# Strategies for movement

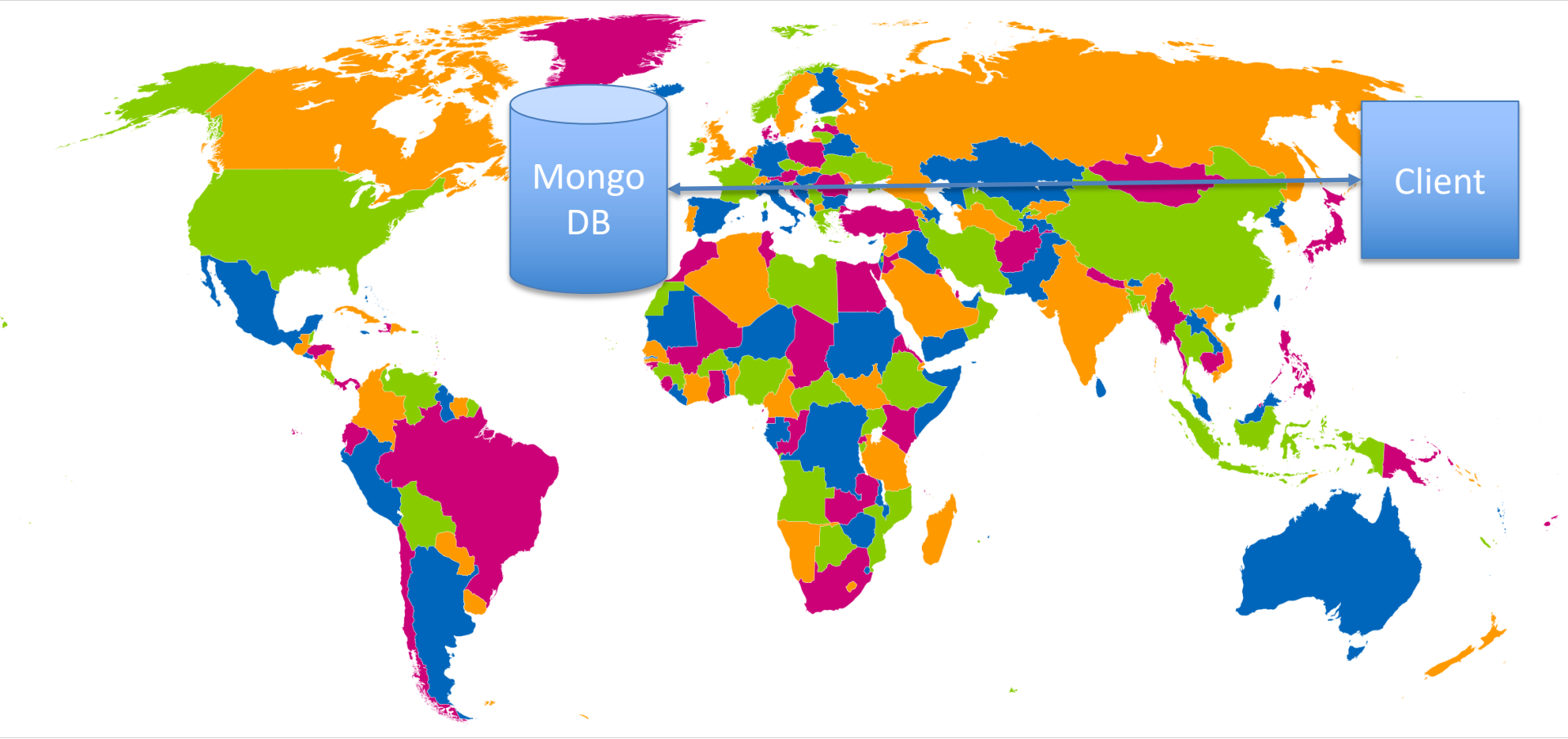
Section 3

# Why do we move data and computation?

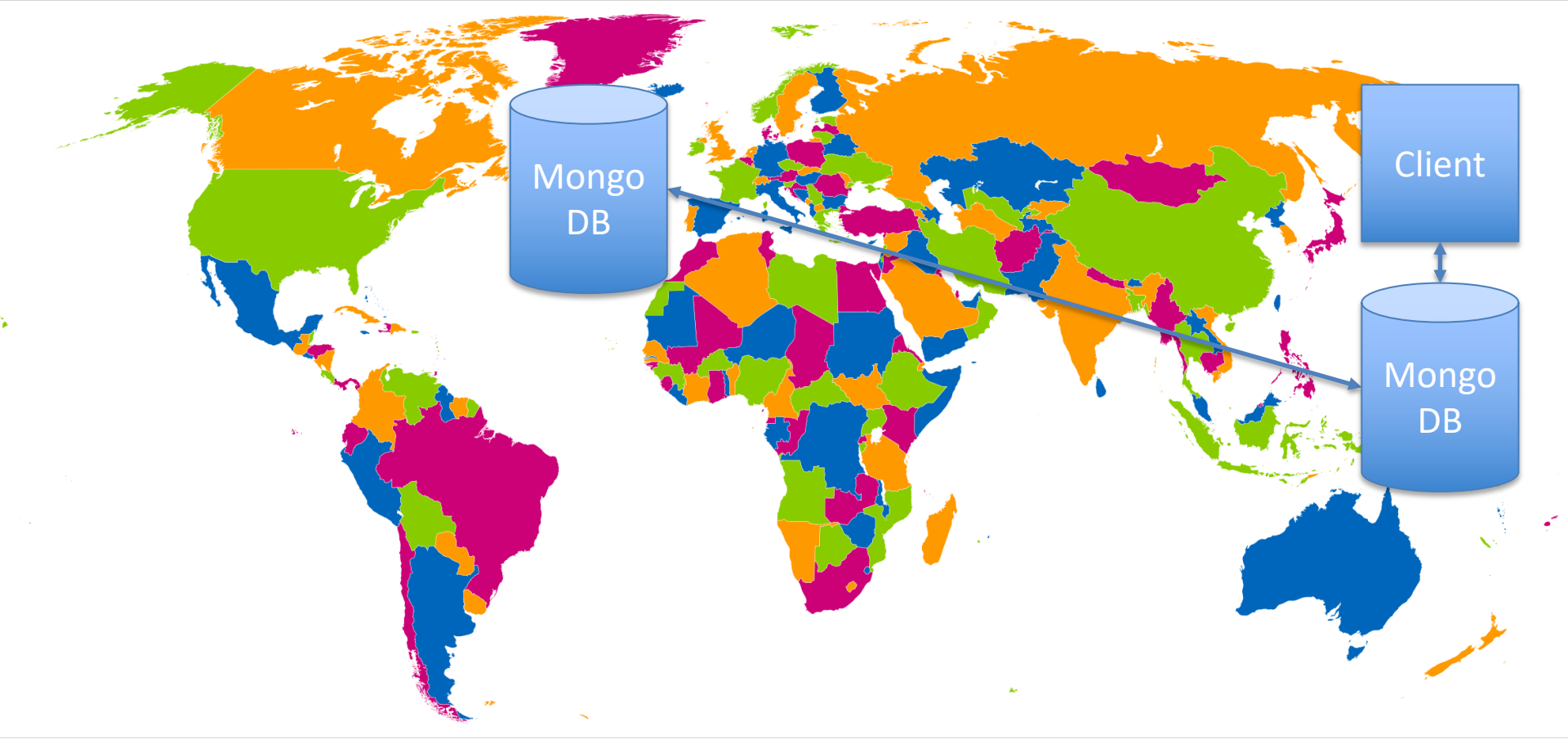
We know how to move data and computation..

Why do we move them?

# Case study description



# Case study description



# Why do we move data and computation?

We know how to move data and computation..

Why do we move them?

To satisfy requirements of users:

- Latency
- Completeness
- Length encryption key
- Location of data
- …

# When do we move data?

Two options

- In advance:
  - Proactive behavior
- When a requirement is not satisfied
  - Reactive behavior

# Reactive behavior: violations management

Definition of violation: one or more requirement is not satisfied.

Examples:

| Requirements | Violations |
|---|---|
| Latency < 5ms | Latency 20 ms |
| Completeness > 80% | Completeness = 70% |
| Encryption key length > 256 | Encryption key length > 128 |

Tolerance accepted, but have to be agreed with users

# Definition of requirements

Requirements is a singular documented physical or functional need (of users) that a particular design, product or process aims to satisfy.

Data utility

- Quality of Service (QoS)
- Quality of Data

Security

Privacy

# The elicitation of requirements

It’s difficult for users to specify which requirements they needs.

They require a certain level of abstraction that can change based on their expertise

Es:

- Latency < 20 ms
- Responsive system
- Fast system

# Goal-based modelling notation

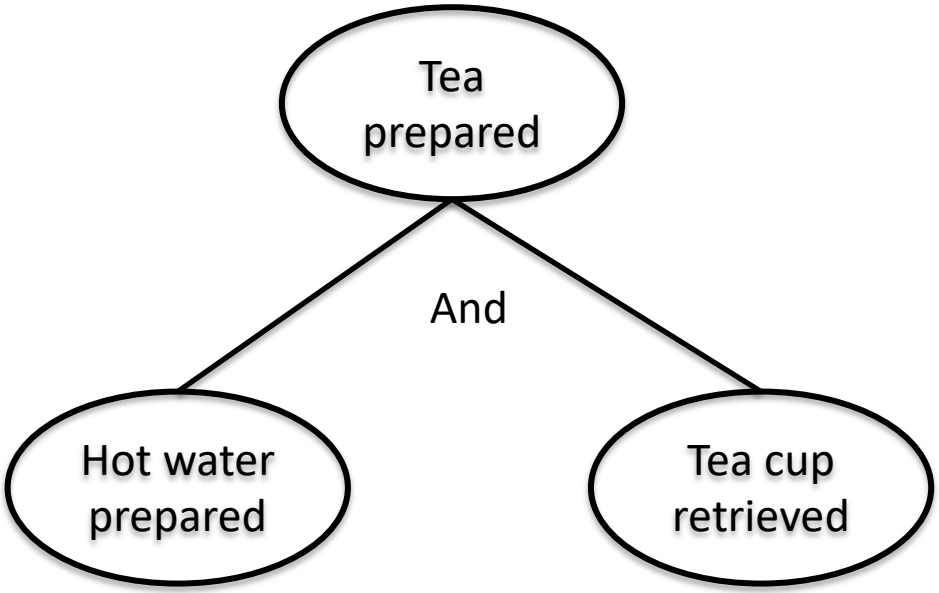
Based on:

- Goals: objectives to be achieved
- A tree-like structure: to organize goals

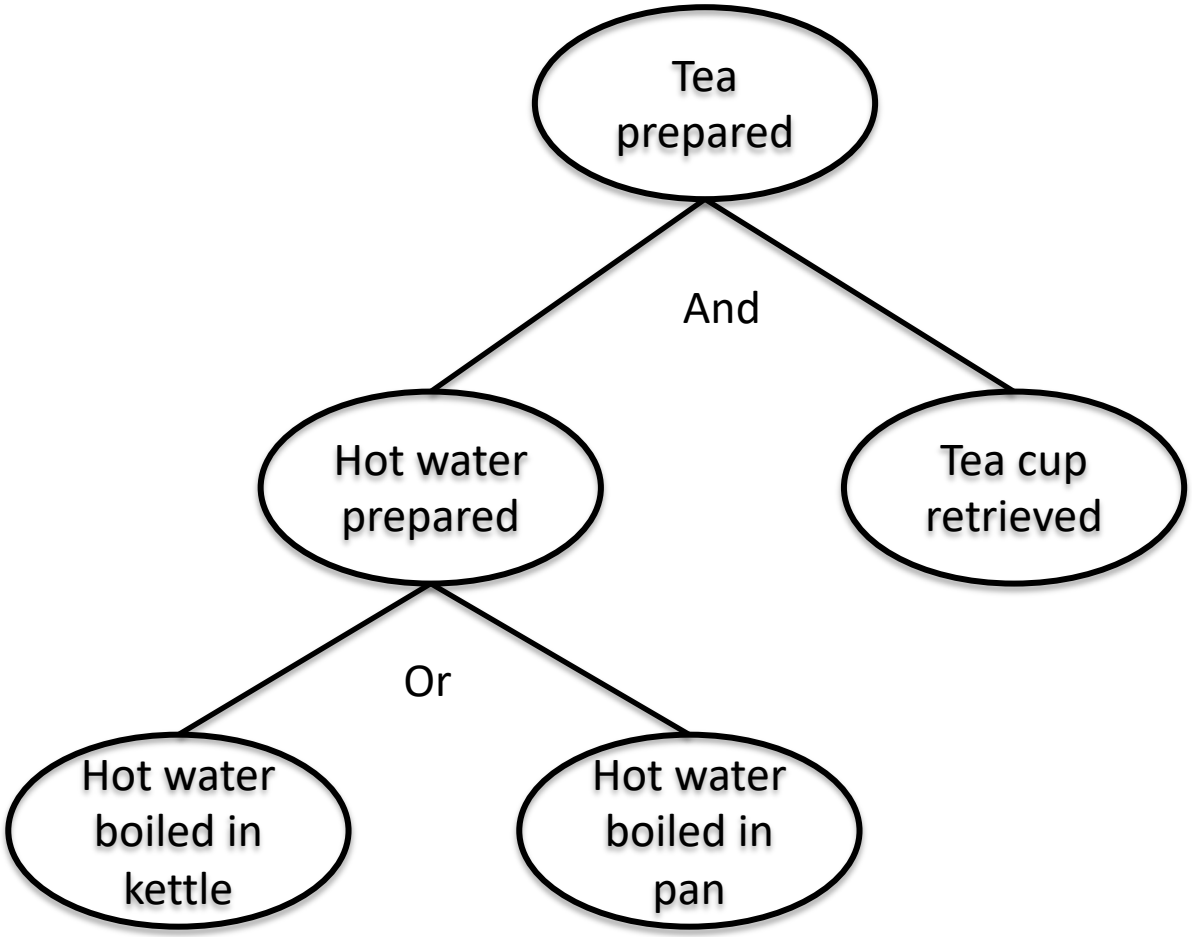
Many goal-based modelling language

- We extended Business Intelligence Model (BIM) [1]

