Radiation Transport Simulation within SpaceGRID

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People

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- **Space Department, QinetiQ**
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- **Thanks to Gene Cooperman from Northwestern University for assistance with TOP-C**

Uses of Radiation Simulation

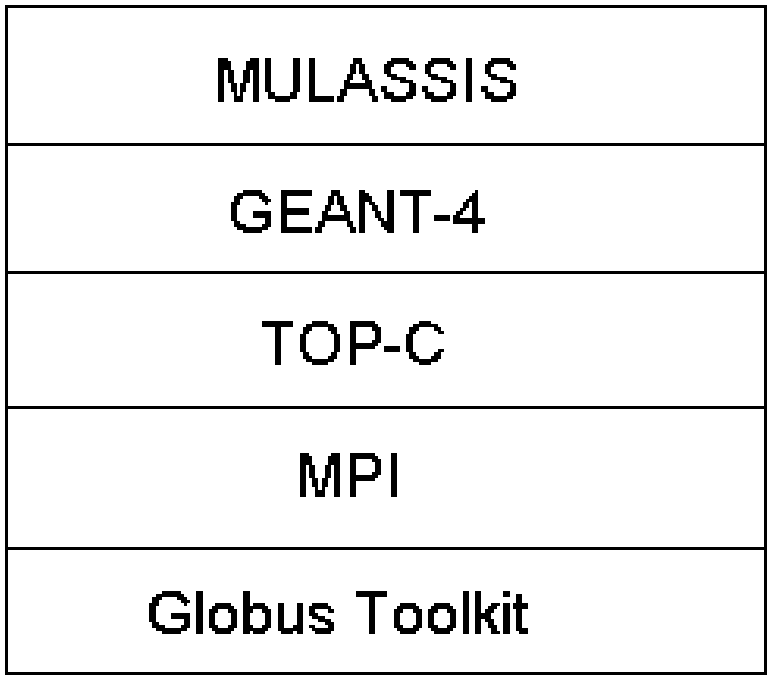
- Spacecraft operate in radiation rich environment
- Since end of the Cold War RAD-HARD equipment has been harder to obtain
- The desire to fly increasingly sensitive instruments on missions such as INTEGRAL and XMM
- Radiation transport simulation is becoming an indispensable tool to spacecraft engineers
- Simulations becoming too large to run successfully on single machines so distributed processing essential
- Enable much more complicated designs to be simulated

Aims of the Prototyping

- **Demonstrate the feasibility of GRID usage with applications of particle transport in space research.**
- **The Gridnised Geant4/Application shall:**
  - ⇨ **Maintain complete Geant4 functionalities with no/insignificant impact to the Geant4 kernel code.**
  - ⇨ **Be optimised to achieve maximum speedup.**
  - ⇨ **Allow dynamical resource utilization as well as user control of the execution and GRID resources used.**

Software Layers

- Layers made up of various already designed software performing the following functionality:
  - ⇨ GRID Authentication and Distribution
  - ⇨ Communications Layer
  - ⇨ Event driven Parallelisation
  - ⇨ Physics behaviour
  - ⇨ Simulation



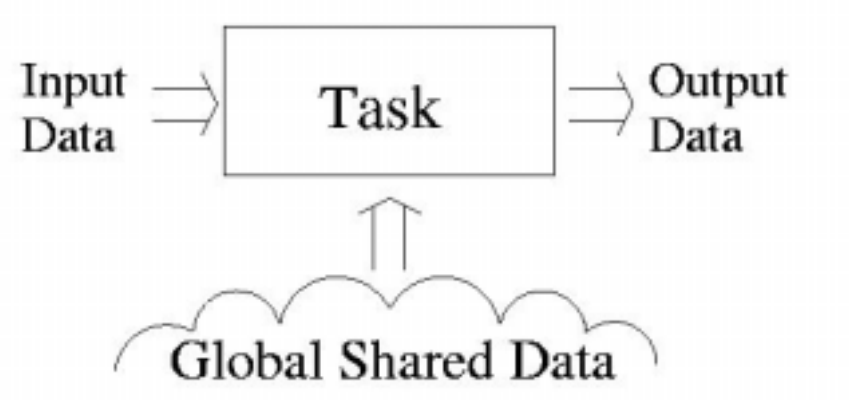
Globus 2 Toolkit

- **Components of the toolkit being used:**
  - **GIIS**
    - **Used to define the nodes that will be used for the simulation using custom Perl script to take output from ldapsearch and format to the correct *procgroup* script.**
    - **Also monitors the behaviour of the GRID during operation.**
  - **GridFTP**
    - **Used to move the executable around before slave execution dependant on the *procgroup* script.**
  - **GSISSH**
    - **This is used instead of GRAM and RSL scripts.**
    - **Uses the Globus certificate system for authentication.**

