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The ASKAP Network

Lessons Learnt, Experience Gained*

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CSIRO Astronomy and Space Science
24 May 2011

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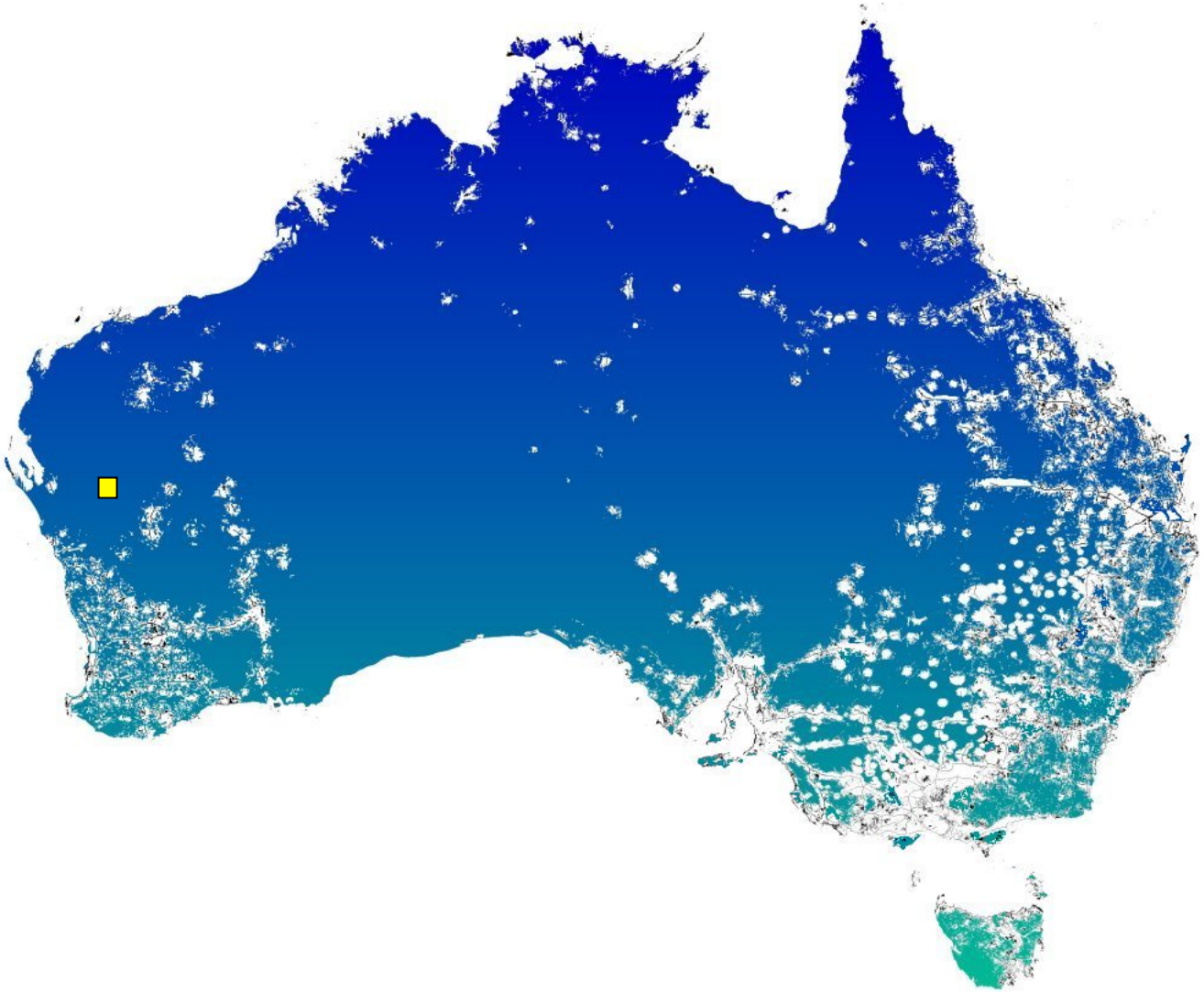
* This is very much a work in progress

Location, Location, Location

The Land “Down-Under”



