Seminar course

Confidential Cloud Computing

(aka “c3-seminar”)

Kick-off meeting

https://dse.in.tum.de/

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Prof. Pramod Bhatotia

Welcome to the c3 seminar!

Course instructors

Chair of Distributed Systems & Operating Systems

https://dse.in.tum.de/team/

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Postdoc

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Confidential cloud computing (c3): Seminar info

https://github.com/TUM-DSE/seminars/

slack

Communication:

Join us with TUM email address (@tum.de)
ls1-courses-tum.slack.com
#ws-24-c3-seminar

Motivation & Context

Cloud & data centers

amazon web services

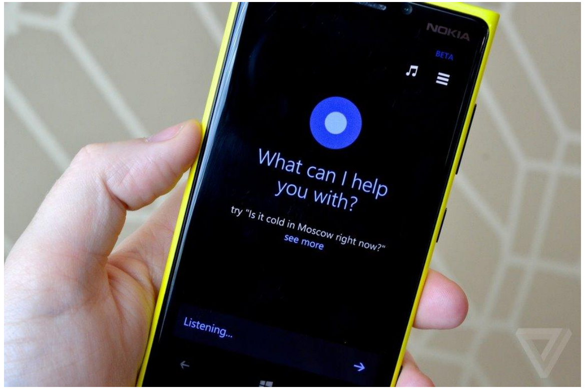
Google Cloud Platform

Microsoft Azure

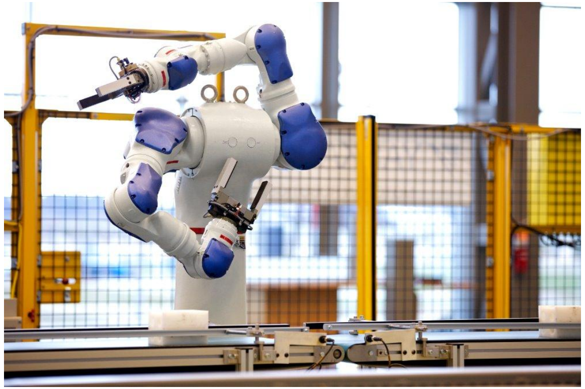
Alibaba Cloud

Scalable, flexible, and fault-tolerant computing substrate

Process and store sensitive data


NOKIA
BETA
What can I help you with?
try "Is it cold in Moscow right now?"
see more
Listening...

