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ETSI ZSM009

Closed-loop automation enablers, solutions and open challenges

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O-RAN WG/ETSI ISG ZSM Collaboration Workshop #1

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Closed-Loop Automation in ETSI ZSM – ZSM009

ETSI GS ZSM 009-1

Zero-Touch Network and Service Management (ZSM) Closed-loop automation: Enablers

ETSI GS ZSM 009-2

Zero-Touch Network and Service Management (ZSM) Closed-loop automation: Solutions

ETSI GR ZSM 009-3

Zero-Touch Network and Service Management (ZSM) Closed-loop automation: Advanced topics

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Outline

1. Basics of closed loops (ZSM009-1)

2. Automation scenarios and solutions (ZSM009-2)

3. Advanced topics (ZSM009-3)

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Basics of Closed Loops (CLs)

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Motivation for ZSM009

- Specify how Automation is possible using closed loops within the ZSM framework

- Improving the ZSM framework and specifying new Management Services for **CL governance** and **CL coordination**
  - Uniformly manage all aspects (life cycle) of different closed loops
  - Coordinate the execution of different (many) closed loops
  - Solve key automation scenarios using closed loops

- Lead the community in this topic

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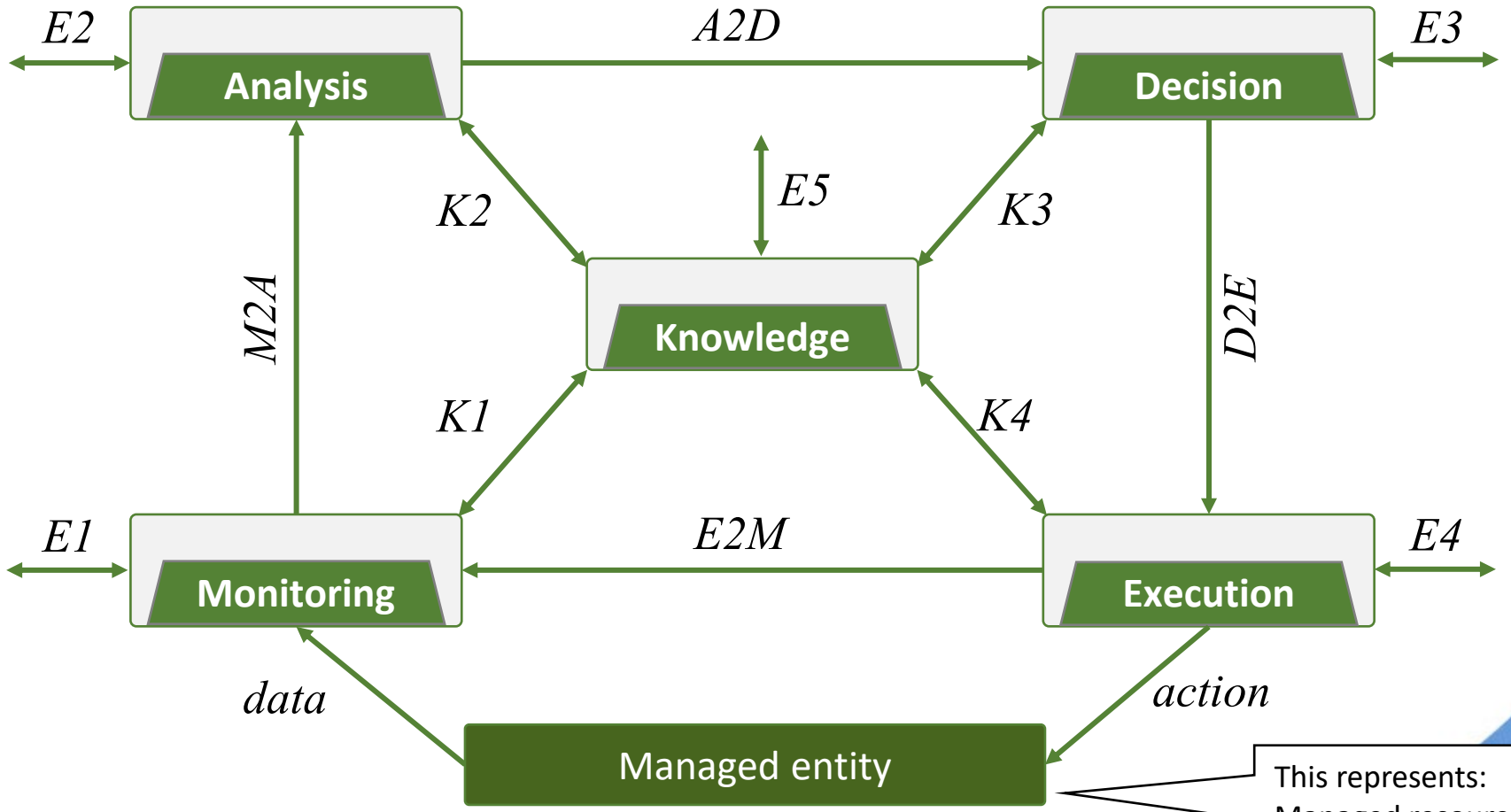
CL in ZSM framework - Functional view



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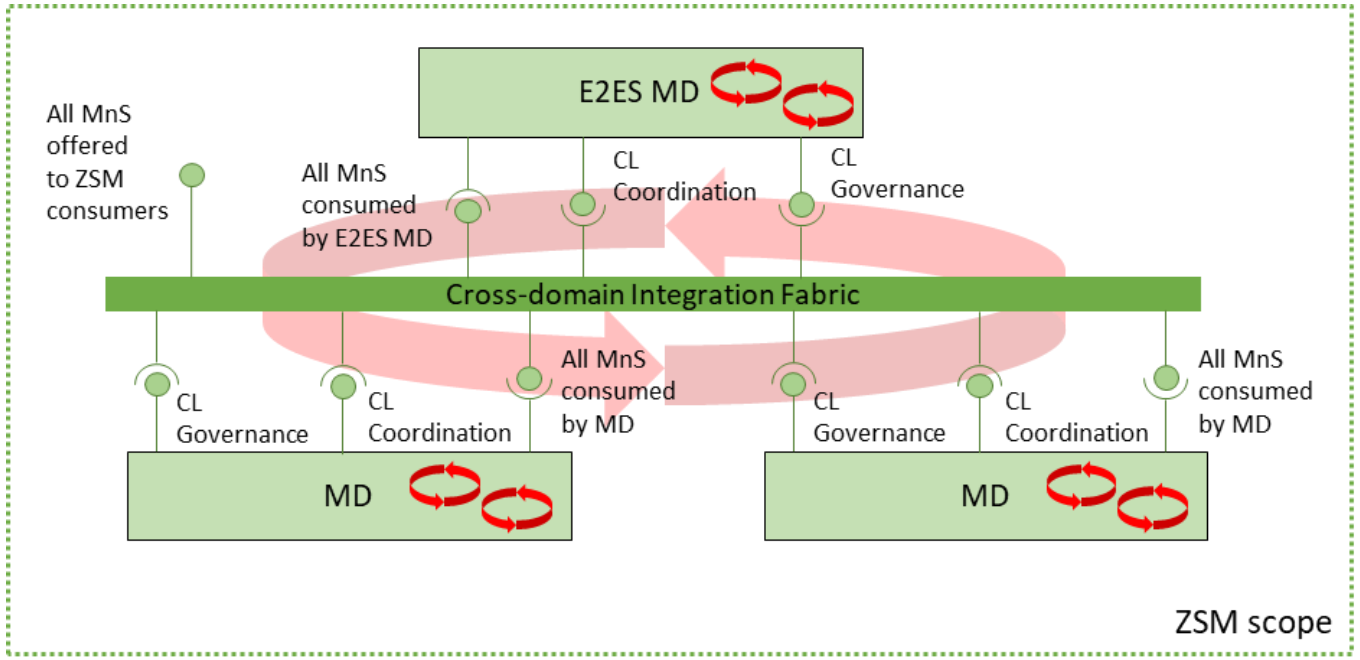
Closed loops within the ZSM framework

Closed loops at:

- E2E service management domain
- Individual management domains
- Across MDs

New management services specific to Closed Loops:

- Closed Loop Governance
- Closed Loop Coordination



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Automation scenarios and solutions

