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Mobile Communications 4G and 5G Effect on Coronavirus (Covid-19) and other Diseases

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ABSTRACT

Mobile communications in various generations up to fifth generation (5G) developed in time have offered a gigantic change in telecommunications field by the applications of digital electronics switching with optical fibre as well as wireless technologies in the world. Presently people have all types of communication facilities to pace in the mobile communications age in 4G, 5G and higher Generation having very high speed data communications by the help of electromagnetic waves transmission-receiving system in MHz to GHz range. It has a tremendous bad effect on human and animal health due to exposure of very high frequency electromagnetic waves. Recently pandemic Coronavirus (Covid-19) disease severely intensifies due to less immunity power of human beings which is caused by 4G and 5G mobile communications system.

KEYWORDS: *First Generation (1G) mobile communications, Global System for Mobile Communications (2G GSM), Code Division Multiple Access (2G CDMA) Mobile Communications, UMTS, WCDMA, CDMA 2000, Blue Tooth, WiFi, WLAN, WPAN, WiMAX, LTE, OFDM, OFDMA, Millimetre-Wave Communications, Massive MIMO, Immunity Power, Coronavirus (Covid-19) disease*

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I. INTRODUCTION AND DEVELOPMENT OF MOBILE COMMUNICATIONS 1G TO 3G

Wireless or mobile communication is the most demand area of communications at present. The first wireless communication established by Guglielmo Marconi of Italy in 1897, when contact between two ships sailing in the English Channel was made through wireless. The development of cellular communications [1]-[8] supports simultaneously voice telephony with other services like transmission of video, image, text, data and multimedia etc. The two resources are very much limited, i.e., availability of radio spectrum or bandwidth and transmitted power of mobile handset or mobile battery power [1]-[8]. By the invention of new processors (VLSI, ULSI, Nano chips etc.), jelly filled battery like Li-ion or Li-Sulfur battery, and different multiple access technologies like FDMA, TDMA, CDMA etc., these two problems are solved. There were existing various types of mobile technologies such as Mobile Radio Systems, Satellite Mobile Systems, Cellular Personal Communications Systems (PCSs), Personal Communications Network (PCNs) etc. up to early 1930s was belonging to 1G (First Generation) mobile communications. All mobile radio systems in operation used amplitude modulation (AM). From the late of 1930 onwards (1936), Frequency Modulation (FM) systems were implemented in mobile communications. At the end of Second World War (1946), the Mobile Telephone Systems (MTS) were extended to commercial purpose in USA; it was introduced in 25 cities. U.S. radio frequency regulatory body known as Federal Communications Commission (FCC) allocates the frequency spectrum for smooth mobile operation. FCC granted license to the American Telephone and Telegraph Company (AT&T) to operate mobile service in 1946. This system used carrier bandwidth per channel of 120 kHz in half duplex mode, a single powerful transmitter to cover a radius of 50 miles or more from the base station. In 1950, the improved technology was enabled to make channel bandwidth to 60 kHz. This bandwidth was depended on the Processor's Capacity, RF Filters, Low Noise Amplifier, front-end receiver Amplifiers etc. By the mid of 1960 in the US, the FM bandwidth of voice transmission was reduced to 30 kHz. Improved Mobile Telephone Service (IMTS) has started functioning from 1960 in the U.S, where the channels were available in full duplex, with extra facilities available like auto dial, auto switching, auto trunking, routing etc. The first generation (1G) mobile systems are not compatible (connected) with each other due to interface mismatching. In 1979, the World's first cellular system was installed by the Nippon Telephone and Telegraph Company (NTT) in Japan; it used 600 FM duplex channels (25 kHz for each one way link) in the 800 MHz band. A full fledge commercial cellular service was introduced in USA from 1983, called Advanced Mobile Phone Service (AMPS). AMPS system was an analog system having two frequency band like 825 – 845 MHz for reverse path (MS to BTS) and 870 – 890 MHz for forward path (BTS to MS), channel width or bandwidth per channel was 30 kHz, for 40 MHz Spectrum where 20 MHz for each path, total number of channels were available 666.

