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η περιφέρεια στο επίκεντρο της ανάπτυξης

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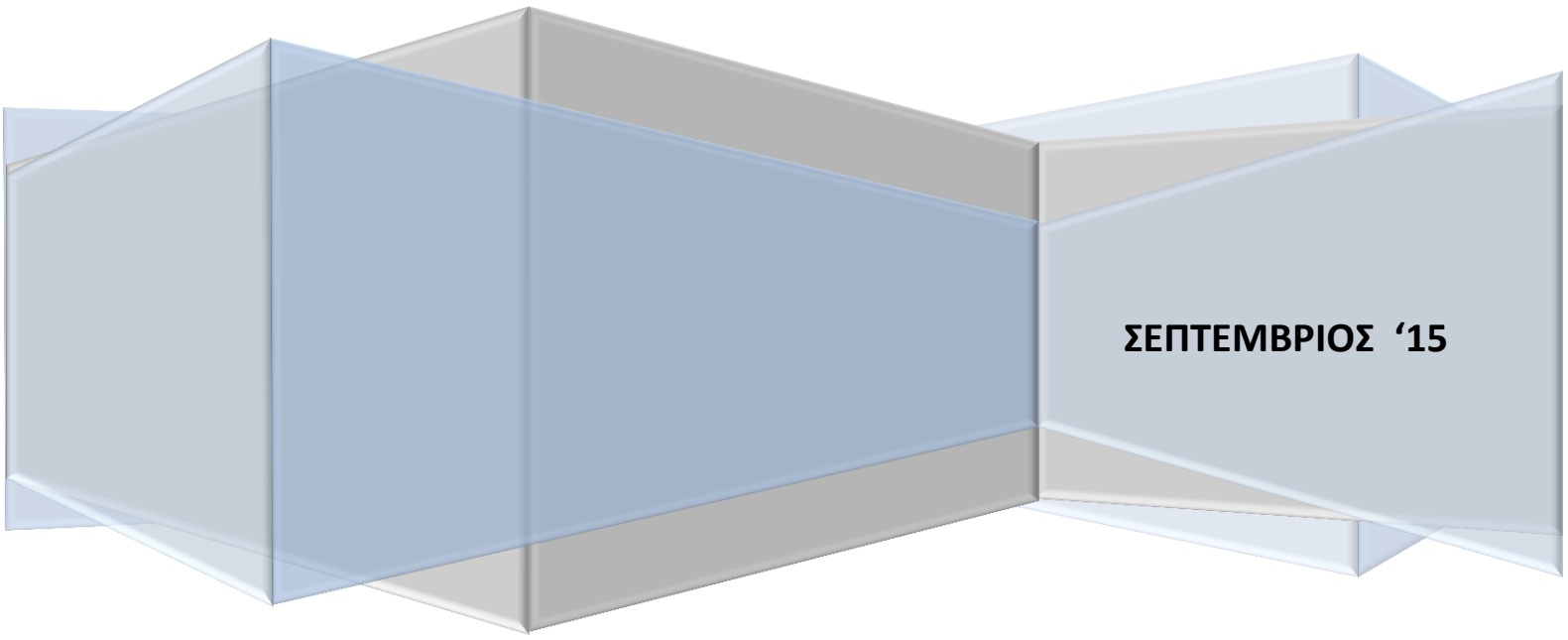
Παραδοτέο 5.1. Αρχιτεκτονική Πλατφόρμας ταχέως Σεισμικού Χαρακτηρισμού

ΕΘΝΙΚΟ ΜΕΤΣΟΒΙΟ ΠΟΛΥΤΕΧΝΕΙΟ



ΣΕΠΤΕΜΒΡΙΟΣ ‘15

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1 The roles of potential users of the RARE system

In the context of the requirements analysis presented in this document, 2 user roles are envisioned:

- The operator, who is a person manning around the clock and in shifts the position of the responsible for the management of traffic across a highway. He/she is responsible for coordinating the necessary resources to keep the road open when it is safe for vehicles to circulate and organize controlled closures and deviations when needed
- The supervisor, who is the superintendant of more than one operators, acting as an escalation point for decisions an operator cannot make on his/her own

2 The concept of workflows

Working is discrete in nature. That is, every piece of work has a beginning and an end, and each can be distinguished from every other type of work, each involving a process being performed. A process consists of a number of tasks which need to be carried out and a set of conditions which determine the order of the tasks. A process can also be called a procedure. A task is a logical unit of work which is carried out as a single whole by one resource. A resource is the generic name for a person, machine or group of persons or machines which can perform specific tasks. This does not always mean to say that the resource necessarily carries out the task independently, but that it is responsible for it. The whole of the processes, tasks, conditions defining the order of execution and resources is called a "workflow".

Workflows are obviously closely related to the way a company conducts its business. Processes, which are their main building block, can widely be categorized into:

- Material processes, whose scope is to assemble physical objects and deliver physical products
- Information processes, which relate to automated tasks (i.e., tasks performed by information systems) and partially automated tasks (i.e., tasks performed by humans interacting with these systems) that create, process, manage, and provide information
- Business processes, which are market-centered descriptions of an organization's activities, implemented as information processes and/or material processes. That is, a business process is engineered to fulfill a business contract or satisfy a specific customer need. Thus, the notion of a business process is conceptually at a higher level than the notion of information or material processes

In the context of the RARE system and this document, the focus is on workflows consisting of information processes which are implemented by the users of the system described herein. The workflow, seen from a user perspective, is usually described using a set of use cases. This approach shall be followed to unveil, codify and record the requirements on the RARE system.

