# International Journal of Interactive Multimedia and Artificial Intelligence

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***There's only one corner of the universe you can be certain of improving, and that's your own self.***
Aldous Huxley, 1944






## Special Issue on Computer Science and Software Engineering

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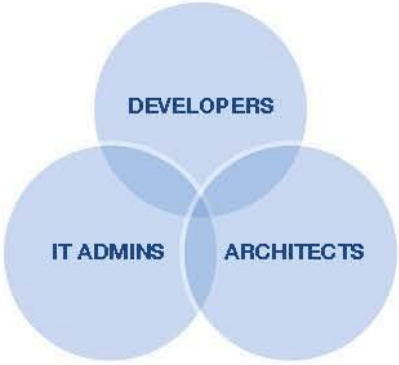


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# Editor's Note

## I. INTRODUCTION

Welcome to IJIMAI and thank you very much to my co-editors for allowing me to be here. I also want to thank our readers for the positive feedback we receive constantly.

Our readers to help us constantly to improve and model what is going to be IJIMAI in the future, they suggest turning IJIMAI in a magazine with abroad scope and a practical nature to show the applications of the newest interactive, multimedia and AI systems

The new special issue is about software engineering. This knowledge area is growing every day and we consider it to show everyone the new researches that our writers are making on their research groups. Of course, we cannot forget the principal scope of the journal and therefore, we decide to include good quality articles which combine artificial intelligence and software engineering.

The journal "International Journal of Interactive Multimedia and Artificial Intelligence" is undergoing a profound process of improvement. There have been many achievements since the inception of the magazine, but the year 2011 has been particularly productive.

Some of the most important achievements we have made are, printed version of the magazine (published by the Pontifical University of Salamanca, Madrid campus); new international scientific committee members, all highly regarded professionals; large increase in the number of articles submitted for publication (we have multiplied by ten the number of items) and increase in the number of external references

New arrangements for the publication of "Special Issues" for Congress International relevance, such as, RTBI WorkShop SAP – CHINA, Pervasive Multimedia Sensor Networks, IEEE - DCAI 2012: 5th International Symposium on Distributed Computing and Artificial Intelligence.

Additionally, it also increased the institutions that index the journal, such as, DOAJ - Directory of Open Access Journals, LatIndex, EBSCO Publishing, etc.

So this year 2012, we face the challenge of improving IJIMAI to achieve an increase in prestige, number of publications and readers. Again, welcome to all.

## II. WELCOME TO NEW MEMBERS

Sukumar Senthilkumar received his B.Sc in Mathematics from Madras University in 1994, M.Sc and M.Phil in Mathematics from Bharathidasan University in 1996 and 1999, PGDCA and PGDCH from Bharathidasan University in 1996 and 1997 respectively and M.Phil in Computer Science & Engineering from Bharathiar University in 2000. He has a doctoral degree in the field of Mathematics and Computer Applications from National Institute of Technology, Tiruchirappalli, Tamilnadu, India. At present, he is a post doctoral fellow at the School of Mathematical Sciences, Universiti Sains Malaysia in Pulau Pinang, Malaysia. He was a lecturer/assistant professor in the Department of Computer Science at Asan Memorial College of Arts and Science, Chennai, Tamilnadu, India. His current research interests include cellular neural networks, digital image processing, numerical analysis & methods, simulation & computing and other related areas.

Sara Rodríguez (PhD). Received a PhD in Computer Science from the University of Salamanca (Spain) in 2010. She is Assistant Professor at the University of Salamanca and researcher at the BISITE research group (http://bisite.usal.es). She obtained a Technical Engineering in Systems Computer Sciences degree in 2004, an Engineering in Computer Sciences degree in 2007 in the same University. She has been co-author of published papers in several journals and recognized international conferences and symposiums.

Pablo Molina de Pablo (PhD.) Ph.D. in Physics (Material Sciences) at Universidad Autónoma de Madrid in 2009. Physics at Universidad Autónoma de Madrid (Spain) in 2005. Specific field: Optics and matter structure Nowadays is a Postdoctoral researcher in the Laser Spectroscopy laboratory at Universidad Autónoma de Madrid (Spain). His main research fields are: Domain engineering in ferroelectric materials, optical spectroscopy of rare earth optically active ions in insulating materials and tunable solid state lasers, and non-linear optical processes and frequency conversion processes.

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# Discover, Reuse and Share Knowledge on Service Oriented Architectures

Jesús Soto Carrión[1], Lei Shu[2], Elisa Garcia Gordo[3]
(1) Head of Artificial Intelligent Department, UPSAM University, Spain
(2) Specially Assigned Researcher, Osaka University, Japan
(3) Innovation consulting manager, ADIF (the Administrator of Railway Infrastructures), Spain

***Abstract* — Current Semantic Web frameworks provide a complete infrastructure to manage ontologies schemes easing information retrieval with inference support. Ideally, the use of their frameworks should be transparent and decoupled, avoiding direct dependencies either on the application logic or on the ontology language. Besides there are different logic models used by ontology languages (OWL- Description Logic, OpenCyc-FOL, ...) and query languages (RDQL, SPARQL, OWLQL, nRQL, etc..). These facts show integration and interoperability tasks between ontologies and applications are tedious on currently systems. This research provides a general ESB service engine design based on JBI that enables ontology query and reasoning capabilities thought an Enterprise Service Bus. An early prototype that shows how works our research ideas has been developed.**

***Keywords* — Service Oriented Architectures, Distributed Computing, Semantic**

## I. INTRODUCTION

Recent advances in distributed computing have given rise a new philosophy of iteration between software components, called SOA. This new software architecture allows software components developed with different technologies can be "plug in" to an Enterprise Service Bus (ESB), that enable the interoperability scenario. Any component interface is described using WSDL (a open standard language using to publish the functionality provided by a service), in this way any software component can understand the operations provided by other components and establish the necessary communications to obtain a specific goal.

This paper shows the impact and utility provided by semantic web technologies "plug in" on ESB. Currently the main ESB manufactures (Oracle, IBM, BEA or Sun) lack of semantic web connectors (Chappell 2004), (Rademakers y Dirksen 2008) this fact forces to build components using a particular semantic web framework with following associated problems (Jesús Soto-Carrión 2008):

- Hinder development tasks: there not exist a common ontology access provider such as ADO or JDBC on data access, each semantic web framework (Jena, Protégé-OWL, Sesame or Redland) provided a specific application programming interface. Besides each framework has been developed with an specific programming language, this fact, joined to previous explained, causes an strongly dependency between application logic and semantic web framework.
- Coupled applications: common semantic web functionality implemented into different components.

On the other hand, component communication are exchanged messages that contain data, usually these data follow a fix structure (schema) without using flexible knowledge expressions provided by the semantic web emerging technology. Knowledge bases formalized with a sound logic model such as OpenCyc[12] or ontologies written in OWL-DL[1], should enhanced the interoperability scenarios between "plugged" components inside an ESB providing a rich semantic knowledge and inference operations.

The problems enunciated above broken the loose-coupling principle of service design[7]. For that reason this research has been focused on services interoperability using a general ontology reasoning connector, that provides a normalize interface to semantic functionality inside an enterprise service bus. A prototype that shows the semantic connector benefits has been developed. The functionality implemented using OpenESB technology to be able to carry out a semantic search on Google maps service using KML3 and a specific ontology to allow semantic annotations. An example of these type of search should be: "retrieve all religious building".

This paper has the following structure: firstly described a brief introduction related to SOA concepts, secondly presents the wide variety of query and knowledge representation semantic web languages, thirdly currently shortcomings in semantic web knowledge interoperability are exposed, fourthly the solution is exposed using the emerging ESB technologies to describe the general ontology reasoning connector, following presents the GORCON prototype, finally conclusions drawn for this work are explained.

## II. SERVICE ORIENTED ARCHITECTURE

SOA is a form of technology architecture that adheres to the principles of service-orientation[10], it is an evolution of past platforms preserving successful characteristics of traditional distributed architectures, and bringing with it the interoperability among services that uses different technologies including legacy applications, databases and another types of backend systems. The main features provided by this


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architecture are:

- Enterprise Application integration: enable the interoperability between new applications and legacy systems, neither risks and collateral effects.
- Loused-coupled architecture: based on services that can perform a delimited task, dependencies between services are modeled on a high level layer (choreography and orchestration).
- Business modeling: the business activities performed by a company can be modeled with a business language [18] that uses real human business language terms.
- Distributed technologies: necessaries to interconnect all different types of services. SOA deploy specifications SCA/SDO[2] and JBI[17] uses open standards in order to enable an interoperability scenario between all different services (DCOM, CORBA, Web Services, etc...).
- Abstraction: SOA abstracts programming language of services. SOA uses languages based on open standards (WSDL, SOAP, BPEL, ...) .

The SOA layers are showed in the figure 1, following are explained from low-level to higher-level:

- Low-Level services: this layer contains all services that perform delimited tasks. These services can be implemented with different languages and interact with information systems such as databases, legacy systems or embedded systems (sonar, radar, and etcetera).
- Middleware services: intermediate layer that enclosed all higher level services. These services uses low-level services in order to perform a specific task, i.e. obtain the best service provider (relative time, cost or effort).
- Business process: they are the more relevant entities inside SOA architecture. These entities work as mediators, they are invoked from an external request (can be origin from presentation layer) or an internal event. They are defined by orchestration and choreography languages[11][3].
- Presentation: represents the visual interfaces of one application or external systems that can invoke the business process to execute a business task.
- Security: vertical layer that contains all security technology artifacts used across all layers. SOA establish security service communication using contract policies [14], besides uses open standards to use a global identifier among different systems[5].
- Government: enclosed all mechanisms that establish a sound structure for decision making and planning. This vertical layer is focused on lifecycle services and optimize business process, analyzing how work SOA applications that uses company politics, procedures and standards (Brown et al. 2009).

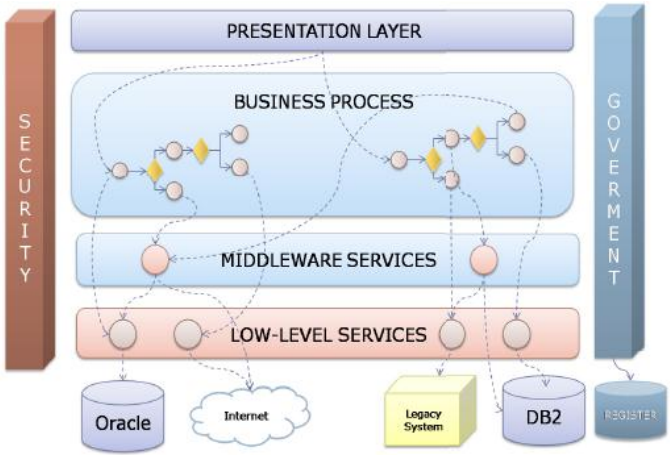


Figure. 1 SOA Layers

### *A. SOA SERVICE – The Basic UNIT*

A service is not only a Web Service, commonly is usual confuse the concept with the technology. In SOA a Service can be developed with different technologies, the interfaces and security policies are described using a neutral open language. Thus the operations provided by a CORBA Servant or a DCOM object can be described in WSDL Language (instead of IDL or MIDL respectively). SOA provides the mechanisms that enable an interoperability scenario between services implemented with different distributed technologies (CORBA, DCOM, JMS,...), due to the use of open languages that facilitate understand the operations.

The interoperability concepts described by SOA architecture require of a robust design principles. There are several studies about the principles of service design (Oracle, IBM..) , mainly all converge in following set of principles annunciating by Thomas Erl[7]:

- Reusable: any service must be designed and developed keeping in mind reuse its operations in a application, company application domain or even for massive use in a public domain.
- Communication based on formal contract : services must provided a formal contract in which contained the narre of the service, access way, the operations implemented including in/out parameters description.
- Loose-coupling: services must be autonomous (such as LEGO puzzle piece), therefore may designed without relationship dependencies.
- Abstraction: services must hide logic and implementation issues from the outside world.
- Composition: any service must be designed in order to be used in higher-level services building.
- Stateless: a service implementation must not manage and store information about state.
- Discover ability: services may be found and assessed by some discover mechanism.

### *B. DEPLOYING SOA*

A Service Oriented Architecture needs an infrastructure to

deploy services, process and applications that interoperate between them with different protocols and data schemes. The software infrastructure that supports SOA is called Enterprise Service Bus (ESB)[6].

*1) ENTERPRISE SERVICE BUS (ESB)*

An ESB provides a software infrastructure necessary to deploy SOA architecture. Among features provided by the most important suppliers (IBM, BEA, Oracle, Service Mix) worth mentioning (figure 2):

- Connectivity between any type of services: there are multitude of service technology that can be used inside a SOA architecture, ie. DCOM, CORBA, EJB, LDAP Servers, FTP, databases, JMS, MSMQ, SAP, CICS, among others.
- Neutral language: used into ESB to describe operations and interconnect services with a specific message exchange protocol (MEP). Any message transmitted inside the ESB can be enrouted.
- Data transformation mechanism: executed when two services, that uses different data schemes, needs translate data in order to establish a communication.
- BPM engine: interprets a business process language, executing actions following the flow defined, invoking services and receiving external request and messages.
- Security services: uses to provide a security layer to protect communications.
- Administration components: enable the components management installed on ESB, common operations that control the component lifecycle are "install", "uninstall", "stop" and "resume".

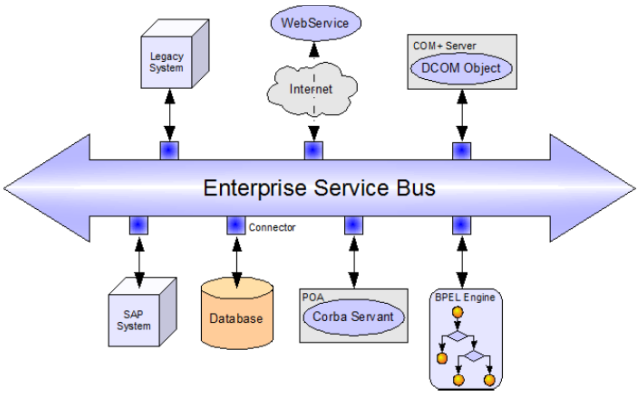


Figure. 2. Components "plugged" - Enterprise Services Bus

The internal architecture can be implemented with two principal approach, Service Component Architecture (SCA) & Service Data Objects (SDO) 4, and Java Business integration [17].

*2) SCA/SDO*

Service Component Architecture (SCA) is a set of specifications that describes an application building model on a service oriented architecture. SCA specifications are focused on component assembly, binding and implementation issues. The component is the basic piece that exposes a group of services using WSDL language. The assembly features provides the mechanism to build composite components describing the relationship structure with an XML languages. Following the principles of SOA, components can be implemented in different languages, for that reason its necessary specify the binding type (jms, soap, etc...).

The messages transmitted between components contain data necessary to execute the operations described on a service interface. Service Data Objects are a set of specifications (complementary to SCA specifications) that describes an simplify data model and an uniform access to heterogeneous data sets. SDO specifications are based on a disconnected data access model, is an alternative to DOM model since allow saving memory. SCA / SDO implementation examples are HydraSCA (Rogue Wave Software), IBM WebSphere (feature pack for SOA), BEA SCA for WebLogic, Oracle SOA/EDA and Active Matrix (TIBCO).

*3) JBI*

Java Business Integration specification[17] defines mediation architecture between heterogeneous services. The structure of JBI is composed of three components (see figure 3): Component Framework, Normalized Message Router (NMR) and Component Management:

Component Framework: describes all issues related to ESB components. JBI specification distinguishes two components types: "Service Engine" and "Binding Component". Service Engine (SE) components are internal services charge of main ESB execution functionalities, such as BPEL interpreter or data translation and transformation services. Binding Components (BC) enable service deploy over a SOA architecture. The internal design allow "plug in" and "unplug" components on an ESB (like a USB device). These features provides a flexible way to establish an enterprise application integration.

NMR provides a normalized message interchange mechanism between ESB "plugged" components. Each service (associate with a SE or BC component) exposes its interface operations using a WSDL descriptor. The operations described on WSDL interface establish the contract relationship with consumers, necessary on SOA architectures to integrate different components "plugged" on an ESB. Each normalized message routed into ESB contains metadata, payload (based on WSDL message structure) and attachments. These messages are translated from a specific protocol to normalized structured (and vice versa) by binding components, and enrouted by means of NMR from start point to end point using one of message exchange patterns (in-only, robust in-only, in-out or in optional-out).

Component 1→BC Start point→
NMR→BC End Point→ Component 2

Component Management enables the component lifecycle management based on JMX. These management components

provide operations to shutdown, stop, start, resume or paused binding or service engine component execution.

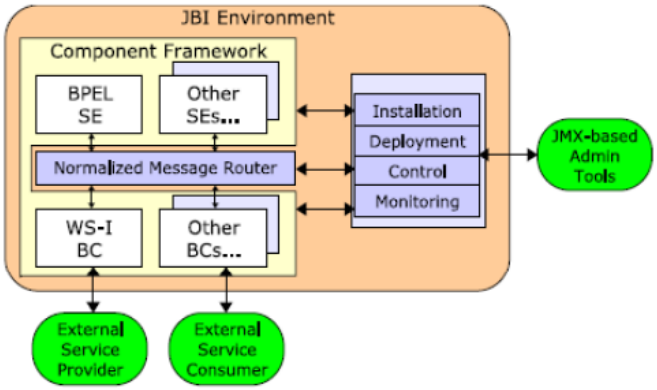


Figure. 3. JBI Components

## III. SEMANTIC WEB LANGUAGES & FRAMEWORKS

Currently semantic web emerging technologies provides a wide range of frameworks that implement common functionalities, among which highlights Jena, Sesame or Redland. Each framework works with an specific set of languages (publish on standards or proprietary specifications) oriented to build and manage knowledge models. The ontology languages widely used are RDF (Resource Description Framework) and OWL (Ontology Web Language).

The general structure of a Semantic Web Framework has been represented in figure 4 (Ontology API):

- Schema API: functions set oriented both building and manipulating of ontology schema objects (class, relationships, properties and data types).
- Individual API: provides the main functionality to manage ontology individual objects.
- Inference API: include inference and reasoning mechanism which allow additional facts to be inferred from instance data and class descriptions. Besides it uses an internal or external reasoner (mainly thought DIG interface based on Description Logic Reasoners) to add check consistency, concept satisfiability, classification and realization operations.
- Query API: also influenced by Inference API, establishes the functionality to analyze and execute an specific ontology query language such as SPARQL or nRQL among others.
- Memory model: contains an ontology model on memory, usually in a graph structure, to carry out ontology API operations. A memory model can be serialized into an storage device using the persistent subsystem.
- Persistent Subsystem: provides the main functionality to work with a serialize ontology model upon a database or a file in a timely and transparent fashion.

There is a framework initiative that defines a general design to manage ontologies, called Protégé. In this research, Protégé structure has been analyzed against other frameworks (Jena, Sesame and Redland) to obtain software design ideas about general ontology management and structure issues. An in-deep explanation can be found in [9],[15],[16]. Based on CLOS MOP (Common Lisp Object System - MetaObject Protocol) and the Dynamic Object Model software design pattern, Protégé provides a set of abstract class and interfaces that allows execute ontology operations on different models (OWL or RDFS).

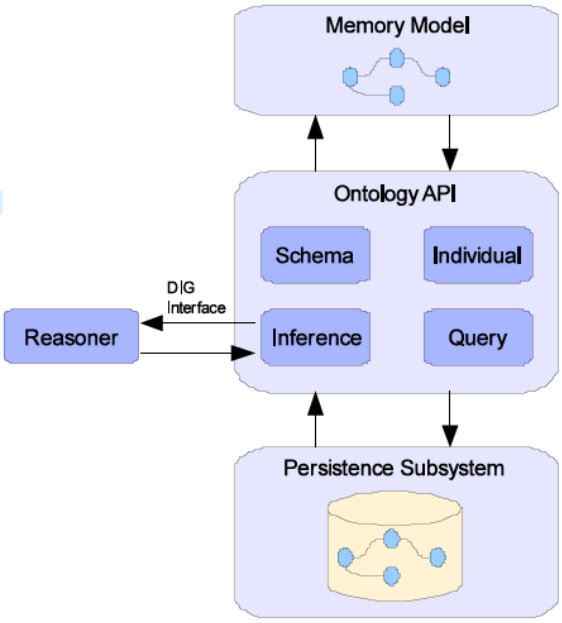


Figure. 4 SWF - general structure

## IV. PROBLEM DESCRIPTION

Semantic frameworks provide a complete functionality focused to manage ontology models as had been previously mentioned, however nowadays there is no consensus aimed to resolve the strongly dependency between logic application and semantic/persistent layer. When a software architect decides change the semantic web framework underlying, just became aware that it is a tedious task because all code is strongly coupled [15].

Another motivation arises from the problem of distributed scenarios when different software components exchange information and need process common knowledge structures (called ontologies). In an Enterprise Service Bus there are binding components provided by third party manufactures that allow "plug in" different pieces of software developed with a vast variety of technology. Not all components can use semantic technologies because its underlying technology is older or not exits the way to create a binding.

Following an scenario is described in order to illustrate an example of these problems: imagine a CICS component that has been implemented using Cobol language and receives a set of messages that contains a sequence of medicine patient history based on OWL knowledge structured provided by open electronic health record ontology (OEHR)[19], COBOL language does not support a semantic library and the component needs some relevant operations such as check the consistency of data or retrieves all instances of one specific

class. In view of this situation, it is necessary developed a specific protocol between the CICS-COBOL component and one semantic framework.

This research is focused to resolve these problems, including SOA philosophy concepts, that suggest the possibility of extend a distributed scenario where several software components can take advantage of semantic functionality deployed on a service engine.

## V.GENERAL ESB SERVICE ENGINE DESIGN

Using the technology offered by an Enterprise Service Bus, a general semantic service that resolves all problems enunciated in the previous section can be developed. Analyzing NMR behavior, external components should consume operations provided by a semantic web framework. This research uses only the following common operations:

- Check consistency: verify if an ontology is well defined, without inconsistencies between data types, duplicate entries, properties definitions, etcetera. Using this operation, component software can check the consistency of one or more individual received.
- Retrieve a specific individual.
- Retrieves individuals using SPARQL language.

Inspired by service engines and binding components provided by JBI developer's community and third party manufactures, a semantic service engine has been implemented. The general infrastructure that has been supported the development is showed in figure 5. The General Ontology Service Engine (GORSE) provides a general interface that supports all operations previously enunciated using Protégé OWL¬API as an underlying framework for ontology processing. GORSE can be deployed on a Enterprise Service Bus in accordance with JBI specification. Our prototype has been developed using OpenESB7.

The figure 5 shows how GORSE receives messages via Normalized Message Router. Using this system, different components implemented with different technologies can used semantic web functionality. For example, a IBM mainframe which contains a COBOL subroutine that needs process a XML file according an ontology schema instead of create a new specific program to do these semantic processing tasks. Another example can be a web service or some type of component (DCOM,CORBA, etc..) witch is deployed within an ESB but it is not possible uses a semantic web framework due to implementation constraints, or if the architecture design requirements establishes a decoupled semantic layer . GORSE has been developed following the ideas provided by OpenESB SQL Service Engine functionality[8]. The design structure is showed in figure 6.

Layer structure showed in figure 6 contains the following components explained from bottom to top:

- OpenESB: provides alI functionality related to build a SOA environment that interconnects heterogeneous services. GORSE has been built using libraries provided to create internal services.

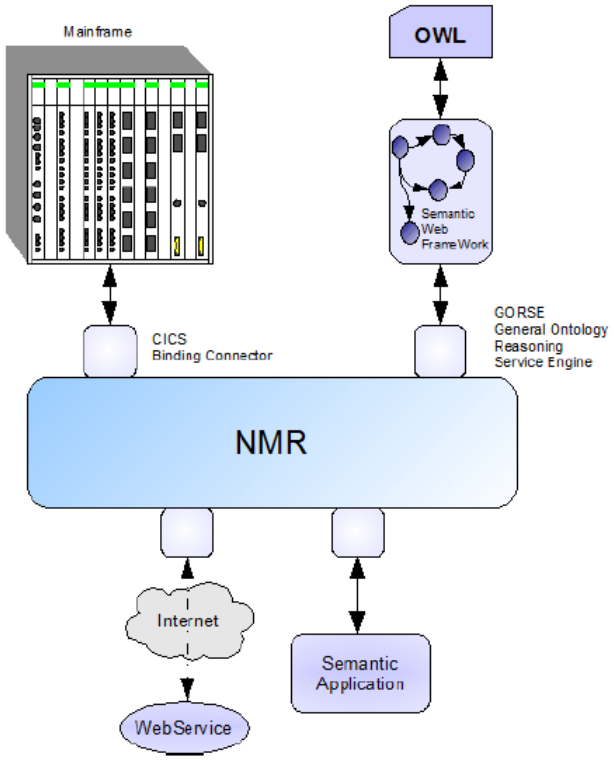


Figure. 5 Connection GORSE to NMR

- Interface Builder: used to develop a specific GORSE service which exposes an interface that contains management and query operations on a knowledge base (owl file or protégé database persistent subsystem) structured according to a
- conceptual model provided by an ontology. This component is an OpenESB - Netbeans plugin.
- Deploy services: a set of libraries that provides common functionality to deploy binding components or services engines. Plugin API uses deploy services to place and allocate resources into a SOA environment.
- Message Handler: is the highlight component focused to parse all operations received by NMR bus and launch suitable execution tasks. This component plays an important role into GORSE layer structure, uses top and bottom components functionality.
- Protege OWL-API: provides the main functionality to manage a knowledge base based structured according an ontology (classes, properties, instances and restrictions). This library contains all functions related to manage an ontology stored in a file or into a persistent subsystem.

GORSE: contains all specific tasks developed according the service interface created thought Interface Builder plugin.

Following we provided a detailed description of Interface Builder and GORSE components. All operations and messages received from NMR follow a schema provided by an auto-generated WSDL interface. The interface builder module has been developed to generate automatically the WSDL ontology

interface using specific parameters with are specified into gorse-settings.xml file, following we show a short example:

```
<connection>
  <database-url
  value=jdbc:mysql://localhost:3306/model>
  <knowledge-base value='ontomaps'/>
</connection>
```

This file contains key information about how GORSE gains access to the ontology persistent subsystem. The given example uses a short set of parameters, other ontology serialized representations can be specified, for example an OWL file instead of a relational database.

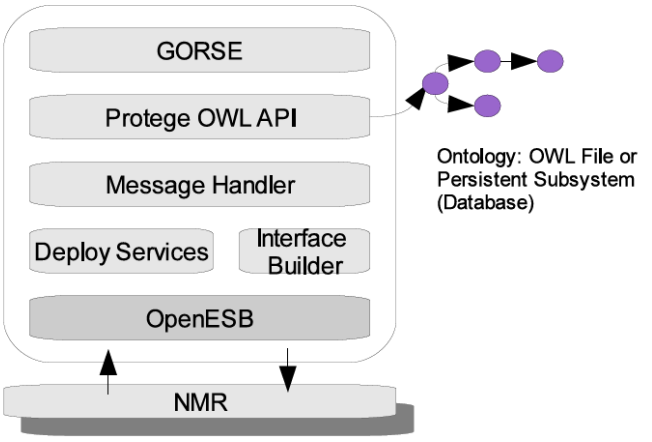


Figure. 6. GORSE Service Engine

Once the user has been configured these parameters, he can launch the build process with which will be created the WSDL interface. The interface builder model generates a WSDL interface using the following short set of rules:

- **For each OWL-CLASS**
  - **Create a XSD ComplexType - XSDOWL-CLASS.**
    - Into a Sequence (*):
      - Include an ontology ID element as xsd:anytype.
      - Mapping OWL Datatype properties - XSD 1 elements
      - Mapping OWL ObjectProperties - XSD ComplexTypes
        - Include references.
  - **Create Add-Operation**
    **AddOnto[CLASS]lndividual and :**
    - Input Message: InputMsg individual ns:XSDOWL-CLASS
    - Output Message - ResponseOperationMsg: resultcode xsd:int
    - Create Remove Operation
  - **RemoveOntolndividual[CLASS]:**
    - One-Way message: IDMsg
      - individuallD xsd:anyURl
    - Create Find Operation - Search[CLASS]
    - Input message - Find:
      - inputdata ns:XSDOWL-CLASS
    - Output message - FindResultsMsg:
      - result ns:LIST-XSDOWL-CLASS
  - **Add SPARQL Query operation:**
    - Input Message:
      - query xsd:string
    - Output Message:
      - LIST-XSDOWL-[CLASS]
  - **Create CheckConsistency Operation**
    - Input message - InputCheckConsistencyMsg:
      - rawXMLdata xsd:string
    - Output message
      - ResultCheckConsistencyMsg:
        - Resultxsd:Boolean

The above algorithm provides ontology control and management common operations inside ESB infrastructures. The service engine which implements WSDL interface is composed of different classes (ref ), as we showed in the figure 7 "ProviderSEMessageHandler" is the mainly class focused to process all messages received from NMR message bus. This class inherits of "AbstractMessageHandler" class, a generic handler that includes relevant operations such as "send" or "processMessage". - The "processInMessageOnProvider" method declared in "ProviderSEMessageHandler" class, contains relevant code necessary to process all messages received from NMR Bus in accordance with ontology WSDL specification interface.

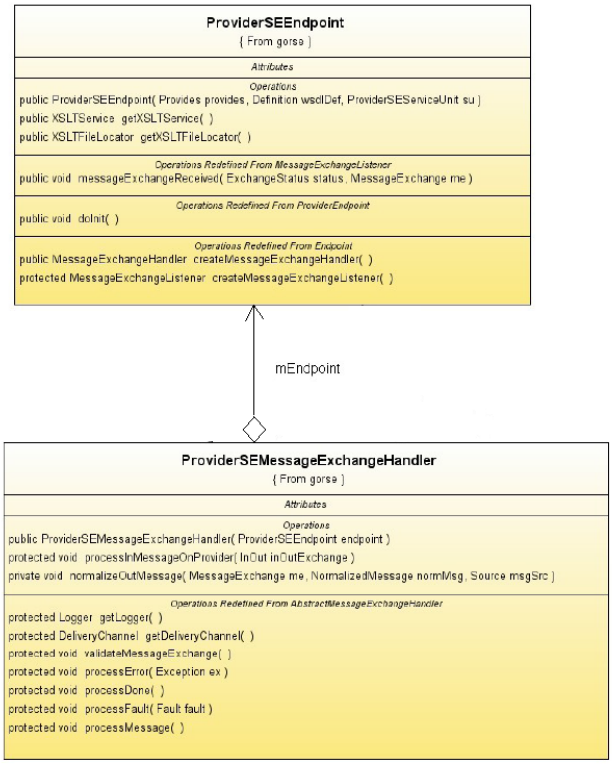


Figure. 7 Main Class Relationships

## VI. PROTOTYPE

In order to illustrate how GORSE works, we have been developed an early prototype with uses and interconnect three services: google maps, a GIS coordination service and finally an ontology inside GlassFish OpenESB.

