Written examination in Cloud Computing

February 19th 2019

Last name: _____

First name: _____

Student number: _____

I confirm with my signature that I will process the written examination alone and that I feel healthy and capable to participate this examination.
I am aware, that from the moment, when I receive the written examination, I am a participant of this examination and I will be graded.

Signature: _____

- Use the provided sheets. Own paper must *not* be used.
- You are allowed to use a *self prepared*, *single sided DIN-A4 sheet* in the exam. Only *handwritten originals* are allowed, but no copies.
- You are allowed to use a non-programmable calculator.
- Do *not* use a red pen.
- Time limit: *90 minutes*
- Turn off your mobile phones!

Result:

Question:	1	2	3	4	5	6	7	8	**Σ**	Grade
Maximum points:	22	5	10	12	12	9	10	10	90	—
Achieved points:										

1.0: 90.0-85.5, **1.3**: 85.0-81.0, **1.7**: 80.5-76.5, **2.0**: 76.0-72.0, **2.3**: 71.5-67.5,
2.7: 67.0-63.0, **3.0**: 62.5-58.5, **3.3**: 58.0-54.0, **3.7**: 53.5-49.5, **4.0**: 49.0-45.0, **5.0**: <45

Last name: First name: Student number:

Question 1)

Points: .....

Maximum points: 3+12+7=22

Your local time in Frankfurt am Main is Monday 10:00 (UTC+1). You need to copy 4 TB of data into a storage service which is located in Ireland (UTC). You have two options:

- **Scenario 1:** You immediately start at 10:00 (UTC+1) to upload the 4 TB of data to the storage service via the Internet. Consider the data rate between your computer and the storage service is 200 Mbit/s.
- **Scenario 2:** You use an Import/Export service that is offered by many storage service providers today. Therefore you copy the data to a SDD. The transfer rate (for write) is 200 MB/s.

  After you copied the data, you pack the SDD into a parcel and send it via a package delivery company to Amazon. DHL, UPS and FedEx can deliver a parcel from Frankfurt am Main in less than 24 hours to most places in Europe.

  You need 15 Minutes to put the SDD into a parcel and another 30 Minutes to bring the parcel to the branch office of a package delivery company.

  The parcel must arrive at the branch office of the package delivery company no later than 16:30 (UTC+1) to arrive at the cloud service provider in Ireland at 8:00 (UTC) the next working day.

  An employee of the cloud service provider needs to copy the data from the SDD into the cloud storage service. The transfer rate of the SDD (for read) is 320 MB/s.

  Consider two hours additional overhead for the in-house mail at the cloud service provider to ship the SDD to the correct employee.

a) Calculate for the first scenario, how long it takes until the data is copied to the storage service:

   Days: _____ **Hours**: _____ **Minutes**: _____

b) Calculate for the second scenario, how long it takes until the data is copied to the storage service:

   Days: _____ **Hours**: _____ **Minutes**: _____

c) Calculate for the second scenario the **Data Rate** [**Mbps**]: _____

(Fill out the empty fields. The calculation steps of all subtasks must be visible.)

Last name: First name: Student number:

Question 1)

Points: .....

Maximum points: 3+12+7=22

(**This page is free space for your calculation steps of Question 1. Do not forget to write the results into the correct fields.**)

Last name: First name: Student number:

Question 2)

Points: .....

Maximum points: 5

Explain one possible way of how the multiplication of two matrices can be done in parallel by using a cluster system. (*In other words: Which parts of the multiplication process can be carried out in parallel by the nodes of a cluster and how is it done and what is the task of the master?*)

Last name: First name: Student number:

Question 3)

Points: .....

Maximum points: 10

Provide a pseudocode solution that implements a parallel matrix multiplication. Focus on the MPI-Functions that are required for the implementation of a parallel matrix multiplication.

Last name: First name: Student number:

Question 4)

Points: .....

Maximum points: 2+10=12

This two diagrams show the total execution time of a Mergesort application from SS2018 for two different problem sizes = number of integer values to be sorted.

