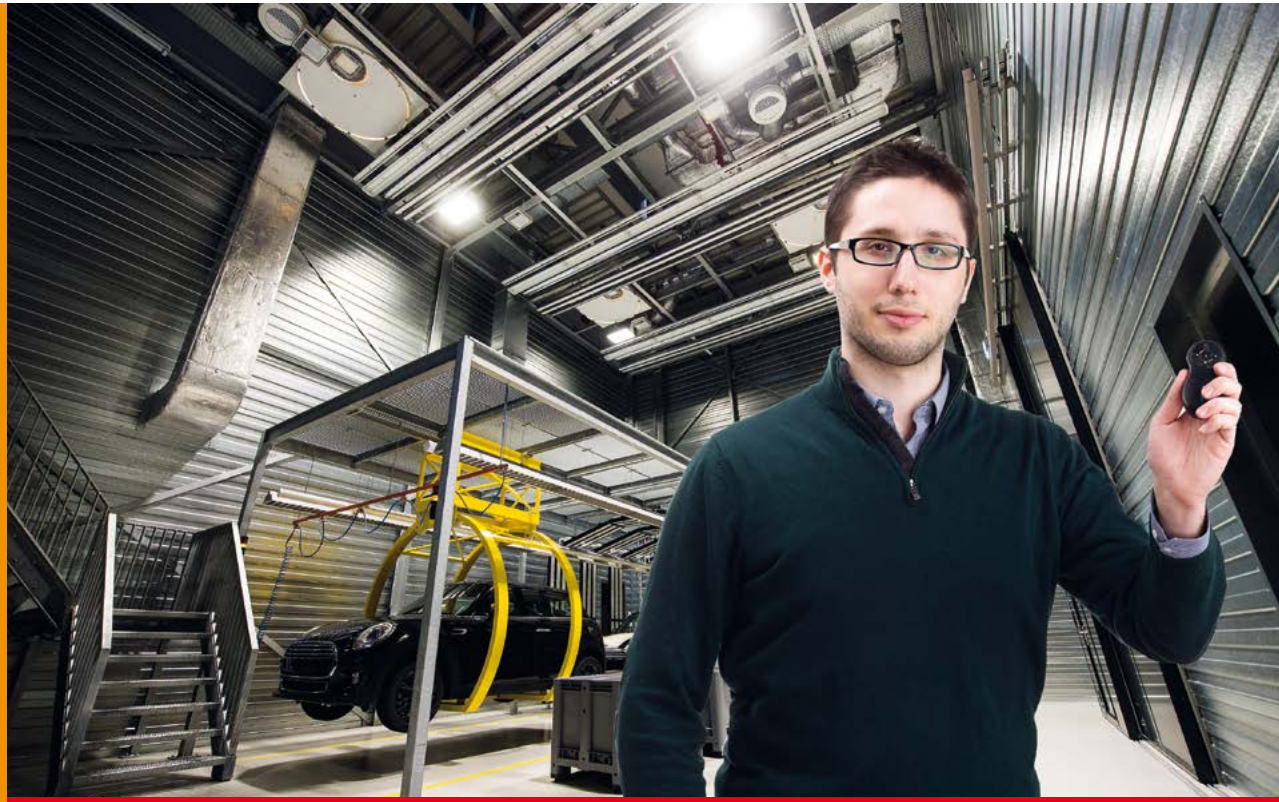
3TU. School for Technological Design

STAN ACKERMANS INSTITUTE

TU Delft Delft University of Technology

TU/e Technische Universiteit Eindhoven University of Technology

UNIVERSITY OF TWENTE.



Software Technology

Eindhoven University of Technology

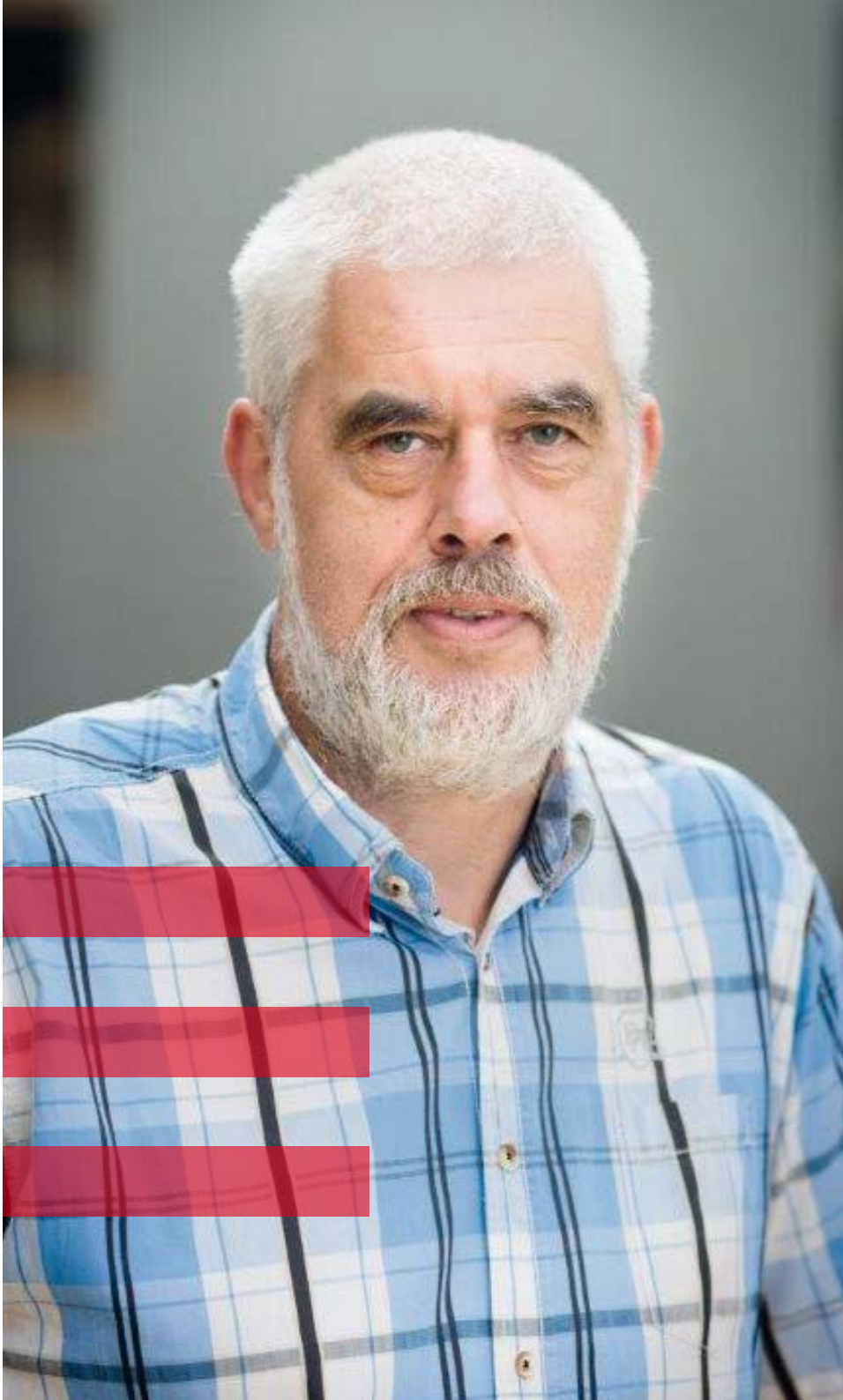
PDEng projects 2015

The Software Technology PDEng (Professional Doctorate in Engineering) degree programme is an accredited and challenging two-year doctorate-level engineering degree programme. During this programme trainees focus on strengthening their technical and non-technical competencies related to the effective and efficient design and development of software for resource constrained software intensive systems in an industrial setting. During the programme our PDEng trainees focus on systems architecting and designing software for software intensive systems in multiple application domains for the High Tech Industry.

The programme is provided by the Department of Mathematics and Computer Science of Eindhoven University of Technology in the context of the 3TU.School for Technological Design, Stan Ackermans Institute.

For more information, visit the website:
www.tue.nl/softwaretechnology

Software Technology - PDEng projects 2015



Prof.dr. J.J. Lukkien

Support for the Professional

One of the biggest assets of many companies in the Brainport area (and beyond) are the highly skilled professionals who are involved in the conception and innovation of the products and services that keep these companies ahead of the competition. The time of these professionals is valuable and every effort that helps them to make better use of their time, is an effort well spent. Companies realize this.

In 2015 we have seen a fair number of projects that address the support for professionals. Several projects focus on creating, adapting or integrating simulators. Simulators are instrumental in making the behavior of complex systems more easy to understand or in bringing the understanding of combined systems within reach. Interactive simulators support exploration and experimentation. Visualization is the focus of another portion of the projects. A suitable presentation of selected aspects of a data set can provide insights not easily gained otherwise. It can moreover be a powerful communication channel to non-experts. We also see projects that deliver toolkits or frameworks that make it easier to compose or automate tests, support professional workflows or knowledge sharing by capturing frequently used functionalities and offering an environment that makes these fit for re-use.

