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Deliverable 1.3.4

Selection of services to be cloudified, deployed and transferred

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Project Presentation

Surfing Towards the Opportunity of Real Migration to Cloud-based public Services (STORM CLOUDS) is a project partially funded by the European Commission within the 7th Framework Program in the context of the Competitiveness and Innovation Framework Programme (CIP) programme (Grant Agreement No. 621089).

The project has the objective of exploring the shift to a cloud-based paradigm for deploying services that Public Authorities (PAs) currently provide using more traditional Information Technology (IT) deployment models. In this context, the term "services" refers to applications, usually made available through Internet, that citizens and/or public servants use for accomplishing some valuable task.

The project aims to define useful guidelines on how to implement the process of moving application to cloud computing and is based on direct experimentation with pilot projects conducted in, at least, the cities participating to the consortium.

STORM CLOUDS will also deliver a consolidated portfolio of cloud-based services validated by citizens and Public Authorities in different cities and, at the same time, general and interoperable enough to be transferred and deployed in other European cities not taking part in the project.

The project is implemented by the following consortium:

Member	Role/Responsibilities	Short Name	Country
Ariadna Servicios Informáticos, S.L.	Participant	ASI	Spain
Hewlett Packard Italiana S.r.l.	Participant	HP	Italy
EUROPEAN DYNAMICS Advanced Systems of Telecommunications, Informatics and Telematics	Participant	ED	Greece
Research, Technology Development and Innovation, S.L	Coordinator	RTDI	Spain
Aristotelio Panepistimio Thessaloniki	Participant	AUTH	Greece
Alfamicro Sistemas de Computadores LDA	Participant	Alfamicro	Portugal
Ayuntamiento de Valladolid	Participant	Valladolid	Spain
City of Thessaloniki	Participant	Thessaloniki	Greece
Câmara Municipal de Águeda	Participant	Águeda	Portugal
Miskolc Holding Plc.	Participant	Miskolc	Hungary

For more information on the scope and objectives of the project please refer to the Description of Work (DoW) of the project.

Executive Summary

The objective of documents D1.3.4 is to register the process for selection of applications that has been carried out at the cities which are participants to the project. This process was inspired by the methodological principles set in Deliverable D1.1 "Report on Best Practises and Guidelines for the involvement of Users and Stakeholders".

In the first three paragraphs of the document (from D1.3.1 to D1.3.3) it was shown how selection process is established for the applications to be migrated to the cloud created in different cities. In the period covered by D1.3.3 the selection process covered all the applications for the rest of the project. Therefore, the selection of the applications has already been completed when this document was to be edited. On the other hand, WP1 members felt that it was worthwhile to document the experiences achieved during the project in this work.

Therefore, the conclusion was to devote the last document of the series to consolidate the work done in a methodology that provides future cities with phases and guidelines to effectively implement a selection process for applications to be cloudified based on the Open Innovation paradigm.

The document presents the main phases of the methodology. Furthermore, there are subsections for each phase of the methodology where the activities are listed to be done, as well as some tips and examples are presented.

The phases defined for the methodology are as follows:

- **Initial design:** This phase is devoted to the formal definition of objectives and associated Key Performance Indicators. In this phase, the project context will be also formally defined.
- **Preparation:** This phase is devoted to prepare all the actors to effectively start the selection process. This includes the selection of stakeholders, a pre-selection of applications that might be moved to the cloud as well as the design of a communication strategy and supporting material.
- **Implementation:** In this phase, a work is carried out with stakeholders using mechanisms as focus groups, e-mails, forms, meetings, etc. With all the information being gathered in the process the applications to be migrated will be selected.
- **Monitoring and Feedback:** Finally, the migration process is to be monitored and the obtained feedback is to be used to improve the process if required.

This document includes some inputs from deliverable D3.4.2 "Best Practises for cloud-based public services deployment", cited in references.

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1 Introduction

This document is the last in a series of four documents (from D1.3.1 to D1.3.4) that shows how the selection process for the applications to be migrated to the cloud is to be done. In the three previous documents, the work carried out at each city has been presented; as well as the conclusions that can be extracted from each period.

For this version, the work package participants discussed how to present the work carried out. Obviously, the easiest way is to describe again the activities carried out for the selection of services to be migrated to the cloud. However this exercise has already been done three times. What is going to feel a potential future reader of these documents if this information is presented again? The introduction of a new perspective was needed to go a step further. D1.3.4 documents are not only presenting the work done but also practical material to replicate this work in other cities Europe-wide.

Therefore, the final decision was to compile the methodological guidelines, material used at each city to support the process and the feedback that each city has obtained from the process.

The document is divided in the following sections:

1. Introduction. This section.
2. Overview of Methodological Guidelines: This section presents briefly the foundations of the approach taken in STORM CLOUDS and the phases defined for the Methodology
3. The Methodology to Select Applications: In this section all the phases of the methodology are presented with suggestion of tools that can be used and examples of situations coming from the experience of the cities in the project.
4. Other EC Projects on Cloud Computing: This section briefly summarises other projects related to STORM CLOUDS that contribute to create a sound body of knowledge about cloud computing for the Public Administrations sector in Europe
5. Section 5, presents the main conclusions.

2 Overview of Methodological Guidelines

2.1 The Foundations

The methodological work in STORM CLOUDS is based on two main authors that support the concepts of open innovation and user-driven innovation:

- The Open Innovation methodology [Chesbrough06][Chesbrough03] identified as a key methodology to define products and services particularly relevant in a context where technology and societal demands evolve very quickly.
- In parallel, Eric Von Hippel [Hippel88] works on user-driven innovation. Hippel states that the drivers of innovaton are more users and consumers than product providers. In his book, "Democritizing Innovation" [Hippel06] Hippel states that "*Users, aided by improvements in computer and communications technology, increasingly can develop their own new products and services*". The figure of the "lead users," who are ahead on marketplace trends and whose innovations are often commercially attractive, is identified as a key element in the innovation process.

