

Santos

Private Cloud and Big Data

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Our Challenge: Clean, Sustainable Energy



A leading supplier of domestic natural gas, we are expanding to export LNG to Asia.

Our challenge is to find more reserves as safely & efficiently as we can.

IT Innovation is crucial to maintain the pace and quality of our exploration projects.

Santos Key Facts

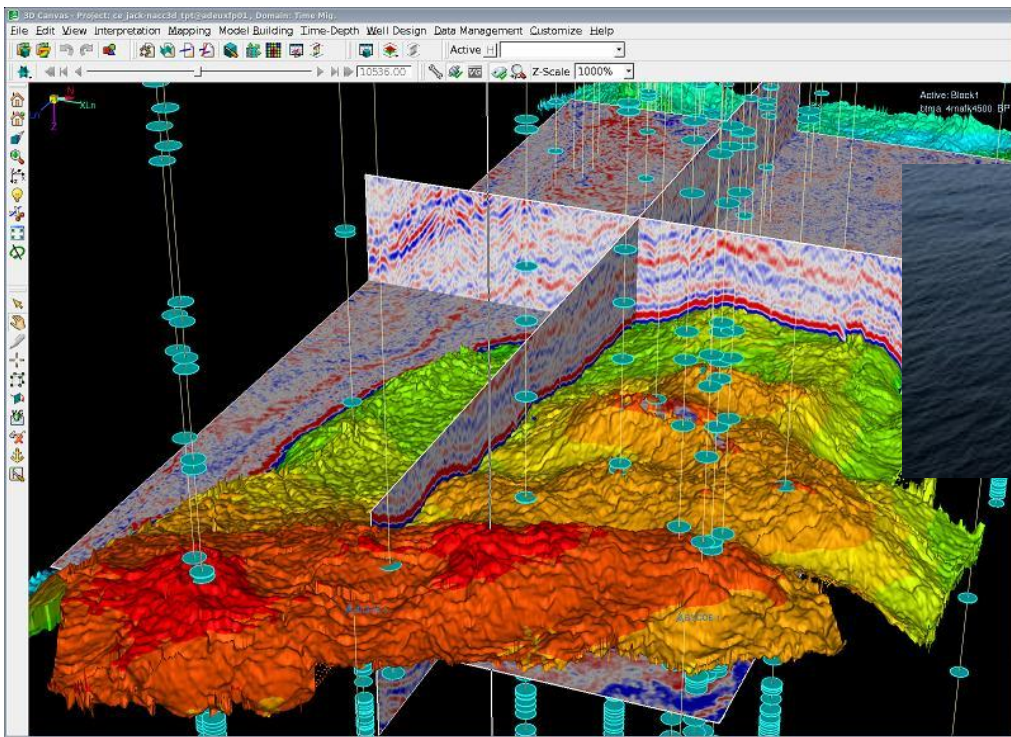
- 52mmboe p.a. production
- 1,965 mmboe 2C resource
- 3,300 FTEs
- \$3.2bn revenue in 2012
- Adelaide, Brisbane, Perth, Sydney, Jakarta, Singapore
- Core Asian countries: PNG, Indonesia, Vietnam
- 4 Transformational LNG projects: GLNG, PNG LNG, Darwin LNG, Bonaparte LNG

The Product: Upstream, we can only predict it through data

- Massive amounts of seismic & well data describe hydrocarbon resources.
- New data processing techniques increase volumes by orders of magnitude.

So how big is Big ?

Chevron: 2 TB/day

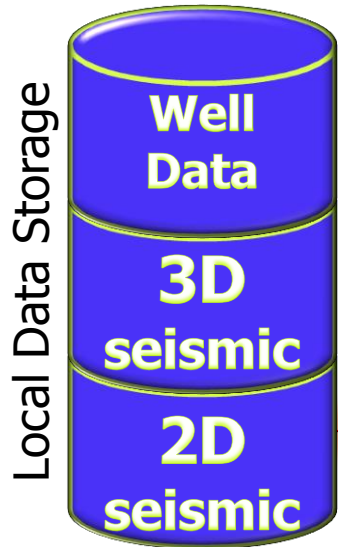


PGS Ramform Titan tows hundreds of thousands of sensors in a 12 km² grid.
How much data is that ? 2TB/day
How do we load it ?

The Problem: To “think” as fast as a geophysicist

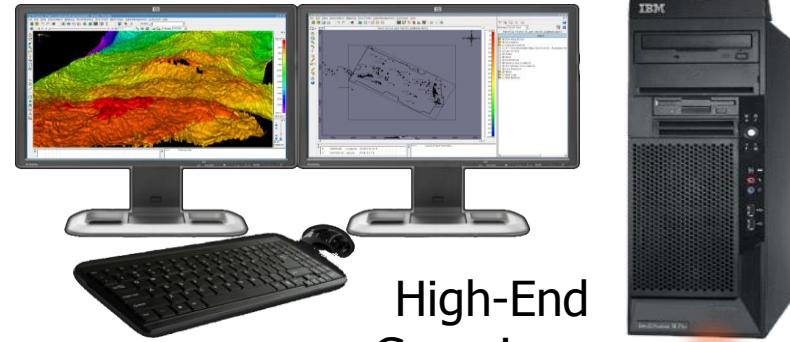
Santos uses Paradigm™, a leading supplier of oil & gas exploration & development software, to interpret and visualise its exploration data.

