

SIH1645

An App and Web Based Software for Productivity and
Safety Management in Coal Mines

CoalWorks

Enhancing Productivity and Safety
From Ground Up

Team Arize : 289



The Black Gold

Coal is often termed "black gold" due to its vital role in India's economy, contributing over **₹70,000 crore** annually in government revenue through royalties and taxes

Total Reserves: **378.21 billion tonnes**

Major Source of Electricity

Coal is the backbone of India's energy sector, contributing to approximately **70%** of the country's electricity generation

Employment Impact

The coal mining sector employs approximately **121,800 workers**, making it a significant source of employment in rural areas

India's AIM

India is targeting for **1.5 Billion ton** coal production by 2030 to cater to the burgeoning energy needs of the country.

- Current Growth Rate: **5.20%**
- Target Growth Rate: **7.92%**
- Increase Needed: **2.72%**
- Time Frame: Next **6 years**

Boosting productivity and safety in coal mining is vital for global energy, akin to agriculture's role in food security and economic stability.

Problem Statement Breakdown

Manual shift handover and safety management processes in mining operations are inefficient, risk-prone, and time-consuming. A digital solution is needed to improve productivity, ensure better safety, and comply with statutory requirements through a unified app and web-based platform.

PART -1

Digital Shift Handover Log System

- ◆ Shift handovers rely on paper logs
- ◆ Manual handovers slow down operations
- ◆ Safety and operational details might be missed
- ◆ Incomplete communication can cause delays, hazards, or worse

Why?

Key Benefits

Time **saved** during handovers, boosting productivity

Readiness **ensured** through better communication.

Improved safety and **reduced** accident risk.

Requirements for the Solution

- ◆ Digitalization of paper logs
- ◆ Align with statutory and non-statutory formats.
- ◆ Ensure timely sharing of critical information.
- ◆ Provide next-shift supervisors a comprehensive overview.
- ◆ Must be compatible with existing ERP systems.
- ◆ Ensure secure handling of sensitive data.

Problem Statement Breakdown

PART -2

Dynamic SMP System

Why?

- ◆ Manual SMP processes rely on manual process to identify hazards.
- ◆ Inefficient risk management and monitoring.
- ◆ Difficulty ensuring DGMS compliance.
- ◆ Incomplete communication can cause delays, hazards, or worse

Requirements for the Solution

- ◆ Digitalize SMPs for hazard control and compliance.
- ◆ Ensure integration with existing systems like ERP.
- ◆ Enhance risk management and safety monitoring.
- ◆ Streamline protocols per DGMS regulations.

**More Work
and
Efforts**



Manual Processes

Consume time, reducing overall productivity.
May result in skipped safety-related information, posing risks to operations and lives.

**Less Results
and
Benefits**

Problem Statement Breakdown

PART-3

Integration with ERP System

ERP systems are used to manage and integrate core processes in any industry.

- ◆ Centralized data management
- ◆ Streamlined workflows

Automatic PDF Report Generation

Data Security

Data security is vital to protect sensitive mining information.

- ◆ Safeguards operational and safety data from unauthorized access, ensuring privacy and maintaining trust.
- ◆ Meets industry-specific regulations for data protection, avoiding legal consequences and fines.

ERP: A Must for Coal Mining

In this large-scale, complex industry, ERP systems are vital for managing operations, ensuring safety, and meeting compliance.

As India's largest coal producer, Coal India banks upon ERP to manage and streamline data

Field Research in Neyveli

We conducted field research at Neyveli coal mines to understand operations, challenges, and safety measures for refining our solution.



Present in Picture:
Rakhul, Prasanth, Shanthosh, Rakesh Kumar,
Murugan (Our Guide)

Key Insights Gathered

- ◆ Mobile devices are prohibited in mining areas.
- ◆ Shift logs are manually written on paper.
- ◆ Workers spend approx 3+ extra hours on pre-shift and post shifts
- ◆ Communication relies on wireless systems.

Efforts on to ban mobile phones in mines: Official

Dhritiman Ray / Jan 22, 2024, 08:23 IST

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Ranchi: The directorate general of mines safety (DGMS) on Sunday said it is urging firms to encourage its staff to shun the usage of mobile phones in mining areas to curb [accidents](#) and fatalities.

