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Problem Statement for IP measurement in mobile networks
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Abstract

This document analyzes the potential problems of applying existing IP-based performance measurement methods to wireless accessing environments. It suggests that a more flexible passive measuring framework and performance metrics, such as congestion ratio are needed.

Status of This Memo

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Table of Contents

1. Introduction

It is well-accepted that mobile Internet usage is going to increase fast in the coming years and replace the traditional voice service to be the dominant revenue source for mobile operators. In the meantime, fast evolving network and terminal technologies and changing service trend (e.g. social networking, video on demand, online reading, etc.) results in higher user service requirement. Therefore, as the basic infrastructure service provider, operators are deemed responsible for mobile Internet end-to-end performance, for subscribers want to get what they want, which gives rise to a basic yet important question: how does network service provider manage end-to-end service quality? In particular, there are two goals for operator's quality management initiative:

- o to make sure and validate the QoS metrics of specific IP flows against the values pre-defined by the service SLA(Service Level Agreement) from the user/service provider's point of view; and
- o to make sure and validate the sanity of network devices/links.

In this draft, we present three usecases and the potential problems of applying existing IP-based performance measurement methods to wireless accessing environments, where resource pooling and dynamic load balancing techniques are employed to accommodate explosively increasing data traffic, and suggest requirements for more robust passive measuring methods and performance metrics for such environment.

2. Motivation

2.1. Dynamic Load Balancing

Pooling technology has been introduced to the user plane in the packet switched domain of operator’s core network for cellular subscribers since 3GPP Release 5 (3GPP TS23.236). With pooling, the traffic path from user equipments to the Internet via core network is not static, but rather dynamically assigned to a proper instance of an device pool, according to load balancing policies. The assignment is dynamically made at the time of user equipment’s attachment establishment with the cellular core network, and would remain unchanged unless the mobile terminal detaches from the network or moves outside the base-stations’ coverage subordinating to the specific core network’s device pool.

As shown by Figure 1, potential device pools along the path all the way from the user terminal via the packet switching domain of the mobile network core to a third party service provider over the Internet. Examples of network devices that can be poolized include SGSN(Serving GPRS Support Node) and GGSN(Gateway GPRS Supporting Node). Moreover, the service provider could also implement load balancing on the server’s side either via server-pooling within a data center or via (third party) CDN nodes.

```
Radio       |Packet                                   |Internet
Access      |Switching                                |
Network     |Core Network                             |
            |                   +--------+       +----+---+       +--------+
            |                   |+------+|       |+------+|       |+------+|
            |                +-->|SGSN_1|+------->|GGSN_1|+--+    ||SERV_1||
            |                |  |+------+|       |+------+|  |    |+------+|
+--+     +--+--+    +-----+  |  |        |       |        |  |    |        |
|  |---->|     +--->|     +--+  |+------+|       |+------+|  |    |+------+|
|UE|     |NodeB|    | RNC |     ||SGSN_2||       ||GGSN_2||  +---->|SERV_2||
|  |....>|     |...>|     |...  |+------+|       |+------+|       |+------+|
+--+     +--+--+    +-----+  .  |        |       |        |       |        |
            |                .  |   ...  |       |  ...   |       |   ...  |
            |                .  |+------+|       |+------+|       |+------+|
  +--------------------+     ...>|SGSN_N|........>|GGSN_M|........>|SERV_K||
  |  Injected Traffic  |        |+------+|       |+------+|       |+------+|
  |  --------------->  |        +--------+       +----+---+       +--------+
  |   Actual Traffic   |                              |
  |  ...............>  |                              |
  +--------------------+
```

Figure 1: Active Measuring Traffic versus Actual Traffic in case of Device Pooling

Hence, under such environments, if active performance measurement methods[RFC4656][RFC5357] are employed, the injected bogus data traffic may traverse along a different path to the one used by the targeted traffic or even interfere with them due to the subtle nature of wireless-involved links (as explained in the next subsection).

2.2. Radio Congestion Detection

Mobile Internet usage is going to increase fast in the coming years due to the following facts: on one hand, as a result of pervasively deployed and fast maturing 3G/4G cellular technologies combined with smartphone’s dominance in mobile handset’s market, Internet data traffic via mobile operator’s packet switched core network manifests to be an increasingly important contributor to the operator’s revenue. On the other hand, wireless technologies (such as Wi-Fi through APs or cellular networks through small cells) are more and more accepted by the end users, either at home, in the office or in a public place, to be carrying the "last mile" to various portable personal computing devices.

There are two common features of the above two scenarios:

- o the combination of both wireless and wired links along the end-to-end traffic path, and
- o almost all the time, the wireless "last mile" would be the bottleneck of end-to-end service quality.

To make more efficient use of relatively more scarce radio resources, it is important for the core network to understand the congestion status of both wireless and wired links along the traffic path, and make proper management of data traffic through cell reselection or load balancing via pooling.