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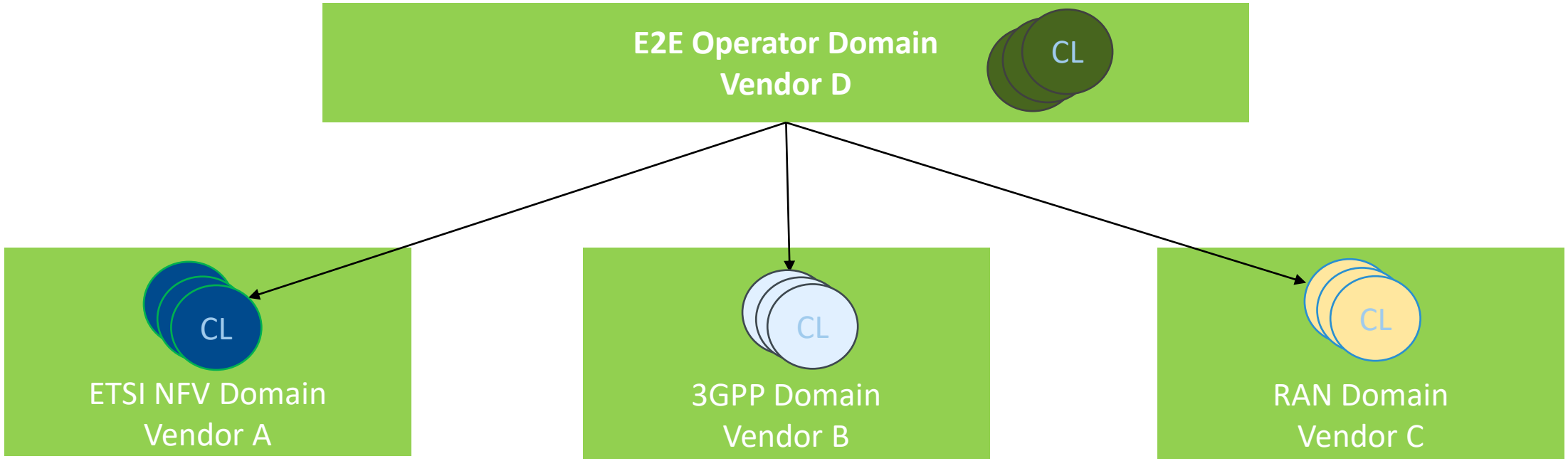
I. Need for uniformly managing CLs



Different vendors will have different implementations of CLs
– A need to manage them uniformly

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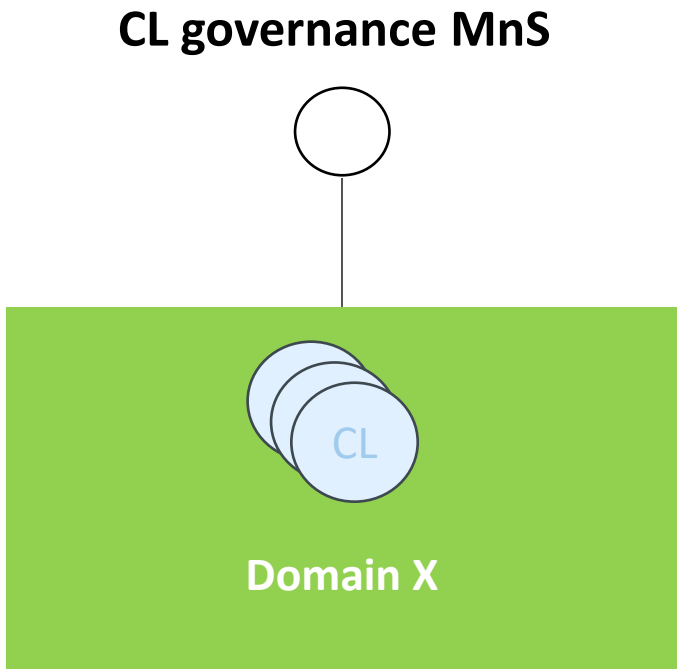
I. Need for uniformly managing CLs – Solution

Basic control for the closed loop

- Closed loops models and life cycle
- Disable, Enable – Lifecycle management
- Configure the target/goal the CL has to achieve
- Retrieve information about the CL, e.g., performance and status



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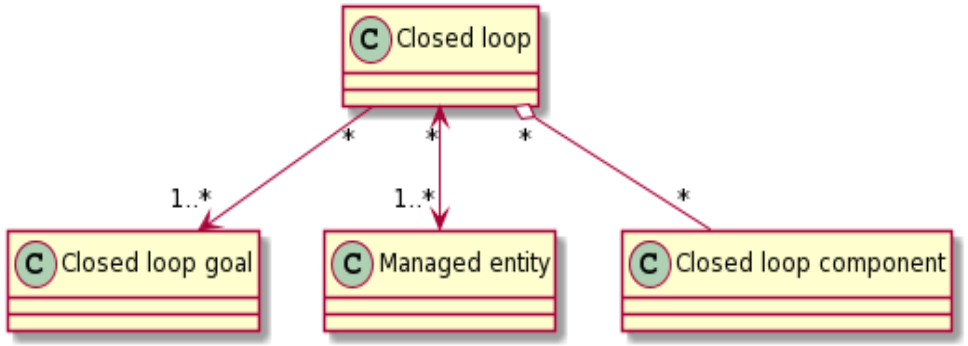
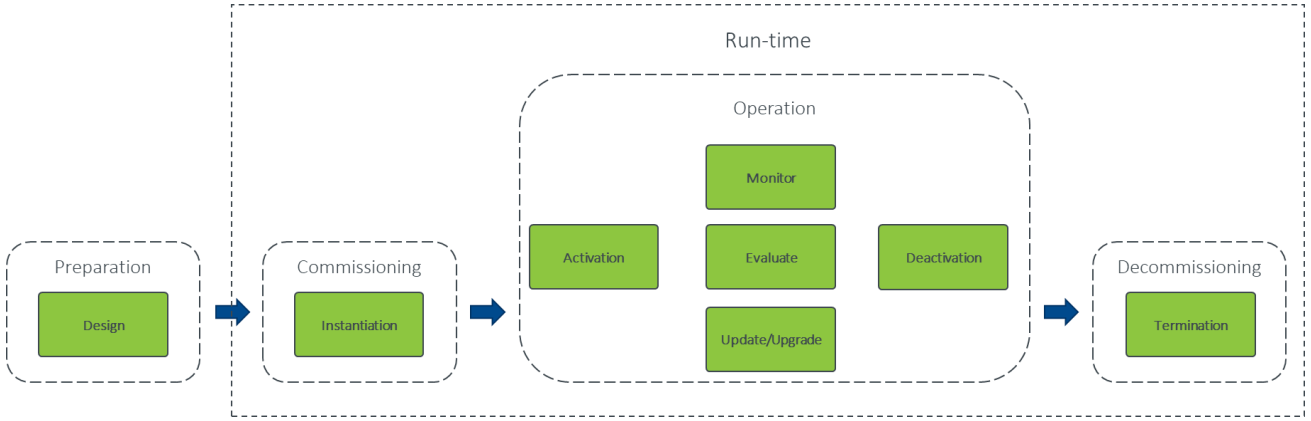
CL Model and life cycle management

- Uniform management of CLs relies on standardized CL models and capabilities for CL lifecycle management
  - Design-time and run-time

Closed Loop model



Lifecycle management of Closed Loops – Phases and activities



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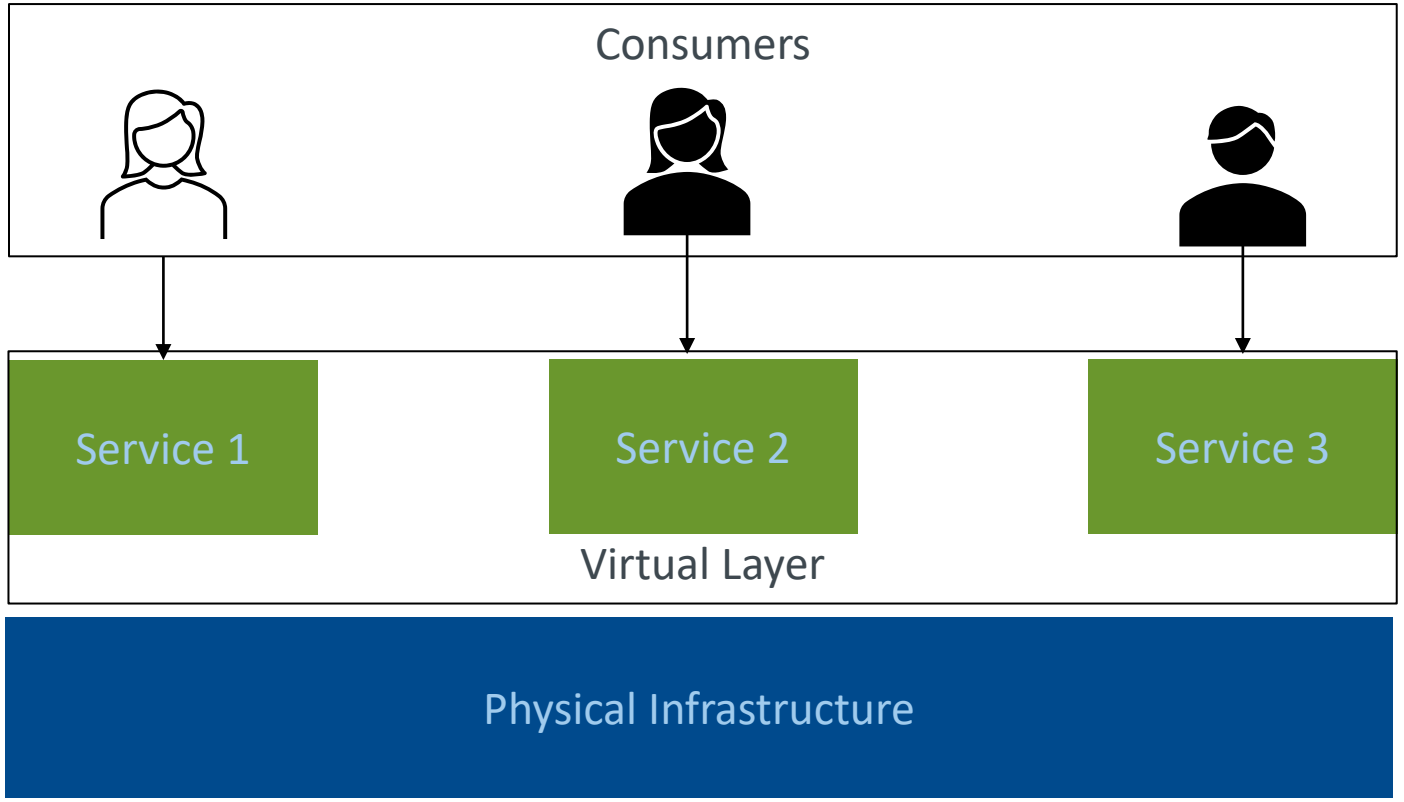
II. Need for coordinating CLs



