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A Comparison and Analysis of Wireless Fidelity to Light Fidelity and its Combination of Networks

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Abstract:- Internet speed is a major issue in today's world and everyone is encouraged to get the right data at the right time and place. Company, agencies, associations, entrepreneurs, for example. Network convergence is proposed to integrate multiple technologies. worlds to overcome the rapidly growing usage of digital devices and their demands placed for Internet services.The recently introduced convincing path to indoor communication networks is the combination of light fidelity (Li-Fi) and wireless fidelity (Wi-Fi), i.e. the hybrid Li-Fi networks (HLWNet). The evolution of connectivity (LI-FI), which will influence all lives, is expressed in this article. This form of network incorporates Li-Fi's high-speed data transfer and widespread Wi-Fi availability.It is a technology that can provide up to 10 Gbps of premium and more efficient and useful bandwidth than Wi-Fi probably. Li-Fi is not supposed to replace Wi-Fi entirely, but the two technologies can be used together to create more efficient technologies. In this paper, we present a survey on the introduction to Li-Fi and HLWNets which includes fast internet connectivity, infrastructure, and a broad spectrum of channels. Furthermore, the specific obstacles that HLWNets encounter and recent achievements are reviewed. We also elaborated it in many research directions.

Keywords:- *Li-Fi(Light-Fidelity);Wi-Fi(Wireless-Fidelity); LED(Light Emitting Diode);VLC(VisibleLight Communication); Wireless technology; network convergence; radio frequency (RF).*

I. INTRODUCTION

The unique visual communication database one which Cisco published Technologies believe that mobile data usage will indeed be cellular around 2022, 71 percent of Ip network activity is compensated for, and much more Indoor connectivity would register for even more than 80% of mobile broadband [2].In the 5th generation and even beyond (5GB) period, this leads to Wireless communication across a short distance. Wireless fidelity (Wi-Fi), for instance, is expected to become a significant factor.To address RF's emerging frequency scarcity, Wireless transmission techniques, that produce incredibly great communication, Increased wavelengths have received great interest. Among the Li-fi demonstrates these technologies By Use of Light [3].As a signal carrier, waves may promote the massive optical signal, nearly 300 THz, withthat same novel technology.It's indeed possible to integrate Li-Fi Wireless Networks into the present technology for light, e.g., light-emitting diode (LED) lamps, Recognition of the dual system which provides light sources and communication. Recent research suggests that Li-Fi can reach a maximum data rate above 10 Gbps with a single LED [4].Using mixtures of red, green, and blue LEDs, with each frequency encoding a separate data channel capable of transmitting data of about 100-500 Mb/s, researchers are working to regulate the wavelength of light. We are presently using campus Wi-Fi resources and connecting our P.C's, laptops, palmtops, and P.C. to about 10-100 meters.The issues affecting Wi-Fi today are power,accessibility, effectiveness, confidentiality, and public safety.Many other benefits are offered by Li-Fi through its RF equivalent, including the optical network which is license-free, the ability to be used in locations with RF limits, and the opportunity to have a protected and healthy workplace,As light, communications systems do not traverse the opaque to entities.Li-Fi has also certain restrictions because that encompasses a Comparatively shortrange with a single AP, normally a few yards, vulnerable to loss of communication due to obstacles. As a complementary strategy to Wi-Fi, moreover, Li-Fi is to meet the future demand for data rates, as a useful technology.

A. THE LIGHT FIDELITY WORK PRINCIPLES

The working principle of Li-Fi was initially proposed by Harald Haas from the University of Edinburgh, UK, in his TED Global talk on VLC. "The working principle of li-fi is very simple, it is based on the transmission of digital data 0's and 1's. The logic is, if the LED is OFF", digital 0 is transmitted and if the LED is ON, digital 1 is transmitted, which can't be detected by the human eye. The Led can be turned on and off very quickly, allowing us to send data using light. White Leds are commonly used to implement the notion of li-fi, which uses a steady current to provide illumination. Fast fluctuations in the current, on the other hand, can cause the light output to vary at extraordinarily high speeds [1]. To build up a message we are flashing the LEDs numerous times. To obtain data rates in the range of hundreds of megabytes per second we can use an array of LEDs which also helps us for parallel data transmission or we can also use a combination of three basic colors LEDs red, green, blue to alter the frequency of light. Visible light between 400 THz (780 nm) and 800 THz (375 nm) is used as the optical carrier for data transmission and illumination in VLC (Visible Light Communication).