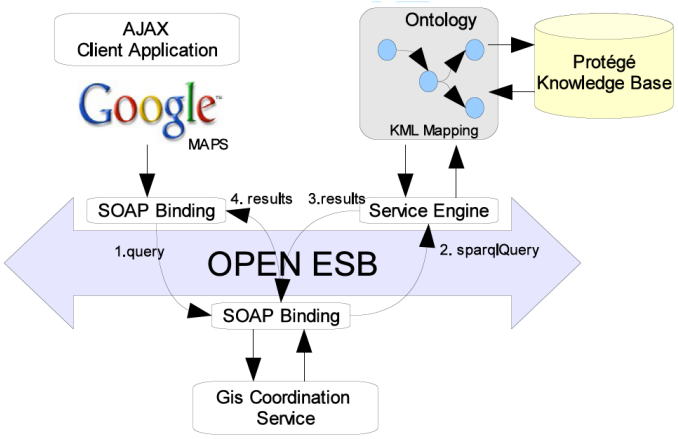


Figure. 8: Sequence of messages

Figure 8 depicts the SOA environment created using OpenESB to execute our test cases. All messages interchanged between different services have been labeled with a sequence number. The ontology has been plugged to OpenESB thought GORSE service. Following the sequence, firstly GIS coordination service receives a client request eg. searching buildings and places thought a web page, examples of this request are "religious buildings" or "has¬picture('Las Meninas')". Secondly, this service uses a SOAP proxy class created through GORSE WSDL interface to launch a request with an SPARQL input message enclosed. Thirdly GORSE service returns all results following a XSD schema. Finally GIS Coordination service decoupled knowledge information and KML data to merge into a Google Maps [13]. As an example, the following query has been executed:

```
author:DiegoVelázquez→ dc:creator[Oil-onCanvas]
```

GIS coordination service translates the previous query to SPARQL language as follows:

```
PREFIX
  ontoK:
  http://www.ijimai.org/2008/OntoKnowledgeBase.owl
SELECT ?resource ?coordinates WHERE{
    ?picture rdf:type ontoK:Oil-OnCanvas .
    ?picture dc:creator ontoK:DiegoVelazquez
    ?track ontoK:uri ?resource .
    ?track ontoK:coords ?coords .
```

"OntoK" prefix linking a limited ontology which have defined classes, properties and individuals in order to execute necessary case tests. This ontology is based on ATT Thesaurus and KML Google Schema, first used on historical-art scenarios and secondly necessary to work together with Google Maps. Our prototype works with a small knowledge base structured according to the ontology aforementioned. Using a wizard (Interface Builder, see figure 6) built following NetBeans philosophy, we have deployed a service on OpenESB that listen and executed all actions received though NMR Bus, such as "AddAuthor", "removeAuthor", "searchAuthor", "sea rchOil-onCanvasPictures", among others class (GORSE Service Engine showed on left side of figure 8). These actions are invoked by GIS coordination service in our case. Results data structure fulfill with an autogenerated XSD schema, and are transfered to GIS Coordination Service into a SOAP message. This service decoupled KML location information

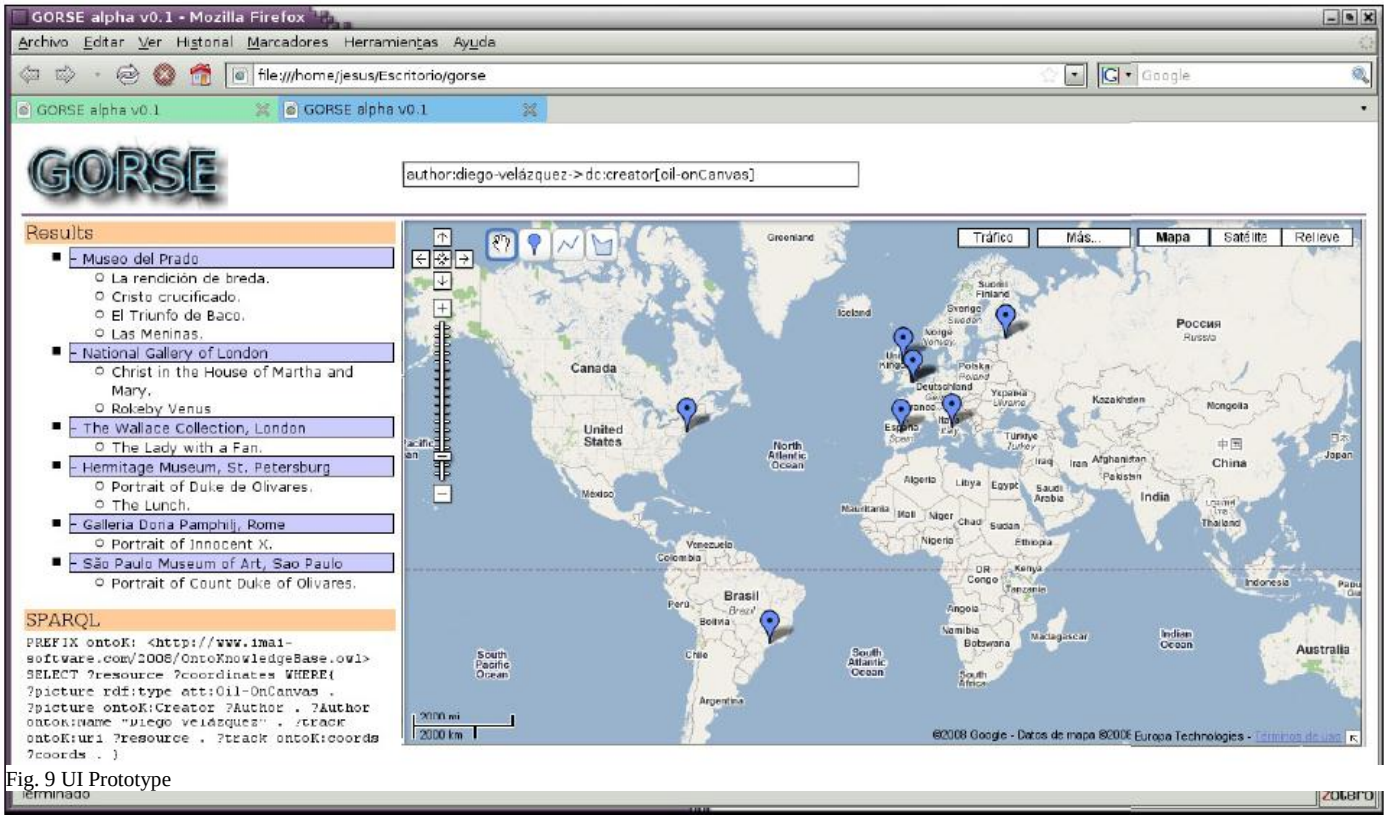


Fig. 9 UI Prototype

attached to individuals (stored into knowledge base) and individual structure to fit on Interface results. Firstly to adding a Google Maps overlay (right panel figure 9) and secondly to depict a resume of results (left panel figure 9). Knowledge structure can be used to create search filters that helps to launch more thorough searches. On right panel of prototype interface (see figure 9) a user can click on "Museo del Prado" element and application straight afterwards launch a pop-up window that shows the ontology structure. Therefore concepts like "religious-buildings" or "art-galleries" can be used to browse on knowledge base using GORSE service like common gateway of ontology query and management operations.

## VII. CONCLUSIONS AND FURTHER WORK

SOA philosophy concepts provide new scenarios where interoperability of heterogeneous services is the key to reuse legacy systems. Using these powerful technologies in our research we have been suggest a new scenario where semantic web technologies play an important role. Legacy systems take advantage of all benefits provided by these technologies into a SOA environment. Further work will be focused to improve knowledge management and transport operations using semantic web services "plugged" on an ESB.

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# Facial Emotion Recognition Using Context Based Multimodal Approach

Priya Metri, Jayshree Ghorpade, Ayesha Butalia
*Department of Computer engineering*
*MIT-COE, Pune.*

***Abstract* — Emotions play a crucial role in person to person interaction. In recent years, there has been a growing interest in improving all aspects of interaction between humans and computers. The ability to understand human emotions is desirable for the computer in several applications especially by observing facial expressions. This paper explores a ways of human-computer interaction that enable the computer to be more aware of the user's emotional expressions we present a approach for the emotion recognition from a facial expression, hand and body posture. Our model uses multimodal emotion recognition system in which we use two different models for facial expression recognition and for hand and body posture recognition and then combining the result of both classifiers using a third classifier which give the resulting emotion . Multimodal system gives more accurate result than a signal or bimodal system**

***Keywords* — Emotion recognition, Multimodal approach, Face Detection, Facial Action Units, Facial expression recognition system, Body posture recognition system**

## I. INTRODUCTION

Different people express their feelings in a different way under different circumstances (different context).The human sciences contain a bank of literature on emotion which is large, but fragmented [1][6][7][8]. The main sources which are relevant to our approach are in psychology and linguistics, with some input from biology. Emotions play an important role in human-to-human communication and interaction, allowing people to express themselves beyond the verbal domain. Some study in perceiving facial emotions has fascinated the human computer interaction environments. In recent years, there has been a growing interest in improving all aspects of interaction between humans and computers especially in the area of human emotion recognition by observing facial, voice, and physiological signals, where the different modalities are treated independently. Here we present a multimodal approach in which we use two different models one for recognizing the emotion using facial expression and second for hand and body posture as context. The design of above approach is shown in Figure 1.

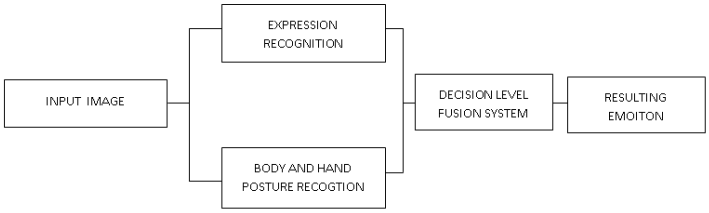


Figure 1. Block diagram for multimodal approach system.

## II. METHODOLOGY

Recently, researchers have also turned to emotional body language, i.e. the expression of emotions through human body poses and/or body motion. An implicit assumption common to the work on emotional body language is that body language is only a different means of expressing the same set of basic emotions as facial expressions. Using a set of emotional body language stimuli, which was originally prepared for neuro scientific studies, we show that human observers, as expected, perform very well on this task, and construct a model of the underlying processing stream. The model is then tested on the same stimulus set. The data we use for our work is should based on the database which was originally created FABO [9] bimodal database consisting of combined face and body expressions recorded simultaneously. Which is as shown in Figure 2. Here segmentation process is applied based on a background subtraction method on image in order to obtain the silhouette of the upper body. We then apply thresholding, noise cleaning, morphological filtering and connected component labeling. We extract the face and the hands automatically from image, by exploiting skin color information. The hand position consists of the position of the centroid and in-plane rotation. We employ the Camshift algorithm [11] for tracking the hands and predicting their locations in image. Orientation feature helps to discriminate between different poses of the hand together with the edge density information. These body features we give to the classifier as input to get the emotion.


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Figure 2.Examples of affective body gestures (from the FABO database).

As you can check in Figure 1, our approach have two different models

1. Facial expression recognition system (FERS).
2. Body posture recognition system (BPRS).

## III. Related Work

### 1. Facial expression recognition system (FERS).

The leading study of Ekman and Friesen formed the basis of visual facial expression recognition. Their studies suggested that anger, disgust, fear, happiness, sadness and surprise are the six basic prototypical facial expressions recognized universally [2].Here we consider eight emotional states: *Anger*, *Despair*, *Interest*, *Pleasure*, *Sadness*, *Irritation*, *Joy* and *Pride*. We choose this set of features in order to obtain emotions. Block diagram of the process to find the features from face is as shown in Figure 3.

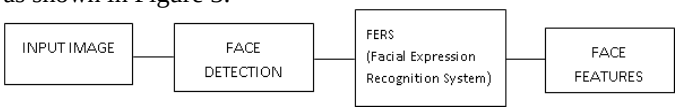


Figure 3.Block Diagram for FERS Model.

Initially a face detection algorithm is applied to find out the face from given image. Face detection is to identify all image regions which contain a face regardless of its three-dimensional position, orientation, and lighting conditions. Such a problem is challenging because faces are no rigid and have a high degree of variability in size, shape, color, and texture [4]. Figure 4 shows the Face features extraction system. Ekman and Friesen [5] have produced a system for describing "all visually distinguishable facial movements," called the *Facial Action Coding System* or *FACS*.

It is based on the enumeration of all "action units" (*AU*s) of a face that cause facial movements [10]. There are 46 *AU*s in FACS that account for changes in facial expression .The combination of these action units result in a large set of possible facial expressions. Table I shows Some AU and their associated facial change obtained from Ekman's study [12].

Table I Some AU and their associated facial change obtained from Ekman's study [12].

| | | | | |
|---|---|---|---|---|
| AU1 | AU2 | AU4 | AU5 | AU6 |
| Inner brow raiser | Outer brow raiser | Brow Lowerer | Upper lid raiser | Cheek raiser |
| AU7 | AU9 | AU12 | AU15 | AU17 |
| Lid tighten | Nose wrinkle | Lip corner puller | Lip corner depressor | Chin raiser |
| AU23 | AU24 | AU25 | AU26 | AU27 |
| Lip tighten | Lip presser | Lips part | Jaw drop | Mouth stretch |

Recognition of facial expressions can be achieved by categorizing a set of such predetermined features as in FACS.Here we take a input face which is an outcome of face detection algorithm .We extract the facial action units from face using FACS .These feature points then given to the classifier which also takes input from body posture recognition system to find out emotion.

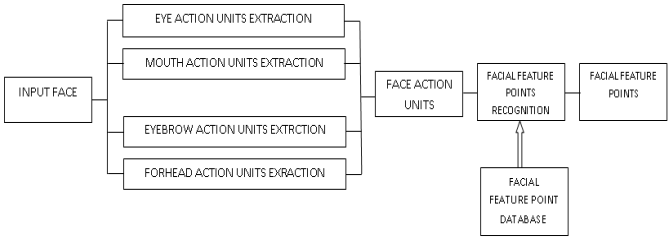


Figure 4. Block diagram of FERS

2. Body posture recognition system (BPRS).

As we extract Facial Action Units from face the same way we extract the body posture and hand postures as Body Action Units (BAU) .We use Clamshift Algorithm [11] to extract BAU's from image as shown in Table II.The block diagram of body posture recognition system as shown in the Figure 5.

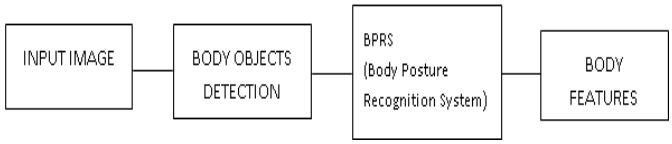


Figure 5. Body posture recognition system

We then classified the data from expressive face and body into labeled emotion categories using Bayesian classifier.

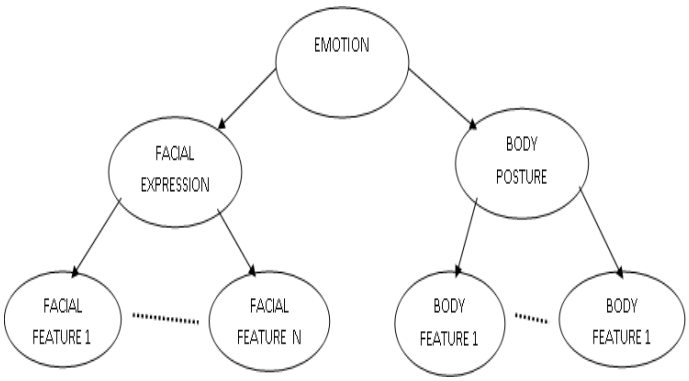


Figure 5 Bayesian classifier for emotion

Table II. Emotion and the respective Facial expression and Body posture

| Expression | Face Gesture | Body Gesture |
|---|---|---|
| **neutral** | no expression | hands on the table, relaxed |
| **anger** | brows lowered and drawn together<br>lines appear between brows<br>lower lid tense/ may be raised<br>upper lid tense/lowered due to brows' action<br>lips are pressed together with corners straight<br>or down or open | open/expanded body<br>hands on hips/waist<br>closed hands / clenched fists<br>palm-down gesture<br>lift the right/ left hand up<br>finger point with right/left hand, shake the finger/hand crossing the arms |
| **Surprise** | brows raised<br>skin below brow<br>stretched, not wrinkled<br>horizontal wrinkles across forehead<br>eyelids opened<br>jaw drops open or stretching of the mouth | right/left hand going to the head<br>both hands going to the head<br>moving the right/left hand up<br>two hands touching the head<br>two hands touching the face, mouth<br>right/left hand touching the face, mouth<br>both hands over the head<br>right/left hand touching the face<br>self-touch two hands covering the cheeks<br>self-touch two hands covering the mouth<br>head shaking body shift- backing |
| **Fear** | brows raised and drawn together<br>forehead wrinkles drawn to the center<br>upper eyelid is raised and lower eyelid is drawn up<br>mouth is open<br>lips are slightly tense or stretched and drawn back | body contracted<br>closed body/closed hands / clenched fist<br>body contracted, arms around the body<br>self-touch (disbelief)/ covering the body parts/ arms around the body/shoulders<br>body shift- backing, hand covering the head<br>body shift- backing, hand covering the neck<br>body shift- backing, hands covering the face.<br>both hands over the head<br>self-touch (disbelief)<br>covering the face with hands |
| **Happiness** | corners of lips are drawn back and up<br>mouth parted/not with teeth exposed/not<br>cheeks are raised<br>lower eyelid shows wrinkles below it<br>wrinkles around the outer corners of the eyes | body extended<br>hands clapping<br>arms lifted up or away from the body with hands made into fists |
| **Disgust** | upper lip is raised<br>lower lip is raised and pushed up to upper lip<br>or it is lowered nose is wrinkled<br>cheeks are raised<br>brows are lowered | hands close to the body<br>body shift- backing orientation changed/moving to the right or left<br>backing, hands covering the head<br>backing, hands covering the neck<br>backing, right/left hand on the mouth<br>backing, move right/left hand up |
| **Sadness** | inner corners of eyebrows are drawn up | contracted/closed body<br>dropped shoulders<br>bowed head |

| | | |
|---|---|---|
| | upper lid inner corner is raised<br>corners of the lips are drawn downwards | body shift- forward leaning trunk<br>covering the face with two hands<br>self-touch (disbelief)/ covering the body<br>parts/ arms around the body/shoulders<br>body extended +hands over the head<br>hands kept lower than their normal<br>position, hands closed move slowly<br>two hands touching the head move slowly<br>one hand touching the neck, move hands together, closed and head bent |

## IV. Discussion

Emotion modulates almost all modes of human communication —facial expression, gestures, posture, tone of voice, choosing of words, respiration, skin temperature and clamminess, etc. Emotions can significantly change the message: sometimes it is not what was said that is the most important, but how it was said. Faces tend to be the most visible form of emotion communication, but they are also most easily controlled in response to different social situations when compared to the voice and other ways of expression. As noted by Picard2 affect recognition is most likely to be accurate when it combines multiple modalities, information about the user's context, situation, goal, and preferences. A combination of low-level features, high-level reasoning, and natural language processing is likely to provide the best emotion inference The reason as to why the system trained with body gesture features proved to be the most successful may reside in the fact that, in the corpus of acted emotional expressions, each emotion is represented by a specific type of gesture: participants were provided with specific instructions in order to perform different gestures for each emotion. While this choice was made in order to build a system capable of recognizing different types of body gestures based on movement expressivity, it may have made the discrimination of emotions from body gesture easier than using facial and speech features [3].

## V. Conclusion

The addition of body gesture information to facial expression for emotion recognition is novel. Consideration of multiple modalities is helpful when some modality feature values are missing or unreliable. By taking all of these aspects into account, we hope to be able to develop into the near future multimodal context-sensitive systems that are smart, perceptually aware, recognize the context in which they act, can adapt to their users, and can understand how they feel, and respond appropriately

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# Introduction to Devices Orchestration in Internet of Things Using SBPMN

Alejandro González García, Manuel Álvarez Álvarez, Jordán Pascual Espada, Oscar Sanjuán Martínez, Juan Manuel Cueva Lovelle, Cristina Pelayo G-Bustelo
*Computer Sciencie Department, Oviedo University, Oviedo, Spain*

***Abstract* — in this research we try to provide an architecture that allows the orchestration of objects that are part of the Internet of things creating business processes. Internet of Things is still in full development; this implies that there is a lack of standards for its proper implementation. Among these gaps is for example the technology used to allow objects to connect to the network, since there are several options but none seems to end imposed that is why this work try to provide architecture that imposes an alternative solution to this problem. However, it is difficult to provide a common solution to all the objects used in everyday life because of its great diversity, it requires us to classify them and thus create an appropriate architecture for each of the types These architectures are designed to facilitate the devices orchestration in a similar way as is currently done with web services enabling business process modeling.**

***Keywords* — Internet of things, Orchestration, BPEL, SBPMN, SOAP, WSDL, REST, and WADL.**

## I. INTRODUCTION

MUCH time has passed since the completion of the first connection between computers in 1969, laying the groundwork for Internet. All this time this technology has been constantly evolving encouraged by the continuing advances in hardware and software, and the wide diffusion has had worldwide, from mere military application to be part of our daily lives. In recent years a new trend has emerged, networked objects that are part of our daily lives, the clearest example is mobile phones. This trend is called Internet of Things and is now a rapidly developing field that offers a wide niche research promoted by agencies such as the European Commission [1]. In literature there are examples of how serious our life thanks to the Internet of Things [2] but still no technology exists for doing that.

On the other hand the model-driven architectures seem to be gaining more strength, since the use of modeling techniques is used as a means to build applications simplified. Thus, the main part of the development of business concepts is through the development of the specification of the application, which abstracts the technical details. More and more these applications seem to be based on business processes. In particular the service coordination is gaining increasing acceptance as there are technologies such as BPEL widely consolidated for which is still being investigated as a solution to new problems [3], [4], [5], [6], [7], [8].

This suggests that the Internet of Things can be benefited from the progress in model-driven architecture, facilitating the orchestration of such objects to create business processes with them. To do this we will rely primarily on the study in [9] which presents a notation for modeling business processes (SBPMN) that appears to be relatively easy and quick for users without technical skills.

## II. SMART THINGS - THE INTERNET OF THINGS DEVICES

The aim of the Internet of Things is that all objects are connected to the Internet world, for it is necessary to provide these objects of some intelligence. Ergo incorporate in them certain hardware to enable them to communicate with the outside. These objects are called Smart Things. But we can ask the following questions: Should we treat all objects equally? Is it necessary to use the same technologies to communicate to the outside? Is it profitable to follow a standard procedure for all of them? From our point of view the answer is No. If we start to think about the objects that surround us every day we can find food on base, even our mobile phones. Food does not perform any function and the container is disposable, mobile phones are essentially mini computers today already are capable of connecting to the Internet and perform diverse tasks. We therefore believe that it is necessary to classify these objects. We will propose a taxonomy based on that processing power has and how complex it may be the architecture that can support the object. Following this criterion we classified the objects of the Internet of Things into 3 groups:

*High-capacity devices - Type A*

These are devices with high processing capabilities, architectures capable of supporting relatively complex and consume considerable bandwidth. For example would be able to publish Web services with SOAP and WSDL architecture. To this group belong a minority group of smart things, for example computers and next-generation devices.

*Medium-capacity devices - Type B*

These are devices with some processing power and withstand lightweight communications protocols that consume low bandwidth. For example would be able to publish REST web services technology. This group includes most of the machines involved in our daily lives, as they could be appliances.

*Low capacity devices - Type C*

These are devices capable of processing very low or negligible, can withstand very simple protocol based on hardware technology with which they were endowed with


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intelligence, such as RFID tags. They would be able to offer such a simple protocol by its ID or other simple data. This group includes most of the objects of the Internet of Things.

## III. ARCHITECTURE FOR THE ORCHESTRATION

We will propose the characteristics that should be the objects of each of the types according to its processing capacity to be orchestrated by SBPMN. It is important to note that since the objective is not to propose a complete architecture but to establish the bases of what we need to publish objects on the network. All the technology that is needed to succeed in providing intelligence to the objects and communicate these is being investigated in many papers and at different levels [10], [11], [12], [13], and [14]. In fact to begin research we rely on the ability of these objects might have to post something similar to web services. There are investigations as [15] Of particular interest to support our approach as they set an example of architecture applies to any object on the Internet of Things will be able to publish an HTML page or even a WSDL. This investigation is not intended to enter into discussions on whether this architecture is the most appropriate or not, since there is no even a specific standard in order to solve the challenge of communicating objects to the Internet of Things, however, that gives us foot to make a proposal based on service-oriented architecture. We will propose a set of features for each of the types of smart objects that have divided the Internet of Things in terms of its processing capacity, i.e. high capacity devices - Type A, medium-capacity devices - Type B, low capacity devices - Type C.

### *A. Architecture for high-capacity devices - Type A*

This Type A devices are those that we classified as more intelligent, we understand that when an object receives this classification has a relatively high processing capacity and a range of consumption of relatively large bandwidth. For this is the least problematic group because we can rely on already established technologies such as SOAP and WSDL. In the WSDL will define the types and methods offered by that object to then publish them as Web services SOAP, for example a mobile phone may have a method to obtain its location, lock in case of theft or access the calendar, among others (Figure III-1).

We think this is the preferred choice, since technology exists for the coordination of web services based business process modeling (WS-BPEL), this specification in its original version is designed precisely to SOAP Web services with WSDL description services. To this we must add that there is a direct translation between the notation BPMN and WS-BPEL, which we can apply processing in [9] of SBPMN to BPMN to that from a business process carried out in which SBPMN involving Type A smart objects are made the relevant changes to the code is generated automatically to run these processes (Figure III-2).

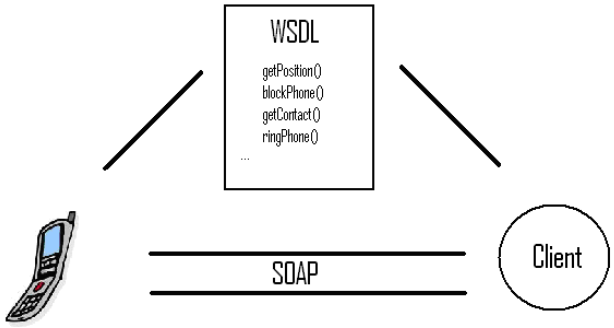



Figure III-1. Example of type A device communication

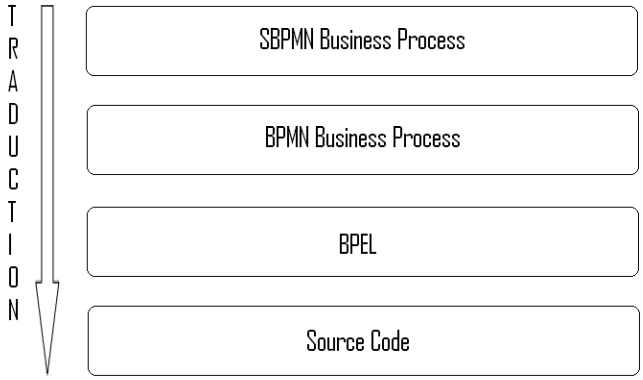



Figure III-2. Translation between technologies for Type A devices

To summarize our proposal for an object can enter the type A is to be able to publish their capabilities abroad in the form of methods for SOAP based web services and described with a WSDL.

### *B. Device Architecture medium capacity - Type B*

These Type B devices are those that have qualified with a medium capacity, we understand that when an object receives this classification has some processing power and a range of consumption of limited bandwidth. This group is more complex because although we use relatively entrenched standards there is no technological coherence as in Type A. In this case we will use REST and WADL technologies. In WADL will define the types and methods offered by that object to then publish them as Web services, REST, for example, could publish an oven temperature and time schedule (Figure III-3).

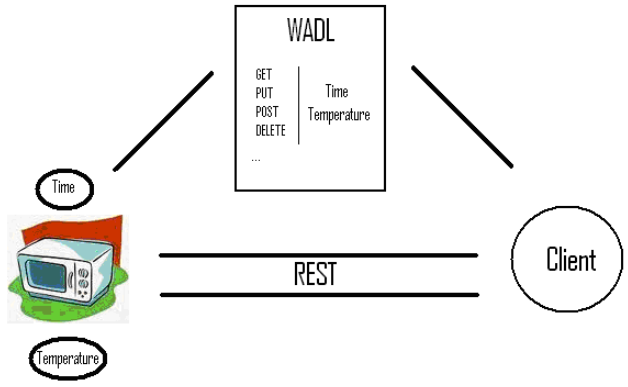



Figure III-3. Example of type B device communication

First we chose REST thinking we need an operation very similar to that in type A devices while taking into account the limitations of Type B. REST technology is lighter than SOAP because it does not add that extra layer above the HTTP protocol and consume less bandwidth by not using any type of packaging in communication as SOAP ago (Figure III-4).

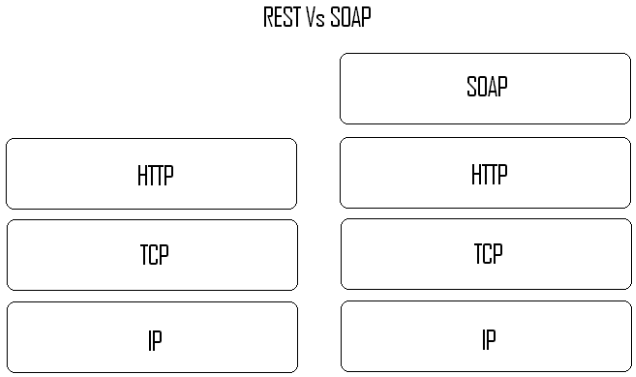



Figure III-4. Protocol stack REST vs SOAP

WADL's election as a service description of REST services may be somewhat controversial for several reasons:

- WSDL 2.0 can be used with REST services [16]: A clear rivalry between WADL and WSDL 2.0 as both compete as a service description for REST. In work [17] as a comparison of these two technologies coming to the conclusion that they are very similar, but have a few differences. Taking into account these differences we decided to opt for WADL due to:
    - WSDL 2.0 is oriented to interfaces description while WADL is oriented to resource description, which agrees more with the REST philosophy.
    - WADL is simpler, and not a drawback to this research that only supports the http protocol.

  Although theoretically the natural evolution of BPEL is to obtain WSDL 2.0, WSDL 1.1 standard is strongly rooted and there are many services in this format. WSDL 2.0 is not yet well established, especially to describe the current API REST services, and there is little evidence that this situation will change in the future [8].
- There is a discussion about whether they really need a REST service description service as WADL [18] [19]: Theories against using these services are essentially that we not need to define procedures as REST services by relying solely on default HTTP means that their operations are GET, POST, UPDATE and DELETE and data types are defined in XML Schema to which it refers. Of the bids for this research can highlight the use of this kind of services facilitates the self in code. Later we explain the fundamental reason why we have opted for WADL.

The main problem we met him at the time of creating the business process with Type B devices and go making changes to the source code that is executed. While the Type A from a business process SBPMN could make a transformation to transform BPMN to BPEL for later in this case the final transformation is not possible because the BPEL only supports SOAP and WSDL originally. However, there are several extensions to meet the new challenges that arise in the coordination of web services and BPEL: BPEL-SPE [3], BPEL4People [4] BPEL4JOB [5], BPEL-DT [6] or BPEL-light [7].

In particular in the work [8] proposes a new extension to allow the use of REST in BPEL. In this research precludes the use of WADL based mainly that most of the REST APIs described using services through human-readable documentation or examples of use because this specification is still recent. Although you get a solution to use REST services for our research we found that this solution is relatively against the fundamental principle of SBPMN notation is abstract the business user of the technical specifications. We understand that this work is necessary to understand the technical documentation of service to BPEL subsequently needed to program the code, while the use of WADL could be implemented automatically as is the case with WSDL in the original specification of BPEL.

Therefore in order to execute business processes involving Type B devices will be necessary to implement an extension of the WS-BPEL for using REST services with WADL. In figure III-5 we can see the evolution from business process to the generated source code execution.

To summarize our proposal for an object can enter the type B is to be able to publish their resources abroad in using Web services with REST and described WADL.

### *C. Architecture for low capacity devices - Type C*

These Type C devices are those that have qualified with a low or almost zero capacity, we understand that when an object receives this classification is not able to post any type of Web service. This group is technologically much simpler to get a chain of devices and processes in accordance with a prearranged agreement. Even so neither will have the technological coherence that we had in Type A. In this case we will provide further details on the hardware necessary to make these objects intelligent type C. The objects will be tagged

with passive RFIDs will be interpreted by a reader to obtain a data string information. For example the packaging of a food product labeled with an RFID could post the code that identifies it and its expiration date (Figure III-6).

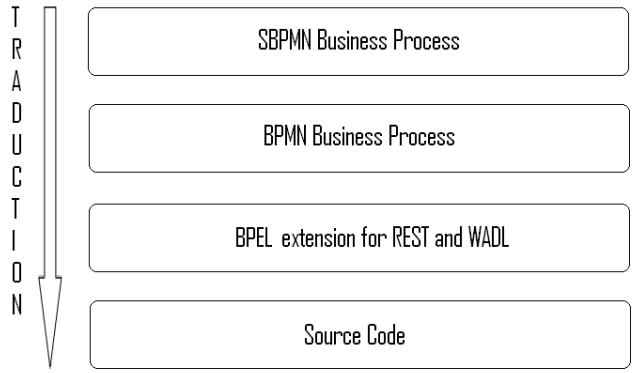



Figure III-5. Translation between technologies for Type B devices

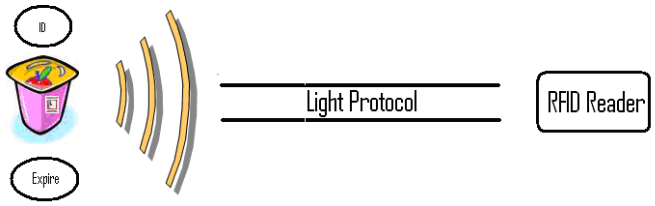



Figure III-6. Example of type B device communication

There is a wide range of RFID tags on the market and greatly varying size and quantity of information they can provide [20]. This influenced the choice of the characteristics of the proposed lightweight protocol. In the relatively open is trying to leave the size that these chains may have obtained by reading the labels. These chains have the following segments:

- ID (mandatory): This is the only mandatory field is the identifier that has been printed on the label for that object.
- Data (optional): This segment represents additional information that the object wants to communicate. Turn is divided into three sections that will be mandatory.
    - Value: The value of data to be transmitted
    - Type: Indicates the type of data, namely, numeric, text, date or Boolean.
    - Description: Briefly describe the data.
- Additional information (optional): full details are to be added to the information transmitted by the object.

By convention establish the character = is the boundary of each of the segments. In Figure III-7 we can see three examples of what these objects could transmit the transmission from simple to more complex.

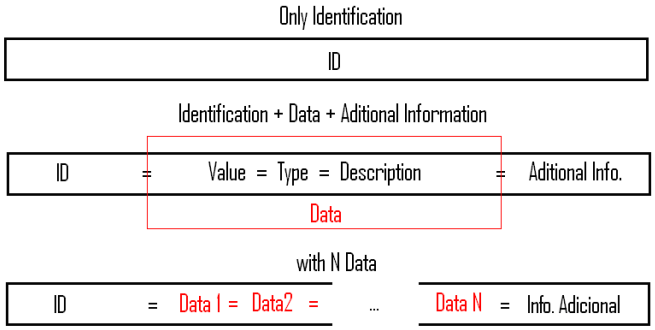



Figure III-7. Example structure of the strings sent by Type C devices

Despite the simplicity of the proposed technology, since there is no need to publish any type of service, we have a problem similar to that of type B and there is no existing technological coherence in Type A. Therefore in order to execute business processes involving C-type devices will be necessary to implement an extension of the WS-BPEL to the correct interpretation of the lightweight protocol. In Figure III-8 we can see the evolution from business process to the generated source code execution.

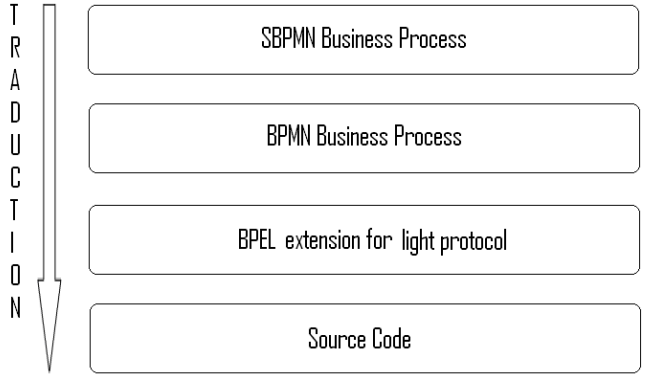



Figure III-8. Translation between technologies for Type B devices

To summarize our proposal for an object can enter into the Type C is that the string read from the label of the object has a structure proposed in this section.

### *D. Summarizing*

We have seen how this classification can save the limitations of the hardware available on the Internet of Things objects by choosing a particular group of technologies. However, this does not mean that objects can not acquire sufficient capacity reserved for technologies lower groups. This is important approached from the perspective of the debate between REST and SOAP [21], [22], [23]. While there is strong disagreement between advocates of one or another, all generally agree that SOAP is oriented procedures while REST is resource-oriented. With the proposed architecture allows a choice to use technology or other information depending on the object you want to publish, as long as they have sufficient capacity to accommodate the technology.