These two authors already were used as inspiration for a previous project where some STORM CLOUDS partners participated: The PEOPLE Project. PEOPLE project aimed at speeding up the uptake of Smart Cities through the rapid implementation, deployment and uptake of innovative internet-based services in order to allow facing the main challenges of developed cities at present and towards their future quality of life. One of its main outcomes was the development and testing of a User-driven Open Innovation Methodology for the selection and deployment of smart city services, which contributes to the establishment of Smart Urban Ecosystems.

STORM CLOUDS builds on top of that methodology, taking from PEOPLE also the structure of iteration over innovation cycles, as represented in the figure

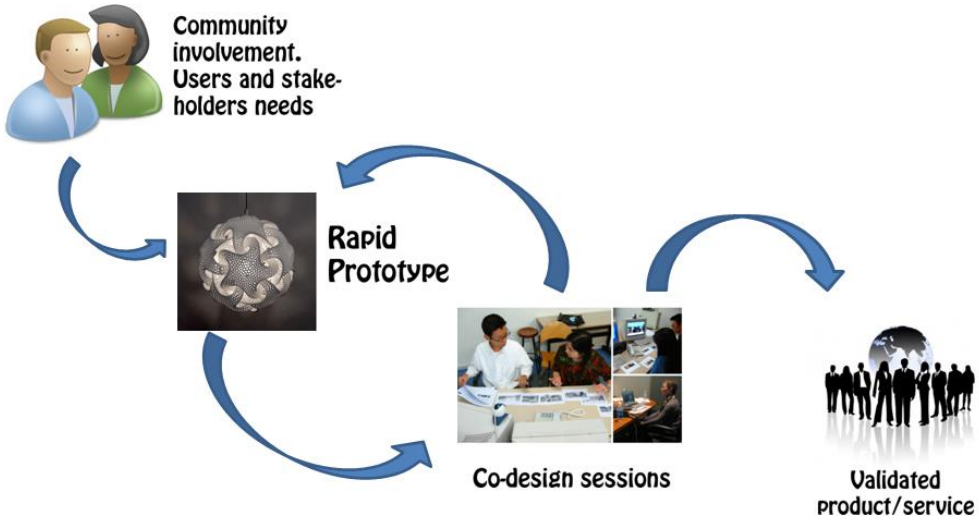

Figure 1: Basic innovation cycle

However, there are important differences among both projects and, therefore, these must be considered before applying to STORM CLOUDS this methodology.

We always must bear in mind that **STORM CLOUDS is not about designing applications or services to be provided to the public; STORM CLOUDS is about migrating applications to the cloud**. The involvement of citizens, local SMEs, etc. in this process must be considered carefully because the fact that an application is hosted in a cloud or at the Municipality premises is transparent to most of users. This is common to all cloud environment: Can an employee definitively state if their company email service is hosted in-house or hired to an external cloud-based provider?

In addition, migration to the cloud is a deeply technical project with implications on performance, budget, organisation, etc. This is important because the involvement stakeholders having different profiles require that they understand perfectly the implications of this technical-managerial decision.

Therefore, the immediate conclusions that we will be considering during the whole process are:

- Who is my stakeholder? We must really define who will be involved in the process and how their opinion will be considered.
- Strong and well designed communication campaigns so all involved actors are really aware of the implications of their decisions.

With these main considerations in mind, the original Innovation cycle is modified as follows:

- Rapid Prototyping does not apply to this process, because the applications to be migrated are already working in the Municipality or in another Municipality.
- Co-design sessions are transformed into sessions to select the best possible application to be migrated to the cloud, according to the benefits that this migration will produce.
- The validation of the process is rather technical and most of the stakeholders involved (citizens, local SMEs, ..:) will not perceive the change of platform. If we want to involve stakeholders monitoring must focus on the features that are provided due to the cloud: scalability, etc.

So the proposed methodology is lineal, not iterative. The main structure is presented in the section hereafter.

2.2 Methodology Structure

Considering the above, the methodology implemented at STORM CLOUDS consists of the phases represented in the figure:

