



2. RELATED WORK

Several works have described how e-government platforms are designed based on web services and their composition to provide services to citizens. [1]–[6]. Cabrera-guzman et al [1], have developed a web-based e-governance platform to realize the interaction between government and citizens. The platform gives the citizens the possibility of posting complaints, ideas and requirements linked to the good conduct of local administration. The goal was to promote collaborative decision-making and transparency. The platform works by considering four (04) actors: the citizen, the web platform system, the local government official and the system administrator who check the correct functionality of the web platform. This platform is not based on web services and only offers a web application for citizens to interact with the government. González et al [4] propose an expanded e-government interoperability platform for monitoring and enforcing data protection laws in inter-agency interactions. The platform uses the Enterprise Service Bus standard (ESB) [7], which allows communication between applications that were not designed to work together. The authors have focused on how to maintain the confidentiality of personal data by simulating web services composition by the standard ESB. In Aggeliki et al [2], a communication channel between citizens and government was proposed. The idea is to use artificial intelligence (AI) and an advanced chatbot [8] technique for allowing complex and non-ambiguous interaction between citizens and government. The channel contains three categories of services: the data management service is used to research and collect data from several sources; the knowledge processing service performs the processing and indexing of data; and the third service performs the interaction between government and citizens. This platform does not use the concept of web services and does not rely on their composition. In Aleksandar Karadimce [5], a platform for mobile public e-government cloud services [9] has been recommended. The aim was to offer e-services to enhance the prospects for employability. The paper shows how the proposed system can be used for promoting the matching of citizens with job offers and how to interact with big data using cloud computing [10]. In Al-Mushayt [6], a smart e-government platform was proposed. The platform is composed of two main layers: a basic traditional layer, which serves as a link to the legacy systems of the e-government platform, and an autonomous smart layer. The latter is in charge of offering relevant services to users using autonomous, intelligent agents that coordinate and administer current services. The proposed platform is based on deep learning models to provide smart services based on semantic web, multi-agent systems, autonomic computing, and artificial intelligence (AI) techniques. In [5], [6], it is not clear how the services are composed to provide responses for users. In Argulan et al. [3], an e-governance infrastructure based on cloud computing is proposed. The paper presents the requirements and criteria to develop this platform. However, the authors have focused on the types of hardware and do not show the techniques and software concepts to use. For

an interested reader, a complete survey on e-governance systems based on cloud computing can be found in [11]. We consider the collaboration between several institutions and the web services composition in order for an institution to serve citizens. In addition, we purport to secure the proposed platform by means of an access control module, which manages users, data access, and web services use and publication. In [12], an access control model, was proposed for inter-institutions services; some parts of this module can be easily integrated into our platform. For data security [13], [14], we propose that the personal data are published in a private Cloud [15] and their security is ensured by institutional suppliers. A comparison between our work and the cited related work is given in Table I.

3. BACKGROUND

A. Digital identity and e-government

The term e-government refers to the application and use of new and advanced technologies such as web applications, mobile applications, web services, and the internet to provide public services. E-government aims to positively transform the relationship between government and society by increasing the responsiveness and accessibility of government, improving the productivity and while reducing the cost. Therefore, e-government uses digital services to increase institutional trust and thereby performing with overall confidence in the benevolence, competence, honesty and predictability of government [16]. E-government platforms have a primordial role in enhancing the economy of governments, citizens, and industries [6]. Using e-government concepts [16], [17], governments have changed the way of working by improving the delivery of public services in efficient and effective manner. Users of e-government services [16] will sense that the government is quite good when accessing the offered services on the cloud. Citizen and institution users will believe that the government is adopting cutting-edge technical concepts, which will improve the government's image. In e-government, digital identity plays an important role. Identity could be defined as "the set of individual characteristics by which a thing or a person is recognised or known" [18]. In the digital world, we can define the digital identity as the digital data set, which represents individual characteristics of an entity in the context of a given application. An entity can be a person, a group of people, an organisation, a process or even a device, that is to say any subject capable of carrying out a transaction. The elements that make up a digital identity are called attributes. These attributes can be assigned, intrinsic to the entity, or derivatives [19], [20]. E-government platforms use digital identity concepts for representing entities like citizens, users, and services [21]. Despite the potential for e-government projects to be implemented, there are a number of challenges that might prevent the creation of e-government platforms that connect numerous organisations, administrations, or both. In addition to challenges relating to financial and human resources, we find challenges relating to the design and security of platforms. The most important challenges for the

TABLE I. Comparison with cited researches. The tick mark (✓) indicates that the module exist, whereas the cross mark (X) indicates that module does not exist.

	[4]	[2]	[5]	[3]	[6]	Our approach
People						
Users (citizens / Institution)	Citizens	Citizens	Institution	Citizens / Institution	Citizens	Institution
beneficiary (Citizens / Institution)	Citizens/ Institution	Citizens/ Institution	Citizens/ Institution	Citizens / Institution	Citizens / Institution	Citizens / Institution
Modules						
Customer profile management module based on digital identity	X	X	X	X	X	✓
Composition module	X	X	X	X	X	✓
Access control module	✓	✓	✓	✓	X	✓
Service search module	✓	✓	✓	X	X	✓
Publication module	✓	X	X	X	X	✓
Other criteria						
Semantic web	X	X	X	X	✓	✓(For discovery and composition)
Cloud computing	X	X	X	✓	✓	✓

implementation of e-government platforms are how they can be accessed by users and how their offered services are secured. E-government platform design and data security are critical tasks which require the management of services and their security, access control policies, change controls and service continuity [22]. For e-government platforms, service continuity is essential for the availability and delivery of services and for building, citizen confidence in the services. Security and particularly privacy also presents a challenge when implementing e-government initiatives. In fact, private information should not be divulged when sharing data and information between institutions and administrations.

B. Web service and composition

A service-based application is flexible because a failed service can be replaced by another without changing the entire application. The main advantage of service-oriented architecture is that this paradigm could meet the needs in terms of flexibility, reusability, portability and rapid adaptability. The discovery and composition of services are the main challenges in service-oriented architecture applications. The benefit of the service-oriented architecture can appear when composing many atomic or compound services into new services with added values for offering more powerful enterprise applications. [10], [23]. The aim of web services composition [24], [25] is to construct a new so-called composite web service, which consists of several services that interact with each other. Figure 1 depicts a general scheme for web services composition. Services composition enables communication, cooperation and coordination between disparate applications from different sources on the internet.

Currently, service aggregation is used to create integrated custom-built systems (EAI) [27] to handle repeti-

tive tasks (for example, scientific processes or long-term processes). This technology is now present in a growing number of systems used daily. The new composite service uses the component service operations to offer new operations. The behaviour of the new composite service is specified by a new sequence of operations. A composition of services can be considered from two different perspectives, choreography or orchestration [10], [28], [29]. Choreography models, on the one hand, a set of interactions that can or must take place between a set of services, as well as the dependencies between these interactions [29]. When designing choreography, the roles of the composition are specified. A role must provide certain operations. In one role, links describe the exchange of messages with other choreographic roles [10], [29]; consequently, each role has a partial description of the composition. The service must also interact with other services according to the sequence of message exchanges described in its role. Orchestration models involve a set of communicative actions and internal actions in which a given service can or must commit as well as the dependencies between these actions. The orchestration describes the sequence of message exchanges between the composite and all the other partners in the orchestration. At the execution of the orchestration, the partner services are solicited by the composite service which has a global description of the interactions [10], [26], [29].

