

SYNCHRONISER

*Synchronising the Research Policy Dialogue to the Indian
Dimension*

FORESIGHT STUDY AND ROADMAP PAPER



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1. Abstract

This study gives an insight into technology priorities in ICT R&D identified by thirty visionaries of India. The technology priorities are identified for India. The study aimed at understanding what India might prefer to invest in, in ICT R&D in the next 2, 5, 10 years. The study was executed to throw insights about India in order to help improve the cooperation between India and EU member states in collaborative ICT R&D projects.

Visionaries were from academia and industry with minimum of 20 years of experience in the Indian ICT sector and some even had up to 40 years. Issues of sample validity and challenges faced using the semi Delphi methods are elaborated in this report. The toughest challenge was to obtain clarity on technology trends in ICT R&D for the 2, 5, 10 year time lines. The technology priorities in core technology development area of ICT and sectorial applications of ICT are brought out. Network technologies, improving the networking capabilities, internet access, mobility applications, security solutions especially on mobile applications, and monitoring systems and large data management challenges including cloud computing were seen as critical technology trends India will notice in the next 2,5,10 years. Typical of a developing country, India's focus on application is high, and health care and energy applications appear to be the most important ones India will focus on in the next 2, 5, and 10 years. Mobility applications, cloud computing, embedded systems are already ongoing and will continue to be developed in the next 2-5 years. Intelligent monitoring systems for health care and environment, intelligent networks, machine to machine communication, smart grids, green computing and designing devices for green computing, and large numbers of internet access including the rural areas and last mile, will be a focus in 10 years. The overall orientation that India will have with technology development in ICT will be low cost, large volume, software dominant and low on energy consumption, irrespective of core technology and sector. Visionaries have also commented on the JWG technologies and provided some insights to enhance the collaborations between India and EU in the area of ICT R&D.

This report integrates the feedback received from the two consensus building sessions with panellists' views & opinions. Fair amount of consensus exists in the technology priority areas stated by the expert panellists in both the consensus building sessions, with the ones stated by the 30 visionaries' interview.

2. Executive Summary

Transnational ICT collaboration has become one of the most important topics for several nations worldwide. For India, ICT is the key driving force for economic and technological boom in the past two decades and Europe is keen on expanding their longstanding relationship with India in this domain, specifically in the R&D space. In addition to inviting Indian research partnerships in the European Commission's Framework Programme for the ICT sector, the two governments have established an Indo-EU ICT Joint Working Group consisting of policy makers, research and industry stakeholders, to identify topics for ICT research collaboration.

The current study on identifying Indian future priority topics for ICT research aims to augment the EU-India political dialogue in the ICT domain, and most importantly, the mission of the ICT Joint Working Group. The study has identified Indian focus areas in the next 2, 5 and 10 years with regard to technology priorities in ICT R&D. It is envisioned that the data from this study, amongst others, will serve as a planning input for European Commission, in order to identify technology priority calls for India.

Thirty Indian ICT technology experts with an average experience of 20 years in the Indian ICT industry were interviewed using the Delphi method. The experts interviewed include 10 professors and 20 industry experts at the CEO and CTO levels. The industry experts were representatives of leading large companies and small and medium enterprises, including start-ups. These experts called 'visionaries' in the study, provided insights into the technology priority areas India must focus on, shared their views on European Commission's Framework Programme and provided valuable suggestions to enhance EU-India collaboration.

Within two consensus meeting, the results of the Interviews have been reviewed and have been approved and supported by the experts of the Consensus meeting.

The foresight study brought out some very interesting and important societal and economic trends that will govern technology priorities for India. These include, low value (low cost) high volume products and services, consciousness of green computing, green devices and low energy consuming, predominance of software over hardware solutions, conscious integration of rural consumers and language diversity.

Two specific areas that India will show R&D trends in clearly emerged through the content analysis of the interviews: Core technology development & Sectorial applications of ICT.

Core technologies pointed out by the visionaries include (a) Internet access: allocation of bandwidth, last mile connectivity, convergence of mobile and internet technologies; (b) Networking technologies: large networked systems, machine to machine communication, cloud computing, wireless networks and smart networks; (c) Monitoring systems, sensors for measurement & remote diagnostics, integrated with wireless networks, generic and mobile devices; (d) Cloud Computing Applications & (e) Security algorithms for various systems and devices

With regard to sectorial application of ICT, healthcare, energy, governance and education emerged as important sectors that will need ICT integration.

The following healthcare development areas were highlighted by the visionaries: Bioinformatics for better diagnostics, information management & retrieval; Connectivity and networking of

medical devices; Smart medical systems with learning ability, patient monitoring, monitoring devices to capture and transmit data; Security in data management systems; Large storage systems and cloud computing; Integration of medical data and monitoring systems with mobile & Telemedicine.

Several focus areas in energy conversion, generation and management were suggested by the visionaries: ICT for Smart Grids; Solar panel electronics, solar gadgets; Green devices, with low power consuming displays, storage devices, and longer life batteries; e Waste management; redesign of consumer goods electronics with energy and green consciousness are the important ones.

There are many important areas of governance and education that India will invest in as per the study: Governance related to land records, digitization, database maintenance, secure storage systems; Person identification and tracking systems; Transportation identification systems and RFID; banking identification; Mobile based payment system; Education and skills training using ICT and Mobile applications for education.

The study also ascertained the visionaries' views and thoughts on the priority areas identified by the EU-India Joint Working Group. Of the lot of technologies listed by the Joint Working Group this visionaries sample stated that RFID, biometrics and smartcards were the priority in India.

Other major highlights of this study include Visionaries' level of awareness about EU, their intentions to collaborate and suggestive measures to improve EU-India collaboration in ICT R&D.

The study also brought to light that Indian experience with EU is inadequate and insufficient yet to galvanize into an active one, which calls for more exposure of Indians to EU technologies. The visionaries opinion is that the Indians engage with EU ICT industry more in the arena of "outsourcing" or "client-vendor" transactional relationship rather than collaborative R&D relationship. Methods to bring out an active interest amongst Indian ICT organizations to seek information on EU ICT R&D must be pursued either at the industry level or the Government levels to enhance this collaboration.

Another important point that emerged clearly through the survey was that the visionaries who represent the Indian ICT diaspora are very positive to collaborate with EU ICT industry both at the academic and industry levels. If the Indian industry is exposed to the benefits of the information seeking activity, then the number of proposals will certainly go up from the Indian side. It would be interesting to do a similar study for EU and assess whether they monitor changes in India.

The study proposes definite measures that could be considered by both the governments towards kindling much interest in Indian and EU organizations to collaborate in R&D. Series of training programs and workshops on proposal writing and accounting practices; Road shows on EC activity in India; bringing top scientists and university professors from EU in various areas of ICT on a road show and for exclusive talks in India and vice versa; creating a directory of EU companies interested in cooperating with Indian partners to help Indians find partners.

The study findings also emphasize that much interest must be shown on the Indian side also to make this success happen. Since fair amounts of R&D financial support is available to Indian

researchers from the Indian government, an extra bit of effort must be shown on the Indian side to increase collaborative R&D with EU.

3. Introduction

Predicting what a country will do in the near future is a challenge and Niels Bohr (1885-1962) adequately stated that, "Prediction is very difficult, especially about the future". Prediction nevertheless has benefits if done in an objective and unbiased manner. This is more so in developing countries where planning is not as sophisticated as it is in the case of developed countries like Europe. In developing countries planning, adherence to planning, monitoring and evaluation is an evolving process since developing countries often have to fire fight real life issues that are often unexpected yet high priority, planning goes awry and needs to evolve changes in direction, constantly. According to Blind et al, 1999, "the term "foresight" is used in the sense of "outlook." This is not the same connotation as "prediction" which would be closer to "forecast." Foresight takes into account that there is no single future. Depending on action or non-action at present, many futures are possible but only one of them will happen. "

Despite the difference between "forecast" and "foresight" in this report we request visionaries in India to provide foresight into what India will do in the next 10 years. Whilst this involves a fair amount of prediction, this report prefers to take the title of "foresight". Providing foresight into what a country like India will engage in with ICT R&D is fascinating not only because of the fact that ICT is currently a flagship technology area in India, but also because of the pervasive nature of ICT and what it can do to develop a country whose population is expected to equal China by 2025 (http://ec.europa.eu/research/social-sciences/pdf/the-world-in-2025-report_en.pdf). This foresight gets even more exciting because of the possible ICT R&D collaborations between India and EU member states, thanks to the futuristic funding activities of the European Commission.

This report describes what India will focus on in ICT R&D in the next 10 years.

3.1 Present EU-India research collaboration

The importance of ICT is seen world-wide. A list of ICT areas typically invested in by developed countries is provided in Annexure 1. ICT is currently the leading sector in R&D investments worldwide. In EU alone ICT is expected to be an important contributor to the 2020 goal of achieving R&D investments close to 3% of the European GDP(<http://ftp.jrc.es/EURdoc/JRC57808.pdf>). ICT is also seen employing more researchers than any other sector.

Given the importance of ICT, EU sees the need for internationalization of ICT activity and partnership or collaboration with other countries in meeting its ICT R&D needs. Cooperation with Asia and especially developing Asia, is seen as important considering that Asia is becoming a competing base for ICT development.

Amongst the Asian giants India is seen as an emerging force in ICT manpower. Rich in logic and mathematics the software development skills of Indians are an asset of the country. Whilst R&D investments are not as high (in comparison to other countries) in ICT, a developing country like India poses as an important partner for Europe in meeting global challenges. The need for EU and India to collaborate for R&D is seen as critical. The aim is to pool in the strengths of various ICT experts of the two geographies. Given the win-win opportunity in such collaboration, today

it is seen as a better approach for social and economic progress. The European commission puts aside investments in various thematic areas of ICT for country wise cooperation. Some of these investments are also for cooperation between EU and India in projects related to ICT R&D. In the last two Frame Work Programme calls for the thematic area of ICT, India has been seen participating in collaborative projects with EU. Details of these collaborative projects are provided in Annexure 2. In FP6 and FP7, approximately 21 projects in R&D (includes support action) were sanctioned between EU and India. The areas of cooperation in ICT R&D were the following:

- e-Inclusion
- Mobile and wireless systems beyond 3G
- Software and services
- ICT for networked businesses
- ICT for environment risk management

Examples of Indian partners who participated on these ICT projects with EU were as follows:

- Mahindra and Mahindra Ltd, India.
- Tech Mahindra Ltd
- Association of Intelligent Transport Systems India (AITS), India
- Tata Consultancy Services
- Centre for Development and Advanced Computing
- Indian Institute of Science
- ITSMA
- IIIT B
- Tata Sons Ltd
- IIT Kanpur
- Tata Institute of Fundamental Research
- Antrix Corporation Limited, India
- Amrita VishwaVidyapeetham, India
- The Energy and Resources Institute (TERI)
- IIT B
- Federation Of Indian Chambers Of Commerce And Industry (FICCI)
- Centre For The Study Of Developing Societies
- Resource Management Group
- GS1
- Documentation Research and TrainingCenter
- Indian Statistical Institute, India

Whilst there is evidence of cooperation between EU and India the numbers and project statistics is expected to rise if the right promotion is made. Cooperation between two geographies is

difficult to achieve when information about the nature of either one country is scarce and less understood. It is in this context that the India specific foresight study was initiated.

