MT on Nmap Repot

Metamorphic Relations

Source test case:
Using Nmap scan the servers with port 22 open in segment 125.65.110.0/24.
• t1 = nmap.scan('125.65.110.0/24', ports='22', arguments='--max-rate 1000')

Follow-up test case:
Using Nmap scan the servers with ports 22, 80 and 8080 open in segment 125.65.110.0/24.
• t2 = nmap.scan('125.65.110.0/24', ports='22,80,8080', arguments='--max-rate 1000')

Using Nmap scan the servers with ports 22, 80 and 8080 open in segment 43.25.141.0/24.
• t3 = nmap.scan('43.25.141.0/24', ports='22,80,8080', arguments='--max-rate 1000')

Using Nmap scan the servers with port 22 open in segment 125.65.110.0/24 and
43.25.141.0/24.
• t4 = nmap.scan('125.65.110.0/24 43.25.141.0/24', ports='22,80,8080', arguments='--max-rate 1000')

MR1, When Nmap scan the same segment:
The expected output (the number of servers) of t1 should grater or equal to t2 since t2 has more limitation conditions (t1 >= t2). If the relation is not satisfied, failure was detected (t1 < t2).

MR2, When Nmap scan different segment with the same conditions:
The expected output (the number of servers) of t1 should equal to t2 + t3 (t1 = t2 + t3).If the relation is not satisfied (t1 != t2 + t3), failure was detected.

Case Generation Strategy

```
# Generate test cases randomly
def generateCasesRandomly(num):
    # Generate 100 cases randomly.
    # Scope: 0~255.0~255.0~255.0
    count = 0
    cases = [] # case list
    while count < num:
            case = [] # one case
            segment_1 = "{}.{}.{}.0/24".format(random.randint(0,255), random.randint(0,255),
random.randint(0,255))
            segment_2 = "{}.{}.{}.0/24".format(random.randint(0,255), random.randint(0,255),
random.randint(0,255))
            t1 = Scan(segment_1, "22", "--max-rate 1000")
            t2 = Scan(segment_1, "22,80,8080", "--max-rate 1000")
            t3 = Scan(segment_2, "22,80,8080", "--max-rate 1000")
            t4 = Scan(segment_1+" "+segment_2, "22,80,8080", "--max-rate 1000")
            case.append(t1)
            case.append(t2)
            case.append(t3)
            case.append(t4)
            cases.append(case)
            count+=1
    print("Generate "+ str(count) + " cases completed.")
    return cases

# Generate 100 cases randomly
cases = generateCasesRandomly(100)
```

Test Result Data:

```
Scan Finished: 100 cases; Time Cost:4923.255269289017s
Case 0 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.16s Time_Diff:0.01s
Case 0 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.33s
Time_Diff:102.8s
Case 1 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.16s Time_Diff:-1.0s
Case 1 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.34s
Time_Diff:102.79s
Case 2 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:0.84s Time_Diff:-0.01s
Case 2 MR2 [PASS] Uphost_Mean:1.33 Downhost_Mean:254.67 Num_Diff:0 Time_Mean:16.99s
Time_Diff:33.5s
Case 3 MR1 [PASS] Uphost_Mean:34.0 Downhost_Mean:222.0 Num_Diff:0 Time_Mean:51.06s Time_Diff:-
4.56s
Case 3 MR2 [FAIL] Uphost_Mean:11.33 Downhost_Mean:244.67 Num_Diff:-1 Time_Mean:52.61s
Time_Diff:17.62s
Case 4 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.62s Time_Diff:0.0s
Case 4 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.32s
Time_Diff:102.8s
Case 5 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.16s Time_Diff:0.01s
Case 5 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.58s
Time_Diff:102.55s
Case 6 MR1 [PASS] Uphost_Mean:5.0 Downhost_Mean:251.0 Num_Diff:0 Time_Mean:58.36s Time_Diff:15.38s
Case 6 MR2 [FAIL] Uphost_Mean:144.33 Downhost_Mean:111.67 Num_Diff:6 Time_Mean:31.33s
Time_Diff:22.12s
Case 7 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.13s Time_Diff:-1.0s
Case 7 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.57s
Time_Diff:102.54s
