A major Australian container terminal.

Private 5G at an automated container terminal

Vocus project case study

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Malcolm Jones

Principal Consultant

Six problems, Six requirements

1

Automated terminal.

85 straddle carriers and 9 quay cranes need deterministic, always-on connectivity across the yard.

2

Wi-Fi at its limit.

Roughly 1 Mbps across the whole straddle fleet, roaming gaps mid-yard, and no QoS to protect automation, so it could not take on other applications.

3

Coverage over moving steel.

Signal has to reach antennas 12 to 16 m up, over container stacks that change shape hour to hour.

4

Many use cases, one network.

Mobile workers, CCTV and IoT had to share the network with automation, without eroding the service guarantees straddle control depends on.

5

Non-stop operations.

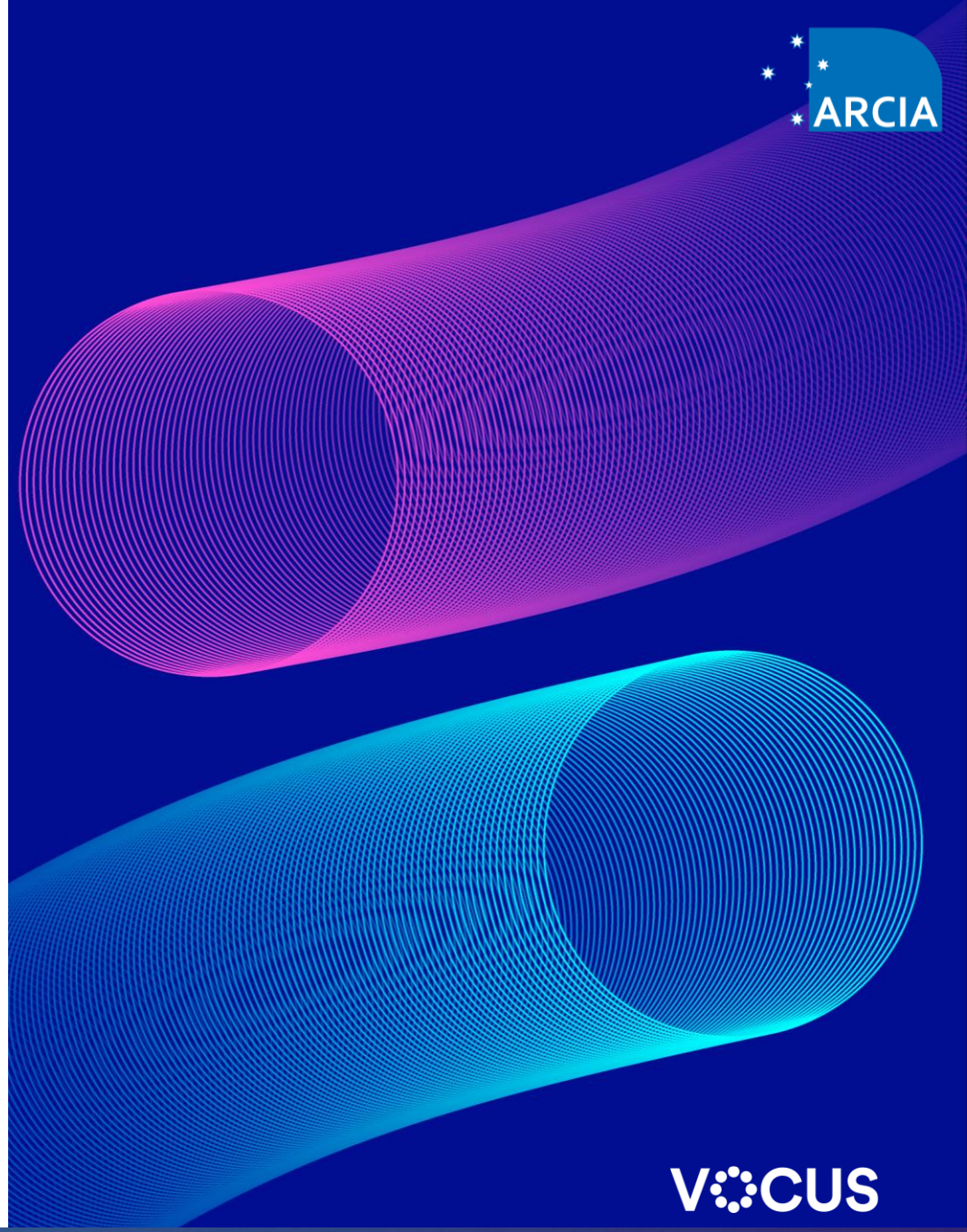
Every install had to sit outside live operating areas at a 24/7 terminal, and losing a radio, a baseband or a comms room must not stop the terminal.

