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ENVELOPE

Technology Enablers and APIs: The ENVELOPE Framework

ENVELOPE Deep Dive & Open Call #1: From Architecture to Experimentation in Future Mobility

HORIZON JU Innovation Actions | 101139048 |
ENVELOPE - HORIZON-JU-SNS-2023

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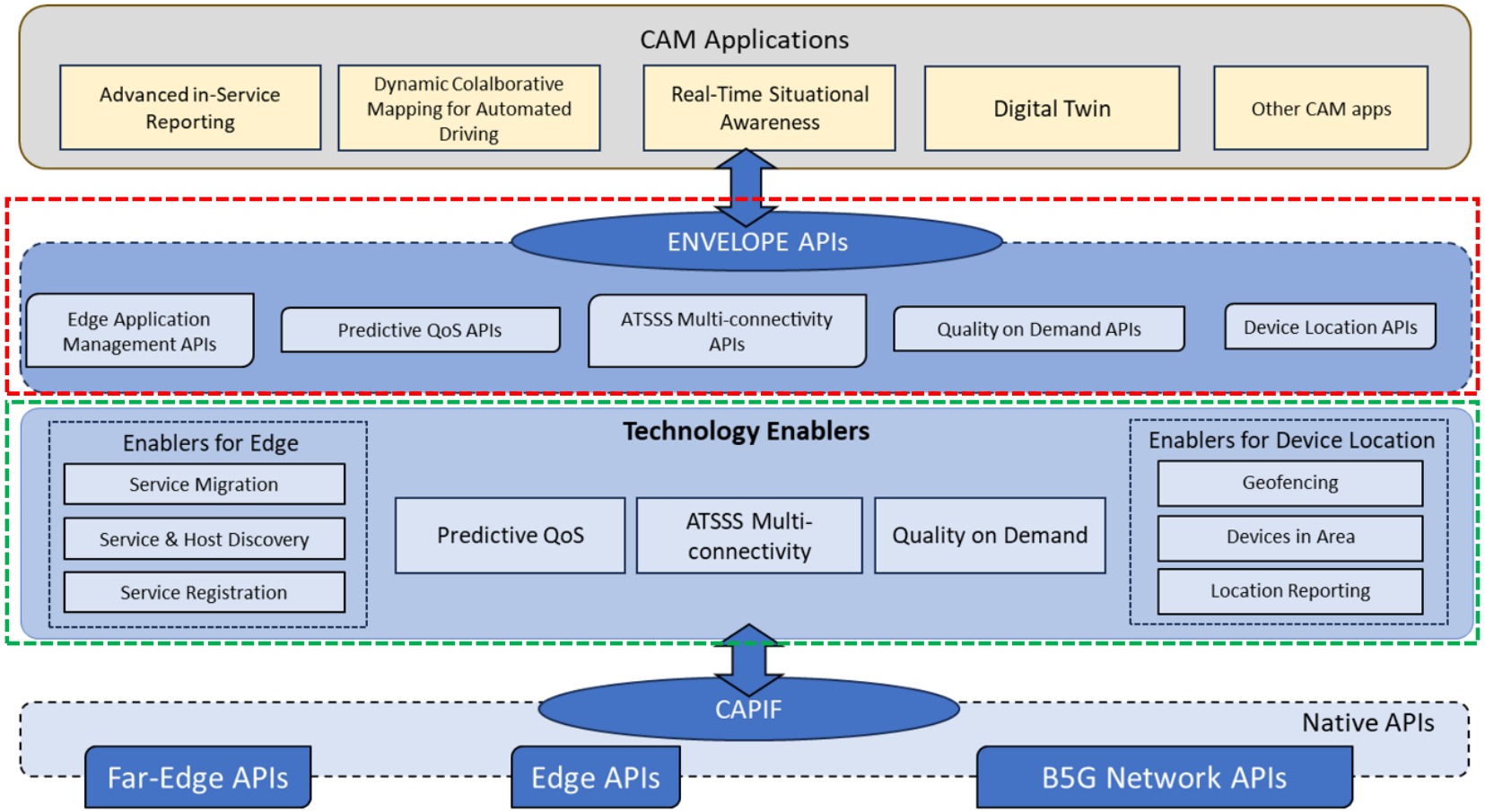
6GSNS

ENVELOPE Architecture



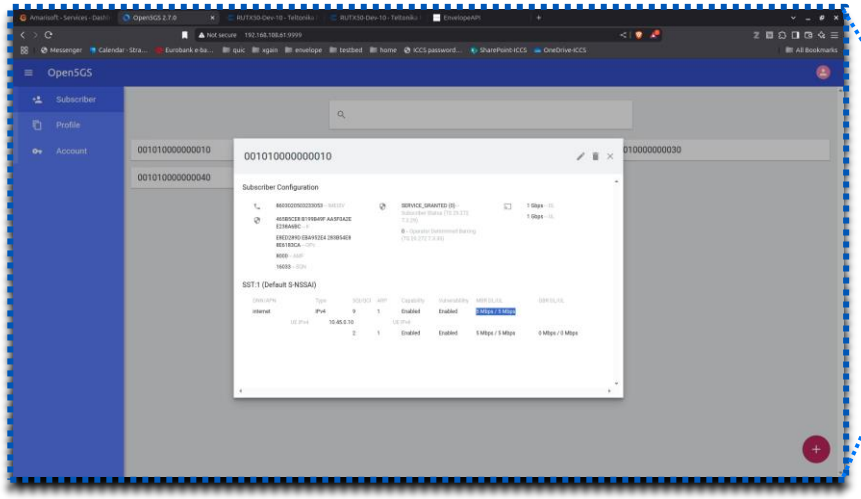
ENVELOPE APIs are simplified northbound interfaces that abstract the complexities of underlying network-compute continuum.