Consumer devices



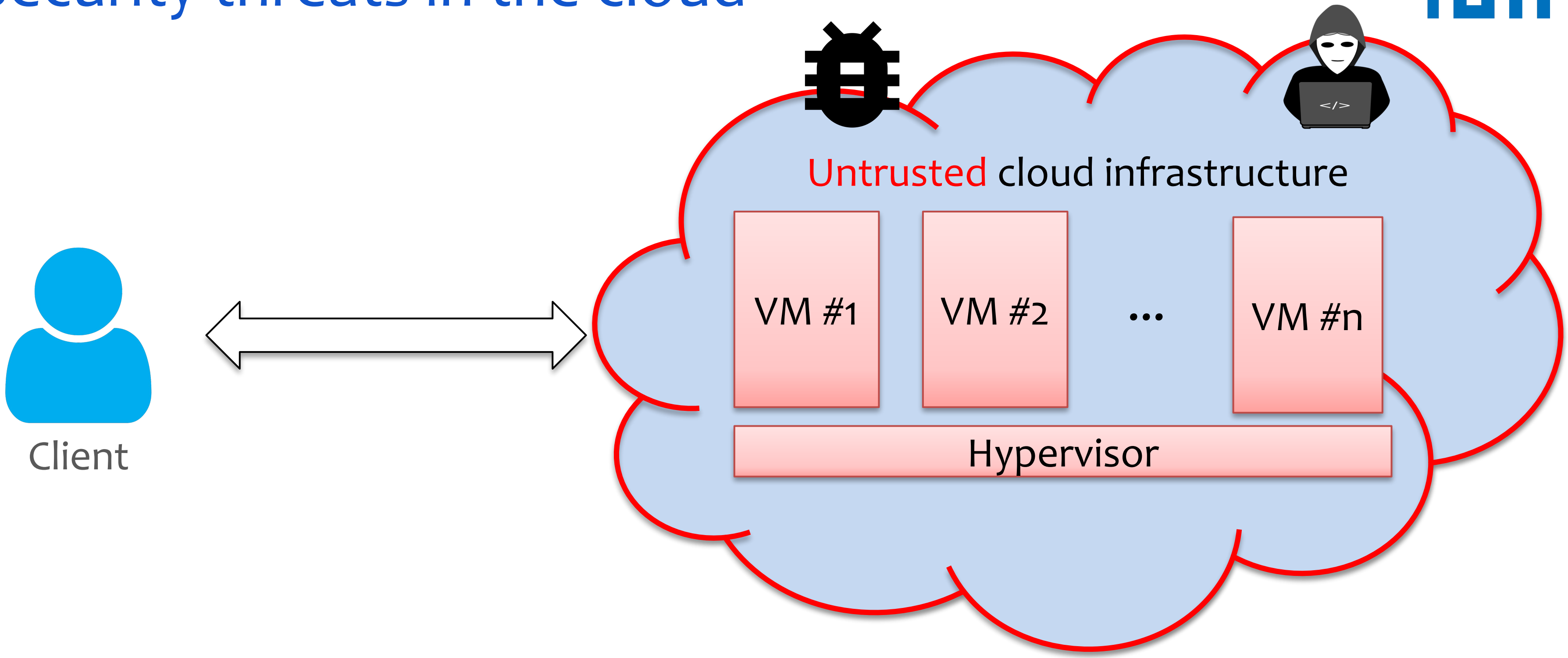
Manufacturing

Healthcare

Transportation

Defense

Security threats in the cloud



How can we provide **security** guarantees for workloads deployed on untrusted cloud infrastructures?

Security properties

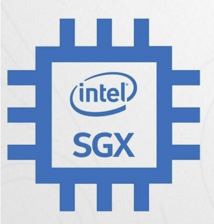
- Confidentiality
    - Unauthorized entities cannot “see” the computation/data
- Integrity
    - Unauthorized changes to the computation/data can be detected
- Freshness
    - Stateful computations are prone to rollback attacks (e.g., databases, storage)
- Authenticity
    - Remotely verify the authenticity of the remote party

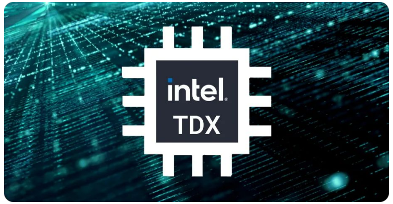
Confidential computing

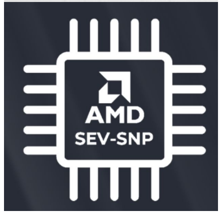
- **Confidential computing** is a cloud computing technology that isolates sensitive data in a protected CPU "enclave" during processing
  - Even the cloud providers is out of the trusted computing base (Hypervisor)

- **Hardware assisted trusted computing**
  - Hardware extensions
  - Transparently encrypt/decrypt data in-use

