NVIDIA

SATURN

SATURNnext Programme - SATGPU

2018 User Group Meeting

November 2018

Final 03/12/18 - UGM2018 SATURNnext Programme - SATGPU

Dirck Van Vliet

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SATGPU – Current Status

Developed in SATURN 11.3

- SATGPU 11.3.26W = 11.3.12W + GPU algorithm
  - *Long in the tooth though!*
- Stable, robust & optimized for Pascal + Volta GPUs
- Performance benchmarking undertaken for:
  - *TfL HAMs, Highways England RTMs + TPS VDM*

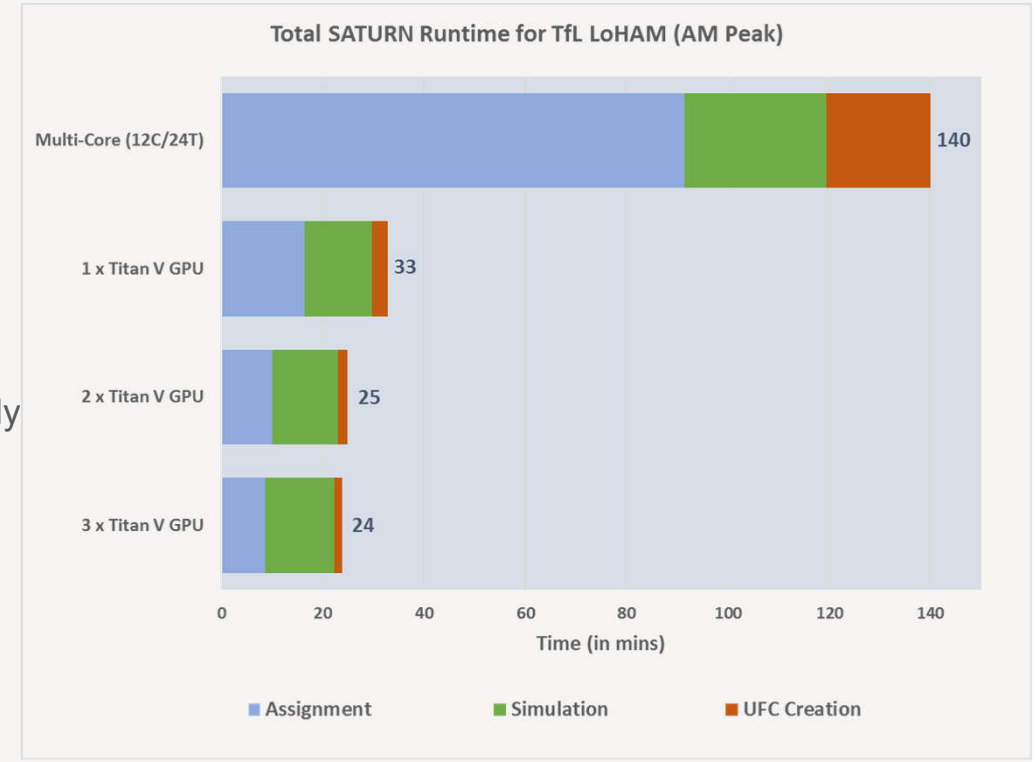
Availability

- **Now** as SATURNnext Beta Release: testing & evaluation only
- Parallel pilot studies
- Commercial 'add-on' release with SATURN 11.5

Wrapping-up Tasks

- Integrate latest UFO file generation
- Add Digital Licence (as per SatView and SatCoder)
- Further performance optimisations including
  - *Support for latest Turing-based RTX 2080Ti GPUs*

Performance on Nvidia Titan V (Volta) GPU Hardware



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Latest Performance Benchmarking (i) – TfL HAMs

Total Runtimes (minutes) for P3 2021 Ref Case AM Peak Hour assignment (SAVEIT=T)

