Assignment 1 Report

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## Exercise 1

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| Perfect Failure Detector Case: γ = 1000, δ = 1000 | |
| Topology:  node(1, "127.0.0.1", 22031);  node(2, "127.0.0.1", 22032);  node(3, "127.0.0.1", 22033);  node(4, "127.0.0.1", 22034);  defaultLinks(500, 0); | Scenario:  command(1, "S1000:X");  command(2, "S6000:X");  command(3, "S10000:X");  command(4, "S500"); |
| Node 1:  1693@SCENARIO {Assignment1aMain} Process 1 has started commands [S1000:X].  0 INFO {Application1a} Sleeping 1000 milliseconds...  11200@SCENARIO {Assignment1aMain} Process 1 has terminated. | |
| Node 2:  1685@SCENARIO {Assignment1aMain} Process 2 has started commands [S6000:X].  0 INFO {Application1a} Sleeping 6000 milliseconds...  4001 INFO {Application1a} 1 was crashed!  10830@SCENARIO {Assignment1aMain} Process 2 has terminated. | |
| Node 3:  2230@SCENARIO {Assignment1aMain} Process 3 has started commands [S10000:X].  0 INFO {Application1a} Sleeping 10000 milliseconds...  4009 INFO {Application1a} 1 was crashed!  8011 INFO {Application1a} 2 was crashed! | |
| Node 4:  2230@SCENARIO {Assignment1aMain} Process 4 has started commands [S500].  0 INFO {Application1a} Sleeping 500 milliseconds...  500 INFO {Application1a} DONE ALL OPERATIONS  4006 INFO {Application1a} 1 was crashed!  8019 INFO {Application1a} 2 was crashed!  12022 INFO {Application1a} 3 was crashed! | |
| Observation:  The nodes failure is detected as expected. | |

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| Eventually Perfect Failure Detector Case: Time Delay = 1000, Δ= 500 | |
| Topology:  node(1, "127.0.0.1", 22031);  node(2, "127.0.0.1", 22032);  node(3, "127.0.0.1", 22033);  node(4, "127.0.0.1", 22034);  defaultLinks(500, 0); | Scenario:  command(1, "S1000:X");  command(2, "S6000:X");  command(3, "S10000:X");  command(4, "S500"); |
| Node 1:  1601@SCENARIO {Assignment1bMain} Process 1 has started commands [S1000:X].  0 INFO {Epfd} Timedelay=1000, Delta=500  500 INFO {Application1b} Sleeping 1000 milliseconds...  5335@SCENARIO {Assignment1bMain} Process 1 has terminated. | |
| Node 2:  1674@SCENARIO {Assignment1bMain} Process 2 has started commands [S6000:X].  0 INFO {Epfd} Timedelay=1000, Delta=500  158 INFO {Application1b} Sleeping 6000 milliseconds...  2168 INFO {Application1b} Node 1 was suspected! Period=1000  10418@SCENARIO {Assignment1bMain} Process 2 has terminated. | |
| Node 3:  1543@SCENARIO {Assignment1bMain} Process 3 has started commands [S10000:X].  0 INFO {Epfd} Timedelay=1000, Delta=500  80 INFO {Application1b} Sleeping 10000 milliseconds...  2087 INFO {Application1b} Node 1 was suspected! Period=1000  7117 INFO {Application1b} Node 3 was suspected! Period=1000  7117 INFO {Application1b} Node 2 was suspected! Period=1000  8126 INFO {Epfd} Increase period by 500 and current period is 1500  8131 INFO {Application1b} Node 3 was restored! Period=1500  14441@SCENARIO {Assignment1bMain} Process 3 has terminated. | |
| Node 4:  1296@SCENARIO {Assignment1bMain} Process 4 has started commands [S500].  0 INFO {Epfd} Timedelay=1000, Delta=500  376 INFO {Application1b} Sleeping 500 milliseconds...  907 INFO {Application1b} DONE ALL OPERATIONS  2385 INFO {Application1b} Node 3 was suspected! Period=1000  2387 INFO {Application1b} Node 1 was suspected! Period=1000  2387 INFO {Application1b} Node 2 was suspected! Period=1000  3388 INFO {Epfd} Increase period by 500 and current period is 1500  3393 INFO {Application1b} Node 3 was restored! Period=1500  3396 INFO {Application1b} Node 2 was restored! Period=1500  9407 INFO {Application1b} Node 2 was suspected! Period=1500  13909 INFO {Application1b} Node 3 was suspected! Period=1500 | |
| Observation:  From the log above, we can see some nodes are suspected and restored after sometime because at the beginning the time delay is same as period but heartbeat message has transition time. Then after the period is increased by 500, there’s no problem. The suspects were detected as expected. | |