The basic concept of cellular mobile telephone from 2G is breaking a coverage zone or area into smaller cells, generally

hexagonal region, each of which reuses portions of the spectrum to increase the same frequency spectrum usage. If frequency channels are only reused after N cells, we identify the frequency reuse factor as $1/N$, then $N = i^2 + ij + j^2$, where i and j are non negative real integers. So, there is a sufficient distance between the same frequency channels, i.e., at least seven cell difference (for $i = 1$ and $j = 2$, N becomes 7) to prevent co-channel interference in GSM system. In the late 1991, the first US Digital Cellular system (USDC) was standardized by Electronic Industry Association as Interim Standard (IS)-54 and later IS-136. It supported three digital channels in the same 30 kHz bandwidth, i.e., the capacity of USDC was three times that of AMPS.

Modern digital electronics switches [1]-[8] like T-S (Time-Space), T-S-T, T-S-S-T etc. provide huge number of connections from one telephone switching system (exchange), and transmission networks like optical fiber, microwave, satellite, co-axial cable network etc. integrate large number of channels through one media with very high speed communication links. Very small aperture terminal (VSAT) using satellite channels are ensuring fast communication to remote places without any wire connections.

From 1980 onwards, a second generation (2G) cellular system is started. It is Global System for Mobile Communication (GSM) [1]-[8] as an International Standard by International Telecommunication Union (ITU), and Code division multiple access (CDMA) system [1]-[8] based on Walsh coding CDMA technique is developed by Qualcomm. Inc and is standardized by the Telecomm Industry Association (TIA) as IS-95. In second generation (2G) cellular system, the channel capacity is increased by using different multiplexing techniques like Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA). The forward channel (BTS to MS) and the reverse channel (MS to BTS) are having different frequencies to prevent from any interference by Frequency Division Duplexing (FDD) method for simultaneous transmitting and receiving signals between mobile phone (MS) and mobile exchange. 2G Mobile System comprises with Mobile Subscriber (MS), Base Transceiver Station (BTS), Base Switching Center (BSC), Main Switching Center (MSC) with various registers like Home Location Register (HLR), Visitor Location Register (VLR), Equipment Identity Register (EIR), Authentication Center (AUC), Operation and Maintenance Center (OMC), Billing or Charging Center and Service Center (for SMS and email). Generally the reverse channel frequency is exactly 45 MHz lower than that of the forward channel to safeguard the communication from interference, noise etc. and at the same time it will minimize the power (battery) consumption of the mobile phone (MS).

2.5G mobile network is developed under General Packet Radio Service (GPRS) and Enhanced Data Rates for GSM Evolution (EDGE) [9]. In these 2.5G networks, separate arrangement is made for data communications. GPRS is introduced into the existing GSM architecture; new types of networks, named GPRS Support Nodes (GSNs) are created. Two types of GSNs are functioning like Serving GPRS Support Node (SGSN) and Gateway GPRS Support Node (GGSN). GSNs are responsible for the delivery and the routing of data packets between the mobile stations and the external Packet Data Networks (PDNs).

2G, 2.5G and 3G mobile networks operate in the frequency bands of 800 MHz, 900 MHz, 1800 MHz, 1900 MHz and 2100 MHz.

