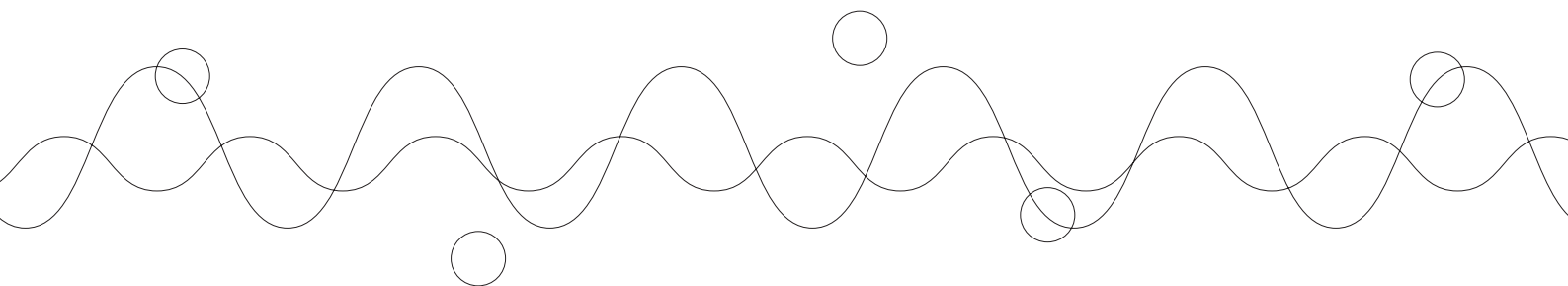


Comparison between the results of international technology level evaluation conducted by KEIT* and CRDS**

*KEIT:Korea Evaluation Institute of Technology

**CRDS:Center for Research and Development Strategy of Japan Science and Technology Agency

Aug.2012



Center for Research and Development Strategy
Japan Science and Technology Agency

Executive Summary

Based on the Memorandum of Understanding dated on the 24th February, 2011, Korea Evaluation Institute of Industrial Technology (KEIT) and Center for Research and Development Strategy of Japan Science and Technology Agency (CRDS) started cooperative activities in the science and technology field. This report is a part of the activities.

This report articulates a comparison between the results of Technology Level Evaluation (TLE) conducted by KEIT and International Technology Comparison (ITC) conducted by CRDS. This year, the comparison was performed in the Information and Communication Technology (ICT) field especially in the Robotics and Mobile Communication fields.

Through the discussions at the workshops held on the 29th June, 2011(@Tokyo, Japan) and the 28th October, 2011(@Seoul, Korea), we have found following items:

- * Different views of technologies of each party result in different categorization of technologies. KEIT has industrial and product oriented view. CRDS has academic and technology oriented view. Differences between the results of TLE and ITC can be mainly explained by the difference of views.

- * Quantitative evaluations based on the patent database of KEIT and qualitative expert's evaluations of CRDS have both pros and cons, and the results of two parties seemed complementary.

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Methodology for Comparison

KEIT has been carrying out Technology Level Evaluation (TLE) for 14 target technology categories. The categories of KEIT are industry oriented and sectorized as focused areas of Korean industry.

CRDS has been carrying out International Technology Comparison (ITC) for 6 target technology categories. The categories of CRDS are basic science oriented and sectorized as academic societies.

KEIT approach is relatively objective, systematic and quantitative. On the other hand, CRDS approach is relatively subjective, flexible and rich in concrete information. We considered both approaches are complementary and it was fruitful to share both results in order to broaden each sight, understand each country, and refine each method.

The characters of two methodologies are different and the results are difficult to compare directly. Therefore, KEIT and CRDS exchanged “Technology Tree” which consists of technology categories and the keywords. Based on the Technology Tree, we tried to identify correspondences of each category and termed abstracted categories for comparison. Then we tried to compare the results of two studies and made discussions.

Part1: Robotics

Correspondence table of “sections” of TLE(KEIT) and “medium categories” of ITC(CRDS).

	KEIT	CRDS
1.1 Manipulation	Manipulation/Mechanism	Manipulation
1.2 Work	Work/Mechanism	Field robots Service robots Industrial robots
1.3 Mobility	Mobile mechanism/Mechanism Action/Intelligence Actuation parts/Parts	Mobility technologies Actuator and mechanism
1.4 Intelligence	Decision/Intelligence Recognition/Intelligence Sensor/Parts	Intelligence technologies Sensing and cognitive technology
1.5 Systems	Platform/System System engineering/System	System Integration

Discussion:

KEIT has been carrying out TLE for “Robotics” as one of 14 target technology categories. The categories of KEIT are industry oriented and sectorized as focused areas of Korean industry.

CRDS has been carrying out ITC for “Robotics” as one of 6 target technology categories. The categories of CRDS are basic science oriented and sectorized as academic societies.

The categories “Robotics” of TLE/KEIT seems to have correspondence to the field “Robotics” of ITC/CRDS. We should note that each “Robotics” of TLE/KEIT and “Robotics” of ITC/CRDS are partially overlapped.

We try to find overlapped technology areas based on the keywords described in technology trees. The technology area covered by the sections “Manipulation/Mechanism” of KEIT seems to overlap with technology area covered by the medium categories “Manipulation” of CRDS. “Work/Mechanism” of KEIT seems to overlap with “Field robots, Service robots, Industrial robots” of CRDS. “Mobile mechanism/Mechanism, Action/Intelligence, Actuation parts/Parts” of KEIT seems to overlap with “Mobility technologies, Actuator and mechanism” of CRDS. “Decision/Intelligence, Recognition/Intelligence, Sensor/Parts” of KEIT seems to overlap with “Intelligence technologies, Sensing and cognitive technology” of CRDS. “Platform/System, System engineering/System” of KEIT seems to overlap with “System Integration” of CRDS.

