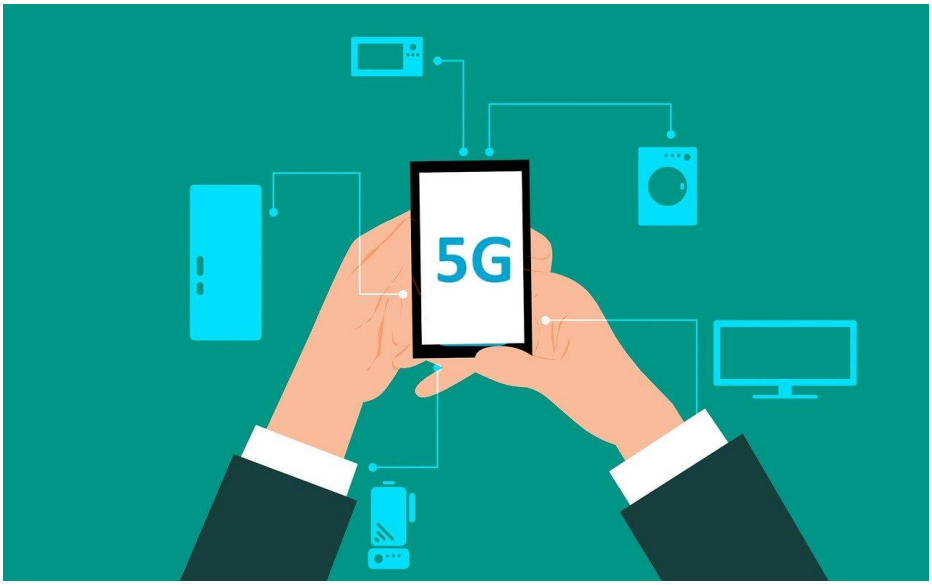
TECHNOLOGIE 5G

Bulletin de veille scientifique : Octobre 2024



Objectifs : réaliser une veille scientifique sur la technologie 5G

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Généralités

Aucun article dans ce bulletin.

Performances et sécurité

Performance Analysis and Prediction of 5G Round-Trip Time Based on the VMD-LSTM Method.

Zhu S, Zhou S, Wang L, Zang C, Liu Y, Liu Q. *Sensors (Basel)*. 2024 Oct 10;24(20).

With the increasing level of industrial informatization, massive industrial data require real-time and high-fidelity wireless transmission. Although some industrial wireless network protocols have been designed over the last few decades, most of them have limited coverage and narrow bandwidth. They cannot always ensure the certainty of information transmission, making it especially difficult to meet the requirements of low latency in industrial manufacturing fields. The 5G technology is characterized by a high transmission rate and low latency; therefore, it has good prospects in industrial applications. To apply 5G technology to factory environments with low latency requirements for data transmission, in this study, we analyze the statistical performance of the round-trip time (RTT) in a 5G-R15 communication system. The results indicate that the average value of 5G RTT is about 11 ms, which is less than the 25 ms of WIA-FA. We then consider 5G RTT data as a group of time series, utilizing the augmented Dickey-Fuller (ADF) test method to analyze the stability of the RTT data. We conclude that the RTT data are non-stationary. Therefore, firstly, the original 5G RTT series are subjected to first-order differencing to obtain differential sequences with stronger stationarity. Then, a time series analysis-based variational mode decomposition-long short-term memory (VMD-LSTM) method is proposed to separately predict each differential sequence. Finally, the predicted results are subjected to inverse difference to obtain the predicted value of 5G RTT, and a predictive error of 4.481% indicates that the method performs better than LSTM and other methods. The prediction results could be used to evaluate network performance based on business requirements, reduce the impact of instruction packet loss, and improve the robustness of control algorithms. The proposed early warning accuracy metrics for control issues can also be used to indicate when to retrain the model and to indicate the setting of the control cycle. The field of industrial control, especially in the manufacturing industry, which requires low latency, will benefit from this analysis. It should be noted that the above analysis and prediction methods are also applicable to the R16 and R17 versions.

Lien vers l'article

Traffic Flow Prediction in 5G-Enabled Intelligent Transportation Systems Using Parameter Optimization and Adaptive Model Selection.

Vo HH, Nguyen TM, Bui KA, Yoo M. *Sensors (Basel)*. 2024 Oct 10;24(20).

