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Root-cause Analysis
MMT-RCA

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Montimage

WAL5Gplus - 16/06/2021

Agenda

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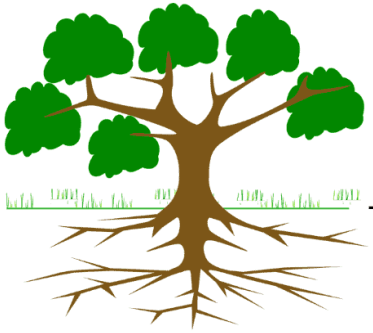
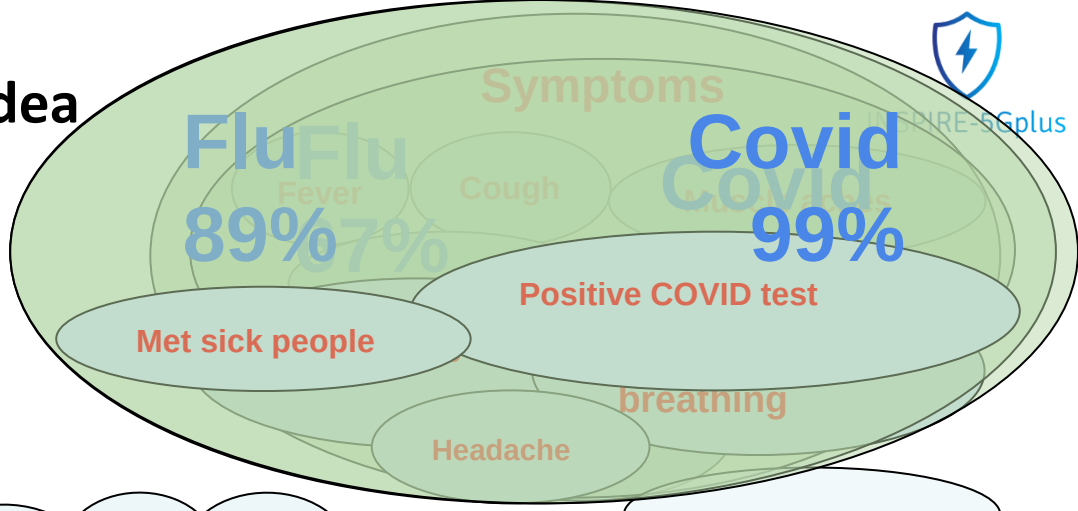
- Our approach and related research topics
- RCA with P4-Enabled 5G Network
- Demo

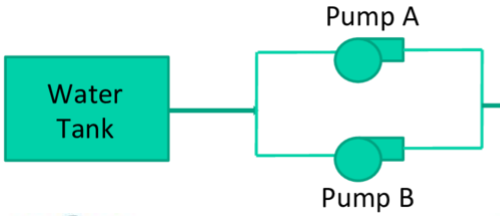
MMT-RCA: Principal idea



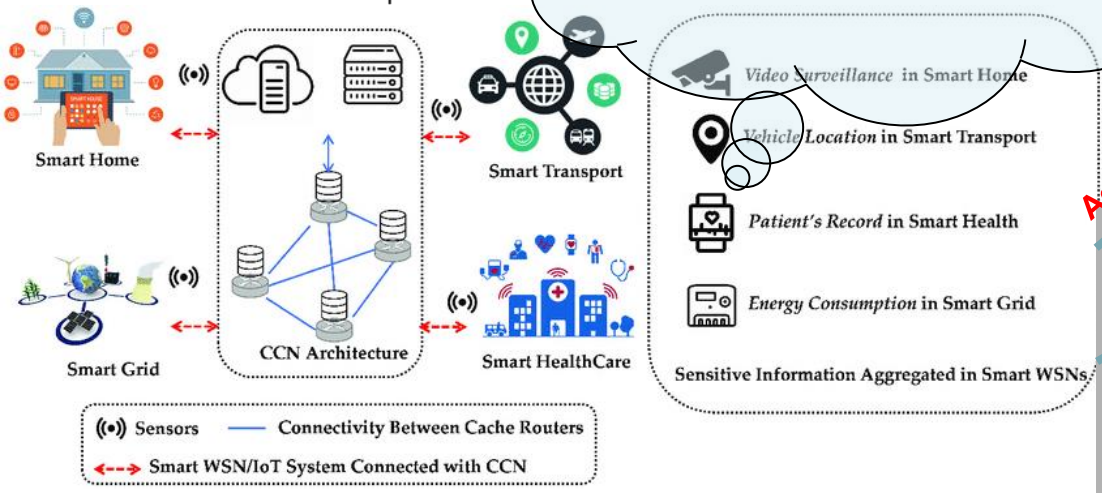
Above the surface you see the **Symptoms** of the problem

