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Cite This:Int. J. Of. Comp. Sci. and Data Eng.2024, 1, 10-20

SciForce

International Journal of Computer Science and Data Engineering
Journal homepage: www.sciforce.org

Design, Analysis, and Optimization of Satellite Communication Networks Systems for Enhanced Global Connectivity

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ARTICLE INFO

Article history:
Received:20240610
Received in revised form: 20240616
Accepted: 20240616
Available online: 20240625

Keywords:
Satellite communication;
ARAS;
Satellite optical communication;
Satellite networks;
Thermal Bending.

ABSTRACT

Satellite Communication Networks System

Systems for satellite communication networks include the technological set-ups and supporting infrastructure used for the transmission & reception of voice, video, and data signals. By utilising satellite technology to help with the transmission of information across several Earth locations, these networks enable long-distance communication. Ground stations, satellite systems, & user terminals are the main components of satellite communication networks.

The importance of communication via satellite network structures in research cuts across several fields, underscoring the critical role they play. These systems play a crucial role in creating global connectedness and facilitating communication, highlighting the importance of this area of study. Satellite communication networks have a number of advantages, including the ability to connect to remote or inaccessible areas, abundant bandwidth capacity, and global coverage. They have several uses, including in remote sensing, disaster management, internet connectivity, broadcasting, and telecommunications.

The Additional Ratio rating approach is a decision-making process used to evaluate and rank options by taking into account a number of factors. It comprises giving each criterion a weight and assessing how well the alternatives perform in comparison to a reference option. The ARAS technique calculates an overall score over each alternative by combining these weighted performance ratios. The choice with the greatest score is considered to be the best one. In situations where several criteria are present, the ARAS technique provides decision-makers with a systematic framework for efficiently evaluating and comparing alternatives.

Laser communication, optical networks, satellite optical communication, vibrations, satellite networks

Solar Radiation Pressure, Thermal Bending, Solar and Lunar Gravity, Micro Meteorite impacts, Earth oblations effects

Through the rank table, we can get the rank of alternative parameters. Whereas satellite optical communication is in 1st position and satellite networks is in 5th position.

First ranking satellite optical communication is obtained with the lowest quality of satellite networks.

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Introduction

Cellular networks work by segmenting the coverage region into cells or just zones, each of which has exclusive channels or resources that are available to network users. Although the exact shape of cells is varied by regional topography circumstances, the coverage area in portable satellite communication networks is often represented as a hexagonal cell structure. Advanced planning tools are frequently used by terrestrial cellular carriers to help with the layout and design of their wireless networks. The base station (BS), which is in charge of delivering radio coverage, establishes the contours and bounds of a cell. The BS maintains connections with mobile users using signalling and traffic channels (TCH). The forward link, also known as the downlink, implies communication between the BS towards mobile devices, whereas the reverse link, also known as the uplink, refers to communication by mobile phones and tablets to the BS [1].

A lot of work is now being done to create and set up communication networks using satellites in low Earth orbit (LEO) as well as intermediate circular orbit (ICO). However, before such networks can function properly, a number of issues must be resolved. The creation of LEODCO-satellite systems must carefully take into account a number of factors. Satellites must be positioned at an altitude high enough to provide adequate global coverage with good link quality. This affects the amount of satellites & orbits required, together with the choice of orbital altitude & inclination. By providing multi-satellite visibility, more satellites improve link availability. Alternately, fewer satellites can be used by choosing higher orbits for the satellites, albeit this may result in longer propagation times and more power-intensive transmissions [2].

As a crucial supplementary element of emerging 5G networks, satellite communication networks are projected to play a significant role. They will provide larger coverage and dependable connectivity in places where installing terrestrial infrastructure is either economically difficult or impracticable. Energy-domain non-orthogonal multiple accesses (NOMA), which serves several users concurrently inside a time/frequency block, is acknowledged as a potential technique for achieving great spectrum efficiency and resource utilisation in 5G networks. The accessibility, coverage, and functioning needs of 5G are addressed in this research by applying NOMA to several satellite systems. Following a discussion of the principles of satellite link budgeting, the benefits and drawbacks of using NOMA in various satellite topologies are examined. These architectures consist of cooperative satellite networks including satellite/terrestrial relays, conventional downlink/uplink satellite connections, cognitive satellite terrestrial connections, & satellite networks [3].

