

MRN - O-RAN Project
Protocol Design and Protobuf Extension for MCS
Adaptation xApp

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1. Protocol Design Choices

The xApp monitors the Downlink Bit Error Rate (BER) for each UE and applies a control action if the BER exceeds a given threshold.

Monitoring Strategy

The system polls the network every **500 ms**, collecting the latest RAN statistics. The monitoring is event-driven and reacts to high BER values without modifying UEs unnecessarily.

Decision Logic

Each received Indication is analyzed. If a UE's downlink BER exceeds a threshold (defined by the user at runtime), a control message is sent to the gNB, forcing a new MCS value for that specific UE.

The logic allows for precise, per-UE control, enabling conservative adaptation strategies and reducing unnecessary control signaling.

If the BER later drops below the threshold, the original MCS value is restored for that UE, ensuring optimal performance is recovered as soon as conditions improve.

2. Protocol Buffer Modification

The predefined protocol has been modified to include the required monitoring and control for BER and MCS.

Indication Request

In the **Indication Request**, the following parameters are explicitly requested:

- **GNB_ID** – used to identify the gNB sending the response.
- **UE_LIST** – contains the list of connected UEs.

For each Indication Response, only essential data for each UE are extracted and processed. Specifically, within the **UE_LIST** parameter map, the following fields are included for every UE:

- **rnti** – UE identifier.
- **ber_d1** – downlink Bit Error Rate.
- **mcs_d1** – current downlink Modulation and Coding Scheme.

All other fields have been removed as they were deemed non-influential for the adaptation logic. This minimal representation ensures efficiency and clarity in data processing.

Indication Response info map:

```
message ue_info_m{
    // this is to identify the ue
    required int32 rnti=1;

    //Bit error rate in downlink
    optional float ber_dl = 2;
    //Modulation and coding scheme in downlink
    optional int32 mcs_dl = 3;
}
```

Control Request

In case of poor downlink BER, the xApp sends a **Control Request** to force a new MCS value. The message contains:

- UE_LIST – same structure as in the Indication, but here used to send a new `mcs_dl` for a given `rnti`.

The simulator applies the new MCS to the matching UE only. The parameter map structure used in the **Control Request** is identical to the one used in the **Indication Response**.