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Developing Curricula for Signaling and Communication Course at Malaysian Railway Academy (MyRa) through Industrial Collaboration Program

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Abstract*: This paper presents the propose development of railway signaling and communication curricula at MyRA. The program commenced on 2016 under Industrial Collaboration Program (ICP) with Technology Depository Agency coordination. Thales Portugal provides the laboratory equipment and teaching module. There are three institutions and one railway operator company participate in the program. The program was conducted due to enhanced strong knowledge on railway signaling and communication among the Malaysian academicians. The universities will be able to develop bachelor and diploma railway programs and able to develop laboratories along with hi-tech railway equipment. The ICP railway signaling and communication, consist of four stages, started with basic Train The Trainer (TTT), advanced training, training installation equipment and training simulator. The trainees have gained a lot of experienced and expose to different kind of railway signaling system during the training. At the end of the program, a module of railway signaling and communication course with a lab railway signaling field equipment and CTC simulator were developed.

***Keywords:* Knowledge transfer program; railway signaling and communication; curricula; module and teaching aid simulator.**

I. INTRODUCTION

This program collaboration between Technology Depository Agency (TDA), Malaysian Railway Academy (MyRA) and Thales Portugal was set up to transfer the knowledge related to railway signaling and communication. This project objective is to transfer the curriculum of railway signaling and communication course and Thales Portugal CTC system simulator to the community partner MyRA, KTMB, Prasarana, UniKL, Politechnic, Komuniti College and KISMEC, then to train and transfer the knowledge about railway signaling and communication to lecturers, trainers, trainees and students. The ICP program was aimed to link the generated academic knowledge on railway signaling and communication of Thales Portugal to targeted community or group as part of commitment to knowledge transfer and sharing [1].

The work presented in this paper focused on developing the related railway signaling and communication course at MyRA and also considers the possibility of producing a CTC system teaching aid simulator laboratory with three field equipments of point machine, signal aspect and axle counter.

The CTC system teaching aid simulator provides hardware CTC1000 Cabinet, PIPC G2 Platform Cabinet 1 and Cabinet 2, Interface Cabinet, field equipment such as point machine Thales L826H, point machine Siemen SIMAX S700KM, ELECTRANS LD-160P three aspect LED signal, EAK ISDN Interface and axle counter, CTC network, PIPC network, CTC workstation, operator workstations and maintenance workstation. Meanwhile, application software includes “Interlocking Module Emule” Simenv for operation simulation of track layout, Simulated Configuration Platform for live interlocking, Logger Interlocking Module for interlocking log files, Maintenance View for commands, Boite a Button for activate, de-activate, verify status input and output interlocking, SIMENV Configuration, KOMIX for simulate several train movement, Limpa-TS for clear section. The demonstration system will be provided with manual handbook and course notes slide presentation on CTC system integrated with field equipment.

II. RELATED WORK

Malaysia government had invested at about RM 160 billion for future rail projects until 2020 in order to fulfilling practical public transportation needs. Rail transportation today is high technology, complex and sophisticated that requires support from all stakeholders in rail industry. There are gaps with regards to local capabilities and capacity to support rail operations.

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The capabilities as defined in the rail industry segmentation will be involving design development, manufacturing, integration, assembly, operation and MRO (Maintenance, Repair and Overhaul) of rail systems. Even though, Malaysia rail transport has existed for more than 100 years and currently employing more than 12,500 workers.

There are no rail courses available in Malaysia, high dependency on foreign OEMs, lack of component makers and lack of capable integrators development. Local rail industry is in dire straits, unless prompt action is taken to mitigate and arrest the situation. The rail industry is facing human capital competency issues such as insufficient multi-skilled workforce especially in specialized technical areas. Strategy to resolve human capital development issues for Malaysia rail industry has started and planned since 2015. Firstly, establish RCOE (Railway Centre of Excellence) to deliver rail-ready professionals based on the demand of the industry, offering generic technical training programs for blue collar tradesmen, bridging programs for graduate engineers and short courses for upgrading of current workforce. Secondly, incorporate rail engineering modules or subjects into institute of higher learning diploma and degree programs. Finally, promote awareness and public interest on rail industry to increase its attractiveness.

