ITEA 3 Call 4: **17010 SAMUEL**

Smart Additive Manufacturing – an AM Intelligent Platform

D4.1 SAMUEL Platform Architecture Definition

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1 INTRODUCTION

This document serves as an overview of the software architecture of the online SAMUEL platform.

As explained in the full project proposal (see lastest version Change Request CR2), The SAMUEL AM toolkit is an ensemble made out of different modules which uses artificial intelligence and 3D model geometric analysis to leverage AM manufacturing data.

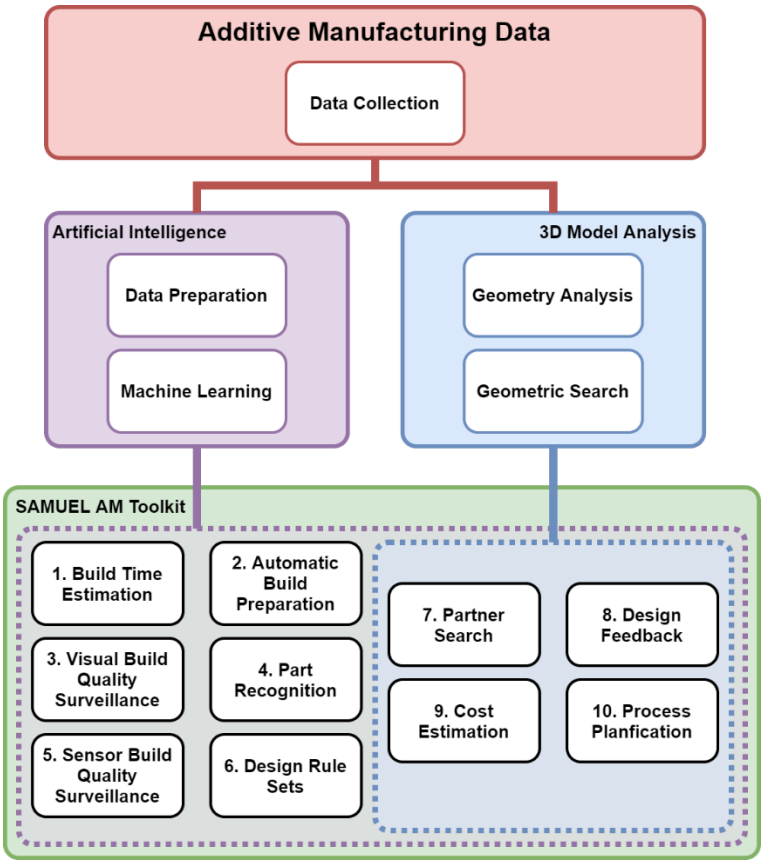

Figure 1: Overall Solution Concept for SAMUEL

The SAMUEL tools are integrated in existing products. Figure 2 below presents this integration, and who each product owner ultimately will be.

