PROJECT DEVELOPMENT DELIVERY OF SPRINT-2

TEAM ID	PNT2022TMID54425
PROJECT NAME	SMART SOLUTIONS FOR RAILWAYS

Proposed architecture for smart track monitoringsystem.

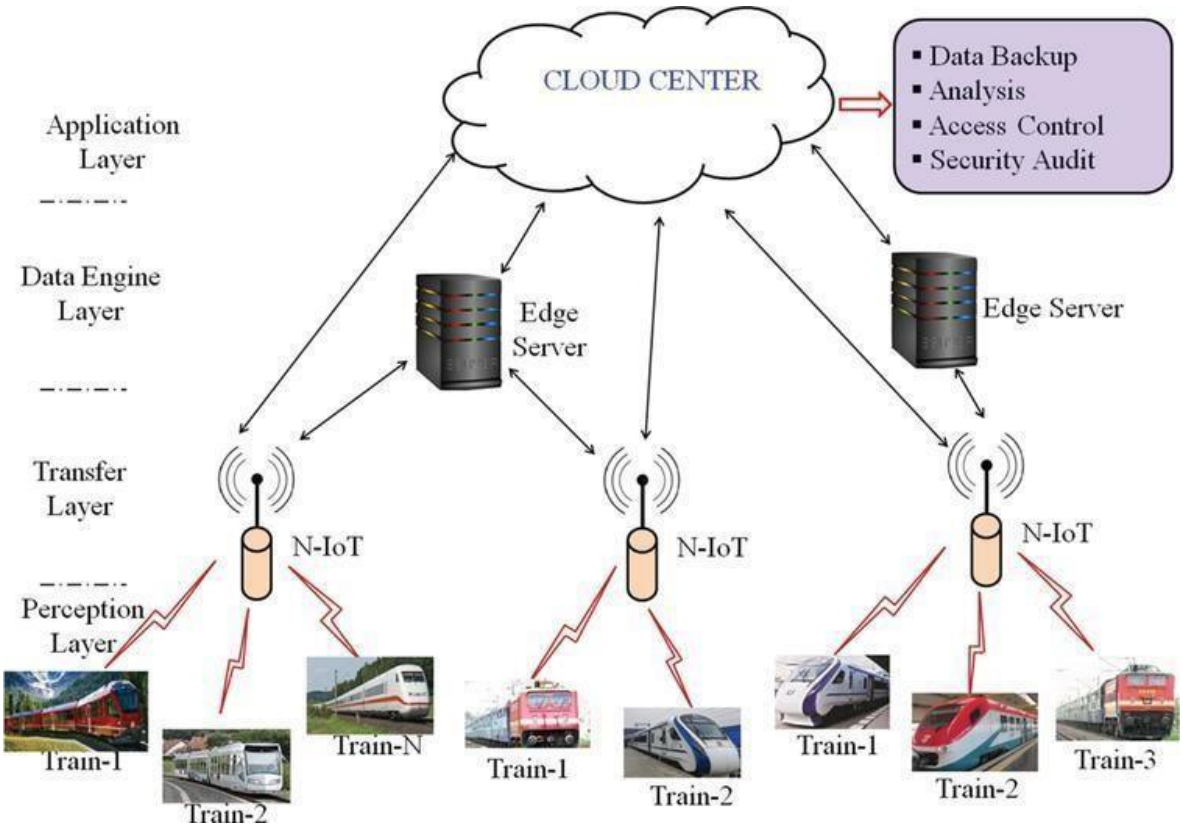
Transportation systems are complex with respect to technology and operations due to the involvement of a wide range of human actors, organisations and technical solutions. There is a need to apply intelligent computerised systems for the operation and control of such complex environments, such as computerised traffic control systems for coordinating advanced transportation.

Industry 4.0 is enabled by smart systems and Internet-based solutions. Maintenance is one of the application areas of self-learning, and smart systems can predict failure and trigger maintenance by making use of the Internet of things (IoT).

Digitisation of Railways Includes:

