361023372857/
[9] Seoul *Hangyore (Internet version-WWW)* in Korean 0940 GMT 02 Aug 02; Article by correspondent Ha Song-pong from Dandong: "'IT Industry at Center of North Korea's Economic Reform'"
[10] "Rodong Sinmun on Informationalization of National Economy," KCNA, 11 March 2006, http://www.kcna.co.jp/item/2006/200603/news03/13.htm#14
[11] Pyongyang *Kyo'ngje Yo'ngu (Electronic Edition)* in Korean 20 Nov 10 pp 10-12; Kyo'ngje Yo'ngu Volume 4 of 2010: Article by Kim Hu'i-suk: "The Development of the Core Basic Technologies Is an Indispensable Demand of Economically Powerful State Construction"
[12] Pyongyang *Kyo'ngje Yo'ngu (Electronic Edition)* in Korean 20 Nov 10 pp 10-12; Kyo'ngje Yo'ngu Volume 4 of 2010: Article by Kim Hu'i-suk: "The Development of the Core Basic Technologies Is an Indispensable Demand of Economically Powerful State Construction"
[13] Pyongyang Kyo'ngje Yo'ngu (Electronic Edition) in Korean 20 Nov 10 pp 13-14; Kyo'ngje Yo'ngu Volume 4 of 2010: Article by Associate Professor Ri Ch'ang-hwan: "Improving Industrial Structure Is an Important Demand of the

Information Industry Age"; Description of Source: Pyongyang Kyo'ngje Yo'ngu (Electronic Edition) in Korean -- Quarterly economic journal posted on the Korean Press Media (KPM) website run by the pro-Pyongyang General Association of Korean Residents in Japan; URL: http://dprkmedia.com

[14] Pyongyang *Kyo'ngje Yo'ngu (Electronic Edition)* in Korean 20 Nov 10 pp 10-12; Kyo'ngje Yo'ngu Volume 4 of 2010: Article by Kim Hu'i-suk: "The Development of the Core Basic Technologies Is an Indispensable Demand of Economically Powerful State Construction"

[15] Pyongyang *Korean Central Broadcasting Station via Satellite* in Korean 10 Mar 11 - 11 Mar 11

[16] Pyongyang *Rodong Sinmun (Electronic Edition)* in Korean 20 Feb 11; Special article by Cho'ng So'n-ch'o'l (affiliation not given): "Chuch'e-orientation and Modernization of the People's Economy and the Embodiment of the Seed Theory"

[17] National seminar on era of information industry, KCNA, May 6, 2001

[18] Seoul *Hangyore (Internet version-WWW)* in Korean 0940 GMT 02 Aug 02; Article by correspondent Ha Song-pong from Dandong: "'IT Industry at Center of North Korea's Economic Reform'"; Description of Source: Seoul Hangyore (Internet version-WWW) in Korean -- WWW-based version of Seoul Hangyore in Korean -- Medium-sized Seoul daily that is very supportive of Kim Tae-chung's "people's government," usually sympathetic toward North Korea

[19] Pyongyang *Kyo'ngje Yo'ngu (Electronic Edition)* in Korean 20 Aug 10; Kyo'ngje Yo'ngu Volume 1 of 2010 article by Cho Myo'ng-ho: "The Role of Information Technology Development in Raising People's Standard of Living"; Description of Source: Pyongyang Kyo'ngje Yo'ngu (Electronic Edition) in Korean -- Quarterly economic journal posted on the Korean Press Media (KPM) website run by the pro-Pyongyang General Association of Korean Residents in Japan; URL: http://dprkmedia.com

[20] Pyongyang Rodong Sinmun (Electronic Edition) in Korean 12 Mar 11; Special article by Kim So'ng-ryong: "Superiority of Socialism of Our Style and the Development of the Information Industry"; Description of Source: Pyongyang Rodong Sinmun (Electronic Edition) in Korean -- Daily of the Central Committee of the Workers Party of Korea; posted on the Korean Press Media (KPM) website run by the pro-Pyongyang General Association of Korean Residents in Japan; URL: http://dprkmedia.com

[21] Seoul *Hangyore (Internet version-WWW)* in Korean 0940 GMT 02 Aug 02; Article by correspondent Ha Song-pong from Dandong: "'IT Industry at Center of North Korea's Economic Reform'"; Description of Source: Seoul Hangyore (Internet version-WWW) in Korean -- WWW-based version of Seoul Hangyore in Korean -- Medium-sized Seoul daily that is very supportive of Kim Tae-chung's "people's government," usually sympathetic toward North Korea