Then 3G mobile communications are started with Wi-Fi for Wireless Local Area Network (WLAN) and Wide Area Network (WAN) [10]-[12], CDMA 2000 for CDMA and WCDMA for GSM technology [10]-[12], i.e., 3-G mobile network are starting function in full order in the field of mobile communications in the world from 2000. Now Bluetooth technology (with modem) operating in the 2.4 GHz Industrial Scientific and Medical (ISM) radio Band, i.e., 2400 MHz to 2483.5 MHz is adopted for limited area (say 100 ~ 200 meters) wireless network like Wireless Local Area Network (WLAN) or Wireless Personal Area Network (WPAN). For effecting packet data services off the Radio Access Network (RAN) in Universal Mobile Telecommunications System (UMTS) in USA under 3GPP's (3^{rd} Generation Partnership Project) release 99 and releases 4 to 7, and overlooking the MSC is the first step for separating the circuit based world of the PSTNs and the packet based world of the PDNs and the Internet. The European counterpart of UMTS is Wideband Code Division Multiple Access (WCDMA), generally commercialized as 3GSM. The WCDMA scheme has been ventured as a joint effort between ETSI (European Telecommunications Standards Institute) and ARIB (Association of Radio Industries and Business) during the second half of 1997, whereas in March 1998, the TIA (Telecommunications Industry Association) TR45.5 committee adores an innovation for 3G mobile system, compatible with IS-95, which has given name as CDMA 2000. In 2000, TIA standardizes IS-856 network. It is known as CDMA 2000 1x EV-DO (Evolution Data Optimized). CDMA 2000 1x is having chip rate 1.2288 Mcps, while WCDMA chip rate is 3.84 Mcps, but CDMA 2000 3x chip rate is 3.6864 Mcps. Thereafter, UMTS is upgraded by High Speed Downlink/Uplink Packet Access (HSDPA or HSUPA) which offers data speed to 1 ~ 2 Mbps in 2006. It can safely take part in Internet or Intranet data handling. 3G mobile network has same pattern as CDMA-One (2G) by MS, BTS, BSC, MSC, HLR, VLR, AUC, Billing Center and IWF (Inter-Working Function). In case of data transfer, PDSN (Packet Data Serving Node) in data communication network handles, and the billing and authentication function are done by AAA (Authentication, Authorization and Accounting) server associated with PDSN.

II. 4G AND 5G MOBILE COMMUNICATIONS WITH FEATURES

Although some Internet Service Providers (ISPs) in the world have started 4G mobile service, they have not achieved up to the expected standard (upto 50 ~ 60 Mbps data speed). Different research organizations in the world like ITU (Radio Unit), WWRF (Wireless World Research Forum), IEEE (Project 802), 3GPP, ETSI motivate to design the 4G mobile communications network. This 4G mobile network is aiming to provide high data rate, better quality of service (QoS) and seamless global roaming due to the demand of speedy data network and Internet technology.

The 4G mobile network [13]-[18] is identified by the integration and the convergence of a multitude of cellular and wireless networking technologies which include 2G and 3G cellular networks with Internet, Public Switched Telephone Network (PSTN), Public Data Network (PDN), Integrated Services Digital Network (ISDN), Wireless Personal Area Network (WPAN), Wireless Local Area Network (WLAN), Wireless Corporate Area Network (WCAN), Wireless Home Area Network (WHAN), Wireless Fidelity (WiFi), Worldwide Interoperability of Microwave Access (WiMAX), Long Term Evolution (LTE), Mobile Ad-hoc Network (MANET), Vehicular Ad-hoc Network (VANET), and all types of mobile ad-hoc networks in the frequency spectrum of 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2500 MHz. 4G mobile communications is based solely on packet switching. All sub networks are connected to the main network through access controllers or gateways. The choice of sub networks depends on the service provider and demand. These heterogeneous wireless technologies in 4G are seamlessly interconnected by the Internet Protocol (IP) such as IPv4 or IPv6 backbone network. WiMAX standardised in 2008 offering data rate up to 40 Mbps, and LTE standardised in 2010 extending data speed up to 100 Mbps using Orthogonal Frequency Division Multiplexing (OFDM) or Orthogonal Frequency Division Multiple Access (OFDMA) technique with Multiple Input Multiple Output (MIMO) antenna are highly solicited for 4G mobile communications. OFDM consists of 256 subcarriers whereas OFDMA contains either 2,048 or 4,096 subcarriers. MIMO is the latest antenna technology that can carry several times more data traffic. LTE system designed as per 3rd Generation Partnership Project (3GPP) releases 8 and 9. 3GPP's releases 10 to 13 develop advanced LTE.

LTE consists of Evolved UTRAN (E-UTRAN) and Evolved Packet Core (EPC). An E-UTRAN has one or more e-NodeBs, called evolved base stations, which are responsible for radio transmission and reception with mobile users (MS/sub network). Latency is measured of how much time it takes for a packet of data to travel from one designated point (sender) to another (receiver), latency in 3G and 4G mobile communications is less. Latency depends upon the protocols used like Transmission Control Protocol (TCP), the Radio Resource Controller (RRC) which is used in UMTS and LTE on the air interface. RRC is a layer that exists between UE and eNB and exists at the IP level. The data rates and latency for an active mobile connection are shown in Table-1.