We can see all the proposed architecture summarized in

Table I.

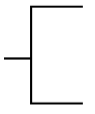
TABLE I
ARCHITECTURE FOR INTERNET OF THINGS DEVICES

| | TYPE A | TYPE B | TYPE C |
|---|---|---|---|
| COMMUNICATION | SOAP | REST | Lightweight protocol: Interpretation of the string read |
| DESCRIPTION | WSDL | WADL | - |
| ADVANTAGES | SBPMN direct translation of the source code executed. | Functionality similar to type A with lower resource consumption. | Simplicity. |
| DISADVANTAGES | High capacity. Bandwidth consumption. | It is necessary to implement an extension of BPEL for REST and WSDL. | It is necessary to implement a BPEL extension to the protocol slightly. |

## IV. SBPMN AND INTERNET OF THINGS DEVICES

In the previous section we have proposed a number of technologies that should be used to perform a SBPMN orchestration in terms of their processing capacity. The next step in this research is defined as represent each of these types with SBPMN.

TABLE II
SBPMN COMMON ELEMENTS FOR ORCHESTRATING INTERNET OF THINGS DEVICES.

| ELEMENT | GRAPHICS REPRESENTATION | DESCRIPTION |
|---|---|---|
| Data Object Web Reference |  | Allows to model data that are processed during a process flow diagram on BPMN. The data objects can represent many different types of electronic or physical. In particular an external object that refers to an external interface |
| Automatic task |  | Business process that can not be divided into threads. A basic unit processes. In this case because it automatically means it is automatically executed by a machine. |
| Textual annotation |  | Allow further describe the associated item of business process. |

Of the proposed elements in the notation SBPMN be used basically three: Task automatically to web reference data and textual annotation. In Table II are explained briefly.

In general we will use these three elements as follows to suit our purposes:

- Web Reference: Represents the object involved in the modeling. It may be accompanied by the identifier of the object or some type of name or reference.
- Automatic Task: Represent the functionality normally published by the objects.
- Textual annotation: Add additional information about the object or its features.

In the following sections we will see how this would be applied to each object type and restrictions will be applied.

### A. Type A device representation with SBPMN

To carry out the modeling of business processes involving Type A devices will need a Web reference that represents the device that will be orchestrated and automatic task for each published method.

If we take the example given in Section III-A mobile phone (Figure III-1) and we had a tool that would allow us to model what is proposed in this research, we should be displayed in the component palette similar to what we see in Figure IV-1.

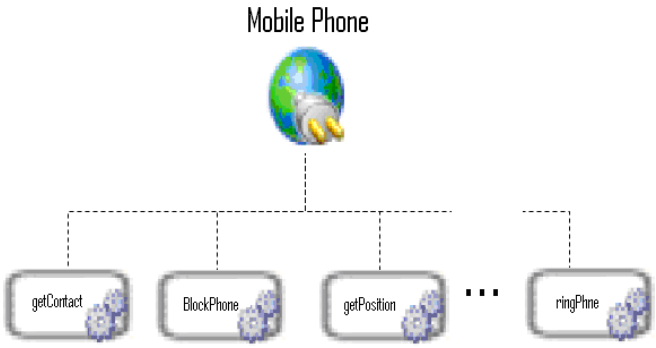



Figure IV-1. Example of components for the orchestration of Type A devices.

We can see the direction in proceedings in this representation due to influence of the technology used (SOAP).In general, these devices can model involving activities, reading, writing or some kind of processing.

### B. Type B device representation with SBPMN

The modelling of Type B devices is similar to the type A in terms of components but conceptually different but similar way as do their protocols reported REST and SOAP.

If we take the example given in Section III-B, smart oven (Figure III-3) and we had a tool that would allow us to model what is proposed in this research, we should be displayed in the component palette similar to what we see in Figure IV-2.

As previously discussed this technology is oriented to REST resources. In the palette presented to us the resources published by the device as well as web references the four methods that we have to interact with them in the form of automated tasks. In general, these devices can model involving activities, reading or writing.

### C. Type C device representation with SBPMN

Device modeling of Type C is the most conceptually different from the other two, as happened with the proposed

architecture, but only used a different item, the textual annotations.

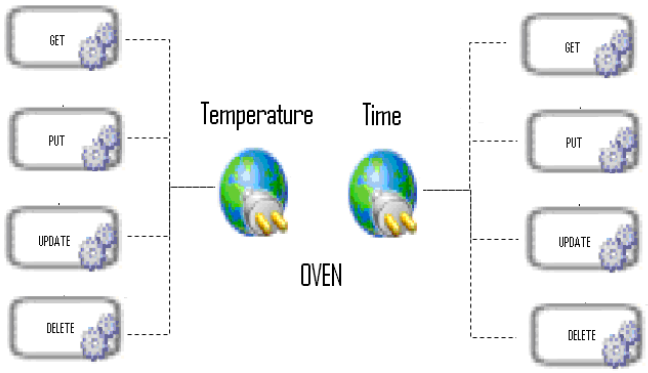



Figure IV-2. Example of components for the orchestration of Type B devices.

Taking the example proposed in section III-C container labeling (Figure III-6) to publish a series of data with the structure presented in (Figure III-7) and we had a tool that would allow us to model what is proposed in this research, we should show in the component palette similar to what we see in Figure IV-3.

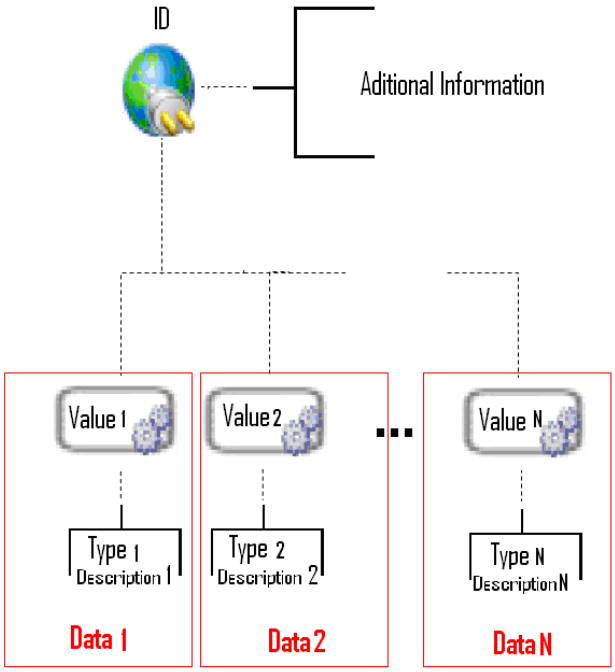



Figure IV-3. Example of components for the orchestration of Type C devices.

For such devices see the additional information and description and type of data allows the user to have enough information of the elements to be used despite not having a service description. Remembering the proposed structure for strings (Figure III-7) shows how to create a Web reference to the segment ID an annotation concerning this textual reference, with additional training segment (if it exists) and automatic activity with a personal annotation for each segment of data that is sent. In particular, the activity will read the data value and the information that appears in the annotation text will be the data type and description, which are the segments that are subdivided Data segment. As a last point to note that these devices allow only read operations.

## V. Conclusion and Future Work

In this work we have laid the groundwork for continuing research on the devices orchestration in Internet of Things:

- We have proposed Taxonomy for the Internet of things objects.
- We have proposed architecture for each of the types described in the taxonomy. These architectures also provide some flexibility if those objects have sufficient resources may use the technology you want, this is important from the point of view of the debate between SOAP and REST because we can use one type or another depending on whether procedures aim to publish articles or rather offering resources.
- We have proposed SBPMN representation for each of the types described in the taxonomy.

Among other points of future development can include:

- Extending BPEL for web services and REST-based technologies WADL.
- Extension BPEL to orchestrate objects that communicate with the proposed lightweight protocol.
- Development environment for BPEL orchestration and the proposed extensions to SBPMN.
- Development of a series of pilot applications in different platforms to enable the orchestration of devices, Internet of Things in real time through a simulated environment.
- Testing the usability of these applications with business users.

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# Virtual Objects on the Internet of Things

Jordán Pascual Espada, Oscar Sanjuán Martínez, B. Cristina Pelayo García-Bustelo,
Juan Manuel Cueva Lovelle.
*Computer Science Department, Oviedo University, Oviedo, Spain*

***Abstract* — As technology advances more and more "things" began to appear in digital format, such as: tickets, agendas, books, electronic purses, etc. Internet of things encourages communication and integration of physical objects with each other and people to automate tasks and improve efficiency. Digital objects like physicists should be part of Internet of Things but the different structures of these digital objects causes in most cases these digital objects can interact only with specific applications that know the specific format. Based on the problems in this paper proposes a structure that supports the generic construction of virtual objects irrespective of their business logic and their integration with other applications and "things".**

***Keywords* — Virtual Object, Internet of Things, DDTS, Web Services, Smart Phone.**

## I. INTRODUCTION

THE main idea in the Internet of Things is that any "thing" or object, conveniently tagged, may be able to communicate with other objects equally tagged through internet or any other protocols. These objects which are part of the net may contain small chips or embedded systems, depending on their purpose [1]. They may range from home equipment to industrial items or even electrodomestic, cars or even supermarket food. Anything can be tagged to be part of the Internet of things [2, 3].

Possibilities of the Internet of things to make people's life easier and to automatize many of our current tasks are huge, for instance, it is possible that the fridge may send an email to our mobile phone if it runs out of milk, we can monitor hospitalized patients by internet... there are lots of practical applications and all of them are seen with a common basis: "things" are communicating with "things" or persons. [4]

Parallel to the development of technology, more and more objects called "things" which are merely physical start to be seen also in digital format. Examples of them can be seen in: books, maps, e-tickets for gigs, plane tickets, agendas, contact cards, agendas, electronic purses etc.

Not all "virtual objects" that are used today are digital models of physical objects, sometimes these objects are new concepts designed for any type of task or information encapsulation. We have defined the term "virtual object" as a digital element has a specific purpose, comprised a series of data and can perform actions.

This work was supported in part by the Oviedo University under Grant IOVD-01. A.

When we observe the behavior of these virtual objects we see there is no standard format or any recommendation to normalize their usage. There is no mechanism by which we can treat them in a general way, store them, share them or process them with other applications which may not know their format.

Problems coming out of this lack of standard format are the following:

- Difficulties for decode: devices with no specific applications to decode the virtual object will not be able to process it. Let's take as an example my Mobile phone; if I transfer a contact card to another user, the Mobile intended to receive it won't be able to decode the incoming information. This handicap leads to the need of installing many applications in case we want to operate with different virtual objects. It makes it harder for a company or developer to place in the market their own virtual object, since nobody would be able to decode it without the suitable software.
- Lack of Communications: Ideally, the objects linked to the Internet of things to interact among themselves and with other applications to automate tasks and increase efficiency [5]. Since there is no standard format way to get actions or services from a giving virtual object, it is very difficult to interact with another application. Let`s illustrate it with a cinema ticket which is basically related to being a mere number code with stored information in a company database. The ticket is decoded by a web application and a specific machine. By focusing on this, it is very complicated for a virtual object to directly communicate with other applications or to transfer the ticket to other user.

Internet of things follows the aim of making the Communication between things possible, so things can communicate by themselves with other things and users. A physical thing may have a catalog of actions which is used to communicate, for instance a sensor connected to the net offering service to get position and temperature. The focus of something connected to a web which has a catalog of actions and is able to communicate by itself with other users is crashing frontally against the focusing of virtual objects, which do not exist themselves, independently, as entities, but only to form part of an application which interprets them.

This work has been divided into the following sections: In


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the second section provides an analysis of current trends in systems based on virtual objects. In the third section we define the objectives to be met by the proposed model. In the next section we examine virtual objects in order to define their features and get their points in common. In the fifth section presents a proposal for a common structure to support the construction of virtual objects. In the following two sections we construct a prototype virtual object with the proposed structure and show the operation of the prototype. At the end of the document refers to: potential uses of virtual objects and standardized research findings.

## II. Current Models of Virtual Objects

At present there are few systems that deal elements that could be considered as virtual objects, mainly there are two different approaches to model them.

### *A. Resources managed by device applications.*

In this type of system virtual objects are composed of a number of records stored in a database. The records are dependent on an application that manages the application contains the business logic that is run against the records in the data store. The information associated with every record that represents a virtual object varies according to each system and business logic (Figure 1). Sometimes there may be rules or conventions to model virtual objects belonging to specific business logic, but there is no general model.

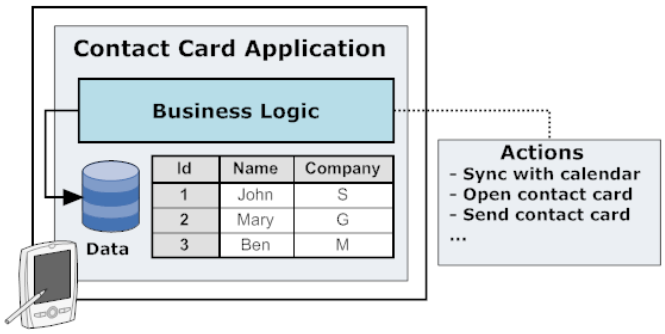


Figure 1. Structure of a management application contact cards.

Localized deficiencies in these systems are:

- One of the objectives is that virtual objects run in a variety of devices. Devices that want to play a virtual object need to have installed a specific application that recognizes the particular format of the object.
- Derived from the first problem devices requires a large number of installed applications, if each application is only able to interpret a particular type of object. In addition to the complication posed by developing an application for each type of virtual object, device and operating system. It would be impractical for every website need a specific browser to be interpreted.

Following the approach of internet of things, the virtual objects should also be able to integrate with other applications, devices and users. When a virtual object is designed as a resource which is treated by a specific application difficulties arise that can be accessed or discovered in a generic way by another application or device. Depending on whether the application managing the virtual object mechanisms offers some kind of integration or other applications may access the object. In an ideal situation a specific virtual object should be able to be accessed by other objects or applications, and should be able to do the same. Communication with the virtual objects should be conducted in a standardized way, although obviously each object will not make the same actions but how to display and access to those shares if it should be common to them all.

### *B. Resources managed by Web applications.*

In such systems, virtual objects are records in a data warehouse and managed by a web application. Users interact with virtual objects using web browser, in some systems also use specific devices such as ATMs (Automated Teller Machine, cash machine) that are connected directly to the management application (Figure 2). This approach gets to the interpretation and management of the object is not conditioned by the applications installed on the client, as it is done through a web browser.

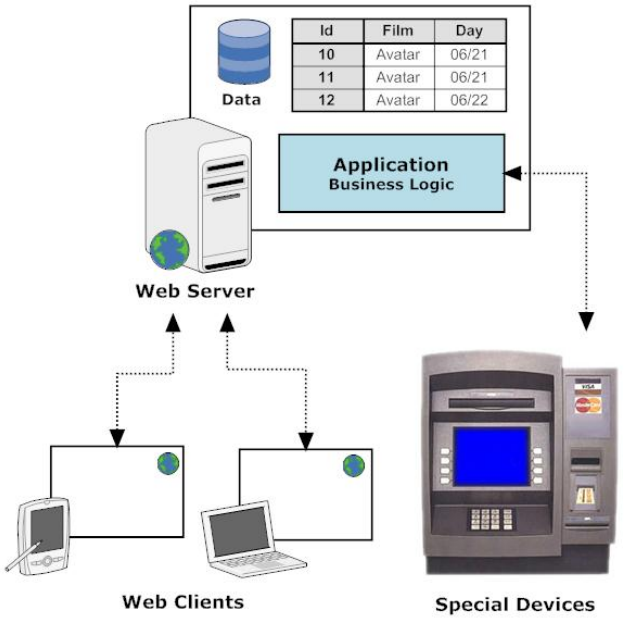


Figure 2. Structure of an application for the sale of cinema tickets.

This type of system continues to make difficult the possibility that virtual objects can communicate with other applications or users outside the application where they are running. Currently there are several web applications which provide APIs as web services for data that are stored in the web application (that model an object) can be integrated applications. Although this alternative may be sufficient in some cases, this solution is far from ideal. There are still difficulties for the virtual object could communicate with a physical object nearby, who holds the location-dependent services [6] (supermarket, parking, etc.). Although the Web

application has access APIs, is difficult for a virtual object hosted in a web application takes the initiative in interacting with other Things or application.

## III. OBJECTIVES

In this document we will give shape to a possible format recommended for the construction of virtual objects. Main objectives are as follows:

- The proposition of a common structure for the construction of virtual object, in which all of them, regardless complexity or business logic, can be: interpreted equally by any electronic device which is provided with the computational capacity needed (enclosed systems, computers PDAs, mobile phones etc) without the need of any previous configuration or specific software.
- To favour the integration and communications of any virtual object with applications and users. It will be similar to the process followed to integrate physical elements to the internet of things since virtual objects should offer the choice of discovering them to other users or applications, as well as getting their action and service's catalogs or even interacting with them.

Another objective is that the designed solution is a technologically possible with the systems and devices that exist today and that also is consistent with the trends and evolution that follows Internet of things.

## IV. FEATURES OF VIRTUAL OBJECTS

### *A. Interaction levels*

The level of integration that can have a virtual object on the internet of things is difficult to determine because it can cover a lot of cases. Physical objects have different levels of integration, for example, a yogurt has an RFID tag [7] that is read by other things such as a smart refrigerator. The intelligent fridge is an object much more "complex" than the yogurt, this object has a catalog of actions that enables it to interact with people or other things such as RFID tagged food.

As physical objects, virtual objects can have different degrees of integration depending on its purpose. For virtual objects could have a similar integration of a complex physical object connected to the Internet of things, the structure of virtual objects should provide the opportunity to discover objects and their associated actions.

The structure of virtual objects should include several levels of interaction, and also be able to model virtual objects with a lower degree of interaction, for example, virtual objects that only have to be read or processed by other applications or devices (similar to happened with the yogurt).

In conclusion, although a specific virtual object may not require all types of interaction, the model should support the following types of interaction:

- Interaction with people. A person must be able to interact with the virtual object and control it through an electronic device. Depending on the purpose of the virtual object could be users with different privileges to control some actions in the object (Figure 3). In the same way that a physical object, a virtual object should be able to change owner, this property could involve a device migration.

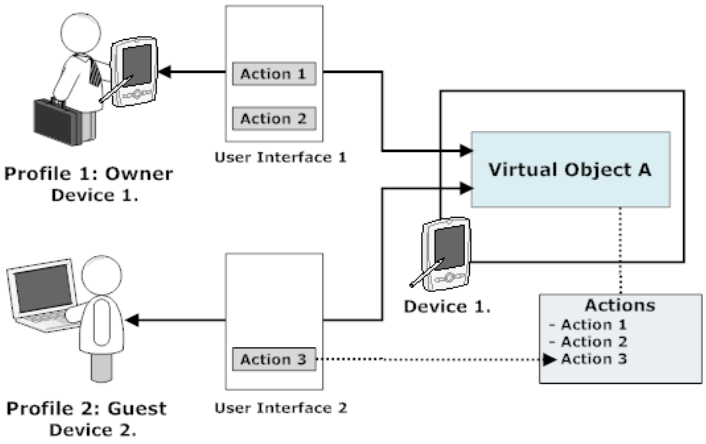


Figure 3. Structure of an application for the sale of cinema tickets.

- Interaction with applications / things. This type of interaction can be divided into two parts (Figure 4):
  1. Interaction as a transmitter: the virtual object has to be able to initiate interaction with another thing or application.
  2. Interaction as a receiver. The virtual object must be able to be discovered by other "things" or applications. Once discovered the virtual object, things can interact with the object invoking actions that have been in their catalog.

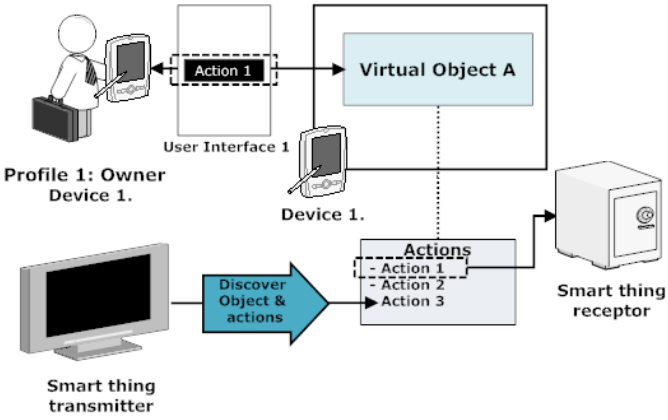


Figure 4. Structure of an application for the sale of cinema tickets.

### *B. Structure and properties*

It deals with the searching of a unique structure which may lead to the rebuilding, in the same way, very different objects: plane tickets, intelligent publicity, contact cards etc.

In a similar way of a conventional application, parts of a given virtual object could be divided in three layers:

- Application layer, in which we include the needed mechanisms so the virtual object can interact with users

and applications. The classic form of interactions with users is by means of a rich graphic interface. The interaction with other applications is normally made through a service catalog.

- Business logic, in which we found all the Business logic, executable coded or services the object can carry out.
- Data access layer, in which necessary data are stored in order to operate with the virtual object.

The design of the structure could be similar to that of a conventional application, but still underlies a great difference in their natures. Frequently, virtual objects are downloaded through internet or are transferred from computers and this is the reason why they should offer a structure very capable of migrating between devices in a very dynamic way, very lightly, and with no installation required. Instead of settling should be run in a "sandbox" with limited permissions [8].

Generally, all objects should have a series of common properties which may allow identification: name, type and identification.

At the time of dealing with an object, there are common actions which are similar to those of a file. Can they be copied? Can they be modified? Can they change owner, or be transferred?

All needs and observations commented, have been taking into count when it comes to elaborate a common structure for virtual objects.

## V. Proposal: Structure of virtual objects

Being based upon detected needs, this proposal defines that the structure of a virtual object is formed by a group of files of different nature. The precise model proposed in this document has been called Virtual Objects DDTS (Device Dependent Temporary Services). The choice of this name is based on the following arguments:

- Services. The virtual object will communicate with other devices or applications sharing the actions it associates for this purpose use a catalog of services.
- Temporary. Most of the virtual objects are not designed to have a persistent character as an ordinary application. The proposed structure attempts to model objects "supplies" which are used in a limited period, until a certain date or activity.
- Device Dependent. The virtual object needs to be placed in an electronic device, which acts as a container of objects. One of the properties of these objects is to be able to change host device to maintain its status and function. Sometimes the objects will be downloaded from the internet; others migrate between devices, etc.

The elements that form the structure virtual object DDST are:

- Descriptor: XML file, which contains information about identity, configuration, general behaviours, arrangement and execution of the virtual object.
- Graphical interfaces: XML files, each one represents a screen, which is the means by which the user can communicate with the logic of a virtual object.
- Service catalogs: there are resources which have the function of showing the applications or programmes, the actions an object may carry out. This interaction is achieved by means of service catalogs, which execute actions in the business logic of the object.
- Executable code: a file which contains the needed code to execute the virtual object logic. The code can be obtained in different formats or languages of programming in order to be executed in devices of different characteristics.
- Data storage: if the logic regarding Business services may require persistence, this must be provided with a file responsible for the arrangement of that information. Virtual objects are relatively simple models when compared to that of a conventional application. They are not thought to store a great deal of registers but only a few values.
- Additional resources: Could be included a Lumber of extra resources, in a non-limited way. Generally, this will be multimedia resources: images, icons and videos, which will be used to complete the graphical parcel regarding virtual object.

## VI. Development of Virtual Objects DDTS

To illustrate the use of virtual objects DDTS has implemented a movie ticket, following the proposed specification; this prototype will be used to illustrate the structure and operation of virtual objects.

Complementing the virtual object input has developed an application "manager of virtual objects," which runs on the Android mobile operating system [9]. The ideal container for virtual objects is an electronic device that we carry with us all day, which allows us to interact with objects at anywhere. We selected the Android mobile platform for developing the prototype because it is open source and devices that have this operating system have characteristics of computing and communication technologies, these features are sufficient to ensure interaction with virtual objects.

This application is able to interpret and work with any virtual object built to specification.

### *A. Executable Code - Business logic.*

In this model the actions associated with cinema ticket will be:

- Show Movie Info: title, synopsis, images, etc.
- Show information about ticket: film, cinema, etc.
- Validate ticket: validation of the cinema ticket at the intelligent door cinema.

The business logic is implemented in a code file as if it were a conventional application. The virtual object can contain multiple source files that implement the same business logic, so that the devices running the object select the appropriate code to run on the operating system. This prototype uses the

Java language for implementation, because we know that only runs on Android system. The implementation is done in standard Java by inheriting the VirtualObject specific class. The code will be dynamically loaded by the manager of virtual objects, so that methods to be invoked must be declared as public.

*B. Data storage - Business logic.*

Sometimes the business logic may require that some data have a persistent nature. Virtual objects are simple models, so they will not store many registers and will not require a traditional database. To support persistent data they are declared as key-value pairs in a specific file. From the executable code one can easy access to the stored values, using special methods (Code 1), which are implemented in the class VirtualObject. This system achieves a simple and efficient synchronization with the data store that is almost transparent to the programmer.

In the case of the cinema ticket that we are implementing the value "used" would be a persistent value.

```
// Validate Ticket.
public boolean useIt() throws Exception{
        // Data warehouse access . Key - used.
        boolean isUsed = loadDataBoolean("used");
        if(!isUsed){
            ...

 // Modify data warehouse . Key - used, Value - true
            saveDataBoolean("used",true);
            ...
}
```

Code 1. Java code. Access to the data warehouse using specific methods contained in class VirtualObject.

*C. Graphical interfaces - Interaction with people.*

Graphic interfaces are the main form of interaction with the virtual object, its use is to provide a simple visual environment to enable communication between user and virtual object. The user interfaces should belong to one of two types:

- Private: used by the person owning the host device.
- Public: can be added if you want other users to discover and connect to the virtual object remotely.

Each XML file refers exclusively to a screen that can be displayed during performance of the virtual object. To describe the elements that appear on the screens and how they behave, we have started from a smaller version of the syntax used by the Android system [10], describing user interfaces in a relative way, so they can be interpreted in the same way regardless of the resolution or screen size of the device. The elements that compose the graphic interface, define its appearance and behavior using XML properties. These properties can refer to methods in the executable code. (Figure 5).

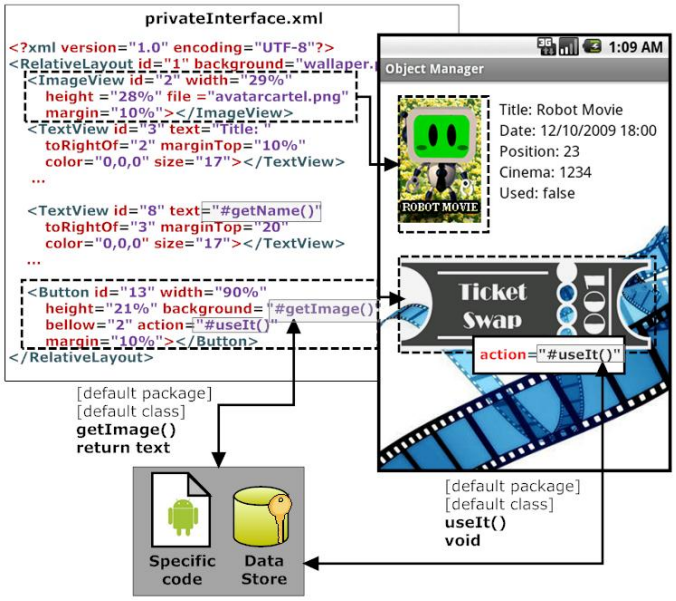


Figure 5. Private graphical interface of the virtual subject: movie ticket.

The graphical interface displayed may be accessed and modified in the executable code using special methods implemented in class VirtualObject. With this functionality, developers can implement changes in the graphic interface as a result of actions (eg pressing a button).

In the case of the cinema ticket it has included a private graphical interface, through which the owner of the ticket could manage, and a public graphical interface that allows other users to connect to the virtual object entry and see an overview of film.

*D. Service catalogs - Interaction with things/applications.*

The virtual object can be accessed by other devices, applications or virtual objects. The object publishes its catalog of services in Web Services Description Language [11] and in a specific API for the integration of virtual objects.

*E. Descriptor – Configuration.*

The descriptor file is an XML document which contains information about the identity, configuration and implementation of the virtual object. The information contained is as follows:

- Identity Object: Name, Type, Unique Identifier (if it is unique) and icon.
- Behavior of the object: If it is transferable, copyable or editable, if you have an expiry date, etc.
- Interfaces: Name the main interfaces of the object.
- Executable code: Name of the source files that may exist, at least there must be one. May also include the name of the main class.
- Data: Name of file data store.

In the particular case of this movie ticket could be a valid configuration file (Code 2).

```
<?xml version="1.0" encoding="UTF-8"?>
<virtualObject>
    <name>Ticket: Robot Movie</name>
```

```
    <type>www.TicketVirtualObject.com</type>
    <id>47236271</id>
    <transferable>YES</transferable>
    <expiration>12-10-2009</expiration>
    <editable>NO</editable>
    <copy>NO</copy>
    <interface
        private="privateInterface.xml"
        public="publicInterface.xml"
        wsdl="interface.wsdl"></interface>
    <code
        android="robotMovie9780.apk"
        j2me="robotMovie9780.jar"></code>
    <data>info.obj</data>
    <mainClass>com.rmovie.Ticket</mainClass>
    <icon>icon_tiket.png</icon>
</virtualObject>
```

Code 2. Configuration file of the virtual object DDTS cinema ticket.

## VII. Using Virtual Objects

Virtual objects DDTS are interpreted by an application which we call DDTS Manager, which is responsible for managing the virtual objects within a device. It must be designed to be installed and run on the given device, taking into account their characteristics, operating system, or programming languages it supports. Objectives of the manager are:

- Load, interpret and run any virtual object that has been built following a proposed structure. The first step to start using an object is to pick a manager, selecting the object configuration file. Once loaded the user can start interacting with the object, the manager interpret their interfaces and execute the corresponding code.
- Store and manage virtual objects. We will often use multiple virtual objects simultaneously; the manager must provide mechanisms to store and manage. Virtual objects that were loaded on the device must be displayed in an orderly manner to the user, so that it can interact with them and manage them, that is: delete, copy or transfer provided that the nature of the subject permits.
- Publish virtual objects and service catalogs. It can be specified in the logic of the object that allows execution of remote or publish their services, the manager has mechanisms to support such protocols relying on Bluetooth (Bluetooth, 2009), or other protocols such as: Internet, wireless etc.
- Discovery and remote execution. The manager will be able to discover the virtual objects that other devices publish. Once discovered the virtual objects may be performed remotely

### A. Local execution

After the file of the virtual object is loaded into the manager, you can open it. The outcome of the interpretation of the virtual object is the main graphical interface through which the user launches events involving invocations of the shares included in the executable code of the virtual object. The most important action of the object movie ticket is validated against the server of cinema (Figure 6).

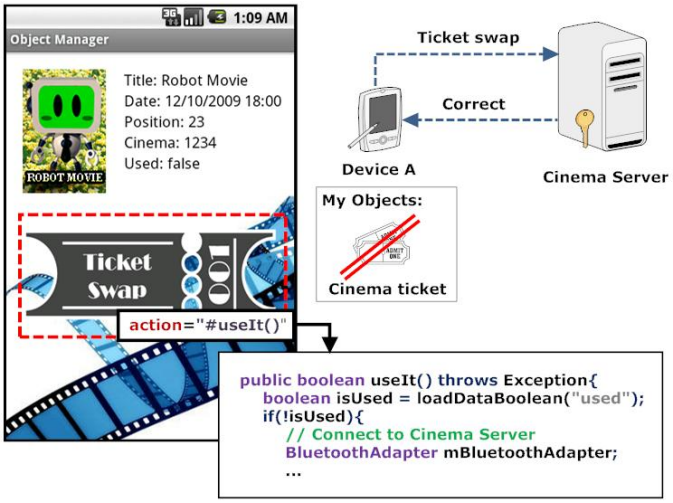


Figure 6. Local execution. The event "touch button" causes the execution of the action: validate the movie ticket.

### B. Remote execution

Depending on the logic of the virtual object DDTS is possible that this has to be used remotely by other people besides the owner. The device operates as a virtual object server, allowing other users to connect to it and run the virtual object remotely.

To initiate the remote execution on virtual objects must be "active" on the server device and be discovered by other client devices using Bluetooth, Wi-Fi or other protocols. The client device receives and interprets the main public graphical interface. Each time the client starts an event; the server receives a message and run the Corresponding code. The execution on the server can lead to changes in current public graphical interface as a result the server sends the new interface for the client device. The operation is similar to a web application server.

In this case the virtual input object accepts the possibility of being discovered and accessed by other users. Remote access is started discovering the virtual object on the device server, and then the client interprets the main public graphic interface, which contains images and the synopsis of the movie (Figure 7).

### C. Virtual object behavior

The movie ticket has been modelled with the properties: unique and transferable, therefore can be atomically transferred between devices. The owner of the virtual object can use DDST manager to find a device which transfers the virtual object. The movie ticket will continue to have the same functionality and state after device migration.

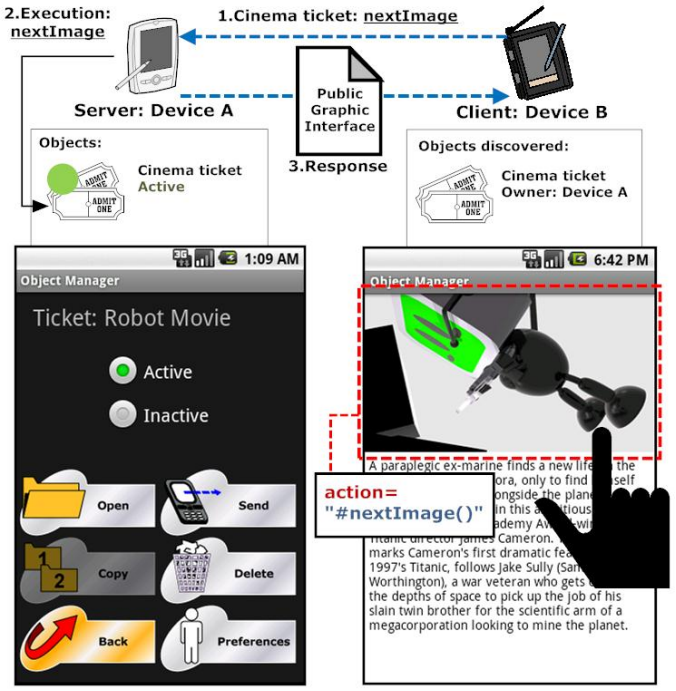


Figure 7. Remote Execution Process.