They translate complex 5G interfaces and edge services into developer-friendly APIs, making them easily accessible and consumable by vertical applications.

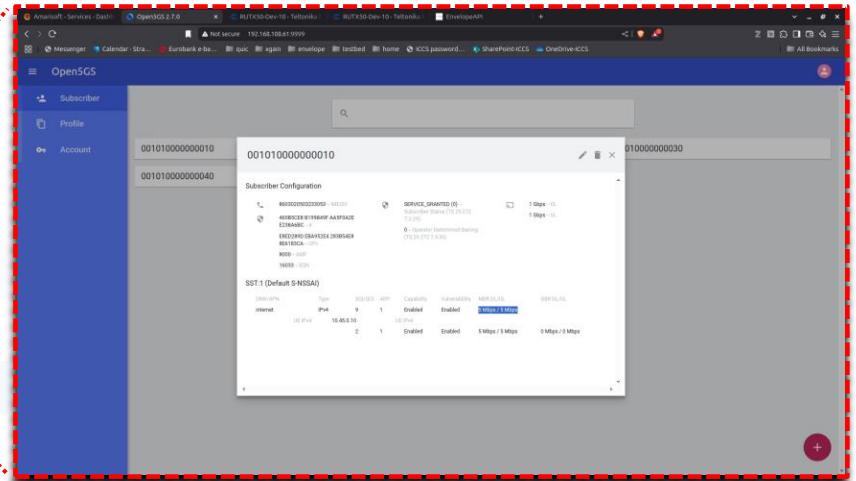
ENVELOPE Enablers are software components that consume southbound APIs, including Far-Edge APIs, Edge APIs, and B5G Network APIs; to interact and actuate upon the underlying 5G network infrastructure and edge computing domains.

Quality on Demand API

The **QoD API** provides a programmable interface for vertical applications to request prioritized and quality-assured data flows in terms of stable latency (reduced jitter) or enhanced throughput.



Before QoD



Applying QoD

CAMARA
THE TELCO GLOBAL API ALLIANCE

```
{
  "duration": {
    "serviceDuration": 86400
  },
  "device": {
    "ipv4Address": "10.45.0.20",
    "ipv6Address": "::12",
    "supi": "imsi-001010000000020"
  },
  "devicePorts": {
    "ranges": [
      {
        "from_": 0,
        "to": 65535
      }
    ],
    "ports": "any"
  },
  "qosProfile": {
    "qosProfile": "QOS_S"
  },
  "webhook": {
    "notificationUrl": "http://192.168.108.61:8000/notify"
  }
}
```

ENVELOPE API

```
{
  "ascReqData":{
    "afAppId":"General Traffic",
    "dnn":"ims",
    "notifUri":"{notifUri}",
    "afAppIds":[
      "General Traffic"
    ],
    "directNotifInd":true,
    "avrgWndw":2000
  },
  "medComponents":{
    "0":{
      "codecs":[
        "downlink",
        "uplink"
      ],
      "fStatus":"ENABLED",
      "marBwDl":"{maximum_bit_rate_DOWNLINK}",
      "marBwUl":"{maximum_bit_rate_UPLINK}",
      "minDesBwDl":"{guaranteed_bit_rate_DOWNLINK}",
      "minDesBwUl":"{guaranteed_bit_rate_UPLINK}",
      "mirBwUl":"{guaranteed_bit_rate_UPLINK}",
      "mirBwDl":"{guaranteed_bit_rate_DOWNLINK}",
      "medCompN":0,
      "medSubComps":{
        "0":{
          "fNum":0,
          "fDescs":[
            "permit out udp from any to any",
            "permit in udp from any to any"
          ],
          "flowUsage":"NO_INFO",
          "afEventSubscription":{
            "upPathChgEvent":{
              "notificationUri":"{notifUri}"
            }
          }
        }
      },
      "medType":"VIDEO"
    }
  },
  "resPrio":"PRIO_1",
  "notifUri":"{notifUri}",
  "sponStatus":"SPONSOR_DISABLED",
  "supi":"{supi}",
  "suppFeat":"16",
  "ueIpv4":"{ipv4Address}",
  "ueIpv6":"{ipv6Address}"
}
```

PCF: /npcf-policyauthorization/v1/app-sessions

```
"QOS_S": {
  "description": "The QOS profile S",
  "status": "ACTIVE",
  "guaranteed_bit_rate_UPLINK": {
    "value": 1,
    "unit": "Mbps"
  },
  "guaranteed_bit_rate_DOWNLINK": {
    "value": 1,
    "unit": "Mbps"
  },
  "maximum_bit_rate_UPLINK": {
    "value": 10,
    "unit": "Mbps"
  },
  "maximum_bit_rate_DOWNLINK": {
    "value": 10,
    "unit": "Mbps"
  },
  "min_latency": {
    "value": 10,
    "unit": "Seconds"
  },
  "max_latency": {
    "value": 300,
    "unit": "Seconds"
  }
},
```

