ISSN No:-2456-2165

Standard Protocols for Smart Future Cloud-Native 5G Network Infrastructure

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Abstract:- Cloud computing is the on-demand usage of computer internet services, particularly data storage as well as processing power, without compromising user quality control. The cloud has the significant impact on utilizing the artificial complexity required in developing and designing quality software. Software developmental organization prefers cloud computing for outsourcing tasks because of its available and scalable nature. Using the artificial complexity needed to create and construct high-quality software is greatly impacted by the cloud. Due to its availability and scalability, cloud computing is used by software development organizations for work outsourcing. The goal of this study is to provide a thorough review of recent developments in architectural frameworks for a future 5G network infrastructure that is cloud native and intelligent. The study looks at how a managing management challenge is made simpler by cloud-native networks. This essay also analyses unresolved issues associated with autonomous or intelligent administration in future networks that are cloud-native in order to identify some potential topics for further research and development.

Keywords:- *Cloud Computing, Cloud-Native Network Architecture, Intelligent and Autonomous Management, Network and Service Management, Machine Learning.*

I. INTRODUCTION

Flexible and effective administration is one of the main issues facing future networks built on cloud infrastructure [1]. Future networks will include very large, diverse, and complex integrated communication, compute, and storage systems, needing highly intelligent and automated management solutions. A system for processing, hosting, and providing information made up of apps, websites, and contents is the internet network [2]. Major issues with seamless Internet use include storage inefficiencies, data security issues, and device failures during network backups. As a result, the management of distant servers and the optimization of the data resources have highlighted the necessity and significance of cloud computing. By providing on-demand electronic storage and remote access through a variety of services including infrastructure as a service (IaaS), software as a service (SaaS), or platform as a service, cloud computing technology facilitates immediate applications (PaaS) [3]. AI is increasingly included into cloud and edge computing to automate difficult, time-consuming processes like data processing. But over time, problems with latency and security have been found in the AI-enabled cloud [4]. An AI-based cloud computing system improves automation overall data flow while assisting in managing data repositories. Additionally, the platform allows for rapid and flexible operation rationalization. The text-to-speech algorithm is one AI model used by the most widely used platforms [5,6] and other well-known cloud Service will make providers are examined in the next sections. The efficiency, digital transformation, and general performance of the cloud may all be improved by integrating AI [7]. To help enterprises become more strategic, insight-driven, and efficient while providing more cost savings, agility, and flexibility, an AI-enabled cloud services environment is required [8].

The two technologies may be integrated in a number of different ways to offer a great foundation for increasing productivity. Business companies may become more flexible and responsive in its interactions and reduce production costs by using cloud-hosted applications and data [9]. As a result, businesses can greatly profit from the combination of these two innovative technologies. The cloud has furthermore been compared to a computer game that generates a lot of operational telemetry and data, similar to the technology used in self-driving automobiles [10]. Since an algorithm is used to interpret all available data instead of relying on people, AI-based cloud computing is essentially AI Ops [11,12]. According to Nastic et al. [13], integrating AI and cloud services can boost operational efficiency while enabling firms to become closer to their consumers. Cost reductions, automation, and better data management are some benefits of implementing AI in the cloud.

As a result, it is crucial that a variety of smart management technologies be implemented on the basis of a consistent integrated framework with a shared global perspective. In order to handle the management difficulties in a comprehensive and interoperable manner, this necessitates the standardization of new management structures that facilitate the smooth integration of diverse ML/data analytics methodologies [14]. Presently, various related network SDOs, such as, ETSI, and ITU-T, are employed actively on this important matter as well as making encouraging progress.

