



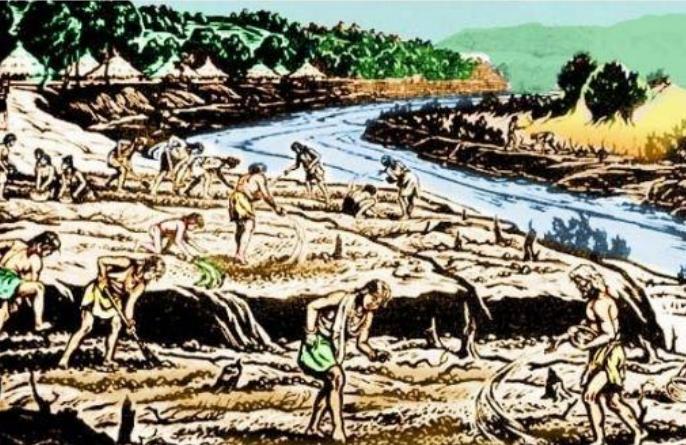
TAGE IDRIVER

The Unmanned Mining Expert

Mar, 2021

SEP / 2020 / VERSION 1.01

Enabling mining with cutting-edge technology is an everlasting business



300,000 years ago, the 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



Low Efficiency

Low intelligence level, lack of data-based management means



Rising cost

High labor and management cost, High operation and maintenance cost



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





ABOUT TAGE IDRIVER

Beijing TAGE IDRIVER Technology Co., LTD., founded in 2016, is a high-tech enterprise focusing on the research and product development of autonomous driving mining vehicles, and the design and implementation of integrated engineering solutions for unmanned open pit mines. TAGE has launched the overall system solution of intelligent mine based on **vehicle-ground-cloud architecture**. This complete set of unmanned transportation solution for open pit mine consists of **cloud based intelligent dispatching management, 4G/5G vehicle network communication, intelligent road side unit and vehicle-mounted intelligent terminal**. This universal system can be adapted to numbers of large mine dump truck and non-rigid dump truck models from different brands, and supports **both new truck pre-installation and existing truck retrofit**. Serving the national development strategy of "new infrastructure" and "smart mine", TAGE continuously carries out technological innovation to provide safe, efficient, economical and green unmanned transportation service for open pit mines.

Development history





INFINITE MINING

采掘无限



Infinite mining

It symbolizes the endless cycle of unmanned transportation.

and represents TAGE's relentless exploration of technology and human's potential.



