

BIBLIOMETRIC SURVEY OF 5G IN INDIA

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Abstract

The telecommunications industry is in strong competition with all service providers and is trying to reach the top by using attractive plans and evolving its network standards to attract and retain its customers. One of subsector of telecommunication industry i.e. 5G is anticipated to deliver data speeds hence enhances the overall customer experience and drastically improves efficiency in IoT devices. This paper gives a comprehensive bibliometric survey of the literature of usage of 5G in India. We have used the Scopus database for searching and analysing the research papers and VOSviewer visualization tool for obtaining the link strength between authors, organizations, countries, and keywords. The survey covers 99 articles. With the emerging technologies 5G has become significant from the year 2006. Based on the analysis there is rise in the publication since last 5 years. The study also investigates top affiliated universities as well as major funding sponsors. Using co-authorship analysis, we have created a map that shows the link strength between authors. Also, using a bibliographic coupling, we mapped the collaborative networks at a country level.

Key words: India; 5G; 4G; High Speed Internet; Network Standards; Design

Introduction

Since 1970 the wireless communication industry has started its evolution of technology and has shown an immense growth in the sector. Today, most of the telecommunication providers provides voice service on its network i.e. Long-Term Evolution (LTE). India is still in its deploying and testing phase for setting up 5G network abiding by the network architecture and security solution. 3G was launched in the year 2001 went through the 1G and 2G eras from early 1900 to 2000. NTT DoCoMo launched a test network of 3G in Japan. By 2007 3G networks had 295 million subscribers worldwide, which represents 9% of the overall subscriber in world.

4G was started in 2008 and has a very short history so far. 4G was improvised by LTE

Evolution of mobile cellular Network:

1G: It was introduced in the year 1979. 1G had a lot of disadvantages with poor network coverage and very low sound quality. Lack of encryption and low compatibility with systems

2G: It was launched in Finland in the year 1991 based on GSM (Global System for Mobile) standard. The fundamental of technology was completely different from 2G. It uses digital communication signals for SMS (send text messages), MMS (multimedia messages) and voice over network. Technologies like “GPRS (General Packet Radio Service), CDMA (Code Division Multiple Access), GSM (Global System for Mobile), EDGE (Enhanced Data for Global Evolution)” was included in 2G. The drawback with 2G was its incapability to make a reach to cell tower as at few location where there was less population, the antenna produced higher frequency which resulted in loss of signal.

2.5G: It was launched in 1990. It uses the support of GPRS technology (General Packet Radio Service). With this technology, packet switching data resources are supplied to GSM networks (Global System for Mobile). An additional function for sending graphic data as packets was made available in 2.5G. Packet switching has had an impact on the Internet and the Internet Protocol. Enhanced Data for Global Evolution (EDGE) is an example of 2.5G.

3G: The EDGE technique had a disadvantage in transmission of packets which made the system less efficient. 3G has a technology of wireless broadband network to improve signal clarity. Packet switching technique used in 2.5G plays role to send the data. In addition to voice services, 3G offers data communication services for video streaming and global roaming. 3G advances with high bandwidth. Energy consumption has increased significantly, which indicates a very rapid reduction in battery life of devices.

4G: It was defined by ITU (International Telecommunication Union) in IMT Advanced (International Mobile Telecommunications Advanced) that replace 3G. It is popularly known as MAGIC2. It stands for "Mobile Multimedia, Everywhere, Global Mobility Solutions Over, Integrated Wireless and Custom Services". 4G network requires a mobile device to exchange data at 100 Mbit / s for communication with high mobility and 1 Gbit / s for communication with low mobility.

5G: It provides network functions that is highly reliable and has low latency that are required to support various applications in different firms. 5G has set a remark to disruptive technology into the market that includes increase in the number of IoT devices and their interconnection with information technology, the advent of advanced computers, an increase in the demand for content streaming services. In early 2000s 3G and 4g networks were confirmed that it would not support ultra-low latency network. 5g provides enhance mobile broadband connectivity, remote control of industrial infrastructure, vehicles and medical equipment.