## VIII. Potential Uses

Nowadays, many objects, either real or virtual, are good candidates to be re-designed as virtual objects. Thanks to these changes we could an improvement in the lifestyle of people, making it easier and automatizing many daily life tasks. Some examples are the following:

- Tickets: cinema, train, parking, etc. The proposal offers the possibility of storing them, for instance in our Mobile or PDA, as if it was our digital Purse.
- Multimedia objects: product catalogs, intelligent publicity, contact cards. The structure proposed offers the possibility of creating Rich interfaces, including lots of control, in sound, videos etc.
- Application generated resources: Shopping lists, events and schedules, since it contains business logic and services, a list cannot be limited to a series of numbered products, it can be also provided with certain intelligence and capacity to interact with other applications or elements.
- Remote control: remote execution gives the ability to communicate with devices that have been programmed public interfaces, whether or not virtual objects. Thus a single device can control a large number of elements.

## IX. Conclusion

The benefits of the proposal on the current solution in the modeling of virtual objects are:

- It unifies the way we build virtual objects with a concrete structure, Strong enough to model complex virtual objects.
- It is designed so devices with the suitable computation ability can be executed or correctly interpreted in any normalized virtual objet, it doesn't matter the object logic or the device characteristics, (operative system, resolution...).
- Easy development, using languages of general purpose and widely extended formats for the construction of virtual objects. It offers automatic support to main properties which may define the object behavior.
- Strengthens and makes it easier the Communications between virtual objects, users and application, the same with the transfer or interchange of virtual objects.
- Virtual objects may have more ability to interact using communication mechanisms and specific recognition of mobile phones as cameras [12], GPS, sensors, etc.

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# The Cambrian Explosion of Popular 3D Printing

Juan Luis Chulilla Cano
*CEO OnLine-Offline.net*

***Abstract* — The unexpected appearance of 3D printing has caught many of technology analyst by surprise. In this paper we aim to provide a social context to the feedback loops that have generated this rapid evolution of technologies and skills involved in 3D printing, as well as and online communities related with 3D printing and the impact of this evolution on media an popular imaginary… and our near future.**

***Keywords* — 3D Printing, Distributed Fabrication, Cambrian-like Explosion, Technological Social Enablers**

## X. INTRODUCTION

In the last three years, The Internet of Things has been one of the hottest Internet topics. Every significant piece of equipment and a lot of meaningless ones is supossed that are going to receive an unique IPv6 address and means to connect to the Internet. It is a powerful forecast and, from its very beginning, a credible one: There are going to be IPv6 directions for all the imaginable beings on our planet, and connection means are less and less expensive. Meanwhile, 3D printing started to attract attention and gain momentum as 3D printer devices low both their economical and knowledge barriers. We are expecting the Internet of things, but almost nobody expected building (actual) things from the Internet.

There is an interesting connection with popular culture. While the Internet of things is a pure Internet phenomena, not predicted by speculative fiction, 3D fabrication is a recurrent topic of different sci-fi eras, with remarkables examples as *Rossum's Universal Robots* of Karel Čapek [1], *The Second Variety* of Philip K. Dick [2], *The Invencible* of Stanislaw Lem [3] and, of course, *The Age of Diamond* of Neil Stephenson [4]; In *The Age of Diamond*, in fact, one of the most important pieces of hardware is a universal constructor, a über3Dprinter which works on a molecular level. It doesn't matter if a future world pictured on a Science Fiction work is an Utopia or a Dystopia. What actually matters for the purposes of this paper is that main traditional Science Fiction topics are disconected to 2012 technological panorama, and main actual technological tendences of 2012 were not foreseen by sci-fi authors. We don't travel anymore to deep space, there aren't Martian or Asteroidal colonies nor interestelar travels. But Internet is ascending in its World adoption curve towards half of human population, and in our pockets are computers more powerful that the ones which sustained the Apollo program. Actually, it can be argued that as some of the bases of modern computer were ellaborated by Von Neumann in seminal works such as *First Draft of a Report on the EDVAC* [5] (Von Neumann:1945), it happens the same with concepts in which 3D printing roots, as we can see in *Theory of Self-Reproducing Automata* [6]. Both share an interesting quality of being opaque to science fiction forecasting, and both were born from theoretical seminal models down to actual operation and, after that, reshaping reality.

Indeed, there is a temporary quick&dirty thought experiment that obtains good results: if you search for "3D printing in science fiction" in Google and DuckDuckGo (hence avoiding Google's search history), the first dozens of results are related with connections between 3D printing and Science fiction. Most of these results shows 3D printing as a technology which is still coming from science fiction to reality, indeed asking to which realm 3D printing belongs. It is quite laughable that, actually, most of the Science-Fiction writers don't cover topics such as personal fabrication and self-replication, much less as what done in (non-fictional) science. But no journalist is asking how Von Neumann ideas about universal constructors are becoming real.

3D printing outside of professional, industrial workshops and inside of classrooms, offices and even homes are a picture of a future that it is supposed to never come. While we have smartphones with gigabytes of storage capacity and multicore CPU of more than 1 Ghz, fabrication is supposed to continue as usual, with hordes of bluecollars mounting consumption items in a world far from our one, and not only because of geographical reasons but also because of cultural, motivational and experiencial reasons too. We are supposed to use fashionable touch interfaces, and powerful workstations, for different kind of services. It doesn't matter if such services are professional, bill-paying services or leisure ones. What really matters is that the huge majority of them are not related to physical reality. When we lecture, or program, or work with quality measurement and procedures, or evaluate, or manage, etc., we are work with people and with intangible beings, never with physical things. Things are related with lower status occupations, or with the weird and arcane activities of industrial engineers. Very few people develop hobbies related with construction, making and building, and from the very beginning of the acceptation of the term, bricolage was an activity chained to analogical means and knowledge.

We can make a double twist to the interesting social metaphor that H. G. Wells develop in *The Time Machine* [7]. On the one hand, the raise in the awareness of working conditions at FoxConn in the first months of 2012, after a serie of articles in NYT [8] implies a shameful echo for all of us PC and gadget users: we are the eloi who dress and uses brilliant things that are built underground, or at the other side of the world for that matter, by chinese morlocks. Those morlocks, instead of devour us, just want to survive and aspire to a consumer way of life. On the other hand, and connecting with


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Stephenson's use of morlocks and elois at *In the beginning was the command line* [9], most of us are elois who use computers for any kind of immaterial services, while the new morlocks are using computers, new pieces of hardware and a brand-new community knowledge for building things.

Building, in our new context, is a set of connected operations: acquire the knowledge of 3D software, of mounting a 3D printer if it came of a kit, of maintaining printer operations; design the thing we want; print it and share all the different pieces of empirical knowledge that we have been obtaining during the process in a never-ending community feedback. Moreover, these new communities are not only sharing the knowledge needed for printing and maintaining operations, but actual 3D models that can be modified and adapted, raising the Free/Open Source model of software development to a new dimension, or distributing commercial fabrication in dozens of thousands of sellers that have to compete and innovate. That is the case of these, well, 3D printer morlocks. But our elois speciation's, world vision and values have no space for 3D printing. IT effects are immaterial for the vast majority of us: we cannot touch a tweet nor taste a blog post. Moreover, as *paper* printers are being exiled from our offices and homes at the last part of the biblical, 40 years old journey to the Paperless office, our computers produce results that are reachable only watching a display. Most of our photos are not going to be pressed, and we are not going to save our movies in individual, physical recipients anymore. Let me insist: we elois don't touch what we do with computers.

We elois live our digital lives in a perfect, immaculate digital loop. The actual effect of this is astounding: more and more white collars develop professional activities and operations with no physical result. However, although most of us don't make things, we need, use and desire objects. On our free time, we go to all kind of shops for spending the money we earn with our immaterial services buying all kind of consumer objects.

Or maybe we should say that we *went* to shops. More and more people are abandoning malls, supermarkets and shops for buying online. This is not a novelty, sure, and actually the adoption curve of online shopping is well advanced in the late majority phase for most of the developed countries. Social awareness of online shopping is close to be completed.

Think about online shopping operation: we use the same device (PC) that we use for immaterial purposes, and with the same web interface we complete the transaction. Days after that, a new package is delivered to our homes or offices and we have the new acquisition *in our hands*.

Obviously, this is a breach of the perfect digital loop. Therefore, the cultural distance between online shopping and 3D printing is less important that it seems to be. Nowadays we all are 3D elois, but with the adequate motivation and with the unavoidable price dropping as the adoption curve of 3D printing progresses, it will be simpler and simpler to abandon the passive, consumerist attitude of only shopping online in order to build some of the products that we want or like. An adoption curve is never a matter of months, and even less with such a complex set of operations as the ones involved in 3D printing. First of all, social awareness of 3D printing is mandatory. Good and quick steps are being made in that direction, but in this year 3D printing is mostly related with technology focused people. Second, price of printers and consumables needs to drop. Droppings have been quite impressive: a factor of ten in the last 3 years. But a price 1500$ and expensive materials make 3D printers a matter only of all kind of enthusiast, not of the general public. Finally, all the operations need to be further smothered, especially 3D designing. We have very capable 3D software since 20 years ago, both for industrial design and for animation. Indeed, too capable, too powerful for non-professionals. Although there are very powerful pieces of FOSS 3D software, such as Blender, the learning curve is quite hard for most users. Most of the 3D designing applications are not intended for 3D prototyping and/or they are quite crufty: given its degree of specialization, a good number of the components of their interfaces are comfortable for the designers only because of the prolonged use, but those interfaces are needlessly complex and non-intuitive. Keeping in mind that a mouse/keyboard combination is not intended at all for 3D operations, the only practical solution for this dilemma would be preemptive, calculating from heuristical models what the user want to do with objects and camera.

Google make a good step in the correct direction when they offered Sketchup. Although it has some quirks and idiosyncrasies, actually it lowers the learning curve and a lot of people are using Sketchup for different purposes, included 3D printing. Autodesk has recently offered 123D for free as a basic version of their famed Inventor software. It is focused on 3D printing and, again, learning curve is even lower than the sketchup one; moreover, it's clearly intended for most of the users who want to design 3D-printable models are not engineers trying to design complex objects. Finally, a new Finnish startup is offering a very interesting SaaS version of 3D design software, focused on 3D printing: Tinkercad. This piece of software has very elegant solutions for the problems of primitives modifications and camera movement, and it is quite close to the level of a 3D software accesible for the masses. Depending on motivation and personal approach to 3D Printing problem, there is an endless reservoir of resources for flattening adoption curve. For instance, one of the most popular 3D application, Sketchup, has a lot of tutorials available at YouTube which make it almost easy and comfortable to use. Almost. The last horse in 3D modeling, 123D, has been launched with a clear community focus, although it is not very popular for now and therefore it is not guaranteed that it is going to achieve a critical mass of users. Thingiverse is a community of builders which is growing very, very quickly in users as well as in the number of models of its library and the rest of the documentation, tutorial and general communication intended to help with a very broad range of building means, software, techniques and materials. Indeed, the raise of awareness of 3D printing is provoking that more and more members of the DIY online scene are paying attention to 3D printing and opening special sections about it, such as happens in instructables.com.

But this approach is quite connected to the "traditional" community software model. Although there are healthy and

strong hardware development communities, the fact that hardware is physical makes more difficult the continuous, quick paced feedback between community members. However, 3D printing is so fertile for transforming ideas or software models in actual objects that it offers a strong motivation for developing together inside a community. One of the early and most impressive cases is RepRap [10]. Replicating Rapid Prototyper was in 2004 a clear departure from the previous steps in 3D building. In fact, the authors affirm that one of their inspirations was the self-reproducing automata of Von Neumann [6], which indeed closes the first grand loop of theoretical formulation / development / building-assembling. The first operational RepRap device was conceived with the objective of reproduct as many part of itself as possible, with an ambitious double objective: a) lower the costs of 3D printing as possible, in order to make it available for more and more people and b) generate as much virical effect as possible, in order to raise awareness, strong the base of a new community of builders and, even more important, extend the effects of the initiative as far as possible. While the concept is nothing sort of astounding, it has certain limitations: a) 40% percent of a RepRap machine of any iteration cannot be built by another one (metal parts, motor, circuits) b) mounting a kit is not a trivial task, especially for people without advanced knowledge. Those limitations don't permit a Cambrian explosion of 3D printing. It's very difficult to find a local, virical copy of the RepRap machine. Think about the Cambrian Explosion for a moment: before it, there were a limited number of animal phyla, but as the critical elements were finally present, Life exploded in a wave of complexity and differentiation. Not in total biomass at the very beginning, but of shapes, adaptations and ecosystem interdependencies. Precisely, Open Source License of RepRap lets other early adopters and entrepreneurs alike reinvent once and again the basic concept in new designs intended for an easier management, for even lowercost, for printing bigger or polymaterial pieces, etc. Although we are at the very beginning of a 3D printing Cambrian-like explosion, the effects are unstoppable: the old, mature players in the sector of prototyping are offering new, personal, cheaper and cheaper 3D printers. Autodesk, one of the veterans of the software part of this sector, has reacted against the unforeseen success of SketchUp for 3D modelling and has offer for free a very interesting piece of software, 123D. More and more 3Dprinting-on-demand services are competing for lowering the costs as more and more people access to 3Dprinters. What is even more impressive, there are almost mature initiatives for going beyond “traditional” 3D materials such as polilactic acid, polivinyl and ABS in order to build from metals, ceramics, etc. What was totally out of question until a couple of years ago, now it seems plausible: circuit printing.

As one of the fathers of RepRap concludes[11], our industrial fabrication model based on assembly lines for mass production has been unavoidable until now. However, 3D printing implies a truly revolutionary promise: besides having the production means for making millions of items in a few hands, we can have the production means for making a few and needed things in millions of hands. This is not fiction in the sense of a speculative writing which departs from our world, but a possible future based on developed models and current trends and events. For interstellar travel there is needed to discover totally new branches of physics; however, personal fabrication of non-complex items are a plausible extrapolation of what we know now. Indeed, we have already experienced a Digital Cambrian Explosion: what happened with computers. Before the PC was born, the computer ecosystem was very limited, with a small number of computers (compared with today's numbers) solving a comparable limited number of tasks. After all the conditions were in place (cost, operative system, killer applications, social and business awareness, the Internet), first the number of computers and after that the number of computers connected to the Internet literally exploded. Moore's law is a shallow symbol of what has happened beyond symbolic numbers such as CPU frequency, RAM amount or HD size: computers are used for a huge range of tasks and objective, both professional, communitarian, public and private. 20 years ago it wasn't foreseeable that it was going to be almost mandatory to use a PC for dealing with different public administration, that most of the companies cannot run without PCs now, that entire cultures were going to be born anew from the social web and online interaction…

We are in the glorious garage days, in which enthusiast toy and tinker with hand-made devices with an intense feeling of wonder, self-fulfilment and grasping of the future. We cannot think about 3D printing as we think about totally mature computing. It's more fair to compare near future of 3D printing with the adventing of the first PC killer applications: What are going to be the equivalents of spreadsheet and word processing software in the 3D printing field?

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# Patterns of Software Development Process

Sandro Javier Bolaños Castro[1], Rubén González Crespo[2], Víctor Hugo Medina García[1]
[1]*District University "Francisco José de Caldas" - Bogotá (Colombia)*
[2]*Pontificial University of Salamanca - Madrid (Spain)*

***Abstract* — This article presents a set of patterns that can be found to perform best practices in software processes that are directly related to the problem of implementing the activities of the process, the roles involved, the knowledge generated and the inputs and outputs belonging to the process. In this work, a definition of the architecture is encouraged by using different recurrent configurations that strengthen the process and yield efficient results for the development of a software project. The patterns presented constitute a catalog, which serves as a vocabulary for communication among project participants [1], [2], and also can be implemented through software tools, thus facilitating patterns implementation [3]. Additionally, a tool that can be obtained under GPL (General Public license) is provided for this purpose.**

***Keywords* — Software Process, patterns**.

## I. INTRODUCTION

The goal of software development is to generate products, with high levels of productivity and efficiency, that ensure good levels of quality. To achieve this, it is necessary to use different strategies. Among such set of strategies, the use of patterns stands out as one of the most popular one. There is already an important and recognized work about patterns in different areas of software engineering, such as design patterns [4], [5], architectural patterns [6], [7], [8], patterns analysis [9] and others. However, to our knowledge, there is no work addressing software process patterns. There is a wide range of software processes and methodologies, and some concepts that can be compiled to promote recurrent usage have been adopted, which may represent a sort of process patterns. This article proposes a set of patterns, which can be found when we use different software processes and methodologies, which can be evidenced in their conceptual cores.

## II. UNDERSTANDING PATTERNS

A pattern has a recognizable structure that makes it special and general. Using a software pattern prevents developers from "reinventing the wheel", also preventing out-of-date reinventions that create more problems than what they really solve (e.g. reinventing a square wheel). The pattern has another key ingredient, namely the ease it provides when communicating an idea, because the pattern itself turns into a vocabulary, not only accepted but also widely recognized. Nevertheless, the most important contribution of patterns might lie in their predictive power. A pattern is a sort of time machine, it is like the Rosetta Stone that allows the understanding of the way an appliction was created, initially employing a language that is difficult to follow – namely, programming language, design language, the language of architecture, language processes – and translates it into the original idea behind such implementation through the vocabulary of patterns. This means you can see the past of software applications and the intention with which they were developed; similarly, you can see into the future of the applications and attain one of the most desirable software features, namely scalability. It is possible to structure future applications to maintain a predictable behavior, and allow for evolution. One can say that the patterns become more powerful because beyond being good practice, patterns become a widely-accepted, spoken vocabulary used by a whole community that has found a simple and effective way of communication [10].

## III. SOFTWARE DEVELOPMENT PATTERNS

Software processes have produced a framework of concepts that originate familiar, widespread recurrent structures that are used over and over again when developing software projects. These patterns can be categorized as process workflow between the different activities that constitute the process architecture. Such categories involve the participants and stakeholders within the software process according to the inputs and outputs that affect software development and also according to the knowledge involved. The form [11] of the process pattern is given by its definition, consequences, its advantages and disadvantages. The definition establishes the concept of pattern, the consequences define the effects that the pattern causes; the advantages establish all positive contributions of the pattern, while the disadvantages set unfavorable situations caused by the pattern. It is important to note that, unlike other forms of patterns, these patterns indicate their own potential problems and thus alert developers so as to be aware. This is because in the application of software process patterns, it is important to note the potential risks entailed.

### *A. Workflow Patterns*

With regard to the desired process architecture, there are three possible configurations for the activities, namely parallel, linear or cyclic. Out of these configurations, combinations that produce more complex processes can be obtained in turn.


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*1. Linear Workflow Pattern*

The first and most important antecedent of linearity was in Royce's proposal, about his waterfall model [12]. The fact of the matter is that, despite much progress, the waterfall model isn't quite dead yet [13]. Linear Workflow pattern suggests that software processes should focus on a linear workflow [14], that is, a set of activities is clearly identified and linked so that each link is used to configure a chain. Under these conditions there is a permanent pre and post activity for almost every activity, except for the initial and final activities (Figure 1).

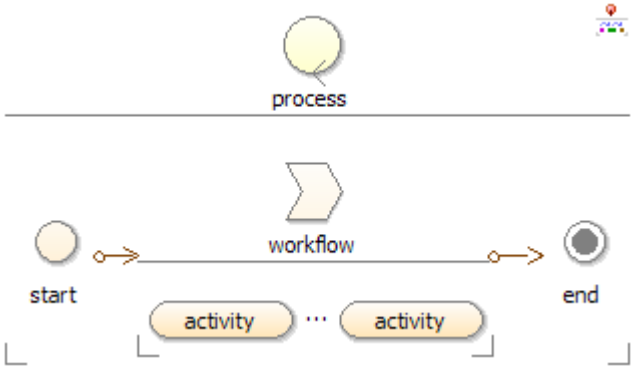


Figure 1. Linear Workflow

*Consequences:*

The main effect of this linear configuration is that the activities are executed sequentially; therefore, an activity i occurs after the i-1 activity and prior to an *i+1* activity only.

*Advantages:*

- There is order and control over the activities
- It is possible to budget resources for activities.
- There is clarity in both roles and disciplines involved.

*Disadvantages:*

- Activity i is highly dependent on activity i-1 and is also the starting point for an activity i +1 in such a way that a domino effect is created between activities whenever there is a problem.
- Time is the most difficult resource to estimate, due to the holistic effect resulting from the integration of activities.
- There are overloaded times for a the roles associated to the activities in execution; when such activities finish, there is uderutilization, wasting a considerable amount of human resources.
- The fall of an activity produces a fall in activity i +1, i +2, ..., i + n, which makes requirements engineering the most critical activity.

*2. Parallel Workflow Pattern*

Process models, such as the model V [15] propose to mitigate the problem of linearity through the simultaneous development of activities. In the case of V model, activities are confronted with tests during the process. Parallel Workflow pattern suggests that software processes focus on a parallel workflow. The particularity of this model is the execution of parallel activities, at least two activities. The results of the activities that are performed in parallel add their outputs to the next tuple of activities, and so on, until reaching a final result (Figure 2).

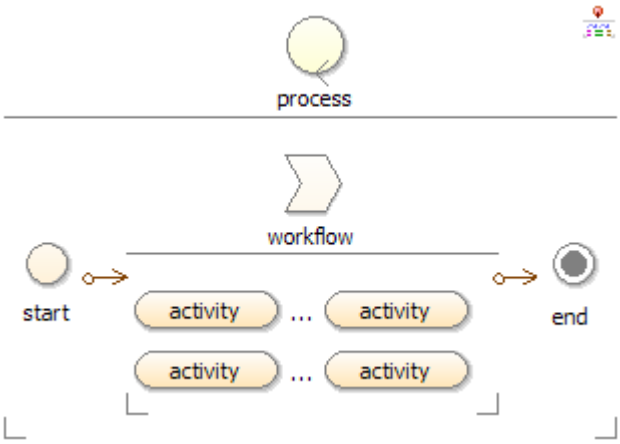


Figure 2. Parallel workflow

*Consequences:*

Running parallel activities may produce effects such as the need for activity synchronization and the addition of results to configure unified inputs.

*Advantages:*

- Clear identification of activities.
- Optimization of resources by the simultaneous execution of activities.
- Creation and integration of roles society.

*Disadvantages:*

- Proper activity synchronization is a difficult task.
- Collaboration between roles requires prior training (as its nurturing factor), which is something most teams lack.

*3. Cyclic Workflow Pattern*

The cyclical nature of the software process is a recurring concept in different software process proposals [16], [17], [18], [19]. Process models such as the spiral model [20], offer feedback processes which suggest the cyclical nature present not only in this model. Cyclic Workflow pattern suggests that software development processes focus on a workflow with feedback, that is, the pattern clearly identifies a set of interlinked activities and closes a loop with them. It is clear that there is an initial activity that can recycle the product of a final activity (Figure 3).

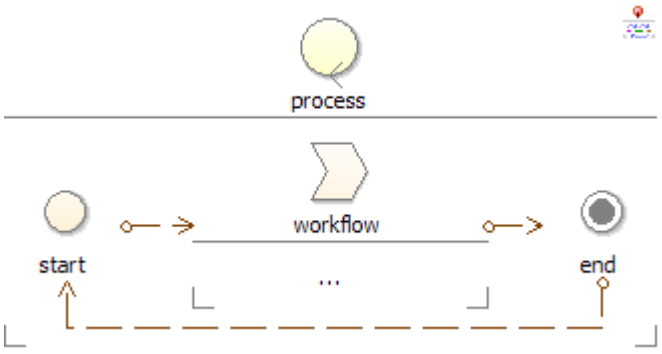


Figure. 3. Cyclic Workflow

*Consequences:*

This cyclic configuration identifies a loop in which the output of an activity is the input of another previous activity; such a feedback can even occur with respect to the same activity.

*Advantages:*

- Settings of product refinement cycles are possible.
- Allows activity repair whenever mistakes are made.
- Enhances knowledge of the process as a result of repetition.

*Disadvantages:*

- Developers may fall into indefinite cycles and therefore lose control of the process.
- It is necessary to make a big efforts and large investments.

### *B. Patterns according to Participants*

Modeling of participants allows to reflect the most important resource in a software process [21]. Individuals and interactions over processes and tools [22]. According to the stakeholders of the process, developers, their communication and role rotation can be modeled.

#### *1. Doer Pattern*

Stakeholder theory is an area of strategic management that defines a stakeholder as someone who affects or is affected by the actions of the organization [23], [24], [25], then the processes of the organization are reflected in the software process and these in turn, by the individuals according to Conway's law. Doer pattern allows clear identification of the key parts present when in the execution of the process, namely the doers of the software process and also the consumers along the process. A doer of the software process directly executes an activity of the process and is responsible for carrying it out, while a consumer is the one who benefits from the products of the process without directly affecting the corresponding activities, except for the activities perception. In other words, while a director is an active performer, a consumer is passive. (Figure 4).


Figure 4. Doers

*Consequences:*

Defining who executes the software development process is essential to define roles and responsibilities and clear roles. Roles also isolate the posibility of noise that is caused by ghost roles (non-doers), who appear in the process due to poor scope estimation.

*Advantages:*

- It is clearly identified who will perform the process, allowing a good estimate of resources.
- This pattern encourages the identification of roles, functions and responsibilities.
- Ghost roles, which generate noise in the process, are removed.

*Disadvantages:*

- The identification of roles should be consistent with their own process-specific creation.
- Ensuring the existence of doers for a particular software process means a considerable investment in skilled labor.
- Organizations do not have the wide range of doers that may arise in the process.

#### *2. Communication Pattern*

Communication, or rather lack thereof, leads to tremendous problems in the workplace and in software [26], the quality of communication within the development team and between the development team and external entities impacts on the performance of the software project [27]. Communication undoubtedly impact the software development [28]; this development may flow better if the interactions of the participants allow effective exchange that is regulated by good communication mechanisms. Communication pattern enhances the communication structure within the process. It identifies the communication transmitter and receiver as well as the channel and the message. Communication is the key to maintaining synergy in the process; it is also the best mechanism to maintain integrity within a project. See Figure 5.

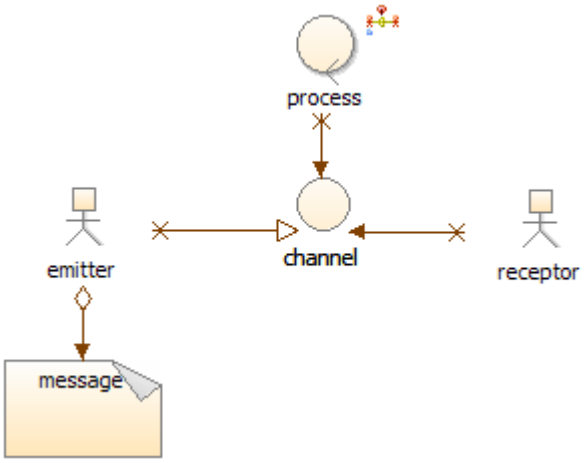


Figure 5. Communication

*Consequences:*

Keeping a communication scheme facilitates the monitoring and the process control. It eliminates the noise generated by information islands and promotes strengthening knowledge management processes

*Advantages:*

- It facilitates the exchange of experiences and insights within the project.
- There is elimination of the noise generated by information islands.
- It promotes role societies and the creation of collaborative communities.

*Disadvantages:*

- Difficulties arise when there are particular interests.
- It is difficult when developers do not speak within the same knowledge domain and there is no attempt to use interfaces in such cases.

### 3. *Role Rotation Pattern*

Roles are very useful in modeling the authority, responsibility, functions, and interactions associated with managerial positions within organizations [29]. Roles in software projects should be similar to a surgical team where there is clarity in the responsibilities with a hierarchical collaboration [30]. There have been studies that show the importance of the dynamics that should have the roles within the organization and the possibility of change as a way of empowering their activities [31]. Role Rotation pattern defines the impact one role may have on the transformation of another role, motivated by doers engaging in a new activity that is different form their previous activity. To take this step, it must be taken into account that the role is competent to assume such a responsibility. This can be seen in two ways. In the first approach, a role produces certain qualities that will be used by a role that accepts them as input. A role played by the same author who assumes another role. (Figure 6).

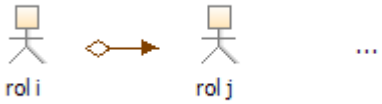


Figure 6. Role Rotation

*Consequences:*

For an organization, stepping from one role to another within the mind of one actor is essential so that the actor has a broader view of the process he is running. This results in maintaining continuity and consistency in the development process.

*Advantages:*

- The actor who rotates activities maintains a more complete understanding of the process.
- It is possible to further extend the human resource.

*Disadvantages*

- Actors get overloaded.
- There is partial and collaborative invasion on actors

### *C. Patterns based on Inputs - Outputs*

In a process, some settings may appear, such as the input-output setting, the document-management setting and the traceability setting, each emphasizes in some features related to the input-output of the process.

#### 1. *Input-Output Pattern*

The classical Leontief model on the correlation of the economy in different industries with respect to their inputs and outputs [32], is also a generalized model of software processes, for example in testing [33], [34], requirements engineering [35], programming [36], among other activities of the development process. Input-Output pattern allows clear identification of the process inputs that are required for its execution and that will be transformed to achieve the expected outputs (Figure 7).

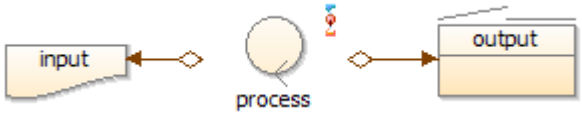


Figure 7. Input - Output

*Consequences:*

Defining inputs and outputs allows estimating the resources that will be transformed by the process into products and / or services to be consumed. It is important to understand what enters the process and what exits in order to plan how the process will behave and so determine the needs and outcomes.

*Advantages:*

- It clearly identifies the resources used for the process and the results to be obtained after completion of the process.
- It encourages the planning of the software process since the available resources as wel as the desired outcomes are known.
- It promotes the structuring of the process to transform inputs into outputs, represented in products and / or services.

*Disadvantages:*

- It is not always easy to identify inputs and outputs.
- Traceability of an input into a product is a wasteful and costly task.

*2. Document Management Pattern*

Documentation is a factor to consider when you want to succeed in a software project [37], people within a development process tend to have a shared understanding of the software documentation [38], creating the channel through which communication flows and provides support for the project; there are patterns of documentation which detail problems related to intensive use and interaction between the documents [39], the pattern proposed in this paper is a general pattern present in the software development process from the perspective of its use and generation. Document Management pattern clearly identifies the documentation required for the process and the resulting documents after execution of the process (Figure 8).

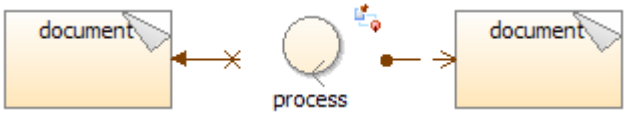


Figure 8. Document Management

*Consequences:*

Defining the documentation used and also the resulting documentation in the software process is critical to support each of the activities carried out and to support the decisions that are defined as the process unfolds. A document sets the source and history that deals with the project management. When you lose a role, that role represented the mind of an expert. A document that builds a good description of the tasks performed by this role and also of his decisions and experiences in a single record, is are a key asset for the organization.

*Advantages:*

- It supports decisión making.
- It storages requirements, contracts and agreements.
- It allows retaking actions based on decisions previously recorded.
- Corrections and defect tracking are recorded.

*Disadvantages:*

- The cost is too high for its realization.
- Updating and maintenance is wasteful.
- The documentation becomes another project that is parallel to obtaining the code. Documents and code should match and support each other 100%.

*3. Traceability Pattern*

Traceability plays an important role in facilitating software evolution [40], in software maintenance and reengineering [41]; in general, traceability is critical to maintain consistency between business processes and system software [42]. Traceability pattern establishes the way artifacts are linked in a process to illustrate how an idea can be transformed into a product resulting from a concept that starts from an abstraction until getting a concrete product (Figure 9).

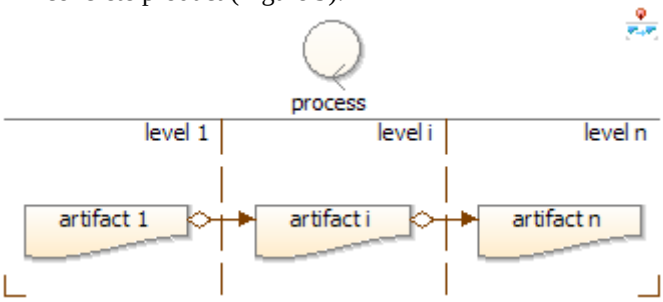


Figure 9. Traceability

*Consequences:*

Traceability enables actors to etablish a road map of the different elements that are developed within the software process. Each concept sets a milestone that can be woven together with the others to ceate a consistent tissue that is visible and understandable.

*Advantages:*

- It allows displaying the process.
- It establishes a roadmap, based on the tissue, which forms traceable items.
- There is support to repair errors due to the easy identification of their causes.

*Disadvantages:*

- There is difficulty in the necessary traceability that must be carried out from the idea itself to its realization.
- There is a lack of inclusive language in the different layers of abstraction.

*D. Knowledge Patterns*

Software companies can decrease the time and cost for development, increase quality, and make better decisions if they manage their knowledge better[43]. There is a direct implication of knowledge management as a theory support for many aspects of software engineering, one of these trends is the school of engineering toward the process [44]. Software process from the perspective of knowledge, can produce knowledge, change their states, and reside in process participants, this is reflected as patterns.

1. Knowledge Production Pattern

Knowledge is produced by the interactions of participants through the processes they run [45]. If we see software engineering as a process it is clear that their results are also knowledge. Knowledge Production pattern provides the knowledge used within a process and the knowledge that is produced: On one hand, the knowledge used is the conceptual framework necessary for carrying out the process, while the knowledge gained is the result of empirical experimentation, resulting in the execution of the process. See Figure 10.


