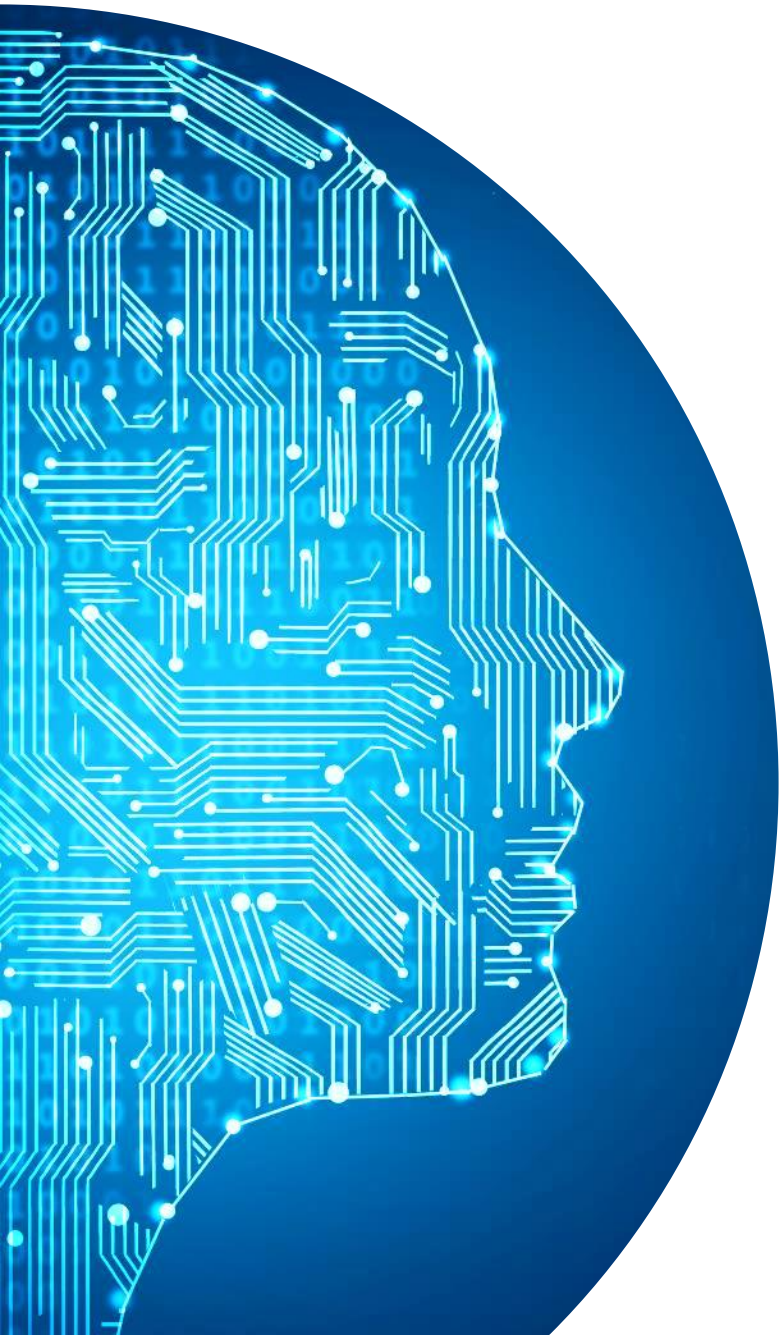
TeraFlow SDN by ETSI

Future Work

Georgios P. Katsikas, Panagiotis Famelis

ETSI TFS – Hackfest #3, October 17, 2023

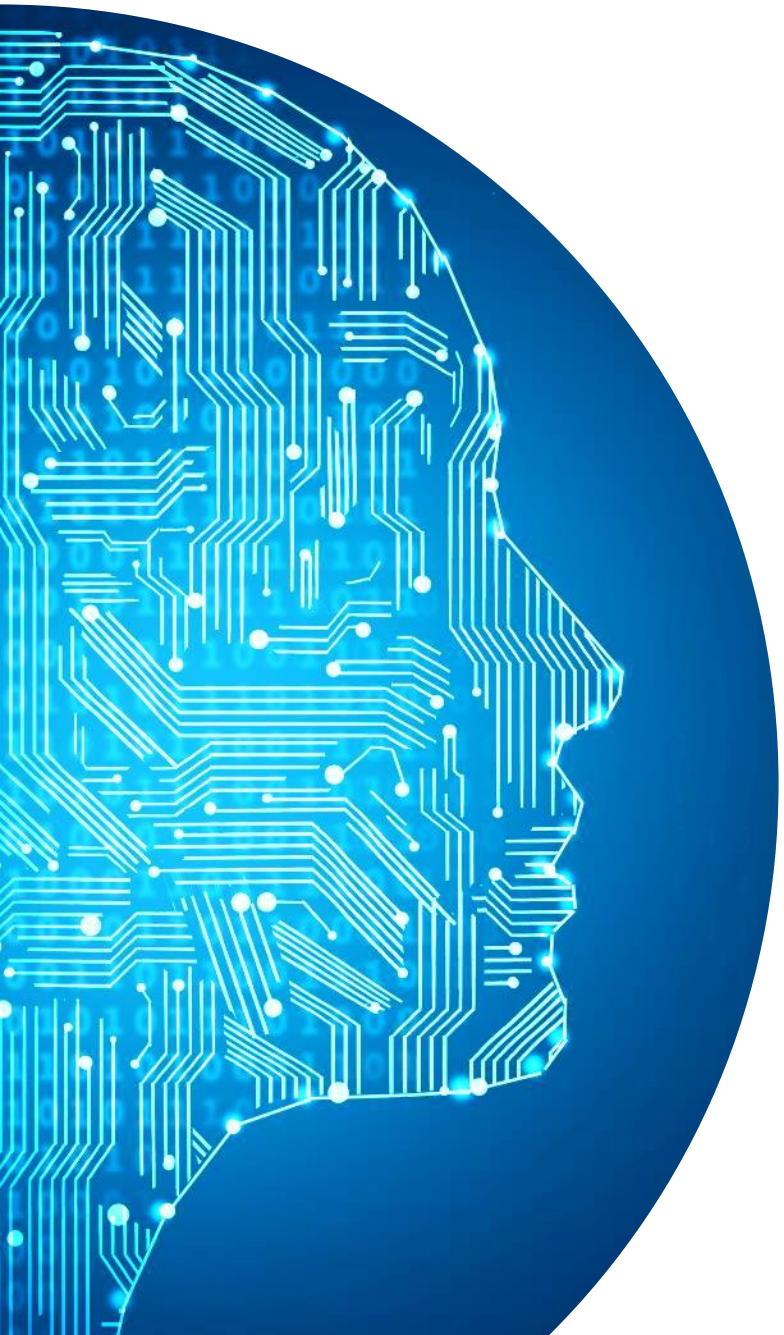


Agenda

- Introduction to In-band Network Telemetry (INT)
  - INT Terminology
  - INT Approaches
    - INT XD
    - INT MX
    - INT MD
  - What to monitor with INT
- Required extensions for ETSI TFS to support INT

TeraFlow SDN

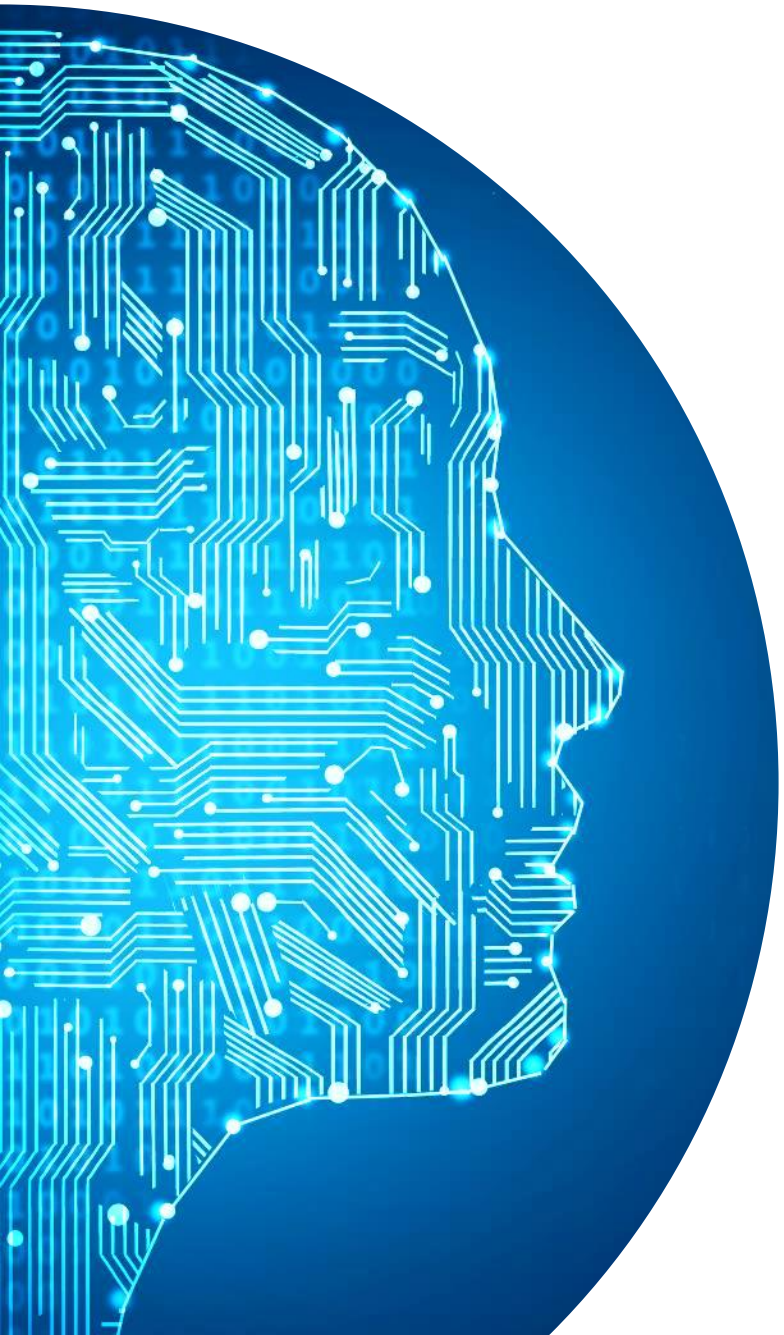
Introduction to In-band Network Telemetry (INT)



Intro to In-Band Network Telemetry

TeraFlow SDN

Q: What is In-band Network Telemetry?



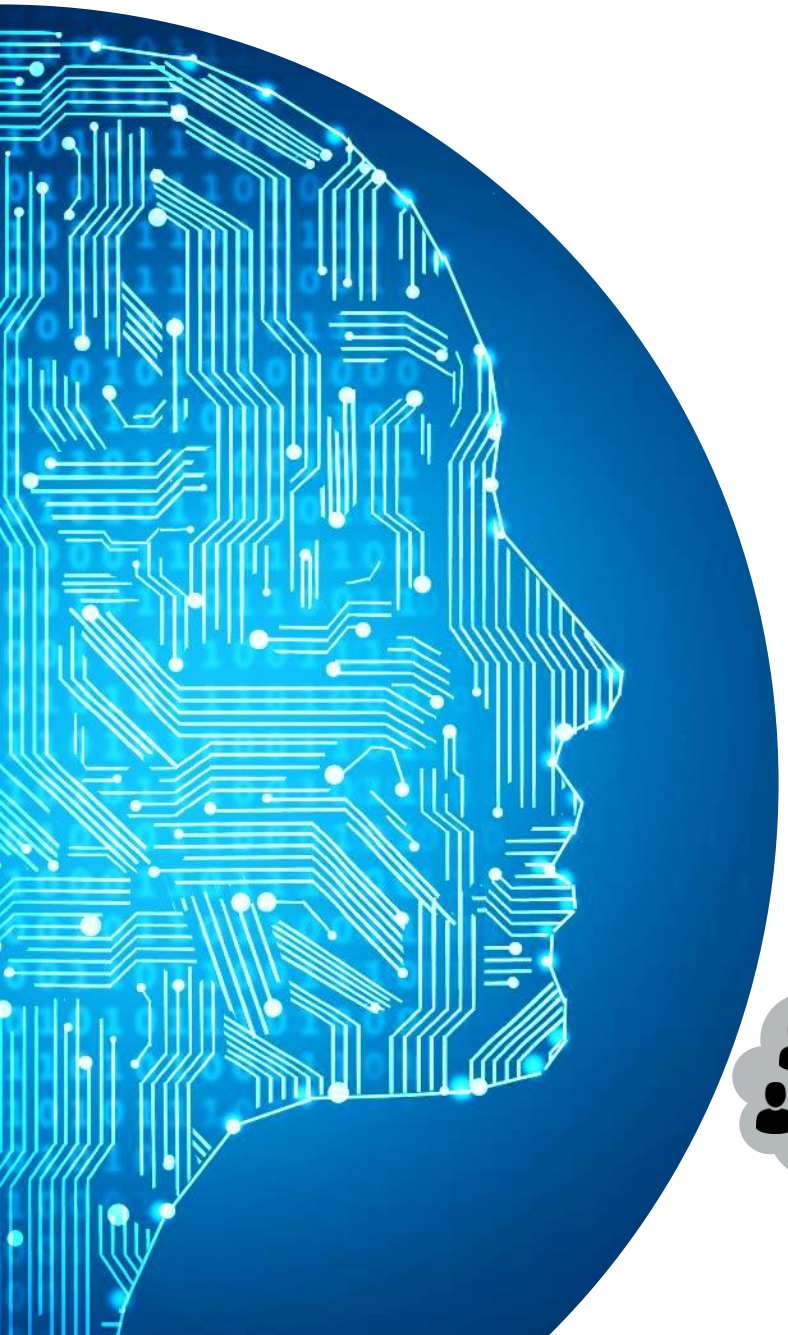
Intro to In-Band Network Telemetry

TeraFlow SDN

Q: What is In-band Network Telemetry?

A: A framework designed to allow the collection and reporting of network state, by the data plane, without requiring intervention or work by the control plane

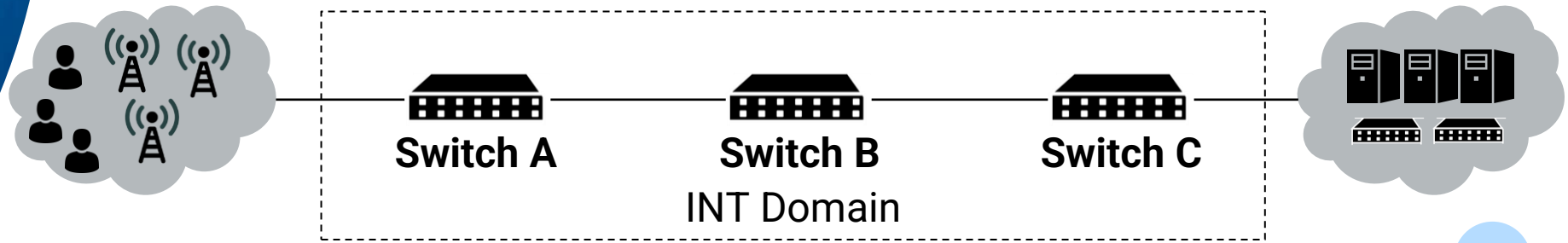
INT Terminology



INT- Terminology

INT Domain

A set of INT nodes that are interconnected, under the same administration. This applies for achieving interoperability for INT nodes from different vendors in the same INT Domain

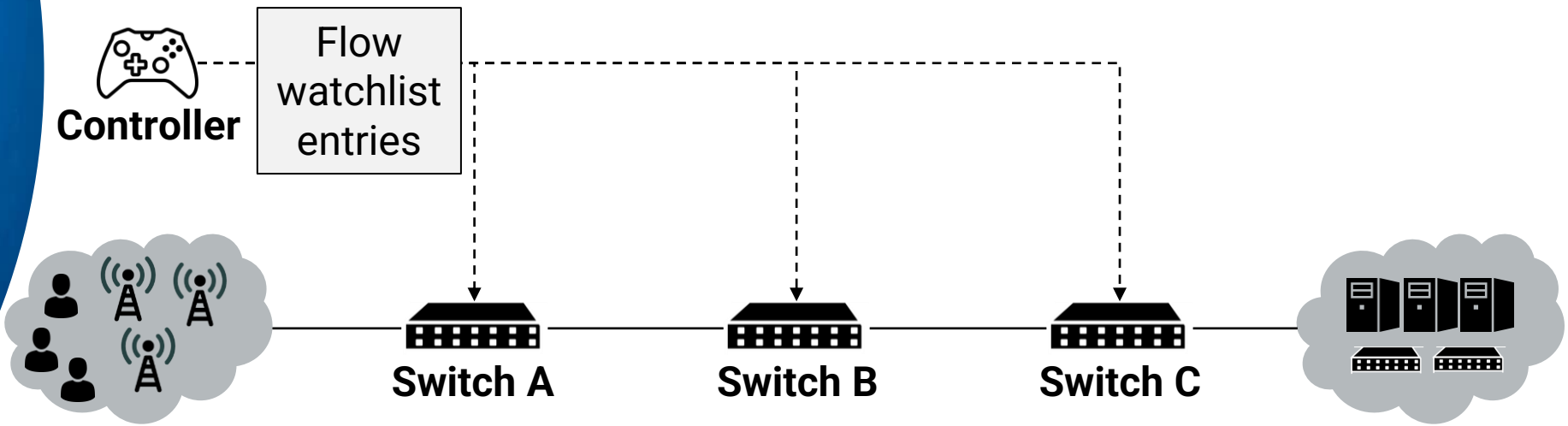


INT- Terminology

TeraFlow SDN

Flow Watchlist

A pipeline table that matches on packet headers. Packets that have the same values on selected header fields belong to the same flow. On each matched flow, INT instructions are inserted or applied.

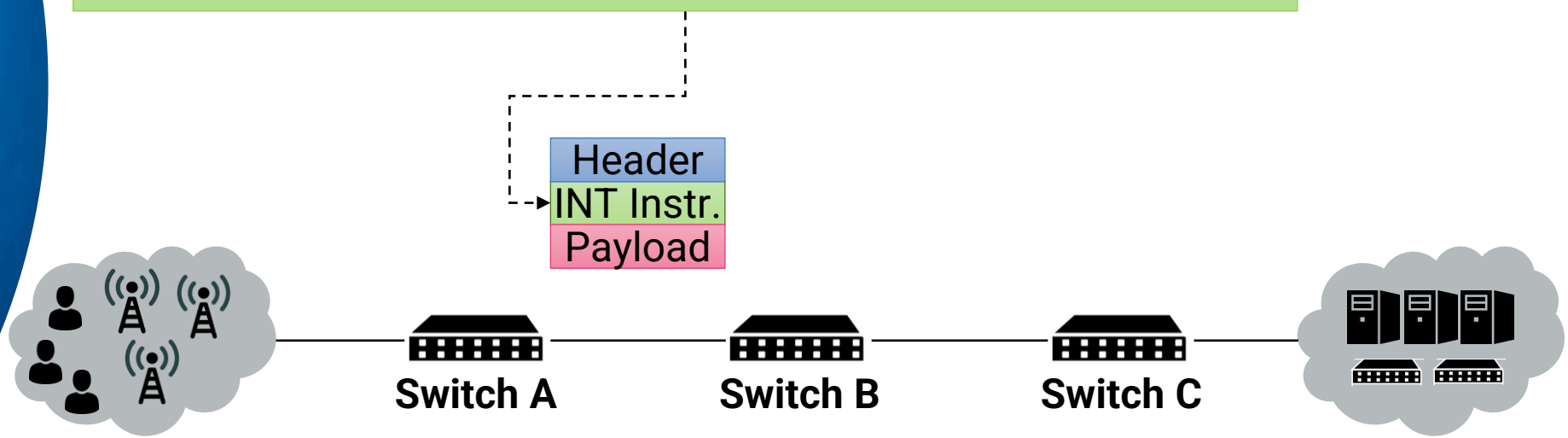


INT- Terminology

TeraFlow SDN

INT Instructions

Instructions that denote what INT metadata will be collected at each INT node. Instructions can be configured in two ways: (i) at each INT-capable node's Flow Watchlist or (ii) directly written into the INT Header.

