Hochschule Esslingen			**Fakulty Graduate School**
Summer Semester 2014		Page No.:	1 of 4
Programme:	Automotive Systems	Semester:	ASM-SB
Module: Lecture:	Reliable Embedded Systems **Real Time System Design**	Lecturer:	Agrawal
Mode:	closed book apart from 2 manually written sheets of paper DIN-A4	Duration:	60 minutes
Name:		Student number:	

Note: Use the blank pages to write your answers. Please number the pages before submitting them. Please follow the time limit provided against each question as a hint as how elaborate your answer should be.

Question 1: (1 Min.)

Consider a combustion engine with an injection valve. The start point of fuel injection must be precise within 0.1 degrees of the measured angular crankshaft position.

1.1 Calculate the temporal accuracy of the system if the crankshaft revolves with 6000 rpm.

Question 2: (1 Min.)

Show the relationship between error, faults and failures through a diagram.

Question 3: (2 Min.)

What is the difference between sampling and polling? Give an example in context with the memory element.

Question 4: (2 Min.)

What is intelligent instrumentation? What are the components in an intelligent instrumentation?

Question 5: (2 Min.)

Mention two different kinds of bus access methods as described in the lecture. Briefly describe how do they access the bus. Why do we need such a method in the distributed system?

Question 6: (4 Min.)

According to the specification of a hard drive, its failure rate is 0.73 failures / year.

6.1 Please calculate lambda for the hard drive.

6.2 Please calculate Mean Time To Failure (MTTF) for the hard drive.

6.3 Please calculate the reliability of the hard drive immediately 1 hour after it has been connected to the computer.

6.4 Considering the Mean Time To Repair (MTTR) to be 24 hours. What is the Availability of the hard drive in hours.

Question 7: (10 Min.)

Protocols are used in real time software in order to avoid deadlock between tasks at the time of acquiring a resource.

7.1 Name the two important protocols?

7.2 What is the algorithm used in each of the protocols at the time of acquring and releasing the resources?

Question 8: (3 Min.)

The industrial plants alarm monitoring system which monitors the change in the pressure of an intake valve is connected to the other nodes in the plant through a bus system. However, since all the nodes are connected to a common bus, the alarm monitoring node should delay its action to set the alarm.

8.1 With the following parameters: $d_{max} = 20$, $d_{min} = 1$,$g_{local} = 10\mu$sec and $g_{global} = 20\mu$sec

a Calculate the action delay when no global clock is available.

b Calculate the action delay when all the nodes are synchronized through a global clock.

Question 9: (5 Min.)

You are asked to design a system with local clocks at each node. The specifications of the ensemble is Latency jitter = 20μsec, Clock drift rate = 10^{-5} sec/sec, Rint= $1sec$.

9.1 Calculate the precision based on the internal synchronizations algorithm for the clock constellations $\mu(5,1)$ and $\mu(5,0)$.

9.2 For the above two clock constellations, which event set you would use through which the temporal order of the events can be definitely established?

Question 10: (5 Min.)

What are the known time standards. Please explain Uniform time format and mention the granularity of the Uniform time format in external and internal time format.

Question 11: (5 Min.)

14. The earliest deadline first is a dynamic priority scheduling algorithm. Using T1 = (1, 4); T2 = (2, 6); T3 = (3, 8); where the value in parantheses are (C, T). Please assume the deadline to be the same as the period.

11.1 Calculate the processor utilization factor of the tasks for the EDF alorithm.

11.2 Compute the hyperperiod of the tasks.

11.3 Fill in the chart to draw the schedulability of the tasks for the EDF algorithm.

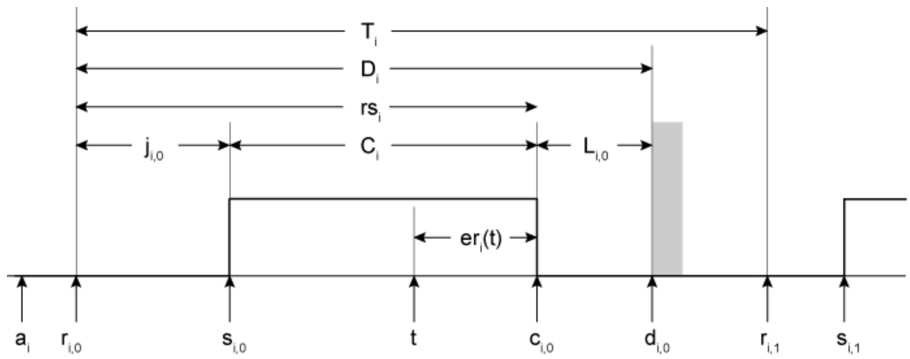
Question 12: (5 Min.)

