LF AI Day Paris 2019

NTT’s Challenges of AI for Innovative Network Operation

September 16, 2019

NTT Network Technology Laboratories

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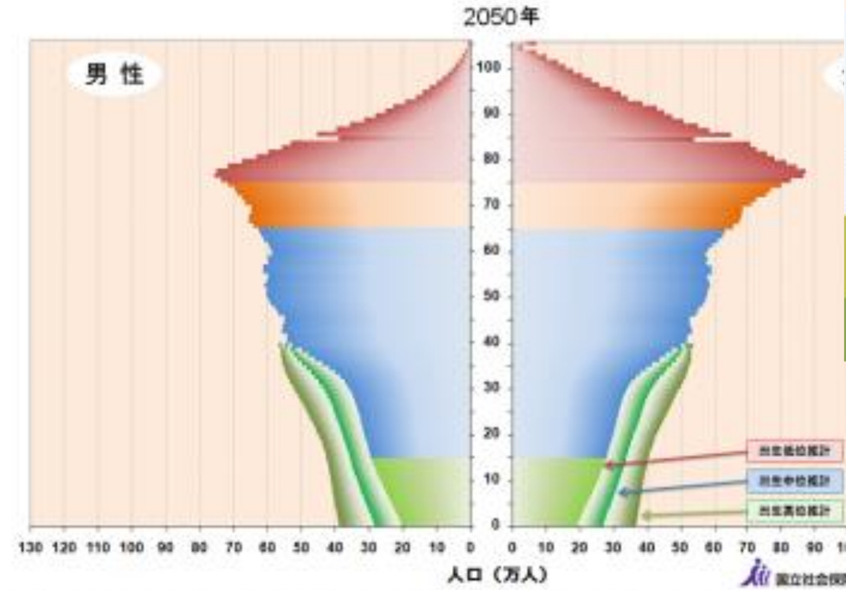
Changes in Operators’ Business