6

Control and security.

Licensed spectrum, a private core on site, and security policy owned by the customer.

From a desktop RF study to a licensed private 5G network, live at an automated container terminal.



The solution at a glance: a private 5G standalone network built for a live port

Radio access:

- 2 baseband units in two comms rooms, with 4 radios on the control tower and yard light poles.
- A dual-layer overlay on 3920 MHz and 3940 MHz means either layer alone still covers the terminal.

Core and devices:

- Private 5G core deployed in both comms rooms, with hot-standby user plane and local breakout.
- 114 SIM profiles live: 75 straddle carriers, 9 quay cranes, 30 IT and OT devices.

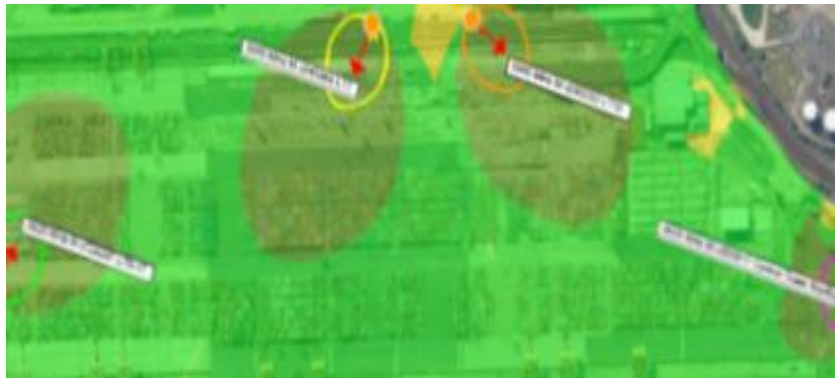
4 radios, 4 sectors, fully redundant-terminal coverage

40 MHz of licensed n77 spectrum

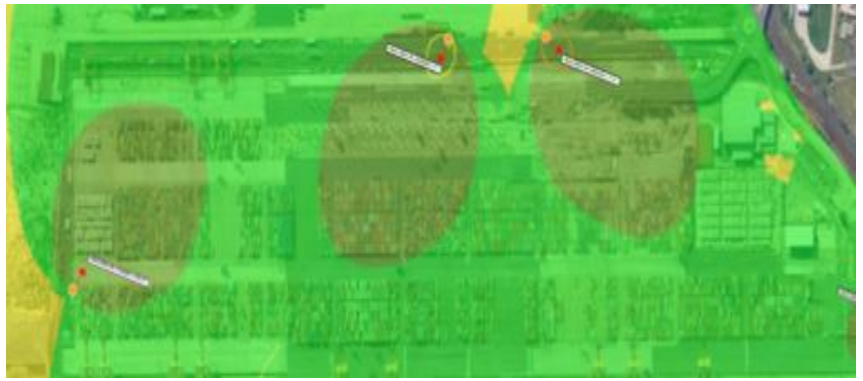
Coverage engineered for a yard that never stands still

Coverage was modelled in ATDI HTZ RF planning tool at 1 m resolution across three device heights: 12 m at the straddle antenna, 16 m for future four-high stacking, and 1.5 m for handhelds carried by mobile workers.