Satellite communication networks are now being built by a number of well-known coalitions with the goal of offering individual users worldwide coverage. The carrier of satellite links in these communication projects is microwave radiation. Additionally, free-space optical connectivity among connected satellites facilitates fast communication between various Earth locations. In free space, optical communication systems have a number of advantages over microwave communication systems, including smaller size and weight, less transmitter power needed, more bandwidth capacity, and improved interference resistance. The great separation between satellites, the small beam divergence angle, plus the vibrations that affect the pointing mechanism make it difficult to precisely aim the satellite antennas in the direction of one another [4]. In places with low population density and in order to provide larger wireless coverage, satellite communication networks have been proposed to be a beneficial addition for terrestrial cellular networks. Terrestrial-satellite communication networks (TSNs) are viewed as a potential architecture to attain extensive and all-encompassing coverage as part of the next-generation network infrastructure. This article discusses the management of cross-layer power, beam resources, and spectrum resources as three key technological challenges to the efficient management for radio spectrum for future TSNs [5].

A new era for satellite networks is beginning, one marked by combined space-ground communication networks that provide worldwide coverage, a wide range of services, and dependable transmission. But when researching traditional satellite networks, it's important to keep in mind a few things. Traditional satellite networks, for one, have a slow organisational structure since satellites can only be set up by ground stations while they pass over them. The complete worldwide network must then be configured, which takes time. Second, due to the decentralised management architecture, planned link allocation, and inflexible routing techniques in conventional satellite networks, traffic planning is ineffective. Due to these restrictions, it is difficult to provide micro-resource management and take into account changing user needs. The final issue is that traditional satellite networks lack flexibility because satellite-related services are often implemented in particularlocations determined by the vendors. These services are designed to fulfill specific functions but lack adaptability to changing demands [6].

Broad coverage and flexibility make satellite communication networks ideal for supporting domestic wireless networks and servicing specialised uses like manned space travel, deep-sea exploration, as well as emergency rescue operations. Enhancing computer capacity in satellite communication networks, however, appears as a serious problem as the demand for data traffic keeps rising. Except for specific satellite network structures and resources, satellite assets are not currently being used to their full potential. As a result, it becomes crucial to address the issue of resource utilisation optimisation within the limitations of limited satellite resources [7].

Small satellite systems, which have been used for both military and non-military reasons, have revolutionised a number of fields, including remote sensing, communications, navigation, and scientific research. These small spacecrafts are limited by their mass, mass, and power capacities. The deployment of constellations or even clusters of tiny satellites, however, can be used to carry out a variety of scientific tasks, including gravity mapping, monitoring of forest fires, and water source discovery. A quick and affordable way to investigate and comprehend the near-Earth environment is to use tiny satellites. It is possible to considerably increase the geographical & temporal resolution for viewing targets by launching many satellites in a constellation. by this novel strategy, the requirement for a single huge asset is replaced by a network of extremely capable tiny satellites, opening up new potential and exciting applications [8].

Future Internet infrastructure is expected to be significantly influenced by satellite links. To accommodate digital video broadcast as well as return channel protocols, satellite system designs that entirely depend on Internet Protocol (IP) are currently being developed. A thorough system update that covers both OSI & TCP/IP protocol stack layers is required to ensure the effective implementation of these cutting-edge satellite network structures and meet the demands of new applications and services. For a variety of contexts, including rural locations, high-speed trains, around emergency or crisis situations, satellites have the advantage of offering vast coverage with no need for complicated infrastructure installations [9]. Compared to geostationary satellites, low earth orbit (LEO) satellites have a lower propagation delay since they are placed at altitudes between 500 and 1500 km. Real-time communication is made possible by the decreased lag, which also improves data flow. In addition, the lower altitudes of LEO satellites reduce the amount of power needed and lessen signal attenuation, allowing for the creation of terminal equipment that is more compact. There is widespread agreement regarding the importance of satellite networks, especially LEO satellite networks, in upcoming ubiquitous communication systems. LEO satellites, in contrast to geostationary satellites, are always moving and only offer coverage to end customers for a short time [10].

