Session 5B: Computing Performance

(co-chaired by Gabriele Cosmo, Gunter Folger and Soon Yung Jun)



Sept. 30, 2022

Computing Performance Results and Issues: CMS (1/2) Vladimir Ivantchenko (CERN/Princeton University) *et al.*

- The most time-consuming part of CMS FullSim is GEN-SIM
 - Run2 SIM: MT mode from 2017, Geant4 10.4.p03+VecGeom from 2018
- Updates for start of Run3 FullSim production
 - New software platform el8_amd64_gcc10
 - 10.7.p02 + backport of few critical patches
 - DD4hep geometry description
 - Tuned FTFP_BERT_EMM physics list
 - Three sets of parameters for tracking in field
- Further improvements for Run3 FullSim
 - Overall CPU improvement by Gamma general process,
 CMSTDormandPrince45, tracking cut (1 keV → 25 keV): ~5%
 - Speedup by advanced compiler options (LTO+PGO variant): ~10%
 - Under preparation: new platform el8-amd64-gcc11, G4FLowE (Gflash for e[±]), Geant4 11.1, Neutron general process and Transportation with MSC (to be confirmed)



Computing Performance Results and Issues: CMS (2/2)

- Problems with Phase-2 simulation
 - Phase-2 geometry includes a novel HGCal fine grain calorimeter
- Performance (CPU and RSS) per event
 - Run3 geometry (2021) and Phase-2 geometry (2026D88)
 - 5 physics lists, FTFP, + {EMM, EMN, EMY, EMZ}

		2021	Setup			2026D88	Setup	
	Min.	Bias	t-	tbar	Min.	Bias	t-	tbar
	CPU	RSS	CPU	RSS	CPU	RSS	CPU	RSS
EMM	1.000	0.75 GB	1.000	0.60 GB	1.981	0.73 GB	2.351	0.73 GB
EMN	1.078	0.75 GB	1.363	0.76 GB	3.829	1.19 GB	3.999	1.24 GB
EMY	1.585	0.76 GB	1.917	0.76 GB	3.320	0.93 GB	3.232	0.98 GB
EMZ	2.571	1.06 GB	3.558	1.06 GB	4.607	1.25 GB	5.959	1.34 GB
Standard	1.722/	0.59 GB	1.505	0.60 GB	2.854	0.74 GB	2.570	0.78 GB
							\checkmark	

- Phase-2 CMS FullSim is a challenge
 - Factor 2-3x increases in CPU depending on event type and physics configuration with respect to Run3

Computing Performance Results and Issues: ATLAS (1/2) Marilena Bandieramonte (University of Pittsburgh)

- ATLAS Run3 MC production
 - Geant4 10.6.p03.atlas03: G4AtlasRK4 stepper, G4MagInt_Driver patch, G4GammaGeneralProcess from 10.7.p02
 - 10.7 might be used for the next year MC campaign
- Geant4 optimization for Run3
 - Geant4 static linking: ~7%
 - GammaGeneralProcess: ~4.3%
 - Switch-off field in *LAr* : ~1-2%
 - p and N Russian roulette: ~10%
 - EM range cuts: ~6-7%
 - New EMEC custom solid: 5-6%
- Further optimizations: ongoing efforts
 - Woodcock tracking: ~ 7-8%

 - VecGeom integration: 2-7%



Computing Performance Results and Issues: ATLAS (2/2)

Run3 Geant4 Optimization: GRID benchmarks

BNL Cluster, 1000 Jobs 100 tt-bar events/job	Walltime,s	sigma	Uncertanty	Speedup Throughput	Speedup CPU time
Athena 22.0.47 (baseline)	28.0k	2.28k	~0.25%	-	
Athena 22.0.47+Run3Opt	21.0k	1.7k	~0.26%	33%	-25%
Athena 22.0.47+VecGeom	25.8k	2.27k	~0.28%	8,52%	-7,85%
Athena 22.0.47+VecGeom+Run3Opt	18.1k	2.64k	~0.46%	54,69%	-35,35%

- Issue: TLS impact reduction (in both 10.1 and 10.6)
 - TLS is used both in Athena (Magnetic Field) and Geant4 (geometry)
 - From single-threaded to Geant4 MT: 5-10% CPU degradation
- Many interesting longer-term developments:
 - Adoption of G4HepEM library: 7-8% in Athena
 - GPU-friendly EMEC implementation
 - New ISF particle killer
 - Integration of Quantized State System (QSS) stepper
 - ML correction for aggressive range cuts
 - EM physics tuning

G4CPT: Summary, Status and Future Updates (1/2) Julia Yarba (Fermilab)

- Regular activities: https://g4cpt.fnal.gov
 - Perform CPU and memory profiling and benchmarking for development and public releases and for specific tags as needed
 - Report results to the WG leaders and follow up issues, if any
 - Maintain and evolve the profiling infrastructure as necessary
- Snapshot of profiling campaign for the 11.0 development cycle CPU trends in Gean4 Memory (footprint) trends



G4CPT: Summary, Status and Future Updates (2/2)

Snapshot of the Geant4 MT performance (weak scaling)

CPU/Event : Geant4-Serial over Geant4-Tasking Memory/Core : Geant4-Tasking over Geant4-Serial



Migration 2021

- New hardware resources: wc-ic (intel) cluster at Fermilab
- Compiler: gcc 8.3.0
- Profiling tools: OpenISpeedshop (2.4.1) and IgProf (5.9.16)
- Ongoing migration: gcc11 (or gcc12)

Performance Analysis and Data Visualization for Geant4 (1/2) Harshil Jani (GsoC2022 student)

- Automatic performance report integrated into Jenkins: "Performance Monitoring Tools" in Plenary 2 (G. Amadio)
 - View performance differences between two versions and related metrices
 - Quickly identify performance regressions when a MR is proposed
- GSoC2022 project: Performance Data Visualization using D3.js
 Performance Analysis ⇒ Data Visualization



Performance Analysis and Data Visualization for Geant4 (2/2)

New reports will be generated and visualized for geant4-dev continuous integrations: HTML-based, interactive and plots **Report Tables**

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Flamegraphs



Scatter Plot and Spider Plot



See the performance link when you propose a merge request!

SFT Nightlies @sftnight · 1 week ago

A performance report for this merge request is available here.

Reporter

Summary

- Computing performance results and issues from CMS and ATLAS
 - Geant4 optimization campaigns keep improving MC performance
 - Challenges are still ahead for HL-LHC MC productions
- Performance monitoring and tools
 - Geant4 computing performance is regularly profiled and monitored
 - Automatic performance reports for geant4-dev continuous integrations are newly added

Thanks to all speakers and contributors, especially for preparing talks with a short notice and within a very limited time!