CLAM: Managing Cross-layer Adaptation in Service-Based Systems

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S-CUBE

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Outline

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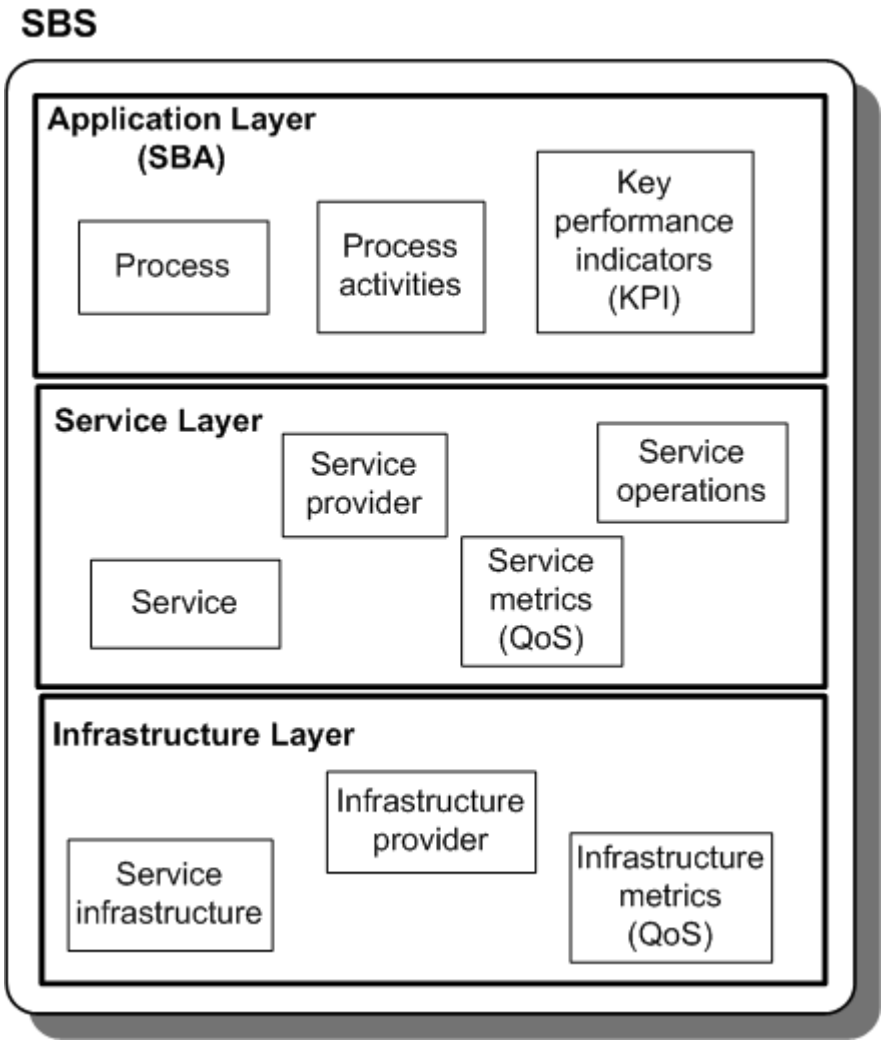
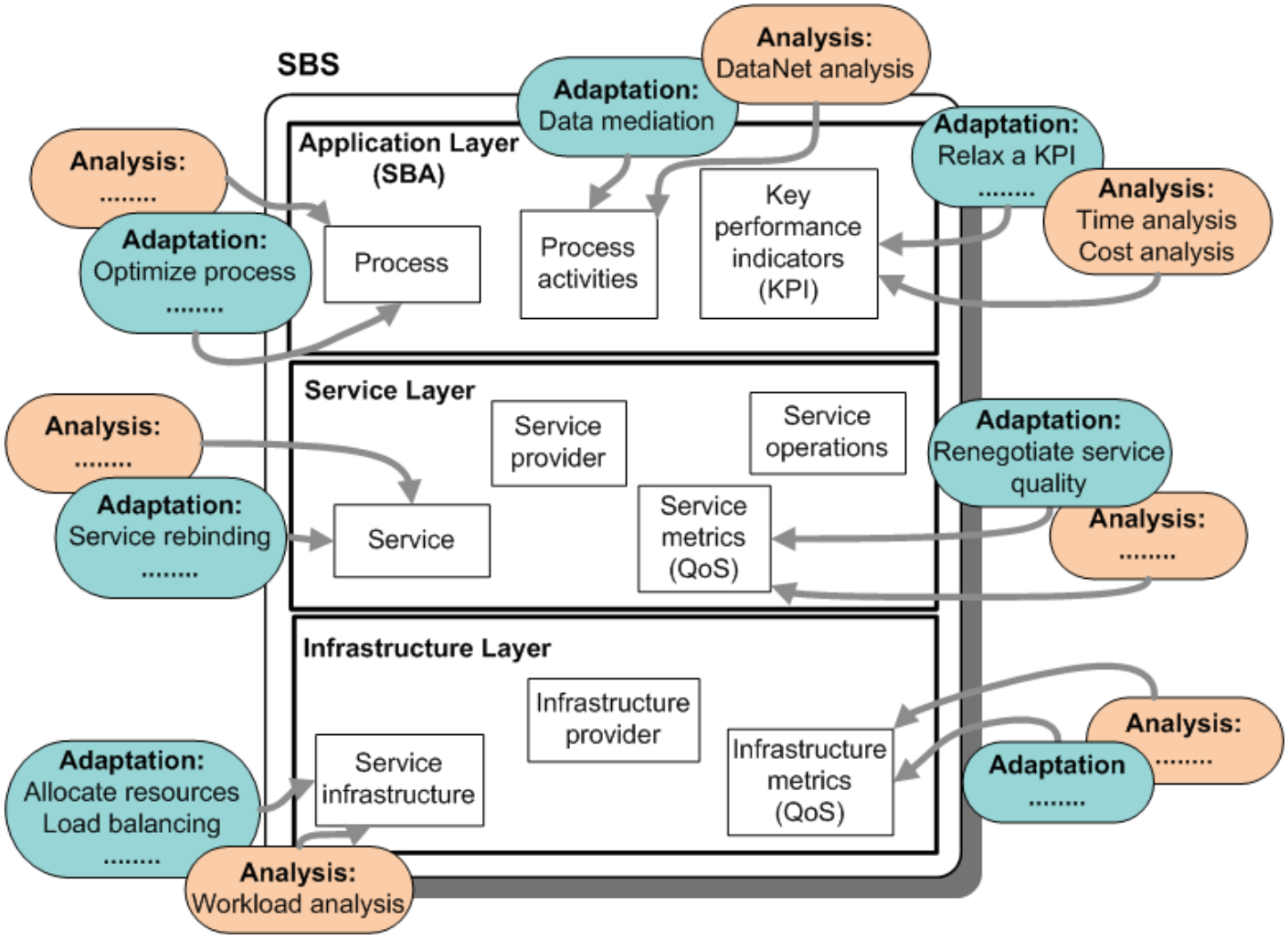
Service-Based Systems