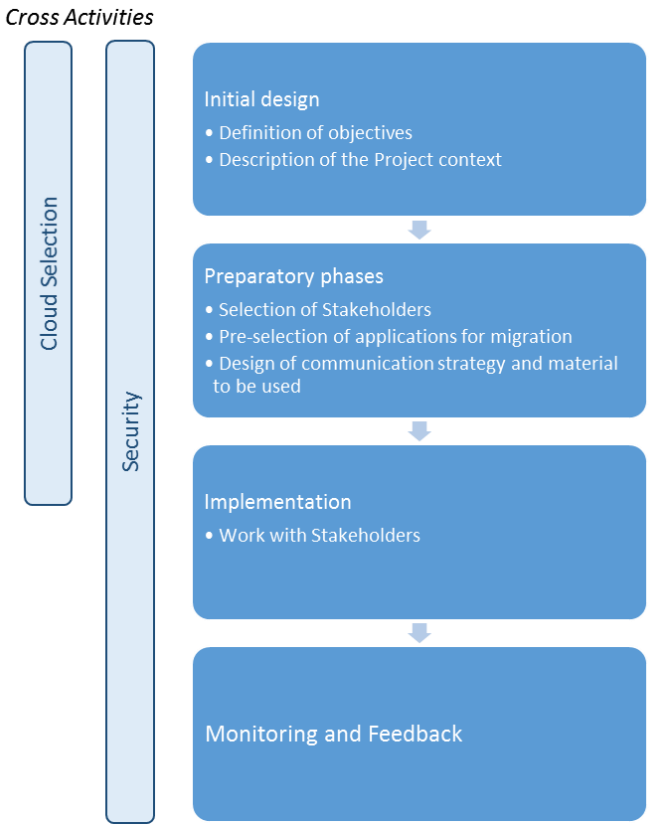

Figure 2: Methodology Phases

Briefly,

- **Initial design:** This phase is devoted to the formal definition of objectives and associated Key Performance Indicators. In this phase, the project context will be also formally defined.
- **Preparation:** This phase is devoted to prepare all the actors to effectively start the selection process. This includes the selection of stakeholders, a pre-selection of applications that might be moved to the cloud as well as the design of a communication strategy and supporting material.
- **Implementation:** In this phase, we will work with the stakeholders using mechanisms as focus groups, e-mails, forms, meetings, etc. With all the information being gathered in the process the applications to be migrated will be selected.
- **Monitoring and Feedback:** Finally, the migration process will be monitored and the feedback obtained will be used to improve the process if required.

This methodological structure does not differ to the initially planned methodology. However, during the project we have fine-tuned a number of aspects and practises with the experience of the four cities. In the detailed description of each of these phases, that is included in the next pages, this experience is reflected as tips, suggestions or best practises propositions.

3 The Methodology to Select Applications

In this section we present the methodology that we propose for future Municipalities and Public Administrations that are willing to migrate their applications to the cloud. This process is the derived from the application during the project at the four participant cities and incorporates all the knowledge gathered in these activities.

WE START THIS PROCESS BECAUSE IT IS UNDERSTOOD THAT

The objective of the process is to select applications to be migrated to a cloud environment.

Instead of select them internally, we firmly believe that the involvement of different profiled stakeholders will produce richer outcome from the project.

This work will require more effort and budget.

It must be remarked that carrying out a selection process using Open Innovation and involving different stakeholders has a number of advantages but also it presents some potential drawbacks, among which, we may mention:

- Possibility of disclosing information to third parties.
- The process increases its complexity.
- Potential deadlocks in the project if different stakeholders provide with very different point of views.

Therefore, the Municipality must be aware of these potential problems – and other similar ones that may arise – prior to entering the process. This is the only way of understanding if we really want to go ahead with this process or not.

Having put on the table the problems, it is fair to say that Open Innovation offers many benefits, among which, we may mention:

- Potential for improvement in the decisions taken.
- Increase in accuracy for "customer" targeting. In out case, the customer is the citizen.
- Potential for synergism between internal and external stakeholders.

In particular, in the case we are dealing in this document, the main benefit is that the citizen gets involved in the activity of their Municipality. At the current moment we are witnessing a clear separation from citizenships and politicians. Public servants are not well considered by their citizens as, in some countries, there exists the belief that they are not answering the problems of the people.

Involving the external stakeholder and having them working with the internal stakeholders is a very interesting activity to promote the work of the Municipality towards the progress of the city. It is a special kind of public participation that will be always welcome by the citizen.

At this point, if the organisation really understands the implications and believe that it is beneficial, let the process start.

3.1 Phase 1: Initial Design

Before start the process there are a number of activities that are to be considered:

1. **Definition of objectives and associated indicators.** The objectives of the process are in line with the standard benefits expected from the usage of cloud based systems and their associated Key Performance Indicators (KPI) to measure them.

   It is recommended to create a table with objectives and the indicators. This table will be used during the process to measure the success or not of the initiative.

Objective	Indicators
Improve performance of applications	Response time Answer to peak levels of demand
Improve expenses on IT systems at the Municipality	Cost of application in cloud vs costs at-home
Improve time-to-market of applicatios	Days from decision to launch an application
Improve Maintenance and Support	% availability time Number of complains from users

When proposing objectives, be sure that objectives are in line with the overall organisation strategy.

Are you sure you can measure appointed indicators? For instance, if cost is an indicator, Are you sure that you can account the cost of a single application? Does the accounting system allow you doing so?

2. **Project context.** The migration to the cloud is a project that is carried out in a specific context. In this sense, it is necessary to analyse all the elements around to prevent possible problems and define contingency strategies.

   The tool proposed for this purpose is the following table

Element	Risk	Contingency Plan
Technical staff	They feel their job is at risk and they don't collaborate in the migration process	Training sessions to improve their skills so they can work with the cloud Job redefintion
Management	The resources required for the project are not provided	Apply a long term reasoning to show that a current investment will bring future savings.
…		

Don't underestimate the change that a technical migration can introduce in your Municipality. From the experience from the project, reluctance to change among their technical employees may be detected. Change Management processes may be required with the involvement of a specific professional/expert.

3.2 Phase 2: Selection of Stakeholders and Preparatory Steps

In this phase we will focus on the selection of the "raw material" that will be the basis for the work ahead in the process. These are two elements: stakeholders selection and a pre-selection of applications to be migrated to the cloud.

1. **Selection of stakeholders.** This is very important because we expect that the opinions, interests and involvement of these groups will be the basis for the process. Therefore, it is recommended that they are all carefully selected.

   Project stakeholders were selected among two very different groups: on one hand, internally to the municipality and externally, on the other.

   - Also the criteria for the selection within each of these groups was different. For the internal users the main criteria is that the migration to the cloud of some applications can affect their job in one way or the other. For instance, the procurement department work is different to buy hardware than to contract a cloud service.
   - For external stakeholders the criteria is to have a representation of the different groups of citizens in the city: people from different ages and professional skills, local SME, entrepreneurs, etc. This was complemented by organisations that play a key role in the coordination of city actors.

   Two different tools are proposed to analyse which groups are to be presented in the process and the relative weight that their input is granted.

