

SEVENTH FRAMEWORK PROGRAMME
Information & Communication Technologies

Coordination and Support Action



EU-India Fostering COOPeration in Computing Systems

D4.2: Brokerage Event Report 2

Document information

Delivery Date	30/11/2013
Confidentiality	Public
Editor	KYOS
Contributors	All partners
Quality Assurance	FORTH

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Executive Summary

During the first year of the project 2 brokerage events (one in Europe and other in India) were organised to get the experts contributions to the Euro-India collaboration opportunities in Computer Systems research. As a result, deliverables D2.2¹ (Preliminary Research Roadmap) and D3.1² (Catalogue of Key Actors) were developed incorporating multiple inputs.

The follow-up actions were organised in the second year to get the feedback from the people active in the research of computing systems research on the EU-INCOOP proposed key challenges for collaborative research detailed in the deliverable D3.2: Research Challenges for Europe and India.

This deliverable reports on number of events organised towards developing various possible collaborative research models and short list the key challenges for joint projects in the area of computing systems.

The workshop in Bangalore, India was organised on 4-5th April 2013 with the invited experts from Europe and India both from academic and research communities. The key challenges identified by the project were presented and had interactive discussions with the participating experts to develop the roadmap document (D5.3) of the project.

The EU-INCOOP also presented the roadmap document in a special session during HIPEAC event in Paris on 2 May 2013, which was co-located with ACM conference. The brief report of this event is also published in the HIPEAC newsletter for wider dissemination.

To improve our roadmap document and disseminate the project results to wider community a special session was organised in '**International Conference on Advanced Computing and Communications (ADCOM 2013)**' at Chennai during 21st-25th October 2013 with the participation of invited experts from International and Indian computing systems research community.

The final dissemination of the project results was made in the ICT2013 networking sessions and distributed the printed version of the 'Research Roadmap' document, in the form of booklet with the key challenges identified.

¹ <http://www.euincoop.eu/documents/deliverables/ICT-287820-WP2-D2.2.pdf>

² <http://www.euincoop.eu/documents/deliverables/ICT-287820-WP3-D3.1.pdf>

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1 Introduction

The main objective of the EU-INCOOP project was to stimulate cooperation between EU and India in computing technologies to develop future joint research projects in Computing Systems in the framework of Horizon 2020.

In this context, the project considered the existing cooperation to bolster future cooperation through a series of activities including identification of common priorities between the two regions. As a result of number of collaborative and cooperation activities across two regions the project developed 'research roadmap' to jumpstart cooperation in priority areas and to make recommendations of these findings to regional agencies in Europe and India on the key topics for sustained cooperation in computing systems development. Both Europe and India have announced large investments to take the lead in the next generation computing systems and building super computers to address the big societal challenges³.

EU-INCOOP organised number of interactive workshops in both regions during the life time of the project:

1. **Gothenburg**, Sweden on 14 April 2012 (co-located with HIPEAC spring event)
2. **Bangalore**, India on 7-8th Aug. 2012 in collaboration with EUCLID project
3. **Bangalore**, India on 4-5 April 2013 with invited speakers from both regions
4. **Paris**, France on 2 May 2013 (co-located with HIPEAC spring event)
5. **Chennai**, India, EU-INCOOP session in ADCOM 2103 conference, 23rd Oct. 2013
6. **Vilnius**, Lithuania; Networking session of ICT2013 conference, 7 Nov. 2013

The last 4 events were organised in the second period of the project.

As a result of different activities, EU-INCOOP project has developed '**Research Roadmap**' document (D5.3), so as to identify key challenges in Computing Systems research and to initiate joint cooperative research projects between India and Europe for mutual benefits based on number of interactive discussions with experts from both regions.

This deliverable provides an overview of the last 4 events organized by the project.

³ <http://egov.eletsonline.com/2012/01/ministry-of-science-and-technology-sanctions-5000-crore-for-supercomputer-research/> and http://www.hpcwire.com/hpcwire/2012-02-16/europe_aims_for_world_leadership_in_supercomputing.html

2 Brokerage events

The project planned to have multiple interactive events involving Computing Systems experts from both regions to capture the more relevant and future challenging issues for defining new research projects within their regions and across the regions. In this context, EU-INCOOP project chose to co-locate their first **brokerage event/workshop** with the well-known **HiPEAC Computing Systems Week**⁴ in Gothenburg. The selected venue was excellent for providing the Indian delegation an **overview of the European research landscape** and personal contacts towards developing more cohesive network.