Case 8 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.6s Time_Diff:0.0s
Case 8 MR2 [PASS] Uphost_Mean:4.67 Downhost_Mean:251.33 Num_Diff:0 Time_Mean:57.88s
Time_Diff:31.69s
Case 9 MR1 [PASS] Uphost_Mean:1.0 Downhost_Mean:255.0 Num_Diff:0 Time_Mean:10.15s Time_Diff:0.0s
Case 9 MR2 [PASS] Uphost_Mean:0.33 Downhost_Mean:255.67 Num_Diff:0 Time_Mean:45.53s
Time_Diff:26.74s
Case 10 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.63s Time_Diff:1.0s
Case 10 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.33s
Time_Diff:102.79s
Case 11 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.63s Time_Diff:1.0s
Case 11 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:51.69s
Time_Diff:51.41s
Case 12 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.63s Time_Diff:0.0s
Case 12 MR2 [PASS] Uphost_Mean:5.33 Downhost_Mean:250.67 Num_Diff:0 Time_Mean:49.05s
Time_Diff:16.56s
Case 13 MR1 [PASS] Uphost_Mean:18.0 Downhost_Mean:238.0 Num_Diff:0 Time_Mean:32.94s Time_Diff:-
15.2s
Case 13 MR2 [FAIL] Uphost_Mean:6.0 Downhost_Mean:250.0 Num_Diff:1 Time_Mean:44.47s Time_Diff:-
1.74s
Case 14 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.62s Time_Diff:0.0s
Case 14 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.31s
Time_Diff:102.79s
Case 15 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.12s Time_Diff:-
1.0s
Case 15 MR2 [FAIL] Uphost_Mean:64.67 Downhost_Mean:191.33 Num_Diff:2 Time_Mean:80.56s
Time_Diff:12.44s
Case 16 MR1 [FAIL] Uphost_Mean:50.0 Downhost_Mean:206.0 Num_Diff:-2 Time_Mean:19.62s Time_Diff:-
7.92s
Case 16 MR2 [FAIL] Uphost_Mean:17.0 Downhost_Mean:239.0 Num_Diff:-3 Time_Mean:36.76s Time_Diff:-
12.18s
Case 17 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.12s Time_Diff:-
0.01s
Case 17 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.32s
Time_Diff:102.8s
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Case 18 MR1 [PASS] Uphost_Mean:5.0 Downhost_Mean:251.0 Num_Diff:0 Time_Mean:10.42s Time_Diff:-
1.01s
Case 18 MR2 [PASS] Uphost_Mean:1.67 Downhost_Mean:254.33 Num_Diff:0 Time_Mean:30.92s Time_Diff:-
18.93s
Case 19 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.14s
Time_Diff:0.01s
Case 19 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.58s
Time_Diff:102.54s
Case 20 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.13s Time_Diff:-
1.0s
Case 20 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.33s
Time_Diff:102.8s
Case 21 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.13s Time_Diff:-
1.0s
Case 21 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.32s
Time_Diff:102.79s
Case 22 MR1 [PASS] Uphost_Mean:2.0 Downhost_Mean:254.0 Num_Diff:0 Time_Mean:58.78s Time_Diff:-
29.57s
Case 22 MR2 [PASS] Uphost_Mean:0.67 Downhost_Mean:255.33 Num_Diff:0 Time_Mean:79.47s
Time_Diff:75.45s
Case 23 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.63s
Time_Diff:0.01s
Case 23 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.07s
Time_Diff:103.05s
Case 24 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:0.83s Time_Diff:0.0s
Case 24 MR2 [PASS] Uphost_Mean:3.33 Downhost_Mean:252.67 Num_Diff:0 Time_Mean:6.39s
Time_Diff:4.27s
Case 25 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.65s Time_Diff:1.0s
Case 25 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:102.83s
Time_Diff:102.3s
Case 26 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.13s Time_Diff:0.0s
Case 26 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.33s
Time_Diff:102.81s
Case 27 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.6s Time_Diff:0.0s
Case 27 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.06s
Time_Diff:103.06s
Case 28 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.66s
Time_Diff:0.01s
Case 28 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.33s
Time_Diff:102.8s