1.1 Manipulation

KEIT results

Type		KOR	US	JPN	CHN	EUR
Manipulation	Qualitative	85.2	100	98.1	72.8	96.9
	Quantitative	65.2	91.7	100	57	50.8

* Qualitative: results of ICT level survey based on the Delphi method

* Quantitative: results of ICT competitiveness analysis using patent information

CRDS results

(10) Manipulation

Phase	KOR			US			JPN			CHN			EUR		
	R	T	I	R	T	I	R	T	I	R	T	I	R	T	I
Current situation	B	B	B	A	A	B	B	B	A	B	C	B	B	A	A
Trend	→	↗	↗	↗	↗	↗	→	→	→	↗	↗	↗	↗	↗	→

R: Research level, T: Technology development level, I: Industrial technology capability

A: significantly advanced, B: advanced, C: behind, D: significantly behind

* This is an absolute evaluation rather than a relative evaluation based on the current situation of Japan.

↗: upward trend, →: maintenance of the status quo, ↘: downward trend

Discussion:

- (1) Industrial technology capability scores of CRDS seem to be consistent with qualitative score of KEIT.
- (2) The high score of JPN and EUR of KEIT results are similar to those of CRDS. Industrial robots in Japan (Yasukawa Electric, etc.) and Germany (KUKA etc.) may contribute to the high scores.
- (3) Though US has the highest score in KEIT result, US was evaluated “B” in CRDS result.
- (4) In KEIT results, quantitative score of EUR is low compared to high-rate qualitative score.

1.2 Work

KEIT results

Type		KOR	US	JPN	CHN	EUR
Work	Qualitative	84.8	100	99.6	72.2	93.1
	Quantitative	78.2	100	87.2	50.1	73.9

* Qualitative: results of ICT level survey based on the Delphi method

* Quantitative: results of ICT competitiveness analysis using patent information

CRDS results

(1) Field robots

Phase	KOR			US			JPN			CHN			EUR		
	R	T	I	R	T	I	R	T	I	R	T	I	R	T	I
Current situation	B	B	B	A	A	B	B	A	B	B	B	C	A	B	B
Trend	↗	↗	↗	→	→	↗	→	→	↘	↗	↗	↗	↗	→	→

(2) Service robots

Phase	KOR			US			JPN			CHN			EUR		
	R	T	I	R	T	I	R	T	I	R	T	I	R	T	I
Current situation	A	B	B	A	A	A	A	A	B	B	B	B	B	B	B
Trend	↗	↗	↗	↗	↗	↗	↗	↗	→	↗	↗	↗	↗	↗	↗

(3) Industrial robots

Phase	KOR			US			JPN			CHN			EUR		
	R	T	I	R	T	I	R	T	I	R	T	I	R	T	I
Current situation	A	B	B	A	A	A	B	B	A	B	C	B	A	A	A
Trend	↗	↗	↗	↗	→	↗	→	→	→	↗	↗	↗	↗	↗	↗

R: Research level, T: Technology development level, I: Industrial technology capability

A: significantly advanced, B: advanced, C: behind, D: significantly behind

* This is an absolute evaluation rather than a relative evaluation based on the current situation of Japan.

↗: upward trend, →: maintenance of the status quo, ↘: downward trend

Discussion:

- (1) Industrial technology capability scores of CRDS are roughly consistent with qualitative score of KEIT.
- (2) In KEIT results, US and JPN is very strong. According to the CRDS results, Heartland Robotics, Fanuc Ltd., Yasukawa Electric, Denso Wave etc., KUKA and ABB are notable in industrial robots.
- (3) In CRDS results, industrial technology capacity scores relatively low in the all countries and regions. It may due to the lack of practical application.

1.3 Mobility

KEIT results

Type		KOR	US	JPN	CHN	EUR
Mobile Mechanism	Qualitative	84	100	97.9	74.1	93.2
	Quantitative	57.2	97.9	100	69.7	94.9
Action	Qualitative	83.2	100	94.3	1.3	90.5
	Quantitative	80	100	92	47.1	43
Actuation Parts	Qualitative	82.9	93.4	100	74.8	93.5
	Quantitative	45.3	100	98	51.3	69.4

* Qualitative: results of ICT level survey based on the Delphi method

* Quantitative: results of ICT competitiveness analysis using patent information

CRDS results

(9) Mobility technology

	KOR			US			JPN			CHN			EUR		
Phase	R	T	I	R	T	I	R	T	I	R	T	I	R	T	I
Current situation	B	B	B	A	A	B	B	B	A	C	C	C	A	B	B
Trend	↗	↗	↗	→	→	↗	↘	→	↘	↗	↗	↗	→	→	↗

(11) Actuator mechanism

	KOR			US			JPN			CHN			EUR		
Phase	R	T	I	R	T	I	R	T	I	R	T	I	R	T	I
Current situation	A	B	B	A	A	B	A	A	A	B	B	B	A	B	A
Trend	↗	↗	↗	→	→	→	→	→	↘	↗	↗	↗	→	↗	→

R: Research level, T: Technology development level, I: Industrial technology capability

A: significantly advanced, B: advanced, C: behind, D: significantly behind

* This is an absolute evaluation rather than a relative evaluation based on the current situation of Japan.

↗: upward trend, →: maintenance of the status quo, ↘: downward trend

Discussion:

- (1) Industrial technology capability scores of CRDS are roughly consistent with qualitative score of KEIT.
- (2) In KEIT results, US and JPN are the most high-score countries. In CRDS results, Japanese scores are much higher than that of US. These results may due to the contribution of conveying systems or servomotor system in JPN.
- (3) In KEIT results, quantitative score of “Action” of EUR and “Actuation Parts” of KOR are low compared to high-rate qualitative score.

1.4 Intelligence

KEIT results

Type		KOR	US	JPN	CHN	EUR
Decision	Qualitative	82.2	100	89.9	74	90.6
	Quantitative	33	70.7	100	32.3	35.6
Recognition	Qualitative	82.9	100	91.1	76	92.6
	Quantitative	60	92.3	100	48.3	69.6
Sensor	Qualitative	80.8	100	94.5	74.2	96.1
	Quantitative	84.8	100	94.3	44	65.4

* Qualitative: results of ICT level survey based on the Delphi method

* Quantitative: results of ICT competitiveness analysis using patent information

CRDS results

(7) Intelligence technology

	KOR			US			JPN			CHN			EUR		
Phase	R	T	I	R	T	I	R	T	I	R	T	I	R	T	I
Current situation	C	B	C	A	B	A	C	B	C	D	C	D	B	B	C
Trend	↗	↗	↗	→	→	↗	↘	→	→	↗	↗	↗	→	↗	→

(8) Sensing and cognitive technology

	KOR			US			JPN			CHN			EUR		
Phase	R	T	I	R	T	I	R	T	I	R	T	I	R	T	I
Current situation	B	B	B	A	A	A	A	A	A	C	C	C	C	C	B
Trend	↗	↗	↗	→	↗	→	↗	↗	↗	→	→	→	↘	↘	→

R: Research level, T: Technology development level, I: Industrial technology capability

A: significantly advanced, B: advanced, C: behind, D: significantly behind

* This is an absolute evaluation rather than a relative evaluation based on the current situation of Japan.

