

Pole-Vaulting the Design Data Management Challenge

CADmium Architectural Overview

A new design data management platform built on the open technologies of SVN and MySQL.
It marries seamlessly with existing design methodologies and offers the benefits of compatibility with existing IT infrastructure along with deeper integration with enterprise-level PLM, PDM and ERP systems.



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CADmium Architectural Overview

Altium's (SVN)DBLibs allow designers to utilize the benefits of well-established technologies such as SVN and MySQL to centrally manage and version control their component and design data. However without a convenient mechanism for administering these systems, users have been left to fend for themselves and the call for an open Design Data Management platform that supports multiple Operating Systems and integrates nicely with existing IT systems and infrastructure has gone unanswered - until now. This whitepaper provides an architectural outline of one such system (called CADmium) that can operate in a standalone fashion or integrate with existing enterprise-level PLM, PDM and ERP systems.

The key benefits of this system are:

- ◎ CADmium is built on the well-proven and open technologies of SVN and MySQL. Experience in these systems and infrastructure compatibility is already broadly available in the marketplace and IT management practices for backing up and maintaining these systems are already well understood.
- ◎ The design methodology used by CADmium is in close alignment with the methodologies used by Altium customers for decades. Implementing CADmium within an organization is less disruptive and requires minimal training.

Not Just A Technology Problem



The challenge of designing electronics products is largely a technical one however the challenge of synchronizing the electronics design processes with Mechanical CAD, procurement, manufacturing and sales & support processes is an enterprise level problem that is critically dependent on the organization's design data management systems.

Solving this challenge has led to the creation of a multi-billion dollar PLM / PDM industry that seeks to integrate all aspects of product development and release process. But with close alignment to the MCAD industry, many of these solutions are yet to provide deep ECAD integration on account of their black box view of the electronics design process.

In response to this, several ECAD-centric solutions have been proposed to the market however they are yet to gain traction on account of their closed-nature and inability to integrate easily into enterprise-level PLM, PDM & ERP systems.



- ⊙ CADmium focuses on solving the centralized access and version controlled storage needs of the design teams without imposing Product Life Cycle concepts that are best left in the hands of enterprise-level PLM, PDM and ERP systems. CADmium emphasizes the need to interface cleanly with these systems rather than imposing its own view of product life cycle management onto the broader organization.
- ⊙ CADmium uses a network appliance model that allows it to run on virtually any Windows or Unix-like (Mac included) Operating System either inside or external to the organization and there are no limitations imposed on the number of users who can simultaneously connect.

The Problem Statement

The problem of architecting an open design data management system is multi-faceted however the following principles should be considered when devising a solution:

- ⊙ Design outputs can only ever be as good as the design data that feeds them. As design teams grow, collaboration should be encouraged and suitable design data management processes and controls need to be established to ensure the integrity and reliability of design outputs is assured.
- ⊙ Effective design data management requires organizations to exert controls over who can access what, when and how, and for change histories to be audited. This is most easily achieved when design data is centralized, and where possible, opportunities for process automation should also be exploited to reduce the likelihood of manual (human) errors being introduced.
- ⊙ Design data management processes should be cognizant of the design workflow so that they increase the designer's capacity rather than burdening them with additional management overheads.
- ⊙ Organizations that are not yet using large scale PLM / PDM systems need a scalable design data management solution that brings immediate benefits to their ECAD processes while still providing the opportunity for future integration with an enterprise-level solution as and when the organization deems it appropriate.
- ⊙ Due to huge variations in data management requirements, an open system that offers ease of customization and extension should be favored over one that is closed and / or proprietary.

Exploiting existing open technologies

While there are many existing technologies that are applicable to the pursuit of an open design data management system, an in depth analysis of the merits of each is beyond the scope of this paper. However a more detailed discussion is warranted to highlight the reasons that SVN and MySQL have been selected as core technologies for our proposed architecture.

