

## Systematic Literature review on 5G developments

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**Abstract:** The ever-increasing demand of mobile users demanding high frequency and high data proximity leads to discovery of 5G. Through the years the telephone networking has been developing step by step where 5G comes at the stage of wireless communication promising to overcome the drawbacks of existing technologies in regards with the future. The traditional communication throughout the years have come up with complicated problems 5G focuses on coming up with simple solution. This paper discovers the upgrowing developments of 5G in light of the recent developments and recent demands. The paper flows through understanding the architecture, growth and challenges faced by 5G network concluding a brief review on its network developments.

**Keywords:** 5G network, propagation factors, Information technology, stimulations, Massive MIMO channel, challenges and prospects of 5G.

**Introduction:** The last decade has been revolutionary in aspects of mobile networking whereas each generations brings something new to the table. 5G known as Fifth generation public private partnership promises to provide wireless network to connect 7 trillion wireless devices with high speed. The requirements of 5G are expected to be met by the new spectrum bands (microwave) and utilizing large bandwidths available. 5G is being in making for years which is next generation of mobile broadband that will eventually replace, or at least augment, 4G LTE connection.

From voice calls in first generation to text messaging in second generation, low-rate data and multimedia services in third generation and mobile internet and mobile social network in the fourth generation, wireless communications have become new reality and greater part of lives. 5G technology will spur in the coverage, capacity and density of wireless networks. It will power a surge in IOT technology and usher in a new era technological capability. 5G is not just going to be faster than 4G it will be the fastest aiming to the ascend speed to 20 Gbps. In addition to that 5G technology will reduce latency from 50ms to 1ms, it will take a leap in coverage, capacity and density of wireless network.[7]

This SLR organized as section 1 explains introduction about 5G, section 2 explains about the databases used and search strategy, section 3 explains about the research questions, section 4 explains about the study selection, section 5 explains about the Data extraction, section 6 explains about how the data is being synthesized, section 7 explains about results for the research questions, section 8 explains about findings in this SLR, section 9 explains about the future work that can be done, section 10 explains about the conclusion.

### **Data sources and Search strategy:**

Here, two digital databases are used for the literature search. They are:

1. IEEE explore.
2. Google scholar

Databases	Search strategy
IEEE explore	Title, abstract
Google scholar	Full text

Fig 1. Search space.

1. Here, we first used the keywords (that are mentioned above) and conducted literature search in the above listed databases and extracted the reference papers.

2. After using the keywords, we didn't get the expected results, so we used the search strings. These search strings are formed by combining the keywords with logical operators AND, OR. SO, by using these search strings we did the literature search and obtained the required reference papers.
3. Then we did the advanced search in IEEE explore by matching our keywords with the title and abstract. By doing this we can easily filter the unwanted reference papers.

### **Research Questions:**

RQ1.What are the technological requirements in 5G?

RQ2.How is performance related to propagation factors?

RQ3.How to overcome propagation factors using stimulators.

RQ4.Using the present methodologies does 5G justifies itself?

**Study selection:** study selection deals with methodology of selecting related literature on the selected topic. It can be classified into two types primary selection and secondary selection.

### **Primary selection:**

Primary selection is known to the first and basic selection method where key words along with logical operations are fed to search engine of the databases. To write this systematic literature review on Developments of 5G keywords like 5G, evolution of mobile networking, massive MIMO channels, propagation factors, and challenges in 5G. These keys were combined in the combinations with AND, OR providing related works in IEEE explorer and Google scholar. This method ensures to come up related literature on the topic giving references.

### **Secondary selection:**

Secondary selection method is in dept screening method to find accurate literature required to write the systematic literature review, for this paper, the literature is assessed on the abstract and introduction to find related literature. This selection is indivial divided on different keywords provided papers to be screened on abstract, introductions and references.

Here, after the primary selection we got several papers then we filtered them by using inclusion and exclusion criteria.

### **Exclusion criteria:**

- Firstly, we obtained 615 papers from the two digital databases (IEEE explore, science direct) and 0 papers from the search engines.
- First step, we excluded the papers that are not in English language.
- Second step, we excluded the papers which doesn't match our required content by reading the abstract of the reference papers.
- Third step, we excluded the papers which are before 2017 this is due to 5G development and evolution starts from 2017.
- Fourth step, we excluded the papers which doesn't match our required content by reading the full text.

### **Inclusion Criteria:**

- Here, we included the papers that are in English language only.
- In second step, we included the papers which are from 2017 to present.
- In third step, we included the papers that matches our required that doesn't deviate from our subject by reading the abstract, conclusion.