Different consumers/tenants have different requirement which may cause automation conflicts in the infrastructure

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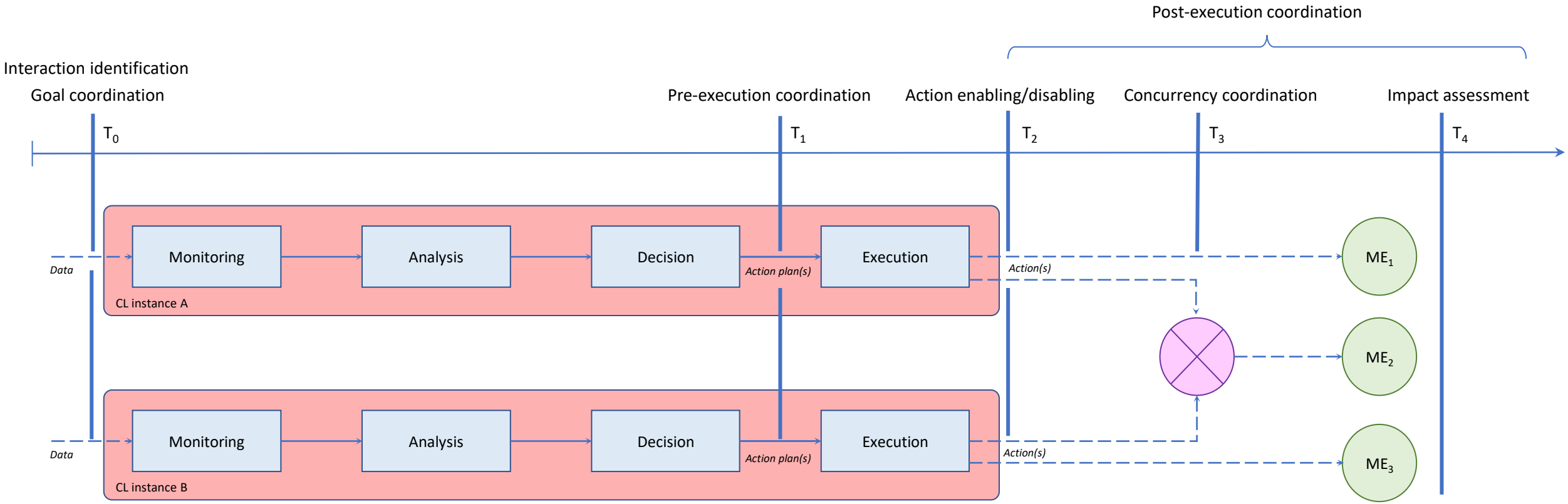
II. Need for coordinating CLs – Analysis



Solution: coordinate collective behavior via a common enabler available to all CLs (Coordination Management Services)

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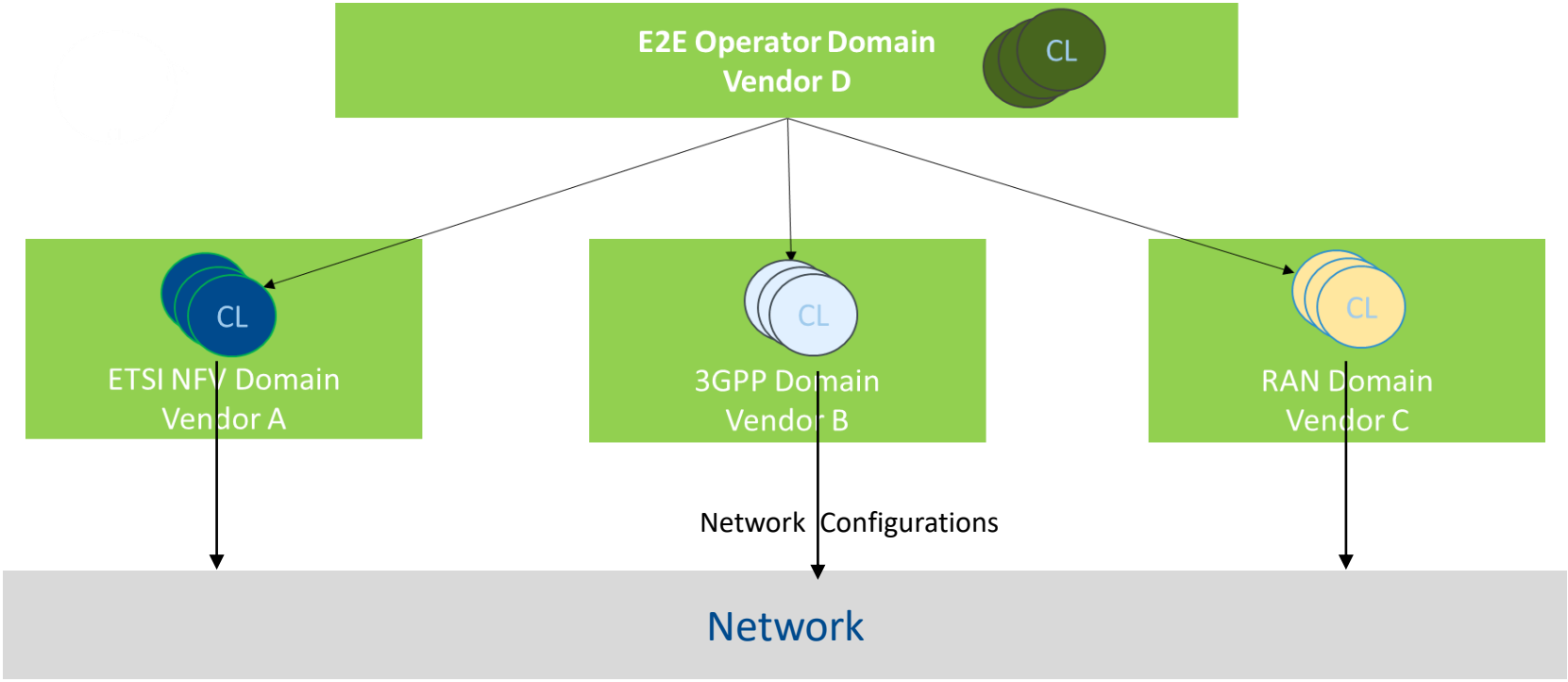
III. Need for trusting CLs



Problem: CLs developed by a vendor can *configure* the operator's network

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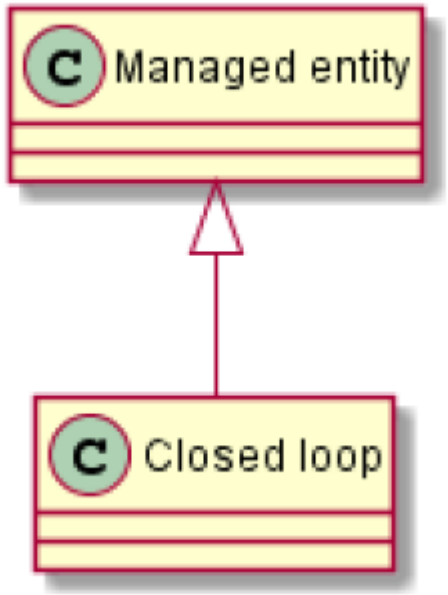
III. Need for trusting CLs – Managing the CL



CL is a managed entity, therefore everything you can do to a managed entity, you can do to a CL, including:

- Lifecycle CRUD operations
- Get performance and usage metrics
- Run a CL over another CL