Integrated high quality data and **fast responses** are critical But



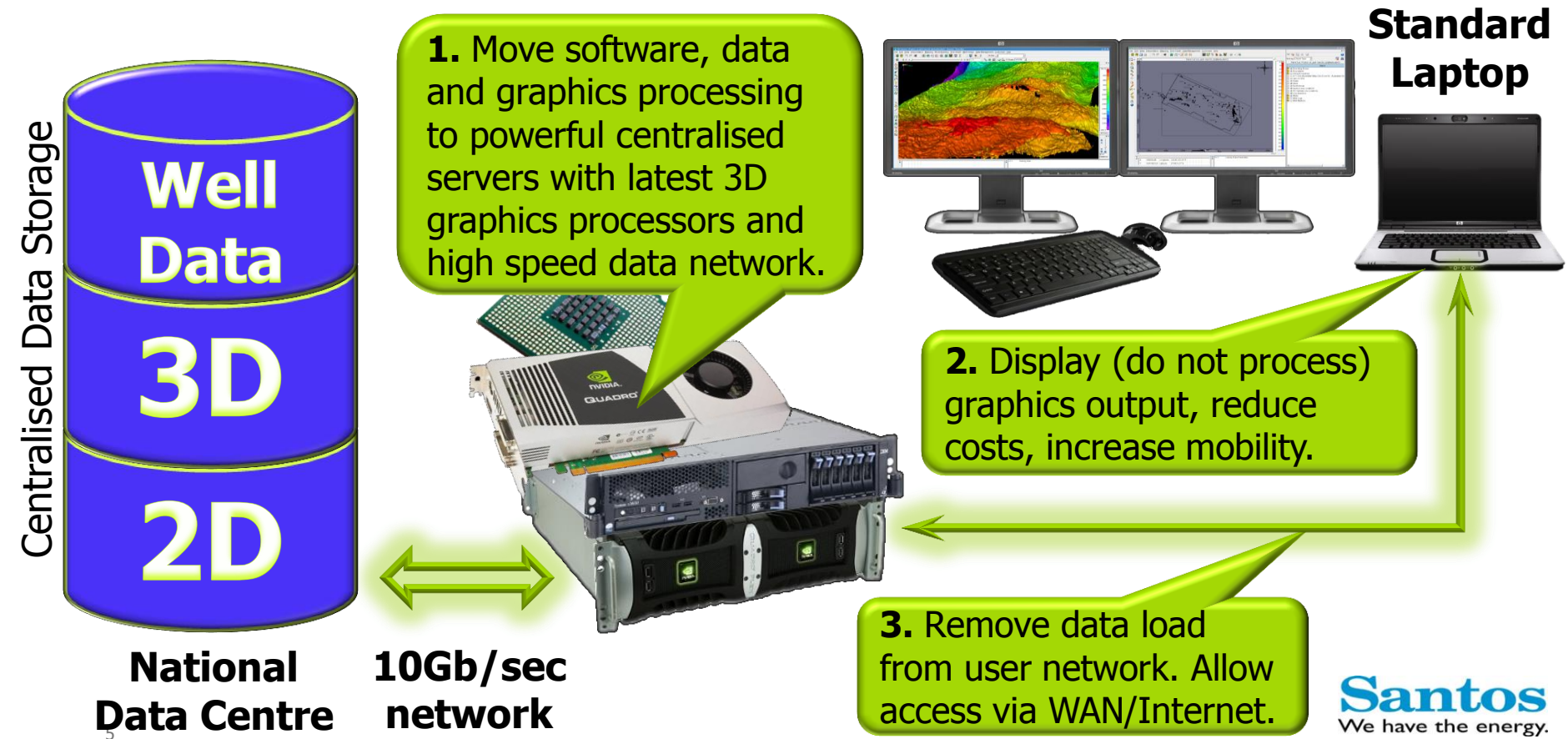
Data volumes too big for workstations - Local data servers create islands of data

User network is a data bottle neck for 200 geoscientists, slowing **all** user applications

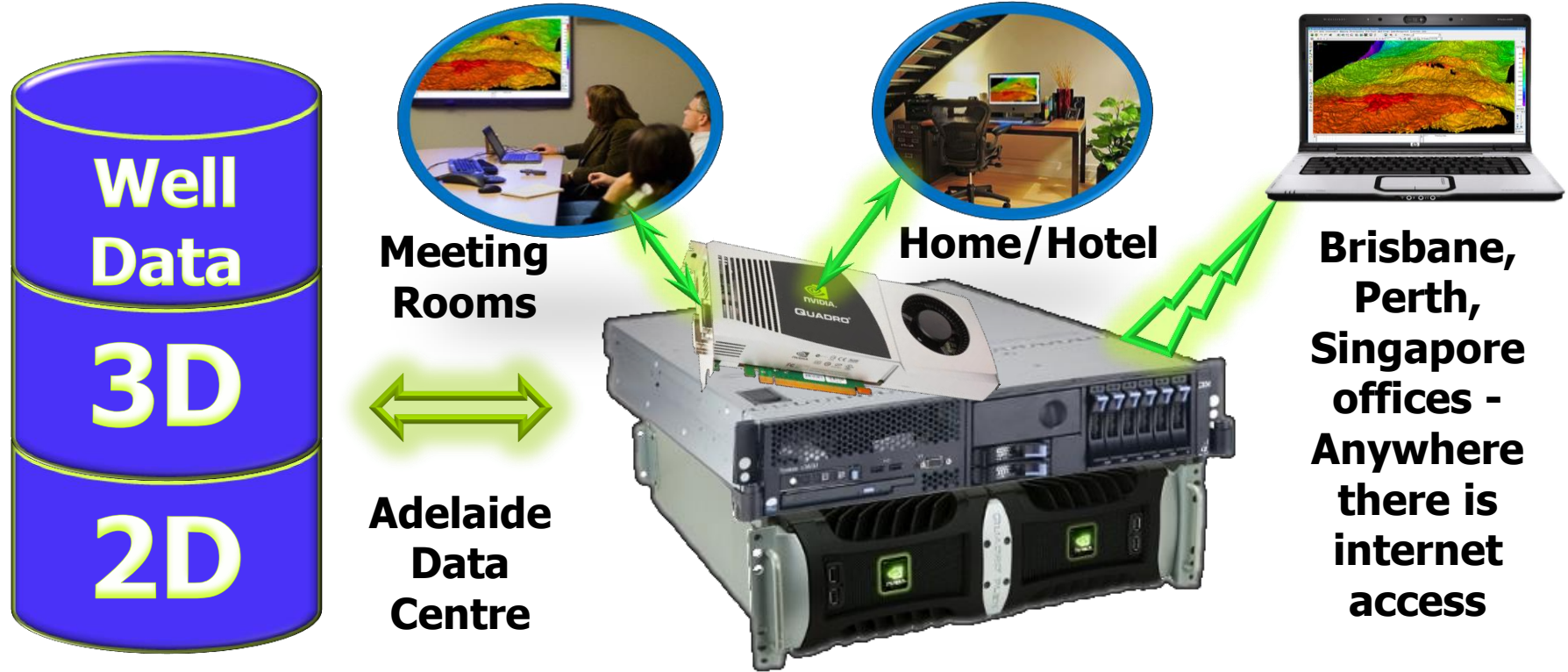


1Gb/sec Client Network – Static data, No Internet input

The Solution: Private Cloud and Thin Client – Nothing new



Private Cloud: Secure, multi-user collaboration on centralised data from any Location.

