FLEET MANAGEMENT SYSTEM AUXIL

AUXIL FLEET MANAGEMENT SYSTEM

Drilling → Charging → Excavation → Transportation → Blending Stacking Crushing
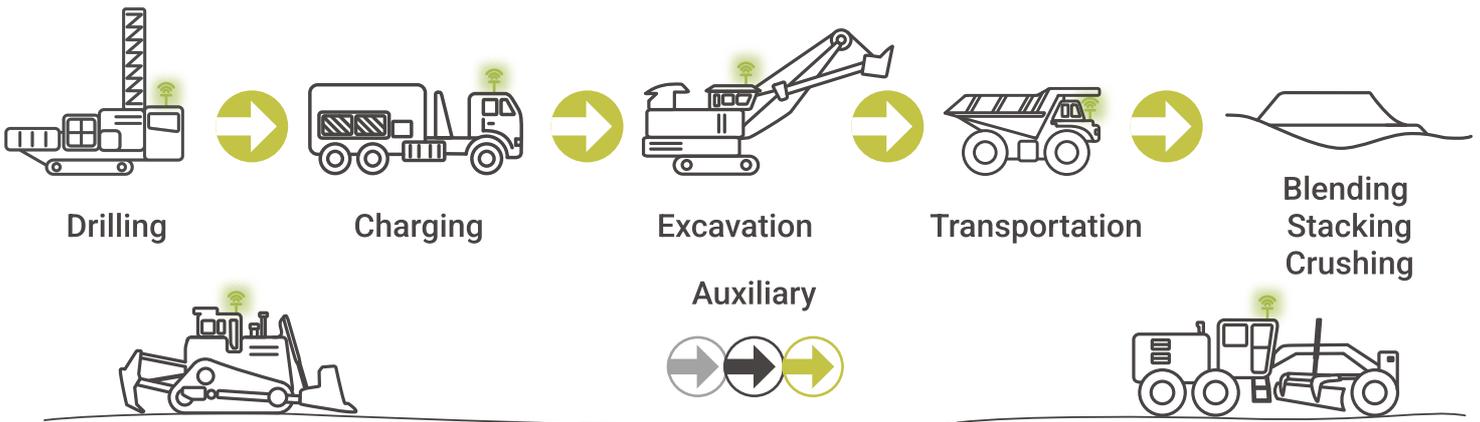
Auxiliary

PROFESSIONAL FLEET MANAGEMENT SYSTEM FOR MINING OPERATIONS. A DIGITAL TOOL FOR MANAGING OPERATIONS WITH OPEN SOURCE CODE

WHY AUXIL

- The system software is developed with consideration of the specifics of mining operations, with an understanding of operational tasks and knowledge of the architectures of other mine fleet management systems
- The system does not lose data when communication is lost. Fleet management is not disrupted when the connection with equipment is interrupted
- The system has open-source code and can be modified by third-party or in-house specialists without the involvement of the vendor company
- The field application software can be installed on various commercially available hardware. This simplifies implementation and reduces costs
- The available functionality covers all mine operation processes, allowing all main equipment in the mine to be managed within a single information space
- The mining dispatcher supervises system operation, while the system itself manages operations into the mine. The dispatcher manually handles only non-standard situations
- The system can be applied or adapted for use even in non-metallic quarries or on construction sites where construction materials are transported