Long considered a viable strategy to improve communication service delivery, the merging of satellite & terrestrial elements into a single telecommunications network. However, limiting economies of scale & technical difficulties have prevented satellite communications from keeping up with terrestrial networks. The satellite industry is aware of the need to reconsider and redefine satellite communications' place in the transition to cutting-edge 5G networks. To ensure a broad and strong connectivity ecosystem for the future, given the imminent problems that 5G networks provide, it is essential to establish a network architecture which allows for numerous technologies, including several layers and satellite communications [11].

The backhaul & direct-to-user services provided by satellite networks of communication operating in the Ka band & higher frequencies are an essential component of the global telecommunications infrastructure. However, the adverse impacts of rain attenuation frequently impair the functionality of these networks. A new strategy has been developed to address this problem, which involves dynamically changing the relative position of multi-beam antennas for satellites to combat fading brought on by attenuation [12].

Due to their accessibility and ease of deployment, small satellites, referred to as cubesats, present a feasible alternative for next satellite communication networks. At the moment, cubesats use specific frequency ranges to operate for communication. However, there is a need for more spectrum bands and better spectrum efficiency as the quantity of cubesats keeps growing and new applications are developed. The creation of affordable and dependable systems to enable a variety of applications, like as detecting, imaging, navigation, and communication, is necessary for the commercial use of space. Traditional satellites in Low Earth Orbits, Medium Earth Orbits, and Geosynchronous Equatorial Orbits presently provide these services [13].

Delivering stable and affordable power to end consumers is a continuing problem for urban electric companies. Equipment failures, lightning strikes, accidents, & natural catastrophes are just a few examples of the situations that can cause power outages and protracted service interruptions. Power system automating is being adopted as a solution to these problems in order to create a reliable and self-healing power structure that can quickly respond to incidents in real time with the necessary responses, maintaining an uninterrupted supply of electricity. Electric utilities must have a high-performance information communication network that can handle both their present day operations and future needs in order to meet their operational and business expectations. As a result, the performance of the system is greatly influenced by the layout of the network architecture [14].

Wireless communication networks have recently faced a substantial problem due to the exponential expansion of mobile users. Additionally, mobile consumers increasingly demand constant, fast connectivity—even in unusual places like trains, aircraft, and ships. By offering trustworthy communications services to users of mobile devices in rural locations, emergency circumstances, and diverse means of transportation, mobile satellite systems provide a workable alternative to address these demands. Mobile Satellite Communication Networks (MSNET) are in a prime position to be instrumental in aiding in disaster relief and prevention because to improvements in on-board processing and computing power. These networks provide broader coverage, improved transmission capacity, increased communication range, and a decreased dependency on terrestrial infrastructure. They are used, among other things, in spatial telemetry, global positioning, and emergency response [15].

Methodology

A significant and recently popularised part of decision theory is multi-attribute decision making (MADM). Making educated decisions requires analysing information, which may include both qualitative and quantitative. Dealing with MADM issues that include many measurement units, nevertheless, presents difficulties. The Additive Ratio Assessment System (ARAS) technique has been introduced to address this problem. This strategy provides a simple and effective means of addressing MADM issues while reducing the impact of various measuring units. The ARAS approach has attracted a lot of interest and has been modified for use in a variety of information environments and application areas [16].

The use of multi-criteria decision-making techniques is widespread and includes a wide range of human endeavours. In a choice problem with many criteria, both qualitative and quantitative criteria are used to evaluate each possibility. These criteria frequently have unique measurement systems and optimisation techniques. Real-world decision-making situations are frequently complex and lack a formal framework that would allow them to be assessed merely based on one criterion, necessitating the use of a multi-criteria approach to arrive at the best choice. Understanding the numerous aspects that affect both the rise and fall of prospective alternatives, in addition to the challenges and hazards related to corporate operations becomes essential in competitive market conditions [17].