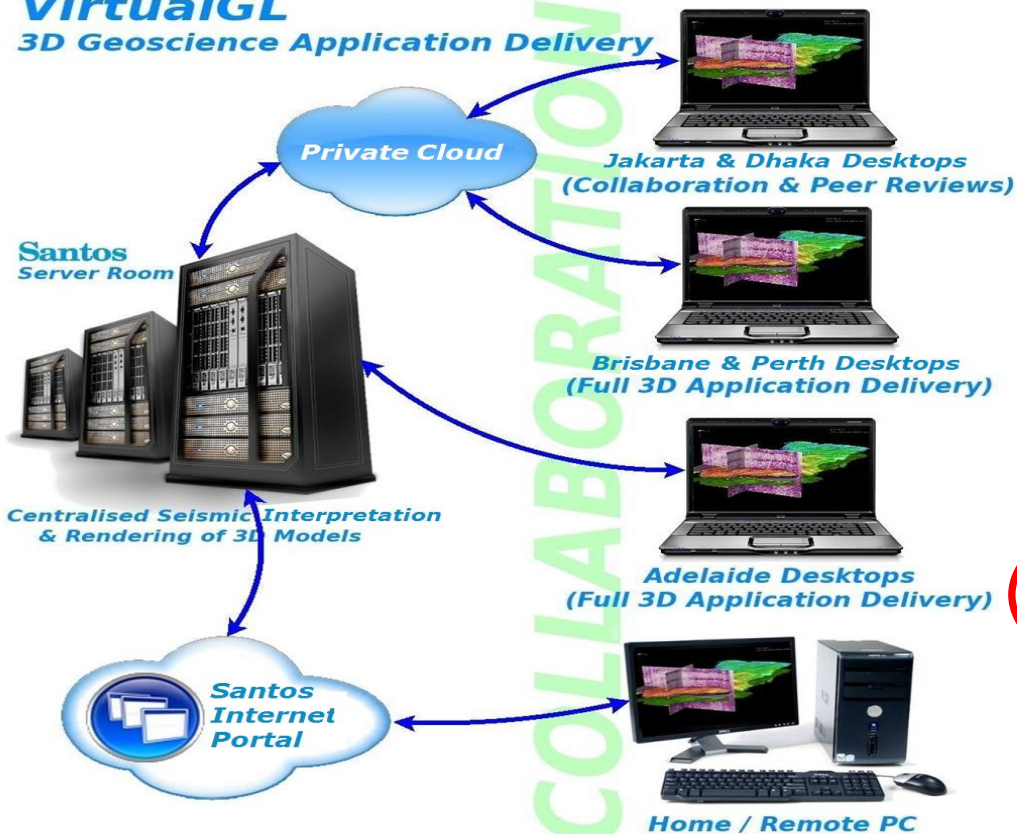


- Data is centralised and secure, does not leave the data centre.
- Multiple users can connect to and share sessions from any location.

The Benefits: \$5M over 5 years + a Big Data platform

VirtualGL

3D Geoscience Application Delivery



Most Efficient Use Of Computing Hardware

Centralised seismic interpretation on high-end server hardware.

Geoscience workstations can be low-end Windows notebooks.



Infrastructure Cost Savings

Immediate \$1.8M saving plus \$767K p.a. support costs saving.



Greater Security For Corporate Data

Valuable data never leaves the server room – Only the graphics..



One Source Of Truth

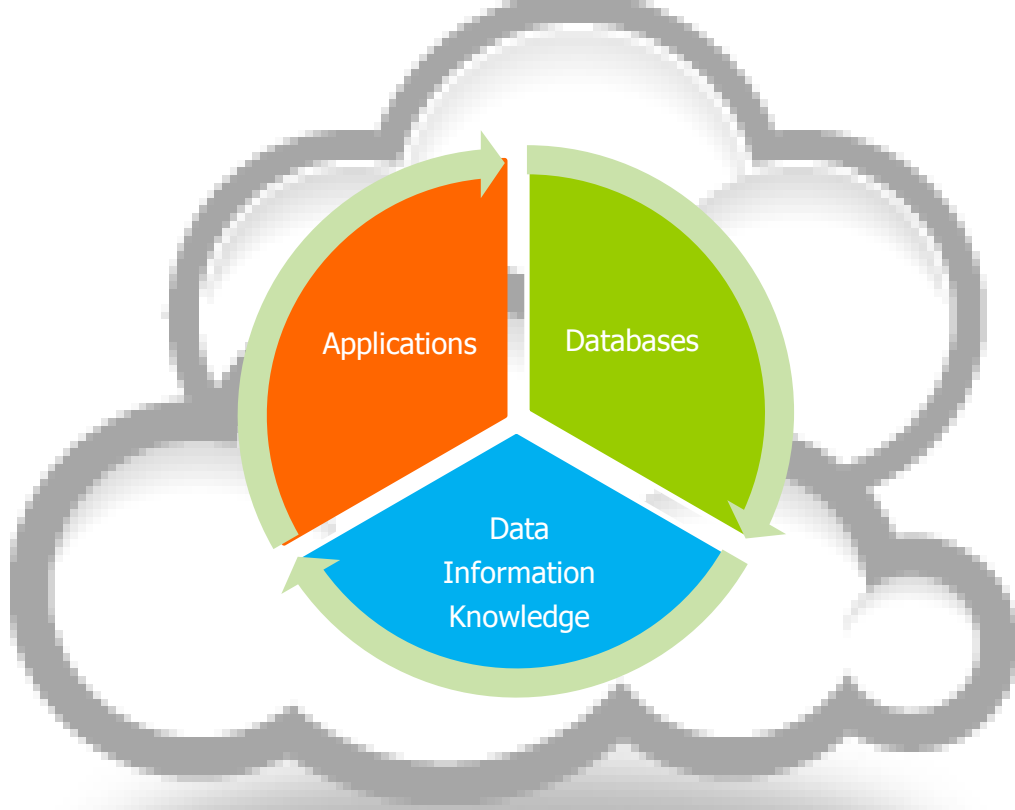
Everyone using one central set of geoscience applications and data. Connected to a central database. No duplication of data on workstations.



Collaboration Across All Santos Sites

Real-time on-screen collaboration where ever you are.

Santos
We have the energy.