You have been given a task to select a real time operating system which would govern an industrial plant. For that you have been invited in the meeting to discuss the various criterias which are important in the proper selection of the product.

12.1 Please mention 5 important criterias what you would present in the meeting?

12.2 One of the criteria is scheduling. Describe the scheduling problem in one line?

12.3 Describe T, D, rs, C, and L in the below diagram.



12.4 In the rate monotonic algorithm, the task with the .... gets the highest static priority. (Please fill in the blank)

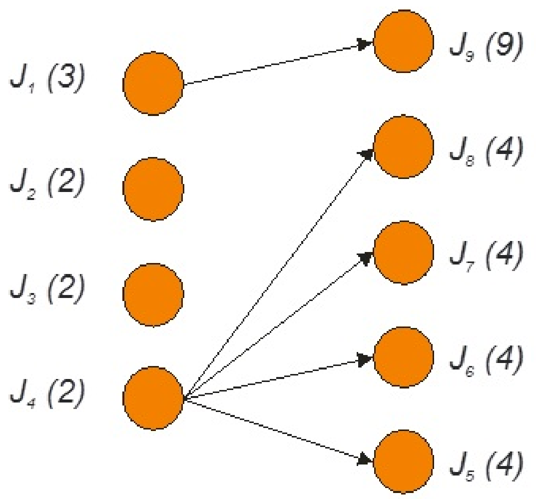
12.5 In the earliest deadline algorithm, the task with the .... gets the highest dynamic priority. (Please fill in the blank)

Question 13: (5 Min.)

In the below precedence tasks with 9 tasks, please fill in the chart in accordance to the priority.

13.1 For a three processor system.

13.2 reduce the computation time by 1 each on a three processor system.



priority(J_i) > priority(J_j) $\forall i < j$

values in parantheses are execution times

Summer Semester 2014		Page No.:	1 of 6
Programme:	Automotive Systems	Semester:	ASM-SB
Module: Lecture:	Reliable Embedded Systems **Real Time System Design**	 Lecturer:	 Agrawal
Mode:	closed book apart from 2 manually written sheets of paper DIN-A4	Duration:	60 minutes
Name:		Student number:	

Note: Use the blank pages to write your answers. Please number the pages before submitting them. Please follow the time limit provided against each question as a hint as how elaborate your answer should be.

Question 1: (1 Min.)

Consider a combustion engine with an injection valve. The start point of fuel injection must be precise within 0.1 degrees of the measured angular crankshaft position.

1.1 Calculate the temporal accuracy of the system if the crankshaft revolves with 6000 rpm.

Question 2: (1 Min.)

What is signal conditioning? How do you describe a device that encapsulates a sensor and a microcontroller in one housing?

Question 3: (1 Min.)

Show the relationship between error, faults and failures through a diagram.

Question 4: (2 Min.)

Calculate the overhead of a trigger task if the WCET of the trigger task is 200 μsec and the laxity of the RT transaction is 10msec. Discuss the advantages and disadvantages of an application task activation by an interrupt versus that by a trigger task.

Question 5: (2 Min.)

The real time image in the controller is based on the sensor values. The sensors have their own bottlenecks with respect to time because of the conversion of the physical entities into the digital entities. These digital values are sent to the controller which would calculate the set point and send the value back to the actuator.

5.1 What are the two kinds of RT images based on the above constellation?

5.2 What is the relation between the temporal accuracy, execution times and the update period for both kinds of images?

5.3 In case the update period is not sufficient to update the RT image in the controller within the temporal accuracy period, how can this be achieved?

Question 6: (2 Min.)

Describe the successive approximation method for ADC conversion. Please draw the chart using a 3 bit, 5 V ADC convertor.

Question 7: (2 Min.)

Mention two different kinds of bus access methods as described in the lecture. Briefly describe how do they access the bus. Why do we need such a method in the distributed system?

Question 8: (3 Min.)

According to the specification of a hard drive, its failure rate is 0.73 failures / year.