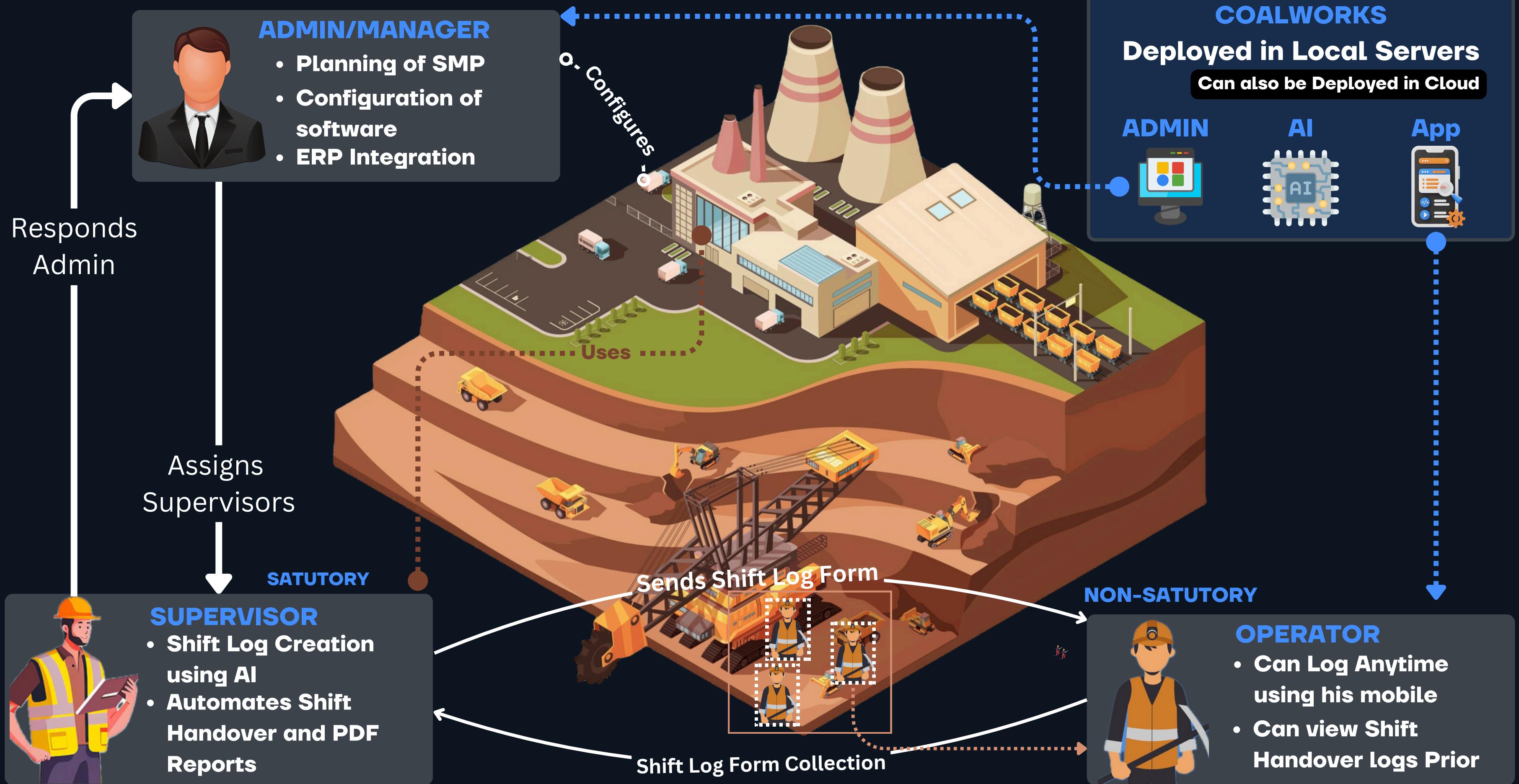
Prabhat Kumar, the director general of DGMS, said: "The last national conference on safety of mines had proposed a ban on mobile phone use in mining areas. Subsequently, a proposal has been

moved to the Centre and regulations are expected any time."

Kumar spoke to TOI on the sidelines of the 61st annual metalliferous mines safety week celebration (Chaitanya) region.

A Times Of India article on ban on mobile phones in coal mines

Sample Solution Approach



Unified Admin Dashboard

COMPONENT 1

A centralized, intelligent platform designed to streamline coal mining operations by enabling real-time monitoring, resource management, and data-driven decision-making for enhanced productivity and safety.

AI Powered Control Planning and Scheduling

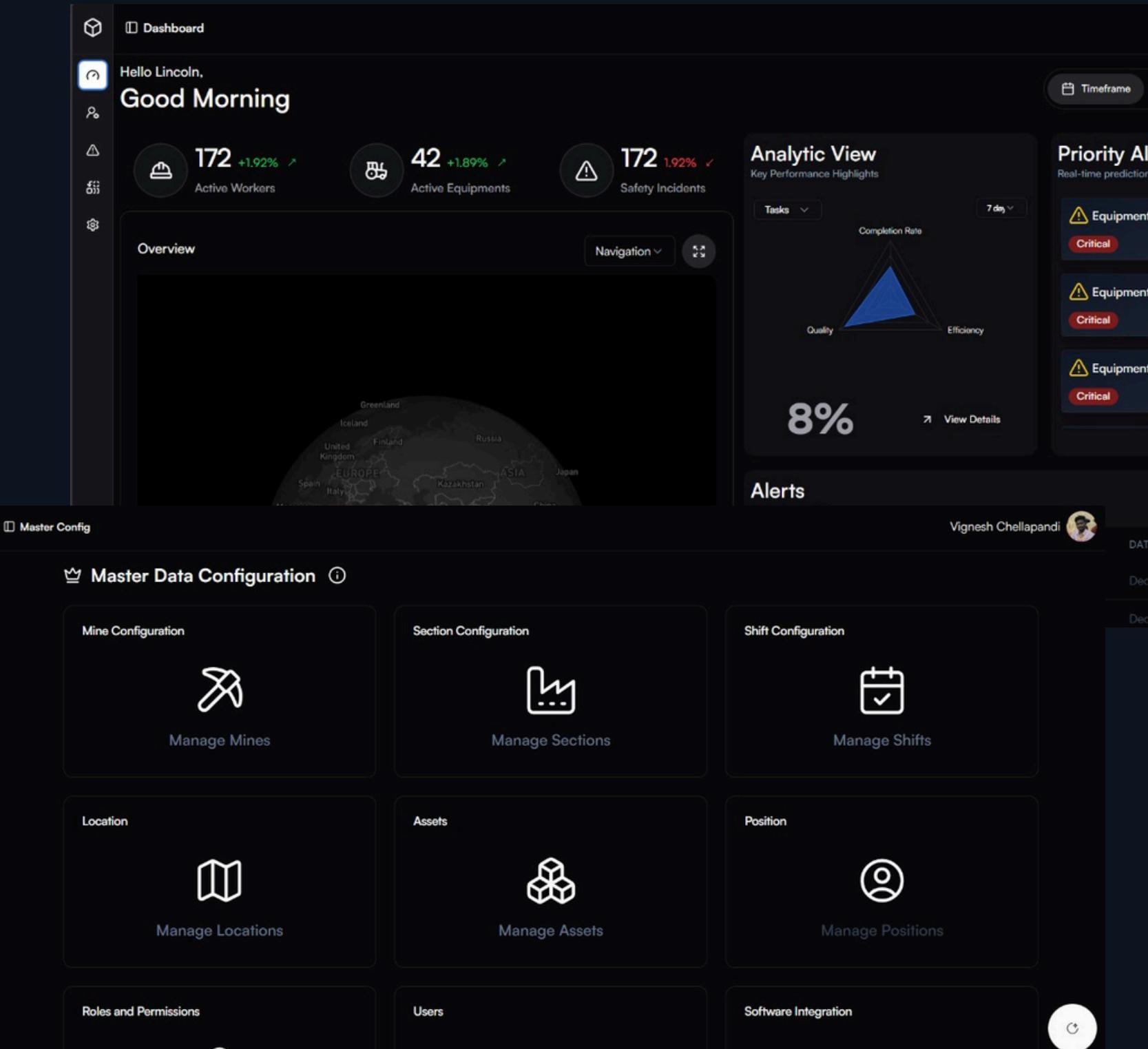
- ◆ Schedules tasks considering worker experience, task priority, and time.