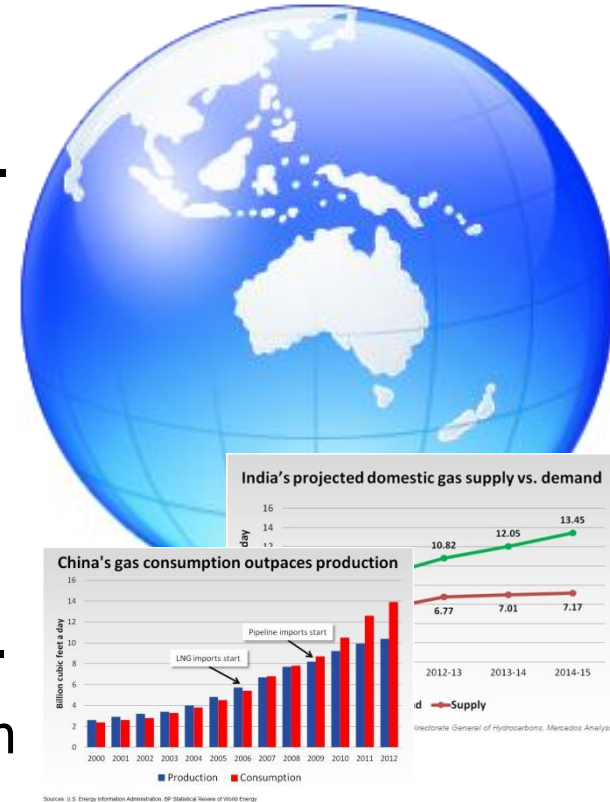


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Data Analytics at Santos

Context: Industry Issues – will prices harden ?

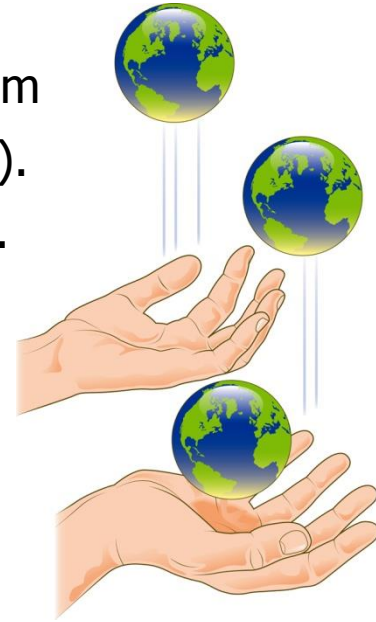
- US and Asian demand for natural gas has driven production up and prices down – “most” of US shale is now uneconomic, \$26bn write-offs in 2012.
- Australia - poised to be the largest LNG exporter but also the world’s most expensive O&G location.
- CSG to LNG projects in Queensland will drill 1000s of wells to 2020, driving increases in data volumes.
- Data turn-around is critical – as is data quality, suggesting centralised, automated data integration.
- Cost control is critical - deriving more value through Big Data analyses can help drive success whilst reducing cost – Big opportunity – will we listen ?



Big Data Potential: Right data = right result

Santos are working on a simple Big Data strategy:

1. Solve the data quality issue **first**. Big Bad Data = Big Bad Problem
2. Mine data for specific heuristics (rules & relationships in the data).
3. Build a knowledge base of historical data, analysis and heuristics.
4. Run live data against the knowledge base to present anomalies and trends (and alarms in the case of operations).
5. “Buy not build” – is this part of the strategy right ?

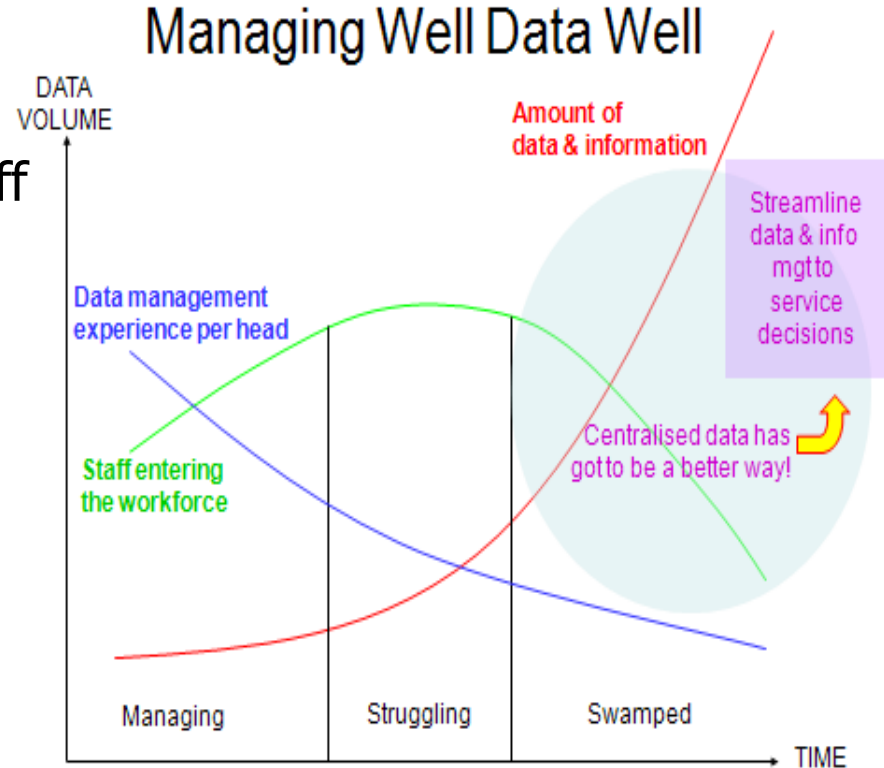


In its proof of concept, Santos was able to predict failures in rotating equipment in the Cooper Basin up to 3 hours in advance - a predicted \$20mm NPV on spend of \$650K.