Figure 10. Knowledge Production Pattern

*Consequences:*

Defining the conceptual framework to be enlarged in a process is critical because it establishes the characteristics that qualify the process and that will be the input to obtain a wealth of experience, which ultimately forms the generated knowledge.

*Advantages:*

- This pattern promotes clear identification of the concepts to substantiate and characterize the process.
- It encourages the establishment of the roles that contain knowledge.
- It generates new knowledge from the experience gained when implementing the process.
- Knowledge sets the differentials in the use and performance of processes.

*Disadvantages:*

- Knowledge is difficult to appropriate by the organization.
- Knowledge is volatile when those responsible for assuming the roles are also volatile in the process.
- Knowledge and experience are not easily transferable to new scenarios and projects.

*2. Knowledge States Pattern*

With this pattern, the possible states of knowledge are set, and the processes that affect such states are formed by states and transactions. In the software process, this is a valuable resource for monitoring the development from the perspective of the artifacts produced, as it is typically done, but adding a description of the knowledge involved to obtain such results (Figure 11).

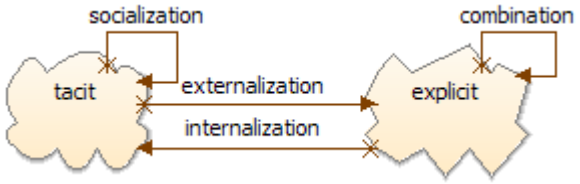


Figure 11. Knowledge States

*Consequences:*

A definition from the perspective of knowledge management proposed by Nonaka [9]. Socialization processes between aspects such as: tacit knowledge, processes of combination between explicit knowledge, externalization processes from tacit to explicit knowledge, and internalization from the tacit to explicit knowledge; form an important conceptual framework for managing organizational knowledge.

*Advantages:*

- Defining the states knowledge passes through allows identifying not only the principles that affect it, but also the conditions that surround such knowledge within the software process.
- It is clear that distinguishing tacit knowledge from explicit knowledge allows locating the origin of knowledge, provided it is possible to encrypt it through computer systems, or else, provided it resides in people.

*Disadvantages:*

- Managing knowledge is not always clear and requires greater effort on the process.
- An additional knowledge-management expert role is necessary for the process.

*3. Knowledge Bowl Pattern*

The software crisis is due to a knowledge gap resulting from the discrepancy between the knowledge integrated in software systems and the knowledge owned by organizational actors [47], people involved play a major role, because upon them rests the knowledge. Knowledge Bowl pattern establishes who the source of knowledge is. Such a source may reside in an author or a role, and knowledge can be soft or hard knowledge (Figure 12).

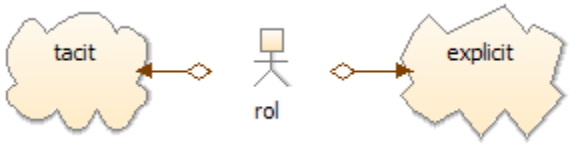


Figure 12. Knowledge Bowl

*Consequences:*

Defining the source of knowledge present in a software process is critical because it allows identifying both the actors and the important roles within the process, like for example knowledge systems and networks that are being developed during the management of the process.

*Advantages:*

- Prioritizing the roles and actors who posess valuable knowledge allows managing the knowledge that resides in them.
- The process is guided in its implementation by using the knowledge being generated.
- A knowledge-based process is more reliable and robust.

*Disadvantages:*

- It is not easy to identify the knowledge repository.
- Knowledge management is a task that goes beyond the engineering discipline.

## IV. PROCESS PATTERNS SUPPORT THROUGH SOFTWARE

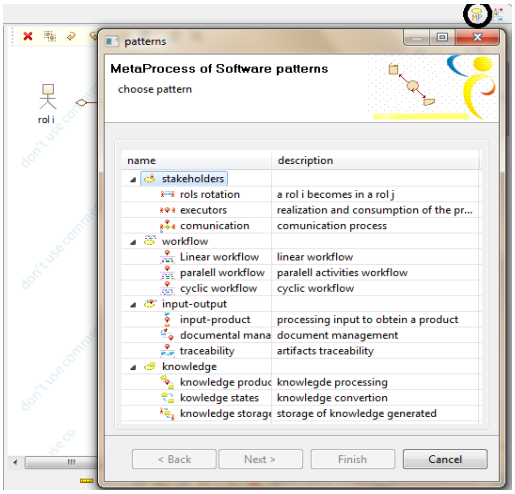


Figure 13. Coloso Software, www.colosoft.com.co

One of the advantages of having a catalog of patterns for software processes is the power to implement the catalog using automated tools, in this case, a process patterns component has been developed for the Coloso platform [10] - (Figure 13) . Patterns implemented on the Coloso PSEE [49] - Process-centered Software Engineering Environments - are modeled with the Process Modeling Language PML [50] that is not matter in this paper but can be used in the tool.

## V. CONCLUSION

In the same way software patterns have been proposed in other engineering disciplines such as software design, software architecture, analysis, and so on; in the area of software processes, a proposal that compiles a set of best practices that occur repeatedly in the software development process is also needed. The patterns proposed in this article, constitute a valuable vocabulary to facilitate communication among the participants in a software process, who will be able to quickly and accurately identify the way a software development process has been structured.

The proposed patterns, compile common elements that are present in the software development processes and methodologies. Additionally, these patterns clearly outline aspects such as the structure, the participants, the knowledge and the input-output, which constitute a software development process and through which it is possible to trace a path towards good practice and implementation of a software process.

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# Antipatterns: A Compendium of Bad Practices in Software Development Processes

Sandro Javier Bolaños Castro[1], Rubén González Crespo[2], Víctor Hugo Medina García[1]
[1]*District University "Francisco José de Caldas" - Bogotá (Colombia)*
[2]*Pontificial University of Salamanca - Madrid (Spain)*

***Abstract* — This Article presents a set of software process antipatterns, which arise as a result of bad practices within application development processes. Process AntiPatterns warn us about the harmful effects that may arise in projects, and also describe the features that identify them. The proposed anti-patterns provide a catalog that serves as a vocabulary for communication among project participants. Such Antipatterns can be implemented through software tools in order to keep better record of their implementation. Additionally, a tool that can operate under GPL (General Public license) is provided for this purpose.**

***Keywords* — Software Process, anti-patterns.**

## I. INTRODUCTION

The goal of software development is to generate products with high levels of productivity and efficiency that ensure good levels of quality. To achieve this, it is necessary to avoid the risks introduced by bad practices of software. These bad practices have been labeled as anti-patterns, and occur in different areas. The catalog of antipatterns is an important road map, particularly on dark paths that might be followed when precautions are not taken, and of course, that cause problems in projects. This article presents a list of harmful practices that represent anti-patterns in the implementation of software development processes.

## II. UNDERSTANDING ANTIPATTERNS

Alongside patterns, the anti-patterns trend is also a major subject of study that should be taken into account. The anti-patterns that constitute harmful practices must be avoided to reduce the risk of failure in software projects. One of the most recognized works on anti-patterns is that proposed by Brown [1], where software development AntiPatterns, software architecture anti-patterns and antipatterns of software project management are put forward. Another work is that of Dikel [2], where a set of anti-patterns for software architectures according to vision, rhythm, anticipation, partnering and simplification is proposed. Unfortunately, it is very easy to be engaged in anti-patterns since they are caused by poor abstraction and poor implementation of the theoretical approaches of software. Usually, "shortcuts" and poor analysis approaches lead to malpractice. The time factor developers always have to compete against does not allow thinking more carefully about good practices; even patterns themselves might become anti-patterns when abusing their implementation. A definition of anti-patterns allows creating a recognizable vocaary that facilitates communication among the participants in software projects regarding dangerous situations you need to be aware of and avoid, or at least reduce their possible impact.

## III. ANTIPATTERNS OF THE SOFTWARE DEVELOPMENT PROCESS

The application of a process in a software project is necessary to monitor and control it. There is a wide range of software processes of different kinds; each process holds out a way to track and coordinate activities, resources and knowledge in order to provide a support tool for the operation of a software project. However, it is easy to incur in poor implementation of procedures and protocols as well as poor resource management, especially human resources, resulting in bad practices that might be called anti-patterns of software processes. Below we propose a set of harmful practices that may occur in software development processes.

### *A. Top Process*

It is common that whenever a process is needed, the first choice is to pick the in-fashion process, which is generally proposed by a large organization, a community, a research center or a person or group of people who pool their expertise to propose a rescuing formula. Generally the top process is proposed as the only silver bullet [3] with regard to the process. However, what worked for a particular project environment does not necessarily work for every project environment. You must take into account the business conditions of the organization, and ultimately you must be careful about the inherent difference that exists between the application domains of the different processes. The main responsibility for achieving success lies in the process, as an essential tool for software projects, regardless of the software singularity [4], so the top process does not guarantee success (Figure 1).


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Figure 1. Top Process

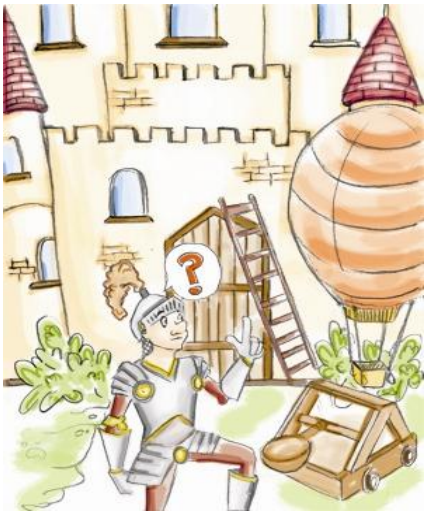

Figure 2. Super Process

### B. Super Process

Explaining any phenomenon from all angles is an approach that can be adopted. Similarly, using complexity to explain a software process is another way; in the words of Morin: "let us take a contemporary cloth, it uses flax, silk, cotton, and wool of various colors. For that cloth, it would be interesting to know the laws and principles concerning each of these types of fibers. However, the sum of knowledge about each of these types of fibers that form the cloth is insufficient to meet not only the new reality which is the tissue, that is, the qualities and specific properties of the texture, but also to help us understand the shape and configuration"[5]. As systems (or objects of study) become more complex, that is, not just consist of more parts but also the interaction between them becomes increasingly complex, it seems that the explanation of the phenomena presented by the behavior of such systems tends to take into account the "context", the environment, that is, the phenomena's "totality"[6]. The complexity theory focuses on identifying that we already have enough to work on only by making the activities of a process harmonize, the proposed schemes end up in incomprehensible schemes, which include size, spirals, tables and other notations, often overloaded unnecessarily, becoming a burden that a development team cannot bare (Figure 2).

### C. Extreme Process

"There are profound differences between theory and mere computer technological rules" [7], for Popper, it is clear that there are two extremes: on the one hand, the theoretical approach, and on the other hand, instrumentalism. It seems that software processes fluctuate between these frequencies; unfortunately for any project, it is inconvenient to fall in these limits. On the one hand, theorizing about the issue of processes is a task not only valuable but also necessary, but the task itself must take into account that the processes should be practical, and it is at this point where the development steers into the other edge, namely instrumentalism. It is common for a software process to be successful in one project and fail in another, so relative success is not universal guarantor for a process, in this sense, pure instrumentalism runs out of arguments. Finding the right amount of theory, mostly as a result of the a-priori approach of reflection, along with a dose of instrumentalism can be a good combination. In this sense, developers should not rely entirely on a theory without proof, nor shoud they rely just on a test (probably successful but without epistemological foundation) when bearing in mind that processes follow a technical application that does not neglect the theoretical reflection on their problematic core (Figure 3).

Figure 3. Extreme Process

### *D. Casual Process*

Conducting a software process often becomes an ad hoc activity, resulting in improvisation of the tasks. Such type of work takes place when an organization is not aware of the importance of processes and usually ends up diverting all the workload onto development activities. Ad hoc processes arise primarily because there is not a process manager who guides the selection of at least one process to perform. Ad hoc processes are not aware of the roles and end up creating handyman roles, promoting anti-patterns that generally resemble the project management anti-patterns [1]. An ad hoc process ends up extending schedules, repeating efforts and consuming resources. Because the process is not clearly identified, it may end up taking different names from a list given by the participants, which is usually inconsistent. A casual process tends to be confused with an organization's customized process, therefore, care must be taken when the course of the process has features like those listed above. (Figure 4)

Figure 4. Casual Process

### *E. Slide Process*

Adopting a process that encourages the production of outputs from a given input regardless of the way in which workflow occurs is generally counterproductive. Software processes should not be slides, which do not pay interest to the way results are obtained, since in the workflow participate a society of roles that may be sacrificing not only the quality in the process, but most importantly, sacrificing performance conditions and quality of life. In a slide process, it is typical to start at a certain speed and finish with acceleration. In the same way, a process without rhythm [2] starts with extended times in its initial phases and have tight schedules in development and deployment phases. A slide process does not control time, delaying projects; it also accelerates at critical stages, sacrificing product quality. These processes end up adjusting schedules, paying fines, conducting renegotiations, and making considerable losses for the organization (Figure 5).

Figure 5. Slide Process

### *F. Immutable Process*

Thinking that an immutable process represents a great advantage is a problem if you consider Heraclitus paraphrased words regarding his theory of perpetual flow "do not use the same process twice." Proposals such as CMM [8], about the repeated process as one of the levels of maturity, point at a feature that is apparently advantageous; however, such a setting is unfeasible given that the conditions and specific process variables are impossible to repeat; even when in the extreme case where conditions are very simillar, time becomes an impediment. A process, as opposed to be considered immutable, should be treated with high doses of adaptation, as proposed by methodologies like ASD [9]. Each time a software process is conducted, it truly becomes a new process. The fact that a process has a general guide should not be confused with executing the same process over and over again. Considering a process as immutable eliminates the possibility

of seeking new knowledge when developing the process, losing the possibility of improving the process (Figure 6).

Figure 6. Immutable Process

### G. Process without evidence

Usually, software development processes involve creating documents related to the product being made, such as developing manuals and user manuals, among others. However, a document of the process itself, which at least provides information about what was learnt from the process execution, is a task that is never performed. When the process lacks evidence of its execution, it is highly probable that the same actions will be re-executed with the same fundamental flaws. These side effects result in process delays, repeating and perpetuating defects. Processes without evidence, are a sign that there is no process manager, who leads the process and records its past history for new process implementations (Figure 7).

Figure 7. Process without evidence

### H. Process without rhythm

A software development process should try to keep a sort of rhythm in each of its activities so that there are no gaps that hinder efforts and resource investment from efficiently contributing to constituent-workflow tasks. It is common to find elongated-time activities, while other activities are time-constraint, the proportions of time allocation must be fair without causing trauma. The time resource should be one of the main variables to govern the processes, the workflow must balance the periods of time employed in each activity, thus avoiding botched executions. A process without rhythm occurs when other antipatterns are inserted, such as paralysis of analysis or design by committee [1]. In these harmful practices, it is evident that the imbalance in a specific activity impedes the normal execution of the remaining activities (Figure 8).

Figure 8. Process without rhythm

### I. Domino Process

A development process tempered by a high interdependence between the activities that constitute its workflow will result in a domino process.Initial activities are critical and cause exponential effects on final activities to the point that it becomes impossible to produce an activity *i +1* if you have not fully completed activity *i*. A domino process leads to stiffness and reduces the possibility of feedback at early stages in the workflow. A problem is detected when the cost has increased considerably, leading to elongation in the schedules, as well as to inefficient use of resources. Unfortunately, when developing software, it is very common to find problems in the requirements phase, given the volatility and ambiguity typical of gathering requirements; under these conditions, if a process does not propose strategies to deal with the activities themselves as well as with the activity-coupling management, a domino process will evolve easily (Figure 9).

Figure 9. Domino Process

### *J. Perpetual Process*

When a process becomes interminable is said to be a *perpetual process*. Generally speakig, the process falls into infinite loops when the workflow is repeated without generating useful products. This type of process is evidence of the immaturity associated to the organization that runs the process as well as of its lack of adequate estimation, its failure to meet the requirements and development. Such immaturity is most obvious when in the testing phase, where developers will need to constantly repair things, with the aggravating circumstance that these repairs might cause further inconveniences. In the perpetuity of the process there is no proper configuration management, and quality control is summarized in trying to fix an accumulation of defects that cause poor reliability [10] of the results obtained at a prticular point of development. When a process becomes perpetual, it usually ends abruptly with negative collateral implications for the participants (Figure 10).

Figure 10. Perpetual Process

### *K. Headless process*

Poorly managed processes, and /or processes with leadership problems in the various disciplines, are referred to as headless processes. This type of process does not define clear functional objectives and responsibilities, there is a poor identification and assessment of the roles and therefore there is no adequate assessment of the disciplines; activities usually focus on the production of code without ensuring appropriate quality conditions; moreover, ad-hoc delegations occur. Headless processes exhibit exaggerated rotation of staff, stalling the workflow and leading to an abrupt end with unfavorable implications for the parties involved (Figure 11).

Figure 11. Headless Process

### *L. Processes without Communication*

Communication between the parts of a process is critical to ensure the flow of information and of the knowledge management processes [11]. For a software process it is important to create role networks to integrate the different functions and responsibilities. The lack of communication makes processes slow, consequently, work flow stagnates and redundancy of labor is produced; moreover, resources wear out and delivery times are easily exceeded. Communication must flow in the organization in every possible way, not only from the command roles to subordinates, but also from basic to higher roles. Some agile methodologies, such as daily meetings, propose good practice regarding communication, where project-roles interaction strengthens the processes. This results in the generation of evidence and promotes continuous improvement. Lack of communication promotes the loss of resources and also slows work flow down (Figure 12).

Figure 12. Process without Communication

## IV. ANTIPATTERNS SUPPORT THROUGH SOFTWARE PROCESS

One of the advantages of having a catalog of antipatterns for software processes is to implement the catalog using automated tools, which allows timely identification of a bad practice within a process. Th purpose is to generate a labelled-fault control record that helps developers avoid following wrong paths whenever running a process in a software project. In this particular case, we have developed a process antipatterns component for the Coloso platform [10], (Figure 13).

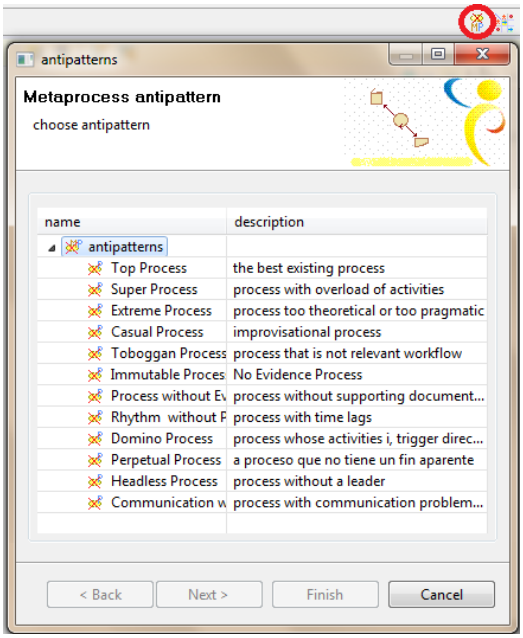


Figure 13. Coloso Software, www.colosoft.com.co

## V. CONCLUSION

The anti-patterns generate a vocabulary and a list of risks that can arise when using a software process. This vocabulary facilitates effective communication between the different roles of the process and contributes to failure detection and quick response whenever risks are encountered in a project.

Software processes have been accepted as heroic formulas but processes themselves are part of the problem of software development and although such processes need not be permanently reinvented, it is extremely necessary to see their weaknesses and strengths in order to avoid trauma when conducting projects.

## ACKNOWLEDGMENT

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# Towards an Ontology to Describe the Taxonomy of Common Modules in Learning Management Systems.

Carlos E. Montenegro-Marin[1], Juan Manuel Cueva-Lovelle[2], Oscar Sanjuan[2], Edward Rolando Nuñez-Valdez[2]
[1] *Engineering Faculty, Distrital University, Bogotá, Colombia.*
[2]*Computer Sciencie Department, Oviedo University, Oviedo, Spain*

***Abstract* — This article have the objective a create ontology for "common modules in a Learning Management Systems", the steps for the build Ontology were: Determine the domain and scope of the ontology, Consider reusing existing ontology, Enumerate important terms in the ontology, Define the classes and the class hierarch, Define the properties of classes—slot and Define the facets of the slot, finally be explained how the ontology is composed.**

***Keywords* — Ontology, Class, Learning Management Systems, common modules, Protégé.**

## I. INTRODUCTION

A very big problem that found in the integration or migration of platforms e-learning or Learning Management Systems (LMS ) is the incompatibility between these, this incompatibility is due to lack of unification regarding the appointment and composition of modules and submodules that integrate the different LMSs, for example the module file management in the Atutor platform is named "File Administrator" while that in others platforms how Claroline or Mooodle is named "Documents" and "Resources" respectively.

Before to working with the LMS platforms is necessary selecting LMS platforms. In this sense we divided the LMS platforms in two types; the private platforms how is the case of BlackBoard and the Open Source platforms how is the case of Moodle.

Due to huge amount of LMS platforms that there in the in the market, is necessary select the most commonly used. For the selection of LMS, we chose Moodle, Sakai, and DotLRN because works such as [1] show that Moodle is the most used open source LMS in Spanish Universities with over 45%. Furthermore, Sakai has 5%, and DotLRN has 4%. Claroline and ATutor were selected because they are also used worldwide. For instance, according to [2] each of these platforms are used by 3% of the Italian Universities.

This article presents an ontology of modules common in LMS platforms, in the first stage had been realized the "MODELING AND COMPARISON STUDY OF MODULES IN OPEN SOURCE LMS PLATFORMS WITH CMAPSTOOL" [3], in this moment was tested five LMS (Moodle, Sakai, DotRLSn, Claroline and Atutor), for each of them is constructs your knowledge map with CmapTools and was obtained a comparative table between its modules. This result is the information source for built the ontology. For the construction of the ontology, the methodology used was "Ontology Development 101: A Guide to Creating Your First Ontology"[4] and this step is developed in the section 2, the section 3 explained the ontology composition and finally in section 4 are located the conclusions.

## II. METHODOLOGY FOR CREATING ONTOLOGY.

For the creating ontology we used the guide official for the ontology development that Stanford University recommend, Stanford University is the creator of protege [4] and the name of the guide is "Ontology Development 101: A Guide to Creating Your First Ontology" [5]. Here define the concept of the ontology how "is a formal explicit description of concepts in a domain of discourse (classes (sometimes called concepts)), properties of each concept describing various features and attributes of the concept (slots (sometimes called roles or properties)), and restrictions on slots (facets (sometimes called role restrictions)). An ontology together with a set of individual instances of classes constitutes a knowledge base" [5] and proposed a methodology for the construction of ontologies, comprising the following steps:

1. *Determine the domain and scope of the ontology.*
2. *Consider reusing existing ontologies.*
3. *Enumerate important terms in the ontology.*
4. *Define the classes and the class hierarchy.*
5. *Define the properties of classes—slots.*
6. *Define the facets of the slots.*
7. *Create instances.*

The following chapters develop the proposed methodology adapted to our special needs. respect to coding standards, uses the same Java recommended[6].


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*A. Determine the domain and scope of the ontology.*

The problem domain this bounded, to the management of an LMS Components and especially of the LMS appointed in the section one, with a focus at the creation of courses. The Ontology is employed for the get respect necessary knowledge at the modules that make up a LMS and the create courses within him, Similar modules or homologous modules between LMS, the ontology may answer questions as ¿A forum is part of the tools of the LMS? Or ¿a teacher is a type of user of a LMS? it's very important clarify that ontology is created to a changing and evolution context, therefore it is necessary maintain, upgrade and expand according to the context need for the ontology.

*B. Consider reusing existing ontologies.*

To consider progress in the area of ontologies for LMS, we made a search of available ontologies, in order to work and enrich more, the search was conducted in the following browsers ontological, Recommended in [5]:

- *http://swoogle.umbc.edu/*: Swoogle is a Ontology search engine for the Semantic Web on the Web [7].
- *http://protegewiki.stanford.edu/wiki/Protege_Ontology_Library*: Page of Ontology's, is organized into the following groupings [4]
- *http://www.ksl.stanford.edu/software/ontolingua/*: Ontolingua provides a distributed collaborative environment to browse, create, edit, modify, and use ontologies. The server supports over 150 active users, some of whom have provided us with descriptions of their projects [8].
- *http://www.daml.org/ontologies/:* The DARPA Agent Markup Language (DAML) Program officially began in August 2000. The goal of the DAML effort is to develop a language and tools to facilitate the concept of the Semantic Web. Michael Pagels is the DARPA Program Manager for DAML. The DAML program will end in early 2006 [9]
- *http://www.unspsc.org/:* The United Nations Standard Products and Services Code (UNSPSC) provides an open, global multi-sector standard for efficient, accurate classification of products and services. Search the code on this website to locate commodity codes that can be used by your company. The UNSPSC offers a single global classification system that can be used for: Company-wide visibility of spend analysis, Cost-effective procurement optimization, Full exploitation of electronic commerce capabilities. You may browse and download the current version of the code at no cost [10].
- *http://www.dmoz.org/:* The Open Directory Project is the largest, most comprehensive human-edited directory of the Web. It is constructed and maintained by a vast, global community of volunteer editors [11].

The search was unsuccessful in these containers and browsers ontological, since all ontology were offered concept of Learning Management System, but do not model the ontology of the LMS, so it is not feasible to use one of these ontologies.

The next step was to find an ontology is search in the academic databases such as ISI Web of Knowledge, Springer, Ebsco, Dialnet, Proquest, ACM, IEEE, Google Schoolar and other similar, there are some jobs such as:

- *A Learner Oriented Ontology of Metadata to Improve Effectiveness of Learning Management Systems*: This paper presents ontology for an e-Learning Management System (LMS), which arranges metadata, and defines the relationships of metadata, which are about learning objects; belong to academic courses and user profiles. This ontology has been incorporated as a critical part of the proposed architecture. By this ontology, effective retrieval of learning content, customizing LMS is expected. Metadata used in this paper are based on current metadata standards. This ontology specified in human and machine-readable formats. In implementing it, several APIs were defined to manage the ontology. They were introduced into a typical open sourced LMS. Proposed ontology maps user preferences with learning content to satisfy learner requirements. These learning objects are presented to the learner based on ontological relationships. Hence it increases the usability and customizes the LMS [12].
- *Towards an ontology about LMS*: This article is a review of the LMS concept and proposes ontology based on the latest definitions. This article is part of an investigation in progress that aims to clarify the systemic quality in the process of implementing an LMS in an organization [13].
- *Justification and description of the domain of knowledge of an Ontology for the formalization and automatization of education scenaries*: This article justifies the need to build an ontology with order to provide technical support for a specification of learning scenarios and a tool for development and validation of new scenarios. Specifically, it justifies the need for ontology and described in natural language the first approach to domain knowledge of it [14].
- *Knowledge Representation of LMS using Ontology*: Though there are no distinct classifications of the approaches while implementing, the union of all the viewpoints is not dealt / applied completely by any of the author. This paper focus on integrating the above said principles on semantic educational servers with the power of eLearning standards. The knowledge items (learning objects) are linked to commonly agreed ontology [15].
- *Towards an ontology of lms a conceptual framework*: This article presents a research in progress whose final objective is to develop a method to select, implement and integrate an LMS into an organization with a systemic quality approach. As a first step, in this article is presented an ontology to conceptualize

the terms associated to LMS, unifying them through their relations [16].

All these papers raise the creation of an ontology in their respective contexts and approaches made to the ontology, but not analyzed common modules between LMS platforms, All these ontologies are used as input for the a ontology building common between some LMS platforms.

### *C. Enumerate important terms in the ontology*

For the enumeration important terms we used a list of terms available in [3], in this list is presented a approximation of modules compatible between LMSs and a generic name for them to define the LMS ontology, this is shown in the table 1.

**TABLE I**

**COMPARISON OF MODULES BETWEEN SOME LMS PLATFORMS AND A GENERIC NAME**

| Generic | Atutor | Claroline | Moodle | .RLN | Sakai |
|---|---|---|---|---|---|
| **File manager** | File Administrator | Documents | Add resources | Documents | Resources |
| **Announcement** | Announcements | Announcements | Home | Ø | Announcement |
| **Help** | Help | Help | Help | Help | Help |
| **Chat** | Chat | Ø | Chat | Chat | Ø |
| **Management Curricula** | Contents | Ø | Add resource | Class material | Resources |
| | | | Add activity | Learning contents | Ø |
| **Educational Design** | Administration | Learning path | Site Administration | Control panel | Portfolios |
| | | | | | Preferences |
| **Course** | Course | Course claroline | Module | Course | Portfolios |
| **Authentication** | Directory | Users | Users | Teachers | Accounts |
| **Survey** | Quiz | Ø | Quiz | Ø | Ø |
| **Evaluation System** | Tests and Quiz | Evaluation System | Questions | Evaluations | Evaluation System |
| | | | | Questions | |
| **Forums** | Forums | Forums | Forums | Forums | Messages and Forums |
| **Glossary** | Glossary | Ø | Glossary | Ø | Ø |
| **Groups** | Groups | Groups | Ø | Groups | Ø |
| **Work Group** | Networking | Ø | Ø | Communities | Profile2 |
| **FAQ** | FAQ | Ø | Ø | FAQ | Ø |
| **Activity calendar** | Ø | Calendar | Activities | My calendar | Calendar |
| **News** | Ø | Ø | Ø | News | News |
| **Wiki** | Ø | Wiki | Wiki | Ø | Ø |
| **Rating system** | Test and task | Exercises | Module | Evaluates | Event |
| | | | Advanced File Uploading | Test | |
| | | Task | | Projects | |
| | | | Upload File | Task | |
| **Administration** | Preference | Yes | Site Administration | Control Panel | Membership (Site administration) |

### *D. Define the classes and the class hierarchy*

For the definition of the classes, we chose a combined process mix between top-down process in which one begins by defining the general concepts and lay the composition of these, for example a course has tools, and process bottom-up which begins with the definition of more specific classes and then generalized, for example a forum is part of communications. The end result of this step, we can see in Figure 1.

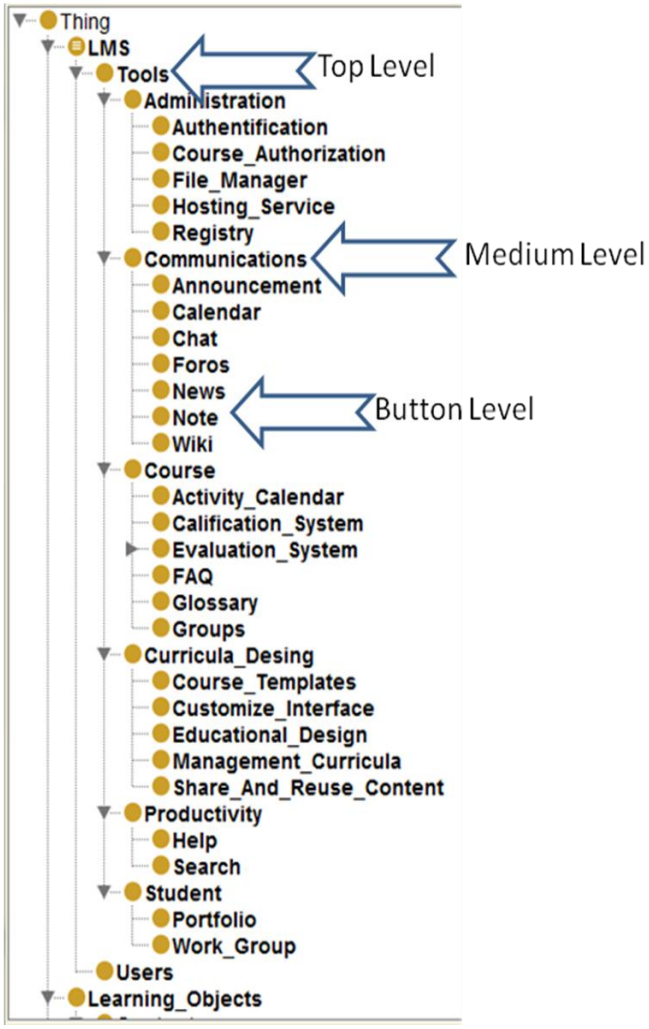


Figure 1. View of the class in Protege with classification levels

### *E. Define the properties of classes—slots*

The properties of the classes are defined basing on types of components that they have, this classification of the components had already been done on the job [3](to appear), using the leaf nodes used knowledge maps for each class used in the ontology, is searched common components in knowledge maps for example, in the conceptual maps of moodle and claroline for the Forum module, we can determine that the common elements for the forums are: forumName, message, subject and attachment is optionally, this means that these are the properties of our classes and are of type: textBox, textBox, textBox and file respectively why this is shown in the leaf nodes, the Figure 2 show the members of the Foro Class and Figure 3 show the type of forumName.