Literature Review

A deep insight about India's readiness for 5G has been given by R. Rupam, G. Dubey and S. N. Singh (R. Rupam, G. Dubey and S. N. Singh , [2017](#)) they have also given vision of 5G and its future scope in Indian market. An overview about the recent entrant for its 4G and VoLTE technology, Jio, and its management principles adopted by the company were analysed on the basis of researches (N, Neethu & Sandeep, Sreelakshmi & K S, Anjumol & Rajan, Niharika. [2019](#)) and studies conducted in these fields. The need for 5G, its advantages, and challenges are described by Albreem (M. A. M. Albreem, [2015](#)) and has explained that 5G is design to be free from limitations and hindrance of the previous generations network standards. The assessment of techno-financial feasibility for 5G deployment in India and its use cases is given by Jha & Saha (Jha, Ashutosh & Saha, Debashis. [2018](#)) and evaluates the demand of 5G for coming 10 years, the requirements of network infrastructure to ensure cellular coverage and capacity.

A study on adaptation of huge leap for usage of mobile phone can be hoisted and executed in current 4G and upcoming 5G Networks advancements with higher level of execution can be accomplished in the system under certain conditions condition. (E. K. Aseri [2019](#)). Also, 134 million mobile phones were sold in India in 2017 which is not trivial and significant that many customers are inclined in the usage of internet with a better connectivity. The concept of "Place Time Capacity" has been discussed by Kumar, Mehta & Prasad (P. L. Mehta and A. Kumar [2015](#)) and states that the problem escalates in usage of data when the group of subscribers roam together, further increases the capacity need at every spot and problem becomes more troublesome on upgrade from 2G to 4G and further expecting 5G by the year end 2020 that immensely increases per subscriber capacity allocation.

Since last few years there has been target to launch 5g in India by 2020 and hence emerging trends related to 5G is discussed by Sourav & Chandrabhanu ([2018](#)) how 5G penetration will be done in rural India and its use in big data analysis Several use case has been studied related to support of machine to machine communication, IoT devices by 5G network.(Neog P., Paul R., Roy S., Bera R. 2018)

In the subsequent sections of this paper, we cover the following points. The *Framing of Keywords* section covers the step-wise procedure of selecting the appropriate set of keywords which is the first and foremost step for gathering relevant papers from the Scopus database. In the *Analysis using the Scopus Database* section, we propose a detailed analysis of the documents we chose. The analysis covers the rise in the research in recent years. *Visualization using VOSviewer* section talks about network visualization and maps based on bibliometric data. We can establish a link between authors, organizations, and countries using VOSviewer. In *Research Gaps*

and Challenges of 5G Internet section, we noted down a few research problems which are expected to help researchers for going forward. Finally, in the *Conclusions and Future Scope of Work* section, we summarize the paper and provide directions for future work in this area.

Framing of Keywords

In any bibliometric analysis, the sample size is a significant component. And to have a proper sample size, the framing of the keywords is important. To explore appropriate research papers from the Scopus database related to the quantum internet, we utilized a three-step procedure. Initially, we established a few keyword combinations in the Scopus database using certain common keywords gathered from different kinds of literature and analysed the resulting documents. These are the keyword combinations, we explored in the first step.

Keyword Pattern	Document Results
("India" AND ("5G" OR "4G") AND "internet") OR ("India" AND "5G" AND ("network" OR "Communication"))	92
("India" AND ("5G" OR "4G" OR "GPRS" OR "LTE") AND "internet") OR ("India" AND "5G" AND "Communication")	112
("India" AND ("5G" OR "4G" OR "LTE" OR "3GPP" OR "GPRS") AND "internet") OR ("India" AND "5G technology" OR "5G network" OR "Network Standards")	98
"India" AND ("5g" OR "4G" OR "LTE" OR "3GPP" OR "LTE" OR "GPRS") AND "high Speed Internet" OR ("Development" OR "Design and Development")	90

In the second step, we removed the keywords which were overlapping with the meaning of other keywords and also removed the papers which are not related to the quantum internet domain. After trying out various combinations in the third step, we finalized the following set of keywords. Each of the keywords we chose in the final set, associates with different solutions or to different physical or mathematical foundations on which the solution is based.

("India" AND ("5G" OR "4G" OR "LTE" OR "3GPP" OR "GPRS") AND "internet") OR ("India" AND "5G technology" OR "5G network" OR "Network Standards") = **99 document results.**

Analysis using the Scopus database

A comprehensive bibliometric analysis of 5G technology area of research in India using the Scopus database and visualization tool VOSviewer is shown in this section. This section aims to give details of the rise in the research in recent years, leading publications, universities, and countries that are publishing research papers in the area.

