Can a Constellation of CubeSats Create a Capability?

Satisfying Australia's Future Need for Multi-Spectral Imagery

Presenter
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Co authors
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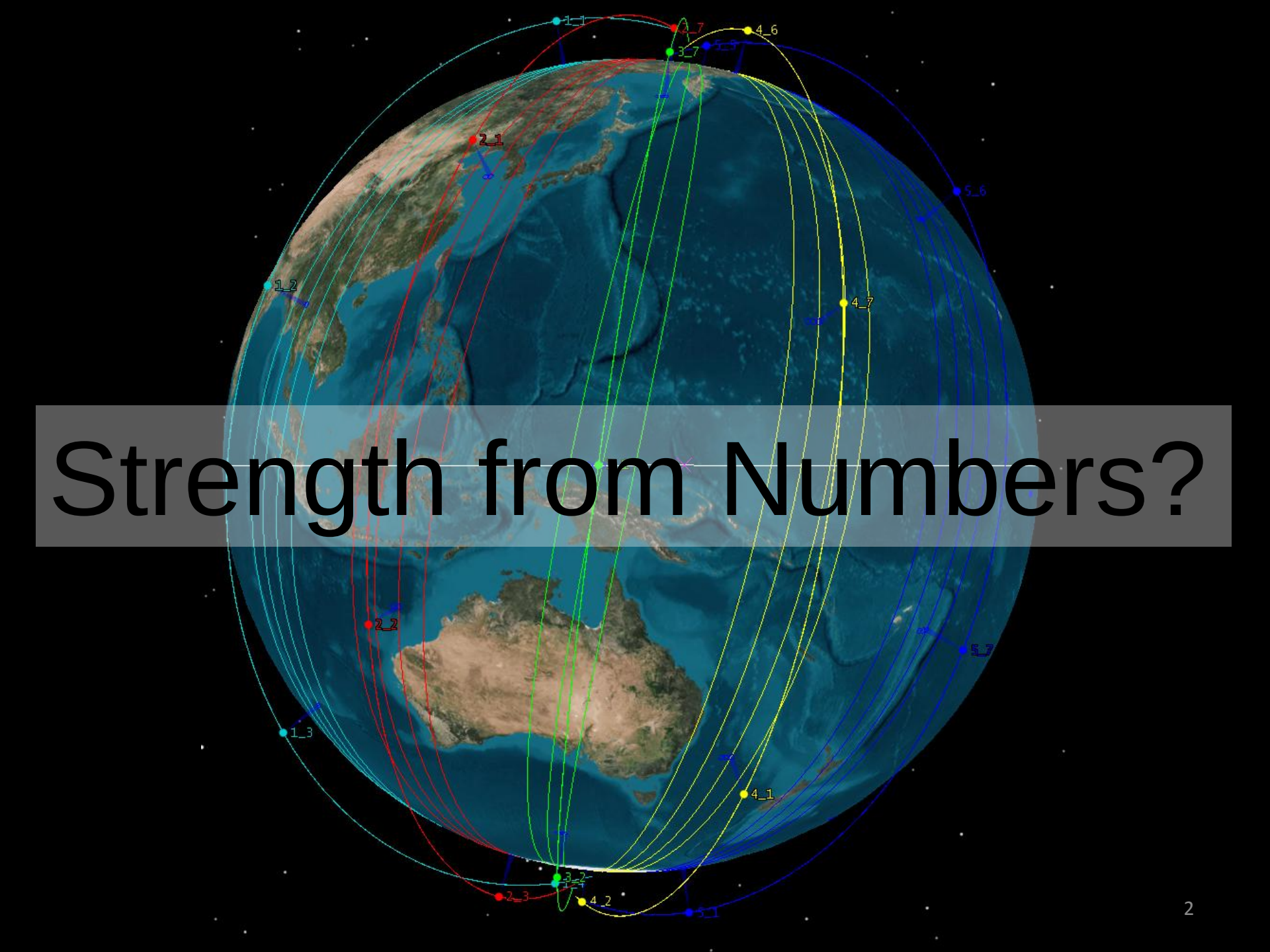
David Lingard

Department of Defence
Defence Science and Technology Organisation

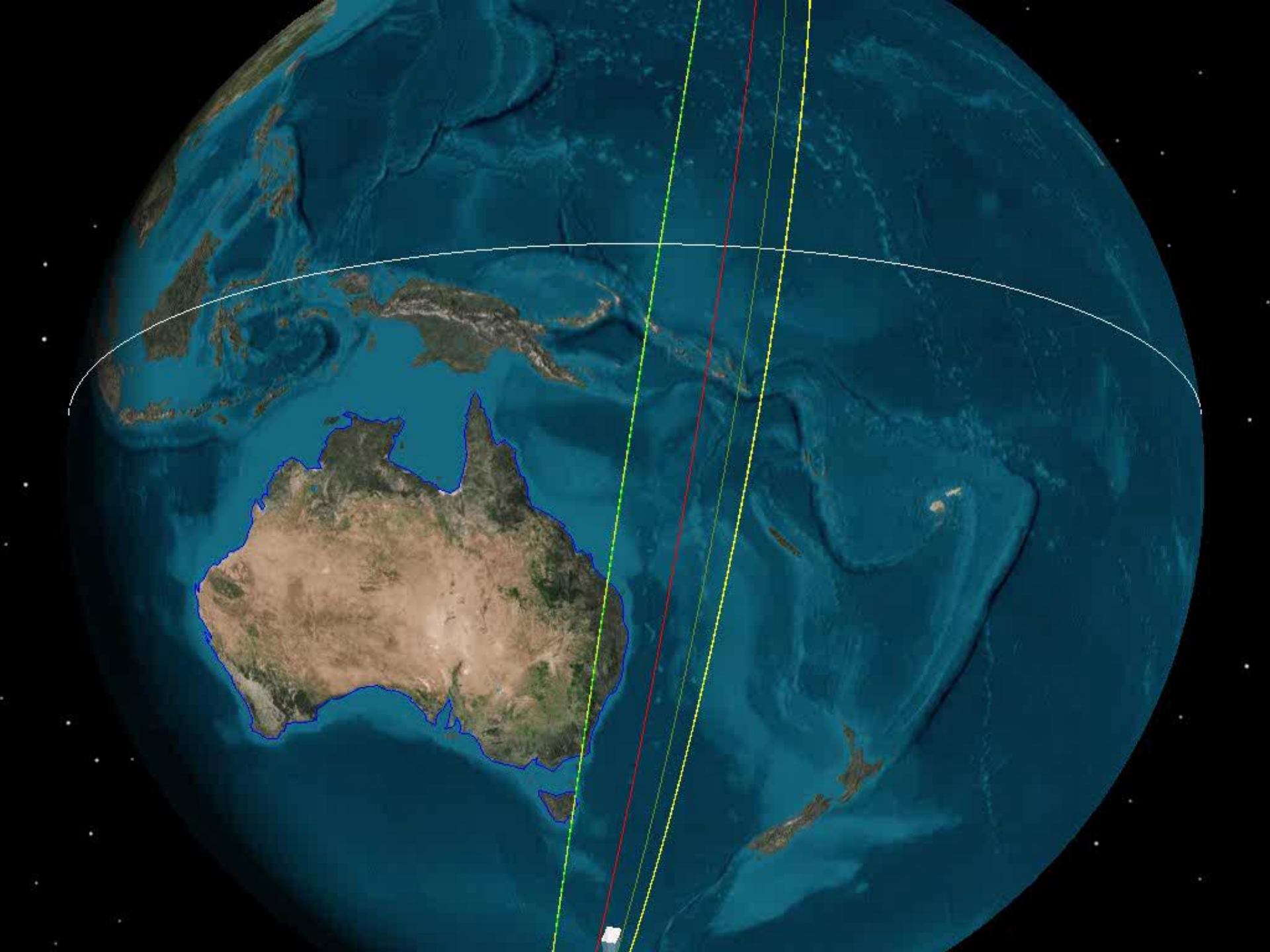


Strength from Numbers?