# And decomposition



# Or decomposition



# Decompositions rules

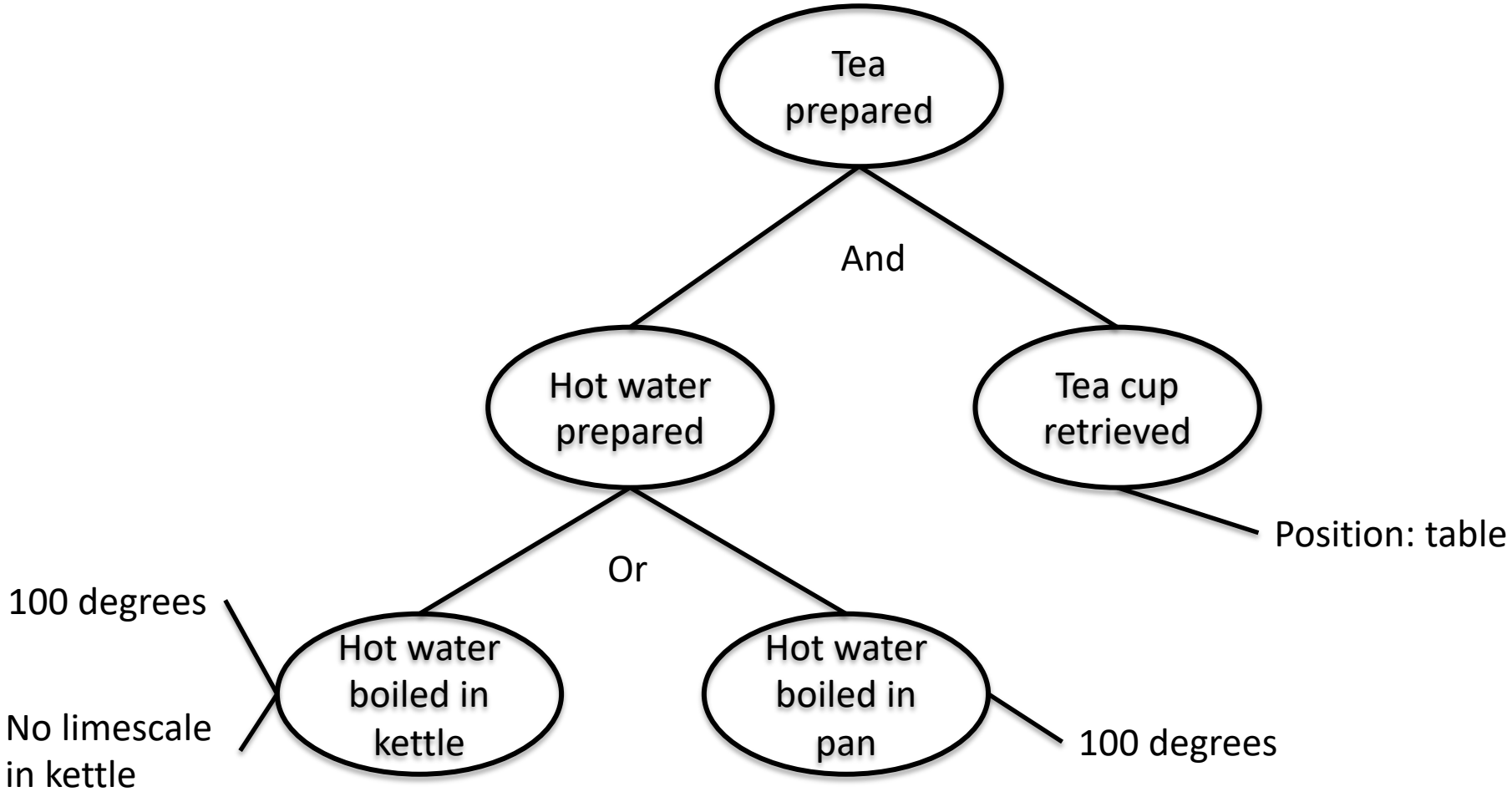
- Only one type of decomposition per goal
- Minimum 2 sub-goals
- No upper bound

# KPI

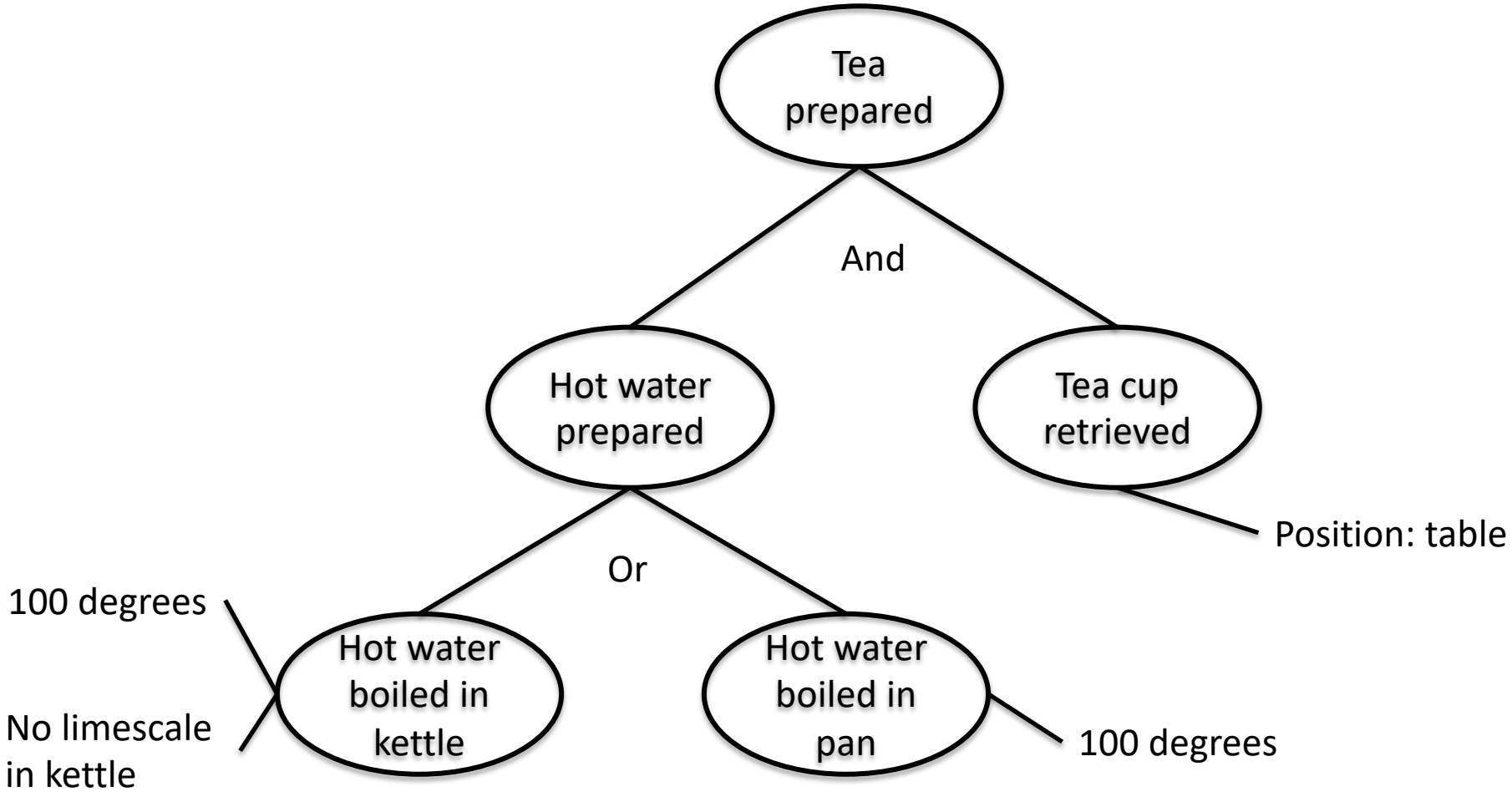
Key Performance Indicator (KPI)

- Specifies a metric and a threshold
- Attached to a goal
- When all KPIs attached to a goal are satisfied, then the goal is considered reached (satisfied)

