Center for Experimental Research in Computer Systems

Georgia Institute of Technology
Ohio State University

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Jay Ramananathan

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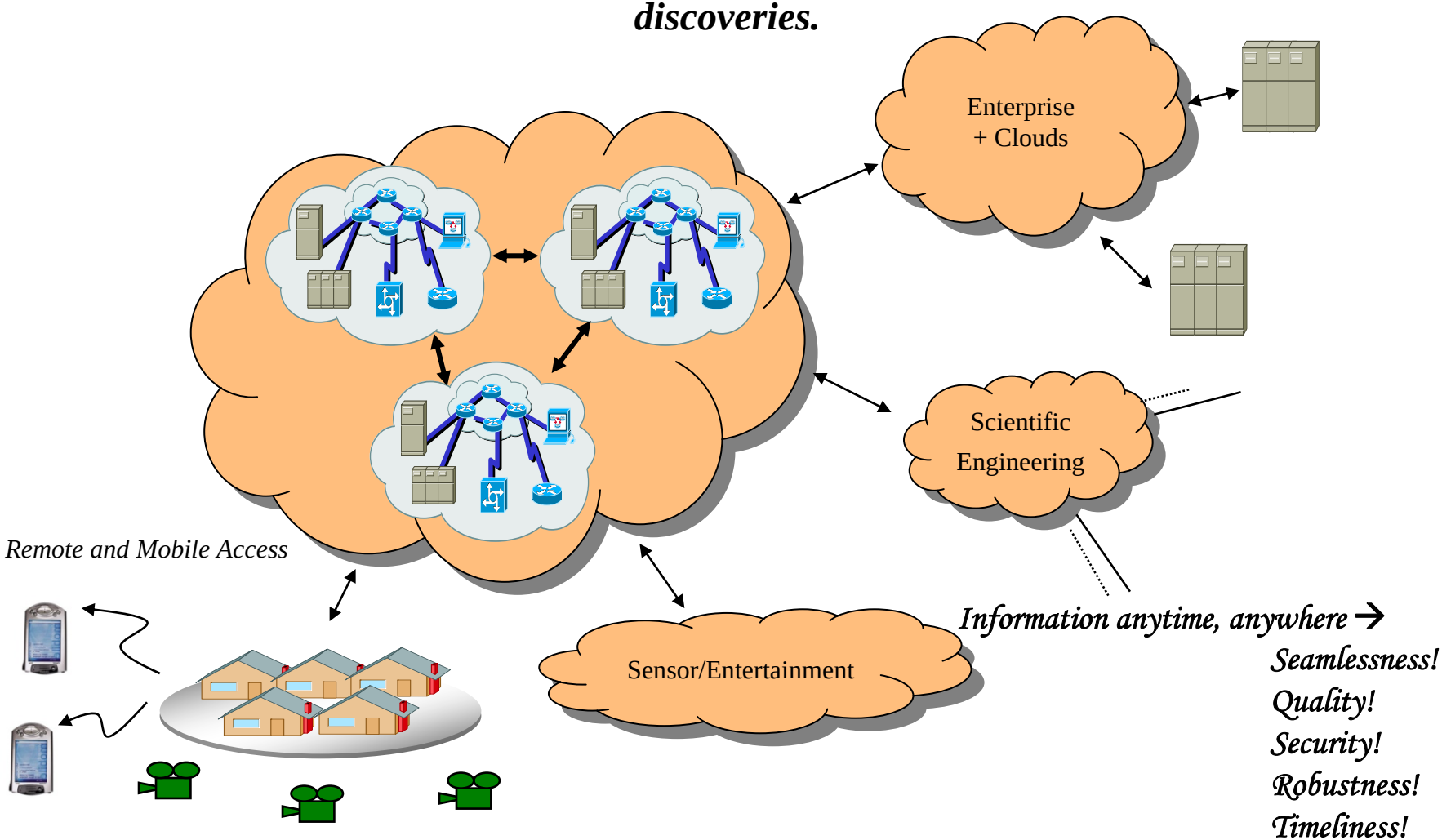
IUCRCERCS NSF Industry University Co-operative Research Center