- **Communications Layer can use MPICH-G2 easily**

TOP-C

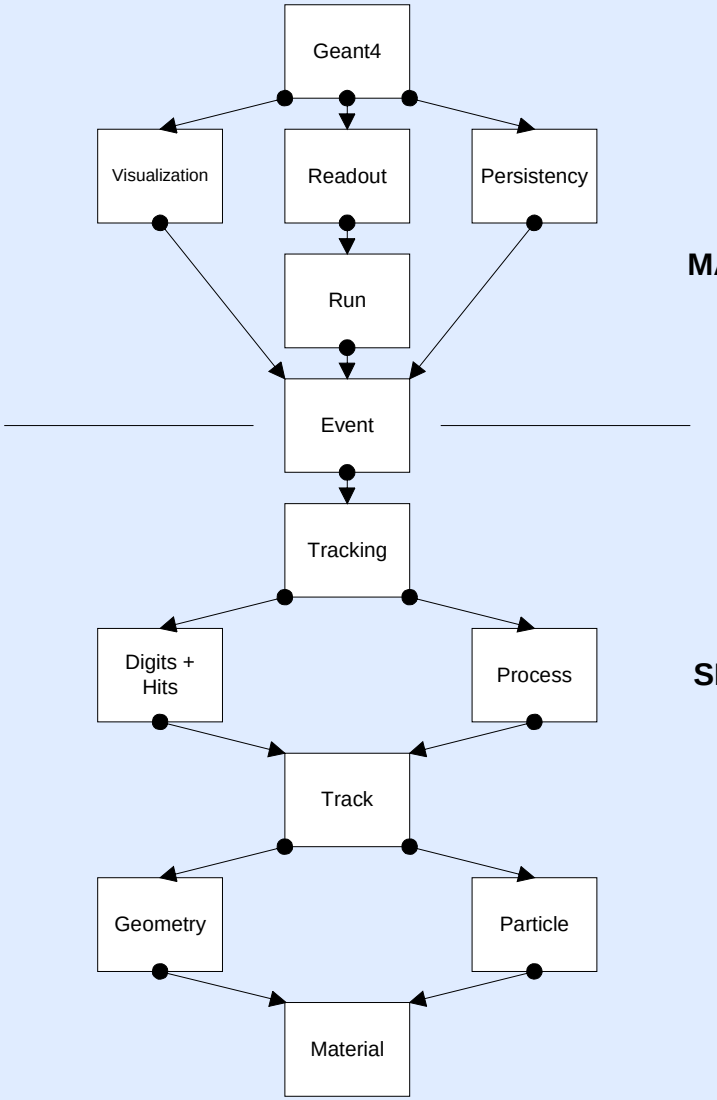
- Based upon a Master-Slave architecture
- Three fundamental concepts:
  - ⇨ the *task* (specified by the master and executed by a slave process),
  - ⇨ the *global shared data*,
  - ⇨ the *action* chosen after a task is completed.
- Inter node communication is only done through these mechanisms
- Currently uses own implementation of MPI



TOP-C Approach to Geant-4

- **The collation functions all stay operating on the master**

- **The data is passed from Master to slave as generic TOP-buffer objects**



TOP-C Cont'

- **Added functionality needed for RTS SpaceGRID beyond current TOP-C implementation.**
  - ⇨ **Dead/slow node removal from available queue**
  - ⇨ **Allocation of spare nodes from initial list for capacity increase**
  - ⇨ **Controlled ending of running job**
  - ⇨ **Current event number to stdout**

- **Attractions of TOP-C**
  - ⇨ **Natural load balancing**
  - ⇨ **Simple interface**
  - ⇨ **Free!**

Mulassis

- Multi-Layered Shielding Simulation Software
- Developed by QinetiQ, ESTEC and Belgian Institute for Space Aeronomy.
- Uses the Particle Physics Geant 4 Monte Carlo simulation Toolkit incorporating a significant range of physics processes.
- Tool for quantifying particle fluence, energy deposition, NIEL damage for one-dimensional planar or spherical shielding geometries.
- MULASSIS can operate as a standalone tool but has also been integrated into the SPENVIS system allowing calculations to be performed over the Internet through a web-page interface.