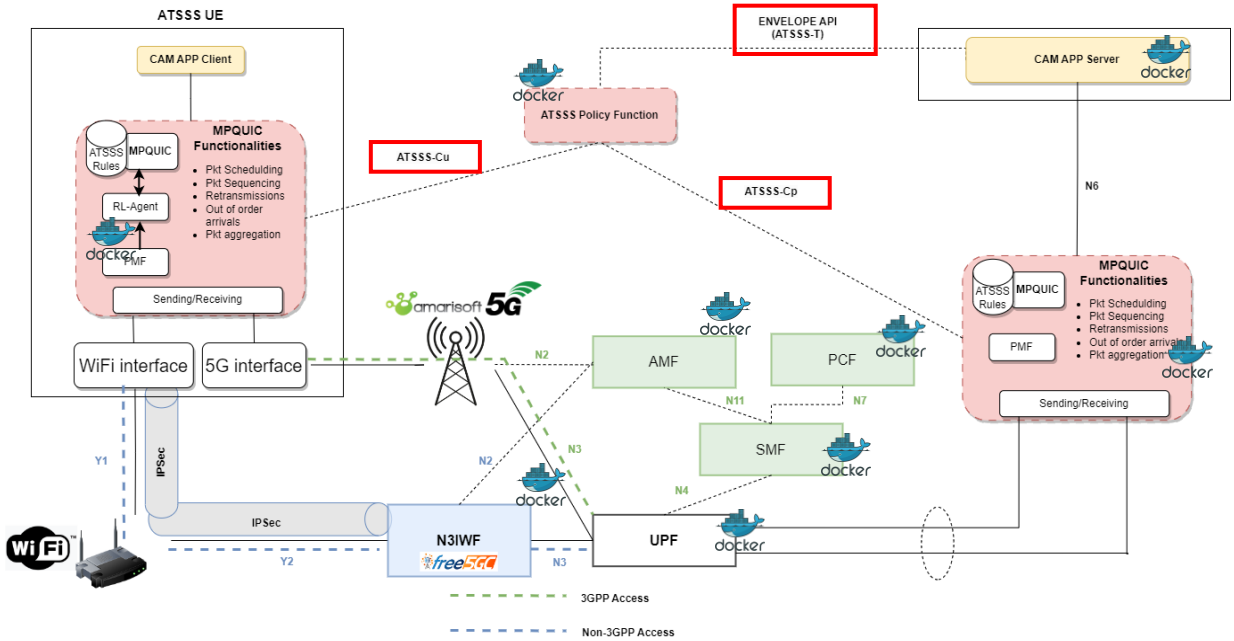
```
"QOS_M": {
  "description": "The QOS profile M",
  "status": "ACTIVE",
  "guaranteed_bit_rate_UPLINK": {
    "value": 10,
    "unit": "Mbps"
  },
  "guaranteed_bit_rate_DOWNLINK": {
    "value": 10,
    "unit": "Mbps"
  },
  "maximum_bit_rate_UPLINK": {
    "value": 20,
    "unit": "Mbps"
  },
  "maximum_bit_rate_DOWNLINK": {
    "value": 20,
    "unit": "Mbps"
  },
  "min_latency": {
    "value": 10,
    "unit": "Seconds"
  },
  "max_latency": {
    "value": 300,
    "unit": "Seconds"
  }
}
```

