Green Networking

Visibility, a first step towards sustainable networking

Graduate

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Introduction: This thesis is a follow-up project to our term paper that proposed green networking metrics aimed at enhancing the energy efficiency of networking infrastructures. The initial study highlighted the lack of visibility into network energy efficiency, which hampers efforts to optimize sustainability. The primary objective of this thesis is to demonstrate a comprehensive use case in a virtualized environment where the energy efficiency indicators, developed in the earlier study, are exported and visualized. This aims to provide network operators with the tools necessary to improve network efficiency.

Approach / Technology: The research involves setting up a proof of concept (PoC) within a simulated network environment. This includes implementing an IPFIX exporter on network switches to gather efficiency data, establishing collecting servers for persistent storage of this information, and creating dashboards to visualize the network's current state. Additionally, an automation solution is implemented to dynamically configure and update the simulation network. The project successfully developed a virtualized demo application that simulates an energy efficiency-enabled network, as proposed in the term paper. The demonstration shows that exporting flow efficiency information using IPFIX is straightforward and feasible. BMv2 models are used as software switches, and P4 is used as the data plane programming language in the PoC. The IPFIX extension is written in C++, and the automation solution is written in Python and utilizes Nornir.

Result: The study concludes that while the export and visualization of efficiency data are straightforward, the collection of such data and the implementation of additional data plane functionalities (such as the

IOAM protocol) require support from vendors and must be advocated at the IETF. The research demonstrates that significant information can be extracted from the network with a manageable processing overhead, paving the way for more sustainable networking practices.

The average network flow efficiency over time is shown in the Network Flow Efficiency statistics.
Own presentment

The end-to-end flow efficiency matrix shows the average flow efficiency between hosts over the last 5 minutes.
Own presentment
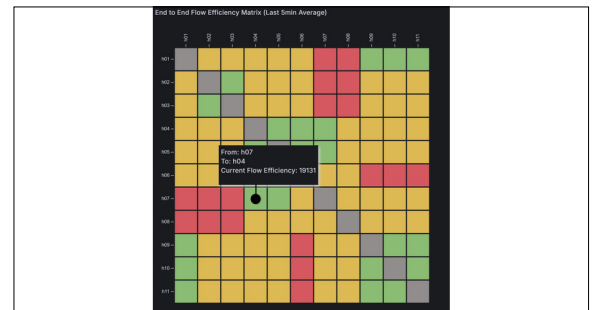
PoC on BMv2 programmable software switches with IOAM Aggregation Option, IPFIX export and an external monitoring system.
Own presentment
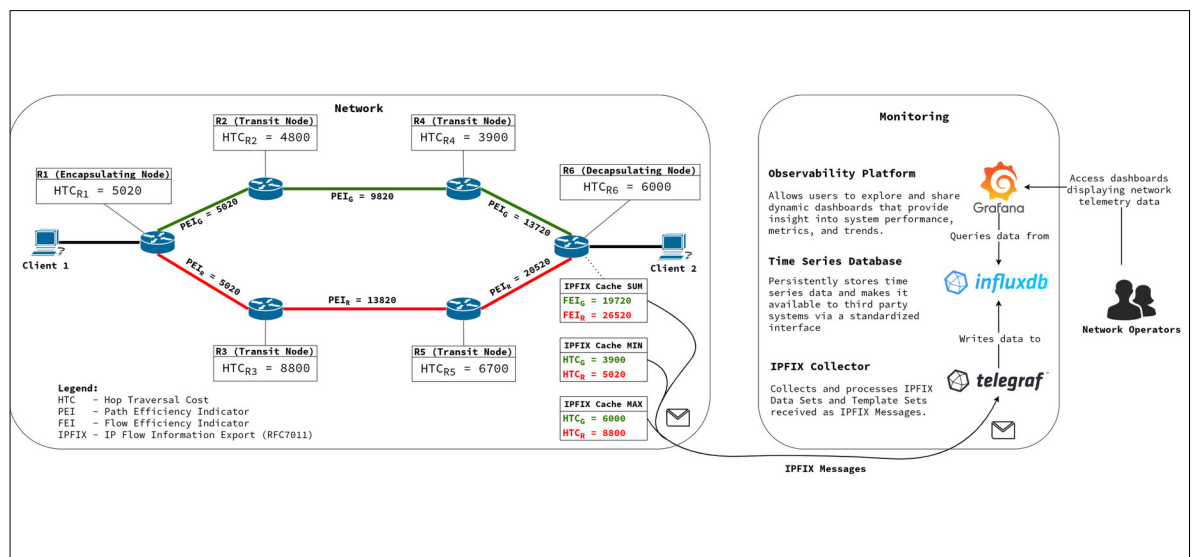
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Subject Area
Internet Technologies and Applications, Networks, Security & Cloud Infrastructure, System Software