The concept of the workflow, however, has a much more important role as far as the envisioned application is concerned; it shall additionally be used to define functionalities of

the RARE system which shall be designed and implemented to assist the user to carry out his/her duties in a guided manner. One more aspect which is greatly benefitted from the inclusion of workflow management principles in the system is that when shift changes occur, the state can be seamlessly transferred from the person leaving to the one arriving at the post.

This does not imply that the RARE system shall aim at substituting any existing workflow management (WFM) system, but the inclusion of workflow management principles is regarded as a key advantage because of the uniqueness of the problem the RARE system targets to resolve. Moreover, this approach generates a future placeholder for integration of RARE with external WFM systems.

Summing up, the “workflow” notion shall be used in a twinfold manner within this document; both as a means to describe use cases and as a basis to design and implement a set of features pertinent to assisted decision making support.

3 Basic entity-relationship mappings

The highway consists of a set of structures which are interconnected using nodes, through which traffic enters or leaves the highway. The structures and nodes, together with their interconnections, form a graph which can be transversed in 2 directions, since traffic can travel from the “start” to the “end” of the highway and vice versa.

Though a complete modeling of the way all structures and nodes are interconnected seems generic and tempting to employ, the additional complexity is not deemed justifiable in the context of the RARE system, since the target is to provision to the system just which nodes have to be closed to avert traffic from reaching structures which have been judged as potentially unsafe by RARE, knowledge which is a-priori available and static.

One additional useful piece of information is that it is always feasible to restrict access to a certain structure by appropriately handling just 2 nodes. The RARE system shall thus support 2 types of entities, the structure and the node and their relationship shall be that each structure shall be associated with exactly 2 nodes.

The RARE system shall rely on a network of accelerographs to collect the necessary data from the field so as to determine the extent of the damage on highway structures so as to appropriately assist the personnel in carrying out their duties. In order for the exploitation of seismic data provided by the accelerographs to be feasible and efficient, key aspects of these devices shall have to be represented to a certain extent within the system.

The following sections analyze the way these 3 types of entities shall be represented.

3.1 The “structure” entity

The properties related to each instance of a “structure” entity shall be sufficient to:

1. Uniquely identify the entity instance in the context of the RARE system
2. Describe it to users using a human-readable name
3. Assign a type to it (e.g. bridge)
4. Establish a relationship of the “structure” entity with the 2 “node” entity instances representing actual nodes which have to be handled so as to restrict the access of the general public to it. Each “structure” shall have a one-to-one relationship with a “node” entity instance. However, a “node” entity instance may be related to more “structure” entity instances, so overall, the relationship is of the “many-to-many” type

The actual values of the properties of a specific “structure” entity instance shall be provisioned to the system either automatically, upon instance creation, or based on human input.

3.2 The “node” entity

The properties related to each instance of a “node” entity shall be sufficient to:

1. Uniquely identify the entity instance in the context of the RARE system
2. Describe it to users using a human-readable name

3. Establish a relationship of the “node” entity with the “structure” entity instances representing actual structures to which access of the general public is restricted by handling the specific node (many-to-many, since one node may affect the access to multiple structures)

The actual values of the properties of a specific “node” entity instance shall be provisioned to the system either automatically, upon instance creation, or based on human input.

3.3 The “accelerograph” entity

Multiple instances of the “accelerograph” entity shall be created upon system initialization, one for each actual accelerograph device interfaced to RARE. Since, during the evaluation of the potential damage, the seismic data from different accelerographs shall be used, based on proximity or other criteria, each “accelerograph” entity instance shall have to be related to one or more “structure” entity instances (many-to-many relationship).

The properties supported by the RARE system and related to each instance of an “accelerograph” entity shall be sufficient (yet not limited) to:

1. Uniquely identify the entity instance in the context of the RARE system
2. Describe it to users using a human-readable name
3. Encode basic information such as its type, manufacturer, position, measurement capabilities etc
4. Encode networking information so that the RARE system can access the actual device in an automatic manner
5. Establish relationships with the time-series data provided by the physical accelerograph device, so that the RARE system can properly retrieve them to perform the necessary calculations
6. Establish a relationship of the “accelerograph” entity instance with the “structure” entity instances whose damage calculations need the data from the actual accelerograph device represented by the specific instance (many-to-many, since one accelerograph may provide data for the calculation of the damage index of multiple structures)

The actual values of the properties of a specific “accelerograph” entity instance shall be provisioned to the system either automatically, upon instance creation, or based on human input.

4 Representing the status of entity instances

Status representation for the entities instantiated within the RARE system shall rely on the concept of state variables, which is a collection of states an entity instance can be found in. These states must be mutually exclusive in order for them to be part of the same state variable, i.e. the entity can be found in only one of them.