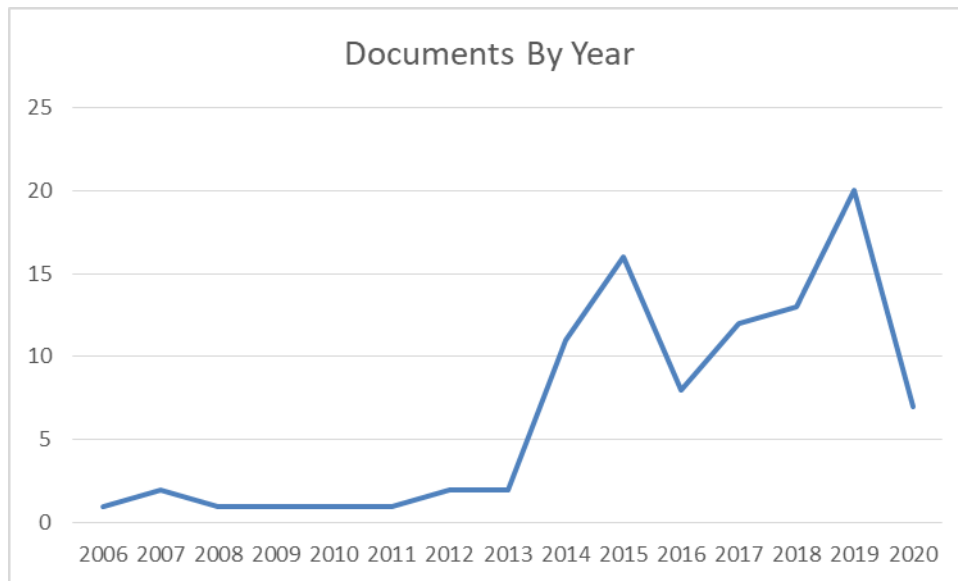


Figure 1: Documents per year from 2006 to 2020

[Figure 1](#) shows the number of research papers published between 2006 - 2020. From the figure, it is clear that the hike in the number of research papers for 5G in India significantly increased from the year 2014. It's also known that the discussion on 5G as a next generation network was started from 2015.

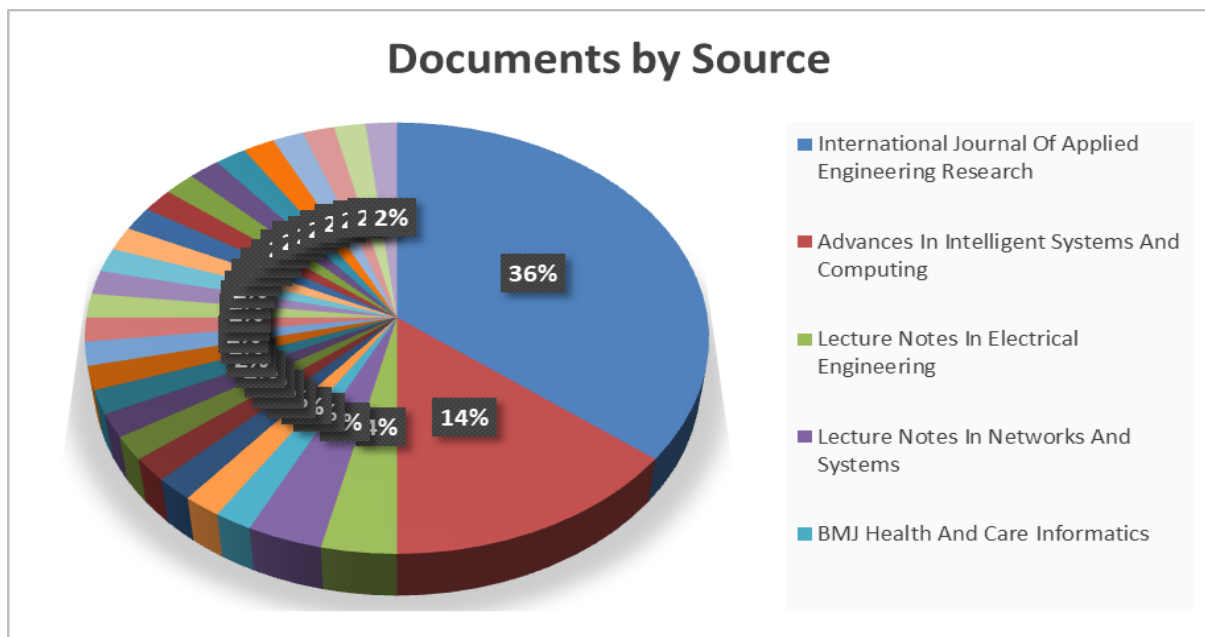


Figure 2: Distribution of documents according to source

[Figure 2](#) shows the leading sources where the research papers have been published. We can comprehend that most of the research papers were published by “International Journal Of Applied Engineering Research” journal, which is a high-impact international journal publishing cutting-edge and quality of service research in migration from old technology to new emerging technology.

