




A Grid-Based Facility for Large-Scale Cross-Correlation of Continuous Seismic Data

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Outline

- Inside the boundary:
Seismic Cross-Correlation and Ambient Noise Tomography

- Outside the boundary:
Workflows and Computational Grids

- So, "No Boundaries" then ?



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Inside the boundary: Existing Science 1

Work described here comes from a project funded by the

- NZ Earthquake Commission's Research Foundation (EQC08/566)

and "builds" upon two talks given at eResearch Australasia 2008

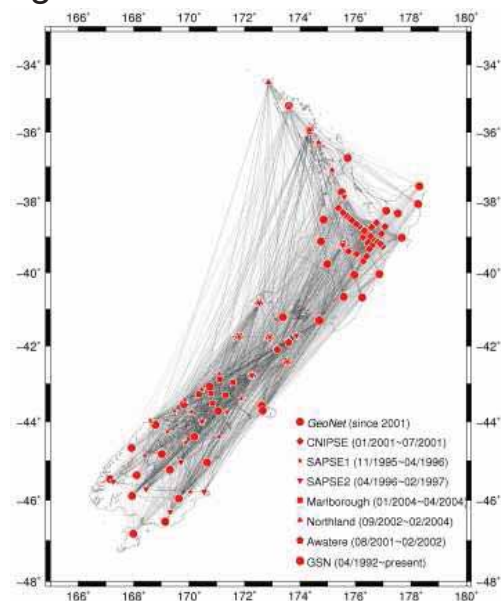
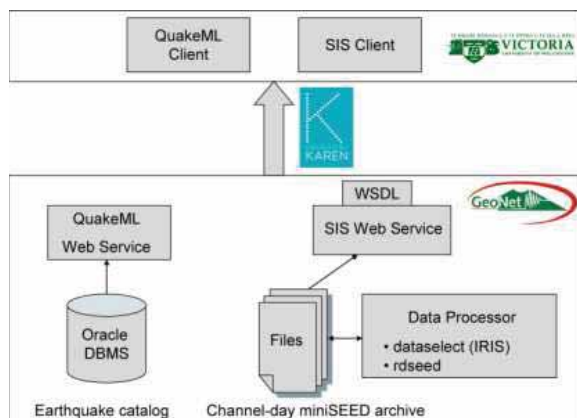
- George Slim's (MoRST) overview of where NZ eResearch was heading
- Paul Grimwood's (GNS) Seismographic Information Service project

Also a second strand of work using the same underlying infrastructure that provided a teaching module and some Google Earth/Maps outputs



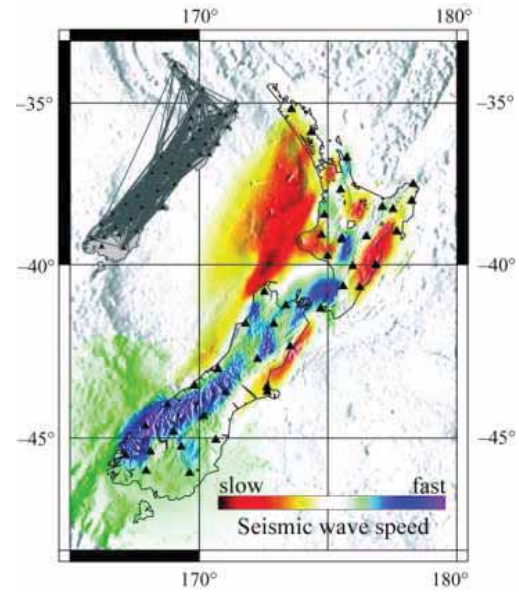
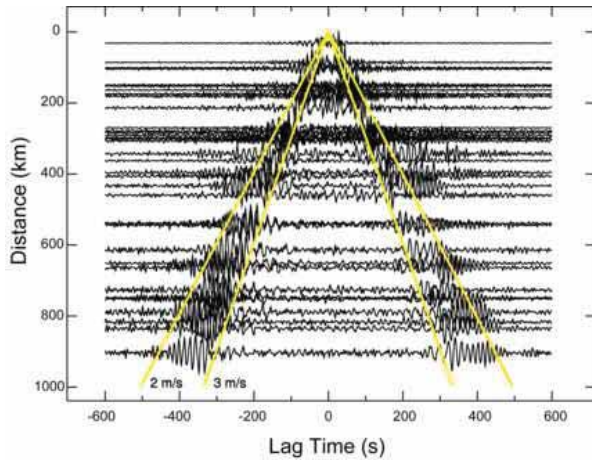
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Inside the boundary: Existing Science 2