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Shire of Murchison

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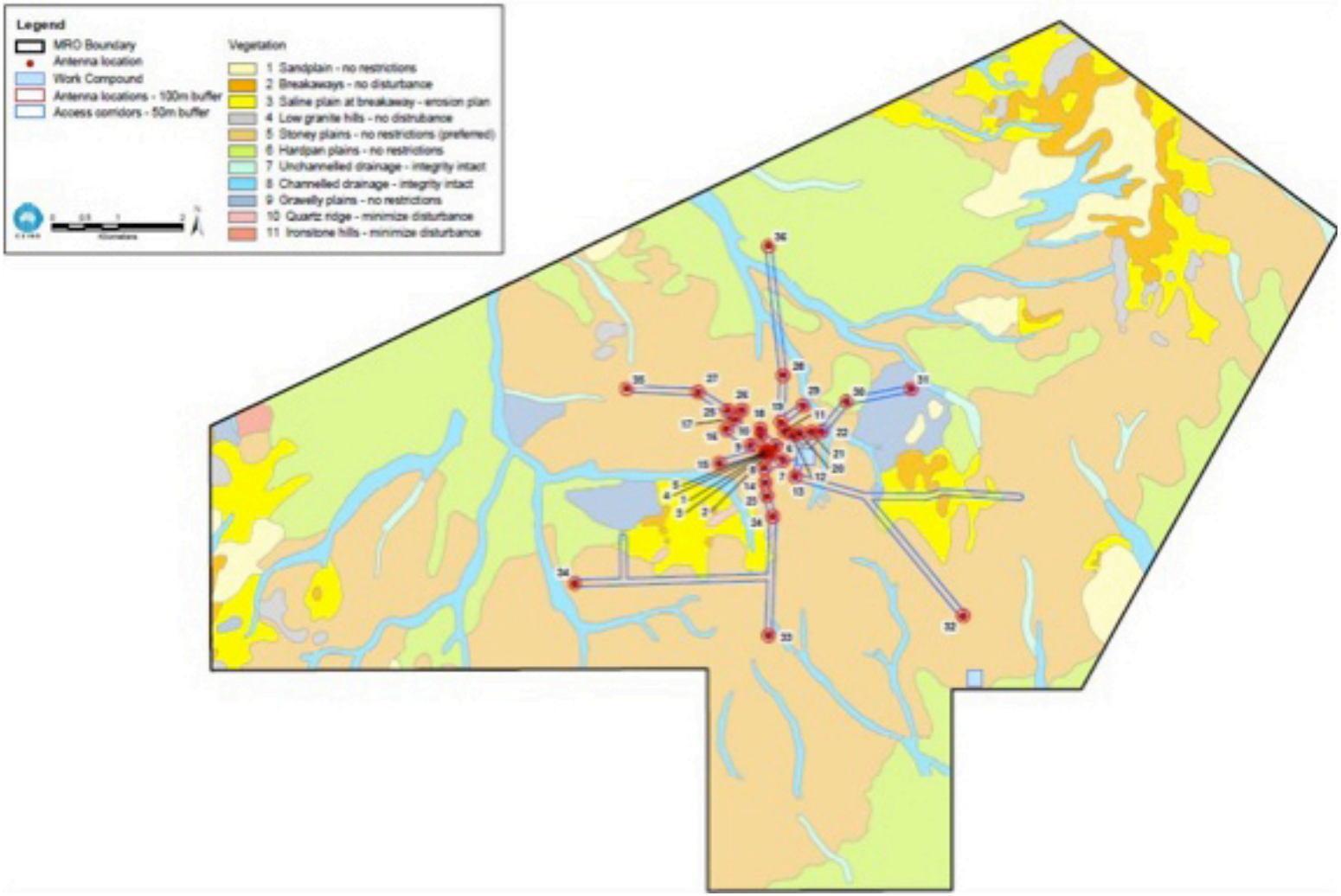
The Murchison Radio Observatory (MRO)



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The Long-Haul Fibre Links

Fibre Network

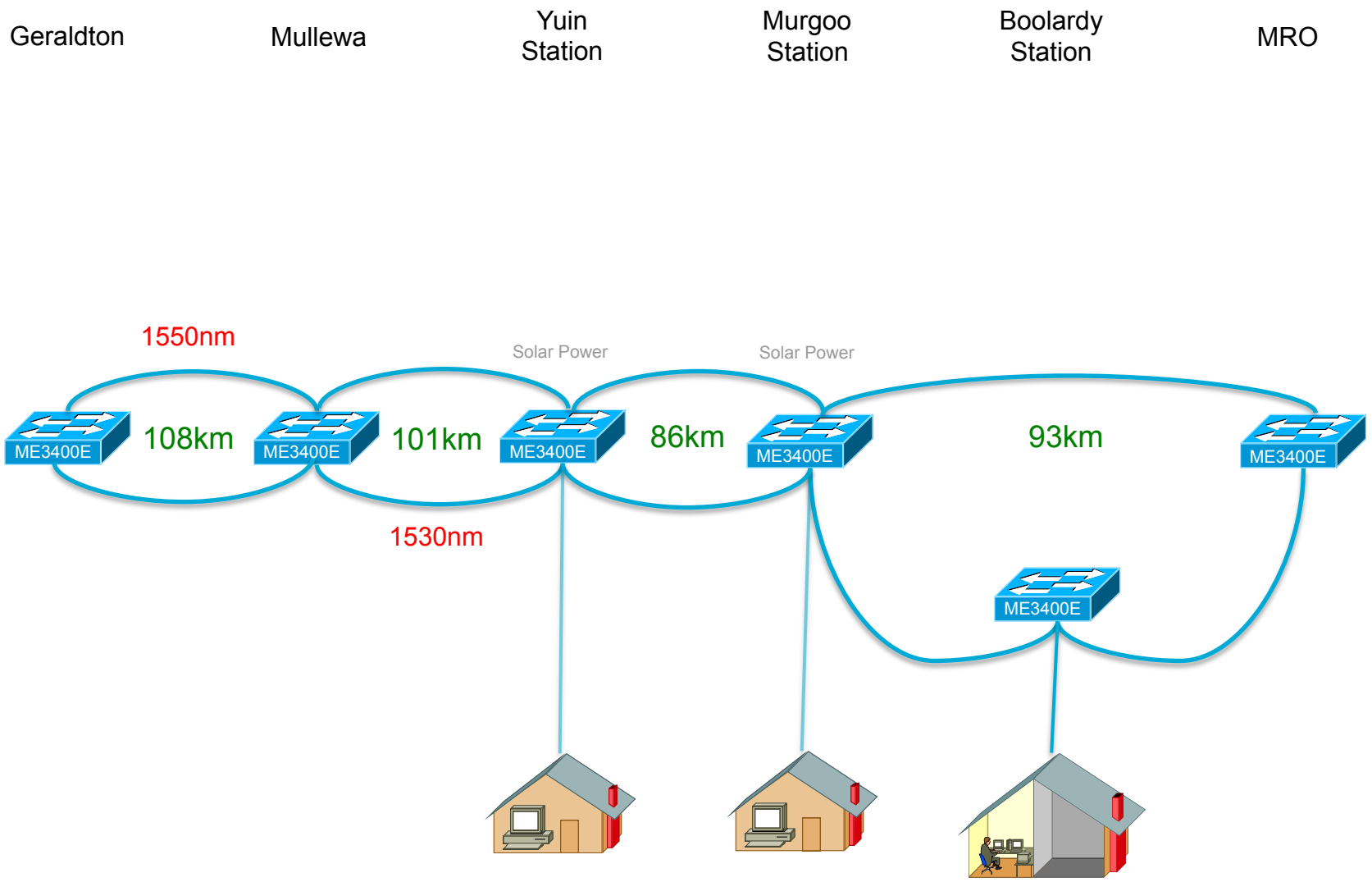
- ASKAP is constructing a fibre link between Geraldton and the MRO:
  - only about 4km of fibre left to be installed (entire link is about 390km of cable),
  - CSIRO has contracted AARNet to manage the build process with CCTS (based on the NSW Central Coast) doing the actual construction work.
- Three re-amplification sites (CEVs) required:
  - Mullewa,
  - Yuin station,
  - Murgoo station.
- Single fibre type:
  - Corning G.652 ULL (Ultra Low-Loss)
- Core count:
  - Geraldton – Mullewa: 72 core
  - Mullewa – Yuin – Murgoo – MRO: 48 core