Case 29 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.15s Time_Diff:-
1.0s
Case 29 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.33s
Time_Diff:102.8s
Case 30 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.13s Time_Diff:-
1.0s
Case 30 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.57s
Time_Diff:102.54s
Case 31 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:0.89s Time_Diff:0.0s
Case 31 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:0.56s Time_Diff:0.53s
Case 32 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:0.45s Time_Diff:0.0s
Case 32 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:26.65s Time_Diff:-
24.45s
Case 33 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.13s
Time_Diff:0.01s
Case 33 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.32s
Time_Diff:102.8s
Case 34 MR1 [FAIL] Uphost_Mean:42.5 Downhost_Mean:213.5 Num_Diff:-1 Time_Mean:47.04s
Time_Diff:14.34s
Case 34 MR2 [PASS] Uphost_Mean:183.0 Downhost_Mean:73.0 Num_Diff:0 Time_Mean:59.34s
Time_Diff:96.69s
Case 35 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.1s Time_Diff:-1.0s
Case 35 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:51.93s
Time_Diff:51.16s
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Case 36 MR1 [PASS] Uphost_Mean:4.0 Downhost_Mean:252.0 Num_Diff:0 Time_Mean:54.47s Time_Diff:-40.0s
Case 36 MR2 [PASS] Uphost_Mean:1.33 Downhost_Mean:254.67 Num_Diff:0 Time_Mean:88.32s Time_Diff:98.9s
Case 37 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.12s Time_Diff:-0.01s
Case 37 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.57s Time_Diff:102.53s
Case 38 MR1 [PASS] Uphost_Mean:16.0 Downhost_Mean:240.0 Num_Diff:0 Time_Mean:12.14s Time_Diff:-2.27s
Case 38 MR2 [PASS] Uphost_Mean:5.33 Downhost_Mean:250.67 Num_Diff:0 Time_Mean:32.1s Time_Diff:-17.39s
Case 39 MR1 [PASS] Uphost_Mean:5.0 Downhost_Mean:251.0 Num_Diff:0 Time_Mean:51.15s Time_Diff:2.1s
Case 39 MR2 [PASS] Uphost_Mean:1.67 Downhost_Mean:254.33 Num_Diff:0 Time_Mean:36.36s Time_Diff:-26.7s
Case 40 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.12s Time_Diff:-1.0s
Case 40 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.57s Time_Diff:102.55s
Case 41 MR1 [PASS] Uphost_Mean:9.0 Downhost_Mean:247.0 Num_Diff:0 Time_Mean:38.09s Time_Diff:-2.18s
Case 41 MR2 [PASS] Uphost_Mean:3.0 Downhost_Mean:253.0 Num_Diff:0 Time_Mean:48.51s Time_Diff:14.6s
Case 42 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.63s Time_Diff:1.01s
Case 42 MR2 [PASS] Uphost_Mean:0.67 Downhost_Mean:255.33 Num_Diff:0 Time_Mean:34.96s Time_Diff:-6.66s
Case 43 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.63s Time_Diff:0.01s
Case 43 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.31s Time_Diff:102.79s
Case 44 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.62s Time_Diff:0.0s
Case 44 MR2 [PASS] Uphost_Mean:7.33 Downhost_Mean:248.67 Num_Diff:0 Time_Mean:37.88s Time_Diff:-9.61s
Case 45 MR1 [PASS] Uphost_Mean:3.0 Downhost_Mean:253.0 Num_Diff:0 Time_Mean:55.52s Time_Diff:14.69s
Case 45 MR2 [FAIL] Uphost_Mean:163.0 Downhost_Mean:93.0 Num_Diff:4 Time_Mean:80.24s Time_Diff:88.29s
Case 46 MR1 [PASS] Uphost_Mean:130.0 Downhost_Mean:126.0 Num_Diff:0 Time_Mean:75.78s Time_Diff:-7.72s
Case 46 MR2 [FAIL] Uphost_Mean:115.33 Downhost_Mean:140.67 Num_Diff:-1 Time_Mean:54.48s Time_Diff:56.93s
Case 47 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.62s Time_Diff:0.0s
Case 47 MR2 [FAIL] Uphost_Mean:7.33 Downhost_Mean:248.67 Num_Diff:-1 Time_Mean:49.47s Time_Diff:0.1s
Case 48 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.66s Time_Diff:0.0s
Case 48 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.08s Time_Diff:103.03s
Case 49 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.16s Time_Diff:0.01s
Case 49 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.58s Time_Diff:102.54s
