

The Challenge of Cloud control

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Vision of cloud data centers

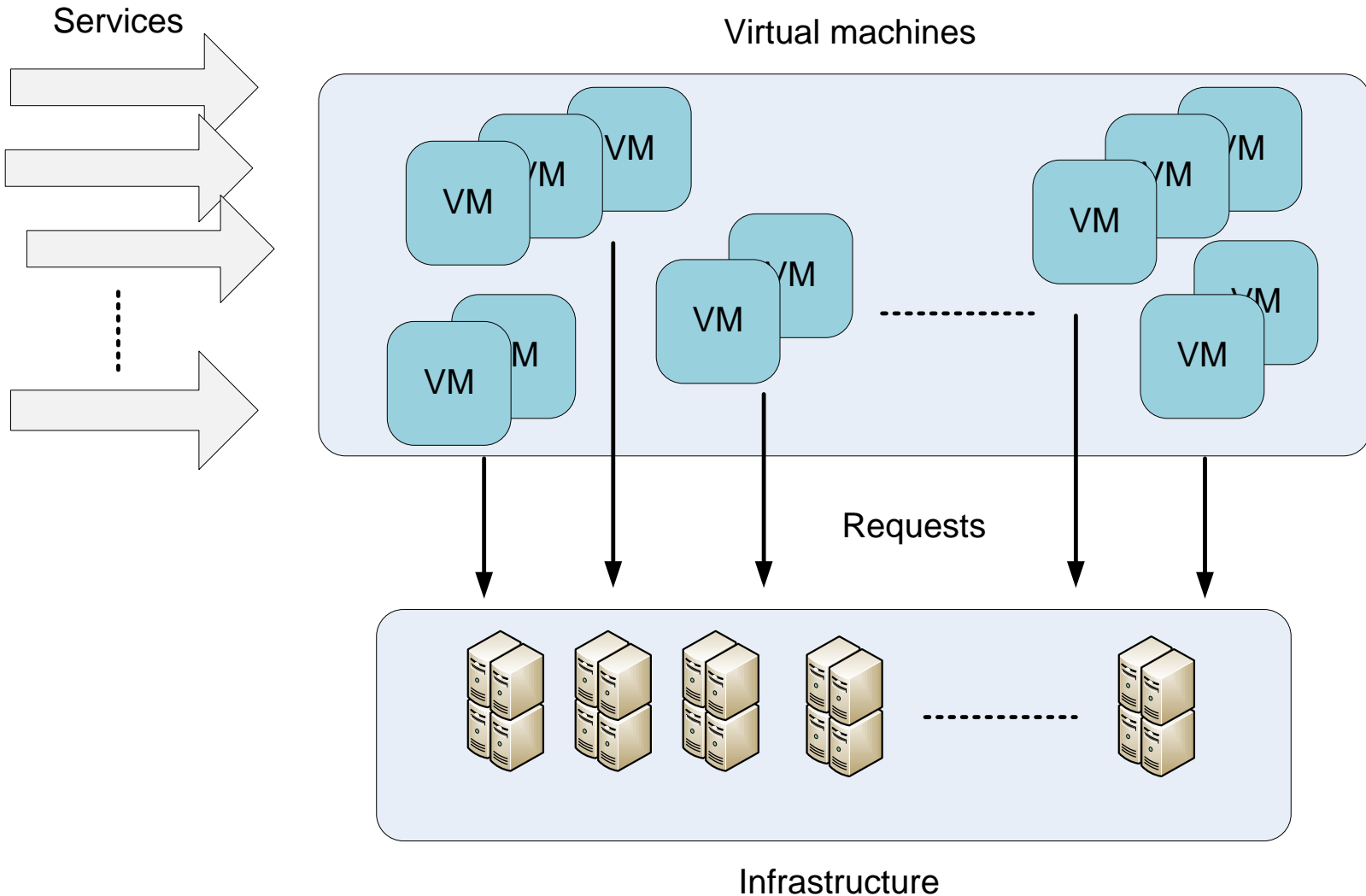


Self-managed, dynamic, and dependable infrastructure, constantly delivering expected QoS with reasonable operation costs and acceptable carbon footprint for large-scale services with sometimes dramatic variations in capacity demands.