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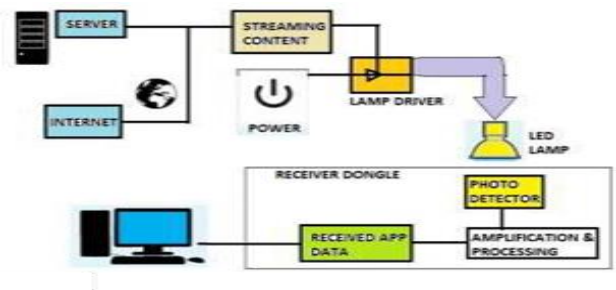

Fig. 1: Block diagram of a transmitter and receiving section of li-fi

figure 1 represents that all the data on the internet will be streamed to a lamp driver at one end whenthe LED is turned ON, the microchip converts the digital data in the form of lightThen the signal is received by a light-sensitive device known as aphotodetector, which will help to convert it back into original data, then it is given to the device which is connected to it.

B. HOW THE BASIC LIGHT ISCONVERTED INTO ELECTRICITY

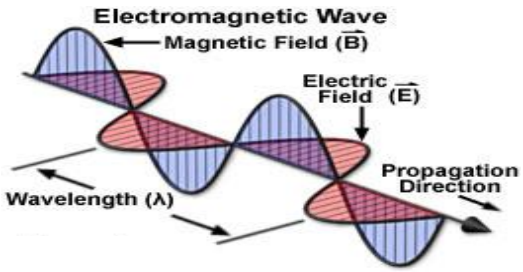

Fig. 2: Diagram of a plane linearly polarized wave propagating from left to right.

Vacuum equations, electromagnetic waves, and speed oflightthat facilitate the concurrent 3D diagram show a plane linearly polarizedwavepropagatingfromlefttoright.

Where E=E0sin(−ωt+k·r) (a)
B=B0sin(−ωt+k·r) (b) (1)

Here (a) and (b)representtheelectricandmagnetic wave equationrespectively. Production of inaregion, such as in a vacuum, with no charges i.e.,ρ=0 and no currents i.e.,J=0, Equation 1 is reduced Maxwell'sequations:

$$\nabla . E = 0 \; \nabla \; X \; E = -\frac{\partial B}{\partial t}$$

$$\nabla . B = 0 \nabla \; X \; B = -\frac{1}{c2}\frac{\partial B}{\partial t} (2)$$

electronic Now, taking the curl (∇×) of the equations, and usingthecurlofthecuridentity∇×(∇×X)=∇(∇·X) $-\nabla^2$X we obtain the wave equations (2)

$$\frac{1}{c^2}\frac{\delta^2 E}{\delta t^2} - \nabla^2 E = 0, \quad \frac{1}{c^2}\frac{\delta^2 B}{\delta t^2} - \nabla^2 B = 0 \quad (3)$$

Which identity, $C = \frac{1}{\sqrt{\mu_0 C_0}} = 2.99792458 \; X \; 10^8 ms^{-1}$

Where C is the speed of light in free space. In materials with relative permittivity εr and relative

perme ability μr, the phase velocity of light becomes m which is usually less thanc.

$$v_P = \frac{1}{\sqrt{\mu_0 u_r c_0 \mathcal{E}_r}}$$

Also, E and B are mutually perpendicular to each other and the direction of wave propagation and are in phase with each other. A sinusoidal plane wave is one special solution of these equations. Maxwell's equations explain how these waves can physically propagate through space.The changing magnetic field creates a changing electric field through Faraday's law. In turn, that electric field creates a changing magnetic field through Maxwell's correction to Amperes' law. This perpetual cycle allows these waves, now known as electromagnetic radiation, to move through space at velocity *c*.The idea of a combination Li-Fi and Wi-Fi framework (HLWNet) was first discussed by Rahaim et al. in 2011, incorporating the greater transmission of data with Li-Fi and the widespread availability of Broadband.[5] The experiment was enhanced to incorporate Li-Fi and cellular antennas. It has been shown that this type of hybrid network provides better results network performance than a discrete Li-Fi or RF system [6]. The main contributions of this paper are reviewing the introduction to Li-Fi and Hybrid networks which includes fast internet connectivity, infrastructure, and a broad spectrum of channels. The unique challenges faced by hybrid network communication and recent achievements.

