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Network Selection in Heterogeneous Wireless Network Technology: Taxonomy

L. Pallavi, A. Jagan, B. Thirumala Rao

Abstract— In globally implemented heterogeneous remote systems, a vital undertaking for versatile terminals is to choose the best system for different radio access correspondences whenever anyplace, as a rule called network selection. As of late, this point has been broadly contemplated by utilizing different numerical algorithms. The utilized hypothesis chooses the goal of advancement, unpredictability and execution, so it is an absolute necessity to comprehend the potential numerical algorithms and pick the suitable one for getting the best outcome. In this manner, this paper methodically contemplates the most vital numerical hypothesis which can display the best network selection compared to other technologies that are already implemented. To find out the best mobile terminal & core network flow was explained. For achieving best network using the priority best network selection algorithm procedure is proposed.

Keywords: Heterogeneous Wireless Network technologys, Mobile Terminal-Driven, Core Network-Driven, RAT, PBNSA

I. INTRODUCTION

The latest methodologies under research in wireless communication have completely upset the entire universe which are bound together by latest communication technology. Multiple technologies are developing at the same time towards giving clients with astounding administrations of broadband facilitations with consistent portability. Of late 5G, 4G, Long Term Evolution-Advance (LTE-A), Wireless Wide Area Networks (WWANs) advance from GSM (Global System for Mobile Communications) to Universal Mobile Telecommunications Systems (UMTS) and past 3G, giving wide scope and great portability abilities. On the contrary, a progression of measures of Wireless Local Area Networks (WLANs), including IEEE 802.11a, IEEE 802.11b, IEEE 802.11g, IEEE 802.11n, and so on., for built up of neighbourhood speed financial remote access. To supplement them, Wireless Personal Area Networks (WPANs), e.g., Bluetooth and Zigbee, and Wireless Metropolitan Area Networks (WMANs), e.g., Worldwide Interoperability for Microwave Access (WiMAX), are created for lesser coverage what are more, urbanite inclusions, separately. The numerous networks listed above consequently shaping a hybrid wireless network access, generally designated as Heterogeneous Wireless Network technologys(HWNs)

To get to the Internet facilitations through HWNs linked terminals, e.g., workstations, mobile phones and so on, are generally introduced with various remote access organize interface locations. One sort of terminals broadly utilized these days is those with various interfaces however no usefulness to help IP versatility or multihoming, designated as multi-mode portable terminals.Multihoming implies that a terminal has various IP associations with one or numerous systems at the same time. Multi-homed terminals utilize numerous interfaces to share the communication load for a similar session and bolster session congruity with low (or no) bundle misfortune amid versatility or connection break. On the contrary, multi-mode terminals can just choose and utilize one interface beyond a shadow of a doubt session at a time[1]. The following diagram Fig 1[16][19] shows the HWN

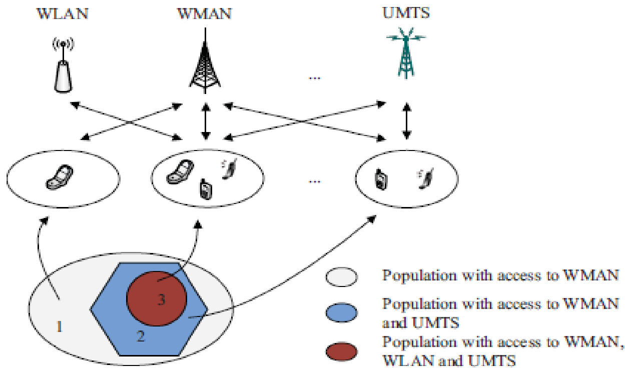

Fig 1: Heterogeneous Wireless Network technologys

Both multi-mode methodology and multi-homed methodology requires persistently setting the entering parametric variables and choosing the pre-eminent outstanding values as "Always Best Connected (ABC). ABC conveys numerous favorable circumstances to clients. With ABC usefulness, terminals with fitting systems to fit for different QoS prerequisites of uses; terminals abstain from choosing a system with high traffic load for dodging blockage; terminals foresee systems' accessibility so they don't interface with systems which vanish soon; and terminals limit flagging expenses by utilizing system choice and handover choice procedures explicitly for this reason. Additionally, ABC benefits administrators.. As per organize determination methodologies, administrators dissect and choose the quantity of WiFi passages they ought to convey to pull in clients to WLANs. At long last, ABC is appropriate to artificially think about clients' and administrators' advantages, with the goal that a success win association can be accomplished [1][16][12].

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The route of disconnecting from a Access Point (AP) of server to a new location of access is called handover. According to Ashana et al, (2012) there are two types of handover namely horizontal handover operation (HHO) and vertical handover operation(VHO) . Horizontal handover occurs on account of a mobile user switching between between networks with the same technology (WLAN to WLAN), while vertical handover occurs when user switches between networks with different technology (UMTS to WLAN)). VHO prescribes handover between a variety of access technology applications, for connectivity purposes such as user preference and network load balancing the parameter for handover within networks of the same technology. RSS is not appropriate and effectual when handover involves multiple wireless network of different standards. Example of Quality of Service (QoS) parametric variables used for vertical handover include Bit Error Rate (BER),Mobile velocity, Delay, Bandwidth, Jitter, Network coverage area, Data rate, Price, Power Consumption, Traffic, Security etc (Ashima et al, 2014) [3]. The specified variety of algorithms that have been engaged to decide the complications of VHO and network selection in HWNs that can be established in the survey, such as utility functional variables, evolutionary game theory and genetic algorithms [11][9].

To accomplish the appropriate enactment with least cost, mobile users in Heterogeneous Wireless Network technologies can execute network augumentation iteratively in a distributed methodology [2][5].