- **Process based & VM-based deployments**



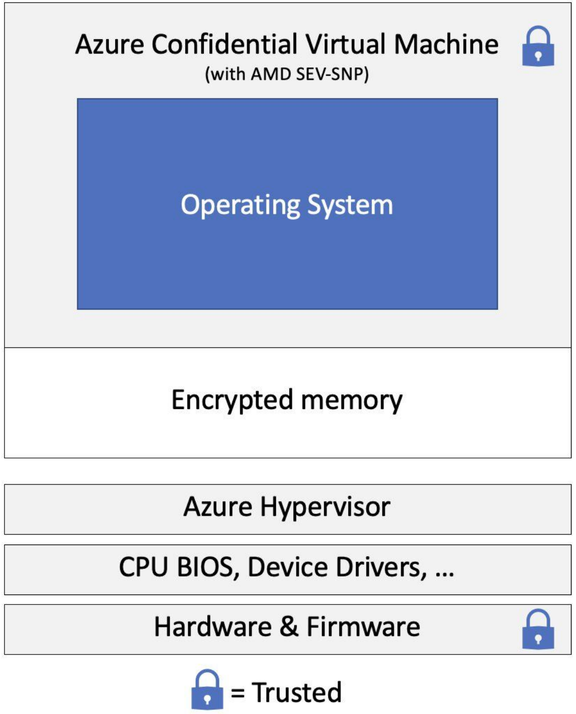




Confidential computing: https://blogs.nvidia.com/blog/2023/03/01/what-is-confidential-computing/

Confidential computing in the cloud

- Hardware-assisted “secure enclaves”
  - Keep the data encrypted in DRAM
  - Special memory encryption engine for cache line data
  - Caches are in the protection boundaries
- Confidential VMs
  - Full VM encryption technology
  - Isolates from the untrusted cloud provider
  - No trust in the cloud infrastructure or hypervisor
- Commercial offered by cloud providers
  - Google Cloud, Microsoft Azure, Alibaba Cloud