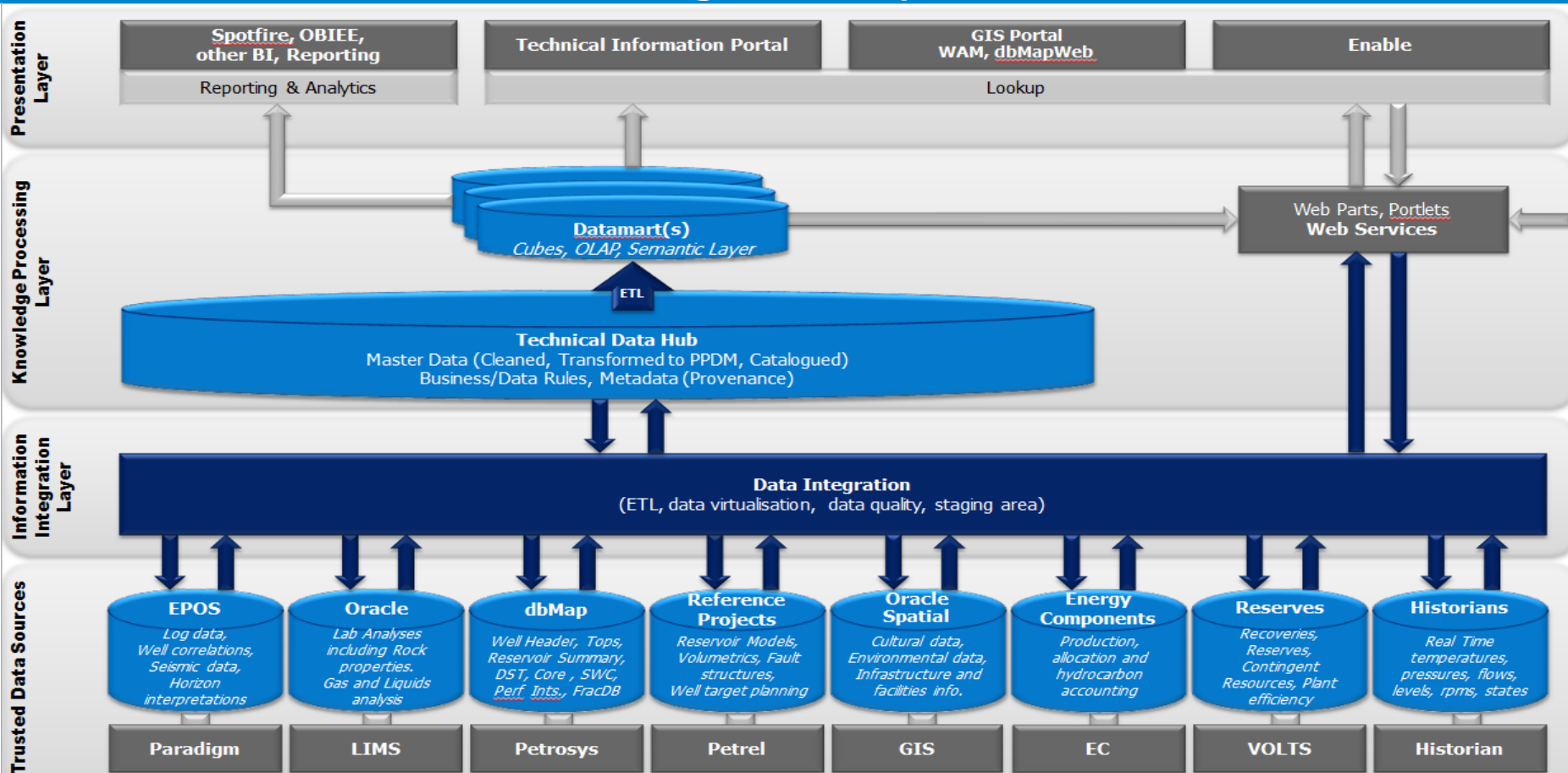
The warning can now be issued 96 hours in advance.

Work Smarter: Drive data management maturity

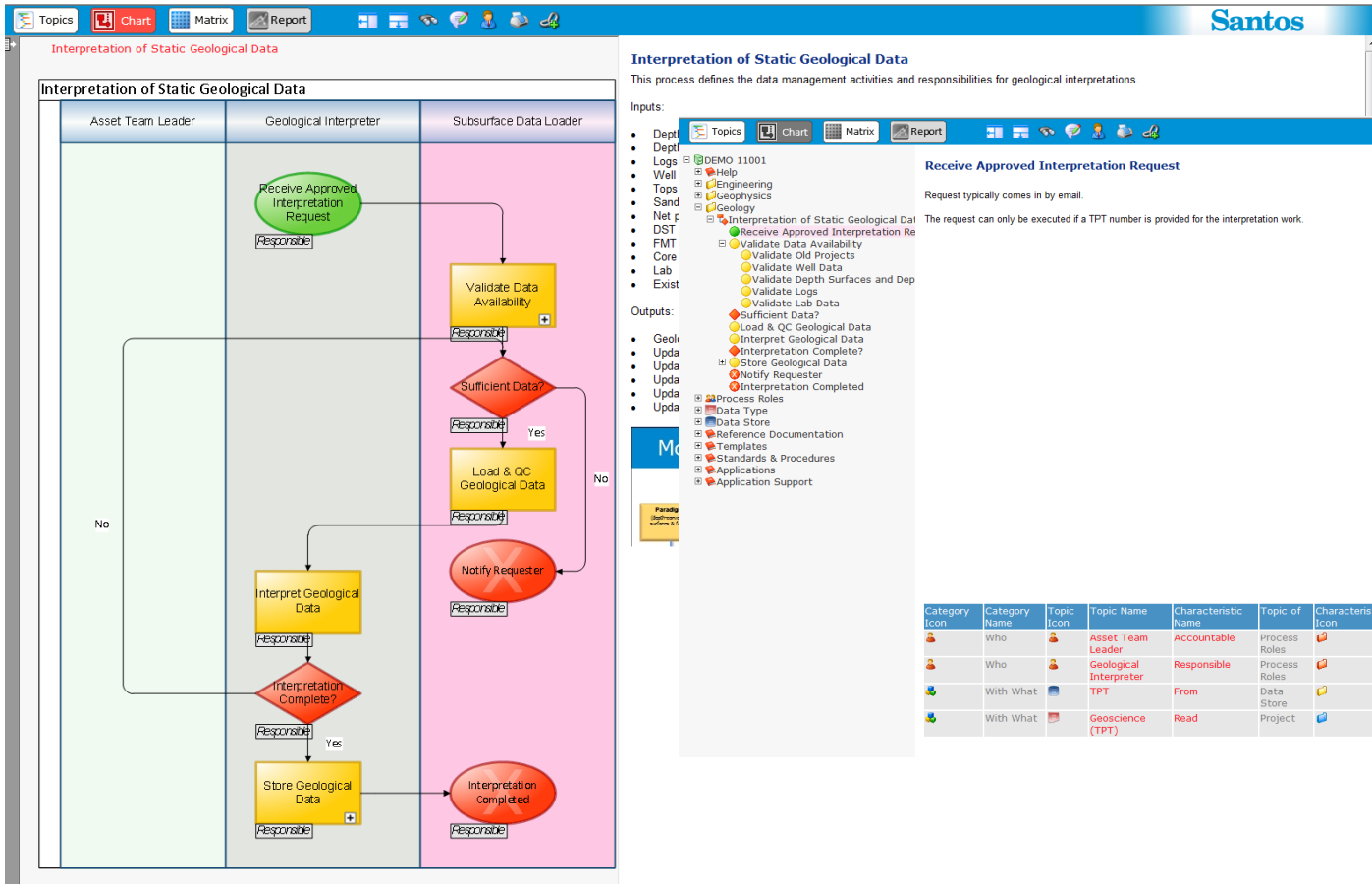
- Manual methods are unsustainable. As data volumes grow so does demand for increasingly rare skilled staff
- Consolidation assists automation. Duplications can be avoided and data quality raised through automated QC.
- Integration allows scarce and valuable geoscience resources to focus on interpretation not data management
- Visualisation exposes data to a wider critical audience and drives up quality



