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In-situ Flow Information Telemetry Framework
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Abstract

In-situ Flow Information Telemetry (iFIT) is a framework for applying techniques such as In-situ OAM (iOAM) and Postcard-Based Telemetry (PBT) in networks. It enumerates several key components and describes how these components can be assembled to achieve a complete working solution for user traffic telemetry in carrier networks.

Requirements Language

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[1.](#) Introduction

Application-aware network operation is important for user SLA compliance, service path enforcement, fault diagnosis, and network resource optimization. In-situ OAM (IOAM) [[I-D.brockners-inband-oam-data](#)] and PBT [[I-D.song-ippm-postcard-based-telemetry](#)] can provide the direct experience of user traffic. These techniques are invaluable for application-aware network operations.

However, successfully applying such techniques in carrier networks poses several practical challenges:

- o C1: IOAM and PBT incur extra packet processing which may strain the network data plane. The potential impact on the forwarding performance creates an unfavorable "observer effect" which not only damages the fidelity of the measurement but also defies the purpose of the measurement.
- o C2: IOAM and PBT can generate a huge amount of OAM data which may claim too much transport bandwidth and inundate the servers for data collection, storage, and analysis. Increasing the data handling capacity is technically viable but expensive.
- o C3: The currently defined set of data is essential but limited. As the network operation evolves toward intent-based and automation, and the trends of network virtualization, network convergence, and packet-optical integration continue, more data will be needed in an on-demand and interactive fashion. Flexibility and extensibility on data acquiring must be considered.
- o C4: If we were to apply IOAM and PBT in today's carrier networks, we must provide solutions to tailor the provider's network deployment base and support an incremental deployment strategy. That is, we need to come up with encapsulation schemes for various predominant protocols such as Ethernet, IPv4, and MPLS with backward compatibility and properly handle various transport tunnels.
- o C5: Applying only a single underlying telemetry technique may lead to defective result. For example, packet drop can cause the lost of the flow telemetry data and the packet drop location and reason remains unknown if only IOAM is used.

To address these challenges, we propose a framework based on our prototype experience which can help to build a workable data-plane telemetry solution. We name the framework "In-situ Flow Information Telemetry" (iFIT) to reflect the fact that this framework is dedicated to the telemetry data about user/application flow experience. In future, other related data plane OAM techniques such as IPFPM [[RFC8321](#)] can also be integrated into iFIT to provide richer capabilities. The network architecture that applies iFIT is shown in Figure 1. The key components of iFIT is listed as follows:

- o Smart flow and data selection policy to address C1.
- o Export data reduction to address C2.
- o Dynamic network probe to address C3.

- o Encapsulation and tunnel modes to address C4.
- o On-demand technique selection to address C5.

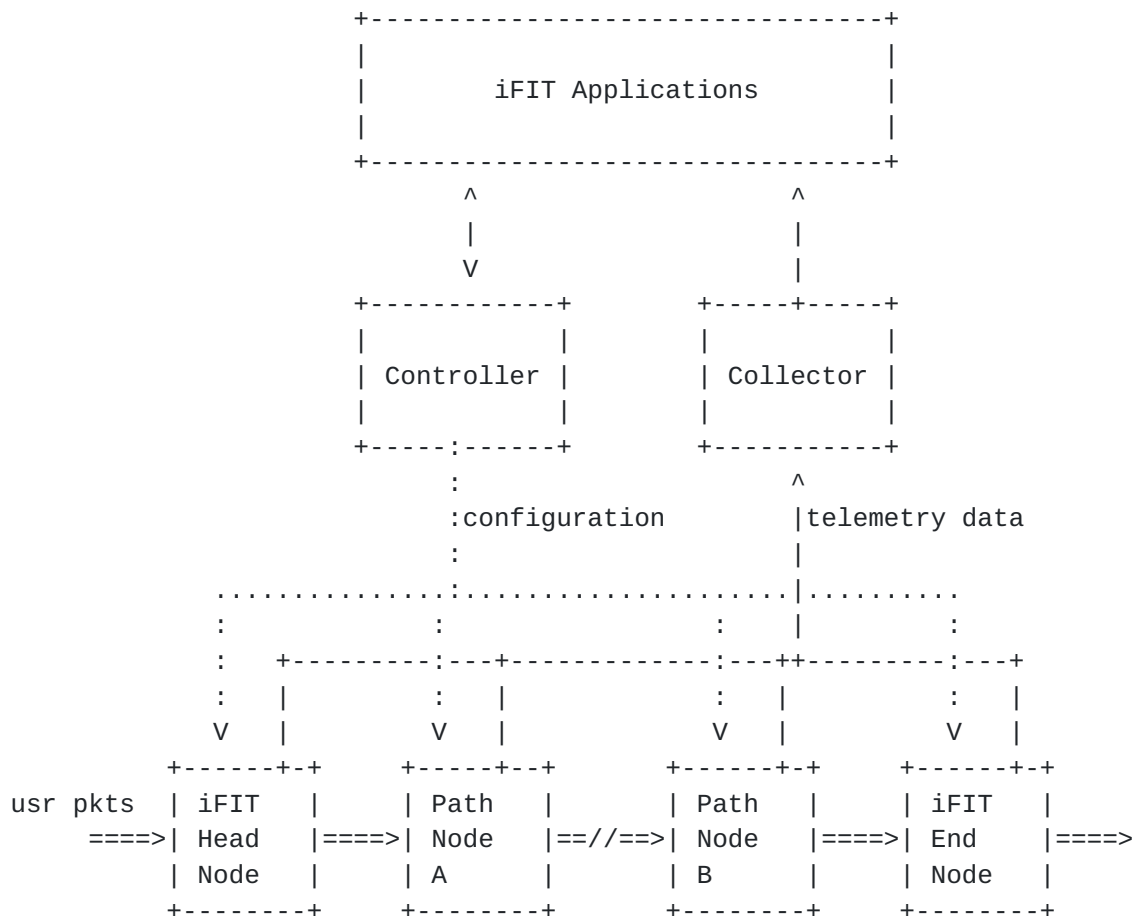


Figure 1: iFIT Architecture

In the remaining of the document, we provide the detailed discussion of the iFIT's components.

