TDDD25
Distributed Systems

Outlook

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Related Courses

PROGRAMMING PARALLEL COMPUTERS
TDDE65   MPI
HPC algorithms

BIG-DATA ANALYTICS/ DATA MINING
Distributed File Systems
MapReduce

DATABASE SYSTEMS
Distributed Transactions

SYSTEM SECURITY

DISTRIBUTED SYSTEMS
TDDD25

OPERATING SYSTEMS

COMPUTER NETWORKS

EMBEDDED SYSTEMS

REALTIME SYSTEMS
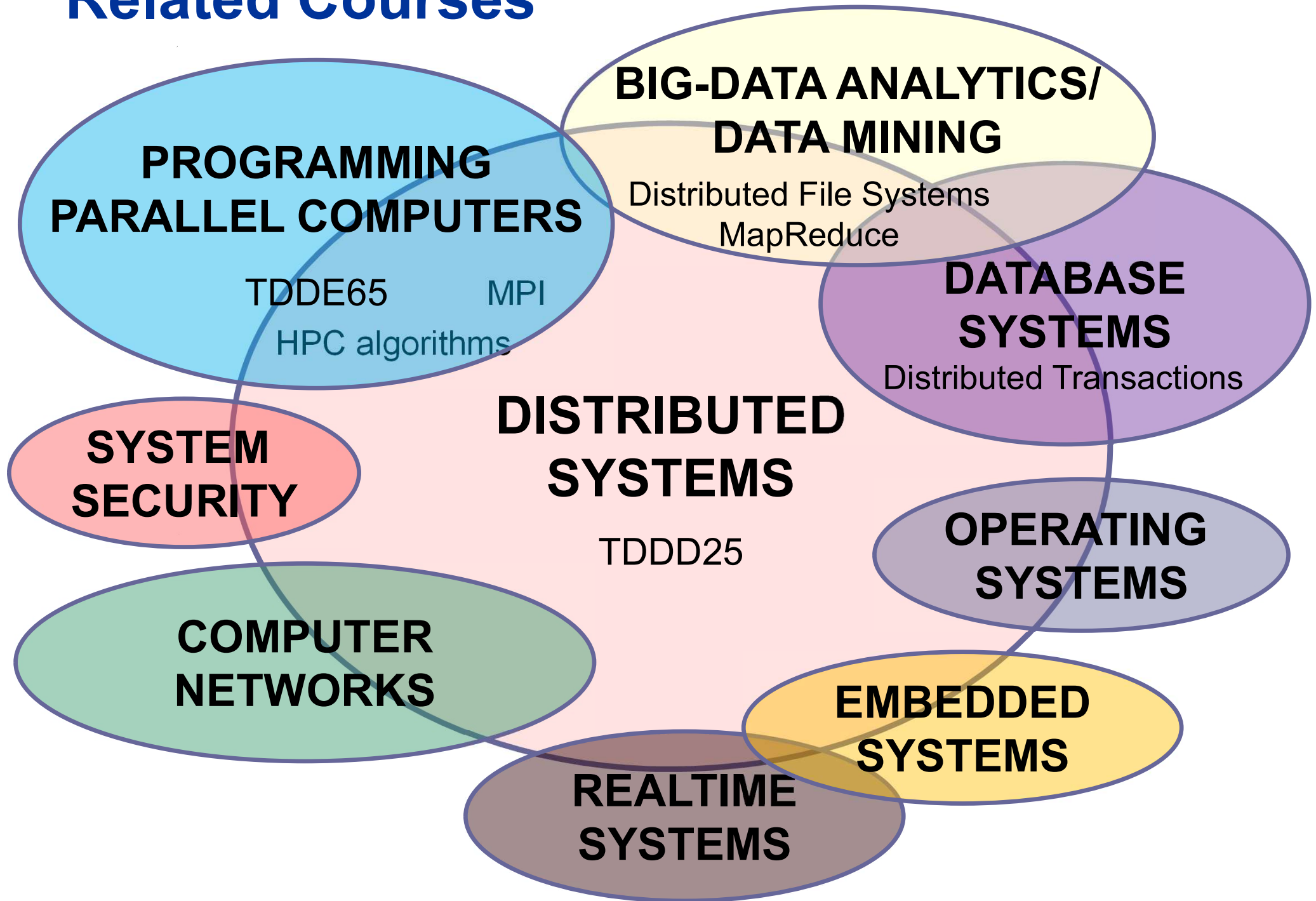
Distributed Parallel Computing in TDDE65