Mission

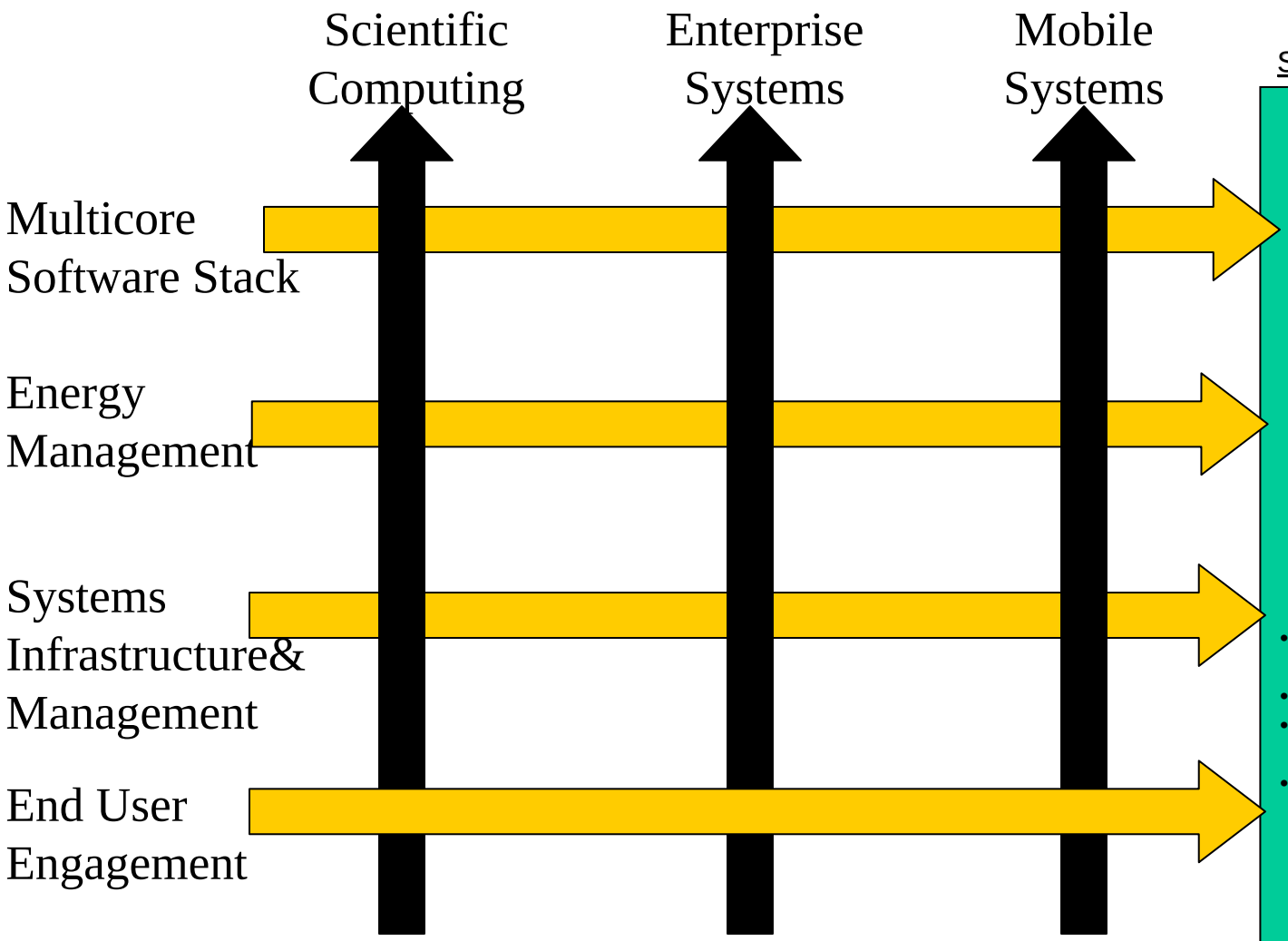
Lead the innovation of systems, computing, and information technologies, to further the development of the interactive and distributed information services of the future, and to create the intellectual capital that can advance these technologies and fuel future discoveries.



