

Finite state machine YANG model augmentation for Transponder Reconfiguration

draft-sambo-ccamp-yang-fsm-transponder-reconf-01

N. Sambo¹, P. Castoldi¹, A. Sgambelluri¹, G. Fioccola²,
F. Cugini³, D. Ceccarelli⁴, H. Song⁵, T. Zhou⁵

1: Scuola Superiore Sant'Anna, Italy

2: Telecom Italia, Italy

3: CNIT, Italy

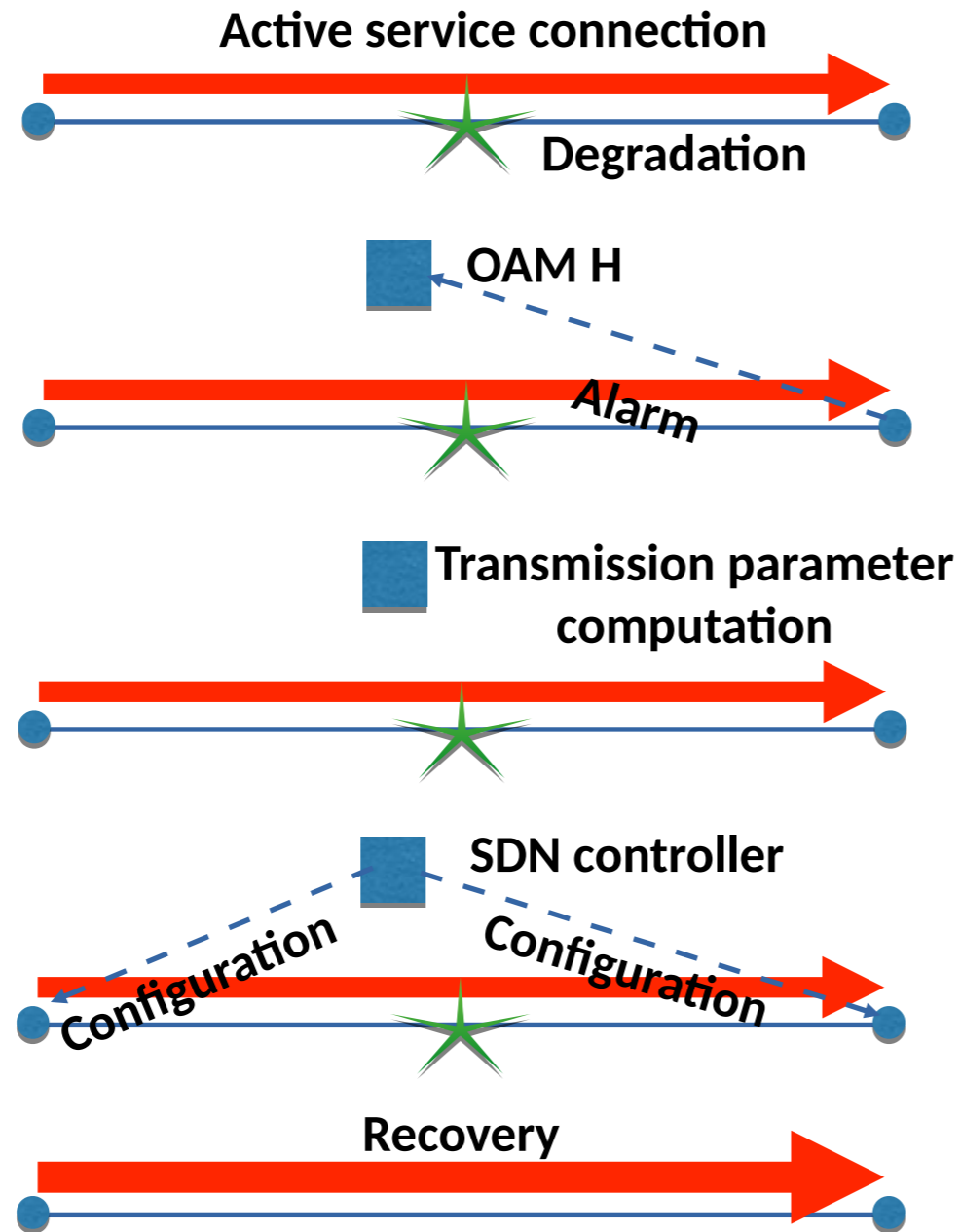
4: Ericsson, Sweden

5: Huawei, China

Proposal

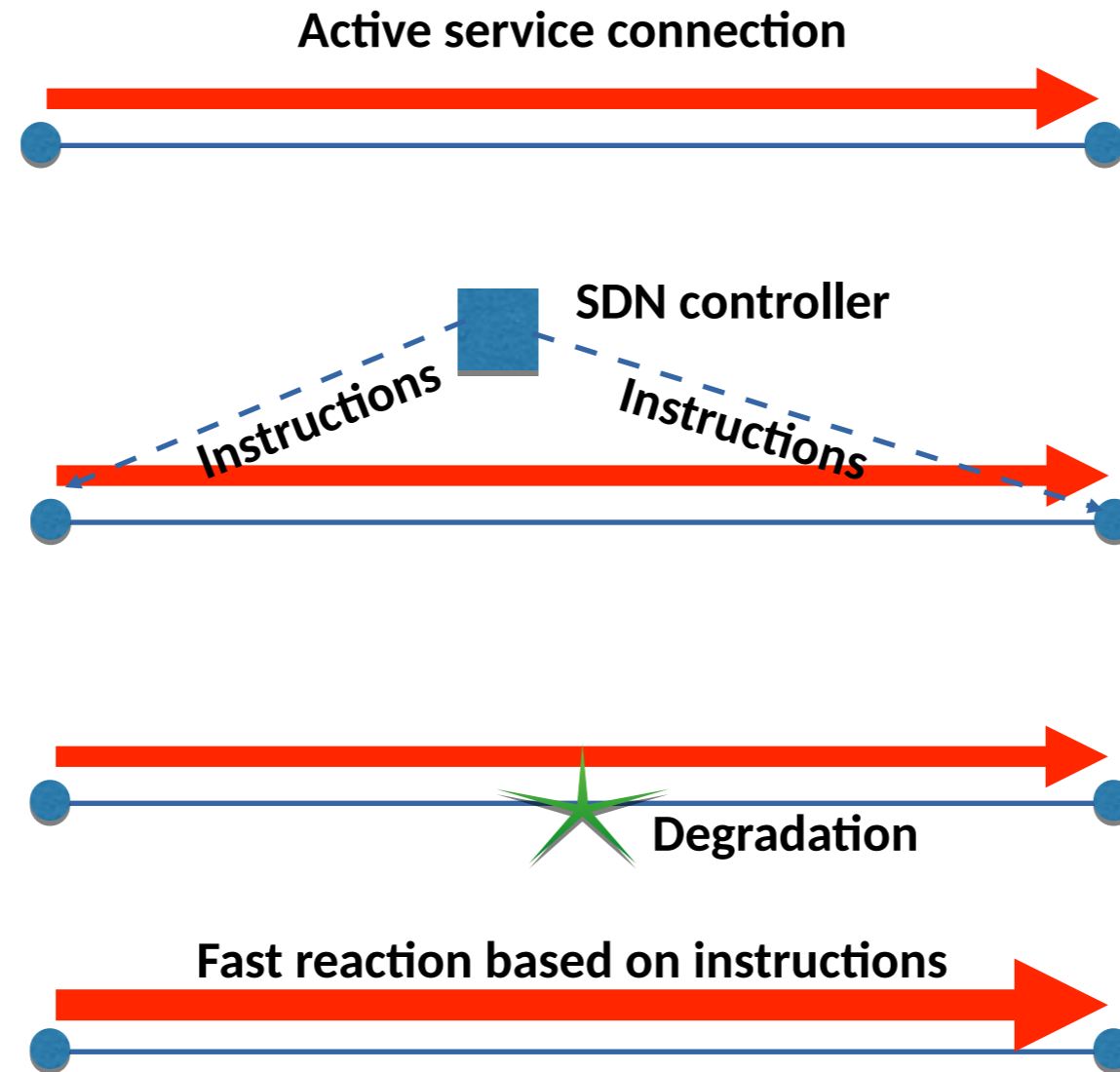
- **YANG models for finite state machine to pre-instruct recovery actions in flexible transponders**
- Augmentation of the model in [draft-sambo-netmod-yang-fsm-03](#)
- Use case:
 - Flexible transponders in elastic optical networks: multiple rates, multiple modulation formats, multiple FECs
 - Format and FEC can be set based on optical physical layer (e.g., PM-QPSK more robust than PM-16QAM)
 - If physical conditions change (e.g., soft failure: BER increase), format or FEC can be adapted to get more robust transmission
 - The YANG model is used to pre-instruct transponders about transmission parameters (e.g., format) to be used based on physical conditions

