**System Level**

**Requirements Analysis Document (RAD)**

**for the**

**Predictive Wastewater Management System (PWMS)**

**Phase 1.0**

Prepared by

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Purpose

This document is intended as an agreement between Eastech and Fairleigh Dickinson University to define the Predictive Wastewater management at the system level. This Document will contain the system UML model from which subsystems are defined and RADs for the subsystems will be created.

Document Control

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# Introduction

This document describes the requirements and the analysis functional model for the Predictive Wastewater Management System in cooperation with Eastech Flow Controls Company.

## Purpose of the System

The Predictive Wastewater Management System (PWMS) is an integrated architecture framework developed to provide measurement, monitoring and ultimately predictive analytics for a participatory network enabled by the flow meter sensors engineered by Eastech. PWMS shall provide an integrated infrastructure toward that end.

PWMS:

* Provides a development framework/tool-kit for adaptive optimization and predictive algorithms.
* Supports security for applications, software components, data, and resources
* Provides Authentication, Authorization and role-based capabilities
* Provides Alert capability for continuous monitoring of the participatory network.
* Provide Audit Capability for retrieval of historical events level.
* Shall leverage Commercial Off-the-shelf (COTS) solutions as appropriate
* Provide data gathering capability for periodic reception and storage of data from the flow cell sensor.
* Provide capability of configuring the flow cell.

This Requirements Analysis Document (RAD) specifies the requirement and analysis model at the system level (i.e. the PWMS).

## Scope of the System

The context diagram for the PWMS is shown in Figure 1. The PWMS shall support the actors shown in section 1.2.1

### Actors

PWMS shall support the following actors.

|  |  |
| --- | --- |
| **Actor Catalog** | |
| **Actor Name** | **Description** |
| System Administrator | The System Administrator is an actor who adds and deletes users to and from the PWMS, assigns roles, and performs other system administration duties |
| Auditor | An actor that traces events and verifies the integrity of the stored data for the PWMS. Extracts report from the data stored. |
| Data Gatherer | An actor that provides (gathers) data to be analyzed by the PWMS from the FlowCells |
| User | An actor that requests permission to become a watchman, auditor, data gathering, data analyst for the PWMS |
| Watchman | The Watchman actor responds to alertable events created by the PWMS |
| FlowCell | The Eastech FlowCell participatory sensing device. It provides the data required for algorithm development and execution. |
| Data Analyst | An actor that performs data analysis by creating and using adaptive optimization algorithms on the data managed by the PWMS |

### PWMS Subsystems

PWMS shall be comprised of the following subsystems.

|  |  |
| --- | --- |
| **Subsystems** | |
| **Subsystem Name** | **Description** |
| DataGathering | The PWMS subsystem that collects the data from the FlowCell participatory sensors. |
| DataAnalysis | The PWMS subsystem that performs data reduction, analysis and provides reports for the Data Analyst |
| AccessControl | The PWMS subsystem that assigns roles and maintains access control lists (ACLs) for the system actors and enables users to assume roles for the PWMS. Authorize and authenticate actors to access the PWMS subsystem. |
| AuditAndAlert | The PWMS subsystem that periodically surveys the PWMS data and alerts the Watchman of a potential emergency situation. Maintains a store of audit records for the PWMS for an audit report. |
| DataStorage | The PWMS subsystem that stores and organizes the PWMS data for use by the DataGathering, DataAnalysis, and AuditAndAlert subsystems. |

### Context Diagram



## Objectives and Success Criteria of the PWMS Project

System acceptance tests shall be created for each of the six RAD documents (this one and one RAD for each of the five subsystems). Success of this project or shall be contingent upon the test criteria being met to the satisfaction of Eastech and Fairleigh Dickinson.

