ABSTRACT

The real Cloud and Ubiquitous Manufacturing systems require effectiveness and permanent availability of resources, their capacity and scalability. One of the most important problems for applications management over cloud based platforms, which are expected to support efficient scalability and resources coordination following SaaS implementation model, is their interoperability. Even application dashboards need to easily incorporate those new applications, their interoperability still remains a big problem to override. So, the possibility to expand these dashboards with efficiently integrated communicational cloud based services (cloudlets) represents a relevant added value as well as contributes to solving the interoperability problem. Following the architecture for integration of enriched existing cloud services, as instances of manufacturing resources, this paper: a) proposes a cloud based web platform to support dashboard integrating communicational services, and b) describe an experimentation to sustain the theory that the effective and efficient interoperability, especially in dynamic environments, could be achieved only with human intervention.

Keywords: Cloud Manufacturing, Cloudlet, Dashboard Services, Interoperability, Pragmatics, Ubiquitous Manufacturing, User Experience, User Pragmatics

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1. INTRODUCTION

It is generally accepted that emergent cloud computing paradigm and its rules, strengths and opportunities, reinforces nowadays Information and Communications Technology (ICT) impact in Manufacturing. The efficient capacity to get a job done when it is needed is again a commandment. But if the quality is assured, who did the job or how it was really done is not as critical as before, indeed. Virtual relations between customer and provider arrived, brought by cloud based services.

If on one hand the timely need for resources (material, persons, processes, etc.), and on the other the need of their interoperability, are the essential requirements to get a real cloud and ubiquitous manufacturing, the system’s effectiveness is dependent of users direct participation and co-creation.

If the cloud assures the resources supply (Charlton, 2008), and advanced dashboards (Yigitbasioglu & Velcu, 2010) of “integrated” (but not interoperable) services sustain and improve their management, the heterogeneity (different specification, support technology, etc.) of those services represents the main challenge for their efficient technological interoperability (Fu, Gong, & Chen, 2012).

Thus, to overcome this evident technological limitation or incapacity, the real context and the user’s (as human) own individual perspective must be considered. Pragmatics represents such add-on.

To complement the emergent and required Rich Internet Applications (RIA) technologies inherent to Web 3.0, and to take advantage of the new technological platform capacities, where more intelligence and human experience participation (Harris, 2008) is required, new communicational services must be efficiently integrated in the system’s user interface to allow human-to-human interaction and to achieve co-decision.

This paper contributes with further investigation of the cloudlet architecture for a dashboard having integrated Pragmatics oriented services (Ferreira et al., 2012), towards user (human) alignment and effective cloud and ubiquitous manufacturing system.

2. INTEROPERABILITY AND UBIQUITY

Besides the on-demand self-service model, the reduction of costs, the improvement of accessibility, the multi-tenancy, and many others technological challenges that can be identified with cloud computing, its flexibility and reliable and scalable processing capacity in particular, made it a potential successful platform to promote the emergence of new business paradigm or opportunities, and to promote change existing business process (Group, 2010).

The Manufacturing, as a traditional business activity that requires timely and sufficient quantities of resources (material, machines, workers, etc.), that behaves under complex and “heavy” production process, has been changing and transforming in an efficient and dynamic activity, with agility to react to continuous change of market demand and with the capacity to be much more competitive. According to the literature, ubiquity represents existence and sufficient availability, anytime and anywhere, which can be seen on manufacturing as the capacity to produce sufficiently, knowing that the necessary resources exist.

The literature emphasizes too the (virtually technological) unlimited capacity (scalability, processing, etc.) achieved with Cloud Computing (Charlton, 2008) and the Ubiquitous Information Systems (UIS) that allow permanent services availability and use. To have systems that support a Cloud and Ubiquitous Manufacturing (CUMS), both properties must be present.

Ferreira et al. (2012) emphasized the potential of the cloud and systems that grant Ubiquity as relevant technological supporting “tools” to nowadays continuous business models changes.

