Project acronym: GROUND-MED

Project title: Advanced ground source heat pump systems for heating and cooling in Mediterranean climate

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Duration: 60 months

Deliverable D4.4: Data management system

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BESEL S.A.

Project co-funded by the European Commission within FP7 Programme		
Dissemination level		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the Consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

FINAL SPECIFICATION

Development of the GROUND – MED Data Management System

Version: 28-May-2010

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1 Aim

This document describes the technical specification presented by BESEL S.A. for the development of the GROUND-MED Data Management System (DMS).
It describes a complete software and hardware system that allows collecting and analyzing the results arising from the different demonstration buildings. This platform will provide a global solution including the data reception, storage and presentation in an easy to use Web interface.

This specification is based on the requirements and specifications explained in:

- GroundMed-Annex I DOW – VS May 16(9_6_2008).pdf
- WP4 Contribution WP3 Padova Meeting - Minutes.pdf
- GroundMed-Meeting-10 Athens Minutes.pdf

The solution provides a complete system that goes beyond a common database, covering multiple aspects and dimensions such us: internationalized web site, different security access levels, technical support, security systems, backup systems, hosting services, complete server deployment (hardware, software and networks)...

The DMS will be one of the most important tools during the technology evaluation activities, allowing a complete building monitoring and also during the dissemination activities, providing buildings performance information.

We have focused our design in three main aspects: security, performance and user-friendly interfaces:

• Security: providing secure data access through passwords, user access levels and a safe database storage (backups and redundant devices).

• Performance: the system will handle a wide data collection, so we have to take special care in processing and reporting response times.

• User-friendly: we focus our work in designing user interfaces as easiest as possible, enabling non expert users managing the system.

2 Technical specification

2.1 Introducing Data Management needs

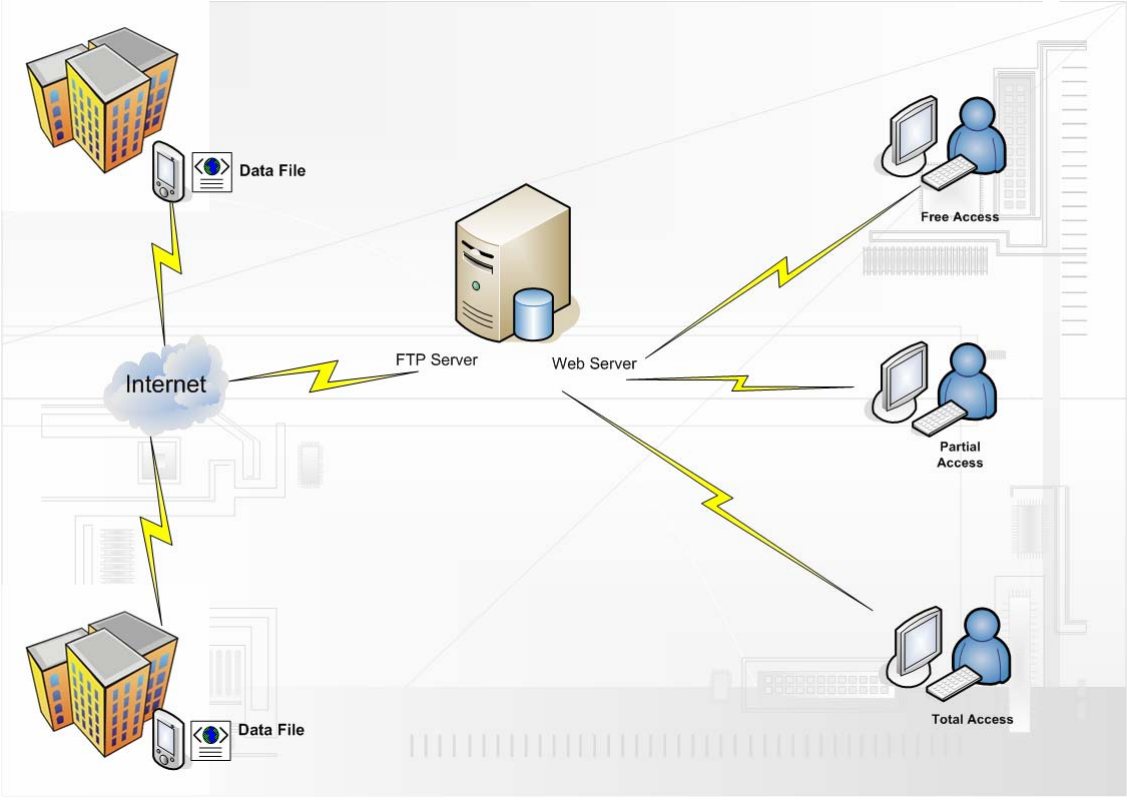
The main system goal consists in developing a common solution for monitoring all the demonstration buildings with different security access levels. Collected info will be stored in a database and will be accessed easily through a Web interface. This info will be presented in real time and different excel files.