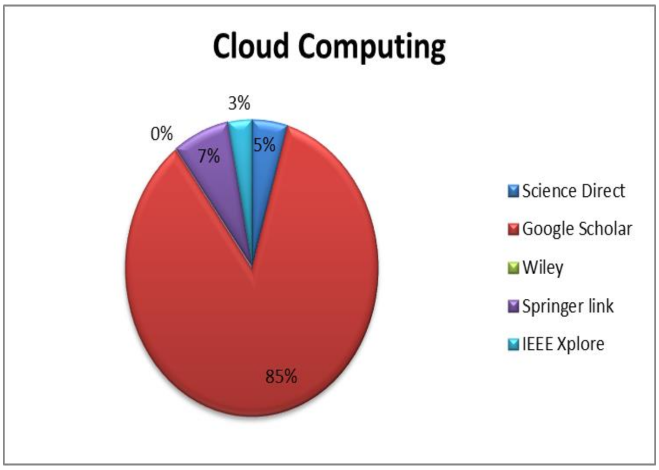

Fig 1 Pie-Chart Showing Web-Based Published Knowledge Available

In order to present a comprehensive overview of the most recent advancements in architecture frameworks enabling autonomous administration in cloud-native future networks, this paper will focus on architectural frameworks. The article begins by providing an outline of the technological trend toward cloud-native network architecture in future networks. The following section of the survey research the most recent significant developments in the standardization of the organization and structure for future optical, such as appears to work by 3GPP, ETSI, as well as ITU-T, and analyses why cloud-native network structure support the change of the architecture for resolving managerial challenges of those networks [15, 16].

The remaining sections of the essay are structured as follows. The motivation for cloud-native architecture is presented in Section 2 along with its implications for future networking. The most recent advancements in management architecture, including ETSI Experiential Networked Intelligence architectural style, the ITU-T Architectural style in ML for Future Networks, and the 3 GPP Network as well as Management Data Analytics Features (NWDAF/MDAS), are then reviewed and analyzed below [17].

II. FUTURE NETWORKS' CLOUD-NATIVE NETWORK ARCHITECTURE

- *Virtualizing Network Functions and using Software-Defined Networking*

Since defining the NFV design in 2012, ETSI has played a key role in the implementation of network virtualization. From designing the basic architectural framework to creating comprehensive standard specifications, ETSI NFV Industry Specification Group (ISG) group has gone through numerous stages of development. Network function virtualization (NFV) permits the realization of network utilities as software instances that are managed by virtual servers or containers that operate on common network/computer hardware, such as servers and switches. The Virtual Network Functions (VNFs) installed on a virtualized infrastructure make up the ETSI NFV architecture. A Virtual Infrastructure Manager (VIM) for united control of network-based assets in the virtualization technology, a VNF Manager (VNFM) for managing VNFs, as well as an NFV Orchestrator (NFVO) for existence supervision of network services are all components of the Management and Orchestration (MANO) scheme of the architecture [18].

The SDN specifications have been developed by a number of internet backbone SDOs, such as ONF, ITU-T, and IETF, but all of them share the same fundamental architecture, which consists of three planes (control plane, the data plane, as well as app plane), as well as two standard interfaces. Decoupling and abstraction are the fundamental ideas driving both SDN and NFV, however they place different emphasis on the layer aspect (for NFV) versus plane dimensions (for SDN) [19]. As a result, it is anticipated that NFV and SDN would be combined in future networks to fully take use of both standards' benefits. For instance, numerous SDN controller instances may be deployed on a network to manage various NFV-based virtual networks (network slices) [20].

- *Design of Cloud-Native Networks*

The contemporary requirements to implement network virtualization and software-defined networking, such as the NFV and SDN frameworks, mainly alter how network functions are implemented and implemented (as software instances hosted on virtual machines or containers), but they make relatively few modifications to how they are designed. Modern NFV systems frequently swap out monolithic software VNFs for their monolithic hardware-based virtual network counterparts, as depicted in fig 2. A monolithic VNF structure may provide several common features that are replicated across various VNFs, which has certain negative effects that hamper network agility and result in suboptimal resource consumption. Additionally, the step interfaces (reference points) that connect the predefined function blocks in both the NFV and SDN designs require standardizations each time a new function block is introduced to the system. The flexibility as well as agility of network infrastructure enabling service provisioning are constrained by such monolithic and tightly coupled architectural elements, which nonetheless cause ossification [21].