II. REVIEW ON LI-FI

Li-fi technology is based on light sources like LED for the transmission of data.With the help of all kinds of light, we can transfer the data, no matter what part of the spectrum they belong to. That is, the light can belong to the invisible, ultraviolet, or visible part of the spectrum. Also, the speed of communication is more than sufficient for downloading movies, games, music, and all in very little time.

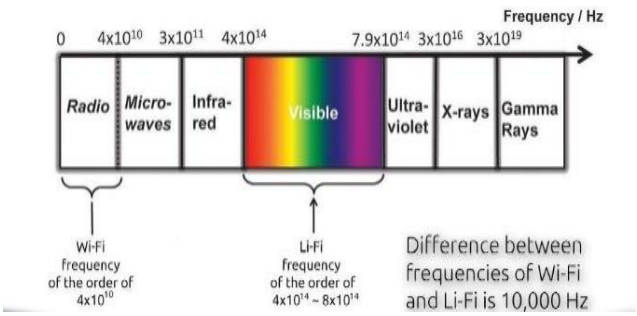

Fig. 3: Electromagnetic spectrum

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Capacity: -The light bandwidth is 1000 times wider than the radio wave bandwidth. Since the equipment is already available and the light sources are already installed, a higher capacity is available.Efficiency: -LED light is highly effective and uses less energy. Cheaper: - Because the cost of the LED is lower and less energy is used, it is cheaper. Availability: As light sources are everywhere; accessibility is not a concern. There are billions of light bulbs around the world, only to be replaced with LEDs for proper data transmission. Security: They cannot be intercepted or misused because light waves cannot penetrate through walls. They're providing safe entry.Free band: - Li-Fi is a free band that does not need licensing will be used. High speed: -The theoretical speed of one gigabyte per second is given. Research challenges of Li-Fi were summarized in multiple articles [8][10],including the fields of system design, optical multiple-input multiple-output (MIMO), channel coding, and networking.

research involves a simple model of light-path blockage, the optimal traffic allocation is only developed for stationary users. Apart from that, [11]fails to consider the frequency reuse among LiFi APs and consequent interference management. A similar system design work was carried out in [12], but with the functionality of spectrum and power allocation. Nonetheless, this work still targets stationary users and lacks a comprehensive overview of theHLWNet.

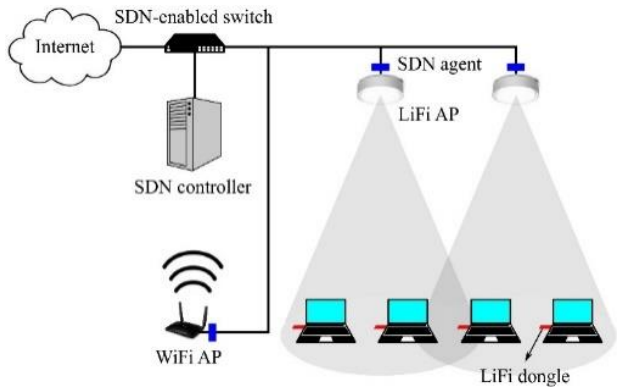

Fig. 3: Network structure of HLWNets based on an SDN platform.