Reliability and strength must be main issues. The system has to be 24x7 available, always operative to receive and present data. Furthermore this data must be protected against unauthorized access and attacks. Therefore as it is explained in next sections, different measures have been applied to protect the system, both physically and digitally.

2.2 Description

2.2.1 System overview

Regarding the requirements explained before, we specify a system whose general diagram comes below:



The system will run in a dedicated server that runs different applications and software:

- Database management system
- FTP server
- Web application
- Security systems

There are 3 different user types or profiles that interact with the system through the web application, each one with different functions, responsibilities and capabilities explained later.

2.2.2 DMS outputs

The DMS output will be Excel files and real time information:

2.2.2.1 Excel files

Based on the DMS Requirements specified in the WP4 Contribution WP3 Padova Meeting - Minutes.pdf document and taking into consideration the need for also including sanitary water supply according to the GroundMed-Meeting-10 Athens Minutes.pdf document, the DMS should generate 2 different excel files types:

- Daily file: with the table1 information collected every minute (1440 rows per day)

Category Sensor	Variable Description	Essential Measurement (Compulsory)	Desirable Measurement (Optional)
External			
PT100	Ambient Temperature	X	
	Solar Radiation		X
Indoor			
PT100	Troom (representative indoor temperature)	X	
	Temperature of other indoor spaces		X
	Indoor humidity		X
Heat Pump			
	Pevap (evaporator pressure)		X
	Pcond (condenser pressure temp.)		X
	Tout cond (liquid subcooling temp.)		X
	Tout evap (evaporator superheat temp.)		X
	Tout comp (discharge temp.)		X
Power Meter	Compressor power, kW	X	
	Cumulative compressor electricity consumption, kWh	X	

Building Circuit	**CI**		
Thermal (heating & cooling) Flow Meter	TIN CI (Temperature exiting the heat pump)	X	
	10 minute average Temperature exiting the heat pump		X
	TOUT CI (Temperature entering the heat pump)	X	
	10 minute average Temperature entering the heat pump		X
	TTANK (Temperature at the water storage tank)		X
	CI Flow rate	X	
	CI Cumulative water volume	X	
	CI Operating hours	X	
	Thermal (heating-cooling) power to the building, kW	X	
	Cumulative heating supply to the building, kWh	X	
	Cumulative cooling supply to the building, kWh	X	
Power meter fans	Total power consumption of all fan coils (kW)	X	
	Cumulative electricity consumption in all fan-coils, kWh	X	
Power meter 1	Power of individual fan coil 1		X
Power meter 2	Power of individual fan coil 2		X
Power meter pump	Total internal pumps power, kW	X	
	Cumulative electricity consumption in internal pumps, kWh	X	
	Differential Pressure – Internal Circuit		X
	Absolute Pressure – Pump Discharge		X
Sanitary Water Circuit	**CW**		
Thermal (heating & cooling) Flow Meter	TIN CW (Temperature exiting the heat pump)	X	
	TOUT CW (Temperature entering the heat pump)	X	
	TWTANK (Temperature in the sanitary water tank)	X	
	CW Flow rate	X	
	CW Cumulative water volume	X	
	CW Operating hours	X	
	Thermal (heating) power to sanitary water, kW	X	
	Cumulative heating supply to sanitary water, kWh	X	
Power meter pump	Total sanitary water pumps power, kW	X	
	Cumulative electricity consumption in sanitary water pumps, kWh	X	
Ground Circuit	**CE**		
Thermal (heating & cooling) Flow Meter	TIN CE (Temperature exiting the heat pump)	X	
	10 minute average Temperature exiting the heat pump		X
	TOUT CE (Temperature entering the heat pump)	X	
	10 minute average Temperature entering the heat pump		X
	Flow rate	X	
	Operating hours	X	

