LEVERAGING NEW TECHNOLOGY TO CREATE HIGHER CAPACITY NETWORKS.

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SUMMARY

Fortescue Metals Group operates the heaviest and longest trains in the world pulled by head end power and is in the Guinness Book of World Records.

Today, FMG's network is based on a Train Order System with a capacity of 55MTPA. To enable FMG to safely expand to 355MTPA and beyond, it has obtained approval from the WA Government Rail Regulator to operate a new Positive Train Control System.

This system, is based on General Electric's (GE) state of the art GPS based Positive Train Control System will be the first of its kind in Australia and will become one of the benchmarks for the industry.

The paper will provide details into how the system operates to provide greater network capacity by safely allowing shorter headways through the use of GPS tracking, in-cab signalling for locomotive drivers and track machine operators, and protection for work gangs and hi-rails.

INTRODUCTION

At 32,880 tonnes each and stretching 2.7km in length, Fortescue operates the longest and heaviest trains in the world pulled by head-end power using two locomotives. We currently have 15 General Electric 4400 horsepower Dash-9 Locos and 2 EMD SD-90 6000 horsepower Locos in operation. Fortescue trains currently have the heaviest axle load in the world at 40 tonnes per axle. Each fully loaded wagon has a total weight of 160 tonnes,, and we are looking at the feasibility of increasing the axle load further to 45 tonnes using higher capacity wagons and bogies, subject to a successful feasibility study and regulatory approval by the Office of Rail Safety. We run consists of 240 wagons over 8km blocks using at a maximum speed of 80km/hr. Each train is equipped with New York Air Brake Electronically Controlled Pneumatic airbrakes which allow a fully loaded train to come to a stop within 800m on the flat.

The safe ramp up of tonnes railed from 55MTPA in 2011 to 355MTPA by 2017 will be achieved with the use of the latest rail technology, specifically:

- Large capacity wagons (160tonne) with 40 tonne axle loads.
- 68kg/m rail, concrete sleepers and ballast/formation designed to accommodate the 40t axle loads.
- Loaded train speeds of 80km/hr.
- 2.7km length trains (240 ore cars).
- Electronically controlled pneumatic braking (ECP) system to allow shorter braking distances.
- A Communications based Positive Train Control System (PTCS) to enforce safe braking if required.
- A Safety Integrity Level of >= 3 to reduce vulnerability to human error.
- A system of shorter fixed virtual blocks, made possible via the PTCS.

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FMG already has a number of these technologies in place. This paper will focus on the Positive Train Control System which is due to be commissioned in June 2012.

POSITIVE TRAIN CONTROL SYSTEM

The following sections outline several safety features of the PTCS being implemented at Fortescue Metals Group Ltd.

Increased reliability, safety and reduced maintenance costs

The ITCS system uses GPS technology, including differential correction, to maintain spatial awareness for Trains, Track Machines, Hi-Rails and Work Gangs. The On Board Computer communicates with the wayside ITCS Server to determine switch positions, Temporary Speed Restrictions, locations of surrounding trains, track machines, hi-rails and gangs. The On Board Computer also has a detailed database of the track gradient and curve profile and permitted maximum speeds and required braking distances of different consist types. It also knows the weight and length of the current consist.

Track mounted transponders and wayside signals are not required, thus improving reliability and reducing maintenance costs. One of the problems with physical signals is that a driver may not "see" a red signal resulting in a Signal Passed at Danger or SPAD. With the ITCS system, a virtual signal is displayed in the drivers cab. SPAD's cannot occur because the system will apply the brakes if the driver does not slow his train down sufficiently to stop the train in time at the location of the virtual stop signal or at the location of his/her limit of authority. Fortescue's current physical track circuits average 8km in length. The ITCS will allow Fortescue to reduce its block size to 4km Fixed Virtual Blocks thus improving headways.