Subversion (SVN) - Version Control

The software development industry has been using version control systems to manage small and large, individual and collaborative software projects for many years. It is a well-established core technology and its value has been proven many times over. And while software developers have largely been



using it to manage their text-based source files, its usefulness continues for binary files too. Specifically, it allows designers to:

- ⊙ Keep a complete history of the evolution of source files.
- ⊙ Revert back to previous versions
- ⊙ Keep backups to protect against lost content
- ⊙ Develop and maintain multiple versions of a product with overlapping source files
- ⊙ Compare the difference between two (or more) revisions
- ⊙ Examine the point at which a bug was introduced and its possible implications
- ⊙ Work collaboratively on the same project without fear of losing each other's changes
- ⊙ Track the development pace and see who is doing what, and to which files
- ⊙ Experiment freely without fear of breaking a working design

The fact that SVN is free, open source, stable, supported by an active community of developers, can run locally or as a web service, supports user access control, and is available for all major operating systems are definite advantages, but the two most critical factors in its favor are Altium Designer's integrated support for it, and its ability to be extended using *hooks*.

SVN's hooks are points at which external programs can intercept version control operations and insert additional checks and balances that ultimately control whether a requested operation proceeds to completion, or is aborted without any changes being applied to the repository contents. In our proposed system, it is this mechanism that allows us to add an extra layer of access control and traceability to establish even greater confidence in the integrity of committed data by ensuring that formal design management processes have been followed. This functionality is explained further under the heading 'Token Management'.

MySQL - Database

Two things drive the need for a database in our system:

- ⊙ It is the simplest (and only practical) way to present externally sourced component data in the form of a library to the design tool; in this case Altium Designer.
- ⊙ It allows the relationships between design data to be tracked and managed.

MySQL stands as the leading database contender because it ticks all the right boxes; it is free, open source, stable, supports user access control, runs as a web service, and remains under active development.

A small detractor is the fact that it requires a unix-like environment to run and this may be unfamiliar to Altium Designer users who are, by necessity, MS Windows users. However given that most implementations of our systems will utilize a server rather than a local PC, it is most likely to fall within the domain of a systems administrator who is already familiar with the unix OS. In any case, the



appliance model (that is one of the key features of our platform) allows it to be easily installed as a turnkey solution without the need for complex administration.

