The Harmonisation of Train Communications and Communications Based Train Control Systems

1. Introduction

Access to the interstate rail system with the view of operating in more than one of the old rail authority areas is difficult. This is because of dispirit train control and communications systems used within these areas. The theme of this paper is the need to harmonise these so that lower cost access can be achieved to improve competition between operators of rail services and to lower the cost of that access.

2. The current situation

Access to track requires the procurement and implementation of the train equipment required to allow operation on the track corridors. This equipment is required so that interworking with the track owners systems is possible in support of his safety management obligations. In the past lineside signalling systems and high levels of manning required few if any specialised communications or signalling devices in the trains themselves. There has been a trend to reduce manning by the implementation of more electronically based signalling system and widespread use of radio communications. To a large extent these developments have proceeded in isolation and have reached the point where in travelling from Brisbane to Perth on the interstate standard gauge network a National Rail locomotive would be expected to interwork with 17 different train to control radio systems and 7 different modes for communication between trains[1].

The equipment investment required to overcome this lack of standardisation is costly, a disincentive to the entry of new operators on the interstate networks and an impediment to the most productive use of locomotives. The lack of standardised train control and communications systems is an electronic break of gauge remaining on the interstate system after the physical one has been overcome. This is a significant inhibition to competition in interstate rail freight services.

3. Why is accredited interworking with train control required?

All modes of transport have movement control regimes in place to avoid conflicts and collisions. These are as simple as defining a single direction of travel on each lane of a road and drive on sight operation (use of observation as the primary collision avoidance mechanism). As the mode changes away from road the movement control requirements become more stringent. Drive on sight operation can be supplemented by other facilities such as the anti collision radar used by shipping and aircraft. The problem of collision avoidance is more severe in aircraft but a mitigating factor here is the ability of aircraft to move in three dimensions whereas for ships only two dimensional movement is possible but speeds are far lower and the potential collision hazard less.

Road traffic have a two dimensional collision avoidance capability and as it operates in full drive on sight mode and there is no need for further movement regulation. The speed at which aircraft operate and the relatively short range of coverage of anti-collision systems necessitate the use of air traffic control to allocate a piece of sky to each aircraft and thereby minimise the need for evasive action to be taken. It also facilitates orderly access to the air corridors and maximum safe throughput.

Railways employ physical infrastructure which is constrained in capacity and supports only single dimension movement. The anti-collision problem is more severe than in aircraft. There is no swerving ability available and the operating speed and mass of trains normally preclude drive on sight operation. Likewise anti-collision systems are not a feature of railway operation due to the technical difficulties of implementing them safely. Train control and signalling systems are used to allow the reservation of a pathway for each train which avoids conflict with others. Train Control also allows the maximum utilisation of the physically constrained track infrastructure in an orderly way by avoiding wasteful conflict between services.

4. Types of train control systems in use.

Train control systems were traditionally formed from line side signalling systems where the movement permission is given by a coloured light similar to road traffic lights. No locomotive equipment is required, the driving of the trains is entirely regulated by the observation of the signals. These provide for ready access by operators locomotives but this cost of access is cannot be optimised to the lowest cost due to maintenance charges.

In recent years communications technologies have advanced to the point where radio communications is seen as an essential requirement for train control systems. On light density rail traffic routes this communications equipment is used to provide verbal movement permission from the train control centre. These light lines operate in a similar way to that used in air traffic control to regulate train movements safely. The growth of communications technology should make it possible to extend a suitable communications based train control systems to all non urban rail lines including those of higher density where train control by verbal permission is impractical allowing the elimination of most line side apparatus. Such a system uses a communications bearer and a safety computer system. The safety computer system used to generate the movement authority provides the safety protection usually provided by line side signals. It also generates the electronic movement instruction to be transmitted to a screen in each train in place of the coloured light displayed on the line side signal.

The effect of this change is expected to lower the installation costs by up to 50% and operating costs of train control systems of the same order. The implementation of such a control system requires a large initial design effort for even a small scale implementation. Reduction of costs of the level stated are applicable for an implementation on a large portion of the interstate rail network. It is noteworthy that although the concept of communications based train control seems simple there have many attempts to implement these systems which have resulted in failure. There are no widespread communications based train control systems in use anywhere in the world in spite of large scale development efforts.

5. Operators interface with current radio systems – the challenge.

In order to progress towards lower cost train control systems a suitable communications bearer is required. Why is it so difficult for a new operator on the interstate network to interface with communications systems in general and the one communications based train control system in use? The answer lies in the historical accidents that brought them into being. Each communications system, with one notable exception RAC of NSW, has generally evolved from earlier systems. From the base of what was in place investments have been made to tailor the communications systems to meet the evolving business requirements of the particular rail authority. While these investments have been made on a rational basis, they have also been influenced by the lack of standardised operating procedures used in each authority requiring different capabilities of the equipment provided.

