Numerical Algorithms Group
Mathematics and technology for optimized performance

Numerical Excellence in Finance

Dr Ian Reid

Results Matter. Trust NAG.

Agenda

- Introduction to NAG
- Use of NAG software & services in finance
- NAG and NVIDIA

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NAG

- Founded 1970
  - Co-operative software project
  - not-for-profit organisation
- £7m+ financial turnover
- 80+ employees
  - >>50% developers/technical consultants
- Main Offices
  - Oxford (HQ), Manchester, UK
  - Chicago, USA
  - Tokyo, Japan
- Over 3,000 customer sites world-wide

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Key NAG Products & Services

- Numerical and Statistical Libraries
  - Over 1600 user-callable components
- Consultancy Services
  - Code development, tuning, tailoring
- HPC Services
  - Procurement advice, market watch, benchmarking
  - Computational Science and Engineering (CSE) support
- Experts in Numerical Engineering

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Use of NAG Software in Finance

- Portfolio analysis / Index tracking / Risk management
  - Optimisation, linear algebra, copulas…
- Derivative pricing
  - PDEs, RNGs, multivariate normal, …
- Fixed Income/ Asset management / Portfolio Immunization
  - Operations research
- Data analysis
  - Time series, GARCH, principal component analysis, data smoothing, …
- Monte Carlo simulation
  - RNGs
- ……

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New for Mark 22

- New global optimization chapter
- ANOVA – Analysis of Variance
- Nearest Correlation Matrix
- Partial Least Squares Regression Analysis
- Prediction intervals for fitted models
  - Allow for uncertainty in forecasts

- Fast quantile selection routine
- Wavelets
- Adoption of LAPACK 3.1
- New Random Number Generators
  - Including Mersenne Twister
  - Sobol Sequence generator (50,000 dimensions)

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NAG Software – work in progress...

- Bayesian Statistics
- Copulas
- Extreme Value Theory Statistics
- Generalised Mixed Effect Regression
- Monte Carlo engine
- Optimisation (particle swarm, ...)
- Special Functions
- Time series
- ..
- and much more

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Why Use NAG Libraries?

- Global reputation for quality – accuracy, reliability and robustness…
- Extensively tested, supported and maintained code
- Reduce development time
- Concentrate on your key areas
- Components
  - Fit into your environment
  - Simple interfaces to your favourite packages
- Regular performance improvements!

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"My team uses NAG mathematical routines wherever possible - NAG are the experts here - we stick to what we are good at!"

Alan Scowcroft,

Retired - Managing Director, Equities Quantitative Research

UBS

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What happened to my treadmill?

- The treadmill has stopped...
- Multi-core/Many-core are a major challenge for existing codes
- GPGPUs offer an interesting solution for some key applications

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NAG and NVIDIA

- NAG encourages strong software stack
  - CUDA/OpenCL, Core math library
- And appropriate hardware
  - Double precision (not always needed, but...), ECC
- Working with Mike Giles on a joint project to deliver monte-carlo components
  - RNGs, distributions, copulas
- Working with existing clients to explore potential products
 - NOT a full NAG Library port

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Early Success with BNP Paribas

- Working with Fixed Income Research & Strategies Team (FIRST)
  - NAG mrg32k3a works well in BNP Paribas CUDA "Local Vol Monte-Carlo"
  - Passes "Diehard tests of randomness"
  - Performance good (next slide)
  - Being able to match the GPU random numbers with the CPU version of mrg32k3a has been very valuable for debugging purposes

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BNP Paribas Results (work in progress)

