Dynamic QoS Optimization Architecture for Cloud-based DDDAS

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Outline

- Background and Motivation
- Objectives
- Challenges

1. Quality of Service (QoS) Sensitivity
2. Conflicting Objectives

- Architectural Solution
- Conclusion

Quality of Service

- What is Quality of Service (QoS)?

"QoS is the service providers' ability to achieve the service users' requirements, such as response time, throughput, availability, security and so forth"

Cloud-based DDDAS

- Dynamic data-driven application
- Computation and data intensive
- Depends on the Cloud

Examples: weather prediction, traffic management, bio-sensing etc.

Motivation

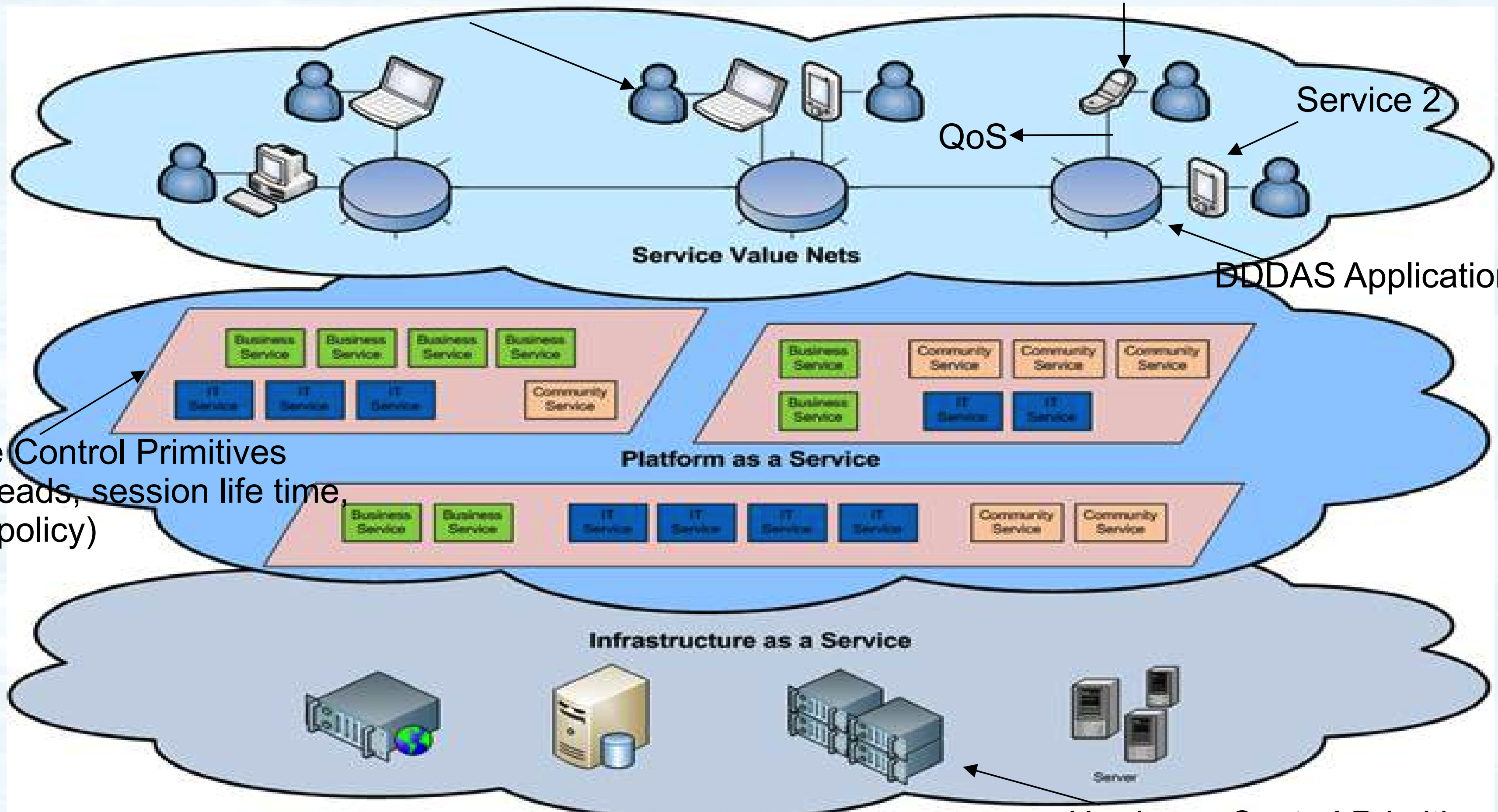
- Large volume and fluctuated data to be executed at runtime.
- Can not estimate demand of DDDAS applications at design time
- Over-/under-provisioning issues in the cloud
- QoS violations

Motivation

- Require new ways for improving the elastic adaptation, so we can cope with dynamic at runtime.
- Require new approach to provide more accurate adaptation with reasonable efficiency.

