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Smart computing: A primer

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Abstract
The computing technology industry has witnessed cycles of mainframe computing, personal computing, and network computing. We are entering a new cycle known as "smart computing." Smart computing refers to the new generation of software, hardware, and network interconnectivity that unites the physical and analytic computing systems. It adds new capabilities of real-time situational awareness to existing technologies. This paper provides a primer in smart computing.

Keywords: smart computing, awareness, provides, computing

Introduction

The modern world is becoming smarter every day. The "smart" directive is already well accepted as a part of our future. It is now been adopted by many governments, authorities, corporations, businesses, and organizations. Enabling a smart life has become a popular idea with an urgent demand. These days we hear about smart phones, smart homes, and smart cities. "Smart" in this sense means adding computing power to our phones, houses, or cities and connecting them to a computer network such as the Internet.

The computing technology industry has witnessed cycles of mainframe computing, personal computing, and network computing. Today, it is witnessing the fourth wave,

Known as "smart computing." As shown in Figure 1, the four waves of technology have had a business impact [1].

Smart computing combines advances in information and communication technologies to create smart systems. These systems are designed to make human life better and provide a new approach for addressing many challenging problems faced by humanity today. Introducing smart computing is an effective approach of integrating the capabilities of various technologies, such as Internet technologies, artificial intelligence intelligent systems, and social media, to realize different innovative applications [2].

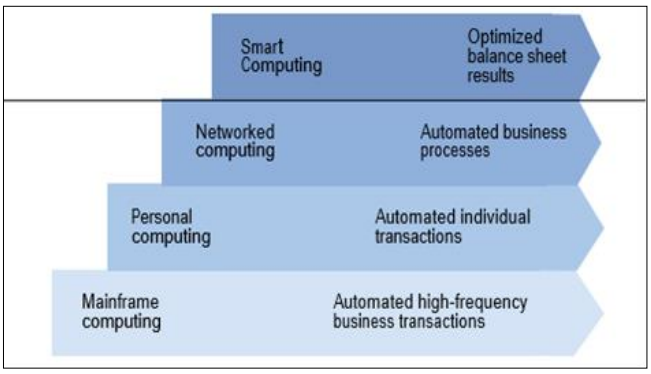

Fig 1: The waves of technology have had a business impact [1].

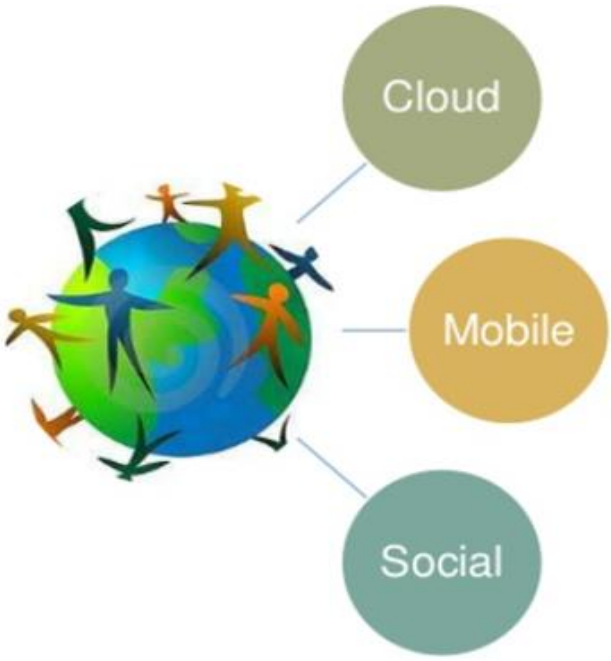

Fig 2: Smart computing drivers [3].

Smart Computing Concept

Computers become "smart" when we connect them to the real world, and they help us make better decisions. Smart computing is regarded as the next big wave, a fourth wave coming after mainframe, personal, and networked computing. Smart computing combine's advances in the Internet of things, cyber-physical systems, edge computing, cloud computing, mobile/pervasive computing, sensor networking, social computing, big data analytics, machine learning, visualization, mobile and wearable technology, cognitive computing, and artificial intelligence. It is the combination of all these innovative advances that will make computing technologies to become smarter. As illustrated in Figure 2 [3],

Smart Computing: Cloud + Mobile + Social

Bartels suggests the five A's of smart computing, which are the key functions of intelligence [1]:

- *Awareness*: Technologies for pervasive interactions such as radio frequency identification (RFID), sensors, video cameras, global positioning system (GPS) chips, smart cards, and other tools will capture data. Communications technologies such as wireless networks will transport the data to central servers for analysis.
- *Analysis*: Businesses and governments use analytical tools, such as data mining, pattern recognition, and artificial intelligence, to make sense of data and also make predictions about what may happen.
- *Alternatives*: This refers to evaluating alternatives and making decisions on alternative courses to pursue.
- *Actions*: These are based on the results of analysis, either automatic or with human intervention. The action may be as simple as placing an order or as complex as adjusting thermostats in tens of thousands of households in the least amount of time as possible.
- *Auditability*: This is a feedback system that ensures that the action has taken place, complies with legal regulations and company policies, and also provides some way to evaluate for improvement.