4. PROPOSED APPROACH

We propose a web services-based platform that provides inter-institutional services basing on the digital identity of citizens. The platform delivers an environment that enables an institution to create a part of the digital identity of a person through the automated consultation of services rendered by other institutions or administrations. The proposed platform thus permits to provide informations and services

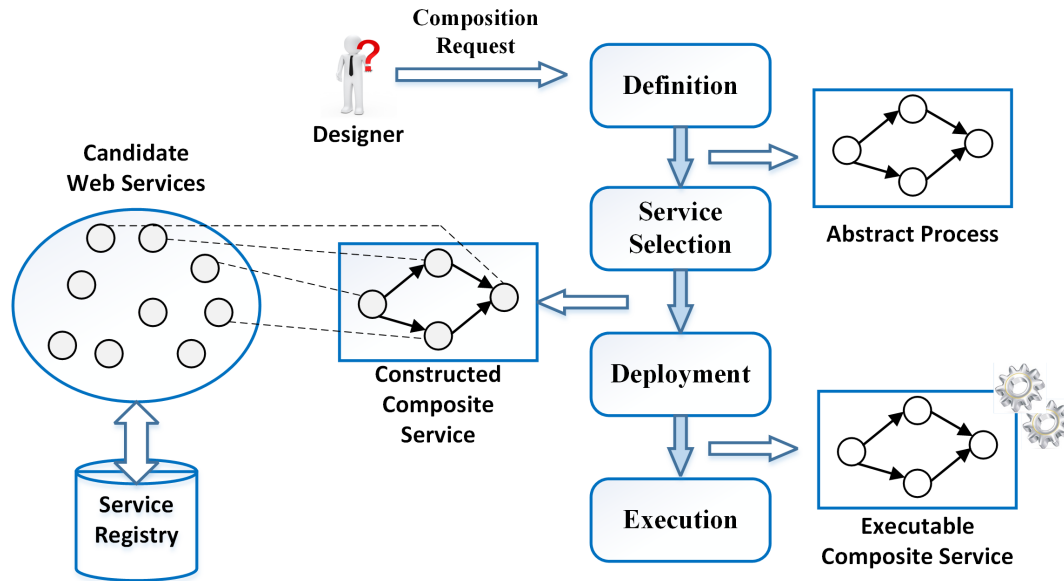


Figure 1. Life cycle of a Web services composition [26].

from an institution to another. This is made possible by offering institutions the capacity to publish web services and by proposing services for the use of such web services as atomic or composite services. Therefore, an institution can access personal data delivered by other institutions by means of web services. Citizen' (Citizen' profiles) for the organisation concerned are stored in the cloud. Figure 2 depicts the architecture of the proposed platform as well as its components.

A. Architecture

The proposed architecture enables access to our platform from many institutions. Notice that citizens' personal data are located in Private clouds, where each institution store a part of identifiable personal data concerning citizens to deliver services from a secured and private cloud. Access to such data is only possible through the use of web services. Institutions publish web services and they are registered in the UDDI directory [30], [31]. The platform is constructed around five (5) modules: web services publication module, the user management module, the web services search module, the profiles' management module and the web services composition module. Access to the platform is allowed only for institutions. These latter can use the services offered by the platform to request elementary or compound services provided by other institutions, in accordance with their profiles and authorisations. Service invocation is initiated by the formulation of a request, which may be composed of many key terms that describe the desired services. This request can also be used for the dynamic composition of web services. the user is unsatisfied, it can reformulate his request. He also can access directly to web services for completing the needed information. Figure 3 describes the use of the proposed platform, by means of a sequence

diagram, where we illustrate how institutions can serve citizens.

B. Platform modules

The platform modules interact between them for offering services to institutions. The platform provides the capabilities to publish, search, compose, and access web services in accordance with the desired service by its name, its description and its publication date. The invocation of services enables the institution user to extract part of the digital identity of the citizen from data provided by other institutions.

- i) The publication module: This module acts as an interface between the web service provider (institutions) and the platform. It enables an institution to publish and upgrade web services in the UDDI directory. After authentication, the institution user (web services administrator) requests the publication or updating of the web services. It may specify and update the access rights of other institutions to web services. The publishing of a web service enables a portion of citizens' personal information (web service data published and provided by the institution) to be made accessible in the cloud. Entry to such data (citizen profiles) is given to other entities (institutions) on the basis of pre-configured permissions. The profile of the published web service is generated, during the publication process, by the profiles' management module. Figure 4 describes the web services publication process by a sequence diagram.
- ii) The discovery module: The discovery module searches for web services required to fulfil the demands of citizens and institutional users' requests.