In the recent announcement for proposals the European Commission appears to have a budget for the following areas. These areas are listed here so as to understand the technical terminology used by EU in describing information and communication technologies, an area that is constantly growing, loosing its boundary and difficult to classify as a family of sub technologies. In the 2011-2012 Budget the following areas are mentioned by European Commission as areas likely to be proposed for collaborative R&D:

- Networking, computing and service infrastructure
- Cognitive systems, robotics
- Alternative paths to components and systems
- Technologies for digital content and languages
- Towards sustainable personalized healthcare
- ICT for low carbon economy
- ICT for enterprise and manufacturing
- ICT for learning and cultural resources
- Future and emerging technologies

More details of this budget are provided in Annexure 3.

3.2 Purpose of this study

This foresight study aimed to throw light on ICT areas India might want to focus on R&D investments in the two, five and ten years. Experts feel that providing an outlook beyond 2-5 years is at times a stretch but others appear more comfortable speaking of a ten year time frame. Hence the time frame of two to ten years was preferred for this study. This study is aimed at obtaining information from experts who are experienced in the ICT sector and with the Indian industry landscape in particular. These experts were referred to as visionaries who can see into the future in a manner that others less skilled, cannot. Much description on how the visionary is chosen is provided in the project deliverable D 3.2 and will not be repeated in this report.

The need to identify what India wants to focus on was seen as important inputs to European Commission when the EC “calls” for proposals between EU and India. In order to synchronize the ‘call’ of technology priorities close to that of India’s needs this study aimed at identifying what those needs will be in the ICT R&D domain.

Using the expert approach to read into the future, the Delphi method was utilized with minor modifications. Round 1 of the Delphi survey elicited rich data that described what visionaries felt India will focus on. Obtained results have been further evaluated in two consensus meetings and have been approved by the participants of the Consensus meetings. Details on the methodology used are provided in D 3.2. This report describes the results of this survey.

4. Visionary Sample

A total of 30 visionaries were interviewed. 28 engaged in direct face to face interviews with the research team, and 2 interviews were conducted telephonically. One key researcher conducted the entire 30 interviews together with a supporting team. For more information about the sample of 30 visionaries go to D3.2 and D3.3, where each visionary is profiled and excerpts from their interview documented.

Since the demographics of the visionary sample is a critical aspect of this survey details of the sample are described below. Their sector, type of organization, gender, educational qualification, experience and designation is graphically represented.

Care was taken to ensure that the visionary was sufficiently experienced and knowledgeable of the Indian ICT industry. A lack of this understanding would result in the visionary providing insights without a true and realistic picture of India. Hence, if the visionary was based outside India and worked abroad whether in USA, EU or any other country, they did not qualify for the interview. We chose to have visionaries that were home grown, have been in India at least 10 years, working in Indian ICT industry. Five, exceptions were made to this rule. They were the inclusion of five visionaries from foreign multinational experience; however these visionaries too have been in India and worked with Indian ICT industry for over 20 years. Only two of these five were foreign nationals, namely the visionary who was the ex CEO of Philips Innovation India, and currently the CEO of Palandrome a startup in India and the President and CEO of Korean Science and Technology Institute, who also headed the IT operations of a leading Indian ICT organization, L&T Infotech. Both these visionaries stayed in India for over 20 years and knew the Indian landscape very well and hence qualified for this study. Thus the average number of years all 30 visionaries spent in the ICT industry of India will be over 20 years.

The reason care was taken to ensure the profile of the visionary was of a certain mix was to ensure that sample validity is maintained throughout and certain errors are avoided. The following highlights are paradigm when choosing the visionary:

- The visionary knew the Indian landscape adequately
- The visionary does not project visions of world trends in ICT R&D as if they were India trends
- The visionary does not provide insights skewed towards India's business interactions with USA and USA's needs, as USA is a dominant client of Indian ICT business, but instead provides what India needs as seen from within India and by being in India
- The visionary must speak from his or her vast experience in dealing with the Indian landscape and not from guesstimates and of the cuff estimates of a trend, colored by thoughts of other markets and world trends in ICT. Although some of this will occur,

other questions were asked to verify where the visionary was coming from in his or her dialogue.

The main query that every visionary was asked was, “what technologies do you think India will invest in the next 2, 5 and 10 years in the area of R&D in ICT?” The interview builds on this query thereafter for about 40-50 minutes on an average. Details of how the interview questions were evolved are provided in D 3.2. A summary of the methodology and the limitations experienced during data collection is provided also provided in D3.3.

There main challenges encountered while executing this study, are described below:

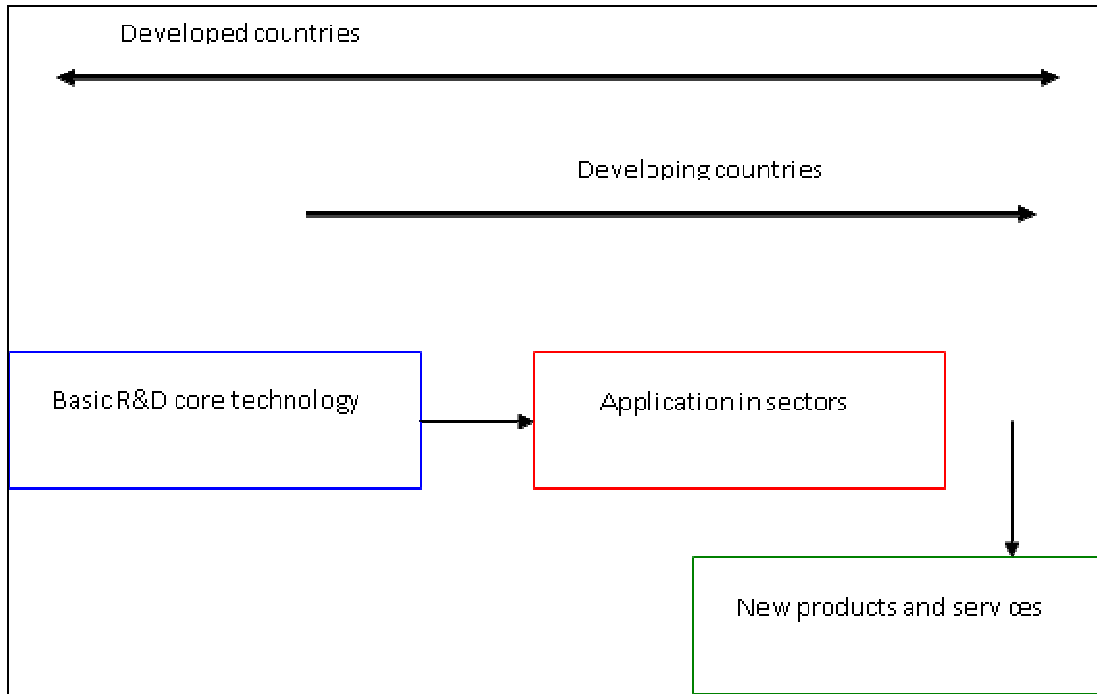
(a) The technical and organizational background of the visionary: Since ICT is a large basket of technologies and every sector today is ICT influenced, it was not possible to limit a definition of ICT to a certain set of technologies, like Future Networks, or ICT for manufacturing as such. Instead it was seen that the visionary tended to speak from his or her background. The background can be the technical area of ICT the visionary is an expert in or the research and product his or her organization develops. Hence, the visionary whose organization has a ICT for health care orientation will tend to speak from a health care orientation and may not speak from some other orientation like security, or mobility and payments as such. Likewise a visionary whose organization is into networks and band with management will under play healthcare and focus on network efficiency.

(b) Since the definition of ICT is not very clear and the various sources of the definition be it OECD, NACE, European Commission documents is attempted, today it remains well known that ICT is all pervasive and whilst there maybe core technology development in mobility, networks, sensors, security and other technical areas, application areas are also classified under ICT R&D. Hence, ICT for energy generation and management, or health care will also qualify for this study. Likewise green computing too will feature as a possible technology area. This breadth of technology was also seen in the interview contents of the visionaries.

(c) The issue of a time line, namely 2, 5 and 10 years was a bit of a struggle to achieve during interviews. There may be many reasons for this difficulty, one is the fast changing pace of ICT, its thus difficult to put a timeline. Another may be the skill to vision, and the clarity to vision, keeping all odds in minds is not an easy one. Hence, the time line appeared quite garbled and unclear, expect for some instances, when visionaries described their technology trends and priorities.

(d) The applied R&D vs Basic and core technology development R&D is another area which appeared difficult to classify. It is possible that developed countries will tend to focus more on ‘core technology development “and developing countries will tend to focus on applications in sectors given the know how of core technology development from developed countries. Figure 1 below shows this trend which was also visible from the qualitative interview data in this study.

