

# Optimized File Transfer In 5g Client-Server Architecture Using Adoptive Routing Protocols

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**ABSTRACT--**The fifth-generation (5G) and beyond cellular networks are expected to support a huge number of mobile devices, roaming seamlessly across very small cells. Consequently, the handover rate for these extremely dense networks is expected to be very high. To reduce the burden caused by rapid handover requests, and to support a massive number of highly mobile devices in 5G and beyond networks, this study suggests using proximity-based clusters as nomadic cells integrated with Aerial Access Networks (AANs). These nomadic cells are formed by two-levels hierarchical partitioning of the mobile devices into proximity-based clusters. Previous distributed mobility management schemes are not sufficiently efficient to support the handover rate expected for 5G and beyond networks. Due to their high computational complexity, previous group-based methods are not applicable for real-time services. In contrast to these schemes, the proposed scheme is scalable with the number of devices. Moreover, the creation of a mobility group raises practical as well as security and privacy issues that were overlooked by previous schemes. These issues are addressed in this study.

**KEY WORDS:** *Index Terms—5G and beyond networks, aerial access networks, cellular networks, mobility management.*

## 1.INTRODUCTION

5G and beyond cellular networks are required to support a massive number of Internet of things (IoT) devices and provides eamle access with Quality-of-Service(QoS)guarantees for all of them. 5G cellular networks are expected to support communications with high mobility. The term “high mobility” does not necessarily refer only to the velocity of the mobile devices. Rather, this term refers to the challenges caused by mobility. For instance, the rate of network disconnection events

caused by handover. In general, the challenges caused by mobility depend, among other things, on the users’ velocity and density, the cell size, and there quired network latency and QoS. Examples for applications in high mobility scenarios are high speed railways, vehicular ad hoc networks, and unnamed aerial vehicle (UAV) communications.5G and beyond networks are expected to support real-timeservices for devices such as autonomous cars, drones, and other smart vehicles. These services require precise knowledge and a very low latency about the exact location of these devices, to react in real-time [1]–[3]. That implies that the exact location of the mobile device (e.g., a UAV) must be known accurately. While existing cellular networks have the time to search for a mobile user upon

## 1. Body of Paper

### Background and Related Work

IP mobility support is provided for IPv4 byMIPv4 [7], [8],and for IPv6 by MIPv6 and its derivatives, such as PMIPv6[9],fast proxy mobile IPv6 (FPMIPv6)[10], and FH-PMIP v6 [11].However, these protocols are not sufficiently efficient to support real-time applications, in terms of high handover latency, and packet loss ratio [11], [12], [13]. Therefore, none of these protocols can support devices in high mobility scenarios.

Recently, it was shown in [14] that due to the small dense cells architecture of 5G networks, physical layer methods used in existing cellular networks for detecting handover may not work properly for 5G extreme high mobility scenarios. The authors in [14] extended the cross band channel prediction proposed in [15] to mobility scenarios, to suggest a new physical layer method for handover detection. The focus of this study is on the networking layer. Therefore, the proposed method can be integrated with the scheme suggested in [14].

Several studies attempted to reduce the signaling cost associated with mobility support. Distributed mobility management(DMM) was proposed in [16], and described in [17]. A Software defined network(SDN)- based version of DMM was suggested in [18]. However, DMM is a network-based scheme, aiming to suggest a solution only for the core network. Hence, the problem of handling frequent handover requests at the network edge.

## Contributions of This Work

The main contributions of this study are:

- 1) A scalable user-based distributed scheme, while previous studies used a centralized approach which is not scalable.
- 2) A significant reduction in the handover rate handled by the network. This contribution is crucial for highly mobile devices moving in 5G and beyond networks.
- 3) Privacy and security issues, that were over looked by previous group mobility schemes can be potentially faraway hostile attacks, in comparison with previous group-based schemes, for which the mobile nodes are vulnerable to such attacks.
- 4) Packet loss ratio can be significantly reduced, in comparison with proxy-based schemes, since the network proxy is very close to the users.

## HPC-A Formal Description

The HPC scheme is as follows:

1) Initialization: For privacy and security reasons, aproximity-based an authentication mechanism is used. The human user is required to bind its MN to the CH using a short- range communication (e.g., Bluetooth), similarly to the existing binding process that binds a smartphone to a car-installed device. A smartphone can be used as a CH for the IoT devices carried by the same person who owns the smartphone, by performing hand- gestures in front of these devices. Here, the authentication mechanism is similar to the one described in [30].

Once the authentication process is completed, the CH initiates a network binding process on behalf of the MN.

2) The CH sends a registration message to the HA of the MN, on behalf of the MN.

3) As long as the CH can sense the MN, the CH is responsible for maintaining the MN address reachable, by using the CH IP address as the MN address. The MNID is used internally in a table maintained by the CH, while externally every message directed to or from the MN uses the CH IP address, as described in detail in NEMO proposal [19].

4) The HA of the MN updates the CH address as the MN current address, and sends a de- registration message to the previous CH, that informs the previous CH that the MN is no longer under its responsibility

5) The previous CH updates its list of MNs, and the MN is deleted from this list. The previous CH sends deregistration acknowledge message to the MN HA.

### The binding process that connects the MN to the network is as follows:

1) Whenever the CH authenticates a new MN within its service area, it reads the MNID and HA

**The CH sends a registration message to the MNHA, which informs the HA that the MN is now residing within its service area.**

1) The HA updates its associated database and sends a registration acknowledge message to the CH.

2) The CH updates its records, and the MN is added to the list of MNs handled by the CH.

1) The CH sends a registration completion message to the MN HA, which confirms that now the MN is handled by this CH.

2) The MN HA sends a registration cancelation message to the previous CH, which handled the MN until now.

3) The previous CH sends a registration cancelation acknowledge message to the MN HA and deletes the MN records from its list.

### B)HPC -An Illustrative Example

Fig. 1 illustrates the HPC feasibility in a real-world

scenario The handoff rate reduction is conducted in two steps. In the first step, at the bottom hierarchical level, the human user smartphone handles the mobility of all the wearable device carried by this user as their CH. Consequently, the number of MNs is reduced to the number of human users. This is still a large number, but feasible, since existing cellular networks handle their human users very efficiently. In the second step, an shared vehicle (e.g., a bus) is used as the CH of its passengers. As illustrated in

Fig. 1, this step reduces the number of MNs further to the number of vehicles. Moreover, the shared vehicle, being recognized as a nomadic "mini" BS, uses an AAN for network acces.Thus,the handoff rate is significantly

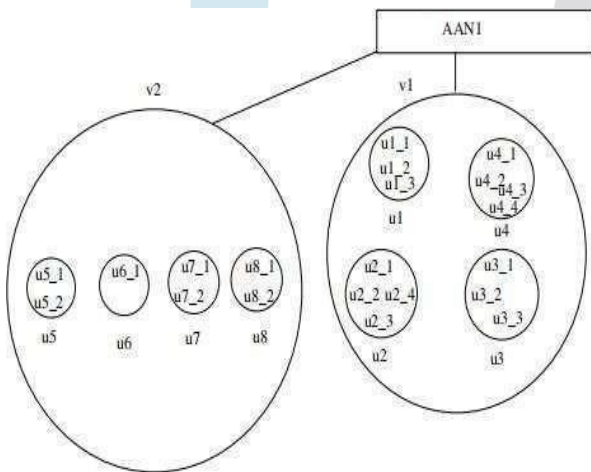


Fig. 1. System description: An illustrative example for an AAN which supports two vehicles and their passenger

**A. Signaling Cost**

The management of a mobility group must handle group disconnection events. Each time a person leaves the group (for instance - get out from the bus/train/subway), we have an event of temporary loss of network connection. Moreover, whenever the group leader is disconnected from his/her group(e.g., because of moving to another direction), all the group members are disconnected from the network. Let  $a_i$ ,  $a$  denote the probability of the group leaving by the MN client  $i$  and the CH, respectively. Then, given that there are  $N$  MNs managed by the CH (including the CH itself), comparing HPC with existing mobility management schemes that are not NEMO based, the CH behaves the same, while the  $(N - 1)$  MNs behave differently. Therefore, the

condition under which the wireless signaling cost associated with HPC mobility management is less than the equivalent cost associated with existing distributed mobility management schemes (e.g., DMM), i.e., the extra signaling caused by frequent location update events for DMM is greater than the extra signaling caused by group leaving events for a NEMO-based scheme is given by:

$$B(N-1)C_i > N-1X_i = 1a_i C_b + a'(N-1)C_b.$$

For vehicle-installed CH,  $a'=0$  when HPC is used. Therefore, subject to this condition, substitute  $a'=0$  in (2), we get that the condition under which the wireless signaling

$$B(N-1) > C_b C_i N - 1X_i = 1a_i.$$

Assuming that  $i, a_i = a$ , it follows from (3) that HPC outperforms DMM for wireless signaling cost when:  $Ba > C_b C_i$ . Independently of the size of the mobility cluster  $N$  ( $N \geq 2$ ). Using (4), the wireless cost reduction caused by using HPC instead of DMM for vehicle-installed CH (assuming that the CH uses DMM, and that  $V_i, a_i = a$ ), is given by

$$w_{costDMM} - w_{costHP} = C = (N-1)(B C_i - a C_b).$$

**B. Privacy and Security**

Previous group-mobility schemes enabled unauthorized access to the MNs via their group leader. This mechanism requires privacy and security consideration. As opposed to this approach, HPC enables a PSK-based authentication process for accessing the MNs. The usage of a smartphone to protect its nearby IoT devices from hostile attacks was described in [30]. The issue of privacy and security was not addressed in any-of the previous group mobility schemes. The possibility of-hacking to many independent MNs using their "group leader"(which is used also as their mobile router) should be carefully-considered. By selecting one individual as a mobile router to all the other members in the mobility group, we give-this individual unauthorized access to the MNs which belong-to another person. In addition. we increase the load on this individual

### C. Packet Loss Ratio

Another aspect of mobility management cost is the packet loss ratio. HPC requires the MN to transmit and receive packets via its CH. Since HPC is a proximity-based mobility management scheme, the MN-CH distance must be relatively short. For most practical cases, this distance should be no more than a few meters. Therefore, the packet loss ratio expected from HPC should be reduced, in comparison with existing-mobility management schemes, in which the proxy is a network element. The reason for this observation is as follows. Since for short-range point-to-point communication along Aline of sight (which is the case for MN- CH communication), the packet loss ratio depends mainly on the signal-to-noise ratio, which depends (among other things) on the distance-between the transmitter and the receiver, the packet loss ratio-expected for HPC must be reduced. This is in comparison with existing proxy-based mobility management schemes (e.g.,DMM), in which the proxy is a network element, whose distance from the MN is significantly larger than the distance from the MN to its CH. Indeed. the CH must still communicate with the network.

However, since the CH should be a much more powerful device than its clients(in terms of radio signal strength), the expected packet loss ratio should be significantly reduced, in comparison with the alternative in which the MN communicates directly with the network.

### D.PERFORMANCE COMPARISON

In this section, the performance of HPC is analyzed and compared with the performance of DMM [16], [17], and GMM [25], which at the time of writing this paper, is the most cited group-mobility scheme for cellular networks.

The probability to move from the current MAG  $i$  to any other MAG is given by:  $p_i = \sum_{j=i} p(i, j)$

Given a uniform probability to move from any MAG  $i$  to another MAG, we get that  $p_i$  is independent of  $i$ . Therefore, from now on  $p_i$  is denoted by  $p$ . Thus, given that  $i$  and  $j$  are neighbors in  $G$ , the probability  $p(i, j)$  to move from MAG  $i$  to MAG  $j$  during a time slot is given by:

$$P(i,j) = p_i N_i$$

Where  $N_i$  is the number of the nearest neighbors of  $i$ . That is, the group of all nodes in  $G$ , such that there exists an edge in  $G$  that connects  $i$  to each one of them. If  $j$  is not a nearest neighbor of  $i$  then  $p(i, j) = 0$ . The transition probability matrix  $P$  represents the transition probabilities  $p(i, j)$  for all  $i, j \in V$ . There exists a unique vector  $\Pi$  which describes the steady state location probability distribution  $\Pi = (\pi_1, \pi_2, \dots)$ . Each element  $\pi_i$  describes the steady state probability to reside in location  $i$ . It is shown in [32]that the vector  $\Pi$  is obtained by solving the equation

It follows from (8) that the steady state location probability vector  $\Pi$  depends on both the network topology as well as on the user mobility. Thus, no general closed form expression can be obtained in general for mobility cost analysis. Let us consider an MN during a session. Given that the probability  $p$  to switch MAG during a time slot is constant for all the MNs and all the locations, then using PMIPv6, the rate  $S$  of handover events during  $t$  time slots is given by:

$$SPM IPv6 = tp$$

As long as the MN remains in the same domain.It is further assumed that the mobility pattern is local within the same domain, with no LMA switch. Given the probability  $p$  to switch BS, the probability to make  $m$  movements from one BS to another during  $t$  time slots is given by:

$$\mu(m, t) = t^m p^m (1-p)^{t-m}, (10) \text{ if } m \leq t, \text{ and } 0 \text{ if } m > t$$

from one BS to another along one axis, say  $x$ , the probability to travel a distance of  $d$  BSs along this direction, either right, left, up, or down, is given by:

$$p_{1D}(d, m_x) = \binom{m_x}{d} p^d (1-p)^{m_x-d} \text{ if } m_x \geq d \geq 1 \text{ and } m_x-d \text{ is even, and } 0 \text{ otherwise.}$$

The explanation for (11) is that to travel a distanced, in terms of the number of BSs, along one direction, the MN must travel along this direction a distance that is greater by exactly  $d$  than the distance along the opposite direction. That is, given that the MN has made  $m_x$  movements along the  $x$  axis,  $(m_x+d)/2$  movements were made along this direction, while  $(m_x - d)/2$  movements were made along the opposite direction. Since the probability to move to any of the four possible.

## CONCLUSION AND FUTURE WORK

This study suggests reducing the burden caused by the mobility of a massive number of highly mobile devices by partitioning the devices into mobility clusters, such that the network has to handle only one representative for each cluster. Using AANs to support highly mobile devices, each cluster moves between large macro cells that are significantly larger than typical cells expected for beyond 5G networks. Consequently, the rate of handover requests can be significantly reduced. The major difference between HPC and previous group mobility schemes is that HPC is a scalable user-based distributed scheme, formed hierarchically by two levels proximity-based clusters, while previous group mobility schemes are centralized network-based schemes, based on consolidating the users' mobility patterns, that are not scalable, and cannot support real-time applications.

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