[22] Seoul Korea Agency for Digital Opportunity and Promotion [KADO] in Korean 01 Dec 06; Thesis presented by Ri Sang-ch'un of the Computer Technical Committee of the KAST [Kanagawa Academy of Science and Technology] at the Third Seminar on the Bridging of an Information Gap Between the North and the South, held in Seoul on 1 December 2006: "The State of and Outlook for North Korea's Informatization From the Viewpoint of the General Association of Korean Residents in Japan [GAKRJ]"; Description of Source: Seoul Korea Agency for Digital Opportunity and Promotion [KADO] – An ROK government-affiliated institute dedicated to increasing open information exchanges and to ensuring the benefits of digitization are fairly distributed across regions and social strata. URL: http://www.kado.or.kr

[23] Seoul Korea Agency for Digital Opportunity and Promotion [KADO] in Korean 01 Dec 06; Thesis presented by Ri Sang-ch'un of the Computer Technical Committee of the KAST [Kanagawa Academy of Science and Technology] at the Third Seminar on the Bridging of an Information Gap Between the North and the South, held in Seoul on 1 December 2006: "The State of and Outlook for North Korea's Informatization From the Viewpoint of the General Association of Korean Residents in Japan [GAKRJ]"

[24] Pyongyang *Rodong Sinmun (Electronic Edition)* in Korean 14 Dec 10; Special article by reporter Ri Kyo'ng-su: "The US Imperialists' Scheming Psychological Smear Campaign That Abused Modern Science and Technology;" Description of Source: Pyongyang Rodong Sinmun (Electronic Edition) in Korean -- Daily of the Central Committee of the Workers Party of Korea; posted on the Korean Press Media (KPM) website run by the pro-Pyongyang General Association of Korean Residents in Japan; URL: http://dprkmedia.com

[25] Joint Calls of WPK CC and WPK CMC, Rodong Sinmun, 3 February 2010, p.1

[26] Central Information Agency for Science and Technology is also known as Scientific and Technical Information and Documentation Center of the Academy of Sciences.

