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# Towards Ensuring High Availability in Collective Adaptive Systems

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Monday, September 8, 2014

**BPCAS 2014**

1<sup>st</sup> International Workshop on Business Processes in Collective Adaptive Systems  
September 8, 2014, Eindhoven, Netherlands

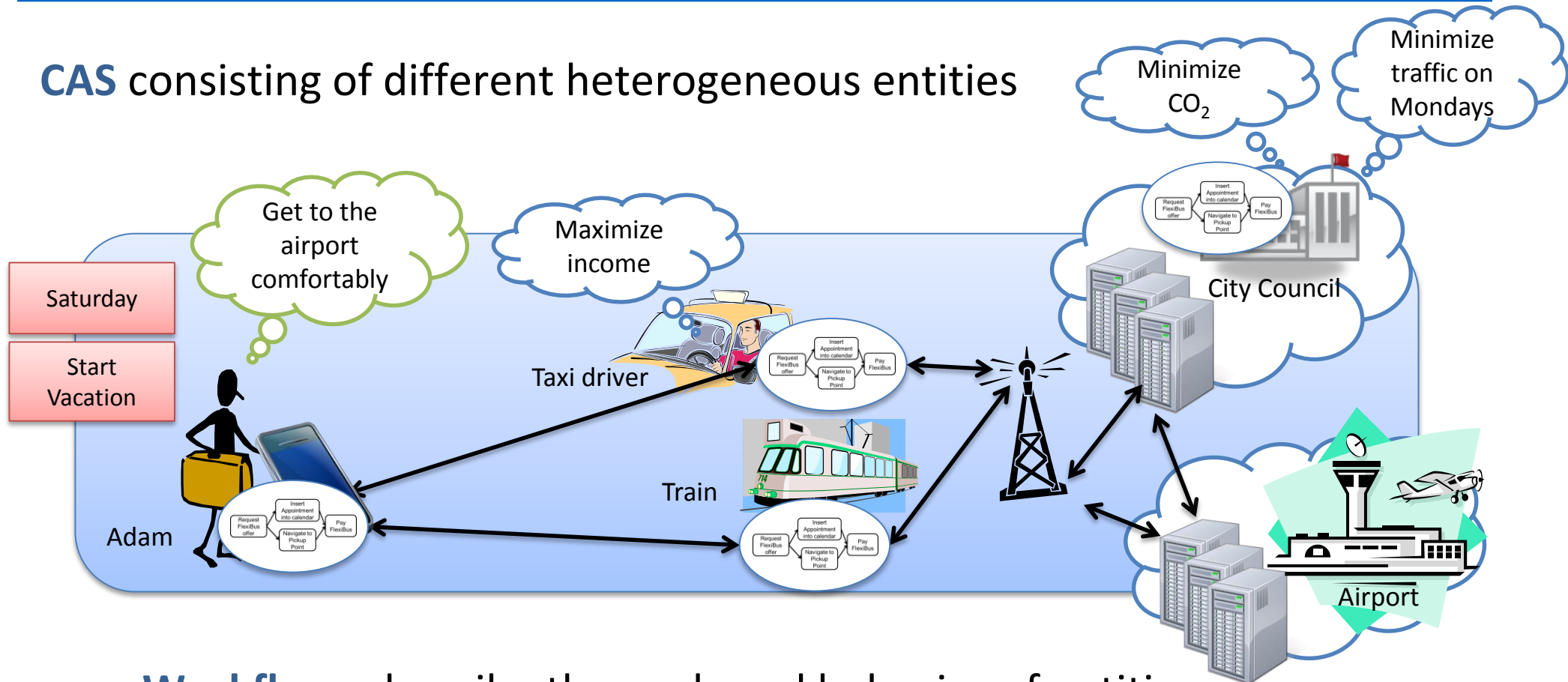
# Overview

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- Introduction
- Motivation
- Vison
  - Workflow Replication
  - Service Selection and Execution
  - Dynamic Compensation
- Conclusion

# ALLOW Ensembles

CAS consisting of different heterogeneous entities



- **Workflows** describe the goals and behavior of entities
- Entities **collaborate** to achieve certain goals
- Highly distributed system where **high availability is critical**