The projects described in this booklet as always give a view on the current concerns in the development of high tech systems and in particular the software tools and components needed for that. They have also provided the Software Technology trainees executing them with sufficient challenges to allow them to show they are capable of producing a high quality design. I therefore can say to all candidates: congratulations with the results and I wish you all the best and a successful career.

Johan Lukkien
Scientific Director

Challenges

The main challenge is to understand the domain of ASML in a very short period of time. In addition, the nature of CPD Integrated Development Toolkit project is to break from the past without losing all the major investments of ASML since 1984.

Results

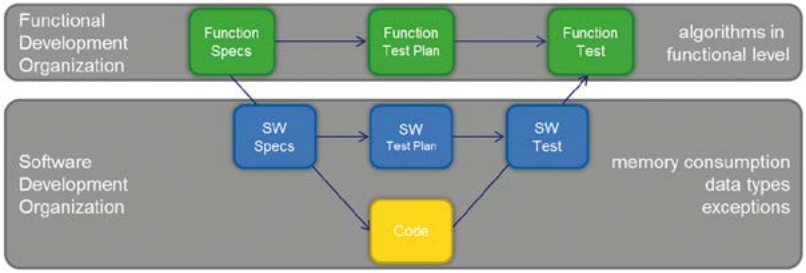
Creating a network of functional engineers was the ignition of the CPD Integrated Development Toolkit idea. Besides that, a first order requirement analysis and a business case were provided to ASML in order to support the continuance of the project. Finally, a CPD functional domain specific language was developed to prove that it is feasible to describe a CPD application only on the functional level.

Benefits

The CPD Integrated Development Toolkit is showing the way to shorten the CPD applications development time. In addition, it brings a fresh and modern approach on developing software by separating the business and services from the targeted platform.

Erikos Alkalai PDEng

CPD Integrated Development Toolkit



"Starting from a green field is always difficult, but you performed very well. You were able to master the problem, building up your own network of people assisting you, and last but not least, gaining the confidence of our intended functional key users by selling the message in a convincing way. The great Greek philosopher Plato phrased this in an inspiring way: The beginning is the most important part of the work".

W.K. Tabingh Suermondt
ASML

ASML develops lithography scanners that are designed to deliver high throughput, measured in wafers per hour, at an exposure precision of nanometers. The CPD (Calibration, Performance and Diagnostics) applications are ensuring the accuracy and the high throughput of the system. However, the design and development process of this software is very time consuming due to difficulties in translating the functional to software requirements. The CPD Integrated Development Toolkit (CIDT) envisions an integrated environment for the CPD functional designers in order to design, develop and test the CPD application without the need of CPD software designers.

The most important factor is the end users to accept this new technology. Therefore, ASML has to understand their needs and involve them in the developing process of such a tool. Requirement engineering and process development was used to adapt the hand-crafted software development to a modern and agile approach. Finally, a business case was initiated by diving into the numbers of CPD applications inside the software archives and project management allocation sheets.

The CPD Integrated Development Toolkit is not just a new tool to provide to the CPD functional designers. It brings a new era at ASML in the way of producing software by building the abstract models of their business and services that will guarantee them against technological obsolescence.

Challenges

There were two main challenges for this project: changing the mindset to use a new paradigm and extending the Océ environment to support Live Sequence Charts (LSCs). Many examples were implemented to get familiar with Scenario Based Programming and, in order to incorporate LSCs in the Océ development environment, libraries and tools developed at were re-used. Since not much documentation was available, reverse engineering and meetings with experts were required.

Results

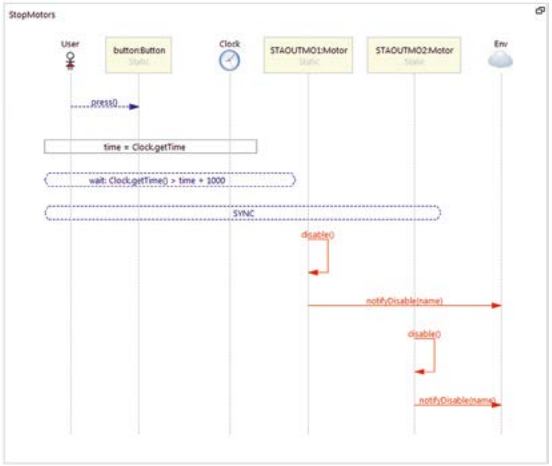
As a result of this project the Océ development environment was extended to support LSCs and a case study, consisting of replicating part of the functionalities of a High Capacity Stacker printer finisher, was implemented. Due to the fact that the time assigned for this project was not enough for a full implementation, only a representative subset of the original functionalities was implemented and validated.

Benefits

After the execution of this project Océ has grounded reasons to support the idea that the paradigm is powerful enough to develop embedded control software. However, since the tools that support such paradigm require further development, the company realized through this project that is not viable to incorporate LSCs in the development process at the moment. Now Océ knows the strengths and limitations of Scenario Based Programming.

Favio Bettiol PDEng

Using Scenario Based Programming to Develop Embedded Control Software



"The final result gives good insight in the applicability of LSCs for developing engine control software. Instead of first creating MSCs and then manually converting them to state diagrams using LSCs the latter step can be skipped. This should save a lot of time provided that the merger of the various LSCs is done correctly. Favio worked very independently. Feedback was quickly picked up and leads to other sources of information were quickly followed."

P. Vestjens PDEng
Océ Technologies

Océ develops professional and innovative high tech printers and software. Through its own Research & Development (R&D) department, Océ develops core technologies and the majority of its own product concepts. Key process indicators of an Océ project are iteration time and iteration efficiency. The challenge for every project is to speed up iterations, while maintaining the quality. The goal of this work is to analyze whether it is possible, or not, to implement using Scenario Based Programming a proof of concept which includes representative functionalities of common products developed at the company. This could improve the current software development process by providing a new abstraction layer to the designers/developers.

There were two main tasks that defined this project: the design/implementation of the proof of concept and the adaptation of the current Océ development environment to support Live Sequence Charts (LSCs). The former consisted of implementing in LSCs representative functionalities of the High Capacity Stacker (HCS) printer finisher. The latter was mainly focused on how to make LSCs to interact with the existing tools at Océ.

The solution is shaped by approximately thirty scenarios written in LSCs, which defines the behavior of the HCS. Due to tools limitations, only Java code could be generated and it was not possible to deploy the system in real hardware. For this reason, in order to check the correct behavior, the system had to interact with a simulator and a C project was created to communicate the LSCs specifying the controlling software with the simulator.

Challenges

The challenge in this project was to connect a tool designed to create video games with professional tools used for commissioning lighting systems. The commissioning tools did not always provide a clean interface or means to connect to it that were compatible with the gaming technology.

Results

The result was a prototype that in its current state is used by the Room Controller team to test the controllers they are developing. The prototype is offered with its user level documentation and information on how the development using a combination of C++ and the gaming scripting languages has been made. Additionally, continuation of the application within Philips Lighting has been ensured through a number of meetings with the purpose of transferring the knowledge acquired while developing Simulight.

Benefits

The design focused from the beginning on providing a tool that would evolve together with the Room Controller project. This facilitated creating application where new types of lighting devices and new areas in which to run simulations can be added in a matter of hours. These times were measured during the development of the project as new features were finished by the Room Controller team.

Johan Bertrand Bonnemason PDEng

Simulight

Creating a realistic real-time interactive simulation of a Lighting System by applying game technologies to industrial solutions

"Johan succeeded to manage these risks in a good way, to get the lighting simulator working, even though the Unreal gaming engine was sometimes not easy to use for other purposes than games. Looking back, it was a pleasure to work together with Johan in this project, he was open minded, found creative solutions and was sometimes working too hard."

ing. H. Stevens
Philips Lighting

Philips Lighting has been trying to achieve a user friendly and interactive way of realistically simulating their products and lighting solutions. With it they aim to connect the world of the software developers, who can use simulations to speed up the process of creating new products and the world of the sales manager, who needs simulations to showcase these products to potential clients.

Simulight aims to be a first step in this direction, providing a software testing solution for the Room Controller team that develops Commissioning Tools within Philips Lighting. Commissioning is the process of configuring an existing lighting system. Some of the requirements of Simulight were defined due to the early stages of the Room Controller project. For example, it was necessary to create a tool that was easily extensible to accommodate for the evolution of the Room Controller project.

Simulight was made by mixing together the needs of a simulation tool, the need for extensibility and the usage of gaming technology. The design was divided in multiple layers that went from the Lighting System simulations, this helps pinpoint where the Simulight needs to be extended, to the tools created with gaming technology that offered the support needed to create test cases for the Room Controller team.

Challenges

Many aspects of the system may have an impact on the design of an integrated simulation solution. In order to deal with this, it is necessary to capture the required technical aspects of the domain, while abstracting from the details that are not relevant to the use cases. The main challenge in this project was to combine these aspects into a solution that fits cleanly into the existing software architecture.

