PRODUCT SPECIFICATIONS

2021 VERSION 1.0


NR83
IND.
REL
CP
MR

CONTENTS

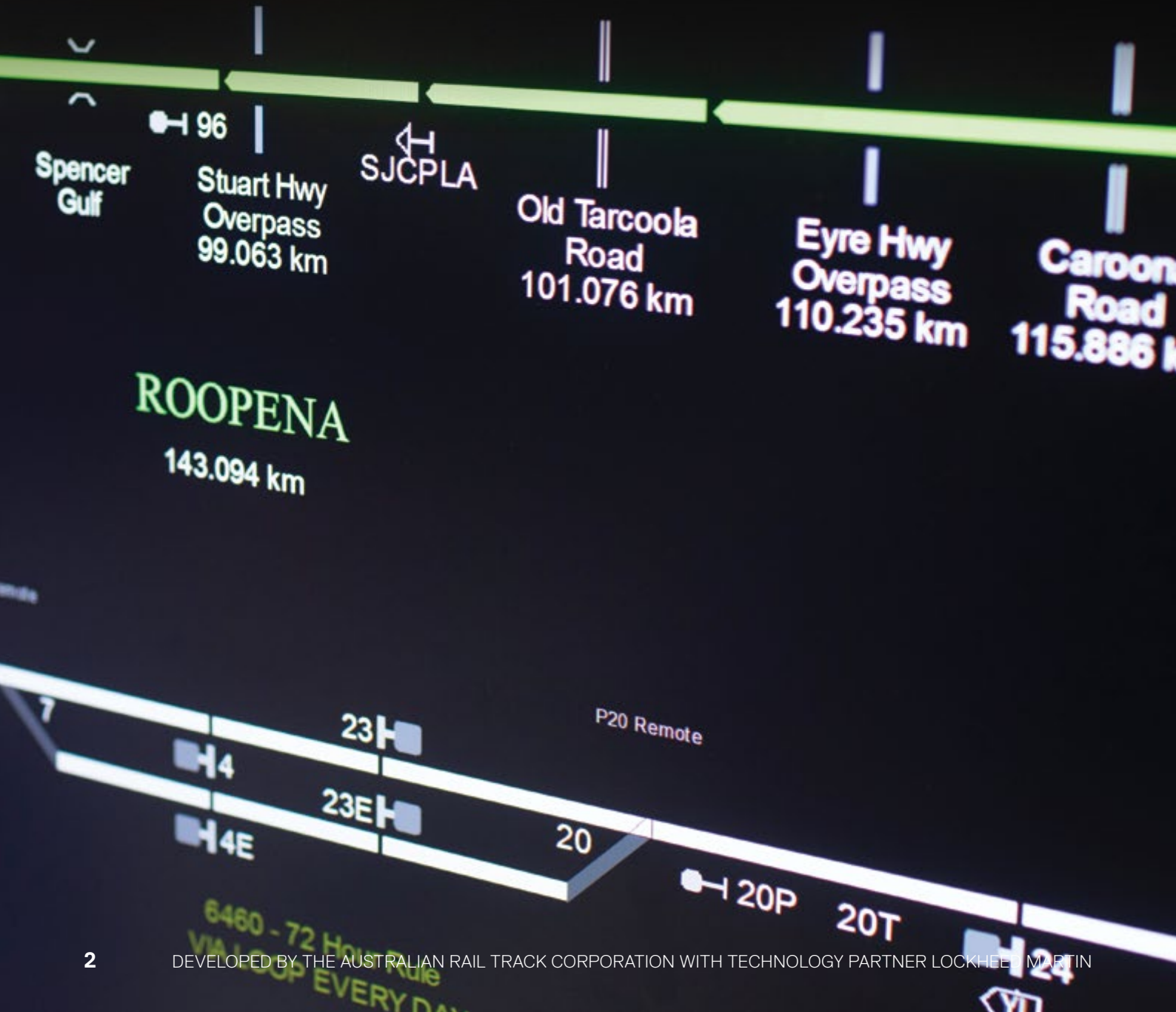
ATMS OVERVIEW

ATMS[1] is an advanced train management system revolutionising Australia's freight rail industry.