This first event was followed up with the second **brokerage event/workshop** involving invited experts from different sectors and areas of research. The workshop was held in **Bangalore** in Aug. 2012 and helped the European partners to **build insight into the Indian research methodologies** and the way they are funded. One of the main concerns identified is the boundary between industry and academia research, which are isolated and have less in common. Discussions showed that academia is content with number of published papers with proof of concepts, where-as the industry research is oriented based on development of prototypes, towards opportunistic exploitation. This aspect also represents cultural differences, where-in the experts would like to become professors in view of starting a business in the developed countries (e.g. U.S.A; U.K, ...), in contrast to be happy as civil servants to pursue their technical interest through publications in the emerging and developing countries. Since there are no instruments in place for industrial-academic collaboration, the main constraint for collaboration is identified as necessity of establishing “Technology platform” type of instruments in India.

All discussions were captured and contributed to the deliverable D3.2 in identifying key topics of interest as challenges to be addressed from both regions. This deliverable was the basis for the next workshops organised in the second period of the project. The details of these workshops are presented below.

2.1 Workshop on research challenges and priorities for Next generation computing systems (4 Apr.2013, Indian Institute of Science, Bangalore, India)

The thematic issue chosen was ‘research challenges and priorities for Next generation computing systems’, to complement the deliverable D3.2 topics of the project. The copies of project deliverables were distributed to the delegates, so that they are aware of the project activities. The event was well attended by experts invited. There were 7 experts from India and 4 from Europe participating in the event with presentations followed up by discussions with participants interactively. The invited experts included Professor N Balakrishnan, Associate Director, Fellow of TWAS, INSA, INAE, IETE, technical coordinator-supercomputing initiative, Dr G V Ramaraju, Senior Director, Department of Electronics and Information Technology (DEITY, funding agency), Professor H P Khincha - Ex Vice chancellor of Visweshwaraiah Technological University, Professor Manjunath- Head Computing systems

⁴ <http://www.hipeac.net/content/goeteborg-hipeac-computing-systems-week-april-2012>

– IIT Mumbai, Professor Govindrajan- chairman- SERC Bangalore, Dr Prahlada Rao-CDAC, Dr Dinakar Sitaram were the experts from India, Professor Neeraj Suri – TU Darmstadt, Professor Avi Mendelson- Technion, Israel. Prof. Jamadani inaugurated the workshop providing an overview of the status of EU-INCOOP as an introduction and Dr. Sathya Rao moderated the sessions. The experts had a day long talk and discussion on the key challenges and topics that could be of interest for Euro-India joint research activities, and had exchange of the research activities in both regions with an openness to cooperate in topics that they found common ground.

The presentations from this event can be downloaded from the project website⁵.

2.1.1 Agenda

The agenda of the workshop was based on the result of the two workshops held in 2012, and the roadmap on common topics between India and Europe. The project team deliberated on the constituents and methodology with which the joint roadmap must be developed. Need

a) For a preliminary research roadmap on the initiatives undertaken by governments, research communities and industry in both the countries undertaken to study and understand the existing roadmaps and research direction was felt.

b) To specify the problems identified in each region

c) To invite experts from the field to give their views on the challenges and solutions and

d) To disseminate these results to the wider computing systems community to validate and invite comments and opinions to take it further.

This four step process was followed by EU-INCOOP in setting up an agenda to come up with the roadmap document as a message from the research and industrial community to the governments of both India and EU to foster cooperation on specific topics.

10.00 am- 10.05 am	Prof Jamadagni-IISc	Welcome address
10.05 am- 10.35 am	Professor Balakrishnan- Associate Director- IISc	India's Supercomputing dream- Way forward (inclusive of Q&A)
10.35 am- 11.05 am	Professor HP Khincha Professor-IISc	Computational requirements for India in Power systems with Security as the key Issue. (inclusive of Q&A)
11.05 am – 11.35 am	Prof Neeraj Suri- TU Darmstadt	Computing systems- the key technological challenges that are being probed by Europe and the various initiatives undertaken to address the issues. <ul style="list-style-type: none"> • Energy efficiency and parallelization • Programmability. • (inclusive of Q&A)
11.35am- 12.05pm	Dr G V Ramaraju- Head Nano science Division- Department of	India's supercomputing Vision- Key Technical Challenges faced. Important needs to be addressed to build state-of art, world class super computers. What is expected from research and academic