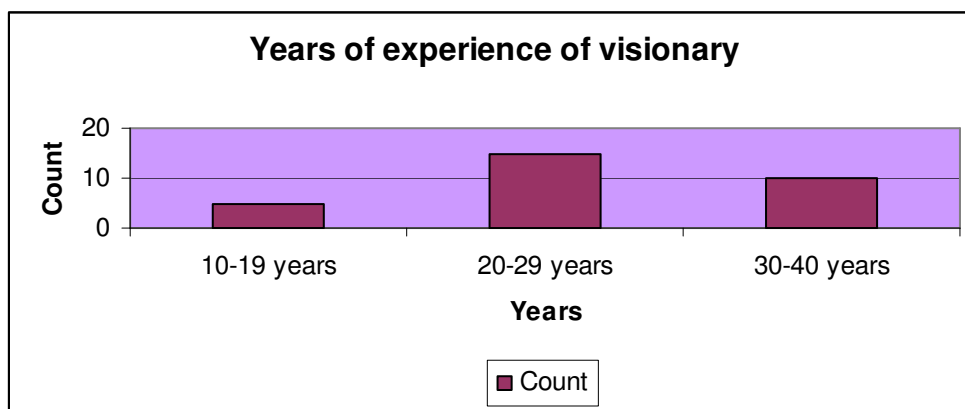
Figure 1: Showing the orientation of developed and developing countries with R&D



The profile of the visionaries is described in the following paragraphs..

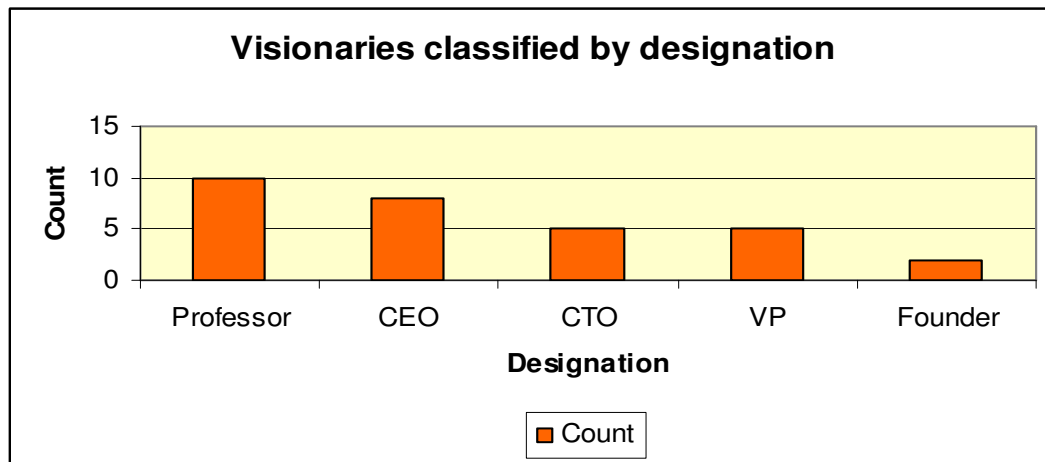
(a) Experience: It was felt that the years of experience the visionary had in his or her career and in Indian ICT industry in particular was critical for validity of the response he or she gave. A large chunk, i.e. 15 out of 30 of the sample of visionaries had a minimum of 20-29 years of experience. 5 had experience of about 10-19 years, and 10 had experiences spanning over 30-40 years. Figure 2 shows this distribution.

Figure 2: Showing the experience profile of the visionaries (n=30)



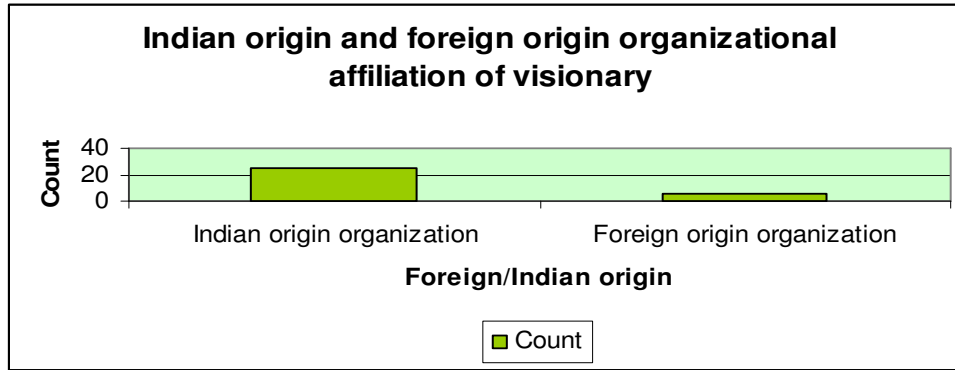
(b) Designation: The designations of these visionaries were understood further; senior experts were desired for this trend study. It was assumed that a certain designation is indicative of the professional experience of the visionary. The designations captured in this study were Professor, CEO, CTO, Vice President and founder (startups after a stint in industry). None from the managerial and lower management cadres were used in this study. The designations shown in Figure 3 indicate a rather senior expert group of visionaries.

Figure 3: showing the designations held by the visionaries (n=30)



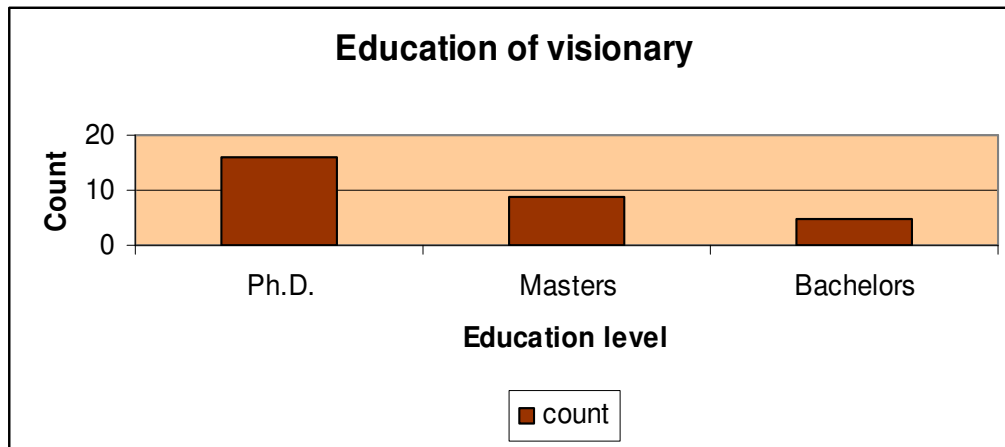
(c) Organizational affiliation foreign or Indian: Care was taken not to choose many visionaries from multi-national organizations whose orientation was some other country other than the EU states and India. Nevertheless, five of the visionaries were from foreign multi-nationals such as SAP, Siemens, Philips, Korean Science and Technology Institute and IBM. The remaining lots of 25 visionaries were from Indian organizations. Figure 4 describes this distribution.

Figure 4: Showing whether the visionary had a foreign MNC affiliation or was from an Indian organization



(d) Education: The education profile of visionaries showed a nice range of higher education amongst them. Sixteen of the visionaries had doctoral degrees. This implies that they had R&D and scientific backgrounds. About nine of the visionaries had masters degrees and about five had bachelors degrees.

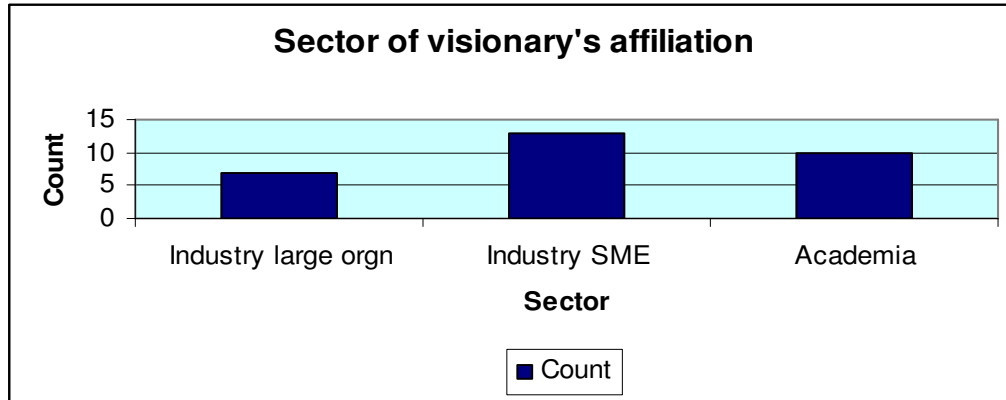
Figure 5: Showing the education profile of the visionaries



(e) Organizational affiliation: Visionaries were carefully picked from both academia and industry. There were ten Professors from academia and about twenty industry experts in ICT from the Indian ICT industry. All professors had academic experiences only and industry visionaries ranged from those from large to small and medium organizations. Seven of the industry experts were from large companies such as Wipro, Infosys, HCL and TCS. The remaining three were from large organizations that were foreign multi-national, namely SAP, IBM and

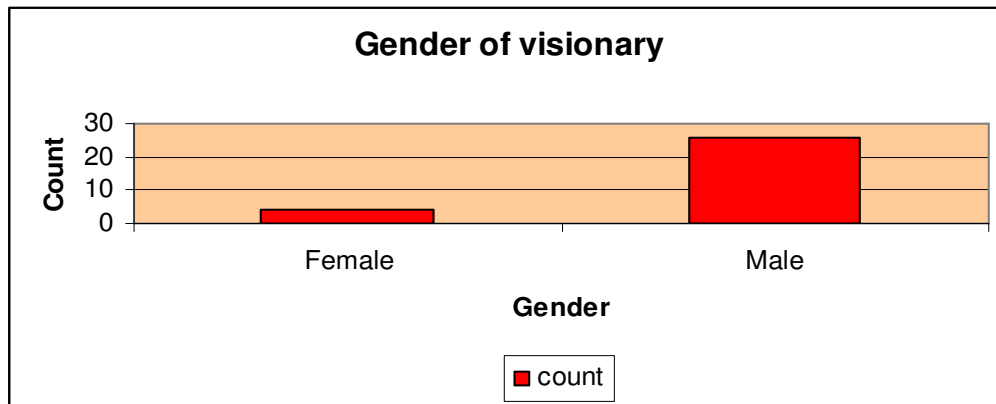
Siemens. One of the visionaries was the ex CEO of Philips, but is currently the CEO of an SME, hence he is classified under the SME list.

Figure 6 showing the sectors' classification of visionary's organizational affiliation



(f) Gender: There was difficulty finding female visionaries in the Indian industry and special efforts were made to identify them. Four of the visionaries were female with experience in Indian ICT industry. Twenty six of the visionaries were male. This is not surprising as the Indian industry is a male dominated one in higher levels of management especially amongst seniors in top management.