Dig deeper to find the **Root Cause** of the problem





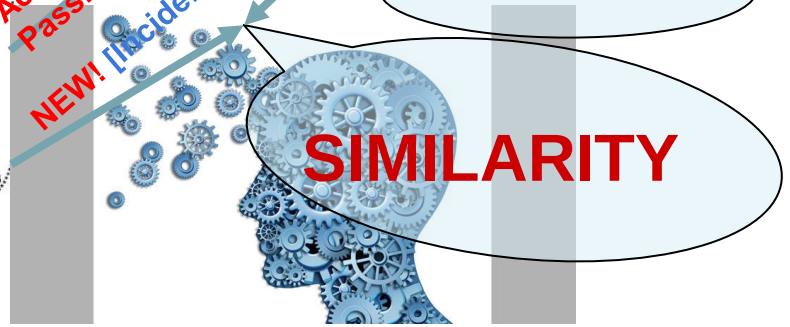
RCA



Actively created incidents

Passively detected incidents

NEW! [Incident + Symptoms]



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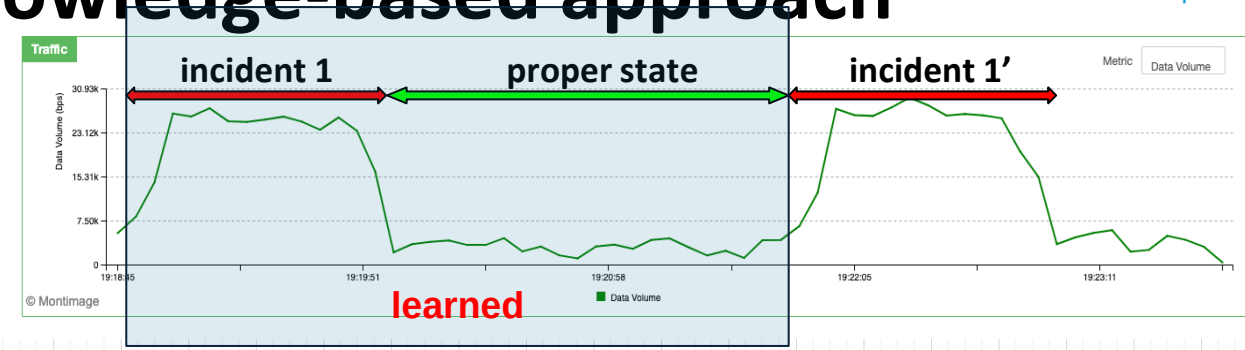
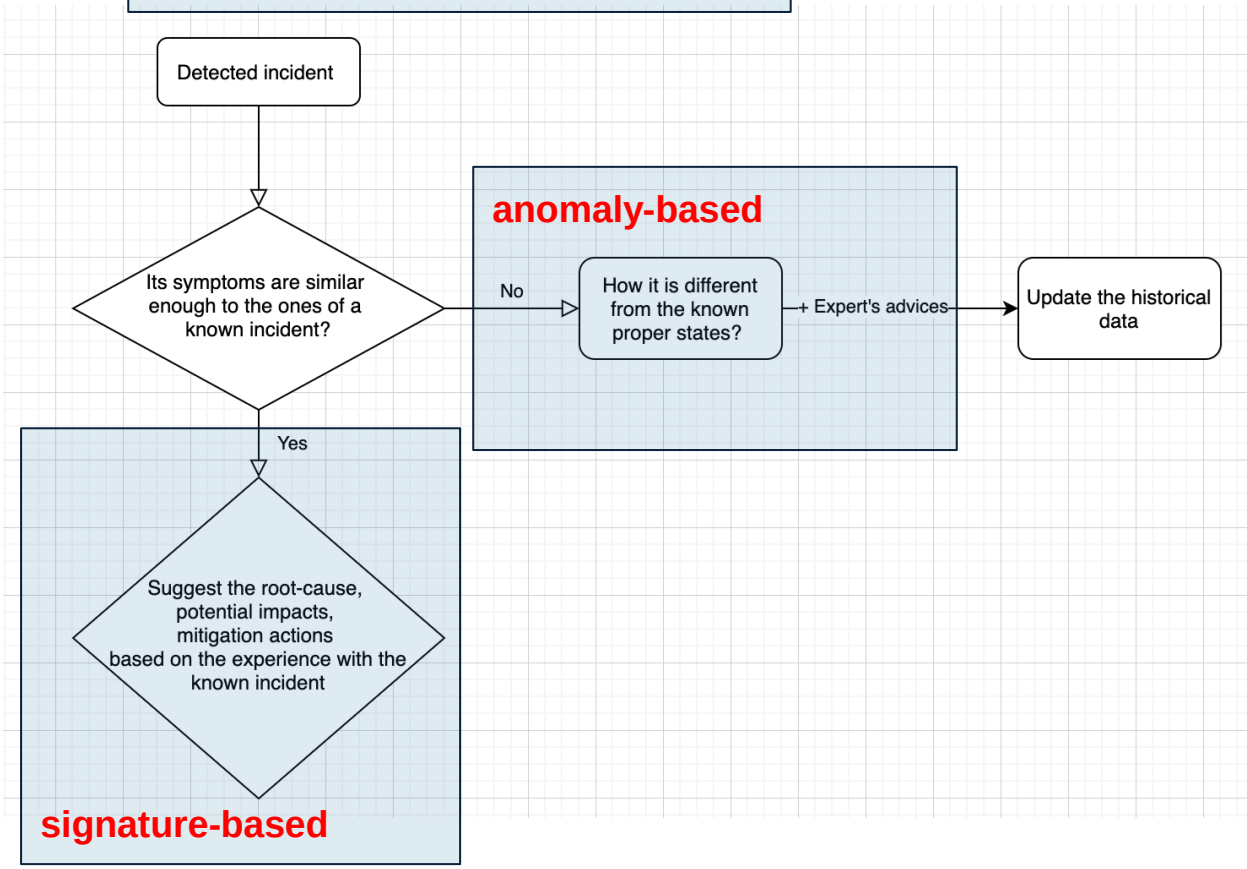
MMT-RCA: Knowledge-based approach