⁵ <http://www.euincoop.eu/events.html>

	Information and Electronics Technology and	institutes and corporate to provide the direction and thrust to build computing systems ecosystem. Q&A
12.05 pm- 12.40 pm	Prof Avi Mendelson- Technion Computer Engineering Centre	HPC- Perspectives from Israel, Key challenges. Experiences of Israeli-European cooperation in computing systems. Q&A
12.40 pm- 1.15 pm	Dr Sotiris Ioannidis- Project Coordinator – Foundation for Research and Technology Hellas.	Overview of the project EU-INCOOP, Presentation on the key topics identified as research challenges that need to be addressed in computing systems during the course of the project. Setting the tone for discussion on the relevance of the key priorities and the need for focussed research attention.
Lunch		
2.15 pm- 2.50 pm	Prof D Manjunath IIT- Mumbai	Shaping the computing systems research - Perspectives from IIT's, Research and technology challenges addressed. Q&A
2.50 pm- 3.25 pm	Prof R Govindrajan IISc	Current trends in research in India with main focus on <ul style="list-style-type: none"> • Big data challenges • Multi core and heterogeneous computing • Common research ground between India and Europe • Q&A
TEA BREAK		
3.45 pm- 4.20 pm	Dr Prahlada Rao- Joint Director Centre for Development of Advanced Computing- Bangalore	Current trends in research with focus on <ul style="list-style-type: none"> • Cloud computing and virtualization in India • Programmability challenges for multi core computing. • Common research ground between India and Europe
4.20 pm- 4.55 pm	Dr Dinakar Sitaram- Professor –PES Institute of Technology	Current research interests in computing systems Q&A
4.55 pm- 5.30 pm	Dr Debabrata Das- Indian Institute of Information Technology- Bangalore	Current research trends addressed in India Q&A
5.30 pm- 6.05 pm	Dr Sathya Rao- KYOS Switzerland	Need for Indo- European cooperation in computing systems.
6.05 pm- 6.30 pm	Ms Rajshree Iyer- ITSMA	Opportunities and available networks to access European funding. Awareness on Ideal-ist. Q&A

2.1.2 Summary of discussions

Both EU and Indian experts met at these workshops to deliberate on the topics and to come to a consensus on the topics that would be of joint interest to both EU and India and that would be beneficial in achieving their individual goals in Computing Systems research through international cooperation.

Excerpts from the talks which are extracted are given below to present to the reader the view points of the people who can steer the research direction in India.

Professor Balakrishnan- Associate Director- Indian Institute of Science

Professor Balakrishnan, who is in charge of the supercomputing initiative, shared many of the governments' vision and plans regarding computing systems research and shed light on the Government of India (GOI) plans for the future with respect to the world.

Giving a brief on the history on how India caught on to the supercomputing vision, Professor Balakrishnan explained that until 2007 (when India had built the world largest supercomputer) India was not counted for its computing technology prowess. But as India grew to be one of the largest software hubs for the world, and software programming technologies being its major strength, it was successful in creating a huge impact value in the computing systems community at large. Indian IT trained human resource is one of the outcome of India's software developing efforts. In the 12th five year plan India is keen on retraining this human talent on multi-core and parallel programming to be able to build the next generation computing systems.

National challenges that need computing systems are compelling, right from strategic sectors like Defence, Energy, and Space to online services. Both Government funded research and private sectors have taken-up computing systems research as one of the top priority, to reach the potential business opportunities.

Talking on specific plans Prof Balakrishnan explained that the 12th five year plan spelt out by the government aims to have exaflop capabilities, with network reach in terms of tera bytes with seamless data integration for remote research to become a reality. India also realizes the need for HPC and supercomputing for wealth creation of the nation with the return on investment in these technologies have established evidence of 10 times the amount invested.

The challenges that are demanding the need for HPC in India are mainly arising from climate modelling, weather forecasting, aerospace engineering, atomic power plants, computational biology, chemistry, cyber physical systems, military applications and large complex systems and social computing.

Assessing the needs, the think tanks of the scientific community came together with a roadmap to meet the grand needs of the many stakeholders at the national level such as the DRDO, DAE, CSIR, NKN, CDAC, CMMACS , IITs and IISc. They recommended various nodal agencies, zonal agencies, regional centres to set up HPC centres, and to form working groups on systems software, parallel algorithm, accelerators for GPU groups etc and to form a national advisory group to understand the current trends on different processor architectures.

As a first step in building the network, three networks are launched. One for the academic institutions, one for the research institutions and one for the strategic operational facilities such as DRDO, weather forecasts, DAE etc.

Three clouds with 1 million cores, 5-6 zonal centres with petaflop capabilities, 10-12 zonal centres with 200- 500 teraflop capabilities, 20 small centres with 10 teraflop capabilities and 50 mini centers with 1-2 teraflop facility is planned to be completed by the end of 12th five-year plan with a planned budget of one billion dollar investment and a 100 million dollar investment in software programming.

