FALCON-Federated AI Linked Cyber-Operational Network

Terrier Cyber Quest 2025 Official Problem Statements

Challenge 1: Drone Flight Anomaly Detection

- Build predictive models for real-time drone flight anomaly detection
- Use telemetry data: altitude, velocity, yaw, pitch, battery, GPS drift
- Identify malfunction patterns, signal jamming, unauthorized diversions
- Prevent mid-air mission failures and hijack scenarios

Challenge 2: Quantum-Enhanced Malware Detection

- Use quantum machine learning for unknown malware pattern detection
- Predict ransomware deployment from user behavior logs
- Build hybrid classical-quantum AI systems for cybersecurity
- Detect zero-day threats faster than classical methods

Source:

(https://www.pib.gov.in/PressReleasePage.aspx?PRID=2161248)

(https://www.cyberchallenge.in/tcq2025)

Limitations of Current Defense Systems

India's existing defense infrastructure relies primarily on imported systems like the S400, Iron Dome partnerships, and indigenously developed Akash missile systems. However, these systems operate in silos, lacking real-time coordination capabilities essential for modern warfare. The Tactical Command, Control, Communications and Information Tacle system, though advanced, faces implementation delays and integration challenges across diverse military units.

Key limitations :

Reactive Defense Architecture:

Current systems respond to threats after detection, creating critical vulnerability windows.

Isolated Base Operations:

Limited real-time intelligence sharing between military installations.

Single-Threat Focus:

Existing systems excel against specific threats (missiles or aircraft) but struggle with combined attacks Human Decision.

Bottlenecks: Critical response delays due to manual assessment and authorization processes.

Quantum Vulnerability: Current encryption and communication systems lack quantum-safe protocols.

SOLUTION

FALCON Vision, Objectives, and Strategic Impact

Vision Statement

To create India's first quantum-enhanced, federated defense network that transforms individual military bases into an interconnected, intelligent shield capable of learning, adapting, and responding to evolving threats faster than human operators.

Core Objectives

1.Real-Time Threat Detection:

Deploy AI-powered sensors across all major Army bases for instantaneous anomaly detection in air, land, and cyber domains.

2.Federated Learning Implementation:

Enable secure knowledge sharing between bases without raw data exchange, preserving operational security while enhancing collective intelligence.

3. Quantum-Enhanced Security:

Integrate quantum machine learning for advanced threat pattern recognition and quantum key distribution for communication security.

4.Automated Response Coordination:

Establish instant multi-base support mechanisms with AI-driven countermeasure deployment.

5.Continuous System Evolution:

Create self-improving defense capabilities that become stronger after each engagement.

Problem-Solution Matrix

Drone Anomaly Detection

LSTM autoencoders + quantum ML detect flight anomalies in <2 seconds
Only system combining quantum pattern recognition with classical AI.

Quantum Malware Detection

Quantum SVM classifiers identify unknown malware patterns invisible to classical AI.

Uses IBM Qiskit + PennyLane for quantum advantage in threat detection.

Predictive Threat Intelligence

Federated learning across 100+ bases shares insights without raw data
Privacy-preserving collaborative learning - first in military applications

Infrastructure Defense

Automated multi-base coordination with quantum-secure communications.

Real-time coordinated response faster than human decision- making .

FALCON Multi-Layer Defense Architecture

Layer 1: Detection & Sensing

AI-Powered Sensors: LSTM/CNN analysis of radar, satellite, drone feeds

Quantum Enhancement: Quantum kernel methods for subtle pattern recognition

Multi-Domain Monitoring: Air, land, sea, space, cyber domains simultaneously

Layer 2: Federated Processing

Local AI Processing: Independent threat analysis at each base

Secure Aggregation: Privacy-preserving model updates using Flower framework

Quantum ML Module: Advanced pattern recognition for unknown threats

Layer 3: Communication & Coordination

Quantum Key Distribution: Ultra-secure base-to-base communication

Post-Quantum Cryptography: Future-proof encryption protocols

Real-Time Intelligence Sharing: Instant threat updates across network

Layer 4: Response & Learning

Automated Countermeasures: AI-driven defense system activation

Multi-Base Support: Coordinated assistance for bases under attack

Continuous Learning: System improvement from every engagement

Core Technologies

Artificial Intelligence Components

LSTM Autoencoders: Time-series analysis for detecting unusual patterns in sensor data.

