EPSRC
Engineering and Physical Sciences Research Council

NG-CDI
NEXT GENERATION • CONVERGED DIGITAL INFRASTRUCTURE

BT

Self-Generated Intent-Based System

Mehdi Bezahaf - Lancaster University
Marco Hernandez, Lawrence Bardwell, Eleanor Davies, Matthew Broadbent, Daniel King, David Hutchison

10th International Conference on the Network of the Future (NoF'19)

Lancaster University

UNIVERSITY OF CAMBRIDGE

University of BRISTOL

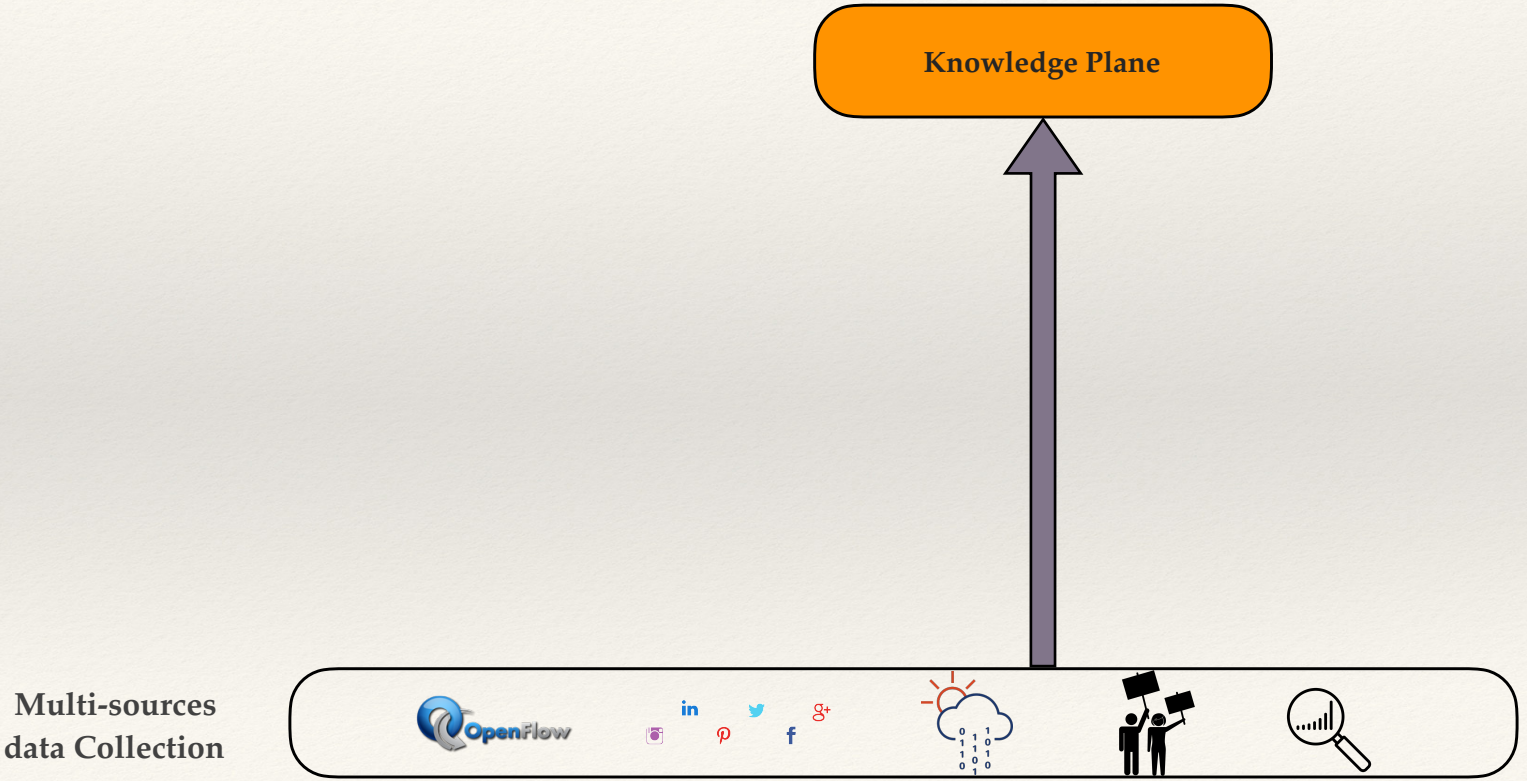
UNIVERSITY OF SURREY

Architecture Planes

Architecture Planes

Multi-sources data Collection

Architecture Planes



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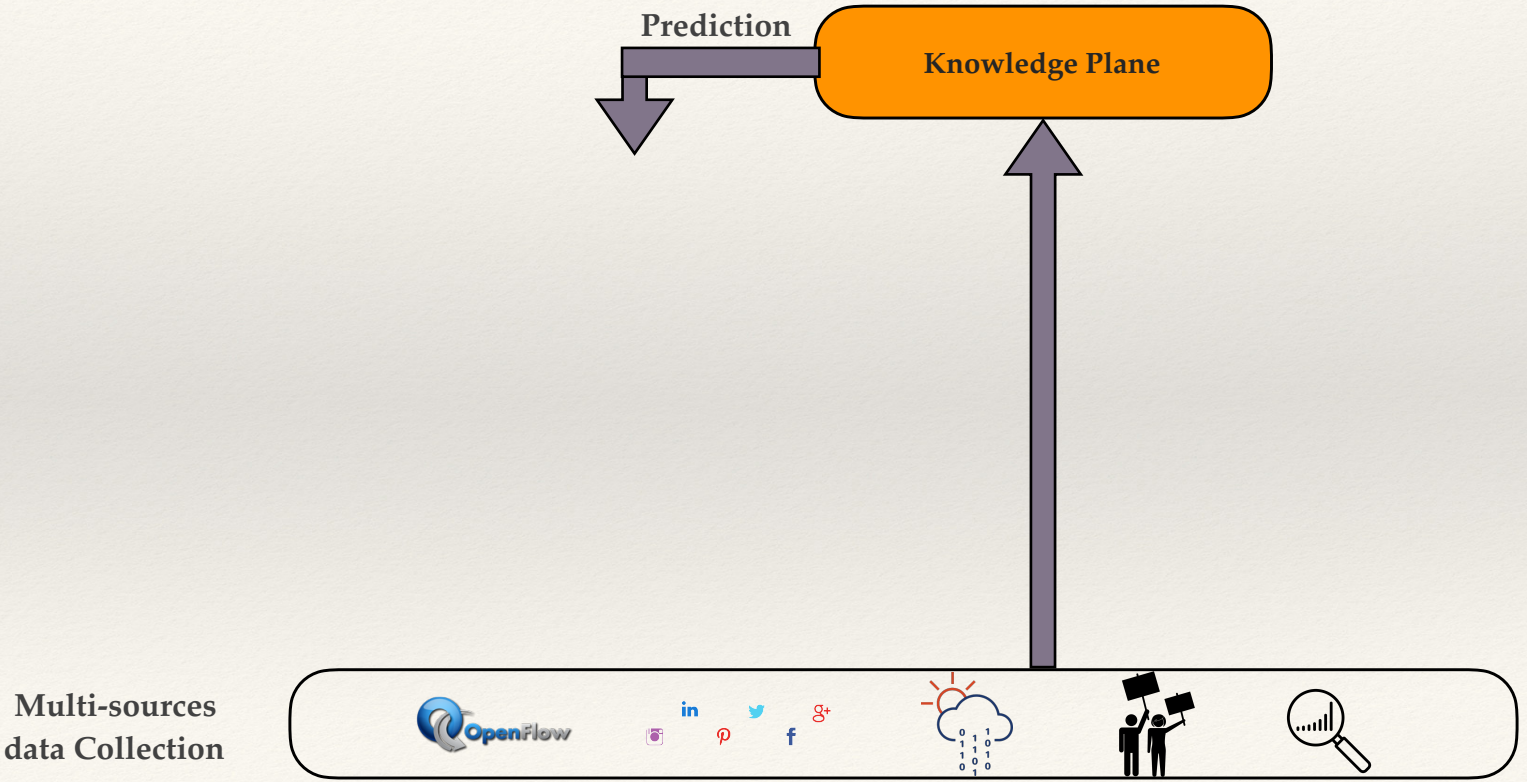

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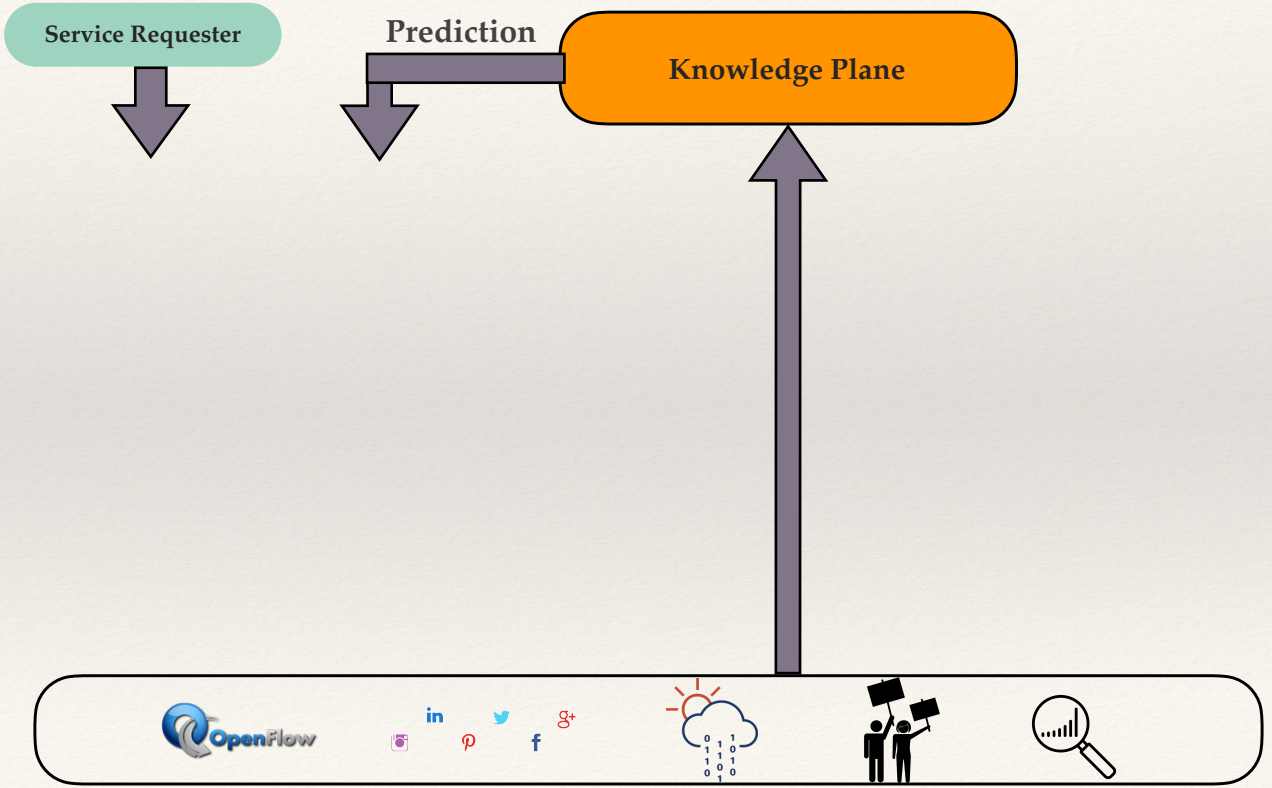

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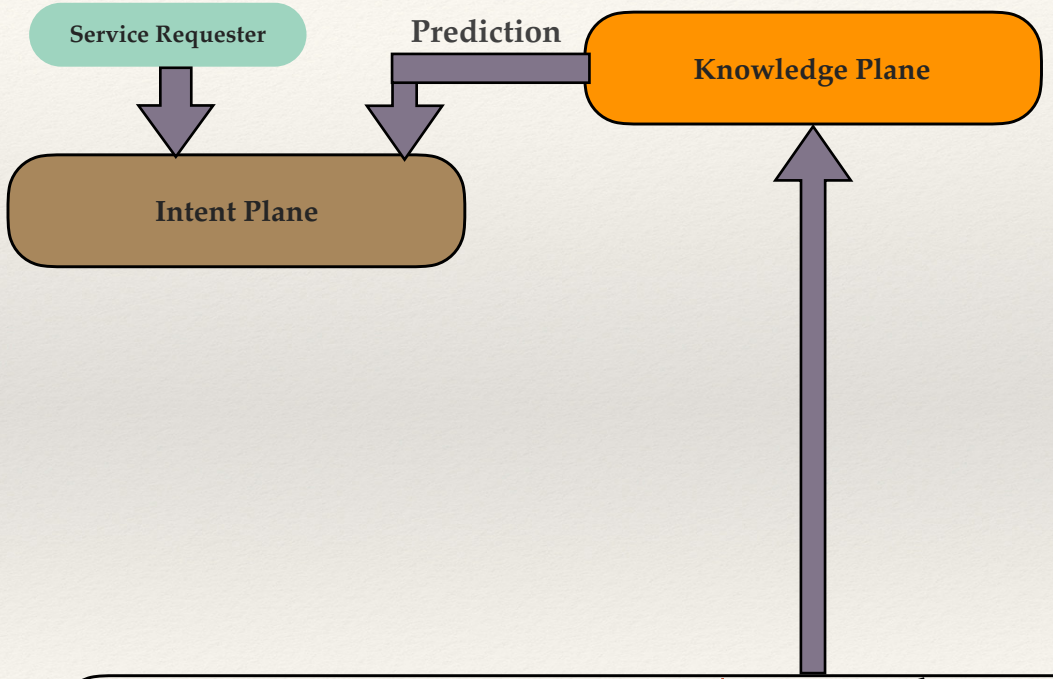

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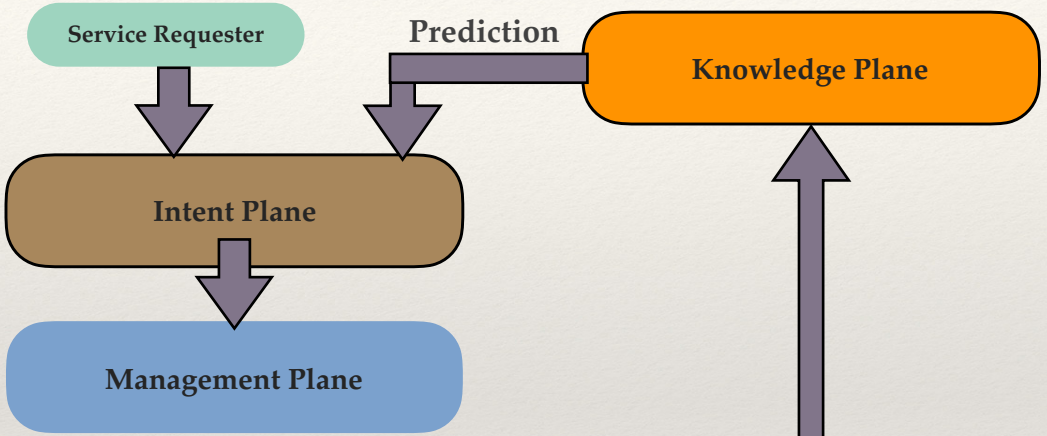

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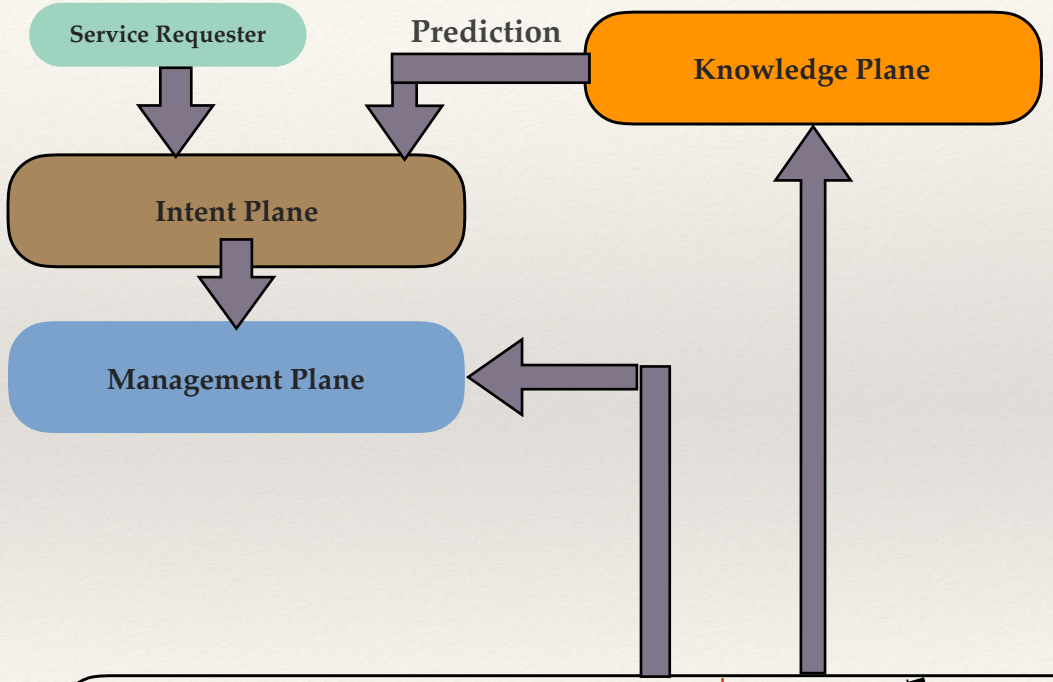

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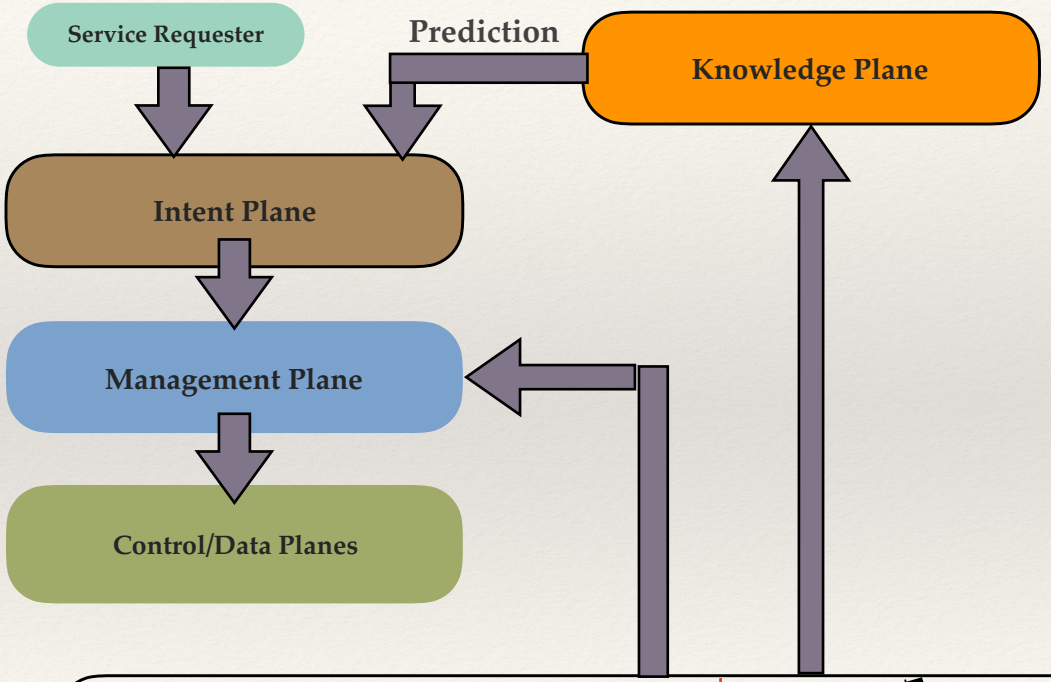