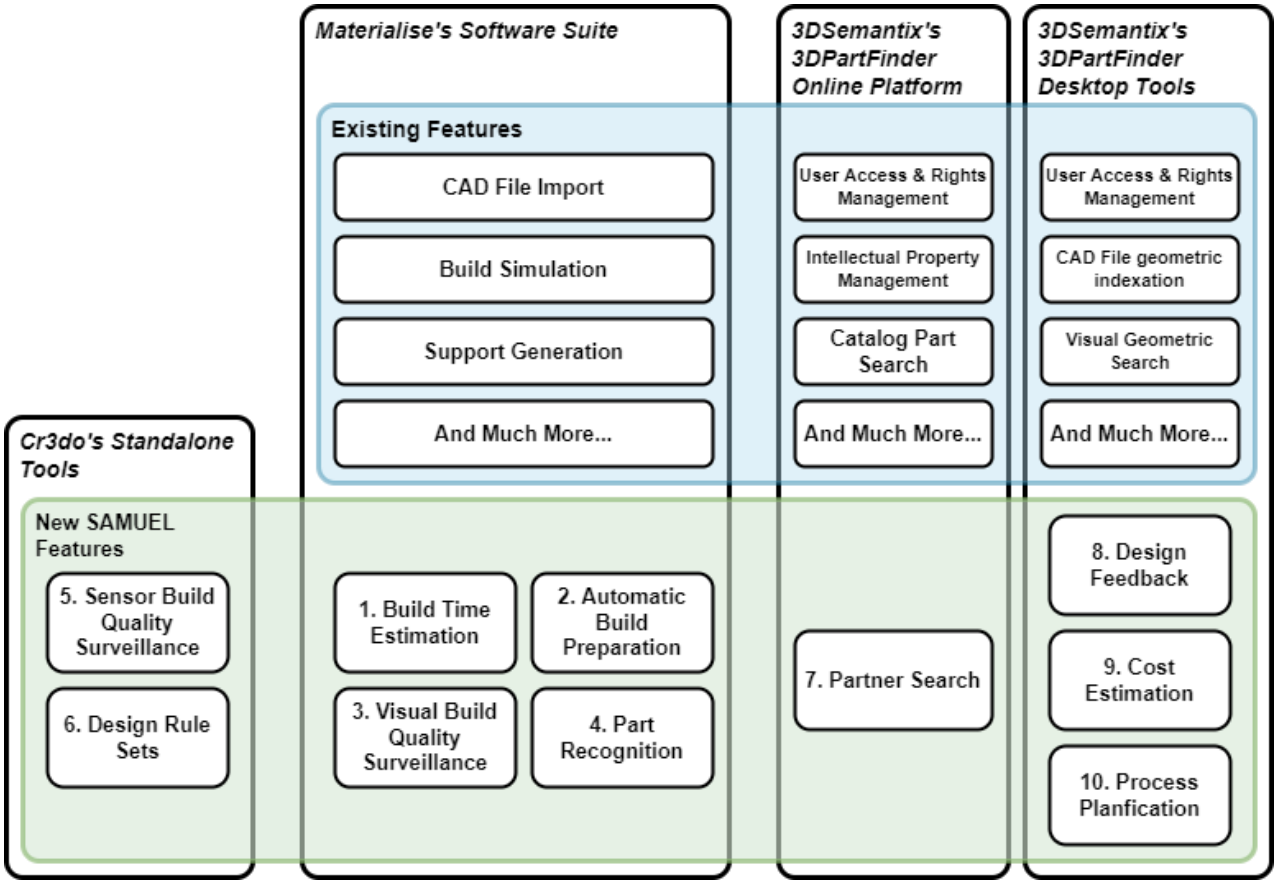

Figure 2: SAMUEL Tools integrated in existing solutions

2 SAMUEL PLATFORM ARCHITECTURE

2.1 CR3DO'S STANDALONE TOOLS

Cr3do developed standalone tools for this project. The architecture of those tools are as follows:

2.1.1 SURVEILLANCE TOOL

Data is gathered from input sensors:

- Direct input analog sensors
- I²C
- Zigbee
- ZWave

And stored in a Database. A visualisation dashboard is available to consult the gathered data. Finally, an automated notification system, with auto shutoff of supporting systems helps reduce the amount of failed builds.

2.1.2 DESIGN RULE SET

Integration in Blender: Simple add-on that provides a single new verification button. Analysis is done off the user's workstation, on a server, with a notification loop (Slack or Email) pointing the user back to a web interface when done.

2.2 MATERIALISE USE CASES

Upon completion, Materialise's research and development done during the project will be integrated in their software suite (MAGICS or others). Given de scope and complexity of the software, the details of each integration may vary and are not detailed in this document.