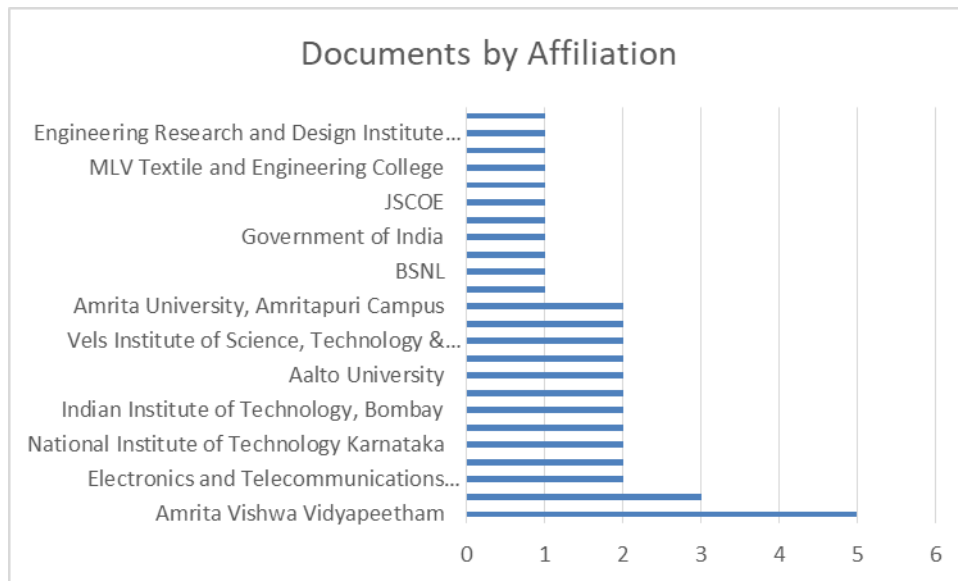


Figure 3: Leading affiliated documents for 5G in India

The top three universities publishing research papers related to the study of 5G in India are private institutes. [Figure 3](#) shows the top 15 institution which are working on quantum internet research.

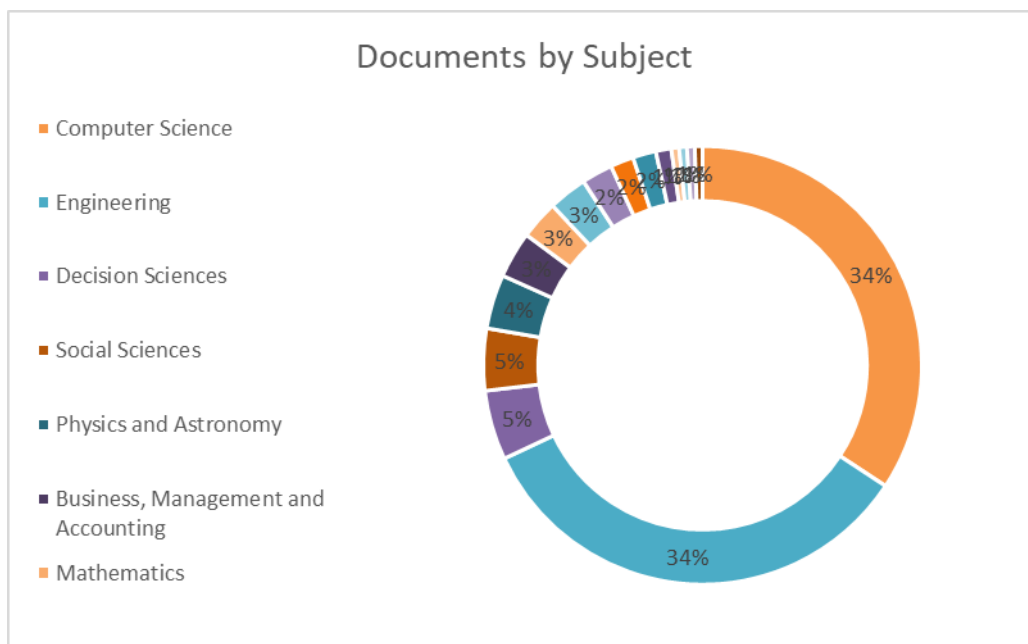


Figure 4: Subject area wise spread of documents

[Figure 4](#) shows the subjects which have been contributing to the research. The internet and network standards for the mobile communication was more studied rooted in communication. Since the computer applications is connected with the usage of network it is understood that high speed connectivity is vital for communication. Therefore, it is but natural that physics contributes to most of the research papers. Computer Science and Engineering are the other contributing research areas.

