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Service Failure Diagnosis in Service Function Chain

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Content

Introduction-Background

Define

- Service Function Chain (SFC): defines an ordered set of abstract service functions and ordering constraints that must be applied to packets and/or frames and/or flows selected as a result of classification.
- Service Failure : Service availability failure and Service quality degradation failure.

Advantage

- Reduce the traffic of active detection
- Using network service header to locate service failure

Introduction-Challenges & Contributions

Heavy traffic of active detection

- Solution: Improved Depth First Traversal
- Target: reduce the traffic of active detection

Multi-types and multiple-layers failures

- Solution: Hierarchical and classification failure location algorithm
- Target: Accurately locate the source of the failure

Inspiring Scenario

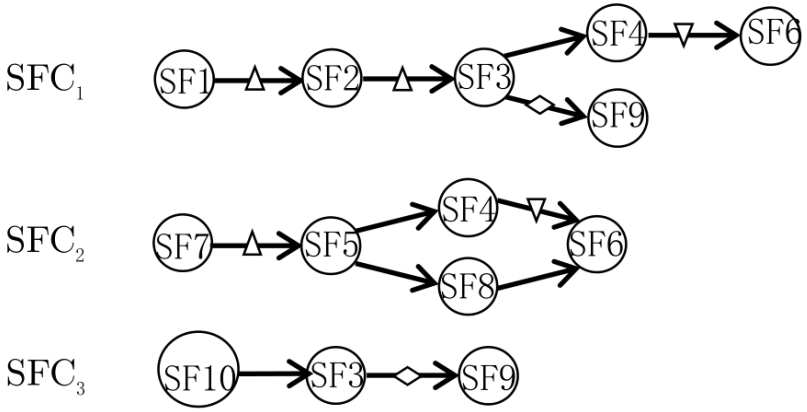


Fig. 1. Service Function Chains

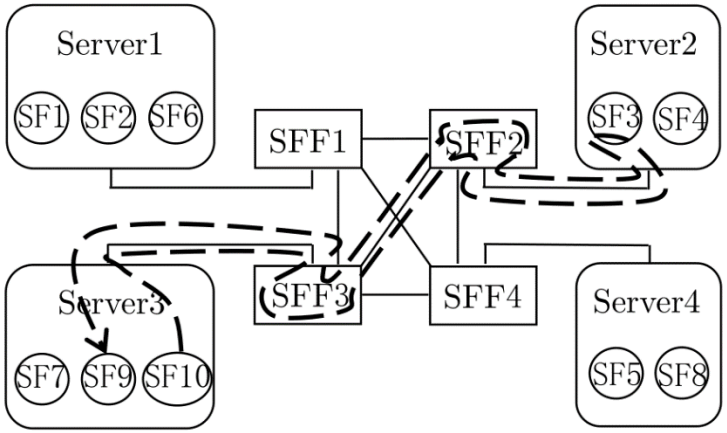


Fig. 2. Service Functions Deployment Graph

- **SFC 1 has the same starting point and different end points with a branching structure. SFC 2 has the same starting point and end point with a branching structure. SFC 3 is a line composed of service functions between the two endpoints.**
- **Figure 2 presents the deployment of service function chains in a network.**

Multi-layer Fault Diagnosis Method

- **Improved Depth First Traversal**
- **Hierarchical and classification failure location**