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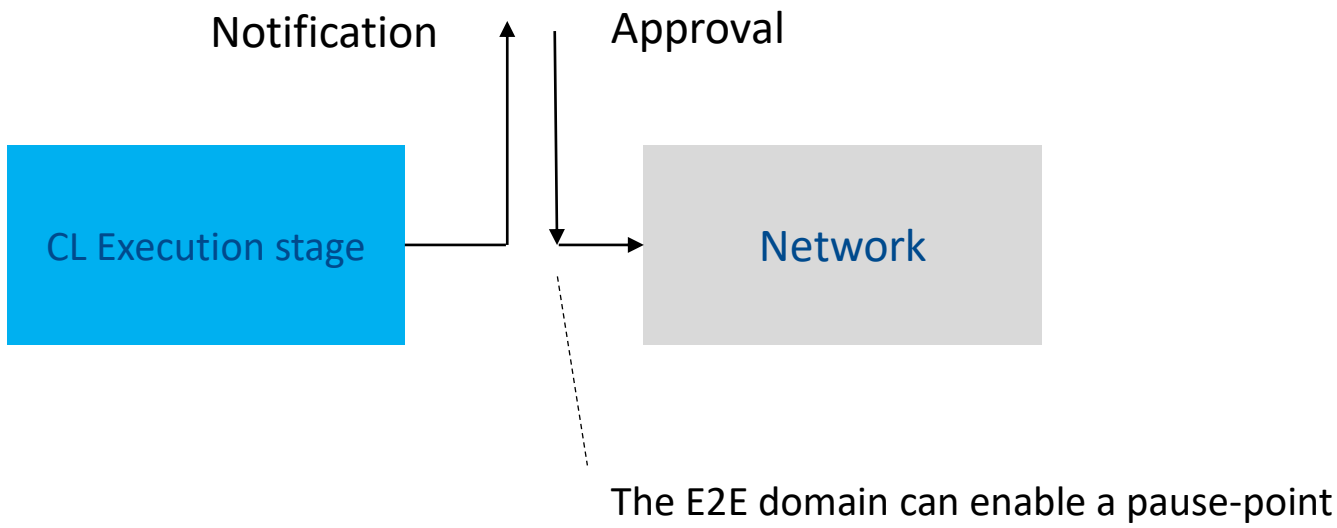
III. Need for trusting CLs – pause and review a CL



Solution: The operator can enable a pause point for review after execution

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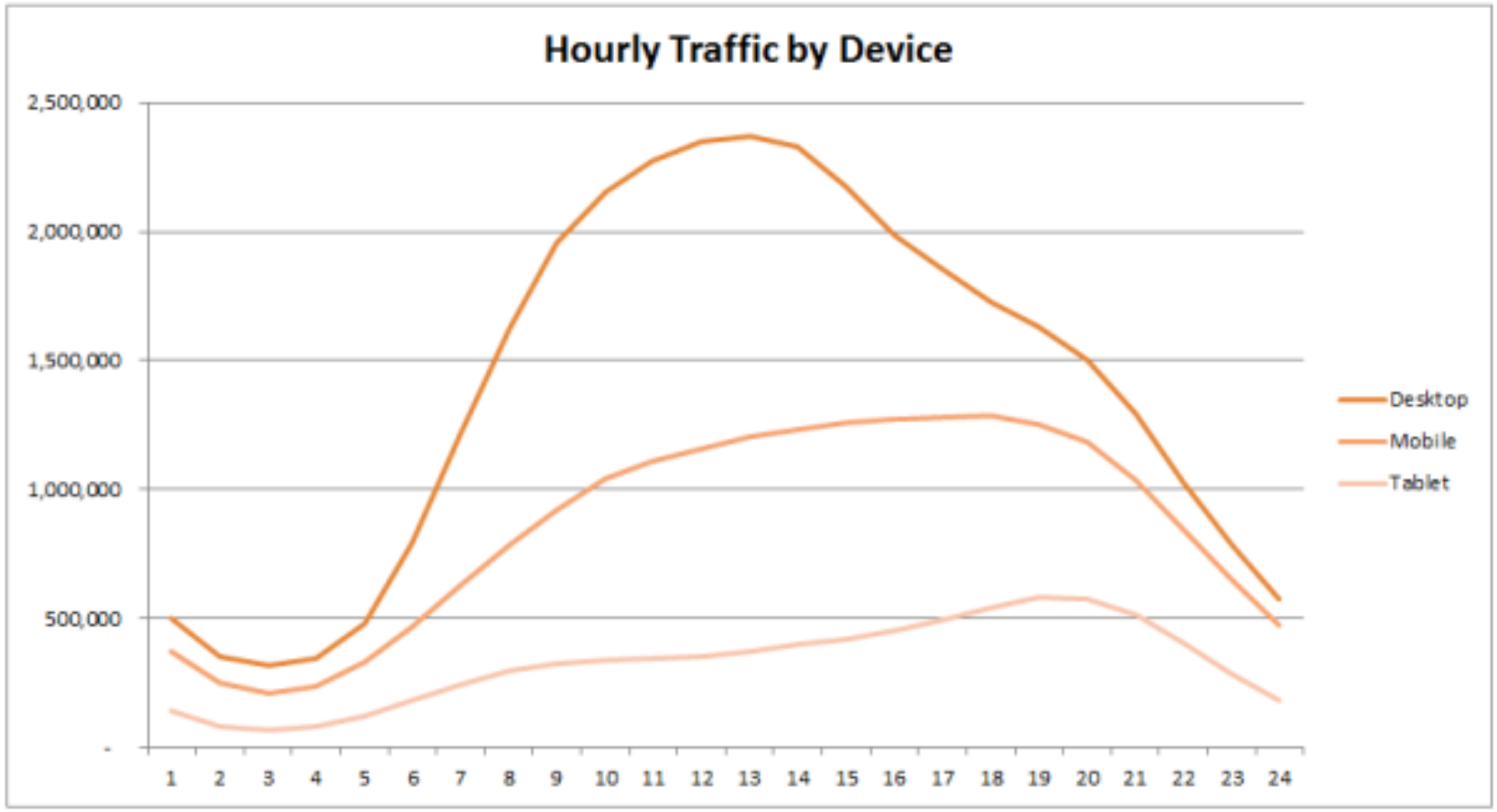
IV. Need for autonomic dynamism



Are automation system at midnight, noon and 6PM doing the same thing?

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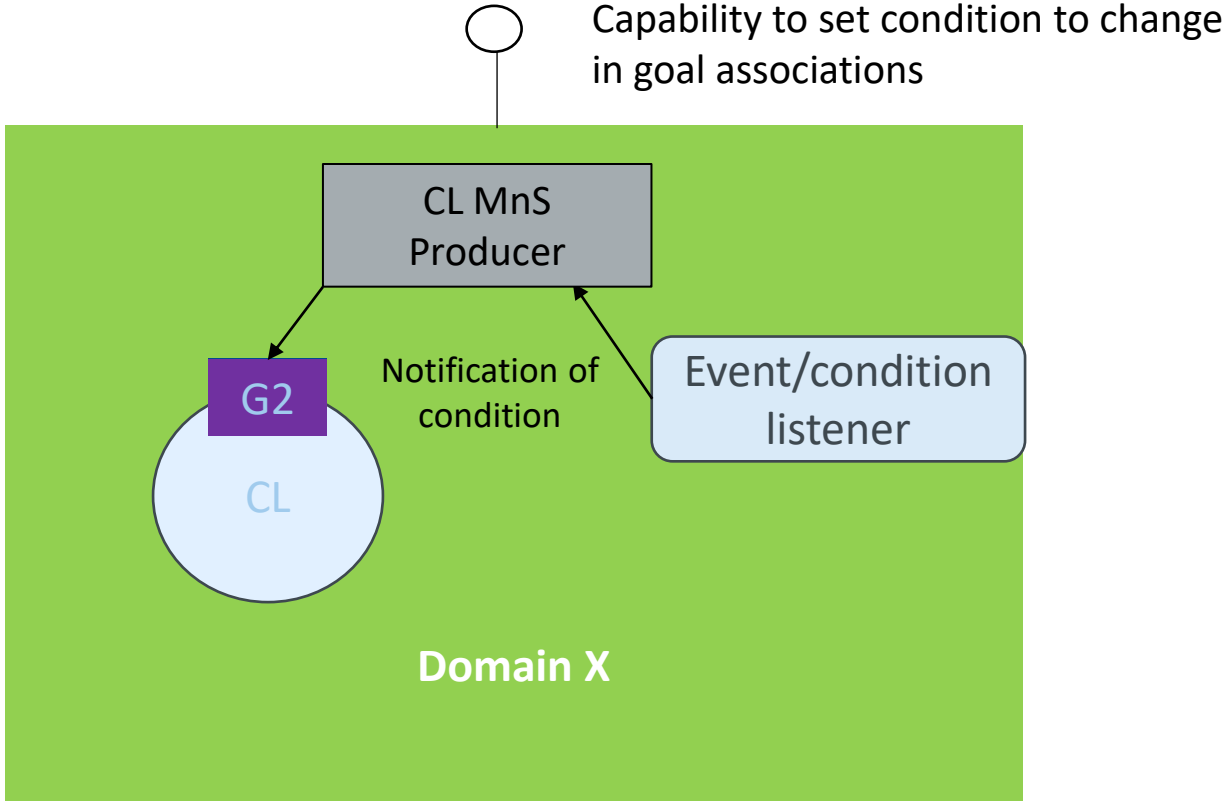
IV. Need for autonomic dynamism
Solution – CLs that can be triggered – Option 1 - Goal Change