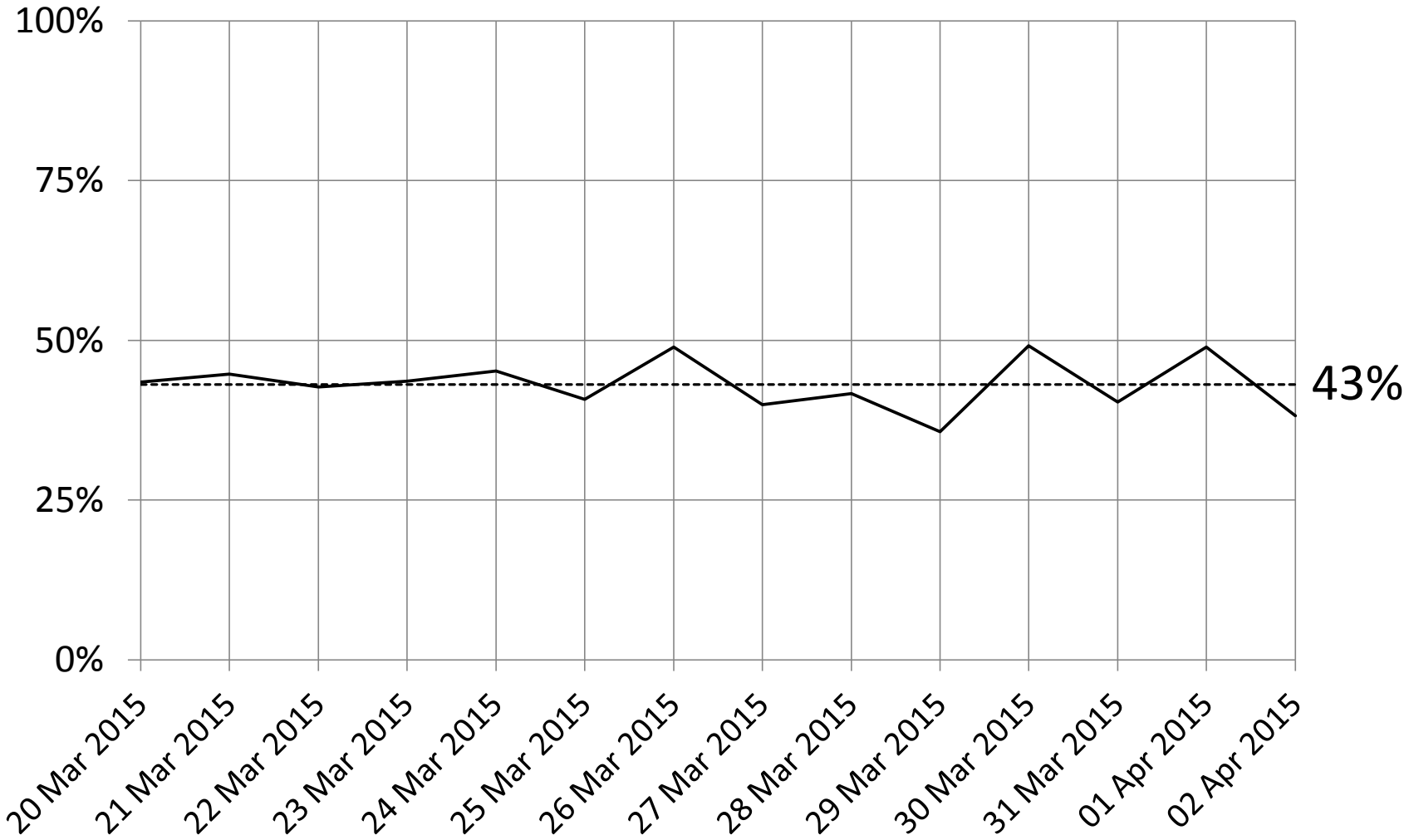
The Problem

GA: Continuity of Earth Observation Data for Australia, Hudson 2011

Darwin
Broome
Cairns
Alice Springs
Brisbane
Armidale
Perth
Adelaide
Sydney
Canberra
Melbourne
Hobart



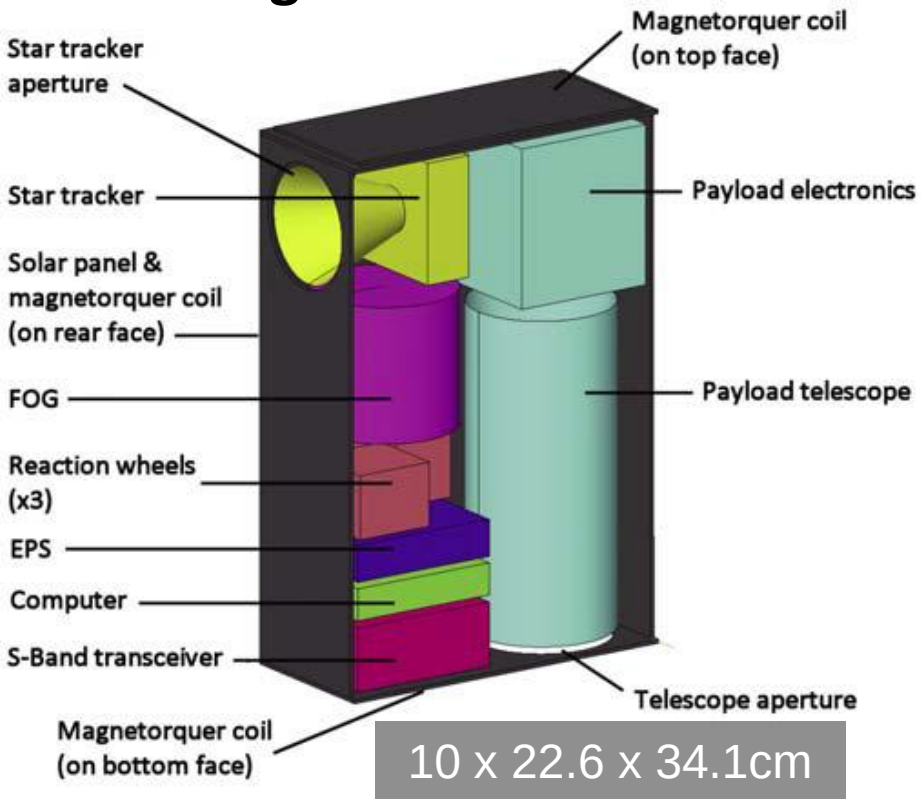
Public Good Collection Contribution



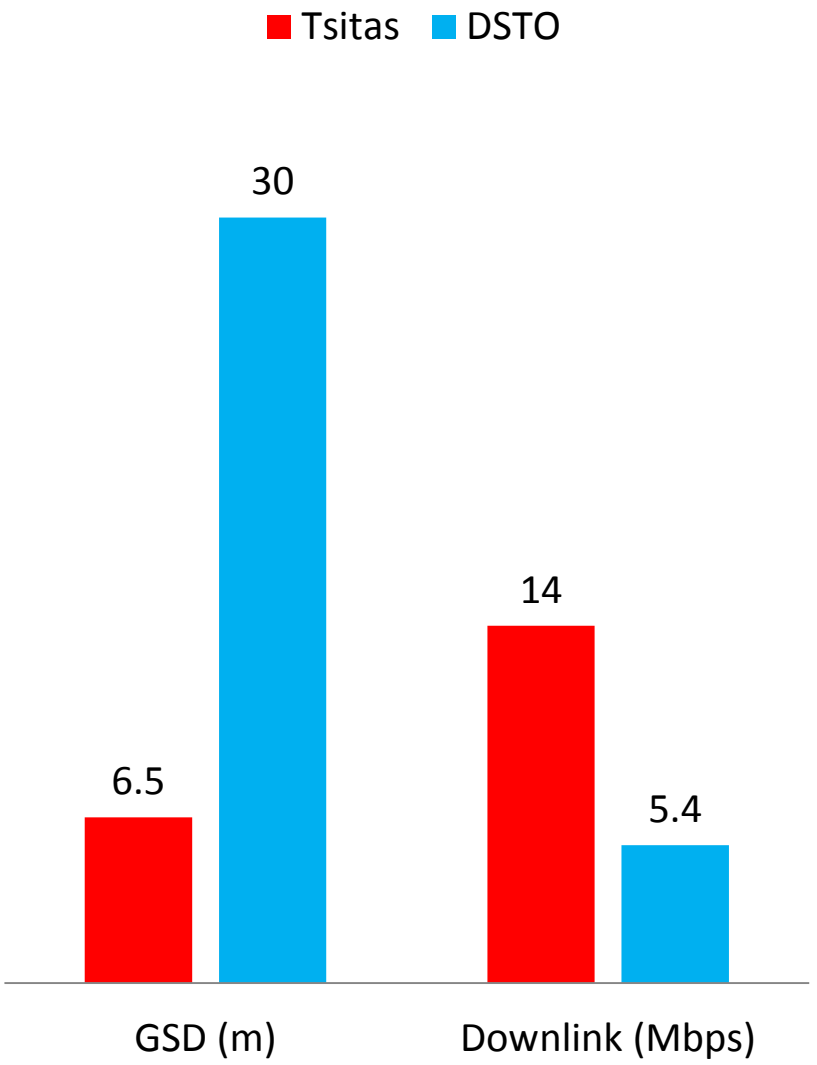
CubeSat Space Segment

S. Tsitas (Uni Cranfield/UNSW):

- **8kg 6U satellite Cubesat, with equivalent mission capability of 150kg satellite.**



10 x 22.6 x 34.1cm



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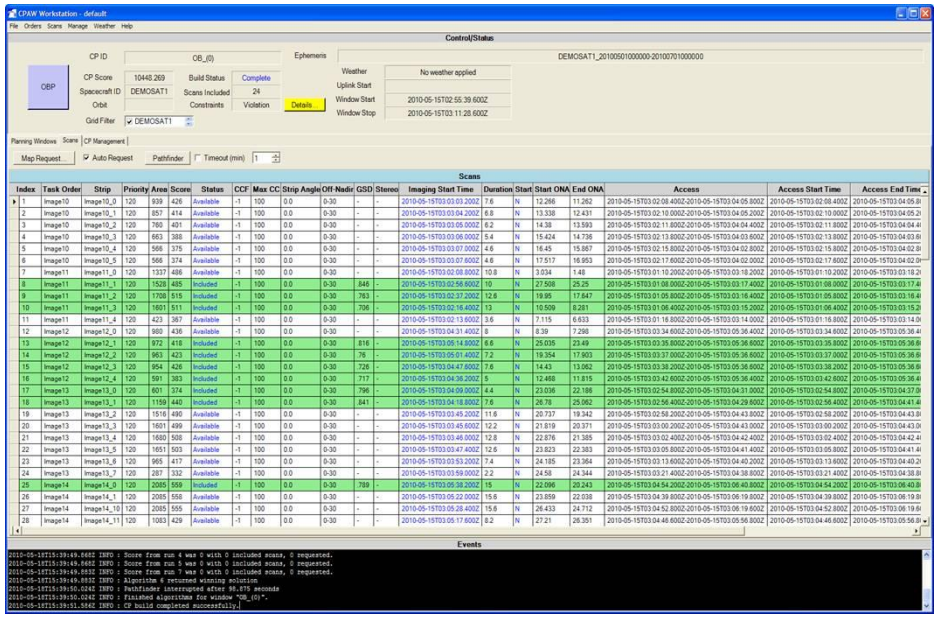
Technology Organisation

Collection Planning & Analysis Workstation (CPAW)

