



# Benchmarking GNU Radio on Various General Purpose Processing Architectures

Nathan West

Douglas Geiger

U.S. Naval Research Laboratory  
Mobile Systems Security

May 31, 2013

Distribution Statement A: Approved for public release, distribution is unlimited



# Outline

- ▶ A Brief History
- ▶ Methodology
- ▶ Results
- ▶ Future Work



# A Brief History of GNU Radio Benchmarks

- ▶ MP-sched, 2008, Eric Blossom
- ▶ Architecture Latency Measurements, 2009, George Nychis
- ▶ VOLK, 2012, Tom Rondeau



# Benchmarking GNU Radio

We attempt to measure

- ▶ Effectiveness of multi-processor
- ▶ Time through a block

Other useful measurements (endless list)

- ▶ Total system latency
- ▶ Symbol analysis (oprofile)



# Supporting Software

- ▶ Open Embedded
- ▶ oprofile



# Benchmark Process

1. Wipe out any residual volk profile results
2. Run 10x10 mp-sched
3. volk\_math and volk\_types
4. volk profile (Determine best SIMD architectures)
5. Repeat 2 and 3

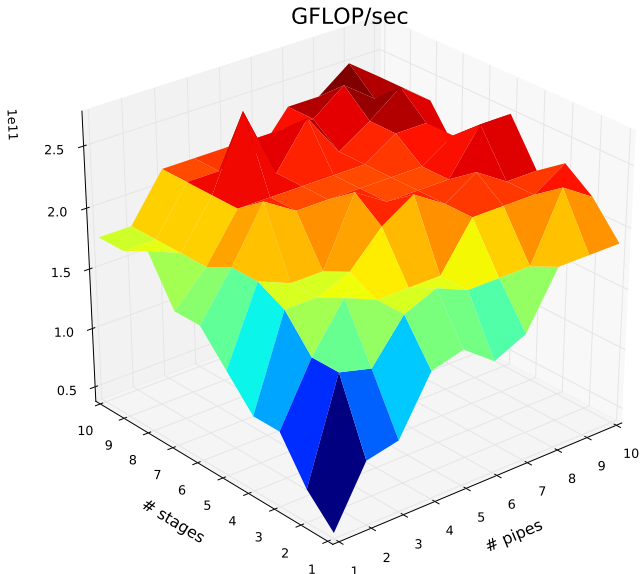


# Benchmarked Processors

- ▶ Intel i7
- ▶ Intel Atom
- ▶ AMD E350
- ▶ ARM Cortex-A8 (Ettus E110)
- ▶ Quad-core ARM Cortex-A9 (ODROID-X)
- ▶ zc702 (Zynq board)