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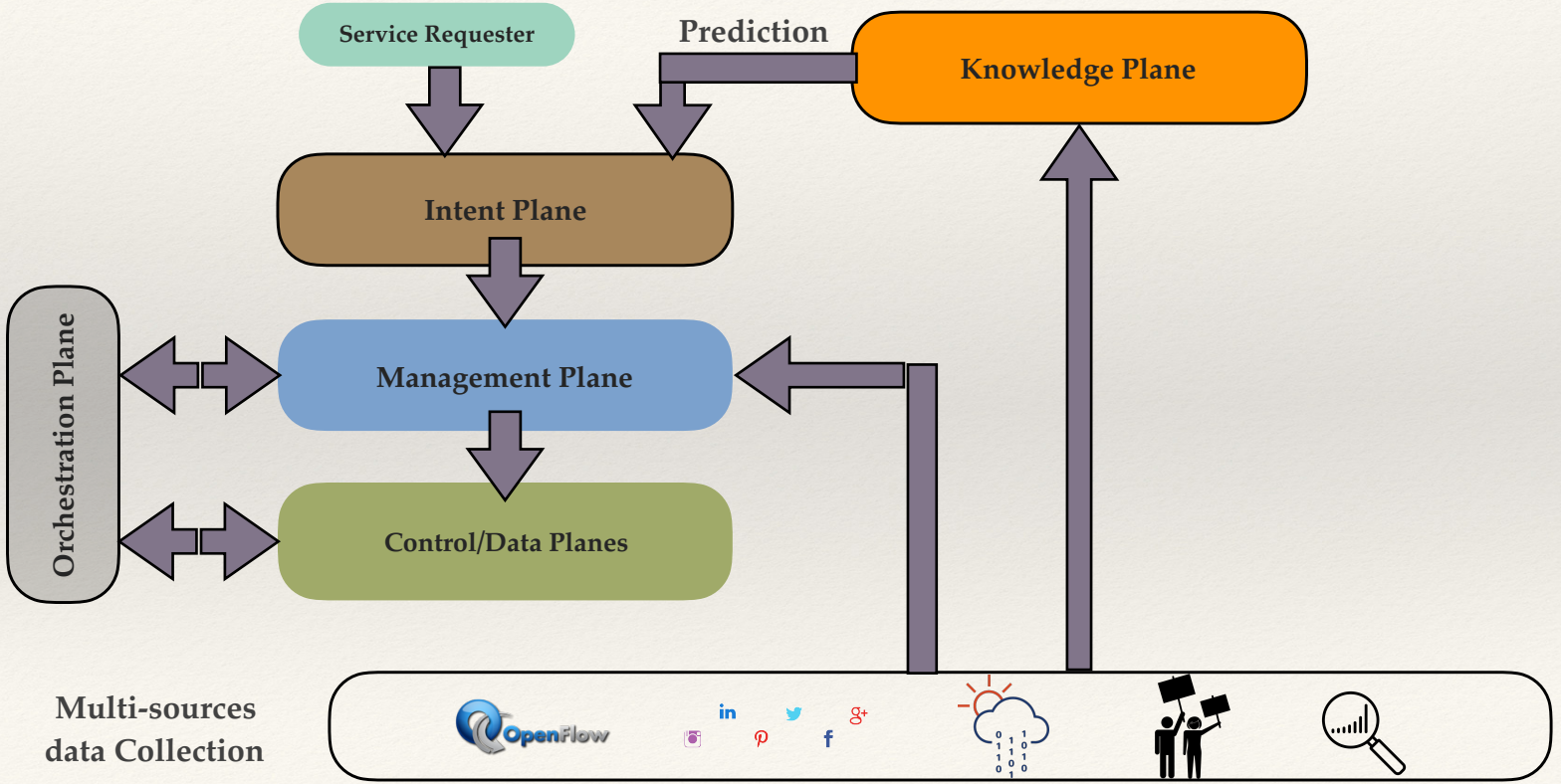
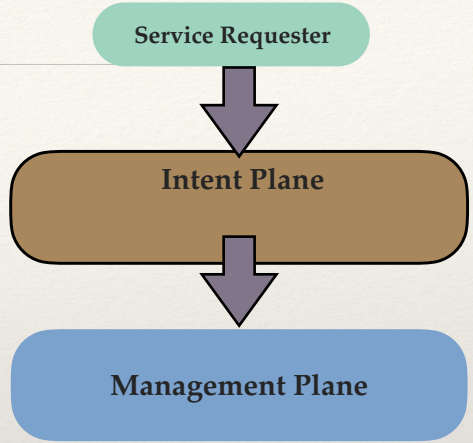
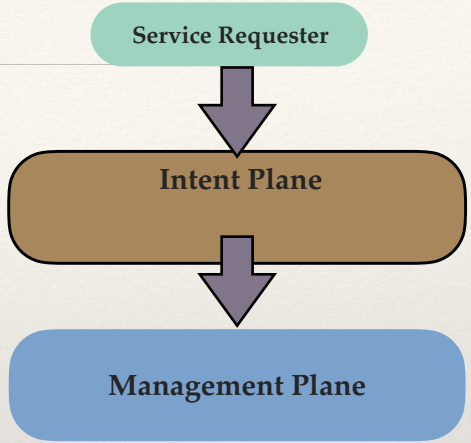


Intent



Intent

- An ***intent*** expresses a requirement:



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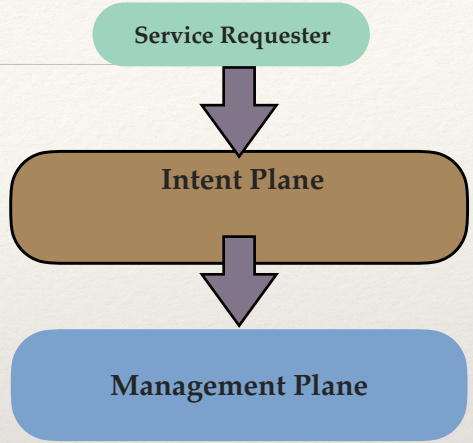
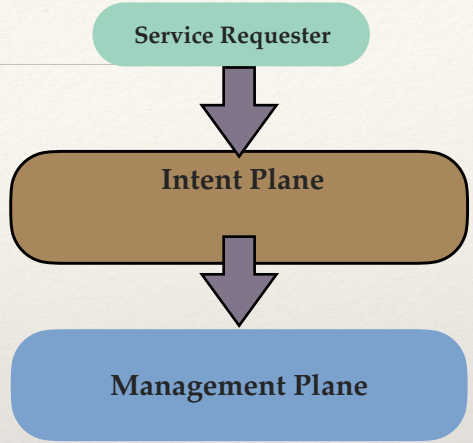
  - Expressed from an external client/app
    - Qualitative
    - High level
    - *I want connectivity, Reserve me an audible connection…*



Intent

- An ***intent*** expresses a requirement:
  - Expressed from an external client/app
    - Qualitative
    - High level
    - *I want connectivity, Reserve me an audible connection…*
  - Owned by the operator
    - Quantitative
    - Might be lower level and precise
    - *Restrict the load to 50% max on a links…*



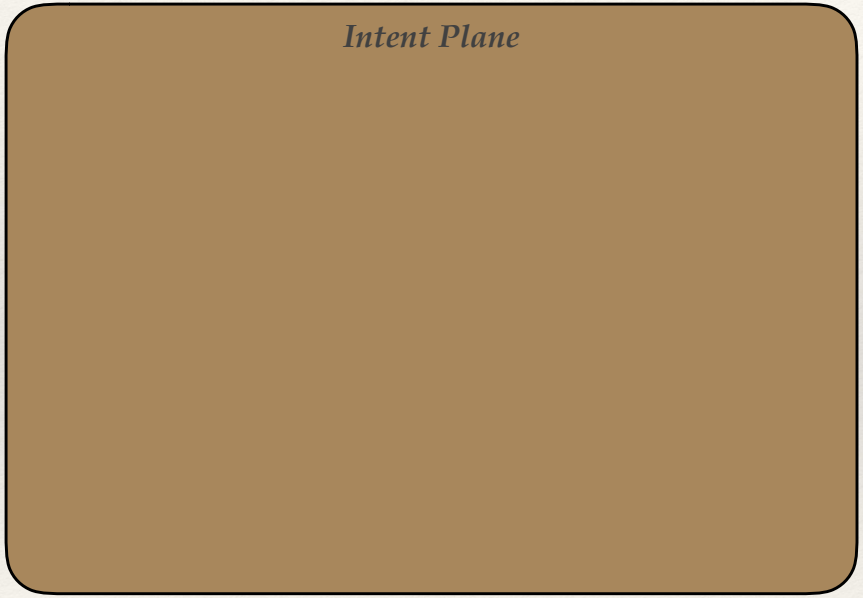
Quality of Service

- QoExperience and QoService are all what the end-users need
- It can be :
  - Jitter
  - Latency
  - Throughput
  - Bandwidth …

Resilience

- Resilience is the ability of the network to preserve all QoS and more face of various faults and challenges
- A system is Resilient, when it is:
  - Available:
    - Accessible when needed;
  - Reliable:
    - Able to provide the service when asked

Multi-layer Intent System



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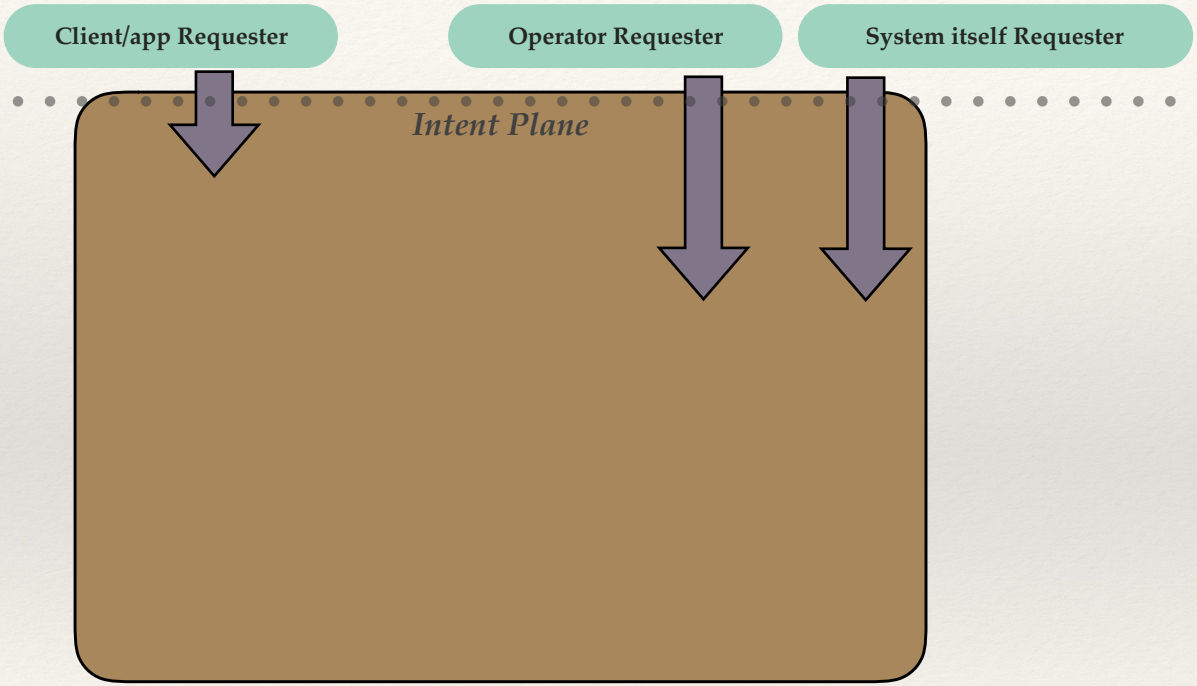

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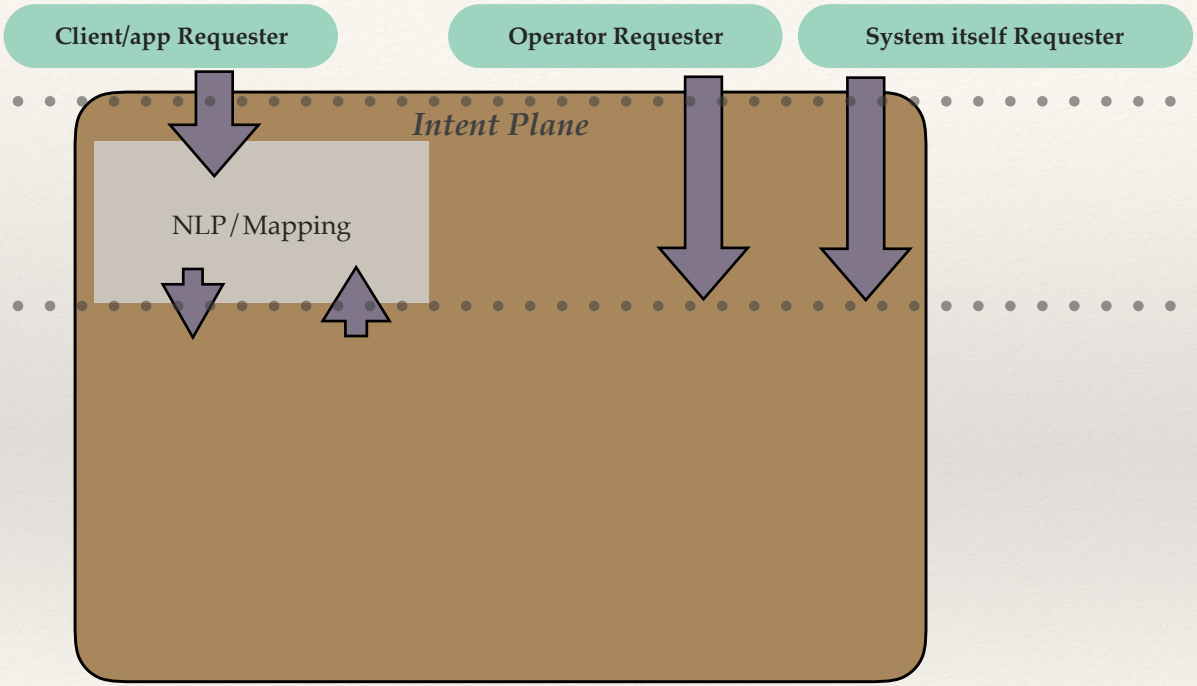

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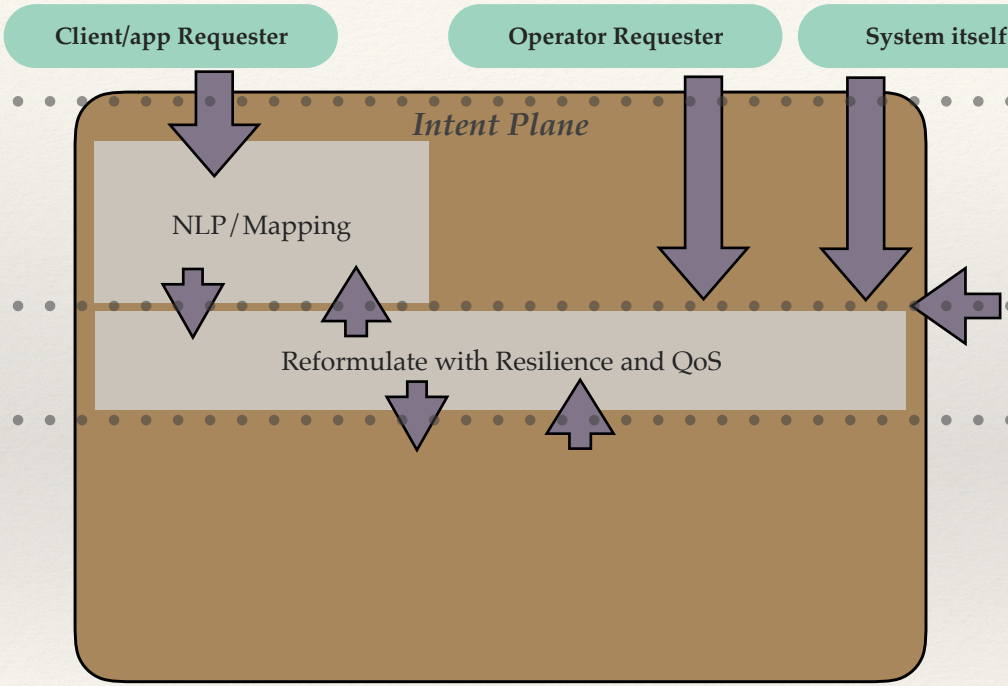

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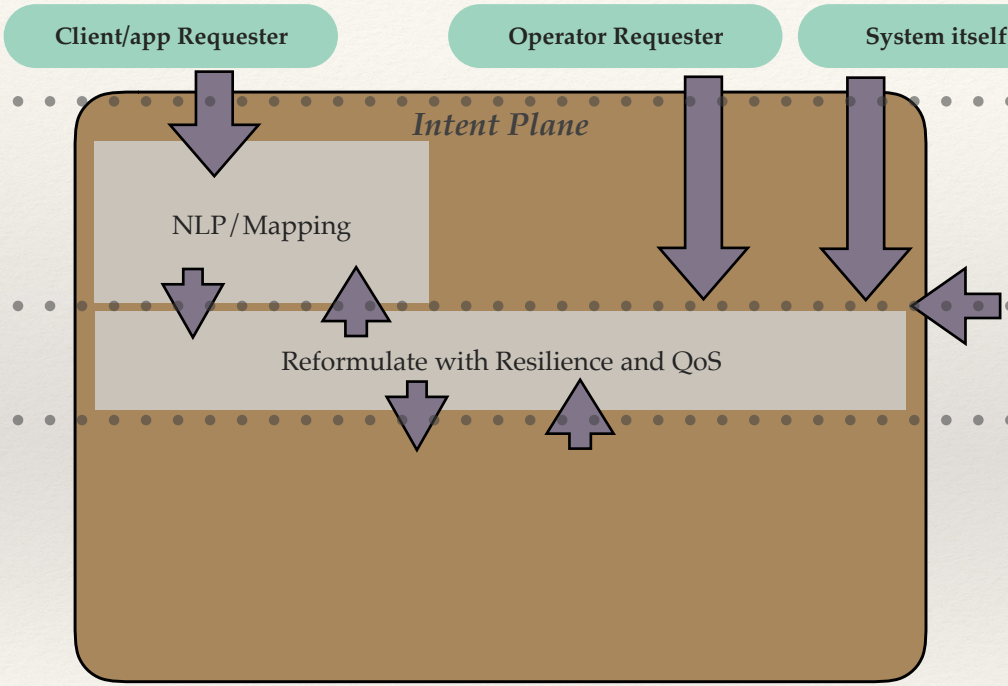

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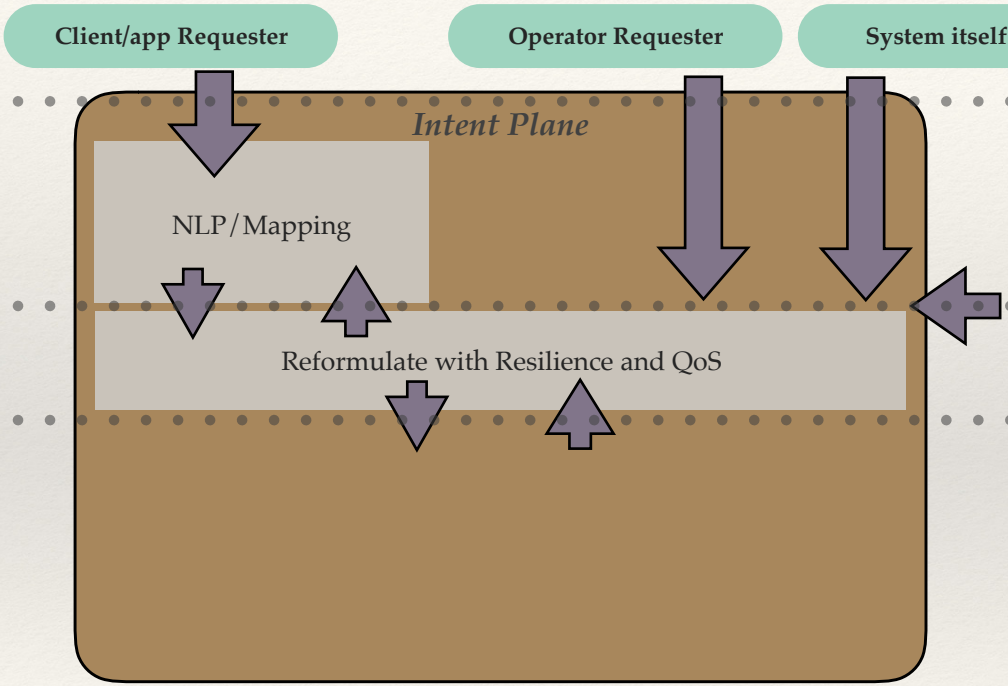

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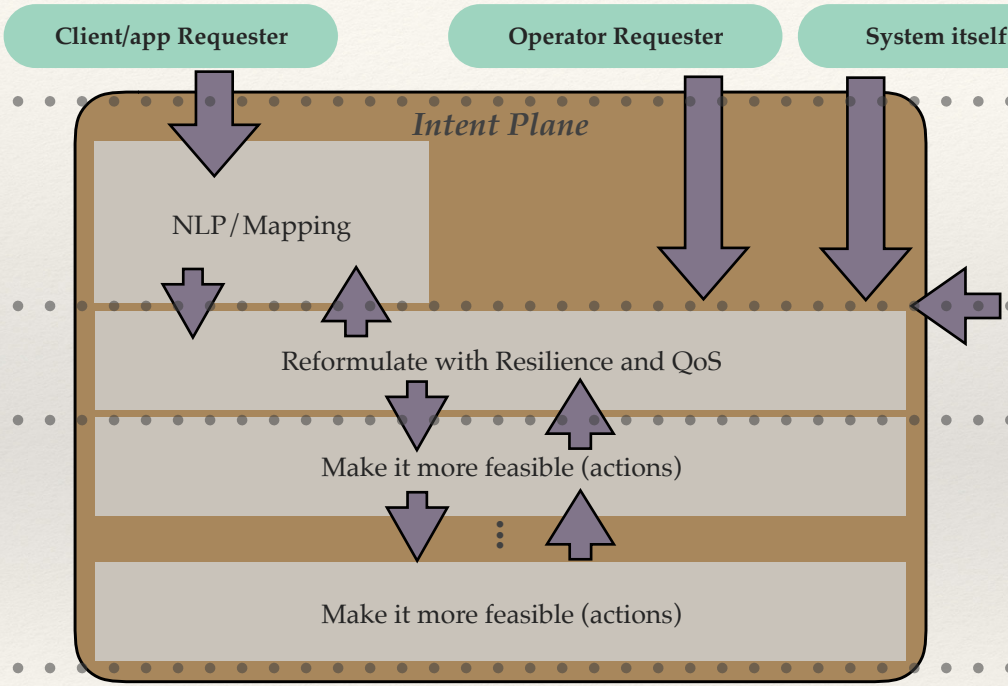