Extended Mission

- Educational:
  - Seed new curricula and serve as a curricular resource for educational institutions worldwide
  - Business models for curricular and professional education delivery
  - Training of graduate students through the administration of an extensive internship program
- Outreach:
  - Work with our alumni to create new opportunities and build networks
  - Service to the broader community

CERCS Research Thrusts

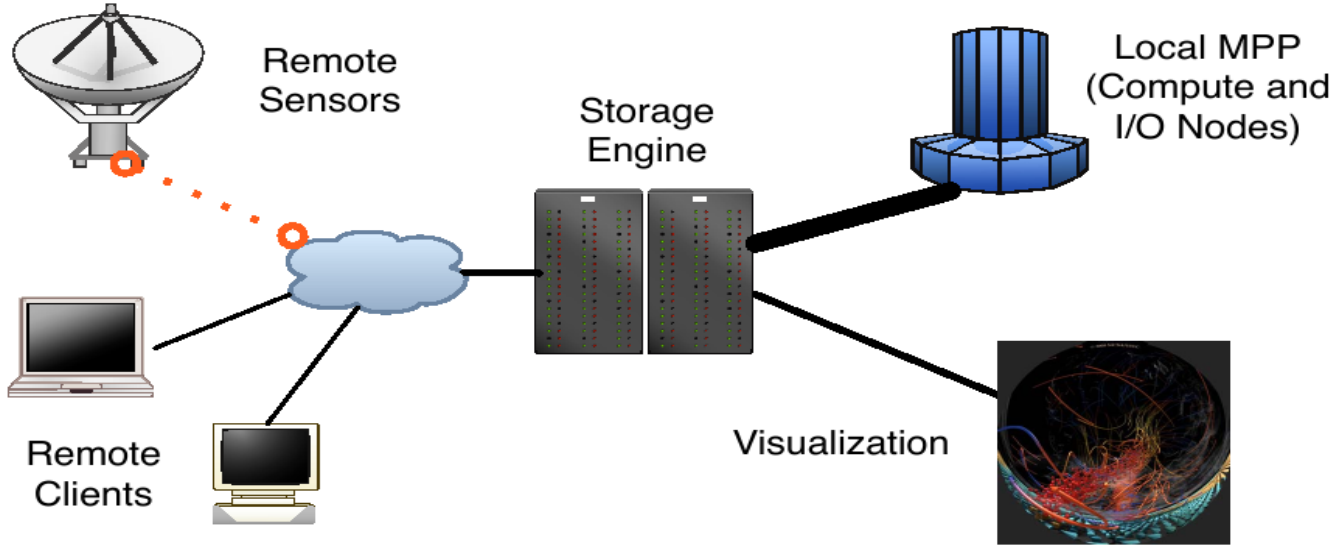


Sample Research Projects

- *Programming models & Compilation – IBM, Intel, Google, Logicblox*
- *Execution models & run-time systems – IBM,, HP, NVIDIA*
- *Heterogeneous Multicore Platforms– IBM, Intel, HP, DOE Sandia, Keeneland*
- *GreenCloud- Intel, HP, IBM, OSISoft*
- *Configuration Management for Power Efficiency – ATT*
- *Power Efficient Global Memory Systems – Intel*
- *Platform Power Usage and Thermal Signatures*
- *Configuration Management for Power Efficiency – HP, ATT*
- *High Performance I/O - DOE*
- *Entertainment Clouds – Motorola*
- *Privacy in Healthcare – Childrens Hospital (joint with GTISC)*
- *CETI program – OSU Datacenter Energy Usage - Nationwide*
- *Cloud Computing Critical Enterprise and Data-Intensive Systems – IBM, ICE, Yahoo, HP, Intel, Wipro*

