*ITU FL-ML5G

Artificial Intelligence Enables a Network Revolution

April 25, 2018

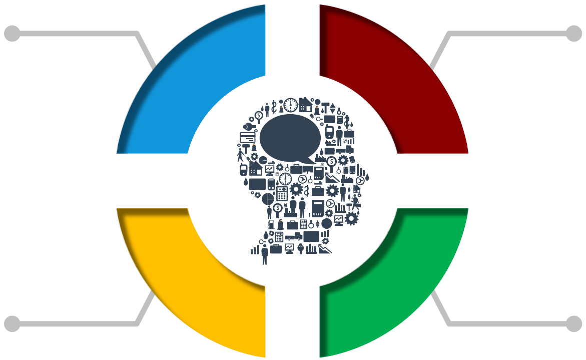
Network Technology Research Institute, China Unicom

A

Part 1

AI application in operators

Several Viewpoints on Artificial Intelligence



The third wave of AI

Deep learning proposed
Big data era coming
Computing power increased

Weak AI, Strong AI and Super AI

Weak AI, NOW
Strong AI, 2040
Super AI, 2060

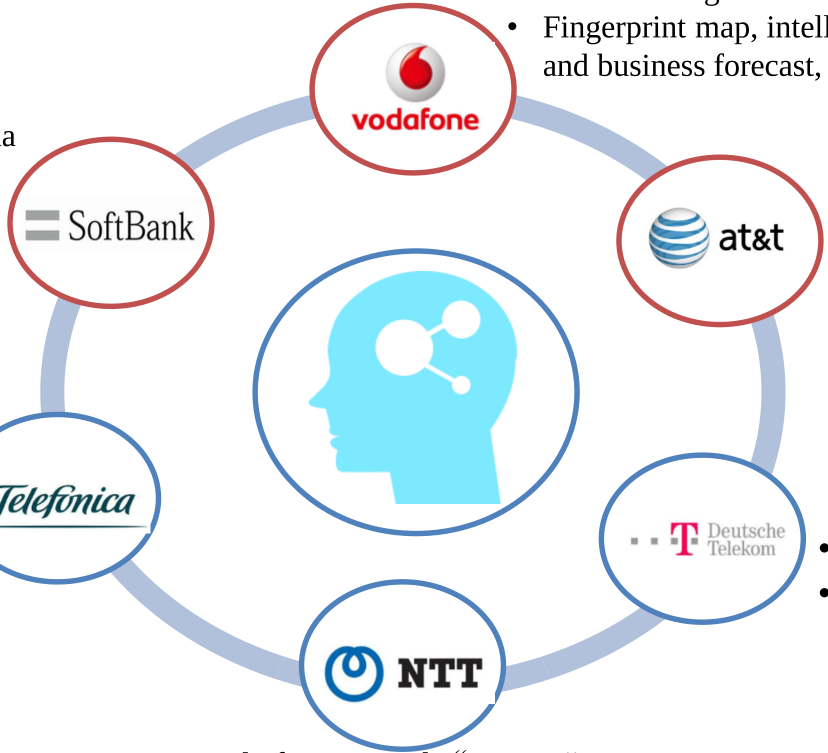
AI enables the fourth industrial revolution

Goal: Intelligentization of Industrial Production, Intelligent Control, Intelligent Machines
Representative Technology: Artificial Intelligence

AI+ all walks of life

Important direction for digital transformation in all walks of life
Deeply affect retail, finance, transportation, manufacturing, medical, security, education, and telecom industries

Global Operators Applying AI Technology



Vodafone
- UAV tracking and control technology
- Fingerprint map, intelligent obstacle avoidance, traffic and business forecast, network parameter optimization

SoftBank
- AI engine developed with Honda
- 50% of network operators optimized, 2019
- 1000 days

AT&T
- Open source AI platform named "Acumos" cooperate with Tech Mahindra

Telefonica
- The fourth platform named "Cognitive Power"
- Voice recognition customer service system "Aura"

