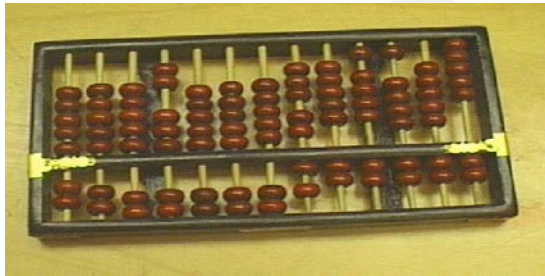# Future Computing Systems

Overview of Key Challenges for the future Research
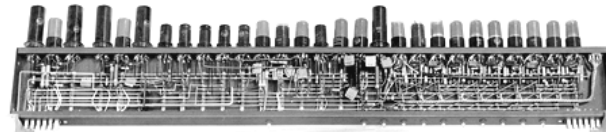
Dr. Sathya Rao

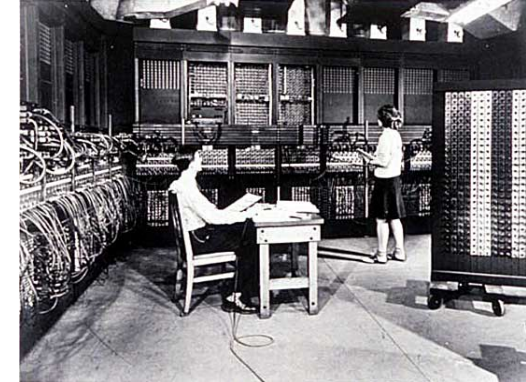*KYOS, Switzerland; sathya.rao@kyos.ch*

Evolution of Computing systems
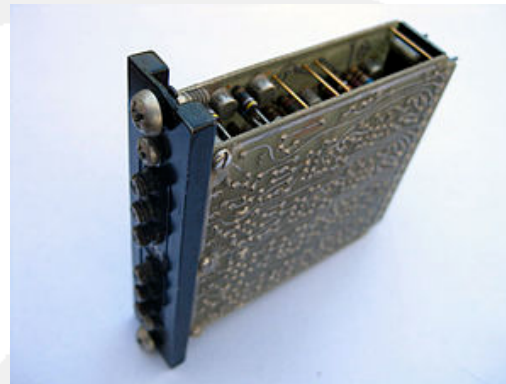

Chinese SWANPAN

1944: Accummulator (Tubes)

First Generation: 1948

Second Generation- 1960
Univac/transistors based
IBM-1400 series
Fortran, ALGOL, COBOL

Third Generation- 1968
CDC6600 Logic Module
IBM 360OL, ICs , Nsec
BASIC; Telecom

Fourth Generation- 1971+
PDP 11, MSI/LSI, Database
Scientific applications, Psec
PASCAL, Minicomputers

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Birth of Micro Computers, PCs, Laptops, Tablets Fifth Generation → Next Generation

- 1968: Intel Founded: Birth of processors, controllers

- 1980: Release of multiple Microcomputers, DEC

Motherboard with CPU, 64 kbytes RAM,
Harddisk, Floppy, Display, I/O ports,
MS-DOS operational system
- VLSI, SW tools
- Desktop applications
- Reaching the end users

- 1990-2000: Explosion of PCs, Laptops, SW Applications, Games, Peripherals, Networking, Communication…

- 2000 +: Pervasiveness of computing to all fields, Key challenges to meet the expectations

Ubiquity in computing and Communication

Meeting the contraints:

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

Challenges lie both in Hardware and Software development with International collaboration
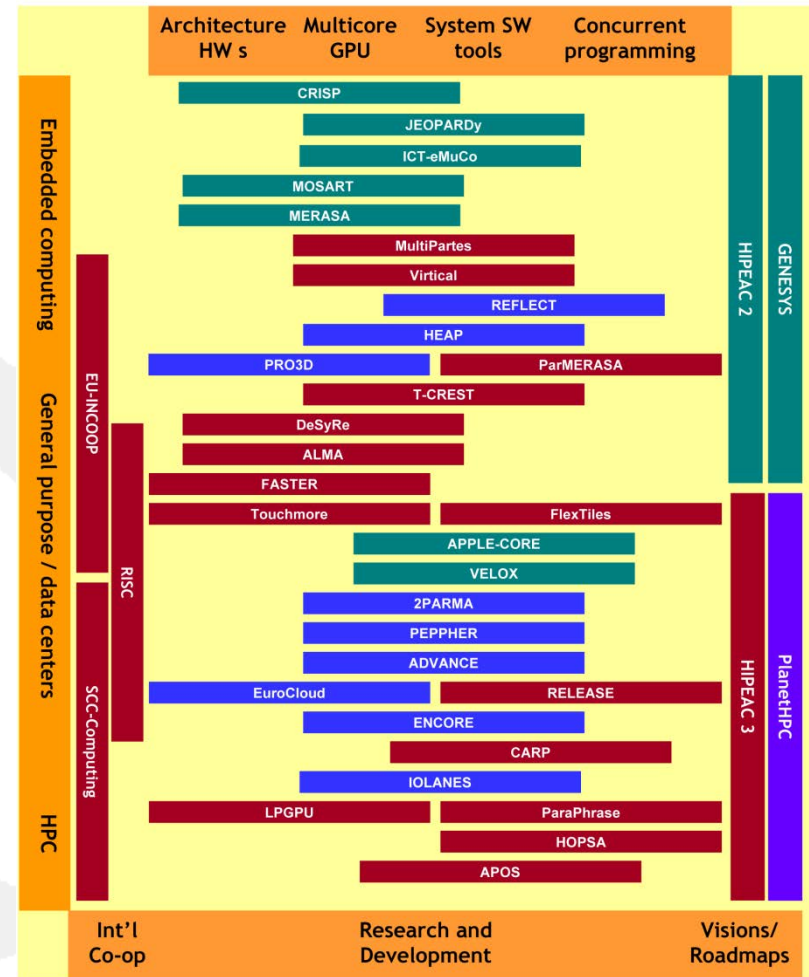
Next Generation Computing system Challenges

- 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
- security, privacy, and trust
- virtualization
- embedded and realtime systems
- fault tolerance, reliability, and availability
- deployment, usage, and experience
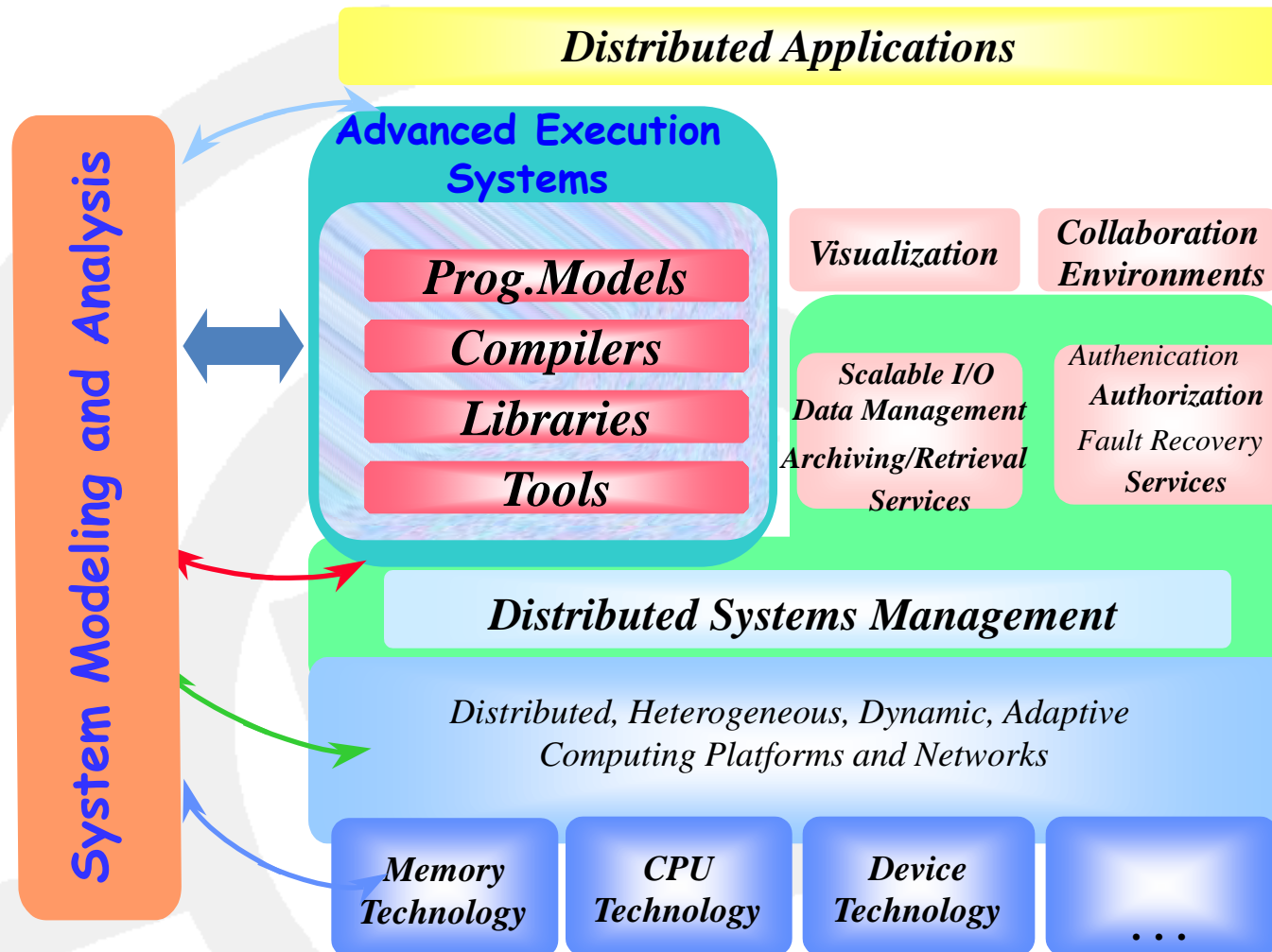- performance evaluation and workload characterization