The choices will advance to the balance time when the result of each client is augmented given the choices of others and nobody can profit by picking different systems singularly. Contrasted and the ideal discernment presumption in customary diversion hypothesis, it is more reasonable to view the mobile clients as with limited sanity. We expect that the clients can perform best reaction to the present state however these clients do not have the capacity to anticipate the practices of others in light of past practices [1][2].

The publication is organized such that in Section 2 presents a Survey Summary on Numerical Modelling for choosing the Network in HWN's in detail. In Section 3 provides the Approaches for Network Selection in HWN's. In Section 4 presents the Proposed Priority Best Network Selection Algorithm (PBNSA). Finally, Section 5 concludes the paper.

II. SUMMARY ON NUMERICAL MODELLING FOR NETWORK SELECTION IN HWN's& RESULTS

In this, the author[1] discussed about the different plans utilizing distinctive numerical hypotheses. On the system side, we think about 4 kinds of accessible systems (i.e., WWAN, WMAN, WLAN and WPAN) and 6 traits (i.e., transfer speed, value, cell span, security, control utilization and traffic), as given in Table I. These qualities are cautiously chosen, transmission capacity, descending property e.g., value, dynamic characteristic like traffic, terminal-related quality such as control utilization, application-related property namely, security and portability related trait called cell span. Note that one characteristic could have different of these highlights. On the client side, we consider 4 kinds of uses with various QoS prerequisites including conversational, spilling, and intuitive and foundation [4]. For each and every application type, we contemplate about 16 clients with various parametric client inclinations (i.e., cash first and quality first) and diverse terminal properties (i.e., battery first and versatility first). Absolutely, there are 16 clients outlined in Table II. [1]

TABLE I
NETWORKS AND SELECTED ATTRIBUTES IN THE UNIFIED SCENARIO

	Bandwidth	Price	Cell radius	Security	Power consumption	Traffic
WWAN	2	50	2000	3	1/100	X
WMAN	10	20	2000	3	1/100	X
WLAN	54	5	75	1	1/50	X
WPAN	1	1	10	2	1/1000	X

TABLE II
SELECTED PROPERTIES OF THE 16 USERS IN THE UNIFIED SCENARIO

User No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Application	Conversational	•	•	•	•												
	Streaming					•	•	•	•								
	Interactive									•	•	•	•				
	Background													•	•	•	•
User	Money first	•	•			•	•			•	•			•	•		
	Quality first			•	•			•	•			•	•			•	•
Terminal	Battery first	•		•		•		•		•		•		•		•	
	Mobility first		•		•		•		•		•		•		•		•

A. Utility function

For settling on a choice, utility alludes to the fulfillment that a merchandise or administration gives to the leader [5]. A related term is utility capacity which identifies with the utility got by a customer from a merchandise or administration. Diverse buyers with various client inclinations will have distinctive utility qualities for a similar item. In this way, the individual inclinations ought to be considered in the utility assessment. While assessing the utility of a characteristic, we ought to recognize the upward and downward attributes. The qualities of which the higher inclination connection is agreeable to the higher esteem are called upward attributes. Then again, the downward attributes incorporate different expenses. Given a trait, its utility can be ascertained in light of certain utility capacity. Also, the utility capacity of one property could be not quite the same as that of others. For kinds of traits, we can group them into vertically aligned attributes, at that point of statically deliberate, dynamical and semi-dynamical attribute.

A few cases of regular utility functions are appeared in Fig 2 [1].

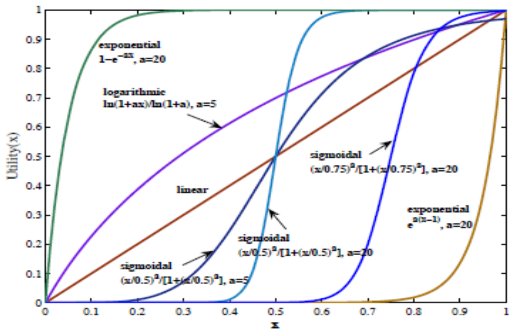

Fig 2: Different Utility Functions

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A great deal of concentrates display the system determination issue with expense or utility capacities, yet they may consider distinctive traits and measure them in various habits. An outline of qualities and their utilization is provided in Table III [1].

B. Numerical hypothesis

A related works have proposed the plans of system determination calculation for portable terminal-driven are utilized to explain multi criteria choice investigation and Evolutionary amusement approach dependent on replicator features was utilized in [4] and [5] to examine the features to show the client stirring conduct in heterogeneous remote systems. In compensatory multi-attribute decision making algorithms (MADM) were communally used to help the terminal in choosing the most realistic network [1].

Analytical Hierarchy Procedure (AHP) was used to explore the parametric factors of evaluation used to determine weights of the criteria.

Grey Related Analysis (GRA) was implemented to select the best network and establish a dreary rapport with the ideal network through grey related coefficient (GRC) which prescribes the status of similarity factors and variability factors with the ideal ethical solution.

Technique for Order Preference by Similarity to An Ideal Solution (TOPSIS) determines the ranking of access network. It chooses the top most outcome of the consequences to provide the most effectually idealistic solution and leads to thruttermost from the non-idealistic solution. The idealistic and the non-idealistic substitutions are acquired by making an allowance for correspondingly the most best and the worst values for each parametric varaible.

Simple Additive Weighting (SAW) it calculates the alternative scores by simple addition of the whole weighted attribute values. SAW is widely used by most studies using cost or utility functional parametric variables as follows

$$c_{SAW} = \sum_{j=1}^{M} w_j v_{ij},$$

Multiplicative Exponential Weighting (MEW) estimates the score of each alternative by the product of weighted attribute values. MEW estimates coefficient by multiplicative operation, given by

$$c_{MEW} = \prod_{j=1}^{M} v_{ij}^{w_j}.$$

Where, wj is theweight of the jth attribute, and vij is the adjusted parametric result value of the jth attribute of the ith network.