TUNRail (Tuning Transatlantic Cooperation in Rail Higher Education) has stated that current education didn't seem to meet with all the priorities expected by the railway industry. This study was conducted between September, 2009 and August, 2011 on the demand and availability of rail higher education in the European Union and the United States [2]. It seems that this issue has also faced by Malaysia railway.

Railway academic programs rapidly grew in Malaysia public and private universities. This trend was the implication of world awareness on railway with huge investment for public transportation. Brazil railway industry for instance, has been developed progressively because of new investment given by the Brazil government. Indirectly, railway education programs were also developed. University of Santa Catarina Brazil, develop technical training into four categories that are vehicle design, operation, maintenance and train & metro management [3].

The basic practical knowledge is not delivered solely through teaching module with dozens of theoretical knowledge. Hence, educational training kit will help in practical knowledge and introduce a better way to educate trainees understanding [4].

Universities usually developed their own training equipment to support academic program funded from university and government grant. They will be gaining experience from the research, developed skill staff and create innovative training equipment [5]. However, rail operator's company in Malaysia received their training equipment under OFFSETS program from OEM main contractor that has won the government tender. Usually, the training equipment will be customized as per requirement in the contract [6].

III. METHODOLOGY

This project was implemented through several phases, comprising of:

1. Selection 19 technical and academic staff of MyRA, KTMB, Prasarana, UniKL, Politeknik, Komuniti College and KISMEC with background in engineering;
2. Training basic railway signalling and communication at MyRA for 1 month by Thales Portugal;
3. Selection 12 technical and academic staff after evaluation on performance test assessment and presentation;
4. Training advance railway signalling and communication at Thales Portugal Headquarters for 4 months by Thales Portugal;
5. Two workshops to fine tune on curriculum of railway signalling and communication course by 12 selected participants;
6. Training installation railway signalling equipment and CTC system;
7. Final fine tuning workshop and printing of teaching module.

The program was initially facilitated through a formalised project plan as part of ICP model in which 19 participants from rail operator and tertiary educational institution having theoretical and technical background in railway signalling and communication were selected. Selection for 12 participants to undergo advance signalling and communication training at Lisbon, Portugal based on course assessment and presentation. The training in Portugal were intensive consist of teaching pedagogy, practical approach, site visits and preparation teaching module. Then, a training workshop was conducted to build the capacity of team members of the program in relation to information of basic and advance railway signalling and communication and program execution plan. Next, Two workshops were conducted to develop and harmonise curricula of railway signalling and communication course. Finally, one more workshops conducted to install equipment and CTC system simulator at Myra Batu Gajah, Perak. TDA, Thales, KTMB and MyRA selected staff had agreed to construct and design a CTC system teaching aid simulator laboratory which implements the RCOE system architecture concept as shown in Fig. 1.

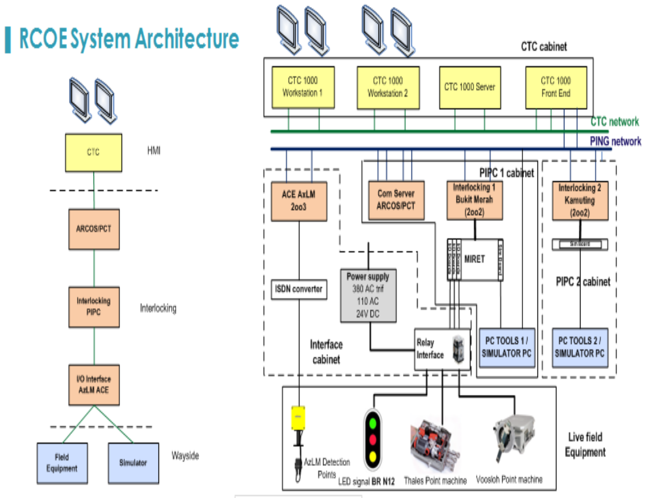
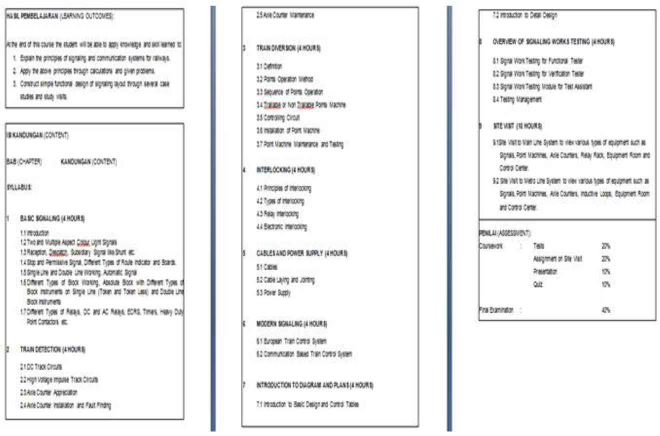