Convolutional Neural Networks: Image and signal processing for drone detection and classification systems.

Natural Language Processing: Real-time translation and analysis of intercepted communications in multiple languages including Mandarin and local dialects.

Federated Learning Framework

Flower Framework: Open-source federated learning platform ensuring privacy-preserving model updates.

TensorFlow Federated: Google's framework adapted for secure military applications.

Privacy Mechanisms: Differential privacy and homomorphic encryption for additional data protection layers.

Quantum Computing Integration

IBM Qiskit Platform: Quantum machine learning development using IBM Qiskit infrastructure.

PennyLane Framework: Quantum machine learning library for variational quantum classifiers.

QNu Labs Solutions: Indigenous quantum key distribution technology recently contracted by the Indian Army.

Cybersecurity and Communication

Quantum Key Distribution: Secure communication protocols developed.

Post-Quantum Cryptography: NIST-approved algorithms for quantum-resistant encryption.

Blockchain Security: Permissive blockchain mechanisms for trusted communication platforms.

Hardware Infrastructure

Edge AI Processors: Ruggedized computing units capable of real-time threat analysis in field conditions.

Quantum-Ready Gateways: Communication hardware compatible with current and future quantum networking technologies

Sensor Integration Platforms: Unified interfaces for radar, satellite, drone, and cyber monitoring systems

FALCON vs Global Defense Systems

	Iron Dome	Patriot	S400	NATO(IAMD)	FALCON
Multi-Threat Detection	*Limited*	*Moderate*	*Good*	*Good*	*Excellent*
AI Powered Analysis	*Basic*	*Limited*	*None*	*Moderate*	*Advanced*
Quantum Security	*None*	*None*	*None*	*None*	*Integrated*
Federated Learning	*None*	*None*	*None*	*None*	*Core feature*
Multi-Base Coordination	*Limited*	*Limited*	*None*	*Good*	*Excellent*
Cyber Threat Defense	*None*	*Limited*	*None*	*Moderate*	*Comphensive*
Continuous Learning	*None*	*None*	*None*	*Limited*	*Excellent*
Indigenous Technology	*30%*	*10%*	*0%*	*20%*	*60%*
Quantum-Safe Communications	*None*	*None*	*None*	*Planning*	*Implemented*

Conclusion

FALCON represents the future of military defense - intelligent, quantum-enhanced, and networked. By combining cutting-edge AI, quantum computing, and federated learning, FALCON provides the Indian Army with unprecedented capabilities to detect, analyze, and respond to modern threats. The system's unique approach to privacy-preserving collaborative intelligence ensures that sensitive military data remains secure while enabling collective learning across the entire defense network.

References & Sources

Jagran Josh (2025) Terrier Cyber Quest 2025: A National Challenge to Boost India's Defence Technology:

https://www.jagranjosh.com/current-affairs/terrier-cyber-quest-a-national-challenge-to-boost-indias-defence-technology-1850000229-

CyberChallenge. (2025). Terrier Cyber Quest 2025. https://www.cyberchallenge.in/tcq2025

India Today. (2022). Indian Army quantum communication tech. https://www.indiatoday.in/india/story/indian-army-to-possess-quantum-communication-tech-joins-elite-list-1988027-2022-08-14

IndiaAI. (2024). AI-Driven Tools in Defense. https://indiaai.gov.in/article/ai-driven-tools-in-the-indian-defense-sector

PIB. (2025). National Quantum Mission India's Quantum Leap. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2111953

CPPR. (2025). Defence Budget Analysis. https://www.cppr.in/articles/analysis-of-the-defence-budget-of-india-2025

PIB. (2025). Union Budget 2025-26 allocation. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2098485

Drishti IAS. (2025). India's Defence Innovation Export Capability. https://www.drishtiias.com/daily-updates/daily-news-analysis/india-s-rising-defence-innovation-export-capability