8.1 Please calculate lambda for the hard drive.

8.2 Please calculate Mean Time To Failure (MTTF) for the hard drive.

8.3 Please calculate the reliability of the hard drive immediately 1 hour after it has been connected to the computer.

8.4 Considering the Mean Time To Repair (MTTR) to be 24 hours. What is the Availability of the hard drive in hours.

Question 9: (3 Min.)

The industrial plants alarm monitoring system which monitors the change in the pressure of an intake valve is connected to the other nodes in the plant through a bus system. However, since all the nodes are connected to a common bus, the alarm monitoring node should delay its action to set the alarm.

9.1 Please explain why is this important?

9.2 With the following parameters: $d_{max} = 20$, $d_{min} = 1$,$g_{local} = 10\mu$sec and $g_{global} = 20\mu$sec

a Calculate the action delay when no global clock is available.

b Calculate the action delay when all the nodes are synchronized through a global clock.

Question 10: (3 Min.)

Please implement a 10ms timer function and use the interrupt mechanism to toggle a GPIO port pin. To realize the program, please initialize the timer hardware, write an ISR for the timer peripheral, write a main function where you would register a callback function.

Question 11: (5 Min.)

You are asked to design a system with local clocks at each node. The specifications of the ensemble is Latency jitter = 20μsec, Clock drift rate = 10^{-5} sec/sec, Rint= $1sec$.

11.1 Calculate the precision based on the internal synchronizations algorithm for the clock constellations $\mu(5,1)$ and $\mu(5,0)$.

11.2 For the above two clock constellations, which event set you would use through which the temporal order of the events can be definitely established?

11.3 Based on the precision calculated above, calculate the true value limits for both the clocks constellation, if the observed duration between two events is 1 millisecond.

11.4 What are the four fundamental limits of time measurement? In which case the fundamental limit of 0/2g would fail? What is the possible solution for this?

Question 12: (10 Min.)

The customer is a big automotive giant and would like to develop an HMI (Human Machine Interface) using hard and soft keys. One of the functional requirement could be a fast scrolling of a phonebook when the user presses and holds a scroll down button for more than 2 seconds.

12.1 Please mention more functional, temporal and dependable requirements of the above mentioned system.

12.2 Draw a block diagram to detect the press of the buttons through CAN Messages. Please use interrupts. (the messages are queued in a FIFO).

12.3 Draw a block diagram to detect the press of a button using a potentiometer. Please use polling.

12.4 Draw an architecture starting from the press of the button till the realization of the functional requirement of the button.

12.5 Please include:

a Diagnostic task (every 50 ms) to check for a fault on the hard keys.
b Driver task (100 ms) to detect the CAN messages using polling.
c Driver task (1 ms) to detect the press of a button based on a potentiometer.
d Application task (event task) to realise the functional requirements.

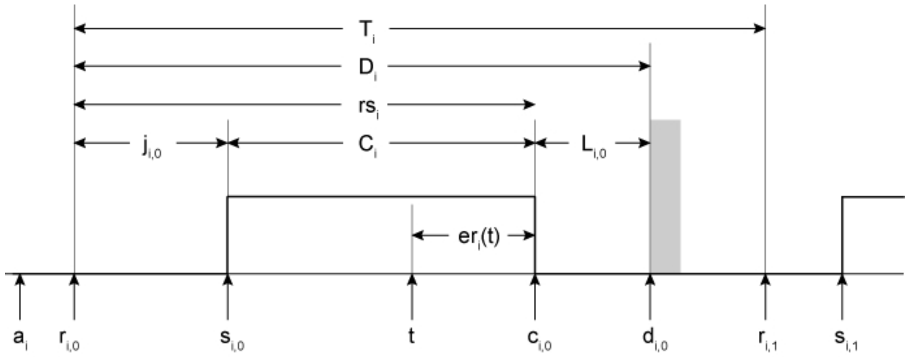
Question 13: (5 Min.)

You have been given a task to select a real time operating system which would govern an industrial plant. For that you have been invited in the meeting to discuss the various criterias which are important in the proper selection of the product.

13.1 Please mention 5 important criterias what you would present in the meeting?

13.2 One of the criteria is scheduling. Describe the scheduling problem in one line?

13.3 Describe T, D, rs, C, and L in the below diagram.



13.4 In the rate monotonic algorithm, the task with the .... gets the highest static priority. (Please fill in the blank)

13.5 In the earliest deadline algorithm, the task with the .... gets the highest dynamic priority. (Please fill in the blank)

Question 14: (10 Min.)

