Assessment of the OpenAccess Standard: Insights on the new EDA Industry Standard from Hewlett-Packard, a Beta Partner and Contributing Developer

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Abstract

The rapidly increasing complexity and quality requirements of integrated circuit design can only be addressed effectively by a design system architecture that supports very efficient, high-quality sharing of IC design data. The OpenAccess Coalition is delivering an industry standard Application Programming Interface (API) and Information Model (IM) that provides access to a shared database as an essential infrastructure component for modern IC design systems. The OpenAccess Standard IM[1] and API, along with its reference implementation will be released to the industry early in 2003. Hewlett-Packard has participated in OpenAccess from the outset and most recently as a Beta evaluation partner for this OA industry release. HP has discovered many insights about the OpenAccess standardization process as well as specifically about the IM/API Standard and its reference implementation, which will be summarized herein, and explained in more detail during the presentation at the ISQED Conference.

1. Motivation for an Open, Industry Standard API & EDA Platform

1.1. Introduction

Integrated circuit design is seldom a simple, serial process that moves steadily forward from initial specification to final mask generation. Analysis performed during the latter phases of design frequently uncovers critical design problems that can only be fixed by revisiting earlier design stages. Such design loops are a primary contributor to missed chip development schedules, particularly when the loop time is large and when loop convergence is unpredictable. The increasing complexity of next generation process technology contributes additional new challenges to be considered in each succeeding IC generation. Design closure and quality challenges are driving the industry from a practice of communicating IC design data via translation of sequentially formatted files to a tightly integrated architecture based upon a common direct-access database with multiple applications that interact with each other and the database through a common Information Model and API [1].

1.2. Overview of The OpenAccess Coalition

During the last several years, many EDA user companies and commercial EDA companies have been independently developing their own integrated tool suites, each around a proprietary IM/API. Recognizing that the industry was progressing rapidly towards many incompatible solutions, a group of EDA user companies representing both IC manufacturing and VLSI design – ASIC and custom -- joined together with 3 EDA vendor companies to form the OpenAccess Coalition (OAC) in the fall of 1999. The intent of the OAC was to establish a common, open, industry standard design data IM and API through which EDA tools from many sources could interoperate with a central database which supported this standard IM/API. The OAC founders recognized that more than just a solid technical solution was required to create a widely adopted industry standard IM/API. The following key success factors were identified:

- Technically sound & sufficiently complete IM/API.
- Membership in the OAC from a broad spectrum of the EDA vendor & user community.
- Broad and active participation from the industry, especially from the coalition.

[1] *An Information Model (IM) for design data specifies the semantics of, and relationships between, the software abstractions of IC circuit elements that are made publicly visible in the Application Programming Interface (API).*

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- Binary reference implementation & source code widely available at little or no cost:
  - Minimal barrier for use in universities & small EDA startups.
  - Binary & source access which enables adopters to quickly respond to user issues and provide support.
  - Like open-source, the standard should be able to benefit from development among the user community.
- No single company shall have sole control over the standard.
- No single company shall derive an unfair advantage due to its participation.
- All companies should be able to derive advantage through participation.
- Promotion of the IM/API as an industry standard.

As listed above, the OAC member companies agreed to not only contribute funding for the effort, but also to contribute engineering resources and provide active development that would help advance the standard. OAC membership is open to any company willing to make such commitments. In return for their commitment, member companies are given direct input into the technical direction and priorities applied to the standardization process.

Many previous efforts to establish a "paper standard" API had failed for lack of a widely available and strongly supported reference implementation database, and IM. A reference implementation is essential for verifying IM/API compliance. To encourage rapid industry adoption, the reference implementation should be made available for use within commercial tools and production EDA systems.

Finally, in order to encourage use by universities and startup EDA companies, the OAC required that the reference implementation and source code be made widely available at little or no cost. Among the founding members of the OAC was Cadence Design Systems who has offered the API, IM, reference implementation and source code of their next generation database to be publicly available and distributed, thus allowing OAC to provide a solution that meets all of these requirements [3,4]. Full availability of source code for the reference implementation enables future industry contribution, and provides for more responsive support and debugging (especially for companies accustomed to an internal proprietary systems.)

Fully supporting these objectives, the OpenAccess Version 2 (OA V2) release (including IM/API, reference implementation and documentation) will be released to the general public in early 2003.

