NSF07-504

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Program Officers:

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Computer Systems Research Program: Components and Thematic Areas

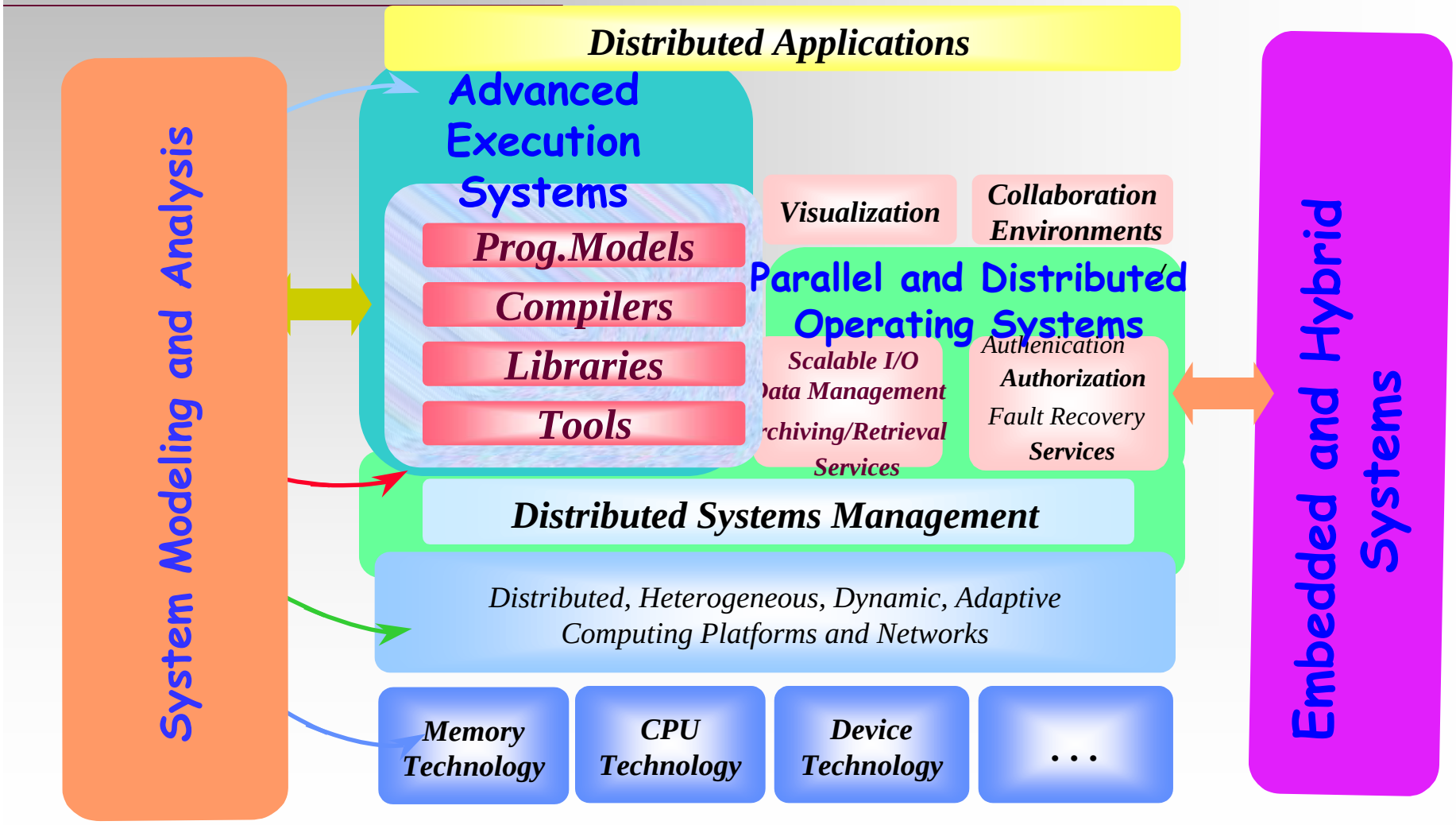
Advanced Execution Systems (AES)
Systems Modeling and Analysis (SMA)
Thematic Area: Cross-Systems Integration (CSI)
(PO – Darema)

Parallel and Distributed Operating Systems
Thematic Area: Virtualization for Configuration Management
(PO – Brett Fleisch)

Embedded and Hybrid Systems (EHS)
Thematic Area: Cyber-Physical Systems
(PO – Helen Gill)

Components of CSR Program:

- (EHS) Embedded and Hybrid Systems (Helen Gill)
- (PDOS) Parallel and Distributed Operating Systems (Brett Fleisch)
- (AES) Advanced Execution Systems (Frederica Darema)
- (SMA) System Modeling and Analysis (Frederica Darema)



Advanced Execution Systems (AES)

Seeks to create systems software to facilitate the development and runtime support of complex applications executing on large, heterogeneous high-end computing and grid platforms

AES emphasizes runtime compiling systems and application composition systems interface with the underlying operating systems services and incorporating systems modeling and analysis methods and tools.