Results

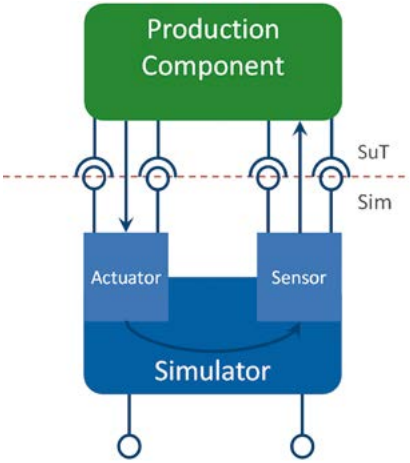
The project resulted in a number of generic steps and guidelines for integrating simulators. The concrete designs that follow from these guidelines demonstrate feasibility of this approach and document an extensible simulator that can be integrated with other simulators. Using prototype implementations of the designs, defects were identified in production code. This demonstrates the value of the integration of simulators for testing on the software-only Devbench environment.

Benefits

Applying the described steps and guidelines to integrating simulators leads to improved test coverage of integration tests of the EUV Source on the Devbench platform. This improved integration test coverage enables engineers to test the EUV Source software more often and earlier in the development process. The result is reliable software with a reduced development cycle time.

Tom Boshoven PDEng

Integrated Simulation in EUV Source



"Tom's work and results have already led to finding a number of defects in the actual product. With that, he has successfully demonstrated the benefits of the approach and the potential of available isolated simulators. This is a step towards standardization of the design, which is not to be underestimated."

D. Coppelmans
ASML

ASML is the world's leading provider of photolithography systems for the semiconductor industry. The new generation of these systems exposes wafers to extreme ultraviolet (EUV) light in order to create integrated circuits. Rigorous testing of the software in the EUV Source system, which generates this EUV light, is important for ensuring software quality. The software-only Devbench platform, supported by simulators, helps engineers test earlier and more often than they could on physical hardware.

Current simulation solutions for Devbench simulate only parts of the system in isolation. Because of this, many integration test cases cannot be executed on this platform. By integrating existing simulation solutions, it is possible to enable simulation of a larger part of the system. This leads to higher integration test coverage on Devbench.

This principle was demonstrated by designing integrated solutions for testing two applications for the EUV Source. In the design of these integrated solutions, a generic approach to solving this type of problem was created. The designs were validated by means of prototype implementations, which showed that that the generic approach works, but also that its application leads to better integration test coverage using simulation. This leads to a lower dependency on a physical machine for testing, which reduces cost and development cycle time.

Challenges

The challenge in this project was to deploy the plugins into the current legacy test code bases. The code bases do not have a very high-level design causing difficulty to understand it.

Results

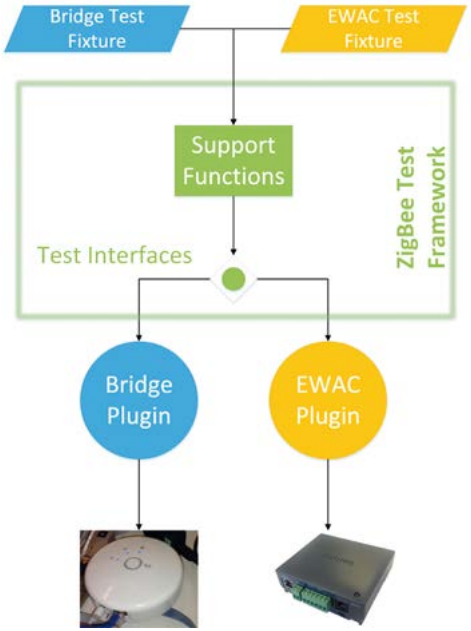
The Hue Bridge and EWAC plugin have been developed and deployed into its test environment for functionality validation. The Hue Bridge plugin deployment results show 96% of 1674 tests run successfully. The configuration tree has been designed for dynamic width and depth requirements.

Benefits

The plugin architecture decouples the development of device abstraction and its test fixtures. This allows the exchange of resources such as test engineer and test infrastructure, i.e. plugins and test fixtures among different development teams.

Minh Tat Bui PDEng

ZigBee Test Framework



"Minh has shown the 'branched' teams that their products can be tested using a common test interface by providing them with reference implementations for their products. Minh has played a major role in the redesign of the configuration subsystem, so that in the future teams can work with a common structure configuration file."

ing. H.T. Hurenkamp
Philips Lighting

At Philips Lighting a single code base for ZigBee device testing has been evolving to different branches for the last six years. The diversity of different test frameworks among six teams causes difficulty to maintain and exchange the test infrastructure between teams. This project aims to build up one re-usable test framework.

One test framework

We build the test framework based on *layers architecture* with three layers: device abstraction (so-called plugin), common test interfaces/support functions and test fixtures. Furthermore, we employ the plugin architecture using C# reflection to allow *plug-and-play* functionality of the device abstractions into different test environments.

One configuration submodule

The test configuration submodule is a support function, which provides all the required information for testing setup. This submodule has been redesigned to support re-usability and flexibility. The configuration interfaces can be re-used, which allows different implementation to adapt to different configuration requirements.

Challenges

The main challenge of this project is designing a modular, extensible and user friendly simulator for scheduling of tasks in the Spark framework. Research on scheduling of resources in large leased cluster machines is expensive and resource consuming. Additionally, processing applications on large datasets (big data) without proper configuration settings might consume hours or days.

Results

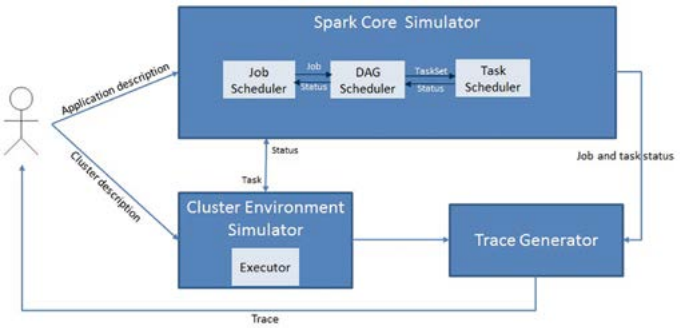
This project delivered an extensible and modular architecture design and an implementation prototype verifying the design. The Spark simulator has three main modules; namely simulation of a cluster, simulation of Spark deployment and simulation of application submission and scheduling. Cluster simulation creates a simulated cluster environment with specified virtual nodes. Those virtual nodes have memory and processor specifications using a cluster configuration setting. Spark deployment simulation is responsible for the selection of master and worker nodes as well as initializing master and worker processes. Application submission and scheduling simulates submission of an application and allocation of cluster resources to the application. Additionally, the task scheduling simulator submits tasks to cluster resources based on the default configuration.

Benefits

The Spark scheduling simulator project gave an insight into the challenges and opportunities in designing a full-fledged Spark simulator. Furthermore, the design and prototype artefact with basic functionalities support the ongoing research on resource scheduling. This simulator and architectural design will be used as initial basis to extend the simulator with more functionalities of Spark framework.

Girmay Teamrat Desta PDEng

Design of Spark scheduling simulator



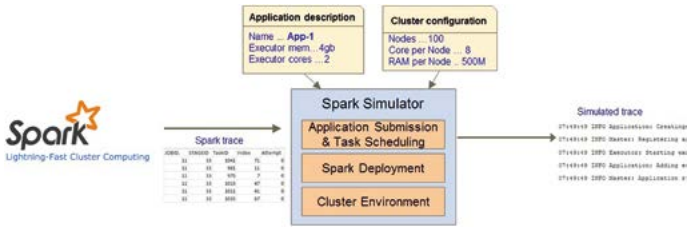
"The prototype Spark simulator developed by Girmay contributes to our research on resource management in clusters by eliminating the need for physical access to these clusters. Thus, it not only allows us to determine a proper configuration for Spark off-line, but also facilitates scalability experiments that on a real cluster are very costly and time consuming. For his simulator, Girmay had to study the open source Spark implementation, which is a very compact and difficult to grasp code. He did this in an admirable way".

dr. R.H. Mak
Eindhoven University of Technology

With the abundance of data flowing among communicating systems and storage disks, the gigantic amounts of data from sensors, machines and other sources brought the concept of big data. Examining large and complex data for hidden patterns, unknown correlations and extracting useful information for decision making is possible with the help of big data analytics frameworks. One of the big data analytics frameworks, Apache Spark, is a general purpose cluster computing engine that abstracts distributed storage and provides faster computation mainly for interactive queries and machine learning. Spark has many configuration parameters that help efficient utilization of resources and influence performance of application execution.

Research on clusters is expensive and time consuming especially for processing large size data. The solution for minimizing cost and time is having a simulator that can mimic the behavior of Spark scheduler, which is the main objective of this project. In this project the Spark standalone mode is considered. In this mode Spark works in a client-server fashion, where a single master is appointed for an application that manages the workers within the Spark cluster.

