1. FRAIRE, Juan A., HENN, Santiago, DOVIS, Fabio, et al. Sparse satellite constellation design for LoRa-based direct-to-satellite Internet of Things. In : GLOBECOM 2020-2020 IEEE Global Communications Conference. IEEE, 2020. p. 1-6.

The article discusses the challenge of getting global Internet of Things (IoT) connectivity through Direct-to-Satellite IoT (DtS-IoT) while reducing the in-orbit infrastructure required for satellite constellations. The proposed solution introduces the idea of sparse satellite constellations, using the maximum clock drift permitted on LoRa devices, to enable a reduced space infrastructure for connecting objects on a global scale.The research shows that LoRa-based DtS-IoT may be supplied globally with a much smaller number of satellites by effectively obtaining quasi-optimal orbital parameters for sparse IoT constellations through the use of an innovative algorithmic methodology. The findings point to the possibility of establishing a worldwide Internet of Things service using a much smaller amount of space than the conventional in-orbit platform, opening the door for additional research into LoRa specifications, the integration of orbiting and ground gateways, and the improvement of algorithmic search heuristics for broad assumptions.

1. MNGUNI, Smangaliso, ABU-MAHFOUZ, Adnan M., MUDALI, Pragasen, *et al.* A review of gateway placement algorithms on Internet of Things. In : *2019 International Conference on Advances in Big Data, Computing and Data Communication Systems (icABCD)*. IEEE, 2019. p. 1-6.

This article examines the methods currently in use for strategically placing IoT gateways while accounting for geography and physical infrastructure. The issue is that adding several gateways can reduce network congestion and boost performance, but doing so raises expenses for installation and interference. Putting in place gateway placement algorithms that give network performance and Quality of Service (QoS) top priority is the solution. The method employed is to examine and contrast a number of current gateway placement methods in Low Power Wide Area Networks and Wireless Mesh Networks to determine their advantages, disadvantages, and frequent problems. The findings demonstrate that there are multiple methods for placing gateways, each with a unique strategy, set of benefits, and drawbacks.Future research should focus on enhancing the current algorithms' scalability, complexity, and cost as well as investigating novel strategies for gateway placement in developing IoT technologies.

1. LOH, Frank, MEHLING, Noah, GEIßLER, Stefan, *et al.* Efficient graph-based gateway placement for large-scale LoRaWAN deployments. *Computer Communications*, 2023, vol. 204, p. 11-23.

Message collisions and data loss in bigger deployments are two of the limits of LoRa technology that are discussed in the article. To minimize these problems and preserve energy efficiency, effective network planning is essential. Full sensor coverage and addressing the scalability issue in big networks are the goals of the suggested solution, a unique graph-based gateway placement strategy for LoRaWAN. The methodology entails analyzing placement limitations, researching various transmission patterns, and simulatively forecasting collision probabilities during network planning and gateway deployment. The suggested method reduces the number of gates needed by up to 40% and the collision probability by up to 70%, according to the results, performing comparably to state-of-the-art related work.The paper also addresses the drawbacks of high processing time requirements for more complex problem cases and suggests a workable workaround. Subsequent research endeavors could encompass enhancing processing time efficiency and implementing the methodology in actual large-scale LoRaWAN installations.

1. CORREIA, Felipe Pinheiro, SILVA, Samara Ruthielle da, CARVALHO, Fabricio Braga Soares de, *et al.* LoRaWAN Gateway Placement in Smart Agriculture: An Analysis of Clustering Algorithms and Performance Metrics. *Energies*, 2023, vol. 16, no 5, p. 2356.

The issue of counting and positioning LoRaWAN gateways (GWs) in smart agriculture applications is discussed in this article. The suggested approach consists of a five-phase method that uses K-Means and its three variations to place LoRaWAN GWs: (1) environment characterization; (2) LoRaWAN GW location calculation; (3) network performance simulation; (4) results evaluation; and (5) selection of the optimal GW placement. The strategy was put to the test in a sizable agricultural region in Petrolina, Brazil, and the outcomes demonstrated that the suggested technique is capable of efficiently organizing and assessing the functionality and conduct of wireless sensor networks (WSNs) in applications related to smart agriculture.Future research will examine the effects of various clustering techniques on GW placement as well as the extension of the technique to other kinds of surroundings.

1. FARHAD, Arshad et PYUN, Jae-Young. LoRaWAN Meets ML: A Survey on Enhancing Performance with Machine Learning. *Sensors*, 2023, vol. 23, no 15, p. 6851.