Topics of Interest

- Runtime compiling system (RCS) technology
  - extends the standard static notion of a compiler by embedding a portion of the compiler in the runtime system and endowing the RCS system with resource awareness and adaptive mapping capabilities;
  - new compiler techniques for determining functional and data dependencies across platforms and across multiple levels of memory hierarchy;
  - mechanisms for matching an application's resource needs to underlying resources when both are changing as the application executes

Advanced Execution Systems (AES)

Topics of Interest

- 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.

System Modeling and Analysis (SMA)

Seeks to develop methods and tools for modeling, measuring, analyzing, evaluating, and predicting the performance and correctness of complex computing and communications systems

SMA emphasizes the development of methods and tools for modeling, measuring, analyzing, evaluating, and predicting the performance and correctness of complex computing and communications systems

Topics of Interest

- Hardware and Software modeling
  - methods tools and measurements, providing multimodal, hierarchical or multilevel modeling and analysis capabilities of such systems;
  - methods that describe components of the system, but also the system as a total, and enable assessment of the effects of individual hardware and software layers and components of these systems;
  - ability to describe the system in multiple levels of detail (characteristics and time-scales);
  - combine different methods of describing components and layers

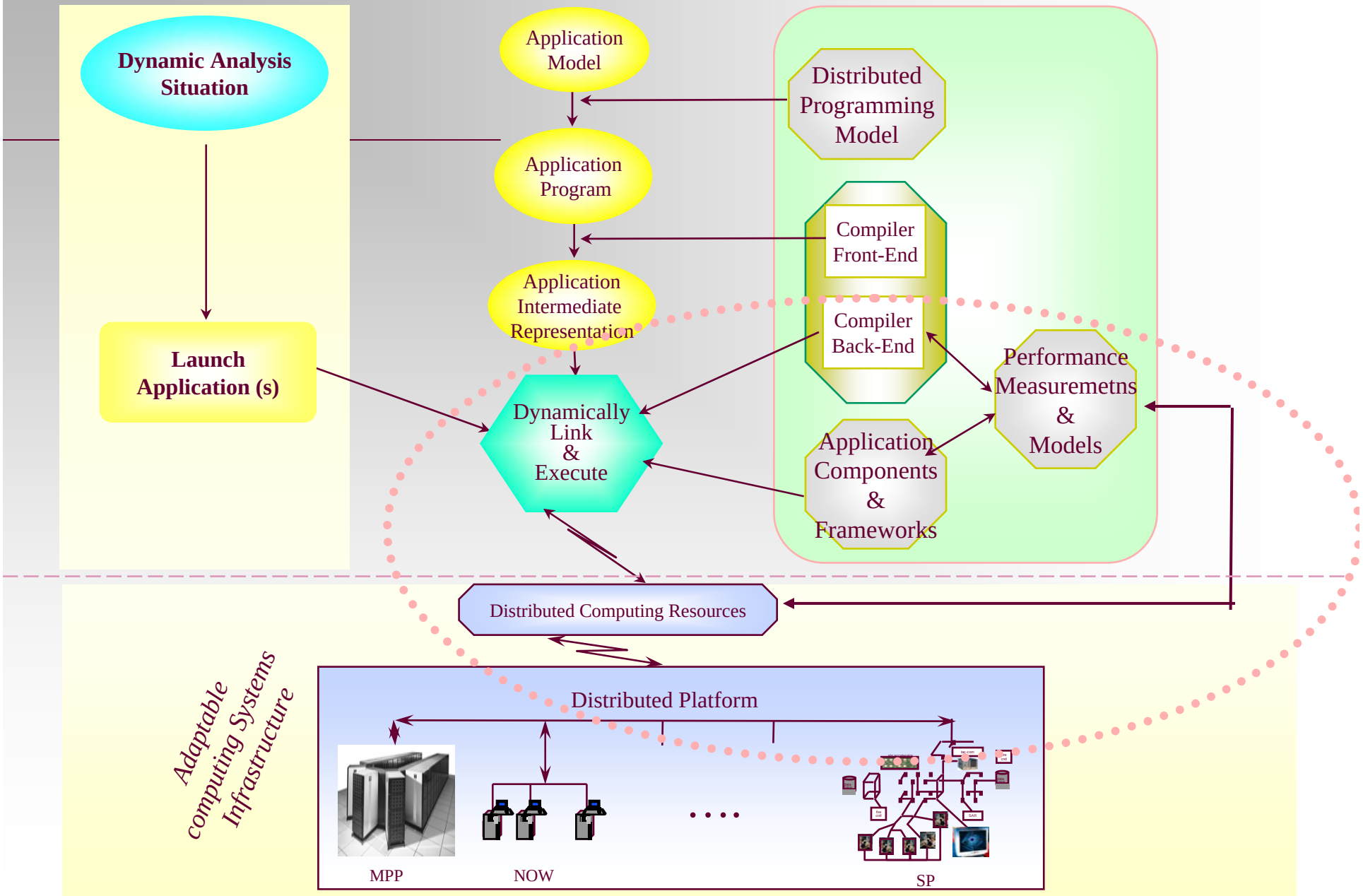
System Modeling and Analysis (SMA)