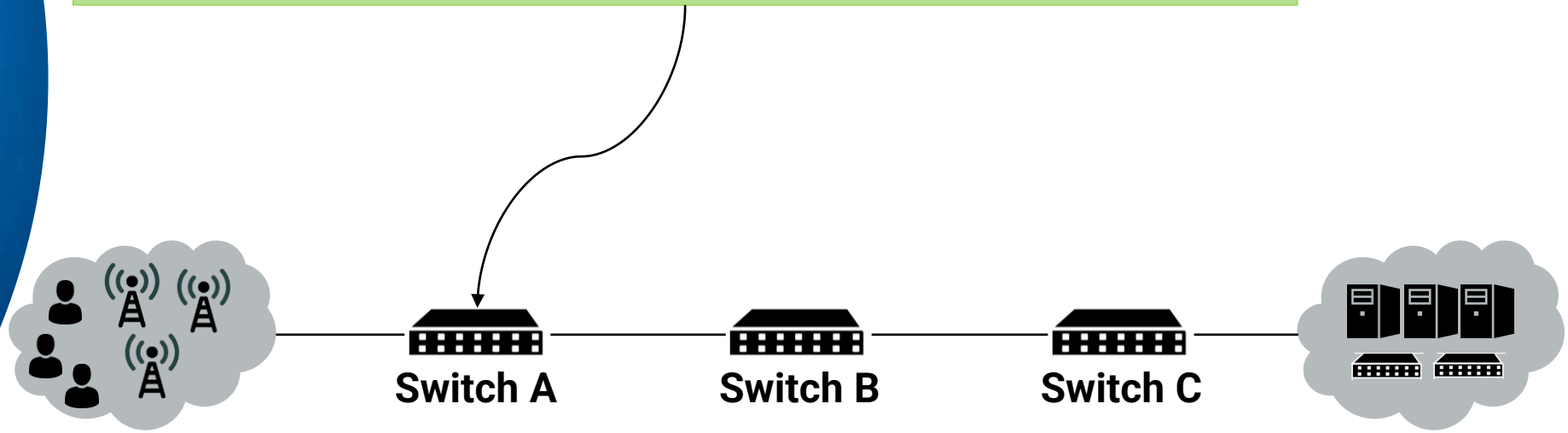


INT- Terminology

TeraFlow SDN

INT Source Node

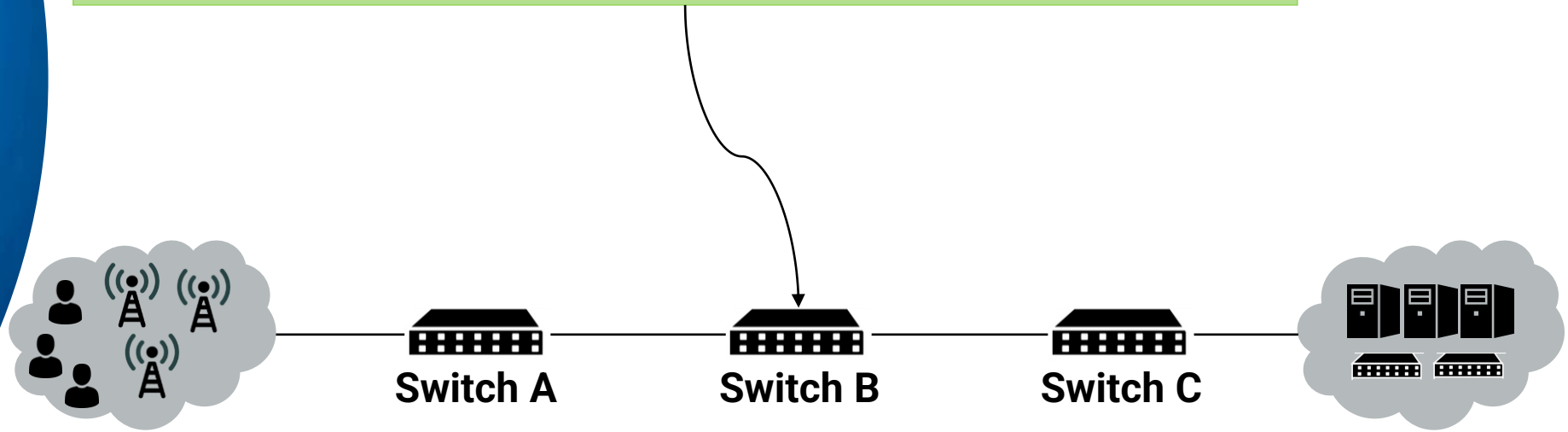
Creates INT Headers and inserts them into packets. The packets are then sent by this trusted entity. To select the flows in which INT Headers are inserted, a Flow Watchlist is configured



INT- Terminology

INT Transit Hop

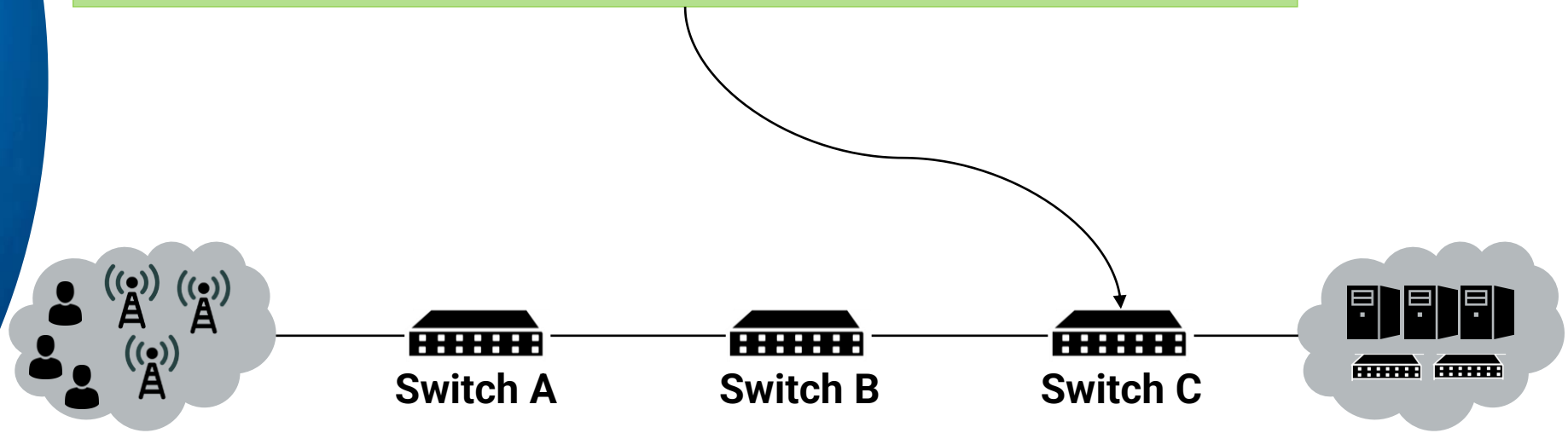
Collects metadata from the data plane. This information is based on the INT Instructions. Metadata can be directly exported to the monitoring system or embedded into the INT header and forwarded to the next node



INT- Terminology

INT Sink

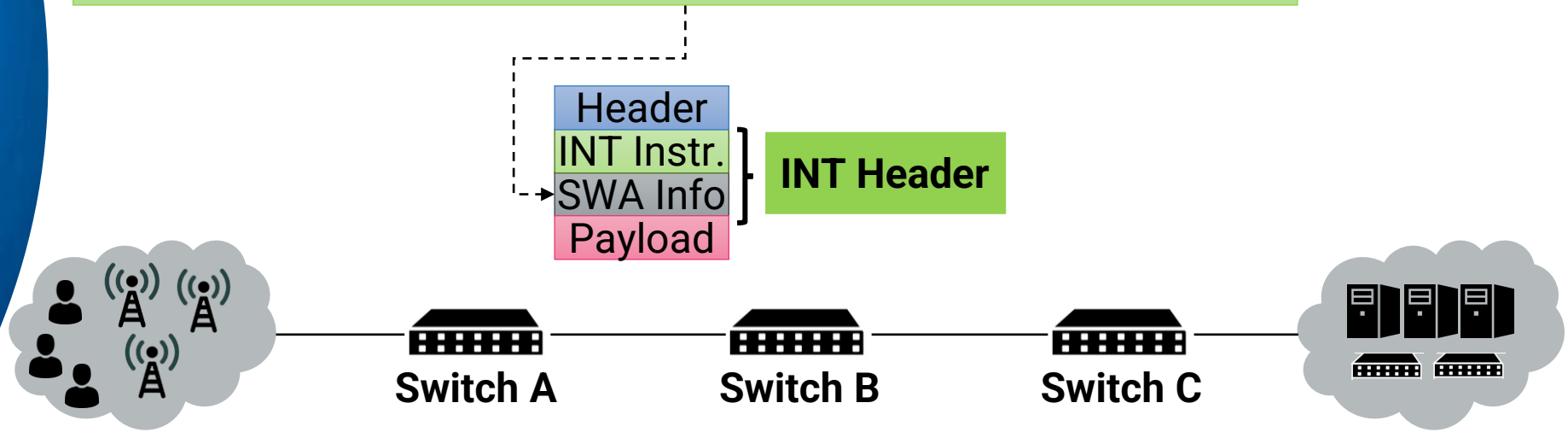
Extracts INT Headers and collects path state from them. Once this is done, this node is responsible for removing the INT Headers to make INT transparent to the upper layers. Exports the collected information to a monitoring system



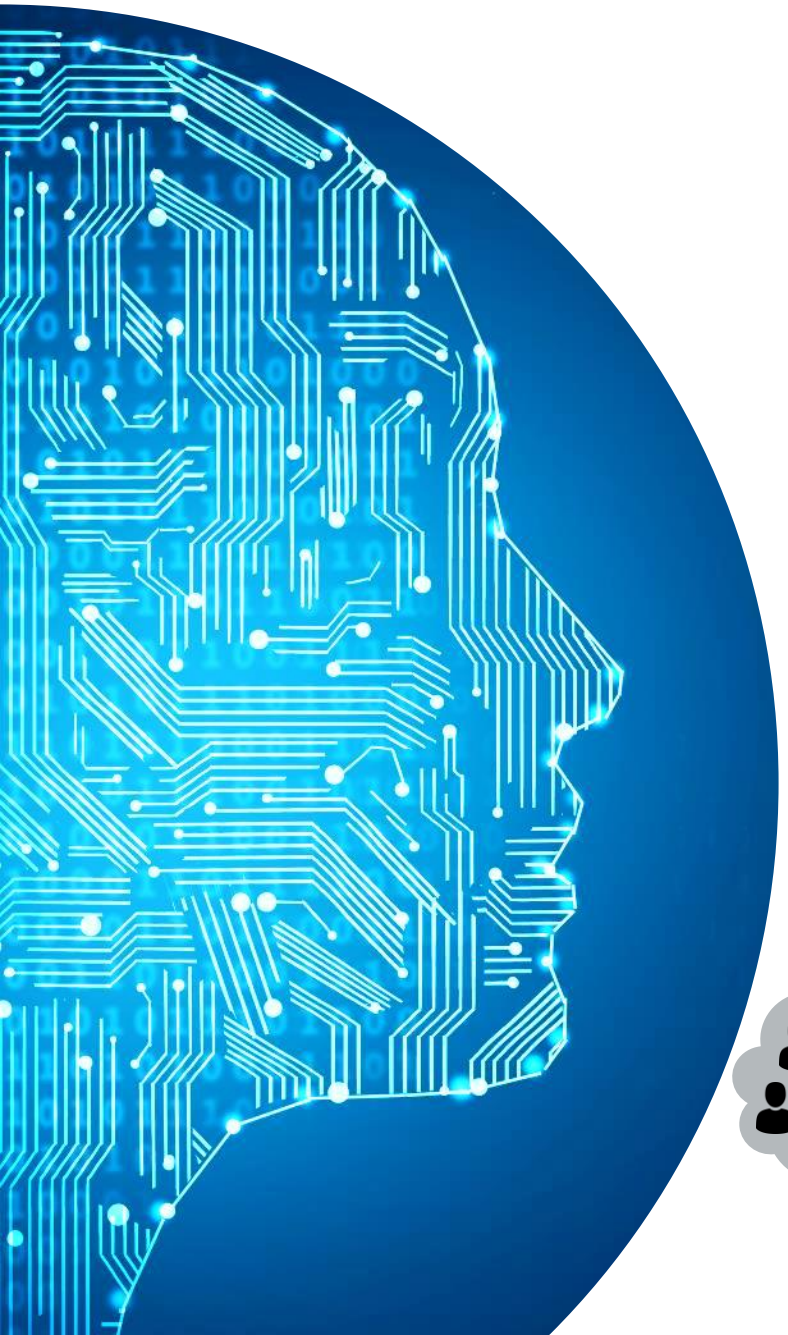
INT- Terminology

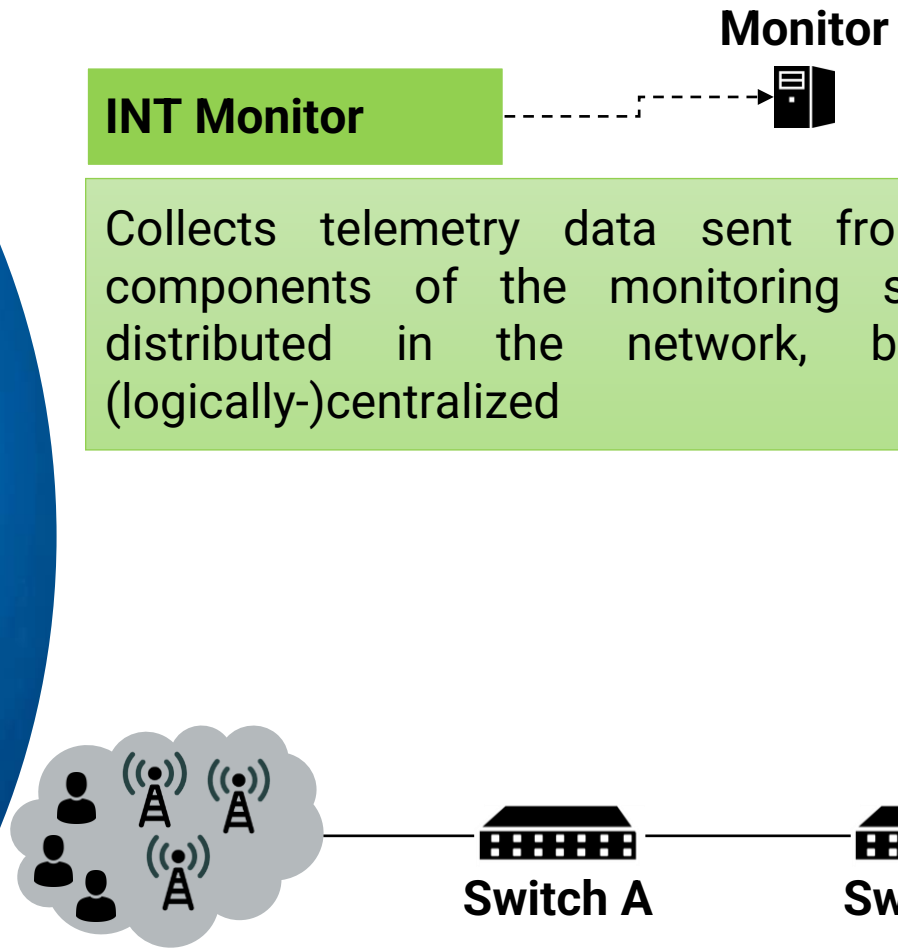
INT Metadata

This is the information inserted into an INT header from an INT Source or an INT Transit Hop



INT- Terminology





Collects telemetry data sent from different devices. The components of the monitoring system can be physically distributed in the network, but the main logic is (logically-)centralized

INT Approaches

INT Approaches (based on P4 App WG)

TeraFlow SDN

In-band Network Telemetry (INT)

INT Approaches (based on P4 App WG)

TeraFlow SDN

In-band Network Telemetry (INT)

1

EXport Data (INT-XD)

Each node exports metadata based on Watchlist config (aka postcards)

No packet modifications

INT Approaches (based on P4 App WG)

TeraFlow SDN

In-band Network Telemetry (INT)

1 EXport Data (INT-XD)	2 EMbed Instruct(X)ions (INT-MX)
Each node exports metadata based on Watchlist config (aka postcards)	Only instructions are embedded in the packet. Each node exports metadata. (aka IOAM immediate export)
No packet modifications	Limited packet modifications (Instructions only)

INT Approaches (based on P4 App WG)

TeraFlow SDN

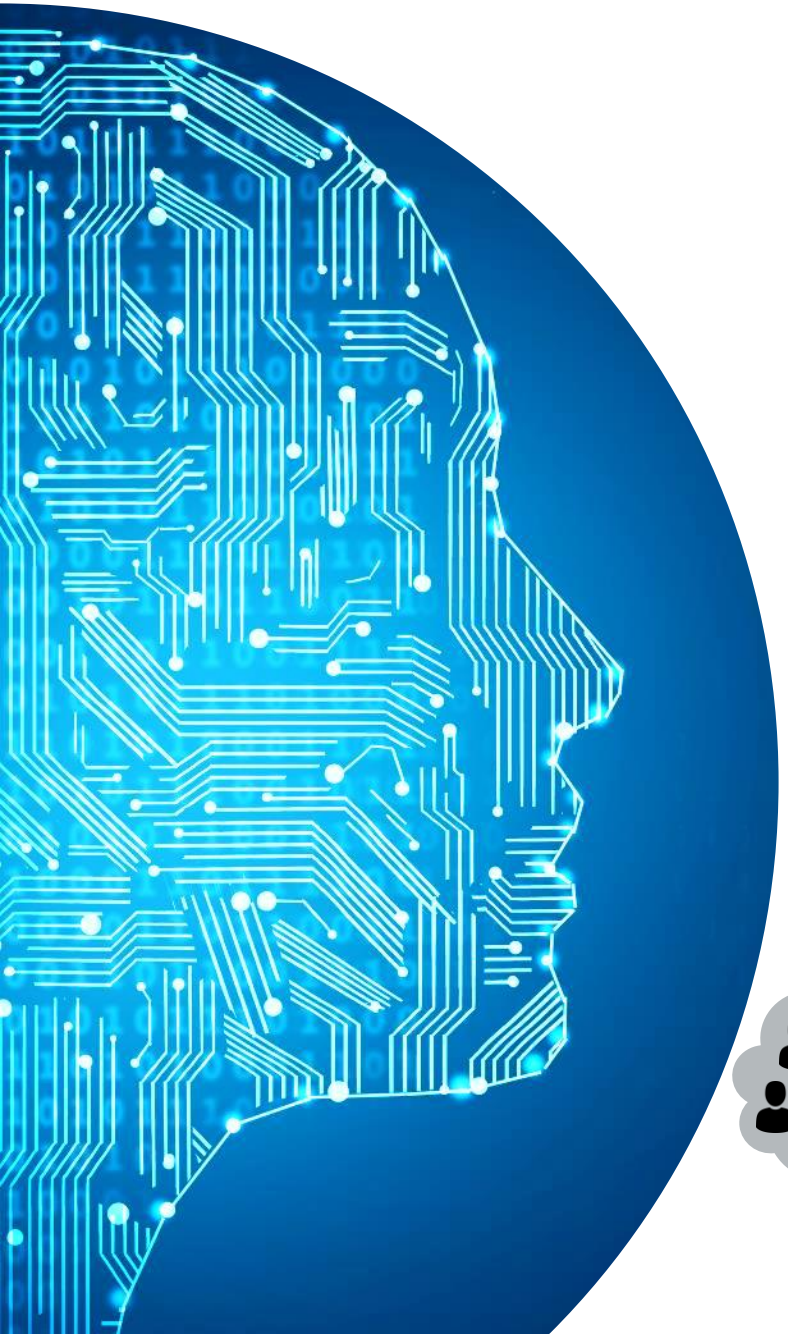
In-band Network Telemetry (INT)

1 EXport Data (INT-XD)	2 EMbed Instruct(X)ions (INT-MX)	3 EMbed Data (INT-MD)
Each node exports metadata based on Watchlist config (aka postcards)	Only instructions are embedded in the packet. Each node exports metadata. (aka IOAM immediate export)	Instructions and metadata are embedded in the packet. Export at the sink node. (aka classic INT)
No packet modifications	Limited packet modifications (Instructions only)	Packet modifications (Instructions & Metadata)

INT EXport Data (XD)

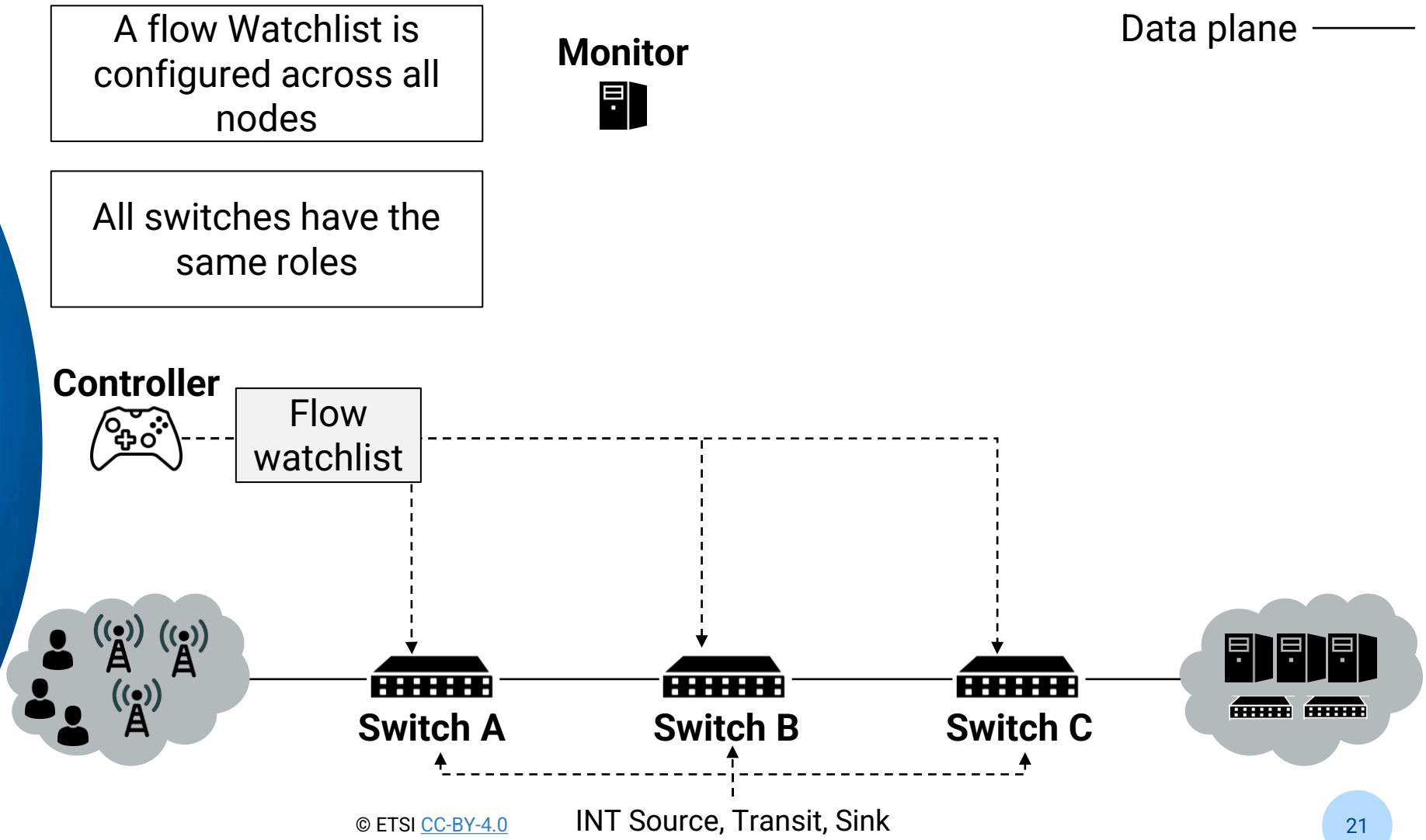
INT- EXport Data (XD)

