



# Handover for 5G Networks using Fuzzy Logic: A Review

Harpreet Kaur

Assistant Professor

Guru Kashi University, Talwandi Sabo, Punjab, India

**Abstract:** The future fifth generation (5G) remote correspondences support the super ultra dense network where arrangements of a huge quantity of little cells coincide with current 4G net-works. Notwithstanding, the dense small cell organization is confronting a specialized test in flexibility the supervisory because of the expanded number of handovers (HOs), particularly in heterogeneous organizations. The expanding likelihood of HOs may cause HO failure (HOF) or HO ping-pong (HOPP) which debases the framework execution. Fuzzy Logic (FL) is a strategy for thinking that looks like human thinking. The methodology of FL mimics the method of dynamic in people that includes all middle prospects between computerized values YES and NO. In this article various analysts' research work is inspected and various issues are looked in 4G/5G organization. The serious issue looked in this exploration territory is the fuzzy framework, speed and direction metric and ping pong aversion isn't thought of, which is a primary Fuzzy handover dependent on Signal strength, Cell burden and Distance. Every one of these issues is settled in future.

**Keywords:** HetNets, self-optimization, handover, fuzzy logic, WSN, 4G and 5G

## I. INTRODUCTION

The fifth generation (5G) of versatile innovations has been created to fulfill expanded requests on high information rates and oblige Quality of Service (QoS) challenges experienced by past portable ages. 5G cell innovation is intended to give high transfer speed and supports high transmission speed, and targets forestalling infiltration misfortune through building dividers by isolating outside and indoor conditions. This is accomplished by Distributed Antenna System (DAS) and monstrous Multiple-Input and Multiple-Output (MIMO) procedures where many circulated radio wire clusters are introduced. In 5G engineering, various organizations comparing to various advances will share a typical foundation executing macrocells, picocells and femtocells that cover among themselves by a picocell [1].

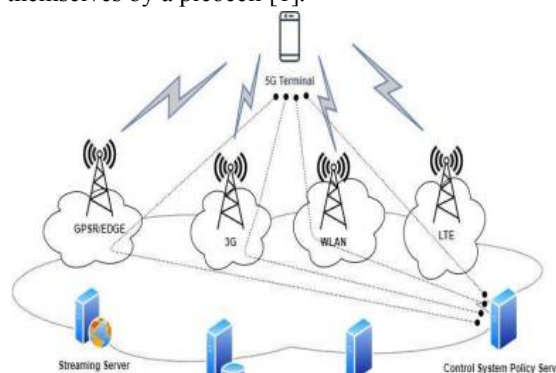


Figure 1: Functional architecture for 5G mobile networks [2].

The framework design of 5G is totally founded on IP model, and contains primary versatile terminal and various free Radio Access Network (RAN) innovations, see Fig 1. Every one of those radio advancements is treated as an IP interface for the external web world, bound to the cloud. Right now, quite possibly the most difficult issues in portable