   Tool 1: Stakeholders profile: The tool proposed is a table to be filled where the Criteria are defined in one column and the groups is written in the other column. Criteria are very different and may include groups that might be involved because cloudification depends on them (their work, their decisions) or because cloudification affects them (the services that they use, their everyday work). Another criteria is the commitment of the stakeholders or their more specific technical profile.

   We propose the use of the following table

Criteria	Stakeholders' group
Cloudification depends on their decision	I.e: Policy Maketrs, Politicians
Their everyday work is affected by the cloudification	I.e. technical staff, accounting, procurement processes personnel
The results of the cloudification may affect their everyday life.	
Have a word to say in the modernisation of the City	
Willingness of stakeholder to cooperate by the end of the migration	

   Once the stakeholders' profile is selected we need to prepare the specific list of people that we will be contacting and their possible replacement as, for example,:

   - Citizens: Profile and how to select them
     - Looking at associations of citizens
     - Issuing a public "call for interest"
     - …
   - Internal Municipality employees
     - Finance department: Name of person and replacement if not available
     - Technical department: person / replacement
   - Local SMEs
     - Small shops associations
     - Associations of Companies
     - …

   With this activity we will end this phase with a **list of names of concrete persons that will be involved in the project**

Focus on "Quality" (involvement, commitment) instead of "Quantity" when selecting stakeholders

Tool 2: Matching the objectives of the project: The next table is proposed to analyse how each stakeholder group is related to the objectives defined in phase 1 of this methodology. From this table we may decide to drop or not some specific groups and/or to assign specific weight to their opinions.

Stakeholder	Objective 1	Objective 2	Objective 3
Citizen			
Technical employee			
…			

The Profile of the stakeholders must be carefully selected in order to have the richest input to the process. It is necessary to select adequate stakeholders and keep them engaged to the project. The stakeholders for STORM CLOUDS will be, therefore, those groups or individuals with any interest in have publicly available services operated from the cloud. This increases the importance of technical and other personnel from the Municipalities while reduces strength of the final user in the whole process. Some real examples on who can be a stakeholders are as follows:

- **Citizens, considering that the impact of cloud migration must be explained in terms of quicker access to services, cost reductions, etc.**
- **Local SMEs**
- **Municipality personnel**
  - **Technicians**
  - **Financial**
  - **Managerial**
- **Political representatives.**

Ideas for stakeholders (Taken from groups used by project partners):

- **Mayor's Office at Municipality of Miskolc**
- **Hungarian Academy of Sciences, Research Institute of Computer Science and Automatization**
- **Miskolci Cultural Centre Nonprofit Ltd.**
- **MVK Plc. – local public transport service provider**
- **Department for supporting Local Entrepreneurship of the Municipality of Thessaloniki**
- **Department for Tourism of the Municipality of Thessaloniki**
- **Department for Operational Planning of the Municipality of Thessaloniki**
- **Thessaloniki Hotels Association**
- **Chalkidiki Hotels Association**
- **Thessaloniki's Integrated Transport Authority**

2. **Pre-selection of the application.** This is also very important because we may risk that stakeholders select an application to be migrated to the cloud that has notable technical difficulties. There are some criteria, deriving from the experience of the project, that are important to consider.

   It is recommended that applications pre-selected should:

   - Represent a broad panorama of the existing systems in a Municipality.
   - Have a technical design that allows its migration to the cloud and that can benefit from this migration

- The applications are relevant for the stakeholders.
  - Applications belong to the Municipality and/or they are Open Source Software.
  - Applications will not imply any development of additional infrastructure in the city.
  - Applications represent services that cover certain specific necessities of a city. They will provide some valuable functions to users and/or public servants. In addition, services might interoperate with each other.

Once the applications are analysed using the table we will be proposing, there are two options: Simply remove the application from the candidate lists or to warn the stakeholders about the difficulties and problems that selecting these applications may bring.

Tool: Scoring list to exclude applications from migration processes.

Application characteristic	Guiding questions
Technological platform	Is the platform available at cloud providers Can be easily upgraded, if not.
Availability of Technical Support	Is the technical support/development team available
Property of the application	The contract between the Municipality and the application provider/owner may restrict migration.
Easy to evolve	Can the application be adapted to new demands of the citizens.
Built for scalability	Important because the mere migration to the cloud would not provide scalability if the architecture of the applications does not allow it.
Other	

From the experience of cities in the project, it is advisable to start gathering the information that will be required for the migration to the cloud, as, for instance:

- The source-codes of applications
- Requirement catalogues
- Existing administrator manuals
- Existing user manuals
- Earlier test results
- Previously occurred difficulties
- User opinions, feedbacks

At this end of Phase 2 of the process we should have the following assets

- Migration process objectives and criteria to measure them.
- Risk identified and contingency strategies.
- List of pre-selected applications.
- List of selected stakeholders (names/ replacement people + share of representation among different stakeholders' groups)

3.3 Phase 3: Work with Stakeholders

At this point it is necessary to start the work with stakeholders and, in parallel, to define the target technological environment and to solve procurement issues related to that.

1. **Communication:** The conclusion from the STORM CLOUDS experience that is offered to public administration facing similar process is clear: If we really want the final user to participate in the selection process of applications for being migrated to the cloud. This is, if we really want to involve a final user in a deeply technical project – be it cloud migration, technology selection, financial management, etc. – there is a profound communication work to do, so these persons can take informed decisions.

   In this sense, it is very practical to collect examples and best practices to show what are the differences from the user point of view of having a system running in a cloud system or in-house the Municipality on a classical IT environment.

   Communication mechanism will have to be designed. We propose

   - Leaflets and brochures informing on the technological innovation being deployed at the city.
   - Presentations to the stakeholders at the meetings.
   - Show improvements and advantages in other cities.
   - Any other mechanism that enforce communication on the process.