Prominent Confidential Computing Technologies

intel

Intel SGX

Intel TDX

AMD

AMD SEV

arm

Arm Trustzone

Arm CCA

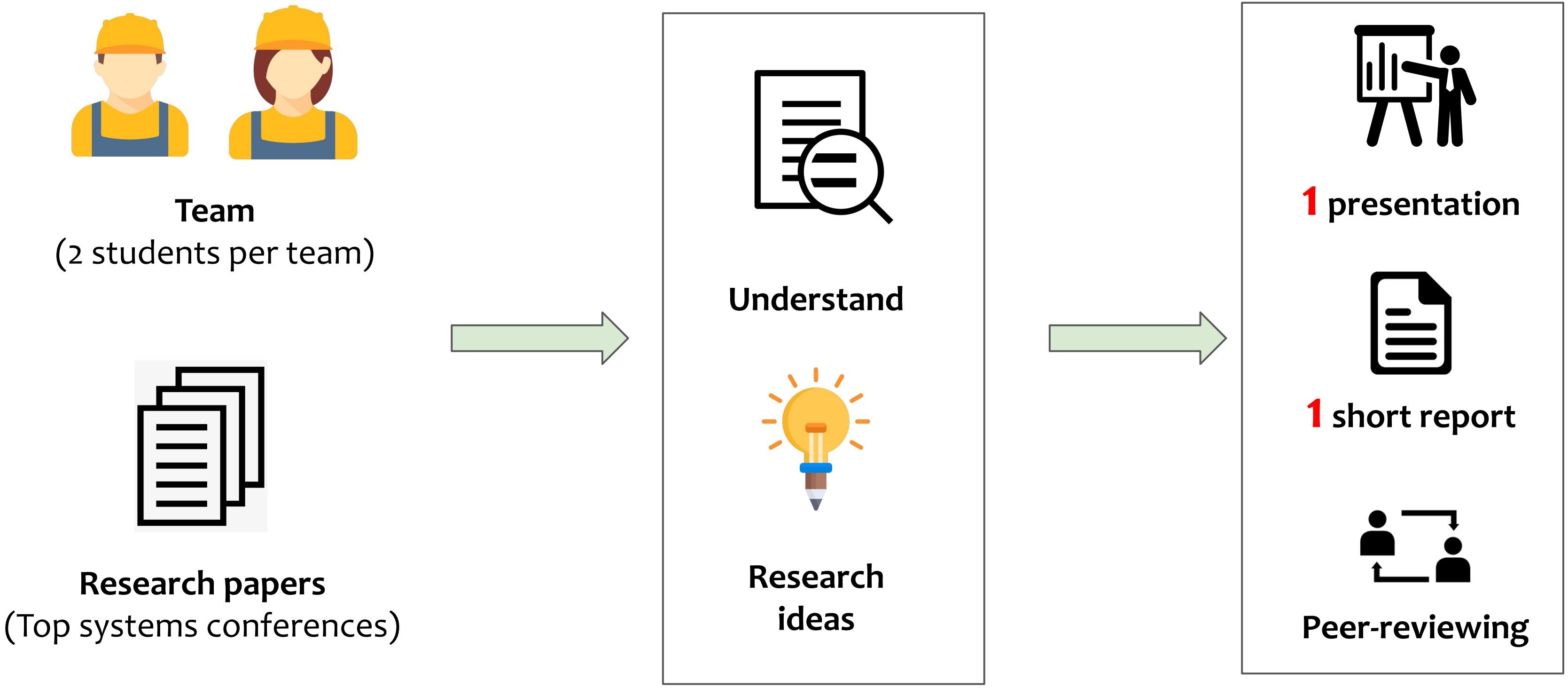
Topics

Papers from top conferences: OSDI, EuroSys, ASPLOS, USENIX Security, IEEE S&P, ACM CCS, NDSS

Topics
Confidential Virtual Machines (CVMs)
Trusted computing in the cloud
Confidential computing primitives
Operating systems and hypervisors
Hardware-assisted memory safety & security
Microarchitectural & software-based attacks & mitigations
…

Format

Bird's eyes view



Team
(2 students per team)

Research papers
(Top systems conferences)

