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Li-Fi Technology: An Overview of Its Basics, Future Potential, Difficulties, and Potential Uses

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Abstract: Features and Services that Set Cloud Computing ApartWe've come a long way in only a few decades, from clunky phones used solely for voice communication to sleek, lightweight smartphones that can multitask, access the web at fast rates, and play high-definition movies. One big difference between now and previous generations is the speed at which information travels. If we want to expand our capabilities and yet keep up with exponential growth, we'll need to increase the data rate correspondingly. We look at a Li-Fi/Wi-Fi hybrid wireless network in this research paper. Data transmission across wireless networks is greatly enhanced by Li-Fi's use of two layers of tiny attocells in the visible light spectrum. LiFi and Wi-Fi utilize wholly different frequency bands since they operate on different parts of the electromagnetic spectrum. Due to their restricted coverage area, Li-Fi APs might degrade overall system performance if even a little amount of client mobility causes frequent handoffs between Li-Fi attocells. However, when the handover period becomes shorter, the data throughput of Li-Fi rises with the growing bandwidth of the Li-Fi AP servicing the client. In addition, a comprehensive comparison between LiFi and Wi-Fi has been created.

Keywords: *CCI, Mobility, Data Rate, Handover, Atocells, Cellular Radio Access Network (C-RAN), Li-Fi, Wi-Fi, Heterogeneous Network*

1. Introduction

Technologists have been motivated to explore the millimeter wave frequency spectrum for multiple gigabit wireless connection by the intensive growth of multimedia wireless devices. Due to recent advancements in antenna technology, the RF CMOS process, and highly mobile baseband signal processing methods, millimeter-wave wireless communication is now a realistic possibility. The enormous data rate of millimeter wave wireless communication systems (multi-gigabits per second) has led to their use in important areas such as WPAN, WLAN, and cellular backhaul. You may choose from frequencies anywhere between 28 and 38 gigahertz, 45 and 60 gigahertz, and even higher than 100 gigahertz. In this ZTE communications special edition, we will discuss recent advances in gigabit millimeter wave wireless communication.

Our government's efforts to promote renewable clean energy and the Digital India initiative may be aided by Li-Fi because it makes use of preexisting lighting infrastructure to transmit data, making Li-Fi a green communication. The human eye is just not capable of detecting the very subtle and rapid changes in light intensity that are employed to transmit data. Because of the limited RF electromagnetic spectrum, internet service providers in many countries are investing in radiation-free, license-free optical wireless communication via hybrid heterogeneous network systems to alleviate traffic congestion.

2. Li-Fi and VLC

The development of data-hungry multi-media mobile devices has led to congestion of the radio frequency band. A license-free and unexploited optical frequency for wireless communication, the 300 THz spectrum band might be used to implement Li-Fi technology as a solution to current congestion [1]. The benefit of Li-Fi is that it does not conflict with RF signals since it uses a different frequency. The ability to build up a heterogeneous network (HetNet) is enabled.

Heterogeneous networks improve the data throughput and quality of service of an indoor system [5]. The overall data rate is higher in a network architecture where Li-Fi and RF systems are coexisting, rather than in a parallel Li-Fi and RF infrastructure, since the RF system is unaffected by Li-Fi.

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Load balancing in hybrid heterogeneous networks may be difficult to get right because of the atto size of Li-Fi service regions. While most of the recent literature [4] has assumed a static resource allocation, in actuality, clients may be mobile, therefore this must be taken into consideration. This results in disruption for users when they transition between Li-Fi atocells.

Two different changes are occurring:
The flat handover between Li-Fi atocells is one kind of handoff.
Different heights are required for the handoff between the Li-Fi and Wi-Fi networks.
Clients provide information to the CU during a handover, which might take time if the algorithm is complicated [8] or if there are transmission issues. However, in a hybrid heterogeneous network, stability is an issue since one changeover might lead to another, but in a traditional RF system, handover happens at a lower signal-to-noise ratio (SNR).
In order to send data, LED light is used in optical wireless communication (OWC). Visible light communication employs a kind of rapid switching that is impossible for human sight to detect. Li-Fi networks need constantly-on LEDs for data transmission, however this light may be dimmed such that it is not visible to the naked eye. It can't be hacked since it has a short range and can't pass through walls.[5] Trying to draw a line between very low latency (VLC) and light fidelity (Li-Fi). By using LEDs to create a fully networked wifi system, Li-Fi enhances VLC. Increased wireless capacity and a path toward the next generation of wireless systems are both benefits of Li-Fi attocells, which help establish the basis for the Internet of Things. All the major lines of inquiry into Li-Fi/Wi-Fi hybrid components are laid out here. There is no in-depth theoretical analysis, but actual implementation is happening [6].