2.2.1 ANOMALY DETECTION

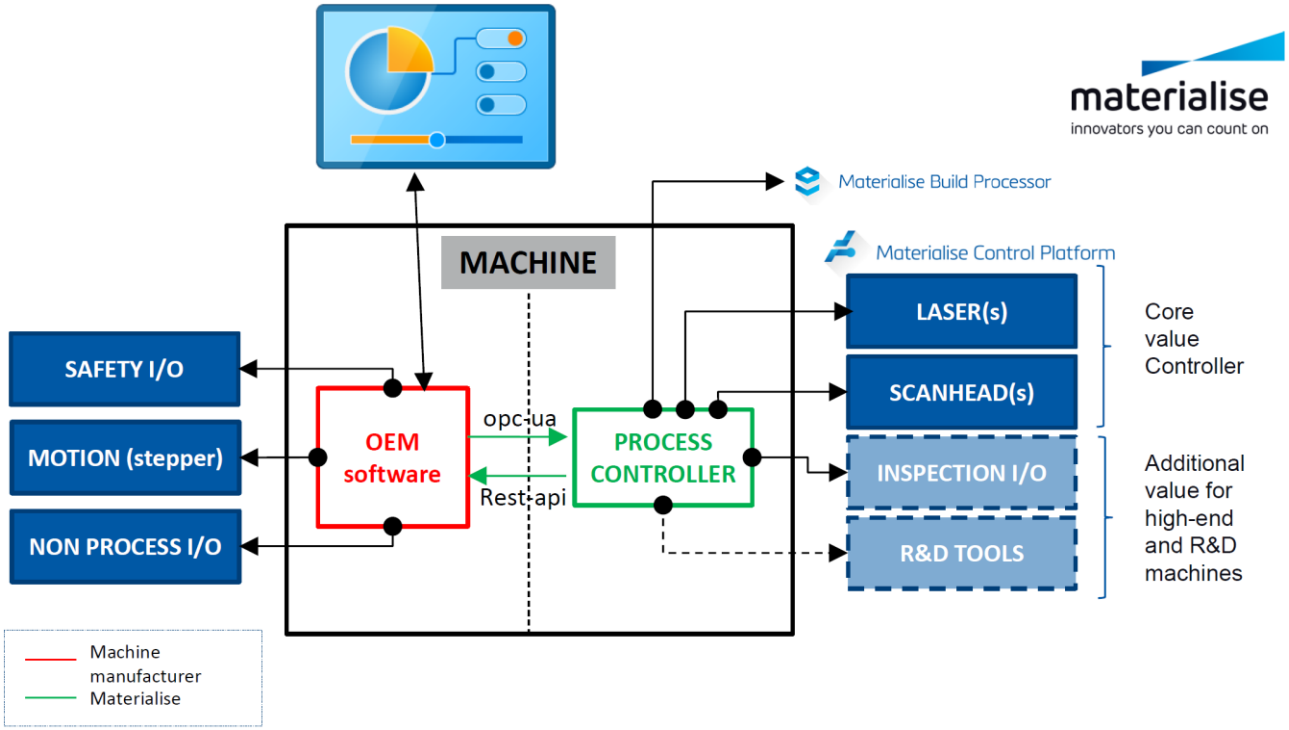

Figure 3: Integration of Anomaly Detection Module

2.3 3DPARTFINDER

2.3.1 3DPARTFINDER ONLINE

The online portion of SAMUEL is integrated in 3DSemantix' 3DPartFinder Online platform. At the end of the project, significant improvements will have been implemented to address the needs and challenges of the AM industry.

Figure 4 presents an high-level overview of the Online SAMUEL platform. The online portion is made out of an front-end, the web interface that the users interact with, and the back-end, the various modules and services driving the platform. Lastly, a production data submission toolkit is used to populate the platform with relevant and useful data.

