Requirement List
Diagnosis of ADAPT system

Version 1.1

Author: Daniel Eriksson
Date: December 4, 2009

Course name:	Control Project	E-mail:	diagnos2009@googlegroups.com
Project group:	FFF	Document responsible:	Daniel Eriksson
Course code:	TSRT10	Author's E-mail:	daner963@student.liu.se
Project:	Diagnosis	Document name:	kravspec1_1.pdf

Status

Reviewed	Erik Frisk	09-09-18
Approved	Erik Frisk	09-09-18

Project Identity

Group E-mail:	diagnos2009@googlegroups.com
Homepage:	http://www.isy.liu.se/edu/projekt/tsrt10/2009/
Orderer:	Erik Frisk, Linköping University
	Phone: +46 (0)13 28 2035 , **E-mail:** frisk@isy.liu.se
Customer:	The Division of Vehicular Systems, Linköping University
	Phone: +46 (0)13 28 1000 , **E-mail:** Vehicular.Systems@isy.liu.se
Course Responsible:	David Törnqvist, Linköping University
	Phone: +46 (0)13 28 1882, **E-mail:** tornqvist@isy.liu.se
Project Manager:	Niklas Wahlström
Advisors:	Mattias Krysander, Linköping University
	Phone: +46 (0)13 - 28 2198 , **E-mail:** matkr@isy.liu.se

Group Members

Name	Responsibility	Phone	E-mail
Niklas Wahlström	Project manager	0705-122349	nikwa148@student.liu.se
Daniel Eriksson	Document manager	073-4405730	daner963@student.liu.se
Erik Almqvist	Software manager	0705-149935	erija952@student.liu.se
Emil Nilsson	Test manager	073-6766558	emini550@student.liu.se
Andreas Lundberg	Design manager	0704-061227	andlu549@student.liu.se

Document History

Version	Date	Changes made	Sign	Reviewer
0.1	09-09-11	First draft.	OK	Daniel Eriksson
0.2	09-09-15	Second draft.	OK	Daniel Eriksson
0.3	09-09-16	Third draft.	OK	Daniel Eriksson
1.0	09-09-18	First release.	OK	Daniel Eriksson
1.1	09-11-17	First revision.		Niklas Wahlström

Contents

1 Introduction

This project is a part of the control-theory CDIO course at Linköping University (LiU) 2009. The given task is to design a system that automatically supervises the energy system in the NASA certified ADAPT[1] system. This is to be done within a certain software framework provided by NASA, so that a possible comparison can be done between different diagnostic systems in a competition.

1.1 Involved contacts

Orderer of this project is the division of Vehicular Systems at LiU. The contact person from the vehicular systems division is Associate Professor Erik Frisk. The actors of the project is group **FFF**[2].

1.2 Purposes and goals

The purpose of this project is to produce a diagnostic algorithm that can participate in the possible DCC'10[3] competiton. In the competition the performance of the diagnostic system will be compared against other diagnostic algorithms within the same framework provided by NASA.

1.3 Future use

The future use of this project is to participate in the DCC'10. An evaluation will be made with existing data measurements from NASA. The performance of the diagnosis algorithm will also be compared to other participants in the competition.

1.4 Background

In March 2009 was the first competition DCC'09[4] finished. The results were presented in June at the DX-09[5] workshop in Stockholm. There were 12 different diagnosis algorithms competing in three tracks.

The competition was started as an implementation of a framework for evaluating and comparing different kinds of diagnosis systems. The framework, called ADAPT, was developed by NASA Ames Research Center, PARC[6] and Delft. [**?**]

[1] ADAPT is an abriviation for *Advanced Diagnostics and Prognostics Testbed*
[2] Finn Fem Fel
[3] The Diagnostic Challenge Competition 2010
[4] The Diagnostic Challenge Competition 2009
[5] 20^{th} Interntional Workshop on Principles of Diagnostics
[6] Palo Alto Resarch Center

1.5 Definitions

All requirements made in this document will be written as in the table below. In the first column the number of the requirement is stated. The second column indicates if the status of the requirement has been changed, for example if it has been removed or updated. The third column provides a short and clear description of the requirement. The fourth and last column marks the priority level of the requirement, where 1 is a mandatory requirement and 2 marks a secondary requirement that is to be implemented if the time for it exsists. A requirement marked by 3 got the lowest priority and is to be implemented last.

