
Need for Indo- European co-operation in computing systems

Challenges and opportunities

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Ubiquity in computing and Communication

Meeting the constraints:

- VLSI density
- Frequency
- Parallelisation
- Energy consumption
- Number of cores
- Task sharing
- Performance



Challenges lie both in Hardware and Software development with International collaboration

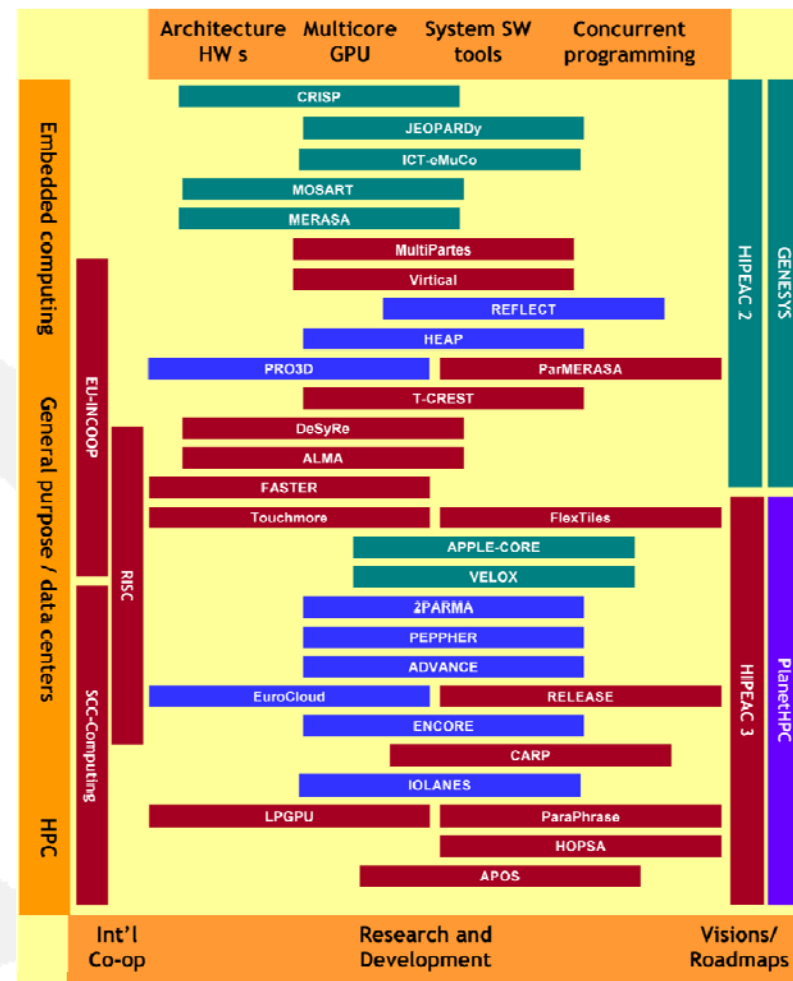
Computing system Challenges addressed in FP7

- operating systems, computer architecture, and their interaction
- System modelling and analysis
- distributed, parallel, and cloud systems
- networking, mobile, wireless, peer-to-peer, and sensor systems
- runtime systems and compiler/programming-languages support
- energy/power management
- file and storage systems
- virtualization
- embedded and realtime systems
- fault tolerance, reliability, and availability
- deployment, usage, and experience
- performance evaluation and workload characterization
- Reconfigurability

European FP7 activities

There are number of running projects addressing multiple issues of Computing Systems research covering;

