D 4.2- EU-China ICT Final Cooperation Plan

Authors: Kay Matzner, Fraunhofer Gesellschaft/Germany

Cao Jiguang, China Academy of Telecommunication Research/ China

Document Number	D 4.2
Document Title	Final Cooperation Plan
Version	4.0
Status	Final
Deliverable Type	Report
Contractual Date of Delivery	
Actual Date of Delivery	01/04/2014
Contributors	CATR: Kang Yanrong, Tang Hao, Yang Fan, Zhang Guoying, Zhang Yi, Zhu QianLong, Li Shaohui BSEAC: Eduard Hollands Fraunhofer: Krister Johnson
Keyword List	ICT, Research, Industry, Policy, Strategy
Dissemination level	PU

Change History

Version	Date	Status	Author (Partner)	Description
1.0	15/03/2013	**In preparation**	Kay Matzner	Created
1.0	1/06/2013	**In preparation**	Kay Matzner	Some CATR contribution
1.1	21/08/2013	**In preparation**	Kay Matzner	Delivery and Integration of contribution of CATR on Chinese Challenges
1.1	2/09/2013	**In preparation**	Kay Matzner	Delivery and Integration of BSEAC contribution on rules for participation of European entities in Chinese programmes
1.1	13/09/2013	**In preparation**	Kay Matzner	Delivery and Integration of BSEAC contribution of Bilateral programmes
1.1	16/09/2013	**In preparation**	Kay Matzner	Integration of the part "Forms of Collaboration" as delivered by CATR
1.1	22/09/2013	**In preparation**	Kay Matzner	Integration of some input of CATR for Collaboration recommendations
1.2	12/10/2013	**Updates**	BSEAC	Quality Check and Contribution
1.3	13/10/2013	**Updates**	Kay Matzner	Update by Kay Matzner and constant quality checks by BSEAC on a daily base till 25/10/2013
1.3	25/10/2013	**Quality Check**	BSEAC	Quality Check
1.3	25/10/2013	**Quality Check**	Sigma Orionis	Quality Check
1.4	26/10/2013	**Update**	Kay Matzner	Update based on comments of Sigma Orionis
1.4	28/10/2013	**Quality Check**	BSEAC	Quality Check of last Kay Matzner update
1.4	28/10/2013	**Submission**	Kay Matzner	
1.4			**EC check**	Quick check by PO of preliminary draft

2.0	28/10/2013	**Final**	Kay Matzner	Integration of Executive summary, CVs
2.0	29/10/2013	**Final**	BSEAC	Quality Check: Proofreading and formatting
2.0	29/10/2013	**Final**	CATR	Provision of CATR CVs
2.0	30/10/2013	**Final**	Fraunhofer	Submission of final
3.0	22/11/2013	**Final**	Kay Matzner	Update based on Workshop input and informal EC feedback
3.1	06/12/2013	**Final**	Kay Matzner	Working out further steps-action plans taking into account contributions from CATR
3.2	10/12/2013	**Final**	Kay Matzner	Integration of Panel discussion and Questionnaire results of final conference in Vilnius
3.2	31/12/2013	**Final**	BSEAC	Quality Check: Proofreading and formatting
3.2	01/01/2014	**Final**	Kay Matzner	Updates
3.2	03/01/2014	**Final**	SIGMA	Quality Check and comments regarding political correctness
3.2	08/01/2014	**Final**	Kay Matzner	Updates and focusing/streamlining of text
3.2	10/01/2014	**Final**	BSEAC-Kay Matzner	Final revision
3.2	23/01/2014	**Final**	BSEAC-Kay Matzner	Inclusion of official Chinese support and endorsement letters
4.0	01/04/2014	**Final**	Fraunhofer	Updates, taking into account reviewers recommendations

List of Tables

List of Abbreviations

- BRIC –Brazil, Russia, India and China
- BSEAC – Beijing Software Enterprise Advisory Center (China)
- CAS – Chinese Academy of Sciences
- CATR – China Academy of Telecommunication Research
- CSC – China Scholarship Council
- DG Connect –Directorate General for Communications Networks, Content and Technology
- EC – European Commission
- ERA – European Research Area
- EU – European Union
- FP7 – Seventh Framework Programme
- GDP – gross domestic product
- GNI – gross national income
- ICT – information and communications technologies
- IPR – intellectual property rights
- ISTCP – International Science and Technology Cooperation Program (China)
- ITS – intelligent transportation system
- MIIT –Ministry for Industry and Information Technology (China)
- MNE – multinational enterprise
- MOST – Ministry of Science and Technology (China)
- NDRC – National Development and Reform Committee (China)
- NSFC – National Science Foundation Committee (China)
- R&D – research and development
- PRC- People Republic of China
- RMB – renminbi (official currency of the PRC)
- RTD – research and technological development
- S&T – science and technology
- SFIC – Strategic Forum for International S&T Cooperation
- SME – small and medium-sized enterprise
- SWOT– strengths, weaknesses, opportunities, and threats

Preface

The OpenChina-ICT EU-China ICT Cooperation Plan is intended to be a guideline for the European Commission, ministries of European Union member states and China to promote European-Chinese cooperation in ICT research.[1] It has therefore been presented to Chinese ministries and the European Commission and is being circulated among research communities throughout both regions.

The EU-China ICT Cooperation Plan outlines the importance of European-Chinese ICT cooperation and current cooperation landscapes in trade, research and politics based on previous and existing cooperation. It presents potential outlooks for future relations and furnishes recommendations for action to establish sustainable cooperation mechanisms. The report is driven by awareness of the unsatisfactory status of cooperation, despite the substantial efforts made in the past.

The primary sources of information in the EU-China ICT Cooperation Plan are expert interviews conducted in Europe and China as well as OpenChina-ICT conferences, workshops, public literature, feedback and documents from European and Chinese officials.

The EU-China ICT Cooperation Plan is the main output of the OpenChina-ICT project. The project was partially supported by research funds from the European Commission's Seventh Framework Programme. Its aim is to contribute to the development of cooperation in ICT research between Europe and China. In addition to the EU-China ICT Cooperation Plan, the ICT research roadmap surveys for Europe and China were developed in the project to identify current and emerging research topics and priorities and to establish a broad base of knowledge about European and Chinese ICT research environments.

The consortium also organized multiple events, including: a European-Chinese ICT research dialogue conference (Beijing, November 2012), two thematic workshops in China dedicated to Smart & Sustainable Cities (Guangzhou, May 2013) and Internet of Things & Future Internet (Beijing, August 2013), and a final conference (Vilnius, Lithuania, November 2013). In the project, a portal website was developed and is being maintained, promotional material has been created and project activities have been interlinked with other European-Chinese research initiatives in order to disseminate project deliverables and to generate awareness of current issues in European-Chinese ICT research.

[1] In the context of this report, China geographically is defined as the People's Republic of China, excluding its special administrative areas of Hong Kong and Macau.

International ICT research and institutional policy stakeholders were involved in project activities throughout the project period. Actions were also taken in the project to enhance direct dialogue on ICT research cooperation issues among policymakers from both the European Union and China. OpenChina-ICT was coordinated by Kay Matzner from the Fraunhofer-Gesellschaft, Germany with support from the following organizations:

The **Fraunhofer-Gesellschaft, Germany** is Europe's largest and leading applied research provider. It pursues applied research that benefits business and society. Contractual partners and clients include industrial and service companies and the public sector.

Sigma Orionis, France is a private company founded in 1984 and in operation since then in Sophia Antipolis Science Park. The company aims to support collaborative research and global innovation in ICT.

CECO/CSTEC, China specializes in consultation services and guidance for Chinese research institutions, enterprises, companies and scientists to participate in the EU Framework Programme. CECO has strong support from the Chinese Ministry of Science and Technology and the EU Delegation in Beijing.

CATR, China is a Chinese government think tank in the ICT sector, which integrates the functions of research, testing, certification and consultancy. It mainly provides decision-making support to the central government (including MIIT, MOST, NDRC, etc.) and local authorities

BSEAC, China is a professional knowledge services firm that specializes in providing a full spectrum of client support solutions in the high-tech field. It is also part of the International Cooperation Department of Beijing Software Industry Association (BSIA), which represents over 600 software and IT companies in Beijing.

Executive Summary

To promote European-Chinese cooperation in ICT research and to improve ICT research cooperation mechanisms between Europe and China, the EU-China ICT Cooperation Plan reviews, analyses and identifies:

- the ICT research cooperation landscape,
- the status of existing cooperation policies,
- the status of experience with cooperation,
- potential technology areas for cooperation and
- recommendations for future cooperation.

ICT Research Cooperation Landscape

The European Union and China legally assure researchers from both the European Union and China free access to its Research and Technological Development (RTD) programmes. In reality, far fewer European researchers participate in China's national RTD programme than Chinese researchers in the EU Framework Programme.

The EC DG CONNECT is presently involved in two ongoing policy dialogues with MOST, which are focused on mutual access to the EU's Framework Programme and China's R&D programmes. They are also involved in dialogues on information technology, telecommunications and informatization with MIIT, focusing on the Internet of Things, Ipv6 electronic communications, green smart cities and Internet security. These dialogues are supported by different EU-China expert advisory groups. There is evidence that China puts more emphasis on bilateral cooperation between China and individual European Union member states than on bilateral cooperation with the European Union as a whole.

The Chinese government considers the development of ICT to be highly important and the primary direction of Chinese-EU ICT research cooperation in the coming years to be the next-generation Internet, broadband mobile communication, mobile Internet, the convergence of three networks, Internet of Things, cloud computing, network and information security, integrated circuits, electronic components, and computers and software.

The main objective of European ICT research is to support development of the ICT industry and to increase Europe's technological competitiveness. China is a preferred country for European research cooperation. In keeping with its consensus process, the European Commission defined pervasive and trusted network infrastructures, cognitive systems and ICT for a low-carbon economy as its priorities for ICT research cooperation with China.

Status of Existing Cooperation Policies

At present, Chinese research cooperation programmes that contain ICT elements and are open to foreign participation include MOST's 973 Programme, MOST's International Science and Technology Cooperation Programme, programmes developed by the NSFC, and activities initiated by the Chinese Academy of Science. European participation in Chinese-funded research is limited because of language barriers, the lack of partner networks, the lack of selection transparency, and the low level of importance given to promoting European participation in Chinese-funded programmes. European entities are often only invited to join publicly funded Chinese research projects in order to supply additional knowledge.

ICT research in the European Union is always an important aspect of European-funded research. The European Union is intent on implementing polices and instruments, e.g. reciprocal access or joint calls, that promote international research cooperation.

In terms of bilateral relationships, most European member states have signed bilateral S&T cooperation agreements with China. There is evidence that the level of research integration between European Union member states and China is influenced by the competitiveness of individual member states' economies.

Status of Experience with Cooperation

Cooperation takes on different forms, including visiting scholar/researcher programmes and student exchanges, joint corporate research and development centres, and government dialogues.

In China, visiting scholar/researcher programmes and student exchanges are run by the China Scholarship Council (CSC). Europe has several programmes and agencies for this.

Companies in Europe and China are increasingly establishing joint research and development (R&D) centres. Foreign investment in China is focused mainly on emerging technologies, including electronics and telecommunications research, biomedical research, vehicular transportation research, chemical research, and software design research.

Government-driven dialogue and cooperation projects are an important aspect of R&D cooperation. The European Union and China have launched special cooperation and development support projects. Furthermore, China has been an active participant in FP7.

The challenges of cooperation identified for China include policy, funding and information. The challenges identified for Europe include culture, legal regulations and IPR.

According to the Chinese “internal-external analysis of cooperation” China can use cooperation to support its market and industrial base and acquire know-how. Additionally, Chinese expect support for research quality, Chinese-European political dialogue and development of the Chinese economy. On the downside, cultural aspects, differing Chinese and European strategies, low-quality and non-existent technology in European-funded research, and legal aspects related to research diminish the attractiveness of such cooperation for Chinese. The Chinese additionally identified several threats to cooperation related to loss of know-how, loss of unique Chinese data, and loss of Chinese resources for European projects with questionable outcomes.

According to the European “internal-external analysis of cooperation”, Europe can use cooperation to facilitate access to markets, research know-how, and cheap, qualified research labour. Additionally, Europeans expect general competitive advantages, such as access to Chinese know-how and opportunities to influence Chinese civil society. On the downside, cultural differences and the unfamiliar legal framework in China diminish the attractiveness of such cooperation for Europeans. Europeans additionally identified several threats to cooperation related to loss of know-how, the possibility of Chinese acquiring greater competitive advantages than Europeans, different legal systems and limited options for law enforcement in China.

Potential Technology Areas of Cooperation

ICT technology priorities common to Europe and China are focused on research as defined in Challenge 1: Pervasive and trusted networks, in Challenge 5: ICT for health, ageing well, inclusion and governance, and in Challenge 6: ICT for a low-carbon economy (smart energy cities).

Recommendations for Future Cooperation

The final OpenChina-ICT recommendations are grouped in categories. They are communication, researcher and student exchanges, cooperation on R&D projects, and research support for industry and dialogue.

- **Communication**

Given the poor reputation of European research in China, the OpenChina-ICT consortium recommends that the European Commission demonstrate the capabilities of its ICT research in China.

The consortium suggests that China establish a single channel communication approach to provide information about various programmes open to European participation. This would effectively foster foreign participation.

- **Researcher and Student Exchanges**

Researcher and student exchanges have been determined to facilitate joint technological innovation and industry developments in ICT both in Europe and in China. The launch of specific, co-funded exchange programmes in potential ICT technology areas of cooperation that target Europe and China as a whole is therefore recommended.

- **Cooperation on R&D projects**

The European options identified revealed that European researchers would experience multiple benefits for the quality and competitiveness of their research if they were to integrate Chinese researchers in their projects. Keeping the same mechanism for the participation of Chinese entities in European-funded projects from FP7 in Horizon 2020 is therefore recommended.

There is evidence that Chinese ICT researchers would welcome extended funding opportunities for partnerships with Europe. It is therefore recommended that China provide more funding opportunities for Chinese researchers to develop research cooperation with Europe.

- **Research Support for Industry**

The "internal-external analysis of cooperation" in Europe and China delivers evidence that Europe and China should develop jointly funded ICT research cooperation programmes to meet the demand for ICT research cooperation from European and Chinese industries already engaged in bilateral trade and cross border production activities. Such support would intensify existing economic integration through additional research functions and thus boost the competitiveness of the European and Chinese ICT industry.

- **Dialogue**

The analysis of challenges to Chinese cooperation and the "internal-external analysis of cooperation" in Europe and China reveal the importance of political factors and related dialogues. The OpenChina-ICT consortium therefore recommends strengthening the mechanisms for dialogue in fields of ICT research.

1 Introduction

This chapter discusses the development of the internationalization of research and the reasons it is important for Europe and China to intervene publicly to facilitate their industries' internationalization of research activities. This discussion is followed by an introduction to the ICT industry and research in China and Europe.

1.1 The Growing Importance of International Research Cooperation[2]

The development of our societies and economies is facing multiple challenges defined in the Europe 2020 strategy by five key points: employment, innovation, education, social inclusion and climate. These challenges are not only of utmost concern in Europe but also need to be addressed in other world regions. If these challenges are met globally, this would provide access to the best expertise and minds available. International research cooperation is crucial to reaching breakthroughs to tackle global challenges.

Internationalization is fully impacting global R&D systems and innovation value chains are interconnected. Innovations created in Europe are always dependent upon innovations created elsewhere. The overall internationalization of R&D investments and activities is widely considered to have a positive economic impact on all of the global regions involved because of the attendant economies of scale, reverse technology transfers, market access and more.

Two types of players are driving and implementing this process. On one hand, public institutions fund researchers, research centres and enterprises to conduct international research. On the other hand, private actors invest in research abroad.

Motives for publicly subsidized, international research are the outcome of non-market political decisions to offset market failures. The market has failed when private actors' decisions are assumed to have impeded a satisfactory level of international research cooperation. Information asymmetries allow the assumption that private actors' decisions related to the level research investments are never satisfactory. This is especially true for investments in international research since additional information asymmetries arise. Public intervention to support international research cooperation is arguably always justified.

[2] This chapter consists entirely of arguments and data provided by the OpenChina-ICT European Roadmap survey.

Market-driven international research follows economic decisions, and various principles of international R&D investments can be identified. Private actors internationalize their R&D activities to support overseas production with market adjustment research. This improves market access through market responsiveness. Actors additionally gain access to new knowledge and resources. A private actor's strategy to internationalize R&D activities also depends on the characteristics of the technology involved. If a technology is tacit, is difficult to protect or if the technology's innovations are dependent upon previous research, private actors could decide against internationalizing R&D activities.[3] If products are produced in a technological field dependent upon supply chain cooperation, private actors might decide in favour of internationalizing their R&D activities.

Countries or regions with high growth rates, skilled workforces, political stability, good public infrastructures, reasonable tax rates and stable legal systems potentially attract more international R&D investments than other countries. Exact and reliable data on the internationalization of R&D activities between Europe and China are not sufficiently available. Generally, statistics confirm that the integration of R&D has increased significantly all over the world in recent years. Nevertheless, the level of internationalization of R&D activities in ICT sectors is low compared to other sectors, e.g. the pharmaceutical sector. Furthermore, the integration of R&D research between Europe and China is evidently growing. Although European private actors are spearheading this trend, more and more Chinese private actors are investing in European R&D activities.

1.2 Overview of the ICT Industry and Research in China[4]

Since commencing its open-door policy in 1978, China is now considered to have one of the fastest growing economies in the world and one of the largest future markets. In this capacity, it has achieved a series of accomplishments in its ICT industry and research.

By the Ministry of Industry and Information Technology's (MIIT) official definition, China's ICT industry consists of three sectors: the electronics and information product manufacturing industry, the telecommunications industry and the software industry.

[3]Tacit technologies are difficult to explain and, therefore, difficult to transfer.

[4]Data and arguments are based entirely on the findings in the OpenChina-ICT Chinese and European Roadmap surveys.

China's Internet users constitute nearly 25% of the world's Internet users, a significant share. The International Telecommunication Union has created the ICT Development Index to measure general ICT development by weighing the level of access to ICT, the level of ICT usage and the level of ICT skill sets for each country surveyed. Since it lacks a widespread telecommunications infrastructure, China ranks only 78th.

ICT accounted for 6% of China's GDP in 2011. The ICT sector's contribution to China's GDP rose from 1.4 trillion RMB (approximately € 168.5 billion) to 2.8 trillion RMB (approximately € 337.3 billion) from 2005 to 2011, an average annual increase of 12.3%.

The total number of employees in the ICT sector had reached 14.3 million by the end of 2010. 2.8 million of these employees were working in the telecommunications sector, 2.7 million in the software sector, and 8.8 million in the electronic information manufacturing sector. The total number of employees in the entire ICT industry accounted for 1.9% of the total employment and 4.1% of the urban employment in China.

China has three key ICT research players: state-owned research and development institutes, institutions of higher education, and private enterprises. Notable state-owned research and development institutes include the China Academy of Telecommunication Research (CATR) and the Chinese Academy of Sciences (CAS). Important institutions of higher education include Beijing University of Posts and Telecommunications, Tsinghua University, Peking University, Southeast University, Zhejiang University and Shanghai Jiaotong University. Notable enterprises include ZTE, Huawei, CETC, Lenovo, and Founder. Private enterprises in particular have been driving China's ICT research at a tremendous rate of development and growth in recent years.

1.3 Overview of the ICT Industry and Research in Europe[5]

In terms of ICT penetration, Europe is the global leader in fixed and mobile broadband availability, which reached 26% worldwide and 54% in Europe in 2011. Europe is also a leader in terms of Internet bandwidth available per Internet user and in terms of the availability of household computer equipment.

Many European countries ranked in the top of the International Telecommunication Union's 2011 ICT Development Index. According to the latest data available, the European ICT sector generated € 470 billion and thus 4% of the European Union's GDP in 2009. The most important ICT subsectors are telecommunications, computer programming, communication equipment manufacturing and electronic component and board manufacturing. Ireland and Luxembourg have the most ICT intensive economies, while Austria and Cyprus have the least ICT intensive economies in Europe. In 2009, 6.1 million people in the European Union worked in ICT sectors, representing 2.7% of EU employment. The overall level of labour productivity in the European Union's ICT sector was € 78,000 per person in 2009, but that figure differs significantly amongst different European Union member states.

A large number of ICT companies are active in Europe. Some worth mentioning are Microsoft, Hewlett-Packard, Polycot, eBay, Oracle, DELL, Capgemini, Dassault Systems, ST Microelectronics, Motorola, LG Electronics, Atmel, IBM, NXP Freescale, Nokia, Siemens, Philips, Atos Origin, SAP, etc.

In 2009, private enterprises in the ICT sectors in the European Union spent € 25 billion on research. The countries in the European Union that are most active in ICT research are Germany, Finland, France, Sweden and the United Kingdom. Over 280,000 people work in ICT research throughout Europe.

Funding of ICT R&D driven by European Union member states' public institutions in 2009 is estimated at € 5.3 billion. Countries driving public ICT R&D spending in the European Union notably are Sweden, Finland, Denmark, Germany, the United Kingdom, Spain, France, and Italy. In the European Union, ICT research has been playing a dominant role in the finalized Seventh Framework Programme, under which € 9.1 billion in funds have been dispersed.

[5] This chapter consists entirely of arguments and data provided by the OpenChina-ICT European Roadmap survey.

2 European and Chinese Research Cooperation Landscape

This chapter reviews all of the important aspects of the European and Chinese research cooperation landscape and included discussions of European and Chinese politics, trade, strategic policies and cooperation priorities.