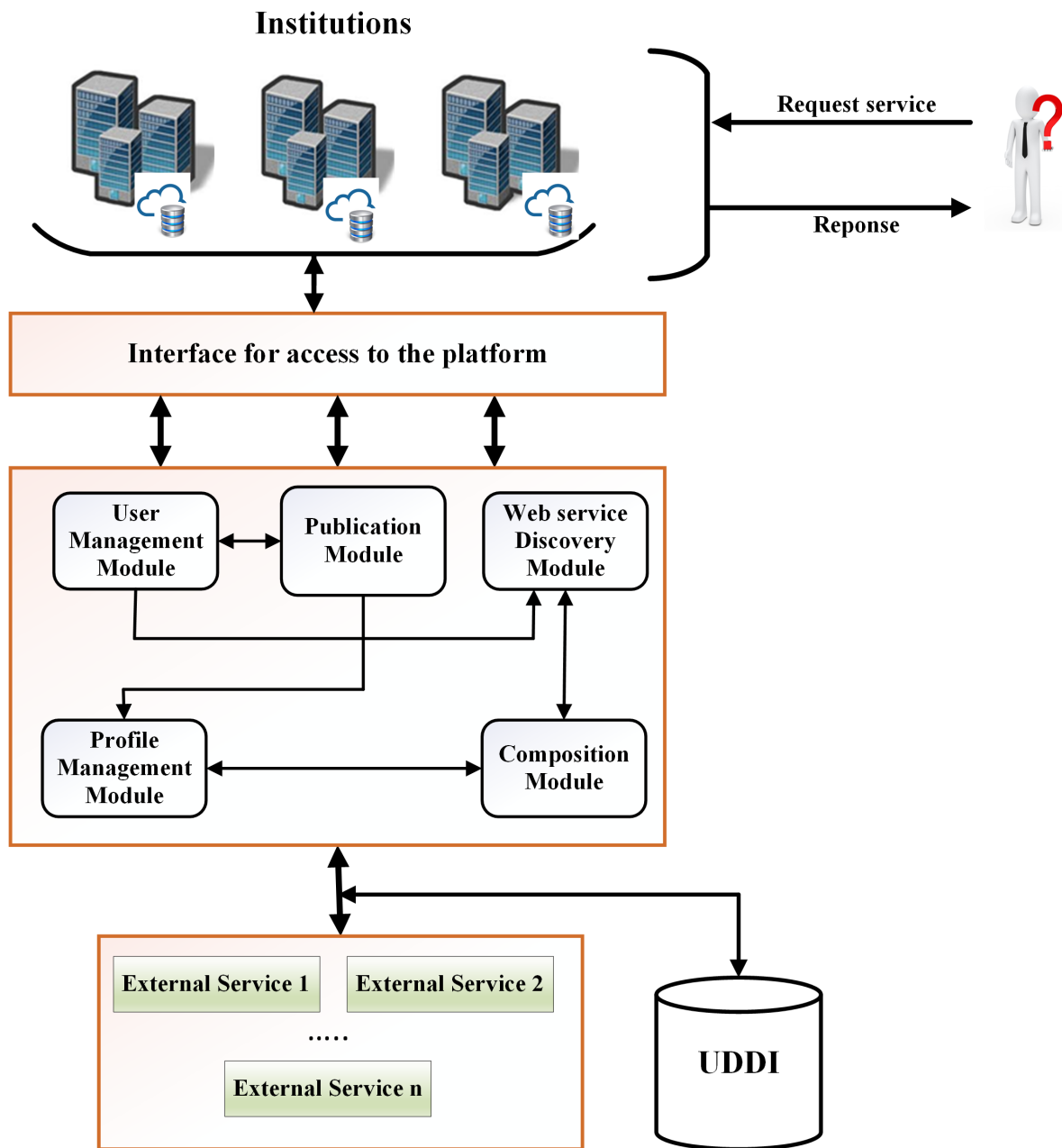


Figure 2. Platform architecture.

The description of the web service invoked and web services published by the other organisations are the basis of this module. Only the services for which the organisation has the requisite permits are returned. It is used by the composition module. The institution user formulates a request for serving a citizen; the composition of web services is achieved in accordance with the key words within this request. First, the discovery module selects the services that are adequate for serving the institution user's request.

- The discovery module is based on computing semantics similarities between the description of the web services offered by different institutions and the request. It then returns the adequate web services necessary for the satisfaction of the citizen. Access to published web services is regulated by authorisations. Consequently, the discovery module only returns the web services allowing access to the institution user.
- iii) The profile management module: The contextual information of the published web services can be saved

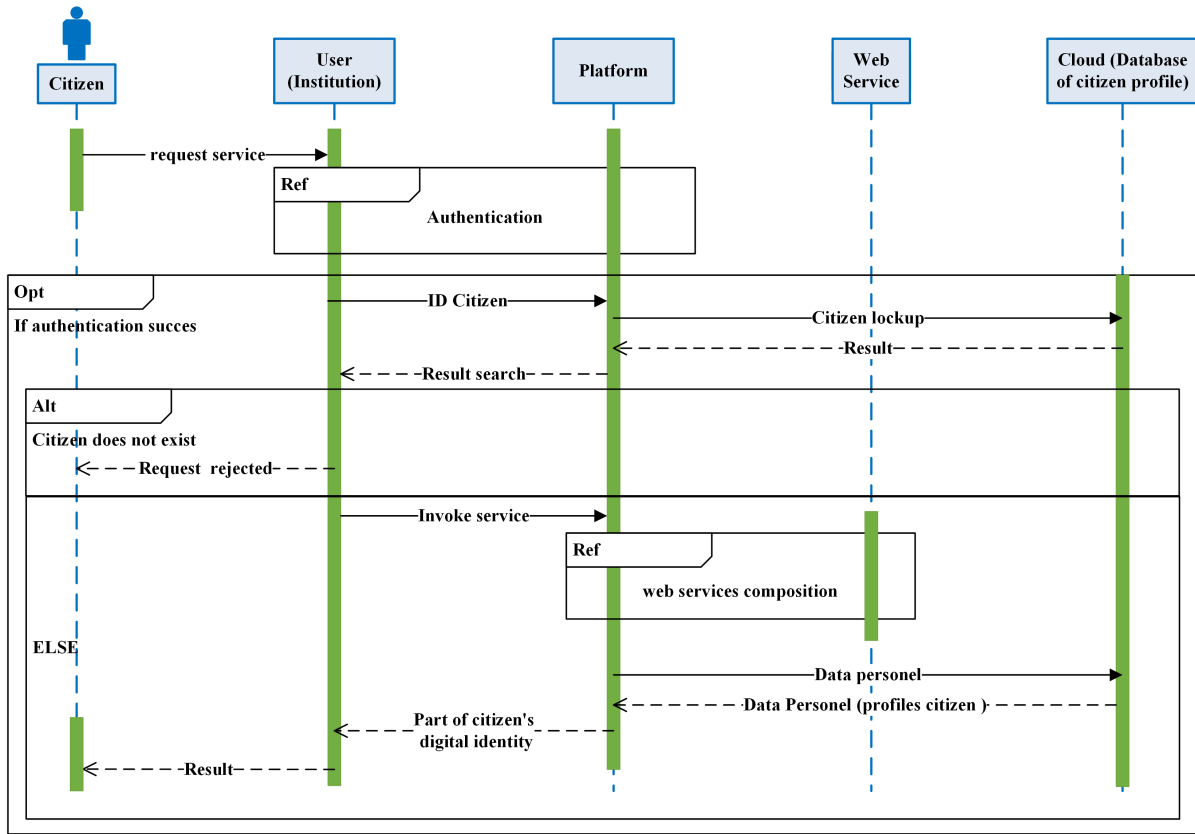


Figure 3. Interactions and functional description of the proposed platform.