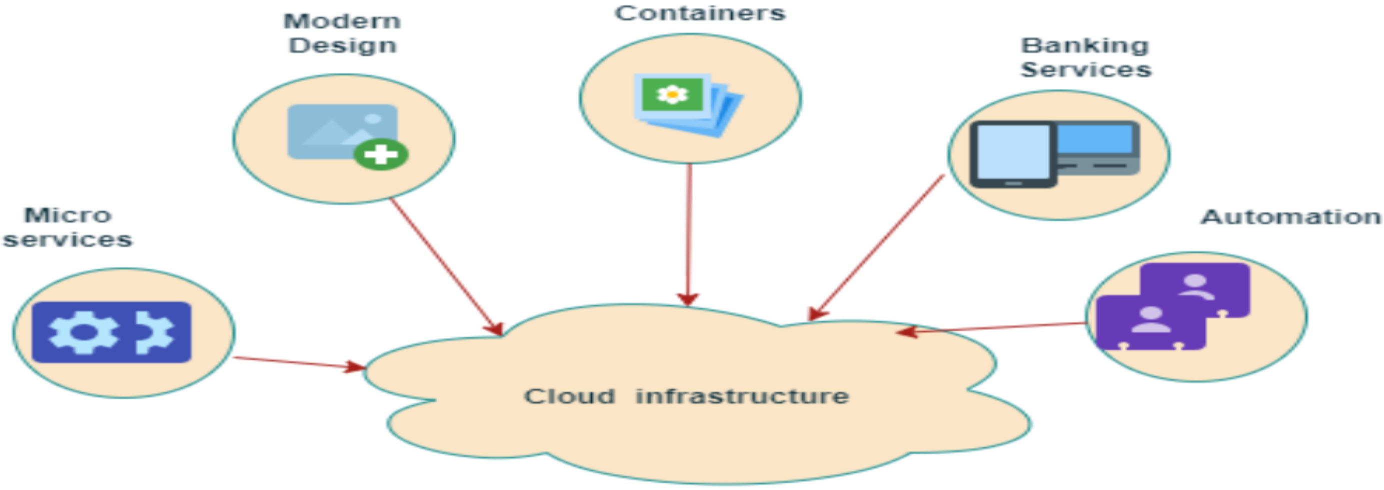

Fig 2 Cloud Native Network Design is Shown

This concept has been adopted by the NFV architects at various levels, even though a network service in the ETSI NFV requirements refers to an ordered list of (simulated) network services stipulated by an application domain (VNF routing graph). For instance, NFV supports the SOA service concepts adopted by NFV Facilities, Virtual Network procedure, as well as Network Slice-as-a-Service [22].

In the 3GPP standards for the 5G provider design, use of the word "server" becomes much more linked with the SOA provider idea than its customary connotation in the networking area. Presently, the Service level agreement Network as a paradigm divides up monolithic network operations into coarsely granular individual service components. By incorporating the newly developing MSA into network architecture, monolithic network operations may be broken down into fine-grained modules which can be dynamically staged to achieve various functionality for service delivery.

Table 1 Components of Cloud Computing.

Entities	Description	References
Cloud users	Users of the cloud are individuals or businesses who purchase cloud applications that satisfy their needs in terms of functionality, cost, management simplicity, etc. The client builds their own model or application on the top of platform using the tools exclusive to the cloud provider.	[48-49]
Servers	The server has all the resources it needs to accept requests from clients and give them the service they seek.	[50]
Platform	Platform acts as a service provider and is dedicated to provide small and medium- sized enterprises on the cloud the best possible development environment. Small businesses who lack the financial resources to maintain security are also given security. Platform is used to construct scalable and adaptable cloud applications. Researchers also refer to platforms as cloud marketplaces. Marketplaces are highlighting the professionalism and innovation of cloud services.	[51-52]
Cloud	Application deployment occurs on the cloud. The cloud also enables the creation of new software development paradigms.	[53-54]
Cloud providers	Cloud providers are businesses that provide a range of services to platforms.	[55,56,57]
Tenants	In a cloud computing system, subscribers, end users, or providers are referred to as tenants.	[58,59]
Brokers	A "cloud broker" is any person or business that acts as a mediator between a customer of cloud computing services and those services' suppliers.	[60,61]
Cloud burners	Burners are resource-starving hijackers who create fake loads.	[62]
Internet	Internet-based communication and cooperation are used by many entities for sharing resources, computing, and storage.	[63]
Cloud creator	They are in charge of building and running a cloud service that, depending on the situation, may be exposed to cloud service users or controlled by cloud service providers.	[64]
Devices	Smart phones, laptops, plus tablets cleared the path for IT flexibility that led to the setting up of cloud computing.	[65,66]
Service providers	organization that offers cloud entities on-demand services.	[67]
Crowd	These persons consist of those who accomplish various jobs. Designers of cloud applications are among them. To ensure high-quality applications, developers use their talents to create, and testers run numerous tests and look for faults.	[68]