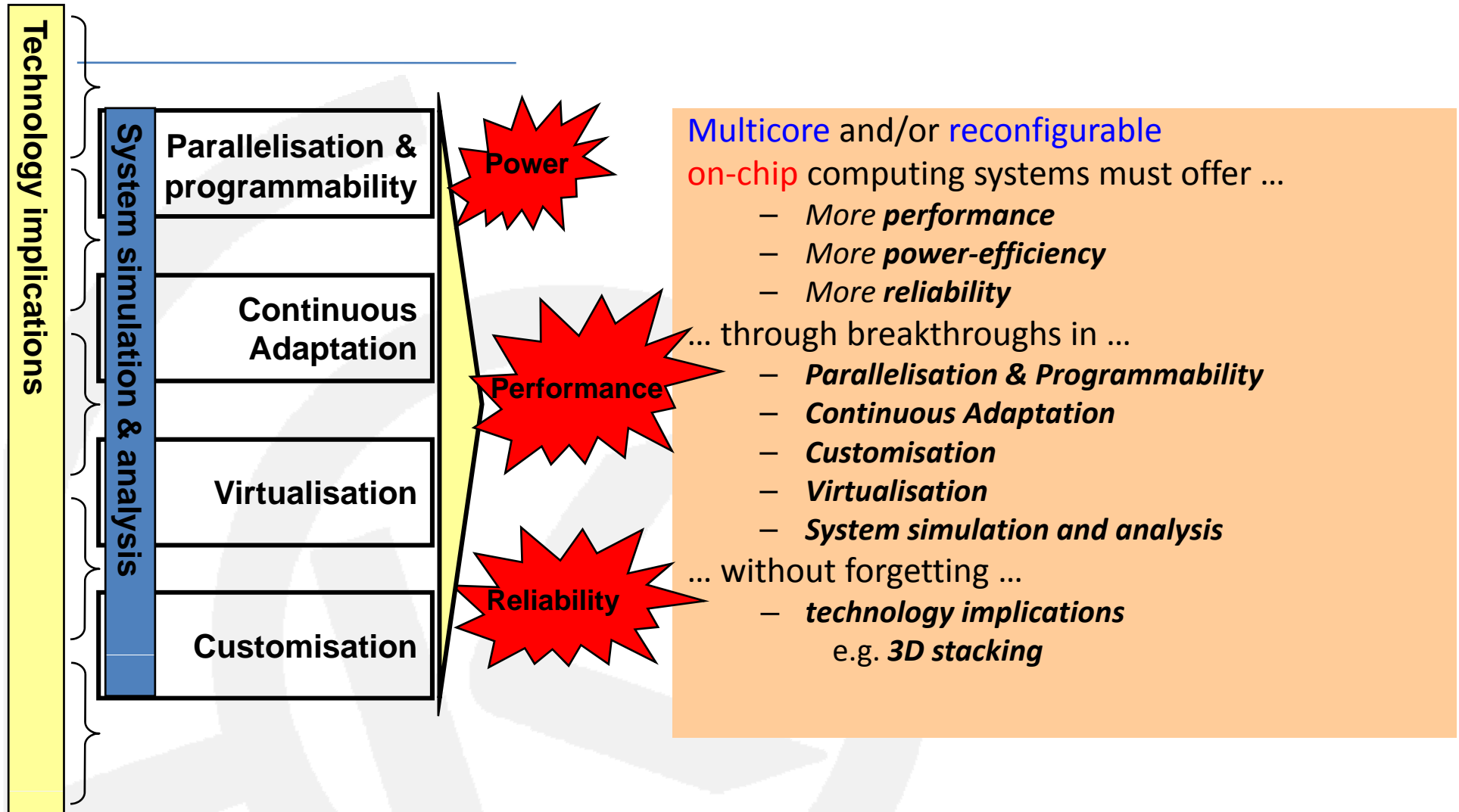
- Architecture and Hardware
- Multicore and GPU
- System Software and Tools
- Concurrent Programming



Visionary Projects

- European Technology platforms (ETPs)
 - ARTEMIS: *Advanced Research & Technology for Embedded Intelligence and Systems*
 - www.artemis.eu
 - NESSI: *Networked European Software and Services Initiative*
 - www.nessi-europe.com
- Network of Excellence
 - HIPEAC
 - www.hipec.net
- Support Project
 - PlanetHIPC
 - www.planethpc.eu