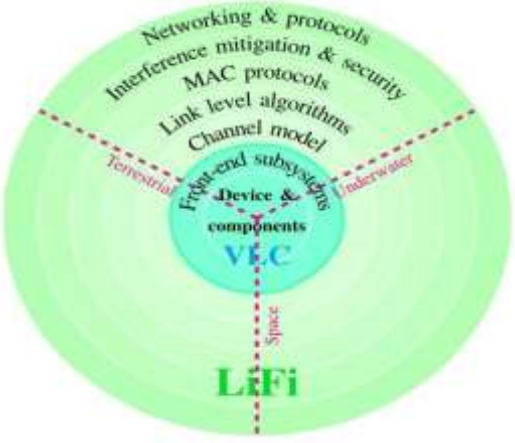

Figure 1. Building blocks of Li-Fi [5]

For its IM-based data transfer, VLC uses LEDs. Direct detection (DD) is used by the photodiode (PD) to receive the signal at the end of the receiving process. VLC may be regarded of as a cable switch in terms of more conventional data transfer networks. Because of this, work has begun to evaluate IEEE802.15.7 [6] VLC standards. Since it defines a complete, multi-client, bidirectional wireless communication system, Li-Fi has been included into this standard. Li-Fi offers the smallest visible atocell for wireless data transport by using a dispersed access point network. Li-Fi enables clients to move about freely and establish a new communication layer inside preexisting wireless networks. Since LEDs are not natural beam producers, local content of Li-Fi signals is possible due to blocking of signals by light walls, and integrated channel interference may be effectively managed and physical layer protection can be enhanced.

3. Need of Heterogeneous Networks

Due to the saturation of the RF frequency range, the ever-increasing demand for data is a major problem in the optical wireless communication sector today. When preparing for the long-term usage of the RF spectrum band, we must take into account the availability of the alternative spectrum band. The capacity of the visible light spectrum band is 300THz and it does not need a license, making it an ideal choice for meeting the ever-increasing demand for data. [10]
Since the band is free, a Li-Fi network must be implemented to solve the current data issue; this network does not interfere with RF transmissions since it uses a different kind of electromagnetic interloping. Therefore, data transmission makes advantage of visible light since it is freely available everywhere on Earth. [4] Connecting our visible light communication systems is an important step for incorporating harvesting of this band into our suitability. Therefore, an LED-based space light system is used to construct a hybrid heterogeneous network for LAN communications inside a building. This networking solution has many benefits over traditional RF-based systems, such as improved isolation between outdoor and indoor systems, smaller receiver and transmitter sizes, and the absence of RF licensing constraints.

The indoor system may be networked with the centralized RF system or it may function as a solo service provider while being networked with the outdoor system, depending on utility, fairness, placement of load area, and availability of access point in the proximity. While light-based access points may be utilized to deliver data to unexplored regions inside their attocells alone, hence reducing the security problem, the system must be tuned to guarantee that the handover and load balancing are carried out properly when the mobility element is present. [4]
The ability to utilize visible light without interfering with RF transmissions is a major advantage.

leverage the convenience of a hybrid heterogeneous network. In addition, visible light's high data rate and storage capacity are advantageous. In comparison to Wi-Fi's reliance on radio frequency, Li-Fi's use of light to transport data in each tiny attocell has a number of benefits, such as scalability to a wide variety of bandwidths, resilience in the face of radiation and interception, and rapid data transfer rates.

In the last several years, this technology has been intensively developed by many organizations throughout the globe. Recent advances in optical wireless communication and visible light communication have helped engineers design a hybrid heterogeneous network that, when put together, can handle the huge data demand of traffic in any given location.
The number of people using the internet is rising rapidly in every country, and a hybrid network will be useful in the future for satisfying the demands of these billions of people. This may be accomplished by setting up the central Wi-Fi to talk to each of the APs in the attocells. Due to the high installation cost and low power of LED based Li-Fi systems, this hybrid network is unable to compete in the competitive telecommunication markets as a key online source of multimedia data demand.