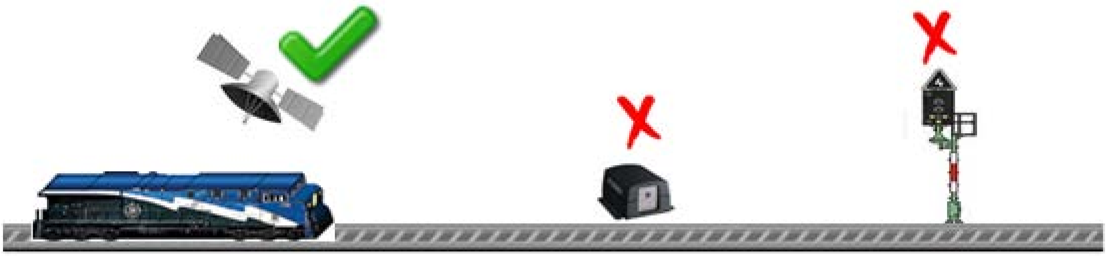

Figure 1: Train Centric On Board Computer with In Cab signalling and GPS location tracking.

Preventing train collisions – train vs train

Train collisions are prevented by the ITCS. The driver can see his/her authorised route on the in-Cab driver display, together with the distance to the target limit of authority and the maximum permitted speed at the trains current location.

If the driver does not slow the train down sufficiently to bring it to a controlled stop within the safe braking distance, then a warning alert is issued to the driver. If the driver does not take any action to apply the brakes, the On Board Computer applies the service brake to bring the train to a safe controlled stop within the calculated safe stopping distance.

There are a number of events that could cause the safe braking distance to be reduced at any given time. An example of this is a broken rail ahead of the train which will drop its track circuit. The trackside equipment will sense this and feed the track status back to the On Board Computer via the wayside ITCS Server. The On Board Computer will then recalculate its current safe breaking distance. Other examples of events which dynamically change the status surrounding a train are asset protection devices such as a Stream Flow detector which may become active or a train or track machine which has broken down and which is occupying the track ahead of the train. In each case the On Board Computer in conjunction with the wayside ITCS Server will re-evaluate the safe braking distance and/or speed.

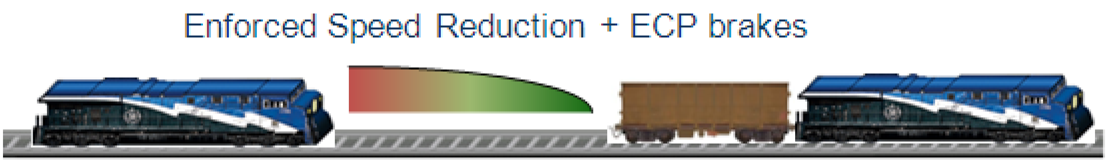

Figure 2: PTCS enforces speed reduction to avoid collisions.

Preventing collisions – train vs track machine

In a similar way, collisions are avoided between trains and track machines and vice versa. In addition, collisions between track machines and other track machines are avoided. This is especially useful in cases where track machines travel in close convoy on their way to a work area. All of this is possible because the Track Machines will be fitted with the same On Board Computer system that is fitted into Locomotives.

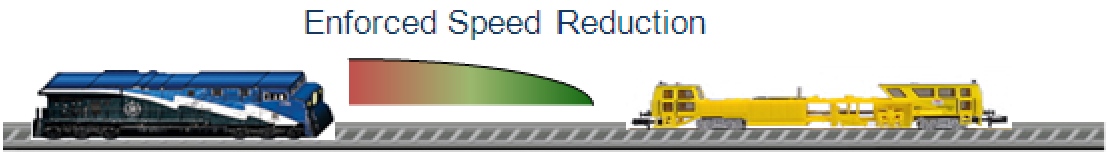

Figure 3: A similar concept applies to collisions between Trains and Track Machines.

Enforcing movement authority limits

In addition to preventing train collisions, the On Board Computer also ensures that a train cannot move beyond its current limit of authority.