↗: upward trend, →: maintenance of the status quo, ↘: downward trend

Discussion:

- (1) In KEIT results, US is the most high-score country. In CRDS results, Roomba of iRobot, Robotic Studio of Microsoft, Automated Guided Vehicle (AGV) management technologies of KIVA are notable in Intelligence technology. Kinect of Microsoft is also notable in Sensing and cognitive technology.
- (2) In CRDS results, Intelligence technology of JPN seems pessimistic due to the lack of practical market.
- (3) In KEIT results, quantitative score of “Decision” of KOR and EUR are low compared to high-rate qualitative score.

1.5 Systems

KEIT results

Type		KOR	US	JPN	CHN	EUR
Platform	Qualitative	83.7	100	92.6	72.5	91.7
	Quantitative	76.9	72.6	100	40.5	45.4
System Engineering	Qualitative	83	100	99.8	73.2	97.6
	Quantitative	45	100	76.4	46.5	51.5

* Qualitative: results of ICT level survey based on the Delphi method

* Quantitative: results of ICT competitiveness analysis using patent information

CRDS results

(5) System integration

Phase	KOR			US			JPN			CHN			EUR		
	R	T	I	R	T	I	R	T	I	R	T	I	R	T	I
Current situation	B	B	B	A	A	B	B	B	B	C	B	B	B	B	B
Trend	→	→	↗	→	↗	→	↘	→	→	↗	↗	↗	→	→	↗

R: Research level, T: Technology development level, I: Industrial technology capability

A: significantly advanced, B: advanced, C: behind, D: significantly behind

* This is an absolute evaluation rather than a relative evaluation based on the current situation of Japan.

↗: upward trend, →: maintenance of the status quo, ↘: downward trend

Discussion:

- (1) In KEIT results, quantitative score of “Platform” of EUR and “System Engineering” of KOR and EUR are low compared to high-rate qualitative score.
- (2) In KEIT results, US is the most high-score country. According to CRDS result, the score may due to the technology development level. ROS of Willow Garage is famous as a open source library of robotic OS but it has not contributed to industrial technology capacity yet. In this technology category, industrial technology capability seems not high at any country and region in the world.

Market trends in robotics industries

- (1) Korea: The most enthusiastic about the industrialization of robots.
 - Educational robots (for kindergartens) are categorized as Edutainment (Education + Entertainment) and from the previous year, they have been introduced to 1,000 kindergartens in Korea.
 - Preparation of and development of contents for these educational robots (about 10,000 contents 2010, 30,000 more in 2011).
 - Recruiting researchers from overseas and at the DGIST (Daegu Gyeongbuk Institute of Science & Technology).
 - MKE selected 10 consortiums for the pilot project of the robots in the fields of education, piping inspection, fire-fighting, industrial use, military use, and medical use.

- (2) Japan: Demands for service robots will increase in Japanese aging society.
 - In 2010, METI (Ministry of Economy, Trade and Industry) of Japan published market forecast of the robot industries.
 - The demands in service robot field will increase drastically and expand the market size up to 9.7 trillion yen in 2035.
 - <http://www.meti.go.jp/press/20100423003/20100423003.html>

- (3) U.S.: New developments are being carried out even in the robot businesses.
 - Near-future service robots by applying the open software development method to the robot technology (Willow Garage).
 - Surgery assisting robot, DaVinci (Intuitive Surgical).
 - Cleaning robot of Roomba (iROBOT).
 - Distributed autonomous robotic systems assisting product delivery for e-Commerce (Kiva Systems).
 - Remote presence robotic platform for hospital use, RP-7i (InTouch Health).

- (4) Communication robots.
 - Create situations that people and robots are interacting in real situations.
 - Find the problems that should truly be solved.
 - R&D area.
 - Communication support for elderly (Denmark).
 - Remote operative communication robots that can replace human presence (tele-work) (U.S.).
 - Educational support for children (Korea).

Part2: Mobile Communication

Correspondence table of “sections” of TLE(KEIT) and “medium categories” of ITC(CRDS).

	KEIT	CRDS
2.1 Wireless systems	Mobility management platform Broadband mobile system Wireless local area network system Mobile application system	Wireless network
2.2 Wireless systems	Convergence mobile terminal	Information and communication terminal technology

Discussion:

KEIT has been performed TLE for “Mobile Communications” as one of 14 target technology categories. The categories of KEIT are industry oriented and sectorized as focused areas of Korean industry.

CRDS has been performed ITC for “Communication Network” as one of 6 target technology categories. The categories of CRDS are basic science oriented and sectorized as academic societies.

The categories “Home-network/Information Appliances”, “Digital TV/Broadcasting”, “Radio/Broadcast/Satellite”, “mobile communications”, “Broad Convergence Network (BcN)”, “RFID/USN” of TLE/KEIT seems to have correspondence to the field “communication network” of ITC/CRDS. We should note that “mobile communications” of TLE/KEIT and “communication network” of ITC/CRDS are partially overlapped.

We try to find overlapped technology area based on the keywords described in technology trees. The technology area covered by the sections “Mobility management platform, Broadband mobile system, Wireless local area network system, Mobile application system, Convergence mobile terminal” of KEIT seems to overlap with technology area covered by the medium categories “Wireless network, Information and communication terminal technology” of CRDS.