## Exercise 2:

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| Eventually Perfect Failure Detector Case: Time Delay = 1000, Δ= 500 | |
| Topology:  node(1, "127.0.0.1", 22031);  node(2, "127.0.0.1", 22032);  node(3, "127.0.0.1", 22033);  node(4, "127.0.0.1", 22034);  defaultLinks(3000, 0); | Scenario:  command(1, "S500");  command(2, "S500");  command(3, "S500");  command(4, "S500"); |
| Node 1:  1577@SCENARIO {Assignment1bMain} Process 1 has started commands [S500].  0 INFO {Epfd} Timedelay=1000, Delta=500  349 INFO {Application1b} Sleeping 500 milliseconds...  849 INFO {Application1b} DONE ALL OPERATIONS  2352 INFO {Application1b} Node 4 was suspected! Period=1000  2352 INFO {Application1b} Node 3 was suspected! Period=1000  2352 INFO {Application1b} Node 2 was suspected! Period=1000  3352 INFO {Application1b} Node 1 was suspected! Period=1000  4423 INFO {Epfd} Increase period by 500 and current period is 1500  4425 INFO {Application1b} Node 1 was restored! Period=1500  5925 INFO {Epfd} Increase period by 500 and current period is 2000  5926 INFO {Application1b} Node 4 was restored! Period=2000  5926 INFO {Application1b} Node 3 was restored! Period=2000  5926 INFO {Application1b} Node 2 was restored! Period=2000 | |
| Node 2:  1486@SCENARIO {Assignment1bMain} Process 2 has started commands [S500].  0 INFO {Epfd} Timedelay=1000, Delta=500  145 INFO {Application1b} Sleeping 500 milliseconds...  646 INFO {Application1b} DONE ALL OPERATIONS  2146 INFO {Application1b} Node 4 was suspected! Period=1000  2147 INFO {Application1b} Node 3 was suspected! Period=1000  2148 INFO {Application1b} Node 1 was suspected! Period=1000  4196 INFO {Application1b} Node 2 was suspected! Period=1000  5196 INFO {Epfd} Increase period by 500 and current period is 1500  5196 INFO {Application1b} Node 4 was restored! Period=1500  5196 INFO {Application1b} Node 3 was restored! Period=1500  5196 INFO {Application1b} Node 1 was restored! Period=1500  5197 INFO {Application1b} Node 2 was restored! Period=1500 | |
| Node 3:  1573@SCENARIO {Assignment1bMain} Process 3 has started commands [S500].  0 INFO {Epfd} Timedelay=1000, Delta=500  640 INFO {Application1b} Sleeping 500 milliseconds...  1142 INFO {Application1b} DONE ALL OPERATIONS  2646 INFO {Application1b} Node 4 was suspected! Period=1000  2648 INFO {Application1b} Node 1 was suspected! Period=1000  2648 INFO {Application1b} Node 2 was suspected! Period=1000  4697 INFO {Application1b} Node 3 was suspected! Period=1000  5697 INFO {Epfd} Increase period by 500 and current period is 1500  5697 INFO {Application1b} Node 4 was restored! Period=1500  5698 INFO {Application1b} Node 3 was restored! Period=1500  5698 INFO {Application1b} Node 1 was restored! Period=1500  5698 INFO {Application1b} Node 2 was restored! Period=1500 | |
| Node 4:  1555@SCENARIO {Assignment1bMain} Process 4 has started commands [S500].  0 INFO {Epfd} Timedelay=1000, Delta=500  196 INFO {Application1b} Sleeping 500 milliseconds...  696 INFO {Application1b} DONE ALL OPERATIONS  2200 INFO {Application1b} Node 3 was suspected! Period=1000  2200 INFO {Application1b} Node 1 was suspected! Period=1000  2200 INFO {Application1b} Node 2 was suspected! Period=1000  5241 INFO {Epfd} Increase period by 500 and current period is 1500  5241 INFO {Application1b} Node 3 was restored! Period=1500  5241 INFO {Application1b} Node 1 was restored! Period=1500  5241 INFO {Application1b} Node 2 was restored! Period=1500 | |
| Observation:  From the log above, we can see some nodes are suspected and restored. And the period was increased as expected. But the increased period is not as much as the 3000ms link delay we defined. The time delay is 1000ms so it will send heartbeat per second. Even the link delay is 3000ms, after 4000ms, the detector can receive heartbeat message every second. So the increased period doesn’t need to be as much as or higher than 3000ms. | |

