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# Digital Innovation in Mining

[zyframining.com](https://zyframining.com)



# Table of contents

1. Zyfra and Zyfra's divisions
2. Zyfra Open Mine FMS
3. Zyfra Underground
4. Zyfra Work & Safety Management
5. Zyfra Smart Excavator System
6. Autonomous and teleoperated solutions
7. Zyfra IIOT Platform

# Zyfra



**400+**  
enterprises



**80+**  
mining enterprises



**22+**  
countries



**24 000+**  
connected units of  
equipment



**30+**  
implemented  
AI projects



**5 100 +**  
oil wells



**80+**  
partners



Entrepreneurial Company of the Year in  
the AI-based Solutions for Process  
Industries



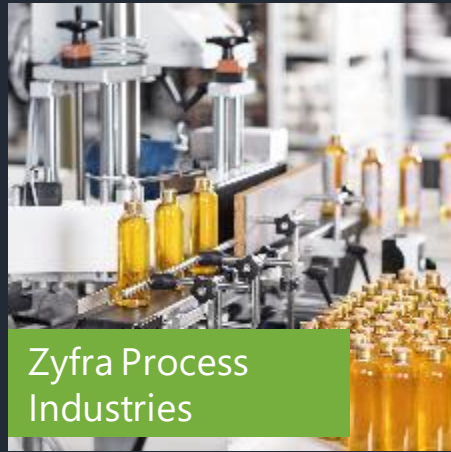
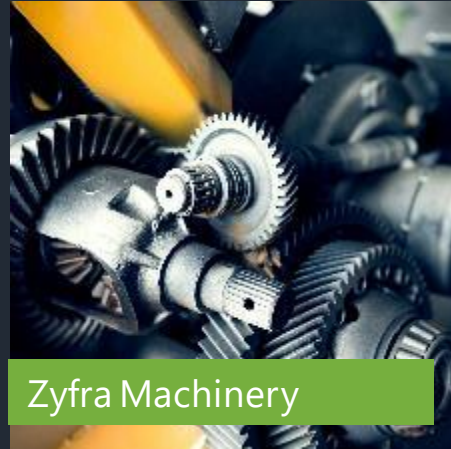
**X2**

THE TOP-10 BEST IOTWC  
2 YEARS IN THE ROW  
2018, 19. Heat Treatment AI,  
Artificial Lift



BUSINESS TRANSFORMATION  
AWARD 2019  
"Intelligent Mine –  
mine of the future"

# Zyfra's divisions





# Zyfra Mining at a glance

- 80+ mines
- work&safety management
- open pit fleet management
- underground dispatch
- autonomous and remote-control systems

30 years  
in Mining



# Zyfra Digital Mine Vision

Maintenance management

Mobility and Connectivity

Tire management

Fuel management

Remote operation center

Precision Drill Autonomous and Tele-operated

Safety and risk management

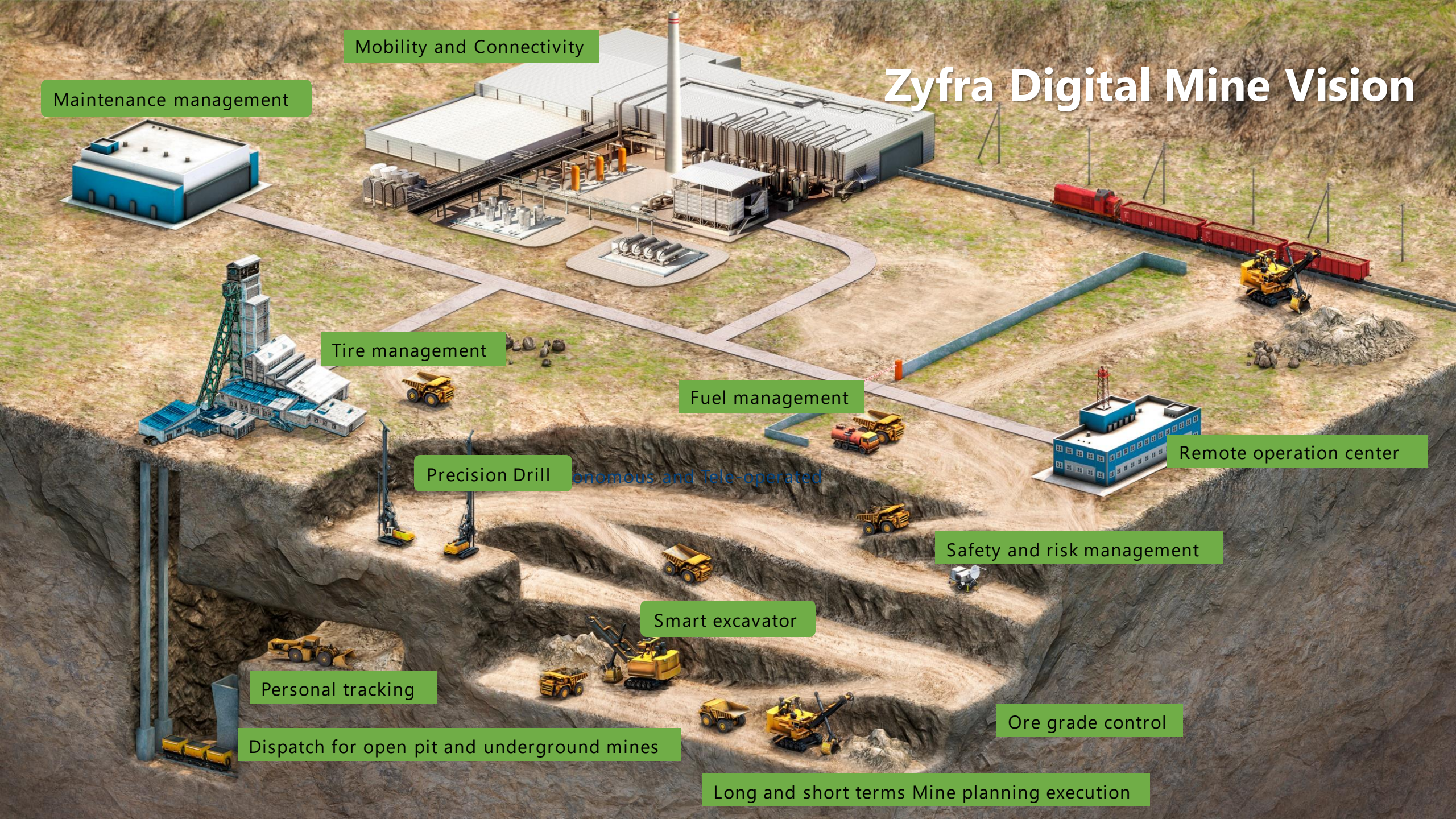
Smart excavator

Personal tracking

Ore grade control

Dispatch for open pit and underground mines

Long and short terms Mine planning execution





We provide value,  
efficiency, low cost  
using our experience  
and technology at  
all levels!