Researchers are always looking for improved methods to construct Li-Fi devices in order to increase data client capacity. That will surely help make the internet more widely adopted as a critical new source of speedy data transmission. While they do a good job of satisfying demand, they do increase network congestion. As a result, it is essential to set up a hybrid heterogeneous network capable of covering a wide range of locations.

4. Li-Fi and Wi-Fi Coupled ConnectedDevices

For communications based on entanglement, a robust, low-power network of linked devices is necessary. Both 5G and 6G have their own quirks and restrictions. LiFi serves as a bridge between these many systems and uses.
Due to the tremendous increase in data traffic in recent years, modern Wi-Fi networks are in risk of collapsing under their own weight, resulting in interferences and other hitherto unseen faults. Previously, it was proposed that we couple Wi-Fi and LiFi ecosystems to meet the needs of the interconnected devices. In this scenario, LiFi would serve as a complement to Wi-Fi. Low-power smart sensors are essential for modern Internet of Things and Internet of Everything devices. Because reliability is more essential than speed, we need a dependable method of transmitting fewer data packets. We need a balance between speed and dependability, however, since business is expected to expand.
Therefore, we need to prepare for this possibility by putting in place the necessary infrastructure now.

On the left side of Fig. 4, labeled "Things in IoT," we may implement a communication-network-based ecosystem in which sensors, actuators, and other ancillary devices interact in real time through a matrix array of these devices.
iv. Sensors in the actual world may provide instantaneous data on environmental conditions including temperature, humidity, and lighting. While it is generally preferable to enter physical parameters, non-physical readable data may be transformed to a signal that the sensor can read if absolutely required. Wireless data transfer may occur thanks to the gateway's field-enabled connection. The gateway's major role is to facilitate communication across various services and applications by using a decentralized cloud-based solution.
We can still compare an actuator in an industrial application to a sensor, even if there would be a massive quantity of unique data points to produce. They allow electromagnetic waves or mathematical logic to be switched between the 1 (on) and 0 (off) states.
The gadget incorporates a wide range of technologies, including as cellphones, laptops, portable devices, cutting-edge AI-enabled chip-based systems, and more. Businesses spend money on multitasking tools because one person just couldn't do certain tasks. In order for sensors to talk to the underlying dispersed network, the IoT gateway must first translate the protocols used in the field into those of the cloud.
Connecting applications and interface middlewares and simplifying interactions across networks, Message Queue Telemetry Transport (MQTT) provides the subscribe/publish architecture, which comprises of a publisher, a broker, and an end user (subscriber). When scalability, latency, and reliability are more critical than throughput, it is common practice to combine MQTT and HTTP in IoT applications. It's possible that the system will use a LiFi downlink.
When downlinking data, a light source driver (for an LED bulb, for instance) is employed. Orthogonal frequency division multiplexing (OFDM) and pulse width modulation (PWM) are two methods of modulation that may be used to transform data into a binary format. A driver receives the necessary instructions and controls the light source. The fluctuating light signal is first captured by a photo-detector and then sent to a signal conditioner. Here, the signal is amplified and read by the program being used by the end user.
[7]

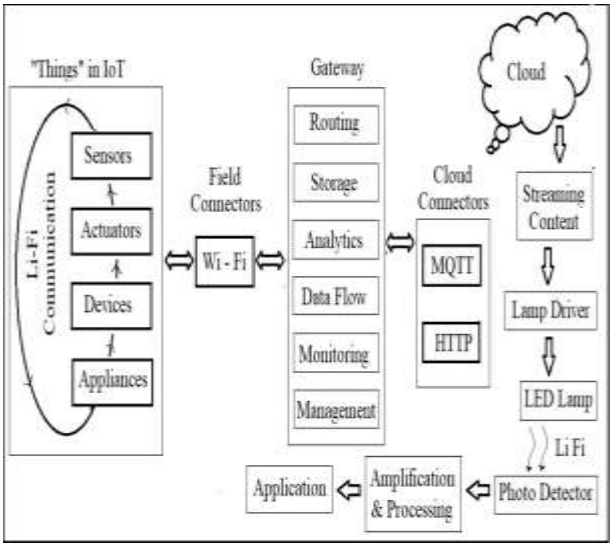

Figure 2. Li-Fi and Wi-Fi combined system design [7]

