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6G and Blockchain Communication: Applications, Challenges, and Predictions

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Abstract: In today's era 5G network is being used globally, and research/technical officialdoms worldwide started work with 5G communication. But providing high-quality services (QoS) and power proficiency 6G communication is predictable in the network. This paper includes a comprehensive analysis of the development of 6G communication. In this paper, we have discussed diverse network generations with specifications and growths, detailed study of different technologies used in 6G communication has been elaborated. This chapter also deliberates on upcoming challenges in 6G communication for canvassers. Various 6G application areas are also presented in this survey. The critical focus is associated with 6G architecture which includes protocols stacks, coverage, and artificial intelligence. This paper aims to give informative direction for consequent 6G communication research.

Keywords: 6G, AI, Architecture, Wireless Network, Blockchain, Security, THz Communication.

1. INTRODUCTION

It is flattering ostensible that numerous facets of our atmosphere can be observed as a schmoozed ecosphere [1]. From broadcasting networks to the worldwide environment, highway transportation networks to stock marketplaces, and organic to communal systems, enormously interrelated and cooperating components create comparatively energetic systems in the ecosphere. These methods can be categorized as various systems [2]. Multifarious systems investigation can be reflected as a science that educates how the fundamentals of a system advance its cooperative performances, and system interrelates through its surroundings. To comprehend the comportment of a manifold system, it is necessary to initially understand its essential fundamentals and how they treat unruffled to prescribe the comportment of the whole system. Multifarious methods and their anticipated comportment often include allusions to adaptability, emergence, self-organization and development, robustness, resilience, regionalization, and speed. Just work emphasizes fundamental features of diverse methods in this perspective that can be classified as reorganized [3]. Multifarious methods, as linkages of interrelating objects, are premeditated empirically through the support of a rapid upsurge of available statistics of different areas. Concomitantly, these other areas stake numerous novel and important hypothetical queries. Portable communication systems and particularly 5G and upcoming 6G are characteristic illustrations of systems that increase quickly [4]. Grasping their difficulty in terms of heterogeneous fundamentals and significant level of independence develops a foremost obstacle, intimidating to interrupt the material rebellion. Conniving, monitoring, demonstrating, and observing the performance of such networks are the significant challenges that need to be tackled. We requisite novel models as we quickly touch from network based on fastened classified or semi-classified edifices to expose and dispersed schmoozed networks [5]. From a broadcasting network's viewpoint, the crucial issue is to acquire how to project these networks that can self-establish, adapt and improve their connections and tasks in an unremitting and healthy way to alleviate customer requests. The diverse systems detained can offer replicas, concepts, tools, and methods that permit a proper project technique to be developed to tackle this main issue [6]. Portable broadcasting systems and particularly 5G systems, and forthcoming 6G systems, are receiving extra intricate and diverse. The symbolic process of these systems through more solid placements, additional proper positions, uncountable users, and novel tools that are predictable to be announced in 6G systems such as Machine Learning (ML), Artificial Intelligence (AI), Terahertz (THz) band broadcasting and much more [7]. It is again impaired by a tendency to develop software of networking specifications and energetic adaptation of networked amenities. Multifarious schemes could create a valuable and operative contrivance proficient to prototypical the specific performance of networks [8].This paper presents diverse systems from a broadcasting network's viewpoint, enlightening issues and challenges towards 6G networks. Work focuses on 5G/6G communication systems, but the key focus is on 6G study by evolving 5G. The rest of the paper presents 6G architecture, technology, and applications.

1.1 Motivation

The world has perceived novel network generations each decade since the 1980s. Every novel generation provides better features than the previous one. In a newly evolving era, 5G has numerous innovative features. Though, it is suspected having multiple deficiencies of 5G when associated with other modern ICT substitutes. These deficiencies will be a crucial motivation for subsequent new network generation called the Sixth Generation of Mobile Communication (6G).

1.2 Research contribution

In this chapter, the following key research contributions are:

- Upcoming challenges in 6G communication for canvassers are deliberated.