ZYFRA MINING

5  
4  
3  
2  
1  
0  
LEVEL LEVEL LEVEL LEVEL LEVEL LEVEL

AUTONOMOUS AND TELE-OPERATION  
SYSTEMS FOR MINING VEHICLES



BIG DATA ANALYSIS,  
PREDICTIVE ANALYTICS



HEALTH AND SAFETY INTEGRATED  
TO PRODUCTION



OPTIMIZATION OF LOADING,  
HAULING, DRILLING, STATISTIC AND  
REPORTING



REAL TIME CONTROL AND ASSET  
HEALTH MONITORING, COLLISION  
AVOIDANCE



ASSET SENSORS INSTALLATION  
AND DIAGNOSTICS



# Mining Portfolio



## Standalone products

(can be installed at a single mining vehicle and as well as can be connected to dispatch systems):

1. **Zyfra LoadPro** – payload and fuel monitoring system for dump trucks
2. **Zyfra Smart Excavator System** – Computer Vision bucket tooth detection and fragmentation analysis
3. **Zyfra Diagnostic** – tire management



## Dispatch:

1. **Zyfra Precision Drill** – high precision drills guidance
2. **Zyfra OpenMine** – Mine Fleet Management System - optimization and automatic dispatching of loading and hauling
3. **Zyfra Underground** – Dispatch for underground hardrock mines



## Safety and risk management:

1. **Zyfra Work&Safety Management** – job orders management system integrated with safety and risk management (includes mobile applications with checklists and positioning)



## Robotics:

1. **Autonomous dump trucks** - retrofit of existing trucks including autonomous fleet management
2. **Autonomous drills** – estimated release 2020
3. **Tele-operated dozers, loaders, excavators**





# Open Mine FMS Mine Fleet Management System

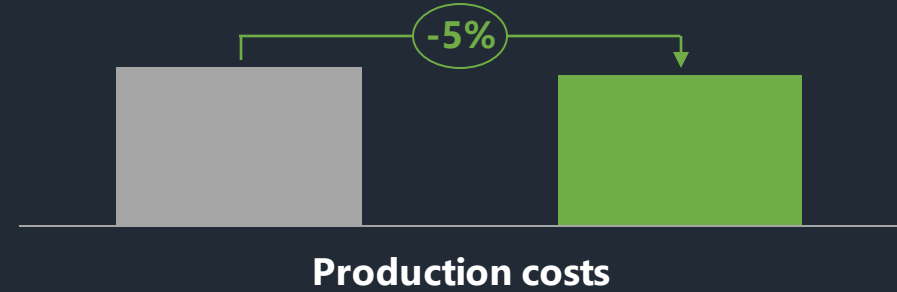
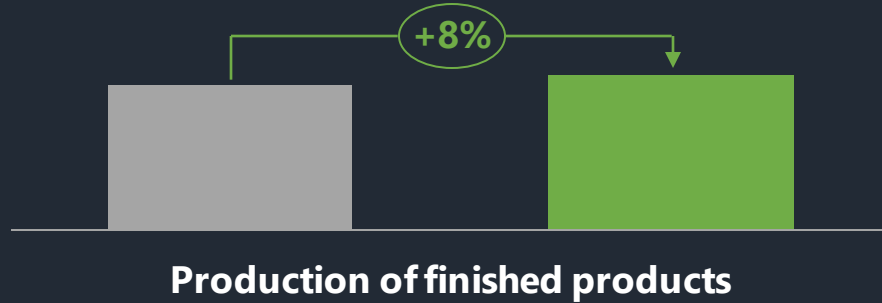
[zyframining.com](https://zyframining.com)



# Benefits of OpenMine

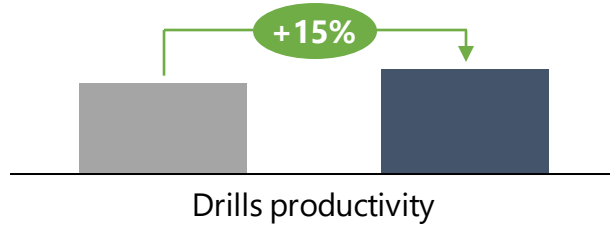
based on data from a large iron ore producer when introducing FMS

Impact on OPEX



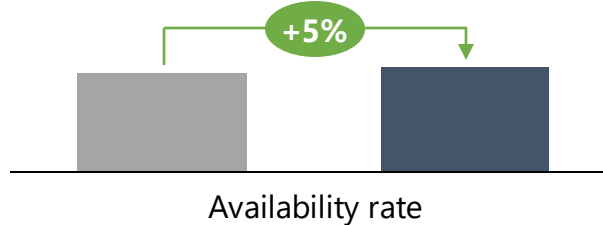
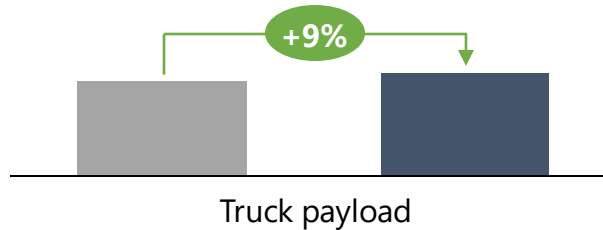
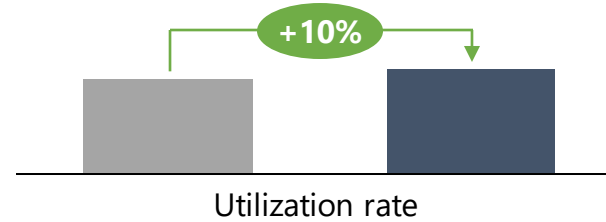
Impact on technical  
Performance KPIs