Dispatcher

Reliability engineer

Shift supervisor
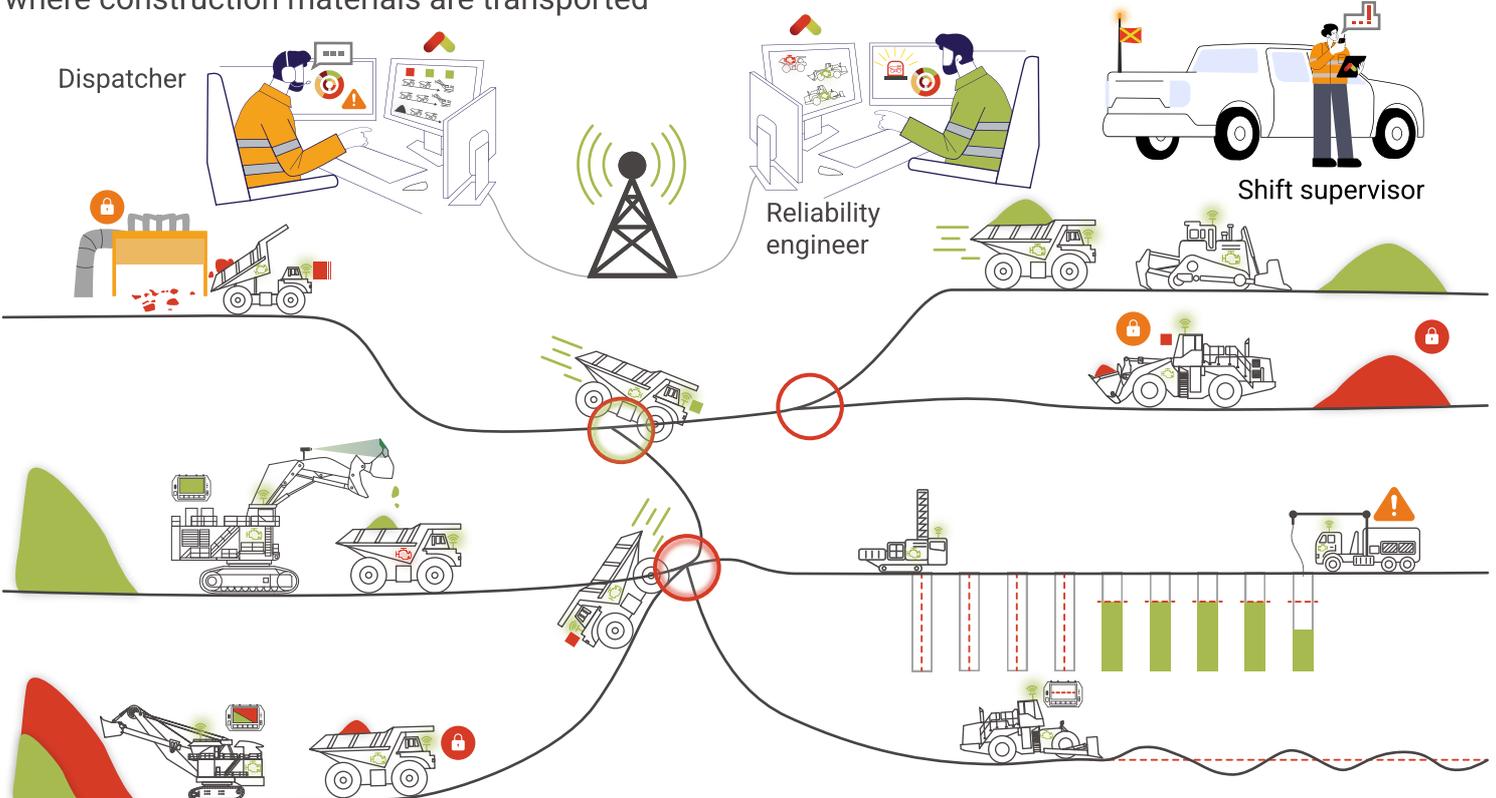
IMPROVEMENTS TO EXPECT

The use of the system makes it possible to increase process transparency and improve the overall efficiency of equipment operation in the mine. Without the system, personnel in the mine work without precise tasks for each operation and without automated recording of operation durations. With the system in place, data collection and task assignment are performed automatically with control of their duration.

Operational efficiency is improved, which is achieved through:

➡ Reduction of equipment downtime

- **Trucks** - in queues, during shift changes, at refueling, and during other technological operations
- **Excavators** - due to more even and accurate allocation of trucks, as well as as a result of reduced truck idle time
- **Auxiliary equipment -** due to real-time monitoring of its downtime

  In the case of any downtime, the system monitors its duration and notifies the dispatcher if it deviates from the defined limit.

