EMMON - EMbedded MOnitoring
ARTEMIS JU – FP7

D3.2 EMMON FUNCTIONALITIES SPECIFICATION

SPECIFICATION OF THE MAIN COMMON FUNCTIONALITIES OF EMMON, FROM END-USERS PERSPECTIVES

EMMON

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SEVENTH FRAMEWORK PROGRAMME

D3.2 EMMON FUNCTIONALITIES SPECIFICATION

EMMON

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Section 4.2	-	Section "Assess Operational Status" was removed. Its contents were placed in Section 4.12. As a consequence, all the subsequent sections were shifted one position.	Section 4.3 to Section 4.10
-	Section 4.10	New section named "Inform Authorities" was added	Page 15
-	Section 4.11	New section named "C&C Services" was added	Page 15
-	Section 4.12	New section named "PDA Services" was added	Page 16

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1. Introduction

1.1 Objective

The objective of this document is to present the study and specification of the main common functionalities of the EMMON system, from end-users perspectives.

1.2 Scope

This document is produced under the scope of Work-package 3 (WP3), Task 3.1 "Consolidation of operational scenario requirements" and is identified as D3.2.

This document intends to provide an intersection of common functionalities of the EMMON system for the various scenarios studied, reflecting end-users perspectives.

1.3 Audience

The target audiences of this document are:

- ARTEMIS JU and the Commission Services;
- WSN research groups;

1.4 Definitions and Acronyms

Table 1 presents the list of acronyms used throughout the present document.

Acronyms	Description
AD	Applicable Document
GUI	Graphical User Interface
WSN	Wireless Sensor Network

Table 1 - Table of acronyms

1.5 Document Structure

Section 1, Introduction, presents a general description of the contents, pointing its goals, intended audience and structure.

Section 2, Documents, presents the documents applicable to this document and referenced by this document.

Section 3, Executive Summary presents an overview of EMMON project.

Section 4, Common EMMON Functionalities, presents the list of main common functionalities of the EMMON system, from end-users perspectives.

2. Documents

This section presents the list of applicable and reference documents as well as the documentation hierarchy this document is part of.

2.1 Applicable Documents

This section presents the list of the documents that are applicable to the present document. A document is considered applicable if it contains provisions that through reference in this document incorporate additional provisions to this document [ECSS-P-001B].

The following documents are applicable to the present document. A document is considered applicable if it contains provisions that through reference in this document incorporate additional provisions to this document:

[AD-1] "Technical Annex", EMMON Project, ARTEMIS Joint Undertaking Call for proposals ARTEMIS-2008-1, Grant agreement no. 100036, 2009-03-23.

[AD-2] “D3.1 Operational Requirements - Operational Requirements Consolidated From End-users Input and Opinions”, EMMON Project, Rui Mónica, Pedro Braga and Manuel Santos, FP7-JU-EMMON-2009-DL-WP3-005, Version 3, 2011-02-28

[AD-3] “D3.4 Water quality scenario operational requirements”, EMMON Project, Pedro Braga, Rui Mónica and Loukas Petrou, FP7-JU-EMMON-2009-DL-WP3-005, Version 2, 2010-02-26.

[AD-4] “D3.5 Urban quality of life scenario operational requirements”, EMMON Project, Paul Bustamante, Karol Grandez and Manuel Santos, FP7-JU-EMMON-2009-DL-WP3-006, Version 2, 2010-02-26.

[AD-5] “D3.6 Marine environments scenario operational requirements”, EMMON Project, Paul Mínguez-Olaondo and Nagore Guarretxena, FP7-JU-EMMON-2009-DL-WP3-007, Version 2, 2010-02-26.

[AD-6] “D3.7 Civil protection scenario operational requirements”, EMMON Project, Rui Mónica and Loukas Petrou, FP7-JU-EMMON-2009-DL-WP3-008, Version 2, 2010-02-26.

[AD-7] “D3.8 Event propagation simulation operational requirements”, EMMON Project, Lubo Jankovic, FP7-JU-EMMON-2009-DL-WP3-009, Version 2, 2010-02-26.

2.2 Reference Documents

This section presents the list of reference documents. A document is considered a reference document if it is referred but not applicable to this document.

Not applicable.

3. Executive Summary

After consolidation of relevant research and studies performed in relation with the operational fields, the technical requirements were derived. From this work, a cross scenario study was carried out to gather a consolidation of operational requirements and constraints and to identify the main common functionalities between them that the project EMMON must have.

The main common functionalities identified for the EMMON system, are:

- Sense Physical Parameters;
- Monitor In Real-time;
- Predict Future Events;
- Low Power Operation;
- Display Information;
- Alarms;
- Security;
- Fault Handling;
- Maintainability;
- Inform Authorities;
- C&C Services;
- PDA Services.

4. Common EMMON Functionalities

This section presents a detailed description of the main common functionalities [AD-2] of the EMMON system, from an end-users perspectives. End-user needs for the studied scenarios (for more detail see: [AD-3], [AD-4], [AD-5], [AD-6], [AD-7]) were analysed in order to identify the common functionalities between them.

