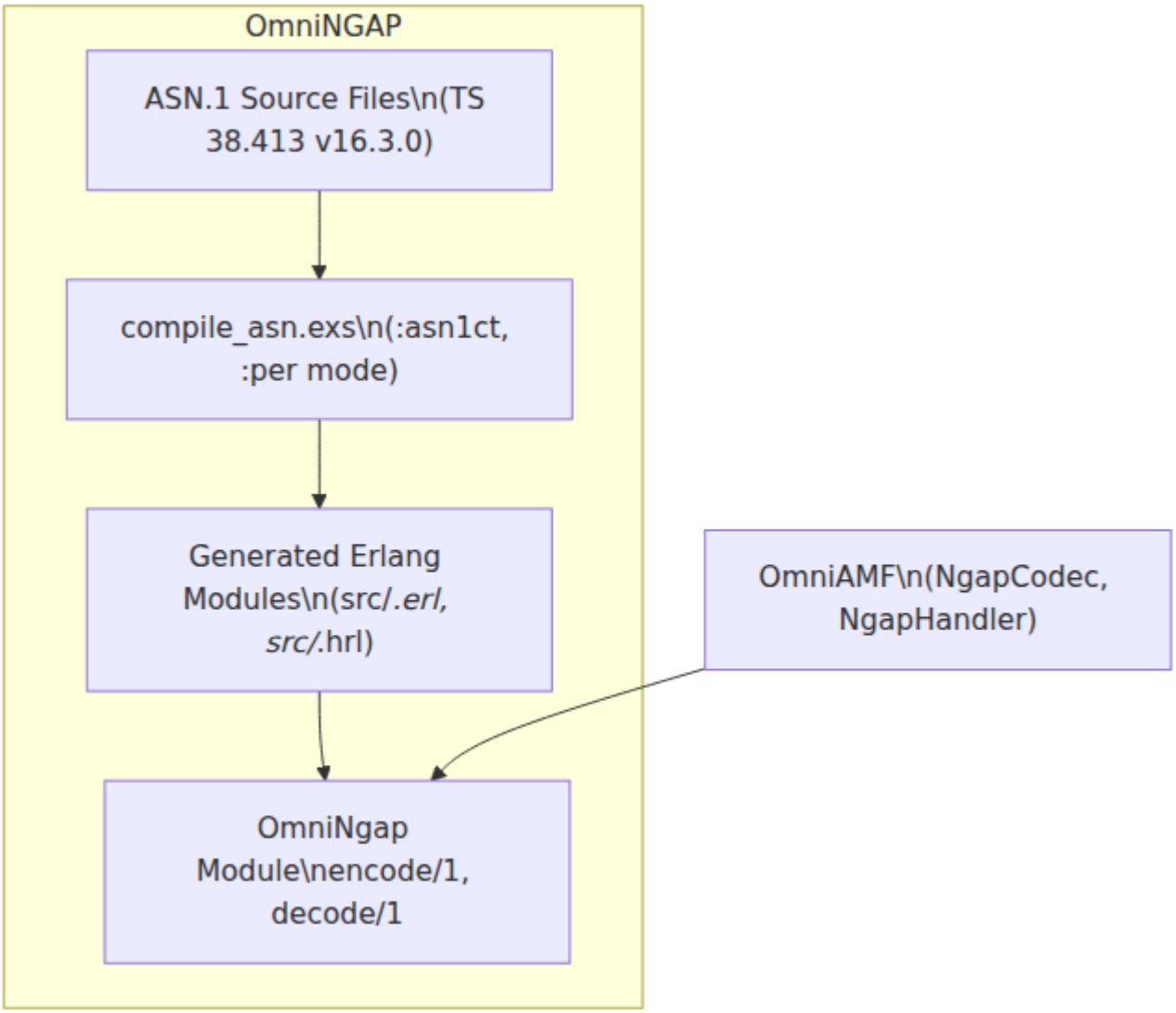
OmniNGAP Operations

1. Component Overview

OmniNGAP is the NGAP ASN.1 codec library for the Omnitouch 5G core. It provides compile-time ASN.1 compilation of the NGAP protocol definitions from 3GPP TS 38.413 and exposes encode/decode functions for NGAP PDUs using Aligned PER (APER) encoding. OmniNGAP is consumed as a dependency by OmniAMF for all NGAP message construction and parsing over the N2/SCTP interface.

OmniNGAP is a library, not a standalone NF. It has no SBI endpoints, no NRF registration, and no runtime configuration. All ASN.1 modules are compiled once at build time using Erlang's `:asn1ct` compiler.



Compile-Once Approach

The ASN.1 compilation is performed by `compile_asn.exs` during the Mix compile phase. The script:

1. Reads `.asn1` source files from the `asn1/` directory in dependency order.
2. Compiles each module using `:asn1ct.compile/2` with `:per` mode (Aligned PER, as required by TS 38.413).
3. Generates `.erl` and `.hrl` files in `src/`.
4. Copies `.hrl` files to `include/` for dependent projects using `Record.extract(from_lib:)`.
5. Skips recompilation when source files have not changed (mtime comparison).

