Implementation of a Converged Transport and Core Network Testbed for 6G

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***Abstract*—In this paper, we present the implementation of a transport-enabled mobile network testbed for 6G systems, utilizing various open-source platforms. The testbed is structured sequentially into UE, RAN, Transport Network, and Core Network components. By enabling interaction between the transport network controller and the core network control functions, the proposed setup realizes a converged architecture integrating the transport and core networks. This testbed provides a practical environment for validating 6G transport–core interworking mechanisms and serves as a foundation for future research on network convergence.**

***Index Terms*—6G mobile network, network convergence, testbed, open-source platforms**

I. Introduction

Recently, mobile networks have been evolving toward the 6G era. The International Telecommunication Union (ITU) has been defining the vision, use cases, and key requirements for 6G networks through its Focus Group on IMT-2030 [1]. In addition, the 3rd Generation Partnership Project (3GPP), one of the largest mobile communication standardization groups, is standardizing the architecture and key technologies of 6G in alignment with ITU's guidelines [2]. In 4G mobile networks, the focus was primarily on supporting mobile services. In contrast, 5G mobile networks tried to support the various services with distinct characteristics through a more flexible and service-oriented network architecture. However, while 5G networks introduced architectural and control plane enhancements to accommodate these diverse services, they have shown limitations in optimizing the data plane for actual data transmission performance. In the upcoming 6G era, high-performance services (e.g., extended reality (XR)) that were emphasized in the 5G roadmap but not widely deployed are expected to be utilized in practice. With this trend, structural approaches and technical advancements for optimizing the data plane become essential in 6G mobile networks. Unfortunately, while the radio access network (RAN) has continued to evolve with performance-optimized technologies, the wired core network still primarily manages logical paths using tunneling mechanisms (e.g., N3, N9 tunnels) to support mobility and data forwarding. This approach overlooks the physical data paths within the transport network, leading to limitations in data transmission performance. As a result, the existing core network design, which does not account for the physical characteristics of the transport network, may become a bottleneck in meeting the ultra-high-speed, ultra-low-latency, and high-capacity requirements of future 6G services. To address this challenge, an optimized and converged architecture that integrates the core network with the transport network is imperative. Therefore, we present a converged transport and core network testbed designed to optimize the data plane for 6G service requirements.

II. Environment Setup

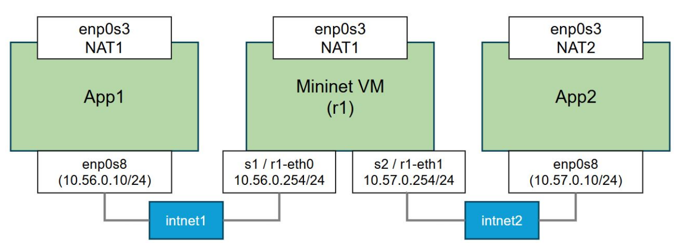

Fig. 1. Testbed topology with s1/s2 and r1

Figure 1 shows a virtualized testbed for validating transport–core interworking in 6G. Three virtual machines (VMs) are interconnected through two virtual L2 networks terminated by the Open vSwitch switches s1 and s2, with the router r1 between them. The access host (App1) emulates the UE/RAN on intnet1; the Mininet VM hosts s1/s2 and r1 as the transport domain; and the core host (App2) represents the 5G core on intnet2. All access–core traffic is forced to traverse r1.

A. Roles of the Three VMs

App1 generates and receives access-side flows; the Mininet VM provides the transport elements by running s1/s2 and r1 so that forwarding between the two L2 domains occurs only through the transport domain; and App2 executes the 5G core functions as the opposite endpoint for control and data exchange with App1.

B. Address Plan

A two-subnet plan is used in which intnet1 hosts App1 and intnet2 hosts App2, while r1 presents one interface to each subnet, creating a single L3 gateway that separates the L2 domains and defines the only routable path between them. To prevent App1 and App2 from sharing the same upstream Internet, we attached them to distinct NAT networks (NAT1 for App1 and NAT2 for App2). The r1/Mininet VM's management interface can attach to any NAT because it is outside the experimental data path; in our setup, it was arbitrarily attached to NAT1.

C. Switch–Router Binding

Within the transport VM, s1 connects to intnet1 and s2 connects to intnet2. The transport VM attaches one interface to each switch, and r1 connects to both switches for L3 forwarding. Thus, traffic from App1 enters s1, passes through r1, and exits via s2 to App2.

D. Routing Configuration

Each endpoint sets r1 as the default gateway, ensuring all inter-VM flows traverse the transport domain. Policies on s1 and s2, therefore, apply to every exchange. IP forwarding is enabled on r1; no additional static routes are configured.

E. Measurement Points and Tools

The path is observed with traceroute and ping to reveal hops and latency. For packet-level inspection, tcpdump is used on the transport VM at the interfaces of s1 and s2. Interface and routing outputs on both endpoints are recorded to verify the configuration.