## Mining and processing

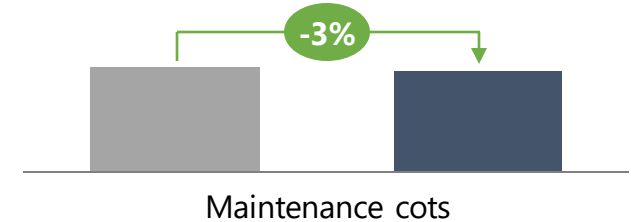
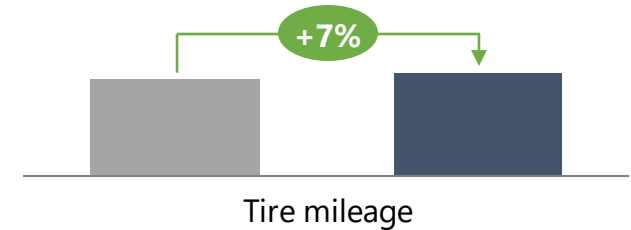
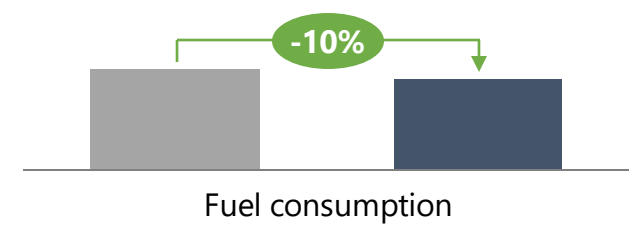


Quality stabilization

## Loading and hauling

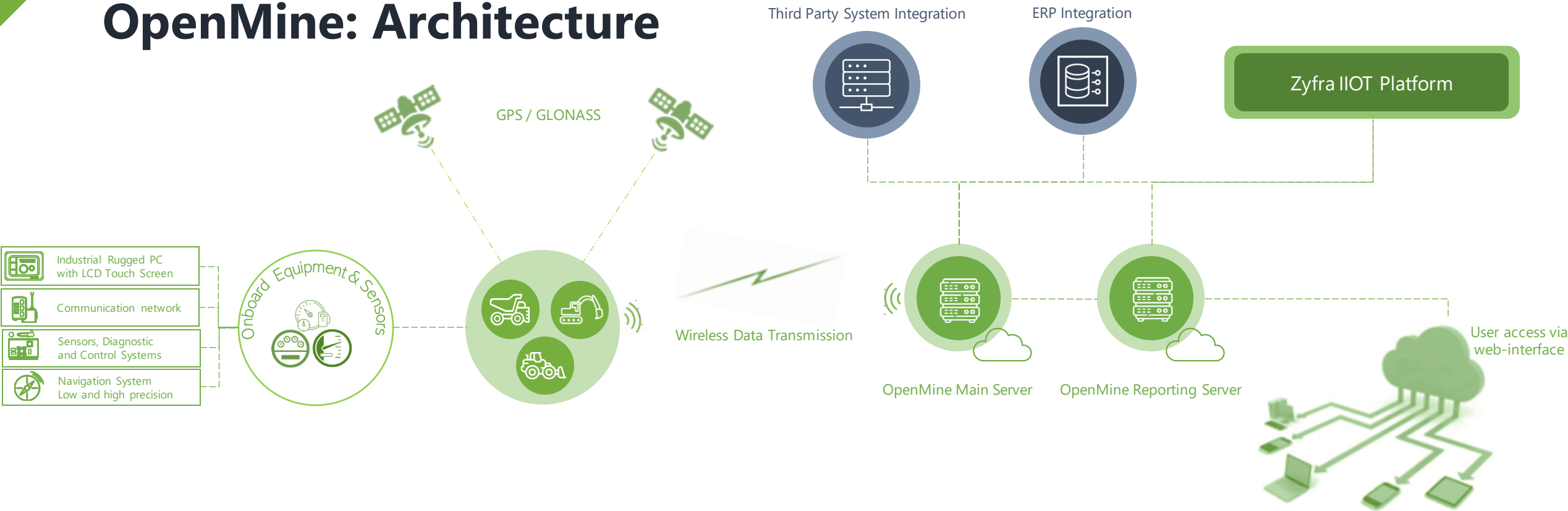


## Cost of operation





# OpenMine: Architecture



## Functionality & Features

Production Statistics	Shift Planning	Optimization & Auto Dispatch	High Precision Guidance	Material tracking	Ore Grade Control	Road Condition Monitoring	Maintenance Management	Fuel Management	Tire Management	Real Time Reporting	BA/BI

# Zyfra OpenMine: Why are we **better**?

## Key advantages



**Greater flexibility of solution**



**More automatic data**



**Greater flexibility of optimization criteria**



**Hardware solutions**



**Deep analysis of client business processes**







Morocco

- **18%** share in global phosphate production
- **32.8 million** tons of phosphate rock produced in 2018
- **\$55.9 millions** revenue in 2018
- **70%** of global phosphate reserve
- **~ 20,000** employees

## Unified fleet management system for 5 mines

**>300 vehicles connected to FMS**

- Increased efficiency and utilization of trucks
- Improved operational control
- Improved safety and production processes



**9%** Operational efficiency






**7%** Utilization of vehicles



**17%** Payload of dumptrucks

- **18,2%** share in the Russian iron ore production
- Production of ore: **13,3 millions** tons (2018)
- **1.6 million** tons of sinter ore in 2016
- **6 billion** tons or 130 years of development: the industrial reserve of the mine
- **375 m** - the depth of the mine
- **~ 6000** employees

> **200 vehicles** – connected to FMS  
> **65 trains** – railroad logistic  
**130 tons** dumptrucks

