# Application of Generative AI for Advanced Network Operations at Fujitsu


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## 1. Introduction

- **Future vision of network operations**

In addition to features such as high speed and high capacity, low latency, and massive connectivity, networks are expected to provide low power consumption, high reliability, autonomy, and extendibility. We can also expect a variety of services to be provided via networks as a vital social infrastructure.

There is therefore a need for flexible networks that can support multi-vendor and diverse service formats in line with a shift toward open networks and virtualization. This high degree of freedom and flexibility in network operations, however, becomes a factor in making the operation and management of a network all the more difficult. To solve this problem, there is an urgent need for Zero-Touch-Operation (ZTO) that aims to reduce the burden on operators through the automation of network operations. Plans are now underway to introduce new technologies in ZTO including AI and generative AI.

Yet, to ensure reliable network operations as automation progresses, it is still important for experts to grasp and understand the state of operations and take appropriate action as needed. This approach is known as Human-In-The-Loop. However, as described above, the types of equipment accompanying multi-vendor operation and the types of operation processes for different services increase as the difficulty of network operations increases. Experts will therefore need to grasp an ever-increasing amount of information while becoming familiar with correct operational processes. In short, they will need to

- accumulate operational knowledge,
- analyze the current state and predict future conditions, and
- decide on countermeasures.

This means accumulating operational knowledge, performing analyses based on know-how, and taking appropriate operational measures. With this in mind, the need is felt for technology that would enable an operator to make efficient use of network operational knowledge.

- **Application of generative AI to network operations**

Generative AI has been rapidly attracting attention in recent years as a key technology for making efficient use of knowledge. It can generate documents by training on large amounts of data or by referencing storehouses of knowledge. In this way, generative AI can automatically provide appropriate answers to inquiries or questions posed by users as in chatbots.

In Japan, telecommunication companies are already providing customer services making active use of generative AI and developing related technologies. They are also beginning to develop original large language models (LLMs) and to provide user services based on those models. Fujitsu too is involved in a variety of initiatives such as providing its large language model called "Takane" in combination with Fujitsu proprietary technologies for using knowledge.

**Figure 1: Conceptual diagram of advanced network operations using generative AI.**


In the communications industry, much attention is being focused on the proactive use of generative AI in services for users such as chatbots. This article, however, introduces technology development related to generative AI and usage examples from the viewpoint of achieving advanced network operations. In this way, we aim to use knowledge in advanced network operations as shown in Figure 1.

Looking to the future, we can envision the use of generative AI throughout network operations, but in the following, we introduce problem solutions in network operations focusing, in particular, on failure response. The aim of the technologies introduced here is to ease the burden on network operators through advanced network operations by efficiently utilizing knowledge with generative AI.

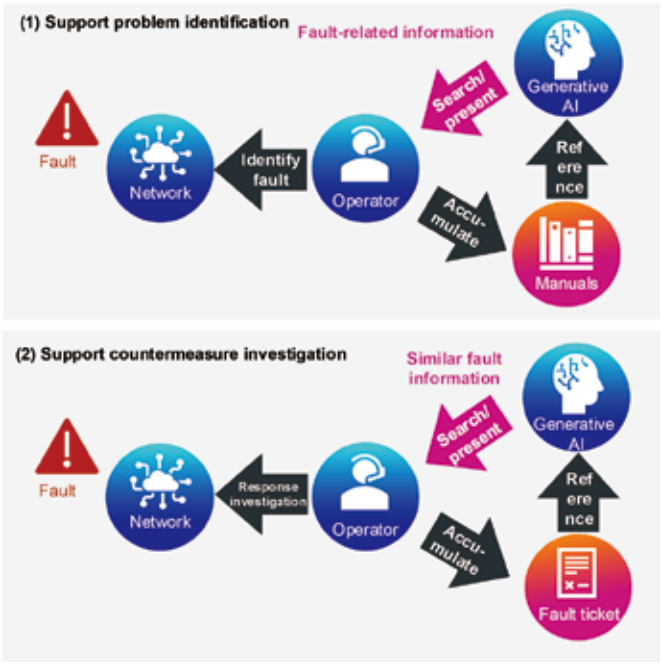
*1 Formerly kowns as Fujitsu Limited

## 2. Fujitsu's use of generative AI in network operations

In network operations, the use of knowledge is essential since quick action is needed particularly in failure response. For example, we can consider the following activities to take place in order to identify a problem and investigate countermeasures in response to a network failure.

- The operator searches for the knowledge needed to sort out the current situation and analyze the problem from manuals or specifications, and identifies the failure in this way.
- The operator then searches for a similar failure from past failure information and investigates causes and countermeasures while referencing the knowledge included on the failure ticket.