The use of virtualization concepts in network architecture assists the realization of network systems based on cloud technologies and the provisioning of network services in accordance with the cloud service model. The term "cloud-native network design" refers to this new advancement in networking technology, that is anticipated to widely used in future networks, including the construction of 5G and 6G networks, as shown below in fig 4. The usage of container-based virtual machines for the deployment of VNF elements as micro services is one major feature of the recent evolution in the NFV standard [23-24].

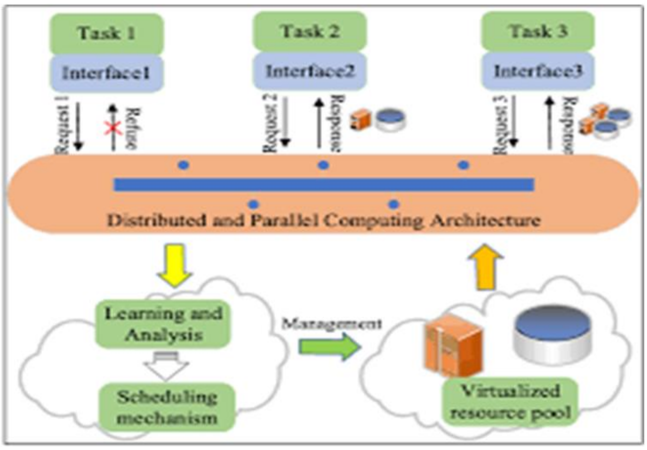

Fig 3 Cloud Assisted Smart Factory Architecture

- *5G Network's Service-Based Architecture*

One example of a network architecture that uses cloud-native design is the Service-Based Architecture (SBA) that is 3GPP designed for 5G core network. Network functions (NFs) just to control the data planes are separated, as well as the NFs specified in the design implemented as software instances installed on a virtual infrastructure, according to the 5G SBA, which is based on virtualization technology and softwarization. The 5G SBA uses the service-oriented philosophy in addition to virtualization and softwarization through concept of NF services exposed by control NFs as well as the Service-Based Interface (SBI) for interfaces among NFS services [25]

Each service user can locate a suitable provider of a performance support thanks to the 5G SBA. The NRF, which maintains the repository of all accessible NF instances as well as the services , supports service finding in the SBA. Each NF instance must register its profile with the NRF, and the profile includes pertinent information about the NF, such as the services it offers and other necessary details for gaining access to those services. The NEF may make available inside-network NF services to approved outside users like AFs. In Release 16, the 3GPP introduced the Service Communication Proxy (SCP), a function for supporting service frameworks that tries to isolate common NF operations for service registration, discovery, and selection [26-27].

The NF product producer as well as consumer can connect in two different ways thanks to the 5G SBA. In the request-response paradigm, a user of a NF service sends a query message to a producer who is providing a target service, and the producer replies with the associated response message. In the subscribed-notify approach, an NF consumer engagement ascribes to a NF services for a specific event(s), and service producer sends the subscribed service consumer a notification message each time the subscribed event takes place [28].

- *Edge Computing*

In essence of the developing edge computing standard installs decentralized cloud services with traditional network edge infrastructures [29]. An example of an edge computing architectural framework is Multi-access Edge Computing (MEC) design created by ETSI. Two layers made up by the MEC architecture: the bottom level is made up of a collection of separate MEC hosts, while the upper level created by MEC system and the MEC servers as well as the network connections that connect them. A number of MEC apps are installed on each MEC host's MEC platform, which is constructed upon top of the network virtualization architecture. Each host's infrastructure, platform, as well as MEC applications are managed by the host-level supervision. An MEC orchestrator, which has a broad perspective of the complete MEC system for synchronizing the host administration for end-to-end service provisioning, performs the essential task of system-level management [30]. This MEC-in-NFV benchmark architecture enables NFV MANO to be used for successful integration and coordination of both VNFs as well as MEC applications by treating the MEC platform with MEC apps in the same manner as the VNFs being managed.