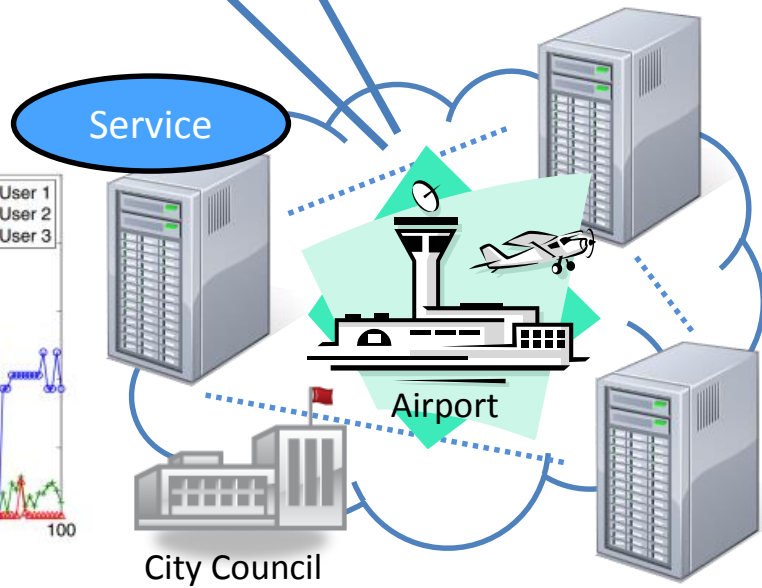
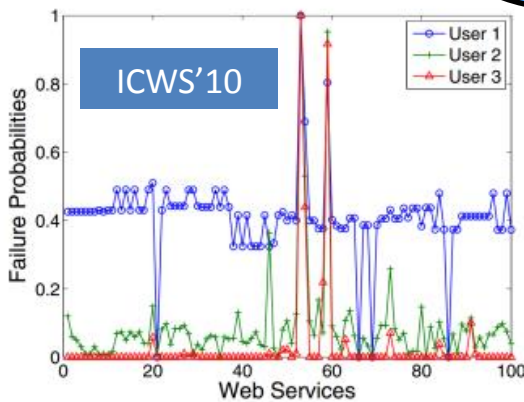
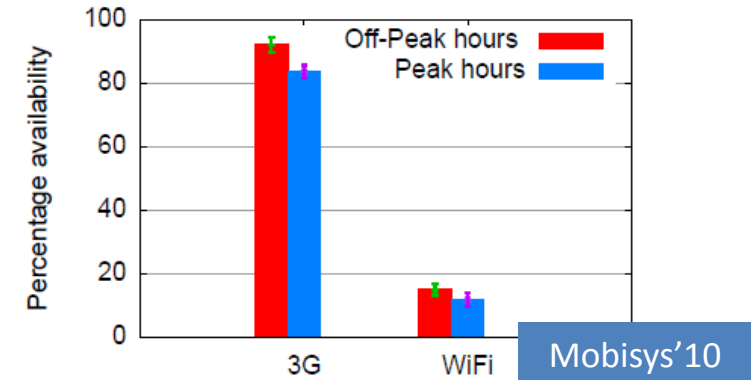
# Why High Availability Matters

40.8 network failures per day with end-user impact  
 Median packet loss of 59,000 packets per failure  
**Network redundancy improves the problem by only 43%**

Microsoft Datacenter

28.1% of customer support account for WAN, LAN connectivity problems  
 Median fixation time ranges from 114 – 188 minutes

HP Enterprise Managed Networks



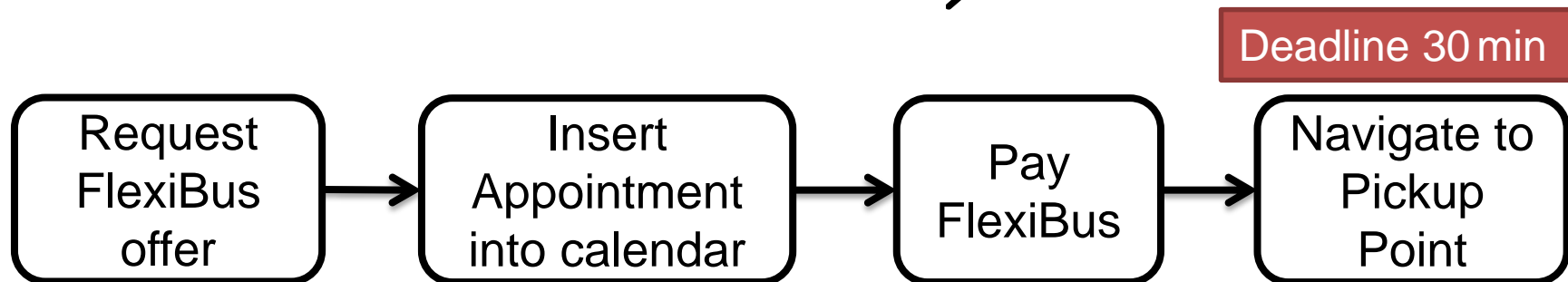
4G LTE: 16% Network failures out of 100 requests  
 3G: 19% network failures out of 100 request