An overview of the application of machine learning (ML) to improve LoRaWAN technology performance in Internet of Things applications is provided in this article. The issue that needs to be addressed is the requirement for effective resource management in LoRaWAN networks, which can be done by using machine learning algorithms. The suggested remedy is to use machine learning (ML) to manage resources, which would transform the optimization of bandwidth (BW), transmission power (TP), spreading factor (SF), and other crucial characteristics. A systematic literature review process is employed, comprising the search for publications on IEEE Xplore, ACM, Elsevier, Wiley, and MDPI databases for AI/ML/DL/RL and LoRa/LoRaWAN. The findings demonstrate that machine learning (ML) techniques have been effectively implemented to enhance LoRaWAN network performance, including a higher packet success rate (PSR) and lower energy consumption.Future work will focus on creating more extensive datasets for machine learning training and testing, as well as investigating the possibilities of deep learning (DL) and reinforcement learning (RL) in LoRaWAN.

1. PRAKOSA, Setya Widyawan, FAISAL, Muhamad, ADHITYA, Yudhi, *et al.* Design and implementation of LoRa based IoT scheme for Indonesian rural area. *Electronics*, 2021, vol. 10, no 1, p. 77.

The main obstacles to the implementation of IoT schemes in Indonesia's rural areas are the scarcity of reliable communication networks and the requirement for durable, low-power devices. The article suggests a solution to this problem that makes use of Long Range Wide Area (LoRa) communication technology, which allows for low-power, long-range communication. The strategy entails creating and putting into action an IoT program based on LoRa that is especially suited for the rural Indonesian agricultural industry. The study's findings show how well the suggested plan works to give Indonesian farmers, especially those in isolated and rural locations, an inexpensive monitoring option.Regarding future research, the paper recommends more examination and refinement of the LoRa-based communication system in actual farming settings.

1. GROCHLA, Krzysztof et POŁYS, Konrad. Heuristic algorithm for gateway location selection in large scale lora networks. In : *2020 International Wireless Communications and Mobile Computing (IWCMC)*. IEEE, 2020. p. 777-782.

This article addresses the issue of choosing access point locations in expansive LoRa networks. Optimizing network coverage while taking capacity dimensioning, radio signal propagation, and client geographical distribution into account is a challenge. The paper suggests a heuristic method for choosing the placement of the access point in order to address this problem. The method is assessed in random topologies as well as real-world situations based on the locations of smart meters around the city, showing that it is more effective than manual selection in minimizing the total number of access points needed for complete coverage. By taking advantage of the algorithm's capacity to take into consideration different network factors, the method places access points more effectively. Although future work is not specifically mentioned in the study, possible directions for research could include improving the method, extending its application to various network topologies, and tackling scalability issues as the network expands.

1. KAEWTA, Chutchai, SAVITHI, Charuay, et NAENUDORN, Ekkachai. An optimization of multiple gateway location selection in long range wide area network networks. *Indonesian Journal of Electrical Engineering and Computer Science*, 2023, vol. 30, no 2, p. 1011-1020.

This article addresses the problem of optimizing the selection of multiple gateway locations in LoRaWAN networks, with a focus on reducing network infrastructure constraints and providing signal coverage for all end nodes in rural areas of Thailand. The proposed solution involves the development of a mathematical model with the objective of maximizing coverage while considering the constraints related to gateway capacity, signal service range, and the distances between gateways and villages. The approach used to solve this problem includes the validation of the mathematical model using the LINGO modeling program. The results demonstrate that the optimized selection of six gateways in LoRaWAN can effectively support signal service for all end nodes, thus addressing the connectivity challenges in rural agricultural settings. As for future work, the article may suggest potential areas for further optimization or expansion of the proposed model to accommodate evolving network requirements or additional use cases.

1. LOH, Frank, BAU, Dominique, ZINK, Johannes, *et al.* Robust gateway placement for scalable lorawan. In : *2021 13th IFIP Wireless and Mobile Networking Conference (WMNC)*. IEEE, 2021. p. 71-78.

In the context of scalable LoRaWAN networks for smart city scenarios, this paper discusses the issue of resilient gateway location. The main issue is identifying how to adapt the current infrastructure to handle the anticipated rise in IoT traffic. By taking into account limitations on gateway ranges and capacities, the authors suggest a novel solution to the capacitated geometric set cover problem. They tackle this issue by introducing the VoronoiLocalSearch algorithm, which is derived from current local search heuristics. The findings show that the suggested strategy is successful in delivering strong gateway placements that can withstand increases in load. The paper also offers an approach based on collision probability analysis for analyzing Quality of Service (QoS) in LoRaWAN networks. Future research entails expanding the placement algorithm to handle an increase in the number of sensors and exploring ways to enhance the existing placement when capacities are exhausted.