Changes among states shall be triggered by state-change events, which shall be generated by the RARE system or its users. Each state-change event shall be archived, including the following data:

- The trigger of the event (RARE system or user)
- The state the event led to in a descriptive form
- The event occurrence date/time in UTC

4.1 Highway structure status

Since all highway structures may be affected by an earthquake, the RARE system shall instantiate one individual state variable for each "structure" entity instance to represent its damage status. This type of state variable, denoted as "Structure status" in the ensuing shall have 3 distinct states:

- The "Normal" state: When the related "structure" entity instance is in that state, it shall be considered known to be healthy as a result of an inspection or repair after it has been damaged
- The "Potentially damaged" state: When the related "structure" entity instance is in that state, the RARE system has determined that it may have suffered damage, but inspection has not been completed yet, so this suspicion cannot be confirmed or rejected
- The "Damaged" state: When the related "structure" entity instance is in this state, it has undoubtedly suffered damage rendering it inaccessible to the general public

4.2 Highway node status

As already stated, the primary target of the RARE system shall be to assist the traffic management personnel in keeping the general public away from unsafe structures, which have been damaged by an earthquake event. This is achieved by closing the 2 nodes leading to these structures with the help of other authorities, such as civil protection and the police. The RARE system shall be designed to keep track of which nodes should be closed and which have indeed been closed through 2 different state variables:

- The "System recommendation" state variable, encoding how the system has proposed to the operator to handle a node
- The "Actual node status" state variable, encoding the actual status of a node, i.e. whether it is open or closed

The use of 2 different state variables enables the design and implementation of important functionalities, facilitating the operator's decision making process. One state variable of each of these 2 types shall be instantiated for each "node" entity instance and related to it.

4.2.1 The "System recommendation" state variable

This type of state variable shall have 2 distinct states:

- The "Should be open" state: When the related "node" entity instance is in that state, all of the associated structures are considered safe by the RARE system (i.e. the current value of all of their "structure status" state variables is "Normal"), so the node should be kept open
- The "Should be closed" state: When the related "node" entity instance is in that state, at least one of the associated structures are considered unsafe by the RARE system (i.e. the current value of its "structure status" state variable is either "Potentially damaged" or "Damaged", regardless of whether positive confirmation has been received or not), so the node should be kept closed

It has to be noted that this specific state variable has an informative role and does not imply the actual status of the node and humans cannot change its state.

4.2.2 The "Actual node status" state variable

This type of state variable shall have 2 distinct states:

- The "Open" state: When the related "node" entity instance is in that state, it has been confirmed to be open by the responsible authorities
- The "Closed" state: When the related "node" entity instance is in that state, it has been confirmed to be closed by the responsible authorities

Since the RARE system shall not receive the status of the nodes in real-time over a machine-to-machine interface, it shall rely on human input to be informed on their actual status.

5 Representing workflows

As already mentioned in section 2, the RARE system shall implement certain principles of workflow management so as to assist the user in making educated decisions and keeping track of them during the stressful moments after an earthquake event. This approach is deemed invaluable as far as usability and user acceptance of the system is concerned.

The primary tool which shall be employed to keep track of how a workflow evolves shall again be the state variable. One such variable shall be instantiated for each workflow instance. 3 types of workflows shall be represented:

1. The “inspection notification” workflow, encoding the logical steps which should be followed to deploy field crews so that they inspect a structure which, according to the RARE system, may have been damaged
2. The “inspection result collection” workflow, encoding the logical steps which should be followed to collect the feedback from field crews with regards to a structure
3. The “authority notification” workflow, encoding the logical steps which should be followed to inform Civil Protection authorities so as to close a certain node leading to a structure which has definitely been damaged

One state variable related to the status of workflows of the first and second types shall be instantiated for each “structure” entity instance and one state variable related to the status of the third type of workflow shall be instantiated for each “node” entity instance. The following sections describe the states which shall be supported for the types of state variables related to each of these 3 workflow types.

5.1 The “inspection notification” workflow state variable

This type of state variable shall have 4 distinct states:

1. The “Idle” state: When the state variable is in this state, no action is required by the operator
2. The “Notify inspection crew” state: When the state variable is in this state, the operator has to alert the crews responsible for the inspection of the related “structure” entity instance, which is potentially damaged
3. The “Notification batch created” state: When the state variable is in this state, the operator has generated a batch of notifications he/she intends to issue. It is an “auxiliary” state, helping in the implementation of the use case presented in section 7.4
4. The “Inspection crew notified” state: When the state variable is in this state, the operator has already dispatched the inspection crew to the related “structure” entity instance and is waiting for the result of their activity

5.2 The "inspection result collection" workflow state variable

This type of state variable shall have 3 distinct states:

1. The "Idle" state: When the state variable is in this state, no action is required by the operator
2. The "Inspection result pending" state: When the state variable is in this state, the operator has dispatched inspection crews and awaits for their response on the actual status of the structure the state variable is related to
3. The "Inspection result collected" state: When the state variable is in this state, the inspection crews have handed over their verdict

5.3 The "authority notification workflow" state variable

This type of state variable shall have 4 distinct states:

1. The "Idle" state: When the state variable is in this state, no action is required by the operator
2. The "Notify authorities" state: When the state variable is in this state, the operator has to alert the civil protection authorities to close the node represented by the related "node" entity instance, so as to avert the general public from accessing a potentially damaged structure
3. The "Notification batch created" state: When the state variable is in this state, the operator has generated a batch of notifications he/she intends to issue. It is an "auxiliary" state, helping in the implementation of the use case presented in section 7.7
4. The "Authorities notified" state: When the state variable is in this state, the operator has already alerted the civil protection authorities and awaits confirmation that the node represented by the related "node" entity instance has been closed

6 Representing earthquake occurrences

The RARE system shall also implement one state variable instance (denoted as "Earthquake in progress" in the ensuing) to record earthquake occurrences. This state variable shall have 2 distinct states:

- "Yes": When the state variable is in this state, an earthquake has been detected by the accelerograph network and is currently in progress
- "No": When the state variable is in this state, no earthquake occurrence has been detected by the accelerograph network

7 Use cases common to all user roles

The following sections present a set of fundamental use cases around which the RARE system user interface shall be designed and implemented. These use cases shall be common to both user roles (operator and supervisor).