- **Signature-based:**
  - Historical data of known incidents and their symptoms (observed in monitoring data)
    + known root causes
    (~ **labelled** data)
  - Similarity?
- **Anomaly-based:**
  - Historical data of proper states
    (~ **unlabelled** data)
  - Dissimilarity? The change reflected in which metrics/ attributes?





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Related research topics

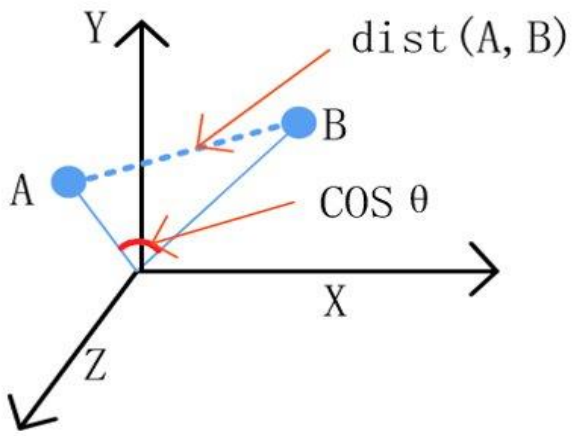
- **How to translate monitoring data to symptoms and vice versa?**
  - Heterogeneous data of different units / ranges:

    => Data normalization/ standardization
  - Data redundancy (noises/ too many dimensions):

    => Feature selection (5 selection models integrated)
- **How to measure similarity/dissimilarity between two sets of symptoms?**

The system's state can be characterized by a set of n attributes: $<a_0, a_1, ..., a_n>$, which can be represented by a vector in n-dimensional space.