This study proposes a novel hybrid method, FVMD-WOA-GA, for enhancing traffic flow prediction in 5G-enabled intelligent transportation systems. The method integrates fast variational mode decomposition (FVMD) with optimization techniques, namely, the whale optimization algorithm (WOA) and genetic algorithm (GA), to improve the accuracy of overall traffic flow based on models tailored for each decomposed sub-sequence. The selected predictive models-long short-term memory (LSTM), bidirectional LSTM (BiLSTM), gated recurrent unit (GRU), and bidirectional GRU (BiGRU)-were considered to capture diverse temporal dependencies in traffic data. This research explored a multi-stage approach, where the decomposition, optimization, and selection of models are performed systematically to improve prediction performance. Experimental validation on two real-world traffic datasets further underscores the method's efficacy, achieving root mean squared errors (RMSEs) of

152.43 and 7.91 on the respective datasets, which marks improvements of 3.44% and 12.87% compared to the existing methods. These results highlight the ability of the FVMD-WOA-GA approach to improve prediction accuracy significantly, reduce inference time, enhance system adaptability, and contribute to more efficient traffic management.

Lien vers l'article

Combining 5G New Radio, Wi-Fi, and LiFi for Industry 4.0: Performance Evaluation.

Navarro-Ortiz J, Ramos-Munoz JJ, Delgado-Ferro F, Canellas F, Camps-Mur D, Emami A, et al. *Sensors (Basel)*. 2024 Sep 18;24(18).

Fifth-generation mobile networks (5G) are designed to support enhanced Mobile Broadband, Ultra-Reliable Low-Latency Communications, and massive Machine-Type Communications. To meet these diverse needs, 5G uses technologies like network softwarization, network slicing, and artificial intelligence. Multi-connectivity is crucial for boosting mobile device performance by using different Wireless Access Technologies (WATs) simultaneously, enhancing throughput, reducing latency, and improving reliability. This paper presents a multi-connectivity testbed from the 5G-CLARITY project for performance evaluation. MultiPath TCP (MPTCP) was employed to enable mobile devices to send data through various WATs simultaneously. A new MPTCP scheduler was developed, allowing operators to better control traffic distribution across different technologies and maximize aggregated throughput. Our proposal mitigates the impact of limitations on one path affecting others, avoiding the Head-of-Line blocking problem. Performance was tested with real equipment using 5GNR, Wi-Fi, and LiFi - complementary WATs in the 5G-CLARITY project-in both static and dynamic scenarios. The results demonstrate that the proposed scheduler can manage the traffic distribution across different WATs and achieve the combined capacities of these technologies, approximately 1.4 Gbps in our tests, outperforming the other MPTCP schedulers. Recovery times after interruptions, such as coverage loss in one technology, were also measured, with values ranging from 400 to 500 ms.

Lien vers l'article

Two-way 5G NR FSO-HCF-UWOC converged systems with R/G/B 3-wavelength and SLM-based beam-tracking scheme.

Hayle ST, Lu HH, Lin HM, Wang CP, Li CY, Wu TM, et al. *Sci Rep*. 2024 Sep 27;14(1):22252.

A two-way fifth-generation (5G) new radio (NR) free-space optical (FSO)-hollow-core fibre (HCF)-underwater wireless optical communication (UWOC) converged systems with a red/green/blue (R/G/B) 3-wavelengths and spatial light modulator (SLM)-based beam-tracking scheme is practically built. It is the first to practically build a two-way FSO-HCF-UWOC converged system with high-speed and long-distance optical wireless-wired-underwater wireless communication characteristics. It shows a 5G NR FSO-HCF-UWOC convergence from drone or buildings to undersea, using R/G/B 3-wavelengths and an SLM as a demonstration. The R/G/B 3-wavelengths are used to enhance the downstream and upstream aggregate transmission rates. An SLM with electrical comparator is used to adjust the laser beam and mitigate laser beam misalignment caused by drone movement or ocean flow. Over a hybrid of 1-km FSO, 10-m HCF, and 10.44-m ocean water-air-ocean water medium, downstream/upstream 5G-millimeter-wave (MMW) 9.1-Gb/s/24-GHz signals are transmitted with satisfactorily low bit error rates and error vector magnitudes, as well as distinct constellations. This demonstrated that the 5G NR FSO-HCF-UWOC converged system exhibits promising potential as it advances the scenario

implemented by the 5G-MMW signals over FSO, HCF, and UWOC convergence, paving the way for high-speed and long-distance communications across diverse media.

Lien vers l'article

5 G new radio fiber-wireless converged systems by injection locking multi-optical carrier into directly-modulated lasers.

Lu HH, Lin HM, Wang CP, Hayle ST, Li CY, Huang XH, et al. *Commun Eng*. 2024 Oct 14;3(1):144.

The integration of fiber-optical wireless convergence with fifth generation new radio is crucial in building high-performance access networks. This approach not only provides high-transmission-rates but also ensures broad coverage, which is vital for future networks. Here we report fifth generation new radio fiber-wireless converged systems by injection locking multi-optical carrier into directly-modulated lasers. Data rates of 10 Gb/s, 20 Gb/s, and 40 Gb/s are achieved by direct modulation on directly-modulated lasers using 16-quadrature amplitude modulation-orthogonal frequency-division multiplexing signal. Through 25-km single-mode fiber, 1.5-km optical wireless, and 12-/22-/33-m millimeter-wave/sub-terahertz wireless integrated-media, 10-Gb/s/20-GHz, 20-Gb/s/60-GHz, and 40-Gb/s/100-GHz signals are transmitted with acceptably low bit error rates and error vector magnitudes, as well as distinct constellations. The successful transport of fifth generation new radio millimeter-wave and sub-terahertz signals at different carrier frequencies through fiber-wireless convergence demonstrates the potential of the system to meet the evolving requirement of next-generation communications.

