SDN/NFV Network AI Assurance In Practice
Agenda

New Challenges of SDN/NFV Network

AI Practice in SDN/NFV Network Assurance

Perspectives in SDN/NFV Network Assurance
5G with SDN/NFV Network Architecture

- Multiple Layers
- Multiple Services
- Multiple Slices
- Multiple Tenants

5G Architecture extracted from NGMN 5G White Paper
The 5G Different scenarios

- eMBB
- mMTC
- URLLC

Industries
- Automobile
- Transport
- Tourism
- Agriculture
- Media
- Healthcare

Scenarios:
- Virtual Reality
- Multi-angle Video
- Extreme traffic density
- Smart city/home
- Wearable devices
- Smart manufacturing
The Challenges on 5G Network Assurance

- Dynamic & Complex Network
  - SmartPhones
  - Car Device
  - Automatic Device

- Difficulties in Fault Demarcation
- Long Time for Fault Recovery
- Massive TT with Low Efficiency

- Decoupled Software and Hardware
- Sliced Network for Different Scenarios
- Increasing Management Objects
The Challenges on Network Assurance

Hard to diagnose trouble by CLI

Hard to have a full view
Agenda

New Challenges of SDN/NFV Network

AI Practice in SDN/NFV Network Assurance

Perspectives in SDN/NFV Network Assurance
AI Enables 5G Network Assurance Intelligent

- Dynamic route self-optimization
- RCA Analysis
- Alarm Suppression
- Fault Prediction
- Intelligent Maintenance
- Intelligent Optimization

AI Machine Learning

5G
AI accelerate network operation & maintenance intelligence

Example: Event A

- Performance characteristics 1: call success rate declined
- Performance characteristics 2: database access alarm
- Performance characteristics 3: network packet loss rate rise

Challenge:
- The growing complexity of the network leads to demarcation difficulties
- Maintenance workload is increased because of the massive new APP
- Maintenance response time affects user experience

Scheme:
Big data + artificial intelligence:
Automatic generation of knowledge base and strategy operation and maintenance model
Establish cross-layer fault correlation model from physical resources, virtual machine to business, use AI data analysis engine with the introduction of machine learning algorithm.

**RCA AI Solution**

**RCA Component**
Based on topological position and fault model, the RCA components using AI engine.

**Machine learning algorithm**
the machine learning algorithm for business knowledge automation identification and learning.

- From a large number of alarms to sort out the relationship between the alarm and root cause alarm
- Based on the current alarm and topology has occurred to predict the possible occurring alarm
- Triggered by rules to detect or self-healing action
- Through the deployment of the AI engine, machine learning (Apriori, prefixspan, FP-growth, ...) algorithm to learn the inherent pattern, the formation of rules
RCA AI Analysis Process

1. Task scheduling
   - Based on historical alarm and intelligent identification rules
   - Automatically Locate Root Cause

2. Data preprocessing Step 1
   - Extract the alarm / business and other key attributes of the data source
   - Data cleaning
   - Data aggregation

3. Data preprocessing Step 2
   - Algorithm-related data conversion

4. Algorithm running
   - Knowledge is transformed into rules

5. Result analysis

RCA Rule base
- Rule 1
- Rule 2
- Rule 3
- Rule 4
- Rule 5
AI RCA Rule Algorithm Design

Algorithm can be tested and design by UI
## RCA Rule AI found in SDN/NFV Network

<table>
<thead>
<tr>
<th>Alarm From</th>
<th>Alarm Code</th>
<th>Alarm Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VNFM</td>
<td>Alarm of peripheral node (30101)</td>
<td>Ethernet port down (3305115659)</td>
</tr>
<tr>
<td>VNFM</td>
<td>Network element foreground alarm (30104)</td>
<td>Main and standby board communication link broken (5122)</td>
</tr>
<tr>
<td>VNFM</td>
<td>Network element foreground alarm (30104)</td>
<td>Communication interface between module and OMP is abnormal (5380)</td>
</tr>
<tr>
<td>VNFM</td>
<td>Network element foreground alarm (30104)</td>
<td>Coupling scission (8402690)</td>
</tr>
<tr>
<td>CSCF</td>
<td>Rack alarm (20383)</td>
<td>Coupling scission (8402690)</td>
</tr>
<tr>
<td>SSS</td>
<td>Rack alarm (20389)</td>
<td>Coupling scission (8402690)</td>
</tr>
<tr>
<td>CSCF</td>
<td>Rack alarm (20389)</td>
<td>Coupling circuit break (8417537)</td>
</tr>
<tr>
<td>SSS</td>
<td>Rack alarm (20383)</td>
<td>Coupling circuit break (8417537)</td>
</tr>
<tr>
<td>CSCF</td>
<td>Rack alarm (20389)</td>
<td>DIAMETER static link construction unsuccessful or link broken (2399734018)</td>
</tr>
<tr>
<td>SSS</td>
<td>Rack alarm (20383)</td>
<td>DIAMETER static link construction unsuccessful or link broken (2399734018)</td>
</tr>
<tr>
<td>USPP</td>
<td>Network element alarm (20272)</td>
<td>Break link with DST (2534034178)</td>
</tr>
<tr>
<td>USPP</td>
<td>Network element alarm (20272)</td>
<td>Abnormal communication between monitoring centers (2533772544)</td>
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<tr>
<td>USPP</td>
<td>Network element alarm (20272)</td>
<td>Multiple master nodes (2533772550) appear in the cluster</td>
</tr>
</tbody>
</table>

In SDN/NFV Network, one ethernet port down may cause so many alarms exceed that our expectations.
RCA AI in Practice

Issues

1. Implementing AI Algorithm daily is not necessary because there is not enough data.
2. One AI Algorithm can discover new rules but it is not enough.
3. Some rules created by AI Algorithm may be invalid.