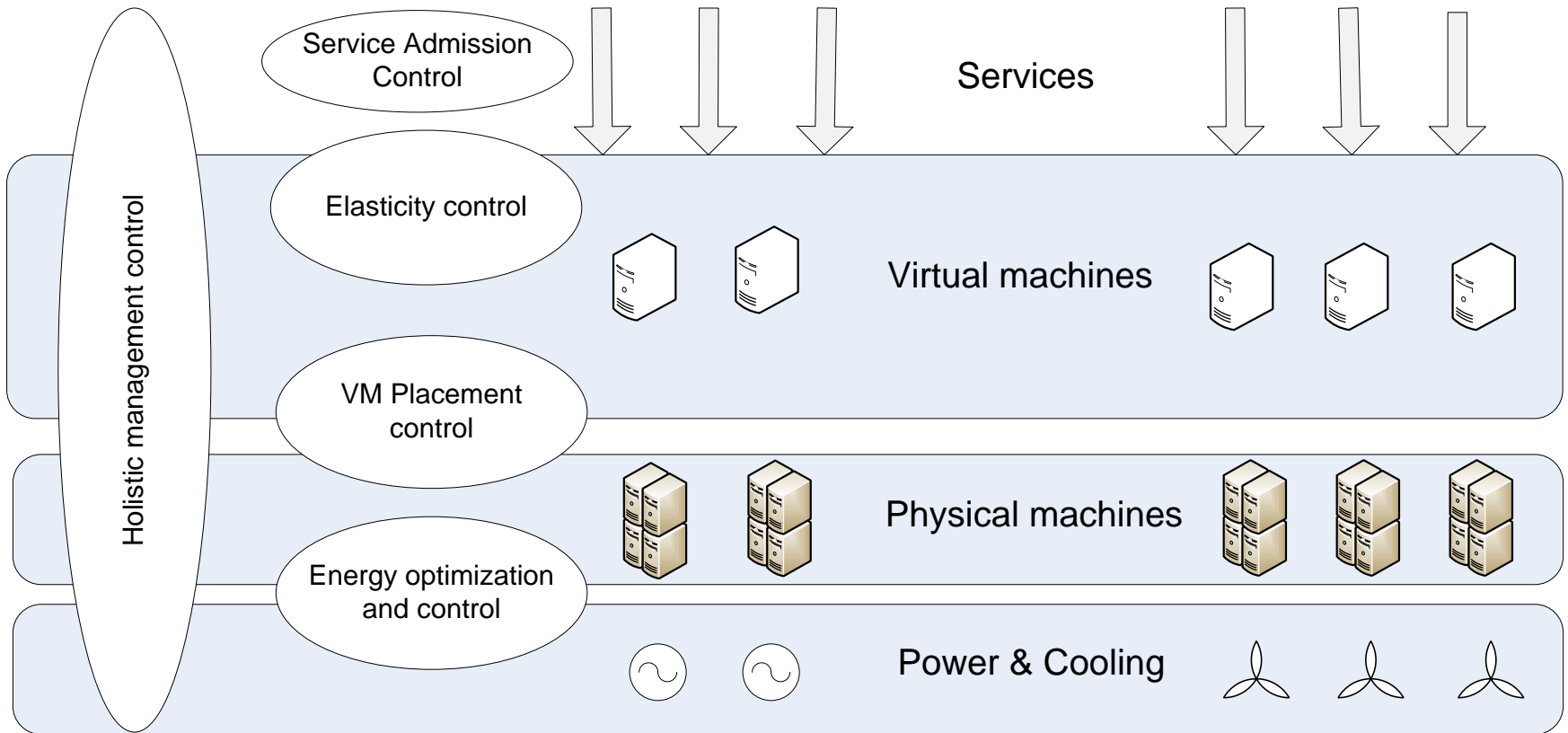


Very basic concept of clouds





Challenges of Cloud Control





Project Cloud Control



Large Framework grant from the Swedish Research Council.