The Cloud Manufacturing (see Figure 1) represents such recent transformation (Bo-hu et al., 2010) where multiple cloud models, mainly hybrid clouds and their Software as a Services
(SaaS), sustain the needed ubiquity of resources (Foust, 1975).

But the required ubiquity of resources demands efficient interoperability between those resources, and this interoperability represents one of the main challenges and opportunities of cloud (Becker, 2012). It is essential that all "orders" can efficiently flow through SaaS and Infrastructure as a Service (IaaS) involved, being it, however, a mere technological question.

To achieve an effective web portal where these cloud processes can be managed and their services coordinated, communicational dimensions need to be integrated, whether
person-to-person (Ferreira, et al., 2012; Putnik & Putnik, 2010) or person-to-system (Tripathi, Gupta, & Bhattacharya, 2006): 

(...) Any (information) system that aims at considering true needs of a customer; i.e. the needs closest to the real customer's needs, with as less as possible abstractions, should consider pragmatic aspects of communication with him (…). (Ferreira et al., 2012) 

Dashboards, even not a recent concept on computer systems (they are present on Business tools, on Management Information Systems, on Web Administration, etc.), continuing to represent a control panel model, are now instances of such web portals. Multiple services for interpersonal communication are there already available, being verbal or non-verbal, using tangible or intangible accessory tools to perform that communication. Despite that they represent autonomous services that allow direct human-human interaction, they are not effectively integrated. To know the real status of a particular resource (a machine) one needs to immediately interact with its owner, for instance.

Even accepting that technological questions make interoperability difficult, we are convinced that human factors represent the main causes for that difficulty, most of them related with the ability to well transmit and understand a message, i.e., communicate. Nevertheless, several other factors can easily sustain the high probability of incapacity, error or failure in this pragmatic competence (Mey, 1993) or communication process.

3. DASHBOARD SERVICES FOR PRAGMATICS 

Some theories and experiments show that effective and efficient interoperability, especially in dynamic environments, could be achieved only with human intervention, in which context the Pragmatics is one of the most important instruments. Pragmatics is the approach which is based on employment of human communication as co-creative instrument in order to overpass the insufficiencies of pure semantic and formal information based instruments.

After visited the Xerox Palo Alto Research Center (PARC) Steve Jobs found revolutionary, and expressed his passion for, user interfaces and theirs relevance in the future user satisfaction of human requirements (Jeffrey, 2005). Even known that dashboard is not a new or recent concept (since HP already used it in 1994), it has been recently explored by the most technological platforms (mainly mobiles) and scientific and management areas (Business Intelligence, CIO of enterprises, Traffic management, Stock Exchange, etc.). Widgets and App Stores are now usual terms, and the emergent platforms/operating systems like Tablets/Wind 8, Tablets/IOS and Smartphones/Android, are real evidences of exploration of this new application models. These platforms behave under a management control panel that manage (these) small and autonomous applications.

There are several widgets (behaving as services or mere applications) that already offer communicational services and can be integrated in the same application (for instance, the application skype efficiently integrates text, audio and video). And several services are already cloud hosted. So, technologically things are going the right way, as usual! However we can see that persists a significant gap between the global developed system (based on a general user, selected user, etc.) and the concrete individual human requirements. The user interfaces (intends to) represent the (common and more efficient) way to interact with the system, mainly. Nevertheless, if one person can immediately and directly contact another (using tools like web chats) they usually represent two distinct and independent features that system needs to support. Usually users don’t interact immediately to decide over a particular context or problem, since they may not even know each other.

Computers are excellent tools for calculus, simulations, forecasts, etc., but, for instance, are not as competent as a human to well describe a person, effectively. The human reasoning is
not susceptible to be formally implemented (Stuckenschmidt & Harmelen, 2005) and any attempt of that, misrepresents its inherent natural characteristic. So the possibility to allow human-to-human direct collaboration to co-create is essential. Furthermore, the human (user) experience and the Information Field (IF) are natural barriers to get effective information systems, making insufficient the interoperability based only on technology (syntax and semantic of things) (Putnik & Putnik, 2010).