TeraFlow SDN

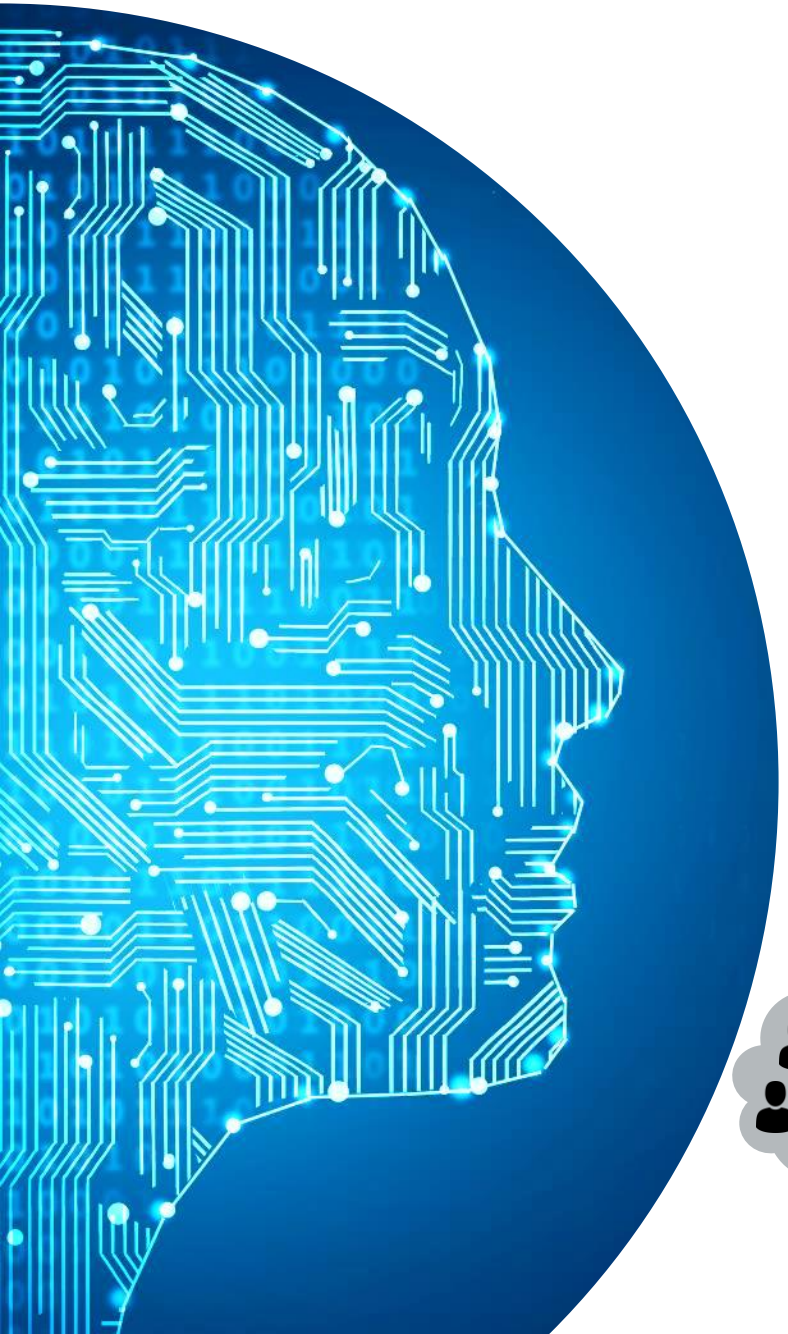


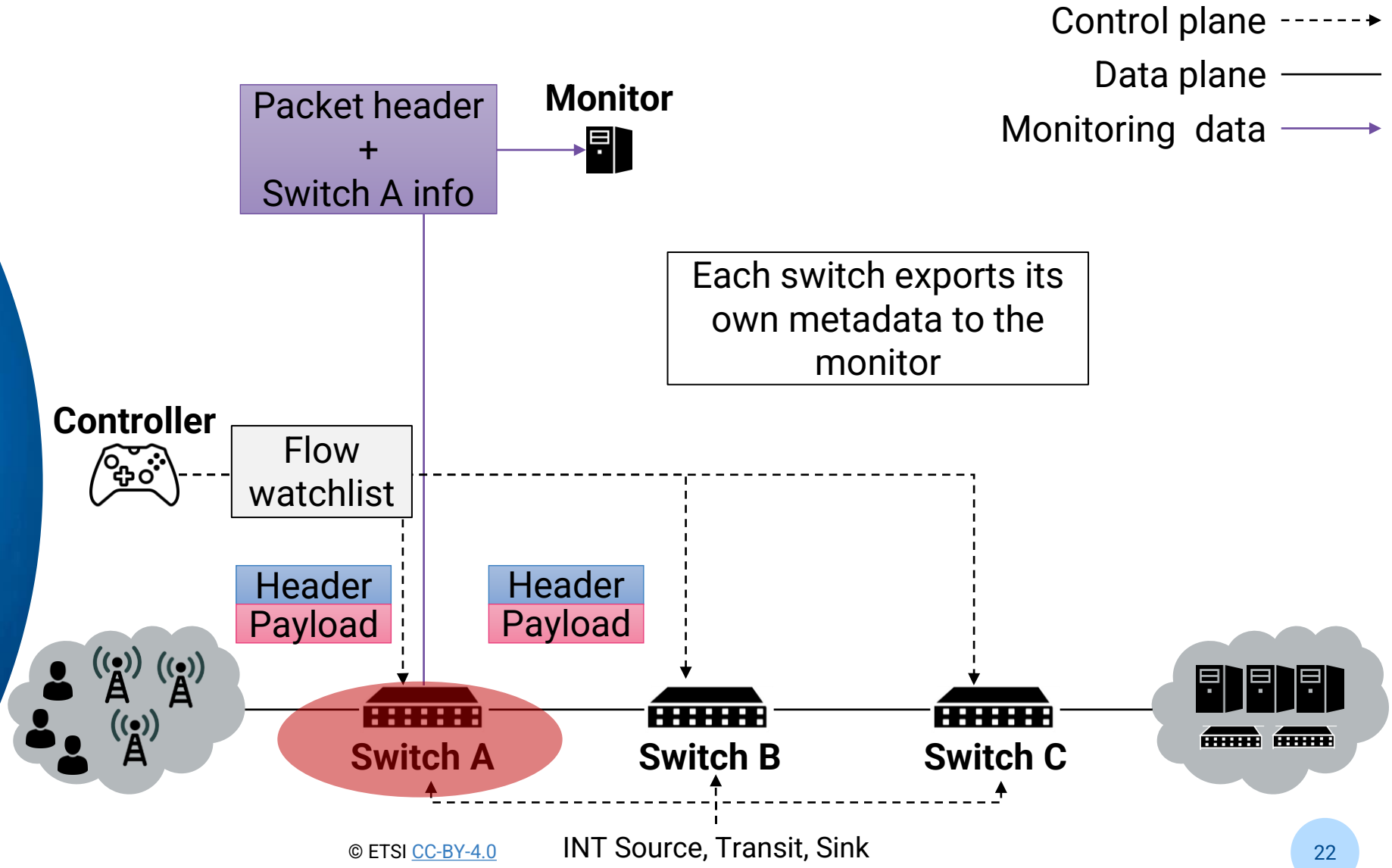
A flow Watchlist is configured across all nodes

All switches have the same roles

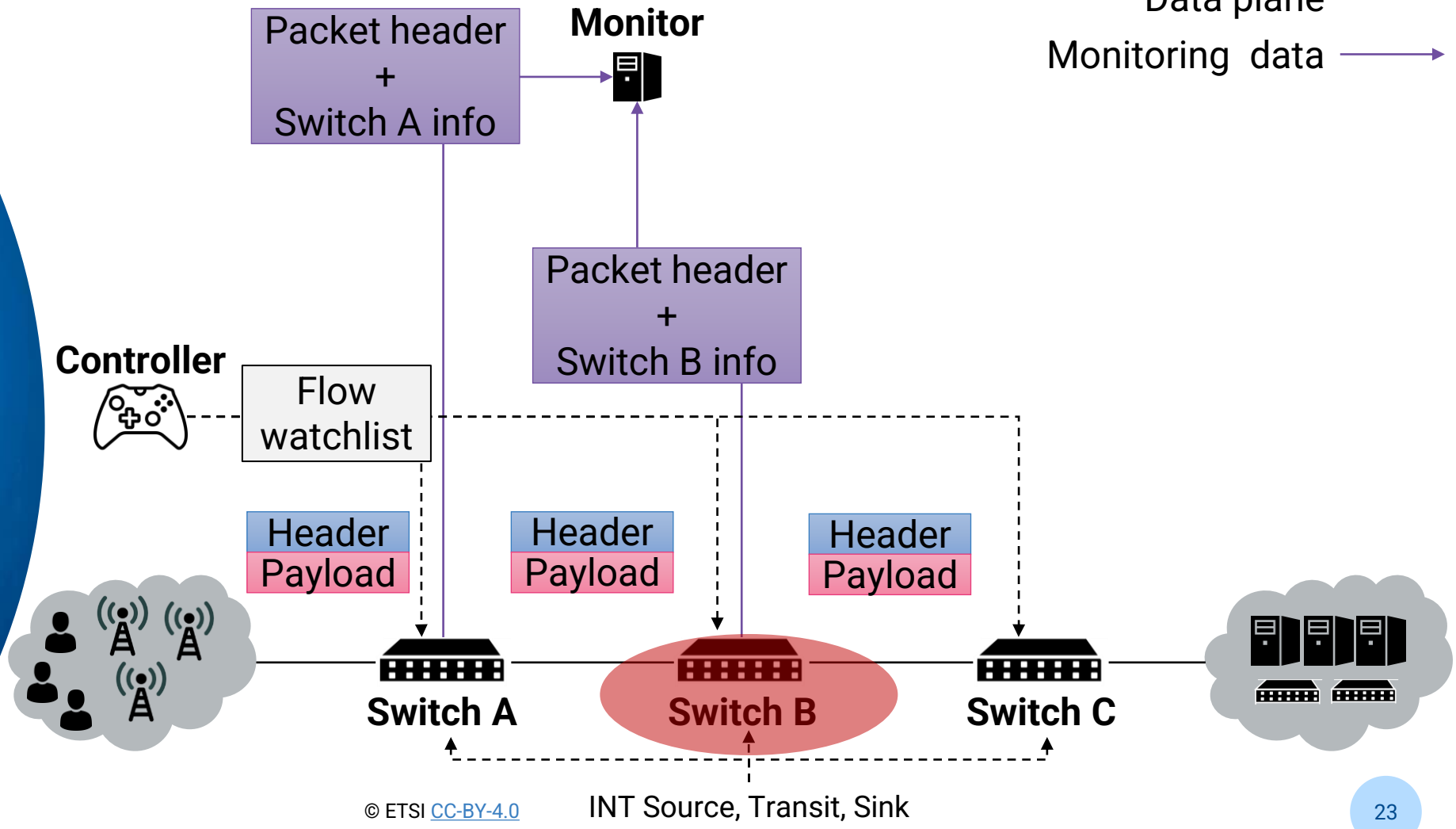


INT- EXport Data (XD)





INT- EXport Data (XD)



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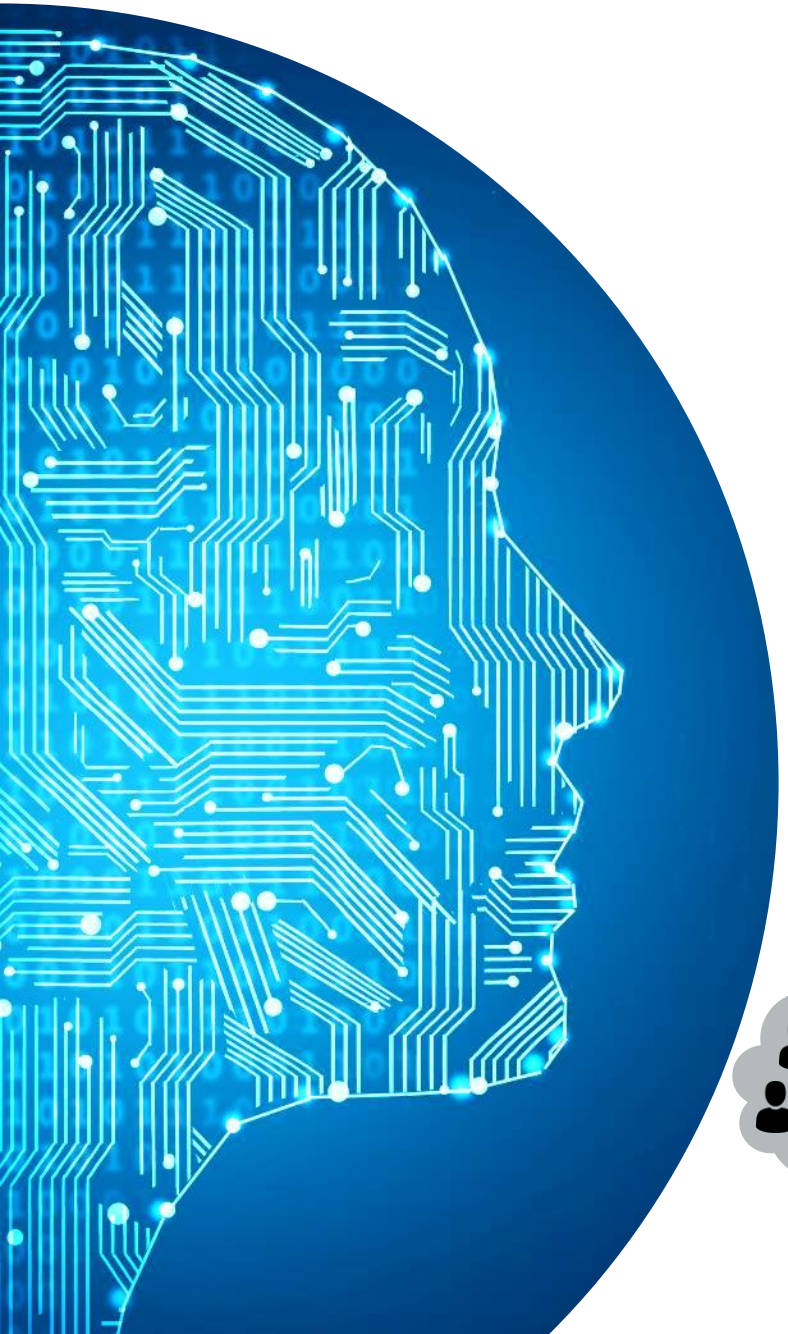

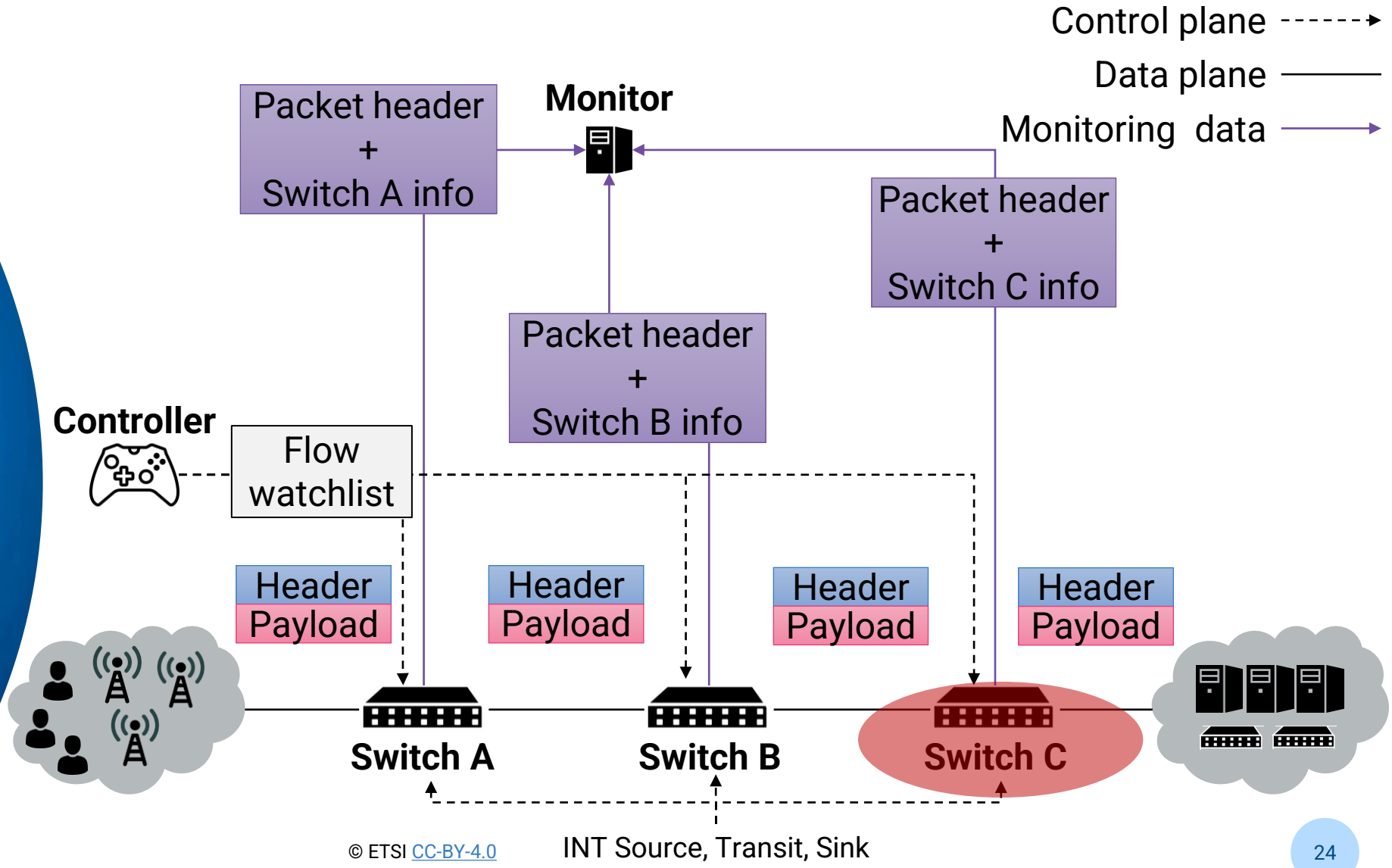

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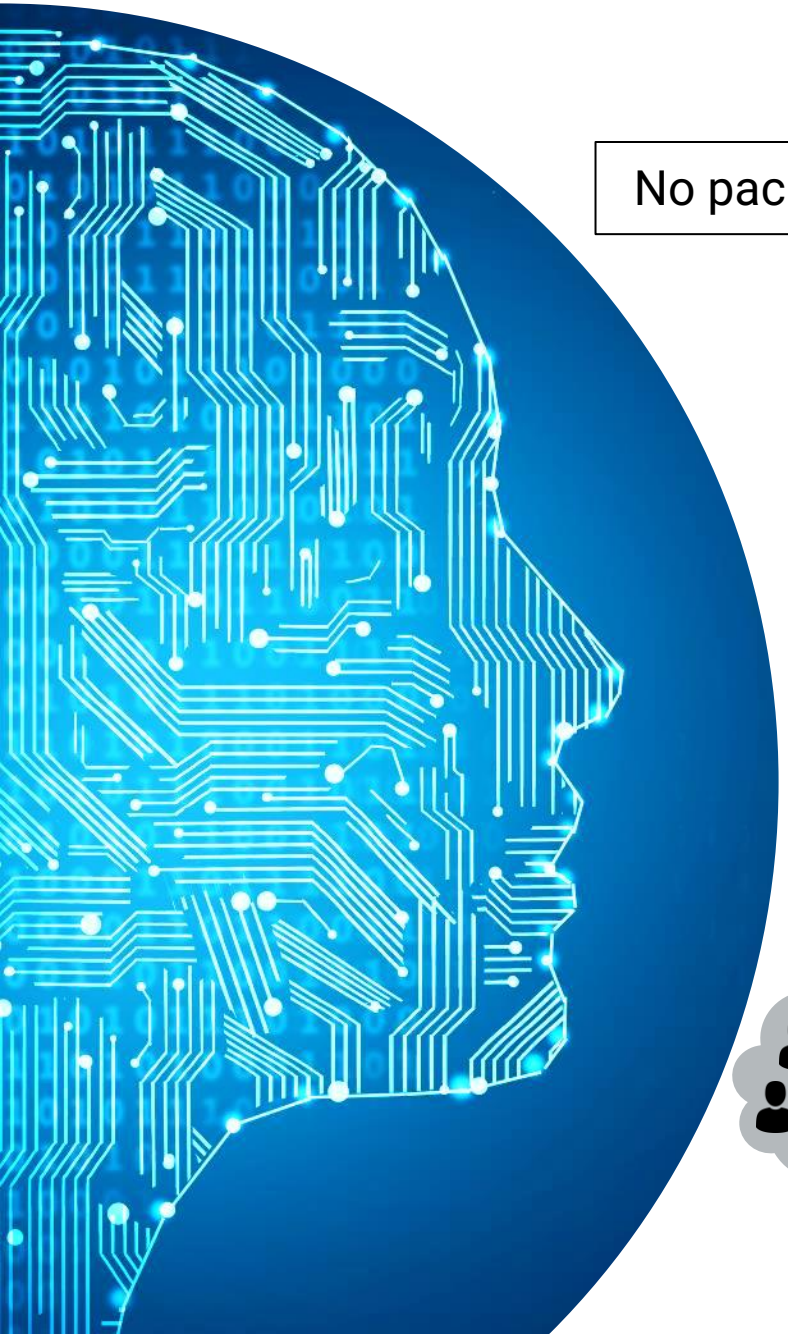