Progress To Date

- Installed Mulassis, GEANT4 and have parallelised it using TOP-C libraries

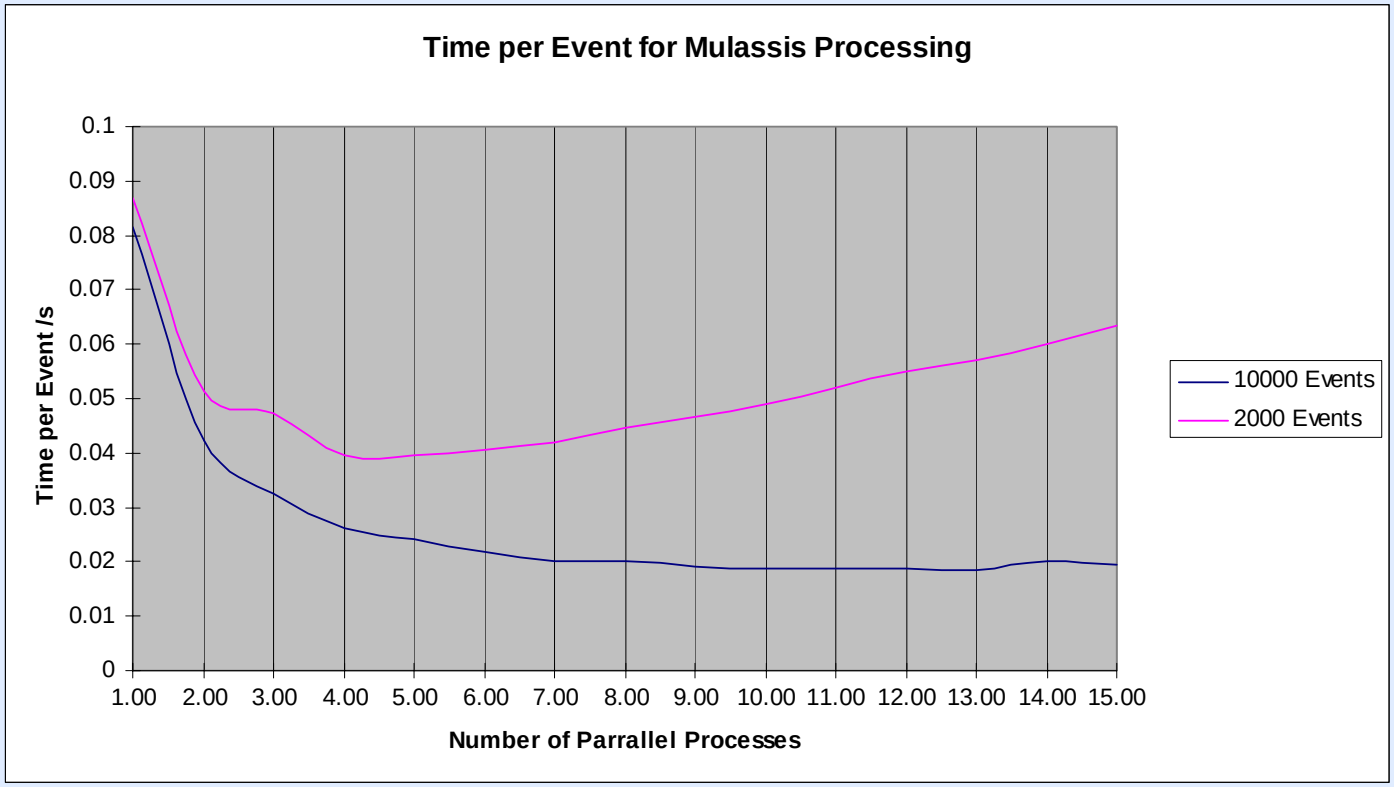
- Prototyping Requirements now implemented but subject to further testing except for
  - ⇨ The dynamic distribution of a number of elements to a node which may require changes to GEANT4 code

Current Prototype Status

- **The prototype will currently run the simulation on a Globus based GRID system performing the following functionality**
  - ⇨ **Recognise node drop out and handle gracefully**
  - ⇨ **Keep spare nodes which can be activated depending on user input**
  - ⇨ **Reassign tasks sent to a dead node to ensure complete execution of the simulation**

Initial Results of Parallel Operation

- Initial testing performed on small Pentium 2 machines running Linux 7.2



Conclusions

- Operation of a parallel version of Mulassis using GRID authentication has been demonstrated.
- Currently no account is taken of speed of either the GRID nodes or network interface between them
- Needs to be able to automatically change the task grain size from single event –> multiple event
- Currently toolkit being developed so that any event based application can be added to the front to produce a 'Gridnised' application.