Case 50 MR1 [PASS] Uphost_Mean:76.0 Downhost_Mean:180.0 Num_Diff:0 Time_Mean:35.25s Time_Diff:-2.76s
Case 50 MR2 [PASS] Uphost_Mean:68.67 Downhost_Mean:187.33 Num_Diff:0 Time_Mean:58.0s Time_Diff:86.25s
Case 51 MR1 [PASS] Uphost_Mean:3.0 Downhost_Mean:253.0 Num_Diff:0 Time_Mean:93.7s Time_Diff:-6.3s
Case 51 MR2 [PASS] Uphost_Mean:1.0 Downhost_Mean:255.0 Num_Diff:0 Time_Mean:59.41s Time_Diff:7.46s
Case 52 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.66s Time_Diff:1.01s
Case 52 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.08s Time_Diff:103.04s
Case 53 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.14s Time_Diff:0.01s

Case 53 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:52.19s
Time_Diff:51.91s
Case 54 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.6s Time_Diff:0.0s
Case 54 MR2 [PASS] Uphost_Mean:18.0 Downhost_Mean:238.0 Num_Diff:0 Time_Mean:37.07s Time_Diff:-
9.1s
Case 55 MR1 [PASS] Uphost_Mean:6.0 Downhost_Mean:250.0 Num_Diff:0 Time_Mean:47.45s
Time_Diff:10.63s
Case 55 MR2 [PASS] Uphost_Mean:2.0 Downhost_Mean:254.0 Num_Diff:0 Time_Mean:49.28s
Time_Diff:20.21s
Case 56 MR1 [PASS] Uphost_Mean:2.0 Downhost_Mean:254.0 Num_Diff:0 Time_Mean:54.59s Time_Diff:5.62s
Case 56 MR2 [PASS] Uphost_Mean:0.67 Downhost_Mean:255.33 Num_Diff:0 Time_Mean:44.06s Time_Diff:-
3.53s
Case 57 MR1 [FAIL] Uphost_Mean:255.5 Downhost_Mean:0.5 Num_Diff:-1 Time_Mean:295.08s Time_Diff:-
24.07s
Case 57 MR2 [PASS] Uphost_Mean:85.33 Downhost_Mean:170.67 Num_Diff:0 Time_Mean:139.5s
Time_Diff:102.65s
Case 58 MR1 [PASS] Uphost_Mean:48.0 Downhost_Mean:208.0 Num_Diff:0 Time_Mean:33.71s
Time_Diff:4.25s
Case 58 MR2 [PASS] Uphost_Mean:16.0 Downhost_Mean:240.0 Num_Diff:0 Time_Mean:37.61s Time_Diff:-
10.88s
Case 59 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.59s
Time_Diff:0.99s
Case 59 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.31s
Time_Diff:102.79s
Case 60 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.62s
Time_Diff:1.01s
Case 60 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:26.46s Time_Diff:-
24.15s
Case 61 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.6s Time_Diff:1.0s
Case 61 MR2 [PASS] Uphost_Mean:0.67 Downhost_Mean:255.33 Num_Diff:0 Time_Mean:43.64s
Time_Diff:11.47s
Case 62 MR1 [PASS] Uphost_Mean:2.0 Downhost_Mean:254.0 Num_Diff:0 Time_Mean:71.16s Time_Diff:30.2s
Case 62 MR2 [PASS] Uphost_Mean:0.67 Downhost_Mean:255.33 Num_Diff:0 Time_Mean:22.59s
Time_Diff:39.89s
Case 63 MR1 [PASS] Uphost_Mean:4.0 Downhost_Mean:252.0 Num_Diff:0 Time_Mean:77.41s Time_Diff:1.09s
Case 63 MR2 [PASS] Uphost_Mean:1.33 Downhost_Mean:254.67 Num_Diff:0 Time_Mean:23.75s
Time_Diff:10.16s
Case 64 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.66s Time_Diff:0.0s
Case 64 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.09s
Time_Diff:103.04s
Case 65 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.19s
Time_Diff:0.01s
Case 65 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.35s
Time_Diff:102.81s
Case 66 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.22s Time_Diff:-
1.01s
Case 66 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.6s
Time_Diff:102.54s
Case 67 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:0.81s Time_Diff:0.0s
Case 67 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:51.93s
Time_Diff:52.17s
Case 68 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.62s
Time_Diff:0.99s
Case 68 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.32s
Time_Diff:102.79s
Case 69 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.14s Time_Diff:-
0.99s
Case 69 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.33s
Time_Diff:101.78s
Case 70 MR1 [PASS] Uphost_Mean:1.0 Downhost_Mean:255.0 Num_Diff:0 Time_Mean:36.87s Time_Diff:7.63s
Case 70 MR2 [PASS] Uphost_Mean:0.33 Downhost_Mean:255.67 Num_Diff:0 Time_Mean:75.9s
