

Conestoga College

Institute of Technology and Advanced Learning

Document Title CAN (Controller Area Network) Diagnostics Design (CDD)
Project Charter

Revision 1.5

Date Issued May 6, 2019

Date Effective May 6, 2019

Department School of Engineering and Information Technology

Program Integrated Telecommunication and Computer Technologies

Audience ITCT Semester 6 Students

Author Semester 6 Team

Reviewers

Michael A. Galle, Professor

Ali Tehrani, Professor

Monzur Kabir, Professor

Jack Cole, Professor

Revision History

Revision	Description of Change	Effective Date
0.1	Charter of year 2014 version 1.0 with dates changed for 2015 delivery - MK	May 11, 2015
1.0	Published for the students - MK	May 11, 2015
1.1	Correction in page 4 and 7 to separate description of call-station panel from floor selection panel.	June 6, 2015
1.2	Charter of year 2015 version 1.1 with modifications for 2016 delivery - MG	May 9, 2016
1.3	Charter update to include new program changes - MG	May 8, 2017
1.4	Charter update	May 7, 2018
1.5	Charter updated to include project modifications	May 6, 2019

Table of Contents

CAN (Controller Area Network) Elevator	3
1. Academic Need	3
2. Deliverables	3
3. Project Description	4
4. Specific Requirements	7
5. Milestones and Schedules.....	9
6. Project Evaluation	10
7. Project Issues and Constraints.....	10
7.1. Risk	10
7.2. Constraints	10
7.3. Assumptions.....	11
7.4. Project Schedule (Tentative)	11
7.5. References	11

CAN (Controller Area Network) Elevator Diagnostics & Control Design Project

1. Academic Need

This project provides students with an opportunity to study and apply design principles for networked systems. They will also apply their Physics, Mathematics, and Software Engineering understanding.

Students will practice the implementation of industry-standard data networking and distributed computing, and enhance their abilities of system integration involving multidisciplinary knowledge and skills. They will also practice engineering safety procedures, and project management skills.

This project delivers learning outcomes as specified in the latest course-outline of Engineering Project VI (EECE73125).

2. Deliverables

The project is divided into 3 phases. The deliverables of these phases are listed below:

Phase-1: (4 Weeks)

1. Design of a CAN messaging protocol that is common amongst all groups
2. A plan of CAN node configuration that is common amongst all groups
3. Fully functioning CAN network involving a variety of controlling and controlled devices and more than two CAN-nodes
4. Test plan and results

Phase-2: (7 Weeks)

5. An accessible (read/write) data repository
6. User interface for remote control
7. An internet based remote access system to monitor and control an industrial system

Phase-3: (3 Weeks)

8. Investigation into a number of techniques for connectivity between the industrial data network and the Internet
9. Complete fully functioning CAN diagnostic system
10. Oral presentation of final project
11. Final project report

All Phases

12. Project plan, weekly status report, meeting minutes, and engineering logbook

3. Project Description

The overall project plan (to be completed in 3 phases) is to build and control an elevator, leveraging the use of a CAN bus communications environment, coupled with networked systems to create a means of tracking the elevator's operational/diagnostics data. The elevator car's position and status must also be viewable to computers over the Internet. See the system diagram, below.

The **final project demonstration** begins with the elevator car at an initial position. As buttons are pressed at each floor, the system will direct the car to service the requests. The system will use a distance sensor to track the car position at all times, determining the distance from the bottom of the elevator shaft, and thus determine the next floor number. Buttons presses will be handled over the CAN bus.

In the first phase of the project, application of the above mentioned concepts and skills is demonstrated through the specification, design, programming, and testing of an embedded controller for low-level communications between buttons, displays, and sensors (implemented via hardware available in our lab). This controller will communicate with the sensors and call buttons using the CAN bus (see Figure-1).

Each call station (Floor controller) will consist of

- Buttons and LEDs to indicate the selection
- A display panel, which will show the elevator car's present position

There will be another controller (Elevator controller) for:

- Floor selection buttons and an LED for each button, and
- Two buttons for door-open and door-close and with associated LEDs.