The highly-cited documents are given in [Table 1](#). These documents provide information on impact of the next generation networks and uses This list contains new as well as old papers that help to understand the shifts and enhancements in the technology.

Authors	Title	Year	Cited by
Kilaru S., Harikishore K., Sravani T., Anvesh Chowdary L., Balaji T.	Review and analysis of promising technologies with respect to Fifth generation networks	2014	92
Kumar N.	Facebook for self-empowerment? A study of Facebook adoption in urban India	2014	39
Zhang L., Wang D.	Sponsoring content: Motivation and pitfalls for content service providers	2014	28
Mekala M.S., Viswanathan P.	A novel technology for smart agriculture based on IoT with cloud computing	2017	32
Chatterjee S., Kar A.K., Gupta M.P.	Critical success factors to establish 5G network in smart cities: Inputs for security and privacy	2017	18
Mohammed A.S., Hamad D.M., Sivaram M., Porkodi V., Manikandan V.	Analysis of mobile IP wireless networks in 5G	2019	6

Table 1: Highly cited publication in the period 2014-2020 from Scopus Database

Visualization using VOSviewer

Using VOSviewer, we can create various network visualizations or maps based on bibliometric data. We have used the Scopus database of the 99 documents for creating these maps. In [Figure 5](#), we have used co-authorship analysis, using full counting methods. In the given network visualization, the relatedness of items is determined based on the number of co-authored documents. The weight parameter we used for visualization is a citation. In this network visualization, a total of 2 clusters have formed for 9 items.