However, the wireless link’s thoughput is consistently subject to other interfering factors (e.g. distance to the nearest base station, terminal’s radio signal strength, random interference, shadowing of buildings, multipath fading, etc.), which should be properly filtered out before handing over to the network management, as they are rooted in terminal mobility and outside the realm of mobile accessing network.

In other words, there is considerable gap between IP measurement results to the performance evaluation and fault detection requirements in mobile-involved environment, if we directly employ existing passive performance measurement methods[I-D.draft-chen-ippm-coloring-based-ipfpm-framework].

2.3. Accurate Troubleshooting

As shown in Figure 2, it is quite common that there are path partitions (belonging to different operation and management departments) along the local data path from the UE to the Internet within an mobile operator’s local network. For large operators, employing layered network operation and management architecture based on geographic partitions, there may be a further more subpath partitioning between local IP backhaul (managed by state sub-ordinaries) and national IP backhaul (managed by header quarters). Moreover, for roaming cases under home-routed mode (meaning all the traffic from a roaming UE would first traverse from the visited ISP and potentially another Internet operator before getting back to homing ISP network.

Take the example of a mobile subscriber getting access from a 3GPP network for example, besides a local mobile network operator, intermediary ISPs may exist between its traffic before it reaches the Internet. Moreover, within the local operator’s network, radio access network (RAN), RAN backhaul and local core network could actually be constructed and managed by stuff from different departments, for they mainly come from different technical background.

In such complex situations, it can become frustrating to respond quickly to a simple UoE complaint, due to the exponentially exploded complexity to accurately locate the potential faults/congestion in a transient wireless-involved end2end data path.

On the other hand, tunnels, including GRE [RFC2784], GTP [TS29.060], IP-in-IP [RFC2003] or IPSec [RFC4301] etc, are widely deployed in 3GPP networks. And in 3GPP network tunnels are used to carry end user flows within the backhaul network. Tunnels brings another complexity in realizing effective troubleshooting using end2end passive methods.

```
           \\|/
             |
             |
           +-|---+           +-------+         +-------+        +-------+
 +--+      |     |  Tunnel1  |       | Tunnel2 |       |  Ext   |       |
 |UE|-(RAN)-| eNB |===========| S-GW  |=========| P-GW  |--------|  SP   |
 +--+      |     |    RAN    |       |  Core   |       |Network |       |
           +-+---+  Backhaul +---+--+ Network +---+--+        +---+--+
```

Figure 2: Example of path partition in 3GPP network

In other words, a flexible passive measurement framework, capable of dynamic troubleshooting for partitioned data link, even in case of tunnels or autonomous entities is highly valuable. However, neither current active measurement framework as used by OWAMP[RFC4656]/ TWAMP[RFC5357], nor the passive framework proposed in [I-D.draft-chen-ippm-coloring-based-ipfpm-framework] could fit in such case.

2.4. Summary

In summary, for mobile-ended data paths, we believe there is need for

- o viable passive measurement framework for active measurements inject extra traffic, which may traverse along a different path to the one used by the targeted traffic or even interfere with them.
- o robust metric against transient wireless conditions, as there is considerable gap between existing IP measurement metrics (e.g. delay, jitter, throughput etc.), which are subject to change caused by external environmental factors and of little use to operator’s traffic management from the network side.

o flexible and trustworthy measurement mechanisms for accurate performance monitory and troubleshooting from multi-hop data link across operation boundaries.

3. Further Considerations

3.1. Congestion ratio metric

ECN signal for congestion measurement are signalled at IP header by intermediary devices before actual congestion occurs, which is expected to be an effective indicator to potential QoE degradation, irrespective to traffic pattern/wireless conditions.

[I-D.draft-hedin-ippm-type-p-monitor] proposes to echo ECN-flags into TWAMP-test feedback for active measurement. While, packet-level echoing is not viable in passive framework, it is also suspected that more meaningful aggregated information (such as congestion extent, defined as the ratio of marked packets versus all packets from a given IP flow) would be preferred.

3.2. Multi-hop Measurement Framework

In current active measurement framework, there is only two entities on the data path, the sender and the reflector. Hence it is not straightforward how to apply this framework to an integral multi-hop passive measurement case.

On the other hand, the centralized multi-hop passive framework proposed in [I-D.draft-chen-ippm-coloring-based-ipfpm-framework] could encounter problems when there is no prior knowledge about or control over different partitions along the overall data path. In other words, path discovery mechanism is needed to identify potential measurement nodes along the way during/before the actual passive measurement.

4. Security Considerations

If measurements nodes from different operational domains are used, proper device authentication and report authenticity protection mechanisms should also be considered in a complete interworking-capable solution.

5. IANA Considerations

None.

6. References

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