[27] "How Chinese Cell Phones Help Information Flow," Martyn Williams, 1 April 2010, http://www.northkoreatech.org/2010/04/01/how-chinese-cell-phones-help-information-flow/
[28] Seoul Korea Agency for Digital Opportunity and Promotion [KADO] in Korean 01 Dec 06; Thesis presented by Ri Sang-ch'un of the Computer Technical Committee of the KAST [Kanagawa Academy of Science and Technology] at the Third Seminar on the Bridging of an Information Gap Between the North and the South, held in Seoul on 1 December 2006: "The State of and Outlook for North Korea's Informatization From the Viewpoint of the General Association of Korean Residents in Japan [GAKRJ]"
[29] Article by staff reporter Yi Pyong-ch'un: "From the Ministry of Post and Telecommunications: Expanding Mobile Telecommunications to Nationwide Scale," Rodong Sinmun, 2003
[30] Shanghai *Northeast Asian Forum WWW-Text* in Chinese 05 Dec 07; Report by Shanghai Northeast Asia Investment and Consultancy Company: "A Comparative Study of Market Analysis and Profit Models of DPRK Mobile Communications Industry" DPRK Mobile Communication Industry.pdf Description of Source: Shanghai Northeast Asian Forum WWW-Text in Chinese -- Website of the Shanghai Northeast Asia Investment & Consultancy Company, a private consulting firm that conducts research and advises strategic direction for investment in the Northeast Asian region, including the DPRK.
[31] Choi and Lee, 2005
[32] "Cable Production Base" "Naenara," Korea Today, No. 602 (8), 2006
[33] Tokyo Seiron in Japanese 01 Nov 06 - 30 Nov 06 pp 302-311
[34] Shanghai *Northeast Asian Forum WWW-Text* in Chinese 05 Dec 07; Report by Shanghai Northeast Asia Investment and Consultancy Company: "A Comparative Study of Market Analysis and Profit Models of DPRK Mobile Communications Industry" DPRK Mobile Communication Industry.pdf Description of Source: Shanghai Northeast Asian Forum WWW-Text in Chinese -- Website of the Shanghai Northeast Asia Investment & Consultancy Company, a private consulting firm that conducts research and advises strategic direction for investment in the Northeast Asian region, including the DPRK.
[35] Tokyo The People's Korea (Internet Version-WWW) in English 01 Mar 03
[36] History of Land Rezoning in the DPRK, KCNA, 11 May 2005
[37] Kim Jong Il, "Improving the Layout of the Fields Is a Great Transformation of Nature for the Prosperity and Development of the Country, a Patriotic Work of Lasting Significance,"Rodong Sinmun, 18 April 2000
[38] Fiber-optic cables are the medium of choice for internet backbone providers for many reasons. Fiber-optics allow for fast data speeds and large bandwidth; they suffer relatively little attenuation, allowing them to cover long distances with few repeaters; they are also immune to crosstalk and other forms of EM interference which plague electrical transmission.
[39] The backbone is a fiber optic trunk line. The trunk line consists of many fiber optic cables bundled together to increase the capacity. The backbone is able to re-route traffic in case of a failure. The data speeds of backbone lines have changed with the times. In 1998, all of the United States backbone networks had utilized the slowest data rate of 45 Mbps. However, the changing technologies allowed for 41 percent of backbones to have data rates of 2,488 Mbps or faster by the mid 2000's. The FCC currently defines "high speed" as any connection with data speeds that exceed 200 kilobits per second.
[40] Tokyo The People's Korea (Internet Version-WWW) in English 01 Mar 03, DPRK Spreading Computer Networks, http://www1.korea-np.co.jp/pk/189th_issue/2003030118.htm
[41] Seoul The Korea Times (Internet Version-WWW) in English 28 Dec 05; Kim Tae-gyu Staff Reporter: "Internet, Mobile Phone Service in KT's NK Card"
[42] Pakistan's biggest telecommunication company PTCL launched its 3G network, EVO, in mid-2008. On 11 December 2008, India entered the 3G arena with the launch of 3G enabled Mobile and Data services by Government owned Mahanagar Telephone Nigam Ltd MTNL in Delhi and later in Mumbai. 3G services were made available in the Philippines on December 2008. New Zealand's Telecom NZ launched its XT Network in 2008. In Turkey, Turkcell, Avea and Vodafone launched their 3G networks commercially on 30 July 2009 at the same time.
[43] http://www.hkvca.com.hk/news/news10_2000.htm and http://www.wallstreet-online.de/diskussion/160391-11-20/pearl-oriental-cyberforce-kooperation-mit-nordkoreas-telecom
[44] In April 1996, Loxley Pacific Co., Ltd. (LOXPAC), a subsidiary of Thai telecommunications giant Loxley Public Company Limited signed a USD 28 million joint venture investment deal for 30 years of telecommunications

network concessions in the North Korean free trade area of Rajin-Sŏnbong. According to the agreement, LOXPAC would have the rights to develop and install all land-line telephone, paging and intranet services in the Rajin-Sŏnbong Free Economic and Zone. As for profits, LOXPAC would retain a majority share in the investment with 70% of shares for the first 15 years of return on the investment, and the remaining 30% would go to the DPRK's Northeast Asia Telephone and Telecommunications Company Limited (NEAT&T), which would eventually receive 60% of the profits from the 16th year onward. At the end of the concession period, all ownership of the fixed assets would revert back to the DPRK.

[45] KCNA, 25 January 2003

[46] North Korean Telecommunications: On Hold Stacey Banks, *North Korean Review*, Fall 2005

[47] DPRK Guidebook, European Union, 2006, http://dprkguidebook.org/contents_3.htm

[48] The People's Korea, http://www1.korea-np.co.jp/pk/032nd_issue/98030406.htm

[49] Seoul Chosun Ilbo in Korean 03 Jun 04; By reporter Kang Ch'ol-hwan: "Rumors of Suspension of Mobile Phone Service in DPRK But Not for Foreigners"

[50] Shanghai *Northeast Asian Forum WWW-Text* in Chinese 05 Dec 07; Report by Shanghai Northeast Asia Investment and Consultancy Company: "A Comparative Study of Market Analysis and Profit Models of DPRK Mobile Communications Industry" DPRK Mobile Communication Industry.pdf

[51] Shanghai *Northeast Asian Forum WWW-Text* in Chinese 05 Dec 07; Report by Shanghai Northeast Asia Investment and Consultancy Company: "A Comparative Study of Market Analysis and Profit Models of DPRK Mobile Communications Industry" DPRK Mobile Communication Industry.pdf