When **<condition>** Minimize Energy, Max QoE otherwise

<condition> could be anything configurable, example : time



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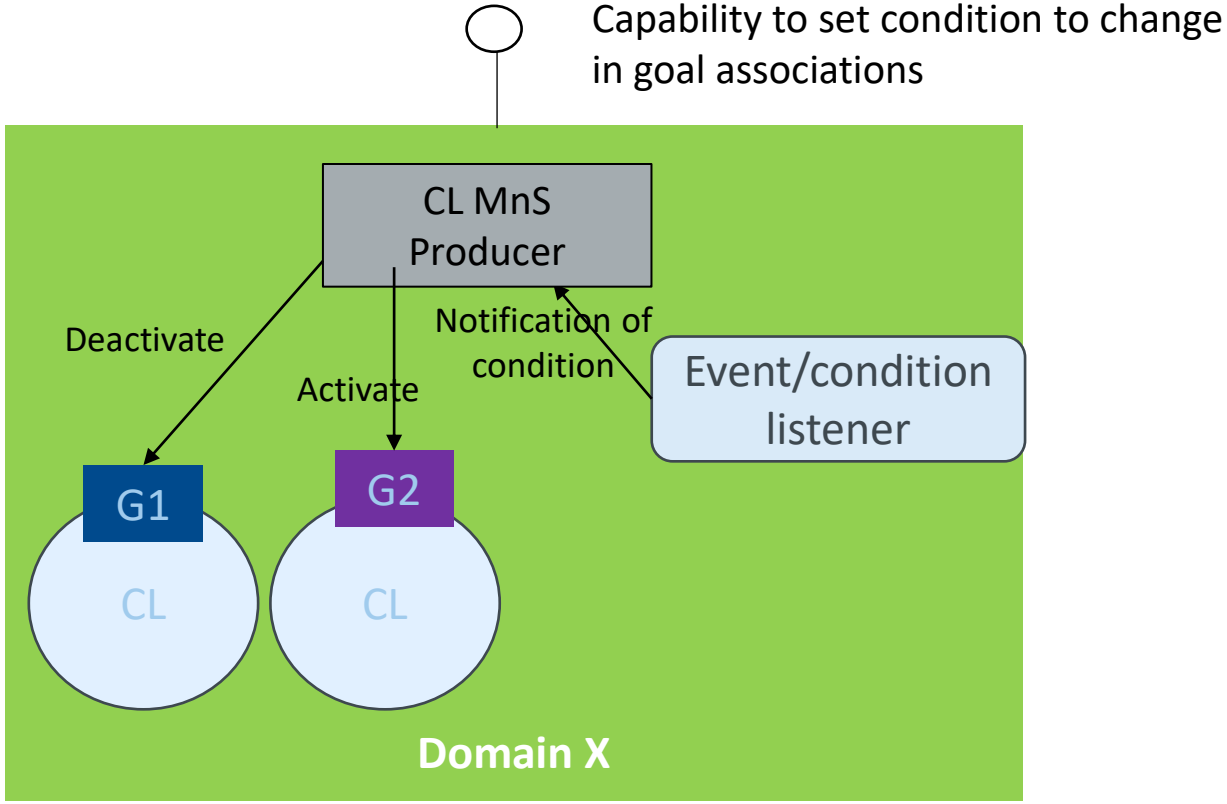
IV. Need for autonomic dynamism
Solution – CLs that can be triggered – Option 2 – CL Change

When **<condition>** Minimize Energy, Max QoE otherwise

<condition> could be anything configurable, example : time



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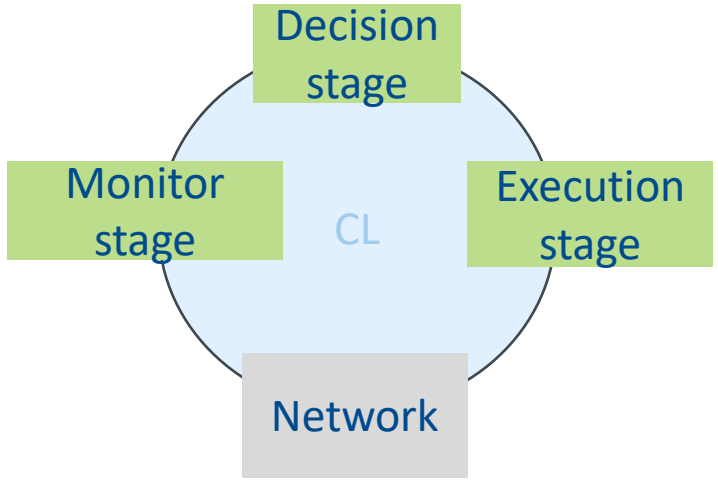
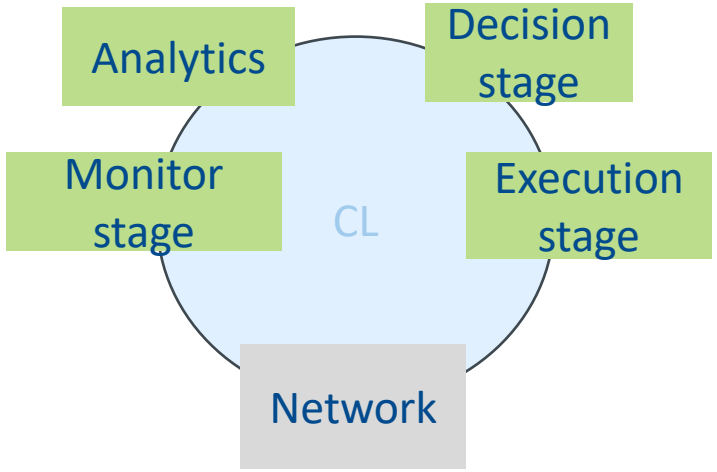
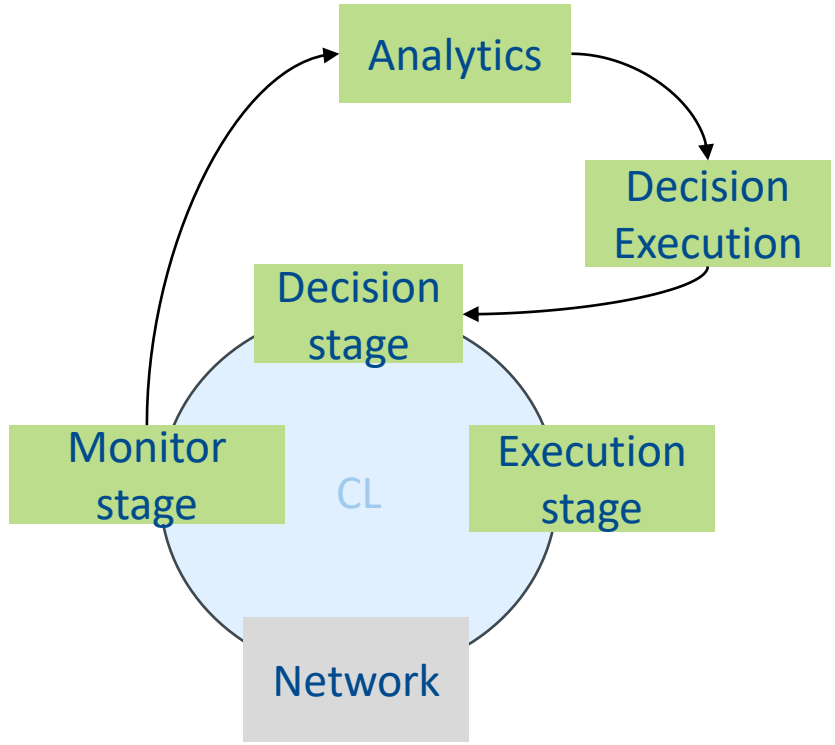
V. Need for creating unforeseen Closed Loops – M2O Loops







