Grouping Intent-based Packet-Optical Connectivity Services

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Abstract *This article illustrates an Intent-based Network solution towards the management of transport resources by showing the process of generating a transport connectivity service request from a generic intent. The architecture, internal interactions between components, and functionalities are presented with a set of initial experimental results.*

Introduction

Near-future networks management and control systems look towards constantly evolving and achieving a higher automotive and efficient level. One of the paths being investigated is to make the current network management and control solutions more independent from humans and so, to give them the intelligence to apply decisions over the network on their own and remove the need to know technical knowledge from the human actor. Intent-based Networks (IBN) reduce the complexity to manage network resources for both operators and tenants by letting them request services (i.e., "What do they need?") without them knowing which other aspects must be applied (i.e., "How do we implement?"). To achieve this complexity removal from the operator/tenant side and leave it to the system, it is necessary to find a way for the operator/tenant and the system to understand each other. Natural Language Processing (NLP) is a sub-field of artificial intelligence that spans the systems management options[1] as it translates natural language to machine-understandable information (and vice-versa), which creates a more smooth interaction between the operator/tenant and the system.

Within the current literature, there are some works looking at different aspects related to how to apply intents and NLP on networks management. For example, M. Xie et al.[2] shows an interesting and clear theoretical article where the authors present the idea of an intent manager for E2E network slicing across 5G domains. In addition, Das S. et al.[3] combined NLP with ML to achieve a wide range of goals such as network intrusion detection and M. Nguyen et al.[4] described the benefits of combining the NLP and SDN technologies to perform network management based on operator requests with some stated limitations such as *"Establish a route from h1 to h2, with latency less than 10 ms and ensure and bandwidth more than 400 Mbps, and allow UDP only"*. In terms of standardization, the ETSI Zero-touch network & Service Management presented early this year (February 2023) its ZSM framework[5] for IBN in which it defines how the intents may be managed by using the ZSM characteristics and functionalities, especially with the close-loop concept.

Despite the examples present in the literature (i.e.,[2],[3],[4]) and to the best of our knowledge, no other works focused on using the innovative IBN elements within the ZSM architecture combined with the NLP technology on packet-optical transport scenarios.

In this paper, a new IBN solution focused on the deployment and management of packet-optical transport Connectivity Services (CSs) is presented by joining the ZSM architecture with the implementation of NLP techniques in order to bring one more level of autonomy and intelligence to the network control and management and reduce its interaction with the human actors by reducing the numerical details in the initial intent request. To do so, the whole translation process from the intent request to the enforced policies is described. Moreover, an initial set of results and conclusions are described.

IBN Solution for Transport CSs

To solve the objectives previously described, the following IBN solution was designed. Its architecture design is based on the properties defined by the ETSI ZSM[5]: a) the use of closed-loop management procedures, and b) the management of multiple management domains through an End-to-End (E2E) management domain. Based on this, it is worth noticing that the current presented IBN solution focuses on the close loop actions in a single domain but it is intended to be evolved towards a multi-domain scenario.

Based on this, the proposed IBN solution architecture is illustrated in Fig. 1 and it is composed of four modules:

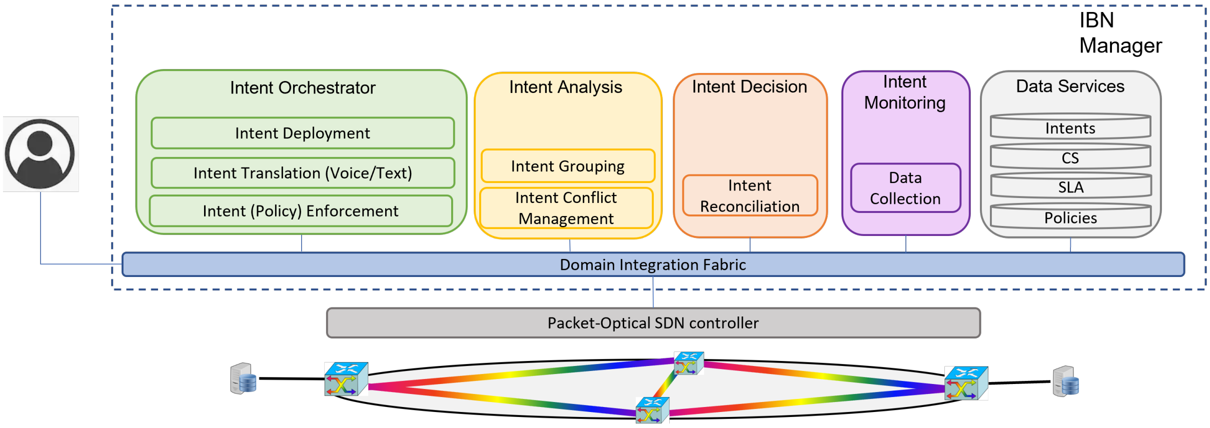

Fig. 1: IBN solution architecture.

- Intent Orchestrator (IOr): It takes care of all those actions to orchestrate the received intent such as the translation from either voice or text sources to the CS request, the selection of SLAs and the management of the policies defined within the SLA such as grouping (i.e., to optimise monitoring resources), CS deployment or the configuration actions to monitor the CS, etc.
- Intent Analysis (IAn): It is in charge of any action related to the evaluation and data processing with the objective to obtain a set of results/metrics that will be used to manage different aspects around the intent objects such as possible conflict or their grouping.
- Intent Decision (IDe): It is responsible to select the best decision possible and the corresponding way (i.e., policy) to resolve any issue such as a conflict between intents. This module will take care to manage those actions related to the intelligence functionalities described in the ZSM.
- Intent Monitoring (IMo): It is in charge to gather all the necessary data related to the generated and deployed intents and apply the right format in it for the Intent Analysis module to process it and the Intent Intelligence to decide about it.

In addition to the previous four modules, there are two more elements that allow their interaction. On the one hand, the Data Services, which is in charge to store any piece of information shared across all the previous modules (e.g., Intent, CS, Service Level Agreements -SLAs-, policies). On the other hand, the Integration Fabric, which has the functionality to bring a unified platform for all the previous modules to exchange information among them in a homogeneous way.

All these modules interact among themselves to deploy the received intent request and monitor

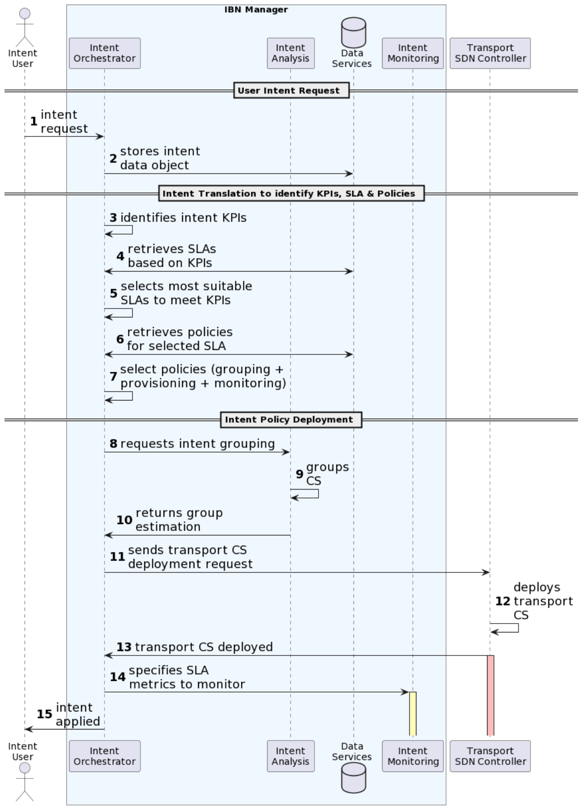

Fig. 2: Intent translation, grouping and deployment workflow.

