Self-Adaptive Quality Requirement Elicitation Process for Legacy Systems: A Case Study in HealthCare

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- Motivation and Background

- Self-Adaptive Quality Requirement Elicitation Process (SAQEP) and Its Application

- Conclusions and Further Work

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MOTIVATION

➢ Instituto Nacional de Rehabilitacion (INR) – Mexico:

❑ Picture and Archiving and Communication System (PACS) currently has several functionalities that are impacting negatively on:

- The delivery of services to end-users such as doctors and patients, and
- The effort invested by system administrators in technical and maintenance tasks.

SELF-ADAPTIVE (AUTONOMIC) SYSTEM

A **self-adaptive system** is:

"*Software which **modifies its own behavior** in response to changes in its operating environment. By operating environment, we mean anything **observable** by the software system, such as end-user input, external hardware devices and sensors, or program instrumentation*".
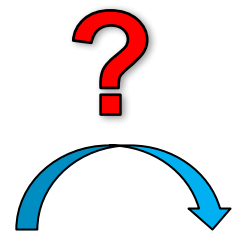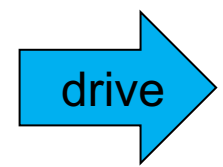
Oreizy, P. et al. 1999

RESEARCH PROBLEM

Self-Adaptive Requirements

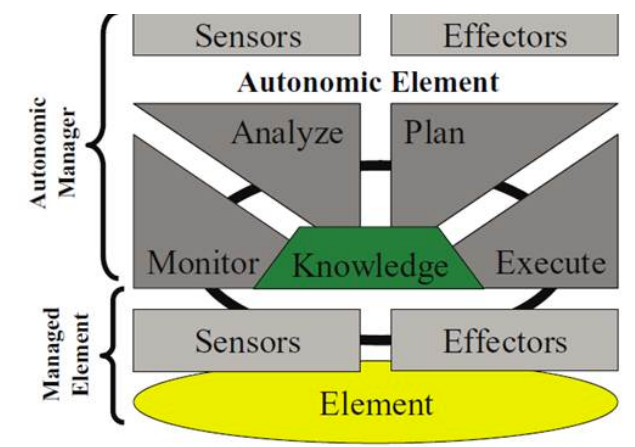**?**

- Elicitation
- Specification
- Process

Self-* properties:

- ◎ Self-configuration
- ◎ Self-optimization
- ◎ Self-healing
- ◎ Self-protection

drive ➜

Autonomic Architecture (MAPE-K)

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BACKGROUND

➢ Quality Attributes Drive the Architecture Design

❑ Quality Attribute Scenarios: Refer to a quality-attribute specific requirement (SEI)

Source	Developer
Stimulus	Wishes to change the UI
Artifact	Code
Environment	At design time
Response	Modification is made with no side effects
Response Measure	In three hours

➢ Literature states that there is a relationship between Quality Attributes and Self-* Properties

- Salehei et al. 2009
- Ganek and Corbi 2003.

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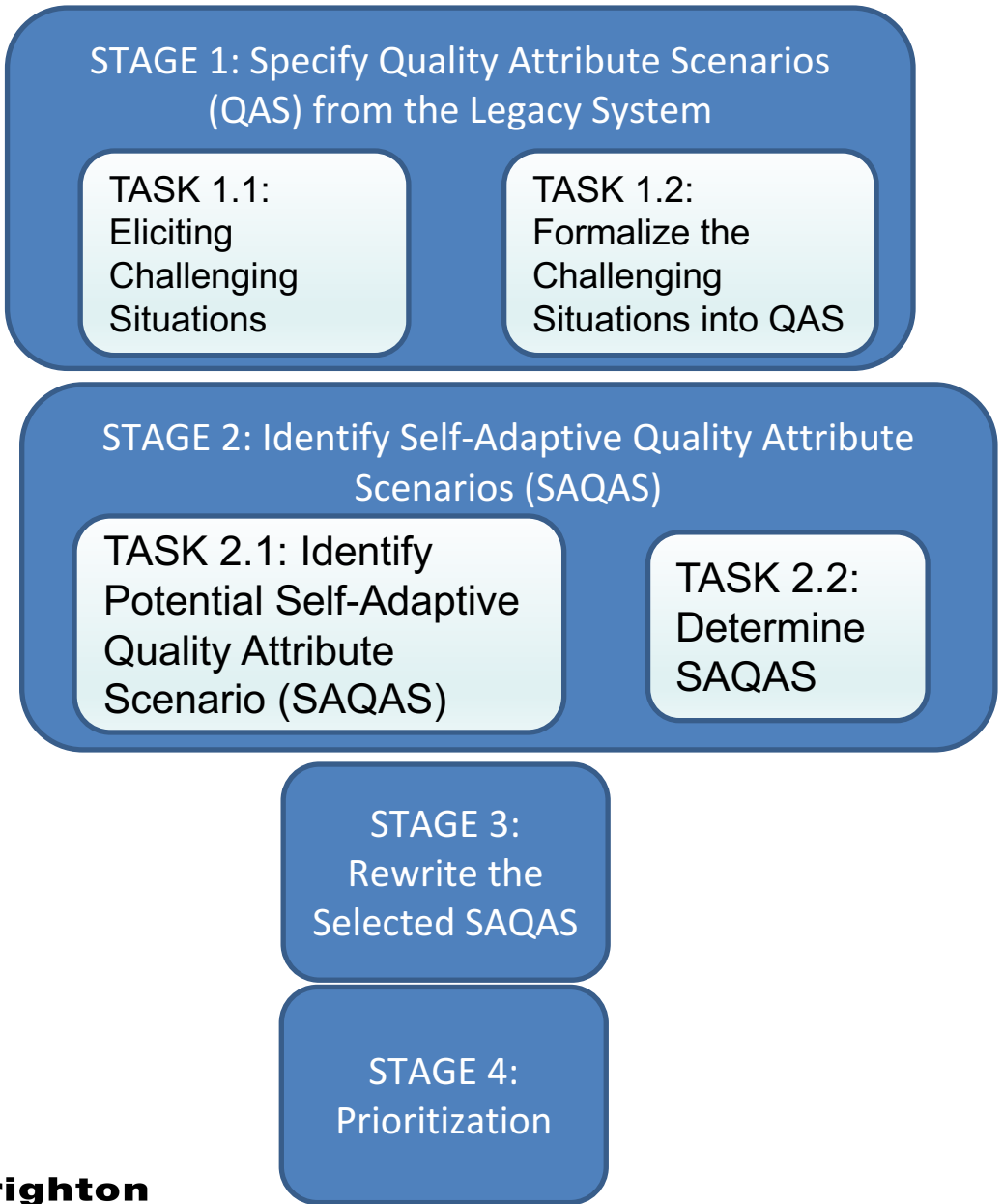# SELF-ADAPTIVE QUALITY REQUIREMENT ELICITATION PROCESS (SAQEP)