In [1][14], the creator think about the execution of seven VHA dependent on MADM strategies. The execution assessment is centered around four parametric variables of QoS in particular parcel delay, bundle jitter, the accessible data transmission and the all out transfer speed. Two distinct applications where voice and ierenformation associations. Each one was related with six qualities: accessible data transfer capacity, complete transmission capacity, bundle delay, parcel jitter, parcel misfortune and cost per byte given in the TABLE III [1].

TABLE III

COMPARISON OF USING DIFFERENT MATHEMATICAL THEORIES FOR NETWORK SELECTION

	Utility theory	MADM	Fuzzy logic	Game theory	Combinatorial optimization	Markov chain
Objective	Utility evaluation	Combination of multiple attributes	Imprecision handling	Equilibrium between multiple entities	Allocation of applications to networks	Consecutive decisions / rank aggregation / priority evaluation
Decision speed	Fast	Fast	Fast	Middle	Slow	Middle
Implementation complexity	Simple	Simple	Simple	Complex	Complex	Middle
Precision	Middle	High	Middle	High	High	High (but Low for WMC)
Decentralized	Yes	Yes	Yes	Yes	No	Yes
User-centric	Yes	Yes	Yes	No	No	Yes
Mobility-oriented	No	No	Yes	No	No	Yes
Traffic-oriented	No	No	No	Yes	Yes	No

In Table III, we judge every one of these plans as versatility situated because of the way that organize choice and VHO choice may be handled together. We contemplated the use of different numerical speculation hypotheses in this instructional exercise for the system determination issue. As should be obvious from the above investigations, they have distinctive highlights and diverse functionalities. To get every one of their advantages, we could consider consolidating them in the route appeared in Fig 3[1] to accomplish a coordinated arrangement:

Utility Theory: organize properties, including traffic load, are balanced by utility capacities, yet traffic load, which is profoundly identified with combinatorial improvement and amusement in later tasks, might be balanced uniquely in contrast to other people.

Fuzzy Logic: when there are many access systems, we characterize every one of the systems into a few gatherings to diminish the time cost on the correlation of the considerable number of changes. This activity depends on some key components, for example, cell sweep, data transfer capacity and value, using fuzzy logic.

MADM: after the modification of the system traits, MADM calculation is utilized to join these characteristics dependent on their loads.

Combinatorial Optimization: before MADM, we may check whether numerous systems' accessible limit wind up restricted. Provided that this is true, rather than MADM, we could utilize certain calculation of combinatorial enhancement for the portion of new administrations. Note that this hypothesis is utilized in a driven way on the system side, not by terminals.

Markov Chain: MDP may be utilized in the tradeoff of VHO choice after the systems are positioned.

Game Theory: after the tradeoff of VHO choice, numerous synchronous (or actually considered as concurrent) giving over terminals may choose a similar best system, which causes clog. We may utilize amusement hypothesis for an entrepreneurial choice, with the goal that these terminals could be circulated into various systems.

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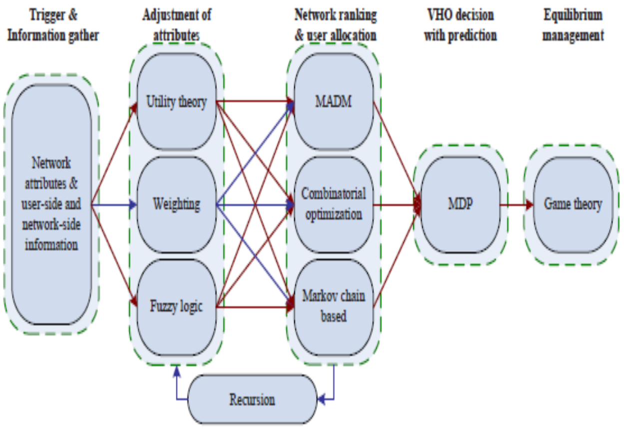

Fig 3: Relationship between various numerical hypothesis theories for network selection

Network results of the 16 users with the results from schemes using other numerical hypothesis theories for comparison.

TABLE IV

SELECTION RESULTS OF DIFFERENT SCHEMES

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sigmoidal utility	M	M	M	M	L	M	L	M	M	M	M	M	P	M	P	M
SAW with AHP	P	M	P	M	P	M	P	M	P	M	P	M	P	M	P	M
Fuzzy logic	L	M	L	WM	LP	L	M	M	P	WM	WMP	WM	P	L	P	WM
Game between users	L	L	W	W	P	M	P	M	W	W	W	W	L	L	P	M
Knapsack with SA	P	M	P	M	L	L	P	M	P	M	M	M	P	M	P	W
WMC	P	M	P	M	P	M	M	M	P	M	M	M	P	M	P	M
Integrated scheme	P	M	P	M	L	L	P	M	M	M	M	M	L	P	P	W

Note: W = WWAN, M = WMAN, L = WLAN and P = WPAN

III. APPROACHES FOR NETWORK SELECTION IN HWN'S

System choice in the projected remote systems can be arranged into two methodologies, i.e., Core Network-Driven (CN-D) and Mobile Terminal-Driven (MT-D) choices. Core Network-Driven methodology, the choice is produced using the system side. Hence, it is reasonable for firmly coordinated condition in which a focal controller disseminates the traffic streams among various systems. Interestingly, with a versatile terminal-driven methodology, clients settle on choices to choose the system in a dispersed design. In this way, it can work as stable system autonomously [2]. Its fundamental yield is the choice of the most appropriate Radio Access Technology (RAT) amid another call foundation or upon a HO execution. The last might be a level (intra-RAT) HO, in which case the entrance innovation supporting an association does not change, or a vertical (inter-RAT) HO, in which the supporting innovation changes. The RAT determination is executed as an exchange off between the client inclinations, the MT area and speed and the heap of each RAT included.