Stakeholders may ask the negotiator to specify their preferences & reservation requirements in the form of extensive sets of preferred values in order to arrive at the best solution. Each criterion's negotiating space is influenced by these values. The ARAS method has been widely used to handle a variety of MCDM problems since it was first developed by Javadskas and Tarskis. Extensions like ARAS-G, ARAS-F, and IVTFN were presented, adding grey and fuzzy techniques to handle the complexity and unpredictability present in decision-making processes, allowing the ARAS method to be used efficiently in handling a wide range of real-world choice issues [18]. The ARAS technique suggests that the cumulative influence of the scores and weights allocated to the primary criteria in a project determines the utility function's value, which analyses the comparative efficacy of a viable alternative. In multi-criteria decision-making (MCDM), ranking a small number of choice options that are each defined by different criteria that must be taken into account collectively is a frequent goal. The cooperation of machinery in technical structures is essential for construction operations. In the setting of process design, efficiency ratios pertaining to the profits and expenses connected with computer usage are extremely important [19]. The ARAS approach is based on the idea that simple relative comparisons might help us understand the complexities of the real world. According to this theory, the ratio results from adding the scales' normalised and weighted values. The sum of the values for the normalised and weighted criteria represents the assessment of an alternative under consideration. These requirements specify the ideal alternative and its associated level, which acts as a standard against which to measure the alternative that is being evaluated. The utility function value used by the ARAS technique is used to evaluate the complex relative effectiveness of a viable alternative and is directly related to the relative importance of the values & weights given to the project's important criteria [20].

According to Wu et al. (2012), the multi-criteria decision-making technique is a well-known decision analysis strategy that has been extensively used to numerous selection issues. Since it takes into account both quantitative criteria like benefit and cost and qualitative factors like excellent service and environmental efficiency, MCDM is very pertinent in the context of choosing green suppliers. Since these factors frequently clash, it's crucial to spend business resources wisely. The selection of green upstream suppliers is essential for success in manufacturing. Companies can lower their environmental costs, improve customer satisfaction later as well as ultimately gain an advantage over their rivals by choosing the right providers who prioritise environmental factors. Consequently, finding appropriate environmentally friendly vendors becomes a procedure that significant and crucial undertaking [21].

Traditional approaches are now viewed as being out of date, hence research is increasingly concentrating on robust hybrid multi-criteria decision-making models. Two innovative hybrid MCDM systems were created in a recent study by combining the additive ratio estimating method with complex proportional estimation, ideal solution TOPSIS, and preference selection. The models were used to solve a real-time robot selection problem with 12 choices and 5 criteria to show their efficacy. The criteria significance - Inter-Criteria Correlation (CRITIC) Objective Weight Assessment Tool was used to assess the TOPSIS-ARAS and COPRAS-ARAS models. The goal of the study was to demonstrate how effective these hybrid models are in complicated decision-making situations where several criteria and options must be taken into account [22].

Many countries are currently looking for efficient ways for handling real estate assets which have both monetary and cultural worth. The issue of using and maintaining cultural goods, which include historic buildings and designed architectural spaces, is made more difficult by the fact that they are governed by national laws. When seeking to align these features with public or out investor requirements, this might impede decision-making processes. In order to ascertain the requirements for their archaeological, past, architectural, financial, social, and reconstruction, this study evaluates the condition of selected buildings located in Vilnius' ancient city centre. Experience has shown us that rash decisions frequently result in mistakes, requiring more effort and resources. Therefore, the essay suggests using the proven decision-making techniques Analytic Hierarchy Process (AHP) & Additive Ratio Assessment (ARAS) [23].

In order to achieve the research goal, fourteen criteria derived from CES EduPack software are used to evaluate different renewable energy solutions. The researchers have divided these criteria into five kinds of sustainability indicators. Determining the weights allocated to each assessment criterion is essential in the selection or ranking process when confronting multi-attribute decision-making situations. For criterion weighting, several methodologies include objective, subjective, and combination methods, have been established in the past. Using their experience and implicit knowledge, experts' personal judgements are taken into account in the subjective method. It can be viewed as a numerical illustration of their level of subject-matter competence [24].