## Exercise 3

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| Eventually Perfect Failure Detector Case: Time Delay = 1000, Δ= 500 (Using Fair loss link) | |
| Topology:  node(1, "127.0.0.1", 22031);  node(2, "127.0.0.1", 22032);  node(3, "127.0.0.1", 22033);  node(4, "127.0.0.1", 22034);  defaultLinks(500, 0.5); | Scenario:  command(1, "S500");  command(2, "S500");  command(3, "S500");  command(4, "S500"); |
| Node 1:  ……  308683 INFO {Epfd} Increase period by 500 and current period is 6500  308683 INFO {Application1b} Node 4 was restored! Period=6500  308683 INFO {Application1b} Node 3 was restored! Period=6500  341188 INFO {Application1b} Node 4 was suspected! Period=6500  341188 INFO {Application1b} Node 3 was suspected! Period=6500  347688 INFO {Epfd} Increase period by 500 and current period is 7000  347689 INFO {Application1b} Node 4 was restored! Period=7000  347689 INFO {Application1b} Node 3 was restored! Period=7000 | |
| Node 2:  ……  208409 INFO {Application1b} Node 4 was suspected! Period=5000  208409 INFO {Application1b} Node 3 was suspected! Period=5000  208411 INFO {Application1b} Node 1 was suspected! Period=5000  213409 INFO {Epfd} Increase period by 500 and current period is 5500  213409 INFO {Application1b} Node 4 was restored! Period=5500  213409 INFO {Application1b} Node 3 was restored! Period=5500  213409 INFO {Application1b} Node 1 was restored! Period=5500 | |
| Node 3:  ……  120516 INFO {Application1b} Node 1 was restored! Period=5500  120516 INFO {Application1b} Node 2 was restored! Period=5500  302026 INFO {Application1b} Node 1 was suspected! Period=5500  302031 INFO {Application1b} Node 2 was suspected! Period=5500  307527 INFO {Epfd} Increase period by 500 and current period is 6000  307530 INFO {Application1b} Node 1 was restored! Period=6000  307530 INFO {Application1b} Node 2 was restored! Period=6000 | |
| Node 4:  ……  424764 INFO {Application1b} Node 3 was suspected! Period=6000  424765 INFO {Application1b} Node 2 was suspected! Period=6000  430765 INFO {Epfd} Increase period by 500 and current period is 6500  430765 INFO {Application1b} Node 3 was restored! Period=6500  430765 INFO {Application1b} Node 2 was restored! Period=6500 | |
| Observation:  From the log above, we can see all nodes are suspected and restored. And the period was increased as expected. At the beginning the increase is frequent. Then as time goes by, the increase is slow down. Then after the period is 6~7 seconds, it doesn’t increase for a long time. The loss rate is 50%. So from the probability point of view, the chance for a node to be suspected is 1/2period. | |