2.1 An Overview of Cooperation between the European Union and China in Trade, Politics and Research,

Cooperation between China and Europe has undergone major changes in recent years. The following is an overview of important aspects of cooperation in trade, politics and research.

Trade

EU-China trade has changed in recent years, and China is now Europe's largest source of imports and, in turn, is an important export market.[6] In 2012, European exports to China were approximately € 290 billion and imports from China were approximately € 144 billion.[11] Today, China is Europe's second largest trading partner, just behind the United States. [10]

Overall, the European Union had a large trade deficit of approximately € 146 billion with China in 2012. The deficit was mainly caused by office and telecommunication equipment, shoes/textiles and iron/steel sectors.[10] While a few member states have rather balanced or even surplus trade with China, most have large trade deficits with China.[6]

The European Commission has multiple trade defence instruments in force to protect the European industries by imposing burdens on imports from China. According to European Commission sources, there are fifty-two anti-dumping measures and two anti-subsidy measures, which affect less than 1% of imports from China.[10][7]

[6] See: http://ec.europa.eu/trade/creating-opportunities/bilateral-relations/countries/china

[7] Such measures to reduce trade with China are often controversial and are debated among European Trade experts and EU member states (see: http://www.ft.com/cms/s/0/cb4b657c-c3d7-11e2-aa5b-00144feab7de.html#axzz2oRAuxnoX)

Chinese industry suffers from European protectionism, notably in such industrial domains as renewable energy generation, steel fasteners, footwear, solar panels, cells and wafers. [8] What is more, the European Commission has launched an anti-subsidy investigation of Chinese imports for mobile telecommunications networks and their essential elements, i.e. radio access network and mobile network core. [9]

To protect its own industries, China focuses more on non-tariff trade barriers, e.g. the introduction of country-specific standards, regulatory burdens, and export restrictions on raw materials. [10] European businesses active in China are, however, often concerned about financial issues, transparency and the predictability of the government's decisions. China has also introduced anti-subsidy and anti-dumping measures against the European Union, e.g. on x-ray security inspection equipment.[11] [10]

Policy

China is increasingly engaged in worldwide affairs and is attaining an important global political status. The European Union's China policy is:[12]

- "To engage China further, both bilaterally and on the world stage, through an upgraded political dialogue.
- "To support China's transition to an open society based upon the rule of law and respect for human rights.
- "To encourage the integration of China in the world economy through bringing it fully into the world trading system, and supporting the process of economic and social reforms that is continuing in China.
- "To raise the EU's profile in China."

[8] See: http://www.wto.org/english/tratop_e/dispu_e/dispu_by_country_e.htm

[9] See: http://europa.eu/rapid/press-release_MEMO-13-439_en.htm

[10] See: http://madb.europa.eu/madb/barriers_details.htm?barrier_id=085196&version=2

[11] See: http://www.wto.org/english/tratop_e/dispu_e/dispu_by_country_e.htm

[12] See: http://eeas.europa.eu/delegations/china/eu_china/political_relations/index_en.htm

Research

The European Union and China signed an S&T cooperation agreement in 1998. [7] It legally assured researchers from both the European Union and China free access to RTD programmes. In reality, European researchers have participated far less in China's national RTD programme than Chinese researchers have participated in the EU's Seventh Framework Programme.

In November of 2013, the European Commission and China started a new dialogue on innovation cooperation with the Ministry of Science and Technology (MOST) that is focused on research and innovation as a means of tackling social challenges and promoting sustainable growth, covering all research areas.[13] In parallel, the EC DG CONNECT is presently involved in two on-going policy dialogues with China:[14]

- The dialogue on ICT research with the Ministry of Science and Technology (MOST) is focused on mutual access to the EU's Framework Programme and China's R&D programmes.
- The dialogue on information technology, telecommunications and informatization with the Chinese Ministry for Industry and Information Technology (MIIT), is focused on the Internet of Things, Ipv6 electronic communications, green smart cities, and Internet security.[15]

Furthermore, the European Commission and Chinese ministries (MIIT and MOST) have recently created different EU-China expert advisory groups[16] on Future Internet & IPv6, Internet of Things, Smart Cities and Broadband Policy that aim to provide input to their ongoing dialogue to promote cooperation in ICT research between China and Europe.[17]

[13] See: http://ec.europa.eu/research/iscp/index.cfm?pg=china

[14] See: http://ec.europa.eu/information_society/activities/internationalrel/dialogue_coop/china/index_en.htm

[15] See:http://ec.europa.eu/information_society/newsroom/cf/itemdetail.cfm?item_id=7722&utm_campaign=isp&utm_medium=rss&utm_source=newsroom&utm_content=tpa-6

[16] Additional information can be found on: http://openchina-ict.eu/background/eu-chinese-expert-groups

[17] European expert advisory groups mainly consist of consultants from small SMEs working primarily on European projects and of experts working for some European research institutions. Chinese expert advisory groups include representatives from leading Chinese research institutions. The European Commission has not yet announced the European experts for the Smart Cities expert advisory group. (source: CATR)

In practise, researchers from the European Union and China were recently able to cooperate through the jointly coordinated but European Union-sponsored CO-REACH initiative in social sciences and through the European Union's Seventh Framework Programme. [18] The S&T Fellowship Programme, which is jointly funded by the European Union and China, has attracted European researchers to China. [19] Furthermore, researchers were able to cooperate through jointly funded, bilateral programmes that are coordinated by individual European Union member states and China.

2.2 Strategic Policies and Cooperation Priorities in China and Europe[20]

This subchapter provides a short overview of strategic policies in Europe and China relevant to ICT research and outlines official thematic cooperation priorities.

China

Chinese government officials indicated to the OpenChina-ICT consortium that China gives great importance to the development of the ICT industry since it expects development of the ICT industry to be an important way to spur economic growth and sustain social progress in China. Strategies and policies that guide and promote technology, R&D, innovation and industrial development in the ICT field in China are defined by:

- The State Council, through the Action Programme of the 12th Five-Year Plan (2011-2015) for National Economic and Social Development, and the 12th Five-Year Plan for Strategic Emerging Industries.
- MIIT through the 12th Five-Year Plan on the Communications Industry and the 12thFive-Year Plan on the Internet.

The strategy and plans are all connected with nearly every aspect of ICT, including ICT in manufacturing, the software service industry, the communications industry and information technologies, including the Internet of Things, cloud computing and mobile communications.

[18] See: http://www.aka.fi/en-GB/A/Academy-of-Finland/Media-services/Press-releases/Academy-news/CO-REACH-opens-call-for-proposals-on-social-science-cooperation-between-Europe-and-China/

[19] See: http://www.euchinastf.eu/?q=node/6

[20] See OpenChina-ICT Chinese and European Roadmap surveys for a more detailed analysis.

These strategies and plans indicate that the key directions of China-European cooperation in ICT will include the next-generation Internet, broadband mobile communication, the mobile Internet, the convergence of three networks, the Internet of Things, cloud computing, network and information security, integrated circuit, electronic components, and computer software.

Europe

The European 2020 strategy's main objective for ICT research is to support the development of the ICT industry and ICT research in order to increase Europe's technology competitiveness.

The digital agenda for Europe defines policy targets for ICT research and development in detail[21] and consists of the seven pillars[22] of reducing the market barriers for digital services, supporting interoperability, data protection, development of ICT infrastructures, the reduction of fragmentation in ICT research, overcoming the digital divide and increasing IT capabilities to support the everyday lives of people.

Economic models demonstrate that its high growth rates, developed educational landscape and competitive business environment make China a preferred country for European research cooperation, ahead of other threshold countries such as India, Russia or Brazil.

The European Union employs a consensus process to prioritise research topics. At present, the European Commission has identified pervasive and trusted network infrastructures, cognitive systems, and ICT for a low-carbon economy as its priorities of ICT research cooperation in China. [23]

[21] See http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=home

[22] See http://ec.europa.eu/digital-agenda/en/our-targets

[23] Compare to the Morton Möller presentation during the OpenChina-ICT Dialogue Conference in November 2012 in Beijing.

3 Status of Cooperation

This chapter provides an in-depth review of Chinese and European cooperation programmes open for cross-national participation, principles for Chinese and European researchers' participation in these programmes, and bilateral cooperation between European Union member states and China. It also reviews existing forms of cooperation and analyses internal-external attributes of cooperation.

3.1 Existing Cooperation Policies

3.1.1 Policy Mechanism and International Research Cooperation Programmes in China in ICT Open to European Entities

The highest national executive branch in China, the State Council, is responsible for planning and developing national industries. As far as ICT is concerned, the State Council mainly guides the macroeconomic development and planning of ICT-related industries. Agencies specifically responsible for ICT-related R&D and industrialization are the National Development and Reform Committee (NDRC), the Ministry of Science and Technology (MOST), and the Ministry of Industry and Information Technology (MIIT). These agencies develop and oversee programmes that also support ICT research. Current Chinese research cooperation policies and programmes that are open to foreign participation and include ICT elements are:

- MOST's 973 Plan, also known as the National Basic Research Program, is intended to facilitate technological achievements in various fields of science.[24] In keeping with the Science and Technology Cooperation Agreement between China and Europe, research projects in the 973 Plan are also open to partnerships with European entities.
  Although the exact number of 973 programmes and details about them remain confidential (as directed by Chinese authorities), there are reportedly quite a few.

[24] See www.most.gov.cn

- MOST's International Science and Technology Cooperation Programme (ISTCP) is intended to encourage researchers to establish extensive and intensive international cooperation and exchange with top researchers and research institutions around the world. It is also intended to promote substantial global research activities on cutting-edge areas as well as to stimulate Chinese researchers to participate in and initiate bilateral/multilateral research cooperation to take full advantage of international research resources.

  European entities and Chinese entities have collaborated in numerous ISTCP projects completed. ISTCP has provided over RMB 91 million (approximately € 10.9 million) of funding to 456 projects in which European entities have participated (2006-2010). The EU member states involved in the most projects were Germany (123), the UK (67), Italy (45), France (44), Finland (27), and Sweden (24).

- NSFC policy on National Science Foundation projects governs the funding of projects in most scientific disciplines.[25] Given the interdisciplinarity of scientific and technological issues in the information field, the NSFC's Department of Information Science pays special attention to cross-disciplinary research in mathematics, chemistry, bioscience, pharmaceutical sciences, material science, earth science and management. It encourages experts to cooperate internationally to develop solutions for common issues of international, cutting-edge science and technology. The NSFC's international cooperation projects are primarily international (bilateral), collaborative research projects and international (bilateral) cooperation and exchange projects.

  The NSFC has supported the following areas of international cooperation on ICT research, by: mobile network and applications, space-sky-earth network and information processing, network information processing and applications, visual/aural information perception computing, the theory and technology of virtual reality and trustworthy software, the scientific application of e-health, green communication networks, high-performance computing for significant demands, the visualization of complex industrial processes, and the evolution of human-machine interaction.

  The NSFC has invested an estimated 10-15% of its budget in international cooperation and has increased the funds it disperses at an annual rate of 20% in recent years). European entities were involved in 279 of the NSFC's Joint Research Programme projects, with a total budget of RMB 237 million (approximately € 30 million) from 2006 to 2011.

[25] See: www.nsfc.gov.cn

- The Chinese Academy of Science supports international cooperation with foreign partners to a limited extent through various government agencies' budgets. [26] Activities include exchange visits, high-level strategic academic symposia on frontier research, and recruitment projects intended to attract talented professionals from abroad to China.[27]

  To this end, the CAS has established formal contacts with major European Union research and academic organizations and has concluded over seventy academic cooperation agreements and over seven hundred institutional agreements with some forty countries worldwide.

- MIIT[28] and NDRC[29] are promoting ICT research on various subthemes of ICT. Respective calls are published on their websites. EU organizations interested in participating in MIIT research programmes are advised to establish a relationship with a trusted Chinese partner in order to receive the information necessary to participate in MIIT-funded programmes.

  Detailed data on European participation in MIIT and NDRC programmes was unavailable in the OpenChina-ICT project.

Unlike the aforementioned Chinese research programmes open for participation by foreign researchers, the 863 National High-Tech R&D Programme coordinated by MOST is not open for participation by European researchers. Although the 863 National High-Tech R&D Programme includes significant ICT elements, it is treated as confidential.

To facilitate participation of European partners in Chinese-funded research programmes, the European-funded ChinaAccess4EU project provides extensive information on participation procedures, which can be found online.[30] The ChinaAccess4EU website informs visitors about research funding programmes, programme launches, structures and research topics, budgets, rules of participation and funding, deadlines, application procedures, and evaluation criteria. A database of potential partners from Chinese universities, research institutions, and industries can be found on the Sociedade Portuguesa de Inovação's (SPI Portugal) website.[31]

[26] www.english.cas.cn

[27] See: http://english.cas.cn/ACAS/BI/200908/t20090825_33882.shtml

[28] www.miit.gov.cn

[29] www.ndrc.gov.cn

[30] www.access4.eu/China/274.php

[31] http://www2.spi.pt/chinafrontier/database.asp

However, there are indications that the participation of European entities in programmes coordinated by China is limited. The OpenChina-ICT consortium identified the following general burdens hindering greater European participation in programmes coordinated by the Chinese:

- The lead applicant must usually be Chinese. Applications must be submitted in Chinese, which presents a potential language obstacle.
- European entities usually have to have prior experience with cooperation with Chinese partners, a permanent representation in China, or, at the least, an established partnership with a Chinese entity.
- Selection procedures lack transparency.
- Chinese ministries tend to place little importance on promoting European participation in Chinese-funded programmes.
- Chinese institutions often give European institutions only the role of a service provider of additional know-how.

3.1.2 Policy Mechanism and International Research Cooperation Programmes of the European Commission in ICT Open to Chinese Entities[32]

In the European Union, thematic research priorities identified in a work programme are defined by a consensus process involving the European Council, the European Parliament and the European Commission.

ICT research in the European Union is always an important aspect of the main European research programmes such as Horizon 2020 or the finalized Seventh Framework Programme. The European Commission prepares and adopts annual work programmes for ICT research based on the overall objectives specified by the Digital Agenda and the Seventh Framework Programme or Horizon 2020, which specifies detailed topics.

The European Commission published its first ICT work programme for the upcoming Horizon 2020 in December 2013. Topics are: [33]

- New generation of components and systems, including micro/nano-electronics and photonics technologies, components and embedded systems engineering
- Next generation computing, advanced computing systems and technologies

[32] See the OpenChina-ICT European Roadmap survey for more details and references.

[33] See: http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/calls/h2020-ict-2014-1.html

- Infrastructure, technologies and services for the future Internet
- Content technologies and information management, including ICT for digital content and creativity
- Advanced interfaces, robotics and smart spaces

European policymakers stipulated that international research cooperation in the upcoming Horizon 2020 must fulfil the requirements of (a) Strengthening the European Union's excellence and attractiveness in research and innovation, as well as strengthening the European economic and industrial competitiveness, (b) Tackling global societal challenges or (c) Supporting the European Union's external policies. [5]Generally, this means that: [5]

- When funded by Europe, international cooperation in Horizon 2020 should create a win-win situation, be of mutual benefit, provide Europe access to external sources of knowledge, attract investments beneficial to Europe, create access for European technology to new and emerging markets, and share common standards for research and exploitation.
- European-funded international research can be supported when global challenges are addressed more effectively by using the best talent and knowledge from other world regions.
- International cooperation can also be supported financially when wider policy goals of the European Union's external strategies, such as enlargement, neighbourhood, trade, common foreign and security policy, humanitarian aid, and development policies are strengthened.

The Strategic Forum for International S&T Cooperation (SFIC), consisting of member states' representatives, is an important actor when it comes to the development of specific research activities with third countries such as China.[34]

Cooperation Instruments:

[34] See: http://ec.europa.eu/research/iscp/index.cfm?pg=sfic

In the majority of cases, the European Commission intends to promote international research cooperation in the future through reciprocal access or funding instruments, which require funding from both participating regions/countries. In a program, these can be coordinated calls (separated proposal evaluation leads to common projects), joint calls (common proposal evaluation leads to common projects) and joint programmes (a set of common calls on different challenges leads to a set of common projects on different challenges). [8][9]

Other instruments in a non-project context could be joint funding of research infrastructures, exchange programmes, and grant and fellowship programmes. Instruments only funded by Europe in order to strengthen the competitiveness and research base of its technology-driven industry abroad are information and brokerage services abroad and specific cooperation programmes aimed at creating market opportunities for innovation, and/or commercialization. [8][9]

Chinese Participation in European-Funded ICT Research:

Although Horizon 2020 will be open to participants from around the world in principle, not all entities from "third" countries will be eligible for funding. Funding will be restricted according to the gross national income (GNI) per capita in combination with the overall gross domestic product (GDP). Thus, China and other BRIC countries will not have automatic access to Horizon 2020 since the Chinese per capita GDP and GNI will exceed the limits. Nevertheless, some dedicated calls for European-funded projects in the ICT Horizon 2020 will presumably be opened to Chinese participation, depending on the overall political circumstances.[35] Information on opportunities for funding projects with Chinese partners will be provided in the respective ICT work programme, which can be found on the ICT Horizon 2020 website.[36]

[35] At the moment, China is one of the countries mentioned as a potential country for cooperation under the objective of Advanced 5G Infrastructure for Future Internet (ICT14)- Source: European Commission

[36] See: http://ec.europa.eu/research/horizon2020/index_en.cfm

Unlike the new European Research Framework Programme Horizon 2020, access to the closed Seventh Framework Programme for non-European entities has been subject to fewer conditions and has been less limited. Third country participation has been strongly encouraged. Table 1 presents the number of projects with third-country participation in FP7-ICT and FP7 research infrastructures ranked by the country of origin. [37] China ranks second in participation. The European Union has funded a total of forty-three distinct FP7-ICT projects with thirty-nine distinct Chinese partners. The European Union has funded six distinct projects with eight distinct Chinese partners in the research infrastructure.[38]

The European Roadmap survey of the OpenChina-ICT project lists most of the Chinese projects funded under FP7-ICT.

Until now, Chinese partners have received € 4,257,112 in funding in FP7-ICT and research infrastructures.[39] Projects with Chinese participation have primarily focused on pervasive and trusted network and service infrastructures, technologies for digital content and languages, and ICT for creativity and learning. [40] Most of the European-funded projects with Chinese participation have been dedicated to road-mapping (similar to OpenChina-ICT) and partnership building. Some have been dedicated to foundational research. Very few projects have had a real industry focus. [41]

[37] FP7 research infrastructure projects often included ICT elements.

[38] Source: European Commission, 28 February 2014

[39] Source: European Commission, 20 November 2013

[40] See the OpenChina-ICT European Roadmap survey for a more detailed analysis.

[41] See the OpenChina-ICT European Roadmap survey and the detailed overview of all funded projects.

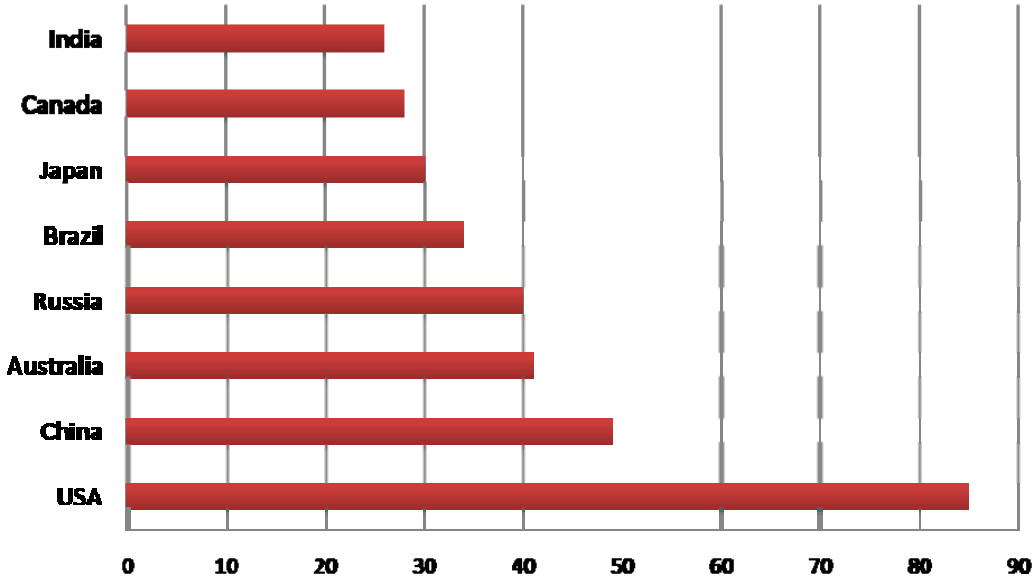


Table1: Third country participation in FP7-ICT[42]

3.1.3 Bilateral Cooperation between China and European Union Member States[43]

According to the European Commission, bilateral initiatives focus mainly on joint projects and scientific exchanges, conferences, workshops and researcher travel. [1] The Chinese institutions MOST, CSC, NSFC, CAS and NDRC are involved in the development of such initiatives. [44] Since China is a preferred country for European research cooperation, the European Commission and European Union member states presumably have strong motivations to develop bilateral and/or trilateral (via the European Commission) research relationships with China. European Commission documents confirm this. [1][3] China's motivation can therefore be assumed to be the crucial criterion for bilateral, vertical integration for European Union member states in research.

A detailed overview on bilateral research relationships between China and select European Union member states is contained in Annex I.

[42] The table is based on data provided via e-mail by the European Commission, 28 February 2014.

[43] Since bilateral cooperation often does not distinguish between ICT and other research; this section examines bilateral, cross-disciplinary research cooperation. Most bilateral cooperation is assumed to include contains ICT research.

