LatSeq

A Low-Impact Internal Latency Measurement Tool for OpenAirInterface

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Introduction

- 5G aims to bring low latency networking to cellular networks
- For research and development purposes, need of thorough understanding of latencies at each segments
- We propose a tool to measure Base Station internal latencies at a fine grain

Definitions

- **Internal Latency** : time between the moment when the packet is fully received by the node from input interface and the moment when all segments making up the packet leave the software part of this node
- **Journey** of a packet is the list of all ordered measurements of this packet inside the node
- **Packet Fingerprint** : The measurement of a packet at a layer
- We propose to measure internal latencies per UE, per Layer inside Base Station (BS)

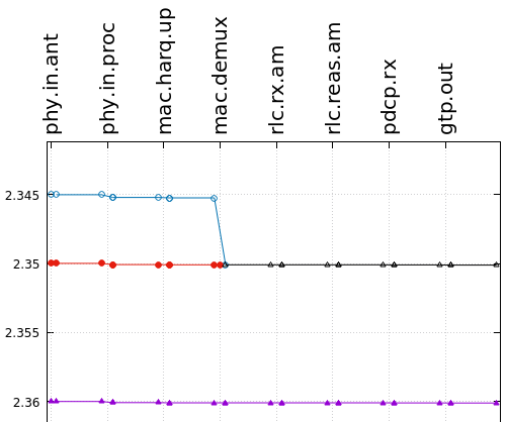

Fig.1 : Journeys of 2 packets inside BS

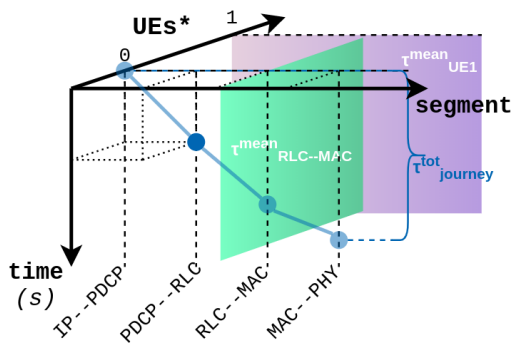

Fig.2 : Matrix of Latencies

LatSeq tool

- Tool to **measure packets' internal latencies**
- Ensure a low-impact on OpenAirInterface Base Station
  - > Reduce CPU instructions number for measurement function
    - => 35 CPU cycles = **16ns**
  - > Offload high consuming functions