Lien vers l'article

Antennes

Beam steerable MIMO antenna based on conformal passive reflective metasurface for 5G millimeter wave applications.

Malik BT, Khan S, Koziel S. *Sci Rep*. 2024 Oct 15;14(1):24086.

A conformal reflective metasurface fed by a dual-band multiple-input multiple-output (MIMO) antenna is proposed for low-cost beam steering applications in 5G Millimeter-wave frequency bands. The beam steering is accomplished by selecting a specific port of MIMO antenna. Each MIMO port is associated with a beam that points in a different direction due to a conformal reflective metasurface. This novel conformal metasurface antenna design has the advantages of higher gain, lower cost, a simpler feeding source, and a lower profile when compared to traditional reflective metasurfaces using bulky horn antennas and phased arrays with complex feeding networks and phase shifters for beam steering. The proposed beam steering antenna consists of a compact five-element dual-band MIMO and a 32 × 32 unit-cell conformal dual-band reflective metasurface placed at the top of the MIMO antenna to obtain the beam steering capability as well as gain enhancement. The proposed reflective metasurface has a stable response under oblique incidence angles of up to 600 at 24 GHz and 38 GHz and its symmetric, single-layer structure, ensures polarization insensitivity and stable response under conformal conditions. The presented MIMO antenna design is not only compact but also offers a wideband response effectively covering the desired 5G mm-wave frequency bands. The overall size of the MIMO antenna alone is 70 × 12 mm2 with a maximum gain of 5.4 and 7.2 dB. It is further improved up to 13.1 and 14.2 dB at 24 and 38 GHz respectively, with a beam steering range of ś 400 by using a

conformal reflective metasurface. Unlike the existing beam steering strategies, the suggested method is not only cost-effective but also increases the overall directivity and gain of the source MIMO antenna. The measured results agree with the simulated results, making it a potential candidate in the 5G and beyond beam steering applications.

Lien vers l'article

A High Gain Circularly Polarized Slot Antenna Array for 5G Millimeter-Wave Applications.

He W, Hong J, Ren Y, Deng Y, Wang X, Fang X. *Sensors (Basel)*. 2024 Sep 24;24(19).

An air-filled substrate-integrated waveguide (AF-SIW) circularly polarized (CP) 1 × 8 mm wave antenna array is presented for fifth-generation (5G) applications. The presented slot antenna array consists of three layers of PCB and one layer of aluminum, which serve as the AF-SIW feeding network and the metal cavity radiation element, respectively. The CP characteristic is achieved by the use of an S-shaped aluminum radiation cavity on the top of the AF-SIW feeding network. The air-filled substrate-integrated waveguide technique is unitized to achieve high radiation efficiency. A wide input impedance bandwidth of 18.4% is obtained for the proposed antenna scheme, ranging from 34.5 GHz to 41.5 GHz, with a peak gain of 18 dBic. As for CP characteristic, the proposed antenna possesses a wide 3 dB axial ratio (AR) bandwidth, which is 16.4% (36.5 GHz to 43 GHz). The antenna scheme is fabricated and measured to verify the potential application as well as the promising performance. The measured results of the 1 × 8 antenna array shows that the wide AR as well as the input impedance are simultaneously achieved, which coincide well with the simulated results. Also, the measured results indicate that the proposed antenna scheme might be a good candidate for future mobile applications.

Lien vers l'article

Architecture réseau

Aucun article dans ce bulletin.

Efficacité énergétique

Rethinking max-min planning on energy-efficient software-defined networking for 5G networks.

Jiang D, Zhu B, Sun J, Wang Z, Lyu Z, Singh AK, et al. *Sci Rep*. 2024 Oct 28;14(1):25709.

Energy efficiency plays an important role in intelligent networking for 5G networks, which concerns environmental, financial, and performance aspects of intelligent networking for 5G networks. To this end, network designers propose energy-efficient approaches to reduce energy consumption of networks and to raise network performance by switching off the links/nodes with low loads or at idle status. The existing energy-efficient approaches can be formulated as a max-min optimal problem, namely maximizing network/node/port throughput via minimum energy consumption. The max-min planning investigates energy efficiency only from the links/nodes perspective. The max-min planning for energy-efficient networking, if not carefully designed from the network-wide standpoint, can lead

to lower energy efficiency for the whole network due to lack of global planning, which in turn results in the degraded performance due to network un-connectivity after closing the nodes/links. In this paper we rethink the max-min planning framework on energy-efficient software-defined networking for intelligent networking of 5G networks, which takes in account combining network connectivity and maximum network flow with minimum energy consumption. Our framework aims at how to deliver dynamic end-to-end traffic demands with the appropriate network topology by building data forwarding plane with maximum network flow and control plane with network connectivity. We discuss the associated challenges and implementation issues. A dynamic max-min planning framework depending on dynamic end-to-end traffic demands is presented to achieve network-wide energy efficiency. Numerical results show the improved energy efficiency performance for the whole network.