- Various 6G application areas are also presented in this survey.
- The critical focus is associated with 6G architecture which includes protocols stacks, coverage, and artificial intelligence.
- A comprehensive analysis of the development of 6G communication is discussed.
- Diverse network generations with specifications and growths are elaborated.
- The main goal of this chapter is to give informative direction for consequent 6G communication research.

2. ADVANCEMENT OF MOBILE COMMUNICATION NETWORK

There has been a phenomenal advancement in mobile communication networks since the emergence of an analog communications network in the 1980s. This advancement is not a one-step process but consists of several generations with different standards, capacities, and techniques. The new generation has been introduced nearly every ten years [9].

2.1 1G-3G Network

In the 1980s 1G communication network was presented, which was premeditated for voice amenities, with a 2.4 kbps data rate. It implemented analog signal to communicate data without presentable wireless customary, prominent to numerous shortcomings including challenging hand-off, squat broadcast competence, and no safety. Associated to 1G system, two generations were built on digital intonation tools including TDMA and CDMA having data rate up to 64kbps, subsidiary voice, and SMS services. All network standards in the 2G epoch were GSM. 3G was projected in 2000 to have high data transferring speed and provide a 2 Mbps data transmission rate accessing the internet [10].

2.2 4G Network

4G was introduced in the 2000s is IP based, which is proficiently providing high-speed data rates up to 1Gbits/s. It advances phantom competence and decreases expectancy, cooperative necessities set by advanced applications such as DV), TV contented, and video conversation. Furthermore, 4G allows incurable flexibility to offer wireless services anywhere and anytime, over instinctive roaming transversely topographical restrictions of networks. LTE-A and WiMAX are deliberated as 4G ethics. LTE assimilates prevailing and novel tools such as CoMP, MIMO, and OFDM [11].

2.3 5G Network

5G communication system has just about accomplished preliminary rudimentary tests, h/w amenities erection, and calibration procedure and will rapidly be placed into commercial use. The objective of 5G is to create radical progresses in connectivity, network reliability, latency, data, and energy proficiency. Not solitary customs, the novel range of microwaves also creatively customs millimeter-wave the first period and enhances up to 10 Gb data rate. 5G smears advanced admittance tools with BDMA FBMC. Numerous developing tools are united into 5G to recover system concert: MIMO for capability upsurge, SDN for tractability in the system, D2D for phantom proficiency, ICN for decreased traffic in the network, and system slicing for rapid utilization of several services [12].

2.4 6G Network

As we know, 5G is in the profitable distribution stage; research organizations worldwide have instigated to pay courtesy to 6G network, which is deliberated to be installed in around the 2030s. Green six generation is anticipated to improve the concert of data broadcast up to 1 Tbps and ultra-least dormancy in microseconds. It topographies THz broadcasting and latitudinal multiplexing, offering 1000 times more sophisticated capability than 5G systems. The solitary aim of 6G is to attain universal connectivity by assimilating satellite broadcasting systems and underwater broadcasting to provide global exposure. Power reaping tools and custom of innovative resources will significantly recover the network power effectiveness and understand supportable green systems [13].

3. RELATED WORK

Z. Lv et al.[14] proposed a practical elucidation to decrease signal intrusion for better transmitting associated signals. Furthermore, node info in sensors is handled by edge and fog computing, and network broadcasting excellence is also arbitrated by transmission power utilization and packet failure rate. Dual-channel design can distinctly transfer control communications, which minimizes single-channel traffic load and evades crashes amid control and sensor messages. It recovers the performance of transmission information of 6G/IoE. The utility representation of the proposed model is given as:

$$I_{utility} = \frac{I_{times}}{T_{current} - T_{first}} \tag{1}$$

The author in [14] has summarized notations and symbols used in Eq. (1).

