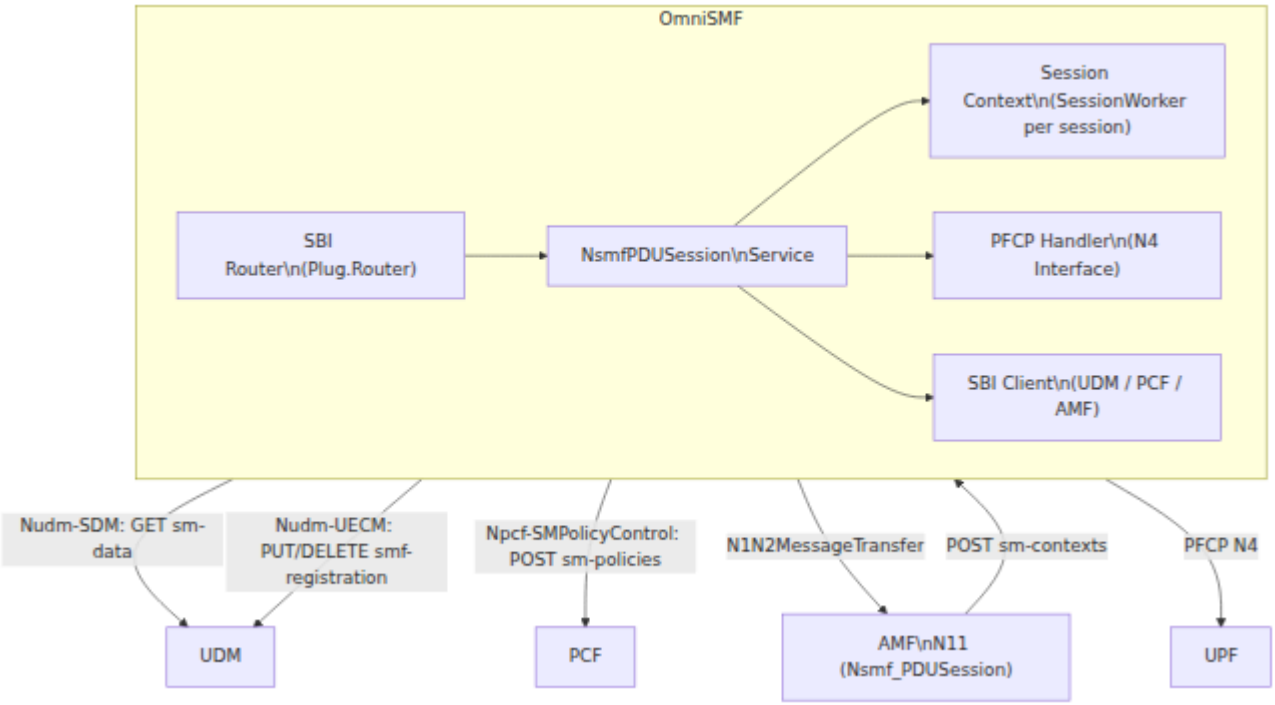
OmniSMF Operations Guide

Overview

OmniSMF implements the Session Management Function (SMF) of the 5G Core, responsible for the full lifecycle of PDU sessions. It anchors the N4 (PFCP) interface toward the UPF, the N7 interface toward the PCF, and the N10/N11 interfaces toward the UDM and AMF respectively.

Each PDU session is managed by a dedicated `SessionWorker` GenServer under a `SessionSupervisor` DynamicSupervisor (process-per-session architecture). All session state (QoS flows, PFCP context, UE IP, UP connection state) is owned by the worker process. One session crash does not affect others. All outbound SBI calls are made over plain HTTP using static URIs configured at startup; NRF-based dynamic discovery is not active in the current release.

