EUINCOOP

Cooperate Collaborate Connect

EU-India Fostering COOPeration in Computing Systems

Key Findings & Expert Recommendations

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About EUINCOOP

"EU – India fostering Cooperation in Computing Systems" (EUINCOOP) is a European Commission funded Framework Programme 7 (FP7) project with an aim to stimulate research cooperation between Europe and India in Computing Technologies in order to support Europe's leading position in computing system, while ensuring mutual benefits for both Europe and India.

EUINCOOP is a 26 months Coordination and Support Action (CSA) project under FP7 that started in October 2011. The partners of EUINCOOP cover a broad spectrum of competencies: Academic, research, small business, consulting and industry. These competencies were further strengthened by our advisory committee created for the span of the project.

The advisory committee helped in concretizing the research priority areas under computing systems, it helped identify the gaps and overlaps between the two regions and also guided in understanding the technical, financial and policy scenarios in the computing systems area that enabled the project team to short list joint areas for future collaboration.

The Roadmap document on Euro-India collaboration in computing systems research developed in the project shows that the number and complexity of common 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. This Roadmap paves the way to strategize and formulate the future research policy in computing systems in Europe and India.

Key findings

EUINCOOP compiled state-of-the-art projects in both regions, identified key actors, policy directives as well as funded projects so that reasonable collaboration can be proposed for joint activities between Europe and India. The results were presented in multiple events with experts' participation from both regions (HIPEAC event, Gothenburg; HIPC 2012, Bangalore; ITBiz2012, India; HIPEAC events in Paris 2012 &2013; ADCOM 2013). The results are compiled in the deliverables (D2.2 and D3.2) available as public documents in the project website www.euincoop.eu.
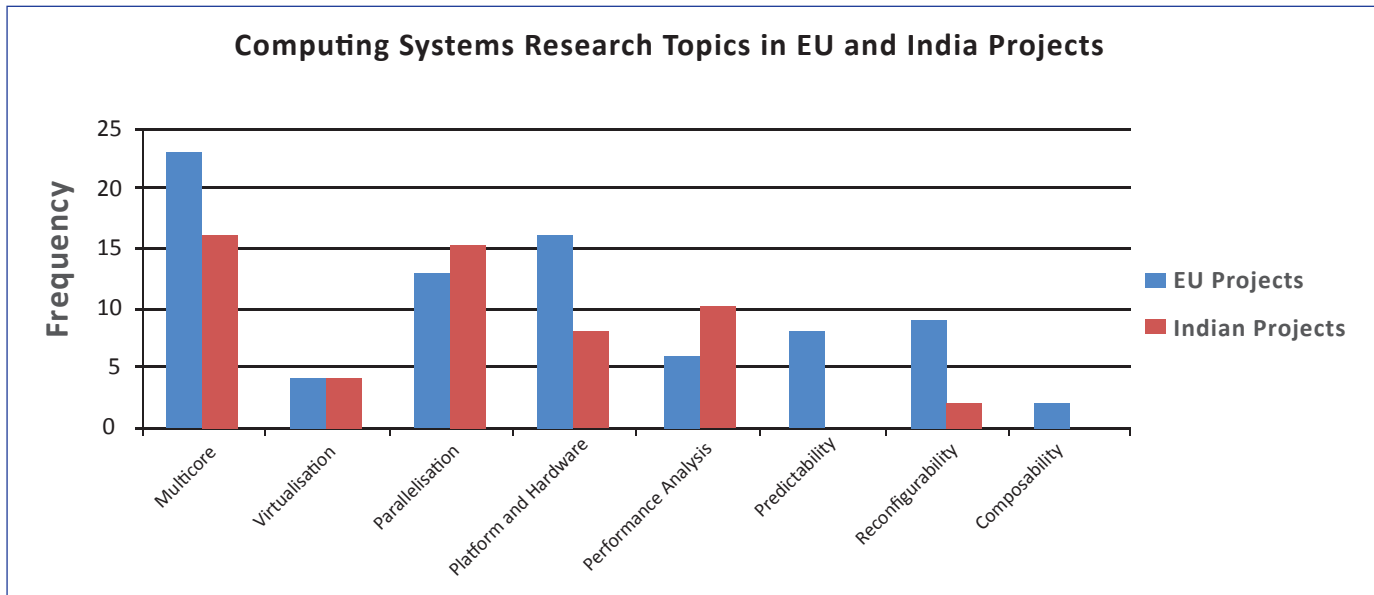
Computing technology has entered a new phase due to fast paced evolution in following key areas:

- Multicore and manycore 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 businesses
- Knowledge mining is becoming a key enabler for industry and applications are becoming increasingly data-centric: Server farms, computer servers, HPC systems converging
- Computing infrastructures rely on components more and more from the mobile world
- System software for server farms is increasingly becoming more complex
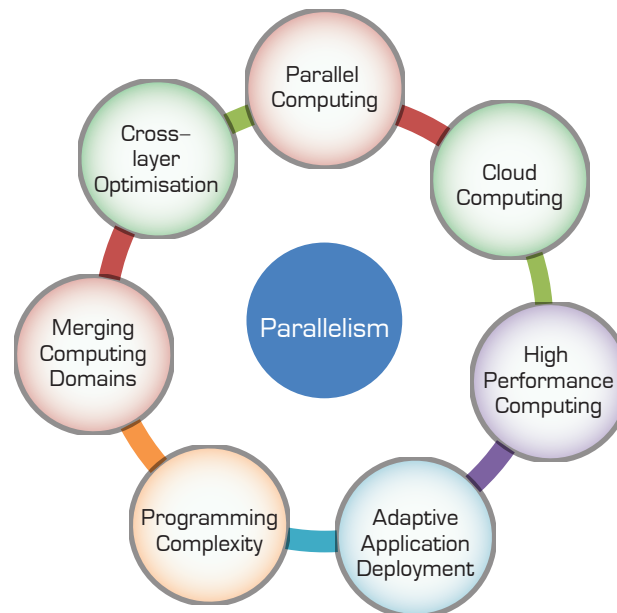- Energy and cost efficiency are becoming as important as processing power

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.

Comparison of computing systems research topics in India and EU funded projects

Computing Systems Research Topics in EU and India Projects

Legend:
- EU Projects (blue)
- Indian Projects (red)

Y-axis: Frequency (0, 5, 10, 15, 20, 25)

X-axis categories: Multicore, Virtualisation, Parallelisation, Platform and Hardware, Performance Analysis, Predictability, Reconfigurability, Composability

Identified technology areas for cooperation

Central: Parallelism

Surrounding areas:
- Parallel Computing
- Cloud Computing
- High Performance Computing
- Adaptive Application Deployment
- Programming Complexity
- Merging Computing Domains
- Cross-layer Optimisation

SWOT analysis of Indian and European cooperation in ICT research

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 conducted.

STRENGTHS

- Traditional linkages between EU & India in computing technologies
- Favourable policies, mutual interest on international cooperation with a good number of S&T cooperation programmes between both the regions
- Existing cooperation mechanism such as bilateral programmes, multilateral programmes with India & EU member states
- Capacity of ICT R&D in India is almost on par with EU countries
- Existence of ICT NCP support for Framework Programme projects in both regions

OPPORTUNITIES

- Job opportunities between both the regions
- Knowledge sharing on Framework Programme project experiences
- Planning emphasis in cooperation programmes on future opportunities between both regions
- Strengthening of foreign knowledge as well as innovation linkages
- Maximising partnerships between both regions will further aid in development of products for world markets
- Improve efficiency of public funded R&D and motivate private sector efforts

WEAKNESSES

- Limited awareness among Indian scientists and R&D organizations regarding EU's Framework Programme opportunities

- Inadequate linkages amongst researchers between EU & India

- Lack of EC project management skills in India

- Lack of participation of Indian R&D organisations in EU computing systems projects

- Different levels of research and technological development between both regions

- Non-reciprocity of Indian S&T programmes to EU researchers

THREATS

- Lack of networking programmes between researchers from different disciplines necessary for co-creation in both regions

- Lack of IPR awareness amongst ICT researchers in both regions

- Gap in expectations between EU & Indian researchers

- Problems with understanding the difference between research and application areas and activities

- Competition with other Indian cooperation programmes such as USA, UK, China

Snapshot of Roadmap Document

With European strength in Hardware and Indian strength being in software, the opportunity for a coordinated effort in computing systems research has perhaps never been greater as both Europe and India are each in the very early stages of implementing new multiyear programmes for funding technology research. Both the regions 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 EUINCOOP advisory committee and the project partners have identified seven areas of shared interests in computing systems research under three main umbrellas – High Performance Computing; Could Computing & Embedded Computing, that would substantially benefit Europe and India and are aligned with the strategies of the government funding programmes established in each region.