➡ Improved quality of work execution

- **Through instrumental control** of operation execution and the ability to make adjustments in real time
- **With high-precision systems,** the system helps the operator perform work with centimeter-level accuracy without surveyor marking, and allows the engineer to remotely monitor execution

➡ Reduction of losses and dilution

The system allows control of the material type and valuable component grade in the moved material from the moment of blasting through to unloading at the crusher or stockpile area

➡ By improving forecasting of production indicators, the budget management process is improved, including a reduction in deviations between plan and actual results

➡ Lower equipment maintenance and operating costs

- **The number of emergency repairs is reduced**
- Through data processing and active actions, **cases of improper equipment use are reduced**

PROCESSES THAT CAN BE MANAGED THROUGH THE SYSTEM

- Organization of truck–shovel fleet operations
- Material control during loading
- Control of haulage routes
- Any downtimes
- Refueling
- Coordinates of excavator face boarders and bench eleveation
- Auxiliary equipment operations
- Charging of blast holes
- Drilling
- Fuel usage
- Operator fatigue monitoring
- Remote real-time analysis of equipment technical condition
- Control of bucket tooth and other bucket element losses

TECHNICAL COMPONENTS OF THE SYSTEM

- Office application accessible via **any browser**
- Server software
- Reporting and data visualization system
- Field software applications installed on onboard computers
- Onboard computers installed on the equipment
- Communication and GPS antennas
- Video cameras with the possibility of using machine learning technology

TO OPERATE THE SYSTEM, THE FOLLOWING IS REQUIRED

➡ People

- **People who will operate the system.** If equipment management is required, at least one dispatcher per shift will be needed. If only data collection from mobile equipment is required, the system will operate automatically
- **A specialist for system maintenance.** In mining operations, equipment works in harsh conditions, which leads to the need for physical maintenance of system components. To configure the FMS components, the specialist may have basic training. If there is a small amount of equipment, a hardware specialist can also support the software part; if there is more equipment, an IT engineer will be required.

➡ A wireless data transmission network

5G, LTE, or Wi-Fi is suitable. A mixed network can be used, for example public 4G (LTE) in some areas and the company's Wi-Fi network in others

➡ System infrastructure elements

On-site servers or cloud resources for deployment of the system itself and the reporting system
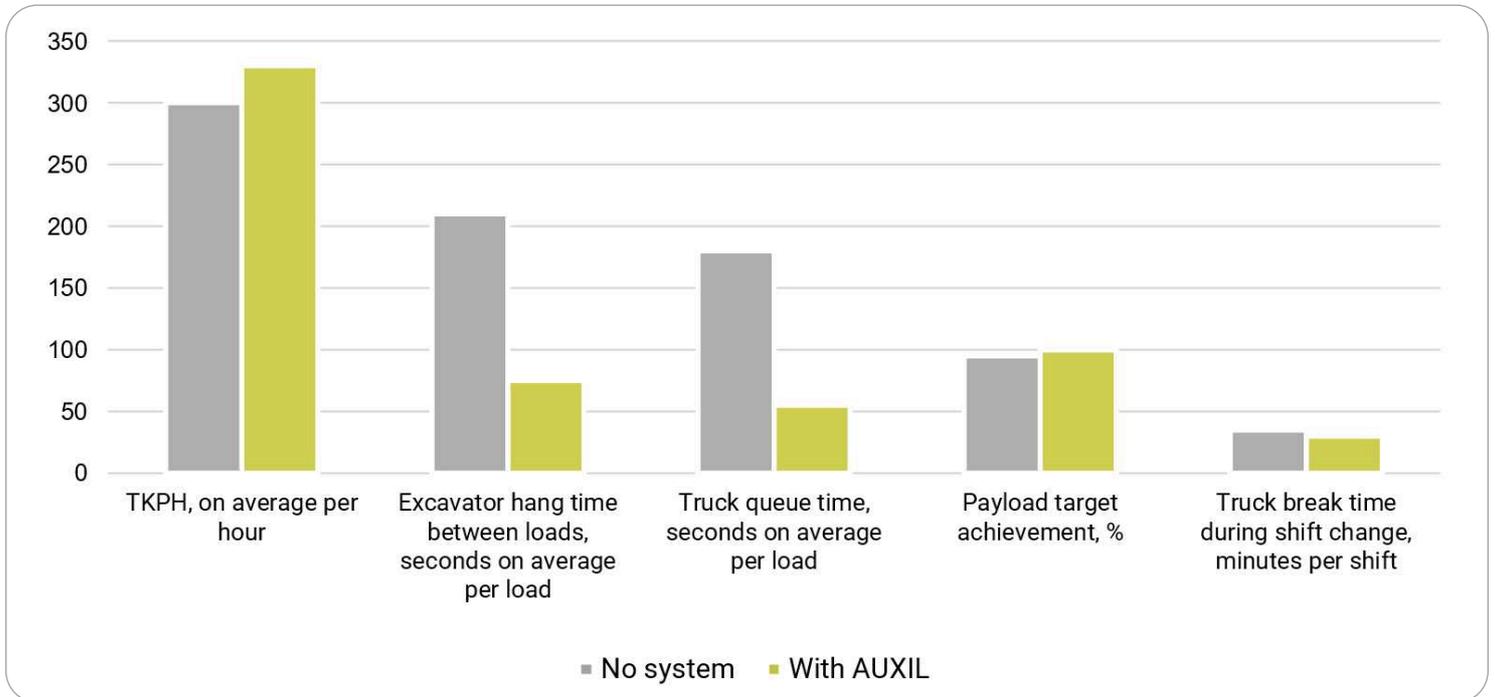
➡ Allocated mining equipment time for installation of the system hardware