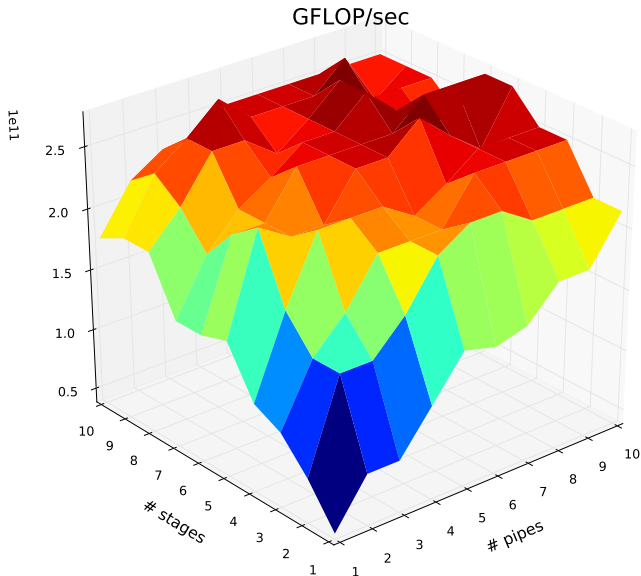
# FFT MP-sched, Atom generic kernel





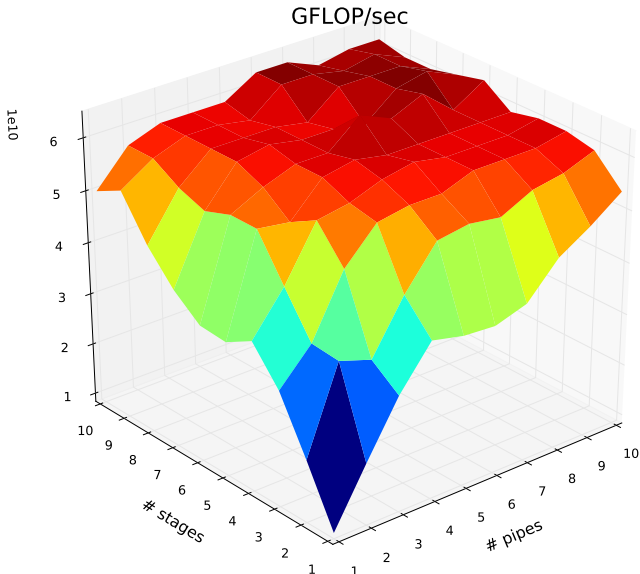


# FFT MP-sched, Atom volked kernel



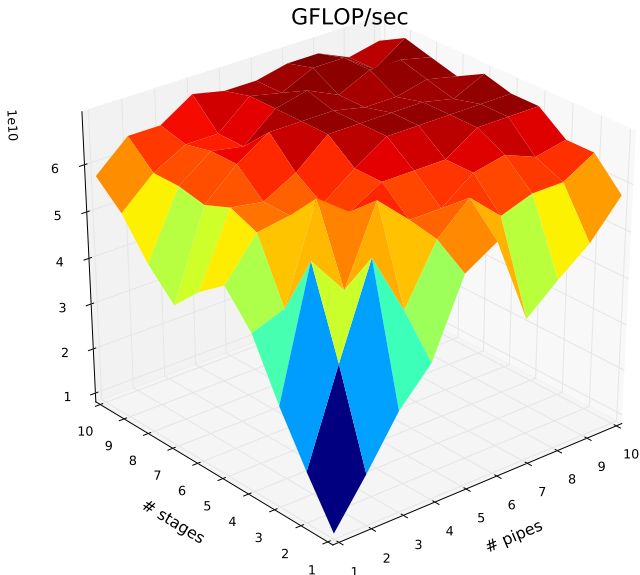


# FIR MP-sched, Atom generic kernel



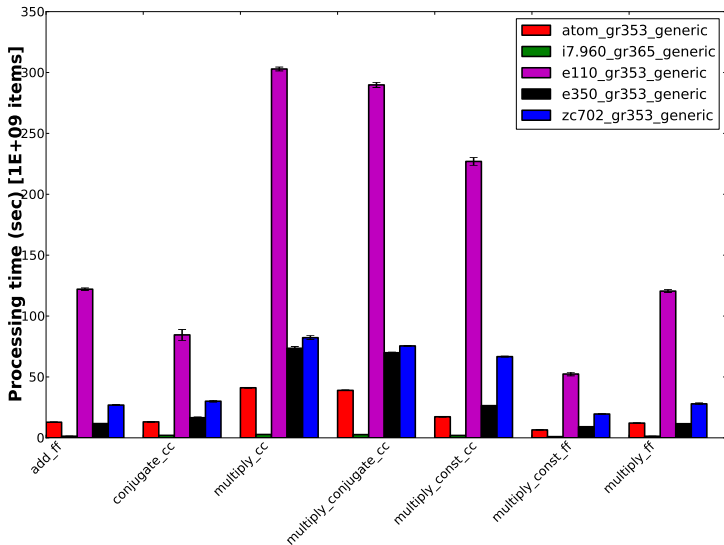