Intelligent & Intuitive Heatmaps and Insights

- ◆ Dynamically visualize operational data, worker locations, and high-risk zones.

Hassle-free Compliance with Comprehensive Reporting

- ◆ Generates key compliance, safety, and performance reports automatically.



AI Based Form Generation

COMPONENT 2

AI-powered form generation automates the creation of control plans and shift log templates, ensuring accuracy, efficiency, and compliance in coal mine operations.

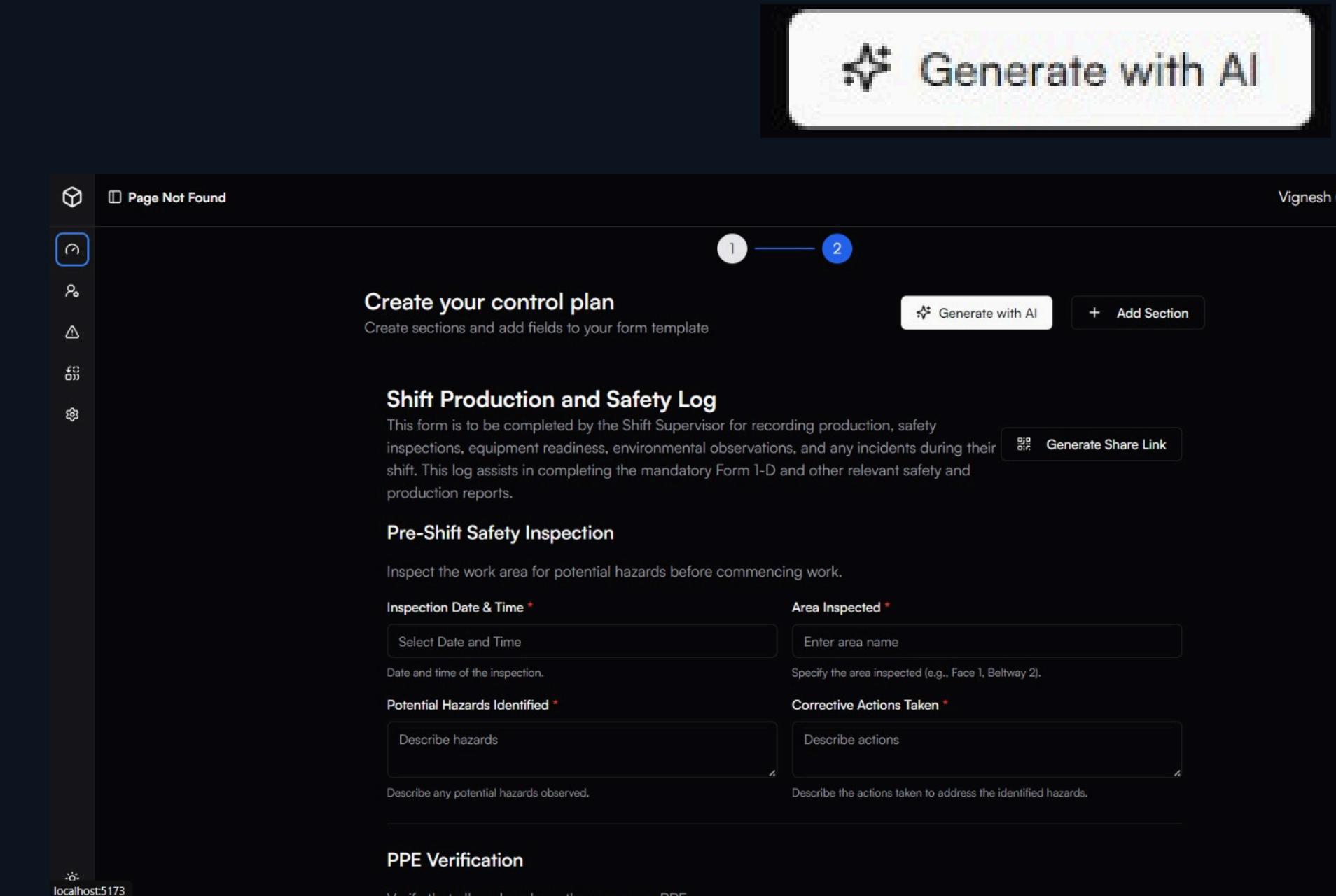
Control Plan Form Generation

- ◆ Automatically generates control plans for identified hazards.
- ◆ Leverages **DGMS documents, mine data, and AI** to suggest mitigation strategies.
- ◆ Ensures safety and regulatory compliance.

Shift Log Template Creation

- ◆ Dynamically creates customizable shift handover templates.
- ◆ Customizes templates by roles and tasks.
- ◆ Enables real-time updates and tracking.

 Implemented



The screenshot shows a user interface for generating forms. At the top right is a large button labeled "Generate with AI". Below it, a progress bar indicates steps 1 and 2. The main area contains two sections: "Create your control plan" and "Shift Production and Safety Log". The "Shift Production and Safety Log" section is detailed with fields for inspection date/time, area inspected, potential hazards, corrective actions, and PPE verification. A sidebar on the left provides navigation icons.

Impacts of Configurable Admin



40%

Improved
operational visibility



50%

Reduced
Planning Time



60%

Reduced
Reporting Time

Impacts of AI Intelligent SMP



50%

Reduced
Incident Rates



7⁺ mins

Faster
Response Time



40%

Reduced
safety violations

Impact of Automated Shift Handover

Study on Cognitive Impact

A study using resting-state fNIRS on coal miners revealed **significant cognitive decline after shifts**, worsened by extra pre- and post-shift handover hours

70% REDUCTION TIME IN SHIFT HANDOVERS

Meaning if 2 Hrs

=> 70 % of 2 Hrs = 1 Hr 24 mins is reduced

1 Hr 24 * 2 FOR PRESHIFT AND POSTSHIFT

2 Hr 48 mins is saved !

The Productivity and Safety of coal mines is indirectly dependent on mental health of the workers too!

assess the cognitive ability before and after the work shift. Results: Results showed significant differences in cognitive ability between before and after the work shifts among the three-shift workers. The brain functional connectivity was reduced ranking as the night, afternoon, and morning shifts. Decreased brain functional connectivity at the end of the

ERP INTEGRATION

EXTERNAL AND INTERNAL

COMPONENT 3



AI-powered form generation automates the creation of control plans and shift log templates, ensuring accuracy, efficiency, and compliance in coal mine operations.