The Spark scheduling simulator uses Spark configuration settings in addition to a cluster configuration. The configurations are used for simulations of cluster definition, Spark deployment and application submission. Spark trace data is used for the simulation of task scheduling. Task scheduling takes place to simulate distribution of tasks for execution in the simulated cluster resources.



Challenges

The challenges in this project were mainly two. Firstly, the need to form a concept model from an architecture candidate was crucial, and adding to that, how to model the reliability aspects on that. The second challenge derived from the first, since we needed an environment where all the modeling should be handled. The framework should support evaluation of functional and non-functional requirements with focus on reliability. It should be possible to do a first quick analysis of possible candidate architectures.

Results

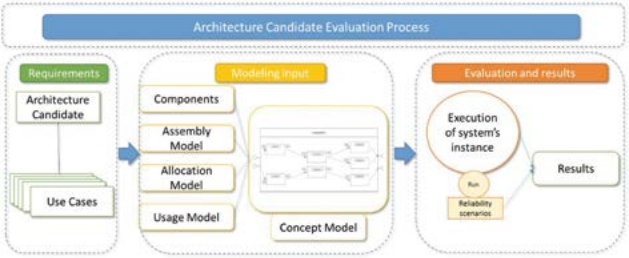
The result was that we succeeded to model a concept model from an architecture candidate in order to provide it as input to a system and run test scenarios on reliability to get performance measurements. The more detailed the input model, more reliable the outcome of the simulation runs. However, there should be a limit on the abstraction level of details. Too many data require tremendous amount of resources.

Benefits

The emphasis on creating a concept model enforced architects to be concrete and specific about architecture candidates at an early stage of the design. Furthermore, they can actually design a model inside the proposed tool, where the behavior of the system is described. Finally, the analysis of the results is done on visualized graphs, where comparison of different candidates are shown.

Konstantinos Filippidis PDEng

A method and a framework to evaluate software architecture based on reliability criteria



"The learnings of the project is that it is not only about the tool, but by modelling the architecture like this, the architects are enforced to get information on the table on system usage and resource needs to do a better evaluation. Konstantinos expressed that to us and to the stakeholders many times."

ing. H. Stevens
Philips Lighting

Philips Lighting is moving from a lighting component business towards lighting solutions business in professional environments offering lighting solutions for energy saving, productivity and effect creation. In these solutions networked based systems are essential and software makes it possible to add intelligence into the system. Reliability aspects at system level are getting more important and architectural analysis is done during brainstorm sessions to evaluate possible system architecture candidates on reliability criteria. It is crucial that the reliability of the architectures is evaluated more formally based on a model of each of the architectural candidates. A method is required that predicts the reliability and other non-functional criteria of the architecture candidates.

The foundation of the project consists of three basic concepts: software architecture, software reliability and component based software systems. In order to evaluate an architecture candidate a clear understanding of them is necessary. Furthermore, it was very important to have a simulation environment, where a concept modelling of each candidate could be drawn.

The solution centered on defying and setting up a framework for analysis of architecture candidates within the lighting domain. The framework should support:

- method to evaluate the proposed architectures using identified components
- adaptation of properties in the model based on non-functional requirements
- execution environment to run (repeatable) test scenarios for reliability as an objective judgment of architectures.

Challenges

The main challenge of this project was to build a number of people predictor model relying on fixed camera sensor count data. The challenge originated from one dimension of the camera which is the count of people leaving the street was incorrect. It was required to correct this data by looking the data itself which was not straight forward.

Results

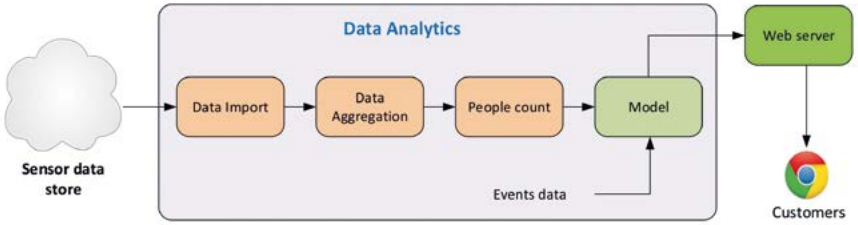
The following results were achieved from this project. First, the noisy data were fixed and processed to determine the number of people in every hour. Secondly, using the number of people as history, weather information and public and social event information the number of people predictor model was implemented. Finally, visualization tooling was implemented to access the predicted result.

Benefits

The result of this project could attract number of potential customers. Bar and restaurant owners in Stratumseind could benefit from optimizing the food and drinks, logistics and storage based on prior information on the number of people that will visit the street. The municipality of Eindhoven could benefit from estimating the amount of resources needed to keep the street clean. Hospitals could also optimize the medical resources needed for alcohol based incidents. The police may allocate the required number of personnel and resources to keep public safety. Moreover, the tools developed in this project can be used to implement other related smart city services.

Weldebrhan Gebrezgabher PDEng

Smart City Data Analytics for predicting number of people in Stratumseind



"In the end, Welde designed and trained a predictive model relying on the fixed data to predict the number of visitors to Stratumseind one week ahead. His solution was demonstrated during the EIT Digital showcase in Helsinki and received very positive feedback."

dr. M. Holenderski
Eindhoven University of Technology

Nowadays, cities are facing major environmental, mobility and public safety challenges. In order to address these challenges companies and technology providers are working to create smart city services. Data driven innovation is one of the techniques used to provide smart city service solutions.

EIT Digital under its smart space department is cooperating with Eindhoven University of Technology, Philips Research and STMicroelectronics to implement Smart City Sensing Platform that includes developing embedded sensing units to collect data from environment, data analytics to process the collected data and implement the use cases and visualization to provide result to end users.

In this project the number of people predictor model is implemented to forecast the number of people one week ahead in a pilot street called Stratumseind. All entry and exit points of the street are monitored by camera sensors to count the number of people coming to and leaving the street. The collected data from sensors along with public and social event information and weather data were used to build the predictor model. Finally, predicted results are accessed using web browser.

Challenges

The main challenge of the project was to improve the processing capabilities of the visualization tool to support processing big data without adding additional configuration dependencies on the tool. Another challenge was to understand process mining techniques and apply them to an event log of UWV.

Results

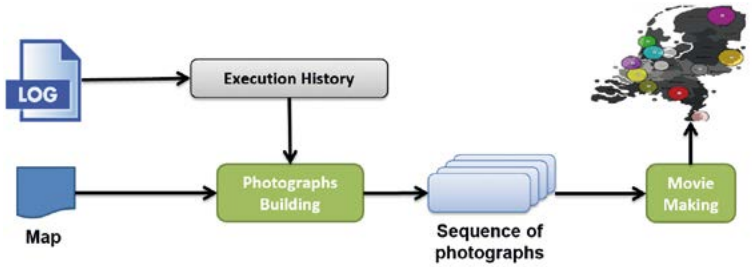
The result of the project was achieved in two-fold. First, improved the scalability of the tool by 10 times. It includes reduction in computation time and the memory usages on a laptop equipped with an Intel Core i7 Processor at 2.20 GHz. An evaluation conducted on UWV data conforms to the expectations of the analysts.

Benefits

The process movies produced by the visualization tool helps business analyst to quickly gain insights about business processes through time from different perspectives using different type of maps in an interactive way. The extended visualization tool with its new features provides an easy way for the business analyst to diagnose various business processes.

Neha Gupta PDEng

Interactive visualization of business processes



"Neha has contributed to extending the functionality and improving the processing speed and capability of handling large amounts of data of a Process Mining tool. Her work is highly relevant since it provides UWV the framework to monitor and analyse processes in a detailed and user friendly way. We thank her for her enthusiasm and wish her all best in her future career."

ir. M. Dees
UWV

UWV is the Social Security Agency of The Netherlands. It is responsible for the implementation of employee insurance such as unemployment benefits and sickness benefits in the Netherlands. To manage their services UWV stores a huge amount of data in their information systems. For example data is recorded while applying for an unemployment or sickness benefit. The managers of UVW want to know the steps of execution and potential scope of improvement in the business processes.

In the context of business processes the analysis of data Process Mining techniques are used to gather meaningful information. Process mining allows extraction of knowledge about business processes from the event logs. In process mining there is a visualization technique called "Turning event logs into a process movie". This technique enables a process/business analyst to replay and visualize the behavior of executed events as recorded in the logs. The LogOnMapReplay is a visualization tool that provides this functionality. The tool is realized in the Process Mining open-source (ProM) framework. UWV is interested in analysing the event logs of its customers on LogOnMapReplay visualization tool. The usability of the tool is limited due to three primary constraints namely memory consumption, missing basic functionalities such as filtering and comparative analysis and manual input file creation.

The focus of this project is to improve the capabilities of processing big data and add new features in the LogOnMapReplay tool. To achieve the project goal the processing capability of the tool is improved multi-fold including reduction in memory consumption. New functionalities such as event and attribute based filtering and comparative and differential analysis are added. A new tool for automatically generating the input map file is developed as well. The results from the process movie generated by the tool are verified against the existing UVW data in correspondence with the business analysts. The evaluation supports the initial findings of the business analysts and provides crucial insights to UVW.