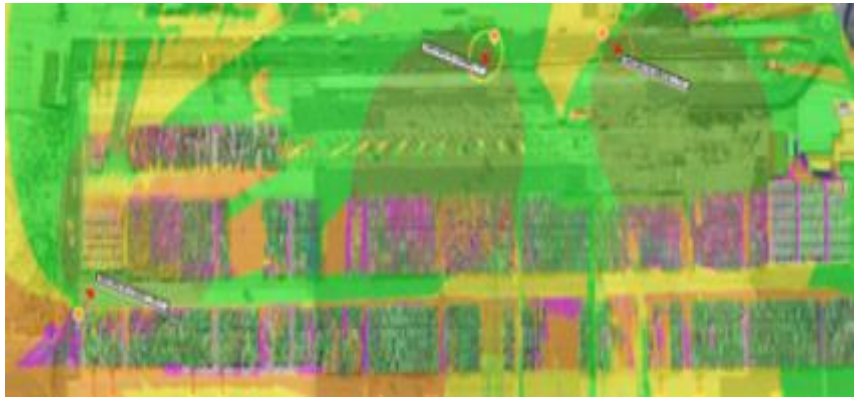
Radio-down scenarios were modelled. The prediction holds RSRP at or above -90 dBm across most of the terminal, and the yard stays covered with a single layer, or a single radio, out of service.



12 m straddle height, both layers



16 m height, four-high stacking



1.5 m handhelds, mobile workers

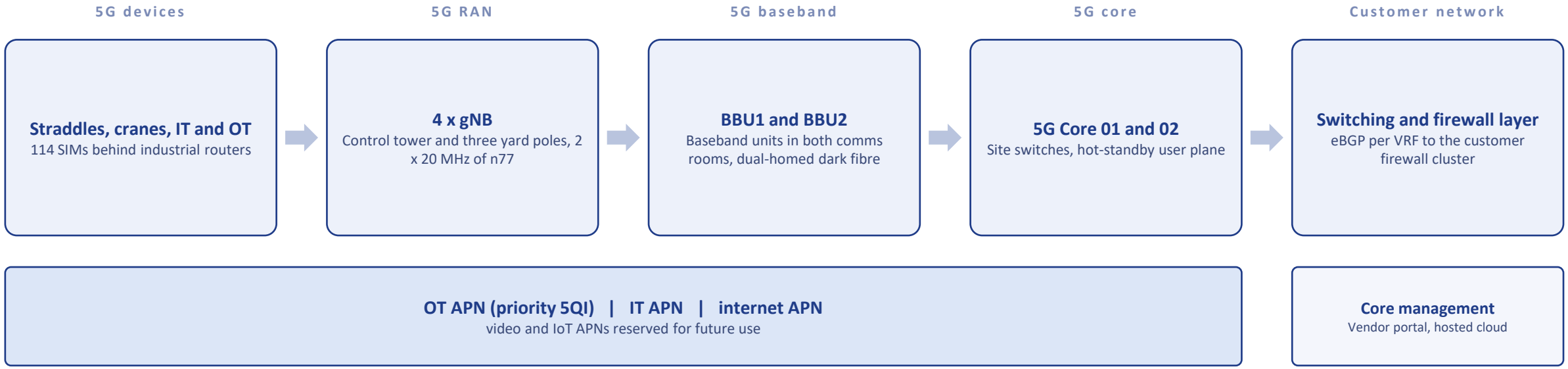
Two radios out of service

One network, five segments of technology.

At a high level the network comprises of 5 segments:

1. UE (Straddles, cranes and IT devices) connect over;
2. Licensed 5G RAN (gNB) and
3. BBU
4. Core that sits on site, so operational traffic is switched locally and never leaves the terminal
5. Customer LAN

Every stage is duplicated across the two comms rooms. The as-built design that follows shows how that redundancy is wired end to end.