# FIR MP-sched, Atom volked kernel



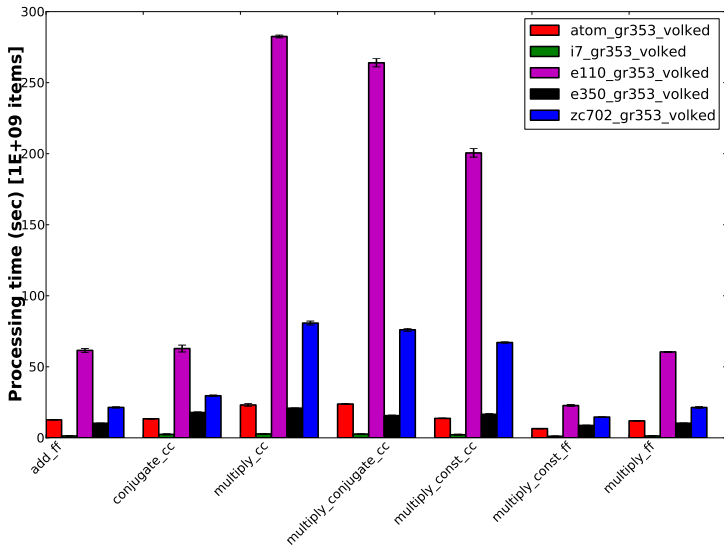


# VOLK Math: all processors generic kernels



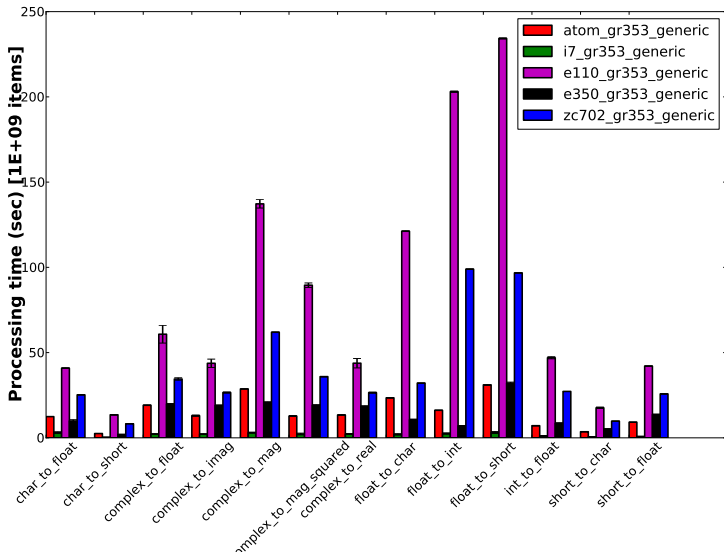


# VOLK Math: all processors volked kernels



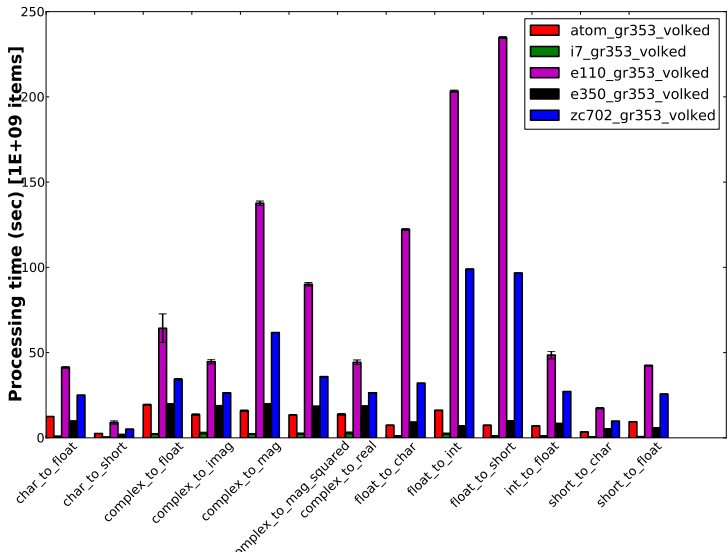