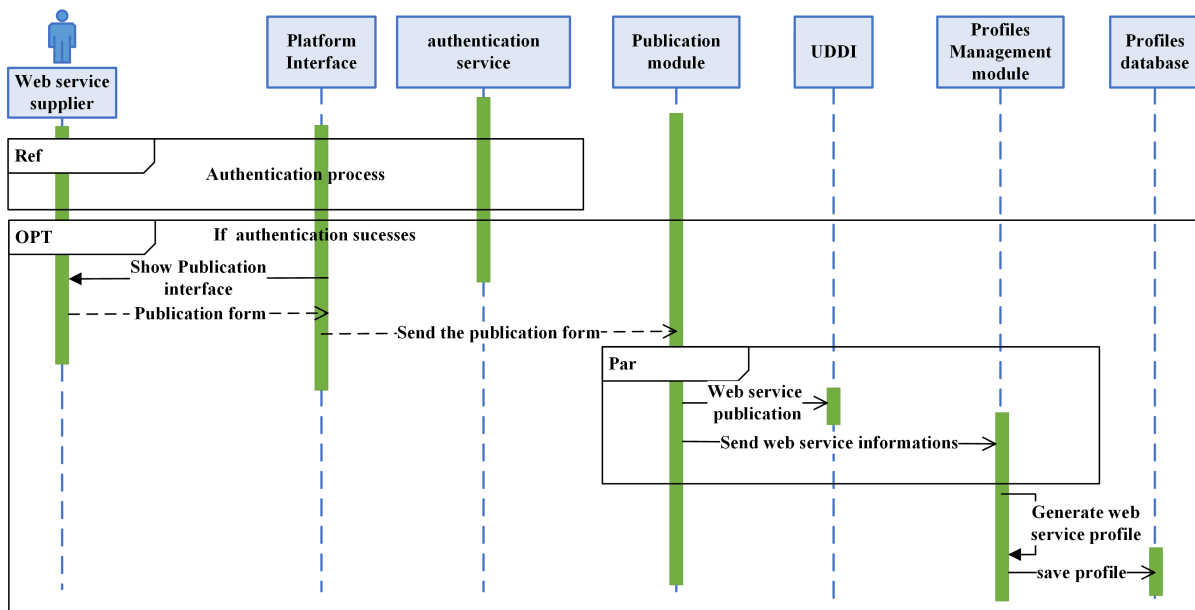


Figure 4. Publication module.

and updated (e.g. the context of use, date of publication). The publication and discovery modules provide this data. The module for profile management is also used to save and update institution users' profiles in the cloud.

- iv) The user management module: This module controls the access to the platform by users from different institutions. It covers the authentication of users and the administration of their authorisations for the publication and use of web services. The mode of operation of this module appears in Figure 5.
- v) The composition module: This module is responsible for composing the web services selected in the discovery phase and returning a composite service that satisfies the institution user' request. Composition is performed dynamically based on the semantics similarities between the input and the output of the atomic web services. Once the discovery module selects the pertinent services, the composition module determines the inputs and outputs parameters of every selected service. Similarities between web services are then computed to determine the composition scheme according to the algorithms (Algorithm 1, Algorithm 2, Algorithm 3, and Algorithm 4).

Algorithm 1: Composition algorithm

```

1 INPUT: L_selected a set of selected web services
2 OUTPUT: G a graph representing the composition
  scheme
3 Begin
4  $L\_ser\_indep\_ser \leftarrow \emptyset$            $\triangleright$  List of independent
  services
5  $L\_dep\_ser \leftarrow \emptyset$            $\triangleright$  list of the other services
6  $G = (\emptyset, \emptyset)$ .
7 if (all inputs of  $WS_i \in$  Instution user request ) then
8 |  $L\_ser\_indep\_ser \leftarrow L\_ser\_indep\_ser \cup WS_i$ 
9 else
10 |  $L\_dep\_ser \leftarrow L\_dep\_ser \cup WS_i$ 
11 end
12 while  $L\_dep\_ser \neq \emptyset$  do
13 | foreach selectedservice  $WS_i \in L\_dep\_ser$  do
14 | | Composition_step( $WS_i, L\_indep\_ser, G, G\_update$ )
15 | | if ( $G\_update$ ) then
16 | | |  $L\_dep\_ser \leftarrow L\_dep\_ser - \{WS_i\}$ 
17 | | |  $L\_ser\_indep\_ser \leftarrow$ 
18 | | |  $L\_ser\_indep\_ser \cup \{WS_i\}$ 
19 | | end
20 | Eliminateredundant_link( $G$ )
21 end
22 end.

```

Similarities between input and output parameters are computed based on semantic similarity using the WordNet::Similarity [32], [33], where we assume

Algorithm 2: Composition similarity algorithm

```

2 Function Comp_Similarity ( $WS_i, WS_j, G,$ 
   $G\_update$ )
3 Begin
4  $G\_update \leftarrow False$ 
5  $L\_inputs \leftarrow Inputs(WS_j)$   $L\_outputs \leftarrow Output(WS_i)$ 
  foreach  $O \in L\_outputs$  do
6 | foreach  $i \in L\_inputs$  do
7 | |  $Sim \leftarrow Similarity(O, I)$ 
8 | | if ( $Sim > 0.5$ ) then
9 | | |  $Update\_G(G, WS_i, WS_j, I, O, Sim)$ 
10 | | |  $G\_update \leftarrow True$ 
11 | | end
12 end
13 end.

```

Algorithm 3: Composition step algorithm

```

3 Function compose_step ( $WS_i, L\_indep\_ser, G,$ 
   $G\_update$ )
4 Begin
5  $G\_update \leftarrow False$ 
6 foreach  $WS_i \in L\_indep\_ser$  do
7 | foreach  $i \in L\_outputs$  do
8 | | Comp_Similarity( $WS_i, WS_j, G, G\_up$ )
9 | | if ( $G\_up$ ) then
10 | | |  $G\_update \leftarrow True$ 
11 | | end
12 end
13 end
14 end.

```

that the semantic links between the web services are used to calculate the similarities between the input and output parameters (see Figure 6). The minimum similarity value considered, to take only relevant links between the inputs and the outputs, is equal to 0.5. The algorithm proposed to construct the composition scheme takes as input a list ($L_selected$) of web services, which are selected according to the institution user' request using the discovery module, and produces a graph (G), which models the composition scheme. First, the algorithm constructs the list $L_ser_indep_ser$ which contains the web services that only need data provided in the request of the institution user; the other web services are stored in the list L_dep_ser ($L_ser_indep_ser \cup L_dep_ser = L_selected$). After that, for each web service WS_i in the list L_dep_ser , we try to perform a composition step with the web services of the list L_indep_ser . The graph representing the composition scheme may therefore be updated. In such cases, the web service (WS_i) used for the composition step will be removed from the list