Programming parallel computers – methods and tools, 6hp, vt2

E.g.,

- **Cluster architecture** for high-performance computing
    - High-end nodes, scalable networks

- **Message Passing Interface** (MPI), including
    - Collective (group) communication
    - One-sided communication (RDMA)

- **Distributed parallel algorithms**
    - esp., basic linear algebra computations

- **Cost models** for communication in distributed computations

- **Labs** on NSC cluster Sigma

NSC Tetralith + Sigma
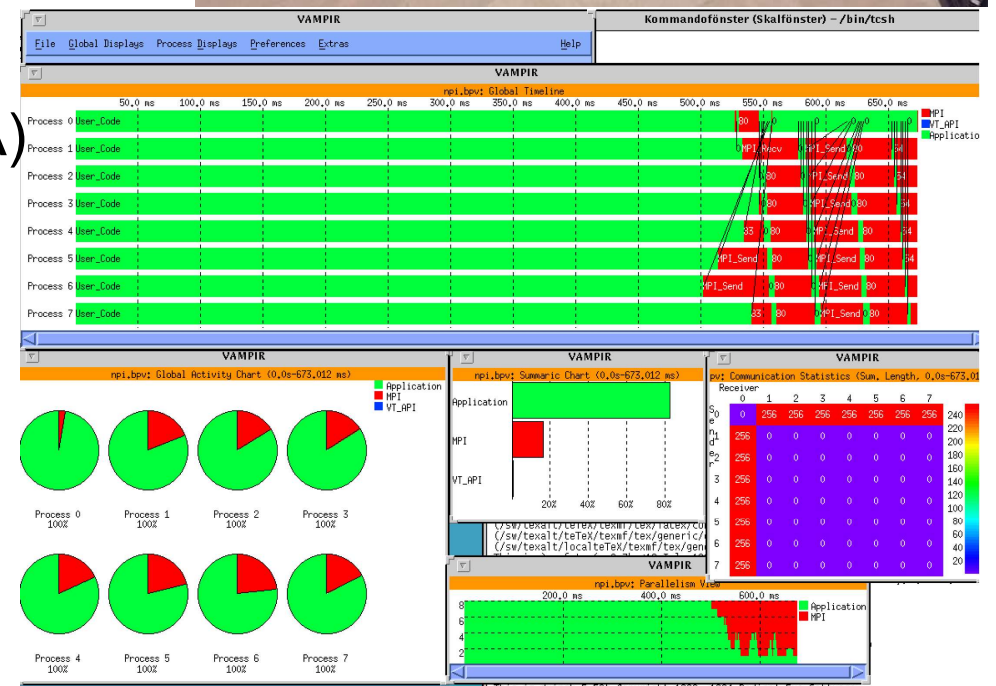
Outlook:
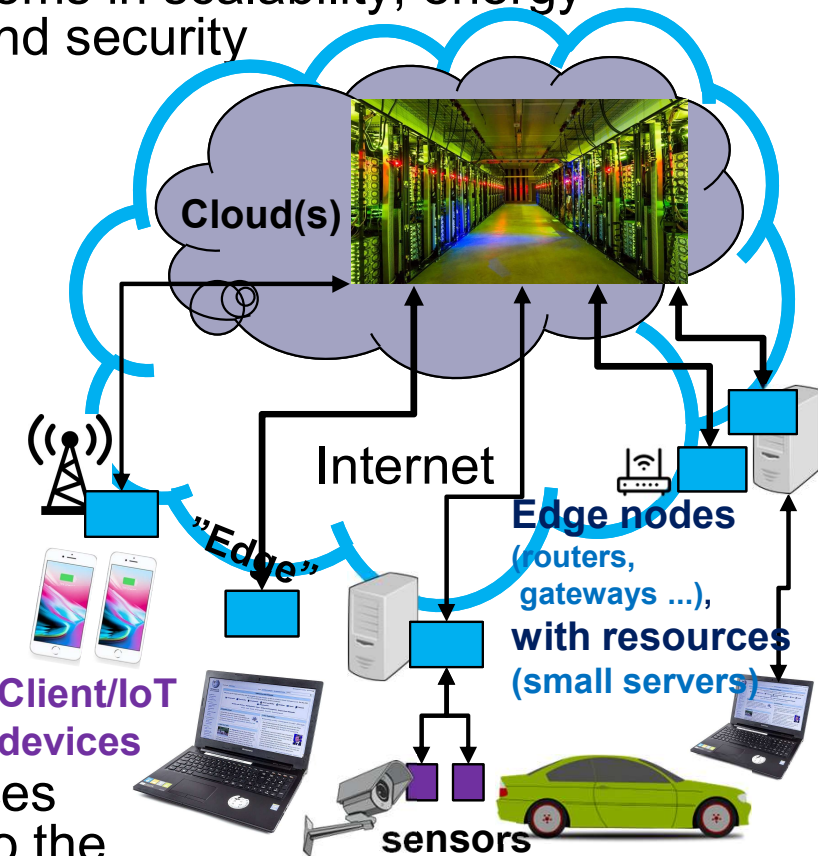# The Edge-Cloud Computing Continuum