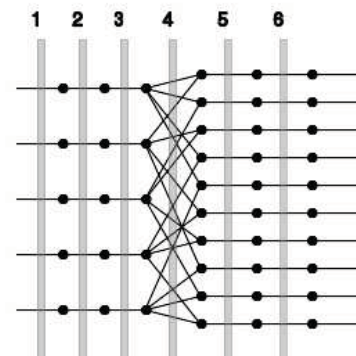
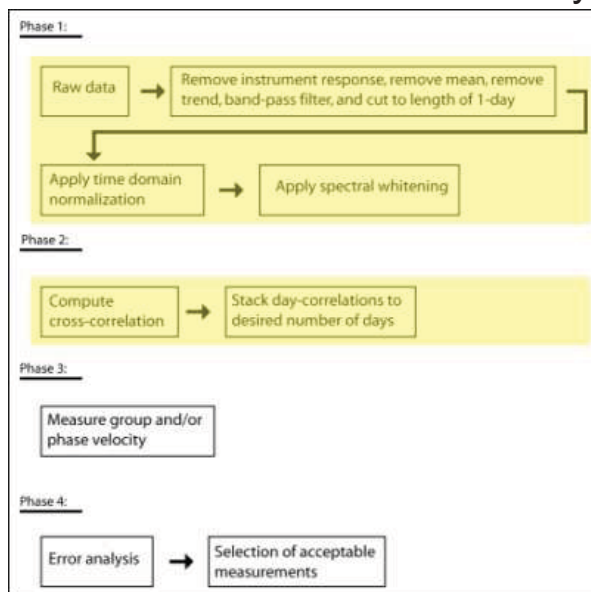
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Inside the boundary: Existing Science 3



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Inside the boundary: Existing Science 4





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Outside the boundary: Workflows

Workflows provide a mechanism for knowledge transfer about processes within an automated representation of the process as a whole.

Two seemingly opposite drivers at work:

Hiding the raw computation in the sub-processes from the end user, eg

- Interact with a specified web service via a WSDL scraper

Making the sub-processes explicit to the end user

- End user might specify a different web service
- End user might not use a web service at all

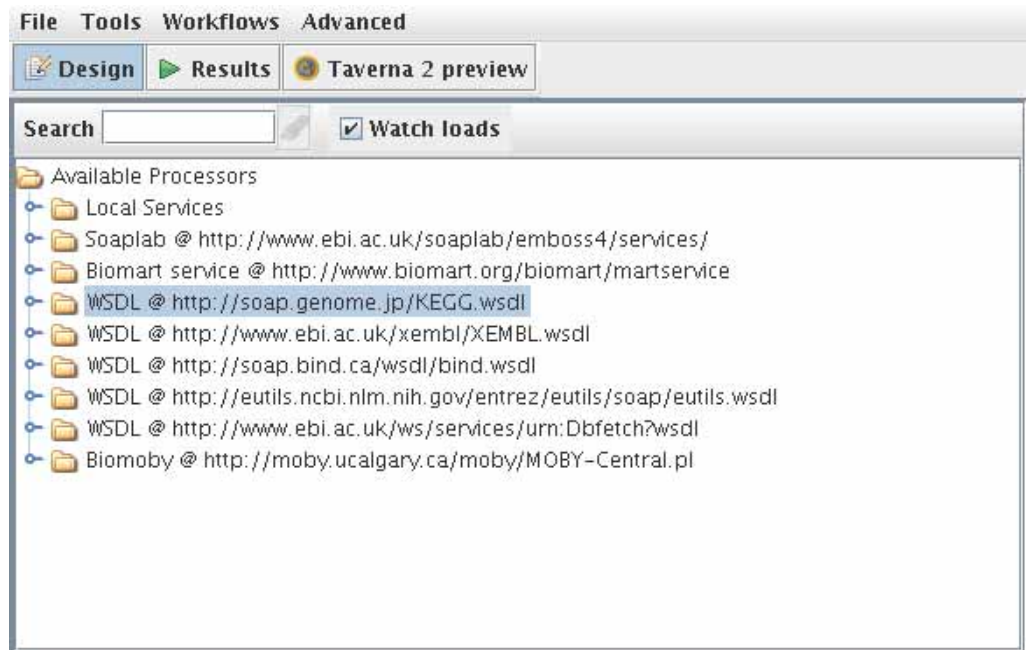
Workflow tool-kits come with a lot of pre-defined process units for "doing things"

Does your domain science, let alone your sub-processes, have units in the workflow tool-kit you want to use, that let you do what you want?