[44] European Union member states' institutions are not listed since a list of institutions from all twenty-eight European Union member states involved in the development of bilateral research relationships with China would be too lengthy.

Table 2 provides an overview of EU member states' and China' integration of bilateral research based on accessible information on bilateral S&T cooperation agreements, signed MoUs, regular dialogues/expert group meetings, joint labs/institutes and joint calls.[1][3] Information was gathered on twenty European Union member states' bilateral research relationships. [45] The twenty countries are ranked according to the World Economic Forum's 2013 Global Competitive Ranking. [46][4]

All of the European Union member states listed have signed bilateral S&T cooperation agreements and thus have some form of bilateral research relationship with China. A review of the level of integration of the European Union, represented by the European Commission, reveal that some European member states have better developed research relationships with China than the European Union has.

Various qualitative and quantitative factors motivate China to pursue integration. One influencing factor apparent in the table is the economic development level of each European member state, as measured by the Global Competitive Ranking.

China is interested in launching jointly funded research cooperation with technologically advanced European countries, whereas cooperation with less developed European countries can still be developed. This indicates that integration of underdeveloped research between the European Commission and China is related to the major differences in competition in Europe. Since competitiveness is evidently a crucial factor for China when developing research cooperation, it can also be assumed that European funded-research in China is not perceived to be competitive.

[45] Data collected by the European delegation in China from European Union member states' embassies in China. Chinese authorities do not publish such data in sufficient quantity.

[46] As explained in the OpenChina-ICT European Survey (Chapter 3.4), the World Economic Forum's Global Competitive Index measures the competiveness of 148 countries worldwide on the basis of twelve pillars including, among others, innovation and education.

MS (ordered by Global Competitive Rank)	Cooperation Agreements	Signed MoUs	Regular Dialogues/ Common Expert groups	Joint Labs/ Institutes	Joint Calls
Finland Rank: 3	x	x	x	x	x
Germany Rank: 4	x	x	x	x	x
Sweden Rank: 6	x	x	x		
Netherlands Rank: 8	x	x	x	x	
United Kingdom Rank: 10	x	x	x	x	x
Denmark Rank: 15	x	x	x	x	x
Austria Rank: 16	x	x	x	x	x
Belgium Rank: 17	x	x		x	
Luxembourg Rank: 22	x				
France Rank: 23	x	x	x	x	x
Ireland Rank: 28	x				
Estonia Rank: 32	x				
Spain Rank: 35	x	x		x	
Poland Rank: 42	x		x		
Czech Republic Rank: 46	x		x		
Italy Rank: 49	x	x		x	
Lithuania Rank: 52	x			x	
Slovenia Rank: 62	x		x		
Hungary Rank: 63	x		x	x	
Greece Rank: 91	x		x		x
European Union	x		x		x

Table2: Bilateral research integration [1][3][47]

3.2 Experience with Cooperation

3.2.1 Forms of Cooperation

Chinese and European cooperation in ICT research assumes different forms, including but not limited to visiting scholar/researcher programmes and student exchanges, joint corporate research and development centres, and government dialogues/cooperation projects.

[47] The table only presents general data. The number of individual criteria analysed (e.g. the number of bilateral calls, signed MoUs, etc.) is not reported.

Visiting Scholar/Researcher Programmes and Student Exchange

The Chinese government attaches great importance to international communication and cooperation among talent in the ICT fields. The China Scholarship Council (CSC) organizes multidimensional state-sponsored talent exchange activities between European countries and China. The CSC has explicitly made ICT a study abroad field that is supported financially by the state.[48] The Chinese Scholarship Council sponsors Ph.D. or joint Ph.D. programmes, visiting scholar and senior research scholar programmes and other academic exchange programmes (Master's, short-term scholars and undergraduates).

China has continuously increased the number of state-sponsored academic exchanges. In 2010, CSC recruited a total of 13,038 candidates for all types of state sponsored study abroad programmes. 5,960 of the grantees were in Ph.D. and joint Ph.D. programmes, 5,677 were visiting scholars and senior research scholars, and 1,401 fell into other categories (Master's, short-term scholars and undergraduates).[49]

Europe has several support programmes for European and Chinese researchers and students to study or research abroad in either Europe or China. The best known programme is Erasmus Mundus. Additionally a wide variety of bilateral initiatives between EU member states and China exist.

One is the CSC and DAAD (German Academic Exchange Service) science and technology cooperation programme.[50] Germany and China co-fund student and researcher exchanges between German and Chinese academic and scientific institutions.

Another is the French-Chinese Cai Yuanpei programme, launched in 2009, with the objective of developing high-standard scientific and technological exchanges between laboratories in both countries.[51] The programme funds the exchange of researchers from both countries, who already have relevant experience with cooperation, in order to enable them to meet researchers in each of the other country's research programmes. Roughly twenty collaborative research projects are funded each year. Priority areas are ICT, energy resources, agriculture, and manufacturing.

[48] See: http://www.csc.edu.cn/chuguo/dafb6ac35dbd477dbe1ba87a6e03a4cd.shtml

[49] See: http://www.csc.edu.cn/Nianbao

[50] See: https://www.daad.de/de/index.html

[51] See: http://www.campusfrance.org/fr/caiyuanpei

Joint Corporate Research and Development (R&D) Centres

(1) EU corporate R&D centres in China

Multinational companies started establishing R&D centres in China in the mid-1990s. Reducing R&D costs, conducting research to modify products for Chinese market requirements, improving market access, improving corporate image in China are some of the motives behind such investments.

According to statistics from the Ministry of Commerce of China, multinational companies had over 1,200 R&D centres of in China at the end of 2009, in which they invested US$12.8 billion (approximately € 1 billion). These are mainly in the Shanghai, Beijing, Guangdong, Jiangsu and Zhejiang provinces.

Investments targeted technology-intensive industries, including electronics and telecommunications, biomedical, transport, chemical, and software design.[52]

In the ICT sectors, global operating telecommunications enterprises, e.g. Ericsson and Nokia, have established R&D centres in China. These R&D centres are mainly located in cities with abundant labour resources, e.g. Beijing, Shanghai, Guangzhou, and Shenzhen.[53]

The Chinese government has created various incentives, including subsidies and tax exemptions, to encourage the establishment of foreign R&D centres in China.

(2) Chinese corporate R&D centres in Europe

Chinese enterprises establish overseas R&D centres in order to increase market access, access technology, and enhance innovation capabilities. The number of overseas R&D centres established by Chinese companies has been increasing recently. Based on data from the OpenChina-ICT partner CATR, in 2010, sixty Chinese companies had 106 R&D centres established overseas, chiefly in developed countries and regions, including North America, Europe and Japan. Huawei Technologies Co. Ltd, ZTE Corporation, and Haier Group are important actors from the ICT industry hereby.

[52] See: http://finance.people.com.cn/GB/11156914.html

[53] See: http://jjckb.xinhuanet.com/wzyw/2009-01/19/content_139370.htm

Huawei has seven overseas R&D centres. Two are located in Sweden - one established in Stockholm founded in 2000 and the other established in Gothenburg in 2009. These R&D centres primarily work on fundamental research. [54] Huawei's overseas branches are gradually switching from technical development to fundamental research. In 2011, Huawei, Vilnius University of Lithuania and the Lithuanian telecommunications company OMNITEL concluded a declaration of intent to cooperate on establishing a joint laboratory at the University of Vilnius. ZTE has also established R&D centres in France and Sweden.

European Union-China Dialogue and Cooperation Projects

China has been an active participant in all 10 thematic priorities of FP7, including ICT. Details of the participation of Chinese entities in FP7-ICT research are presented above. Most of the Chinese participants in FP7 have been universities, colleges and state research institutes.

Additionally, in order to support exchange and cooperation between their ministries in certain fields, the European Union and China have launched several cooperation and development support projects, e.g. the EU-China Information Society Project, the EU-China Trade Project (EUCTP I and II), and the EU-China Policy Dialogue Facilitate Project (PDSF I and II phases). The cooperation and development support projects share a common background and principles:

- The European Commission and the Chinese government jointly established development projects with various objectives and intended to last several years. For instance, DG INFSO of the European Commission (now DG CONNECT) and the State Council Informatization Office of China (now under the purview of the Ministry of Industry and Information Technology) established the EU-China Information Society Project (2005-2009) to advance policy exchange and cooperation in ICT fields.
- Project offices are established in China to facilitate the implementation of said projects. The European Union generally funds the offices, while the organizations that run them are selected by bidding from European Union companies. European companies send senior managers and experts to China. Some employees are hired locally.
- Generally, the implementation office drafts an annual or quarterly work plan based on talks with the European Union and Chinese authorities. It then recruits staff with pertinent expertise in order to implement the plan. Activities include research, study trips and training programmes.

[54] See: http://www.huawei.com/cn/

Specific EU-China cooperation projects are implemented based on the actual needs of authorities in the European Union and China. Projects facilitate understanding and cooperation among European and Chinese stakeholders.

3.2.2 Challenges of Cooperation

Challenges and obstacles that hinder efficient cooperation may arise when researchers from different geographical and cultural backgrounds are collaborating on research. Such challenges have to be identified and addressed if cooperation is to produce effective results.

Challenges faced by Chinese and European ICT researchers cooperating or willing to cooperate with each other were identified and analysed in the OpenChina-ICT project. Chinese researchers with experience in collaborating with European researchers on ICT research were been surveyed. European coordinators of FP7-ICT research projects with Chinese partners in their consortia were also surveyed.

Chinese Challenges:

The OpenChina-ICT Chinese Roadmap survey questioned researchers about challenges of policy, culture, information channels, funding and technology. They found all of the challenges to be important. The three most relevant challenges that hinder effective ICT research cooperation with European partners are:[55]

- Policy Challenge

  Policy is the largest barrier for Chinese researchers, who wish to participate in European Union projects. Chinese and the European Union policies cover human rights, environmental protection, bilateral/multilateral trade, and China-EU economic cooperation. Smooth China-EU cooperation in ICT hinges on respective policy issues. If China and the European Union can reach agreements on macro-policies, then a harmonious, stable environment for political and economic cooperation can be created for both. This would pave the way for smooth and beneficial China-European Union cooperation and exchange in many aspects of ICT. Responses to the questionnaire revealed that trade agreements and trade disputes between China and the European Union are the primary concerns of Chinese experts and researchers in the ICT field.

[55] The selection of five potential challenges is a result of internal brain-storming and had been predefined in preparation of the Chinese questionnaire, as open questions are not common in China.

- Funding Challenge

  Funding of cooperation between China and Europe in the ICT field constitutes a second challenge. Potential sources of funding are government funds and private investment funds. Most Chinese respondents from universities, academies and institutions identified government funds as the primary source of support for Chinese-European research cooperation. Chinese researchers should consider working with the private sector to acquire more financial support for European-Chinese ICT research to meet this challenge. It is also advised that the Chinese government provide more funding to support Chinese-European ICT research cooperation.

- Information Channels

  The information channels used to access public funding for Chinese-European research cooperation in ICT are limited. The analysis revealed that cooperative projects such as OpenChina-ICT are the most important information channels for Chinese researchers that participate in European research projects. Other information channels include the Chinese government's website, the European Union's website, networks and European partners. Existing options for funding opportunities ought to be promoted better to meet this challenge.

European Challenges:

European researchers who have coordinated and worked on or are coordinating and working on European-funded ICT research projects with Chinese partners were asked to identify cooperation strengths, weaknesses, risks and threats.[56] On the basis of their responses, the following European challenges were identified:[57]

- Cultural Challenges

  Cultural challenges are applied here to denote the difficulties that European researchers have understanding Chinese approaches to work, internal organizational structures and informal hierarchies. If joint research projects are to be completed effectively, it is important that European researchers better understand their Chinese partners' work cultures and receive guidance during the early stages of joint European-Chinese projects.

[56] See the OpenChina-ICT European Roadmap survey.

[57] All of the weaknesses and threats cited in the internal and external analysis of European cooperation were assessed to determine whether they constitute relevant challenges to cooperation.

- Legal Challenges

  Legal challenges are applied here to denote unclear import and export regulations and European reservations about law enforcement in China. European and Chinese laws are not always easy to understand or to comply with, particularly in research in high-tech fields. In addition, some European entities worry about their capability to enforce contractual rights in China. Legal challenges can be an obstacle to involvement in European-Chinese ICT research. This obstacle could be reduced if potential participants were better informed about legal options and regulations.

- Intellectual Property Challenge

  Although none of the European entities surveyed had their intellectual property rights violated during an EC-funded ICT research project with Chinese partners, most European entities involved in ICT research with Chinese partners indicated that intellectual property protection is an important challenge. Funding agencies ought to inform European research entities better about real situations and means to protect their intellectual property rights.

A more general analysis of challenges hindering the establishment of international cooperation from a European perspective is provided by the official European CREST Forum, cited in the OpenChina-ICT European Roadmap survey.[2] The Crest Forum identified challenges to cooperation stemming from insufficient information about respective S&T landscapes in Europe and the potential cooperation country, insufficient intellectual property regulations in third countries, and travel burdens arising from visa procedures and social security arrangements for researchers. Other challenges identified at the forum are the lack of bilateral funding schemes to solve common scientific questions, legal issues related to the export/import of “know-how” and research equipment, complex legal regulations for establishing joint institutes, and the lack of know-how/expertise in potential partner countries.

Therefore, challenges to cooperation, e.g. intellectual property rights, culture, funding and legal aspects, arise not only between China and Europe but also between China and other countries and regions.

A comparison of the challenges to cooperation identified in China and Europe reveals that Europeans feel more challenged by aspects that ensue directly from cooperation. Chinese researchers, on the other hand, are challenged more by access to funding and information, and by general political issues that hinder cooperation.

One reason for this difference could be that it has been easier for European researchers to establish collaborative relationships with Chinese partners since FP7 was opened fully to Chinese participation. Since the Chinese government has historically not provided the funding needed to establish collaborative research with European partners, Chinese researchers, on the other hand, have had to rely on their partners in Europe to establish cooperation.

3.2.3 Internal-External Analysis of Cooperation

An internal-external or SWOT (strengths, weaknesses, opportunities and threats) analysis of Europe and of China was conducted to examine important factors of cooperation and to identify significant attributes of cooperation.

In OpenChina-ICT, the internal factors (strengths and weaknesses) and the external factors (opportunities and threats) were analyzed on the basis of the following parameters:

- The object of analysis is the Chinese-European ICT research cooperation landscape.
- The goal of analysis is to improve the cooperation mechanisms of the Chinese-European ICT research cooperation landscape.
- Factors identified in the "internal-external analysis" are based on subjective experiences and expectations of the population surveyed. Factors incorporate all of the attributes that the interviewed population considers to be important for the cooperation mechanisms of the Chinese-European ICT research cooperation landscape. Identified factors therefore cover a wide expanse of the cooperation ecosystem, e.g. project experience, policy issues, market implications, technological aspects, social behaviour, etc.
- Factors identified in the **internal analysis** reflect attributes that the population surveyed has observed or identified as a direct (internal) feature of cooperation. The identified factors are therefore generated by cooperation itself and are influenced or controlled by actors in projects, partnerships and cooperation.

  The strengths reflect attributes that the population surveyed feels have a positive impact on improving cooperation mechanisms of the Chinese-European ICT research cooperation landscape. Thus, identified strengths justify actions to reinforce the landscape.

Weaknesses are factors of cooperation that are perceived to have a negative impact on improving the cooperation mechanisms of the Chinese-European ICT research cooperation landscape. Thus, identified weaknesses do not justify actions to reinforce the landscape.

- Factors identified in the **external analysis** reflect socio-economic attributes that the population interviewed has observed or identified as external features influencing the Chinese-European ICT research cooperation landscape. The reflected attributes cannot be influenced directly or controlled by actors of projects, partnerships or collaborations.

  Opportunities are perceived exogenous circumstances that facilitate improvement of cooperation mechanisms.

  Threats are perceived exogenous circumstances that do not facilitate improvement of cooperation mechanisms.

Since the external analysis and the internal analysis each has a different dimension, they both may contain factors with a similar context.[58]

Contradictory factors in the external or the internal analysis may indicate that either the population surveyed had opposing views or that a factor was identified but ranked insignificantly. [59]

Chinese SWOT Analysis

The Chinese SWOT analysis was developed at a workshop in Beijing in February of 2013, which was attended by representatives from the Chinese MIIT and MOST ministries and supported by CATR. The discussion was moderated by the main author of this EU-China ICT Cooperation Plan, Kay Matzner from the Fraunhofer-Gesellschaft in Germany.

[58] The identification of the factor of market access in both the internal and the external analysis cooperation, for example, would mean cooperation would bring about market access and improved cooperation mechanisms would additionally do the same.

[59] The identification of the factor of market access as a strength but limited market access as a weakness, for example, would mean either that the population surveyed had contrary views or that, although cooperation would lead to it, the level of market access would be unsatisfactory.

The SWOT concept, as described above, was explained at the beginning of the workshop. Following active and intensive discussion of each of the sections – strengths, weaknesses, opportunities and threats – all of the attendees provided input by filling out a card, which they then individually presented and explained. Afterward, the cards were affixed to a white board. Implications of hierarchy were avoided by having Chinese participants higher up the hierarchy present their ideas to participants after those participants lower in the hierarchy.

At the close of the strategy workshop, a summary of all of the results was presented and discussed once more by the attendees. Once the strategy workshop had ended, all of the findings (identified factors) were summarized in writing and distributed to the attendees, who confirmed their correctness.

Internal Analysis: Strengths	Internal Analysis: Weaknesses
• Accessing European know-how in ICT • Gaining European market access for the Chinese industry • Learning from European research implementation and management procedures • Supporting European-Chinese production value chains through research support • Training of Chinese researchers • Development of common solutions for global challenges • Good Chinese – European relations are a strong base for fruitful common research	• Language and cultural barriers hinder fruitful exploitation of research cooperation • Limited market access in Europe for Chinese enterprises hinders fruitful exploitation of research cooperation • Educational shortcomings in parts of Europe • Unclear advantages for Chinese industry • Low quality of European Commission-funded research • EC administrative procedures are too difficult • Different IPR approaches in European and Chinese research programmes • Difficulties in defining common goals with DG CONNECT

External Analysis: Opportunities	External Analysis: Threats
• Gaining market access in Europe • Implementing Chinese standards in Europe • Access to European human resources • Access to European know-how and technology • Understanding advanced European methodologies • Enhancing the general relationship between Europe and China • Improving the experiences of Chinese researchers • Improving Chinese research capacities	• Losing control of Chinese IPR • Brain-drain in favour of Europe • Losing contact to other global research nations • Losing exclusivity of Chinese data and, therefore, creating competitive disadvantages for China • Losing Chinese resources for European projects with questionable outcomes

Table 3: Chinese SWOT analysis

Validation of the Chinese SWOT Analysis in OpenChina-ICT Thematic Workshops

The Chinese SWOT analysis was presented to and discussed by the attendees of the first and second OpenChina-ICT thematic workshops in Guangzhou (May 2013), which was dedicated to smart and sustainable cities, and in Beijing (August 2013), which was dedicated to the Internet of Things and the Future Internet.

Attendees confirmed the factors of the Chinese SWOT analysis during workshop discussions.

In order to more credibly validate the SWOT analysis, attendees of the thematic workshops were asked to complete a questionnaire indicating whether or not they supported the findings of the SWOT analysis (see Annex II). The results of the questionnaire validation are summarized below.

Strengths:

The attendees of the Guangzhou workshop confirmed all of the strengths identified since they were all weighted with 3 or higher. The strength "Gaining European market access for Chinese industry" was ranked lowest and the strength "Good Chinese-European relationships are a good base for fruitful common research" highest.

The attendees of the Beijing workshop confirmed all of the strengths identified since they were all weighted with 3 or higher. The strengths “Training of Chinese researchers” and “Supporting European-Chinese production value chains by research support” was ranked lowest and the strength “Learning from European research implementation procedures” highest.

The strengths identified in the Chinese SWOT analysis were fully validated by attendees of both workshops.

Weaknesses:

The attendees of the Guangzhou Workshop confirmed almost all of the weaknesses identified. Since it received a ranking of 2.9, only a minority of workshop attendees confirmed the weakness “Educational shortcomings in some parts of Europe”. Among the weaknesses ranked above 3, “Unclear Advantages for Chinese Industry” and “Low quality of European-funded research” were ranked lowest. The weakness “EC administrative procedures are too difficult” was weighted highest.

The attendees of the Beijing Workshop took a neutral view of the weaknesses “Educational shortcomings in some parts of Europe” and “Low quality of European-funded research”. Furthermore, the weakness “EC administrative procedures are too difficult” was rejected since it received a ranking of 2.7. Among the confirmed weaknesses, the weakness “Difficulties to define common goals with DG CONNECT” was ranked lowest and the weakness “Different IPR approaches in European and Chinese research programmes” highest.

In conclusion, weaknesses received similarly high and low rankings in both workshops. The weakness “Educational shortcomings in some parts of Europe” was ranked neutrally in one workshop and not validated at all in the other. In addition, the weakness “EC administrative procedures are too difficult” was rejected in Beijing was ranked highly in Guangzhou. Since a relevant share of the workshop attendees nevertheless considered both of these weaknesses to be relevant, they will remain in the Chinese SWOT analysis and thus be part of the other analysis.

Opportunities:

On average, the attendees of the Guangzhou Workshop confirmed nearly every one of the opportunities identified. They only had a neutral view of the opportunity: “Implementation of Chinese Standards in Europe”. The opportunity “Enhancing General Relationship between Europe and China” received the most support.