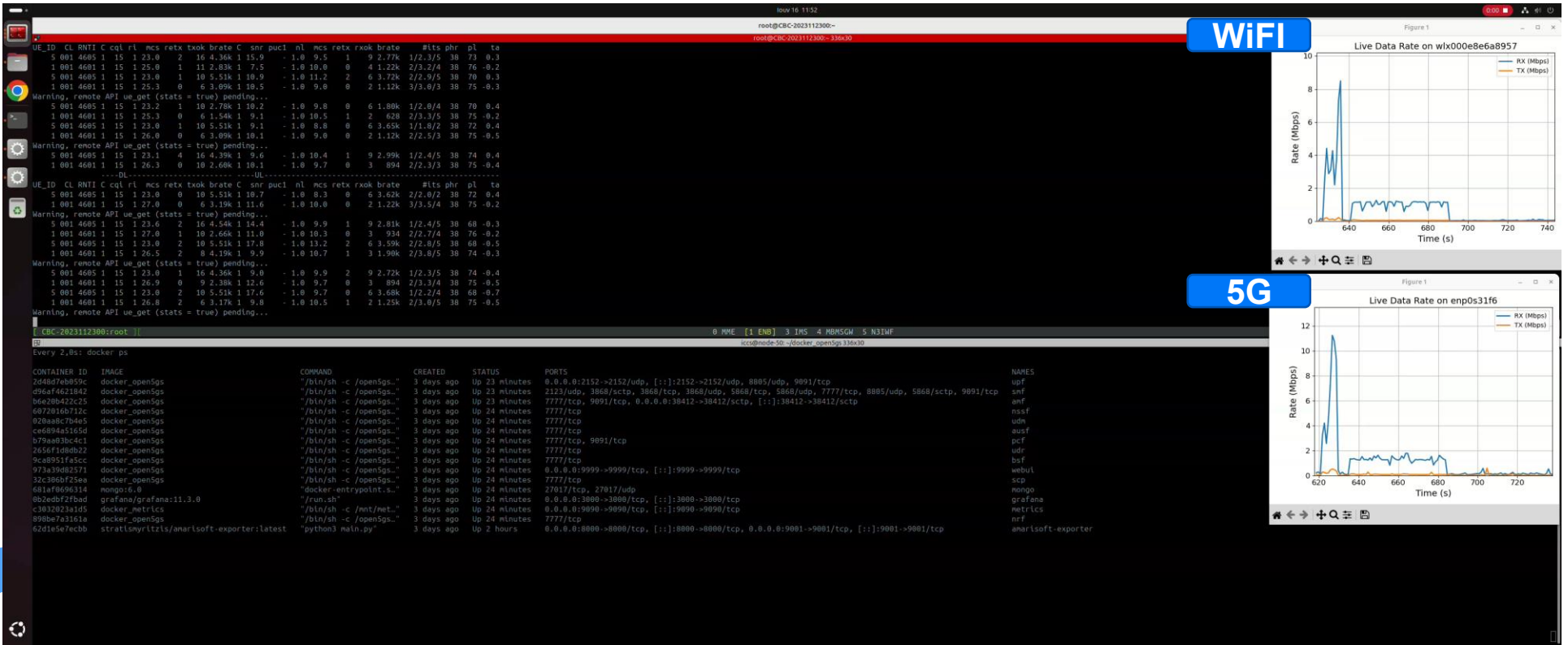
```
"QOS_L": {
  "description": "The QOS profile L",
  "status": "ACTIVE",
  "guaranteed_bit_rate_UPLINK": {
    "value": 20,
    "unit": "Mbps"
  },
  "guaranteed_bit_rate_DOWNLINK": {
    "value": 20,
    "unit": "Mbps"
  },
  "maximum_bit_rate_UPLINK": {
    "value": 40,
    "unit": "Mbps"
  },
  "maximum_bit_rate_DOWNLINK": {
    "value": 40,
    "unit": "Mbps"
  },
  "min_latency": {
    "value": 10,
    "unit": "Seconds"
  },
  "max_latency": {
    "value": 300,
    "unit": "Seconds"
  }
}
```

QoS Profiles

ATSSS APIs

- **ATSSS-T**
  - Provides traffic steering rules from CAM (*load balancing, smallest delay, duplication*)
- **ATSSS-Cu**
  - Applies traffic steering rues at the UE
- **ATSSS-Cp**
  - Applies traffic steering rues at the network