The broadcast strategy has been professed as an arbitrarily performing object amid receiver and transmitter by E. Basar et al. [15], which reduces the excellence of acknowledged signal because of irrepressible connections of communicated radios by nearby substances. Current initiation of recon intelligent outsides in broadcast enables. Instead, system machinists control radio waves' sprinkling, response, and bending features by incapacitating undesirable properties of expected propagation in wireless. Baseband signal strength is used as follows:

$$r(t) = \frac{\lambda}{4\pi}\left(\frac{e^{\frac{-j2\pi l}{\lambda}}}{l} + \frac{R \times e^{\frac{-j2\pi(r_1+r_2)}{\lambda}}}{r_1 + r_2}\right) x(t) \tag{2}$$

The author in [15] has described specific symbols and notations mentioned in Eq. (2).

M.S. Sim et al. [16] presented DNN construction and clarified how to evaluate PDP of sub-6 GHz station, which is implemented as input of DNN, then authenticate its recital by actual surroundings-built 3D ray-outlining imitations over midair experimentations using mmWave archetype. The m-th ray is used to design this prototype is as:

$$h_m^{sub} = \sqrt{P_m e^{j\phi_m^{sub}}} F_{TX}^{sub}(\theta_m^{ZoD}, \phi_m^{AoD}) \quad (3)$$

The author in [16] has summarized symbolizations used in Eq. (3).

An IAP-SP reduces the operational difficulty in preserving precise channel retrieval. Using the assessed station, data rate expansion delinquent is expressed and is transformed into a different stage modification exploration problem. X. Ma et al. [17] proposed a comprehensive exploration scheme to acquire an optimum broadcast rate and tolerate a tremendously high operational load. Formerly, a local exploration scheme is developed to minimize separate-stage IRS candidates who experience palpable performance defeat. The transition contribution is implemented to develop the schemes.

$$\sigma = \frac{2e^2}{\pi\hbar^2} k_B T . \ln\left[2\cosh\left(\frac{E_F}{2k_B T}\right)\right] \frac{i}{\omega + i\tau^{-1}} \quad (4)$$

The author in [17] has elaborated on notations and symbols used in Eq. (4).

R. Ahmad et al. [18] proposed TPCSS technique for 6G solution. A complexity exploration is conceded to evaluate the effect of medium and laser constraints on TPCS and comparative TPA drifts. Reconnoitered laser constraints are minimum power and beat size. Variable medium constraints are peroxide elucidation attention and illustration length. TPCS is originated to be sovereign of variation in minimum power. The best-fitted data can be calculated using TPA as follows:

$$T(z) = \sum_{n=0}^{\infty} \frac{(-q_0)^n}{(n+1)^{3/2}(1+x^2)^n} \quad (5)$$

The author in [18] has described symbolizations used in Eq.(5).

The SERS technique is proposed by N. Sykam et al. [19] to uncover the squat attentiveness of peroxide molecules to perceive water prevention. Here, there is little cost, a quick and productive method for the manufacture of EG below microwave radioactivity in 1 min at 800W, and outstanding adsorption substantial for R6G. The consequence of adsorption procedure constraints, including contact time, pH, isotherm replicas, and kinetic reproductions on rinse elimination underneath aqueous resolutions, were explored. Adsorption capability can be intended as follows:

$$q_e = (C_0 - C_e)\frac{V}{m} \quad (6)$$

The author in [19] has described notations used in Eq. (6).

V.A. Chhabra et al. [20] stated the amalgamation of merged polyaniline using PbS QDs, which was successively engaged for snap catalysis of peroxide and Rh-6G. This PbS/PANI amalgamation was organized by commissioning biochemical oxidative polymerization in the occurrence of PbS QDs. Amalgamated has been considered by X-ray precipitate deflection, FTIS, broadcast microscopy electron, and UV spectroscopy. NOMA and mmWave NOMA for forthcoming B5G and 6G network explored by L. Zhu et al.[21]. A unique characteristic of mmWave NOMA is to receive/transmit beam-founding using big staged arrays. A. Yazhar et al. [22] projected 5G NR with possible waveform edifices to estimate waveform constraints in 6G. There will be various waveform constraint selections in the forthcoming. TPs will implement these waveform constraint possibilities even though transmission to dissimilar users using optimum resource distribution pronouncements. R. Goul et al. [23] measured CVD on tasters of dissimilar attentions of R6G on Grapheme/AuNPs substrates by implementing minimum energy. Limited component simulations were done for a network using hemi ellipsoids over numerous circumstances including R6G investigative wrapper the superficial with graphene nanoparticles. Graphene exists amid nanoparticles produced by redshift in plasmatic timbre rate and grapheme reduced electric arena of external.