The attendees of the Beijing Workshop confirmed all of the opportunities identified, since they all had an average ranking of 3 or more. The opportunity "Access to European Human Resources" received the least support, the opportunity "Enhancing General Relationship between Europe and China" the most.

Thus, the attendees of both workshops fully validated the opportunities of the Chinese SWOT analysis. The opportunities validated or not validated by attendees was similar at both workshops.

Threats:

The attendees of the workshop in Guangzhou did not confirm the majority of threats identified. They only validated the threat "Losing Control of Chinese IPR", which received an average ranking of 3.

On average, the attendees of the workshop in Beijing confirmed all of the threats identified. The threat "Losing Chinese resources for European projects with questionable outcomes," received the least support, the threat "Losing control of Chinese IPR" the most.

The attendees of the workshop in Guangzhou and the attendees of the workshop in Beijing did not validate similar threats. The four threats not validated at the Guangzhou workshop were fully validated at the Beijing workshop. As positively validated in Beijing, the threats that were not validated at the Guangzhou workshop have been retained in the SWOT analysis for further analysis. Further analyses will have to make allowance for the possibility that Chinese researchers might have divergent views of threats.

Summary and Findings of the Chinese Internal-External Analysis of Cooperation

The aggregate strengths of cooperation, which provide a justification for improving cooperation mechanisms, reveal a multitude of benefits for China and Chinese researchers. China could improve its market access and strengthen its industry, and Chinese researchers and research administrations could accumulate new knowledge. The validation at the workshops reveals that the general relationship between Europe and China is an important aspect of cooperation, which improves research cooperation. What is more, the attendees of both workshops felt that China would especially profit from the knowledge acquired from European research implementation and management procedures.

On the other hand, several weaknesses of research cooperation were identified, which would not justify improving cooperation mechanisms for China.

Weaknesses include cultural differences, differing Chinese and European strategies, the low-quality of European-funded research and the absence of technology in it, and legal uncertainties.[60] The validation at both workshops identified complicated administrative procedures and different IPR regulations as major weaknesses of cooperation.

The external opportunities that would facilitate improvement of cooperation mechanisms would equally improve the quality of Chinese research and Chinese-European political dialogue and have a positive effect on the Chinese economy. The attendees at both workshops strongly felt that improved cooperation mechanisms would improve the general political relationship between Europe and China.

The external threats that would not facilitate improvement of cooperation mechanisms are related to know-how transfer from China to Europe, loss of control of unique testing facilities in China, and European-funded research's poor reputation in China. The validation at both workshops revealed that the loss of Chinese IPR and misspending of Chinese resources are especially viewed as major threats.

European SWOT

The European SWOT analysis was compiled from phone interviews of coordinators of FP7 ICT projects with at least one Chinese partner in the consortium. The concept of the OpenChina-ICT SWOT analysis was explained at the beginning of the interviews, before any questions were asked. Unique strengths, opportunities weaknesses and threats identified by coordinators are cited individually. The full interviews are included in the OpenChina-ICT European Roadmap survey.

[60] Several attendees indicated that they feel that European Commission-funded research neither delivers nor develops world-class technology and new research.

Internal Analysis: Strengths	Internal Analysis: Weaknesses
• Know-how inflow coming from Chinese partners. • Cheaper research services • Widespread dissemination possibilities in China • Potential market access • Use of testing possibilities not available in Europe. • Implementation of European standards in China • Better understanding of the Chinese research system	• Different work cultures lead to irritations, delays and significant communication and management efforts. • Europeans felt it is difficult to understand Chinese organizational structures and Chinese hierarchy, leading to irritations and work delays. • Europeans should be better prepared to make dissemination in China more effective. • Unclear import/export rules for know-how intensive goods
External Analysis: Opportunities	**External Analysis: Threats**
• Market access for European technology • Access to qualified labour/ improvement of European research quality • Improve European innovations system by learning from China • Quicker development of technology in benefit of Europe • Influencing Chinese civil society with European democratic standards • Chinese respect Europeans more than Americans, and this advantage should be used for common developments	• Unwanted know-how transfer to China while Chinese protect their technology better • Quick assimilation of new knowledge in China • Competitive disadvantages as China can exploit commonly developed ideas cheaper • Violation of IPR • Limited law enforcement of European entities in China

Table 4: European SWOT analysis

Unlike the Chinese SWOT analysis, it was not possible to additionally validate the European SWOT since the only OpenChina-ICT project event held in Europe was the one in Vilnius, Lithuania in November 2013. Even though the attendees of the final OpenChina-ICT conference were not systematically surveyed about them, the factors identified in the European SWOT analysis were deemed to be correct, directly and indirectly in the discussions.

Summary and Findings of the European Internal-External Analysis of Cooperation

Internal strengths of cooperation, which provide a justification for improving cooperation mechanisms, reveal a variety of benefits for Europe. Europe could improve its market position in China by transferring standards and obtaining knowledge of the Chinese market. Access to Chinese knowledge would additionally enable Europe to improve the effectiveness of its research and to gain access to less expensive Chinese researchers.

On the other hand, several internal weaknesses of cooperation were identified, which would not justify improving cooperation mechanisms. Among other things, the weaknesses are related to cultural aspects and basic legal and contractual terms and conditions, which are important for research cooperation.

External opportunities that would facilitate improvement of cooperation mechanisms are related to competitive advantages that could be gained, greater access to Chinese know-how, and capability to influence Chinese civil society.

External threats that would not facilitate improvement of cooperation mechanisms are related to potential loss of know-how and the risk of China gaining a greater competitive advantage over Europe through cooperation. The different legal systems and limited options for Europeans to enforce laws in China were additionally identified as threats.

The Significance of the Factors of the OpenChina-ICT SWOT Analysis

The Harvard Business School developed the extremely flexible strategy analysis tool of a SWOT analysis for the identification and categorisation of significant internal and external factors.[61] The critical phase of a SWOT analysis is the qualification and quantification of the individual factors. Since this is generally recognized to harbour a risk of subjectivity, methods that minimize the subjectivity of the selection of factors should be employed.[62] Nevertheless, it is impossible to fully eliminate subjectivity from the identification of factors.[63] It is essential to involve stakeholders with good knowledge of the object of analysis in the identification of factors to ensure that factors are identified on the basis of "hard facts" and that subjectivity is minimized.[64]

In China, OpenChina-ICT did this by having representatives of relevant ministries (MIIT and MOST), with good knowledge of all important factors of cooperation, identify the factors for the Chinese SWOT analysis at a workshop. In Europe, OpenChina-ICT did this by surveying project managers with experience with research cooperation with China.[65] The factors they identified for China were additionally validated at two workshops in order to boost the significance and thus the plausibility of the Chinese SWOT. Since they were validated twice, the subjectivity of the factors of the Chinese SWOT can be assumed to be minimal. This assumption is supported by the official Chinese letters and the outcome of the discussions during the final OpenChina-ICT conference in Vilnius, both of which are displayed in the annex of this report. Naturally, as mentioned above, subjective emotions and transient phenomena can always have played some role in the identification of the factors of both SWOT analyses and, thus, may affect the findings in some way.

---

[61] See: http://forlearn.jrc.ec.europa.eu/guide/4_methodology/meth_swot-analysis.htm

[62] See: http://paginas.fe.up.pt/~tasso/pdf/sp/sp06-safeguarding%20swot.pdf

[63] See: http://www.wikiswot.com/swot.htm

[64] See: http://forlearn.jrc.ec.europa.eu/guide/4_methodology/meth_swot-analysis.htm

[65] See: The significance of the European population analysed is discussed in this report and the European Roadmap survey.

4 Potential Technology Areas for Cooperation

Potential technologies for European-Chinese ICT research cooperation were identified in the OpenChina-ICT European and Chinese Roadmap surveys. The following chapter provides an overview of the technologies identified, technologies for common cooperation and further steps to strengthen cooperation.

4.1 Chinese Priorities of ICT Research Cooperation with Europe

Based on the key findings and analysis of the OpenChina-ICT Chinese Roadmap survey, areas relevant to China for further ICT research cooperation between China and Europe are:[66]

- Internet of Things

  Potential foci of Chinese research cooperation with Europe in this area are M2M communications and application platform technologies, lightweight IPv6, integrated intelligent sensor technologies, ultra high frequency and microwave RFID, and short distance wireless communication.

  The research area of Internet of Things was covered in the European FP7 ICT research challenge 1, pervasive and trusted network infrastructures.

- Cloud Computing

  Potential foci of Chinese research cooperation with Europe in this area are cloud security, cloud operating systems, cloud server and storage systems, data centre energy savings, and data centre networking technologies.

  The research area of cloud computing was covered in the European FP7 ICT research challenge 1, pervasive and trusted network infrastructures.

[66] See Open-China-ICT China Roadmap survey. The OpenChina-ICT partner CATR surveyed Chinese researchers with experience with cooperation with European partners in order to identify thematic priorities.

- Broadband Mobile Communication

  China's top cooperation priority in this area is new generation mobile communication technology (i.e. LTE and LTE Advanced). Other cooperation priorities are service and customer oriented network architecture, hot point and indoor microcell technologies, distributed antennas, heterogeneous network coordination and convergence, self-optimised technology, and cognitive radio.

  The research area of broadband mobile communication was covered in the European FP7 ICT research challenge 1, pervasive and trusted network infrastructures.

- Next-Generation Internet

  China's cooperation priorities in this area are security control and management, routing and addressing control and management, network virtualization, next-generation Internet protocol architecture, and ubiquitous synergy technologies.

  The research area of the next generation Internet was covered in the European FP7 ICT research challenge 1, pervasive and trusted network infrastructures, and challenge 3, alternative paths to components and systems.

- Network and Information Security

  Chinese cooperation priorities in this area are encryption technology, information identification and control, information system protection, mobile intelligent terminal security, network identification management, security of the Internet of Things, and security tests and evaluation.

  The research area of network and information security was covered in the European FP7 ICT research challenge 1, pervasive and trusted network infrastructures, and challenge 6: network for a lower carbon economy.

- Optical Communication

  Chinese cooperation priorities in this area are ultra-high speed optical transmission technology, ultra-large capacity optical switching and networking, next-generation PON, data centre optical interconnection technologies, etc.

The research area of optical communication was covered in the European FP7 ICT research challenge 1, pervasive and trusted network infrastructures, and challenge 3, alternative paths to components and systems.

- Smart Terminal

  Chinese cooperation priorities in this area are chip technology, terminal operating systems, human-machine interactive technology of smart phones and smart TVs, new human-terminal interaction, application services, and new materials.

  The research area of smart-terminal research area was covered in the European FP7 ICT research challenge 1, pervasive and trusted network infrastructures, and challenge 5, ICT for health, aging well, inclusion and governance.

- Smart Cities

  Smart cities were identified as an important cooperation area during the OpenChina-ICT Dialogue Conference in Beijing in November 2012. Chinese cooperation priorities in this area are high performance data processing for city management, human-centric smart city public service support technologies, multi-mode data system interconnection technologies, and multi-level intelligent decision making support systems for city management.

  The research area of smart cities was covered in the European FP7 ICT research challenge 1, pervasive and trusted network infrastructures, and challenge 6, network for a lower-carbon economy.

Chinese priorities of cooperation with Europe are all centred on ICT European Seventh Framework Programme **challenge 1**, pervasive and trusted network infrastructures, and partially on **challenge 3**, alternative paths to components and systems, **challenge 5**, ICT for health, aging well, inclusion and governance, and **challenge 6**: network for a lower carbon economy.

4.2 European ICT Research Cooperation Priorities with China

The OpenChina-ICT consortium endeavoured to define thematic priorities of European ICT research with China so that the findings were significant rather than random. It was therefore essential that the European data population analysed have as much experience as possible with ICT research in China and have made or intend to make decisions about research activities in China based on private incentives.

In theory, these requirements are met by three data populations from the a) analysis of European ICT R&D investments in China, b) analysis trade integration among European ICT sectors and China, and c) survey of European managers of multinational companies about on their plans to invest in ICT research in China.

The population (a) cannot be analysed since not enough data is available. Data on population (b) are available but data on traded products in research fields are difficult to interpret since most of the traded products cover a wide range of fields of research. The population (c) is also difficult to analyse since only a limited number of European MNEs have ICT research plans in China. Surveying MNEs with strong trade relations with China could be an option but recruiting a sufficient number of managers for such a survey is generally difficult. Even if a sufficient number of managers could be recruited, they would presumably not fully disclose their strategic investment plans. The literature calls this phenomenon a moral hazard.

The OpenChina-ICT consortium, therefore, concentrated on analysing an accessible population with sufficient experience with ICT research in China and identified three approaches: the consensus approach, the proposal approach and the questionnaire approach. [67]

Consensus Approach:[68]

When defining the priorities in new work programmes, the European Commission follows the consensus approach, which incorporates feedback obtained from European stakeholder. The European Commission employed the consensus approach to identify the following priorities in the FP7 ICT programme:

- Challenge 1: Pervasive and trusted network infrastructures with a focus on future networks, Internet of Things and cloud computing

[67] A detailed discussion of advantages and limitations of each approach presented is included in the European OpenChina-ICT Roadmap survey. The three most relevant priorities for each approach are presented.

[68] Data provided by the European Commission on 15 November 2012.

- Challenge 2: Cognitive systems with a focus on robotics, whereby EC stakeholders are most interested in standardization aspects, safety, benchmarking and possibly certification
- Challenge 6: ICT for a low-carbon economy (smart energy cities)

Proposal Approach:[69]

The proposal approach was employed to analyse the proposals in previous FP7 ICT calls with Chinese partners on the consortium. This approach has been selected because European applicants are assumed to have knowledge of the Chinese ICT research scene and a need for European-Chinese ICT research in one of the call challenges.

- Challenge 1: Pervasive and trusted network infrastructures
- Challenge 4: Technologies for digital content and languages
- Challenge 8: ICT for learning and access to cultural resources

Questionnaire Approach:

The questionnaire approach is based on interviews of coordinators of FP7 ICT projects with Chinese partners. Since coordinators of previous European-Chinese FP7-ICT research projects have real experience with cooperation, they qualified to identify ICT research priorities for China.

- Challenge 1: Pervasive and trusted network infrastructures
- Challenge 5: ICT for health, ageing well, inclusion and governance
- Challenge 7: ICT for the enterprise and manufacturing

All of the European approaches to setting priorities include Challenge 1. Substantial demand from European ICT researchers for European-Chinese ICT research in Challenge 1 can therefore be inferred, specifically research on:[70]

- Future networks for wired and non-wired broadband technologies
- Cloud computing, Internet of Services, and advanced software engineering
- Architecture and technological foundations for Internet-connected sensors, actuators and other smart devices and objects
- Trustworthy ICT, including security in networked service and computing environments; trust, privacy and claims management infrastructures; and data policy, governance, and socio-economic aspects of trustworthy ICT

[69] Data provided by European Commission on 14 December 2012

[70] See: http://cordis.europa.eu/fp7/ict/docs/ict-wp2013-10-7-2013-with-cover-issn.pdf

- Networked media and search systems, including digital media delivery platforms, end-to-end immersive and interactive media technologies, and multimedia search technologies
- Experimental facilities (known as FIRE) for experimentally-driven research in the Future Internet

At least one of the three approaches was used to set the priorities of all of the challenges, except Challenge 3. This indicates that European ICT researchers are largely interested in cultivating collaboration with their Chinese counterparts and are focused on more than a small range of topics. Since China and Europe are diversified regions with wide varieties of expertise, broad prioritization of European interests in research with China is not surprising.

4.3 Common European and Chines ICT Research Priorities

Joint European-Chinese research priorities are largely concentrated in **Challenge 1**, pervasive and trusted networks but are also prevalent in **Challenge 5**, ICT for health, ageing well, inclusion and governance, and **Challenge 6**, ICT for low-carbon economy (smart energy cities).

The joint research priorities identified also reflect the global consumer trends identified in the OpenChina-ICT Chinese and European Roadmap survey. Research is needed in the fields of mobile broadband, smart terminals, cloud computing and others to meet consumer demands.

It is therefore recommended that upcoming policy dialogues concentrate on the three aforementioned areas of ICT research in order to develop and support more joint European-Chinese ICT research projects.

The three joint research priorities identified cover a large number of sub-areas. Considerations of cost and benefit necessitate discussion of whether further development of cooperation should concentrate on sub-areas such as **Future Internet & IPv6, Internet of Things, Smart Cities and Broadband Policy** for which supporting infrastructures have already been established and expert advisory groups already exist.

Before joint cooperation programmes can be established in the thematic fields identified, European and Chinese policymakers will have to reach a consensus on all circumstances relevant to cooperation case-by-case. To this end, they should assess the strengths, weaknesses, opportunities and threats of cooperation. The SWOT analysis and the cooperation options identified in this report would be helpful aids.

Such an analysis of cooperation might conclude, for example, that political and/or competitive threats preclude further pursuit of certain fields of research in the in the identified joint priorities. [71]

Limits of the analysis:

Different approaches were employed in China and Europe to analyse and identify priorities of ICT research cooperation. In Europe, fields of ICT research cooperation were prioritised on the basis of European ICT research challenges. In China, Chinese ICT researchers experienced in conducting ICT research with European researchers were asked to prioritize ICT cooperation fields based on topics of interest predefined by the Chinese authorities in domestic development plans. Since the approaches to analysis differ, researchers surveyed in China were able to select topics from defined subareas of ICT, whereas the European analysis was more abstract since it covered more subareas of ICT. Any effect of the different approaches to analysis on the quality of the findings has to be accepted.

Had European priorities been analysed based on Chinese authorities' predefined topics of interest, the qualitative results would not have reflected the scope of European ICT research.

Had the Chinese been interviewed following the European challenges model, the results would have been misleading since Chinese ICT researchers are unfamiliar with European ICT challenges. Moreover, the results would have been irrelevant since the Chinese Planning Commission defines the country's main ICT developmental objectives.

4.4 Further Steps toward Cooperation in Thematic Priority Areas

The areas of Internet of Things, cloud computing, broadband mobile communication, next generation Internet, network and information security, optical communication, smart terminal and smart cities were identified above as priority areas of public cooperation between Europe and China in the coming years. In the following, the OpenChina-ICT consortium proposes further steps for the cooperative development of the specific priority areas. The proposed steps are subjective and reflect the opinion of the OpenChina-ICT consortium. Studying the identified steps in bilateral discussions with dedicated thematic experts from China and Europe could be helpful.

[71] One critical area for Europe could be cooperation in the mobile telecommunications network since the European Commission recently opened corresponding trade investigations against China.

1. Internet of Things (IoT)

China considers itself to be at the primary stage of development in this area. With government support, China has laid a foundation in technology, industry and application in IoT. The National Sensor Network Innovation Area was built in Wuxi City, and significant progress has been made in the standardization of sensor network interfaces, identification, security, and network architecture. Applications for the grid, transportation, medical processing, and environmental protection are under development. Nevertheless, China wants more research to be done in such areas as sensing, transmitting, processing, and manufacturing technologies.

In **Europe,** IoT is considered to enhance Europe's competitiveness and to advance the development of an information-based economy and society.[72] Europe has the advanced ecosystem needed to take the lead in this field of research. It is advancing the Internet of Things with research by creating new applications for connected devices and by developing the necessary sensors.[73]

The European Commission created the ERC - Internet of Things European Research Cluster, which is working on approximately 40 projects. According to Dr. Peter Friess, who is in charge of Internet of Things in the European Commission, the ERC aims to "provide a light-weight portfolio management approach for overcoming isolated and redundant research and knowledge barriers" for the Internet of Things. [74]

According to the OpenChina-ICT consortium's observations, one **obstacle to further cooperation** between China and Europe is the lack of a common IoT technology architecture and a system of common standards. Another obstacle is the emergence of common pilot applications, while different Chinese and European applications and equipment are not always interoperable. Additional aspects, such as internet governance, security and privacy policy, need further analysis and consensus in a Chinese-European cooperation environment. These issues are currently being addressed in the dialog between MIIT, China and the DG CONNECT by the EU-China IoT Expert Advisory Group established in 2011.[75]

[72] See: http://www.internet-of-things-research.eu/about_ierc.htm

[73] See: http://www.internet-of-things-research.eu/about_ierc.htm

[74] See: http://www.internet-of-things-research.eu/pdf/IERC_Cluster_Book_2012_WEB.pdf

[75] For more on the expert advisory groups, see the OpenChina-ICT Chinese Roadmap survey.

Potential Benefits of Cooperation:

Benefits of cooperation in the thematic field of IoT were discussed at the OpenChina-ICT Internet of Things Workshop held in Beijing in August of 2013. The workshop addressed cooperation on the architecture of the Internet of Things, standards for the Internet of Things, intelligent sensor technologies, M2M communications, and application platform technologies.

Regarding standards, common IoT technical standards can be expedited by ITU, ETSI, IETF and other standard organizations. This would facilitate the establishment of an overall IoT technology architecture.

Discussions during the workshop indicated that substantial mutual benefits are also expected from the implementation of a large, cross-continent IoT test bed. A test bed would advance research that creates business innovations and supports industry developments in Europe and China.

The OpenChina-ICT consortium proposes taking the following cooperation steps with the support of the existing IoT expert advisory group:

1. Jointly promoting IoT governance and security and privacy policy cooperation through regular research of IoT industrial, technology and regulatory policies.
2. Conducting joint research of IoT technology frameworks and jointly promoting IoT international standards.
3. Strengthening cooperation in IoT technology and in the standards of the ITU-T\IETF and other international standard organizations.
4. Using interoperable IoT applications in select pilot cities.
5. Establishing joint IoT test-beds for technological, research and as business and innovation platforms.