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

View of Computing System challenges

HiPEAC Research Challenges

System complexity

- Cost-effective software for heterogeneous multi-cores
- Cross-component/cross-layer optimization for design integration
- Next-generation processor cores

Applications

- Architectures for the Data Deluge
- Reliable systems for Ubiquitous Computing

Efficiency

- Heterogeneous computing systems
- Locality and communications management

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Technology areas for cooperation

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

EURO-INDIA Co-operation opportunities

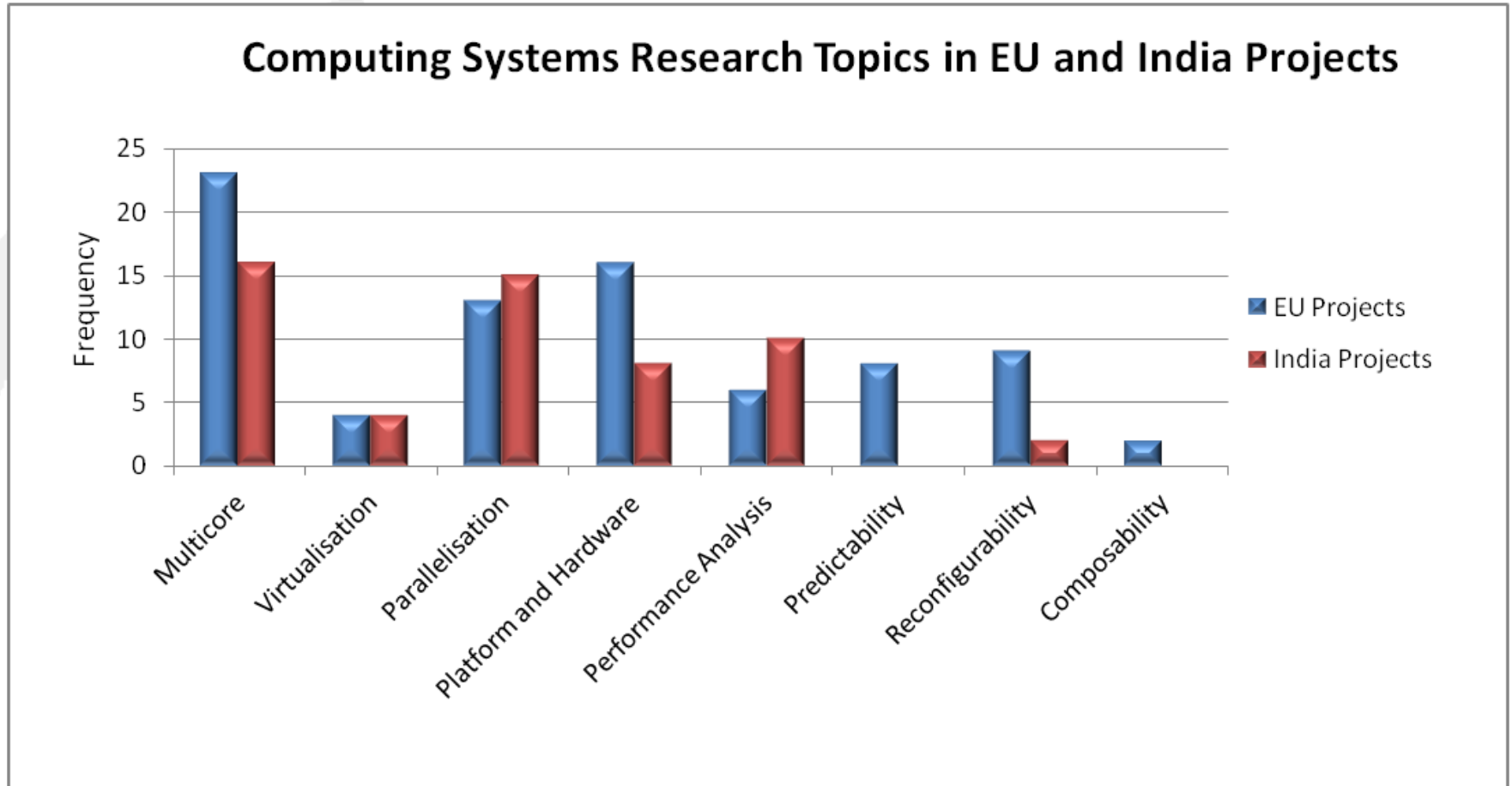Computing Systems Research Topics in EU and India Projects