  - Similarity/ Dissimilarity score calculation:
    - distance of **orientation** (the angle)
    - distance of **magnitude** (the length)



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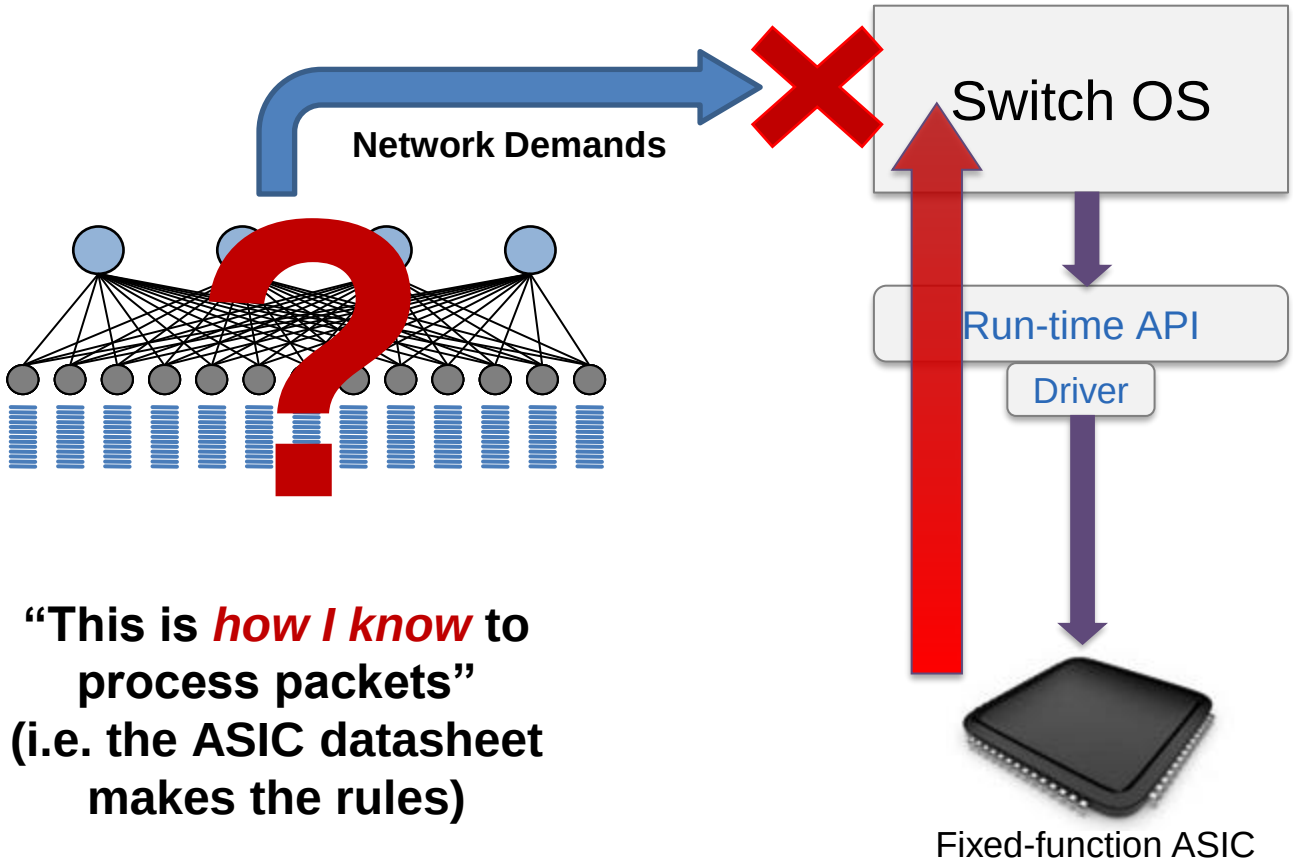
RCA with P4-Enabled 5G Network

Why P4?



"This is *how I know* to process packets" (i.e. the ASIC datasheet makes the rules)