Challenges

ASML Metrology Department produces a vast amount of Machine Diagnostics Logging (MDL) data for recording the behavior and performance of the lithography machines. The main challenge of this project was to create a model for representing the Metrology domain knowledge and to utilize this model for interpreting the MDL data. Due to the lack of context information in MDL it was hard to associate the fragmented data to the domain model.

Results

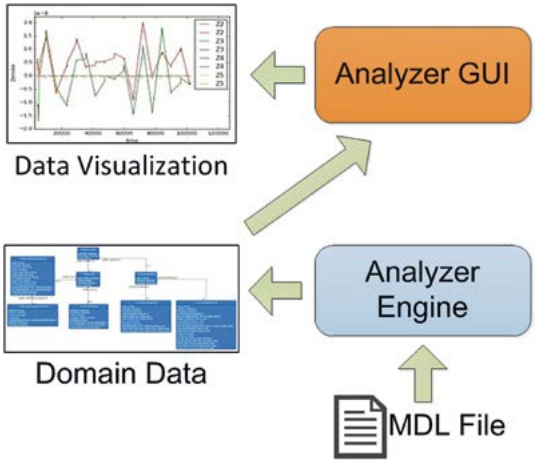
This project serves as a proof of concept for applying the domain-driven approach in designing diagnostic tools within ASML. The main results are a sub-function domain model, and a Domain-based MDL Analyzer prototype that utilizes this model for analyzing the MDL data. This prototype is designed to be easily extensible with other domain models, which paves the way for future adoption of it in the whole Metrology Department.

Benefits

With the Domain-based MDL Analyzer the analysis of the MDL data becomes more efficient and intuitive. The fragmented data is assembled and presented in the way that the domain experts can easily understand. Furthermore, this tool greatly reduces the cost and time required for future maintenance and extension.

Hang Liu PDEng

Context-rich and Domain-based Machine Diagnostic Logging Analyzer



"Hang distilled the metrology domain knowledge into fresh context-rich software architecture and, in addition, he implemented the domain-driven MDL Analyzer Tool as a proof of concept. We thank Hang Liu for his excellent contributions and we are glad he will work with us in making the metrology software in future."

ir. K. Maoju Wu

ASML is the world's leading provider of photolithography systems for the semiconductor industry. These complex machines involve extreme movement of the hardware components with nanometer accuracy, which cannot be achieved using mechatronics alone. To help achieve this the Metrology Department develops and maintains models, functions and system software, which are used for measuring and correcting the mechanical inaccuracies in the machines.

In the past years due to the increasing complexity of the ASML machines many diagnostic tools have been developed in the Metrology Department for analyzing the Machine Diagnostics Logging (MDL). In general these tools suffer from two issues: low extensibility and low maintainability. These issues are caused due to the legacy software architecture of these tools. They not only lead to unnecessary cost and time, but also can result in unmaintained or abandoned tools, which is a waste of investment for the company.

The solution was to design and implement a Domain-based MDL Analyzer tool. It adopts the Onion Architecture pattern for creating a domain-centric architecture, which includes a domain model for capturing the domain concepts and their relationships. This architecture decouples the domain knowledge from the technology-dependent implementation, which helps to improve on the above-mentioned issues. In addition, Domain-Driven Design (DDD) is applied, which defines a collection of principles, patterns and guidelines that help craft the domain model.

Challenges

There are many technical challenges for building an interactive 3D object rendering application from scratch. For this project two important factors to be considered are: performance of the application as the object is complex and development time as the trainee has only nine months. Based on these factors an investigation of WebGL, Unity, and other game engines was made to decide which one was most suitable for this project.

Results

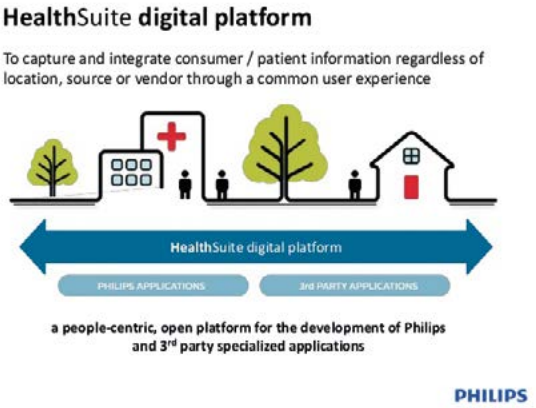
The interactive application is developed from scratch using the latest version of the Unity game engine to import and render the 3D object. The timeline is developed using the D3 Javascript library and SVG elements of HTML Five. The timeline application can interact with the 3D rendering application by getting a reference to the Unity web player object and sending messages to game objects.

Benefits

The developed prototype serves as a starting point for further development in the field of 3D object visualization. Furthermore, to some extent it can be used by Philips Design to demonstrate the capabilities of the project vision. It has also got a lot of interests from Philips businesses.

Duc Luu PDEng

Visual Patient Records



"Over time Duc grew in his role as an advanced software developer, he showed confidence, initiated many activities and fully supported the project. He was very successful in all aspects from developing the software to building the interactive demo, working in a multi-skilled design team and writing clear and to the point reports."

J. de Bont
Philips Design

Philips Design, which is headquartered in Eindhoven, is a global design agency that provides design services to two sectors of Philips Royal N.V.: HealthTech and Lighting. Philips Design has many teams in Amsterdam, Andover, Atlanta, Eindhoven, Hong Kong and Singapore. In Eindhoven the Philips Design Team is involved in the very early stages of new business development to explore innovation and opportunities.

Typical questions studied are "What will life be like in 2025?" and "What will interest human beings and make their lives healthier and happier?" Philips wants to lead and shape the future in a way that new developments in technology can be deployed to improve the quality of people's lives, for instance their living spaces and clinical care.

The project is being initiated by the Philips Research genomics team in Briarcliff, USA. The project owner is Nevenka Dimitrova. The idea for the PaPaYa vision project was developed in several workshops led by Jeanne de Bont - Creative Lead Data Design Team of Philips Design. It is a highly confidential project for Philips in healthcare domain. The main goal is building an interactive 3D rending application on top of a game engine. Users can use the application to turn on or off layers of information. Users can also browse events in a chosen case study in the New England Journal of Medicine. A client-server architecture is chosen as it makes the application easy to be integrated with other web services or applications, especially with the Health Suite Digital Platform (HSDP) in the near future.

Challenges

The challenge in this project was to reengineer a complex large codebase. The codebase has more than 3000 classes. An efficient visualization was needed to represent the codebase. In addition to that, the improvement should not ruin the codebase that is already working well. The design should be relatively simple to implement since complicated steps tend to break the working codebase.

Results

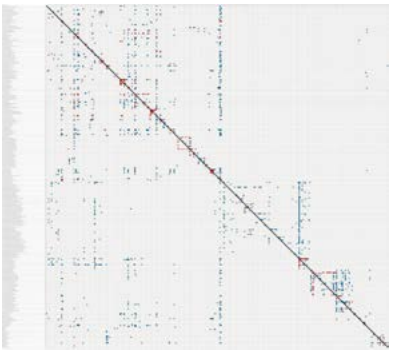
The result was an improved structure of the codebase. Furthermore, a plugin that can keep (static) software architecture clean was established. It can trigger awareness to software developers if they fail to keep the structure nice and clean. This plugin could be used in daily development since it is installed in the Integrated Development Environment (IDE). It can produce real-time warning in the code as the developers type even before they have finished the line.

Benefits

A modular architecture allows the complex codebase tolerant of flexibility against future modifications and welcomes experimentation in the modules. Modules could be changed and improved over time without undercutting the functionality of the system as a whole. In addition to that, the modularity enables the parallel work and eases the maintenance effort.

Lindung Manik PDEng

Modular Software Architecture for YieldStar's High Accuracy Critical Dimension Metrology



"Lindung helped us investigating the current state of our software to get insight and to create a baseline measurement of the quality of our codebase. He suggested changes to the current architecture that better reflect our software structure. He also investigated several methods to get insight into existing modules and interactions between different parts of the software. He helped us getting our software ready for the transition to high quality software that is able to fulfill our customers' high quality demands and offers the flexibility in developing new features."

M. Häberle
ASML

A large and complex codebase is evolving. It tends to be large networks of interrelated modules. Maintenance and change management become big problems. Failing to keep the structure clean can cause various maintainability problems. A nice and clean modular structure is needed to improve maintainability. It makes the codebase easier to understand and to maintain. This project was created to provide a proof of concept for the modularity improvement of the large complex codebase.

Static analysis was performed in order to grab first insight of the codebase. The designed solution used the Dependency Structure Matrix (DSM) as the visualization tool. Two strategies were designed to improve the structure, the restructuring strategy and the refactoring strategy. A clustering algorithm that is applied in the DSM was also implemented during the restructuring to make the improvement process partly automated. As a result an improved subdivision was proposed. The implementation of the new proposed structure improved the software flexibility. The structure can accommodate more varied and complex use cases.