2013 US Study by J.D. Power



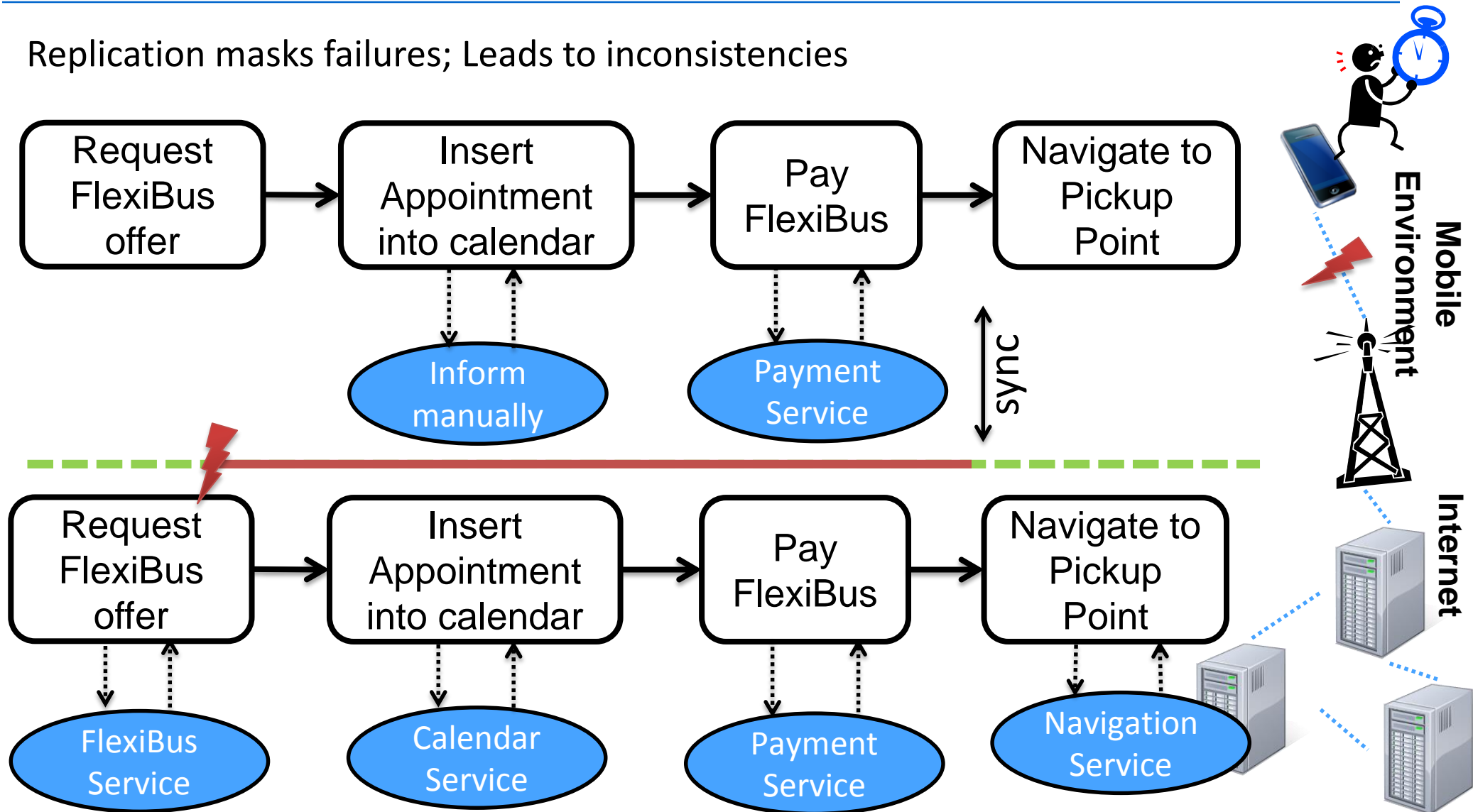
# Why Availability Matters – Example

- Adam gets a call from his boss that he needs to attend a meeting in a different part of the city in half an hour
  - He specifies this goal and receives the following flow from the system:
    - Use a FlexiBus
    - Cancel all other appointments