To explain a little more about the On Board Computer, it has numerous inputs including current location, consist, gradient, curve, Temporary Speed Restrictions if any, switch positions, surrounding trains and track machines. It has only one output which is a Service Brake application which will take affect if the driver does not take action to apply the brake if either the safe braking distance has been reached or the speed limit has been exceeded. In terms of GPS location information which tells the On Board Computer where it is, a system of differential GPS correction is used to maximise the accuracy of location information. As you may know, standard GPS systems have a nominal accuracy of 15 metres. Differential GPS improves the accuracy to about 10 cm. This works as follows. The ITCS Server knows with 100% accuracy, where it is located. When a Locomotive passes by the ITCS Server, the On Board Computer reports what it believes to be its GPS position to the ITCS Server. The ITCS Server checks this for accuracy and sends back a correction offset to the On Board Computer.

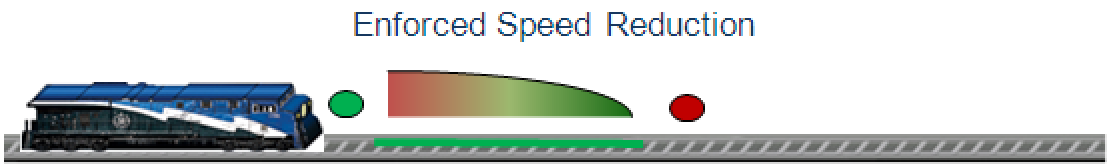

Figure 4: Enforcing authority limits of trains and track machines..

Hi-Rails – Position tracking and alarms

Hi-Rail vehicles such as Hi-Rail light vehicles and Hi-Rail trucks do not have an On Board Computer fitted. But they do have a system which improves the safety of hi-rails on the network. This is achieved again by the use of GPS technology. The Hi-Rails limit of authority, as defined by the Train Controller and Rail Edge system is known by the ITCS system. If a Hi-Rail exceeds its limit of authority an audible and visual alarm is raised in Train Control on the Rail Edge System panel monitored by the Train Controller. The Train Controller would then contact the Hi-Rail driver and request him/her to bring the vehicle to a stop. In addition, Hi-rails have a built in vigilance control which will apply the brake if the vigilance control is not acknowledged by the driver as required.

Figure 5: HI-Rails – position tracking and alarms.

Protection of Work Gangs

One of the other safety requirements Fortescue has is to ensure Work (Track) Gangs working on and around the track are afforded a similar level of protection against trains or track machines inadvertently encroaching upon their work area. The ITCS system allows a Track Gang supervisor to request a designated work area which we call a Track Access Authority or TAA, and a designated Temporary Speed Restriction, or “No Entry” between two track locations. This request is made via an ITCS “Employee in Charge” terminal located in his/her vehicle directly to Train Control in Perth. If the request is accepted by Train Control, then the ITCS will enforce the speed of Trains or Track machines coming through the area in accordance with the temporary speed restriction or “No entry requirement”. The Work Gang will still layout their normal protection system of observers, flags and audible track warning devices as an additional layer of safety controls. The Employee in Charge terminal is also connected to a GPS system and the Work Gang supervisor cannot request a TAA for a Work Area unless his/her vehicle is within a minimum specified distance of his/her requested Work Area.

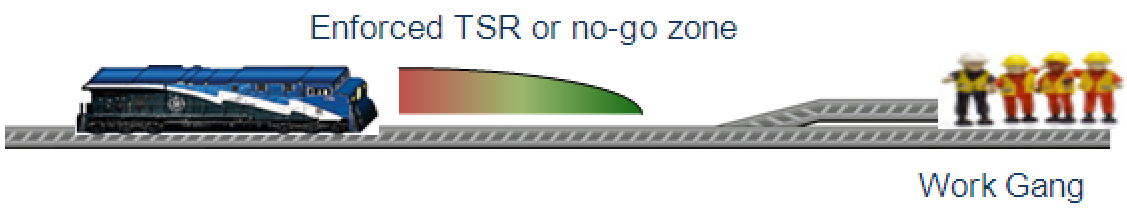

Figure 6: Protection of Work Gangs.