Research Collaboration: EU vs India

	Heterogeneous computing systems	Locality and communications management	Software for heterogeneous multi-cores	Cross-component/cross-layer optimization	Next-generation processing cores	Architectures for the Data Deluge	Reliable systems for Ubiquitous Computing
Parallelism and Programming Models							
9.1.1. Locality Management	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	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	x
9.3.3. Intelligent Optimization			x	x	x		x
Systems Software and Tools							
9.4.1. Virtualization	x		x	x		x	x
9.4.2. Input, Output, Storage, and Networking		x		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

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International cooperation

- Computing systems are managed in terms of optimised Hardware and Software components

- Europe has an edge in Semiconductor technologies with number of Internatoinal 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

System Modelling and Analysis

- Novel modeling and measurement approaches
  - Develop capabilities to describe, analyze and predict the behavior of the components as well as the systems; Analysis and prediction due to changes in the application, system software, hardware; multilevel approaches and multi-modal approaches
- Performance Frameworks
  - combine tools in "plug-and-play" fashion
  - multiple views of the system

Advanced Execution System

- Programming models and tools
  - expressing application partitioning across distributed, heterogeneous computing platforms; application-level checkpointing and recovery
- Application composition system (ACS) technology
  - constructing applications to fit the available resources and to adapt to changes in the underlying execution environment;
  - methods for automatically selecting application components;
  - creating knowledge bases for application components; interfacing with the underlying computing platform models to determine suitable application components;
  - and developing appropriate application component libraries and interfaces so the run-time portion of the RCS can link to such libraries.

Statements from EU and India

- February 16, 2012

Europe Aims to Become World Leader in Supercomputing

  - The plan would increase Europe's public HPC spend from €630 million to €1.2 billion and pump a greater share of the money into development, training, and creating "new centres of excellence."

- Sept. 2011

(India) Ministry of Science and Technology Sanctions 5000 Crore (1 b$) for Supercomputer Research

  - The ambitious project will be headed by Bangalore based Indian Institute of Science (IISc).

Main funding authorities and research centers in India

- Funding: Department of Electronics and Information Technology (DEIT)
- Research activities:
  - CDAC
  - IISc and IITs
  - CSIR labs
  - Number of Technical Universities
- Type of ongoing activities:
  - BioInformatics, Ubiquitous computing, GARUDA grid, NKN, Computing applications,…

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Thank you

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