IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

VOLUME : 10 ISSUE : 11 Print / Issue Publication Date: 18-Apr-2026

ISSN : 2455-2143

DOI : 10.33564/IJEAST.2026.v10i11.007

Indexed In

Google SCHOLAR OPEN ACCESS doi Crossref

WWW.IJEAST.COM

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International Journal of Engineering Applied Sciences and Technology, 2026
Vol. 10, Issue 11, ISSN No. 2455-2143, Pages 43-49
Published Online March 2026 in IJEAST (http://www.ijeast.com)

AN ANALYSIS AND DESIGN OF 7-LAYERED ARCHITECTURE FOR SMART COMPUTING

Er. Khusboo Roy
Department of Computer Engineering
Sardar Vallabh Bhai Patel University of Agriculture and Technology
Meerut, U.P., India

Dr.Neelendra Badal
Department of Computer Engineering
Kamla Nehru Institute of Technology, Sultanpur, U.P

Abstract— **New generation computing technology, Smart computing, is a combination of hardware, software, and network technologies to provide real-time awareness of real-time systems. This paper presents a brief overview of smart computing and a proposed 7-layer architecture for it. The identification of various factors affecting smart computing through a proposed CLS model is also discussed. These factors were identified hypothetically. Lastly, some application areas and future scope are also discussed.**

Keywords— **Smart Computing, layered architecture, factors, OSI model, CLS model**

I. INTRODUCTION

Not since today but from the eras, computer technologies are working on their tools and techniques to make our daily lives simpler and easier [26]. Today, the world is full of smart technology working in a smart environment with smart devices where each object can connect, communicate, and transfer information to one another. These objects are hardware and software devices that we use in our daily lives that communicate using the internet to share their data and current status over the internet [10][20]. Computers are performing more secure and faster computations. Examples of such smart environments consuming smart technologies are Smart watches, smart-phones, smart-homes, smart-cities, smart agriculture, and so on. In this paper, a detailed description of smart computing is provided along with the evolution of computing technologies. Next, a proposed 7-layered architecture of smart computing is designed and explained. Then, the factors of smart computing are identified through a proposed CLS model hypothetically. Lastly, the application areas of smart computing are discussed along with the conclusion and future scope.

SMART COMPUTING

Smart Computing is a combination of two words: Smart and Computing, where SMART means Self-Monitoring, Analyzing, and Reporting Technology. And Computing means performing computational analysis. Therefore, it collects and stores the data, monitors, and detects for what purpose it was designed, analyzes it, and reports in advance according to the user [5][9][20][26]. According to some researchers, SMART also refers to Specific Measurable / Measurement Achievable Relevant Time Oriented and computing to perform calculations quickly [5]. Monitoring, analyzing, and reporting in a faster and smarter way to make a system, as a smart system. The main focus of smart computing is to provide cheaper technology for solving an existing problem, and look ahead to future problems and preempt them before they happen [26]. It is a sensor-based technology, with the combination of the Internet of Things (IoT), machine learning, Big Data, Artificial Intelligence, etc[18] [20][31].

EVOLUTION OF SMART COMPUTING

Smart computing is a next-generation technology that is among the most recent and widely used. The evolution of computing is illustrated in the following Figure 1:

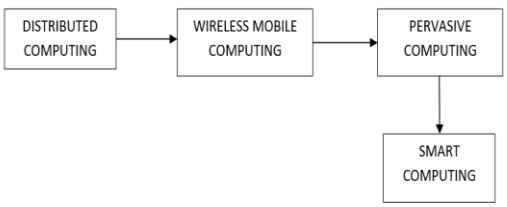

Figure1: Evolution of Smart

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COMPONENTS OF SMART COMPUTING

The components explain how the information travels in this technology and how smart computing functions. These are as follows:

- Sensor devices for sensing the data from hardware and software devices
- Device processors for processing and learning with the previous data
- Cloud for storing the information
- Communicating protocols such as HTTPs or MQTT
- Communicating in languages such as Python

In smart computing, there is 70% of the hardware utilization that is a more efficient use of resources with the smart OS. Smart OS makes computation faster, more efficient, and smarter [28].