# Replicated Workflow Execution

Replication masks failures; Leads to inconsistencies



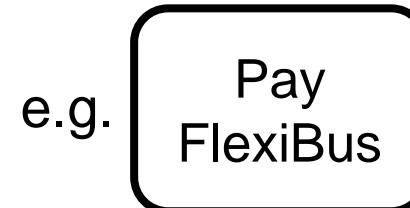
# Replicated Workflow Execution

- Classify activities into replicable

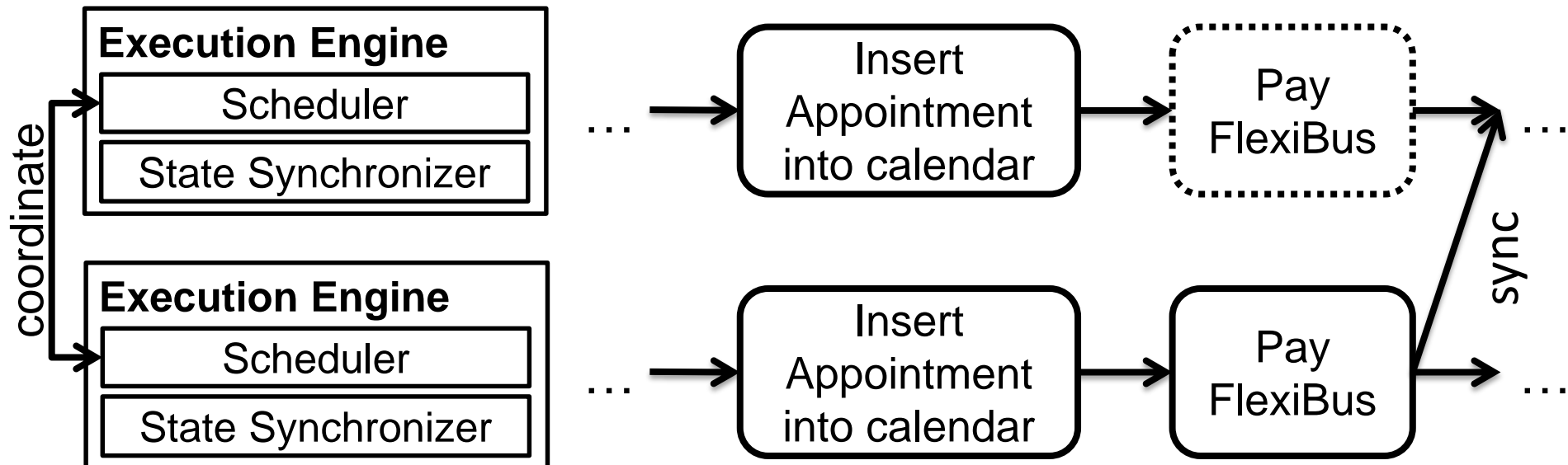


Compensation needed

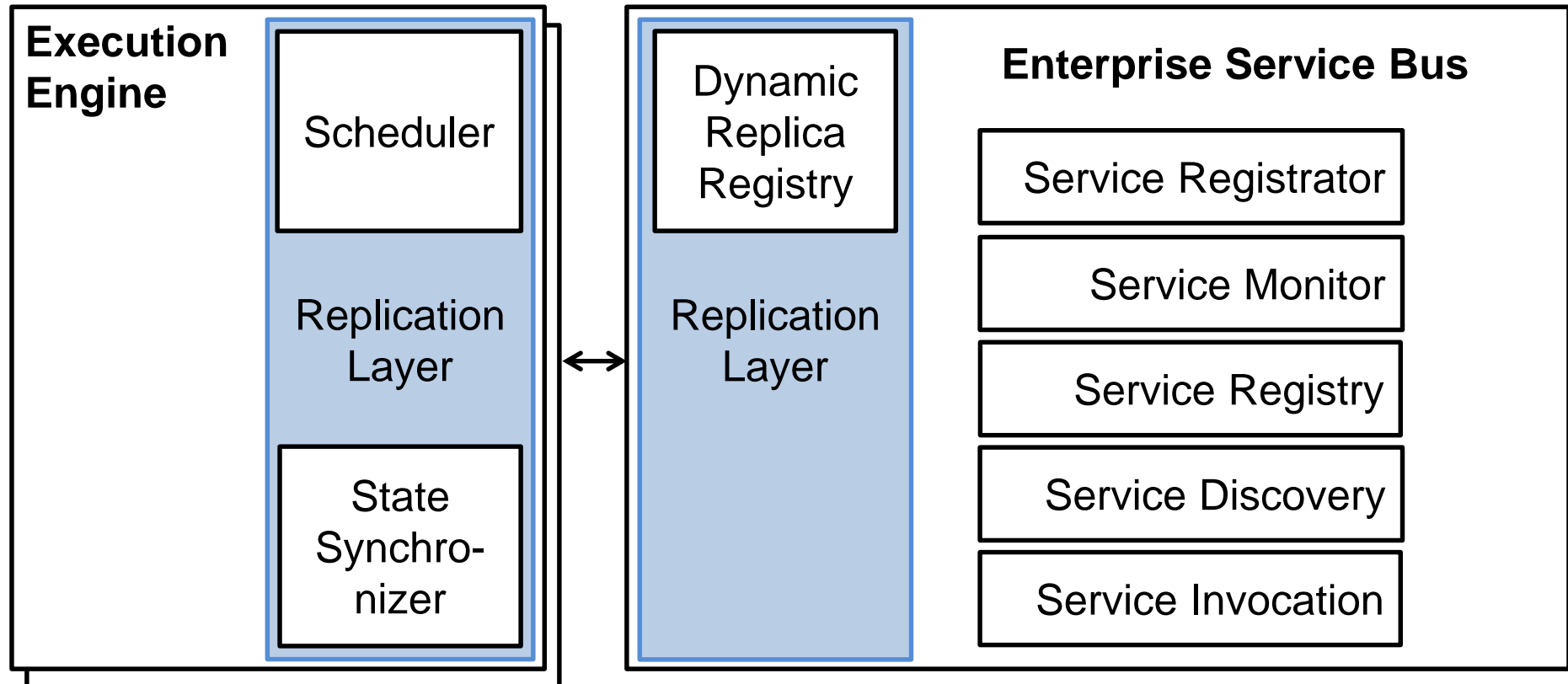
non-replicable



→ Synchronize replicas and schedule accordingly

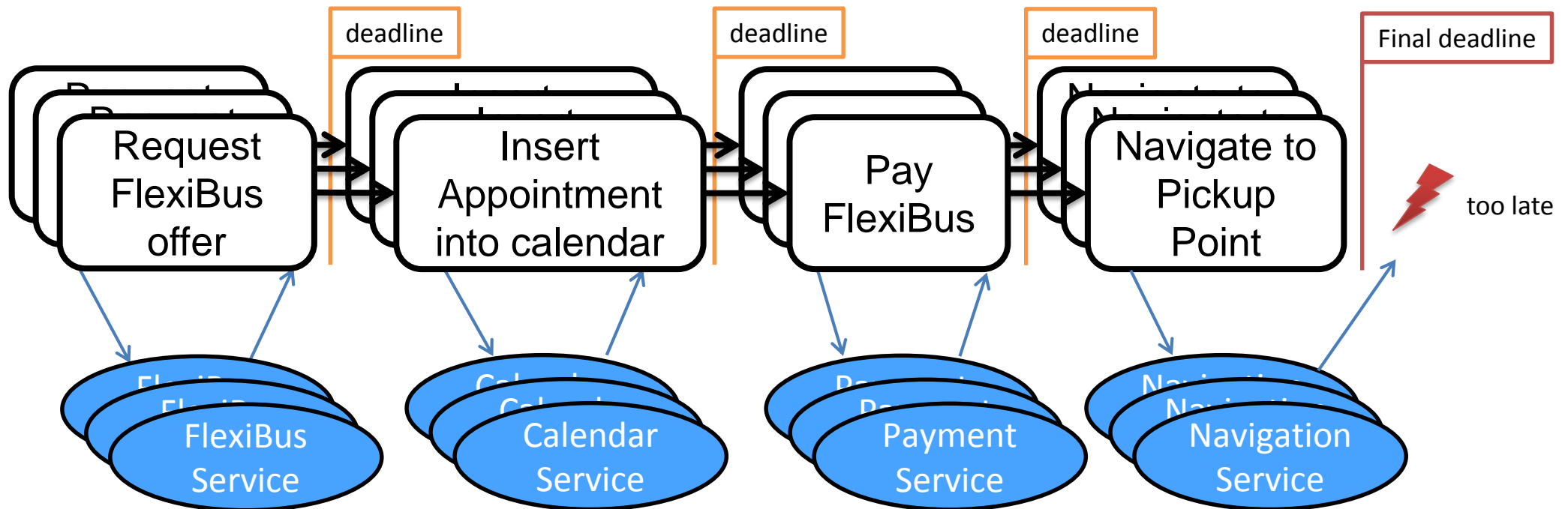