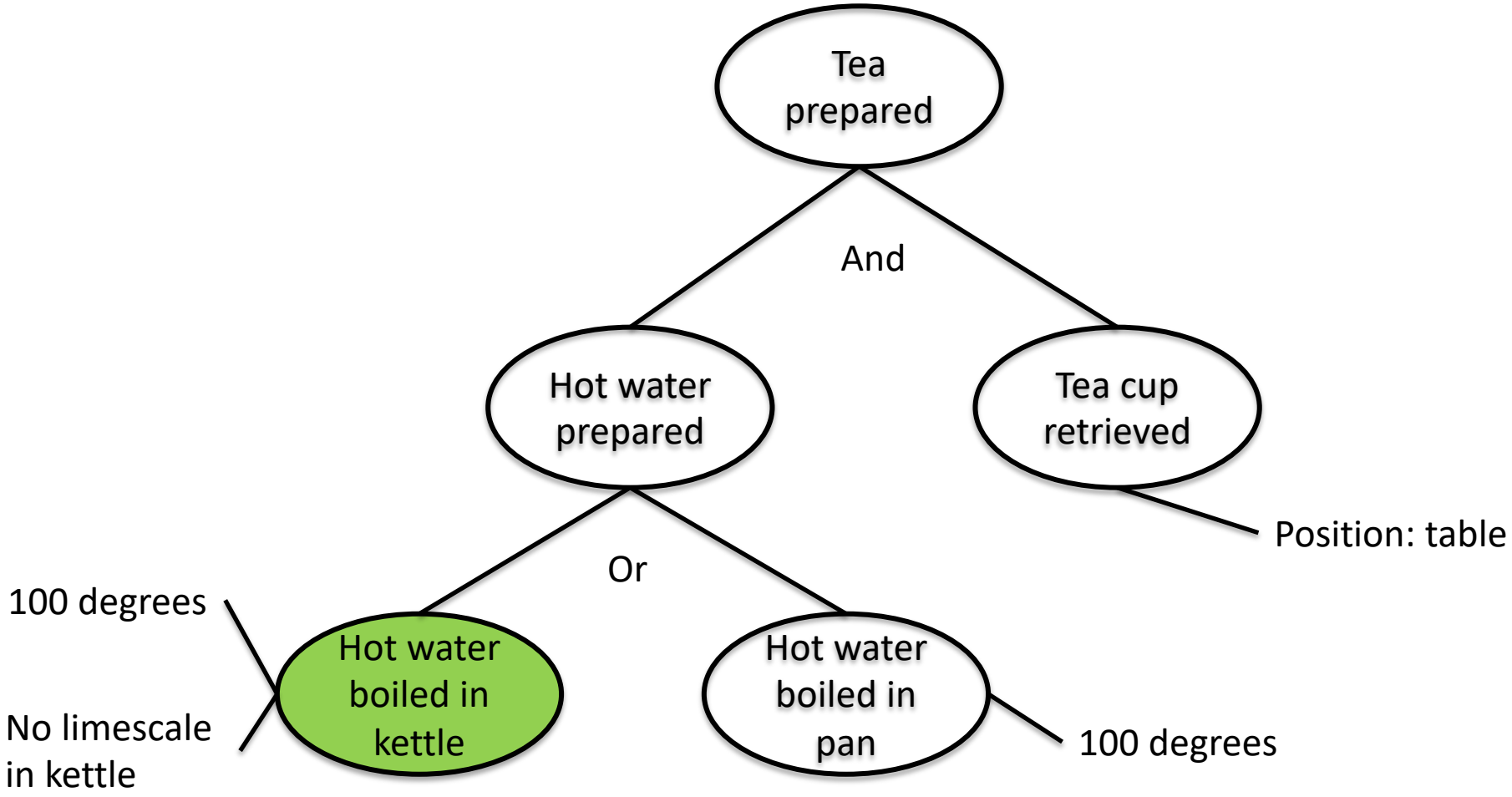
# Or decomposition



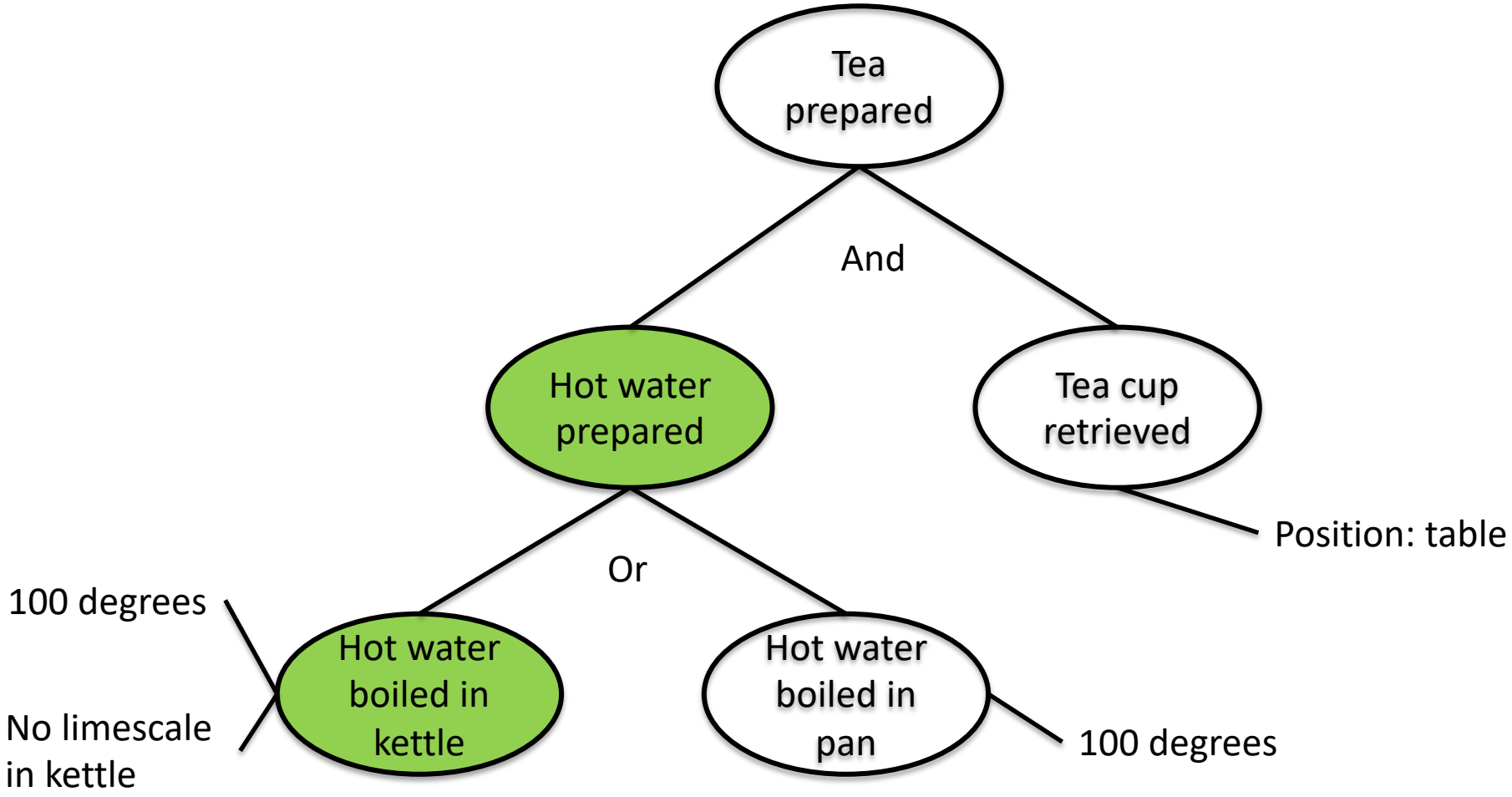
# Or decomposition



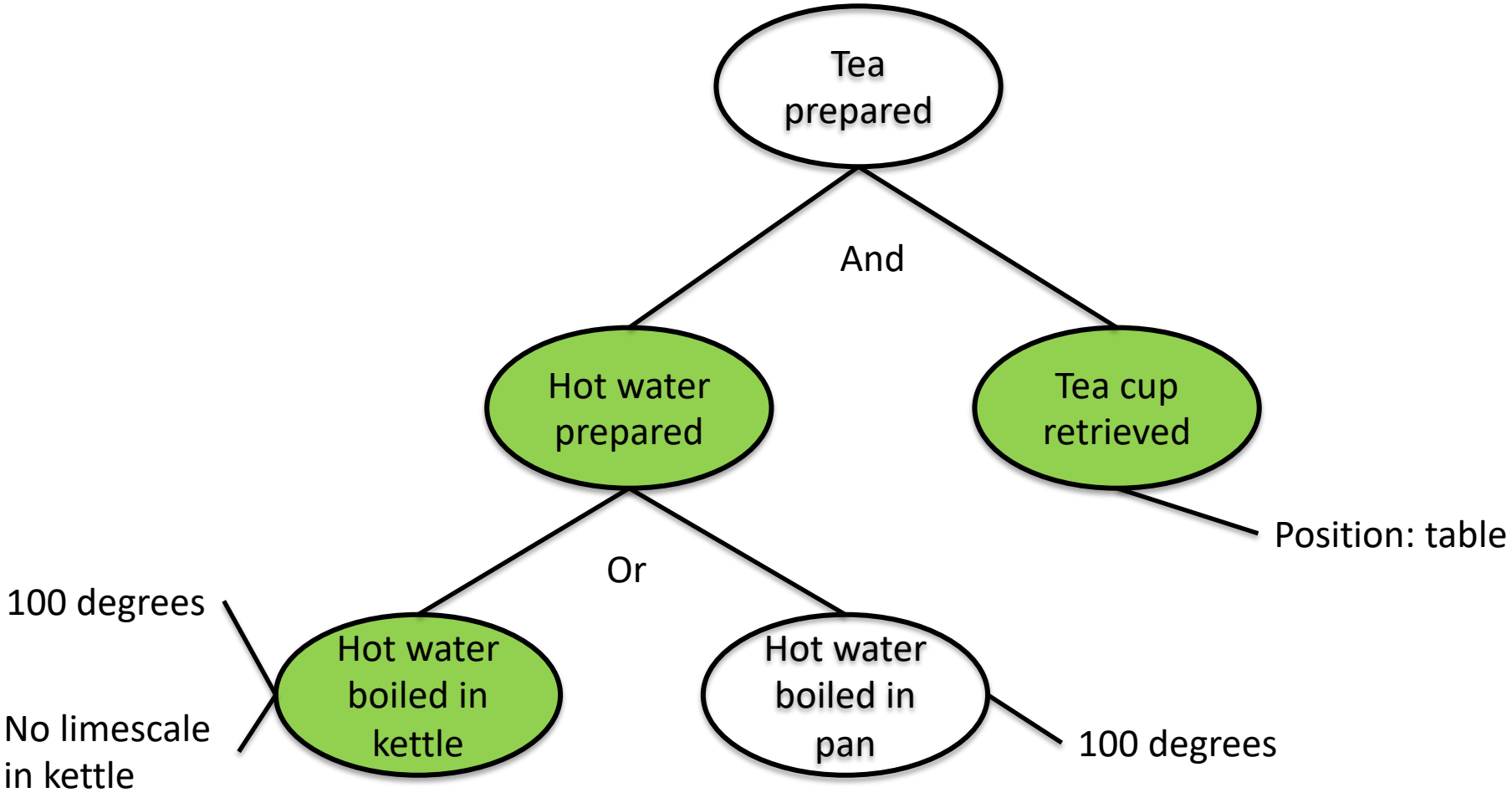
# Or decomposition



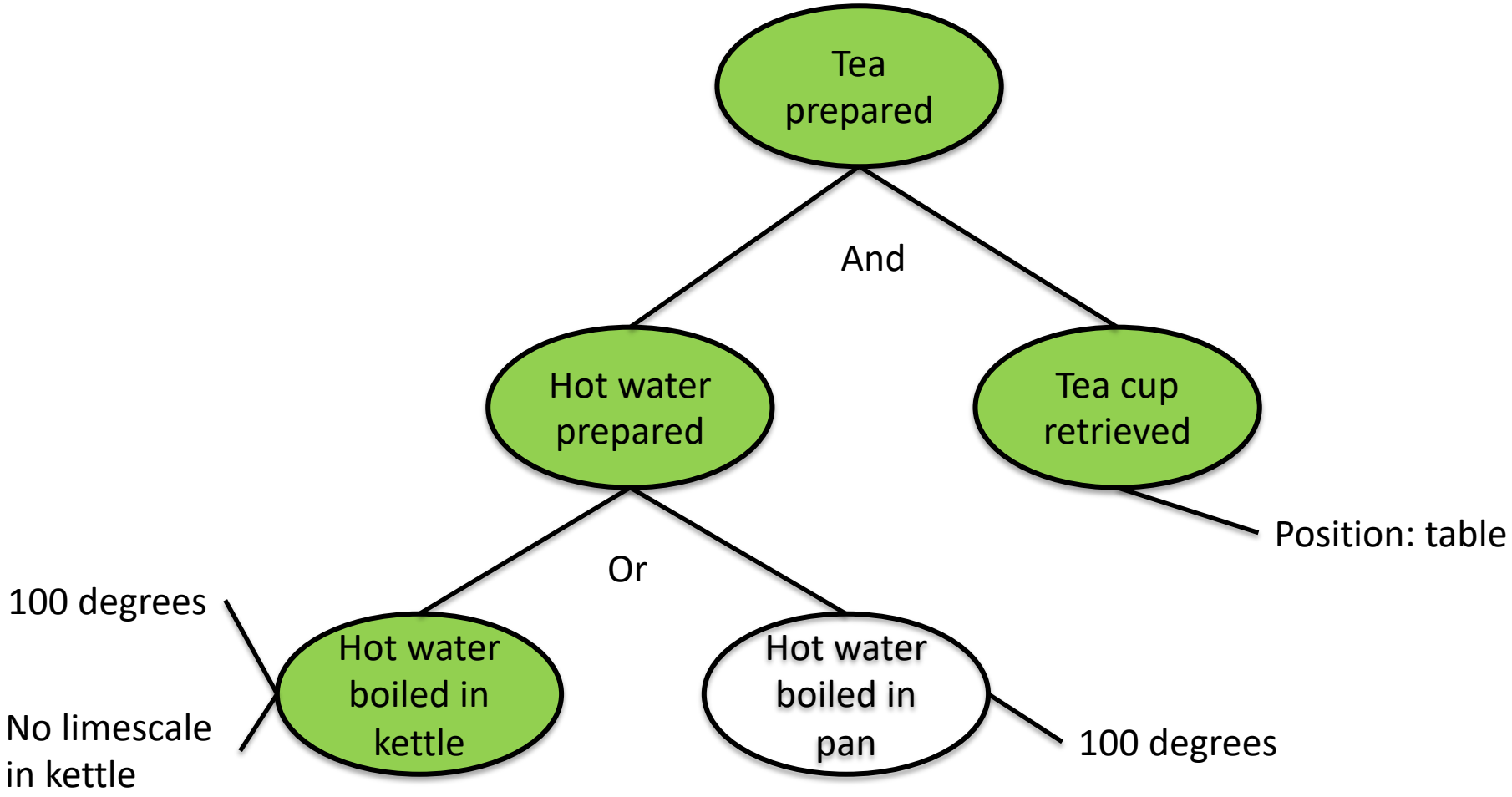
# Or decomposition



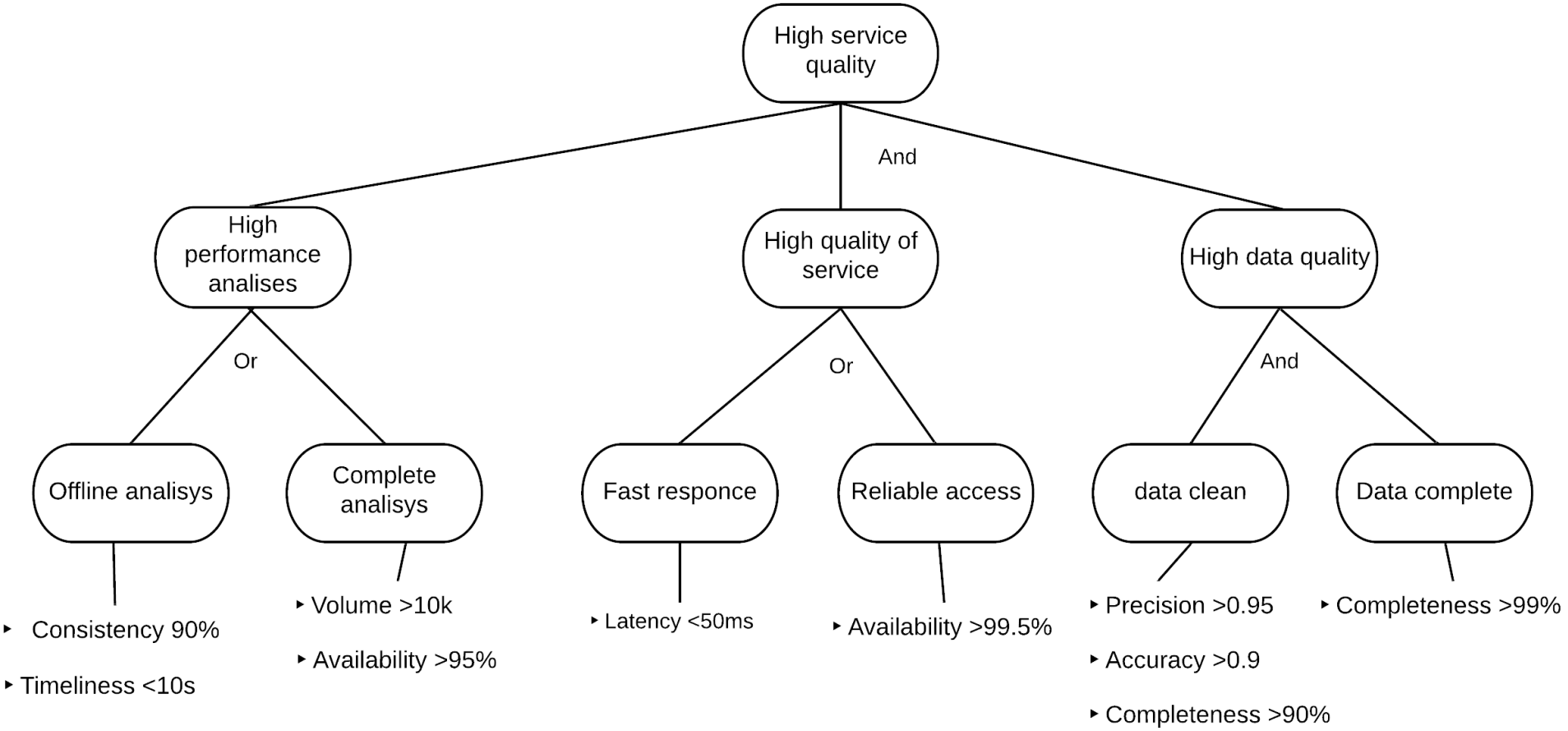
