Use Case for P4 Programmability by Tenants of Future Mobile Virtual Networks

https://tools.ietf.org/html/draft-defoy-coinrg-p4-by-tenants-in-mobile-nw-00

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Programming Mobile VNs by Tenants

- This draft describes a use case for COIN
  - A P4 programming interface is provided to tenants of (industrial/enterprise/home) virtual networks
  - P4 is used as **an external interface** by the operator of the underlying network (e.g., a mobile network operator)

- Virtual network support for P4 has been discussed in COINRG [1]
  - A use case can help **looking more broadly at the impact** of data plane programming of virtual networks (e.g., w/r to the operation of the underlying network, to devices mobility…)

- 5GLAN is used as a base for the use case
  - It has a well-documented architecture
  - This is for study only at this point, there is no related work in 3GPP

[1] Stoyanov, R. and N. Zilberman, "MTPSA: Multi-Tenant Programmable Switches", ACM P4 Workshop in Europe (EuroP4'20) , 2020, https://eng.ox.ac.uk/media/6354/stoyanov2020mtpsa.pdf

Rationale for P4 Programming for Mobile VNs

- Data plane programming can be used by tenants to control increasingly complex virtual mobile networks
  - Cope with the evolution of future mobile networks towards more and more customized environment

- Enable interchangeable or portable programs for VNs over fixed physical networks, datacenters, and mobile networks
  - Use the same tools, mix and match portions of physical/DC/mobile network segments

Use Case: High Level Description

- A 5GLAN connects VN group member devices (UE1…UE4 and attached devices Device1 and Device2)

- A 5GLAN tenant can be an industrial or enterprise network operator, a homeowner