In the NSW case the implementation of train communications was a new development in this decade but to a certain extent reflects NSW operating practice which is by no means universal. The prime focus of the systems was to provide the communications function in a vertically integrated railway context against the almost universal use of line side signalling systems. Equipment for the ground terminals and locomotives was purchased at the same time from a common tender. No consideration was given to the possible need for others to independently purchase compatible locomotive equipment in a competitive market place. Like wise the need to standardise equipment interworking protocols did not received any attention.

In truth the needs of the interstate freight network was not a significant factor in a context where large losses were being made while intra state freight was the mainstay of the business. Transport studies have shown that a predominant intrastate traffic in NSW is coal at 50 Million tonnes compared with about 5 Million tonnes moved on the interstate corridors[2]. Also locomotives were changed at the borders making all operations effectively intrastate. Investment decisions were focussed on vertically integrated intrastate operations alone. The best example of this situation is in Victoria where the author of this paper was involved in the procurement of a proprietary data communications system for locomotives building on an existing communications system before competition issues were on the agenda. To this day this communications system presents a barrier to access of the interstate corridor.

6. Interface with communications based control systems

There is only one communications based train control system currently in use at this time; in Victoria. The communications bearer equipment available to support interworking with this train control system at this stage is only available from one supplier and its design is technologically obsolete. This restricts new entrants to use of the Melbourne to Adelaide corridor. It is accepted in the light of experience that the train control system design concept requires improvement to allow it to replace all non urban train control systems and satisfy the operating requirements of all of the parties involved in control of the interstate rail network. It also requires revision to allow use of more universal communications bearers. The dilemma is that manufacture of equipment to interface to this obsolete proprietary system is extremely costly and represents a dead end investment.

7. The harmonisation of technical access requirements for the communications system

It would be considered anachronistic for there to be differing road law requirements in the states necessitating the fitting of interstate road vehicles with different equipment (for example different coloured headlights) to allow operation between the states. This is exactly the situation prevailing on the interstate rail network. The task of formulation of a new communications system standard and ultimately a universal train control system has been commenced by the track owners. From previous experience the magnitude of this task could well be underestimated and this will further delay this important access measure.

The outcome of the universal train control concept studies will also influence the functional requirements of the communications bearer provide for train control purposes. The finalisation of the standardisation of technical interworking protocols will be ultimately constrained to the completion of the universal train control concept. The specification of a universal communications train control concept will involve investment by the parties which on one hand is recognised as having benefit to the cost of operation and ease of access to the interstate rail network. On the other hand the required investments to allow conforming train control systems however may not be justified in an investment sense for individual track controllers and certainly would be of questionable benefit to an owner of a network operating with predominantly intrastate traffic. Referring back to the road analogy previously used, state road uses would see little direct benefit in providing uniform headlight colours, only an unnecessary cost burden.

8. The future – harmony should prevail

To follow the road analogy further, a national body similar to the National Road Transport Commission is required within the rail industry along the lines proposed in various forums as a National Rail Transport Commission. It was the NRTC who were responsible for harmonising road transport regulations and design standards to the great benefit of users of that transport mode and the economy. Various attempts have been made to harmonise standards within the rail industry, but all relied on the voluntary commitment of resources. Progress has been made but needs to be accelerated with an independent resources and management. During a time of structural change it is important that independent funding and arms length management of the harmonisation process takes place to ensure the most appropriate outcome is achieved rather than the most convenient at the time. Some of the outcomes of the work will involve investment in new technology which will not be the lowest cost solution for a particular operator.

Likewise strategic implementations funded by the Federal Government will almost certainly be required as demonstration systems to ensure that the rail network can be progressively changed over to a more economical train control regime. A more economical rail industry will be able to compete with road with a view to minimise total investment in both modes to the benefit of the Australian economy as a whole. A harmonised access requirement allows equity to prevail in the equipment manufacture market. It also helps place rail in a position where as an industry it can survive and be in a position to be developed further in the future in the case of significant change in relative fuel costs.

9. Conclusion

Train control and communications systems are significant obstacles to access to the interstate rail network. The Federal Government needs to take the lead in the reform agenda and facilitate harmonisation. This will provide simplified and equitable access to all potential operators enhancing competition and providing benefit to the Australian economy.

10. Notes:

1. This has been pointed out also in:

Study of Rail Standards and Operational Requirements
Australian Transport Council
Maunsell Pty Ltd
February 1998

2. See: Bureau of Transport and Communications Economics
Adequacy of transport infrastructure- Rail
Working Paper 14.2,
December 1994