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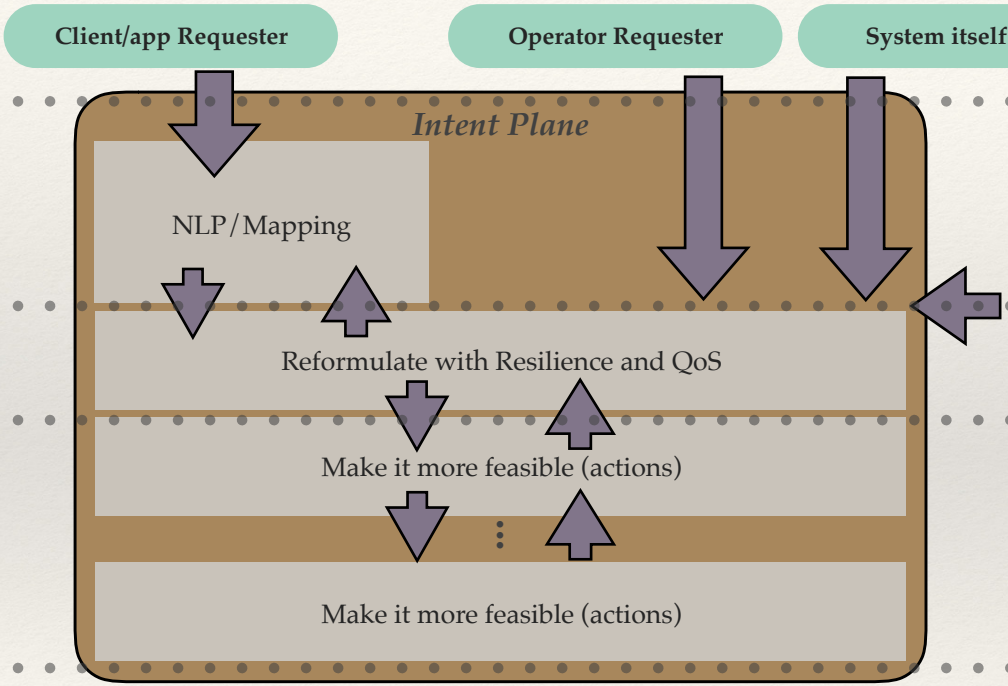

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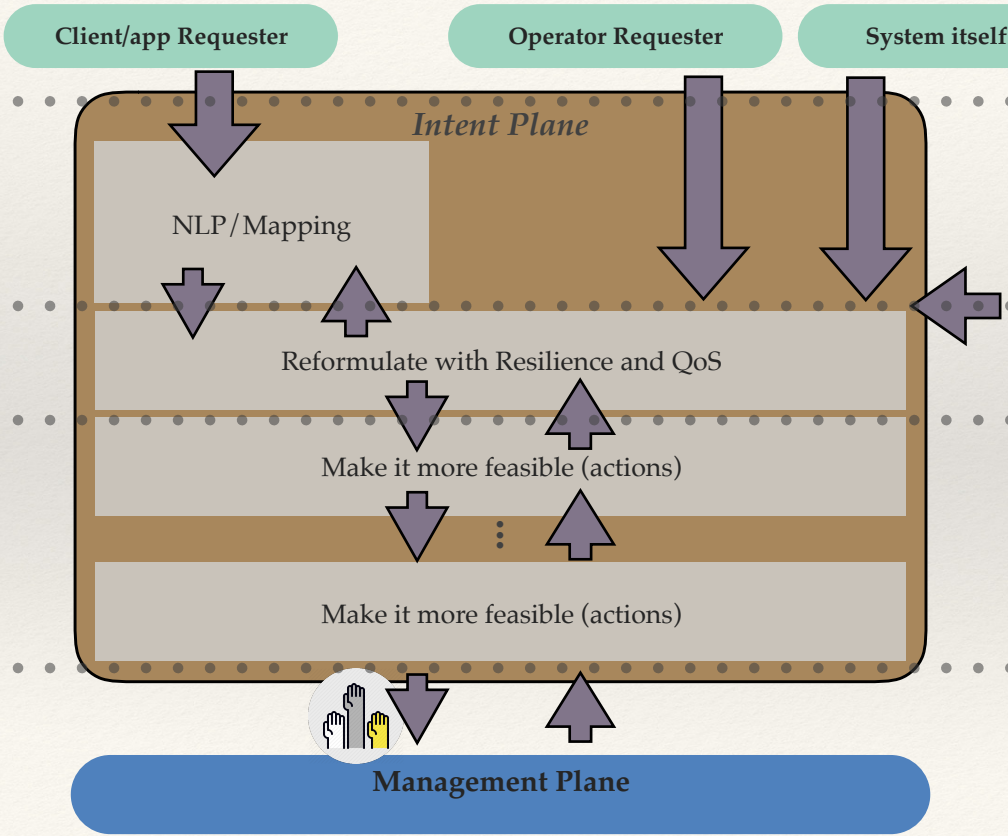

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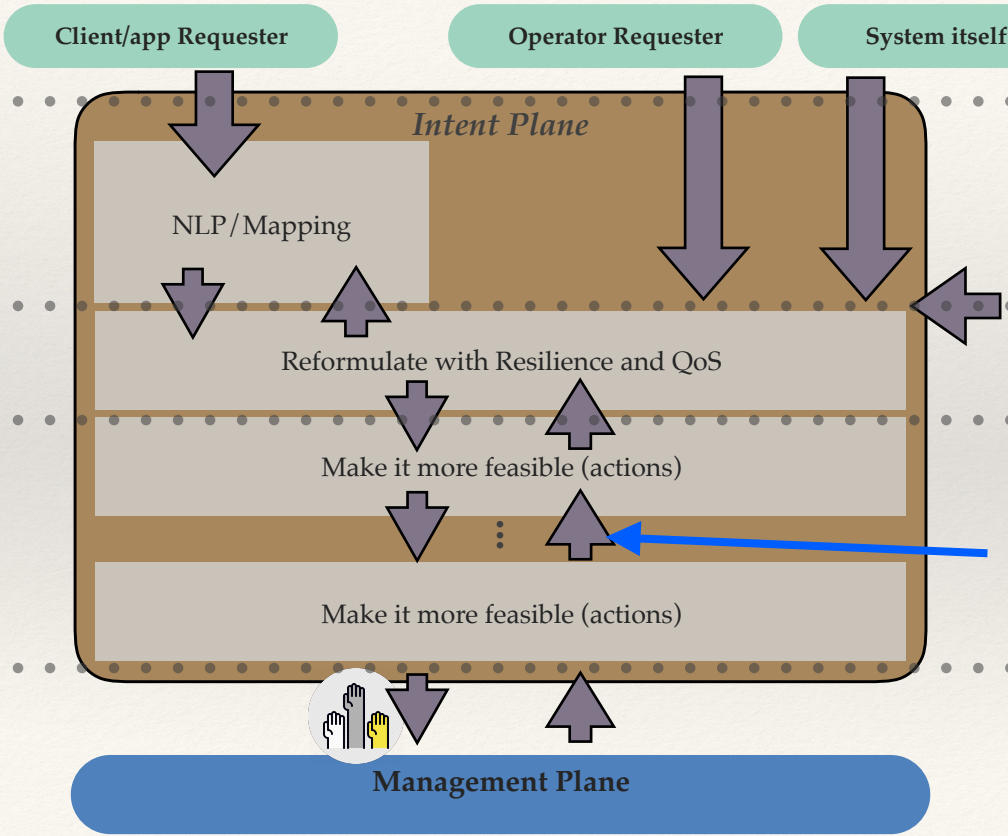

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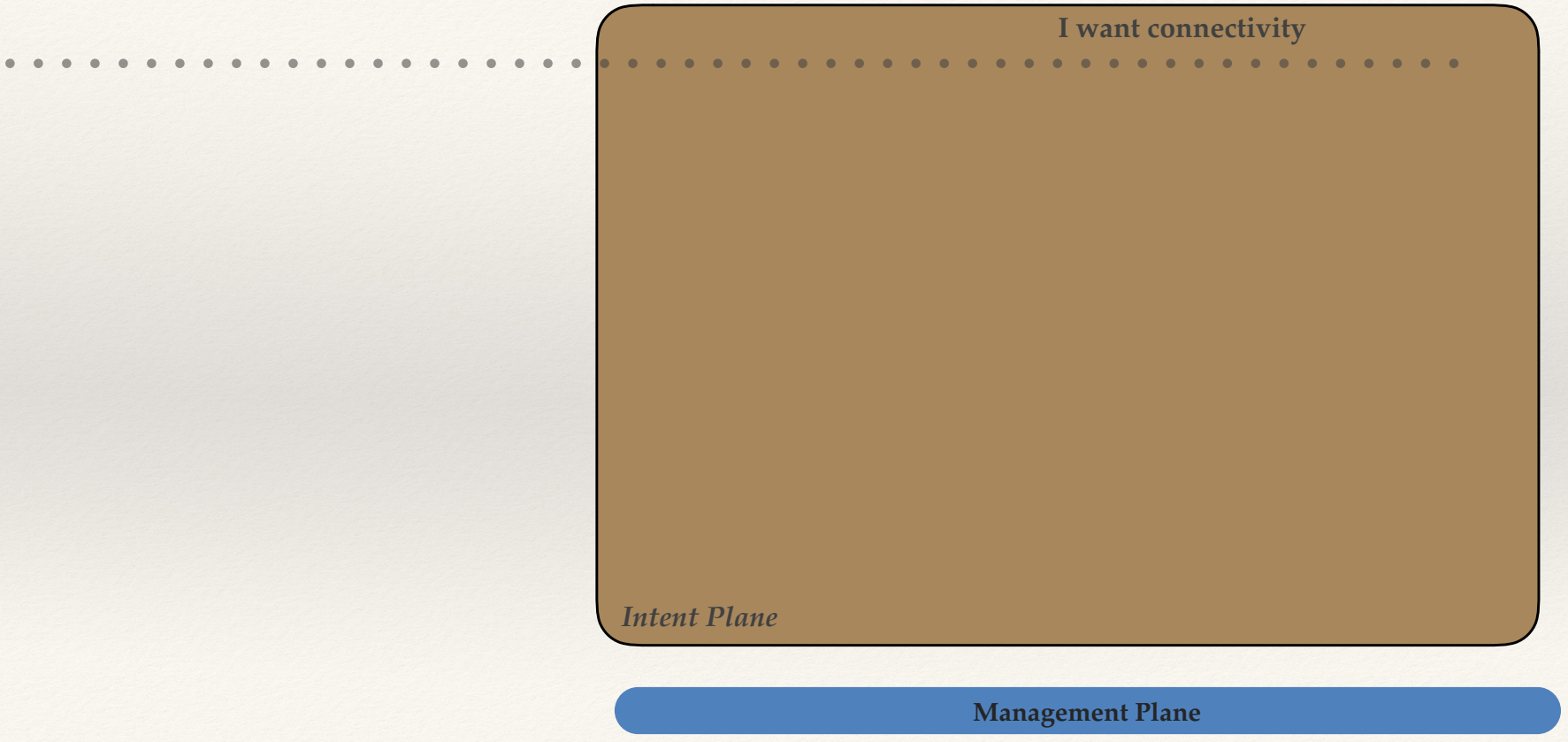
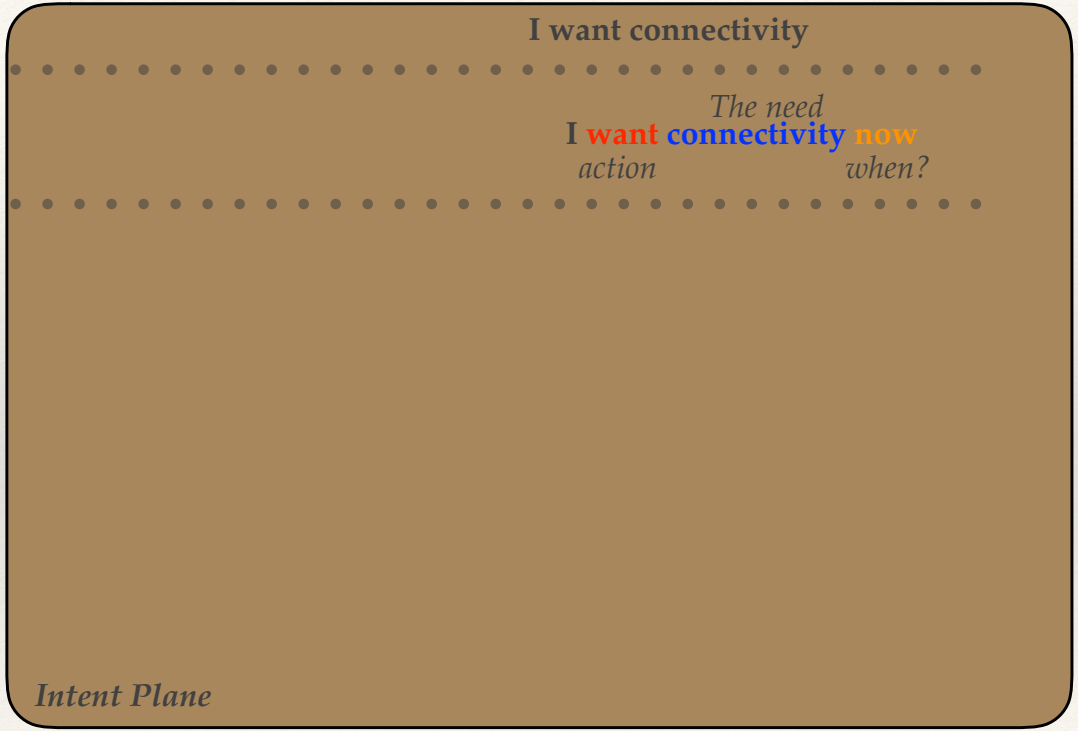


Example – Parallel with RM-ODP model

Entreprise View *what for? Why? Who? When?*

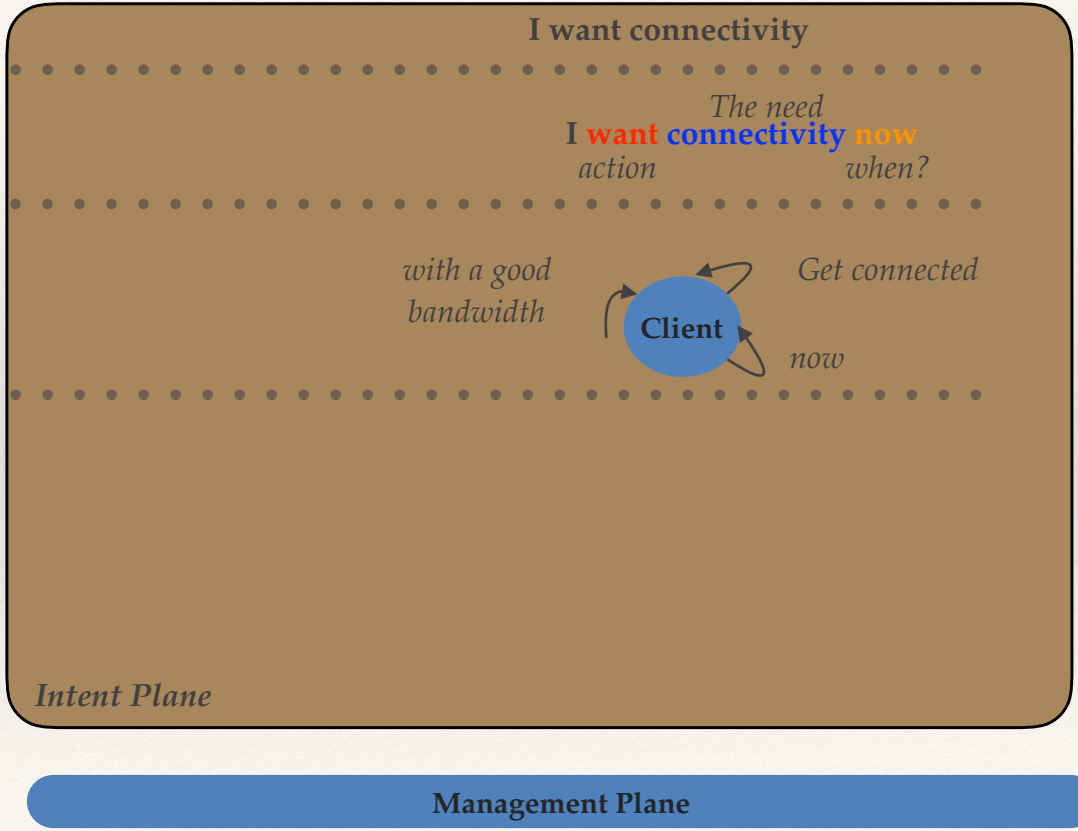


Management Plane

Example – Parallel with RM-ODP model

Entreprise View *what for? Why? Who? When?*

Information View *what is about?*

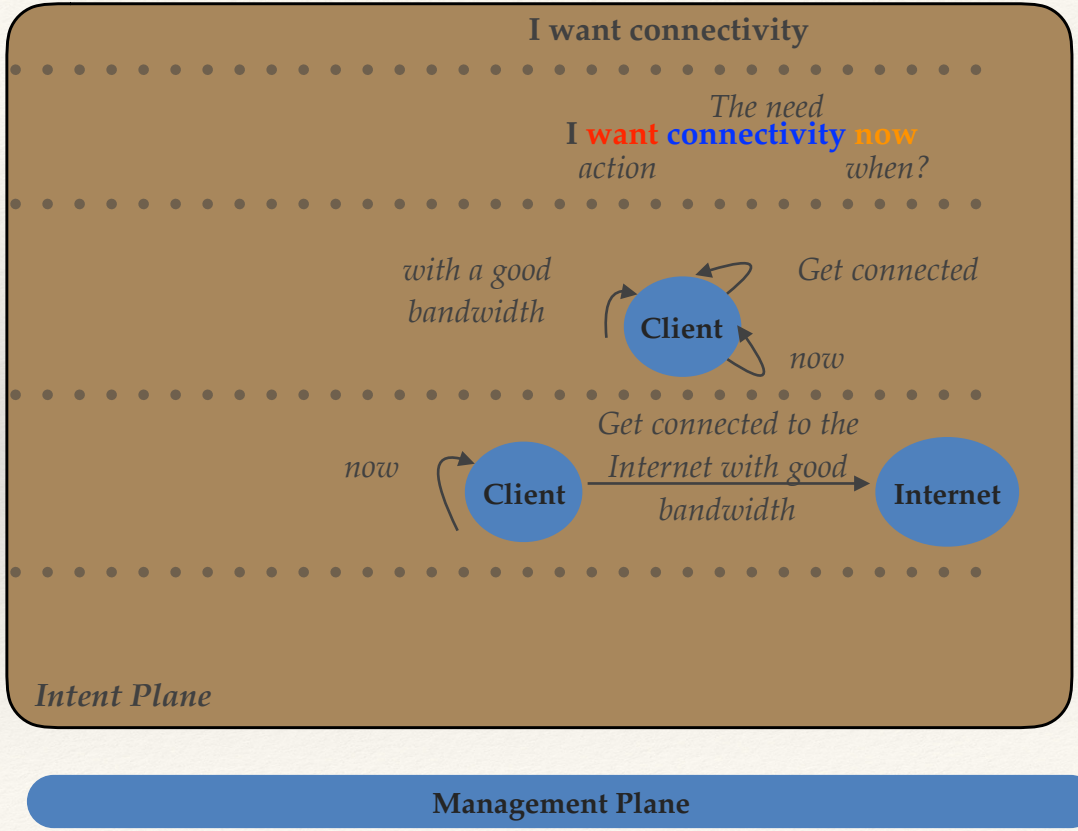


Example – Parallel with RM-ODP model

Entreprise View *what for? Why? Who? When?*

Information View *what is about?*

Computational View *How does each bit work?*



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Example – Parallel with RM-ODP model