2.1 Wireless systems

KEIT results

Type		KOR	US	JPN	CHN	EUR
Mobility Mgt. Platform	Qualitative	90.9	100	92.4	79.5	96.5
	Quantitative	95.6	95.4	84.2	64.1	100
Broadband Mobile System	Qualitative	91.9	100	90.1	83.4	97.5
	Quantitative	98.4	100	80.7	54.1	67.5
Wireless Local Area Network System	Qualitative	86.8	100	88.9	76.6	91.4
	Quantitative	100	66.6	43.1	40.9	65.7
Mobile Application System	Qualitative	84	100	90.5	79	93.9
	Quantitative	41	100	45.5	50	44.6

* Qualitative: results of ICT level survey based on the Delphi method

* Quantitative: results of ICT competitiveness analysis using patent information

CRDS results

(2) Wireless network

	KOR			US			JPN			CHN			EUR		
Phase	R	T	I	R	T	I	R	T	I	R	T	I	R	T	I
Current situation	C	B	B	B	B	A	A	B	B	A	B	B	A	A	A
Trend	→	→	→	→	→	→	→	↗	↗	↗	↗	↗	↗	↗	↗

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A: significantly advanced, B: advanced, C: behind, D: significantly behind

* This is an absolute evaluation rather than a relative evaluation based on the current situation of Japan.

↗: upward trend, →: maintenance of the status quo, ↘: downward trend

Discussion:

- (1) Industrial technology capability scores of CRDS are roughly consistent with qualitative score of KEIT.
 - US and Europe >> Korea and Japan >> China
- (2) In KEIT results, US and EUR are technology leaders. According to CRDS results, Verizon's LTE, as the world's first, can use 700MHz band which has less transmission loss compared to 2.6GHz in US. In EUR, they are increasing their market size by setting up standard systems as EU and also gaining global share by selling standards such as GSM and IMT to other countries.
- (3) In KEIT results, quantitative results of "Mobility Mgt. Platform", "Broadband Mobile System", "Wireless Local Area Network System" of KOR are high. It may due to the strategic R&D in KOR under the Korean government initiative called IT839 strategy (comprises 8 services including WiBro, DMB (Digital Mobile Broadcasting, and W-CDMA Home Network Service, 3 infrastructures of Broadband, sensor net, and IPv6, and 9 new growth engines such as next generation mobile technology) from 2005.

- (4) In KEIT results, quantitative score of “Network System” of JPN and “Mobile Application System” of KOR, JPN, and EUR are low compared to high-rate qualitative score.

2.2 Terminal technology

KEIT results

Type		KOR	US	JPN	CHN	EUR
Convergence Mobile Terminal	Qualitative	87.9	100	88.6	74.2	91
	Quantitative	87.3	100	50.4	53.8	51.2

* Qualitative: results of ICT level survey based on the Delphi method

* Quantitative: results of ICT competitiveness analysis using patent information

CRDS results

(6) Information and Communications terminal technologies

Phase	KOR			US			JPN			CHN			EUR		
	R	T	I	R	T	I	R	T	I	R	T	I	R	T	I
Current situation	B	A	A	A	B	A	B	B	B	C	B	A	B	B	B
Trend	↗	↗	↗	→	↗	→	→	→	→	↗	↗	↗	→	→	↗

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A: significantly advanced, B: advanced, C: behind, D: significantly behind

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↗: upward trend, →: maintenance of the status quo, ↘: downward trend

Discussion:

- (1) In KEIT result, US is the big leader. It is consistent with CRDS result that describes Apple, Microsoft, Google (android) as the giants of the terminal providers.
- (2) In CRDS result, even though qualitative score of KEIT result does not high, KOR and CHN is also a big country as a provider of information terminals. Samsung, LG in KOR are the famous providers of mobile terminals. Renovo, ZTE etc. in CHN are also famous providers of PC.
- (3) In KEIT results, quantitative score of “Convergence Mobile Terminal” of JPN and EUR are low compared to high-rate qualitative score.

Market changes in mobile communication industries

- (1) Japanese carriers make up about half of their revenues from data communication.
 - Approximately 80% of the revenues of mobile carriers in the U.S. and Europe are generated from voice communications.
- (2) NTT docomo, au, and Softbank have announced the use of LTE.
- (3) ARPU (Average Revenue per User) is decreasing due to fierce competition.

More specifically, pay attention to terminal development movements along with activities of IoT (Internet of Things), CPS (Cyber-Physical Systems), Smart grid, and Smart city.

Smart phone's share is growing up.

Shipment of mobile phone is 37M in Japan.

Smart phone's share is 22.7%.

Appendix 1 (Technology Trees)

Technology Tree (KEIT)

Next mobile communication

Mobile service platform

Mobile convergence service platform

- Multimode multimedia convergence service platform: API, Context-aware, OTA, FOTA, APP-store, IMS
- Location & CS service platform: Location-aware Context-aware, Cooperative service, Augmented reality, LBS platform
- Distributed mobile network service platform: Cloud computing, SaaS, PaaS, Peer to peer service

Mobility mgt. platform

- Location registration & mgt.: Network discovery, Network selection, Roaming, Handover
- Mobile security & authentication: USIM, Authentication, Mobile security, Ciphering
- Mobile engineering platform: Overlay network, Network QoS, Heterogeneous network, Hierarchical network, Cell planning

Mobile access system

Broadband mobile system

- 3GPPx based mobile system: OFDM/OFDMA, SU/MU MIMO, Carrier aggregation, Variable BW, Enhanced MBMS(Multimedia Broadcast & Multicast Service)
- IEEE802.16 based mobile system: OFDM/OFDMA, SU/MU MIMO, Carrier aggregation, Variable BW, Enhanced MBS(Multicast Broadcast Service)
- Beyond IMT-advanced based mobile system: Cooperative communication, Machine-to-Machine (M2M) communication, Mobile cloud network, Heterogeneous/Multi-tier communication, Cognitive radio

Wireless local area network system

- Next generation WLAN system: MU-MIMO(Multi-User MIMO), Multi-channel access, Channel bonding, Higher-order MIMO, TVWS & smart grid communication
- Next generation WPAN system: MultiBeam steering, Directional MAC, Mm wave, Channel bonding, Visible light communication

Mobile application system

- Military mobile application system: Wireless/mobile mesh network, Anti-jamming, Cognitive radio military application, OTM (On-the-Move) communication, Tactical Information and Communication Network(TICN)
- Broadband wireless back-haul: Group handover, Free space optics, Intelligent multi-hop networking, Ultra-distance wireless backhaul, Wireless ethernet backhaul