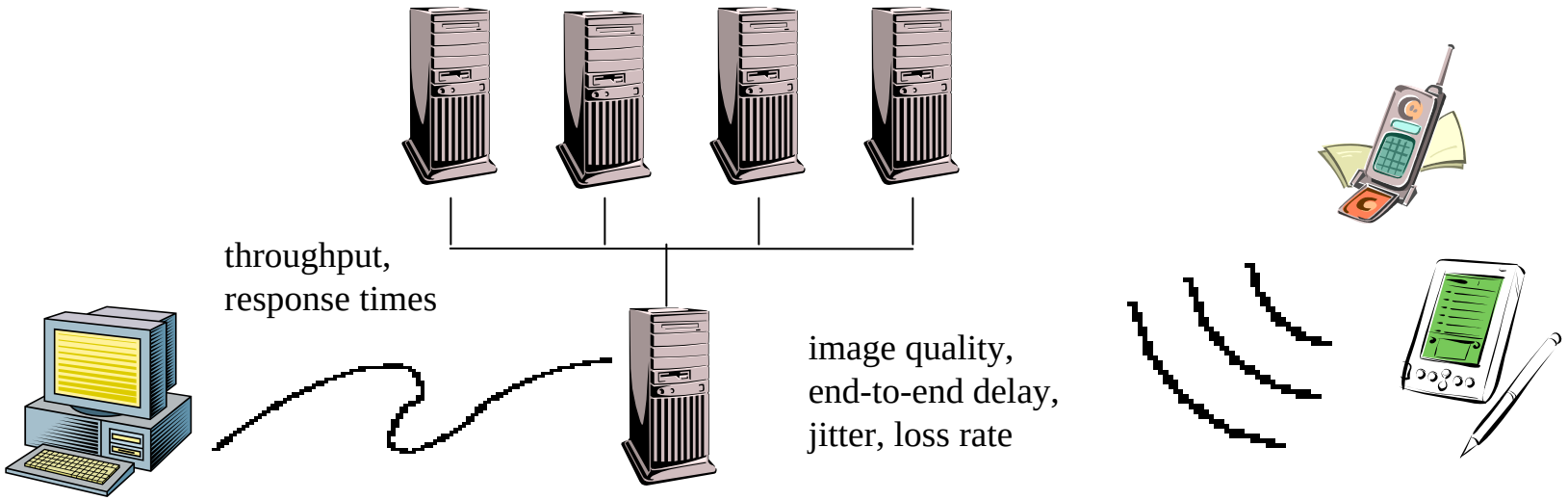
Strategic Thrusts - Highlights

- **Scientific/Technical Computing – *`Big Data': Scalable, Reliable Access:***
  - **GT**: **IHPCL Laboratory** (**Intel and NVIDIA** donations *Heterogeneous Virtualized Multicore (HVM) Platforms Lab – GPU, Tolopai, and newer asymmetric platforms)*; **Intel** multicore education - cercs.gatech.edu/multicore;
  - **DOE: ORNL, Sandia:** *High Performance I/O initiative*; involvement with startups (RNet – Ohio); joint proposals, joint research/interns, joint papers, joint work with CMU.
  - **IBM/Intel** (IBM OCR grant: managed multicore systems, **Intel** - HVM; **LogicBlox** (Atlanta); interest from **ICE** (Atlanta)
  - **News:** Exascale dimensions explored in outstanding proposals; **NSF Track II** `Keeneland' heterogeneous cluster machine, July 1 installation; New awards from **DOE** ORNL, Sandia; **Intel** educational efforts; joint proposals with **Emory CCI** – complex data sets