Professor Balakrishnan ended his talk with listing the many societal benefits the investment in HPC is expected to bring about

- quality weather forecast
- green computing and reduced carbon foot print
- impact on innovative and creation of national wealth oriented research.
- e-governance, National security, improved finance sector, e-commerce
- biological research for a healthier society
- energy efficiency and software development.
- trained man power.

Dr G V Ramaraju- Senior Director, Department of Electronics and Information Technology

Dr Ramaraju is the Senior Director and group coordinator for the electronics and information technology related projects, representing the government funding agency, the Department of Electronics and Information technology (DEITY). He has reflected on the interests of the government that are the major drivers of R&D in the IT and computer industry in India.

Currently Government of India (GOI) is keen on promoting technologies that support IT infrastructures, hardware manufacturing, language technologies, and skills promoting ICT. Within the computing systems domain India is looking at broadband technologies, Bio-informatics, HPC, Green computing, cloud and mobile computing, ubiquitous computing, perception engineering and scientific computing as the major drivers to fulfil societal needs and achieve economic growth.

As a policy in-charge officer he mentioned that the government is open to cooperation with EU in some of the new emerging areas like Big Data, Cloud computing and Green computing and technologies for the elderly which are also the major focus areas in Europe.

Dr Ramaraju mentioned that India was keen on promoting entrepreneurship, SMEs, product and human talent development in some of the above areas, encourage public private partnership and support international cooperation, which is broadly the R&D framework India is looking at. The demand estimate in terms of petaflops is about 10-12 petaflops arising from the bio-informatics, weather forecasting, material science, space domains, and the computing power demand for other domains is around 3 petaflops and with the given targets India aims to reach its targets with aid of new emerging technologies.

He summarized that India's approach to supercomputing is going to be in

- Applications centric HPC development with associated infrastructure
- R&D for exascale computing

- Standards based scalable architecture growth.
- Grid based national infrastructure to share resources.
- HPC manpower development.

The exascale R&D needs that are being explored are cited below:

- Exascale system architecture
- New methodologies and technologies for designing applications
- Redesigning software for exascale system architecture
- Power optimization techniques

Professor Avi Mendelson- Head Technion - Israel

From the European side, Professor Avi Mendelson- Head of Technion- Israel and governing council member of HiPEAC gave a brief overview on the vision, targets and challenges addressed by the ETPs, HiPEAC, Artemis and Planet HPC.

The vision of European Technology Platforms are to address 'design and implementation' challenges of HPC commodity devices. They address processor devices, compiler infrastructure, and the evaluation of upcoming applications made possible by the increased computing power of future devices. They recommend creation of 'virtual centre of excellence' in HPC and embedded processor with HPC community in Europe.

HiPEAC which is the most focused group for computing systems and compilers has a research program that focuses on creation of task forces for

- Low power devices
- Education and training
- Reliability and availability and applications.

It brought together members, companies, researchers, and publications in several technological areas such as multi core architecture, reconfigurable computing, binary translation and virtualization, interconnects, simulation and compilation platform. It has also created tasks to spread excellence through conferences, webinars, workshops, summer schools etc. Conferences are held once a year and cover all the above mentioned topics intensively.

Realizing that the old time way of functioning in the field of computer architecture needs a tectonic change, Europe is inviting open discussions from all over the world to redesign the computer architecture such that it takes care of the foreseen future challenges.

His talk mainly was to create awareness on the ways and methods Europe has adopted to take computing systems research to the next level.

Professor Neeraj Suri – Professor TU- Darmstadt- Germany

Professor Suri shared the discussion points he had with the Ministry of Science and Technology of India on topics for cooperation.

He mentioned that during the course of the meeting the Indian side was excited about supercomputing and HPC topics while Europe looked at these topics more falling under the Cloud and Data management areas.

He emphasized that today's focus is more on the Internet of Things front with focus on

- WSN and Wireless Sensor Activation Networks or WSN
- Mobile computing.

Under these main topics the sub topics of sensory systems, connectivity problems, functional architectures, and mixed criticality integrations play the lead role in addressing the challenges of the main themes. He also brought out the main elements that would be of interest to Europe:

- Data acquisition
- Data dissemination
- Data storage
- And Data usage

The enabling technologies encompassing data acquisition plus dissemination also have mobile protocols, virtualization layers, and concurrent multi-core programming as the enablers that fit into the whole spectrum of distributed computing in the context of data acquisition and dissemination.