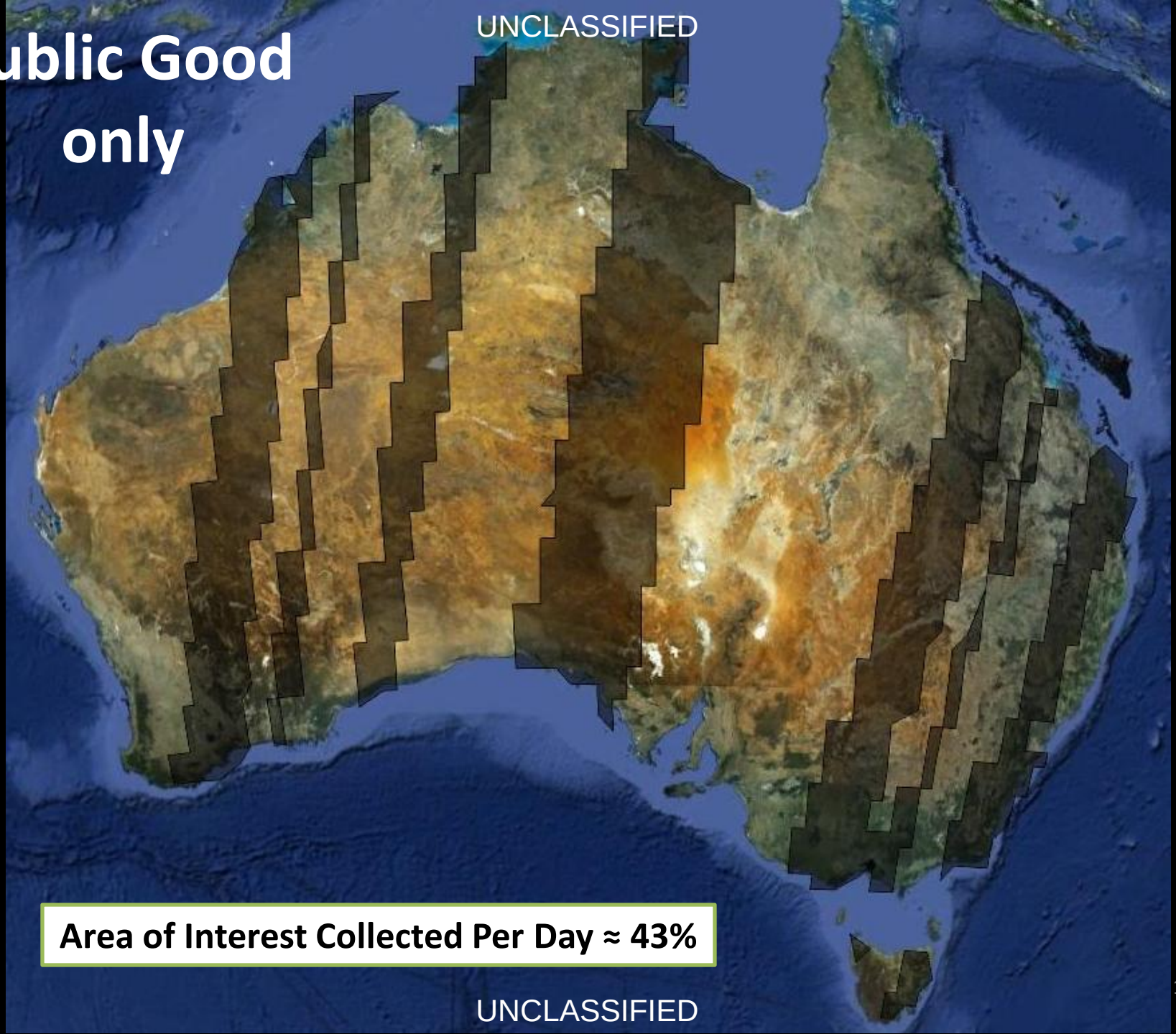


Constraints & Resources:

- Data
- Downlink
- Battery
- Cloud

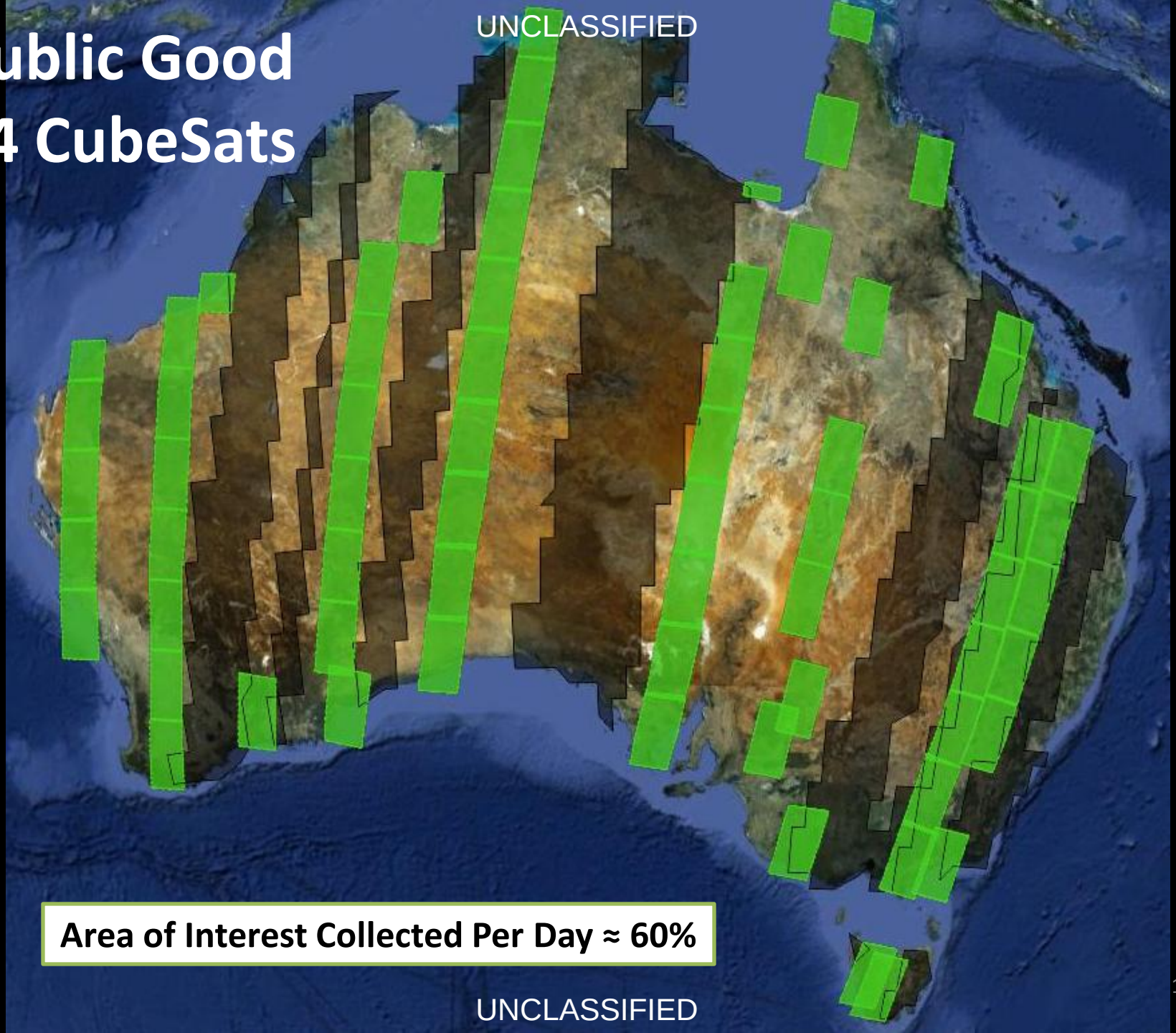
ORBIT LOGIC INCORPORATED

Public Good only



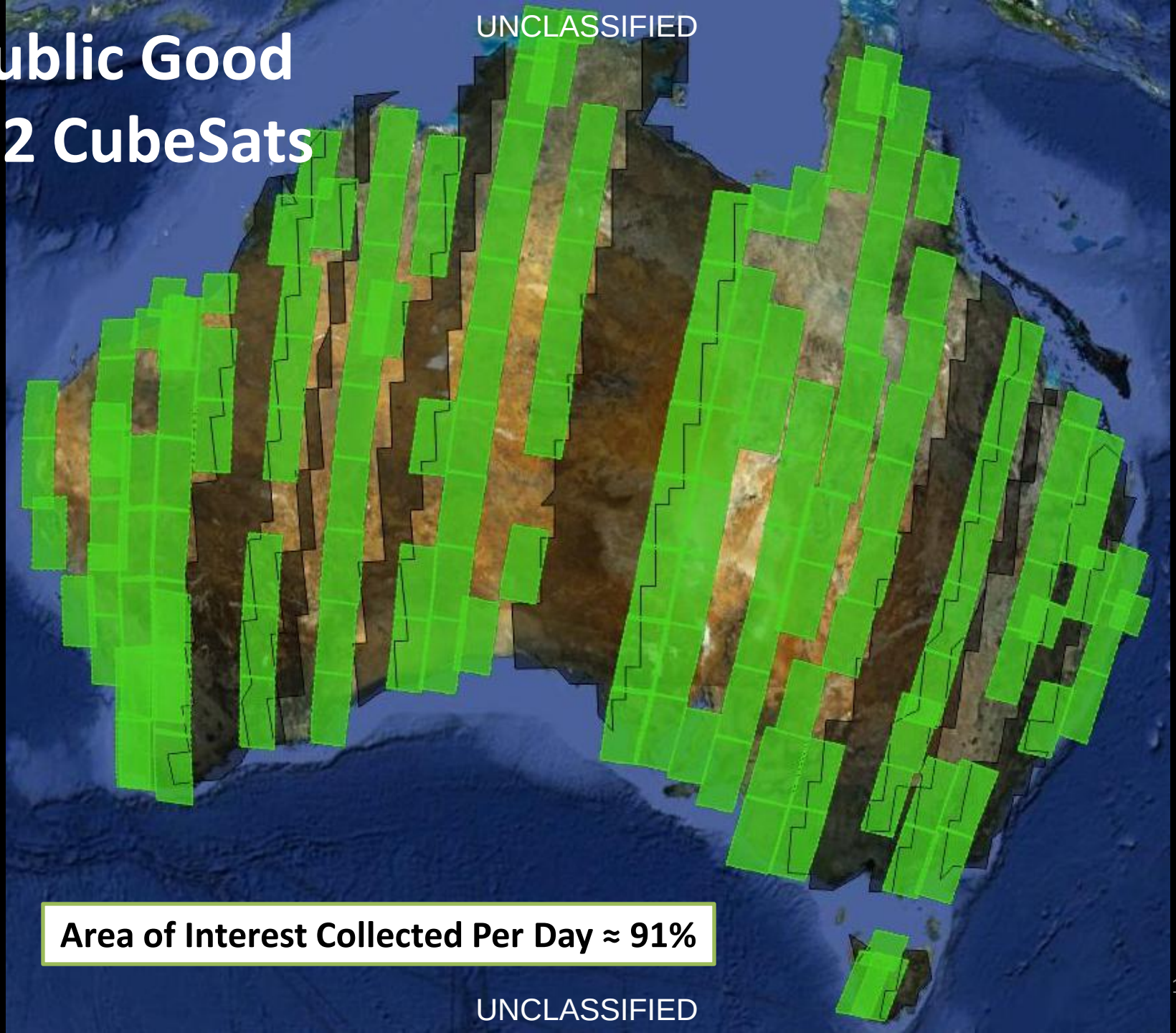
Area of Interest Collected Per Day ≈ 43%