It is clear for any person that a new concept must be accordingly described to be well understood. However, even a data access (web, databases, etc.) can be easily technically supported, it requires some intelligence to be interpreted and transformed into useful information (Baeza-Yates & Ribeiro-Neto, 1999) in order to be effectively integrated (Gio, 1992). Indeed, this intelligence is only a human capacity, yet!

According to Bremer (2008), during a process of data (texts, symbols, figures, etc.) interpretation (see Figure 2), many “personal” contributions exist when ambiguities or questions arise. Where syntactic (morphology) and semantic (meaning) questions arises, Pragmatics (own interpretation and reasoning) solutions are used! Paraphrasing Bremer (2008):

(... the final result of the process of text understanding may include some information not overtly present in the source text. For instance, it may include results of reasoning by the consumer, aimed at filling in elements required in the representation but not directly obtainable from the source text. It may also involve reconstructing the agenda of rhetorical goals and plans of the producer active at the time of text production and connecting its elements to chunks of meaning representation (...).

Pragmatics is one of the semiotic fields (the others are Syntactic and Semantics) (Putnik & Putnik, 2010) and concerns the relation between ‘signs’ (the foundation of Semiotic Theory (Saussure & Baskin, 1916; Peirce, 1958) and their interpreters (Morris, 1938; Morris, 1946). Paraphrasing Saussure “you cannot have a totally meaningless signifier or a completely formless signified” and Peirce “nothing is a sign unless it is interpreted as a sign”. For example, in linguistic terms, the word ‘full’ (used, for instance, when a recipient cannot have more contents) is a ‘sign’ with: signifier (the word ‘full’) and signified (the recipient cannot have more), according to Saussure. But the same signifier (‘full’) could means different signified and thus be a different ‘sign’ (‘full as ‘have no patience’, for instance). Another example, the semaphore’s red light as a ‘sign’ have: red light (the representamen), cars stop (the object) the idea that the red light indicates that cars must stop (the interpretant), according to Peirce. But how it is perceived the same element of those who know nothing about traffic?

Each one of these examples exposes well the meaning of pragmatics because, and paraphrasing Charles Moris (1995), “deals with the origin, uses and effects of signs within the behaviour in which they occur”. The fundamental, qualitative, differences between the pragmatics, semantics and syntactic, are virtually the best described in Carnap (1942), based on their degree of abstractness in relation to complete signs and semiosis:
If in an investigation explicit reference is made to the speaker, or, to put it in more general terms, to the user of language, then we assign it to the field of pragmatics… If we abstract from the use of the language and analyse only the expressions and their designate, we are in the field of semantics. And if finally, we abstract from the designate also and analyse only the relations between the expressions, we are in (logical) syntax. (Carnap, 1942, p. 9; cited in Recanati, 2006)

All this scientific perspective reflects in practice on information systems that aims to align with the customer’s true needs, i.e. the needs closest to the real customer’s needs, with as less as possible abstractions, should consider pragmatic aspects of communication with him.

According to Ferreira (2013) and Putnik and Putnik (2010):

(...) sign interpretations are, thus, context dependent, meaning that actually it is hardly possible to exist an ‘absolute’, common and universal, interpretation of reality (in our case the reality of the customer needs), but, rather, there are multiple interpretations by multiple communities (i.e. specific for each one customer and by multiple scenarios for satisfying his customer’s needs) and in different times (i.e. and in continuous change) (...).

And even known that it is already possible to have interpersonal direct communication, the use of these mechanisms to deal with decisions’ discrepancies or divergences, in the immediate problem context and time, falls short. A late decision could be not efficient. The actual information systems’ platforms are mere control panel of several not interoperable small applications. The App Store model of emergent Cloud computing is an evidence of this.

