Homework 10
1.264, Fall 2013
Communications, and software process

A. Communications

1. VPN
    a. What bandwidth is provided over the IPsec VPN DSL links from Green Bay, WI and Chicago IL? Look up the typical DSL bandwidth in the telecom book. Then look at the bandwidth needed at these sites on page 24. Propose a way to use DSL to provide this amount of bandwidth. If DSL can't provide this bandwidth, describe strategies to meet the needs of these two offices. For example, Verizon offers business FIOS and cable companies offer business data services.

    21 Mbps is required, at least in the future. DSL typically provides 1.5 Mbps, so DSL is not feasible to meet the stated needs (21 Mbps). Cable modems and FIOS can provide 30 Mbps downstream and perhaps upstream; these are feasible.

    b. Does DSL connect Green Bay and Chicago with Syracuse, or is it an access technology? If DSL is an access technology, what wide area technology do you think it connects to? If DSL is a wide area technology, explain its distance limits, if any.

    DSL is an access technology limited to 18,000 feet; it links these offices to the open Internet, as provided by an Internet Service Provider (ISP).

    c. Is the VPN running over the open Internet?

    Yes. This is why the VPN encryption/security is required.

    d. Why would TacDoh use DSL links and a VPN for these offices instead of a T1, T3 or OC3 link?

    DSL offers the same bandwidth as a T-1 and is typically much cheaper. The next increment in bandwidth offered by carriers is typically T-3, 28 times as much. This is much more expensive (10 times a T-1) and not needed. Companies who need more than a T1 but less than a T3 have have few options before carrier Ethernet.

2. Carrier Ethernet
    a. Why would TacDoh explicitly prefer carrier Ethernet over other alternatives, such as a VPN for all sites, or T3 (OC1) or OC3 links running SONET?

    VPN. VPNs are expensive: software or hardware is bought, the VPN must be administered. VPNs are point-to-point but the company's

topology is more complex than that. VPNs are typically used for small branch offices or employees working remotely; this is not the case here.
T3: Expensive and not needed everywhere. No redundancy. Need to convert from Ethernet to T3 and back, which cost something and must be managed.
Carrier Ethernet: Same protocol as LAN, little or no extra hardware expense, no software, little or no administration, flexible

b. Last mile: Qwest provides Ethernet local access via native Ethernet (MAN Carrier Ethernet) or SONET. Compare the configurability of MAN carrier Ethernet versus SONET: which one can provide more bandwidth options?

MAN carrier Ethernet is preferred, for the same reasons as part a above. Same protocol as LAN, less hardware expense, less management

c. Does the Qwest VPLS (MPLS) service encrypt your traffic? If not, is this satisfactory?

Qwest does not mention encrypting your traffic, and MPLS typically does not. Your traffic is physically secure since it does not go over the open Internet. You must trust Qwest to deliver your traffic only to your Ethernet ports (and to no one else's) and you must trust the MPLS protocol and configuration to not allow eavesdropping by others.

d. Compare the redundancy of the Qwest proposal with your current network.

The current network has redundancy between the 3 headquarters nodes, but not otherwise. The Qwest network has redundancy between all nodes. The local access link to the Qwest network, if on MAN carrier Ethernet, also has redundancy. Otherwise it may not.

3. Cost. The Qwest proposal costs $142,000 per month.
   a. What is the cost of your current network, as shown in Figure 1? Typical monthly costs are $45,000 for OC-3, $15,000 for T-3, and $1,000 for 7 Mbps business DSL.

3 OC-3	**$135,000**
5 T-3	**$ 75,000**
2 DSL	**$ 2,000**
Total	**$212,000**

   b. Does the Qwest proposal offer a cost savings over your current network?

   Yes, about $70,000 per month

   c. Your CEO asks what network changes can be made, and savings obtained, if video is eliminated. Provide a brief analysis.

Video is only 3-10Mbps out of 21-170 Mbps total bandwidth needed, or 1/7 (14%) to 1/17 (6%) of total bandwidth. Its elimination will result in little savings, since such a small increment in bandwidth does not allow the company to reduce the bandwidth at any node or link. There might be isolated cases where bandwidth could be reduced, but the savings would be negligible.

4. Metro area network (MAN)
   a. Which of your sites, if any, can be connected by a metropolitan area network (MAN)? Assume MANs are available in all the metro areas in which your company has facilities. Briefly explain your answer. If the MAN is feasible and it is inexpensive, briefly explain how the company might use it.