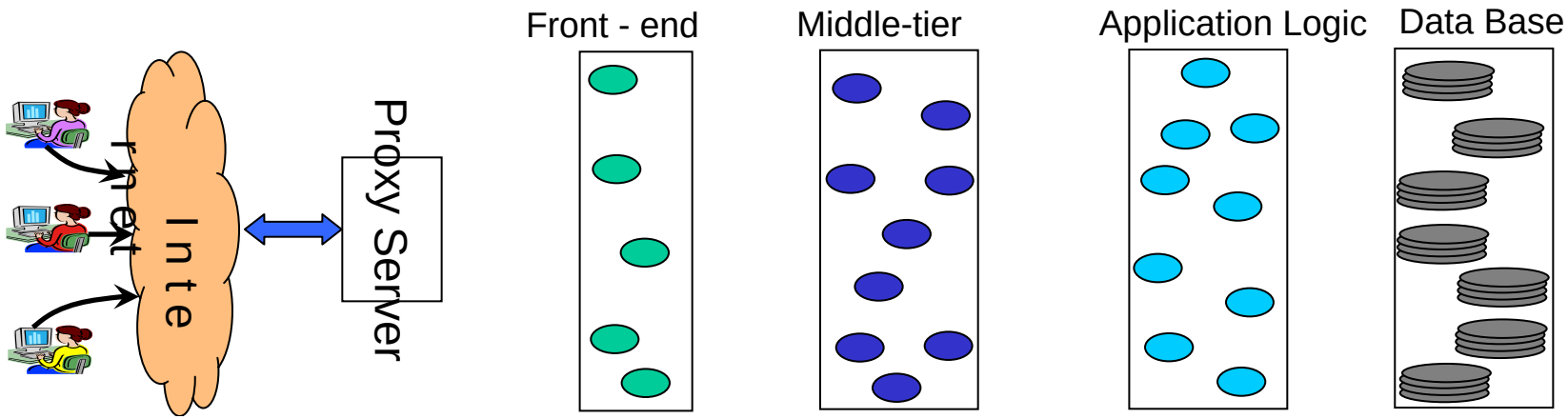
Strategic Thrusts - Highlights

- **Embedded Systems/Computer Architecture: *Focus on Multicore:***
  - Boeing (testing – Mary Jean Harrold, also continued collaboration with TATA)
  - **IBM/Intel** (asymmetric multi-core platforms; 'islands of cores'; NUCA and NUMA properties); **NVIDIA** GPU-based results (Kim, Yalamanchili)
  - **Motorola** (virtualizing mobile platforms; future home entertainment)
  - **Federal**: pervasive applications (transportation, robotics, sensor)
  - **Google** (data structure recognition and perf. characterization)
  - **Logicblox** (heterogeneous parallelism – data/threads and GPU acceleration)
  - Samsung (Star Center) center - separate efforts
  - **News:** GreenIT focus permits linkage with 'Smarter Planet' initiative (**IBM**); **Motorola** (joint with GVU and other research centers at Georgia Tech) with focus on EaaS (entertainment clouds): IP-TV head end used at GT; **NSF** award in privacy in mobile and pervasive systems (Ling Liu); **NSF** 'Web on Demand' (Ramachandran/Essa); **NSF** CRI simulation award (Yalamanchili et al.); **NSF** GPU autotuning award; **NVIDIA** and **Intel** equipment and student fellowship awards; Gavrilovska book on high performance communications; **NSA** funding on 3D die stacking (Lee)