2. Cloud Computing

China is at the primary stage in the cloud computing service market and has certain strengths in cloud technology research and in cloud computing server and storage device manufacturing. The “National Mid-and-Long-Term Science and Technology Plan” and “The Twelfth Development Plan of the ICT industry” cite cloud computing as one of the important areas for research and development in China. Cloud computing research in China focuses on cloud operating systems, cloud computing security, data centre networking, data centre energy-saving technology, and cloud computing testing and evaluation.

As outlined in a recent report, a wide range of pilot projects in **Europe** have demonstrated how cloud computing transforms science, addresses the challenges of big-data, and facilitates better collaboration, not only for the research community. [76] In Europe, cloud computing development is facing challenges, such as the need to develop open standards, the need to design and develop innovative and integrated services, capacity limitations, technical and legal privacy issues, the need for more user-centric developments, and the development of business and funding models for cloud computing services.[77]

Potential Benefits of Cooperation:

Improved cooperation in the standardization of cloud computing in organizations such as the ITU will facilitate the development of common standards and, therefore, will create more mutual market access, intensifying competition. This will improve service quality and reduce costs in Europe and China. Potential fields of joint cloud computing technology development are virtualization, big-data storage, data mining, and 3D data presentation technologies. The following actions could be undertaken:

1. European and Chinese experts should meet in dedicated conferences to exchange their visions. [78]
2. An EU-China Cloud Computing Expert Advisory Group should be established to create a cooperation channel.
3. Dialogues and cooperation on cloud computing standards should be increased.

3. Broadband Mobile Communication

China's broadband mobile communication industry and related research are mature**.** The Chinese are mainly focusing on new-generation broadband mobile communication. China has invested considerable effort in TD-LTE research and industrialization and holds a plethora of proprietary IPRs in this area.

[76] See: http://cordis.europa.eu/fp7/ict/e-infrastructure/docs/final-report-clouds-study.pdf

[77] See: http://cordis.europa.eu/fp7/ict/e-infrastructure/docs/final-report-clouds-study.pdf

[78] There are currently two influential cloud computing alliances in China, the "Cloud Computing Development and Policy Forum," and the "Cloud Computing Development Forum". The two alliances organize to three workshops every year, which are open to foreign enterprises and experts. Many conferences held as part of European Commission-funded research are open to Chinese participation. For the most recent developments in Europe, see: http://ec.europa.eu/digital-agenda/telecoms-and-internet/cloud-computing.

According to **European**-funded research experts and their reports, broadband mobile communication is a key technology for overcoming the economic crisis in Europe. Development in Europe is driven by the need for broadband mobile communication to become "ubiquitous" and "smart". [79] Experts recommend that future European research on broadband mobile communication should concentrate on latency, energy efficiency, spectral efficiency, scalability, and stability. They also recommend that work be done to produce specifications and standards for an emergency network.

Potential Benefits of Cooperation:

More intense cooperation in the area of broadband mobile communication will enable Europe and China to share experiences with 4G network implementation, to jointly research 5G application scenarios, and to promote and develop common standards. This will enable them to increase mutual market access, reduce consumer costs and improve technical quality. As mentioned, trade issues may be an obstacle to further cooperation in this thematic area. The following is recommended to strengthen cooperation:

1. Increasing cooperation on standards in the 3GPP and ITU of 4G and 5G.
2. Organising joint Chinese-European 5G technology seminars.
3. Establishing a dedicated Chinese-European expert advisory group.

4. Next-Generation Internet

China is working intensively on the next-generation Internet. With the support of national innovation projects, China has built the world's largest IPv6 network (CNGI-China next-generation Internet) and has conducted large-scale network experiments and application demonstrations, reaching breakthroughs in IPv6 migration technologies, next-generation trusted Internet architecture and addressing (based on real IPv6 source addresses). China has also contributed to dedicated international standardisation and is a global leader in the manufacture of routing products. China intends to focus its future research on the area of the next-generation Internet, including high scalability, virtualisation, security and energy efficiency.

[79] See: http://www.networks-etp.eu/fileadmin/user_upload/Publications/Position_White_Papers/NetWorks_White_Paper_ICT_CritNatInfra_Final_12-07-02.pdf

Europe has invested significant resources in next-generation Internet research. As summarized by the experts of the EU-China FIRE project, European challenges in next generation Internet research will be experimentally-driven advanced research consisting of iterative cycles, the design of and experimentation with new networking and service architectures, and horizontal research of system complexity and security. [80]

Potential Benefits of Cooperation:

Improved European-Chinese cooperation on the next-generation Internet could support the development of technological approaches and, even more importantly, increase the test-bed facilities and computing capacities available and needed to test European and Chinese next-generation Internet solutions. This will expedite Internet innovation and the incubation of future Internet prototypes. China and Europe's DG Connect established a China-EU IPv6&FI expert advisory group in 2010. Having also studied the expert advisory group's work, the OpenChina-ICT consortium proposes the following actions:

1. Adding industry experts to existing expert advisory groups.
2. Continuing to expand the FIRE platform to attract the participation of more Chinese institutions, thus initializing more technical innovations.
3. Jointly making efforts to develop a common future Internet model architecture.
4. Organising a joint conference on next-generation Internet measurement technology.
5. Continuing cooperation on the development and promotion of common next-generation Internet standards.
6. Improving cooperation on international Internet governance issues and regulatory mechanisms.

5. Network and Information Security

Rapid development of the ICT network and information security areas is steadily growing in importance in **China**. It is primarily working on encryption technology, information identification and control, important information system protection, mobile intelligent terminal security, network identification management and security of the Internet of Things, and security test and evaluation.

[80] See: http://www.euchina-fire.eu/about-fire/fire-in-the/

Research on network and information security is also extremely important in **Europe**. Usability and socioeconomic aspects of privacy, privacy in the Future Internet, policy for preserving privacy in the information society, and security privacy by design, trust, and accountability have been identified as European research areas.[81]

Potential Benefits of Cooperation:

Combined European and Chinese expertise is expected to lead to the development to advanced technological developments. The OpenChina-ICT consortium considers the fields of spam and network virus defence mechanisms to be a promising area of joint research.

The OpenChina-ICT consortium proposes the establishment of an EU-China Network and Information Security Expert Advisory Group in order to create common communication channels and platforms and explore and clarify future dialogue and cooperation pathways in detail.

The expert advisory group could focus its work on defining common actions and bilateral research related to:

1. Spam and harmful information control, network viruses and defence mechanisms.
2. International Internet governance as well as technology and regulatory policies.
3. Seminars for the exchange of views on technology and to strengthen cooperation.

6. Optical Communications

China considers optical communications to be one of the most promising technologies for future communication networks. Optical communication is an important pillar of China's broadband strategy. The National 973 and 863 Plans include considerable efforts to develop optical communications technologies in China. Equipment vendors, such as Huawei and ZTE, are becoming top manufacturers in the global optical communication equipment market. Research foci in this area include ultra-high-speed transmission, large capacity optical switching, NG-PON, and data centre optical interconnection.

[81] http://cordis.europa.eu/fp7/ict/security/workshop-report-privacy-research-ideas-public.pdf

According to Thomas Skordas, who is in charge of **Europe's** Photonics Technologies in the DG Connect, increased data traffic requires new technical solutions.[82] Photonic technologies, e.g. lasers, optical fibres, optical components, optical systems and optical coding technologies, meet that challenge. The EU is therefore funding research projects on faster optical networks, more dynamic networks, fully transparent optical networks, and greener optical networks.[83]

Potential Benefits of Cooperation:

European-Chinese cooperation in optical communications, technologies for the 100G network and beyond, data centres, and optical interworking ought to be stepped up. This would also expedite relevant international standards. Intensified cooperation would facilitate developments in the optical communications industry and the establishment of national broadband networks in Europe and China. The consortium suggests the following actions to foster cooperation:

1. Focusing cooperation on regulatory mechanisms and developing policies.
2. Organising joint conferences to exchange views on optical communication technologies, e.g. 100G network and beyond and optical data centre interconnection.
3. Facilitating cooperation on international technical standardisation, e.g. VDSL2, vectoring, super MIMO, and GFast.

7. Smart Terminal

China considers smart terminals, especially mobile intelligent terminals, to be the gateway to IoT and mobile Internet applications. China has achieved significant breakthroughs in TD-SCDMA terminal technology and smart TV technology. Chinese research institutes and vendors are currently researching next-generation displays, human and machine interactions, and new web technologies based on HTML4. China has demand for research in the fields of smart terminal operating systems, radio chip design and smart terminal manufacturing.

Europe has an advanced technological foundation for smart terminal technology. Enabling smart terminals to communicate not only with networks but also with platforms, thus creating new distribution channels for services and applications, is one challenge being addressed in European technological research.[84]

[82] http://photonicssociety.org/newsletters/jun11/RH_Overview.html

[83] http://photonicssociety.org/newsletters/jun11/RH_Overview.html

[84] See: http://www.rand.org/content/dam/rand/pubs/technical_reports/2012/RAND_TR1262.pdf

Potential Benefits of Cooperation:

Intensified Chinese-European cooperation in smart terminal research would enable China to access European technology and Europe to access the China market better. China could especially benefit from technologies related to chip design, smart terminal open-source operating systems and HTML5 smart terminal application platforms. The OpenChina-ICT consortium recommends taking the following actions:

1. Intensifying technical cooperation in the open-source operating system and application platforms based on HTML5.
2. Cooperating on technology developments for wearable devices and chips.
3. Exchanging experiences with new business models.

8. Smart Cities

Smart cities will improve public services and the quality of public life and will foster environmental protection, traffic management, industrial transformation, and social stability. At present, **Europe is** focusing on green, low-carbon cities smart cities in, while **China** dealing with more complex challenges related to rapid growth and migration.

Potential Benefits of Cooperation:

European-Chinese cooperation could focus on sustainable city development, city management, efficient governance and city transformation. At the OpenChina-ICT Thematic Workshop in Guangzhou in May of 2013, Chinese and European experts identified green and low-carbon technology research, the deployment of efficient city broadband networks, traffic management, industrial transformation, and smart buildings as areas of cooperation on smart cities. Intensified cooperation would facilitate sharing of experiences and thus improve the quality of public life in Chinese and European cities.

The Chinese-European Green Smart City Expert Advisory Group was established in 2013. It plans to select fifteen pilot cities in China and Europe to exchange experiences. Other steps toward cooperation should include:

1. Developing common ICT applications for the challenges of urbanization.
2. Compiling typical European and Chinese methods and models of smart city construction in order to share examples and experiences with other cities.
3. Promoting best practise solutions for smart cities developed in both China and Europe, thus creating mutual market access for developers and providers.

5 Recommendations for Cooperation

This final chapter focuses on recommendations made by the OpenChina-ICT consortium. It includes a brief discussion of European trends toward cooperation with third countries and a detailed analysis of options for European and Chinese cooperation that were identified by the internal-external analysis of cooperation. Finally, it outlines the recommendations for cooperation made by the OpenChina-ICT consortium.

5.1 Trends in European Research Cooperation with Third Countries such as China

International cooperation with non-European countries is a major topic of discussion among the European research community and its stakeholders. Changes in the rules for participation of partners from third countries in European-funded research in Horizon 2020 are one of the major outcomes of this discussion. The new rules stipulate a substantial European benefit if funding is to be provided to a partner from another developed country. Changes in the funding for research cooperation between Europe and third countries are to be expected since partners from China and other BRIC countries will no longer be automatically eligible to receive European funding for collaborative projects with European partners.

China is concentrating on bilateral research cooperation with Europe since this offers specific and selective access to research know-how and resources of scientifically advanced and competitive European Union member states. More competitive EU member states may see advantages in focusing more on bilateral cooperation than on the development of multilateral European cooperation as this enables them to access Chinese research know-how and resources in keeping with their needs.

If a European-level cooperation mechanism is not established, other European periphery countries with limited research bases and competitiveness may be left behind since they will no longer be able to access know-how that is available only in China. This would further diminish their research capability and competitiveness.

Hence, funding instruments need to be developed under the new participation rules in Horizon 2020, which are based on European needs and bilateral consensus with third countries such as China. (See section 3.1.2.)

5.2 Options for Cooperation

The findings presented in this report (especially the internal-external analyses of cooperation) provided the basis for identifying options for cooperation that could be acted on by Chinese and European policymakers to intensify European and Chinese cooperation in ICT research. While there are many more options than can be treated here, the OpenChina-ICT consortium considers the following to be the most relevant for ongoing development of European and Chinese cooperation in ICT. The following approaches were employed to identify options from the internal-external analysis of cooperation:

1. Strengths and Opportunities (SO)

This approach was employed to identify options for further development of ICT research cooperation between China and Europe. Identified strengths are used to maximize identified opportunities.

2. Strengths and Threats (ST)

This approach was employed to identify options for further development of ICT research cooperation between China and Europe. Identified strengths are used to minimize identified threats.

3. Weaknesses and Opportunities (WO)

This approach was employed to identify options for further development of ICT research cooperation between China and Europe. Identified opportunities are used to minimize identified weaknesses.

4. Weaknesses and Threats (WT)

This approach was employed to identify options for further development of ICT research cooperation between China and Europe, with the aim of minimizing identified weaknesses and avoiding identified threats.

5.2.1 Chinese Views and Options

Based on Chinese views and the Chinese SWOT, the following theoretical options were identified as deserving of consideration when collaborative research programmes with Europe are created and organised. Four guiding areas of intervention extracted from the Chinese SWOT based on the identified strengths, weaknesses, opportunities and threats were used to define the options. The four guiding areas of intervention are policy, administration, industry and people:

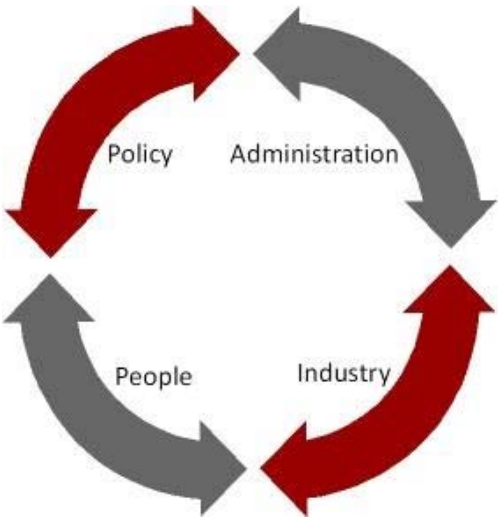


Table 5: Chinese options for cooperation

Policy:

Policy was identified as a major Chinese challenge to collaboration with Europe. Some of the factors identified in the Chinese SWOT analysis also have a strong bearing on policy.

SO: Strengthen dialogues

Since Chinese researchers identified the strength "good Chinese–European relations are a strong basis for fruitful common research", China ought to put an emphasis on maintaining good relations and partnerships with Europe in as many areas of interest as possible by establishing and maintaining dialogues in diverse fields of ICT research. This would enable China to take advantage of various opportunities for cooperation to access European know-how, improve access to European markets and improve competitiveness.

ST: Involve other world regions in dialogues

Where feasible, China and Europe could decide to involve other world regions in their dialogues in order to avoid the threat of "losing contact with other research nations" and to benefit from the strength of "finding common solutions for global challenges" or even to create common global research funding infrastructures in areas in need of intervention.

WO: Focus on specific flagship interventions

The Chinese identified the difficulty previous dialogues had identifying common goals for Chinese–European interventions in ICT research as a weakness. Rather than starting with overly ambitious programmes or umbrella themes, we propose concentrating on well-defined, specific "flagship" interventions based on the lowest common denominator and with concrete outcomes to accomplish opportunities of cooperation.

WT: Intervene globally

The feasibility of embedding flagship themes based on the lowest common denominator in ubiquitous, multi-national programmes involving other regions or nations ought to be evaluated to avoid the threat of losing contact with other global research nations.

Administration:

Since some of the findings of the Chinese SWOT relate to administrative issues, one block of options is labelled administration.

SO: Provide European research implementation and management training

The Chinese identified advanced European research implementation and management procedures and their superiority over Chinese procedures as strengths of cooperation. Future jointly funded collaboration, therefore, ought to follow European research implementation administration and rules. This would boost the capability of China's research administration and facilitate negotiations with the European Commission on joint calls or joint programmes. China could require staff training so that they better understand European research

administration.[85] This could make it possible to translate collaborative ICT research opportunities into action more quickly.

ST: Implement European research administrative procedures

In another step, European administrative procedures for research ought to be implemented in China to improve its own administrative procedures. This would improve the efficiency of the Chinese ICT research landscape in general and, thus, make Chinese research more attractive for Chinese researchers. This would reduce the threat of a Chinese brain-drain.

WO: Localise European administrative procedures

Although European research implementation and management procedures are considered to be advanced, their failure to meet Chinese needs was identified as a weakness. When employed in China, they should be localised for the demands there in order to be able to take advantage of cooperation opportunities, identified, nonetheless.

WT: Acquire additional administrative expertise from other counties

When improving their research implementation and management procedures, Chinese authorities also ought to examine other countries' and world regions' management of such procedures and then consider additional non-European models for improvement. This would avoid the threat of losing contact with other global research nations.

Industry:

Since many of the findings of the Chinese SWOT relate to industry, one block of options is labelled "industry".

SO: Follow patterns of economic integration governed by transnational value chains

[85] See "forms of cooperation" above for approaches followed by development support projects.

The internal-external analysis of cooperation revealed that the Chinese manufacturing industry's European–Chinese manufacturing value chains (strength) profits from ICT research cooperation with Europe by developing common solutions to mutual and global challenges, accessing existing European ICT know-how and gaining access to European markets. When creating new cooperation programmes, funding authorities ought to factor in the demands of existing value chains. Systematic funding of research needed by existing value chains will enable them to take better advantage of opportunities of cooperation, such as improved access to markets, European know-how and European human resources and the transfer of Chinese standards to Europe.

Such approaches could also benefit European counterparts in manufacturing value chains since competitiveness of European industry would also be boosted.

ST: Involve industry in dialogues

If European–Chinese value chains are to receive subsidies to develop their research activities, the programmes developed will have to be organised to utilise Chinese public funds effectively. This could be achieved if representatives of the respective value chains are already involved and thus present their needs in policy dialogues. Given their knowledge of the market and technology, the representatives can contribute to reducing the probability of the threat of unintentional loss of Chinese data and IPR.

WO: Employ targeted selection

Since intervention in publicly funded ICT research cooperation ought to focus on leading European-Chinese manufacturing value chains with potential to attain a high degree of competitiveness, only partners involved should be that European and Chinese leaders in their field[86] that have European–Chinese competitive manufacturing value chains.[87]

Such targeted selection would reduce any weaknesses and negative consequences of cooperation. Weaknesses are the involvement of less educated European partners, the involvement of European nations with limited economic and competitive capacities, the low quality of European-funded research, and the unclear advantages for Chinese industry. A selective approach would increase the probability of establishing the opportunities for Chinese cooperation identified.

[86] Some Industry and research leaders are mentioned in the OpenChina-ICT European and Chinese Roadmap surveys.

[87] This does not necessarily mean that large multinational companies have to be targeted. A large number of European SMEs that are leaders in niche ICT markets are involved in European-Chinese value chains.

WT: Consider targeting global value chains

Targeting global European-Chinese value chains with partners located outside of Europe and China could also be important to avoid the threats of "Losing contact to other global research nations" and "Losing Chinese resources for European projects with questionable outcomes". Doing so could reduce the impact of low-quality European-funded research since other innovation systems could neutralize it. Furthermore, this could also avert the impacts of such weaknesses as "EC administrative procedures are too difficult" and "Educational shortcomings in some parts of Europe".

People:

Since some of the findings of the Chinese SWOT relate to issues of interpersonal exchange, one block of options is labelled "People".

SO: Focus on travel and exchange programmes with a European dimension

Chinese researchers take advantage of strengths in collaboration to increase their scientific expertise and know-how. China should, therefore, start establishing mutual researcher exchanges and mobility programmes on a European rather than a EU member state level in order to obtain wider access to European research institutions and technology-driven enterprises.

This would present opportunities such as accessing European know-how and technology and improving Chinese researchers' experiences. Joint creation of such programmes would also enable Chinese companies to take advantage of the opportunity of increased access to European human resources.

ST: Raise Chinese researchers' awareness of domestic career opportunities

The increased travel and exchange resulting from greater interventions by Chinese and European programmes should be accompanied by improved curricula from the Chinese to curtail the threat of a Chinese brain-drain by giving Chinese researchers interesting career opportunities once their stays in Europe end. This would benefit China since Chinese researchers would be able to increase their experiences in Europe and could act upon some of the identified strengths of cooperation for China upon their return. Such models also would be interesting for Europe since Chinese researchers influenced by European know-how and culture would be more open to European technology and culture in their future professions upon their return to China. This could, in turn, improve the terms of European trade in the future.

WO: Offer training in language and cultural challenges

Participants in European and Chinese travel and exchange programmes should be selected and prepared carefully in order to overcome the weakness of language and cultural barriers. Selection should be based on existing language proficiency and preparation should concentrate on cultural training. Effective preparation and selection would enable China to take advantages of opportunities of cooperation such as improving the experiences of Chinese researchers, gaining a better understanding of advanced European methodologies, improving Chinese research capacities, etc.

WT: Target reputable European partner entities

Travel and exchange programmes should target highly reputable entities in each respective European member state in order to avoid the threat of "Chinese resources being lost for European projects with questionable outcomes". This would mitigate weaknesses such as "Educational shortcomings in some parts of Europe" and "Low quality of European-funded research".