Along with the designed solution, future works were also addressed. The transition steps to the new structure were planned. The impacts and the risk of the improvement that could complicate the migration were also spotted. Furthermore, live checking tools that can ease the migration efforts were identified. These tools could be used during the transition in order to keep the structure nice and clean.

Challenges

One of the challenges of this project was to analyze the guidelines and provide a model that will represent the information correctly and serve as a basis for development of decision support tools. Another challenge was to select appropriate visualization techniques that are easy to understand and use as well as at the same time provide valuable feedback to end users.

Results

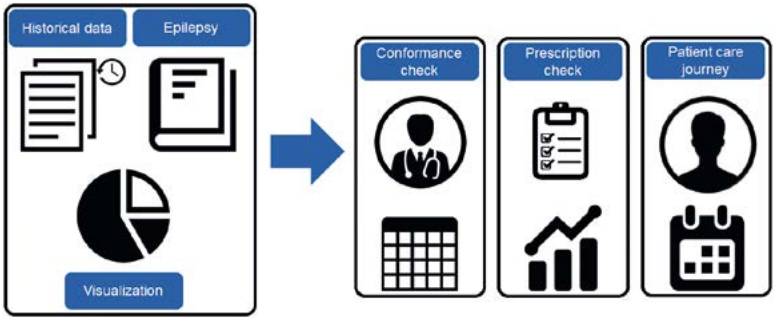
The main result of the project is analysis and interpretation of epilepsy-related information, channeled via a prototype of a web-based system that utilizes visualization techniques to convey the information to end users. The prototype developed provides decision support tools for checking conformance of doctors' prescriptions against the epilepsy guidelines, checking of future prescriptions for conformance and patient-specific applicability and exploring patient's care journeys with epilepsy.

Benefits

The prototype proves that historical data can be used to provide feedback that will directly or indirectly improve epilepsy care. Combined with data visualization users can interpret the information more easily and timely, thanks to the clear data representation. By using the provided tools, users (primarily doctors) can learn from their past to improve future treatments.

Trajche Masinov PDEng

Web-based visualization of guidelines and drug use in epilepsy



"Due to Trajche's very intelligent reasoning and tactical attitude towards the health care professionals he succeeded in his mission without using too much the language of an information expert. Furthermore, he showed much flexibility to adapt to doctors' wishes that are not always logical. Thanks to him we now have a very attractively looking prototype epilepsy program that allows us to give feedback to individual doctors and groups of doctors or other interested parties."

prof.dr. J. Arends
Kempenhaeghe

Kempenhaeghe is a leading center of medical expertise in epilepsy, sleeping disorder and neurological learning disabilities. Epilepsy is a chronic brain disease with unpredictable recurrence of seizures. It is not a curable disease and the treatment for it is long and often difficult for the patient. That is why improving patient's care is of great importance to Kempenhaeghe. A solution was needed that will provide healthcare professionals with the tools that improve epilepsy care.

As a leading center Kempenhaeghe has almost a hundred years of experience. Throughout these years more than 30,000 patients have been treated and different treatments have been applied. In the last forty years, in parallel with the evolution of the computer, Kempenhaeghe has gathered a vast quantity of data regarding epilepsy treatment. In parallel to this rules and regulations have been devised in the form of epilepsy guidelines. The goal of this project was to utilize this information and produce insights that will guide caregivers in making better future decisions. All these insights derived from the data represent nothing if they are not properly delegated to the end users in a way they immediately understand. The use of data visualization was another goal of the project as a way to convey information to end users.

A solution was developed that provides doctors with tools that directly or indirectly improve epilepsy care by providing feedback and decision support based on historical data. The tools are supported by visualizations that provide the user with immediate data interpretation.

Challenges

The main challenge of this project was designing a generic and at the same time an extensible Data Model for storing data from multiple and yet different game types. The challenge in the design process emanated from the lack of crisp understanding of the domain concepts associated with different games/apps since each game or app models the domain differently. Furthermore, some of the technologies used within this project were not fully mature resulting in difficulties in making good design decisions. There were yet a few technologies, which I had to develop an understanding before utilizing them in the project.

Results

Three main results were achieved in this project. First, generic and extensible Data Model was defined. Secondly, an extensible, RESTFUL backend was developed. Thirdly, a number of game integration efforts were realized based on the first two results.

Benefits

Any third party application developers can now easily integrate their app into the GameBus platform for any type of app related to physical, social and cognitive activities. The apps integrated into the platform demonstrate that the new integrations are much easier and smooth. Since the code has been improved based on the feedback, issues encountered during prior integration efforts. In addition to that, the integration process has been documented well, which reduces the help required from the GameBus staff. This will dramatically reduce the integration time and cost of making new integrations. On top of all that, GameBus provides a unique, integrated experience for a player and eliminates the needs and issues associated with the concept of having different apps and combining their data.

Chan Naseeb PDEng

Software Integration between external Game APIs and the GameBus repository

"Chan has delivered a usable backend in which he showed that he realized the integration of three different apps/ games. In this, he has demonstrated two properties that will be very fruitful in his further career:
1) the ability to create real life integration and a backend as well as
2) the perseverance to learn and master new skills and technologies.
Chan has booked quite impressive results for the GameBus project.
I am happy that he wanted to finalize his technical work with pride."

dr. P. Van Gorp
Eindhoven University of Technology

Software integration is a challenging landscape, this is due to many different factors.
The primary element for this integration process is a Data Model which can capture and store data from different apps, where each one is made for a different purpose. GameBus aimed to integrate different apps covering physical, social and cognitive well-being of people.

All those different apps offer different capabilities and store data in a different format. Accordingly in an integration effort we need to come up with such a generic data model which can tackle each game specialty. Developing and maintaining separate data models for each game is costly, time consuming and almost impossible.

This project was aimed at defining a generic and an extensible data model. Based on the generic data model, development of an extensible GameBus platform was also a key requirement. The GameBus platform was built on top of the data model.

To capture the player data from different apps, business logic was implemented including the transformation of the data into the required format. Business logic further included realizing services which could enable different challenges and rewards capability. On top of the BL layer, REST services were realized to enable storing and retrieval of the players data.

Challenges

The main challenge of this project was reverse engineering the existing system which lacked test support and documentation. Furthermore, requirements were not clear about the test support. It was a challenge to address various issues like lack of documentation as well as test support and testing web application together in one requirement as test support.

Results

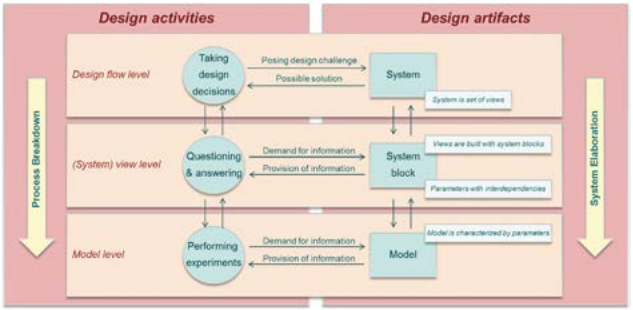
Two main results were achieved in this project. First, architecture evaluation and refactoring of the existing Design Framework tool was achieved. Several redesigning techniques were applied to achieve this goal. Code size and database size were significantly reduced. Secondly, test support for the further development of the tool was provided. Behavior Driven Development (BDD) approach was applied to provide test support, which was able to address both issues of lack of documentation and lack of test cases.

Benefits

TNO-ESI has adopted result from both milestones. New refactored system has made the tool more maintainable and understandable. Provided test approach has made the tool more robust and will be helpful for the future developers. Use of Behavior Driven Development approach has increased shared understanding, coupled requirements as well as tests together and finally made it easy to write test scenarios.

Navaraj Neupane PDEng

Design Framework: Redesign and new multi-user and testing support



"Navaraj has tackled the challenges presented to him individually and together with Arash as a team very successfully. The result of their architecture evaluation and refactoring was implemented shortly after that part of their assignment was finished. The second part was about providing testing support and his much needed solution is already being adopted by the tool developers at TNO-ESI. We are very happy with the result."

ir. H. Moneva PDEng
TNO-ESI

The use of models to conceptualize systems is an important part of the process of building Cyber Physical Systems. While designing such systems, which in general is a multi-disciplinary activity, multiple designers are involved in the design decisions. Those decisions most likely are not captured and eventually forgotten after a period of time. The Design Framework is a visual modeling tool that aims to help architects and designers to documents the design rationales besides the design artifacts. It also helps them to collaborate to design a system together in a multidisciplinary environment.

The Design Framework was at the level of a good prototype, but it was not ready for operational application by end-users in industry. One of the main issues with the Design Framework system was a sub-optimal code structure due to the lack of proper design and development approach.