Fig. 1 The design for a CTC system simulator with live field equipment

IV. RESULT AND DISCUSSION

Through a series of trainings, workshops and discussion conducted, a module named railway signalling and communication was developed, consisting of two differentiate areas that are railway signalling and railway communication. Under railway signalling teaching module as shown in Fig. 2, consist of 9 chapters: 1. Basic Signalling; 2. Train Detection; 3. Train Diversion; 4. Interlocking; 5. Cables and Power Supply; 6. Modern Signalling; 7. Introduction to Diagram and Plans; 8. Overview of Signalling Works Testing; 9. Site Visit. Under railway communication teaching module, consist of 12 chapters: 1. Railway Communication System Components and Technologies; 2. BTS - Telecommunication Principles; 3. BTS - Communication Technologies; 4. BTS - Ethernet and Networks; 5. Telephone Networks; 6. Close Circuit Television (CCTV); 7. Public Address and Voice Announcement System (PAVAS); 8. Radio System and Wireless System; 9. Passenger Information System; 10. SCADA system; 11. Demonstration and Practical for BTS; 12. Demonstration and Practical for Integrated PA, PIDS and TEL system; as a reference to the professional course that will be conducted.



HASIL PEMBELAJARAN (LEARNING OUTCOMES):

At the end of this course the student will be able to apply knowledge and skill learned to:
1. Explain the principles of signaling and communication systems for railways.
2. Apply the above principles through calculations and given problems.
3. Construct simple functional design of signaling layout through several case studies and study visits.

ISI KANDUNGAN (CONTENT)

BAB (CHAPTER) KANDUNGAN (CONTENT)

SYLLABUS:

1 BASIC SIGNALING (4 HOURS)
1.1 Introduction
1.2 Two and Multiple Aspect Colour Light Signals
1.3 Reception, Departure, Subsidiary Signal like Shunt etc.
1.4 Stop and Permissive Signal, Different Types of Route Indicator and Boards
1.5 Single Line and Double Line Working, Automatic Signal
1.6 Different Types of Block Working, Absolute Block with Different Types of Block Instruments on Single Line (Token and Token Less) and Double Line Block Instruments
1.7 Different Types of Relays, DC and AC Relays, ECRS, Timers, Heavy Duty Point Contactors etc.

2 TRAIN DETECTION (4 HOURS)
2.1 DC Track Circuits
2.2 High Voltage Impulse Track Circuits
2.3 Axle Counter Appreciation
2.4 Axle Counter Installation and Fault Finding
2.5 Axle Counter Maintenance

3 TRAIN DIVERSION (4 HOURS)
3.1 Definition
3.2 Points Operation Method
3.3 Sequence of Points Operation
3.4 Trailable or Non Trailable Points Machine
3.5 Controlling Circuit
3.6 Installation of Point Machine
3.7 Point Machine Maintenance and Testing

4 INTERLOCKING (4 HOURS)
4.1 Principles of Interlocking
4.2 Types of Interlocking
4.3 Relay Interlocking
4.4 Electronic Interlocking