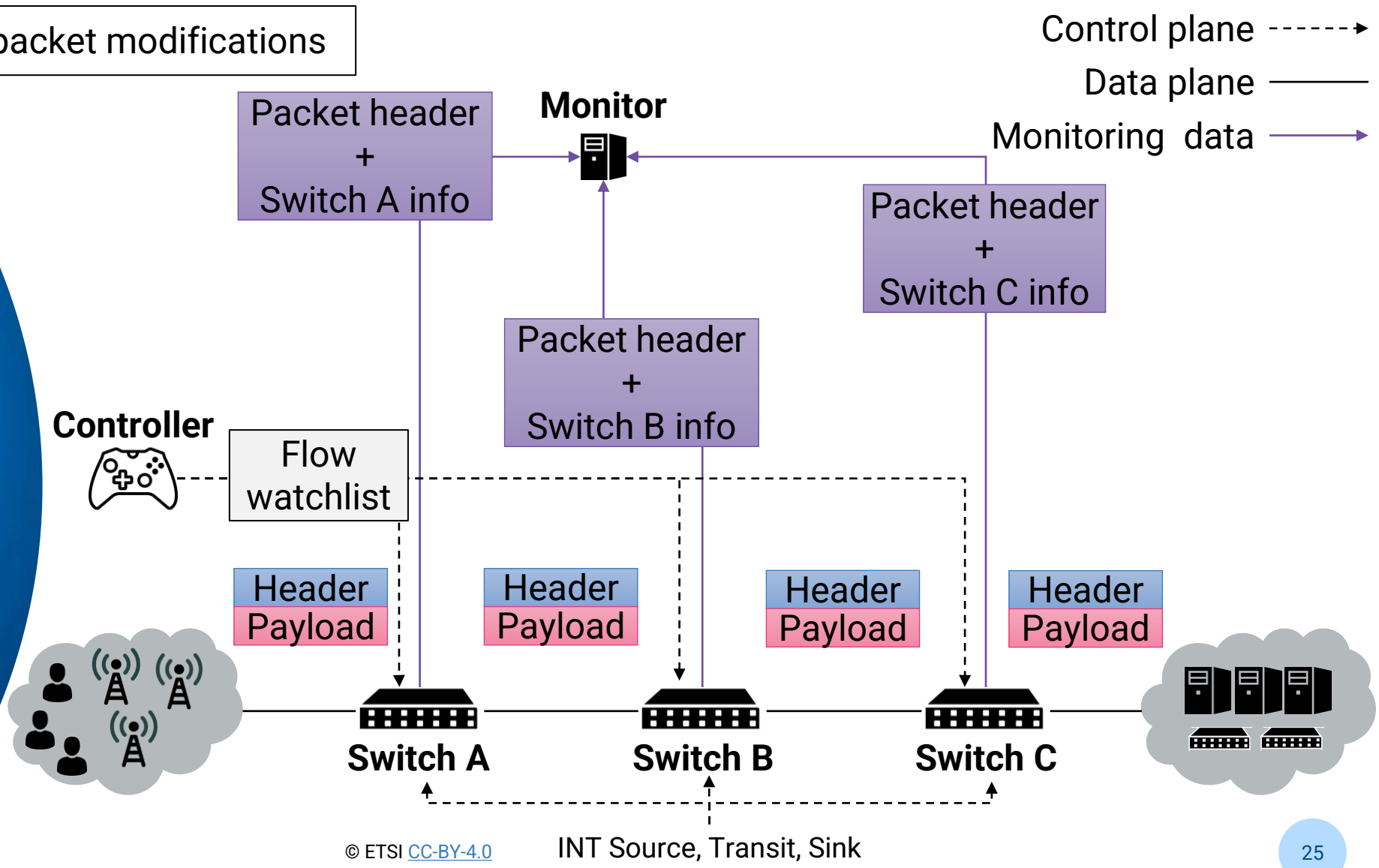

INT EMbed Instruct(X)ions (MX)

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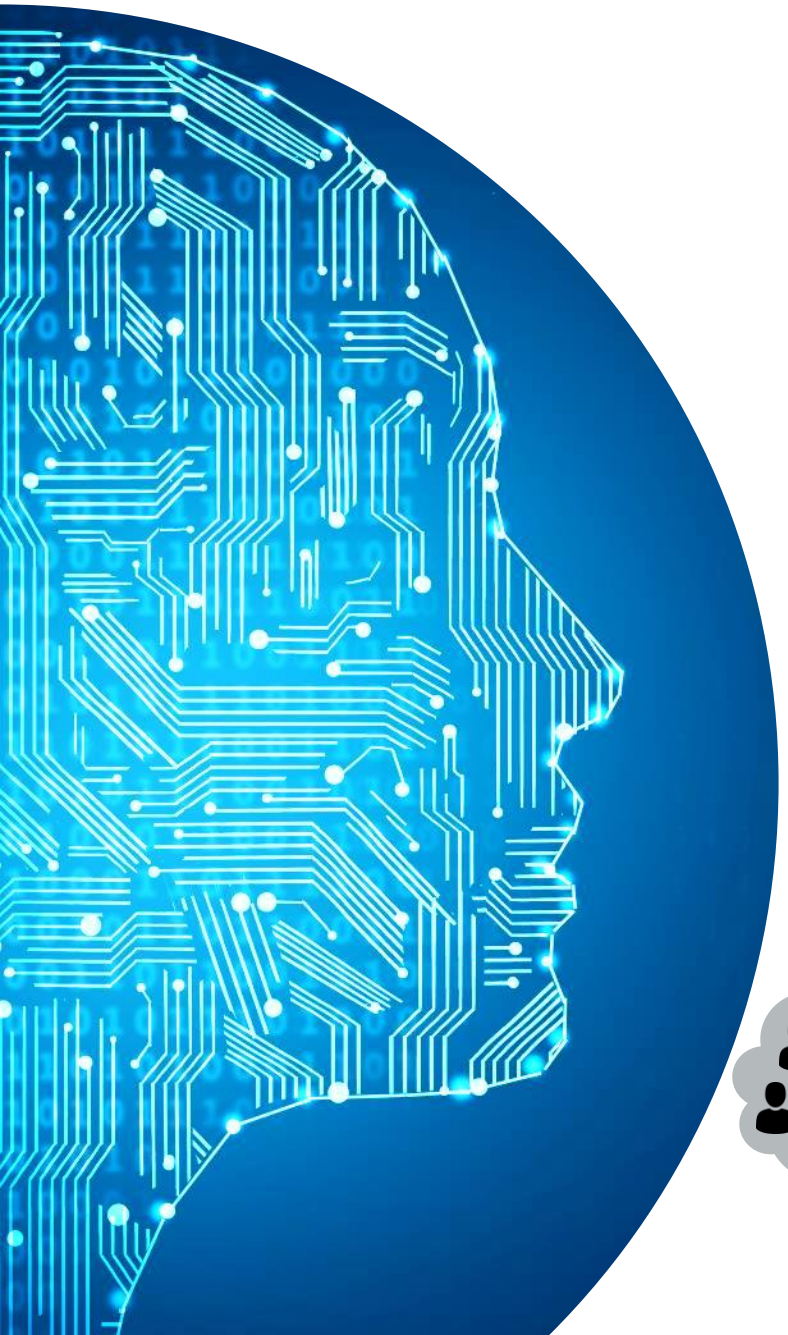
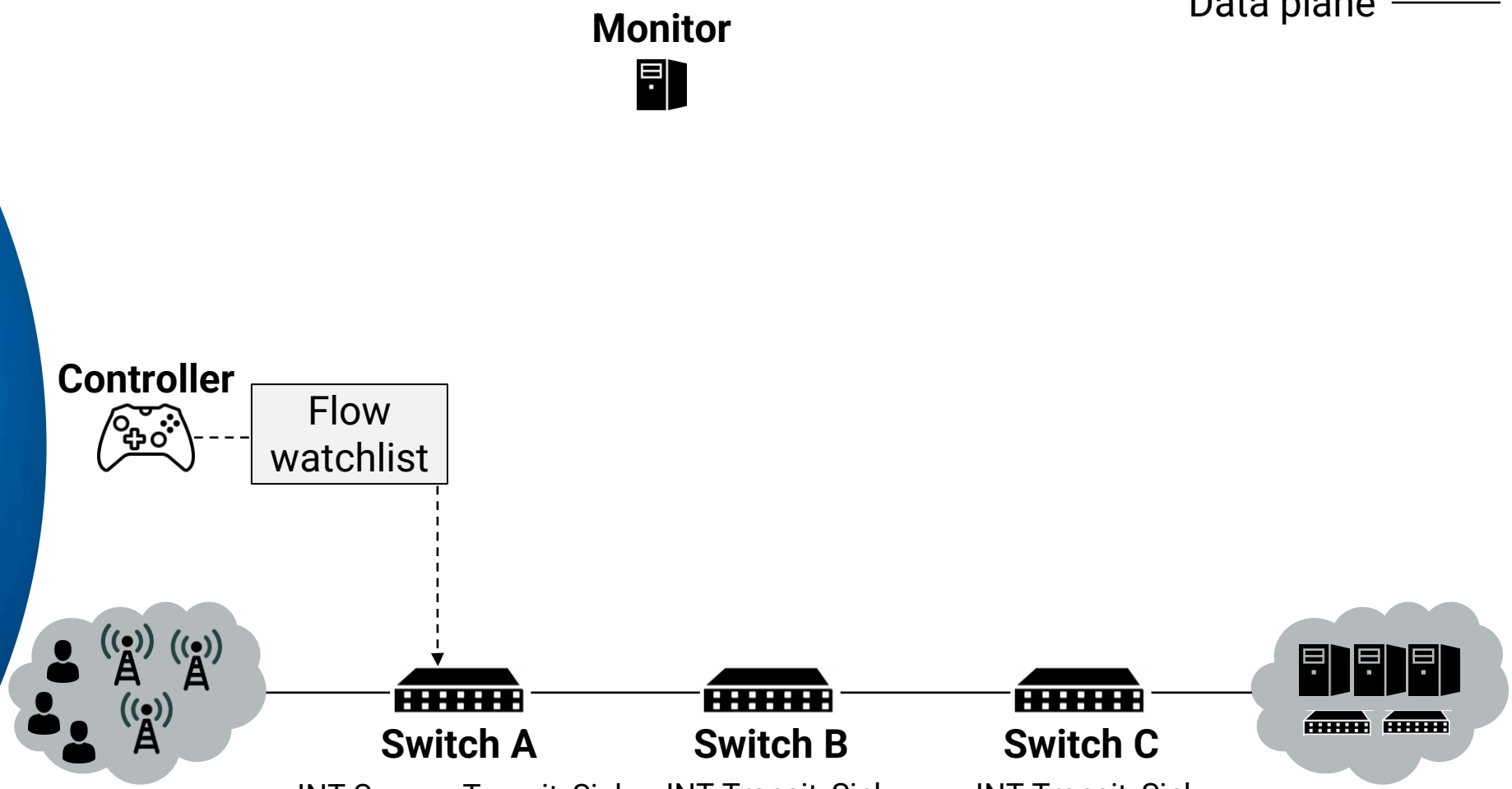
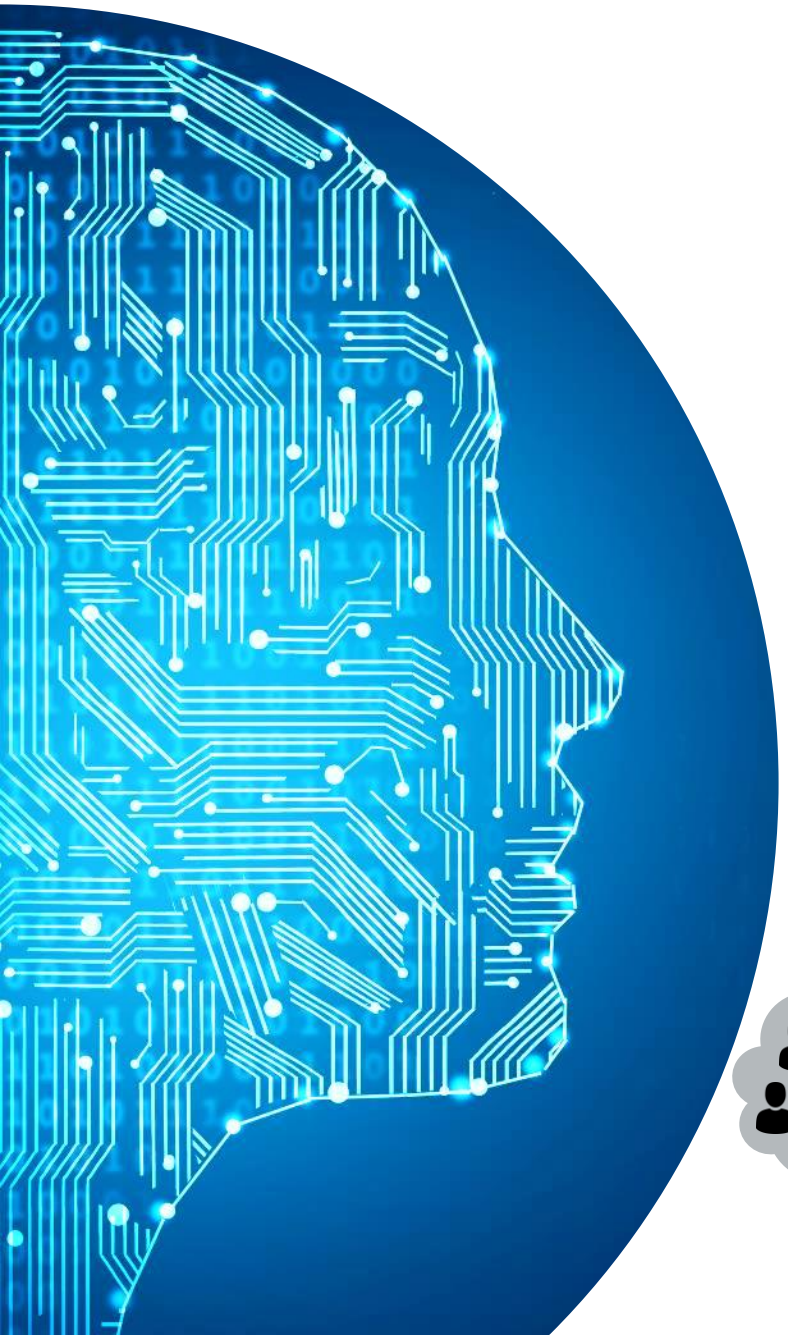
TeraFlow SDN

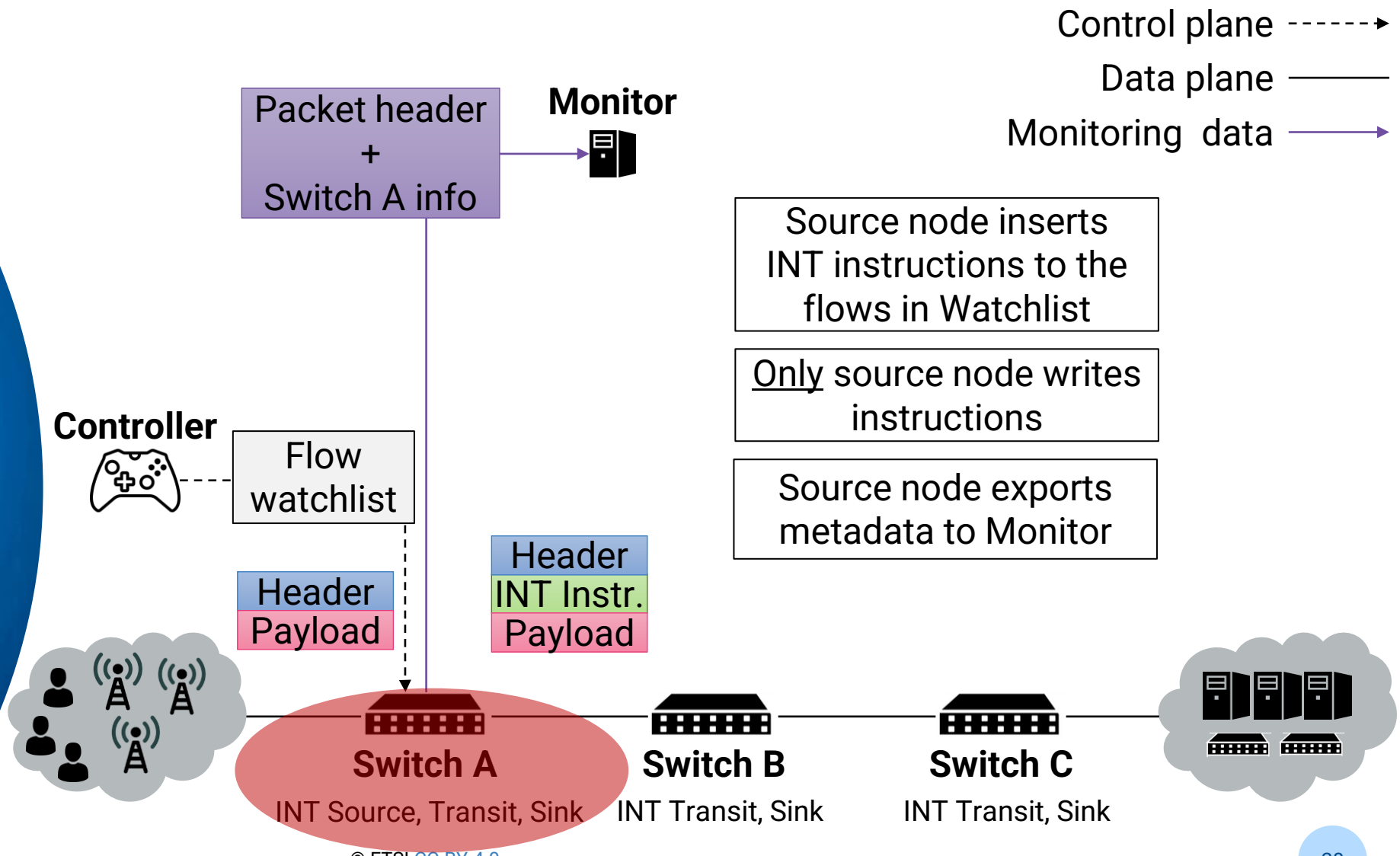




INT- EMbed Instruct(X)ions (MX)

TeraFlow SDN





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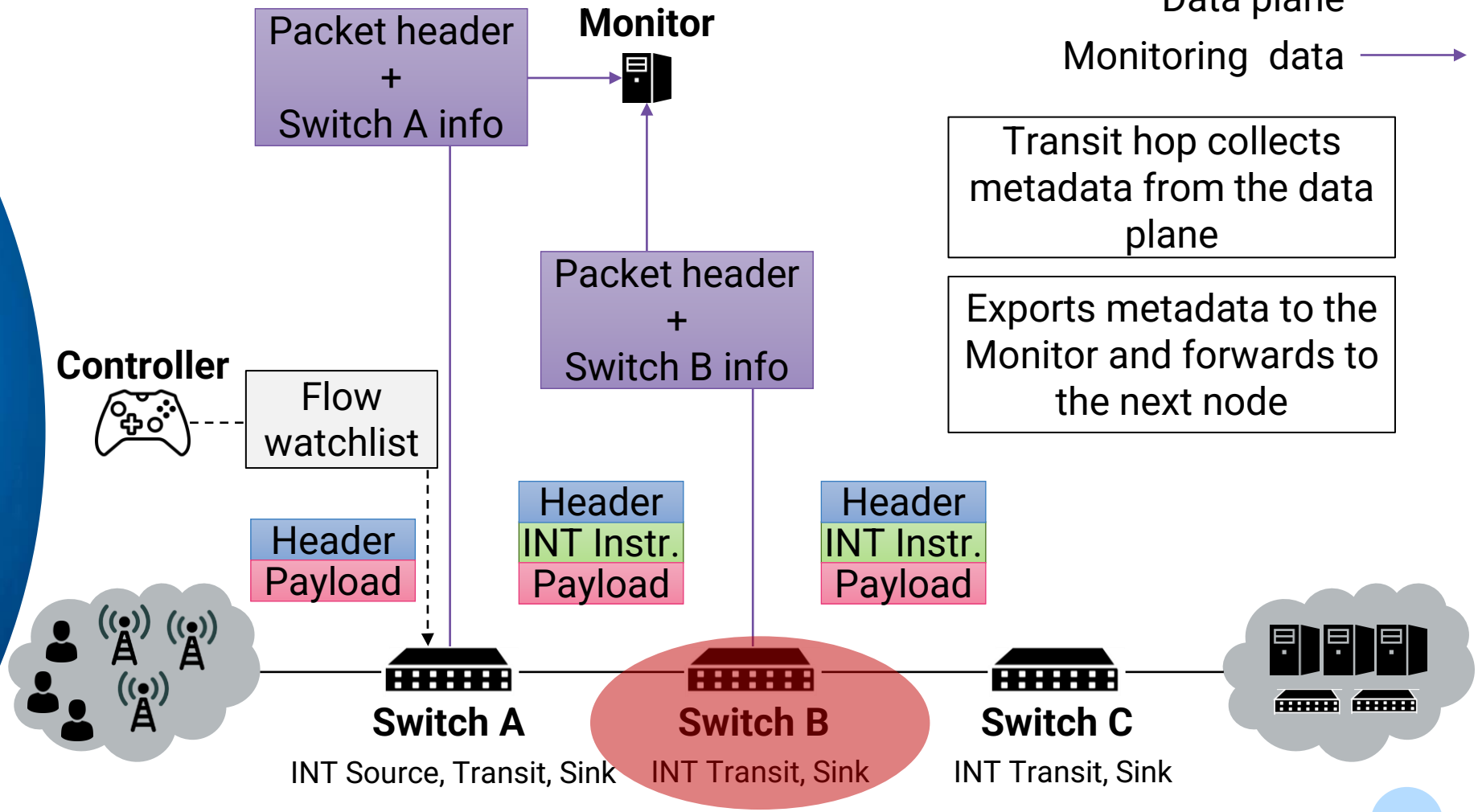