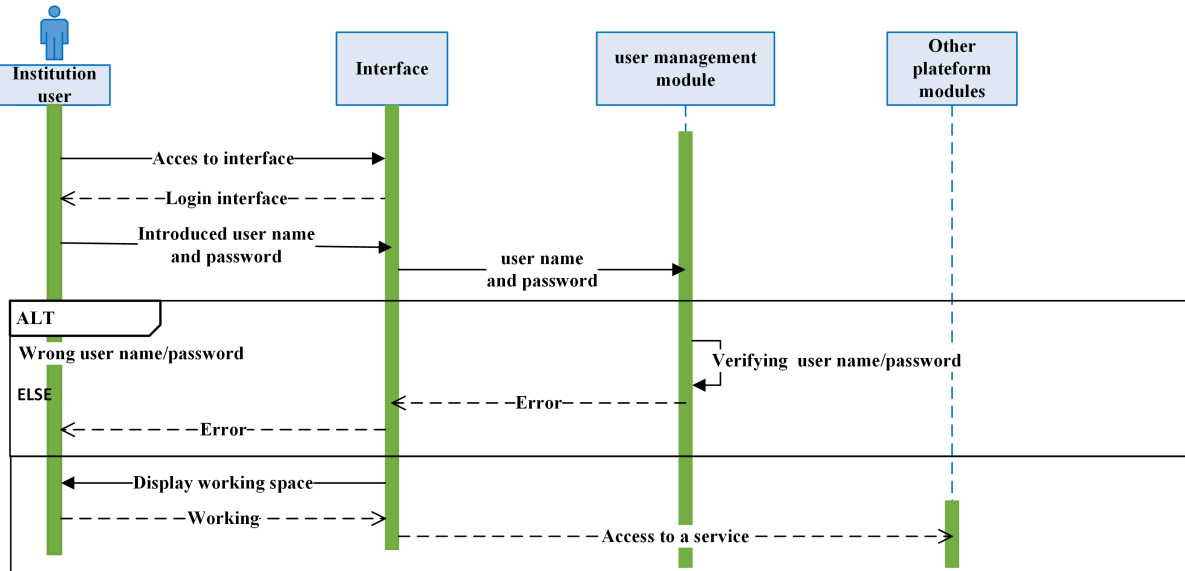


Figure 5. User management module.

Algorithm 4: Similarity algorithm

```

4 Function Similiraty (L_word1, L_word2, sim)
5 Begin
6 i ← 1
7 j ← 1
8 foreach Wordi ∈ L_word1 do
9   foreach Wordj ∈ L_word2 do
10    Sim_array[i, j] ← semantic_similarity(Wordi, Wordj) > using wordnet
11    i ← i + 1
12    j ← j + 1
13  end
14  j ← 1
15 end
16 foreach j=1 to number_words (L_word2) do
17   Sum ← 0
18   foreach j=1 to number_words (L_word2) do
19    Sum ← sum + Sim_array[i, j]
20  end
21  Sim_moy[i] ← sum/number_words(L_word2)
22 end
23 sim ← MAX(Sim_moy)
24 end.

```

L_dep_ser and added to the list L_indepant_ser. Those steps are repeated until the emptiness of the list L_dep_ser. The algorithm terminates by eliminating the redundant links in the obtained graph based on the maximal similarities computed in the comp_similarity function. A composition step in the algorithm consists of updating the graph representing the composition scheme using the comp_similarity

function. This function is based on computing the semantic similarities between the inputs and the outputs of two web services to update the graph representing the composition scheme.

5. CASE STUDY AND EVALUATION

A. Employment process case study

We consider a case study of an organisation that needs to implement an employment process. The institution needs to obtain the candidate’s details (e.g. civil status, diplomas, police record). This information required for making decisions can be provided by other organisations such as, the Ministry of the Interior, the Ministry of Education, the Ministry of Justice and the like through web services. Complete descriptions of these web services are given in Table II.

With regard to the publication of web services, we take the example of the publication by the Ministry of Interior of the civil status web service. This institution must access the proposed platform in order to publish this service. The access point, named web service publication, must then be chosen. The profile management module holds a description of the web service as well as identifiable personal data on the cloud’s civil status, and the published module is used to publish the service in the UDDI directory. 7 depicts the release of the web service on civil status.

To get back the information of a given candidate, the institution user must introduce a query to specify needed information to process his recruitment. As an example, the query might be: ” **national identification number, civil status, university diploma, engineer or master, Medical information’s, professional experiences, police record** ”. The selection module determines the relevant web services by calculating the semantic similarities between

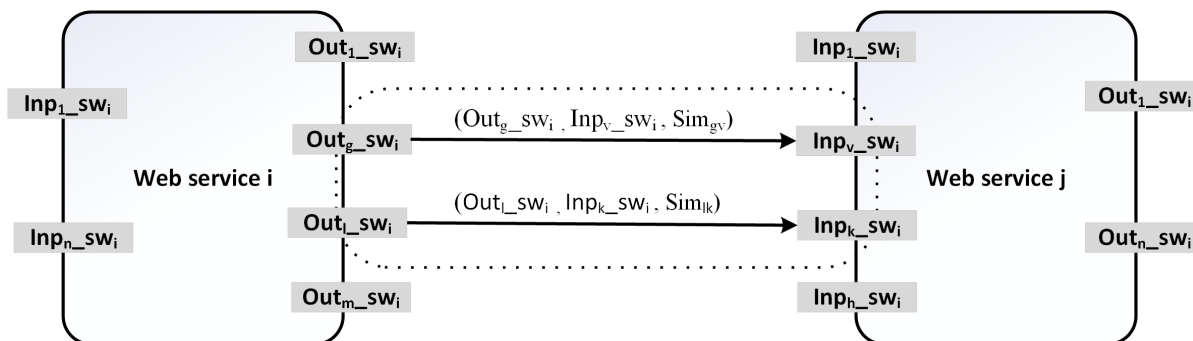


Figure 6. Similarities between input and output web service parameters.

TABLE II. List of web services with their descriptions of the employment process case study.

Service Name	Description	Provider	Parameters			
			Input		Output	
			Name	Type	Name	Type
Civil status	The service returns the civil status of a given citizen (First name, last name, birth date, male or female, age, family situation (married, not married)). The service bases on the national identifier number (NIN).	Interior ministry	NIN	String	NIN Citizen Last name Citizen First name, Breath date citizen, Gender citizen, Family situation citizen	String String String Date String String
Diploma university	This service allows return of the university diploma obtained by a given citizen. The service follows searches basing on the Last name, first name and the birth date of the citizen, on NIN identifier.	University ministry	NIN, Student last name, Student first name, Student Birth date, diploma graduate	String String String Date String	Diploma identifier Diploma Name Diploma Nature University name	String String String String
Diploma education	This service allows returning the scholarly diploma obtained by a given citizen. The service follows searches basing on the Last name, first name and the birth date of the citizen.	Education Ministry	NIN Pupil last name Pupil first name Pupil birth date Diploma name	String String String Date String	Diploma identifier Diploma Name Diploma Nature Institution	String String String String
Diploma professional	This service allows returning the professional diploma obtained by a given citizen. The service follows searches basing on the Last name, first name and the birth date of the citizen.	Professional Ministry	NIN, Trainee Last name, Trainee First name, Trainee Birth date, Diploma name	String String String Date String	Diploma identifier Diploma Name Diploma Nature Delivering Institution	String String String String
Qualification	This service allows returning all the professional experiences of a given citizen. The service follows searches basing on the Last name, first name and the birth date of the citizen. The search is done for a given diploma and a given job.	Work ministry	NIN Diploma identifier	String String	List of (Employer Name, Post description Begin date End date)	List
Health	This service allows returning the medical information for a given citizen. The service follows searches basing on the Last name, first name and the birth date of the citizen.	Health ministry	NIN Patient last name Patient first name Patient birth date	String String String Date	NIN Medical file	String Object
Police record	This service returns, according to the name of the citizen and his birth date, a police record according to the requested police record type.	Justice ministry	NIN Citizen last name Citizen first name Citizen Breath date police record type	String String String Date String	Police record	Object