Accepting that pragmatics represent the missing stone of the puzzle, i.e., the technology per se cannot assure the human reasoning effectively, yet, the possibility to allow human relations is a must requirement to support.

To explore the significance of human-to-human direct collaboration to co-create or co-decide, an experimentation was undertaken. As a global analysis of this experimentation, the resultant disagreements or absences of opinion inherent in people who collaborated using ontologies (formal technological tools), were efficiently managed and overcome with mechanisms that allow the co-creation (through direct conversation) between the participants (Ferreira, 2013).

3.1. The Experimentation

The problems of systems interoperability must be seen as not a pure technological question. Ferreira (2013) sustains that syntax and semantics represent part of that problem (mainly data heterogeneity), and the subjective interpretation of the context, referred as Information Field, represents the necessary complementary part. Paraphrasing Stuckenschmidt and Harmelen (2005):

(...) the attempt to provide interoperability suffers from problems similar to those associated with the communication amongst different information communities. The important difference is that the actors are not persons able to perform abstraction and common sense reasoning about the meaning of terms, but machines. In order to enable machines to understand each other we also have to explicate the context of each system, but on a much higher level of formality in order to make it machine understandable (...).

The experimentation focused on mechanisms to overcome these interoperability limitations, using a non-technological (semiotic) integration solution. Assuring a common formal base of knowledge (using ontologies) description (to avoid initial discrepancies), some collaboration mechanisms (mainly communication) were used between participants to deal with discordant ontological terms. The essence of the experimentation followed the premise that a communicational architecture is relevant to achieve effectiveness.
Reinforcing that the experimentation were not to explore ontologies limitations, nor to create a new ontology, but to sustain rigor in the process instead, the experimentation workflow started with a personal interpretation (according to user experience) of a particular user interface (UI), transcribed to an ontology. After ontologies interpretations (using mapping terms, mainly), some discrepancies emerged and disagreements on interpretations were expressed. Allowing users conversation, they could argument their different points of view (their own information field) and new terms arose and others have being removed. At the end, it was possible to get a new version of initial ontologies that describes initial user interface, in which both authors are in agreement.

It was demonstrated that pragmatics behaves as an instrument for effective ontologies interoperability, contextualized for Graphical User Interfaces (GUI) of services composition. The experimentation was structured in four phases: a) definition of an ontology to describe a particular User Interface (UI); b) interpretation of that ontology; c) validation of the interpretation and d) co-creation of correct interpretation ontology.

The User Interface (UI) ergonomic and functional details, the User Experience (UX) that support the human analysis, and the User Pragmatics (UP) that sustains the reasoning on the co-analysis process, are basic “phenomena” that influence the human-system interaction (Putnik et al., 2012). The results of this experimentation show exactly that: a) different IF exists, since different users interpret differently the same interface in the same context; b) IF influence the ontologies interpretations and their interoperability, since different mapped terms difficult ontologies mapping (interoperability); and c) Pragmatics mechanisms help the resolution of “discordances”, because, after conversation, it resulted accordance in the co-created ontology (see Figure 3).

Table 1 summarizes the results achieved between two particular participants showing: a) the mapped terms (considered equivalents before the co-creation process) of the distinct initial ontologies (cells with the mark ✓ on the table’s gray area). For instance, Speed_Orientation was equivalent to Set_Speed_and_Direction term; b) the (yellow) terms that were considered equivalent after the co-creation process (cells with the mark ✓ on the table’s brown area), for instance, the term Select_Axis was considered equivalent to SelectAxis; c) the (green) terms that appeared after the co-creation process, the Operations term, for instance, ; and d) the unmapped (strikethroughs) terms that were ignored and removed on final ontology (cells...
without the mark ✓ on the table’s brown area). The Label term, as example.