2. Hewlett-Packard Participation in the OAC Standard Effort

2.1. High Level Overview of HP's participation in the OAC Effort.

Along with other members of the OpenAccess Coalition, HP has made a strong commitment of EDA talent and database expertise to contribute to the success of the OpenAccess Standard. HP supports the establishment of a common Industry Standard IM/API with a reference database implementation, and has contributed and participated in the following ways:

- HP was one of the original sponsors of OAC;
- HP chaired the Design Technology Council when the decision was made to establish the OpenAccess Coalition.
- As of Dec 2002, HP has participated (or is participating) in 6 Working Groups: Extensibility, Occurrence, Parasitics, Logical-Physical Hierarchical Mapping, TechnologyDB and Interoperability Bridge Working Groups.
- HP is a member of the Change Team.
- HP engineers have attended the OpenAccess version 2 (OA V2) training.
- HP participated in the OA V2 Beta program.

Finally, HP is a strong advocate for defining the mappings to key, open file formats and key, open databases in the industry as an important OAC responsibility.

2.2. HP's Experience in OA Working Groups

HP has participated in every technical working group since the inception of OpenAccess. In HP's experience, the working groups operate in a similar manner to an in-house infrastructure design team. Typical activities include requirements specification, use case/scenario specification, information modeling, API and header file design, and creation of code examples. Although the public design and interface is the primary focus of the working group activities, experienced software designers know that private implementation considerations cannot always be ignored. In such cases, the impacts of implementation alternatives are explored in order to create an interface design that will allow for a variety of implementation choices.

Each working group has had a minimum of 4 participants from 4 different companies (usually including a senior Si2 engineer). Despite the multi-company participation (often across international time zones), the OpenAccess working groups have been well attended and very effective at making steady progress. This is, in part,

due to the high quality of the engineers working on OpenAccess and their shared vision of the primary objectives of the OAC. Although there is often a broad range of inputs, similarities in each companies needs are generally found, with only occasional significant differences. Si2's technical and business leadership has been very effective at hosting and facilitating meetings and driving an objective decision making process when conflicting views do arise. Finally, the working group leadership is very conscientious about respecting the time of each participant and balances the use of phone conferences with email and internet-based tools very well.

2.3. HP's role as a "Beta Partner"

HP participated in a three-pronged evaluation in the role of an Early Beta Partner for OA V2. The three prongs consisted of

- OA training evaluation
- Documentation and Source Code evaluation of the OA V2 reference implementation.
- Performance and Capacity evaluation of the OA V2 reference implementation.

The "training evaluation" involved taking the training class, learning the material and providing feedback on the three-day event to improve the training material and course content for future training events.

The "evaluation of the API documentation" involved downloading the HTML package from the OpenEDA web site, installing it on HP's internal web site for local access, and then using the documentation throughout the project. The "evaluation of the source code" involved downloading the source code from the Si2/OAC site, installing it in the HP internal CAD manufacturing system, commencing nightly builds, and testing compilation for multiple platforms. Some code inspection was also involved, including some actual experiments with alternative implementations of the OA V2 code.

The "evaluation of the reference implementation" involved measuring performance, memory capacity and disk capacity as compared with existing HP internal tools using HP internal design data and test cases. Test cases were selected if they were representative of the kinds of iterations and traversals used frequently in the HP internal tool algorithms. The evaluation first identified the most fundamental and prolific database elements used in our typical microprocessor designs. Tests were done to determine average speed for creating, searching for, deleting, saving, and loading of these database objects. The tests were focused on identifying scalability issues with the reference implementation, while assessing overall performance and memory usage.

2.4. HP's experience as a "Beta Partner"

The Beta effort has served to build additional confidence within HP for the new OpenAccess reference implementation and the OA Standard. The key message that HP wishes to share with the industry as a result of the early and detailed analysis on the OA v2 software is the following:

- The Code Quality was generally excellent. This may in part be attributed to a comprehensive database test suite with a code coverage exceeding 95%.
- The code was self-consistent, well-written, well-structured, very modular and well encapsulated. This code was developed with the intent of making the source open to public scrutiny.
- The OA software build and release infrastructure readily integrated into the HP internal CAD manufacturing system.
- There exists an excellent base of quality on-line documentation for the OA reference implementation, IM and API.
- Additional work remains in fully documenting the details of the more subtle semantics of the IM and/or API.
- The measured performance of the reference implementation database was comparable to the HP internal database. (This is considered very good.)
- Capacity utilization of OA v2 was more efficient than the internal HP Database, which has been significantly tuned for IC design over the last decade.
- HP received excellent response from Cadence in support of the beta evaluation. This included not only bug fixes and answers to questions, but also a willingness to accept constructive criticism, suggestions for change, and a clear hunger for early feedback on tuning the base implementation.

Additional details will be shared during the oral presentation at the ISQED conference in March 2003.