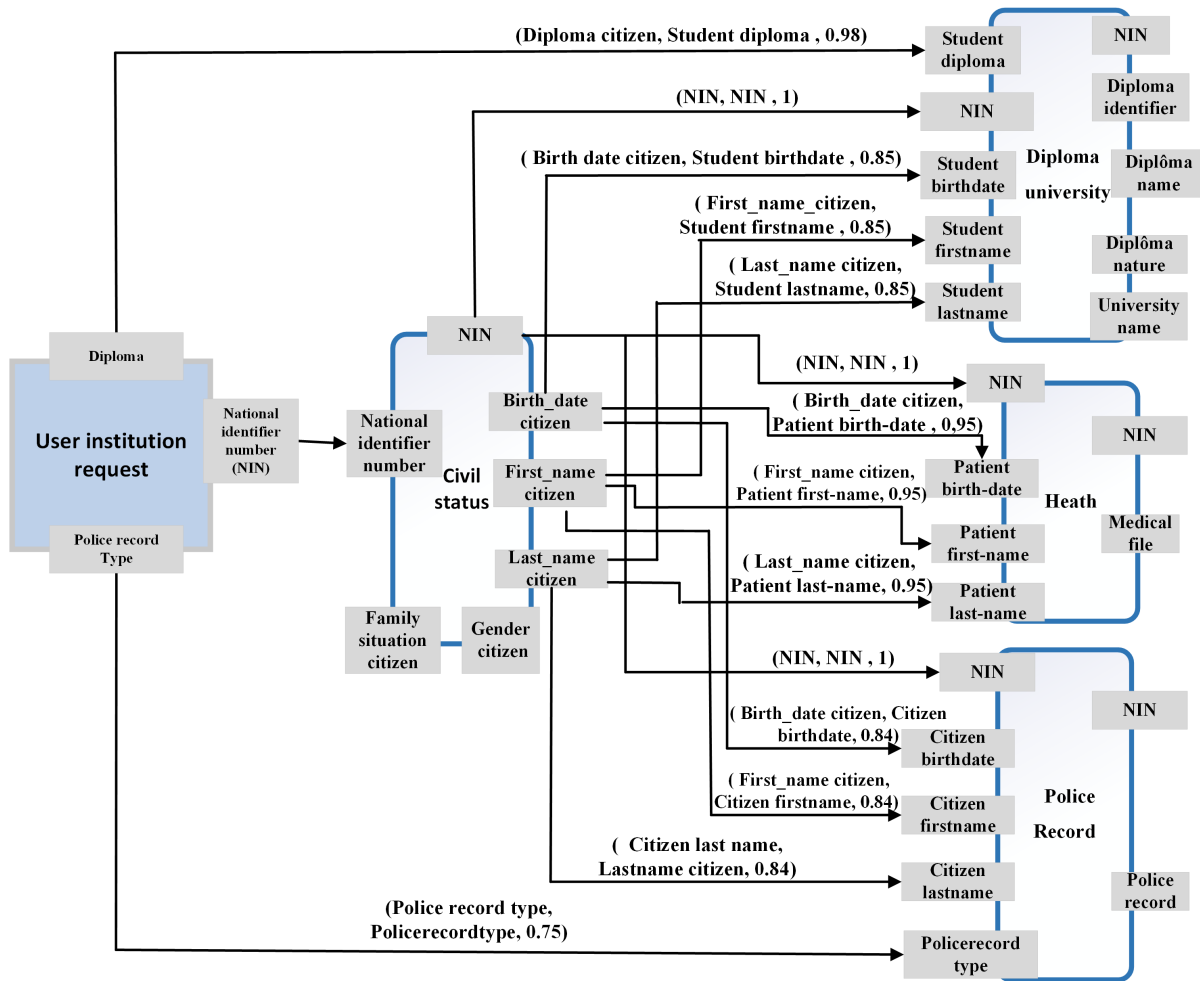


Figure 7. Graph of the first step of composition.

the descriptions of web services and the request made by the user of the institution. It uses the similarity function (Algorithm 4 depicted in section 4.b.v). The calculated similarities are listed in Table III.

We select only the web services which have a similarity greater than 0.5. For our example, the selected services are: "Civil Status, Diploma University, Qualification, Health and Police Record". Once the selection is complete, the composition module performs a dynamic composition to construct a composite web service. First, it determines all the services that require only inputs formulated in the request of the institution user. In our case, the 'Civil Status' web service is the only one that has all its inputs formulated in the request of the institution user. This step allows construction of the list of independent services (L_{ser_indep} in Algorithm 1) and the list of other services ($(L_{dep_ser}$ in Algorithm 1). The list of independent services is then processed to perform the composition step by step. Each composition step allows constructing a part of the composition graph. Each processed web service is deleted from

the list of services. The algorithm terminates when the list of services is empty. In our example, the first composition step produces the graph is shown in Figure 7.

The final composition graph is shown in Figure 8. Regarding the implementation aspects of the platform, soap web services have been developed and published as APIs for the atomic services provided by institutions. The composition scheme was created based on the algorithm 1. The obtained composition scheme, is then transformed into a BPEL code to deliver the composite service.

Figure 9 shows the use of our proposed platform for handling the recruitment request of the institution user.

B. Investment Requests processing case study

We take an example of a service for treating investment requests (STI) that service needs to implement a process for delivering investment authorisation. The STI treats investment requests by inspecting investor details (e.g. civil status, property deed, trade register); this information is required for decision-making. These are provided through