## Definitions, Acronyms and Abbreviations

PWMS- Predictive Wastewater Management System

AAS – Audit and Alert Subsystem

COTS – Commercial off-the-shelf

RAD – Requirements Analysis Document

SA – System Administrator

DGS – Data Gathering Subsystem

DAS – Data Analyst Subsystem

ACS– Access Control Subsystem

DSS- Data Storage Subsystem

UML- Unified Modeling Language

## References

Bernd Bruegge and Allen H. Dutoit, *Object-Oriented Software Engineering: Using UML, Patterns and Java*, 3rd

Edition, Prentice Hall, 2010 (ISBN 0-13-606125-7)

Jacobson, Ivar *Object-Oriented Software Engineering-A Use Case Driven Approach.* Addison Wesley 1992.

Martin Fowler, *UML Distilled: A Brief Guide to the Standard Object Modeling Language,* 3rd ed., Addison

Wesley, 2003.

Roger S. Pressman, *Software Engineering: A Practitioner’s Approach*, 7th Edition, McGraw Hill, 2009 (ISBN

9780071267823)

Black and Veatch, Smart Integrated Infrastructure White Paper, September 23, 2014.

## Overview

The overall requirements for PWMS, considering the subsystems as analysis objects are described in this RAD. PWMS gathers (DataGathering subsystem) and stores data (DataStorage subsystem) from the participatory network formed by a collection of Flowcell sensors and stores that data in order. The stored data is periodically monitored for anomalous or emergent situations in the wastewater system being monitored (AuditandAlert subsystem). A framework shall be provided for use by the Data Analyst in order to create, package and run predictive, optimization algorithms (DataAnalysis subsystem ) to head off potential problems in the wastewater network.

Since we are using a scenario/use case based approach, modeling of the system shall begin with the creation of scenarios and these shall evolve into the use cases for the PWMS. The roles (actors) of the PWMS shall be implemented by a security system that handles authentication and authorization for PWMS.

# Current System

There is no current system in place for the PWMS. However, there are a number of applications involving participatory sensing systems and how those systems operate and can be made secure. The literature shall be thoroughly researched to leverage the state-of-the-art in implementing and securing the PWMS from unauthorized users.

# Proposed System

Our vision closely resembles the system described in the Black and Veatch Whitepaper. By employing the scenario/ use case driven approach we intend to define how end users will employ the system toward the measurement, monitoring, analysis, storage and role-enforcement functions of the PWMS.

## Functional Requirements

1. The PWMS shall allow the System Administrator to add and delete users to and from the PWMS.
2. The PWMS shall allow the System Administrator to add and delete roles to and from user.
3. Valid roles for users of the PWMS are System Administrator, Data Gatherer, User, Data Analyst, Auditor and Watchman.
4. The System Administrator shall have the capability of assigning multiple roles to a User.
5. The PWMS shall display on an output device any Alertable Events reported to the AAS.
6. The PWMS shall sound an audible alarm to the Watchman when an Alertable Event is detected.
7. The Data Gatherer shall collect the data from the FlowCell and store in Data Storage.
8. All Auditable and Alertable events shall be retrievable by an Auditor based on the time limit.
9. The Data Analyst shall have the capability to create optimization algorithm.
10. The Data Analyst shall have the capability to execute optimized algorithm.
11. Auditable events are,
    1. FlowCell sensor malfunction
    2. User created
    3. Role Assigned
    4. User Deleted
    5. Role Removed
    6. User Removed
    7. FlowCell sensor joins network
    8. PWMS Subsystem Malfunction
    9. PWMS Defined Event
    10. Any Alertable event
12. Alertable events shall be
    1. Defined by each of the PWMS subsystems and displayed to the Watchman.
13. Data Gatherer shall configure Flow Cell.

## Nonfunctional Requirements

### Implementation

COTS products shall be used whenever possible. It is anticipated, due to the networking capabilities and mobile devices required by this distributed system that Java will the implementation language for those portions of the PWMS that Farleigh Dickinson will develop.

### Interface

The human interface devices shall be either hand-held, Android-based devices or flat-panel touch screen devices, easily read from a distance of six feet.