5 CABLES AND POWER SUPPLY (4 HOURS)
5.1 Cables
5.2 Cable Laying and Jointing
5.3 Power Supply

6 MODERN SIGNALING (4 HOURS)
6.1 European Train Control System
6.2 Communication Based Train Control System

7 INTRODUCTION TO DIAGRAM AND PLANS (4 HOURS)
7.1 Introduction to Basic Design and Control Tables
7.2 Introduction to Detail Design

8 OVERVIEW OF SIGNALING WORKS TESTING (4 HOURS)
8.1 Signal Work Testing for Functional Tester
8.2 Signal Work Testing for Verification Tester
8.3 Signal Work Testing Module for Test Assistant
8.4 Testing Management

9 SITE VISIT (10 HOURS)
9.1 Site Visit to Main Line System to view various types of equipment such as Signals, Point Machines, Axle Counters, Relay Rack, Equipment Room and Control Center.
9.2 Site Visit to Metro Line System to view various types of equipment such as Signals, Point Machines, Axle Counters, Inductive Loops, Equipment Room and Control Center.

PENILAIAN (ASSESSMENT):

Coursework	:	Tests	20%
		Assignment on Site Visit	20%
		Presentation	10%
		Quiz	10%
Final Examination	:		40%

Fig. 2 Railway signaling teaching module

Then, a teaching aid simulator based on the model of a CTC system was constructed, with additional hardware representing field equipment sources, which can be controlled by interlocking system.

V. HARDWARE MODULE OF PROPOSED SIGNALING AND COMMUNICATION RAILWAY LAB SYSTEM

A. Cabinet Room and Field Equipment and Operation Room Design Model

A laboratory with well design as shown in Fig. 3 and Fig. 4, are divided into two zone, 1. Cabinet Room, and 2. Field Equipment and Operation Room. A raise or lift floor was installed into the whole room. Cabinet room was to locate cabinet rack which equip with CTC1000 cabinet, PIPC G2 cabinet 1, PIPC G2 cabinet 2 and Interface cabinet. Mean while, field equipment and operation room consist of CTC1000 workstation1, CTC1000 workstation2, PC Tools 1 Kamunting Simulator, PC Tools 2 Bukit Merah Simulator, PC Comm server, point machine Thales L826H, point machine Siemen SIMAX S700KM, ELECTRANS LD-160P three aspect LED signal, EAK ISDN Interface and axle counter.