5 A's OF SMART COMPUTING

Smart computing comprises five key functions, which are the 5 A's of smart computing [5][10][26], that is discussed below:

a. Awareness
b. Analysis
c. Alternative
d. Action
e. Auditability

All the functionality of smart computing evolves around these 5 A's, and analyzing, reporting, and monitoring functions are performed accordingly. The detailed discussion of the 5 A's is discussed below in Table 1:

S.no	5 A's	Description
A	Awareness	Identification of tools and devices, use of sensors, GPS, RFID [26] Identification of customers (a type of user, identity, location, status) [26][28] Identification of integrated communication technology such as 3G, 4G, etc [5].
B	Analysis	Easy and adaptable servers Storage device enabled by server visualization Data-center automation Storage life cycle management Stretchy processing expansion Increased storage capacity
C	Alternatives	Identify rule engines and workflow [31] What decision should trigger necessary actions
D	Action	Correct action occurs at the correct time On-time notification [10] Type of process application (action will execute through integrated links to the application)
E	Auditability	Technology needs to capture, track, and analyze information What actions are taken (right or wrong) How to improve analysis Identify better alternatives [5][10].

Table 1: Description of the 5 A's of smart computing

Awareness is the most important A among all the 5A's of smart computing. **Innovations in Awareness will have the most revolutionary impact [5]**. The statement justifies that there is a lack of awareness, and then the analytical tool detects and stores the wrong information. An alternative triggers the wrong action that makes a wrong decision, which may lead to a serious problem in the future [26].

For example, A navigation system uses maps and GPS signals to navigate and locate the exact location of the vehicle or a device. If there is a lack of awareness, the navigation system transmits wrong signals, due to which a wrong action may be taken and a vehicle may get stuck in a heavy traffic jam or may take a wrong path. Proper awareness and improved analytical tools are used to avoid such problems. There must be proper tuning among the 5A's of smart computing [5].

II. REVIEW RELATED TO SMART COMPUTING

In Forrester's white paper report, Andrew H. Bartels [5] gives a basic idea of smart computing along with its 5 A's that are its key functions and discusses how it can help in driving the new era of IT growth. This report explains the evolutions in the generation of computing. The main focus is to explain how smart computing helps in predicting future business risks and the growth of the market in the field of technology.

Mrs. Monika Garg, Mr.Promod Kumar, Miss Swati Aggrawal [27] explain how green computing is smart computing. The idea behind it is energy-efficient energy and eco-friendly computing. Effective coding is to conserve resources to make less use of the hardware by having the program.

Matthew N. O. Sadiku, Sarhan M. Musa, and Yu Zhou [26] provide a detailed review of the introduction of smart computing and its application areas.

Muntasser A.Wahsh and Jaspaljeet Singh Dhillion [25] review the factors impacting the implementation of cloud computing for e-government and public sectors. This study follows a systematic literature review (SLR) approach that

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helps to identify what are the various factors that affect cloud computing. As a result, Fifty-nine factors were identified based on their frequencies and seven among them appear to be the most important.

III. 7-LAYERED ARCHITECTURE OF SMART COMPUTING

A 7-layered architecture of smart computing is contrasted with the OSI model of networks, as shown in Figure 1, illustrated below, where all the 7 layers of the OSI model are represented on the left-hand side, and the proposed architecture is represented on the right side. A1, A2, A3, A4, and A5 represent the 5 A's of smart computing, where A1 is the awareness, A2 is the analysis, A3 is the alternative, A4 is the actions, and A5 is the audibility. This proposed model aims to drive a contrast that is similar to the network layer of the OSI model. The analysis of the proposed model and its contrast with the layers of the OSI model is described below: Layer 1 of the OSI model is the physical layer, which indicates the communication between two devices which is connected with transmission media. This layer is contrasted with the hardware devices layer as all the hardware devices were identified and connected and the communication takes place.

Layer 2 of the OSI model is the data-link layer, which indicates the link that is used in the communication. This layer is contrasted with the data-interface layer of the proposed architecture. At this layer, similarly, the link is identified for the communication between the devices.

Layer 3 is the network layer that is used for the connection between the devices. In the proposed architecture, the connection layer is identified for identifying the connections for the devices necessary for communication.

Layer 4 is the transport layer, which provides the messages to the devices regarding the communication. Similarly, in the proposed model, the monitoring layer itself monitors the work for which it is designed.

Layer 5 is the session layer that sets up a session for data transmission. In the proposed architecture model, the analysis layer detects the problem or fault at an early stage.

Layer 6 is the presentation layer in the OSI model, which manages the network characteristics, protocols, and architecture of the communication model. In the proposed model, the reporting layer is designed to report to the user early about the defect.

Layer 7 is the application layer in the OSI model, which provides the details of the applications and communications protocols, and in this architecture model, the smart user layer provides the details of the devices, users, interfaces, and protocols.