Solution

1. one~two month (depends on how many NEs in your network)
2. The results of several different AI Algorithms should be compared.
3. Verification is necessary.
Vehicle Scheduling for Intelligent Maintenance

1. Historical Data
   - Data cleaning, Marking
   - Site, transmission, work order, equipment, vehicle, environment, personnel, date...

2. Factor Extraction

3. Machine Learning

4. Schedule Algorithm
   - Work Order Rule library
   - Intelligent Scheduling Library
     - Real Time Schedule
     - Pre-schedule

5. Training
   - Work Order System
     - Work Order
     - eFlow
     - AI Platform
     - Feature matching
     - Pattern Matching
   - Outdoor
     - Vehicle location, oil volume, vehicle networking...
     - Real-Time Information
     - TT
Vehicle Scheduling for Intelligent Maintenance

Vehicle efficiency **20% increased** & operating cost **10% off** by AI

**Issue**

- Vehicle cost is the largest accounting in Outdoor Maintenance (over 25%);
- The daily use efficiency is uneven
- Real-time Data are not visible, vehicle usage is not associated with the job (task) (not knowing the resource consumption of the work order)

**Improvement**

- **Visual**: real-time vehicle mileage and oil volume, base station location and work related;
- Intelligent scheduling algorithm
- **Efficiency**: Analyze Historical work order to create the thermal chart for the intelligent schedule; The optimal routing is based on the work order/site/vehicle/personnel information;
Hard disk high failure rate because of system stores high utilization.

Traditional maintenance can only be dealt with passively, replaced temporarily.

AI Fault prediction:
- Predict the hard disk failure rate, replace the high-risk disk in time;
- For the running environment of the hard disk, the tuning parameters are in time and the service life of the hard disk is prolonged;
Intelligent Elastic Strategy

- Realization of closed loop of operation and maintenance based on elastic expansion and self recovery of strategy;
- On the Deep Learning AI platform, automatic generation strategy, and implementation of adaptive strategy optimization.

Value

Intelligent Resilience Strategy

1. History Characteristics
2. Trained Model by Deep Neural Network
3. Current Characteristics
4. Generate elastic policies and Implement
5. Strategy continuous optimization

Cloud Network Slicing

- Cloud Network Slicing
- History Characteristics
- Current Characteristics
- Customer
- Traffic
- KPI
- KQI
- QoE
- Location
- Business
- Time
- Resource Demand
- vCPU
- RAM
- Net
- Scale out/in
- Net
- Customer experience
- Resource Consumption
- Elastic Effect
Dynamic Route Intelligent Optimization

Network status monitoring and analysis:
- Performance
- Traffic
- Topography
- Routing

1. Data Collection

2. Status

3. Control Info

4. Information

5. Run

6. Feedback

Traffic Forecasting:
- Regional flow forecasting
- Port flow prediction
- Traffic forecast

Policy Module:
- Business quality policy
- Load balancing
- Protection strategy

Routing Algorithm

Resource Schedule

Issue:
- Long cycle, low efficiency, can not meet the sudden demand
- The utilization rate of network resources is low
- require high skill and many efforts

Value:
- Dynamic optimization routing strategy to improve transmission efficiency
- Dynamic scheduling of resources to improve network efficiency
- Bandwidth adjustment, path adjustment, priority protection
- The process is efficient and automatic and meets the sudden demand
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New Challenges of SDN/NFV Network

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Perspectives in SDN/NFV Network Assurance
Current BSS/OSS

BSS
(Usually Tier-1 CRM do most of these functions)

- Catalogue Management
- Customer Management
- Customer WebSelf Service
- Partner Management
- Point of Sales Settlement
- Settlement
- Order Capture
- Order Fulfillment
- Receivables

OSS

- Inventory Management
- Work Force Management
- Work Flows Management
- Service Catalogue
- Service Activation
- Business Intelligent/Analytical
- Online Charging OCS
- Mediation
- Fault Management
- Performance Management

EMS

- NE
- NE
- NE
- NE
- NE
- NE
Software Definition drives the OSS system control NE directly and Control NE more efficiently.
AI In Further OSS

AI Work Force Assignment

AI Multidimensional Analysis: Performance+Alarm+Configurations+TT+Log Analysis

AI Resource Allocation
Current BSS AI and OSS AI are silos. Further BSS AI and OSS AI will be Union AI.
Software become to a lots of microservices and integrated by demand.
Further OSS Perspectives

Multidimensional Analysis from topology graph/abstraction models (customer)/Log/Performance/Alarms

Data Collection & mediation will require de-duplication and continuous updates of resources to build a topology graph including Alarm/Performance/Configuration.

Cover all Domains in Telecom Network