Research project at IDA:

Adaptive Software for the Heterogeneous Edge-Cloud Continuum (ASTECC)

The heterogeneous edge-cloud continuum

- **Cloud computing:** centralized processing and storage accessed from devices via internet is convenient, but faces fundamental problems in scalability, energy efficiency, privacy, safety (real-time guarantees), and security
    - Variation: private clouds

- **Edge/fog computing** as a **complement**: process / store data closer to where it originates – at the edge of the internet
    - **Edge/fog nodes** (devices / servers / resources)
    - **+** Data locality, network traffic efficiency, energy-efficiency, privacy
    - **–** Resource-constrained, e.g. memory (RAM/Flash), battery, cooling capacity, size

- Huge and complex **distributed system:** heterogeneous device, edge/fog and cloud resources from different administrative domains aggregated to the "**heterogeneous edge-cloud continuum**"
    - No central manager, no shared memory
    - Heterogeneity, portability challenges
    - **Multi-provider, multi-tenant** resources
    - **Dynamic**, **multi-application**, **multi-criteria** execution scenarios
    - Complex **multi-service** applications

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Vision: Autonomous adaptive software
for the heterogeneous edge-cloud continuum

- Uniform specification and tool/system support for **portable**, **autonomous**, **resource-efficient adaptive** execution of applications over the entire continuum
  - The **programmer** specifies *what* to do,
    the objectives (e.g. QoS) and other constraints for execution
  - The **system** decides *where* to execute,
    when and *how* to migrate tasks, move data etc.
- Equip application software components/microservices, their **interfaces** and their compositions to **workflows** with sufficient **metainformation** about own structure and **adaptivity options with exploitable trade-offs** to support its autonomous execution in the continuum
- **Distributed virtual execution environment** in the continuum
  - **Distributed monitoring and prediction**
    - ‣ load on resources, QoS, new tasks, changing requirements, intrusion/threat detection,…
    - ‣ no shared memory, no central coordinator
  - **Orchestration** and **distributed resource management**
    - ‣ (self-)adaptation/reconfiguration, resource allocation, mapping, scheduling, migration, …
    - ‣ Coordinating adaptation mechanisms of different layers in the SW/HW stack
- **Security** by design
  - Application security
  - System security

ASTECC Project at IDA

Adaptive Software for the Heterogeneous Edge-Cloud Continuum

- https://astecc.gitlab-pages.liu.se/

- Funded by *SSF* in the *Future Software Systems* programme

- Methods for the design, automated orchestration and dynamic adaptation of software to enable its autonomous, efficient and secure execution in dynamic, heterogeneous, **distributed** device-edge-cloud environments,
i.e., in multi-provider, multi-service, and multi-criteria scenarios, without relying on a global resource manager.

- Cooperation by 4 research groups from IDA

- 4 industrial domains for use cases: computer networks and applications, smart energy grids, automotive, aviation

- **Final thesis projects available!**

- **Part-time student project assistant position**