Topics of Interest (cont'd)

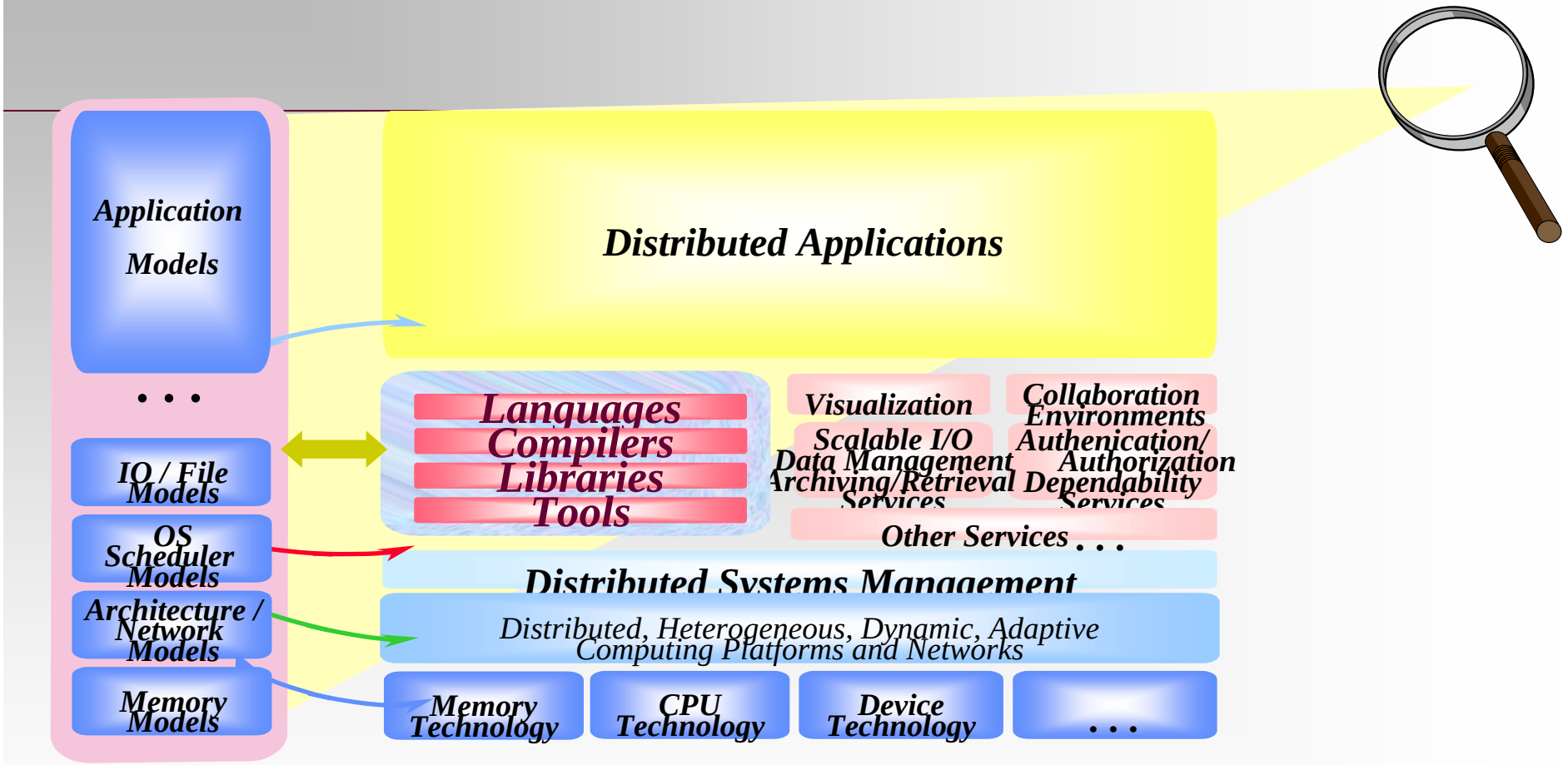
- Novel modeling and measurement approaches
  - Develop capabilities to describe, analyze and predict the behavior of the components as well as the systems; Analysis and prediction due to changes in the application, system software, hardware; multilevel approaches and multi-modal approaches
- Performance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