Architecture



3GPP Role and Specification References

Specification	Relevance
TS 23.501	System architecture — SMF role, PDU session concept
TS 23.502	Procedures — PDU Session Establishment (4.3.2), Modification (4.3.3), Release (4.3.4)
TS 29.502	Nsmf_PDUSession API (HTTP/2 SBI)
TS 29.244	N4 interface — PFCP protocol between SMF and UPF
TS 29.503	Nudm_SubscriberDataManagement and Nudm_UEContextManagement
TS 29.512	Npcf_SMPolicyControl — SM policy association toward PCF
TS 29.518	Namf_Communication — N1N2MessageTransfer toward AMF

SBI Endpoints

All endpoints are served under the base URL `{sbi_scheme}://{sbi_addr}:{sbi_port}`.

Method	Path	Service	Descr
POST	`/nsmf-pdusession/v1/sm-contexts`	Nsmf_PDUSession	Create Contex session establis
POST	`/nsmf-pdusession/v1/sm-contexts/{smContextRef}/modify`	Nsmf_PDUSession	Update Contex info, UP change handov release
POST	`/nsmf-pdusession/v1/sm-contexts/{smContextRef}/release`	Nsmf_PDUSession	Release Contex (sessio teardo

Request / Response Summary

Create SM Context — mandatory request fields: `supi`, `sNssai`, `servingNetwork`, `dnn`, `smContextStatusUri`, `pduSessionId`. Returns `201 Created` with `Location: /nsmf-pdusession/v1/sm-contexts/{ref}`.

Update SM Context — dispatches on the first recognized key in the body:

Body key	Scenario
`n2SmInfo` + `n2SmInfoType`	N2 SM information from gNB (PDU_RES_SETUP_RSP / PDU_RES_REL_RSP)
`upCnxState: DEACTIVATED`	AN release / UE idle entry
`upCnxState: ACTIVATING`	Service request — returns N2 PDU_RES_SETUP_REQ
`release: true`	AMF-initiated release
`servingNfId`	AMF instance change during mobility

Release SM Context — body may include `ueLocation` for final location recording. Returns `204 No Content`.

Configuration Reference

Configuration is read from the application environment key `:omnismf`. The standard deployment mechanism is `config/runtime.exs` or OS environment variables mapped at startup.

```
config :omnismf,
  sbi_scheme: "http",
  sbi_addr:   "127.0.0.4",
  sbi_port:   7777,
  nrf_uri:    "http://127.0.0.10:7777",
  udm_uri:    "http://127.0.0.12:7777",
  pcf_uri:    "http://127.0.0.13:7777",
  amf_uri:    "http://127.0.0.5:7777",
  upf_addr:   "127.0.0.7",
  upf_pfcp_port: 8805,
  mcc: "999",
  mnc: "70",
  heartbeat_interval: 10_000,
  pfcp_addr: "127.0.0.4",
  ue_ip_pool: "10.45.0.0/16",
  dns:  ["8.8.8.8", "8.8.4.4"],
  dns6: ["2001:4860:4860::8888"],
  mtu:  1400
```