The goal of the project was to reverse engineer the current design of the Design Framework and to come up with a new design. In order to maintain a system in use, presence of a test framework is necessary. Since the Design Framework is used in a multidisciplinary environment, an improvement in the multi-user support of the system is also needed. In the first part of the project the Design Framework was redesigned. To redesign the Design Framework a number of refactoring techniques were applied. As a result the code complexity was reduced and hence the maintenance was increased. The second part of the assignment included multi-user support and testability. The Design Framework manages the changes to design descriptions and maintains the history of the design artifacts. In this respect it operates similar to version control systems. Some multi-user features are improved and developed. A set of unit tests and end-to-end tests including the test for multi-user support were implemented using Behavior Driven Development approach. The provided test sets and the approaches used to setup test environment made the Design Framework more stable and maintainable.

Challenges

The main challenge in the refactoring part was controlling the process. Since the Design Framework is designed with a multi layer architecture and the codebase is of medium size, the first question to answer was to determine how the process could be broken down.
The challenge in the multi-user part was to clarify the requirements based on vague initial statements.

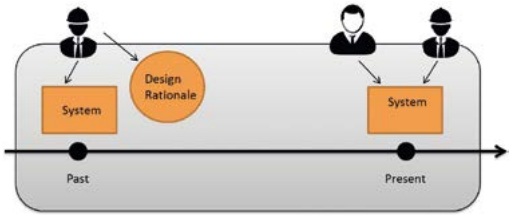
Results

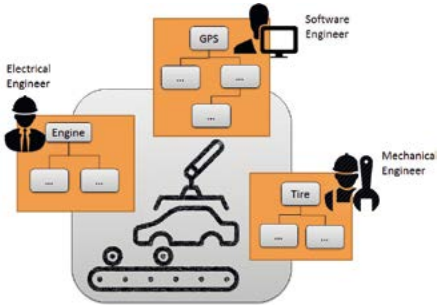
Quality metrics which are used to measure the quality of the code are the number of lines and cyclomatic complexity. After the refactoring part the number of lines were reduced by 25% and the cyclomatic complexity was slightly improved. In the multi-user part the requirements were engineered and a number of flaws in the current multi-user support were detected. A new model for the version control aspect of the Design Framework was proposed and improvements were made on the legacy code.

Benefits

The result of the refactoring part was used in the main product line and it was reported to bring up some hidden issues to attention. In the multi-user part few synchronization issues were found and some new perspectives were explored for future development of the Design Framework.

Arash Shafiei PDEng





Design Framework: Redesign and new multi-user and testing support

"Arash has tackled the challenges presented to him individually and together with Navaraj as a team very successfully. The result of their architecture evaluation and refactoring was implemented shortly after that part of their assignment was finished. The second part was about redesigning the multi-user concepts and functionality of our tool. His conceptual thinking and prototype brought a lot of insights to us at TNO-ESI. We are very happy with the result."

ir. H. Moneva PDEng
TNO-ESI

The Design Framework is a visualization tool for designers of embedded systems. What makes the Design Framework different from other visualization tools is its ability to capture the design rationales. In the process of system design, designers take implicit and explicit design decisions based on some rationales. Therefore the Design Framework not only stores the design artifacts but also the design decisions. The Design Framework is also able to handle multi-users when different designers are working on the same project.

Since the Design Framework was still at a prototype level when the project was kicked-off, there was a need for refactoring the code. One part of the project was therefore defined to refactor the code. But in order to refactor the code a good testing environment must be in place. This is where another part of the project comes in; investigating on how the Design Framework can be tested. As the Design Framework is designed for multi-users, it is essential that multiple users can easily access and work together. Another part of the project which was done in parallel to the testing part was to investigate on different approaches to improve the multi-user functionality.

The project was conducted partly in a group and partly individual. I was responsible for the refactoring part as well as the multi-user part.

Challenges

First challenge was to handle the various data formats from different data source providers. Second challenge was to identify the number of influential features from the data sources. Third challenge was related to the business domain and technological use, where the business world has to be modelled. The model should be constrained from predicting burglaries on a non-feasible region. Fourth challenge was to address the increasing volume of data and computational load.

Results

The result of the project is a prototype implementation of the system, which could predict burglaries at a given location in a specified time duration. The output of predictions are plotted on a map. The system deliverables include a simple GUI to interact with different modules of the system.

Benefits

A concrete proof of realization through the prototype implementation. The prediction results could be used to advise preventive measures to a specific group of customers to avoid burglary and hence increase the revenue by reducing claims. The results could be used for better human resource deployment by the Police. The system components are highly cohesive and independent to be used for devising other inter-domain prediction systems.

Karthik Srinivasan PDEng

Predicting Burglaries and Other Incidents

"Great the way Karthik managed, executed and delivered this project. It helps Interpolis in her ambition to make the Netherlands safer. From the start Karthik's drive and creativity helped us to come up to speed with this project and its many stakeholders. He managed to quickly align all interest of the stakeholders and develop a system for predictive analytics. His system has inspired us to go ahead with this field of expertise and he has shown us a way forward in this challenging part of our business."

J.A.J.J. van Nieuwkuijk, J. Ringeling
Achmea/Interpolis

Achmea is a large insurance company that provides a wide range of financial services and products. Achmea has several brands as a part of the Achmea Holdings, Interpolis is one such brand. Interpolis is one of the largest insurance companies in the Netherlands. The company has gained wide recognition with its advertising campaign "Interpolis.Crystal clear". Besides financial compensation, Interpolis also offers compensation in kind. Prevention and Risk management are revenue enhancers by reducing claims. One of the focus areas are burglary claims reduction.

Predicting Burglaries and Other Incidents is a project to estimate the possibilities of burglary at a given location and time. The system uses data from different sources to create a probabilistic prediction model, which is used to predict burglaries. This is achieved by performing the following tasks:

- Making an inventory of required data sources.
- Creating a prediction model out of the data sources.

The result of this project is a proof of concept, which gives a concrete indication that the prediction of residential burglaries is possible. The accuracy of the prediction depends on various factors ranging from feature selection to model generation.

Challenges

The main challenge in this project was to learn fast quality measure standards and their suitability. The domain is vast, complex (requires deep understanding of clinical processes), multiple concepts included and many extensible options exist. Healthcare standards contain a high level of complexity and require extensive study in order to understand the fine details. As a result it was a challenge to come up fast with a proposed standard-based architecture during this limited time of nine months.

During this project we did not have access to HSDP or available APIs of it. As a result we had to come up with a flexible and decoupled architecture as well as data model which give insights of handling HQMF elements transforming them into platform executable queries.

Results

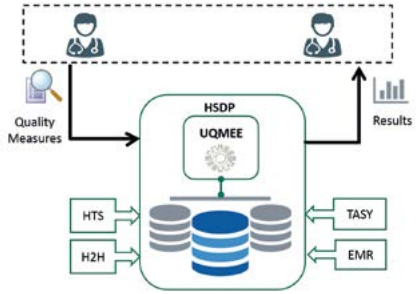
The result was to provide a modular architecture through a web application. This architecture will be used by Philips Research as input to HSDP team with whom Philips Research is closely working. This software solution is backward compatible to the previous releases of HQMF documents. In addition, it is tested in a relational data model using health elements such as encounters, patient characteristics, medications, diagnosis, procedures or costs.

Benefits

This project provides a standard-based solution highlighting the added value using quality measure standards. The development of such a module in HSDP allows multiple businesses inside Philips to provide quality measure dashboards to their customers. Furthermore, HSDP needs a scalable quality measure execution engine that could address needs of different business using HSDP.

Pelagia Sykoudi Amanatidou PDEng

A Unified Quality Measure Execution Engine (UQMEE) for Philips Health Suite Digital Platform (HSDP)



"One can only improve quality, if he can monitor and measure it. In the future quality measurement is going to be key in outcome driven healthcare delivery, evaluating performances of clinicians and efficacy of existing process based on evidence rather than feelings."

M. Asim
Philips Research

Healthcare delivery is shifting from volume driven care to outcome driven care (pay per visit, hospitalizations & tests). This has resulted in increased focus on quality and safe, effective, patient-centered, timely, efficient and equitable healthcare delivery. Quality measure is a quantitative tool to assess the performance of an individual or organization's performance in relation to a specified process or outcome via the measurement of an action, process or outcome of clinical care.

This project is focusing on the implementation of a quality measure execution engine using HL7 standards i.e. Health Quality Measure Format (HQMF). HQMF is standard for concise and unambiguous representation of quality measures, hence enable interoperable execution of quality measures and benchmarking. HQMF specifies semantics, data concepts and logic for representation of data and population criteria. UQMEE is envisioned as a common asset for HSDP due to its applicability for multiple business units of Philips HealthTech.