Can be achieved by leveraging on DDDAS engineering principles to assist runtime adaptation.

Cloud Architecture



Objectives

Dynamically optimizing QoS of cloud-based DDDAS by provisioning the best combination of control primitives, while minimizing the cost of these primitives and considering various constrains.

The theoretical optimal QoS is:

reach the best possible value of the QoS using the allocated control primitives, while not leaving any of these primitives idle.

The info-symbiotic loop of DDDAS principle is a promising approach to achieve this objective.

QoS sensitivity

QoS is sensitive to both control primitives and environmental primitives.

- Questions to solve:
- *Which* primitives could correlate with a QoS?
- *When* these primitives correlate with the QoS?
- *How* the uncertainty of the QoS can be apportioned and sensitive to these primitives?

QoS modeling – a model that takes correlated primitives as inputs and predict the expected QoS as output.

Conflicting Objectives

Conflict could be *intra* and *inter* services. e.g. Performance versus Costs, Security versus Performance, Consistency versus Performance, Availability versus Costs etc.

Questions to solve:

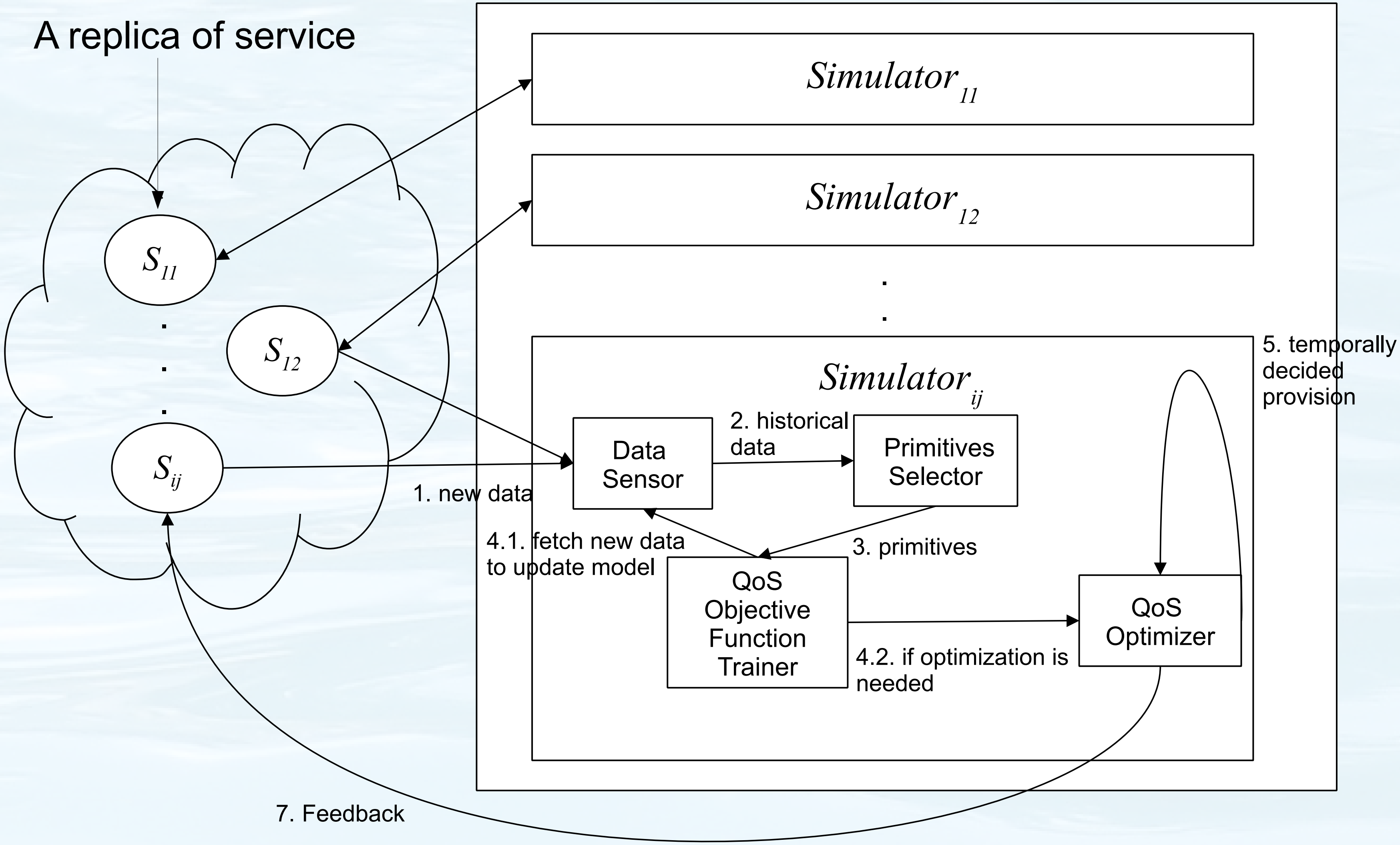
- Which objectives to trade?
- How much proportions to trade?