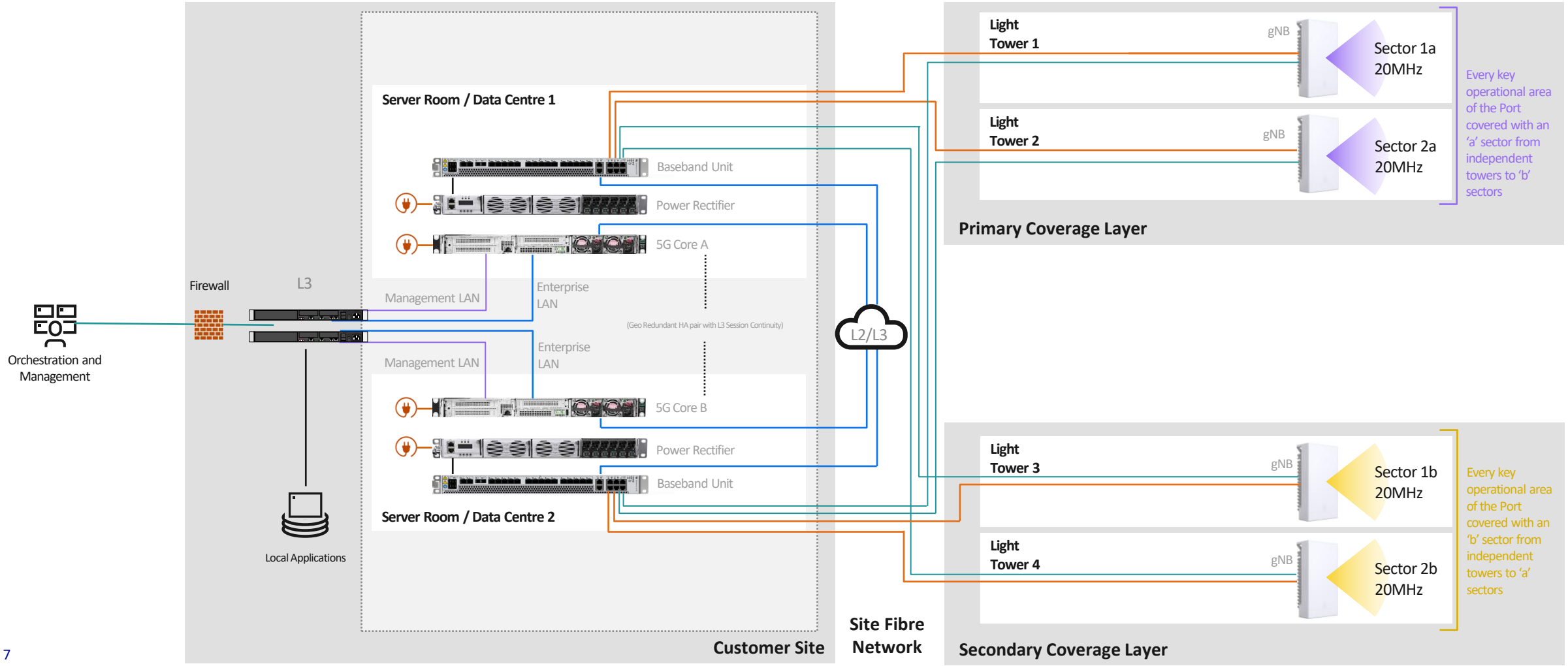


Two comms rooms, one continuous network.

1. The as-built architecture puts a complete 5G core at each end of the terminal, so no single room, link or radio is a single point of failure.

2. Both comms rooms hold a private 5G core, a baseband unit and a site switch, with every radio dual-homed to both basebands.

3. Traffic is separated by APN and VRF, and OT carries a higher-priority 5QI than IT and internet, so straddle control data is protected under load.



Challenges solved along the way.

Five key issues shaped the final design more than anything on the original solution proposal.

Mean time to repair

Issue:

- Can be long in a live port. Restricted access and safety processes can stretch out MTTR

Solution:

- Network designed as two overlapping coverage layers. If a radio or baseband fails, devices hand over to the remaining layer and the terminal keeps running.
- All radios installed on poles outside the operating perimeter avoiding the need to stop operations

Core redundancy fail over

Issue:

- Asymmetric routing after failover. Return traffic to the UE subnet took the wrong path after a core failover. (Discovered during LAB testing)

Solution:

- Resolved it with BGP MED following the active controller, giving a clean 30-second settling window.