1. CAN, Batuhan, UYANIK, Halit, et OVATMAN, Tolga. Gateway Placement in LoRaWAN Enabled Sensor Networks. 2023.

In order to limit the number of gateways while maintaining complete sensor network coverage, the paper addresses the challenging issue of gateway location in LoRaWAN equipped sensor networks. Two different strategies are suggested to address this issue. While the second strategy uses mixed-integer programming (MIP) to optimize the distance between the gateways and sensors, the first approach concentrates on determining the minimal set of gateway sites that cover all the sensor coverage intersections. Validation was conducted using actual sensor locations from Turkey's Ergene River, and the findings showed that automated gateway placement significantly reduces the number of gateways needed while preserving the sensor network's effective coverage.The study also evaluated the communication quality obtained by the network using ns-3 and LoRaPlan simulators. Future work could involve experimenting with different sensor position distributions to identify scenarios where the proposed approaches may perform suboptimally, as well as investigating the impact of using finer resolutions in the optimization model. Additionally, the article suggests exploring additional constraints such as ease of transportation to gateways and terrain information for further refinement of the gateway placement strategies.

1. LOUBANY, Ali, LAHOUD, Samer, SAMHAT, Abed Ellatif, *et al.* Improving Energy Efficiency in LoRaWAN Networks with Multiple Gateways. *Sensors*, 2023, vol. 23, no 11, p. 5315.

The problem of increasing LoRaWAN networks' energy efficiency when they have many gateways is discussed by the writers in this article. For example, when node density rises, the Aloha access technique utilized in LoRaWAN might result in collisions and decreased network capacity. Reconfiguring nodes to use larger spreading factors can help solve this issue, however doing so can improve energy efficiency at the expense of increased power usage. The authors suggest EE-LoRa, an algorithm that optimizes transmission powers to the lowest feasible values and carefully distributes nodes among various spreading factors, as a solution to this problem. EE-LoRa's energy efficiency may be greatly increased while keeping network throughput high, as demonstrated by the authors' simulation-based evaluation of the technology. The algorithm will be tested in practical settings in the future, and the impact of different gateway configurations on energy efficiency.

1. IDRIS, Sadiq, KARUNATHILAKE, Thenuka, et FÖRSTER, Anna. Survey and comparative study of LoRa-enabled simulators for internet of things and wireless sensor networks. *Sensors*, 2022, vol. 22, no 15, p. 5546.

The problem of increasing LoRaWAN networks' energy efficiency when they have many gateways is discussed by the writers in this article. For example, when node density rises, the Aloha access technique utilized in LoRaWAN might result in collisions and decreased network capacity. Reconfiguring nodes to utilize larger spreading factors can help solve this issue, however doing so can improve energy efficiency at the expense of increased power usage. The authors suggest EE-LoRa, an algorithm that optimizes transmission powers to the lowest feasible values and carefully distributes nodes among various spreading factors, as a solution to this problem. EE-LoRa's energy efficiency may be greatly increased while keeping network throughput high, as demonstrated by the authors' simulation-based evaluation of the technology. The algorithm will be tested in practical settings in the future, exploring the impact of different gateway configurations on energy efficiency.

1. MARINI, Riccardo, MIKHAYLOV, Konstantin, PASOLINI, Gianni, *et al.* Lorawansim: A flexible simulator for lorawan networks. *Sensors*, 2021, vol. 21, no 3, p. 695.

LoRaWANSim is a flexible simulator for LoRaWAN networks that addresses the need for a tool to evaluate the performance of different application scenarios. The simulator includes a physical layer simulator and a MAC/Net-layer simulator and takes into account the energy-saving capabilities of LoRaWAN. The authors present the results of their simulations, which demonstrate the effectiveness of LoRaWANSim in evaluating the performance of LoRaWAN networks. Future work could focus on extending the simulator with new functionalities missing as of today, such as more advanced propagation models, enabling the support of multiple channels and other device classes and providing a more dynamic formation of data traffic.

1. WANG, Zheng, CUI, Gaofeng, LI, Pengxu, *et al.* Design and implementation of NS3-based simulation system of LEO satellite constellation for IoTs. In : *2018 IEEE 4th international conference on computer and communications (ICCC)*. IEEE, 2018. p. 806-810.

The paper discusses the requirement for a more economical and effective protocol architecture for Internet of Things (IoT) connection based on LEO satellite constellations. The issue is that current IoT technologies are not suitable for satellite settings, necessitating the development of a protocol that may minimize complexity, streamline authentication and random access processes, and maximize channel mapping given constrained wireless resources. In order to address this, the study presents a unique protocol design that makes use of spread spectrum Aloha in the reverse connection, simplifies the processes of random access and authentication, and creates a network architecture that uses intersatellite links to reduce access latency. The protocol design can be analyzed through the use of an NS3-based simulation platform. The investigation of techniques including the handover procedure, location update strategy, backoff algorithm,location update strategy, and paging to further enhance the protocol's efficiency and performance.