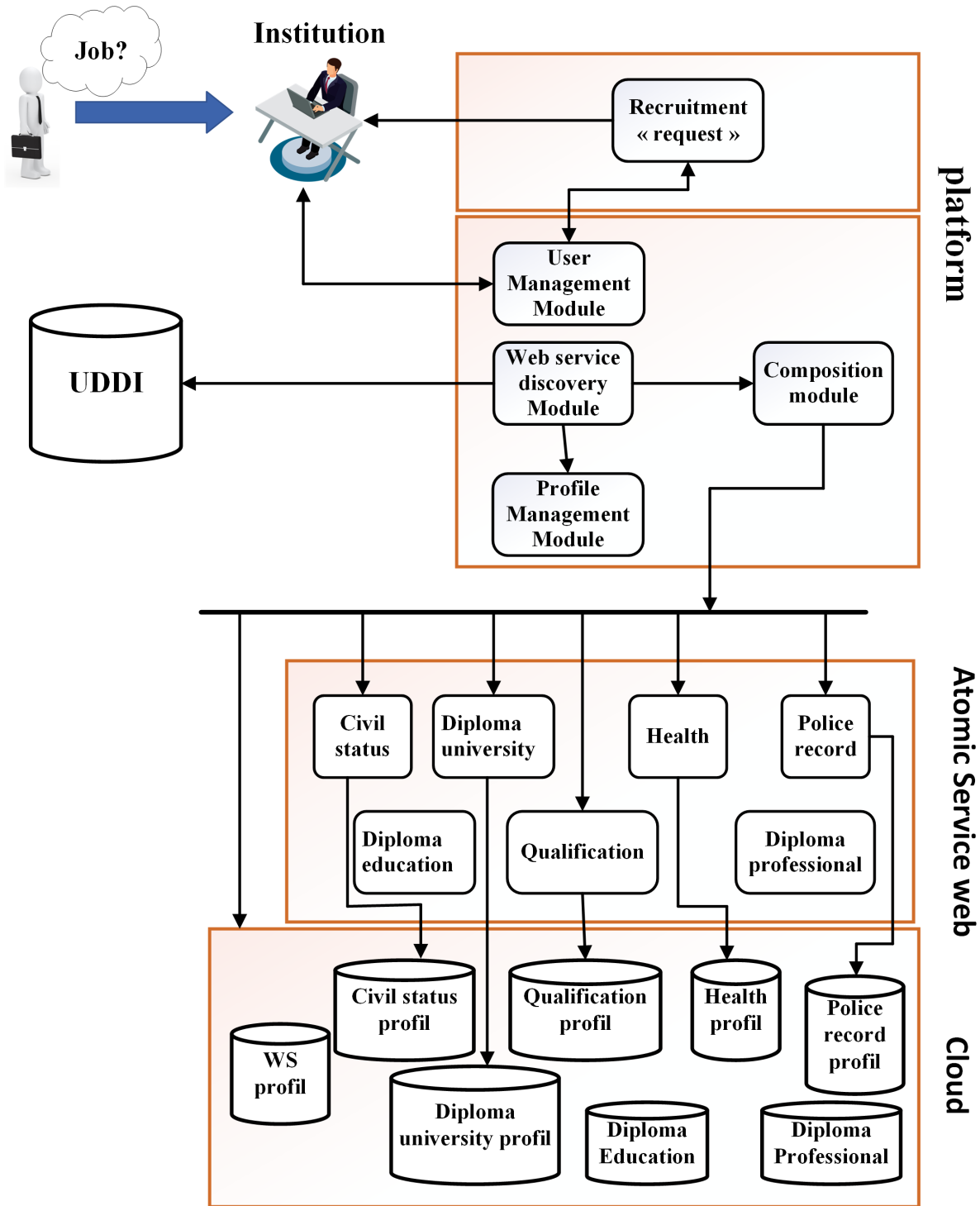


Figure 9. Employment service.



TABLE III. The similarity between the users institution request and the description of the Web services.

	Civil status	Diploma university	Diploma education	Diploma professional	Qualification	Health	Police record
national identification number, civil status	0.8	0.2	0.2	0.2	0.2	0.2	0.2
university diploma, engineer or master	0.2	0.6	0.4	0.4	0.4	0.2	0.2
Medical information's	0.33	0.33	0.33	0.33	0.33	0.76	0
professional experiences	0	0	0	0	0.76	0	0
police record	0	0	0	0	0	0	1

web services by other organisations (e.g. Ministry of Interior, Ministry of Commerce, Ministry of Finance). Full descriptions of these web services are given in Table IV.

To retrieve the information of a given investor, the user of the STI must submit a request to specify the information necessary to process his investment request. For example, the request could be 'national identification number, civil status, deed of property, property deed number, budgetary information, bank name, trade register, company name, building permit, industrial authorisation'. The selection module determines the relevant web services by calculating the semantic similarities between the descriptions of the web services and the request made by the STI user. We use the similarity function (Algorithm 4 described in section 4.b.v). We only select web services that have a similarity greater than 0.5. For our example, the services selected are: "Civil status, property deed, investment budget, trade register and industrial authorisation". Once the selection is made, the composition module performs dynamic composition to build a composite web service. The steps for constructing the composition scheme are exactly as in the employment process case study, see section 5.A). The final composition scheme is shown in Figure 10.

C. Evaluation of the proposed composition algorithm

For evaluating our composition algorithm, we consider a set of six (06) services where each is needed to compose several atomic web services for satisfying institution user requests. A request dataset (available in the Github platform¹,) was prepared for this purpose. The dataset contains, for each service, a set of institution user requests classified into correct and incorrect requests based on their similarities with the service description. Similarities are computed using the Algorithm 4. For each request, we generate a composition scheme using our composition algorithm and compare it to the expected composition scheme, i.e the correct scheme for the service. In Table V, we report the number of correct composition schemes and the number of incorrect composition schemes compared to correct and incorrect requests. We have observed that the results obtained by

our algorithm are satisfactory. For example, out of 1440 correct requests formulated by the institution users for the recruitment service, our algorithm generates 1287 correct composition schemes a rate of 89.37% and out of 150 correct requests formulated by the institution users for the sports club registration service, our algorithm generates 137 correct composition schemes a rate of 91.33%. The global rate of correct composition schemes generated by our algorithm for the six services is around 90.04%. The evaluation of the approach shows that, compared to the searches mentioned in Table I, our approach makes it possible to deliver compound services by dynamically composing web services based semantic similarities and digital identities.

6. CONCLUSION

Inter-institution platforms are needed to facilitate collaboration and communication between institutions for providing new applications and services. We have proposed a platform that delivers services by composing atomic web services. In addition to basic functions such as web service publication, discovery and selection, the proposed platform is based on dynamic composition of atomic web services to deliver responses to institution requests by composing web services. The proposed algorithms select the needed atomic services and compute the adequate composition scheme according to the institution user request. We have tested the proposed platform using a set of six (06) services and a dataset containing 5040 requests. For each request, we have generated a composition scheme using the proposed algorithms, which we have compared to the expected composition scheme. The result shows an overall rate of correct composition schemes around 90.16%. Sharing individual identifiable information between institutions requires consideration of the security. This aspect as well as the improvement of the functioning of the discovery and the composition modules by adding other semantic search criteria, will constitute the perspectives of this research.

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¹<https://github.com/toubal-elbahi/Webservice-Composition-Requests-Dataset>