Deutsche Telekom
- Automatically switch APP
- AI assistant

NTT
- AI platform named "Corevo"
- Intelligent driving and IIOT

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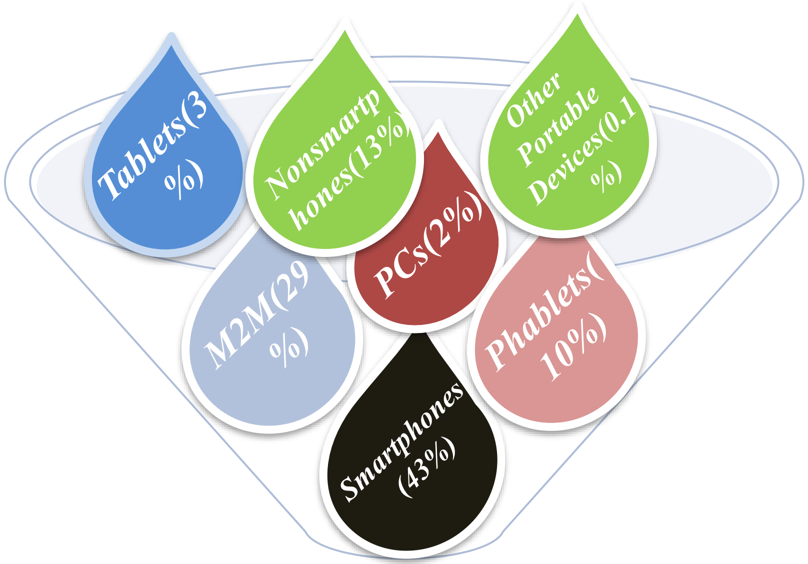
Part 2

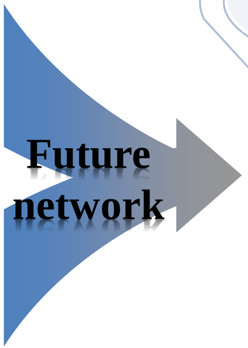
AI enables network revolution

Challenges on the Telecom Industry（1/2）

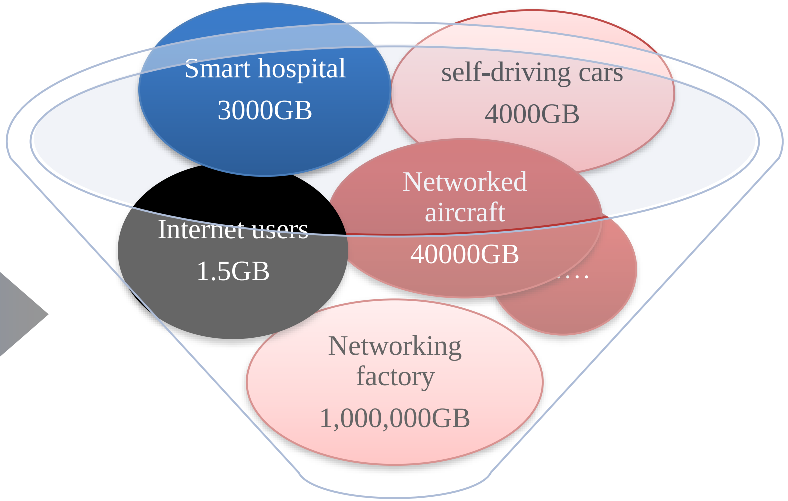
✓ **Mass growth of devices**



In 2020, global IOT devices will grew to 50 billion， 6 times more than the devices in 2011.



✓ **Mass growth of data**



In 2020, global mobile data traffic generated 35 EB per month.