Get Organised: Industry data model (PPDM) helps integrate disparate data-sets



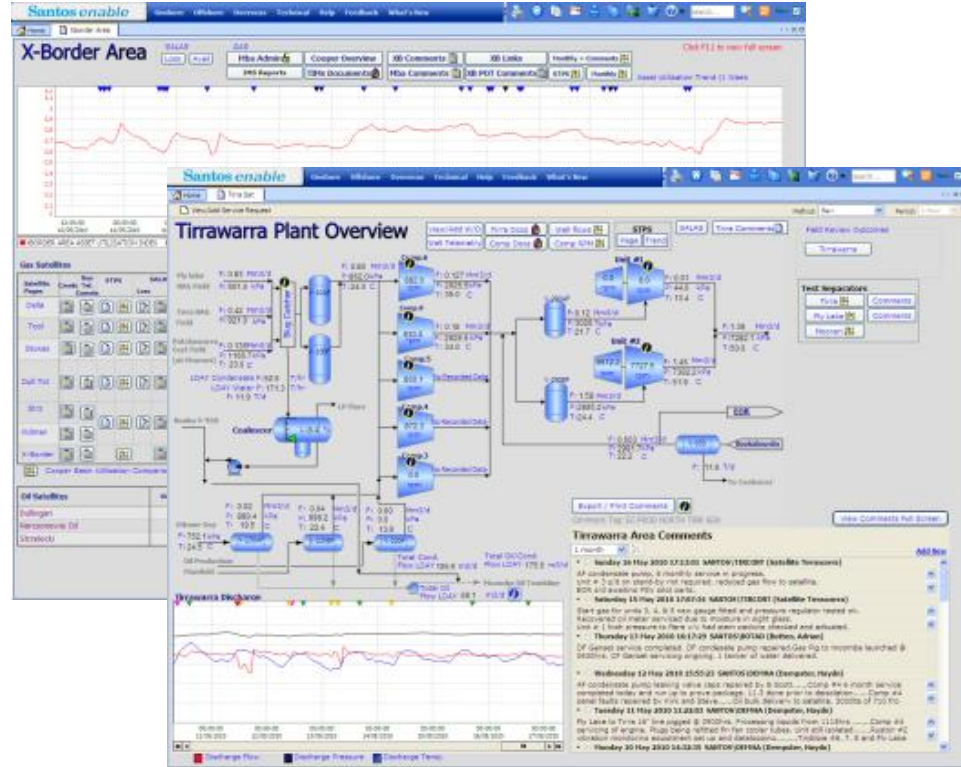
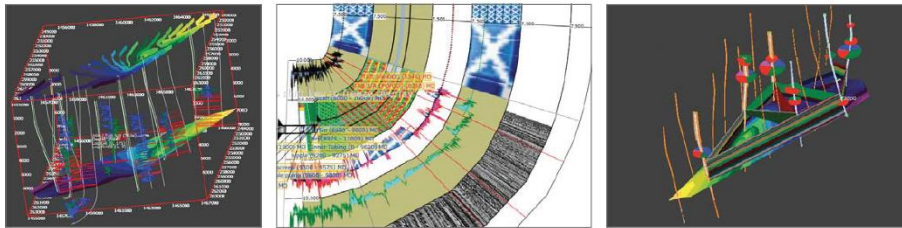
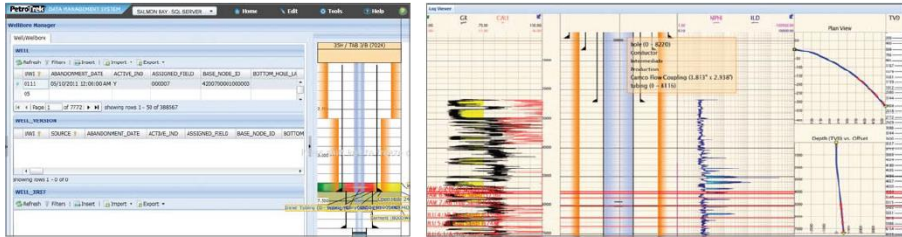
Business Rules: Mavim Rules business process mapping and Roles & responsibilities



Category Icon	Category Name	Topic Icon	Topic Name	Characteristic Name	Topic of	Characteristic Icon	Characteristic Code	Characteristic Number	Topic Order Number	Topic Code	Topic Path	Myview
	Who		Asset Team Leader	Accountable	Process Roles			6			DEMO 11001	Myview
	Who		Geological Interpreter	Responsible	Process Roles			20			DEMO 11001	Myview
	With What		TPT	From	Data Store			33			DEMO 11001	Myview
	With What		Geoscience (TPT)	Read	Project			3			/Relationship Categories/With What/Data Catalogue	Myview

Technical Information Portal: Visualise data, spark ideas, raise quality

- A quick and easy combined *view* of structured & unstructured data reveals relationships and informs the question "***What do you want to know?***"



Data Analytics: Real-time drilling predictive analytics

Areas where Santos are seeking to exploit data analytics:

- Real-time drilling predictive analytics.

Santos is seeking a commercial product. There are 2 approaches

1. Monitoring & computing downhole physics (mechanical, hydraulic, thermodynamic) in real-time. E.g. Sekal Drillscene source SPE paper 150422

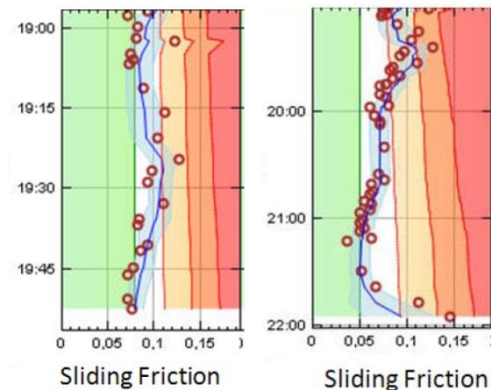
“In field studies of fifteen N. Sea wells, alarms were raised in advance for all major events, such as stuck-pipe, at different time scales:

Rapidly changing downhole conditions were typically warned 30 minutes in advance

Medium duration deteriorations were detected up to 6 hours in advance

Slow changing downhole conditions were signalled up to 1 day in advance.”