- **Cloud Research group at Umeå University** (Prof. Erik Elmroth, Assoc. Prof Johan Tordsson, Prof. Bo Kågström)
- **Lund Center for Control of Complex Engineering Systems** (Prof. Karl Erik Årzén, Prof. Anders Rantzer, Prof. Anders Robertsson, Assoc. Prof. Maria Kihl)



Lund Center for Control of Complex Engineering Systems (LCCC)



- Research center at Lund University, Sweden, funded by the Swedish Research Council.
- LCCC is developing theory, methods and tools for control of large-scale engineering systems.
- Main research areas:
 - Distributed Decision-Making and Control
 - Implementation in Networked and Embedded Systems
 - Modeling Support for Design and Verification

Read more: <http://www.lccc.lth.se/>



LCCC Research on Networked and Embedded Systems



In LCCC, we have a high competence in control of computing systems.

- Performance modelling and load control.
- Prediction based and stochastic control mechanisms.
- Adaptive resource management for embedded systems.
- Experimental validation and testbeds.



Umeå University



The Umeå University distributed systems' research focuses on flexible and scalable IT infrastructures, and covers a range of topics central to cloud and grid computing.



+ several senior researchers, postdocs and PhD students

Web: cloudresearch.se



UU competence



- The group focuses on systems-oriented research on cloud management with industrial partners like IBM, SAP, ATOS, Telefonica, and British Telecom.
- Their competence is based on profound understanding of the challenges of future cloud infrastructures and the technology required to make them reality.
- The Umeå group is central to three of Europe's leading industry-driven cloud research projects.
- The team includes the director for the High Performance Computing Center North (HPC2N).