➢ This process allows the requirements of a legacy system to be analysed to be reengineered for self-adaptation.

➢ As an output of the process, we produce a **list of QAS** and **Self-Adaptive Quality Attribute Scenarios (SAQAS).**

Self-Adaptive General Scenario

Source	Administrator, Developer, Operator, System, User		
Stimulus	Challenging Situation		
	Current Actions		
	Current Measure		
Artifact	Locate which architectural element(s) of the legacy system are affected by the stimulus. These elements can be components (servers, software, etc.), connectors, services, subsystems, hardware.		
Environment	Runtime		
Response	Actions	Indicate the actions that the *system* will perform in: 1) observing its own behaviour and 2) self-adapting its behaviour.	
	Self-Adaptive Response	List the self-adaptive properties	
Response Measure	Effort, QAS measurements, Expenditure, etc.		

SELF-ADAPTIVE QUALITY REQUIREMENT ELICITATION PROCESS (SAQEP)

STAGE 1: Specify Quality Attribute Scenarios (QAS) from the Legacy System

TASK 1.1: Eliciting Challenging Situations

TASK 1.2: Formalize the Challenging Situations into QAS

QAS List.

STAGE 2: Identify Self-Adaptive Quality Attribute Scenarios (SAQAS)

TASK 2.1: Identify Potential Self-Adaptive Quality Attribute Scenario (SAQAS)

TASK 2.2: Determine SAQAS

Selected SAQAS List.

STAGE 3: Rewrite the Selected SAQAS

List of SAQAS.

STAGE 4: Prioritization

Prioritized SAQAS

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APPLYING SAQEP

> ***STAGE 1: Specify Quality Attribute Scenarios (QAS) from the Legacy System***

> > TASK 1.1: Eliciting Challenging Situations

> > > A workshop was carried out with all the stakeholders of PACS-INR

> > > > 1 doctor, the Responsible Administrator and 2 Operators.

> > > Analysed log files

> > > **Output**: 13 challenging situations

SQuaRE model in ISO 25010

ID	Challenging Situation	Qual
1	A failure is detected in the application, file system or database servers. This failure prevents the normal PACS-INR operation.	Reliability Sub-attribute: Availability
2	A new version of the visualization component is released which must be installed manually in each client PC of the doctors.	Portability Sub-attribute: Installability Replaceability Adaptability
3	Each time a new equipment for visualizing medical images is installed to be part of the PACS-INR system, the DICOM (Digital Imaging and Communications in Medicine) compatibility is assured in the new server since the PACS-INR system protocol to transfer images is specified in DICOM.	Compatibility Sub-attribute: Co-existence Interoperability

APPLYING SAQEP

> ### STAGE 1: Specify Quality Attribute Scenarios (QAS) from the Legacy System

>> ### TASK 1.2 Formalize the Challenging Situations into QAS

Availability QAS

ID	Challenging Situation	Quality Attribute
1	A failure is detected in the application, file system or database servers. This failure prevents the normal PACS-INR operation.	Reliability Sub-attribute: Availability