Dynamic Multi-objectives Optimization Problem (DMOP)

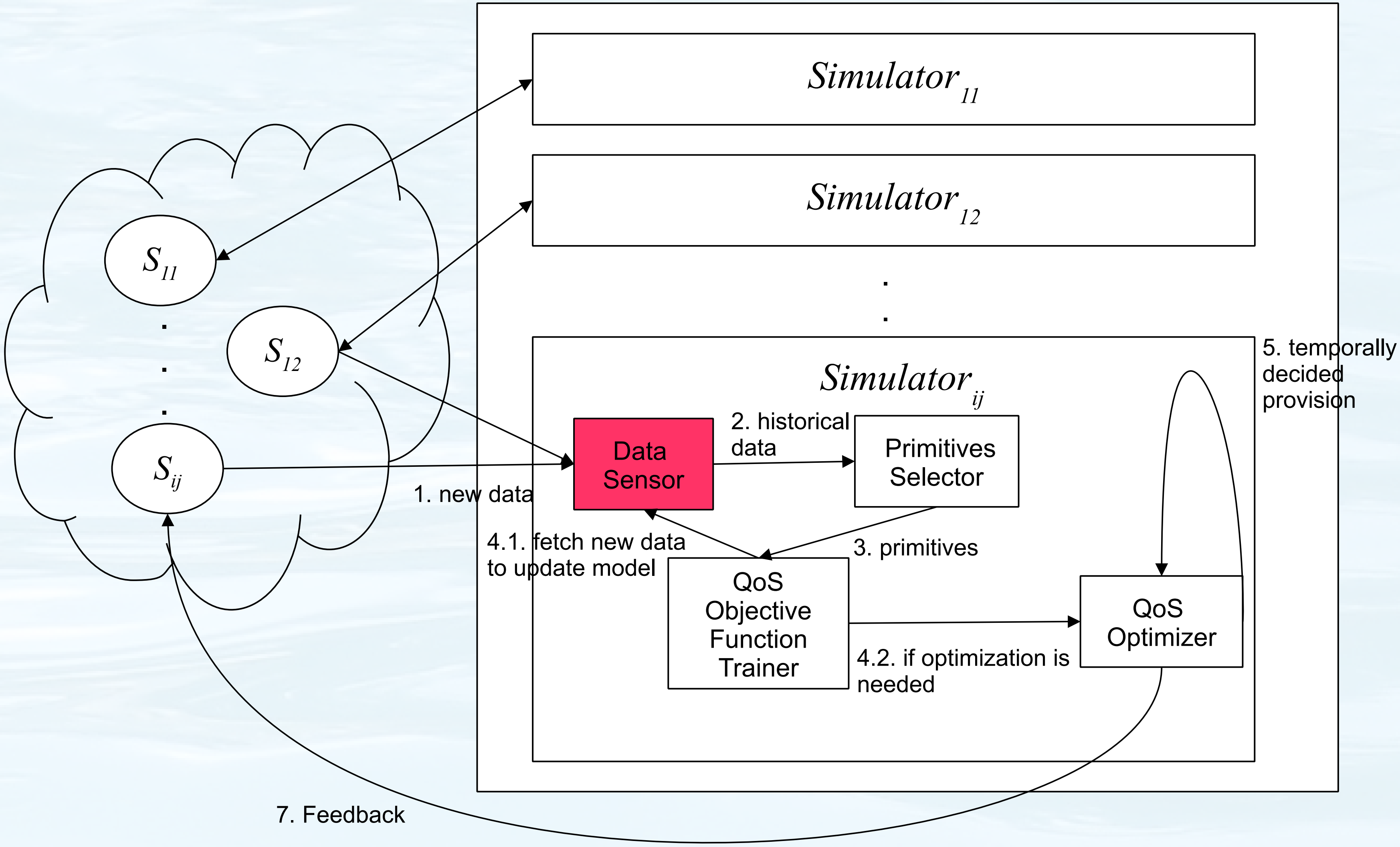
Dynamic QoS optimization for the cloud-based DDDAS can be formulated as DMOP.