III. APPLICATIONS OF LI-FI

From access to the internet by the common society via street lamps to auto-pilot cars interacting by their headlights, the LI-FI system finds a range of applications in many fields. Also, LI-FI is an option that can offer higher data access speeds in places such as pharmacies and airplanes where WI-FI cannot be used. Education system: In educational facilities, LI-FI can replace WI-FI to have a faster Internet. Medical applications: In operation rooms, WI-FI is not permitted because it can interfere with medical equipment. Also, radiation poses risks to patients. LI-FI uses light and can, thus, be used instead of WI-FI. Internet connectivity in aircraft: The use of WI-FI in aircraft is forbidden because it can interfere with the aircraft's navigational systems. Users are provided very low-speed internet connections at high prices. As it uses light and can provide quicker internet connectivity, LI-FI is thus a safe alternative to WI-FI in aircraft. Underwater application: Underwater ROVs (Remotely Operated Vehicles) operate from large power supply cables that enable their pilots to receive signals from above. But it is not long enough for the cable used in ROVs to allow them to explore larger areas. They would be much freer to explore if their wires were replaced with light, such as from a submerged, high-powered lamp. They could also use their headlamps to communicate with each other, autonomously process data, and regularly return their findings to the surface. Where Wi-Fi fails, LI-FI can also operate underwater, thereby opening the doors to unlimited potential for military activities. Radio broadcast: Radio masts take a high amount of power to broadcast and this makes them very inefficient. LEDs, on the other hand, require very low operating power, which ensures that LI-FI uses very little power as well.

A. FEW MORE IMPLEMENTATIONS

Want to Live a Little Longer: Medical technology has been a few steps behind the wireless world since its inception.Owing to radiation issues, operating rooms do not accommodate WI-FI, and there is also a complete lack of dedicated spectrum. Wi-Fi interference triggers signal blocking from tracking devices from mobile phones and computers.

Li-Li addresses both problems: the most glaring fixtures in the room are lamps, and Li-Fi has 10,000 times the Wi-Fi spectrum as well.Provide their energy and enable them to receive the above signals from their pilots. Except when the tethers are not long enough to explore an area, but when something gets trapped on it, ROVs work well. They would also be very free to explore if their connections were removed and replaced by light, say from a submerged, high-powered lamp. They could also communicate with each other through their headlightsSmarter Airlines: Wi-Fi airlines, Ugh, you have to be either an adventure freak or a fool to play on an airplane around radio waves, which is a security issue, and then during a flight, we are asked to turn off our electrical devices. The best I've learned so far is that a "soon" connectivity on certain airlines and speeds as high as 9.8 Mbps per aircraft would "high-speed like" be provided to passengers. Li-Fi, however, can easily add that kind of speed to the reading light for each passenger seat.Better and Effective Power Plants: For vulnerable areas like power plants, Wi-Fi, and many other forms of radiation are poor. But to track things like demand, grid integrity, and (in nuclear plants) core temperature, thermal power plants need quick, interconnected data systems. For these sensitive areas, Li-Fi may provide stable communication (like no radiation). Not only does this save a lot of money from the existing designs of power plants, but if they have not yet switched to LED lighting, the draw on the reserves of a power plant will be reduced.

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IV. A FRAMEWORK OF HLWNET

A HLWNet architecture consisting of six components is introduced in this section: network structure, cell deployment, multiple access schemes, modulation strategies, lighting specifications, and backhaul.

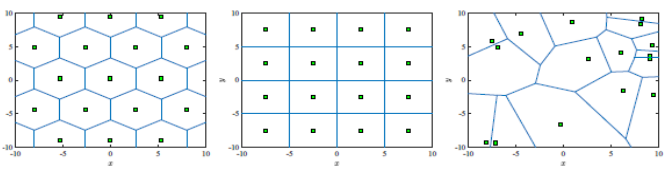
A. Network of structure

A hypervisor controlling all APs is necessary to achieve a flexible user association and allocation of resources.Using software-defined networking (SDN)[13], which decouples the control plane from the data plane of the forwarding devices, this can be realized. SDN platform development for HLWNets is still in its infancy.In [14], the Medium of ApplicationIt was suggested a cross-layer access control (MAC) scheme that uses flow admission control to dynamically distribute LiFi and WiFi MAC layer resources. An SDN-enabled switch links and extracts main APs from LiFi and WiFi.Input on performance indicators (KPI) from them by SDN agents, as shown in Fig. 3. This information is then transmitted to the SDN controller, which makes decisions about the flow routes of each data packet received.