**Figure 2: Conceptual diagram of failure response using generative AI.**




In these activities, using generative AI that has been trained on a huge number of documents and past failure-related information would enable the operator to ask questions in natural language and quickly get hold of the information needed (Figure 2). In this way, generative AI has the potential of supporting an operator much like a brilliant assistant and contributing to efficient handling of network failures.

However, using generative AI requires documents for training purposes. In addition, the know-how essential to reliable network operation is wide-ranging that includes not only that during times of normal operation but also that at times of failures. Such know-how also differs according to the scale and complexity of the network. There is therefore a need to possess both:

- know-how of communications equipment/technologies of equipment vendors, and
- know-how of network design/operation of telecommunication carriers.

At the same time, it is often the case that documents like manuals and specifications are not in a format that generative AI can use for training.

Against the above background, Fujitsu has developed generative AI "Takane"*2 featuring enhanced Japanese-language proficiency for the Japanese market and full customization capabilities for using domain-specific knowledge. Takane is equipped with high-accuracy Retrieval-Augmented Generation (RAG) and is designed for use in a secure environment. Additionally, in conjunction with generative AI services like Takane, Fujitsu is developing data structuring technologies for structuring vast amounts of information as know-how into a format that enables efficient training of generative AI while ensuring the quality of that information as knowledge. This technology makes it possible to merge know-how of network communications equipment and network technologies cultivated by Fujitsu as a total vendor of network communications equipment and know-how of network design/operation of telecommunication carriers into the latest generative AI technology.

In addition to this technology, Fujitsu is developing technologies to enable know-how gained from training generative AI to be provided as knowledge that can be used by network operation managers. These include technology for analyzing the causes of failures and trends in countermeasures and performing cause-and-effect analysis and technology for improving the reliability of generative AI answers.

The following introduces such key technologies being developed by Fujitsu.

- **Accumulation of operational knowledge**

Training of generative AI requires large quantities of high-quality data. In documents that contain an accumulation of know-how and failure-related information in particular, such information will often be stored in a complicated manner. For example, multiple items of failure-related information may be mixed in the same document and some information may overlap different documents. Moreover, in addition to equipment manuals and text documents containing failure-related information, there are documents that contain a variety of data formats and file formats such as operation logs and time series data. Generative AI cannot be trained with these formats in their present state. Documents may also contain e-mail addresses and street addresses, and training generative AI with such information as-is raises ethical issues. Fujitsu is developing the following data structuring technologies to deal with these problems.

*2 Fujitsu has begun offering large language model "Takane" for corporate use having the highest Japanese language proficiency in the world.

- Data restructuring technology
  This technology extracts only necessary information from network-related documents (specifications, manuals, and failure-related information) in diverse formats, and structures that information into a format that can be used for training generative AI.
- Multimodal technology (tables, logs, images)
  This technology turns unstructured data like tables, logs, and images into documents and then structures that data into a format that can be used for training generative AI.

- **Analysis of current state and prediction of future conditions**

A network is configured in a complicated manner, so in operations management, the occurrence of a phenomenon must be judged not in a fragmentary manner but from a comprehensive point of view. Although generative AI must be trained while including, for example, the relationships between document content and failures that have occurred, there are few documents that explicitly describe such relationships.

To deal with these problems, Fujitsu has been developing the following analysis technologies.

- Fujitsu Knowledge Graph enhanced RAG for Root Cause Analysis
  This is Fujitsu's original technology for representing the relationships between diverse factors such as documents and symptoms and causes of multiple faults in graphical form to clarify the causal relationships among them*3 (released on Fujitsu AI platform "Kozuchi"*4).
- Trend analysis technology
  This technology analyzes and presents trends in causes and countermeasures with respect to past failure information in relation to a certain problem.

- **Countermeasure decision-making**

In network operations requiring high reliability, the role of generative AI is to support decision-making since final responsibility lies with the operator. However, AI including generative AI is essentially a black box that makes it difficult to judge whether its answers are correct. In addition, the way in which an operator poses a question may cause generative AI to misunderstand the operator's intent and return an inappropriate answer.

In response to these issues, Fujitsu has developed the following technologies for improving the reliability of answers.

- Query correction technology
  This technology converts inconsistencies, ambiguities, technical terms and abbreviations, and domain-specific phrases contained in operator questions into a form that makes it easy for generative AI to understand the operator's intent.
- Hallucination suppression technology
  This technology evaluates the likelihood of an answer returned from generative AI and presents the most likely answer.
- Evidence presentation technology
  This technology presents the data that serves as a basis for an answer returned by generative AI was generated.