CLs **are not always** a collection of 4 stages

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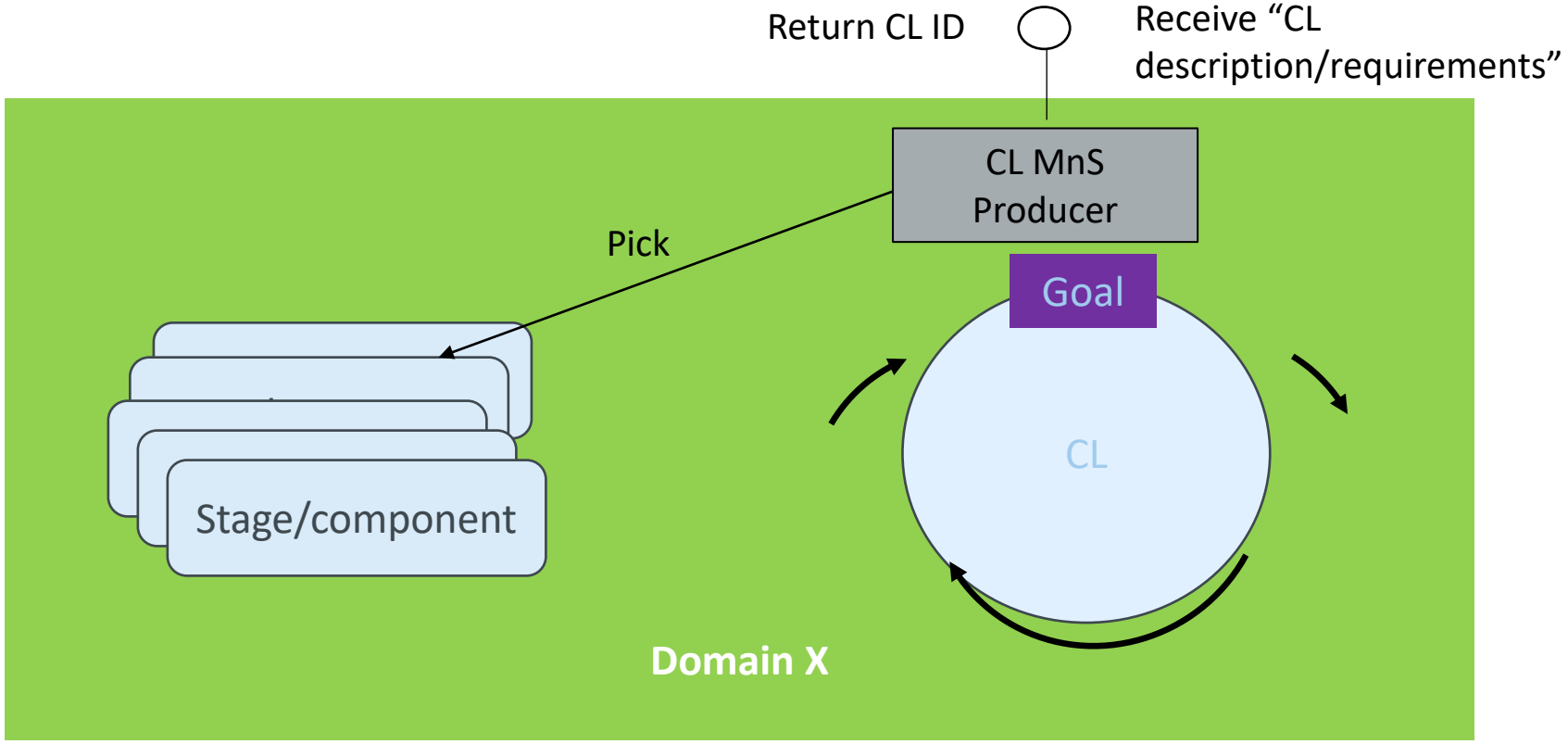
V. Need for creating unforeseen Closed Loops



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Extension to ZSM architecture Management Services

New MnS and capabilities for Closed Loop Governance and Closed Loop Coordination

Closed Loop Governance

1. Closed loop governance service
   - Manage closed loop lifecycle (M)
   - Manage closed loop models (M)
   - Manage goal (M)
   - Request issue resolution (O)
   - Escalate issue (O)

2. Closed loop information reporting service
   - Provide CL performance information (O)
   - Provide notifications about CL information (M)
   - Query CL information (M)
   - Configure service (O)

3. Closed loop execution management service
   - Provide closed loop pause point information (O)
   - Enable/Disable pause point(s) (M)
   - Provide notification for a pause point reached (M)
   - Manage action plans (M)
   - Continue closed loop execution (M)
   - Pause a closed loop (O)

Closed Loop Coordination

1. Pre-execution coordination service
   - Configure conflict detection (O)
   - Provide notifications of conflicting action plans (M)
   - Manage subscriptions (O)
   - Get recommended action plans (O)
   - Get the results of pre-action evaluation (O)

2. Post-execution coordination service
   - Provide list of managed entities and respective attributes modifiable by a CL (O)
   - Enable/ Disable actions (M)

(Source: ETSI GS ZSM009-1)

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Advanced topics

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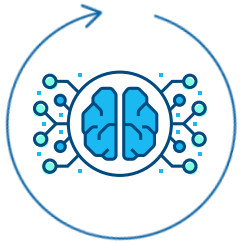
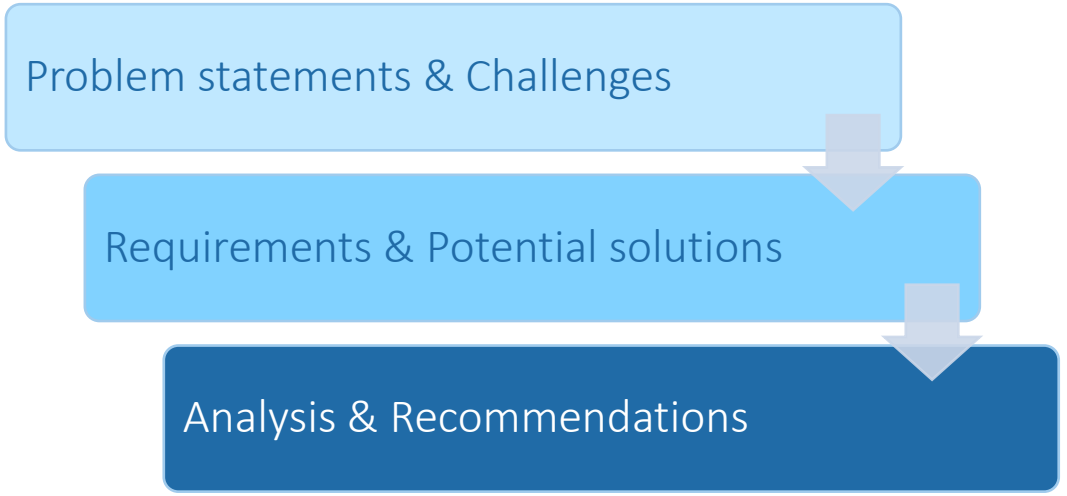
Goal & approach



Enabling next-generation AI-powered closed-loop operations

Investigate advanced concepts for closed-loop operations such as learning and cognitive capabilities, ways to set and evaluate levels of autonomy and supervision, intent-driven…



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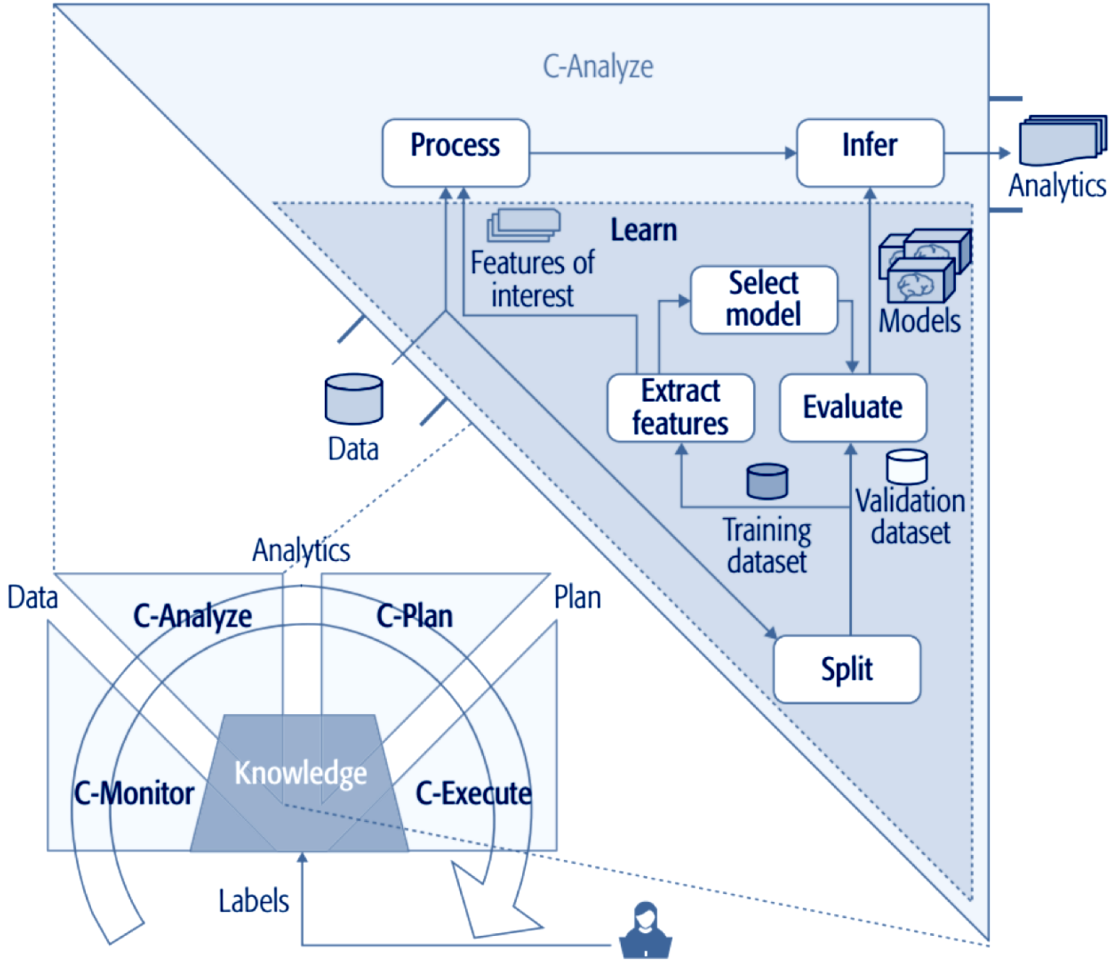
Towards Cognitive Closed Loops

"Cognitive MAPE"

Control loop incorporates ML at each stage [1]

- *C-Monitor*: performs intelligent probing
- *C-Analyze*: detects and predicts changes in networks
- *C-Plan*: automated planning engine to react to changes
- *C-Execute*: Optimal scheduling for plan execution



[1] S. Ayoubi, et al. Machine Learning for Cognitive Network Management. IEEE Communications Magazine. 2018.