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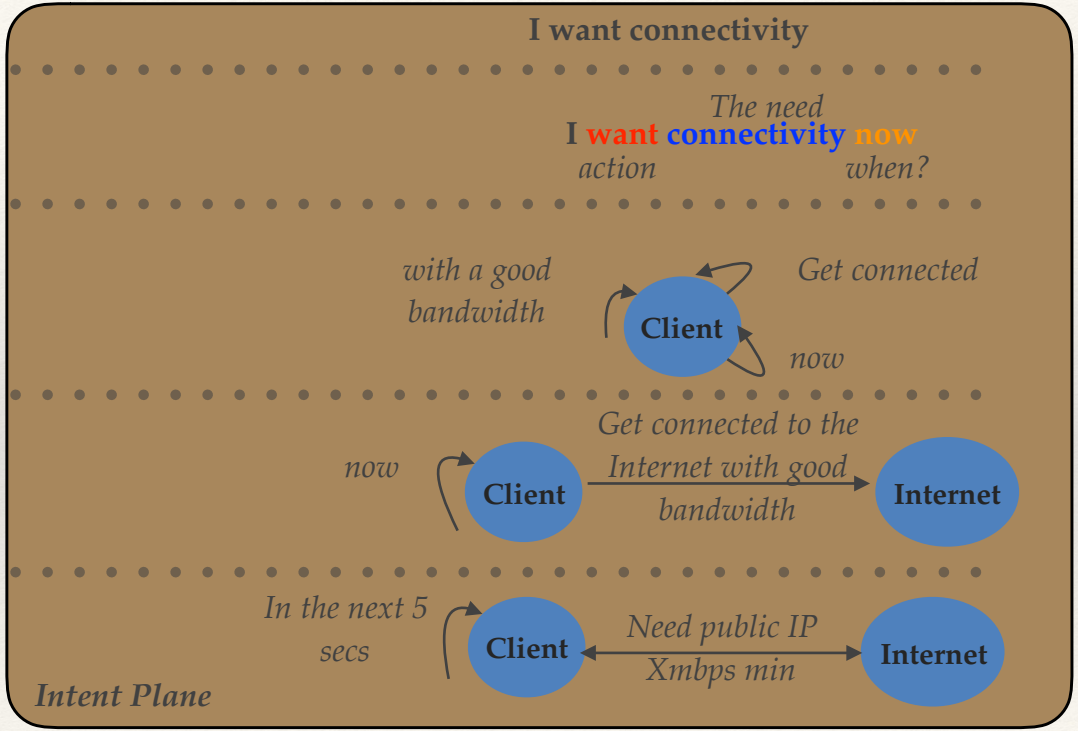

Management Plane

Example – Parallel with RM-ODP model

Entreprise View *what for? Why? Who? When?*

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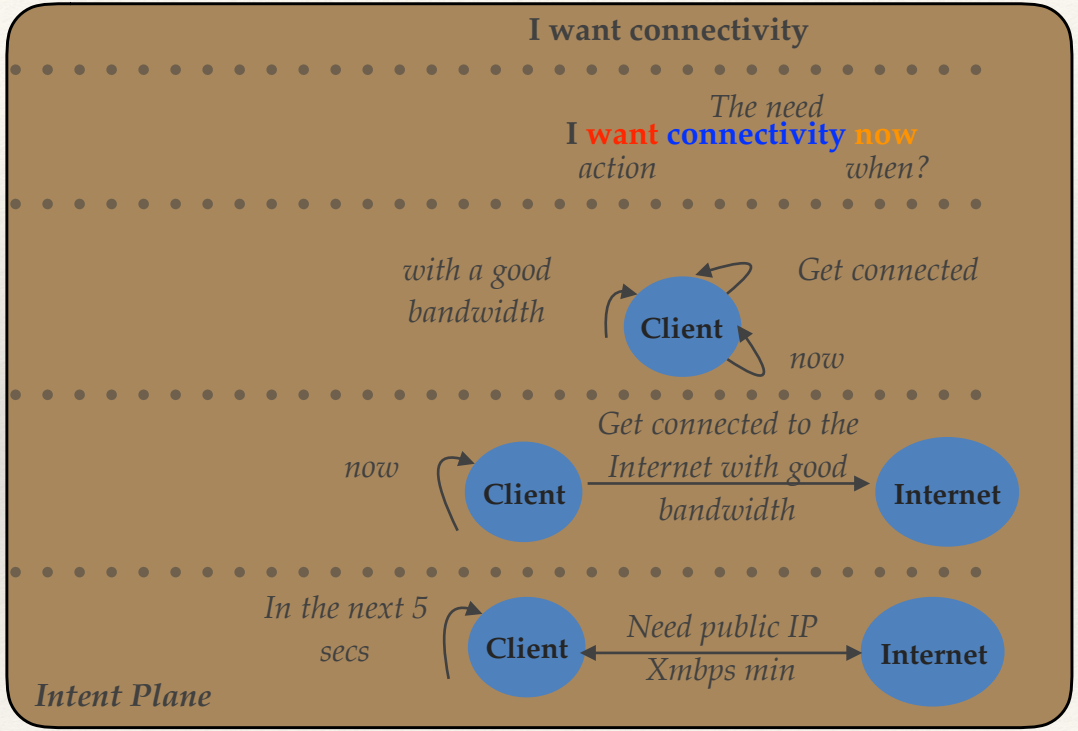
Computational View *How does each bit work?*

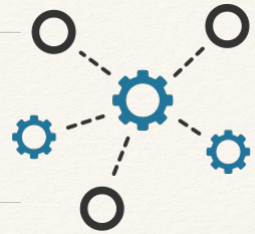
Engineering View *How does components work together?*

Topology View *With what?*



Management Plane

Instrumentation – *Cross-source data*



Knowledge Plane

Control/Data Planes

Legacy NMS

SDN Controller

Collection

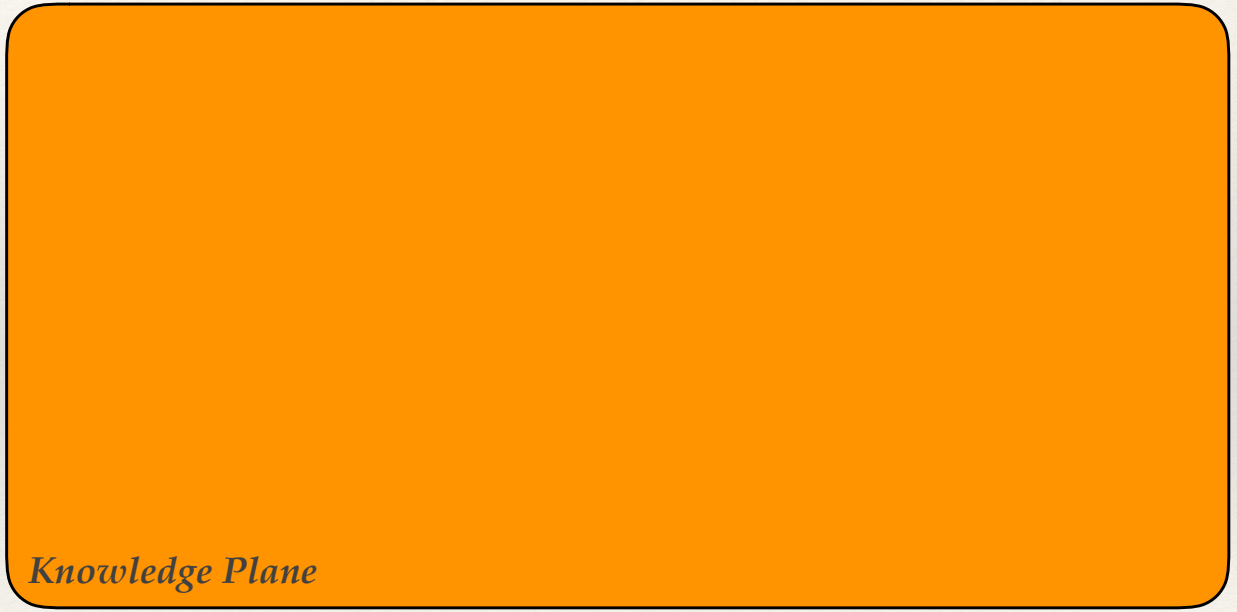
Societal behaviours

Weather events

Political decisions

… and more

Knowledge Plane



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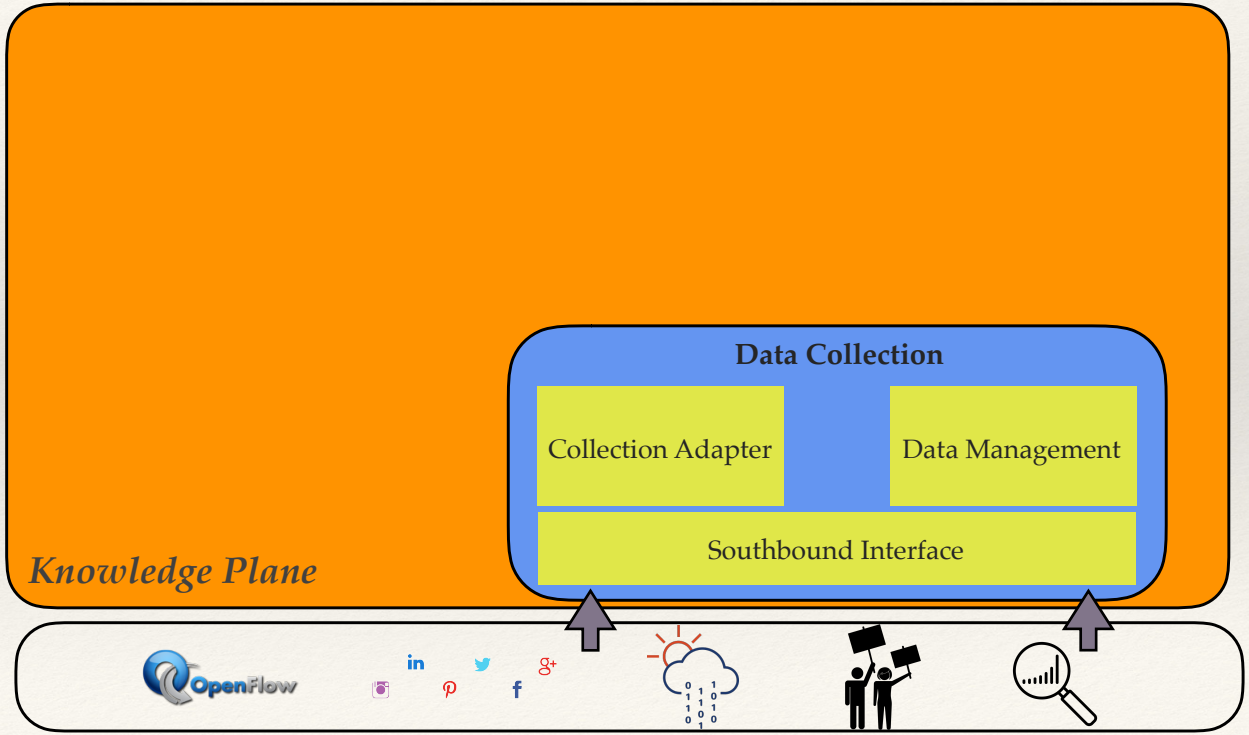

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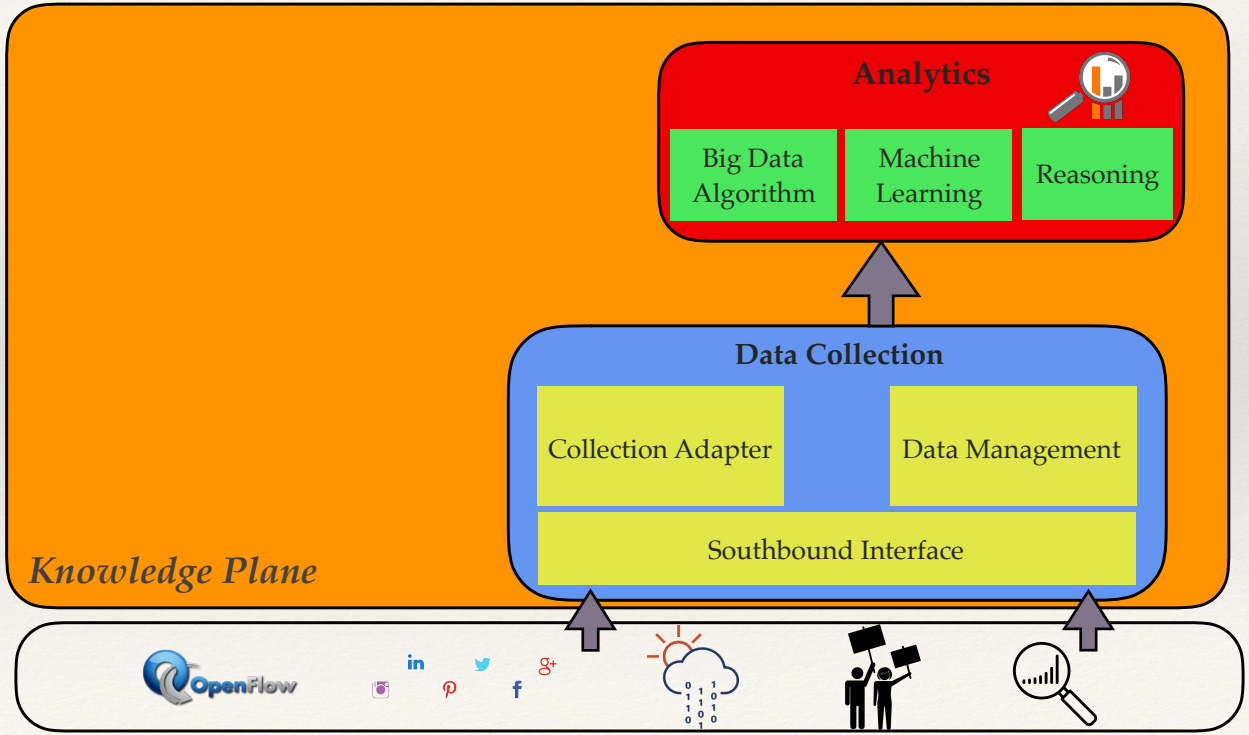

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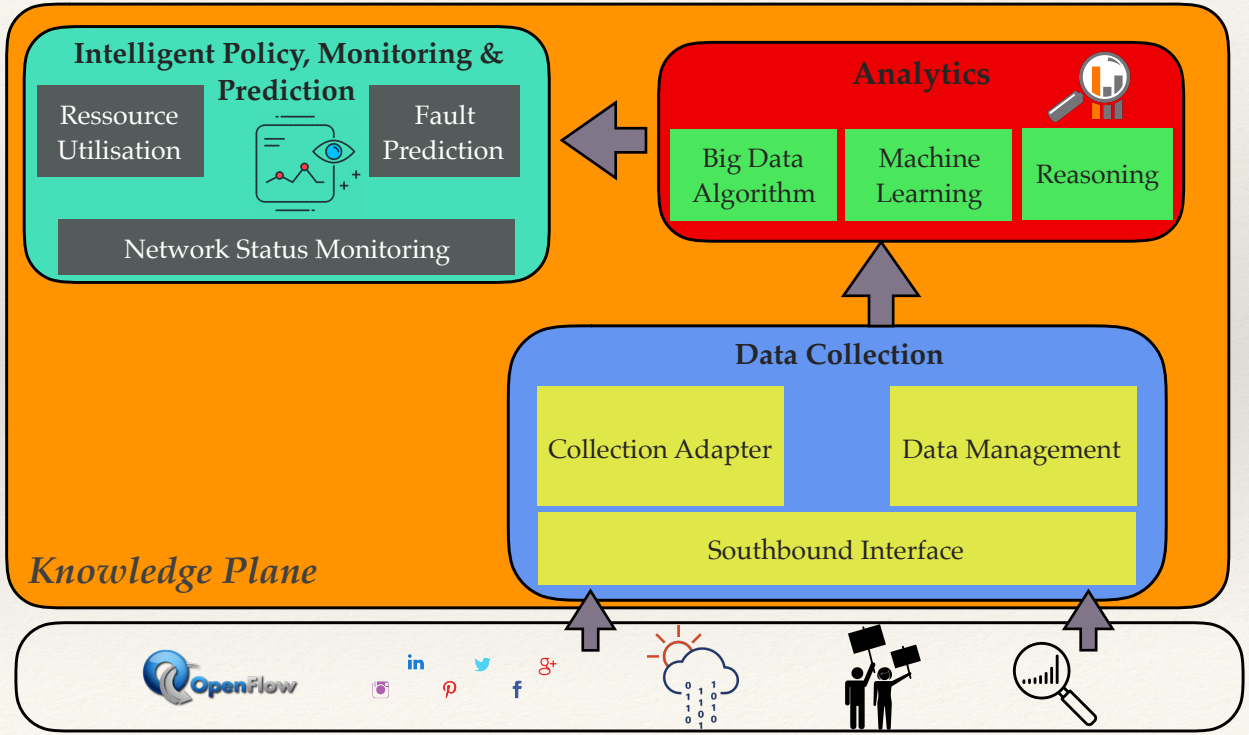

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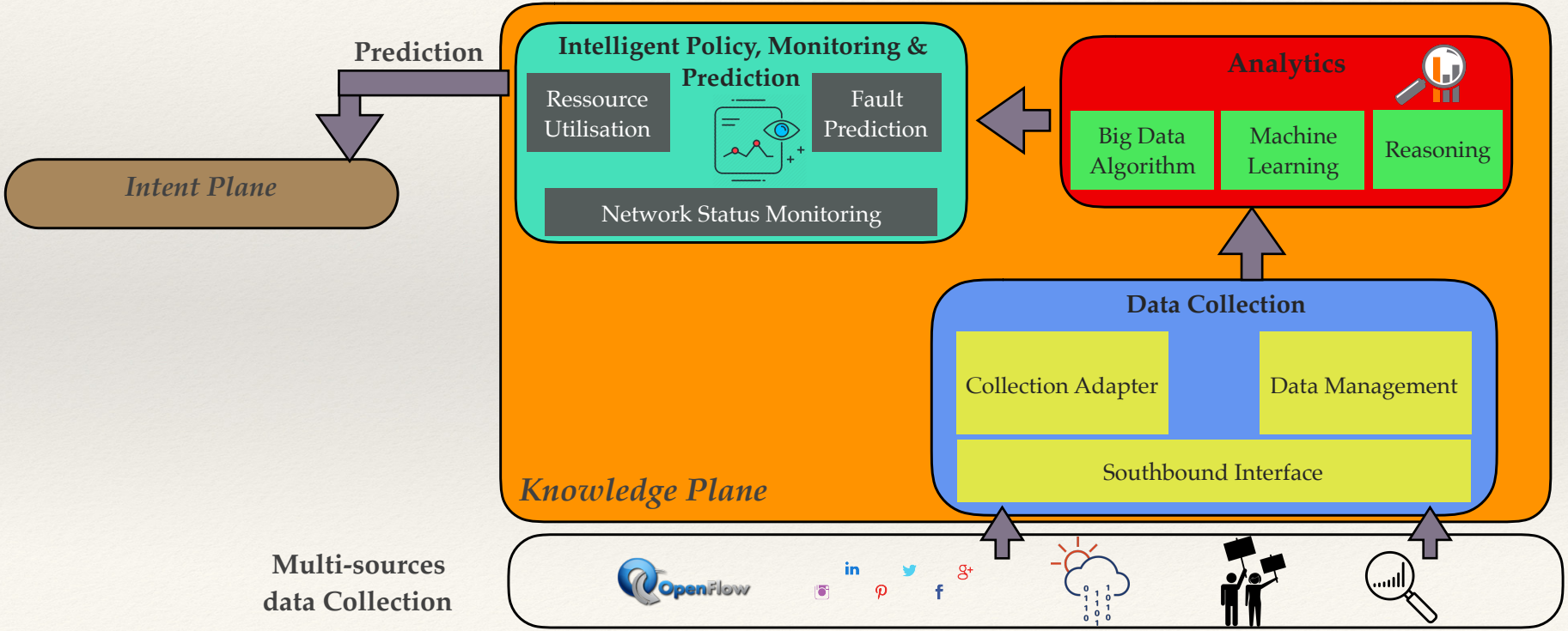

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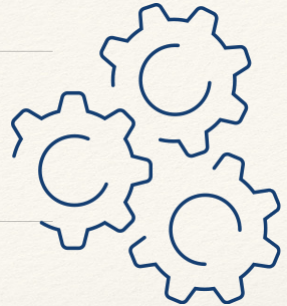


Intent Plane

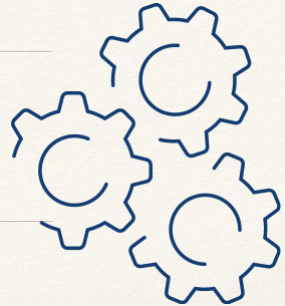
Management Plane

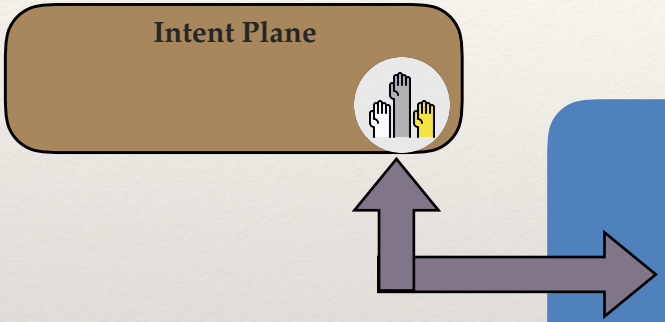
Control/Data Planes

Network Element

Network Element

Management Plane





1- The Intent Plane sends the request to the management plane.

