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Establish a generic railway electronic interlocking solution using software engineering methods

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ABSTRACT

A research investigation has been undertaken to establish a generic software interlocking solution for electronic railway systems. The system is intended to be independent of the physical station layout and easily adaptable in any country of application. Railway signalling principles and regulated safety standards are incorporated into the system design. A literature review has been performed to investigate existing interlocking methods and to identify common aspects amongst these methods. Existing methods for the development of electronic interlocking systems are evaluated. The application of software engineering techniques to interlocking systems is also considered. Thereafter a model of the generic solution is provided. The solution is designed following an agile life cycle development process. The structure of the interlocking is based on an MVC (Model-View-Controller) architecture which provides a modular foundation upon which the system is developed. The interlocking system is modelled using Boolean interlocking functions and UML (Unified Modelling Language) statecharts. Statecharts are used to graphically represent the procedures of interlocking operations. The Boolean interlocking functions and statechart models collectively represent a proof of concept for a generic interlocking software solution. The theoretical system models are used to simulate the interlocking software in TIA (Totally Integrated Automation) Portal. The behaviour of the interlocking during element faults and safety–critical events is validated through graphical software simulations. Test cases are derived based on software engineering test techniques to validate the behaviour and completeness of the software.

The software simulations indicate that the general algorithms defined for the system model can easily be determined for a specific station layout. The model is not dependent on the physical signalling elements. The generic algorithms defined for determining the availability of the signalling element types and the standard interlocking functions are easily adaptable to a physical layout. The generic solution encompasses interlocking principles and rail safety standards which enables the interlocking to respond in a fail-safe manner during hazardous events. The incorporation of formal software engineering methods assists in guaranteeing the safety of the system as safety components are built into the system at various stages. The use of development life cycle models and design patterns supports the development of a modular and flexible system architecture. This allows new additions or amendments to easily be incorporated into the system. The application of software engineering techniques assists in developing a generic maintainable interlocking solution for railways.