   In addition to these communication mechanisms, it is particularly important to define promotion actions over the whole process in order to maintain the level of engagement and to keep the stakeholders informed on any progress made.

2. **Work with Stakeholders:** The work with stakeholders will be based on a mix of live meetings but also on-line/phone mechanisms so they can be continuously involved without a hard impact in their everyday lives. In these sense, it will be defined a plan consisting of:

   - Meetings/Focus Groups: where stakeholders physically meet and share their points of view on a specific topic proposed by the moderator. We suggest to mix different profiled stakeholders so the resulting group can reach richer conclusions. Some tips to manage these focus groups:
     - Make the user feel comfortable and explain the project in details as well as the services proposed to be activated. We must be sure that user has completely understood the idea. If it is possible, show an example of the service or the application released. Let use and explore it.
     - Allow the end-user to ask any question.
     - Keep it interesting, use non-technical language where possible and let end-users to speak.
     - Present to the user a questionnaire and let enough time to complete it.
     - Let them know how important their opinions in the project are.
   - On-line (or phone) questionnaires. Between two meetings, it may be also possible to contact stakeholders through questionnaires that can be filled in a few minutes. These questionnaires will be elaborated on the conclusions from the previous meeting. These questionnaires will be the tool to keep the engagement between two meetings with a low impact in the daily routines of stakeholders. In addition, they are a valuable tool to fine tune the conclusions of the meetings.

It is important to have a number of stakeholders in the process but it is even more important to motivate stakeholders to participate and to keep them involved and active through the whole process.

With the results of the questionnaires and conclusions from meetings, it will be possible to know what services are prioritised for cloud migration from the point of view of stakeholders.

Example: Scoring mechanism. One possibility is to create a mathematical scoring system to select the applications to be migrated to the cloud in the second round. This mechanism is included in next page as an example.

Having such a strict mechanism may be risky because we lose control of the process and leave it in the hands of the stakeholders absolutely. But it is also very interesting because it really reflects the results of the process without further elaboration by Municipality coordinators.

For the purpose of analysis, a questionnaire is elaborated. This may be filled in live-meetings with a group of stakeholders. Some other inputs were obtained by direct phone call or contacting some other stakeholders by email. The next table summarizes the results of the process.

Stakeholder	Contacted	Answers received
Citizens		
Local SME (mostly shops)		
Technical personnel at Municipality		
Business Associations of City/Region		
Political representatives at Municipality		

The questionnaire may be:

Application Name: _____

Score from 0 to 10

a) I like the application appearance

b) The application is useful

c) The application is innovative

d) The application is useful for the city

The team will decide the weight on each criteria. Therefore, the formula to have the final scoring for the application will be like:

$$Scoring = a*0,1 + b*0,15 + c*0,25 + d*0,5$$

In addition to that, each group of stakeholders may also be assigned a different weight, as

- Citizens: 25%
- Local SME: 25%
- Technical personnel at Municipality: 15%
- Business Associations of City/Region: 25%
- Political representatives at Municipality: 10%

3.4 Phase 4: Migration Process

This phase involves the effective deployment of the applications onto the cloud platform. During the project, these activities have been carried out in WP3 and the reader is referred to the material released under that WP. In particular, the reader is referred to:

- Deliverable D3.4.2 - Best practices for cloud-based public services deployment.

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  Contributors: Komninos N., Kakderi C., Papargyriou C.

As a summary, the STORM CLOUDS migration approach proposes the following steps

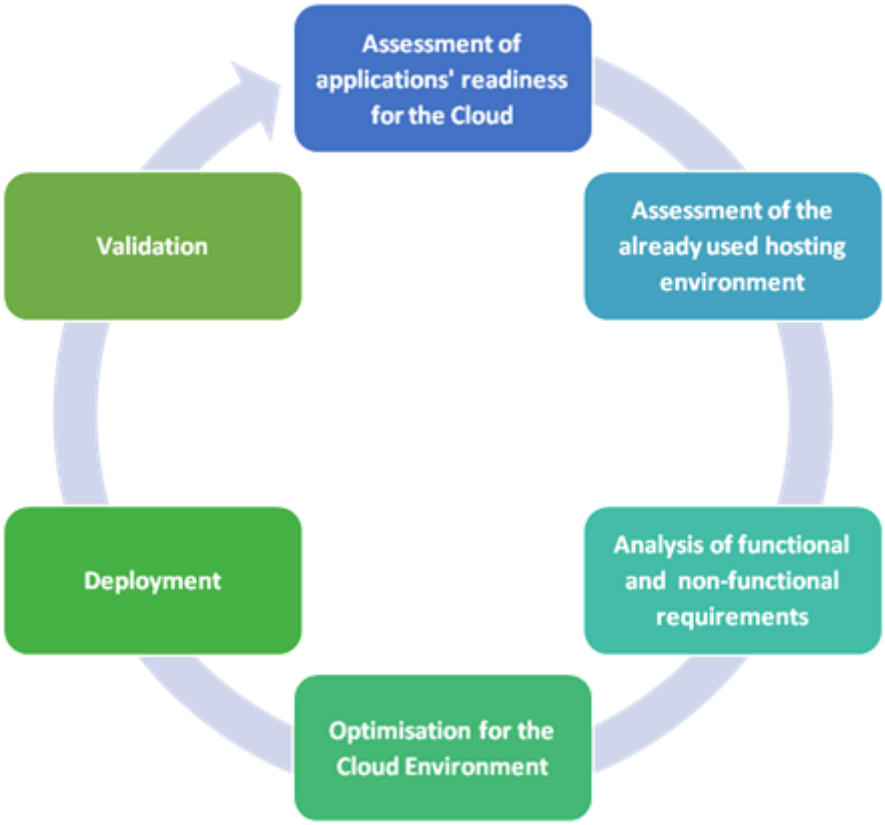

Figure 3: Technical Migration Process

The STORM CLOUDS migration process includes the following six steps:

Step 1 - Assessment of applications' readiness for the Cloud

The 1st step aims to evaluate if the services are ready for the cloud environment. Aspects such as customization, regulatory compliance, complex service architectures and service maturity are carefully investigated, as they would negatively impact the cloudification process. A crucial aspect is the availability of both the application's source code and documentation (installation manual, code dependencies, required software packages, etc.). Finally, the commitment of the application's development and support team should be ensured.

