# Thin[gk]athon: Sustainability in software development

Task setting

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## General Ideas

The goal of the Thin[gk]athon is to develop solutions for better integrating sustainability into the software development process. The following scenario is outlined for participants to evaluate using a template. Based on this evaluation, teams are expected to expand on the template and develop strategies for reducing the CO2e footprint of the described system during development. Reductions can be achieved in a variety of ways but must be sustainable and not short-term. Additionally, measures taken must be explained and assessed credibly, including the expected savings and underlying assumptions, with reference to relevant literature where appropriate. It is worth noting that the proposed measures need not be purely theoretical, and comparable practical examples may be used to illustrate assumptions.

## Tasks bound to the concrete scenario

The goal of the scenario is to standardize the context of the overall task to allow for comparable solutions during the Thin[gk]athon. In consultation with the mentoring team, participant teams may make modifications to the scenario. This includes the technology stack used for the two main components of the system – the sales units and the portal. However, it is important that their basic character remains the same. Therefore, it should be considered for example that a pure migration of the portal to a cloud infrastructure is associated with migration costs which might cause a rewrite of the whole system.

As a starting point for further investigation, it is assumed that the quality goals described in the "Quality Goals" chapter will be extended by an additional one.

| Priority | Attribute | Explanation |
|---|---|---|
| **Priority 2** | Sustainability | The software system and development processes must be designed to minimize its environmental impact by reducing resource consumption and optimizing energy efficiency |

The questions that must be answered for the Thin[gk]athon are:

- What is our current status regarding this goal?
  - Please use the given template for this.
- What changes do we need to achieve it?
  - Describe the changes and factor these into a second version of the given template which can and should be extended by your team.

## The Scenario “FotoMaX”

### About the Product

FotoMaX is a white label solution for ordering photo products. It enables retailers of various types to offer their own customers additional services, related to the processing and ordering of photographic content. This solution consists of two parts, the device hardware and software, which in their combination are set up at various partners as “Sales Units” or just “Units”. This document primarily describes the software and only discusses the hardware when it influences the software design significantly.

FotoMax does not take care of the actual printing of the orders. It provides the link between the companies that set up a sales unit in their stores and those that do the actual printing of the photo products. Based on the chosen version of FotoMax these could even be the same companies. The products are paid directly in the respective store or via mobile payment solutions.

In the simplest case, printing takes place directly in the store ("FotoMaX Standalone") or can be forwarded to a print shop ("FotoMaX Connect") to allow a larger variety of products like cloths, coffee cups or posters.

Typical points of sale:

- Supermarkets
- Drugstores
- Hotels
- …

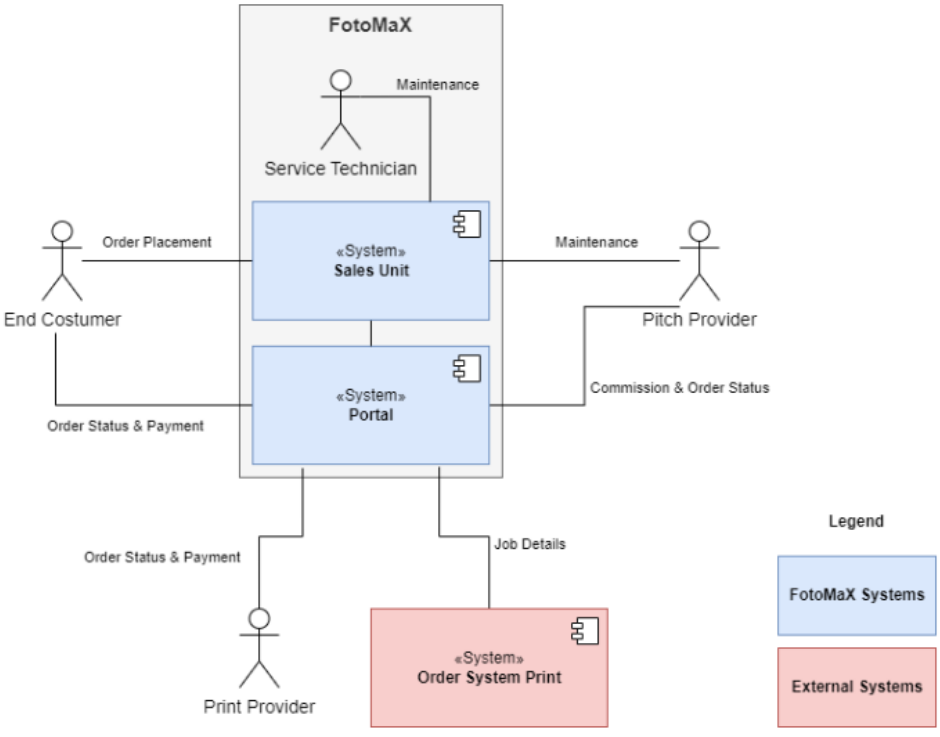
## System Scope and Context

In this chapter the system is delimited from its environment. This way user roles, external systems and the associated interactions, as well as the necessary interfaces are identified.

### Business Context

The business context describes the external dependencies of the software system from a domain-oriented perspective.

FotoMaX maps two different workflows: In standalone mode, all jobs are processed on the client's premises; in connected mode, jobs are forwarded to external print service providers.



| Designation | Description |
|---|---|
| **End Customer** | A person who uses photo printing services via a sales unit and can track them via the portal. |
| **Service Technician** | An employee of FotoMaX GmbH who performs initial submission and maintenance work on Sales Units. |
| **Pitch Provider** | An employee of the respective pitch provider who performs minor maintenance work on sales units. This includes replenishing printing paper and cartridges of the receipt printer or retrieving orders in standalone mode. In the Connected case, the parking space provider can view orders and check invoices. |
| **Print Provider** | An employee of the print provider who can view order data and modify orders. |
| **Sales Unit** | The hardware/software combination set up at a parking space provider to take orders from end customers. |
| **Portal** | Customer and partner portal via which orders can be tracked. |
| **Order System Print** | The external system of the print provider to which print orders are forwarded. Each print provider can be expected to have its own system. |
| **Billing System / Printing Site** | The billing system of the printing site provider, via which print jobs are billed. |

*Standalone Setup*

In standalone mode the sales unit is only connected to a local printer and has no internet connection. All orders are processed and paid for within the premises of the pitch provider. The supplier rents both the sales unit and the printer from FotoMaX at a fixed monthly rate. In addition, consumables such as ink and paper are billed according to usage. In addition to printing the ordered items, the sales unit also prints a receipt, which has to be paid by the end customer at the checkout of the pitch provider. FotoMaX is not involved in the actual billing process.