The Fibre Route

The Network(s)

- There are TWO wide-area networks.
- Long-Haul High-Bandwidth:
  - MRO to Pawsey Supercomputing Centre,
  - DWDM (nominal 80 channels/fibre pair in C-band),
  - carrier-class transmission equipment,
  - *n* × 40Gbit/s per λ,
  - client-side connections will be 10Gbit/s Ethernet,
  - only amplification required.
- MRO – Geraldton "Christmas-Tree Lights" Network:
  - will be the first network implemented,
  - COTS equipment (transceivers and metro-Ethernet switches),
  - 2 × 1Gbit/s (on two fibre pairs),
  - O-E-O (regeneration) at each CEV using Ethernet switches,
  - allows monitor and control and access to the network at each CEV,
  - backhaul for the homesteads.

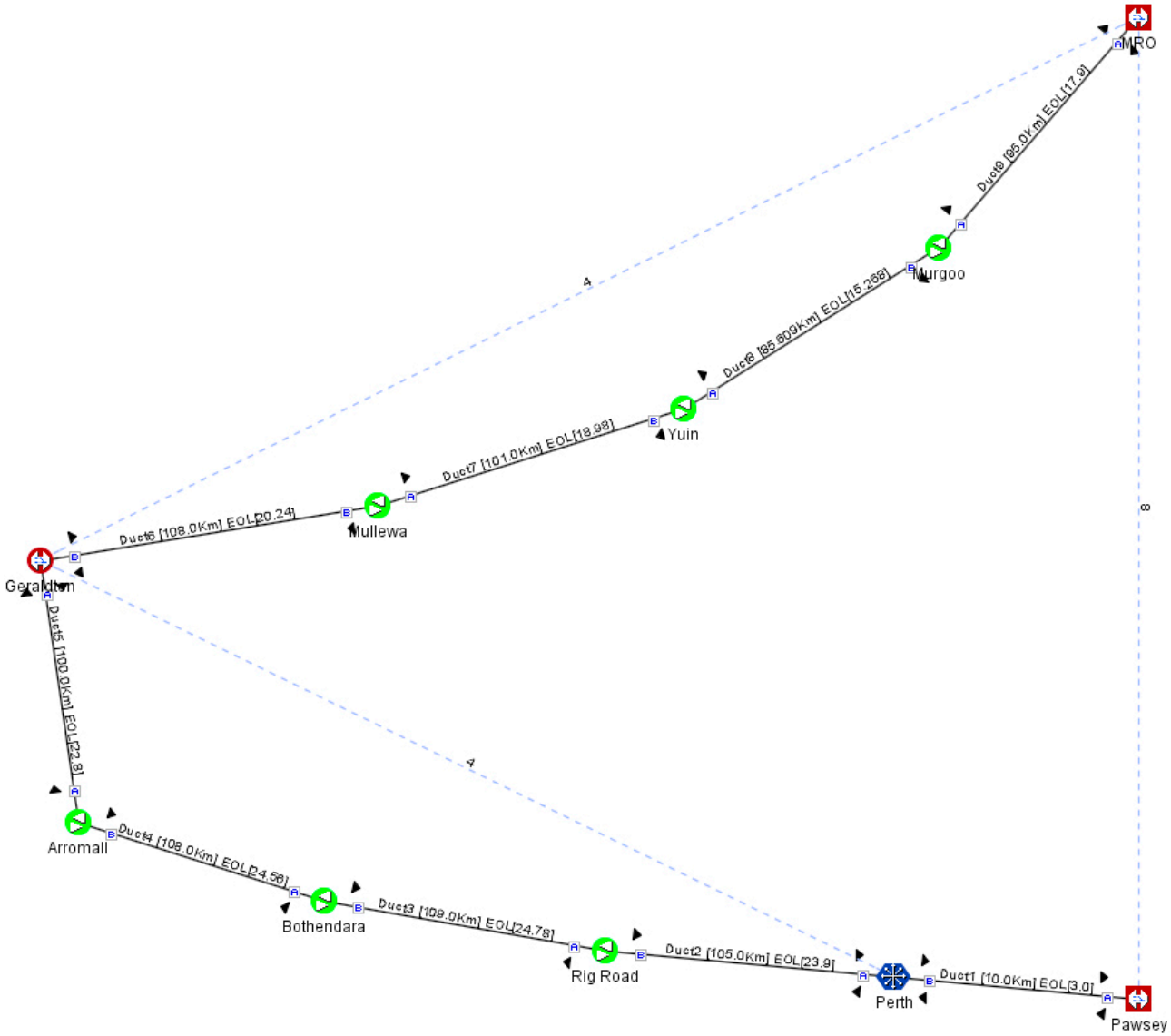
The “Christmas-Tree Lights” Network



What about Geraldton to Perth…

- ASKAP is not funded to build or light this segment:
  - Federal Government RBBS programme has recently completed the installation of fibre between Perth and Geraldton.
- CSIRO and AARNet have designed a network that will realise a contiguous DWDM-based high-bandwidth network between the MRO and Pawsey Centre:
  - Terminals: MRO and Pawsey Centre
  - ROADMs: Geraldton and Perth