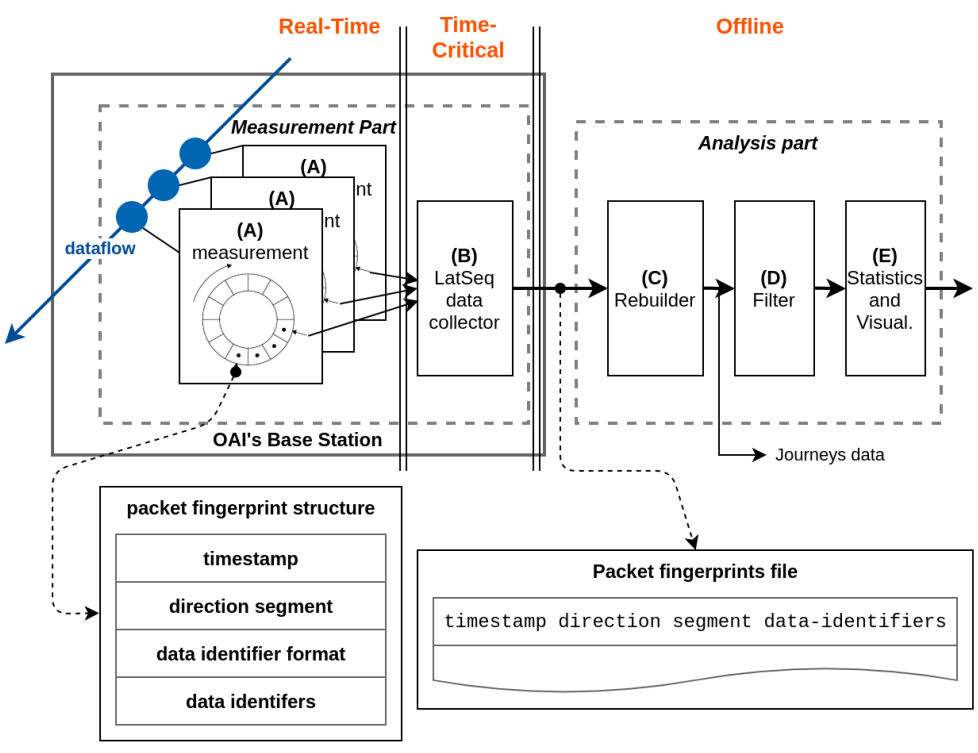

Fig.3 : LatSeq's architecture

Method and Results

- (A) Measurement of packet fingerprint at multiple points in the BS (Fig.6)
- (B) Collect all packet fingerprints in timestamped log file
- (C) Rebuild packets' journey from fingerprints (high complexity algorithm)
- (D) Optionnal filtering of packets
- (E) Visualizations and Statistics

```
#ifdef LATSEQ
    LATSEQ_P("D rlc.tx.am--rlc.seg.am",
             "len%d:rnti%d:drb%d.sdu%d.rsn%d.rso%d",
             sdu->size, entity->ue_rnti, entity->channel_id, sdu->sdu_num, pdu->sn, pdu->so
             );
#endif
```

```
20201030_203524.504785 D pdcp.tx--rlc.tx.am len62:rnti53421:drb1.psn87.sdu88
20201030_203524.506512 D rlc.tx.am--rlc.seg.am len62:rnti53421:drb1.sdu88.rsn72.rso0
20201030_203524.506513 D rlc.seg.am--mac.mux len64:rnti53421:drb1.lcid3.rsn72.rso0.reqfm686
```

Fig4 : Measurement point (A) and result (B)

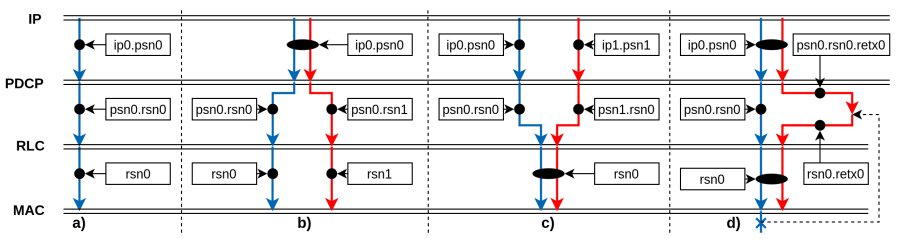

Fig.5 : Packet's journey from fingerprints (C)

