CASE STUDY PRACTICE QUESTIONS - 24 Oct 2018 - by Dave Mulkey

1. Explain 2 important reasons that Bangbai wishes to replace their CAD
   system with a new EMIS system. You must EXPLAIN the reasons -
   for example, if you state that "the CAD uses old technology", you must
   EXPLAIN why this is a problem.   [4 marks]

There are several reasons. Any two of the following:

*(a) older technologies do not provide desirable features, such as REAL TIME (fast)
   feedback, since they depend on rather slow human operators*

*(b) the CAD system was designed for a smaller population and fewer alerts,
   but the need has grown. For example, there are more traffic accidents now
   than 20 years ago, as well as more traffic jams making emergency response difficult.*

*(c) CAD system does not supply as much automation as desirable,
   for example using AI to make quick decisions of how to respond*

*(d) newer technologies, such as cell phones, are more familiar and usable
   for the citizens and will encourage a higher level of user buy-in -
   e.g. quicker acceptance and more usage*

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2. Describe 2 advantages and 2 disadvantages of depending on
   modern Smartphones rather than depending on old-fashioned
   wired telephones.   [4 marks]

Advantages
- Smartphones are mobile - not tied to a wire - and hence more often available
*- Smartphones provide more types of data flow - graphics, GPS, voice - than old phones
   that are strictly voice*

Disadvantages
*- Under some circumstances Smartphones may be less reliable, as cell-phone towers
   may fail in hurricanes, but buried wires are safer and more reliable*
- old phones "just work", with no need to install an App
*- The Smartphone system outlined in the diagram on page 4 implies that there will be
   no human operators available - this could be a problem in a complex, unpredicted
   disaster situation - but this could be solved by having backup Operators available*

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3. (a) Discuss 2 important advantages of using a Multitier Architecture
       in the new EMIS, as opposed to wrapping all functionality into
        just a few standard Java applications/apps.   [4 marks]

*- it plans the entire solution in a MODULAR way, which should make maintenance
  and revisions easier, as single modules can be repaired or replaced without
  the need to change other modules. In a less modular system, changes often
  require changes throughout the system.*

*- developers and support staff can focus on the smaller area (module) where they
have significant expertise. For example, the "back-end" data-bases require more
attention to hardware technical issues, where as the user-interface end requires
more attention to user needs and presentation.*

    (b) Explain which TIER of the Multitier architecture would implement
        a FAIL-OVER system, including WHY this is important.   [2 marks]
    *Fail-over means that a backup device can instantly take over the function
    of a significant device, such as a server. Fail-over is essential in the database
    backend, where servers are supporting the rest of the tiers and must run 24/7.*

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4. Describe how the EMIS can properly handle URGENT vs NON-URGENT
    emergencies, especially how the DECISION would be made about
    the level of urgency.   [4 marks]

*Studying the Multi-tier Architecture, we notice that the Logic Tier is central.
Presumably some sophisticated algorithms, possibly AI, are available in this tier.
One should probably attempt to implement at least some basic AI algorithms
to make decisions about urgency. This could depend on how many reports
are received in a short time, as well as the amount of damage reported. Then the
logic tier could look at the emergency databases in the back-end tier and
see how many responders are actually busy or available. Presumably these
decision would be monitored in real-time by the Control Room Operators,
who could modify or over-ride inappropriate decisions from the AI.*

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5. Describe the need for compatibility between the old CAD system
    and the new EMIS system, including:
    - ethical considerations
    - technical issues
    - reliability   [8 marks]

*There is a lot of data in the system about the available emergency services.
This data needs to be taken over in the new EMIS, so compatibility would help here.
Assuming that the old CAD system will continue running temporarily during the
change-over, it's better if the two systems can share data. That doesn't mean that
old phone calls to the CAD must be received IDENTICALLY into the new EMIS, but it's
better if they can easily be converted to function in the new EMIS because there will
probably be some citizens who don't immediately have the App running on a cell-phone.
The slow adapters - those who don't yet own a cell-phone - will likely belong to
specific groups, like old people, very young children, and poor citizens. It would be
unethical to create a new EMIS and knowingly disadvantage such groups.
It is likely that the EMIS will still depend on some old technology, like normal
phone connected Internet access (e.g. a home WIFI router), so the new system
should remain compatible with such older infrastructure. And at a simple technical level,
they will want to have an App that runs on the most standard cell-phones - e.g. Android -
so that it's not necessary to buy a specific phone or install a specific Operating System.*

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6. Describe 2 possible approaches to LOAD-BALANCING, including:
    - when/why load-balancing is necessary
    - how each of your approaches will perform better than alternatives
    - what technical requirements must be met in order
       to implement each approach   [6 marks]

*Load Balancing is especially important when there are a large number of
simultaneous requests, as would happen during a large disaster, like
an earthquake. This is not such an important issue for small reports
like a single automobile accident. The most common approach is
to use many servers (many thousands or more) and to split up reports
so that each server only needs to handle a few. Even then, it is possible
that a single server is handling hundreds of messages simultaneously.
A Weighted-Round-Robin approach will probably be effect in this case.
Since individual messages are relatively short, a few times around the
service cycle will dispose of many messages. And if the more
urgent requests are prioritized above the less urgent, the Weighted
approach can process urgent requests more quickly. Hence, the combination
of thousands of servers and Weighted-Round-Robin on each server should
work well, barring catastrophic failure of many of the servers.*

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7. Explain the difference between STATEFUL and STATELESS
    communication, including an example of where each
    commonly occurs.   [4 marks]

*STATELESS means that the two ends (client and server) can complete their
tasks without knowing specific information about the current "state" of the
other end. I also means that whenever the connection is interrupted,
possibly by power failure or communication channel interference, it's possible
to reconnect and simply continue, with no need to catch up on what
happened during the disconnection. The Internet was designed to be
a stateless system. Another example is any broadcast system, like radio and TV.
Although a temporary disconnection might lose information, it is still easy
to reconnect and start listening again. A common example of a STATEFUL
system is any industrial control system, like controlling a manufacturing robot.
The controlling computer must ensure that the robot is functioning correctly
in real time, and this requires constant timely feedback sensors so that the
controller can figure out what commands need to be sent immediately.
In such cases, temporary disconnections usually require that the robot
be shut down and restarted to a normal starting configuration.
(Many other answers are possible)*