5. Crucial Applications of LiFi

It's possible to see LiFi as a supplement to Wi-Fi (see also: 14). When combined, they might be a game-changer by making internet access considerably quicker than with just regular Wi-Fi. In this article, we'll look at the most common scenarios when LiFi is superior over Wi-Fi:

Damage to existing service towers from natural catastrophes like tsunamis, earthquakes, cyclones, and tornadoes might make it difficult or impossible for them to continue delivering their usual services.

Here, the retrofitted LiFi-enabled LEDs in the lampposts might be useful. Given that the area's well-lit roadways are spaced at regular intervals. So, even if an emergency were to happen, the safeguards may still work.

Before landing or taking off, flight attendants often request that passengers turn off or put their personal devices into flight mode. 16. We may, however, make up for this in a just and reasonable way by using LiFi.

Because of concerns about the impact of radiation on patients' heart rates and other vital indicators, Wi-Fi has been prohibited in critical care units. The signal may interfere with the functioning of hospital equipment. LiFi has the potential to revolutionize contemporary medical treatment methods that include robots.

Jammers used in electronic warfare might be used against traditional military weapons. But if we need to do things on a smaller scale, LiFi connection might come in handy. Since the communications would be contained inside the room, we may also have a secure connection that is difficult to detect and abuse remotely.

V. Subsea Survey (19) Wi-Fi is useless at depth and serves no use. However, if its capabilities are limited to that role, LiFi might be used to perform untethered exploratory activities. [3]

6. Advantages of Li-Fi

The fundamental benefit of LiFi-based communication is the possibility of making available a high data rate. Working at a higher frequency allows for the potential of a broader bandwidth and, by extension, a greater data rate when the system is used in the visible light spectrum. It's estimated that the visible light frequency band will be 10,000 times more accommodating than the standard radio frequency range. The pursuit of gigahertz frequencies has been predicted for quite some time.

ii. It's no surprise that customer demand for data transport has skyrocketed, requiring ever expanding bandwidth. Spectrum scarcity is an issue that has to be addressed. The radio frequency spectrum has been widely used, yet there is an increasing need to make place for more use. A further problem is getting the required permits to operate an RF-based communication system. The good news is that the visible light range, which may be used in the area, is immune to this problem. Taking use of this frequency range has the potential to resolve the problem.

Older radio communication systems easily overheat due to their high energy consumption, thus they need a cooling mechanism that takes even more energy. LEDs, in contrast to conventional lighting systems, use less power and need no special cooling setup. It's also really informative.

Since light waves cannot pass through solid walls, the communication channel may be restricted to the immediate region surrounding the signal's origin, making it harder for hackers to get access from afar.

v. Disruptions to traditional systems are brought on by multi-path propagation. When the transmitted and reflected signals are out of phase with one another, the summed signal cannot be trusted.

possible rejection of the signal, etc. The light signals add to and build upon one another rather than canceling one another out.

Due to the necessity for a synchronous-demodulation circuit, the receiver system of a traditional radio communication system is infamously complicated. Any wireless communication system would be useless without an RF (radio frequency) circuit. However, establishing LiFi connectivity is simple. It uses direct modulation and demodulation, using a photodetector at the receiving end and a light source at the sending end. [10]

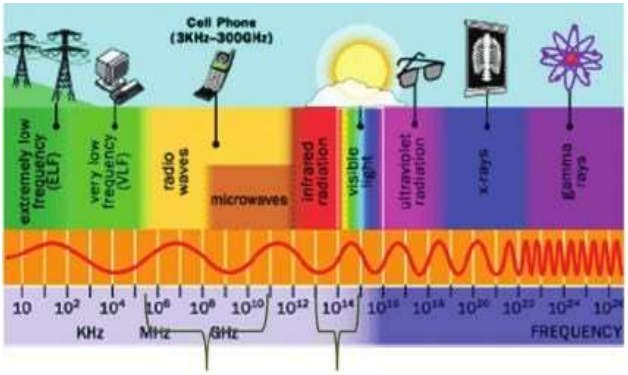

Figure 3. Frequency spectrum of visible light [10]

Expected Challenges for Li-Fi

Despite the incredible potential of LiFi, there are now unresolved issues that must be dealt with. Among the most pressing problems that must be solved are:

Noise signals and glitches in the original transmission may be produced by an external source of light.