Issues relating to Big Data have questions such as performance, accountability and trust to render the data meaningful and trustworthy. These raise challenges on one side for a bigger data environment such as a cloud which scale less and on the other side, a demand for very structured data that is trustworthy with all the trust stacks that need to be integrated. This by itself is a difficult challenge. Professor Suri advocated the cooperation at technology level based on their local interests of the countries cooperating. In short he was more for the use of technology to be customized for the local interest rather than focusing on the application area of each cooperating country. As such the application areas might differ from country to country but if the technology can be adaptable and customized it would lead to a meaningful and beneficial cooperation.

Professor Govindrajan- Chairman Supercomputing Education and Research, IISc

Professor Govindrajan gave a brief on the current research happenings in his group, in IISc and other computing research groups of other institutions to give a flavour of the research scenario and the likely collaborations possible in these areas.

The focus of his group is more into

- Performance centric memory architecture, hierarchy and design
- Memory systems for multi cores
- Memory performance improvement and making multi core memory aware.
- Compiler Analysis and optimization.
- HPC using accelerators (particularly GPU's) based architectures
- Programming models, languages and compilers.

He mentioned that their group has been successful in bringing about a synergistic execution of the programming languages available on multiple heterogeneous cores.

He summarized his talk endorsing the strong groups working on almost all areas of computer architecture, focused development groups, HPC applications research group with a good spread of highly motivated students and faculty taking interest in HPC and other related areas.

He opined on India’s major limitations which are:

- Limited hardware development capability
- Large open source software yet to mature
- Large research groups are limited
- Large visionary projects absent.

He said it was widely agreed by his colleagues that a sustained effort from the government, industry and academia is needed to address the limitations.

2.1.3 Pictures from the event





2.2 HIPEAC workshop, Paris 2 May 2013⁶

The Spring 2013 Computing Systems Week (CSW) of HIPEAC was held within the First ACM European Computing Research Congress (ACM ECRC) at the Palais des Congrès de Paris, on May 2-3, 2013. A special thematic session was devoted to the EU-INCOOP supporting action within the EU FP7 framework, whose main objective is to strengthen collaboration between Europe and India in the field of computing systems research, with the help of experts from both regions. The EU-INCOOP session was more targeted as a dissemination event and feedback collection rather than collection of more information from the European experts on the roadmap document developed by the project.

The latest roadmap document and proposed activities in the timeframe of Horizon 2020 were presented in the recent HIPEAC event in Paris on 2 May 2013 and the presentation is also available at HIPEAC website, which is frequently visited by the research community. The presentation included the profiles of both regions in terms of culture, knowledge resources and priorities identified by Indian Government and the European Commission for advancing computing systems research towards socio-economic development of their respective citizens.

Computing technology has entered a new phase due to fast paced evolutions in following key areas:

- Multi-core and many-core processors including heterogeneous systems with various types of on-chip or off-chip accelerators.
- Software is becoming an important part of all kinds of computing systems
- Mobile devices like smartphones and tablets have emerged as the new "general-purpose" computing devices providing cloud access to millions of citizens and business.
- Knowledge mining is becoming a key enabler for industry and applications are becoming increasingly data-centric: Server farms, computing servers, HPC systems converging.

⁶ Euro-India Collaboration in Advanced Computing System Research in the Horizon 2020; Report published in HIPEACinfo 35, newsletter July 2013; <http://www.hipeac.net/content/hipeacinfo-35-july-2013>

- Computing infrastructures rely on components more and more from the mobile world.
- System software for server farms is increasingly becoming more complex
- Energy and cost efficiency are becoming as important as processing power.

Based on the analysis done across the full spectrum of activities, the SWOT (Strength, Weakness, Opportunities and Threats) analysis addressing the Euro-India collaborative issues in the development of next generation advanced computing systems research was presented.

A key challenge in advanced computing system research ahead of both communities is that of mastering parallelism, concurrency, and heterogeneity on all levels from hardware, to system software, to services, and to applications.

The roadmap document towards Euro-India collaboration in computing system research developed in the project shows that the number and complexity of the research challenges shared by Europe and India provides a clear indication that both regions could substantially benefit from a more collaborative approach to government funded computing systems research. With European strength in hardware and Indian strength being in software applied in developing more useful computing systems applications, the opportunity for a coordinated effort in computing systems research has perhaps never been greater. Both Europe and India are each in the very early stages of implementing new multi-year programmes for funding technology research, are seeing new opportunities to benefit from the changing landscape of computing technologies, and each have referenced the importance of international collaboration as part of their multiyear funding strategies. These new circumstances bode well for being able to establish a genuine joint effort between Europe and India in addressing computing systems research technologies that are strategic to each region.