As a final remark, the final “agreed” ontology that corresponds to the interoperable version of the initial ones, did not result through a normative approach, indeed, but by using pragmatics instruments as support for the effective resolution of resultant discordances:

(... it was necessary that the participants could intervene in a way to clarify eventual doubts or questions about decisions taken so far. This was achieved through communication channels, in this case the face-to-face between the people involved (...). (Ferreira, 2013)

### 3.2. Communicational Dimension

If the context sustains multiple-domain and support multiple users, the probability of conflict is high, in particular when dealing with different specialty areas. Technologically, the use of taxonomies or ontologies are the most common tools to manage potential inconsistencies (Kontchakov, Wolter, & Zakharyaschev, 2010). Even existing several ontologies, their interoperability (Fonseca, Câmara, & Monteiro, 2006) depends essentially on the ability to map terms (Kalfoglou & Schorlemmer, 2003) between taxonomies of the different ontologies.

Thus, considering that multiple (technical) solutions to map syntactic terms (taxonomies elements) are needed, and considering the ex-
istence of different solutions to “map” semantic concepts (thesaurus, ontologies, etc.) and the need to sometimes describe that semantics, e.g.:

(…) ‘The important difference is that the actors are not persons able to perform abstraction and common sense reasoning about the meaning of terms, but machines (...)’ so sometimes (…) ‘In order to enable machines to understand each other we also have to explicate the context of each system, but on a much higher level of formality in order to make it machine understandable’ (…) (Stuckenschmidt & Harmelen, 2005), we defend that a pure services interoperability solution cannot be merely technological.

The experimentation here described demonstrates that the relationship (i.e., interoperability) between terms is not always easy, and the mapping of terms is not sufficiently clear only with the use of these technological tools. Against the disagreements or inconsistencies resultant from the used technological solutions, the participants’ information field (their own experience) was shown as the essential argument, and the direct conversation between participants was the efficient and effective communicational “tool”. It resulted in co-creation, i.e., a jointly creation, of several new terms and the final creation of consensus ontologies (that had been initially interpreted as non-consensual).

Thus, a non-technological perspective emphasizes Pragmatics (as one of the three Semiotic fields) (Putnik & Putnik, 2010) as the base for the communicational capacity needed. This capacity is supported by communicational services efficiently integrated that assure effectiveness in all processes. To be aligned with this point of view, the traditional transactional information system’s services must be enriched with communicational services, efficiently integrated.

With Service Oriented Architecture (SOA) emerged new business models as well as new applications development patterns. The applications need to be agile and loosely coupled that allow them to respond quickly to continuous business requirements changes. Thus, the traditional complex and weighty applications become a set of autonomous and interoperable components (services) and the web becomes their main integration channel (Daigneau, 2012). The services discovery, composition and coordination are essential steps and their interoperability is the essence for their efficient use.

With the emergence of cloud computing paradigm and new RIA technologies, promoted essentially by mobile smart-devices and cloud-hosted services, significant changes in traditional web applications, occurred too. The Metro style (Microsoft, 2012), responsive and multimodal interfaces (Repenning & Sullivan, 2003), represent significant and recent user experience manifestations of emerged changes in user interfaces.

Dashboards are (once again) “ergonomic” mechanisms that allow services integration and organization towards a user friendly and effective user interface. The App Store (application marketplaces, indeed) is now a web place where those services (widgets, applications, etc.) are available. Those services that allow human-human communication and are easily composed with (or integrated on) existent services, and represent for them a new feature or add-on that offers communication channels, behave as pragmatics instruments (see Figure 4).