- The mobile network appears as a logical switch to the tenant

- The tenant deploys P4 programs in the logical switch and in other P4 switches

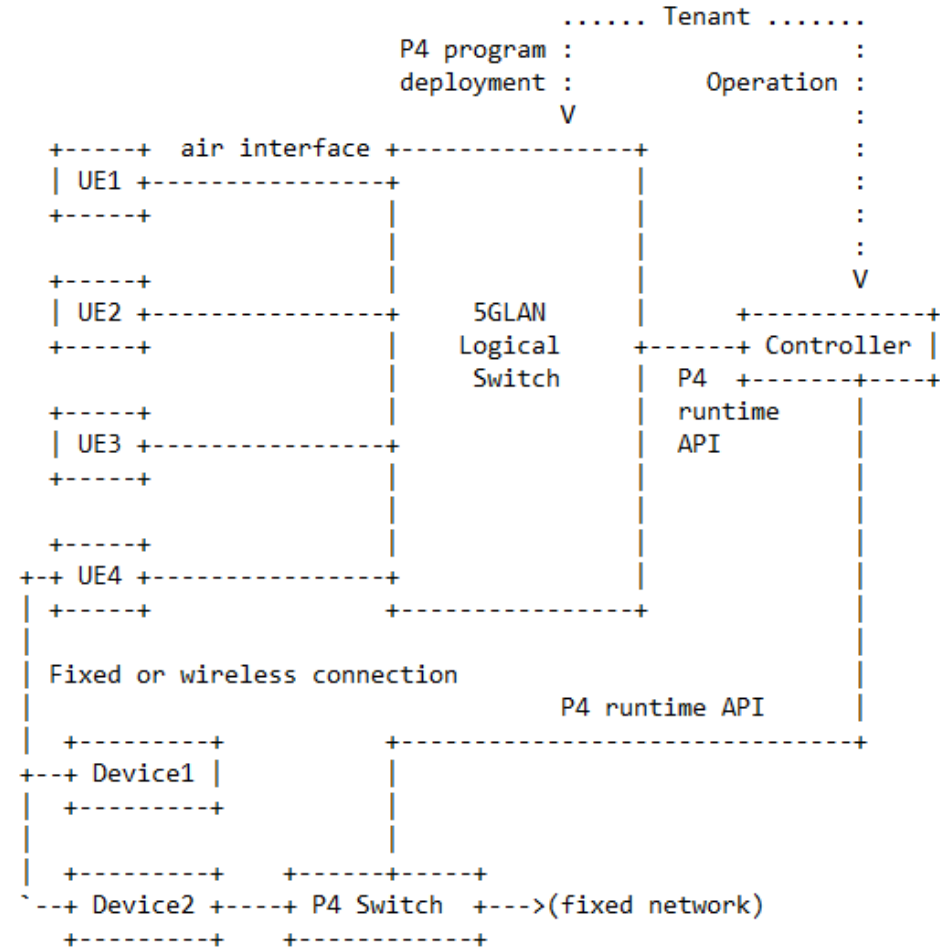- The tenant can also operate a controller, which communicates with the switches using the P4 runtime API

```
                              ...... Tenant .......
               P4 program :                        :
               deployment :         Operation :
                          V                         :
  +-----+  air interface +---------------+          :
  | UE1 +---------------+               |           :
  +-----+               |               |           :
                        |               |           V
  +-----+               |               |     +-----------+
  | UE2 +---------------+  5GLAN        |     +------+ Controller |
  +-----+               |  Logical  +------+ P4  +-------+----+
                        |  Switch       |     | runtime   |
  +-----+               |               |     | API       |
  | UE3 +---------------+               |     |           |
  +-----+               |               |     |           |
                        |               |     |           |
  +-----+               |               |     |           |
+-+ UE4 +---------------+               |     |           |
| +-----+                   +---------------+ |           |
|                                             |           |
| Fixed or wireless connection                |           |
|                                         P4 runtime API  |
|  +---------+        +-------------------------------+
+--+ Device1 |        |
|  +---------+        |
|                     |
|  +---------+    +------+-----+
`--+ Device2 +----+ P4 Switch  +--->(fixed network)
   +---------+    +------------+

       Figure 1: Use Case for P4 Programming by a 5GLAN Customer
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Use Case: How P4 Programs are Deployed

- A P4 program for the 5GLAN logical switch needs to be deployed on physical node(s)
  - Possible locations for P4 program fragments are anchor UPFs and mobile devices (UEs)

- There are 3 types of 5GLAN data paths:
  - UE1-UE2 through a local switch component in UPF1
  - UE1-UE3 through a tunnel between UPF1 and UPF2.
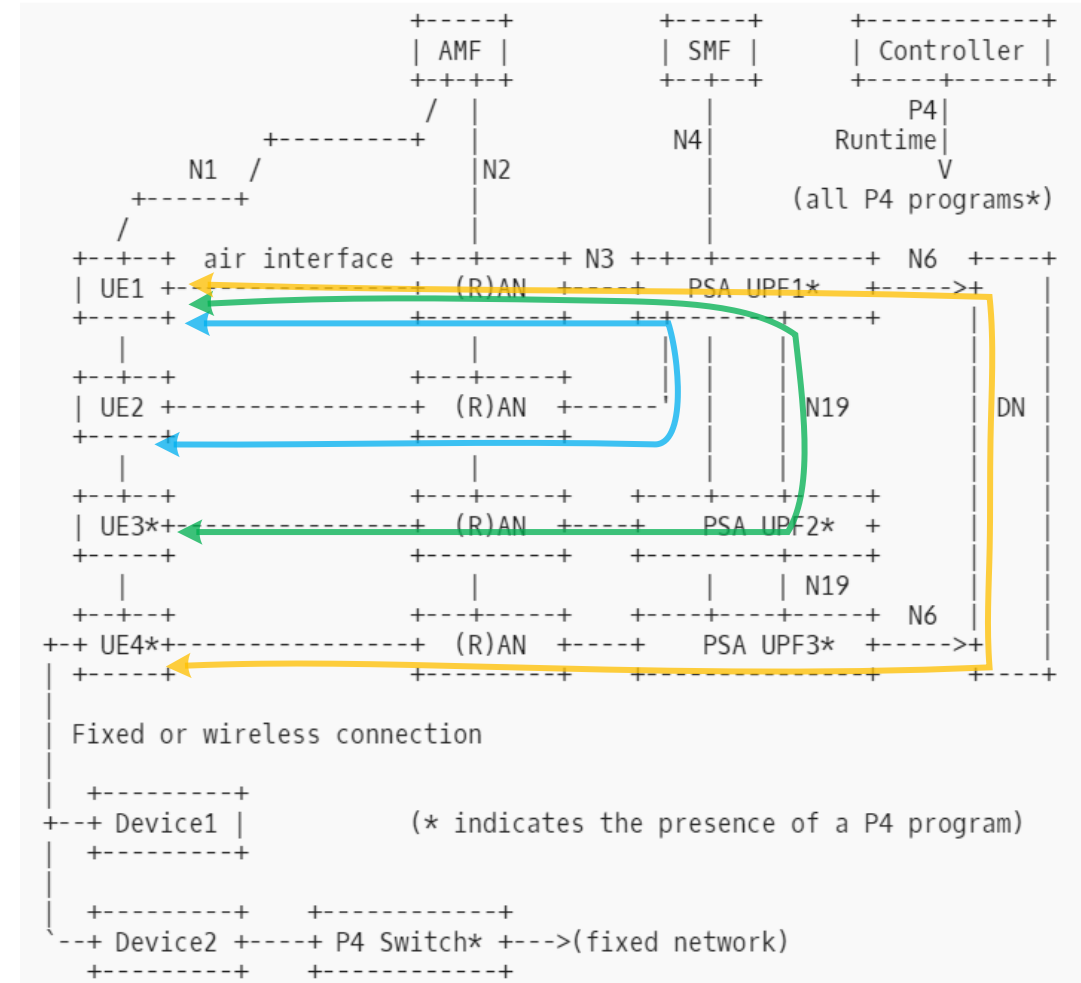 - UE1-UE4 through an external Data Network

Figure 2: Use Case Details

Requirements / Opportunities & Research Questions

1. Splitting/Distribution
   - Data paths are distributed, with no central node in the general case
     - [1] studies distribution of P4 programs

2. Multi-Tenancy Support
   - Multiple 5GLANs can share the same infrastructure
     - MTPSA and other studies on virtual network data plane programming provide useful solutions in this space

3. Mobile Network Awareness
   - A P4 program could interact with the mobile network system

4. Mobility Support
   - P4 programs should follow the data flow when mobile devices move to other attachment points

5. Security
   - Security risks include overusing network resources, injecting traffic, unauthorized access of traffic

[1] draft-hsingh-coinrg-reqs-p4comp, "Requirements for P4 Program Splitting for Heterogeneous Network Nodes"

Next Steps

- Summary: data plane programming is a way for tenants (e.g., industrial/enterprise/home network operators) to control virtual networks over mobile, DC and fixed underlying networks

  - This work is a starting point, using P4 for data plane programming, a Mobile Network as underlying network, and 5GLAN as virtualization technology

- Is this use case appropriate for COINRG?

- Please let me know if you are interested in collaborating on this use case