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A HARDWARE DEVELOPMENT TOOL STACK FOR FUTURE SPACE EXPLORATION - TOOL
SELECTION CRITERIA**Abstract**

The concept of a hardware development tool stack for future space exploration was first presented at the International Astronautical Congress in Adelaide 2017. This paper extends those findings and describes selection criteria for a tool stack to further streamline the engineering process. Modern hardware engineering can be greatly improved by choosing the right tool stack based on three key criteria; 1) browser-based, 2) concurrency, and 3) data-driven integration. A detailed overview of the three criteria is presented as well as a vision of a modern engineering workflow that is enabled by the tool stack.

Recent trends show that engineering tools are moving to the browser. Examples of tools that already exist include browser-based CAD, requirements management, simulation and data management. These will soon become a standard throughout the industry because of the benefits compared to non-browser-based systems. For example, a browser-based tool is platform independent and can be accessed from any web browser on a computer, mobile phone or tablet, allowing for more flexibility. The user interface is extendable so all team members can get customisable live views of the data.

The concept of concurrency emphasizes the parallelization of tasks and the integration of different engineering functions to reduce the development time of a new product. With today's common document-based engineering approach, concurrency is difficult to achieve because there is no common ground between the island solutions created in each engineering discipline. With modern, browser-based tools on the other hand, changes are propagated automatically and become immediately visible to engineers across all disciplines, which allows for identifying problems and inconsistencies earlier.

Data-driven integration refers to the interoperability between engineering tools that are used in different disciplines. Browser-based tools often include a RESTful API, which allows for tools to exchange information and notify each other without user interference. For example, CAD data can be exchanged with data management and simulation software to ensure a unified, data-driven engineering approach across disciplines.

As a last step, this paper presents a modern engineering workflow, all the way from idea generation to system design and optimization, with an outlook towards verification and production. This workflow is enabled by browser-based engineering tools which implement concurrency, integrations and seamless updates across disciplines. With the given example it becomes evident that a browser-based hardware development tool stack is a necessary foundation for the agile development of future space exploration missions due to their high level of interdisciplinary complexity.