The most basic issue that must be addressed is flickering. LEDs are designed to be turned on and off, and this on/off cycle must be executed in unison for the lights and the communication to work as intended. When a series of data packets are sent, the LED turns on and off, altering the amount of light spread throughout the area. Furthermore, repeated changes might eventually cause damage to human eyes.

Because light cannot travel through opaque objects, such as walls, LiFi's potential applications are limited to indoor settings. When passing through a transparent material, even the intensity is diminished. Uncertainty surrounds the widespread implementation of LiFi until this problem is resolved.

iv Clear, unobstructed line of sight is required for reliable LiFi data transmission. Therefore, the full potential of that device cannot be used without adequate line of sight. [3]

7. Conclusion

When paired with a Wi-Fi network, LiFi can reach its full potential. Despite having different throughputs and methods of exercise, they are shown to be correlated. Improving local coverage with the robust and fast data rates that are in high demand both now and in the future is attainable via the strategic integration of Wi-Fi and LiFi. We may expect that LiFi will be a facilitator of

these needs because of the nature of advances in the technology supporting connected devices.

Despite the technology's obvious benefits, it's not yet ready for widespread use across very long distances. The system may be disrupted by any opaque object, whether it is inside or out. A major drawback of the system is its limited uplink capacity, which prevents the transmission of light-based signals from User Data to Access Port.

LiFi is unlike any other kind of wireless Internet connection. It's effective just in the range of light that humans can see. LiFi is a wireless networking technology that does not use antennas but rather a system of lights, gateways, and photodetectors. More gadgets can be linked with LiFi since the light frequency spectrum is significantly bigger than the radio frequency band. The possibility of avoiding license issues also exists. Furthermore, this technology already has safeguards against remote hacks.

References

[1] A good example is "Light fidelity (Li-Fi): Towards alloptical networking," which was presented by D. Tsonev, S. Videv, and H. Haas at the Proc. SPIE, Broadband Access Communication Technologies VIII conference in December 2013 in San Francisco, California, United States.

[2] Based on the work of X. Li, R. Zhang, and L. Hanzo, "Cooperative load balancing in hybrid visible light communications and Wi-Fi," IEEE Trans.

[3] Please refer to [3]K. T. Swami and A. A. Moghe, "A Review of LiFi Technology," 2020 5th IEEE International Conference on Recent Advances and Innovations in Engineering (ICRAIE), pages 1-5.

See [4] for more information: "Resource allocation under delay guarantee constraints for heterogeneous visible-light and RF femtocells," IEEE Trans. Wireless Communication, volume 14, number 2, pages 1020-1034, February 2014. Reference: [4] F. Jin, R. Zhang, and L. Hanzo.

The article "What is Li-Fi?," authored by H. Haas, Y. Wang, and C. Chen, was published in the March 15, 2016 edition of volume 34, number 6 of the IEEE Journal of Lightwave Technology.

According to [6] "IEEE 802.15.7 visible light communication: Modulation schemes and dimming support," IEEE Commun. Mag., volume 50, issue 3, pages 72-82, March 2012. In reference to: [6] S. Rajagopal, R. Roberts, and S.-K. Lim.

[7] "Li + Wi Fi: The Future of Internet of Things," by S. P. Bhanse and S. R. Pawar, presented at the 2018 Third International Conference on Communication and Electronics Systems (ICCES), pages 538-543.

[8] For example, see [8] "Capacity bounds for wireless optical intensity channels with Gaussian noise," IEEE Trans. Inf. Theory, volume 56, issue 12, pages 6066-6077, December 2010.

In 2020, at the 15th IEEE International Conference on Industrial and Information Systems (ICIIS), J. M. Abraham, H. Kumar, and G. J. Bala will publish "Li-Fi: Illuminating the Future of Internet," which will be published on pages 550-554 of the conference proceedings.

[10] Reference: [10] Future Applications of LiFi Technology Exploration. (2018). Alfattani, Safwan. Journal of Optical Communications, Volume 42, Issue 2.