Requirement	Status	Description of the demand.	Priority level

2 System overview

Figure 1 provides an overview of how the diagnostic algorithm is to be implemented into the framework provided by NASA.

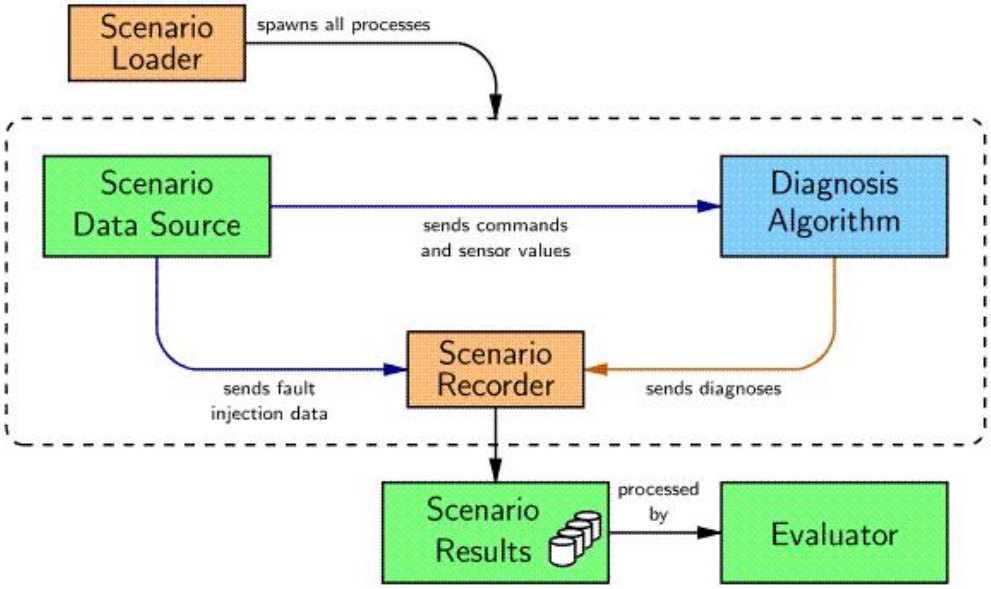

Figure 1: A brief overview of the system and the DCC framework.

2.1 Brief description of the product

The given task is to automaticly supervise the electrical power system of ADAPT. ADAPT is a facility desiged by NASA for testing diagnostic tools and algorithms against a standardized testbed. The facilities hardware consists of an electrical power system with components for power generation, storage and distribution. Over a hundred sensors reports the status of the the system.

The testbed provides a controlled environment to inject faults, either through software or hardware in a controlled manner. It also provides an API for integration of diagnositic

technologies[**?**]. An overview of the ADAPT system, along with sensors and components, can be seen in Figure 2. Our task is to develop a diagnostic algorithm for detecting injected faults that is integrated and working with the ADAPT and its API. There shall also be noted that a simplified version of ADAPT, called ADAPT-lite exists and provides an scaled down system than the full ADAPT. The ADAPT API is also called DxC, as it was first used at the DCC'09 competition.