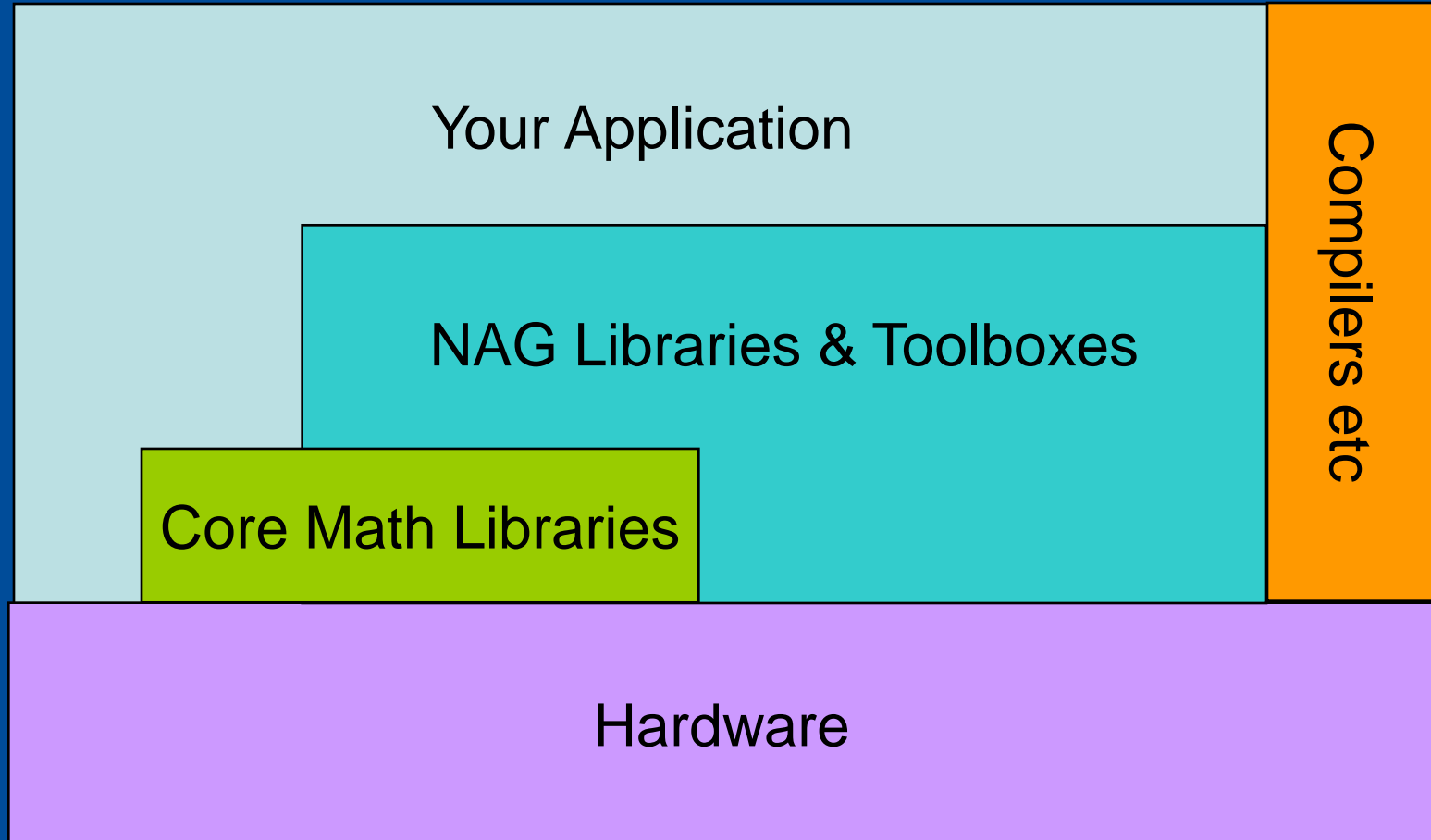Speed-up NAG MRG32k3a/GX260 versus BNP CPU version
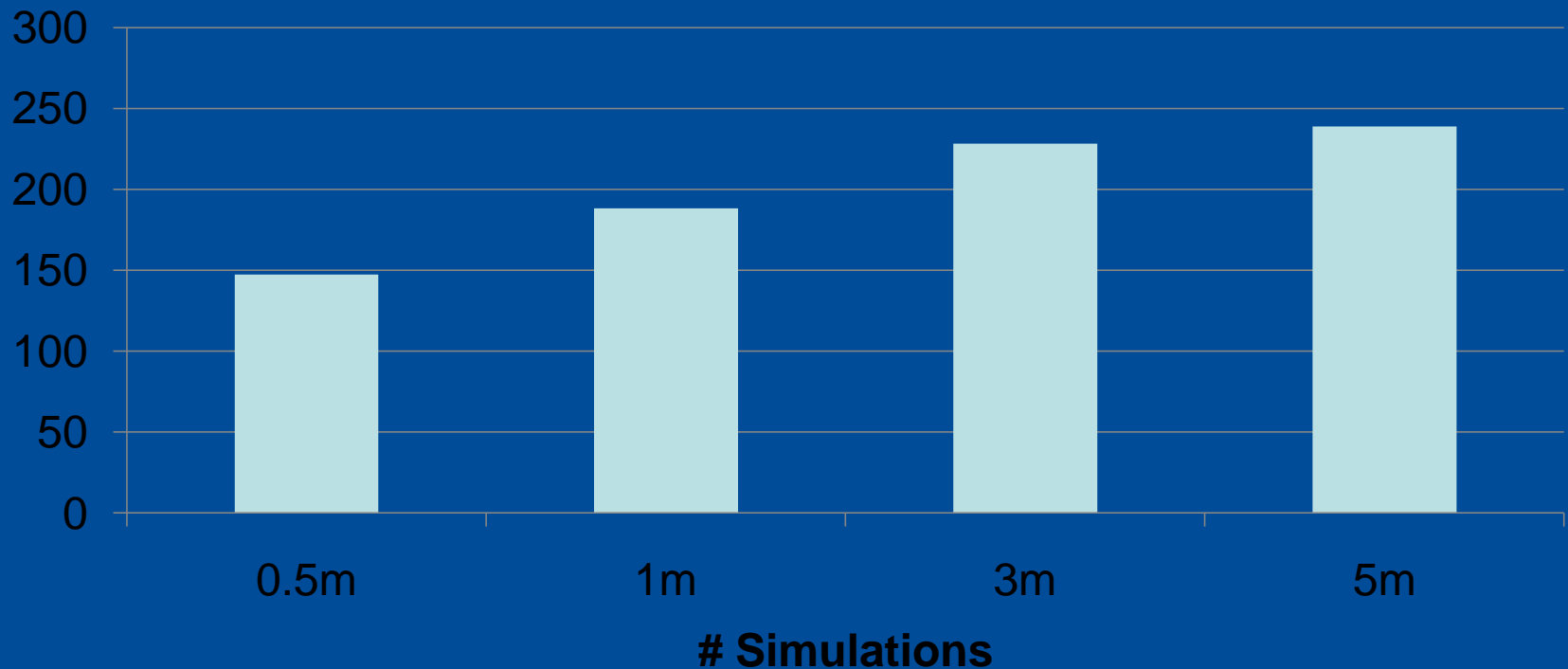
Summary