Platform	Hardware	CLoHAM	NLoHAM	ELHAM	SLoHAM	WeLoHAM	LoHAM
HPZ840 (Win10, 128Gb RAM, 1 x Xeon E5-2687W v4 3.0GHz)	MC (12C/24T)	51	77	*112*	93	85	140
	1 x 1080Ti GPU (£650)	28	17	18	22	15	51
	Speed-up Factor	***1.8x***	***2.9x***	***3.9x***	***2.8x***	***8.9x***	***2.8x***
	1 x Titan Xp GPU (£1,000)	25	23	25	30	21	45
	Speed-up Factor	***2.0x***	***3.3x***	***4.5x***	***3.1x***	***4.0x***	***3.1x***
	1 x Titan V GPU (£1,850)	19 *(2.7x)*	17 *(4.6x)*	18 *(6.3x)*	22 *(4.2x)*	15 *(5.6x)*	33 *(4.3x)*
	2 x Titan V GPU (£3,700)	15 *(3.5x)*	12 *(6.4x)*	12 *(9.1x)*	17 *(5.5x)*	11 *(7.7x)*	25 *(5.6x)*
	3 x Titan V GPU (£5,550)	14 *(3.6x)*	11 *(7.0x)*	11 *(10.2x)*	16 *(5.8x)*	10 *(8.9x)*	24 *(5.9x)*
	Speed-up Factor	***2.7x -> 3.6x***	***4.6x -> 7.0x***	***6.3x -> 10.2x***	***4.2x -> 5.8x***	***5.6x -> 8.9x***	***4.3x -> 5.9x***

Note: (i) Performance will vary between models and hardware; (ii) All times for equivalent # of MC loops – varies +/- between algorithms; (ii) All prices exclude VAT

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Latest Performance Benchmarking (ii) – Highway England RTMs

Total Runtimes (minutes) for 2031 Ref Case AM Average Hour assignments (SAVEIT=T)

Platform	Hardware	TPS	SERTM	NOR	MRTM	SWRTM
HPZ840 (Win10, 128Gb RAM, 1 x Xeon E5-2687W v4 3.0GHz)	MC (12C/24T)	48	22	7	7	7
	1 x 1080Ti GPU (£650)	27	13	3	5	5
	Speed-up Factor	***1.8x***	***1.7x***	***2.2x***	***1.5x***	***1.4x***
	1 x Titan Xp GPU (£1,000)	25	12	3	5	4
	Speed-up Factor	***1.9x***	***3.3x***	***2.3x***	***1.6x***	***1.5x***
	1 x Titan V GPU (£1,850)	22 *(2.2x)*	10 *(2.2x)*	3 *(2.5x)*	4 *(4.2x)*	4 *(1.9x)*
	2 x Titan V GPU (£3,700)	21 *(2.3x)*	10 *(2.3x)*	3 *(2.8x)*	4 *(5.5x)*	3 *(1.9x)*
	3 x Titan V GPU (£5,550)	21 *(2.3x)*	9 *(2.4x)*	3 *(2.8x)*	3 *(5.8x)*	3 *(2.1x)*
	Speed-up Factor	***2.2x -> 2.3x***	***2.2x -> 2.4x***	***2.5x -> 2.8x***	***2.0x -> 2.2x***	***1.9x -> 2.1x***

Note: (i) Performance will vary between models and hardware; (ii) All times for equivalent # of MC loops – varies +/- between algorithms; (ii) All prices exclude VAT

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Performance Benchmarking (iii) – TPS VDM (SATURN + DIADEM)

Identify updated processes & software to reduce runtimes

- Focus on TPS RTM 2031 Ref Case Forecast
- Performance will vary between scenarios & hardware

Reviewed individual modules

1) Optimised SATURN Assignment Parameters
2) # of DIADEM Loops for *pragmatic* convergence
3) UFO-based skimming
4) OMX Binary Data File Exchange
5) DIADEM Optimisation
6) SATGPU

Delivery:

- Combination of revised settings, new products & software development
- **Estimated runtimes reduce from 38hrs to ~10-15hrs**

Group	Process	Time (hrs)	%Time	Time (hrs)	
				All 6 Mods	Mods 1,3,4,6
SATURN	Assignment	**21.8**	**57%** 1	2.9	**4.0** 1
	Skim Time	3.0	8% 3	0.9	1.3 3
Process	Reading Skims	**6.1**	**16%** 4	1.0	**1.4** 4
	Reading Demand	0.4	1%	0.1	0.1
	Writing Demand	0.2	1%	0.0	0.1
DIADEM	VDM Loop	**5.7**	**15%** 5	3.0	5.2
Process	Other Background	1.0	3%	0.2	0.3
Total		**38.2 hrs**	**100%**	**8.2 hrs**	**14.5 hrs**
(11 VDM Loops)				**8 Loops**	**11 Loops**