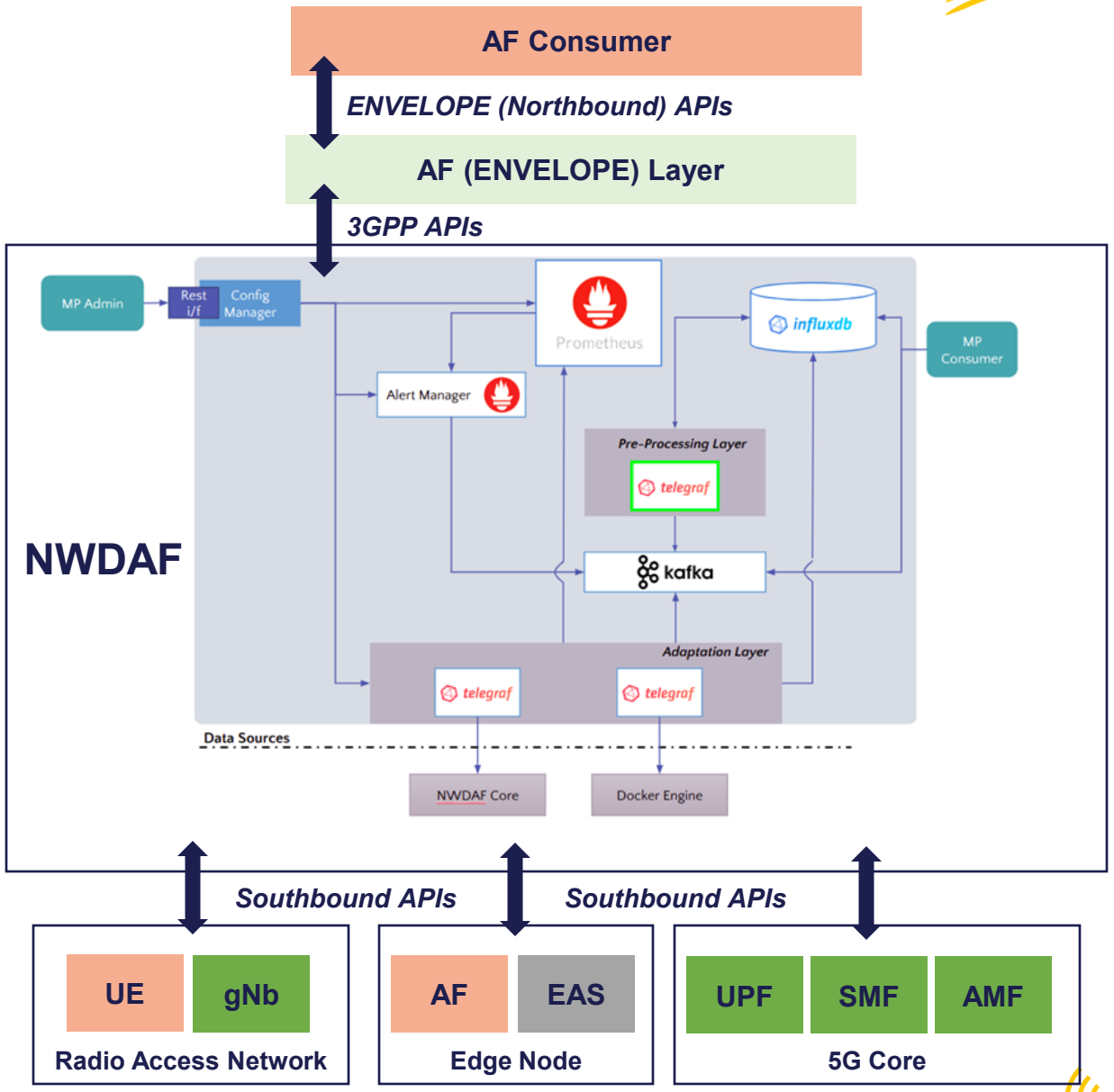


Transport Layer Protocol support

- **MP-TCP**
- **MP-QUIC (picoquic)**

PQoS Architecture

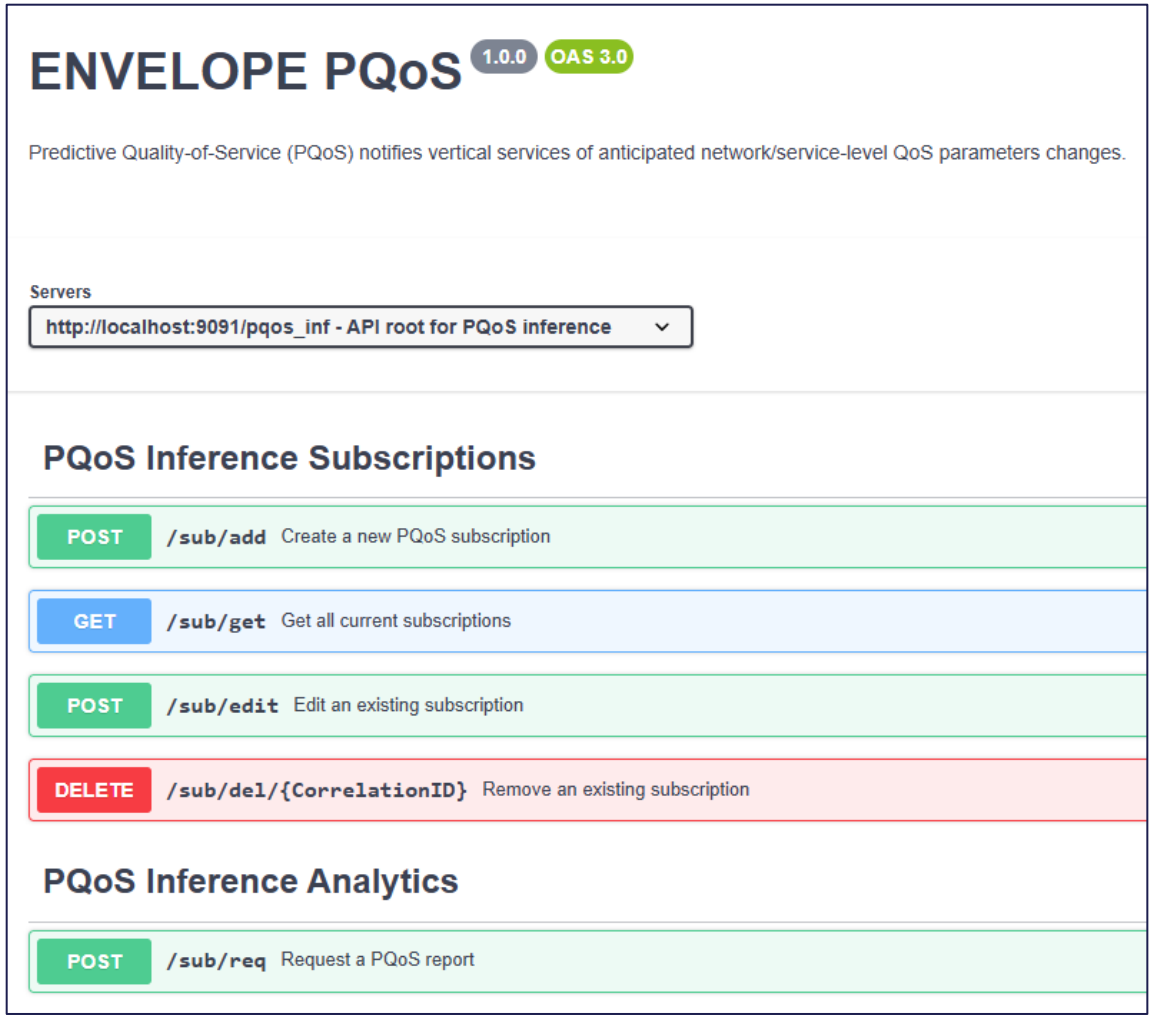
- pQoS Functionality
  - **pQoS-Inference** (pQoS-I): Delivers analytics and proactive notifications to vertical services based on predicted changes in **network-level** or **service-level** QoS KPIs
  - **pQoS-Training** (pQoS-T): Enables vertical services to configure the ENVELOPE platform for training and deploying AI/ML-based predictive QoS models.
- Components
  - **Network Data Analytics Function (NWDAF)**: Implements 3GPP-defined logical functions i.e., **Analytics Function** (**AnLF**) and **Model Training Function** (**MtLF**) to provide inference and model training capabilities
  - **Network/Edge infrastructure**: Facilitates real-time monitoring to support analytics and predictive modeling
  - **AF Layer**: Simplifies communication by abstracting complex 3GPP NWDAF APIs, enabling easy integration for AF consumers



