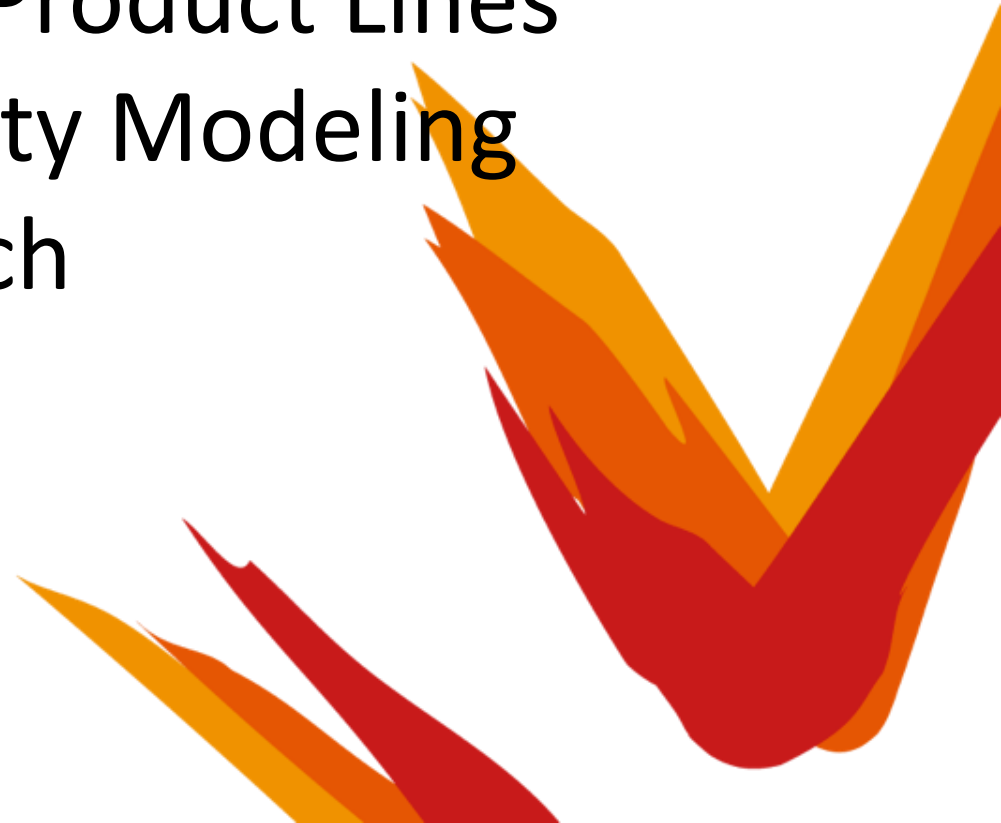


# Achieving Run-time Evolution of Dynamic Software Product Lines through a Variability Modeling Approach

Lorena Arcega

FOSD 2015



# Index

- Introduction
- Background
- Evolution challenges
- Evolution strategy
- Case Study
- Conclusions



# Introduction

Dynamic Software Product Lines (DSPLs) extend existing product line engineering approaches by moving their capabilities at run-time.



# Introduction

Software evolution has emerged as a key research field in software engineering.



# Introduction

However, Dynamic Software Product Lines (DSPLs) evolution has not yet deserved enough attention.



# Introduction

This work addresses the use of DSPLs to achieve the evolution by means of integrating new developed components.



# Background

## PervML DSL

DSL for describing pervasive systems using high-level abstraction concepts.

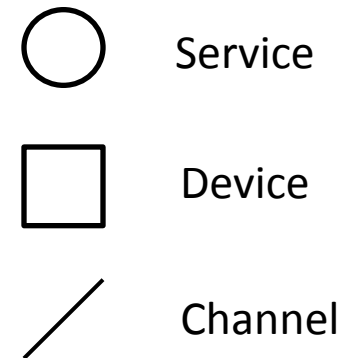
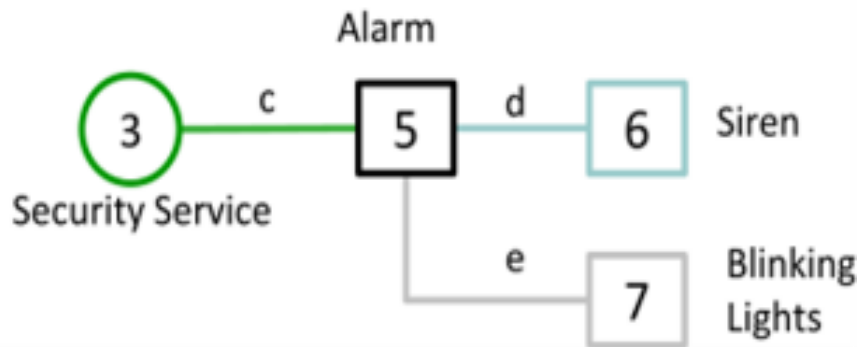
J. Muñoz. *Model Driven Development of Pervasive Systems. Building a Software Factory*. PhD thesis, Universidad Politécnica de Valencia, 2008.