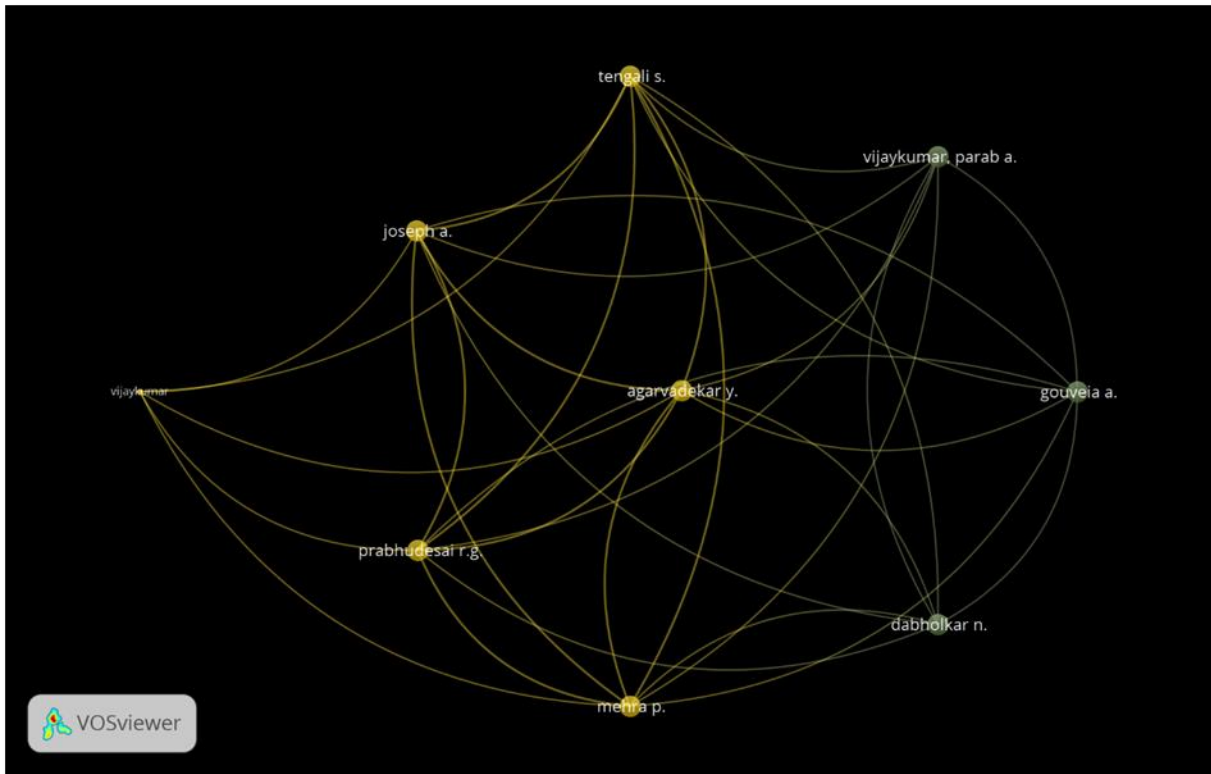


Figure 5: Link strength of the authors using co-authorship analysis (Weight parameter = Citation)

Higher the weight of an item, the larger the label of the item in the visualization. From [Figure 5](#), we can discover which ‘one author is linked with how many other authors’ and ‘what is the total link strength of that author’. As we chose citation as a weight parameter, we also get to know the citation of a particular author from [Figure 5](#).

For eg. 1) Author Joseph A.: - Links = 8, Total link strength = 12 and citation = 3

2) Author Prabhudesai R.G.: - Links = 8, Total link strength = 12 and citation = 3

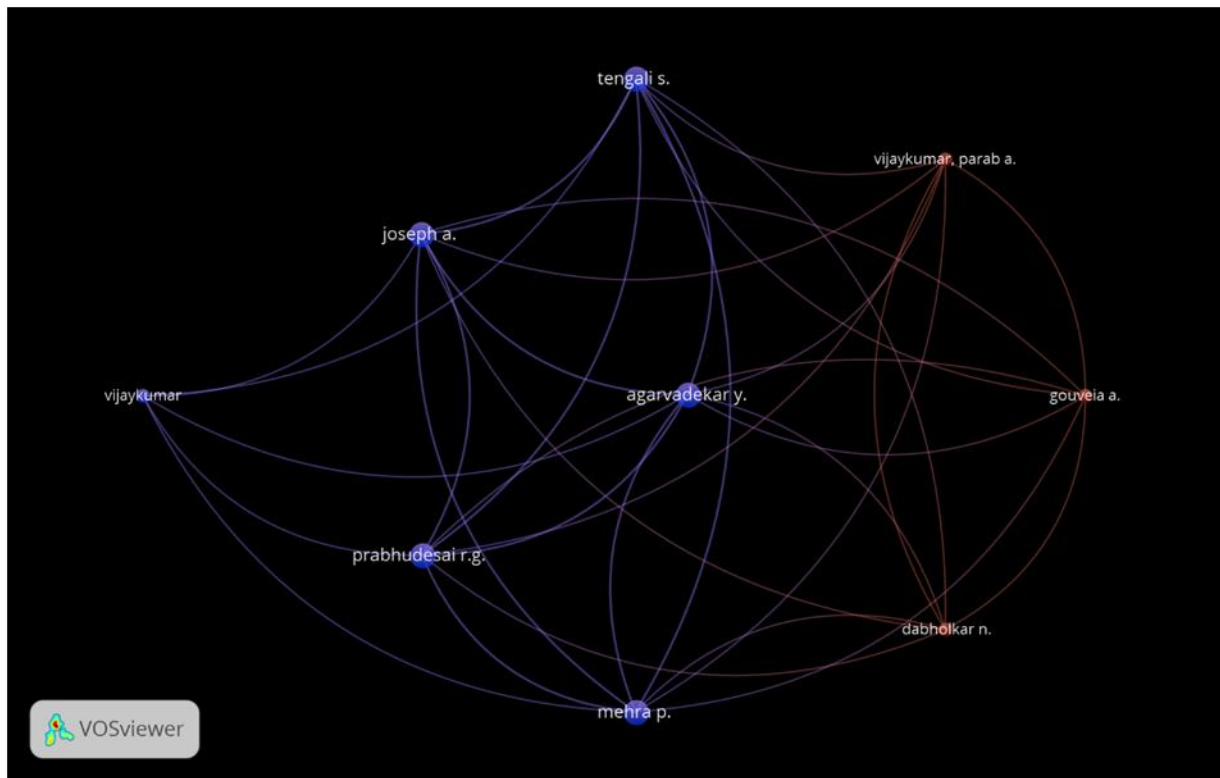


Figure 6: Link strength of the authors using co-authorship analysis (Weight parameter = Documents)

In [Figure 6](#), we have taken documents as a weight parameter. So, instead of a citation, we determine the number of documents published by an author. From the co-authorship analysis, we can interpret, among 9 authors maximum of them i.e. 5 authors have total link strength of 12. Likewise the figure shows the number of documents published by an author and what is the strength of the links which are connecting different authors.