	Cumulative water volume	X	
	Thermal (heating-cooling) power to the BHE, kW	X	
	Cumulative heating supply to the BHE, kWh	X	
	Cumulative cooling supply to the BHE, kWh	X	
Power meter pump	External pump power, Kw	X	
	Cumulative electricity consumption in external pump, kWh	X	
	Differential Pressure – External Circuit		X
	Absolute Pressure – Pump Discharge		X
ALARMS			
Input constant values	Minimum allowed evaporation pressure	X	
	Maximum allowed condensing pressure	X	
Alarm 1[1]	Alarm triggered if evaporation pressure becomes lower than the minimum allowed one	X	
Alarm 2[2]	Alarm triggered if condensing pressure becomes higher than the maximum allowed one	X	
Main alarm[3]	Alarm triggered if there is no flow neither at the building nor at the sanitary water circuits	X	

Table 1

[1] *If evaporation pressure is equal or higher than the minimum allowed evaporation pressure Alarm 1 equals "NORMAL", otherwise it becomes "LOW PRESSURE"*

[2] *If condensing pressure is equal or lower than the maximum allowed condensing pressure Alarm 2 equals "NORMAL", otherwise it becomes "HIGH PRESSURE"*

[3] *If either(or both) the flow at the building circuit or the flow at the sanitary water circuit are higher than zero Main alarm equals "SYSTEM ON", otherwise it becomes "SYSTEM OFF"*

- Summary file: one row per day with the table2 information (730 rows of data for 2 years).

Category	Variable Description	Daily average	Last reading of the day
External			
PT100	Ambient Temperature	X	
	Solar Radiation	X	
Indoor			
PT100	Troom (representative indoor Temperature)	X	
Heat Pump			
	Cumulative compressor electricity consumption		X
Building Circuit	**CI**		
Thermal (heating & cooling) Flow Meter	TIN CI (Temperature exiting the heat pump)	X	
	TOUT CI (Temperature entering the heat pump)	X	
	Cumulative heating supply to the building, kWh		X
	Cumulative cooling supply to the building, kWh		X
	Cumulative electricity consumption in all Fan-Coils, kWh		X
	Cumulative electricity consumption in internal Pumps, kWh		X
Sanitary water Circuit	**CW**		
Thermal (heating & cooling) Flow Meter	TIN CW (Temperature exiting the heat pump)	X	
	TOUT CW (Temperature entering the heat pump)	X	
	TWTANK (Temperature in the sanitary water pump)	X	
	Cumulative heating supply to sanitary water, kWh		X
	Cumulative electricity consumption to sanitary water Pumps, kWh		X
Ground Circuit	**CE**		
Thermal (heating & cooling) Flow Meter	TIN CE (Temperature exiting the heat pump)	X	
	TOUT CE (Temperature entering the heat pump)	X	
	Cumulative heating supply to the BHE, kWh		X
	Cumulative cooling supply to the BHE, kWh		X
	Cumulative electricity consumption in external Pump, kWh		X

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Cummulative SPF			
SPF1[4]			
SPF2[5]			
SPF3[6]			
SPF4[7]			
Daily average COP			
COP1[8]			
COP2			
COP3			
COP4			

Table 2

[4] *SPF1 = cumulative heating + cooling + sanitary water energy supply divided with the cumulative compressor electricity consumption.*