# Background

## PervML Model

Illumination  
Service





# Background

## Feature Modelling

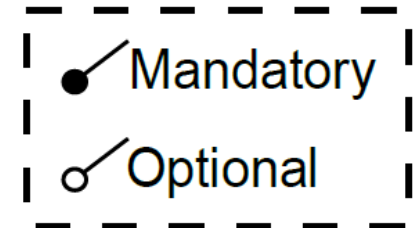
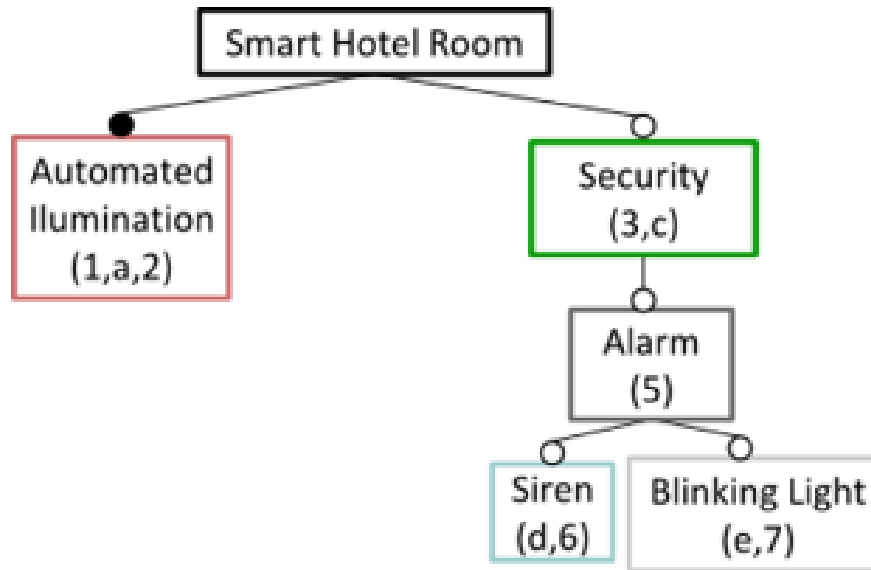
A widely used formalism for modeling and reasoning about commonality and variability of a system.

S. She, R. Lotufo, T. Berger, A. Wąsowski and K. Czarnecki. *Reverse Engineering Feature Models*. In Proceedings of the 33rd International Conference on Software Engineering, ICSE'11.



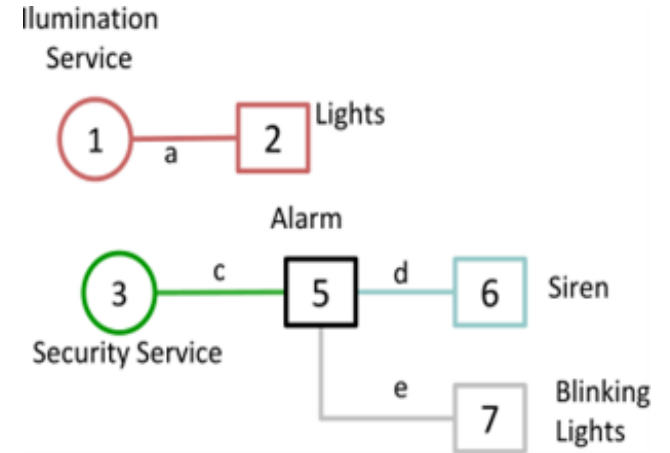
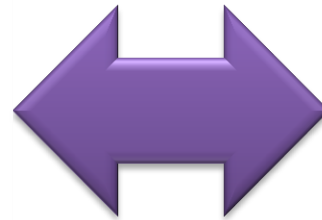
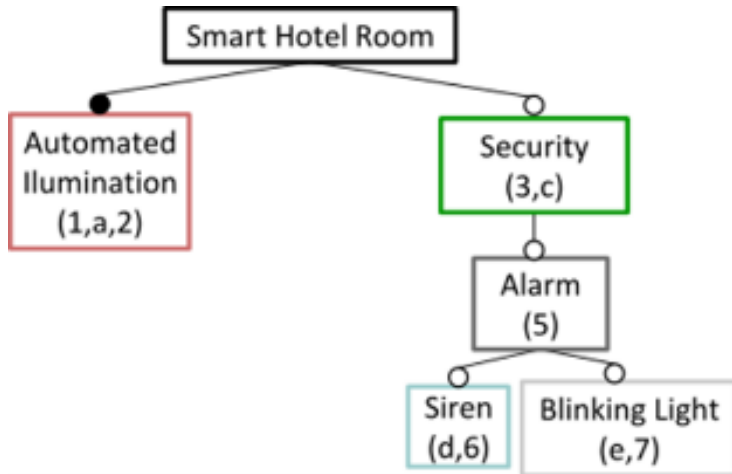
# Background