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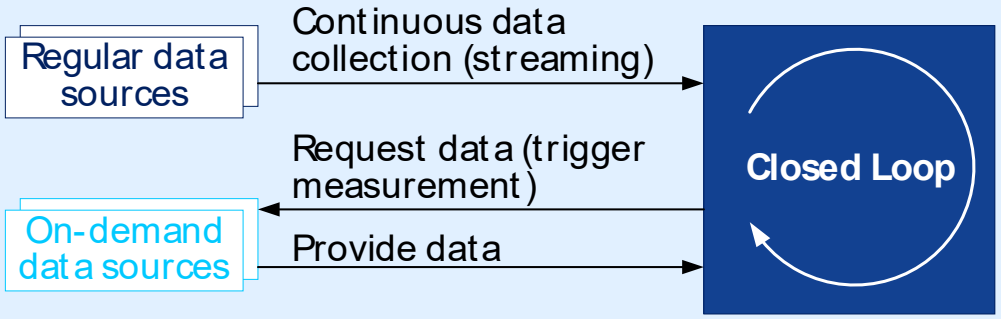
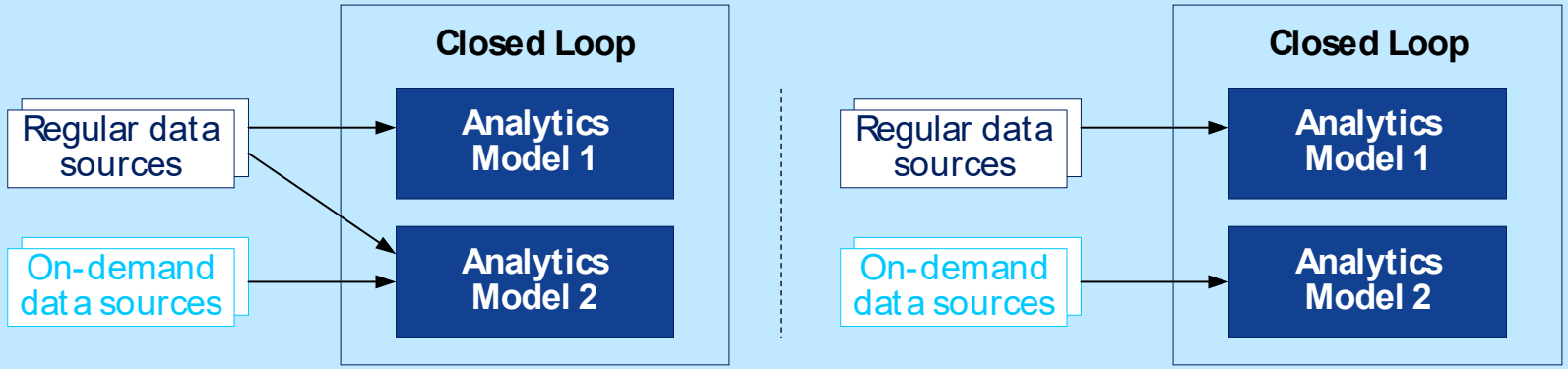
Cognitive Closed Loops



Dynamic interaction with data sources

Closed Loop
with multiple analytics models



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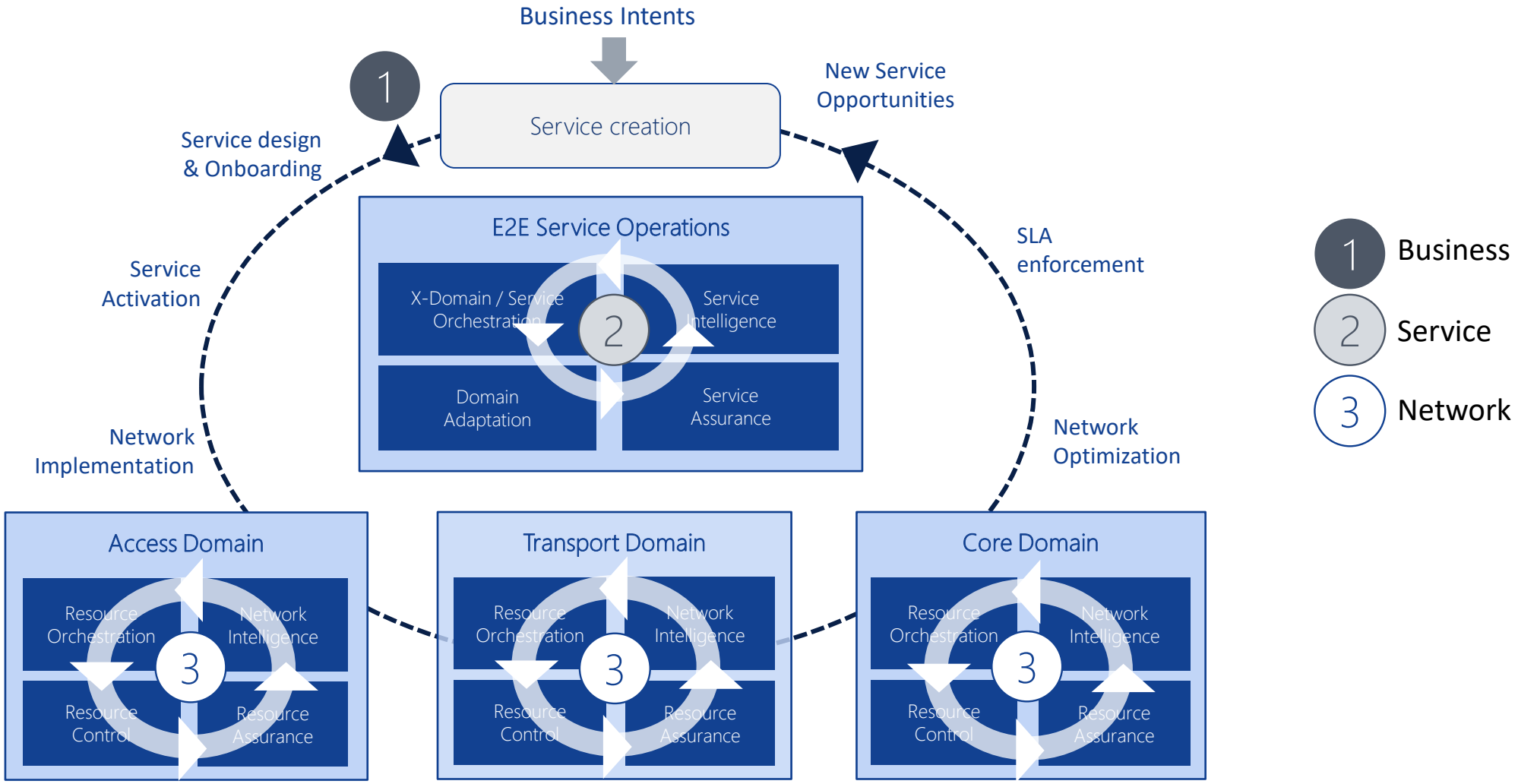
End-to-end, intent-driven closed loop automation



