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CASE STUDY

Design and Deployment of 3GPP Compliant CUPS Implementation of SGW/PGW/SAEGW

Customer Overview

The customer is one of the largest wireless carriers in the United States, with 100+ million subscribers. They provide wireless voice and data services, and also serve as the host network for many mobile virtual network operators.

The Context

Traditionally, the Control Plane and User Plane functions of SGW and PGW have been part of the same network function. However, newer versions of 3GPP specifications have defined an architecture – popularly known as CUPS architecture, to separate out the Control Plane and User Plane functions. The separation enables various deployment scenarios like distributed User Plane functions without any impact on the functionalities provided by EPC entities.

The customer wanted the design and deployment of a 3GPP specification-compliant CUPS implementation of SGW/PGW/SAEGW. Furthermore, the customer wanted to open source the solution.

Type of Service Provided

Product Engineering

Technologies Used

Telecom, 3GPP, EPC Protocols, C, C++, Terraform, Ansible, TS 23.214, TS 29.244, TS 29.212, TS 29.303, TS 23.401, TS 29.272

Solution Summary

GS Lab | GAVS is a significant contributor to Open Network Foundation's (ONF) Open Mobile Evolved Core (OMEC) project, and also a partner to the customer's and Intel's 4G research teams. Our experience in these projects helped craft the most appropriate solution. The GS Lab | GAVS team architected and designed a 3GPP-compliant open source gateway from ground up – with the implementation of SGW/PGW/SAEGW in strict accordance with 3GPP procedures listed in TS23.401 and TS23.214 specifications.

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Challenges

- Requirement of core technical expertise in several protocols, specifications, interfaces, technologies
- Absence of 3GPP definition for conversion of element values from one interface to another
- Unavailability of any reference implementation
- Complex design for scalability and performance of user plane

Solution Highlights

- Rearchitected and redesigned existing open source gateway implementation
- Implemented 3GPP procedures in SGW/PGW/SAEGW per TS 23.401, TS 23.214 specifications
- Open sourced code to promote private LTE and edge services deployment
- Converged multiple 3GPP specifications for correct mapping of element values from one interface to another
- Designed extremely efficient pipeline based on DPDK to handle high traffic in UPF
- Implemented TS 29.244-compliant Sx interface to support CUPS architecture in SGW/PGW/SAEGW
- Implemented TS 29.212-compliant Gx interface between PGW-C/SAEGW-C and PCRF
- DNS based discovery of SGW-U/PGW-U/SAEGW-U per TS 29.303
- Framework support for deployments on bare metal, VM, private cloud, public cloud
- Extensive testing of all call flows, 3GPP procedures and functionalities

Solution Impact

- First-of-its-kind open source implementation of 4G Core compliant with 3GPP CUPS architecture
- Provided open source reference architecture and implementation for other players
- Simplified distribution of control and user plane components either centrally or on edge
- Independent interactions of the split network entities with other core entities in the network
- Independent scalability of the planes since the control plane function could interface with one or more user plane functions

