Hetergenous Wireless Networks

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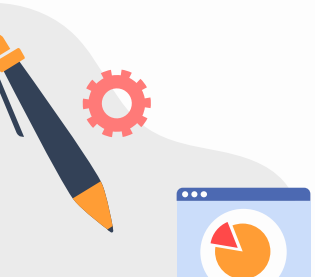


Abstract

Unified Connectivity: Exploring the World of Heterogeneous Wireless Networks

Hetergenous Wireless Networks refers to a network architecture that integrates different types of wireless networks, such as celluar networks, Wi-Fi, satellite communication, and Bluethooth, into a signle integrated system. This integration allows for more efficient use of resources, improved coverage, and enchanced connectivity speeds.

This integrated system enable devices to switch between different types of networks without any effort, ensuring that users always have the best possible connection based on their location a the network conditions. The concept of Hetergenous wireless networks also plays key role in development of next-generation wireless technologies(Such as 5G).

Literature Survey

This Literature Survey on heterogenous wireless networks explore various types, methods and mechanisms that enables these networks to provide seamless connectivity and efficient communication.

Types Of Networks in HWNs:

1. **Cellular Networks -** 4G, 5G, Wide-area coverage and high speed data services.
2. **Wi-Fi Networks –** Local area connectivity, High speed internet access.
3. **Satellite Communication –** Global Coverage, useful in remote areas (Ex: Starlink)

Methods For Integration in HWNs:

1. **Single Attribute Based Mechanism:** This Mechanism is a decision-making approach where decisions are made based on evaluating on single arrtibute such as, Signal strength, Bandwidth etc.
2. **Multi Attribute Based Mechanism:** Multi-attribute based decision making involves evaluating and comparing options based on several different attributes simultaneously. This approach depends on multiple factors, each contributing to the overall value.

    1. **Fuzzy Logic**
    2. **Analytic Hierarchy Process (AHP)**

Fuzzy Logic: Fuzzy Logic is a method that resembles human reasoning. It deals with reasoning that is approximate rather than fixed or exact. Unlike traditional Boolean logic where variables may only be 0 or 1 and True or False, Fuzzy logic variables may have a truth in handling between 0 and 1, representing the degree of truth.

Analytic Hierarchy Process (AHP): AHP is a structured technique for organizing and analyzing complex decision, based on ranking and psychology. It makes decision making easy as it breaks down a complex problem into hierarchy of simple sub-problems. AHP is very useful in planning, selection etc.

Mechanisms for Efficient Communication

Handover Mechanisms

Enable Devices to seamlessly switch between different network types

Resource Allocation

Dynamically allocate network resources to meet the user demands.

Load Balancing

Distributes network traffic evenly across all network types to prevent overloading.

Quality of Service (Qos)

Prioritizes network traffic to ensure important applications receive the bandwidth and speed for optimal performance

Energy Efficiency Management

Reducing the power consumption of network devices and operations while maintaining performance and service quality

Security Protocols

Addressing the divesre security challenges of integrating multiple networks types, data integrity etc.

Simulation

Simulation 1

HWNs Network Selection Using Fuzzy Logic

To Simulate the Network Selection between two Heterogenous wireless Networks we have used “**MATLAB”**

Pre-Set Fuzzy Logic rules in the Matlab simulation code:

```
rules = [
    "If signalStrengthA is strongA and bandwidthA is highA then network is NetworkA"
    "If signalStrengthB is strongB and bandwidthB is highB then network is NetworkB"
    "If signalStrengthA is weakA and bandwidthA is lowA and signalStrengthB is weakB and bandwidthB is lowB then network is NetworkB"
    % Default rules for when both networks have weak signals
    "If signalStrengthA is weakA and signalStrengthB is weakB then network is NetworkB"
    % Default rules for when both networks have strong signals
    "If signalStrengthA is strongA and signalStrengthB is strongB then network is NetworkA"
];
```

HWNs Network Selection Using Fuzzy Logic

Membership Functions of Fuzzy interface system (FIS):

For Signal Strength:

1. Weak (weakA, weakB) – 0 to 70, with full weak from 0 to 30
2. Strong (strongA, strongB) – 30 to 100, with full strong from 70 to 100

For Bandwidth:

1. Low (lowA, lowB) – 0 to 80, with full low from 0 to 20
2. High (HighA, HighB) – 20 to 100, with full high from 80 to 100

HWNs Network Selection Using Fuzzy Logic

Result:

```
Time: 84, Signal Strength A: 1, Bandwidth A: 99, Signal Strength B: 16, Bandwidth B: 10, Selected Network: 2
Time: 85, Signal Strength A: 37, Bandwidth A: 20, Signal Strength B: 49, Bandwidth B: 34, Selected Network: 2
Time: 86, Signal Strength A: 96, Bandwidth A: 92, Signal Strength B: 5, Bandwidth B: 74, Selected Network: 1
Time: 87, Signal Strength A: 27, Bandwidth A: 42, Signal Strength B: 55, Bandwidth B: 95, Selected Network: 2
Time: 88, Signal Strength A: 42, Bandwidth A: 99, Signal Strength B: 30, Bandwidth B: 70, Selected Network: 2
Time: 89, Signal Strength A: 67, Bandwidth A: 54, Signal Strength B: 70, Bandwidth B: 67, Selected Network: 1
Time: 90, Signal Strength A: 17, Bandwidth A: 12, Signal Strength B: 100, Bandwidth B: 17, Selected Network: 2
Time: 91, Signal Strength A: 3, Bandwidth A: 56, Signal Strength B: 89, Bandwidth B: 67, Selected Network: 2
Time: 92, Signal Strength A: 19, Bandwidth A: 37, Signal Strength B: 46, Bandwidth B: 99, Selected Network: 2
Time: 93, Signal Strength A: 15, Bandwidth A: 86, Signal Strength B: 65, Bandwidth B: 38, Selected Network: 2
Time: 94, Signal Strength A: 19, Bandwidth A: 43, Signal Strength B: 48, Bandwidth B: 12, Selected Network: 2
Time: 95, Signal Strength A: 59, Bandwidth A: 22, Signal Strength B: 38, Bandwidth B: 58, Selected Network: 1
Time: 96, Signal Strength A: 25, Bandwidth A: 29, Signal Strength B: 62, Bandwidth B: 26, Selected Network: 2
Time: 97, Signal Strength A: 83, Bandwidth A: 99, Signal Strength B: 73, Bandwidth B: 34, Selected Network: 1
Time: 98, Signal Strength A: 58, Bandwidth A: 10, Signal Strength B: 91, Bandwidth B: 88, Selected Network: 1
Time: 99, Signal Strength A: 82, Bandwidth A: 26, Signal Strength B: 60, Bandwidth B: 2, Selected Network: 1
Time: 100, Signal Strength A: 42, Bandwidth A: 31, Signal Strength B: 16, Bandwidth B: 18, Selected Network: 2
```

