Detecting Ephemeral Optical Events with OpTel

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Wide-Area Networks (WANs)

- The workhorses of cloud services
- Exchange of TBs of data every day.
Optical Backbone Networks

- Optical hardware and fiber cable.
Optical Failures

Degradation or fail

Average cost of downtime is $8,000 per minute.

SLAs
This talk: OpTel

Troubleshoot optical events in a few seconds, which is orders of magnitude faster than the state-of-the-art.
Talk outline

- State-of-the-art: Highly fragmented and pull-based monitor
- OpTel: Streamlined telemetry pipeline with unified control
- Evaluations: Operational experiences
Traditional Telemetry Pipeline

Vendor 1

Vendor 2

Vendor 3

Northbound API

Indirect control of heterogeneous devices

Highly fragmented control plane

Challenge 1: hard to extract a consistent (synchronized) view of the network.
Traditional Telemetry Pipeline

- Telemetry pipeline
  - Request data once
  - Push data once

SNMP-based workflow

1. SNMP GET request.
2. Traverse MIB database.
3. Obtain data by function.
4. Report data.

Consumes a lot of CPU cycles!
Traditional Telemetry Pipeline

Challenge 2: improper for high-frequency data collection.

CPU (time) consuming workflow

Serialized request for multiple indicators at device
Traditional Telemetry Pipeline

Inelastic computing resources

Challenge 3: impossible to correlated data across devices on a short time scale.

Serialized request for multiple devices at controller side
Existing Telemetry System

Design Goal
- Detect all optical events.
- Troubleshoot optical events in real time

Ephemeral optical events

Persistant optical events

State-of-the-art approach
- Unable to detect ephemeral optical events.
- Slow in detecting and troubleshooting the more disruptive persistent events.
Talk outline

State-of-the-art
Highly fragmented and pull-based monitor

OpTel
Streamlined telemetry pipeline with unified control

Evaluations
Operational experiences
OpTel high-level design

- Highly fragmented control
- Coarse-grained optical data
- Inefficient failure detection
- Standardized device model
- Push-based optical telemetry
- Centralized data collection
- Vendor-agnostic control
- High-precision optical data
- Real-time event detection
Design and implementation

- Standardized device model

Logic model

- Abstraction of logical components
- Workflow between components
Design and implementation

- Standardized device model

**Optical amplifier**
- 

**Optical supervisory channel**
- 

Data model
Design and implementation

- Push-based optical telemetry

Configured once!

Data pushed periodically!
Design and implementation

• Centralized data collection

- Hundreds indicators
- Thousands devices
- One-second granularity
Centralized data collection

- Real-time analytics
Talk outline

- State-of-the-art: Highly fragmented and pull-based monitor
- OpTel: Streamlined telemetry pipeline with unified control
- Evaluations: Operational experiences
Dataset

- Optical telemetry dataset (1-second granularity data)

<table>
<thead>
<tr>
<th>15min Performance</th>
<th>1s Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data:</strong> four tuples (max, min, avg, current)</td>
<td><strong>Data:</strong> four tuples (max, min, avg, current)</td>
</tr>
<tr>
<td><strong>Time resolution:</strong> 15min (900s)</td>
<td><strong>Time resolution:</strong> 1s</td>
</tr>
</tbody>
</table>

Traditional system

OpTel
Optical events

- Intermuption vs. Degradation

Fiber Degradation

Affect physical layer indicators, but do not affect data transmission in the data link/network layer
Optical events

- Ephemeral vs. Persistent events

Ephemeral event: Less than 10 seconds

CDF

Length of event (s)

50% at 10s
Optical events

<table>
<thead>
<tr>
<th>Type</th>
<th>Percentage</th>
<th>Degradation</th>
<th>Ephemeral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistent Interruption (P-I)</td>
<td>44.63%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persistent Degradation (P-D)</td>
<td>4.28%</td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>Ephemeral Interruption (E-I)</td>
<td>16.85%</td>
<td></td>
<td>✅</td>
</tr>
<tr>
<td>Ephemeral Degradation (E-D)</td>
<td>34.24%</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>38.52%</td>
<td>51.09%</td>
</tr>
</tbody>
</table>
Data collection overheads

CPU Usage(%)

0 25 22 19 16 11 15 10

0.1s 0.5s 1s 5s 10s

SNMP
OpTel

Controller

SNMP Manager
MIB

Device 1

Card 1 Card 2 Card 3

Controller

Telemetry Manager

Device 1

Card 1 Card 2 Card 3

OpTel
Detecting optical events

Not detect ephemeral events

Wrongly identify ephemeral events as persistent events
## Troubleshooting optical events

<table>
<thead>
<tr>
<th>Category</th>
<th>Troubleshoot</th>
<th>Existing system</th>
<th>OpTel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber</td>
<td>Fiber cut</td>
<td>5min~10min</td>
<td>10s</td>
</tr>
<tr>
<td></td>
<td>Fiber jitter</td>
<td>Unknown</td>
<td>3s</td>
</tr>
<tr>
<td></td>
<td>Fiber degradation</td>
<td>Unknown</td>
<td>10s</td>
</tr>
</tbody>
</table>

Our OpTel Troubleshoots optical events in a few seconds, which is orders of magnitude faster in production networks.
Concluding summary

• OpTel uses standardized device model for vendor-agnostic control

• OpTel introduces optical telemetry for high-precision data collection.

• OpTel takes advantage of Tencent cloud for large-scale data collection and real-time data analysis.

• OpTel detects ephemeral events and enables troubleshooting optical events in a few seconds.
Q&A

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