## Feature Modelling

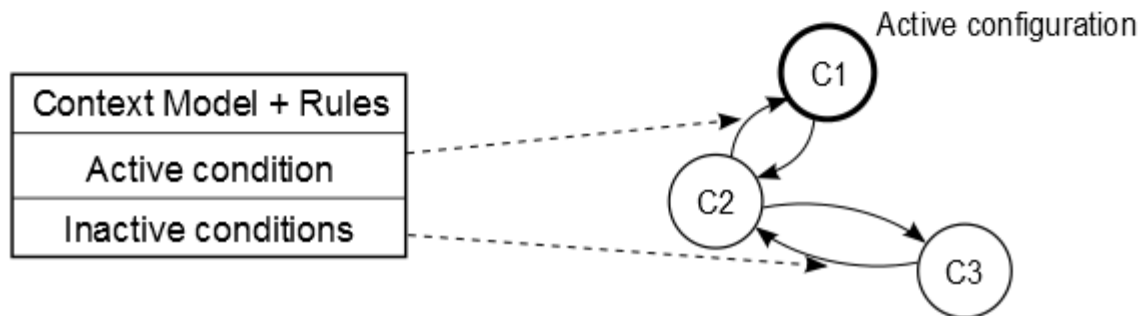
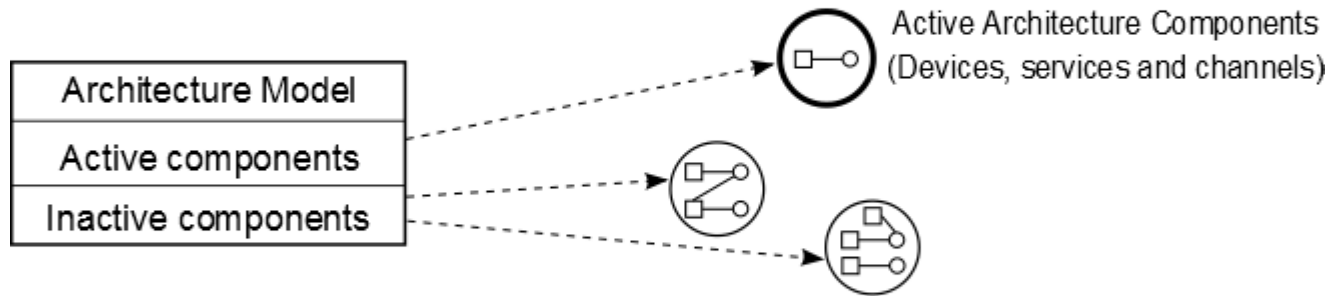
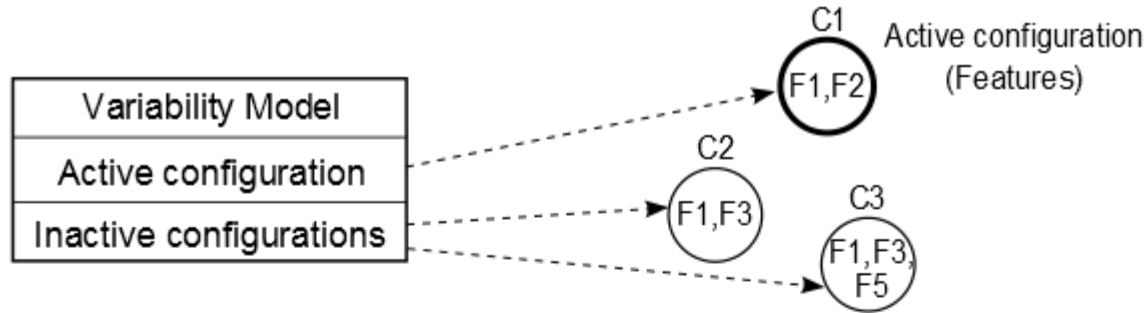