- **External API Access:** Our system provides APIs for external ERP solutions to fetch real-time data, enabling seamless integration with existing products or workflows.

Asset Management

- POST** /asset Create a new asset
- GET** /asset Get all assets
- GET** /asset/{id} Get a single asset by ID
- POST** /asset/{id} Update an existing asset
- DELETE** /asset/{id} Delete an asset by ID

AssetTypes

- POST** /assettype Create a new asset type
- GET** /assettype Get all asset types
- POST** /assettype/{id} Update an asset type by ID
- GET** /assettype/{id} Get a specific asset type by ID
- DELETE** /assettype/{id} Delete an asset type by ID

Your Company Name

Plan Name
New Plan

Description
New Plan Description

Notes
Hell World, jasfobasfdf

Sections

Section 1

Tasks:

Task Name	Response Type
Task Name	text
sadfsd	text
asfsf	image

Questions:

Question	Response Type
New question on Section 2	text



- **AUTOMATED PDF GENERATION**

Base Level of pdf generation for the shift handover log reports and Control Plan Responses for efficient communication and compliance reporting

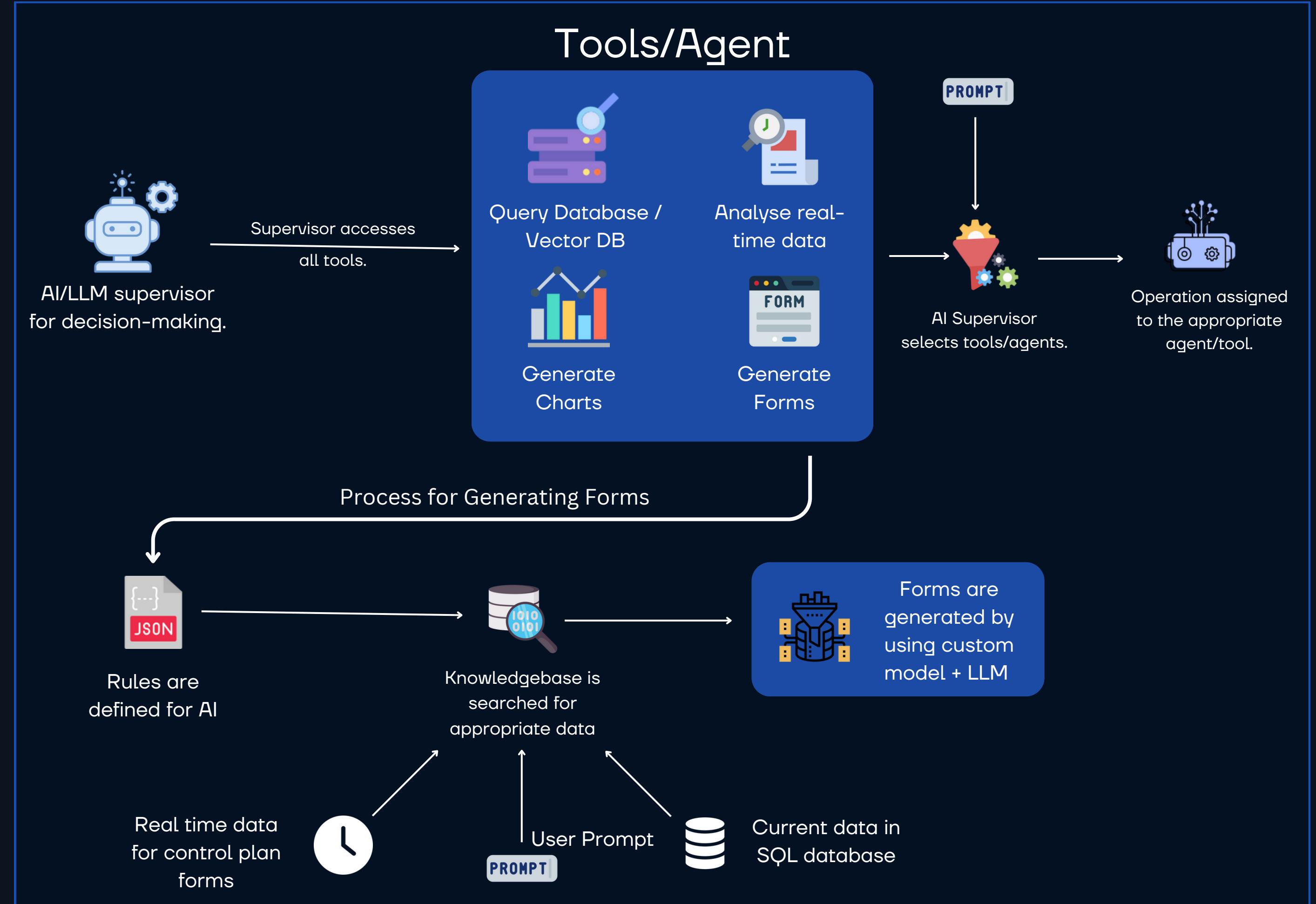
- **Custom Internal APIs:** For software-specific like SAP we can analyze the codebase to develop tailored APIs that integrate our solution directly into proprietary systems.

TechStack

This tech stack is a powerhouse for modern software development, covering Web, Mobile, and AI with a diverse range of tools!