- Need to ensure scalability as we need to take into account other experiments at the MRO, including the MWA, which is looking at around 80Gbit/s from the MRO to the Pawsey Centre:
  - succesfully modeled a full 80 × 40Gbit/s system from MRO to the Pawsey Centre – could build it today but …

Optical Network Design



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Construction

Zero-Tension Plough

It’s a long way to…

Heading Off Into the Distance…

It’s Blue!

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Pit Stop

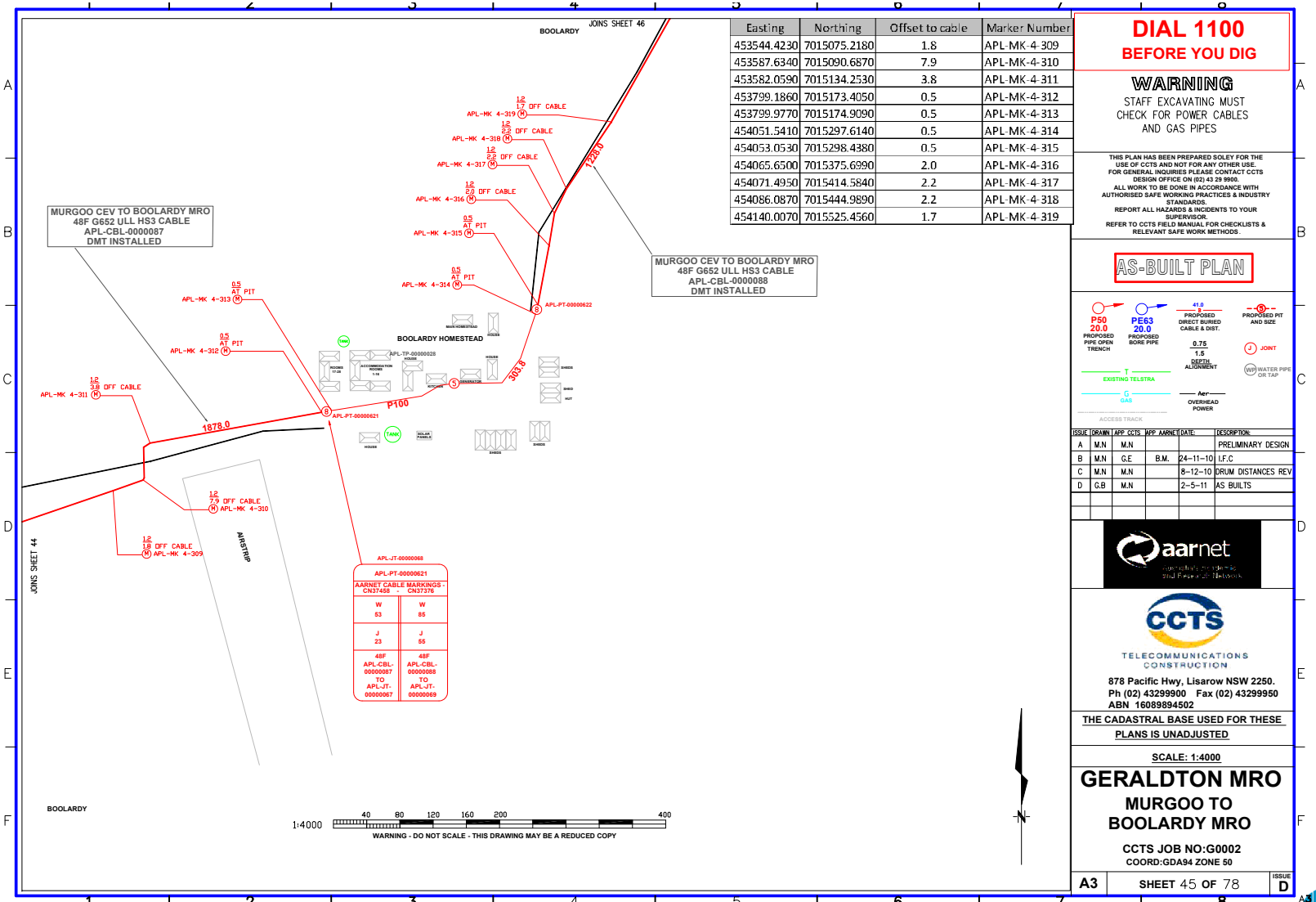
Home Away from Home…

Testing and Verification

Standard Requirements

- Methodology follows standard Telecommunications Infrastructure techniques:
  - final “as-built” diagrams:
    - route,
    - pits and joints,
    - marker posts etc
  - location of joints and details of cable length between joints,
  - two-way insertion loss (IL) measurements for each core,
  - two-way OTDR measurements at three wavelengths for each core:
    - 1310nm,
    - 1550nm,
    - 1625nm.
- Verified jointly by AARNet and CSIRO:
  - walk the route, to inspect restoration work and pits,
  - two-way IL and OTDR.