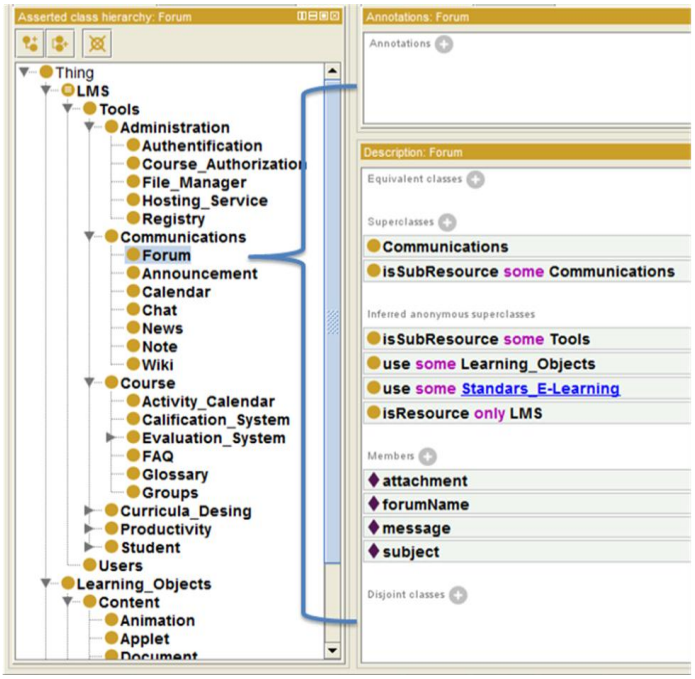


Figure 2. Members of the Forum Class

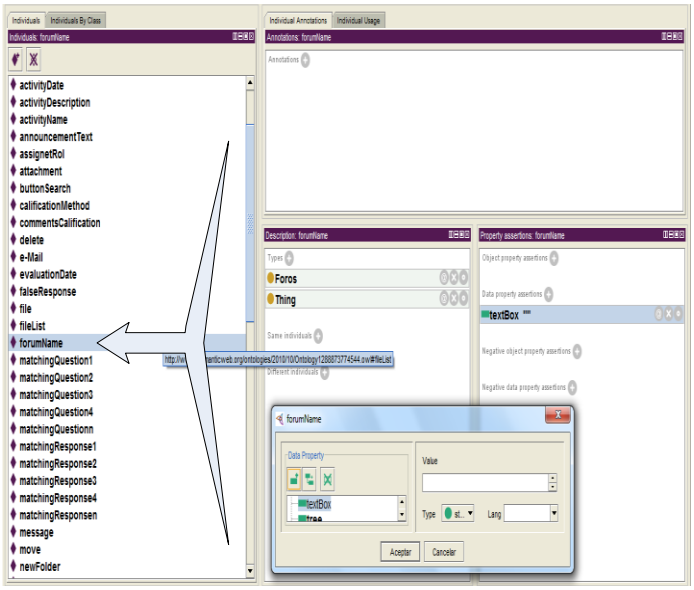


Figure 3. Type of the furumName

### F. Define the facets of the slots

Here we define the facets that describe the type of value, valid values, the number of values (cardinality) and other characteristics that the slots can take, for example the item evaluationDate is a type calendarDate and the values it receives only Activity_Calendar, are as shown in Figure 4 and the same types of securities may be as common as strings or numbers.

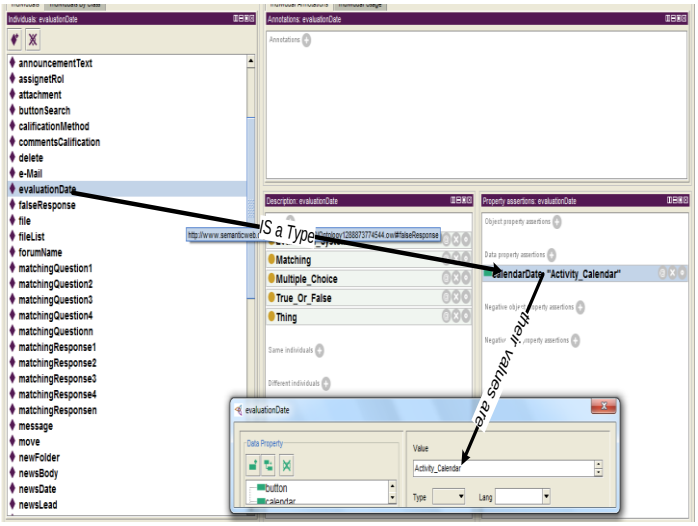


Figure 4. Element evaluationDate, that is of the type calendarDate and their values are Activity_Calendar

### G. Create instances

This last step is not proved, because not is provided in the scope of the this article and our case will be the responsibility of the domain specific language for the generation of learning management systems modules [17], this project was developed in the Informatics department of the University of Oviedo.

## III. Ontology Generation

The generated ontology is composed of 50 classes including the Thing Class, 4 Object Properties, 16 Data Properties, 69 Individuals, each of these components with their respective descriptions the more general classes are LMS, Learning_Objects and Standars_E-Learning, this classes show in the Figure 5, their classes visualization is done in Asserted class hierarchy of Protege ant the view offered by OWLViz Plugin.

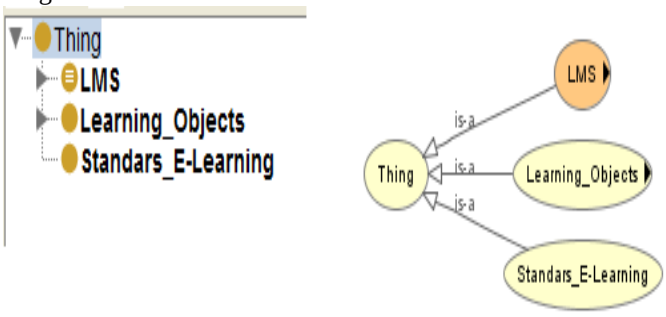


Figure 5. View of more general class in Protege Asserted class hierarchy and OWL Viz Plugin

The LMS Class has Users and Tools, the Users has assignetRol, e-Mail, password and UserName how members of him, and the Tools class has the subclasss: Tools Administrations, Communications, Course, Curricula_Desing, Productivity, and Student, Figure 6 shows these classes.

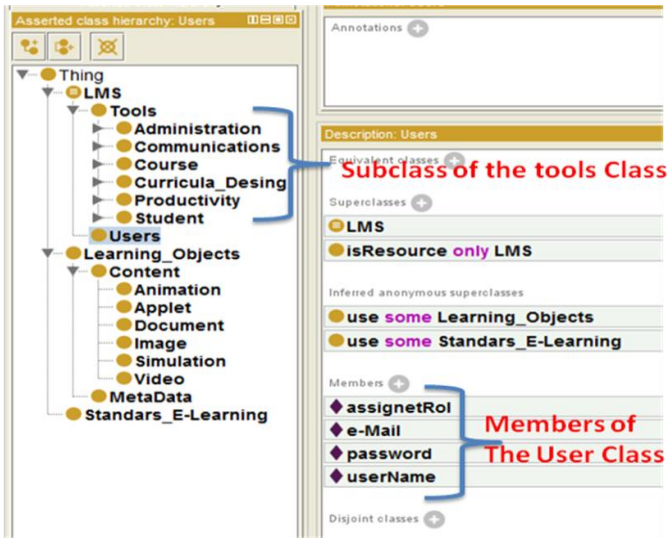


Figure 6. Subclass of Tools and Members of the Users

The Administration class is son of Tools class and have five subclasses; Authentication, Course_Authorization, File_Manager, Hosting_Service, Registry. The Authentication class, have a password of textBox type and userName of textBox type too. The Course_Authorization class, have a assigneRol of comboBox type and userList of list type. The File_Manager class, have a delete of event type, fileList of list type, move of event type, newFolder of button type, rename of event type and uploadfile of explorator type. The Registry class, have a registerOfUsers of link type. And the Hosting_Service class. All this is show in figure 7.

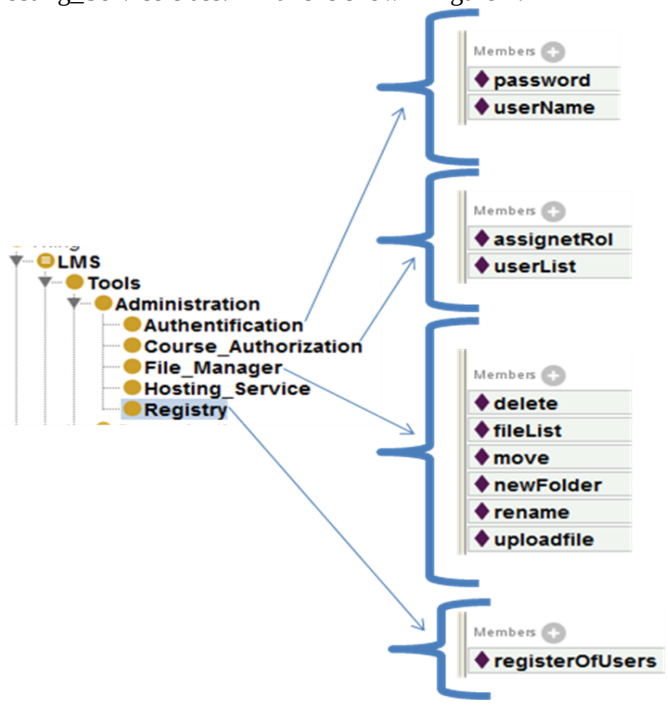


Figure 7a. Sons of the Administration class and your members

The Communications class is son of Tools class and have seven subclasses; Announcements, Calendar, Chat, Forums, News, Note and Wiki. The Announcements class, have a announcementText of textArea type. The Calendar class, have a showCalendar of calendar type. The Chat class, have a roomName of textBox type, send of button type, sendText of textBox type, textWrittenByUsers of nonEditableTextArea type and userList of list type. The Forum class, have an attachment of file type, forumName of textBox type, message of textBox type and subject of textBox type. The News class, have a newsBody of textArea type, newsDate of textBox type, newsLead of textBox type and newsTitle of textBox type. The Note class, have a message of textBox type, send of button type and userName of textBox type. And the Wiki class, have a wikiEdit of textArea type and wikiView of view type. All This is show in figure 8.

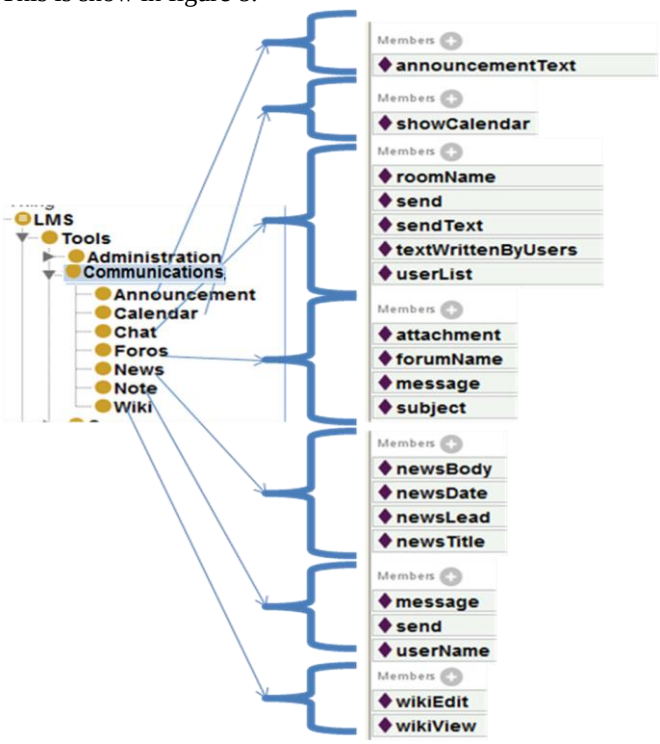


Figure 7b. Sons of the Communications class and your members

The Course class is son of Tools class and have six subclasses; Activity_Calendar, Calification_System, Evaluation_System, FAQ, Glossary and Groups. The Activity_Calendar class, have a activityDay of calendarDate type, activityDescription of textaArea type, activityName of textBox type and attachment of file type. The calification_System class, have a activityName of textBox type, commentsCalification of textArea type and valueCalification of textBox type. The Evaluations_System class, have a calificationMethod of textBox type, evaluationDate of calendarDate type, statementQuestion of textArea type, and has three subclasses, Matching class that additionally has, matchingQuestion1, 2, 3, 4 to n of textBox type and matchingResponse1, 2, 3, 4 to n of textBox type. Multiple_Choise class that additionally has, MultipleResponse1, 2, 3, 4 to n of textBox type and percentageHitResponse1, 2, 3 ,4 to n of textBox type and True_Or_False class that additionally has, falseResponse of textArea type and trueResponse of textArea type. Other sons

of Course class, are FAQ class, have a viewFAQ of textArea type, Glossary class, have a viewGlossary of textArea type and Groups class, have a userList of list type. All This is show in figure 8.

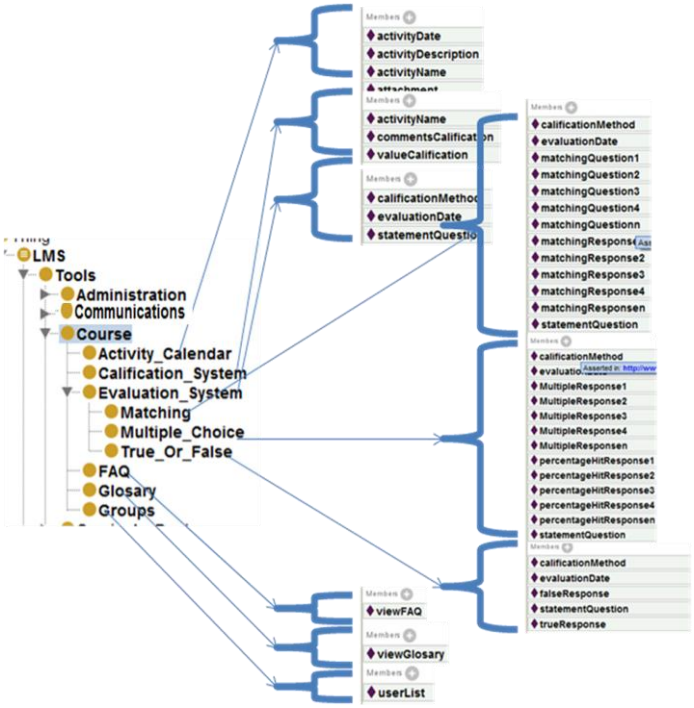


Figure 8. Sons of the Course class and your subclass and members

The Curricula_Design class is son of Tools class and have five subclasses; Course_Templates, Customize_Interface, Educational_Design, Management_Curricula, Share_and_Reuse_Content. The Course_Templates class, have a viewCourseTemplate of view type. The Customize_Interface class, have a viewcustomizeInterface of view type. The Educational_Design class, have a viewEducationalDesign of view type. The Management_Curricula, have a viewmanagementCurricula of view type and Share_And_Reuse_Content class, have a fileList of checkButton type. All This is show in figure 9.

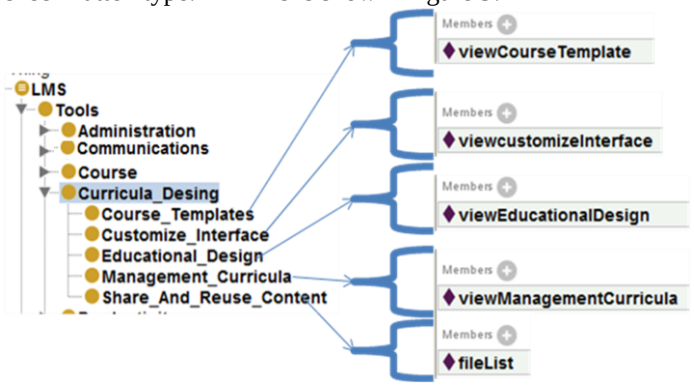


Figure 9. Sons of the Curricula_Design class and members

The Productivity class is son of Tools class and has two subclasses; Help and Search. The Help class, have a viewHelp of view type. The Search class, have a buttonSearch of button type and have textSearch of textBox. All This is show in figure 10.

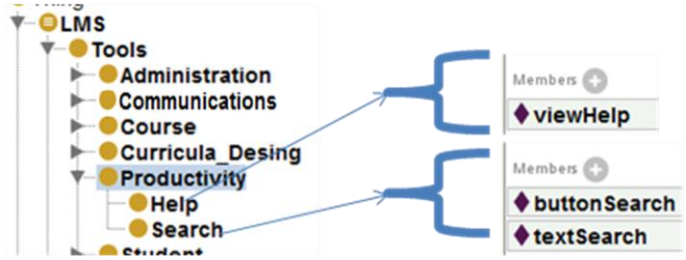


Fig. 10. Sons of the Productivity class and your members

The Student class is son of Tools class and has two subclasses; Portfolio and Work_Group. The Portfolio class, have a viewPorfolio of view type and the Work_Group class, have a viewworkGroup of view type. All This is show in figure 11.

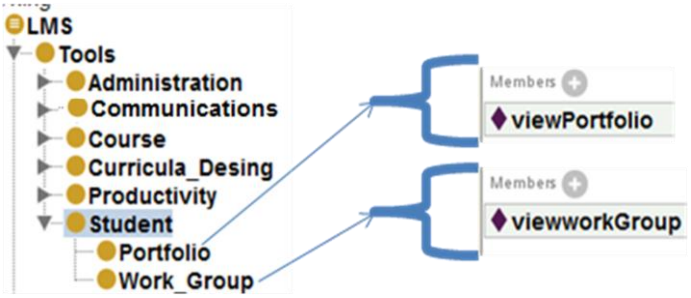


Figure 11. Sons of the Student class and your members

And finally, Standars_E-Learning class and Learning_Objects class, whose subclass are Metadata and Content. The Content class has Animation class, Applet class, Document class, Image class, Simulation class and Video class. This is show in the figure 12.

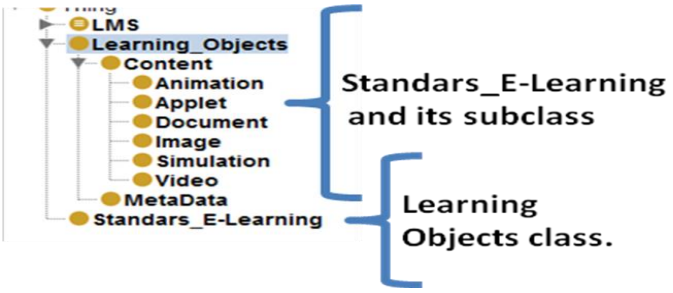


Figure 12. Standars_E-Learning and its subclass. and Learning_Objects

## IV. Conclusions

The complete Model of the Ontology is show in the figure 13, and shows similar elements between the LMS analyzed, and the modules common among LMS, these are : File_Manager, Registry, Announcements, Calendar, Chat, Foros, News, Note, Wiki, Activity_Calendar, Calification_System, Evaluation_System, FAQ, Glossary, Groups, Help, Search, portfolio, Work_Group, Users, and Learning_Objects.


Figure 13. LMS Ontology

The LMSs use a different Standards, but the principal modules its similar in all standards, but the problem is that technology implementation in each LMS is different and this is cause of incompatibility, is necessary create a method for the create modules independent of the platform, one solution could be applied Model Driver Engineering or web services, or other technologies.

The previous step for the perform the ontology, is know the domain of the context, And a good way for this, is interact and navigate for each of the platforms, for exploring the modules that comprise it.

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# Design of a System for Monitoring Technology Multiple Application in Order to Measure the Gap in Technology Companies "MiPymes"

Álvaro Espinel Ortega, Víctor Martín García and Adriana Marcela Vega Escobar
*Computer Science Department, Pontifical University of Salamanca, Madrid, Spain*

***Abstract* — This is one of several articles that aims to disseminate the research results in developing advanced doctoral paper entitled: Model of System for Technological Surveillance for multiple application to measure the technological gap in Colombian companies.**

**This paper is related to the design of Technological Surveillance, following the Rational Unified Process for software development, commonly known as RUP® [1], UML® [2] and implemented with the programming language C# [3], database engine SQL Server, set to an architectural model of three (3) layers (3-Tier). This document takes into account especially related to requirements, architecture and modeling and subsequent articles are related to testing, evaluation and results of the prototype was implemented and results in the field of technologically surveillance exercises, all in accordance with the objectives of the Doctoral Paper.**

***Keywords* — Bibliometrics, Competitive intelligence, Data mining, Metasearch engines, patents, Scientometrics, Technological Surveillance, Technology roadmaps.**

## I. Introduction

Colombian companies are oriented either to the production of goods or services, especially those classified as micro, small and medium enterprises, usually called by the acronym "MiPymes" do not have friendly computational tools for monitoring processes to different aspects related to technological advances, which have to do with its production facilities, which is why many of these companies currently have obsolete technologies or do not use any of them. A question arises?. If the technology is and has been the key for countries to position themselves at the head of economic development, because they also observed by the use of technological advances in different fields that make up to use the knowledge gained to benefit those who need, ie companies and especially those that make up the vast majority who have no resources for undertaking this type of research, such as the "MiPymes". "MiPymes" mean *"**Mi**cro, **P**equeñas **y** **Me**dianas Empresas"* in Spanish. In English micro, small and médium enterprise.

## II. Problem

This raises the second question. How much is the difference or gap between Colombian companies and their counterparts in developed countries?. It is possible to measure the gap? and similarly raises other questions such as: The gap in technology is just as it has always wanted to see? Or it may be related to methodologies? Or with the knowledge that people have that make the company? This is a complex problem that must be addressed comprehensively and in a first phase that would allow making diagnosis of the current situation of Colombian companies to establish or at least propose state policies which address those areas that laggards are to become competitive.

### *A. Formulation of the Problem*

It is possible to design and implement a surveillance system of multiple applications, to measure the technology gap, based on indicators of different types, configurable and manageable, so that as a result of this process is to propose strategies or policies for improving processes in Colombian businesses and / or discover new areas that make the country more competitive?

## III. Objectives

### *A. General Objective*

Show the processes used for designing a model surveillance system technology to measure the technology gap between Colombian companies and similar businesses elsewhere. This is to show some of the results of a doctoral paper and for the benefit of entrepreneurs who want to improve their competitiveness.

### *B. Specific Objectives*

Perform modeling and design a system to manage information for "MiPymes" to process the basic data related to their sector or workplace.

Perform design and modeling of a document management system, which allows searches of documents related to innovation like patents and scientific articles in order to classify and catalog, to get them relevant information associated with technological surveillance.

Perform design and modeling of a system of indicators, associated with human resources, technological indicators,


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indicators on innovation and economic and financial indicators.

Implement a prototype system to measure the digital divide so that comparisons can be made at the company level, in terms of chains, links, sectors and economic activities.

## IV. Surveillance Technology Concepts

"Technology Watch is an organized process, selective and permanent, to capture information from abroad and the organization of science and technology to select, analyze, disseminate and communicate it to turn it into knowledge to make decisions with less risk and be able to anticipate the changes. "Definition according to UNE 166006:2006. [4]. Spain.

All this in an atmosphere of legality, that the difference of espionage.

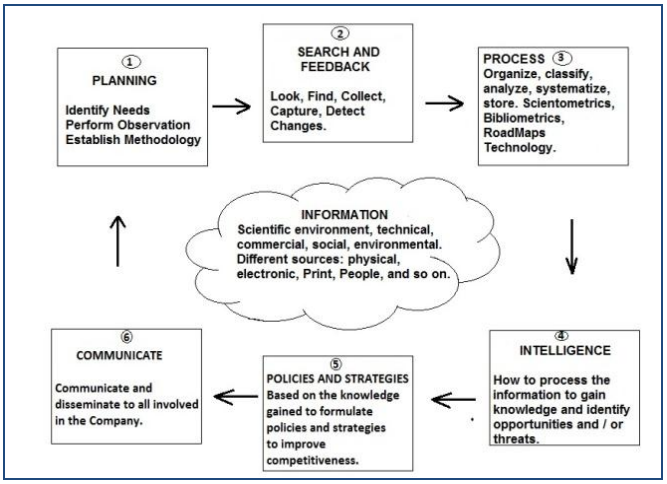


Figure 1. The cycle of technological surveillance.

The purpose of surveillance technology can be considered the following:

**Anticipate:** To detect the changes: new technology, machines, markets, competitors, internal, external.

**Reducing Risk:** Detect threats: Patents, products, regulations, alliances, new investments.

**Progressing:** Improve cost benefit.

**Innovate:** Improve the quality, performance, new ideas, new solutions.

**Cooperate:** Contribute to improving the environment.

**Compete:** Have permanence and excel in the market.

**Fields of application:** Develop strategies to establish R & D programs, to establish cooperation agreements to facilitate the implementation of new technological developments, identify opportunities for investment and marketing.

**Sources of Information:** We have formal and informal. In the case of formal sources are: scientific databases (eg, Scopus ®, Compendex ®, Chemical Abstracts ®, SCI ®, SSCI ®), patent databases (Eg WIPO ®, WPI ®, EPAT ®, CIBEPAT ®), scientific journals. In the case of informal information sources: public Internet, trade magazines, fairs, Invisible Web.

### *A. Competitiveness*

The best indicator of the competitiveness of a country's per capita income of its inhabitants. "The competitiveness of a nation is its ability to produce goods and services in international markets, maintaining or increasing real incomes of its citizens. Competitiveness is the basis of standard of living of a country. "OECD. (Organization for Economic Cooperation and Development). [5]

### *B. What Issues Should Watch*

According to Michael Porter of Harvard University. [6], among others should monitor technological, competitive and commercial environment.

#### *1) Technological aspects*

It should monitor progress of science and technology, the result of basic and applied research, products and services, manufacturing processes, materials, their processing chain, technology and information systems. [7]

#### *2) Competitive aspects*

Analysis and monitoring of current and potential competitors.

#### *3) Commercial aspects*

Markets, customers, the evolution of their needs, their solvency, suppliers, its strategy of launching new products, the labor force in the industry and value chain

#### *4) Aspects of environment*

The laws and regulations, culture, people, non-tariff barriers, free trade, environment, etc.

### *C. Technology Watch and Competitive Intelligence*

The word competitive intelligence tends to replace the term technological surveillance at establishing a more active character, presents a more elaborate and better prepared for decision-making. Between the two disciplines is a slight difference, while surveillance technology puts the emphasis on seeking and obtaining relevant information for decision making, competitive intelligence refers to the same process but with the emphasis on the development of this information often involves the obtaining of new information to really understand. [7].

## V. Design Process Steps

### A. Phase I: Conceptual Review.

We conducted a conceptual review process on the theoretical foundation for technological monitoring systems, taking national and international benchmarks in Europe and the United States and the international sector taking as reference points include the Organization for Economic Cooperation and Development (OECD) [5] World Trade Organization, World Economic Forum, the European Community and later other regions such as Asia and emerging countries of Latin America. Were taken into account also the Oslo Manual [8] and Frascti Manual [9].

We performed a process review of experiences in the field of technological surveillance nationally and internationally to learn about the sources of information valid for information extraction processes at the level of scientific articles, patents and documents related to innovation technology, such as databases indexed and the mechanisms used by those who have completed this process. Among others was a comprehensive review of the standards UNE 166000, 166001.166002, 166003, 166004. [10].

### B. Phase II: Selection and classification of indicators and sources of information valid as the basis for the technology gap.

It should set up a different kind, which are necessary to classify, catalog and rank in the social, economic, technical and scientific in accordance with international benchmarks. The indicators provide the basis for setting the gap based on the proposed monitoring system. You must also choose valid sources of information, based on selected indicators and taking into account international references in order to establish the requirements for the automated search systems, using "metasearch", which receive information parameterized by the systems plans to design and implement. For this case we used a metasearch engine called Copernic Agent ®, with its accessories COPERNIC TRACKER ® and Copernic Summarizer ® [11].

### C. Phase III: Development of Model for Technological Surveillance System proposed.

Based on the requirements established in previous phases, will proceed with the construction of UML ® models [2], following the RUP ® [1] known as the Unified Process of Software Development.

### D. Phase IV: Implementation of a Functional Prototype.

Working prototype was implemented with a database in SQL Server ®, Visual Studio development tool NET ®. The prototype includes some exercises with Colombian companies properly classified according to the international codification of economic activities ISIC ®, in order to validate the model. This prototype is being tested in collaboration with the Economic Development Secretariat of Bogotá and some businessmen from different sectors.

### E. Phase V: Testing, Prototype Evaluation And Publication Of Results.

The final results of the testing and evaluation of the prototype are scheduled for publication in later articles, as indicated in the summary of this document.

## VI. Surveillance System Design Technology

### A. Requirements.

Functional requirements are the needs of users viewed from the perspective of software and generally relate below: Requirements for Business Management "MiPymes" documentary requirements, requirements for indicators, monitoring requirements on technological requirements on technology gap measure, requirements for system users

### B. Requirements Specification

In the final design document requirements are specified using the following guidelines: Specified in writing, with opportunities to test or verify, based on the needs of current and potential users of the information system and described with a feature of the system develop as clearly and concisely as possible in order to avoid misinterpretation. The same analysis was performed based on individual formats based on scenarios.

### C. Requirements as Expression of Use Cases

After analyzing the requirements are documented as case proceeded to use the software in a format that considers: Use case name, Actors, entry conditions, processes, output and flow conditions alternate.
In summary use cases to observe a general view seen below:

#### 1) Use Cases user management subsystem

System users are four types: Entrepreneur, Expert in the area Technology Watch, Coordinator of Surveillance Technology and System Administrator, who are defined by these profiles and user roles.

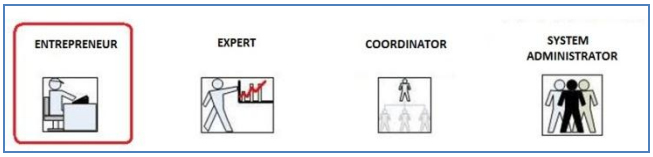


Figure 2. System Users and Roles

- **Manage user roles:** user Create Role, Change user role, user role See, Delete user role.
- **Manage Users:** Create User, Edit User, Delete User, Browse User.

#### 2) Use cases document management subsystem

Manage processes with scientific papers (Scientometrics, Bibliometrics for scientific databases), manage patent documents processes (search for information on patent

databases), document management tools for technological maps (Road-Map).

*3) Subsystem use case management indicators*

Manage types of indicators Qualitative indicators, manage domain of qualitative, quantitative, quantitative indicators to manage scale, manage categories of indicators, indicators on human resources management, management training indicators, management indicators employment, manage Research and Innovation indicators, manage patent indicators, management indicators on R & D, Innovation indicators managing companies, managing technological indicators, output indicators, indicators, production processes, process indicators, service level indicators, process innovation, innovation indicators for customer relations, indicators of organizational innovation, global innovation indicators, indicators on new concepts, new product management indicators, management indicators redefinition of production processes, manage indicators redefining marketing processes indicators to business model innovation, manage economic and financial indicators.

*4) Measurement subsystem use case gap*

Determine or manage technological gap, seek information are automatically respective subsystems, creating technological surveillance study, upload information manually, assign responsible for the study, surveillance study technological change, seeking technological surveillance study, see technological surveillance study to determine gap, generate technological surveillance study report, graphical reporting on technological surveillance study.

*5) Subsystem information on "MiPymes"*

Managing Information "MiPymes", create, modify, consult codes, refer to by name, delete data "MiPymes" manage economic activity, manage supply chains, manage location, manage link in the chain.

*6) Chaos overview of the system use*

According the above analysis and after performing a process of cohesion, Technology Surveillance System consists of the following subsystems: management "MiPymes" User Management Subsystem (the main plot is omitted) management subsystem documentary Subsystem Indicators, Measurement Subsystem Technology Gap.

*D. Use Case Diagrams*

Diagrams are shown modeled General - Private (Top-Down), ie the general view showing first and then the detail.

*1) Use case diagram overview of the surveillance system technology*

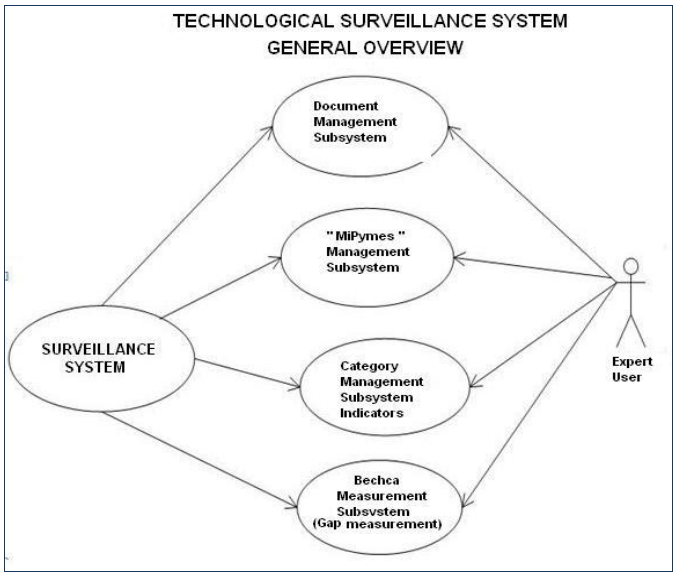


Figure 3. General Diagram view Use Case TS System

*2) General diagram view detailed system use cases overview of the surveillance system technology*

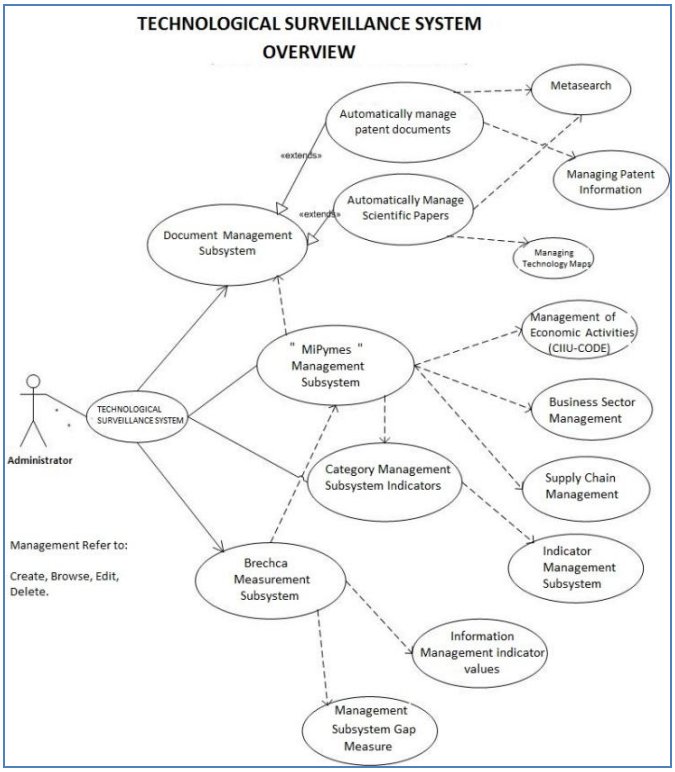


Figure 4. General diagram view detailed system use cases.