Lien vers l'article

Autres équipements

Durable Superhydrophobic Coatings with Attapulgite for Inhibiting 5G Radome Rain Attenuation.

Li Y, Zhang J, Wang A. *Langmuir*. 2024 Oct 10.

5G radomes are easily wetted and stained by rainfall, which greatly reduces the quality of signal transmission. Superhydrophobic coatings are expected to solve this problem because of their unique wettability, but it is still challenging to develop robust superhydrophobic coatings via simple methods. Here, we report the design of robust superhydrophobic coatings containing oxalic acid-modified attapulgite (MDP) for inhibiting rain attenuation of 5G radomes. First, a homogeneous suspension was prepared by nonsolvent-induced phase separation of a silicone-modified polyester adhesive (SMPA) solution containing fluorinated MDP (F-MDP) nanorods. Superhydrophobic coatings can be easily prepared by spraying the suspension. The effects of phase separation and the SMPA/F-MDP ratio on the surface morphology, superhydrophobicity, and stability of the coatings were systematically investigated. The micro-/nanostructure and low surface energy endow the coatings with excellent static and dynamic superhydrophobicity. Compared with previous studies, the coatings exhibit excellent mechanical stability, flexibility, chemical stability, and pressure resistance due to the combined effects of adhesion by SMPA, self-similar micro-/nanostructures, reinforcement by the MDP nanorods, etc. Consequently, the coatings show good performance in preventing rain attenuation of 5G radomes, an emerging application of Superhydrophobic coatings. We believe that the coatings have great application potential in various fields, including 5G communication.

Lien vers l'article

Applications industrielles

Towards a Unified Management Interface for 5G Sensor Networks: Interoperability between Yet Another Next Generation and Open Platform Communication Unified Architecture.

Sambandan D, Thirupathi D. *Sensors (Basel)*. 2024 Sep 26;24(19).

Fifth-generation (5G) sensor networks are critical enablers of Industry 4.0, facilitating real-time monitoring and control of industrial processes. However, significant challenges to their deployment in industrial settings remain, such as a lack of support for interoperability and manageability with existing industrial applications and the specialized technical expertise required for the management of private 5G sensor networks. This research proposes a solution to achieve interoperability between private 5G sensor networks and industrial applications by mapping Yet Another Next Generation (YANG) models to Open Platform Communication Unified Architecture (OPC UA) models. An OPC UA pyang plugin, developed to convert YANG models into OPC UA design model files, has been made available on GitHub for open access. The key finding of this research is that the proposed solution enables seamless interoperability without requiring modifications to the private 5G sensor network components, thus enhancing the efficiency and reliability of industrial automation systems. By leveraging existing industrial applications, the management and monitoring of private 5G networks are streamlined. Unlike prior studies that explored OPC UA's integration with other protocols, this work is the first to focus on the YANG-OPC UA integration, filling a critical gap in Industry 4.0 enablement research.

Lien vers l'article

The Shared Experience Actor-Critic (SEAC) Approach for Allocating Radio Resources and Mitigating Resource Collisions in 5G-NR-V2X Mode 2 Under Aperiodic Traffic Conditions.

Aslam S, Khan D, Chang K. *Sensors (Basel)*. 2024 Oct 21;24(20).

5G New Radio (NR)-V2X, standardized by 3GPP Release 16, includes a distributed resource allocation Mode, known as Mode 2, that allows vehicles to autonomously select transmission resources using either sensing-based semi-persistent scheduling (SB-SPS) or dynamic scheduling (DS). In unmanaged 5G-NR-V2X scenarios, SB-SPS loses effectiveness with aperiodic and variable data. DS, while better for aperiodic traffic, faces challenges due to random selection, particularly in high traffic density scenarios, leading to increased collisions. To address these limitations, this study models the Cellular V2X network as a decentralized multi-agent networked Markov decision process (MDP), where each vehicle agent uses the Shared Experience Actor-Critic (SEAC) technique to optimize performance. The superiority of SEAC over SB-SPS and DS is demonstrated through simulations, showing that the SEAC with an N-step approach achieves an average improvement of approximately 18-20% in enhancing reliability, reducing collisions, and improving resource utilization under high vehicular density scenarios with aperiodic traffic patterns.

Lien vers l'article

Satisfaction analysis of 5G remote ultrasound robot for diagnostics based on a structural equation model.