### **Data extraction:**

For this SLR to be written we have used total number of 10 literature papers where all the RQ's have different number of papers. There are 4 RQ's each RQ has 2 papers whereas all the papers are correlating helping in writing different sections of this paper. The papers provided definitions and technical knowledge giving nice references, having each paper something to add to the mini SLR.

### **Data synthesis:**

The initial search provided over hundreds of papers where all were not requisites. On the initial screening based on the titles of the papers, 20 papers were selected related to the topic. These 20 papers were then read to understand the topic and get a foundation on the topic. On further understanding of the topic, the RQ's were formed, due the questionnaire the further screening of the paper started to give 13 papers. Then after eliminating the repeated work 10 papers were for SLR writing. These 10 literatures were used extracting data from them, pictures. The data was synthesized further on subtopics provided and answers required.

Summary table:

RQ1:

Multiple input multiple output	[1][2][3]
Spatial Diversity	[1][2][3]
Spatial Multiplexing	[1][2][3]
Millimeter technology	[1][2][3]

RQ2:

Reflection	[1][6]
Diffraction	[1][6]
Scattering	[1][6]
Human Blocking Shadow Loss	[1][6]

RQ3:

NYSUM simulator	[6][7]
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RQ 4:

Spectrum Availability	[3][4]
Security and privacy	[3][4]
Air interface	[3][4]
Ultra-dense deployment	[3][4]
Device to Device communication	[3][4]

### **Results:**

RQ1. The basic technology used in 5G are multi input and multioutput and millimeter wave technology.

Multi input and multi output (MIMO):

This is the major technology used in 5G for digital transfer of data from transmitter to receiver where there will be multiple transmitters and multiple receivers

There are special cases in this MIMO known as single input and multiple output (SIMO) and multiple input and single output (MISO),[3]

These can be used in reference to the requirement of the customers and devices used.

Massive MIMO is used in 5G which provides excessive coverage and key to high speed these are considered because of channel capacity to improve bandwidth gain, polarization, diversity and reduce coupling between the inter elements.

MIMO antennas are used for achieving diversity and for decreasing the effects caused by multiple feeding, there are two antenna techniques present [1]

- Spatial multiplexing
- Spatial diversity

Spatial multiplexing: Generally, MIMO utilizes two sets of antennas but there is no reason for using multiple antennas but in this case, we use

more antennas for increasing throughput in any case of multiplexing

$R_x = T_x$  ( $R_x$ =Receiving antenna)

( $T_x$ =Transmitting antenna)

Matrix multiplication is used to send signals and at receivers, first the MIMO decodes the signal and estimates the individual transfer channels finally inverse matrix is applied and signals are collected.[1]

**Spatial Diversity:** In MIMO we use multiple antennas in a system for different paths. For increasing the reliability of the system, we send same data across different propagation paths this is called spatial diversity.[1]

This phenomenon leads to lot of fading of data but since sending in different paths somehow the data is received. MIMO uses different diversity techniques to increase diversity gain, this helps in improving in reliability.

**Millimeter wave technology ():** Millimeter waves are situated between 30Ghz to 300Ghz, with the wave length between 1-10 mm.

This range provides large bandwidth for larger spectrum band with interference resistance. mm wave signals are emitted in very narrow beams this increases the uses of same frequency range for different applications.[2]

Millimeter waves range from 30Ghz-300Ghz in these there are 254Ghz potential frequencies suitable for wireless communication, Millimeter waves suffer from atmosphere and molecular absorption.[2]

There is one major drawback to millimeter waves they can't travel through buildings or obstacles and they can be absorbed by rain.

By using millimeter waves and other technologies the engineers hope to construct wireless network for future smartphone users and autonomous vehicles in daily life.[3]

**RQ2.** The many propagation factors in 5G channels which effect on the performance of the network. In 5G the mainly propagation factors occur in channels which leads to sign errors like, disturbance in frequency, amplitude and receiver id. There are three basic propagation mechanism

**Reflection:** when an electromagnetic wave propagates up an object which has larger dimensions (such as earth, building, land) compared to the wave length of the propagating wave is known as reflection. This reflection phenomena causes to receive the reflected wave back which are less strong and have corrupted data. The extend of radio wave reflection depends on incident angle and surface char of the object. Basically, reflections are source of multi path signal, and the reflected waves may interfere constructively or destructively at the receiver. [1]

**Diffraction:** It is phenomena that occurs when the path between the transmitter and receiver is obstructed by an object that has sharp edges. The diffraction mainly depends on the structure of the building or the object amplitude, phase, and polarization of the incident wave. These diffracted waves find their way back to receiver even when transmitter is not in line of site which can cause strengthening or weakening signal. [6]

**Scattering:** it is a special case of reflection and it occurs when radio wave propagates through the medium which consists of irregular objects that is smaller compare to the wave length. All though the scatted wave signal strength is low but it can provide additional radio energy level at the receiver and causes small case scatterings [6]

**Human blocking shadowing loss:** this is a newfound phenomenon created due to the crowds where human itself is proving a blocking object for the receiving devices such as smart phones tablets laptops and another smart devise.[6]

There are other minor factors such as penetration loss at atmospheric attenuations etc.