PQoS-I ENVELOPE APIs

- QoS-Inference (pQoS-I) Analytics Variants
  - QS-PQoS (**QoS Sustainability**): Targets network-level performance metrics, aligned with 3GPP TS 23.288
  - DNP-PQoS (**Data Network Performance**): Focuses on service-level performance metrics, as defined in 3GPP TS 23.288
  - H-PQoS (**Hybrid**): A custom variant that predicts service-level performance using a combination of service-level & network-level input data.
- Analytics Exposure Modes

  (As per 3GPP TS 23.288)
  - **Subscribe-Notify**: Receive real-time notifications on predicted QoS changes.
  - **Request-Response**: On-demand retrieval of QoS prediction analytics.
- Supported QoS Types
  - Downlink Throughput
  - Uplink Throughput
  - Prediction Horizon up to 10 secs

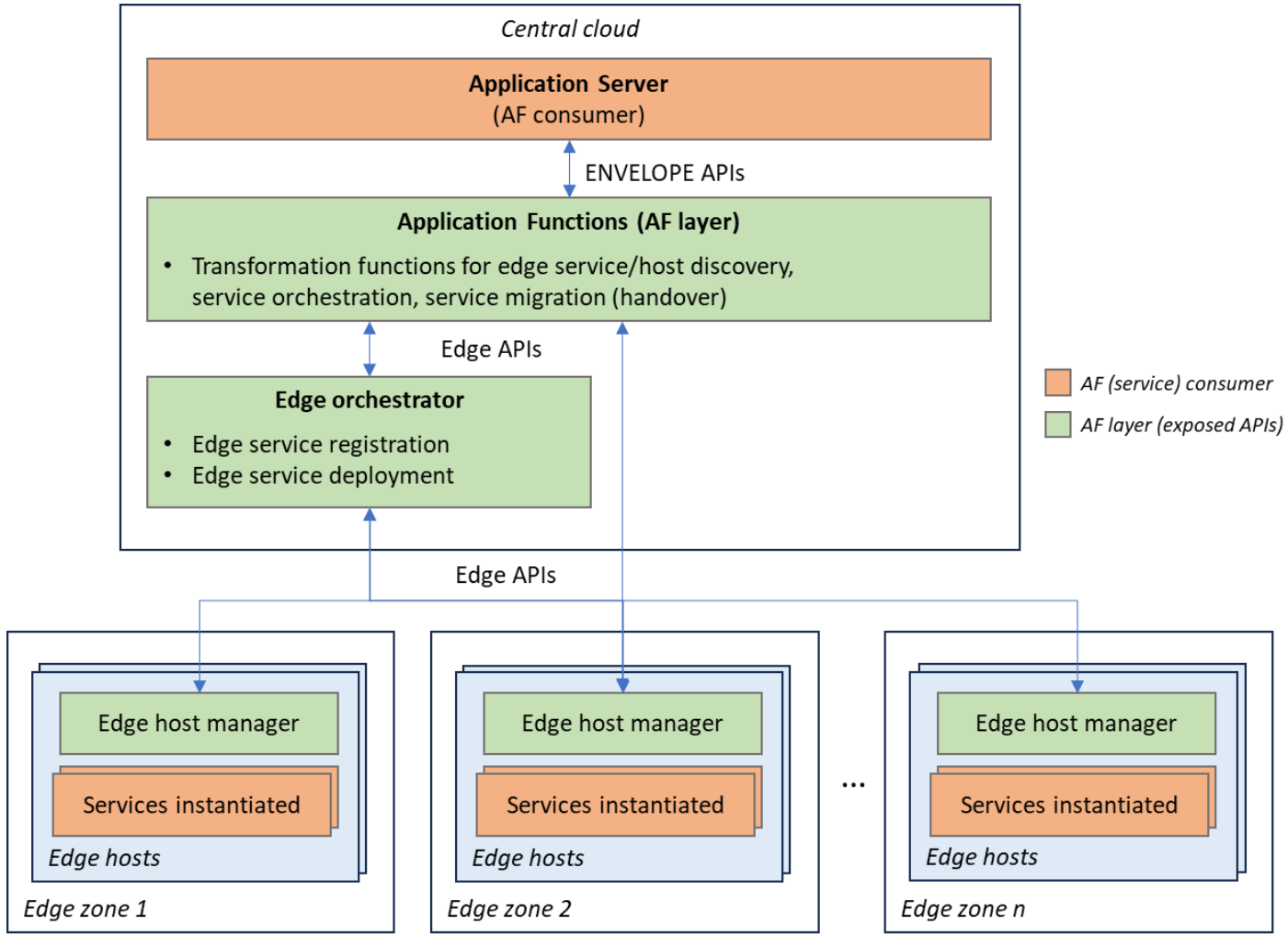


Enablers for Device Location

Functionality	ENVELOPE APIs	Brief description
• **Device Location (Geofencing) API**	• **Northbound**: CAMARA Device Location Geofencing APIs • **Southbound:** NEF MonitoringEvent API to subscribe to event monitoring location information	• Allows vertical applications to subscribe to geofenced event-based notifications related to the location of specified devices, i.e., when a device enters or leaves a certain geographical area
• **Devices in Area API**	• **Northbound**: CAMARA Device Location APIs • **Southbound**: MEC Location APIs (ETSI GS MEC 013 V3.1.1, “Multi-access Edge Computing (MEC); Location API”	• Allows vertical applications to query which devices are present in a given geographical area
• **Location Reporting API**	• **Northbound**: ENVELOPE API that simplifies subscription to and consumption of location update events • **Southbound:** NEF API (MonitoringEvent)	• Enables vertical applications to subscribe to location changes of specific UEs, with options for one-time or continuous location reporting

Enablers for Edge

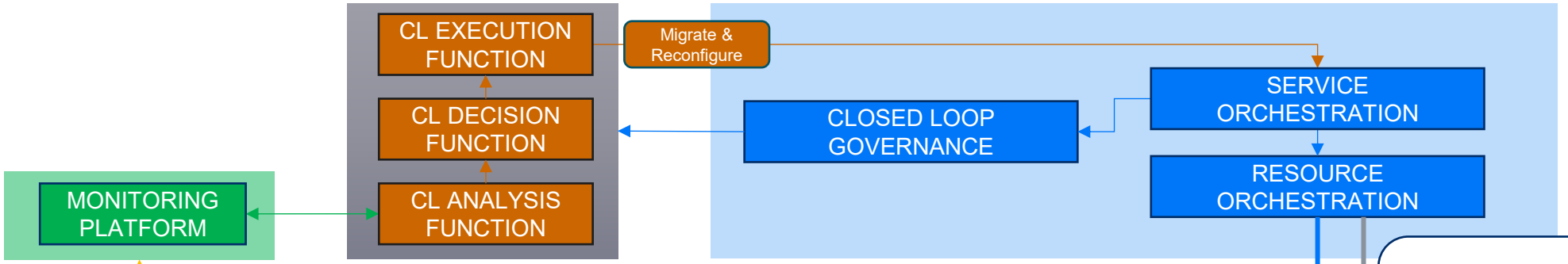
- Cloud-native edge architecture with containerized design for service deployment (i.e., Kubernetes clusters)
- Common edge enabling functions:
  - edge host and service discovery,
  - Edge service orchestration (service registration and instantiation), and
  - Service migration (handover)
- Common edge Envelope APIs:
  - CAMARA Edge Cloud (Edge Application Management)