The digital solution uses GPS and mobile communications to make trains and the network they operate on 'smart'.

Simplifying train control and network operations, ATMS delivers vast safety improvements, reduces operational and maintenance costs, and improves network efficiencies.

1 Developed by the Australian Rail Track Corporation with technology partner Lockheed Martin



ATMS ON-TRAIN EXPERIENCE

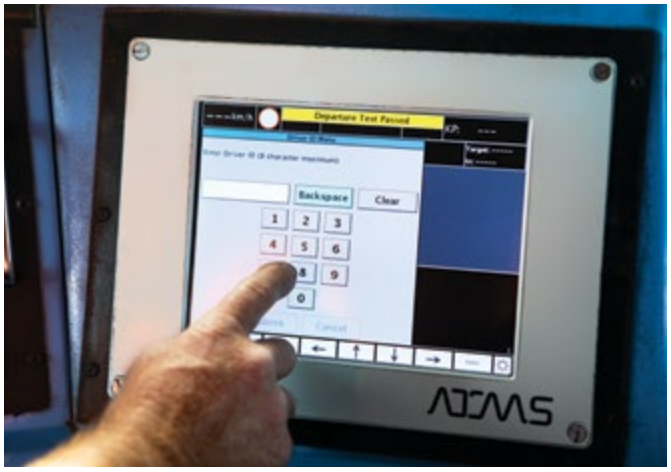


Figure 1: Driver Machine Interface

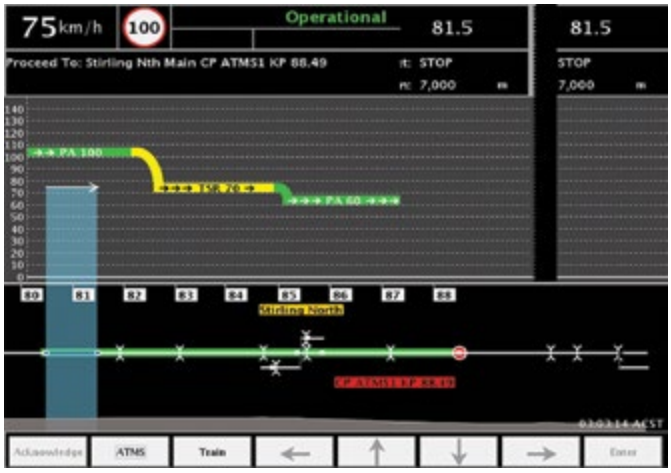


Figure 2: DMI – custom engineered for long distance travel

Drivers use a touch screen device located in the console – called a Driver Machine Interface or DMI – which provides information on the train's movement and integrity, authority, target speed location, as well as other traffic, geographic and track features.

The DMI enhances a driver's situational awareness through a 10km 'look ahead' view of work sites and changes in network conditions. A blue column bar represents the train's length, direction of travel as well as the kilometre post position. The lower green horizontal line represents the train's movement authority. Once a train has an authority, it can continue to the limit of its authority autonomously even if communications fail.

Before moving into ATMS territory, the train communicates with the Network Control Centre (NCC) and the driver enters data via the DMI - digitally connecting the driver, train and NCC in real time.

Train crews are automatically advised of speed restrictions, approaching speed limit changes as well as track work locations. When a train is within 10km of a temporary speed restriction, a yellow braking curve followed by an alert will appear on the DMI.

ATMS ENFORCES LIMITS OF AUTHORITY AND SPEED

If ATMS detects that the train is exceeding the track speed limit or is predicted not to stop before the limit of authority, ATMS will warn the driver. If this unsafe situation is not corrected by the driver, ATMS will automatically engage the train service brake (and possibly emergency brake) bringing the train to a controlled stop. The network controller is automatically advised of any enforcements.