State-of-the-art Adaptation and Analysis Approaches for Service-Based Systems



CLAM – Cross-layer Adaptation Manager
Research Context

Research Problem:

- We want to see the impact of an adaptation on the whole SBS to avoid
  - incompatible or useless adaptations for the application.

Challenge:

R1. identify the problems that might occur in different concerns of the SBS layers due to a local adaptation.

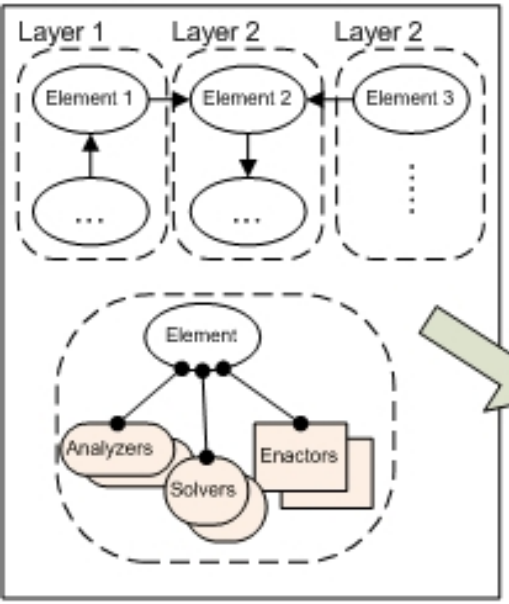
R2. tackle these problems by proposing new adaptations in a consistency with the overall system.

Proposed Solution: Cross-layer Adaptation Manager (CLAM):

>>> **A platform that integrates different analyzers & adaptation mechanisms** for cross-layer analysis and extension of an adaptation.