-  Fleet management system
-  High-precision excavation
-  Quality management

 **10%** Fuel consumption

 **15%** Tire lifecycles

 **13%** Productivity increasing

 **±2%** Quality stabilization





# Zyfra Underground

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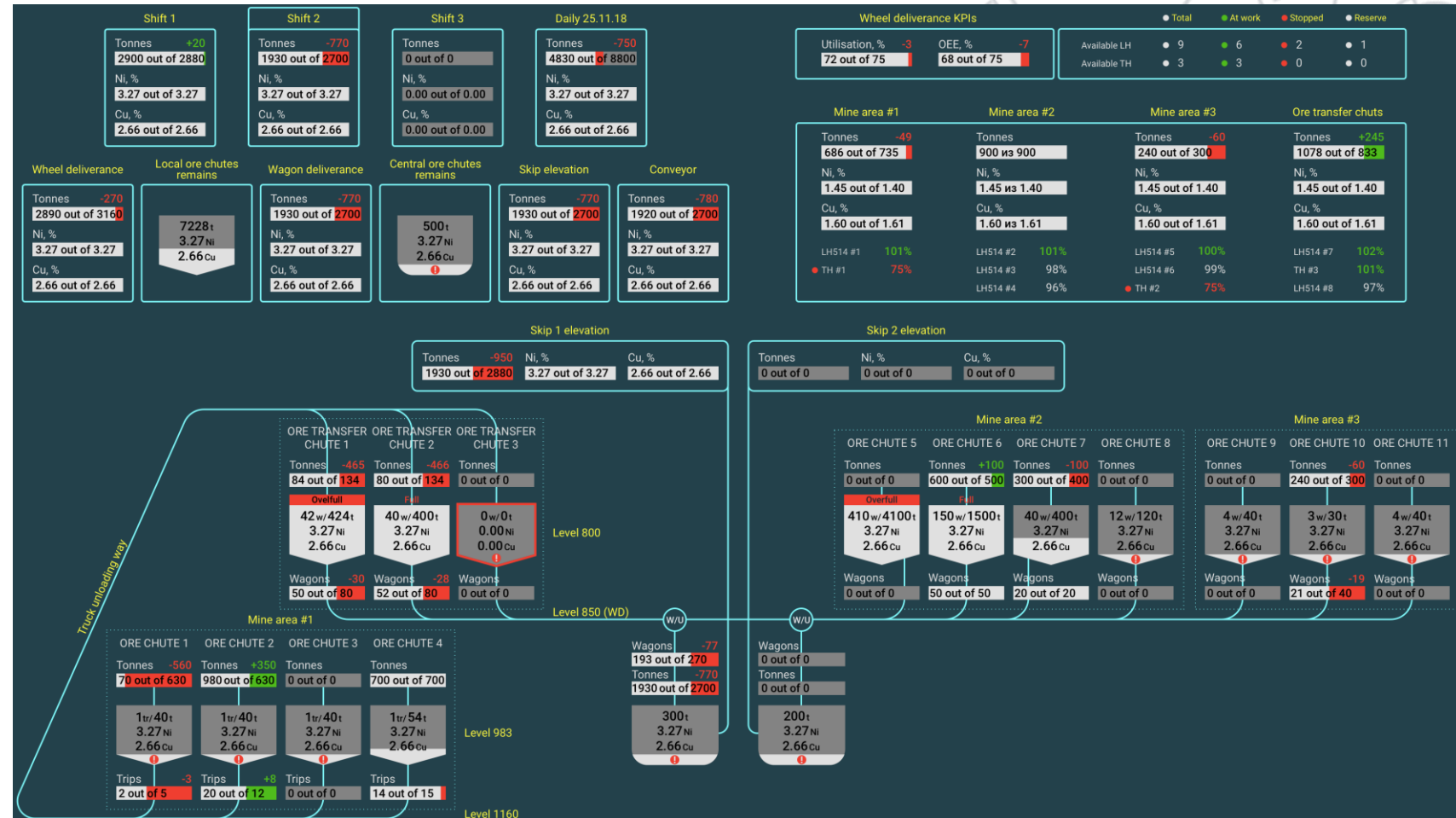
Zyfra  
Underground

Dispatch center



# Ore flow visualization

This scheme indicates an ore flow process from face through ore pass network to skip elevations on the ground