The EU-INCOOP partners have identified seven areas of shared interests in computing systems research that would substantially benefit Europe and India and are aligned with the strategies of the government funding programmes established in each region.

The most substantial computing systems research and technology challenges that have been identified as being common to both Europe and India are the following:

- Software for emerging platforms
- Software for internet based systems
- Software for Big Data
- System software for enterprise
- Network embedded system interoperability
- Software for social computing
- HPC Technology Platform

Within each area the EU-INCOOP project has indicated several specific technology topics for collaborative research. The technological and scientific challenges identified are substantial and the resources required to address all of the shared challenges would likely far exceed the combined funding resources that could possibly be allocated for joint initiatives by the two regions. In this context EU-INCOOP project partners are still working towards narrowing

down the key areas of research within the framework of the seven identified challenges for recommending the joint Euro-India research projects in the framework of Horizon 2020.

2.2.1 Pictures from the workshop/conference



2.3 Advanced Computing Conference, 22-25 Oct. 2013, Chennai

ADCOM 2013 was a major conference addressing the major topics of Computing systems organised under the banner of ACCS-India, society of IEEE Computing Society. The hot issue of Big Data was one of the major topics discussed. The conference had multiple invited speakers from International industrial and academic institutes to address the adaptive computing to address cloud computing, Big Data and social computing issues. EU-INCOOP had proposed their Roadmap document in the form of the Conference paper. The Organising Committee considered our proposal as an important issue to progress the research work with International Collaboration and hence they proposed to organise a special session to address the cooperation and identify the way to achieve it. This was followed by a panel with experts from International organisations such as IBM research, Strand Life Sciences, North Dakota University and Indian Institute of Technology-Chennai.

The EU-INCOOP session had defined their objective with the following communication to the Community:

ADCOMP 2013 EUINCOOP Session 23 Oct. 2103, Chennai

Next Generation Computing Systems: Challenges Ahead

Session Chairs:

Dr. Sathya Rao, KYOS, Switzerland

Prof. H.S. Jamadagni, Indian Institute of Science, Bangalore

There are number of projects active in Computing Systems research, working towards realizing key technologies across all computing segments: embedded, mobile, desktops, servers, datacentres, clouds and applications. Because of its overarching nature of computing systems, the challenges from different computing disciplines across computing system layers and across international market segment have to be identified.

Hence, the objective of the session is to address the new approach for addressing the challenges ahead with international cooperation involving joint research activities.

One of the major challenges is to develop Software to support the advanced computing systems. Software development has not evolved as fast as hardware capability and network capacity. The session would address improvements and automation in software and Hardware development for the next generation computing systems addressing societal applications and challenges reinforcing industrial competitiveness enabled by advanced computing systems. The session will have invited experts discussing potential research topics for Euro-India joint research projects.

EURO-India Cooperation

Computing systems are universal. All aspects of public, private and commercial life are affected by computing systems. The dominance by desktops, laptops, and server PCs is waning and being replaced by smart embedded systems, mobile devices, and large-scale data centers. The European computing industry has a strong embedded ecosystem spanning from low power VLSI technologies to consumer products. However, the advanced computing systems performance depends on coordinated functionalities across Software and Hardware. EUINCOOP has studied this problem and has identified international cooperation in developing such a balanced system and getting access to International expertise in SW development to complement HW expertise available. Thus this session should be of high interest to Researchers in advance computing systems and industry partners of India.

Expected outcome

The traditional computing systems market is being replaced by a new market of smart embedded systems, mobile devices, and large-scale data centers, all converging to support global-scale applications that gather data from embedded systems and users, process it in large data centers, and control our environment or provide customized, timely information to millions of users through their mobile. With this background EUINCOOP project has produced research roadmap of advanced computing systems for the Horizon2020 framework. International cooperation through joint projects for the future competitive next generation computing systems will be discussed in the session, which can be of high value for research consortium to identify the partners with SW and HW expertise at the international level, and develop networks for mutual benefits. The session would identify key topics and challenges to be addressed for joint Euro-India research projects in the framework Horizon2020.

Prof. Jamadagni introduced the project objectives, work done and introduced Dr. Sathya Rao who leads overall technical coordination of project activities to talk about the 'Computing Systems Research Roadmap', for joint Euro-India Collaboration.