In 2020 , global data amount to 40ZB , 50 times more than the data in 2011

***Source：CompTIA and CISCO**

Challenges on the Telecom Industry（2/2）

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✓ **Mass growth of network complexity**

The Trend of Internet Connection Evolution

Internet → Mobile Internet → Internet of Tings → Internet of Intelligence

- 2G/3G
- xDSL/LAN

Traditional connection » Ubiquitous connection

- Satellite
- Balloon
- 4G/5G
- FTTx

The Trend of Network Architecture Evolution

Traditional network architecture → SDN/NFV → Automatically Orchestrated and Managed

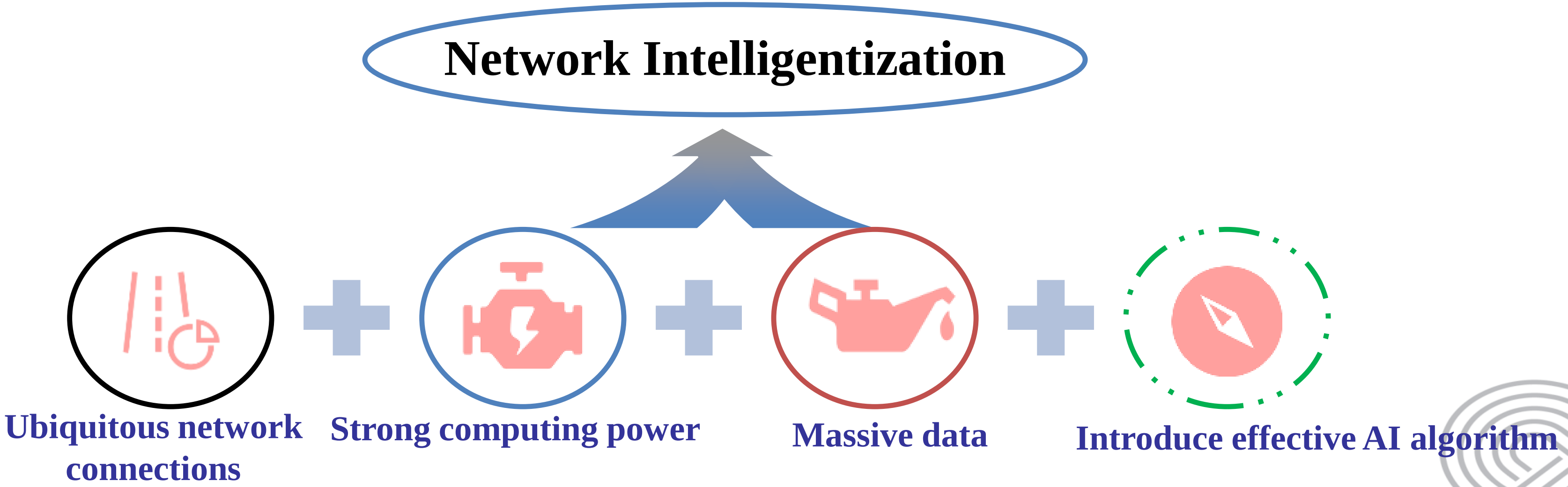
- Separation of control and data planes(SDN)
- Virtualization(NFV)
- Cloudification

- Openness and programmability
- Service diversity, diverse traffic requirements（eg.MANO）
- Full end to end automation of network and service management(eg. Zero-Touch Operations)

Network Intelligentization is Imperative

- AI could analyze massive data by heterogeneous computing and edge computing. AI could adaptively adjust and optimize network connections by combining optimal strategy learning algorithms such as reinforcement learning with SDN technology. AI could realize fully end to end automated network architecture by semantic understanding and auto-optimized technology.

- The challenges mentioned above are also the advantages of realizing network intelligentization.



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Part 3

The road of China Unicom network intelligentization

China Unicom Intelligent Network Logical Framework

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AI Innovation and incubation — SaaS

Basic applications
- Intelligent Planning
- Intelligent O&M
- Intelligent design
- Intelligent Construction
- Intelligent optimization

incubation applications
- Survey application
- Maintenance tool
- Automatic trouble-shooting
- Supervision application
- Network assessment
- optimization application

AI Enablement Platform — AIaaS / PaaS

- Image Identification
- Natural language processing
- AI Data fusion capabilities And Interface open service
- Speech Recognition
- Data Fusion

AI Framework
Software infrastructure
Third-party capability access

- External data collection capabilities
- M-domain data collection capabilities
- B-domain data collection capabilities
- O-domain data collection capabilities

Basic computing and network environment — IaaS

- Heterogeneous Computing Cluster IDC（CPU/GPU/FPGA）
- SDN/NFV Network
- Edge Cloud Edge Compute