[Figure 7](#) shows the link strength of keywords using co-occurrence analysis considering weight parameter as a Occurance. As a threshold, the minimum number of occurrences of a keyword is 5. Here we consider occurrence as a parameter for weights in visualization. Mobile telecommunication system, wireless telecommunication and internet of things are most occurred keyword. Shorter the distance between keywords, stronger the bond, or relatedness between them.

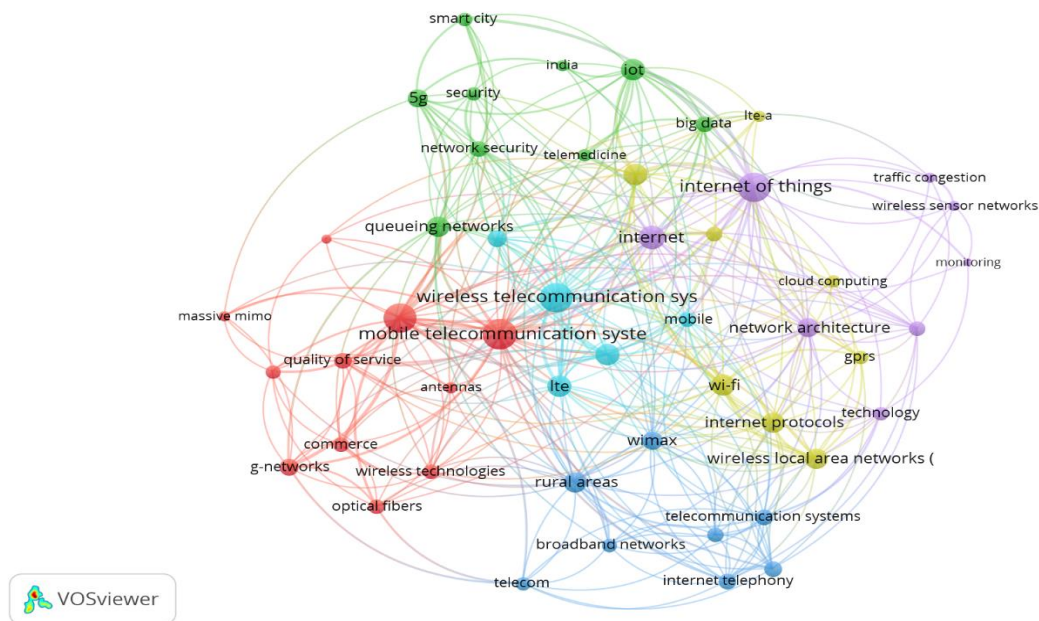


Figure 7: Link strength of the keywords using co-occurrence analysis (Weight parameter = Occurrence)