Time_Diff:105.14s
Case 71 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.13s Time_Diff:0.0s
Case 71 MR2 [FAIL] Uphost_Mean:12.0 Downhost_Mean:244.0 Num_Diff:6 Time_Mean:46.1s Time_Diff:5.91s

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Case 72 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.64s
Time_Diff:1.01s
Case 72 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.33s
Time_Diff:102.8s
Case 73 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.66s
Time_Diff:0.99s
Case 73 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.1s
Time_Diff:103.05s
Case 74 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.65s Time_Diff:1.0s
Case 74 MR2 [FAIL] Uphost_Mean:71.33 Downhost_Mean:184.67 Num_Diff:3 Time_Mean:57.5s
Time_Diff:8.05s
Case 75 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:0.81s Time_Diff:0.0s
Case 75 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:51.67s Time_Diff:51.4s
Case 76 MR1 [FAIL] Uphost_Mean:72.0 Downhost_Mean:184.0 Num_Diff:-2 Time_Mean:47.2s Time_Diff:-
8.71s
Case 76 MR2 [PASS] Uphost_Mean:24.33 Downhost_Mean:231.67 Num_Diff:0 Time_Mean:44.52s Time_Diff:-
6.79s
Case 77 MR1 [PASS] Uphost_Mean:10.0 Downhost_Mean:246.0 Num_Diff:0 Time_Mean:23.47s Time_Diff:-
13.01s
Case 77 MR2 [FAIL] Uphost_Mean:10.67 Downhost_Mean:245.33 Num_Diff:3 Time_Mean:16.76s
Time_Diff:9.77s
Case 78 MR1 [PASS] Uphost_Mean:7.0 Downhost_Mean:249.0 Num_Diff:0 Time_Mean:48.39s
Time_Diff:22.07s
Case 78 MR2 [FAIL] Uphost_Mean:37.0 Downhost_Mean:219.0 Num_Diff:-1 Time_Mean:19.2s
Time_Diff:19.52s
Case 79 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.13s
Time_Diff:0.01s
Case 79 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.32s
Time_Diff:102.8s
Case 80 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.17s
Time_Diff:0.03s
Case 80 MR2 [PASS] Uphost_Mean:4.67 Downhost_Mean:251.33 Num_Diff:0 Time_Mean:41.03s Time_Diff:-
8.79s
Case 81 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.64s
Time_Diff:0.01s
Case 81 MR2 [PASS] Uphost_Mean:1.33 Downhost_Mean:254.67 Num_Diff:0 Time_Mean:75.12s
Time_Diff:53.36s
Case 82 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:154.62s
Time_Diff:0.01s
Case 82 MR2 [FAIL] Uphost_Mean:4.0 Downhost_Mean:252.0 Num_Diff:1 Time_Mean:42.82s Time_Diff:1.76s
Case 83 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.12s Time_Diff:0.0s
Case 83 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:26.64s Time_Diff:-
24.45s
Case 84 MR1 [PASS] Uphost_Mean:1.0 Downhost_Mean:255.0 Num_Diff:0 Time_Mean:106.09s
Time_Diff:10.38s
Case 84 MR2 [PASS] Uphost_Mean:0.33 Downhost_Mean:255.67 Num_Diff:0 Time_Mean:93.7s
Time_Diff:114.21s
Case 85 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:0.83s Time_Diff:0.0s
Case 85 MR2 [PASS] Uphost_Mean:2.0 Downhost_Mean:254.0 Num_Diff:0 Time_Mean:14.46s Time_Diff:22.5s
Case 86 MR1 [PASS] Uphost_Mean:42.0 Downhost_Mean:214.0 Num_Diff:0 Time_Mean:62.74s
Time_Diff:0.34s
Case 86 MR2 [FAIL] Uphost_Mean:19.33 Downhost_Mean:236.67 Num_Diff:-9 Time_Mean:24.89s
Time_Diff:17.73s
Case 87 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.11s Time_Diff:-
1.01s
Case 87 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.31s
Time_Diff:102.79s
Case 88 MR1 [PASS] Uphost_Mean:4.5 Downhost_Mean:251.5 Num_Diff:1 Time_Mean:39.59s
Time_Diff:23.26s
Case 88 MR2 [PASS] Uphost_Mean:2.0 Downhost_Mean:254.0 Num_Diff:0 Time_Mean:26.59s
Time_Diff:27.39s
Case 89 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:0.83s Time_Diff:0.0s
Case 89 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:51.92s
Time_Diff:52.16s
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Case 90 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.62s
Time_Diff:0.99s
Case 90 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.08s