correspondences is the smooth combination of little measured cells into the transcendent large scale cell network format. Femtocell was sent to take care of these issues with minimal expense, power saving ability and simple establishment [3]. Nonetheless, the little scope of femtocell's inclusion, permits straightforward clients' movement to leave a femtocell or arrive at the boundary of macrocell which requires a handover. Keeping up assistance and availability while moving starting with one cell's inclusion then onto the next is a test; regardless of whether the two cells are identified with a similar organization innovation or not. In this way, the requirement for powerful handover the executives approach has gotten basic for quick and consistent handover while keeping up network QoS [4]. The presentation of femtocell innovation in cell networks has improved cell inclusion and limit permitting the arrangement of rich and intuitive correspondence administrations. Be that as it may, the cost of these benefits are; expanded obstruction, high bundle misfortune, dreary handovers, expanded handover postponement and disappointments, and high energy utilization [1]. Such issues will grow in fast User Equipment (UE) situations and in indoor conditions. Subsequently, progressed handover the board procedures are needed to have the option to satisfy femtocell lacks, limit pointless handovers and forestall administration corruption went with handovers [5]. A few examination work have researched handover the executives strategies thinking about various factors such organization accessible assets, network thickness and sign strength. An escalated outline of handover the board strategies in 5G new radio (NR) and in long term advancement (LTE) and was given in [6]. What's more, an outline of Vertical Handover (VH) procedures in 4G and 5G organizations was introduced in [3]. Where this investigation introduced a handover approach planned thinking about network types and recurrence system considering consistent incorporation across networks and improved QoS. Thinking about Received Signal Strength Indicator (RSSI), in [7] handoff calculation was introduced to contrast RSSI esteem and predefined RSSI limit and afterward chooses to perform handover or not; this methodology have decreased the superfluous handovers. It merits referencing that RSSI shows the got signal capacity to UE from one or the other serving or encompassing passages. In a similar concern, a handover choice calculation dependent on RSSI and speed of client in open access femtocells networks was proposed in [8]. Likewise, analysts in [9] utilized RSSI, client speed, cell sweep, distance among client and passageway as a boundary to perform consistent handover that diminishes superfluous handovers and parcel misfortune. In [10], Reference Signal Received Power (RSRP) alongside client position, development course, and organization limit were utilized to give handover choice. The premise of this model was to enhance handover interaction and upgrade the presentation of femtocell network in LTE by expanding achievement likelihood of handover. An improved handover calculation to decrease both superfluous handover and the call hindering likelihood was introduced by [11]; thinking about a bunch of organization boundary, for example, cell limit, cell range, transfer speed, number of clients, limit of microcell and client speed. In [12] a handover calculation was introduced dependent on improving the rundown of the competitor femtocell passageways by examining just the passageways that is exist alongside the client development. Creators utilized direct relapse model as an AI indicator device that relies upon the client development history. In the wake of upgrading the rundown of passages, the calculation chooses the passageway with best RSSI and high limit at that point plays out the handover. Versatile position and heading were likewise examined by [13], to decrease the superfluous handover and improving the organization dependability. The calculation was intended to decrease the likelihood of disengagements by anticipating the client's future position utilizing Markov model and afterward picking the reasonable passageway. An extra handover the board framework which intends to take care of the impedance issue, diminish clamor proportions and enhance handover choice was introduced in [14]. This model was known as Hand Over-driven Femtocell Interference Management (HO-FIM). A few exploration works have characterized strategies used to determine handover issues in macrocell and femtocell conditions. The detailed procedures include utilizing a bunch of boundaries, for example, RSSI, UE speed, cell burden and limit, number of associations, distance and development bearing. Nonetheless, arriving at wanted organization QoS while handover is as yet a test particularly in thick femtocell and indoor conditions because of administration interferences that go with handover. Additionally, it is essential to consider the operational intricacy and generally speaking handling deferral of handover the board methods. Cutting edge Wireless Systems will give an assortment of administrations to versatile clients, including rapid information, ongoing applications and mixed media support [1]. Since there is nobody single remote organization innovation that



can fulfill the necessities of all the present and forthcoming remote administrations, the concurrence of heterogeneous remote organizations to offer support anyplace whenever is an inescapable pattern in the improvement of the NGWNs [2]. Perhaps the main pieces of any portable correspondence network is the handoff the board technique. Change of a functioning association from one Base Station (BS) to another is called handover measure. In the handover cycle, the new BS relegates one of its vacant channels to the Mobile Terminal (MT) while the association of MT with the old BS stays dynamic for quite a while openings. Arrangement of the specific season of starting the handover cycle is a significant issue. Handoff choice depends on the Received Signal Strength (RSS) [2]. The handoff technique ought to be completed effectively before the MT moves out of the inclusion space of the old BS. In this paper, we surveyed a fuzzy logic based handoff the executives framework and use GA as the indicator of the results of the fluffy principles with the goal that the base number of handoffs happens and the all out number of cut associations decline. We utilize the MT's speed and the distance of the MT with the limit of the BS and the quantity of free channels of it as contributions of our fuzzy network and the RSS edge will be the yield. At the point when this edge dips under a foreordained worth  $S_{th}$  then the handover cycle is started and when it dips under  $S_{min}$ , it shows that the MT moves past the inclusion space of the BS and separated from it. Portable broadband heterogeneous organizations (HetNets) are one of the biggest and most huge correspondence networks that offer remote types of assistance.