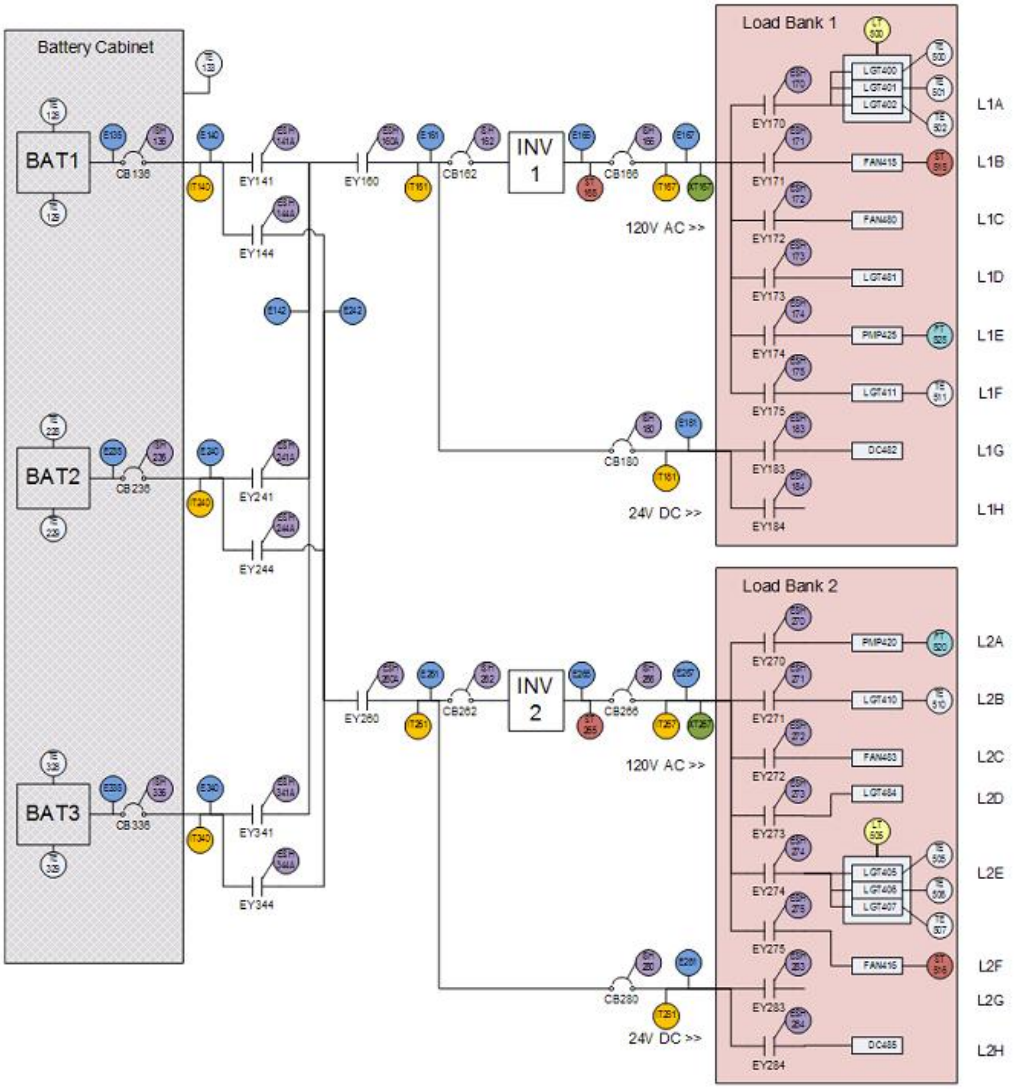

Figure 2: An overview of the ADAPT system and it's components[**?**].

2.2 Product components

In addition to the diagnostic algorithm itself, a technical documentation for the system and a brief user manual will be provided.

2.3 Dependencies on other systems

The diagnostic algorithm will be dependent on the DxC framework.

2.4 Subsystems

In this document, the projects requirements will be divided into modelling requirements, requirements on the developed diagnostic algorithm itself and requirements on the software and it's integration into the DxC.

2.5 Limitations

Our diagnostic algorithm is limited to only finding possible faults in the given ADAPT system, and not in a general system.