Architectural Overview

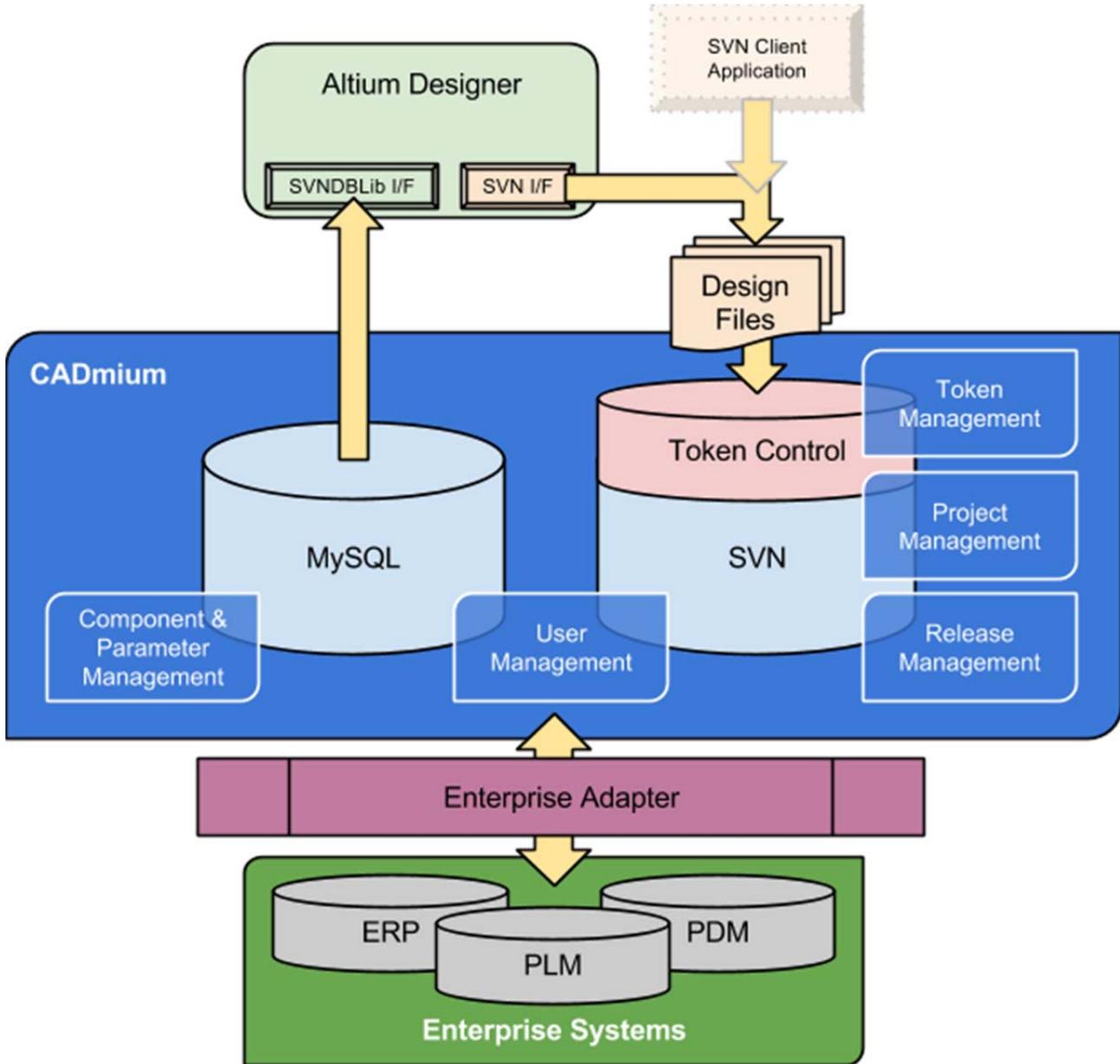


Figure 1. the CADmium Architecture

CADmium is a self-contained software appliance that includes MySQL and SVN servers as well as a collection of support services that streamline their management and provide the additional functionality needed to deliver a complete design data management solution. The specifics of those services are given below:



Component & Parameter Management

The Component & Parameter Management service provides a user interface into component & parameter information held within the MySQL database.

The screenshot shows the 'Component Library' section of the application. The 'Capacitor' category is selected. A table lists six capacitor items with their respective revisions, originators, designs, and capacity units. The table is filtered to show 6 entries out of 324 total.

Item	Revision	Originator	Design of capacitor	Capacity unit
1A002002A	01	Migrated Data	SMD	nF
1A002003A	01	Migrated Data	SMD	uF
1A002004A	00	Migrated Data	SMD	nF
1A002005A	01	Migrated Data	SMD	nF
1A002006A	00	Migrated Data	SMD	nF
1A102002A	01	Migrated Data	SMD	nF

Figure 2. Accessing Component Lists

New Parameter definitions can be added and edited along with their values.

The screenshot shows the 'Parameter Definitions' section for the 'Capacitor' category. A table lists various parameters such as 'Part status', 'Operating Voltage max (VDC)', 'Type of capacitor', 'Design of capacitor', 'Capacity unit', 'Capacity', 'Tolerance of capacitor (%)', 'Footprint', 'Electronic Schematic symbol file', and 'Electronic PCB footprint file'. Each parameter has a unique ID and a display name.

ID	Name	Display Name	Format
12	Part status	Part status	
13	BaaNDescription	BaaNDescription	
34	Operating Voltage max (VDC)	Operating Voltage max (VDC)	
35	Type of capacitor	Type of capacitor	
36	Design of capacitor	Design of capacitor	
37	Capacity unit	Capacity unit	
38	Capacity	Capacity	
39	Tolerance of capacitor (%)	Tolerance of capacitor (%)	
23	Footprint	Footprint	
40	Electronic Schematic symbol file	Electronic Schematic symbol file	
41	Electronic PCB footprint file	Electronic PCB footprint file	

Figure 3. Editing component parameters



Furthermore, a complete history of parameter and model edits is maintained.

