TDDD25
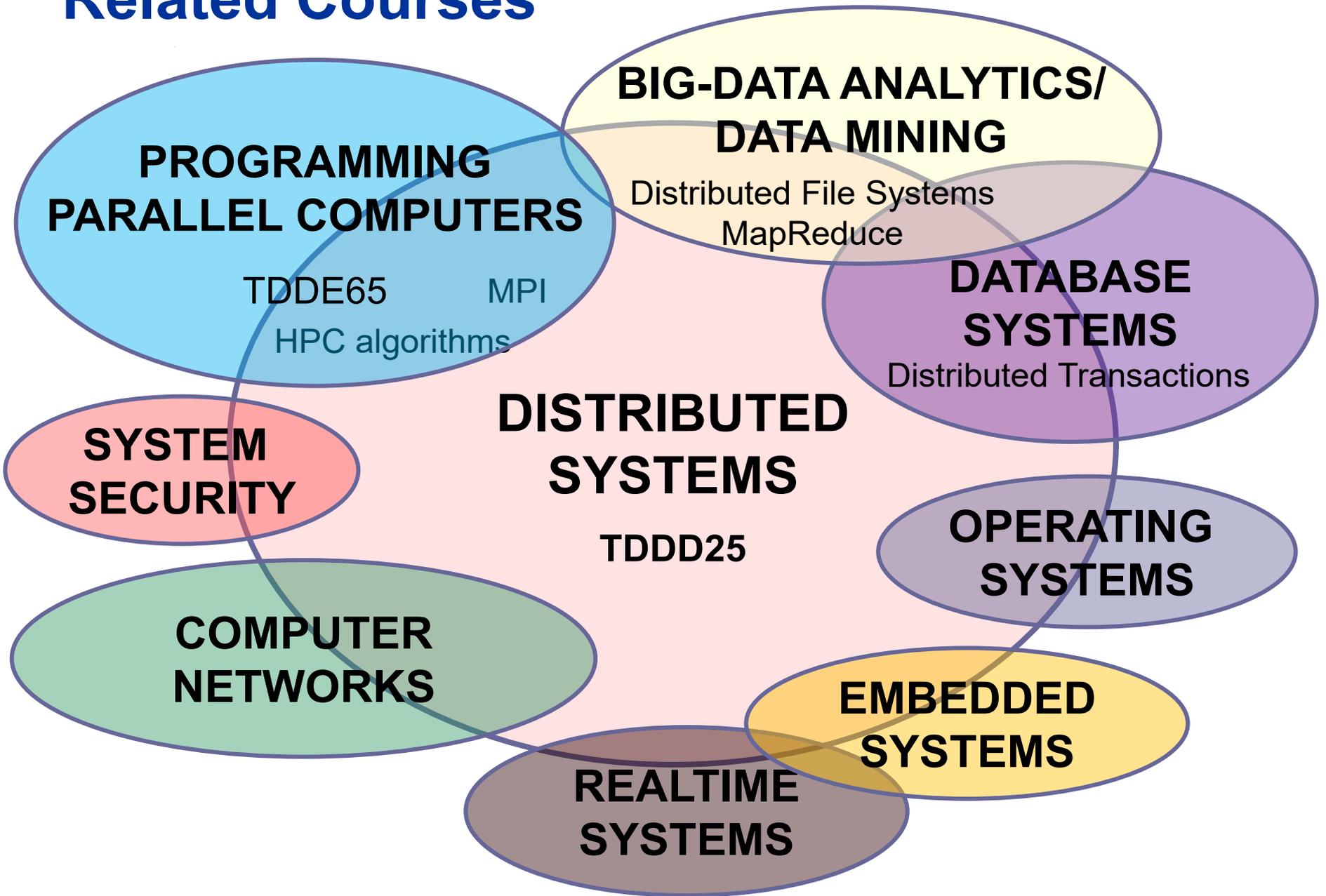# Distributed Systems

Outlook

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Related Courses

Distributed Parallel Computing in TDDE65

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

E.g.,

- **Cache coherence and sequential consistency**

- **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:
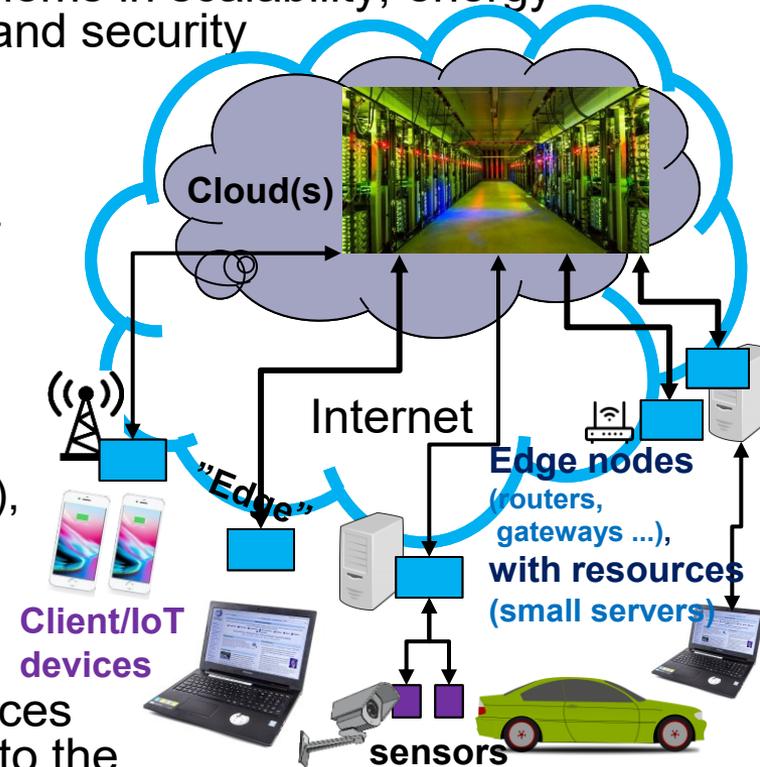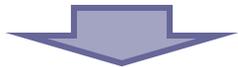# The Edge-Cloud Computing Continuum

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

Cloud(s)

Internet

"Edge"

Edge nodes
(routers, gateways ...), with resources (small servers)

Client/IoT devices

sensors

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**