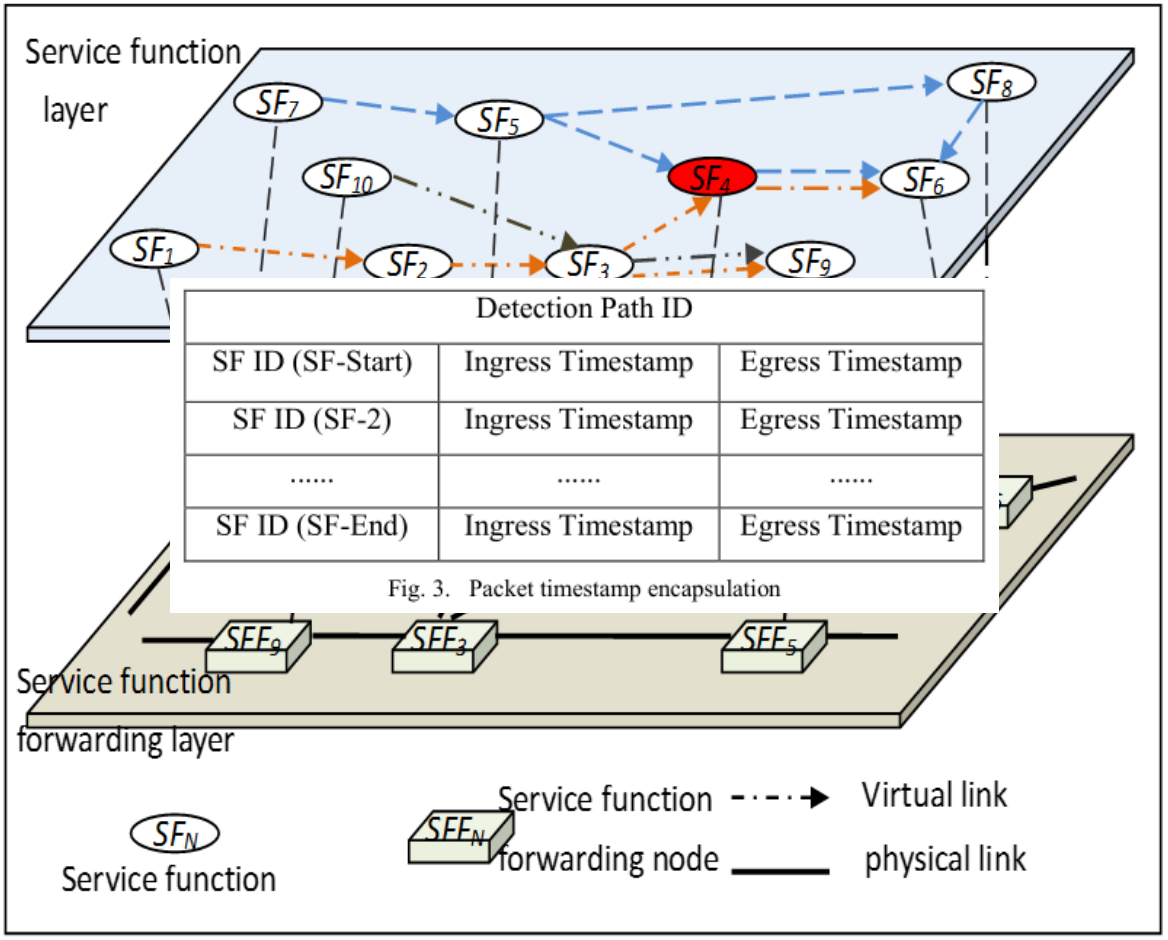
Improved Depth First Traversal

Algorithm 1 Improved Depth First Traversal (IDFT)

Input: v, **M**
Output: A Detection Path (DP)
Procedure:

1: DP ←null, add v to DP
2: select $\forall\ v' \in$ V, and **M**[v][v'].selected = **false**
3: **M**[v][v'].selected = **true**, add v' to DP
4: Remove the link between v and v' from E
5: v.outdegree--, v'.indegree--, S = **M**[v][v'].SFP
6: **for** v'' in V
7: **if M**[v'][v''].connected & !**M**[v'][v''].selected
8: **if** (S ∩ **M**[v'][v''].SFP != null)
9: **S** = S ∩ **M**[v'][v''].SFP
10: **break**
11: **end if**
12: **end for**
13: **if** $v'' \neq$ null
14: v=v', v'=v'', **go to** step 3.
15: **end if**

Hierarchical and classification failure location



Detection Path ID		
SF ID (SF-Start)	Ingress Timestamp	Egress Timestamp
SF ID (SF-2)	Ingress Timestamp	Egress Timestamp
.....	.....	.....
SF ID (SF-End)	Ingress Timestamp	Egress Timestamp

Fig. 3. Packet timestamp encapsulation

Hierarchical and classification failure location

Algorithm 2 service quality degradation localization

Input: DP_{Normal}, DP_{SQD}, NSH

Output: Set of service quality degradation S

Procedure:

init: SQS_{map} < key, value > =null , SQS = null

01 for(Path p : DP_{SQD})

02 for(Element e : p)

03 if(e is SF && e.time> $T_{sfnormal}$) S.add(e) ;

04 if(e is a virtual link && e.time> $T_{vlnormal}$) SQS.add(e) ;

05 for(Element e : SQS)

06 mapping e into the Set Q

07 for(Element q : Q)