4. TECHNOLOGIES USED IN 6G

4.1 Spectrum Communication Technique

Spectrum is the underpinning of broadcasting. Since the increase of communication in the 1980s, we have perceived the marvelous development of spectrum possessions in each novel generation because of endless recreation for data rates. The maximum marks of 6G provide Tbps accumulated bit. Terahertz (THz) and visible light are two striking spectrums [24].

4.1.1 THz Communication

The THz is a spectral ensemble amid warm and visual costumes with frequencies from 0.1 THz to 10 THz. Excluding great immature spectrum assets, numerous sole features inspire to implement of THz for forthcoming networks [25].

4.1.2 Perceptible Light Communication

OWC are reflected as harmonizing tools for RF-based broadcasting, and frequency limit contains ultraviolet, perceptible light, and infrared spectrum. The detectable nimble range is the most auspicious continuum of OWC because of scientific improvements and the extensive implementation of LED. LED differentiates from grownup

lighting expertise because of switching to dissimilar light strength echelons rapidly, which allows encoded data in produced light in diverse ways. Perceptible light broadcasting receipts the full benefit of LED to attain double goals of the whirlwind and large rapidity data transmission [26].

4.2 Fundamental Techniques

4.2.1 Blockchain for Decentralized Security

Blockchains are distributed record-based catalogs, and transactions can be steadily recorded and restructured, deprived of central mediators. The intrinsic geographies of blockchain include dispersed interference, confrontation, and secrecy, create it perfect for numerous applications. Blockchain is reflected as a subsequent rebellion for forthcoming broadcasting tools. It assurances tougher safety topographies during broadcast since it allows multiple system objects to strongly admittance precarious. Blockchain also delivers numerous assistances in resource instrumentation and system access [27].

4.2.2 Flexible and Intelligent Material

Notwithstanding marvelous achievements in the broadcast system in previous years, a concert of customary semiconductor resources such as silicon appears to grasp its restrictions and resources by improved large-frequency and large-temperature features are imperative for ultrahigh broadcasting. Silicon and Grapheme used to project succeeding-generation broadcasting devices [28].

4.2.3 Energy Harvesting and Management

Reliable calculation strains for AI dispensation and enhancing the explosion of IoT strategies are posturing critical challenges to the power efficacy of broadcast equipment. Consequently, power-competent broadcast tools will sparkle in 6G, having shorter broadcast distances. In previous years, much exertion has been expended on power reaping and organization investigations. SR tool provides a conceivable elucidation to power delinquent, which assimilates unreceptive backscatter strategies with vigorous broadcast network [29]

4.3 New Communication Paradigm

In the 1980s 1G communication network was presented, which was premeditated for voice amenities, with a 2.4 kbps data rate.

4.3.1 Molecular Broadcast

A novel broadcast model stirred by the environment is a conceivable elucidation that implements biological signals to transmit data, mentioned to molecular broadcast (MB). In MB, biological signals are characteristically minor elements of certain nanometers to some micrometers in extent, including phospholipid vesicles and atoms, which are typically broadcast in gaseous. Associated with the radio broadcast, MB has definite benefits in micro and macro gage [30].

4.3.2 Quantum Broadcast

Quantum broadcast (QB) is a different auspicious broadcast prototype using public safety. The ultimate variance between quantum broadcast and traditional binary-based broadcast is snooping can be sensed on-site. The data is encrypted in the quantum stage with photons/quantum atoms and cannot be retrieved or replicated, deprived of interference it because of quantum ideologies, including the association of tangled atoms and unchallengeable law. Moreover, QB can recover data rates because of the superposition environment of cubits. Another striking fact of QB is its enormous perspective in the large-distance broadcast. QR is a serious strategy for a large-distance universal quantum system. It is proficient in separating QB's detachment into smaller intermediary sections and modifying photon damage and process faults [31].1G-3G Network.