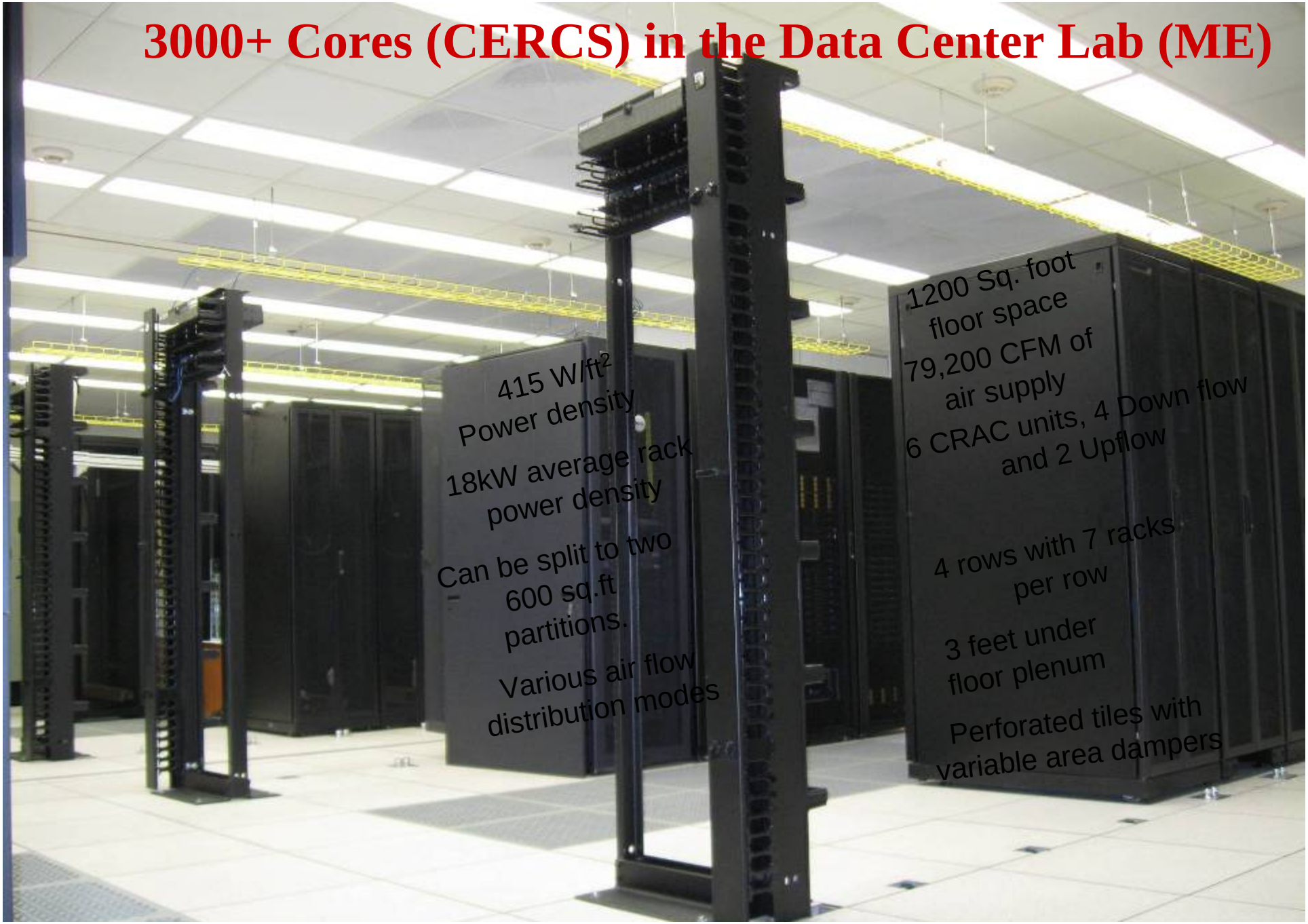


Strategic Thrusts - Highlights

- **Enterprise Computing – *Clean Information: Adaptive, Trusted, Sustainable:***
  - Cisco, (Netronome) (network and device virtualization)
  - **IBM, Intel, OSISoft, Yahoo** (critical enterprise cloud computing (CECCS); autonomics in virtualized systems; SOA; I/O virtualization; trusted passages/reliable operation; coordinated power management; `GreenIT' effort joint with ME; **GreenIT FRP** award to GT faculty group; new **GT TechWay** facility)
  - **HP** (automated deployment; scalable, `vManage' open source data center management and monitoring; toward `monalytics' exascale utility clouds, via OpenCirrus)
  - **Travelport** (runtime behavior/fault detection)
  - **ICE** (high performance financial codes; automated configuration management – also with **ATT** Labs)
  - **VMWare** (joint effort in cloud computing); numerous summer interns
  - **Wipro** (cloud computing) and Wipro – India; **Infosys** – India; **GT India**; `Service' focus for Fall 2010 meeting
  - **News**: **GreenIT** effort receives large award: **NSF CRI**; **OpenCirrus** membership; **NSF**-funded projects on data privacy in mobile and in healthcare (**Childrens Hospital**); `health cloud' collaboration with Center on Comprehensive Informatics (**Emory**); new **NSF** awards (e.g., debugging – Orso, spam detection - Pu); joint work with **CMU, Intel Pgh;** keynotes and invited talks by CERCS faculty; **Yahoo** student award



3000+ Cores (CERCS) in the Data Center Lab (ME)

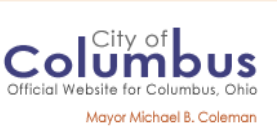


Strategic Thrusts - Highlights

End user engagement – CETI@OSU (Ramanathan, Ramnath)

Vision: "Enable Enterprise Transformation with Innovations and Dissemination of Advanced Knowledge for ***Service Intensive Processes***"