Understand

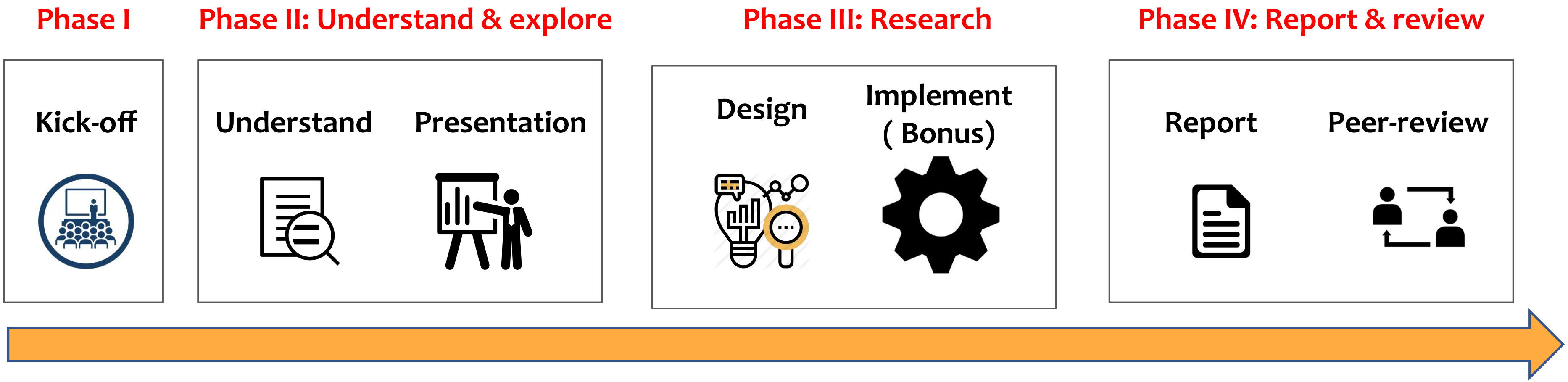
Research ideas

1 presentation

1 short report

Peer-reviewing

Overview



Phase I

Kick-off

Phase II: Understand & explore

Understand

Presentation

Phase III: Research

Design

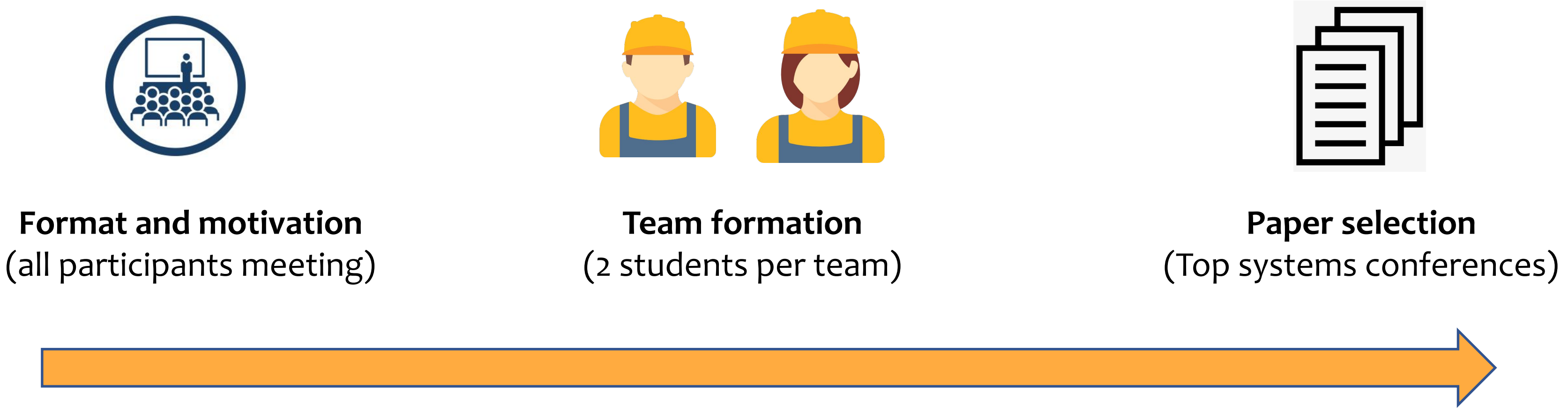
Implement (Bonus)

Phase IV: Report & review

Report

Peer-review

Phase I: Kick-off meeting



Format and motivation
(all participants meeting)

Team formation
(2 students per team)

Paper selection
(Top systems conferences)

The first week

NOTE

1. A list of papers will be provided for FCFS bidding
2. Paper presentation guidelines will be provided for the next phase

Phase II: Understand & explore

Understand the paper(s)

Focus

1. **Understand** the paper and related work
2. **Explore** a "laundry list" of research ideas/directions

Paper presentation

Focus

1. Explain the work/related work (**"why?"** and **"how?"**)
2. Explain and discuss all possible research directions
3. Pick a research direction

Phase III: Research

Research work

Focus:
Indepth research work to nail-down the problem and detailed approach to solve it!

Research prototype

Bonus:
(Optional)
“Build the system to solve it!” and show us the working idea and associated results