Challenge in Computing: System of Systems



Technology Trends

- Parallel computing
- Cloud computing
- High performance computing
- Adaptive application deployment
- Programming complexity
- Merging computing domains
- Cross-layer optimisation

Parallelisation & Programmability

- Automatic parallelisation, new high-level parallel programming languages and/or extensions to existing languages taking into consideration that **user uptake is a crucial issue**.
- Projects on programmability & parallelism of multi-core and/or reconfigurable architectures should adopt a **holistic approach** addressing issues related to the underlying hardware and to the system software.
- Research areas include
 - beyond static auto-parallelisation by exploiting dynamic (run-time) information;
 - new support environments including testing, verification and debugging, program & performance monitoring and analysis;
 - specific hardware support for parallel programming models.
- High impact on performance and energy to be managed by Software

Methodologies, techniques and tools

- **Continuous Adaptation:** Multicore and/or reconfigurable systems that continuously adapt to a constantly changing environment **by going beyond the strict separation between compiler, runtime and hardware.**
- **Virtualisation** technologies that ensure **portability, flexibility, optimised use of resources and overcome legacy issues** for multicore and/or reconfigurable systems. This includes hardware/software interfaces for efficient virtualisation as well as machine abstractions and performance models for virtualised homogeneous or heterogeneous systems applicable to cloud computing.
- **Customisation:** Rapid extension and/or configuration of existing systems, architectural templates and tool-chains to **optimally address specific application needs and performance/Watt envelopes.**

System simulation and analysis

- **System simulation and analysis:** Advanced simulation and analysis of complex multicore systems to **drastically improve the simulation speed** of new complex, homogeneous or heterogeneous, multi-core systems
- Date deluge system management and software to manage concurrency in exascale HPC systems
- Need of tight cooperation between hardware and software technologies, including the operating, runtime systems and applications, is necessary to address the energy challenge in new generation HPC systems

New challenges

- Merging computing domains
 - migration towards a computing continuum
 - Same key technologies and players acting across all computing segments: embedded, mobile, desktops, servers, data centres, clouds
 - application usage of computing resources cutting across the computing spectrum such as embedded systems utilising HPC functionalities and HPC systems used in time- and safety-critical applications

New challenges

- Embedded computing
 - single core controllers to multi to manycore systems; from local buses to switched and open embedded system networks; from single application contexts to application integration and from individually maintained systems to autonomous, self-X systems
- Power Consumption and related functionalities
 - increasing influence on both hardware and software architecture, while timing, safety, reliability, availability and security are of increasing importance at the core of critical systems
- Low cost clusters
 - powered by multicore CPUs and GPUs takes HPC capabilities to a much wider audience

European Horizon 2020

- 7 year major programme involving multi-billion € funding
 - Solutions for Societal challenges: Europe's productivity and innovation capacity and ensuring Europe has an advanced, sustainable and competitive economy, global leadership in high-tech application sectors
 - 'Leadership in enabling and industrial technologies' following a technology-driven approach to develop enabling technologies that can be used in multiple areas, industries and services to meet Societal challenges
 - Key Enabling Technologies (KETs): micro- and nanoelectronics, photonics, nanotechnology, biotechnology, advanced materials and advanced manufacturing systems

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- Business oriented vision
 - Strong private sector involvement
 - public private partnerships, involvement of SMEs a must
 - market needs and the requirements of the societal challenges