### Packaging

See the PWMS Software Development and Configuration Management Plans for Software Configuration Items’ Identification, control, auditing, and packaging and delivery information

## Use Cases

### System Administrator Assigns Roles to User

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PWMS Use Case** | | | | |
| ***Project*** | PWMS | | | |
| ***ID Number*** | PWMS001 | ***Status*** | For Customer Review | |
| ***Creation Date*** | 01/30/15 | ***Last Revision Date*** | | 02/10/15 |
| ***Author(s)*** | Kanchana Mala Umapathy Gunasekar | | | |
| ***Requirements Map*** | 1,2,3,4 | | | |

**Description/Intent**.

This use case is initiated by a User who sends a request to the System Administrator and request to assign the role of Watchman and remove the role of Auditor

**Actors**

User, System Administrator, Watchman

**Extends**

None

**Uses**

None

**Pre-Conditions**

User and System Administrator are operating normally.

**Post-Conditions**

Requested new user and role is created and added

**Ideal Course of Action**

1. User requests for a valid role of watchman.
2. The System notifies system administrator.
3. The System Administrator reviews the user information.
4. The System Administrator assigns the role of watchman to user.
5. System Responds “Watchman added” to the system.
6. Notifies watchman role is added to the watchman.
7. The system Administrator removes the role of auditor from auditor.
8. Notifies auditor role is added to the system.
9. The use case ends.

**Exceptional Course of Actions**

BadLogin

1. User logs in the system with his/her credentials.
2. If the credentials are incorrect
3. Use case ends.

Roles unavailable

1. After creating a new user, the system administrator tries to create a valid role for the user as Watchman. If this role is already filled, it assigns another valid role as Auditor. If both the valid roles are not available
2. Use case ends

**Comments**

Any role is handled in the same manner.

**3.3.2 Data Gatherer Configures FlowCell**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PWMS Use Case** | | | | |
| ***Project*** | PWMS | | | |
| ***ID Number*** | PWMS002 | ***Status*** | For Customer Review | |
| ***Creation Date*** | 01/30/15 | ***Last Revision Date*** | | 02/10/15 |
| ***Author(s)*** | Kanchana Mala Umapathy Gunasekar | | | |
| ***Requirements Map*** | 13 | | | |

**Description/Intent**.

Configuration Data is written to the selected FlowCell

**Actors**

Data Gatherer, FlowCell

**Extends**

None

**Uses**

None

**Pre-Conditions**

Flow Cell and System operates normally

**Post-Conditions**

Selected Flow Cell is configured

**Ideal Course of Action**

1. The Data Gatherer logs into the system with credentials.
2. If the Credentials are correct, the system authenticates and authorizes the role.
3. Data Gatherer selects the Flow Cell to configure.
4. Data Gatherer selects configuration information to be written to the Flow Cell
5. The system retrieves data from Flow Cell
6. System responds selected Flow Cell configured.
7. Use case Ends.

**Exceptional Course of Actions**

None

**Comments**

None

### Data Gatherer Collects PWMS Data

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PWMS Use Case** | | | | |
| ***Project*** | PWMS | | | |
| ***ID Number*** | PWMS003 | ***Status*** | For Customer Review | |
| ***Creation Date*** | 01/30/15 | ***Last Revision Date*** | | 02/10/15 |
| ***Author(s)*** | Kanchana Mala Umapathy Gunasekar | | | |
| ***Requirements Map*** | 7 | | | |

**Description /Intent**. Data Gatherer collects/ gathers the data for PWMS from the FlowCell participatory Sensor.

**Actors** Data Gatherer, FlowCell

**Extends**

None

**Uses**

None

**Pre-Conditions**

FlowCell remains in normal operation

**Post-Conditions**

Intended data required for the system is collected from FlowCell

**Ideal Course of Action**

1. Data Gatherer logs in the system with his/her credentials.
2. If the Credentials are correct, the system authenticates and authorizes the role.
3. Data Gatherer selects “Select FlowCell” to gather data from FlowCell.
4. Data Gatherer enters the data to be collected and how often.
5. The system periodically retrieves the data from FlowCell.
6. The System Stores the flow cell data.
7. The system reports any alertable events and data.
8. Use case ends.