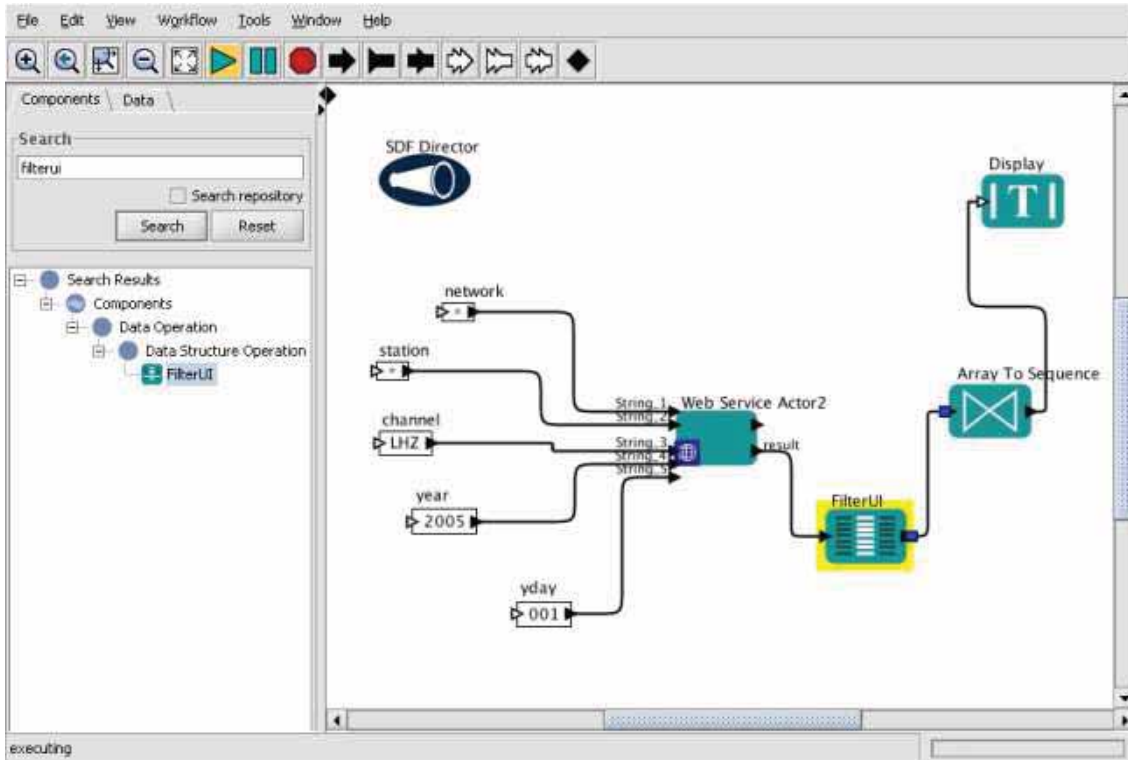
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Taverna's Bio Roots



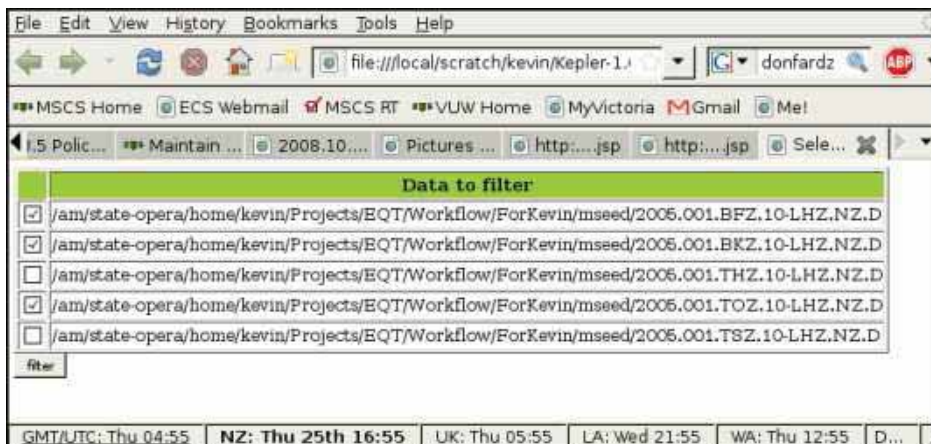
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Kepler WSDL