Public Good
+4 CubeSats



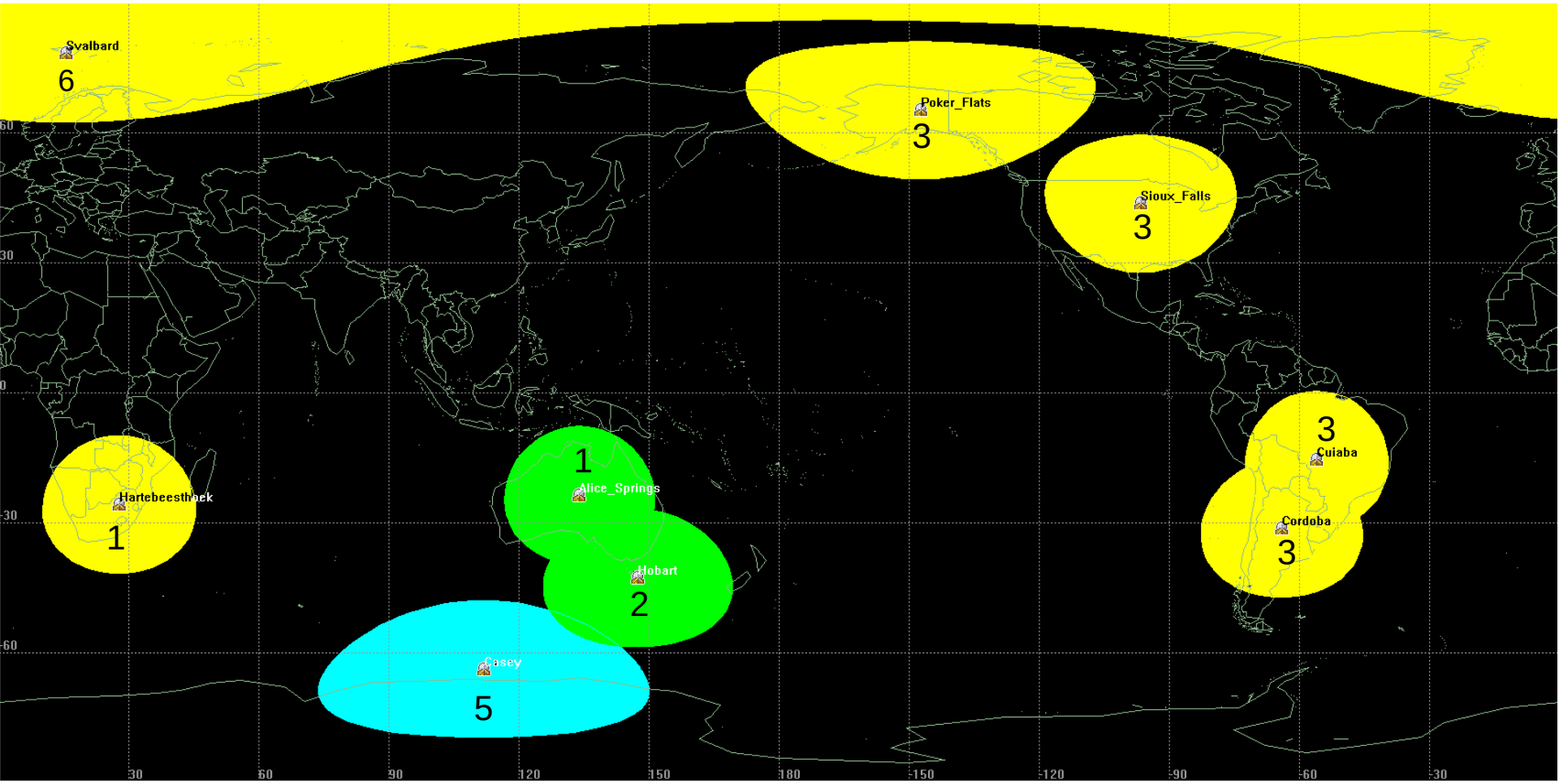
Area of Interest Collected Per Day ≈ 60%