ATMS IN THE NETWORK CONTROL CENTRE

Figure 3: Operator in front of the network control panel

One of the many benefits of ATMS is increased network capacity, because unlike the traditional physical blocks controlled by manual authorities or fixed signals, ATMS uses virtual moving blocks, enabling significant capacity improvements including permitting train fleeting at up to four-minute intervals.

The train's data is displayed on the network controller's board, including the train's location, status, authorities, speed restrictions driver acknowledgements and any alerts – all without any verbal communications. These reports are sent securely via an encrypted channel over Telstra's mobile network.

When a train requires authority to proceed, the network controller proposes an authority. ATMS validates this authority, sets the route and provided these two conditions succeed, uploads the authority to the train. Network controllers can pre-load authorities, which ATMS verifies, and communicates to the train.

Examples of other alerts raised to the network controller include a driver incorrectly operating the ATMS bypass switch whilst on territory, points changing state, a driver failing to acknowledge an alert, and train or trackside communications failures.

ATMS TRACKSIDE INFRASTRUCTURE OPERATION

ATMS trackside infrastructure is in constant communication with Network Control. If communications fail, an alert will appear on the driver's screen warning them that ATMS can't confirm the route. At this stage the driver must verify that the track condition is safe to proceed - Failure to acknowledge will result in an enforcement.

When exiting ATMS territory, the system will automatically protect the boundary through enforcement unless the driver confirms they have authority to proceed to enter the adjacent safe working territory.

If a track worker has an authority in the vicinity, it will be displayed on the network control board and driver's screen with a blue line labelled BP (Blocking Protection).

As ATMS uses 'in cab' signalling the need for trackside signalling infrastructure trackside is greatly reduced. In addition, ATMS' train location reporting completely removes the need for train location beacons.

ATMS also supports unequipped trains, however because onboard location reporting is not available, a network controller must rely on traditional block allocation and location reporting, foregoing the capacity and safety benefits that ATMS offers. These trains must receive their authorities using traditional voice exchanges and follow visual trackside indicators over points when travelling within ATMS territory.

ATMS SAFETY ASSURANCE

The Australian Office of National Rail Safety Regulator has accredited ATMS as a safe working system, therefore ATMS must maintain a Safety Integrity Level (SIL) rating for vital rail operation functions, including reactive/predictive braking enforcement, train control, train integrity, authority management and trackside control/monitoring – each rated to SIL3[2].

To maintain ATMS' SIL rating and safety assurance, any changes to the product are safety assessed and documented in both the Generic Application Safety Case (GASC) that describes product safety assurance and the Specific Application Safety Case (SASC) that describes deployment safety assurance.

To ensure its safety integrity level, ATMS does not currently incorporate alternative component configurations or automated integration with other train management systems.