https://github.com/camaraproject/EdgeCloud

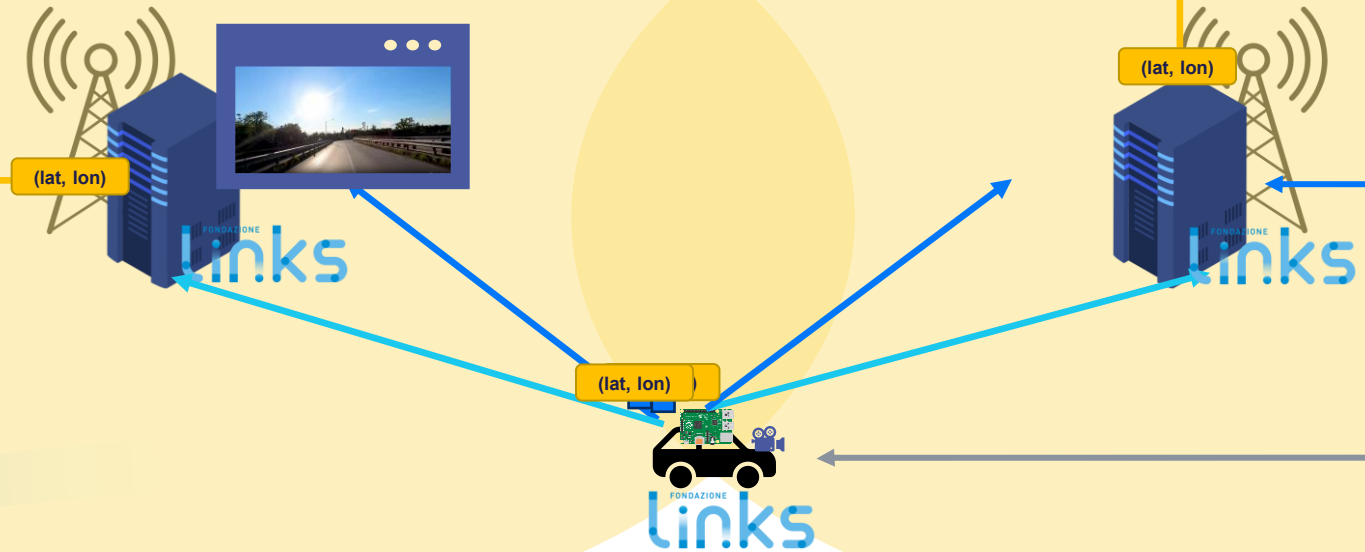
ENVELOPE Edge APIs Overview

Functionality	ENVELOPE APIs	Brief description
• **MEC service discovery**	• CAMARA API (edge cloud): **Edge Application Management** (/apps, /appinstances) • CAMARA API (edge cloud): **Application Endpoint Discovery**	• **/apps** (GET): retrieves list of existing apps • **/appinstances** (GET): retrieve information about app instances of a certain app • **/retrieve-closest-app-endpoints** (POST): returns the app instance with the shortest network path to the end user device identified in the request
• **MEC host discovery**	• CAMARA API (edge cloud): **Edge Application Management** (/clusters)	• **/clusters** (GET): Retrieve a list of the available clusters and associated 'nodePools', filtered by the optional query parameters.
• **MEC service registration**	• CAMARA API (edge cloud): **Edge Application Management** (/apps)	• **/apps** (POST): Registers/submit application metadata to the Edge Cloud Provider (app repository)
• **MEC handover (service migration)**	• CAMARA API (edge cloud): **Edge Application Management** (/apps, /appinstances)	• **/appinstances** (POST): instantiate an application to one or several Edge Cloud Zones (*stateless service migration*)
• **UE traffic (re-)routing to optimal edge (UPF)**	• CAMARA API (edge cloud): **Traffic Influence**	• **/traffic-influence-devices** (POST): influences the traffic toward local instances of the Application for a specific user
• **MEC Federation ENVELOPE API**	• MEC Federation Enablement API **(ETSI MEC 040)**	• facilitating cross-domain orchestration and the support of service migration across edge zones



The Closed Loop System decides to migrate and reconfigure the services

The Service and Resource Orchestration layer applies the decision taken from the CL functions



ENVELOPE API Summary

Trial Site	API	Category	Description
Greek	QoS/MonitoringEvent API	NEF (Network API)	QoS Level of session
Greek	Quality on Demand (QoD)	CAMARA with ENVELOPE extensions	Details to be defined
Dutch		CAMARA	Dynamic change of QoS profile for QoS flows of specified devices (based on port range, IP range)
Italian		CAMARA	Dynamic change of QoS profile for QoS flows of specified devices (based on port range, IP range)
Greek	UE Location/MonitoringEvent API	NEF (Network API)	Location of User Equipment (Cell ID)
	UE location API	CAMARA with ENVELOPE extensions	Simplified UE location API
Dutch	Device Location (geofencing)	CAMARA	Geofenced event-based notification for mobility of specified devices (location reporting of cell-level events)
Italian	Devices In Area	CAMARA	Geofenced event-based notification for mobility of specified devices (location reporting of cell-level events)
Greek	Edge-Cloud Continuum APIs	aerOS APIs	Orchestration over federated continuum resources
	Edge Application Management APIs	CAMARA	Mapping of aerOS APIs to CAMARA APIs
Dutch	Edge cloud	CAMARA with extensions	Discovery and instantiation of services based on requirements for specified devices and traffic re-routing to the new edge
Italian	Edge cloud	CAMARA based	Discovery and instantiation of services based on requirements for specified devices and traffic re-routing to the new edge
Greek	Nwdaf_analytics_subscribe, Nwdaf_AnalyticsInfo_Request (ref. to QoS Sustainability and DN Performance Analytics params)	PQoS-Inference (PQoS-I)	Network-/Service-level prediction of QoS value changes
	Nwdaf_model_provision, nwdaf_model_monitor, nwdaf_model_training	PQoS-Training (PQoS-T)	Configuration/Training of a QoS prediction AI/ML model
Dutch	Predictive QoS (Connectivity Insights)	CAMARA with extensions	Prediction of throughput performance for specified devices on cell-level
Dutch	Performance Metrics (NWDAF)	New ENVELOPE API	Subscription of periodic performance metrics (e.g., throughput)
Italian	MEC Handover	ENVELOPE - ETSI MEC based	Manage the handover of applications between edge servers
Italian	MEC Federation	ENVELOPE - ETSI MEC based	Manage edge server applications when UEs belong to different MNO networks
Greek	ATSSS-T, ATSSS-Cu, ATSSS-Cp	ENVELOPE-ATSSS (T, Cu, Cp)	Request ATSSS service, retrieve multi-connectivity traffic steering rules from the ATSSS Policy Function;

Contact

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Thank you!

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