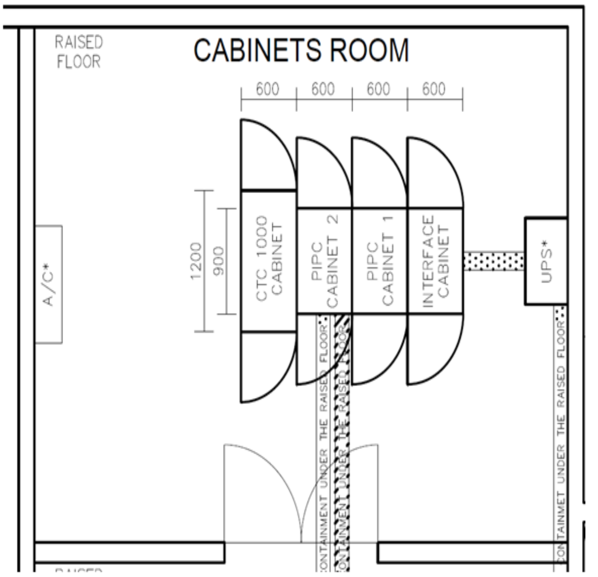


Fig. 3 Design model for cabinet room

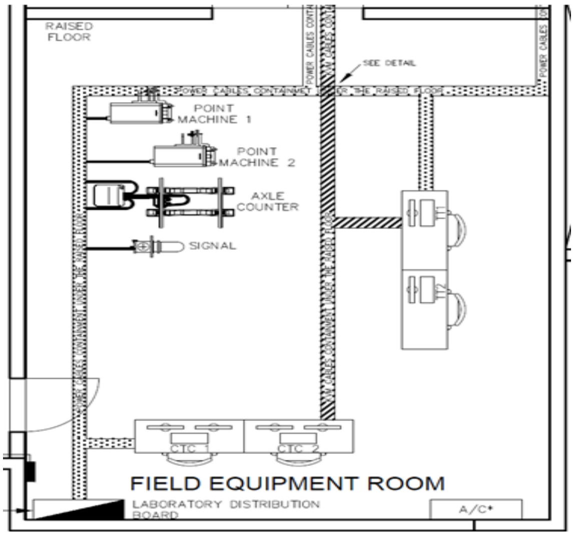


Fig. 4 Design model for field equipment and operation room

B. Actual Cabinet Room

Fig. 5 shows the organize structure of the cabinets. Starting from left are Interface Cabinet, PIPC1 Cabinet for Bukit Merah Station, PIPC2 Cabinet for Kamunting Station and CTC 1000 Cabinet.

Fig. 5 Actual hardware cabinets in cabinet room

C. Actual Field Equipment and Operation Room

Fig. 6 shows two monitors displayed track layout images in synoptic view represent for Kamunting Station and Bukit Merah Station at workstation 1. There were two sets of workstations installed in the lab, workstation 1 and workstation 2. These were planned purposely to show segmentation of an administrator control and an operator control.

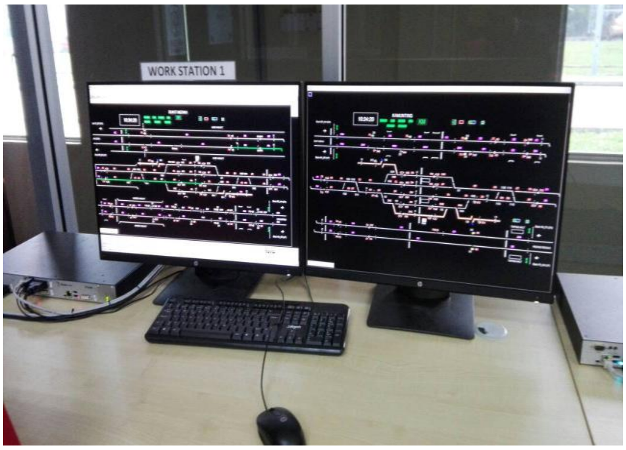


Fig. 6 Work Station 1

Fig. 7 shows a monitor represents for Bukit Merah Simulator/TT, a monitor represent Comm Server and another monitor represents Kamunting Simulator/TT. TT means Technical Terminal. Usually these monitors were use for maintenance and simulation activities. Comm Server is for network gateway computer server.

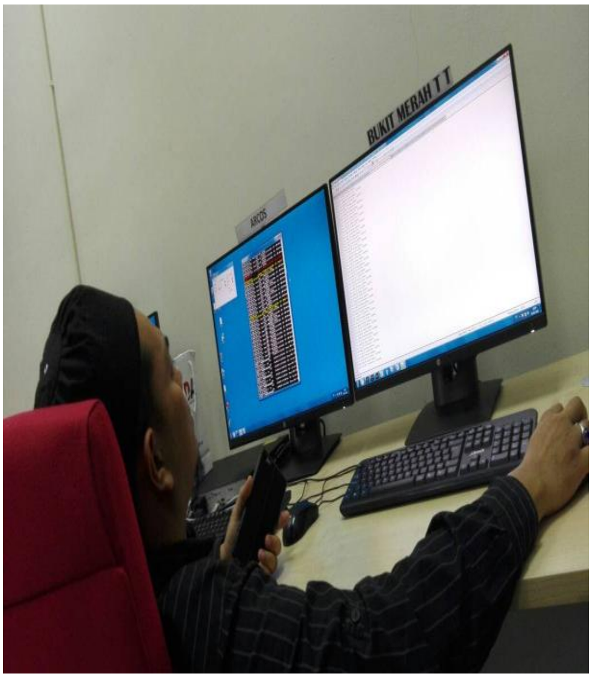


Fig. 7 Bukit Merah Simulator/TT

Fig. 8 shows two different point machine installed in the lab. Thales new point machine L826H is a non-trailable version. Another point machine is SIMAX S700KM from Siemen that has been used by KTMB.

