Optimizing Shipping Lanes.

In this problem set you will be working for a company with operations in the Northeast. They are preparing to issue a Request For Proposal (RFP) for bids on their shipment operations within the region. You have been asked to help prepare the RFP and then to select the best providers after the bids have been received. You should be able to complete this problem set in Excel, taking advantage of the provided spreadsheet.

Problem 1:
The first part of the combinatorial lane optimization is the enumeration of all the possible shipping lanes. While this is simple in a small network, the task can quickly become overwhelming. Your employer has facilities in Boston (BOS), Buffalo, NY (BUF), New York City (NYC) and Cleveland, OH (CLE) and maintains shipping lanes as shown in Figure 1.
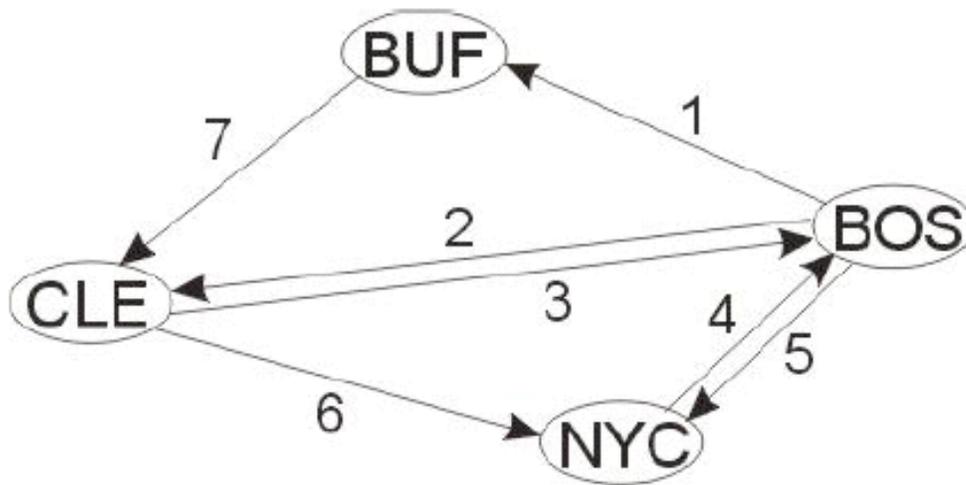

Figure 1: The network of shipping lanes connecting the shipper's facilities with lane numbers shown.

There are a total of 26 possible lane-combinations (we ignore the starting point of "round-trip" routes). In order to ensure some uniformity in the bidding you have been asked to provide a list of all the possible lane combinations. In addition, if the carriers bid on all the combinations, you will have a greater search-space over which to look for an optimal solution, hopefully giving you a lower total cost[1]. In this case, your co-worker was working on the enumeration, but called in sick today – the day you need to release the RFP –, telling you that he hadn't finished writing down all the pieces. Please find the

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[1] Of course, if the network were much larger, the number of such pieces would be extremely high and neither you nor the bidders would want to deal with an exhaustive enumeration.

two missing pieces, add them to the distributed spreadsheet and clearly mark the two missing entries.

Problem 2:

Following the RFP, the company received bids from three carriers. These bids are provided in the attached spreadsheet. Note that the bids are given for the two columns you needed to find in the previous part and are listed as "Missing 2-piece-trip" and "Missing 3-piece-trip". (In other words, you should have found one 2-piece and one 3-piece trip in the previous problem.) With no constraint other than the requirement that all lanes be covered exactly once, please find the optimal lane-carrier matching.

A solution tip: Because the Excel solver is not very powerful or smart, you may have to adjust the options you give it as to the nature of the solution (under the "Options" button). A good first check is to make sure you're giving it enough time. If that's not working, think about what other properties you know about the solution and check the appropriate boxes. If you do have to make any of these assumptions please note this on your solution and state why the assumption is valid. (As a final note, the computer should take no more than a minute or two to find the solution on even the slowest computers – if it's taking you longer you should rethink your assumptions.)

Problem 3:

In order to ensure a degree of profitability out of contract with a shipper, a carrier may require that it be awarded some minimum level of business. At the same time, a supplier may want to limit its administrative overhead and deal only with one carrier. You are asked to examine the effects of each such choice. For each part please also include a formulation of the IP as you solved it.

(a) Solve the problem with the constraint that no carrier be awarded fewer than two lanes.

(b) Solve the problem with the constraint that only one carrier is awarded all the lanes. (Note that you need to be careful how you formulate the problem, lay it out in Excel and ask the solver to solve it. If it tells you that there is no solution, think: does this make sense? How might you reformulate the problem so that it can find a solution?)

(c) How does your answer to each of the previous two parts compare with the original solution? How do they compare with each other? Do the differences make sense?

Problem 4:

You have since learned that Carrier B has lost its license to pick up cargo in Boston (they are, however, still allowed to make deliveries). You have been asked to find the lowest-cost alternative, given this constraint.

Please submit a hard-copy summary of your results and write-up. For Problems 2, 3 and 4 you should make sure to include a clear formulation of the problem you solved.