Smart computing can be classified into two main areas: (1) Designing and building smart computing systems, and (2) Using computing technology to design smart things that will make human life better [2].

Smart Computing Systems

Smart computing systems are designed to improve the performance of data centers, vehicles, and other resource-intensive physical assets. They refer to systems that are not isolated but interconnected with communication networks, and capable of remote data collection, processing, exchange, and analysis. A smart system is based on the interaction, communication, connectivity and interoperability of smart technologies. It provides the basis for data collection and storage as well as explores ways of sharing and analyzing this information. It can be applied on a small scale as a smart phone or expanded to smart home or city. Innovation enables conceiving new applications and services as well as improving the efficiency and reliability of the existing ones. It combines together theoretical and practical aspects to design and build smart computing systems that will make human life better.

Applications

Applications of smart computing include transportation, energy, smart and connected communities, healthcare, banking, entertainment, social media, environment, security, surveillance, industrial systems, information retrieval, publishing, entertainment, creativity, social activities. Smart buildings, smart cities, smart grids, precision agriculture, smart health, smart communities, and other innovations contributing to smart living. In addition, many interdisciplinary applications link smart computing to more traditional scientific disciplines such as biology, chemistry, neurosciences, medicine, physics, and economy. Typical examples of smart computing solutions include [1]:

- *Power Systems*: Smarting computing can be applied in various areas of the power system. Smart meter and smart energy are common examples. Smart meters are wireless, high-tech, digital communication devices that will replace the old, analog electricity meters and allow remote electricity readings. They use small computer chips to capture real-time electricity usage in homes and businesses and transmit to servers at the utilities. Using smart meters provides us with some environmental benefits as well as eliminating the need for manual meter reading. Smart energy refers to an approach in which smart electricity, thermal and gas grids are combined. Smart energy is used in smart homes, smart cities, commercial buildings, electric vehicles, smart irrigation, and wherever energy is used. Cost optimization in an autotransformer manufacturing can be done using smart computing techniques [4, 6].
- *Healthcare*: The healthcare industry has been slow to adopt new technologies. It is challenging to convince physicians, nurses, and other healthcare providers to use the systems and reassuring patients that their records will be kept private.
- *Governments*: Every local or regional government is looking for ways to improve transactional processes. Smart computing allows anytime, anywhere, device-agnostic interconnectivity between leaders and their citizens. Governments that choose to invest in a central data repository are benefitting from shared data, streamlined workflows, greater efficiency, and satisfied digital citizens [7].
- *Animal Welfare*: Animals play a important role in our lives. Dogs have been human companions for thousands of years. Farm animals are a critical part of sustainable agriculture today. Smart technologies are designed for the welfare of domestic and wild animals. They appear to be a promising and economically sustainable option to ensure animal welfare. There are technical and economic challenges to overcome. For example, cost is a limiting factor for just having a unique ID for each animal [8].

Tech vendors such as IBM, Apple, Microsoft, Dell, Siemens, HP, and EMC been developing software and hardware capabilities for smart computing. For example, IBM smart computing aims to optimized business processes in a holistic approach.

Benefits and Challenges

Smart computing will grow rapidly because it will help business solve problems that could not be addressed before. It allows businesses, governments, and nonprofits to tackle previously unsolvable critical problems. It will help solve balance sheet business problems. Smart computing can be used to provide new solutions to many complex and challenged problems faced by humanity today. It can deliver alternate solution for today's computing architecture to satisfy the future generation needs. It also be used

To develop a multi-disciplinary solution to a complex humanitarian problems.

Just as the benefits of smart computing for business are substantial, challenges are equally substantial. There are big challenges in navigating the shift to smart computing.

Smart computing raises some troubling issues of data privacy for customers.

Conclusion

Smart computing is an evolution as well as an extension of

three generations of computing. It is one step towards future generation needs. Smart computing along with collaboration tools will transform business in the coming decades. Digital government and smart computing will continue to evolve.

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