A portion of multi-criteria decision making (MCDM) strategies, the Additive Ratio Assessment System, was first put forth by Zavadskas and Turskis in 2010. It solves complex issues using uncomplicated relative comparisons. By comparing the ratio of the sum of the normalised and weighted criteria values, it selects the best option from a variety of possibilities. Researchers frequently use the ARAS approach to rate different options and determine which one is best in a certain situation [25].

Alternate Parameters

Laser Communication: A method known as laser communication, also known as optical communication, free-space optical communication, uses laser beams to send data through free space, such as the atmosphere of the Earth and outer space. Using lasers, data is converted into light signals that are then transmitted straight to a receiving destination.

The original data is retrieved at the point of reception by decoding the light signals. For purposes that require effective and dependable communication without the use of physical connections or wires, laser communication offers a high-speed and safe transmission method.

Optical Networks: Optical networks are systems of communication that use optical fibres as a way of transferring data signals. They are also known as networks of optical communication, optical transport networks. These networks use optical technology to quickly and effectively communicate across great distances by sending and receiving data as pulses of light. In order to transmit data at fast speeds and in huge volumes, optical networks use optical fibres as the transmission medium. This makes them ideal for applications like telephony, internet networking, and data centre interconnectivity that demand quick and dependable communication.

Satellite Optical Communication: The practise of transmitting data signals between satellites via optical technology is known as satellite optical interaction, also known as optical communication via satellite, space-based optical communication. With this technique, optical signals are sent into the vastness of space using lasers or other light sources, enabling fast and far-reaching communication between satellites. In space-based applications like satellite-to-satellite communication, observation of the earth, scientific research, and deep space exploration, satellite optical communications offer the possibility for effective and quick data transmission by using the power of light. This technology has the potential to enable sophisticated and dependable satellite networks and space mission communication systems.

Vibrations: A body or system moving rapidly and repeatedly in relation to a fixed location is said to be vibrating. There are many other patterns that these movements can adopt, such as back-and-forth, up-and-down, or from side-to-side patterns. An object may vibrate as a result of external forces operating on it, internal mechanical interactions among its parts, or natural phenomena. They can appear in a wide range of situations, from small mechanical devices to massive constructions, and even natural events. They are frequently noticed as repetitive or cyclical disturbances. Understanding vibrations' features and behaviour is essential for creating stable and effective systems since they play a vital part in physics, engineering, and a number of different sectors.

Satellite Networks: To enable effective communication and data sharing across great distances, satellite connections are a type of network infrastructure made up of an assortment of satellite orbiting the Earth. These networked satellites are essential elements for a variety of uses, including remote sensing, broadcasting, navigation, and scientific research. Satellite networks provide worldwide connectivity and information transfer by establishing seamless links between various points on the earth. As a result, people, organisations, and even whole countries can access essential services and exchange information on a global scale.

Evaluation Parameters

Solar Radiation Presssure: The pressure that sunlight exerts on objects in space is referred to as solar radiation pressure, additionally referred to as solar pressure as well as solar radiation force. Solar radiation pressure is the outcome of the momentum that sunlight imparts to a surface when it interacts with it.

Thermal Bending: The term "thermal bending" describes how an object or structure bends or deforms as a result of temperature variations. A material expands or contracts as a result of temperature changes, creating thermal stresses that cause the material to stretch or deform.

Solar And Lunar Gravity: The gravitational pull that the sun, the dominant star in our solar system, has on other celestial objects including planets, moons, & satellites is referred to as solar gravity. The gravity of the Sun is a fundamental factor that governs the motion and conduct of solar system objects. On the other side, lunar gravity describes the gravitational pull that the moon has on nearby objects. The Moon is the only natural satellite of Earth, and because of its gravitational attraction, numerous natural events take place here, including tides in the ocean.

Micro Meteorite Impacts: Micrometeoroid impacts are when tiny meteorites, usually made of dust or small rocks, collide with space objects like satellites, spacecraft, as well as planetary surfaces. These tiny meteorites, known as micrometeorites, are left over from comets, asteroids, as well as other celestial bodies. They move quickly through space.