# VOLK Types: all processors generic kernels



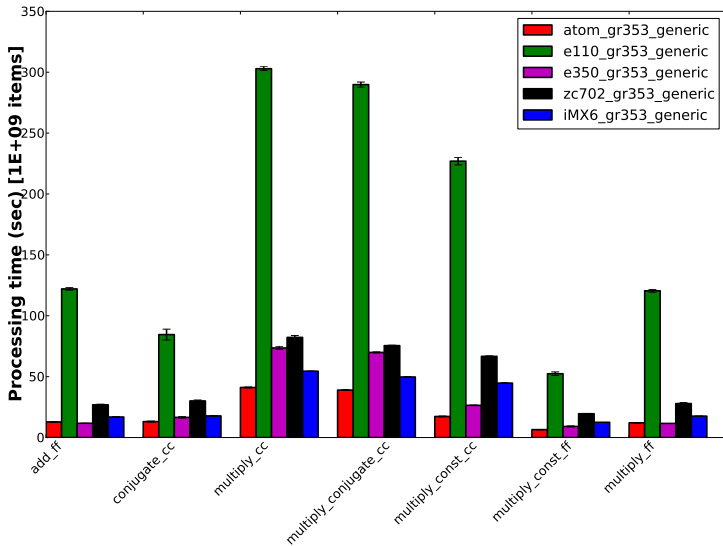


# VOLK Types: all processors volked kernels





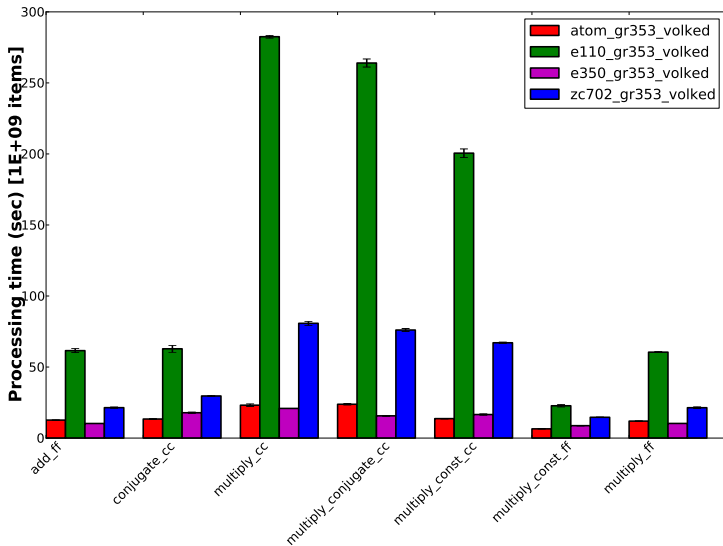
# VOLK Math: all processors (minus i7) generic kernels