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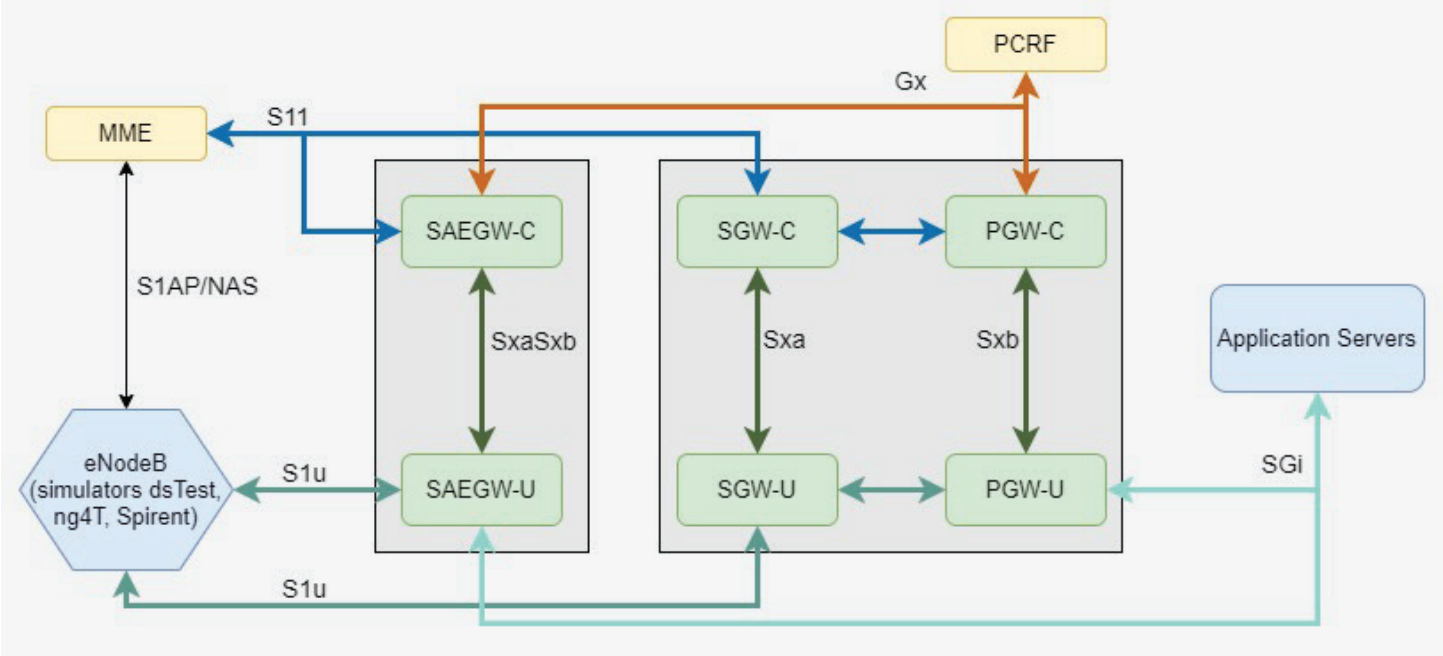
Solution Details

The first-of-its-kind solution required core technical expertise in several protocols, specifications, interfaces, and technologies, since 3GPP specifications mention what functionalities may be supported, but not how. Being a significant contributor to Open Network Foundation's (ONF) Open Mobile Evolved Core (OMEC) project, and a partner to the customer's and Intel's 4G research teams helped the GS Lab | GAVS team architect, design, and implement the most appropriate solution - a 3GPP-compliant open source gateway from ground up. The team leveraged SDN and NFV to develop the CUPS compliant gateway. Historically, prominent vendors have been providing proprietary solutions that have controlled the telecom industry and slowed down private LTE adoption. So, the customer wanted to open source the code to promote private LTE and edge services deployment.

The implementation of SGW/PGW/SAEGW was in strict accordance with 3GPP procedures listed in TS 23.401 and TS 23.214 specifications. The gateway was decoupled into separate components for the control plane and user plane as defined in TS 29.244, which is the implementation of the Sx interface. Further, the Gx interface was added between PGW-C/SAEGW-C and PCRF per the TS 29.212 specification. DNS-based discovery of SGW-U/PGW-U/SAEGW-U per TS 29.303 was also achieved. Since converting element values received on one interface to element values to be sent on another is not defined in 3GPP specifications, the team converged multiple 3GPP specifications for correct mapping. An extremely efficient pipeline based on DPDK was designed for high scalability and performance of the user plane (SGW-U/PGW-U/SAEGW-U). The deployment framework supports bare metal, VM, private cloud, and public cloud deployments. The complexity of the architecture and new protocols demanded extensive testing. So, a vast range of test cases was created to test various call flows, 3GPP procedures and functionalities.

The solution provided an open source reference architecture and implementation for many other players, enabling deployment of reliable, scalable, private 4G/5G platforms over public and private cloud for those who adopted it.

Solution Architecture



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