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Use-cases for Passive Measurement in Wireless Networks
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Abstract

This document presents use-cases for passive IP performance measurements in wireless networks.

Status of this Memo

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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 as the dominant revenue source for mobile operators. In the meantime, fast evolving network and terminal technologies and changing service trends (e.g. social networking, video on demand, online reading, etc.) result in more stringent user service requirements. Therefore, as the basic infrastructure service providers, operators are deemed responsible for mobile Internet end-to-end performance because 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 Quality of Service (QoS)? 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 Service Level Agreement(SLA) from the perspective of either the subscriber or the Internet Content Provider (ICP); and

o to make sure and validate the sanity of network devices/links.

Passive measurements, where observation on existing traffic is the only means for measurement entities, have been extensively used in scenarios where active measurement alone may not be sufficient to characterize performance over a particular service path. For example, the active measurement traffic may not be in-band with the real traffic that it is intended to simulate as a result of dynamics in routing techniques, e.g. Equal Cost Multi-Path (ECMP) [RFC2991] or device pooling[3GPP TS23.236].

Overall there are many characteristics of injected active test traffic that can render behaviors and measured metrics may be different from the actual user traffic flows and performance. Since the ultimate goal is understanding the actual user traffic performance, measuring the actual (Passive) traffic itself, represents an important measurement method to achieve effective and accurate results.

In this draft, we present three use-cases of passive measurements for wireless networks, where active IP performance measurements are not desirable or accurate enough in achieving the above goals.

2 Conventions Used in This Document

2.1 Terminology

ECMP - Equal Cost Multi-Path

ISP - Internet Service Provider

QoE - Quality of Experience

QoS - Quality of Service

RAN - Radio Access Network

SLA - Service Level Agreement

UE - User Equipment

2.2 Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

3 Use-cases

In light of the introduction of more capable passive measurement methods than pure observation in[I.D-zheng-ippm-framework-passive], it is expected that passive measurements would be the basic building block in performance monitoring in highly dynamic and resource-limited production networks like wireless access networks.

This section presents use-cases for passive measurements in wireless networks.

3.1 Performance Monitoring for Network Planning/Optimization

As mentioned earlier, it is important for Internet Service Providers (ISPs) to understand their network performance through continuous and accurate performance monitoring in terms of the experience of network customers in addition to the status of the physical network.

Especially for network planning, it is important to evaluate the Quality of Experience (QoE) and network performance during the peak hours, where active measurements are not desirable. It is also desirable to understand the user experience in non-peak hours, to better assist the application and verify of sophisticated dynamic resource provisioning schemes, such as elastic resource pooling.

Due to the traffic dynamics in terms of its geographic and time distribution, continuous monitoring of QoS, necessary for adaptive

network optimization, cannot be achieved by active measurements alone. Because active measurement methods measures performance metrics by means of carefully designed and injected active measurement traffic, whose characteristics may be quite different from those of the real traffic in a production network, and not flexible to account for the impact from traffic dynamics. The injected active traffic could even skew results or measurements. This could be especially problematic when associated results are used for performing network planning & optimization.

On the contrary, by deploying passive measurement points in the wireless network, it is possible for the ISP to draw a continuous graph of the network usage and performance metric as the basis of network/resource planning. Since no interference to network performance is introduced by traffic injection for a passive measurement, it can be initiated almost any time of the day and applies to rush hours as well.

3.2 End-to-end Measurement for Wireless Subscribers

For wireless networks, almost all the time, the wireless "last mile" would be the bottleneck of end-to-end QoS and QoE, indicating the necessity to include the wireless segment into the measurement path.

However, due to the limited availability and/or relatively high cost of wireless resources, it is not economic for either ISP or the user to conduct resource-demanding active measurements over the wireless "last mile".

For instance, unlike the fixed network providers where the access network resource is shared by a group of subscribers who are charged by the duration of their subscriptions independent of their actual network usage, wireless/mobile ISPs make extensive use of resource allocation and reservation for individual terminals/IP flows and often use the traffic volume consumption as a basis for subscription billing. In other words, the subscriber may be charged for the active measurement traffic in despite the fact that it degrades QoE of real application data transfer during the active test.

Measurements pertaining to the performance of Subscribers or End Users, are particularly dependent upon passive measurements. As stated, Active measurements conducted in this realm can be expensive and even affect QoE. Possibly even greater concern is that the results of the Active measurements may not match the results of the actual End User traffic (for various reasons discussed earlier). The Passive measurements more likely match the results of the actual End User traffic, because they are based on the same traffic.

3.3 Accurate Fault Identification

It is quite common that there are multiple domains (belonging to different operational or administrative bodies) along the data path from a mobile user equipment (UE) to the Internet.

Consider the example of a mobile subscriber getting access from a 3GPP network. Besides a local mobile network operator, intermediary ISPs may exist in between before subscriber's traffic 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 staff from different departments.

As shown in Figure 1, 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 headquarters).

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

Figure 1: Example of path partition in 3GPP network

Moreover, for roaming cases under home-routed mode, 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.

In these cross-domain scenarios, in order to do effective trouble shooting for degraded QoS, one needs to first identify the faulty domain or cross-domain interconnection from well performing domains, and then further drill down for the overloaded device/link within the identified domain. If active methods are employed, cross-boundary traffic and cross-provider coordination on the interconnections may be required to complicate the process.

On the contrary, passive measurements can help in accurate trouble-shooting and problem demarcation between various networking technologies or operational domains that together compose an end-to-

end traffic path, since it does not require extra cross-boundary traffic to be injected into the path or strict synchronization to be conducted between participating measurement points as active measurements do.

Passive measurements can be used both for the end-to-end problem identification and the hop-by-hop demarcation. By deploying measurement agents both within the domains and at the cross-boundary interconnections, passive measurements can quickly identify the faulty domain/device/link without introducing extra cross-boundary measurement traffic.

For instance, passive measurement agents can be deployed at both the ingress and the egress point of each domain and work independently along the path for the passive performance measurement. A simple aggregation at a third-party data collector can do the drilling measurement result analysis to identify the problematic flow.

More importantly, in the above cross-domain cases, timely fault isolation is critical. Alerts/alarms and other indications of potential faults may be provided more quickly by monitoring and measuring on data traffic. As alluded to in the previous paragraphs, active monitoring may require significant set up and coordination. By the time this occurs, it is conceivable that network conditions, may have changed. It is also conceivable that the difference in traffic characteristics between the actual traffic, and active traffic injected into the network, (no matter how slight the differences), may not experience the same issues or faults.

4 Security Considerations

TBA.

5 IANA Considerations

There is no IANA action in this document.

6 References

6.1 Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

6.2 Informative References

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