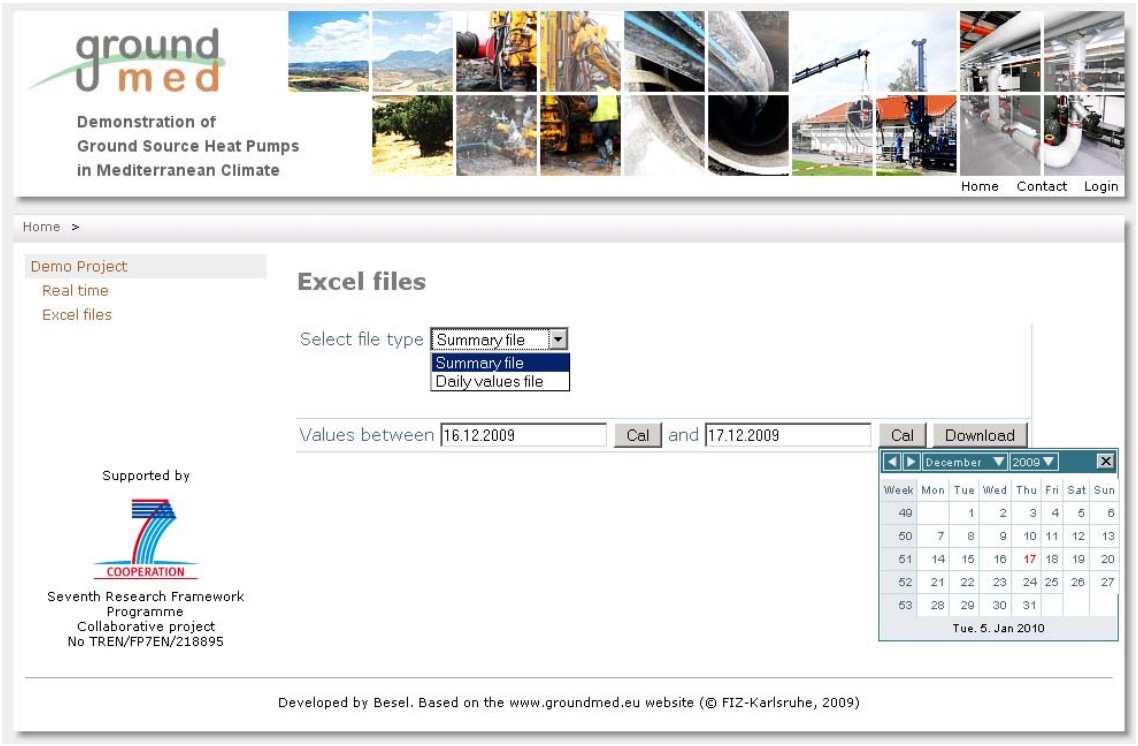
[5] *SPF2 = cumulative heating + cooling + sanitary water energy supply divided with the cumulative compressor + external pump electricity consumption.*

[6] *SPF3 = cumulative heating + cooling + sanitary water energy supply divided with the cumulative compressor + external pump + internal pumps+ sanitary water pumps electricity consumption.*

[7] *SPF4 = cumulative heating + cooling+ sanitary water energy supply divided with the cumulative compressor + external pump + internal pumps + sanitary water pumps + all fancoils electricity consumption.*

[8] *Average daily COPs will be calculated as above using the daily energy supply and electricity consumption instead. The daily energy value equals the difference of the daily cumulative value minus the cumulative value of the previous day.*

Allowed users will download this Excel files through a web interface similar to the following example:

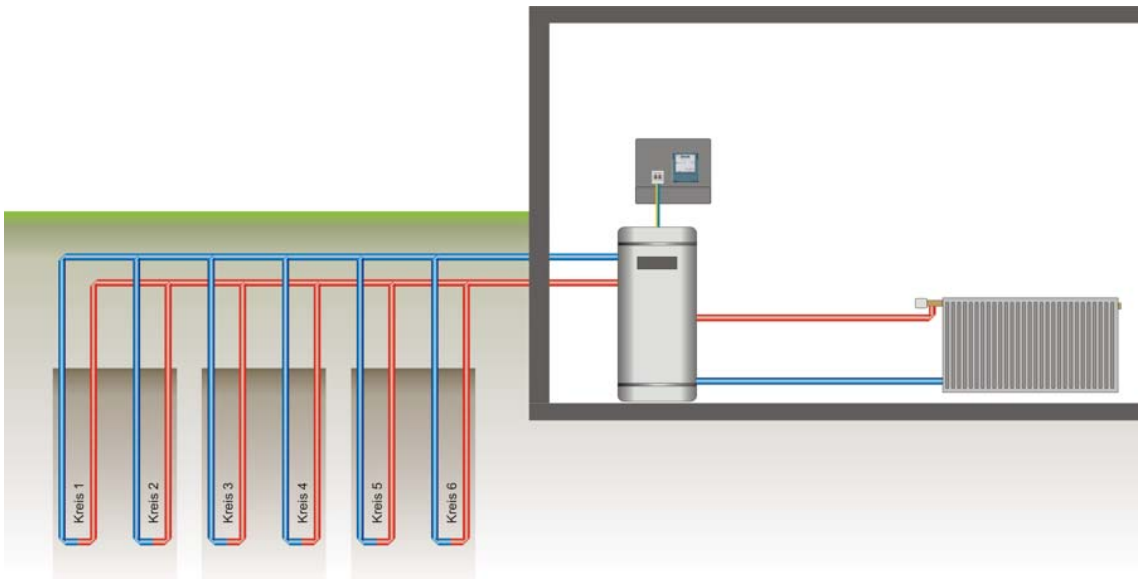


There are two enclosed examples of this excel files named “Daily file.xls” and “Data summary.xls”.

2.2.2.2 Real Time Web Display

The DMS will also display a graph showing the following information updated automatically every 10 minutes.

An indicative graph used for the Groundhit project is shown below:



The information presented with the graph is listed in the following table:

	Category	Variable Description
Heat Pump	Power meter	Compressor power
		Cumulative compressor electricity consumption
Building Circuit	Thermal (heating & cooling) Flow Meter	10 minute average Temperature exiting the heat pump
		10 minute average Temperature entering the heat pump
		Thermal (heating-cooling) Power to the building, kW
		Cumulative heating supply to the building, kWh
		Cumulative cooling supply to the building, kWh
	Power meter	Total Power in all Fan Coils
		Cumulative electricity consumption in all Fan-Coils, kWh
	Power meter	Total Pumps Power, kW
		Cumulative electricity consumption in Pumps, kWh
Sanitary water Circuit	Thermal (heating & cooling) Flow Meter	Temperature exiting the heat pump
		Temperature entering the heat pump
		Thermal (heating) Power to sanitary water, kW
		Cumulative heating supply to sanitary water, kWh
		Temperature in the sanitary water tank
	Power meter	Total sanitary water Pumps Power, kW
		Cumulative electricity consumption in sanitary water Pumps, kWh
Ground Circuit	Thermal (heating & cooling) Flow Meter Flow Meter	10 minute average Temperature exiting the heat pump
		10 minute average Temperature entering the heat pump
		Thermal (heating-cooling) Power to the BHE, kW
		Cumulative heating supply to the BHE, kWh
		Cumulative cooling supply to the BHE, kWh
	Power meter	Pump Power, kW
		Cumulative electricity consumption in Pump, kWh
Main alarm [3]		"SYSTEM ON" or "SYSTEM OFF"

Table 3

2.2.2.3 Access levels

There will be three different levels (there could be different users in one level):

- Free access: allowing everybody access to the real time web display information (without password required).
- Partial access: enabling Ground-Med partners access to the Excel sheets download, although this sheets will not contain the heat pump confidential information (Pevap, Pcond, Tout comp, Tout cond and Tout evap) (with password). A different password will be allocated for each demo site, so that only BESEL, the HP manufacturer and the demo site owner will have access to the confidential data.
- Total access: enabling full access to the Excel sheets. BESEL only.