- Difficult/exciting times for all

- Exciting developments on NVIDIA GPGPUs

- NAG is actively involved in R&D in this area and has beta software available

- NAG is seeking feedback on further areas of interest from your community

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Backup Slides

NAG and Vendor libraries

Your Application

NAG Libraries & Toolboxes

Core Math Libraries

Hardware

Compilers etc

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NAG Library Contents

- NAG provides high-level maths and stats components
  - Nonlinear equation solvers
  - Summation of series and transformations, FFTs
  - Quadrature
  - ODEs, PDEs and integral equations
  - Approximation and curve and surface fitting
  - Optimization and operations research
  - Dense linear algebra, including LAPACK
  - Sparse linear systems and eigenproblems
  - Special functions
  - Random Number Generators
  - ...

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NAG Libraries Ease of Integration

- C++ (various)
- C# / .NET
- Visual Basic
- Java
- Borland Delphi
- Python
- F#
- …
- and more

- Excel
- MATLAB
- Maple
- LabVIEW
- R and S-Plus
- SAS
- …
- and more

Partnerships with leading academics

- University of Aachen
  - Prof. Uwe Naumann
    - Automatic Differentiation (AD)
- K.U. Leuven
  - Prof. Wim Schoutens
    - Option Pricing, Advanced Lévy models
- University of Manchester
  - Profs. Nick Higham (FRS), Peter Duck and Ser-Huang Poon
    - EVTs, Nearest Correlation Matrix, PDEs, Risk,
- University of Oxford
  - Profs. Mike Giles, Stephen Roberts
    - Monte Carlo simulation engine/ latest techniques/ high-end SIMD arch's
- University of Warwick
  - Prof. Nick Webber, Prof. Mark Salmon
    - Monte Carlo, Derivative Pricing, Copulas, Wavelets

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