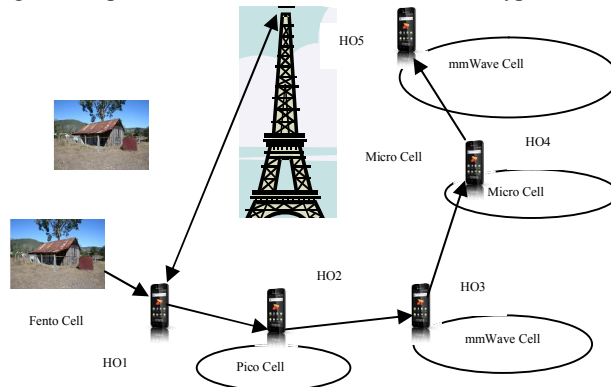


Figure 2: HO concept of in HetNets[1]

## II. DIFFERENT APPROACHES TO HANDOVER

### 2.1 Centralized

In the GSM framework, handover starting with one cell then onto the next is totally incorporated. Base stations consistently screen they got signal quality and if this drop under a encoded threshold, adjacent base stations perform a field strong point measurement to find the best base station to which the call can be handed over.

### 2.2 Decentralized

Then again, in DECT handover are decentralized. The convenient terminal constantly looks generally advantageous, i.e., most grounded or most clear, base station signal.

Handover approach:	<u>GSM</u>	<u>DECT</u>
	Centralized	Decentralized
	Initiated by BS	Initiated by MS
	To stay away from poor reaction	look for unsurpassed channel
	Separated from	Part of Dynamic Channel
	Frequency Management	Allocation (DCA)
	Needs tuning of BS-s	Requires setting of parameters
	Ping-pong effects	Potential instability
	H-O to other carrier	May remain on same carrier



III. FUZZY LOGIC

Fuzzy Logic (FL) is a technique for thinking that looks like human thinking. The methodology of FL mirrors the method of dynamic in people that includes all transitional potential outcomes between computerized values YES and NO. The traditional rationale block that a PC can comprehend takes exact info and produces an unequivocal yield as TRUE or FALSE, which is identical to human's YES or NO. The innovator of fuzzy logic, Lotfi Zadeh, saw that dissimilar to PCs, the human dynamic incorporates a scope of conceivable outcomes among YES and NO, for example,

CERTAINLY YES
POSSIBLY YES
CANNOT SAY
POSSIBLY NO
CERTAINLY NO

The fuzzy logic deals with the degrees of conceivable outcomes of contribution to accomplish the distinct yield.

3.1 Execution

- It can be executed in frameworks with different sizes and capacities going from little miniature regulators to huge, organized, workstation-based control frameworks.
- It can be executed in equipment, programming, or a combination of both.

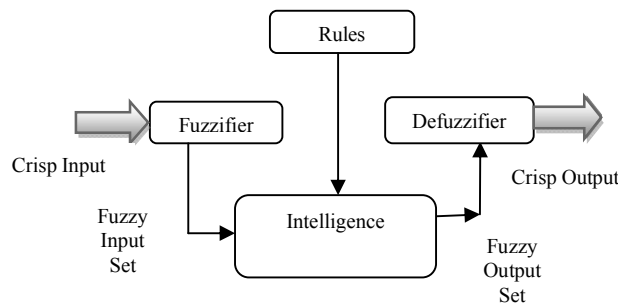
3.2 Fuzzy Logic Systems Architecture

It has four main parts as shown –

- **Fuzzification Module** – It transforms the system inputs, which are crisp numbers, into fuzzy sets. It splits the input signal into five steps such as-

LP	x is Large Positive
MP	x is Medium Positive
S	x is Small
MN	x is Medium Negative
LN	x is Large Negative

- **Knowledge Base** – It stores IF-THEN rules provided by experts.
- **Inference Engine** – It simulates the human reasoning process by making fuzzy inference on the inputs and IF-THEN rules.
- **Defuzzification Module** – It transforms the fuzzy set obtained by the inference engine into a crisp value.





The membership functions work on fuzzy sets of variables.

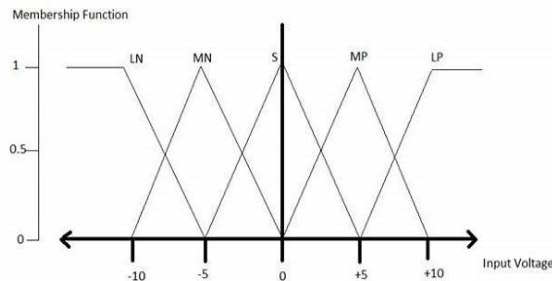
**Relationship Function**

Relationship functions allow you to compute linguistic term and represent a fuzzy set graphically. A membership function for a fuzzy set A on the universe of discourse X is defined as  $\mu_A: X \rightarrow [0,1]$ .