14. The rate monotonic algorithm is a static priority scheduling algorithm and the earliest deadline first is a dynamic priority scheduling algorithm. Using T1 = (1, 4); T2 = (2, 6); T3 = (3, 8); where the value in parantheses are (C, T). Please assume the deadline to be the same as the period.

14.1 Calculate the processor utilization factor of the tasks for both the alorithms. Does the calculated factor suffice the schedulability test? Please answer why?

14.2 Compute the hyperperiod of the tasks.

14.3 Fill in the chart to draw the schedulability of the tasks for both the algorithm.

Question 15: (5 Min.)

Using T1 = (1, 4); T2 = (2, 8); T3 = (3, 12); where the value in parantheses are (C, T), please

15.1 Calculate the processor utilization factor of the task using RM algorithm.

15.2 Compute the hyperperiod of the task set.

15.3 Fill in the chart to draw the schedulability of the tasks using the RM algorithm.

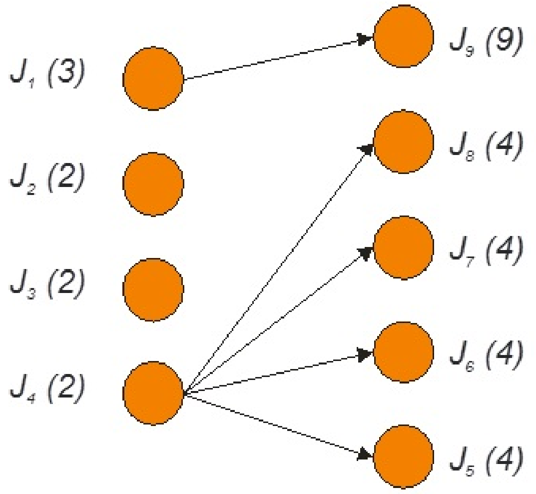
15.4 Can an aperiodic task with the release time of 2, deadline of 20 and computation time of 3 fit in this algorithm? Please calculate the response time of this aperiodic task.

Question 16: (5 Min.)

In the below precedence tasks with 9 tasks, please fill in the chart in accordance to the priority.

16.1 For a three processor system.

16.2 For a four processor system.



priority(J_i) > priority(J_j) $\forall i < j$

values in parantheses are execution times

University of Applied Sciences Esslingen

Summer Term 2013		Page no.	1 of 11
Faculty:	Graduate School, Information Technology	Semester:	ASM 2
Topic:	Distributed Real-Time Systems	Topic no.:	
Exam aids:	Two DIN-A4 sheets, calculator	Time:	90 minutes

Name, Surname: ____

Question 1: (35 Minutes)

1.1 What are typical functions a real-time computer system must perform?

Answer:

1.2 What does signal conditioning mean? Give an example.

Answer:

1.3 Explain the term “error containment region”.

Answer:

1.4 Define the notions of offset, drift, drift rate, precision, and accuracy.

Answer:

1.5 What are the basic techniques for error detection?

Answer:

1.6 How can clock synchronization assist in finding the primary event of an alarm shower?

Answer:

1.7 Explain the three different types of orders with regard to alarms in a distributed real-time system. Which of the orders implies another?

Answer:

1.7 A quadrocopter has a maximum acceleration (downwards) when all engines are stopped. With what sampling rate do we have to scan the acceleration sensor when we want to make sure that the deviation between the real-time entity and real-time image of the relative position in space is less than 2 mm, i. e. the quadrocopter moves by at most 2 mm during a sampling interval. Assume that initially the quadcopter is hovering (v = 0).

Answer:

1.9 Explain the difference between state correction and rate correction for a clock. What are the advantages and disadvantages for each method?

Answer:

1.10 What is a hidden channel? Define the notion of permanence.

Answer:

Question 2: (35 Minuten)

2.1 What is the difference between a state observation and an event observation? Discuss their advantages and disadvantages.

Answer:

2.2 What is a ground state in a real-time computer system?

Answer:

2.3 What are the basic techniques for error detection? Compare ET systems and TT system from the point of view of error detection.

Answer:

2.4 Assume a computer system that can control three concurrently operating trains running on a model railway track, containing 5 switches and 12 signals.