“As-Built”: Route through Boolardy Homestead



Easting	Northing	Offset to cable	Marker Number
453544.4230	7015075.2180	1.8	APL-MK-4-309
453587.6340	7015090.6870	7.9	APL-MK-4-310
453582.0590	7015134.2530	3.8	APL-MK-4-311
453799.1860	7015173.4050	0.5	APL-MK-4-312
453799.9770	7015174.9090	0.5	APL-MK-4-313
454051.5410	7015297.6140	0.5	APL-MK-4-314
454053.0530	7015298.4380	0.5	APL-MK-4-315
454065.6500	7015375.6990	2.0	APL-MK-4-316
454071.4950	7015414.5840	2.2	APL-MK-4-317
454086.0870	7015444.9890	2.2	APL-MK-4-318
454140.0070	7015525.4560	1.7	APL-MK-4-319

DIAL 1100
BEFORE YOU DIG

WARNING
STAFF EXCAVATING MUST
CHECK FOR POWER CABLES
AND GAS PIPES

THIS PLAN HAS BEEN PREPARED SOLELY FOR THE USE OF CCTS AND NOT FOR ANY OTHER USE. FOR GENERAL INQUIRIES PLEASE CONTACT CCTS DESIGN OFFICE ON (02) 43 29 9900. ALL WORK TO BE DONE IN ACCORDANCE WITH AUTHORISED SAFE WORKING PRACTICES & INDUSTRY STANDARDS. REPORT ALL HAZARDS & INCIDENTS TO YOUR SUPERVISOR. REFER TO CCTS FIELD MANUAL FOR CHECKLISTS & RELEVANT SAFE WORK METHODS.

AS-BUILT PLAN

P50 20.0 PROPOSED PIPE OPEN TRENCH
PE63 20.0 PROPOSED BORE PIPE
41.0 0.5 PROPOSED DIRECT BURIED CABLE & DIST.
0.75 1.5 DEPTH ALIGNMENT
PROPOSED PIT AND SIZE
JOINT
WATER PIPE OR TAP
EXISTING TELSTRA
GAS
OVERHEAD POWER
ACCESS TRACK

ISSUE	DRAWN	APP. CCTS	APP. AARNET	DATE:	DESCRIPTION:
A	M.N	M.N			PRELIMINARY DESIGN
B	M.N	G.E	B.M.	24-11-10	I.F.C
C	M.N	M.N		8-12-10	DRUM DISTANCES REV
D	G.B	M.N		2-5-11	AS BUILTS

aarnet

CCTS
TELECOMMUNICATIONS CONSTRUCTION

878 Pacific Hwy, Lisarow NSW 2250.
Ph (02) 43299900 Fax (02) 43299950
ABN 16089894502

THE CADASTRAL BASE USED FOR THESE PLANS IS UNADJUSTED

SCALE: 1:4000

GERALDTON MRO
MURGOO TO BOOLARDY MRO

CCTS JOB NO:G0002
COORD:GDA94 ZONE 50

A3 | SHEET 45 OF 78 | ISSUE D

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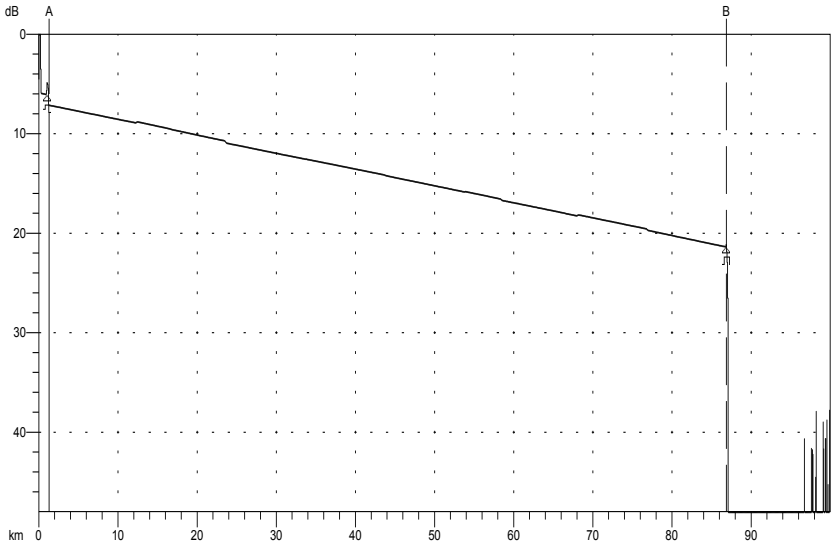
Sample OTDR Traces