The AES component developsTechnology for integrated feedback & contro

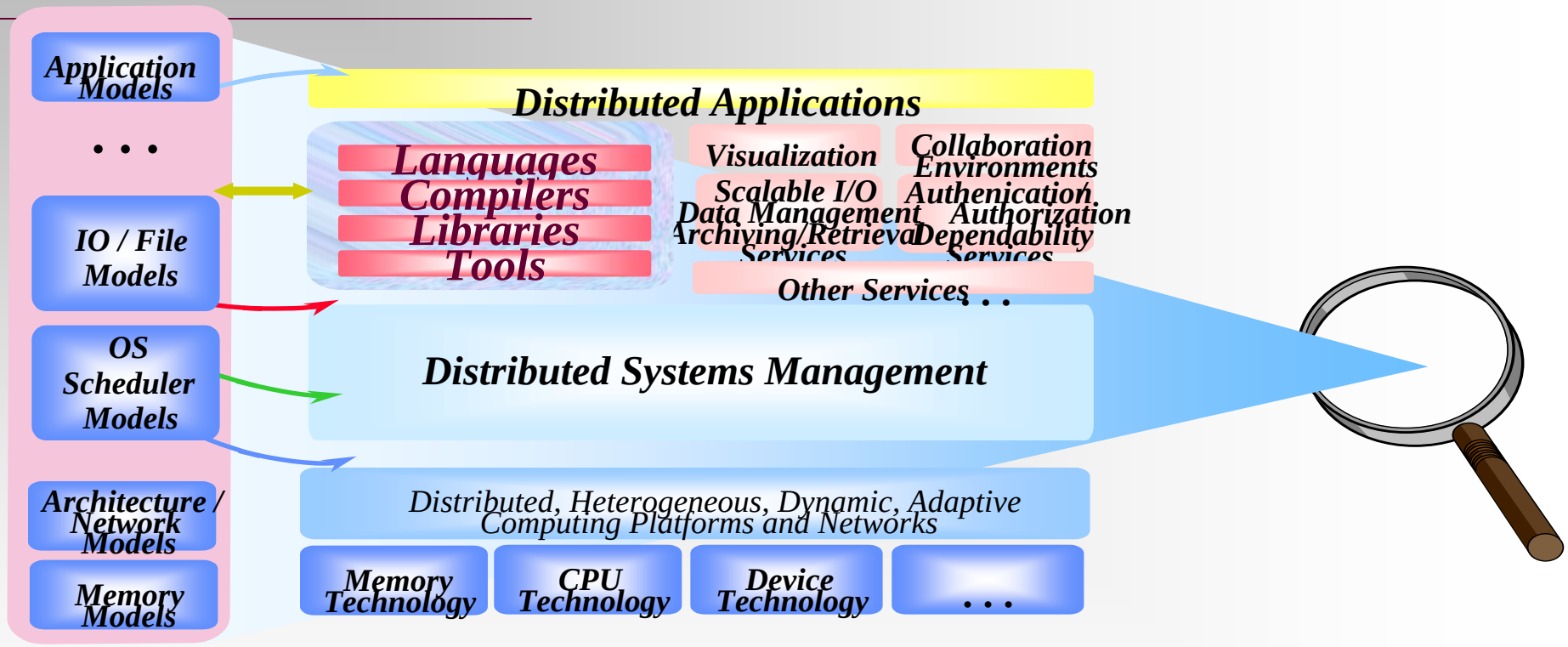
Runtime Compiling System (RCS) and Dynamic Application Composition



