**Title: Methods of optimizing handoff hysteresis values in a cellular telecommunication network**

Inventors: Ali Shah, Plano, TX (US);

Hossam Hmimy, Plano, TX (US)

Date Jun. 7, 2002

**OTHER PUBLICATIONS**

Senadji B et al: “Estimation of the Hysteresis Value for Handover Decision Algorithms Using Bayes Criterion” Pro ceedings of ICICS. International Conference on Information Communications and Signal Processing, XX, XX, pp. 1771-1775, XP002076868 the whole document.

1. **Problem statement**

However, every MS is affected in the particular cell when the automated hysteresis value is determined and set. If the hysteresis value is not optimized, the network’s handoff performance is adversely affected. For MSs experiencing severe handoff oscillation problems, this trade-off may be acceptable. However, all MSs are not uniformly affected by oscillating handoffs. This creates unbalanced handoff bor- ders and excessive interference, requiring that the value of the hysteresis be set higher, thereby further degrading hand- off performance for all MSs in the cell.

In order to overcome the disadvantage of existing solutions, it would be advantageous to have a method of optimizing the automated hysteresis value in a cellular network. The present invention provides such a system and method.

1. **Objectives**
   1. General Objectives

The method of optimizing handoff hysteresis values in a cellular telecommunications network.

* 1. Specific Objectives
* Optimizing the SS method ,handoff border by subtracting from the current hysteresis value.
* Optimizing An amount approximately equal to the difference between the midpoint
* Optimizing the average SS measurement from the present cell.

1. **Data used (including its type-Quantitative and qualitative)**

Calculate recommended hysteresis

Using CP, EP and current hysteresis

Specify default hysteresis

MS Measures SS from present cell before handoff

d

MS Measures SS from neighbor cell after handoff handoff

is recommended hysteresis default hysteresis

yes

Sufficient Measurements?

NO

NO

Use default hysteresis

Is SS for present cell < threshold 1 ,and SS for Neighbor cell > threshold 2 ?

yes

Calculate CP: CP means for average SS on the present Cell

yes

Calculate CN: CN means for average SS on the neighbor Cell

Calculate Midpoint SS using CP and CN. Midpoint=

Adjust hysteresis based on calculated Midpoint\_ ss

Calculate EN using Midpoint SS

is the step size the MS output power (typically about 4 dB)

Calculate EP using Midpoint SS

is an adjustment factor account for rounding error

NO

Adjust hysteresis based on measured\_ SS

Fine Tune Hysteresis

?

Yes

NO

* In one aspect, the present invention is directed to a method in a cellular telecommunications network for optimizing a handoff border between a present cell and a neighbor cell.
* The method optimizes a current hysteresis value utilized to ensure that a mobile station (MS) is receiving a stronger signal from the neighbor cell than the present cell before a handoff is performed from the present cell to the neighbor cell.
* A midpoint SS is then calculated by determining an average SS measurement from the present cell, an average SS measurement from the neighbor cell, and an overall average of the average SS measurement from the present cell and the average SS measurement from the neighbor cell.
* In another aspect, the present invention is directed to a method of optimizing an outgoing hysteresis value utilized for controlling handoff of an MS from a present cell to a neighbor cell at a handoff border in a cellular telecommunications network.
* The steps of determining a current outgoing hysteresis value, and
* Collecting a plurality of SS measurements taken by a plurality of MSs operating near the handoff border.

The SS measurements include

* a first SS measurement of a signal received by the mobile station from a first base station serving the present cell
* a second SS measurement of a signal received by the mobile station from a second base station serving the neighbor cell.
* The SS measurements are then utilized to calculate an average SS on the present cell side of the handoff border (CP), and an average SS on the neighbor cell side of the handoff border (CN).

In yet another aspect, the present invention is directed to a method in a cellular telecommunications network .

The method includes

* the steps of determining a current incoming hysteresis value
* and collecting a plurality of SS measurements taken by a plurality of MSs operating near the handoff border.

1. **Method of data analysis**

It is thus believed that the operation and construction of the present invention will be apparent from the foregoing description. While the method shown and described has been characterized as being preferred, it will be readily apparent that various changes and modifications could be been characterized as being preferred, it will be readily apparent that various changes and modifications could be made therein without departing from the scope of the invention as defined in the following claims.

What is claimed is:

1. a handoff A method in a cellular telecommunications network of optimizing border between a present cell and a neighbor cell, said method comprising the steps of:

* determining a current hysteresis value utilized to ensure that a mobile station (MS) is receiving a stronger signal from the neighbor cell than the present cell before a handoff is performed from the present cell to the neighbor cell, said stronger signal being stronger by the hysteresis value;
* collecting pairs of signal strength (SS) measurements from a plurality of MSs operating near the handoff border, each SS measurement pair including an SS measurement from the present cell prior to a handoff and an SS measurement from the neighbor cell follow- ing the handoff;
* calculating a midpoint SS by determining an average SS measurement from the present cell, an average SS measurement from the neighbor cell, and an overall average of the average SS measurement from the present cell and the average SS measurement from the neighbor cell; and
* optimizing the handoff border by subtracting from the current hysteresis value, an amount approximately equal to the difference between the midpoint SS and the average SS measurement from the present cell.