Parameter Table

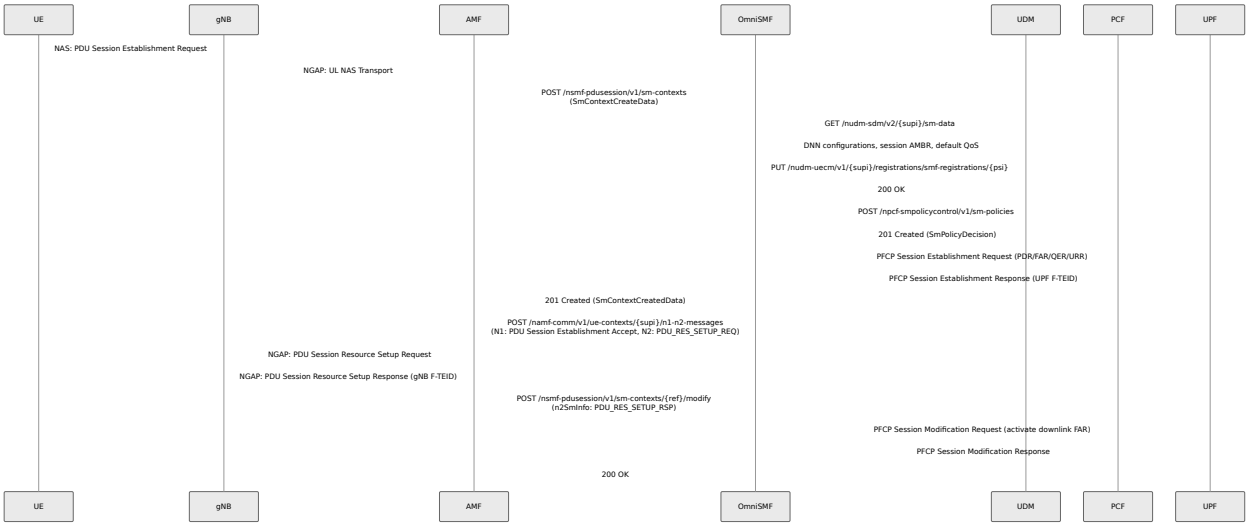
Parameter	Type	Default	Descrip
`sbi_scheme`	string	`"http"`	HTTP scheme SBI listening (`http` or `htt`
`sbi_addr`	string	`"127.0.0.4"`	IP address th HTTP server
`sbi_port`	integer	`7777`	TCP port the server listens
`nrf_uri`	string	`"http://127.0.0.10:7777"`	Base URI of t Used for NF registration a heartbeat on based discov not active)
`udm_uri`	string	`"http://127.0.0.12:7777"`	Base URI of t Used for Nud (sm-data) an UECM (smf-registrations)
`pcf_uri`	string	`"http://127.0.0.13:7777"`	Base URI of t Used for Npc SMPolicyCont policies) calls
`amf_uri`	string	`"http://127.0.0.5:7777"`	Base URI of t Used for N1N2Messag (namf-comm Overridden p

Parameter	Type	Default	Descrip
			session by th `smContextSt` host if preser
`upf_addr`	string	`"127.0.0.7"`	IP address of PFCP endpoi interface)
`upf_pfcp_port`	integer	`8805`	UDP port of t PFCP endpoi Standard PFC per TS 29.24
`mcc`	string	`"999"`	Mobile Count of the servin
`mnc`	string	`"70"`	Mobile Netwo of the servin
`heartbeat_interval`	integer (ms)	`10000`	Interval in milliseconds NRF heartbea requests. Als derive the UP threshold (heartbeat_in 1000 * 6 sec
`dns`	list of strings	`["8.8.8.8", "8.8.4.4"]`	IPv4 DNS ser addresses de to the UE in P Session Establishmer