Typically, installation takes one shift per excavator and half a shift per truck

RESULTS

Equipment performance indicators at the mine are improved. The following key indicators: TKMH, idle time of haul trucks and excavators during the operating cycle, utilization of equipment payload capacity, and equipment downtime during the breaks.

Bar chart comparing "No system" and "With AUXIL" across: TKPH, on average per hour; Excavator hang time between loads, seconds on average per load; Truck queue time, seconds on average per load; Payload target achievement, %; Truck break time during shift change, minutes per shift.

WITH ALL SYSTEM COMPONENTS IN PLACE IT'S POSSIBLE TO MANAGE AND CONTROL A WIDE RANGE OF MINE OPERATING PROCESSES, WHICH INCREASES SAFETY AND EFFICIENCY

SYSTEM TOOLS

The core functionality of the system includes the Routes, Map, and Reports applications, as well as applications for the equipment with high-precision GNSS hardware. The Routes application is used to manage the equipment fleet. The Map application is used to track equipment locations. Applications for working with high-precision equipment make it possible to gain a detailed understanding of the quality of equipment operation.

Depending on the implemented set of functionalities, the following may be available:

- Reports
- High-precision management for excavators, loaders, and dozers
- High-precision system for drills
- Operator fatigue monitoring system
- Missed bucket tooth monitoring system