NetTest NetWorks/OTDR - Version 3.0a
Date: 02/10/11 Time: 10:18 AM

YUIMUR500 (24).TRC 125 km/8.000 m



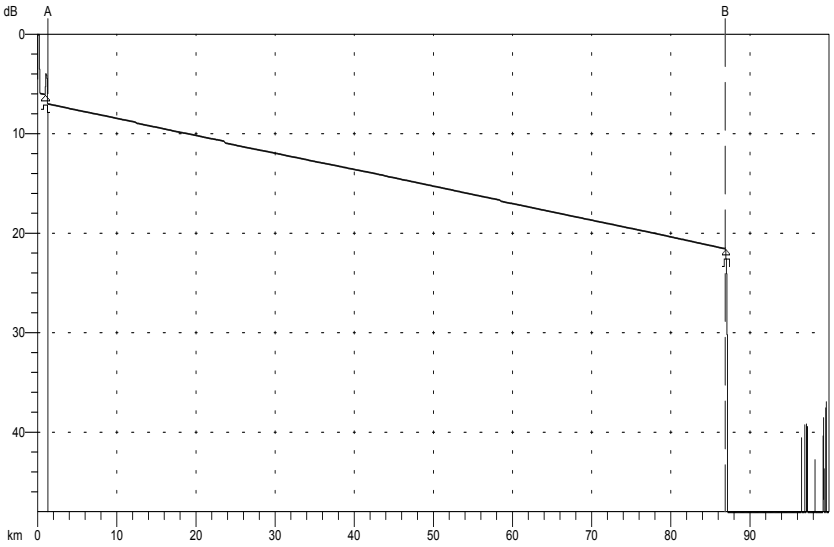
A: 1.2987 km	Index: 1.468200	[H] 2.0µs / 200.0m
B: 86.8733 km	2-Point Loss: 14.073 dB	Avg: 54144 / N/A
A -> B: 85.5746 km	Reflectance: N/A	5246-211-OTDR-2/1550 nm/SM

Analysis Results -- YUIMUR500 (24).TRC

Feature #/Type	Location (km)	Event-Event (dB)	(dB/Km)	Loss (dB)	Refl (dB)
1/R	1.0010	0.18	0.178	1.03	-49.93
2/E	86.8346	14.29	0.167	>3.00	-58.98

Overall (End-to-End) Loss: 15.49 dB

YUIMUR500 (25).TRC 125 km/8.000 m



A: 1.2987 km	Index: 1.468200	[H] 2.0µs / 200.0m
B: 86.8733 km	2-Point Loss: 14.561 dB	Avg: 54528 / N/A
A -> B: 85.5746 km	Reflectance: N/A	5246-211-OTDR-2/1550 nm/SM

Analysis Results -- YUIMUR500 (25).TRC

Feature #/Type	Location (km)	Event-Event (dB)	(dB/Km)	Loss (dB)	Refl (dB)
1/R	1.0010	0.18	0.180	0.88	-46.42
2/E	86.9489	14.59	0.170	>3.00	N/A

Overall (End-to-End) Loss: 15.65 dB

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Results

- G.652 ULL fibre results *very* encouraging:
  - Yuin-Murgo (85.6km): 0.168dB/km at 1550nm (12 splices)
  - Murgoo-MRO (92.6km): 0.170dB/km at 1550nm (12 splices)

- OTDR as expected:
  - optimal fibre performance is at 1550nm (note choice of CWDM wavelengths for the “Christmas-Tree Lights” network),
  - not surprisingly, standard G.652 has relatively poor performance at 1310nm.

- Own testing is VERY important:
  - on the first segment tested, one broken fibre was found at the first joint:
    - having good documentation was essential,
    - reported to the contractor and fixed immediately so we could re-test the following day.

Independent Verification

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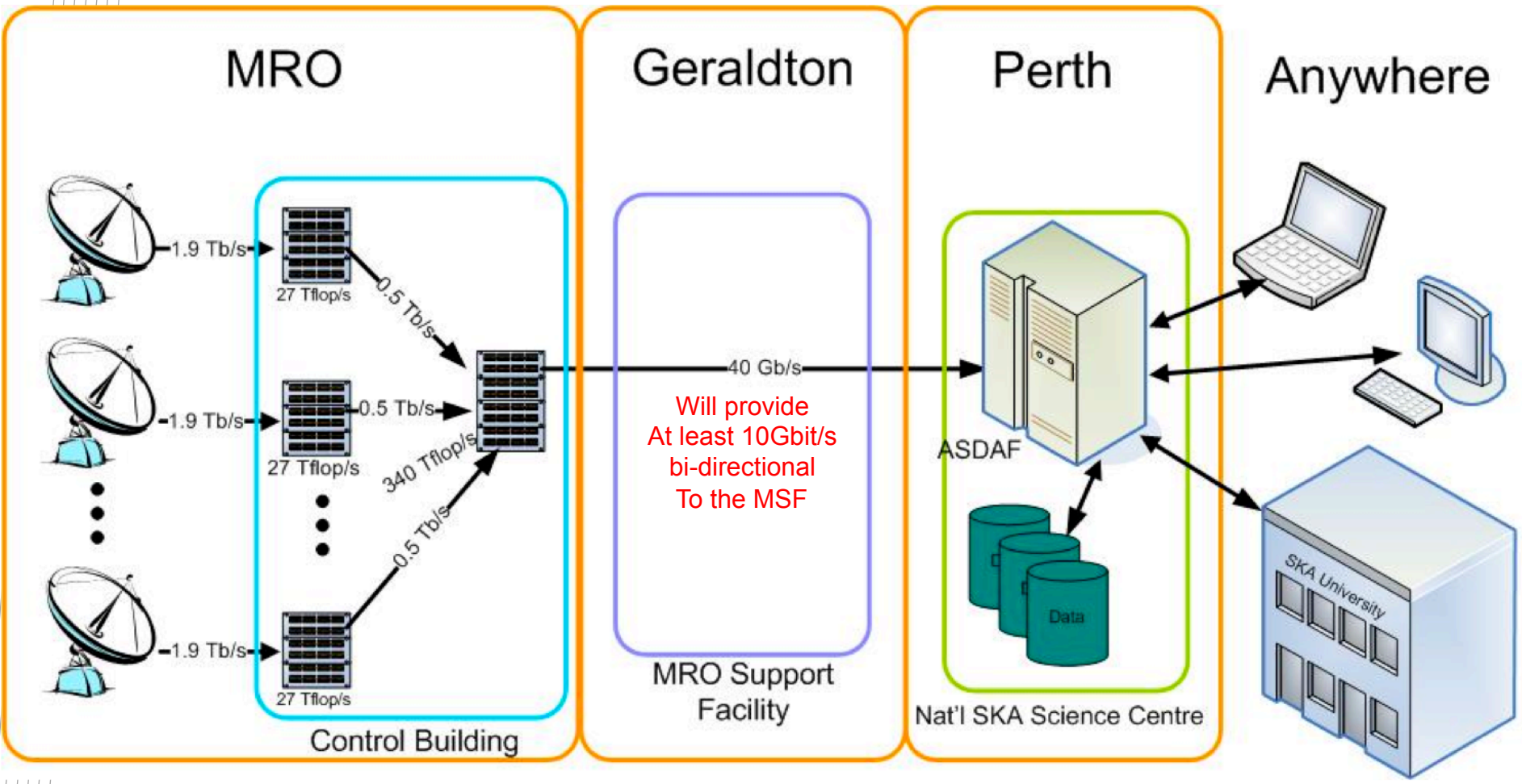
The MRO Site Network