# Embedding into Existing Architecture





# Service Selection and Execution

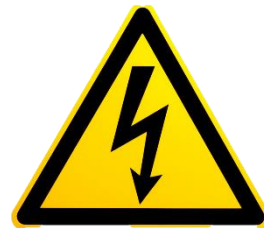
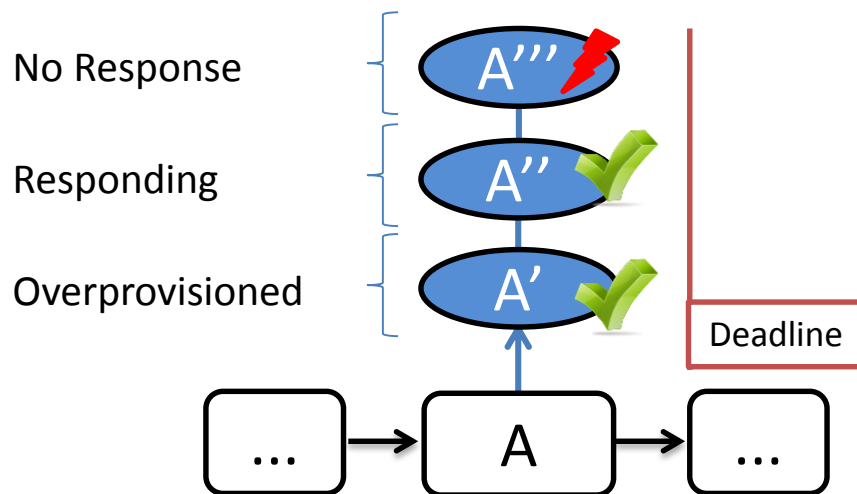


- Ensure a timely execution / maintain deadlines
- Minimize Cost
- Find appropriate sub-deadlines
- Execute several (backup) services over time

# Parallel vs. Sequential Service Execution

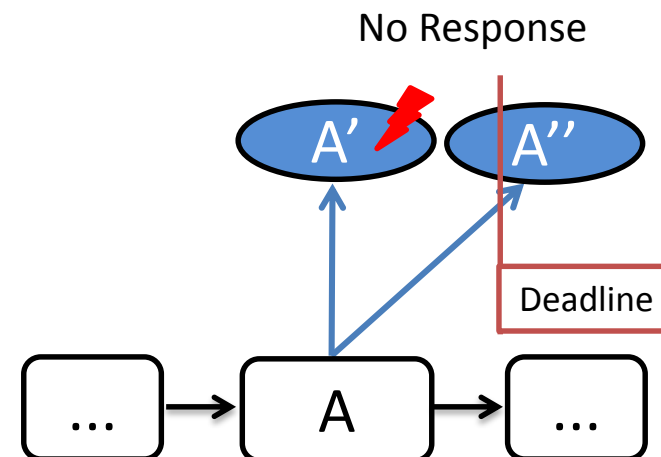
Common strategies to access several services