- The tool allows tracking truck routes and managing their distribution between loading and dumping locations. For excavators, this interface makes it possible to configure both workload and constraints (productivity, number and types of trucks), as well as assign material types. In the menu, the dispatcher can change equipment statuses
- The application includes a window for handling exceptional situations that are excluded from automatic processing due to their significant impact on the process
- The application allows monitoring of key performance indicators. Quantitative metrics help manage productivity to achieve the best results
- Location configuration functionality includes dump locations, special areas, and the garage.
  For dump locations, it is possible to define parameters of the accepted material, maximum throughput, or proportions of accepted materials (when they are mixed)
  For special areas, their type is defined (shift change area, garage, fueling area, etc.); it is possible to set the time for changing their status, maximum capacity, and configure other logic.
  Areas are defined as separate entities, have unique IDs, and equipment automatically appears at the corresponding secton after arriving there
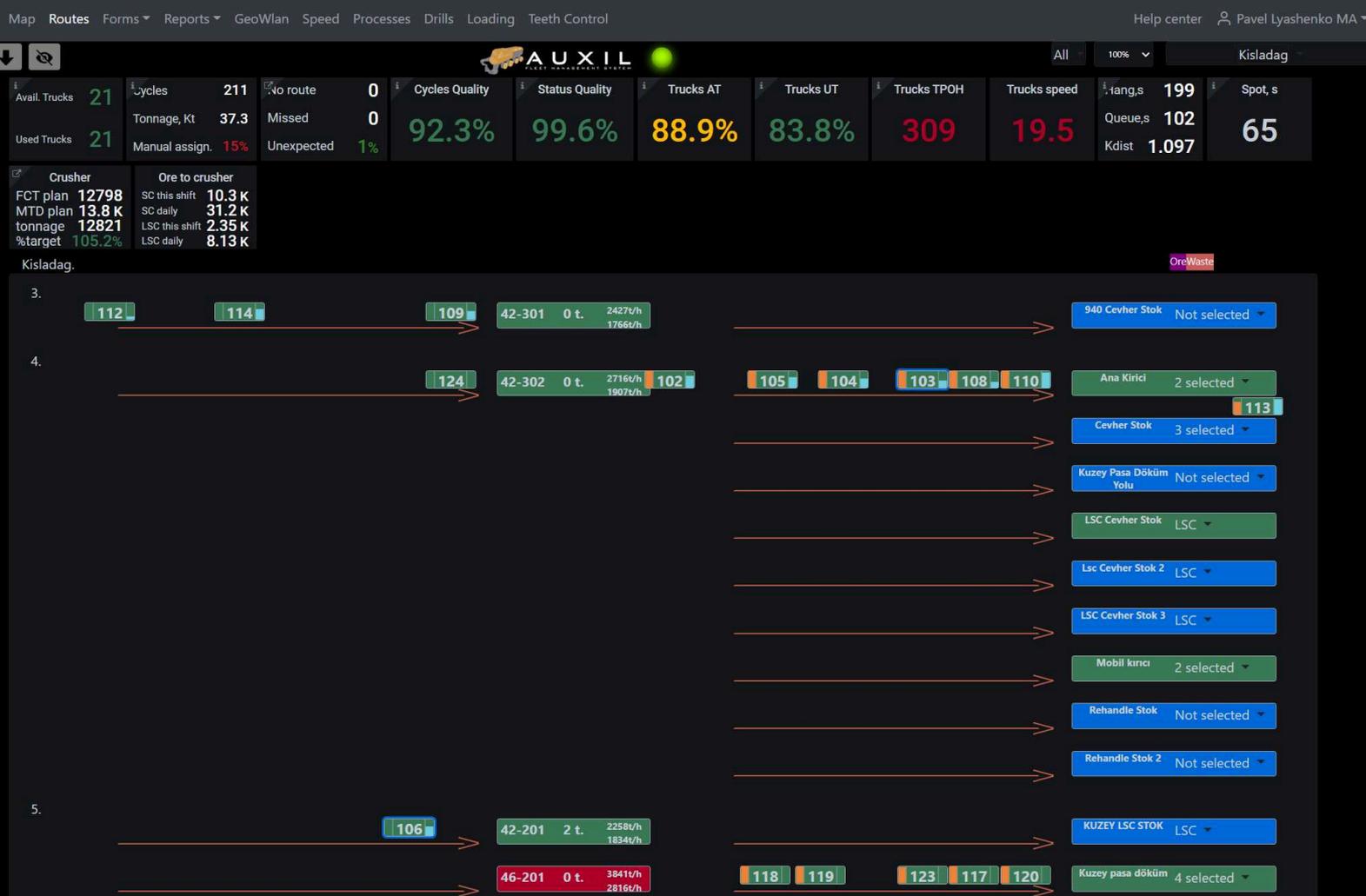
EXCEPTIONS WINDOW

In case situations arise that require dispatcher intervention in the system logic, a message appears in a dedicated window. The message may be accompanied by a sound.


MAP

Using the map, it is possible to determine the location of equipment, check distances, monitor compliance with haul routes and roads, and track other information that requires visual representation on the plan. Management functions can also be performed.