Han ZL, Lei YM, Yu J, Lei BS, Ye HR, Zhang G. *Front Robot AI*. 2024;11:1413065.

OBJECTIVES: With the increasing application of 5G remote ultrasound robots in healthcare, robust methods are in critical demand to assess participant satisfaction and identify its influencing factors. At present, there is limited empirical research on multi-parametric and multidimensional satisfaction evaluation of participants with 5G remote ultrasound robot examination. Previous studies have demonstrated that structural equation modeling (SEM) effectively integrates various statistical techniques to examine the relationships among multiple variables. Therefore, this study aimed to evaluate the satisfaction of participants with 5G remote ultrasound robot examination and its influencing factors using SEM. METHODS: Between April and June 2022, 213 participants from Wuhan Automobile Manufacturing Company underwent remote ultrasound examinations using the MGIUS-R3 remote ultrasound robot system. After these examinations, the participants evaluated the performance of the 5G remote ultrasound robot based on their personal experiences and emotional responses. They completed a satisfaction survey using a self-developed questionnaire, which included 19 items across five dimensions: examination efficiency, examination perception, communication perception, value perception, and examination willingness. A SEM was established to assess the satisfaction of participants with the 5G remote ultrasound robot examinations and the influencing factors. RESULTS: A total of 201 valid questionnaires were collected. The overall satisfaction of participants with the 5G remote ultrasound robot examination was 45.43 ± 11.60, with 169 participants (84%) expressing satisfaction. In the path hypothesis relationship test, the dimensions of examination efficiency, examination perception, communication perception, and value perception had positive effects on satisfaction, with standardized path coefficients of 0.168, 0.170, 0.175, and 0.191. Satisfaction had a direct positive effect on examination willingness, with a standardized path coefficient of 0.260. Significant differences were observed across different educational levels in the dimensions of examination perception, communication perception, value perception, and examination willingness. Participants with different body mass indices also showed significant differences in examination perception; all p-values were less than 0.05. CONCLUSION: In this study, value perception was identified as the most significant factor influencing satisfaction. It could be improved by enhancing participants' understanding of the accuracy and safety of 5G remote ultrasound robot examinations. This enhances satisfaction and the willingness to undergo examinations. Such improvements not only facilitate the widespread adoption of this technology but also promote the development of telemedicine services.

Lien vers l'article

Construction and Application of a Private 5G Standalone Medical Network in a Smart Health Environment: Exploratory Practice From China.

Chen B, Shi X, Feng T, Jiang S, Zhai Y, Ren M, et al. *J Med Internet Res*. 2024 Oct 24;26:e52404.

BACKGROUND: To date, the differentiated requirements for network performance in various health care service scenarios-within, outside, and between hospitals-remain a key challenge that restricts the development and implementation of digital medical services. OBJECTIVE: This study aims to construct and implement a private 5G (the 5th generation mobile communication technology) standalone (SA) medical network in a smart health environment to meet the diverse needs of various medical services.

METHODS: Based on an analysis of network differentiation requirements in medical applications, the system architecture and functional positioning of the proposed private 5G SA medical network are designed and implemented. The system architecture includes the development of exclusive and preferential channels for medical use, as well as an ordinary user channel. A 3-layer network function architecture is designed, encompassing resource, control, and intelligent operation layers to facilitate management arrangements and provide network open services. Core technologies, including edge cloud collaboration; service awareness; and slicing of access, bearer, and core networks, are employed in the construction and application of the 5G SA network. RESULTS: The construction of the private 5G SA medical network primarily involves system architecture, standards, and security measures. The system, featuring exclusive, preferential, and common channels, supports a variety of medical applications. Relevant standards are adhered to in order to ensure the interaction and sharing of medical service information. Security is achieved through mechanisms such as authentication, abnormal behavior analysis, and dynamic access control. Three typical medical applications that rely on the 5G network in intrahospital, interhospital, and out-of-hospital scenarios-namely, mobile ward rounds, remote first aid, and remote ultrasound-were conducted. Testing of the 5G-enabled mobile ward rounds showed an average download rate of 790 Mbps and an average upload rate of 91 Mbps. Compared with 4G, the 5G network more effectively meets the diverse requirements of various business applications in prehospital emergency scenarios. For remote ultrasound, the average downlink rate of the 5G network is 4.82 Mbps, and the average uplink rate is 2 Mbps, with an average fluctuation of approximately 8 ms. The bandwidth, performance, and delay of the 5G SA network were also examined and confirmed to be effective. CONCLUSIONS: The proposed 5G SA medical network demonstrates strong performance in typical medical applications. Its construction and application could lead to the development of new medical service models and provide valuable references for the further advancement and implementation of 5G networks in other industries, both in China and globally.

Lien vers l'article

Evaluation (Mesure des niveaux d'exposition)

Méthodes d'évaluation

Aucun article dans ce bulletin.

