

Insights on Cognizant Computing: Concepts, Technologies and Trends

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Abstract One of the emerging trends that have gained increasing prominence and is fast becoming a household name in the global IT industry is the concept of cognizant computing. Research has repeatedly suggested that this technology may hold the key to satisfying nearly all the computing needs of humanity even down to the preferences of the unique individual, by harnessing and then enhancing the capabilities of the cloud services and the internet of things like nothing ever before experienced, in the next decade [1]. This research provides new insights on a more wholesome approach to viewing cognizant computing – the continuum approach; it also illuminates this emerging technology by studying its basic concepts, technologies as well as emerging trends; and highlights specifically how the technologies of the Internet of Things (IoT) and Cloud Computing (CC) would help to drive the goals of Cognizant Computing.

Keywords: cognizant computing, cloud computing, virtualization, IoT

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1. Introduction

Cognizant computing is a computing technology that is centred on consumer experience in such a way that individual consumers are met with personalized services that are tailored to meet their specific needs [1]. Such a consumer experience is made possible by data about the individual that is pooled from a continuum of various sources that contain stored histories of custom, favourite and / or preferred user services, configurations, applications, credentials and identities, etc., that are then processed and provisioned in such a form that delivers to the individual consumer, that user experience that meets their unique point of need.

Imagine that you wake up late in the morning and are unable to take breakfast, and you rush off to the office only to find your favourite coffee waiting on your desk just the way you like it mixed and served. All thanks to your mobile phone that noticed that your didn't turn off your alarm at the time you always do when it went off in the morning and sensed you were still asleep and may wake up too late to have breakfast; your phone then activated a pre-set rule to send a message to your coffee vendor with specifications on how you like your coffee served, requesting that coffee be delivered to your office address before 8am, and *voila!* – Now that was made possible by cognizant computing.

Gartner Technology Research Inc. carried out a thorough and comprehensive survey of cognizant computing which

revealed bright prospects and industrial perspectives [1,2]. The research postulates four phases that are exigent to attainment of a complete personal cloud experience. These are illustrated in Figure 1 below:

The ultimate goal of cognizant computing should be to serve each individual consumer as though no other consumer existed. The focus here is to meet the user / consumer at their point of need in such a manner that is unique to their preferences / favourites and customizations.

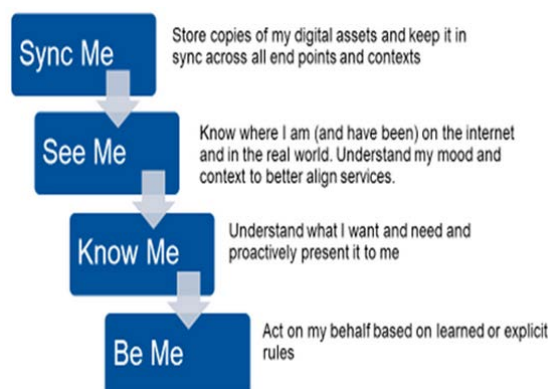


Figure 1. Four Phases of Cognizant Computing [2]

2. Justifying the Continuum Approach to Cognizant Computing

With no goal in mind to undermine the findings of this comprehensive survey, the research suggests a review of

the phased perspective to cognizant computing, as proposed by Gartner, to a continuum perspective. The need for this review is informed by the following reasons:

Firstly, and most importantly, the phased perspective to computing usually implies that once a transition is made, it is difficult to establish some form of contingency with the preceding phase(s). In the technology of cognizant computing, the real-world entity (the human / consumer / user) is the ultimate repository of everything that is needed to attain the goals of cognizant computing if the enhancement of the consumer experience remains the goal. Hence, there must be a cascaded flow of information between the human entity and all aspects of the “sync”, “find”, “know” and “be” repositories; all phases must remain in direct, constant contact with this real-world entity; and for the ultimate goal of cognizant computing to be achieved, this contact must be maintained.

Secondly, and in extension to the first point above, because human desires / needs, choices and behaviour are largely dynamic and difficult to stereotype barring value systems and other related independent factors – a fact that

has been confirmed repeatedly by various researchers in the behavioural sciences [3]. The implication of this fact is that a human need that could previously be met and satisfied by activating a particular set of processes / rules may not be adequately met using the same set of rules at a later time. As a result, the cognizant computing infrastructure must be put in a perfectly elastic learning paradigm in which it has to constantly interface with the individual consumers / users to be able to learn new ways of meeting their needs.

In light of the above reasons, the continuum approach to viewing cognizant computing as a continuous, seamless series of interactions between the real-world human entity and the computing infrastructure that would result in complex learning processes, interactions and activities relating to the human entity, in order that the cognizant computing infrastructure be better suited to meet such an entity at its point of need may be a more wholesome approach.

The continuum approach to viewing the concepts and technology of cognizant computing is illustrated in Figure 2.