China Unicom Vision of AI Application in Network

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AI +network planning
2020： 30% utilization

AI+ network design
2020： 30% utilization

AI+ network construction
2020： 40% utilization

AI+ network security
2020： 70% utilization

AI+SDN/NFV
2020： 50% utilization

AI+ network optimization
2020： 40% utilization

AI+ network maintanence
2020： 60% utilization

AI&5G network
2020:AI-enabled Mobile Edge Computing

AI-enabled network: overall utilization ratio will reach 45% in 2020

China Unicom Network Intelligent Application （1/2）

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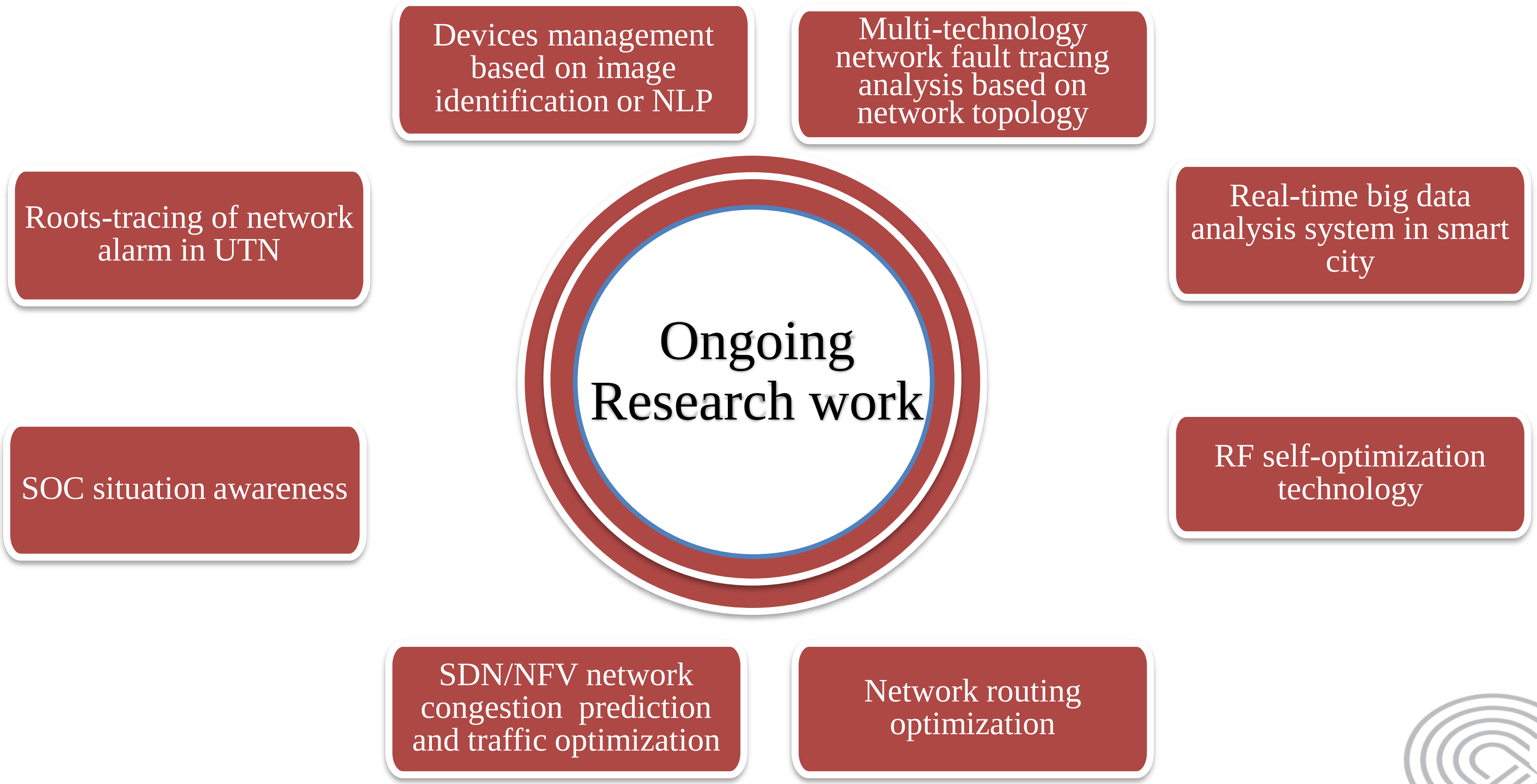
Realized network intelligent application