A. Algorithm In The Mobile Terminal-Driven (MT-D)

The MT part mulls over parametric variables situated in the client profile and particularly the client's inclinations identified with the cost, the QoS and the battery length. Too, the administration necessities identified with the Received Signal Strength (RSS) (mistake rates, delay, and so forth.) what's more, the MT qualities identified with the power utilization of its radio interfaces. This calculation is displayed in Figure 1. Its fundamental design is to manufacture organized arrangements of target RATs that are perfect with the client inclinations. This is performed freely for each association, either dynamic or new, so as to accommodate greater adaptability and better client fulfilment. Five distinct boosts may conjure the execution of the calculation. These are demonstrated as (i), (ii), (iii), (iv) and (v) in Fig 4 [16].

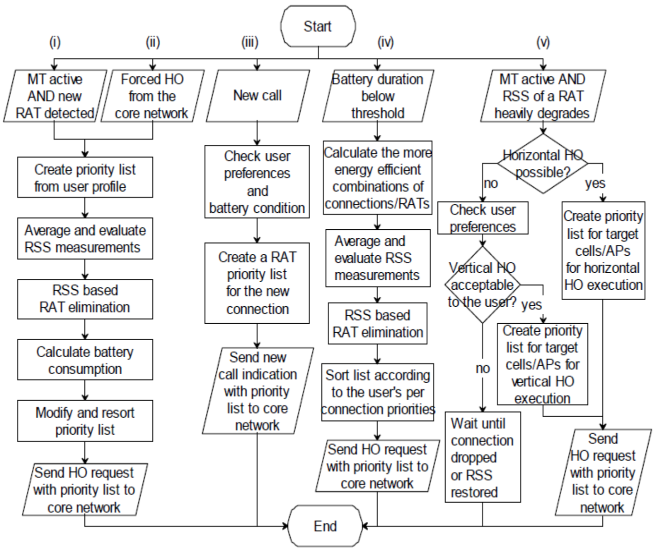

Fig 4: Flowchart for Mobile Terminal-Driven (MT-D)

1. The MT has no less than one dynamic association and another RAT with sufficiently solid radio flag is distinguished. At that point, the MT makes a two-dimensional need rundown of N lines and M sections, where N is the quantity of dynamic associations and M the quantity of option RATs. This need list is filled as per the client profile. From that point forward, the calculation checks if all RATs associated with the past advance give sufficient radio connection quality to help the asked for administrations. This is expert by assessing all accessible RSS estimations gathered by the MT. On the off chance that a RAT does not satisfy these necessities, it is dispensed with from the rundown. Next, the MT computes the battery utilization for the synchronous task of all interfaces included and adjusts the need list concurring to the significance the client provides for the battery span. Now, the rundown is arranged in dropping request per line (i.e., association) with the goal that each line at last contains the elective RATs for one specific association, beginning from the one that serves it best to the one that serves it most exceedingly awful. This rundown is sent profoundly organize alongside a message asking for a HO. All the preparing required here necessities some an opportunity to be refined. We expect that there is sufficient time for this, since the activating occasion is the revelation of another RAT and not the corruption of the RSS, the

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calculation attempts to check whether it can better fulfill the client by giving access to a more most loved RAT.

2. A constrained HO order is gotten from the center system, concerning particular or all associations of the MT. This might be because of load adjust purposes and is chosen by the administrator's system segments. This case is dealt with an indistinguishable route from the past one, since the time confinements are not tight once more. The system administrator is capable not to trigger such HOs at the specific last minute. As in the past case, an exertion is made to think about the client inclinations, under more prohibitive examples this time, since a few RATs may not be allowed in the event that they are over-burden.
3. Another call is started. The MT might be sit or have dynamic associations. This time the calculation considers the client inclinations from the client profile and the battery condition and makes a rundown of organized RATs just for the new association. At that point it sends profoundly arrange a message showing the new call inception alongside this need list. The calculation does not reconsider every single dynamic association since this may just be vital in the event of low battery life. Be that as it may, this case is dealt with from the following trigger.
4. The rest of the battery length falls beneath a specific edge, whose esteem is a client subordinate factor and might be joined in the client profile. At the point when this span falls underneath a period interim, a client might will to forfeit some QoS or certain associations with a specific end goal to stay reachable. Another client not inspired by such proactive conduct may have this limit esteem equivalent to zero. This is unmistakably a for each client setting. The remaining battery life is intensely reliant on the dynamic radio interfaces of the multi-mode MT. At the point when this falls under certain time length, a modification of the dynamic associations is performed, with a specific end goal to expand battery life. To start with the MT finds which mixes of associations and RATs are the more vitality productive. This is possible, since the MT knows about the power utilization of every interface. At that point, it dispenses with all RATs with lacking sign quality for every association, so it rejects a portion of the mixes it simply figured. The rest of the blends are arranged by the need the client provides for every specific association. This will permit the center system to dismiss, if required, the slightest critical associations in the event that that the blends sent can't all be satisfied.
5. The MT is dynamic and the gathered RSS estimations show a corrupting sign from a RAT and an approaching HO. For this situation, the time imperatives are tight. The most astounding need is on the continuation of the call rather on tweaking the choice as indicated by all parametric variables. Here, we look at that as a level HO is desirable over a vertical one. This is because of the way that the utilized RAT is as of now known to be worthy to the client and a flat HO has generally less inactivity. This is particularly valid in a free coupling situation. In this way, if an even HO is possible, a HO ask for is send profoundly organize alongside a rundown of applicant cells/APs. The likelihood of a vertical HO is viewed as just if an even HO isn't conceivable. Such a case could be the point at which a WLAN association must be given over, in light of the fact that the MT is moving out of the scope territory and there are no neighboring APs to be served by. A vertical HO will be permitted, just on the off chance that it is satisfactory by the client inclinations. For instance, the client may not will to pay a higher cost for UMTS network for a FTP download. In this way, on the off chance that it is satisfactory, a comparable system as before is taken after. If not, there is no activity and either the association will be dropped because of radio connection debasement, or the flag might be re-established (e.g. alter of client course development) and the association goes on.