- Public safety & other mobile applications: Dynamic group mobile communication, Dynamic self-organized network, Direct mode operation, Delay tolerable mobile network, Public Protection and Disaster Relief (PPDR)

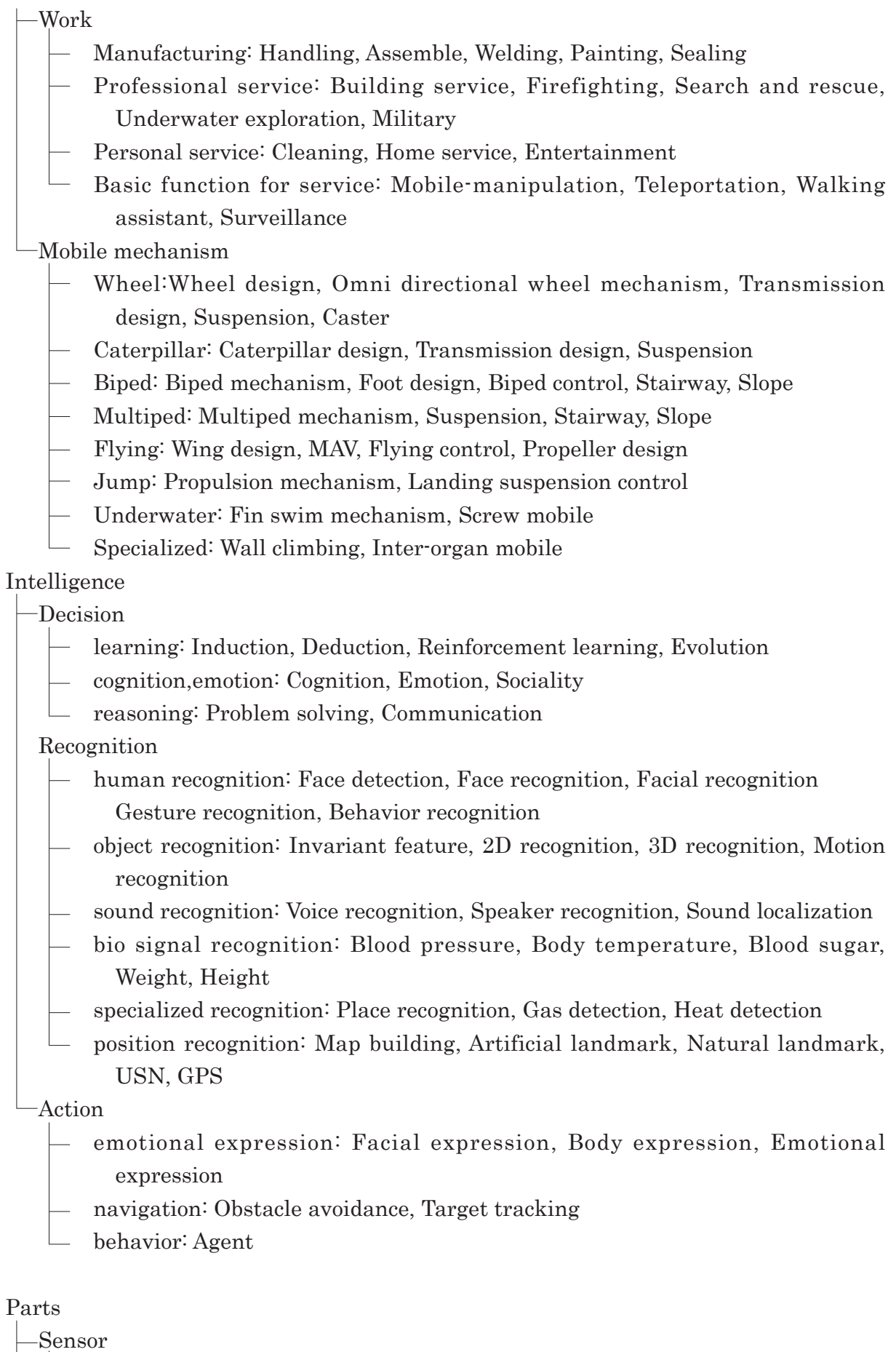
Mobile terminal & components, test & certification

