OpenDB, OpenROAD's Database

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https://github.com/The-OpenROAD-Project/OpenDB

***Abstract*— Open Source EDA has been progressing along a 1980's style EDA tool flow with each tool reading standard formats like Liberty, LEF, DEF, Verilog, and other design files, doing some processing, and writing results in standard formats. This 1980's style EDA tool flow worked well until process technologies' complexity necessitated iterations to previous steps in the flow to account for unexpected device performance. Initially these loops back to previous flow steps were performed as the whole flow was, via file based transfers. As design sizes grew, in the 1990's, it was discovered that more time was being spent reading and writing files than actually processing and optimizing designs in the EDA tools. During this time period the EDA industry as a whole discovered that for an EDA tool system to be efficient, all of the applications from initial netlist through routing needed to be on a shared incremental database with access to incremental performance analysis engines including static timing, delay calculation, routing and congestion estimation.**

I. Introduction

At the core of all Industrial EDA tools is an incremental infrastructure which requires an incremental database. For open source EDA to be successful and for research based on it to advance the leading edge of EDA technology, open source EDA will need an efficient incremental database as the core of an incremental infrastructure.

The Open Access database donated to Si2 by Cadence in the early 2000's showed a lot of promise in providing an open source robust EDA database. The Open Access database is however not open source but requires a license. This requirement was unacceptable to the OpenROAD sponsor DARPA. The OpenROAD effort therefore went in search of another database and has worked with its owner to open source it on github with the BSD-3 permissive license.

This paper provides an overview of the OpenROAD open source database named OpenDB. The overview of the database will cover its primary features. It will also cover areas where further development is needed.

The source code for the database is located on github at https://github.com/The-OpenROAD-Project/OpenDB

II. Features of OpenDB

OpenDB is an EDA database or more correctly an EDA physical data model which is capable of representing the netlist connectivity and the physical information of a VLSI cell based design. More specifically, it is able to store all of the information contained in the LEF/DEF standard. It supports N levels of physical hierarchy. Open DB also supports a robust sparse property mechanism which allow properties on objects to be efficiently stored. Dense properties that exist on the vast majority of objects are part of the data model itself. In order to optimize memory use, OpenDB supports optimized routed wire geometry storage. It also supports a full physical search of objects by type, objects in a region, and other searches often needed in the implementation of a design viewer and editor.

OpenDB also provides a LEF/DEF reader and the ability to read those formats into the data model and store the information persistently on disk for much faster rereading and incremental editing of the design. It also supports export of LEF/DEF/GDSII.

At the time of this writing OpenDB supports all of LEF/DEF 5.6 with 5.8 support currently being implemented.

The API is very straightforward and easy to learn. For example here is sample code to iterate all of the nets in a design and count the number of connected instance terminals.

```
size_t CountNets(dbSet<dbNet> &nets) {
  size_t pinCNT = 0;
  size_t netCNT = nets.size();
  dbSet<dbNet>::iterator nIter;
  for(nIter = nets.begin(); nIter != nets.end(); ++nIter) {
    dbNet* curDnet = *nIter;
    pinCNT += curDnet->getITermCount() +
                    curDnet->getBTermCount();
  }
return pinCNT;
}
```

OpenDB also supports storing detailed parasitic information for use in delay calculation.

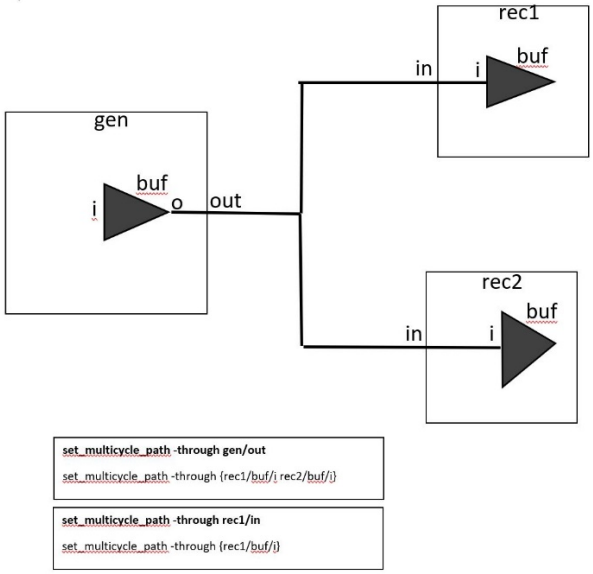
III. Features that need to be added to OpenDB

At the time of this writing there are some features that we would like to see added to OpenDB.

- Verilog logical hierarchy which is kept synchronized with the DEF view during netlist editing and optimization
- Notification mechanism for applications to subscribe to during netlist editing
- Multi-mode SDC schema
- Multi-corner delay information
- SPEF reader and writer for data model
- TCL API
- Python API

OpenDB as it is today has the features necessary for the first production release of OpenROAD in July 2020. However the additions listed above will bring the database closer to its industrial counterparts so that research which is performed on this infrastructure will become increasingly relevant to industry and to the developers of the industrial tools.

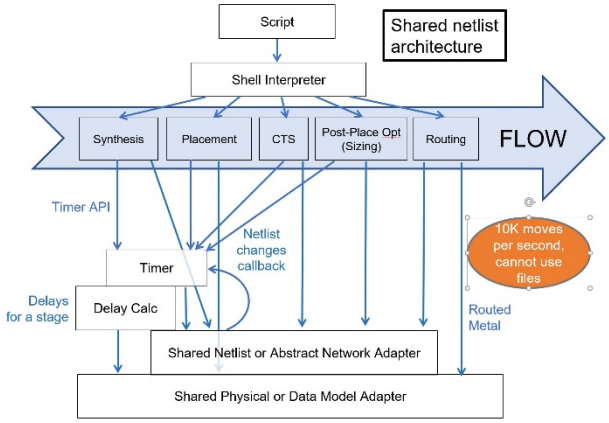
For example, in the research context complex timing constraints, multi-mode and multi-corner analysis are rarely considered. Also the flow of timing constraints from their being placed on RTL hierarchical objects and migrating to leaf level objects in the flattened view is rarely considered



whereas this flow of information is critical in a real design flow.

Another example is the need for the various steps in the EDA flow to have a shared incremental data model versus communicating via files as was done in industry in the 1980's. Many research papers are based on code using this 1980's EDA architecture.

Having a database which can support an embedded incremental static timing analyzer is also key. As of the writing of this paper the OpenROAD tool set is being integrated onto OpenDB in much the same way as the EDA industry has integrated all steps in the flow on to a common database and timing engine.



The OpenDB database becoming open source with a permissive license is an exciting development for open source EDA and for the mission of OpenROAD which is to create an open source tool chain capable of going from RTL to GDSII. This tool chain will be a vehicle for significant research whose output can have strong relevance to industrial EDA and foster technology advances.

Acknowledgment

I would like to acknowledge Dimitris Fotakis the former CEO of Athena Design Systems who made the open sourcing of OpenDB possible.

References

[1] Repository : https://github.com/The-OpenROAD-Project/OpenDB