**Exceptional Course of Actions**

BadDataRequest

1. If the entered data not available for the particular FlowCell.

2. Use Case ends

**Comments**

None

### Data Analyst Creates Algorithm

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PWMS Use Case** | | | | |
| ***Project*** | PWMS | | | |
| ***ID Number*** | PWMS004 | ***Status*** | For Customer Review | |
| ***Creation Date*** | 01/30/15 | ***Last Revision Date*** | | 02/10/15 |
| ***Author(s)*** | Kanchana Mala Umapathy Gunasekar | | | |
| ***Requirements Map*** | 9 | | | |

**Description/Intent**. Data analyst creates algorithm based on various functions of the FlowCell Sensor

**Actors**

Data Analyst

**Extends**

None

**Uses**

None

**Pre-Conditions**

Data Analyst logged into the system normally

**Post-Conditions**

Algorithms are created

**Ideal Course of Action**

1. Data Analyst logs in the system with the credentials.
2. If the Credentials are correct, the system authenticates and authorizes the role.
3. DA enters into the framework and starts creating an algorithm.
4. DA hits DEBUG button.
5. The system reports any alertable events and data.
6. Use Case Ends.

**Exceptional Course of Actions**

BadLogin

1. Data Analyst logs in the system with the credentials.
2. If the credentials are incorrect
3. Use case ends.

**Comments**

None

### Data Analyst Executes Algorithm

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PWMS Use Case** | | | | |
| ***Project*** | PWMS | | | |
| ***ID Number*** | PWMS005 | ***Status*** | For Customer Review | |
| ***Creation Date*** | 01/30/15 | ***Last Revision Date*** | | 02/10/15 |
| ***Author(s)*** | Kanchana Mala Umapathy Gunasekar | | | |
| ***Requirements Map*** | 10 | | | |

**Description/Intent**. Data analyst executes algorithm which was already created

**Actors**

Data Analyst

**Extends**

None

**Uses**

None

**Pre-Conditions**

Data Analyst logged into the system normally

**Post-Conditions**

Algorithms are executed

**Ideal Course of Action**

1. Data Analyst logs in the system with his/her credentials.
2. If the Credentials are correct, the system authenticates and authorizes the role.
3. DA enters into the framework and starts executing the algorithm.
4. DA hits the RUN button to execute the algorithm created.
5. The system retrieves data for analysis from the storage system.
6. The code uses the data input provided and finally displays a printable result in the OUTPUT Window.
7. It also displays error, notes or any warning associated with the code as well as program statements on the LOG window during execution.
8. The system reports any alertable events and data.
9. The other system reports alertable events and data
10. Use Case ends.

**Exceptional Course of Actions**

Bad Unsuccessful Run

1. When the RUN is unsuccessful.
2. Data analyst corrects the logic of the code.
3. Use case ends.

**Comments**

None

### Create Audit Report.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PWMS Use Case** | | | | |
| ***Project*** | PWMS | | | |
| ***ID Number*** | PWMS006 | ***Status*** | For Customer Review | |
| ***Creation Date*** | 01/30/15 | ***Last Revision Date*** | | 02/10/15 |
| ***Author(s)*** | Kanchana Mala Umapathy Gunasekar | | | |
| ***Requirements Map*** | 8 | | | |

**Description/Intent** This Use Case is initiated by an Auditor to create an audit report over a specified time period as requested.

**Actors**

Auditor

**Extends**

None

**Uses**

None

**Pre-Conditions**

Auditor is ready to create the audit report.

**All the reports**

Created as per the time period mentioned. It contains a detailed report of audit findings. It includes statement of User/Session activities; schedule of events, defined events, periodic system snapshots, and any auditable and alertable events.

**Post-Conditions**

Audit report is created as per the time period requested by the actor

**Ideal Course of Action**

1. Auditor logs in the system with the credentials.
2. If the Credentials are correct, the system authenticates and authorizes the role.
3. Auditor request for Audit report.
4. The system creates the audit report based on the user details mentioned
5. The system verifies the time limit.
6. The system displays the Audit report.
7. The system creates an auditable event.
8. Use case ends.