AI FLOW APPROACH PROCESSS



Technical Feasibility of the Product



Docker enables CoalWorks to run on legacy hardware, making it **suitable for resource-constrained mining environments.**



Kafka efficiently **handles large data streams** in real-time and is **cost-effective due** to its **open-source nature.**



Elasticsearch ensures **fast queries** for **real-time data retrieval** and decision-making across **extensive datasets.**

TIMELINE FOR HACKATHON

FOR ROUND - 2

- **Overall Integration of system - Web, IoT, AI, App**
- **Specific Digitalization of overman and sirdar registers and flow of system**
- **AI Based SMP Dynamization and Digitalization**
- **Scalable Infra with Kafka for Data streaming (handle upto 40 Million requests per second) , Elasticsearch for DB (Rapid Fast DB Queries)**
- **Interactive Map For Data Visualization and Insights and at the Admin Side**

FROM MENTOR SUGGESTIONS

FOR ROUND - 3

- **Fully Utility Chat Assistant - Anthra (The CoalWorks AI)**
- **Compliance Documentation AI**
- **Full Demo and Scalability Prospects**
- **Fully Feasible Level of Business and Implementation of Coalworks**

IoT

1. Why IoT?

- IoT showcases CoalWorks' capability in handling large sensor data streams with Kafka, transforming coal mining operations.

2. Importance of Live SOS Alerts

- A scalable IoT network provides real-time SOS alerts to admins for immediate danger response.

3. Environment Data Monitoring

- Monitors real-time data like gas leaks and SOS alerts for improved analysis and decision-making.

4. Scalability and Reliability

- Easily adds/removes nodes; the mesh network ensures continuous operation despite node failures.

SCALABILITY

SCALABILITY



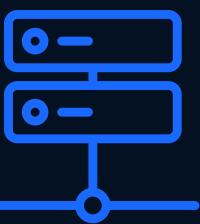
Easily scale software deployment across multiple systems, even those with **legacy infrastructure**.



An **open-source platform**, can handle over **40 million data streams** simultaneously,

SECURITY

[SEE REPORT](#)



Local systems ensure controlled access and enhanced security.



Restricts data access to authorized users **based on roles**.



Protects data integrity through cryptographic **hashing**.



Zero Knowledge Proofs enables privacy without revealing sensitive data.

FEASABILITY

Cost Effectiveness

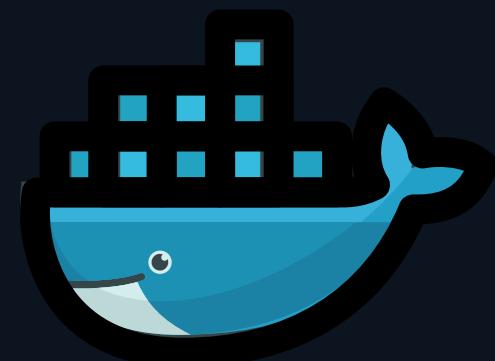
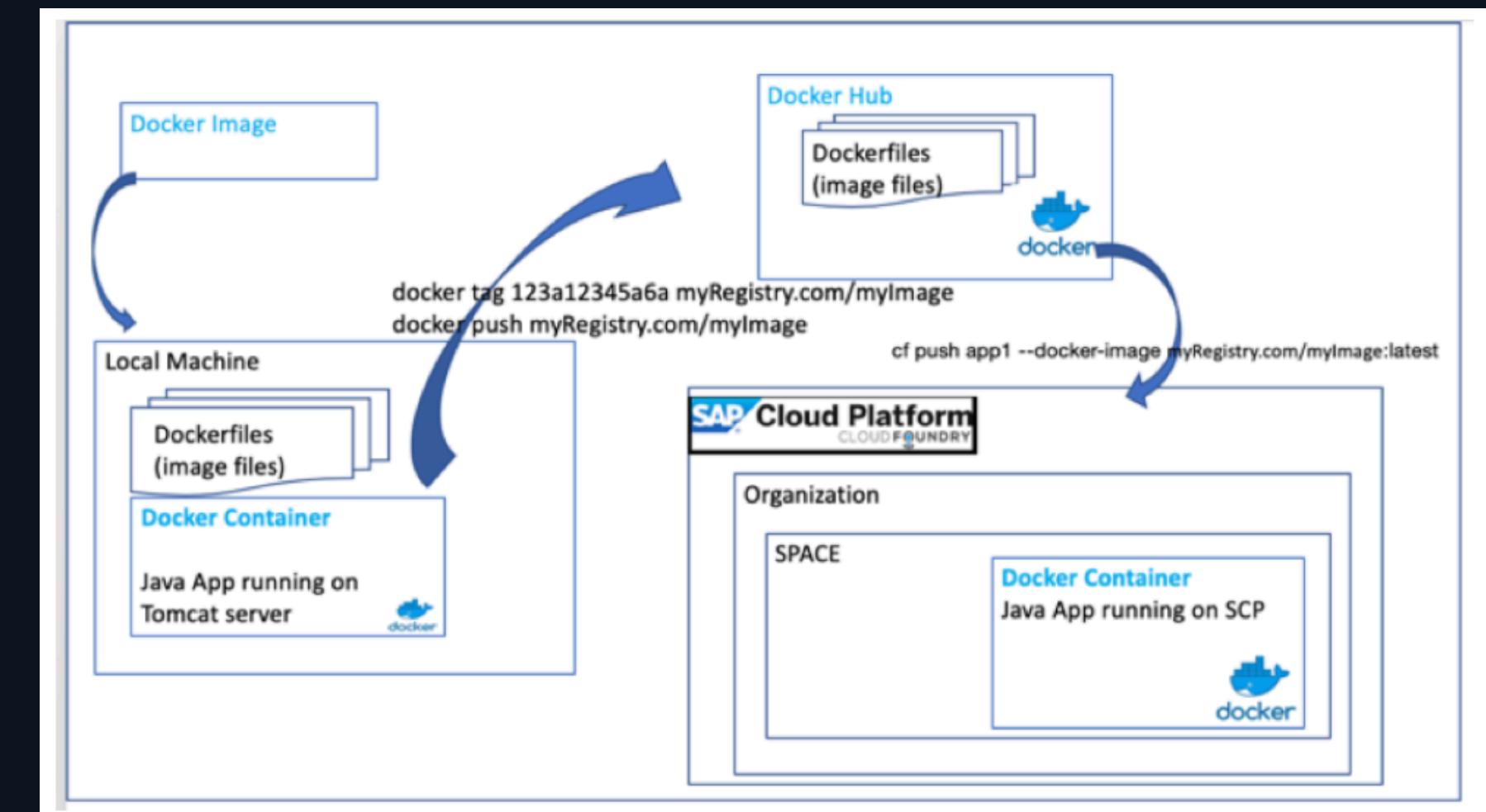
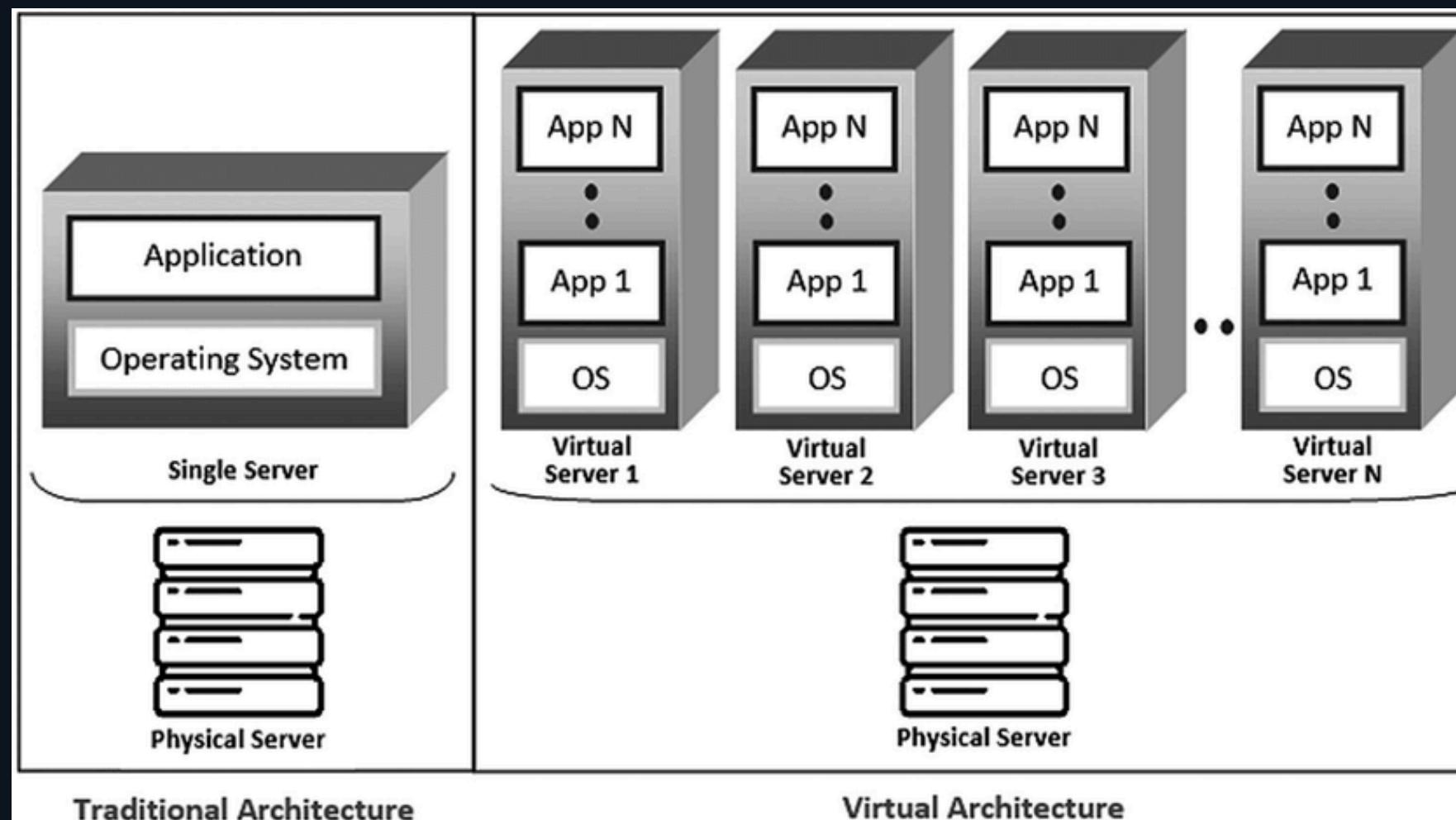
Leveraging **open-source** tools like Kafka and Docker **reduces** development and maintenance costs

