Chapter 55

Μίνθα: A Framework for Auto-Programming and Testing of Railway Controllers for Varying Clients

Jörn Guy Süß
University of Queensland, Australia

David Carrington
University of Queensland, Australia

Neil Robinson
RGB Assurance, Australia

Paul Strooper
University of Queensland, Australia

ABSTRACT

Implementation of railway controller application logic is a highly safety-critical and time-consuming task carried out individually for each client and station by specialised signalling engineers, with corresponding high costs. Μίνθα is a software development framework designed to create code generators for application logic for the client railway companies of Ansaldo STS that use the Microlok II controller to lower the cost and increase repeatability. This chapter describes the evolution of Μίνθα from prototype to framework, and introduces the software engineering approaches of object-oriented meta-modelling and framework development along the way. It also presents known limitations and further application areas of the framework.

INTRODUCTION

Many advances in the development of rail technology have been accompanied by an increase in risk to the passenger. Shared track use meant an increased number of trains, but carried the risk of rear collisions; points brought an increase in route flexibility, but at the cost of potential derailment and head-on collisions; higher train speeds allow passengers to travel faster than small planes, and metro rail trains accelerate and decelerate in shortest distances, but these types of trains cannot be driven by sight alone any more. Each increase in risk has been managed by signalling engineers through the introduction of corresponding increasingly sophisticated control machinery. The safe conduct of today's rail traffic relies on computer-based interlocking controllers. The programs that these controllers execute reflect the whole complexity scope of signal engineering.

DOI: 10.4018/978-1-4666-4301-7.ch055

Since interlocking controllers are specialised computer devices, the creation of application logic for these controllers is essentially a software-programming task. The professional discipline that examines and develops methods and tools for the production of software is software engineering. The Mint project is a software engineering project that investigates the process of writing interlocking controller logic to suggest ways to improve the process. The Mint project applies three software engineering techniques to deal with the complexity of the domain: object-oriented modelling to capture and describe the artefacts and terminology of signal engineering, feature modelling to describe the varying aspects among different clients, and framework development to reduce the cost of construction by providing a common infrastructure.

This chapter introduces the software engineering approach of the Mint project in detail to show how it derives client-specific tools that automate the process of generating controller application logic as far as safely possible.

BACKGROUND

The Mint project is a joint project of Ansaldo STS and The University of Queensland. In the following section, we introduce Ansaldo and its business requirements. After that, we turn to Ansaldo's Microlok system that forms the target platform of the Mint project, and describe its functionality in detail.

Ansaldo STS: International Railway Engineering

Ansaldo STS is a global railway engineering service provider that specializes in automation and turnkey delivery of passenger and freight rail systems. Ansaldo STS was created through a merger between Union Switch and Signal and Ansaldo Trasporti Sistemi Ferroviari, and US-American and European technologies determine its offerings. In 2009, Ansaldo STS achieved revenue of €1.176 billion and an operating income of €125.0 million, with 4,340 employees worldwide. Ansaldo's clients vary considerably by their operational objectives and implementation of railway principles. Clients range from metropolitan rail operators to mining rails, and stock spans from electrified high-speed locos to double-traction diesels. Communication may be by coded track, radio, or GSM-R; signals may be physical installations at trackside, or console indicators in the driver's cabin. Ansaldo's task is to manage these variations to provide safe signalling systems that respect the clients' existing customs and requirements.

The Microlok System

One of Ansaldo's most successful products is the system of Microlok integrated controllers, designed by Union Switch and Signal. Before the arrival of the Microlok system, signalling controllers were usually custom-built devices that were programmed in machine language. The Microlok I controller introduced a language that signalling engineers found easy to adopt, because it modelled the wiring logic of the relay grids that they were familiar with. The Microlok II controller expanded the approach by applying the principle of the IBM personal computer to the signalling system: a Microlok system consists of a powered case that holds a central-processing unit and several interface cards on separate plug-in boards that connect to the CPU via a common bus. While the Microlok architecture was designed to serve as a platform for vital controllers, the standardisation also allowed Ansaldo to build a non-vital controller as a parallel product to share the components.

The CPU of the Microlok II is built on the well-established and understood Motorola 68000 series of microprocessors. The bus between CPU