The distance sensor will be interfaced directly to the controller to provide a distance estimate, which can be displayed on an LCD or 7-segment LED display and ultimately used for positional feedback.

The elevator **motor** will interface with the controller via servo electronics.

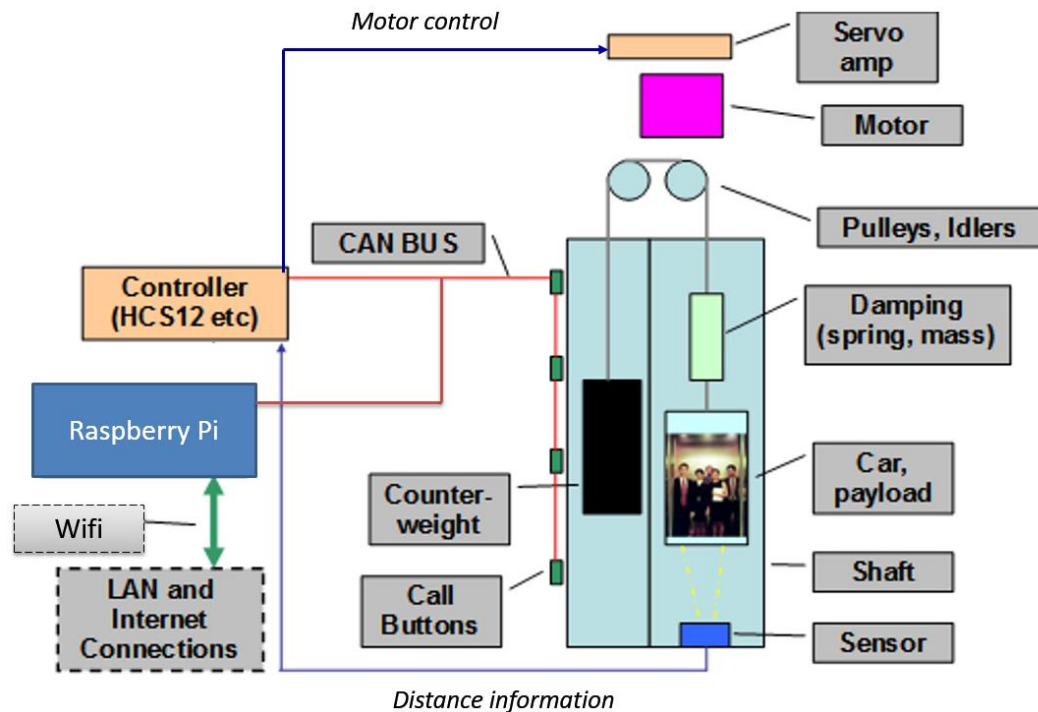


Figure-1

(Note: Above figure depicts an approximate schematic of the system. Actual implementation may be different from this.)

The minimal project (in **Phase 1**) is a CAN network consisting of the controller, the call stations, the distance sensor, and LCD/7 Segment display. Extra credit projects will extend both the hardware design and the software capabilities to include additional functionality; however, these must be approved by the faculty team prior to embarking on extra credit work. Examples of possible extensions include a passenger on/off detection and counter system to enable the tracking of elevator utilization, or a security camera control system.

In **Phase 2**, the elevator controller will also interface to a PC on a Local Area Network (LAN), and thence to the Internet (see Figure-2). Each group will make its own decision on what type of CAN-LAN interface it wants to implement. Events from the elevator's operation will be logged to a computer on the LAN (called the Elevator Monitor or EM), which will contain software designed, programmed and tested by the student group. This latter software will consist of two parts:

1. **A data server** which will monitor and store data from the controller/CAN network, and
2. **A diagnostics display program** that will collect and display this data on the elevator module or at any other PC connected by a LAN interface to the elevator module.

An aspect of elevator control (such as shutting the elevator down completely, or requesting the elevator via a phone app rather than the floor button) will be included.

Finally, in Phase 2, software will be developed to retrieve elevator status information from the elevator module, over an Internet connection.