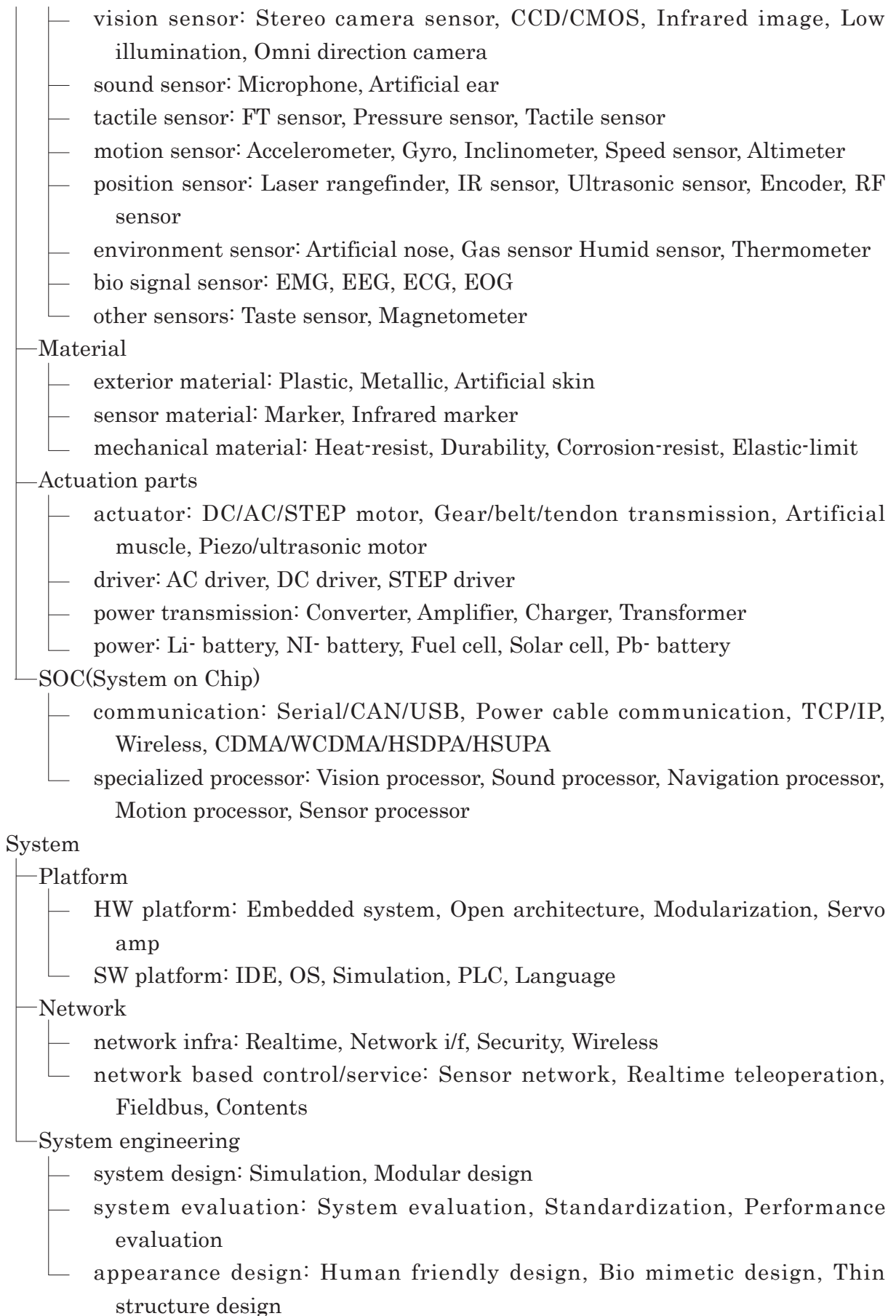
- Convergence mobile terminal
 - Terminal service platform: Smart Phone SW platform, Flexible HW platform, Web OS platform, Context-aware computing platform, User interface/user experience platform
 - Service convergence terminal: Mobile features platform(push over cellular, video sharing, instant messaging, P2P, presence, open AP, Mobile internet service SW platform(scalable data, mobile mash-up, mobile advertisement, mobile map), Mobile social network client SW platform, Position, location based SW platform, DRM(Digital Right Mgt.) SW platform, Muilti-Sensor based Platform
 - CR/SDR platform: SDR HW and SW modem, CR HW and SW controller, TV white space, Reconfigurable HW & DSP, Multi-mode, Multi-band communication
- Convergence mobile components
 - Convergence/broadband mobile modem & AP components: Multi-mode modem, Multi-media application processor, Multi-band Modem, Flexible interface processor, Low power, fast boot processor
 - Broadband RF & antenna: Flexible RF chipset, Multiband flexible antenna, Active RF components, Passive RF components, MEMS RF components
 - Open user interface convergence mobile components: Touch/tactile sensor, Voice recognition, OLED, 2D/3D camera module, G-sensor
- Mobile test & certification
 - Mobile test/measurement & certification equipments: Protocol conformance test, Radio conformance test, BS/MS emulation, Signal generation, Signal analysis
 - Validation of certification equipments: Validation, Conformance Uncertainty, TSS & TP, Certification

Next G. Robot

Mechanism

- Manipulation
 - Arm: Compliance, Redundant, Flexible, Precision, Safety
 - Hand, gripper: Dexterous, Flexible, Multi-function, Nano-manipulation
 - Facial expression: Facial, Ocular motion
 - Haptic: Force feedback, Tactile, Force/position hybrid





Technology Tree (CRDS)

Communication Network

- Optical network
 - 100Gb/s, All Optical Network, Passive Optical Network (PON) Wavelength Division Multiplexing (WDM), wavelength selective switching, Optical router, Optical add-drop multiplexer (OADM), Network Neutrality
- Wireless network
 - 3G, LTE, IMT-A, WiMAX, DSA, 4G, Coordinate MultiPoint format (CoMP), Multiple Input MultipleOutput (MIMO), Cognitive wireless networks, Smart grid
- Internet
 - Quality of Service(QoS), data center, cloud service, IPv4/IPv6, Internet Service Provider (ISP)
- Next-generation network
 - Cyber Physical Systems (CPS), Internet of Things (IoT), RFID, Machine-to-machine (M2M), ubiquitous sensor network
- Service technology(Cloud computing technology)
 - virtual networks, Platform as a Service (PaaS), Software as a Service (SaaS), High Performance Computing (HPC), Hadoop, Unified Communication (UC)
- Information and communication terminal technology
 - CPU, Orthogonal Frequency Division Multiplexing (OFDM), Multiple Input Multiple Output (MIMO), User Interface, Human Interface
- Image compression technologies / Applied Multimedia technology
 - MPEG, JPEG XR, ITU-T, H.264, HDTV, 3DTV, Free-viewpoint TV (FTV), Multiview Video Coding (MVC)
- Network security
 - VPN, NAT, Winny, Share, Firewall, Digital Right Management (DRM), Data security, Privacy security
- Source coding / Error Correcting coding (Channel coding) / Network coding
 - Error detection and correction, Shannon limit, Low-Density Parity-Check code (LDPC), Polar codes
- Communication Traffic theory
 - Data traffic, Measurement, Statistical analysis, Probability density estimation, Malcov chain, Central limit theorem

Robotics

- Field robotics
 - Agriculture, Mining, Construction, Under water, Atomic power plant, Space, Military

—Service robots	Healing, Cleaning, Education, Kindergarten, Servitazation
—Industrial robots	Industrial robot, Robot arm, Robot hand, Automation, Manufacturing
—Medical robots	Surgery, Endoscope, Diagnostics, Therapy
—System Integration	Modulization, Integration, Middleware, Operating System, Interface specification
—Human-robot interaction	Human robot interaction, Cognition, Interface, Psychology
—Intelligence Technologies	Pattern recognition, Planning, Control, Modeling, Learning, Intelligence
—Sensing and cognitive technology	Computer vision, Facial recognition, Motion capturing, Laser range finder, Gyro sensor
—Mobility Technologies	Simultaneous localization and mapping (SLAM), Biped robot, Environment recognition, Movement control, Positioning
—Manipulation	Manipulation, Handling, Haptics, Vision, Force control
—Actuator and mechanism	Actuator, Mechanism, Motor, Servomotor, Harmonic drive

Appendix 2 (Government Organizations and Strategies)

ICT related government organizations

Korea

NSTC (National Science and Technology Commission)

Korea Communications Commission

*** Broadcasting and communication service, radio wave and network policies.

+Korea Radio Promotion Agency (1990.8.)

