



Unmanned transportation technologies promote the sustainable development of the mining industry

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TAGE IDRIVER Jul, 2021

Why does mining matter?



70% agricultural resources come from mining
85% raw material comes from mining
95% energy comes from mining

300,000 years ago, the homo sapiens
Obtained resources by gathering

10,000 years ago, humans after the agricultural revolution
Obtained resources by agriculture and gathering

Today, WE
Obtaining resources by agriculture and gathering **STILL!**

Mining is our primary means of gathering.

Why do open-pit mines need unmanned solution

4 prominent pain points,
unmanned solution is urgently needed



Labor Shortage

Remote and harsh working condition causes labor shortage



Rising cost

High labor and management cost, High operation and maintenance cost



Low Efficiency

Low intelligence level, lack of data-based management means



Frequent Safety incidents

Harsh working environment, frequent safety incidents

Mining area is the ideal scene for
autonomous driving



Mining area characteristics

Enclosed, and well controlled

Semi-fixed lane

Low speed, P2P

Mining area is ideal for unmanned vehicle



旷谷™ *Unmanned Valley*

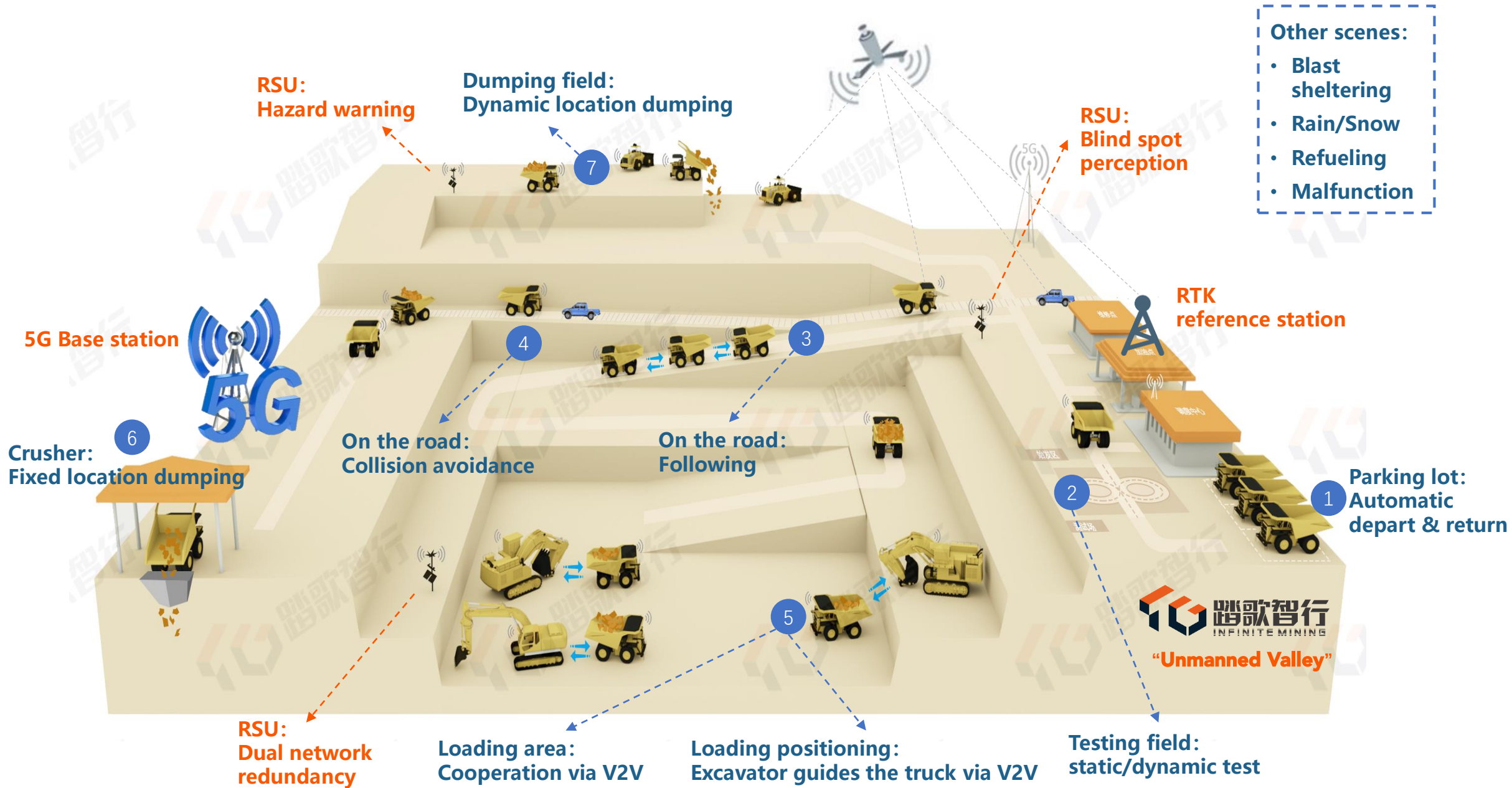
幽谷空旷，唯机械朝夕而作
无人，无险，旷古而烁今

“*Unmanned Valley*” , TAGE’ s unmanned solution for open pit mines,
is a complete set of unmanned transportation system consists of :

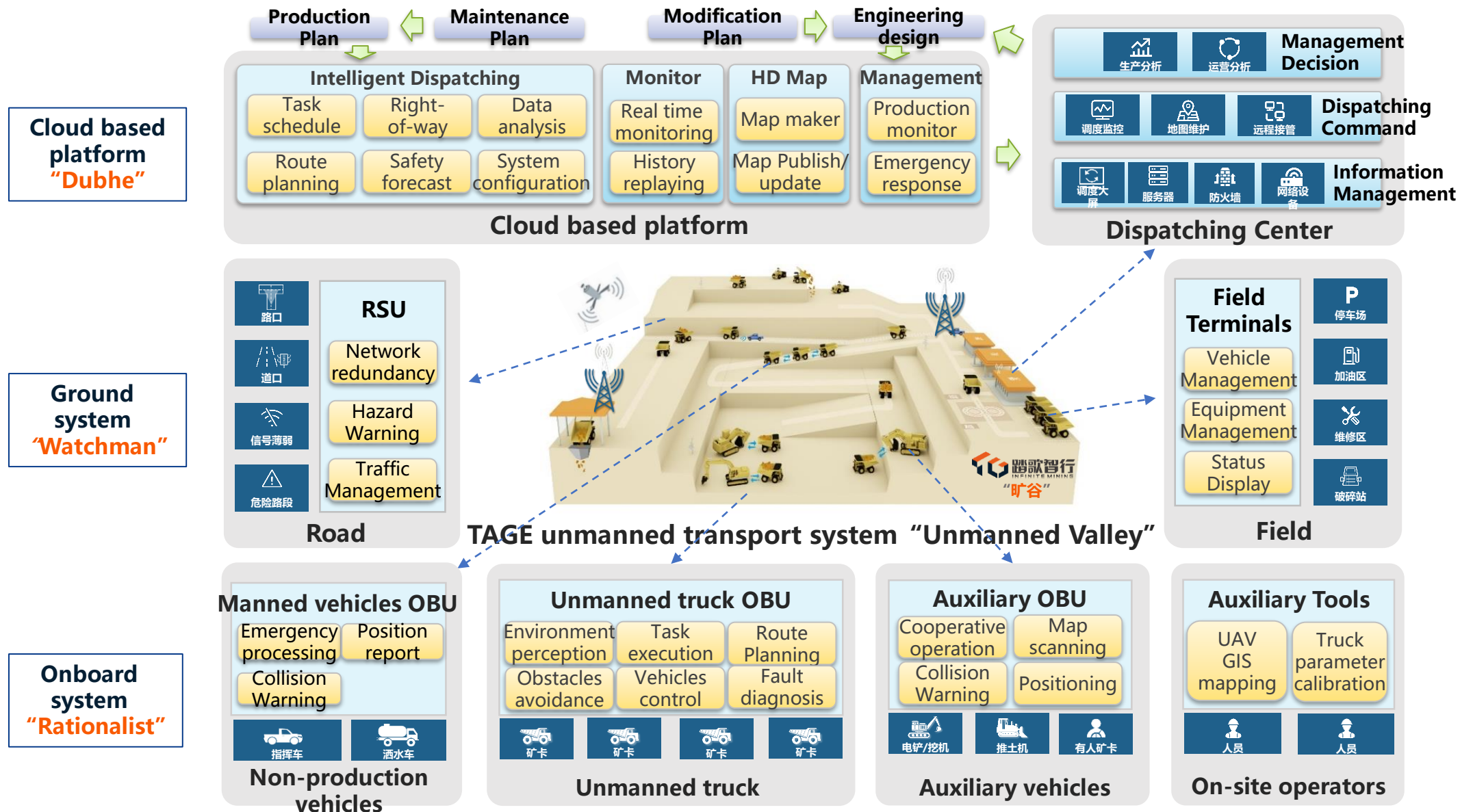
- Onboard system – “*Rationalist*” ,
- Ground system – “*Watchman*” ,
- Cloud based fleet management system – “*Dubhe*” .