Multiple views of the system
The applications' view

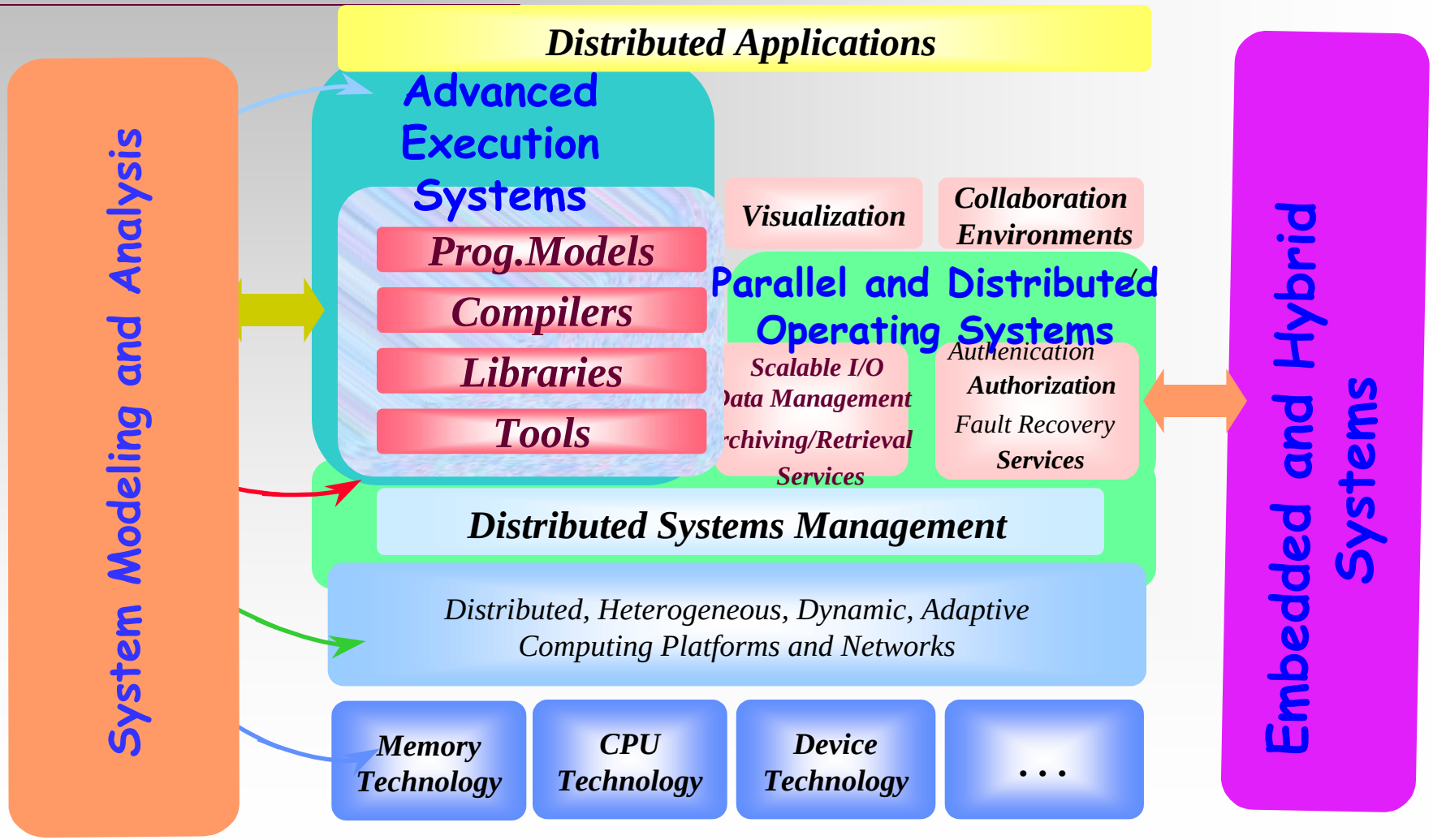


Multiple views of the system
The Operating Systems' view



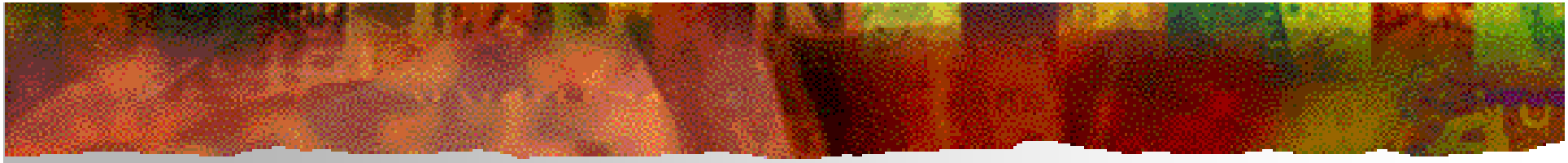
Components of CSR Program:

- (EHS) Embedded and Hybrid Systems
- (PDOS) Parallel and Distributed Operating Systems
- (AES) Advanced Execution Systems
- (SMA) System Modeling and Analysis



CNS Thematic Area: **Cross Systems Integration (CSI)**

- Systems Software to seamlessly support dynamically integrated computational and real-time data acquisition environments.
  - The emphasis here is on the integrative aspects of systems software across the spectrum of such environments. Measurement processes involve instruments or sensors and sensor networks, and data acquisition, storage and access, and have become an important aspect extending the traditional computational grids. Traditionally, computation and data acquisition aspects of an application have been considered as separate processes. In the emerging environments considered here, they are dynamically correlated, with data dynamically streamed into an executing application and in reverse the executing application controlling and steering the measurement process.
  - These emerging environments go beyond the traditional control systems, which typically deal with special purpose applications and customized data acquisition, and where the interaction between model and measurement entails an analytic function representing the application model, with an ensuing simple relation between model and measurement. In distinction in the dynamic systems addressed here, there is a simulation model representing the application.
  - Such environments also provide a unique opportunity for architecting and for adaptive control of sensor networks and methods to enable such capabilities to be supported under this focus area.
- Example Environments:
  - **Dynamic Data Driven Applications Systems**
  - **Sensor Networks**



Thank You!

Embedded and Hybrid Systems (EHS)

Seeks to develop the scientific foundations and systems technology that will revolutionize the design and development of embedded and real-time systems.

EHS emphasizes temporal and hybrid (discrete and continuous) aspects of computational control for this class of systems.

EHS systems pertain single application – customized hardware

Topics of Interest

- Embedded systems software composition