Step 2 - Assessment of the already used hosting environment

The 2nd step is aimed at analysing the environment used to host the services. The analysis covers both the network (e.g. configuration, connectivity requirements from the municipality premises to the cloud environment, and supplementary services such as SMTP, DNS and WWW) and architecture (e.g. use of resources, underlining technologies, licenses, and security mechanisms) of the service.

Step 3 - Analysis of functional and non-functional requirements

The 3rd step aims to define the technical characteristics of the Virtual Machines that will host the applications on the new Cloud Environment. The analysis of the functional requirements covers technical details (e.g. Operating System, Scripting Language, Database, Web/Application Server, Data Formats, Frameworks/Libraries and External Services used), interoperability issues, and static characteristics such as hard-coded IP address and directory paths. Furthermore, the analysis of the non-functional requirements addresses issues related to the proper functioning of the application such as security, regulatory compliance, performance, availability, backup; privacy, reusability, and interoperability. An

estimation of the use of resources regarding RAM, Disk Space, CPUs, Bandwidth, Hits/Month, Registered Users, Max On-line Users, and Average On-line Users contributes to the calculation of the expected workload per application. An important precondition that should be examined in this step is whether the application's design supports its deployment in multiple servers. In that case the application will take full advantage of the performance benefits that cloud offers.

Step 4 - Optimisation for the Cloud Environment

The 4th step aims to solve the problems identified in the previous step, so the application to be ready for deployment in the new environment. Moreover, it includes modifications that enable the application to support natively the most prominent Cloud characteristics (e.g. high-availability and scalability). The latter is closely related to the available budget or the internal IT capabilities.

Step 5 – Deployment

The 5th step aims to transfer the ready to be cloudified applications to the new Cloud environment. The deployment process includes the following actions:

a) setup of the cloud environment that will host the selected services;

b) launch the VM instances that will host the applications and their data (e.g. database and file sharing modules).

c) migrated both the applications and their data to the Cloud environment

Step 6 – Validation

The final step aims not only to ensure that the deployed applications are operational but especially to guarantee that they meet the initial set of requirements regarding cloudification. The validation is made in collaboration with the municipalities and includes functional tests ensuring that the deployed application performs as designed.

Automation

The cloud encourages automation because the infrastructure is programmable. To ensure a high level of automation along with accuracy in the migration of the applications to the cloud, a set of tools and procedures have been designed and developed. The automatic deployment is implemented using Heat, the OpenStack "orchestration engine to launch multiple composite cloud applications based on templates in the form of text files that can be treated like code" [32]. The aim of orchestration is to create a human- and machine-accessible service for managing the entire lifecycle of infrastructure and applications within the SCP Cloud environment.

The 1st step in the automation process is to prepare the bash shell scripts that will configure the VM hosting the application, and install and configure the application and its dependencies.

The 2nd step is to create the Heat scripts (Heat Templates) that describe the infrastructure (servers, floating IPs, security groups, ports) of the cloud applications and to integrate with them the application's installation and configuration scripts made at the previous step.

The available Heat Templates allow interested cities to automatically deploy the selected applications from the cloud-based service portfolio, as well as the municipalities to re-deploy their services in another instance of STORM CLOUDS Platform.

3.5 Phase 5: Monitoring and Fine-Tuning

At this stage we will have our applications up and running. It is the time to assess the process and the results obtained. For this purpose we have two basic tools

- **Key Performance Indicators**, created in phase 1 when the project objectives were defined. There are not many comments to add here. As the objectives of the Municipality were defined in Phase 1, we need now to check if these have been fulfilled.
- **Monitoring indicators on the services migrated to the cloud**. These are an additional set of indicators that are used to evaluate the degree of use and the acceptance of the service from the final user. We will focus on this second aspect.

  As an example of the work done in the project we propose the indicators mechanism implemented by, Thessaloniki Municipality along with URENIO-AUTH. They established a four dimensions group of indicators for each service separately. These indicators fall into four dimmensions:

  - **Supply**: Depending on the application, this correspond to the service that is provided by the applications moved to the cloud, for instance
    - In the case of a Virtual Shopping Center, the supply are the local shops that are willing to have a place in the shop. For instance, the indicators from Virtual City Mall deployed at Thessaloniki are:

Supply	Demand	Dissemination	Validation
Nbr of shops participating in the app	Total nbr of users – visitors	Total presence of the platform in third party websites	Number of users providing feedback for the application
Nbr of shops per category	Total nbr of registered users	Total e-mails/newsletters sent	Number of stakeholders providing feedback for the application
% of shops participating in the platform/shops in the area (total)	Mean nbr of visitors per shop		Number of modifications (new characteristics that have been modified based on the feedback received)
% of shops participating in the platform/shops operating in the area (category)	User demographics (area, age, education level)		
Nbr of shops that have extended their online presence in the platform			
Nbr of shops making online transactions through the platform			
Nbr of offers per shop			
Nbr of synergies between two or more shops			

Figure 4: Indicators for Virtual City Mall - Thessaloniki

    In other cases, the supply may be the Municipality employees that provide the service to the citizen. In the case of Urbanismo en Red, at Valladolid, the supply consist of the employees in charge of the City Hall infrastructure that are receiving and answering the demands of the people
  - **Demand**: These are the users of the service who - in most of cases - will be the citizens and local businesses / companies of the city.
  - **Dissemination:** Another interesting parameter to measure is the degree of penetration that the application has among the target users.
  - **Performance:** Finally it is interesting to really understand if the performance is better than previously.