Here, each element of X is mapped to a value between 0 and 1. It is called association value or degree of association. It quantifies the degree of association of the element in X to the fuzzy set A.

- x axis represents the universe of discourse.
- y axis represents the degrees of membership in the [0, 1] interval.

There can be multiple membership functions applicable to fuzzy a numerical value. Simple membership functions are used as use of complex functions does not add more precision in the output. All membership functions for LP, MP, S, MN, and LN are shown as below-

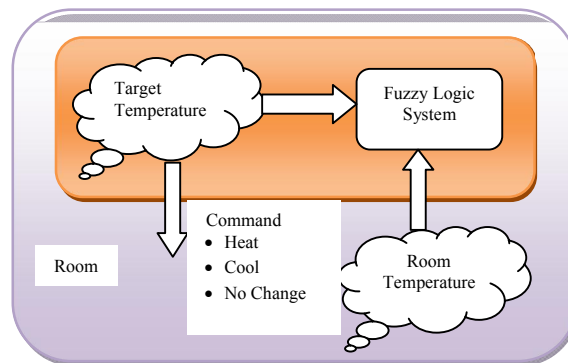


The triangular membership function shapes are most common among various other membership function shapes such as trapezoidal, singleton, and Gaussian.

Here, the input to 5-level fuzzifier varies from -10 volts to +10 volts. Hence the corresponding output also changes.

**Example of a Fuzzy Logic System**

Let us consider an air conditioning system with 5-level fuzzy logic system. This system adjusts the temperature of air conditioner by comparing the room temperature and the target temperature value.



**Algorithm**

- Define etymological Variables and terms (start)
- Construct enrollment capacities for them. (start)
- Construct information base of rules (start)
- Convert fresh information into fluffy informational indexes utilizing enrollment capacities. (fuzzification)
- Evaluate rules in the standard base. (Derivation Engine)
- Combine results from each standard. (Induction Engine)
- Convert yield information into non-fluffy qualities. (defuzzification)

**IV. REVIEW OF LITERATURE**

Mohammad Alaul Haque Monil[1] have been contemplated a strategy has been proposed to ascertain speed and heading of MS comparative with base station as a solitary measurement utilizing estimation information. Likewise, a fluffy rationale based handover calculation is carried out to try not to ping pong impact. By taking relative speed and heading, traffic load, signal strength and distance, the fluffy induction framework decides the best competitor neighbor dependent on the estimation reports from MS. Reenactment has been done in Matlab climate and a correlation of various methodologies has been performed. Abdulraqeb Alhammadi[2] have been examined fifth era (5G) network is a forthcoming norm for remote interchanges that exists together with the current 4G organization to build the throughput. In this paper, they proposed a speed based self-advancement calculation to change the HO control boundaries in 4G/5G organizations. The proposed calculation uses the client's gotten force and speed to change the HO edge and an opportunity to trigger during the client's portability in the organization. Reproduction results show that the proposed calculation accomplishes a noteworthy decrease in the pace of ping-pong HOs and RLF contrasted and other existing calculations, consequently beating such calculations by a normal of over 70% for all HO execution measurements. George Edwards [3] have been done a movement to microcells will expand the quantity of handoffs, and require quicker handoff calculations – as far as dynamic. On account of view transmission, it is significant that the handoff calculation distinguishes the cell limit sufficiently early, in any case this will prompt channel hauling into the new cell consequently expanding the opportunity of co-channel interference. This paper presents two new handoff methods utilizing fluffy rationale as potential answers for microcellular handoff. The principal calculation utilizes a versatile fluffy indicator, while the second uses a fluffy averaging strategy. The aftereffects of the reproduction show that fluffy is a suitable choice for microcellular handoff. Tarek Bchini [4] have been contemplated outside remote correspondence organizations, for example, versatile WiMAX (802.16e), portable stations move constantly, in this way they should be given off to various base stations dependent on specific models. In this paper, a fluffy rationale based plan for quick determination of best base station and of handover procedure at the handover time is introduced to limit the deferral during handover for delicate sight and sound traffic. The plan considers a few boundaries, for example, recipient power levels, handover type, traffic type, base station burden and versatile station speed for settling on the handover choice by the portable station. Through reenactments, they look at their proposed handover plot dependent on fluffy rationale displaying with old style handover choice. Lastly, the outcomes dependent on Quality of Service (QoS) standards to affirm the legitimacy of the proposed approach. P. Muñoz [5] have been considered Load Balancing (LB) and Handover Optimization (HOO) have been recognized by industry as key self-sorting out components for the Radio Access Networks (RANs). Specifically, the proposed calculation adjusts handover boundaries to upgrade the fundamental Key Performance Indicators identified with LB and HOO. Results show that the proposed plot viably gives preferable execution over autonomous substances running all the while in the organization. V. Kavith, G. Manimal, R. GokulKannan [6] have been proposed with outstanding expansion in advanced information move and developing buyer base, there is a need to productively deal with huge arrangement of clients. They proposed a three-sided method of deciding the following expected base station ahead of time. This technique takes out the hexa-directional equivocality and decides the following one entirely ahead of time subsequently expanding the effectiveness complex. Reservation of band is done dependent on the forecast consequently diminishing availability delays. Improving the current ones complex will diminish the prerequisite of extra equipment subsequently working with maintainable advancement by lessening the perilous effects on Mother Nature.