The process incorporates dynamic tradeoffs decision making, where the dynamics are attributed to continuous changes in the objective function, their degree of conflict and constraints.

Architectural Solution



Architectural Solution

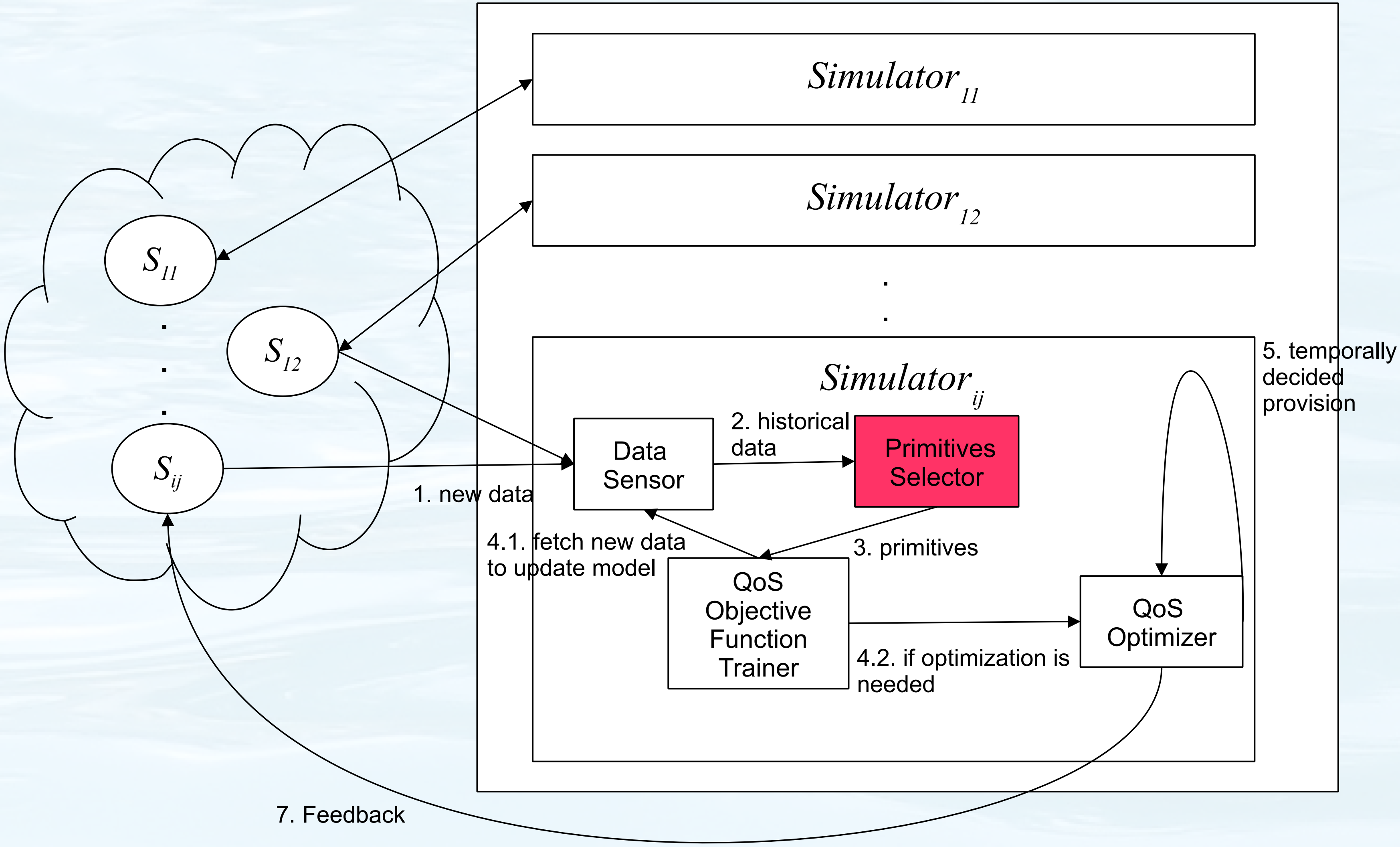


Data Sensor

- Collect QoS data, demand of hardware and software primitives etc.