Digital Transformation

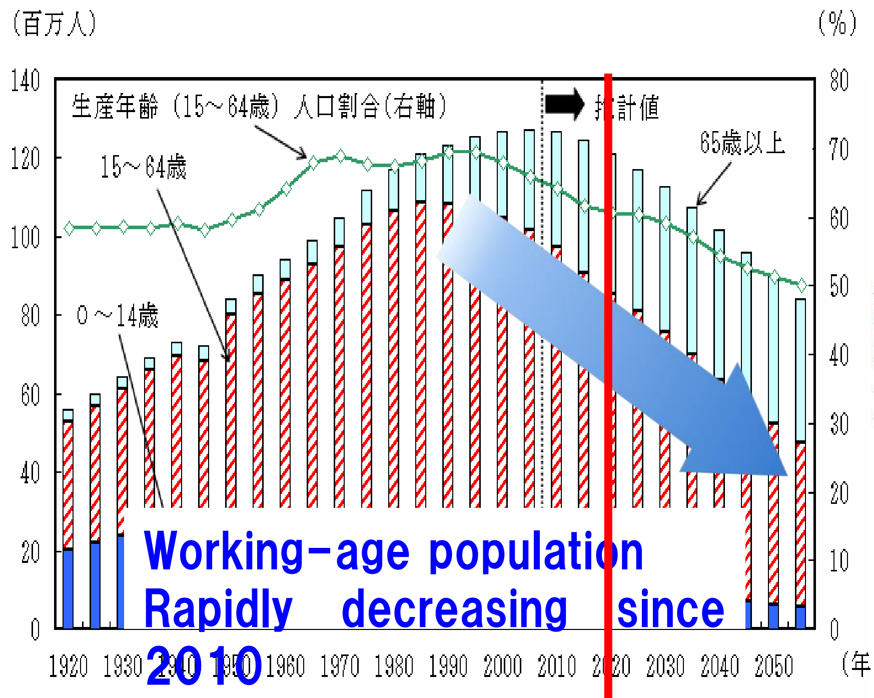


資料：1920～2010年：国勢調査、推計人口、2011年以降：「日本の将来推計人口（平成24年1月推計）」。

Aging Population

Aging Engineers at NTT

Working-age population in Japan



Working-age population Rapidly decreasing since 2010

（備考）2005年までは総務省統計局「国勢調査」、2010年以降は国立社会保障・人口問題研究所「日本の将来推計人口（平成18年12月推計）」により作成。

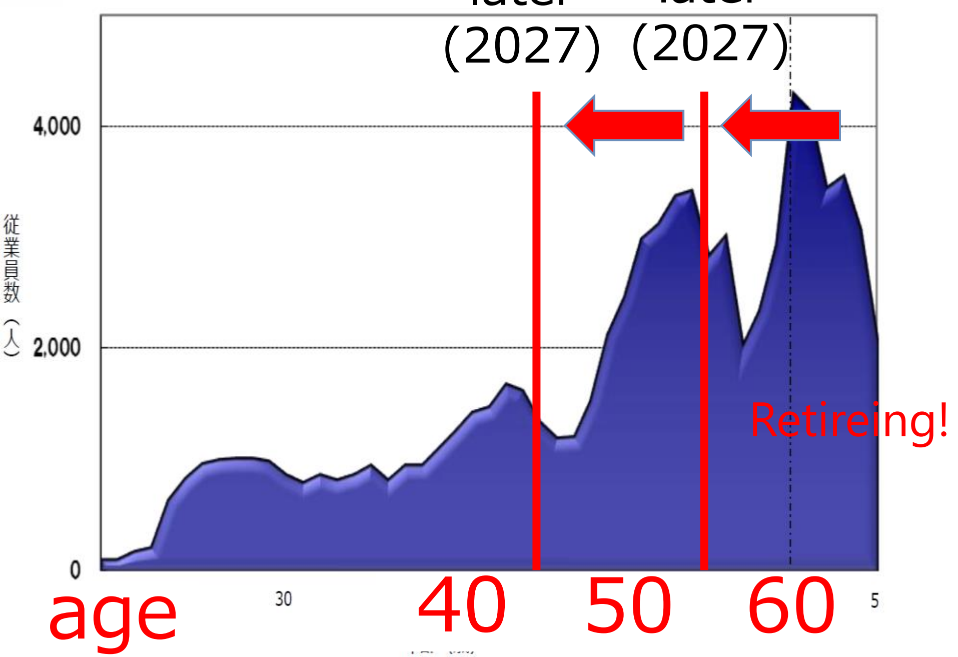
Now

NTT's demographic change

20Y later (2027)

10Y later (2027)

Now



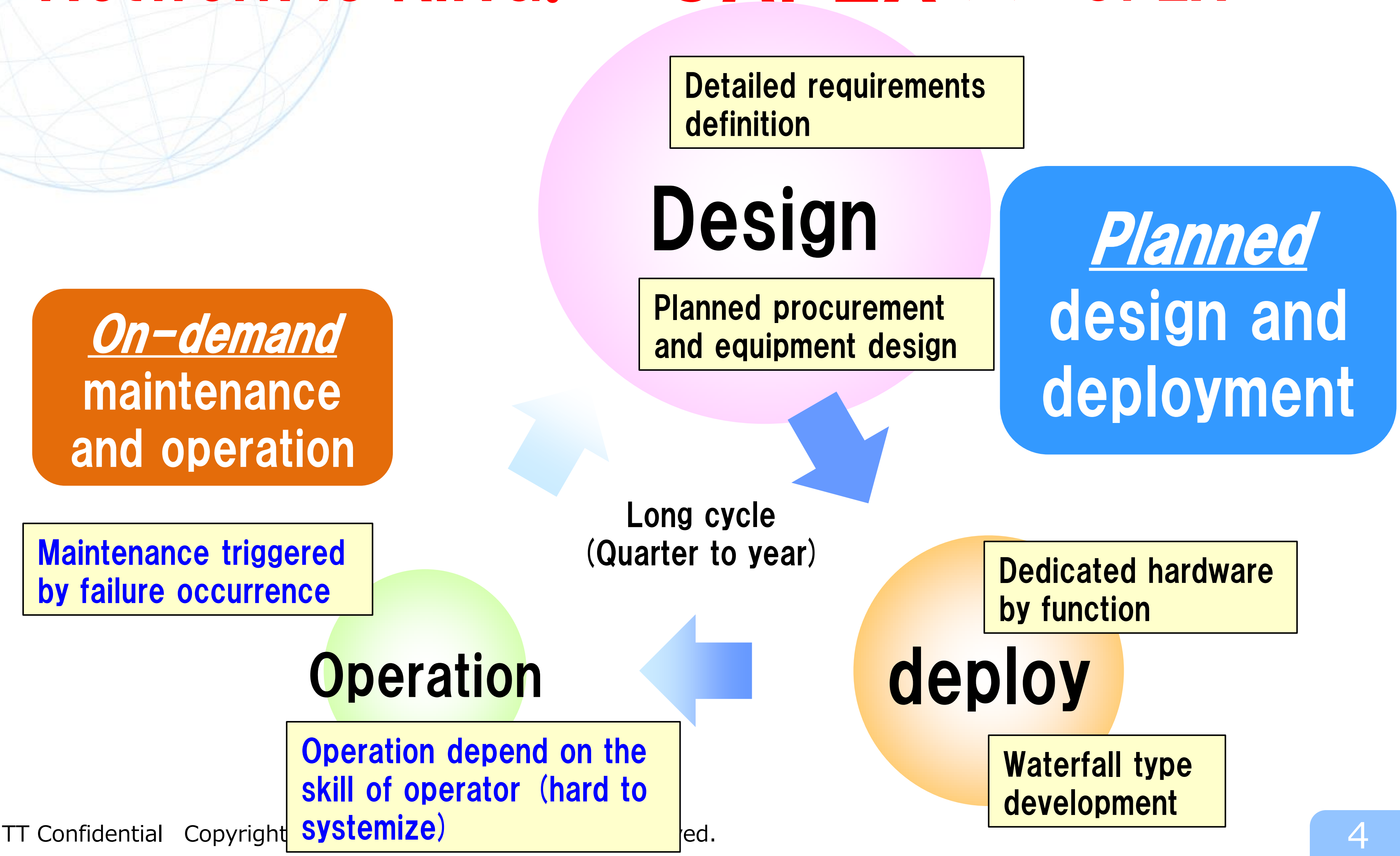
Retireing!

age

NTT ホームページ: IR Presentation
http://www.ntt.co.jp/ir/library/presentation/2018/roadshow_1710.pdf

OLD Operator's Business Process

Network is KING! CAPEX >> OPEX



Detailed requirements definition

Design

Planned procurement and equipment design

Planned design and deployment

On-demand maintenance and operation

Long cycle (Quarter to year)

