ATKINS

SATURN

- Running Assignments Faster

SATUGM16

Friday 4th November 2016

Final v1.1 Upload

SATGPU: Step Change in Runtimes

ATKINS

- Collaboration between Atkins, Highways England and TSC
- Specialist resources from University of Sheffield and The Hartree Centre (Science Technology Facilities Council)
- 50% / 50% private and public funding
  - demonstrate to modelling industry feasibility and value of applying GPU technology
- AND
  - provide a step change to SATURN runtimes using GPU technology

Switch to GPU Key to Roadmaps

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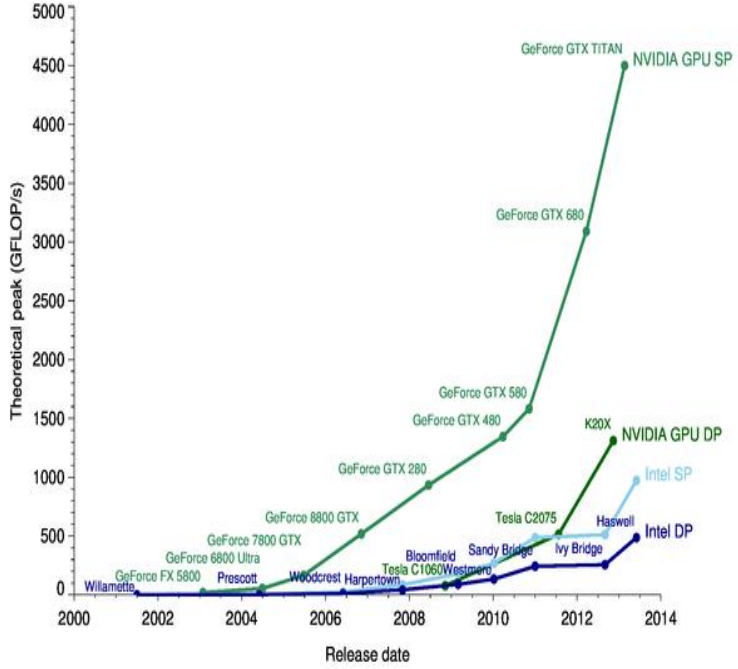
- CPU multi-threading common but limited threads (0.1 TFLOPs)
- GPU massively parallel architecture with thousands of smaller but more efficient threads designed for multiple tasks simultaneously (6 TFLOPS)
- Replace old CPU path build algorithm with new GPU optimised algorithm and make process highly parallelised
- Shortest path algorithms can be parallelised for every source-destination pair
- Software optimised for typical High Spec PC Hardware
  - HP Z820 Xeon Workstation (6C/12T) (£2k)
  - NVidia Geforce Titan X Graphics Card (£1k)



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SATURN

Evaluation Framework - Real-life models

- Representative cross-section of SATURN models
  - CLoHAM closest in size to the five RTMs

Model	Size	Zones	User Classes	Simulated Junctions	Runtimes (hrs)*	
					Single	Multi
Derby	'M'	547	13	3,686	0.47	0.14
CLoHAM	'L'	2,548	5	12,932	4.18	0.62
LoHAM	'XL'	5,194	5	25,575	15.4	1.80

** Based on Standard Test Machine (H7)*

SATGPU Headline Results

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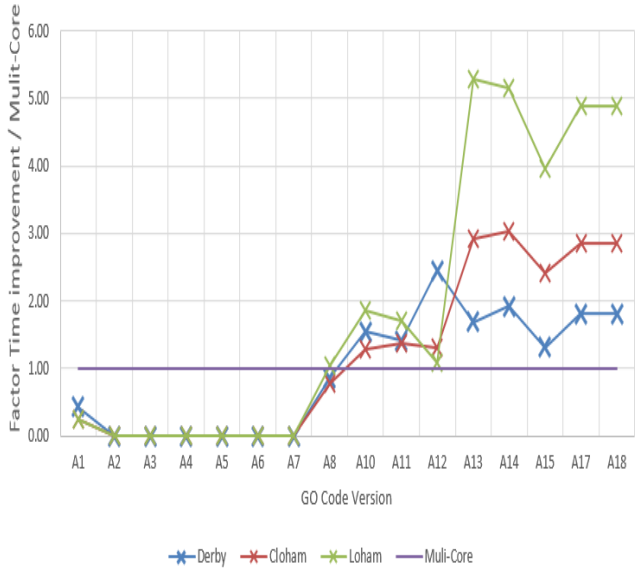
- Path builds can be highly parallelised by accepting some waste
- Bellman Ford best path build algorithm
- Data transfer to GPU device critical aspect
- Bigger models faster, diluting data transfer overhead
- Model runs stable
  - A15 new path build no change to flow accumulator
  - A17 (RC) new path build stable double precision emulator for flow accumulator
  - A18 (RC) as A17 but with improved single precision accuracy
- Desktop PC Titan X GPU step change achieved
  - SATGPU path tests up to 5 * faster than Multi-Core depending on numerical accuracy
  - and tests up to ~35 * faster than serial
- Reproduced London HAM validation



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Performance: Convergence & Summary Statistics

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- Reported for CLoHAM – similar differences for Derby & LoHAM

Measure / Criterion		SM	A15	%Diff
Convergence*	Stability (%Flows)	98.5%	98.8%	
	Stability (%Delays)	99.3%	99.4%	
	Proximity (%GAP)	0.009%	0.009%	
Summary Statistics	Total Distance (pcu-km)	2,522,793	2,522,916	0.00%
	Total Time (pcu-hrs)	114,903	114,918	+0.01%
	Total Delays (pcu-hrs)	4,370	4,369	-0.02%

Converged & Little Change

** Based on WebTAG M3-1 Table 4*

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LoHAM: Checks on Validation

Measure / Criterion	Aspiration	SM	A15	Diff
Links - GEH <5	85%	64%	64%	0%
Links - GEH <7.5	85%	78%	78%	0%
Links - DMRB Flow Criteria	85%	74%	74%	0%
Screenline - Flow Difference <5%	85%	90%	90%	0%
Enclosure - Flow Difference <5%	85%	94%	96%	+2%
Mini screenline - GEH <5	85%	91%	91%	0%
JT Routes - Time Difference < 15%	85%	92.1%	92.6%	+0.5%
Links - GEH <5	85%	64%	64%	0%

Little Change

SATGPU Next Steps

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- Phase 1 concluded in Jun'16 (see MW16 & ETC16)
- Phase 2 funded by Atkins (with UoS only)
  - Hardware: Pascal GPU (Summer'16)
  - Software:
    1. Parallel MUC for single / multi-GPU
    2. Extend to secondary analysis
    3. Increased network density
    4. Optimisation of Bellman Ford algorithm
- Longer term - simulation?

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