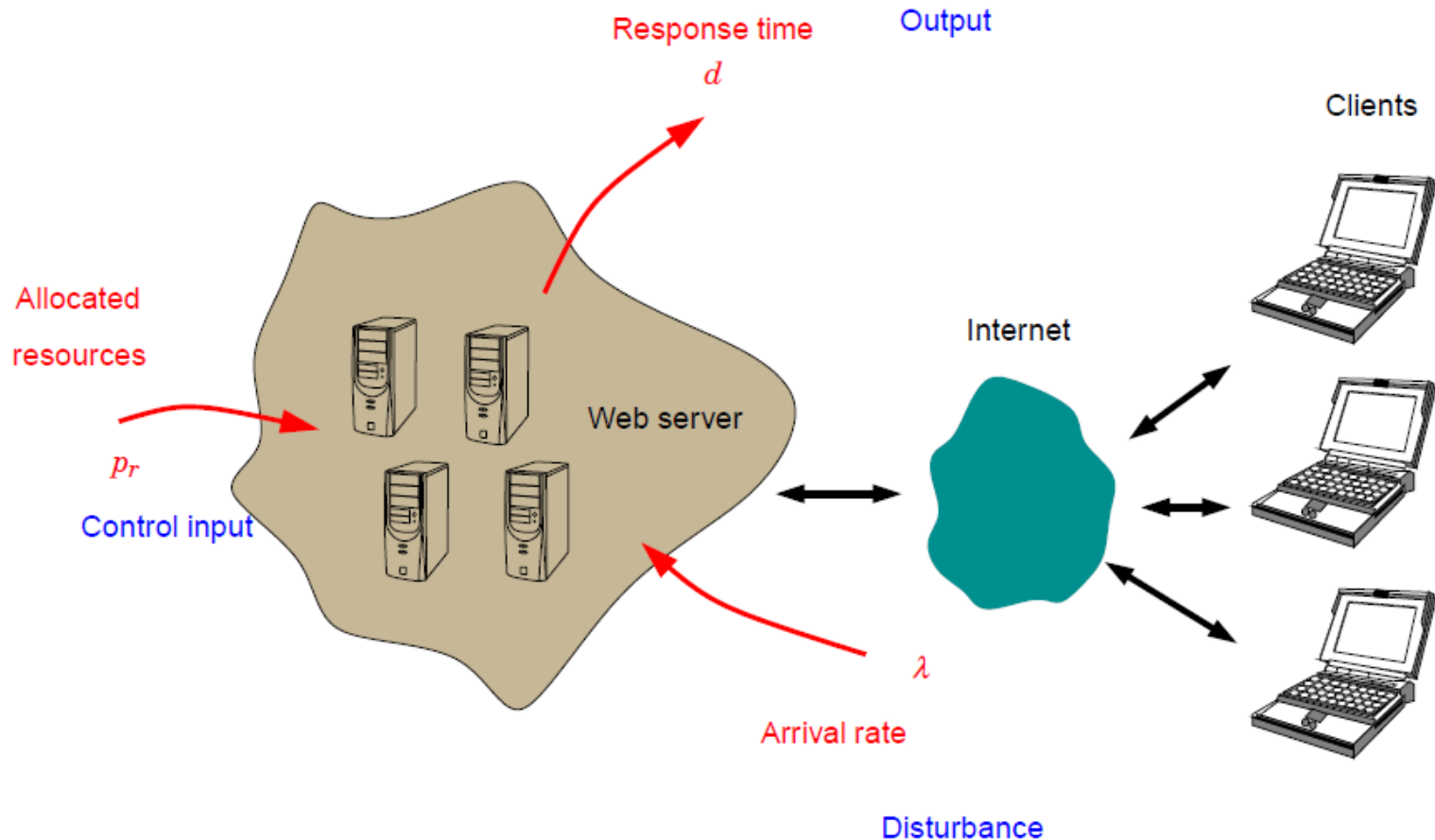
Main vision of project



- Cross-disciplinary project based on the "perfect match" of complementing expertise on cloud management and control of computing systems.
- A control theoretic approach to a range of cloud management problems.
- Main aim to transform today's static and energy consuming cloud data centers into self-managed, dynamic, and dependable infrastructures, constantly delivering expected quality of service with acceptable operation costs and carbon footprint for large-scale services with varying capacity demands.



Example: Performance models

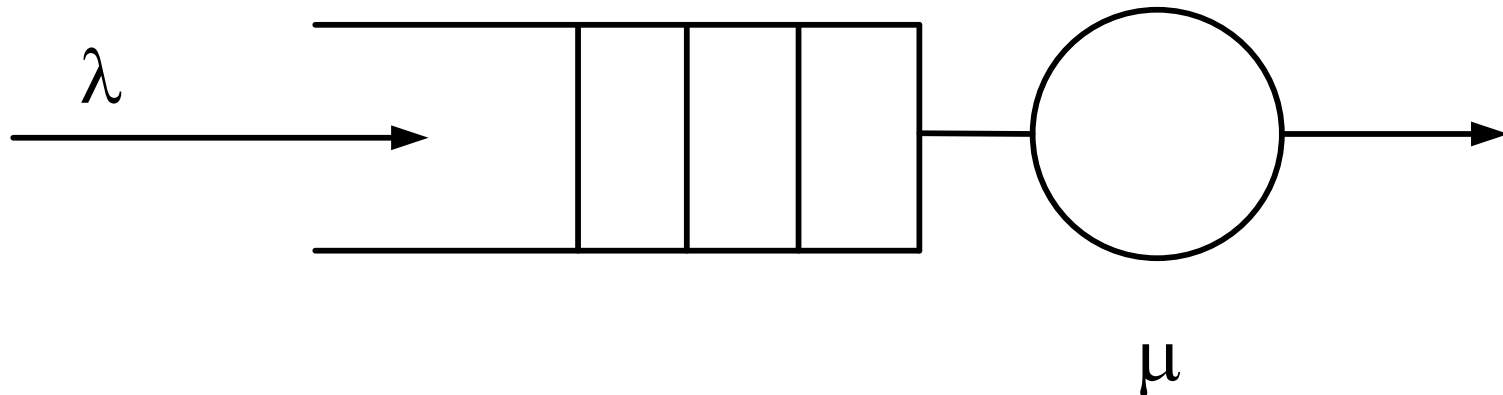




Performance models



- Example: Computing systems with CPU-intensive workload can be modelled as single server queues (M/M/1 dynamics).