TAGE IDRIVER

The unmanned solution for open pit mine transportation
露天矿无人驾驶运输解决方案





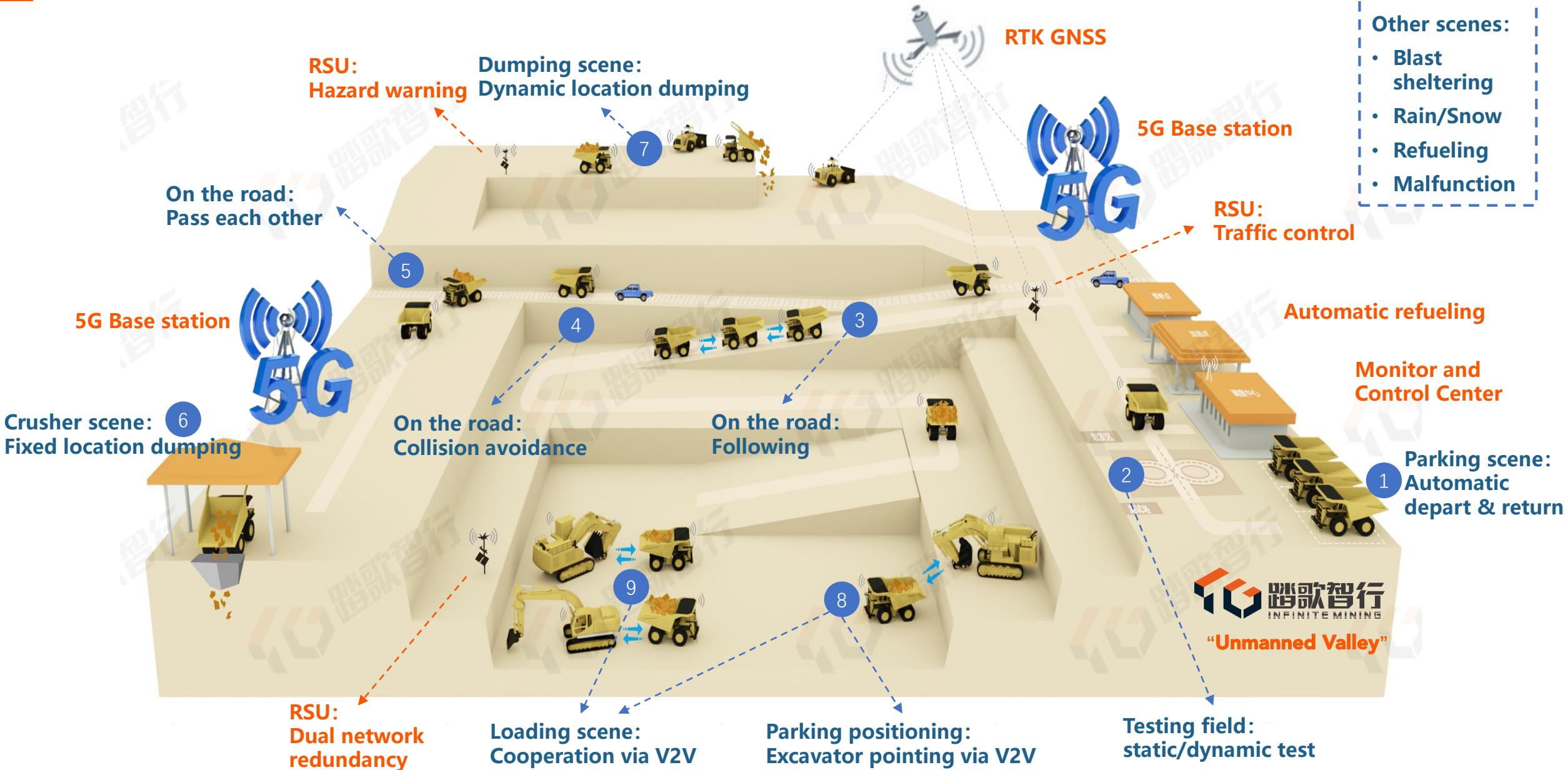
/// 旷谷™ *Unmanned Valley*

幽谷空旷，唯机械朝夕而作
无人，无险，旷古而烁今

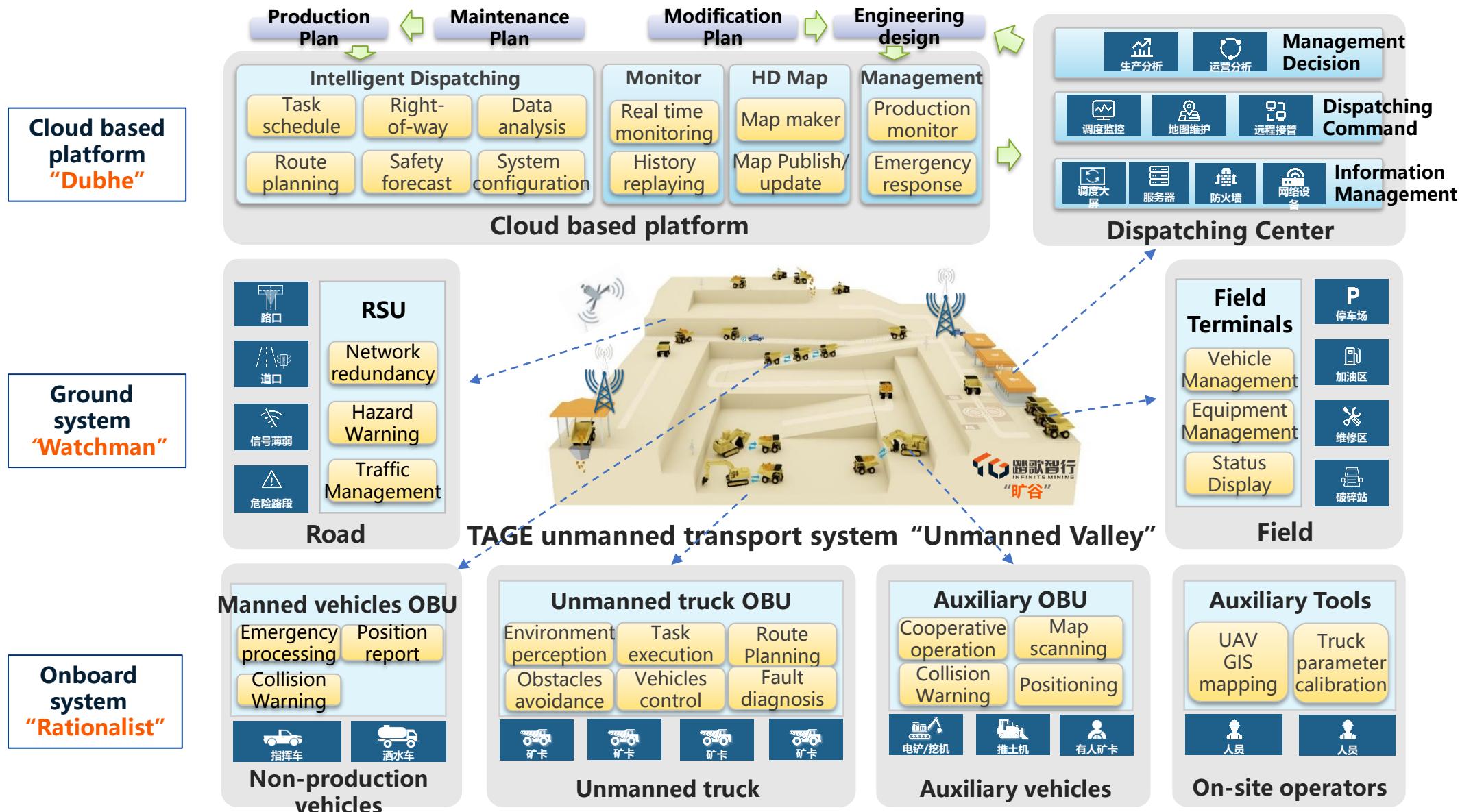
“*Unmanned Valley*” , TAGE’ s unmanned solution for open pit mines,
it is a complete set of unmanned transportation system consists of :