# Or decomposition



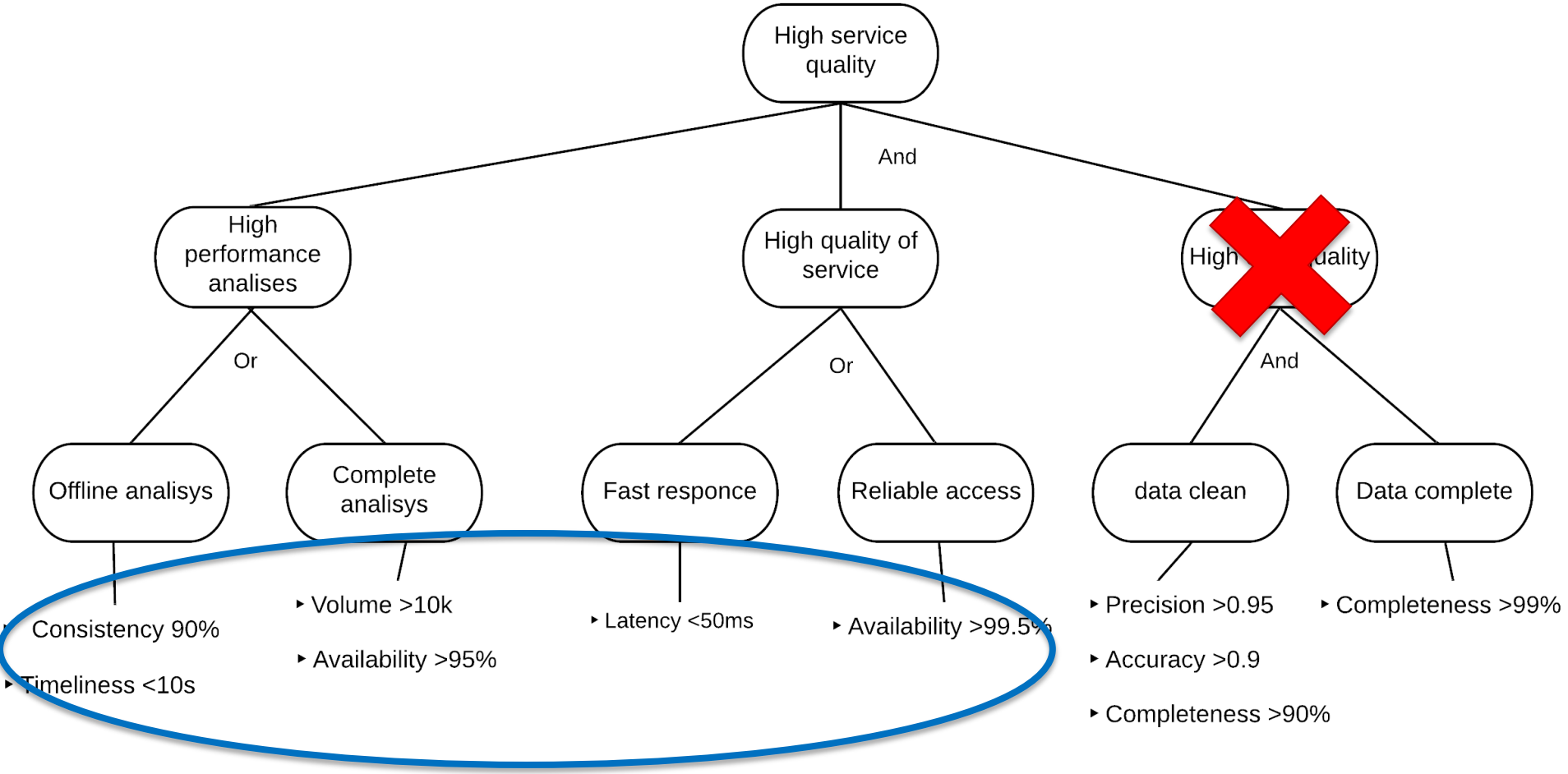
# Or decomposition



# A more realistic example



# Goal model customization

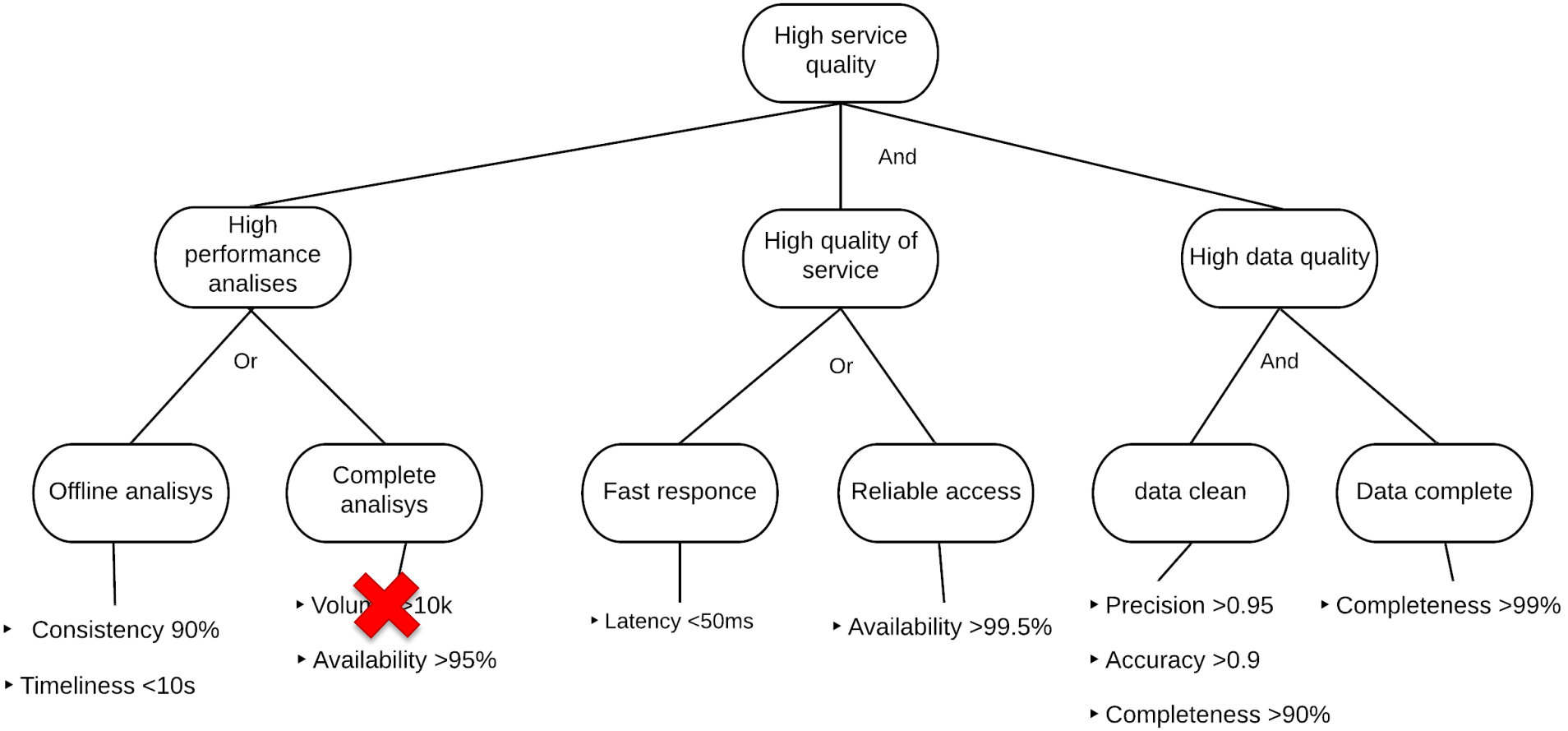


# Violation

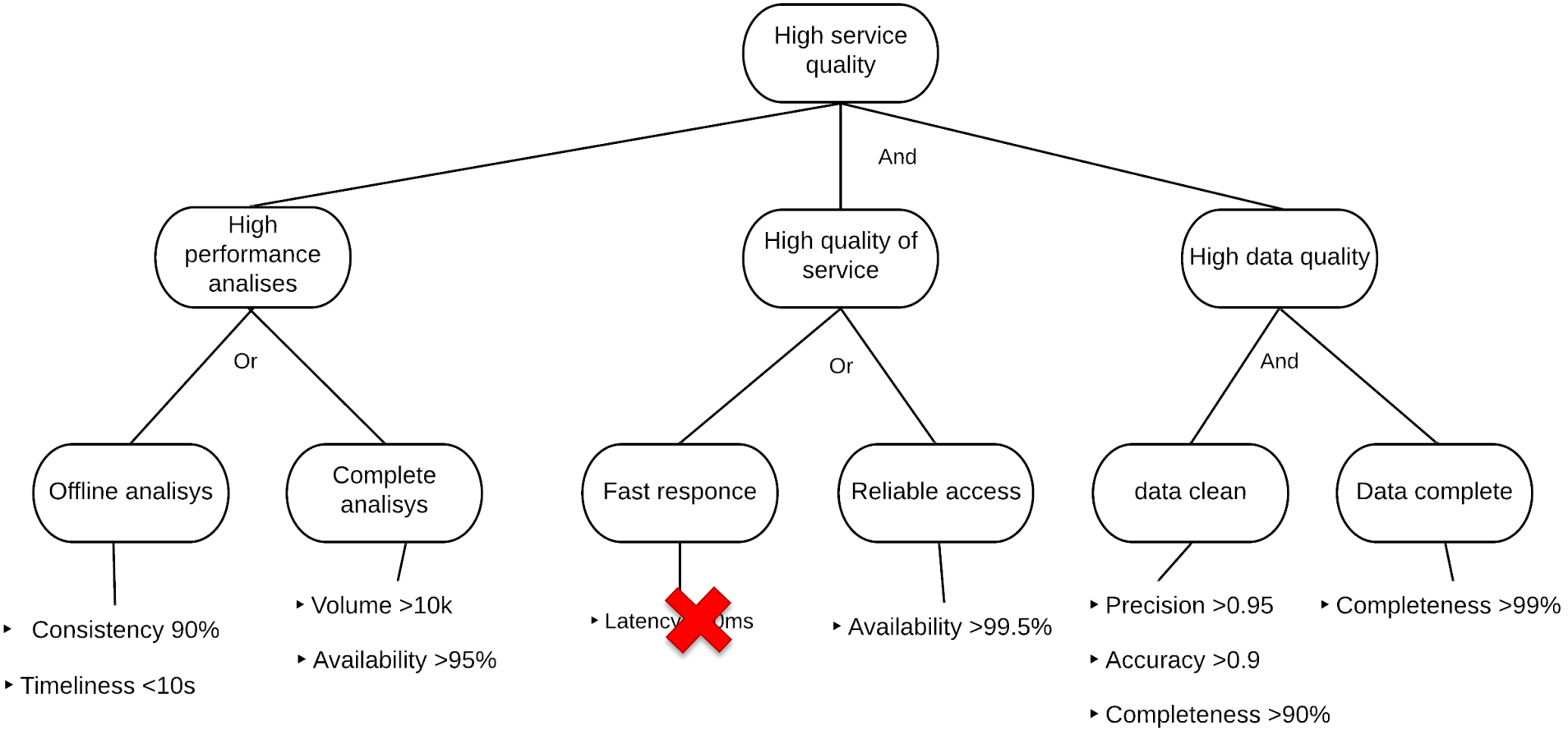
A violation is not a KPI under performing