[52] "Thai Foreign Minister Gives Interview to Press" Ministry of Foreign Affairs, Bangkok, August 30, 2005

[53] According to KCNA, the 27th meeting of the North-East Asia Telephone and Telecommunications Co., Ltd. Directors' Board took place on September 24, 2010, in Pyongyang. Present there were members of the delegation of the Loxley Pacific Co., Ltd. of Thailand headed by Jingjai Hanchanlash, chairman of the North-East Asia Telephone and Telecommunications Co., Ltd. and executive vice-president of the Loxley Public Co., Ltd. of Thailand, Kim In Chol, vice-chairman of the North-East Asia Telephone and Telecommunications Co., Ltd., and members of its Directors' Board. The meeting discussed the matters on the management and operation of communication facilities of the North-East Asia Telephone and Telecommunications Co., Ltd. and reached an agreement.

[54] Internet, Mobile Phone Service in KT's NK Card, Yonhap, 28 December 2005

[55] Jong-Heon Lee, S. Korea Eyes North's Mobile Market, UPI, Seoul, 6 June 2002, http://www.upi.com/Business_News/2002/06/06/SKorea-eyes-Norths-mobile-market/UPI-64361023372857/

[56] Seoul Yo'llin Pukhan Pangsong in Korean 09 Feb 09; Article by reporter Sin Yong-po'm: "North Korea's Abnormal Cellular Phone" from second edition of Open News for North Korea; Description of Source: Seoul Yo'llin Pukhan Pangsong WWW-Text in Korean -- Internet homepage of Yo'llin Pukhan Pangsong (Open Radio for North Korea), a pay-per-broadcast radio service that allows "any" individual or organization to transmit programming to North Korea. URL: www.nkradio.com

[57] "Orascom Goes Global with a Bang," Emirates Business 24/7, 19 May 2009, accessed 19 May 2009

[58] "Telecommunications in North Korea: Has Orascom Made the Connection?" Marcus Noland, Peterson Institute for International Economics, September 8, 2008

[59] "Korea, Egypt Cooperate in Post and Telecommunication," KCNA, 19 January 2007

