2019 FIG Commission 7 – Annual Meeting

SEOUL, SOUTH KOREA

Smart Data and Smart Processes Building Capacity to Upgrade Fit-for-Purpose Land Administration

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Outline

1. Land Administration and Cadastre as foundation components of the natural and built environments of the real world and the Digital Twin.
2. From Fit-For-Purpose Land Administration Systems to Digital Twin
   a) Northern Territory, Australia
   b) New South Wales, Australia
3. Managing the Cadastre in a future Digital Twin

1. Land Administration and Cadastre as foundation components of the natural and built environments of the real world and the Digital Twin

Security and Spatial Definition of tenure in the cadastre is the foundation to:

- The economy
- Political stability
- etc

1. Land Administration and Cadastre - Australia

In Australia we are in the transition from the manual measurement based title systems of the past to the digital location based title systems of the future.

Existing mapping based cadastral databases are always being upgraded to benefit from digital efficiencies.

1. Land Administration and Cadastre - Australia

In Australia the accuracy of cadastral digital models can vary considerably, even though Torrens Title is considered one of the leading Title Systems

The economics to approach a **true digital twin** for a 2D cadastre is challenging but for a 3D cadastre it is not currently sustainable.

1. Land Administration and Cadastre - Australia

In the Torrens Title system inconsistencies between historical survey plans have always existed.

The Registered Surveyor has always resolved those inconsistencies.

The problem is that inconsistencies cannot exist in a digital database model or Digital Twin

1. Land Administration and Cadastre - Australia

Spatial upgrading is using smarter applications and processes to:

1. take advantage of access to greater intelligence attached to survey data
2. automate the intuitive logic of Registered Surveyors to manage the database.

1. Land Administration and Cadastre - Australia

The challenge is to determine what level of Digital Twin in Australia is achievable based on the 90%/10% budget rationale.

i.e. - 90% of a task budget can be spent on the last 10% of the task.

1. Land Administration and Cadastre - Australia

Problems usually relate to individual parcels in a database of millions of parcels.

This becomes a management decision as to what levels of spatial precision are acceptable for the budgets available. So it becomes:

A Fit-For-Purpose Digital Twin

Fit-For-Purpose Land Administration

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Stig Enemark
Keith Clifford Bell
Christiaan Lemmen
Robin McLaren

Fit-For-Purpose Land Administration - Forward

"At the annual World Bank Conferences on Land and Poverty concerns were raised by various stakeholders that **the current procedures and requirements for mapping and boundary delineation were often too cumbersome and expensive** and did not comply with the actual needs of most citizens for achieving security of tenure."

Fit-For-Purpose Land Administration - Forward

"This perspective calls for a **flexible** and **pragmatic** approach rather than requirements imposed through rigid regulations, demands **for spatial accuracy and systems** that may be unsustainable for less developed countries"

Fit-For-Purpose Land Administration

The FFP document implied that the capacity of technology was one of the drivers of complexity in implementing land administration systems.

That has been a symptom of aspects of the cadastral digitisation systems being implemented in Australia.

Technology Drivers

- Measurement tools - EDM, GNSS, Scanners, high resolution imagery.
- Computing power.
- Software, Applications, AI, etc

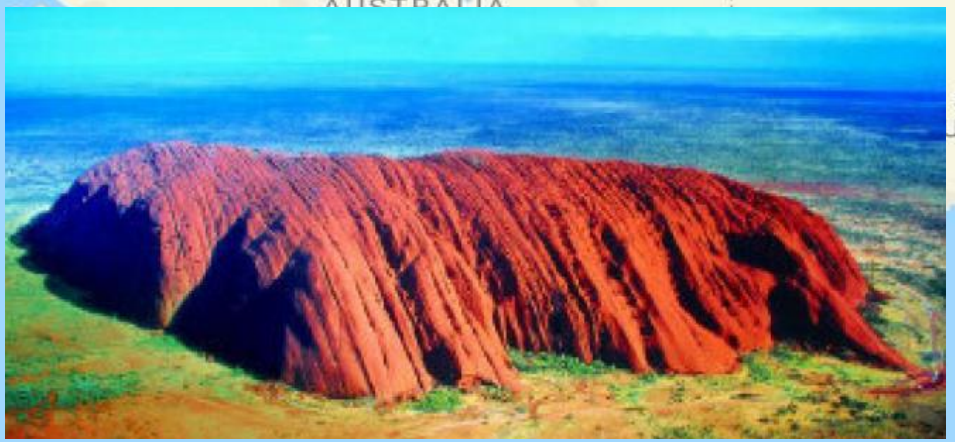
CASE STUDY

Northern Territory

Area - 1.3 mill sq kms

Population - 250,000

Total Parcels - 85,000



Digitisation in the Northern Territory (NT)

For over 20 years the NT has been extracting relevant measurement and other data from all NT survey plans and is now all but complete.

