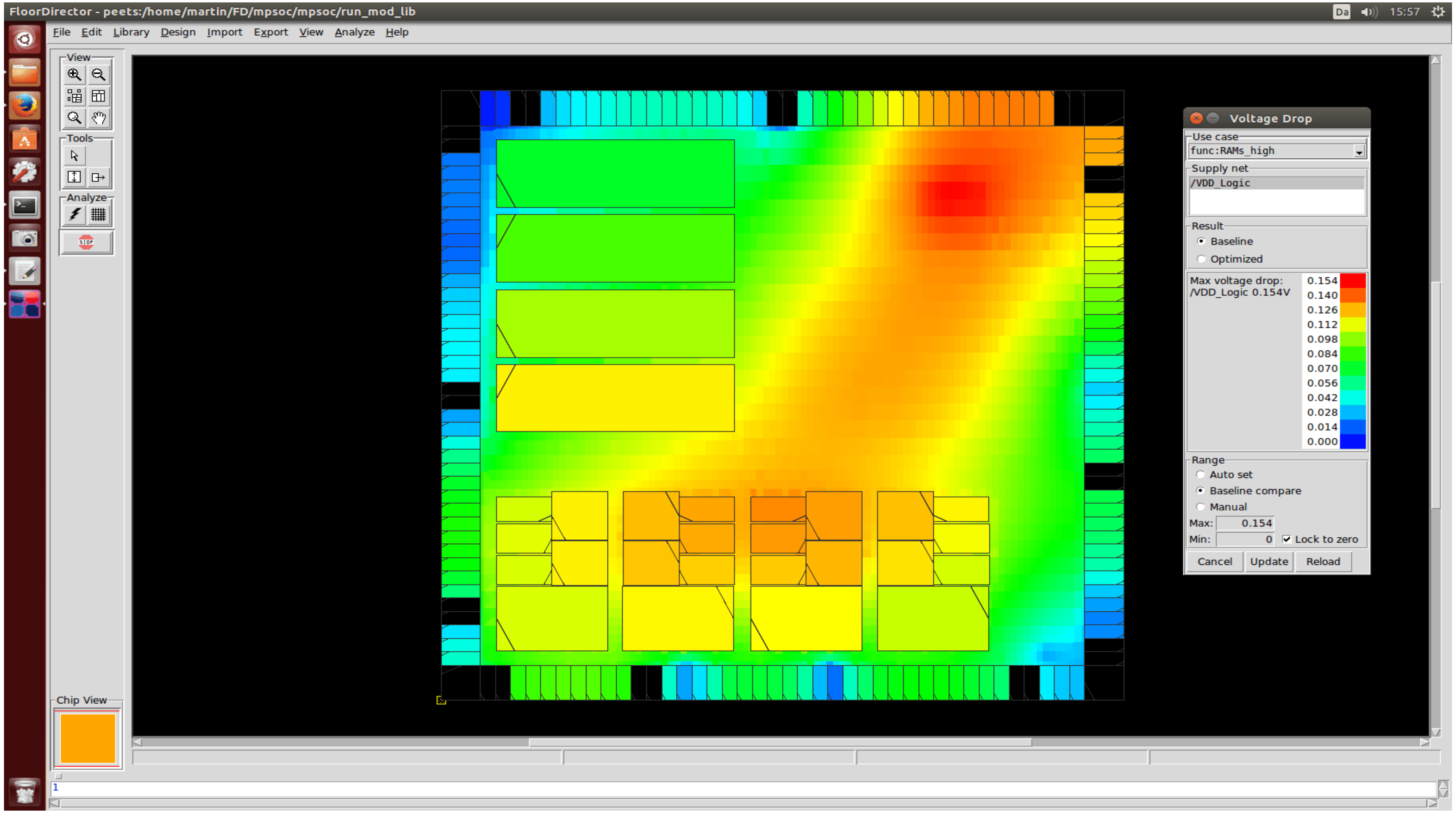
Dynamic Voltage Drop

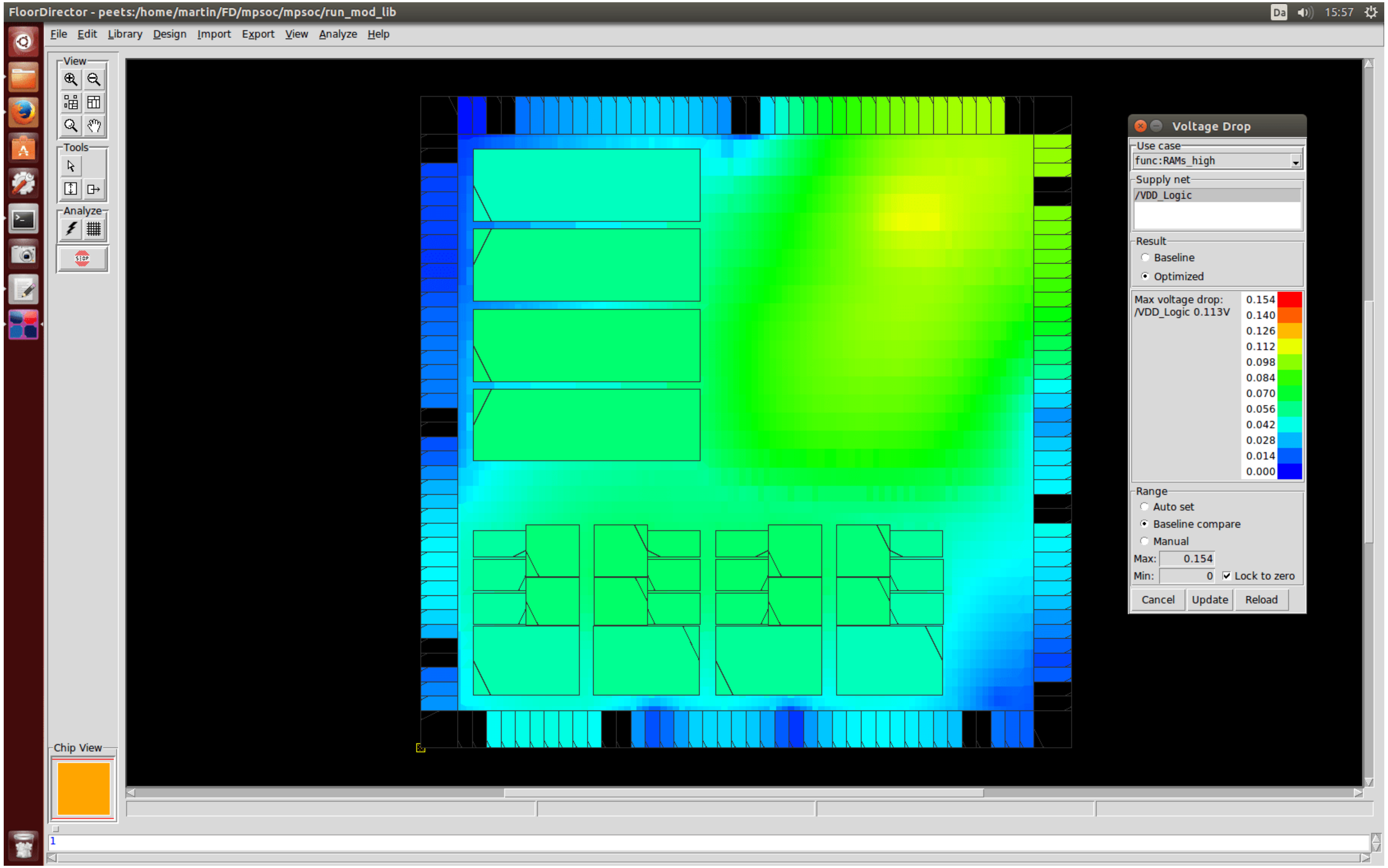
By: Engineer.Rawan Adel

- Dynamic voltage (IR) drop, in contrast to the static voltage drop depends on the switching activity of the design, and hence it is vector dependent.
- It concerns have grown substantially at the 10nm and 7nm silicon process nodes.
- It refers to the transient voltage drop that a local power grid on a chip might experience if there is a rapid change in current.
- Beefing up the power grid metal might seem to be the obvious fix, but, at these process nodes, metal is scarce; there is not enough to provide both signal routing and a uniformly generous power grid. As many high-end designs are routability constrained, the cost of metal is high.
- A better solution is first to optimize the circuit itself, to reduce the causes of DVD, and then implement a minimal power grid, just strong enough to support the DVD targets of the optimized design.
- Because of the possibility of DVD, it is standard practice to run a dynamic power-integrity (PI) analysis as part of the tape-out sign-off process. Such analysis is highly detailed and highly accurate. But this is late in the game; your circuit implementation is locked down and you're ready to make masks. Trying to optimize against DVD at this point is difficult and time-consuming.
- It is better to optimize for DVD at the beginning of the physical implementation process – before routing. Changes are more easily accommodated at that stage, but not enough is known yet about the circuit to do full analysis. Even if we knew the implementation details, full sign-off quality DVD analysis is too time-consuming to use directly in an optimization loop.
- So, getting back to the headline topic, the question is, is there anything else available at that time to act as a proxy for DVD optimization?
- Because the underlying cause of DVD is a burst of current, it makes sense that peak current – which can be calculated at this point in the design cycle – could be such a proxy. Teklatech AEs ran some optimizations to illustrate how reducing peak power can lead to optimized DVD.
- We ran peak power optimization with no power grid. In order to check our results, we then added a power grid and ran DVD analysis to show how the peak power optimizations improved DVD. In a second optimization, we further included placement information in the optimization, to show how this improves results further. We thus did a three-way comparison in the DVD analysis: no optimization; basic peak power optimization, and placement-aware peak-power optimization.