Figure 7 showing the gender distribution of the visionaries



5. R&D Trends for Indian ICT

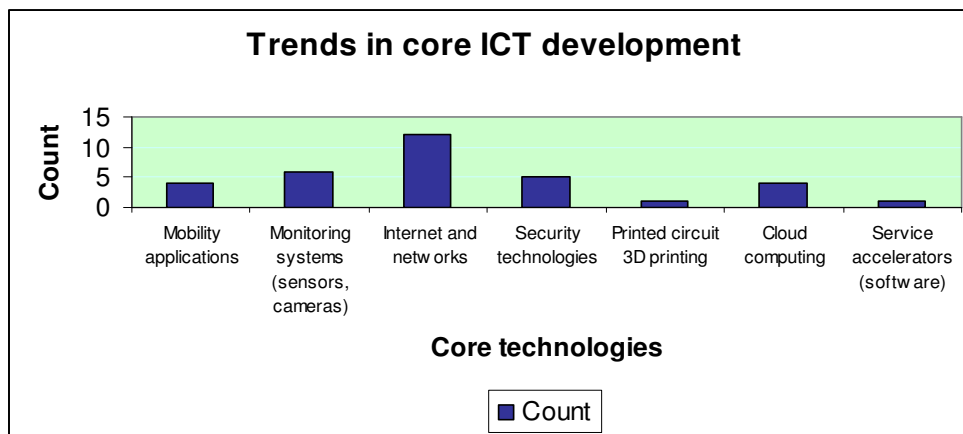
5.1 Technology Priorities in Indian ICT: Visionary responses

Two specific areas that clearly emerged after a content analysis of the interviews of thirty visionaries is that there is expectation that India will show R&D trends in both:

- (a) Core technology development
- (b) Sectoral applications of ICT

(a) Core technology development: Such technologies involve basic and applied R&D activities in core technologies related to the ones mentioned in Figure 8. These are technology development activities not per se related to a sector. There will be good amounts of basic R&D activity in these priority areas, implying that the university systems will play an active role here. Once university develops such technologies, industry will take it further and apply it to a sector and customize it for health care, education, energy, agriculture and such. Whilst the mobile is mentioned by few visionaries applications in it will only be fruitful if 3G and 4G is in place and the penetration which is growing increasing. Nevertheless, such developments will be low cost, for example SMS solutions may be chosen over NFC solutions in mobile payments in countries like India.

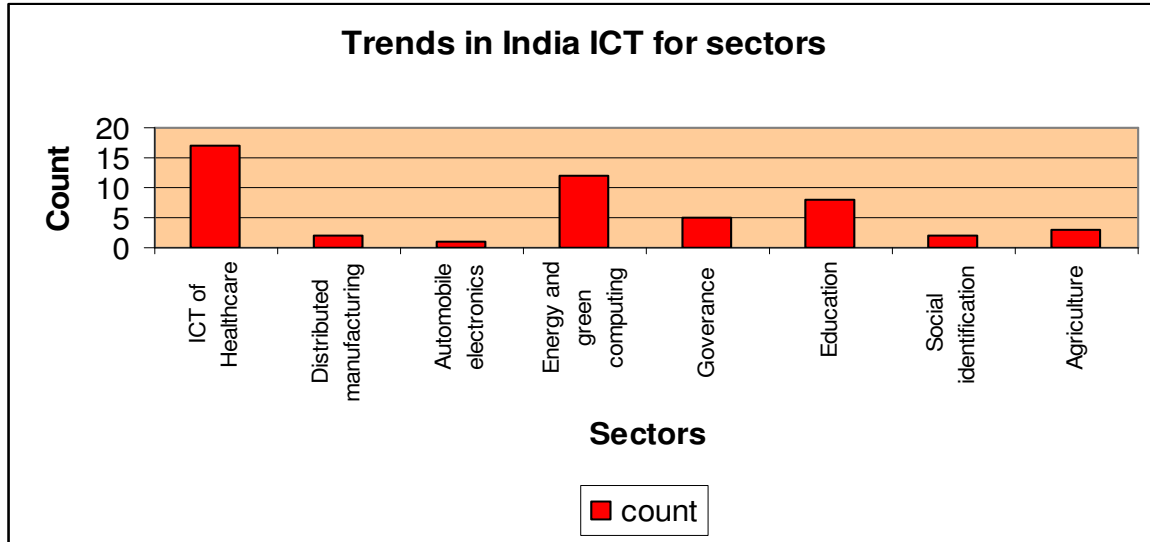
Figure 8: showing trends in India for core ICT development



(b) Sectoral applications of ICT: These technology development activities involve customizing Solutions for various sectors like health care and energy. Figure 9 describes the visionary insights on technology priority trends in the sector where ICT can be used. Health care clearly emerges as the most important area for India. This is followed by a consciousness of energy. There are many aspects of these applications those visionaries feel need not be made but can be bought off developed countries. It will not be necessary to reinvent the wheel in these cases, however they feel the unique application of these technologies and identifying user needs to be

able to integrate those needs into the solution systems will be more the emphasis in India. Language diversity will also have to be addressed, since the languages vary and so does literacy and per capita income in rural area. They feel integrating the rural areas is critical for the overall growth of India. Hence ICT cannot be an urban agenda but also be a rural agenda.

Figure 9: showing the trends in India for ICT in sectors



5.2. The summary of ICT R&D trends as seen by visionaries

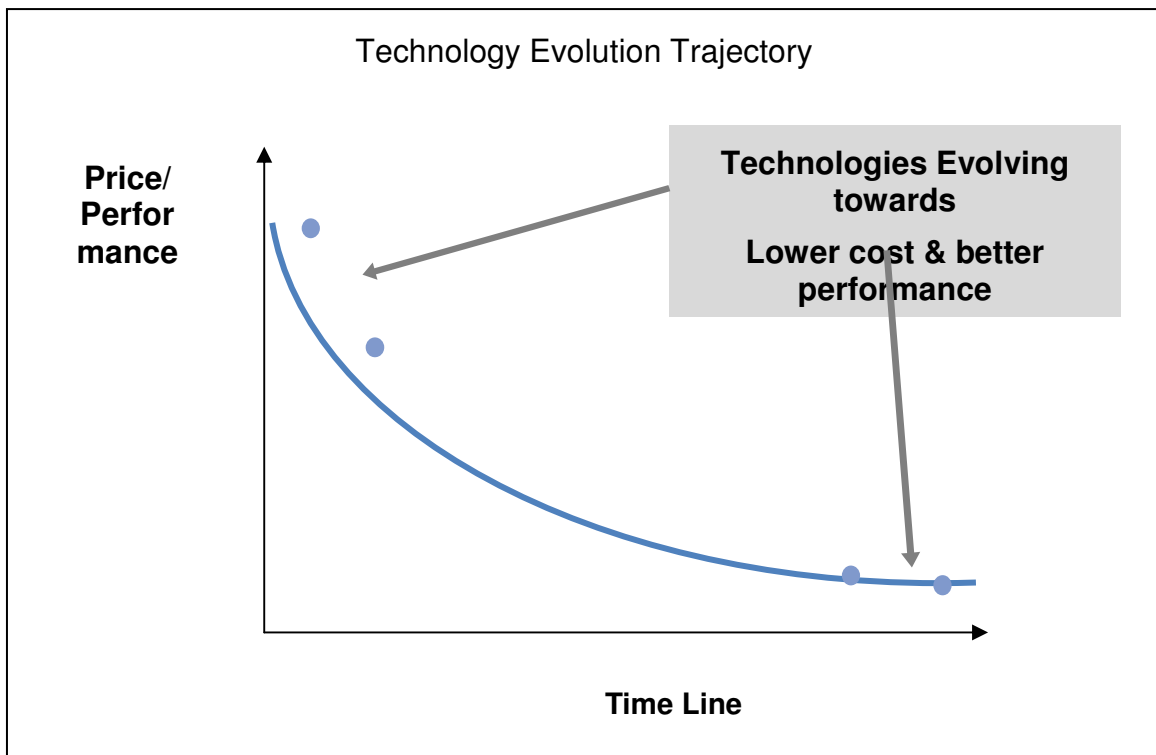
The thirty visionaries outlined technology priorities in the next two, five and ten years but also provided some directions in social and economic trends that will govern technology developments in India. These will first be discussed in 4.2.1. A summary of the trends in ICT R&D will then be described in 4.2.2.

5.2.1 SOCIETAL AND ECONOMIC TRENDS THAT WILL GOVERN TECHNOLOGY PRIORITIES FOR INDIA

(A) COST OVER PERFORMANCE

Indian consumers do not compromise cost over performance. Describes the figure, Indian consumers need more functionalities at lower costs. Hence, unless development happens around this rule success will be low.

Figure 10: Showing the trend India will use in determining how ICT R&D will be done in the next 2, 5, 10 years



(B) LOW VALUE HIGH VOLUME

Indian business industry are evolving to a business model to serve low value and yet high volumes in products and services. For example, as the mobile penetrates further into the population of one billion, the price of communication is tending towards zero. As mobile devices become more pervasive in the Indian population, companies are creating mobile value added services are cheaper rates.

(C) GREEN COMPUTING AND GREEN DEVICE REDESIGN

There is a strong need to arrest power consumption by developing more energy efficient devices whether in large storage, display technologies, embedded devices, or software systems. Experts feel that the country is conscious of minimizing carbon foot prints and designing ICT solutions around this theme. If India consumes energy at the rate the western countries have and are currently consuming energy the world will become energy bankrupt in a few decades.

(D) DOMINANCE OF SOFTWARE SOLUTIONS OVER HARDWARE

Since the Indian skill set are largely rooted in software development, both algorithm development, design, architecture and programming, Indian ICT solutions will capitalize on this trend and have a preference for software based solutions over hardware based products.

(E) CONSCIOUSNESS ABOUT INTEGRATING RURAL CONSUMERS

A large percentage of Indians live in rural setting with low literacy rates and poor per capita incomes (of about 1100 Euro at year). This strata of consumers need to be integrated in solutions and technology development, and their need identified and enabled by ICT. Additionally, with more than 5000 scripts language diversity poses a challenge to develop interoperability of ICT systems. Hence, unless the language challenge is addressed proliferation of ICT will remain low in these consumers. ICT cannot be an urban solution alone.

5.2.2 TECHNOLOGY TRENDS IN INDIA IN THE NEXT 2, 5, 10 YEARS

Visionaries mention core technologies that India needs to focus on. These are first discussed. Further, visionaries provided insights into sectors where technology applications will be required. These will cover basic and applied R&D.