- *Fog Computing*

A layered approach called fog computing enables universal access to a common field of scalable computer resources. The concept, which comprises of fog nodes8 (physical or virtual), located halfway between smart end-devices and cloud services. This makes it easier to develop dispersed, latency-aware applications and services [31]. The fog nodes provide a standard data communication and management framework and are context aware. It can be grouped either vertically to provide isolation, horizontally to facilitate federation, or according to how close the fog nodes to the smart end devices in terms of latency. Fog computing reduces the time it takes for supported applications to receive requests and to respond. It also provides end devices access to local computing resources and network connectivity to centralised services. Edge computing and fog computing are sometimes mistaken for one another, however there are important distinctions between the two ideas. Fog computing uses a multi-layer architecture to execute programmes, which allows for dynamic rearrangements for various applications while providing intelligent processing and transmission services. Edge computing offers a direct implemented while running certain programmes at a fixed logic location [32].

- *Networking wth Cloud/Edge Computing Convergence*

The virtualization underlying service-oriented architectural concepts in networking are adopted by cloud-native network architecture in a manner that is substantially similar to how they are used in cloud/edge computing. In order to allow the convergence of networking and cloud-native networking design enables systems and networks to be realised based on cloud technologies enabling network services to be provisioned in the cloud service model. In order to allow integrated approach of networking-computing functions as well as unified configuration management of network or cloud/edge services, such convergence requires for a comprehensive perspective that spans the network and computing domains [33]. network-cloud/edge convergence, is based on NFV architecture because it offers an uniform virtualization layer for telecommunication networks and shared administration of virtual network/compute services. The 5G network brings the same features concerning virtual network interactions, system operations, or led to growth shared with cloud as well as edge computing through its acceptance of cloud-native architecture in the SBA [34]. Future networks are therefore anticipated to have a focus on network-cloud/edge convergence with interconnected infrastructures enabling edge provisioning of hybrid network-cloud/edge services. The network-cloud/edge integration may greatly enhance resource utilization and service performance, lesser capital and operating costs, and create opportunities for technological and commercial innovations. It also enables holistic design documentation, strategic planning, operation of the system, and service provisioning. In contrast hand, all of these advantages will only be realized if future networks' integrated network-cloud/edge technologies are correctly managed. To effectively utilize different cognitive approaches, such as AI/ML to govern configurations and integrate multiple administration realms for end-to-end service provisioning, standardization of organization and structure for cloud-native wireless optical is critical [35]. The representative standardization effort on organization and structure that solves the difficulties of autonomous and intelligent administration in future networks will be examined in the next parts of this article.