The NT the mapping based Cadastral Database is now being replaced by a survey database (SPICAD) built by compiling the machine readable text files of individual survey plans.

This is a transition from a Mapping Database to an object based Survey Database that utilises historical title measurements and geodetic control in the adjustment with survey data quality analysis.

Digitisation in the Northern Territory

Total Digital lodgement was made mandatory in 2017. That lodgement is simplified with a mixture of formats:

1. **a digital image of the new survey plan**
2. **A file of machine readable text file -** parcel dimensions and other measurements that can benefit the spatial upgrading of the parcel fabric (SPICAD) or statutory jurisdictional content needed for transactions.
3. **A standard Plan Examination Report** generated by Surveyors.

The NT is building a Digital Twin but it is far from identical. The approach is minimalist compared with other states but scalable if more rigour or cadastral intelligence is required in the future.

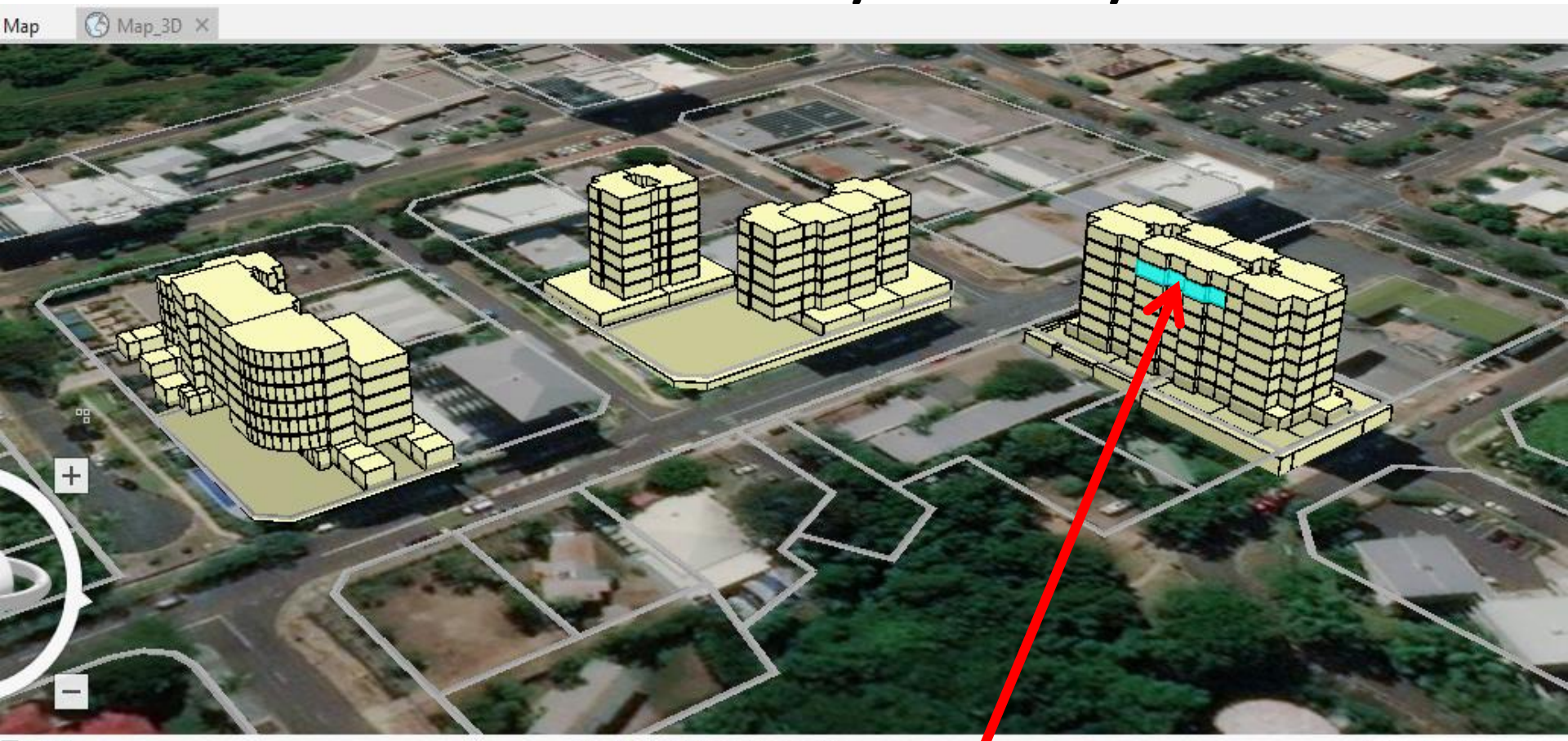
Digitisation in the Northern Territory

The NT is taking the same approach to 3D.

Basic heights are also captured in the machine readable text file.

They are stored as parcel attributes when capturing Strata / Apartment / Condominium survey plans for 3D modelling from the SPICAD survey database in the future.

The Northern Territory Survey Database



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	Type	StatedArea	Accuracy	Shape_Area	OBJECTID_1	Plan	Lot	Floor_leve	Ceiling_He	Floor	Lot_Plan
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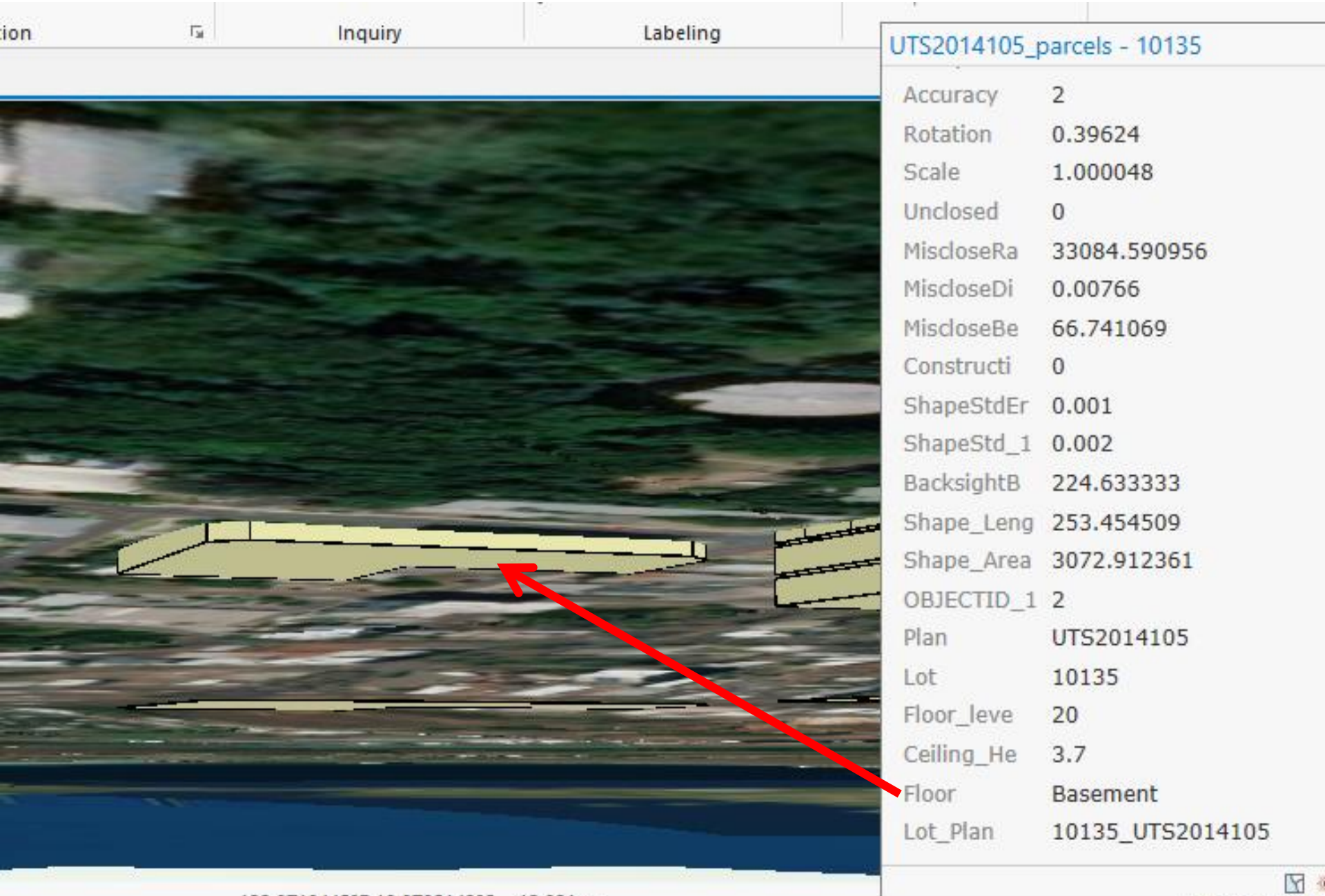
	59	155	2	155.180805	15	UTS2014016	9074	26	2.7	Second_Floor	9074_UTS2014016
	59	155	2	155.180805	57	UTS2014016	9116	44	2.7	Eighth_Floor	9116_UTS2014016
	59	155	2	155.180805	50	UTS2014016	9109	41	2.7	Seventh_floor	9109_UTS2014016
	59	155	2	155.180805	36	UTS2014016	9095	35	2.7	Fifth_Floor	9095_UTS2014016