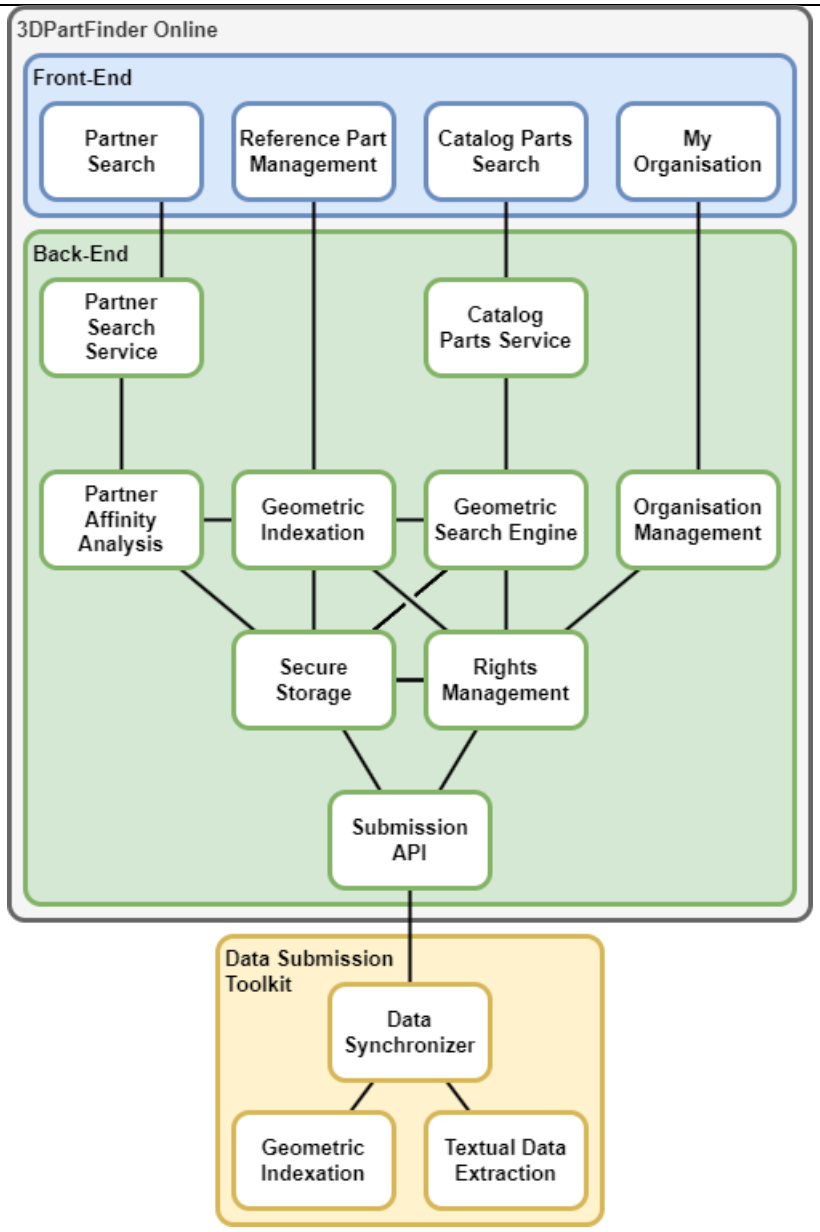

Figure 4: SAMUEL Online Platform Architecture

Figure 5 details which modules are new addition to the platform (green boxes), which are existing modules that will be improved in the course of the project (yellow boxes) and which may be used as-is (blue boxes).