Management Plane

Control/Data Planes

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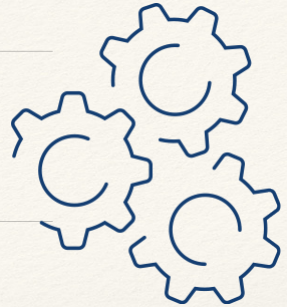
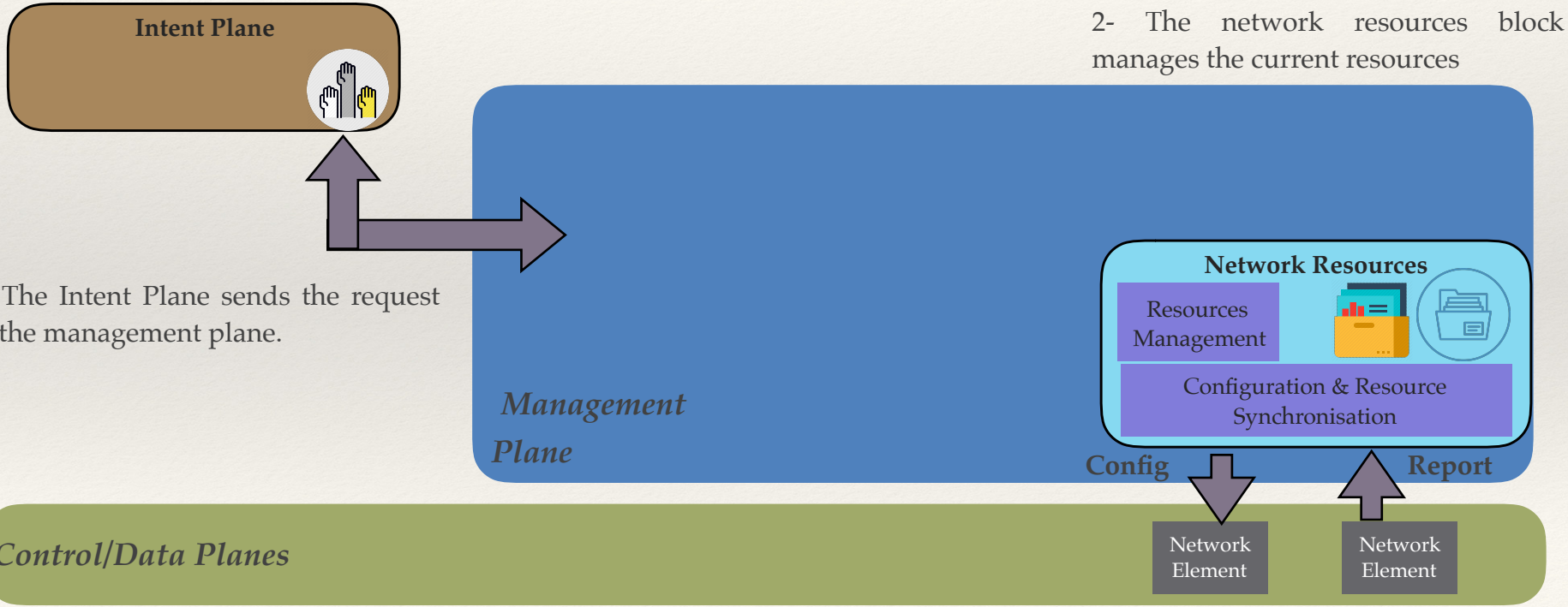
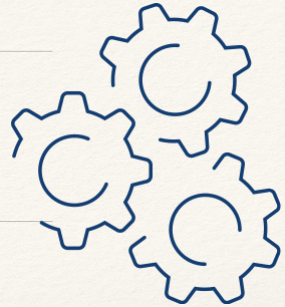




2- The network resources block manages the current resources

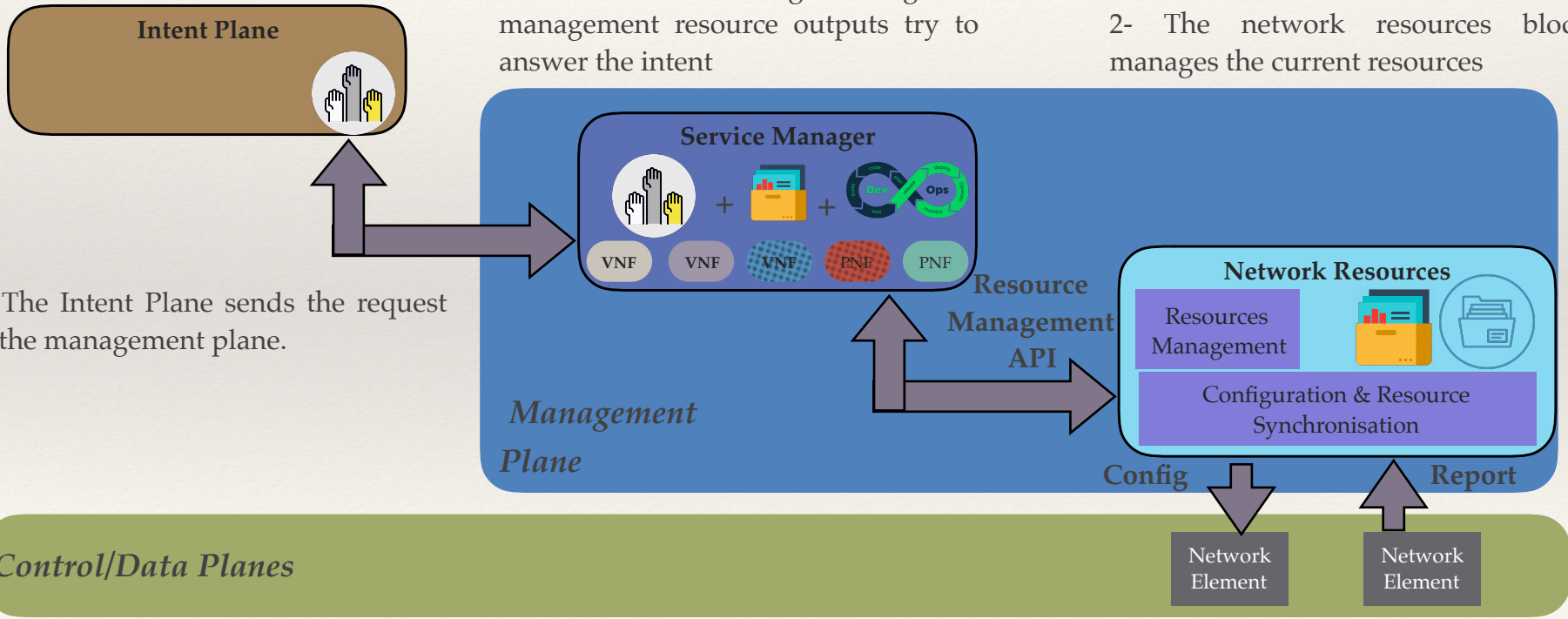
1- The Intent Plane sends the request to the management plane.

Management Plane



3- The service manager using the management resource outputs try to answer the intent

2- The network resources block manages the current resources



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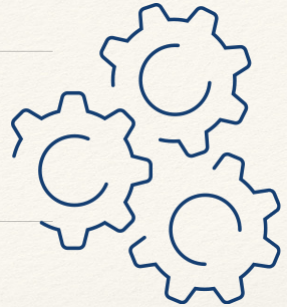

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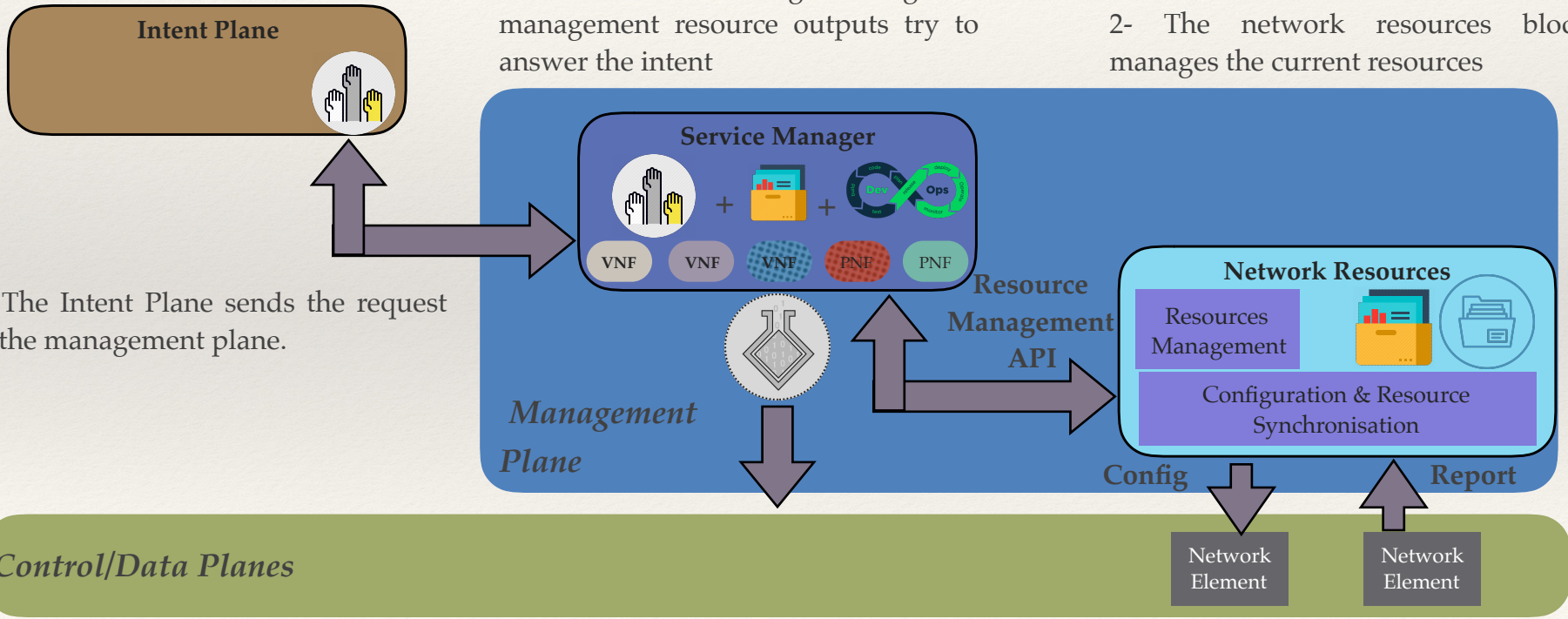

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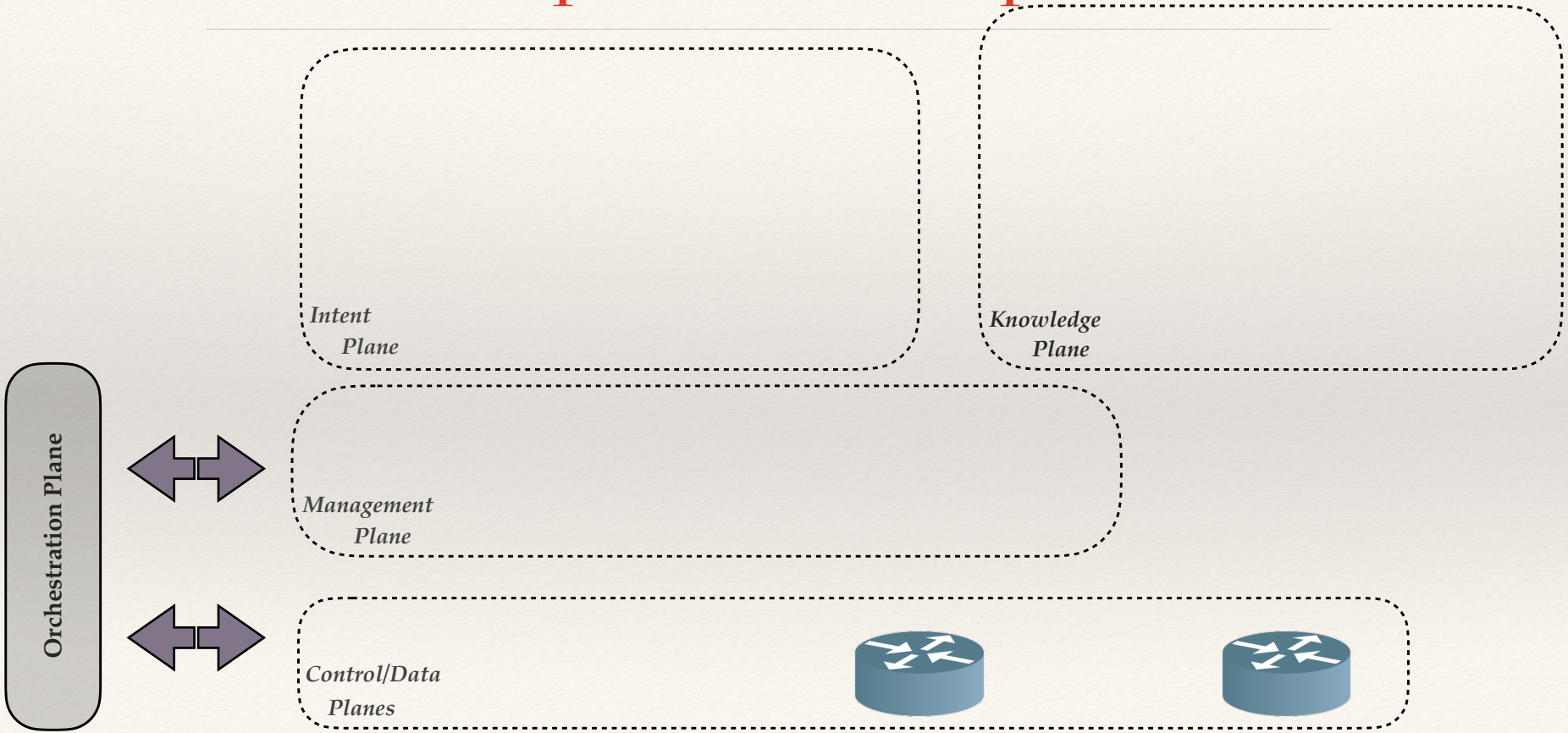
Orchestration

- Two types of orchestration:

  - Ressource orchestration
    - Governance of VNF instances sharing resources
  - Service orchestration
    - Creation of E2E services composing different VNFs

Operational Loop



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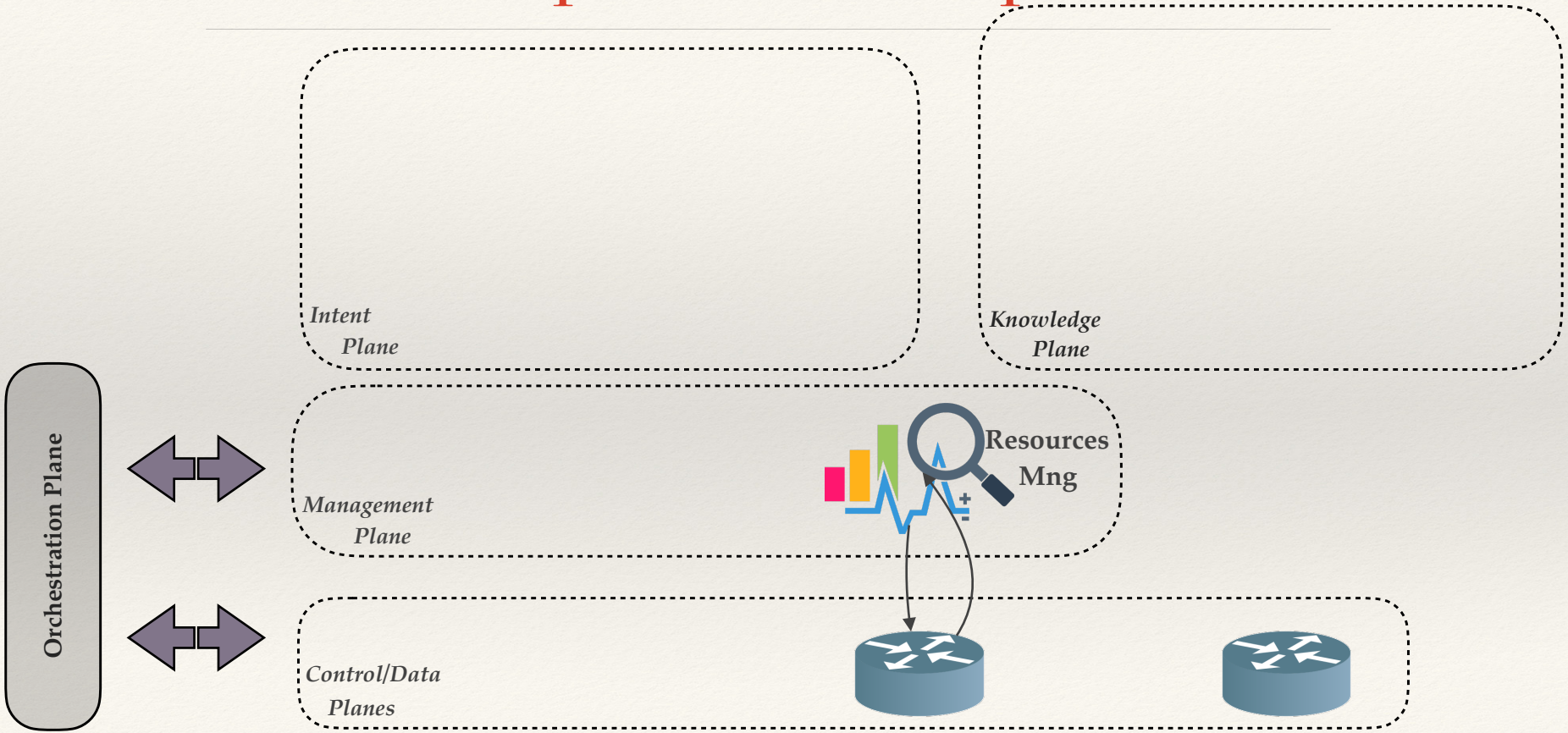

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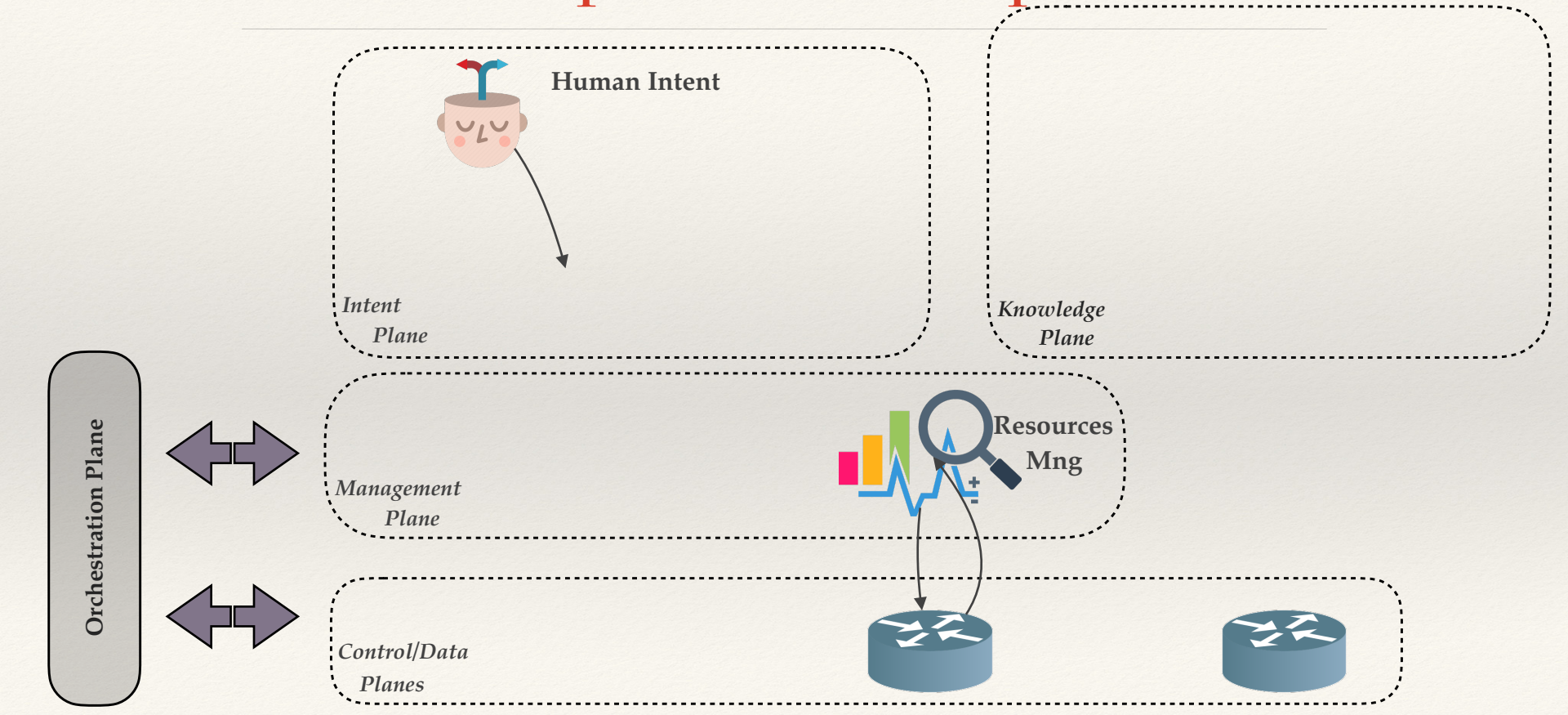