   Your Manhasset and New York sites can be on a MAN, and your San Mateo and San Francisco sites can be on a MAN. These pairs are each in the same metro area. Traffic between them can be handled just on the MAN, lowering the demands on the MPLS network, and they can share an access point to the MPLS network. This is likely to lower your costs.

5. Bandwidth
   a. How many phone conversations can be carried in 50 Mbps of bandwidth, as the headquarters sites require? Assume maximum utilization is 70% and that the average bandwidth used in a voice call is 32 kbps.

   If each call requires 32 kbps, and we have .7 * 50 Mbps, or about 35 Mbps of capacity, we can carry approximately 1,000 calls on the link.

   b. In Lotus Notes, how many 1MB documents can be shared (replicated) per minute with 20 Mbps of bandwidth? Assume 70% maximum utilization.

   A 1 MB document is 8 Mb. .7 * 20 Mbps yields 14 Mbps of bandwidth, or 60*14 = 840 Mb per minute. We can transfer about 100 documents per minute.

6. Bandwidth to external sites
   a. Your biggest customer requires you to send all their documents in a single daily batch transmission that must start after 5pm and must be complete by 6pm. They are currently in Syracuse, NY, adjacent to your facility and connected via a shared LAN, but are moving to Atlanta, GA. The size of the files to be sent daily is approximately 300 MB. Describe and briefly discuss at least 3 options you have.

   300MB is 2400 Mbit. 2400 Mbit divided by 3600 seconds, yields a data rate of 670 kilobits/second. This is about half a T1 line. Options:
   1. Lease a private T1 line and send the data over it.

2. **Set up a VPN with the customer and send the data over the Internet, encrypted. The two ends of the connection are fixed, managed, etc. so a VPN would work.**
3. **Include the customer in the Qwest VPLS network, at a very low bandwidth**
4. **Negotiate to send the data during the day, not just as a batch. If it's sent in 10 hours instead of 1 hour, the data rate is only 67 kbps. This is very close to 64 kbps, a basic voice circuit, and this capacity is likely to exist in the current networks of both organizations. You might be able to do this for no incremental cost.**

b. Your company has a subsidiary in a remote area, connected only by a VSAT satellite link. You have a choice of 9.6kbps or 64kbps service. The site has the following traffic in a 10 hour day:
   i. Lotus Notes documents: 500 messages per day, averaging 1MB
   ii. Web/Internet access: 25 users, requiring general Web browsing capabilities as part of their jobs. Assume 2MB/hr/user.
   iii. ERP (SAP) XML data: purchases, invoices, shipments, payroll, etc. 500 messages per day, averaging 250 KB per message
   iv. Voice is handled via landline phones; it is not carried over the VSAT link, and there is no video.

Could you use 9.6kbps? Could you use 64kbps? Or is neither sufficient? What if you spread ERP and Notes traffic over 24 hours instead of 10?

Notes: 500MB
Web: 25 users at 2MB/hour (?) times 10 hours= 500 MB
ERP: 125MB
Total: 1.125 GB/10 hours= 112.5 MB * 8/3600 sec=~ 280 kb/sec
Neither is sufficient. You would need to cut your traffic by a factor of 4 to use the 64 kbps VSAT link. If you spread ERP and Notes traffic over 24 hours, they would be 10/24, or about 40% as much per hour. This is more than a factor of 2, but not a factor of 4, so the 64 kbps link is not enough, even without the Web traffic.

7. Two railroads, UP and CSX, offer you the use of their fiber optic networks, which serve all your locations, as an incentive for you to sign a contract with them. Assume that the transportation economics are favorable, that the railroad fiber network can handle your data traffic, and that the telecom cost is half of Qwest's bid. You would have to get to the railroad network point of presence. Assume a MAN is available in all cities in which you have facilities, and that the MAN costs would be $20,000 per month for all 8 sites and would provide the same bandwidth as the Qwest proposal. Would you move your data traffic onto the railroad's private network? If so, what conditions would you require? Discuss briefly.

The cost is attractive: $71,000 per month, plus $20,000 in MAN cost, instead of $142,000 per month. If you access the railroad comm. networks through a MAN, it is easy to change to another network if the need arises. You would

want to assure that the service level (availability, uptime, etc.) meets the same standard as Qwest, and that your data will be protected.

B. Review of Development Cycle 1

Take out your homework 2 solutions and revise them to reflect the knowledge gained from doing the first cycle of development. Don't rewrite the document; just make changes, additions or deletions to reflect what you've learned. They can be brief; they can refer to homework sets 3-9 as needed.