# Background

## Weavig Model



# Background



# Background

## **Model-based Reconfiguration Engine (MoRE)**

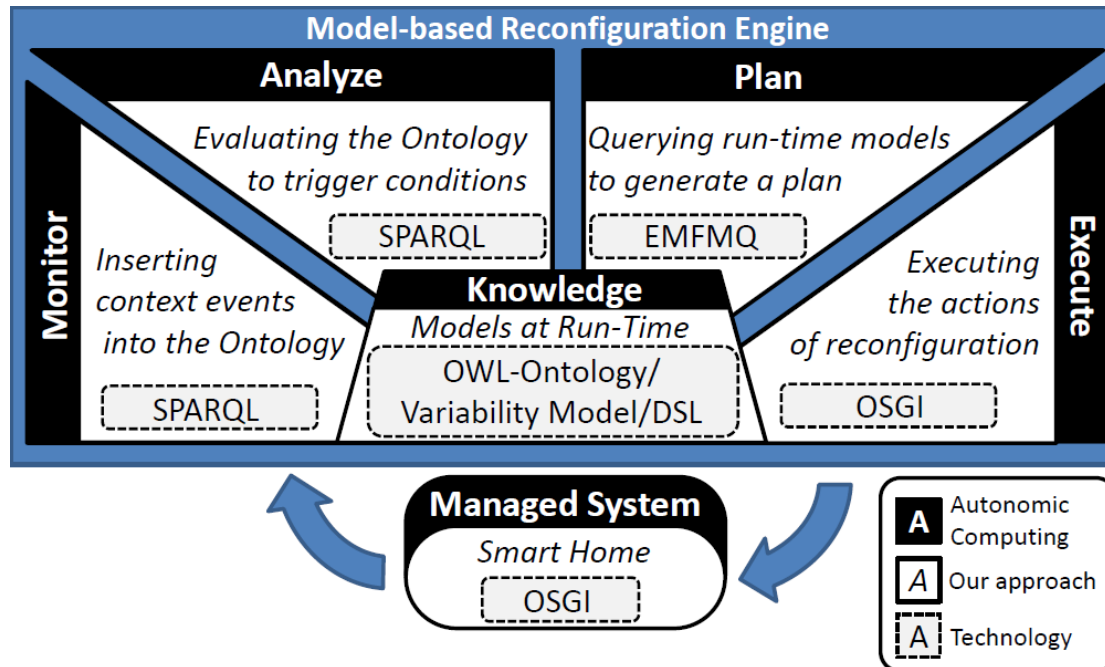
Translate context changes into changes in the activation/deactivation of features. Then these changes are translated into reconfiguration actions that modify the system components accordingly.

*C. Cetina. Achieving Autonomic Computing through the Use of Variability Models at Run-time. PhD thesis, Universidad Politécnic de Valencia, 2010.*



# Background

## Model-based Reconfiguration Engine (MoRE)



# Evolution Challenges

## Challenge 1

Co-evolution as in SPLs but maintaining more models such as the context model and the reconfigurations.



# Evolution Challenges

## Challenge 2

Keep the models partially connected to the running system and keep the interaction between the running system and the context throughout the evolution.