7.1 Use case 0 – Logging in/out of the RARE system

The user shall be presented with an initial screen through which logging into the RARE system shall be achieved. The user shall provide a username and a password. If these are successfully entered, the user shall proceed to the next screen of the system. If not, he/she shall be notified on the event and shall remain at the same screen.

During a user session (i.e. once successfully logged in and until logged out), the RARE system shall clearly present the username and role of the logged in user as well as a logout button.

7.2 Use case 1 – Alerting the user when an earthquake occurs

When an earthquake occurs and as already presented:

1. The accelerographs shall be triggered and the ground acceleration shall be recorded
2. The RARE system shall collect the related information from the field devices and archive it for further use
3. The damage indices shall be calculated and thresholded so as to encode potential damage on the highway structures
4. The open/close recommendations for the highway nodes shall be generated

Steps 3 and 4 of this process may take some minutes to complete. The aim of this use case is to put the user in an alert state prior of that time so as to react as promptly as possible when the system recommendations reach him/her. The RARE system shall thus:

- Calculate a set of metrics, using data collected from the accelerograph network and drive the “Earthquake in progress” state variable presented in section 6
- Issue a visible alarm on the user screen accompanied by an audible cue so as to draw the user to the terminal when the value of the “Earthquake in progress” state variable is “Yes”
- Allow the user to silence the audible cue for the alarm

7.3 Use case 2 – Presenting the user with the list of potentially damaged structures

Once the RARE system has calculated the indices for each structure, it can discern those which may have experienced damage rendering them potentially unsafe. The first step when that information is available shall be to present it to the user so that the relevant workflows (one for each “structure” entity instance) can be initiated. In order to avoid overloading the user, only “structure” entity instances whose related “Structure status” state variables have a value of “Potentially damaged” or “Damaged” AND the current value of the “actual node status” state variable of at least one related node is “Open” shall be presented.

A table shall be used for the presentation, containing 1 row per structure and 5 columns:

1. The first shall contain the name of the structure (content of the “Name” property of each “structure” entity instance – see section 3.1)
2. The second shall contain the value of the related “Structure status” state variable, which can be either “Potentially damaged” or “Damaged” (see section 4.1), the time the state variable has last changed and the trigger of this change
3. The third shall contain the current status of the “inspection notification” workflow state variable related to the specific structure, the time the state variable has last changed and the trigger of this change
4. The fourth shall contain the current status of the “inspection result collection” workflow state variable related to the specific structure, the time the state variable has last changed and the trigger of this change
5. The fifth shall contain the related “node” entity instances, using color coding to indicate their actual status (current value of the related “Actual status” state variable. The colors which shall be used are vivid red if the value is “Open” and grey if the value is “Closed”, since it is only in the first case that the user may have to react towards restricting public access to the affected structure

7.4 Use case 3 – Assisting the user to notify field crews so as to inspect potentially damaged structures

As already presented, if a structure is suspected of having sustained damage from an earthquake, an in situ inspection shall have to be requested and performed so as to determine whether the assessment of the RARE system was correct or not and to decide on further necessary steps. Since many structures are expected to enter the "potentially damaged" state in the case of a severe earthquake, the RARE system shall assist the decision-making process of the user by imposing a set of logical steps for him/her to easily follow during the aftermath of the event.

The entry point for this use case shall be a single button labeled "Initiate inspection notification" visually connected to the table of section 7.3. The button shall be blinking if the current value of at least one "inspection notification workflow" state variable related to the "structure" entity instances within the same table is "Notify inspection crew". When pressed, a separate area on the screen (denoted as "Pending inspection crew notifications" in the ensuing) shall be updated with the list of structures for which the "inspection notification workflow" state variable was "Notify inspection crew" at the time the button was pressed.

If no notifications are pending (the values of all "inspection notification workflow" state variables are "Inspection crew notified"), the button shall be greyed out, since it makes no sense to make use of it when all inspections have been commanded to the field crews. If new structures are inserted in the table, the button shall no longer be greyed so that the user can press it to issue these additional notifications. In this way, the button can also be considered as a visual cue for the user to easily understand whether he/she has to perform an action or not.

It is obvious that this approach shall lead to the creation of one or more batches of notifications, each corresponding to a click on the "Initiate inspection notification" button. The "Pending inspection crew notifications" area on the screen shall thus be divided into multiple sub-areas, each containing a notification "batch", using divider lines. This summarization approach is expected to help the user issue a single notification towards the field crews, containing all of the structures they shall have to inspect.

Once the notification has been successfully issued for the first batch, the user shall be capable of moving on to the next. To reduce visual clutter while minimizing the user workload, a button labeled "Notification OK" shall appear within each of the sub-areas. When the user clicks on it and following additional confirmation within a popup window, the respective sub-area shall be removed and the value of all "inspection notification workflow" state variables of all corresponding structures shall be updated to "Inspection crew notified".