Date	Action	User	Time
Mar 7, 2014	Created parameter : Footprint Path	System Admin	01:18:33
Mar 7, 2014	Created parameter : Footprint Ref	System Admin	01:18:33
Mar 7, 2014	Created parameter : Library Path	System Admin	01:18:33
Mar 7, 2014	Created parameter : Library Ref	System Admin	01:18:33
Mar 7, 2014	Created parameter : Electronic PCB footprint file	System Admin	01:18:33
Mar 7, 2014	Created parameter : Electronic Schematic symbol file	System Admin	01:18:33

Figure 4. tracking change histories

User Management

The User Management service allows an administrator to centrally manage user roles and access rights to MySQL and SVN. This information is also used when logging changes to the design data.

Token Management

Before any changes can be made to design data contained within the SVN repository, the user wishing to make the change must have a valid *Commit Token*. Commit Tokens can be requested by anyone but are typically only issued by the reviewing manager. The following information is recorded at the time of the Token's creation:

- ⦿ The Token's Title and Description
- ⦿ The name of the Manager (the Token Issuer)
- ⦿ The name of the person authorised to make the commit
- ⦿ The time window that the Token is valid for
- ⦿ The number of commits that are allowed
- ⦿ The scope (files / projects / folders) that are allowed to be touched by the commit

Figure 5. Administering Users



The screenshot shows a web form titled "New ticket". It contains several input fields and a dropdown menu. The "Title" field contains "Modify Power Supply Subsystem to 240V". The "Description" field contains "The existing power supply was designed for a 110V system. This needs to be changed to support 240V". The "Project" dropdown menu is set to "/". There is a "Scope" field which is empty. Below the "Scope" field are two buttons, "+" and "-". There is a large empty text area below the "Scope" field. The "Valid from" field contains "08/04/2014 12:16" and the "Valid to" field contains "08/04/2014 13:16". There is a checkbox labeled "Use commit count" which is checked, and a "Commit count" field containing the number "3". The "Manager" dropdown menu is set to "Dejan Stankovic". At the bottom of the form are two buttons: "Back" and "Create Ticket".

Commit Tokens provide an effective means for controlling the volume of changes being applied to the project and can be used to throttle development when leading up to critical release milestones without needing to adjust individual access rights.

Figure 6. Creating a New Token

Project Management

SVN orders its contents by *Projects* but it places no restrictions on what data can be stored within those projects. In essence, *Projects* are akin to a top-level folder name and are useful for ensuring that related material is all kept together. The Project Management service provides a convenient and easy to navigate interface into all SVN projects and provides a simple mechanism for viewing the Project's history and associated Tokens.

