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Averaging Mechanisms to Decision Making for Handover in GSM

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Abstract**—**In cellular networks, limited availability of resources has to be tapped to its fullest potential. In view of this aspect, a sophisticated averaging and voting technique has been discussed in this paper, wherein the radio resources available are utilized to the fullest value by taking into consideration, several network and radio parameters which decide on when the handover has to be made and thereby reducing the load on Base station .The increase in the load on the Base station might be due to several unnecessary handover taking place which can be eliminated by making judicious use of the radio and network parameters.

Keywords**—**Averaging and Voting, Handover, QoS.

I. Introduction

THE future telecommunications networks (such as the third-generation wireless networks) aim at providing integrated services such as voice, data, and multimedia via inexpensive low-powered mobile computing devices over wireless infrastructure.

As the demand for multimedia services over the air has been steadily increasing over the last few years, wireless multimedia networks have been a very active research area. To support various integrated services with a certain quality of service (QoS) requirement in these wireless networks, resource provisioning is a major issue [1].

GSM (Global System for Mobile communication) is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1,800 MHz frequency band. Mobility is the most important feature of a wireless cellular communication system. Usually, continuous service is achieved by supporting handover from one cell to another because of which a handover algorithm is very important in mobile communications.

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The decision to trigger a handover and the subsequent choice of target cell has a collective purpose which can be grouped into major objectives of handover.

This paper is organized as follows. Section II explains the situations under which a handover might occur. Section III gives an overview of different types of hand off. Section IV discusses the various radio and network parameters used to cause a handover initiation followed by section V which discusses the averaging and voting mechanism used to perform a handoff. Paper is concluded in Section VI.

II. Handover Situation

Handover is a GSM feature by which the control of communication of a mobile is transferred from one cell to another if certain criteria are met. In cellular networks there may be different reasons as to why a handover might be needed-

a) To avoid loosing a call in progress when the Mobile Station leaves the radio coverage area of the cell in charge. This type of handover has an important weight in the overall perception of the quality of service by the subscriber since it has a high probability of loosing the call if the cell is not changed.

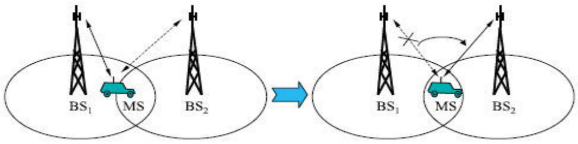
b) Channel ought to be changed in case of severe disturbance (interference). Sometimes mobile stations would be required to change serving cells because the cell corresponding to minimum path loss will minimize the mobile station transmit power when power control is being used. So handover happens not only for the sake of ongoing communication but also to optimize the interference level.

c) Traffic reason handover takes place depending on system load and capacity of the serving and adjacent cells.

III. Types of Handover

Handover are broadly classified into two categories—hard and soft handover. Usually, the hard handover can be further divided into two different types—intracell and intercell handover. The soft handover can also be divided into two different types—multiway soft handover and softer handover.
A hard handover is essentially a “break before make” connection [3]. Under the control of the MSC, the BS hands off the MS’s call to another cell and then drop the call. In a hard handoff, the link to the prior BS is terminated before or as the user is transferred to the new cell’s BS; the MS is linked to no more than one BS at any given time. Hard handover is primarily used in FDMA (frequency division multiple access)

and TDMA (time division multiple access), where different frequency ranges are used in adjacent channels in order to minimize channel interference. So when the MS moves from one BS to another BS, it becomes impossible for it to communicate with both BS's (since different frequencies are used).



(a) Before handoff (b) After handoff

Fig. 1 Hard Handover between MS and BSs

A hard handover occurs when the old connection is broken before a new connection is activated. The performance evaluation of a hard handover is based on various initiation criteria [4, 5, 8]. It is assumed that the signal is averaged over time, so that rapid fluctuations due to the multipath nature of the radio environment can be eliminated. Numerous studies have been done to determine the shape as well as the length of the averaging window and the older measurements may be unreliable [2]. Fig. 1 shows a hard handover taking place when a MS is moving from one BS (BS_1) to another (BS_2). The mean signal strength of BS_1 decreases as the MS moves away from it. Similarly, the mean signal strength of BS_2 increases as the MS approaches it.

IV. What Triggers a Handover?

A. Handover may occur either because of deterioration of radio parameters or network parameters as listed below.

Radio criteria/radio parameters:

a) Received quality (RX QUAL) too low / bit error rate too high.

b) Received level too low (RX LEV on uplink and downlink)

c) MS-BS distance handover (Timing Advance)

d) Power Budget handover (handover to a better cell with regard to relative received level.)

Network Criteria / network parameters:

a) Serving cell congestion

b) MS-BS distance too high in extended cells.

The first three handover causes in radio criteria are known as mandatory or imperative causes because of the fact that an occurrence of one of these causes mean that a handover is necessary to maintain the call. In a well planned network handover to a better cell with better QoS should be the overwhelming cause for handoff's to happen.

In network criteria a directed retry cause occurs due to congestion situation and not due to the radio conditions of the link. This handover is performed from a dedicated control channel (DCCH) in a congested cell to a traffic channel (TCH) in a neighbor cell during Call Setup phase. Maximum propagation delay within one time slot allows a MS-BS distance of 35 kms in GSM. In an extended cell configuration TCHs are optionally configured as double time slot channels where two contiguous time slots are used to provide coverage beyond 35 kms. Extended cell handover is an intracell handover between a single time slot channel and a double time slot channel and vice versa. Hand off detection is based on comparison of actual MS-BS distance with a set threshold.

B. Parameters to be considered for a Handover decision Process:

Some of the parameters to be taken into consideration while a handover decision is to be made are:

Static data:

a) Maximum transmit power of the mobile station

b) Maximum transmit power of the serving BTS

c) Maximum transmit power of the neighboring BTS's.

Measurements made by Mobile station:

a) Downlink transmission quality (Bit error rate)

b) Downlink reception level of the serving cell

c) Downlink reception level of the neighboring cells

Measurements made by the BTS:

a) Uplink transmission quality

b) Uplink reception level on current channel

c) Timing advance.

Traffic considerations:

a) Cell capacity and load of the serving and neighboring cells.

C. Handover Process

For making a handover decision the BSS will process, store and compare certain parameters from the measurements made and predefined thresholds. During every slow associated control channel (SACCH) multiframe, the BSS compares each of the processed measurements with the relevant thresholds. We can broadly classify the handover causes into four broad categories [9].

a) RXLEV-Received signal level.

b) RXQUAL-Received signal quality.

c) DISTANCE

d) PGBT (Power budget)

D. Handover Margin

Handover Margin is a parameter used in order to prevent repetitive handover between adjacent cells. It may also be used as a threshold in handover cause. The Fig. 2 shows the handover threshold margin. [5]

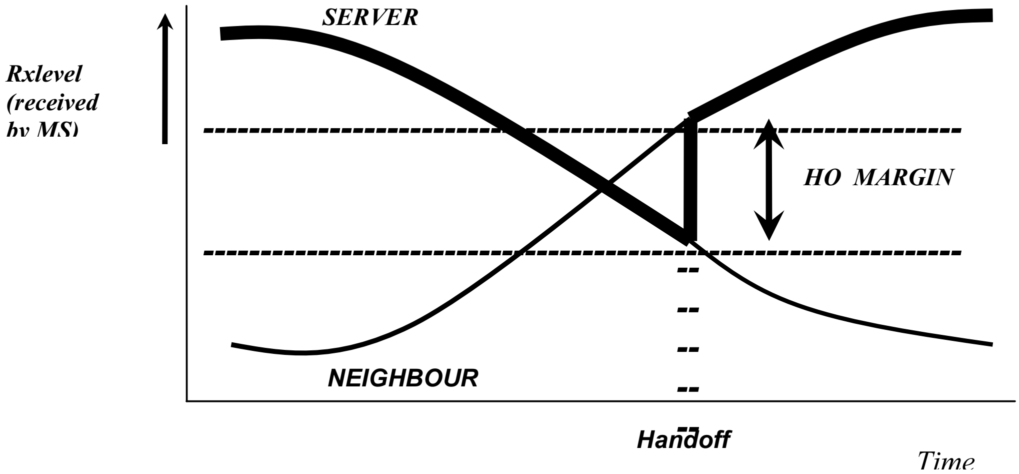


Fig. 2 Handover Threshold Margin

E. Handover Initiation Conditions

Handover is initiated by the network based on radio subsystem criteria (RF level, quality, distance) as well as network directed criteria (e.g. current traffic loading per cell, maintenance requests, etc.). In order to determine if a handover is required, due to RF criteria, the MS shall take radio measurements from neighboring cells. These measurements are reported to the serving cell on a regular basis.

Additionally, the handover decision by the network may take into account both the measurement results from the MS and network directed criteria. In the case of an ongoing voice group call (GSM 03.68) this criterion only applies to the mobile station currently assigned the uplink and other users with a dedicated connection, and no actions will be taken for the listening users.

V. Averaging and Voting Mechanisms

The handover detection and power control process in the RSS software is responsible for detecting the need for a conncetion to be handed over to another cell. When all the relevant criteria have been met, this process will generate a handoverrecognised message which will contain the information about why the handoveris necessary and the number of qualified neighbors for taking up the new call.This is processed by the SSM and is transmitted via RRSM to pick up the relevant connection identity. On receipt of this message, a timer for that connection is started by the HDPC and no new connection will be entertained until the timer expiresIn most circumstances a handoverwould have been completed before the expiry of the timer and the connection will be deleted from the previous cell.

If the timer were allowed to expire, then the hand off triggering mechanism will begin again and a decision about whether an intercell or an intracell hand off is to be performed is taken. If the handoveris intercell , then the SSM will generate a handoverrecognised message which will be sent to the MSC.When this message is sent, the SSM will start the GSM timerT7 (BSSMAP-17)[7] .While this timer is running, no more handoverrequired message will be sent with reference to the same connection.On expiry of this timer, the SSM may generate another message, but only if a new handoverrecognised message has been received frrom the HDPC. This timer is not a repetition timer, but, a timer that just ensures that the same handoverrequest is not repeated again.This functionality is important as in this elapsed time, the course for handovermay have changed along with the number of qualifed neighbours. One method of performing the handover is the averaging and voting mechanism which is shown in the block diagram (Fig. 3).

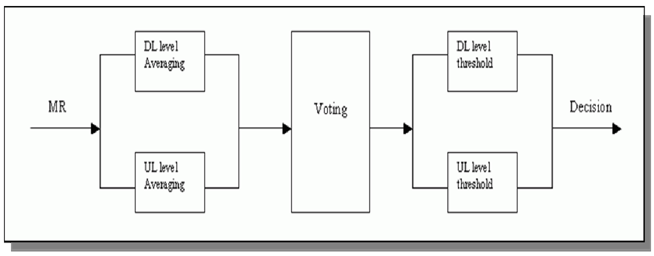


Fig. 3 Block Diagram of Averaging and Voting Mechanism

Here the radio and the network criteria parameters namely the uplink and down link signal quality, uplink and downlink received signal level, surrounding cells downlink quality and timing advances are considered. The Measurement Report (MR) sent by the Mobile Station once in every 480ms consists of samples of information regarding the variation in the network and radio parameters. These samples represented as DLRxLe (Down link received signal level) are averaged as shown in the Fig. 4 [8].

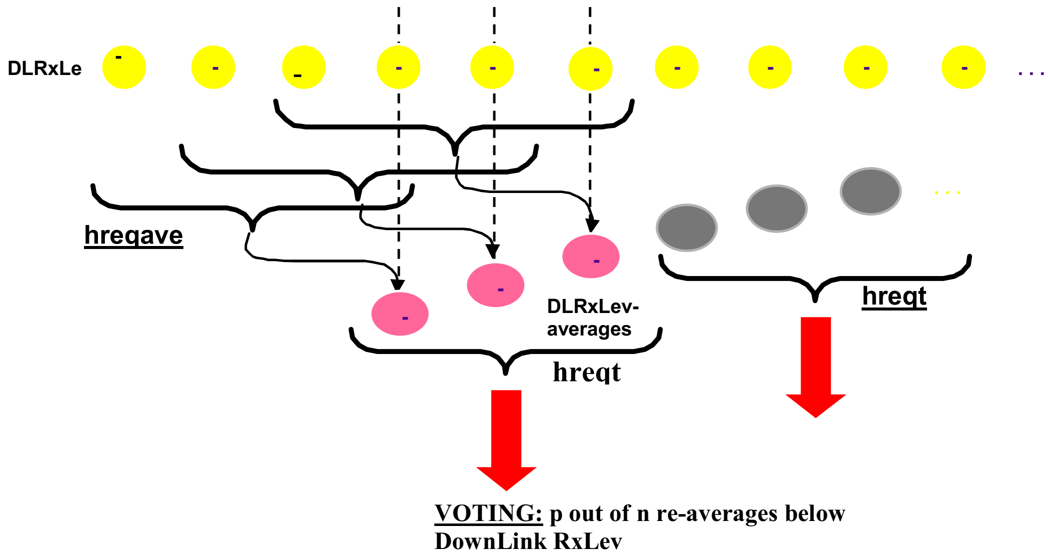


Fig. 4 Averaging of Sampled Parameters

Each parameter is considered at least twice to ensure that the degradation on the quality of a parameter is not momentary but due to the Mobile Station actually moving away from the serving Base Station. The averaged values are represented as hreqave or 'n', which represents the number of BSS produced averages required for a decision to be made .These N values are further averaged to obtain hreqt or 'p', a value that is compared with the threshold value to cause a positive trigger to handoff.

V. Conclusion

Optimization in radio resource is needed because of inaccuracy of radio planning, implementation due to antenna radiation pattern and its distortion, or due to the environmental changes like new highways, new buildings and seasonal changes. Optimization can be provided for good coverage, good handover behavior and also good quality of air interface in a call, with respect to traffic distribution which should also be good for the maximum amount of traffic that can be handled.

As a future course of work, more importance can be given to the QoS issues where in more number of radio and network parameters are taken into consideration for averaging the threshold values. This ensures that a handover can be hastened or delayed as the situation requires and also prevent unnecessary handover that may take place due to momentary fading of any one of the parameter. Hastening the handover ensures that a call is not dropped due to non availability of resources. Handover delayed ensures that unnecessary handover does not take place leading to loading of the base station.

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