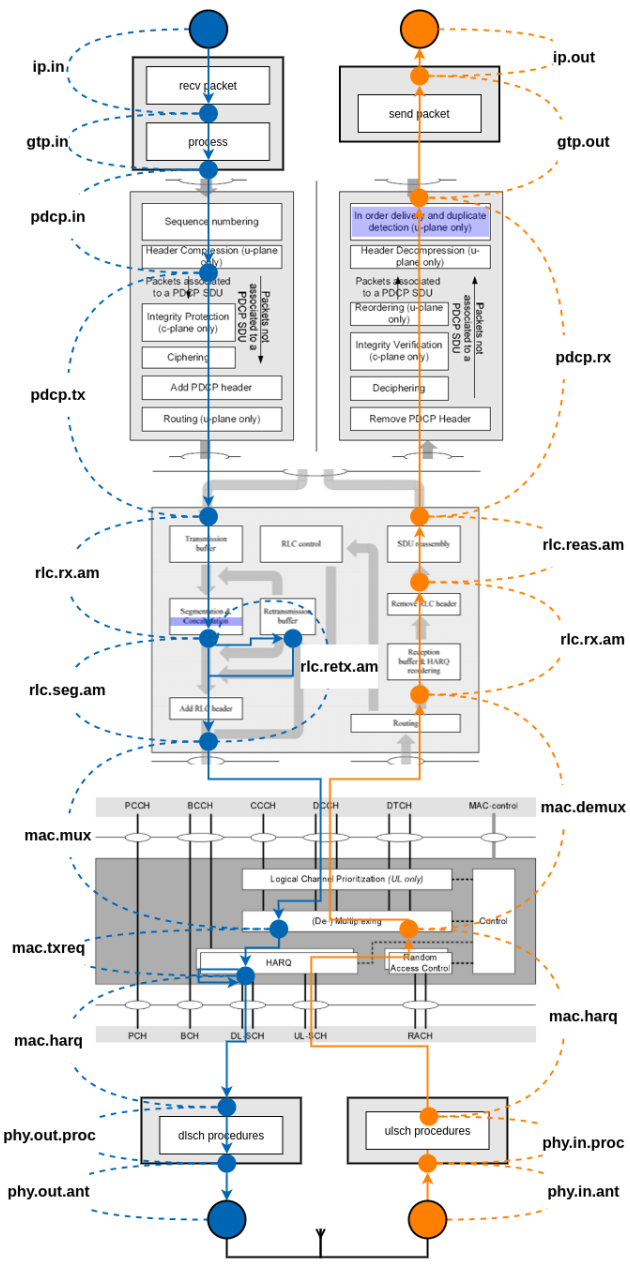

Fig.6 : LatSeq points on the OAI Base Station LTE stack

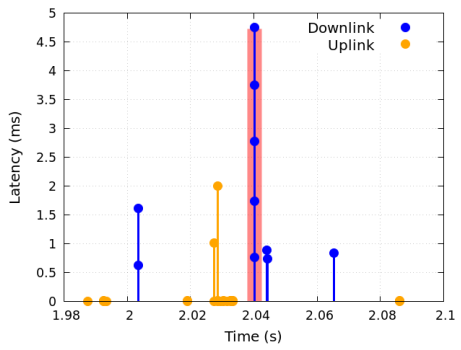

Fig.7 : Internal latency by packet segment (E)

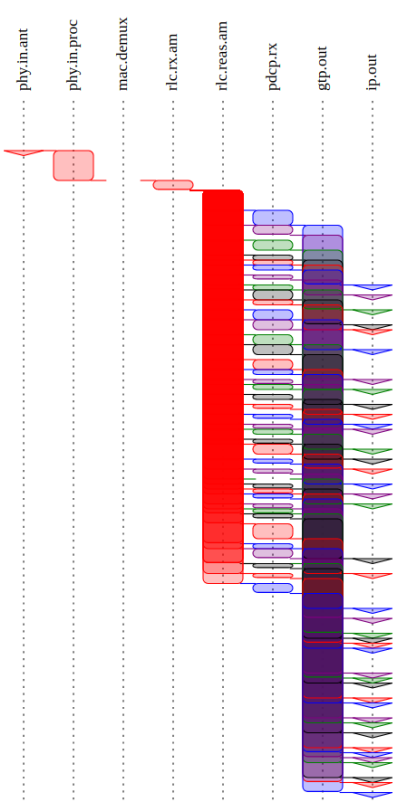

Fig.8 : Packets waterfall of an uplink transmission (E)

Conclusion

- LatSeq successfully implemented in OAI for latency analysis at a packet segment level
- Open-sourced code at `github.com/Orange-OpenSource/LatSeq`
- Used for uplink acknowledgement packet bundling problem analysis
- Extension with "I" point to correlate User Data packet with Control informations such as scheduling decision, BSR, SR, HARQ acknowledgment,...