Evaluation population générale

Aucun article dans ce bulletin.

Risques professionnels

Aucun article dans ce bulletin.

In silico

Aucun article dans ce bulletin.

In vitro

Wireless neuromodulation at submillimeter precision via a microwave split-ring resonator.

Marar C, Jiang Y, Li Y, Lan L, Zheng N, Chen G, et al. *Sci Adv*. 2024 Oct 4;10(40):eado5560.

A broad spectrum of electromagnetic waves has been explored for wireless neuromodulation. Transcranial magnetic stimulation, with long wavelengths, cannot provide submillimeter spatial resolution. Visible light, with its short wavelengths, suffers from strong scattering in the deep tissue. Microwaves have centimeter-scale penetration depth and have been shown to reversibly inhibit neuronal activity. Yet, microwaves alone do not provide sufficient spatial precision to modulate target neurons without affecting surrounding tissues. Here, we report a split-ring resonator (SRR) that generates an enhanced microwave field at its gap with submillimeter spatial precision. With the SRR, microwaves at dosages below the safe exposure limit are shown to inhibit the firing of neurons within 1 mm of the SRR gap site. The microwave SRR reduced seizure activity at a low dose in both in vitro and in vivo models of epilepsy. This microwave dosage is confirmed to be biosafe via histological and biochemical assessment of brain tissue.

Lien vers l'article

Effect of 1800 MHz radiofrequency field exposure on cytokine and signal transduction protein expression in differentiated THP-1 cells.

Bellier PV, McGarr GW, Smiley S, McNamee JP. *Int J Radiat Biol*. 2024;100(11):1594-600.

PURPOSE: To evaluate the effects of 1800 MHz continuous wave (CW) and global system for mobile communications (GSM) modulated radiofrequency electromagnetic field (RFEMF) exposures on signal transduction (ST) protein and cytokine expression in differentiated human-derived monocytic THP-1 cells. MATERIALS AND METHODS: THP-1 cells were differentiated into adherent macrophage-like cells using phorbol 12-myristate 13-acetate (PMA). Following differentiation, cells were exposed to 1800 MHz CW or GSM modulated RFEMF for 0.5, 4, or 24 h at a specific absorption rate (SAR) of 0 (sham) or 2.0 W/kg. Concurrent positive controls (lipopolysaccharide for cytokines; anisomycin for ST proteins) and negative controls were included in each experiment. The expression levels of cytokines (GM-CSF, IFN-γ, IL-1β, IL-6, IL-10, TNF-α) from culture media and phosphorylated and total ST proteins (CREB, JNK, NF-κB, p38, ERK1/2, Akt, p70S6k, STAT3, STAT5) from cell lysates were assessed using Milliplex magnetic bead array panels. RESULTS: No consistent effect of RFEMF exposure was observed in differentiated THP-1 cells. A statistically significant effect of overall exposure condition was observed for IL-6 with GSM modulation ($P = 0.042$), but no difference between RFEMF and sham for any exposure condition remained following adjustment for multiple comparisons ($P \geq 0.128$). No statistically significant effect of exposure condition was detected for any other cytokine evaluated with

either of the RFEMF modulations (P ≥ 0.078). There were no statistically significant changes in expression levels for any of the ST proteins under any studied exposure condition (P ≥ 0.320). CONCLUSIONS: In this study, no evidence of changes were observed in differentiated human derived THP-1 cells following exposure of up to 24 h to 1800 MHz RFEMF at SARs of 0 and 2.0 W/kg on the expression of ST proteins or cytokines.

Lien vers l'article

Redox cell signalling triggered by black carbon and/or radiofrequency electromagnetic fields: Influence on cell death.

López-Martín E, Sueiro-Benavides R, Leiro-Vidal JM, Rodríguez-González JA, Ares-Pena FJ. *Sci Total Environ*. 2024 Nov 25;953:176023.

The capacity of environmental pollutants to generate oxidative stress is known to affect the development and progression of chronic diseases. This scientific review identifies previously published experimental studies using preclinical models of exposure to environmental stress agents, such as black carbon and/or RF-EMF, which produce cellular oxidative damage and can lead to different types of cell death. We summarize in vivo and in vitro studies, which are grouped according to the mechanisms and pathways of redox activation triggered by exposure to BC and/or EMF and leading to apoptosis, necrosis, necroptosis, pyroptosis, autophagy, ferroptosis and cuproptosis. The possible mechanisms are considered in relation to the organ, cell type and cellular-subcellular interaction with the oxidative toxicity caused by BC and/or EMF at the molecular level. The actions of these environmental pollutants, which affect everyday life, are considered separately and together in experimental preclinical models. However, for overall interpretation of the data, toxicological studies must first be conducted in humans, to enable possible risks to human health to be established in relation to the progression of chronic diseases. Further actions should take pollution levels into account, focusing on the most vulnerable populations and future generations.