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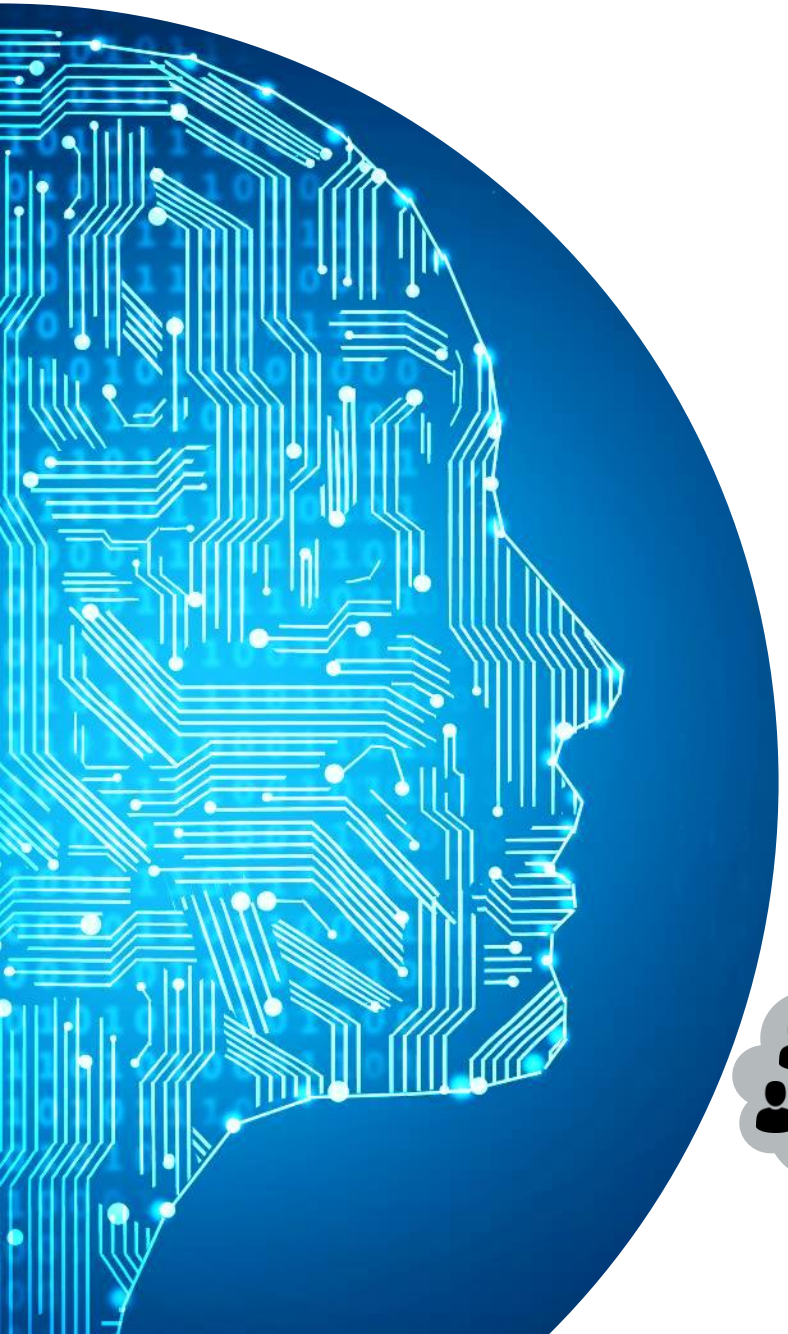
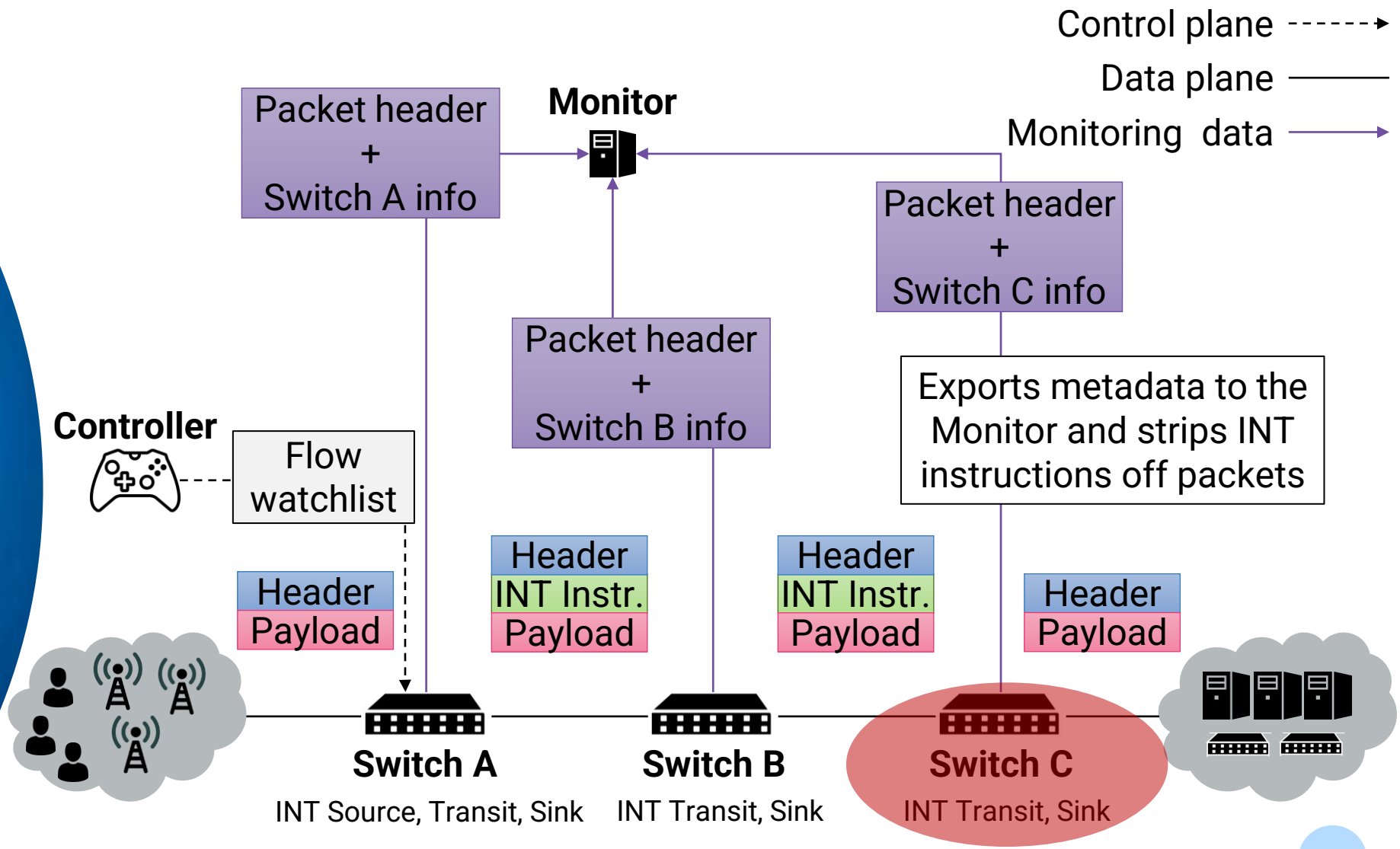
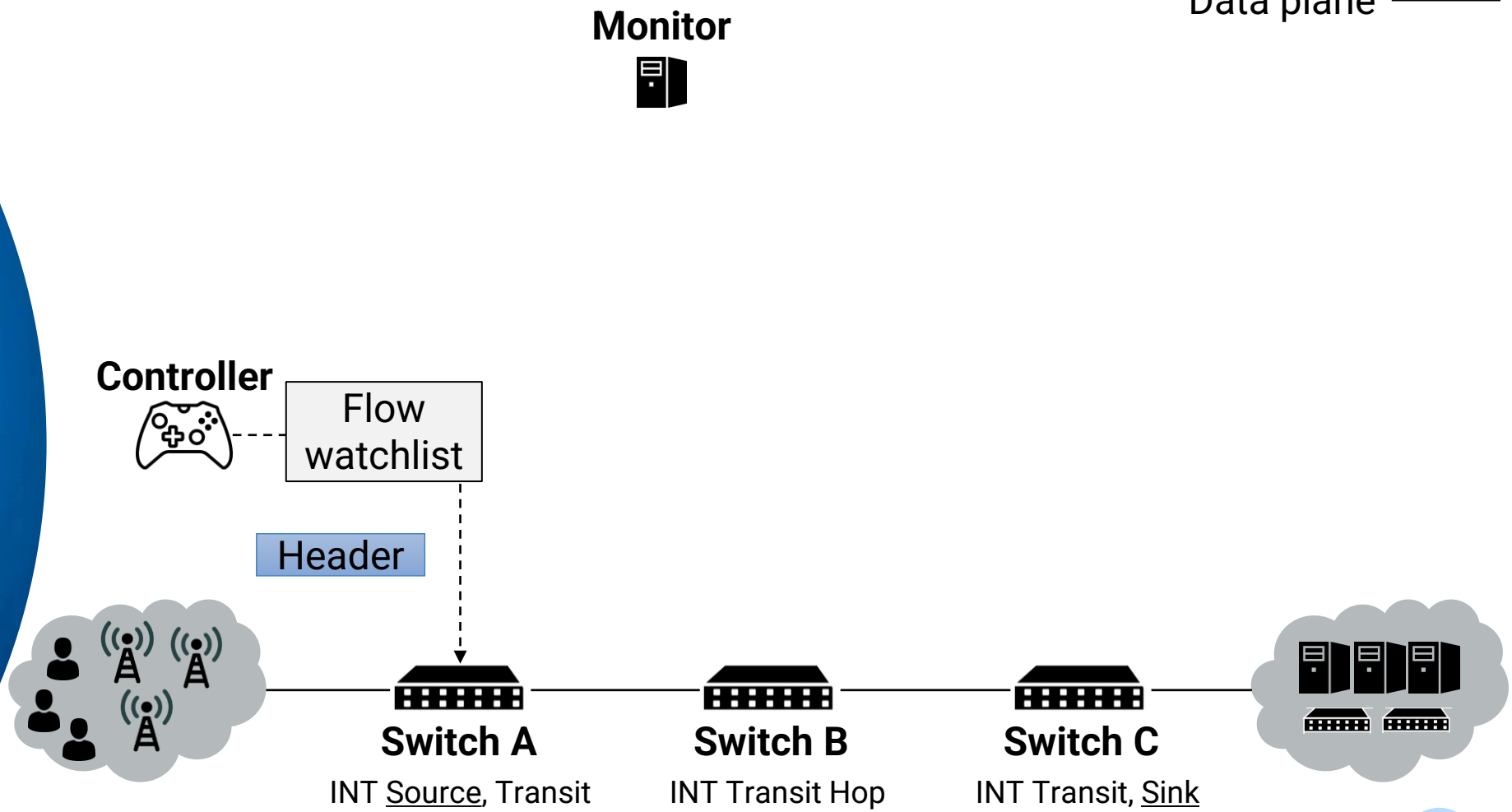




TeraFlow SDN

INT EMbed Data (MD)

INT- EMbed Data (MD)



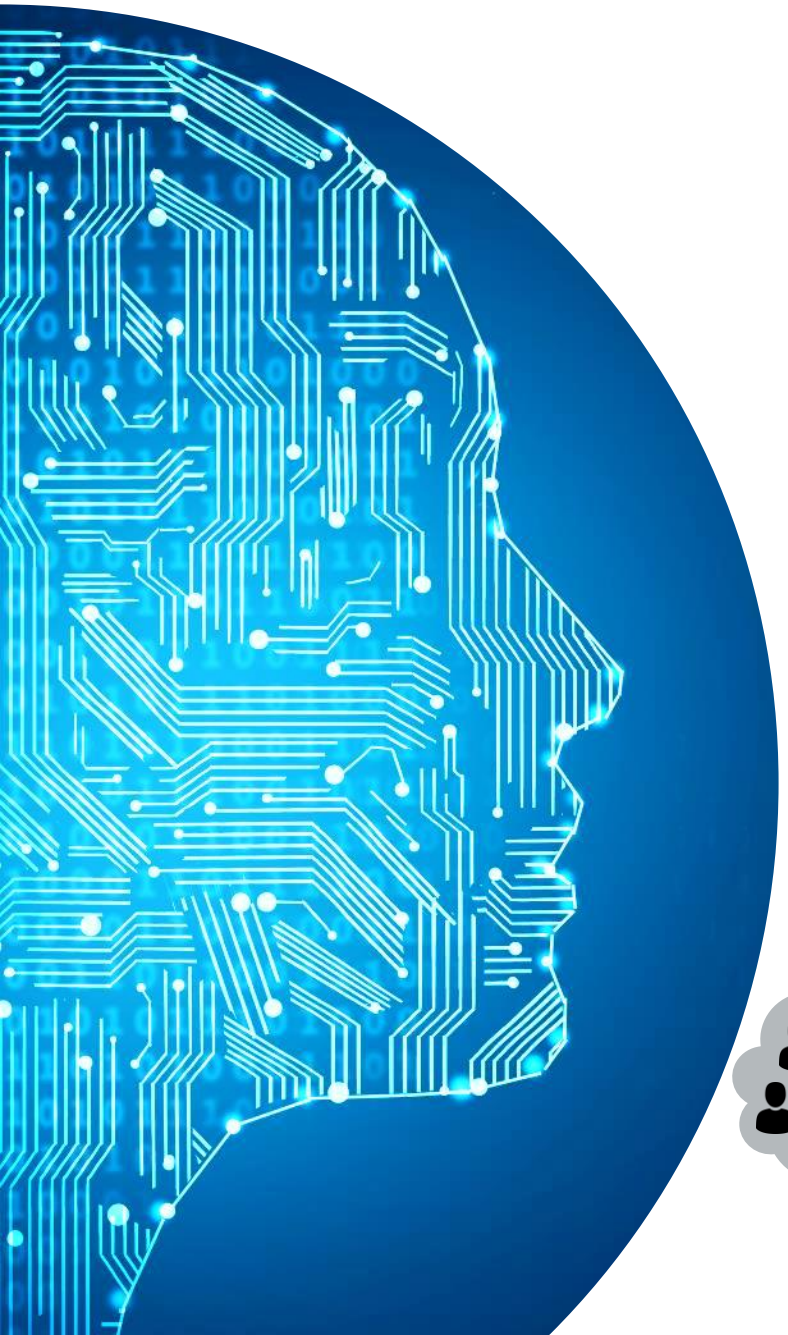
INT- EMbed Data (MD)

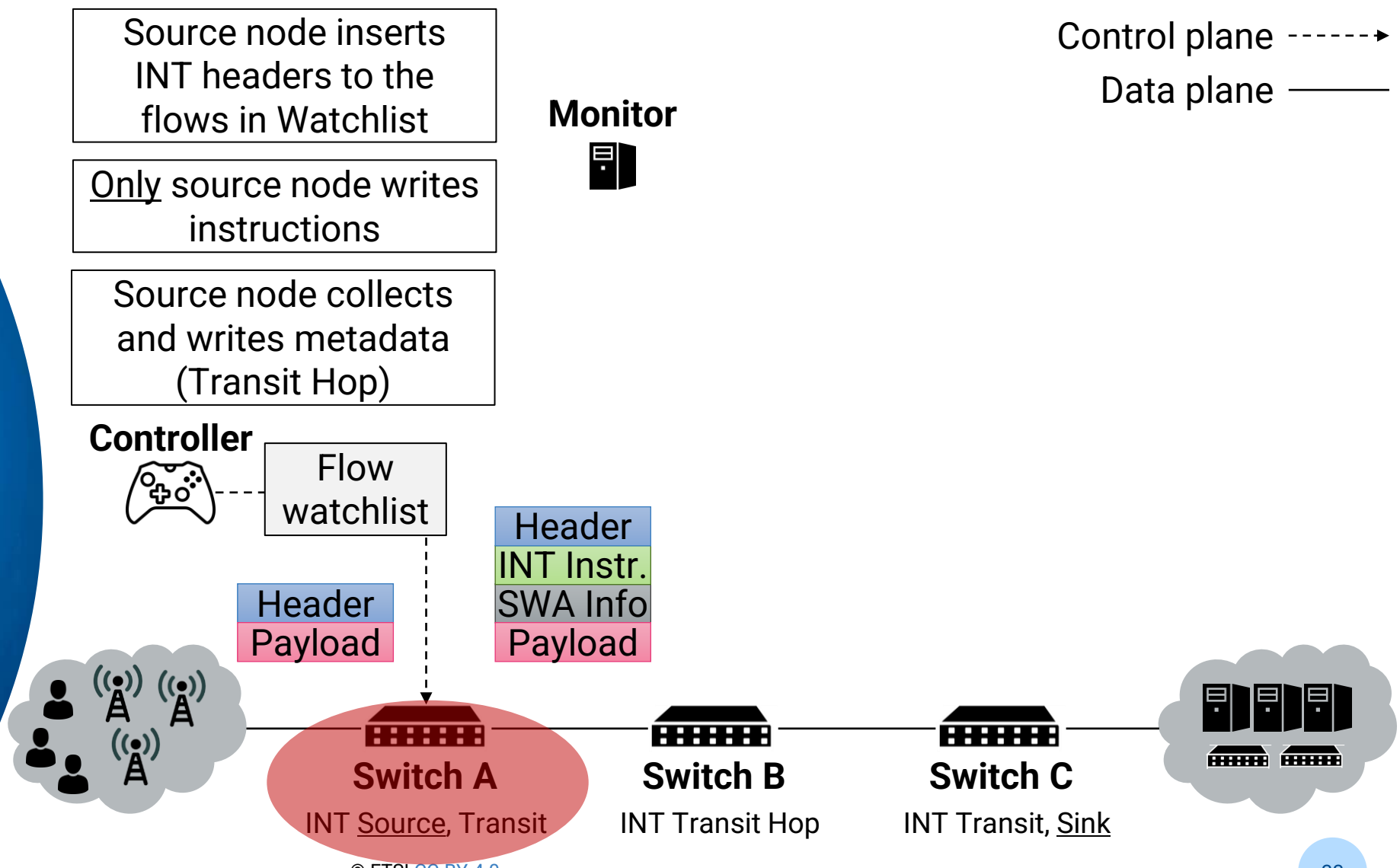
TeraFlow SDN

Source node inserts INT headers to the flows in Watchlist

Only source node writes instructions

Source node collects and writes metadata (Transit Hop)