Dr.Rao presented the overall picture of ongoing activities in both Europe and India on different topics of the Computing Systems and the new directions set forth by the European Commission and Indian Government in their 12th five year plan (as part of Decade of Innovation). He also highlighted big budgets (of 1 b\$ in India, and 1 b€ in Europe) for supercomputing activities. In this background, it is important to cooperate across the two regions to achieve cost-efficient, technically complementary and mutually beneficial optimized results. Adaptive computing is the major area of the future computing systems to support the Big Data future with mobile devices generated data from common citizens, research needs of e-Science (Health, climatic change, Astronomy/space etc...) across Cloud computing and big data centers with Interoperability features following agreed standards. In

view of the universal application of computing systems for all business sectors, EU-INCOOP has developed 7 major lines of research challenges for joint collaboration across Europe and India.

Dr. Rao also stressed model of funding for consortium based research community involving both Academic and Industrial organisations. Unless, Industry participates with partial funding for collaborative research, the results that can be achieved only by the research institutes will have less impact. The participants agreed on this aspect and once again stressed the need to have a platform in the form of Technology platforms, following the ETPs in European research, to develop the strategic agenda and policy framework.

The Roadmap presentation was followed with the interactive discussions and resulted in achieving the top 3 key challenges in the short term out of 7 identified by the project team in consultation with experts and advisory board. These 3 challenges are:

- High Performance Computing : Technology Aspects
- HPC Technology Platform: Coordination to develop strategic technology agenda
- Social Computing: Web and Mobile aspects

The Session was followed with a panel discussion with the participation of eminent International experts, to address 'Adaptive Computing' as a theme for future computing systems research.

The panel had the following experts participation

- Dr. Prasenjit Dey, Senior Research Scientist, IBM Research
- Dr. Santhosh Kumar, Strand Life sciences
- Dr. Prakash Ranganathan, Assistant Professor, Dept of Electrical Engineering at the University of North Dakota
- Dr. Rajeswari Mukesh, Professor, Department of CSE, Hindustan University
- Prof. Kamakoti, IIT Madras
- Dr G S Madhusudan, IIT Madras
- Dr. Sathya Rao, Kyos, Switzerland

The discussions were moderated by Prof. Kamakoti, of Indian Institute of Technology, Chennai.

Professor Kamakoti opened the session with the question 'why adaptive computing? Each of the panelists stressed the need for adaptive computing as the future of computing. The panel agreed on mainly a few important topics that were of immediate concern to the computing systems world not only felt by India but also the rest of the world. The points are listed below.

- Shortage of Parallel programming skill force is experienced globally and hence there is an immediate need for parallel programming training for the next generation CS engineers.
- Self healing, self configuring systems and cyber physical security are major concerns that needs research attention by both academia and industry.

- Dr Sathya Rao informed the audience and the panel on the perspectives from Europe, he narrated that Europe has been investing in projects on adaptive computing as it has realized the need for dependable, energy efficient and easily available and testable hardware and software computational techniques.
- Prof Kamakoti emphasized the challenges of ‘how to manage high volume, high variety, and high velocity data with the right balance of low power and power efficient hardware.
- Dr G S Madhusudhan stressed on the need for machine learning an adaptive human augmented computing as the next generation computing techniques.
- Dr Ranganathan pointed out the limitations of today’s operating systems as they are not adequately equipped to respond to dynamic load scaling, voltage and power and hence due research attention is needed on the computer architectural, digital and power efficient hardware designs.

The interactive discussions with the participants demonstrated the importance of International collaboration with respect to Big Data, HPC and social computing to achieve significant progress in scientific and technology development and improving the national economy. Both industrial and academic research institutes want to collaborate, when appropriate instruments of collaboration can be established.

2.3.1 Photos from the event



2.4 ICT 2013, 6-8 Nov. 2013, Vilnius

ICT 2013 was a major event involving all FP7 projects and beyond to cover the Horizon 2020 framework programme. The conference covered Conference programme with invited speakers to address different issues in Horizon 2020, networking sessions with experts' participation on thematic based issues, brokerage events and exhibition of latest development from different projects.

EU-INCOOP had proposed networking session on Advanced Computing Systems: Challenges ahead.

Session Title: Advanced Computing systems: Challenges Ahead

Objective of the proposed session

There are number of projects active in computing systems research, working towards realizing key technologies across all computing segments: embedded, mobile, desktops, servers, datacentres, clouds and applications. Because of its overarching nature of computing systems, the challenges from different computing disciplines across computing system layers and across international market segment have to be identified. Hence, the objective of the session is to address the new approach for addressing the challenges ahead with international cooperation involving joint research activities.