Cadastral Database with 3D Parcel



Digitisation in the Northern Territory

The successful innovations in the Northern Territory cadastral database have been due to doing what is readily achievable and not trying to pursue complicated outcomes even though technology has the capacity for those outcomes.

DIGITISATION CASE STUDIES

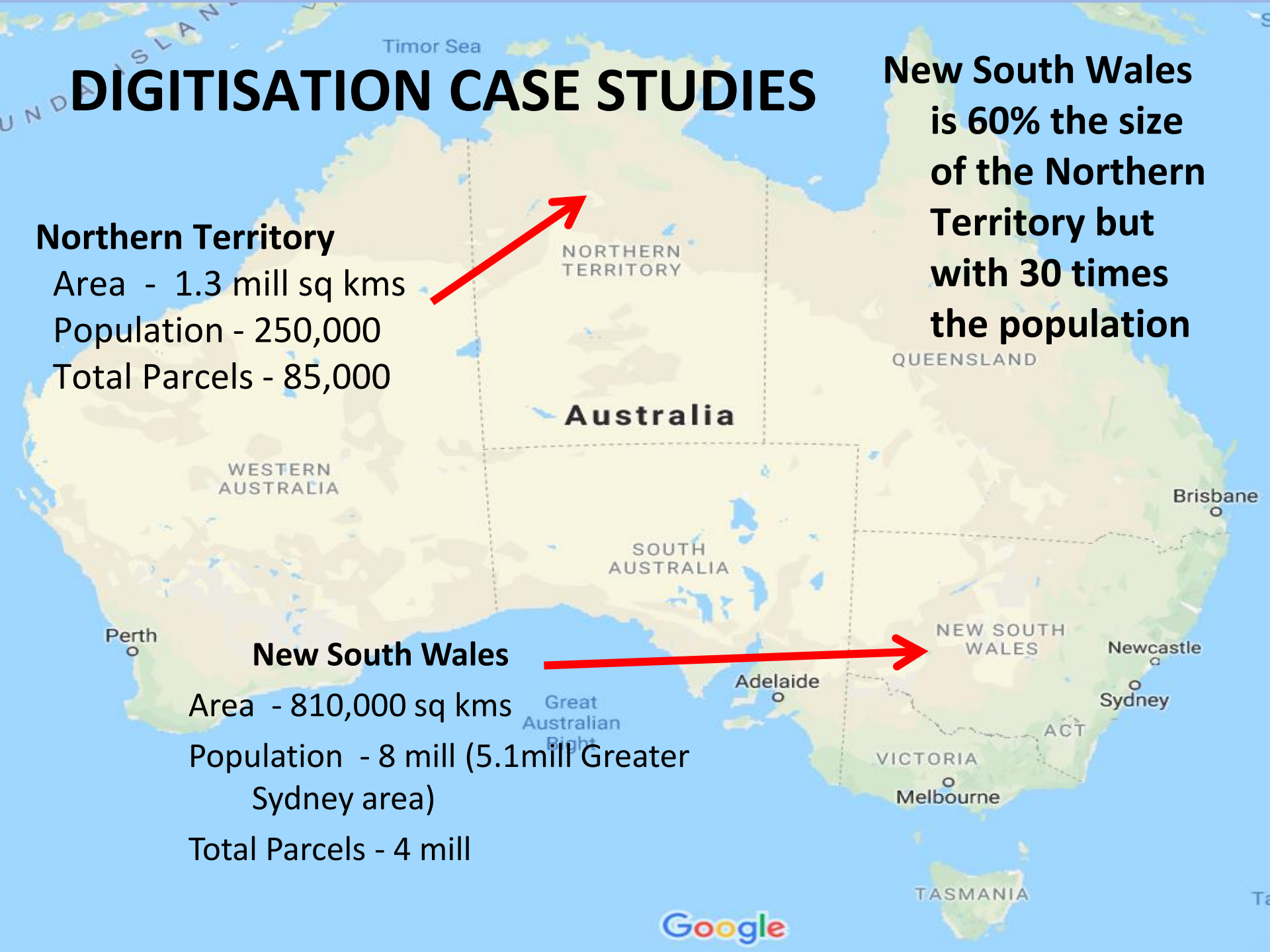
New South Wales is 60% the size of the Northern Territory but with 30 times the population