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

Overview of the "Unmanned Valley"



The “Vehicle – Ground – Cloud” system architecture



睿控™



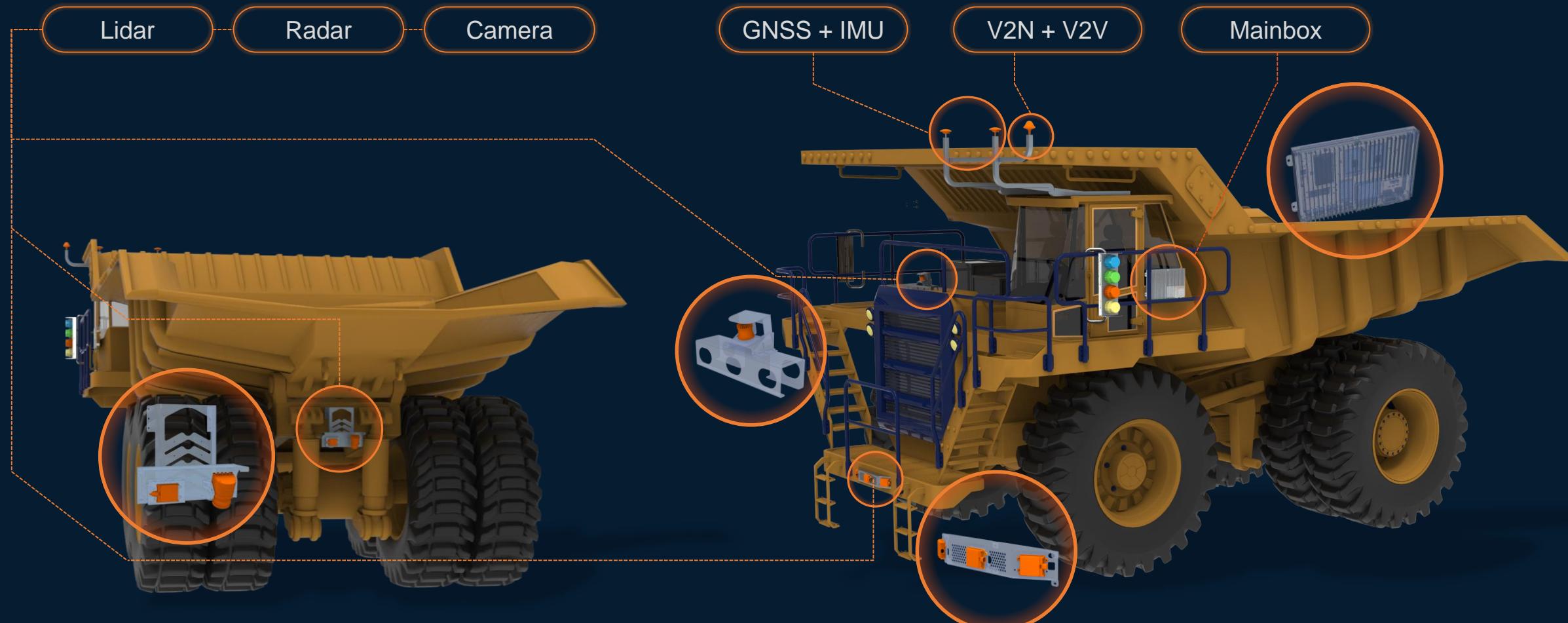
Rationalist

睿者谋，控者行
谋而后行，无所不达

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



The most adaptive HW configuration scheme for open-pit mining scene



"Rationalist" unmanned truck terminal



V2X and Positioning

Perception



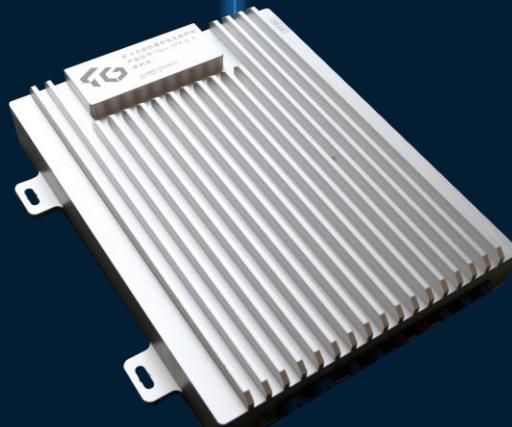
HMI



Wire controlled chassis