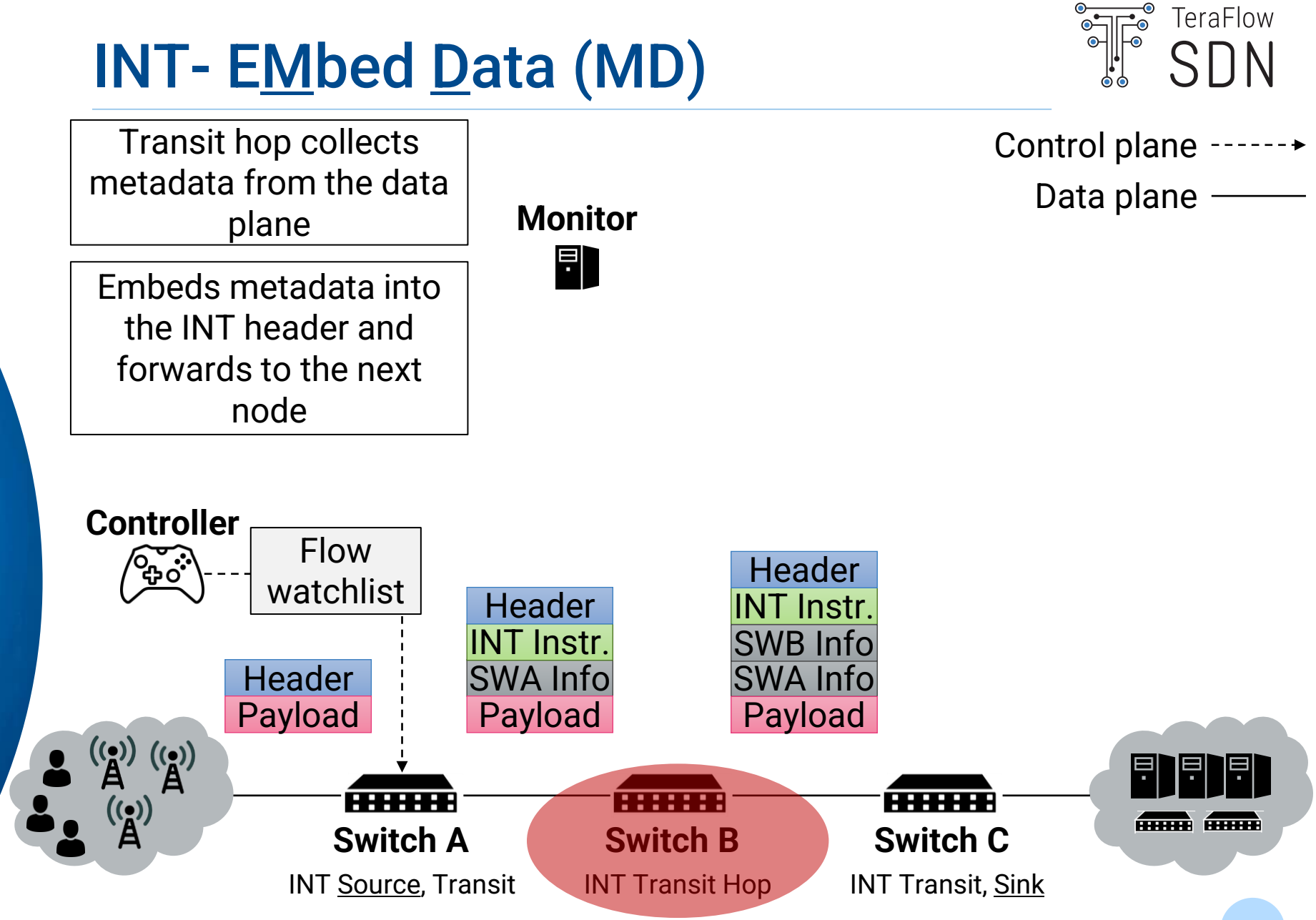


INT- EMbed Data (MD)

TeraFlow SDN

Transit hop collects metadata from the data plane

Embeds metadata into the INT header and forwards to the next node



INT- EMbed Data (MD)

Sink node first acts as a Transit Hop

Sink node extracts all INT headers and exports state to the monitor

Sink node removes INT headers to make INT transparent to upper layers

Control plane

Data plane

Monitoring data

Monitor

Packet header + Switch A,B,C info

Controller

Flow watchlist

Header
Payload

Header
INT Instr.
SWA Info
Payload

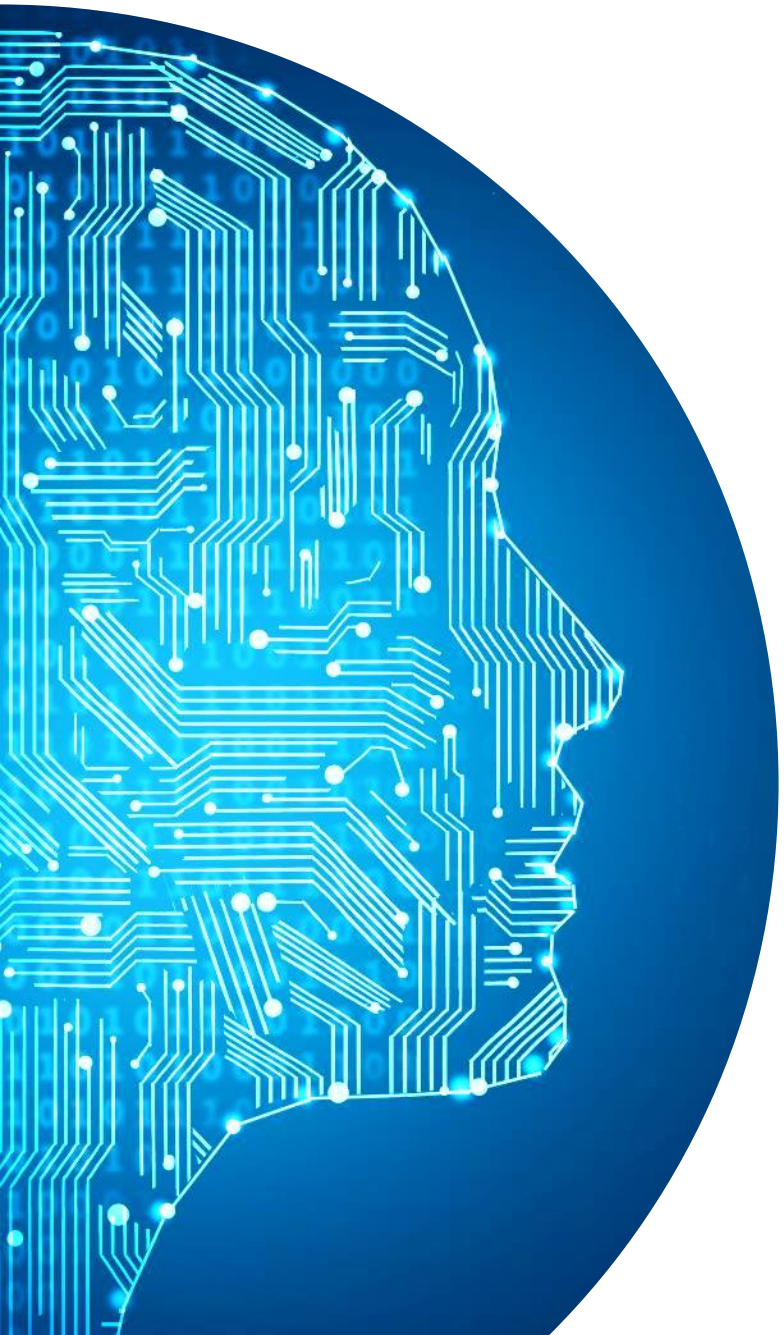
Header
INT Instr.
SWB Info
SWA Info
Payload

Header
Payload

Switch A
INT Source, Transit

Switch B
INT Transit Hop

Switch C
INT Transit, Sink



What to Monitor with INT

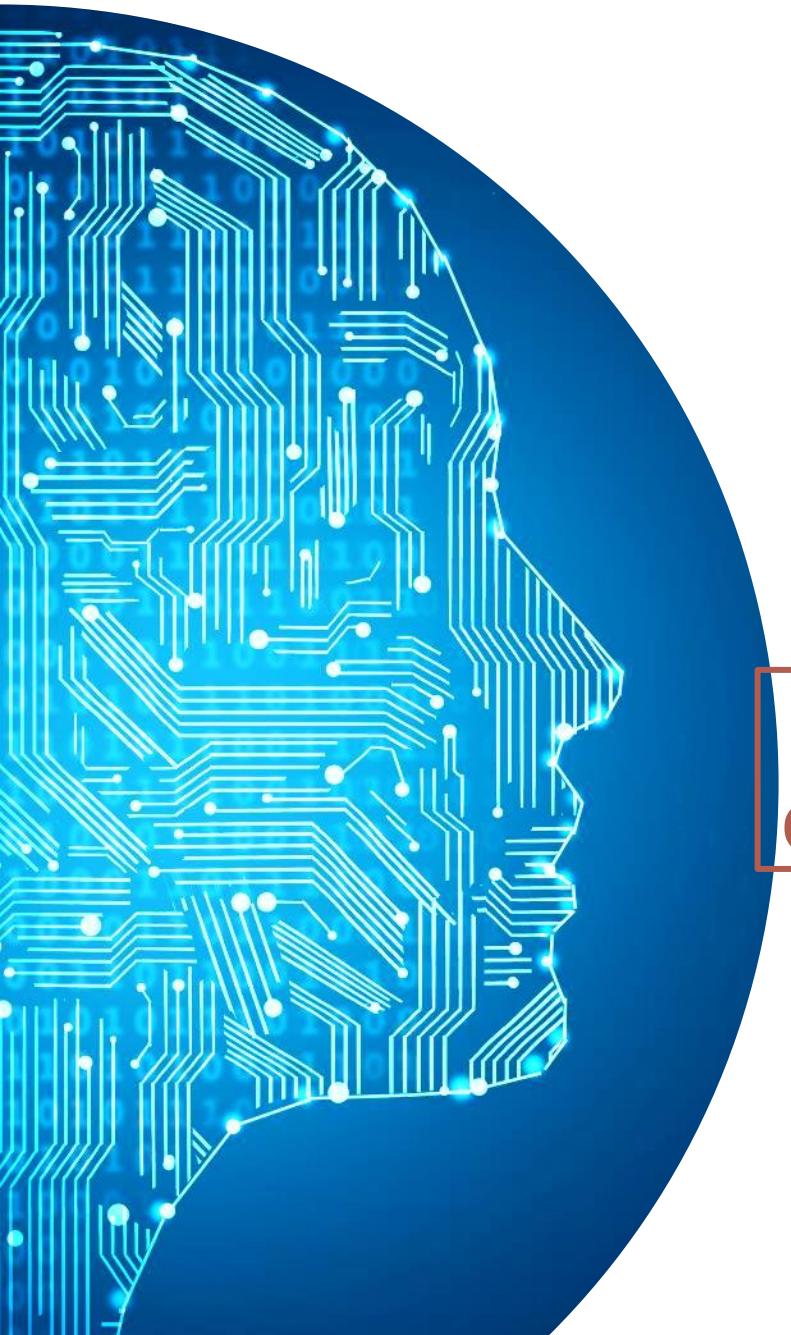
- Device info
  - Node id
- Ingress info
  - Ingress interface identifier
  - Ingress timestamp
- Egress info
  - Egress interface identifier
  - Egress timestamp
  - Hop latency
  - Egress interface Tx link utilization
  - Queue occupancy
  - Buffer occupancy

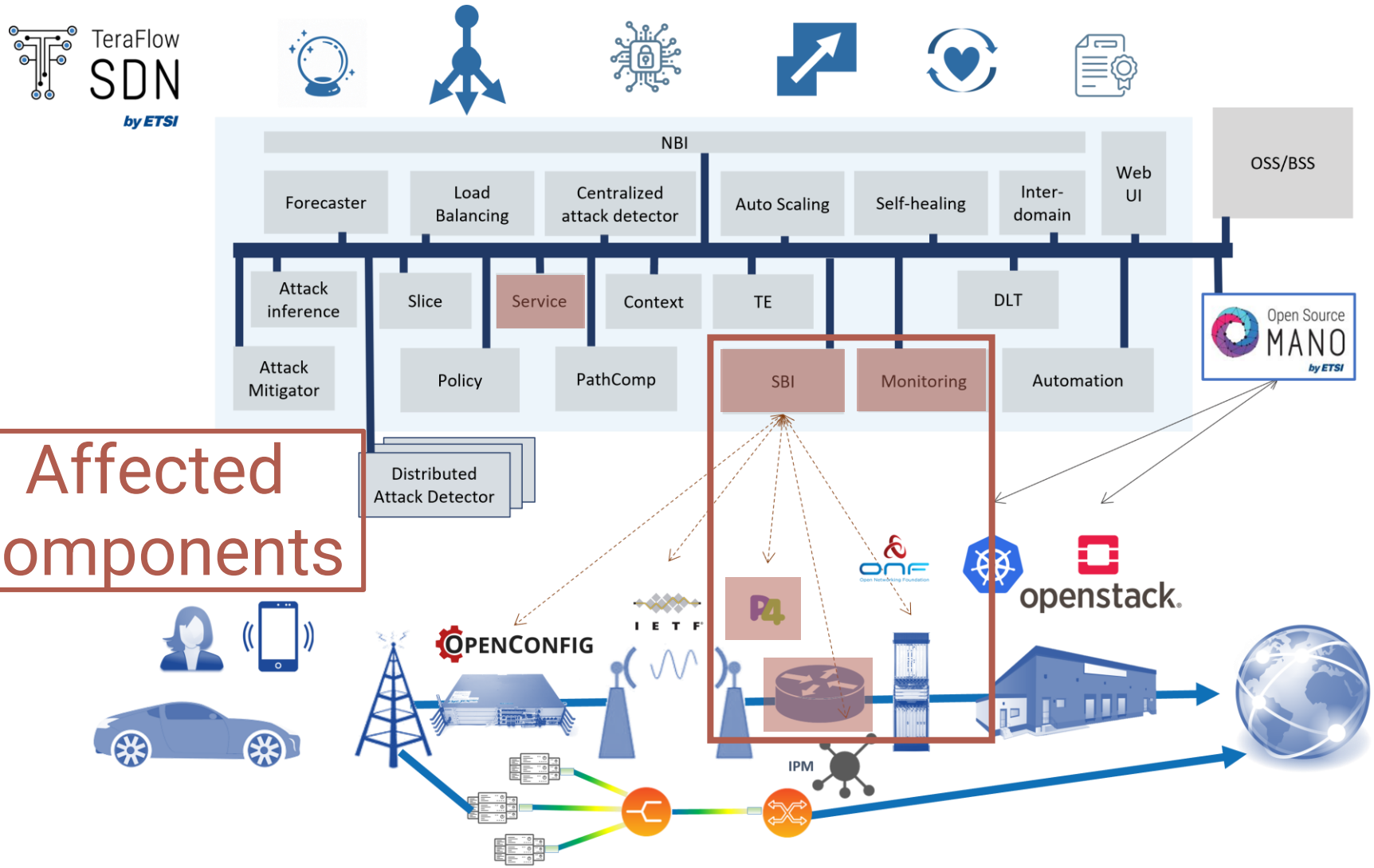
TeraFlow SDN

ETSI TFS Extensions to Support INT

ETSI TFS SBI, Monitoring, and Service

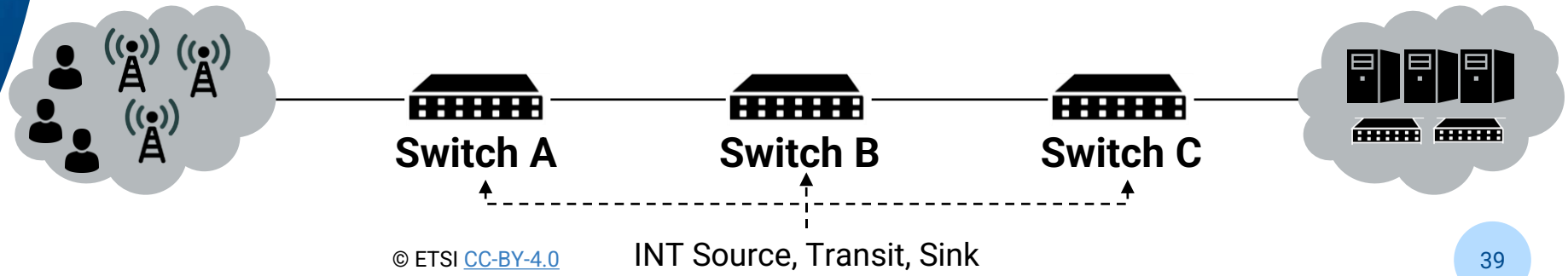
ETSI TFS Architecture





General requirements to support INT

Requirements	Supported
1 Install INT program	✓

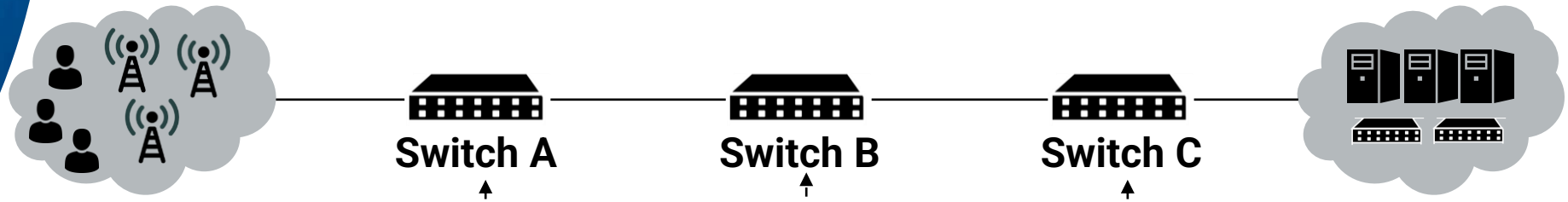


General requirements to support INT

TeraFlow SDN

Requirements	Supported
1 Install INT program	✓
2 Configure Flow Watchlist tables	✓

TeraFlow SDN by ETSI Controller

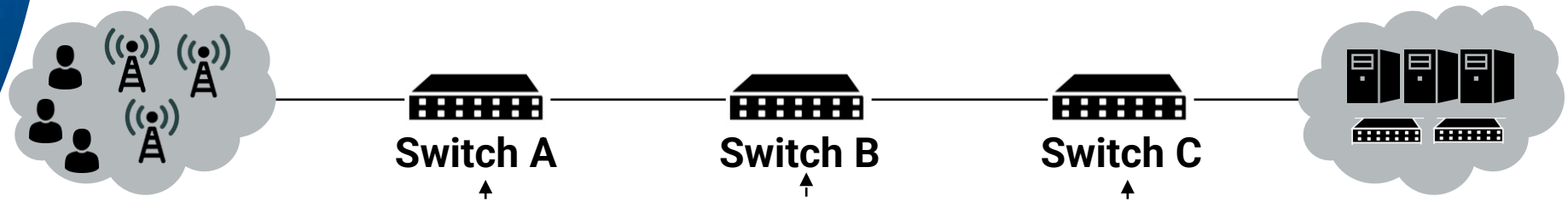


General requirements to support INT

TeraFlow SDN

Requirements	Supported
1 Install INT program	✓
2 Configure Flow Watchlist tables	✓
3 Setup INT Monitor	✗

TeraFlow SDN by ETSI Controller

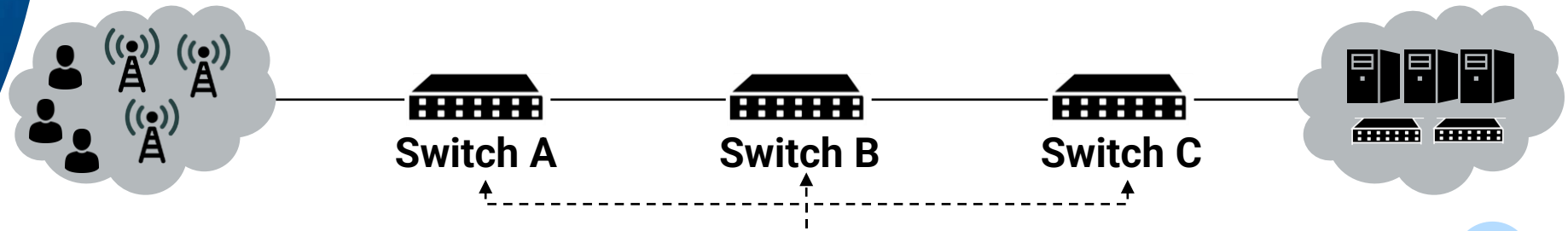


General requirements to support INT

TeraFlow SDN

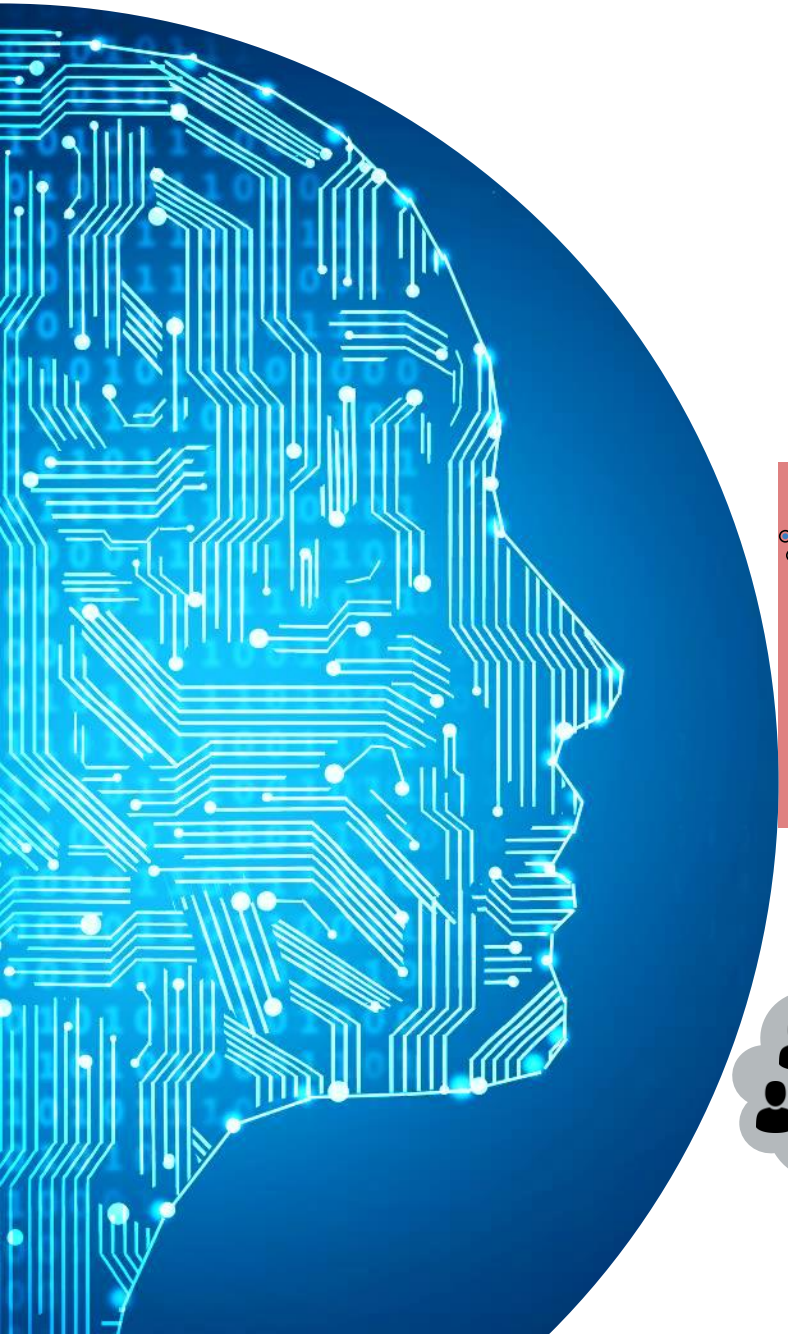
TeraFlow SDN by ETSI Controller

Requirements	Supported
1 Install INT program	✓
2 Configure Flow Watchlist tables	✓
3 Setup INT Monitor	✗
4 INT Monitor creates Monitoring KPIs	✗