(BGP MED=Border Gateway Protocol Multi Exit Discriminator)

Challenges solved along the way (cont/d).

Coverage Design

Issue:

- Continuously changing clutter - container stacks vary by the hour.

Solution:

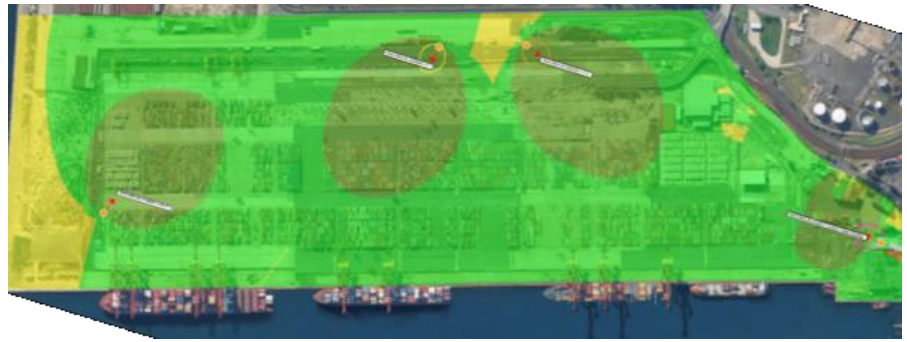
- Modelling at 16 m, 12 m and 1.5m antenna heights confirmed the design holds as the operator moves toward four-high stacking.

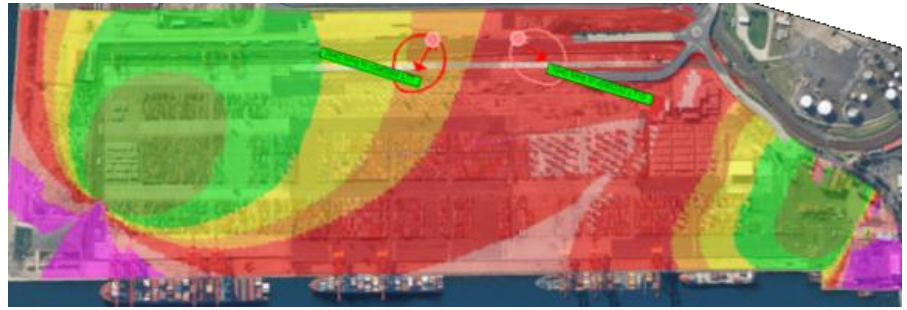
Issue:

- Interference (SINR) across a heavily overlapped yard.
- Covering the whole terminal with four radios two (sites/channel) means sectors overlap, and overlap drives interference that pulls SINR down.

Solution:

- Azimuths, tilts and power were optimised against modelled SINR plots (finding the balance)





Challenges solved along the way (cont/d).