Phase IV: Report & review

Report

Focus

Prepare a single “short & sweet” report summarizing

(a) Paper

(b) Research work

Peer-review

Focus

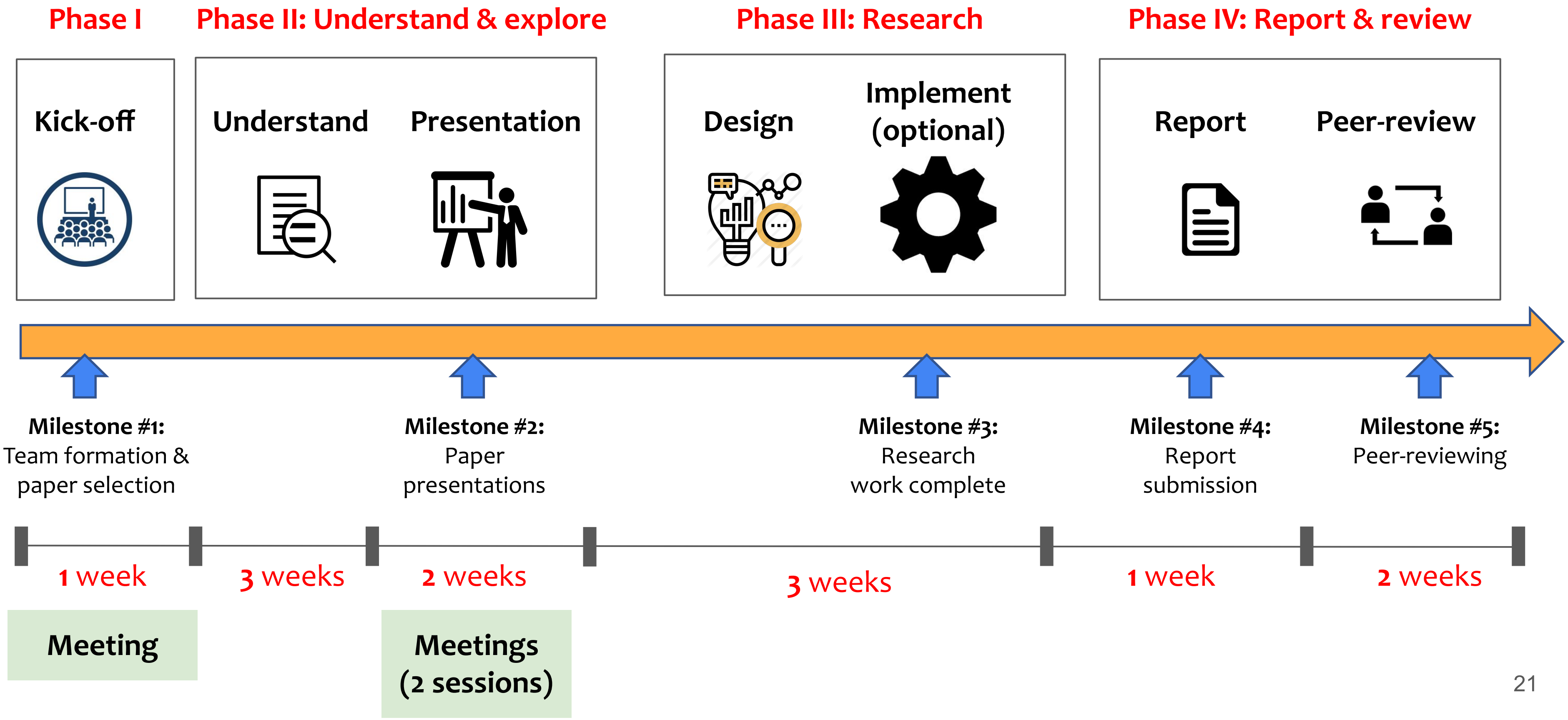
Give constructive (positive and critical) feedback for

(a) Paper summary

(b) Research work

END.

Overall timeline



Phase I

Kick-off

Phase II: Understand & explore

Understand

Presentation

Phase III: Research

Design

Implement (optional)

Phase IV: Report & review

Report

Peer-review

Milestone #1: Team formation & paper selection

Milestone #2: Paper presentations

Milestone #3: Research work complete

Milestone #4: Report submission

Milestone #5: Peer-reviewing

1 week

3 weeks

2 weeks

3 weeks

1 week

2 weeks

Meeting

Meetings (2 sessions)

Organization

- Format
  - Team-based seminar course (2 students per team)
- Communication
  - Slack for announcements and information sharing
  - Hotcrp for report submission and peer-reviewing
- Meetings (**in-person,** attendance is **compulsory**)
  - **Meeting #1:** Kick-off
  - **Meeting #2:** Paper presentation (Session 1)
  - **Meeting #3:** Paper presentation (Session 2)

Learning goals

- Learn about the cutting-edge research in computer systems
- Promote critical thinking
- Cultivate an environment for innovation
    - To push the boundaries by advancing the state-of-the-art
- Improve scientific skills
    - Presentation
    - Writing
    - Communication: discussion and arguing
    - Mentorship: giving feedback and moderating discussion
- Encourage system building and evaluation
    - Learn by building, breaking, and benchmarking systems
- Importantly, to have fun!

Code of conduct

- University plagiarism policy
  - https://www.in.tum.de/en/current-students/administrative-matters/student-code-of-conduct/

- Decorum
  - Promote freedom of thoughts and open exchange of ideas
  - Cultivate dignity, understanding and mutual respect, and embrace diversity
  - Racism and bullying will not be tolerated

Contacts

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  - dimitrios.stavrakakis@tum.de

- **All seminar-related info:** https://github.com/TUM-DSE/seminars

slack

Workspace: http://ls1-courses-tum.slack.com/

Channel: #ws-24-c3-seminar

Join us with TUM email address (@tum.de)