Dedicated hardware by function

deploy

Waterfall type development

Maintenance triggered by failure occurrence

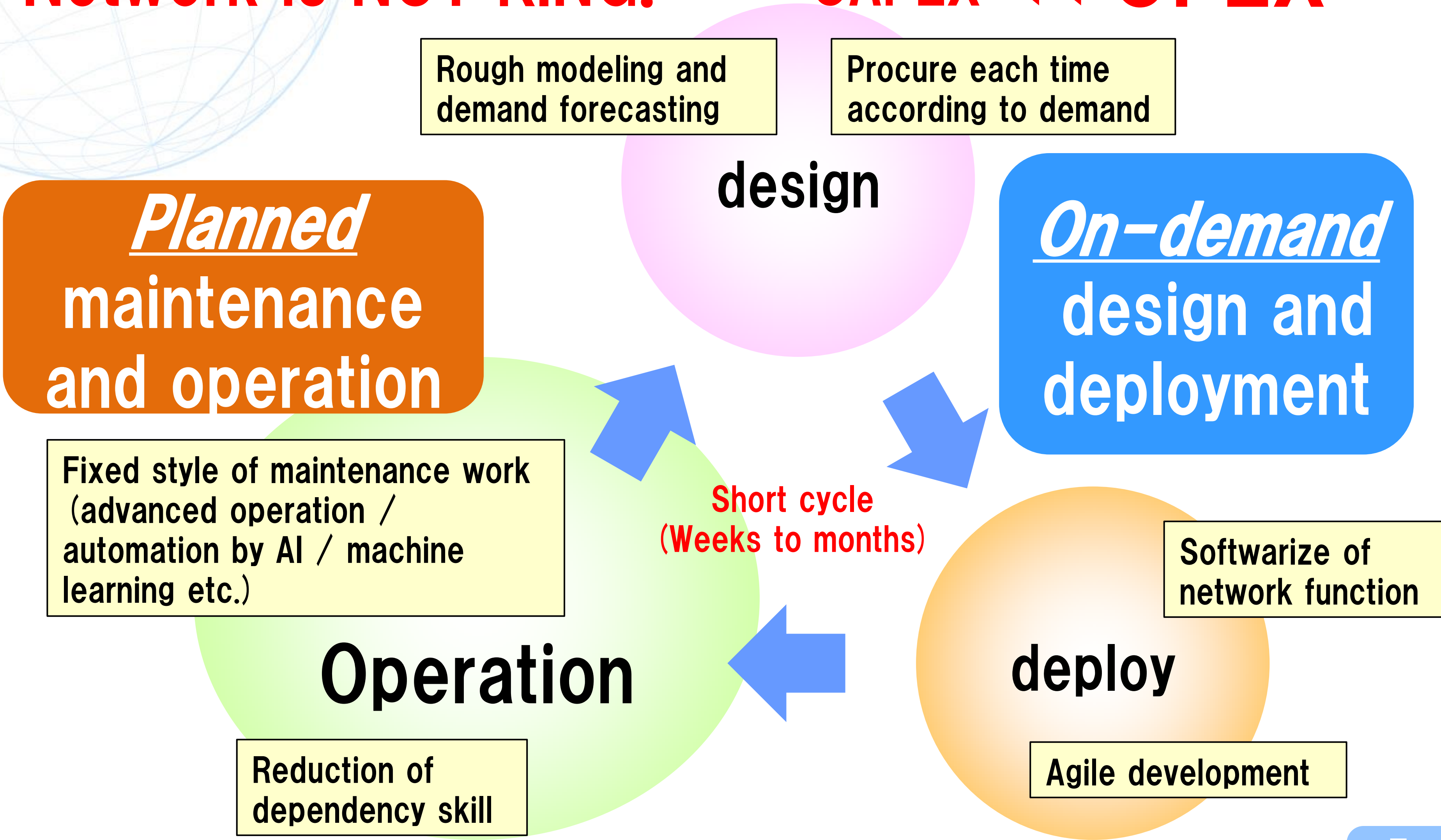
Operation

Operation depend on the skill of operator (hard to systemize)

FUTURE Business Process

Network is NOT KING!

CAPEX << OPEX



Rough modeling and demand forecasting

Procure each time according to demand

design

Planned maintenance and operation

On-demand design and deployment

Fixed style of maintenance work (advanced operation / automation by AI / machine learning etc.)

Short cycle (Weeks to months)