Traditional approach

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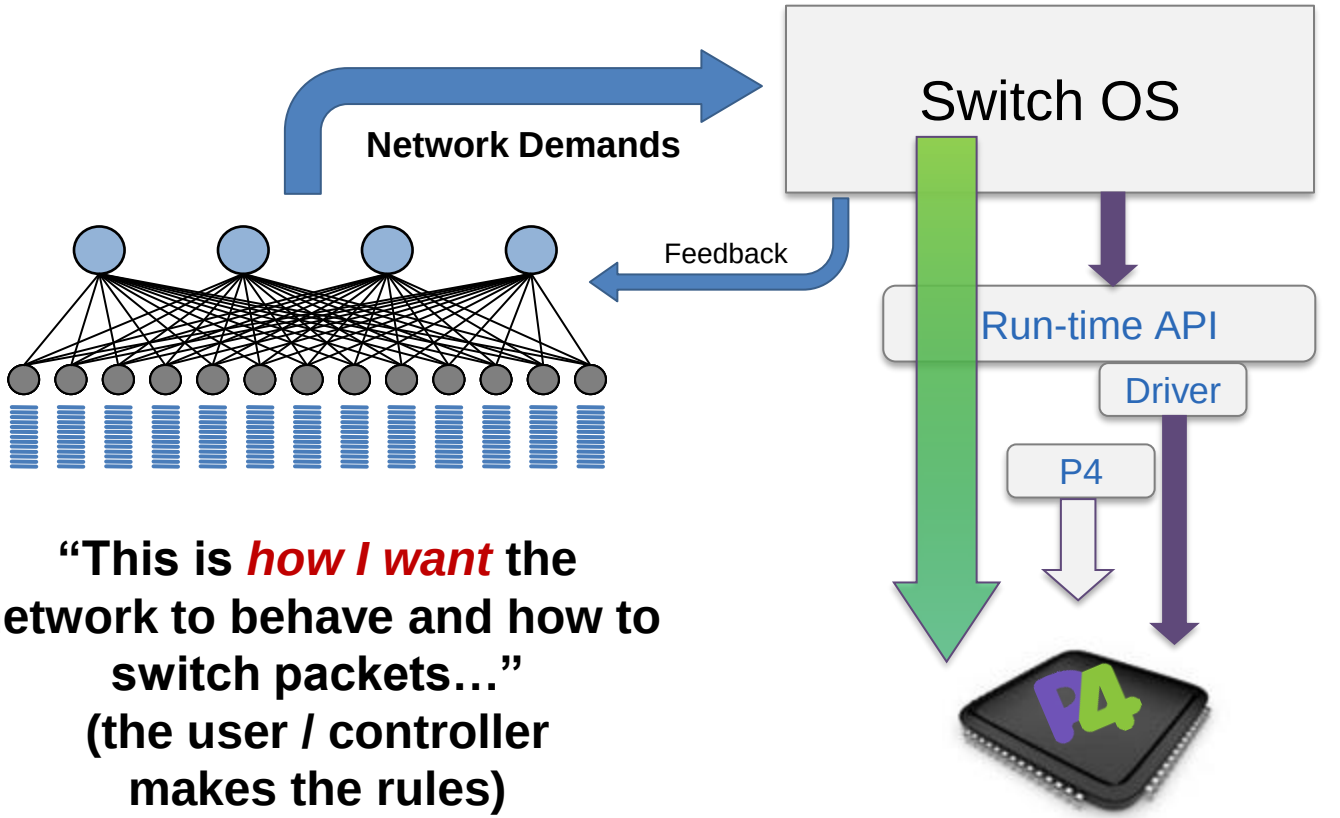
RCA with P4-Enabled 5G Network

Why P4?



"This is *how I want* the network to behave and how to switch packets…"
(the user / controller makes the rules)
Data Plane Programming