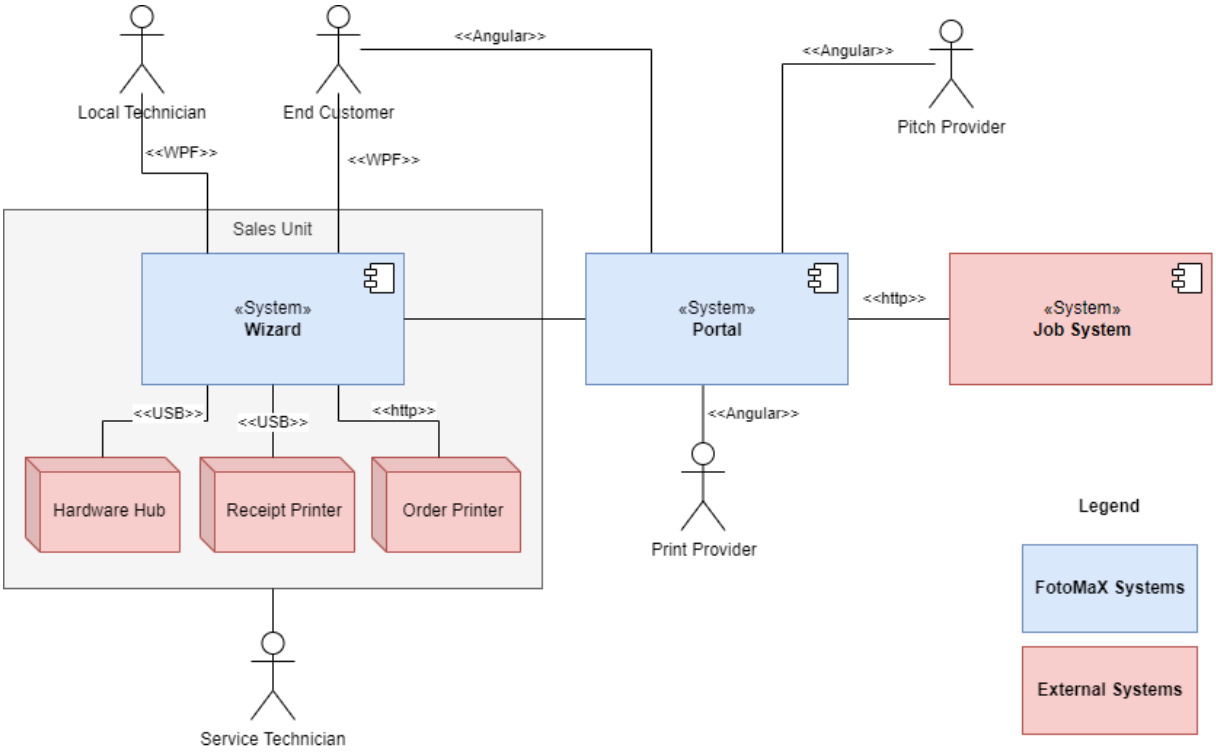
*Connected Setup*

The connected setup allows end customers to place more extensive orders and track them online. In addition, the orders are not executed exclusively on the premises of the provider's premises, but also at a corresponding print provider on additional products such as mugs, t-shirts or similar articles. In a partially connected setup, the billing is done by the pitch provider.

In a full connected setup, the orders are then either paid for by EC or credit card at the device or the customer receives an invoice via e-mail. In this case, the pitch provider is not involved in the billing of an order, but receives a fixed monthly stand fee, and commission on all sales. They can view their earnings at any time via the portal.

## Technical Context

The technical context highlights the technical environment in which the software system exists and the respective interfaces to external systems.