- Business intelligent recommendation capability
- MR Intelligent positioning and analysis
- NPS derogate prediction model
- Content based charging correlation model
- Spam SMS intelligent diagnosis
- IPTV user behavior and defect analysis
- Customer churn prediction model
- Automated debug scenario self-learning
- Intelligent network optimization virtual testing
- Video stalling automated problem locating
- Customer resident location model
- Alarm Association Rule Machine Learning Model

China Unicom Network Intelligent Application （2/2）



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Part 4

Case study

Case Analysis: AI applied in Roots-tracing of Network Alarm

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Research Background

- Amounts of device alarms of UTN: UTN is the local integrated carrier transmission network of China Unicom. UTN is mainly used for 3G/4G mobile service, and VIP customer service, and UTN uses IP/MPLS dynamic protocol. Compared with the traditional network, the protocol used by UTN is relatively complex, and the logical connection of the network is complicated. Compared with the traditional network management system, the UTN network system receives a large number of device alarms, many of which are caused by the root alarm.
- The current processing method: For the alarms, the current method is to solve the alarms depending on the expert experience, which means transforming the expert experiences into rules, and filter out the non-critical alarm through the rules . The downside of this approach is that in order to avoid filtering out the important alarms, the filter rules are relatively relaxed, which means the rules have limited filtering ability.
- It is hoped that applying AI to trace the root alarm can form a more efficient solution.

Research Objective

- Look for the rules with higher filtering capabilities
- Compress alarms to get the valuable ones
- Get the alarms collection that contains the root alarm