Nadine Kashmar, Mirna Atieh, Ali Haidar [7] have been read the requirement for consistent portability inside the heterogeneous climate of cell networks forced the requirement for discovering distinctive vertical handover (VHO) instruments to choose the best organization. The choice cycle depends on various components, for example, cost, battery status of Mobile Terminal (MT), the limit of each organization interface, accessible data transmission (ABW), got signal strength (RSS), and so forth. The summed up information was then broke down by utilizing graphic and representation procedures to track down the best boundaries for handover (HO) measure. Three powerful boundaries were acquired: the Received Signal Strength (RxLev/RSCP), the Available Bandwidth (ABW) and the Received Signal Quality (RxQual/EcNo). Results showed that they agreeably cooperate to achieve a similar



undertaking. Gamal Abdel Fadeel ,Mohamed Khalaf, Hesham ZariiefBadr[8] have been clarified multi-standards vertical handoff framework touchy to different versatile terminals' portability boundaries remembering distance and speed for a heterogeneous remote organization is systematically defined and approved by means of recreations. It is focused to gauge the fundamental handoff boundaries including blackout likelihood, lingering limit, and sign to obstruction and commotion edge just as organization access cost. To stay away from the ping-pong impact in handoff, a sign advancement expectation framework is defined and its exhibition is analyzed. Reenactment results are appeared to follow well the scientific definitions. Aabha Jain [9] have been considered the group of people yet to come of remote framework is required to give interactive media, multi class benefits any time anyplace with consistent portability and Quality of administration (QoS). In such climate, ideal vertical handoff is a difficult issue. Pointless handoff causes wastage of organization assets and in this way influences the QoS of organization. In this paper, they proposed the upward handoff choice relies upon inclusion space of the organization and the speed of the portable client. They have decided application-wise basic speed for specific inclusion scope of organization during which handoff is helpful. The reproduction is performed utilizing Network Simulator NS-2 with NIST (National Institute of Standards and Technology) portability module. Thanachai Thumthawatworn [10] have been proposed wireless versatile organizations later on are imagined to request more keen handover choice instruments to accomplish consistent portability and administrations. Fluffy rationale calculations were proposed to upgrade the handover choice cycle as of late. Notwithstanding, most proposed calculations convey fixed fluffy participation capacities (FMFs). This methodology gives an inadmissible organization determination execution when distinctive traffic types (administration choices) are required. In this work, they proposing another way to deal with handover choice framework (HDS) plan. The proposed configuration fuses self-tuning of FMFs, which progressively adjusts the FMFs to coordinate with the necessities mentioned. The reproduction results show enhancements in network choice execution. Shiwen Nie , Di Wu, Ming Zhao[12] have been examined Heterogeneous organization (HetNet) is considered as a superb method to address the constraints of framework limit and broadband help inclusion in conventional organization. A handover improvement calculation dependent on upgraded versatility state assessment (EMSE) is proposed. Thinking about both client hardware (UE) speed and handover types, the advancement calculation dependent on EMSE joins specific Time-to-Trigger (TTT) and dynamic handover edge (HM)- changing in SON. Moreover, the calculation execution is contrasted and two diverse reference cases. Reproduction results show that complete handover disappointment has an undeniable decay with our self- advancing calculation. Subsequently, handover execution gets improved and UEs have better portability power in HetNet through our calculation.