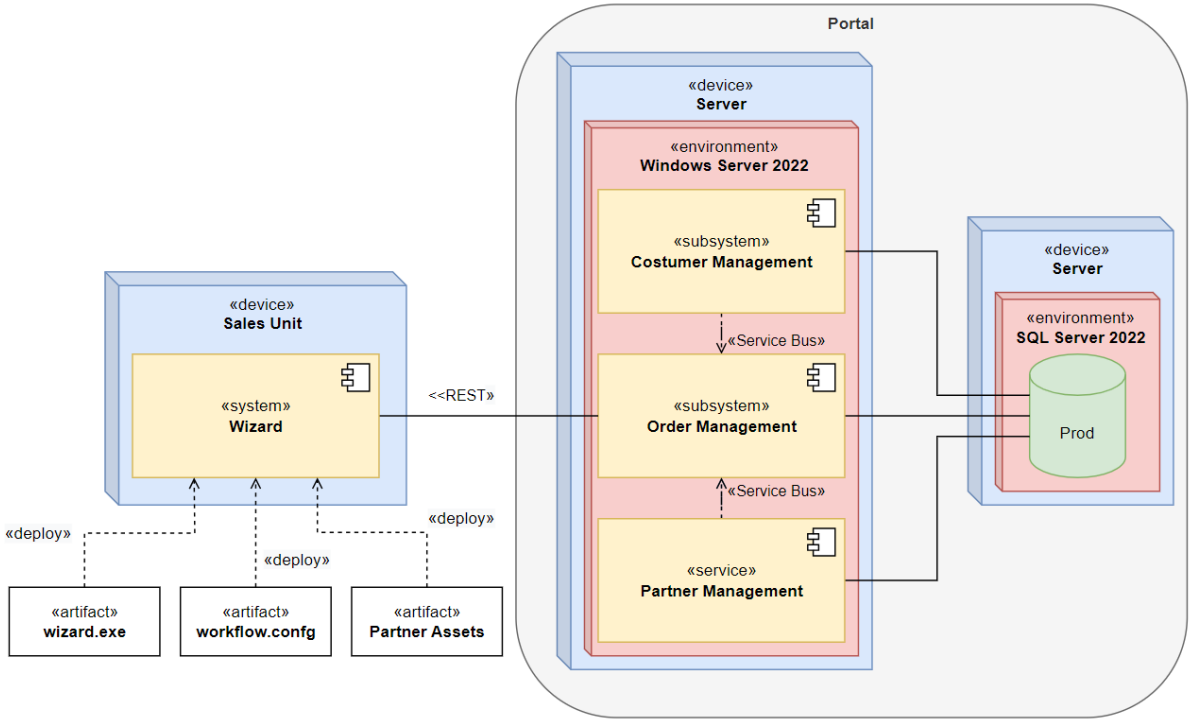


| Element | Description |
|---|---|
| **Service Technician** | An employee of FotoMaX GmbH, who performs maintenance work on sales units on site. |
| **Local Technician** | An employee of the respective sales pitch provider, who performs minor maintenance work on sales units. This includes replenishing printing paper and cartridges of the receipt printer or retrieving orders in standalone mode. The wizard's UI is used to confirm all maintenance tasks. Local technicians have no access to the sales unit's operating system. |
| **End Customer** | A person who uses photo printing services through a sales unit, or views order data on the customer management website. |
| **Wizard** | The software that takes orders and initiates prints either locally or remotely. |
| **Hardware Hub** | The central control unit via which various hardware components can be addressed. This is used to read images from cameras, USB sticks or memory cards. The connection is made via USB and is standardized for all sales units. |
| **Receipt Printer** | A thermal printer used to print out receipts for orders that then have to be paid at a cash register. |
| **Order Printer** | FotoMaX can forward print orders directly to printers of the location provider and thus trigger immediate printing. Printers can be connected via USB or as network printers. |
| **Pitch provider** | An employee of the pitch provider who can view orders and check invoices. |
| **Print provider** | An employee of the print provider who can view and, if necessary, change job status and orders. |
| **Portal** | The web portal that contains customer administration, order administration, and partner administration. |
| **Job system** | The external system of the respective print provider, to which jobs are forwarded. The connection varies greatly depending on the system and is therefore assumed in simplified form only as HTTPs. |

The hardware is connected to the Wizard via the API of the operating system during a standardized configuration process after the manufacturing of the units. Thus, no special protocols must be considered. The only exceptions are order printers: when integrated as network printers, those must be configured separately.

## Deployment View

The deployment view clarifies the runtime environments in which the individual components of the system are installed and executed.




For the sake of clarity, the above illustration only shows the production environment in a simplified form. This does not contain virtualization environments, development environment, staging environments, and fallback servers.

FotoMaX hosts its servers in-house to maintain control and security. The company uses two servers for production purposes. A test environment has been set up to mirror the production environment's structure, which includes two databases. One database has an anonymized snapshot from the production database, and the other has pure test data. There are three servers dedicated to testing, which can also act as fallback options. Two weaker servers are used for the development environment.

| Artifact | Description |
|---|---|
| **wizard.exe** | Executable file of the wizard, which is installed by a service technician on a sales unit before delivery. Updates are done by the service technician on site. |
| **workflow.config** | Specially adapted configuration of the workflows for the respective parking space providers. |
| **Partner Assets** | Logos, fonts, theme, etc. in the corporate identity of the parking space provider. |
| **CostumerManagement.svc** | Installation package for the Costumer Management subsystem installed on the runtime server. |

| Artifact | Description |
| --- | --- |
| **OrderManagement.svc** | Installation package for the Order Management subsystem installed on the runtime server. |
| **PartnerManagement.svc** | Installation package for the Partner Management subsystem that is installed on the runtime server. |
| **Prod DB** | Production database with all customer data. It is backed up incrementally once a day; a full backup is created every Sunday. |
| **Test DB** | Special database with anonymized test data. This is used for acceptance tests by the departments and for quality assurance. |
| **Dev DB** | Developer database, which is reset irregularly and is used by the developers to implement new features. It contains only anonymized test data. |

## Constraints

### Organizational Constraints

The company basically has two main products that are customized depending on the business partner in terms of features, workflows and graphical assets.