(I) Core technologies that India needs to focus on include

- a. Internet access: allocation of bandwidth, last mile connectivity, convergence of mobile and internet technologies
Increasing bandwidth demands brings a pressing need for better utilization of band width through efficient spectrum allocation, IPV6 methodologies, LTE.
- b. Networking technologies: large networked systems, machine to machine communication, cloud computing, wireless networks and smart networks
Since ICT permits the scope for devices to be linked to larger networks and thus communicate with each, device specific protocols through embedded systems can be developed to facilitate linkages.

- c. Monitoring systems, sensors for measurement & remote diagnostics, low cost camera, integrated with wireless networks, generic and mobile devices
Since the population is large and phenomenal data will be lost if not monitored, there is a need to evolve low monitoring technologies, using DSP algorithms, many low cost sensors and error compensating software.
- d. Cloud Computing Applications: Since there is expected large numbers of data, cloud computing will push down costs and offer low cost storage and accessibility
- e. Security algorithms for various systems and devices

(II) Some of the important application that India will be focusing on include applications in sector such as

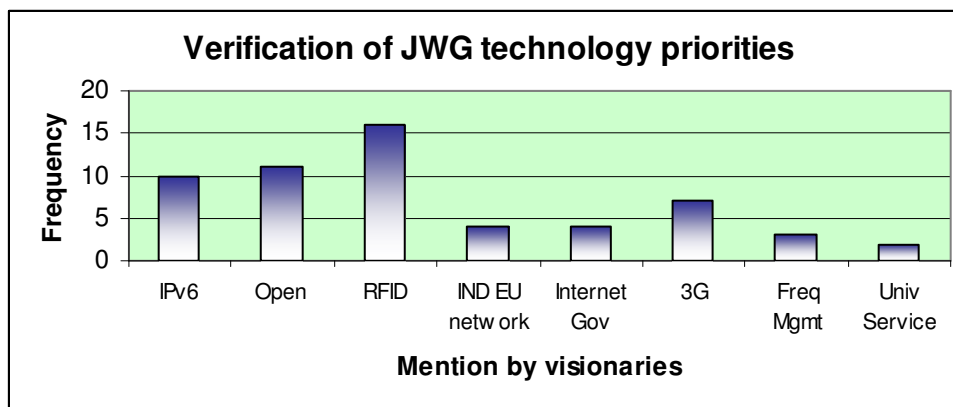
- i. Healthcare: The important development areas within healthcare include:
 - Bioinformatics for better diagnostics, information management & retrieval
 - Connectivity and networking of medical devices (to be redesigned such that connectivity is included)
 - Smart medical systems with learning ability, patient monitoring, low cost cameras, monitoring devices to capture and transmit data
 - Security in data management systems
 - Large storage systems and cloud computing
 - Integration of medical data and monitoring systems with mobile
 - Telemedicine
- ii. Energy: The important areas in energy conversion, generation and management are:
 - ICT for Smart Grids: India is driving towards convergence of the ICT networks & the existing electric grids. A few applications include smart grids with smart metering, bi-directional information flows in networks, distributed power generation.
 - Solar panel electronics, solar gadgets
 - Green devices, with low power consuming displays, storage devices, and longer life batteries
 - eWaste management
 - redesign consumer goods electronics with energy and green consciousness
- iii. Governance and education: There are many focus areas of governance that India will invest in, these are listed below:
 - Governance related to land records, digitization, database maintenance, secure storage systems

- Person identification and tracking systems
- Transportation identification systems and RFID
- Banking identification
- Mobile based payment systems
- Education and skills training using ICT
- Mobile applications for education

6. Visionary view on the JWG List

Visionaries were required to comment on the technology areas mentioned by the Joint Working Group between EU and India. The technologies mentioned by the Joint Working Group are: (i) IPv6 and NGN, (ii) open source software, (iii) RFID, biometrics and smart cards, (iv) India EU research network connectivity infrastructure, (v) internet governance (vi) 3 G deployment (v) frequency management, (vi) universal services. The visionaries that made comments about these technologies showed that some technology priorities were more critical than others. Figure 11 shows what visionaries felt about this list of technology priorities. Visionary stated whether they thought these technologies were a priority for India and their frequency count of mentioned technologies is shown in the graph in Figure 11.

Figure 11 showing the importance visionaries gave technologies in the JWG list



Of the lot of technologies listed by the JWG this visionaries sample preferred to state that RFID, biometrics and smartcards were the priority in India.

Some visionaries made comments that are worth a mention.

“These are hardly technologies, some are, most are regulations topics, they are generic and vague, and they have less of a research component in them”.

Yet another mentioned that, “TRAI the regulator must be consulted about these topics”. “This is a traditional list nothing new in it”. “I am not sure if these technologies are a goal for the

collaboration between India and EU”.

“Open source must not be under such a collaboration, open source needs lower infrastructure levels, most innovations come from open source”.

“Some of these technology areas are relevant to a pure ICT company and not so important for those using ICT say for bio initiatives”.

The implications of Figure 11 are many. The JWG being a joint working group from India and EU is engaged in deciding what areas of ICT India and EU might want to cooperate upon. The findings we have obtained in Section 4 of this report show that the technologies mentioned by JWG are more in the domain of Core ICT developmental areas. Applications of ICT are totally missed out of the JWG list. The focus on the JWG is more on internet access infrastructure management, and facilitation of mobile based infrastructure. Both of which are very critical to Indian and also mentioned by the visionaries in this report. The only challenge is that some of the developmental activity under internet access and mobile infrastructure, also involve standards and regulations which is an area related in some ways to R&D activity. Standards and regulations related to telecommunications which can be a broad label for internet access and mobile infrastructure apparently is not very different from that of EU as stated by one of the visionaries in this report. This is possibly the reason for the emphasis on core ICT development in the JWG technology priorities list. Additionally, it must be stated that RFID, biometrics and smartcards are also mentioned by the visionaries in this report. This the area visionaries feel must have greater focus for R&D collaboration. The role of open source although popular with some visionaries received variations in the way it must be promoted. Whereas on the one hand some visionaries clearly emphasize joint ownership of intellectual property others mentioned support for open source. Well, this divide is echoed world over and India appears to only mimic this divide about intellectual property versus open source in ICT activity.

The main point to note in the analysis of JWG technology priorities is that while this list is an important one as seen by some visionaries there may be many more technologies to be mentioned for the India – EU ICT R&D cooperation as seen in Section 4 of this report. However, the technologies mentioned in the JWG list are critical for telecommunication expansions in India and low cost high volume developmental solutions in these areas may benefit both India and EU. As one of the non visionary JWG officials put it whilst this report was being developed, “after all the technology list by JWG is only illustrative and it is not the only list to be followed”.

7. Collaboration

The possible collaboration between India and EU member states was probed with the visionaries in our sample. The views of all visionaries are taken into consideration at two levels. First, their levels of awareness about EU are assessed followed by their intentions to collaborate. A rating scale is used to assess this. Second, qualitative statements made by various visionaries from ICT SMEs, larger ICT companies and academia show where improvements can be made in order to have better cooperation between India and EU in ICT R&D. Suggestive measures to improve the collaboration are listed out.

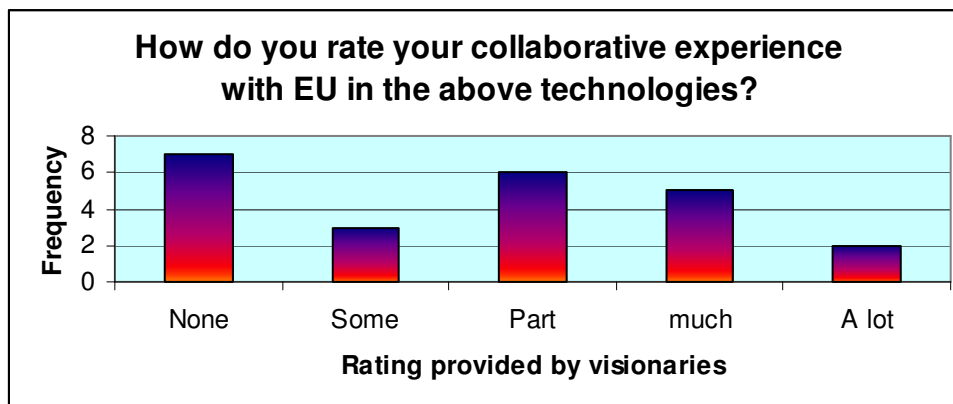
(a) Knowledge and Intentions of visionaries on EU

In order to find out the knowledge and intentions visionaries had about EU they were asked four critical questions. The first three questions asked if the visionaries were exposed to EU collaborations, EU information via reading material, participation in conferences, and working with EU experts. The last interesting question asked if the visionaries had intentions of working with EU on collaborations in the near future. Analyses of these questions are presented below.

(i) How do you rate your collaborative experience with EU in the above technologies?

The first question addressed the experience of the visionary with EU. Figure 12 below clearly shows that the experience is leaning away from a lot to the ‘some’ side. In other words the Indian experience with EU is inadequate and insufficient yet to galvanize into an active one. More exposure of Indians to EU technologies is called for.

Figure 12: showing the experience of visionaries with EU technologies



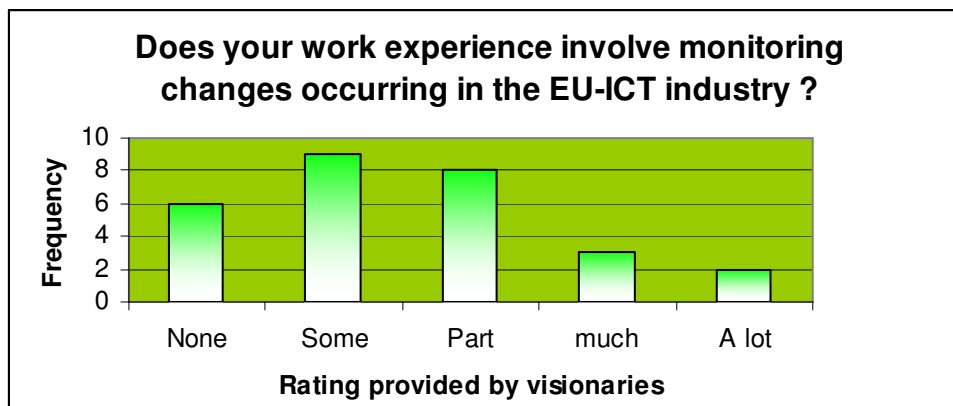
(ii) Does your work experience involve monitoring changes occurring in the EU-ICT industry ?