Identify the h-state at the reintegration point. Which part of the h-state can be enforced on the environment at the reintegration point? What is the minimal remaining h-state at the reintegration point?

Answer:

2.5 Explain the terms fault, error, an failure.

Answer:

2.6 Compare the efficiency of event-triggered and time-triggered communication protocols at low load and peak load.

Answer:

Question 3: (20 Minuten)

3.1 Given a bandwidth of 10 MBits/sec, a channel length of 500 m and a message length of 48 bits, what is the maximum protocol efficiency that can be implemented by the media access level of a bus system?

Answer:

3.2 Consider a PAR protocol with a bus transport delay of 1 msec, an acknowledgement detection timeout of 3 msec, 2 retries and a negligible computation time on each node. What is the maximum protocol jitter this system can exhibit?

Answer:

3.3 Estimate the average and worst-case response time of a TTP/C system with 8 FTUs, each one consisting of two nodes that exchange messages with 5 data bytes on a channel with a bandwidth of 1 Mbit/sec. Assume that the interframe gap is 8 bits.

Answer:

3.4 How is the consistency of the data transfer across the CNI enforced by the TTP protocol?.

Answer:

3.5 Calculate the data efficiency of a TTP/A system that consists of 10 nodes where each node sends periodically a three byte message (user data). Assume that the intermessage gap between the Fireworks byte and the first data byte is 4 bitcells, and the intermessage gap between two successive data bytes is two bitcells. The gap between the end of one round and the start of the next round is 12 bitcells.

Answer:

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Summer Term 2012		Page no.	1 of 11
Faculty:	Graduate School, Information Technology	Semester:	ASM 2
Topic:	Distributed Real-Time Systems	Topic no.:	
Exam aids:	Two DIN-A4 sheets, calculator	Time:	90 minutes

Name, Surname: ____

<u>Question 1: (35 Minutes)</u>

1.1 One important parameter for many real-time computer programs is the WCET. Why is it difficult to obtain the WCET? Give as many reasons as you can think of.

Answer:

1.2 Explain the term “composability”. Give examples.

Answer:

1.3 Explain the term “error containment region”.

Answer:

1.4 What types of failures can a physical clock exhibit? Please explain briefly.

Answer:

1.5 What are the basic techniques for error detection?

Answer:

1.6 What are the advantages of having a global time available on nodes in a distributed real-time system with regard to interval measurements, action delay, and alarm root cause detection?

Answer:

1.7 Explain the three different types of orders with regard to alarms in a distributed real-time system. Which of the orders implies another?

Answer:

1.8 What is an agreement protocol? Why would one try to avoid it?

Answer:

1.9 Explain the difference between state correction and rate correction for a clock. What are the advantages and disadvantages for each method?

Answer:

1.10 Given a resynchronization period of 1000 msec, and a clock drift rate of 10^{-6} sec/sec, what precision can be achieved in case of a latency jitter of 15 µsec using the FTA algorithm in a system with 5 clocks where 1 clock could be malicious ($\mu(5,1) = 1{,}5$)?

Answer:

Question 2: (35 Minuten)

2.1 Please explain the difference between an instant and an event.

Answer:

2.2 What is a ground state in a real-time computer system?

Answer:

2.3 Assume we have a distributed system with the following parameters: dmax=20msec, dmin=5msec. What granularity does your time base (local or global) need if you want to keep the action delay below 50 msec? Consider the following two cases:
a) global time available
b) no global time

Answer:

2.4 What are the temporal obligations of clients and servers at a client-server interface in a real-time system?

Answer:

2.5 Explain the difference between a parametric and a phase-sensitive RT image. How can you create parametric RT images?

Answer:

2.6 What is the relationship between action delay and temporal accuracy?

Answer:

Question 3: (20 Minuten)

3.1 Given a bandwidth of 5 MBits/sec, a channel length of 300 m and a message length of 40 bits, what is the maximum protocol efficiency that can be implemented by the media access level of a bus system?

Answer:

3.2 Consider a PAR protocol with a bus transport delay of 1 msec, an acknowledgement detection timeout of 3 msec, 2 retries and a negligible computation time on each node. What is the maximum protocol jitter this system can exhibit?