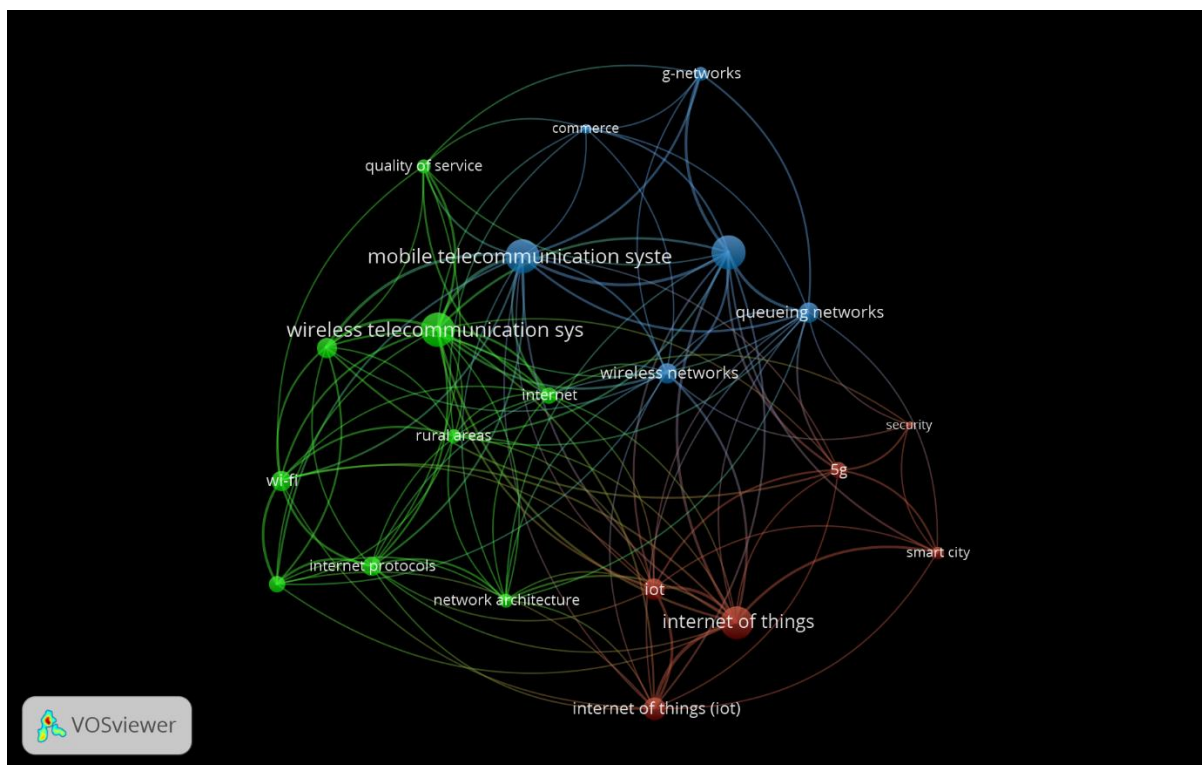


Figure 8: Link strength of the keywords using co-occurrence analysis (Weight parameter = Total Link Strength)

[Figure 8](#) shows the link strength of keywords using co-occurrence analysis considering weight parameter as a Total Link Strength. There are 3 clusters, 21 items, 120 links and 222 total link strength. As a threshold, the minimum number of occurrences of a keyword is 5. Maximum occurrence of a key word is 19 i.e. Internet of things. Larger the radius of the keyword node, more is the number or occurrence, and more link strength between them.

Research Gaps and Opportunities

Research interest in the domain of is continuously increasing since last few years, and since the technology is in evolving state their certain challenges for its establishment.

Puri, Rai and Saxena categorised the challenges into 4 broad categories i.e system level, network level, spectrum level and performance-based challenges.(S. Puri, R. S. Rai and K. Saxena, [2018](#))

Finding a spectrum of 5G frequency is very crucial. The Telecom Regulatory Authority of India (TRAI) has estimated that the spectrum is going to be expensive, it will cost six times higher than that of similar spectrum sold recently in foreign countries.

As there are huge and massive equipment for this setup, if the network connectivity expands there should be a greater number of antennas and a greater number of network towers. Also, the devices to support 5g aren't affordable. There is a lot more enhancement to be made in infrastructure in India when compared to Europe and US. There has also been calculations for productive economy and more population, as the speed per area depends on number of users using the network. (Pandey ,Gaurav and Kumar, [2015](#))

Conclusions and Future Scope of Work

In this paper, we have utilized bibliometric methods and visualization tools to carry out an in-depth study of the literature of quantum internet using the Scopus database and VOSviewer tool. The survey assesses 99 documents in the Scopus database. From the Scopus database, we observe that the 5G discussion in India has consistently been effective from 2014 till date, and this interest is expected to further increase in the near future. We have identified the top 10 sources for the publication of the papers related to a quantum internet. We investigated top affiliated universities as well as major funding sponsors for this area. On analyzing documents by subject area, around 34% of the research documents are related to the areas such as computer science and engineering. From the VOSviewer visualization, we discovered the links between authors, organizations, countries, keywords, sources, documents, and references. As a future course of study, we will give a deeper insight into the highly cited research papers and undertaking a comprehensive review of the work and use cases of 5g in various field and industries.

Acknowledgements

I express my deep scene of gratitude towards mentor Dr. Mandaar Pande for encouraging me, with healthy discussion. I am also grateful to Symbiosis Centre for Information Technology for providing me a platform for research activity. An open-source VOSviewer software tool supported in visualizing and mapping bibliometric network diagrams.

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