Time_Diff:103.05s
Case 91 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.71s
Time_Diff:1.04s
Case 91 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.35s
Time_Diff:102.8s
Case 92 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.16s Time_Diff:-
0.01s
Case 92 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.33s
Time_Diff:102.79s
Case 93 MR1 [PASS] Uphost_Mean:2.0 Downhost_Mean:254.0 Num_Diff:0 Time_Mean:83.93s Time_Diff:-
15.33s
Case 93 MR2 [PASS] Uphost_Mean:2.67 Downhost_Mean:253.33 Num_Diff:0 Time_Mean:40.95s
Time_Diff:18.24s
Case 94 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:156.15s Time_Diff:0.0s
Case 94 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.58s
Time_Diff:102.54s
Case 95 MR1 [PASS] Uphost_Mean:15.0 Downhost_Mean:241.0 Num_Diff:0 Time_Mean:49.47s Time_Diff:-
4.95s
Case 95 MR2 [FAIL] Uphost_Mean:10.33 Downhost_Mean:245.67 Num_Diff:-1 Time_Mean:27.21s
Time_Diff:18.35s
Case 96 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.16s Time_Diff:-
1.01s
Case 96 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:26.66s Time_Diff:-
24.43s
Case 97 MR1 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:155.63s Time_Diff:1.0s
Case 97 MR2 [PASS] Uphost_Mean:0.0 Downhost_Mean:256.0 Num_Diff:0 Time_Mean:103.07s
Time_Diff:103.04s
Case 98 MR1 [PASS] Uphost_Mean:226.0 Downhost_Mean:30.0 Num_Diff:0 Time_Mean:54.91s Time_Diff:-
36.82s
Case 98 MR2 [PASS] Uphost_Mean:84.67 Downhost_Mean:171.33 Num_Diff:0 Time_Mean:58.39s
Time_Diff:85.69s
Case 99 MR1 [FAIL] Uphost_Mean:75.5 Downhost_Mean:180.5 Num_Diff:-1 Time_Mean:182.03s Time_Diff:-
13.64s
Case 99 MR2 [PASS] Uphost_Mean:25.33 Downhost_Mean:230.67 Num_Diff:0 Time_Mean:108.43s
Time_Diff:91.76s
**** Verification Result ****
MR1 pass rate: 95.0%
MR1 time mean: 111.94s
MR1 time difference: 4.26s
MR1 time mean in fail case: 118.19s
MR1 time difference in fail case: 13.74s
MR1 num difference in fail case: 1.4
MR1 max num difference in fail case: 2

MR2 pass rate: 85.0%
MR2 time mean: 69.33s
MR2 time difference: 61.24s
MR2 time mean in fail case: 44.29s
MR2 time difference in fail case: 19.5s
MR2 num difference in fail case: 2.87
MR2 max num difference in fail case: 9

Result Analysis
Value explanation:
- pass rate: the pass rate regard to a metamorphic relation
- time mean: the mean of time to scan a segment (256 hosts)
- time difference: the difference between running one scan command and time mean
- time mean of fail case: the time mean of fail cases

- time difference in fail case: the mean of time difference of fail cases
- num difference in fail case: the mean of up host number difference of between expectation and result
- max num difference in fail case: the maximum of num difference in fail cases

As the result data shown above, the pass rate of MR1 and MR2 are 95% and 85% respectively. Obviously, Nmap has a better accuracy in MR1, the difference between expectation and result is small, around 1.4. For MR2, the result difference in fail case is 2.87 and maximum is 9, which is much higher than MR1.

For MR1, given the t1 and t2 are started together and the time consuming is similar, the possibility of causing fail by sleep host turning to awake (or vice versa) is very small. I believe there was something wrong in the process in the 5% cases. Maybe the signal was marked incorrectly or transmission error, I don't know.

I infer that the reasons causing MR2 fail has two:
1. There were sleep host turning to awake (or vice versa) happening after t2 & t3 done.
2. Something wrong as MR1.
However, I print out the time difference in the fail case of MR2, which is even smaller than the total mean of cases (19.5s vs 61.24s). It means the possibility of causing by reason 1 is small. Either way, Nmap shows a lower accuracy when scanning two segments at the same time.