*3) Use case diagrams managing "MiPymes"*

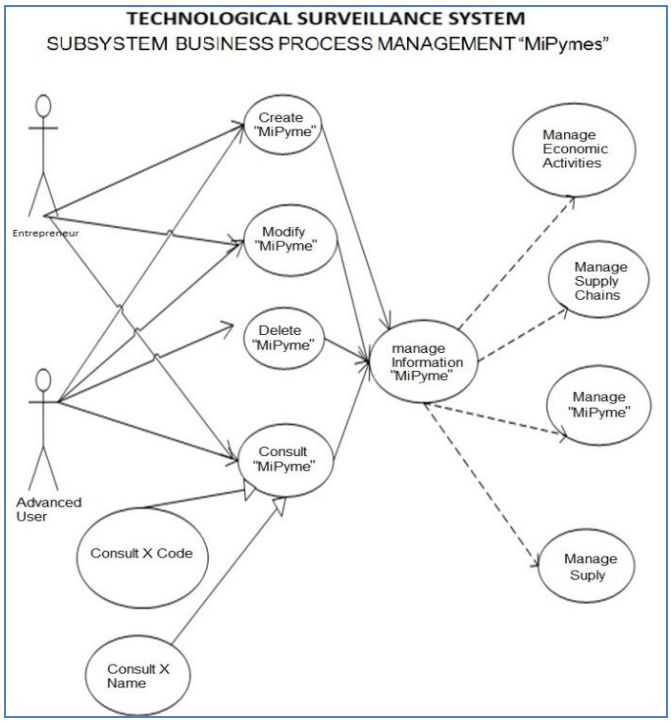


Figure 5. Use case diagrams. Managing "MiPymes"

*4) Use case diagrams Managing indicators.*

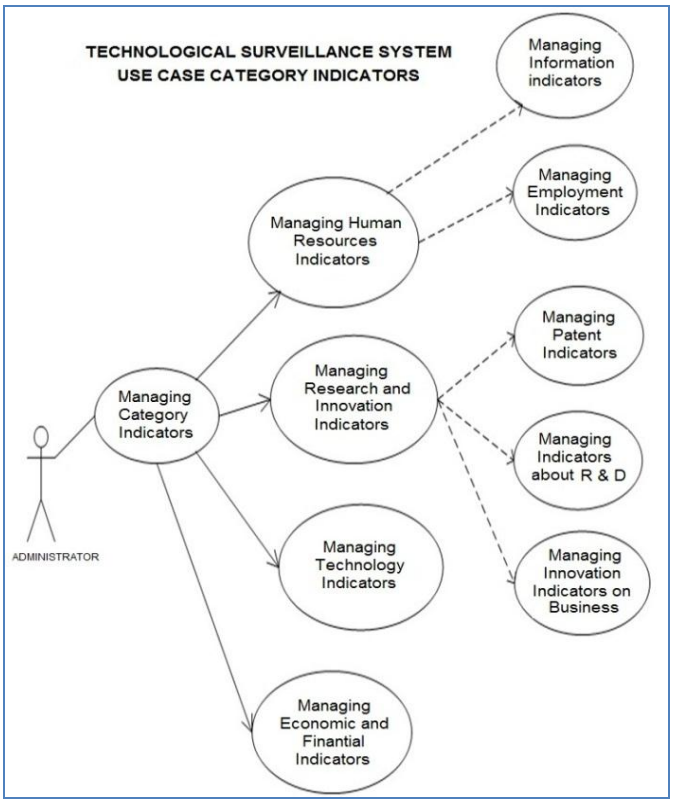


Figure 6. Use case diagrams Managing indicators.

*5) Use case diagram Measuring technology gap*

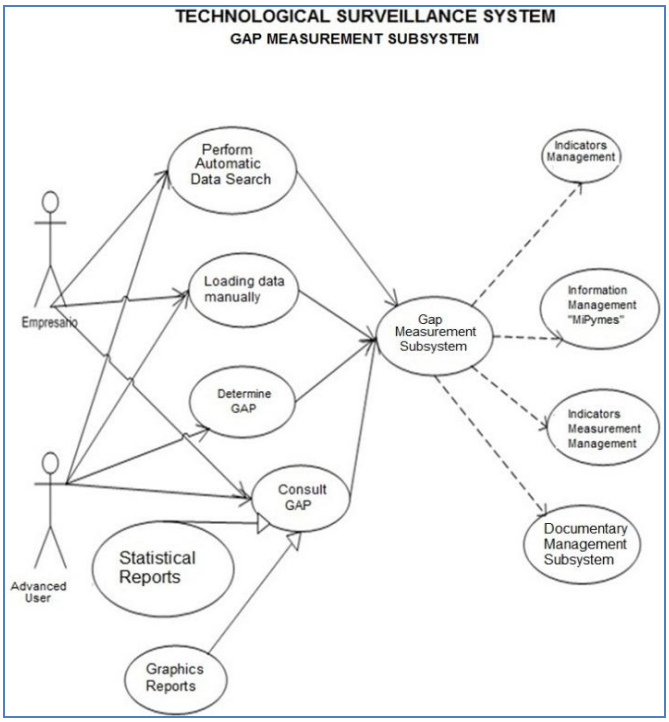


Figure 7. Use case diagrams. Measuring technology gap

*E. Class Diagram*

It shows a class diagram of the surveillance system technology by way of illustration we have chosen the related Management "MiPymes"

*1) Class Diagram Managing "MiPymes"*

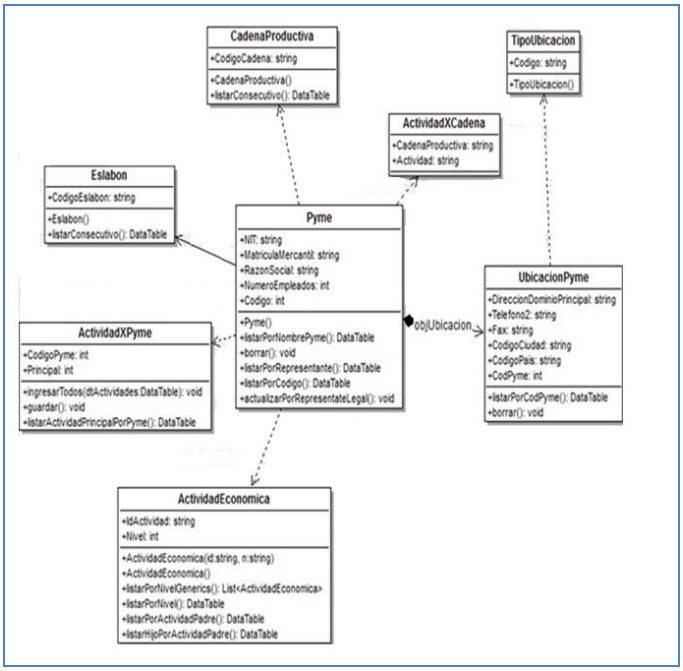


Figure 8. Class Diagram Managing "MiPymes"

*F. Packages diagram Technological Surveillance System*

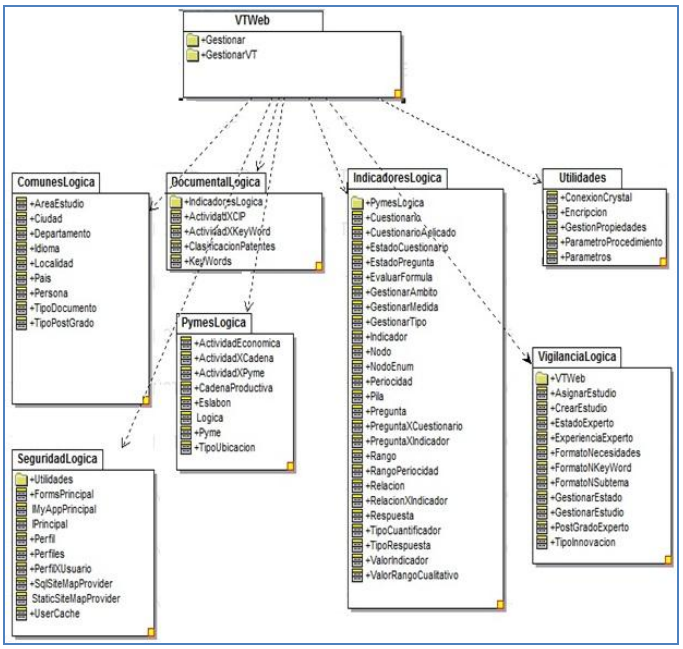


Figure 9. Packages diagram Technological Surveillance System

*G. Deployment diagram showing the components of the Technological Surveillance.*

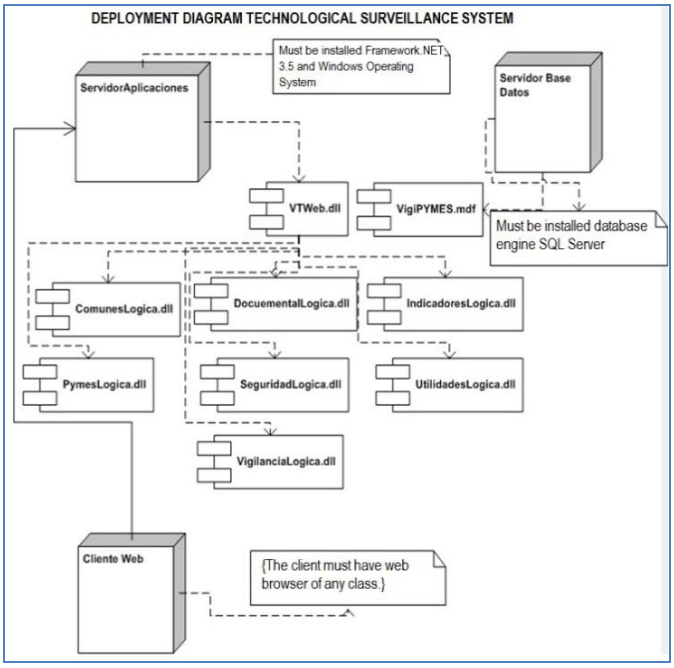


Figure 10. Deployment diagram showing the components of the TS System

## VII. System Commissioning And First Tests Results.

The system has been installed and put into service on a server of the Ministry of Economic Development, Bogotá DC, and the exercises have been conducted demonstration, of which you can see the following screen shot.

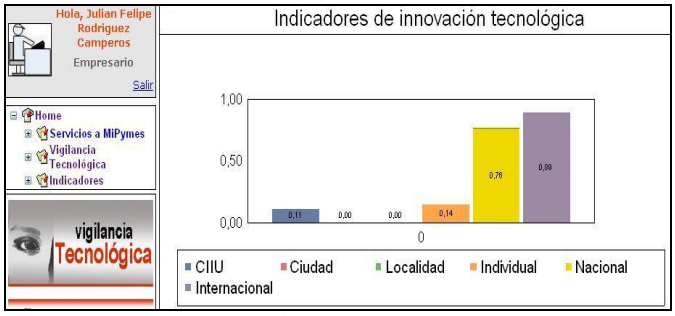


Figure 11. Report with results of Technological Innovation Indicators

Both entrepreneurs and experts and coordinator (s) Technological Surveillance System have the ability to view the indicators, special forms have been configured to make comparisons between different areas of the indicators.

The system has a configuration to store historical data and therefore generate display options indicators.

The system administrator has the option to export the historical data of the scenario indicators formats that allow the system to do data processing.

## VIII.CONCLUSIONS

These findings relate to the design process and implementation of the system and the possibilities it can have the system in national and international context. The analysis of results on measurement exercises will the gap in subsequent publications, for which to date has fifty surveys Entrepreneurs Bogotá D, C, in the Republic of Colombia.

Are known as the country's businesses, companies face a similar character in the international context, by selecting a set of indicators based on international benchmarks, to measure the technology gap, allows decisions to establish policies on the part of employers and state policies to reduce this gap and increase business competitiveness through better use of human and financial resources.

With an observation of this kind, performed computational tools based on the Colombian state and the businessmen may have some references, to propose policies to support those sectors that are in crisis, discover new areas potentially important to support and discard those who lost their validity.

This tool can be potentially useful for multiple applications, it can be configured so that it applies to any kind of company, whether of goods or services, regardless of the economic activity performed and production chains to which they belong.

This tool not only to measure technological gap, but conforms to the observation and measurement of different aspects given the ability to configure and establish hierarchies in the indicators. These indicators can be set as qualitative or quantitative case in which you can set the range and scale of possible values that can take.

There are no state policies in Colombia, regarding technological surveillance exercise or at least observation in the fields of science, technology and innovation that will

improve their production processes, which is why this tool can be a good reference upon making the process of testing and evaluation in the Ministry of Economic Development of Bogotá D, C, where there are already several surveys about to process the results will be subjected to analysis.

Technological surveillance studies in the vast majority focus on purely technological aspects that ignore methodological aspects and human resources that the system here designed is able to cover.

Micro, small and medium enterprises in most Latin American countries regardless of their economic activity, do not use or have tools for monitoring processes to different aspects of technological advances and innovation, they have to do with the improving their knowledge, processes, procedures and equipment, which is why they are at a competitive disadvantage compared to similar companies in developed countries.

This research was a first step to promote small and medium entrepreneurs in Colombia, the importance of observation on various technological aspects involved in the production processes of their companies, in order to improve competitiveness.

Have been generated as a result of this investigation a number of documents and an application that can be very useful for entrepreneurs so they can be used from their companies.

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# Social Voting Techniques: A Comparison of the Methods Used for Explicit Feedback in Recommendation Systems

Edward Rolando Nuñez-Valdez[1], Juan Manuel Cueva-Lovelle[1], Oscar Sanjuan[1], Carlos E. Montenegro-Marin[2], Guillermo Infante Hernandez[1]
[1]*Informatic Department, Oviedo University, Oviedo, Spain*
[2] *Engineering Faculty, Distrital University, Bogotá, Colombia.*

***Abstract* — Web recommendation systems usually brings a content list to users based on previous ratings made by them to other similar contents through some social voting mean. This paper aims to present a comparison of the main explicit rating methods used by web recommendation systems. The goal of this survey is to determine which of the studied methods fits better to user preferences when they rate a content on the web; based on the obtained results, a recommendation system can be implemented using an explicit feedback method to achieve this goal.**

***Keywords* — Recommendation system, explicit feedback, explicit rating, method "5 stars", method "Like".**

## I. INTRODUCTION

Due to the large amount of information available on the Internet, sometimes it is difficult for users to find the content that they really need in a quick and easy way. The user tends to: seek for recommendations from others who have previously had the same needs; or select those items that are closest to what they were looking for [1].

The use of recommender system as an information retrieval technique attempts to solve the problem of data overload. They filter the information available on the web and help users to find more interesting and valuable information [2-4].

For recommendation systems to be more effective we believe that is necessary to determine which method is more suitable for the feedback process. The most common solutions and wider spread methods are those based on explicit ratings, which two main methods are "5 stars" and "Like". In this sense our goal is to determine which method is preferred by the users.

In this paper is presented a comparative study between two methods of explicit feedback process: "5 stars" and "Like". The paper is structured as follows: in section 2 we explain the feedback techniques, section 3 describes the problems into explicit feedback, section 4 shows our case study and prototype, section 5 presents the analysis of the obtained results, and finally in section 6 we explain our conclusions.

## II. RECOMMENDATIONS SYSTEMS

The use of recommendations system as an information retrieval technique attempts to solve the problem of data overload. They filter the information available on the web and help users to find more interesting and valuable information [2-4].

In general, a recommendation system is defined by [5] as *"A system that has as its main task, choosing certain objects that meet the requirements of users, where each of these objects are stored in a computer system and characterized by a set of attributes."*

Recommendation systems consist of a series of mechanisms and techniques applied to information retrieval with the purpose to solve the problem of data overload on the Internet. These help users to choose the objects that can be useful and interesting for them, these objects can be any type, such as books, movies, songs, websites, blogs [6].

Recommendation systems are based on personalized information filtering, used to predict whether a particular user likes a particular item (prediction problem), or identify a set of N items that may be of interest to certain users (top-N recommendation problem) [7].

### *A. Feedback techniques*

The information feedback is a fundamental process of the recommendation systems, and the reason is that it provides the information these systems need to make recommendations to the users. In this sense the feedback techniques are classified into two types: Implicit and Explicit feedback [7-9], being the last one the most used in the recommendation systems in force, this is caused because is the user himself whoever value the importance of interest objects.

#### *Implicit feedback*

This process consists on evaluate the objects without users interventions. This evaluation is performed without the user being aware, capturing the information obtained from the actions made by the users in the application. For example,


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when the user accesses to news or read an article online, according to the time it takes for reading, the system could automatically infer whether the content is on its interest.

Implicit feedback techniques have been used to retrieve, filter and recommend a variety of items: movies, journal articles, Web documents, online news articles, books, television programs, and others. These techniques take advantage of user behavior to understand user interests and preferences [10].

Types of implicit feedback include web purchase history, browsing history, search patterns, or even mouse movements. For example, an user that purchased many books by the same author probably likes that author [11].

*Explicit feedback*

Through a survey process, the user evaluates the system by assigning a score to an individual object or a set of objects. Explicit feedback provides users with a mechanism to unequivocally express their interests in objects [12]. Figure 1**¡Error! No se encuentra el origen de la referencia.** shows the most common explicit feedback system used by users on the web to express their interest by objects.

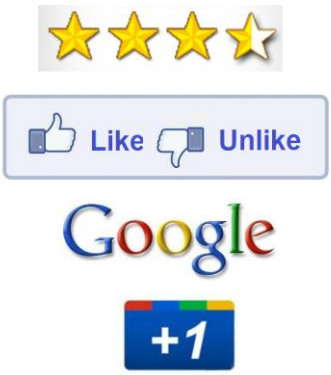


Figure 1: Most common explicit feedback systems.

For example, Amazon online store, Film affinity, Movies and other, use the "5 stars" ratings system that allows users to indicate which products are of their interest.

On the other hand, social networks as Facebook, YouTube and others use the "Like" rating system to allow the users to rate the contents.

Finally, Google+1 is a new feature that Google added to its search engine so users can evaluate explicitly the websites they like. So, they recommend websites to their contacts.

Although there are different ways of explicit rating, the most used in the majority of applications are:

*Explicit rating "5 stars*"

As shown in Figure 2, through the explicit rating "5 stars", the users gives each content a value between 1 and 5 stars. These values are defined as follows:

- One star: The content is not interesting.
- Two stars: The content is a bit interesting.
- Three stars: The content is interesting.
- Four stars: The content is very interesting.
- Five stars: The content is essential.

Figure 2: Explicit rating "5 stars"

*Explicit rating "Like"*

As shown in figure 3, through the explicit rating "Like", the users gives a positive or negative rating to contents. If this method of rating is compared with the "5 stars" method it could be said, that it uniquely assign values of 1 or 5 stars.

When the user push the button "Like", it means that user likes the content, but if the users push the button "Unlike" it means that content does not like to user. The Figure 3 shows the buttons used in this type of rating.


Figure 3: Explicit rating "Like"

## III. PROBLEMS OF THE EXPLICIT FEEDBACK

In the recommendation systems the most effective way to know the users interest to determine objects is across of the explicit rating, due to the user express its liking for an object. But normally the users do not like to rate the objects, mainly because they are not interested or will not receive any benefit in return. In this sense the main problem of the explicit rating is the low interest from users to rate the content.

Other of the problems of the explicit rating as according to Claypool [13], is the alteration in the reading sequence and the normal navigation of the users, because they must stop the interaction with the system to rate the objects.

In order to find a solution to these problems, this work presents a study that determines an approximation to a better way of rating the objects explicitly.

## IV. CASE OF STUDY AND PROTOTYPE

The goal of this section of the study is to measure the most comfortable and easy way the users use to rate a content explicitly in order to determine which of the two methods of rating is more effective and most used by users.

With the results obtained from the analysis of this data, we can know which is the most effective way to collect information of explicit feedback in a user interface.

To achieve an approach to the solution of the explicit feedback, we developed an application based on ***eInkPlusPlus*** project; it contains a series of photo books sorted by categories. Each category and photo book is composed by the same amount of objects. Specifically, each category contains 10 photo books and each photo book contains 10 pictures, this is so that each object has the same assessment probability. We choose photo books because we think that the interaction with them is more comfortable, fast and efficient than the complete e-books reading. This enables the users to navigate through several photo books in the shortest time possible, allowing us to extend the tests to a greater number of users. The application is designed like a library books that consists in:

- Categories: Categories represent the classifications of books (e.g., comics, computer and internet, novels, biographies, science, etc.).
- Photo books: Each photo book represents a reading object (e.g., a book, a magazine, a scientific paper, etc.). From now on we will call it "content".
- Photos: Each photo is a page of a content, which users can view and interact with it, allowing the user to go forward or back one page to another. From now on we will call it "items".

The users that interacts with the application can browse the different categories, contents and items. Each user can view individual items of the contents, comment the contents, send these to his friends and explicitly assess them, indicating which are of his interest.

On the other hand, transparently to users, we recorded the user's interaction with each object (category, content and item) of the application, to capture the implicit parameters and determine the number of times a user visits a category, content or item, the time taken per session reading it, etc.

This application has been distributed to 58 users with different skill levels, different ages, without prior knowledge of the contents and selected at random, which provided the data necessary to carry out the study said.

Later we will describe how the data were obtained and the relations established between them. Subsequently, an analysis of the same and will present final conclusions.

### *A. Graphic User Interface*

The Graphical User Interface is a ubiquitous web application developed in ***RubyOnRails*** and can be run on any device with a Web browser (e.g., Mozilla Firefox, Microsoft Internet Explorer, Google Chrome, etc.). In this Web application we can register as a user, create contents, add items to the contents, comment the contents, browse the different options of the application, etc.

As Figure 4 shows, when a registered user is logged in the application shows the homepage with different categories, through which the user can navigate and access different content.

Each category shows the contents that belong to it, including the content cover image, title and author of contents. Clicking on the title or on the cover the users access the selected content.

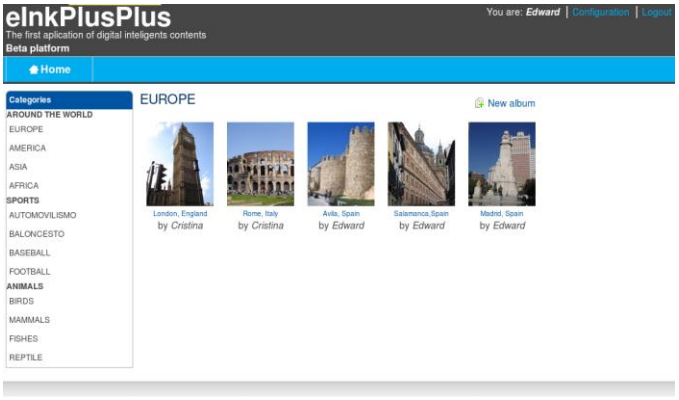


Figure 4: Graphical User Interface.

### *B. Catching explicit parameters*

To perform the analysis and comparison between “5 Stars” and “Like” System, we need some way to know the real value of the user regarding to the content (explicit evaluation). When the user is registered in the recommendation system, it has the option to rate the different contents in an explicit way. This way, the user can give a rating between 1 or 5 stars to content or push the button "Like" or "Unlike". Each user can rate the content only using one of the given ways. In other words, rate cannot be assigned to the same content (by same user) with the method “5 stars" and the method "Like" at the same time. The Figure 5 shows the graphic interface that implements the before condition.

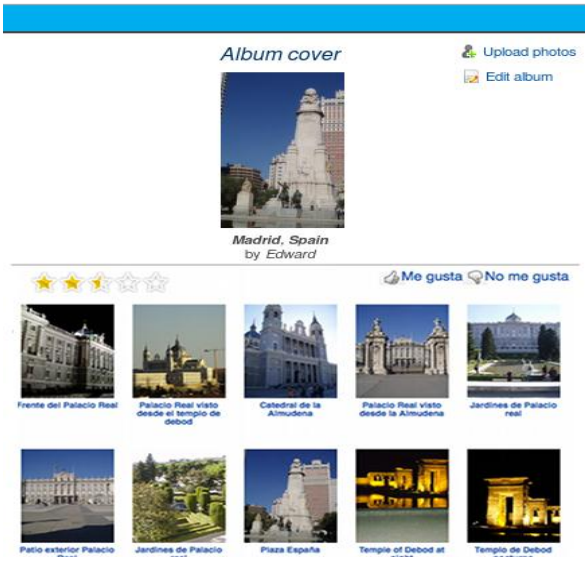


Figure 5: Presentation of the photo album for explicit rating.

## V. ANALYSIS OF DATA

In this section the results of the experiment are shown in a

series of charts, these will represent which are the most used feedback techniques by the users at the moment of rating an object.

*A. Comparison between explicit rating methods "5 stars" and "Like".*

The first scenario to study is the amount of users that have used some of the two rating methods, the figure 6 shows the percentage of the contents that have been rated by some of two methods ("5 stars" or "Like") and the method more used is "5 stars".

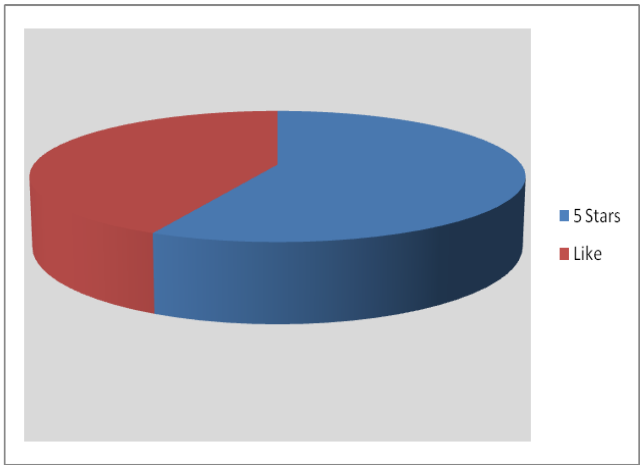


Figure 6: Method "5 stars" V.S. method "Like"

*B. Method "5 stars" classified by assigned punctuation.*

The next scenario shows the information from the users that used the rating method "5 stars". In this method the user have to rate the contents with values between 1 to 5, where 1 means that does not like it and 5 that likes it a lot. The figure 7 shows the results of the users performance in the process of assignment value to contents.

The Figure 7 also indicates that the vast majority of the contents were liked by users, in this sense the 3% of the users did not like the contents. The 83% of the users has assigned a rate between 4 and 5 stars; it means that they likes the content. The 48% of the rates is 5 stars, this indicates that the user likes the content, it trend is to assign a rate with 5 stars.

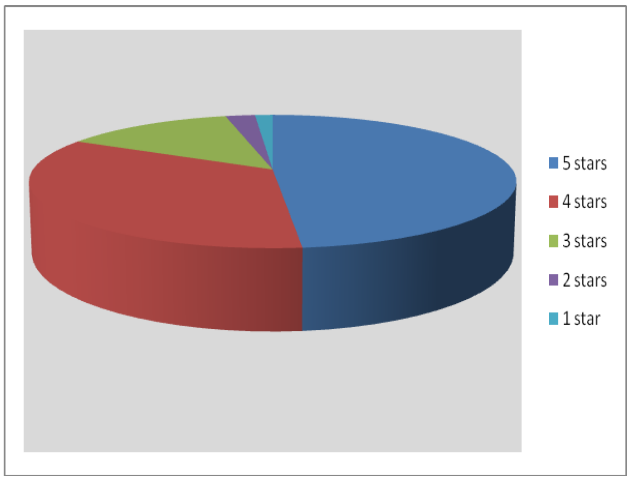


Figure 7: Method "5 stars" classified by punctuation.

*C. Method "Like" classified by assigned punctuation.*

The next scenario shows the information from the users that used the rating method "Like". In this method the user have rated the contents with two unique cases "Like" or "Unlike", The figure 8 shows the results of the users performance in the process of assignment value to contents.

This is a similar case to the method "5 stars", the vast majority of contents have liked to users, in this sense the 17% of the users considered that does not like the contents and the 83% of the users has assigned "Like" to the contents. Precisely this value matches with the percentage of the contents that users been assigned a rate between 4 and 5 stars, in others words users likes it. .

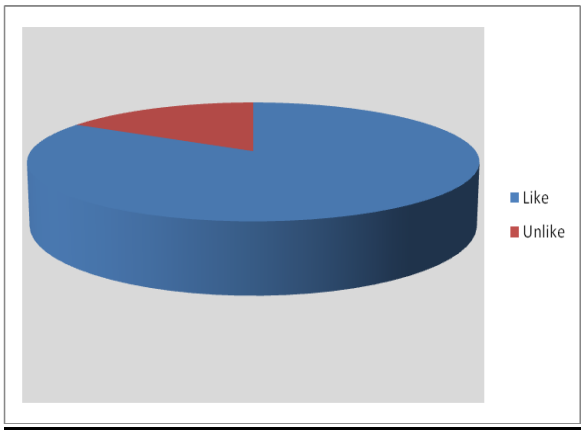


Figure 8: Method "Like" classified by assigned punctuation.

*D. Method of rating with "5 stars" and "Like" classified by gender*

Figure 9 shows the amount of ratings by gender, as shown, the number of men that has used the method "5 stars" is slightly major than women. But in the method "Like" differences are more significant, the number of men than has used this method is three times greater than the number of women, the men preferred to use the method "Like" with a small-gap on women and the women preferred to use the method "5 stars" with a difference of three times more over the method "Like".

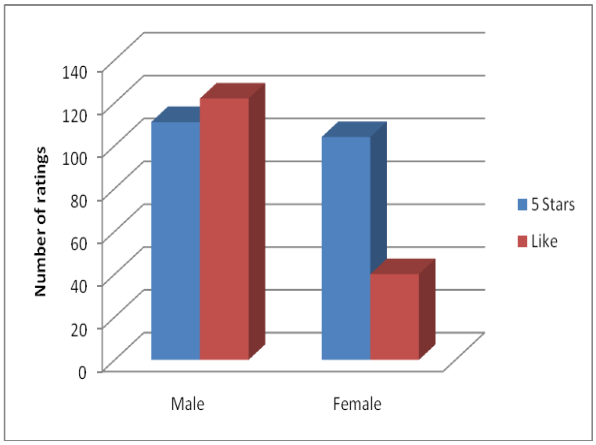


Figure 9: Method of rating with "5 stars" and "Like" classified by gender.

### *E. Method of rating with "5 stars" classified by gender.*

Figure 10 shows the amount of ratings by gender with the method "5 stars", as shown, women prefer to assign a rate of 5 stars when they like the content. In this method, the number of ratings of women is twice bigger than men. The men prefer to assign a rate of 4 stars when they like the content.

In conclusion, when the women registered in the system likes the content , they assign the maximum rating, but generally the men in this case assign a rating of 4 stars.

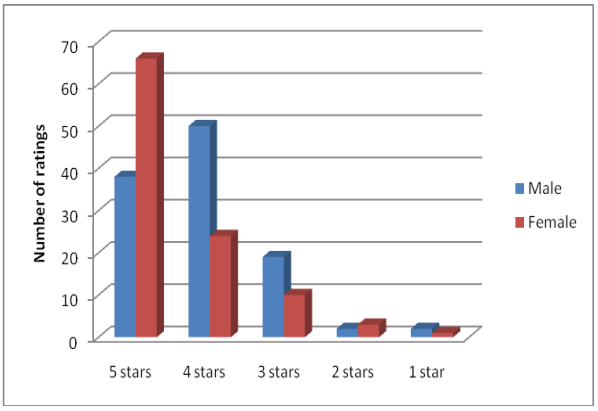


Figure 10: Method of rating with "5 stars" classified by gender.

### *F. Method of rating with "Like" classified by gender*

Figure 11 illustrate the amount of ratings by gender rated with the "Like" and "Unlike" methods. As shown, "Like" method is more used by men that women.

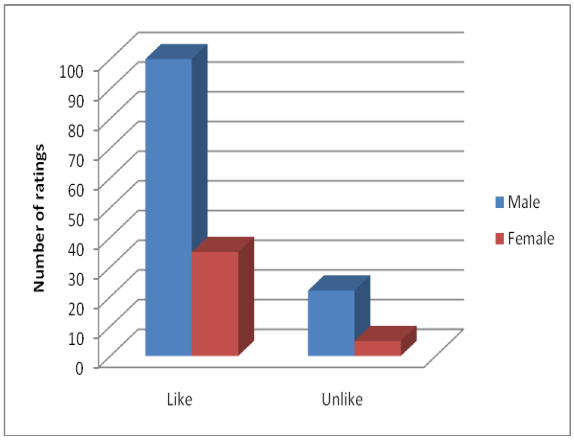


Figure 11: "Like" rating method classified by gender.

### *G. Method of rating with "5 stars" classified by category*

Figure 12 shows the amount of ratings by category with the method "5 stars", as shown, in all categories, the distribution is similar, the most used is "5 stars", then follows "4 stars" and so on until "1 star".

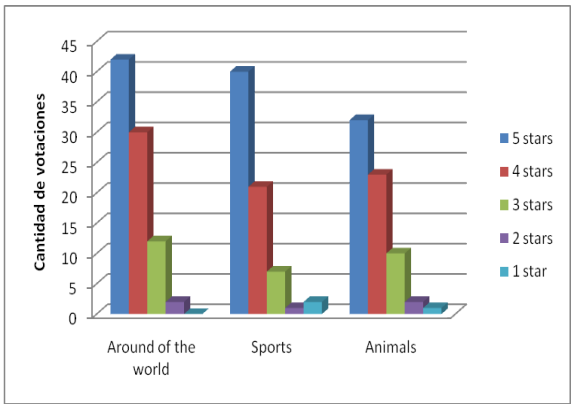


Figure 12: Method of rating with "5 stars" classified by category.

### *H. Method of rating with "Like" classified by category*

Figure 13 indicates the amount of ratings by category with the method "Like", the users used this method for qualify contents positively, in others words, when user likes the content, it assign a positive qualification, this is also shown in figure 8.

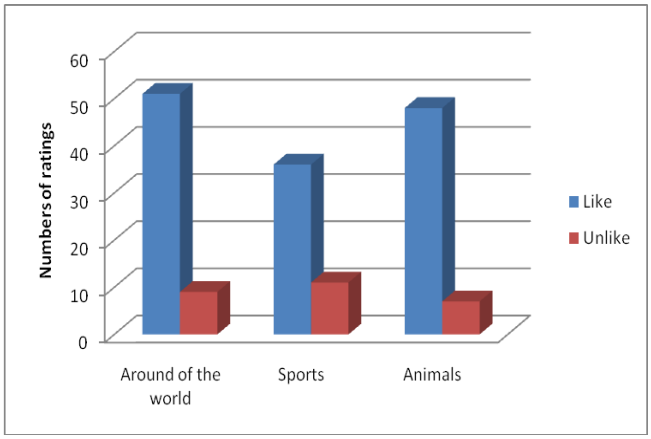


Figure 13: Method of rating with "Like" classified by category.