A violation is the top goals that becomes not achieved

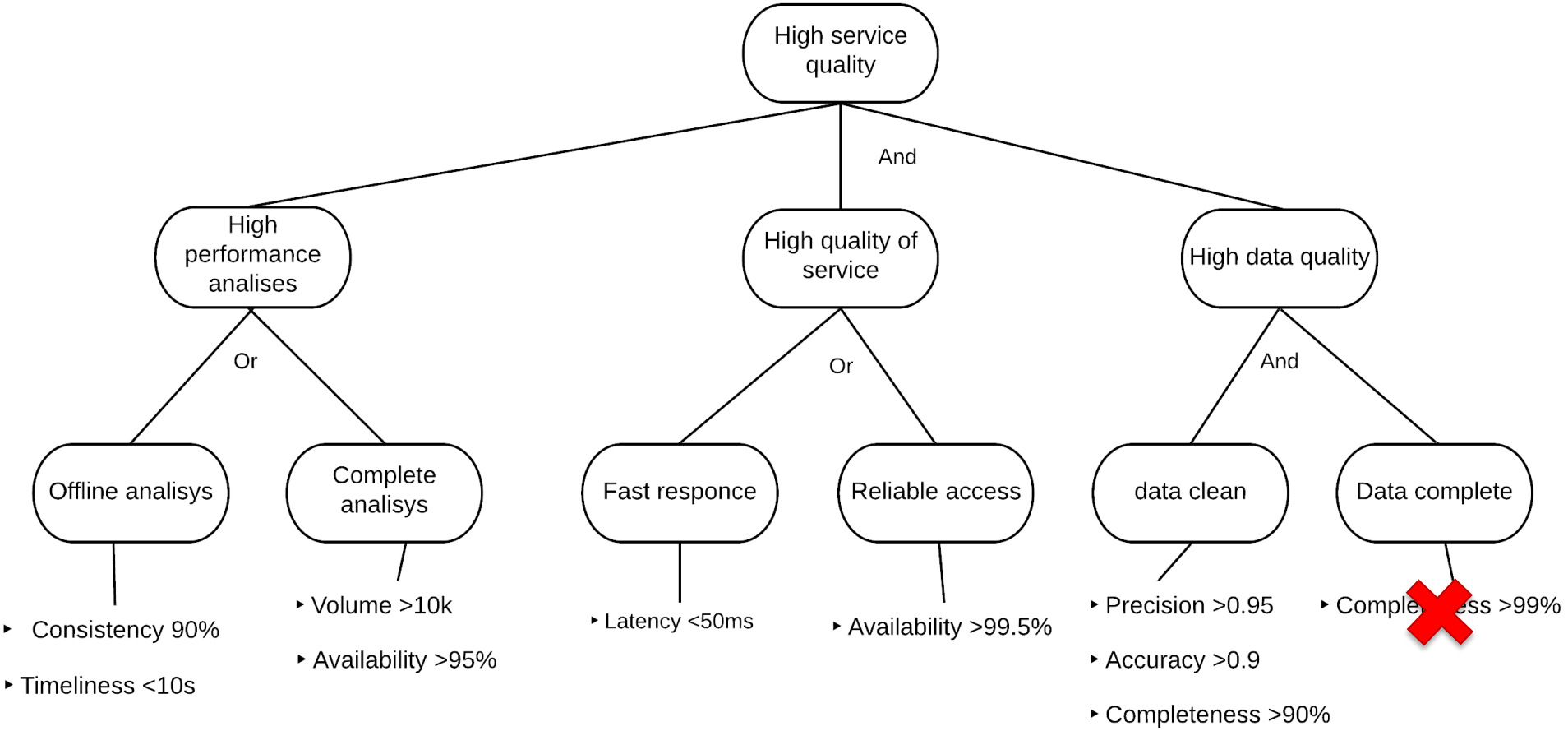
# Violation example



# Violation example



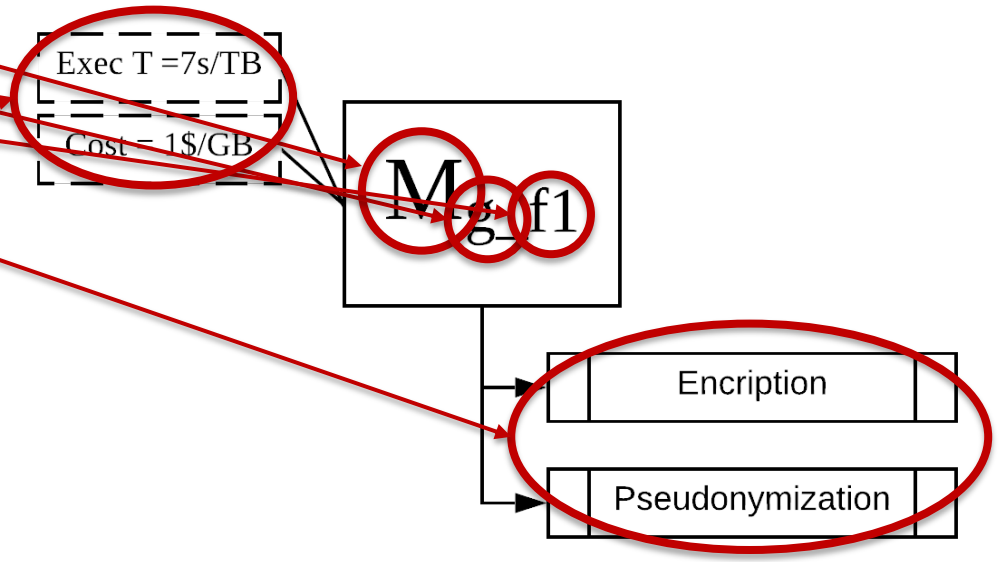
# Violation example



# How do we represents movement actions?

Information needed

- Type
- Source
- Target
- Transformation
- Costs



# Connecting movement actions

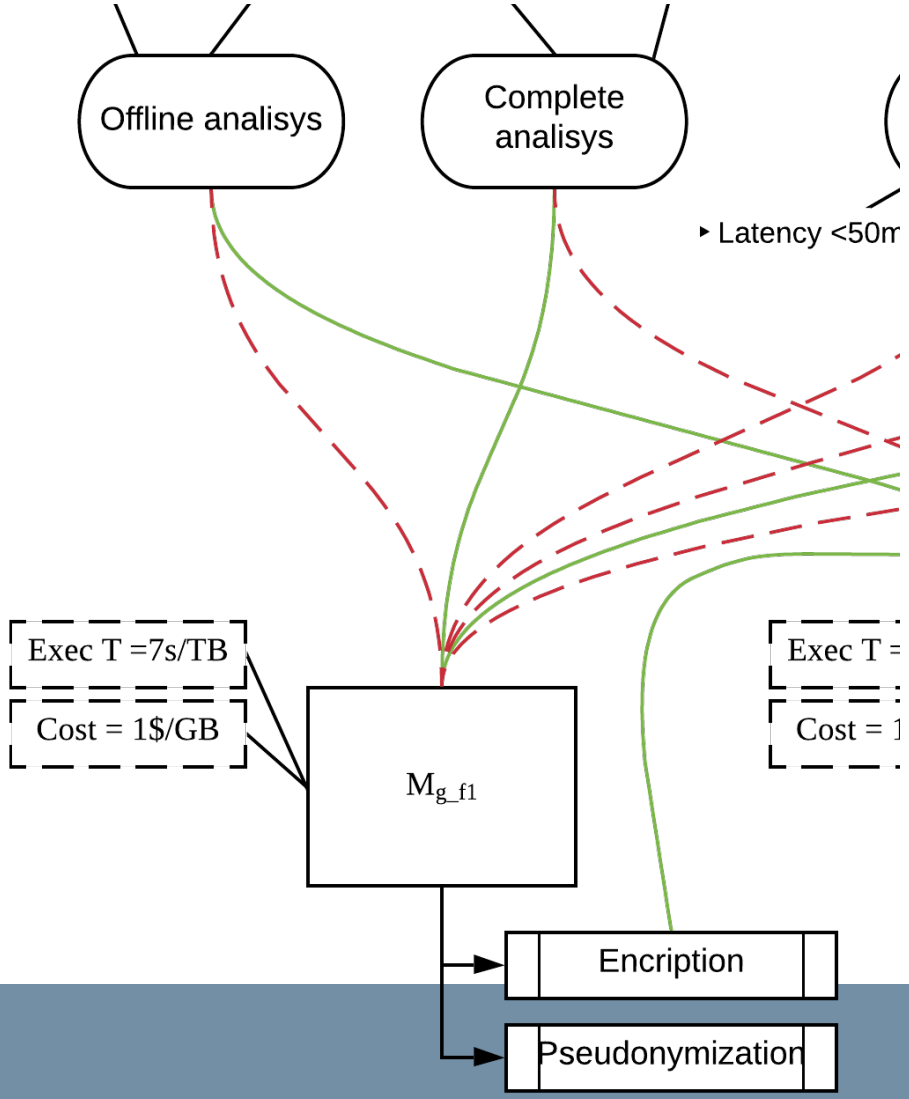
When a movement action is enacted the status of the fog environment changes

The movement action impacts on the data qualities

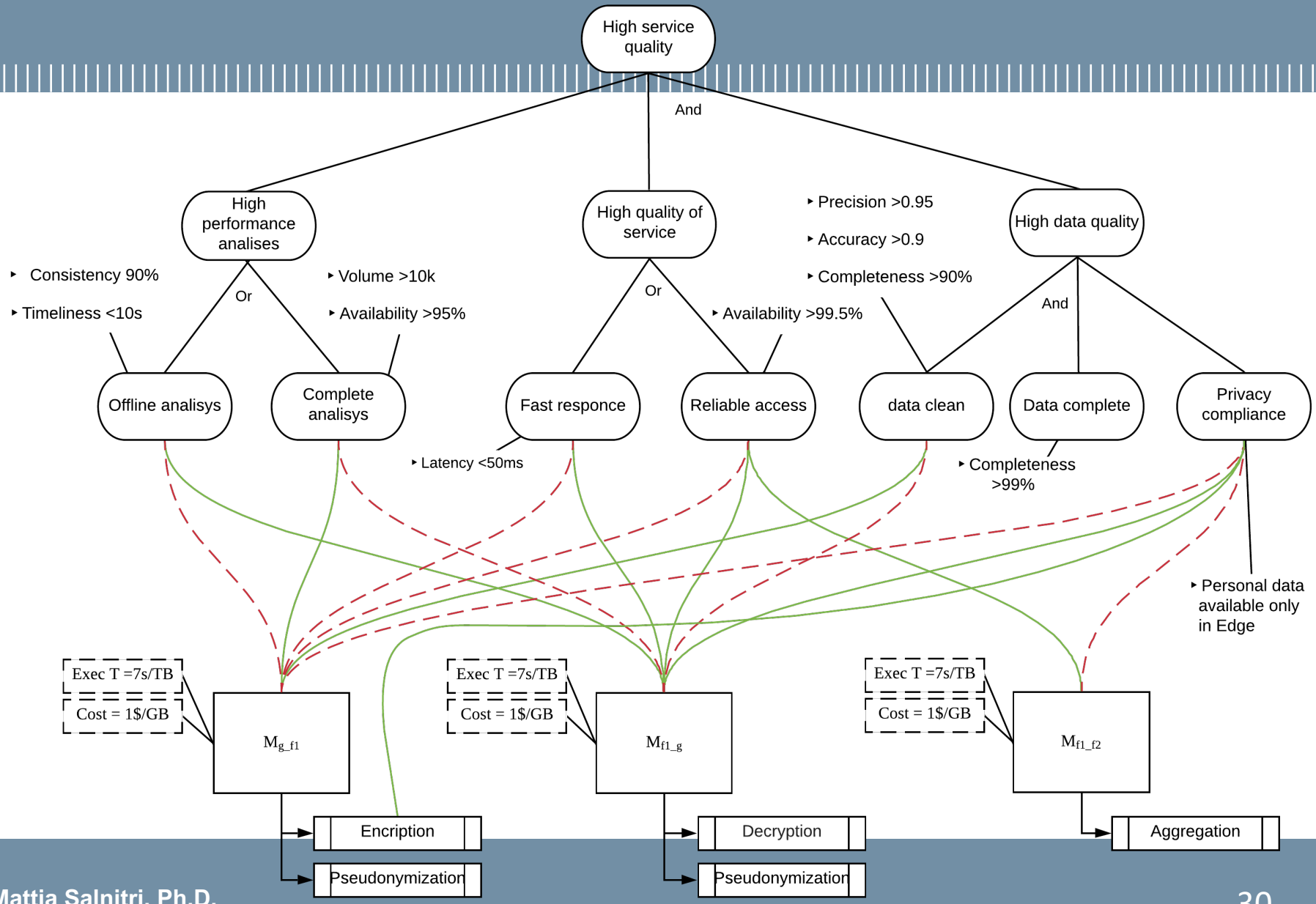
We use two types of impact relations:

- Positive impact
- Negative impact

# Example of impact relations



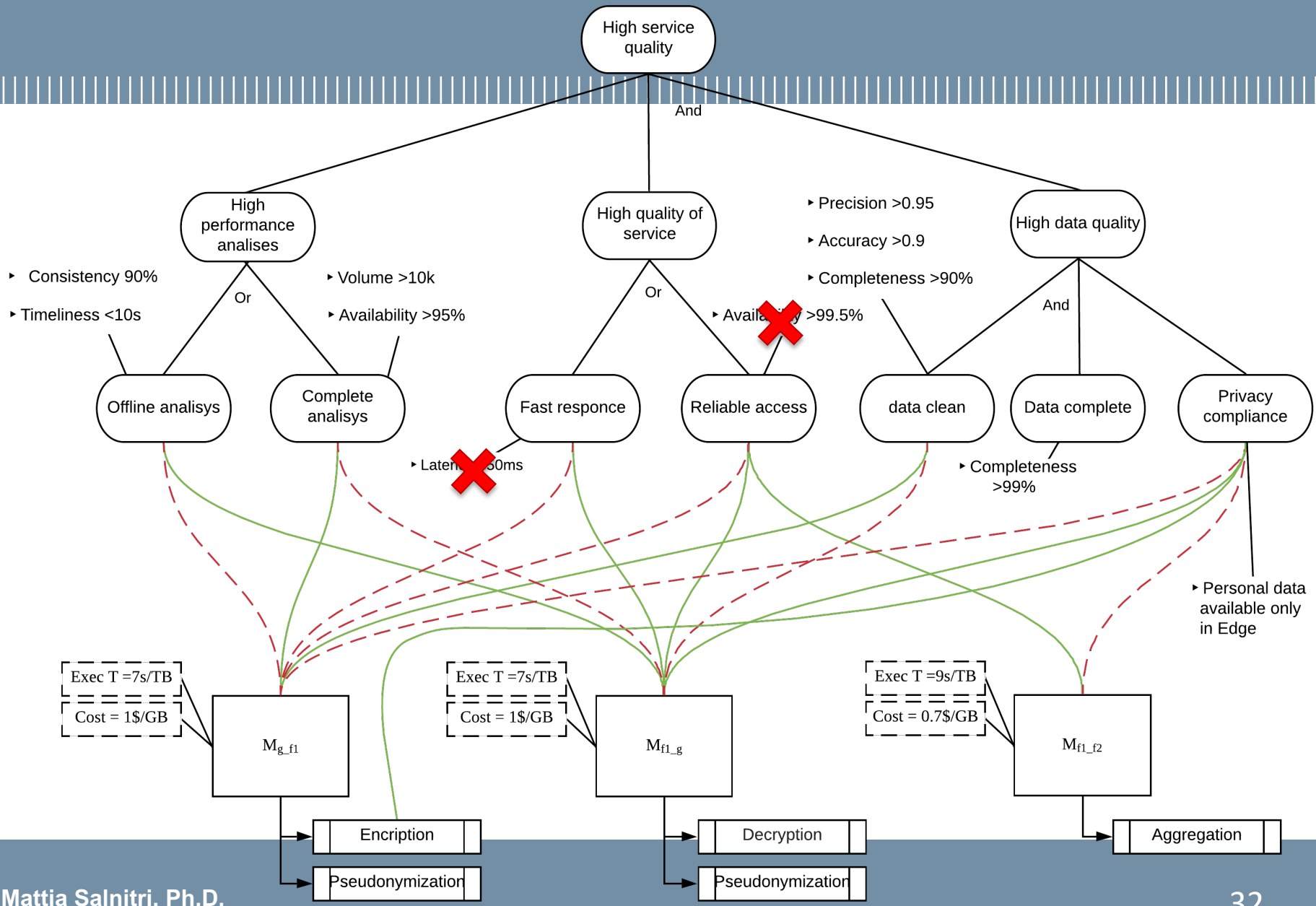
# The complete goal model



# The selection process

1. Violation is detected
2. Top-goal satisfaction is checked
3. Identification of possible movement actions

# The selection of data movement



Two movement selected

- $M_{f1\_g}$
- $M_{f1\_f2}$

Which one do we choose?