Preventing derailments and run throughs

Another requirement Fortescue has is to ensure where possible that there are no derailments caused by excessive speed through turnouts or around curves. The On Board Computer has a database detailing the location of all turnouts and their type, for example 1:20 or 1:12 and whether left or right hand. This database will be updated whenever a physical change is made to the railway network, such as installing an additional turnout or a new track section. The On Board Computer will enforce the speed, via a service brake application if the driver takes no action to bring the speed to less than or equal to the maximum permitted speed for the turnout or curve. In addition the ITCS will not allow a train or track machine to go through misaligned switches in ITCS territory.

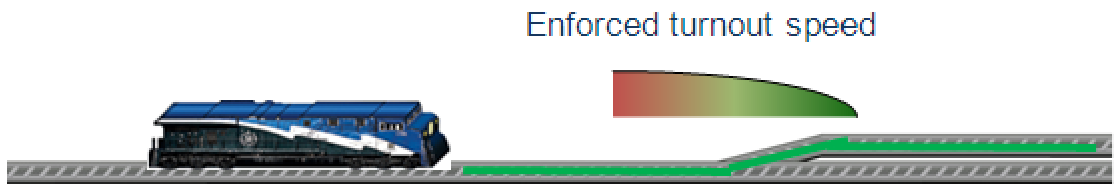

Figure 7: Preventing derailments and run throughs.

In cab information to the train driver

Train Drivers and Track Machine operators will have an in-cab display as shown on the slide. I'll briefly run through some of these for you. The Type of Train is important. This would have been selected by the Driver from a Drop-down list prior to departure. It essentially tells the On Board Computer what train mass and train length it needs to calculate Safe Braking Distances for.