State of the art



Time consuming

Use case of application for FSM YANG model



Faster

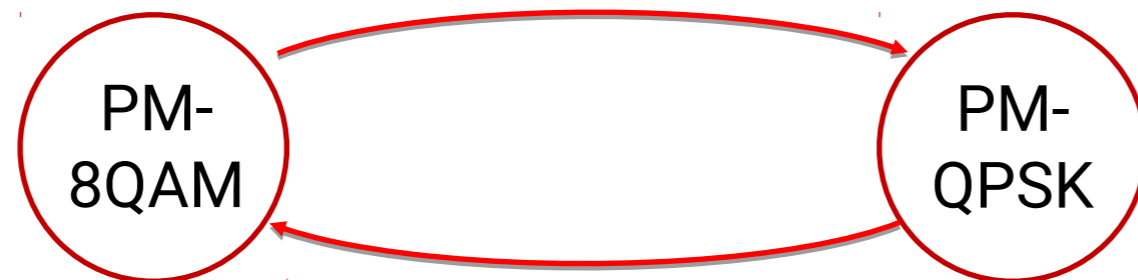
YANG model

```
module: ietf-treconf
  +--rw current-state?  leafref
  +--rw states
    +--rw state [id]
      +--rw id          state-id-type
      +--rw description? string
      +--rw transitions
        +--rw transition [name]
          +--rw name          string
          +--rw description?  string
          +--rw threshold-parameter? decimal64
          +--rw threshold-operator? string
          +--rw transition-action
            +--rw action [id]
              +--rw id          transition-id-type
              +--rw type        enumeration
              +--rw simple
                +--rw execute
                +--rw next-action? transition-id-type
                +--rw next-state? Leafref
```

- List of states: each state can be associated to a modulation format
- The transition to another state can be triggered by the BER over a threshold
- threshold-parameter: value of the threshold
- threshold-operator: >, <, and so on
- action: if BER over a threshold, the action can be the change of modulation format
- Then, a new state is achieved

Implementation

- Event: $BER > BER_{th}$
- Reaction: e.g., format adaptation



- Event: $BER < BER_{th}$
- Reaction: format adaptation

Considerations added in this new draft

Synchronization:

- When the Digital Signal Processing at the receiver reveals BER over threshold and decides to change the modulation format, the remote transponder at the transmitter side has to do the same state transition.
- The transponder at the receiver side sends a message to the transmitter to synchronize about the transmission parameters to be adopted
- We implemented this message over a control channel

Impact on the rate:

- Modulation format change at fixed baud rate changes bit rate:
e.g., 25Gbaud of baud rate, PM8QAM supports 150Gb/s and PM-QPSK supports 100Gb/s
- Thus, when changing from PM-8QAM to PM-QPSK, 100Gb/s can be promptly recovered with FSM, while 50Gb/s requires central controller (e.g., for rerouting)
- Within 150Gb/s:
 - 100Gb/s HIGH PRIORITY traffic recovered with FSM
 - 50Gb/s BEST EFFORT traffic recovered with central controller

Next steps

- Define all the list of actions including the operations to be done at the data plane: e.g., change of modulation format, transmitter and receiver synchronization
- Include information about classes (e.g., high priority and best effort)