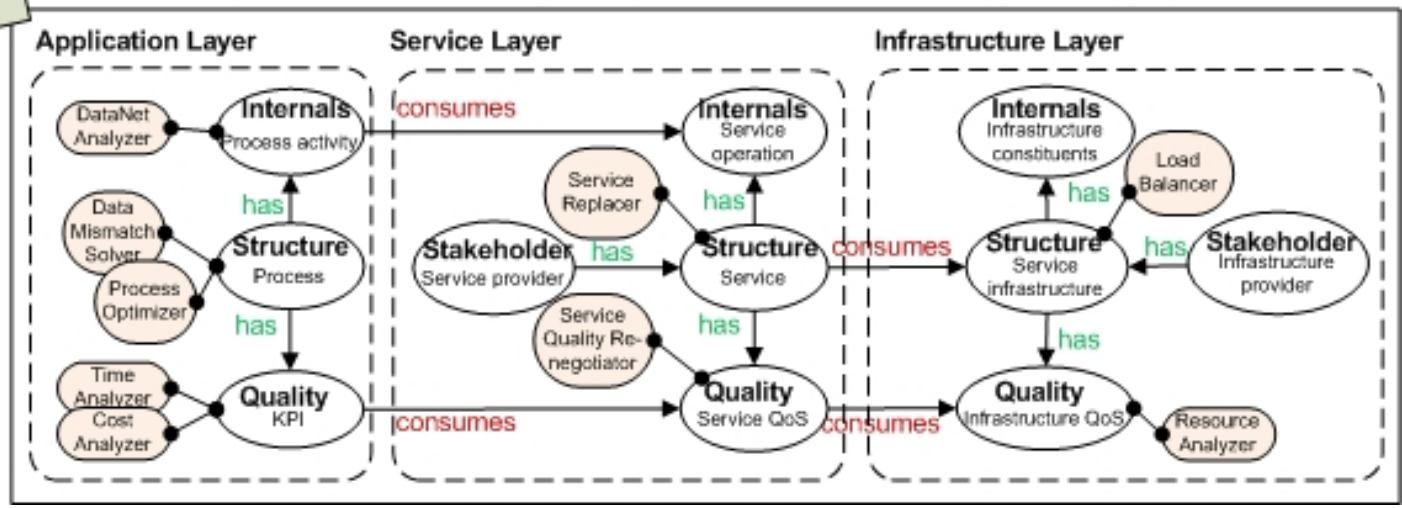
CLAM Approach
1. Cross-layer System Modeling

Cross-layer System Representation
(System Meta Model)



High level dependency model of the system parts:
Make "already existing implicit dependencies" explicit!

A Sample Meta Model
(partly used for the case study by having the components only at the application layer)



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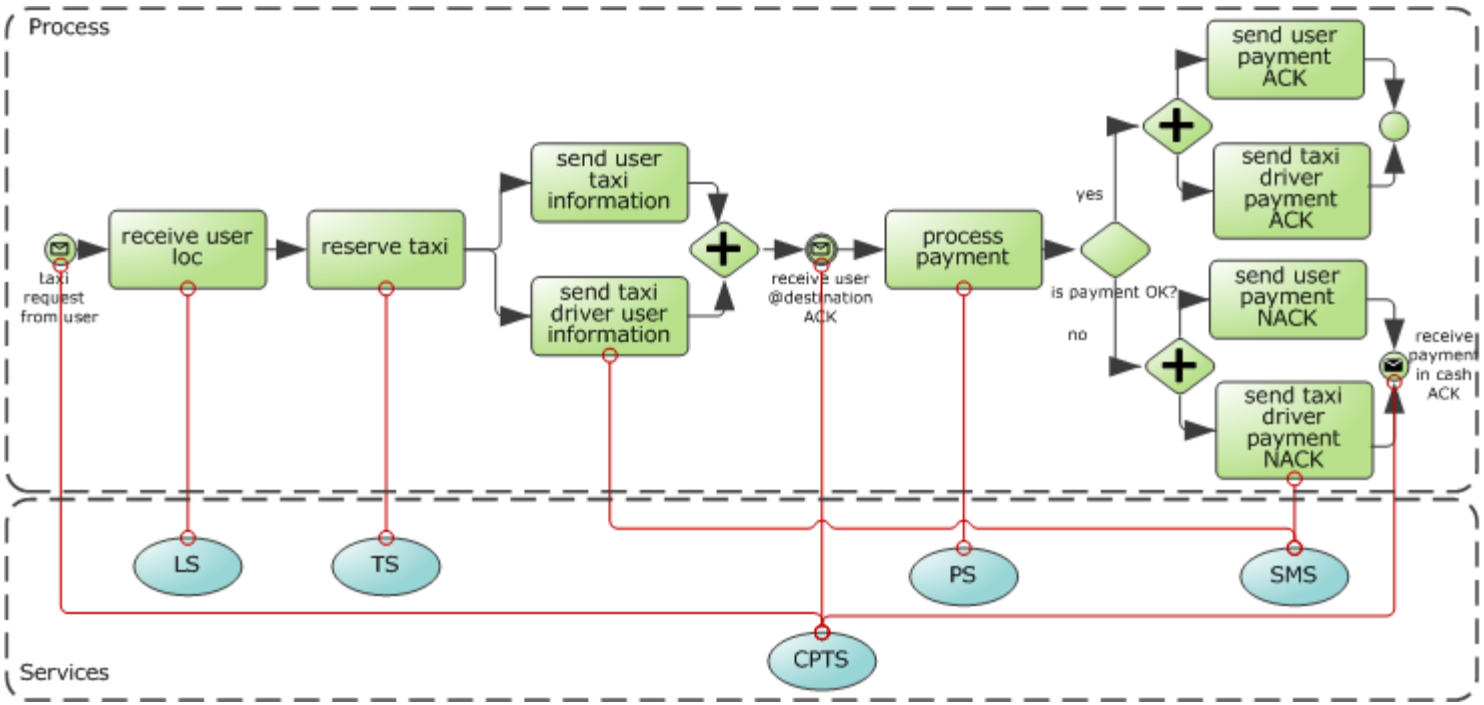
Cross-layer Rule Engine
Predefined CLAM Rules

