TDA596 / DIT240 (2nd academic period 2018/2019)

Exam: Distributed Systems

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Means allowed: Nothing except paper, pencil, pen and English - xx dictionary.

Please answer all questions (1 to 6).

General information: All questions should be answered in English. Each question answer should be started on a new sheet of paper. Write clearly and use the pages in a structured way so your answers are easy to read. All answers should be motivated, explained, elaborated, detailed, precise and accurate.

Important suggestion: Read all questions before answering. Plan your time so that you can (at least) write a brief answer to all questions (and sub-questions). Please notice the weight that is given to each question (and sub-question).

Grading: GU: G 24p, VG 48p; CTH: 3:a 24p, 4:a 36p, 5:a 48p of maximum 60 points.

Review: Please keep your exam code. Information about individual exam review will be published on the course website.

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2. Leader Election and Mutual Exclusion (10 points)

2 a) (5 points) Leader Election and Bully Algorithm.

- In general, what properties should a leader election algorithm in distributed systems have?
- Please describe how the Bully algorithm works.
- How does the algorithm deal with nodes failing during election?
- What message complexity does the algorithm have (best case, worst case and on average), and why?
- How does the algorithm ensure safety and liveness?
- Compared to the Ring algorithm for Leader Election, what key advantage and disadvantage do you see?

2 b) (5 points) Mutual Exclusion in Distributed Systems

- What is mutual exclusion and its goal in Distributed Systems?
- In the course, we discussed the Ricart & Agrawala algorithm for Mutual Exclusion. Please explain this algorithm.
- What is the message complexity of a single access operation of this algorithm (please explain)?
- Any algorithm for mutual exclusion must fulfill two goals: safety and liveness. Explain how the algorithm achieves these.
- Is Ricart & Agrawala a centralized, decentralized, or a distributed algorithm (please explain)?

4. Consistency and Replication (10 points)

4 a) (3 points) Data-Centric vs. Client-Centric Consistency Models

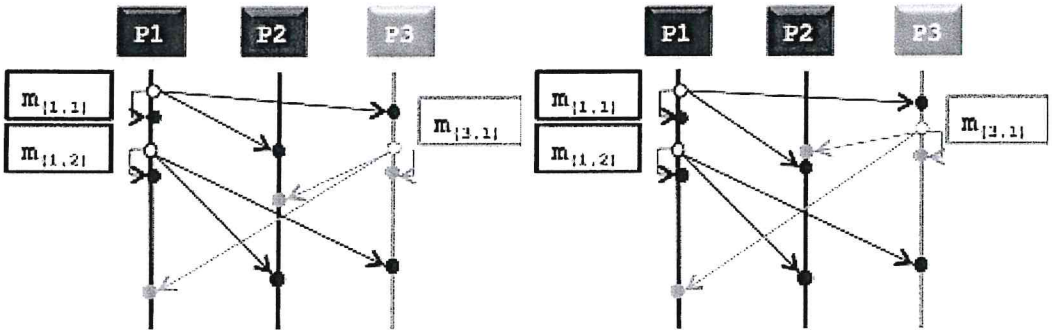
- Please explain the key difference between Data-Centric and Client-Centric Consistency Models
- Please define Eventual Consistency (within one short sentence).
- Is Eventual Consistency a Data-Centric or Client-Centric Consistency Model?

4 b) (3 points) We discussed the Bayou System, that provides a distributed calendar.

- What consistency model does Bayou use? And Why? How are activities ordered in Bayou?
- How are conflicts resolved in Bayou? Is this transparent, i.e., not visible, to the user?
- When are conflicts resolved? Does Bayou give a guaranteed upper bound for this?

4 c) (4 points) We discussed the concepts of Total Ordering, Sequential Ordering, and Causal Ordering

- Briefly explain and formally define each concept.
- Below you see two figures. For each figure, please note weather it describes Total Ordering, Sequential Ordering, and Causal Ordering. Briefly describe your decisions.



6. Fault Tolerance and Applications (10 points)

6 a) (3 points) Orphans: A client might crash while the server is performing a corresponding computation requested by the client. Such an unwanted computation is called an *orphan* (as there is no parent waiting for it after done).

- What problems do orphans cause?
- In the course, we discussed four strategies to deal with orphans. Please explain each of them.

6 b) (3 points) Failure Models: In the lecture we discussed different failure models. Please note four of them and describe each briefly.

6 c) (2 points) We discussed TOR, which enables, for example, anonymous Internet browsing.

- Briefly explain how TOR provides anonymous Internet browsing. You can draw a figure to illustrate your argumentation.

6 d) (2 points) We discussed the BitTorrent protocol, which enables, for example, peer-to-peer data exchange

- Briefly explain how a downloader joins a swarm and explain the role of the tracker.
- What are the contents of a ".torrent" file?