The Big Brain Theory - Visualizing SoC Design & Verification Data

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Introduction

Collection, analysis and visualization of design and verification data is what we do, in our daily design/verification workflows, helped along by our favorite D/V methodologies and EDA tools. Successful teams get more out of the data they capture and how they use it, and avoid being overwhelmed by too much of the wrong data or the wrong kinds of processing. Recognizing that value, and amplifying it, is the next step to process maturity.

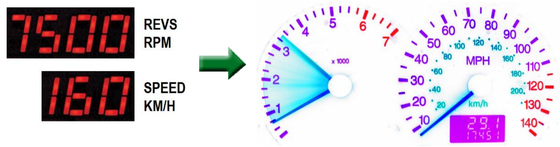
The biggest challenge we face is maximizing utilization of the best design/verification tool we possess - our engineering brains.

Their performance is limited by the rate we feed them with meaningful data - data at the right level of detail or abstraction to solve the problem at hand, and ideally data which is presented in a fluid, visual form to make the most of our parallel processing superpowers.

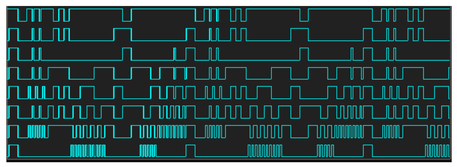
Advanced data visualization techniques are becoming standard practice in other industries and they can be leveraged in ours. We must pay heed to the challenges of managing 'Big Data' in our domain, so that it works for us rather than overwhelming us.

Data Management – Size, Shape, Dimensionality

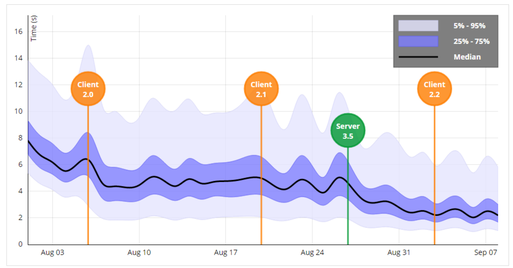
Is there such a thing as Static Design Data?



Dynamic Data – the Temporal Dimension
Hierarchical Data – the Vertical Dimension



Data Across Time – the Historical Dimension



Data Visualization – Distance and Focus

Learn from the principles of centuries of scientific endeavor and the instruments used to present information in a meaningful way.

General principles to follow here are simple but often overlooked or only partially implemented as a favor to the user. These should always be implemented:

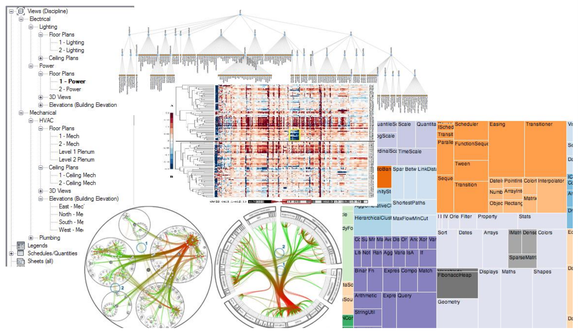
1. Where more detail is available below this data item, announce its existence and invite elaboration
2. Where more context is available above this data item, announce its presence and invite exploration
3. Where relationships or linkage exists between two or more data items, announce their existence and invite investigation
4. Where membership of a class of item is denoted by an attribute, denote that clearly and invite filtering, searching, and association

Data Filtering – Distractions and Indicators

There are bad distractions (requiring filtering) and good distractions (requiring smooth context switch and motion when navigating the data set). Some general principles in this area are worthy of mention and discussion:

1. When switching context vertically, horizontally, or via linkage, preserve sufficient context of origin to reinforce the relationship
2. When elaborating detail on an item, retain sufficient context to reinforce the membership that detail has of the original item
3. When ascending data hierarchy, retain sufficient depth of open detail to link the two levels of data with a degree of persistence

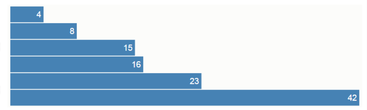
Examples of Design data visualization of different kinds of data structures and recorded series:



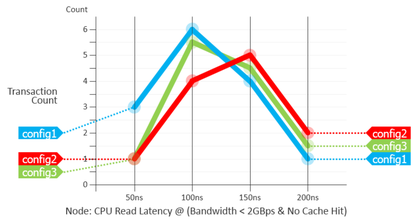
The D3.js Data Visualization Library

Combines Web HTML, CSS, SVG (Scalar Vector Graphics) and JavaScript enabling compelling interactive visualization solutions.

