Intent Based Networking

Dual Degree Project

Jul'22-May'23

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***Abstract*—This document is a discussion about the Intent Based networking (IBN), a technology which is taking the industry by storm. This paper discusses about what an IBN is, what an Intent in an IBN is and how market leaders are using it to revolutionize the industry using machine learning. Further we are going to see the advances in the technology and how one can create an IBN for their company.**

***Index Terms*—Intent Based Networking, Natural Language Processing, Named Entity Recognition**

I. Introduction

The network industry has a new buzzword Intent Based Networking. Intent Based Networking is a new technology which aids companies in network planning, maintenance and reducing the downtime in networks. IBN uses high level machine learning and advanced orchestration to reduce the complexity of management and maintaining network policies. Many businesses are turning to this technology to help reduce the errors they face daily and increase the productivity of their departments. The exponentially growing number of nodes in the region has led to the need for increased workforce to maintain all these nodes. Network administrator have been responsible for managing network equipment, provisioning user access, configuring policies and ensuring the system is doing what it is supposed to do. Admins use command-line interface to control their network and this type of management does not scale very well. This led to the need to have a network that can 'take care' of itself. A network that can find errors and rectify them, a network that with time will notice an impending danger and deal with it or take the correct action. This increases speed and efficiency.

II. Problem Statements

For the sake of understanding we have divided the problem in two parts:

A. Sub-problem Statement A

Build a knowledge graph using device specification documents to store the current state and information about the devices used in the network

B. Sub-problem Statement B

Use the information in the knowledge graph to fulfill the intent given by the user e.g - Add router to the backend.

Before discussing the problem lets first understand what is IBN

III. Intent Based Networking

The idea of Intent Based Networking is very simple. The network administrator simply tells the network what their intent is and the network automatically implements it without the need of the administrator to tell it how to do it. IBN automatically configures the network hardware if the network changes.IBN can also ingest intent involving security changes from the administrator and can automatically the security policies. This frees up the admin to focus on instant response rater than working hours on implementing policies.

IV. Intents

Any task which the admin want to achieve can be considered as an Intent. Depending upon the complexity it is divided into two types.

A. Type I

Type I intents are direct intents which gives the network a task task can be are in form of connecting and configuring network devices. Example - add a firewall, connect 2 more routers etc.

B. Type I

Type II intents are more complex in nature. They are task which involves a combination of multiple policies to be activated. Example - Tomorrow there is an online meeting at 10 AM with the managers (this will involve a lot of policy changes to ensure smooth video conferencing)

V. Examples of Intent

- Steer networking traffic originating from endpoints in on geography away from a second geography, unless the destination lies in that second geography. (states what to achieve, not how.)
- Avoid routing networking traffic originating from a given set of endpoints (or associated with a given customer) through a particular vendor's equipment, even if this occurs at the expense of reduced service levels." (states what to achieve, not how, providing additional guidance for how to trade off between different goals when necessary.)
- Maximize network utilization even if it means trading off service levels (such as latency, loss) unless service levels have deteriorated 20% or more from their historical mean. (a desired outcome, with a set of constraints for additional guidance, that does not specify how to achieve this.)
- Ensure VPN services have path protection at all times for all paths. (a desired outcome of which it may not be clear how it can be precisely accommodated.)
- Generate in situ Operations, Administration, and Maintenance (OAM) data and network telemetry for later offline analysis whenever significant fluctuations in latency across a path are observed. (goes beyond event-condition-action by not being specific about what constitutes "significant" and what specific data to collect.)
- Route traffic in a Space Information Network in a way that minimizes dependency on stratospheric balloons unless the intended destination is an aircraft. (does not specify how to precisely achieve this)
- For a smart city service, ensure traffic signal control traffic uses dedicated and redundant slices that avoid fate sharing. (a desired outcome with a set of constraints and additional guidance without specifying how to precisely achieve this.)