5. CHALLENGES IN 6G COMMUNICATION

5.1 Dynamic Topology

The network topology in the sixth generation is predictable to be dynamic. Because every operator over its system/smart devices forms IoT systems will be associated vigorously to network and offers preeminent QoS at a contemporary instant, will severely variation dynamic networks. Drones, UAVs, drones, radar, and satellite broadcasts will be rapid stirring nodes that should support the complexity. The essential appropriately prototypical meddling subtleties so that devices can become conferral to sub-network rapidly and maintain network reliability [33].

5.2 THz Frequencies

The necessities for sophisticated data rates and sizeable spectral power proficiency execute mistreatment frequencies outside mmWave at terahertz (THz). It provides slight cell enlargement, whose range is limited up to meters. Minute cells will initiate much thicker positioning. Thicker positioning will unavoidably dynamism the investigators to reflect on novel traffic flow supervision methods, novel movement controlling, mobbing mechanism algorithms, and much more [34].

5.3 Access Network for Backhaul Traffic

Network tools will necessitate an enormous escalation in data evolution and reduce the network's access for Backhaul unable to manage it. Research enhancement at progressive bands such as D-Band, including 60 GHz ranges, is accessible and will be personified. FSO and quantum broadcast also reflect 6G backhaul to come across necessities. Drones and telluric stations may involve satellite connection with squat trajectory satellites and CubeSats for providing backhaul sustenance and upsurging ample area attention [35].

5.4 Artificial Intelligence and Machine Learning

Because of the difficulty of 6G systems, it is predictable to include AI for the efficacious and effectual process of such types of systems. AI has previously been implemented in

broadcasting in each OSI layer. Concerning 6G systems, AI is predictable to simplify their process and probable to influence the difficulty. An inescapable outline of AI as the system's superiority is predictable to create important roles in such as semantic broadcast, ML, and NN to complete supervision of broadcasts [36].

5.5 Network Functions Virtualization & SDN

SDN & NFV are the tools that depend on virtualization. The motive of these tools is to permit system projects and structure in s/w execution by fundamental s/w crosswise generic h/w platforms and strategies. SDN emphasizes unraveling system mechanism tools from network advancing tools, whereas NFV eliminates system going and former schmoozing means from the h/w for running, foremost to solarisation of system tools. System amenities adaptation, execution of functioning processes convoluted in manipulative, making, and distributing E2E services. NFV and SDN will improve adaptively in 6G networks [37].

5.6 Blockchain

A blockchain is a predictable tool to sustain in 6G systems. Subsequently, it is reflected a tool that can expressively underwrite the organization of enormous statistics that are predictable for creating and touching in 6G broadcast networks. Blockchain is attained by peer-to-peer systems and exists deprived of being accomplished by integrated authority. Blockchain can probably deliver numerous amenities, including interoperability transversely devices, big traceability data, and communications of different IoT schemes automatically [38].

5.7 Moving Networks

As users will request extensive excellence Internet facilities for moving trains/vehicles/planes, much more is enormously enhancing. Users request similar services as stationary substructure operators, and 6G systems should be capable of offering it. To tackle these apprehensions idea of dynamic networks has been presented. Active networks are a distinct group of adhoc networks. Dynamic networks, because of their volatile environment, knowledge noteworthy quality disputes can be perceived because of the rapidity of vehicles [39]

5.8 Intelligent Surfaces

Intelligent Surfaces are encouraging the developing h/w tool to recover the range and power efficacy of WSN. MIMOs implement antennae composed of large number arrays to amend their radioactivity designs over periods and occurrence for both broadcast and receiving. HSFs know the broadcast surroundings of electromagnetic surfs through programmatically organized meta-exteriors to outfit specified purposes. The RIS-associated idea encompasses RIS array components. Meta-exteriors are thin planar, artificial edifices that have newly permitted the comprehension of original electromagnetic and visual mechanisms by engineerable amenities [40].