API Documentation

Provides **detailed API documentation** for seamless integration with the **mine's ERP system**

How do we scale it ?

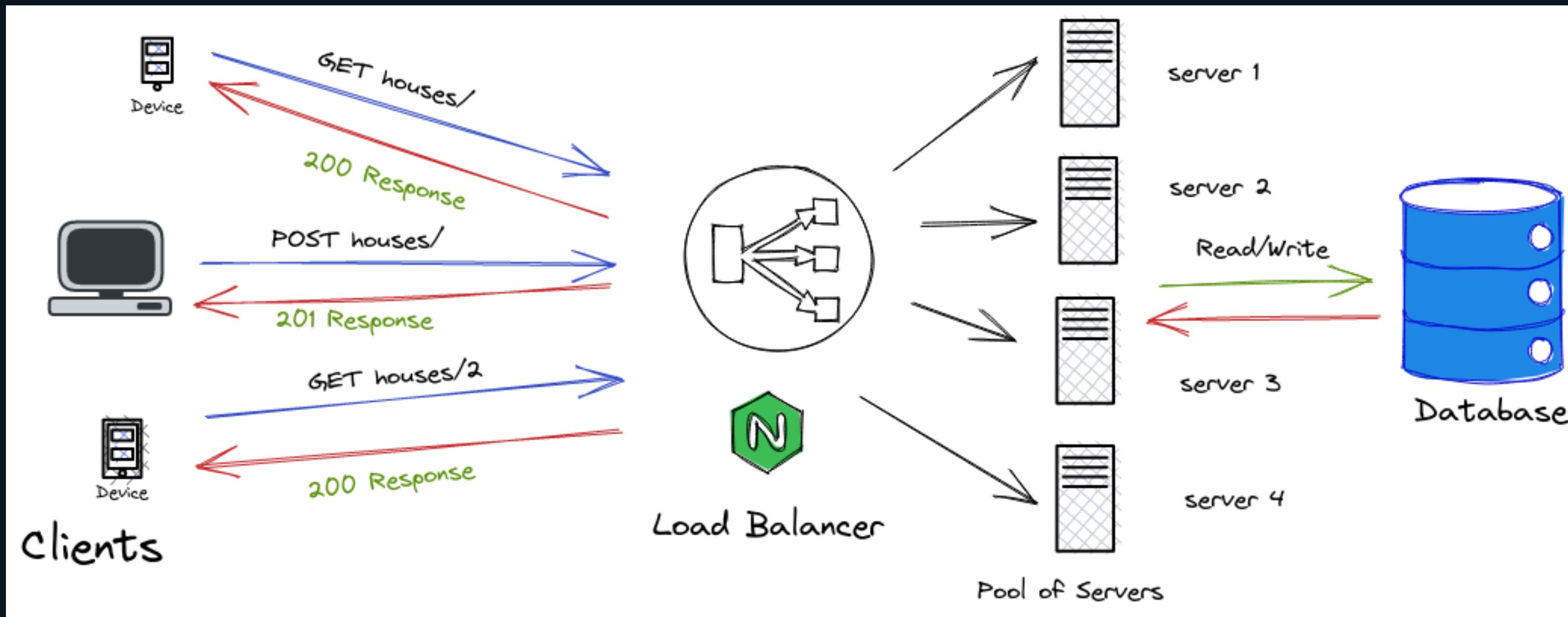
It is Instance Based , we can create and multiply!