08 if(SQS_{map}.get(q)==null) SQS_{map}.put(q,1);

09 else SQS_{map}.put(q,SQS_{map}.get(q)+1) ;

10 sort(SQS_{map});

11 Iterator iter= SQS_{map}.entrySet().iterator()

12 while(iter.hasNext()&&DP_{SQD}!=null)

13 entry=iter.next(); Element e=entry.getKey();

14 if(e is SFF) find the set SFQ that are connected with e

15 if(∀sf ∈ SFQ, DP_{Normal}.*contains*(sf)) continue;

16 else S.add(e) ;

DP_{SQD}.remove(paths that contain the sf);

17 if(e is a link between SFFs)

find the virtual link set VLQ which are related to e

18 if(∀vl ∈ VLQ, DP_{Normal}.*contains*(vl)) continue;

19 else S.add(e) ;

DP_{SQD}.remove(paths that contain the vl) ;

20 return the set S ;

Hierarchical and classification failure location

Algorithm 3 service availability failure localization

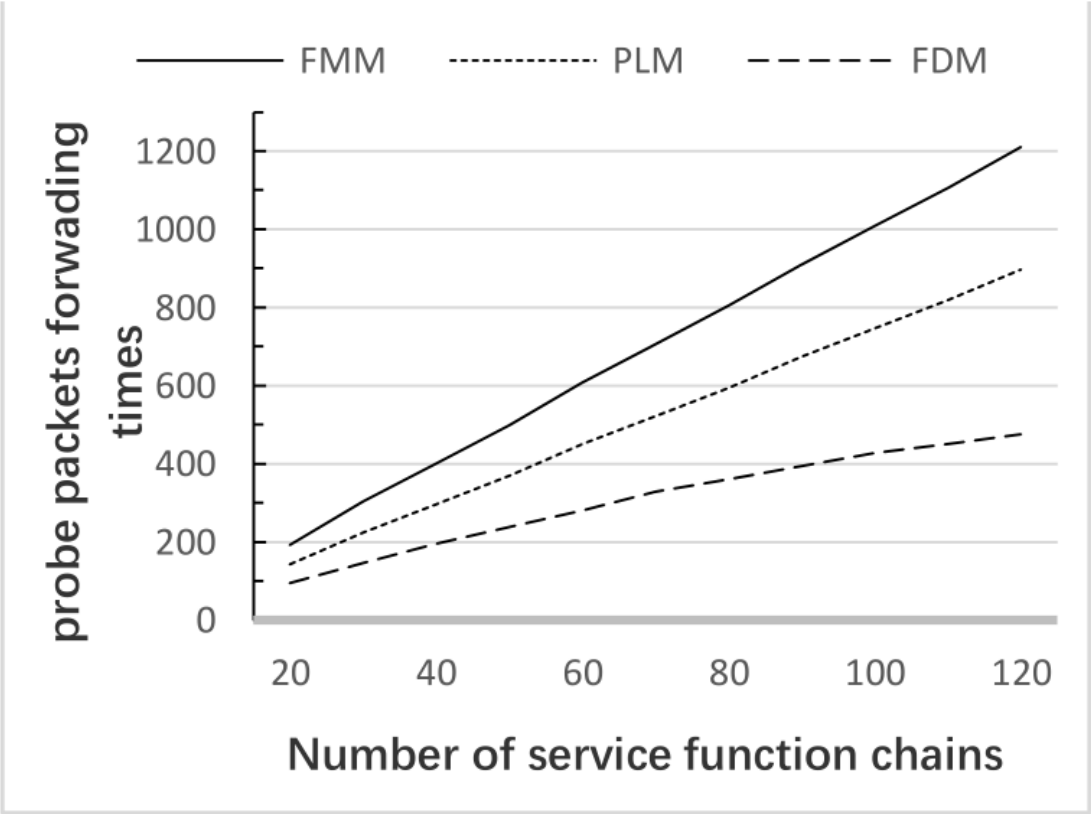
Input: DP_{Normal}, DP_{SAF}, DP_{SQD}

Output: Set of service availability S

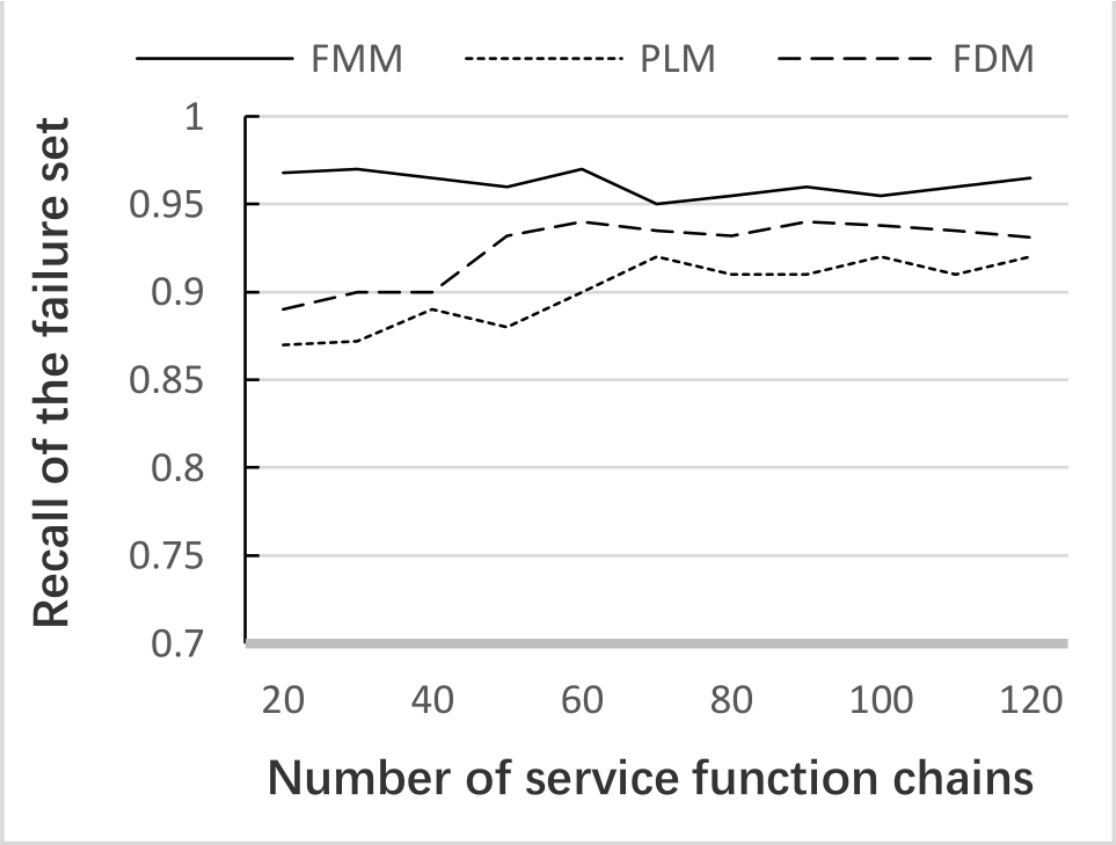
Init: $SAS_{map} < key, value > = null$, $SAS = null$

```
1  for(Path p : DP_SAF)
2    for(Element e : p)
3      if(!DP_Normal.contains(e) && !DP_SQD.contains(e))
4        SAS.add(e);
5  for(Element e : SAS)