In this software solution UQMEE is a web application which provides the following capabilities:

- A clinician or quality analyst will be able to select a clinical or claims quality measure from a list of quality measures
- The system is able to generate a quality measure according to the HQMF standard. Clinician or quality analyst will be able to use a document quality measures in HQMF form
- A system is able to generate results of executing a quality measure in according to QRDA standard
- A clinician or quality analyst will be able to view the results of executing a quality measure via graphs and tables

Challenges

To reduce the complexity of software change and improve productivity, flexibility is required with respect to how data is handled in the TWINSCAN software architecture. Keeping proper coupling between domain and technology concepts was one of the most important design challenges in this project. To protect pollution of domain models with implementation details it is necessary that the repository generation tool decouples domain models from repository implementation and technology details. The repository generation tool must allow users to flexibly select from different flavors of repositories and technology choices.

Results

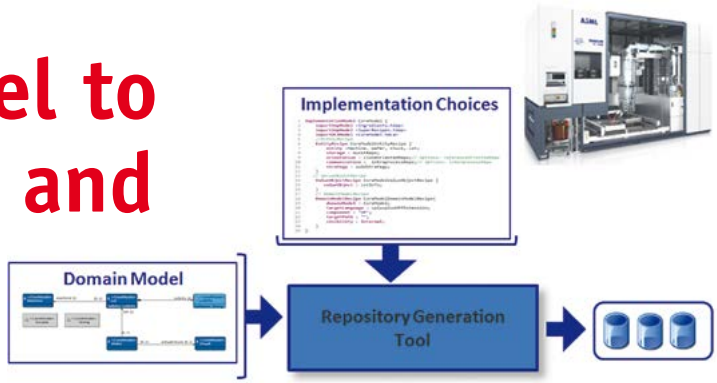
The result was a repository generation tool that is used to generate repositories from domain models. The tool consists of an Implementation Model Language that enables users specify choices of implementation patterns without polluting their domain models with implementation details. To maximize productivity and facilitate learning the Implementation Model Language and its syntax, the tool contains an Implementation Model Wizard capable of creating initial implementation models from domain models. To early discover errors in the implementation model before code generation, the tool is equipped with an Implementation Model Validation. This protects the tool from producing a code that does not compile or a wrong code that compiles. The tool consists of a repository generator component to allow generation of repositories from domain models based on the choices in their corresponding implementation models.

Benefits

This project has created an understanding about how feature extraction methods work in practice to detect and track vehicles, pedestrians, traffic signs and lanes. These methods were compared to each other with respect to their suitability and effectiveness in an automotive context. The comparison was carried out against challenging automotive images by using state-of-the-art datasets and evaluation methods. Lastly, data reduction and CPU load of the pipeline steps were analyzed for a possible smart camera chip solution.

Tesfahun Tesfay PDEng

From a data model to generated access and store patterns



"Though in general it is not advised to depend on the work of a student for a product that needs to be delivered in time to customers, we decided to use the work of Tesfahun within the context of an actual ASML project. The ASML team executing the project has put real pressure on Tesfahun. His flexibility and motivation have been stress tested as well as his product. The team is really satisfied and they are appreciating the benefits of the improved productivity. Large quantities of code are being generated now that otherwise would need laborious manual typing."

W. Alberts PDEng,
R. Koster PDEng
ASML

ASML is the leading provider of lithography systems in the world. These lithography systems are complex machines that are critical to the production of integrated circuits (ICs) or chips. The TWINSCAN system is the most important product line of the ASML lithography systems. The ASML TWINSCAN produces up to 200 wafers per hour. These wafers are 300 mm diameter and are exposed at 22 nm resolution.

The TWINSCAN system handles a huge volume of data. In the current TWINSCAN SW Architecture, data transfer is combined with control flow. Data transfer to a component that is not under the sender's control must be performed through a common parent in the hierarchy. There are several problems with this approach with respect to execution, encapsulation and locality of change. These problems drive the need to separate data, control and algorithms of the scanner's software architecture.

To tackle the data handling problems the main objective of this project was to design and implement a repository generation tool for generating data repositories from domain models. The tool is accompanied by a means to flexibly select from a set of repository flavors and implementation patterns, allowing the generation of an implementation of data repositories and access interfaces from a domain model. The structure of this data is defined by a domain model in an implementation independent formalism. As a result of the flexibility of the architecture it is possible to switch between different flavors of repositories, technologies and implementation patterns without touching domain models. This tooling support maximizes productivity and efficiency.

Challenges

The biggest challenge of this project was to provide a generic approach of indirect communication for all the hosts. This approach should allow a host joining the monitoring system easily. Previously, it was not easy for a host to communicate with other hosts on a private network.

Results

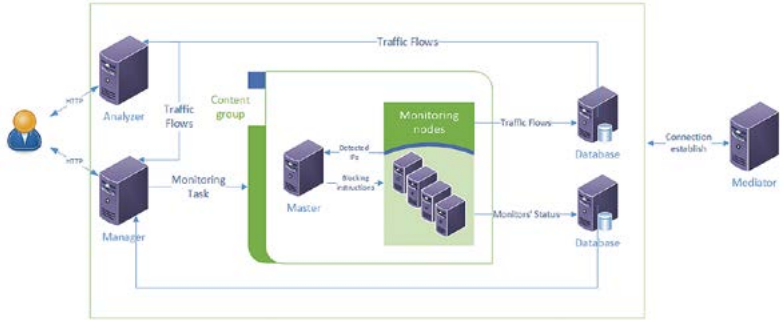
An architecture for monitoring P2P streaming was designed based on the existing system. A generic approach to solve the indirect communication problem for host components was designed. Currently a host can join a monitoring task easily using a protocol defined between a host and a mediator. The architecture was implemented and deployed in the company and Amazon EC2 environments.

Benefits

The design and implementation provided Irdeto an enhanced system that performs measurements of P2P traffic for an arbitrary system. It is also helpful for the content providers to understand the extent of the piracy of their content.

Jiazhuo Zhang PDEng

A Monitoring System for Peer-to-Peer Streaming



"Jiazhuo created a system that is capable of monitoring the audience of an arbitrary P2P system. By design the system may be easily deployed in a local environment as well as in a cloud, thus making the solution extremely scalable. The system has been verified by a series of tests in a life environment."

dr. D. Jarnikov PDEng
Irdeto

The Internet is a powerful platform to transmit multimedia content. People can easily access content such as movies, music or live programs. Content providers spend a large budget on buying the copyright for content and they provide the content to end users who pay for it. However, pirates do exist on the Internet and they redistribute content without authorization. The project aims to provide a solution to find out where these pirates are on the Internet.

Based on the analysis of the Internet multimedia delivery technologies we put focus on peer-to-peer streaming technology because of its cost-effectiveness and scalability for pirates. We selected a passive measurement approach to monitor both the transport and network layers for observing network traffic flows with a peer.

An architecture was designed for a system user to execute a monitoring task and store the detected traffic flows in databases. Based on detected IP addresses the system can present a geolocation visualization. Multiple monitoring nodes were deployed in the company and Amazon EC2 environments. The architecture provided a scalable solution for illegal service audience measurement and analysis.

Credits

Edited by:
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Software Technology programme
Eindhoven University of Technology

Text:
PDEng graduates of the Software Technology programme

Production:
Communication Expertise Centre,
Eindhoven University of Technology

Photography:
Rien Meulman Fotografie, Eindhoven

Design:
Grefo Prepress, Eindhoven

Printing:
De Digitale Drukker, Eindhoven

Erikos Alkalai PDEng; CPD Integrated Development Toolkit. **Favio Bettiol PDEng;** Using Scenario Based Programming to Develop Embedded Control Software. **Johan Bertrand Bonnemason PDEng;** Simulight: Creating a realistic real-time interactive simulation of a Lighting System by applying game technologies to industrial solutions. **Tom Boshoven PDEng;** Integrated Simulation in EUV Source. **Minh Tat Bui PDEng;** ZigBee Test Framework. **Girmay Teamrat Desta PDEng;** Design of Spark scheduling simulator. **Konstantinos Filippidis PDEng;** A method and a framework to evaluate software architecture based on reliability criteria. **Weldebrhan Gebrezgabher PDEng;** Smart City Data Analytics for predicting number of people in Stratumseind. **Neha Gupta PDEng;** Interactive visualization of business processes. **Hang Liu PDEng;** Context-rich and Domain-based Machine Diagnostic Logging Analyzer. **Duc Luu PDEng;** Visual Patient Records. **Lindung Manik PDEng;** Modular Software Architecture for YieldStar's High Accuracy Critical Dimension Metrology. **Trajche Masinov PDEng;** Web-based visualization of guidelines and drug use in epilepsy. **Chan Naseeb PDEng;** Software Integration between external Game APIs and the GameBus repository. **Navaraj Neupane PDEng;** Design Framework: Redesign and new multi-user and testing support. **Arash Shafiei PDEng;** Design Framework: Redesign and new multi-user and testing support. **Karthik Srinivasan PDEng;** Predicting Burglaries and Other Incidents. **Pelagia Sykoudi Amanatidou PDEng;** A Unified Quality Measure Execution Engine (UQMEE) for Philips Health Suite Digital Platform (HSDP). **Tesfahun Tesfay PDEng;** From a data model to generated access and store patterns. **Jiazhuo Zhang PDEng;** A Monitoring System for Peer-to-Peer Streaming.

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