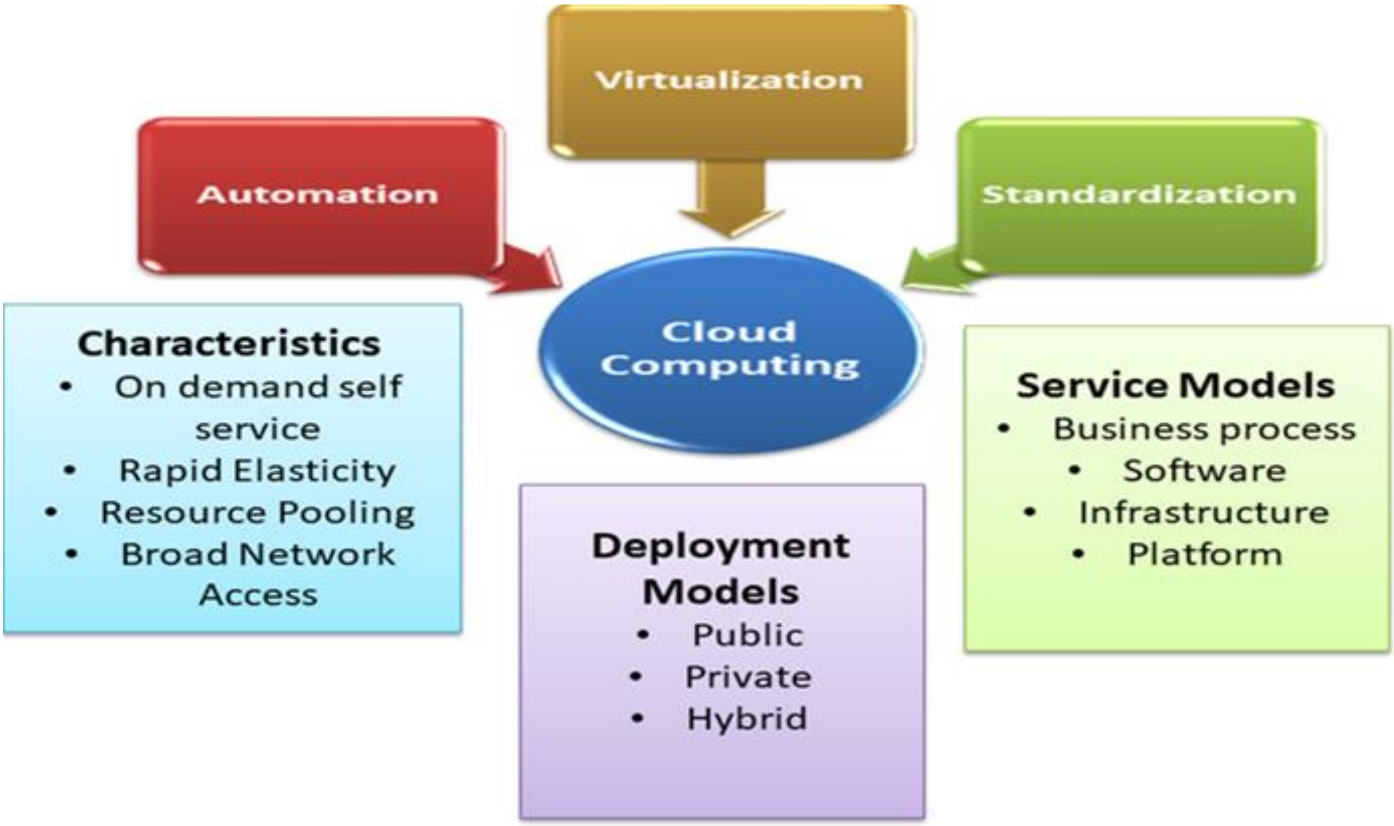

Fig 4 The Components of Cloud Computing Networking are Depicted.

III. ANALYTICS OF NETWORK AND CONTROL DATA INSIDE THE 5G NETWORK INFRASTRUCTURE

The Network Data Analytic Function (NWDAF) is a key feature that supports intelligent network operations, according to the 3GPP definition of the 5G SBA [36]. The 5G network architecture's NWDAF is a general system that enables the integration of different data-driven AI/ML-based analytics technologies. Figure 6 shows a broad structure for 3GPP-developed NWDAF-based 5G communication networks [37]. In order to do the analytics, the NWDAF gathers data from several 5G system modules, such as NFs, AFs, including data repositories (UDR), as seen in this picture. The NFs/AFs that made the request for the analytics are subsequently provided with the analytics information by the NWDAF, who then uses it to make judgments on network operations and maintenance actions. Within this context, the NWDAF also closely collaborates with both the operation Of the network, Administration, as well as Management (OAM) system to gather data from of the OAM and expose analytical information to the OAM.