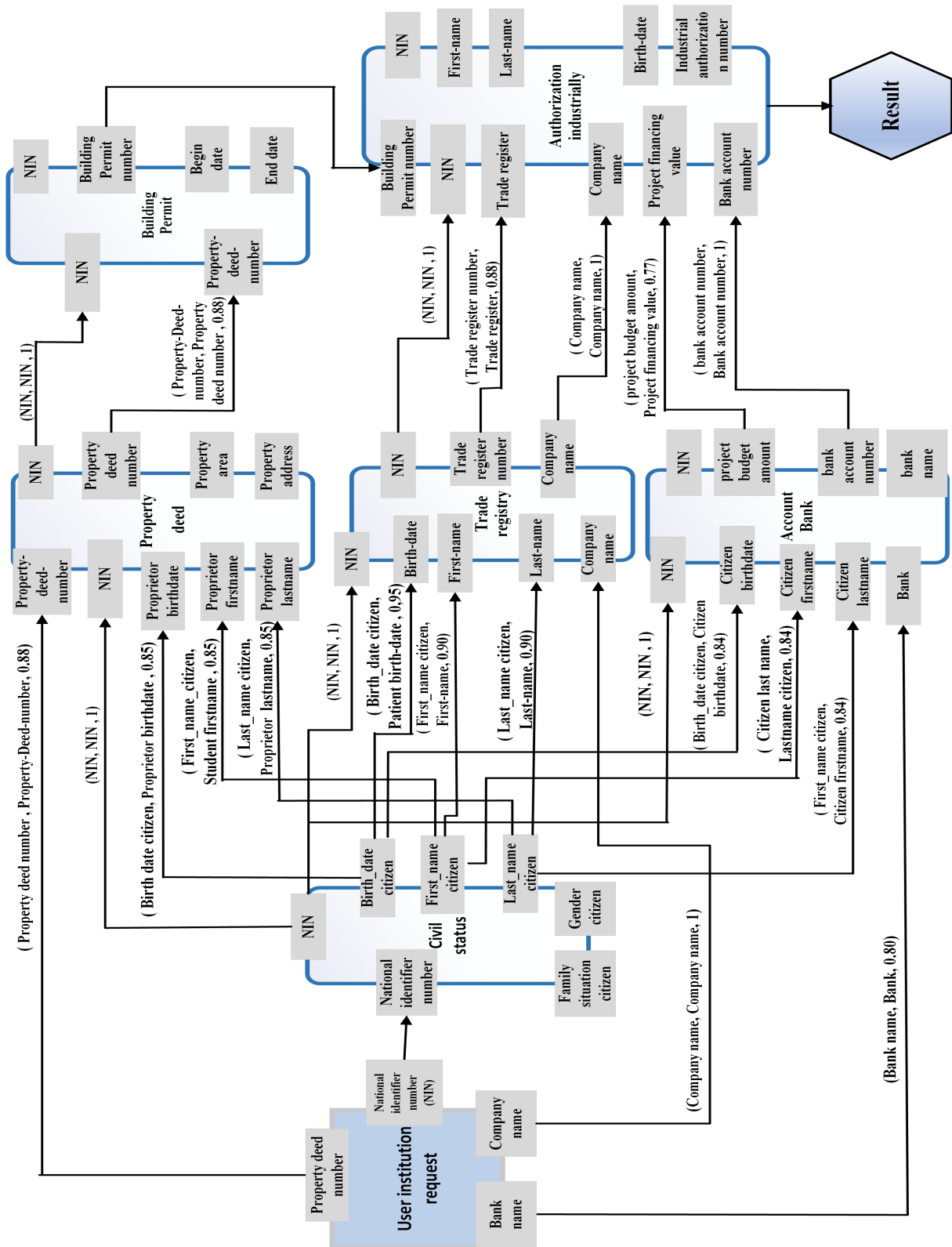


Figure 10. The final composition scheme of the investment request processing study.



TABLE IV. List of web services with their descriptions of the investment request processing study.

	Description	Provider	Parameters			
			Input		Output	
			Name	Type	Name	Type
Civil status	The service returns the civil status of a given citizen (First name, last name, birth date, male or female, age, family situation (married, not married)). The service bases on the national identifier number (NIN).	Interior ministry	NIN	String	NIN Citizen Last name Citizen First name, Breath date citizen, Gender citizen, Family situation citizen	String String String Date String String
Property deed	This service returns the information concerning a property title based on the information of a citizen and property deed number.	Finance Ministry	NIN, Proprietor last name, Proprietor first name, Proprietor birth date, property deed number	String String String Date String	NIN Property deed number Property area Property address	String String Float String
Account bank	This service makes it possible to justify the financing of the investment for an applicant. The service follows searches based on the name, first name, date of birth, account number and name of the citizen's bank.	Finance Ministry	NIN citizen last name citizen first name citizen birth date bank name	String String String Date String String	NIN project budget amount bank account number bank name	String String String String
Trade registry	This service makes it possible to bring information concerning the business registers of a given citizen. The service carries out searches based on the NIN, Name, first name and date of birth of the citizen and the company name.	Commerce Ministry	NIN, Last name, First name, Birth date, Company name	String String String Date String	NIN, Trade register number. Company name	String String
Building permit	This service returns information concerning the building permit of a given citizen concerning a given property. The service performs searches for a given property based on Name, first name, date of birth of the citizen.	Interior ministry	NIN property deed number	String String	Building Permit number Begin date End date	String Date Date
Authorization industrially	This service makes it possible to deliver the industrial authorisation for a given investor. The service requires the citizen's information, the building permit number and the company name.	Industry Ministry	NIN Building Permit number Trade register number. company name project budget amount bank account number	String String String string	NIN Industrial authorisation number	String String

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TABLE V. Execution results of test requests.

Service name	Atomic web services	Number of requests		Number of correct composition schemes		Number of incorrect composition schemes	
		Correct requests	Incorrect requests	By Correct requests	By incorrect requests	By Correct requests	By incorrect requests
Recruitment service	- Civil status - Diploma university - Diploma education - Diploma professional - Qualification - Health - Police record	1440	60	1287	5	160	55
Treating investment requests	- Civil status - Property deed - Trade registry - Building permit - Authorisation - Industrially	1440	60	1290	4	150	56
Passport issuing service	- Civil status - Health - Police record - Qualification - Passport	950	50	862	8	88	42
Social assistance service	- Civil status - Qualification - Health - Social Security affiliation	600	50	546	5	54	45
Sports club registration	- Civil status - Health - Insurance	150	20	137	3	13	17
Trade service register	- Civil status - Notarial act - Taxes - Trade registry	200	20	176	16	24	4

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ElBahi Toubal Is a doctoral student in computer science at USTHB University - Algeria - and lecture in the mathematics and computer sciences department at University of Medea - Algeria. His research interests are but not limited to web services, semantic web and model driven architecture. Elbahi received engineer diploma in computer science from USTHB University of sciences and technology and a magister diploma in computer science from the high school of computer science (ESI), Algeria



Belkhir Abdelkader Is a full professor at the Computer Science Department, Faculty of Electronic and Computer Science, USTHB University, Algiers. He leads a research team whose theme is web technology and computer security (LSI laboratory). His research field is web technology and computer security.



computer science (ESI), Algeria.

Messaoud Rahim Currently Associate Professor of computer sciences at the University of Medea, Algeria. He received the Ph.D. degree in computer science from the University of USTHB, Algeria. His research interests include design and formal verification of systems, designs with digital twin, ontologies and Web services. Messaoud Rahim received engineer and magister diplomas in computer science from high school of com-



puter science (ESI), Algeria.

Ahmed Kheldoun Received the Ph.D. degree in computer science from the University of USTHB, Algeria. He is currently an Associate Professor of computer sciences with the University of Medea, Algeria. His current research interests include Petri net theory and applications, software engineering, Business Processes, Distributed and reconfigurable systems and Web services. Kheldoun received engineer and magister