- Store historical data for simulating the physical system.

Architectural Solution

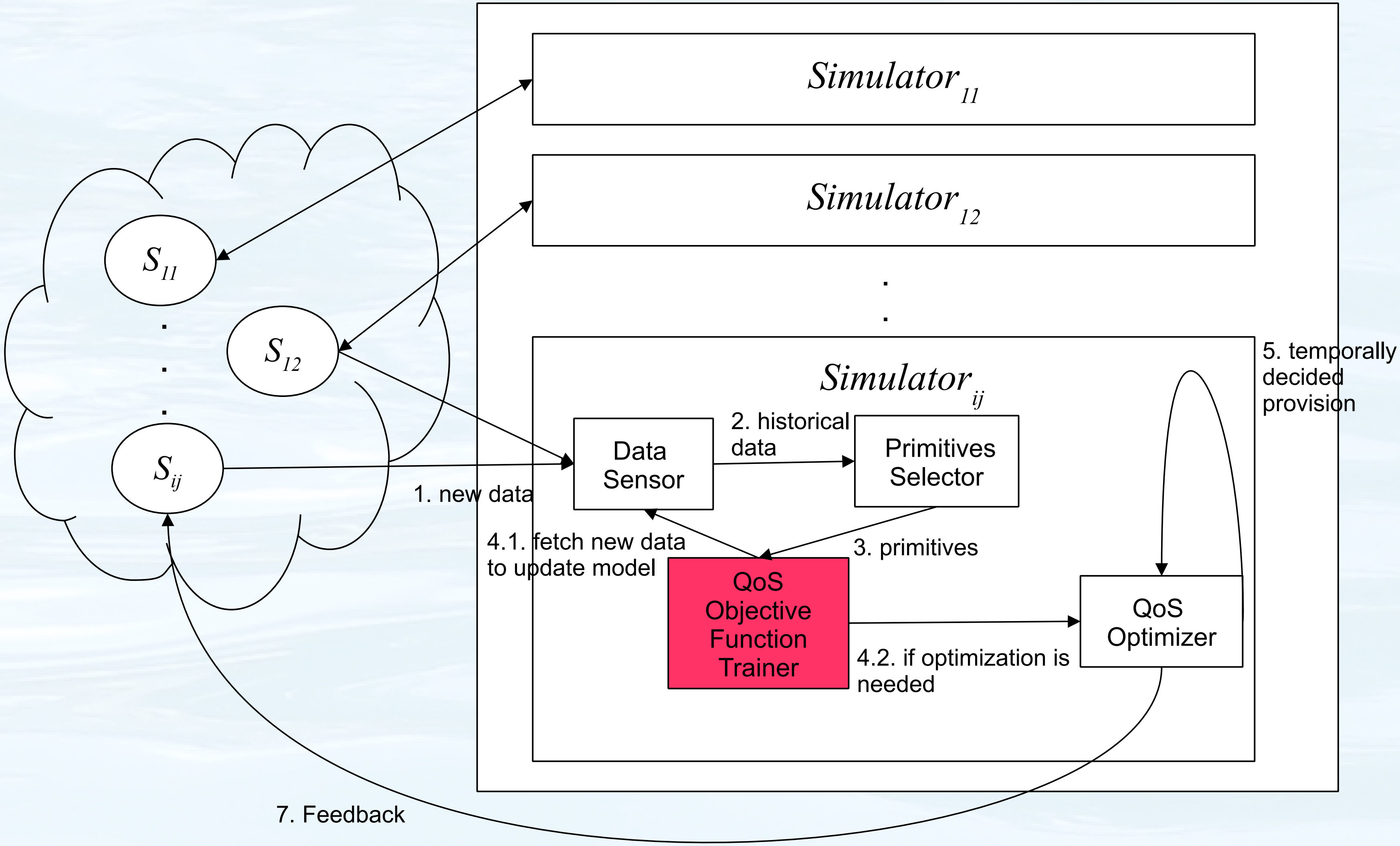


Primitive Selector

- Apply general techniques from information theory (e.g., Mutual Information)