## VI. Conclusions

According to users ratings in the recommendation system, they preferred to use the method "5 stars" with 57% of the total, respect to method "Like" that represents the 43% of the total, however this is not a significant difference to assert that method "5 stars" is more used by the users.

The 83% of the contents, have been positively rated with the two methods, this means that the users liked the contents.

The 48% of the contents, have been rated with 5 stars, this means that almost the half of the contents of the recommendation system are very much liked by users or that their rates are usually 5 stars when they likes the content.

Each user in the recommendation system assigned a rating with average 1.84 times with the method "5 stars" and 1.83 times with the method "Like".

The male users have used more the method "Like" than the method "5 stars", on the contrary, the female users have used more the method "5 stars" than the method "Like". This means that the men do like the method "Like" and the women do like the method "5 stars".

In the recommendation system when a men use the method "5 stars" he prefer to assign a qualification of 4 stars to the contents they like while women prefer to assign a qualification of 5 stars. The method "Like" is more used by the men than women, in total men have qualified 122 contents and the women 40 contents through the method "Like".

Despite the similarity of the evaluation results retrieved from both methods, we believe that the "like" method could be more accurate than the five star method which tends to be like the first. The gathered data shows that the user that likes a content assigns the maximum score, in this case (between 4 and 5 star) and if do not like it then assigns the lowest score (1 star), which is equivalent to "Like" or "Un like".

Finally, the single button mechanism, in this case the "Like" button would be a good alternative since users do not rate the content if they do not like it.

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# Clasification Of Arrhythmic ECG Data Using Machine Learning Techniques

Abhinav Vishwa, Mohit K. Lal, Sharad Dixit, Dr. Pritish Vardwaj
[1]*Indian Institute of Information Technology, Allahabad*
*India*

***Abstract* — In this paper we proposed a automated Artificial Neural Network (ANN) based classification system for cardiac arrhythmia using multi-channel ECG recordings. In this study, we are mainly interested in producing high confident arrhythmia classification results to be applicable in diagnostic decision support systems. Neural network model with back propagation algorithm is used to classify arrhythmia cases into normal and abnormal classes. Networks models are trained and tested for MIT-BIH arrhythmia. The different structures of ANN have been trained by mixture of arrhythmic and non arrhythmic data patient. The classification performance is evaluated using measures; sensitivity, specificity, classification accuracy, mean squared error (MSE), receiver operating characteristics (ROC) and area under curve (AUC).**

**Our experimental results gives 96.77% accuracy on MIT-BIH database and 96.21% on database prepared by including NSR database also.**

***Keywords* — ECG arrhythmia, Sensitivity, specificity, accuracy, Arrhythmia classification, artificial neural networks.**

## I. INTRODUCTION

One of the ways to diagnose heart diseases is to use Electrocardiogram (ECG) signals. ECG signals are formed of P wave, QRS complex, and T wave. They are designated by capital letters P, Q. R, S, and T. In the normal beat phase of a heart, the main parameters, inspected include the shape, the duration, and the relationship with each other of P wave, QRS complex, and T wave components and R-R interval. The changes in these parameters indicate an illness of the heart that may occur by any reason. All of the irregular beat phases are generally called arrhythmia and some arrhythmias are very dangerous for patient. Some automatic ECG interpreting systems is available. Moreover, the computer-based interpreter systems are currently being developed to diagnose arrhythmia in time, and various methods are applied to these systems with one of them being Artificial Neural Networks (ANN) [1].

In this study, using architecture of multilayered neural network, we performed ECG waveform detection.

## II. RELATED RESEARCH WORK

Several methods for automated arrhythmia detection have been developed in the past few decades to attempt simplify the monitoring task [4][5]. These include Wavelet transformation, RBF Neural Networks, self-organizing map [14] and fuzzy c-means clustering techniques. Multilayer neural networks have also been used to classify arrhythmia QRS complexes, and for ischaemia detection. Dayong et.al. developed an arrhythmia detection system with ECG signals based on a Bayesian ANN Classifier and its performance is compared with that of other classifiers, specifically Naive Bayes, Decision Trees, Logistic Regression and RBF Networks. A review of classification methods suitable for ECG signals can be found in [6][7].

## III. METHODOLOGY

In this study, the back-propagation learning algorithm is used since it is the most popular supervised learning algorithm[1] .

### *A. Data preprocessing*

In this research, we use MIT-BIH arrhythmia database from physionet [2]. This database contains 48 recordings from 47 subjects studied by the BIH Arrhythmia Laboratory between 1975 and 1979. Each record contains two 30-min ECG lead signal, mostly MLII lead and lead V1/V2/V4/V5. The frequency of the ECG data was 360Hz. For this research, we only use 2 channels as our source data. The first step of ECG data preprocessing is baseline noise reduction.

Original ECG contains irregular distance between peaks, irregular peak form, presence of low-frequency component in ECG due to patient breathing etc. To solve the task the processing pipeline should contain particular stages to reduce influence of those factors.

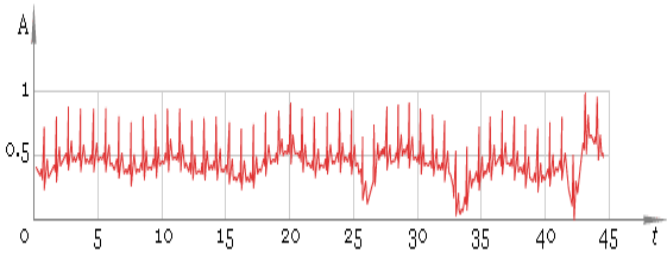


Figure 1: Raw ECG data

(This Figure contains raw ECG data, which is unfiltered and contains noise which is required to be removed before further operations)


DOI: 10.9781/ijimai.2011.1411

We removed low-frequency component. we applied direct Fast Fourier Transformation remove low frequencies and restore ECG with the help of inverse FFT.

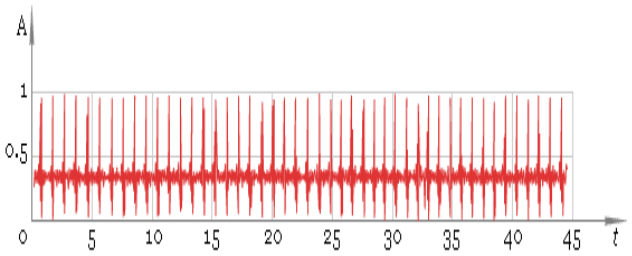


Figure 2. FFT filtered ECG.

(Data which was obtained after applying fast fourier transform, which removes low frequencies components of data, then low frequency components were removed and inverse FFT was applied to get back straightened ECG data)

After baseline noise reduction, segmentation of ECG beat was done. In this step, the continuous ECG signals were transformed into individual ECG beats. The width of individual beat was approximated to 300 sample data and the extracted beat is centered around R peak [3][13]. For this purpose we utilize the annotation provided by the database to do the transformation. We use the R peak annotation as the pivot point for each beat. For each R-peak, we cutoff the continuous signal for each beat start at R-150 pos until R+149 pos, therefore we will get a beat with 300 sample data in width.

### *B. Feature Extraction*

To handle the Multi channel data, summation of data from both channels was done to prepare an input vector as the input to Artificial Neural Network. Thus, in effect reducing the **chances** of False Positive cases, when exertion may create a abnormal ECG signal in a particular channel [7]. Thus, adding data from both channels minimizes the chances of incorrect identification of Arrhythmia.

In this paper one ECG beat corresponds to one sample of 300 inputs, which covers the whole ECG beat. The inputs for the networks were selected considering two important points [13]:

a) The inputs must be of a standard size such that it is neither too small to cover up one ECG cycle and nor two high to increase the number of beats required to analyse the signal, thus increasing the hardware requirements.
b) The input must be so arranged that the R peak in the QRS complex must be at the centre of the signal cycle under considerations.

The first condition was achieved by setting up an arbitrary value of 300 samples of MLII lead data obtained from the database in which the 150 samples were on the left side and 149 samples on the right side of the 151st sample value, which in turn is the detected R peak.

Now, Similar was done for other lead, and generated samples were added to create an input of 300 samples.

Thus the input becomes a matrix of 300x<no of samples> and ready to be used in MATLAB. The same process was repeated to make all the inputs of all the kinds of beats that are normal, fusion and ventricular premature.

The second condition was achieved by allowing the 150st sample to be the best value of both channels obtained from the database for particular conditions. E.g. If a number (2250-150=) 2100 to sample number (2251+150=) 2400 will be the input data.

### *C. Traning And Testing*

A part of researches in this work is devoted to consideration of different neural networks in order to determine their accuracy in identification and separation of categories or classes.

Among all neural networks Feed Forward back propagation has been chosen based on the below mentioned reasons,

1. It has 2 hidden layers including input layer and output layer shown in fig 3.
2. As result of this fact that the numbers of existed neurons in hidden layer is an effective parameter for improvement of learning results, neuron numbers was chosen in order to achieve the optimum number based on output results. So 1 hidden layer has 3 neurons and 5 neurons in second layer.
3. Tansig and Purelin function and also their combination function have been compared as transfer function of network neurons and finally, the effective one has been chosen [13].
4. For training utilized of BP algorithm and traingd function.
5. Lr parameter 1 has been chosen.
6. For teaching of mentioned neural network, mean squared error (MSE) or goal parameter criterion was utilized in which error of 0.0001 was the stopping point of teaching and maximum repetitions was 1000 times[8].

#### *1)Training of ANN*

Structures of ANN were trained using abnormal and normal patients. If the value of node output of output layer was logic-1, we interpreted this as arrhythmia. If the value was logic-0, this was considered as normal. If $y(i) \geq 0.5$, we accept as logic-1 and we used $h(i)=|1-y(i)|$ in the error calculation. If $y(i)<0.5$, it was considered as logic-0 and we used $h(i) = | 0-y(i)|$. Trained ANN architectures is given in Fig 3.

Normal sinus arrhythmia and abnormal were mixed in sequence. The length of the training pattern was 21200 samples (106 sets). The test pattern was done similarly. Both patterns, used in training of ANN, and used in testing trained ANN were occurred from MIT-BIH ECG database and normal sinus rhythm database obtained from MIT-BIT NSRDB database Learning rate (ε) was 0.01 and momentum coefficient

(α) was 0.2. Whereas training error was found 0.1% after 1000 iteration, test error became 3.79%.

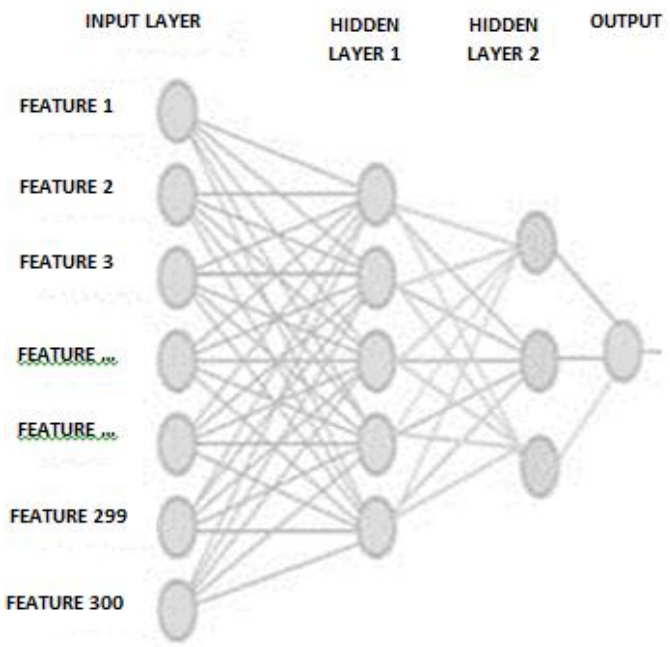


Figure 3 Architecture of the Artificial Neural Network
(Visual representation of 300:5:3:1 neural network architecture)

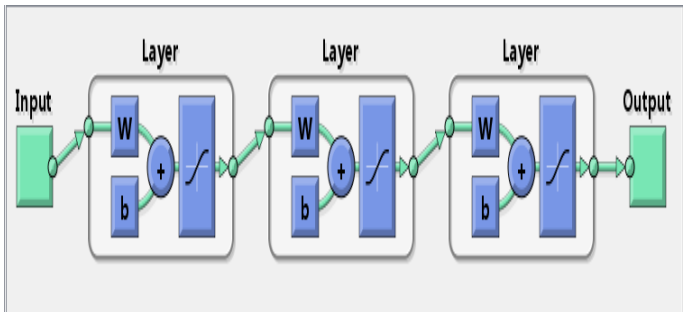


Figure 4 Model of Neural Network using NNtool Box Matlab

*2) Testing*

For testing purpose we use mixture of MIT –BIT Arrhythmia, QT database and NSR database.

They are randomly mixed. On simulating the resultant network with the test dataset, the results are summarized in Table 1. A detection accuracy of 96.21% was obtained.

## IV. Experiments And Results

### A. *Performance Measures*

We have evaluated the performance of the classification algorithms using six measures; sensitivity, specificity, classification accuracy, mean squared error (MSE), receiver operating characteristics (ROC)[9,10]and Youden Index. These measures are defined using True Positive (TP), True Negative (TN), False Positive (FP) and False Negative (FN). TP decision occurs when an arrhythmia detection of the classifier coincided with a decision of the physician. TN decision occurs when both the classifier and the physician suggested the absence of arrhythmia. FP occurs when the system labels a healthy case as an arrhythmia one. Finally, FN occurs when the system labels an arrhythmia case as healthy. Fig. 5 and Fig. 6.

1) *Classification Accuracy*: Classification accuracy is defined as the ratio of the number of correctly classified cases and is equal to the sum of TP and TN divided by the total number of cases N.
Accuracy = (TP + TN)/N [4]

2) *Classification Sensitivity*: Sensitivity refers to the rate of correctly classified positive and is equal to TP divided by the sum of TP and FN. Sensitivity may be referred as a True Positive Rate.
Sensitivity = TP/(TP + FN) [5]

3) *Classification Specificity*: Specificity refers to the rate of correctly classified negative and is equal to the ratio of TN to the sum of TN and FP. False Positive Rate equals (100 − Specificity).
Specificity = TN/(FP + TN) [6]

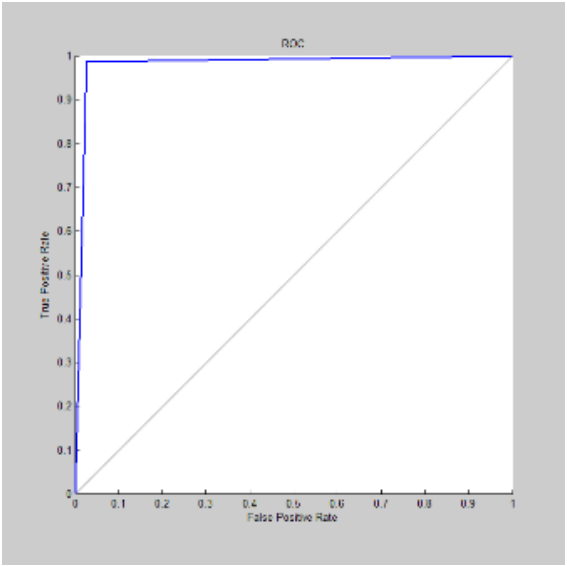


Figure 5 ROC Plot after Training stage ( MIT- BIH data)
(Reverse operating characteristic plot which is graphical relationship diagram between true positive rate vs. False positive rate, showing results of training phase)

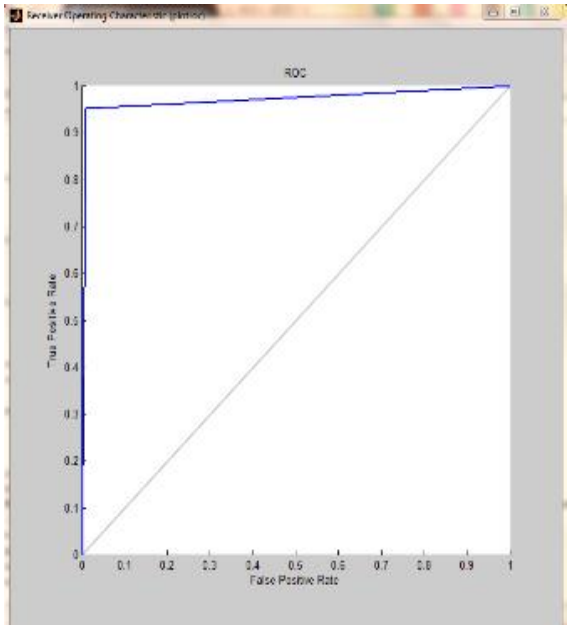


Figure 6. ROC plot Mixed -data
(Reverse operating characteristic plot which is graphical relationship diagram between true positive rate vs. False positive rate, showing results of training phase)

*TABLE I -- RESULT OF VARIOUS DATABASES*

| Cardiac signal Database | Data set Testing | Correctly Classified | Sets Mis-qualified | % Accuracy | Youden index |
|---|---|---|---|---|---|
| MIT-BIH | 248 | 240 | 8 | 96.77 | 0.9415 |
| NSRDB | 27 | 27 | 0 | 100 | 1 |
| Mixed | 264 | 255 | 10 | 96.21 | 0.9277 |

*TABLE II – COMPARISON FROM PREVIOUS RESEARCH WORK*

| **Our Accuracy** | Accuracy from [4] | Accuracy from [8] | Accuracy from [14] | Accuracy from [15] |
|---|---|---|---|---|
| **96.21** | 92.5 | 95.7 | 90.56 | 95.00 |

## V. CONCLUSION AND FUTURE SCOPE

This paper proposes an effective automated ANN based system for multi class Cardiac Arrhythmia classification from ECG signal data. Every ANN has been tested and compared with the most common traditional ECG analyzers on appropriate databases. Thus, based on the results, the ANN's approach is shown to be capable of dealing with the ambiguous nature of the ECG signal.

The crucial role of data pre-processing and post processing comes out, either for reducing the input space dimension or for more appropriately describing the input features. It is clear that the estimated feed forward ANN with error back propagation algorithm operate as an excellent classifier for given cardiac arrhythmia data set. Therefore our future scope will be further fine tuning design of MLP and pre-processing of ECG signal data so that classification results for other classes will be improved and design of MLP model to classify all 16 arrhythmia classes in one MLP design only. We hope that this system can be further developed and fine-tuned for practical application.

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# Accurate location estimation of moving object In Wireless Sensor network

Vijay Bhaskar Semwal , Vinay Bhaskar Semwal , Meenakshi Sati and Dr.Shirshu Verma,
*Indian Institute Of Information Technology,Allahabad,India*

***Abstract* — One of the central issues in wirless sensor networks is track the location, of moving object which have overhead of saving data, an accurate estimation of the target location of object with energy constraint .We do not have any mechanism which control and maintain data .The wireless communication bandwidth is also very limited. Some field which is using this technique are flood and typhoon detection, forest fire detection, temperature and humidity and ones we have these information use these information back to a central air conditioning and ventilation.**

**In this research paper, we propose protocol based on the prediction and adaptive based algorithm which is using less sensor node reduced by an accurate estimation of the target location. We had shown that our tracking method performs well in terms of energy saving regardless of mobility pattern of the mobile target. We extends the life time of network with less sensor node. Once a new object is detected, a mobile agent will be initiated to track the roaming path of the object.**

***Keyword s— Localization and Prediction, Piggybacking, Voronoi Graph, WSN (Wireless Sensor Network).***

## VIII. INTRODUCTION

It is always difficult to track a exact position of moving object by sensor network. In this I used protocol to find the exact position based on data aggregation algorithm and voronoi graph[13] .Each Wireless Sensor node has ability of collecting information, processing then, and storing information, and communicating with its nearest nodes. Take more sensor node in group is used to collect information is waste of resource and we have energy constraint always once we deploy sensor in hostile environment .We can use this technique for detection of many disaster and by collecting information

we can take decision accordingly. If object is moving it is always costly to collect or maintain data. In order to maintain data on particular node it might possible node can fail in this case we can lose data.

The sensors are used to collect information about mobile target position and to monitor their behavior pattern in sensor field. Intruder surveillance in military regions. Wild animal habit monitoring is emerging as applications of moving targets are. We have following problem to track the moving object. It is a challenging task with below mention points-target detection, localization, data gathering, and prediction. If we consider the above problem in localization we have main problem when we have to focus on only some object and we are using whole network and suppose condition can arise we need to monitor object to long so sensor will always have to wake up to detect a mobile target. It is one of the wastes of costly resource. As energy is main requirement of sensor once it is deployed in field it is not possible to us change batter, therefore each sensor must minimize its battery power usage for desired longevity of network operation, which can be accomplished by properly managing sensor's operation.

We have many protocols to monitor moving target [11, 12].Some prediction based protocol [8] we cannot perform well once prediction wrong. This is based on liner target trajectory. The focus of this paper is to develop a solution which can efficient track the path with minimize the participating nodes; we use protocol which are based on prediction of moving object in 3-dimension wireless sensor with linear estimation.

## IX. LITERATURE SURVEY

### *2.1Currently Existing Technologies*

As we all knows that wireless sensor network is either partially or fully developed and lot of research is still going .As lot of research is going for good MAC layer protocol [2].
Physical Layer – Which is basically used to transfer of data and all the physical media come under it. In this layer really data transfer happened.
Mac Layer - In this layer we send the data as the form of Frame. It controls the frame and guarantee time slot .So it is guarantee for secure service.

### *2.2Problem definition and scope*

As we know sensor node are using battery power and they communicating with other mote .All the sensor node finally send the data to base node which finally collect on sink .The position of sensor node are unknown. Some application are-

1. Finding the position of moving entity to monitor the animal
2. To control the traffic by monitoring the speedy vehicle.
3. In Building. to find the any fracture and crack.

### *2.3Formulation of the present problem*

When the moving entity is moving and reached in area where sensing range of particular sensor is less that time we need


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some other sensor node which can take position of that particular sensor but during this many other sensor can also sense the that particular entity to overcome we send a special message which indicate no need to you take place by message passing. But we have to consider some fact like as sensor node ahs energy or sensing restriction so w need to do some trade of between both.

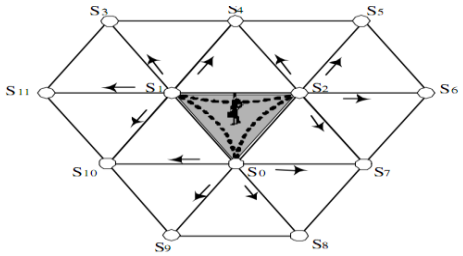


Figure 1. Multiple Sensing Objects

*The already existing protocol for location tracking are based on master slave communication in which location tracking*
By each sensor node is taking part and working together. When and entity detect in particular range of sensor it start his own SELECTION PHASE[6] process start by one sensor node to find on which simulation engine can be install to track the position. As the entity will visit on another region, the slave point will be called and assign then again responsibility. And here we will take one more point in consideration signal strength thresholds which is used for the purpose when to called and assign back again the responsibility to slave point, any slave point node who did slave job is marked by black. We are using two slave point node but for more accurate location we can use more than 2 sensor node as a slave. To reduce the volume of position data to be propagate on, a master point forward some tracking information to position server.

*2.4 Protocol Details.*

In already existing approach sensor node is able to make difference in one entity to another .This is possible by when sensor node will send unique ID code periodically. Even taking multiple entities in consideration but doing processing separately. Here a start transition diagram of sensor node. All sensor node stays in IDLE state in starting and performing protocol. In this state sensor always monitor the entity and one any entity come in the area of sensor it start ELECTION phase for serving as master .The sensor which is nearest one win the process and become the master point and select the two slave point on other two sensor node . Once we have master point it will become master and start working on protocol and same slave will go in slave state and start slave protocol .One the entity enter in the backup area new process start to select master and slave point.

## X.PROPOSE WORK

*3.1 Network Model with 2D plane*

Here we are deploying sensor node in 2D plane i.e. our network structure is 2D plane .We can place sensor in regular or irregular network .Here we are assuming the each sensor node is aware of it's own physical location and neighbor location and each node also using piggy backing concept also to send own data to neighbor node so that if any node fails due to some disaster we can recover data from neighbor node cause node is sending data to neighbors as a piggybacking. We also only need the 3 sensor node to detect the location of moving entity .by three sensor node we can get the exact position of particular entity and once sensor node has detect the position sensor node is sending to server by time to time depending based on priority either it is real time or not. We are dividing all the sensing range into 2 area interested area and supportive area which is used during handover.

*3.1.1Work done in research period*

The previous works motivate to carry this work on more elegant way and expand it up to four sensor node. In this paper we collect the data from various sources and simulate it on trimsim which shows the proper result and indicating the success of paper. This paper taking 3 sensor nodes to detect the position of entity and drawing in 2 D plane. We have assumed the some of agent which will work one by one. One node will come another will wait if entity will come in the range of that particular range then that particular sensor node will take responsibility. Once one node had took responsibility it will do whole work with collection of data, passing that data to neighbor and in case of node failure it is taking appropriate action like in case of disaster flying of data from one node to another managing memory and in case of flooding of data removing old data. New cloud computing tool window Azure of Microsoft is used for collecting data and store so it is also helping to reduce the overhead of memory requirement and fear of data loss .Even we do not have much capacity we can direct store on Azure as a sink node. As I collect data on the three sensor node and simulate on TRMSIM and I also placed the four sensors and collect the data and deploy on the TRIMSIM .It is obviously good to have exact position four sensor id better in compare to 3 sensors. I also observe it there is very less data loose in node failure because we are using piggy backing concept and one more point to notice here in 4 sensor nodes due to less collision of data we are getting good and more close look of entity which is moving. And for future reference my suggestion to have such protocol which can trace the path of highly fast object. One of the important drawback of 3 sensor node is if object is in the sensing range of two sensor node .It is difficult to sensor who will take the control. And one more improvement is how to distinguish between moving entity. All the experiment I did and analysis it with 3 sensor node or 4 sensor node .And I tried to keep balance between both of it. I have performed simulation on trimsim-regular release which provides a simulation framework for 3 d sensor network. We have implemented our approach and chord selection approach mentioned in and the comparative results are presented in the subsequent subsections.

*3.2 Active Update Algorithm*

Active Update entails a broadcast of a sensor's measurement to all sensors within its transmission range. This process is

recursively continued and enables the sensors to progressively and collaboratively share and piggyback measurements amongst themselves. Resulting in the aggregation of global knowledge at every sensor. Thus, when a sensor floats within transmission range of a Pick-up station, it not only reports its measurement but also the measurements of other sensors (piggybacked onto itself) with which it participated in following step of Active Update Algorithm.

*3.2.1 Assumption*

Consider the case where a set of k targets need to be tracked with 3 sensors per target from the resource requirement viewpoint. They show that the probability that all targets can be assigned 3 unique sensors shows phase transition properties

*3.2.2 Protocol for Update*

Here each sensor network is broadcasting measurement to the entire sensor network within transmission range. We do this process recursively which allow sensor to share data with agreement .Here we are using the concept of piggybacking i.e. every one sensor node storing its own information and taking information from other. In our assumption each sensor node is storing the following details 1- Sensor ID, 2 - Value, 3- Data Table, and 4- Flag of Change in table

Here In this describing the step of my Algorithm -

Step 1- In this step quick wake up sensor node will try to sense value and will collect-

Collect Value ();

Step 2- After sensing value sensor node will send sensing data and id-

Distribute to all (Table of Data);

Step 3- If sensor is sensing first time then flag should be false

Changed in Data Table value=False;

Step 4-On receiving a Distributed value containing a Table

For every data in table i.e. sensor Id and collect value

Step 5- If there is no previous sensing value

Then add Sensor Id and Collect Value in table

Step 6- If any change will happen i.e.

Changed in Data Table value==true

Step 7- Distribute

Distribute (table);

Step 8 –At point if a signal is received from the pointing station,

Transmit (Value of Table) to pointing station and exit.

For irregular network in which we do not have idea how to choose master and two slaves point for given entity. So here I am applying Voronoi graph problem in geometry. We have set of point P in a 2D plane, by vornoi graph we ill divided in sector. The total no of sector are |p| and each segment have point which are close of it. And point in particular sector will serve as master. We can slave 3D problem by divided and conquer approach..And the other point in region will server as slave point. We will do it repeatedly and each time one node will consume by P-k.

## XI. SIMULATION

Use either As we are developing our network model on randomly deploy sensor node .My algorithm is simulating on a chunk of randomly generated network. And result is the average. The most attracting feature of my simulation is that, we are assuming sensor node is usually assumed to isotropic. Due to this the range of sensors is perfect circle. Under such an assumption, the Localization results provide the best-case performance for an algorithm.

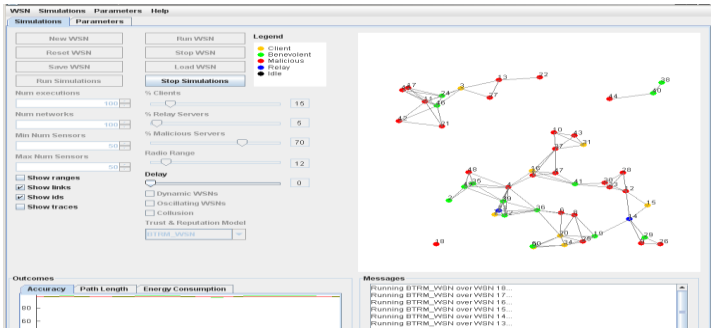

Figure 2. Simulation Result

| | DB | TB(t=12) | TB(t=40,000) | NAB |
|---|---|---|---|---|
| 1 | 5 | 5 | 7 | 8 |
| 2 | 5.67 | 7 | 8 | 15 |
| 3 | 6 | 8.6 | 7.8 | 20 |
| 4 | 6.1 | 9 | 8.2 | 30 |
| 5 | 8 | 10 | 8.4 | 35 |
| 6 | 10 | 12 | 11 | 40 |
| 7 | 11 | 13 | 12 | 55 |

## XII. RESULT

As In this performing in 2D plane with 3 sensor node and I collect the data and I found it in 4 sensor node we are getting more accuracy but in 3 sensor node we are getting higher performance cause we are consuming less using less sensor node and finding the position. We deployed whole data gather by me on trimsim which is working on 2 d plane it is basically java applet called in c#.net. We have some more API using and need some jar file to support our application. As I implemented it in 4 layer Business layer, User interface layer, Data Base layer. As In this using 5 parameter taking

Input parameter –

Data In binary Array

Byte [] b=getDataInBinary ();

Location calculate

String strLocation x , strLocation y

And we have two output parameter Out Graph, param simulation result.

By using above protocol I find the following desired result. As we have deployed the thousand of sensor mode randomly and as object is moving these sensors is tracing the path. These graph

showing the dotted path of tracing location. We are getting accurate position of object.

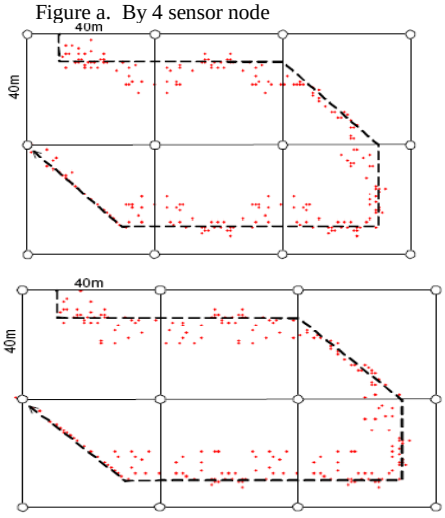


Figure a. By 4 sensor node

Figure b By 3 sensor node

Figure 3. Tracking Result

### *5.1 Data Set Using for Simulation result*

This simulation result using the following Data Set in which db, tb, tb are the sensor mode with different capability and generating the result on upon data set

Table 1. Data Set of Different Sensor Mote

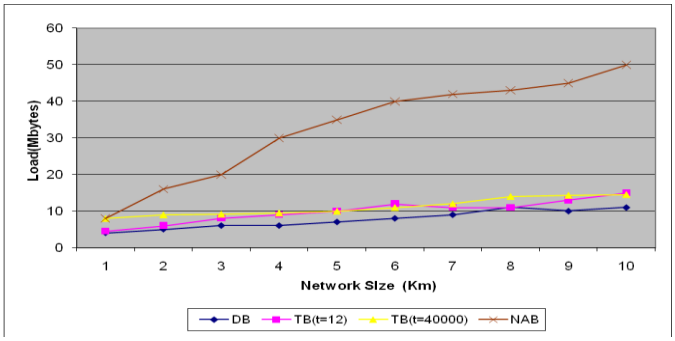


Figure 4. Graph over network size and load of different sensor mote

This graph is indicating the comparison between Load and Network. As the network size of network is increasing load is also increasing .But in this DB is performing well.

## XIII. Conclusion

In this Research Paper we propose a method which is using less sensor node reduced by an accurate estimation of the target location. As two sensor node have intersection area which is not giving exact position so we are using minimum three sensor node to get the accurate position .We can extend it up to four or five to find more accurate location but we have energy constraint so we are using three with accurate estimation of location help us to reduce sensor node. We show that our tracking method performs well in terms of energy saving regardless of mobility pattern of the mobile target. Our simulation result shows we are to extend the life time of network with less sensor node and find the exact position of tracking object. It is all regardless of mobility pattern defined by Random Waypoint model and Gauss Markov model [8,9]. Here in this paper I proposed a position-finding protocol for regular or irregular networks. A simulation Point approach is adopted, which enables point to move around to follow the moving agent, so it is greatly reducing the communication and sensing overhead. My protocol is using the approach to send data to next node (near node) so we can save data without losing it. In this using 3 sensor nodes to find the location of moving entity. As we are aware with the cost or other factor of sensor node so in this not using 4 sensor node which is reducing the overhead. As piggybacking is the important concept which I add here by which I not only saved the data of failed node but also reduce the overhead of saving data because we are forwarding the data to neighbor node. So great reduction of overhead of data storage and no overhead of node failure. Once we have successfully started data gathering we can simulate it on simulator then we can find all the desire result.

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