| | |
|---|---|
| **Start of development** | *Wizard:* 07.2010 *Portal:* 03.2018 |
| **Team Wizard** | Five members, responsible for the implementation, adaptation and customizing of the software for the end-customer approach on the sales units. |
| **Team Connect** | Four members, responsible for processing, forwarding and accounting of orders. |
| **Team Portal** | Eight members, responsible for the portal solution where customers can view their orders and partners can view their commissions. |
| **Team Data** | Two members, responsible for the analysis and preparation of the accruing data for partners and for product maintenance. |
| **Wizard Installations** | Approx. 250 in different versions |
| **Customers** | Approx. 60 different pitch providers, approx. five different print providers, approx. 12 000 registered end users *(December 2023),* 20% of the users order approx. 30 images per month. |

The company policy of FotoMaX requires all employees of each team to work on-site. To facilitate efficient work, each employee is provided with a notebook (Dell Latitude 5540) and two monitors (Dell S2725DS) at their designated workspace. The employees work 40 hours per week.

### Technical Constraints

- **Technologies Used:**
  - **Wizard:** .NET 4.8, C#, WPF
  - **Portal:** .NET 6, C#, Angular 11, NServiceBus for internal communication between services
- **Runtime Environment:**
  - **Wizard:** Windows 10, SQLite,
  - **Portal:** Windows Server 2022, SQL Server 2022,
- **Release Cycles:**
  - **Wizard:** About once every two to six months, depending on the partner, over the air.
  - **Portal:** Approx. every two weeks
- **Dev Environment:**
  - **Notebook:** Dell Latitude 5540 (65W @ 100% - 40W @ 60%)
  - **Monitor:** Dell S2725DS (21,4W when active)
  - **Server:** Dell Smart Selection PowerEdge R250 Rack Server (115W)
- **Production Environment:**
  - **Wizard:** DELL OptiPlex 7050 i5-6500T (75 W)
  - **Portal:** Dell Smart Selection PowerEdge R350 Rack Server (175W – 240W)
  - **Test Systems**: Dell Optiplex 7050 (75W), Beetronics 22" Touch screen (18.5W)

## Quality Goals & Scenarios

### Goals

Quality goals described in this chapter explain which none-functional requirements are most valued during implementation.