TABLE I. DATA RATES AND LATENCY 2G, 3G AND 4G MOBILE COMMUNICATIONS

Mobile Generation	Data Rate	Latency
2G	10 – 200 kbps	300 – 1000 ms
3G	0.5 – 2 Mbps	100 – 500 ms
4G	1 – 50 Mbps	< 100 ms

The main distinguishing characteristics between 3G and 4G mobile communications are increased data rates up to 50 Mbps, enhanced multimedia services, new transmission techniques such as Orthogonal Frequency Division Multiplexing (OFDM) or OFDMA (OFD-Multiple Access) with Multiple Input Multiple Output (MIMO) antennas, advanced Internet access protocol and technology like Internet Protocol Version 6 (IPv6), greater compatibility in interfacing with wired backbone networks and the addition of security mechanisms. 4G mobile communications also provide smooth global roaming ubiquitously at a lower cost.

This 4G mobile network [13]-[18] can provide circuit switched voice service, circuit switched data service like 2G (CDMA-One or GSM), 3G (WCDMA, CDMA 2000, UMTS), in addition to this packet switched data and multimedia service including voice service at a very high data rate. Data rate dimensioning targets for 4G is 50 to 500 bit/s/Hz/km^2, i.e., 100 Mbps to 2 Gbps, presently upto 50 Mbps achieved, whereas in 3G it is around 10 bit/s/Hz/km^2, i.e., 1 ~ 2 Mbps using HSDPA/HSUPA technology.

In this heterogeneous networks environment, in addition to the traditional challenges such as roaming, horizontal handoffs, security, quality of service (QoS) and charging, new challenges such as vertical handoffs, i.e., a terminal device is to change network between different types of networks (2G, 3G, 4G, MANET, VANET etc.), global roaming exist, and these have to be met with appropriate solutions. Especially quality of service (QoS) is computed considering several parameters like bandwidth, delay, packet loss, jitter or Bit Error Rate (BER) and throughput etc.

5G mobile communications system [19] has a great impact on data speed in very high range like 2 Gbps to 20 Gbps. Operating frequencies of the 5G mobile system are designed as per 3GPP's releases 14 to 16 in very high ranges such as 2.5 GHz, 3.5 GHz, 4.5 GHz, 28 GHz, 39 GHz, 86 GHz etc., thus the wave length (λ) of these mobile signals are few millimeters to 1 mm range. Presently developments of 5G mobile system are carried on 2.5 GHz to 3.5 GHz (2020). Therefore, 5G mobile communications promise faster speed, enormous capacity, lower latency, IoT (*Internet of Things*) capability, and many more new facilities. 5G mobile communications has been driven by the need of society to provide ubiquitous connectivity for applications as diverse as automotive communications, remote control with haptic style feedback, huge video downloads, as well as the very low data rate applications like remote sensors and that is being termed the IoT, *Internet of Things*. The evolved 5G mobile technology has been driven by specific uses and applications. 3GPP are aware of the development and innovation of 5G mobile technology, but are not actively planning the 5G mobile technology system yet (2021). Many companies and universities are looking into research of 5G mobile technology; it is gradually focused on developing the technologies for 5G mobile system.

5G mobile communications offer huge facilities and spectrum with very high speed data volumes. The following characteristics are the prime criteria for 5G mobile communications.

(i) Millimetre-Wave Communications: Frequency used in 5G mobile communications is very high frequency spectrum in GHz which provides more channels with the possibility of having much wide channel bandwidth in the range 1 GHz – 2 GHz, but it extends challenges for handset (mobile phone) development where maximum frequency of around 2 GHz. Bandwidths of 10 MHz – 20 MHz are currently in use. For 5G mobile, frequencies of above 50 GHz are also considered and

this will present some real challenges in circuit design. Since the frequencies used in 5G mobile communications are in GHz range and they do not travel long distance because of absorbed almost completely by obstacles. Different countries are allocating different spectrum of 5G mobile. Since wavelengths of 5G mobile are very small range (millimeter waves), and network densification is required to provide the required data capability more use of small cells with low power transmitting base stations for physical obstructions.