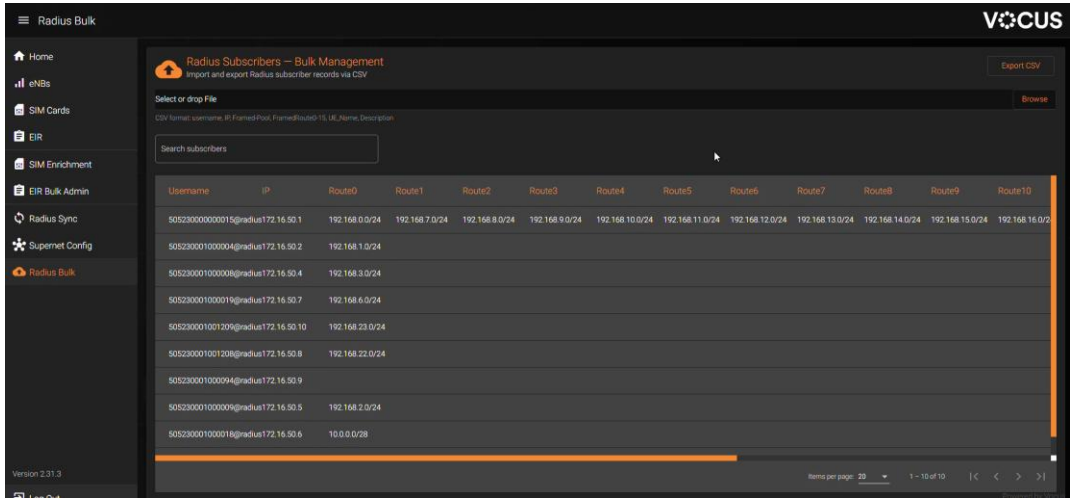
Application integration and migration

Challenge:

- Migrating existing mobile applications without changing local network addressing on machines (routing behind the UE)
- Solution needs to scale for manageability

Solution:

- Static UE addresses with 1:1 NAT on industrial routers gave every straddle a predictable identity for OT systems
- Implemented framed routing to manage connection to multiple applications on machines (Vocus ACM)



VOCUS

Vocus tools on top of the 5G platform, Analytics and ACM.

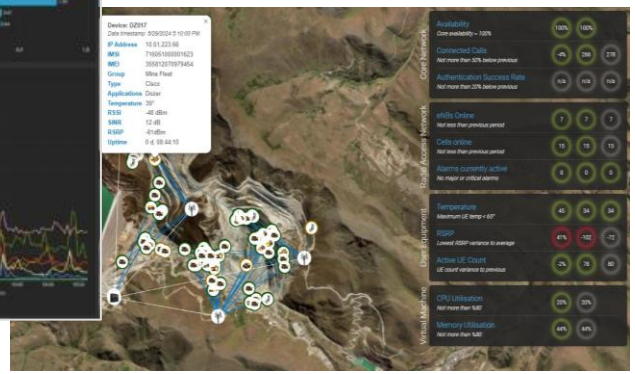
Two in-house Vocus platforms are integrated into the 5G solution.

Network Analytics (NMS): real-time, end-to-end visualisation of the whole system, not just the network elements.

Alarms and KPIs from radio, core and the high-value end points, straddles, cranes and their modems, sit in one multi-dimensional view, so events are identified quickly rather than pieced together from separate vendor tools.

Access and Configuration Manager (ACM): a single administration tool for error-free management of every SIM and device.

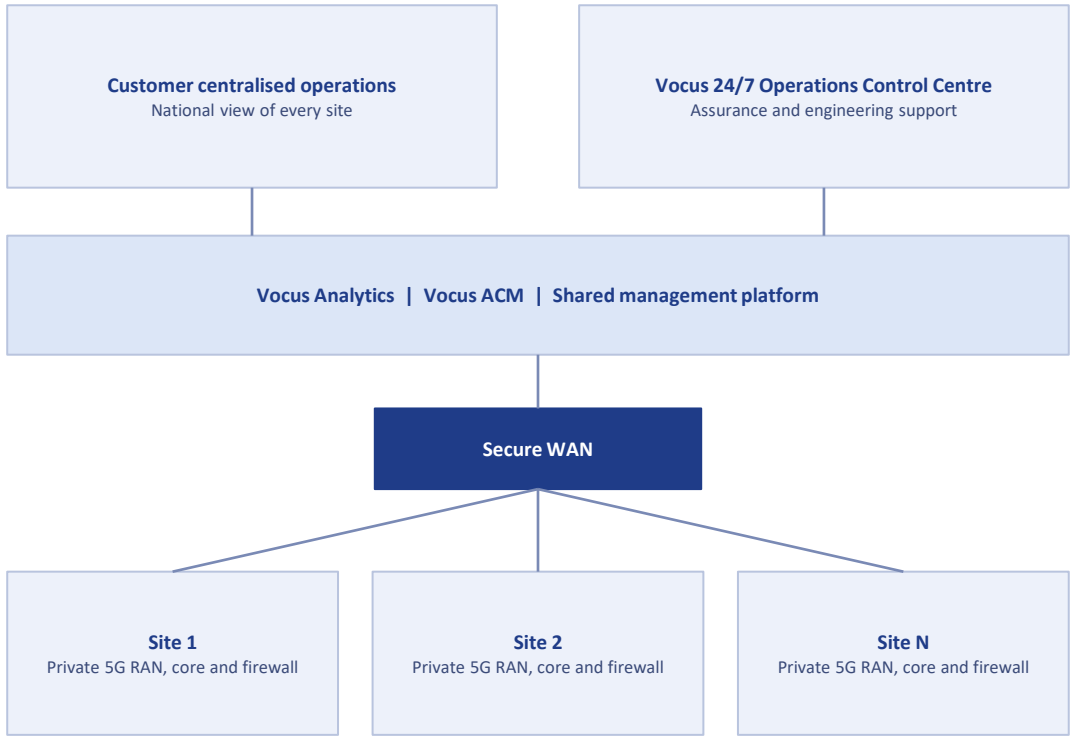
Real-time visibility of SIM provisioning status, active gNBs and subscribers with a live session, with eSIM support for staff and contractor devices, removing the misconfiguration risk that grows with every device added.