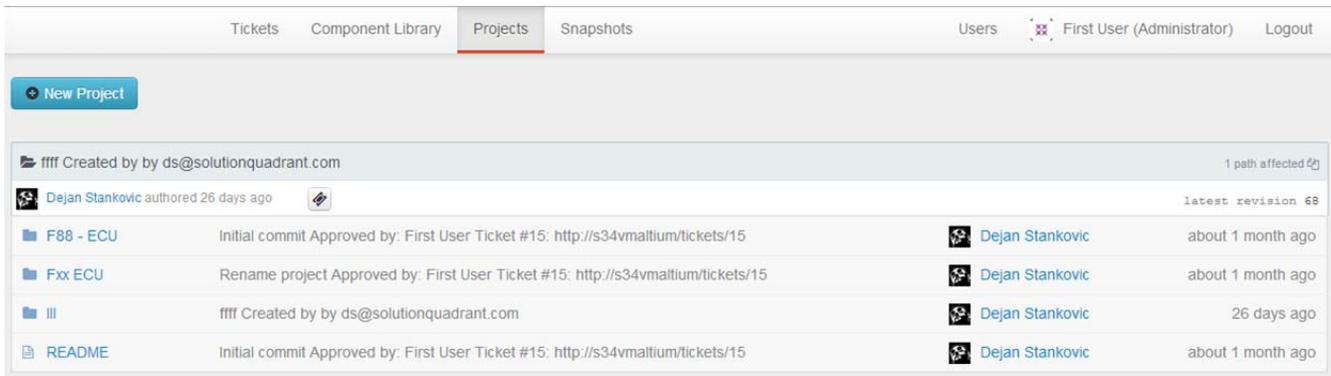


Figure 7. the Project view

Furthermore, when navigating into a Project, the Project Management service immediately looks for a README file within the Project's root folder and displays its contents in the user interface. README files are text based and use a lightweight markdown syntax to provide a restricted set of formatting options. They are version controlled like all other files and can serve as a type of notice board that indicates the Project's current status.

Integrating CADmium with Enterprise Systems (PLM/PDM/ERP)

A key consideration in the creation of CADmium was the need to offer integration services to broader PDM/PLM/ERP systems. The complexity of these enterprise-level systems and the extent to which they have been tailored to an organization's specific requirements makes it impossible to create a single, turn-key integration solution. However the architecture of CADmium has been developed with an abstraction layer at the point of interfacing to external enterprise-systems so that the process of creating custom adapters is greatly simplified.

In the Architectural Overview example, the Enterprise Adapter is shown as performing the following tasks:

- ⊙ Running as a background service, it monitors activity within the Enterprise-System and propagates component and parameter data into MySQL and SVN so that they can be presented to Altium Designer through its SVNDBLib interface. This ensures that the Enterprise System remains as the master source and designers have ready access to the latest, approved components.
- ⊙ In conjunction with the Release Management service within CADmium, projects that have been checked into SVN and have had their snapshot taken and then released back into PDM. The Release Management service is responsible for assembling the information into a suitable format before handing it off to the adapter layer for conveyance to the Enterprise-System. The Enterprise-System maintains its status as the ultimate source of design data truth and remains responsible for managing the relevant approval and change authorization processes mandated by the organization.

Additional tasks can also be performed by the Enterprise Adapter according to the specifics of the PLM / PDM / ERP integration that is required.



For organizations that have not yet ventured into the realm of a PLM / PDM / ERP system, they can elect to deploy CADmium as a standalone system and begin reaping the benefits of its design data management capabilities immediately while still keeping open the possibility of integration with Enterprise-Systems later on. CADmium's ability to track component change histories and manage parameter information in a tabular format is a huge improvement over traditional library files. Furthermore, by removing unapproved component libraries from the workplace and replacing them with a centralized component database that is exposed through a network-accessible service, the integrity of design outputs can be assured and design spins reduced.

As designs continue to evolve and ultimately emerge from the design team, the use of SVN and Commit Tokens ensure the design's history is tracked to a fine level of granularity and the volume of change can be readily monitored and/or throttled as needed - i.e. when nearing an important release milestone. As organizations begin to master control over their design data, the design processes can be steadily improved and a culture of continuous improvement adopted - ultimately resulting in better design team efficiency, shorter times to market and additional savings from the decreased number of design spins.

Conclusion

CADmium has been developed in response to the growing need for electronics product creators to bring stronger design data management practices to their engineering teams and to integrate their electronics design processes with existing enterprise-level PLM, PDM and ERP systems. By combining industry leading version control and database technologies with a collection of purpose built services that streamline the data management experience, it represents an open Design Data Management system that supports multiple OS platforms that integrates seamlessly with well-established IT systems and infrastructure.

While the example provided in this whitepaper targets Altium Designer as the design tool, the principles guiding the creation of CADmium and its architecture can be equally applied to other design tools. Custom Enterprise Adapters can also be created to provide deep integration with existing enterprise-level PLM, PDM and ERP systems.

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