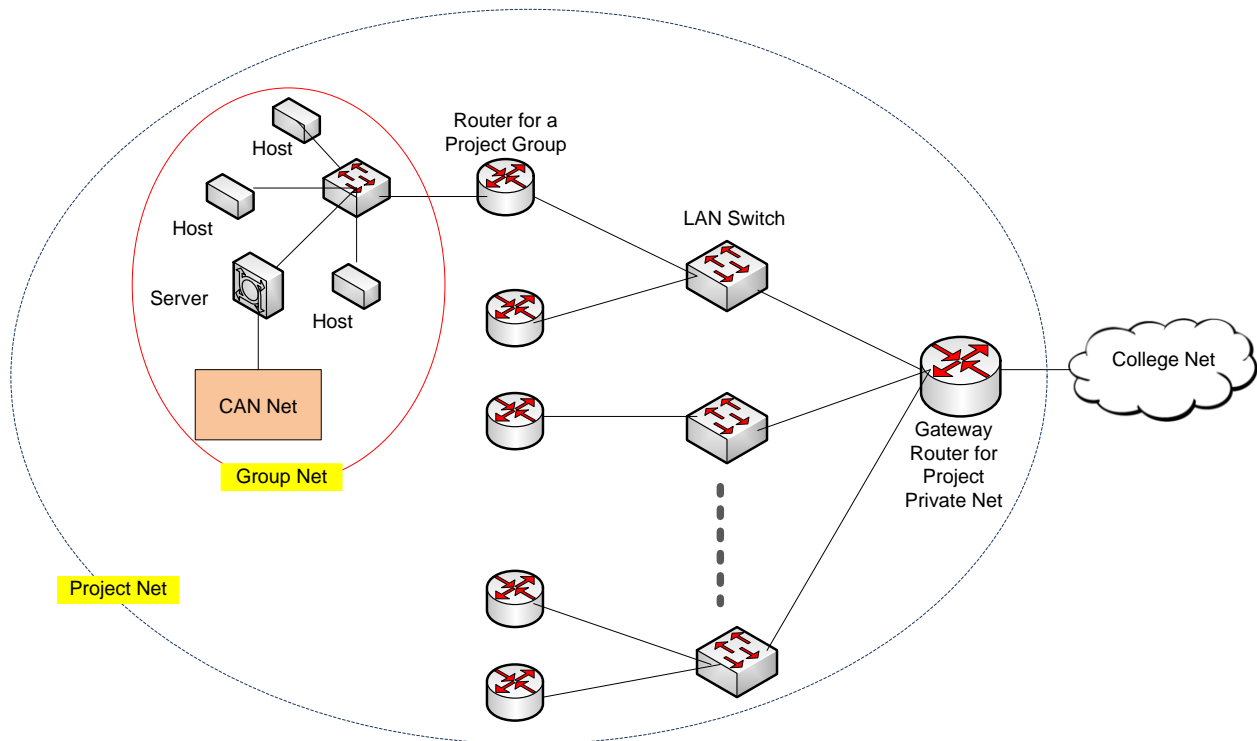


Figure-2

(Note: Above figure depicts an approximate schematic of the system. Actual implementation may be different from this.)

In **Phase 3** the two modules (developed in phases 1 and 2) will be *integrated* to complete the system. This phase also encourages each student group to incorporate features that are not specifically stated in this charter document. This phase includes a final demonstration, oral presentation and report.

Students will work in groups of three or four students (if applicable).

4. Specific Requirements

This project will meet the following criteria (requirements are identified as **Must**, **Should**, **Could** or **Won't**):

MUSTs

Phase 1 (4 Weeks)

1. The **elevator system** will cover at least *three floors*, with **one CAN node per floor**. Each node will have *up/down switches and lights*
2. The **elevator car will have a node** with *door open/close switches & lights, floor-selection switches & lights, and LCD/7-segment display* for displaying current location of the elevator.
3. A **controller CAN node** (already installed in the elevator) will perform the following tasks:
 - Detect the *location of the elevator car* (with the distance sensor) and distribute this information to all call-stations for displaying on LCD/7-segment display.
 - Detect up/down request at any floor and switch on the respective LED
 - Detect floor selection at any floor and switch on the respective LED
 - Detect door open/close request at any floor and switch on the respective LED
4. Students will design and implement a **CAN messaging protocol**

Note: student groups are not required to implement the actual elevator car operation in this phase. However, they need to move the elevator car up and down manually in order to test distance sensor operation.