Northern Territory

Area - 1.3 mill sq kms

Population - 250,000

Total Parcels - 85,000



New South Wales

Area - 810,000 sq kms

Population - 8 mill (5.1mill Greater Sydney area)

Total Parcels - 4 mill

Digitisation of Survey Processes in New South Wales (NSW)

NSW has invested strongly in the digitisation of survey and cadastral processes and have implemented a high level of rigour and automation.

The complexity of those processes has meant they have had to revue some of those goals.

They are also looking to progress the Digital Twin Strategy.

The NSW Digital Twin

NSW has developed an interactive platform to capture and display real-time 3D and 4D spatial data in order to model the urban environment.

This upgrade from traditionally held 2D spatial data is the NSW 'Digital Twin'. The State Infrastructure Strategy 2018 recommended an upgrade to NSW's spatial data from 2D to real-time 3D and 4D, the launch of this platform is the first step in making this recommendation a reality.

For more information:

https://www.digital.nsw.gov.au/article/twinning-spatial-services-has-created-digital-twin-nsw

The NSW Digital Twin

4D Model showing the internal structure of a building in Penrith as at December 2018

3. Managing the Cadastre in a Future Digital Twin

Technology has the capacity to generate an effective Digital Twin but the quality of the data will determine the quality and effectiveness of the outcome.

The cadastral component will be a challenge when the existing cadastral database is spatially poor or lacking the data for 2D and 3D components.

3. Managing the Cadastre in a Future Digital Twin

Spatial precision is the foundation for an effective Digital Twin so spatial upgrading of existing cadastral databases is required.

Smarter survey databases have the capacity for the higher precision by managing all types of spatial data (survey traverses, GNSS, imagery location, crowd sourcing, etc) where the spatial integrity of the data is taken into consideration in a rigorous adjustment. (As used in the NT)