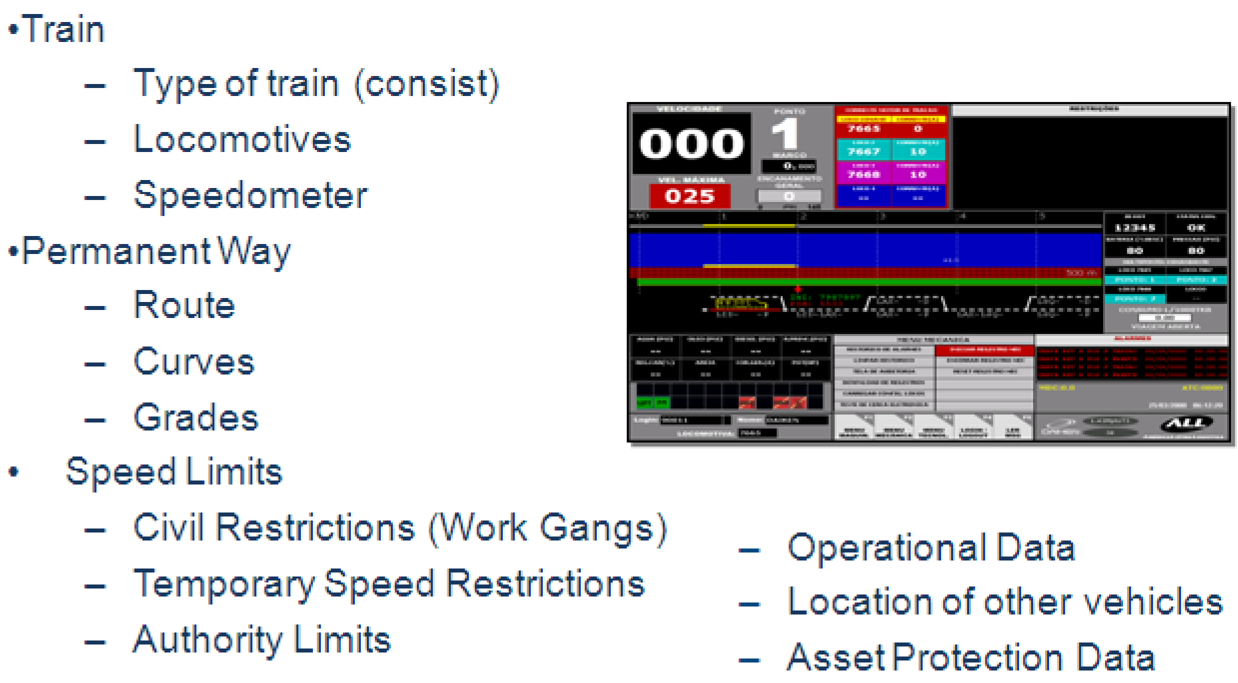

Figure 8: In cab information to the train driver.

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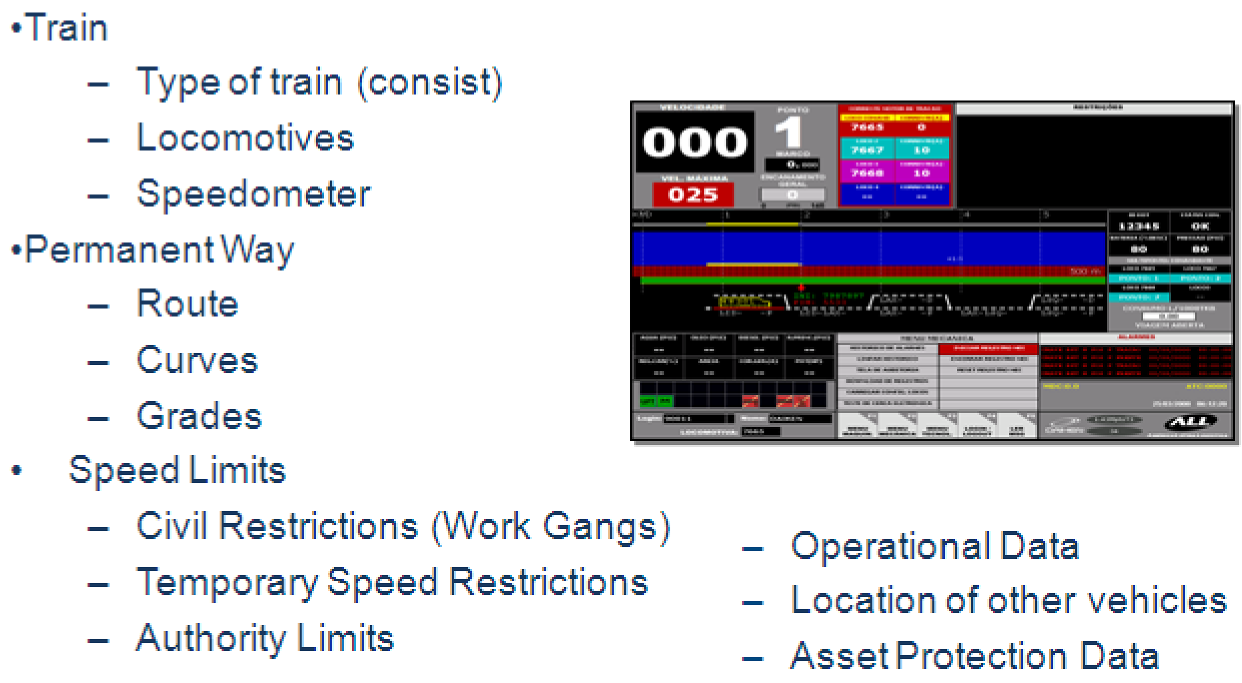

Figure 9: In cab information to the train driver.