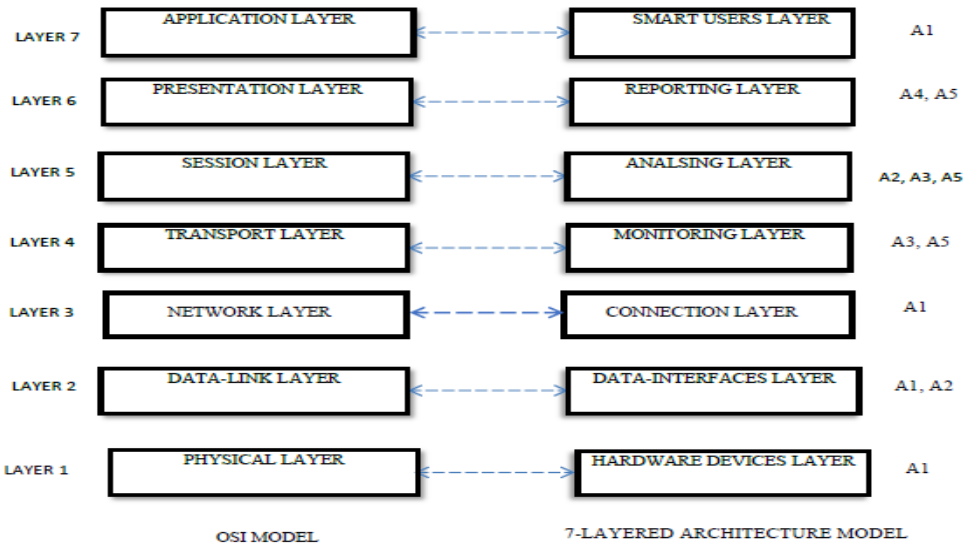

Figure 2: The 7-layered architecture of smart computing

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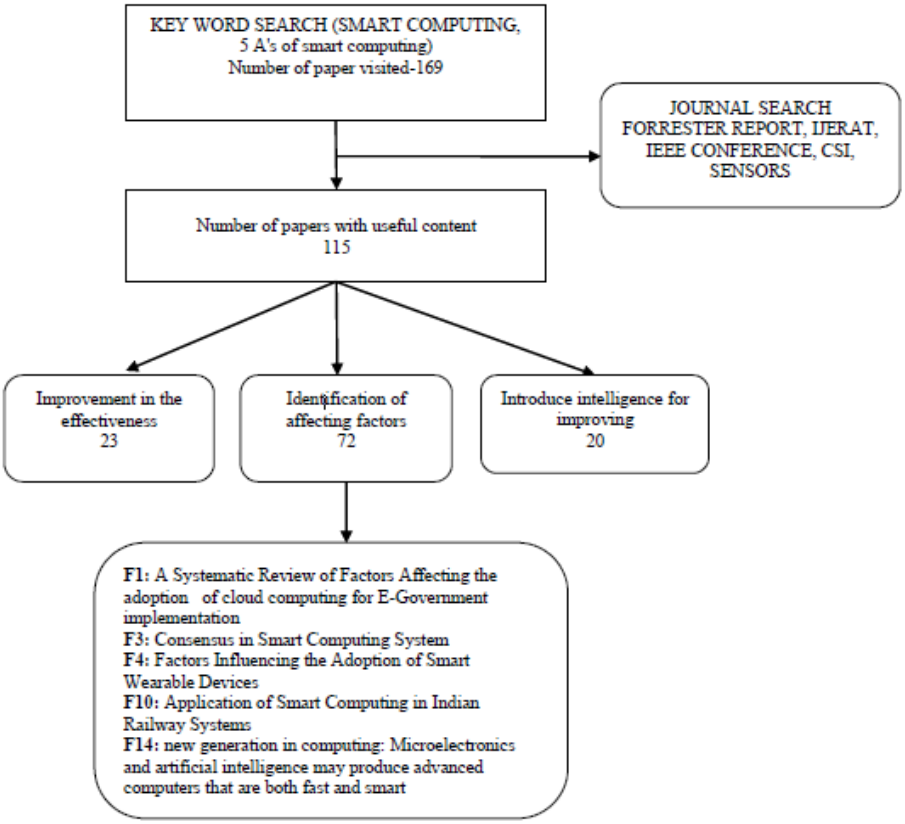

Figure 3: CLS MODEL

FACTORS OF SMART COMPUTING

Adaptability [1][25], Verification [2][28], Authentication [28], After the literature survey, it is found that every computing technology is dependent on some factors. But in this case, no research work describes the factors on which the 5 A's of smart computing are dependent, which further motivates to identify the factors on which smart computing is dependent. Hence, some questions arise that gave birth to this research work, which is discussed below:

- Which factors influence the 5 A's of smart computing?
- Which factors are more important?
- How do these factors affect the adoption of smart computing?
- What are the different challenges associated with the affecting factors?

