Study Guides on Computer Networks and Distributed Systems

Clock synchronization and NTP

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Questionnaire

1. The Network Time Protocol (NTP) can be used to synchronize computer clocks. Explain why, even with this service, no bound is given for the resulting time difference between two clocks even right after synchronization.

   Computing the offset necessary to add to the requester clock (C_{Req}) which needs to be set to the responder clock (C_{Resp}) time entails determining $Delay_{Return}$ or the average of the return path delay over time. The approximation to $Delay_{Return}$ that we can compute is just $\frac{Rtt}{2}$, which, in reality can depart a lot from the actual $Delay_{Return}$ depending on the degree of asymmetry between the forward and the return paths and their respective delays, so the accuracy of this approximation can introduce a substantial error in the clock.

   Perfect synchronization would entail zero-Rtt which is impossible to achieve.

2. What transport does NTP use?

   NTP is documented in RFC 5905. The transport used by NTP is UDP

3. When synchronizing computer clocks, can a clock be set back? Explain what has to be done in order for a clock to acquire the same real time as another clock.

   Computer clocks, in general, must not be brought back, since that might cause the repetition of certain actions configured by system administrators. The correct action to take upon a clock that must be brought behind consists in reducing its speed so that in a certain period of real time it will be in sync with a remote clock (One that, for some reason, has a good reference time). By decelerating the clock, it will continue generating a sequence of growing time values, though with a reduced accuracy. This so-called *clock monotonicity* will avoid the foregoing undesirable effects altogether. POSIX function adjtime() will accelerate or decelerate the clock to gain or lose some time monotonically.

4. Solve the synchronization example included in the lecture slides

   The present example aims to illustrate the synchronization process of two hosts A and B. Host A is the time sync requester and B is the time sync responder. The requester host executes a *naïve* form of Cristian's algorithm in which it performs ten time requests to host B.The relevant timestamps are recorded in the spreadsheet below. The cells in green background represent the problem data that we are given and the gray-blue cells represent the calculations that we have to

do in order to obtain the desired final result: the new time computer A must be set to so it be in sync with B's clock.

Assume min (ms) = 10					
	Timestamps				
Request no.	Receive	Transmit	Rtt ms	Tresp time (ms)	RttN (ms)
1	1:20:32.150	1:20:32.154	31	4	27
2	1:20:34.040	1:20:34.044	29	4	25
3	1:20:37.510	1:20:37.514	28	4	24
4	1:20:40.320	1:20:40.324	29	4	25
5	1:20:44.750	1:20:44.754	28	4	24
6	1:20:49.020	1:20:49.024	30	4	26
7	1:20:55.270	1:20:55.274	29	4	25
8	1:20:58.650	1:20:58.654	30	4	26
9	1:21:02.340	1:21:02.344	31	4	27
10	1:21:08.900	1:21:08.904	31	4	27

5. Does TCP offer some facility to allow a transmitter to compute the *network Rtt* (Rtt_N) of a connection, *i.e.*, the Rtt that doesn't include the IRQ time (T_{RESP}) consumed by the destination host servicing the request received from the client.

   TCP's timestamps can only be used to calculate the overall Rtt, which includes T_{RESP}.

6. Describe the kind of operations caused by the reception of a layer-2 frame. Specifically we wish to obtain a perspective about what happens right after the microprocessor deals with the hardware interrupt which initially reports the full deserialization of a new frame.

   This exercise consists of having you review the lab practices of Computer Networks.

7. Explain the basic principles underlying the Christian's synchronization algorithm

8. Clock synchronization over the internet suffers from a lack of precision, can you explain the cause?

9. Tell several ways to have a host synchronized with a UTC source over the Internet

10. What is *clock drift?* What is its basic cause?

11. Give an explanation of the following diagram:
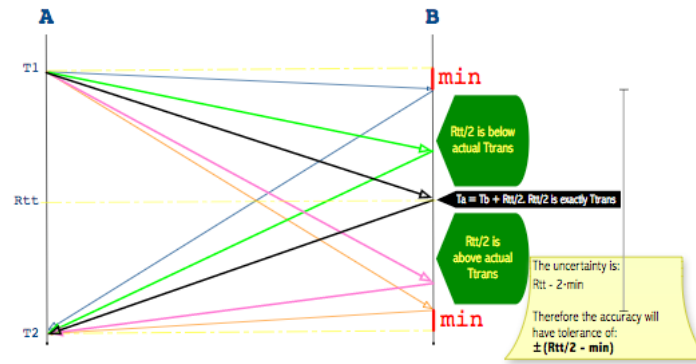
12. Study the solved exercise about Clock Synchro in paloalto.unileon.es/ds

13. Solve exercises **14.1 – 14.5** from Dollimore/Kindberg/Coulouris/etc (You can access the problem statements on the last page of the Physical Clocks ppt lecture presentation)