6. Handles read-only filesystems (e.g., Docker) by falling back to precompiled modules.

ASN.1 Modules

Module	Description
`NGAP-CommonDataTypes`	Base ASN.1 types (Criticality, PresenceInformation, etc.)
`NGAP-Containers`	NGAP container types (ProtocolIE-Container, ProtocolExtensionContainer)
`NGAP-Constants`	NGAP constants (procedure codes, IE IDs, max values)
`NGAP-IEs`	NGAP Information Elements (all IE definitions)
`NGAP-PDU-Contents`	NGAP PDU content structures (InitiatingMessage, SuccessfulOutcome, etc.)
`NGAP-PDU-Descriptions`	Top-level NGAP-PDU type definition and procedure dispatch

2. 3GPP Role and Spec References

Aspect	Reference
NGAP protocol definition	TS 38.413
NGAP transport (SCTP)	TS 38.412
NGAP encoding (Aligned PER)	TS 38.413 Section 9, ITU-T X.691
AMF / gNB interface (N2)	TS 23.501 Section 8.2.5
NGAP procedures	TS 38.413 Section 8

3. API Reference

OmniNGAP exposes two functions via the `OmniNgap` module:

`OmniNgap.decode/1`

Decodes a binary NGAP PDU (APER-encoded) into an Erlang ASN.1 record.

```
{:ok, ngap_pdu} = OmniNgap.decode(binary)
```

Returns `{:ok, record}` on success or `{:error, reason}` on decode failure.

`OmniNgap.encode/1`

Encodes an Erlang ASN.1 record into a binary NGAP PDU (APER-encoded).

```
{:ok, binary} = OmniNgap.encode(ngap_pdu_record)
```

Returns `{:ok, binary}` on success or `{:error, reason}` on encode failure.

Erlang Record Access

NGAP IE records can be accessed from Elixir using `Record.extract/2`:

```
require Record
Record.extract(:"NGAP-PDU", from_lib: "omni_ngap/include/NGAP-PDU-
Descriptions.hrl")
```

4. Build and Compilation

Prerequisites

- Erlang/OTP 27+ (provides `:asn1` application with `:asn1ct` compiler)
- Elixir 1.17+

Build Steps

```
cd OmniNGAP
mix deps.get
mix compile
```

The `mix compile` alias runs `compile_asn.exs` before standard Elixir compilation. On first build, all six ASN.1 modules are compiled. Subsequent builds skip unchanged modules.

Dependency Usage

OmniAMF depends on OmniNGAP as a path or git dependency:

```
# In OmniAMF mix.exs
{:omni_ngap, git: "...", branch: "main"}
```

OmniAMF's `NgapCodec` module uses the generated Erlang records and `OmniNgap.encode/1` to construct NGAP messages (NG Setup Response, Initial

Context Setup Request, Handover Request, Paging, etc.).

5. NGAP Procedures Supported

The following NGAP procedures are encoded/decoded by OmniNGAP and used by OmniAMF:

Procedure Code	Name	Direction	Usage
21	NGSetup	gNB -> AMF	gNB connection establishment
14	InitialUEMessage	gNB -> AMF	First NAS message from UE
4	InitialContextSetup	AMF -> gNB	Security context and registration accept
46	DownlinkNASTransport	AMF -> gNB	NAS PDUs to UE
47	UplinkNASTransport	gNB -> AMF	NAS PDUs from UE
24	Paging	AMF -> gNB	UE paging in idle mode
41	UEContextRelease	AMF -> gNB	UE context teardown
1	HandoverPreparation	AMF -> Target gNB	Handover request
0	HandoverResourceAllocation	AMF -> Source gNB	Handover command
25	PathSwitchRequest	gNB -> AMF / AMF	Xn handover path switch

Procedure Code	Name	Direction	Usage
		-> gNB	
29	PDUSessionResourceSetup	AMF -> gNB	PDU session resource allocation

6. Known Limitations

ID	Area	Description
NGAP-1	ASN.1 version	ASN.1 source files are from TS 38.413 v16.3.0 (Rel-16). Later releases may add new IEs or procedures not covered by this version
NGAP-2	Encoding only	OmniNGAP provides raw encode/decode. Message construction (populating IE values, handling optionality) is the responsibility of the consuming application (OmniAMF NgapCodec)
NGAP-3	No runtime configuration	OmniNGAP is a compile-time library with no runtime configuration or telemetry

7. Troubleshooting

ASN.1 compilation fails

Check that Erlang/OTP includes the `:asn1` application. Run `erl -eval 'application:ensure_all_started(asn1), halt().'` to verify. If compilation fails with a specific module, check the error output from `:asn1ct.compile/2` for syntax issues in the `.asn1` source file.

Encode/decode returns {:error, reason}

The input record or binary does not conform to the NGAP ASN.1 schema. Common causes:

1. Missing mandatory IEs in the record passed to `encode/1`.
2. Corrupted or truncated binary passed to `decode/1`.
3. IEs with values outside the defined ASN.1 constraints (e.g., integer out of range).

Check the error reason tuple for the specific IE or constraint that failed.

Read-only filesystem in Docker

The `compile_asn.exs` script detects read-only filesystems and falls back to precompiled modules in `src/` and `include/`. Ensure the Docker image was built with a full compilation pass so that `src/*.erl` and `include/*.hrl` files are present.