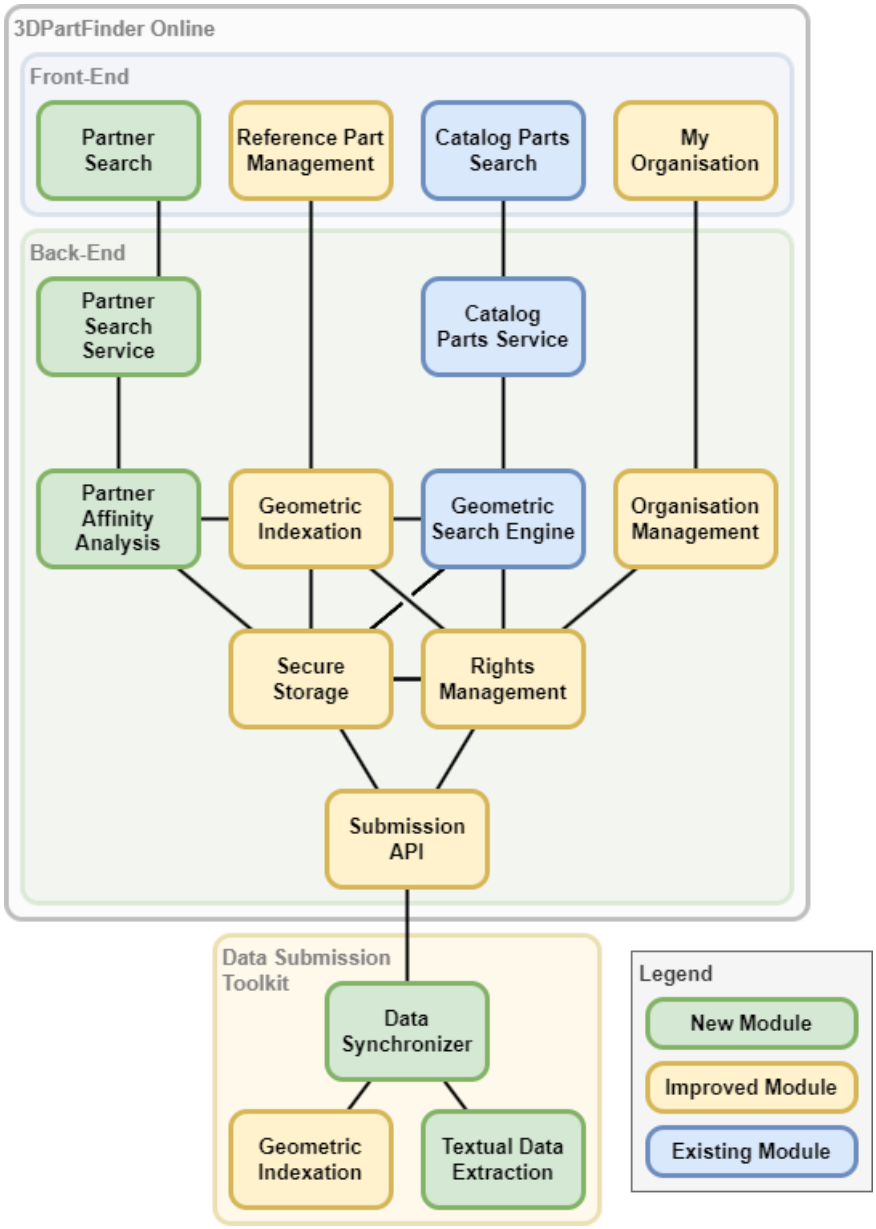

Figure 5: SAMUEL Online Platform Architecture - Existing, improved and new modules

2.3.1.1 FRONT-END MODULES AND RELATED SERVICES

Tools on the platform are accessible through the front-end, and backed by a dedicated service on the back-end. They are presented as *workshops*, with the exception of the reference part management which is a tool panel, common to most workshops.

- The existing **Catalog Parts Search** workshop consists of technical documents and of 3D models of products sold or distributed by parts manufacturers or part distributors, searchable either via conventional text search or the innovative geometric similarity search.

- **My Organisation** workshop serves as the central hub for managers to access and manage information related to their organisation on the platform: User invites and roles, access rights, product configuration, etc.
- The **Reference Part Management** is a common tool panel where the platform user may upload 3D models for analysis. The listed, uploaded models can then be used as reference in the various platform workshops.
- The **AM Partner Search** workshop is a new SAMUEL tool. It helps users find manufacturers by matching their reference model with the production history of the AM manufacturers registed on the platform.

2.3.1.2 BACK-END INFRASTRUCTURE

Modules in the back-end supports the front-facing services.

- The **Partner Affinity Analysis** drives the main innovative function of the AM Partner Search workshop. This is the module which calculates the "compatibility" between a reference model and each manufacturer's production history.
- **Geometric Indexation** is an integral part of the platform. This is the module which analyses and extracts the anonymized geometric index of the various 3D models, either uploaded from the front-end or submitted through the API. In addition to existing support for native CAD formats and STEP files, STL and Materialise Magics formats are supported.
- The **Geometric Search** engine exploit the geometric indexes and find parts based on geometric similarity.
- All data is stored in a **Secured Storage**. Modules have access only to the information needed for their functions. Access is managed through the **Rights Management** module.
- The **Submission API** is the service endpoint to which external actors may submit data to the platform. This API let registered users populate their organisation production history with the relevant data and geometric indexes which will be used by the various modules and workshops.

2.3.1.3 HISTORICAL PRODUCTION DATA SUBMISSION TOOLKIT

3DSemantix provides a toolkit to our SAMUEL partners to help them submit data to the online platform. Partners could also write their own tools, following our API documentation.

The submission toolkit was made with IP protection in mind. The workflow is broken down in two distinct steps: Local data indexation, then online submission.

As its name implies, the local data indexation takes place completely behind the company's firewall. Geometric indexation of 3D models is done using the **3DPartFinder Server**. Textual data related to production history is extacted with the new **3DPartFinder Text Indexation** tool. All indexed data is saved in a local SQL database, which can be inspected by the users.