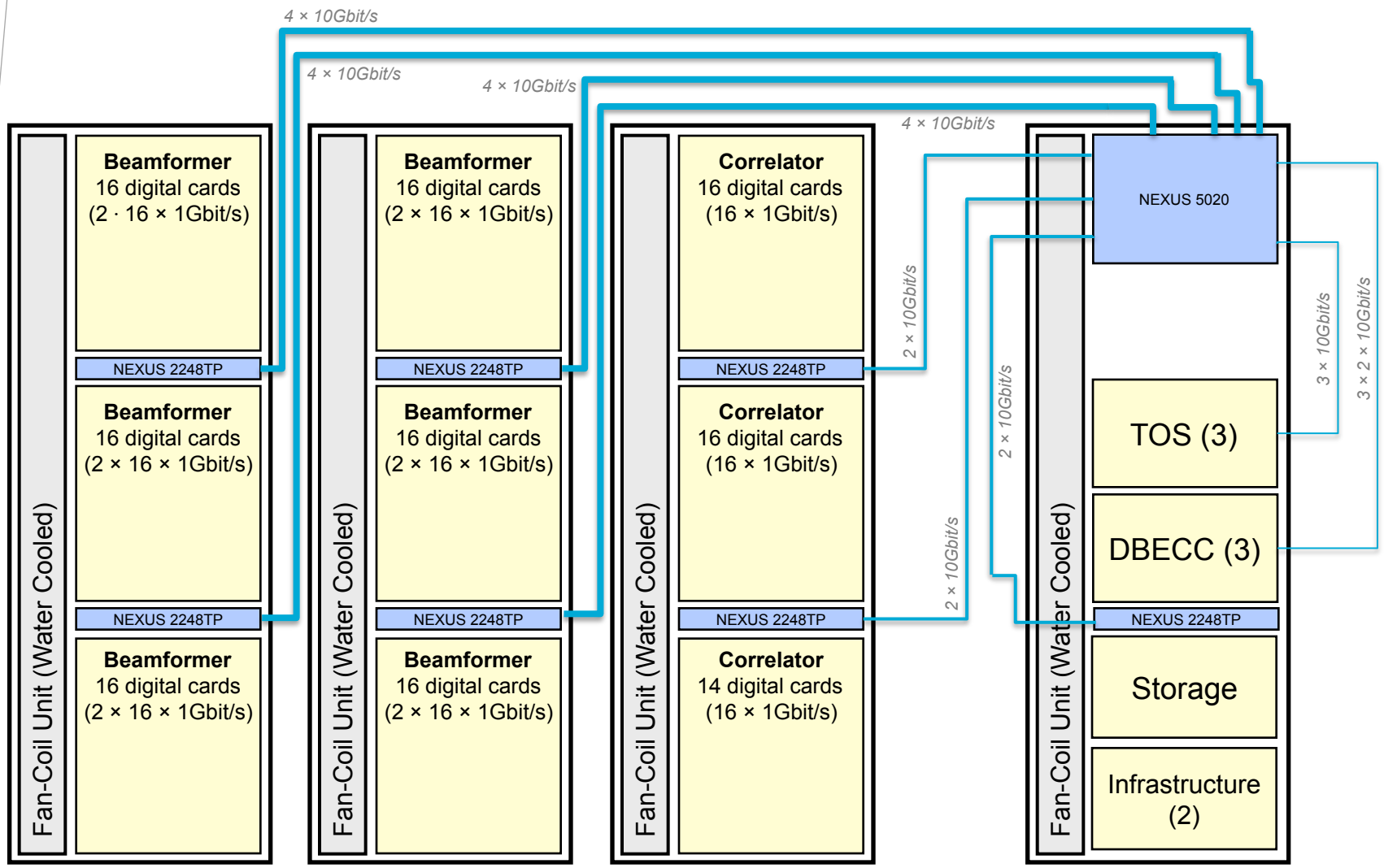
ASKAP System and Data Flow



MRO Site Network Considerations

- The network core will consist of a large chassis-based switch with scalable switching fabric capacity to Tbit/s.
- Need to consider carefully over-subscription:
  - most equipment has some over-subscription,
  - need to understand the data flows (sustained and peak) to ensure no data loss (mainly UDP):
    - each 1Gbit/s port can produce about 800Mbit/s of data.
- Will used a scaled-down system for BETA until the MRO Central Site building is completed.
- Need to consider client-side connections and I/O at each end.
- Think about “performance” versus “services”.
- Each antenna will have a dedicated switch in the pedestal.
- Virtual LANs to segment (and secure) classes of traffic:
  - data versus monitor and control
  - standard production and visitor connectivity