Overview of the "Unmanned Valley"



The "Vehicle - Ground - Cloud" system structure



睿控™ 

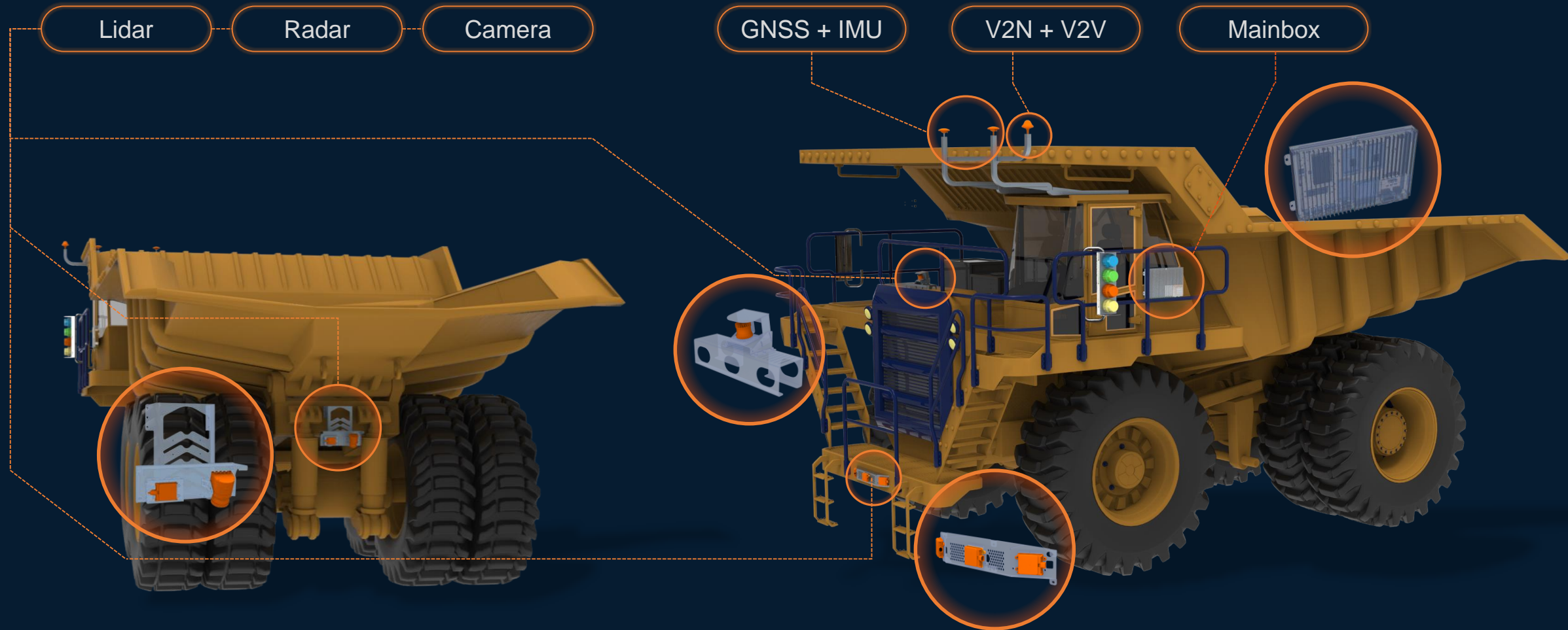
Rationalist

睿者谋，控者行
谋而后行，无所不达

The onboard system "**Rationalist**" consists of unmanned truck terminal, auxiliary vehicles' terminals (excavator, dozer, etc)