- Modeling and Analysis Frameworks for Adaptive Complex Enterprises (ACE)
  - Enterprise modeling and analysis for architecture evaluation, operational improvements
  - Outputs: Reference Enterprise Architectures, Governance methods. Roadmaps, Portfolios
- Collaborative Enterprise Systems (KI) – The `Mirror'
  - For enabling collaboration, service composition, intelligence mining, location-based services
  - Outputs: Reference system architectures, Design of intelligent services, component models, integration architectures.
- Integrated Development Environments (IDE)
  - For developing, managing and monitoring the ACE
  - Outputs: Tools, cognitive models
- Software Engineering Research and Education (SE)
  - Agile and structured SDLC, ITIL, Technology Strategy and Management, Enterprise System Architecture Design and Evaluation
  - Outputs: Case studies, methodologies, education models, curriculum



High Quality Engagement

Nationwide Insurance 2005-2010

Current Research

- **Data center power conservation**
- **Document management reference architecture**
- **Business Intelligence Reference Architecture**

Classroom and Peer-Based Learning

- **11 EA Forums**
- **Enterprise Java workshop**
- **Innovation and leadership workshop**
- **CETI Colloquia**
- **Curriculum influence of MEL program**

Collaboration metrics to-date:

- **8 research projects**
- **Interactions with 30+ local companies and CERCS at Georgia Tech.**
- **35 Nationwide personnel**
- **40 students**
- **5 internships (one current), 1 hire**

Next Steps:

- **Placement: graduate interns and hires**
- **Involvement in Capstone projects**
- **Professional development programs**

nities for broader impact/reach: Agrawal, Arora, Srinivasan, Stev

CERCS Personnel

- Faculty
  - Mustaque Ahamad, Mostafa Ammar, Doug Blough, George Biros, Nate Clark, Greg Eisenhauer, Nick Feamster, Richard Fujimoto, Ada Gavrilovska, Jon Giffin, Alexander Gray, Mary Jean Harrold, Hyesoon Kim, Hsien-Hsin Lee, Wenke Lee, Ling Liu, (Gabriel Loh), Saibal Mukhopadhyay, Alex Orso, Henry Owen, Santosh Pande, Milos Prvulovic, Calton Pu, Kishore Ramachandran, Jay Ramanathan (Ohio State), Rajiv Ramnath (Ohio State), George Riley, David Schimmel, Karsten Schwan, Rich Vuduc, Matthew Wolf, Hongyan Zha, Sudhakar Yalamanchili, (Ellen Zegura)

- Associated Faculty/Researchers
  - Tucker Balch (GT-Robotics), Patrick Bridges (UNM), Ron Brightwell (Sandia),Irfan Essa, Byron Jeff (Clayton State), Yogendra Joshi (ME), Scott Klasky (ORNL), Tahsin Kurc (Emory),Kang Li, Sung Kyu Lim, Arthur Maccabe (ORNL), Vernard Martin (Emory), Vincent Mooney, Jeff Nichols (ORNL), Ron Oldfield (Sandia), Kalyan Perumalla (ORNL), Joel Saltz (Emory), Jeff Vetter (ORNL), Patrick Widener (Emory)

Industrial Relations

- IUCR CERCS Center
  - Contributors (GT): Boeing, Cisco, Delta, **DOE**, **Fujitsu**, **HP, IBM, ICE, Intel, LogicBlox, Motorola**, Netronome, **NVIDIA, OSISoft,** TCS, Travelport (Worldspan), **VMWare, Wipro,** more in **Ohio**
  - Industry Workshops and Industrial Advisory Board

- Joint initiatives - e.g., Ohio State (joint curriculum/facility efforts), joint work with Emory's CCI, OpenCirrus participation, CMU collaboration

- Internship Program
  - Amazon, ATT, CISCO, Dell, Delta, (DoCoMo), DOE (ORNL, Sandia), Google, HP, IBM, ICE, Intel, Microsoft, Motorola, NEC, NetApp, QualComm, (Radisys), TCS, TravelPort (Worldspan), VMWare, Wipro, Yahoo

- Evolving relationships:
  - **Amazon**, **ATT**, DoCoMo, **Microsoft**, **NEC, NetApp**, NVIDIA, QualComm, Raytheon, RNet, VMWare, **Yahoo**, Xilinx