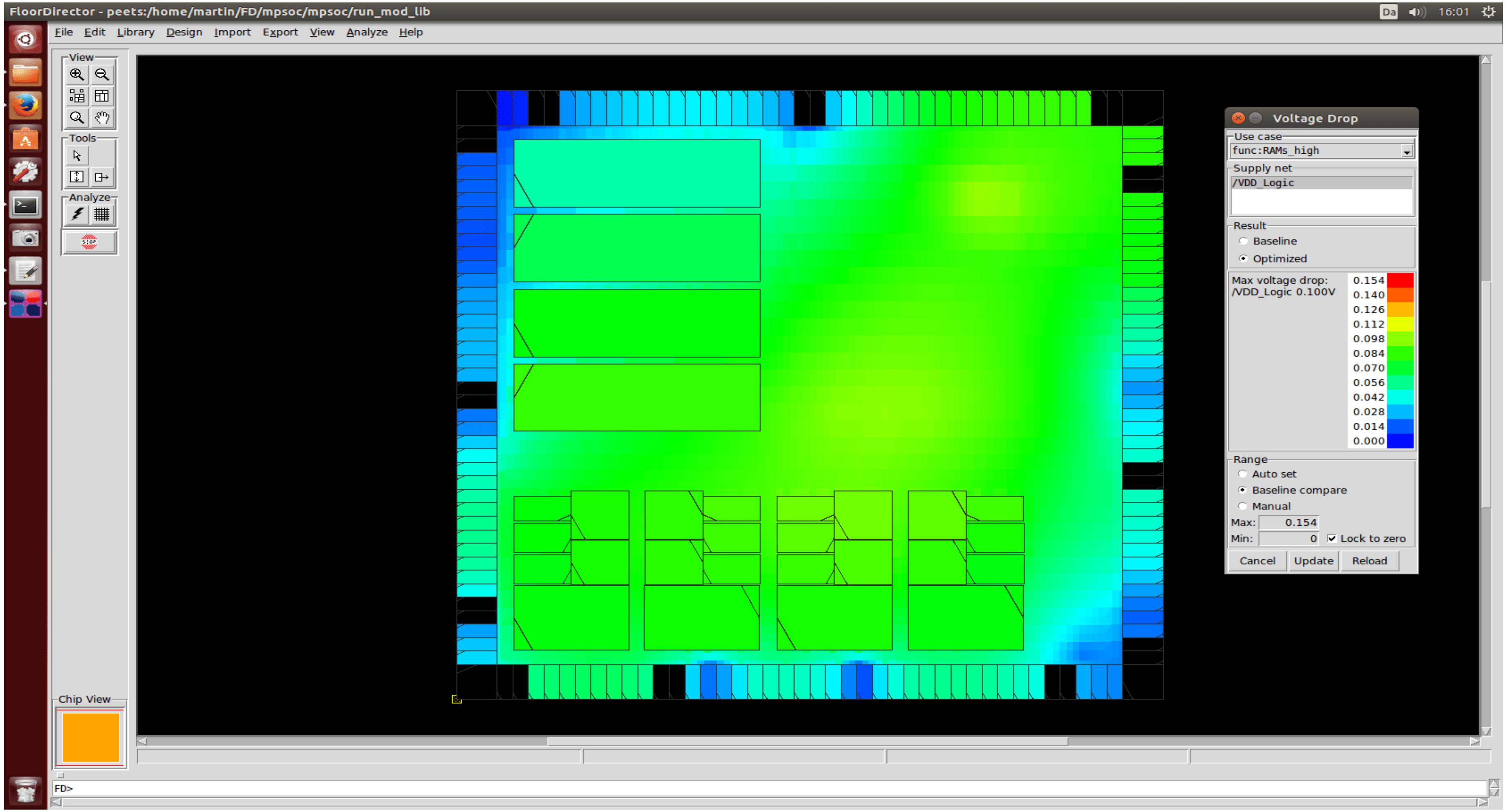
- The results are readily evident in the following images. The first one shows the baseline: no optimization performed. Significant DVD issues can be seen in the upper-right red areas.



- Running basic peak power optimization resulted in the following image. The DVD hot spot has been significantly dissolved. There is, however, still a more delicate DVD situation in the upper right than in the rest of the circuit.



- Placement-aware optimization – which we refer to as “powershape group”-based optimization, optimizing according to geographical groups of cells in the floorplan – is much more detailed, taking advantage of the known locations and proximities of the various circuits. The result of this optimization is shown next. There are no longer any significant “hot spots,” and the “coloring” of the circuit is well distributed across the die.



CONCLUSION

- This confirms that basic peak-power optimization can provide good DVD results, and that using the placement information is even more effective. Optimizing at this stage of the design flow makes it far less likely that you will run into failures during sign-off, and allows designers to spend less metal in the power grid. Furthermore, the DVD profile expresses a more even characteristic, which allows better results even in a homogeneous power grid implementation. This corresponds well to our experience: placement-aware optimization provides excellent DVD results across a wide range of circuits.