Fig. 8 Point machine Siemen SIMAX S700KM and Thales L826H

Fig. 9 shows an axle counter with 1 set module sweeper and calibration tool briefcase provided by Thales.

Fig. 9 Thales Axle counter with sweeper

Fig. 10 shows a three aspect LED Signal branded ELECTRANS LD-160P.

Fig. 10 ELECTRANS LD-160P three aspect LED signal

VI. COMPONENTS OF PROPOSED APPLICATION

A. SIMENV (Simulator Application)

Fig. 11 shows an application SIMENV installed in PC Tools at Bukit Merah Simulator/TT and Kamunting Simulator/TT.

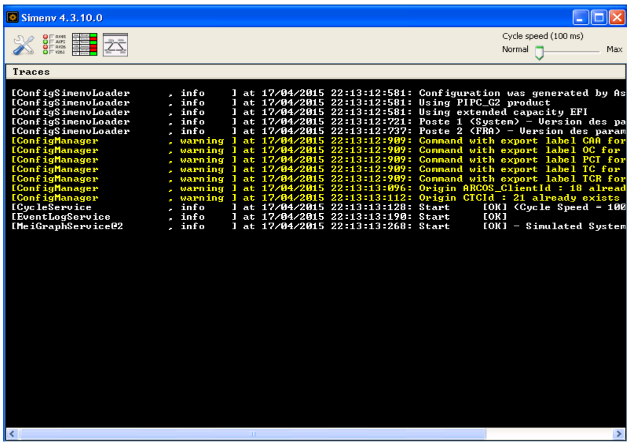


Fig. 11 SIMENV application

Fig.12 shows SIMENV Configuration menu that have the ability to select possible simulation configurations on platform such as full simulation, partial simulation configuration 1 and partial simulation configuration 2.

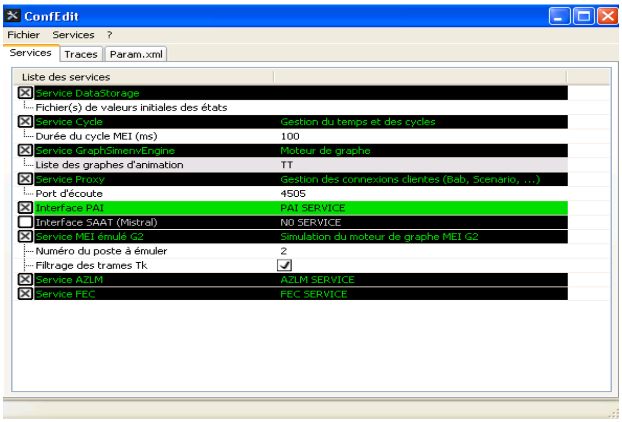


Fig. 12 SIMENV configuration

Full simulation means live interlocking system (CTC, TT, Comm Server, Interlocking Module), simulation on 1 signal and 2 point machines and simulation on axle counter using one of the simulator PC (SIMENV) as shown in Fig. 13.

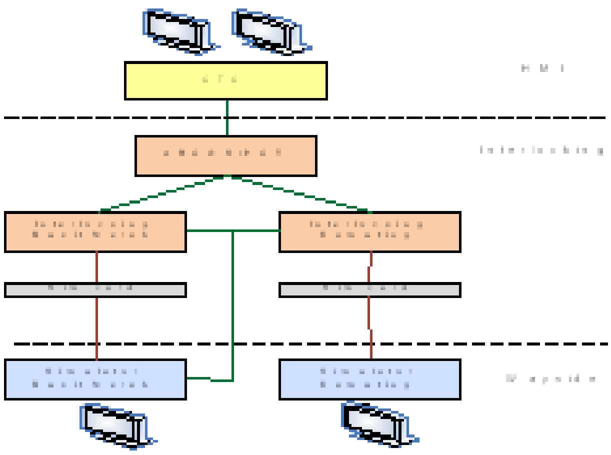


Fig. 13 Full Simulation System

Partial simulation configuration 1 means live interlocking at Bukit Merah platform for 1 signal and 2 point machines. Simulation interlocking at Bukit Merah platform for remaining field equipments. Simulation interlocking at Kamunting platform for all equipments. Simulation axle counter for section using one of the Simulator PC (SIMENV) as shown in Fig. 14.