The second query related to the degree with which Indian visionaries in the sample monitored changes in the EU ICT industry. It is clear that Indian visionaries will monitor changes in EU ICT industry only if they are aware of the information and communication technologies being developed in EU and they are interested in collaborating with EU on these technologies. Again the summary of Figure 13 below shows that the experience in monitoring changes in EU is only

“some”.

Indians do engage with EU ICT industry as mentioned by few visionaries, however they are in the arena of “out sourcing” and not R&D collaborations. One of the visionaries mentioned that maximum revenues of his company come from EU and not USA, the company being the telecommunications sector. Another visionary mentioned that their relationship with EU is more to do with “client-vendor” a transactional relationship rather than a collaborative R&D relationship. Thus, while monitoring for vendor – client relationships is occurring in some sectors like telecommunications and chip design, monitoring for R&D activity in EU member states appears to be missing completely from the Indian side.

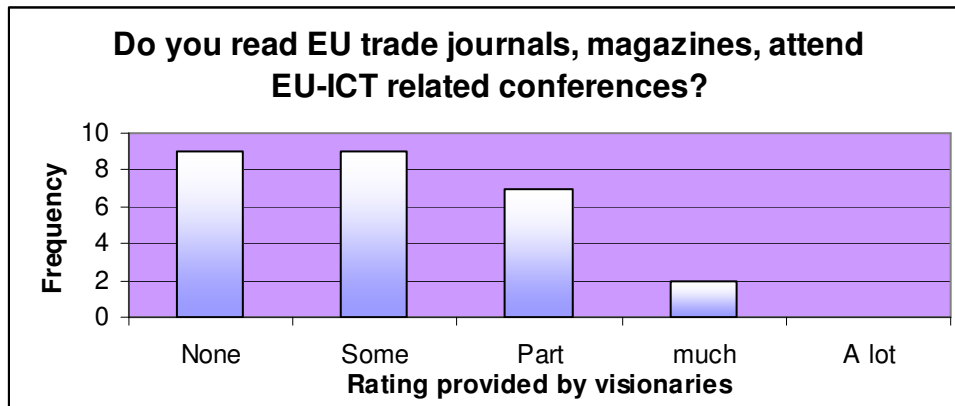
Figure 13 Shows whether Indian visionaries monitor change in EU



(iii) Do you read EU trade journals, magazines, attend EU-ICT related conferences?

The third query related to active reading about EU ICT activities on the part of the Indian visionary. The answer to this query appears to be closer to no reading and some or part reading. None of the visionaries mention “a lot”. Hence, unless an active interest is created amongst Indian ICT industry members to pursue information on EU ICT R&D the collaborative efforts will not increase. Methods to bring out an active interest must be pursued either at the industry level or the Government levels if this collaboration must grow. Figure 14 shows the results of this query.

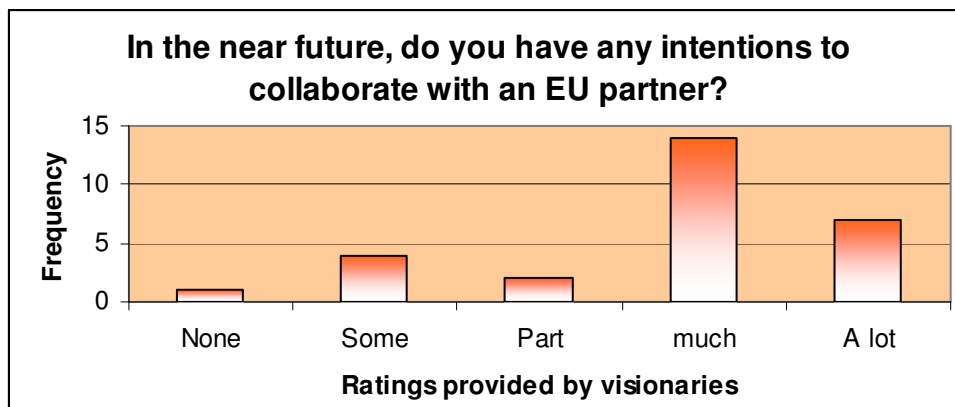
Figure 14: shows the reading about EU ICT activity on the part of Indian visionaries



(iv) In the near future, do you have any intentions to collaborate with an EU partner?

The fourth query is an eye opener and a happy one at that. Figure 15 shows a complete contrast in comparison to Figures 12, 13, and 14. Visionaries clearly have an intention to collaborate with EU ICT industry both at the academic and industry levels. Academic and industrial visionaries share this view. One of the visionaries clearly states that although we work closer with USA, our psyche is more matched with the Europeans, and our fore fathers worked with Europeans more.

Figure 15: showing the intentions of visionaries to collaborate with EU

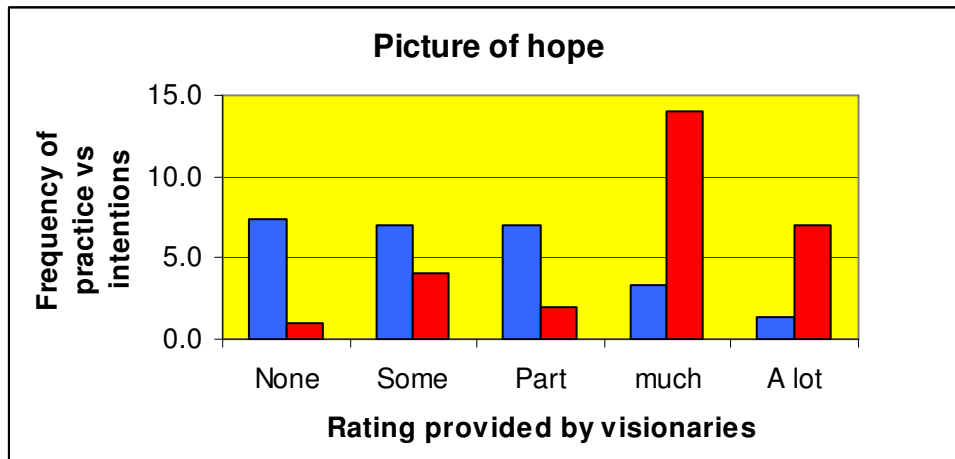


(v) A picture of hope:

Figure 16 is a picture of much hope. A comparison was made between the current practice and the intended practice and it was seen that Indians are very positive about collaborating with EU ICT industry although their current practices do not engage in information seeking about EU. Hence, since the intention is clearly identified as positive, the mechanisms to encourage this intention must be put in place. This finding in Figure 16 is an excellent one in a foresight study when two geographies are keen to initiate collaboration. The intention is shown in red color

and the current practice of information seeking is seen in blue color. If the blue can also be increased more proposals will happen between India and EU.

Figure 16 shows the current practice in blue and the intention of visionaries in red



The importance of the findings in Figures 12-16 is many. It means that Indian visionaries who represent the Indian ICT diaspora are not seen actively seeking information on the EU ICT industry. There must be reasons for this. Most certainly they have not been exposed to the benefits of this information seeking activity. If the benefits are made clear, then the number of proposals will certainly go up from the Indian side. It is important to do a similar study for EU and assess whether they monitor changes in India more than Indians monitor changes in EU. Nevertheless, there is much hope for collaboration.

(b) Suggestions from Indian visionaries

Regarding suggestions to improve the relationship between India and EU member states in the area of ICT R&D collaborations various visionaries made suggestions worthy of mention. Some points stated are critical of European Commission proposal practices and others are ways in which the collaboration can be improved. These insights will be important for European Commission's understanding of India. Much of what has come out in this section reflects an emerging market syndrome.

Visionaries from smaller ICT companies like SMEs and start-ups clearly find the overhead of working with EU for funds difficult. Since these Indian companies are typical of the *emerging market syndrome* of speed, impatience, desire for low bureaucracy and lengthy procedures, the highly procedure oriented EU proposal writing is seen as a deterrent. One of the visionary says, "I have no experience with EU, but I am open to opportunities available. I think the factors that will enhance this cooperation are the following: minimum overheads when working with EU members on proposals, avoidance of uncertain timelines, for example if one has spent bandwidth writing and modifying a proposal and may not get funding its frustrating, there must be clarity in getting these budgets. Such overheads will demotivate Indian companies, for us time

is too risky, and I would rather get a real customer and get money, than spend time on such uncertainty”.

Specifically from the perspectives of “languages” one of the visionary says that, *“I don’t know what has been done in EU in languages, since I have not worked with EU on this topic, also finding a large number of partners is unwieldy and not easy to achieve, but this is an EU requirement”.*

From an academic perspective one of the female visionaries had interesting things to say. *“Normally academics have a lot of freedom and something exciting. In the issues of intellectual property we prefer joint ownership. I have noticed that in visits from EU, they are very formal in their approach, but research needs personal networks. It is better if researchers visit each other rather than agents. I have not heard much about EC grants to collaborate. But if EU professors come and give talks professors in India we will get interested. Unfortunately in Indian institutions we are not evaluated on grant money brought, so academics may not actively seek such money. But, student travel grants must be encouraged in these projects. Researchers are individualistic people, if we see someone from EU whose name we read in journals then we get interested if that person comes to India and talks to us”.*

Another visionary who is an SME has this to say. *“I had good relationships with EU companies Symbian initially. It was an outsourcing relationship and later on we worked on the core operating systems for the mobile, some of their EU people even came here to Bangalore and worked here. We also worked with GE in Sweden, and a company in Finland. We had associations with Germany, Finland, Denmark, France, Switzerland, and Sweden. I have not collaborated for EC grants only had vendor client relationships with EU. In the case of intellectual property sharing this must be made clear up front. Also how to value intellectual property and who will do what with the property is also to be understood”.*

One of the EU multinationals felt that there is a need for EU to “understand the Indian eco system and we here need to revitalize our system here too. Delegations from other funding agencies come and go around India to seek partners, EC does not do this. EC tends to be far too bureaucratic”.