B. Cell deployment

One of the cellular networks' main functions is to resolve the problem of cellular networks.Spectrum congestion problem. The creation of cellular networks can beVia various kinds of cell deployments. Based on their measurements, mainstream cell deployments can be categorized. The Wyner model, which organizes APs in a linear array [15], is a standard one-dimensional (1D) cell deployment.For outdoor scenarios along a path, highway, or railway [16], this model is often used. In certain special cases, such as drone systems [17], three-dimensional (3D) deployments are studied. For an indoor situation, which is the primary objective of thisPaper, grid-based two-dimensional (2D) cell deployments areAs they can provide a general type of coverage, they are preferable.Normally, LED lamps, which act as LiFi APs, are fixed onThe ceiling of a chamber. Three types of deployments for 2D cellsLattice, hexagon, and Poisson are commonly seen in literature:Phase of points (PPP) [18].Fig. 4 illustrates these deployments, which are presented and answered below.

Hexagon: The deployment of the hexagon, which is seen in Fig. 4a, is commonly used as an ideal cellular structure. Due to the ready implementation of frequency reuse, networks. This deployment gives the highest likelihood of SINR coverage.Li-Fi in [18]. Although it is impossible in a practical scenario to have such a deployment, it is necessary to research this deployment to provide an upper bound review.



(a)Hexagon (b)Lattice (c) PPP

Fig. 4: Different types of 2D cell deployments

Lattice: The most realistic deployment of the lattice isDue to the topological character, and is widely used for LiFi,Lamps for walls. The deployment, shown in Fig. 3b,-3b,Many research linked to HLWNets have been widely adopted.[19] to [21]. Research in [18] shows that signal-to-interferenceis the signal.The probability of coverage plus-noise ratio (SINR) ofThe lattice deployment is very similar to the hexagonal deployment.Poisson Point process: Alternative to normal and deterministic processesThe PPP deployment mimics deployments at random.APS that are located, as shown in Fig. 4b.4c. This is unusual and impractical.Due to the task of using this deployment for LiFi,in meeting the requirements of illumination. Other than that, the PPPProvides the worst probability of SINR coverage among the notedThree [18] deployments. Consequently, only a few studies[12], using the Li-Fi network PPP deployment.

C. Multiple access

The well-known IEEE 802.11 series standards for Wi-Fi areMultiple access with a collision that adopts carrier-sense(CSMA/CA) avoidanceThe Li-Fi standardization continues to beIn development, primarily in three classes of tasks: IEEE P802.15.13,ITU G.vlc and 802.11bb IEEE [22]. We introduce in this papermultiple-access systems that are future access systemsFor LiFi, like CSMA/CA [23], multiple time-divisionAccess (TDMA) [24], [25], orthogonal division of frequenciesMultiple Access (OFDMA) [26]-[28], multiple space-divisionAccess Multiple Access (SDMA) [29],[30], and Multiple Access Non-orthogonal(NOMA) [31].

CSMA/CA: Mobile terminals according to this schemethe channel and nodes try to prevent collisions by sensing the channel andThe data packet is then transmitted if the channel is found to beBecome idle. Optionally, CSMA/CA may benefit from the request to—The exchange of send (RTS) and clear-to-send (CTS) between theReceiver and transmitter [32]. When you can enter a node,It can use the entire bandwidth of the channel.CSMA/CA adopts a slotted exponential binary backoffCollision avoidance scheme due to parallel transmissionAround nodes. This is known as crash prevention.The protocol functions. Hence, nodes before transmission. Listen to the channel for a distributed time interval calledSpace Inter-Frame (DIFS). Then if the channel is discovered toBe idle, random backoffs are created by the nodes, CSMA/CA adopts a slotted binary exponential backoff scheme to minimize collisions due to node transmission simultaneously. This is known as the protocol's collision avoidance feature. Hence, nodes before propagationfor a time interval called distribute, listen to the channelSpace Inter-Frame. The node with the lowest backoff sends the RTS frame to the AP before transmission.Before other nodes. If it receives the RTS frame at the APAfter a short inter-frame space, the AP effectively responds(SIFS) with frame CTS. Once the CTS is received by the node,After the packet, the data frame will continue to be transmitted after theSIFS-defined time interval. An acceptance, finally,after another SIFS seconds, the (ACK) packet is transmitted to inform the serving AP of good packet receipt. Fig.4 shows the four-way handshaking of the CSMA/CA witha Mechanism for RTS/CTS.