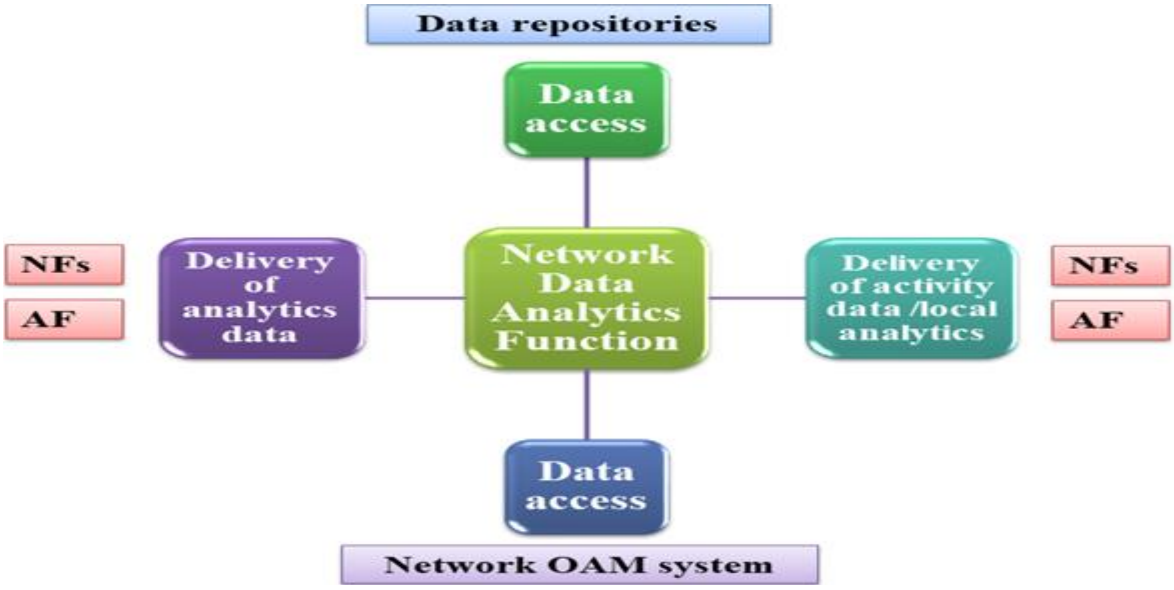

Fig 5 Network Data Analytics Function (NWDAF)-Based Framework for 5G Network Automatic Management.

Inside the 5G SBA architecture, NWDAF is described as a network control. In addition, 3GPP created a framework and provider management architecture (SBMA) for managing and orchestrating 5G networks in accordance with the service-oriented philosophy [38]. The Management Services are the core component of the SBMA (MnSs). A MnS is a collection of network management tools that can be accessed and used through a common service interface. A Management Function (MnF) is with this that may act as a producer or consumer of MnS. An MnF can be implemented as a standalone entity or integrated into an NF, and a collection of MnSs can be freely join in a MnF [39-40]. The Management Data Analytics Platform is that contains the data analytics features of the SBMA (MDAS). Similar to how the NWDAF functions in the control plane, MDAS functions similarly in the 5G control plane and collaborates with the NWDAF. The management loop is handled by MDAS in accordance with current 3GPP standards, whereas the NWDAF concentrates on control loop specifically connected with various networks. However, in actual implementations these two are closely connected features of data advanced analytics in 5G networks may be combined into a single system module to achieve greater effectiveness and performance.

IV. LATEST TECHNIQUES IN AI

Due to the growing development of information technology in cloud computing, several advanced technologies leveraging. AI can be integrated into cloud computing to improve its applicability to various fields. Some of these latest technologies are highlighted the following subsections.

➢ *AI for Cloud-Assisted Smart Factory (CaSF)*

The paradigm shift in the production industry is apparent in near-daily advances in the manufacturing environment. Lately, it has been moving from conventional production patterns to intelligent production settings [41]. Presently, the market demands are overloaded, and conventional single and mass production industries find it challenging to meet these growing demands in terms of different varieties, personalized customization, and small batches [42]. Therefore, transitioning from a conventional manufacturing platform to an intelligent production model is a pressing issue that must be addressed. Wan et al. [43]. Fig. 3 presents a schematic of the Cloud-Assisted Smart Factory Architecture, and there are four distinct layers—the application layer, smart device layer, cloud layer, and network layer. Incorporating AI in intelligent factories enhances the manufacturing system performance in terms of analysis, perception, data processing, and communication [44].