"Rationalist" auxiliary vehicles' terminals



TBox



Excavator terminal



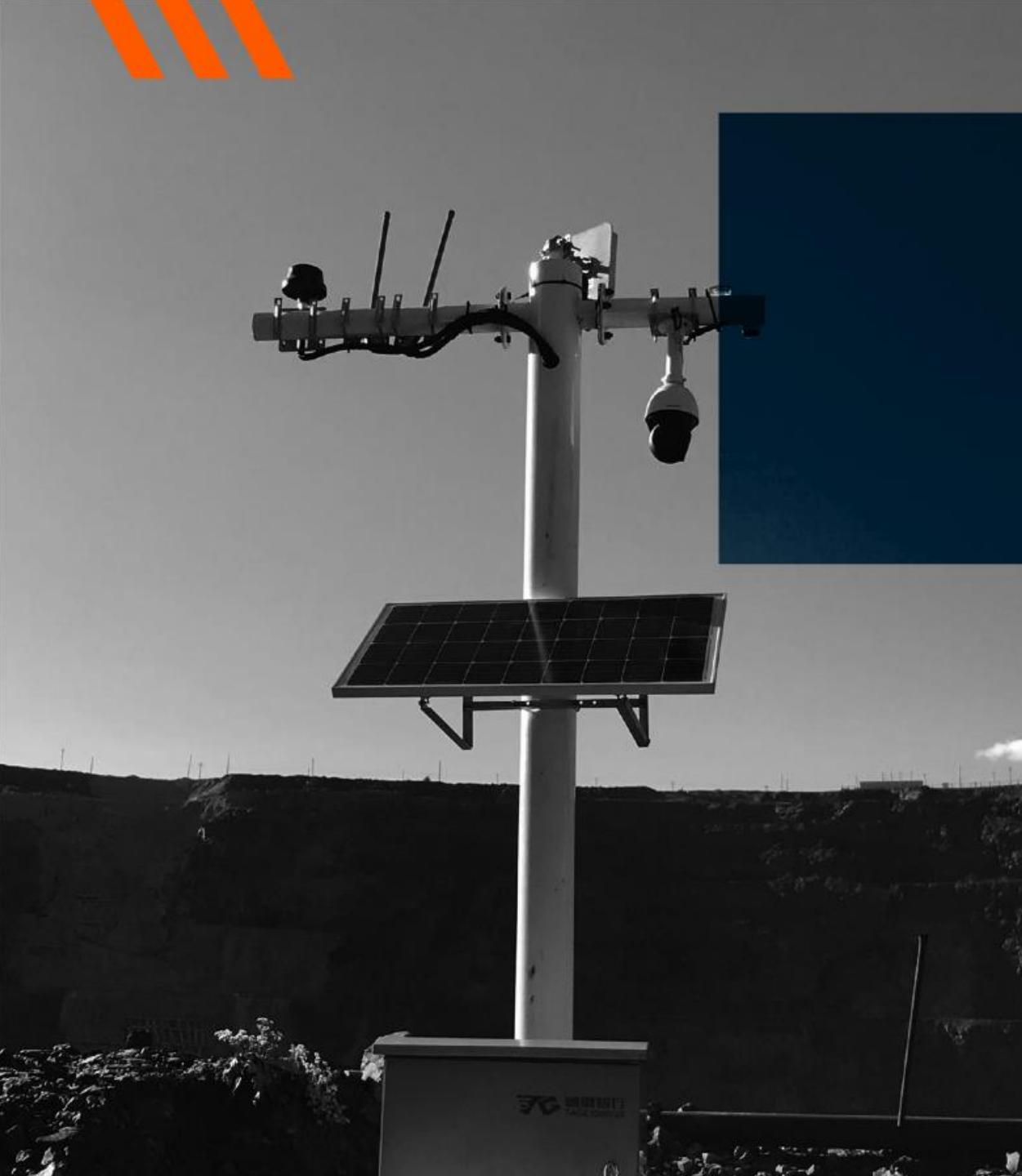
Dozer terminal



Manned/unmanned composite fleet terminal



Foreign vehicle monitor and protection



御疆™



Watchman

疆内无人之境
御者持炬执剑
顾而守之

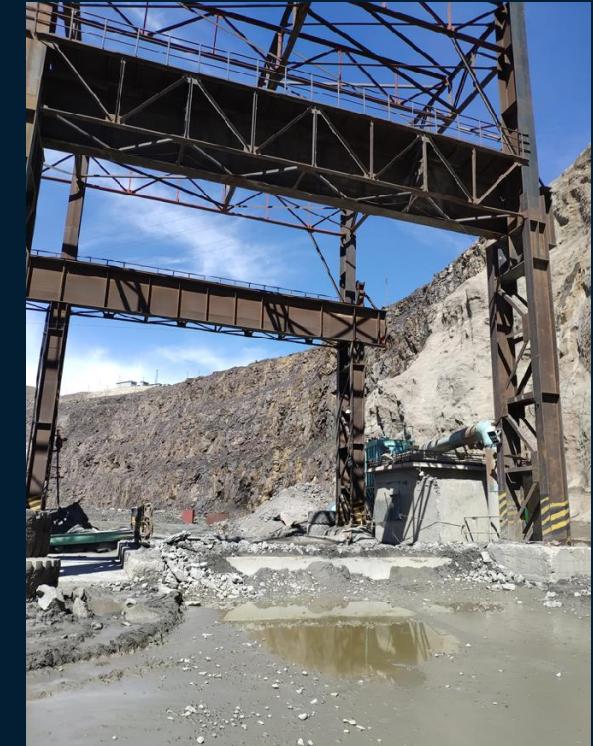
The ground system "**Watchman**" includes road side units (RSU) and various ground control terminals (refueling area, crushing station, maintenance area, etc.) which are the safeguards for the stable operation of the system.