2. Smart Flow and Data Selection

In most cases, it is impractical to enable the data collection for all the flows and for all the packets in a flow due to the potential performance and bandwidth impacts. Therefore, a workable solution must select only a subset of flows and flow packets to enable the data collection, even though this means the loss of some information.

In data plane, the Access Control List (ACL) provides an ideal means to determine the subset of flow(s).

[[I-D.song-ippm-ioam-data-validation-option](#)] describes how one can set a sample rate or probability to a flow to allow only a subset of flow packets to be monitored, how one can collect different set of data for different packets, and how one can disable or enable data collection on any specific network node. The document further introduces enhancement to IOAM to allow any node to accept or deny the data collection in full or partially.

Based on these flexible mechanisms, iFIT allows applications to apply smart flow and data selection policies to suit the requirements. The applications can dynamically change the policies at any time based on the network load, processing capability, focus of interest, and any other criteria. We have developed some adaptive algorithm which can limit the performance impact and yet achieve the satisfactory telemetry data density.

3. Export Data Reduction

The flow telemetry data can catch the dynamics of the network and the interactions between user traffic and network. Nevertheless, the data inevitably contain redundancy. It is advisable to remove the redundancy from the data in order to reduce the data transport bandwidth and server processing load.

In addition to efficiently encode the export data (e.g., IPFIX [[RFC7011](#)] or protobuf [[1](#)]), iFIT can also cache the data and send the accumulated data in batch if the data is not time sensitive. Various deduplication and compression techniques can be applied on the batch data.

From the application perspective, an application may only be interested in some special events which can be derived from the telemetry data. For example, in case that the forwarding delay of a packet exceeds a threshold or a flow changes its forwarding path is of interest, it is unnecessary to send the original raw data to the data collecting and processing servers. Rather, iFIT takes advantage of the in-network computing capability of network devices to process the raw data and only push the event notifications to the subscribing applications.

4. Dynamic Network Probe

Due to the limited data plane resource, it is unlikely one can provide all the data all the time. On the other hand, the data needed by applications may be arbitrary but ephemeral. It is critical to meet the dynamic data requirements with limited resource.

Fortunately, data plane programmability allows iFit to dynamically load new data probes. These on-demand probes are called Dynamic Network Probes (DNP) [[I-D.song-opsawg-dnp4iq](#)]. DNP is the technique to enable probes for customized data collection in different network planes. When working with IOAM or PBT, DNP is loaded to the data plane through incremental programming or configuration. The DNP can effectively conduct data generation, processing, and aggregation.

DNP introduces enough flexibility and extensibility to iFIT. It can implement the optimizations for export data reduction motioned in the previous section. It can also generate custom data as required by today and tomorrow's applications.

5. Encapsulation and Tunnel Modes

Since MPLS and IPv4 network are still prevalent in carrier networks. iFIT provides solutions to apply IOAM and PBT in such networks. PBT-M [[I-D.song-ippm-postcard-based-telemetry](#)] does not introduce new headers to the packets so the trouble of encapsulation for IOAM and PBT-I is avoided. If IOAM or PBT-I is preferred, [[I-D.song-mpls-extension-header](#)] provides a means to encapsulate the extra header using an MPLS extension header. As for IPv4, it is possible to encapsulate the IOAM or PBT-I header in an IP option. For example, RAO [[RFC2113](#)] can be used to indicate the presence of the new header.

In carrier networks, it is common for user traffic to traverse various tunnels for QoS, traffic engineering, or security. iFIT supports both the uniform mode and the pipe mode for tunnel support as described in [[I-D.song-ippm-ioam-tunnel-mode](#)]. With such flexibility, the operator can either gain a true end-to-end visibility or apply a hierarchical approach which isolates the monitoring domain between customer and provider.

6. On-demand Technique Selection and Integration

With multiple underlying data collection and export techniques at its disposal, iFIT can flexibly adapt to different network conditions and different application requirements.

For example, depending on the types of data that are of interest, iFIT may choose either IOAM or PBT to collect the data; if an application needs to track down where the packets are lost, it may switch from IOAM to PBT.

iFIT can further integrate multiple data plane monitoring and measurement techniques together and present a comprehensive data plane telemetry solution to network operating applications.

7. Summary and Future Work

Combining with algorithmic and architectural components, iFIT framework enables a practical solution based on existing techniques such as IOAM and PBT for user traffic telemetry in carrier networks.

There are many more challenges and corresponding solutions for iFIT that we did not cover in the current version of this document. For example, how the telemetry data are stored, analyzed, and visualized; how the telemetry data interfaces and work with the network operation applications which run machine learning and big data analytic algorithms; and ultimately, how iFIT can support closed control loops for autonomous networking? A complete iFIT framework should also consider the cross-domain operations. We leave these topics for future revisions.

8. Security Considerations

TBD

9. IANA Considerations

This document includes no request to IANA.

10. Contributors

TBD.

11. Acknowledgments

TBD.

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12.3. URIs

[1] <https://developers.google.com/protocol-buffers/>

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