+National Internet Development Agency of Korea (2009.7.)

Ministry of Knowledge Economy

*** ICT industries, IT R&D and technology policies.

+National IT Industry Promotion Agency (2009.8.)

+Electronics and Telecommunications Research Institute (1976.12.)

+Korean Electronics Technology Institute (1991.8.)

+Korea Photonics Technology Institute (2000.12.)

+Korea Lighting Research Institute (1999.5.)

+Korea Robotics Industry Promotion Agency (2010.7.)

Ministry of Public Administration and Security

*** Informatization, electric government, protection of national information.

+National Information Society Agency (2009.5.)

Ministry of Culture, Sports and Tourism

+Korea Creative Content Agency (2009.5.)

Ministry of Education, Science and Technology

*** Digital Contents, game industry

Japan

Prime Minister of Japan and His Cabinet

+IT Strategic Headquarters

CAO (Cabinet Office, Government of Japan)

+CSTP (Council for Science and Technology Policy)

+NISC (National Information Security Center)

METI (Ministry of Economy, Trade and Industry)

*** Electronic commerce (EC) , personal information protection, electronic government, IT-related research and development (R&D), human resource development, and information security.

+NEDO (New Energy and Industrial Technology Development Organization) *F

+IPA (Information-technology Promotion Agency) *F

+AIST (National Institute of Advanced Industrial Science and technology) *R

MISC (Ministry of Internal Affairs and Communications)

*** Global ICT strategy, digitalization of broadcasting and advanced use of Information & Communications Technology (ICT), telecommunications business, the development of a secure and reliable environment for using information-communications infrastructure, efficient use of radio waves and establishment of a globally-advanced wireless broadband environment.

+NICT (National Institute of Information and Communication Technology) *F *R

MEXT (Ministry of Education, Culture, Sports, Science and Technology)

*** Education, Promotion of basic research.

+JST (Japan Science and Technology Agency) *F

+JSPS (Japan Society for the Promotion of Science) *F

+NII (National Institute of Informatics) *R

*F: Funding Agency, *R: Research Institute

Laws, Strategies and White papers

Korea

➤ ICT related Laws

ICT industry promotion Law

➤ ICT R&D Program

Mid-Long term R&D Programs (528,700 million won)

Electronic information device, IT media, Next-generation communication network, SW and Computing, IT convergence, and etc.

Short term R&D Programs (84,900 million won)

Global expert technology development, Development of IT application technologies (loan), 3D industry Competitiveness Reinforcement, and etc.

➤ 5 core strategies*:

(1) IT convergence: Growing 10 major IT convergence industries

Creating 10 IT convergence industries with domestic production exceeding 1 trillion won (shipbuilding, energy, automobile, medical industry, textile, machinery, aviation, construction, defense, robotics)

(2) SW: Growing the software industry as a source of industrial competitiveness

Growing 8 domestic companies as members of the “top global 100 companies” (IT services: 6, package software: 2), growing 27 companies with sales of over 100 billion won.

(3) Key IT: Global supply base for key IT equipment

3 major products: achieving the number one position in the world market share.
5 major IT equipment industries: improving the localization of equipment and doubling their world market share.

(4) Broadcasting and communication: Providing convenient and advanced broadcasting and communication services

Providing the world’s best broadcasting and communications service (early invigoration of WiBro/IP TV/3D TV markets)

(5) Internet: Realizing faster and safer Internet environments

Establishing UBcN (Ultra broadband convergence network) and the most advanced information protection center in the world (building up safe ultra broadband networks)

* Reference: 2010 Annual Report on the Promotion of IT Industry (Summary), Ministry of Knowledge Economy, Republic of Korea

➤ Policy Direction of MKE

<http://www.mke.go.kr/language/eng/policy/Ipolicies.jsp>

Industry Policies

- +Improve the Investment Climate
- +Promote Regional Economic Growth
- +Establish an Innovative R&D System
 - ✓ Establish an R&D network to expedite information-sharing and commercialization.
 - ✓ Streamline research procedures.
 - ✓ Collaborate with universities, companies, and institutes conducting R&D.
 - ✓ Increase R&D outsourcing and encourage participation of associations and academic groups in carrying out a large-scale R&D project.
 - ✓ Strengthen global cooperation in joint technology development.
 - ✓ Expand financial support for developing and commercializing technologies.
 - ✓ Intrinsically enhance companies' ability to self-innovative.
 - ✓ Facilitate private investment in R&D.
- +Upgrade Flagship Industries
- +Foster New Growth Engines
 - ✓ Green Technology
 - ✓ High-Tech Convergence
 - ✓ Value-Added Service

Trade Policies

- +Expand Export Markets
- +Attract Foreign Direct Investment (FDI)
- +Pursue Bilateral Trade Agreements
- +Intensify Ties with Major Trading Partners

Energy Policies

- +Manage the National Energy Supply
- +Promote Overseas Energy Development Projects
- +Implement Environmentally Responsible Growth Policies
- +Combat Climate Change

- Korea internet White paper
<http://isis.nida.or.kr/eng/ebook/ebook.html>

Japan

- ICT related Laws
Basic Law on Formation of an Advanced Information and Telecommunications Network Society (November 29, 2000) Cabinet Secretariat
- ICT R&D Program

- A New Strategy in Information and Communications Technology (2010)
http://www.kantei.go.jp/foreign/policy/it/100511_full.pdf
 1. Delivering a citizen-oriented electronic administration
 2. Recreating bonding in local communities
 3. Creating new markets and expanding internationally

- White paper: Information and Communications in Japan (2010)
<http://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2010/2010-index.html>
<http://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2010/2010-outline.pdf>

- White paper on Science and Technology 2010
<http://www.mext.go.jp/english/whitepaper/1302537.htm>

**Appendix 3 (Agenda of workshops in Japan and
Korea)**

Agenda of the 1st workshop @Tokyo Japan

Date: June 29 (Wed), 2011 10:00-15:30

Venue: Center for Research and Development Strategy, Japan Science and Technology Agency (CRDS/JST)

Conference Room (2nd Floor), Kojimachi Square Bldg., 3, Nibancho Chiyoda-ku, Tokyo 102-0084 JAPAN

<http://crds.jst.go.jp/en/access.html>

Organizer: CRDS/JST

Language: English

1. Scope

Based on the MOU between CRDS/JST and KEIT, CRDS/JST holds a workshop with KEIT in order to exchange information related to key trends and issues in Information and Communication Technology (ICT) field. The discussion points will be identified based upon “Technological Level Evaluation (KEIT)” and “International Technology Comparison (CRDS)”.