"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

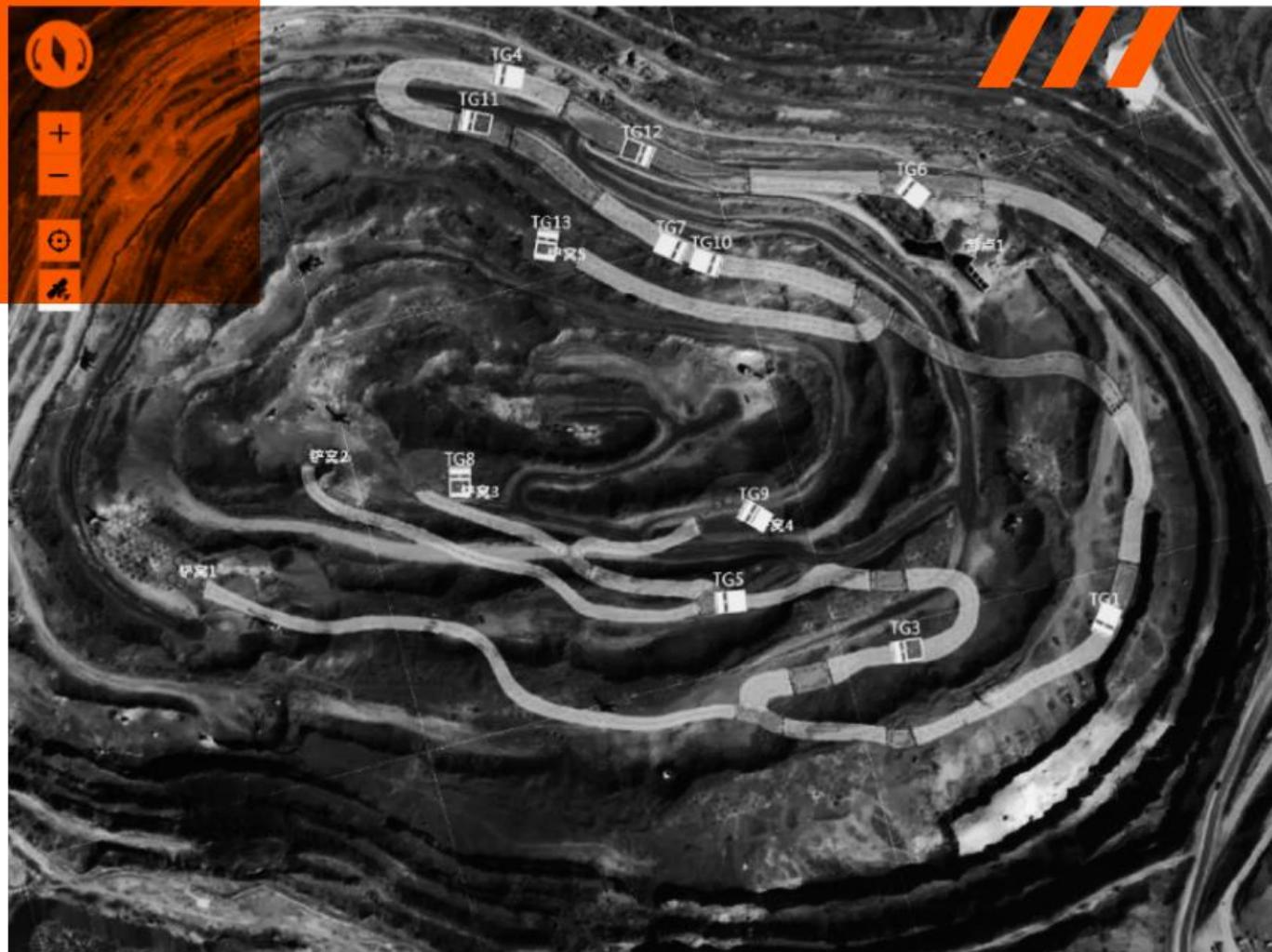
天枢™



Dubhe

北斗指四向，天枢驭北斗
四向二十八宿，皆听号令

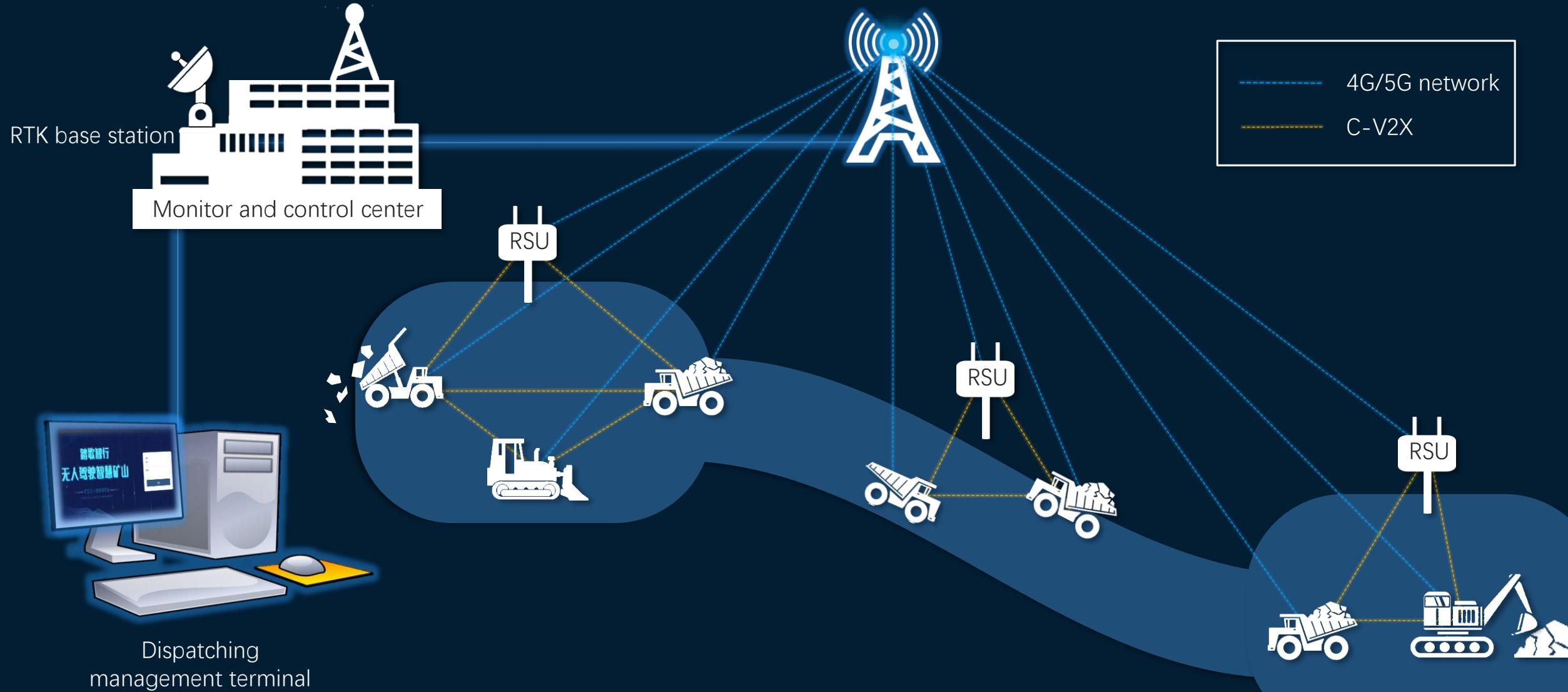
As the intelligent management center of the unmanned transportation system, the cloud based platform "**Dubhe**" is managing dispatching plan, right-of-way command and centralized supervision to provide safe and reliable cloud services for the unmanned transportation system.





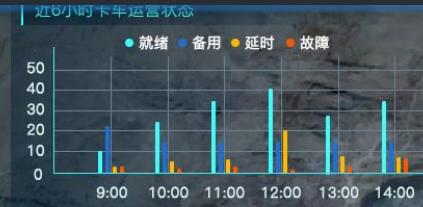
"Dubhe" cloud based supervision and control system

TAGE





“Dubhe” cloud based supervision and control system



"MineSIM" simulation system



矿区仿真

地图

统计

作业 79 趟 05:43:33 实时效率

20,012.50 秒 01/01/2020 05:43:33

II ■ :

↑ ⊗ > ⊛ > ... ⊜

← ⊗ ⊛ 135% ⊕ viewMap ⊜

控制台 ⊛ ⊞ 事件



稀土矿 + 停车1

车道标注 模型速度 x



...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] 因[降磅卸停车场]由[就绪]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[就绪] 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 TG9 发送道路58路权释放申请
2020-07-02 16:47:10 TG9 道路58路权释放成功
2020-07-02 16:47:11 TG11 发送道路87路权申请
2020-07-02 16:47:11 TG11 收到路权应答: 道路类别2, 道路方向2, 道路编号30, 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 TG1 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 TG9 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