2 No safety claim is currently made for predictive braking assurance.

ATMS TECHNOLOGY

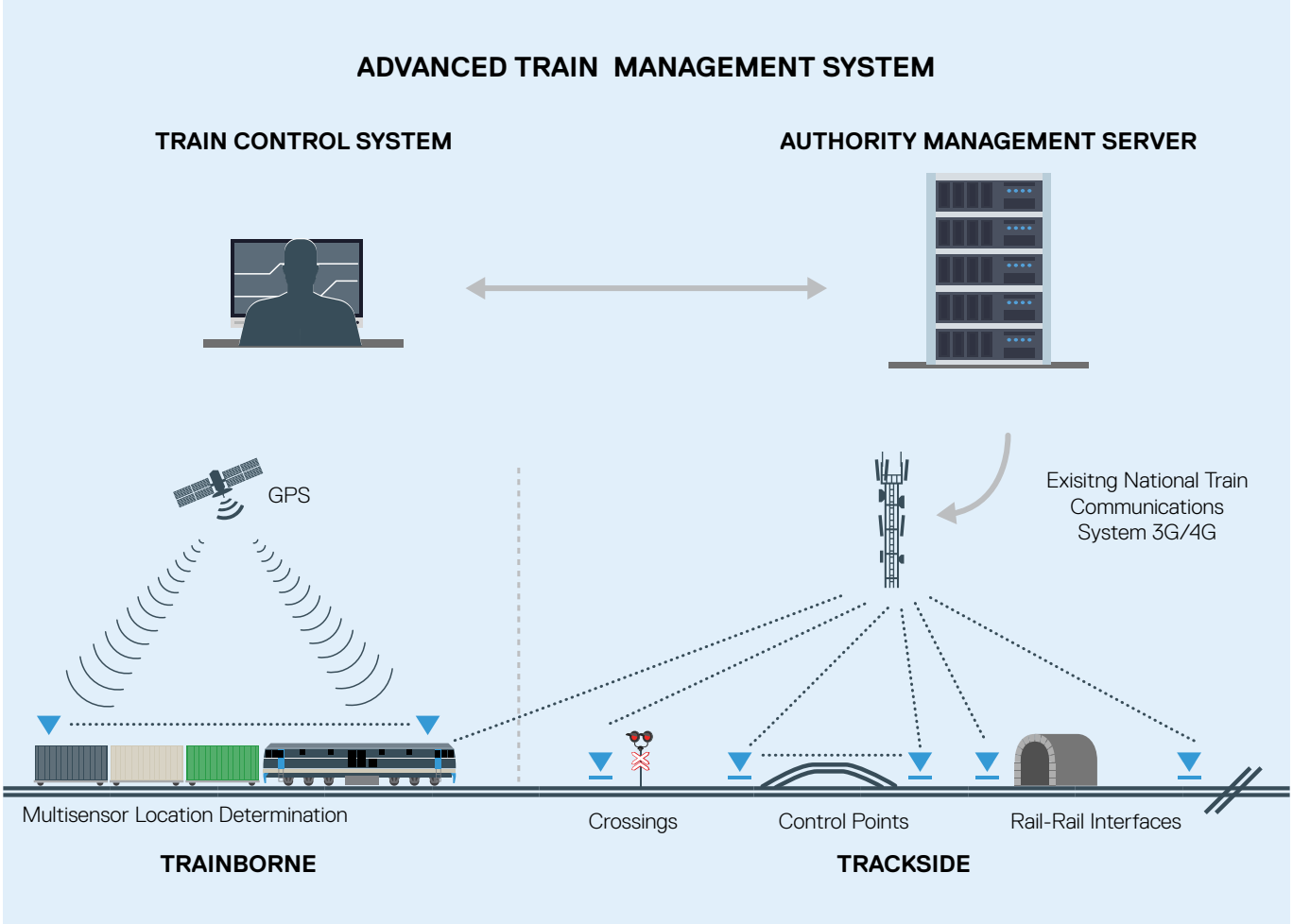


Figure 4: ATMS Technology Architecture

ATMS is a SIL3 rated safe working system comprising integrated software and hardware solution that resides on trains (trainborne), in the Network Control Centre, and on the track (trackside).

ATMS COMPONENTS

ATMS technology comprises five components:

COMPONENT	FUNCTION
Trainborne	Location determination, train control and integrity reporting.
Trackside Interface Unit (TIU)	Electronic interface unit between ATMS and controlled/monitored point machines.
Train Control System (TCS)	Network controller's board for train movement control/monitoring.
Authority Management Server (AMS)	Vital automatic authority validation, route interlocking and authority transmission to trains.
Communications System	ARTC encrypted network connection between ARTC Network Control Centre(s), ATMS equipped rail traffic and trackside interface units over Telstra's mobile network.
Track Database (TDB)	Electronic representation of track layout/features. A version of the TDB resides in trainborne, TCS and AMS software.

ATMS TRAINBORNE SOFTWARE AND HARDWARE

The **Location Determination System (LDS)** software uses a highly sophisticated dual feed from two GPS antennas to fix the train's location. The software compares these two GPS inputs then further compares onboard sensors, the tachometer, and the track database to exactly fix the train's location. Under normal conditions, location reporting to ATMS occurs every 15 seconds.