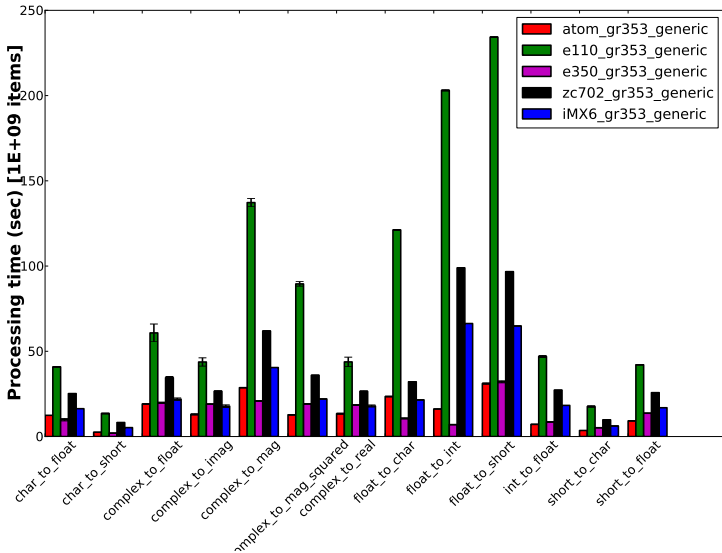


# VOLK Math: all processors (minus i7) volked kernels



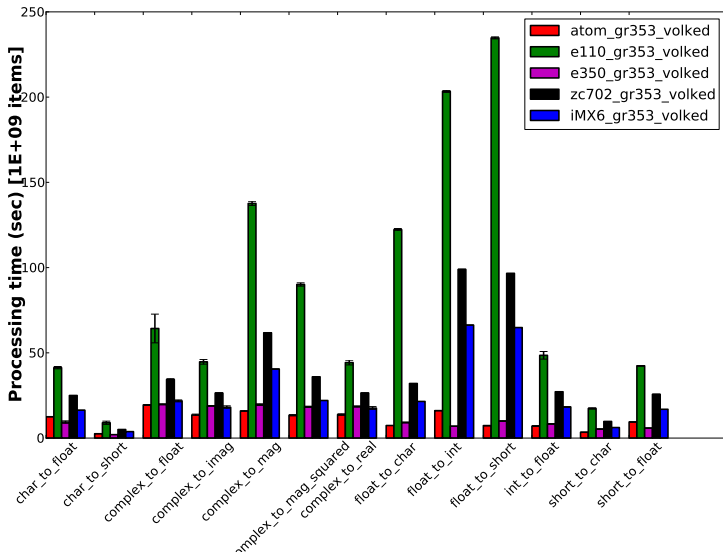


# VOLK Types: all processors (minus i7) generic kernels



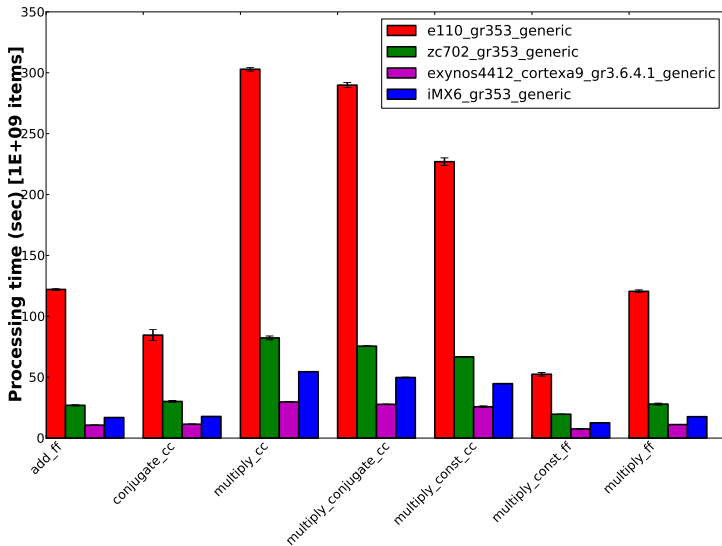


# VOLK Types: all processors (minus i7) volked kernels



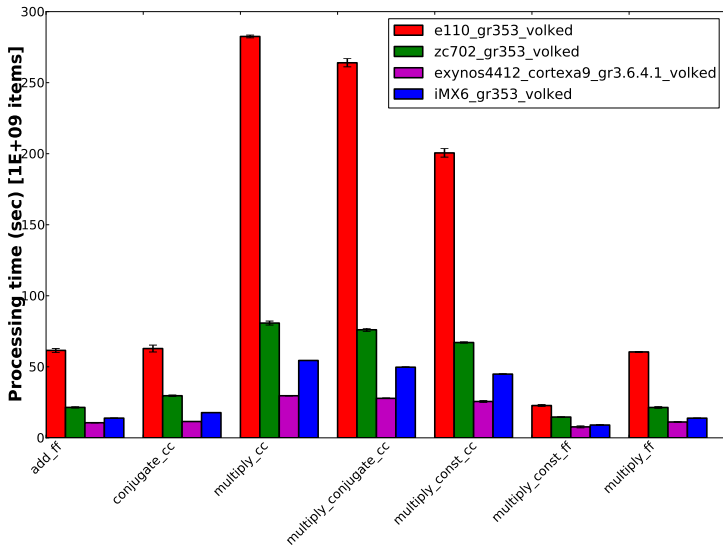


# VOLK Math: ARM processors generic kernels



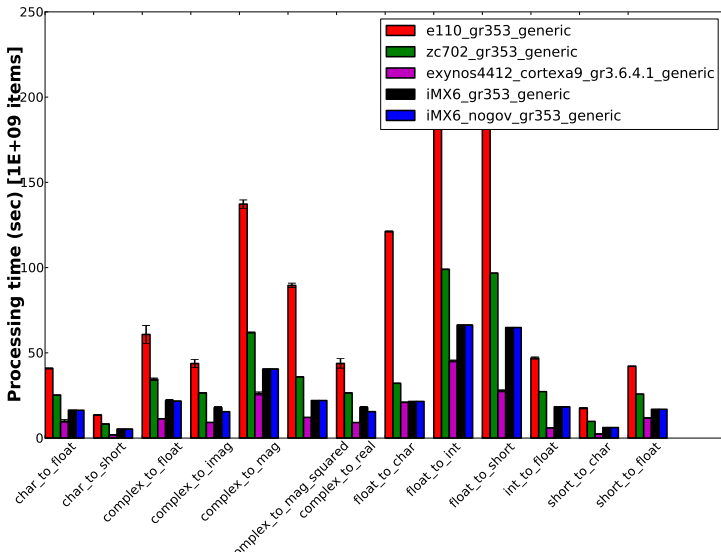