RQ3. These types of simulators are used to overcome propagation factors:

There are simulators used in the 5G. among all the simulators, In this paper we are discussing about the NYUSIM and Ns-3 simulator.

“NYUSIM simulator is an open source millimeter wave channel simulator, which can produce accurate omnidirectional and directional CIRs, PD s and three-dimensional angular power spectrum” (refer). There are mainly three important modeling components which are implemented in NYUSIM simulator [6]

*Spatial consistency:* Spatial consistency indicates continuous and realistic channel evolution along the user terminal (UT) trajectory in a local area. NYUSIM with spatial consistency simulates spatially correlated channel impulse responses when a UT moves in a local area or multiple UT s are closely spaced. To realize spatial consistency, spatially correlated largescale parameters such as shadow fading, line-of-sight (LOS)/non-LOS(NLOS) condition are generated, and time-variant small-scale parameters such as angles, power, delay, phase of each MPC are generated. Specifically, a geometry-based approach using multiple reflection surfaces is implemented to update spatially correlated and time-variant angular information [7].

Human blockage shadowing loss occurs in four stages un shadowed, decay, shadowed, rising. These are overcome by using a stimulator implementing four-state Markov model

This simulator is able to overcome penetration loss using its stimulation methods.

RQ4. 5G network is new future of the mobile networking but not without any major hurdles with are the clinches to this new reality and hence taking time to be implemented.

- Spectrum Availability: For mobile networking frequency spectrum is

biggest asset and also very scare, where currently the bandwidth being used is 300Mhz-3Ghz, which is not the range for 5G. Fifth generation aims to achieve high speed which is only possible through higher frequency bandwidth.[3]

- Security and Privacy: The implementation of 5G creates wireless and open network which are prone to security and privacy threats such as Denial of Service (DoS) attacks, illegal interceptions, threats ordinating from the internet.[3]
- Air Interface: The demanding 5G requires new air interface, which are being developed based on the modulation schemes which are also being modulated on future demand of mobile networking.[4]
- Ultra-Dense Deployment: Need to improve the connection density, coverage and traffic capacity, ultra-dense communication is required, which can be obtained by deploying a massive number of small cells.[4]
- Device to Device Communication: For 5G, the advantages associated with the device to device communications are mainly a reduction on end to end latency, capacity gains and higher peak data rates.[4]

**Principle finding:** 5G network dedicates itself to achieve open, wireless and fast network complimenting the high-speed devices coming in the market. It aims to overcome the replaces of the previous generations, increasing latency, coverage, connectivity density along with decreasing interference, traffic congestions, error of data. The architecture of 5G mobile networking itself is contradiction to the traditional architecture introducing new techniques and whole new range of frequency range. 5G is currenting working with concepts like:

- **Massive MIMO:** Massive multi-input and multi-output antennas are used to increase the sector throughput, capacity density using antennas in huge numbers, where each antenna can be individual controlled embedding radio frequency transmission.
- **Edge Computing:** This phenomenon involves computing servers closer to the ultimate user, which in turn reduces latency and data traffic congestion.
- **Beamforming:** As the name suggests it directs radio waves in form of a beam to the target. This is done by combining array of antennas in such manner that waves are incident in a particular angle.

#### **RESEARCH GAP :**

- Here many propagation factors and the techniques to overcome these propagation factors are discovered but these techniques cannot completely mitigate the propagation factors. SO, future work can be done in order to overcome these propagation factors.

#### **Conclusion:**

This mini SLR concludes on the latest developments of 5G mobile networking explaining its major concepts, propagation factor its overcoming and understanding the challenges faced during developing the network. This SLR explains about the different technologies that are used in 5G. It also explains about Propagation factors which affect the speed and performance of the 5G networks, the techniques used to overcome these propagation factors. Though 5G is still being developed its polls to be successful and edging towards being future and achieving its

goals still in development to over the challenges.

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