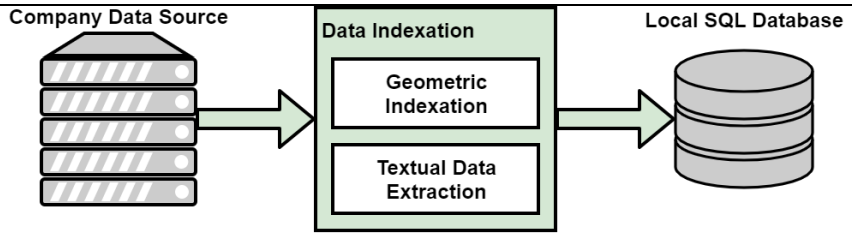

Figure 6: Data submission toolkit - Local data indexation

Once data indexation is completed, the second, separate step is a simple submission to the online platform using the **Production Data Synchronizer** tool. This tool only needs access to the aformentionned local SQL database and the Submission API endpoint on the SAMUEL online platform.

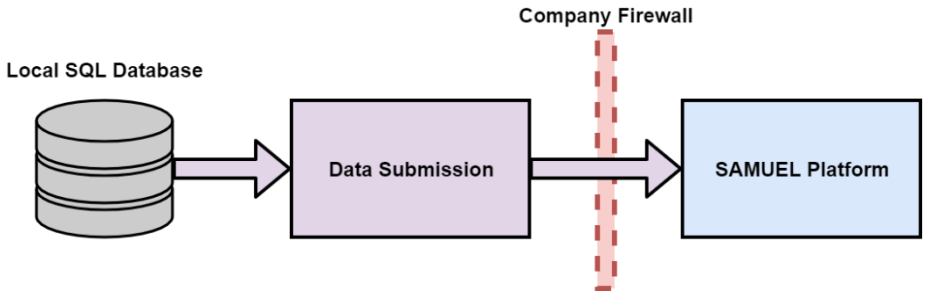

Figure 7: Data submission toolkit - Submission to the platform

Both steps are independent from one-another and can be run separately. Both may be automated to run a schedule, or they can be executed manually if preferred.

2.3.2 3DPartFinder Desktop

The desktop solution is integrated in 3DPartFinder desktop offerings. Figure 8 presents an overview of the desktop architecture and Figure 9 presents the new, modified and existing modules.