4 Cross-Activities

In this section we include two activities that are to be carried out in the process but they are not a specific step in the methodological process to select applications to migrate:

4.1 Selection of Cloud Platform

For a detailed description of this topic, the reader is referred to WP2-WP3 results where the technical characteristics of the cloud are described. As a summary, we include some recommendations in this lines:

- It is necessary to decide if the cloud model to be used is Public, Private or Hybrid. Each of them has their advantages and drawbacks. It will depend mostly on the structure of the applications and on the separation between application and data that it is required.
    - **Private Cloud**: The cloud infrastructure is used exclusively for internal applications within an organisation comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off site of the premises.
    - **Community Cloud**: The cloud infrastructure is used exclusively by multiple organizations that have shared concerns (e.g., mission, security requirements, policy and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises.
    - **Public Cloud**: The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider.
    - **Hybrid Cloud**: The cloud infrastructure is a composition of two or more distinct cloud deployment models (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g. cloud bursting for load balancing between clouds).

The following table summarises the pros and cons of the different deployment models [Tsarchopoulos16].

Option	Pros	Cons
Private Cloud	+ More control and reliability: IT can control the security of data, set compliance requirements, and optimize networks more effectively with cloud. + Customizable: IT can customize storage and networking components so that the cloud is a perfect fit for the specific organization and its needs.	- Requires IT expertise: A high-level of IT expertise is required to ensure maximum effectiveness and optimal configuration of the deployment. - More expensive: The long-term costs may be higher due to increased management responsibilities and smaller economies of scale.
Public Cloud	+ Ease of management: Organisations IT departments do not manage their public cloud; they rely on Cloud provider to administer the cloud. + Ease of deployment: With the public cloud, there is low barrier to entry, so you can quickly configure and stand up a cloud. + Flexible: Users can add or drop capacity easily. Moreover, the environment is typically accessible from any Internet-connected device, so users don't need to jump through many hurdles to access.	- Can be unreliable: Public cloud outages are quite common, leading to headaches for users. - Less secure: The public cloud often has a lower level of security and may be more susceptible to hacks. In some cases, cloud providers may not be able to meet the strict constraints mandated by government institutions.
Hybrid Cloud	+ Flexible and scalable: Organisations are able to combine and match for the ideal balance of cost and security. + Cost effective: Organisations can take advantage of the cost-effectiveness of public cloud computing, while also	- Complexity of management: Moving parts between public and private clouds can be a challenge. - Requires IT expertise: A high-level technical staff is required to guarantee security vulnerability on

	enjoying the security of a private cloud.	all aspects is decreased.

- From a more technical perspective, it is necessary to define if the model is IaaS, PaaS or SaaS.
    - Infrastructure-as-a-Service (IaaS): The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources in order to build a customized computing environment. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of selected networking components (e.g., host firewalls).
    - Platform-as-a-Service (PaaS): The capability provided to the consumer is to use the provider's development platform (programming languages, libraries, services, and tools) in order to create, test and host new applications. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.
    - Software-as-a-Service (SaaS): The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a programming interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.
- With respect to Cloud Providers, it is important to review the proposed SLA and the Terms and Conditions in particular to ensure that their applications are hosted in a country where current laws can be applied.
- Last, but not least, it is the question of costs. The work in STORM CLOUDS Project has produced a tool based on an Excel file that can calculate the cost of a cloud hosting given a specific

4.2 Security Issues

It is particularly relevant to analyse the security of the cloud environment and the applications to be migrated before and after the migration. STORM CLOUDS has defined a guidelines for analyse and detect vulnerabilities [Giannakoulias16] that answer to most common demands of industry and market [EC-Sec-1-2015]. The penetration testing tools used in the project are:

- Zed Attack Proxy (ZAP) (https://www.owasp.org/index.php/OWASP_Zed_Attack_Proxy_Project), an easy to use integrated penetration testing tool for finding vulnerabilities in web applications
- OpenVAS (http://www.openvas.org/download.html), a framework of several services and tools offering a comprehensive and powerful vulnerability scanning and vulnerability management solution
- SQL Inject Me (Available at https://addons.mozilla.org/en-US/firefox/addon/sql-inject-me/eula/88410?src=collection&collection_id=203cc10a-26b3-5921-12ef-6ba80b06fe07), a Firefox Extension used to test for SQL Injection vulnerabilities
- Qualys SSL Server Test (https://www.ssllabs.com/ssltest/index.html), an online service performs a deep analysis of the configuration of any SSL web server on the public Internet.
- Vega (https://subgraph.com/vega/), an open source scanner and testing platform to test the security of web applications.

5 Other EC funded initiatives

The work being done in STORM CLOUDS must be considered within the global initiative of the "Cloud of Public Services" proposed by the European Commission that involves a number of projects as the mentioned in the picture here below.