Softwarize of network function

Operation

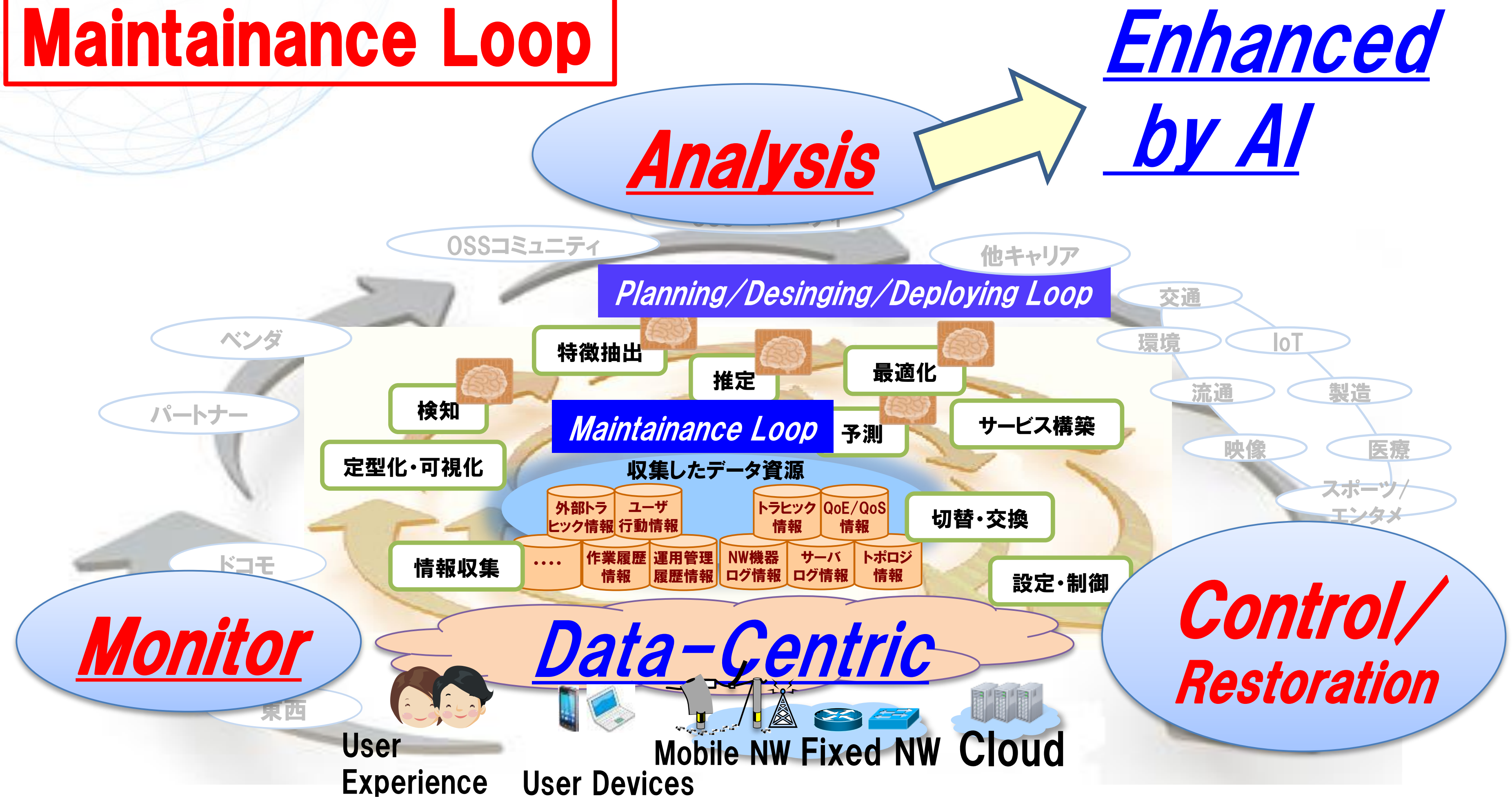
deploy

Reduction of dependency skill

Agile development

Future Vision for Network Management

Autonomous Maintainance Loop



NTT’s AI UseCase

(1)DeAnoS:
Deep Anomaly Surveillance System

(2)RCA:
Root Cause Analysis

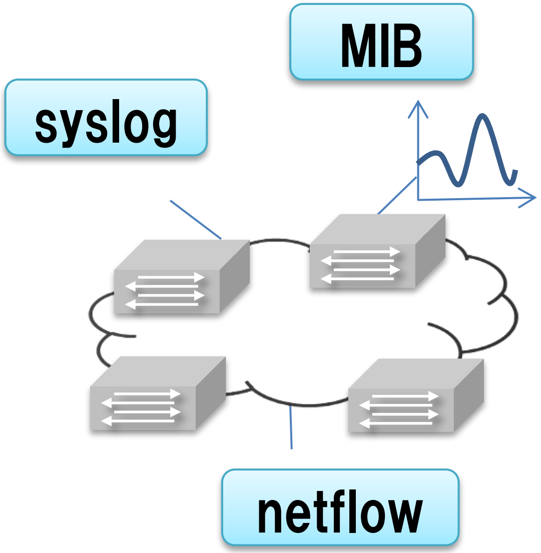
(3)MMS:
Mobile Mapping System

Anomaly detection using deep learning

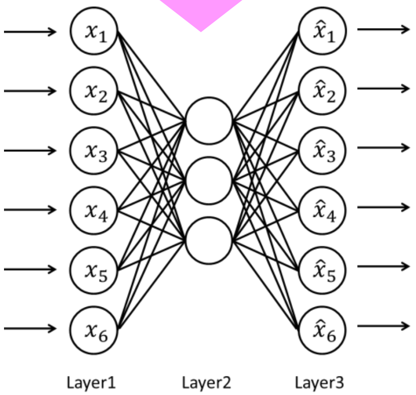
Collection of diverse NW data

Feature generation (time series of numerical vectors)

Input the current data to the learned model and judge the degree of abnormality

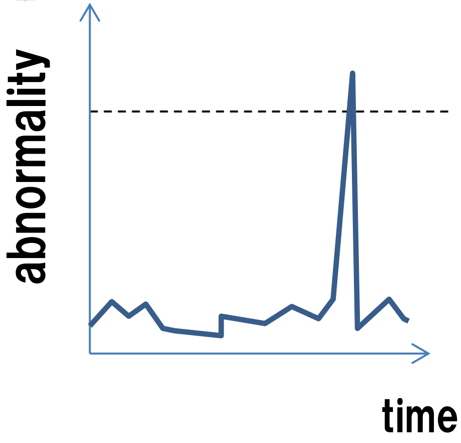


```
00:00  {0.2, 0.4, 0.7, ….}
00:01  {0.4, 0.8, 0.3, ….}
…
```