# Movement strategies

Optimization functions define by users

- Prioritize gain
- Prioritize time
- Prioritize positive impact
- …

# The selection process

1. Violation is detected
2. Top-goal satisfaction is checked
3. Identification of possible movement actions
4. Selection of movement action based on movement strategy
5. Enactment of the movement action

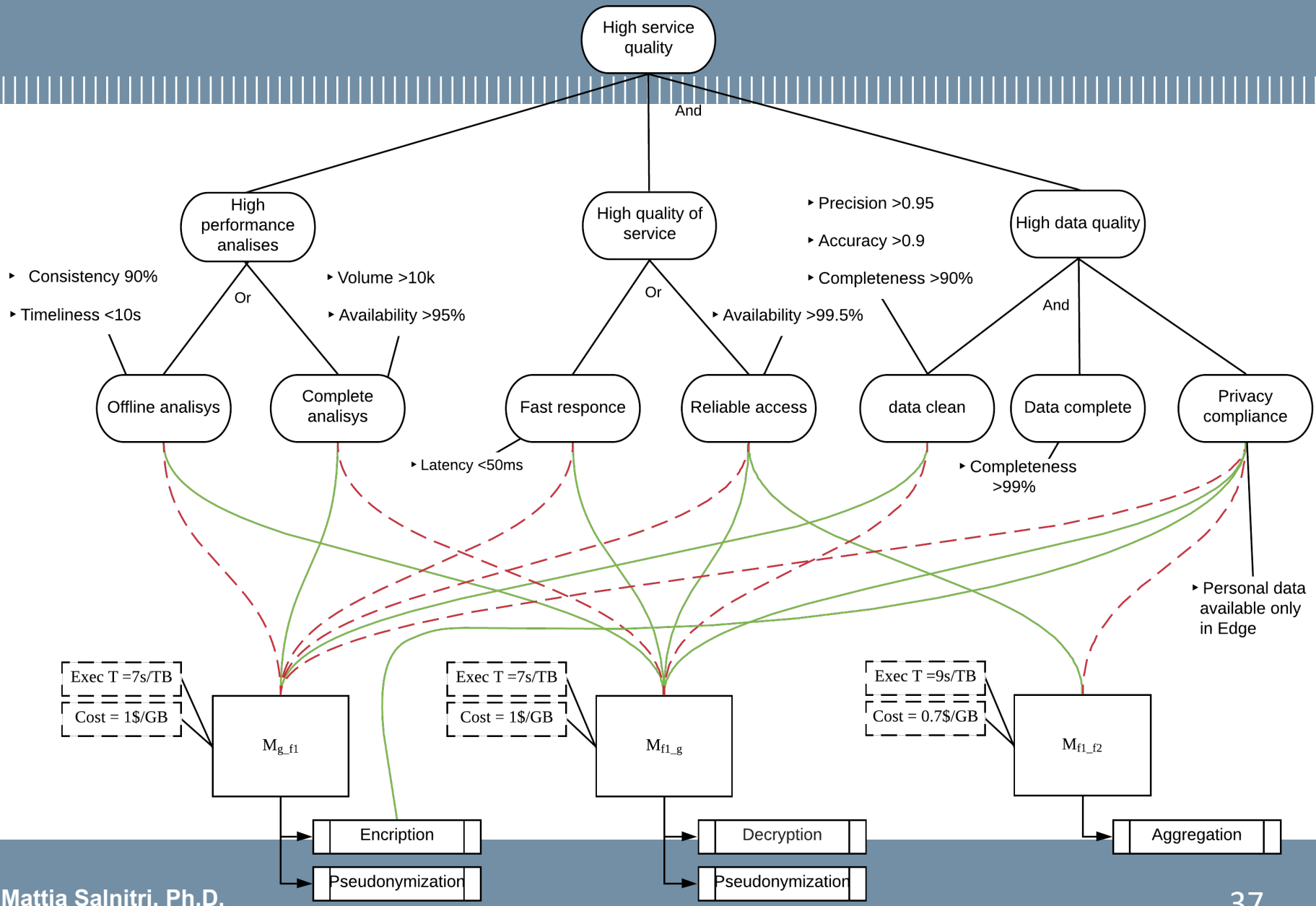
# Contribution link update

Every enactment of a movement action influences the fog environment

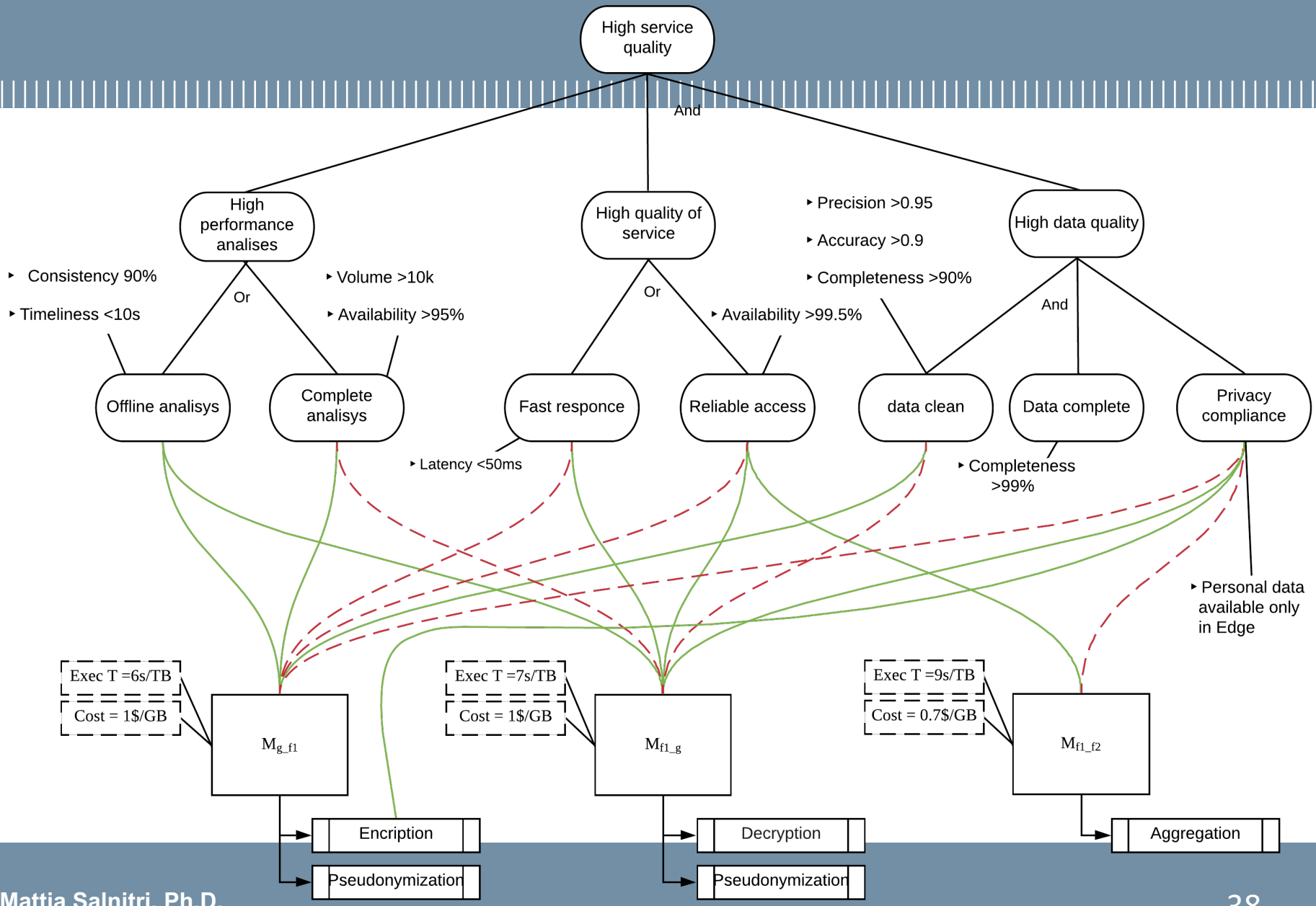
If we monitor the requirements before and after the enactment…

we can refine the contribution links of a goal model

# Contribution link update



# Contribution link update



# Multiple data consumers

Frequently multiple users use data/perform computation

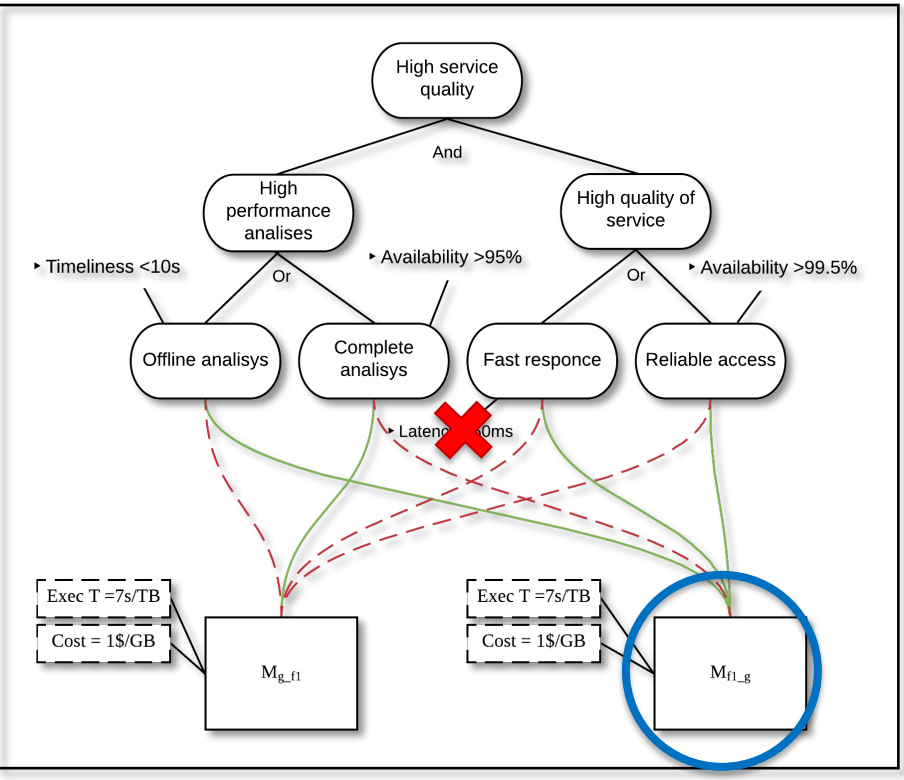
- For different purposes
    - With different requirements
- From different locations
    - Different impact of data movement

Solution:

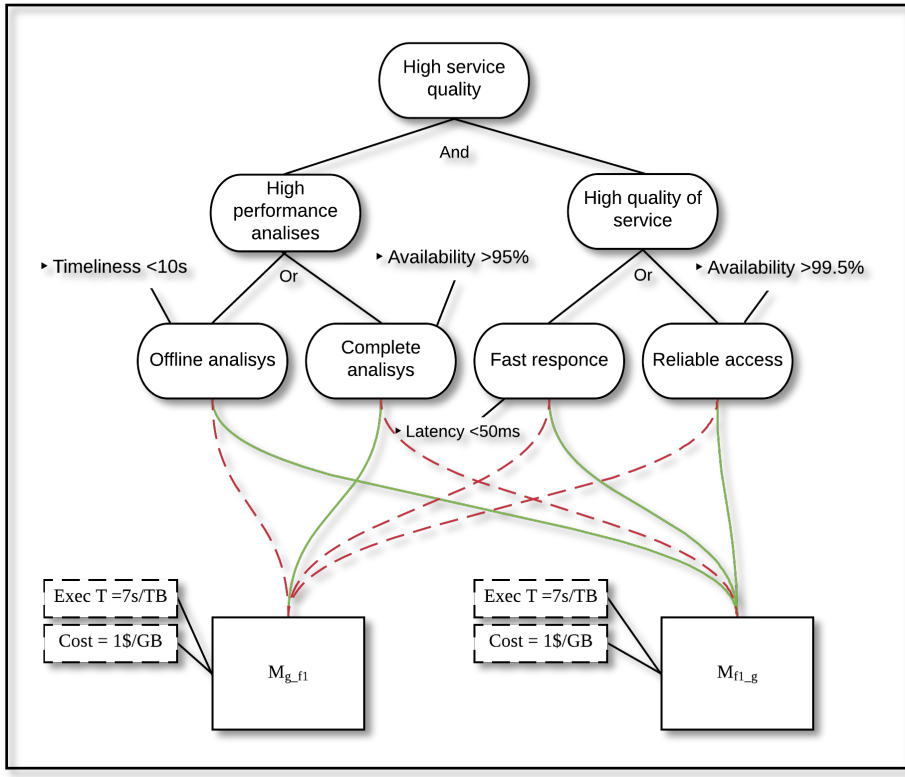
- Use one goal model for each user

# Cycles on movement actions

User A



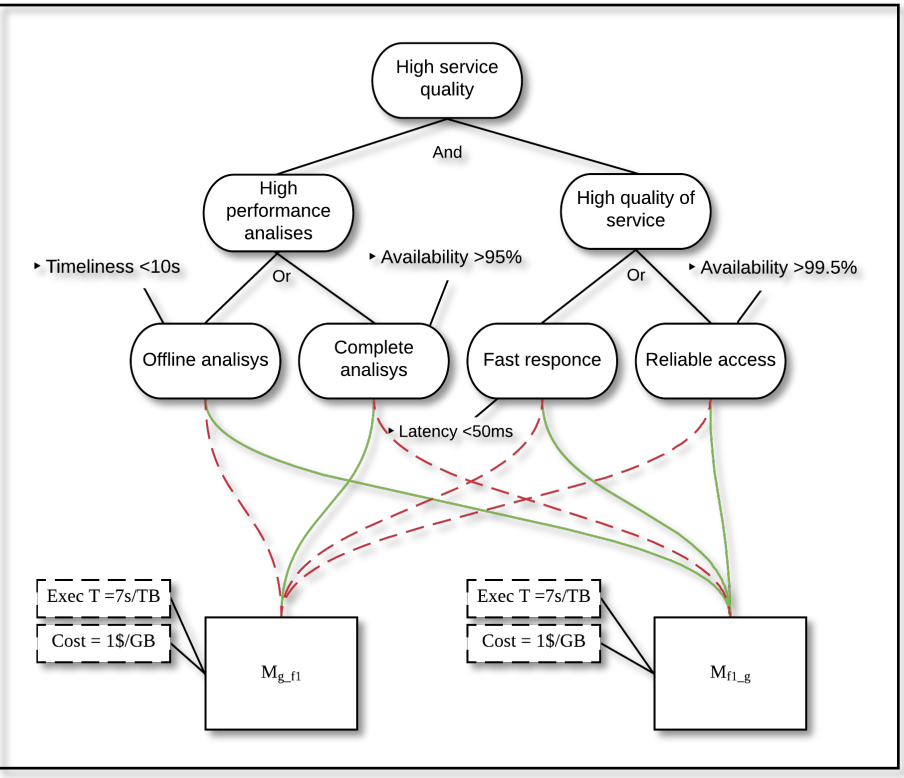

User B



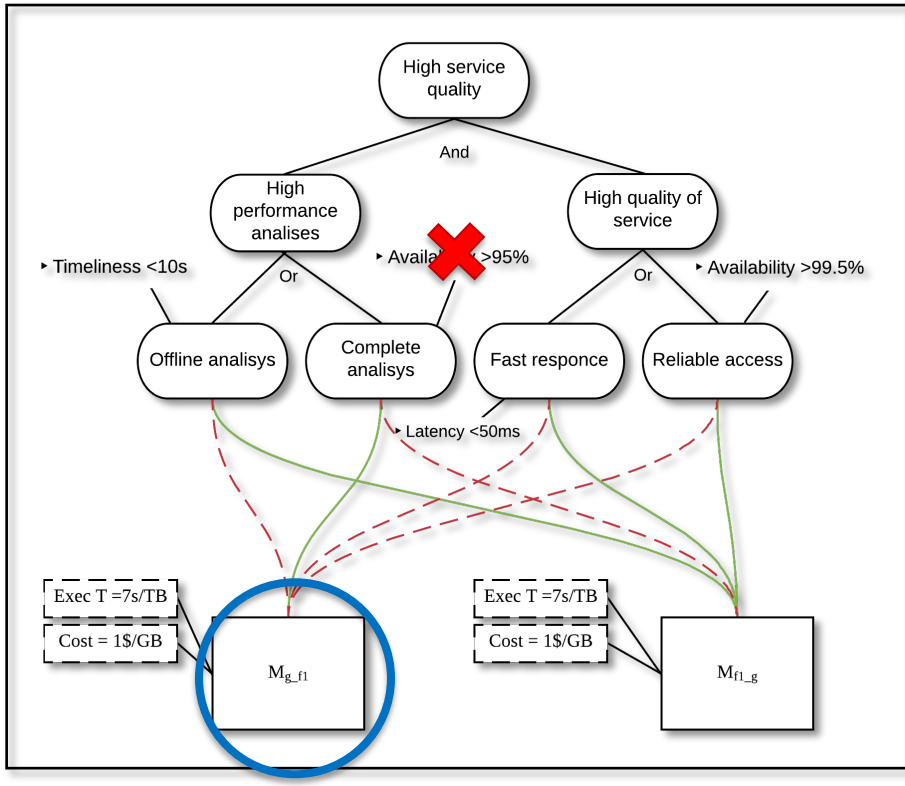

A: $M_{f1\_g}$,

# Cycles on movement actions

User A



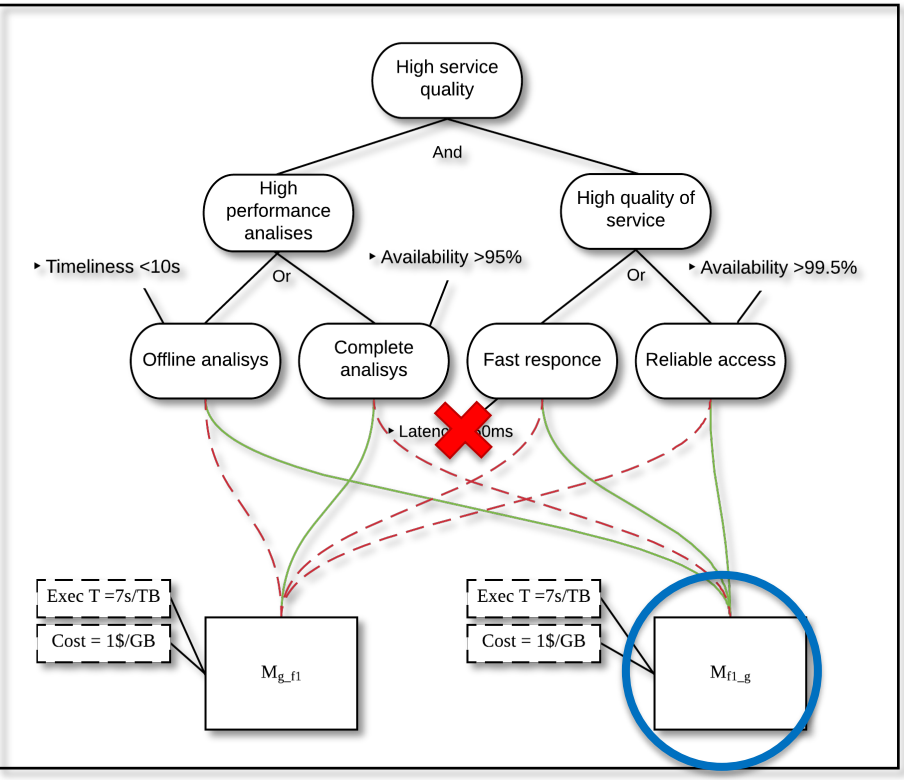

User B



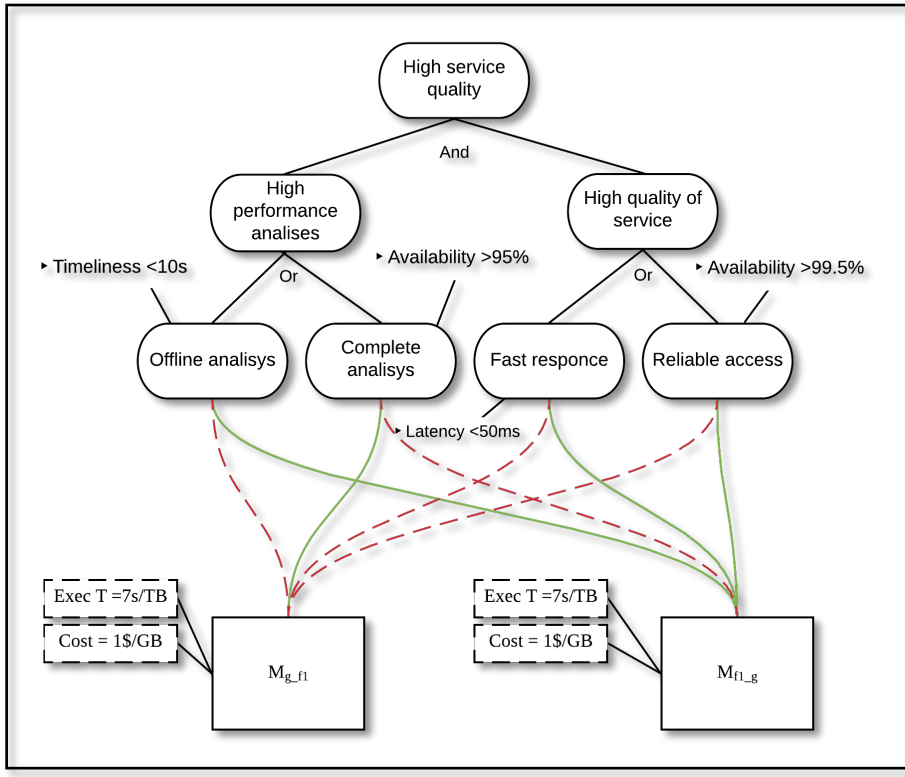

A: $M_{f1\_g}$ ,B: $M_{g\_f1}$,

# Cycles on movement actions

User A




User B




A: $M_{f1\_g}$,B: $M_{g\_f1}$, A: $M_{f1\_g}$

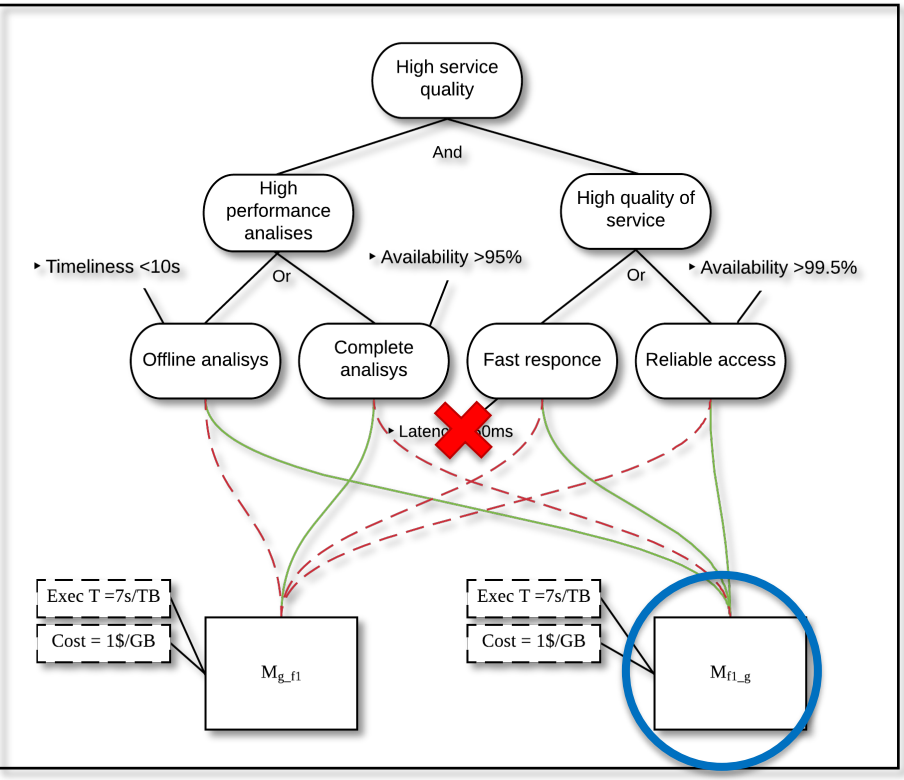
# Cycles on movement actions

Cycles must be avoided

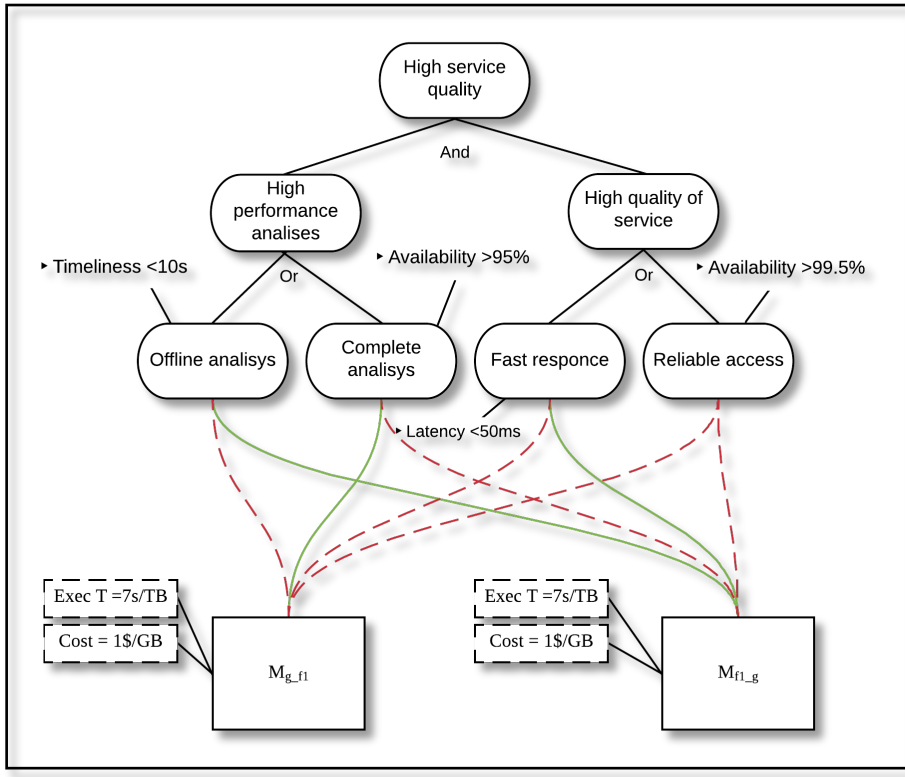
- Waste of resources
- Hard to detect (multiple parties involved)