it. Within the scope of this article, the intents are translated into CSs with an associated SLA and mapped into the right policies to finally achieve the deployment of the requested transport service. As illustrated in Fig. 2, the process has the following steps. The deployment begins when the user expresses (i.e., voice or text) a request such as *"Deploy 1 transport connectivity service between servers A and B with high availability and capacity."* (step 1). This request is received by the IOr, which stores it in the Data Services (step 2) and processes it to extract the different elements to create the CS request for the Packet-Optical SDN Controller (steps 3-7). First, the KPIs within the intent are identified (step 3) and used to retrieve a first set of SLAs (step 4). Then, the SLA is selected (step 5) and based on it, the policies are retrieved (step 6) and, as defined by the SLA, selected (step 7). At this moment, all the information is available and the policies applied. First, the grouping policy (i.e., optimization of monitoring resources) is requested to the IAn (step 8-10) to identify if the requested intent may be placed into a group sharing the same monitoring rules together with already deployed CSs or needs to be isolated with specific rules and metrics. Then, the deployment policy is applied (step 11-13) and based on the grouping policy result (i.e., isolated or group-based), the monitoring policy is implemented by applying the necessary monitoring configuration actions (step 14) using the metrics defined by the SLA that allow to monitor the KPIs and check possible SLAs violations. Finally, the user is informed (step 15).

In all this process, the main feature involved is the translation from the intent to the final CS and the associated policies. To do so, first, the intent is processed by applying NLP and then by filtering the obtained data. First, the intent is decomposed word by word (i.e., word tokenization) and each word is classified into one of the possible classes: operation (e.g., deploy, create, etc.), resources (e.g., connectivity service, bandwidth etc.), location (e.g., origin, destination, etc.) and time (e.g., start, finish, etc.). Based on this classification, the KPIs are identified and used to filter and select the most suitable SLAs. With the SLAs, the right Policies are retrieved and so, the system has all the information and actions (i.e. policies) to enforce the CSs through the Packet-Optical SDN Controller.

Experimental Validation

Using the experience from previous work[6] an emulated scenario was developed in order to demonstrate the feasibility of the IBN solution previously described. To evaluate this initial solution, a set of tests requesting a CS were done and the delay values for each action were obtained. To trigger the different test, different sentences such as *"Create a connection service from origin A to destination B with medium bandwidth during 2 hours with medium availability and high capacity."* were used. The user does not specify values but conceptual levels of the different desired KPIs for the connectivity service.

Table 3 shows the different times extracted before the CS request is ready to be sent to the Packet-Optical SDN Controller. The delays are

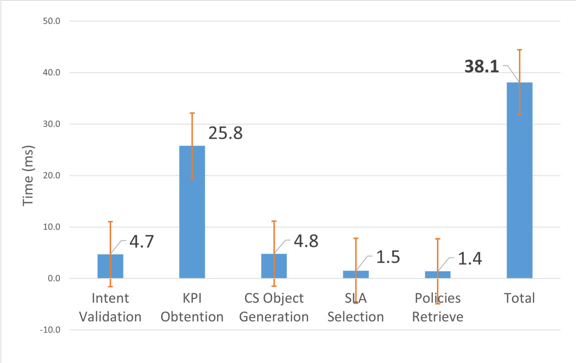

Fig. 3: Intent to CS request translation time delay

mapped to the first part of the workflow illustrated in Fig. 2 and correspond to the following actions: a) the Intent Validation (steps 1-2) to verify that the incoming request follows certain orthographic rules (e.g., a subject and a verb are used), b) the KPIs extraction to identify the KPIs within the incoming request (step 3), c) the CS data object generation (end of step 3 and beginning of step 4), d) the SLA selection process based on the KPIs (steps 4,5) and, finally e) the Policies Retrieve based on the KPIs and SLAs (steps 6,7). As illustrated in Tab. 3, the delays are very low (e.g., a total mean time value of 38.1 ms) with the highest influence coming from the Intent Validation and the KPIs Extraction actions. In general, the obtained results create a very positive expectation towards the solution designed due to the fact that we are adding an additional layer to the management and orchestration architecture and, moreover, the process to translate from a generic intent towards a specific request with detailed configuration parameters is not an easy task.

Conclusions

This paper illustrated the architecture, translation and deployment processes of a new IBN and ZSM-based solution to manage transport connectivity services and a set of results related to the intent to CS translation are presented. In the next tasks, the authors have planned to research on the resolution of conflicts between intent requests and to evolve towards E2E scenarios with multiple transport domains.

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