Public Good
+12 CubeSats



Area of Interest Collected Per Day ≈ 91%

Ground Station Network Downlinks



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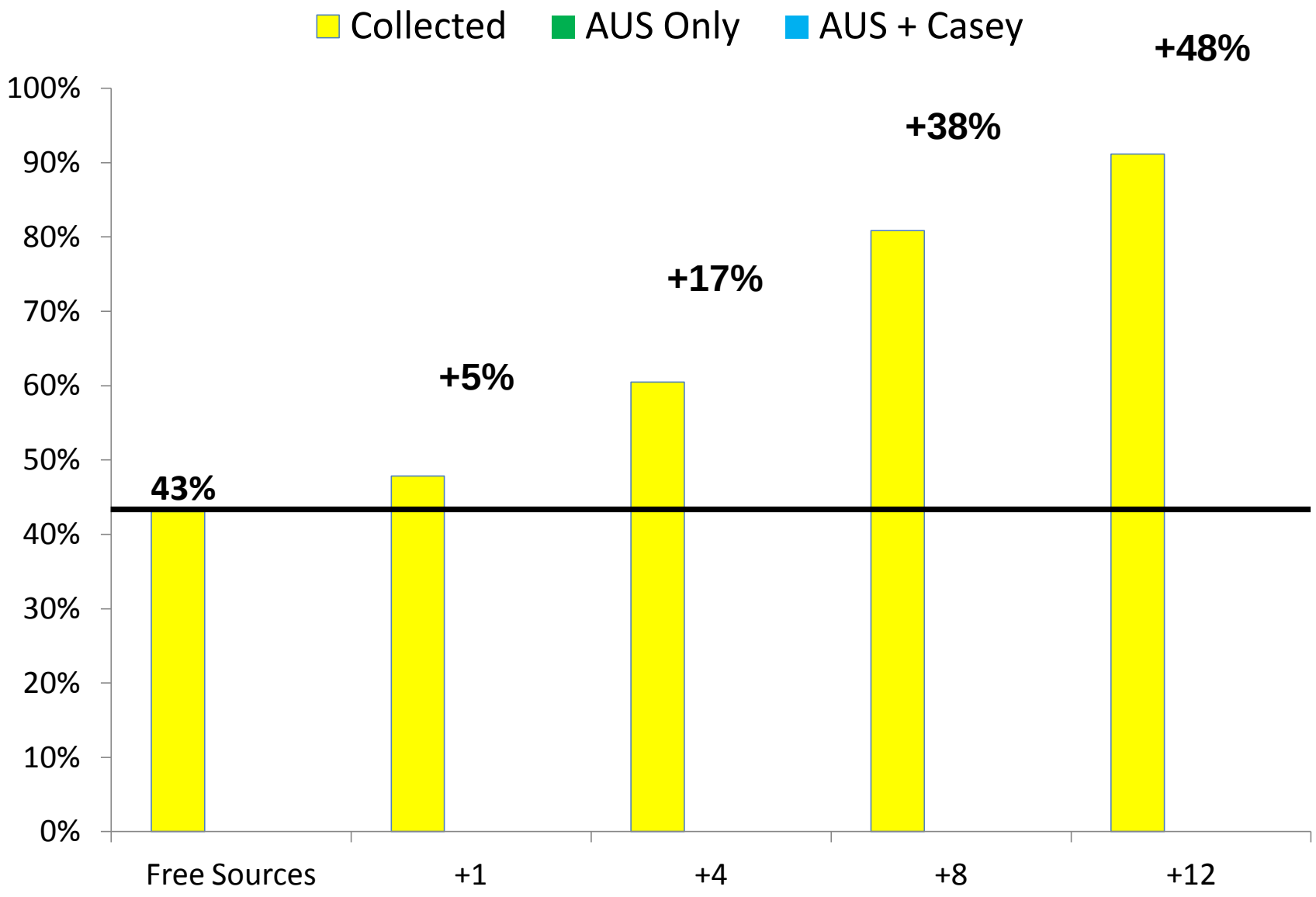
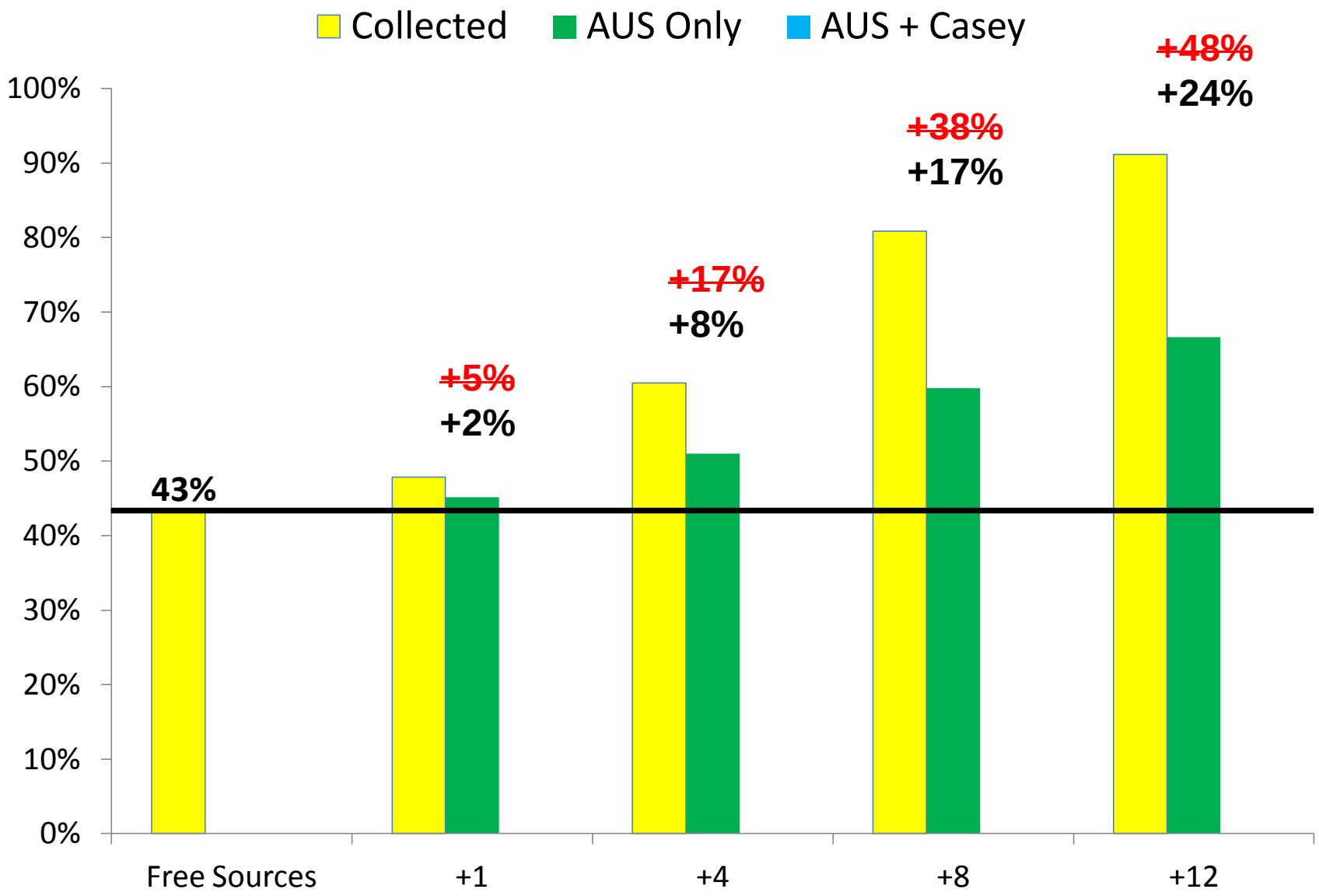
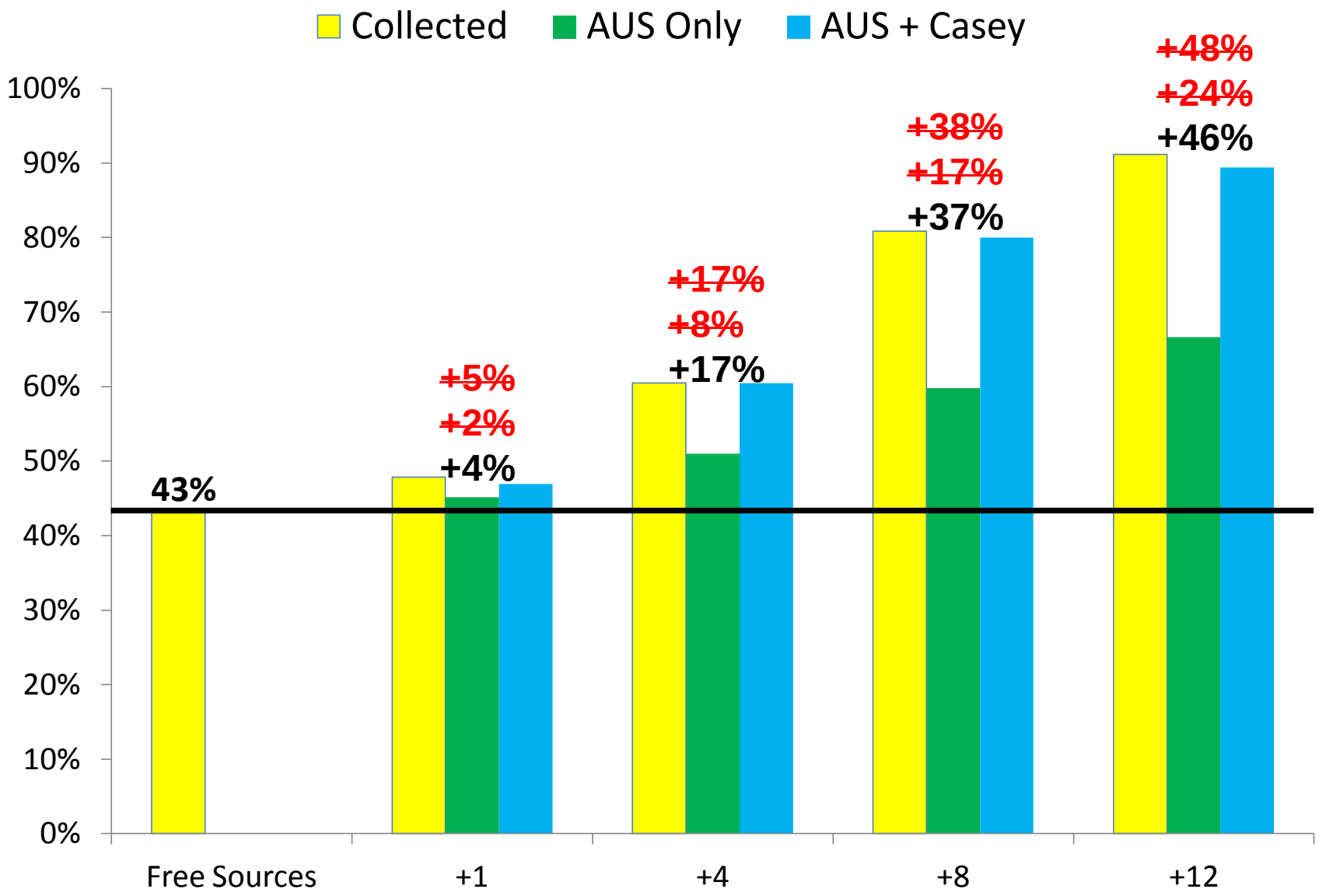
Casey Base	5
LS7 GSN	19

Example: single satellite 24 hours

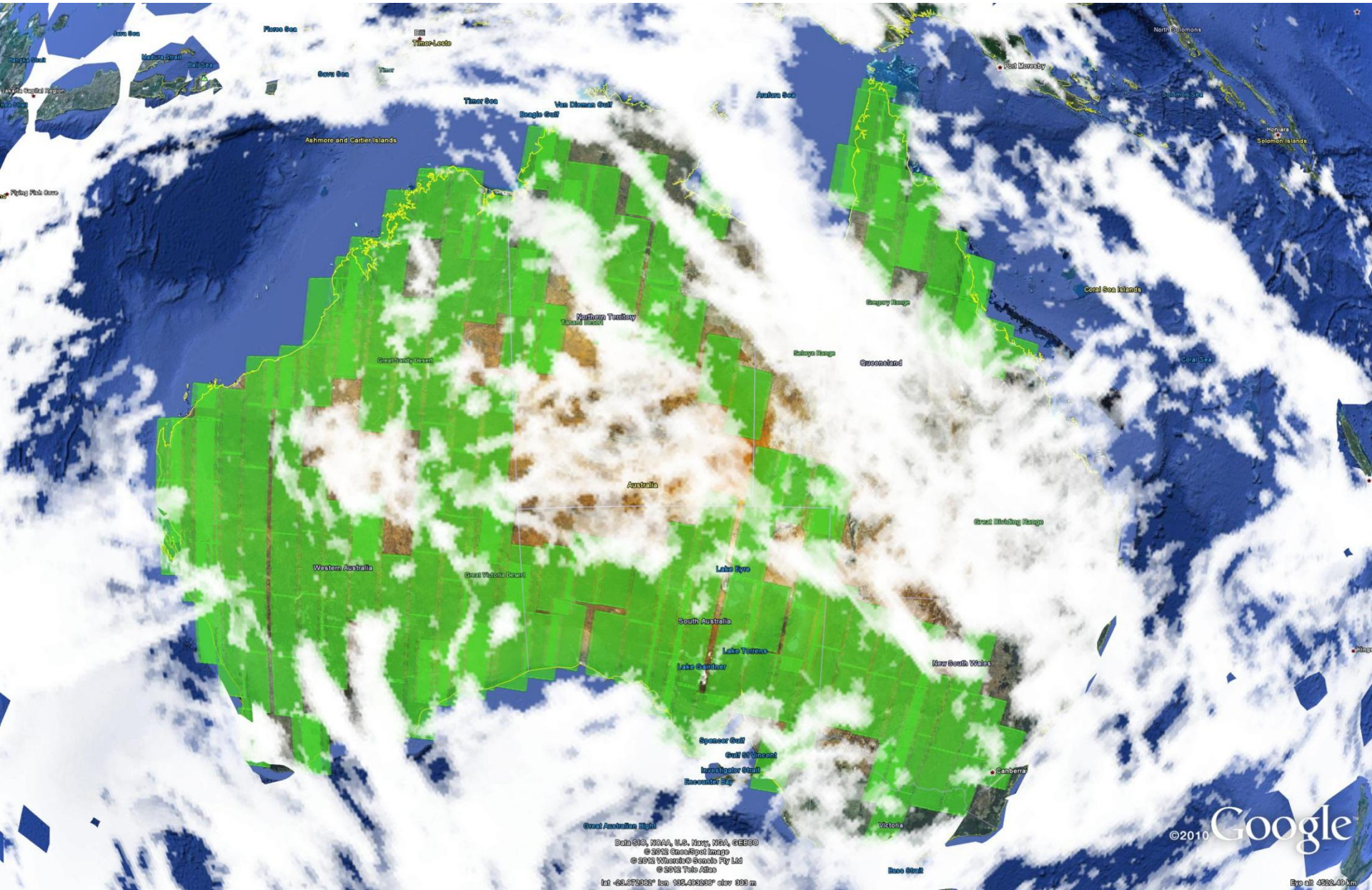

Collected
AUS Only
AUS + Casey
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
43%
+5%
+17%
+38%
+48%
Free Sources
+1
+4
+8
+12