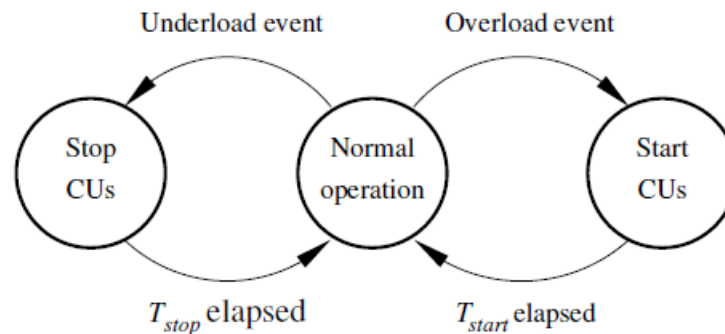
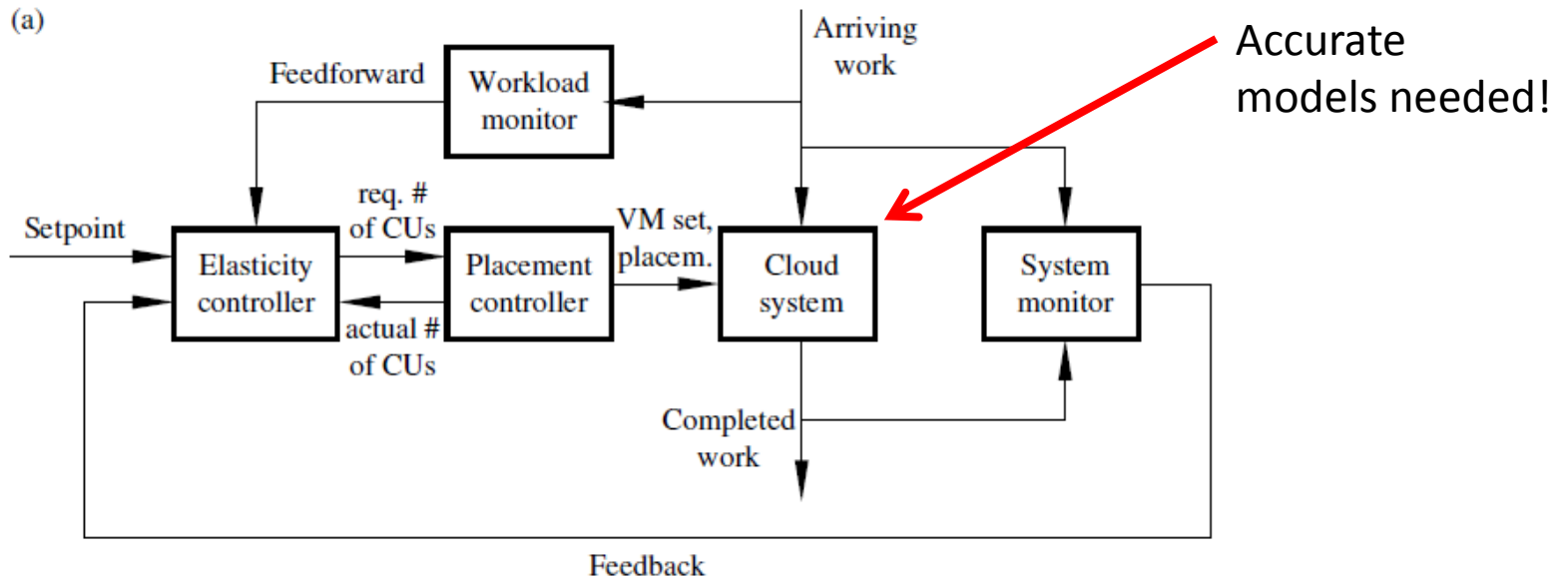
Challenges for clouds



- Traffic performance monitoring of large distributed systems
- Workload models
- Scalability effects



Example: Stochastic elasticity control





Other topics



- VM placement control
 - Optimization of the mapping of virtual resources to the infrastructure
- Data center energy optimization
- **Holistic management**
 - How do different optimization and control mechanisms interact with each other?
 - A global control system that monitors the complete system behavior and optimizes the local management systems.



Testbeds and experiments



- One important goal is to validate theories in experiments.
- Available testbeds:
 - Umeå's cloud infrastructure (40+ servers)
 - Green server farm at University of Illinois at Urbana-Champaign
 - Energy monitoring!
- Small cloud testbed at Lund University



Focus period on Cloud Control



- LCCC will host a focus period and workshop on Cloud Control in April/May 2014.
- Some planned topics:
 - Management and control of cloud infrastructures (e.g. elasticity control)
 - Heat and power control in data centers
 - Distributed Mobile Clouds
- More information will follow...