2.2.3 DMS inputs

The DMS will receive buildings data through FTP (File Transfer Protocol) sent by the microprocessor control systems. This information will be sent in a .txt file containing the table1 information (one row per minute) and a defined structure, for example:

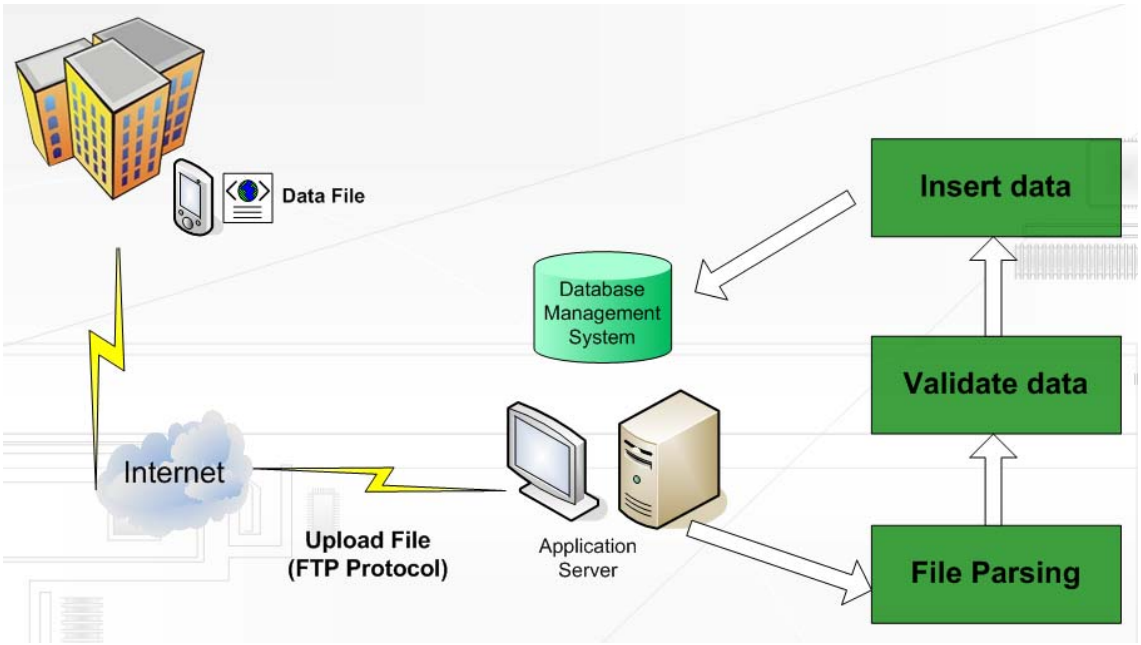
```
Date;ValueName1;ValueName2;ValueName3;ValueName4;.............;ValueNameX

06/12/2009 00:00:00;value1;value2;value3;value4;..........;valuex
06/12/2009 00:01:00;value1;value2;value3;value4;..........;valuex
06/12/2009 00:02:00;value1;value2;value3;value4;..........;valuex
06/12/2009 00:03:00;value1;value2;value3;value4;..........;valuex
06/12/2009 00:04:00;value1;value2;value3;value4;..........;valuex
06/12/2009 00:05:00;value1;value2;value3;value4;..........;valuex
06/12/2009 00:06:00;value1;value2;value3;value4;..........;valuex
06/12/2009 00:07:00;value1;value2;value3;value4;..........;valuex
06/12/2009 00:08:00;value1;value2;value3;value4;..........;valuex
06/12/2009 00:09:00;value1;value2;value3;value4;..........;valuex
```

Many of these table1 data are needed in the real time web display section with a 10 minutes refresh rate frequency, so the microprocessor control system should send this data files (at least) with this frequency. The DAQ should consider the development of some resend method in case the building lost the internet connection (eg. store the files in memory and send them later when the communication comes back).

Once a file is received there will be an automatic process that introduces its contained information into the database. This process, know as “parsing” will check the correct

file format and syntax defined previously with the control system developer. If no errors were found, the information will be accessible in the database through the web application.