5.2.2 European Views and Options

Based on European views and the European SWOT, the following theoretical options identified as deserving of consideration when collaborative research programmes with China are created and organized. The three guiding areas of intervention extracted from the European SWOT and based on the identified strengths, weaknesses, opportunities and threats, i.e. project/research quality, innovation system, and industry, were used to define the options:

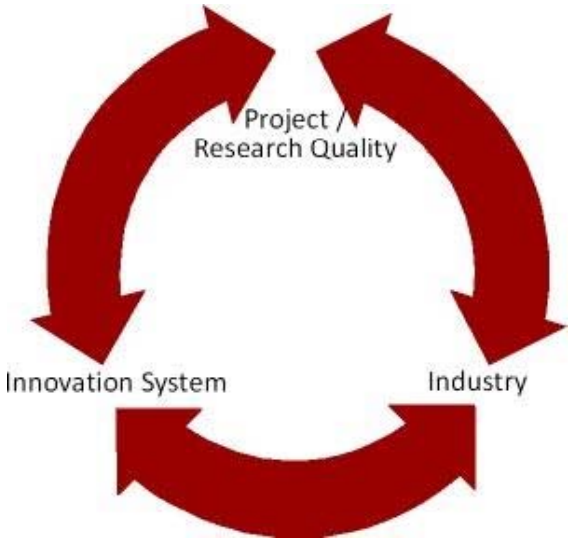


Table 6: European options for cooperation

Project /Research Quality

Since some of the European SWOT findings relate to the quality of projects and/or research in European-Chinese research cooperation, they are analysed in detail below:

SO: Leave European research open for Chinese research providers' services

European respondents identified a number of strengths in collaborations. They not only benefiting from Chinese know-how and Chinese testing capabilities but also conducting research less expensively and are able to disseminate research findings and access the market. These strengths allow European respondents to make the most of opportunities of cooperation such as access to qualified labour, faster completion of research, etc. When establishing future ICT research cooperation with China, Europe should continue to create funding opportunities for Chinese participation whenever Chinese research services can contribute to the quality of the research and project to the benefit of Europe. The European benefit should be the prime criterion for decisions on funding Chinese participation in a one-way European approach.

ST: Focus on tacit technology and provide legal advice and support if needed

While European researchers take advantage from significant strengths and added value from Chinese participation in their projects, many also worry about the threat created by competitive advantages that Chinese entities gain from joint projects through unintended know-how transfer, IPR violations, and faster and cheaper adoption of new technologies. IPR violations can be avoided if effective contracts are concluded with Chinese partners at the beginning of projects. Large European research entities usually have dedicated and effective internal infrastructures in place. The European Commission could improve its consulting services on contract preparation in collaborative project for smaller European entities. Participating European organizations also ought to be better informed about means to enforce contractual law in China. Unintended know-how transfer is a phenomenon common to any collaborative research project, not just European-Chinese cooperation. The occurrence of this phenomenon can only be prevented if cooperation is approved only for tacit technologies or Chinese organizations only support research. Chinese partners would not automatically have access to core research activities and related databases.

WO: Require strict project management and cultural preparedness

Weaknesses of cooperation that have to be limited to take advantage of opportunities of cooperation are related, in a wider sense, to management issues in projects and are a result of different work cultures and difficulty understanding Chinese organizational structures. Other weaknesses are caused by a lack of prearrangements for dissemination and legal conditions. These weaknesses can be limited if European participants are either required to involve experienced project managers or if project managers are required to receive some preparatory training on cultural aspects, import/export regulations and opportunities for dissemination. Strict project management, including clear definitions of contacts and responsibilities in Chinese partner organizations, generally eliminates cultural challenges.

WT: Limit Chinese participation strictly to value adding services

If the attributes of the project and technology make the identified weaknesses (cultural skills and insufficient dissemination capability) and threats (unpaid know-how transfers and quicker technology uptake) a dominant factor, Chinese involvement ought to be curtailed, for instance, by only having Chinese organisations supply additional knowledge as contracted providers. Subcontracting would most likely be the model of cooperation preferred for Chinese involvement.

Industry

Since some of the findings of the European SWOT relate to industry aspects, they are analysed in detail below:

SO: Create collaborative research programmes for industry in technology priority areas

Several cooperation strengths that are important for the European ICT industry's competitiveness were identified. These strengths relate to improving European market access by acquiring market knowledge, promoting European technology, implementing standards and advanced technology by means of less expensive research services, acquisition of know-how, and improved testing capabilities. Expanded market access and faster, more sophisticated technological developments were identified as opportunities for cooperation with relevance for industry.

In order to fully exploit opportunities for cooperation for the European ICT industry, dedicated programmes should be developed, which focus on the sectors in which opportunities for cooperation will most likely have the strongest impact. (See the discussion of European thematic priority areas in the previous chapter.)

ST: Meet the demands of the European ICT industry players already present in China

In addition to the aforementioned strengths of cooperation with relevance to industry, European researchers also identified relevant threats related to European competitive disadvantages caused by faster and cheaper adoption of technology, unpaid know-how transfer and a lack of contractual law enforcement. Newly created cooperation programmes that benefit the dedicated European ICT industry should target European-Chinese value chains already present in China. Given the existing cultural know-how, this would reduce the threats identified and would strengthen the research base of existing value chains, thus facilitating the growth of economic integration.

WO: Provide consulting for ICT industry research activities

The weaknesses identified (cultural implications, complex import/export regulation) apply to the majority of industrial entities not frequently present in China. Even European industries with experience in China may not have enough experience to meet major challenges when they step up their manufacturing activities in China by adding research. It is therefore recommended that relevant consulting services be offered, which will enable European industries intensifying their involvement in European-Chinese ICT research to be able to better meet the challenges and take advantage of the opportunities of collaboration.

WT: Focus on local adaptation research for Chinese markets from the start

When developing its Chinese research capabilities, European industry could face threats such as unintended know-how transfer to China, quick assimilation of new knowledge in China, and cheaper development of jointly developed ideas in China. Limiting cooperation by localizing European technology for the Chinese market could be an expedient means to avoid and neutralize these threats. Increasing the offers for dedicated consulting services and subsidizing such research could be an expedient means to limit the weaknesses identified.

Innovation systems

Since some findings of the European SWOT relate to the wider issues of Chinese and European innovation systems, steps Europe could take are discussed below.

SO: Start dialogues on options for integrating Chinese and European ICT innovation systems

Better understanding of the Chinese research system and implementation of European standards in China were identified as strengths of cooperation. Also identified was the opportunity that stepping up cooperative efforts could encourage democratic values in Chinese civil society. Since democratic development in China could support wider European strategic interests, dialogue on options for integrating the two innovation systems could contribute to taking advantage of this opportunity. Broader, general integration of innovation systems would range from setting joint goals for individual topics to joint research programmes.

ST: Identify mutually beneficial implementation procedures

Dialogues will have to focus on mutually beneficial implementation regulations in order to avoid threats to integration, such as unilateral Chinese competitive and know-how gains. In and of themselves, threats cannot be eliminated when innovation systems are integrated. Should integration increase both partners' competitiveness and know-how, a "Pareto" efficiency would be attained.

WO: Apply experiences gained from European integration

Weaknesses of cooperation, such as cultural challenges, could adversely affect the outcome of innovation systems integration. Different cultures, methodologies, backgrounds and organizational structures in Europe often make ERA integration challenging but the European Commission has acquired experience with uniting different interests and views to reach consensus and agreement among ERA member countries on common strategies and goals. These experiences and the processes developed could be used when China is more included in the ERA.

WT: Allow significant freedom and target priority technologies

Limiting the level of integration is recommended as a means to minimize the impact of identified weaknesses largely arising from cultural differences. Technologies should only be integrated when both partners are willing to share their experience and transfer know-how. This would eliminate identified threats such as unintended technology transfers or IPR violations.

5.3 General Recommendations from OpenChina-ICT

Action in and exploration of European and Chinese cooperation, particularly in ICT areas have yielded significant achievements, mutual benefits, and challenges. Thus, recommendations and guidelines are being proposed to make cooperation more effective in the future and to integrate EU-China research programmes better. The recommendations are the outcome of and identified from this EU-China ICT Cooperation Plan's prior analysis. Although the analysis allows other and even contradictory recommendations, the OpenChina-ICT consortium believes the recommendations cited here are the most suitable.

Recommendations have been grouped in categories, including communication, researcher and student exchanges, cooperation on R&D projects, research support for industries, and dialogues.

European Communication

Since China has clear and valid concerns about the usefulness and quality of European-funded research, the OpenChina-ICT consortium strongly advises the European Commission to undertake the following actions to demonstrate the world-class quality of ICT research and European-funded research's its impact on European businesses' competiveness:

- Communication should go beyond the typical window-dressing public relations strategies of the past. Instead, concrete success stories about the competitiveness of European-funded research should be presented to interested Chinese researchers and industries. This could be done by establishing and expanding special funding programmes for a selection of existing outperforming research projects in order to strengthen their dissemination activities in third countries.
- Furthermore, reliable data on the effectiveness and competitive impacts of investments in European ICT research should be presented to Chinese governmental authorities in upcoming dialogues.
- Since documentation of the impact of European-funded ICT research is publically available but is apparently not always convincing at some levels, consideration should be given to improving the communication and analysis of its impact.

Heightening Chinese awareness of the usefulness and impacts of European-funded ICT research could help European and Chinese policy dialogues on coordinated calls, joint calls or joint programmes for ICT collaborative technology areas produce concrete results.

Reason and validation: *As shown in the Chinese SWOT and as validated at the OpenChina-ICT workshops in China, the Chinese have serious concerns about the quality and competitive impact of European-funded ICT research. On the other hand, the majority of European attendees of the final OpenChina-ICT conference do not support the thesis that the competitive impact of European-funded research is weak (see Annex III). Furthermore, as demonstrated by the OpenChina-ICT European survey, European-funded ICT research has demonstrably made major contributions to important technological achievements driving the European ICT industry and influencing global society. Targeted promotion of European-funded research in China could, therefore, heighten awareness of it there and facilitate joint European-Chinese research interventions.*

Chinese Communication

China uses multiple channels for European researchers to participate in Chinese-funded research activities, but European researchers who are not well networked in China have difficulty obtaining the information necessary to become involved. Furthermore, Chinese researchers find it difficult to obtain information on funding opportunities for cooperation with European partners.

China would, therefore, be well advised to establish a one-channel communication approach to provide information on various programmes open to European participation and the terms and conditions of involvement. Such a one-channel approach should incorporate the official governmental websites of the National Development and Reform Commission (NDRC), the Ministry of Science and Technology (MOST), and the Ministry of Industry and Information Technology (MIIT).The approach should also incorporate social networks accessible in China, such as LinkedIn.

Reason and validation: *At the OpenChina-ICT workshops and in interviews, European and Chinese researchers commented on the difficulty of obtaining any information on participation of European entities in Chinese-funded research. Furthermore, as validated at the OpenChina-ICT workshops in China, Chinese stakeholders apparently have great desire and need for Chinese researchers to cooperate with their European counterparts. By making information on open programmes more transparent, China could attract more European researchers to its programmes.*

Researcher and Student Exchanges

There are a large number of researcher and student travel programmes. Based on the discussions at the OpenChina-ICT Dialogue Conference, the OpenChina-ICT thematic workshops, and the findings of the OpenChina-ICT internal-external analysis of cooperation, such exchanges can be assumed to facilitate mutual technological innovation and industry developments in ICT in both Europe and China.

The following is, therefore, recommended:

- Specific, jointly funded exchange programmes in potential ICT technology priority areas targeting Europe as a whole should be launched.
- Such exchange plans should be split up into short-term programmes focusing on cooperation in current key fields and long-term programmes focusing on fundamental and common technology fields. Both programmes would foster technological innovation and cultivate talent in ICT.

- Policymakers creating such exchange programmes should incorporate Chinese options presented in this report: (1) Programmes should be combined with recurrent programmes for Chinese researchers in order to prevent Chinese brain-drain to Europe. (2) Programmes should include preparatory training for participants to prevent inefficiencies caused by cultural and language barriers. (3) Only reputable European partners with technology leadership should be allowed to participate in programmes in order to avoid undesirable results caused by the participation of unqualified European partner organisations.

Reason and validation: *Travel programmes are effective tools for mutually accessing know-how and market knowledge and for establishing personal global networks. As reflected in and validated by the Chinese SWOT, the Chinese put a great deal of emphasis on travel programmes with Europe. What is more, current travel programmes funded by both sides are working and do not furnish much potential for political disputes. Restricting such programmes to a select, exclusive group of countries or entities might be controversial in Europe since the attendees of the final OpenChina-ICT conference did not support this idea (see Annex III).*

European Cooperation in R&D Projects

Chinese entities have long been eligible for European-funded research projects and many have already contributed to European-funded ICT research. In the internal-external analysis of cooperation, European researchers identified numerous benefits for the quality and competitiveness of European research. It is, therefore, recommended that the mechanism for Chinese entities' participation in European-funded projects be kept the same. Whether or not this step is taken, the following, based on the European options identified, should be considered case-by-case whenever Chinese entities are included in projects:

- Is it probable that Chinese research providers will contribute to the quality of research and projects to the benefit of Europe?
- Restricting funding to Chinese participating in projects with tacit technologies should be considered as a means to avoid diverse threats identified for Europe. Participating European organisations should also receive legal and contractual advice to avoid identified threats.
- Activities should either be limited to European entities with experiences in China or cultural training and preparation should be provided to avoid negative cultural impacts.

- When cultural challenges and unintended know-how transfers are dominant factors of cooperation, Chinese participation should be reduced solely to the role of a service provider without access to key technologies in the project.

Reason and validation: *In phone interviews documented in the European SWOT, European researchers cited a number of advantages for Europe from Chinese-European research cooperation projects. Factoring in the aforementioned recommendations, thought should therefore be given to whether European-funded ICT research should remain open to the participation of Chinese organisations. This view was validated very positively at the final OpenChina-ICT conference (see Annex III).*

Chinese Cooperation in R&D Projects

Chinese researchers identified funding as a primary challenge when establishing collaboration with European partners. Furthermore, in the internal-external analysis of cooperation, the Chinese identified a number of benefits from an expansion of research activities with European partners. Apparently, Chinese ICT researchers would welcome increased funding opportunities for collaborative partnerships with Europe.

The data provided in this report indicates that Chinese funds available for such collaboration are rather limited. It is, therefore, recommended that China provide more funding for Chinese researchers to increase their cooperation with Europe. Such a unilateral approach would give China all of the instruments it needs to avoid the weaknesses and threats of cooperation identified. China could additionally organize its own cooperation programmes to optimize the identified strengths and opportunities in its own interest.

Reason and validation: *In the internal-external analysis of cooperation, Chinese researchers identified a need for funding opportunities for projects with European entities as well as a number of benefits of such cooperation. These findings were validated at the Chinese OpenChina-ICT project workshops and in interviews with Chinese experts.*

Support for Industry Research

The European and Chinese internal-external analysis of cooperation presents strong evidence that Europe and China should develop jointly funded ICT research cooperation programmes to meet the demand for ICT research cooperation from European and Chinese industries already engaged in bilateral trade and manufacturing. Existing cooperation mechanisms have not addressed industry needs explicitly. Such support would enhance existing economic integration with research programs and, thus, boost European and Chinese competitiveness in the ICT industry. Furthermore, such interventions should take the aforementioned technology priorities into account.

The internal-external analyses of cooperation (see "Options for Cooperation") suggest that the following should be considered when programmes are created:

- Industry representatives should be involved in the creation to minimize threats and weaknesses.
- Leading and competitive industry entities should be supported to avert the failure of interventions.
- Multinational value chains with additional bases outside of Europe and China should also be considered in order to avoid losing contact with other research nations.
- Since even industries with pertinent experience with Chinese-European cooperation will face challenges when they add research to cooperation, it is recommended that programmes are supported by consulting services.
- Local adaptation research to launch existing products and technologies on European or Chinese markets could also be supported. This type of research averts unintended know-how transfer and its consequences.

China and Europe could go one step further by promoting policies of equality. They could encourage European enterprises to establish R&D centres in China and vice versa through policies that reduce the burdens on foreign enterprises and attract enterprises through tax deductions or exemptions, accelerated depreciation and/or reduced administrative burdens.

Reason and validation: *As indicated in the Chinese and European SWOT analyses, adding research to European-Chinese manufacturing value chains would benefit China und Europe. Previous research cooperation did not focus explicitly on industry demands. Economic theories and econometric findings indicate that increased international research integration increases social welfare in the countries involved. Given the economic advantages, research could be expected to enhance trade and manufacturing ties sustainably. Panellists and attendees of the final OpenChina-ICT conference validated and supported this view (see Annex III).*

Dialogue

The analysis of challenges to Chinese cooperation and the European and Chinese internal-external analyses of cooperation revealed the importance of political issues and related dialogues. Furthermore, prior dialogue mechanisms, including the discussions during sessions of the OpenChina-ICT workshops and conferences have demonstrated the potential for more intense dialogues between China and the European Commission.

Based on those experiences, the challenges to Chinese cooperation identified and the theoretical considerations summarized above in the section on Chinese and European Options, the OpenChina-ICT consortium recommends the following:

- The dialogue mechanisms in ICT research fields should be strengthened and developed further in order to provide China and Europe a platform for the latest updates on European-Chinese progress in ICT, to strengthen networking in ICT fields and to develop concrete common actions, such as coordinated calls, joint calls, joint programmes and others.[88]
- As indicated by the Chinese challenges identified, such dialogues should have a procedure for ongoing exchange about and updating on the progress of agreements between Europe and China on policies related to human rights, environmental protection, bilateral/multilateral trade, and general economic cooperation.
- To support dialogues, expert advisory groups in priority fields could be systematically established and existing expert advisory groups could be improved to assume more significant roles. Such expert advisory groups should only include representatives from the European-Chinese ICT industry leaders and the leading research societies since this will guarantee progress in economically sustainable fields of interest for the European and Chinese research community and industries.
- Consideration should be given to involving other non-European countries in dialogues and expert advisory groups in response to the Chinese concern that contact to other global research nations might be lost. Dialogues with input from reconstituted expert advisory groups could target certain selected flagship interventions with common benefits and industry support. Potential priority areas for flagship interventions were defined by the OpenChina-ICT priority areas. In the beginning and for reasons of cost efficiency, such flagship interventions ought to be limited to areas in which cooperation support mechanisms already exist (Internet of Things, Future Internet & IPv6 and Smart Cities).

[88] The cooperative technology priorities of the OpenChina-ICT EU-China ICT Cooperation Plan could provide guidance.

- Since Chinese researchers and experts feel European research implementation and management procedures are superior, discussions should be held on possibilities to support improvements of Chinese procedures. The introduction of European administrative standards in Chinese ministries could be expected to have a positive effect on other dialogues.
- In the internal-external analysis of cooperation, both Chinese and European stakeholders acknowledge the importance of standards for their ICT industries' success. Furthermore, the Horizon 2020 guidelines mention that agreements on common standards are a prerequisite for European funding of international cooperation. Therefore, the enhancement of cooperation in the activities of standard organizations, such as 3GPP, ITU and IETF in potential thematic cooperation technology areas may also be included in the dialogue discussions. Dialogues should address improving collaboration among standards organisations, e.g. 3GPP, ITU and IETF, in the thematic areas of technology cooperation.

Reason and validation: *Findings of the EU-China ICT Cooperation Plan, as detailed in the section on internal-external analysis of cooperation and challenges to cooperation, indicate the need for improved policy dialogue. This recommendation is based on the findings of both the Chinese and European internal-external analyses and also on the Chinese challenges.*

The current make-up of expert advisory groups is a critical aspect. As indicated in the introduction to this report, many appointed European experts work exclusively on research projects funded by the European Commission. It was revealed, however, that future European-Chinese ICT research cooperation programmes should respond more to the needs of transnational value chains and existing trade integration. Existing expert advisory groups should therefore be improved by adding industry from reputable companies with appropriate backgrounds. Panellists and attendees of the final OpenChina-ICT conference strongly supported this view (see Annex III).

Attendees of the final conference endorsed the recommendation that policy dialogue ought to concentrate on flagship interventions with mutual benefits and on the lowest denominators (see Annex III).

Attendees of the final conference full supported the recommendation of increased cooperation on the definition of standards and increased cooperation in standard organizations (see Annex III).

References

[1] *European Commission (2012) http://ec.europa.eu/research/iscp/pdf/co-operation-europe-china-may-2012_en.pdf, retrieved August 30th, 2013*

[2] *European Commission (2009):http://ec.europa.eu/research/iscp/pdf/crest.pdf, retrieved January 15th, 2013*

[3] *European Commission (2011): http://ec.europa.eu/research/iscp/pdf/eu-ms-activities-with-china_en.pdf, retrieved September 5th, 2013*

[4] *World Economic Forum (2013): http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2013-14.pdf, retrieved September 5th,2013*

[5] *European Commission (2012) http://ec.europa.eu/research/iscp/pdf/com_2012_497_communication_from_commission_to_inst_en.pdf, retrieved December 6th, 2012*

[6] *Eurostat (2012) http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/6-18092012-AP/EN/6-18092012-AP-EN.PDF, retrieved September 5th, 2013*

[7] European Commission (2000) Agreement for scientific and technological cooperation between the European Community and the Government of the People's Republic of China. Official Journal of the European Communities, 11.01.2000, L 6/40-45

[8] *European Commission (2010) http://www.era.gv.at/attach/sfic_report_of_activities_2009-10.pdf, retrieved September 7th, 2013*

[9] *European Commission (2009)http://ec.europa.eu/research/iscp/pdf/drivers_sti.pdf, retrieved September 20th, 2013*

[10] *European Commission (2013) http://trade.ec.europa.eu/doclib/docs/2009/september/tradoc_144591.pdf, retrieved December 5th, 2013*

[11] *European Commission (2013)http://trade.ec.europa.eu/doclib/docs/2006/september/tradoc_113366.pdf, retrieved 20th December, 2013*

Annex I: Bilateral Research Relationships between China and Select Member States

The following is an overview of bilateral research relationships between China and select member states:[89]

- **Denmark[1]**

  In 2009, the Danish Agency for Science, Technology and Innovation and the Chinese MOST's Innovation and Technology Commission signed a MoU on cooperation in the natural sciences. Furthermore, Denmark opened the "Innovation Centre Denmark" in Shanghai in 2007, intended to foster relationships between Chinese and Danish researchers and companies.