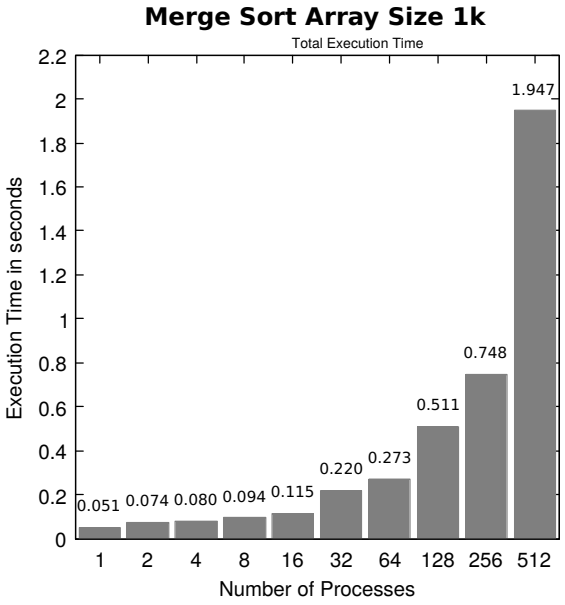


Figure 1: Problem Size = 1,000 values

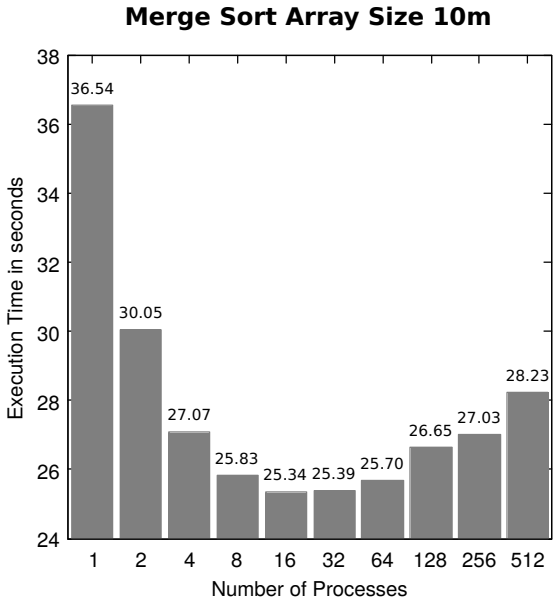


Figure 2: Problem Size = 10,000,000 values

The two diagrams demonstrate two fundamental laws and limitations of parallel computing.

a) Name the two fundamental laws and limitations of parallel computing which are relevant here.

b) Explain the two fundamental laws and limitations of parallel computing by using the two diagrams.

Last name: First name: Student number:

Question 5)

Points: .....

Maximum points: 4+8=12

Company X runs 500 computer workplaces.

- Scenario 1: Fat clients (PC)
  - Electrical power rating per desktop: 450 watts
  - Electrical power rating per screen: 80 watts
- Scenario 2: Thin clients
  - Electrical power rating per thin client: 30 watts
  - Electrical power rating per screen: 80 watts
  - Electrical power rating per server blade: 600 watts
  - Each server blade has enough resources to interact with 30 thin clients

What are the electricity costs per year for 24/7 operation when the electricity price is 0,32 €/kWh?

Last name: First name: Student number:

Question 6)

Points: .....

Maximum points: 4+1+2+2=9

a) Explain what the Twelve-Factor-App is.

b) To which sort of applications and programming languages is the Twelve-Factor-App compatible?

c) Explain the purpose of the MPI function `MPI_Get_processor_name`.

d) Explain what the communicator of an MPI application is.

Last name: First name: Student number:

Question 7)

Points: .....

Maximum points: 10

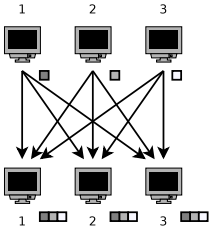
a) Name five of the main components (services) of OpenStack and explain what the purpose of each mentioned component (service) is.

Last name: First name: Student number:

Question 8)

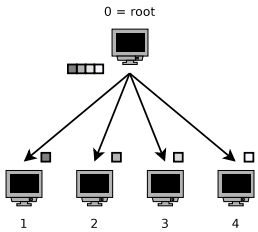
Points: .....

Maximum points: 2+2+2+2+2=10

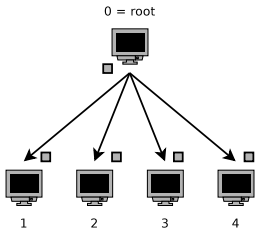


a) Name an MPI function that implements this sort of communication.

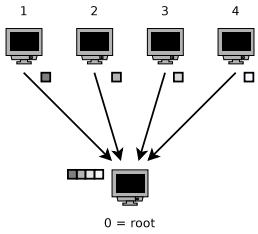
b) Name an MPI function that implements this sort of communication.



c) Name an MPI function that implements this sort of communication.



d) Name an MPI function that implements this sort of communication.



e) Name an MPI function that implements this sort of communication.