## 3. Application examples

The technologies developed by Fujitsu are provided as "Virtuora AX Network Coach," a solution for achieving advanced network operations.

**Figure 3: Document search screen in Virtuora AX Network Coach**


- **Similar-failures search**

**Case study: Making search for similar failures more efficient in operations management**

When a failure occurs, determining whether it's an existing failure, a new failure, or a failure caused by the environment can result in many hours of primary troubleshooting in operations management.

In response to this problem, we conducted an application-effectiveness test using the "similar-failures search" function of

*3 Introducing Fujitsu Knowledge Graph Enhanced RAG (4 sessions) #1 Fujitsu Knowledge Graph Enhanced RAG for RCA (Root Cause Analysis)
*4 Fujitsu releases advanced AI technologies through it's "Fujitsu Kozuchi (code name) - Fujitsu AI Platform" to accelerate the implementation of an AI society toward a sustainable world.

this solution. Specifically, we constructed a database for use in generative AI training from failure management information that manages past failures. We also designed a mechanism that, on the occurrence of a certain failure, can search for similar failures from past problem management information by simply inputting a description of that failure into this solution in natural language.

This test used failure-processing information targeting Fujitsu equipment as training data. We performed an evaluation using three items—response rate, correct answer rate, and primary troubleshooting time—as indices for verifying application effectiveness.

**Table 1: Results of evaluating application of similar-failures search**
(Below are the results obtained in this test.)

| Item | Result |
|---|---|
| Response rate | Could present information even for questions about failures that do not exactly match the keywords and could return answers with information enabling a failure/non-failure judgment. Response rate was therefore 100%. |
| Correct answer rate | Could generally respond with similar failures with a correct answer rate greater than 80%. In particular, for frequently appearing failures that are difficult to judge from the ticket title, similar failures could be identified by asking additional questions. |
| Primary troubleshooting time | Could generally shorten search time compared with conventional keyword searches. In particular, for alarm-type failures for which related tickets exist in vast quantities, search time could be shortened to 1/10 or more. |

In the past, after receiving the results of searching failure-processing information, it was necessary to open up one ticket for each failure and check the analysis of that failure described in lengthy sentences. This solution, in contrast, presents information summarized by generative AI, so it has the effect of significantly reducing the amount of text that needs to be checked and making primary work at the time of a failure occurrence more efficient.

- **Document search**

**Case study: Making manual searching more efficient**

A network system uses equipment from a number of vendors. Each piece of this equipment features complex functions and option settings, so to operate such equipment, a large number of complicated manuals must be checked and understood.

Equipment manuals, however, contain expressions and terminology unique to each type of equipment, which require skills and time to understand. The knowledge of specific equipment and functions may also be biased depending on the operator. Additionally, when implementing new equipment and functions, they, of course, need to be understood, but localization is also required to handle multilingual manuals.

In response to these problems, we conducted an effectiveness test using the "document search" function of this solution (Fig. 3). For this test, we constructed a database for use by generative AI from specifications and manuals of Fujitsu equipment. We also designed a mechanism that enables a user to search for desired information, such as how to use a certain piece of equipment, from a massive number of manuals by inputting questions into this solution using natural language.

We performed an evaluation using four items—consistency, accuracy, context, and response time—as indices for verifying application effectiveness.

**Table 2: Results of evaluating application of document search**

| Item | Result |
|---|---|
| Consistency | Able to respond to questions mixed with abbreviations, Japanese and English expressions, etc. |
| Accuracy | Able to return answers that grasp the questioner's intent from ambiguous expressions. Could also return answers with respect to unstructured data (figures and tables), and would return "Unable to answer" for content not contained in documents thereby preventing hallucinations and guaranteeing accuracy. |
| Context | Able to reply in logical, natural Japanese with few grammatical errors. |
| Response time | Able to return answers generally within 30 seconds enabling stress-free use. |

In the past, it was necessary to check the table of contents in many documents to look for a chapter that may be relevant to the information needed, or keywords had to be correctly input to conduct a search. This solution, however, lists out the information relevant to the questioner's intent as determined by generative AI, which makes it possible to list the information needed from a large quantity of documents in a short time.

## 4. Conclusion

From here on, we can expect advancements to be made in "advanced decision-making" and "autonomous operations" applying AI and "digital rehearsals" based on digital twins. Going forward, Fujitsu plans to expand the application of generative AI and provide solutions that leverage new technologies such as AI agents with a view to more advanced network operations.