The ASKAP BETA Network



Note: Beamformer – Correlator Data is via a direct non-Ethernet connection between ATCA chassis

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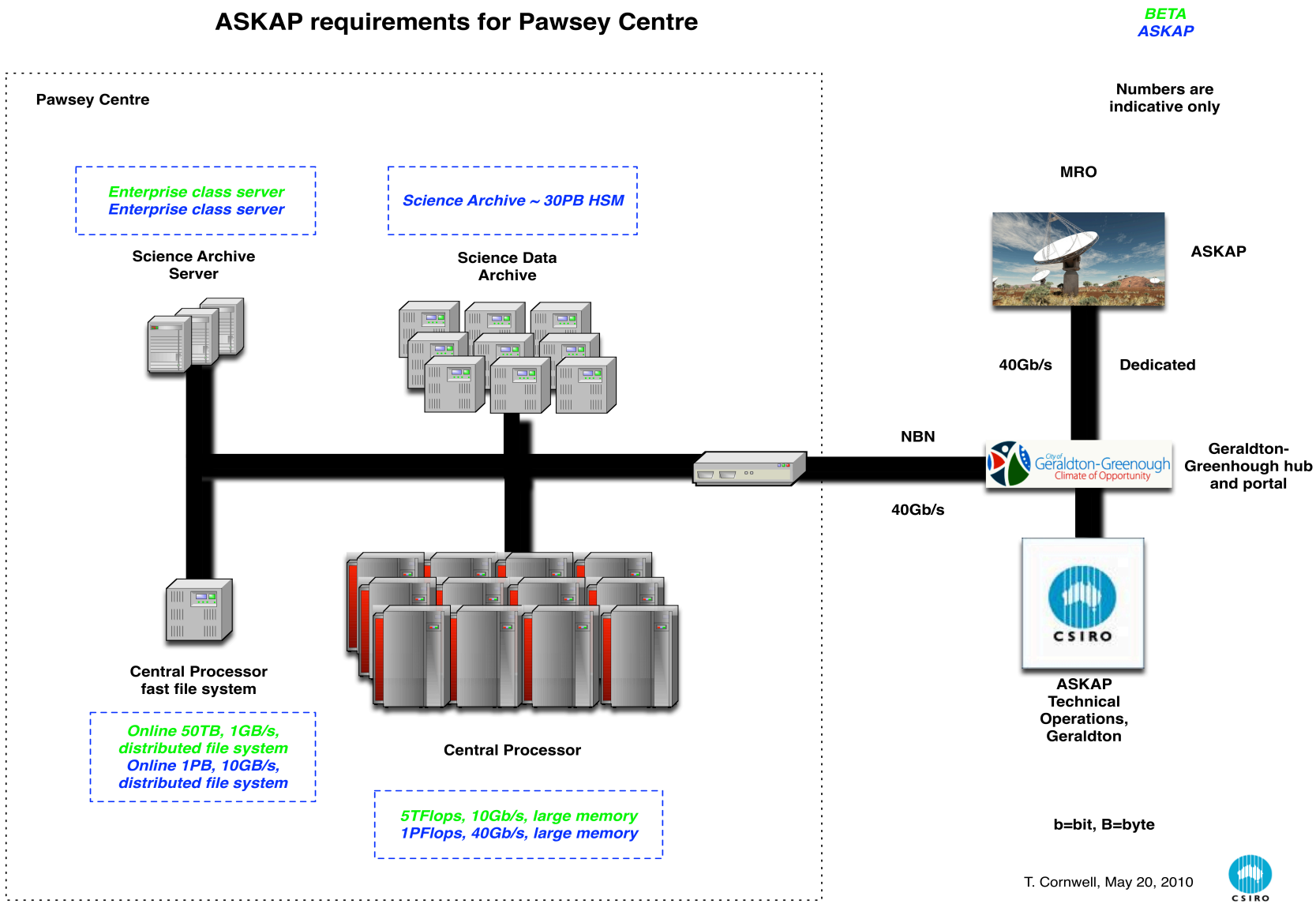
ASKAP Computing Requirements



Conclusion

Some Other (Random) Thoughts…

- Transceiver and connector “hell”:
  - 1Gbit/s: GBIC, SFP: world has converged on SFP,
  - 10Gbit/s: XENPAK, XFP, X2 and SFP+: not all media types available in all physical packages (e.g. LX4 and LRM),
  - ST, FC, SC, SCA, LC, LCA, E2000, SMA, … : minimise if possible.
- Fibre types:
  - Multimode:
    - OM1 and OM3 common,
    - OM4 has now been standardised.
  - Singlemode:
    - patch leads and the like much easier,
    - active equipment more expensive (LASERs over VCSEL or LEDs).
- Optical Power Monitoring:
  - transmission equipment usually very good,
  - LAN equipment typically poor but improving,
  - transceivers need to support this as well.

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Thank you