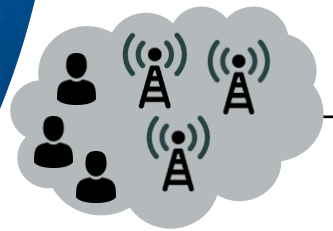
General requirements to support INT

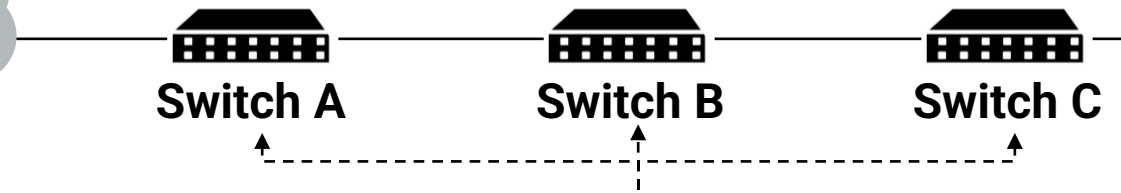
TeraFlow SDN

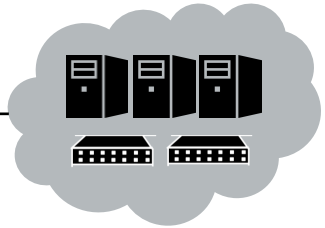


TeraFlow SDN by ETSI
Controller

Requirements	Supported
1 Install INT program	✓
2 Configure Flow Watchlist tables	✓
3 Setup INT Monitor	✗
4 INT Monitor creates Monitoring KPIs	✗
5 Multi-protocol SBI (P4Runtime+GNMI)	✗



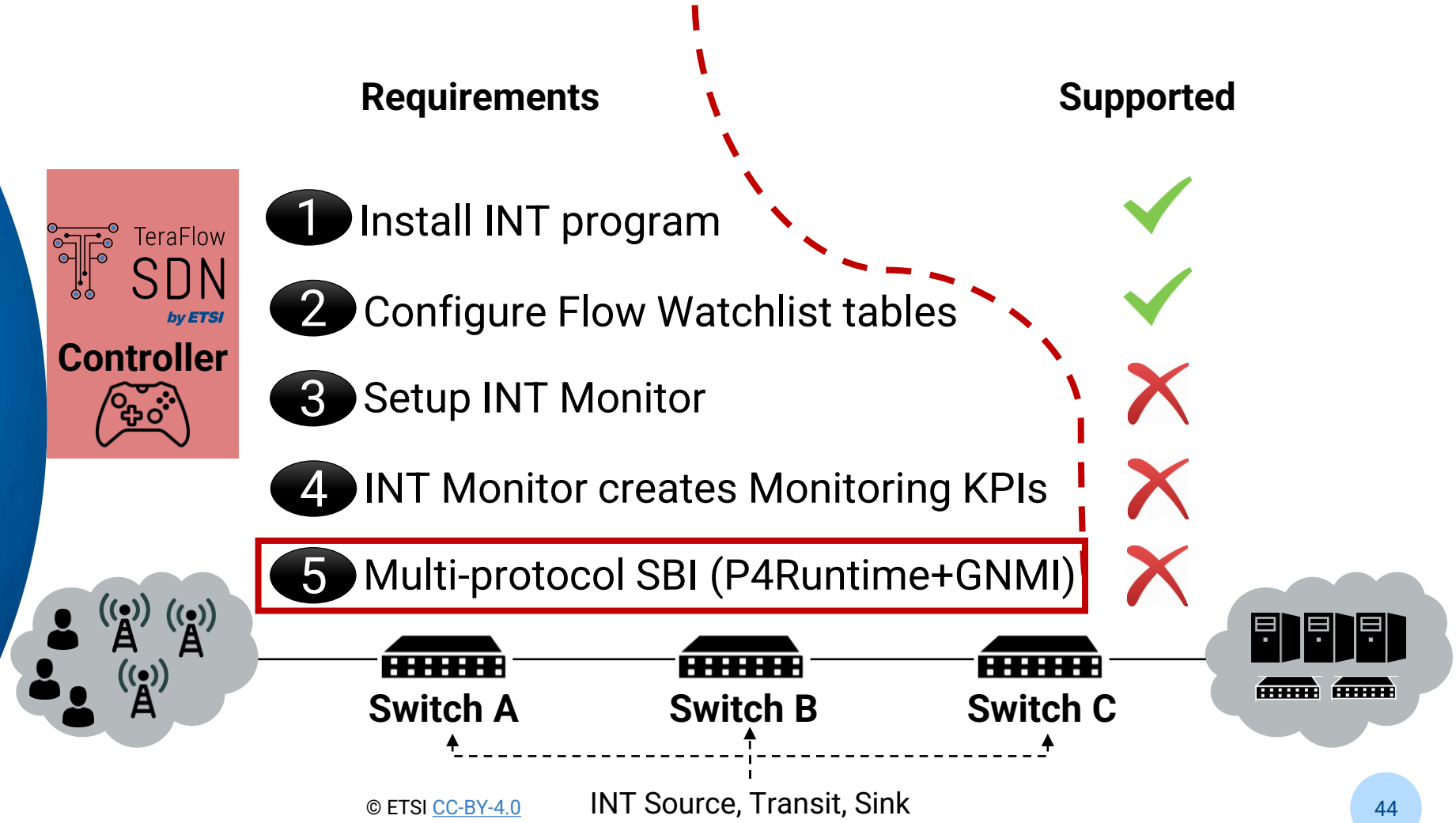




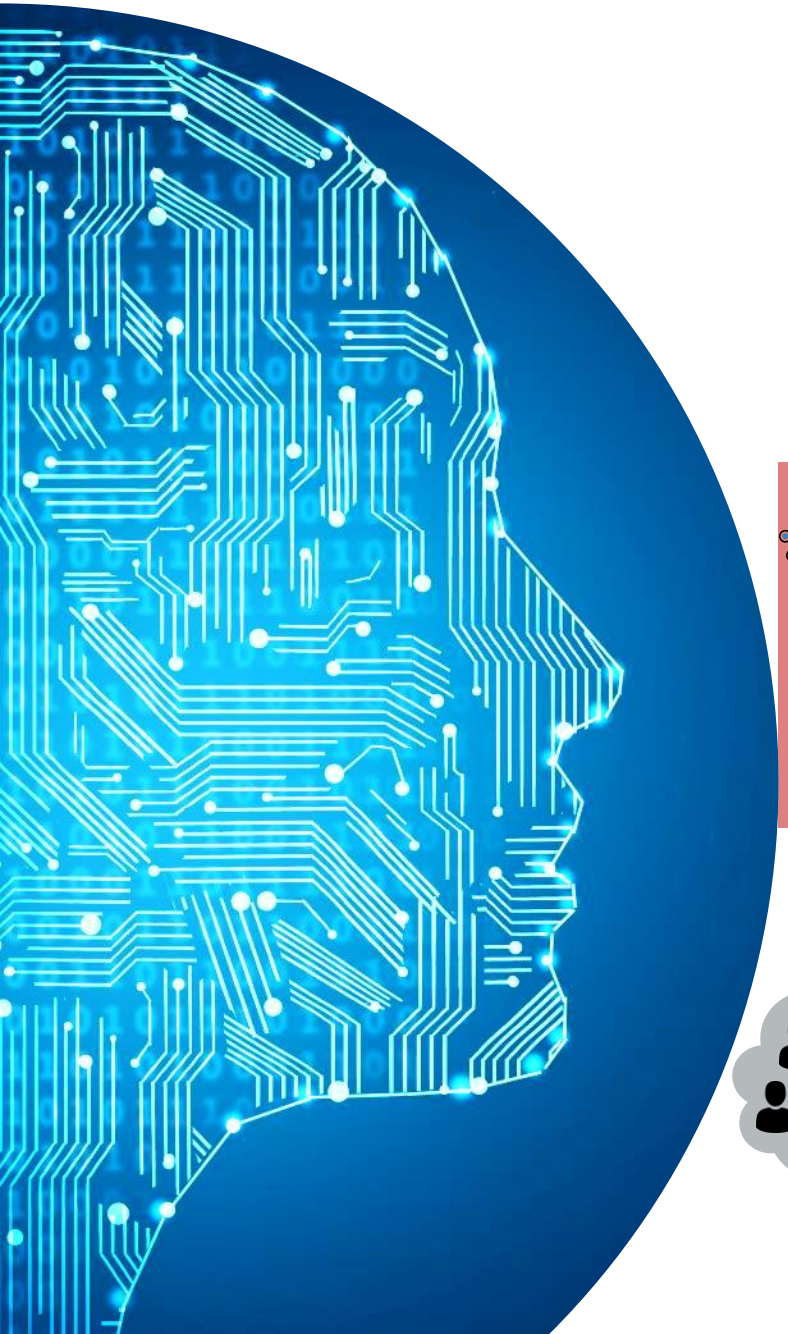
General requirements to support INT

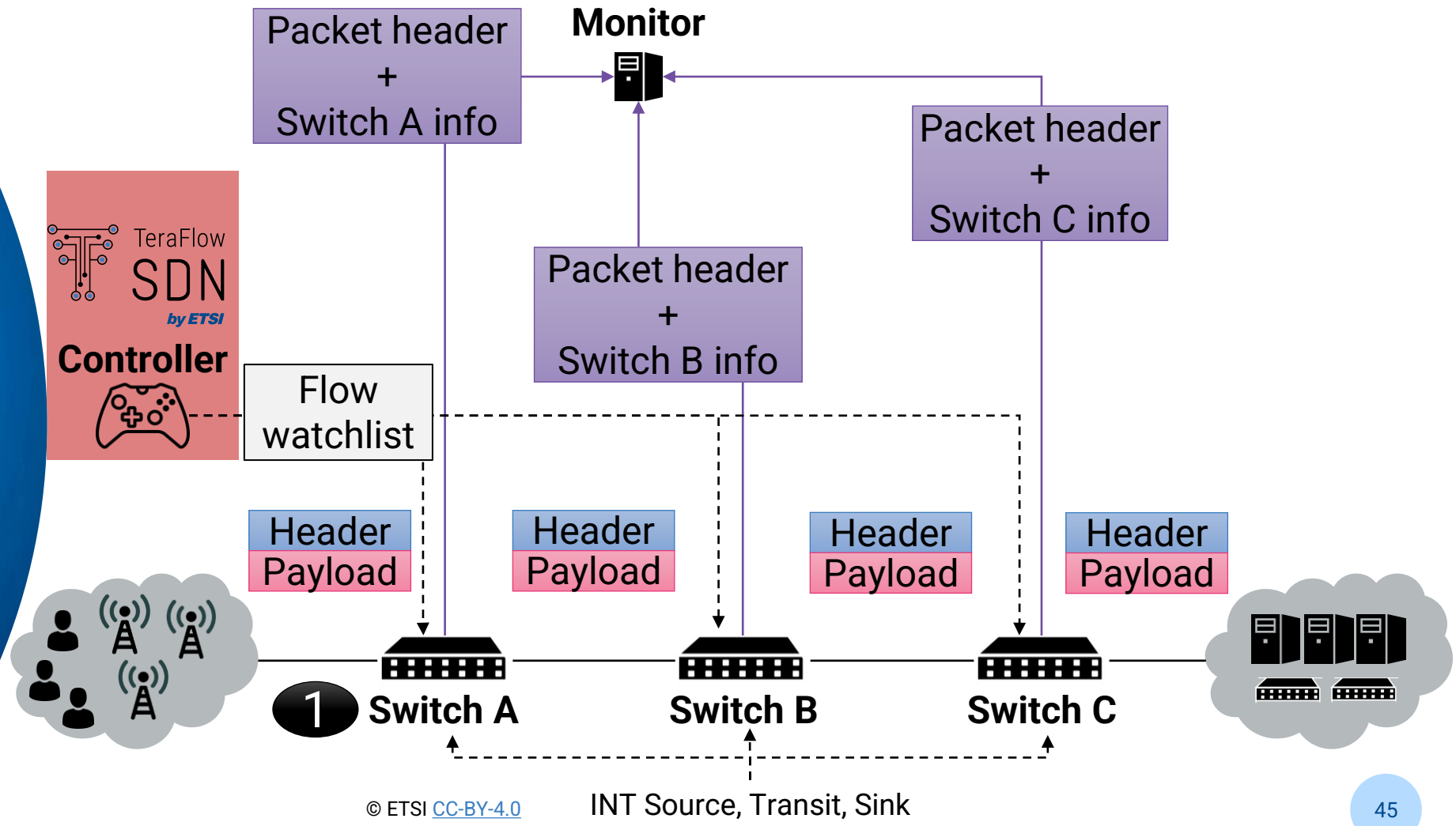
TeraFlow SDN

A dedicated session tomorrow at the ETSI TFS Plenary



INT- EXport Data (XD)

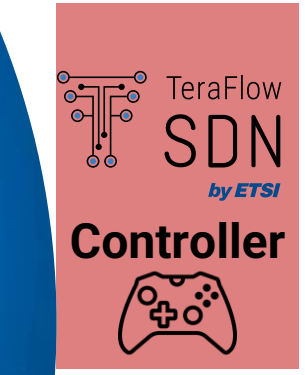


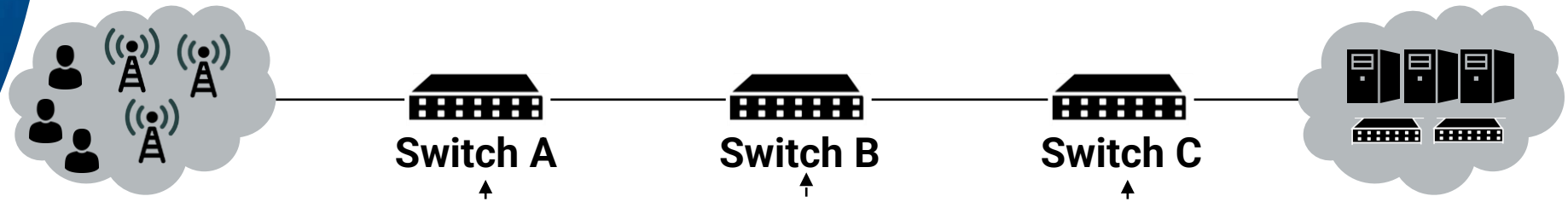


Requirements to support INT XD

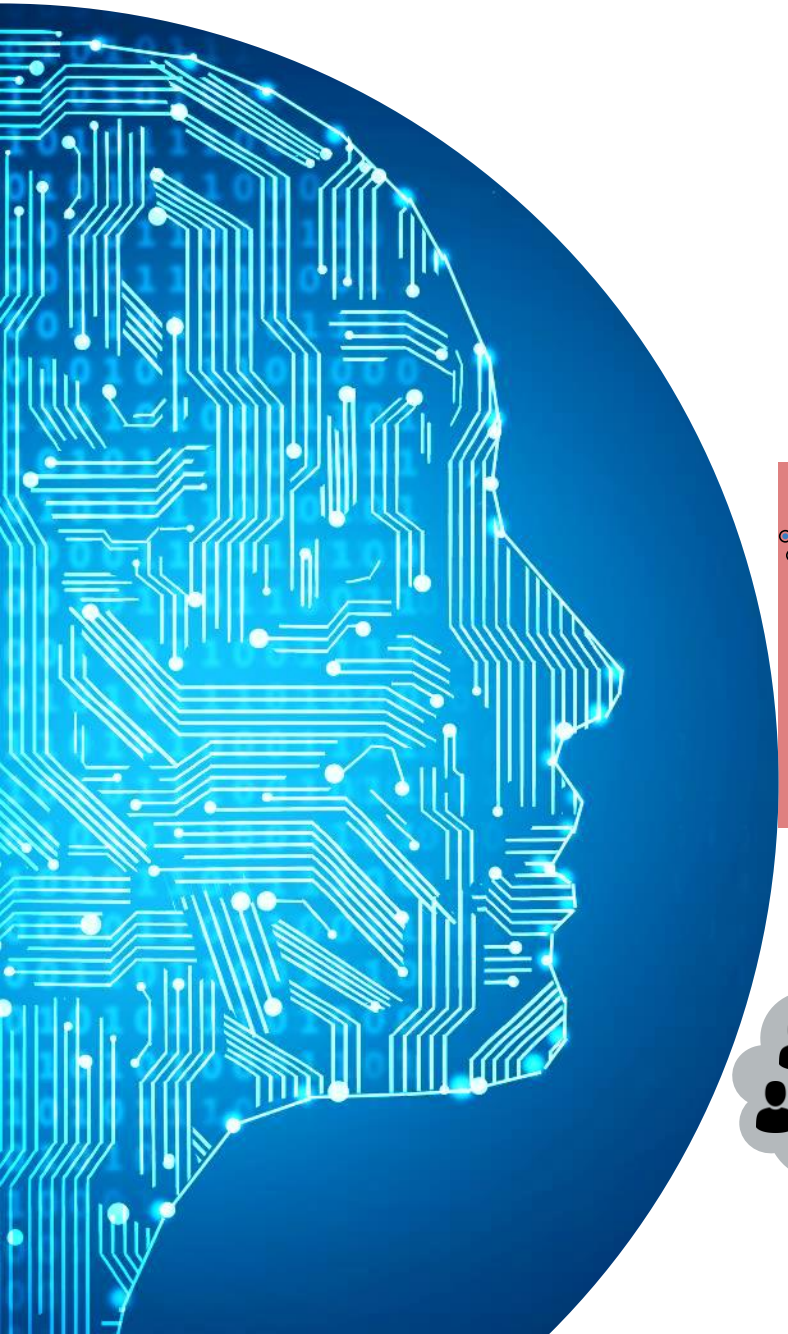
The easiest model to support first!