REPORTS

Reports allow users to review performance data. The set of reports is presented in the form of charts, graphs, and tables. The standard package includes the necessary set of reports for operations and can be integrated into the customer's existing reporting system, if available. The standard set can be extended at the customer's request. The provided reports can be modified by the customer without involving Mining Art. Data from the system can be integrated into other corporate reporting systems. To reduce the cost of system implementation and operation, the reports and data visualisation are built on open-source software.The reports help identify processes that require improvement.
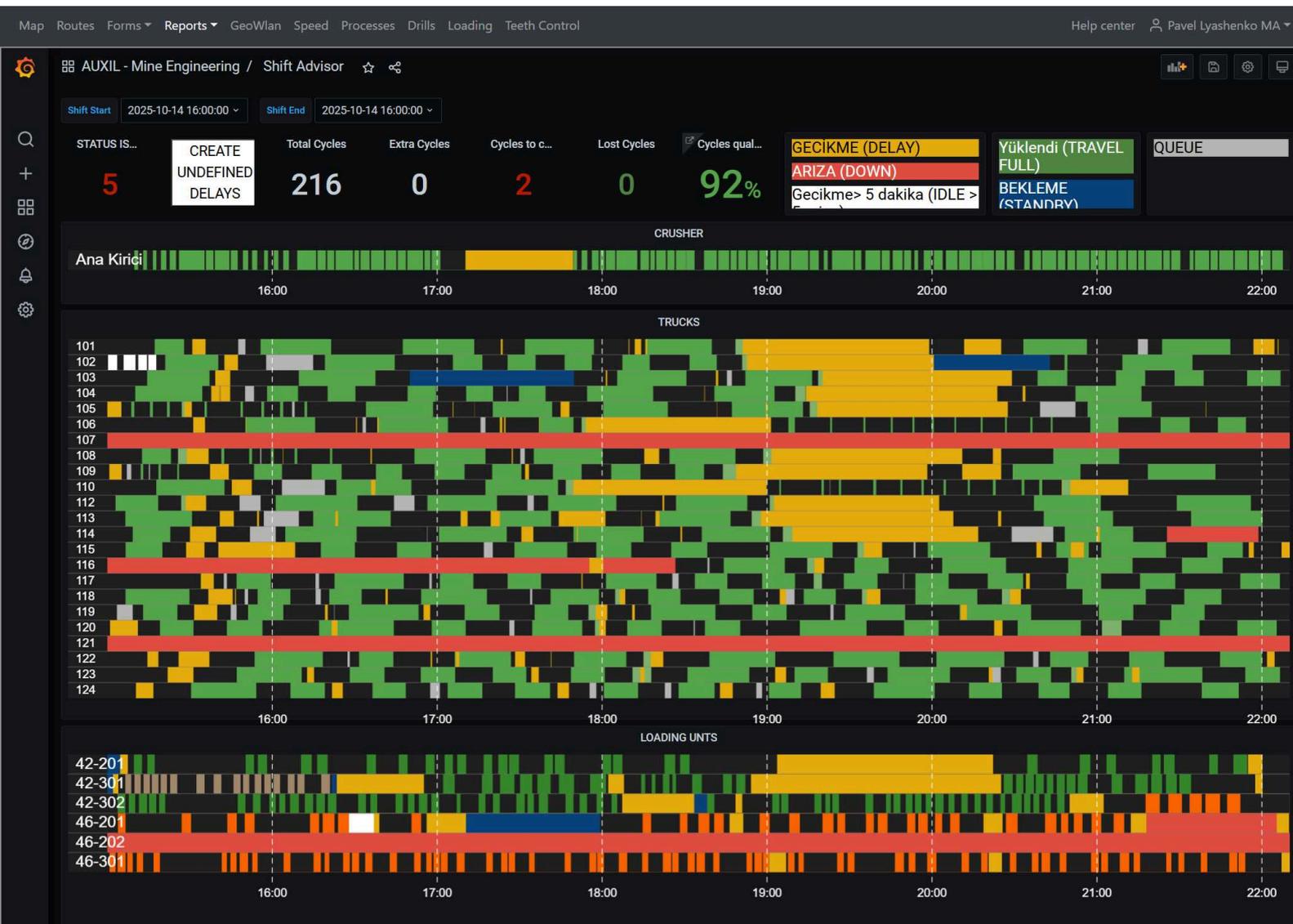
OPERATOR'S INTERFACE