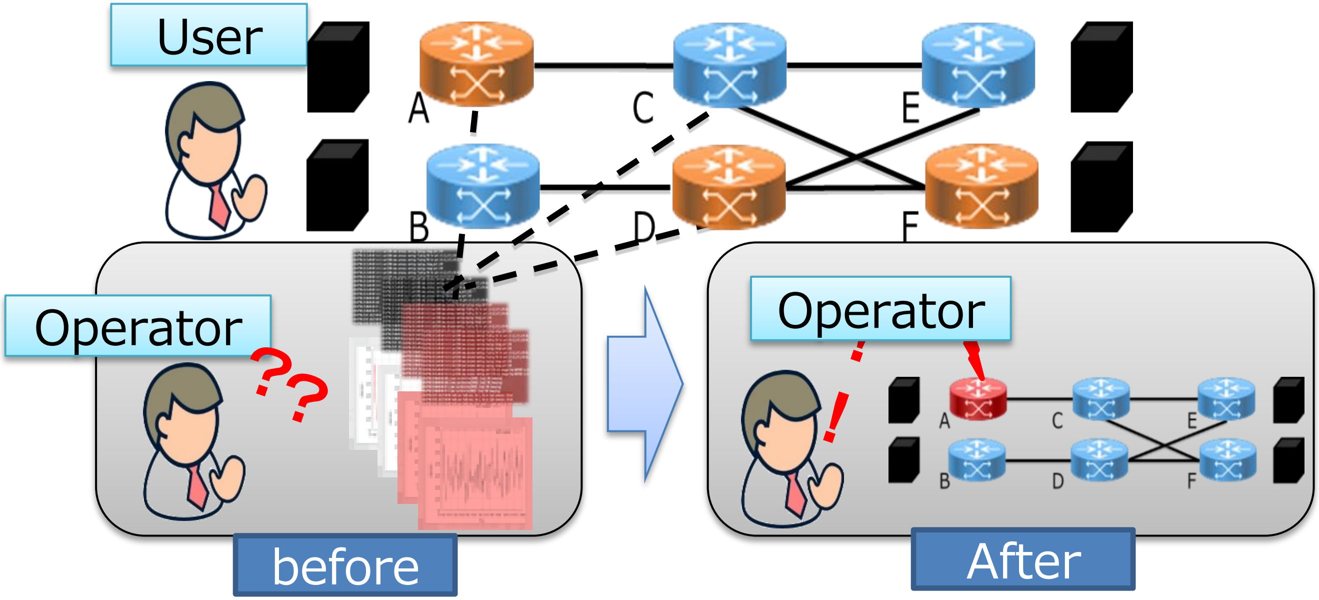
Learn state at normal time from past data

Anomaly detection



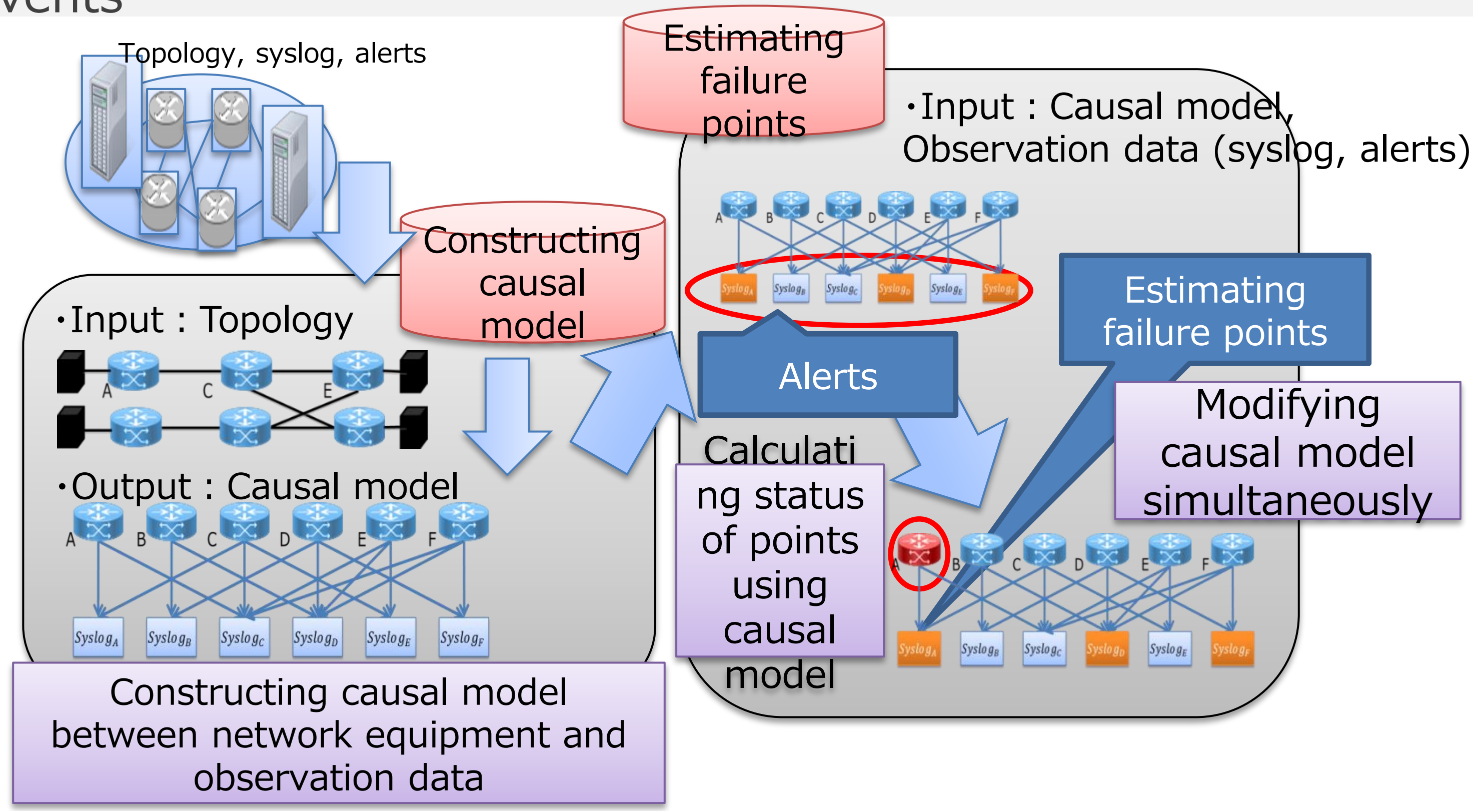
RCA (Root Cause Analysis)