P4 Programmable Device

P4 approach

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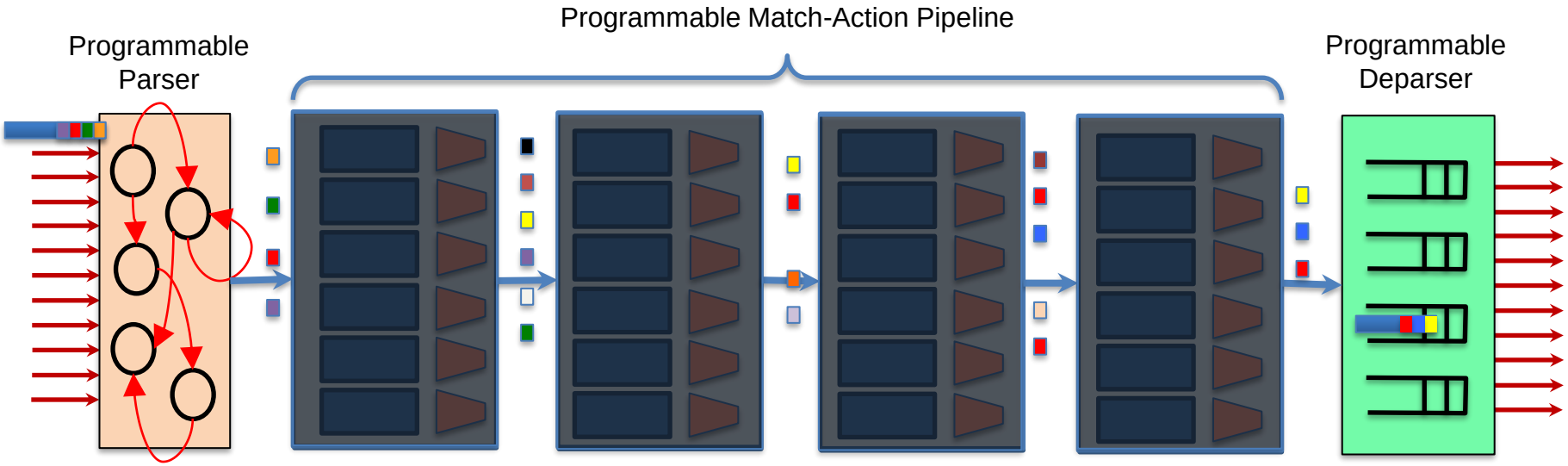
RCA with P4-Enabled 5G Network

Why P4?

- Packet is parsed into individual headers (parsed representation)
- Headers and intermediate results can be used for matching and actions
- Headers can be modified, added or removed
- Packet is deparsed (serialized)



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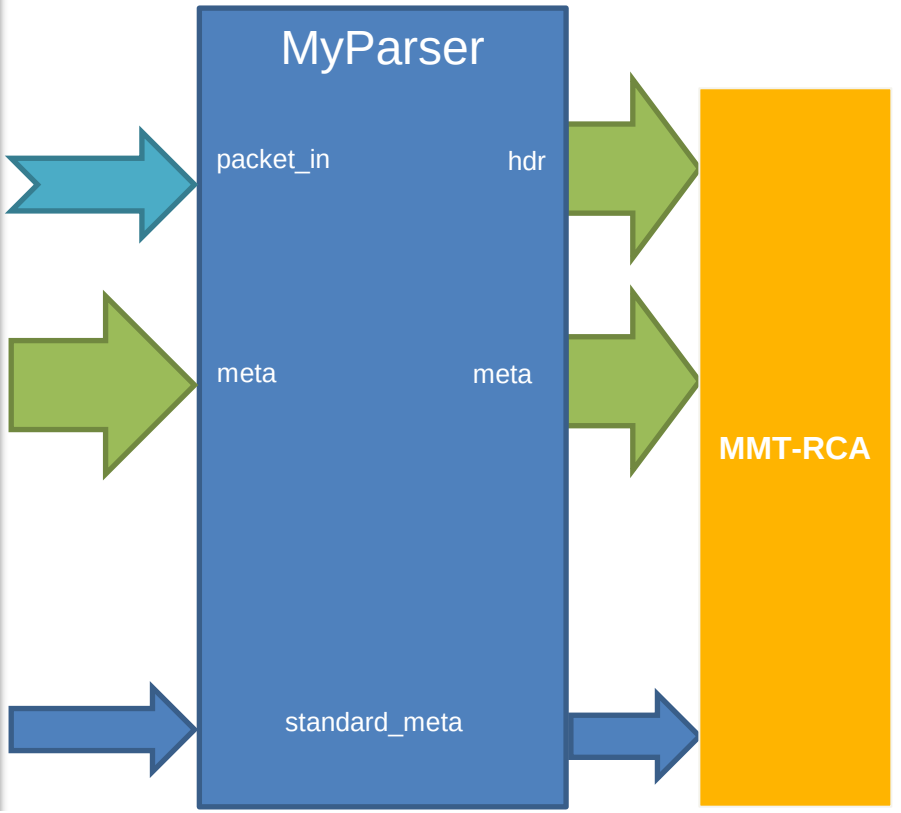
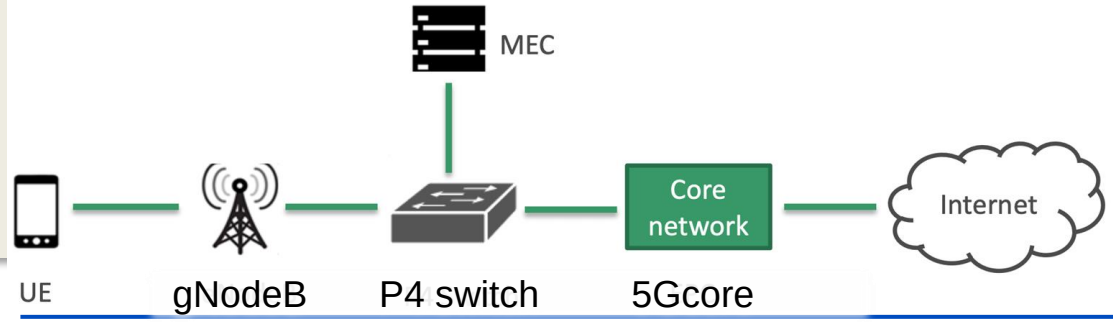
RCA with P4-Enabled 5G Network

```
/* From core.p4 */
extern packet_in {
  void extract<T>(out T hdr);
  void extract<T>(out T variableSizeHeader,
                  in bit<32> variableFieldSizeInBits);
  T lookahead<T>();
  void advance(in bit<32> sizeInBits);
  bit<32> length();
}
/* User Program */
parser MyParser(packet_in packet,
                out headers hdr,
                inout metadata meta,
                inout standard_metadata_t std_meta) {

  state start {
     packet.extract(hdr.ethernet);
     transition accept;
  }

}
```