THE POWER OF DOCKER

How do we handle data ?

Use of NGNIX to balance the load!



HOW WE ALIGN WITH CMPDI'S VISION

Empowering the coal mining industry through innovation, safety, and productivity, aligning with **CMPDI's vision** of sustainable development and advanced resource management for a secure energy future.

Mission

The Mission of CMPDIL is to provide total consultancy in coal and mineral exploration, mining, engineering and allied fields as premier consultants in India and a leading one in the International arena.

Vision

The Vision of CMPDIL is to be the market leader in an expanding earth resource sector and allied professional activities.

Mission

To integrate cutting-edge technologies and safety measures, enhancing operational efficiency and sustainability in coal mining operations nationwide.



Vision

To revolutionize coal mining with innovative solutions, ensuring safety, productivity, and sustainability, supporting India's energy goals.



COMPETITOR LANDSCAPE: HOW COALWORKS STANDS OUT

An in-depth comparison of CoalWorks with leading competitors in mining digitization, showcasing unique features and market advantages.

FEATURE	COALWORKS	INNOVAPTIVE	EVOTIX	IFX
Shift Handover Automation	✓	✓	✓	✓
Dynamic Safety Management	✓	✓	✓	✓
Integration with Other Software	✓	✓	✓	✓
AI Chat bot	✓	✓	✓	✓
Real-Time IoT Monitoring	✓	✓	✓	✓

DEVELOPMENT TIMELINE

DEVELOPMENT TIMELINE

1-2 Weeks

RESEARCH



Product feature and component research, categorized with guidance from CMPDI

2-4 Weeks

DESIGN



User Base Testing and KPI Based Designing
CMPDI

5-10 Weeks

DEVELOPMENT



Begin development with refined product features and feedback.

11th Week

DEPLOYMENT



Deploy the product in stages, ensuring functionality and scalability.