F. Assumptions and Scope

Only the data path between App1 and App2 is considered. Management interfaces are excluded from measurement. The RAN emulator and the 5G core remain unmodified, while variability resides only in the transport VM through switch binding and routing via r1, ensuring that experiments are reproducible.

```
nam@nam-VirtualBox:~$ traceroute 10.57.0.10
traceroute to 10.57.0.10 (10.57.0.10), 30 hops max, 60 byte packets
 1  10.56.0.254 (10.56.0.254)  6.035 ms  6.005 ms  5.702 ms
 2  10.57.0.10 (10.57.0.10)  7.763 ms  7.463 ms  7.156 ms
```

Fig. 2. Traceroute from access to core

```
nam@nam-VirtualBox:~$ ping 10.57.0.10
PING 10.57.0.10 (10.57.0.10) 56(84) bytes of data.
64 bytes from 10.57.0.10: icmp_seq=1 ttl=63 time=1.42 ms
64 bytes from 10.57.0.10: icmp_seq=2 ttl=63 time=6.69 ms
64 bytes from 10.57.0.10: icmp_seq=3 ttl=63 time=3.73 ms
^C
--- 10.57.0.10 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2004ms
rtt min/avg/max/mdev = 1.415/3.946/6.692/2.159 ms
```

Fig. 3. Ping from access to core

III. Experimental Results

Figure 2 presents a traceroute from App1 to App2, confirming the enforced path described in Section II. The output shows forwarding via s1, the router r1, and s2, verifying that r1 is the only hop between the two L2 domains. Figure 3 reports ICMP echo measurements for the same pair, confirming successful end-to-end delivery over the enforced path and providing the baseline round-trip latency.

IV. Main Results

In our study, we implemented the converged transport and core network testbed with various open-source projects. To build the testbed, we utilized VMs, each representing a distinct component of a mobile network: the access network (including the UE and base station), the mobile core network, and the transport network responsible for forwarding data between the base station and the core network. We also created two isolated virtual networks to ensure that data from the mobile core network is not transmitted directly to the base station. The first virtual network connects the base station VM to the transport network VM, while the second connects the transport network VM to the core network VM. This configuration enforces that all data exchanged between the core network and the base station must traverse the transport network VM, thereby emulating realistic transport–core separation. In each VM, several open-source projects related to mobile and general networking were utilized. First, to implement the mobile core network, we adopted Open5GS [3], and for the access network between the UE and the base station, we employed UERANSIM [4]. Finally, to construct the transport network between the Open5GS VM and the UERANSIM VM, we used Mininet [5] to simulate various transport scenarios. Two virtual interfaces were configured in the Mininet VM—one connected to the UERANSIM VM and the other to the Open5GS VM. These interfaces were linked to the Mininet-emulated network topology, allowing us to observe and validate data exchanges between Open5GS and UERANSIM under different transport network conditions. In future work, we plan to enable control message exchange between the core network functions of Open5GS and the controller of the Mininet-based simulated transport network. This integration aims to dynamically optimize the data plane based on transport network conditions.

V. SUMMARY

In this paper, we present the design and implementation of a converged transport and core network testbed for 6G systems. Using open-source platforms such as Open5GS, UERANSIM, and Mininet, the testbed enables data-plane evaluation across access, transport, and core network components. The virtualized architecture enforces all user traffic to traverse the transport network, allowing realistic performance analysis and future coordination between control and data planes. This testbed lays the foundation for further research on transport–core convergence and data-plane optimization in 6G mobile networks.

ACKNOWLEDGMENT

This work has been supported in part by National Research Foundation (NRF) of Korea Grant funded by the Korean Government (MSIT) (No.RS-2025-00558169) and in part by Institute of Information & communications Technology Planning & Evaluation (IITP) grant funded by the Korea government(MSIT) (No. RS-2023-00225468)

REFERENCES

[1] ITU-T Focus Group on IMT-2030, Framework for the development of IMT-2030 networks, ITU-T FG IMT-2030 Output Document, Jul. 2023. [Online]. Available: https://www.itu.int/en/ITU-T/focusgroups/imt-2030/

[2] 3GPP TR 23.700-91 V0.7.0, Study on 6G architecture; Stage 2 (Release 19), Dec. 2023. [Online]. Available: https://www.3gpp.org/DynaReport/23700-91.htmI. S. Jacobs and C. P. Bean, "Fine particles, thin films and exchange anisotropy," in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.

[3] Open5GS, "Open source 5G/4G EPC and 5GC," [Online]. Available: https://open5gs.org

[4] UERANSIM, "Open source 5G UE and RAN simulator," [Online]. Available: https://github.com/aligungr/UERANSIM

[5] B. Lantz, B. Heller, and N. McKeown, "A network in a laptop: Rapid prototyping for software-defined networks," in Proc. 9th ACM SIGCOMM Workshop on Hot Topics in Networks (HotNets '10), Monterey, CA, USA, Oct. 2010, pp. 1–6. [Online]. Available: https://mininet.org