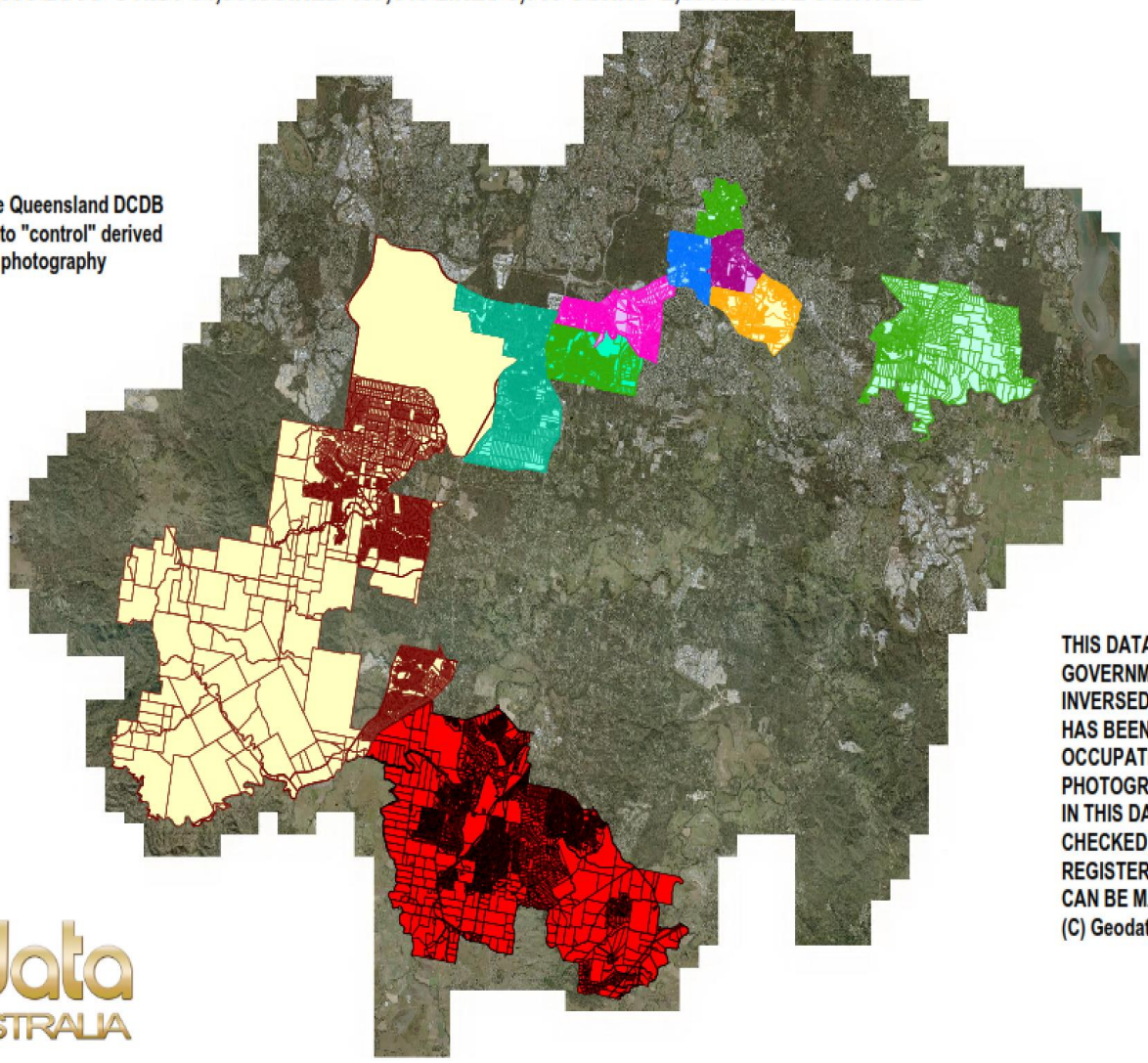
3. Managing the Cadastre in a Future Digital Twin

With the applications available, states should be rapidly looking at digitisation implementations to capture and retain the integrity of good data moving forward while considering how historical legal records are brought into the system.

Commercial options in upgrading methods must be a consideration.

Spatial Upgrading Case Study

Upgrade of approximately 55,000 parcels (to date) in urban and peri-urban areas in Queensland.



Spatial Upgrading Case Study

Initial setup

1. Convert the mapping database to a survey database. Initial parcel dimensions are adopted from the mapping database
2. Resolve issues of topology and connectivity for the Least Squares Adjustment

Spatial Upgrading Case Study

Ongoing upgrading

1. Add survey control from varied sources:
   i. Initial coordinated control points (occupations/fencing) adopted from imagery
   ii. Where uncertaintanty exists, measurement data from survey plans was back captured and replaced dimensions adopted from mapping database
   iii. If uncertainty remains, field survey is required.
2. Continue upgrading (in-house) as needed or as resources became available.