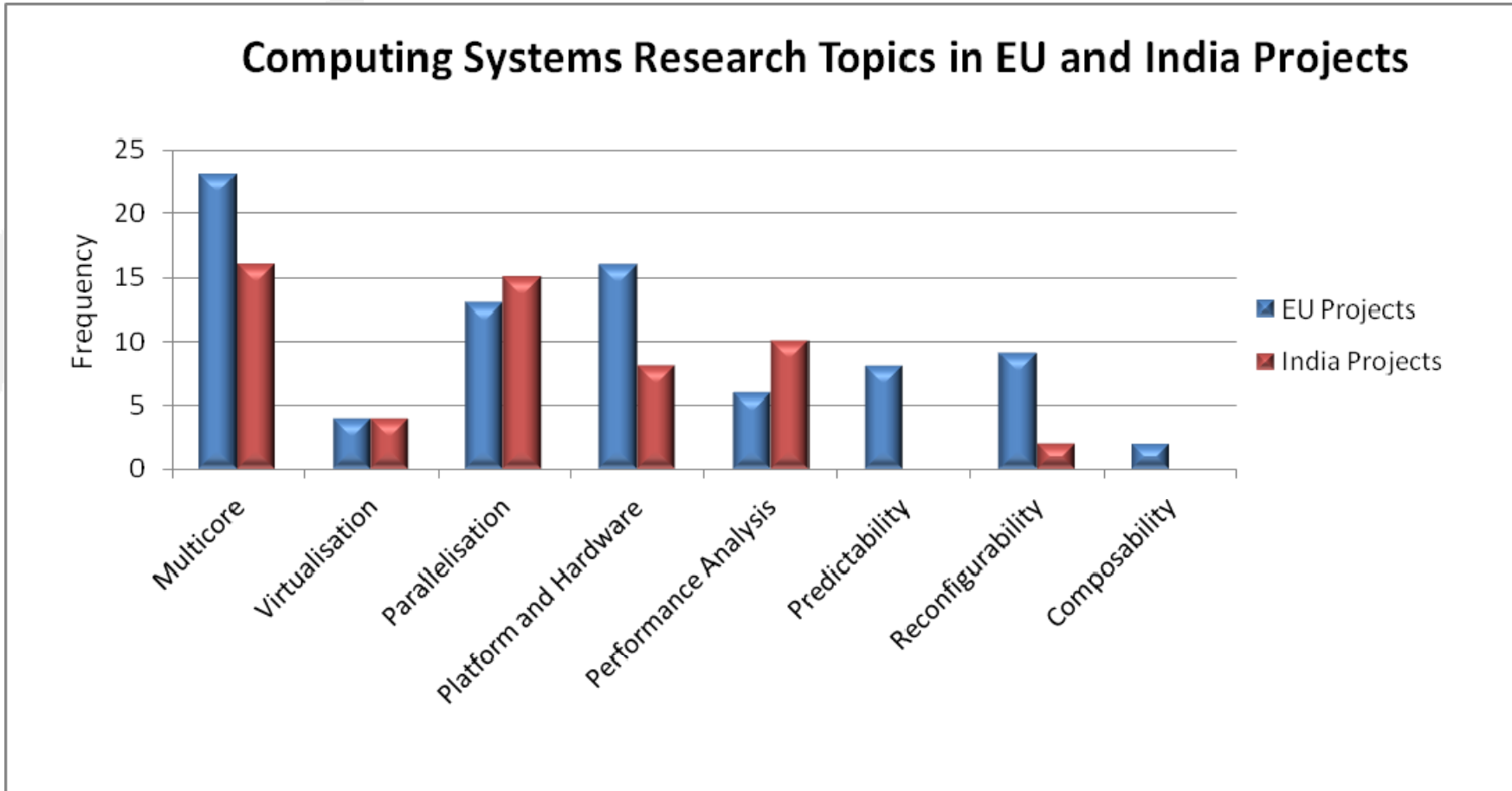
Indian Vision and challenges

- Consortium funding systems.
- Possibilities of funding international S&T cooperation
- Participation in global research consortia.
- Research in national priority areas such as Water, Energy, affordable Health Care etc,
- Stronger focus on enlarging the role of private sector into Research and Development
- Establishment of Technology Platforms
- Soceital applications and next generation computing

Technology areas for cooperation

- Multicore
- Virtualisation
- Parallelisation
- Platform and Hardware
- Performance Analysis
- Predictability
- Reconfigurability
- Composability