Please put in revised screen shots from your Web site to replace the initial Web pages in your homework 2 solution. Also, revise your estimate of the number and complexity of Web pages to implement your requirements.

Hand in the revised requirements narrative document. Keep it the same length and organization as your original document. Update the user interface, process descriptions, resource estimates, etc. Change the error bounds on the resource estimates to reflect the later stage of development.

While you would normally include the UML models, data model, sample database and prototype Web application in the revised requirements (and/or design documents), assume that they are available and will be delivered to the management as separate documents, to which you may refer. Thus, you should assume that homework sets 3-9 are being handed in to the management as well, and that they have been appropriately edited.   Again, revise only homework 2.

Add one or two pages of comments at the beginning of your revised requirements, addressing the following questions:
- What do you believe the outcomes of development efforts would be in the following two cases:
  - Contracting development of your system to a vendor based on your original homework 2
  - Contracting development of your system to a vendor based on a package containing your homework sets 3-9 and revised homework 2
- Do you believe the error bounds? Do they reflect the uncertainty that has been removed by the first cycle of the spiral model?
- Do you feel the current requirements can be translated into a design and system with low risk, or are there still substantial elements of uncertainty? If so, identify some of the substantial elements of uncertainty.

No formal solution is provided. The key items in the revised requirement document are:

1. The user interface should reflect ASP.NET features, navigation and look and feel. It should reflect the structure of the Web site as implemented in ASP.NET. The contents of each Web page should match those in the Web site in homeworks 6-9.

Students should copy screen shots into their revised requirements document. Students should compare their finished Web site with their original requirements and comment on the major differences. Items in the original requirements that were omitted to save time, as stated by the instructions in homeworks 6-8 (such as not handling account creation, browsing carriers, handling quantity limits or back orders, etc.) should be estimated for the next spiral.

2. Scenarios in the narrative should be revised. These almost certainly were simplified during the construction of the Web site. The order process may be substantially different from the original requirements.

3. Resource estimates. Based on the revised requirements (changed Web pages, changed processes, and actual database design), students should recompute the resources required using the same method as in homework 2. The actual estimates will vary by group, since the requirements and implementations vary. Students should comment on whether their new estimates fall within the range of their original estimates. The range of the estimate at this point should be at the 'Approved Product Definition' level. We know more than at the original product specification; some groups may be able to justify using the 'Requirements Specification' level.

The comments should cover the following:
1. Outcome of efforts in the following two cases:

    a. Contracting development to a vendor after HW 2: Vendor would probably have stated that the requirements are inadequate and would insist on a change order process that would be invoked many times as changes are made and details are specified. It would be a slow, costly and contentious process to build a production system from your initial requirements. The data model would have to be built, processes would be changed, the user interface would be changed, etc. Alternatively the vendor could propose a prototype that would probably be thrown away; it would be less contentious but would leave some issues unresolved until the next spiral that could have been resolved.

    b. Contracting development to a vendor after HW 9: Vendor would be much more pleased that the requirements are defined and a first version of the system exists, albeit with missing parts and imperfections. Data model, processes and user interface would probably be quite stable. Effort would be much more likely to succeed, since both the company and developers would have a much clearer concept of the system, and better-defined expectations.

2. Error bounds on next cycle. Error bounds on person-months at the 'Approved product definition' level are 0.5 to 2.0 times the point estimate. These are narrow ranges but they should be attainable as long as essentially all issues omitted in spiral 1 (homeworks 2-9) are addressed in the revised requirements. Examples are carrier browsing, order entry exceptions,

customer account creation, reports (none were specified), SQL transactions for order entry, credit card handling, etc. A risks list would be a useful element of the assessment of error bounds.

3. Can requirements from the end of spiral 1 be translated into a design and a system? Yes, with additional work; it will take more than just one additional spiral. A functional system could be produced after the second spiral but it would still have some issues. It might be satisfactory for a subset of users. Note that a second spiral (and additional spirals) would usually assume full time professional staff, so that much more could be done than in the first spiral that you did in one of your many classes this term. The major issues or risks are difficult to guess in the absence of a real company, but they might include:
   a. Clumsiness in browsing the large product catalog and carrier database
   b. Errors in the data (carrier, product, customer)
   c. Complications in payments (credit card or purchase orders), which were not explored in spiral 1
   d. Editing and deleting order items; this could be a difficult user interface design issue. Editing and deleting products, carriers, customers, etc. are probably straightforward since they are done by company staff, who can be trained, and the tasks are easier anyway.
   e. Etc.

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