Collected
AUS Only
AUS + Casey
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
43%
+5%
+2%
+17%
+8%
+38%
+17%
+48%
+24%
Free Sources
+1
+4
+8
+12


Collected
AUS Only
AUS + Casey
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
43%
+5%
+2%
+4%
+17%
+8%
+17%
+38%
+17%
+37%
+48%
+24%
+46%
Free Sources
+1
+4
+8
+12

Area of Australia – 7.74M km²
Area Collected – 4.18M km²
Percentage – 54% (down from 93%)

20 satellites & Cloud Constraint

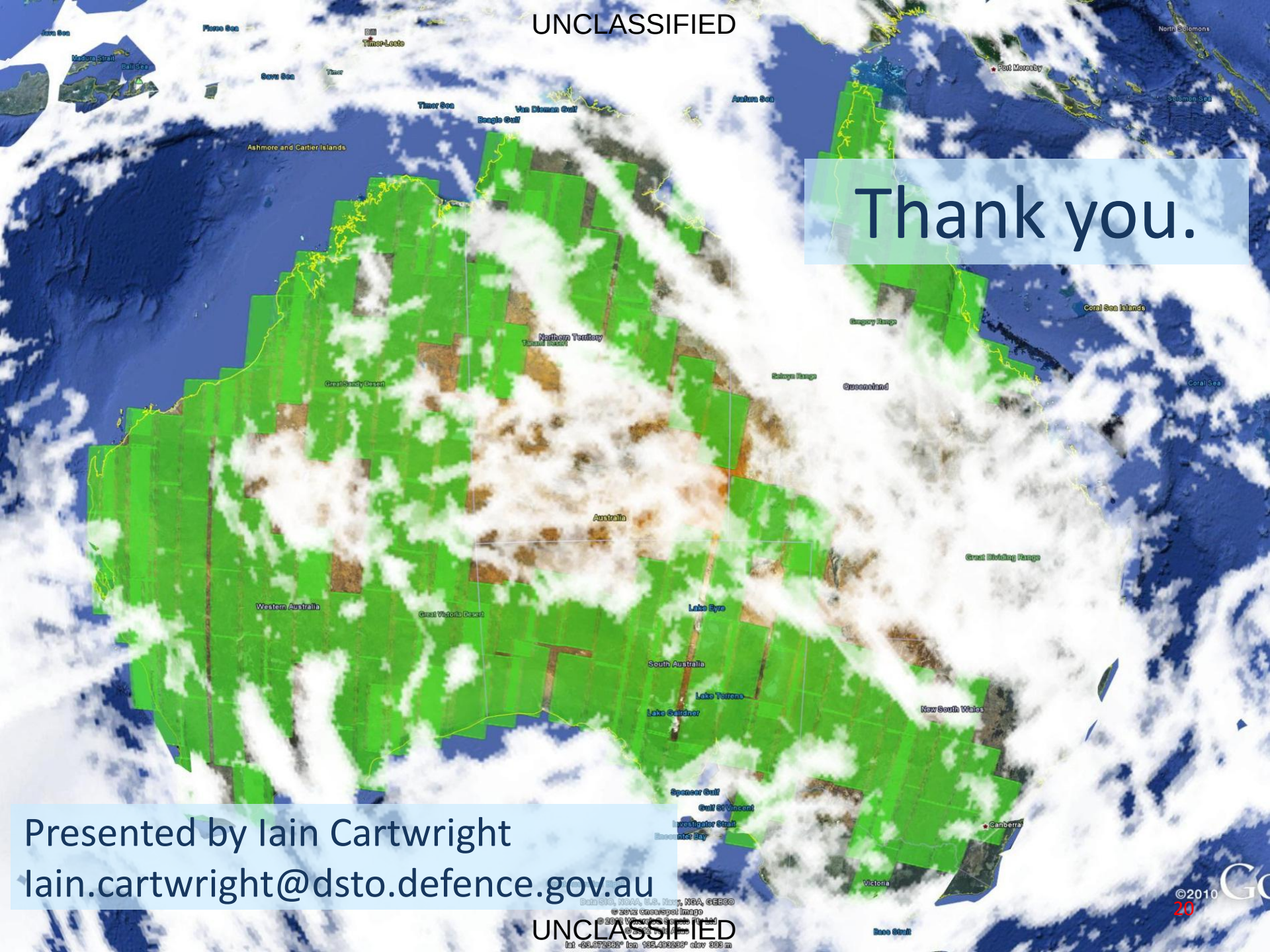


Conclusions

- Medium Resolution/Whole of Australia/Daily Revisit
- System performance is dependent upon *both* the space **and** ground segments.
- **Suitable to CubeSats** vs. Large infrastructure.
- **12 x 6U CubeSats contributed 48% making 91% of requirement**.

Further Work

- Emergency Response Case
- Higher fidelity system model



Thank you.