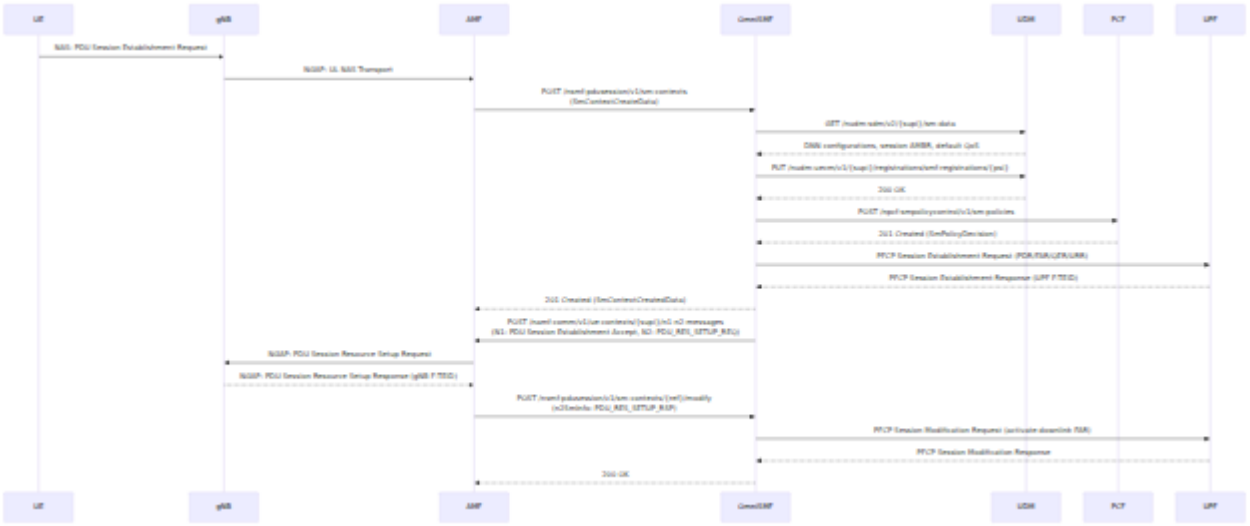
Parameter	Type	Default	Descrip
`dns6`	list of strings	`["2001:4860:4860::8888"]`	IPv6 DNS ser addresses de to the UE in F Session Establishmer
`pfcp_addr`	string	`"127.0.0.4"`	Source IP adc PFCP (N4) me sent to the U be routable f UPF
`ue_ip_pool`	string	`"10.45.0.0/16"`	CIDR subnet which UE IPv addresses ar allocated. Ma by `UeIpPool` GenServer w deduplicatior release-on-te
`mtu`	integer	`1400`	MTU value ac to the UE for session

Key Procedures

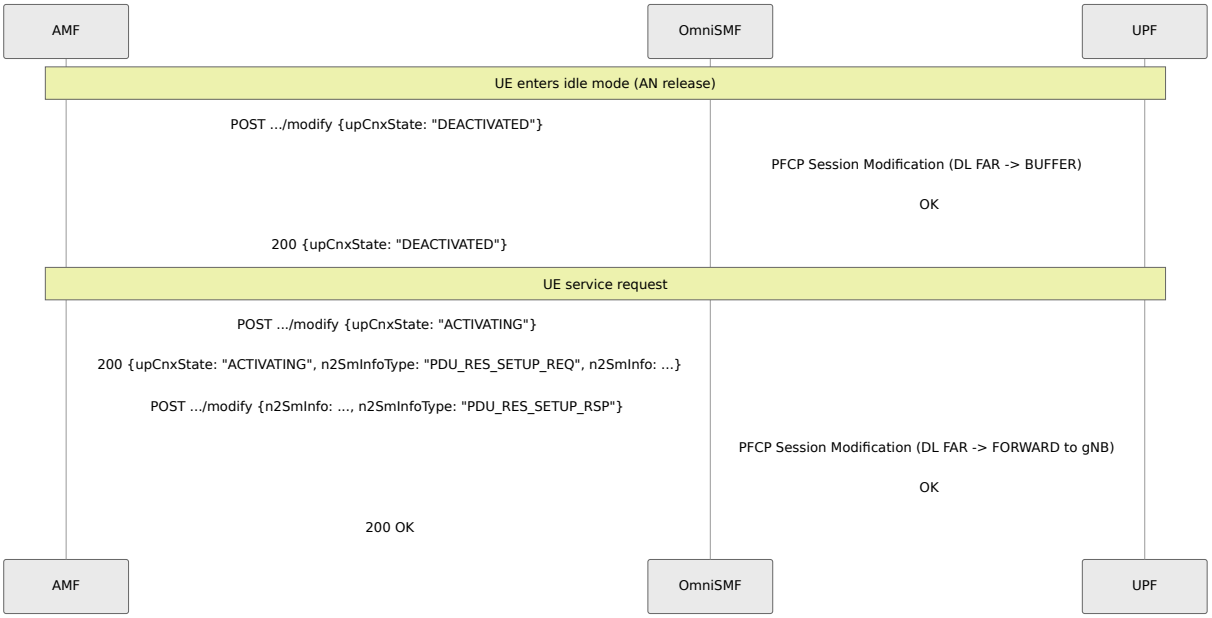
PDU Session Establishment (TS 23.502 Section 4.3.2)