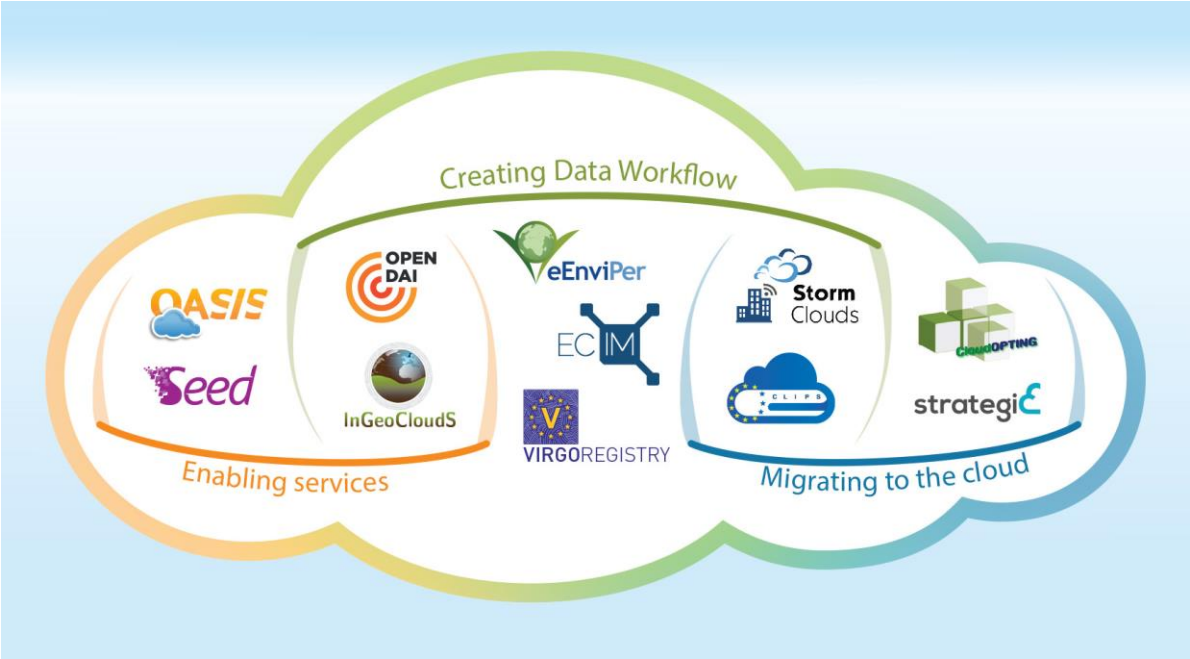

Figure 5: Projects in the area "Towards a Cloud of Public Services"

The reader is referred to the Digital Agenda section on cloud computing where links to the projects in the area of cloud computing can be found, not only projects from FP7 as STORM CLOUDS, but also new initiatives under Horizon 2020 umbrella. See (https://ec.europa.eu/digital-single-market/en/programme-and-projects/research-and-innovation-software-services-and-cloud-computing)

In particular, there are a number of projects related to cloud migration in Public Administrations, these are:

- **CLIPS** (CLoud approach for Innovation in Public Services) (www.clips-project.eu) is based on the collaboration between civil servants, public authorities, citizens and businesses (both large and SMEs) for the development of a new approach to the delivery of public services through the use of cloud computing.
- **CloudOpting** project (www.cloudopting.eu) aims to increase the usage of cloud computing by public administrations by providing a shared platform where public institutions and government bodies can migrate existing IT systems in order to deliver online public services to citizens and third-parties, centrally manage operational data and citizen information within a controlled environment and allow citizens to develop innovative new services.
- **STRATEGIC** (www.strategic-project.eu/) addresses the need of organisations (notably public sector bodies) to adopt cloud computing and to leverage the benefits of public cloud services. The STRATEGIC framework will comprise cloud infrastructures and tools that will ease public sector organisations to flexibly and effectively migrate their services to the cloud.

A specific mention is devoted to the Horizon 2020 project **SLA Ready** (http://www.sla-ready.eu/): Making Cloud SLAs readily usable in the EU private sector. Their indications on SLA for cloud services are really useful to cloud adopter both in the public and private sector.

6 Conclusions

In this document we have presented a practical guideline on how to face the selection of application/services to be migrated to the cloud following an Open Innovation mechanism. These guidelines come from the experience of the project partners that have applied this paradigm for the selection of the applications.

We firmly believe that carrying out this process is much more interesting than selecting the applications internally at Municipalities. There are a number of risks already defined and the process will devote more effort but, undoubtedly, it will produce richer results.

As a conclusion, we include the analysis carried out on the first monitoring of applications migrated to the cloud and included in deliverable D1.4.1 [GonzalezQuel15]. These conclusions are very representative of the process and useful for any future city aiming to implement this process themselves.

The initial selection of applications is particularly relevant as it will direct the whole project as it may restrict the opinion of the stakeholders. From the information gathered, it is not clear if a more transparent process could have been implemented at this stage.

For future recommendations the open innovation process should include

- Initial explanation on cloud migration benefits for non-technical people
- Participation of broad groups of people since the initial stages of the project, probably by implementing on-line participation mechanisms.

We firmly believe that a deeper implication of the personal of the Municipality is required as they are the key stakeholders in the cloud migration process. The extensive involvement of final users (citizens, local entrepreneurs) is very positive but it is hard to get them involved over the time if they don't feel a difference from an application hosted internally vs. hosted in the cloud.

Concerning future recommendations, the stakeholder engagement process is to be enforced using different incentives and a communication campaign in the City that allows them to understand that they are participants to an important modernisation process taking place in the city.

During the cloud migration process a number of technical actions on applications was required in some cases they had been previously foreseen but in some other they arise when the initial set of users started with the application.

This situation is common in every production launching process and it must not be considered a specific problem of the cloud migration process. However, having the need for a revision and migration of the applications is a good opportunity to review the existing applications. IT Maintenance work should include a periodical revision of all applications to see if they can be improved, but in many cases, there is lack of resources for doing it. Cloudification is a good opportunity to carry this out.

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