HW configuration has been optimized to adapt to the open-pit mining environment



"Rationalist" unmanned truck OBU



V2X and Positioning

Perception



HMI



MainBox



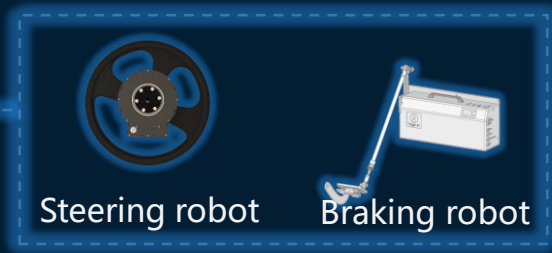
Remote stopper



Vbox



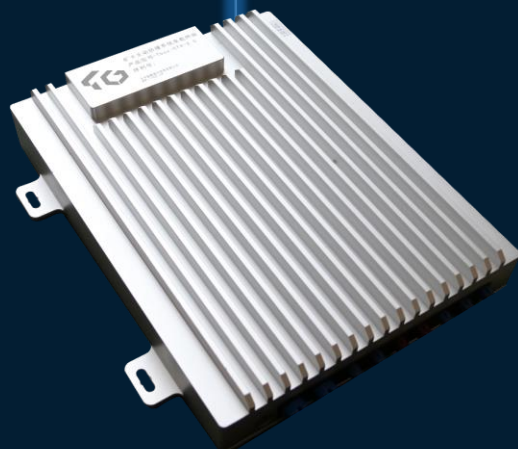
Wire controlled chassis



Steering robot

Braking robot

"Rationalist" auxiliary vehicle OBU





御疆™



Watchman

疆内无人之境
御者持炬执剑
顾而守之

The ground system "**Watchman**" includes road side units (RSU) and various ground control terminals (refueling area, crushing station, maintenance area, etc.) which are the safeguards for the stable operation of the system.



"Watchman" ground system



Roadside unit (RSU)

- HD video monitoring via 5G
- Intersection blind area perception
- Regional dispatching based on edge computing
- Relay station for dual network redundancy