(ii) Waveforms: New waveforms and modulation schemes are implied in 5G mobile communications. Although OFDM has been used very successfully in 4G LTE as well as a number of other high data rate systems, but it has some limitations in some circumstances. Other waveform formats may be used like Generalized Frequency Division Multiplexing (GFDM), Filter Bank Multi-Carrier (FBMC), and Universal Filtered Multi-Carrier (UFMC). There is no perfect waveform, and it is possible that OFDM in the form of OFDMA is used as this provides excellent overall performance.

(iii) Multiple Access: A variety of new access schemes are being investigated for 5G mobile technology. The techniques include OFDMA, SCMA, NOMA, PDMA, MUSA and IDMA. As mentioned these techniques it appears that the most popular format is OFDMA.

(iv) Massive MIMO with Beamsteering: Since MIMO is being used in many mobile communications from 4G LTE to Wi-Fi, etc., the numbers of antennas are fairly limited. Using microwave frequencies in GHz range (wavelength few millimeters) extends the possibility of using many tens of antennas in single equipment which includes different antenna sizes (small sizes for GHz frequencies) like Multi-User MIMO and spacing according to wavelength and obstacles. This will enable beams to be steered for providing enhanced performance.

(v) Dense Networks: Reducing the size of cells provides a much more overall effective use of the available spectrum. Techniques to ensure that small cells in the macro-network and deployed as femtocells (small low power base stations called wireless access points) can operate satisfactorily. There is a significant challenge in adding huge numbers of additional cells to a network.

5G mobile communications is coming enthusiastically within very short time, expected within 2020-2022. Thus 5G mobile will be able to encompass a huge number of various applications with different (very high to low) data speeds. Therefore, 5G mobile network ensures the optimum use of the available wide variety spectrum bands, whether it is licensed, shared or unlicensed.

III. HEALTH EFFECTS AND ENVIRONMENTAL POLLUTION BY 4G, 5G AND HIGHER GENERATION MOBILE COMMUNICATIONS

This super high frequency electromagnetic waves transmitted by 4G, 5G and higher generation mobile communications system (Mobile Exchange like BTS, BSC, MSC etc., Mobile Instrument or Phone) in MHz to GHz range radiating in different paths (multiple paths) by MIMO antennas have ailing (sick) effect on animals, birds and human health including trees [20]. This high frequency electromagnetic (EM) waves gradually decrease human and animal's body immunity (resistance) and causes severe illness, even death. It is observed that the most of the small birds and insects pass away from the nature due to the high frequency intensified electromagnetic waves. If human body immunity and lungs activity are checked especially in city and suburban area people, then it will be clearer about the effect of high frequency electromagnetic wave signals from 4G and 5G mobile communications.

This is clearly explained by Max Planck and Albert Einstein's Modern Quantum Theory such as electromagnetic waves consist of photon particles and the energy (E) possessed by the waves or photon particles are calculated [21]-[22]. Photon is a massless and chargeless elementary particle having particle and wave properties both. If the energy of each photon is E;

Then, $E = hf$ .....(1)

where h is called Planck's Constant, $h = 6.626 \times 10^{-34}$ joule–second; f is the frequency of the electromagnetic waves.

If velocity of electromagnetic waves is c and λ be the wave length, we know, $f\lambda = c$, then $f = c/\lambda$,

Therefore, $E = hf = hc/\lambda$ .....(2)

Velocity of electromagnetic waves, c is equal to the velocity of light, Hence, $c = 2.9979 \times 10^8$ meters/second or 1,86,000 miles/second.

Therefore, it is seen that if frequency of the electromagnetic waves is high, it will possess more energy, and thus it will penetrate the atoms, i.e., living body with more energy or power. It is already proved by Albert Einstein in Photoelectric Effect (earned Nobel Prize in 1921 for this) that when high frequency electromagnetic waves consisting of photon particles fall any atoms (metallic or non-metallic), the photons will release electrons from the atoms, called photoelectrons, cause current generation or current flow through the circuit.