Earth Oblateness Effects: Earth analogue effects, also referred to as the Earth's oblate shape, show that the Earth's shape differs from an ideal sphere. The Earth isn't a perfect spherical; it has a bulge at the equator and a tiny flattening at the poles. The rotation of planet Earth is principally to blame for this departure from spherical shape.

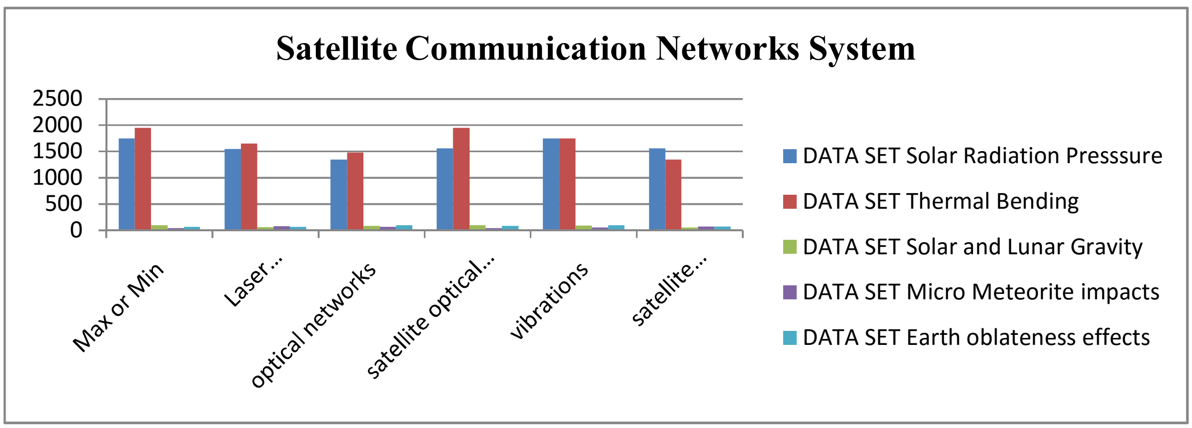
Results And Dicussion

Table 1. Satellite Communication Networks System

	DATA SET				
	Solar Radiation Pressure	Thermal Bending	Solar and Lunar Gravity	Micro Meteorite impacts	Earth oblateness effects
Max or Min	1750	1950	97.8	40.5	63.5
Laser communication	1550	1650	57.8	75.6	63.5
optical networks	1350	1480	86.5	60.6	95.3
satellite optical communication	1560	1950	97.8	40.5	88.6
vibrations	1750	1750	90.5	50.5	98.4
satellite networks	1560	1350	50.6	67.6	69.79

Table 1 provides the value for evaluation parameters: Solar Radiation Pressure, Thermal Bending, Solar and Lunar Gravity, Micro Meteorite impacts, Earth oblations effects for the given respected satellite communication network system

Figure 1. Satellite Communication Networks System



Through the above graph figure 1, we can view the value for evaluation parameters for Satellite Communication Networks System

Table 2. Weight

weight				
0.2	0.2	0.2	0.2	0.2
0.2	0.2	0.2	0.2	0.2
0.2	0.2	0.2	0.2	0.2
0.2	0.2	0.2	0.2	0.2
0.2	0.2	0.2	0.2	0.2
0.2	0.2	0.2	0.2	0.2
0.2	0.2	0.2	0.2	0.2

Table 2 gives the weight for the given data set. the weighted of data set is evenly distributed and has the same value

Table 3. Satellite Communication Networks System

Solar Radiation Presssure	Thermal Bending	Solar and Lunar Gravity	Micro Meteorite impacts	Earth oblateness effects

1750	1950	97.8	0.024691	0.015748
1550	1650	57.8	0.013228	0.015748
1350	1480	86.5	0.016502	0.010493
1560	1950	97.8	0.024691	0.011287
1750	1750	90.5	0.019802	0.010163
1560	1350	50.6	0.014793	0.014329

In table 3 we reciprocal the value of non-benefit terms: Micro Meteorite impacts, Earth oblateness effects