Crusher

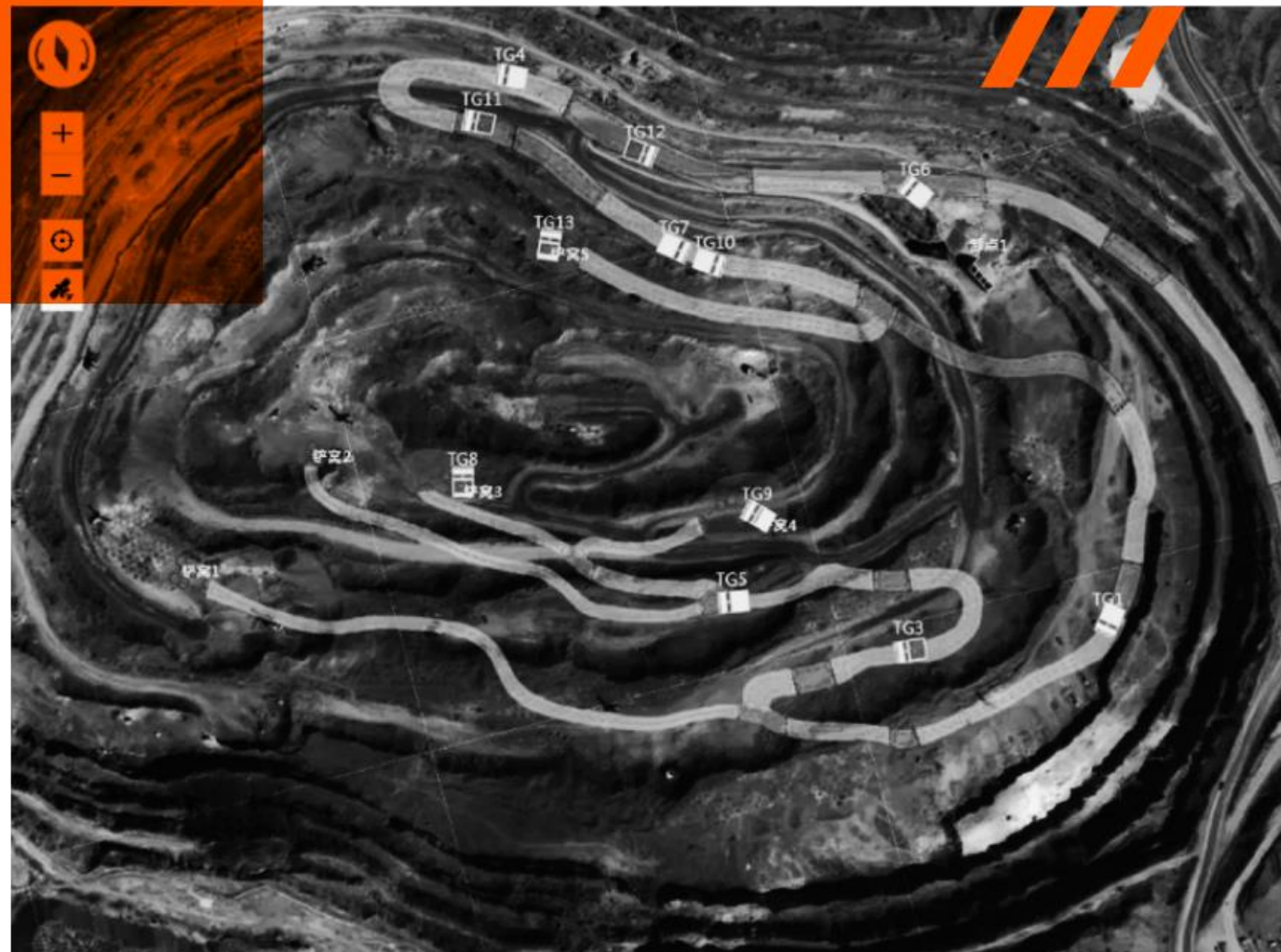
- Crusher status management
- Unloading position dynamic allocation
- Parking area queuing management
- Remote emergency braking



Dubhe

北斗指四向，天枢驭北斗
四向二十八宿，皆听号令

As the intelligent management center of the unmanned transportation system, the cloud based platform "**Dubhe**" is managing dispatching planning, right-of-way command and centralized monitoring to provide safe and reliable cloud services for the unmanned transportation system.



智慧矿山无人驾驶调度中心



系统登录

👤 用户名

🔒 密码

记住用户名密码

我已阅读并接受 [《服务条款》](#)

登录

"MineSIM" simulation system



矿区仿真

地图

统计

作业 79 趟 05:43:34 实时效率



稀土矿 + 停车1

■ 车道标注 模型速度 x



20,012.30秒 01/01/2020 03:45

|| ■ :

↑ ⊗ > < > ... ▾

← 135% viewMap ▾

控制台 事件

...6045 项目删除...