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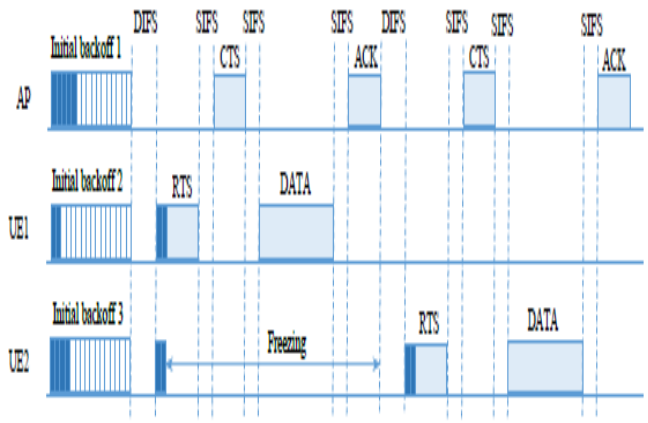

Fig. 5: CSMA/CA with four-way handshaking RTS/CTS mechanism

In both Wi-Fi systems, CSMA/CA can be used.HLWNets networks and Li-Fi systems. The study job, however,is found in [33] that the conventional CSMA/CA will activateIf it is used for Li-Fi in an HLWNet, an unexpected collision.This is attributable to the use of different techniques of transmission.Visible light and infrared in the downlink and uplink of Li-Fi,respectively, respectively. An updated CSMA/CA is therefore proposed in [33].To decrease the number of collisions that can be attributed to the collisionsHLWNets' Li-Fi framework.

D. Modulation techniques

Typical methods of modulation that accommodate LiFi structures can beClassified into two designations: single and multiple carriers. On-off keying (OOK), modulation of the pulse position, unipolar keying (OOK),Modulation of pulse amplitude (PAM), modulation of pulse widthModulated discrete multi-tone enhancement of pulse amplitudeSingle carrier modulation techniques are traditional. These methods of single carrier modulation are simple to implement and areIdeal for low-speed applications. Among them, modulation of OOKLow-medium data rate transmission is more common forBecause of its low difficulty.

E. Illumination requirements

One efficient way of enhancing HWLNets energy efficiency is the location or arrangement of the LEDs is properly planned. Under the considered method of indoor Li-Fi. Via the optimization of the Places and the regulation of the LEDs' output power levels, the minimum consumption of energy, and, at the same time, the optimal It is possible to achieve illumination pattern. It is quite important that, when designing an HLWNet that is energy efficient, the lightingThe space cap should also be exceeded. According to theInternational Standardization Agency (ISO) onLight and decoration, the criteria for indoor illuminationin the atmosphere should be between 300 and 1500 lx [34].The illuminance at the corners of a room is usually poor, whileAt the core of the place, it is high. A cautious style, therefore,Uniform illuminance must be given to meet the ISOObligation

V. CHALLENGES IN LI-FI

It faces a few challenges, apart from many advantages over wi-fi technology, that need to be overcomethe transmission of data requires for a line of sight.We lose connection to the internet if the light source malfunctions. We focus on a source of light for internet connectivity.If the device is set up outdoors, we have to deal with changing weather conditions. As visible light cannot passthrough brick walls, anyone who simply walks in front of an LED source can easily block it. even after they have been How the receiving system can relay the data back to the transmitter is a big challenge.

VI. CONCLUSION

LiFi is a modern technology that has wide applications. Every bulb can be used to transmit wireless data as a wifi hotspot if this technology can be put into practical use. This concept can be used to solve problems such as the lack of radio frequency bandwidth.This technology thus offers various advantages. We will proceed towards a greener, safer, and cleaner future by using this technology. It's an advanced strategy that soon would make our lives more powered by technology.The unavoidable trade-off between the rate of data transfer andThe spectrum of coverage supports the coexistence of LiFi and WiFi,Composition of HLWNets, a promising option for futureWireless Indoor Communications. Not only can HLWNetsNetwork efficiency can be greatly improved, but it can also benefitApplication facilities such as positioning indoors and physical implementationsProtection for layers. Handovers are classified as a key problem inHLWNets, especially a choice between a vertical handoverA horizontal handover as well. Load Balancing Low-ComplexityForHLWNets, techniques are important, because Traffic overload is vulnerable to WiFi APs. Accordingly,A central control unit, such as an SDN platform, is essential.

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