# Zyfra Underground

**P**roduction data

**P**osition, movement, and utilization analysis

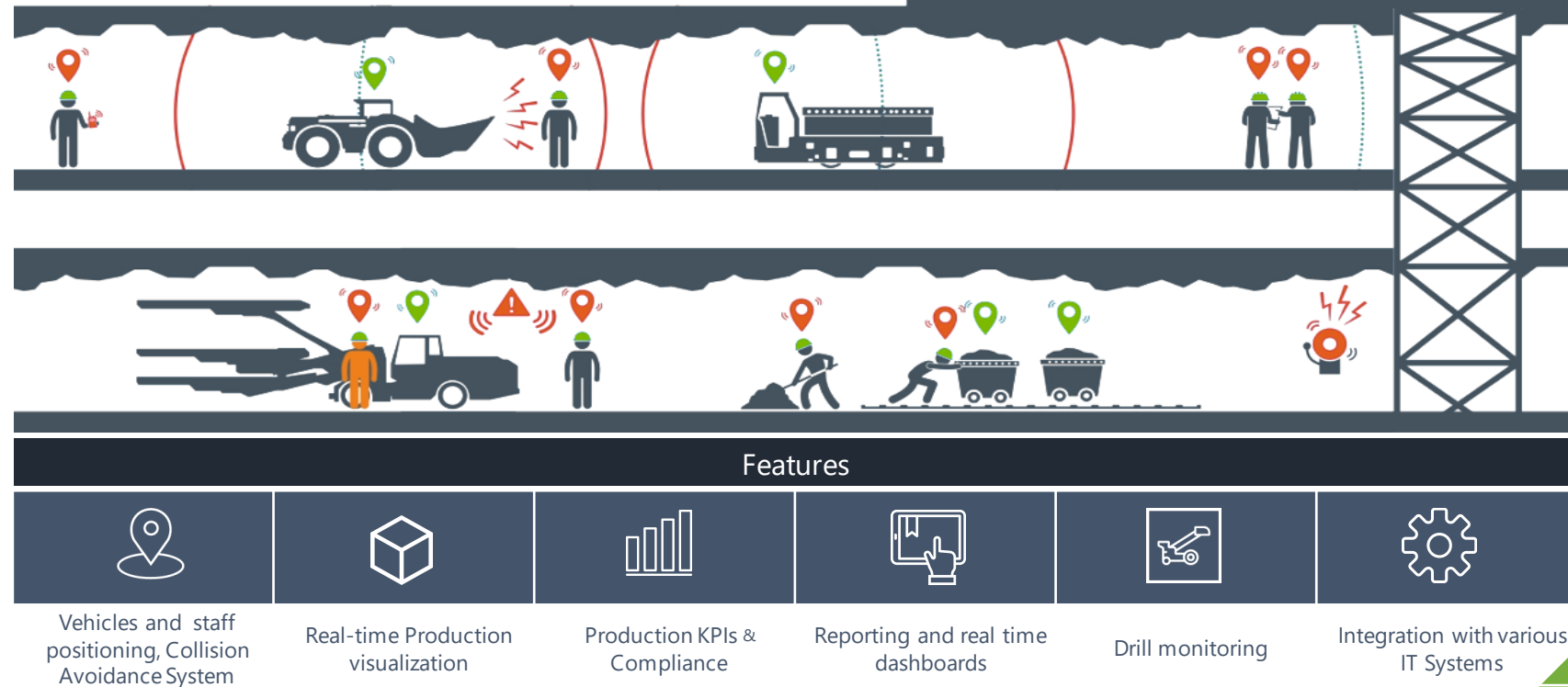
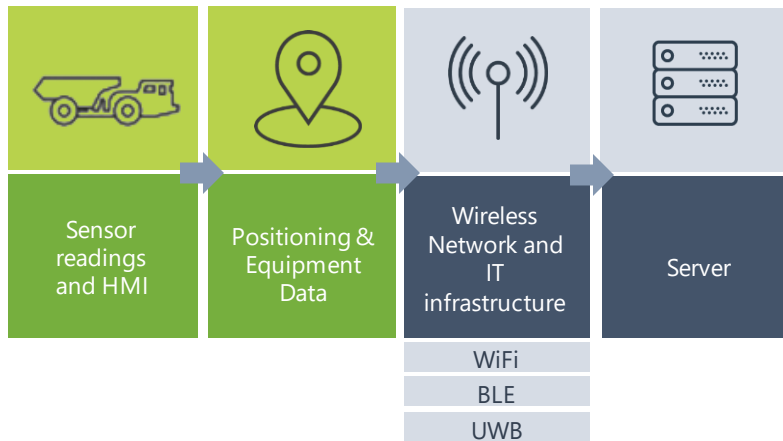
**C**ollision avoidance

**B**roadcast of emergency messages

**H**azardous zones breach alert

**A**utomatic man-down alert

## Architecture







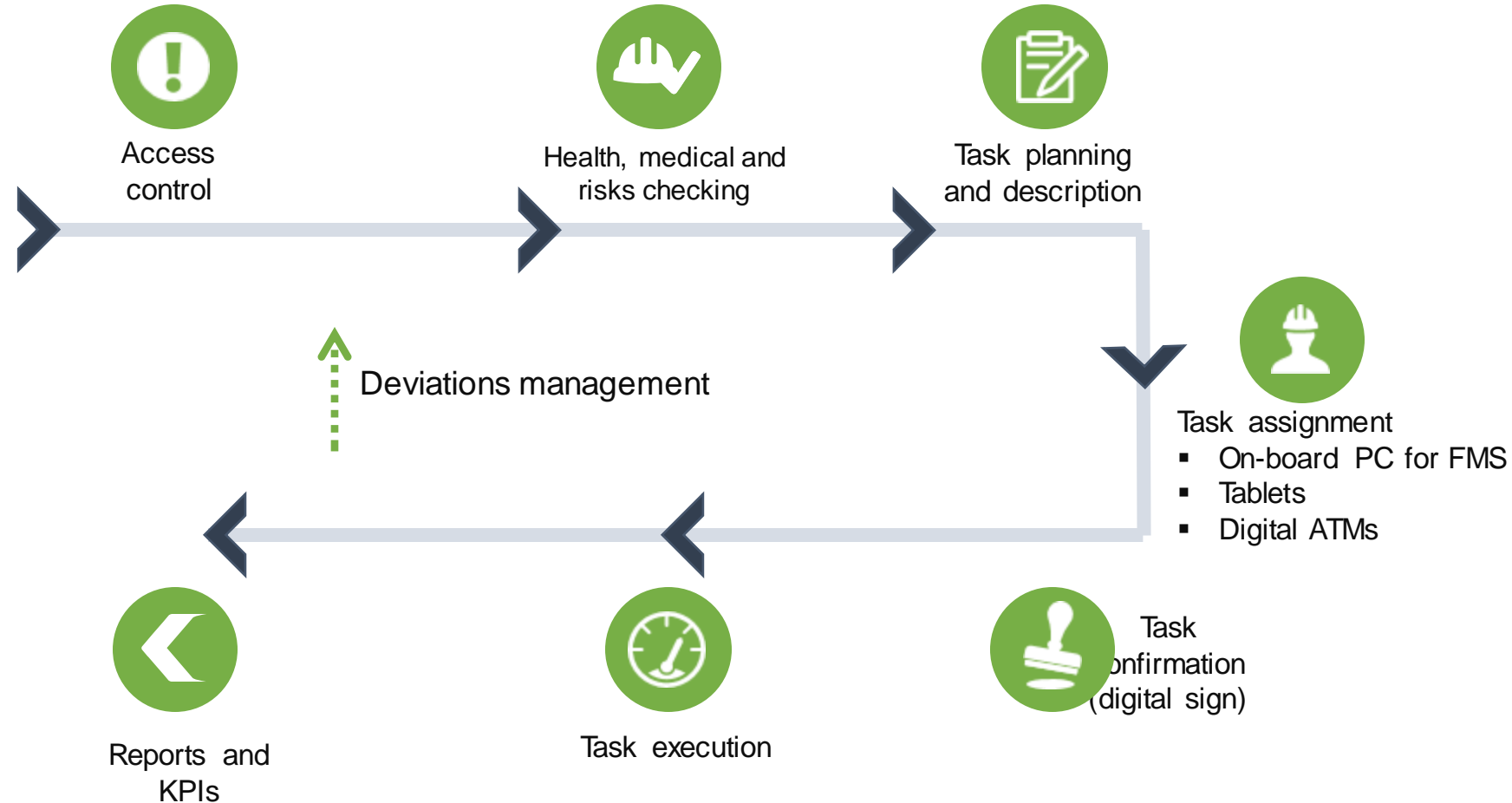
# Zyfra Work & Safety Management

[zyframining.com](https://zyframining.com)