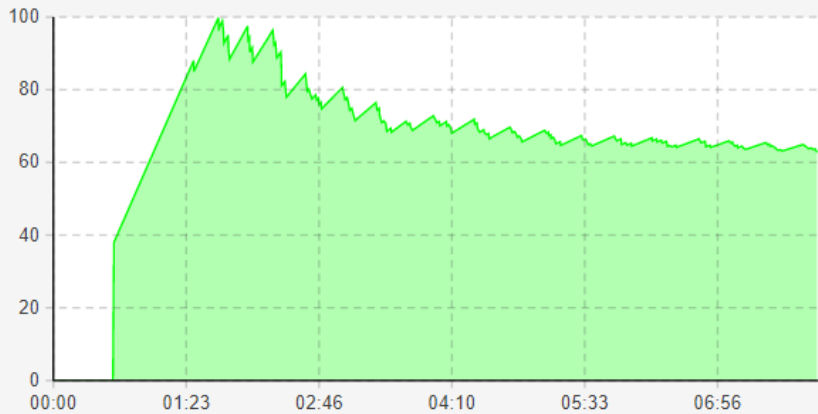
- 2020-07-02 16:47:08 TG11 收到路权应答: 道路类别2, 道路方向1, 道路编号18, 申请结果1
- 2020-07-02 16:47:08 TG6 发送道路87路权释放申请
- 2020-07-02 16:47:08 TG6 道路87路权释放成功
- 2020-07-02 16:47:08 TG3 发送道路81路权释放申请
- 2020-07-02 16:47:08 TG3 道路81路权释放成功
- 2020-07-02 16:47:08 TG11 发送道路101路权释放申请
- 2020-07-02 16:47:08 TG11 道路101路权释放成功
- 2020-07-02 16:47:09 websocket客户端收到新消息: [TG7]由[等待卸车]由[取煤]转为[延时] 2020-07-02 16:47:04
- 2020-07-02 16:47:09 websocket客户端收到新消息: [TG3]由[延时]转为[取煤] 2020-07-02 16:47:04
- 2020-07-02 16:47:09 TG6 发送道路81路权申请
- 2020-07-02 16:47:09 TG6 收到路权应答: 道路类别2, 道路方向2, 道路编号81, 申请结果1
- 2020-07-02 16:47:10 TG3 发送道路53路权申请
- 2020-07-02 16:47:10 TG6 发送道路59路权释放申请
- 2020-07-02 16:47:10 TG6 道路59路权释放成功
- 2020-07-02 16:47:10 TG9 收到路权应答: 道路类别2, 道路方向2, 道路编号88, 申请结果1
- 2020-07-02 16:47:10 TG5 发送道路58路权释放申请
- 2020-07-02 16:47:10 TG5 道路58路权释放成功
- 2020-07-02 16:47:11 TG5 发送道路87路权申请
- 2020-07-02 16:47:11 TG11 发送道路18路权释放申请
- 2020-07-02 16:47:11 TG11 道路18路权释放成功
- 2020-07-02 16:47:12 TG1 收到路权应答: 道路类别2, 道路方向2, 道路编号53, 申请结果1
- 2020-07-02 16:47:12 TG9 发送道路30路权申请
- 2020-07-02 16:47:12 TG9 收到路权应答: 道路类别1, 道路方向2, 道路编号30, 申请结果1
- 2020-07-02 16:47:12 TG7 收到路权应答: 道路类别2, 道路方向2, 道路编号88, 申请结果1
- 2020-07-02 16:47:12 TG11 发送道路80路权申请
- 2020-07-02 16:47:12 TG9 发送道路88路权释放申请
- 2020-07-02 16:47:12 TG6 道路88路权释放成功

23.27秒/秒 事件每秒: 885 帧每秒: 39

步数: 785,921 运行: 889.94秒

0% 共 16.384百万

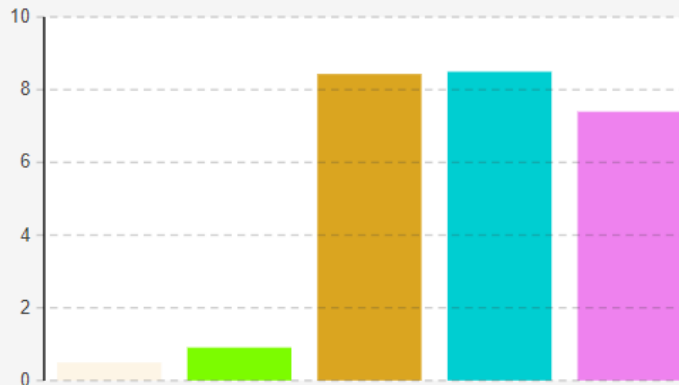
无人驾驶作业效率 (分钟/趟)



矿卡数量: 15 台
 矿卡速度: 15.0 km/h
 矿卡故障率: 无故障
 矿卡故障时间: 无故障
 停车时间: 108 分钟/车
 作业效率: 63 分钟/趟

● 作业效率 (分钟/趟)