PDU Session Release (TS 23.502 Section 4.3.4)



UE Idle / Service Request (UP Connection State)



N4 PFCP Session Structure

Each PDU session results in the following PFCP IEs being installed on the UPF:

IE	ID	Direction	Purpose
PDR (uplink)	1	Access -> Core	Match GTP-U traffic from gNB on UPF N3 F-TEID
PDR (downlink)	2	Core -> Access	Match traffic from N6 by UE IP address
FAR (uplink)	1	Core	Forward to N6 (no outer header)
FAR (downlink)	2	Access	Initially BUFFER; updated to GTP-U FORWARD after PDU_RES_SETUP_RSP
QER	1	Both	Enforce session AMBR (uplink and downlink MBR)
URR	1	Both	Time-based usage reporting (threshold = heartbeat_interval * 6 s)

Prometheus Metrics

SBI / PDU Session Metrics

Metric	Type	Tags	Descript
`omni_smf.pdu_session.create.count`	counter	`result`	PDU sess create operation
`omni_smf.pdu_session.modify.count`	counter	`result`	PDU sess modify operation
`omni_smf.pdu_session.release.count`	counter	`result`	PDU sess release operation
`omni_smf.pdu_session_creates.total`	counter	`result`, `dnn`	Total PDU session creates b DNN
`omni_smf.pdu_session_releases.total`	counter	`result`	Total PDU session releases
`omni_smf.active_pdu_sessions.count`	gauge	`dnn`	Number o active PD sessions DNN
`omni_smf.session.duration_seconds`	distribution	--	PDU sess duration seconds (buckets:

Metric	Type	Tags	Descript
			5, 15, 30, 60, 300, 900, 360 86400)

PFCP / UPF Metrics

Metric	Type	Tags	Description
`omni_smf.pfcp_sessions.total`	counter	`operation`	Total PFCP session operations
`omni_smf.upf.health`	gauge	--	UPF PFCP association health (1=up, 0=down)

NRF Metrics

Metric	Type	Tags	Description
`omni_smf.nrf.registration.status`	gauge	`nf_type`	NRF registration status (1=registered, 0=not)

BEAM VM Metrics

Metric	Type	Description
`beam.memory.total`	gauge	Total BEAM memory in bytes
`beam.memory.processes`	gauge	Memory used by Erlang processes
`beam.memory.processes_used`	gauge	Memory actually used by processes
`beam.memory.system`	gauge	System memory
`beam.memory.atom`	gauge	Total atom memory
`beam.memory.atom_used`	gauge	Used atom memory
`beam.memory.binary`	gauge	Binary memory
`beam.memory.code`	gauge	Code memory
`beam.memory.ets`	gauge	ETS table memory
`beam.processes.count`	gauge	Number of Erlang processes
`beam.ports.count`	gauge	Number of Erlang ports
`beam.atom.count`	gauge	Number of atoms
`beam.vm.uptime`	gauge	VM uptime in seconds

Known Limitations

The following gaps were identified during an operational audit. Reference IDs correspond to internal tracking.