Source	Internal to the system	
Stimulus	Challenging Situation	A crash is detected in the application, file system or database servers. This failure prevents the normal PACS-INR operation.
	Current Actions	The administrator manually sets up a mirror server by using the same parameters as the failed server.
		Once the mirror server is configured, the administrator performs the following reliability checks:
		- To verify that all the application, file system and database servers are in normal operation.
		- Several transactions are launched from the application server to the database server.
		Once the above checks are performed, the administrator publishes and activates the servers to be online to provide services to the end-users.
	Current Measure	The effort of one administrator takes 60 minutes
Artifact	- Application server	
	- File system server	
	- Database server	
Environment	Runtime	
Response	The Administrator is notified that there is a failure in any of the servers, and then he/she launches an automatic process that consists of a) configuring a mirror server and b) checking that the mirror server has been properly configured to ensure that doctors will be able to save, retrieve and visualize medical images, c) Publishes the new mirror server.	
Response Measure	-The repair time in executing the automatic process takes 5 minutes.	
	-The effort of developing this automatic process is 1 developer during two months.	

APPLYING SAQEP

- *STAGE 2: Identify Self-Adaptive Quality Attribute Scenarios (SAQAS)*
  - TASK 2.1: Identify Potential Self-Adaptive Quality Attribute Scenario (SAQAS)
    - We selected all the QASs which have Runtime in the Environment
    - In addition, a Potential SAQAS can have one of the following:
      - The **Response** indicates actions to be performed by the system.
      - The **Response** states that a set of actions are to be conducted repeatedly by stakeholders.
    - **Output**: 7 Potential SAQAS

APPLYING SAQEP

➢ *STAGE 2: Identify Self-Adaptive Quality Attribute Scenarios (SAQAS)*

   ➢ TASK 2.1: Identify Potential Self-Adaptive Quality Attribute Scenario (SAQAS)

Source	Internal to the system	
Stimulus	Challenging Situation	A crash is detected in the application, file system or database servers. This failure prevents the normal PACS-INR operation.
	Current Actions	The administrator manually sets up a mirror server by using the same parameters as the failed server.
		Once the mirror server is configured, the administrator performs the following reliability checks:
		- To verify that all the application, file system and database servers are in normal operation.
		- Several transactions are launched from the application server to the database server.
		Once the above checks are performed, the administrator publishes and activates the servers to be online to provide services to the end-users.
	Current Measure	The effort of one administrator takes 60 minutes
Artifact	- Application server	
	- File system server	
	- Database server	
Environment	Runtime	
Response	The Administrator is notified that there is a failure in any of the servers, and then he/she launches an automatic process that consists of a) configuring a mirror server and b) checking that the mirror server has been properly configured to ensure that doctors will be able to save, retrieve and visualize medical images, c) Publishes the new mirror server.	
Response Measure	-The repair time in executing the automatic process takes 5 minutes.	
	-The effort of developing this automatic process is 1 developer during two months.	

> ### *STAGE 2: Identify Self-Adaptive Quality Attribute Scenarios (SAQAS)*
>> ### TASK 2.2: Determine SAQAS

Source	Internal to the system	
Stimulus	Challenging Situation	A crash is detected in the application, file system or database servers. This failure prevents the normal PACS-INR operation.
	Current Actions	The administrator manually sets up a mirror server by using the same parameters as the failed server.
		Once the mirror server is configured, the administrator performs the following reliability checks:
		- ✓ SAQAS ion, file system and database servers are in normal op
		- Several transactions are launched from the application server to the database server.
		Once the above checks are performed, the administrator publishes and activates the servers to be online to provide services to the end-users.
	Current Measure	The effort of one administrator takes 60 minutes
Artifact	- Application server	
	- File system server	
	- Database server	
Environment	Runtime	
Response	The Administrator is not ~~Observation~~ lure in any of the servers, and then he/she launches an ~~Manual~~ automatic process that consists of a) configuring a mirror server and b) checking that the mirror server has been properly configured to ensure that doctors will be able to save, retrieve and visualize medical images, c) Publishes the new mirror server.	
Response Measure	-The repair time in executing the automatic process takes 5 minutes.	
	-The effort of developing this automatic process is 1 developer during two months.	

APPLYING SAQEP

> ***STAGE 3: Rewrite the Selected SAQAS***

Response	The PACS-INR system:
	1) Detects that one of the server fails.
	2) Automatically a) configures a mirror server and b) checks that the mirror server has been properly configured to ensure that doctors will be able to save, retrieve and visualize medical images, c) Publishes the new mirror server.
	Self-Awareness Self-Healing Self-Configuration
Response Measure	- The PACS-INR takes 6 minutes to detect and repair the failure. -The effort of developing this automatic process is 1 developer during two months.

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CONCLUSIONS AND FURTHER WORK

➢ We have defined a process called SAQEP that attempts to synthesize guidelines for conducting a quality attribute requirement elicitation for re-engineering a legacy system to become self-adaptive.

➢ From 13 quality attribute challenging situations elicited from INR stakeholders, our process selected 7 self-adaptive quality attribute scenarios.

➢ Further Work:

❑ We have designed initial autonomic architecture.

❑ Evaluate how SAQEP has helped in designing the autonomic architecture.

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QUESTIONS?

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