Total 100 iteration, in each iteration there are two networks and one network is selected based on Fuzzy logic pre-set rules as shown above.

Simulation 2

HWNs Network Selection Using Fuzzy Logic

Input Variables:

- delay: Represents delay in network transmission.
- jitter: Indicates the variation in packet delay.
- packLoss: Reflects the percentage of lost packets.
- monetary: Represents the cost factor associated with the network.

Output Variable:

- QI (Quality Index): Indicates the quality level of a given network (1-5)

Fuzzy Inference System (FIS):

- Utilizes membership functions to fuzzify inputs (delay, jitter, packLoss, monetary) and outputs (QI).
- Rules are defined to map specific input conditions to QI values.

HWNs Network Selection Using Fuzzy Logic

Rule base:

```
% Add rules for fuzzy logic
rules = [
    "If delay is low and jitter is low and packLoss is low and monetary is low then QI is great"
    "If delay is low and jitter is low and packLoss is low and monetary is medium then QI is great"
    "If delay is low and jitter is low and packLoss is low and monetary is high then QI is good"
    "If delay is low and jitter is low and packLoss is medium and monetary is low then QI is good"
    "If delay is low and jitter is low and packLoss is high and monetary is medium then QI is bad"
];
```

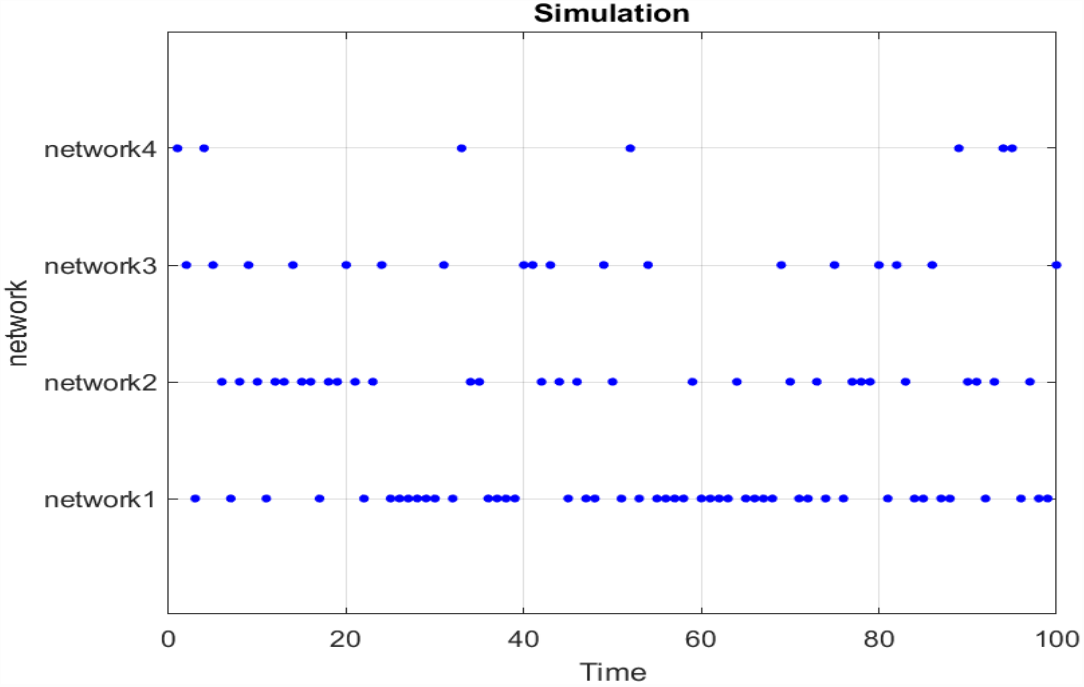
HWNs Network Selection Using Fuzzy Logic

Simulation:

- Random network conditions (delay, jitter, packLoss, monetary) are generated.
- Fuzzy logic is applied to evaluate the network quality (QI) for each of the four network options.
- **The network with the highest QI value is selected.**
- Plots the selected network over time.

HWNs Network Selection Using Fuzzy Logic

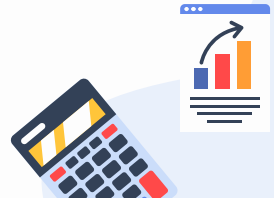
Result:



Conclusion

Summary

- Discussed what is Fuzzy logic
- Took a look at what is heterogenous networking
- Discussed what is handover
- Discussed what are all the problems with handover
- Discussed the parameters of selecting the network
- Discussed the algorithms we proposed



Thank You!!