B. Algorithm in the Core Network-Driven (CN-D)

The piece of the calculation running in the core network takes an official choice about the permission of another association or the HO of a current one. It is summoned under three triggers, (i), (ii) and (iii), appeared in Fig 5 [16]. Every one of these triggers are the messages got as the after effect of the relating calculation at the MT, depicted in the past subsection.

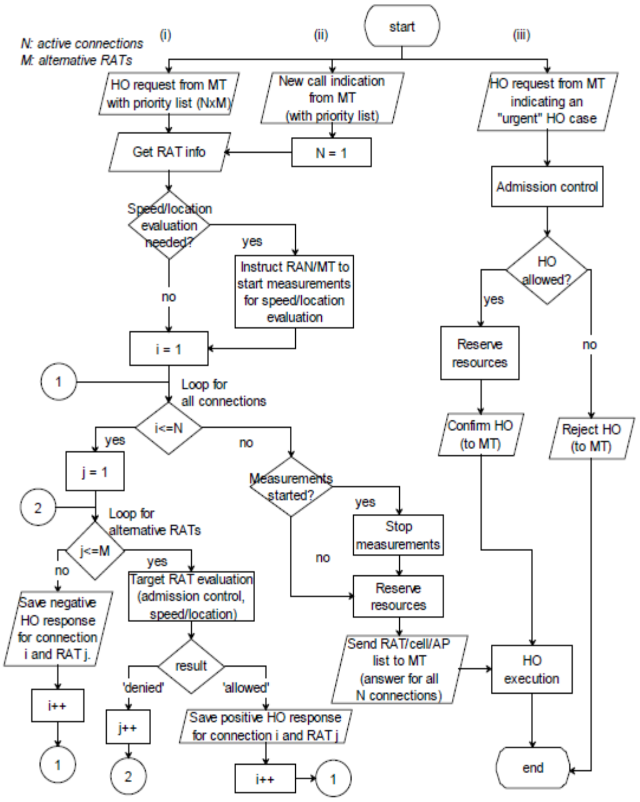

Fig 5: Flowchart for Core Network-Driven (CN-D)

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1. The primary trigger is a HO ask for message from a MT showing the need to reconsider all its dynamic associations. It tags along the need list framed by the MT calculation. At that point, data identified with all objective RATs, for example, scope and load, is considered. On the off chance that the determination of a particular RAT ensnares area and speed contemplations, e.g. a constrained range WLAN, at that point the strategy for their assessment is begun. This is required since it is good for nothing to HO to an AP if the MT's speed is high and will leave the AP's scope in a couple of moments seconds, or if the MT is close to the AP's fringe scope and moving far from it. There are a considerable measure of techniques for speed and area assessment. Some are proposed by 3GPP [10], where the MT's area and alternatively speed estimation is accomplished by estimating the radio flags and utilizing strategies, for example, OTDOA (Observed Time Difference Of Arrival). The clarification of the specific strategy for speed and area computation is out of the extent of this paper. At the following stage a settled circle is begun. The external one relates to the number N of the dynamic associations. Thus, each association is assessed independently. The inward circle is for the M elective RATs of each association. Along these lines, for every association (I = 1,… ,N) each elective target RAT is assessed, beginning from the first, since this was the choice taken by the MT after thinking about the client's inclinations. This assessment for the UMTS case implies that the confirmation control calculation is executed and the HO to this specific RAT is either 'permitted' or 'denied'. For the WLAN, aside from checking the heap of the objective AP, the speed and the area of the MT are evaluated. This is achievable in the wake of gathering all estimations made up to now for this particular reason. In the event that the MT's speed and area are worthy, the HO is 'permitted' for this particular RAT and the choice taken is positive. At that point, the calculation goes ahead with the following association and a similar methodology is rehashed for each RAT j. At the point when all associations are finished, the center system trains the end of the estimations for area and speed following. At that point, a response to the HO ask for of the MT is sent back, alongside the rundown of the last RAT decision for every association.
2. The second trigger is another call sign from a MT. This is dealt with as the past trigger, where every one of the associations are assessed. The main distinction, for this situation, is that lone the association with be started is assessed, hence N=1.
3. The last trigger is a HO ask for showing a "critical" HO. For this situation, the affirmation control calculation of the RAT chose by the calculation in the MT is executed and settles on the HO plausibility. We remind here that the MT has officially checked the elective RATs, and proposes just a single of them as per scope and client inclinations. At that point, if the HO is permitted, at that point the HO execution continues, else the MT is educated about the HO dismissal.

IV. PROPOSED PRIORITY BEST NETWORK SELECTION ALGORITHM (PBNSA)

In heterogeneous conditions, criteria to determination the best system is one of the primary difficulties for consistent versatility as there does not exist a solitary factor than can give a reasonable thought of which to choose. The absolute most essential choice features are:

User satisfaction degree, Offered Bandwidth, Velocity, Signal Strength, Interference (Load balancing), Power Requirements.