There are some slight differences regarding the scenarios that were analysed for the second version of this document and the ones that were analysed for this third version. The Water Quality and Marine Environments scenarios were discarded along with Water Pipelines and they have been left out of in this version, as they were both considered not feasible scenarios for the EMMON project [AD-2].

4.1 Sense Physical Parameters

All scenarios present a need to have some physical parameters measured. Without the ability to sense physical parameters, no monitoring can be performed.

4.2 Monitor In Real-time[1]

Timeliness is a very important factor. In order to act quickly, end-users need to have information about the monitored physical parameters in a timely manner. When dealing with emergency situations, information that arrives too late is as good as erroneous information.

This real-time monitoring can be performed at two distinct levels:

- **Global** – consists on the monitoring of the whole network, through the C&C interface. This is where most of the monitoring activities will take place. Users will have access to graphical and numerical information about the network's sensing points.
- **Local** – done through a PDA device connected to the network, consists on the monitoring of a sub-section of the whole network, to which the PDA is directly connected to. Graphical and numerical information will be provided to the PDA users regarding the sensing points in this sub-network.

4.3 Predict Future Events

Being able to use historical and present data to make predictions regarding future events would be a great tool to help anticipate (or even prevent) an emergency situation and be better prepared to deal with it.

4.4 Low Power Operation

Since batteries have a limited lifespan, and harvesting power under this context can be challenging and very expensive, it is crucial that the system is designed to function using as little power as possible.

- **Sleep mode** – ensuring that while the nodes are not measuring physical parameters or transmitting data, they remain in a lowest-power consuming state (sleep) most of the time. In fact, most of the power consumption of the nodes is due to the RF system.

[1] This term is used in a broad sense in this document. It refers to when entities respond to events as they occur, having no significant delay in its timeliness. Although different end users have different needs, they all have deadlines which need to be fulfilled.

4.5 Display Information

Communication from the system to the end-users will be mostly done through a graphical user interface (GUI). It must therefore be as functional and easy to use as possible.

Since this visual information is very helpful for the decision making process, end-users need to have access to a rich set of visual indicators regarding the monitoring process. Visual information will be provided at two different levels: in the C&C centre and on a PDA device locally connected to the system. While the C&C centre has to present information regarding the whole network, a PDA device will only present information regarding the sub-network to which it is connected to.

For the C&C centre, the following common functionalities were identified:

- **Charts and diagrams** – numerical and statistical information is presented to the user, helping to study and analyse past events, draw conclusions about the occurrence of emergency events and establish cause-and-effect relationships.
  - **Historical** – storing data from past readings and events makes it possible to present historical information about them.
  - **Real-time** – information about current sensor readings and current events.
  - **Future** – using historical and real-time data, present predictions of future events.
  - **Comparative** – allowing the comparison between data from different points in time (whether past, present or future), or at different locations, for example, can be very helpful to understand the characteristics of the monitored parameters and the occurrence of emergency events.
- **Geographical maps** – it is fundamental for a system such as this to provide geographical information regarding the network.
  - **Navigation** – present maps of the monitored regions, allowing end-users to navigate through it as also select sub areas of the monitored regions, thus focusing on specific areas.
  - **Zoom** – to get some further detail on a specific location, possibly where an emergency event is occurring, the ability to zoom in is instrumental. Reversely, being able to zoom out provides an overall view of the whole network.
  - **Node information** – the geographical maps provide information about the nodes, allowing end-users to get a clear picture of their status - to know whether or not the node is operating correctly - and also get information about the values read.

The common functionalities regarding visual information provided by a PDA device locally connected to the system are highlighted below:

- **Geographical maps** – it is important for the system to provide geographical information regarding the local nodes to which the PDA is connected to.
  - **Navigation** – present maps of the monitored regions, allowing end-users to navigate through it, thus focusing on specific areas.
  - **Node information** – as one of the main functions envisaged for the PDA device is for diagnostic and maintenance activities, it is fundamental to have visual information regarding the operational status of each node, as well as having information regarding the values read.

4.6 Alarms

Understandably, in order for the system to be useful for the prevention of, and quick reaction to emergency situations, end-users must be alerted when these situations occur.

- **Alert when an emergency occurs** – end-users must be alerted as soon as an emergency situation occurs.
- **Configurable alarm parameters** – end-users have to be able to configure the parameters that determine when alarms are set off. The measured parameters might vary (even for a particular scenario) or the thresholds might not be static throughout the whole year, for example.
- **Display visual information with area status** – apart from the visual information provided regarding the status of the nodes, highlighting nodes that are getting abnormal values allows end-users to have an easy and quick geographic understanding of a particular emergency situation, in terms of content and location.
- **Enable/disable alarm notifications** – end-users can enable or disable specific alarm notifications. This can be useful when a user is dealing with a particular situation on the field (or in maintenance activities), to prevent users to get notifications due to those actions.
- **Change alarm status** – while an alarm is not acknowledged by the end-user, the system keeps notifying of it. Therefore changing its status acknowledges that the user is aware of the alarm.