2.6 Design philosophy

A diagnostic algorithm shall be implemented so that the score in the DCC'10 gets as high as possible. The structure of the code should also make it easy to adapt the diagnosis algorithm to changes in the system architecture.

2.7 Requirements on the whole system

Req. 1		The diagnostic algorithm shall be integrated into the given DxC framework	1

3 System modelling

There are different approaches on developing diagnosis systems. In this project we have decided to have a model based approach where knowledge of the components behaviour will help us to detect faults. Each component type will have a specific model that are able to describe the properties of the component and its fault modes. Models are simplifications of real world behaviour so an analysis is necessary to tell how accurate the model is.

Req. 2		The diagnostic algorithm shall be based on a physical model of the system.	1
Req. 3		Each component of the system shall have its own model.	1
Req. 4		Each mode in each component shall have its own model.	1
Req. 5		An analysis of how good the models are shall be included in the Technical Documentation.	2
Req. 6		To automatically generate a model of the whole system given a description of the system in a standard XML form and a model for each type of component.	3

4 The diagnostic algorithm

A diagnosis algorithm is a method that can detect, and also isolate, faults in a system. This is an autonomus procedure that require that some measurement data from the system is known, e.g. via different kinds of sensors. The diagnosis system is based on the model of the system. Therefore the algorithm have to work even if the model is partially inaccurate when it comes to e.g. simplifications and nonlinearities that might be hard to describe. This robustness of the diagnosis system is therefore important and also an analysis of the necessity of the different sensors will be made. Changes in the real system should easily be able to implement in the diagnosis system.

The algorithm performance is a deliberation of different aspects like execution time, memory usage and reliability. It would therefore be convenient if it would be possible to have parameters that you could change for optimum performance.

Req. 7		Each fault that we introduce into our system model shall be analysed if detectable. The analysis will be presented in the Technical Documentation.	1
Req. 8		The diagnosis algorithm shall be able to detect all detectable single fault that is among the test data. The results will be presented in the Technical Documentation.	1
Req. 9		The diagnosis system shall be able to detect detectable double faults from the test data. The results will be presented in the Technical Documentation.	2
Req. 10		The diagnosis system shall be able to detect detectable multiple faults of higher degree from the test data. The results will be presented in the Technical Documentation.	3
Req. 11		An analysis of single fault isolability of the system shall be performed. The results will be presented in the Technical Documentation.	1
Req. 12		The diagnosis algorithm shall be able to isolate all isolable single fault, according to our analysis, that is among the test data. The results will be presented in the Technical Documentation.	1
Req. 13		The diagnosis algorithm shall be able to isolate all isolable double fault that is among the test data. The results will be presented in the Technical Documentation.	2
Req. 14		The diagnosis algorithm shall be able to isolate all isolable multiple fault of higher degree that is among the test data. The results will be presented in the Technical Documentation.	3
Req. 15		The real systems sensors necessity for isolation and detection shall be analysed. The results will be presented in the Technical Documentation.	2
Req. 16		An analysis of the robustness of the diagnosis system shall be performed. The results will be presented in the Technical Documentation.	1
Req. 17		The diagnosis system shall contain parameters for weighting contradictory performance properties.	1

5 Requirements on the software

In order to possibly take part of the NASA Diagnostic Challange Competition there is a strong Requirement that the diagnosis algorithm can be integrated into NASA's given framework, DxC. Shortly, the DxC provides scenario data for the diagnostic algorithm and stores and evaluates the results from the diagnostic algorithm. How the evaluation of the diagnostic algorithm is made at a possible competition is listed in section four of the Diagnostic Challange Competition Announcement document[**?**].

The requirement of integration with the DxC automatically generates a set of subrequirements. For example, it automatically follows that the diagnostic algorithm must be implemented in a way that is able to handle the input and output from and to the DxC framework. This provides rules for the communication made between the scenario data source and the diagnosic algorithm as well as performance limits on the diagnostic algorithm. The algorithm simply has to be able to take care of data at the frequency that the DxC sets.