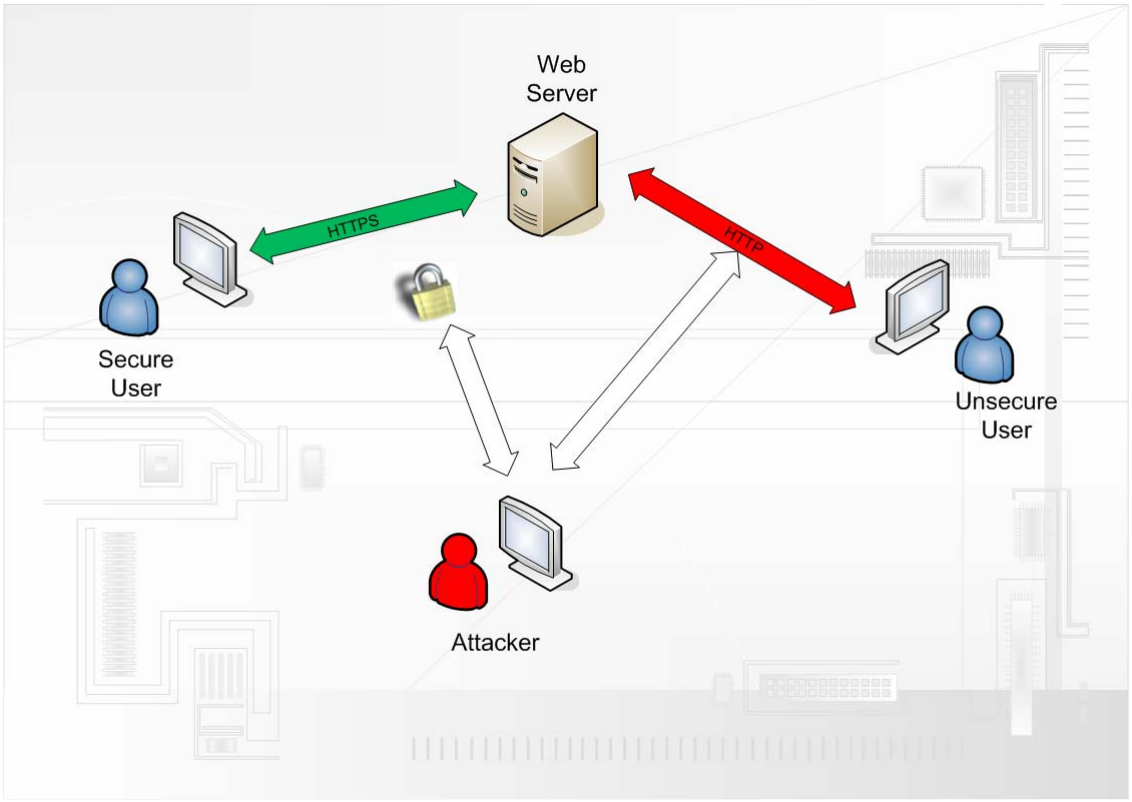
2.2.4 Other issues

2.2.4.1 Security access

The web application will be protected with an authentication form (login and password). Users with access rights are the only ones allowed to enter (to restricted areas). Furthermore depending on level rights each user will have access to their own space and functionalities.

