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AI-Based Wi-Fi Performance Prediction and Intelligent Network Optimization System

(A Proposed Framework)

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***Abstract*—The performance of a Wi-Fi network depends on many interacting factors such as signal strength, interference, channel utilization, traffic load and the number of connected devices. Conventional management is largely static and reactive, so problems are noticed only after users are affected, and prediction and optimization are usually treated as separate tasks. This paper proposes an integrated framework that uses machine learning to predict Wi-Fi performance from measured network parameters, classifies the network condition, and generates optimization recommendations such as channel selection, transmit power adjustment and traffic management. The workflow, input parameters, outputs, system architecture and two algorithms of the framework are described. The work is at the design stage: the architecture and methodology are finalized, while model development and experimental evaluation are planned, and no experimental results are reported in this paper.**

Keywords*—Wi-Fi; IEEE 802.11; performance prediction; machine learning; network optimization; channel selection

I. INTRODUCTION

Wi-Fi is the main way in which homes, campuses and offices connect devices to the Internet, and the number of connected devices and the volume of traffic keep growing. Networks based on IEEE 802.11 are becoming more complex because of dense deployments, many configuration parameters and sharing of the radio spectrum with other networks [1]. As a result, the performance seen by users can change quickly with signal strength, interference, channel utilization and load.

Most Wi-Fi networks are still managed with fixed settings and threshold-based monitoring. Such methods react after performance has dropped and need manual intervention to correct it. Machine learning (ML) can learn the relation between network conditions and performance from data, and many studies have used it to predict throughput, link quality and traffic [1]–[6]. However, prediction and optimization are often studied separately.

This paper proposes an AI-based system that predicts Wi-Fi performance, classifies the current and predicted network condition, and turns the result into optimization recommendations. The contributions are: (1) a problem formulation and research gaps for predictive Wi-Fi management; (2) a workflow and architecture that connect data collection, feature engineering, prediction, condition analysis and optimization in one loop; (3) two algorithms for prediction and optimization; and (4) a plan for implementation and evaluation.

II. RELATED WORK

A recent survey analyzed over 250 papers on improving IEEE 802.11 performance with ML, organized the areas where ML is applied, and listed open challenges [1]. Several studies focus on prediction. Machine learning models such as artificial neural networks, k-nearest neighbors regression and random forest regression were used to predict throughput in dense next-generation WLANs [2]. Artificial neural networks were also used to predict the quality of a Wi-Fi transmission channel, with preliminary results showing higher accuracy than conventional adaptive techniques [3]. A spatio-temporal deep learning methodology predicted a Wi-Fi traffic metric using real measurements from 100 access points over three months, and a hybrid of CNN and RNN performed best in that study [4]. More recently, a comprehensive analysis of prediction models for accurate and efficient Wi-Fi link quality forecasting was presented for industrial environments [6].

On the optimization side, a deep reinforcement learning scheme with graph convolutional networks was proposed for channel allocation in dense WLANs, and its simulation results showed higher system throughput than the compared methods [5]. Table I summarizes the reviewed works. The studies address prediction or optimization of one aspect, such as throughput, link quality, traffic or channel allocation, whereas this paper aims at a single framework that links prediction of overall performance with recommendations for several optimization actions.

TABLE I SUMMARY OF RELATED WORK

Ref.	Year	Focus	Main idea
[1]	2022	Survey	ML for improving IEEE 802.11 performance; over 250 papers; open challenges
[2]	2022	Throughput prediction	ANN, k-NN and random forest regression for dense WLANs
[3]	2021	Link quality prediction	ANN to predict Wi-Fi channel quality
[4]	2024	Traffic prediction	Spatio-temporal deep learning on real measurements from 100 APs
[5]	2020	Channel allocation	Deep reinforcement learning with graph convolutional networks
[6]	2026	Link quality prediction	Comparison of prediction models for accuracy and efficiency

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III. PROBLEM STATEMENT AND RESEARCH GAPS

Wi-Fi performance is affected by the number of connected devices, signal strength, channel utilization, traffic, interference, bandwidth, latency and packet loss. Traditional management is largely static and reactive. The problem addressed here is to develop an AI-based system that predicts Wi-Fi network performance and identifies suitable optimization actions based on current and predicted network conditions. The following research gaps motivate the work:

- Static configuration cannot adapt to changing conditions.
- Reactive monitoring detects problems only after degradation.
- Threshold-based methods have limited adaptability.
- Conventional optimization requires manual intervention.
- Prediction and optimization are often treated separately.

IV. OBJECTIVES AND SCOPE

The objectives of the work are: (1) to collect Wi-Fi network performance data; (2) to preprocess and analyze the data; (3) to identify the features that affect Wi-Fi performance; (4) to develop an AI/ML model for performance prediction; (5) to design an intelligent optimization mechanism; and (6) to evaluate the system with suitable performance metrics. The scope covers Wi-Fi monitoring, performance prediction, network-condition classification, congestion identification, channel analysis, resource optimization, intelligent recommendations and performance evaluation.

V. PROPOSED METHODOLOGY

A. Workflow

The proposed workflow has nine stages: data collection, preprocessing, feature engineering, AI/ML model, performance prediction, condition analysis, intelligent optimization, recommendation, and evaluation. The result of the evaluation is fed back to data collection so that the system can continue to monitor the effect of its recommendations.

B. Input Parameters and Outputs

The model uses nine network parameters, listed in Table II. The outputs are the predicted Wi-Fi performance, a performance level, the network condition (good, moderate or poor), and an optimization recommendation.

TABLE II INPUT PARAMETERS

Parameter	Meaning
RSSI	Received signal strength at the client
SNR	Ratio of signal power to noise power
Throughput	Rate of successful data delivery
Latency	Delay experienced by packets
Packet loss	Share of packets that are not delivered
Channel utilization	Fraction of time the channel is busy
Bandwidth	Channel width available for transmission
Connected devices	Number of clients served by the access point
Traffic load	Amount of traffic carried by the network

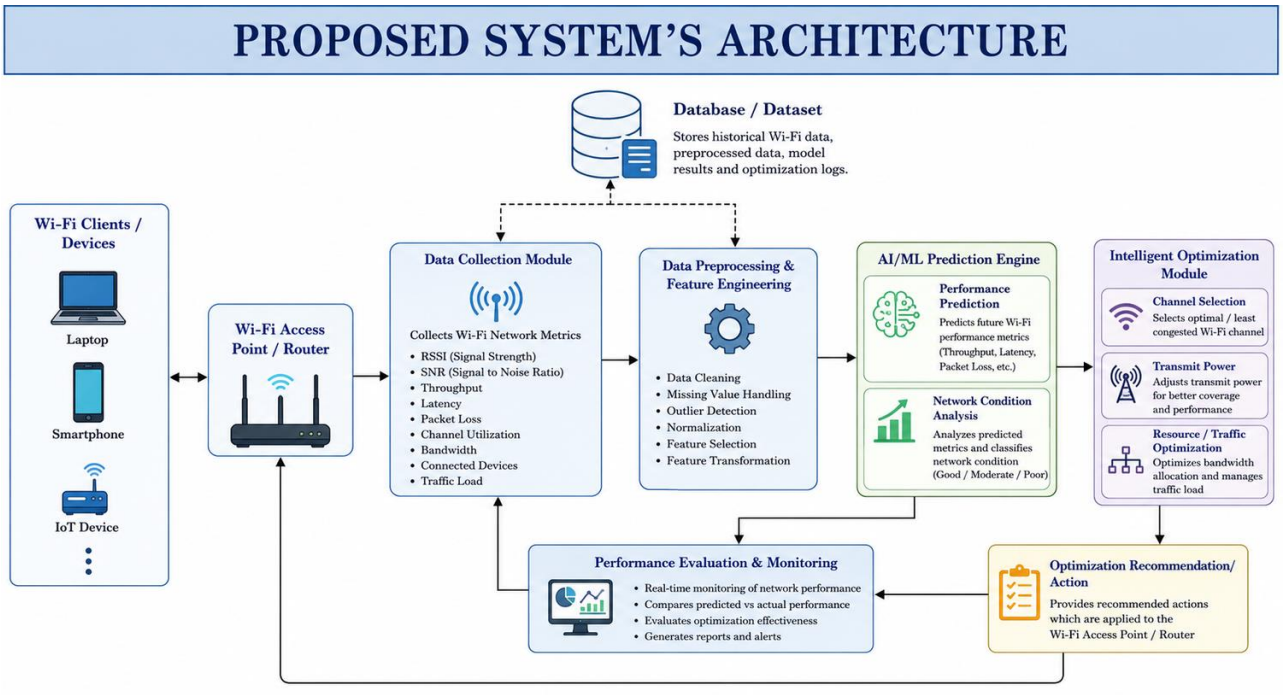


Fig. 1. Proposed system architecture.

VI. SYSTEM ARCHITECTURE

The proposed architecture is shown in Fig. 1. Wi-Fi clients such as laptops, smartphones and IoT devices connect to a Wi-Fi access point or router. The data collection module gathers the network metrics, and the preprocessing and feature engineering module performs data cleaning, missing value handling, outlier detection, normalization, feature selection and feature transformation. A database stores historical data, preprocessed data, model results and optimization logs.

The AI/ML prediction engine has two parts. Performance prediction estimates future metrics such as throughput, latency

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and packet loss, and network condition analysis classifies the predicted condition as good, moderate or poor. The intelligent optimization module then proposes actions in three areas: channel selection, which selects the optimal or least congested channel; transmit power, which is adjusted for better coverage and performance; and resource and traffic optimization, which manages bandwidth allocation and traffic load. The recommended actions are applied to the access point, and the performance evaluation and monitoring module compares predicted and actual performance, evaluates the effectiveness of the optimization, and generates reports and alerts.

VII. ALGORITHMS

A. Algorithm 1: Wi-Fi Performance Prediction

1) Collect network parameters.
2) Clean and preprocess the data.
3) Handle missing and noisy data.
4) Select relevant features.
5) Split the dataset.
6) Train the ML model.
7) Test the model.
8) Evaluate the prediction performance.
9) Generate the predicted performance.

B. Algorithm 2: Intelligent Optimization

1) Monitor network parameters.
2) Predict the network condition.
3) Identify degradation.
4) Analyze possible causes.
5) Generate optimization actions.
6) Evaluate the available actions.
7) Select a suitable action.
8) Generate the recommendation.

VIII. IMPLEMENTATION STATUS AND EVALUATION PLAN

The work is divided into six modules, whose status is given in Table III. The problem definition, architecture, methodology and identification of the network parameters are completed. Development of the AI/ML model is in progress, the optimization module is planned, and testing is scheduled. Model selection and the implementation approach are being planned, and the model type is not fixed in this paper.

TABLE III IMPLEMENTATION STATUS

Module	Plan	Status
Problem definition and literature review	Week 1–2	Completed
System architecture and methodology	Week 3–4	Completed
Dataset and parameter identification	Week 5–6	Completed
AI/ML model development	Week 7–9	In progress
Intelligent optimization module	Week 10–11	Planned
Testing and performance evaluation	Week 12–14	Scheduled

For evaluation, it is proposed to measure prediction quality with the mean absolute error, root mean square error and coefficient of determination for numerical targets, and with accuracy, precision, recall and F1-score for the classification of network condition. The effect of the optimization will be measured by comparing throughput, latency and packet loss before and after the recommended actions are applied, and predicted values will be compared with actual measurements. Standard textbook methods will be followed for preprocessing and for learning [8]–[11]. These metrics are proposed choices, and the results will be reported after the experimental phase.

IX. CONCLUSION AND FUTURE WORK

This paper presented a framework that combines Wi-Fi performance prediction, network-condition classification and optimization recommendations in one monitoring loop. The problem, research gaps, objectives, workflow, architecture and algorithms have been defined. The next phase will collect and preprocess network data, develop and compare ML models, implement the optimization module and evaluate the full system. Future work may also study reinforcement learning for automatic selection of actions [5], [10] and the use of spatial information from neighboring access points [4].

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REFERENCES

[1] S. Szott, K. Kosek-Szott, P. Gawłowicz, J. Torres Gómez, B. Bellalta, A. Zubow, and F. Dressler, “Wi-Fi meets ML: A survey on improving IEEE 802.11 performance with machine learning,” IEEE Commun. Surveys Tuts., vol. 24, no. 3, pp. 1843–1893, 3rd Quart., 2022.

[2] R. Mohan, K. Venkat Ramnan, and J. Manikandan, “Predicting the throughput of next generation IEEE 802.11 WLANs in dense deployments,” Procedia Comput. Sci., 2022, doi: 10.1016/j.procs.2022.07.006.

[3] S. Scanzio, G. Cena, and A. Valenzano, “Predicting Wi-Fi link quality through artificial neural networks,” Internet Technol. Lett., 2021, doi: 10.1002/itl2.326.

[4] S. S. Shaabanzadeh and J. Sánchez-González, “A spatio-temporal prediction methodology based on deep learning and real Wi-Fi measurements,” Comput. Netw., vol. 250, Art. no. 110569, Aug. 2024.

[5] K. Nakashima, S. Kamiya, K. Ohtsu, K. Yamamoto, T. Nishio, and M. Morikura, “Deep reinforcement learning-based channel allocation for wireless LANs with graph convolutional networks,” IEEE Access, vol. 8, pp. 31823–31834, 2020.

[6] G. Formis, G. Cena, L. Wisniewski, and S. Scanzio, “Accurate and efficient prediction of Wi-Fi link quality based on machine learning,” IEEE Trans. Ind. Informat., vol. 22, no. 2, pp. 763–774, Feb. 2026.

[7] J. F. Kurose and K. W. Ross, Computer Networking: A Top-Down Approach, 9th ed. Pearson, 2025.

[8] J. Han, M. Kamber, and J. Pei, Data Mining: Concepts and Techniques, 3rd ed. San Francisco, CA, USA: Morgan Kaufmann, 2011.

[9] C. M. Bishop, Pattern Recognition and Machine Learning. New York, NY, USA: Springer, 2006.

[10] R. S. Sutton and A. G. Barto, Reinforcement Learning: An Introduction, 2nd ed. Cambridge, MA, USA: MIT Press, 2018.

[11] I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning. Cambridge, MA, USA: MIT Press, 2016.

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