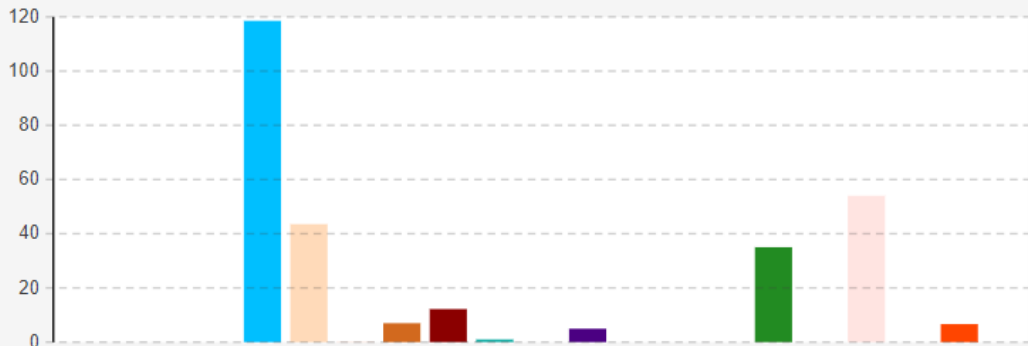
装卸载区平均排队时间 (分钟/车)



装载时间: 10 分钟
 电铲故障率: 无故障
 电铲故障时间: 无故障
 卸载时间: 2 分钟
 卸点故障率: 无故障
 卸点故障时间: 无故障

卸点1 0.49 ● 卸点2 0.91 ● 铲窝2 8.43 ● 铲窝3 8.5
 ● 铲窝1 7.4

等待区平均停车时间 (秒/车)



L#21 0 L#28 0 L#50 0 L#57 0 L#82 118.55 L#83 43.54 L#84 0.06
 L#85 6.98 L#90 12.18 L#91 1.02 L#94 0 L#95 4.93 L#96 0 L#99 0
 L#115 0 L#116 35.02 L#119 0 L#120 54 L#132 0 L#136 6.64
 L#137 0

装载区作业次数比例



铲窝2 38 (32%) ● 铲窝3 40 (34%)
 ● 铲窝1 40 (34%)

卸载区作业次数比例



卸点1 52 (45%) ● 卸点2 63 (55%)