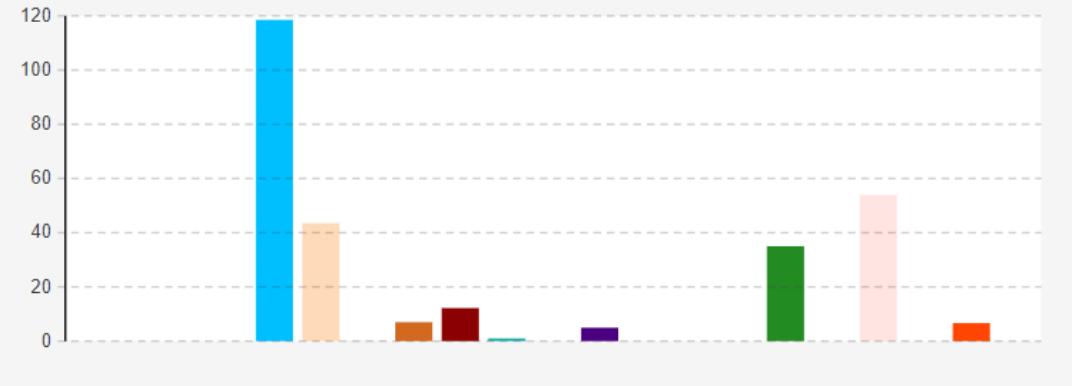
矿卡故障率 : 无故障

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

等待区平均停车时间 (秒/车)



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

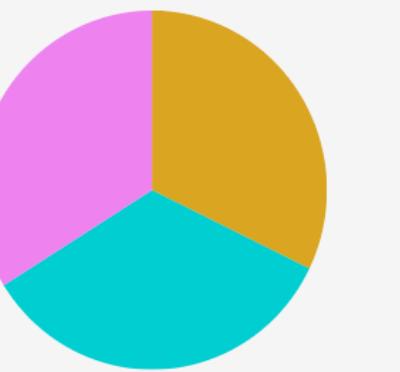
电铲故障时间 : 无故障

卸载时间 : 2 分钟

卸点故障率 : 无故障

卸点故障时间 : 无故障

装载区作业次数比例



卸载区作业次数比例



...8922 项目删除...

2020-07-02 16:53:03 TG7 发...

2020-07-02 16:53:03 TG7 收...

类别1, 道路方向2, 道路编号30,

2020-07-02 16:53:03 TG11 发...

放申请

2020-07-02 16:53:03 TG11 通...

功

2020-07-02 16:53:03 TG7 发...

申请

2020-07-02 16:53:03 TG7 通...

2020-07-02 16:53:04 TG5 发...

收申请

2020-07-02 16:53:04 TG5 收...

类别1, 道路方向2, 道路编号30,

2020-07-02 16:53:04 TG5 发...

申请

2020-07-02 16:53:04 TG5 通...

2020-07-02 16:53:04 TG8 发...

申请

2020-07-02 16:53:04 TG8 通...

2020-07-02 16:53:04 TG11 发...

申请

2020-07-02 16:53:04 TG4 发...

申请

2020-07-02 16:53:04 TG4 通...

2020-07-02 16:53:05 TG4 发...

申请

2020-07-02 16:53:05 TG7 收...

类别2, 道路方向2, 道路编号81,

2020-07-02 16:53:06 TG7 发...

申请

2020-07-02 16:53:06 TG7 通...

2020-07-02 16:53:06 TG5 发...

收申请

2020-07-02 16:53:06 TG5 收...

类别2, 道路方向2, 道路编号81,

2020-07-02 16:53:06 TG12 上...

UNLOADED

2020-07-02 16:53:06 TG8 发...

申请

2020-07-02 16:53:06 TG8 通...

2020-07-02 16:53:06 TG11 收...

类别2, 道路方向2, 道路编号87,

2020-07-02 16:53:06 TG9 上...

UNLOADED

2020-07-02 16:53:06 TG5 发...

申请

2020-07-02 16:53:06 TG5 通...

0 秒/秒 事件每秒: 0 帧每秒: 4

步数: 1,102,008 运行: 1,245.5

1% 共 16,384 百万

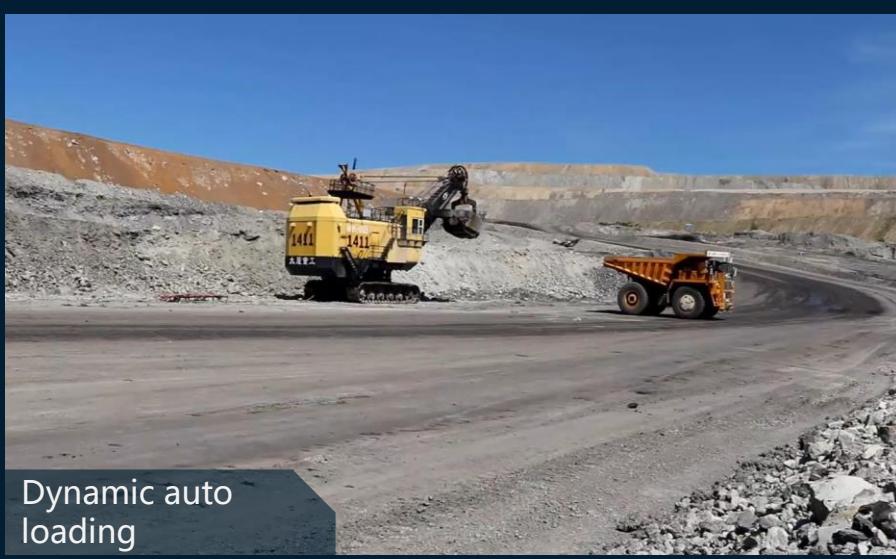


完成

HIL for rapid iteration



Actual Running – mine trucks



Actual Running – Open-pit coal mine (Non-rigid dumper)