The order that the user shall follow to handle the notifications "batches" is up to him/her. Additionally, it is his/her responsibility to declare that the notifications have been successfully issued (i.e. to click on the "Notification OK" button).

7.5 Use case 4 – Assisting the user to collect inspection results and record the actual structure status

Once a notification has been issued, the inspection crew is mobilized and the inspection result is bound to appear at a certain point in time, related in a stochastic manner to the time the notification has been issued, depending on the conditions the field crew encounters. While the workload until the notifications are issued is quite high, all that the user can do afterwards is wait until the field crew gets back to him/her. Additionally, it is quite improbable that all inspection results will come in at the same time, so a summarization approach as the one presented in section 7.4 is not applicable.

The inspection results shall be recorded for each structure separately. User data entry shall be made possible through a separate pop-up which shall open when the user clicks on the table entry containing the current value of the "inspection result collection workflow" state variable (see section 5.2). Clicking shall be allowed only for entries having a current value of "Inspection result pending", i.e. related to "structure" entity instances for which the inspection crews have been notified – the value of the "inspection notification workflow" state variable is "Inspection crew notified". This popup shall contain:

- A text box so that the user can write any information provided by the field crew
- 2 buttons, one changing the value of the related "Structure status" state variable to "Damaged" and another changing the value of the same information element to "Normal", depending on the outcome of the inspection

Taking into consideration the minimum time the data entry process is expected to take, only one pop-up at any given time shall be allowed, so that the room for error is minimized. The pop-up shall contain clear indications as to the structure for which the data entry is being carried out.

Once the pop-up has appeared, the scope of the user interface shall be restricted to it. The user can exit either by closing the pop-up or by clicking one of the 2 buttons.

7.6 Use case 5 – Presenting the user with the list of nodes which have to be handled

Once the inspection results are in, the user has a very clear picture on which structures are unsafe. The next step shall be to notify the authorities (civil protection and/or police) so as to restrict the access of the general public to the nodes leading to the damaged structures. It has to be noted that the user does not have the authority to command the civil protection to act accordingly, since the latter may choose to leave the highway open for other reasons, unknown to the former, i.e. the civil protection has the overall control. To that extent, it is obviously preferable for the user to engage the authorities only when he/she has concrete evidence they should act, i.e. after the inspection has been carried out.

In order to assist the user in notifying the authorities, the RARE system shall present the nodes to be dealt with (nodes for which the value of the "Structure status" state variable of at least one related structure is "Damaged" – no duplicate entries shall be allowed) in a table with 5 columns:

1. The first shall contain the name of the node (content of the "Name" property of each "node" entity instance – see section 3.2)
2. The second shall contain the value of the related "System recommendation" state variable (see section 4.2.1), which, as already explained can be either "Should be open" or "Should be closed", the time the state variable has last changed and the trigger of this change
3. The third shall contain the current status of the "authority notification" workflow state variable related to the specific node, the time the state variable has last changed and the trigger of this change
4. The fourth shall contain the current value of the "Actual status" state variable related to the node, which can be either "Open" or "Closed" (see section 4.2.2), the time the state variable has last changed and the trigger of this change
5. The fifth shall contain the related "structure" entity instances, using color coding to indicate their status (current value of the related "Structure status" state variable. The colors which shall be used are vivid red if the value is "Damaged" and grey if the value is any other. This column shall be purely informative

7.7 Use case 6 – Assisting the user to notify the authorities regarding the indicated nodes

The entry point for this use case shall be a single button labeled “Initiate authority notification” visually connected to the table presented in section 7.6. The button shall be blinking if the current value of at least one “authority notification workflow status” state variable related to the “node” entity instances within that table is “Notify authorities”. When pressed, a separate area on the screen (denoted as “Pending authority crew notifications” in the ensuing) shall be updated with the list of nodes for which the “authority notification workflow status” state variable was “Notify authorities” at the time the button was pressed.

If no notifications are pending (the values of all “authority notification workflow status” state variables are “Authorities notified”), the button shall be greyed out, since it makes no sense to make use of it.

If new nodes are inserted in the table according to section 7.6, the button shall no longer be greyed so that the user can press it to issue these additional notifications. In this way, the button can also be considered as a visual cue for the user to easily understand whether he/she has to perform an action or not.

The same “batching” approach presented in section 7.4 shall be followed. The only difference is that the “inspection notification workflow status” state variables of all corresponding nodes are the ones which shall be updated to “Authorities notified” when the “Notification OK” button is clicked.

7.8 Use case 7 – Changing the actual status of a node

Once the authorities have been informed, the user awaits feedback on when the node is closed so that the whole workflow is completed successfully. When such information is relayed back to him/her, it shall be declared to the RARE system by clicking on the table entry containing the current value of the “Actual status” state variable related to a specific node. Only transitions from “Open” to “Closed” shall be allowed to the user, i.e. when the current value of the state variable is “Closed”, the item shall not be clickable.

When the button is clicked, an additional confirmation popup shall appear. The confirmation pop-up shall contain clear indications as to the node of which the actual status is being changed. Once the pop-up has appeared, the scope of the user interface shall be restricted to it. When the user confirms his/her action, the value of the “Actual status” state variable shall change to “Closed”.

8 Use cases pertinent to the supervisor role

The following sections present use cases which apply only when the user has logged in with supervisor credentials. The supervisor is assumed to have stronger rights when compared to the operator, since he/she undertakes the coordination with other divisions of the highway operating entity.