One of the major challenges is to develop software to support the advanced computing systems. software development has not evolved as fast as hardware capability and network capacity. The session would address improvements and automation in software production for the next generation computing systems addressing societal challenges reinforcing industrial competitiveness enabled by advanced computing systems.

Stakeholders to be attracted (who and how)

Computing systems are universal. All aspects of public, private and commercial life are affected both directly and indirectly by computing systems. The dominance of the computing systems market by desktops, laptops, and server PCs is waning and being replaced by a new market of smart embedded systems, mobile devices, and large-scale data centers. The European computing industry has a strong embedded ecosystem spanning the entire spectrum from low power VLSI technologies to consumer products. However, the advanced computing systems performance depends on coordinated functionalities across software and hardware. European software skills have to be improved in developing competitive advanced computing systems for international market. EU-INCOOP has studied this problem and has identified international cooperation in developing such a balanced system and getting access to international expertise in SW development to complement HW expertise available. Thus this session should be of high interest to researchers in advance computing systems and industry partners of Europe.

Expected outcome

The traditional computing systems market is being replaced by a new market of smart *embedded* systems, *mobile* devices, and large-scale *data centers*, all converging to support *global-scale applications* that gather data from embedded systems and users, process it in large data centers, and control our environment or provide customized, timely information to millions of users through their mobile. With this background both EU-INCOOP and HIPEAC networks have produced research roadmap of advanced computing systems for the Horizon2020 framework. International cooperation through joint projects for the future competitive next generation computing systems will be discussed in the session, which can be of high value for research consortium to identify the partners with SW and HW expertise at the international level, and develop networks for mutual benefits.

The project was happy to get the Networking booth.

EU-INCOOP organized a 90 minutes Networking Session titled "Advanced Computing Systems: Challenges Ahead" at the ICT 2013 Conference on 7th November 2013 between 6pm and 7.30pm at Booth 2, Hall 1 at Litexpo Exhibition Centre, Vilnius. EU-INCOOP partners, Dr Sathya Rao from KYOS and Ms Sourabha Rani from ITSMA coordinated the networking session. We had a slide show presentation of the project results, a poster for the

people who wanted to understand what we are doing and flyers and booklet with our recommendations to distribute among the visitors. Networking booth allowed one to one discussion rather than a session. This facilitated more personal discussions with the visitors. Since, it was the last slot (18.00 -19.30 hrs), we were not expecting many visitors. We were very happy to receive more than 30 persons visiting us and discussing the different topics related to Computing Systems. The partners highlighted the key findings of the project and the steps forward. A booklet that summarized the key findings and expert recommendations was given to the participants at the session along with the project flyer. The participants appreciated the project outcomes, especially the recommended joint priority areas, and expressed their willingness to get connected to the project. Most of them were aware of Indian expertise in Software technologies and hence agreed that it would be of high interest to collaborate in R&D activities. They would be willing to participate in any initiative for such Euro-India research activities. They concurred with the project outcome that there is lot of scope and opportunity for collaboration between Europe and India in the Computing Systems space, and that they are looking forward for such joint initiatives to take shape.

2.4.1 Photos from ICT2013 networking session



3 Conclusions

The number of events provided ample information to develop the Euro-India joint research roadmap for computing system research with cooperation across two regions. The roadmap document was circulated across HiPEAC community and the key experts to obtain their feedback, and was revised to reflect the opinion of research community across Europe and India.

Participants in the events clearly showed major interest to cooperate in joint projects within the HORIZON 2020 framework. The networking across researchers of both regions will help in defining joint projects.

4 GLOSSARY

ADCOM – Advance Computing and Communication Society

ARTEMIS- European Technology Platform for embedded systems

CDAC- Centre for Development of Advanced Computing

C-MMACS- Centre for Mathematical Modelling and Computer Simulation

CSIR-Council of Scientific Industrial Research

CSU – Computing Systems Week

DAE – Department of Atomic Energy

DEITY – Department of Electronics and Informtic Technology

DRDO – Defence Research and Development Organisation

ECRC- European Computing Research Congress

ETP – European Technology Platform

FORTH- Foundation for Research and Technology Hellas

GOI – Government of India

IISc- Indian Institute of Science

IIT's- Indian Institute of Technology

ITSMA- Interactive Technology Software and Media Association

HiPEAC- High Performance and Embedded Architectures and Compilation

HPC – High Performance Computing

NESSI-Networked European Software and Services Initiative

NKN – National Knowledge Network

Planet HPC- European Technology Platform for High Performance Computing

TOG- The Open Group

WSAN – Wireless Sensor Actuation Network