The operator interacts with the system through a mobile application on the onboard computer installed in cab of mining equipment. Using the onboard computer, the system receives data from the equipment and from the central system server. The operator performs only non-automated actions; this is a small number of operations, since the main functions are automated. Through the mobile application, the operator receives tasks (assignments), records the start and end of shifts and breaks, enters a personal employee ID, and sends and receives short text messages. In an emergency situation, the operator can send an alarm signal to the dispatcher or receive a general alarm signal.

THE SYSTEM CAN BE INSTALLED ON ANY EQUIPMENT FOR THE OPEN-PIT MINING

● **Navigation**
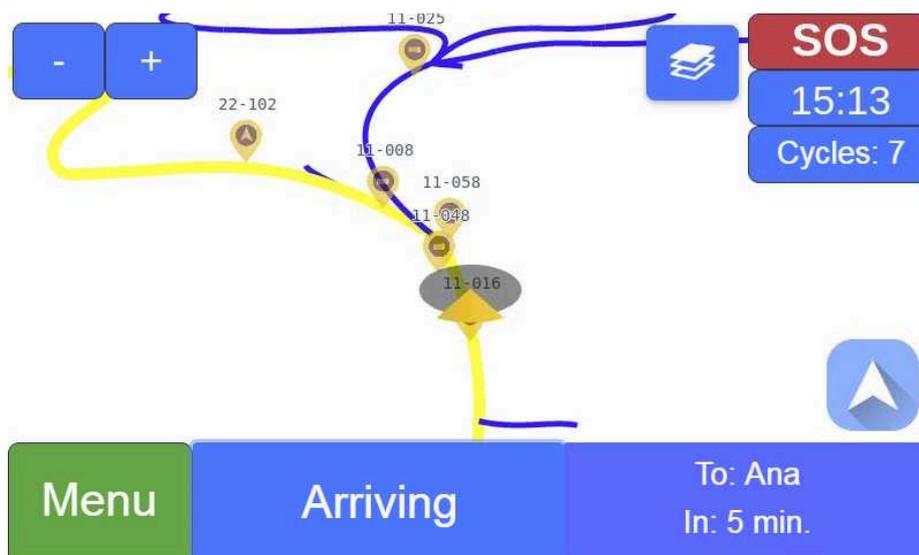
OPERATORS HAVE ACCESS TO THE NAVIGATION WITHIN THE PIT

ROI AND TIMING

- The standard payback period of the system ranges from six months to one year. This depends on the speed of implementation and how quickly personnel adapt. The technical part of the implementation takes the least amount of time in the overall process
- System adaptation, process changes, and refinement of statistical data make up the main part of the project. If all processes at the mine are already well established, the system will begin delivering maximum results immediately after completion of the technical implementation phase

ONBOARD COMPUTERS

We have selected several rugged onboard computers available on the market that we recommend for use. Installation of the onboard computers in the cab is well established and is performed quickly and with high quality. We propose optimal mounting locations and a set of brackets to ensure maximum convenience and reliability in operation. The computers used are resistant to vibration and harsh operating conditions.

THE SYSTEM SOFTWARE CAN BE INSTALLED ON MANY MODELS OF INDUSTRIAL COMPUTERS

The system allows fleet management both directly within the mine and outside of it, provided that connectivity is available. Equipment operating over long distances will be included in a single information space. Data exchange between mobile devices and the server can be carried out via public cellular networks.