# VOLK Math: ARM processors volked kernels



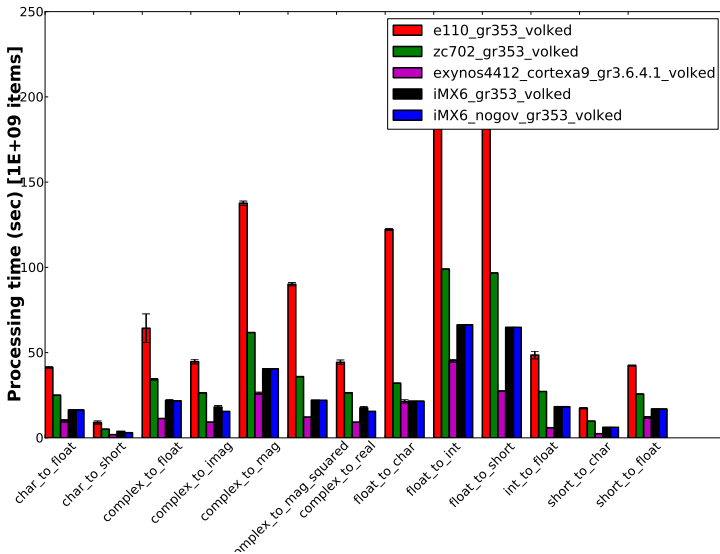


# VOLK Types: ARM processors generic kernels





# VOLK Types: ARM processors volked kernels





# Future Work

- ▶ More hardware!
- ▶ Add more tests to VOLK suite (modulation)
- ▶ Latency through graph, and to hardware





# Conclusion

- ▶ Demand for GNU Radio Benchmarks
- ▶ Using SIMD instructions is important on GPPs
- ▶ Still a lot to understand