**Exceptional Course of Actions**

BadLogin

1. Auditor logs in the system with the credentials.
2. If the credentials are incorrect
3. Use case ends.

**Comments**

None

### Alertable Event Reported.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PWMS Use Case** | | | | |
| ***Project*** | PWMS | | | |
| ***ID Number*** | PWMS007 | ***Status*** | For Customer Review | |
| ***Creation Date*** | 01/30/15 | ***Last Revision Date*** | | 02/10/15 |
| ***Author(s)*** | Kanchana Mala Umapathy Gunasekar | | | |
| ***Requirements Map*** | 5,6,11,12 | | | |

**Description/Intent**

This use case reports any alertable event detected.

**Actors**

Watchman

**Extends**

None

**Uses**

None

**Pre-Conditions**

System is powered up and running normally

**Post-Conditions**

Watchman is notified about the alertable events with an audible alarm sound.

**Ideal Course of Action**

1. The system notifies the alertable event to the watchman with message and audible alarm.
2. Watchman stores and maintains details in a log file for the all the alertable events occurred throughout the day.
3. Use Case Ends**.**

**Exceptional Course of Actions**

None

**­­­­­­**

**Comments**

None

### Use Case Diagram



## Object Model

The object model for the PWMS is described in this section.

The object model is also known as the analysis model or the conceptual class diagram. For this Top-Level RAD the conceptual objects are the subsystems of the PWMS. Assume that each subsystem has the appropriate Boundary object to handle interactions with that subsystem. Entity, Boundary and Control objects shall be described in the RADs that describe each of the PWMS subsystems.

### Conceptual Class (Subsystem) Diagram



## Dynamic Model

### Overview

The dynamic model depicting interaction among the PWMS subsystems are described in this section. Dynamic modeling at this level shows interactions amongst the PWMS subsystems with those subsystems decomposed into entity, boundary and control objects for each subsystem in the individual RADs for each of the subsystems. Sequence, communication, state and activity diagrams are the Unified Modeling Language (UML) components that are used to show the dynamic model.

The sequence and communication diagrams correspond one-to-one with the use cases of this document.

### Sequence Diagrams

#### System Administrator Assigns Roles to Users



#### Data Gatherer configures FlowCell



#### Data Gatherer Collects PWMS Data



#### Data Analyst creates algorithm



#### Data Analyst executes algorithm



#### Create Audit Report



#### Alertable Event Reported



### Communication Diagrams

#### System Administrator Assigns Roles to Users



#### Data Gatherer configures FlowCell



#### Data Gatherer Collects Data for PWMS



#### Data Analyst creates algorithm



#### Data Analyst executes algorithm



#### Create Audit Report



#### Alertable Event Reported



# Glossary

|  |
| --- |
| **System** **Administrator**  The System Administrator is an actor who adds and deletes users to and from the PWMS, assigns roles, and performs other system administration duties  **Auditor**  An actor that traces events and verifies the integrity of the stored data for the PWMS  **Data** **Gatherer**  An actor that provides (gathers) data to be analyzed by the PWMS from the FlowCells  **User**  An actor that requests permission to become a watchman or auditor for the PWMS  **Watchman**  The Watchman actor responds to alertable events created by the PWMS  **FlowCell**  The Eastech FlowCell participatory sensing device  **Data** **Analyst**  An actor that performs data analysis by creating and using adaptive optimization algorithms on the data managed by the PWMS |

**Audit Message**

Audit Messages are messages written to a store to record significant events (e.g. unsuccessful use of a Secure Resource).

**Auditing**

Auditing is a defined, formal process of tracing events and User/Session activity.

**Basic Authentication**

Basic Authentication is the process whereby a user is challenged to verify his identity by supplying a user name and password.

**Derived** **Requirements**

Derived Requirements are those requirements arrived at by analysis modeling and analysis of the Levied Requirements.

**Levied** **Requirement**

Levied Requirements are those requirements imposed by outside this organization.

**Role**

A Role is a legal or authorized agent that can act or perform specific functions. The roles are System Administrator, Auditor and Watchman.