# Shift tasks management



**Zyfra Work&Safety management track and manage your personnel during all process of operations**



Reduced personal injuries and stops of production due to this

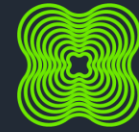
Repetitive safety violations: \$40%↓

LTIFR: Reduced by 2.5 times



**zyfra mining** | 20





zyfra mining

# Zyfra Smart Excavator System

[zyframining.com](https://zyframining.com)



# Bucket teeth monitoring



## Online status

Less than 5 seconds on analysis



## Alerting to machine operator

Optional: cabin screen, sound etc.



## Provides information to your systems

Manage better with more information



## Works in any conditions

Night, bad weather, sun glare



## Flexible settings

Works with any teeth number and size





# Boulder detection



## **Reduce crusher downtime**

Oversized rocks don't fall into the crusher



## **Energy saving**

More stable fragmentation in the crusher



## **Alerting the machine operator**

In the bucket, dump truck and face



## **Automatics signal to rock breakers**

To crush boulders in the face





# Fragmentation monitoring



## Plan-fact analysis in drilling and blasting

Verify and improve blasting calculations



## Manage mine effectiveness

Make processes transparent



## Know fragmentation in every truck

Manage better with more information



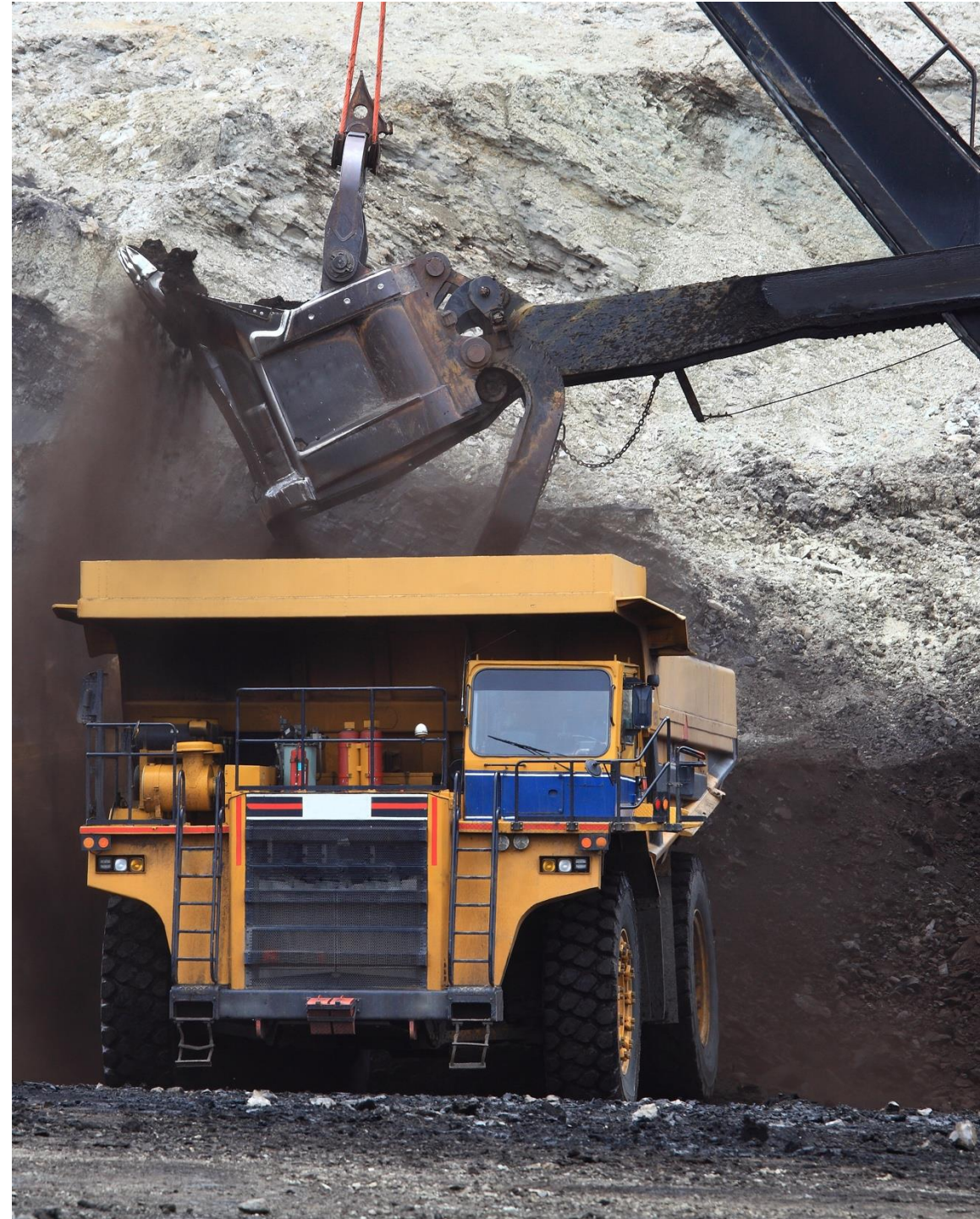
## View fragmentation on the map

FMS required



## Detect too large fragments / rock

Prevent getting it into the crusher







# Autonomous and teleoperated solutions

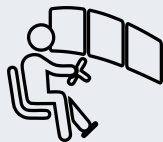
[zyframining.com](https://zyframining.com)

# ZR RoboTruck – Autonomous Haulage Solution

## Benefits



- Retrofit of any type of OEM truck
- mixed-OEM fleet capability
- Unified HW equipment minimizes spares



**Dump truck supervision & control from a single dispatch center for various OEMs**



**Possibility of quick pilot implementation - from 6 months**



**3 operation modes:**

- **Autonomous**
- **Tele-operation**
- **Manual**

## Key features

- autonomous loading with any type of loading equipment – rope shovels, excavators, loaders.
- automatic detection of spills on roads.
- autonomous unloading at dump edge, stockpile, crusher.
- when moving backwards: automatic detection of bench edge and previous piles.