- Determine *which* and *when* a primitive correlate with a QoS

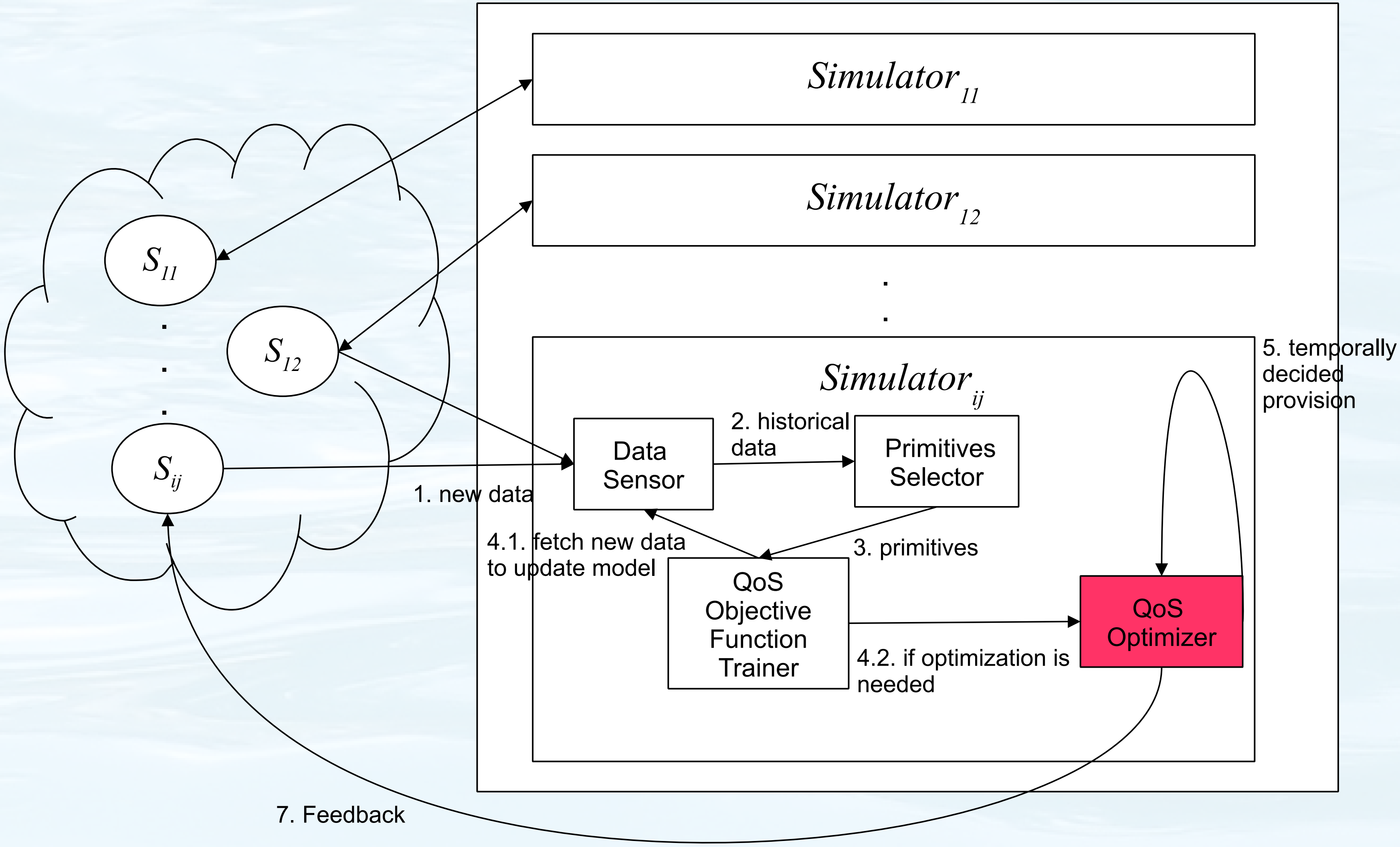
Architectural Solution



QoS Objective Function Trainer

- Apply machine learning techniques (e.g., Neural Network)
- Determine *how* a primitive correlate with a QoS