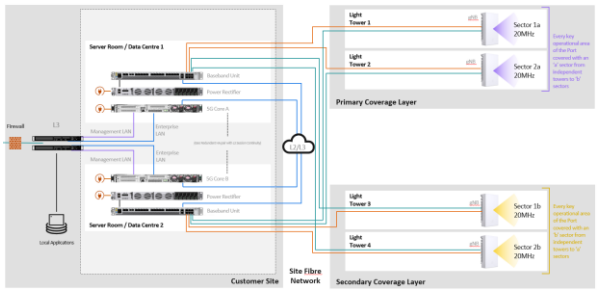
Centralised O&M, one platform for many networks.

The terminal is engineered as the first site of a national footprint, which is exactly where Analytics and ACM pay back.

- Multi-site by design. The management architecture scales beyond one terminal, so each new port joins a single national view instead of becoming another island to run.
- Consistent operations everywhere. ACM gives one place to provision and manage SIMs and user equipment across every site, keeping device configuration consistent as fleets change.
- Assurance, not just monitoring. The Analytics edge collector feeds the Vocus 24/7 Operations Control Centre, with weekly performance reporting and a monthly performance and support review.
- A shared support model. Customer teams hold Level 1 and 2 on site with the same visibility, while Vocus engineering, the team that designed the network, sits behind them 24/7.



Service/Support Flow Diagram



Customer Service Team(s) [Onsite L1/L2]

Customer NOC 24/7 *"2nd Line Support"*

Vocus Wireless Service Desk 24/7 *"3rd Line Support"*

Core Team | RAN Team | Application Team

RAN vendors

3rd party vendors

Core vendors

13

The journey, from proposal to as-built.

Design and proposal

Initial Proposal

- two-site and a five-site option with desktop RF studies
- Customer chose the five-gNB design for purposes of resiliency
- Following site survey and design workshop arrived at full redundancy design using four-gNB
- Site design reached first draft in March 2026.

Build and integration

- Core network design was baselined through April and May 2026:
- QoS values, UE address pools and framed routes per straddle
- Radios up on the control tower and three yard poles, all outside live operating areas
- Network live with UE's attached before EoFY