Each system determination techniques treated in the writing have their own particular focal points; they are all intended to address singular portable client's issues in transfer speed, dependability, cost or power protection. They didn't give careful consideration on the framework execution, for example, the blocking likelihood which can be expressed as takes after. We consider an arrangement of access systems accessible and approaching movement streams from mobile terminals (MT) that should be appointed to get to systems while fulfilling the accompanying goals:

- Exploiting the offered data transfer capacity from the chose arrange Nj,
- Accommodate the client's inclinations, for example, speed bolster, the associations prerequisites, for example, the RSS level and the framework exhibitions regarding lessening and dropping probabilities,
- Establishing a need instrument for handoff brings over new requires each class of movement,
- Achieving a heap adjusting among accessible Radio Access Technologies (RAT) to enhance normal framework use,
- Minimizing the power utilization on MT.

A. System model

In this area, we demonstrate the best system choice issue keeping in mind the end goal to locate the ideal chose organize that fulfills the idea of Always-Best-Connected (ABC).

1. Application Description

Let A = (A_1, A_2, A_3,……, A_n) denote the set of new applications. A QoS Request (QR) ought to be created with MT before discovery another entrance organize. The QoS ask for contains the call write, benefit class, and data transmission and defer necessities.

The QoS Request escribed using a 6-tuple:
(P_i , B_i^{req} , B_i^{min} , B_i^{max} , D_i^{req} , D_i^{max})

Where, B_i^{req}: bandwidth capacity of A_i
B_i^{min}: is the minimum bandwidth capacity of the application A_i
B_i^{max}: is the maximum bandwidth capacity of the application A_i
P_i: service class of A_i
D_i^{req}:is the req delay of A_i

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D_i^{max}: is the delay maximum of A_i

At the point when the framework is underutilized, all arriving new and handoff calls are conceded with the most elevated data transmission level B_i^{max} for the calls. This approach expands transfer speed usage for the heterogeneous remote system. Be that as it may, when the framework is completely used, data transmission adjustment controller is conjured.

It is assumed that each call is assigned a priority from one of (P_1 , P_2 , P_3 , ……., P_k) where $P_i < P_{i+1}$
what's more, the bigger file number demonstrates the higher need. This relative need of each call is
mapping with 3GPP QoS definition reliably. For instance, P_4 demonstrates the discussion benefit class, P_3 demonstrates the steaming administration class, P_2 shows the intelligent administration class, also, P_1 demonstrates the foundation benefit class. The discussion benefit class will have higher need than the steaming administration class, the gushing administration class will have higher need than the intuitive administration class, and the intelligent administration class will have a higher need than the foundation benefit class [16].

2. Access Network Description

Let:
- N = (N_1, N_2, N_3,……, N_m) = be the set of access networks available.
- V = (V_1, V_2, V_3,……, V_m) = be the set of threshold values of velocities for a mobile station for the respective networks.
- RSS = (RSS_1, RSS_2, RSS_3,……, RSS_m) = be the set of threshold values of received signal strengths of respective networks.
- C = (C_1, C_2, C_3,……, C_m) = be the communication costs of one unit time of respective
networks.
- B_j total bandwidth capacity of access network *Nj*,
- D_j is the maximum communication delay of A_i
- PB_j, PT_j, PR_j are power consumption cost parametric variables defined below.
- $O_{(j,t)}$ denotes the number of ongoing call in a cell of access network *Nj* at time t.
- $X_{(j,t)}$ denotes the number of calls in a cell of access network *Nj* at time t.
- $n_{(j,t)}$, and $h_{(j,t)}$ denote respectively, the number of ongoing new calls and handoff calls, in *Nj*.
- $B_{(i, j, t)}^{assg}$ denotes the assigned bandwidth by network *Nj* for call i at time t.
- $D_{(i, j, t)}^{off}$ denotes the offered delay to call i by access network *Nj* at time t.
- I (state) denote the condition expression as below.

$$\begin{cases} I(condition\ expression)=1, if\ expression=true \\ I(condition\ expression)=0, if\ expression=false \end{cases}$$

An access network N_j (1≤J≤m) is described using a 5-tuple (B_j, D_j, PB_j ,PT_j ,PR_j) . The assignment function Asgn_Net maps a application A_i to access network N_j, i.e. Asgn_Net(A_i)=N_j if is assigned to N_j.

A call i is degraded if $B_{(i,j,t)}^{assg} < B_i^{req}$ whereas the call is upgraded if $B_{(i,j,t)}^{assg} > B_i^{req}$ The sum of occupied bandwidth of the cell N_j at time t.

$$B_{(j,t)}^{occp} = \sum_{i=j}^{O_{(j,t)}} B_{(i,j,t)}^{assg} \quad (1)$$

The available bandwidths in network N_j at time t.

$$B_{(j,t)}^{avai} = B_j = B_{(j,t)}^{occp} \quad (2)$$

3. Handoff Decision Metric Calculation

The handoff choice metric computation is performed among hopeful's systems, to maintain a strategic distance from measures at the versatile terminal side, every Nj registers the system quality esteem, at that point this esteem is sent to the portable terminal. Bandwidth degraded call ratio (BDCR) We characterize the data transfer capacity debased call proportion of progressing brings in get to arrange Nj as:

$$BDCR_{(j,t)}^{O} = \sum_{i=j}^{O_{(j,t)}} \frac{(B_i^{req} - B_{(i,j,t)}^{assg})}{B_i^{req}} I(B_{(i,j,t)}^{assg} < B_i^{req}) \quad (3)$$

$$BDCR_{(j,t)}^{n} = \sum_{i=j}^{n_{(j,t)}} \frac{(B_i^{req} - B_{(i,j,t)}^{assg})}{B_i^{req}} I(B_{(i,j,t)}^{assg} < B_i^{req}) \quad (4)$$