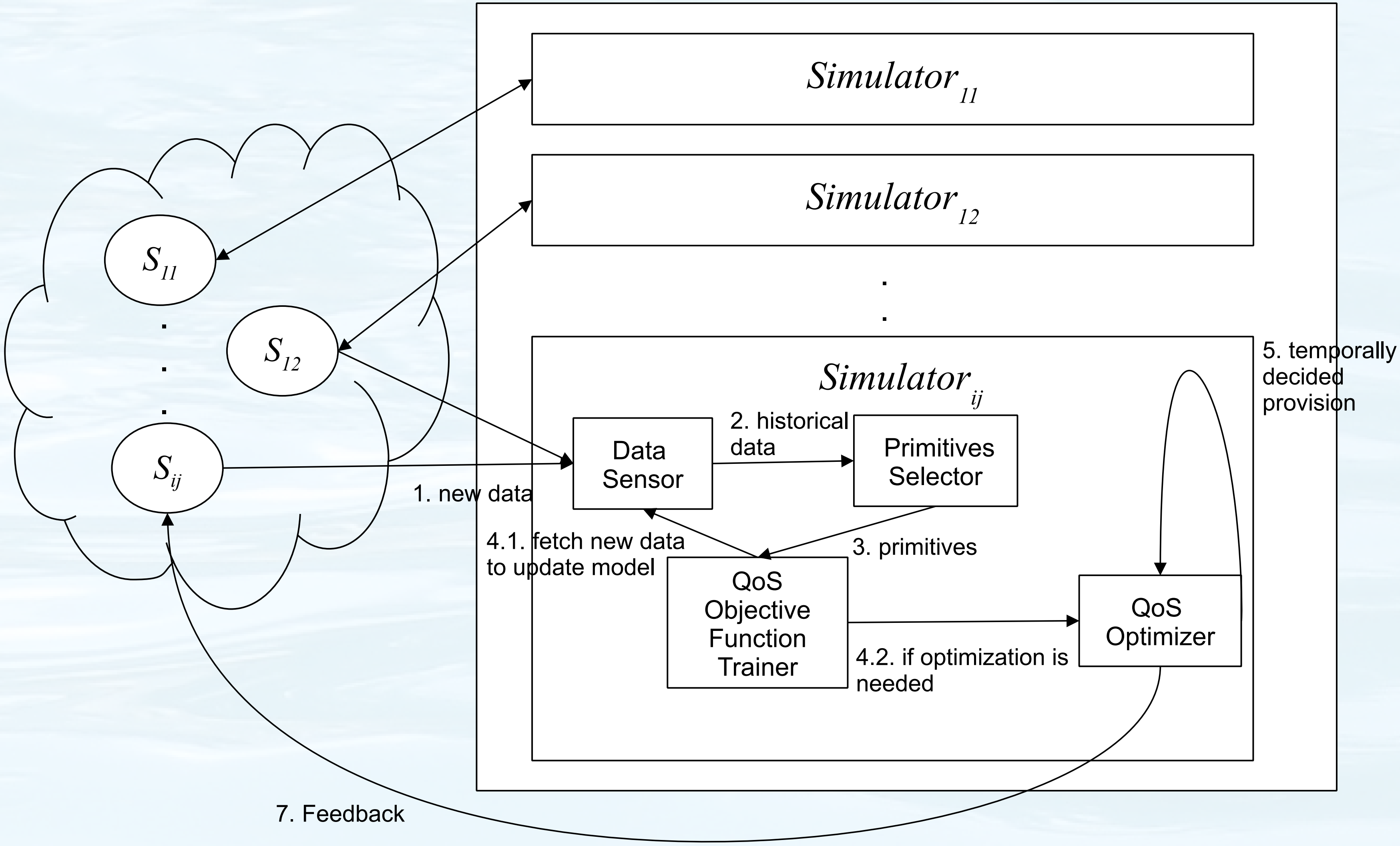
Architectural Solution



QoS Optimizer

- Apply evolutionary techniques (e.g., Metaheuristics)
- Search for the near optimal trade-off decision of adaptation, based on the previously defined objective functions

Architectural Solution



Conclusion

- We motivate the needs for adaptively optimizing QoS of cloud-based DDDAS.
- We outline our objective and the challenges.
- We describe our DDDAS based architectural solution and the potential techniques that can be applied within the architecture.

Thank You!

Questions?

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