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**ENERGY USAGE OPTIMIZATION**

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Phase 4: Project Performance Summary

**TITLE: ENERGY USAGE OPTIMIZATION**

Objective:Phase 4 is focused on improving the AI-Powered Healthcare Assistants performance, scalability, and energy efficiency. The main aim is to enhance system componentsfrom AI model processing to IoT integrationwhile reducing overall energy consumption. This phase also includes preparing for multilingual support and enforcing strong, efficient security practices.

1. AI Model Performance Optimization

Overview:

The AI symptom-checker is refined not only for improved accuracy but also for reduced energy consumption through model optimization.

Key Enhancements:

* Model Optimization: Techniques like pruning and knowledge distillation are applied to reducemodel complexity and energy use.
* Compact Architectures: Smaller models are adopted to maintain performance while using lesspower.
* Sustainable Compute: Utilization of renewable-powered GPU/TPU cloud environments.

Outcome:

Faster, more energy-efficient diagnostics with reduced carbon footprint.

2. Chatbot Efficiency Improvements

Overview:

Chatbot enhancements target low latency and minimal compute usage.

Key Enhancements:

* Optimized Responses: Use of quantized models for quick, low-energy reply generation.
* Low-Power NLP: Integration of transformer models designed for edge deployment.
* Smart Load Balancing: Dynamically scaling server resources to minimize idle energy usage.

Outcome:

Consistent performance during high demand with reduced energy draw.

3. IoT Integration Enhancements

Overview:

Improving IoT device communication with the system for efficient, low-power operation.

Key Enhancements:

* Edge Computing: Local data filtering reduces the need for continuous cloud communication.
* Smart Polling: Efficient data request mechanisms prevent unnecessary power drain.
* Low-Energy Protocols: Bluetooth Low Energy (BLE) and compression strategies reducetransmission load.

Outcome:

Longer battery life on devices and reduced cloud resource consumption.

4. Security and Privacy Optimization

Overview:

Maintaining strong security protocols without excessive power consumption.

Key Enhancements:

* Lightweight Encryption: Use of fast, energy-saving cryptographic methods.
* Efficient Audit Scheduling: Batch security tasks to avoid continuous processing.
* Eco-Friendly Infrastructure: Hosting in green-certified data centers.

Outcome:

High-level security maintained with minimized environmental impact.

5. Performance and Energy Metrics Collection

Overview:

Tracking not just system speed and responsiveness, but energy metrics too.

Key Enhancements:

* Energy Profiling: Monitoring consumption at each module level.
* Realistic Load Testing: Simulating user activity while measuring energy use.
* Feedback Loops: Data-driven improvements for ongoing energy optimization.

Outcome:

A fully optimized system ready for high-traffic, low-energy deployments.

**Key Challenges & Solutions**

Scaling Efficiently:

* + Challenge: High traffic increases energy needs.
  + Solution: Adaptive resource scaling.

Securing Under Load:

* + Challenge: Security processing adds energy overhead.
  + Solution: Optimize encryption and consolidate operations.

IoT Compatibility:

* + Challenge: Devices vary in power use.
  + Solution: Customized protocols and polling rates.

Outcomes

* + High-accuracy AI with lower energy needs.
  + Fast, efficient chatbot interactions.
  + Power-conscious IoT data handling.
  + Secure systems running in eco-friendly environments.