V. ARCHITECTURE FOR EXPERIENTIAL NETWORKED INTELLIGENCE

Data gathering and information dissemination features of intelligent management are main areas of attention for NWDAF/MDAS-centric automation architecture in 5G SBA. The process of converting gathered data into knowledge for controlling entire network in a "observe-orient-decide-act" loop is the other central part. In order to achieve context-aware, ML-driven, as well as policy-based autonomous management, it is crucial to establish an infrastructure for integrating these approaches seamlessly. Different ML techniques could be used at various phases in such a loop. The Experiential Networked Intelligence (ENI) design created by ETSI was designed with this as its primary goal 45].

The information processing component, the analysis module, as well as the output generating module are the three basic components that make up the ENI architecture, as seen in Figure 3. Data integration function and the normalization function are both included input processing modules. The analysis module includes capabilities for managing knowledge, context, cognition, situational awareness, model-driven design, and policies. The demoralization function as well as the output generation routines are both included in the output generation module [46].

Table 2 Table is Showing Literature Already Reported for Networking and Computing.

Authors and Reference	Main Contribution of the Study
Chiregi and Jafari [69]	A thorough analysis of the literature on the most recent strategies for evaluating trust. In terms of integrity, security, dependability, dependability, safety, dynamicity, secrecy, and scalability, they compared 28 researches. (They examine how such controls depend on the architecture and how multi-cloud security techniques are lacking.)
Kratzke and Quint [70]	A thorough analysis of cloud native apps a thorough mapping analysis of cloud native apps (di d not examine challenges unique to multi-cloud)
El-Gazzar [71,72]	A research on the critical concerns surrounding the adoption of cloud computing, including mi gration methods and methodologies; security and confidence in the cloud, and cloud monitorin g (did not investigate multi-cloud- specific concerns when dealing with independent heterogeneous architectures).
Hamzehloui et al. [73], Niknejad et al. [74], Soldani et al. [75]	Studies on various techniques and strategies for breaking down a programme into separate soft ware parts are categorised, discussed, and analysed. These apps' multi-cloud deployments are not addressed.
Liaqat et al. [76]	Review of federated resource management activities in several clouds, broken down into price, discovery, selection, monitoring, allocation, or disaster management of resources.
Ye et al. [77]	The primary criteria for multi- cloud were identified and analyzed from an architecture standpoint (not service and application level). They simply emphasized the necessity for native multi-cloud applications to address various concerns.
Iliashenko et al. [78]	A study on cloud resource monitoring tools (which did not examine multi-cloud specific problems when dealing with different heterogeneous architectures).
Litoiu et al. [79], Edmonds A et al. [80], Almeida et al. [81]	Studies on the operations of federated resource management. There is no specific discussion of multi-cloud.

- *Future Directions*

Gill et al. [47] identified unresolved problems and clear research paths that require wide-ranging investigation to ensure efficient implementation and optimum performance of AI-based cloud computing. 1. QoS and cloud service reliability must be sustained using advanced deep or machine learning algorithms. 2. AI-based autonomic computing is increasingly becoming an essential platform for the IoT and other systematic applications. 3. To reduce energy consumption and boost reliability, network visualization must be made available at a realistic cost in a software-defined, network-based cloud computing environment that employs AI models. 4. Resources scheduling in cloud computing can be enhanced by incorporating AI-enabled algorithms. 5. Cloud-based big data analysis tools deployed with AI functionality can identify trends in customer behavior and provide better understanding and decisions for the customer. This process can be implemented seamlessly through efficiently processing scaling choices.

VI. CONCLUSIONS

Future networks that are cloud-native must have autonomous governance of core network and service provisioning. Future networking will likely be multi-tenant and multi-domain, which calls for standard project management architecture can integrate different management technologies into a single, comprehensive framework. This is due to the wide range of AI/ML-based technology solutions being developed to address various management aspects. In order to enable automated management in future networks that are cloud-native, this research examined the present state of management paradigm standards. First introduced were the idea of cloud-native routing protocol and its effects on upcoming networking. The paper then examined how cloud-native network design supports the latest advancements in fair representation management architectures, such as the 3GPP Network and Strategic planning The report also examined unresolved challenges in intelligent and self-driving management from an analysis were performed and suggested some potential lines of further study.

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