Intent-Based Networking for Network Management Automation in 5G Core Networks

Patrick Lingga[1], Jeonghyeon Kim[2], Jiyong Uhm[2], Jaehoon (Paul) Jeong[2]
[1] Department of Electrical and Computer Engineering, Sungkyunkwan University
[2] Department of Computer Science and Engineering, Sungkyunkwan University
{patricklink, jeonghyeon12, jiyong423, pauljeong}@skku.edu

5G 코어 네트워크 관리자동화를 위한 의도기반 네트워킹

패트릭 링가, 김정현, 엄지용, 정재훈
성균관대학교

Abstract

Intent-Based Networking (IBN) is a network management system that uses Artificial Intelligence (AI) and network orchestration to automate administrative tasks. It translates an operator's intent into a policy based on the system's capabilities and allows for easy configuration and operation without requiring a deep understanding of the network's structure and operations. IBN can also identify and automatically adjust unwanted or faulty problems to optimize the networks. The management of 5G core networks, IBN can improve the Quality of Service (QoS) of the network.

I. Introduction

The emergence of 5G technology has allowed more devices to connect to the Internet. However, an intelligent support of policies in enterprise networks has been a major challenge for network operators, as they need to break down business models into specific, low-level policies or instructions and apply them to the entire network. Intent-Based Networking (IBN) is a recent development that aims to address this support by allowing operators to focus on the desired outcomes of a policy rather than the details of its implementation. This IBN offers several benefits, including increased efficiency, flexibility, and scalability, as well as reduced reliance on human intervention and a lower risk of human errors. To achieve these benefits, IBN relies on artificial intelligence (AI) techniques, which help to advance network automation to a higher level. By focusing on the desired outcomes of a policy, rather than the details of its implementation, IBN allows operators to easily use their networks. Thus, IBN is expected to play a key role in the future network by having the potential to transform the way that networks are managed and operated.

II. IBN in 3GPP and IETF

The advent of IBN has sparked a lot of research and development in intelligent networks. In order to support this work, the 3rd Generation Partnership Project (3GPP) and the Internet Engineering Task Force (IETF) have made efforts to discuss and define the foundations of IBN, including its terminology and functionality. These efforts will help to guide future research for combining the concept of IBN with 5G Core Networks.

Based on 3GPP TS 28.312 [1] and 3GPP TR 28.812 [2], an intent outlines the requirements, objectives, and restrictions for a particular service or network management workflow. Placing emphasis on “What” is needed rather than “How” this can be carried out. Furthermore, an intent is categorized based on different user types or different management scenario types such as Communication Service Customer (CSC), Communication Service Provider (CSP), and Network Operator (NOP). 3GPP refers to IBN as an Intent Driven Management Service (MnS). There is an Intent Driven MnS for each CSC, CSP, and NOP. When deploying an intent, it is deployed through a chain of these MnSes into which the intent is translated. The evaluation of the network is performed through Intent Assurance, where it is checked whether the intent is continuously satisfied.

In the IETF, the term of an “intent” was first introduced in RFC 7575 [3] as “an abstract, high-level policy used to operate the network”. However, this definition does not differentiate “intent” from “policy”. A more refined definition of “intent” is provided by RFC 9315 [4] as “a high-level, declarative goal which is used to define outcomes and high-level operational goals, without specifying how those outcomes can be achieved”. IBN can be divided into two categories such as Intent Fulfillment and Intent Assurance. Intent Fulfillment consists of functions that ingest, translate, and orchestrate an intent with appropriate devices. Intent Assurance validates and monitors not only the IBN but also makes an abstract report to let the user understand the status of the networks.

III. IBN for 5G Core Network

Fig. 1 shows the integration of the IBN’s concept in 5G core networks to provide a closed-loop system. This integration allows IBN-based Management and Automation systems that reflect users’ intent with AI/ML technologies on top of the traditional 5G core networks. The main components are as follows:

- **Intent User:** The operators or administrators who are responsible for managing and operating the network infrastructure for 5G services and infrastructure with an "intent".
- **Controller:** A centralized entity that takes a high-level "intent" of the intent user and converts it into specific low-level instructions for providing the requested service. This entity helps to ensure that the desired service is delivered while networks are efficiently managed.
- **Network Data Analytics Function (NWDAF):** The 3GPP 5G standard entity for collecting data from various sources in 5G core networks. The data can include various raw data from user equipment, network functions, and OAM (operations, administration, and maintenance) systems, among others. The collected data can be used for analytics purposes to help understand and optimize the performance of the network.
- **5G Core Network:** The 5G infrastructure network that is responsible for providing a range of services to users, including data and voice communication, as well as supporting a wide variety of applications and services. The 5G Core network also includes various functions such as User Plane Function (UPF), Policy Control Function (PCF), Network Slice Selection Function (NSSF), Access and Mobility Management Function (AMF).

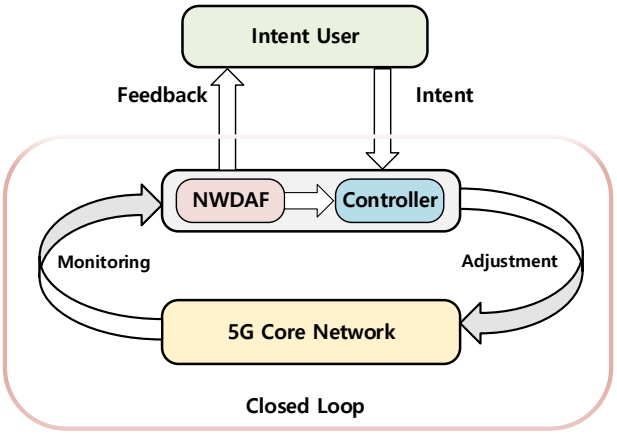

Fig. 1. Intent-based closed loop for system 5G core networks

In Fig. 1, the intent from the Intent User is sent to the Controller. The Controller then converts this intent into specific instructions and distributes them to the 5G core networks. The NWDAF continually monitors events from the selected network functions. It makes sure that the outcomes of the intent have been fulfilled by the network functions. The NWDAF can also integrate AI or Machine Learning (ML) to adjust the network functions to optimize the services based on real-time status and performance of the 5G core networks.

For example, a user may want to ensure that wireless communications autonomous vehicles (e.g., V2V and V2X) is given higher priority during rush hours in a smart city by using dedicated and redundant network slices to avoid network bandwidth sharing in traffic signal control communications. The user can express this intent to the controller, which will translate it into specific instructions for network slicing in 5G and apply them to the relevant network functions. The NWDAF will collect real-time data and update the instructions as needed to ensure that the desired Quality of Service (QoS) is achieved for autonomous vehicles. If the required QoS is being met, the NWDAF can provide a report on the QoS to the intent user to give feedback on the satisfaction with the service. The user can then ask for any desired improvements to the controller in order to maximize the performance of the 5G networks.

IV. Conclusion

Intent-Based Networking called IBN is a promising new approach to managing enterprise networks that aims to make it easier for operators to implement high-level policies. By focusing on the desired outcomes of a policy rather than the details of its implementation, IBN allows operators to achieve higher levels of efficiency, flexibility, and scalability, while also reducing the risk of human errors. By integrating IBN with 5G core networks, a closed-loop system can be created to reflect a user's intent with the help of AI and ML technologies. This system allows for the automated management of 5G core networks and the delivery of high-quality services to the network users.

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