6    if(e is SF)   find the SFF which is connected with e
7      if(SAS_map.get(e) == null)  SAS_map.put(e,1);
8      else  SAS_map.put(e,SAS_map.get(e)+1);
9      if(SAS_map.get(SFF) == null)  SAS_map.put(SFF,1);
10     else  SAS_map.put(SFF,SAS_map.get(SFF)+1);
11   if(e is virtual link) mapping e into the Set Q
12     for(Element q : Q)
13       if(SAS_map.get(q) == null)  SAS_map.put(q,1);
14       else  SAS_map.put(q,SAS_map.get(q)+1);
15 sort(SAS_map);
16 Iterator iter=SAS_map.entrySet().iterator()
17 while(iter.hasNext() && DP_SAF != null )
18   entry=iter.next(); Element e=entry.getKey();
19   if(e is SF) S.add(e);
20   if(e is SFF) find the set SFQ which are connected with e
21     if(∀sf ∈ SFQ, DP_Normal.contains(sf) || DP_SQD.contains(sf)) continue;
22     else  S.add(e), S.remove(∀sf ∈ SFQ);
23     DP_SAF.remove(paths which contain the sf in SFQ);
24   if(e is a link between SFFs) find the virtual link set VLQ which are related to e
25     if(∀vl ∈ VLQ, DP_Normal.contains(vl) || DP_SQD.contains(vl)) continue;
26     else  S.add(e); DP_SAF.remove(paths which contain the virtual link in VLQ);
27 return the set S;
```