Lien vers l'article

Sur l'animal

Aucun article dans ce bulletin.

Sur l'homme

Relationship between radiofrequency-electromagnetic radiation from cellular phones and brain tumor: meta-analyses using various proxies for RF-EMR exposure-outcome assessment.

Moon J, Kwon J, Mun Y. *Environ Health*. 2024 Oct 10;23(1):82.

INTRODUCTION: The authors conducted meta-analyses regarding the association between cellular and mobile phone use and brain tumor development by applying various radiofrequency-electromagnetic radiation (RF-EMR) exposure subcategories. With changing patterns of mobile phone use and rapidly developing Wireless Personal Area Network (WPAN) technology (such as Bluetooth), this study will

provide insight into the importance of more precise exposure subcategories for RF-EMR. METHODS: The medical librarian searched MEDLINE (PubMed), EMBASE, and the Cochrane Library until 16 December 2020. RESULTS: In these meta-analyses, 19 case-control studies and five cohort studies were included. Ipsilateral users reported a pooled odds ratio (OR) of 1.40 (95% CI 1.21-1.62) compared to non-regular users. Users with years of use over 10 years reported a pooled OR of 1.27 (95% CI 1.08-1.48). When stratified by each type of brain tumor, only meningioma (OR 1.20 (95% CI 1.04-1.39)), glioma (OR 1.45 (95% CI 1.16-1.82)), and malignant brain tumors (OR 1.93 (95% CI 1.55-2.39)) showed an increased OR with statistical significance for ipsilateral users. For users with years of use over 10 years, only glioma (OR 1.32 (95% CI 1.01-1.71)) showed an increased OR with statistical significance. When 11 studies with an OR with cumulative hours of use over 896 h were synthesized, the pooled OR was 1.59 (95% CI 1.25-2.02). When stratified by each type of brain tumor, glioma, meningioma, and acoustic neuroma reported the pooled OR of 1.66 (95% CI 1.13-2.44), 1.29 (95% CI 1.08-1.54), and 1.84 (95% CI 0.78-4.37), respectively. For each individual study that considered cumulative hours of use, the highest OR for glioma, meningioma, and acoustic neuroma was 2.89 (1.41-5.93) (both side use, > 896 h), 2.57 (1.02-6.44) (both side use, > 896 h), and 3.53 (1.59-7.82) (ipsilateral use, > 1640 h), respectively. For five cohort studies, the pooled risk ratios (RRs) for all CNS tumors, glioma, meningioma, and acoustic neuroma, were statistically equivocal, respectively. However, the point estimates for acoustic neuroma showed a rather increased pooled RR for ever-use (1.26) and over 10 years of use (1.61) compared to never-use, respectively. DISCUSSION: In this meta-analysis, as the exposure subcategory used became more concrete, the pooled ORs demonstrated higher values with statistical significance. Although the meta-analysis of cohort studies yielded statistically inconclusive pooled effect estimates, (i) as the number of studies included grows and (ii) as the applied exposure subcategories become more concrete, the pooled RRs could show a different aspect in future research. Additionally, future studies should thoroughly account for changing patterns in mobile phone use and the growing use of earphones or headphones with WPAN technology.

Lien vers l'article

Understanding Digital Dementia and Cognitive Impact in the Current Era of the Internet: A Review.

Ali Z, Janarthanan J, Mohan P. *Cureus*. 2024 Sep;16(9):e70029.

Dementia encompasses symptoms resulting from brain damage that impairs cognitive functions, surpassing natural aging effects. This condition affects emotional regulation, behavior, and motivation while preserving consciousness. Dr. Manfred Spitzer coined the term 'digital dementia,' highlighting the cognitive decline associated with excessive reliance on digital devices such as smartphones and Google, potentially exacerbating attention deficit hyperactivity disorder (ADHD) and memory loss. This condition mirrors terms like 'digital amnesia' and 'the Google Effect,' highlighting the brain's tendency to offload peripheral information, leading to panic and forgetfulness. Spitzer's book, Digital Dementia, focuses on gaming effects on children and has thus popularized the term. Teenagers are known to use electronic devices regularly, correlating with rising cognitive impairments. The advent of the internet's fifth generation (5G) has transformed technology use, impacting mental health treatments and clinical practices globally. Digital media's influence on the developing brain encompasses motor skills, language, and cognition. Excessive digital media use in young adults correlates with lower cognitive empathy, affecting interpersonal understanding and facial recognition. Studies link heavy reliance on web-based media to decreased white matter integrity, crucial for language skills. Adolescents may be more vulnerable to anxiety and unrealistic expectations due to digital media overuse. Digital media overuse impacts brain development, especially cognitive and inhibitory control, attention, memory, and reasoning, essential for adapting to dynamic environments. Early exposure to fast-paced media can impair motor skills, spatial awareness, problem-solving, and language learning. Neuroimaging studies reveal that environmental factors like screen usage affect brain networks controlling social-