To answer these questions, the proposed CLS model (comprehensive literature survey) is designed.

Figure 3 represents the CLS (Comprehensive literature survey) model that shows how previous work is beneficial in the identification of factor work. In the model, the procedure of factor identification is explained. At first, the keyword search is performed, which is SMART computing, the 5 A's of smart computing. In this step, any word that is related to smart computing is searched on a search engine.

A total of 169 papers were downloaded and visited. These papers were mostly from the Forrester Report, IEEE Conference, CSI, Sensors, International Journal of Emerging Technology and Advanced Engineering, and many more. Then, sorting of the paper based on useful content is performed. A total of 115 papers were selected and visited. These papers were further classified into three categories based on the objectives of the work. For the identification of affecting factors, 72 papers were reviewed and selected. For improvement in the effectiveness, 23 papers were reviewed and selected, and for introducing intelligence for improving the effectiveness, 20 papers were reviewed and selected.

Lastly, for the first objective, these 72 papers were reviewed, and factors were identified among them. For example, Muntasser A.Wahsh and Jaspaljeet Singh Dhillion [25] review the factors that affect the adoption of cloud computing for e government and public sectors. This study follows a

systematic literature review (SLR) approach that helps to identify what are the various factors that affect cloud computing. As a result, fifty nine factors were identified based on their frequencies, and seven among them appear to be the most important. A similar approach is used for

identifying the factors that affect the effectiveness of smart computing.
A CLS model is designed for the same.
To answer these questions, the following factors are identified that are associated with smart computing.
As a result, the following 19 factors were identified hypothetically that are associated with smart computing indexed in the paper referred. The identified factors are Authorization [28], Accessibility [2], Availability [22], Security [2], Autonomy, Flexibility [23], Adaptability [6][25], Reliability [19], Manageability [24], Predictability, Fault tolerance, Failure management, Accuracy [19], Maintainability, Transparency [2], Robustness, and Reusability.

IV. APPLICATION AREAS

Application areas of smart computing and its architecture are discussed below:

- Real-time working ISRO projects: Presently, most of the recent real-time working projects of ISRO use smart computing technology. Some of the examples are the development of durable and smart catalyst layer structures of the LT PEM Fuel Cell, and real time monitoring of the Electron Beam Welding process by using AE. Smart computing is used largely in ISRO projects, and its architecture may help to understand the application and its working in a more effective way.
- Technologies used in smart systems: smartphones, smart-watches, smart glass, smart banking, smart transportation, smart railways, smart grid in smart cities are some of the examples of the use of smart computing in smart systems. IT applications evolve into highly context-sensitive devices. The architecture designed helps to create smarter applications for a smart environment.
- Smart computing use in learning and engineering education: Smart E-learning models are used for customized and personalized services to the user. Based on student internal performance scores, decisions are taken by management to increase the score of the engineering institution.
- Use of smart computing in animal welfare crowd funding: Advanced tracking and monitoring technologies have been used for pets and wild animals. They can be easily monitored by GPS- and cellular network-based animal trackers.
- Application of smart computing techniques in cost optimization of 1200 kV autotransformer: The statistical analysis of data obtained can be processed through statistical analysis software that uses smart computing techniques to identify the scope for cost optimization, efficiency improvement, and cost-saving in manufacturing. The architecture helps to understand better how this technology works and what may be various ways to obtain optimization.

V. CONCLUSION

Smart computing is an inexpensive technology that tends to smarter and more secure living and better at solving existing complex problems. This study showed smart computing and its 5 A's. Factors have been identified hypothetically. A proposed 7-layered architecture has been designed. A summarization of the identification of factors that may affect smart computing has also been illustrated.

VI. FUTURE SCOPE

It is believed that in the future, smart computing will provide solutions for settling the problems of cloud computing and the complex existing problems of businesses. It is assumed that the 7-layered architecture can provide a clear indication that it will be the most advanced and widely adopted technology across all-over the world, therefore, it will be more sustainable and flexible in the future. A relationship between the 5 A's and affecting factors will provide clearer and more detailed information regarding this technology in the future. The proposed architecture can be expanded in the future.

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