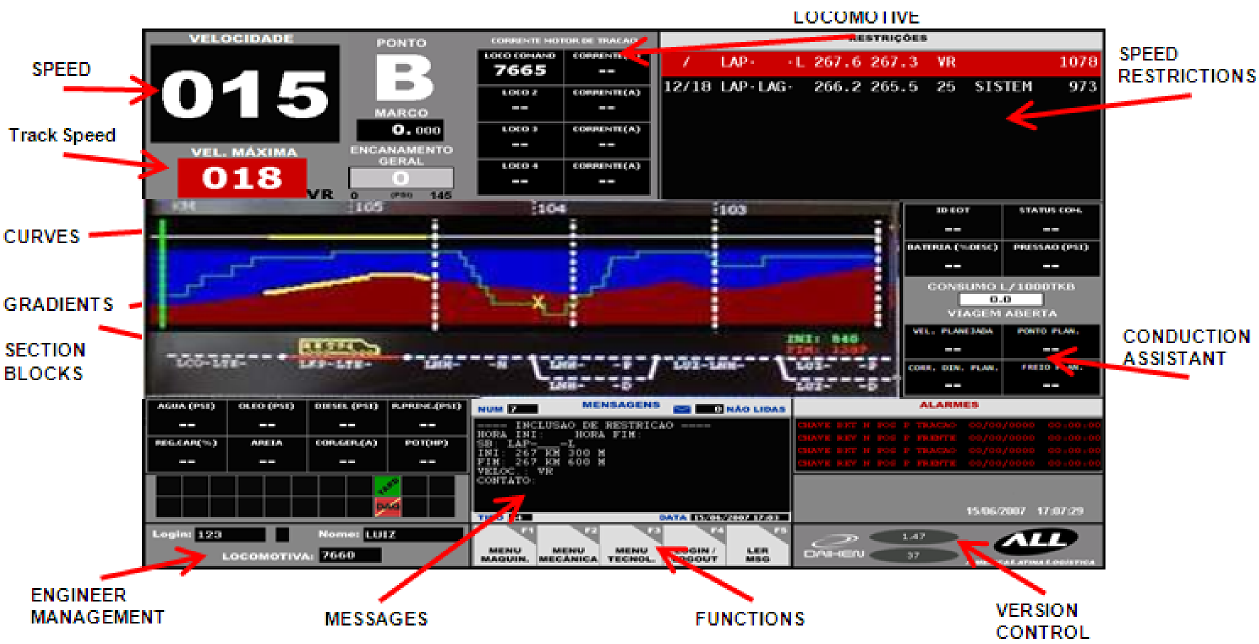

Figure 10: Close-up view of In cab information to the train driver.

Movement Authority Process

The driver requests and confirms a Movement Authority through the On Board Computer. When a Movement Authority is confirmed by Train Control, the Block Sections for the route are marked in green. The On Board Computer also informs trains in the neighborhood of the train's location, via the wayside ITCS Server.

Figure 11: Movement Authority Process.

Active Asset Protection

The other dimension to running a safe railway is through using state of the art Asset Protection Equipment. One recent addition to our asset protection equipment was the addition of a Bearing Acoustic Monitor which is able to help predict a bearing failure weeks or months before it fails. This is in contrast to traditional Hot Bearing detectors which notify Train Control and the Driver that a Bearing has just failed, in other words, after the event.