Considering the Cloud and Ubiquitous Manufacturing that requires resources ubiquity, where brokering mechanisms assure the efficient discovery and selection of resources; considering the flexibility of requirements and dynamic changes of the resource status, an efficient reconfiguration and dynamic selection of alternative resources is essential and the capacity to interact in real-time with the owner of the resource can be critical. This is in line with Ferreira (2013):

(…) in the context of a Market of Resources, the broker (Resources Broker) has as its main task ‘to find’ resources. But to ensure that resources are found, they must be properly registered in the Market of Resources. The resources ‘enter’ on the market with meta-information for terms
of specific domain ontology which they belong. These cataloging processes (or classification) shall allow: a) reuse existing domain ontology terms; b) reuse existing terms in different domain ontologies (ontology library) and c) to create new terms (...).

4. DASHBOARD SERVICES FOR CLOUD AND UBIQUITOUS MANUFACTURING SUPPORTING ARCHITECTURES

Several facts show that the more independence from technology, the best architecture robustness and flexibility we get. Since technology does not stop evolving, everything which depends on it, needs to change too, continuously. These Communicational Services must be easily integrated with existent services. They must be autonomous, platform independent and hosted in cloud to assure their ubiquity. This cloudlet model (Ferreira et al., 2012) works well in social-web like architectures, where each participant (resource provider in cloud manufacturing) promotes its resource and publish their communicational channels.

There is a cloud engine that acts as broker in the discovery and selection of resources (see Figure 5). Each resource, once registered in this engine, could be referenced and selected for anyone who wants resources for a particular task. Thus, the availability of many ways to immediately contact (video, conversation, messages, etc.) a particular resource owner, could become determinant for its selection (see Figure 6).

The Dashboard represents the web Presentation Layer of our multi-layer (MVC) cloud-based semiotic architecture that supports our
Cloud and Ubiquitous Manufacturing System (Ferreira, 2013). The layers below are supported by synchronous or asynchronous cloud based WCF and Restful services and the first layer (dashboard) are based on RIA, multimodal and responsive technologies where Jquery, AJAX, HTML5, CSS3 are the base. The Pragmatics renderer (see Figure 7) must be based on real-time communicational technology over Internet (not necessarily over HTTP), such as HTML5 Web Sockets, WebRTC, XMPP or SignalR. The available communicational channels for each resource depend on the resource status and their channels operability.

In practical terms, the communication channels must be technological transparent mechanisms that allow direct relation between the resource owners. This can be easily understood considering the concrete scenario where a Skype user can make a chat with a Google Talk user or a video session with a Viber session (see Figure 8), for instance.

Figure 5. Dashboard integrating cloud brokering services applied to manufacturing

Figure 6. Dashboard services including communicational channels
5. CONCLUSION

Theoretically, with the advent of Services Oriented Architecture (SOA) and cloud a tremendous set of services that can easily be used (reused or composed) emerged. But the lack of easy and efficient interoperability between them represents a serious handicap for their success.

Nowadays the easiness that persons can communicate represents the main advantage and one of the strongest factors for actual change in several business activities. Social networks can be seen well succeed evidences of this:

Figure 7. Pragmatics instruments in dynamic reconfiguration process

Figure 8. Multiple communications channels
(...) the new social operating system of ‘networked individualism’ liberates us from the restrictions of tightly knit groups; it also requires us to develop networking skills and strategies, work on maintaining ties (...). (Rainie & Wellman, 2012)

And this phenomenon must be harnessed in information systems, since human-to-human capacity to decide outperforms computer “intelligence”.

Thus, if the linguistic competence on communication can be the base for human-to-human success communication, the need of pragmatics instruments that allow human-human co-creation and co-decision, are the mechanisms to support that competence in information systems. Considering a more practical perspective, where the information systems represent the basic tools to manage dynamics business activities like Manufacturing, and being persons essential in these management processes, the capacity to allow them to communicate is essential. The availability of cloud services assures the ubiquity and scalability needed to supply manufacturing resources and their integration requires efficient interoperability architectures. Accepting that technological details only faces a part of the integration requirements, these architectures need to be effective and therefore equipped with efficiently integrated communication channels. The presentation layers are supported with Dashboards that, besides the services integration, are enriched with complementary services that assure pragmatics interoperability.

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