Parallel → overprovisioning



Requires expensive compensation

Sequential → too late

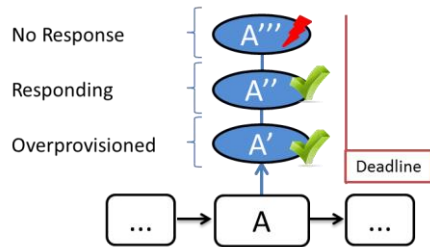


Deadline missed

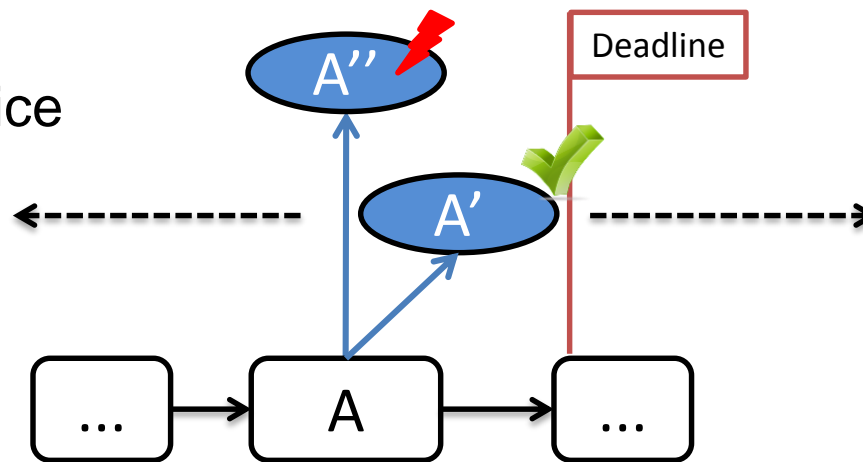


# Search Space Between Parallel and Sequential

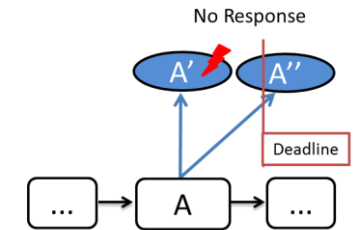
Parallel → overprovisioning



Start backup service early to satisfy the deadline



Sequential → too late



Start backup service as late as possible to give the earlier service(s) maximal time to respond