## Exercise 4

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| Eventually Perfect Failure Detector Case: Time Delay = 1000, Δ= 500 (Using Fair loss link) | |
| Topology:  node(1, "127.0.0.1", 25031);  node(2, "127.0.0.1", 25032);  defaultLinks(500, 0); | Scenario:  command(1, "S2000:Phello:S2000:X").recover("R:PI am alive", 3000);  command(2, "S2000"); |
| Node 1:  1343@SCENARIO {Assignment1bMain} Process 1 has started commands [S2000:Phello:S2000:X].  0 INFO {Epfd} Timedelay=1000, Delta=500  99 INFO {Application1b} Sleeping 2000 milliseconds...  2129 INFO {Application1b} Sending perfect message hello to 2@127.0.0.1:25032  2130 INFO {Application1b} Sleeping 2000 milliseconds...  6910@SCENARIO {Assignment1bMain} Process 1 has terminated.  9991@SCENARIO {Assignment1bMain} Process 1 has recovered commands [R:PI am alive].  0 INFO {Epfd} Timedelay=1000, Delta=500  61 INFO {Application1b} Sending perfect message I am recovering to 2@127.0.0.1:25032  61 INFO {Application1b} Sending perfect message I am alive to 2@127.0.0.1:25032  61 INFO {Application1b} DONE ALL OPERATIONS  2064 INFO {Application1b} Node 2 was suspected! Period=1000  3064 INFO {Epfd} Increase period by 500 and current period is 1500  3065 INFO {Application1b} Node 2 was restored! Period=1500 | |
| Node 2:  1408@SCENARIO {Assignment1bMain} Process 2 has started commands [S2000].  0 INFO {Epfd} Timedelay=1000, Delta=500  87 INFO {Application1b} Sleeping 2000 milliseconds...  2090 INFO {Application1b} DONE ALL OPERATIONS  2093 INFO {Application1b} Node 2 was suspected! Period=1000  2649 INFO {Application1b} Received perfect message hello from 1@127.0.0.1:25031  3098 INFO {Epfd} Increase period by 500 and current period is 1500  3098 INFO {Application1b} Node 2 was restored! Period=1500  6103 INFO {Application1b} Node 1 was suspected! Period=1500  8750 INFO {Application1b} Received perfect message I am recovering from 1@127.0.0.1:25031  8752 INFO {Application1b} Received perfect message I am alive from 1@127.0.0.1:25031  10608 INFO {Epfd} Increase period by 500 and current period is 2000  10622 INFO {Application1b} Node 1 was restored! Period=2000 | |
| Observation:  In this case, node 1 crashed and recovered. After recovered, node 1 will get a “R” command and then triggers the doRecovery() which will send a message “I am recovering” to all neighbors. And then sending “I am alive” to all neighbors. In the node2 log, we can see node1 is detected and recovered and all messages are shown. | |

## Question 1:

What is the earliest and latest time that a crash may be detected in a perfect failure detector (with respect to delta and gamma)?

Best case: crash just before sending heartbeat the first time. The undetected time isδ.

Worst case: crash just after sending heartbeat, the heartbeat delay is just δ and the heartbeat just arrives after the check. The undetected time is δ+ 2(δ+γ)

## Question 2:

Can you improve the algorithm for PFD, such that it improves the worst case failure detection time?

One simple method is to reduce the check interval after the first heartbeat was sent.

Change “startTimer(δ+γ, CHECK);” to “startTimer(γ, CHECK);” in line 21.

The Nth heartbeat shall arrive at time N\*γ+δ. So except the first check timer, for other check timer, the timeout needs only to beγ.

Then the worst time isδ+2\*γ

Another method is to start a CHECK timer whenever a heartbeat arrives.

For example, when P1 receives Pi’s heartbeat, P1 will start theδ+γTimer to check Pi.

Then the worst time is 2\*δ+γ

## Question 3:

Can you improve the algorithm for PFD, such that it requires a single timer?

Keep the heartbeat timeout timer and the check reuse this timer.

Init: heartbeat\_times = 0;

Upon event <Timeout | Heartbeat> do

SendHeartbeat();

heartbeat\_times++;

if(heartbeat\_times\*γ>=δ+γ)

doCheck();

heartbeat\_times=0;

end if

startTimer(γ);

End event