Python-based DCC Tools Development and Implementation

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This paper introduces *DCC Tools*, a suite of open-source Python-based software tools developed to streamline the handling of Digital Calibration Certificates (DCCs). These tools are designed to generate DCCs compliant with the XML schema proposed by the Physikalisch-Technische Bundesanstalt (PTB) [1] [2] and facilitate the embedding and extraction of human-readable PDF versions of calibration certificates. The transition from traditional paper-based or PDF certificates to machine-readable DCCs addresses the limitations of current practices, which often involve manual transcription of calibration data, leading to inefficiencies and errors. The proposed tools aim to enhance the digitalization of calibration processes, enabling seamless integration with modern digital workflows and improving accessibility, interoperability, and efficiency.

The *DCC Tools* package includes several key functionalities: *dccGenerator*, which generates PTB-compliant DCCs from JSON inputs; *dccAddPdf*, which embeds human-readable PDFs into DCCs; and *dccGetPdf*, which extracts PDFs from XML DCCs. Future plans include the development of *dccReader*, a tool for extracting measurement data from DCCs and converting it into JSON or spreadsheet formats. For this task we plan to use the pyDCC library developed by Siemens, which is available on GitHub [3]. The system architecture is serverless, using AWS Lambda for scalability, cost-efficiency, and ease of integration with existing workflows. The tools are designed to operate within the AWS Lambda free tier, making them accessible to calibration laboratories of various sizes and budgets. The tools are implemented as Python scripts, so they can be easily adapted for running on a local server or private cloud if needed.

The adoption of DCCs represents a significant step toward true digitalization in calibration processes. Unlike traditional methods, which rely on paper or closed digital formats like PDF, DCCs store data in a machine-readable XML format, enabling automated processing and integration with digital systems. This is particularly important in the context of Industry 4.0, where real-time data exchange and automation are critical. The proposed tools also support the inclusion of digital cryptographic signatures, enhancing trust and security in the calibration process. *DCC Tools* software is freely available on GitHub [4] under the GPLv3 license, providing a practical and cost-effective solution for calibration laboratories seeking to modernize their workflows.

In conclusion, the *DCC Tools* represent a significant advancement in the digitalization of calibration processes. By enabling the generation, embedding, and extraction of machine-readable DCCs, these tools reduce the reliance on manual transcription, minimize errors, and improve productivity. The serverless architecture ensures scalability and cost-efficiency, making the tools accessible to a wide range of laboratories. Future work will focus on expanding the tools' capabilities and integrating them with emerging standards and technologies, such as the Digital SI (D-SI) format and metrology clouds, to further enhance their utility and impact.

References

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