February 3, 2015

2010 Paper 5 Question 6

1. (a) When distributed systems are designed and engineered, certain fundamental characteristics have to be taken into account, including: [10]

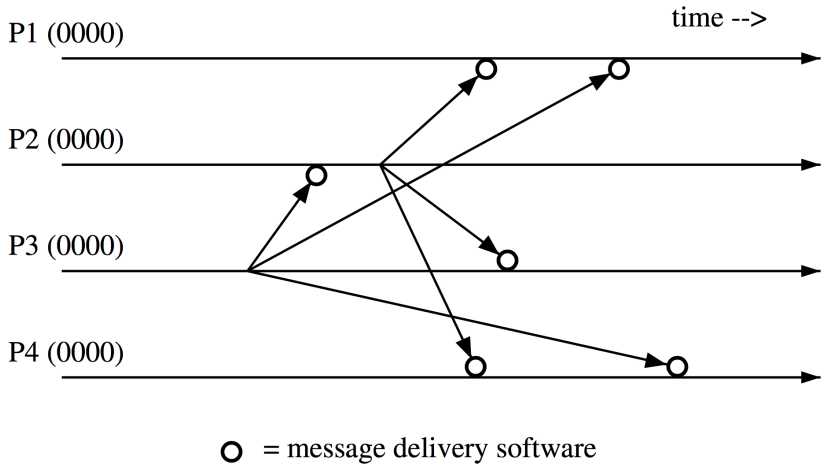
    1. Concurrent execution of components.
    2. Independent failure modes
    3. Communication delay
    4. No gobal time

    In the light of these characteristics, discuss the monitoring of a widely distributed industrial process with the following properties:

    Distributed monitoring computers analyse regions of the process. Each region contains a number of sensors at identified locations and with the ability to generate timestamps. Some sensors monitor temperature, others monitor pressure.

    If both temperature and pressure are found by a monitoring computer to be above their defined thresholds in a given locality within its region it sends an alarm signal to the process control centre, indicating the time and place of the occurrence. The control centre initiates action to bring the values under control.

    (b) The diagram below represents a process group that communicates by means of multicast messages. [10]



At each process-hosting node, message delivery software decides whether an incoming message should be delivered to the process or buffered for later delivery. This is achieved by the use of vector clocks.

With reference to the example shown in the diagram, describe the vector clock algorithm for delivery of messages in causal order.

2011 Paper 5 Question 9

2. (a) We have considered four types of middleware: remote procedure call, object-oriented middleware, message-oriented middleware, and event-based middleware.

   i. Each middleware has a core action, such as a remote procedure call or a remote method invocation. This entails data transfer that is either unidirectional (out of or into the calling context) or bidirectional (in and out). State which is used by each of the four types of middleware. [4]

   ii. Does each of these; uni and bidirectional data transfer have sufficient expressive power for programming? Explain your answer. [2]

   iii. One of the characteristics of distributed systems is that they lack global time. Given your answers above, what effect might this have on middleware use? [4]

   (b) i. What are causal and totally ordered message delivery? [2]

   ii. Which does vector clocks provide? [1]

   iii. The vector clock algorithm is a way of sharing state, ensuring that every process knows what it needs to about how far the others have progressed. Why is it critical that messages having vector timestamps are never lost? [2]

(c) i. Storage services can be *stateful* or *stateless*. Give **one** advantage and **one** disadvantage of each. [2]

ii. If you were designing a service to support film production, which would you use and why? [3]