## Productivity

**typ. +25%**

- 24/7 performance without shift change, lunch time, bio breaks, etc.
- Increased average speed
- Increased availability

## Operational costs

**typ. -15%**

- fuel and tire savings through optimal driving
- labor cost reduction

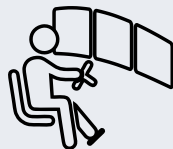


# ZR RoboDrill – Autonomous Drilling Solution

## Benefits



- Retrofit for any type of OEM drills
- Electrical and diesel drill compatibility.



**Drill supervision & control from a single dispatch center for various OEMs**



**Unified HW equipment minimizes spares**

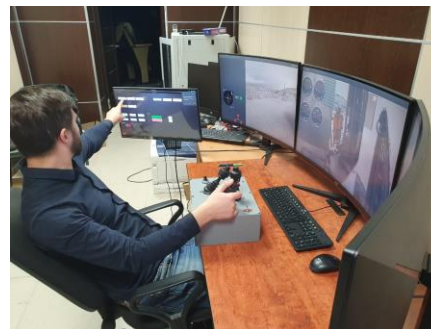


**Easy upgrade with same equipment:**

1. HP drill guidance
2. autonomous drilling + tele-operation
3. fully autonomous drilling

## Key features

- Fully autonomous drilling cycle – guidance, levelling, drilling.
- Fast adaptation to mine condition using AI and Big Data analysis to optimize autonomous drilling algorithms.
- Rod assembling automation (if not installed from OEM).



## Productivity

**typ. +20%**

- 24/7 performance without shift change, lunch time, bio breaks, etc.
- Increased availability

## Operational costs

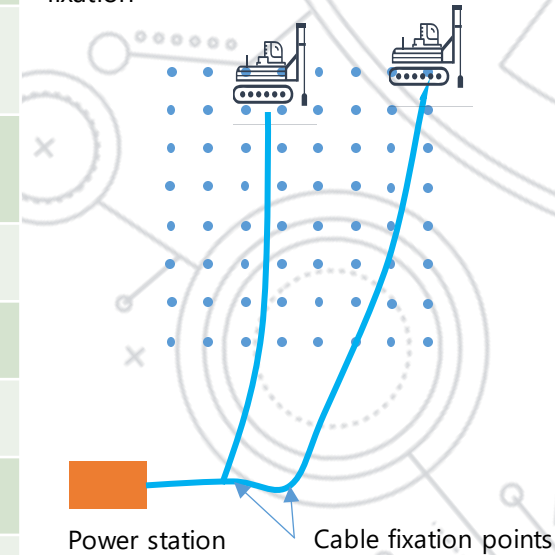
**typ. -15%**

- lower consumption of fuel, drill bits, spares, etc. through optimal drilling
- labor cost reduction

# Autonomous diesel vs electric drills

Autonomy features	Diesel drills	Electric drills
<b>Performance</b>		
Autonomous guidance between holes	+	+ (2-3 rows) <sup>1</sup>
Autonomous leveling and leveling during drilling	+	+
Autonomous drilling	+	+
Rod assembling and disassembling	+	+
Cable winding	Not required	reel <sup>2</sup> or manual
<b>Safety</b>		
People and obstacle detection	+	+
Bench edge detection	+	+
Emergency stop button, access control	+	+
Cable detection	Not required	+ <sup>3</sup>

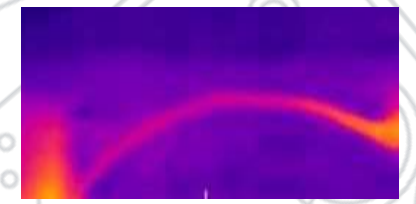
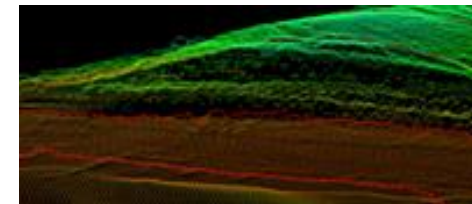
1) status quo: cable to be fixed in different positions to avoid spillage into drilled holes, usually manual fixation