[60] "DPRK and Egypt to Cooperate in Field of Cement," KCNA, 16 July 2007

[61] "Egyptian Delegation Here," KCNA, 27 February 2007

[62] "Kim Yong Nam Meets Egyptian Delegation," KCNA, 1 March 2007

[63] "Kim Yong Il Meets Egyptian Delegation," KCNA, 15 December 2008

[64] "Gift to Kim Jong Il from Egyptian Businessman," KCNA, 15 December 2008

[65] "DPRK Government Hosts Reception," KCNA, 16 December 2008

[66] "Kim Yong Nam Meets Chairman of Orascom," KCNA, 30 September 2009

[67] "Gist to Kim Jong Il from Chairman of Orascom," KCNA, 30 September 2009

[68] "Chairman of Orascom Honored with DPRK Order," KCNA, 30 September 2009

[69] "Kim Jong Il Receives Egyptian Businessman," KCNA, 24 January 2011

[70] "Egyptian Businessman Here," KCNA, 21 January 2011

[71] By Donald Kirk — Special to GlobalPost, published: February 8, 2011 06:15 ET in Asia, http://www.globalpost.com/dispatch/south-korea/110207/north-korea-egypt-kim-jong-il-naguib-sawaris
[72] Seoul Yonhap Online in Korean 0110 GMT 11 Aug 09; Article by reporter Chang Yong-hun: "Egyptian Investment Bank Says, 'North's Cell Phone Subscribers To Top 560,000 in Two Years'"
[73] KCNA, December 16 2009
[74] http://www.snmobi.com/HelpList.aspx?id=3&aid=1
[75] http://ashen-rus.livejournal.com/643.html
[76] Blog post by Martin Williams, http://www.northkoreatech.org/2010/08/31/dprk-cell-phone-dialing-codes/
[77] http://koryo-reporter.livejournal.com/53130.html
[78] Shanghai *Northeast Asian Forum WWW-Text* in Chinese 05 Dec 07; Report by Shanghai Northeast Asia Investment and Consultancy Company: "A Comparative Study of Market Analysis and Profit Models of DPRK Mobile Communications Industry" DPRK Mobile Communication Industry.pdf
[79] N. Korea Plans to Produce Own Mobile Phones to Meet Rising Demand, Yonhap, April 19, 2010
[80] North Korea Begins Mass-producing Cell Phones, Yonhap, 15 November 2011
[81] A Plain Analysis of DPRK's Mobile Communications Industry"; Shanghai Northeast Asian Forum WWW-Text in Chinese 23 Feb 06
[82] Phone Handset Prices Fall as Users Rise, By Park Jun Hyeong and Lee Seok Young, Daily NK, 20 May 2011
[83] Cell Phones All the Rage in Pyongyang, Chosun Ilbo, 20 June 2011
[84] Seoul Yo'llin Pukhan Pangsong in Korean 09 Feb 09; Article by reporter Sin Yong-po'm: "North Korea's Abnormal Cellular Phone" from second edition of Open News for North Korea; Description of Source: Seoul Yo'llin Pukhan Pangsong WWW-Text in Korean -- Internet homepage of Yo'llin Pukhan Pangsong (Open Radio for North Korea), a pay-per-broadcast radio service that allows "any" individual or organization to transmit programming to North Korea. URL: www.nkradio.com
[85] Shanghai *Northeast Asian Forum WWW-Text* in Chinese 05 Dec 07; Report by Shanghai Northeast Asia Investment and Consultancy Company: "A Comparative Study of Market Analysis and Profit Models of DPRK Mobile Communications Industry" DPRK Mobile Communication Industry.pdf Description of Source: Shanghai Northeast Asian Forum WWW-Text in Chinese -- Website of the Shanghai Northeast Asia Investment & Consultancy Company, a private consulting firm that conducts research and advises strategic direction for investment in the Northeast Asian region, including the DPRK.
[86] DPRK on US 'Psychological Warfare' in Iraq; Urges 'Vigilance' 'Even in Peacetime'; P'yongyang *Nodong Sinmun* in Korean 04 Jul 03 p 6; Article by Staff Reporter Kim Nam-hyok: "Let Us Heighten Vigilance Against the US Imperialists' Psychological Strategic Warfare -- The 'Shock and Awe' Operation the United States Perpetrated in Iraq"
[87] DPRK on US 'Psychological Warfare' in Iraq; Urges 'Vigilance' 'Even in Peacetime'; P'yongyang *Nodong Sinmun* in Korean 04 Jul 03 p 6; Article by Staff Reporter Kim Nam-hyok: "Let Us Heighten Vigilance Against the US Imperialists' Psychological Strategic Warfare -- The 'Shock and Awe' Operation the United States Perpetrated in Iraq"
[88] Pyongyang *Rodong Sinmun (Electronic Edition)* in Korean 14 Dec 10; Special article by reporter Ri Kyo'ng-su: "The US Imperialists' Scheming Psychological Smear Campaign That Abused Modern Science and Technology;" Description of Source: Pyongyang Rodong Sinmun (Electronic Edition) in Korean -- Daily of the Central Committee of the Workers Party of Korea; posted on the Korean Press Media (KPM) website run by the pro-Pyongyang General Association of Korean Residents in Japan; URL: http://dprkmedia.com
[89] Shanghai Northeast Asian Forum WWW-Text in Chinese 05 Dec 07; Report by Shanghai Northeast Asia Investment and Consultancy Company: "A Comparative Study of Market Analysis and Profit Models of DPRK Mobile Communications Industry" DPRK Mobile Communication Industry.pdf Description of Source: Shanghai Northeast Asian Forum WWW-Text in Chinese -- Website of the Shanghai Northeast Asia Investment & Consultancy Company, a private consulting firm that conducts research and advises strategic direction for investment in the Northeast Asian region, including the DPRK.
[90] Pyongyang Korean Central Broadcasting Station via Satellite in Korean 04 Jun 11 - 05 Jun 11
[91] Pyongyang Korean Central Television via Satellite in Korean 1100 GMT 12 Aug 09
[92] US Troubled by Smartphone, KCNA, February 11, 2011