One of the more senior academicians felt, *“matching grants from India will help in such cooperation’s; I feel the EC is caught in the processes but the soul is missing. Processes are important for evaluation etc., but yet soul is missing. Having collaborations is not about more travel and this will not help, as no one has time, everyone but pause to think and conceptualize, rushing around cannot help”.*

One of the free software expert visionaries felt that, *“There is learning in this collaboration. I missed my last proposal by half a mark, so we revamped the partners and got the project through. My experience was that writing had structure. It was nice to see management and administrative package in the budget, someone has to oversee the project, the project accounting is intense, i.e it takes time, its nice if EC simplifies that by making formats and templates for accounting. We were able to find partners but we need more information about the EU companies that are willing to collaborate, smaller ones not the known, some large ones are. It’s nice if there can be an SME road show which can be a virtual album of small EU companies initially, and then later this can become a face to face EU road show. Likewise, Indians may have to do similar things, and Indian SMEs must collaborate”.*

Another academic stated clearly that, *“there is a lack of awareness, EU should visit us and push*

for collaborations. I have not been seeing them push for it we need to exchange this information much more and Indians will be receptive. USA is more aggressive about this marketing. Europeans are more closed and keep amongst themselves. As a commission we have not seen any marketing, individual countries come and market themselves, but not the European Commission. SAARC countries come. There is a lot of scope for collaboration”.

Another academic stated that, “the initial effort to obtain projects takes a lot of effort. After that, working with EU partners is nice. In my project there are two persons here full time to take care of all project related paper work. Another thing is the review process that EC uses, I think people who are qualified should review the proposal not government officials. The reviewer should have the same training and give the right feedback about the proposal. We have to gradually build relationships through faculty and students exchanges. Your social networks matter, how transparent the process is and whether you understand the rules of the game, in USA I have a network but in EU I don’t have such a good social network, but it’s a transparent system. Exchange of students is the best way to start these relationships with EU”.

One of the visionaries from an SME with a health orientation, states that, “There should be an institution in EC that believes that collaboration with India is meaningful and giving value. We made attempts to work on the REACH standard for toxicity profiles of synthetic chemicals. This is needed for therapeutic and medicine oriented solutions. The EU will be held to this standard and animal testing will be restricting to essential drugs and so one needs a different approach to verifying these drugs, it’s an opportunity to predictive science. We hope to reach out to some EU companies and academic Institutes in the REACH standard; we tried to reach out but did not get a response when we reached out. We have not closed the door, we are already working with two institutions. Although we are more US oriented and trained that way. Our parents had more European orientation like us who now have US networks”.

Another academic visionary had this to say, “EU projects have too much overheads, travels, meetings, on the other hand the Indo French (IFCPAR) with one French collaborator and one or two from my Institute are easier to handle, its leaner. The UKERI is also easy to handle but they too promote large consortiums. Large consortium is a drawback. The research community in India is not too large and for the small size of researchers we have here in India, there is money in India too for R&D. The Indo French model, Indo Swiss programs are worth looking at. In partnerships its important to maintain equal partnership, an Indian should not be made a lesser partner. We in India need money for infrastructure and not money for student scholarships. The model of collaboration should be worked out properly”.

The bigger ICT companies have this to say, “There is much possible look at the clusters of groups for Life Sciences in the Cambridge area. Although this is UK, EU has much inventive capability. The Nordic areas have great capability in design, they are user friendly, they are good at communications technologies. Indian ICT is on develop and innovate cycle and not in the invent cycle which EU is, and unless we are into invent cycles we do not go to some conferences, this awareness is to be made known. The top Indian ICT companies are already in these EU countries, we have a presence and we are aware of these countries. There are barriers such as language and cultural barriers, interactions barriers (visa), and we have less contact with EU countries from India’s side. There is less reach out by European companies to India. Oxford and Cambridge have an India forum and there are not any such organized forums from EU. Motivation for EU to look to India is limited. Fraunhofer has been around for decades yet they just made an office in India, so there is less push from EU to see India as a R&D destination. For example in Cloud

Computing or Frugal Engineering of Health, new entrants and entrepreneurial activities will happen. These will be analytics, social media, cloud, etc, in the services base such cooperation is unlikely. Indians will adapt to new technology changes as there is awareness with Indians about what technology can do. The art of the possible is visible to a large part of our population, and the success of the mobile phone will determine how adaptation will happen. It's all about what I can do with the device or technology that is the much bigger deal. In designing the 'water filter' for example we were able to get low value high volume. Awareness is needed with large and small companies. We need to stay in touch with the EU partners since I do not know what I can do with all EU countries. Some European institutions have reached out to us. Different tiers of companies need different inputs. We deal with start up companies in France and UK".

Another SME in the energy for ICT sector say the following, "to improve the relationship awareness of India's capability must be made known, and this exposure must be made known to EU companies. The level of comfort to do work with India in ICT is not so high in EU. EU is more closed to us, compared to US. For example EU knows India more as a software service provider, rather analog circuit chip design. Another thing is the motivation to work with Indian companies is low because if EU companies work with other EU companies they get a tax break, hence Indian companies lose out this way, US does not do that. Indian presence in EU is not strong in UK as it is in the present. US is a melting pot of cultures with a lot of Indians are there so it was easy to work with them".

Another SME in the telecommunications areas says that, "Telecom technologies and standards of EU are similar to what India uses. Most of us have more US exposure more because we studied there (education), this makes US collaboration easier, but in technologies and standards we are closer to EU".

Another SME in the telecommunications area says that, "The cost structures between EU and India are very different. Technology can be substituted with labour in India but when EU substitute's technology for labour the cost goes up, this must be understood. My company has more revenue from EU than any other country because it's in the telecom sector".

Another large ICT company visionary states that, "We will put in place a few employees dedicated to EU proposals to assess how we can make use of this opportunity. There is a lack of awareness in EU about working with India. Fewer managers, the better in the consortium, more the partners more the governance and less the actual research. There should be mechanisms in place to spend the money in the right way. Need reviews through the journey. If few companies work successfully with EU this information will spread by word of mouth and more companies will join in project proposals that are governed well. The real issues are one of awareness: a 2-4 year plan need to target company's not general seminars".

These statements are illustrative of the things needed to be understood, done for the bigger collaboration picture.

(a) Whilst, the European Commission is not likely to change its proposal writing and accounting practices for India alone, more training programs on proposal writing workshops must be encouraged. Clarity about accounting practices also must be made clear. There is an assumption that India must make its own efforts at understanding the EU accounting procedures. This assumption can be avoided and more clarity must be made during kick off

meetings and by the project managers of the EU partners in helping Indian partners manage the accounting requirements.

(b) Since the emerging markets syndrome is going to be common across a few countries it is possible that European Commission make plans for “fast track proposal assessments and feedback” to countries with companies for who time is critical. Its possible to have a membership drive of such companies and evolve a new program for them.

(c) There is a view that European Commission does not market itself as much and marketing strategies of EC may help in countries like India. Road shows on EC activity in India will help.

(d) The view that most of the activity in proposal seeking and submission is made by agents and note by researchers is also felt by the visionaries. Bringing university professors from EU in various areas of ICT on a road show to India will make the difference an agent cannot make in this collaboration. European Commission can initiate practices similar to the UK practice of bringing top Scientists and Professors for exclusive talks in India.

(e) A directory of EU companies interested in cooperating with Indian partners will help Indians find partners.

(f) Lastly, whilst most of the suggestions appear to be “to do” actions on the side of the European Commission, Indian visionaries clearly state that much interest must be shown on the Indian side also to make this success happen. Since, fair amounts of R&D financial support is available to Indian researchers from the Indian government, collaborative R&D with EU will require an extra bit of effort to make it all happen.

The consensus building events were two in number and organized by EIRC. The objective was to ascertain public feedback of the trend study, especially the technologies highlighted in the trend study. To meet this objective EIRC organized two consensus meetings: the first was during the (a) the Karnataka State Government run annual event called the IT.BIZ where a multitude of local and international participants attend to hear about technology trends in ICT, on 16th October, 2011). The second event was organized during the Bangalore Chamber of Industry and Commerce event called SAM VRIDDHI Partnering for Progress (on 11th January, 2012). Both these events and their outcomes are described below. Both events were conducted in panel discussion mode.

8. Consensus on the Results of the of the Delphi Study

To recheck the results of the conducted Delhi Study, it is necessary to find a consensus on the obtained result. This has been by two consensus building events. Two approaches were used to obtain proper feedback.

In the first event, there were four participants in the panel discussion plus one moderator from IISc. Of the four, three participants were from the visionary group (sample in this report), and one was a European familiar with the FP activities of European Commission. The moderator presented her findings of the technology priorities and the panellists were required to comment on whether they agree on these technologies mentioned or not. Subsequent to the panellists presenting their views, the views of the audience (about 150) were asked. There was no perceived deviation on what the moderator presented as technology priorities. The technologies mentioned in this report appear to have acceptance from a larger audience as technologies India must focus on in the next two, five and ten years.

In the first consensus event, the following 4 panelists were present:

- Mr. Swami Manohar, Chief Executive Officer, LimberLink Technologies Pvt. Ltd
- Mr. Ananth Koppa, Chief Executive Officer, Ktwo Technologies
- Mrs. Chitra Hariharan, Vice President & Co-founder, Concept2silicon system
- Dr. Sotiris Ioannidis, Principal Researcher, Institute of Computer Science of the Foundation for Research and Technology - Hellas (FORTH-ICS), Greece

Panelists Views & Opinion in First consensus event:

Mrs. Chitra Hariharan, stressed the importance of product innovation through (smart) technology integration. She repeated the same technologies areas in healthcare that she mentioned during her visionary interviews. She described how she used to ask customers what they want to see in a mobile, whether a camera or MP3 player, clock, GPS, and a mobile phone. This integration is called a smart phone. She stressed the need for gadgets like the mobile or other single gadgets that will help whether it's a BP measure or any other detection. She displayed a non cuff and cuff based BP monitor and non invasive glucometer. Mrs Chitra said "The power of computing will help us gather data into a single gadget this must reach to the masses."