6. 6G APPLICATION AREAS

To enhance Internet implementation in rural regions, users must get assistance offered for everyday existence, strengthening performance and ultimately making the commercial situation feasible for machinists. Significance to rustic operators can be revealed through. Moreover, the operator's necessity to espouse the available facilities, which will enhance the petition and inspire users to increase the connectivity delivered. There are various 6G applications areas as follows [41]:

6.1 Health

In rustic zones, patients are the absence of excellent healthcare. Tele prescription signifies an appropriate elucidation to tackle this issue. Main fitness hubs can be exploited with regular stopovers; however, transfer to subordinate and tertiary fitness hubs does not precisely include custom machinery to hand over patient info. Dissimilar methods are projected where community employees assist patients in the rustic zone to interconnect with medics, implementing hypermedia equipment trusting on strengthened broadband reinforced by broadcasting [42].

6.2 Education

Education is a significant facility for delivering distant rustic zones. In-distant teaching is delivered to rural zones via virtual programs based on multimedia. Flipped-based classroom archetypal was implemented to support online teaching. Candidates were incapacitated by poor connectivity in rustic zones that delayed the enactment of classroom setup for video conferencing. A communication teaching method implementing satellite TV networks is verified for rural regions. Because of the absence of dependable Internet broadcasting, learners can mostly use custom tablets to interpret eBooks [43].

6.3 Farming

Agriculture is a distinctive application region for rural zones that can assist in Internet broadcasting or LAN. For instance, IoT-based devices are used for achieving exact irrigation in fields through imperfect obtainability of irrigation marine. Trickle irrigation uses the accurate volume of aquatic and improves sprayed fields nearby herbal ancestries [61]. Sensor nodes in IoT are projected for agriculture applications in rustic areas deprived of broadcasting or cloud communication. UAVs are implemented to gather capacities from sensors connected with IoT and communicate them to adjacent 5G base stations [44].

6.4 Financial services

ATMs development and using POS tools posture many issues in rural regions. A key challenge is the need for dependable broadcasting for performing transactions through cards by users in real time. Improved safety can be attained with

smartphones accompanied by smart card rendering to the broadcasting approach. Though convinced disputes endure being tackled, the utmost significant possibility of overdrawing with definite bank A/C is to collect the amount on a card and permit reliable ATMs to modify it while withdrawing [45].

6.5 E-Commerce

A system for associating support assemblies in rustic regions was developed. The main goal is to provision micro businesspersons in rural zones to enlarge their productions and upkeep native frugality. The system implements IVR and mVAS to permit transactions amid rustic shareholders to upkeep micro businesspersons in rural regions and permit them to increase commercial events. In the mobile-based system, it is assumed that inhabitants lack good teaching and monetary revenues to individual workstations and access to web services [46].

6.6 eGovernment

A bottom-up method is projected before founding e-supervision in rural regions, where amenities connected to agriculture, health, and education in the rural areas should spread a certain standard level earlier boarding on the e-supervision plan. Or else, an e-supervision plan would not be attained envisioned assistance as the rural region is nevertheless prepared for acceptance [47].

6.7 Other Services

Kiosks offer to employ prospects in rural regions to upkeep native frugality. Career searchers can upload their info at the kiosk. However, workers upload available openings. Similar kiosks can be implemented for selling/buying objectives. Wherever vendors can promote their harvests at kiosks. Every kiosk is connected to the server through Internet. Bus ticket service is also considered in different areas, and ticket retailing positions in rural regions agonized from unhurried connectivity to dominant servers. Consequently, the ML approach is implemented on dominant servers for handling services [48].