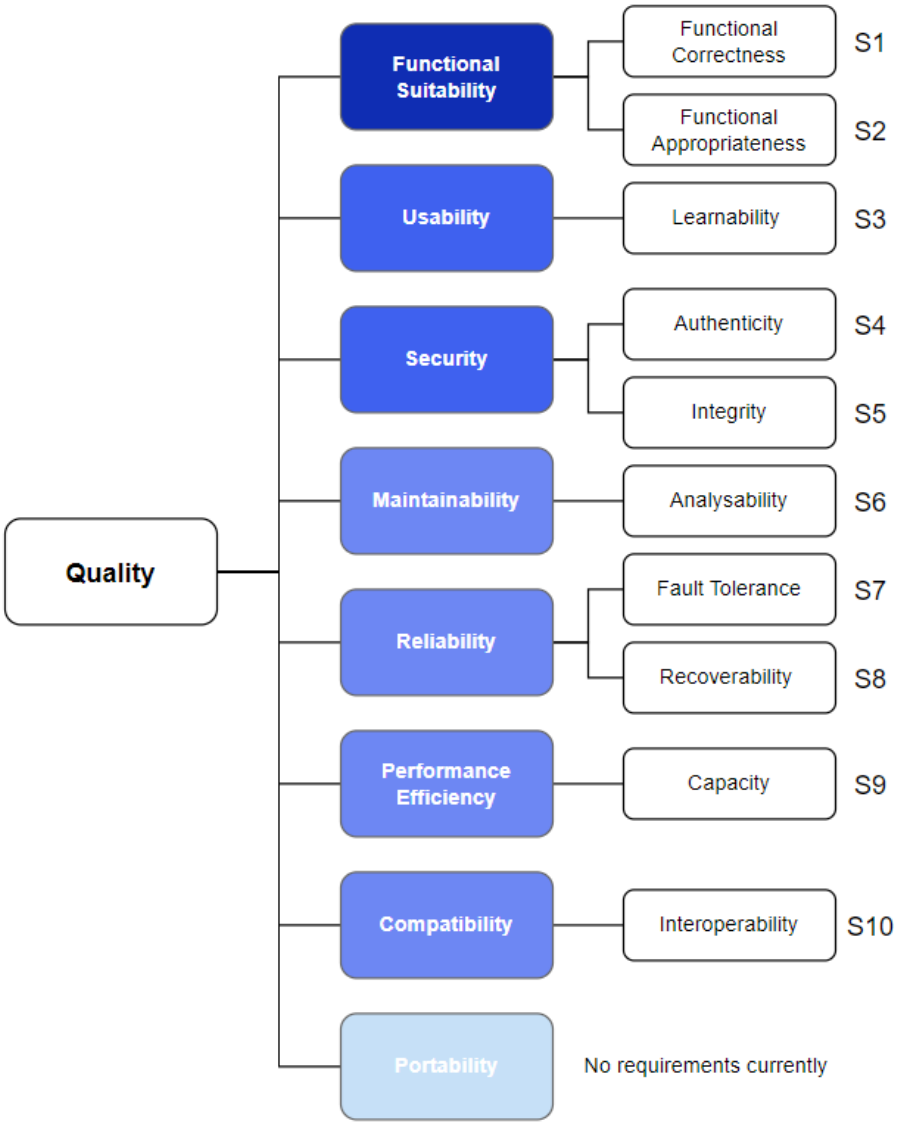
| Priority | Attribute | Explanation |
|---|---|---|
| **1** | **Functional Suitability** | The functional correctness and completeness of the software has top priority; as no logical errors may occur during operation and all workflows or processes must be implemented in a way that leads to a successful order. |
| **2** | **Usability** | The software must be easy to use by people with different levels of technical knowledge and be perceived as appealing. It must be possible to place an order as quickly and conveniently as possible to attract walk-in customers. |
| **2** | **Security** | The sales units are located in a public space and offers various possibilities for data transmission. |
| **3** | **Maintainability** | The software system is comparatively extensive and must be able to be redesigned for different partners, so it should be modular and easily testable for different configurations. |
| **3** | **Availability** | If the service is not available, it does not generate any revenue. Therefore, it must always be possible to place orders localy on sales units. The actual transfer of orders to the central services can take place with a certain delay. |
| **3** | **Efficiency** | The expected load on the units is comparatively low, since they can only be used by one person at the same time. When implementing the system, consideration must be given to the manufacturing and hardware costs. |
| **3** | **Compatibility** | The software is primarily used for ordering photo products, so there should be compatibility with common image formats. It should also be possible to retrieve data from common capture devices without much effort. |
| **4** | **Portability** | The runtime environment, including both hardware and software, rarely changes and thus the system does not need o be portable at all. |

**Legend:**

| | | |
|---|---|---|
| **1** | Very important | Compromises are only possible in absolute exceptional cases. |
| **2** | Important | Compromises are only allowed if features with higher priority are strengthened. |
| **3** | Significant | Compromises are possible, as long as the core requirements are not disturbed. |
| **4** | Negligible | The characteristic is only to be considered to a minor extent. |

## Scenarios

The following scenarios specify how exactly the software system should behave in certain situations and what compromises may be possible.



| # | Attribute | Description |
|---|---|---|
| **S1** | Functional Correctness | When a customer places an order, the system must round the final amount in a commercially correct manner. |
| **S2** | Functional Appropriateness | When a standard photo is ordered, it is subjected to compression. Compression artifacts must not be visible to the naked eye in the printed version of the photo. |
| **S3** | Learnability | A user who has not seen the software before must be able to order four different photo products within five minutes. |
| **S4** | Authenticity | When persons identify themselves as service technicians, all changes to the system must be automatically and immediately logged in an unalterable way. |
| **S5** | Integrity | If the software is started and an unknown file has been placed in the configuration directory, then the start must be aborted with an error message. |
| **S6** | Analyzability | New developers must be able to make value-adding changes to the software within one week. |
| **S7** | Error Tolerance | If the user enters invalid characters in an order, the error is highlighted to the user at the location of the error and the further order processing is be blocked. |
| **S8** | Recoverability | If the device is restarted after an error, a sanity check runs and an error report is provided for further analysis, logging all errors that occurred. |
| **S9** | Capacity & Time Behavior | If a customer orders 1000 different images with a total size of one gigabyte, he must receive an order confirmation within five minutes. |
| **S10** | Interoperability | If a service technician connects a new printer, it must be operational within ten minutes without installing special drivers. |