[93] Seoul Korea Agency for Digital Opportunity and Promotion [KADO] in Korean 01 Dec 06; Thesis presented by Ri Sang-ch'un of the Computer Technical Committee of the KAST [Kanagawa Academy of Science and Technology] at the Third Seminar on the Bridging of an Information Gap Between the North and the South, held in Seoul on 1 December 2006: "The State of and Outlook for North Korea's Informatization From the Viewpoint of the General Association of Korean Residents in Japan [GAKRJ]".
[94] Prior to becoming the national Intranet, the Kwangmyong's content was limited to science and technology databases with over 30 million scientific documents posted on the network.
[95] This figure is taken from the May 2000 edition of North Korea's science magazine "Kwahak-ui Segye" [World of Science]. The figure entitled "Intranet," which appeared on page 60 of the magazine, depicted a system in which the "fire wall" established between the Internet and the Intranet filtered Internet information. This is perceived as a signal that North Korea is working to establish a system that can inspect and control information, prior to its opening up the Internet.
[96] http://faculty.nps.edu/dedennin/publications/cno%20threat.pdf
[97] Seoul NK Chisigin Yo'ndae in Korean 12 Apr 11; Paper presented by Kim Hu'ng-kwang, head of the North Korea Intellectuals Solidarity.
[98] Seoul Korea Agency for Digital Opportunity and Promotion [KADO] in Korean 01 Dec 06; Thesis presented by Ri Sang-ch'un of the Computer Technical Committee of the KAST [Kanagawa Academy of Science and Technology] at the Third Seminar on the Bridging of an Information Gap Between the North and the South, held in Seoul on 1 December 2006: "The State of and Outlook for North Korea's Informatization From the Viewpoint of the General Association of Korean Residents in Japan [GAKRJ]"
[99] Seoul Korea Agency for Digital Opportunity and Promotion [KADO] in Korean 01 Dec 06; Thesis presented by Ri Sang-ch'un of the Computer Technical Committee of the KAST [Kanagawa Academy of Science and Technology] at the Third Seminar on the Bridging of an Information Gap Between the North and the South, held in Seoul on 1 December 2006: "The State of and Outlook for North Korea's Informatization From the Viewpoint of the General Association of Korean Residents in Japan [GAKRJ]
[100] IANA Report on the Delegation of the .KP Top-Level Domain, 11 September 2007, http://www.iana.org/reports/2007/kp-report-11sep2007.html
[101] "N.Korea Likely to Provide Internet Service from 2009" Digital Chosun Ilbo, Seoul, 7 August 2008
[102] Seoul NK Chisigin Yo'ndae in Korean 12 April 11; Paper presented by Kim Hu'ng-kwang, head of the North Korea Intellectuals Solidarity, a Seoul-based research organization founded by North Korean defectors with university degrees and higher, at an international forum on North Korea's communications market held in Seoul on 12 March under the title, "3G Penetration Trends and Investment Opportunities in North Korea Mobile Infrastructure"; Description of Source: Seoul NK Chisigin Yo'ndae in Korean -- "North Korea Intellectuals Solidarity," a research organization formed by North Korean defectors in South Korea, which studies North Korean and reunification issues.
[103] Redelegation of the .KP domain representing the Democratic People's Republic of Korea to Star Joint Venture Company, IANA, 1 April 2011, http://www.iana.org/reports/2011/kp-report-20110401.html
[104] Seoul Korea Agency for Digital Opportunity and Promotion [KADO] in Korean 01 Dec 06; Thesis presented by Ri Sang-ch'un of the Computer Technical Committee of the KAST [Kanagawa Academy of Science and Technology] at the Third Seminar on the Bridging of an Information Gap Between the North and the South, held in Seoul on 1 December 2006: "The State of and Outlook for North Korea's Informatization From the Viewpoint of the General Association of Korean Residents in Japan [GAKRJ]"
[105] "N. Korean Delegation Inspects Google Headquarters," Digital Chosun Ilbo, Seoul, 4 April 2011
[106] http://www.hhnec.com/EN/AboutUs/Overview.aspx
[107] Shanghai Hua Hong NEC Electronics Company, Ltd. manufactures semiconductors in Mainland China. It offers IC foundry services. It provides embedded non-volatile memory platforms in various applications, such as microprocessors, communications, consumer products, and smart cards, as well as offers design support, chip manufacturing, and testing services.
[108]It was in January 2001 that the company boasted of a "breakthrough in domestic foundry service: it co-developed with its customer the first chip for the Social Security Card, which successfully took off and entered into volume production" http://www.hhnec.com/EN/AboutUs/Milestones1.aspx