2) Cable reel installation

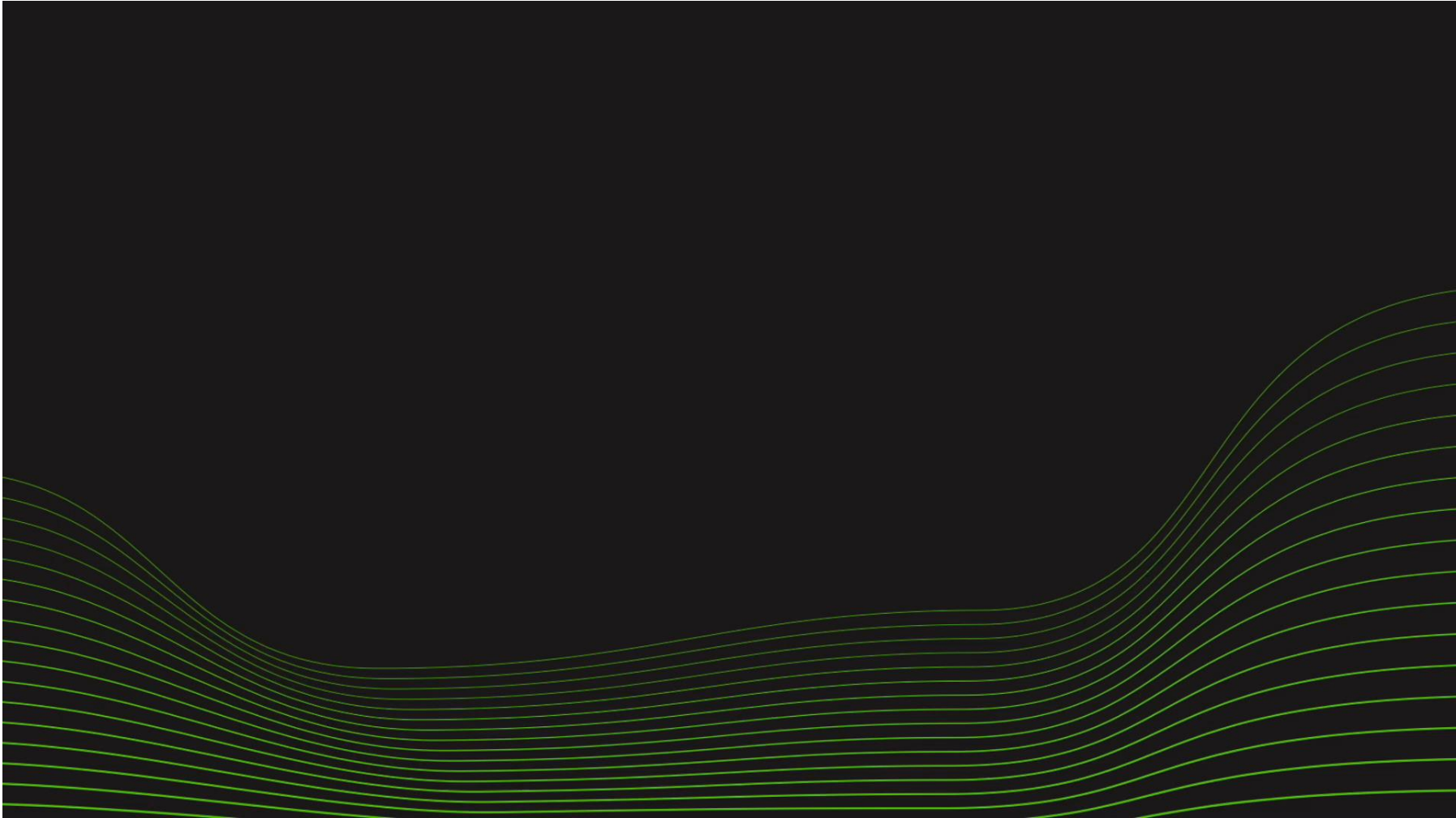


3) Cable detection – combination of Lidar and thermal camera vision to detect cable location – and suited movement of drill rig





# Demo Video







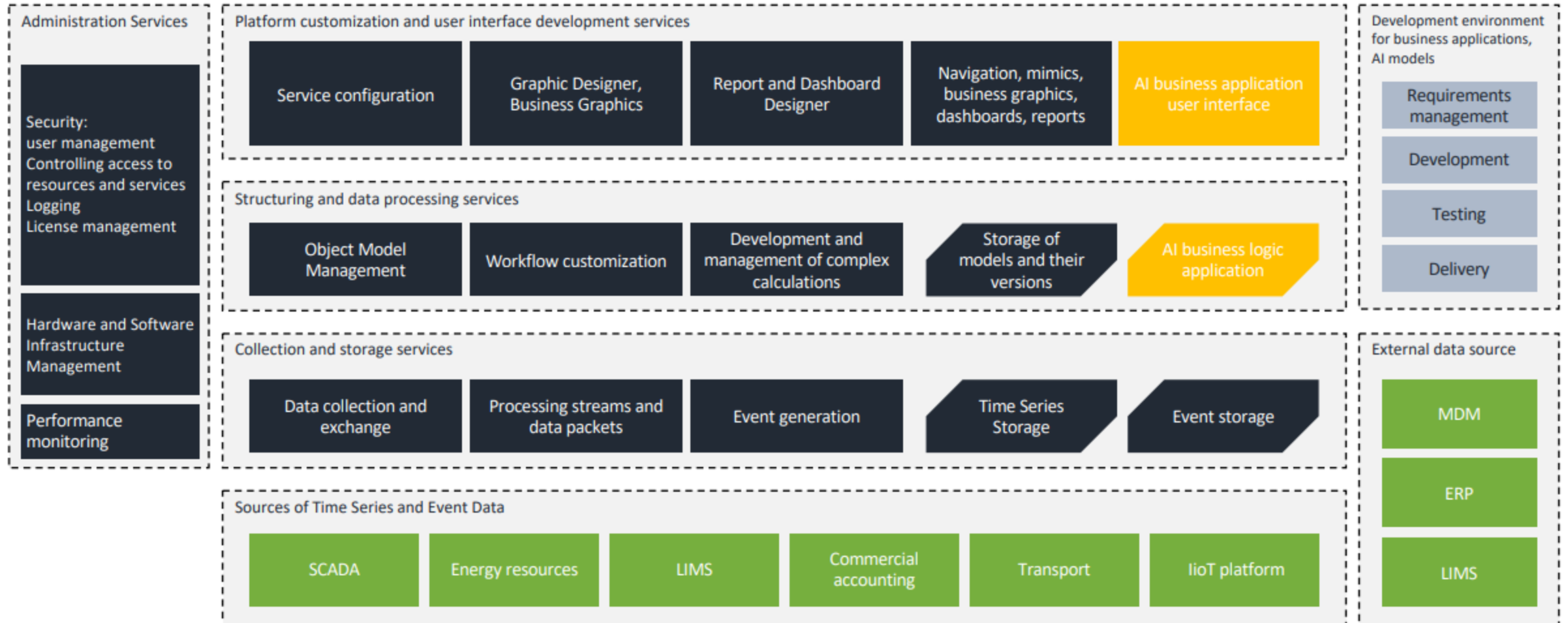
**Zyfra IIOT  
Platform**  
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# Zyfra IIOT: Integrate models of all level

## Functional architecture

### Portal





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