Bandwidth degraded call ratio of handoff call j as:

$$BDCR_{(j,t)}^{h} = \sum_{i=j}^{h_{(j,t)}} \frac{(B_i^{req} - B_{(i,j,t)}^{assg})}{B_i^{req}} I(B_{(i,j,t)}^{assg} < B_i^{req}) \quad (5)$$

Weighted bandwidth degraded call ratio as:

$$BDCR_{(j,t)} = \alpha_1 BDCR_{(j,t)}^{o} + \alpha_2 BDCR_{(j,t)}^{h} + \alpha_3 BDCR_{(j,t)}^{n} \quad (6)$$

The system administrator relegates weights to the transmission capacity debasement parametric variables with a specific end goal to decide the parametric variables' levels of significance. The entirety of the weights α_1, α_2 and α_3 must be equal to 1. The parametric variables are more essential to the client than those with low weight esteem and the other way around [16].

BANDWIDTH UPGRADED CALL RATIO (BUCR)

The bandwidth upgraded call ratio of ongoing calls in access network N_j as:

$$BUCR_{(j,t)}^{o} = \sum_{i=1}^{O_{(j,t)}} \frac{Max((B_{(i,j,t)}^{assg} - B_i^{req}), B_i^{max})}{B_i^{req}} I(B_i^{req} < B_{(i,j,t)}^{assg}) \quad (7)$$

The bandwidth upgraded call ratio of new calls in access network Nj as:

$$BUCR_{(j,t)}^{n} = \sum_{i=1}^{n_{(j,t)}} \frac{(B_{(i,j,t)}^{assg} - B_i^{req}))}{B_i^{req}} I(B_i^{req} < B_{(i,j,t)}^{assg}) \quad (8)$$

The bandwidth upgraded call ratio of handoff call j as:

$$BUCR_{(j,t)}^{h} = \sum_{i=1}^{h_{(j,t)}} \frac{(B_{(i,j,t)}^{assg} - B_i^{req}))}{B_i^{req}} I(B_i^{req} < B_{(i,j,t)}^{assg}) \quad (9)$$

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The resultant bandwidth upgraded to incoming call ratio as:

$$BUCR_{(j,t)} = \alpha_1 BUCR^o_{(j,t)} + \alpha_2 BUCR^h_{(j,t)} + \alpha_3 BUCR^n_{(j,t)} \quad (10)$$

DELAY DEGRADED CALL RATIO (DDCR)

Similarly to BDCR to BUCR, we define:

The defer debased call proportion of continuous brings in get to arrange Nj as the deferral between required postponement and offered deferral of existing calls at time t:

$$DDCR^O_{(j,t)} = \sum_{i=1}^{O_{(j,t)}} \frac{(D^{off}_{(i,j,t)} - D^{req}_i)}{D^{req}_i} I(D^{req}_i < D^{off}_{(i,j,t)}) \quad (11)$$

- The delay degraded call ratio of new calls in access network Nj as:

$$DDCR^n_{(j,t)} = \sum_{i=1}^{n_{(j,t)}} \frac{(D^{off}_{(i,j,t)} - D^{req}_i)}{D^{req}_i} I(D^{req}_i < D^{off}_{(i,j,t)}) \quad (12)$$

- Nj for handoff calls in access network as:

$$DDCR^h_{(j,t)} = \sum_{i=1}^{h_{(j,t)}} \frac{(D^{off}_{(i,j,t)} - D^{req}_i)}{D^{req}_i} I(D^{req}_i < D^{off}_{(i,j,t)}) \quad (13)$$

DDCR is given as:

$$DDCR_{(j,t)} = \alpha_1 DDCR^o_{(j,t)} + \alpha_2 DDCR^h_{(j,t)} + \alpha_3 DDCR^n_{(j,t)} \quad (14)$$

Delay call ratio DUCR Nj

BDCR to BUCR:

- Nj :

$$DUCR^O_{(j,t)} = \sum_{i=1}^{O_{(j,t)}} \frac{(D^{off}_{(i,j,t)} - D^{req}_i)}{D^{req}_i} I(D^{req}_i < D^{off}_{(i,j,t)}) \quad (15)$$

- Nj for new calls in access network Nj as:

$$DUCR^n_{(j,t)} = \sum_{i=1}^{n_{(j,t)}} \frac{(D^{off}_{(i,j,t)} - D^{req}_i)}{D^{req}_i} I(D^{req}_i < D^{off}_{(i,j,t)}) \quad (16)$$

- Nj for handoff calls in access network Nj as:

$$DUCR^h_{(j,t)} = \sum_{i=1}^{h_{(j,t)}} \frac{(D^{off}_{(i,j,t)} - D^{req}_i)}{D^{req}_i} I(D^{req}_i < D^{off}_{(i,j,t)}) \quad (17)$$

We define the DDCR as:

$$DUCR_{(j,t)} = \alpha_1 DUCR^h_{(j,t)} + \alpha_2 DUCR^n_{(j,t)} \quad (18)$$

B. Priority Best Network Selection Algorithm (PBNSA)

This publication establishes the works in the writing [5, 13, 16], we have assumed that every MT incorporates a Priority Best Network Selection Mechanism (PBNSM) that embraces three specific modules:

User Profile Datastructure (UPD): it keeps Up expected data to help the choice calculation when it settles on the best system determination choices. The accompanying information are put away in the database:

Information identified with client inclinations and administrator limitations, for example, favored and taboo access organizes, the weights influenced to various parametric variables taking an interest in the choice choices as arrangements. In this manner, we indicate for every application which is the more vital objective by giving the reasonable qualities to the choice objective parametric variables.