Answer:

3.3 What is the purpose of the bus guardian in a TTP/C controller? How is it controlled?

Answer:

3.4 What is the membership service in the TTP/C protocol? Explain its purpose and briefly explain how it works.

Answer:

3.5 Calculate the data efficiency of a TTP/A system that consists of 8 nodes where each node sends periodically a three byte message (user data). Assume that the intermessage gap between the Fireworks byte and the first data byte is 3 bitcells, and the intermessage gap between two successive data bytes is two bitcells. The gap between the end of one round and the start of the next round is 8 bitcells.

Answer:

University of Applied Sciences Esslingen

Summer Term 2011		Page no.	1 of 11
Faculty:	Graduate School, Information Technology	Semester:	ASM 2
Topic:	Distributed Real-Time Systems	Topic no.:	
Exam aids:	Two DIN-A4 sheets, calculator	Time:	90 minutes

Name, Surname: ______________________________________

Question 1: (35 Minutes)

1.1 Sketch a simple model of a real-time system and partition it into three important parts. Name each cluster and the interfaces between them.

Answer:

1.2 What is the difference between a real-time image and a real-time entity?

Answer:

1.3 Hard disk drives are often advertised with very high MTBFs. Some manufacturers have switched to a different specification, the annual failure rate (AFR). The AFR is defined as that percentage of a large number of disc drives that exhibit a defect when continuously being run for a year.

What is the MTBF for a hard disc drive when the observations of the last year gave an AFR of 0.73%, that is 0.73% of all disc drives that had been running continuously for a year exhibited a defect?

Answer:

MTBF=________________hours

1.4 Is real-time computing equivalent to fast computing? What is the main goal in the design of real-time computing systems? Please discuss briefly.

Answer:

1.5 The start of an injection in a modern combustion engine must be controlled to better than 1°, to adhere to environmental standards. The idle motor speed of an engine is 800 rpm, the maximum rate is 4500 rpm. The maximum change in motor speed in case of a load change is 1500 rpm/sec.

a) Compute the maximum temporal accuracy for the start of the injection.

b) Compute for a one-cylinder four cycle engine at constant rpm the minimum time that is available for the computation of the injection time. A four cycle engine needs to inject only every other full crankshaft turn. Assume that there are no other processes running on the computer calculating the injection time.

c) When the injection time is calculated early, it can become imprecise due to a change in rpm during this time. Compute how far in advance the injection time can be calculated without violating the 1° limit, assuming a maximum motor speed change. Assume for your calculation that the computation doesn't take any time at all.

Answer:

a) maximum temporal accuracy = ________________________

b) minimum computation time = __________________________

c) maximum advance computation time = ____________________________

1.6 Explain the three different types of orders with regard to alarms in a distributed real-time system. Which of the orders implies another?

Answer:

1.7 How can a sparse time base help to avoid agreement protocols?

Answer:

1.8 Assume you have node clocks running at a frequency of 100 MHz. What precision can you achieve when measuring a time interval, where the start event and the end event can origin from different nodes, and the node clocks are synchronized to a global clock?

Answer:

1.9 Given a resynchronization period of 500 msec, and a clock drift rate of 10^{-6} sec/sec, what latency jitter can be tolerated to achieve a precision of 20 µsec using the FTA algorithm in a system with 5 clocks where 1 clock could be malicious (µ(5,1) = 1,5)?

Answer:

Question 2: (35 Minuten)

2.1 Please explain the difference between a simple task (S-task) and a complex task (C-task).

Answer:

2.2 What is a history state? Please explain with an example.

Answer:

2.3 Calculate the action delay in a distributed system with the following parameters:
dmax=20msec, dmin=5msec,
and a) no global time available, granularity of local time is 100 µsec
and b) global time with granularity of 500 µsec.

Answer:

2.4 When is a set of nodes replica determinate?

Answer:

2.5 What is state estimation?

Answer:

2.6 Explain the terms fault, error, an failure.

Answer:

Question 3: (20 Minuten)

3.1 Given a bandwidth of 10 MBits/sec, a channel length of 200 m and a required protocol efficiency of 90%, what is the maximum message length in bit that can be implemented by the media access level of a bus system?

Answer:

3.2 What mechanism can lead to thrashing? How should you react in an event-triggered system if thrashing is observed?

Answer:

3.3 How can one distinguish between a Fireworks byte and a data byte in the TTP/A protocol?

Answer:

3.4 Calculate the data efficiency of a TTP/A system that consists of 5 nodes where each node sends periodically a two byte message (user data). Assume that the intermessage gap between the Fireworks byte and the first data byte is 4 bitcells, and the intermessage gap between two successive data bytes is two bitcells. The gap between the end of one round and the start of the next round is 6 bitcells.