Presented by Iain Cartwright
Iain.cartwright@dsto.defence.gov.au

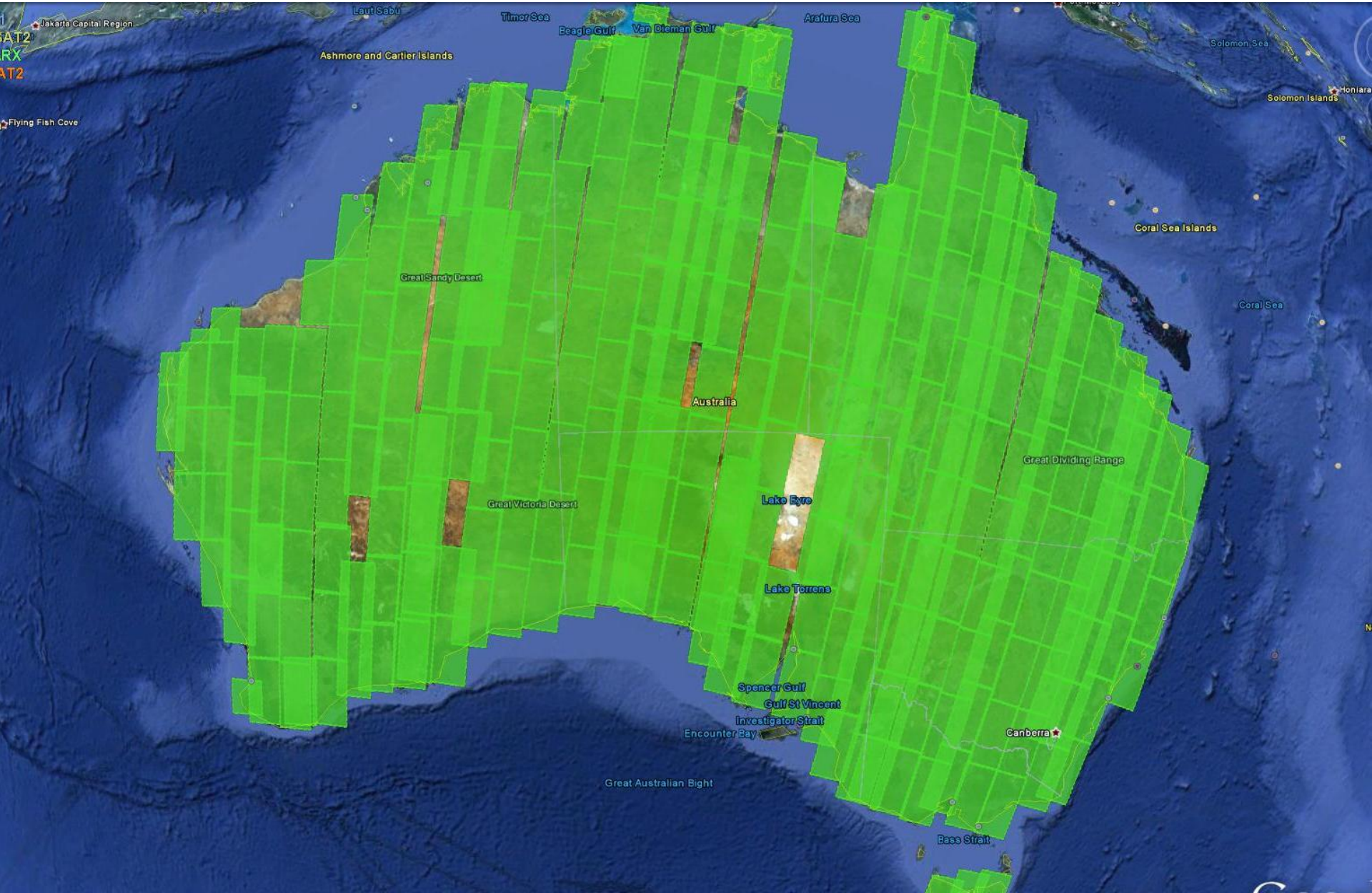
Happy Birthday!
Roger Franzen

Additional Slides

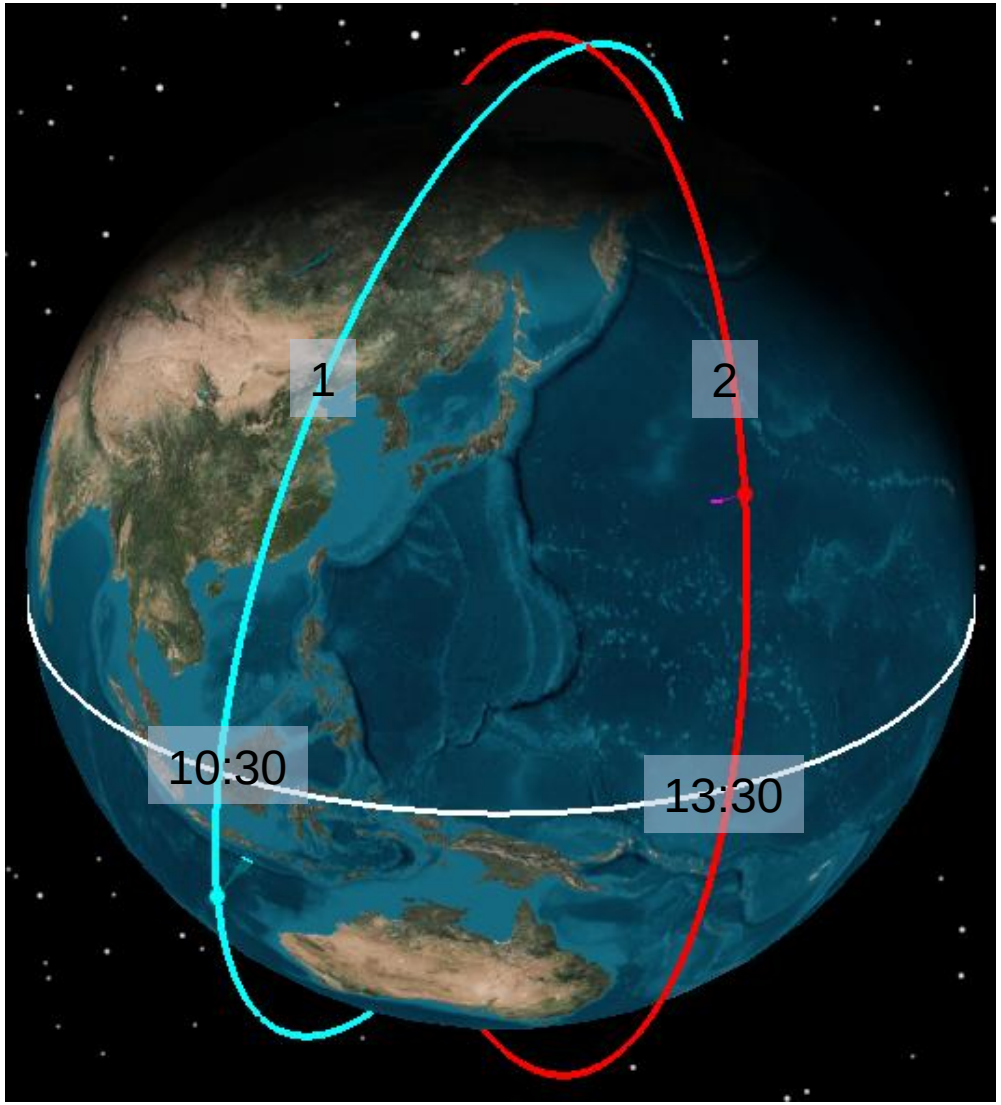
- Cloud Free 93%
- Constellation Design
- GSN temporal characteristics
- Resources

Area of Australia – 7.7M km²
Area Collected – 7.2M km²
Percentage – 93%

20 satellites

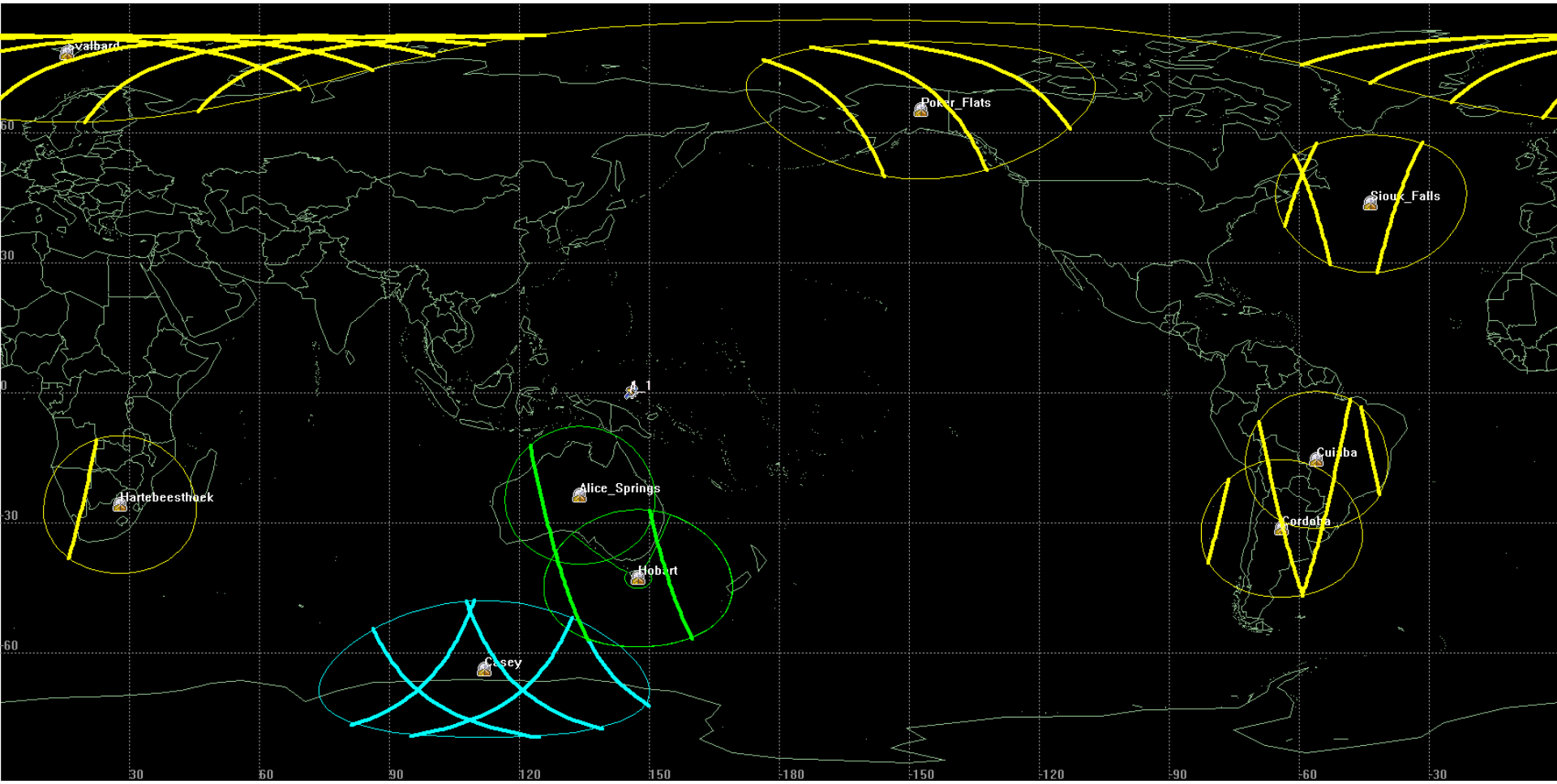


Constellation Design



Variant	Orbital Planes	Sats Per Plane	Total Sats
A	1	1	1
B	1	4	4
C	1	5	5
D	2	4	8
E	2	10	20

GSN Downlink Opportunities (1/3)