emotional behavior and executive functions. Overreliance on smartphones diminishes gray matter in key brain regions, affecting cognitive and emotional regulation. The internet generation, characterized by advancements such as Web 3.0, introduces artificial intelligence and semantic web technologies, reshaping digital content processing. The neurobiological basis of digital dementia involves changes in the brain structure and function, with excessive screen exposure linked to cognitive impairments. Neuroplasticity, or the brain's adaptability, plays a role in cognitive decline from digital media overuse. Early childhood and adolescent brain development stages exhibit significant plasticity, influencing cognitive trajectories. Addressing digital dementia requires strategies to reduce screen time, promote cognitive exercises, and enhance awareness. Parents should regulate children's screen usage, encourage digital detox periods, and substitute screen time with other activities. Cognitive training programs such as Cogmed (Neural Assembly Int AB, Stockholm, SWE) and CogniFit (San Francisco, CA, USA) can improve memory and attention in older adults. Promoting balanced technology use and educating on the risks of excessive digital media consumption is crucial for maintaining cognitive health in the digital age.

Lien vers l'article

Reproduction

Effect of radiofrequency electromagnetic waves of mobile phone stations on male fertility.

Gharib TM, Almekaty K, Abdel Aal AM, Abdel-Al I, Deif H, Hassan GM, et al. *Arch Ital Urol Androl*. 2024 Oct 2;96(3):12595.

PURPOSE: To determine the effect of electromagnetic waves of mobile phone stations on several sperm parameters and the male reproductive system. METHODS: This observational study was performed on 216 subjects, aged 18-60 years. Two equal groups of subjects were assigned to group A (study group) if they were living close to cell phone tower stations for at least 6 months and group B (control group) formed from individuals living 100 meters away from cell phone tower stations. Every subject underwent a comprehensive history taking, a clinical assessment, and laboratory testing. RESULTS: Regarding morphology index in the studied groups, the exposed group exhibited a trend of reduced percentage of normal morphology compared to the non-exposed group, with no statistical difference between the two groups. Regarding the total sperm motility (A+B+C) and progressive sperm motility (A+B) in the studied groups, the exposed group showed a trend of decreased total sperm motility and of progressive sperm motility in contrast to the non-exposed group, with no statistical difference between the two groups. CONCLUSIONS: Personal wrong lifestyles with exposure to electromagnetic waves have shown a trend towards a reduced percentage of normal morphology and reduced motility although nonstatistically significant compared with non-exposed populations.

Lien vers l'article

Effects of 5G radiofrequency electromagnetic radiation on indicators of vitality and DNA integrity of in vitro exposed boar semen.

Butković I, Vince S, Lojkić M, Folnožić I, Tur SM, Vilić M, et al. *Theriogenology*. 2024 Dec;230:243-9.

The effects of radiofrequency electromagnetic radiation (RF-EMR) on semen quality have been in the spotlight in recent years, though research results to date have been contradictory. The effects of RF-EMR amongst others depend upon frequency, and there is currently no literature concerning the influence of 5G frequencies on both DNA integrity and spermatozoa vitality in males. The aim of this study was to investigate the effect of 5G RF-EMR on sperm membrane integrity, mitochondrial potential, and DNA integrity of in vitro exposed semen of breeding boars. The study included semen samples of eight breeding boars of the Pietren breed and four breeding boars of the German Landrace breed, from 1.5 to 3.5 years in age. Freshly diluted semen of each boar was divided into a control (n = 12) and experimental group (n = 12). The samples of the experimental group were exposed for 2 hours to continuous RF-EMR at a single frequency (700 MHz, 2500 MHz and 3500 MHz) and an electromagnetic field strength of 10 V/m using a transverse gigahertz electromagnetic cell. Sperm DNA fragmentation was assessed using a Halomax® kit and sperm membrane integrity and mitochondrial potential was assessed using a PI/SYBR-14 LIVE/DEAD viability kit with JC-1. A significantly higher proportion of spermatozoa with DNA fragmentation was found in exposed semen samples for all frequencies compared to the control group. The highest DNA damage was recorded in semen samples exposed to 5G RF-EMR at 2500 MHz ($p < 0.01$) and 3500 MHz ($p < 0.05$) vs. control semen samples. A significantly higher proportion of spermatozoa with damaged cell membrane and good mitochondrial potential was recorded in semen samples exposed with 3500 MHz. In vitro exposure of breading boar semen to 5G RF-EMR significantly increases the proportion of DNA fragmentation. The harmful effect of 5G RF-EMR on the proportion of spermatozoa with damaged DNA was frequency dependent. The

3500 MHz frequency displayed the most harmful effects due to significant impacts on DNA integrity and spermatozoa vitality indicators.

Lien vers l'article

Dispositifs médicaux implantables

Aucun article dans ce bulletin.