Standard Operating Procedure

Pixel Quality

Purpose

A pixel quality program (pq.py_) takes Landsat L1T and NBAR scene pairs and produces a Pixel Quality scene mask as output.

This document describes how to run the Pixel Quality job via PBS script to process production data.

The Pixel Quality PBS job uses Luigi to run multiple instances of the pixel quality program in parallel. By adjusting the system resources used by the PBS job, hundreds (or thousands) of L1T input files may be processed in a short period of time.

Schematic

The diagram below shows the basic operation of the Pixel Quality Job
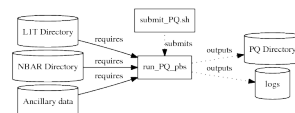
Key elements are:

- shell script submit_PQ.sh is used to submit the run_PQ.pbs script to the PBS job queue
- run_PQ.pbs reads scene data from the L1T (product code "OTH") and * NBAR input directories (product code "NBAR")
- data are also read from the ancillary data directory
- output scenes (Pixel Quality scenes) are written to the PQ Output Directory
- log files are written to the logs directory

Obtaining the code

The production code can be found in the GitHub repository. Obtain a copy of the production code into a convenient directory by following this procedure:

```
cd <base directory of your choice>
git clone git@github.com:GeoscienceAustralia/ga-neo-landsat-processor.git
cd ga-neo-landsat-processor
git checkout develop
```

Now change directory into the GA image processing directory (gaip)

```
cd ga-neo-landsat-processor/workflow
```

PBS Scripts

Two scripts are used to run Pixel Quality processing

- submit_PQ.sh – a convenience script to bootstrap the PBS job
- run_PQ.pbs – main PBS job scipt

You can view these scripts by clicking on the links above.

Procedure

To run the Pixel Quality job, follow these steps:

1. Specify inputs and outputs
2. Set job resources
3. Submit and monitor job
4. Review results
5. Handling errors

Specify inputs and outputs

Edit the submit_PQ.sh script file and specify the following paths

Variable	Description
L1T_PATH	Path to directory containing L1T files. Files in this directory must comply with the file naming standards described in Appendix A
NBAR_PATH	Path to directory containing NBAR files. Files in this directory must comply with the file naming standards described in Appendix A
LAND_SEA_PATH	Path to directory containing the LAND/SEA mask Geotiff files. Refer to Appendix B
OUTPUT_PATH	Path to the directory where output files are to be placed. The PQA files output by this job will have a filename compliant with the standard described in Appendix A. The product code will be "PQA". The remaining components of the filename will be those of the L1T input filename.
LOG_PATH	Path to the directory where log files will be placed.

Set job resources

The current version of the Pixel Quality program requires the following resources to process one input scene:

Resource	Quantity
CPUs	1
Wallclock time	4 minutes
Memory	8 GBytes
Job file system (solid state disk)	1 MB (for log files)
Luigi Workers	1

Luigi parallel processing

Luigi employs multiple CPUs to run many instances of the pixel quality program at the same time, within the context of a single PBS job. This is quite different from the previous way of doing PQ processing. Operations staff are required to adjust the PBS job resource parameters by editing the submit_PQ.sh script so that the input workload can be processed efficiently and in a reasonable timeframe.

Scaling up

Where there are many input scenes to processed additional resources need to be allocated to the PBS job to allow processing to complete in a reasonable (wallclock) time. The following table provides a guide to the resources that should be allocated.

Scenes	1	10	100	1,000	10,000	100,000	500,000	500,000
CPUs	1	16	32	128	512	1024	3072	4096
Nodes	1	1	2	8	32	64	192	256
Wall clock	5	5	50	125 2 hrs	312 5 hrs	1562 26 hrs	2604 43 hrs	1953 33 hrs
Memory (GB)	8	32	64	256	1024	2048	6144	8192
Job FS (GB)	1	1	1	1	10	100	500	500
Luigi Worker / node	1	4	4	4	4	4	4	4

Key constraints to note:

1. A maximum of 4 Luigi workers per node is allowed (4 workers X 8GB per worker = 32GB = max memory available per node)

2. For any production workload, NCPUS (number of CPUs) should always be a multiple of 16 (so that whole Nodes will be allocated to the PBS job)

Specify scale of job

Edit the following two lines in the submit_PQ.sh script file

```
WALLCLOCK='01:30:00'    # <---- Change this depending on workload (see SOP)
NODES=2                 # <---- Change this depending on workload (see SOP)
```

using the information above as a guide to the number of CPUs and wallclock time required to process the current workload.