EURO-INDIA Co-operation opportunities



Research Collaboration: EU vs India

		Reliable systems for Ubiquitous Computing	Architectures for the Data Deluge	Next-generation processing cores	Next-generation multi-cores	Cross-component/cross-layer optimization	Software for heterogeneous management	Locality and communications management	Heterogeneous computing systems
Parallelism and Programming Models									
9.1.1.	Locality Management	x	x	x	x	x	x	x	x
9.1.2.	Optimizations programmer hints, tuning	x	x	x	x				x
9.1.3.	Runtime Systems and Adaptivity	x	x	x	x				x
Architecture									
9.2.1.	Processors, Accelerators, Heterogeneity	x	x					x	x
9.2.2.	Memory Architectures	x	x			x	x	x	
9.2.3.	Interconnection Architectures	x	x			x	x	x	
9.2.4.	Reconfigurability	x	x			x	x		
Compilers									
9.3.1.	Automatic Parallelization			x	x		x		
9.3.2.	Adaptive Compilation				x				x
9.3.3.	Intelligent Optimization				x	x	x		x
Systems Software and Tools									
9.4.1.	Virtualization	x		x	x				x
9.4.2.	Input, Output, Storage, and Networking			x					x
9.4.3.	Simulation and Design Automation Tools	x				x	x		
9.4.4.	Deterministic Performance Tools	x	x	x	x	x	x	x	x



Opportunities on different challenges

Disruption	European Opportunity	Indian Opportunity
Energy efficiency is becoming as important as performance where components increasingly come from the low power mobile world rather than the more power hungry desktop world. Tablets and smartphones are driving new innovation and markets.	Europe has significant strengths in low power, low cost processing for battery powered devices.	India has strong expertise in system software to develop new features for energy awareness and to exploit these at application design and deployment.
The data deluge and the end of the increase in processor clock speeds for powering hardware innovation are leading to a new generation of computing systems, which are increasingly parallel and heterogeneous.	Europe has the skills in parallel processing and the ability and expertise in both embedded and supercomputing technologies which when combined provide opportunities for capitalising on this technology revolution.	India has substantial skills in addressing large data challenges in several scientific disciplines and years of experience in parallel processing that can be applied to scale applications to exploit new heterogeneous architectures.
There is a trend towards a computing continuum with the same key technologies and players acting across all computing segments, and application usage cutting across current computing disciplines.	Europe can expand from its strengths in embedded, mobile and high performance software.	Indian can extend from its strengths in HPC computing to further develop world class expertise in embedded and mobile software.
A new era of enterprise software given the emergence of ground breaking technologies such as cloud computing, multi- and manycore processors, and main memory database technology. In addition, the Internet of things has become reality generating massive data volumes.	Europe has world leading capabilities in enterprise software and expertise in developing system software that exploit new platform architectures especially in areas related to mission or safety-critical domains.	India has world leading capabilities in enterprise software and expertise in exploiting new technologies for developing enterprise applications and adapting technologies to many different industrial domains.
High bandwidth networks based on the widespread deployment of broadband – fixed and mobile – enables promising new business models leveraging the cloud computing paradigm.	This opens access to advanced computing resources and application services to European actors to who these were out of range in the past, in particular SMEs.	This creates new opportunities for India's large base of software suppliers to access and exploit new HPC technologies for innovative applications and services.
The cost of developing new hardware approaches in silicon is dropping due to the use of FPGAs for prototyping and novel ASIC manufacturing methodologies.	Europe has world leading expertise in integrated circuit design through its embedded community.	India has world leading expertise in developing applications that exploit new hardware designs and lower cost platforms.

Common Research Challenges

- 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

International cooperation

- Computing systems are managed in terms of optimised Hardware and Software components
- Europe has an edge in Semiconductor technologies with number of International companies such as STMicro electronics, Infineon, ARM,...
- Has number of research centers for collaborative work, though limited in Industry-Academia networks
- India is a software powerhouse to complement.
- Number of National research institutes and international companies are active in India

Thank you



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