P7 (P4 Programmable Patch Panel): an instant 100G emulated network testbed in a pizza box

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Agenda

• P7 overview
• Link characteristics
• Generated files
• Demo
• Topology definition and generation
• Challenges
• Future of P7
## Link characteristics and implementation approaches

| Link Connectivity | Jumper cabling with/without internal Tag  
|                  | Intern Recirculation + internal Tag  
| Latency [ms]     | Internal timer + recirculation  
|                  | TM + Pipelines recirculation  
| Jitter [ms]      | Hash to determine recirculation times  
|                  | Lookup table with mathematical functions  
| Packet loss [%]  | Random function to determine the probability to discard packets  
|                  | Realistic packet loss model  
| Re-ordering      | TNA TM features  
|                  | Targeted probabilistic packet (ID) recirculation within a flow  
| Bandwidth        | Rate limit TNA TM feature  
|                  | Port configuration and mapping  

Network topology

Diagram showing network topology with switches SW1, SW2, SW3, SW4, SW5, and hosts H1, H2, H3, H4.
P7 topology
Generated files

- P4 program
- Interfaces configuration
- TM
- Tables information

User needs to define the port distribution
DEMO
**Link characteristics**

- **Physical Topology**
  - Direct link

- **Emulated Topology**
  - Device in the middle

- **Emulated Topology**
  - Various devices in the middle
Link characteristics

- **Direct link**
  - Physical Topology
  - Emulated Topology

- **Device in the middle**
  - Emulated Topology

- **Various devices in the middle**
  - Emulated Topology

- **P7 vlan**
  - other vlans
  - no P7 processing
from src.data import *

topo = generator('main')

# Stratum ip:port
topo.addstratum("192.168.119.238:9550")

# Recirculation port default 68
topo.addrec_port(68)

# addhost(name, port, B_P, speed bps, AU, FEC, vlan)
topo.addhost("h1", 19, 20, 100000000000, "False", "False", 1920)
topo.addhost("h2", 20, 28, 100000000000, "False", "False", 1920)

# addlink(node1, node2, bw, pkt_loss, latency)
topo.addlink("h1", "h2", 100000000000, 0, 5)

topo.generate_chassis()
topo.generate_p4rt()
topo.generate_p4code()
topo.generate_graph()
Direct link

donode 1
donode 2
link bw
latency
pkt loss

```python
from src.data import *

topo = generator('main')

# Stratum ip:port
topo.addstratum("192.168.110.238:9559")

# Recirculation port default 68
topo.addrec_port(68)

# addhost(name, port, D, P, speed, bps, AU, FEC, vlan)
topo.addhost("h1", 19, 20, 10000000000, "False", "False", 1920)
topo.addhost("h2", 20, 28, 100000000000, "False", "False", 1920)

# addlink(node1, node2, bw, pkt loss, latency)
topo.addlink("h1", "h2", 100000000000, 0.15)

topo.generate_chassis()
topo.generate_p4rt()
topo.generate_p4code()
topo.generate_graph()
```
from src.data import *

topo = generator('main')

# Stratum ip:port
topo.addstratum("192.168.110.238:9559")

# Recirculation port default 68
topo.addrec_port(68)

# addswitch(name)
switch_name = "sw1"

# addhost(name, port, D_P, speed_bps, AU, FEC, vlan)

# include the link configuration

# addlink(node1, node2, bw, pkt_loss, latency)

# generate Chassis

topo.generate_chassis()

topo.generate_p4rt()

topo.generate_p4code()

topo.generate_graph()}
Future of P7

- Address open challenges
  - Topology Size
  - Buffers consumption
- New features
  - Packet generation for background/congestion traffic
  - In-band Network Telemetry (INT)
  - Dynamic link behaviors (e.g., pkt loss patterns)
  - Trace base link characteristics
- Open source repository and community
- Embed into disaggregated network testbed initiatives
P7 repository

Available soon at:

https://github.com/intrig-unicamp/p7
References / Related Work

- TurboNet: Faithfully Emulating Networks with Programmable Switches. [Link Code](http://mininet.org/)
- CrystalNet: Faithfully Emulating Large Production Networks. [Link](http://mininet.org/)
- BNV: Enabling Scalable Network Experimentation through Bare-metal Network Virtualization. [Link](http://mininet.org/)
Thank You

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