Information identified with applications QoS prerequisites. It contains chiefly the QoS level incorporated in almost all the applications. For instance, the helpful parametric variables from the application QoS prerequisites takes into account Minimum fundamental piece rate (kb/s), bolstered bit blunder rate, benchmarked safety level safety level and most extreme endured interruption.

Information identified with the accessible systems exhibitions, for example, the mean piece rate, the most extreme bundle measure, the parcel mistake rate, the bit blunder rate, along with normal inertness to guide a bundle.

User Profile Manager (UPM): it administers every one of the features affecting the best system determination choice (organize, client, application, and terminal) and stores the fundamental data in the profile database. The UPM additionally decides when it is important to trigger the Priority Network Selection Algorithm and helps the PBNSA when it settles on the decision of the "best" access.

To be sure, the UPM triggers the PBNSA in the accompanying cases:

- An adjustment of system interface status,
- An application stream has been made or erased,
- Stream observed parametric variables esteems alteration,
- Client inclinations or administrator limitations change,
- System exhibitions change.

Also, the UPM can influence the programmed choice of an entrance to arrange by keeping up all the vital data for appropriate interface design.

The PBNSA does not have to know how the parametric variables are gathered inside profiles or how the determination choices are implemented. The UPM must control superfluous triggers, generally the PBNSA could be actuated time after time and it will debilitate the CPU or the battery. In light of the triggers got from the User Profile Manager, the PBNSA questions the User Profile Database and begins its computational system. In this manner, different dynamic profiles are utilized as contribution by the PBNSA with a specific end goal to select the "best" interface for every application stream. The system utilized by the PBNSA is to characterize get to arrange score capacities to take care of this numerous objective issue. It is worth to take note of that the PBNSA could execute various choice process, yet few of those can take into record such a vast board of parametric variables (mean piece rate, normal postponement, security level…) also as to take a shot at a stream for each stream premise.

Keeping in mind the end goal to determine the issue of assets control and administration, we have selected to put new features in the system side committed to checking, breaking down and dealing with the system assets which ensure systems stack adjusting while in the meantime settling on the choice taken by the MT-D without administrator exigencies that points for the most part to take benefits. The MT-D sends adaptable determination choice calculations that utilization the idea of weights which will be appointed to various parametric variables as indicated by client inclinations and applications necessities. In this manner, our approach permits choosing the best system reacting to client and applications

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desires and also best assets administration and system usage streamlining.

The PBNSA fundamental object is to circulate the bundles from various lines in light of client decision by reacting to QoS necessities and wellbeing basic applications. Any QoS steering calculation needs to strike a harmony amongst overhead and quality. Multi Attribute Decision Making (MADM) calculations have been utilized as a part of heterogeneous remote system conditions, keeping in mind the end goal to pick the best RAT, to discover adequate options or to locate the best option [5]. An immediate correlation between these calculations is troublesome as it requires the utilization of another MADM calculation. They can by and by be part into two primary classes: compensatory and non-compensatory. Compensatory calculations consolidate different credits to locate the best option, for example, The GRA utilizes a reference framework, set subjectively by the client, to look at the grids acquired for each system. Favorable position of the GRA approach contrasted with the other recorded calculations chooses the system that offers the nearest administration, and r surpasses long shot administrations of QoS prerequisite. Despite what might be expected, non compensatory calculations are utilized to discover worthy options which fulfill a base cut-off.

The PBNSA algorithm presented in

1. Decide the quantity of accessible RATs for every emphasis and allocate an irregular identifier for every user profile.

2. Decide the queue write to send wallets from (z) and the quantity of wallets to send (n).

3. Ascertain the Score (Sx) of each accessible RAT for the recovered queue (z).

4. Wallets are led on accessible RATs pertaining to Sx > 0.

5. In the event that there are accessible RATs staying for that emphasis, the procedure is rehashed for the lower need queues (just for Parallel Transmission Profiles).

V. CONCLUSION & FUTURE WORK

The future-generation remote frameworks will consolidate heterogeneous remote access advances to give mobile clients consistent access to a various arrangement of uses and administrations. Determination of the most ideal access organize is a vital issue for benefit conveyance in a HWN. The choice is affected by a few on-screen characters where every one tends to remove benefit. In this article we have proposed a PBNSA for best system choice and assets administration in heterogeneous condition in light of mobile terminal driven with arrange help for data accumulation, observing and assets reservation.

We exhibited another system for choosing among a few RATs in a heterogeneous situation. The component thinks about various parametric variables, for example, client inclinations, flag quality, battery level, arrange blockage, speed and heading of a terminal. Its fundamental objective is to fulfill the inclinations of the clients and not just o stack adjust the activity between the accessible systems. To accomplish this, the component has two choice focuses. The first is on the versatile terminal and assembles an organized rundown of RATs for every single one of its associations, in view of client inclinations. The second choice point is situated on the system and checks fundamentally if there are assets to fulfill client's solicitations.

Network Selection has been broadly contemplated by utilizing different numerical hypotheses in the review segment. The utilized hypothesis is critical on the grounds that it chooses the goal of enhancement, multifaceted nature and execution, however there does not have an instructional exercise on the numerical models utilized for the system determination issue. A brought together situation was utilized to clarify and analyze chosen organize choice plans utilizing these speculations utilized for this issue, including utility function, MADM, fuzzy logic, game theory, combinatorial optimization, Markov chain.

In future work, we can implement the PBNSA to the both approaches for network selection in HWN's and also finding the optimal time by using numerical hypothesis techniques.

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