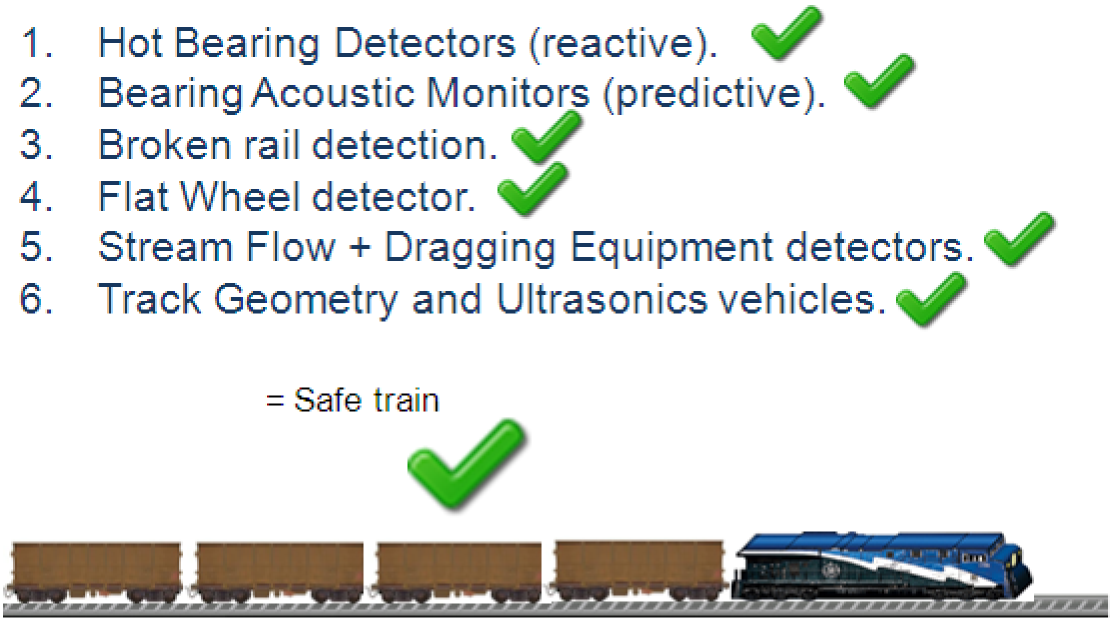

Figure 12: Active Asset Protection.

Future Steps - Cruise Control

The GE Locomotive Cruise Control system is something that Fortescue will have a closer look at in the future. The system will have a detailed database of optimum train speeds and optimum braking at every point along the network and will automatically drive the train once engaged by the driver. This will reduce in train forces and eliminate events such as broken knuckles whilst also reducing fatigue on draw gear. Fuel consumption will also be optimised for greater efficiency. A driver will still be required to monitor the overall performance of the train and to drive the train into non ITCS areas.

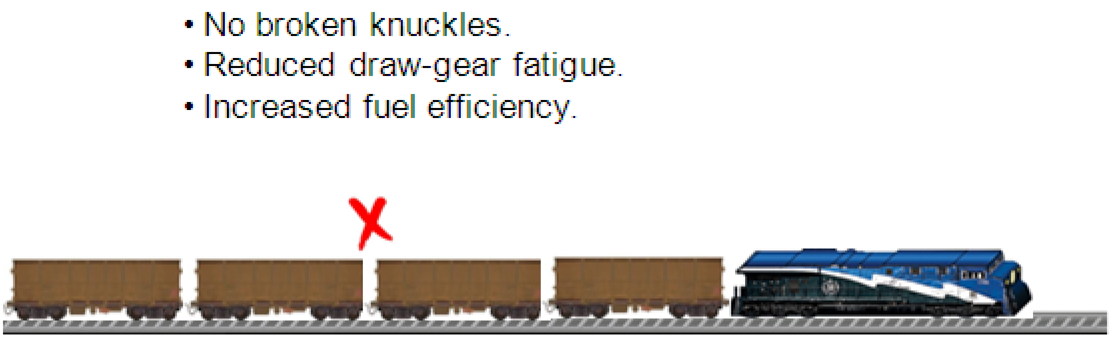

Figure 13: Future Steps – Cruise Control.

CONCLUSION

Fortescue Metals Group Ltd believes that the future of safe, higher capacity networks relies on the use of technologies like the Positive Train Control System with GPS location tracking for Locomotives and Track Machines, together with shorter virtual blocks, work gang protection and Hi-Rail tracking.

This, in conjunction with other newer technologies such as ECP brakes, higher axle loads, longer trains and higher quality track will go a long way to achieving higher capacity rail networks in Australia and beyond.