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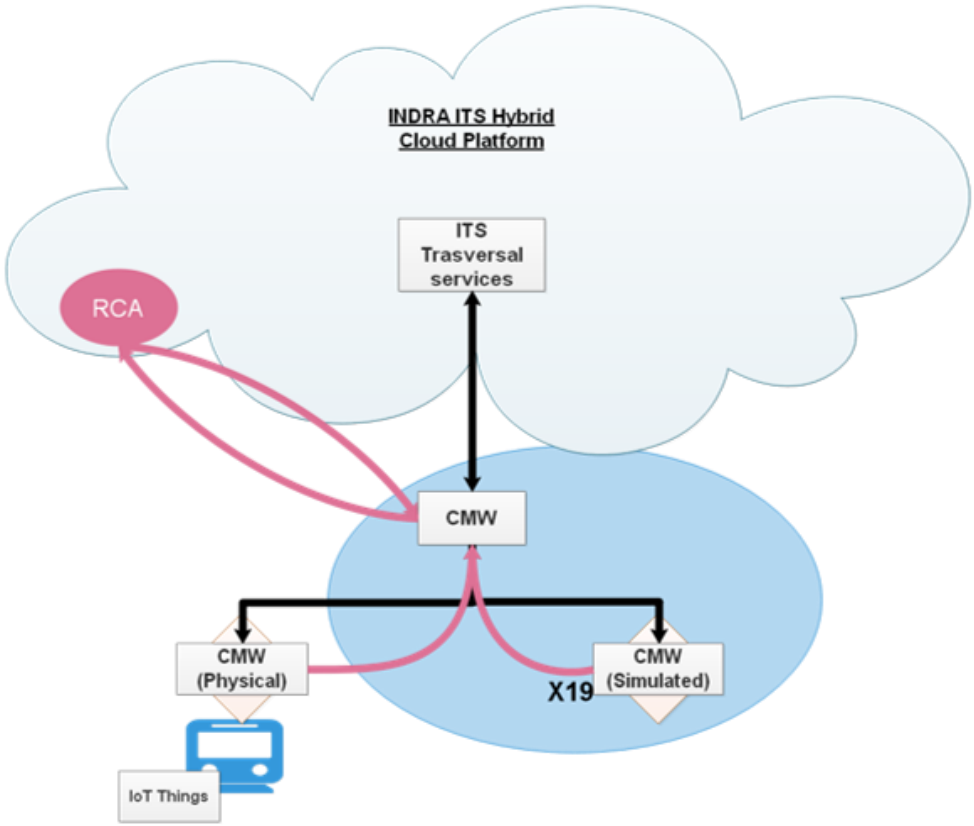
Demo

- RCA analyzes in real time possible CMWs status.
  - **Failures 1:** Gateways are disconnected.
  - **Failures 2:** Services are disconnected.
- RCA tool provides a report in the ITS Safety internal protocol format.



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Demo

Thank you for your attention!

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