  - algorithms, middleware, virtual machines, and system services; new concepts for distributed real-time and light-weight operating systems; component technology for functional and non-functional aspects

Embedded and Hybrid Systems (EHS)

Topics of Interest (cont'd)

- Foundations and technology for distributed software control
  - hybrid discrete and continuous models; new concepts to support and secure future generation supervisory control and data acquisition (SCADA) systems and process control systems (PCS)
- Methods for modeling and design of embedded software and systems
  - foundations, design, implementation, synthesis, analysis, and certification methods; and, innovative approaches for failure modes, self-test, and recovery and reconstitution
- Resource management and optimization
  - methods and tools for allocating, scheduling, and managing real-time, power-aware, distributed embedded systems; and, static and real-time dynamic scheduling for real-time guarantees, power, clock frequency, thermal gain, RF emission and interference

Parallel and Distributed Operating Systems (PDOS)

Advance the state of the art in operating systems software for the range of computer systems include uniprocessors, shared-memory multiprocessors, mobile devices and applications, local area distributed systems, clusters, wide area distributed systems, and computational grids.

Main goals are to improve the capabilities, reliability, and efficiency of existing systems, to create new ways to utilize current technologies, and to harness the potential of emerging technologies.

Topics of Interest

- Resource management:
  - Scheduling, virtual memory management and protection; management of multiple levels of memory hierarchy and file systems; process and data migration, etc

Parallel and Distributed Operating Systems (PDOS)

Topics of Interest (cont'd)

- System services:
  - Mechanisms that enable dynamic coalitions, such as peer-to-peer or ad-hoc groups; membership, naming, and authorization services; local and remote resource discovery and resource requests etc
- System architecture:
  - New ways to organize systems, such as peer-to-peer; software architectures that scale to handle thousands of components; software architectures addressing changing hw technology trends, etc
- System properties:
  - Fault-tolerance and reliability; efficiency; security; scalability; and, ability to cope with unexpected events.