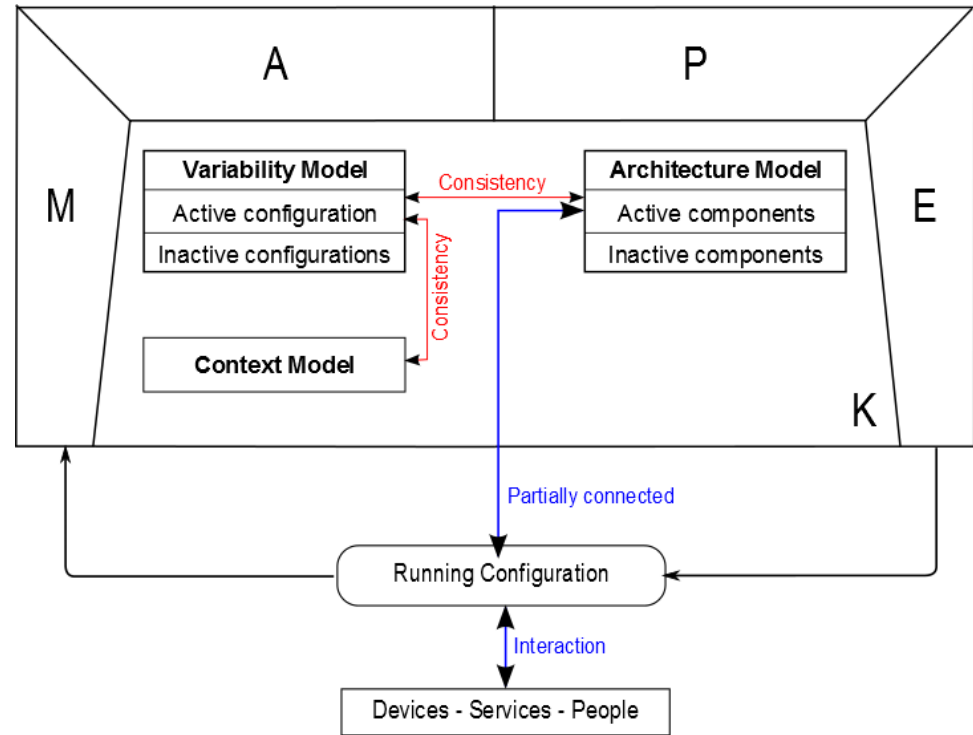




# Evolution Challenges

## Challenge 1

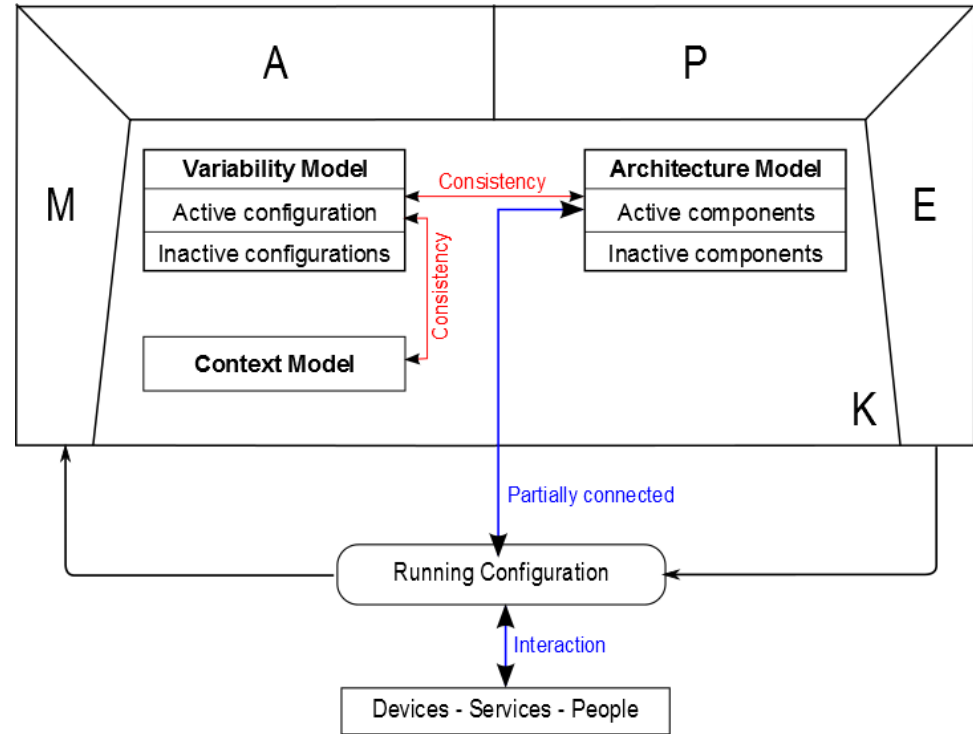
Co-evolution: If the assets evolve the variability specification must to evolve and vice versa.



# Evolution Challenges

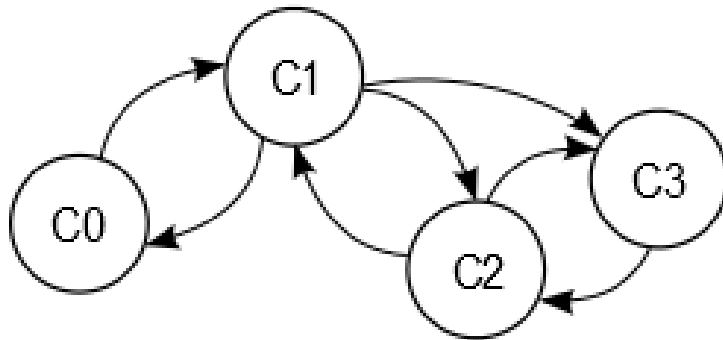
## Challenge 2

Keep the models partially connected to the system and keep the interaction between the system and the context.