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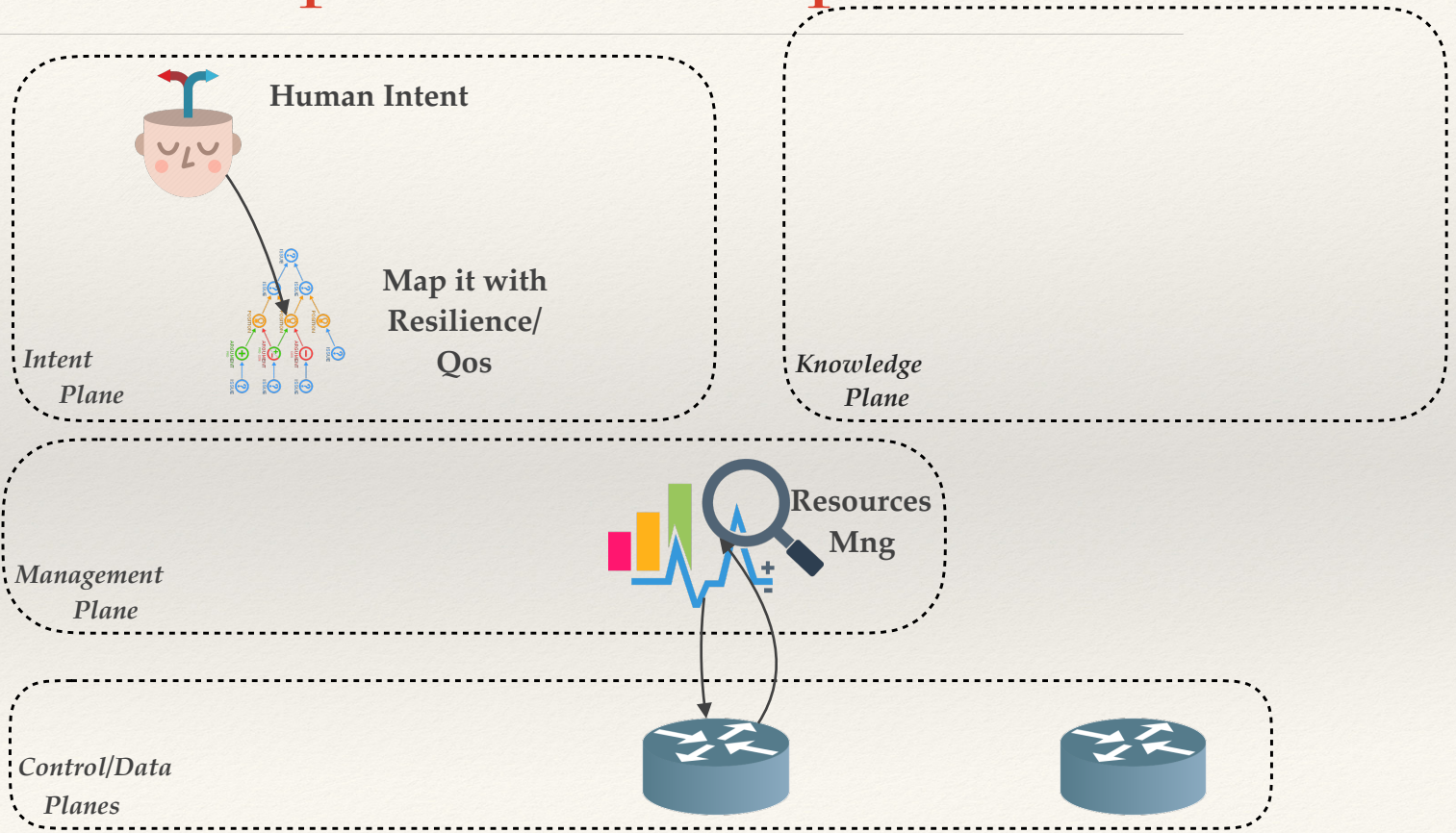

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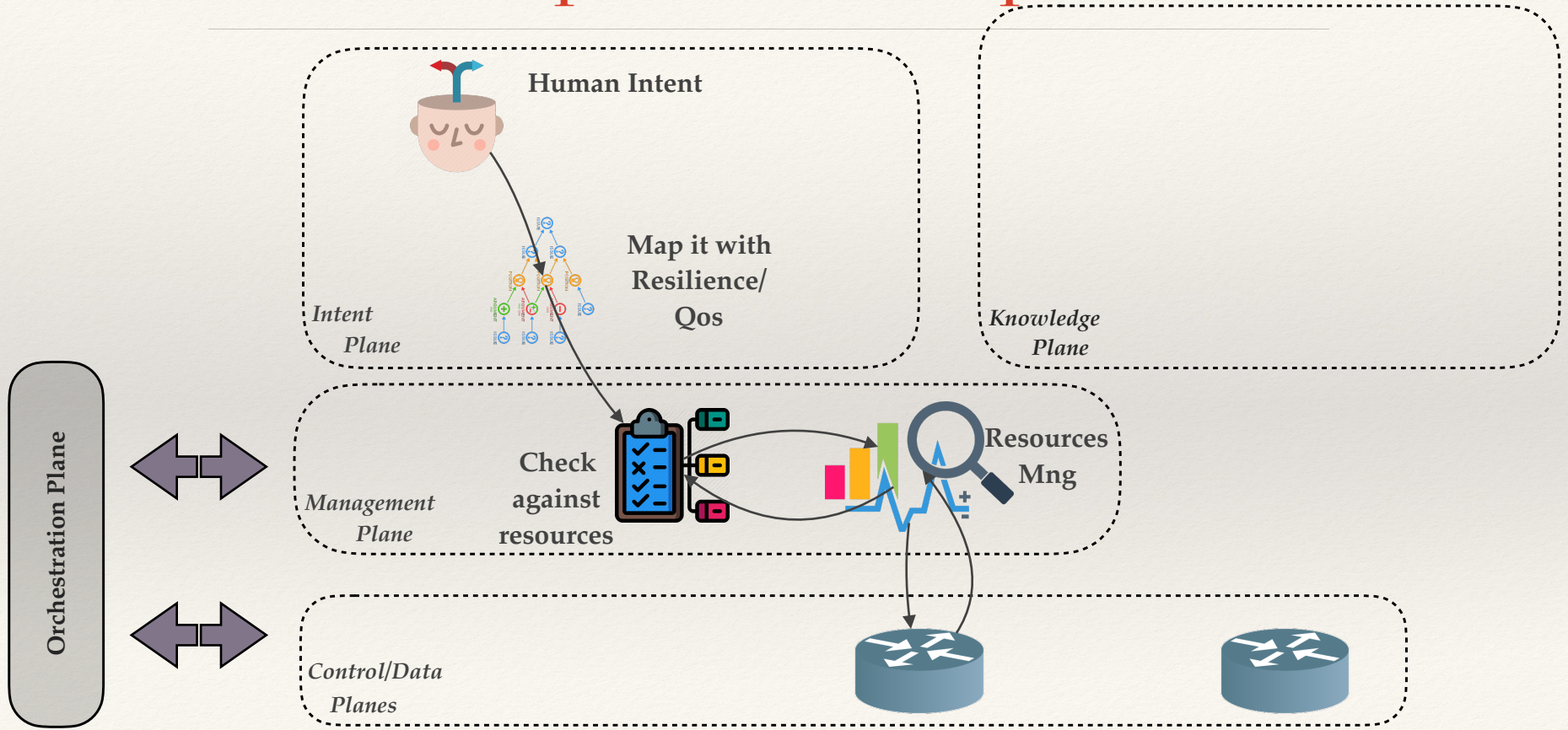
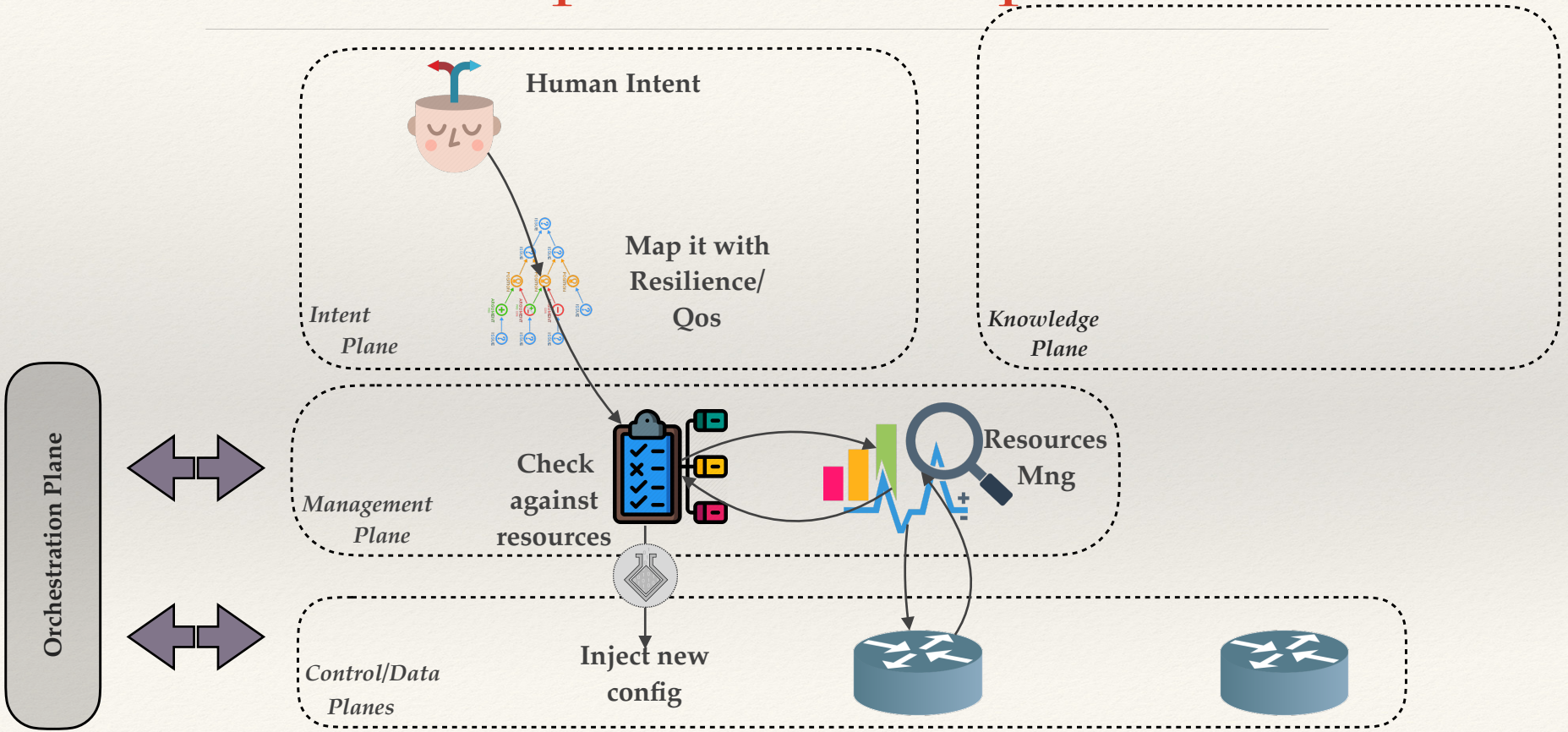
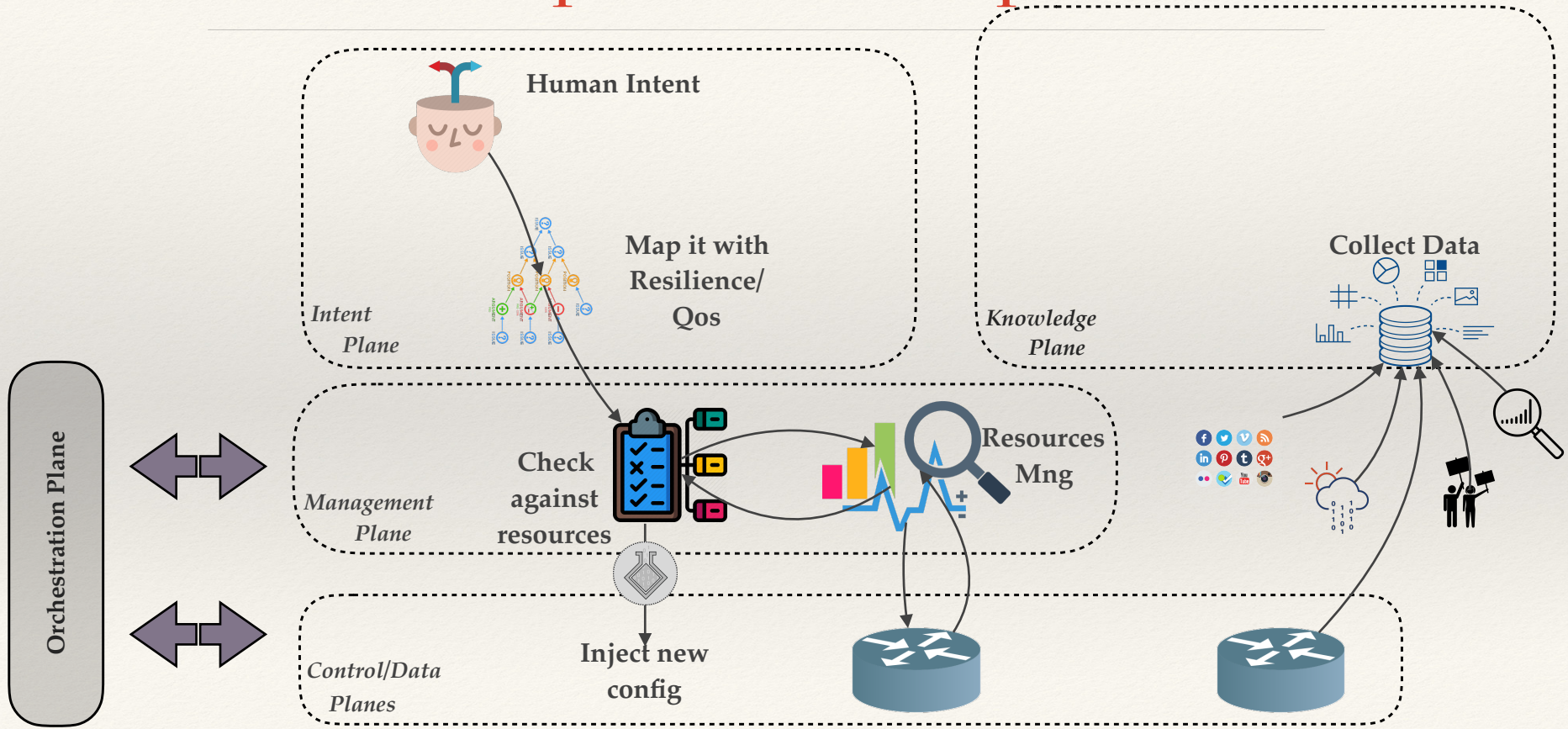


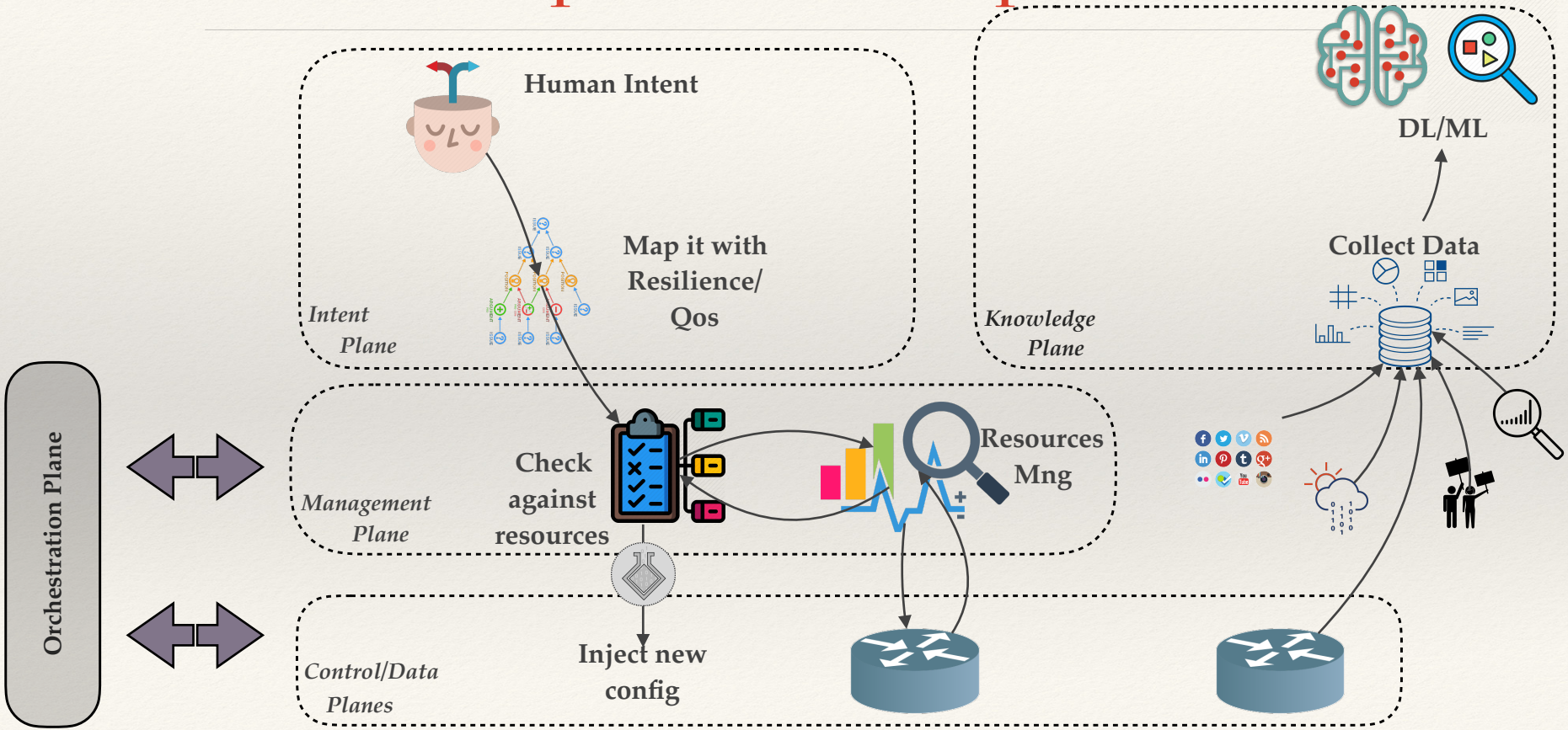
Operational Loop



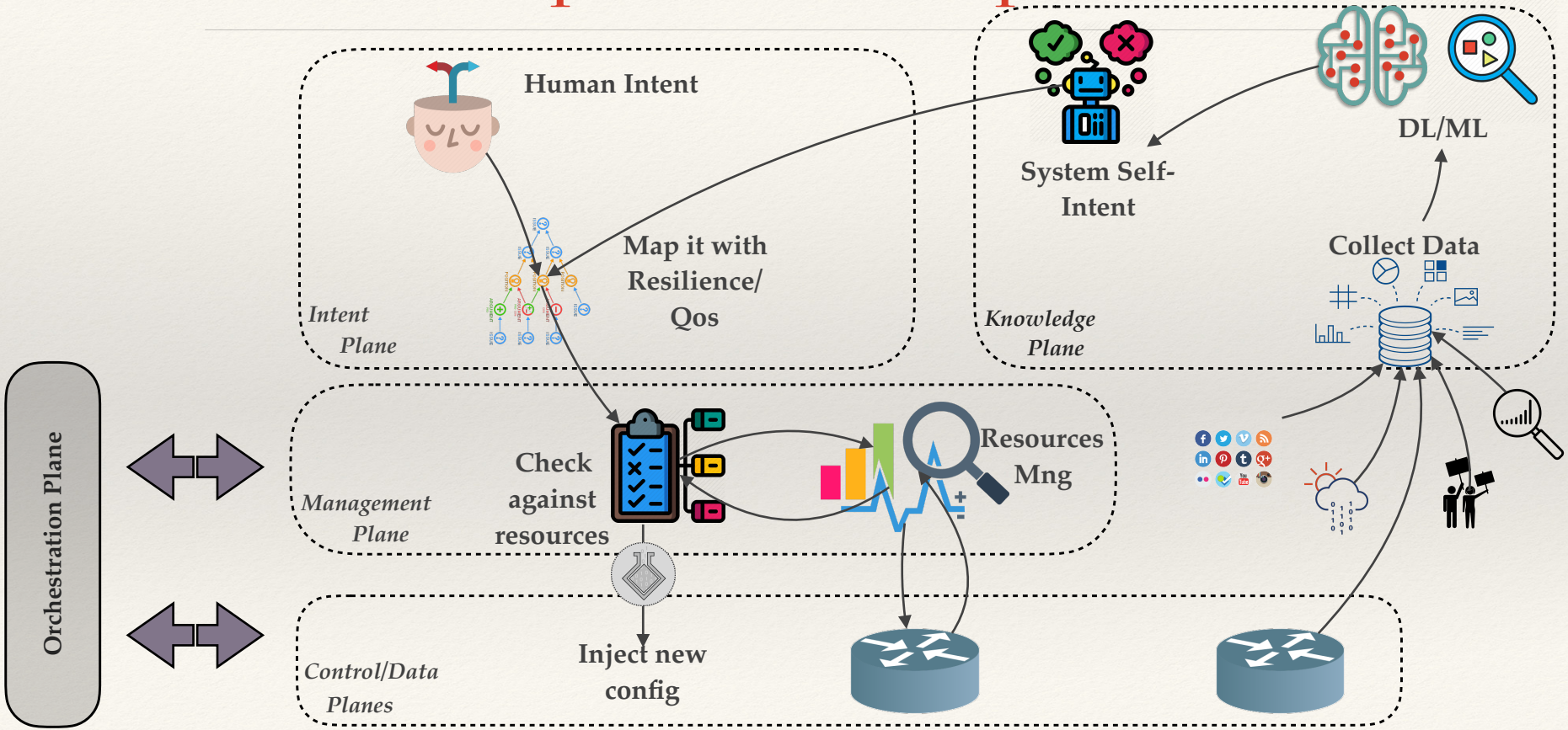
Operational Loop



Operational Loop



Operational Loop



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Demo

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Technologies

- *mininet*, a popular network emulator using SDN and OpenFlow
  - Real-time
  - Full-stack
  - Uses OVS for networking
- *ONOS* OpenFlow controller used to control the network forwarding
- Modified *iperf* for traffic generation
- Service Manager Agent and Digital Asset Agents in *Scala*
- Anomaly Detection in *R*