2. Monitoring and comparing down-hole physics with historical data (E.g. Oracle/Infosys)



Data Analytics: Stress orientation and fracture density

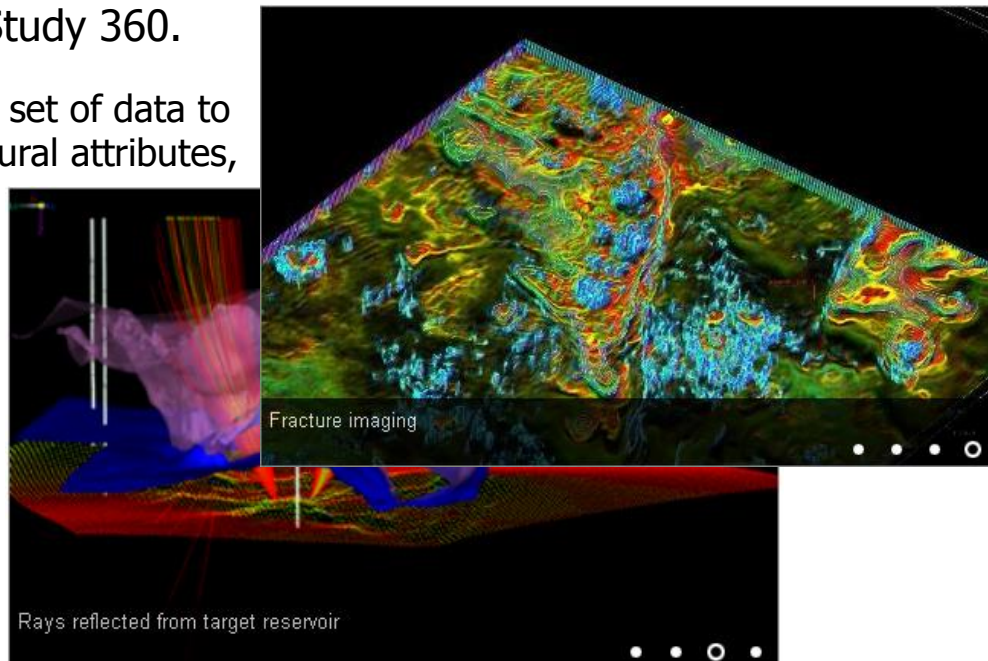
- Predicting stress field orientation and fracture density from multi-azimuth seismic

Building on work undertaken at Adelaide School of Petroleum. Again, Santos is seeking a commercial product – E.g. Paradigm Earth Study 360.

“EarthStudy 360 is designed to deliver a complete set of data to obtain accurate subsurface velocity models, structural attributes, medium properties, and reservoir characteristics”

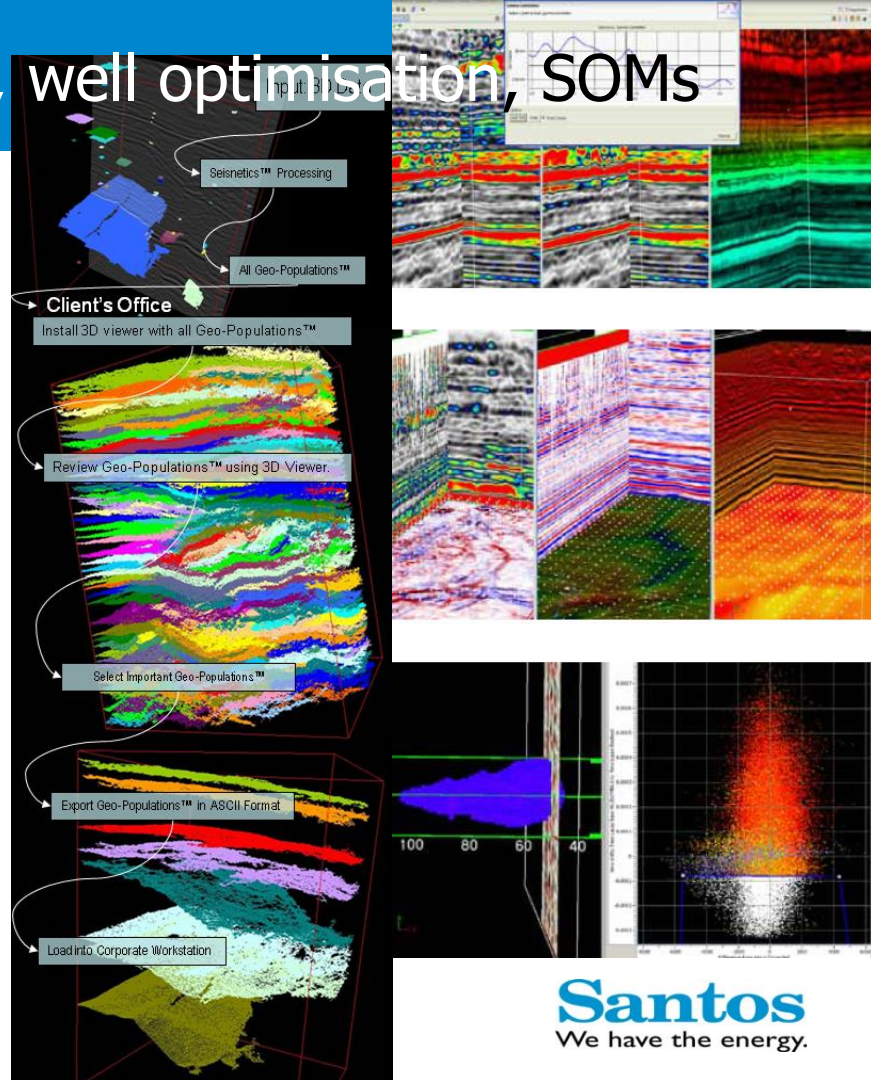
“These images can reveal the information needed for velocity model determination, and provide details regarding the presence of micro-fractures, the orientation of faults and fractures, the elastic properties of target reservoirs, and the boundaries of those reservoirs”

In summary –
it helps find “sweet spots”



Data Analytics: 3D Seismic, well optimisation, SOMs

- Santos has for some time used Seismic Unix and Delivery: an open-source model-based Bayesian seismic inversion program from CSIRO
- Now, 'no-pick' pre-interpretation software, e.g. TotalDepth Seisnetics, can reduce interp time by at least an order of magnitude
- Automated merging of seismic volumes, e.g. TransformSW TerraMorph, improves QA/QC.
- Well optimisation is an obvious target for research into relationships between formations, production and frac data.
- Self Organising Maps help identify hidden data relationships - offering potential for rock properties & reservoir characterisation.