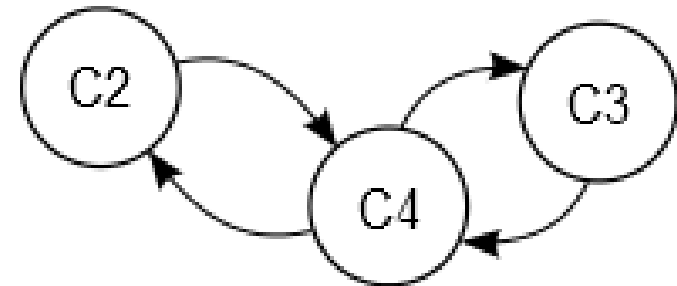


# Evolution Strategy

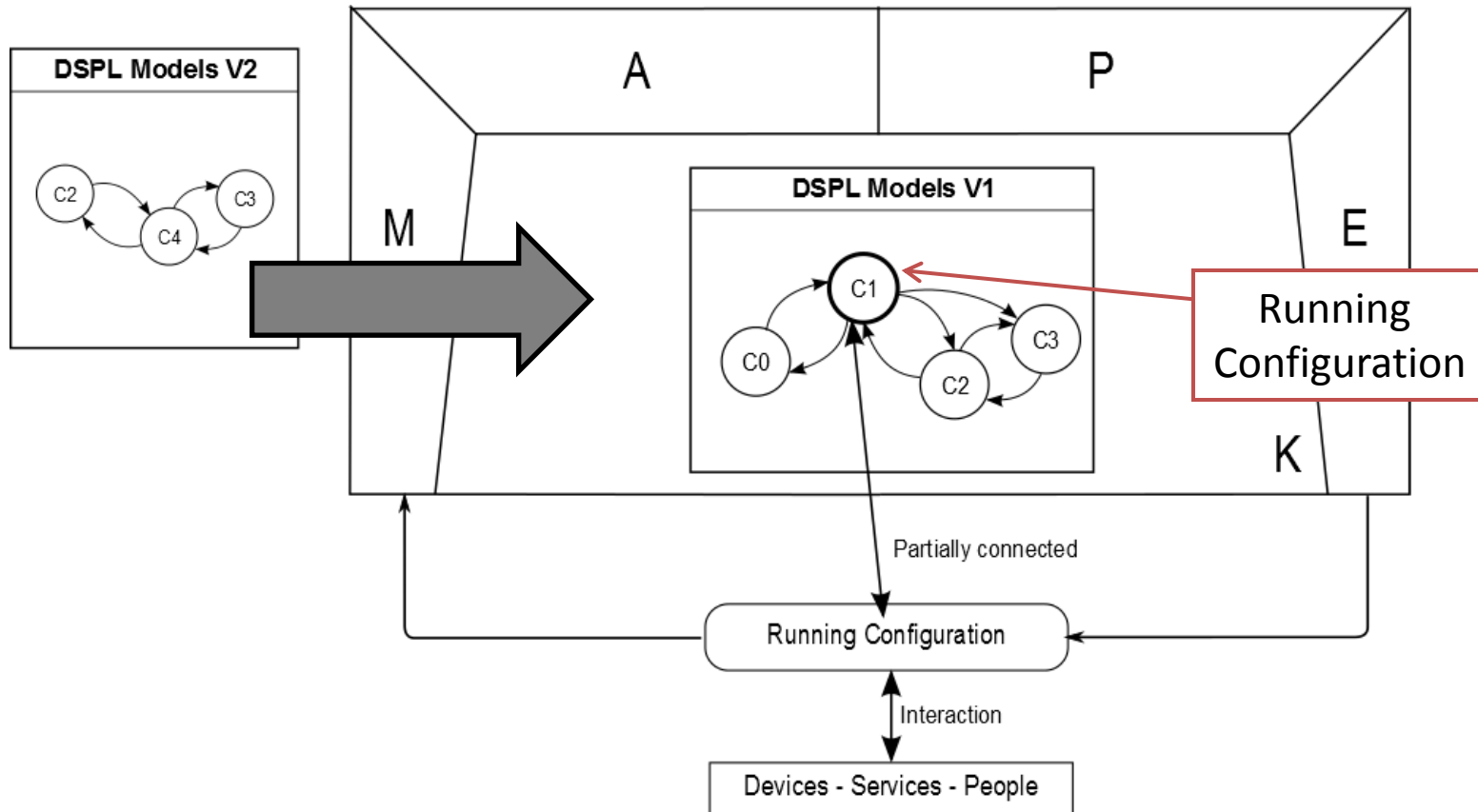
DSPL Models V1



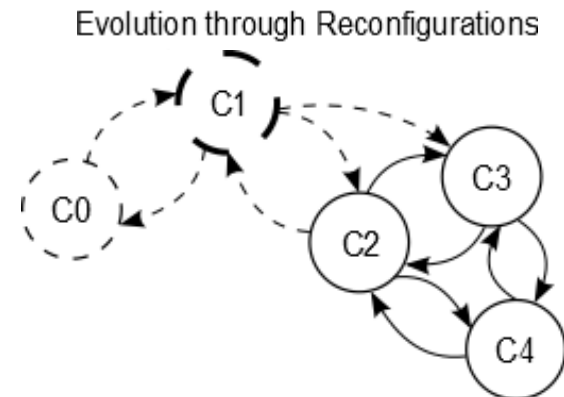
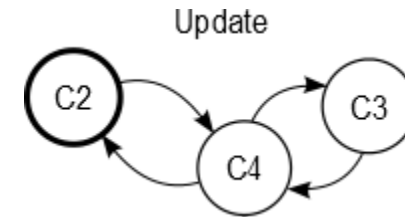
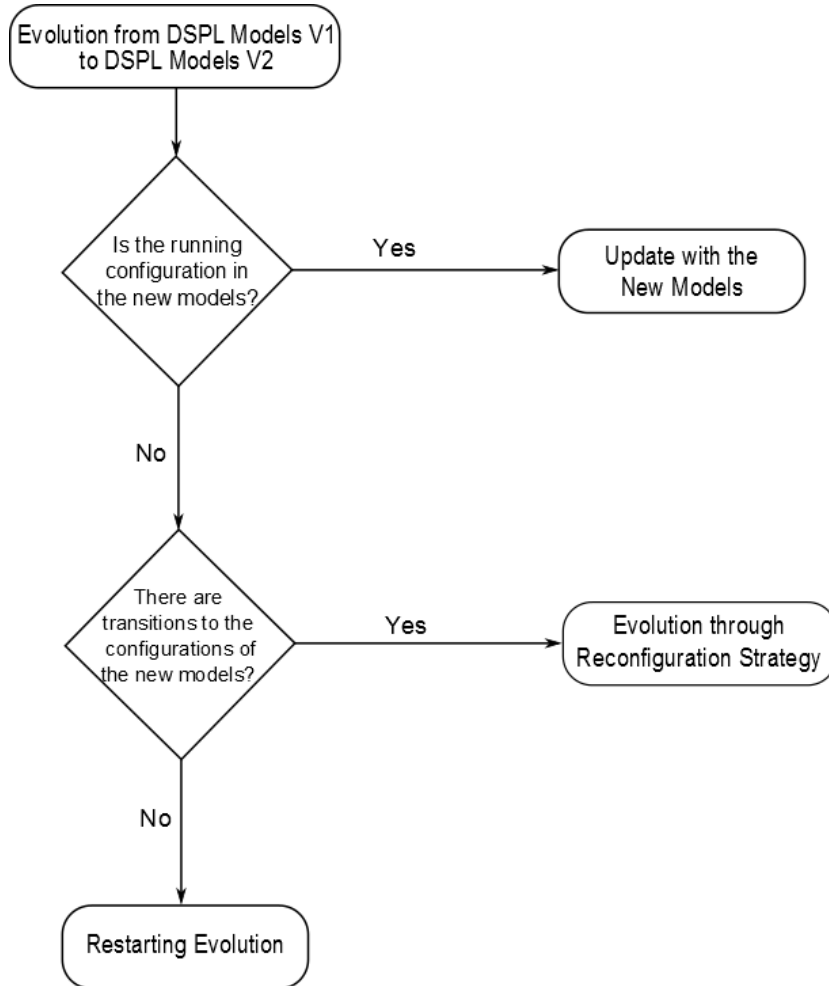
DSPL Models V2