Dynamic auto
loading

倒车入位



Queue up for
dumping

自动倾倒



Smooth driving
control

重载爬坡



Around-the-clock
operation 夜间作业

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



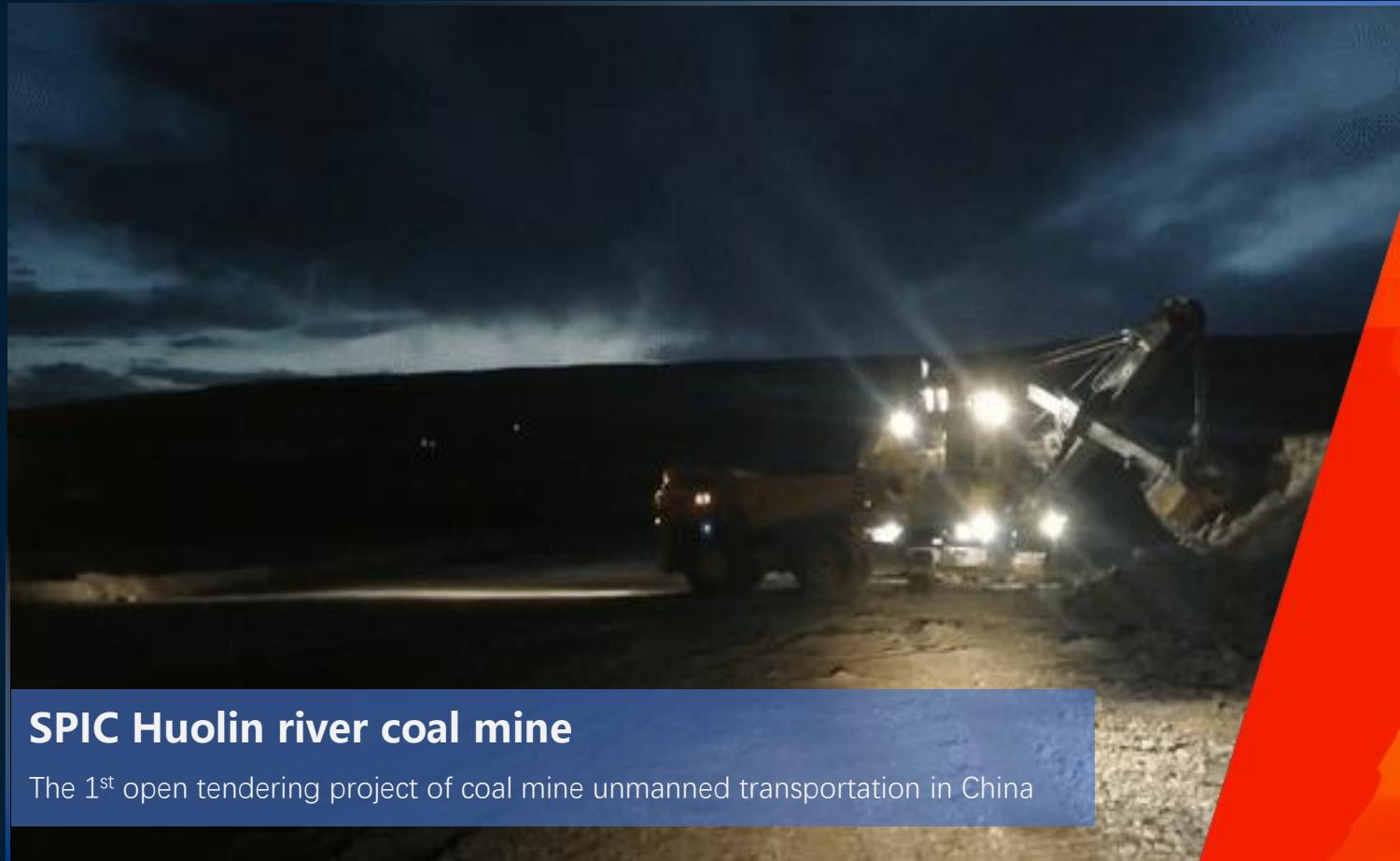
2019, Sep Signed commercial contract

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

Business cases



SPIC Huolin river coal mine

216 sets of mine truck Autonomous Emergent Braking (AEB) system

2020, May Signed commercial contact

2020, Aug Deployed 50 sets

2020, Oct Finish deployment of all the 216 sets



891 days 0 accident operation

Cumulative driverless operation 51406km

Cumulative freight volume 324325tons



THANKS

AUG / 2020 / VERSION 1.01