The **Train Control & Display (TC&D)** software controls train functions such as train integrity monitoring, braking enforcement, driver display management and message exchange between the DMI and AMS.

ATMS TRAINBORNE HARDWARE

The following hardware is permanently installed on a train:

Figure 5: Driver Management Computer/Display

Figure 6: Locomotive Control Unit (LCU)

Figure 7: Head of Train (End of Train not shown)

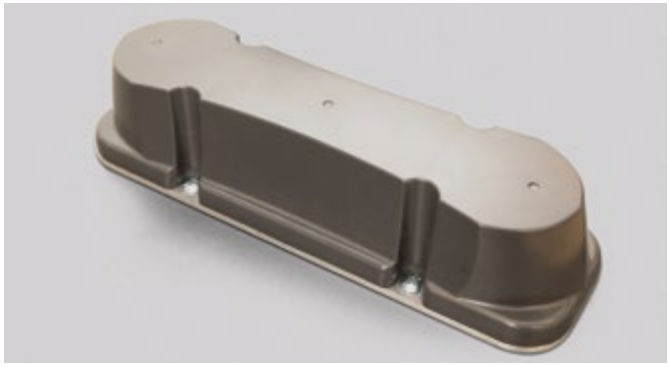


Figure 8: GPS/Mobile Antenna

Figure 9: Router

Figure 10: Cabling Loom

BACKOFFICE SOFTWARE AND HARDWARE

AUTHORITY MANAGEMENT SERVER

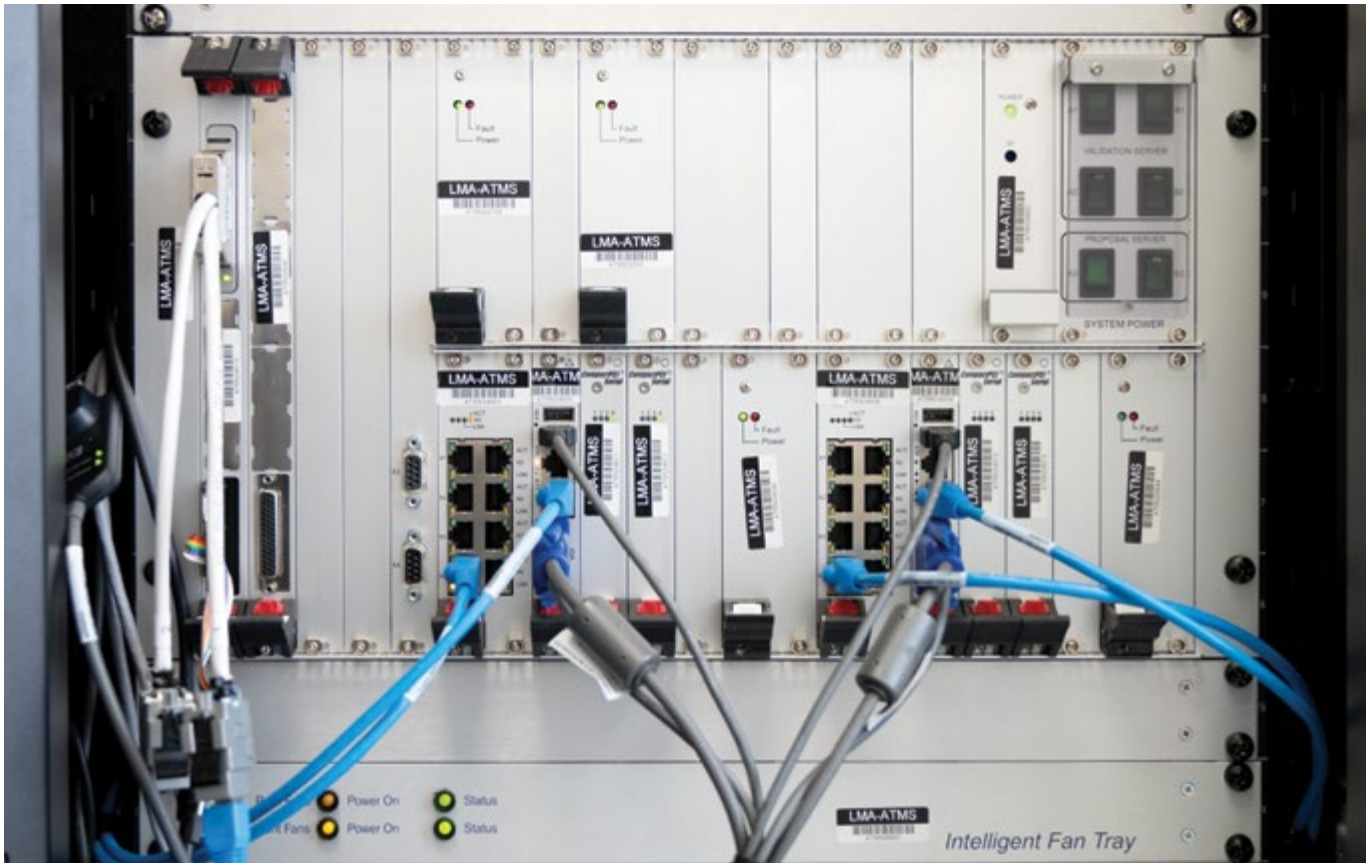


Figure 11: Authority Management Server (AMS) Hardware

The Authority Management Server (AMS) represents the 'brains' of ATMS. AMS software resides on a SIL4 rated bespoke server and performs both vital and non-vital functions. Vital AMS functions are authority validation, train location monitoring and interlocking control/monitoring. Non vital functions include proposal receipt and identity management.

The AMS hardware resides in a data centre.

TRAIN CONTROL SYSTEM (TCS) SOFTWARE

The Train Control System (TCS) provides the interface between network controllers and ATMS to control/monitor train movements, manage authorities and action alerts. It's a SIL 0 rated system that does not control any vital functions. TCS software resides on a virtualised backend server platform located in a data centre. Windows 10 workstations provide the hardware platform for the TCS client used by the network controllers. One TCS server can support multiple TCS clients (control boards) within a Network Control Centre.