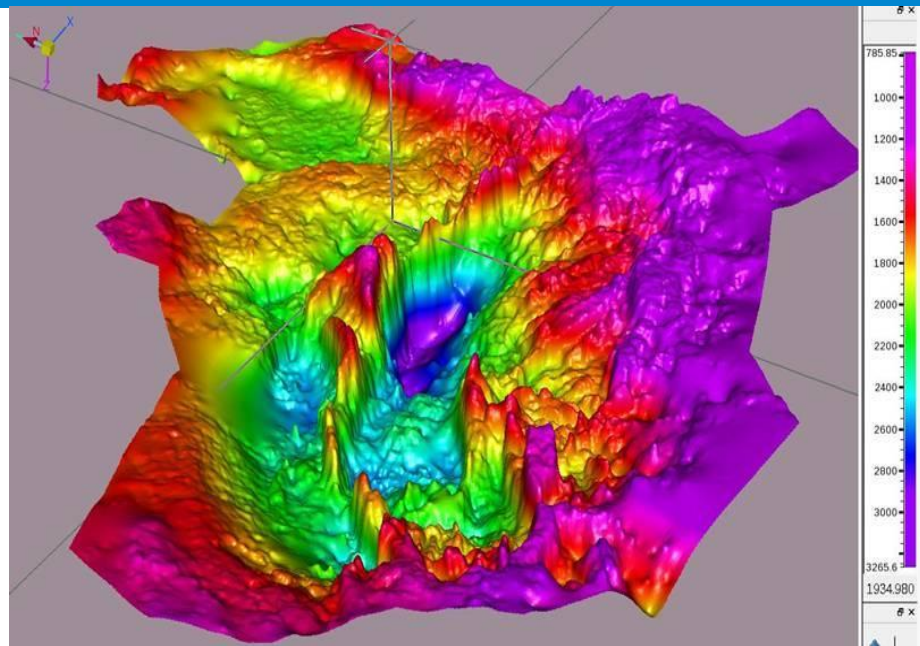


Cooper Basin: Mapped by The Cloud

- This map of the entire Cooper Basin was made in 2011 by storing all the data in one place, not by stitching a number of smaller project outputs together or by re-sampling the data to fit the memory in a single workstation.

- 76 GB of seismic data was rendered as one holistic model, manipulated in 3D in the memory of a single server.

- In 2011 the production of this map was not possible on a traditional workstation. By 2013 a single workstation could hold 496 GB of data in RAM – ***What next ?***



The mapped area is about **20,000 km²**. Features previously hidden now become visible, such as regional fault trends.

The Future: Is Cloud Shaped

- **Moore's law** says the number of transistors that can be placed inexpensively on an integrated circuit **doubles** approximately **every two years**.
- **Kryder's Law** predicts that hard disk storage capacity will **double every 2 years**. (Plus solid state memory is *theoretically* **1,000,000 x faster**)
- **Butter's Law** says throughputs in optical fibre will **double every 9 months**.
- **Nielsen's Law** says available Internet bandwidth **increases by 50% every year**.



Only a **cloud approach** can take **full advantage** of the changes that ***we know are coming***, such as the need to deal with the petabytes of data.

Moore's Law: Supercomputing is cheap as chips

- In **1997** the US Sandia National Laboratory broke the **teraflop** barrier - one trillion floating point operations per second – using **10,000 Pentium chips** at a cost of **\$55M**.

- In **2008** the US Los Alamos National Labs broke the **petaflop** barrier for a cost of **\$125M**

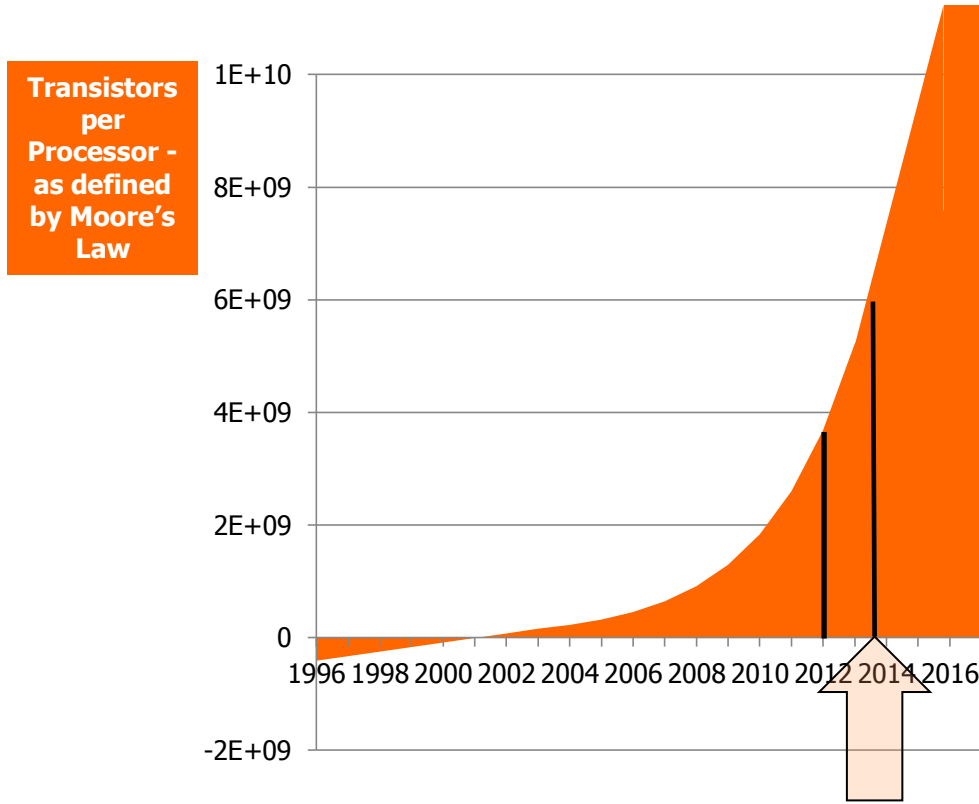
- In **2011** Intel announced the 'Knights Corner' chip, **1 teraflop** from a single chip that cost \$55M just 14 years previously. Intel later branded the chip **Xeon Phi** and in Nov 2012 priced it at under **US\$2,000**

- In June 2013, Tianhe-2 at the National Supercomputing Center **Guangzhou** was declared the world's fastest supercomputer, using Intel Xeon Phi processors to achieve **33.86 petaflops**. Source: Wikipedia



Image courtesy : Intel Corporation 2011.

The Challenge for our Industry



Is our industry and geoscience practices ready and able to introduce new techniques to take full advantage of this onslaught of processing power and anticipated data volumes?



YOU ARE HERE !

- The **Private Cloud** model takes advantage of technology and data management improvements and is well placed to benefit from the **National Broadband Network** for remote access, making it an ideal platform for Big Data Analytics

- Cloud Computing and Big Data are 21st century issues. **21st century thinking** and volition is required to apply new scientific methods to realise orders of magnitude more benefit.

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Conclusion

Santos TurboVNC- Global innovation winner

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The Runners-up:



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We have the energy.