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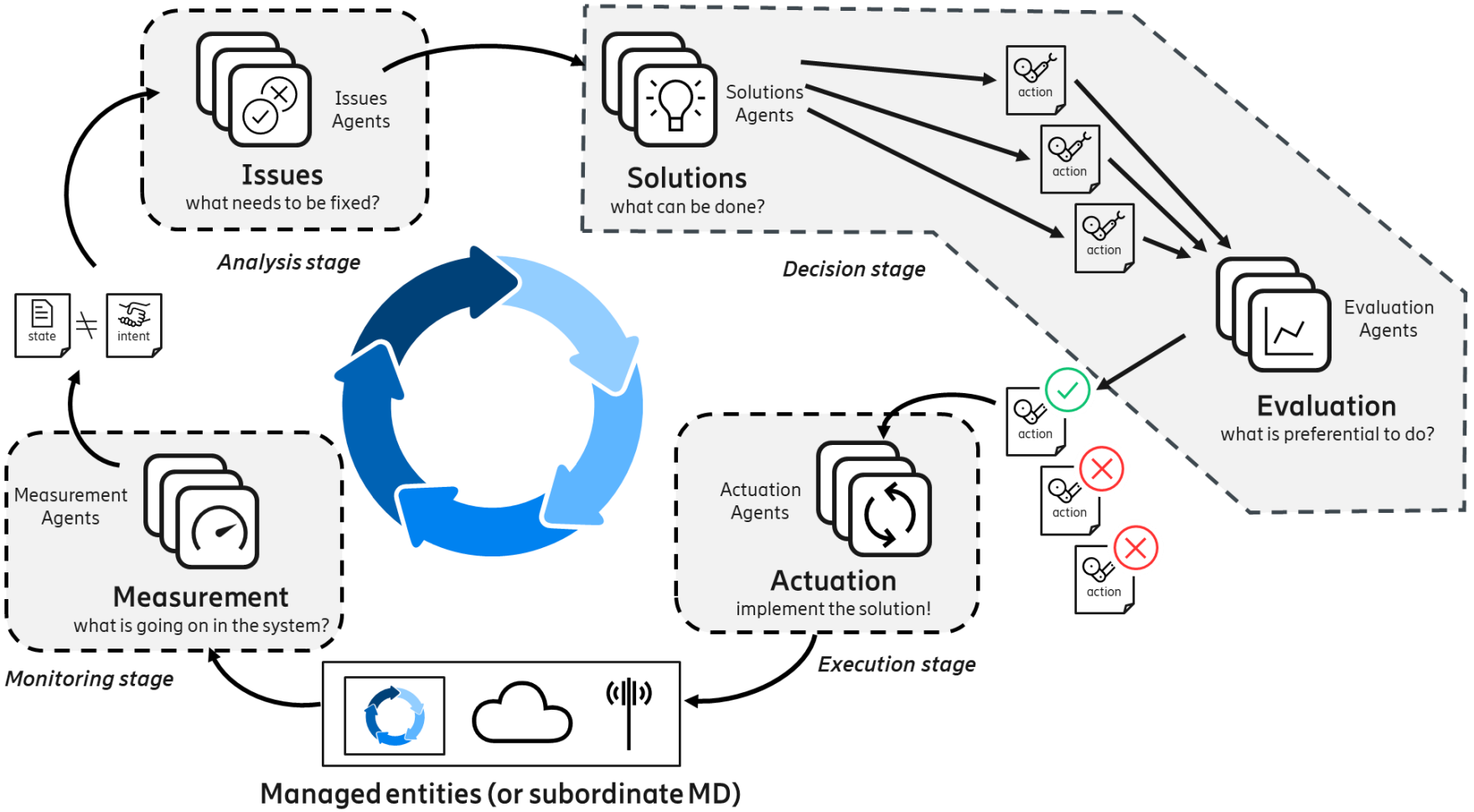
Source: Nokia

Example of a Closed loop driven by intents



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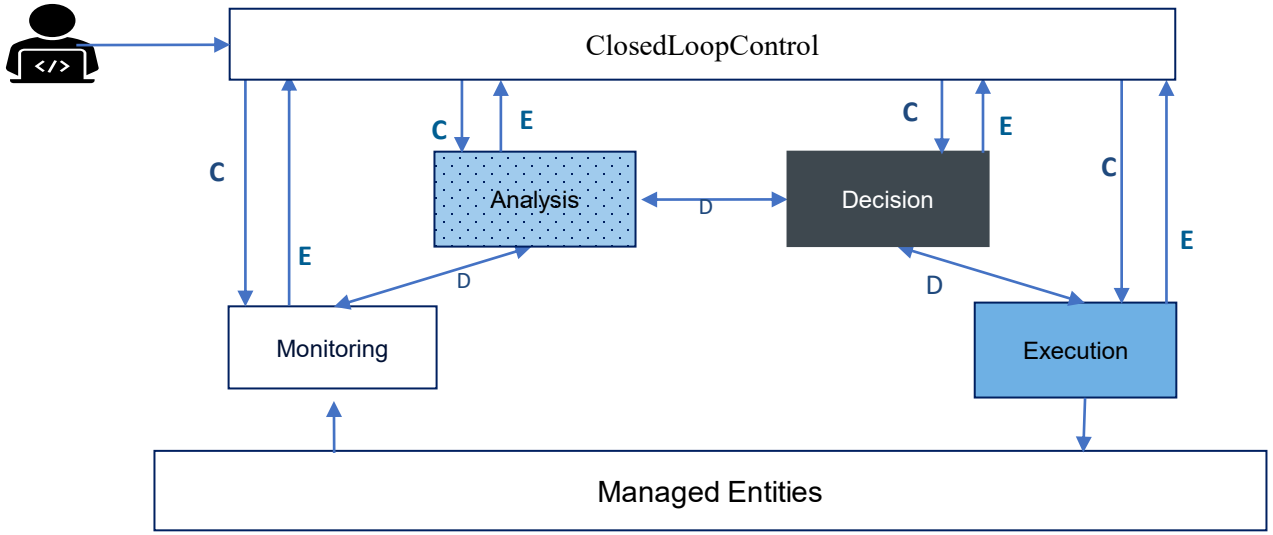
Dynamic composition of multi-vendor closed loops



- Multi-vendor CLs support specific modules for accomplishing specific tasks, e.g., to provide a specific analysis on some data. CLs may be composed from multi-vendors components using standardized services
- The different stages can support control and exposure services (marked with "C" and "E“)
- A flexible/abstract way to submit a M2O CLs composition may require:
  - minimum needed information to form M2O CLs such as catalogues of CL components, CL goal and description, required capabilities of management functions that combine to form M2O CLs
  - number of stages and capability to form M20 CLs.
  - to configure the M2O CL stages, e.g., with their sources of data or where to deliver their reports
  - to map output of one stage to the input of subsequent stages e.g., data transformation might be required between the stages to facilitate mapping

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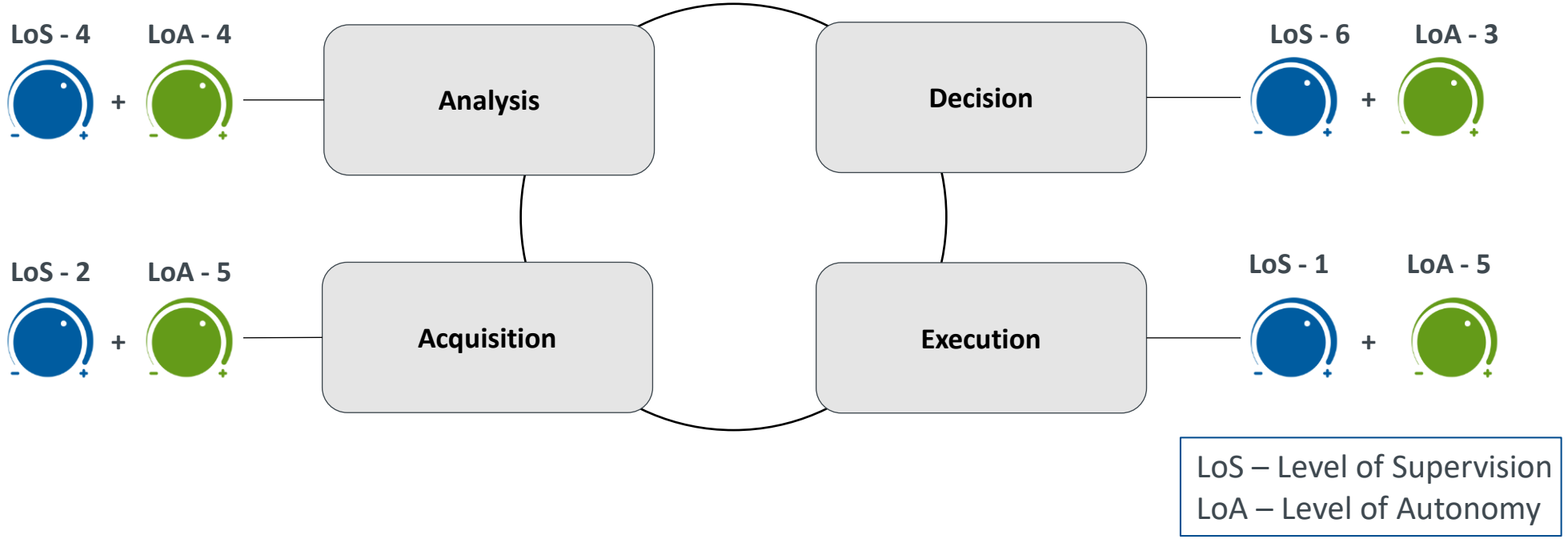
Dynamic levels of autonomy & supervision



Dynamic, conditional activation and deactivation of CL autonomous operation

- Who decides when the control of function must be shifted?
- Different autonomy and supervision requirements per CL stage
- Operator defines when and for what he needs to be “in the loop”
  - What information shall be reported, recorded and when…

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Take aways

- ZSM009 provides enablers for
  - Closed loop governance (CL models, lifecycle management)
  - Closed loop coordination (conflict detection and resolution)
- Challenging automation scenarios can be solved with new CL capabilities
- Future work on advanced topics still open for contributions

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Questions / Discussion

More information on ETSI ZSM

ZSM Technology Page: http://www.etsi.org/zsm

ZSM Wiki: https://zsmwiki.etsi.org/

ZSM Open Area (Draft specs): http://docbox.etsi.org/ISG/ZSM/Open

ZSM Portal (members' working area): http://portal.etsi.org/zsm

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