The aim of this workshop is to deepen understanding and to share landscapes of S&T research and innovation mechanism of each country in the ICT field. This year, two parties will discuss about two target fields, “Robotics” and “Mobile Communication”.

At the workshop, two parties exchange information and knowledge about discussion items and identify additional action items for the next workshop scheduled on October 20th.

2. Discussion items

- * Major findings from each result.
- * Facts supporting the results.
 - Remarkable technologies in each country
 - Structure of industries in each country
 - Funding priorities of each government
 - Mega trends in the ICT application fields in each country
- * Preparations for October 20th.

3. Program

Mobile Communications session

10:00-10:05 Objective and Discussion items

10:05-10:35 Presentation from CRDS, Q&A

Methodology and Results(Mobile Communications) of CRDS ITC

10:35-11:05 Presentation from KEIT, Q&A

Methodology and Results(Mobile Communications) of KEIT TLE

11:05-12:00 Discussion*

* Identify additional action items for the next workshop (October 20th)

12:00-13:30 Lunch Meeting

Robotics session

13:30-13:35 Objective and Discussion items

13:35-14:05 Presentation from CRDS, Q&A

Methodology and Results(Robotics) of CRDS ITC

14:05-14:35 Presentation from KEIT, Q&A

Methodology and Results(Robotics) of KEIT TLE

14:35-15:30 Discussion*

* Identify additional action items for the next workshop (October 20th)

4. Participants : KEIT(6) + CRDS(7)

Dr. Sang Moo Lee, Robotics Program Director, KEIT

Dr. Hyeon Woo Lee, Mobile Communications Program Director, KEIT

Dr. Ilgu Cho, Technology Planning Team Leader, KEIT

Dr. Keun Dae Kim, Senior Researcher, KEIT

Dr. Min Kyun Kim, Senior Researcher, KEIT

Dr. Jin Yang Lim, Researcher, KEIT

Dr. Kazuhiro Kosuge, Professor, Tohoku University

Dr. Haruhisa Ichikawa, Professor, University of Electro-Communications

Dr. Kunihiko Niwa, Principal Fellow, CRDS/JST

Dr. Kotaro Katsuyama, Fellow, CRDS/JST

Mr. Kenji Kaneko, Fellow, CRDS/JST

Dr. Ichiro Kuriki, Fellow, CRDS/JST

Dr. Kazuyoshi Shimada, Fellow, CRDS/JST

Agenda of the 2nd workshop @Seoul Korea

■ Objective

- Discussion about the result of CRDS' International Technology Comparison and KEIT's Technology level evaluation focused on "Robotics" and "Mobile Communication".
 - (Discussion point) (1) Similarity or discrepancy between CRDS result and KEIT result, (2) The background of the discrepancy, (3) Facts of (emerging) market change.
- Drawing conclusions and Discussion of Next year joint research plan

■ Outline

- (Date) '11.10.28(Fri) 10:00 ~ 15:30
- (Place) Conference room #2(7th floor), Sam-jung bldg., Yuk-sam Dong 701-2, Gangnam Gu, Seoul, South Korea

■ Participants

Institution	Participants
Japan JST-CRDS	* General contact : Dr. Kazuyoshi Shimada, Dr. Kotaro Katsuyama(JST-CRDS) * Mobile communications : Dr. Haruhisa Ichikawa(Professor, University of Electro-Communications) * Robotics : Dr. Kazuhiro Kosuge(Professor, Tohoku University)
Korea KEIT	* General contact : Dr. Ilgu Cho, Dr. Jin Yang Lim * Mobile communications : Dr. Hyeon Woo Lee(PD) * Robotics : Dr. Sang Moo Lee(PD)

■ Time table

Time	Contents	Reference
10:00-10:10	Welcome comment /Reply comment	KEIT /CRDS
10:10-10:20	Brief Introduction of the workshop	Dr. Ilgu Cho
10:20-10:40	Robotics	KEIT presentation
10:40-11:00		JST presentation
11:00-12:00		Discussion
12:00-13:30	Lunch	Korean style
13:30-13:50	Mobile communications	KEIT presentation
13:50-14:10		JST presentation
14:10-15:10		Discussion
15:10-15:30	Closing comment	

Appendix 4 (Project Members)

Project Members

Dr. Sang Moo Lee, Robotics Program Director, KEIT (Expert of Robotics)

Dr. Hyeon Woo Lee, Mobile Communications Program Director, KEIT (Expert of Mobile Communication)

Dr. Ilgu Cho, Technology Planning Team Leader, KEIT

Dr. Keun Dae Kim, Senior Researcher, KEIT

Dr. Min Kyun Kim, Senior Researcher, KEIT

Dr. Jin Yang Lim, Researcher, KEIT

Dr. Kazuhiro Kosuge, Professor, Tohoku University (Expert of Robotics)

Dr. Haruhisa Ichikawa, Professor, University of Electro-Communications (Expert of Mobile Communication)

Dr. Kuniyuki Niwa, Principal Fellow, CRDS/JST

Dr. Kotaro Katsuyama, Fellow, CRDS/JST

Mr. Kenji Kaneko, Fellow, CRDS/JST

Dr. Ichiro Kuriki, Fellow, CRDS/JST

Dr. Kazuyoshi Shimada, Fellow, CRDS/JST

CRDS-FY2012-XR-02

Comparison between the results of international technology level
evaluation conducted by KEIT and CRDS

Aug,2012

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