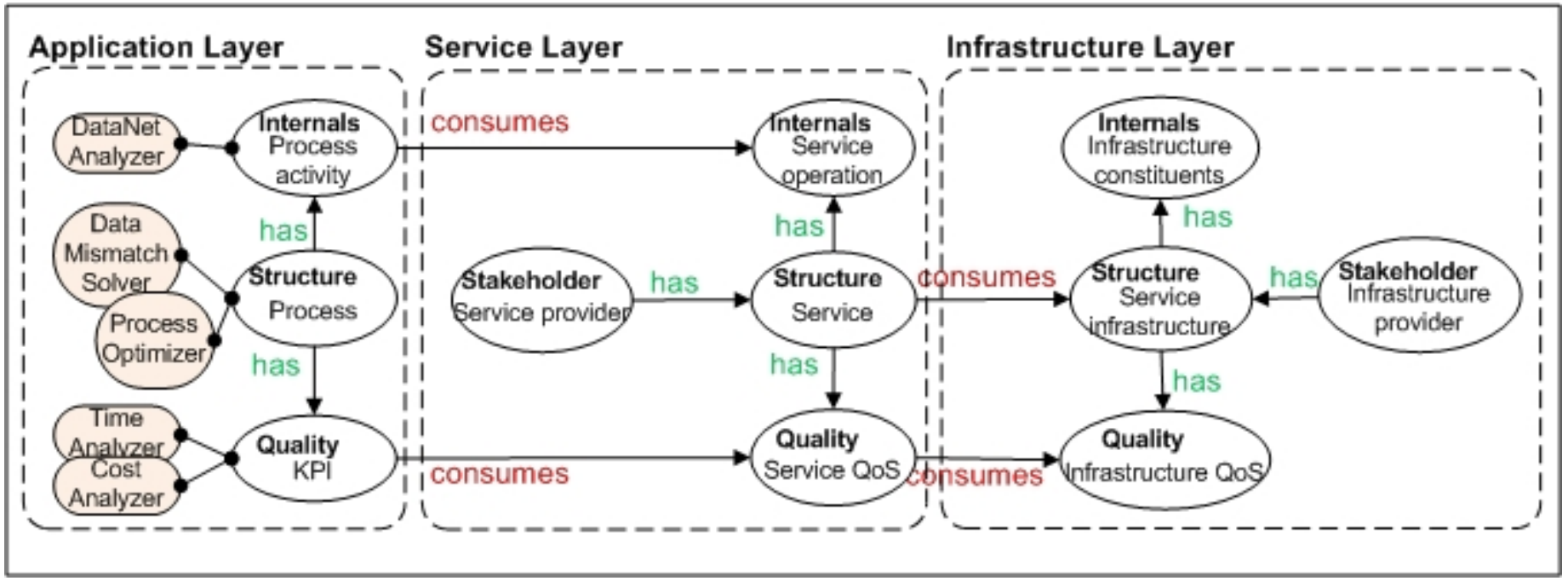
- Analyzer Rules associate analyzers with system elements.
  - E.g., *KPI →cost analyzer, time analyzer*
- Solver Rules associate a set of solvers with each adaptation need defined in the system.
  - E.g., *reduce process time →process optimizer, service quality re-negotiator, service replacer*
- Enactor Rules associate a set of enactors with each adaptation action included in the system.
  - E.g., *add service →dynamic service binder*