4.7 Security

Security is an important aspect of any WSN system and EMMON is no exception.

- **Secure data transmission** - in order to protect the integrity and confidentiality of the data transmitted throughout the network, it is fundamental for the system to use secure data transmission. The most important aspects here are not allowing third-parties to taint the transmitted data in any way and not allowing access to the data to everyone (in case of a particular emergency, this might trigger a generalised panic, which would only degrade the situation further).
- **Authentication** – not everyone can access the system. End-users need to use authentication mechanisms in order to access it. This provides a means of preventing unauthorised users to have access to the system.
- **Configurable accounts** – the use of different account types, according to the type of user (regular user, system administrator, etc) makes it possible to have the security features for each account type tuned to suit the needs of that particular account. It can also prevent system faults, by restricting sensitive parts of the system to be only manageable by users qualified to do so.

4.8 Fault Handling

In any system, a fault will surely occur at some point. The system must therefore be prepared to handle it without compromising its correct operation.

- **Detect erroneous sensor readings** - as there is the real possibility that occasionally the sensor readings are erroneous, it is an advantage to be able to detect them, either correcting the reading or disregarding it and marking the corresponding sensor as faulty.
- **Node enabling/disabling** – having the ability to enable and disable nodes is particularly important when dealing with faulty sensor nodes, as they can taint the data collection with erroneous values. This way, end-users can disable them so that their readings are disregarded by the system.
- **Connectivity verification** – to have the system making periodical verifications to establish whether the nodes are connected and reachable is fundamental. Not only

does it allow the system to identify disconnected nodes, but it is also important for network re-configuration activities.

4.9 Maintainability

Apart from the correction of faults and defects, it is an advantage to be able to adapt to new requirements or to changes in the environment (such as a need to monitor different physical parameters).

- **Reprogramming / Over-the-air programming** – updating the firmware of the nodes can improve performance by introducing some optimization or bug correction, or it can make sensor nodes able to sense different physical parameters, for example.
- **Operation autonomy** – it is important that the sensor network itself is able to operate normally, without requiring maintenance or human intervention, for as long as possible. Maintenance of a network with thousands of nodes and possibly with many of them in locations that are hard to reach is a huge challenge.
- **Long battery life or self-sustained** – in order to have minimum maintenance, the nodes should have a long life cycle, ideally requiring no battery replacements during the system's lifetime.
- **Schedule maintenance operations** – since maintenance activities can have a significant impact on the operation of the system, it is important to provide a means to schedule these activities, in order to plan them carefully.

4.10 Inform Authorities

In all of the analysed scenarios, if the monitored physical parameters go over the established thresholds, there will be severe consequences for the human population and/or the environment. Therefore, and since typically there are authorities specialised in dealing with various types of emergency situations, it is important to provide mechanisms to inform them by forwarding them some of the alarms, in case of an emergency.

4.11 C&C Services

The C&C is where most of the interaction between the end-user and the system will take place. Following are the common functionalities that were identified at this level:

- **GIS environment** – it is obviously important for the system to provide a Geographical Information System enabling the presentation, capture, storage, analysis and management of data that is linked to specific locations.
- **Node operating parameters** – it is fundamental in any scenario to have some mechanism that enables users to have some understanding of the node's operational status. Otherwise, there is no way of knowing whether it is operating correctly or not.
- **System operating conditions** – as for the operating parameters of the nodes, it is fundamental to have some mechanism that enables users to have some understanding of the network's operational status. Otherwise, there is no way of knowing whether the system is operating correctly or not.

4.12 PDA Services

A PDA device can be locally connected to the network. Its main functions will be to perform local monitoring of physical parameters, as well as diagnosis and maintenance activities. The following common functionalities for this device have been identified:

- **Map local sensors** – providing a geographical mapping of the local area to which the PDA is connected is fundamental for the local monitoring activities.

- **Positional information during installation** – in order to know the location of each node in the network, the position of each node must be available. This can be done during the installation process, as the nodes are expected to remain in fixed positions throughout the network's lifetime.
- **Supervision of local sensors' operating conditions** – in order to perform diagnostic and maintenance activities, it is important to know if the nodes are operating correctly or not.
- **Over the air programming** – this is another helpful feature for local maintenance, allowing over the air programming of the sensor nodes to be done locally, and not just at the C&C level. One of the advantages is that a small team can be focusing on a specific node or group of nodes, while C&C users can focus on the monitoring activities.
- **Field sensor programming** (or over the air configuring) – being able to change parameters such as thresholds, sampling frequency, position or even communication parameters through the PDA can help making the system much more flexible, allowing it to adapt easier in case of necessity, such as changes in the monitored environment.

5. Conclusions

Through the D3.1 deliverable [AD-2], which presents the consolidation of the operational requirements and constraints, derived from end-user needs for the various scenarios studied it was possible to specify of the main common functionalities of the EMMON system.

This deliverable identifies the EMMON main common functionalities and presents their detailed description.