  Denmark has also implemented primary initiatives and programmes, e.g. block grants, with China to foster the cooperation between Danish and Chinese researchers and institutions. In addition, the Danish National Research Foundation and the Danish Research Council have agreements with the Natural Science Foundation of China, to promote bilateral exchanges of experts in life, natural and engineering sciences. In 2009, the Danish Council for Strategic Research and the Chinese MOST implemented a joint sustainable and renewable energy research programme.

- **United Kingdom[1]**

  In 1978, the United Kingdom and China concluded an agreement on scientific and technical cooperation, which has since been followed by other agreements. At present, various dialogues and working groups are addressing different fields of science and technology. Many joint institutes and labs operated by UK universities or research societies and their Chinese counterparts have been established. The UK Research Council has established a number of joint calls with Chinese natural science foundations in various fields. Discussions with the Chinese MOST on the establishment of jointly funded pilot initiatives are ongoing.

[89] The European Union member states are the same as those in the OpenChina-ICT European survey.

- **Germany[1]**

  Germany not only has more projects with Chinese participation in the EU's Seventh Framework Programme but also cooperates bilaterally with China more than any other EU member state.

  In 1978, Germany concluded an agreement on science and technological cooperation with China. German and Chinese science and technology commissions include steering committees for specific fields that meet regularly.

  Germany and China's top bilateral priorities range from ICT and environmental technologies to electric-vehicles. A number of calls for bilateral research projects supported and co-funded by various agencies in China are issued regularly.

  Institutionally level, the Fraunhofer-Gesellschaft is the leader in German bilateral cooperation in science and technology with China. Notable initiatives of the Fraunhofer-Gesellschaft and Chinese institutions are the Sino-German Joint Laboratory of Software Integration Technologies in Beijing and the German-Sino Mobile Communication Institute in Berlin. They are supported by the Chinese MOST and the German Federal Ministry of Education and Research.

- **France[1]**

  In 1978, France and China concluded an agreement on scientific and technical cooperation, which has since been followed by other agreements. In 2011, China and France signed an agreement to support joint calls for proposals in various fields, including ICT and smart cities. French and Chinese working groups meet regularly. France and China have established a number of joint labs, such as the LIAMA Lab of Informatics, Automatics and Applied Mathematics.

- **Spain[3][1]**

  In 1985, Spain and China concluded a science and technology agreement and have also concluded two joint declarations and several MoUs on S&T cooperation. The most important initiative is an innovation programme (CHINEKA) between the Spanish Centre for the Development of Industrial Technology and the Chinese Institute for High Industrial Technology. China is interested in joint projects with Spain on renewable energies and with related facilities. Spain is interested in accessing Chinese funding for joint research projects and Chinese travel grants for Spanish researchers. Spanish and Chinese research entities have established several joint institutes in a variety of fields.

- **Austria[3]**

  In 1984, Austria and China concluded an agreement on science and technology cooperation. An Austrian-Chinese commission meets tri-annually, the last time being 2012. The commission is comprised of representatives from MOST and BMEAI-BMWF. "Currently, there are six bilateral agreements between the Austrian Federal Ministry of Transport, Innovation and Technology or appertaining organizations (e.g. Austrian Institute of Technology) and respective Chinese counterparts (e.g. MOST, CASTED)."[90] The establishment of a China-Austria Technology Park (CATP) in Vienna is under discussion. Bilateral calls in various fields have been issued or are being prepared.

- **Estonia[1]**

  Estonia is in an early stage of it research cooperation with China. Cooperation focuses on professor exchanges and joint scientific seminars. In 1993, Estonia and China concluded an agreement on scientific cooperation but a steering committee has not been established yet. The two countries chiefly cooperate in EU-funded research programmes.

[90] http://ec.europa.eu/research/iscp/pdf/eu-ms-activities-with-china_en.pdf

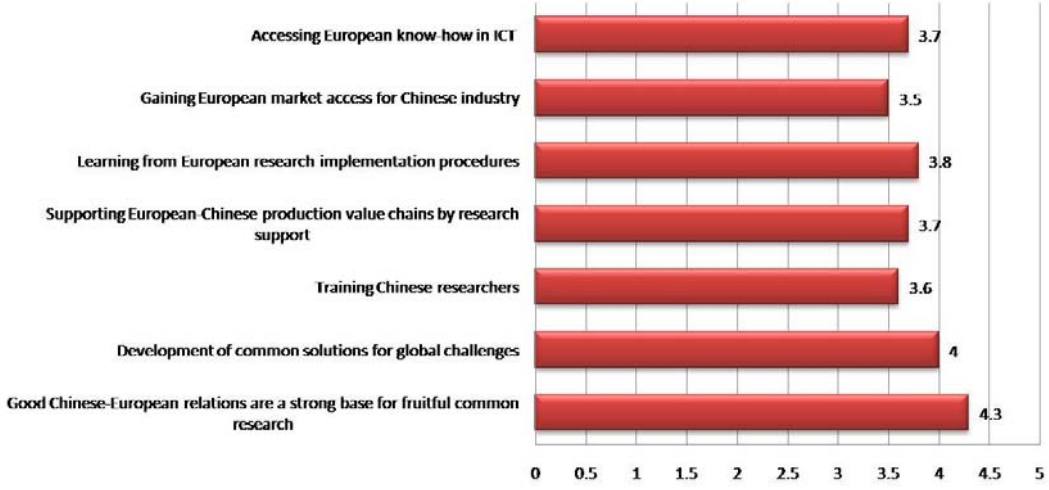
Annex II: Validation of the Chinese SWOT

- **OpenChina-ICT Thematic Workshop on Smart and Sustainable Cities held in Guangzhou on May 31, 2013.**

The table below presents the results of a questionnaire that surveyed workshop attendees' support of the SWOT factors presented at the workshop. Attendees were asked to rank each item listed under strengths, weaknesses, opportunities and threats *(5= very important, 1 = not important).*

	Points	1	2	3	4	5	No Idea
	STRENGTHS						
1	**Accessing European know-how in ICT**	1	1	1	5	3	1
2	**Gaining European market access for Chinese industry**	0	2	4	2	3	1
3	**Learning from European research implementation procedures**	0	1	3	5	3	0
4	**Supporting European Chinese manufacturing value chains with research support**	0	1	5	3	3	0
5	**Training Chinese researchers**	0	2	3	5	2	0
6	**Development of common solutions for global challenges**	0	3	0	2	6	1
7	**Good Chinese-European relations are a strong basis for fruitful common research**	0	1	2	2	7	0

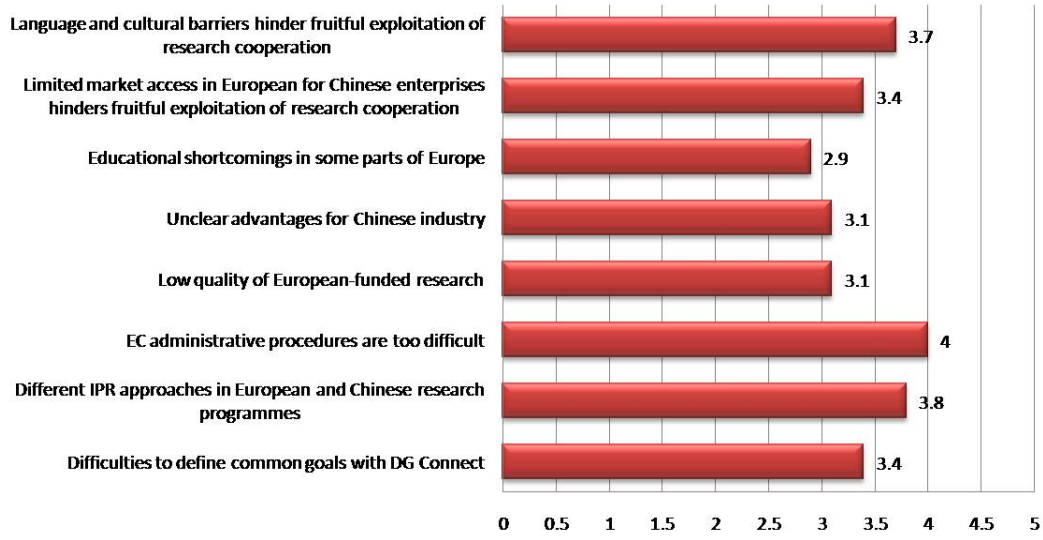
The bar chart below presents the average rankings from the survey, from 1 (not important) to 5 (very important).



	Points	1	2	3	4	5	No Idea
	WEAKNESSES						
1	**Language and cultural barriers hinder fruitful exploitation of research cooperation**	0	3	3	1	5	0
2	**Limited access to European markets for Chinese enterprises hinders fruitful exploitation of research cooperation**	1	1	4	3	2	1
3	**Educational shortcomings in some parts of Europe**	1	4	1	3	1	2
4	**Unclear advantages for Chinese industry**	1	2	4	3	1	1
5	**Low Quality of European-funded research**	0	3	3	2	1	3
6	**EC administrative procedures are too difficult**	1	0	1	4	3	3
7	**Different IPR approaches in European and Chinese research programmes**	0	2	1	5	3	1

8	**Difficulties defining common goals with DG Connect**	1	1	2	5	1	2

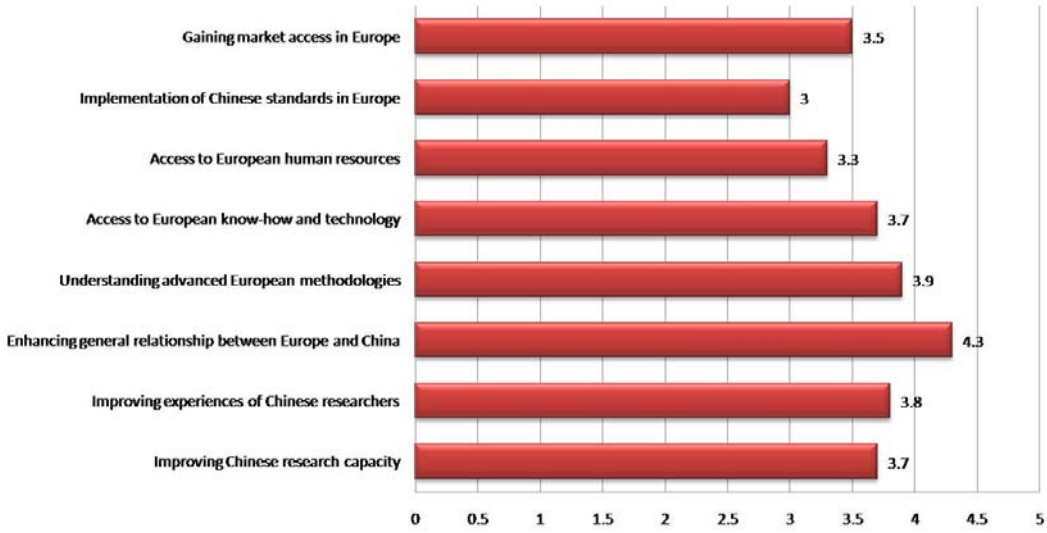
The bar chart below presents the average ranking from the survey, from 1 (not important) to 5 (very important).



	Points	1	2	3	4	5	No Idea
	OPPORTUNITIES						
1	**Gaining market access in Europe**	0	2	3	4	2	1
2	**Implementation of Chinese standards in Europe**	2	2	3	4	1	0
3	**Access to European human resources**	1	2	4	3	2	0
4	**Access to European know-how and technology**	1	0	4	4	3	0
5	**Understanding advanced European methodologies**	0	3	1	2	6	0
6	**Improving the general relationship between Europe and China**	0	0	2	5	5	0

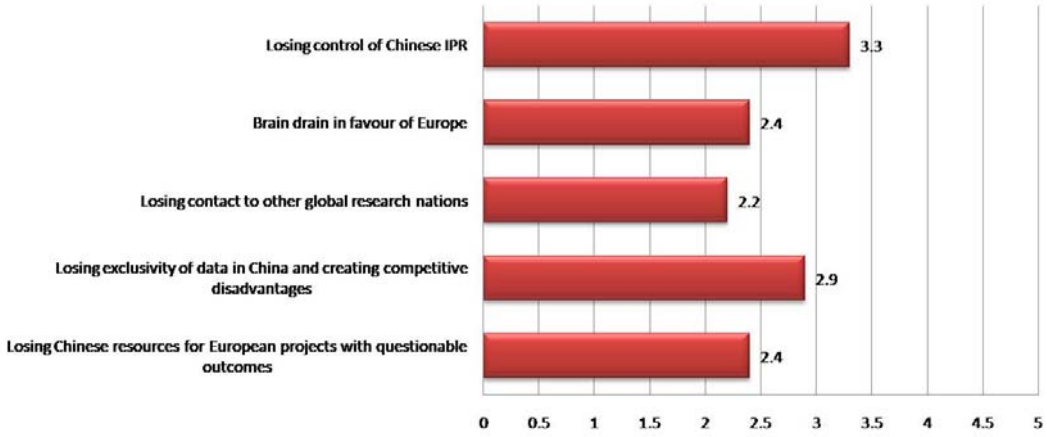
7	**Improving Chinese researchers' experiences**	0	0	6	3	3	0
8	**Improving Chinese research capacity**	0	0	6	2	3	0

The bar chart below presents the average ranking from the survey, from 1 (not important) to 5 (very important).



	Points	1	2	3	4	5	No Idea
	THREATS						
1	**Losing control of Chinese IPR**	1	0	6	3	1	1
2	**Brain-drain to Europe**	2	4	2	2	0	2
3	**Losing contact to other global research nations**	3	3	5	0	0	1
4	**Losing exclusivity of data in China and creating competitive disadvantage**	1	3	3	2	1	2
5	**Losing Chinese resources to European projects with questionable outcome**	2	5	3	0	1	1

The bar chart below presents the average ranking from the survey, from 1 (not important) to 5 (very important).

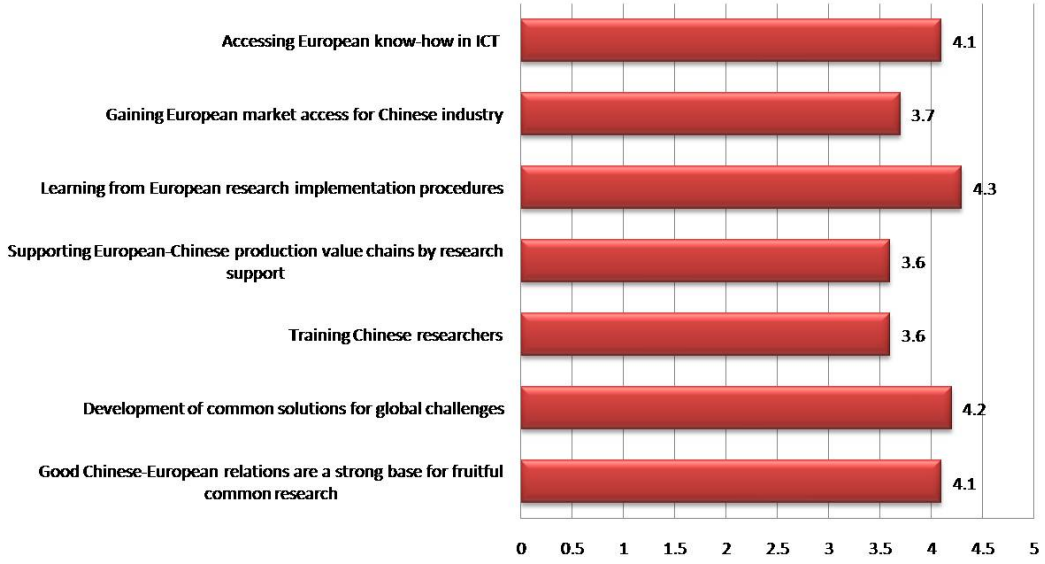


- **Second OpenChina-ICT Thematic Workshop on Internet of Things & Future Internet held in Beijing on August 23, 2013.**

The following table indicates the results of a questionnaire which asked the workshop participants to indicate whether they support the SWOT factors as presented during the Workshop. The participants had been asked to mark each item listed under Strengths, Weaknesses, Opportunities and Threats. *(5= very important, 1 = not important)*

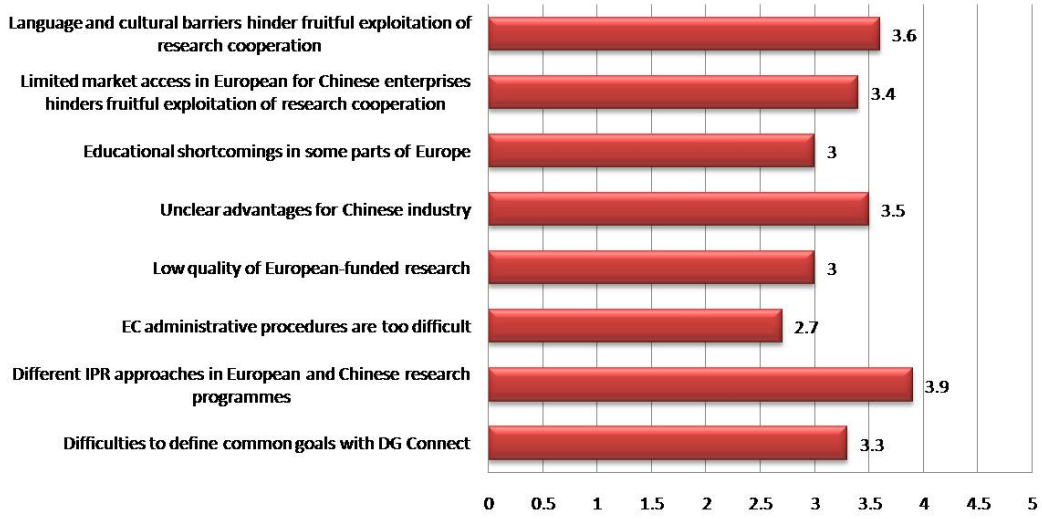
	Points	1	2	3	4	5	No Idea
STRENGTHS							
1	**Accessing European know-how in ICT**	0	1	4	7	7	0
2	**Gaining European market access for Chinese industry**	2	2	3	5	7	0
3	**Learning from European research implementation procedures**	0	1	3	4	11	0
4	**Supporting European Chinese manufacturing value chains with research support**	1	0	6	10	2	0
5	**Training Chinese researchers**	0	3	7	2	6	1
6	**Development of common solutions for global challenges**	1	1	2	4	11	0
7	**Good Chinese-European relations are a strong basis for fruitful common research**	0	1	4	5	8	1

The bar chart below presents the average ranking from the survey, from 1 (not important) to 5 (very important).



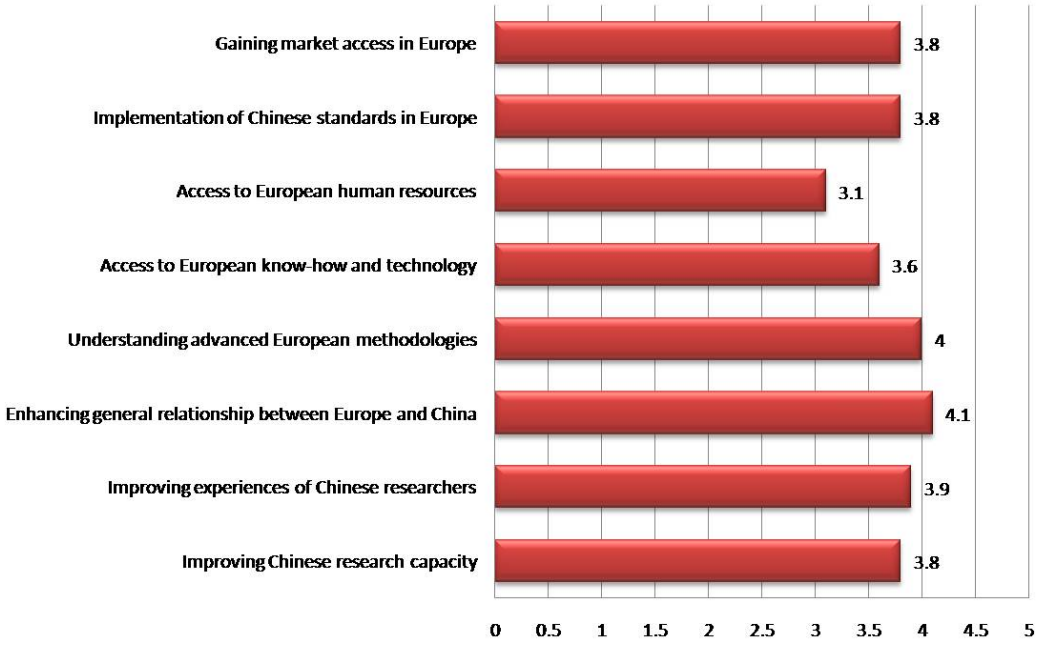
	Points	1	2	3	4	5	No Idea
	WEAKNESSES						
1	**Language and cultural barriers hinder fruitful exploitation of research cooperation**	0	3	4	3	4	2
2	**Limited access to European markets for Chinese enterprises hinders fruitful exploitation of research cooperation**	1	2	5	4	3	1
3	**Educational shortcomings in some parts of Europe**	2	3	6	2	2	1
4	**Unclear advantages for Chinese industry**	1	3	3	3	5	1
5	**Low Quality of European-funded research**	1	3	7	3	1	1
6	**EC administrative procedures are too difficult**	0	1	7	3	3	2
7	**Different IPR approaches in European and Chinese research programmes**	0	2	3	5	5	1
8	**Difficulties defining common goals with DG Connect**	1	2	5	4	2	2

The bar chart below presents the average ranking from the survey, from 1 (not important) to 5 (very important).



