

Innovation-09

1. Brief Name of the Innovation:

Energy and QoS Aware FUZZY-TOP Vertical Handover Mechanism for Heterogeneous Wireless Networks (WP3)

2. Contact Information:

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3. What is the technology?

Energy efficient and QoS based vertical handover mechanism to ensure the seamless mobility in heterogeneous wireless networks.

4. What does the technology do?

This technology provides energy efficient and QoS guarantee based network selection for the mobile user during vertical handover in heterogeneous wireless networks.

5. Explain the specific problem this technology has created to address or solve

As the mobile user is always expecting better QoS for the services it uses such as rich multimedia applications (IPTV) and real time services (VOIP), guaranteeing the QoS for the user, needs efficient handover mechanism in heterogeneous wireless networks. As well as mobile devices are energy constrained providing energy efficient solution for the handover in heterogeneous wireless networks is a challenging problem. This technology addresses both the problems and provides a unified solution to make the vertical handover decision in heterogeneous wireless networks.

6. Why is it better? How much better?

As our technology is compared in terms of the performance with the existing state-of-the art solutions it is better solution for the problem. Qualitatively we can say that our technology is much better than others in terms of energy efficiency. Even our technology is much better compared to others in terms of QoS such as delay, jitter, BER. Whereas in terms of bandwidth it gives moderate performance compared to others. So, as an overall basis our technology is much better than the existing solutions for the vertical handover mechanism in heterogeneous wireless networks. As our technology makes use of combined fuzzy logic and TOPSIS properties to evaluate the best network, during the handover in heterogeneous wireless networks, it provides better mechanism to decide to handover.

7. Have you filed for Intellectual Property (IP)? Have Patent Cooperation Treaty (PCT) applications filed?

Yes, we already started the filing process. Complete specification of patent draft is done. Filing of the patent application is under process. We have yet to receive the filing number.

8. What is the development stage of this innovation?

Development of the technology is already done. We still have to better fine tune the technology in terms of other performance parameters.

9. Have any prospective users or buyers shown interest in this technology?

No, we have not yet reached the community as our patent filing is still under process.

10. Who do you consider competitors or competing technology?

Technology / solution providers such as Samsung, Ericsson, Huawei, Cisco etc.

11. List the milestones remaining to be accomplished to bring your technology to full development and ready for the intended end-user?

Prototype demonstration of the technology in a real telecom networking environment needs to be accomplished to full development and ready for the end-user.

12. Broad Technical Specifications

| QoS and Traffic Classes | BER | E2Edelay | Jitter | Bandwidth |
|--------------------------------|-----------------|-------------------------|-----------------|---------------------------|
| Conversational | Need not be Low | Should be Low | Should be Low | Need not be High |
| Streaming | Need not be Low | Should be Low or Medium | Should be Low | Should be High |
| Interactive | Should be Low | Medium or Low | Need not be Low | Need not be High |
| Background | Should be Low | Need not be Low | Need not be Low | Should be Medium at least |

Table-1: QoS (Quality of Service) requirements and traffic classes where the QoS parameters: BER, E2Edelay, Jitter, Bandwidth; and Traffic Classes: Conversational, Streaming, Interactive, Background.

| Conversational | | | | |
|----------------|----------|-----------|-------------------|---------------|
| Rule No. | E2Edelay | Jitter | Power Consumption | Handoff score |
| 1 | VeryLow | VeryLow | VeryLow | VeryHigh |
| 25 | VeryLow | VeryHigh | VeryHigh | VeryLow |
| 50 | Low | VeryHigh | VeryHigh | Low |
| 75 | Medium | VeryHigh | VeryHigh | Low |
| 100 | High | VeryHigh | VeryHigh | VeryLow |
| 125 | Low | VeryHigh | VeryHigh | VeryLow |
| Streaming | | | | |
| Rule No. | Jitter | Bandwidth | Power Consumption | Handoff score |
| 1 | VeryLow | VeryLow | VeryLow | High |
| 25 | VeryLow | VeryHigh | VeryHigh | VeryHigh |

| | | | | |
|-------------|----------|-----------|-------------------|---------------|
| 50 | Low | VeryHigh | VeryHigh | VeryHigh |
| 75 | Medium | VeryHigh | VeryHigh | VeryHigh |
| 100 | High | VeryHigh | VeryHigh | VeryHigh |
| 125 | VeryHigh | VeryHigh | VeryHigh | VeryHigh |
| Interactive | | | | |
| Rule No. | BER | E2EDelay | Power Consumption | Handoff score |
| 1 | VeryLow | VeryLow | VeryLow | VeryHigh |
| 25 | VeryLow | VeryHigh | VeryHigh | VeryLow |
| 50 | Low | VeryHigh | VeryHigh | VeryLow |
| 75 | Medium | VeryHigh | VeryHigh | VeryLow |
| 100 | High | VeryHigh | VeryHigh | VeryLow |
| 125 | VeryHigh | VeryHigh | VeryHigh | VeryLow |
| Background | | | | |
| Rule No. | BER | Bandwidth | Power Consumption | Handoff score |
| 1 | VeryLow | VeryLow | VeryLow | Medium |
| 25 | VeryLow | VeryHigh | VeryHigh | Medium |
| 50 | Low | VeryHigh | VeryHigh | Medium |
| 75 | Medium | VeryHigh | VeryHigh | Medium |
| 100 | High | VeryHigh | VeryHigh | Medium |
| 125 | VeryHigh | VeryHigh | VeryHigh | Medium |

Table-2: Sample fuzzy rule base for illustrating the mechanism depicted in Fig. 6

| | UMTS | GPRS | WLAN |
|------------------------|--|--------------------------------------|---------------------------|
| Bandwidth (kbps) | [32, 64, 128, 256, 512, 1024, 2048] | [21, 42, 64, 85, 107, 128, 149, 171] | [1000, 2000, 5500, 11000] |
| E2Edelay (msec) | [190, 160, 130, 100, 70, 40, 10] | [185, 160, 135, 110, 85, 60, 35, 10] | [160, 110, 60, 10] |
| Jitter (msec) | [3, 5, 7, 9, 11] | | |
| BER | [0.01, 0.001, 0.0001, 0.00001, 0.000001] | | |
| Power consumption (mW) | [2000, 900, 800, 40] | [1000, 450, 400, 20] | [1100, 555, 18.8] |

Table-3: Networks with their QoS and power consumption parameter values used for illustrating the proposed mechanism where networks are UMTS, GPRS, and WLAN.

| | BER | Delay | Jitter | Bandwidth | Power Consumption |
|-----------------------|---------------|---------------|---------------|---------------|-------------------|
| Conversational | 0.0416 | 0.3269 | 0.3269 | 0.0416 | 0.2629 |
| Streaming | 0.0324 | 0.0798 | 0.2989 | 0.2989 | 0.2906 |
| Interactive | 0.5548 | 0.1366 | 0.0356 | 0.1366 | 0.1366 |
| Background | 0.5650 | 0.0435 | 0.0435 | 0.1735 | 0.1735 |

Table-4: QoS, and Power consumption values with their relative importance weights for Conversational, Streaming, Interactive, and Background kind of traffics. These weights are derived using AHP (Analytical Hierarchical Processing).

13. Diagram or Pictures if any (submitted as a separate file)