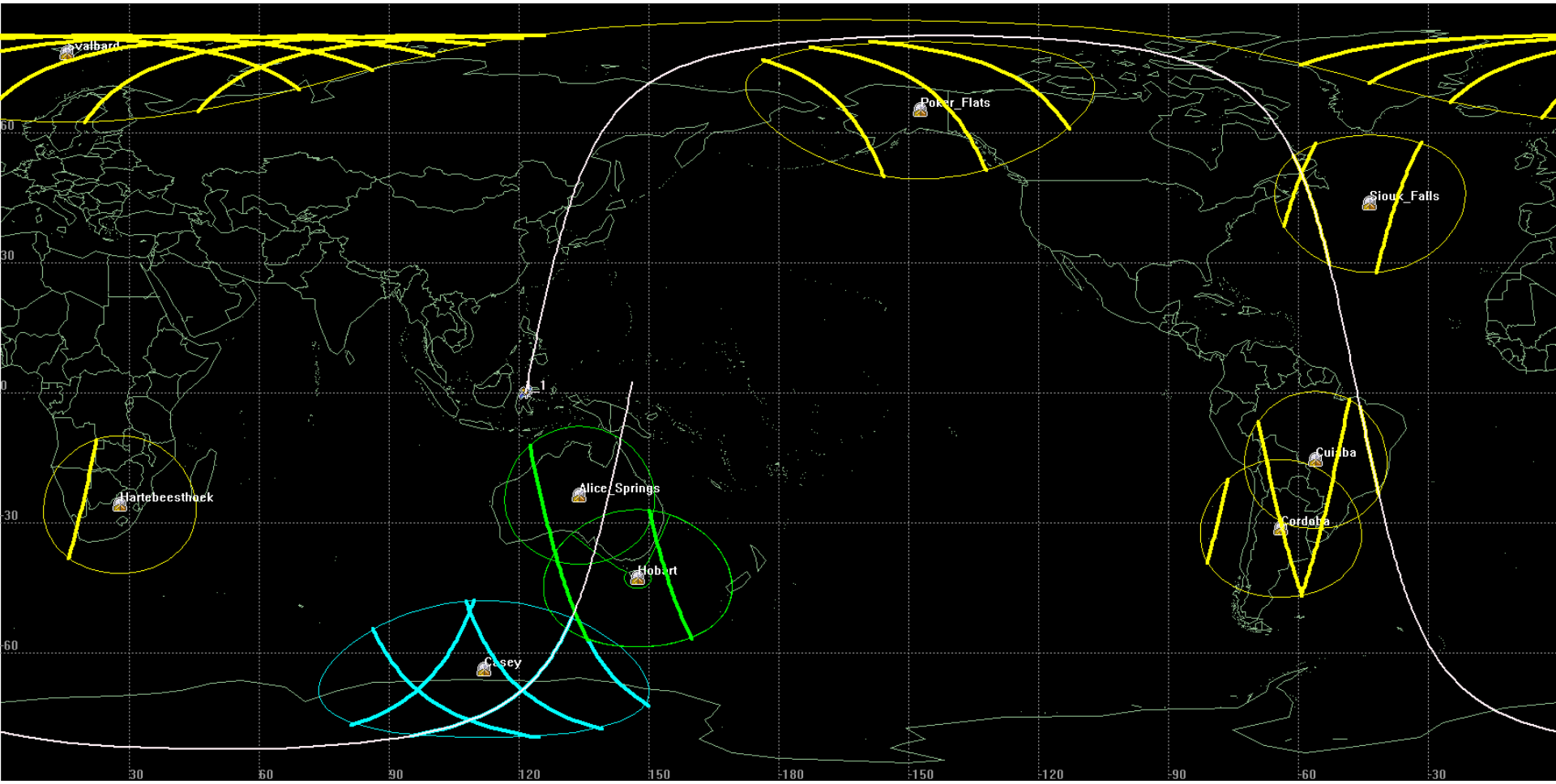
AUS Only

Casey Base

LS7 GSN

00:55 GMT

GSN Downlink Opportunities (2/3)



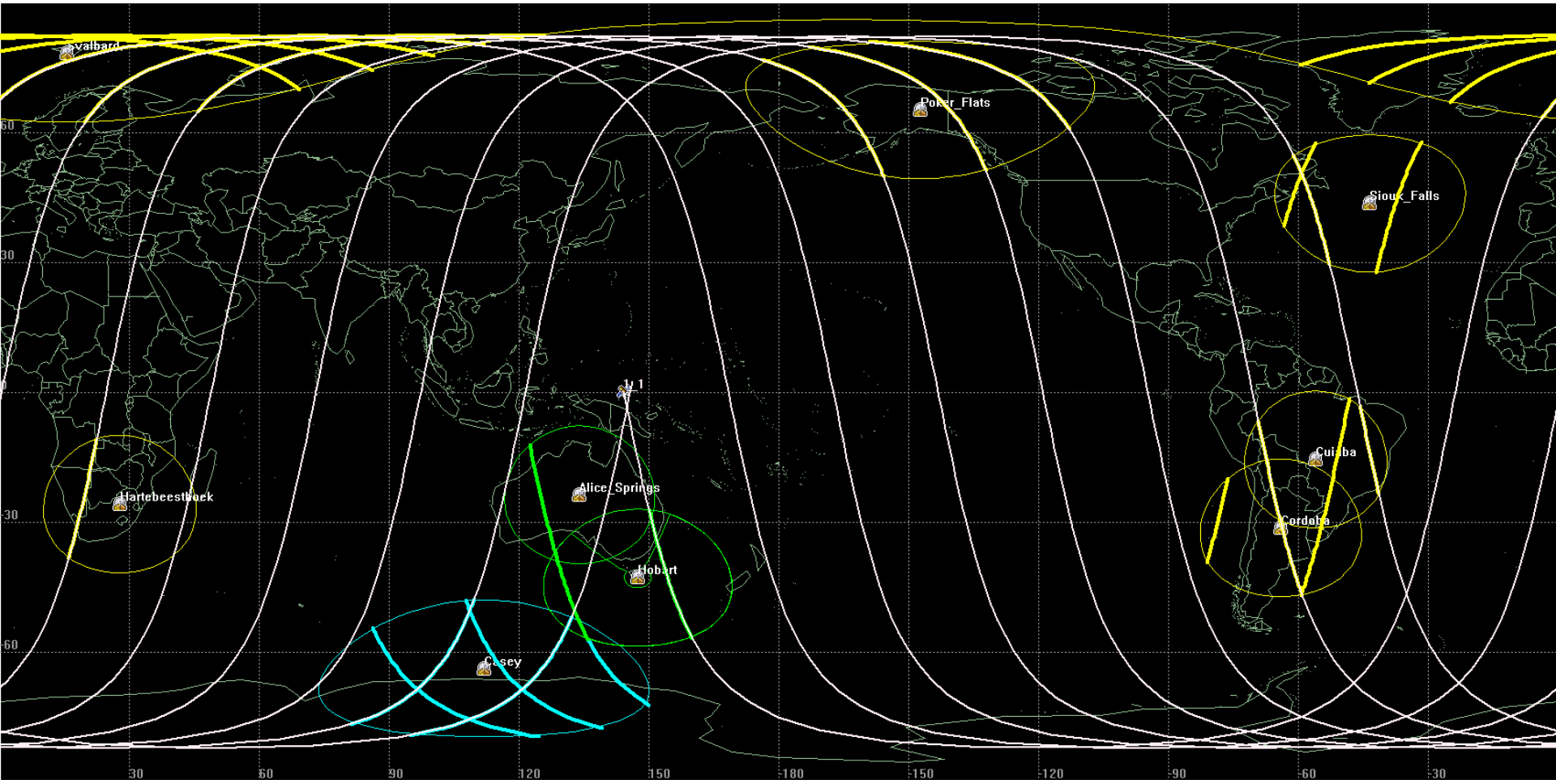
AUS Only

Casey Base

LS7 GSN

02:32 GMT

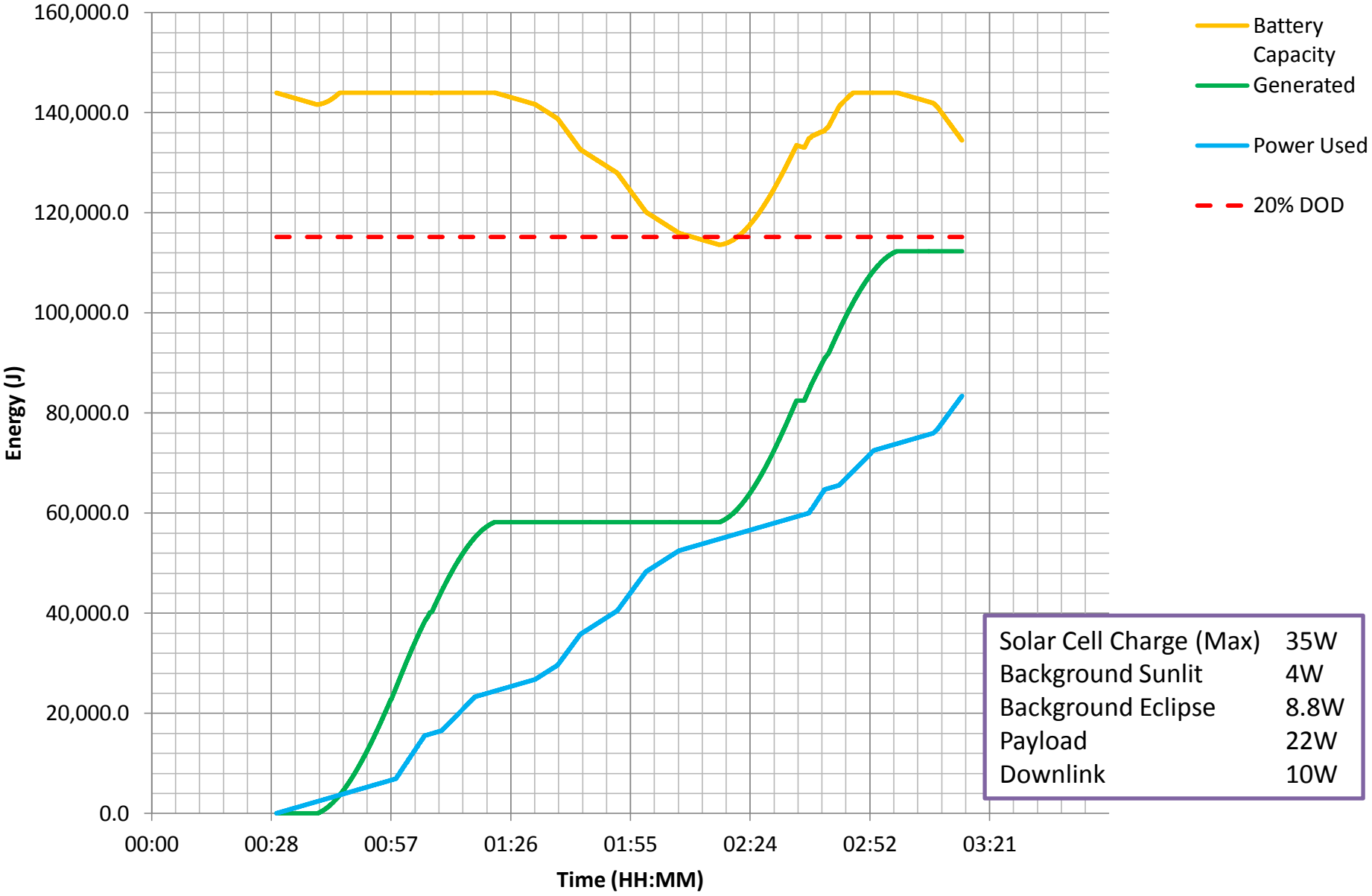
GSN Downlink Opportunities (3/3)



AUS Only

Casey Base

LS7 GSN

13:01 GMT

Resource: Power