- Root cause analysis for network operators who are troubled with managing operation from massive amount of syslog
  - Before: Being hard to Localizing failure points
    - One of the switch fails generates a massive logs in the network
  - After: Making it possible to estimate failure point
    - RCA Estimates failure points and show them for operators



Root Cause Analysis (Continued)

- Constructing causal model between network equipment and observation data using topology data
- Estimating failure points from syslog or alerts collected from network
  - Modifying causal model simultaneously to adapt unseen failure events



Topology, syslog, alerts

Constructing causal model

・Input : Topology

・Output : Causal model

Constructing causal model between network equipment and observation data

Estimating failure points

・Input : Causal model, Observation data (syslog, alerts)

Alerts

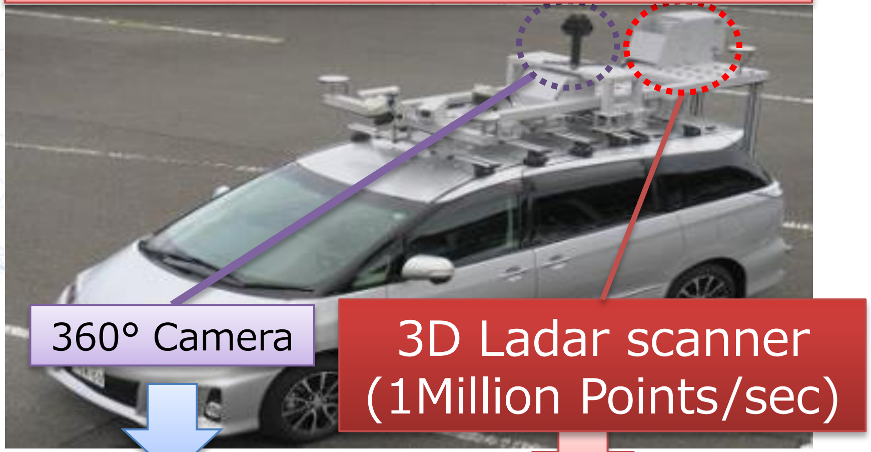
Estimating failure points

Calculating status of points using causal model

Modifying causal model simultaneously

3D Inspection

Mobile Mapping System

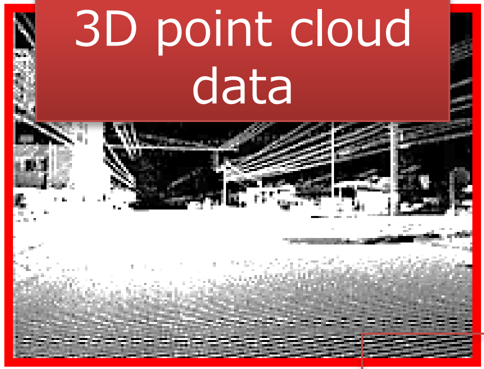


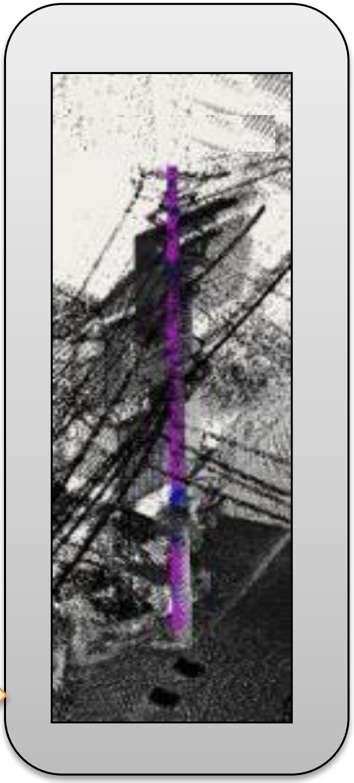
360° Camera

3D Ladar scanner (1Million Points/sec)

