Toward Building a Context-Aware Data Aggregation Framework for Network Monitoring

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Introduction
Main Ideas

• Deal with **heterogeneous** data sources
  • Multi-domain, multi-technology, multi-...
  • Transport protocols
  • Encoding formats
  • Subscription mechanisms (pull vs push)

• Metadata to characterize the data sources
  • **Context information management** based on ETSI CIM

• Semantic framework for network monitoring
  • Applies **streaming telemetry** techniques
  • Leverages metadata for configuration/description of **data pipelines**
  • **Transformation** between data models
ETSI ISG CIM

• Focused on mechanisms to deal with context information
  • Information shared through data publication platforms (Context Brokers)
• Standardizes the **NGSI-LD protocol** for exchanging context information:
  • NGSI-LD information models describing entities, properties, and relationships (property graphs)
  • Definition of NGSI-LD API based on REST
• Mainly applied to IoT scenarios
Context Components

• **Context Brokers** → Store and exchange context information

• **Context Sources** → Provide context information to the Context Broker (e.g., YANG-based devices)

• **Context Consumers** → Request and subscribe to context information from the Context Broker (e.g., database services)
Context Modeling
Prometheus-based Data Source

(*)

**MetricFamily** NGSI-LD entity aligned with OpenMetrics initiative ([https://openmetrics.io/](https://openmetrics.io/))
Telemetry-based Data Source
Semantic Data Aggregator (SDA) Framework
SDA Architecture Overview

**SEMANTIC DATA AGGREGATOR**

- Scorpio
- NGSI-LD Broker

**NGSI-LD API**
- Send notifications

**Weaver**

- Metric A
  - Topic X
- Metric B = avg(Metric A)
  - Topic Y
- Metric B
  - URI Data Consumer

**NGSI-LD API**
- Navigate tree +
- Define data pipeline

**DATA FABRIC**

- Apache NiFi
- Apache Flink
- Apache Kafka

**NGSI-LD API**
- Provide metadata information

- Data Source

- Collect data

- Collection Agent
- Dispatch Agent
- Aggregation Agent
- Write topic X
- Read topic Y

- Apache NiFi
- Apache Flink
- Apache Kafka

- Deliver data
- Data Consumer
Context Modeling of Data Pipelines
Real Use Case
Anomaly Detector (I)

Module that analyzes the status of a RAN cell:

- Learns from data traffic patterns and mobility patterns
- Identifies and predicts anomalies based on RAN KPIs
- Exposes REST API for ingesting streams of events
- Provides a future notification/alert system

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>ul_delay</td>
<td>Float</td>
<td>Uplink delay (ms)</td>
</tr>
<tr>
<td>dl_delay</td>
<td>Float</td>
<td>Downlink delay (ms)</td>
</tr>
<tr>
<td>lost_packets</td>
<td>Integer</td>
<td># of lost packets, per service per user</td>
</tr>
<tr>
<td>rsrp</td>
<td>Float</td>
<td>RSRP (dB)</td>
</tr>
<tr>
<td>transfer_protocol</td>
<td>Boolean</td>
<td>TCP or UDP encoded [0,1]</td>
</tr>
<tr>
<td>urlx_cell</td>
<td>Integer</td>
<td>UE Bytes received from the cell</td>
</tr>
<tr>
<td>timestamp</td>
<td>Datetime</td>
<td>Measurement timestamp (datetime format - &quot;yyyy-MM-dd HH:mm:ss&quot;)</td>
</tr>
<tr>
<td>cell_id</td>
<td>Integer</td>
<td>RAN cell ID</td>
</tr>
</tbody>
</table>
Anomaly Detector (II)

- Context describes which data source provides which RAN KPI measurements
- SDA collects measurements and aggregates per cell ID and time window
- Aggregated data combined and transformed into the data model of the Anomaly Detector module
- SDA delivers data through the Anomaly Detector’s REST API
Conclusions
Summary

• Data-driven network management requires the integration of heterogeneous data sources and data consumers
• Context-aware management based on the ETSI CIM standard
  • Modeling of data sources, data consumers and data pipelines
• Development of monitoring framework for collecting and aggregating data
  • Separation between monitoring context and data planes
Next Steps

• Combination of context information from different levels:
  • Operations level → network functions, network services
  • Business level → network policies, intents, SLAs, owners

• Alignment with the SAIN architecture

• Auto discovery of context information

• Northbound API for interacting with the semantic data aggregator

• Closing the loop → Collection, processing, and application of configuration data
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