1. The method of optimizing a handoff border of claim 1 further comprising repeating the steps of claim 1 utilizing SS measurements from a greater number of MSs.
2. A method in a cellular telecommunications network of optimizing an outgoing hysteresis value utilized for control- ling handoff of a mobile station from a present cell to a neighbor cell at a handoff border, said method comprising the steps of:

* determining a current outgoing hysteresis value; collecting a plurality of signal strength (SS) measurements taken by a plurality of mobile stations operating near the handoff border.
* calculating an average SS on the present cell side of the handoff border (CP).
* calculating an average SS on the neighbor cell side of the handoff border (CN.
* calculating a midpoint SS between the present cell and the neighbor cell by calculating an average of CP and CN.
* calculating an expected signal strength on the present cell side of the handoff border following the handoff (EP) by subtracting a factor due to rounding errors from the

midpoint SS; and

* calculating a recommended hysteresis value for outgoing handoffs from the present cell to the neighbor cell by subtracting from the current outgoing hysteresis value, the difference between EP and CP.

1. The method of optimizing an outgoing hysteresis value of claim 3 further comprising updating the outgoing hysteresis value by repeating the steps of claim 1 utilizing the most recent SS measurements from MSs in the present cell.
2. The method of optimizing an outgoing hysteresis value of claim 3 further comprising fine tuning the outgoing hysteresis value by repeating the steps of claim 1 utilizing SS measurements from all of the MSs operating in the present cell.
3. The method of optimizing an outgoing hysteresis value of claim 3 further comprising the steps of:

* determining whether the recommended hysteresis value is less than or equal to a default hysteresis value; and
* upon determining that the recommended hysteresis value is less than or equal to the default hysteresis value, utilizing the default hysteresis value to control handoff...

1. The method of optimizing an outgoing hysteresis value of claim 3 further comprising the steps of:

* determining whether the SS for the present cell is below a predefined threshold for weak signal strength while the SS for the neighbor cell is above a predefined threshold for strong signal strength; and
* adjusting the current hysteresis value based on the calculated midpoint SS, upon determining that the SS for the present cell is below the weak SS threshold and the SS for the neighbor cell is above the strong SS threshold.

1. The method of optimizing an outgoing hysteresis value of claim 7 further comprising adjusting the current hysteresis value based on the measured SS, upon determining that either the SS for the present cell is above the weak SS threshold or the SS for the neighbor cell is below the strong SS threshold.
2. A method in a cellular telecommunications network of optimizing an incoming hysteresis value utilized for con- trolling handoff of a mobile station from a neighbor cell to a present cell at a handoff border, said method comprising

the steps of:

* determining a current incoming hysteresis value; collecting a plurality of signal strength (SS) measurements taken by a plurality of mobile stations operatingnear the handoff border.
* calculating an average SS on the present cell side of the handoff border (CP).
* calculating an average SS on the neighbor cell side of the handoff border (CN).
* calculating a midpoint SS between the present cell and the neighbor cell by calculating an average of CP and CN.
* calculating a recommended hysteresis value for incoming handoffs from the neighbor cell to the present cell by subtracting from the current incoming hysteresis value ,the difference between EN and CN.

1. A method in a cellular telecommunications network of optimizing outgoing and incoming hysteresis values utilized for controlling when a mobile station is handed off between a present cell and a neighbor cell at a handoff border, said55 method comprising the steps of:

* determining a current outgoing hysteresis value; determining a current incoming hysteresis value.
* calculating an average SS on the present cell side of the hando8 border (CP).
* calculating an average SS on the neighbor cell side of the hando8 border (CN).
* calculating a midpoint SS between the present cell and the neighbor cell by calculating an average of CP and CN.
* calculating an expected signal strength on the present cell side of the hando8 border following the handoff (EP).
* calculating an expected signal strength on the neighbor cell side of the hando8 border following the handoff(EN).
* calculating a recommended hysteresis value for outgoing handoffs from the present cell to the neighbor cell by subtracting from the current outgoing hysteresis value, the difference between EP and CP; and hando8s from the neighbor cell to the present cell by subtracting from the current incoming hysteresis value, the difference between EN and CN.

**Weakness of the Articles are:**

* Such exaggerated weakness It doesn't exist, but we think that there is a certain problem with the Flow chart, and the problem is that it is repeated.
* Second, when preparing the flowchart, the steps are written in capital letters, which can be tedious to understand.
* Thirdly, the message on the text and the flow chart will be repetitive The flow chart could have been clearer.

**The strong side of the article**

* Although the text is repetitive, it is better in terms of clarity

1. **Results**

FIG. 1A are a flow chart illustrating the steps of the preferred embodiment of the method of the present invention for optimizing hysteresis values for a given cell.

The method utilizes signal strength measurements obtained from all of the MSs in the cell via the Mobile Switching Center (MSC) or Base Station Controller (BSC).

Based on these measurements, a midpoint algorithm optimizes the handoff border by calculating the best possible hysteresis values for outgoing and incoming handoffs.

The method may also modify the calculated hysteresis values in order to balance the traffic load in each cell, or to delay handoffs due to low handoff effectiveness as a result of congestion or interference.

1. **Conclusion**

The values in Cellular Telecommunications Network optimized by the method such as: then optimizes the handoff border by subtracting from the current hysteresis value, an amount approximately equal to the difference between the midpoint SS and the average SS measurement from the present cell