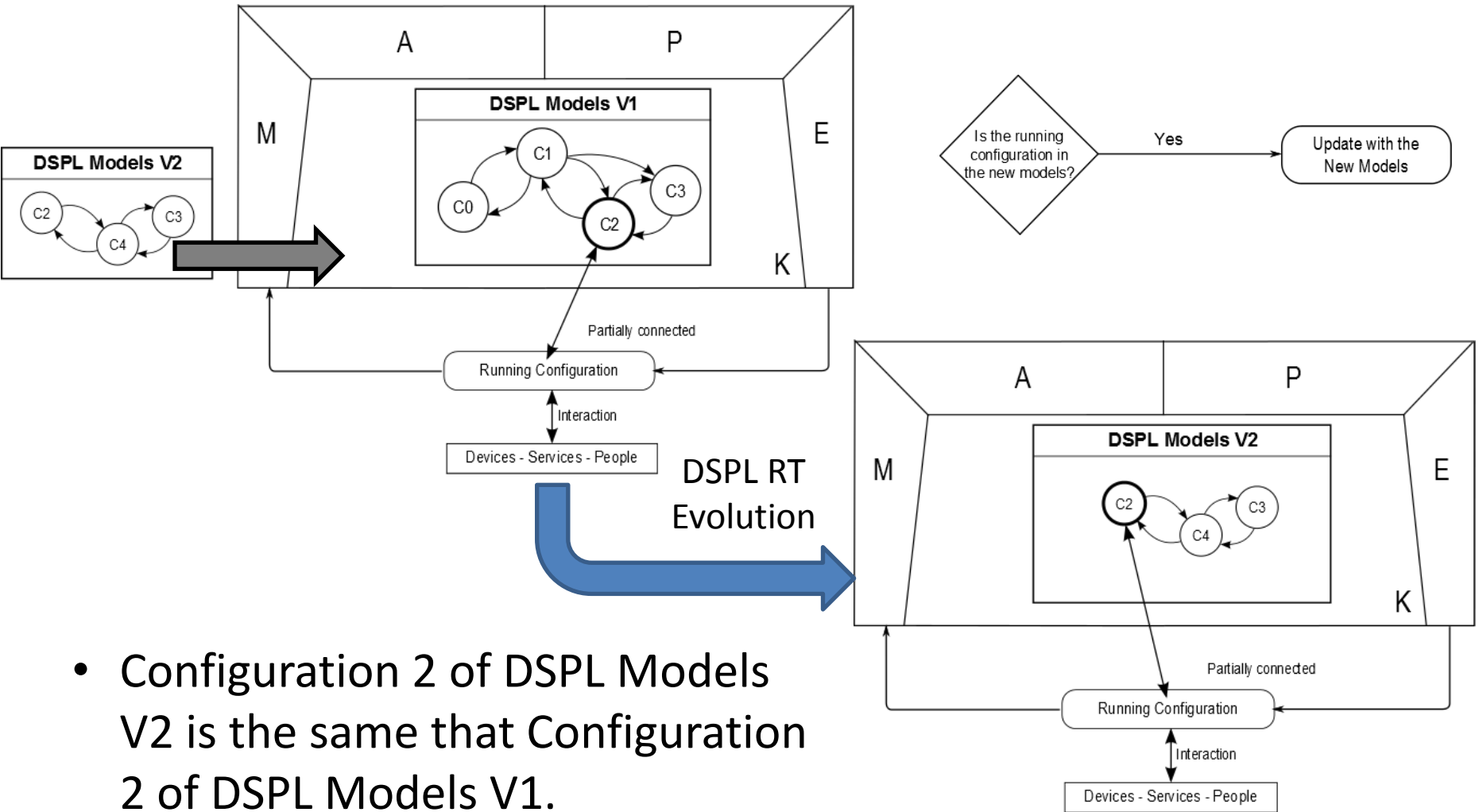
# Evolution Strategy



# Evolution Strategy



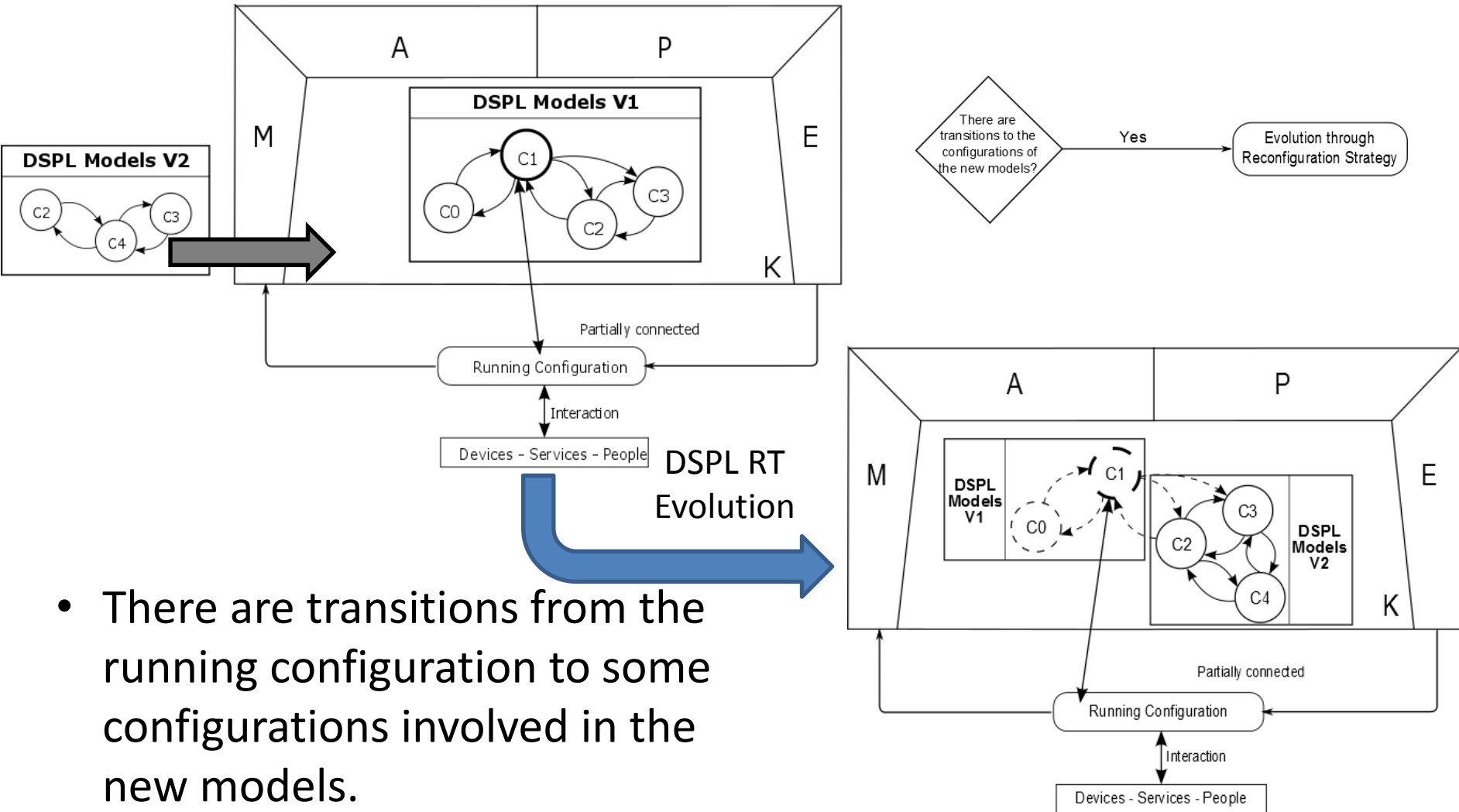
# Evolution Strategy



- Configuration 2 of DSPL Models V2 is the same that Configuration 2 of DSPL Models V1.



# Evolution Strategy



- There are transitions from the running configuration to some configurations involved in the new models.



# Case Study

- Smart Hotel case study:
  - Simulated environment.
  - Average occupancy of about 18 simultaneous clients.
  - MoRE reconfigures the system following the context changes triggered by the clients.





# Case Study

- Evolution in the Smart Hotel:
  - Eight versions were developed at design-time.
  - Initial derivation from version 1 to version 8.
  - MoRE reconfigured the architecture of the system.
  - An evolution to one of the next versions was performed.



# Conclusions

This work address the evolution of a DSPL by integrating newly developed components.



# Conclusions

The evaluation of our strategy in the Smart Hotel DSPL has shown that the models were evolved while the current configuration of the Smart Hotel kept running.



**Lorena Arcega**  
**FOSD 2015**

[larcega@usj.es](mailto:larcega@usj.es)

<http://eps.usj.es/svit/>