# Conflicts on multiple goal models

User A



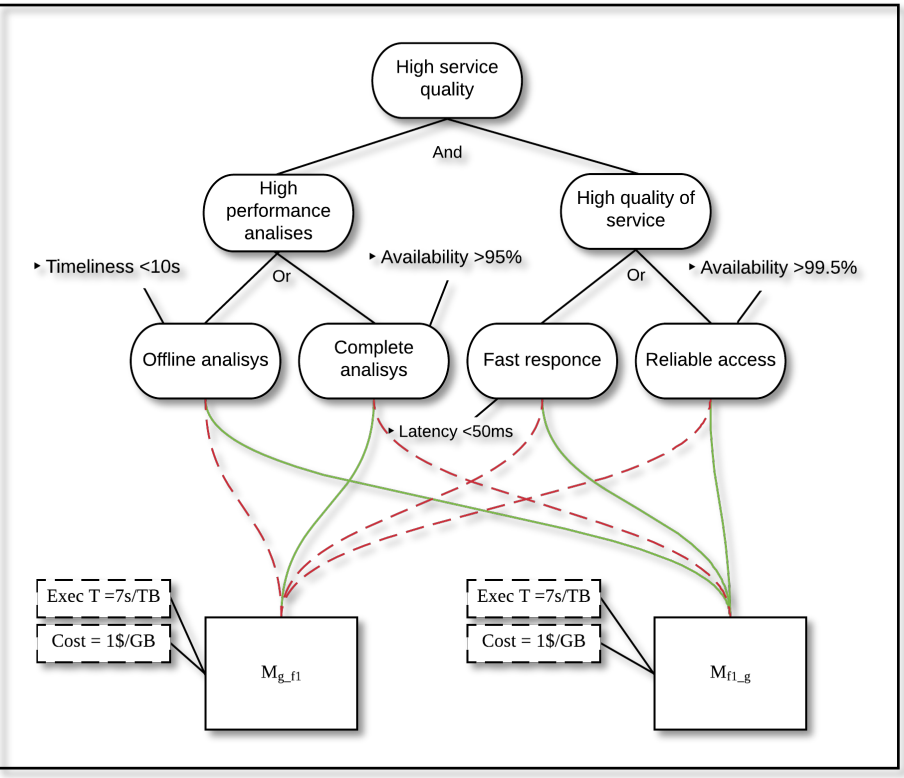

User B



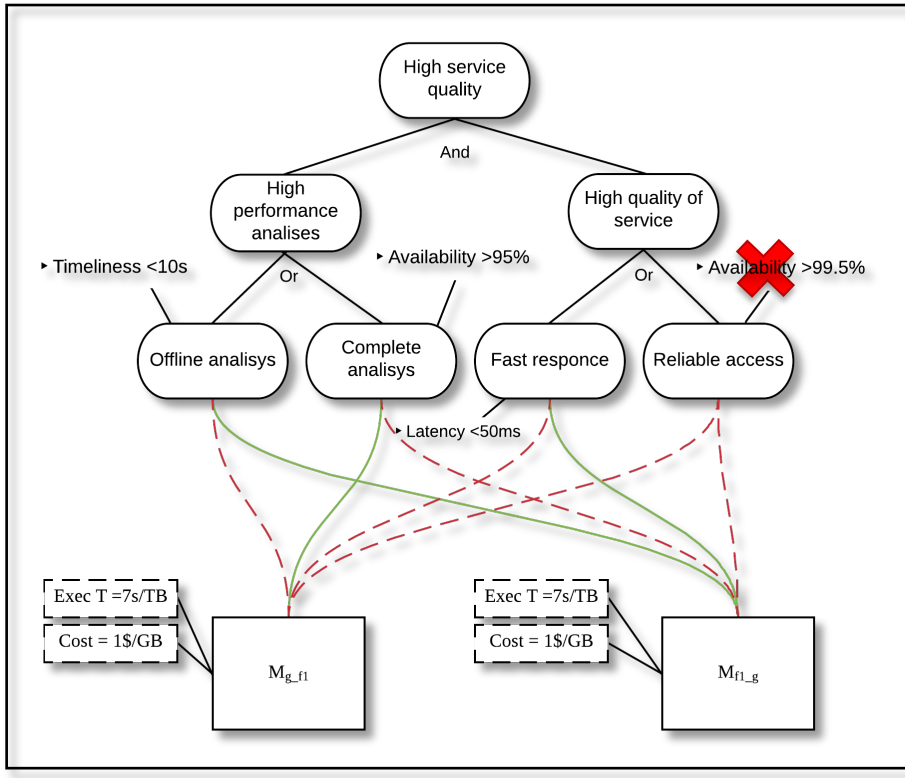

A: $M_{f1\_g}$

# Conflicts on multiple goal models

User A




User B




A: $M_{f1\_g}$

# Possible solutions

- Centralized manager
  - DITAS approach
- Decentralized solution
  - Reinforcement learning

# Centralized manager

Virtual Data Container (VDC)

- Access point for consumer
- Computation tasks performed by the VDC (that can be moved)
- Data provided by the VDC
- One VDC per user -> 1 goal model per VDC

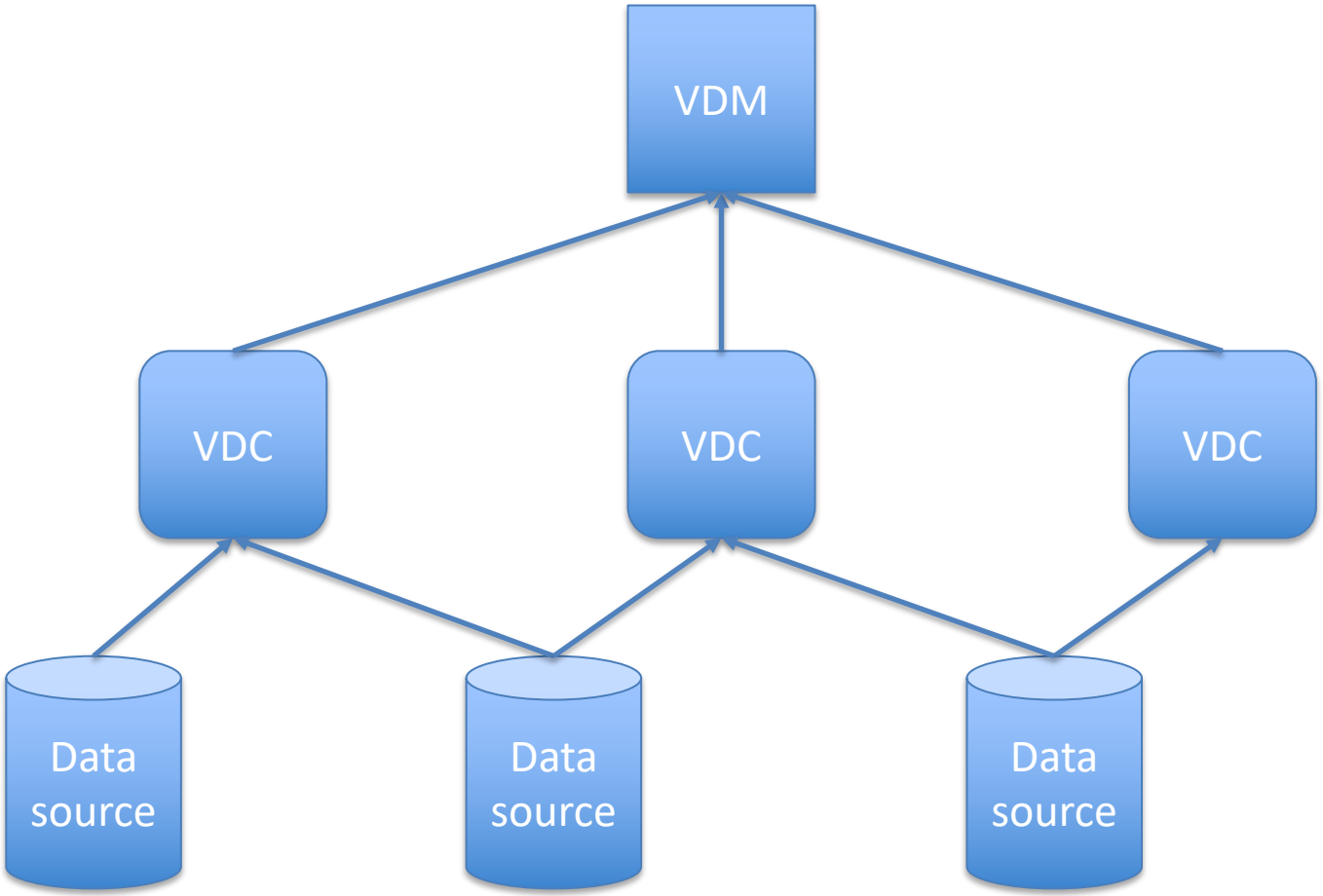
Virtual Data Manager (VDM)

- Coordinates VDC
- Blocks movement action cycles

# Centralized manager

Computation movement

Data Movement



# Decentralized solution

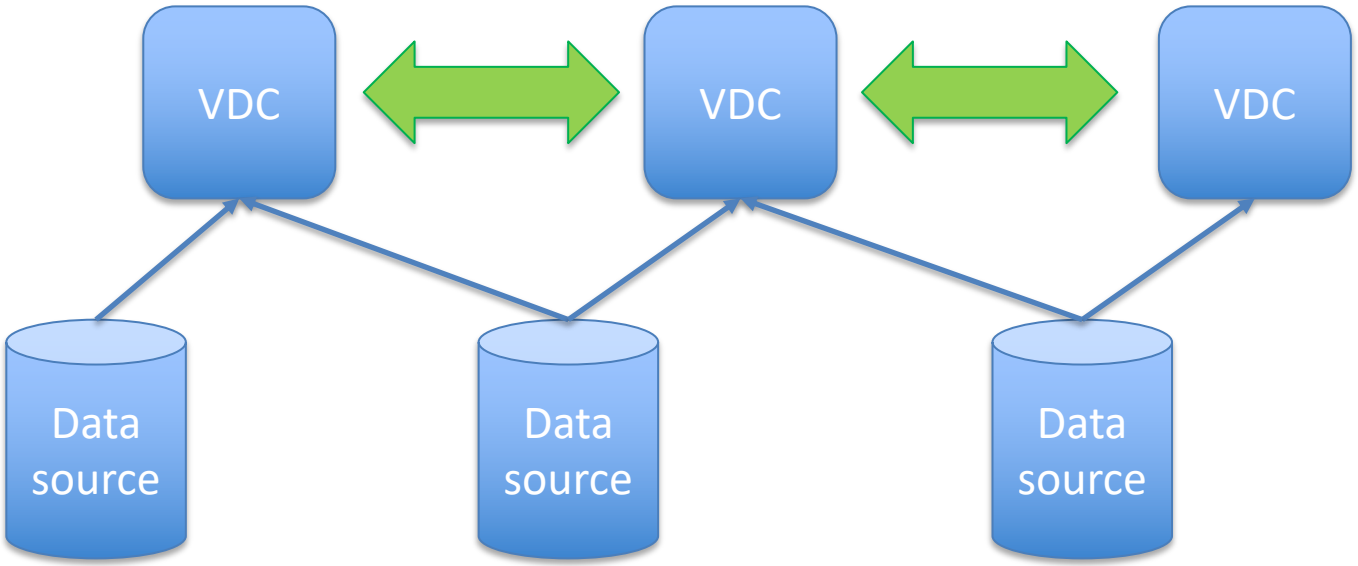
Each  VDC is independent

Every time a movement action is enacted, feedbacks arrive from other VDC who uses the resources moved.

# Decentralized solution

Computation movement

Data Movement



The DITAS framework uses a centralized approach

- Monitoring component in VDCs detect violations,
- A decision system in the VDM enacts the movement actions considering all goal models.


# Thank you!

Pierluigi Plebani, Mattia Salnitri, Monica Vitali
name.surname@polimi.it

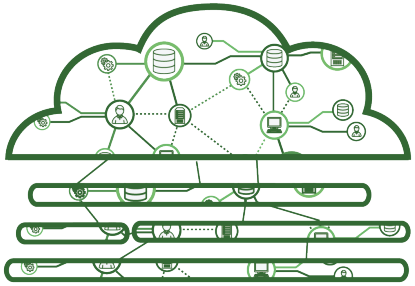
Jeju, 23rd September 2019

DITAS
Data-intensive applications Improvement by moving daTA and computation in mixed cloud/fog environmentS

# Acknowledgements

This research work have been fouded by Ditas Project.

DITAS project is funded by the European Union's Horizon 2020 research and innovation programme under grant agreement RIA 731945.



DITAS

Data-intensive applications Improvement by moving daTA and computation in mixed cloud/fog environmentS

# Bibliography

1. Horkoff, J., Borgida, A., Mylopoulos, J., Barone, D., Jiang, L., Yu, E., Amyot, D.: Making data meaningful: The business intelligence model and its formal semantics in description logics. In: Proc. of On the Move to Meaningful Internet Systems. pp. 700–717 (2012)