Technical Scheme and Process

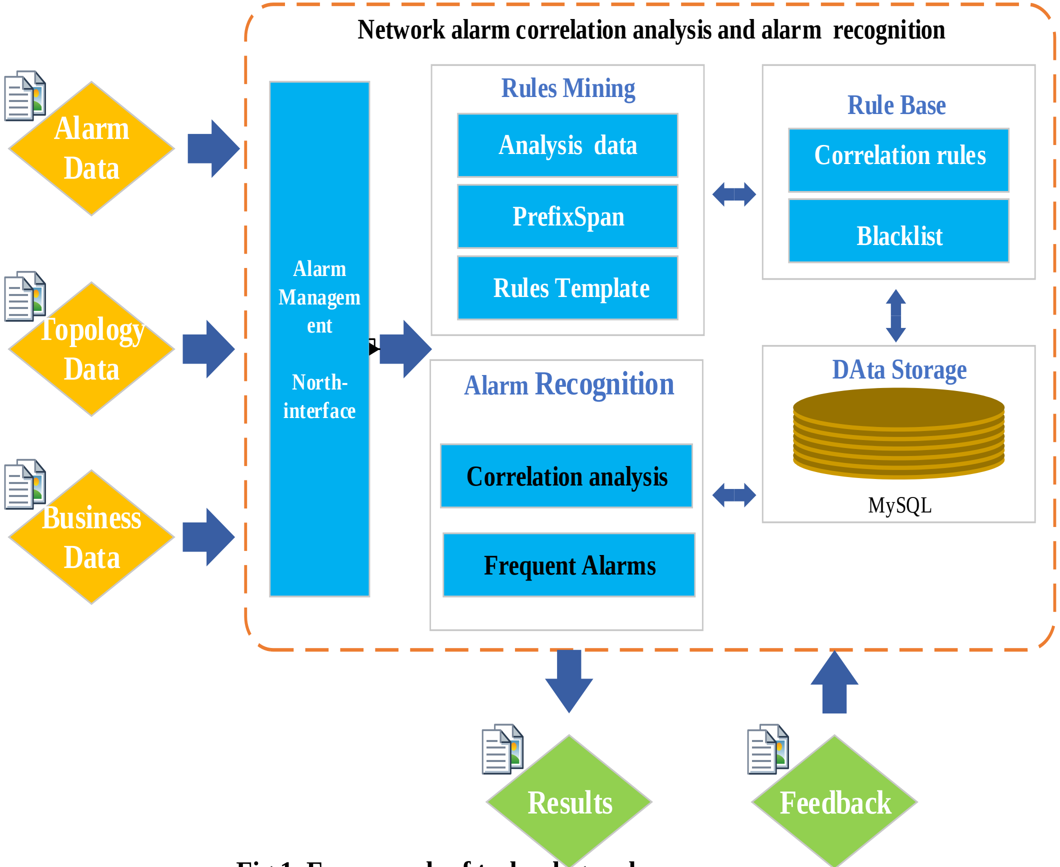

Fig.1 Framework of technology scheme

Step One: Data preparation

- Identifying frequent alarms

Step Two: Correlation rules mining

- Improving PreFixSpan algorithm

Step Three: Alarm correlation rules confirming and storing

- Correlation rules
- Blacklist

Step Four: Root alarm identification

- Labelling alarms

Data Preparation

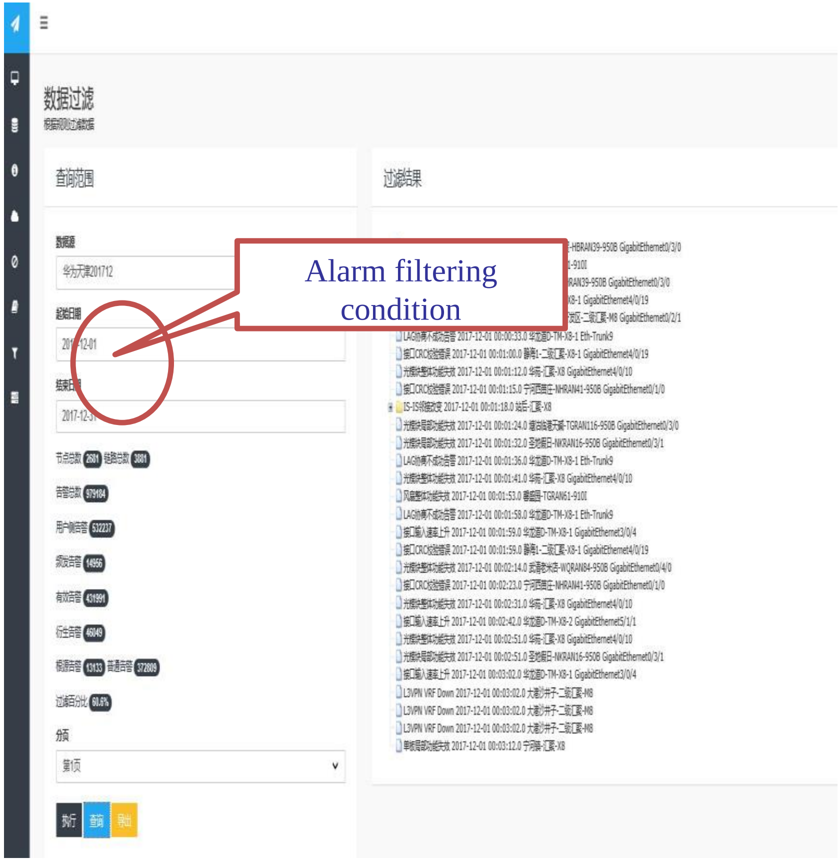

Fig.2 Interface data preparation process

Frequent Alarms

➢**Problems and Analysis**

Many alarms being discovered are frequently reported continuously at the same time or in a continuous period of time, such as alarm of link down. When the data is analyzed, it will only lead to the rule of “Link down->Link down”. Such a rule is not a reflection of the derivative relationship.

✓ **Solution**

Compressing the same alarm on the same port for a period of time to be only one alarm. Others are marked as filterable alarms.