TRACK INTERFACE UNIT

ATMS controls and constantly monitors trackside points, their associated visual indicators and train occupancy detection within ATMS territory. This trackside infrastructure is electronically connected to an ATMS Trackside Interface Unit (TIU) (refer Figure 12) which in turn vitally communicates over an encrypted channel on Telstra's cellular network. One TIU can control multiple point machines, however, one TIU is typically deployed at each end of a loop and at the start/end of an ATMS territory. ATMS can be configured to support uncontrolled/unmonitored points, which is sometimes used for mechanically operated points on sidings.

Figure 12: Track Interface Unit

ATMS COMPONENT SUPPLIERS

ATMS components are system integrated to provide exceptional performance and safety assurance of vital functions. Product suppliers are as follows:

COMPONENT	COMPONENT	VENDOR
Trainborne	Software (LDS, TCC, DMI)	Lockheed Martin
	Locomotive Control Unit (LCU)	Lockheed Martin
	Driver Machine Interface (DMI)	Lockheed Martin
	Bypass Switch & Sonalert	Lockheed Martin
	Router	AVVERO
	Antennas (2)	Huber+Suhner SENCITY® Rail
	Head/End of Train	ART
	Cabling loom	Lockheed Martin
Trackside Interface Unit (TIU)	Interlocking software/hardware	Hitachi Microlok II or HIMA Himatrix
Train Control System (TCS)	Workstation	Microsoft Windows 10
	Server	VMWare
	Train Control System	Hitachi (based on Phoenix)
Authority Management Server (AMS)	Server (SIL 4)	Lockheed Martin
	Software	Lockheed Martin
Communications System	ARTC network connection	Cisco
	Trackside Router	Cybertec
	Carrier	Telstra (3/4G)