⇒ Find the perfect start time for backup services

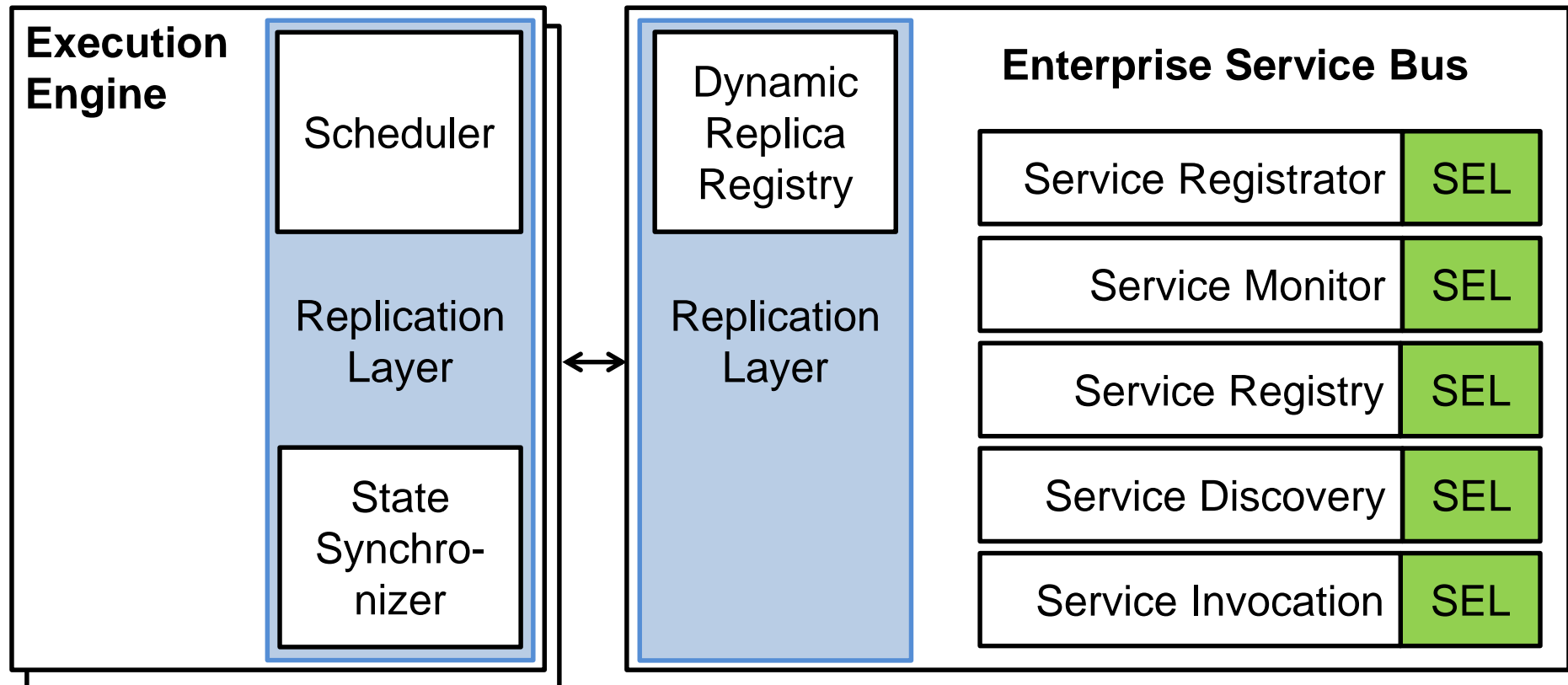
## Goals

- Obeying probabilistic deadlines
- Minimize overall cost



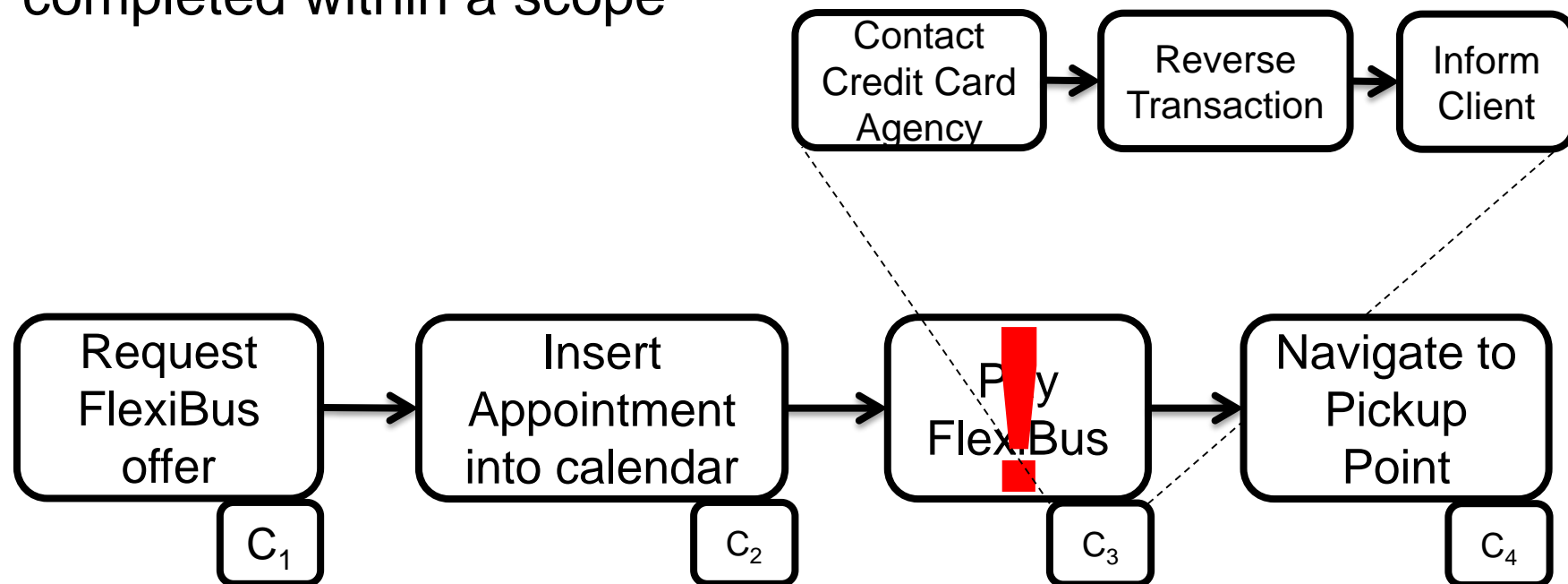
Compensation cannot be always avoided

# Embedding into Existing Architecture

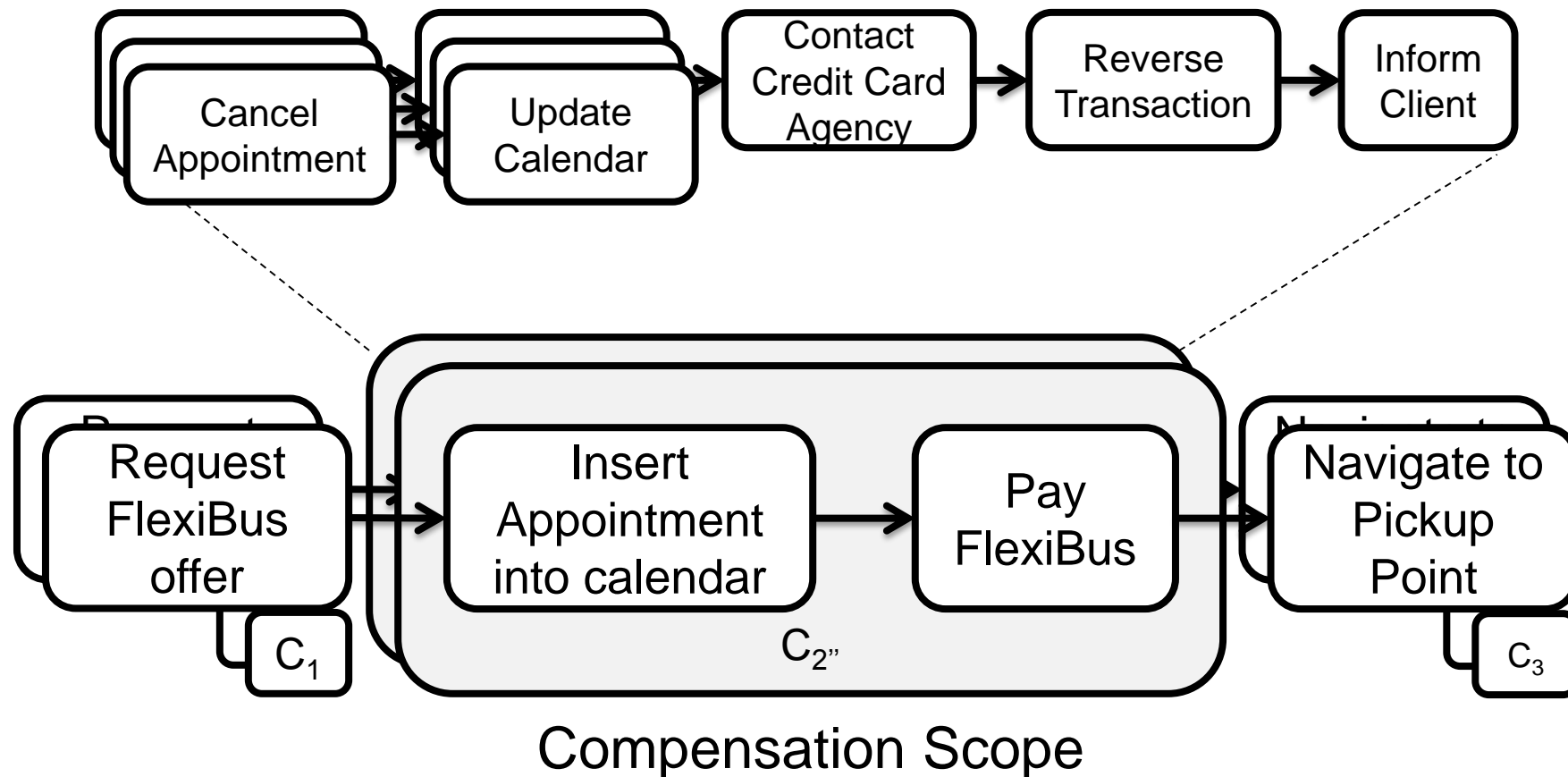


# Workflow Technology - Compensation Handling

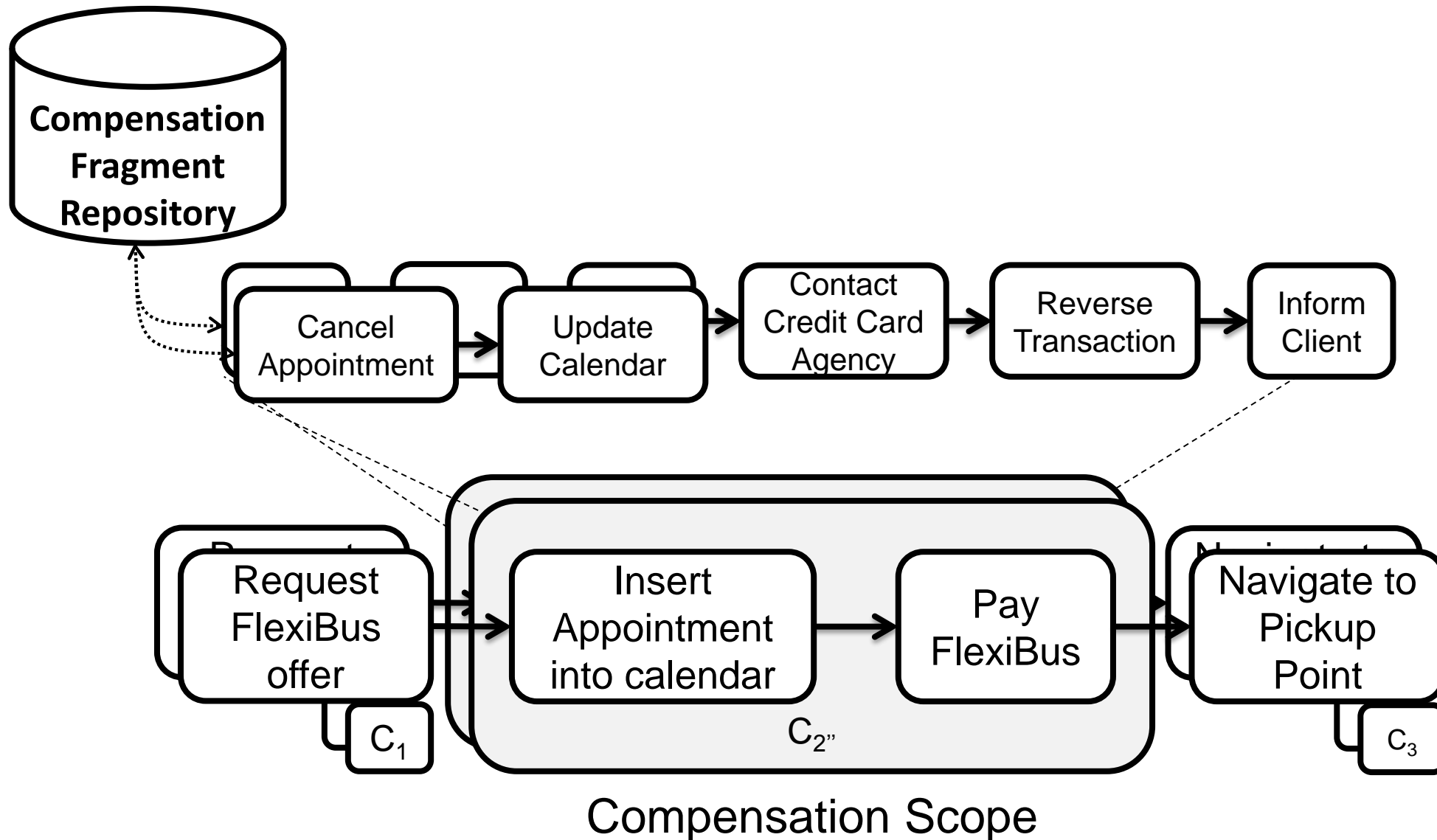
- Native support for compensation capabilities
- Usage of *Compensation Scopes* comprising one or multiple activities
- *Compensation Handlers* are used to reverse the work already completed within a scope



# Workflow Technology - Compensation Handling



# Dynamic Compensation Handling



# Conclusion

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- Promising approaches to ensure high availability
  - Workflow replication
  - Service Selection and Execution
- Embedding concepts into existing architecture by extending
  - Execution Engine
  - Enterprise Service Bus
- Manage Dynamic Compensation
  - Injection of process fragments



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# *ALLOW*

*Ensembles*

<http://www.allow-ensembles.eu>

**Thank you for your attention**

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