Motivating Application Scenario

- Call & Pay Taxi Workflow (CPTS composite service)
  - Telecom Co provides Parlay X services:
    - SMS, location service (LS), payment service (PS)
  - Taxi companies provide real taxi service (TS)



Analysis and Adaptation Tools used in CLAM for the Application Scenario



CLAM Approach
2. Supporting Architecture

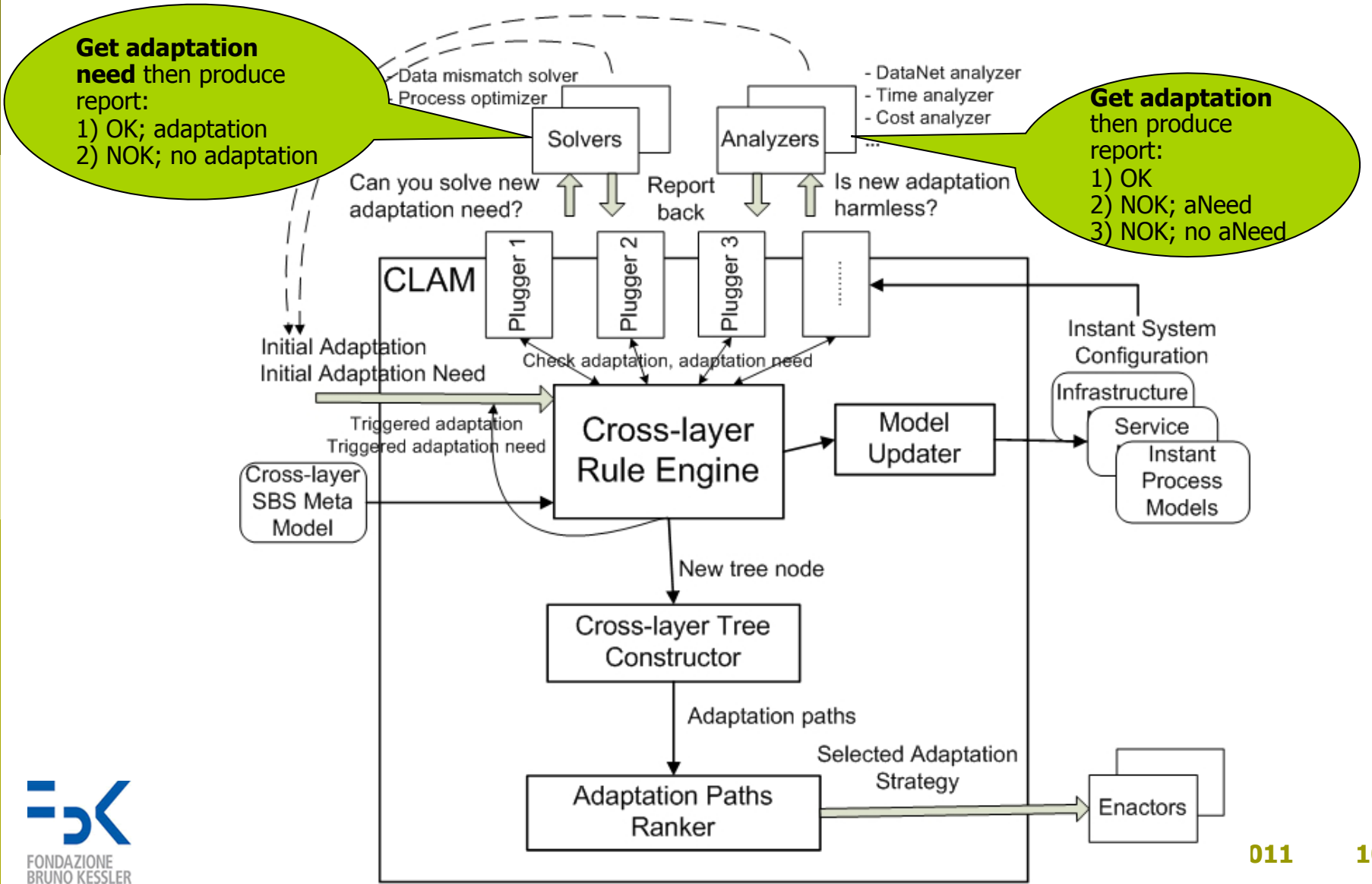
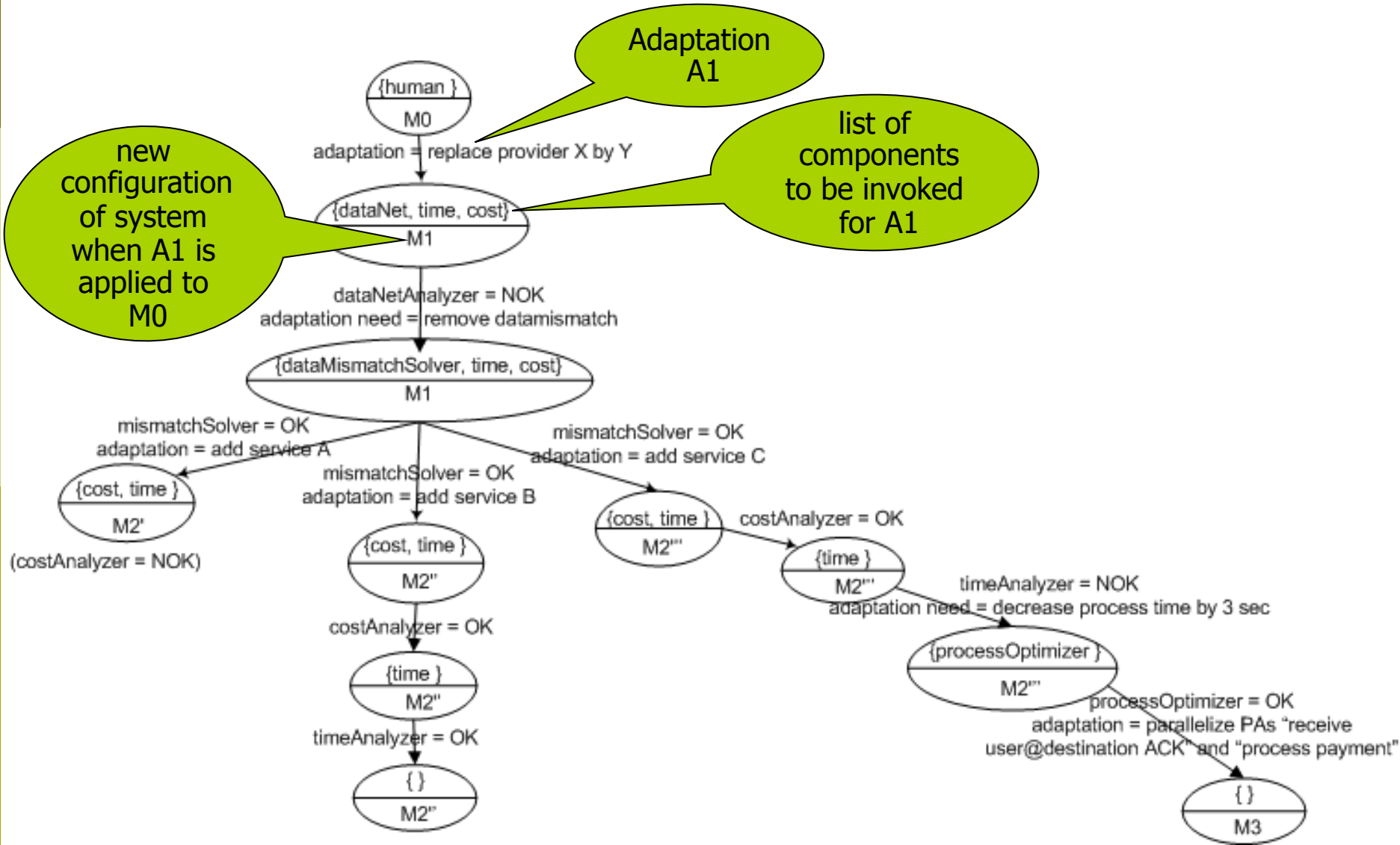
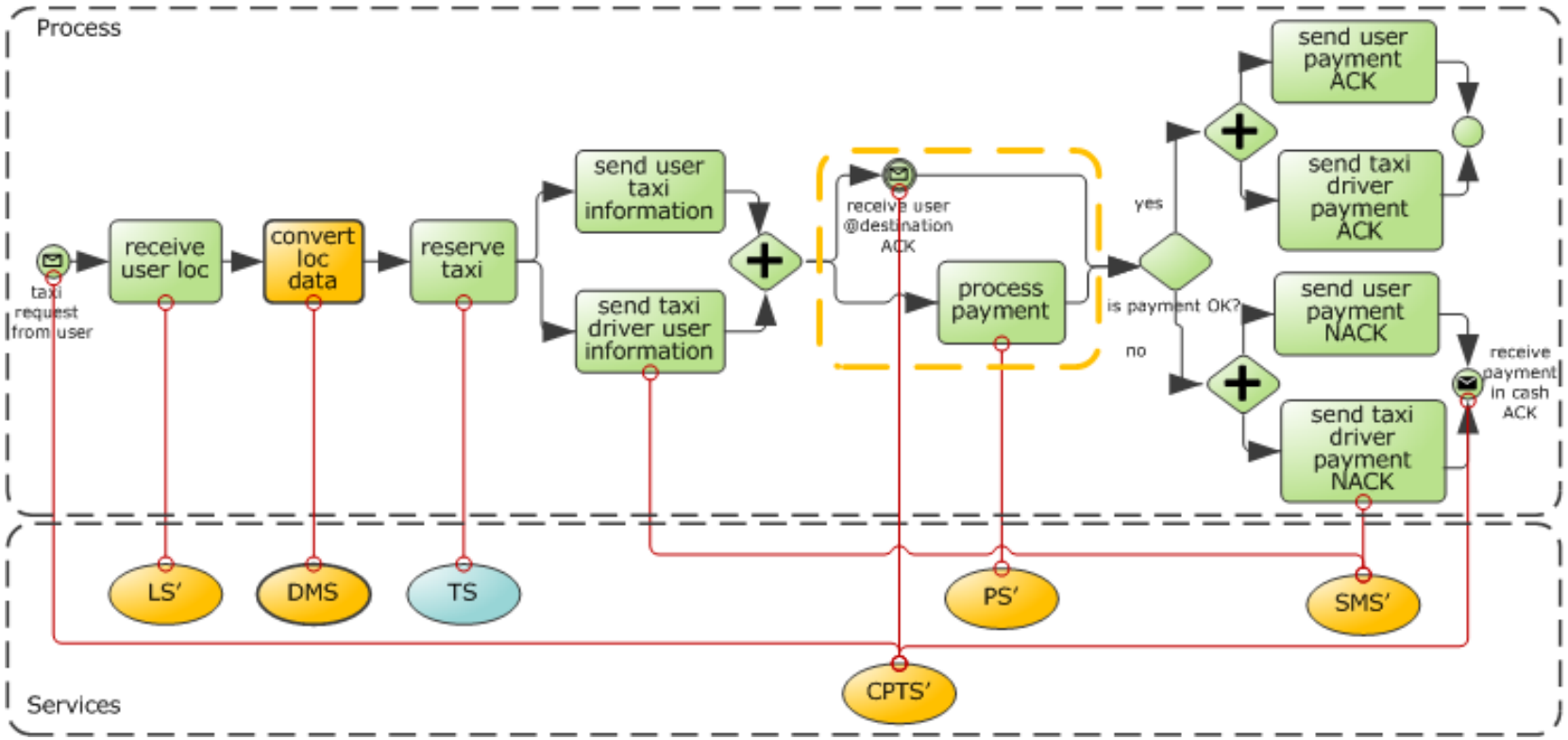