Answer:

3.5 Explain three major problems that we encounter in interrupt-driven software.

Answer:

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Summer Term 2010		Page no.	1 of 12
Faculty:	Graduate School, Information Technology	Semester:	ASM 2
Topic:	Distributed Real-Time Systems	Topic no.:	
Exam aids:	Written material, calculator	Time:	90 minutes

Name, Surname: ______________________________________

<u>Question 1: (35 Minutes)</u>

1.1 Give an example for an end-to-end protocol in the context of a distributed real-time system. Why would you have to use an end-to-end protocol at the interface between a computer system and the controlled object?

Answer:

1.2 State three functional requirements for real-time systems.

Answer:

1.3 An average car is operated about 400 hours per year. Compute the permissible MTTF if one out of one thousand cars may fail to provide the requested service throughout that year. Would such a car be considered a system with an ultrahigh reliability requirement? Please explain.

Answer:

MTTF=_________________

1.4 Why can there be conflicts between reliability and maintainability? Please explain.

Answer:

1.5 Discuss the advantages and disadvantages of an event-triggered communication system vs. a time triggered communication system. What would you prefer for ultra-dependable systems, and why?

Answer:

1.6 Explain the two failure modes of a clock.

Answer:

1.7 How many binary digits (bits) would a digital counter need, if it was to directly measure a time interval of 1 hour with a digitization error of less than 10 nsec?

Answer:

1.8 Assume you need to measure a time interval with a precision of 10 nsec, where the start event and the end event can origin from different nodes, and the node clocks are synchronized to a global clock. What frequency must your node clocks at least have?

Answer:

1.9 Given a latency jitter of 10 µsec, a resynchronization period of 100 msec, and a clock drift rate of 10^{-6} sec/sec, what precision can be achieved by the FTA algorithm in a system with 5 clocks where 1 clock could be malicious (µ(5,1) = 1,5)?

Answer:

Question 2: (35 Minuten)

2.1 Please explain why it is difficult to determine the WCET of processes in a hard-real time system. State three methods that have been advised to determine WCET, and discuss their limitations.

Answer:

2.2 What is an observation in the context of real-time systems? Explain the two major types of observations and discuss their advantages and disadvantages.

Answer:

2.3 Calculate the action delay in a distributed system with the following parameters:
dmax=10msec, dmin=2msec,
and a) no global time available, granularity of local time is 50 µsec
and b) global time with granularity of 100 µsec.

Answer:

2.4 What kind of redundancy would you employ if you needed to detect errors caused by independent software faults and by transient and permanent physical hardware faults?

Answer:

2.5 What is triple modular redundancy (TMR)?

Answer:

2.6 Fault tolerance can be implemented by two fail-silent nodes or by Triple Modular Redundancy (TMR). Discuss the advantages and disadvantages of each approach.

Answer:

Question 3: (20 Minuten)

3.1 Given a bandwidth of 1 MBits/sec, a channel length of 100 m and a message length of 64 bits, what is the limit of the protocol efficiency that can be achieved at the media access level of a bus system?

Answer:

3.2 Explain the role of the three time-outs in the ARINC 629 protocol. Is it possible for a collision to occur on an ARINC 629 bus?

Answer:

3.3 What mechanism helps to ensure the fail-silence of a TTP controller in the temporal domain?

Answer:

3.4 Estimate the average and worst-case response time of a TTP/C system with 8 FTUs, each one consisting of two nodes that exchange messages with 10 data bytes on a channel with a bandwidth of 10 MBit/s. Assume that the interframe gap is 8 bits.

Answer:

3.5 Explain the difference between polling and sampling.

Answer:

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Summer Term 2009		Page no.	1 of 10
Faculty:	Graduate School, Information Technology	Semester:	ASM 2
Topic:	Selected Topics on Real-Time Systems	Topic no.:	
Exam aids:	Written material, calculator	Time:	90 minutes

Name, Surname: ____

Question 1: (30 Minutes)

1.1 An RT entity changes its value periodically according to $y(t) = A_0 \cdot \sin(2\pi\, f\, t)$ with amplitude A_0 and frequency f. What is the maximum permissible frequency $f_{\max}$ for the entity value if the entity is sampled with a period of $T_{sample} = 1\, m\sec$, and the maximum change of value between two sampling points should never exceed 0.1% of the full range value?