ID	Area	Description
SMF-H5	N4 Reporting	Session Report Request messages received from the UPF are not processed. Usage reports from URR triggers are silently discarded.
SMF-H7	NAS	The N1 SM container in SmContextCreateData is not decoded. NAS PDU Session Establishment Request content (5GSM capability, extended protocol configuration options) is not inspected or forwarded.
SMF-M1	Handover	Handover state handling is partial. Xn-based handover and inter-AMF N2 handover path switches are not fully supported; the `servingNfId` update path handles AMF change but the full handover procedure (TS 23.502 4.9) is not implemented.
SMF-M3	UE IP	UE IPv4 addresses are allocated randomly from `10.45.0.0/16` on each session establishment. There is no address pool management, no overlap detection, and no IPv6 prefix delegation.
SMF-M4	Notifications	SM context status notifications to the AMF callback URI (`smContextStatusUri`) are not sent. The AMF is not informed of SMF-initiated state changes (e.g., network-triggered release).
SMF-M5	NRF Discovery	An NRF registration module exists and the SMF registers with the NRF. However, all outbound SBI calls (to UDM, PCF, AMF) use static URIs from configuration. NRF-based discovery is not performed.
SMF-M7	PFCP Reporting	SessionReportResponse is not sent to the UPF in response to Session Report Requests.

ID	Area	Description
SMF-L1	SM Context Retrieval	There is no `GET /nsmf-pdusession/v1/sm-contexts/{ref}` endpoint. SM context retrieval by external consumers is not supported.
SMF-L3	QoS Modification	QoS flow modification after session establishment is not supported. Adding, modifying, or deleting QoS flows (TS 23.502 4.3.3) cannot be triggered post-establishment.

Troubleshooting

PDU Session Establishment Fails with 404 DNN_DENIED

The UDM returned session management subscription data that does not include the requested DNN. Verify that the UDM's subscriber data for the SUPI contains a `dnnConfigurations` entry matching the requested DNN (case-insensitive). Check the SMF log for the line `SM context creation failed: dnn_not_found`.

PDU Session Establishment Fails with 503 NF_DISCOVERY_FAILURE

The SMF could not reach the UDM at `udm_uri`. Verify connectivity from the SMF host to the configured `udm_uri`. Check firewall rules and that the UDM SBI port is reachable. The SMF log will show `[SBI->UDM] GET sm-data failed` with the underlying reason.

PFCP Session Establishment Rejected

The UPF returned a non-"Request accepted" cause in the PFCP Session Establishment Response. Common causes:

- `upf_addr` or `upf_pfcp_port` is incorrect — verify with `ss -ulnp | grep 8805` on the UPF host.
- The UPF does not support the PDR/FAR IEs sent by the SMF — check UPF capability logs.
- PFCP heartbeat (association) is not established — the SMF must complete PFCP Association Setup before sending session requests. Check logs for `[PFCP] Association` messages at startup.

The SMF log will contain `[PFCP] Session establishment rejected: <cause>` or `[PFCP] Session establishment failed: <reason>`.

N1N2MessageTransfer to AMF Fails

After the SMF returns 201 to the AMF for context creation, it asynchronously sends the N1N2MessageTransfer. If this call fails, the PDU session is created in the SMF and UPF but the UE will not receive the Establishment Accept. The SMF logs `[SBI->AMF] N1N2 transfer failed`. This failure is currently non-fatal from the SMF's perspective — no retry is attempted. To recover, release the SM context and retry the PDU session establishment.

UE Receives No IP Address

IP allocation is performed at PFCP session establishment time using a random selection from `10.45.0.0/16`. If the UPF returns a different IP in its Created PDR (UPF-allocated addressing), the SMF will use the UPF-returned F-TEID but will still record its own randomly generated IP. Ensure the UPF is configured to accept SMF-specified UE IP addresses or to allocate and return them via the Created PDR. See limitation SMF-M3.

High Session Count / Memory Growth

Session contexts are stored in an in-process Agent. They are only removed on explicit `release_sm_context`. If AMF or UE-initiated releases are missed (e.g., due to AMF restart), orphaned contexts will accumulate. Monitor with the `/statistics` internal API endpoint. There is currently no session timeout or garbage collection.

Log Correlation

Each log line from the session path is prefixed `[{supi}:{pdu_session_id}]`. Filter by SUPI to trace a subscriber's session lifecycle end-to-end. PFCP-path log lines are prefixed `[PFCP]` and SBI client calls are prefixed `[SBI->UDM]`, `[SBI->PCF]`, or `[SBI->AMF]`.