Correlation Rule Mining

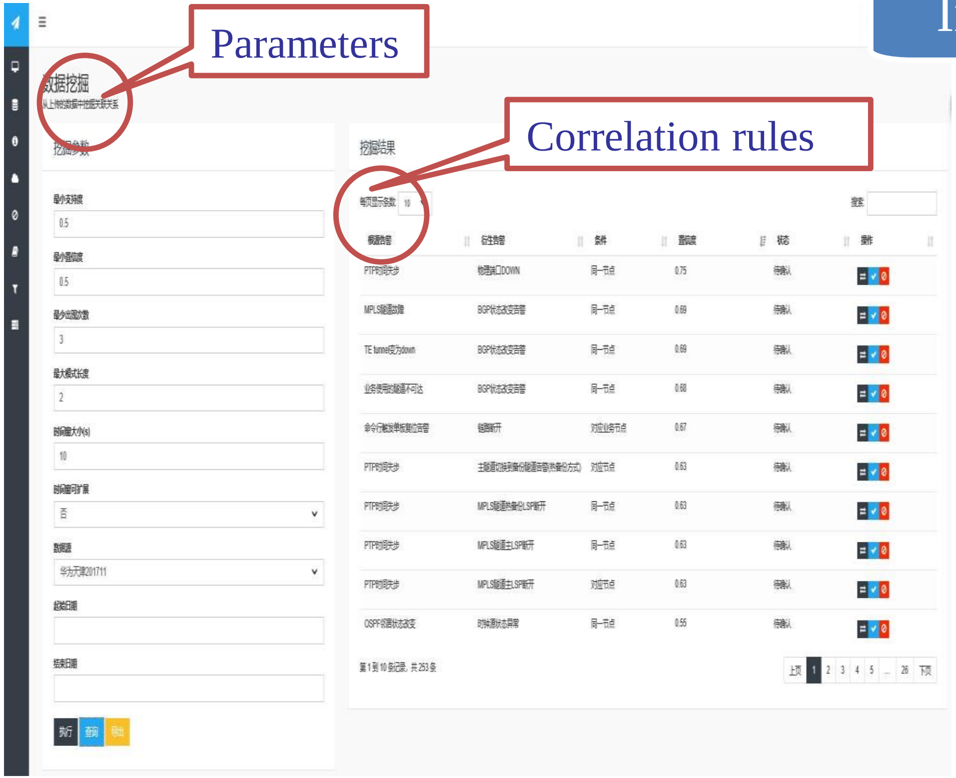

Fig.3 Interface of data mining process

Improved PreFixspan Algorithm

➢ **Problems and Analysis**

It was found that the rules obtained by the classic PreFixSpan algorithm do not have the corresponding trigger conditions in the early stage of the study, leading experts unable to determine the validity of the rules.

For example, there are two frequent item sets candidate objects:[A->B, constraints H1] (a), and [A->B ,constraints H2] (b)

When the probability of (a+b) occurrence exceeds the confidence interval, it will be recognized as one rule [A->B]

✓ **Solution**

Improving the PreFixSpan algorithm, the same alarms with different trigger conditions do not appear to be considered as one rule, but two.

Current Results

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Amount of Data	1135817	Time of Data	30 days	Total number of nodes	2681
Total number of links	3881	Numbers of rules before modification	78	Effective rules	Unable to Judge
Numbers of rules after modification	179	Effective rules	148	Total rules of Industry standard and manufacturer	61
Derivative alarm /Amount alarm （rules of data mining）	19%		Derivative alarm /Amount alarm （rules of standard and manufacturer）	2%	
Total percentage of filtered by rules and frequent alarm recognition	40%				

Further Optimization Methods and Work

- ✓ Analyzing the time parameter in the frequent alarm model;
- ✓ Modifying alarm identification to simulate online mode;
- ✓ Analyzing the similarities and differences between the alarm rules of different equipment manufacturers in different regions;
- ➢ Improving the algorithm according to the rules;
- ➢ Adding VM network topology to display the related information of alarms ,including the parameter of alarms, the performance parameter of network element ,the correlation of other alarms
- ➢ Researching the method to deploy this system into existing network.

THANK YOU!

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