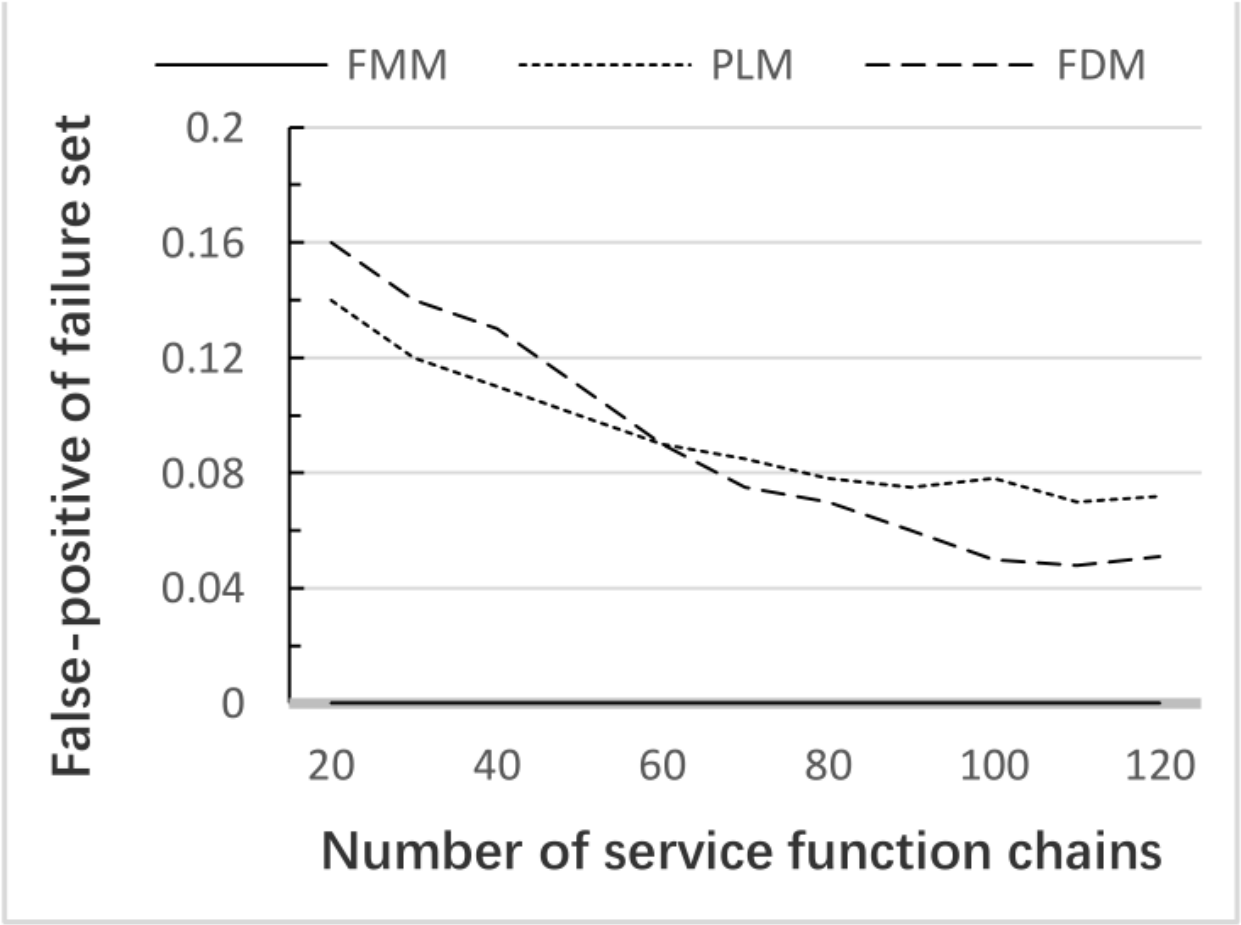
Simulation and Result Analysis(1)



Simulation and Result Analysis(1)



Simulation and Result Analysis(2)



Conclusions

The results of the experiments show that:

- Our improved depth first traversal method can significantly reduce the active detection cost.
- Our failure localization algorithm improves the recall and false positive by removing nodes with less probability of failure.

Q&A

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