It is recommended that you start to think about how you will implement the elevator operation logic as a finite state machine at this stage (see stage-3)

Phase 2 (7 Weeks)

5. Develop a **user interface** (may be web-based) for a **logging & control PC**, which will:
 - Implement a *repository to log all the information the CAN nodes display on their LCD/7-segment display*, and a program for data logging and retrieval.
 - Display *diagnostics reports* (all the information the CAN nodes display on their LCD/7-segment display).
 - Provide *user action buttons/icons* to send commands to CAN-based elevator system in order to control the elevator operation and/or collect system diagnostic data.

(Note: student groups are not required to implement any communication between the logging and control PC and CAN-system at this stage. This interface will be implemented in phase-3. However, it is highly recommended that groups work ahead)

6. Develop a **server program** on the **logging & control PC** to provide data from the repository upon request from a PC on the Internet but **only to authorized users**.
7. Write a **client program** on the networked PC's (may be web based) that can access the data **server** (in logging & control PC) and display diagnostics report. (E.g. This may be implemented as a web site, accessible through a browser interface.).

Phase 3 (3 Weeks)

1. Research on ways to **connect the CAN network with internet** and select one from the options.
2. Implement a **CAN node** to *interface* with the **Logging & Control PC** to establish PC-CAN communication and diagnostic data logging into the data repository.
3. Develop a **finite state machine** for the *elevator operation logic*, and implement it accordingly. (Students are advised to start working on this as early as possible).
4. Demonstrate the fully functional integrated system
5. Give an oral presentation and final report

For All Phases

6. Practice safety procedures
7. Practice project management, teamwork, and professionalism
8. Create an appropriate test plan and document test results
9. Create appropriate design documentation
10. Maintain engineering logbook

SHOULDs

11. Include maximum hardware aids for debugging including test points, LEDs, start/stop switches, analog input knob
12. Provide for future reuse of software and hardware in subsequent projects of the term

COULDs

13. Announce the next floor as it approaches (from the elevator module).
14. New features for the elevator operation (to be considered above and beyond).

5. Milestones and Schedules

- Project Start Date: **May 6, 2019**. Project End Date: **August 9, 2019**
- This document listed the milestones for each phase in Section-3 (MoSCoW list). The schedule for each phase is given in the following table.

Deadline	Milestone Deliverable
Beginning of Week 5	• All the tasks for Phase-1
Beginning of Week 12	• All the tasks for Phase-2
End of Week 14	• All the tasks for Phase-3

- Each student-group is responsible for developing a **project plan** and weekly schedule for each phase by the end of first week of that phase. The project-plan will break down the tasks of each phase into weekly tasks.
- Each week a student-group will complete its weekly tasks as indicated in the project plan, and will **write in their engineering log book, produce a project status report, appropriate test-plan and document test results**.
- There will be a weekly briefing to provide more specific information. Some of the briefing session will be used to provide students with additional knowledge and information, which may be required for the project but not adequately covered earlier.

6. Project Evaluation

- Students' **project plan** for each phase will be evaluated at the beginning of the second week of that phase.
- Students' **project work will be evaluated weekly**. Approved project plan will be the basis of the weekly evaluation. Demonstration, engineering log, project status report, appropriate test-plan and documented test results are examples of the items that will be considered during the evaluation. Safety practice and professionalism are also important aspects of the evaluation.
- At the **end of each phase** the work of each group will be evaluated on the basis of the specific requirement as stated in Section 4 (MoSCoW list).
- **Final report, final demonstration and final oral presentation** will be marked using evaluation-rubrics. The rubrics will be *made available to the students in advance*. External people may be invited as audience and/or evaluators.