Spatial Upgrading Case Study

Outcomes

1. Database conversion (Qld Case Study)
   i. Desktop costs for setup stage < $5 per parcel
   ii. Precision generally reduced from 3 - 10m to <1m (not guaranteed as mapping data may be spatially poor)
2. Previous projects with back capture of survey data and some field survey
   i. Desktop component - Approx $30 per parcel
   ii. Spatial outcomes subject to quality of survey plans and amount of field survey
      - 0.1m - 0.3m Urban
      - 0.5m – 1m Rural

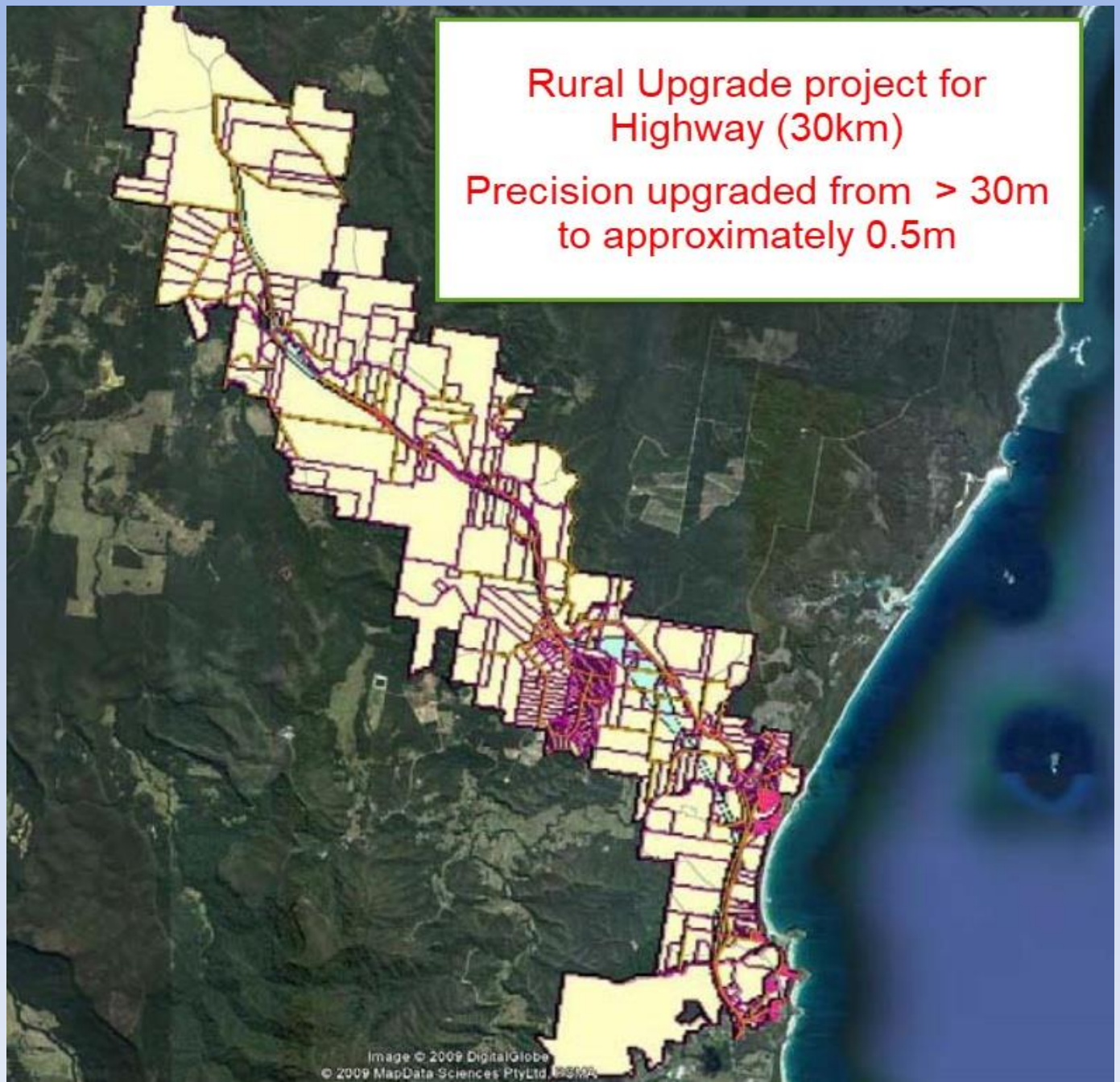
Spatial Upgrading Case Study

Outcomes

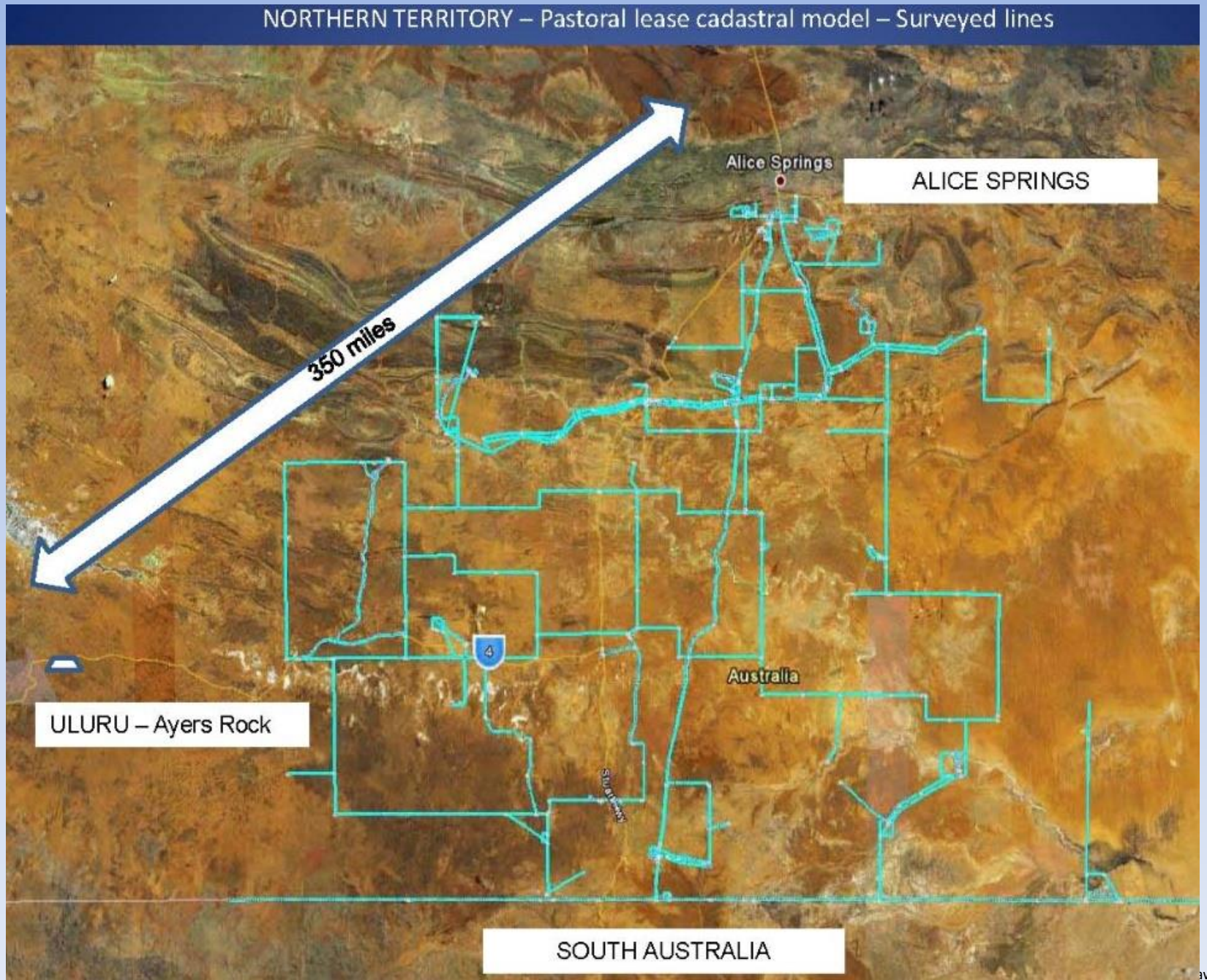
In **back capture projects** all required data is manually entered into the system and joined to a topology. This is a costly task but will achieve the highest spatial outcomes from the data available. Some parcels may have no surevy measurements so work is required to populate the parcel attributes.

In the **Database Conversion** Process the existing parcel already has all the attributes required so data entry for those fields is not required. All parcels have starting boundary dimensions so if there are no records for a parcel, it already exists and the weighting is kept low in the adjustment to reflect that. Parcel topology also already exists.

Spatial Upgrading Case Study



Back Capture Case Study – NT Pastoral Leases



Managing the Cadastre in a Future Digital Twin

The business benefits of the Digital Twin are recognised but the **initial goals must be achievable** so the outcomes do not get bogged down in the detail that does not get mentioned in business strategies.

Essential reading

Essential Reading for Future Digital Twin Production

Fit-For-Purpose Land Administration

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Thank You

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