Illustration of CLAM:
Output of CLAM impact analysis



Application after CLAM Impact Analysis



Current Status of Work

- We have implemented CLAM v1.0 and evaluated it on the presented application scenario.

- Currently we are working on
  - formalization and implementation design of CLAM v2.0.

CLAM v2.0 will enable the customization of the overall analysis:

- CLAM configuration parameters:
  - Check a proposed adaptation again via the same analyzer (that triggered the problem): *ON / OFF*
  - Set how to invoke solvers for a given adaptation need: *invoke all / invoke the highest priority / custom selection*
  - Set how to invoke analyzers for a given adaptation: *invoke all / invoke the highest priority / custom selection*
  - Set how to construct the tree: *breadth first / depth first / whole tree*
  - Set how to prevent infinite trigger of adaptations: *stop at the repetition of an adaptation need / stop at a threshold number of iterations*

Research Plan for Future Work

- Formalization & Implementation of CLAM v2.0
- Evaluation of the implementation on various case studies:
  - show that CLAM works well:
    - Flexibility
      - Changing configuration parameters
    - Run-time applicability
      - Trade-off between time performance vs having larger set of alternative paths
    - Scalability
      - See the performance when we increase the number of tools in the analysis
  - show that CLAM costs little:
    - Evaluate the efforts required to integrate a new tool
    - Evaluate the design-time efforts needed to use CLAM
- Validation:
  - Formally show that the proposed solution addresses the cross-layer adaptation problem.

Conclusions

- **CLAM makes a comprehensive impact analysis of an adaptation:**

  Given *(i)* the local adaptation and analysis tools and *(ii)* the cross-layer system dependency model:

  - **CLAM platform** validates an initial adaptation trigger for the entire service based system.

- **CLAM is generic:**

  Abstraction of the service-based system into the high-level dependency model enables a generic solution:

  - CLAM can work with **different application domains having different layers and system elements.**

- **CLAM is extensible:**

  One can always plug in new tools to the integration platform

  - to enhance analysis
  - to switch to another application domain

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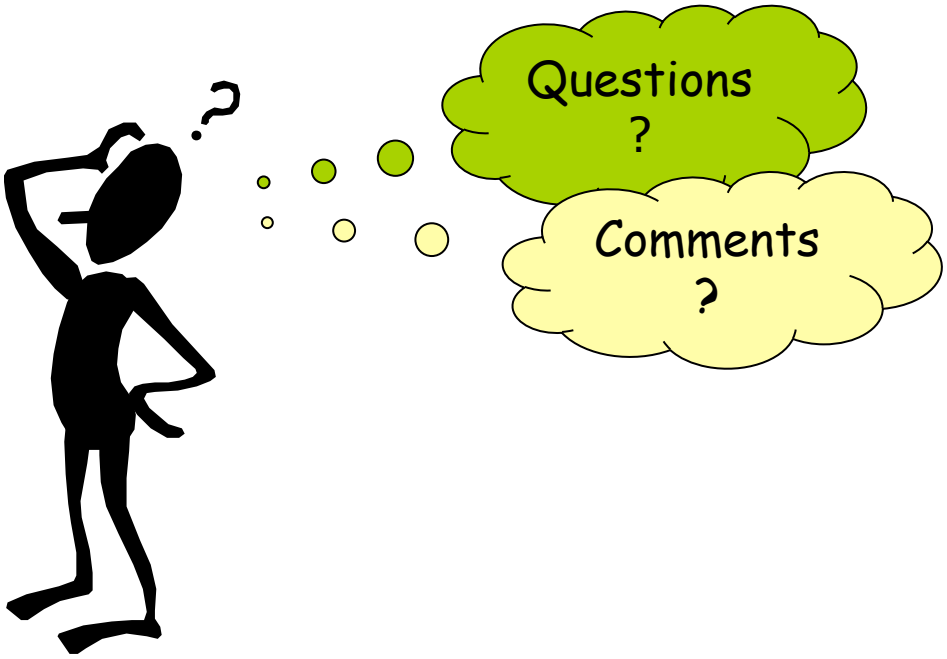
THANK YOU!



Solution Overview
Algorithm of the Overall Impact Analysis

COMPONENTS DISCOVERY *(through CLAM rules)*

- upon receiving adaptation
  - update current system configuration
  - identify a list of analyzers to be invoked, put them in the priority queue.
- upon receiving adaptation need
  - identify a proper solver (adaptation proposer) to be invoked, put it in the priority queue.

TREE CONSTRUCTION

- invoke components continuously
  - Upon receiving analyzer report for an adaptation:
    - If **OK** >> contact next component in the queue
    - If **NOK & no AdaptationNeed proposed** >> stop analysis for that SBS configuration
    - If **NOK & AdaptationNeed** >> find the proper solver, add it in the queue, contact next component
  - Upon receiving solver report for an adaptation need:
    - If **OK & Adaptation** >> find the relevant analyzers, add them to queue, contact next component
    - If **NOK & no Adaptation found** >> stop analysis for that SBS configuration
- update cross-layer adaptation tree:
  - Tree branches: analyzer/solver reports
  - Tree nodes: current SBS configuration + current queue (list of analyzers, solvers to be invoked)
  - Update tree upon receiving a report: add branch and add node