Submit and monitor job

Once the job script submit_PQ.sh has been edited and the correct entries inserted, run the script so that the PBS job will be submitted:

```
./submit_PQ.sh
```

Check that the job is queued and, after some short delay is executing

```
nqstat | grep run_pq
```

Review Results

Reviewing the results involves:

1. Checking output files

2. Reviewing exit code of PBS job

3. Check PBS standard error file

4. Checking Luigi Worker Logs

Checking output files

Check that the expected number of pixel quality files have been written to the output directory.

Checking log files

Review the files in the log directory. An example is shown below.

```
run_PQ_raijin4_4596.stderr   run_pq_r82_7646.log   run_pq_r83_29470.log
run_PQ_raijin4_4596.stdout   run_pq_r82_7648.log   run_pq_r83_29472.log
run_pq_r82_7642.log          run_pq_r83_29466.log
run_pq_r82_7644.log          run_pq_r83_29468.log
```

Three types of files are present, job STDOUT, job STDERR (recognised by the familiar file suffix). The remaining files (with the .log suffix) are Luigi Worker log files. Reviewing exit code of PBS job The job STDOUT file should be inspected to ensure that the Exit Status: 0 message is present as shown below. Any other status should be investigated.

```
================================================================================
              Resource Usage on 2014-12-24 11:16:38.991116:
JobId:  8538551.r-man2
Project: v10
Exit Status: 0 (Linux Signal 0)
Service Units: 4.34
NCPUs Requested: 32                            NCPUs Used: 32
                                               CPU Time Used: 00:23:20
Memory Requested: 65536mb                      Memory Used: 25536mb
                                               Vmem Used: 33966mb
Walltime requested: 01:30:00                   Walltime Used: 00:08:08
jobfs request: 200mb                           jobfs used: 2mb
================================================================================
```

Check PBS standard error and output files

Both the job STDERR file and the STDOUT file in the logs directory should be checked for errors and warnings. They should be free of errors and can be checked using:

```
cd <log directory>
grep ERROR *.std*
grep WARN *.std*
```

Look carefully at these files particularly if the job terminated with a non-zero exit status (see previous section)

Check Luigi Worker Logs

Each Luigi Work (up to 4 per Node) will produce a log file recording all events that the worker has encountered. A set of typical work log files looks like:

```
run_pq_r82_15108.log   run_pq_r83_11591.log   run_pq_r85_25905.log
run_pq_r82_15110.log   run_pq_r83_11593.log   run_pq_r85_25907.log
run_pq_r82_15112.log   run_pq_r84_3376.log    run_pq_r85_25909.log
run_pq_r82_15114.log   run_pq_r84_3378.log    run_pq_r85_25911.log
run_pq_r83_11587.log   run_pq_r84_3380.log
run_pq_r83_11589.log   run_pq_r84_3382.log
```

Each log file includes the host name of the Node on which the job ran (e.g. "r82") as will as the process ID of the worker on that host (e.g. "15108")

Check for error messages in these file by:

```
cd <log directory>
grep ERROR *.log
grep WARN *.log
```

Investigate any errors found by this process.

Handling errors

It is impossible to predict the various types of error that may occur during PQ processing. Evaluate each error and decide on the appropriate actions to fix the error.

As a general rule, Pixel Quality jobs are completely re-runnable. So once errors have been fixed (and offending data files have been fixed or deleted), simply re-submit the Pixel Quality job and allow it to re-run.

When a Pixel Quality job is re-run, Luigi ensures that steps that previously completed without error will not be re-run. This property allows a strategy of "run, fix and rerun" to be employed until the workload has been fully processed.

Appendix A - Scene input file formats

Scene data (both L1T and NBAR) used by the Pixel Quality job are stored in directories, one scene per directory. The directory names subscribe to the following convention demonstrated here by example.

> Directory name: `LS5_TM_NBAR_P54_GANBAR01-002_092_086_20090115`

The name is broken into fields using the underscore "_" character as a field delimiter. The following table describes the fields:

Field	Example	Comment
Satellite	LS5	
Sensor	TM	
Product	NBAR	"OTH" for L1T scenes
Product ID	P54	
Product code and version	GANBAR01	
Station ID	002	
Path	092	
Row	086	
Acquisition Date	20090205	

Appendix B - Land/Sea data files

Land sea raster files are currently stored in `/g/data1/v10/eoancillarydata/Land_Sea_Rasters` and have a filename format like `WORLDzone57.tif`, where, in this case, 57 is the UTM zone.