Table 4. Weighted Normalized Data

Weighted Normalized Data				
0.03676	0.03850	0.04067	0.04343	0.04050
0.03256	0.03258	0.02403	0.02327	0.04050
0.02836	0.02922	0.03597	0.02902	0.02699
0.03277	0.03850	0.04067	0.04343	0.02903
0.03676	0.03455	0.03763	0.03483	0.02614
0.03277	0.02665	0.02104	0.02602	0.03685

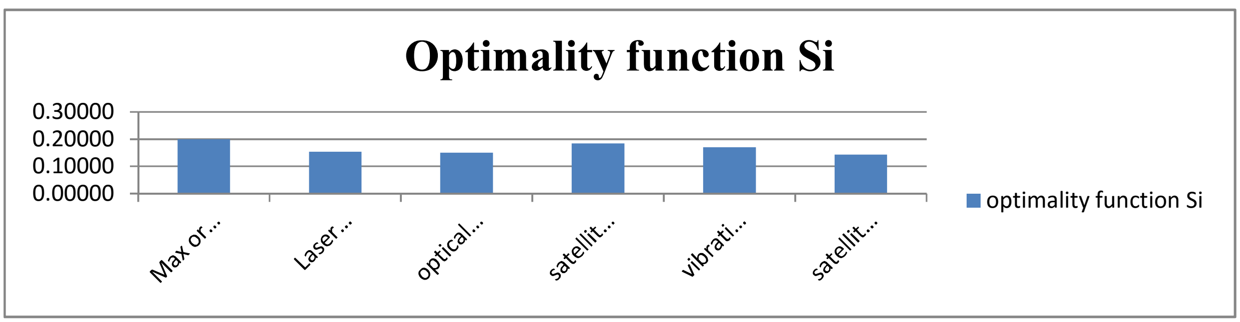
Weighted Normalized Data value is shown in above table 4 and the values are got from the data set and weight of data set

Table 5. Optimality function Si

	optimality function Si
Max or Min	0.19986
Laser communication	0.15294
optical networks	0.14956
satellite optical communication	0.18439
vibrations	0.16991
satellite networks	0.14334

Table 5 provides the value of optimality function Si for the alternative parameters

Figure 2. Optimality function Si



` Figure 2 displays the optimality function Si for Laser communication, optical networks, satellite optical communication, vibrations, and satellite networks

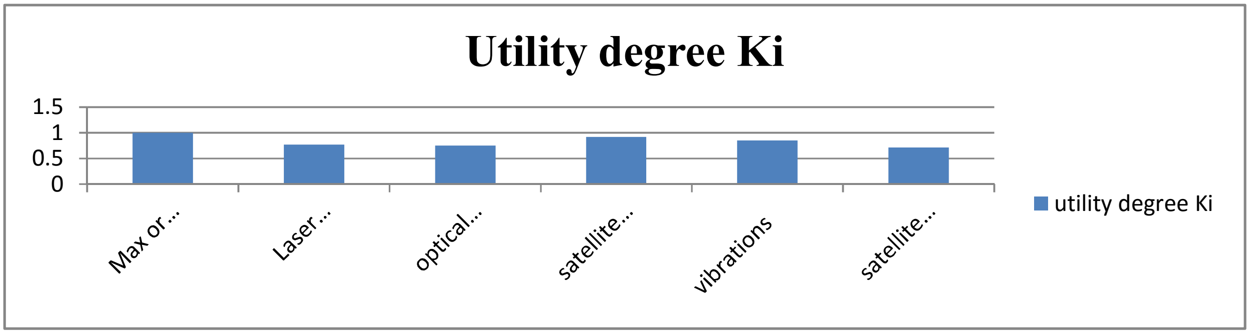
Table 6. Utility degree K_i

	utility degree K_i
Max or Min	1
Laser communication	0.765233

optical networks	0.748321
satellite optical communication	0.92262
vibrations	0.850153
satellite networks	0.717181

Utility degree Ki is got from the table 6 through dividing optimality function to sum of all the optimality function

Figure 3. Utility degree K_i



Here we see the schematic view of utility degree Ki for alternative parameters in the figure 3

Table 7. Rank

	Rank
Laser communication	3
optical networks	4
satellite optical communication	1
vibrations	2
satellite networks	5

Table 7 provides the rank for alternative parameters: Laser communication, optical networks, satellite optical communication, vibrations, and satellite networks. Satellite optical communication is in the first position and satellite networks got the last rank.

