Adaptative Systems Based on Continuous Observation of Petri Net Product Lines

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Abstract

Traditionally, critical systems have been deployed in isolation, that is, in closed environments where the access control was easily managed. However, the increasing complexity and connectivity of these systems make them vulnerable to cyberattacks, malfunctioning or any kind of uncontrolled events. In this work, we propose a framework that is capable of automatically adapt its configuration for addressing the challenges of an environmental change. To this end, we model the critical system as a Petri net which is enriched with product lines that implement actions for different scenarios. The execution traces are then continuously monitored and provide information to the control logic responsible for achieving the critical system goals by means of the product lines.

Keywords

Petri net, Product line, Runtime verification

1. Introduction

Traditionally, critical systems have been deployed in isolation, that is, in closed environments where the access control was easily managed. Recently reports indicate that these systems are vulnerable to cyberattacks as well [1]. Security flaws may directly impact safety in critical systems. Current approaches and tools concerning security do not ensure their adequacy to industrial standards for safety level.

2. Background

We combine the following concepts for our approach: 1) Petri nets as formal model, 2) Product Lines for designing, and 3) Runtime verification for system monitoring.

A Petri net will model the critical system, where each product line implements a specific configuration. Depending on the Key Performance Indicators (KPI) defined by the customer and the measurements the monitor extracts by simulation of the formal model, our new framework checks if the critical system will manage to achieve the user requirements by switching on/off the product lines on runtime.

We are basing our approach on the following previous works:

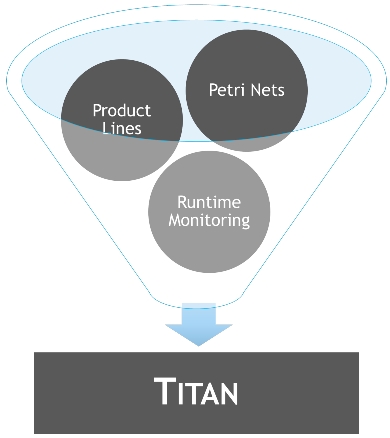

Figure 1: Titan framework

- A framework for modelling product lines with Petri nets, using an eclipse plug-in, called Titan [2].
- A framework for abstracting data and datatypes as colours and hierarchies in Coloured Petri Nets [3, 4].
- A transformation of product Lines with Petri nets into Coloured Petri Nets [5].
- A language for the specification and runtime verification of systems [6].

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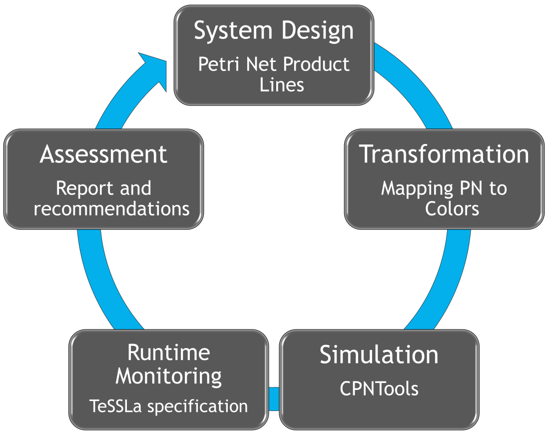

Figure 2: Titan

3. Approach

In contrast to [2], our new approach includes a *Transformation phase*, which maps product lines to colours in Coloured Petri Nets [3].

Then, the *Simulation phase* runs the model, which now supports all the features that the Access/CPN engine provides such as timed information.

The *Monitoring phase*, aimed at detecting concurrence and performance issues, analyses the simulation traces via TeSSLa [6] in order to report performance and concurrence reports.

During the *Assessment phase*, the framework will automatically turn on/off specific product lines in order to achieve the target KPI.

4. Ongoing work

We are currently working on two directions. Firstly, we are extending the PNPL modelling framework capabilities to support additional features such as timed information. Secondly, we explore how to automatically (de)activate product lines based on the monitoring of Key Performance Indicators (KPI). In particular, we are connecting Titan with 1) AccessCPN, the kernel of CPNTools, for simulation purposes; and 2) TeSSLa, a runtime monitoring engine, for providing information to the control logic responsible for managing the product lines.

5. Conclusions

In this work in process, our aim is to:

- augment our framework for enabling software engineers to express and monitor performance, safety and security requirements and system characteristics in a single picture.
- automatically adapt the system configuration based on the simulation reports.

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