1, Solution 2.23: My logic for the third link does not work! (See below).
I will change the question to ask instead for the expected cost of the second link.

For example, let us assume the following costs:
A to B: 60
A to C: 30
A to D: 40
B to C: 50
B to D: 20
C to D: 70
Then the first link is B to D with a cost of 20.
The second link is A to D with a cost of 40.
(The cost of A to C does not enter into this decision.)
Of necessity the cost of B to C is greater than the cost of the second link.
Of necessity the cost of D to C is greater than the cost of the second link.
However, the cost of A to C of 30 is less than the cost of the second link of 40.
Thus, we can not apply my logic to the third link, by subtracting 40 from 30.

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