Figure 4. Rank

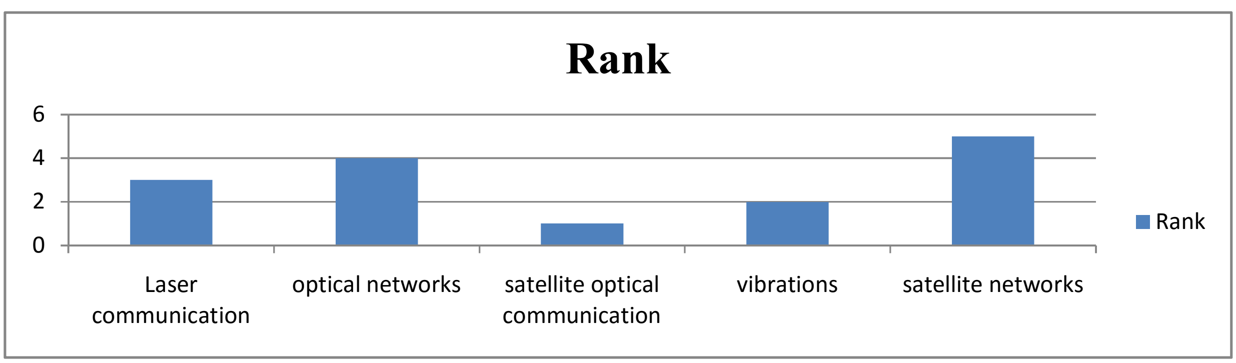


Figure 4 shows the rank of alternative parameters in a schematic view

Conclusion

Cellular networks work by segmenting their coverage area into separate cells as well as zones, each having exclusive channels and resources for network users. In order to illustrate their coverage, mobile satellite networks for communication often use a hexagonal cell structure, while the precise shape of the cells is dictated by regional topographical characteristics. Terrestrial cellular providers frequently use sophisticated planning tools to support network planning. Base stations

(BS), that provide radio coverage, govern the size and borders of cells. Communication between BSs and mobile users is established by signalling and traffic channels (TCH). The forward link, also known as the downlink, is the transmission from BS to mobile, while the reverse link, also known as the uplink, is the transmission between mobile to BS. By providing extensive coverage and dependable connection, satellite networks for communication are anticipated to play a significant role in completing the next 5G networks, particularly in regions where deploying terrestrial infrastructure is difficult or economically unviable. In addition, energy-domain non-orthogonal multiple access (NOMA), which enables simultaneous serving of many users inside a time/frequency block to improve spectrum efficiency and resource utilisation, has emerged as a promising technology in 5G networks. This article gives a thorough description of the way NOMA can be used to improve the performance, availability, and coverage of various satellite designs. As a core feature, the basic principles of satellite communication budgeting are also covered. A crucial component of decision theory that has received a lot of attention recently is multi-attribute decision making (MADM). Different units of measurement might provide complications when analysing information in MADM situations because both qualitative and quantitative components are involved. The Additive Ratio Assessment System (ARAS) approach has been presented as a resolution to this problem. The ARAS approach seeks to effectively and simply address MADM difficulties while minimising the effect of different measuring units. The ARAS approach has attracted a lot of interest and is frequently used in a variety of information environments as well as application domains. Methods of multi-criteria decision making (MCDM) are widely employed in a variety of human endeavours. In MCDM problems, many criteria which may be either quantitative or qualitative in nature—are used to evaluate each possibility. In terms of measuring units and optimisation directions, these criteria frequently diverge. Real-world decision-making situations are frequently complicated and unorganised, making it difficult to rely on just one standard or viewpoint in order to make the best choice. Competing in the market requires a thorough awareness of intricate circumstances and regions where bankruptcy is possible. It is necessary to learn about criteria determining both development and downfall of feasible alternatives.

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