- 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
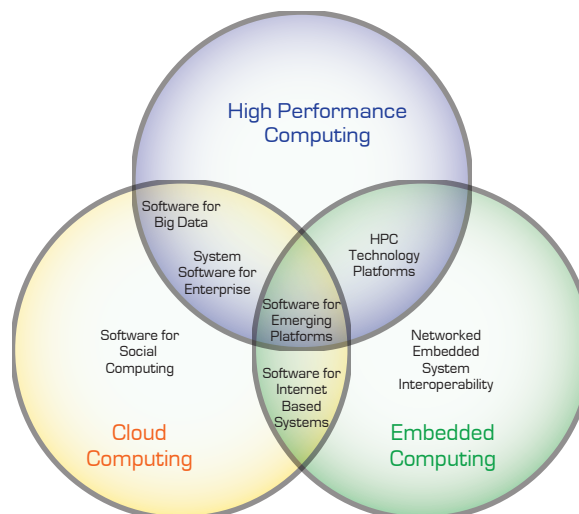
Software for Emerging Platforms

Joint research direction that India and Europe can explore

- Automated parallelization with use of abstraction

- New transformation technologies to automate exploitation of parallelization at deployment combined with model-based engineering technologies

- Increased run-time intelligence to dynamically adaptive software to better exploit parallelism of the platform

- New languages that aid in the expression of parallelism and that provide better mapping or automation of algorithm design

- Emphasis on portability and scalability to optimize investments

- Research in human aspects to have an understanding into how people should program for ease of use

- Adaptive curricula to garner the necessary skills to address greater levels of parallelism

System Software for Enterprise

Joint research track that India and Europe can explore

- Automating interoperability of systems between enterprises

- Automating adaptation of systems including techniques to recognize when adaptation is required

- Distributed systems technology addressing the complexities of interfacing, managing and exploiting data from manufacture products with embedded intelligence that may have been sold around the world

- System software supporting real-time data analytics and new enterprise database technologies and related programming and design tools to support rapid adoption

- Many core programming methods and models that transform service oriented architectures to better exploit dynamic service composition, virtualization and main memory techniques for enterprise software

Software for Internet based systems

Joint research track that India and Europe can explore

- Large scale distributed software systems modeling, mechanisms to reduce costs of verification to ensure run time behavior

- Dynamic resource allocation while providing appropriate guarantees on performance and energy efficiency in many core embedded and high performance systems

- Cloud-like resource management infrastructures aiming to harmonize the approaches to dynamic allocation across the complete spectrum with soft performance guarantees

- Resource allocation techniques that are sufficiently lightweight to be applied during runtime and that are able to take into account performance guarantees for timing and energy use

- Scalable resource allocation techniques that are capable of supporting different kinds of cloud-like infrastructures including embedded clouds, micro clouds and high-performance clouds

- Extensions to existing system software (OS, virtual machines, middleware) to support predictable runtime migration of tasks with monitoring and back-propagation for dynamic optimization

- A collaborative approach to addressing large scale distributed systems that support new Internet based services would greatly benefit markets in both India and Europe

Software for Social Computing

Joint research track that India and Europe can explore

- Data intensive distributed computing system software and middleware

- Semantic-based data integration and standardization

- Software optimizations and acceleration for reasoning in a huge-scale distributed environment

- Technologies for discovery, surveillance and managing dynamic and mobile data

- Scalability of new technologies will be another area that can be tapped for collaborative potential

Networked Embedded Systems and interoperability

Joint research track that India and Europe can explore

- Distribution and composability of operating systems and virtual environments are able to support dynamic reconfiguration

- Resource augmentation enabling devices to identify resources accessible across a network such as cloud computing, HPC and to exploit these to dynamically improve quality of service and energy usage

- Connectivity schemes that support ubiquitous syntactic and semantic integration of heterogeneous sub-systems, under the constraints of minimum energy usage and limited bandwidth

- Self-configuration, self-organization, self-healing and self-protection of computational components to establish connectivity and services, using knowledge acquired from the environment

- Monitoring techniques for object and event recognition making possible new control tasks in large-scale systems

Software for Big data

Joint research track that India and Europe can explore

- Data centric system software exploiting many core parallel computing platforms

- Asynchronous computing and distributed data focused run-time environments

- Scalability of open data management platforms and support for new approaches to analysis and visualization

- Optimization through balancing or delegating work using techniques such as moving algorithms to local data stores

- Improving interoperability of data, techniques, and methods across tasks and scenarios

- Scalability as the volumes of data stores is expected to increase

HPC Technology Platform

Joint research track that India and Europe can explore

- Programming models, languages and methodologies for many core HPC architectures and tools to automate applications and improve developer productivity

- Technologies for energy-aware application and system modeling, compilation and run-time environments for building energy efficient HPC systems

- Modeling and simulation techniques that scale to expected levels of parallelism in many core based HPC platforms

- Exploiting technologies from other computing domains for mobile, embedded, cloud, telecommunications and sensors to address HPC

- Definition of a common access framework for the HPC infrastructures

Project Partners

Partners	Country
Foundation for Research and Technology Hellas (FORTH)	Greece
Kyos SARL (KYOS)	Switzerland
X/Open Company Limited (TOG)	United Kingdom
Interactive Technology, Software and Media Association (ITSMA)	India
Centre for Development of Advanced Computing (C-DAC)	India
Indian Institute of Science (IISc)	India

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www.euincoop.eu