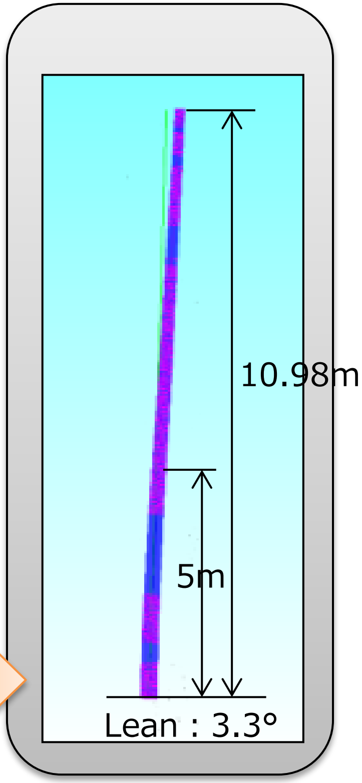
Photograph

3D point cloud data



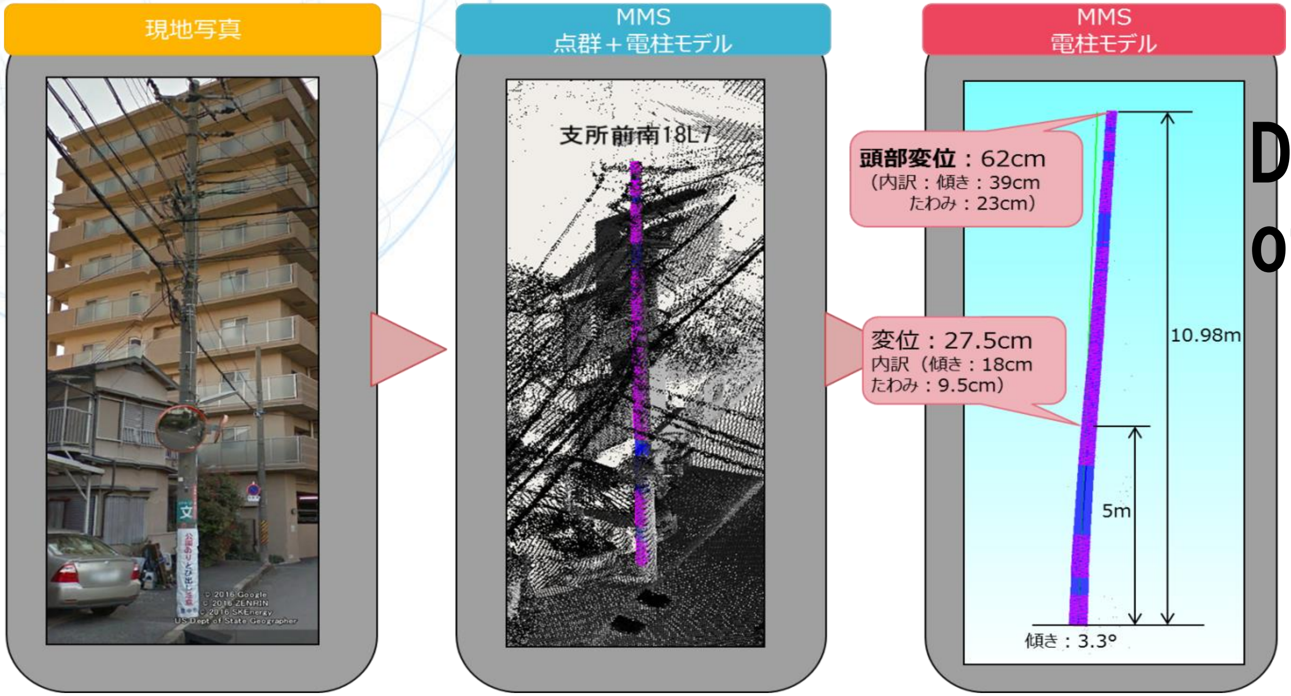


Automatic Extraction NTT's facilities (Telephone Pole)



Automatic Measurement (Lean/Deflection of Poles, Height of Cables, etc)