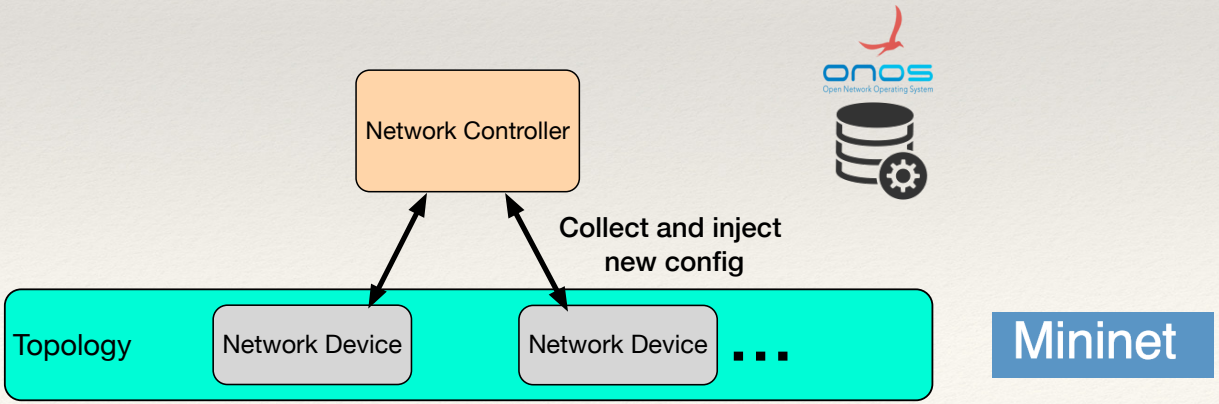
Scenario

- Simple network topology
  - *4 hosts*
  - *3 network nodes*
- Observe a QoS feature of the network that can be improved
  - In this case, *throughput*
- Identify a possible improvement in this feature
- React to this change by modifying the network in some way

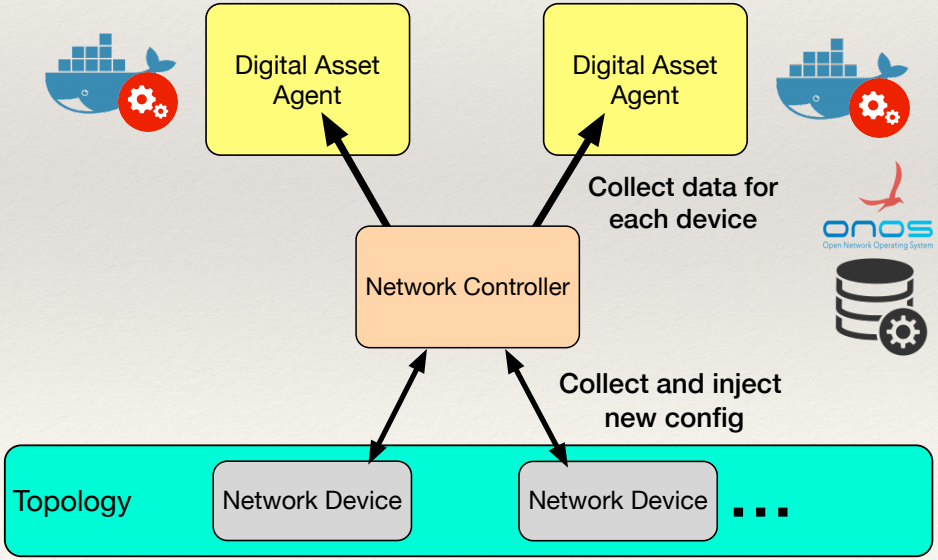
Scenario

Scenario

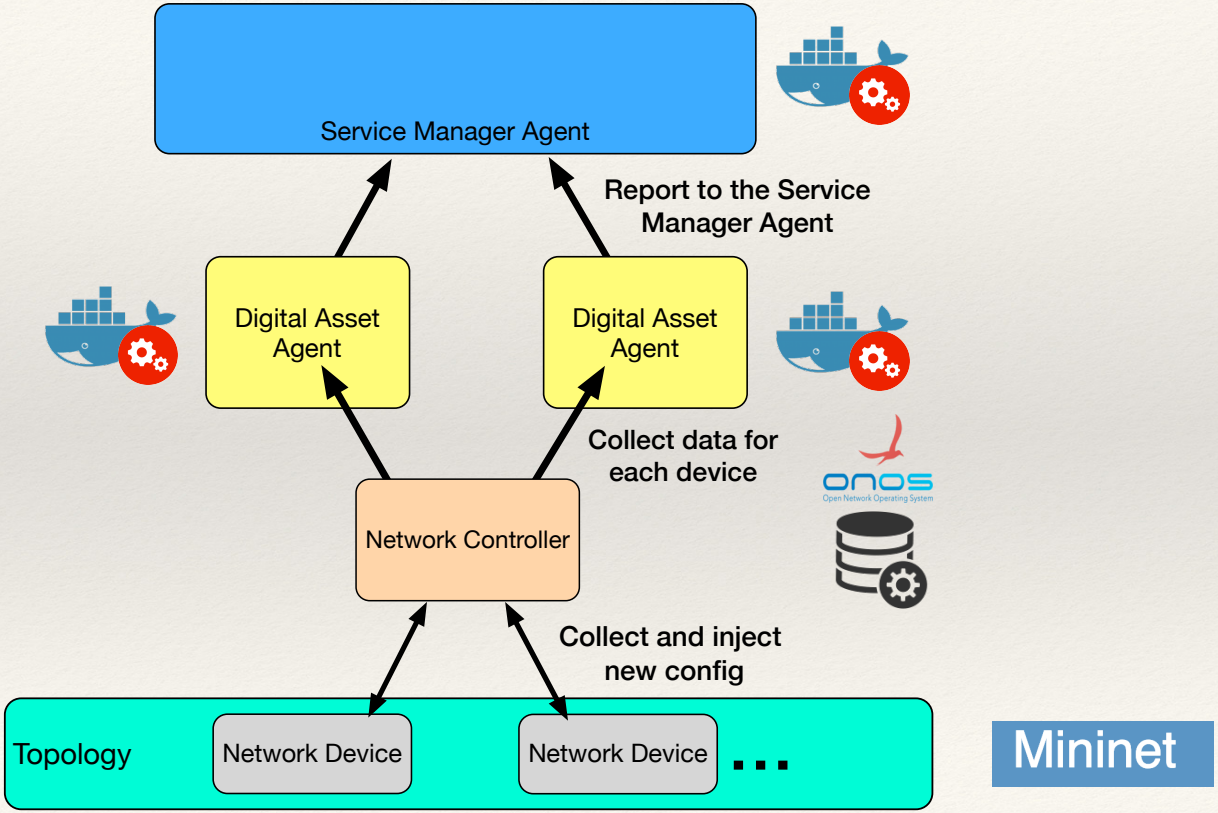
Scenario


Network Controller
Collect and inject
new config
Topology
Network Device
Network Device
...
Mininet

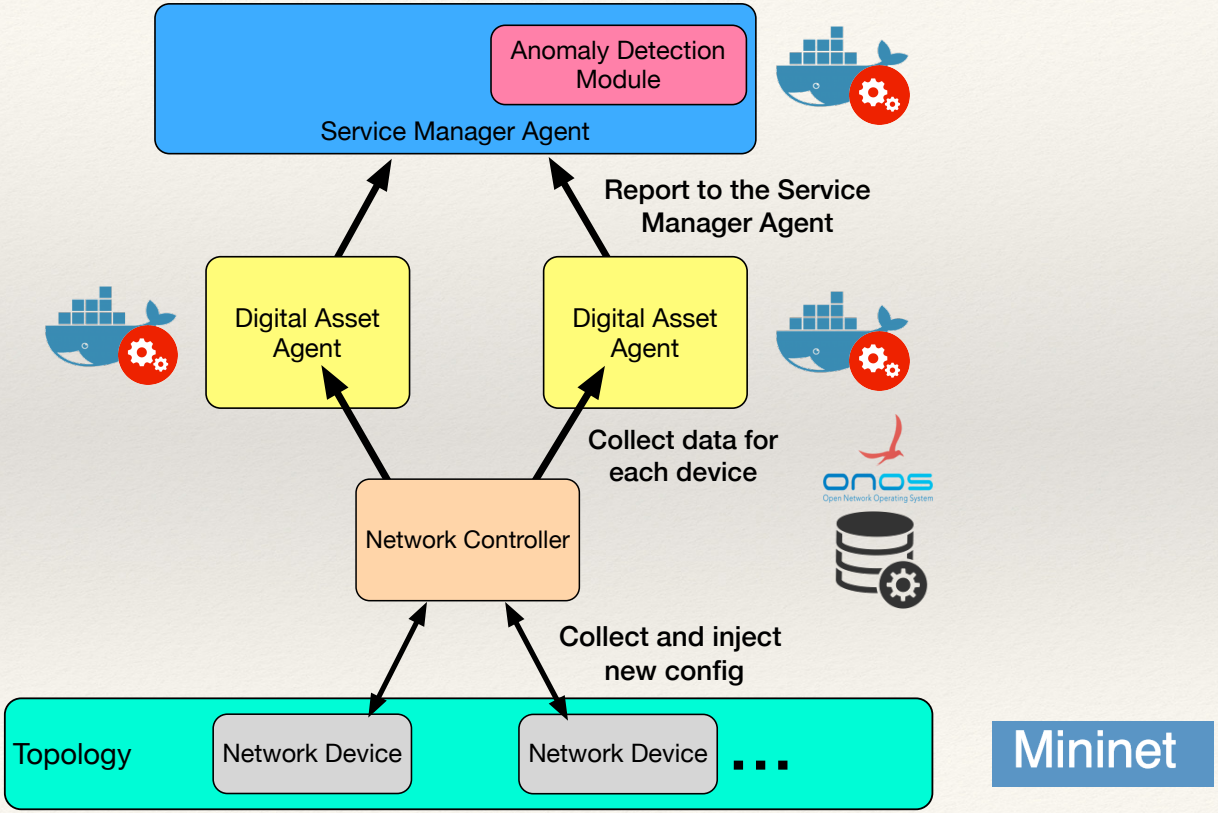
Scenario


Digital Asset Agent
Digital Asset Agent
Collect data for each device
Network Controller
Collect and inject new config
Topology
Network Device
Network Device
...
Mininet

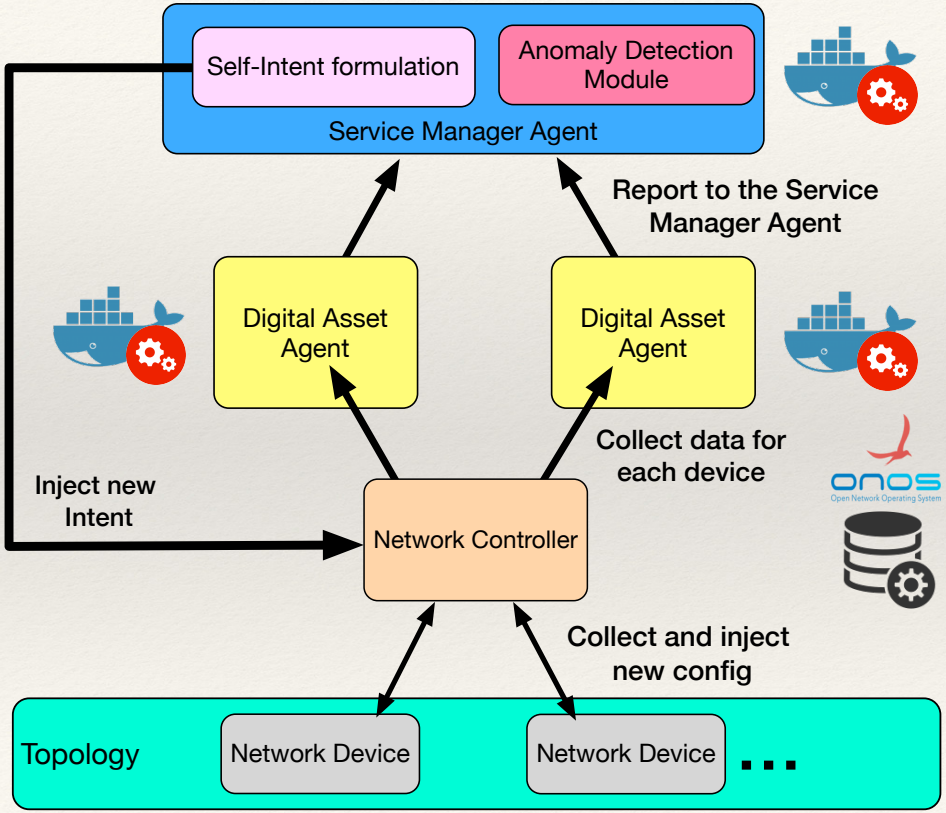
Scenario


Service Manager Agent
Report to the Service Manager Agent
Digital Asset Agent
Digital Asset Agent
Collect data for each device
Network Controller
Collect and inject new config
Topology
Network Device
Network Device
...
Mininet

Scenario

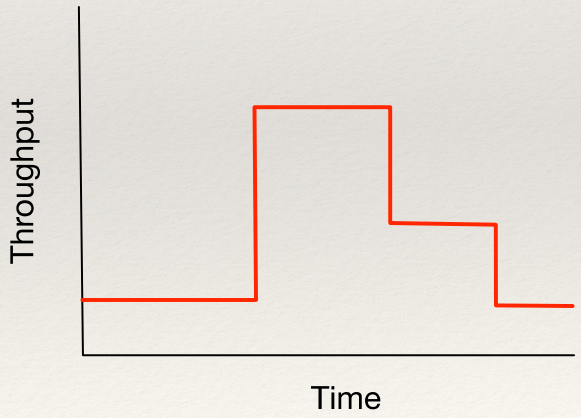

Anomaly Detection Module
Service Manager Agent
Report to the Service Manager Agent
Digital Asset Agent
Digital Asset Agent
Collect data for each device
Network Controller
Collect and inject new config
Topology
Network Device
Network Device
...
Mininet

Scenario

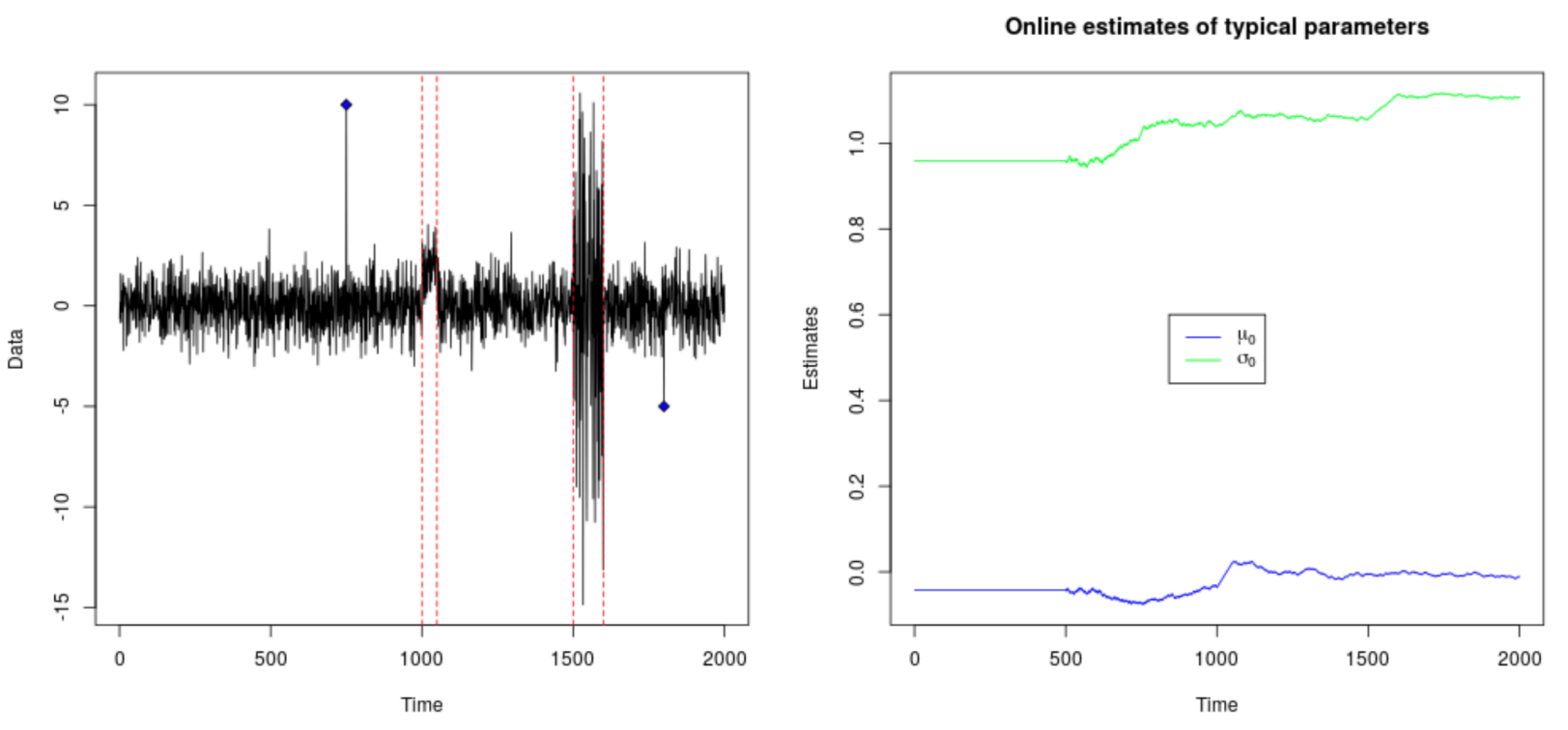

Self-Intent formulation
Anomaly Detection Module
Service Manager Agent
Report to the Service Manager Agent
Digital Asset Agent
Digital Asset Agent
Collect data for each device
Inject new Intent
Network Controller
Collect and inject new config
Topology
Network Device
Network Device
...
Mininet

Traffic

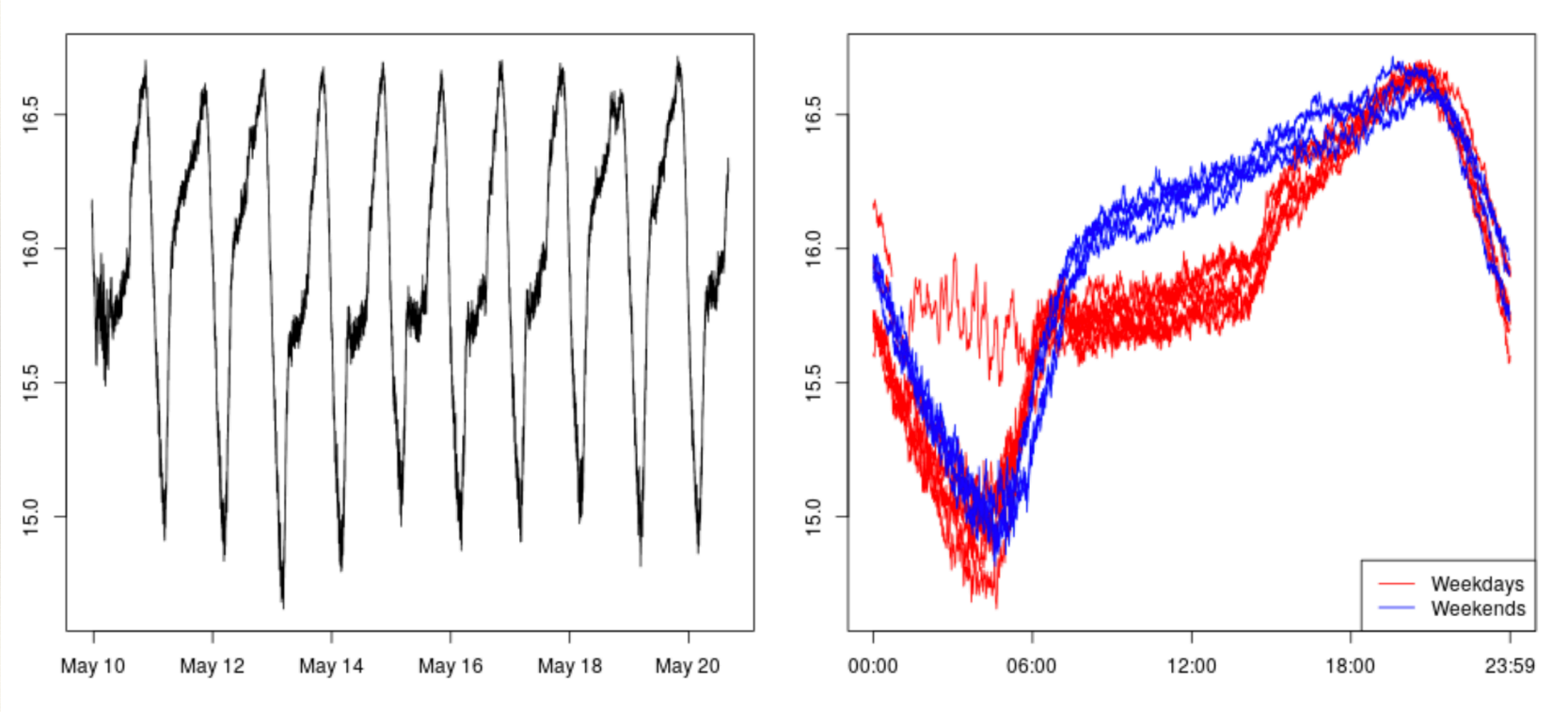
- Generate varying “UDP” traffic between the hosts to exercise the anomaly detection
  - From a low level of sustained throughput
  - Up to a high level of sustained throughput