Marks allocation:

- Marks allocation for each phase will be as per the distribution indicated in the course outline of the Engineering Project VI course. The mark for each phase is mostly for the overall group performance, however the evaluator reserves the right to allocate the marks on an individual basis if there is any significant imbalance between individual student's workload and achievements.
 - **Phase-1, 2:** about **80%** of the available marks will be for **technical achievements** and **20%** for **others** (project management, group dynamics, safety and professionalism)
 - **Phase-3:** about **50%** of the available marks will be for **technical achievements** including final demonstration, **25%** for **oral presentation** and **25%** for **final report**.
- The course outline also allocates some marks for individual performance. This mark will be based on the student's active participation, attitude, aspects of professionalism, and contribution to project. Individual student's performance will be observed throughout the project duration, and the mark will be assigned at the end of the project.

7. Project Issues and Constraints

7.1. Risk

- Some required knowledge might not be delivered (by the instructors) in a timely manner. This will be remedied as soon as it is detected.
- Any external factors that are beyond the control of the project team

7.2. Constraints

- This project shall be completed in 14 weeks.

- Each student group shall complete this project separately from other groups. While it is expected that students in a group would divide the workload each student requires understanding and to be able to explain other members' work.
- Copying of source code is not permitted unless the academic-term lead professor, or his representative, gives written permission.

7.3. Assumptions

- Each student will dedicate one hour of outside study time for each scheduled class hour.
- Each student will attend all scheduled classes, briefings and debriefings.
- Each student will make wise and efficient use of scheduled class time.
- Each student bench is equipped with the required computer and software.
- Each student bench is equipped with logic analysers and troubleshooting equipment.
- Failure to attend classes, or briefings, or debriefings, or to submit material according to given schedules may result in academic penalties at the discretion of the professor or academic team.

7.4. Project Schedule (Tentative)

See semester schedule for briefing and debriefing time.

7.5. References

- STM32 documentation
- PCAN USB/CAN documentation
- CodeWarrior documentation
- HCS12 documentation from Freescale Semiconductor
- Axeman Development board documentation
- Huang,H-W. The HCS12/9S12: An Introduction to Software and Hardware Interfacing. Thomson-Delmar, 2006. ISBN 1-4018-9812-2
- Alberto Leon-Garcia and Indra Widjaja. Communication Networks (2nd edition). McGraw-Hill
- Norman S. Nise. Control Systems Engineering (6th edition), John-Wiley Publishers
- Specification documents for various selected components

Appendix A – Graduate Attributes

Professional Body of Knowledge

KB	KB1	KB2	PA	PA1	PA2	PA3	IV	IV1	IV2	IV3	ED	ED1	ED2	ED3	ED4	ED5	ET	ET1	ET2	ET3	ET4
Knowledge base	Facts	Concepts	Problem analysis	Decomposition	Methodology	Validation	Investigation	Research	Measure	Experiment	Design	Problem Defn & Research	Preliminary Design	Detailed Design	Implementation	Verification & Validn	Use of engineering tools	Models/Simulations	Measurement Tools	Manufacturing Tools	CAD Systems
								A	A	D			A	A	A	A			A		

Employability Skills

TM	TM1	TM2	TM3	CM	CM1	CM2	PR	PR1	PR2	PR3	PR4	LL	LL1	LL2	LL3	LL4
Individual and team work	Personal Contribution	Collaboration	Infrastructure	Communication skills	Log Engineering Info	Convey Engineering Info	Professionalism	Work Ethic	Professional Conduct	Professional Contribution	Professional Practice	Life-long learning	Autonomous Learning	Applying Knowledge & Skills	Self Direction & Reflection (Metalearning)	Learning Strategies (Metacognition)
					A	A		A	A					A		

Professional Responsibility

SC	SC1	SC2	SC3	EE	EE1	PM	PM1	PM2	PM3	PM4	PM5
Impact on society and the environment	Environmental Awareness	Product Life Cycle	Balance & Tradeoff	Ethics and equity	Ethical Responsibility	Economics and project management	Project Scheduling	Resource Allocation & Costing	Risk Management	Business Planning	Economic Analysis
							A				

LEGEND		
I	Introduced	first experience/use
D	Developed	continued experience/use
A	Applied	integration/extension of knowledge & skills