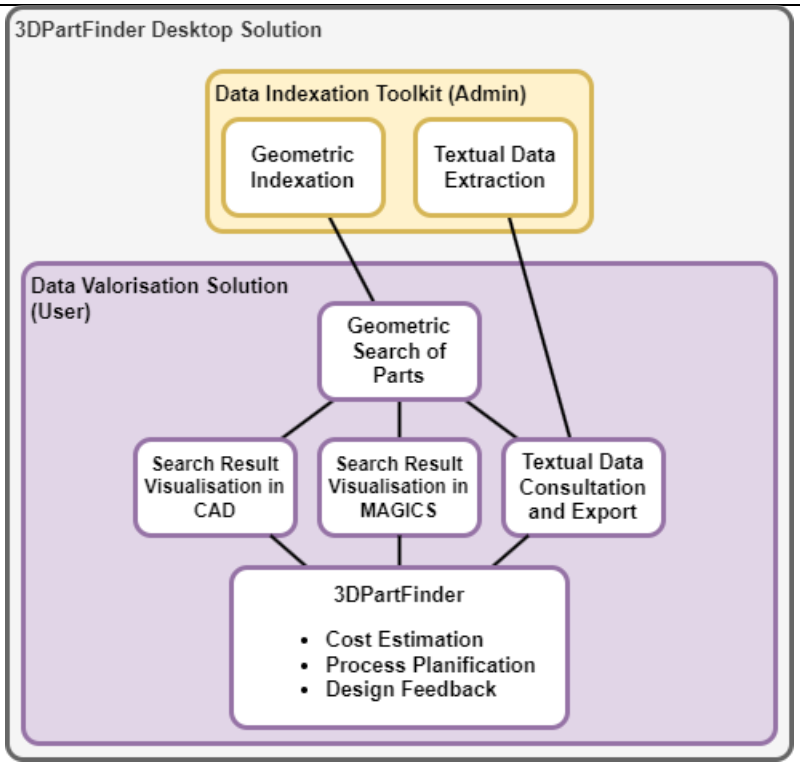

Figure 8: 3DPartFinder Desktop Architecture

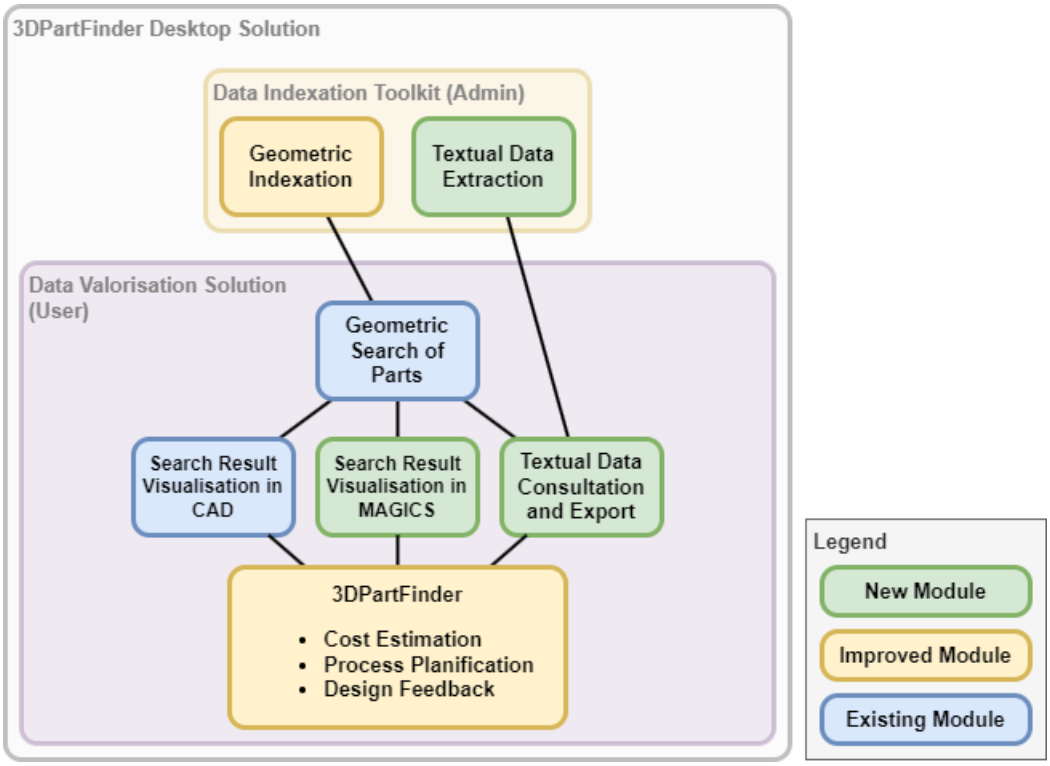

Figure 9: 3DPartFinder Desktop Architecture - Existing, improved and new modules

The desktop solution shares it's Geometric Indexation and Textual Data Extraction with the online solution. This greatly simplifies the work of the administrators as the same process can be used to populate the company's online production profile and the on-site production historical reference database.

The Cost Estimation, Process Planification and Design Feedback use cases are integrated into the existing **3DPartFinder For All Users** software. Geometry-based search is the cornerstone of the solution, where the user can easily access their company's history of production to find relevant designs, produced parts and documents.

- **AM Cost Estimation**: Helps AM manufacturers quickly and precisely answer RFQs. It leverages the organisation's production history and similarity search to help the user easily estimate the needed values for his RFQ.
- **AM Design Feedback**: Lets AM part designers quickly and efficiently gather relevant examples of previously produced parts. Leverages the whole company's experience to improve designs, reduce build failures and reuse existing designs.
- **AM Process Planification**: Helps manufacturers prepare their AM process plan based on part specifications by reusing internal knowledge and expertise.

Materialise MAGICS is added to the list of available geometric search results presentation supports (in addition various CAD software such as SolidWorks, CATIA, NX, SolidEdge, and more). Results relevant to the user's current task can be displayed directly in their MAGICS environment, with all the benefits that comes with it. Parts can be displayed in the standard result grid, or can be presented in their original build orientation, for easy consultation and quick inference of configuration.