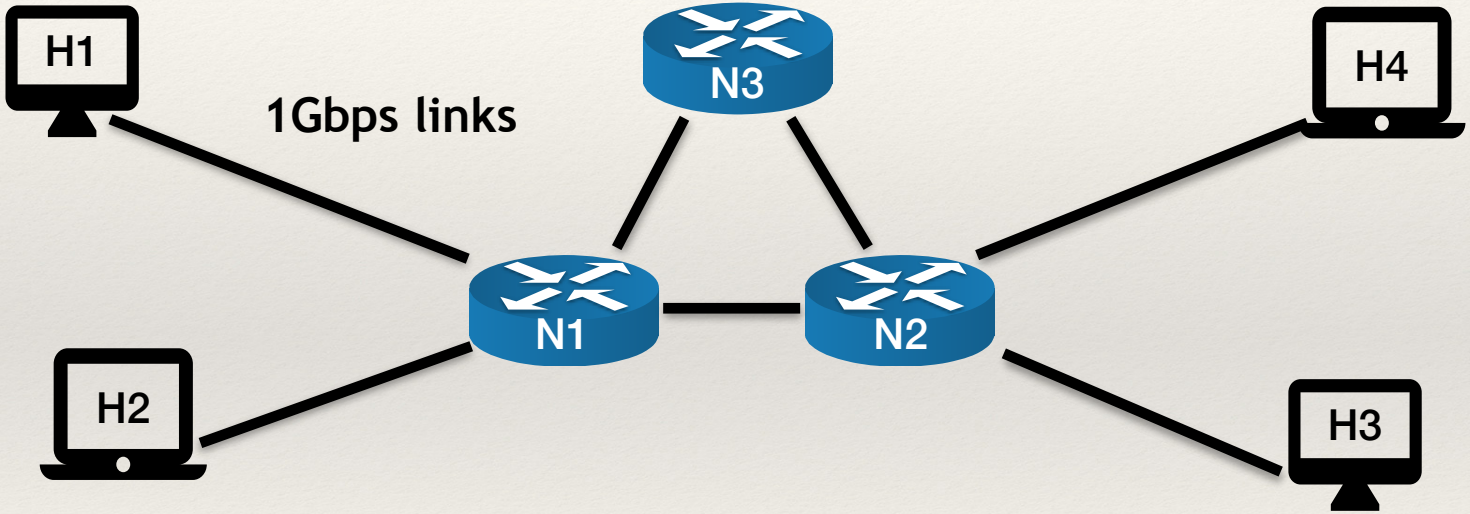
Online Failure Detection



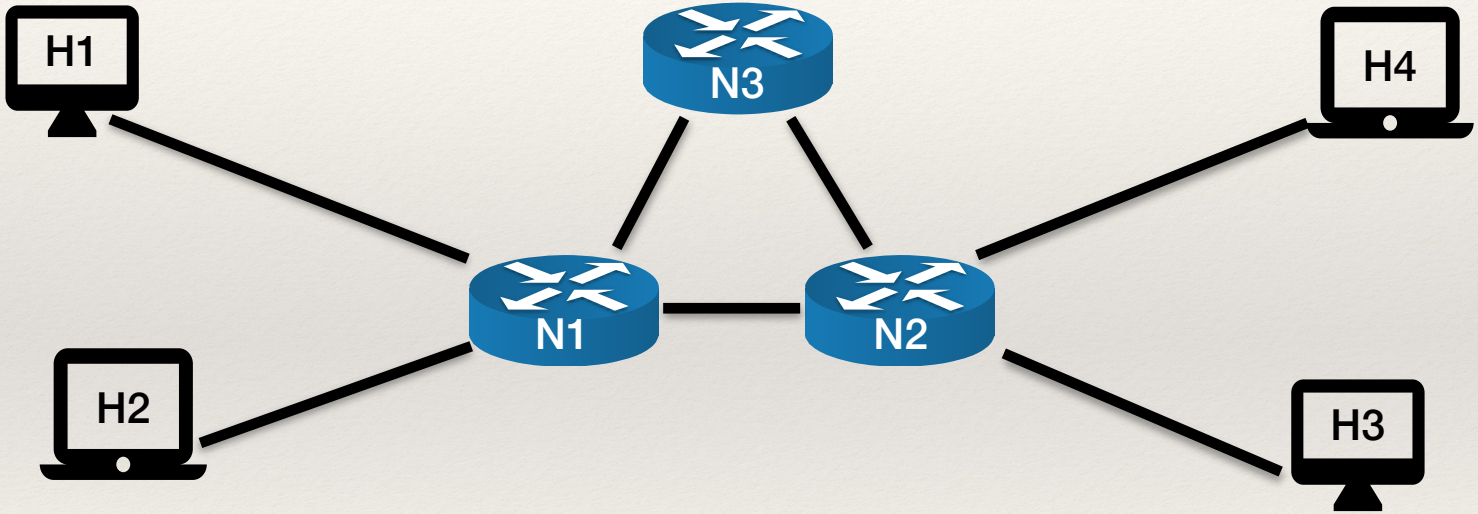
Online Failure Detection



Base Topology

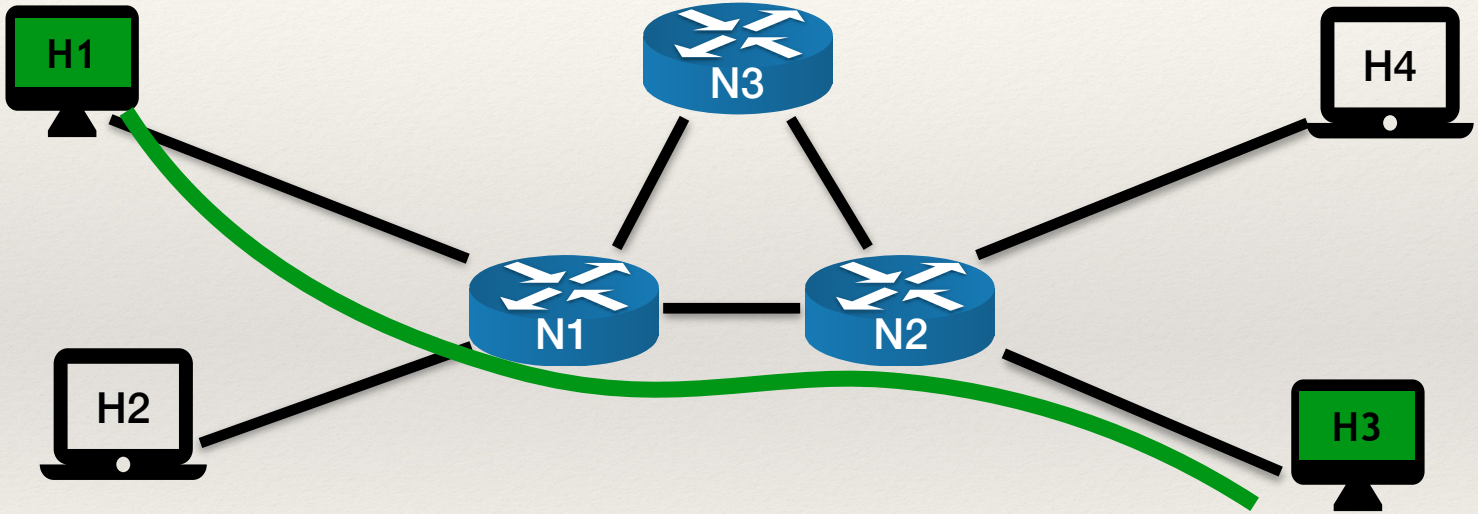


User-Intent



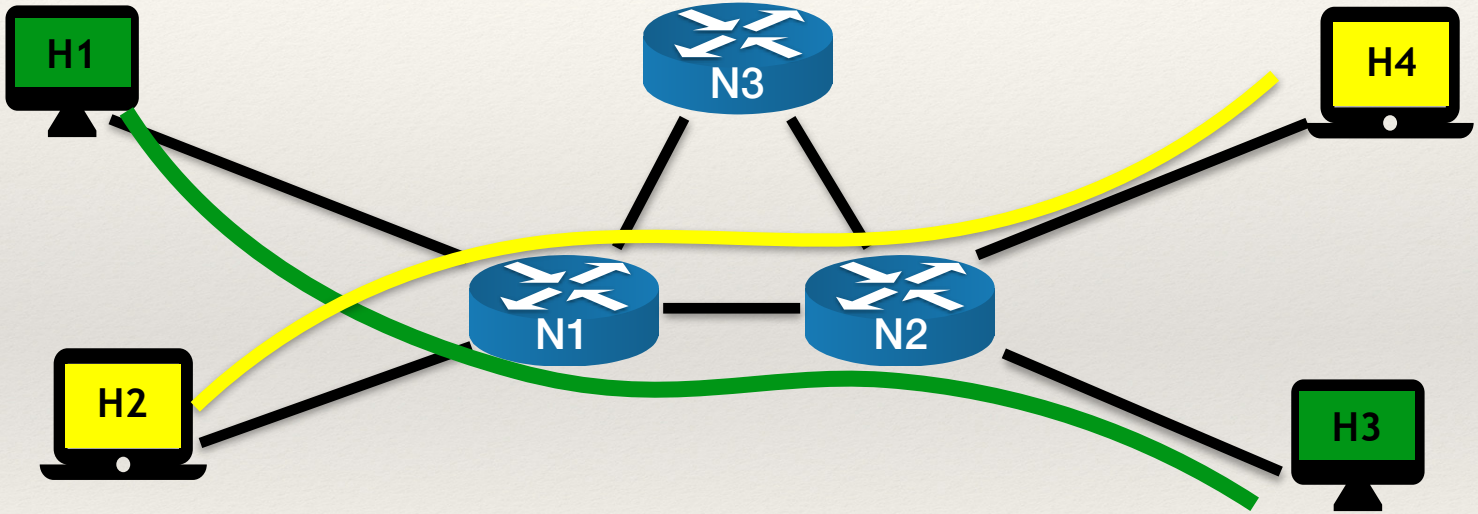
Host-to-host intent

User-Intent



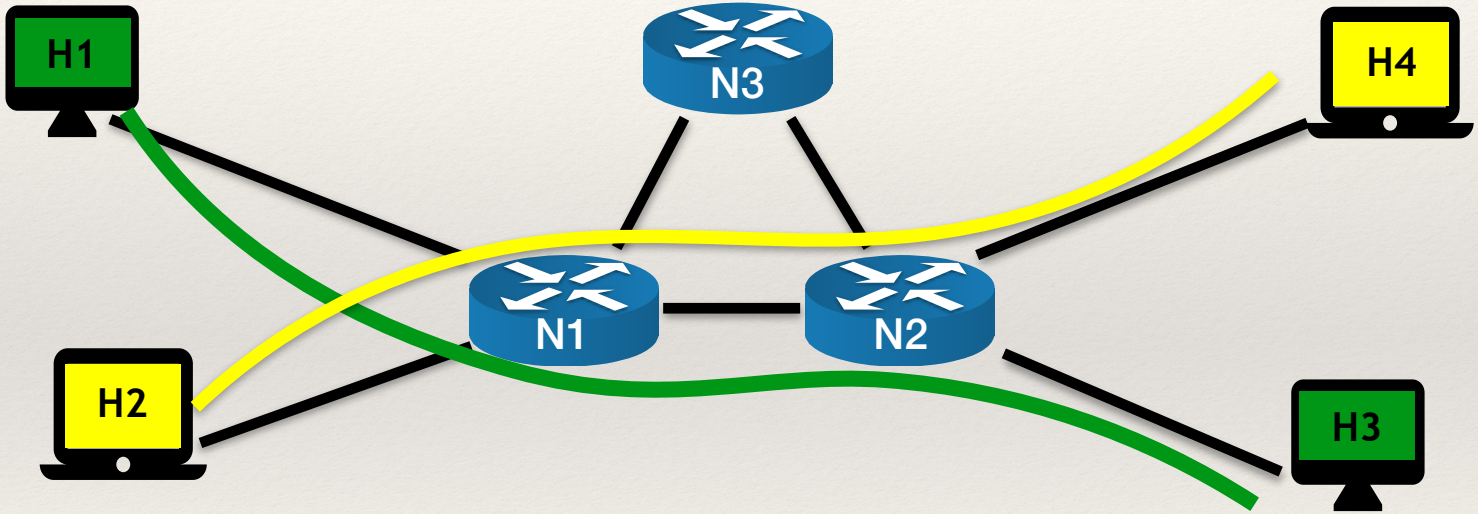
Host-to-host intent

User-Intent

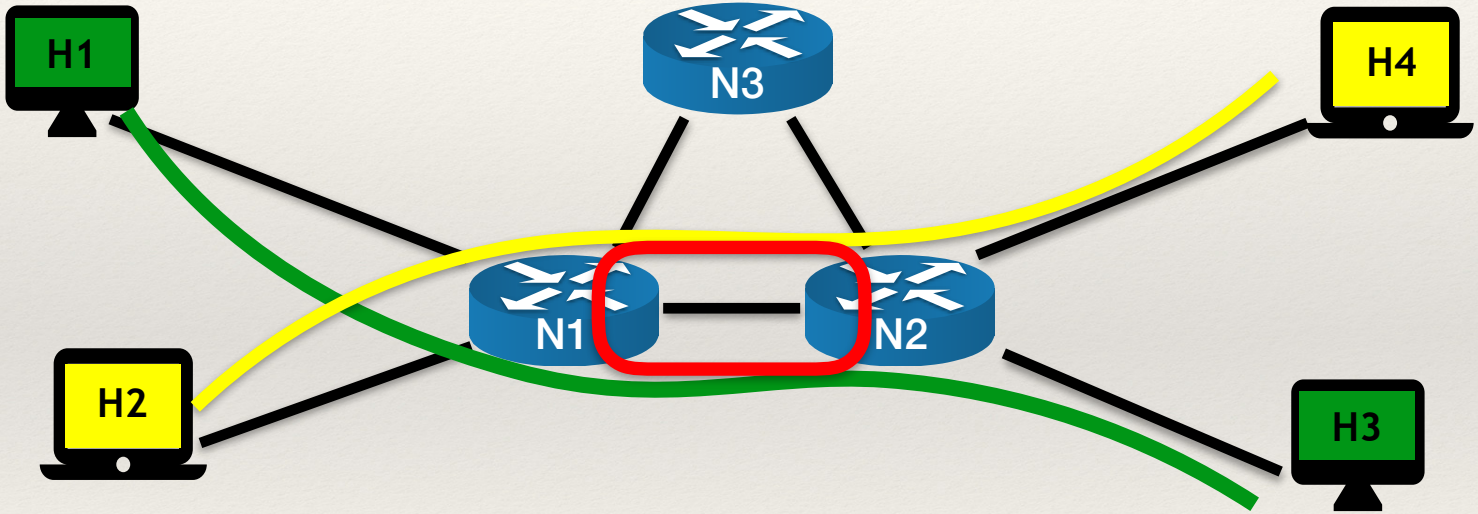


Host-to-host intent

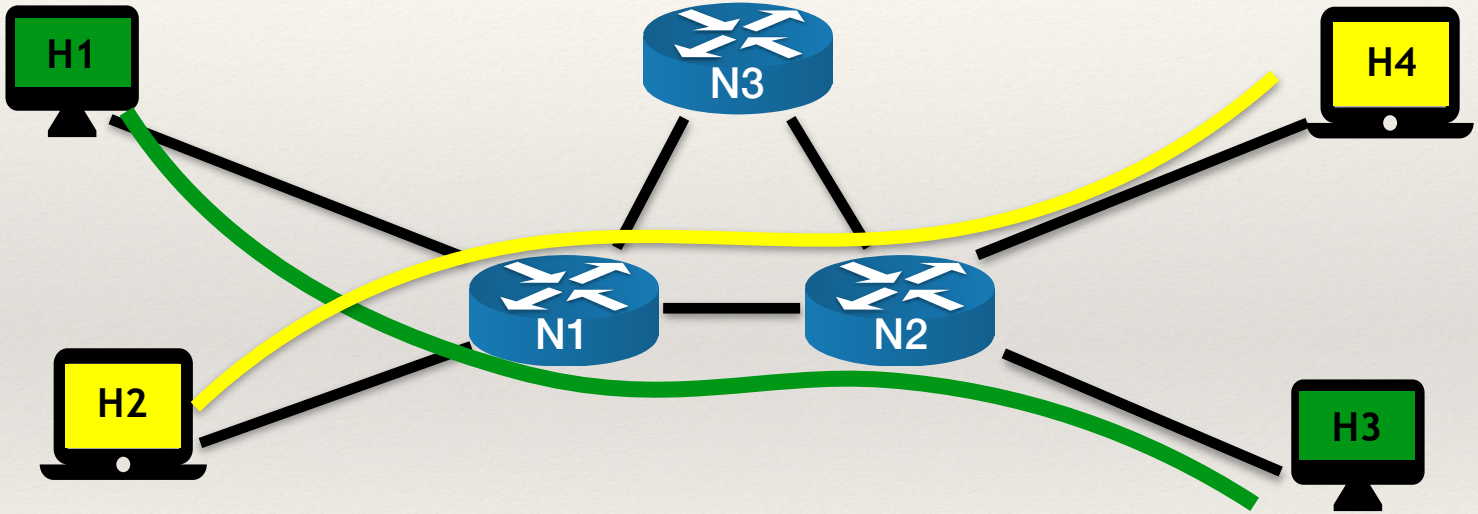
Busy link



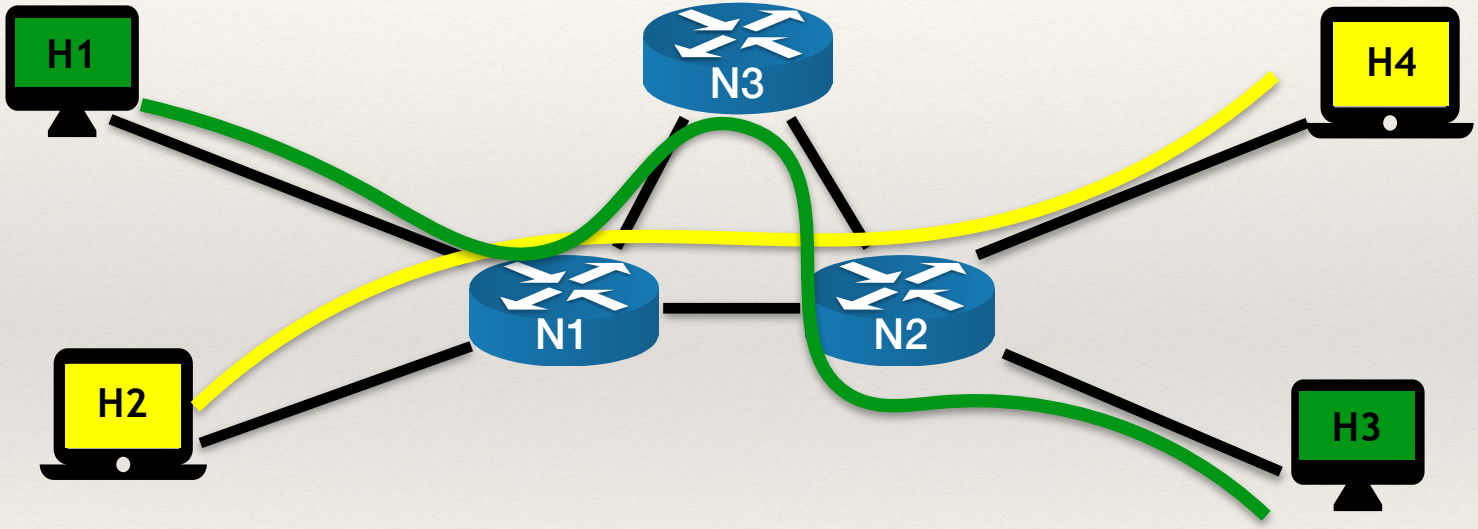
Busy link



Self-intent reaction



Self-intent reaction



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Showtime

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Future Work

- The conditions in which a change is detected could be anything:
  - Device temperature
  - Costs changing
  - Multiple features
- Measure the impact of instrumentation (agents' cost)
- The response could also be tailored to more complex intents!
- Can we *predict* when a failure may occur and react accordingly?
- Can we *recommend* a series of remediation strategies and have a human choose?

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Questions?

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