[109] Both Shanghai Bell and Loxley Pacific are active in Burma, according to Bangkok-based Business and Human Rights Resource Center at http://www.business-humanrights.org/Categories/Individualcompanies/B/BangkokBank
[110] Alcatel-Lucent Shanghai Bell Co., Ltd. operates as a telecommunication and information enterprise. The company has six business divisions covering switching networks, mobile telecommunication networks, data communication networks, transmission networks, network applications, and multi-media terminals. The company's products include narrowband and broadband switching system, narrowband and broadband access system, serial module system, environment surveillance system, integrated access system and wireless access system, and mobile switching system.
[111] http://www.iie.com/publications/papers/noland1208.pdf
[112] http://www.zjpark.com/zjpark_en/
[113] http://www.zjpark.com/zjpark_en/zjgkjyq.aspx?ID=9
[114] http://www1.korea-np.co.jp/pk/154th_issue/2001012501.htm
[115] "Program development centres to appear," February 7, 2002
[116] Pyongyang Korean Central Television via Satellite in Korean 0841 GMT 29 Jan 06
[117] http://www.qiyeyi.com/ShangHai/Changfei-Optical-Fiber-Optical-Cable-shanghai-32011-en.html. In 2006, YOFC was named as "2006 Top Ten Innovative Enterprises in China IT Industry." http://en.yofc.com.cn/about/&FrontComContent_list01-1293438028857ContId=b5c35d76-1a6e-4284-bcee-56464c8fe35b&comContentId=b5c35d76-1a6e-4284-bcee-56464c8fe35b&comp_stats=comp-FrontComContent_list01-1293438028857.html Since 1992, YOFC has solidly held the No.1 position in the China optical fibre and cable market and is now among the top 3 suppliers globally. In China, YOFC's optical fibre and cable products have been massively used by China Telecom, China Mobile, China Unicom and other telecom operators, and widely applied in the electricity, CATV, transportation, education, defense, aerospace, chemical, petroleum, medical and other industries. http://www.changfei.com.cn/
[118] For further details, see the corporate website at http://www.fenghuomobile.com/english/news/newsview.asp?id=189
[119] For further details, see the corporate website at http://www.fenghuomobile.com/english/story/
[120] For further details, see the corporate website at http://rixinelectronics.en.made-in-china.com/company-Guangzhou-Rixin-Electronics-Co-Ltd-.html
[121] For further details, see the corporate website at http://www.icbc.com.cn/icbc/corporate%20banking/clearing%20and%20settlement%20service/introduction/
[122] For further details, see the corporate website at http://en.eastcompeace.com/
[123]For further details, see the corporate website at http://en.eastcompeace.com/about/&FrontComContent_list01-85509374689ContId=2deb02c9-8502-426b-9f87-8ac1f85bfb4d&comContentId=2deb02c9-8502-426b-9f87-8ac1f85bfb4d&comp_stats=comp-FrontComContent_list01-85509374689.html
[124] For further details, see the corporate website at http://www.huawei.com/en/about-huawei/index.htm
[125] For further details, see the corporate website at http://www.digitalchina.com/Public/Home.aspx
[126] For further details, see the corporate website at http://www.digitalchina.com.hk/html/index.php
[127]For further details, see the corporate website at http://www.digitalchina.com.hk/html/about_profile.php
[128] "Kim Jong-il Winds Up China Trip with Look at IT Firm,"Chosun Ilbo, 27 May 2011, http://english.chosun.com/site/data/html_dir/2011/05/27/2011052700991.html
[129] For further details, see the corporate website at http://www.panda.cn/SJTCMS/html/JCK/about_e/about_us.asp
[130]Paul French, North Korea: the paranoid peninsula--a modern history. p. 177, http://books.google.ca/books?id=mdyJS5iD9wYC&pg=PA177
[131] Seoul NK Chisigin Yo'ndae in Korean 12 Apr 11; Paper presented by Kim Hu'ng-kwang, head of the North Korea Intellectuals Solidarity, at an international forum on North Korea's communications market held in Seoul on 12 March under the title, "3G Penetration Trends and Investment Opportunities in North Korea Mobile Infrastructure"
[132] This list was developed by Martyn Williams. It is posted on North Korea Tech blog. Version 1.2, last updated: 4 August 2011. URL: http://www.northkoreatech.org/the-north-korean-website-list/
[133] Click on the thumbnail pictures to see more details and a link to the site.

[134] Server: the location of the server, determined by its IP address
[135] Blocked: whether the site is blocked in South Korea (determined via South Korean web proxy server from Tokyo)
[136] Ch'ek'om Technology Joint Venture Company is also known as also known as CHEO Technology JV Co.