Req. 18		The file structure of the diagnostic algorithm shall match the requirements that the DxC have on the file structure.	1
Req. 19		The communication between the DxC framework and the diagnostic algorithm shall be made with the data types provided in the DxC.	1
Req. 20		The diagnostic algorithm shall be tested against the scenario data provided by NASA.	1
Req. 21		The diagnostic algorithm shall have a startup time that is no longer than 30 seconds.	1
Req. 22		The diagnosis algorithm shall be designed so that it can implement a new component. A tutorial for this will be included in the User Manual.	3

There are also requirements on the diagnostic algorithm that's closer bound to the hardware and it's components. For example, it shall be possible to implement a minor change in the given system. It shall be possible for the diagnostic algorithm to handle a case where a sensor is removed from the system.

The diagnostic algorithm can also be able to handle a change in a specific component. For example, if the manufacturer of a certain component changes its component, this shall be possible for the diagnostic algorithm to handle.

Req. 23		The diagnostic algorithm shall be designed so that it is possible to handle a change in a model parameter for a specific component. A tutorial for doing this will be included in the User Manual.	2
Req. 24		The diagnostic algorithm shall be able to produce a diagnosis even if a sensor is removed from the system.	1

Further, the diagnostic algorithm shall be able to have a best proposal on the status of a system even if the scenario is not completed yet. That is, if the scenario is paused in the middle of a simulation, a best proposal on the status of the system should be available.

Req. 25		If the diagnostic algorithm is interrupted during simulation, it shall always have a best proposal on the current diagnosis.	1

6 Economy

The following requirements are defined from the resources of the project.

Req. 26		This project shall require in total 1200 h or 240 h per project member.	1
Req. 27		The project shall not use more than 25 h of the project advisors help.	1

7 Delivery requirements and partial deliveries

The following documents are to be delivered during the project.

Req. 28		At decision point 2, September 19^{th}, the following shall be delivered to the orderer: Requirement List, Project Plan, Time Plan and System Lay-out.	1
Req. 29		At decision point 3, October 14^{th}, the following shall be delivered to the orderer: Design Specification, Test Plan and a Presentation of the work made so far.	1
Req. 30		At decision point 5, November 30^{th}, the following shall be delivered to the orderer: Test Protocols and User Manual.	1
Req. 31		At decision point 6, December 7^{th}, the following shall be delivered to the orderer: Technical Documentation, Poster, Presentation, Evaluation Study and a Project Webpage.	1
Req. 32		An updated Time and Status Plan for each group member should be delivered every week to the orderer.	1

8 Documentation

Here is a short description of all the documents that is to be produced.

Document	Language	Purpose	Target group	Format
Requirement List	English	Definition of the task together with the orderer.	Orderer	PDF
System Layout	English	A first sketch of the system for an idea presentation for the orderer.	Orderer	PDF
Project Plan	English	A description of the project work organisation, procedures and rules.	Orderer	PDF
Time Plan	English	A detailed work assignation and estimation of required time needed for each part of the project	Orderer	MS Excel
Design Plan	English	A description of the technical work and system details.	Orderer	PDF
Test Plan	English	A description of the testing procdures.	Orderer	PDF
Technical Documentation	English	A complete manual of the result.	Orderer, Technical personel	PDF
Test Protocols	English	Protocols from testing the systems functionality.	Orderer, Technical personel	PDF
User Manual	English	A manual of the software and diagnosis algorithm.	Orderer, Technical personel	PDF
Evaluation Study	English	An evaluation of the project, team work and other issues during the period.	Orderer	PDF
Poster	Swedish	A poster presentation of the project and the results.	Potential customers	PDF
Webpage	Swedish	An internet presentation of the project and the results.	Technical personel, Potential customers	HTML