8.1 Use case 8 – Manually setting the value of the "structure status" state variable

As already mentioned, the supervisor shall have the right to set the value of the "structure status" state variable. Only transitions from "Normal" to "Damaged" and from "Damaged" to "Normal" shall be supported. The problem that appears is that the table presented in section 7.3 shall contain a structure only when the current value of the related state variable is either "Potentially damaged" or "Damaged" and not "Normal". In order to force the table to present all of the structures known to the RARE system, a separate toggle button, visually connected to the table shall exist. This button shall be greyed when the user has logged in with operator rights and shall be operable only when the user has logged in with supervisor rights. Its default state shall be set so that the table presents all of the structures and this state shall be appropriately denoted using text. When the button is clicked once, its state shall change, so that the table presents structures according to the use case presented in section 7.3. The new state shall be annotated using text. If clicked again, the reverse shall happen.

The table entry containing the current value of the "structure status" state variable shall also be clickable, only when the user has logged in with supervisor rights and the current status is either "Damaged" or "Normal". When clicked, a popup window shall appear with a button used to change the value of the state variable to the opposite of the current one. Additional confirmation shall be requested. The user shall be capable of closing the window and rejecting any change. Only one popup shall be allowed at any time and the scope shall remain with that window until closed to reduce the possibility of human error.

8.2 Use case 9 – Manually setting the value of the "actual node status" state variable

This use case shall operate in the exact same way as the previous one. The only differences are that the scope of specification is now on the table containing the nodes (see section 7.6) and the state variable whose value shall be changed is the "actual node status" one.

9 Outline of the user interface design

The previous sections have outlined a set of basic elements which shall have to be employed in the design of the user interface of the RARE system. These are:

- A table with clickable cells, capable of being divided into sub-tables, required by practically all use cases. The content shall have to be programmatically determined so as to allow for different configurations
- A popup window, required by the use cases of sections 7.4, 7.5, 7.7, 7.8, 8.1 and 8.2
- A text entry window, required by the use case of section 7.5
- Buttons and toggle switches, required by practically all use cases
- An audio playback “module”, required by the use case of section 7.2

These “building blocks” shall be combined to create a user interface. An exemplary screen layout is presented in the figure below. The elements are ordered in 6 different areas:

- A “general information” area, existing to contain data which are either semi-static or are not directly related to the entities represented within the RARE system
- A “structure table” area, which shall contain the table presenting the structures and the status of associated state variables as well as the related controls
- A “node table” area, which shall contain the table presenting the nodes, their state variables and controls
- 2 “batch notification” areas, allowing the user to handle batch notifications towards inspection crews and authorities

The next figure presents the same example, but populated with exemplary elements which could be employed. Future versions of this document shall include a presentation of how the user is expected to interact with the proposed user interface, possibly in the form of an interactive mockup.