6 2

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Performance Benchmarking (iv) – Microsoft Azure Cloud Platform

Total Runtimes (minutes) for P3 2021 Ref Case AM Peak Hour assignments

(i) Similar performance between physical PC and MS Azure Virtual Machines with / without GPU; (ii) Changes arise from differences in hardware

Platform	Hardware	CLoHAM	NLoHAM	ELHAM	SLoHAM	WeLoHAM	LoHAM
HPZ840 (Win10, 128Gb RAM, 1 x Xeon E5-2687W v4 3.0GHz)	MC (12C/24T)	51	77	*112*	93	85	140
	1 x Titan V GPU	19	17	18	22	15	33
	2 x Titan V GPU	15	12	12	17	11	25
	3 x Titan V GPU	14	11	11	16	10	24
	Speed-up Factor (3GPUs)	***3.6x***	***7.0x***	***10.2x***	***5.8x***	***8.9x***	***5.9x***
MS Azure NC24S_v3 (Win10, 448Gb RAM, 2 x Xeon E5-2690W v4 2.6GHz)	MC (24C/48T)	45	68	100	80	76	124
	4 x V100 GPU	12	9	9	15	8	22
	Speed-up Factor (4GPUs)	***3.6x***	***7.2x***	***10.8x***	***5.5x***	***9.3x***	***5.7x***

Note: (i) Performance will vary between models and hardware; (ii) All times for equivalent # of MC loops – varies +/- between algorithms

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Pilot Studies

Two pilot studies:

Trans Pennine Tunnel Study (TPTS+)

- As part of technical consultancy & software support to TfN
  - Collaborative project between Atkins, TfN, Highways England, DfT and WSP
  - Based on existing Highways England TPS RTM
    - *SATURN + DIADEM*
    - *Parallel testing & scheme optioneering*

Highways England RIS2 Scheme

- As part of current Atkins project for one of the M25-based schemes
  - *SERTM-based derivative*
  - *Parallel testing*

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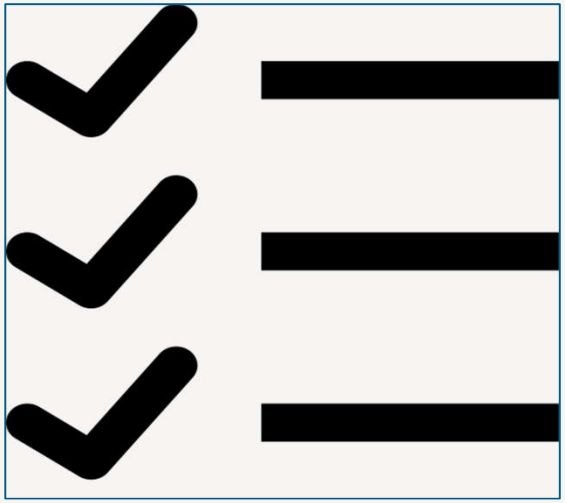
SATURNnext – Requirements, Terms & Conditions, Limitations

Available under SATURNnext FY18/19 programme

- See Terms & Conditions
- Provided as Beta release for free
- Used at organisation's own risk

Restrictions:

- As per standard T&C **plus**
  - Provided for testing and evaluation purposes only
  - SATGPU Executables are time-limited
    - *Will expire prior to SATURN 11.5 release*



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Requirements:

- Suitable PC running Windows 7/10
- NVidia 1080Ti, Titan Xp or TITAN V GPUs

Limitations

- Short-term: Generation of UFOs using GPU to follow
  Support for Turing GPUs (RTX 2080Ti)
  Scrolling performance display (ie WINDY=F)
  Lower performance for parallel assignments on multiple GPUs
  Area Tolling may not be initially in GPU

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Next Steps

User Registration

› Register interest in SATGPU for SATURNnext FY18/19 now!

Release Bundle

› Finalise 11.3.26W release bundle + documentation
› Access via usual web-based downloader

Next Steps

Development

› Support for Turing-based GPU
› Improved memory management for parallel assignments on multiple GPUs
› Incorporate digital licencing
› Port across to SATURN 11.5 Release

Release

› Follow-up SATGPU 11.5 Beta Release
› Commercial release in spring 2019

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