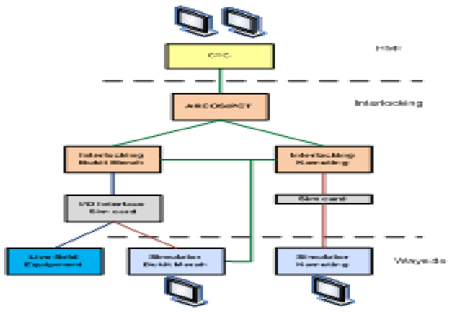


Fig. 14 Partial Simulation Configuration 1 System

Partial Simulation Configuration 2 means live interlocking at Bukit Merah platform for detection point, 1 signal and 2 point machines. Simulation interlocking at Bukit Merah platform for remaining field equipments. Simulation interlocking at Kamunting platform for all field equipments as shown in Fig. 15.

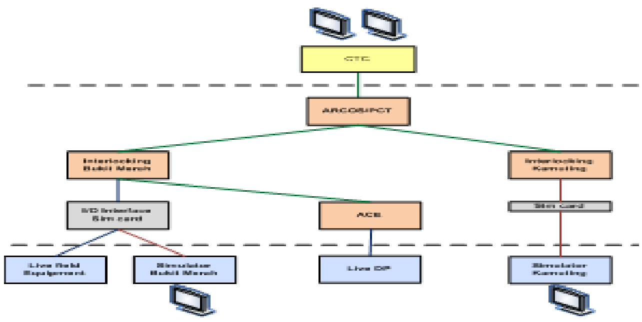


Fig. 15 Partial Simulation Configuration 2 System

B. Logger Interlocking Module Application

Fig. 16 shows an application for interlocking log files that stored in simulator computer.

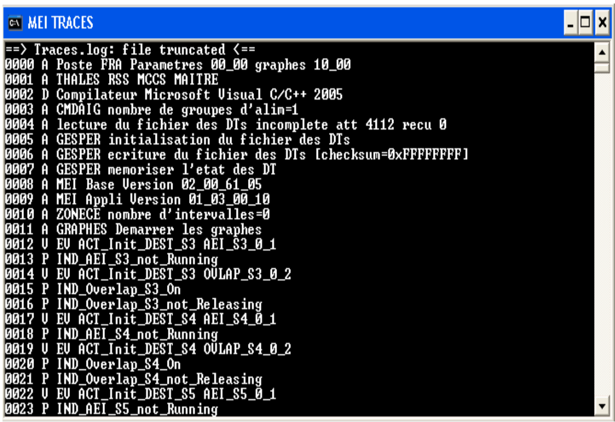


Fig. 16 Logger Interlocking Module application

C. Boite A Button Application

Fig. 17 shows an application Boite a Button control activation and deactivation of PIPC interlocking Inputs. It can also verify status of PIPC interlocking outputs.

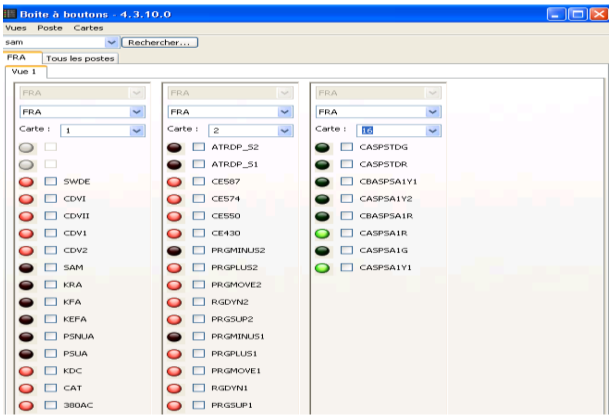


Fig. 17 Boite A Button application

D. Maintenance View Application

Fig. 18 shows an application for Maintenance View. The function of this menu is for submitting command to simulation interlocking.