12th Week

UAT & CHANGE

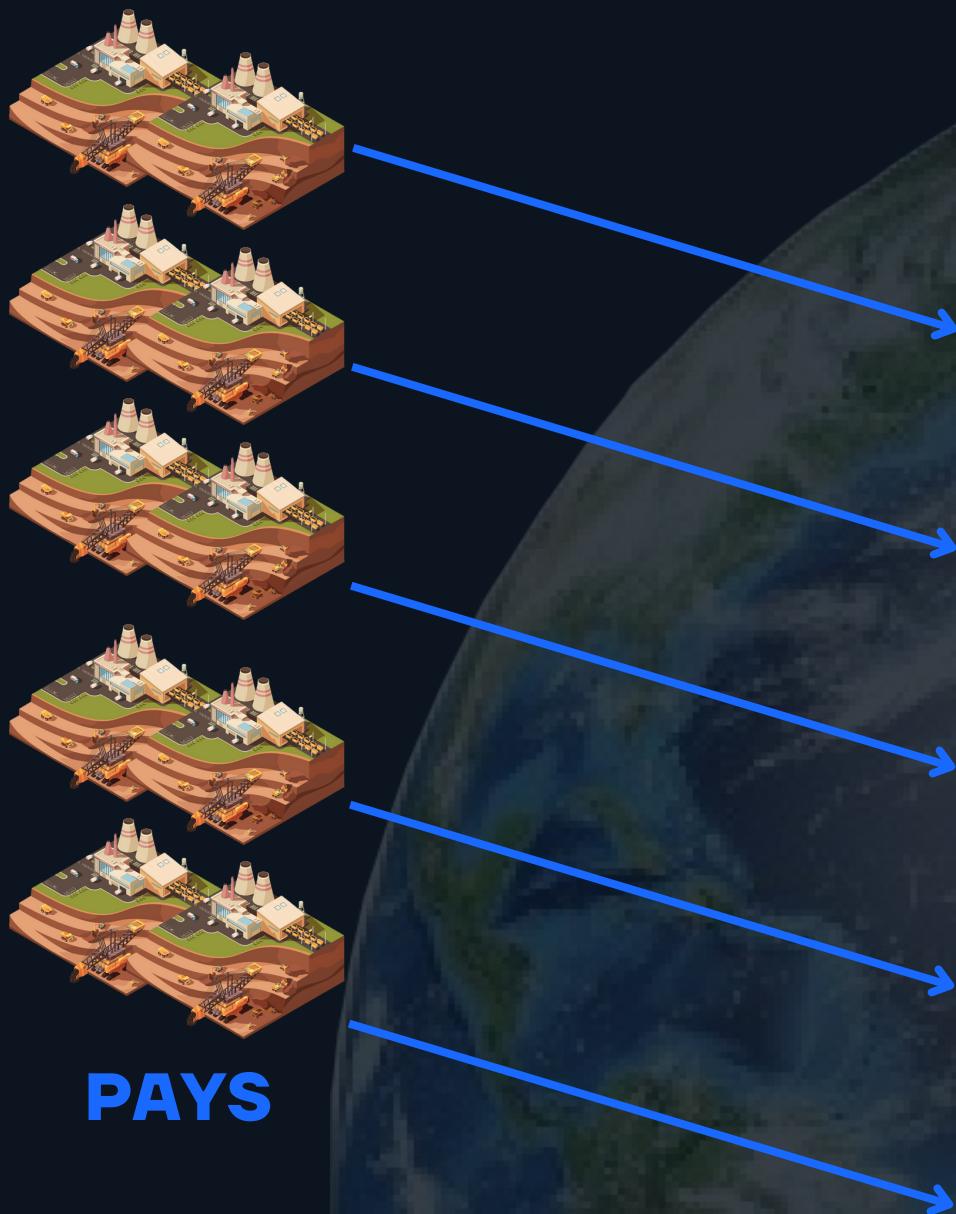


Based on Feedbacks from users the system will be reiterated

OPEN NETWORK FOR MINE DATA SHARING

AN IDEA FOR THE FUTURE

Mines



D
A
T
A

API

Share
Regulators
COAL INDIA

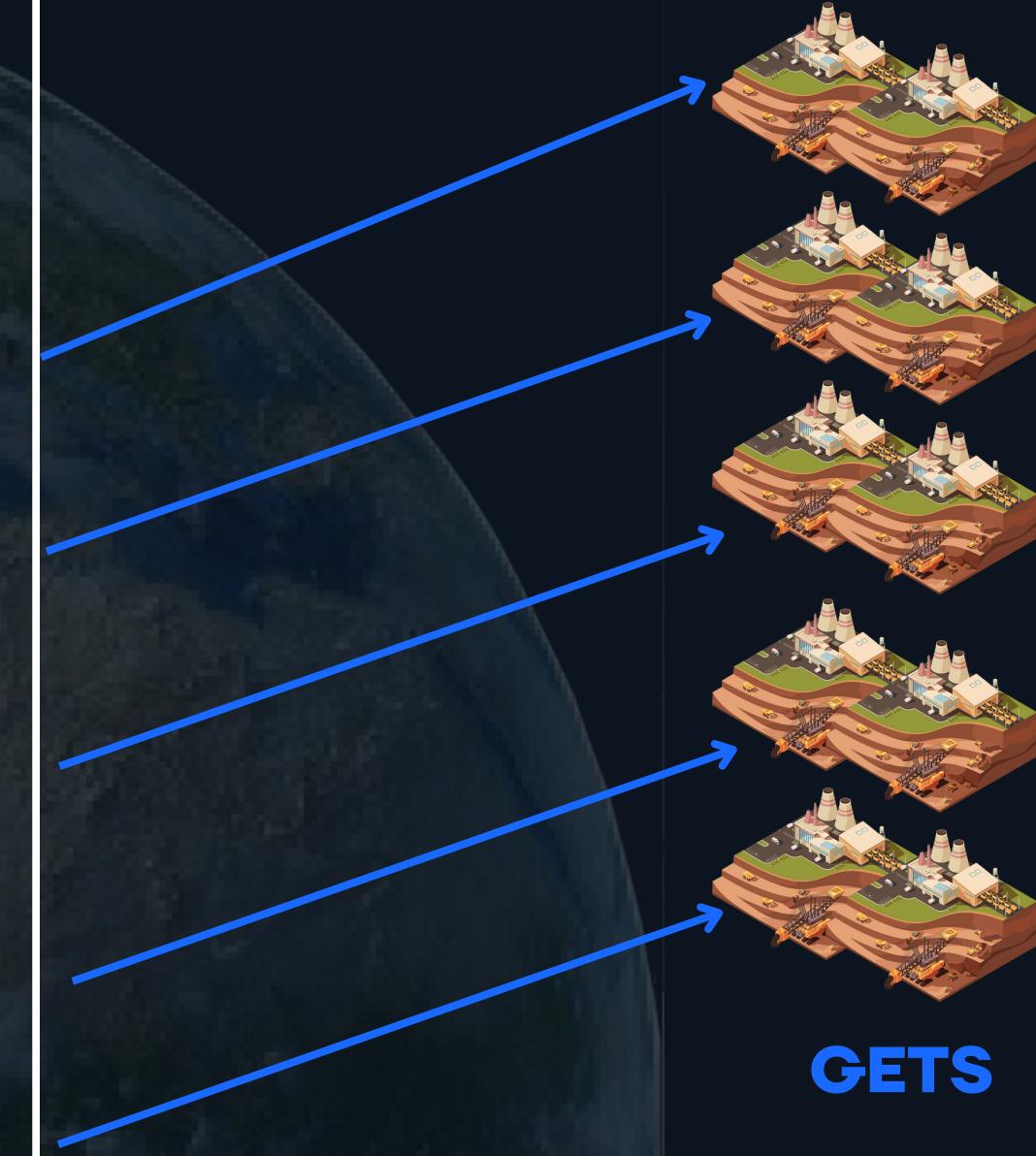
Share
Distributors
CMPDI

Share
Authors
CoalWorks

D
A
T
A

API

Mines



One Idea to revolutionalize the mining Industry

Development of a API Based Data Sharing Framework For Connecting Mines !

Proof of Approach and Feasibility!



India's AIM

India is targeting for **1.5 Billion ton** coal production by 2030 to cater to the burgeoning energy needs of the country.

- Current Growth Rate: **5.20%**
- Target Growth Rate: **7.92%**
- Increase Needed: **2.72%**
- Time Frame: Next **6 years**

Recorded an Increase of 3.6% Operational Increase
ie if the annual profit is 100crs year 1
the compounded annual profit of year 2 -> 103.6 crs

Compounded
3.6 crs +
3.71 crs+

TOGETHER LETS REACH WORLDWIDE



Our Promise

Enhanced Efficiency

CoalWorks is projected to **improve efficiency by 7.69%**, validated against existing solutions.

Contribution to Government Targets

This **7.69% increase** translates to an additional **385.275 million tons** of output, **significantly reducing** the government's 2030 coal production target by **22.67%**.



To know more,
check out our brochure!



[Click here](#)

And for Other Works



[Click here](#)

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CoalWorks
Brochure

Enhancing Productivity
and safety from ground up

with dedication, Team ARIZE