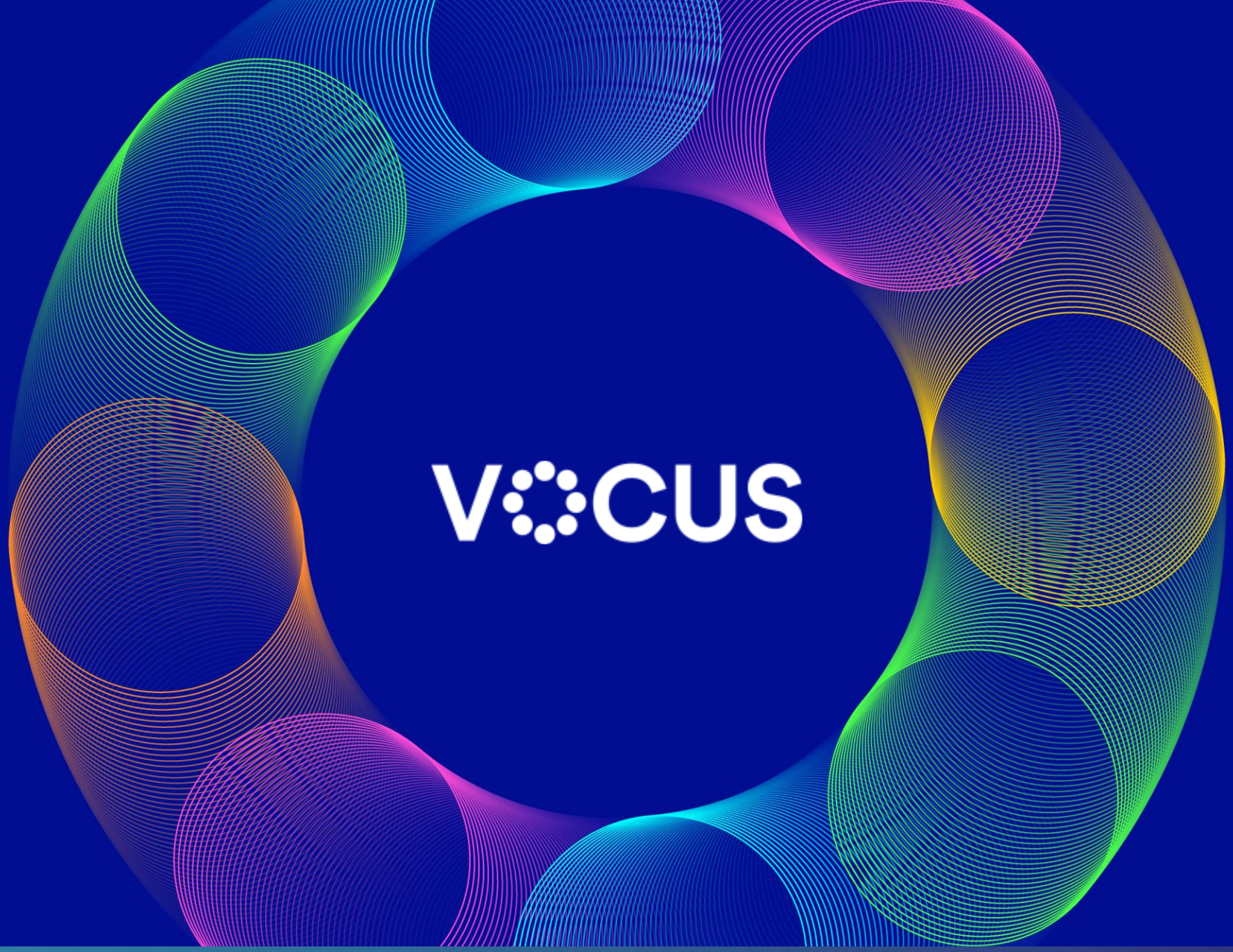
As-built and handover

- Implementation "As Builts" submitted August 2026
- Customer sign off 3 September 2026.
- SIMs provisioned and the network handed over with documentation and spares
- Training to OT team scheduled for next yard shutdown October
- Site now fully operational

The outcome: a private network the customer owns and operates.

A licensed, redundant 5G standalone network covering the automated container terminal, delivered without interrupting operations.

- Coverage and capacity purpose-built for automation, replacing single use Wi-Fi with a dedicated network engineered around straddle and crane operations, with priority for OT traffic.
- Resilience by design: geographic redundancy across two comms rooms, dual-homed fibre to every radio, and a coverage overlay that survives the loss of a layer.
- Room to grow: spare fibre to every radio, a five-site option already costed, and APNs reserved for video and IoT as the terminal automates further.


VOCUS