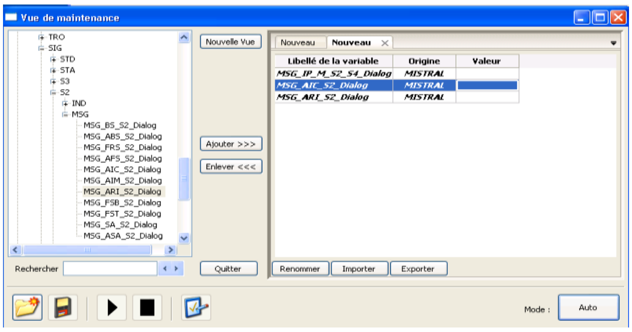


Fig. 18 Maintenance View to submit command

Fig. 19 shows the function of this menu to verify Interlocking Module variables state true or false at simulation interlocking.

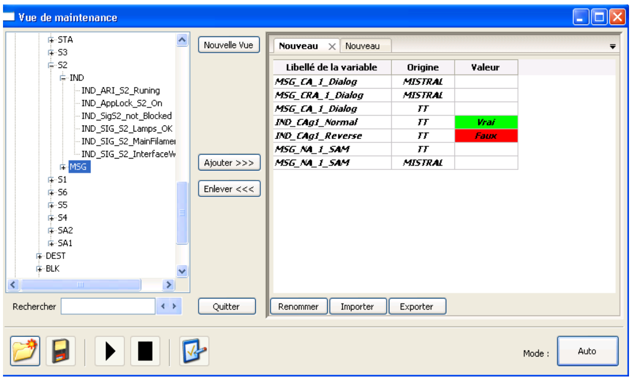


Fig. 19 Maintenance View to verify Interlocking Module variables

E. KOMIX Application

Fig. 20 shows an application of KOMIX. KOMIX is an application that allows the user to simulate several train movement at the same time. It will run train automatically starting from the berth section according signal clear and route set. It can also occupy or clear any section and control train simulation speed factor.

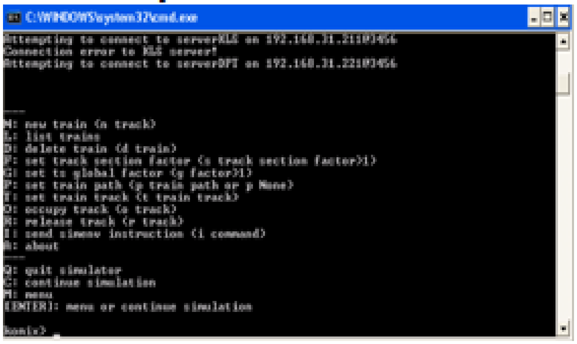


Fig. 20 KOMIX application console

VII. CONCLUSION

Through Railway Signaling and Communication module, trainees are able to gain appropriate knowledge on railway signaling principles, railway communication technology, develop positive attitudes towards railway safety management and provide them with the opportunity to study on reliability, availability, maintainability and safety. The installation of signaling and communication equipment in the laboratory with Thales railway signaling engineer will help trainees understand more on the practical side of railway signaling and communication system.

The future plans of this knowledge transfer program are to expand the knowledge related on railway signaling and communication to other interested higher education institutes, and to develop more teaching aids related to the course in order to assist teaching, learning and understanding. The laboratory model can further be improved and extended by adding more resources on Automated Fare Collection (AFC), Data Communication System and Train Simulator Model. Meanwhile, a proposed to supply a full simulation environment in a single pc in the simulator can be an added advantage if future contract with Thales occur.

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Hasry Harun obtained his Bachelor of Engineering in Mechanical Engineering from University of Birmingham City, United Kingdom. He works as a Director at Technology Depository Agency Berhad for 8 years already. He had conducted many ICP program in railway development in Malaysia,