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Kepler UI Filter



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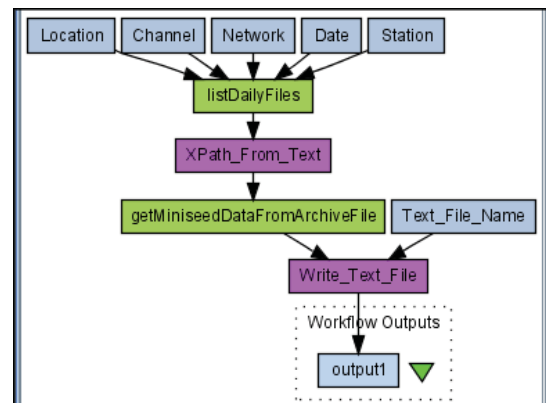
Taverna WSDL

The screenshot displays the Taverna WSDL interface. On the left, the 'Available Processors' pane lists various services including 'Local Services', 'Local Java widgets', 'String Constant', 'AbstractProcessor', 'RShell', 'Notification Processor', 'Beanshell scripting host', and 'WSDL @ http://localhost:8080/GnsMimic/GnsMimic?WSDL'. Below this is the 'Advanced model explorer' showing a workflow tree with nodes like 'Workflow: GDS', 'Workflow inputs', 'Workflow outputs', and 'Processors'. A table lists workflow objects with columns for 'Workflow object', 'Retries', 'Delay', '#ack-of', 'Threads', and 'Critical'. The main workspace shows a graphical workflow diagram with nodes: 'listDailyFiles' (receiving inputs from Location, Channel, Network, Date, Station), 'XPath_From_Text', 'getMiniseedDataFromArchiveFile' (receiving 'Text_File_Name' as an output), and 'Write_Text_File' (receiving 'Workflow Outputs' as an output). The diagram is titled 'Taverna 2 preview'.

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Taverna WSDL 2

This screenshot shows the 'Available Processors' pane from the Taverna WSDL 2 interface. It lists the same set of processors as the previous screenshot, including 'Local Services', 'Local Java widgets', 'String Constant', 'AbstractProcessor', 'RShell', 'Notification Processor', 'Beanshell scripting host', and 'WSDL @ http://localhost:8080/GnsMimic/GnsMimic?WSDL'.



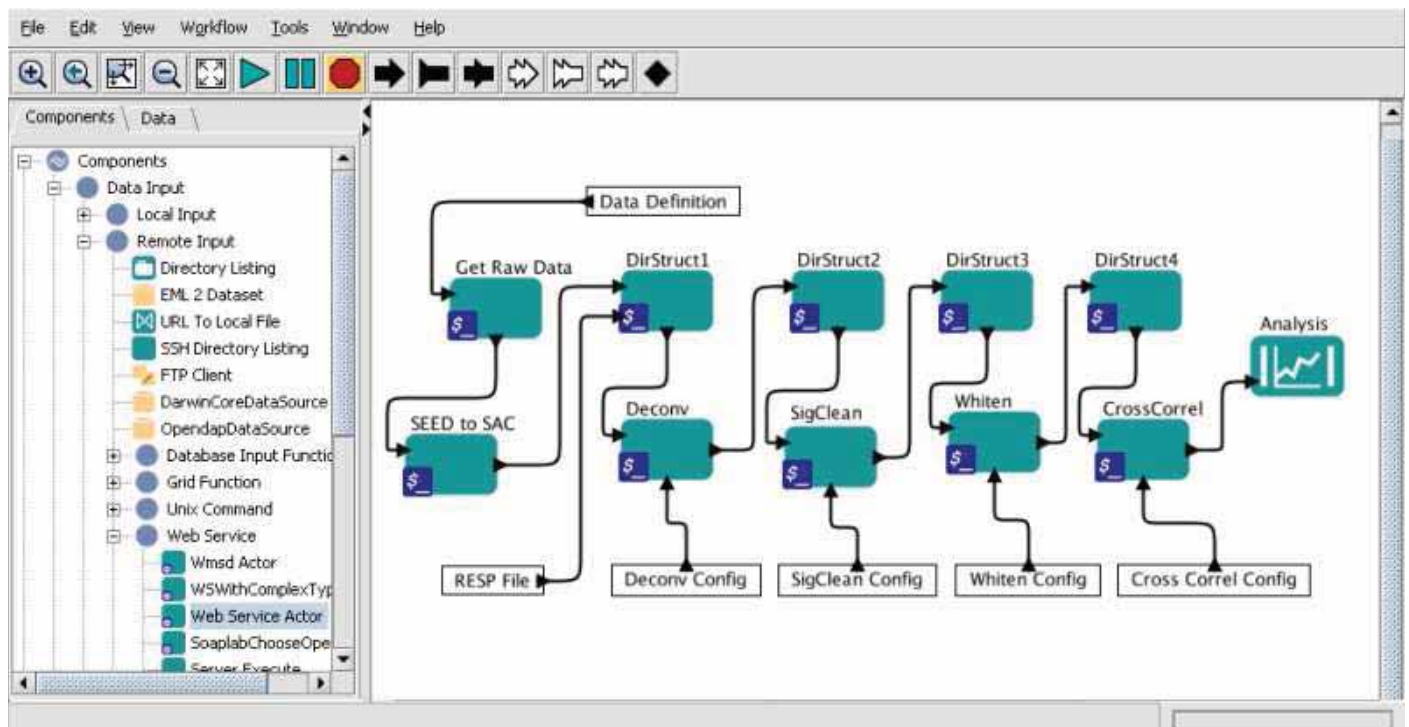
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Taverna WSDL 3