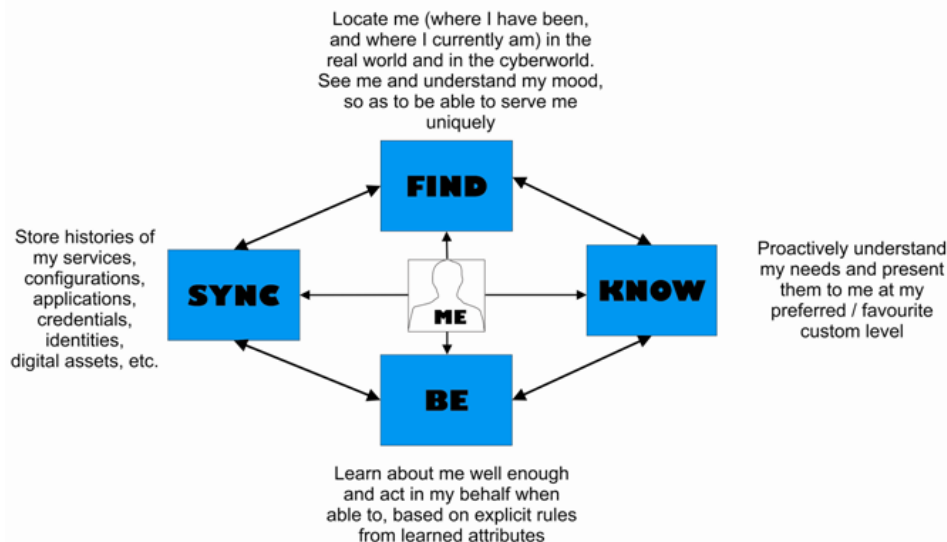


Figure 2. Cognizant Computing Continuum[own research]

3. Cognizant Computing Continuum (CCC)

For the ultimate consumer experience to be possible, the cognizant computing continuum must be noted. This continuum incorporates four major parts necessary for acquiring, storing and forecasting the user / consumer experience across. These are namely:

1. Sync: This can be seen as the most important stage of this continuum. More so due to the fact that if users / consumers must be served at the point of their unique needs, prior information about these needs must have been gathered and stored in such a way that it is made available readily. In the sync stage, information about user experience is harvested from histories of previous services, configurations / settings, applications, credentials, identities as well as other digital assets, and stored [2].
2. Find: In the find stage, the user / consumer is traced and located as an active entity in the cyber world that corresponds to a real world individual. Through this means, specific information about the users' moods /

emotions can be inferred and / or gathered based on the current location; and the consumer can then be served in such a manner that fulfils the requirements / needs of the users' location specific mood / emotion [2].

3. Know: At the know stage, the user should have been well known, and the requirements / needs well understood in such a form that the user / consumer can now be proactively satisfied even without providing any specifications, while not losing contact with the user to be able to promptly and adequately relearn, combine and integrate new perspectives on possible solutions to the user needs [2].
4. Be: Transcending from the know stage, at the be stage, the user as well as unique interests and experiences can now be adequately represented in the digital world as an entity that can act in behalf of the real world individual based on sets of explicit rules that have been drawn from learned attributes, while still not losing contact with the individual user / consumer for the same above reason [2].

With this complete continuum in view and the information available to it, the user / consumer's next move, next purchase, next action and next location can now be more accurately predicted [1].

This new approach to computing integrates and incorporates other concepts that have long before now become forces to watch out for in the IT industry. Principal among these are the concepts of Internet of Things (IoT) and Cloud Computing.

3.1. The Role of Internet of Things (IoT) in Cognizant Computing

The Internet of Things (IoT) is the interconnection of uniquely identifiable embedded computing devices within the existing Internet infrastructure, thereby providing an advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communications (M2M) and covers a variety of protocols, domains, and applications [4].

[2], estimated that by the year 2020, nearly 26 billion devices would be on the Internet of Things; also, [5] estimated that by the year 2020, more than 30 billion devices will be wirelessly connected to the Internet of Things (Internet of Everything).

With the interconnection of these devices, the internet of things would be able to ensure routing and transferring of information between and amongst several interconnected devices, the human entity, and the cloud. This would mean that more information necessary to drive cognizant computing would be more readily available across various devices. Also, the interconnection of these devices would ensure that tasks can be more automatically done and task reminders more automatically managed by creating new things to do (based on patterns or past work) or following up on things that need to be done (based on patterns of recent work) [1].

Furthermore, certain security policy features and restrictions in the internet of things are expected to mitigate privacy issues in cognizant computing by making it possible for clients to retain privacy even for shared data.

3.2. The Role of Cloud Computing in Cognizant Computing

Cloud Computing (CC) is "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction; having characteristics of *on-demand self-service, broad network access, resource pooling, rapid elasticity* and *payment per usage of various business models*." [6]

Carolina Milanesi, the research vice president at Gartner pointed out that by the year 2017, mobile phones will be smarter than people and would be capable of acting as our secret digital agent if we would allow them. This would definitely not be because of any form of intrinsic intelligence whatsoever, but because the cloud and the data stored within it will provide them with the computational ability to make sense of the information they have, applying them to various contexts, so that they can appear smart [7].

[1], also predicted that the cloud system is only going to get smarter in the years ahead. Cloud computing and its associated infrastructure are expected to provide the ubiquity that would propel cognizant computing. This is because personal cloud systems would now be able to interact with the smart devices of the coming years in a complex ecosystem of various applications, communications, signal transfers and processing activities, thus ensuring that the user experience data collected are made more ubiquitously available.

In addition to ubiquity, the agility that is expected to make the concept of cognizant computing more globally relevant can only be sustained by robust cloud infrastructures.

4. Conclusion

Even though privacy and regulatory / policy issues are perceived as possible challenges to the future of cognizant computing because most users may not be comfortable with the amounts of information is being collected and stored about them, and ethical, regulatory, as well as legal concerns would emerge where attempts are made to gather such information without consent; the reality still holds, from available facts, that cognizant computing would be the key to meeting the computational needs of every individual on the globe with such uniqueness of service that is also perfectly suited for the particular context of need.

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