VI. Lifecycle

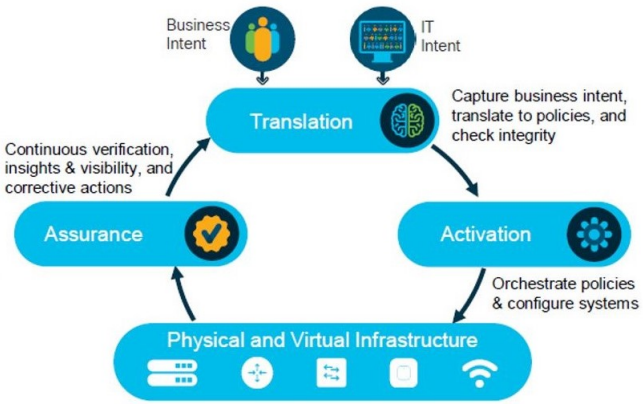

Fig. 1. Lifecycle on an Intent.

- Intent: Required Outcome
- Translation: Conversion of the intent to policies that network can act upon
- Activation: Installation of these policies across the physical and virtual network infrastructure, using network-wide automation.
- Assurance: use analytics and machine learning to continuously monitor and verify that the desired intent has been applied and business outcome is being achieved.

As soon as the network encounters a Business or IT intent in Natural Language, Machines learning algorithm converts it in network policies. These policies are then given to orchestrate which configures the networks physical and virtual infrastructure. The network then verifies that the given intent is being fulfilled. If not then the required changes can be applied else admin can check and analyse what the actual problem is.

VII. Sub-Problem A

We want to extract important information about the devices used in the network and the network itself.We are going to use specification document of the devices used and feed statements relevant to the network. Our model will extract the underlying important entities from this corpus of text. We are using information on Ruckus R550 router for our project. This information is collected using corpus generated using ChatGPT.

Few sentences from the corpus: The Ruckus R550 is a powerful and feature-packed Wi-Fi 6 router that is designed for indoor use in homes, small offices, and medium-sized enterprises. This router is an excellent choice for those who demand high-performance, reliable, and secure Wi-Fi connectivity for their business or personal use.

By using networkx library and pre-trained BERT transformer spacy model for entity extraction we are extracting entities and generating the knowledge graph

VIII. Sub-Problem B

Now we have our knowledge graph and we we can use it to extract information.The intent provided by the user undergoes Named Entity Recognition and we label the components in the intent. Then we search for components connected to out entities one by one. For this the labels are fed in the pipeline for different devices, actions, products, targets etc.

IX. Result

The knowledge graph generated from the given corpus is shown on the next page. After feeding an intent like "Add router r550 to backend", we can see our model extracting connected components. We can use this information to check for next steps for the tasks. Whether to proceed with the execution or do some changes to the network.

```
router :
          router
          multiple speed devices
          potential network attacks
R550 :
          R550
          greater frequency flexibility
          two Gigabit Ethernet ports
          various  methods
          unauthorized security access
```

Fig. 2. Extracted components

X. Next steps

- We are using a pretrained model for our project which will perform similarly for any domain hence we need to retrain our model according to our needs.
- 200 - 300 labeled documents are needed to make this project ready for our domain. Devices and their specification should be labeled as they are of our relevance.
- Subproblem B uses rule based pipeline to perform NER. More task are can be added according to our needs.
- NER performed on the given intent can be converted to a fuction and given to the next stage which is activation. For example - Add firewall and intrusion detection from the gateway to the backend for client B with at least 100 Mbps of bandwidth, and allow HTTPS only Our model will generate the following output:

Firewall	middlebox
Intrusion detection	middlebox
Gateway	endpoint
Backend	endpoint
Client B	group
At least	min
100 Mbps	bandwidth
HTTPS	traffic

Later this labeled entities can be converted and stored as a function to be used for activation.

```
define intent qosIntent:
  from   endpoint('gateway')
  to     endpoint('database')
  for    group('B')
  add    middlebox('firewall'), middlebox('ids')
  set    bandwidth('min', '100', 'mbps')
  allow  traffic('https')
```

Fig. 3. Activation policies.

XI. Challenges

- IBN is a very new technology and big market leaders like Cisco and Juniper are working extensively on this.
- Very less data is available to train our NLP models.
- Due to multiple vendors and multiple networking devices there are thousand of different policies and configuration for the devices

Acknowledgement

I would like to express my special thanks of gratitude to Dr. Gaurav Raina for his guidance and Mr. Prashant Maloo for giving me the opportunity to work on this wonderful project. I would also like to appriciate the support and feedbacks provided by Ms. Kavya. I would like to thanks Mr. Shubham for providing me with the helping me execute the project smoothly.