7. 6G PROPOSED ARCHITECTURE

6G networks are anticipated to attain power-proficient and communally unified wireless links worldwide. However, prevailing network design cannot assure forthcoming application provisions restraints such as high throughput, low latency, and consistency. Consequently, onward observing investigation on forthcoming network outlines is essential. In this paper architecture of the 6G network is proposed and formulated till 2030 [2]. Though it is impractical to precisely demonstrate the open 6G network architecture, we presented 6 G-associated architecture. This architecture has three basic categories: enhanced stratification, intelligent connection, and universal coverage. The Stratification network view includes content-driven routing, management plane, dynamic spectrum access, fluid antenna, blockchain, new spectrum THz, and VLC. Intelligent connection is a significant view of this architecture introducing novel technologies in distributed artificial intelligence, intelligent radio, and real-time intelligent edge [49]. 6G network coverage will include space, aerial, terrestrial, undersea, and much more. HTS methods are proficient in broadband network service similar to telluric facilities, including evaluating and bandwidth. NGSO system provides minimum-latency, large-bitrate worldwide network access, and numerous satellite collections to instigate commercialization. LEO networks have been definitude in concept and simulation surroundings with laser and RF mechanisms to deliver low latency broadcast than terrestrial [50].

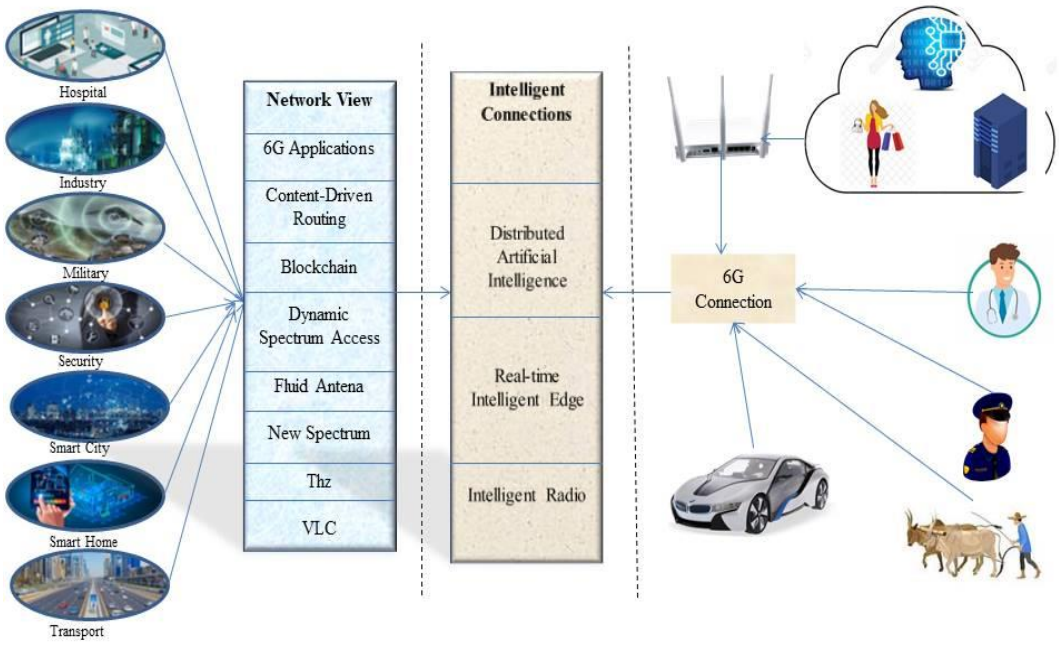

Fig. 1. Network Architecture for 6G

8. CONCLUSION

Nearly exponential upsurge in broadcast data, particularly multimedia statistics and quick propagation of all intelligent devices for subsequent broadcast development towards 6G. 6G communications are encouraging, a significant upsurge in QoS, and a supportable future. In this chapter, we have discussed a detailed survey of 6G communications. We instigate with development of network generations from 1G to 5G, which designates the expansion drift of 6G to a certain level. Detailed studies of different technologies used in 6G communication have been elaborated. This chapter also deliberates on upcoming challenges in 6G communication for canvassers. Various 6G application areas are also presented in this survey. The critical focus is associated with 6G architecture which includes protocols stacks, coverage, and artificial intelligence. The goal of this chapter is to give informative direction for consequent 6G communication research.

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