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Outside the boundary: Workflow representation





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Removing the boundary: Workflows

Once raw data is converted, stage inputs and outputs are the same format - simple pipeline ?

Compare that workflow representation, itself a mere schematic, with the schematics of what the domain scientists think of as what's happening

A lot more stuff (local/domain knowledge) going on, eg

- overcoming directory requirement impedences between the components
- handling errors at various stages

and that "stuff" becomes visible in the workflow tools.

Tempting to say "keep things hidden" - but it's not a package, it's a workflow

Other benefits to being explicit



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Outside the boundary: Grids

Underlying expectation (and maybe even what's being promised?) from "the grid"

"Hand something over and just have it run faster"

Different people have different ideas and expectations about grids - hardly surprising

Different grids: Compute, Data and Collaboration

Grids vs Clusters? The Grid as Utility? The Grid /as a/in the/ Cloud ?

What about "Package Grids" ? Do users even see the grid they are using?

Headline figures can hide the realities:

- 4096 processors at UoC: ~1900 at VUW: 512Mb vs 1Gb (or 2Gb)
- More/Faster processors => smaller run time - did we mention the queuing time?



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Now remove the boundary

Our grids

- VUW actually has two totally separate grids
- Neither are dedicated resources: cycle-stealing grids
- So neither really allow for message-passing approaches

Our science: where were the boundaries for us now?

- Data - constant access to raw data vs storing raw/modified data
- Data - three distinct processes: only need the whole at the end
- Compute - discretisation gives us resilience to failure
- Collaboration - not all users happy at the command line



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No boundaries: Grid submission

After all the knowledge transfer, we came up with something as simple as this:

(Stage 2 for 30 stations over three months, rather, 90 days: 90 * 435 x-Crlns)