3. Next Steps in the HP OAC Progression

The HP Beta experience was typical of HP's wide range of positive experiences thus far with OpenAccess. HP considers the Beta evaluation of OA V2 to have been a success for HP, OAC and the industry at large. HP will continue to engage in supporting the overall objectives of the OAC.

With the success of the OA V2 Beta effort, HP will continue to work closely with other development partner companies to rapidly mature the OA reference implementation and expand the base IM/API to include native operations for new data types such as parasitic, logical, IC process technology, occurrence and timing.

Non-IM additions will include an extensibility API, and database interoperability via standard I/O formats and direct DB integrations. Additional experiments on the future revisions of the OA reference implementation will be accomplished to validate robustness in a production environment.

HP is aggressively moving internal EDA applications to the OA V2 API as well. In addition to testing these internal applications, early flow and integration testing will be performed with commercial applications that are early adopters of the OA V2 API.

Broad industry acceptance is an important next step for the OA Standard. The OAC intends to continue interactions with EDA industry leaders in order to identify a way that all major commercial EDA vendors can support the OAC IM/API standard. HP will join the OAC in efforts to influence all EDA companies to support this API standard. Universities will also be encouraged to utilize the standard for algorithm implementations, benchmarks, tool/methodology prototyping and even CAD database research.

The real win for the industry comes when commercial EDA providers and internal EDA organizations can unify on the same infrastructure standard, or at a minimum, have open and available interchange points at the API level.

4. The Beneficiaries of OAC

As the OAC Standard is released to the industry, there is an expectation that the entire industry will benefit from this standard, enabling EDA application developers from universities, EDA vendors, and user company internal EDA groups to focus on developing next generation algorithms needed to meet the challenges of future IC design.

IC design companies will benefit by having the ability to plug together tools from various vendors more easily, enabling a tool flow that meets the specific needs of that company. Companies with internal EDA development teams will be able to easily integrate their point tool solutions with the tools from commercial EDA companies. Integration cost savings can be significant as explained by Richard Goering as he analyzed the 2002 EDA Cost of Ownership Survey conducted by Si2, Gartner Group, and EETimes [2]. This study states that for every $1 spent on commercial EDA tools, an additional $2 was spent to support those purchases, with $0.57 spent directly on tool integration software development.

Large commercial EDA companies will benefit by reducing the cost of purchasing and integrating the technologies of smaller EDA companies. This integration has historically been a very significant issue for the larger EDA companies. As stated in the Cost of Ownership Survey, the customer companies will have more funds to invest in commercial tools because of the savings in integration costs. Many large EDA customers (including HP) do not currently use various external point tools because of the barrier and cost of tool integration, both for the purpose of initial benchmark testing, and then later to fully integrate these tools into production flows. A standard IM/API will help resolve this issue, and enable EDA companies to capture larger application market share.

Smaller commercial EDA companies will benefit by having a solid database infrastructure, and the ability to plug and play within the structure of industry standard infrastructures. They will be able to focus their development investment on their real value add, which is typically the next generation algorithms needed to solve a point technology challenge.

Universities will also benefit from using a standard IM/API and reference database. Universities will be able to rapidly conduct research and develop prototypes on a robust platform. Using a common platform will make their research immediately accessible by the EDA providers and the IC development community. This would raise the practical value of their research and development. Given the common IM/API and opportunity to use a common reference database platform, the IC design industry can find it much easier to provide significant "real data" test cases for the universities to use in their prototyping. Furthermore, making the reference platform source code available enables university research into new database technologies that can be applied to this industry standard as well.

5. Conclusions

The industry faced a serious communication bottleneck as dozens of proprietary IM/API/DBs were under construction throughout the industry. The OpenAccess Coalition has joined together to push for a common, open, industry standard IM/API. The Coalition is also engaged in providing an open reference database implementation of the standard IM/API that the industry can use at little or no cost, enabling a rapid deployment of the OAC standard IM/API. By sponsoring a standard IM/API and a reference database, the OAC believes that the industry as a whole can benefit from a rapid move to a more integrated architecture, and enable EDA application developers from universities, EDA vendors, and user EDA groups to focus on developing next generation algorithms needed to meet the challenges of future IC design. HP is supporting this standard through efforts including the OA V2 Beta evaluation. These efforts are establishing a positive track record of success for this new industry standard.

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7. References

[1] T. Blanchard, et. al., "The OpenAccess Coalition -- The Drive to an Open Industry Standard Information Model, API, and Reference Implementation for IC Design Data", ISQED, March 2002.

[2] R. Goering, "No Progress Seen in Interoperability since '94", *EE Times*, Nov 25, 2002, pp. 39.

[3] ***www.OpenEDA.org/openaccess.***

[4] ***www.si2.org***.