SIL / HIL / DIL / VIL for agile iteration

V2X 天线

T-Box

HMI

V2X天线

差分GPS定位

HMI

T-BOX

电铲终端设备

V2X 天线

M-Box

HMI

V2X天线

差分GPS定位

激光雷达

HMI

IMU

毫米波雷达

M-BOX

矿卡终端设备

V2X 天线

T-Box

HMI

HMI

仿真主机

仿真模型

仿真显示平台

仿真平台



Dynamic auto loading



Dynamic auto dumping

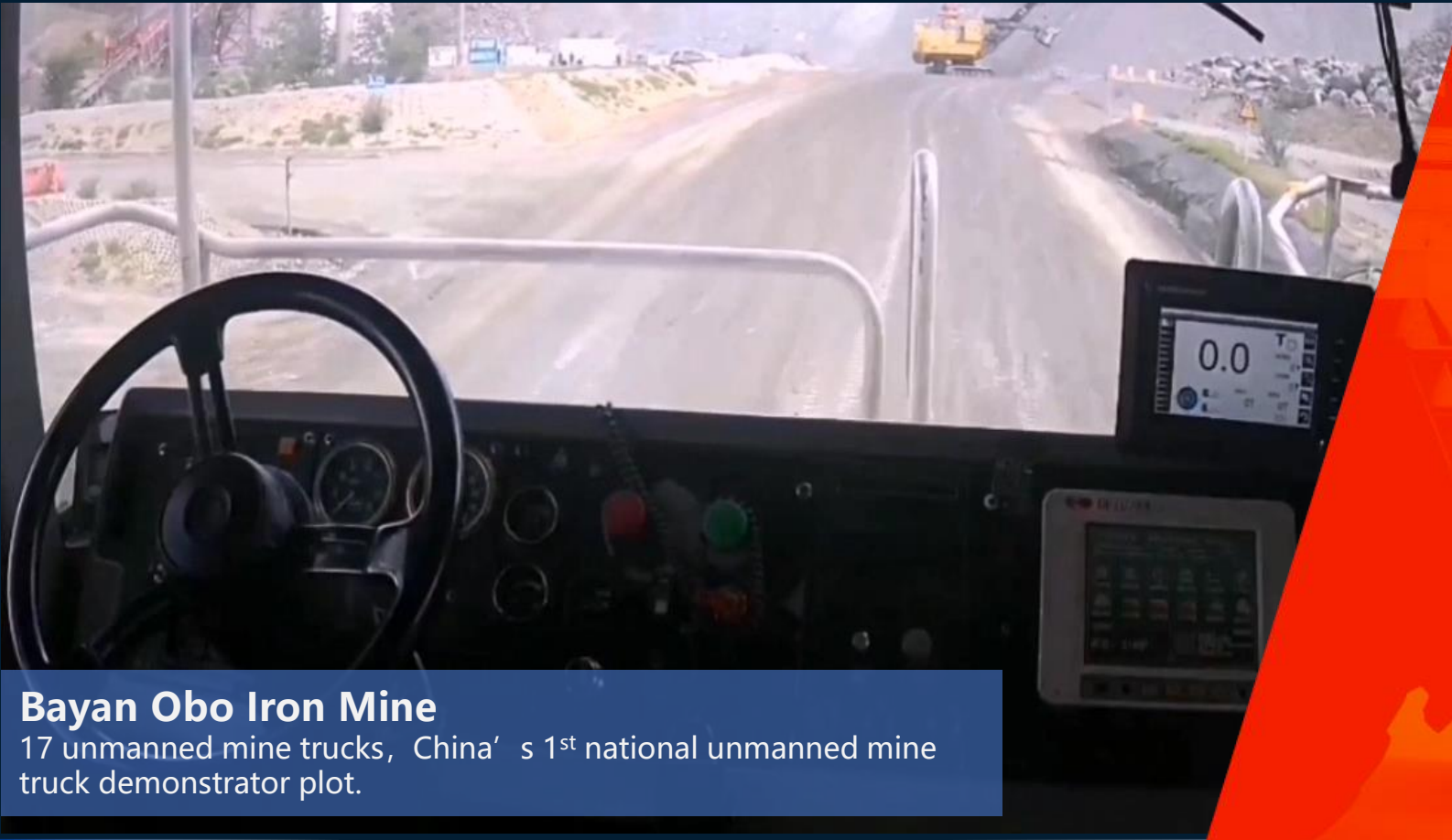


Remote takeover



Automatic depart/return

Business cases



Bayan Obo Iron Mine

17 unmanned mine trucks, China's 1st national unmanned mine truck demonstrator plot.

- 2018, Oct Launched the 1st unmanned truck
- 2019, Sep Passed expert group review
Signed commercial contract
- 2019, Dec Stage I Acceptance of
4 trucks' fleet
- 2020, Oct Stage II Acceptance of
6 trucks' fleet 7x24h
- 2021, Aug Final Acceptance of 17
unmanned trucks fleet

Business cases



Erdos Yongshun coal mine

Signed commercial operation contract of 200 unmanned non-rigid dumper with one of the largest mine transportation EPC - Inner Mongolia ZHXL

- 2019, Sep Signed commercial contract
- 2020, July Stage I Acceptance of 8 unmanned dumpers fleet
- 2021, Feb Stage II Acceptance of 20 unmanned dumpers fleet
- 2022, July Final Acceptance of all 200 unmanned dumpers

Business cases



SPIC Huolin river coal mine

The 1st open tendering project of coal mine unmanned transportation in China

2019, Sep Signed commercial contract

2019, Nov Phase 1 acceptance

2020, May Realized night shift work

2020, Jun Final acceptance

1015 days 0 accident operation

Cumulative driverless operation 71406km

Cumulative freight volume 564325tons

The background of the image is a dark blue technical drawing or blueprint, featuring various mechanical parts, gears, and structural elements. A diagonal line divides the image, with the top-left portion being dark blue and the bottom-right portion being a light, textured grey. The word "THANKS" is written in a bold, white, italicized sans-serif font across the center of the image.

THANKS

AUG / 2020 / VERSION 1.01