Inspection by Image recognition



現地写真

MMS
点群＋電柱モデル

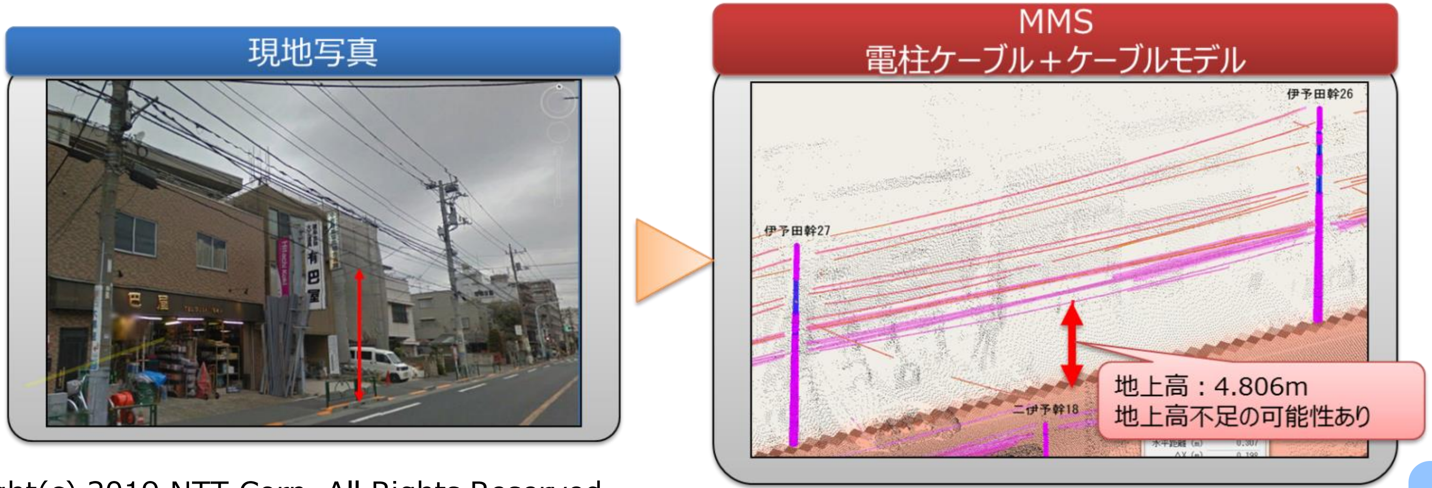
MMS
電柱モデル

頭部変位：62cm
（内訳：傾き：39cm
たわみ：23cm）

変位：27.5cm
内訳（傾き：18cm
たわみ：9.5cm）

Deflection/Lean of Telephone poles

Height of Cables



現地写真

MMS
電柱ケーブル＋ケーブルモデル

地上高：4.806m
地上高不足の可能性あり

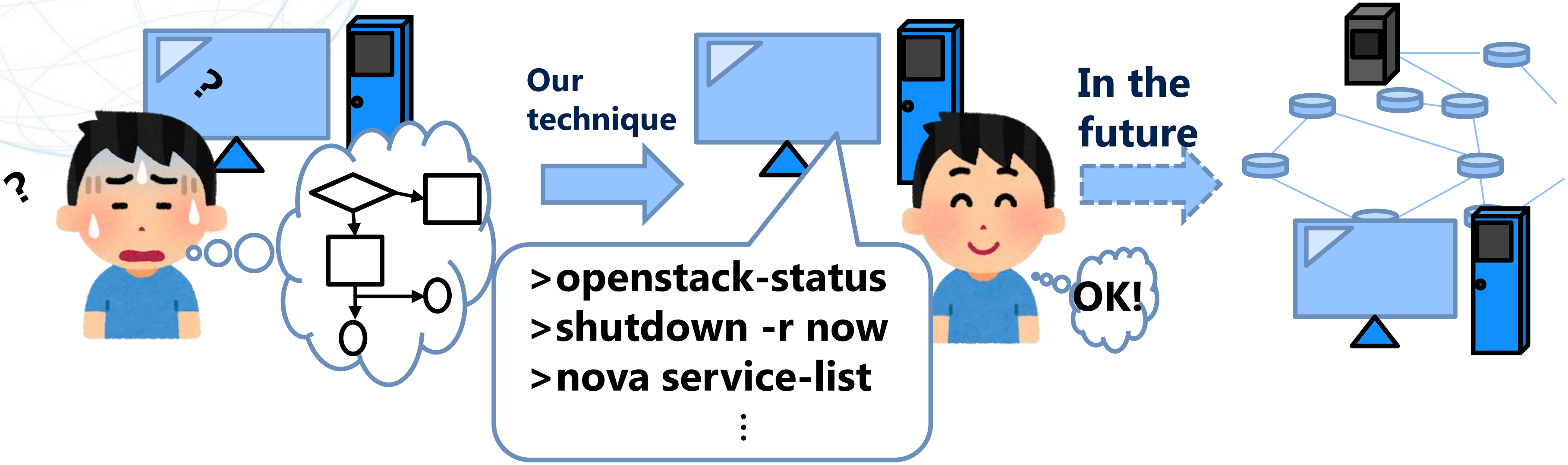
Beyond Zero Touch Operation…

- New Version/ New Type of Equipment
- New Service / Application
- Severe Disaster

NW Changes drastically/dynamically…
but follow-up changes are not easy task…

Evolving Network Operation by AI

Automatic generation of recovery actions



```
>openstack-status
>shutdown -r now
>nova service-list
⋮
```

Create recovery command sequences
from a huge amound of alarm/command records

Mechanism of Automatic command generation

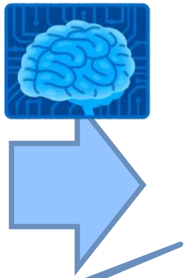
NTT

- **Automatic generation of recovery command sequences by Seq2Seq（A kind of DNN）**
- **Calculating risk score and reliability degree to ICT systems of action command sequences**

Input

Alarm sequences

```
Jun 19 14:00:00 proc01 DEBUG [req-12345] accepted ( IPv4, 12345) server /***/***/***
Jun 19 14:00:01 proc02 INFO [req-56789] Get http://***
Jun 19 14:00:03 proc01 DEBUG [req-24680] Failed to fetch instance by id server1 get /***/***
Jun 19 14:00:03 proc01 DEBUG [req-13579] Returning 404 to user: Could not find instance ***
Jun 19 14:00:03 proc01 DEBUG [req-98765] HTTP exception thrown: Could not find instance ***
Jun 19 14:00:04 proc01 DEBUG [req-43210] Returning 404 to user: Could not find instance ***
…
```



Output

Action sequences & safety/stability

```
# openstack-status | grep down          95%
nova-scheduler ***                      80%
# systemctl restart nova-scheduler      99%
# openstack status | grep scheduler     99%
*** running                             80%
(finish)                                -
```

Pattern①
（reliability：80%, risk score：10）

```
# openstack-status | grep down
nova-compute ***
# systemctl restart nova-compute
# openstack status | grep compute
*** running
(finish)
```

Pattern ②

```
# openstack-status | grep down
*** Critical Error ***
# shutdown –r now
# openstack status | grep down

(finish)
```

Pattern ③

・Prediction: action command sequences using seq2seq

・reliability: accuracy of prediction
・risk score: impact to the system with these sequences

Merci beaucoup!

ありがとうございました

Thank you!

NTT