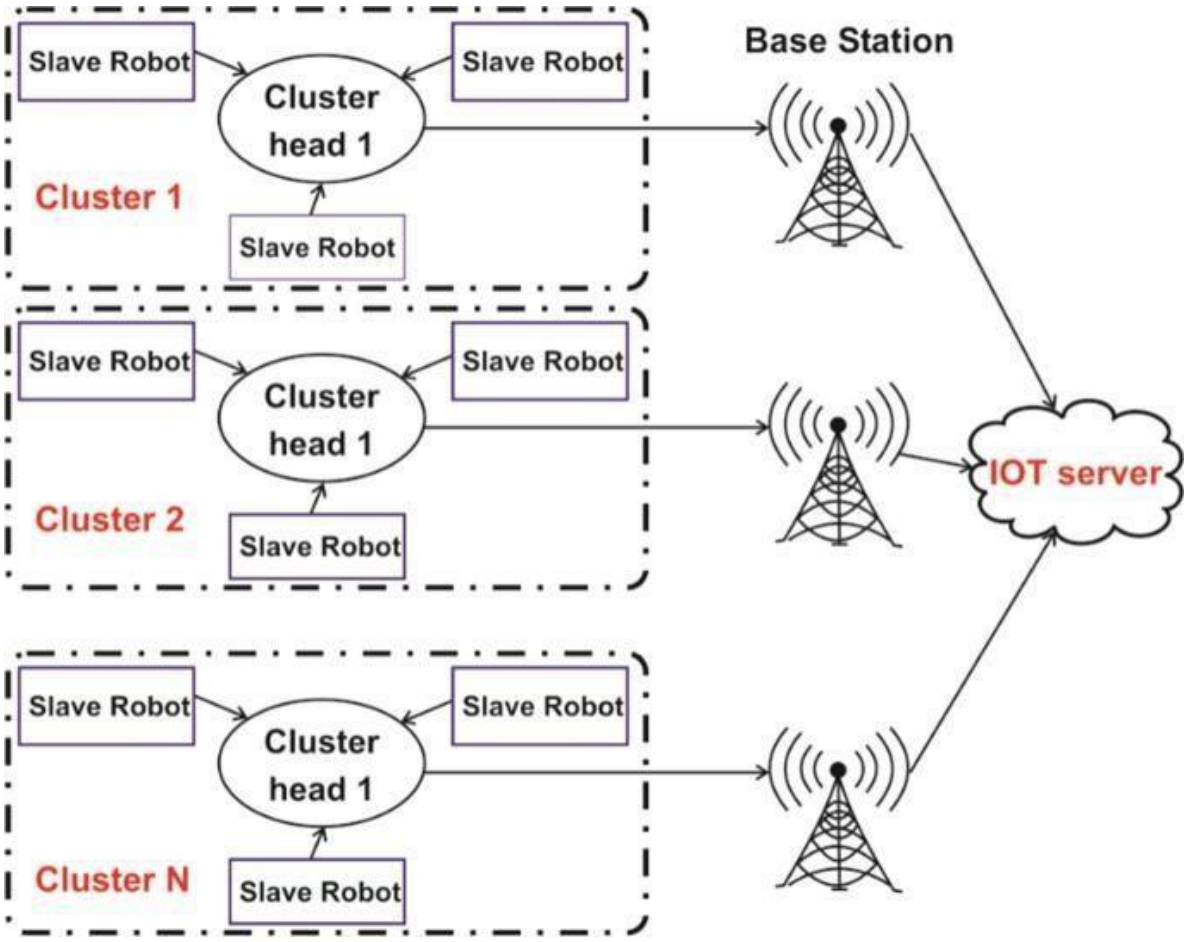
- B-scan ultrasonic rail flaw detection (both non-stop and stop-and-verify systems) and track inspection with automated high-speed test trains.
- Train control system levels 2 and 3 for high-density routes to increase network capacity and maintain the required safety standards.
- Increased surveillance of personnel with both interior and exterior locomotive-mounted video surveillance to improve monitoring.
- Track-laying machines for mechanisation of construction.
- Electrification through machines such as self-propelled overhead electrification laying trains.

- Complete train scanners for improved diagnostics and maintenance.
- Use of distributed power to improve the efficiency of train operations with coordinated acceleration and deceleration.
- Establishment of smart railway stations by implementing access control at entry points.
- e-ticketing with services such as infotainment and app-based systems.
- Use of training simulators and virtual reality (VR) training systems to improve personnel capabilities.



Structural health monitoring of railway tracks usingIOT-based multi robot system:

A multi-robot-based fault detection system for railway tracks is proposed to eliminate manual
human visual inspection. A hardware prototype is designed to implement a master–slave robot mechanism capable of detecting rail surface defects, which include cracks, squats, corrugations, and rust. The system incorporates ultrasonic sensor inputs coupled with image processing using OpenCV and deep learning algorithms to classify the surface faults detected. The proposed Convolutional Neural Network (CNN) model fared better compared to the Artificial Neural Network (ANN), random forest, and Support Vector Machine (SVM) algorithms based on accuracy, R-squared value, F1 score, and Mean-Squared Error (MSE). To eliminate manual inspection, the location and status of the fault can be conveyed to a central location enabling immediate attention by utilizing GSM, GPS, and cloud storage-based technologies. The system is extended to a multi-robot framework designed to optimize energy utilization, increase the lifetime of individual robots, and improve the overall network throughput. Thus, the Low Energy Adaptive Clustering Hierarchy (LEACH) protocol is simulated using 100 robot nodes, and the corresponding performance metrics are obtained.


Base Station
Slave Robot
Slave Robot
Cluster head 1
Slave Robot
Cluster 1
Slave Robot
Slave Robot
Cluster head 1
Slave Robot
Cluster 2
IOT server
Slave Robot
Slave Robot
Cluster head 1
Slave Robot
Cluster N