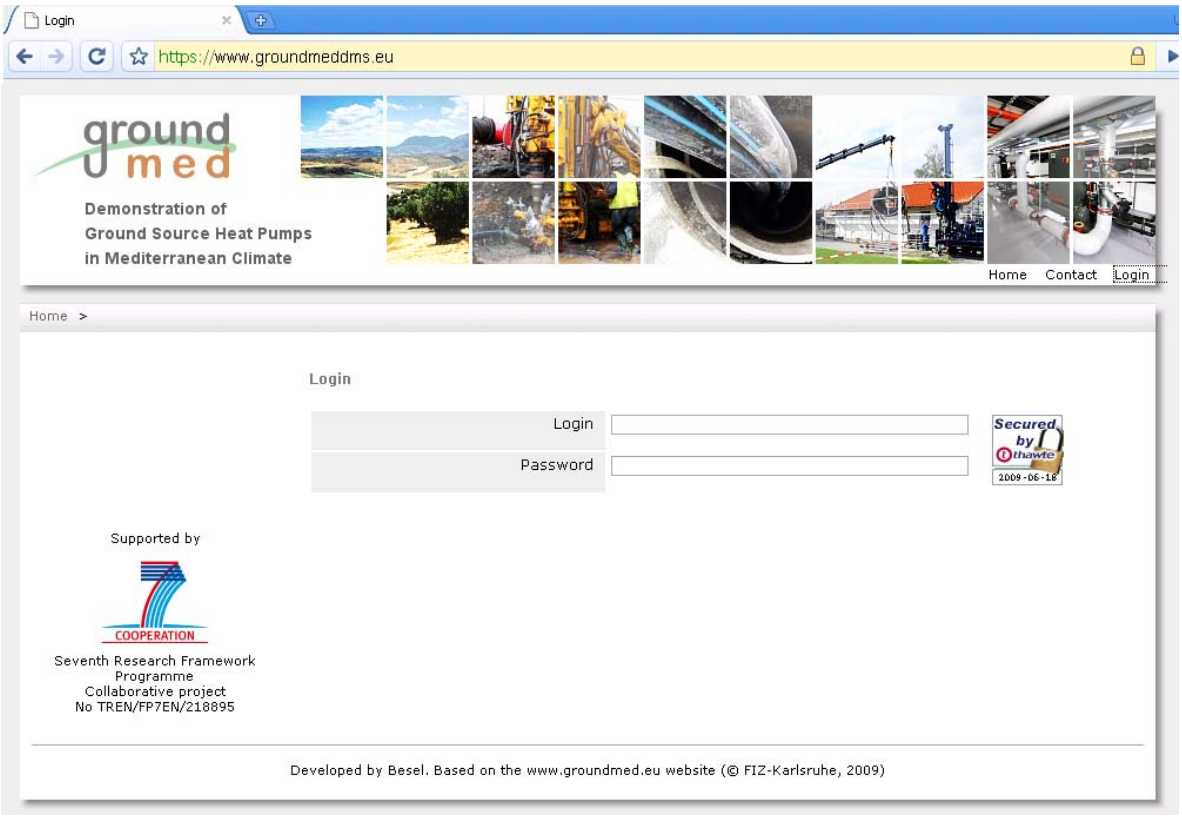
This login and password form isn't enough if the transmitted information is confidential, so we provide additional measures to ensure data confidentiality.

Common websites uses the HTTP protocol (HyperText Transfer Protocol). This protocol transmits the information between the web server and the user in plain text (without encryption). For example someone could intercept the login and password from the administrator and get full system control.



To avoid this, we will use the HTTPS protocol (HyperText Transfer Protocol Secure) that uses SSL (Secure Sockets Layer) technology to encrypt data communications.

This security technology is used by banks or online shops to protect customer's data and money transfers and these secure webs can be differentiated for the address bar colour (yellow or green) and padlock and for the SSL certificate logo.



2.2.4.2 Safety database

Collected data are the most important value of the system, so we have had special focus in enabling measures to ensure a high safety level, listed bellow:

- Database backups in external disks: the whole database will be copied daily in externals hard disks protecting data against disasters like thefts, fires …

- RAID1 disks (Redundant Array of Inexpensive Disks): Server hard disks will be RAID1. This means that we have at least two disks, the main and the mirror disk where all data will be replicated automatically.
  If main disk crashes or fail frequently, the system detects it and starts using the mirroring disk without system availability interruptions.

2.2.4.3 Internationalized website

The DMS and the corresponding website will be developed in the English language.

2.2.4.4 Hosting and deployment

BESEL will provide the web server, the hosting and the web site domain like http://www.groundmeddms.eu until the 60th project month (January 2014).

2.2.4.5 Documentation and support

BESEL will also provide a complete Users Manual explaining all the platform capabilities and functionalities and technical support via email (there will be a dedicated account like support.groundmeddms@besel.es) available until the 60th project month (January 2014).