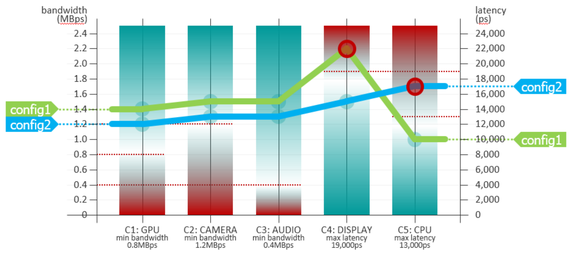
```
var data = [4, 8, 15, 16, 23, 42];
var width = 420,
    barHeight = 20;
var x = d3.scale.linear()
    .domain([0, d3.max(data)])
    .range([0, width]);
var chart = d3.select(".chart")
    .attr("width", width)
    .attr("height", barHeight * data.length);
var bar = chart.selectAll("g")
    .data(data)
  .enter().append("g")
    .attr("transform", function(d, i) { return "translate(0," + i * barHeight + ")"; });
bar.append("rect")
    .attr("width", x)
    .attr("height", barHeight - 1);
bar.append("text")
    .attr("x", function(d) { return x(d) - 3; })
    .attr("y", barHeight / 2)
    .attr("dy", ".35em")
    .text(function(d) { return d; });
```



Complex visualizations can be built from these idioms, the result is a very high performance, scalable, flexible implementation.



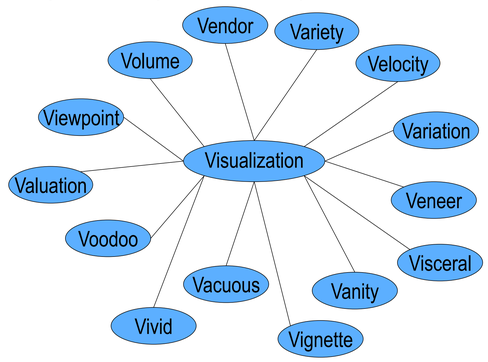
Rich data sets can be combined and overlaid in a configurable manner including features for interaction, animation, hovering and adjustment by mouse or touch interfaces.



Some examples of SoC data visualization using the D3.js library:

Scaling Things Up – Big Data

SoC Design/Verification is a Big Data problem today – but we are only scratching the surface of data analysis and presentation. IBM observes the "Three V's of Big Data Analytics": Volume, Variety, and Velocity. There are many more V's we can think of:



Volume is the size of each transmitted/ processed/ consumed item of data, in records, transactions, or terabytes. Challenges with increased data volume: storage capacity, accessibility, latency. Caching, parallel storage and processing are common when we need to find quick answers by trawling large data sets.

Variety of data at this larger scale is diverse, leading to complex relationships and degrees of structure and indexing in order to get value from the data. Big data is not "new" but organizations that have "hoarded" data now realize the value and are turning to analysis, need to correlate many disparate data sets.

Velocity is the rate at which data is being generated and consumed. It may be near real time, or batches of historical data. Technology can be applied in different ways to get the data feeds from A to B, i.e. out of A quickly so that A can get on with its normal function and produce more data, and stored in B where it can be later analyzed in the required timeframe.

With increased use of hardware emulators and FPGA prototyping platforms as accelerated simulators, there is more emphasis on Volume, Variety and Velocity in our data capture and processing challenges. Our industry still thrives on "throwaway" data and does not lean enough from cumulative / historical data.
That tipping point has yet to arrive but with current SoC design Emulation capacity it is not far away. Watch this space.

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