## V. RESEARCH GAP

From the above literature survey the below is the research gap:

- The increasing probability of HOs may cause HO failure (HOF) or HO ping-pong (HOPP) which degrades the system performance.
- The authors extensively studied that if MS moves away from BTS, signal gets weaker after reaching a certain threshold, control of that call is transferred to another base station with strong signal.
- The conventional Handover depends mostly on signal strength.

The fluctuations of signal strength due to shadowing and fading cause ping-pong effect and they taken into consideration RSSI, BER, SNR and Outage Probability parameters for fast and seamless handover decisions .

## VI. CONCLUSION AND FUTURE WORK

A handover is a process in telecommunications and mobile communications in which a connected cellular call or a data session is transferred from one cell site (base station) to another without disconnecting the session. To study existing techniques of speed and direction with fuzzy logic based handover algorithm and to improve power control metric and intelligent averaging for managing signal fluctuation. A more efficient speed and direction finding process



introduced to get more realistic handover decision which may improve the handovers performance and compare it with existing work.

**REFERENCES**

- [1]. Anbalagan, S., Kumar, D., Raja, G. and Balaji, A., 2019. SDN assisted Stackelberg Game model for LTE-WiFi offloading in 5G networks. *Digital Communications and Networks*, 5(4), pp.268-275.
- [2]. Neupane, K. and Haddad, R.J., 2019. Secrecy sum-rate analysis of massive MIMO systems under dual-threat attacks using normalization methods. *Digital Communications and Networks*, 5(4), pp.237-244.
- [3]. Srinidhi, N.N., Kumar, S.D. and Venugopal, K.R., 2019. Network optimizations in the Internet of Things: A review. *Engineering Science and Technology, an International Journal*, 22(1), pp.1-21.
- [4]. Alhammedi, A., Roslee, M., Alias, M.Y., Shayea, I. and Alquhali, A., 2020. Velocity-aware handover self-optimization management for next generation networks. *Applied Sciences*, 10(4), p.1354.
- [5]. Monil, M.A.H., Qasim, R. and Rahman, R.M., 2013, July. Speed and direction based fuzzy handover system. In 2013 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE) , pp. 1-8.
- [6]. Kavitha, V., Manimala, G. and Kannan, R.G., 2019. AI-Based Enhancement of Base Station Handover. *Procedia Computer Science*, 165, pp.717-723.
- [7]. Kashmar, N., Atieh, M. and Haidar, A., 2016. Identifying the Effective Parameters for Vertical Handover in Cellular Networks Using Data Mining Techniques. *Procedia Computer Science*, 98, pp.91-99.
- [8]. Khalaf, G.A.F.M. and Badr, H.Z., 2013. A comprehensive approach to vertical handoff in heterogeneous wireless networks. *Journal of King Saud University-Computer and Information Sciences*, 25(2), pp.197-205.
- [9]. Lahby, M., Essouiri, A. and Sekkaki, A., 2019. A novel modeling approach for vertical handover based on dynamic k-partite graph in heterogeneous networks. *Digital Communications and Networks*, 5(4), pp.297-307.
- [10]. Chaudhari, A.B., Chaudhary, V., Gohil, P. and Patel, K., 2016. Investigation of delamination factor in high speed drilling on chopped GFRP using ANFIS. *Procedia Technology*, 23, pp.272-279.
- [11]. Abuhasnah, J.F. and Muradov, F.K., 2017. Direction prediction assisted handover using the multilayer perception neural network to reduce the handover time delays in LTE networks. *Procedia computer science*, 120, pp.719-727.
- [12]. Nie, S., Wu, D., Zhao, M., Gu, X., Zhang, L. and Lu, L., 2015. An enhanced mobility state estimation based handover optimization algorithm in LTE-A self-organizing network. *Procedia Computer Science*, 52, pp.270-277.