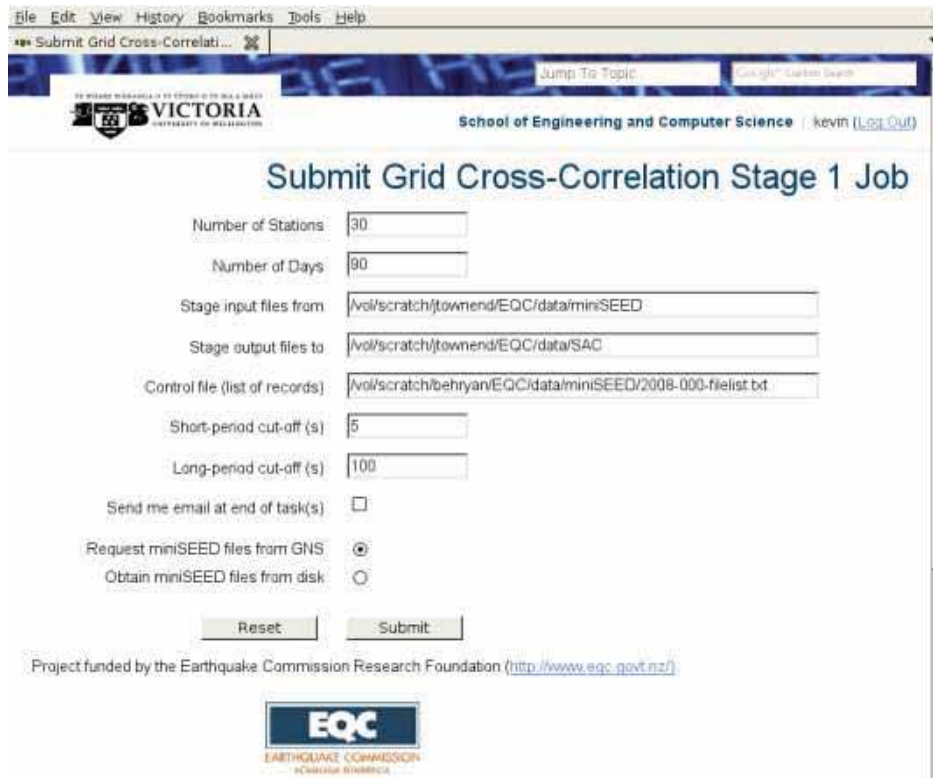
```
qsub -t 1-39150 \  
-q all.q \  
-wd /vol/grid/sgeusers/emily \  
-M Emily.Alias@vuw.ac.nz \  
-m e \  
/vol/grid/pkg/SGEES/gbfccsd/bin/stage2-args-001.sh \  
/local/tmp/emily \  
/vol/scratch/emily/EQC/data/SAC \  
/vol/scratch/notemily/EQC/data/minISEED/2008-000-filelist.txt \  
/vol/scratch/emily/EQC/data/SAC \  
5 100 90
```

The DQS/SGE aware will notice there's an implied step size (of 1) there



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No Boundaries: Grid Submission - Web



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TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI

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Submit Grid Cross-Correlation Stage 1 Job

Number of Stations:

Number of Days:

Stage input files from:

Stage output files to:

Control file (list of records):

Short-period cut-off (s):


Long-period cut-off (s):

Send me email at end of task(s):

Request miniSEED files from GNS:

Obtain miniSEED files from disk:

Project funded by the Earthquake Commission Research Foundation (<http://www.eqc.govt.nz/>)




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Beyond the Boundary

One job was run whilst Yannik was back in Germany - no boundaries indeed !

Reductions of up to 87% (91% and 51%, stage 1 and 2 resp.) in processing times were seen
 (5 stations over 99 days, 1Hz sampling data, 170Mb of disk)

(Time in mins)	Desktop	Grid
Stage1 time	34.2	2.9
Stage2 time	5.2	2.2
Total time	39.4	5.1

Managed to get a concurrent usage of 180 (out of ~230) otherwise idle processors
 (10 stations over 360 days, 100Hz sampling data, 114Gb of disk)

(Time in hrs)	Desktop	Grid
Stage1 time	~120	~3



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Summary: Seismic Processing

- Moved a desktop process onto the "grid"
- Built in resilience and flexibility across generic grid resources
- Maximised use of local grid resources
- Hidden "the grid" from the user
- Questions raised informed future domain science approaches

As to the future:

- Investigate other approaches upon dedicated grid resources
- Actual implementation of processes in a workflow tool



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Summary: Here be boundaries Domain Science

- Processes operating in a simple, understandable, pipeline
- Become wrapped, for operational simplicity, into one process

Workflow Boundary

- Individual processes become hidden - (package or workflow?)
- Additional operational artefacts not externally visible

Grid Computing Boundary

- No visible loops to parallelise
- Data placement/distribution is hard

Avoiding Boundaries

- Clearly identifiable processes with simple (maybe NO) interfaces between them
- Explicit loops over monolithic processing



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And finally ... who is supposed to do this "no-boundary" science ?

Domain scientists ?

- Might need to brush up on their BEPL, SCUFL, WSDL, MPI and DRMAA

Workflow/Grid computer scientists ?

- Might need to read up on SEED, SAC, QuakeML

Phew !

Might still be a few jobs for people who can straddle the boundaries



Colophon

Slides for this talk have been created using MagicPoint

<http://member.wide.ad.jp/wg/mgp/>

An X11 based presentation tool which has the slide sources in plain text and which also provides for creation of an HTML slide-set.