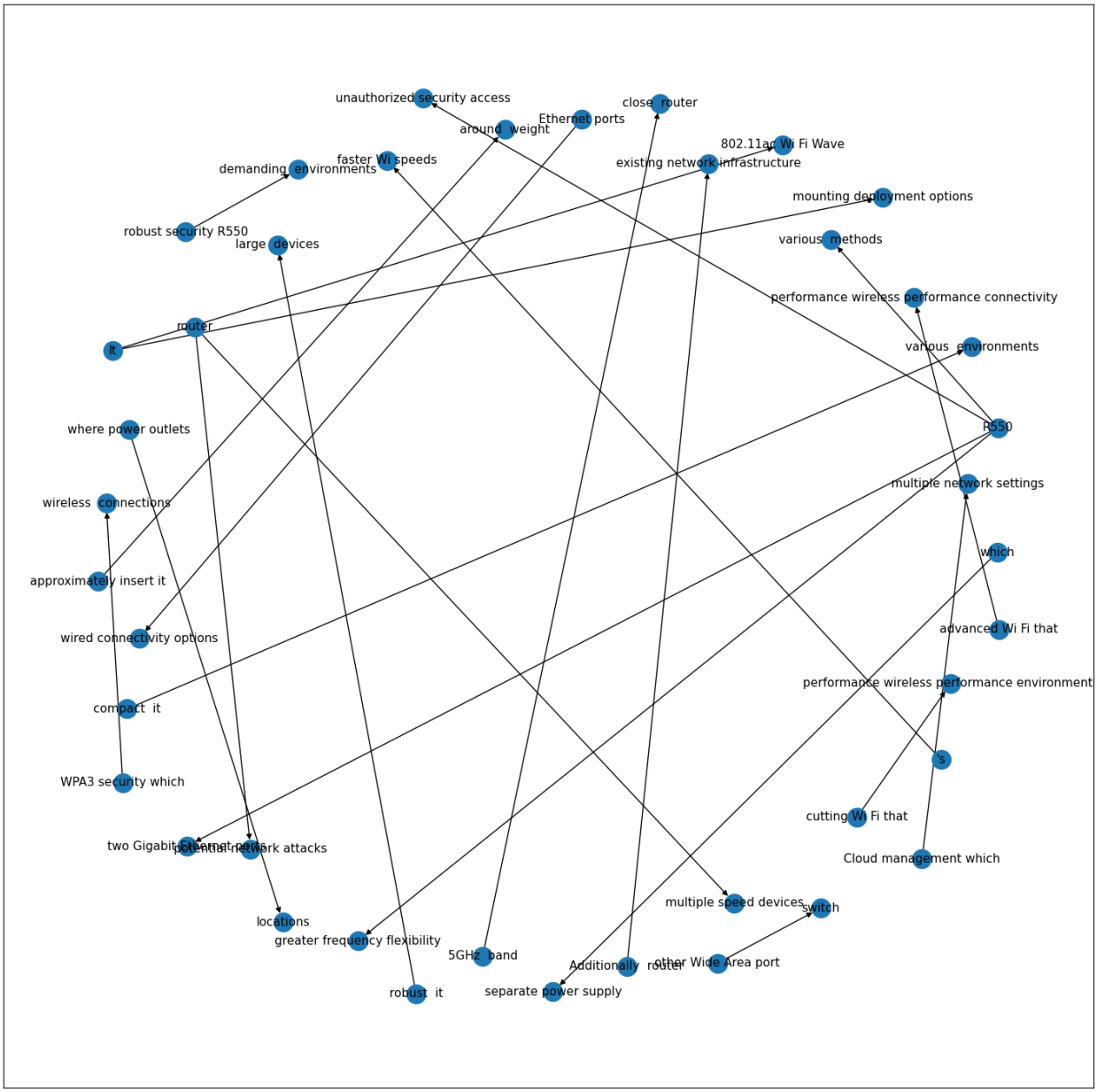

Fig. 4. Knowledge Graph

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