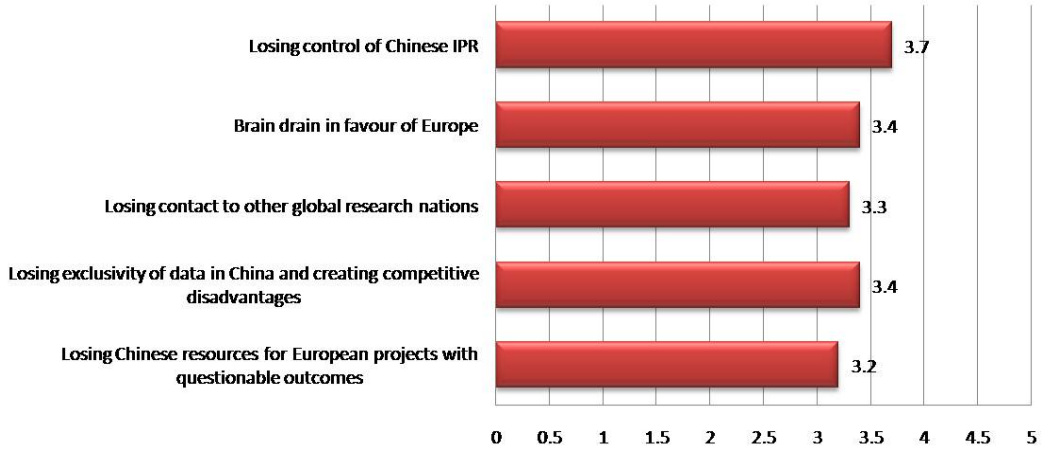
	Points	1	2	3	4	5	No Idea
OPPORTUNITIES							
1	**Gaining market access in Europe**	2	1	2	5	7	0
2	**Implementation of Chinese standards in Europe**	1	2	4	2	7	1
3	**Access to European human resources**	1	2	8	3	1	2
4	**Access to European know-how and technology**	1	1	4	7	3	1
5	**Understanding advanced European methodologies**	1	1	1	6	6	2
6	**Improving the general relationship between Europe and China**	0	2	2	5	7	1
7	**Improving Chinese researchers' experiences**	0	2	4	3	7	1
8	**Improving Chinese research capacity**	1	2	2	5	6	1

The bar chart below presents the average ranking from the survey, from 1 (not important) to 5 (very important).



	Points	1	2	3	4	5	No Idea
	THREATS						
1	**Losing control of Chinese IPR**	0	1	6	4	4	2
2	**Brain-drain to Europe**	0	3	5	5	2	2
3	**Losing contact to other global research nations**	3	1	4	2	5	2
4	**Losing exclusivity of data in China and creating competitive disadvantage**	0	1	8	3	2	3
5	**Losing Chinese resources to European projects with questionable outcome**	0	5	3	2	3	4

The bar chart below presents the average ranking from the survey, from 1 (not important) to 5 (very important).



Annex III: Feedback on and Validation of Recommendations from the Final OpenChina-ICT Conference in Vilnius

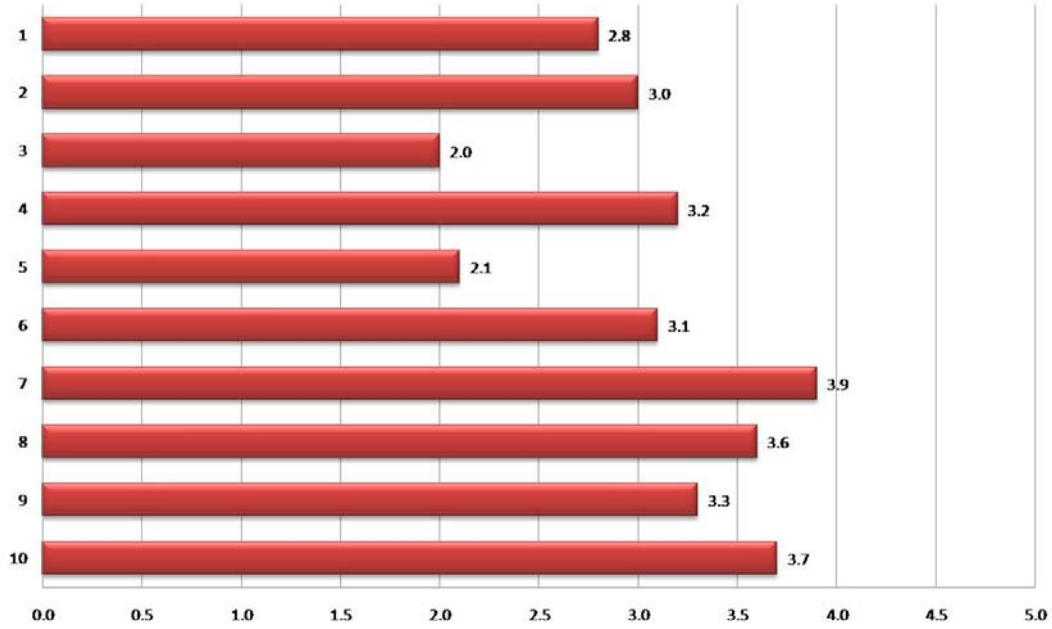
	Points	1	2	3	4	5	No idea
1	Do you share Chinese worries that the impact of European-funded research may be weak and its contribution to competiveness of the economy doubtful?	2	9	4	6	1	2
2	Would you support the recommendation that the role of the European Commission should be strengthen also regarding a better coordination of bilateral cooperation activities of European member states?	5	1	8	6	3	1
3	Would you support the recommendation that some newly created cooperation programmes with China should be restricted to an exclusive group of experienced European entities of appropriate size, competitive leadership or reputation?	9	6	4	3	0	2
4	Would you welcome it if Chinese service provision can be included into European-funded Horizon 2020 ICT research without prior conditions in the future?	2	4	4	7	2	3
5	Would you support the idea of the European Commission developing customized cooperation programmes with China for different groups of European member states based on economic strengths and needs?	12	3	0	6	1	1
6	Should Chinese-European ICT research concentrate more on real industry needs and mutual market access for Chinese-European value chains and therefore limit foundational research?	5	2	3	8	3	3
7	Should political dialogues be extended to all OpenChina-ICT priority areas?	1	1	2	10	5	4
8	In order to better reflect European industry and research needs, should existing ICT expert groups be upgraded by representatives from competitive and reputable European ICT industry and research organizations?	3	0	3	10	4	3
9	Instead of diversified cooperation approaches, should dialogues concentrate on carefully selected flagship cooperation initiatives on which a consensus can be reached?	2	4	4	6	4	3
10	If Europe and China speak with one voice in standards organizations, such as 3GPP, ITU and IETF, do you feel this would support European economic interests?	1	2	3	8	4	5

At the final OpenChina-ICT conference in Vilnius, the consortium collected feedback from interested researchers by means of a questionnaire and an open panel discussion in which all attendees actively participated.

1. Questionnaire

The table below presents the results of a questionnaire that surveyed Vilnius final workshop attendees' support of a number of recommendations in the Cooperation Plan. Attendees were asked to rank each recommendation *(5= very important, 1 = not important).*

The bar chart below presents the average ranking from the survey, from 1 (not important) to 5 (very important).



2. Results of the final OpenChina-ICT conference panel discussions among panellists and attendees on comment on the available version of the EU-China ICT Cooperation Plan and the general development of EU-China research collaboration.[91]

General comments on Cooperation Plan:

- The broad findings of the Chinese SWOT were confirmed by a European participant, who has recently been in contact with the Chinese MOST.

Comments on communication recommendations of Cooperation Plan:

- One attendee believes that it might be difficult for the EC to demonstrate the competitiveness of its funded ICT research programme since is generally difficult to measure.
- Some attendees commented that European-Chinese research should not be measured by results and outcomes.
- The recommendation that China should establish a one-channel approach to attract foreign researchers met with support during the discussion.

Comments on dialogue recommendations of Cooperation Plan:

- Several individuals supported the recommendation that future cooperation target well-selected flagship initiatives with mutual benefits.
- Panellists and attendees widely supported the recommendation that expert groups be improved by adding experts from leading European research and industry entities.

Comments on recommendations for cooperation on R&D projects:

- Due to value added and bettered European industries' access to Chinese markets, several panellists supported the recommendation that European-funded research remain open to Chinese researchers.

Comments on industry recommendations

- Several panellists and attendees supported recommendations for the focus on industry in future collaboration.

[91] Summarized remarks are the opinions of European attendees of the workshop. Chinese officials present at the conference did not actively participate in the discussions.

General comments on means to further develop European-Chinese ICT research collaboration:

- One panellist mentioned that China should simply take or leave European-funded research as it is.
- One panellist supported the Chinese suspicion that European-funded research is weak.
- Mention was made that European-Chinese ICT research should switch its focus to global challenges related to health, demographics and big data.
- One panellist commented that European-funded research should remain European and that eligible European countries should not be preselected.
- One attendee called for improvement of internal communication between different EC DGs on the development of European and Chinese research cooperation.

Deleted Recommendation:
The Recommendation Bilateral vs. European cooperation was deleted on the basis of the validation at the final OpenChina-ICT Final Conference in Vilnius. The first draft of the Cooperation Plan contained the recommendation:

"Bilateral vs. European cooperation
The analysis in the EU-China ICT Cooperation Plan indicated that individual European member states have their own approaches to the development of research relationships with China. To avoid value picking by Chinese authorities that contravenes European visions, it is recommended that the European Commission and member states improve their internal mechanisms to better coordinate bilateral and EU activities. Consideration should be given to defining European ICT research cooperation strategies and integrating European member states' individual bilateral activities under this umbrella. In theory, this would strengthen the ERA and give Europe a stronger voice in negotiations with China. China should try to accept the representatives of the European Commission as its primary entrance points for dialogues on research cooperation. This would give China the advantage of having one primary contact for different national economies."

Reasoning for deleting:

1. Attendees opposed said recommendation during the panel discussion
2. Analysis of the questionnaire revealed that conference attendees merely had a neutral view of the recommendation
3. Implementation of said recommendation would require a substantial commitment from all European Union member states, something difficult to obtain in practice.

Annex IV: Author and Contributor Profiles

Authors

Kay Matzner

Kay Matzner, a German national, received his Diplom degree in economics from Otto von Guericke University Magdeburg (Germany) and the University of Hull (UK) in 2000. He currently works for the Fraunhofer-Gesellschaft. He specializes in the implementation and analysis of innovation systems. He has over ten years of extensive experience in international projects in China, India and Asian Pacific and NIS countries. He has authored various papers on innovation systems and internationalization.

Cao Jiguang

Senior Engineer, Deputy Chief Engineer of Institute of Communication Standard Research, China Academy of Telecom. Research, MIIT, China, He engages in IP bearer network technology research, such as IPv6, Future Internet, and relevant policy research on the telecom and Internet industries. He has actively participated in ITU-T activities since 2003 and is the editor of nearly 10 ITU-T recommendations. As the leader of the work group 4 in China telecommunication Standard Association，he presides over and participates in the standard research of new IP technologies in China. Since 2004, as a Chinese government delegation participates in United Nations Internet Governance process, he attends all WSIS meetings and WGIG consultation meetings, and now attends IGF meetings. He is involved in the editing and proofreading of the book of "Internet governance" (Chinese version).

Contributors

Kang Yanrong

Senior engineer of China Academy of Telecommunication Research. She gained her master degree in International Business Law from Southwest University of Political Science and Law in 2002 and has since joined CATR as a researcher. She gained her doctorate degree in Administrative Law from China Academy of Social Science in 2011. Her research fields are in the regulatory policies and laws within ICT sector. She has been involved in the regulatory policy research in telecommunication market access, interconnection, pricing and protection of users since 2003 and is a member of the draft group of *the Telecommunication Bill.*

Yanrong had actively been involved in the *EU-China Information Society Project* and acted as a coordinator from 2005 to 2009, four books in Chinese and one book in English published under the project. She was involved in the research group in the*12th ICT Plan of China, the Strategic Research on Internet of Things, State Council decision on pushing forward the Internet of Things.* She is the coordinator of EU-China FI/IPv6 and IoT Working group, the coordinator of EU-China Smart City Cooperation, as well as the coordinator of CATR MoU with the EU commission.

Tang Hao Yang Fan

Senior engineer of China Academy of Telecommunication Research, which works for the Research Institute of Communication Standards, focusing on research of Internet related protocols, technologies and testing methods. He participated in several "973", "863" and national science and technology projects, contributed to several working groups of ITU-T, IETF and other standards organizations.

Zhu QianLong

Senior engineer at the Institute of Economy and Policy Research of CATR, the Vice-Chairman of the Internet research filed in CATR, and the main participant in some major research projects at national level. He has many years of experience in the research field of Telecommunication and Internet.

Zhang Guoying

Senior engineer at the Institute of Communication Standard Research, China Academy of Telecom. Research, MIIT, China. Zhang Guoying has been with CATR for more than 12 years as a researcher and is interested in the topics of optical network management, intelligent control systems, and broadband access networks. From 2010 to 2011, she did research about elastic optical network in the University of California, Davis, as a visiting scholar.

Li Shaohui

Senior engineer at the Institute of Communication Standard Research, China Academy of Telecom. Research, MIIT, China. Li Shaohui received his Ph.D. in physical electronics in 2008 from Beijing Institute of Technology, China. He now engages in telecommunications network system standards research, optical communication especially optical transmission and access technologies, and telecommunications business regulation.

Zhang Yi(Ian)

Senior engineer at the Institute of Planning and Designing Research of CATR, the key member of the internet quality monitoring centre of CATR, and the main participant in some major research projects of internet at the national level. He has strong experience in the research field of Telecommunication and Internet.

Yang Fan

Engineer at the Institute of Communication Standard Research, China Academy of Telecom. Research, MIIT, China. Mr. YANG got his M.S. degree in Computer Science from Duke University in the United States and received a bachelor's degree in Telecommunication Engineering from Huazhong University of Science and Technology (HUST) in China. Now, he studies on the research of advanced technologies, industry and policies of the Internet, including Software-defined Network (SDN) and future networks.

Annex V: Official Chinese Letters of Endorsement and Support

Support letter from the Ministry of Industry and Information Technology (MIIT) of the People's Republic of China:

中华人民共和国工业和信息化部

January 12th, 2014

Subject: Support to OpenChinaICT EU-China ICT Cooperation Plan

Dear Kay Matzner,

Thank you very much for having informed me that you, as the leader with the support from CATR, MIIT and other China research units, had finished the report of EU-China ICT Cooperation Plan under OpenChinaICT project of FP7 ICT Call 7. In ICT fields, China and EU are facing similar challenges in ICT technology development, service innovation, and industry enhancement, so It is very important and necessary for China and EU to enhance ICT cooperation comprehensively.

I know the project had attract a lot of contributions from China ICT experts based on questionnaire and face to face meetings, and the report summarizes the existing EU-China cooperation, and analyzes future cooperation priority fields. I believe the report will benefit for the future ICT cooperation between China and EU. The results of the project will improve official Dialogue to reach a better integration of both ICT research landscapes.

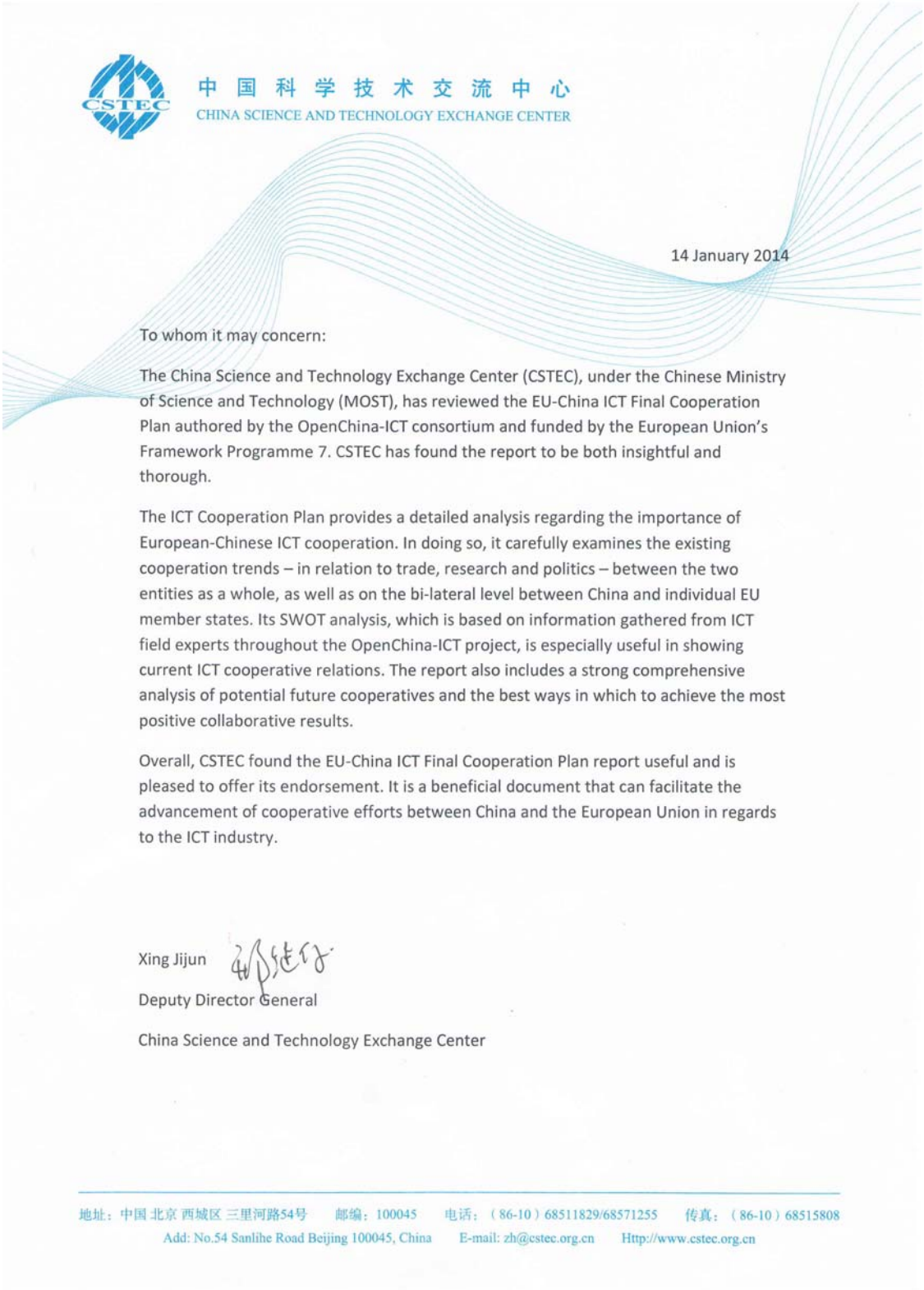
I hope, based on these valuable research results, EU and China can open wider cooperation perspectives in ICT field, and push EU-China ICT cooperation from policy research to more concrete industry cooperation. And I am very glad to hear your future research achievements.

Yours sincerely.

Signature

Deputy Director, Division of Network Development, Department of Telecommunication Development ,
Ministry of Industry and Information Technology of the People's Republic of China

Endorsement letter from the China Science and Technology Exchange Center (CSTEC), under the Chinese Ministry of Science and Technology (MOST):



中 国 科 学 技 术 交 流 中 心
CHINA SCIENCE AND TECHNOLOGY EXCHANGE CENTER

14 January 2014

To whom it may concern:

The China Science and Technology Exchange Center (CSTEC), under the Chinese Ministry of Science and Technology (MOST), has reviewed the EU-China ICT Final Cooperation Plan authored by the OpenChina-ICT consortium and funded by the European Union's Framework Programme 7. CSTEC has found the report to be both insightful and thorough.

The ICT Cooperation Plan provides a detailed analysis regarding the importance of European-Chinese ICT cooperation. In doing so, it carefully examines the existing cooperation trends – in relation to trade, research and politics – between the two entities as a whole, as well as on the bi-lateral level between China and individual EU member states. Its SWOT analysis, which is based on information gathered from ICT field experts throughout the OpenChina-ICT project, is especially useful in showing current ICT cooperative relations. The report also includes a strong comprehensive analysis of potential future cooperatives and the best ways in which to achieve the most positive collaborative results.

Overall, CSTEC found the EU-China ICT Final Cooperation Plan report useful and is pleased to offer its endorsement. It is a beneficial document that can facilitate the advancement of cooperative efforts between China and the European Union in regards to the ICT industry.

Xing Jijun
Deputy Director General
China Science and Technology Exchange Center

地址：中国 北京 西城区 三里河路54号　邮编：100045　电话：（86-10）68511829/68571255　传真：（86-10）68515808
Add: No.54 Sanlihe Road Beijing 100045, China　E-mail: zh@cstec.org.cn　Http://www.cstec.org.cn