AUXIL

PRIVATE LTE   PUBLIC LTE   WI FI

FUEL
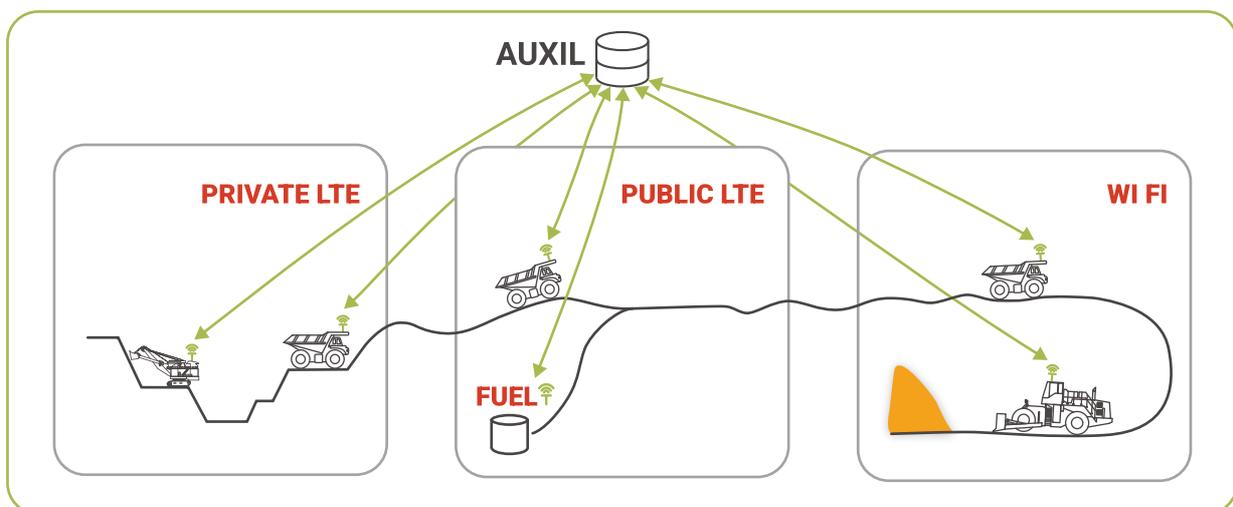
IF THE EQUIPMENT LEAVES THE PIT FOR A LONG RIDE, IT WILL REMAIN CONNECTED

AUXIL CONFIGURATIONS

➡️ **Basic set of functions with low-precision positioning**

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➡️ **Extended set of functions with high-precision positioning**

For:
- Excavators (with bucket positioning system)
- Drills
- Loaders
- Dozers

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➡️ **Additional systems:**

- Missed tooth and bucket component detection system
- Operator fatigue monitoring system
- Fuel level monitoring system
- Integration with enterprise systems (for example, weighbridge systems)

| Videocameras | Fuels sensors | High-precision antennas |

LIST OF MODULES

The system consists of modules. Some of them are standard, while others are separate additional products.

➡️ **Standard (core AUXIL functionality):**

- Pitmap
- Routes
- Cycles record
- Route and unloading location control
- System interfaces for tablet computers on any mining equipment
- Automatic task assignment
- Load control
- Automatic tracking of any downtime
- Automatic allocation of trucks to excavators
- Material blending at unloading locations
- Classifier for detailing types of downtime
- Abnormal situation monitoring
- Equipment condition monitoring
- Real-time monitoring of production indicators (KPI)
- Equipment utilization monitoring
- Speed control
- Pre-start checklists

- Shiftchange and other brakes management
- Refueling management
- Locations management
- Network quality monitoring
- Chatting
- Reporting
- In-pit navigation
- Data export to ERP
- Auxiliary equipment management

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Additional:

- High-precision positioning for drills
- High-precision positioning for shovels
- High-precision positioning for loaders
- High-precision positioning for dozers and graders
- High-precision positioning for charging trucks
- Teeth control
- Third party systems integration

MINING ART – YOU PAY THE VALUE ONLY

- **Availability** - We use hardware in our solutions that are openly available on the market, which reduces the overall project cost and simplifies subsequent maintenance.

- **Reliability** - All equipment comes with a manufacturer's 1-2 years warranty. Our software meets 99.9% SLA requirements.

- **Flexibility** - Our software is open to modifications tailored to your business needs. You can make adjustments independently.

- **Transparency** - Forget about subscription fees for technical support and services. You pay for the provided services only.

- **Experience** - Since 2015, we have been developing and implementing our own software solutions for the mining industry.