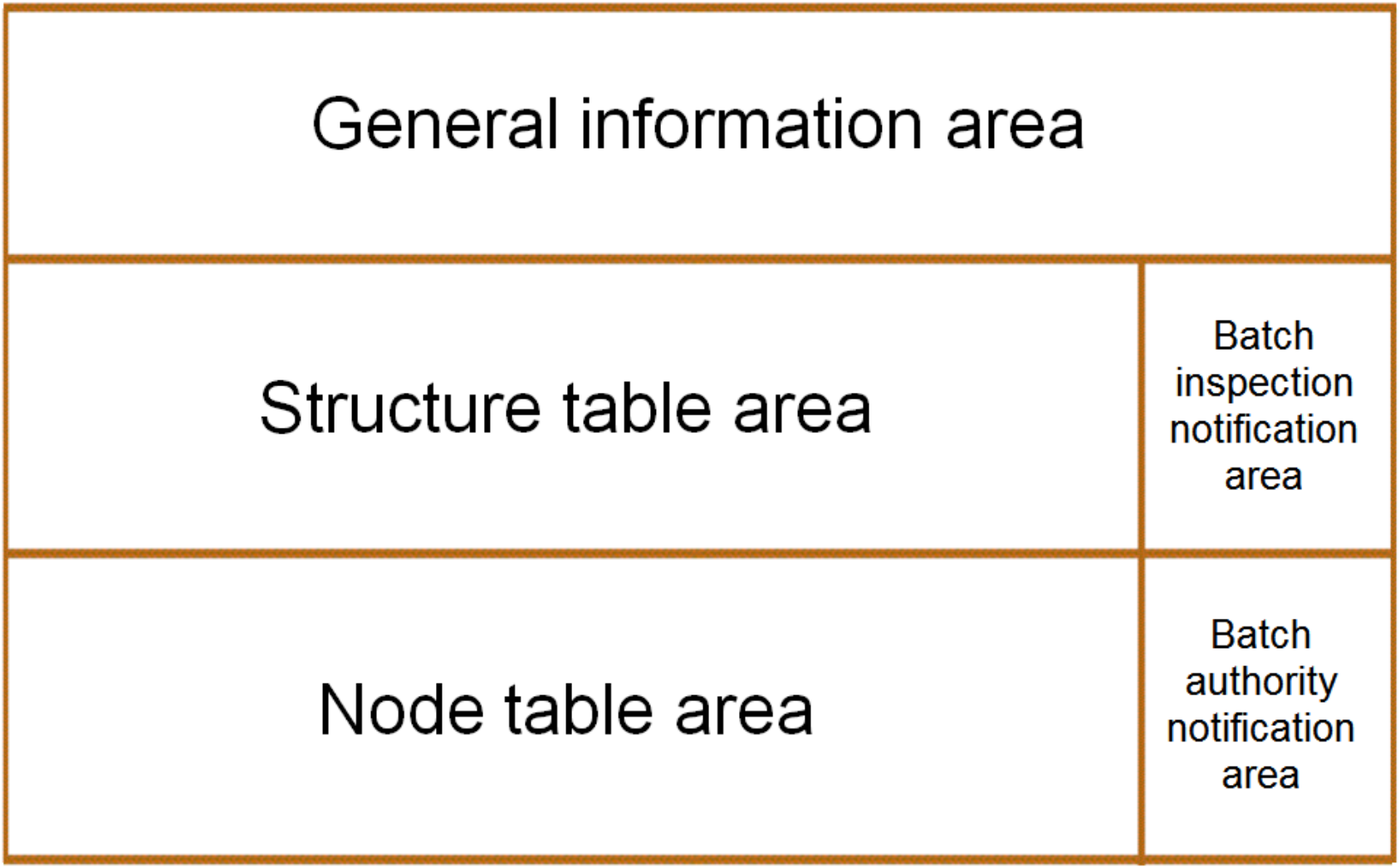


Figure 1. Exemplary page layout for the RARE user interface

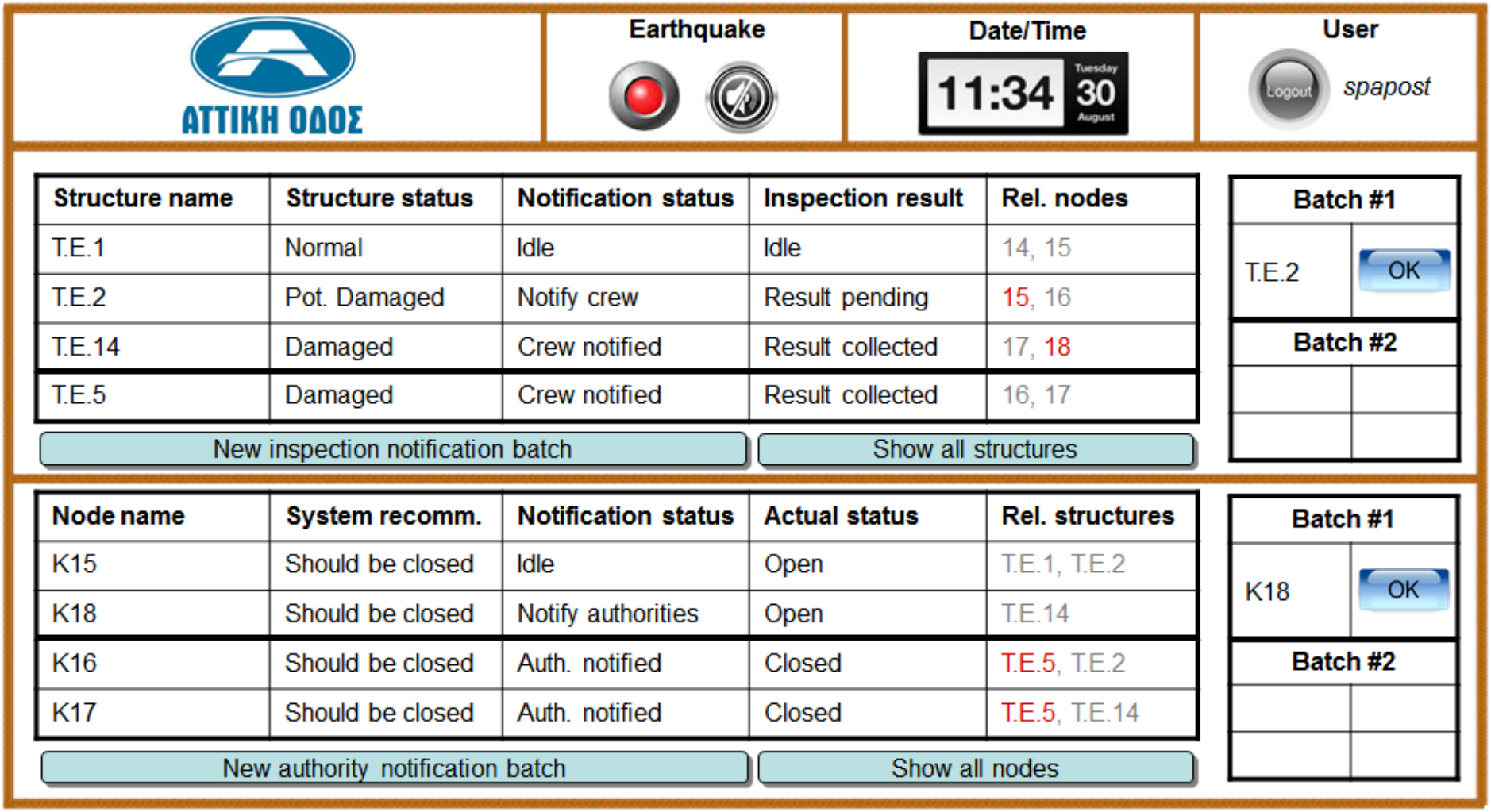


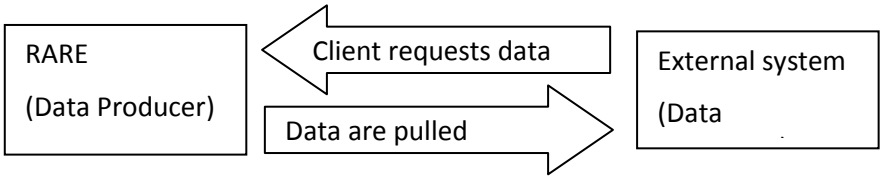
Figure 2. Populated example

10 Interfacing with the GIS system of Attiki Odos

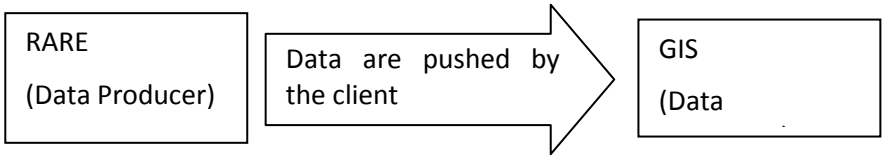
This last section describes the requirements on the software interface to be implemented within RARE, so as to enable the exchange of real-time status information with the GIS system of Attiki Odos.

10.1 Definition of the GIS Feeding RARE Database Client *(GFRDC)*

According to the initial proposition, the RARE system would expose a simple API to allow external entities to view the status of structures in the context of a single infrastructure. Communication-wise, the mode of operation was envisioned to rely on the external components pulling data from RARE.



An alternative scheme, based on RARE pushing data to the GIS system, was proposed. Regardless of the means of communication, the data presented within the previous version of this specification were identified to be adequate.



In order to accommodate this need, an additional component will be developed: “GIS Feeding RARE Database Client” (GFRDC in short).

10.2 General Description of the GFRDC

The GFRDC will be implemented as an extension of RARE, but will be specifically customized for feeding status data to the GIS database. However, since RARE and GIS are two separate systems, their functional interdependency must remain minimal despite the introduction of the GFRDC.

GFRDC, as its name suggests, will act as a client of the database management system already in use by the GIS system. Access to the database shall be limited to a single table (RARE_STATUS_OF_STRUCTURES) where the GFRDC shall have write permissions. No other

components shall be writing on that table during normal operation. Proper declaration of the schema and access rights to the table shall be the responsibility of the GIS system. The exact schema of the table is specified in the following section of this document. The proposed table must have no dependencies on other tables of the database (foreign keys or other constraints), since GFRDC must remain unaware of any other internals of the GIS system.

The GFRDC will be implemented as an external agent, employing the RARE REST interface, instead of an internal component of RARE. In this way:

- The most appropriate technology (programming language, execution environment etc) can be selected given the database connectivity specifications
- There will be more flexibility on the network setup to meet the server to server integration of the two systems

10.3 Functional Description

The purpose of the GFRDC is to adapt the original pull data approach to the proposed push data approach. Therefore, the GFRDC must periodically poll RARE for the current status of all structures and push this information to the GIS database table. The period of the pull/push cycle shall be configurable. The range shall be from 5 to 3600 seconds with a default value of 30 sec. However:

- A pull/push cycle may occur at any point in time
- Two pull/push cycles may be spaced more than the configured period apart but not less
- If for any external reason (network congestion, RARE or GIS system resource limitations) a pull/push cycle takes more than the half the configured period to complete, it may be aborted

Only the current status of structures shall be communicated, therefore GFRDC:

- Needs only to access current status of structures
- Need not maintain state between two pull/push cycles
- Has no synchronization constraints with other GIS components

All data elements (fields, variables) shall be mapped one-to-one between the 2 systems using the same encoding. No conversion, transformation or manipulation shall be performed on the data values.

10.4 Data Description

This section describes the data to be inserted by the GFRDC to the RARE_STATUS_OF_STRUCTURES table of the GIS database. The SQL DDL (data definition language) statement that defines the structure of that table is given below, followed by a brief discussion on the defined data elements (fields).

```
CREATE TABLE RARE_STATUS_OF_STRUCTURES {
     structure_id           INTEGER PRIMARY KEY,
     structure_name         VARCHAR(150),
     status_code            INTEGER NOT NULL,
     status_description     VARCHAR(50),
     occurrence_time        TIMESTAMP WITH TIME ZONE,
     read_value_time        TIMESTAMP WITH TIME ZONE
}
```

- **structure_id:** This is the RARE structure identifier. There is no expected practical use for the GIS system per se other than it is the best candidate for a unique identifier to be used in the table from the point of view of GFRDC
- **structure_name:** This is the display name given to the structure in RARE
- **status_code:** This is the numeric code of the status, defined within RARE
- **status_description:** This is a textual representation of the status, defined within RARE
- **occurrence_time:** The status change event occurrence time
- **read_value_time:** This is the time that the GFRDC pulled the data from RARE. It could be used as a "data age" indicator for the table records

10.5 Requirements pertinent to semantic interoperability

In order to achieve the required functionality, the 2 systems shall have to share the same semantic interpretation of the information they exchange. For that purpose, 3 data elements, already defined within the previous section, shall be used:

- The "Structure name", which shall be a human-readable description of the structure whose status is being communicated
- The "Status code", which shall be a numerical representation of the current status of a structure
- The "Status description", which shall be a human-readable description of the current status of a structure