Therefore, the continuous exposure of high frequency electromagnetic waves to human and animal body by 4G and 5G mobile signals generate photoelectrons in the atoms or molecules of human and animal body causing current flow which effectively diminishes the body immunity, and hence several diseases will attack the body. This current is having very small value (few milliamperes), because matured human body has an internal resistance 500 ~ 700 ohms and dry skin resistance 1000 ~ 1,00,000 ohms. Generally the resistance of an animal body is more than that of human one. Moreover, electromagnetic waves are absorbed by water particles. Human and animal adult bodies content about 60% water, some amount of electromagnetic waves from 4G and 5G mobile communications are soaked up by the body's water particles, as a result the absorbed electromagnetic energy will increase the body temperature which evaporates the water particles at a faster rate; Hence water – electrolyte imbalance produces headache, fatigue and dehydration etc. Therefore, the continuous exposure in electromagnetic waves of 4G and

5G mobile communications causes damage to heart, lungs, kidney, brain and all other organs of the human and animal body, turning to less immunity as a whole.

It is already observed that those persons, working in high frequency electromagnetic waves zone like mobile exchange (MSC, BSC, BTS etc.), satellite earth station, radar system etc., are suffering from respiratory problems like bronchitis, asthma, pneumonia, tuberculosis etc. frequently, and they are prone to attack by the other severe diseases like diabetics, heart problem, blood pressure, kidney problem, cancer etc. This is happening because of the high frequency electromagnetic waves diminishing their immunity power completely.

The first outspread of Coronavirus (Covid-19) happened in Wuhan city, China in December 2019, where huge numbers of people died due to severe acute respiratory syndrome (SARS), and thereafter it spreads to all over the world by human carriers as the greatest pandemic in 21st century. It may be due to vigorous testing of 5G and 6G mobile networks in Wuhan city (Hi-tech industrial area), China by high frequency electromagnetic waves in GHz range. This should be well investigated what the environmental pollutions are created by the continuous exposure of high frequency electromagnetic waves radiation in MHz to GHz range. Therefore, a trade off must be maintained for use of the range of frequency (electromagnetic spectrum) in GHz, the number of antennas in MIMO system, the number of trans-receivers (BTSs) in a locality and the data speed.

Presently it is observed that Coronavirus (Covid-19) [RNA type] is mainly attacking human respiratory organ like alveoli in lungs and malfunctioning the working of lungs, i.e., exhaust carbon di-oxide (CO_2) from blood and absorption of atmospheric oxygen (O_2) to blood with water evaporation; as a result severe breathing trouble or asthmatic condition with cough and fever like pneumonia appears, it will continue to the patient till either automatic vaccine of the Coronavirus (Covid-19) disease is produced within the human body (patient) by the immune system or supply antibody (vaccine) from outside which kills or destroys the Coronavirus (Covid-19). Therefore, our precaution from Coronavirus (Covid-19) and other diseases is to minimize the exposure of electromagnetic waves from 4G, 5G and higher generation mobile communications system. This can be done by restricting the number of Mobile Exchange Systems (hence mobile SIMs), and the use of mobile phones by keeping switch off condition maximum time in a day and switch on condition call or message duration time only (communications have to be made by the help of email, sms, whatsapp, missed call etc.); so that human and animal body's immunity boosts up and safe guards from all diseases.

IV. CONCLUSION

Different existing mobile communication systems from first generation (1G) to fifth generation (5G) are elaborately described, and all are also compared. Presently mobile communications system is stepped to fifth generation (5G) for achieving high speed data communications which is urgently required for Internet, e-mail, e-business, e-education, multimedia, video conferencing, and so on. Generally, data communications speed in 2G mobile systems such as GSM and CDMA is very low up to 14.4 kbps, it is little bit improved in 2.5G mobile communications system like GPRS up to 56 kbps arranging separate packet switching circuit for data communications, and lastly affordable solution has reached in 3G mobile communications such as UMTS, WCDMA and CDMA 2000 systems extending data rate from 384 kbps to 1 ~ 2 Mbps. 4G mobile communications is an emerging technology and it is highly demanded in the society due to higher impact on data communications speed from 3 Mbps to 2 Gbps (presently 50 ~ 60 Mbps in 2021) in ubiquitous nature. 5G mobile communications is yet to come with very high data speed (> 2 Gbps) and global features, but the main drawback of 4G and 5G mobile communications is that it has a great bad impact on human and animal health system; it degrades continuously health immunity system. It has to be carefully studied in practically by the help of case history of several patients how high frequency electromagnetic waves cause ill effects such as Coronovairus (Covid-19) and other harmful diseases.

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