Answer:

1.2 Explain the difference between safety and reliability in hard real-time systems.

Answer:

1.3 Explain the term “signal conditioning” in hard real-time systems.

Answer:

1.4 Discuss the advantages and disadvantes of a distributed architecture vs. a centralized architecture in terms of cost, reliability, and safety.

Answer:

1.5 Explain the terms *offset*, *drift*, *drift rate*, *precision*, and *accuracy* in the context of real-time clocks. Use a sketch if appropriate.

Answer:

1.6 Assume k clocks behave maliciously faulty. How many clocks N do you need at least to achieve clock synchronisation?

Answer:

N = ______________________________

1.7 Explain the difference between the *accuracy* and *precision* of a clock.

Answer:

1.8 Explain the difference between *state correction* and *rate correction* for distributed clocks

Answer:

Question 2: (25 Minuten)

2.1 Describe the structure of a node. Why is it important to distinguish between the i-state and the h-state of a node in an embedded system?

Answer:

2.2 What is the difference between a parametric RT image and a phase-sensitive RT image? How can we create parametric RT images?

Answer:

2.3 Calculate the action delay in a distributed system with the following parameters:
dmax=10msec, dmin=2msec,
and a) no global time available, granularity of local time is 20 µsec
and b) global time with granularity of 30 µsec.

Answer:

2.4 What are the problems with event observations?

Answer:

2.5 What are the basic techniques for error detection?

Answer:

2.6 Given a bandwidth of 10 Mbit/sec, a channel length of 1000 m, and a message length of 100 bits, what is the limit of the protocol efficiency that can be achieved at the media access level of a bus system?

Answer:

Question 3: (35 Minuten)

Given are four tasks which access resources (A,B,C):

τ_1(r_0 = 10, C = 4, Prio=4; [A;1]), where the task executes for two time units, and then requests the resource A.

τ_2 (r_0 = 7, C = 4, Prio=3; [A;1][B;1]), where the task executes for one time unit, and then requests the resource A, and thereafter B.

τ_3 (r_0 = 4, C = 4, Prio=2; [B;1][C;1]), where the task executes for one time unit, and then requests the resource B, and thereafter C.

τ_4 (r_0 = 4, C = 4, Prio=1; [A;5[B;2]][C;1]), where the task executes for two time units, then requests the resource A, holds it for one time unit, and then makes a nested request for resource B, and then requests C.

Notation: r_0 is the release or request time, C is the execution time, Prio is the priority of the tasks (higher number means higher priority). [A;5] means request to resource A for five time units. [A;a[B;b]] means a nested critical sections, where the usage of A includes in turn the usage of B, and time a includes time b.

This task set shall be scheduled with two different resource access protocols.

3.1 Construct the schedule for this task set using the ***priority inheritance protocol***. Use the the diagram furnished below. On the first four lines draw the schedule of each task as if there were no other tasks. On the last line, draw the resulting schedule. Do not use a different diagram template.

Answer:

3.2 Construct the schedule for this task set using the ***priority ceiling protocol.*** On the first four lines draw the schedule of each task as if there were no other tasks. On the last line, draw the resulting schedule. Use the diagram provided below. Do not use your own diagram templates.

Answer:

3.3 Take a look at another periodic task set with periods Ti and the following parameters:

τ_i	r_i	C_i	T_i
τ_1	0	4	36
τ_2	0	3	8
τ_3	0	2	24
τ_4	0	8	39
τ_5	0	1	27
τ_6	0	1	25

Is it possible to create a schedule that meets all deadlines using the rate monotonic algorithm (RMA)? Please explain.

Answer:

3.4 Construct the schedule (mark using X) for the task set above and priority driven RMA into the table below (two lines, second table is continuation of first table):

τ_1																				
τ_2																				
τ_3																				
τ_4																				
τ_5																				
τ_6																				
0		2		4		6		8		10		12		14		16		18		***t***

τ_1																				
τ_2																				
τ_3																				
τ_4																				
τ_5																				
τ_6																				
20		22		24		26		28		30		32		34		36		38		***t***

3.5 For the task set given in 3.3 consider the context switch time (the time it takes to switch from execution of one task to another). This time shall take 0.8 time units, including the start of the first job. Is it possible to create a valid schedule under these conditions? Please explain.

Answer: