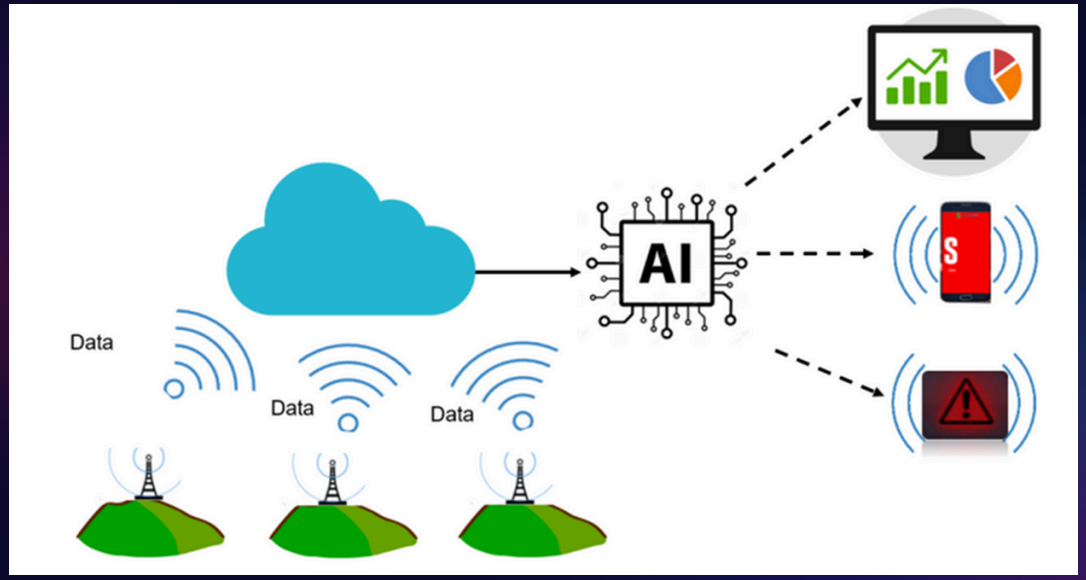
Use ESP32s to Gather Real-Time Meteorological Data

Harnessing the power of ESP32 microcontrollers, we can build a robust system to collect real-time meteorological data, providing valuable insights into the local climate and weather patterns.

Objective

Proposed Solution:

Our solution incorporates a unique Multi-Layered Architecture: This layered approach allows us to tackle cloud burst prediction from both ground-level sensor data and high-altitude satellite observations.



Time Series Model:

Utilizes meteorological data from IMD and Open-Meteo API to analyze historical weather patterns for cloud burst prediction using advanced Time series algorithms like RNN & LSTM.

Real-Time Hardware Data Collection:

Integrates sensors (e.g., DHT22, BMP180) to collect environmental data, which is fed into the time series model for real-time analysis and prediction refinement.

Comprehensive Sensor Suite

Temperature and Humidity

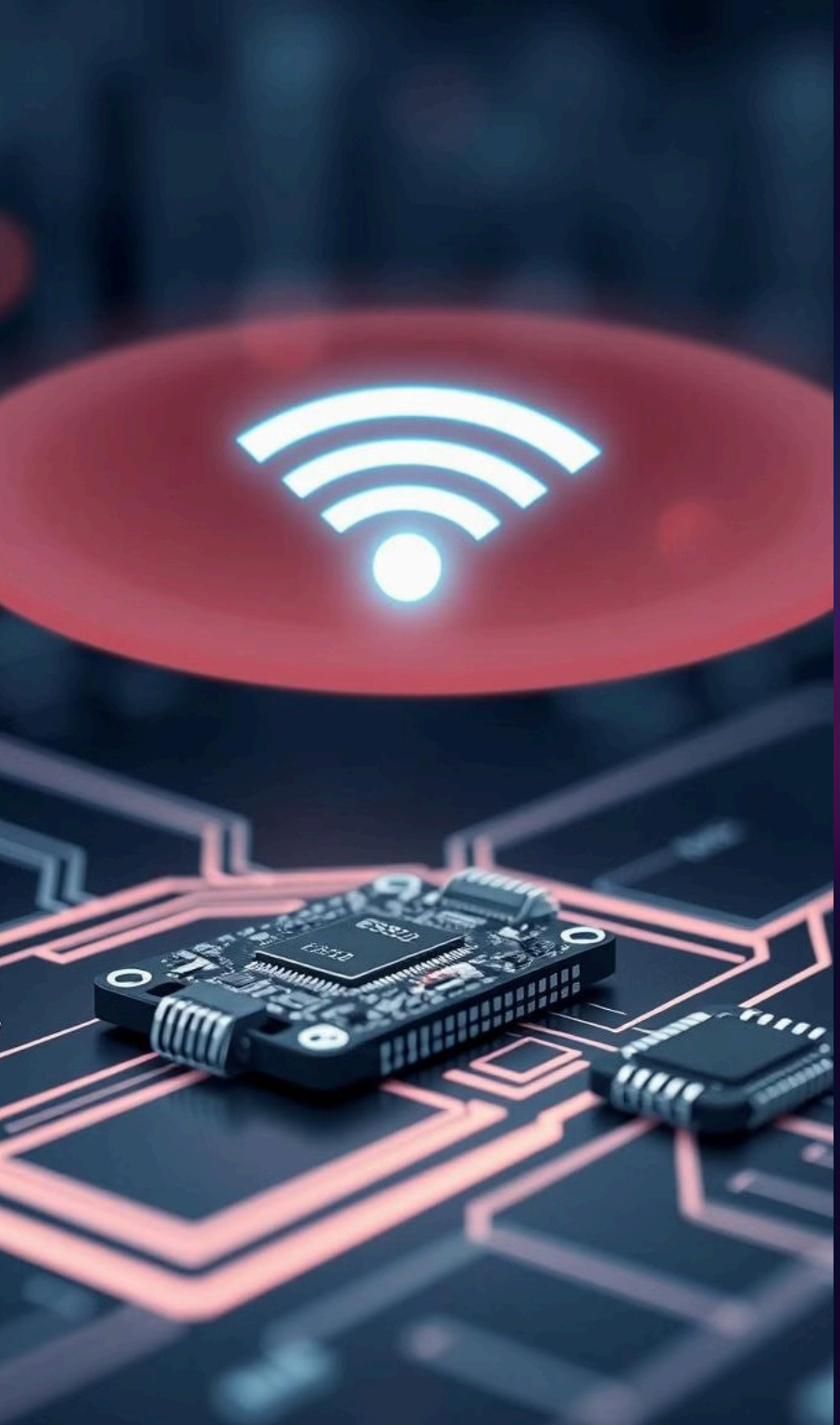
The DHT11 sensor accurately measures temperature and relative humidity, enabling comprehensive environmental monitoring.

Air Quality

The MQ135 air quality sensor tracks changes in air quality, which can indicate incoming weather patterns.

Precipitation

Rain sensor module provide valuable data on precipitation levels.



Reliable Data Transmission

ESP-NOW Protocol

Utilizing the ESP-NOW protocol, the system can reliably transmit data between ESP32 nodes without the need for a central Wi-Fi network.

Cloud Storage

The collected data is securely stored in the Firebase cloud platform, ensuring easy access and long-term retention.

Local Processing

On-board processing on the ESP32 microcontrollers allows for real-time analysis and decision-making at the edge.

Robust Power Supply

Continuous Operation

A reliable power supply, such as a solar panel system and battery bank, ensures uninterrupted data collection and transmission.

Energy Efficiency

Careful power management strategies on the ESP32 microcontrollers optimize energy consumption, maximizing the system's runtime.

Resilience

The robust power supply maintains the system's operation even during periods of inclement weather or grid outages.

Data Visualization and Analy tics

1

Real-Time Monitoring

The web-based dashboard provides live updates on the collected meteorological data, enabling immediate insights and decision-making.

2

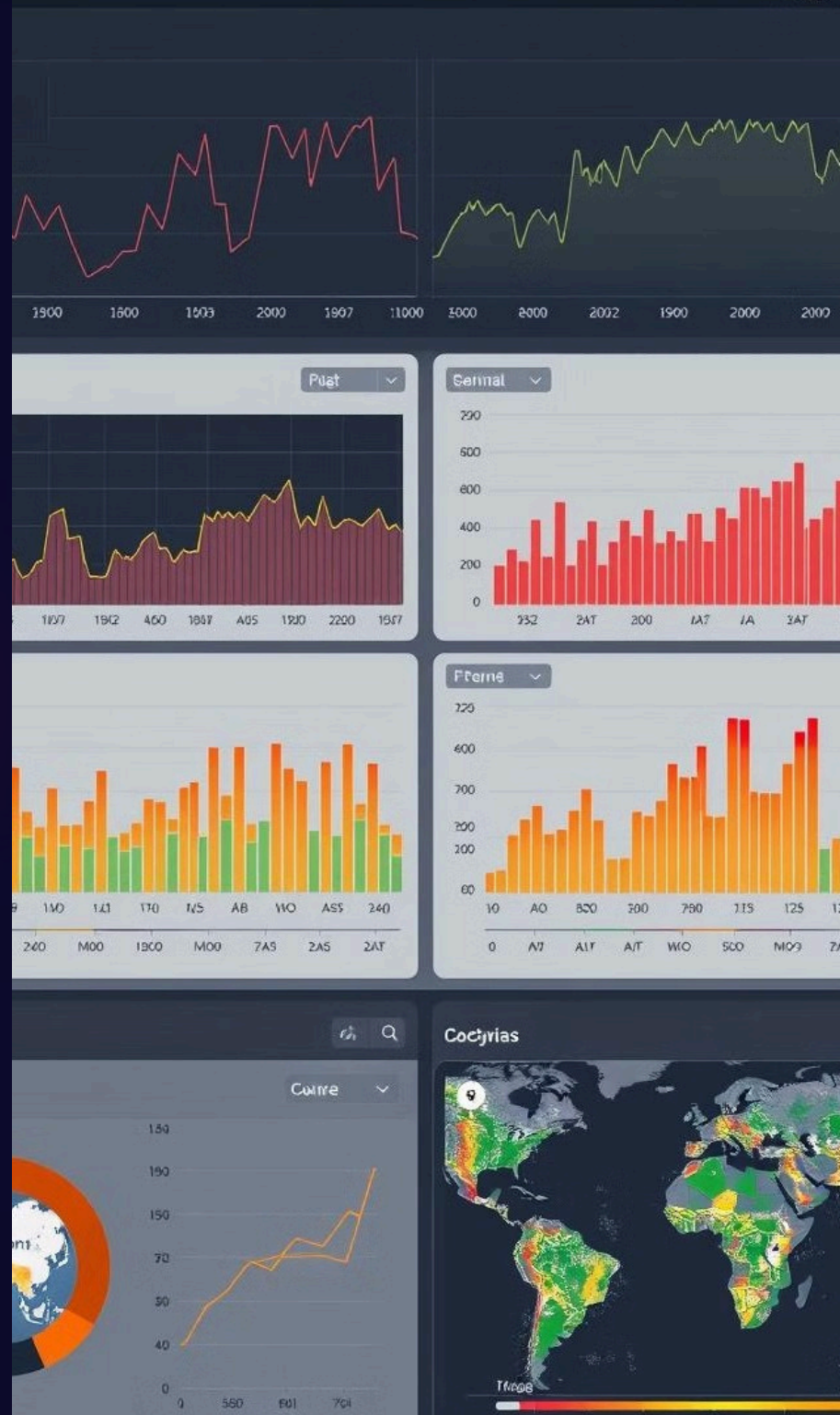
Historical Analysis

Comprehensive data logging in Firebase allows for in-depth analysis of trends and patterns over time.

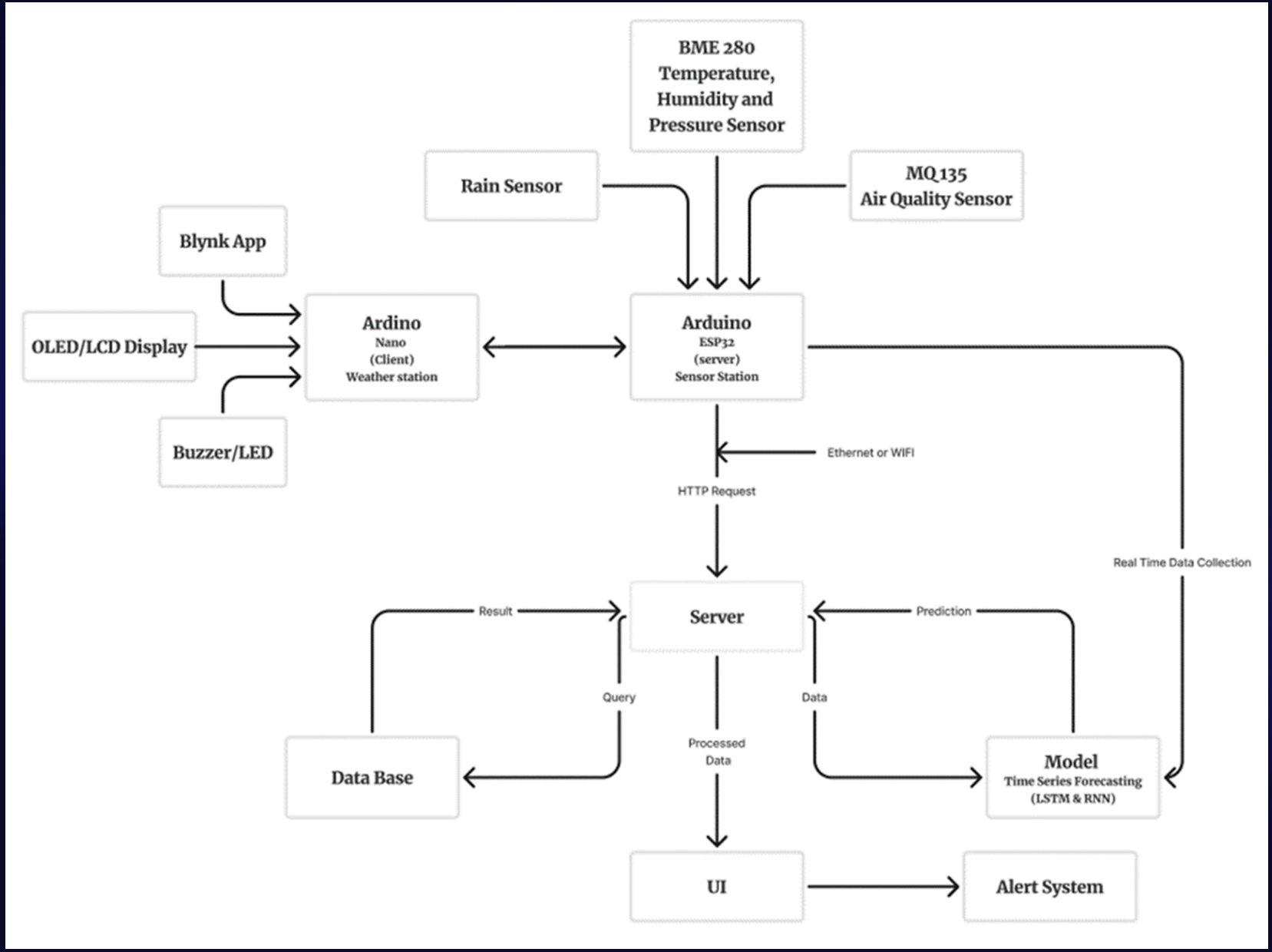
3

Predictive Modeling

Advanced analytics can leverage the real-time and historical data to generate reliable weather forecasts and predictions.



Technical Approach



Scalable and Modular Design

1

Expandable Network

The modular architecture allows for easy expansion, enabling the deployment of multiple ESP32-based weather stations across a wide area.

2

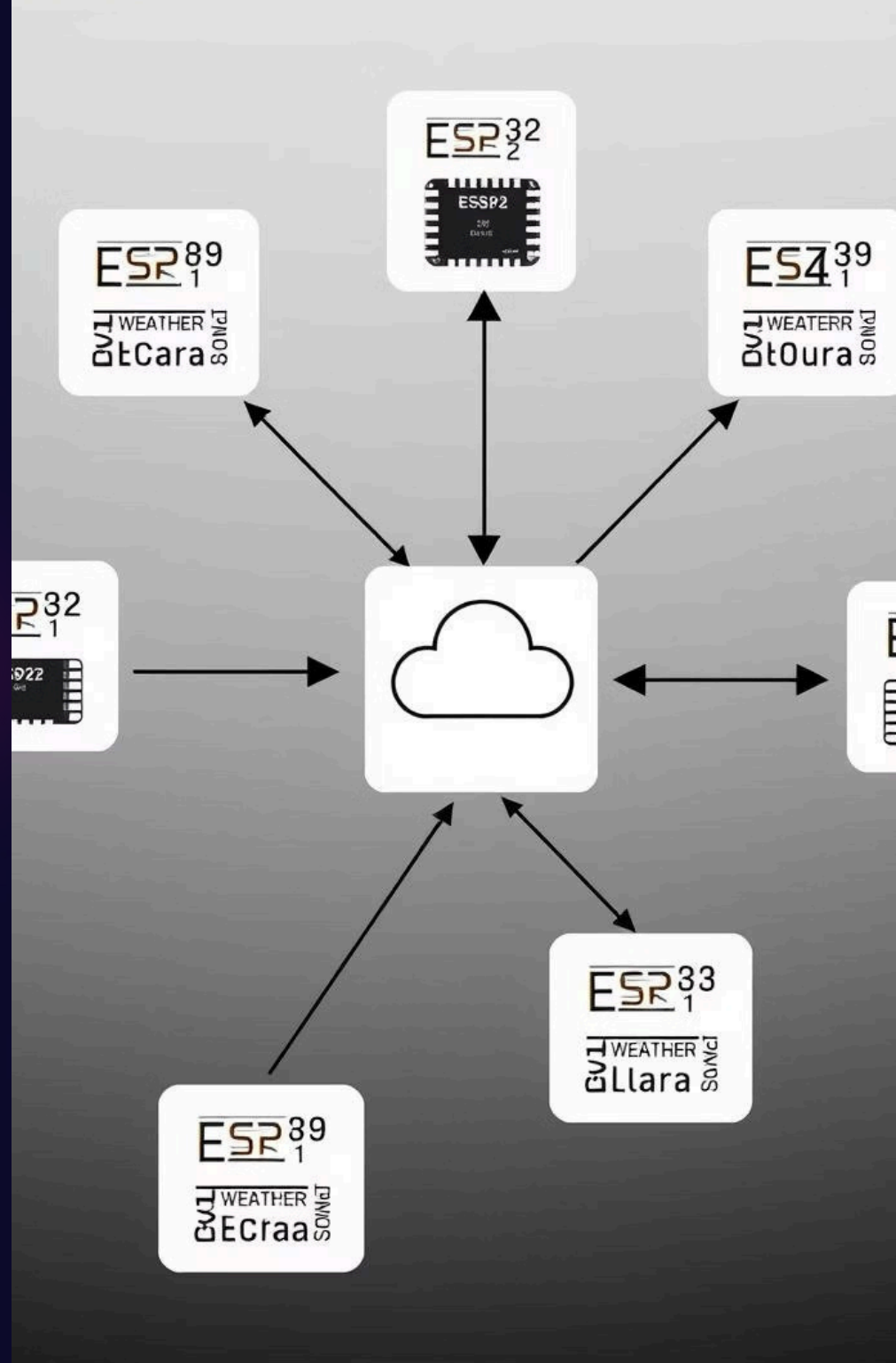
Centralized Management

A central data hub coordinates the data collection, storage, and analysis, providing a unified view of the meteorological information.

3

Cloud Integration

Seamless integration with cloud platforms, such as Firebase, ensures secure storage, remote access, and advanced data processing capabilities.



Innovative Applications

1 **Precision Agriculture**

Farmers can optimize irrigation, pest control, and crop management based on the real-time weather data.

2 **Disaster Preparedness**

Early warning systems can leverage the meteorological data to predict and mitigate natural disasters, such as floods and storms.

3 **Urban Planning**

City planners can use the data to improve infrastructure, transportation, and public safety initiatives based on weather patterns.

Conclusion and Future Considerations

This comprehensive system leverages the power of ESP32 microcontrollers, a diverse sensor suite, and robust data transmission to gather real-time meteorological data. The scalable and modular design, coupled with advanced data visualization and analytics, opens up a world of innovative applications in various industries.