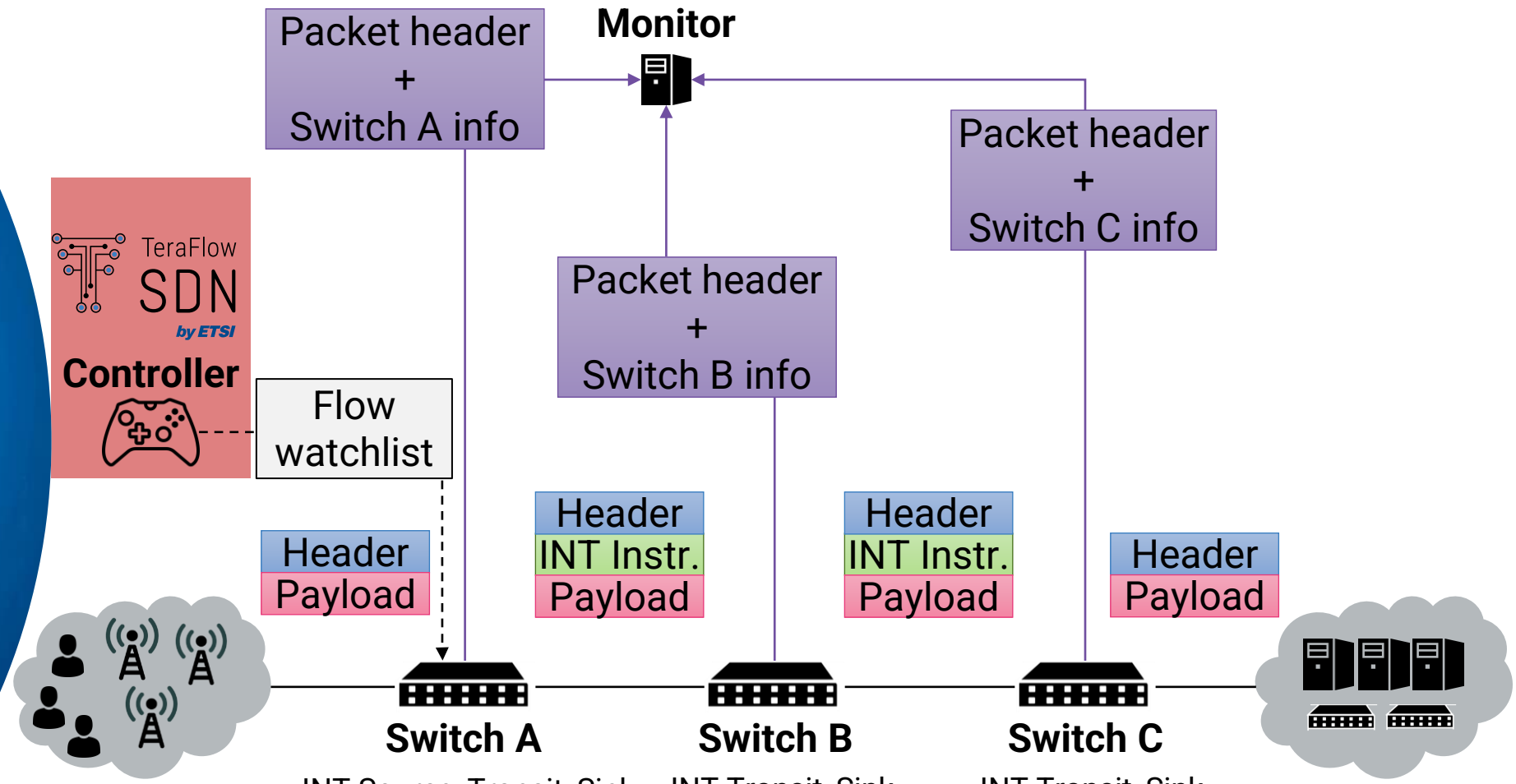
Requirements	Supported
Covered by the general requirements	Partially





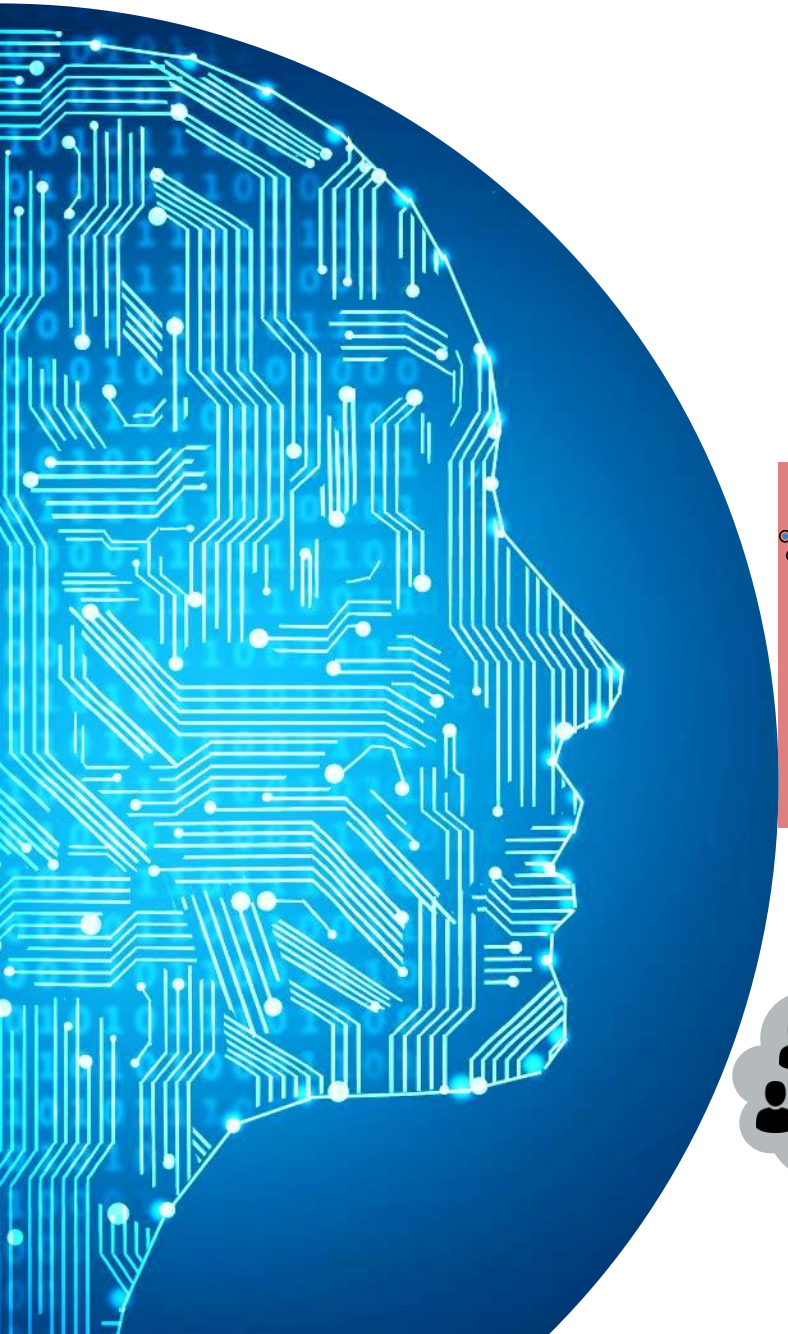
INT- EMbed Instruct(X)ions (MX)





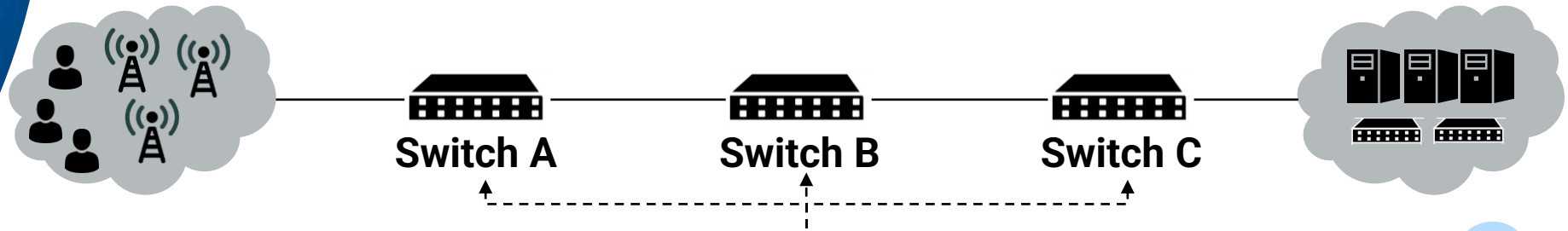
Requirements to support INT MX

TeraFlow SDN

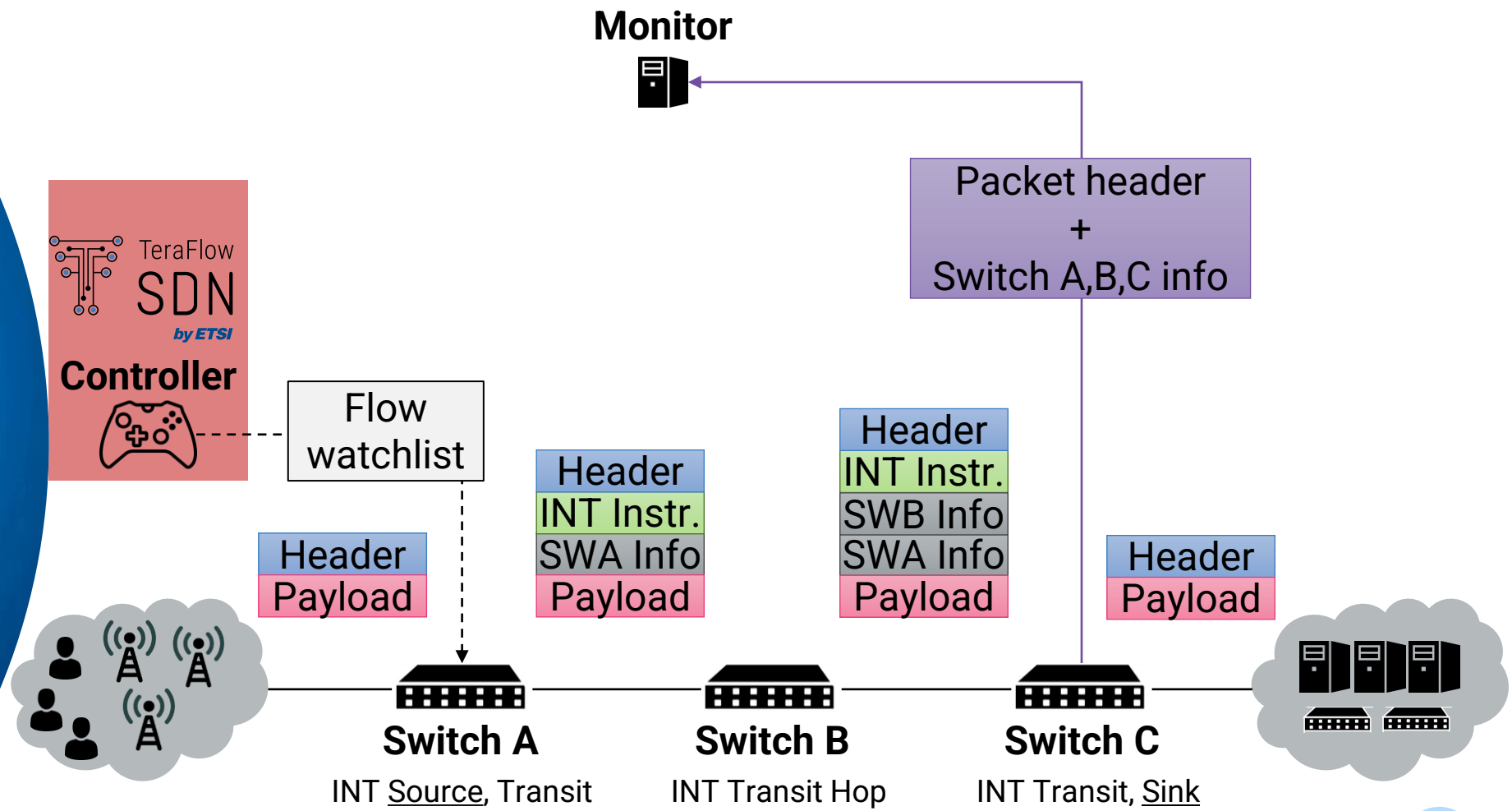


TeraFlow SDN by ETSI Controller

Requirements	Supported
0 General requirements	Partially
1 INT roles for MX	✗
2 Setup INT Domain (as a Service?)	✗

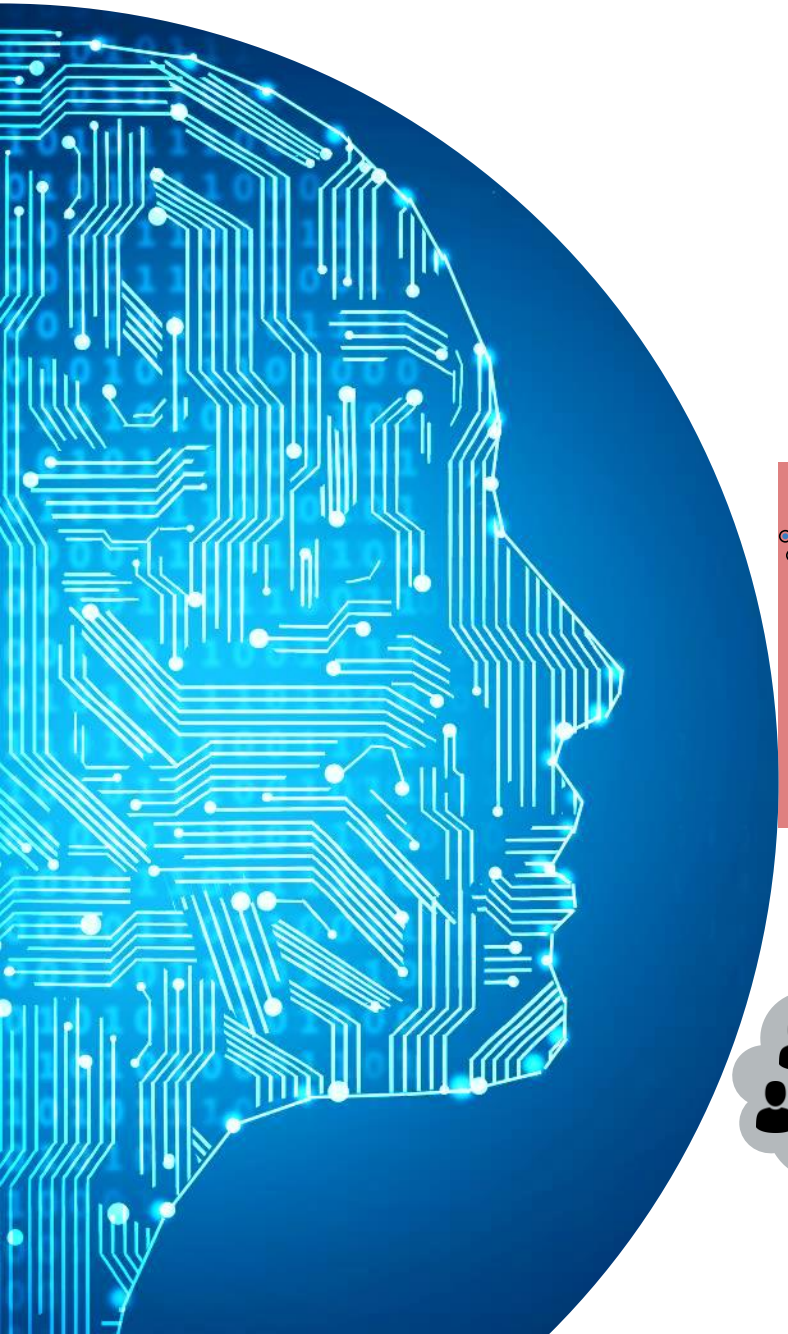


INT- EMbed Data (MD)



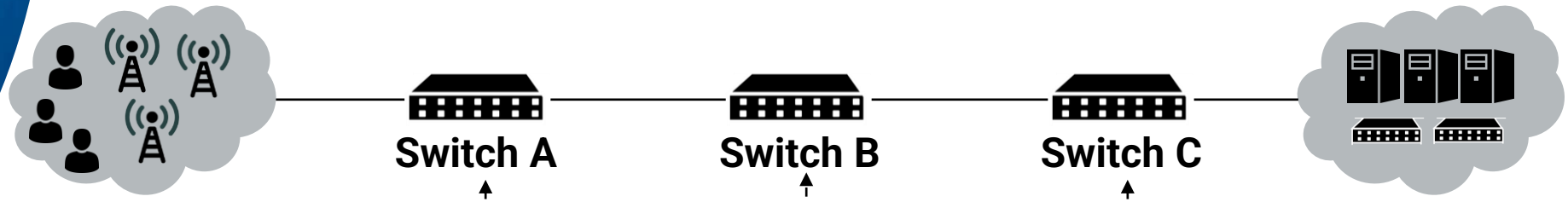
Requirements to support INT MD

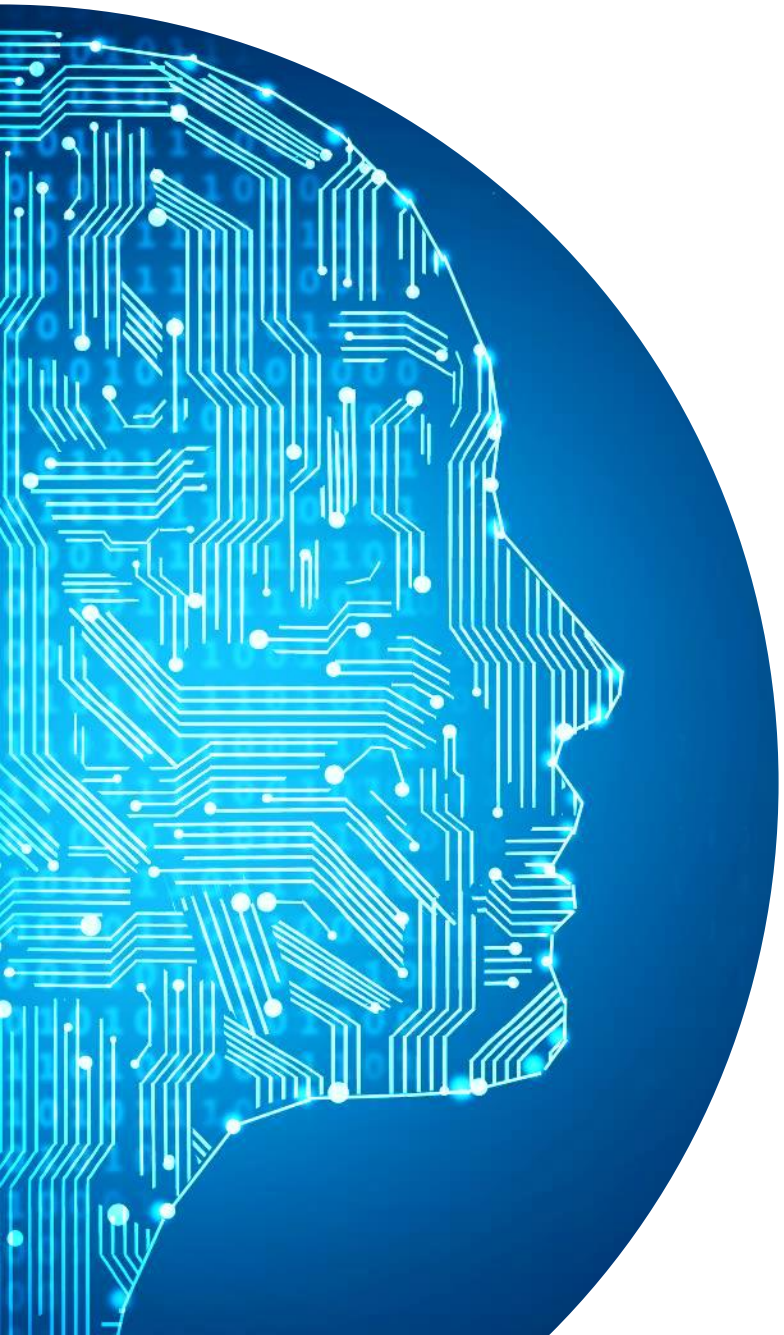
TeraFlow SDN



TeraFlow SDN by ETSI Controller

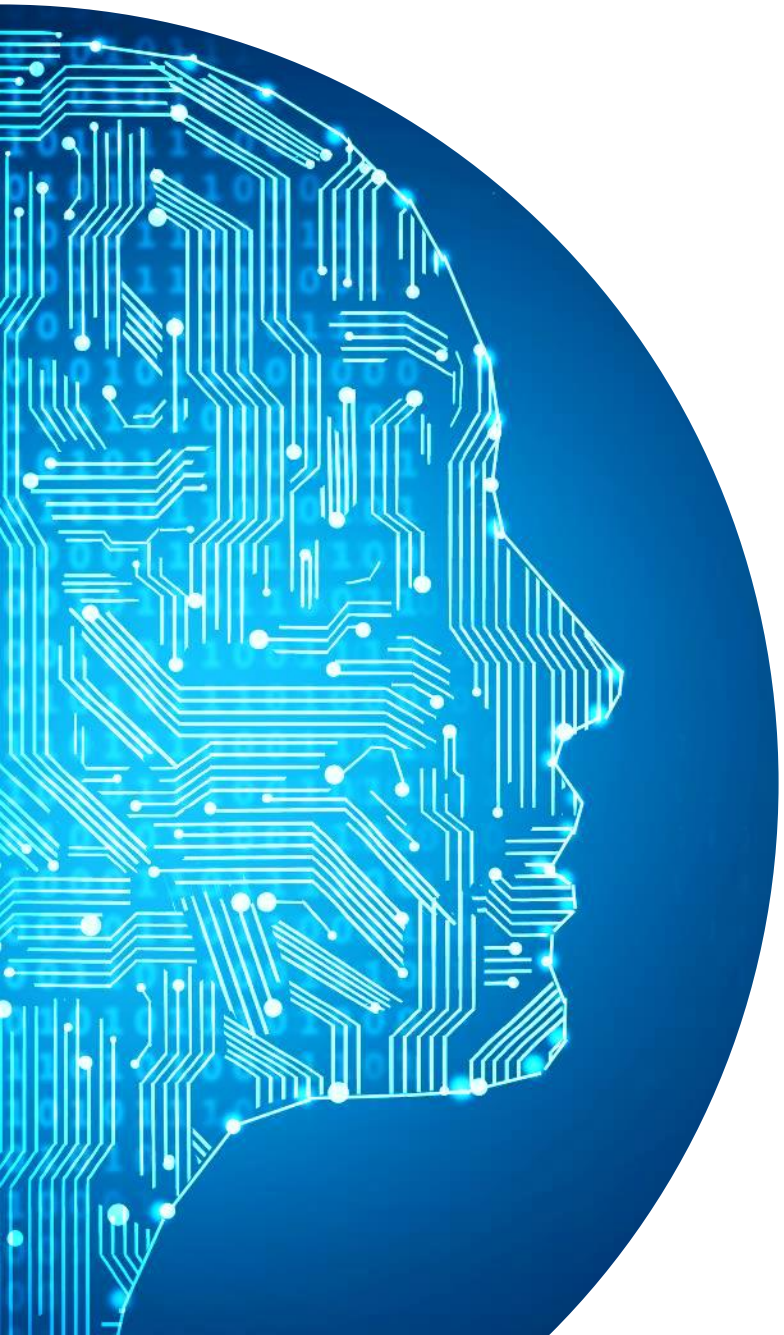
Requirements	Supported
0 General requirements	Partially
1 INT roles for MX	✗
2 Setup INT Domain (as a Service?)	✗





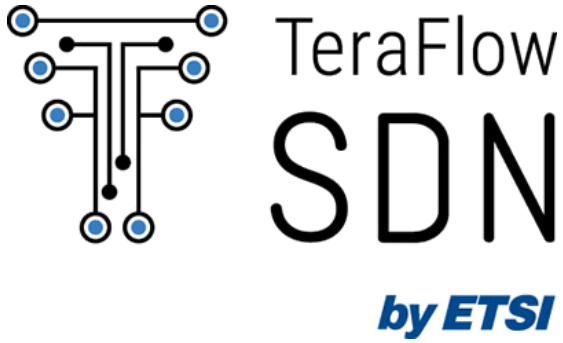
Call for Action

- Plan for support in future releases
  - Preliminary support in early 2024
  - Full support later
- Community assistance is more than welcome!



References

In-band Network Telemetry (INT) Dataplane Specification v2.1:
https://p4.org/p4-spec/docs/INT_v2_1.pdf



Thank you!

TFSsupport@etsi.org