High Performance and Cloud Native Design Aspects in OAI 5G Core

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Outline

1. OAI Activities in BUPT
2. Functions and Performance
3. Stateless and Intelligent Design
1. OAI Activities in BUPT

- Beijing Lab of Advanced Information and Networks
  - A long history cooperation between BUPT and OAI since 2014

- OAI Activities in BUPT
  - OAI 5G core development
  - RAN Development: PRACH Procedures, UL-MIMO, Accelerations
  - Use cases: Location, Timing, New Multiaccess (OAM)
2. Functions and Performance

- Basic functions development

AMF: Access and Mobility Management Function
AUSF: Authentication Server Function
SMF: Session Management Function
UPF: User Plane Function
UDM: Unified Data Management
UDR: Unified Data Repository
UDSF: Unified Data Service Function
NWDAF: Network Data Analytics Function
OAI-5G-Core: Open Air Interface 5G Core

- Basic functions development

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OAI-5G-Core: Open Air Interface 5G Core
2. Functions and Performance

- **Performance of the current OAI 5G Core**

**Environment:**

- 5G gNB: Amarisoft gNB, also tested with commercial 5G base stations, Huawei/Baicells/Sageran;
- 5G UE: Xiaomi K30i, also tested with Huawei 5G Routers, Quectel 5G Modules (Qualcomm X55);
- 5G Core: OAI- AMF, SMF, SPGWu/UPF, also tested AUSF/UDM/UDR.
2. Functions and Performance
2. Functions and Performance

- **Performance of the current OAI 5G Core**
  
  - The OAI 5G Core is also tested with commercial core tester, and simulators.

  ![Diagram showing testing scenario with Choicete™ 5G Core Tester and UPF testing with Trex](image)

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2. Functions and Performance

**Code Directory**

- n4
  - `/SRC`
    - cmd: Main function and executable file
    - conf: Configuration file
      - log: Log function
    - pfcp: Encoding and decoding PFCP messages
    - pkg: Receive and send pfcp messages
    - util: Toolkit
    - vpp: Interact with vpp

**Buptvpe**

- `/src`
  - plugins: VPP bundled plugins directory
  - svm: Shared virtual memory allocation library
  - vlib: VPP application library source
  - vlibapi: VPP API library source
  - vnet: VPP networking source
  - vpp: VPP application source
  - vpp-api: VPP application API source
  - vppinfra: VPP core library source

**Module Composition**

- UDP Server
  - Classifier
    - PFCP Decode
      - Heartbeat
      - Association
      - Session Establishment
      - Session Modification
      - Session Deletion
      - PFCP Encode
    - UDP Client
      - Govpp Unix socket

- DATA
  - Forward according to Rules
    - UL TEID PDR FAR
    - DL TEID PDR FAR

- N4
  - GTP
    - VPP
    - Drop
  - NAT
  - N6
  - ARP
2. Functions and Performance

- Performance of the current OAI 5G Core

Users and bears can be up to 10k in current version.

UPF uplink throughput: ≈7.8Gbps, downlink: ≈8Gbps

@: Intel(R) Xeon(R) CPU E5-2670 2.60GHz; 32GB RAM, 10Gbps NIC
3. Stateless and Intelligent Design

**Objectives**

- Cloud-native, to support horizontal scaling in cloud environment;
- Data and analysis capabilities exposure, support intelligent orchestration.

**Possible use cases**

- **Automatic failure recovery**
  Discover failed NFs, and recover from failures without causing interruptions to connections.

- **Horizontal scaling**
  Measuring NF instances work load, and dynamically adjust the numbers, locations and resources of NF instances.
3. Stateless and Intelligent Design

- **Problems**
  - Contexts are coupled with NFs, can’t be shared among each other;
  - Servitization interface is not supported in RAN, connection-oriented;

- **Undergoing work**
  - UDSF, storage the unstructured NF contexts in USDF, and shared among NFs.
  - RAISE, RAN integrated servitization enabler, work as a middlebox between gNB and Core.
  - NWDAF, collect NF and service status, generate strategies to manage the network.
3. Stateless and Intelligent Design

- **UDSF Development**

<table>
<thead>
<tr>
<th>NF service</th>
<th>Service Operations</th>
<th>Operation Semantics</th>
<th>Example Consumer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstructured Data Management</td>
<td>Query</td>
<td>Request/Response</td>
<td>Any NF</td>
</tr>
<tr>
<td></td>
<td>Create</td>
<td>Request/Response</td>
<td>Any NF</td>
</tr>
<tr>
<td></td>
<td>Delete</td>
<td>Request/Response</td>
<td>Any NF</td>
</tr>
<tr>
<td></td>
<td>Update</td>
<td>Request/Response</td>
<td>Any NF</td>
</tr>
</tbody>
</table>

- The latency to UDSF can be significant, the response time must be kept at a minimum.
- A stateless NF service consumer can maintain a local cache which will reduce the requests to the UDSF and the response time significantly.
3. Stateless and Intelligent Design

- **NWDAF Development**

  NF Services consumed by NWDAF for data collection

<table>
<thead>
<tr>
<th>Service producer</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMF</td>
<td>Namf_EventExposure</td>
</tr>
<tr>
<td>SMF</td>
<td>Nsmf_EventExposure</td>
</tr>
<tr>
<td>PCF</td>
<td>Npcf_EventExposure (for a group of UEs or any UE)</td>
</tr>
<tr>
<td></td>
<td>Npcf_PolicyAuthorization_Subscribe (for a specific UE)</td>
</tr>
<tr>
<td>UDM</td>
<td>Nudm_EventExposure</td>
</tr>
<tr>
<td>NEF</td>
<td>Nnef_EventExposure</td>
</tr>
<tr>
<td>AF</td>
<td>Naf_EventExposure</td>
</tr>
<tr>
<td>NRF</td>
<td>Nnrf_NFDiscovery</td>
</tr>
<tr>
<td></td>
<td>Nnrf_NFManagement</td>
</tr>
</tbody>
</table>

- Slice load level related network data analytics.
- Observed service experience related network data analytics.
- NF load.
- UE related analytics, user data congestion analytics.
- QoS sustainability analytics.
Thank you very much
Merci beaucoup
ありがとうございます
고맙습니다
Danke bestens
شكرا جزيلا
весьма благодарить
Muchas gracias
תודה רבה
Muito obrigado

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