Mr. Ananth Koppa thought the ICT area is vast and each one will focus on something or other; he chose to give a perspective on what must be done in 2, 5 and 10 years. He said one of our major challenges is 'Education' and it needs top priority from Government, Industry and others & we have used developed country's standard for education when actually we need to do something more indigenized. The other sector which he emphasized about is health care. Mr Koppa said, "Health care should be made accessible. ICT, medical electronics and its integration with ICT must help solve this problem. Devices developed by Ktwo technologies are on display at IT.BIZ and they have various energy sources. It is not so much about accuracy and confidentiality it is more about accessibility. Regulatory mechanisms for health care are needed for India. We will develop applications on phones; we need to think of what can run on Rs 1300/- mobile phones as only this may reach the masses. The first step is regulations for these devices. In two – three years we need to have access via networks for people. After we put in

place regulations and standards we should develop application. Less than 10% use smart phone and others use ordinary phones. Mobile is the medium we will work on. 5 to 10 years later we need to fund and work on nano technology and its integration with ICT.”

Mr. Swami Manohar spoke about Mr. Sanjoy Das Gupta and his vision to start this kind of conference many years ago. That’s when Mr Manohar and his team discussed the beginning of Simputer, with Mr. Sanjoy Das Gupta. They stated a Management Declaration for ICT. One phrase from the declaration is that “you need to keep local solutions for any three local problems”. Mr Manohar said, “Most of the money spent on below poverty lines is about 80,000 crores and mostly Governments only can spend this kind of money. Only 20% reach the beneficiary and the 80% is used for administration and other costs not reaching the beneficiary. How do we make the money reach the right beneficiary? Can ICT play a role for this? Local solutions for local problems will only solve the problem. The “Electricity bill metering” product of Balaji is case in point. It was a dream in 2001. Now Balaji has put 50,000 meters everywhere. The technology was not fancy. Technologists think technology is a fancy thing and consist of 90% of the solution and the remaining 10% was other things. Ten years later, we realized that technology is 10% and 90% is something else in India, if we don’t realize this we fail. None of the technology evolved in mobile phones was developed here. However, we used it a lot. Our Bharathi’s and Airtel’s changed the Business Model and changed everything to cost per minute. Technology not invented here is reinvented and used to reach 600 million here. Modification and customization is required not innovation and R&D, except few Institutes like IISc.” Dr. Mathew then described few more points that Mr Manohar raised during her interview.

Dr. Sotiris Ioannidis, an academician and researcher was the European panel speaker and he agreed with the Indian speakers. To some extent, there is a difference between Europe and India since India has real problems to solve. He works close to the research side and makes the application at the lower levels (not close to products levels and real solutions to real people like India is planning to do). “Computing systems market is rising although laptops are lowering. We see penetration in such devices. Tools that we use will have to change to meet the broader requirement. My mobile phone is smarter than my desktop today. He sees a convergence of technologies onto the mobile rather than desktop.” According to Dr Ioannidis, challenges are programmability, stability, efficiency, and legacy software migration. He feels security is more important although the India partners see difference in mindset. He said that there should be more international collaborations to solve such problems and importance should be given to core ICT side and not from the sector side.

In the second event, there was three panellists plus one moderator from IISc. The difference with this panel is that none of the panellists were visionaries of this study, they were IT experts external to this study and needing to provide an external view on the technology priorities listed in this report. Each panellist presented their views on what should be the focus and consensus on the findings of this study was remarkable. In this session there was no time to ask the audience their views on the technologies; however it was presented to a group of engineering faculty and students who can use this information for further research.

In the first consensus event, the following 4 panelists were present:

- Mr. Vinod P Deshmukh, President, Technology and Products – PES at MindTree Limited, Bangalore

- Mr. Raghuveer B K, Head of Communication Product R&D Unit Group, Infosys, Bangalore
- Mr. Ganga Prasad, Associate Director at CDAC Bangalore

Panellists' Views & Opinion in Second consensus event:

Mr. Raghuveer B K agreed with the areas presented by Dr. Mathew concerning core ICT areas & ICT for sectors. He shared an interesting perspective on how he would classify the top priority topics for future R&D in India. His thoughts are as follows: In India presently there are 3 grand challenges that India is currently facing and will continue to face for the next 20 years: 'Utilization of 'Natural resources'; -'quality of 'Education'; and Problems in 'Healthcare'. Across these 3 grand challenges there would be multiple reasons that would cause problems. He concluded that problems can be solved with specific steps: First it has to be measured (the usage of natural resources/or in Healthcare measure the BP, etc), second it has to be collected (data to be collected) & further connected and centralized in order to analyse (here may be also through wireless & wire line etc) & lastly data has to be analyzed & further optimized. He put these aspects in ICT terms as 'process of connectivity, cloud infrastructure and massive computing infrastructure. These according to him should be the focus of the Indian government and ICT industry for the next 2, 5 & 10 years.

Mr. Vinod P Deshmukh opined that 'ICT plays dominant role in almost all sectors' and therefore need for ICT must be encouraged on a day-by-day basis. He mentioned that in India 'Core technology for ICT' has to be developed in fast pace as compared to EU. He said that two emerging areas under 'Core technology for ICT' are: 'Big or large Data' and 'Internet of Things' (with network devices and signalling). Most of the people complain that 'Big Data' is complex and voluminous and this needs to be addressed. According to him 'ICT for sectors' or 'ICT for application' areas would be e-health, e-governance, e-learning which he called as 'social infrastructure'. According to Mr Deshmukh for the next 2, 5 and 10 years the following areas will be the focus: Big data, Real time data generation, Communication infrastructure, Building algorithm and Data analytics with sector specifications.

Mr. Ganga Prasad's opinion was based on his past participation in Euro-India ICT cooperation programmes, conferences, events. He said Indian government is encouraging certain high end technologies & the 12th five year plan and 13th five year plan in the coming years will invest more than 12 crores Indian Rupees in High performance computing (HPC), super computers (to develop large scale computing environment with innovative methods), cloud computing and mobile technologies reaching to village communities in India. There are several research organizations focusing on communication technologies and language technologies. Collaborations between European & Indian private educational institutions are being encouraged by government. He said that 12th five year plan & 13th five year plan will also focus on skilled manpower development with ICT intervention or innovative methods. Another important area would be 'Smart grids technology' where much research is presently going on in the Indian context. He also said that EU & India can collaborate in 'Multilanguage & Language technology' area as both regions are multilingual. He opines that development of

'communication infrastructure' will need 5 years and development of 'compute infrastructure' will need another 5 years. According to him, 3 main areas that would gain importance in next 2, 5 and 10 years are language technology, communication technology and compute infrastructure respectively.

Although a very qualitative assessment of consensus it can be said that no one raised an opposing view regarding the technologies identified in this report.

9. Conclusions

The study presents the R&D investments within the ICT areas India might want to focus on in the next two, five and ten years. The study has identified and analyzed the ICT policies and research priorities, including long term perspectives in India which are aligned with the priorities of the EU in order to make recommendations for future co-operation initiatives and to identify the avenues and areas for EU-India co-funding.

A total of 30 visionaries were interviewed. 28 engaged in direct face to face interviews with the research team, and 2 interviews were conducted telephonically. One key researcher conducted the entire 30 interviews together with a supporting team.

The methodology on which Synchronizer has based its approach and the results obtained so far can be considered as consistent. We therefore hope that they constitute an information useful to the authorities of both regions and, more widely, to the European and Indian ICT communities.

As global trends for enhancing EU-Indian cooperation on ICT research, the following research topics are of interest for India and will develop further in Indian ICT

- ICT for Healthcare
- ICT for Energy and green computing

As far as core ICT technology priorities are concerned, India will mainly focus on the following areas

- internet and networks
- monitoring systems
- security technologies
- cloud computing and
- mobility applications

Specific Joint Call with India targeting concrete sectors may be fostered and will follow Indian development trends. Topics of such calls might be generic as it has been noticed by the visionaries, the JWG technology Priorities are inflexible and appear politically wanted.

Cooperation on ICT Research with India is a priority for the European Commission and both the EU as well as India can mutually benefit from increasing participation in common ICT research programmes. As show in the study there is much intension from the Indian side, to collaborate with the European Union in terms of research.

In Terms of collaboration, Indian experts feel there is a great interest from Indian side to cooperate with Europe, but Indians feel there should be much done to lower administrative burdens accessing European Programmes by Indians. Also Europeans should demonstrate a greater willingness to cooperate with India as Americans do. As large European player as Fraunhofer have only limited activities in India.

10. Indian visionary group

	Name of Visionary	Organization
1	Prof Ashok Jhunjhunwalla	Indian Institute of Technology
2	Prof H S Jamadagni	Indian Institute of Science
3	Prof N Balakrishnan	Indian Institute of Science
4	Dr Bob Hoekstra	Palindrome Technology Solutions Pvt. Ltd
5	Vinay Deshpande	Encore Software
6	Dr. Vijay Chandru	Strand Life Sciences
7	Dr. Swami Manohar	Limberlink Technologies
8	Anant Koppar	Ktwo Technology Solutions
9	Anil Kumar	SLN Technologies
10	Prof Veni Madhavan	Indian Institute of Science
11	Prof Balaji Parthasarathy	Indian Institute of Information Technology
12	Dr Mukul Saxena	Siemens Corporate Technology
13	Dr G Venkatesh	Sasken Technologies
14	Prof Varsha Apte	Indian Institute of Technology
15	Prof Kumkum Garg	Manipal Institute of Technology
16	Vijaya Kumar	Wipro Technologies
17	Subrahmanyam Goparaju	Infosys
18	Prof Sandeep Sancheti	National Institute of Technology
19	Prof Anurag Kumar	Indian Institute of Science
20	Gopi Garge	Founder Free Software Movement Bangalore
21	Ananth Krishnan	Tata Consultancy Services

22	Prof Partha Ramachandran	Indian Institute of Science
23	Paul Jeong	Indo Korean R&D Center
24	Dr. Kumar Sivarajan	Tejas Networks
25	Manjunatha Hebbar	HCL Technologies
26	Chitra Hariharan	Concept2Silicon
27	Dr. Satya Gupta	Indian Semiconductor Association
28	C. Srinivasan	Cosmic Circuits
29	Ravichandran Mahadevan	SAP
30	Pamela Kumar	IBM India

SYNCHRONISER Partners

Partners	Partners' short name	Country
Technical Support for European Organisations Sprl.	TESEO	Belgium
Euro-India Research Centre	EIRC	India
Rose Vision, S.L.	ROSE	Spain
Centre for Development of Advanced Computing	C-DAC	India
Software Technology Park of India	STPI	India
Indian Institute of Science, Bangalore	IISc	India
Fraunhofer Gesellschaft	FhG	Germany

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