潞安集团智慧矿山
异构网络融合平台研究

Smart Mine System of Lu'an Group
Research on Heterogeneous Network Integration Platform

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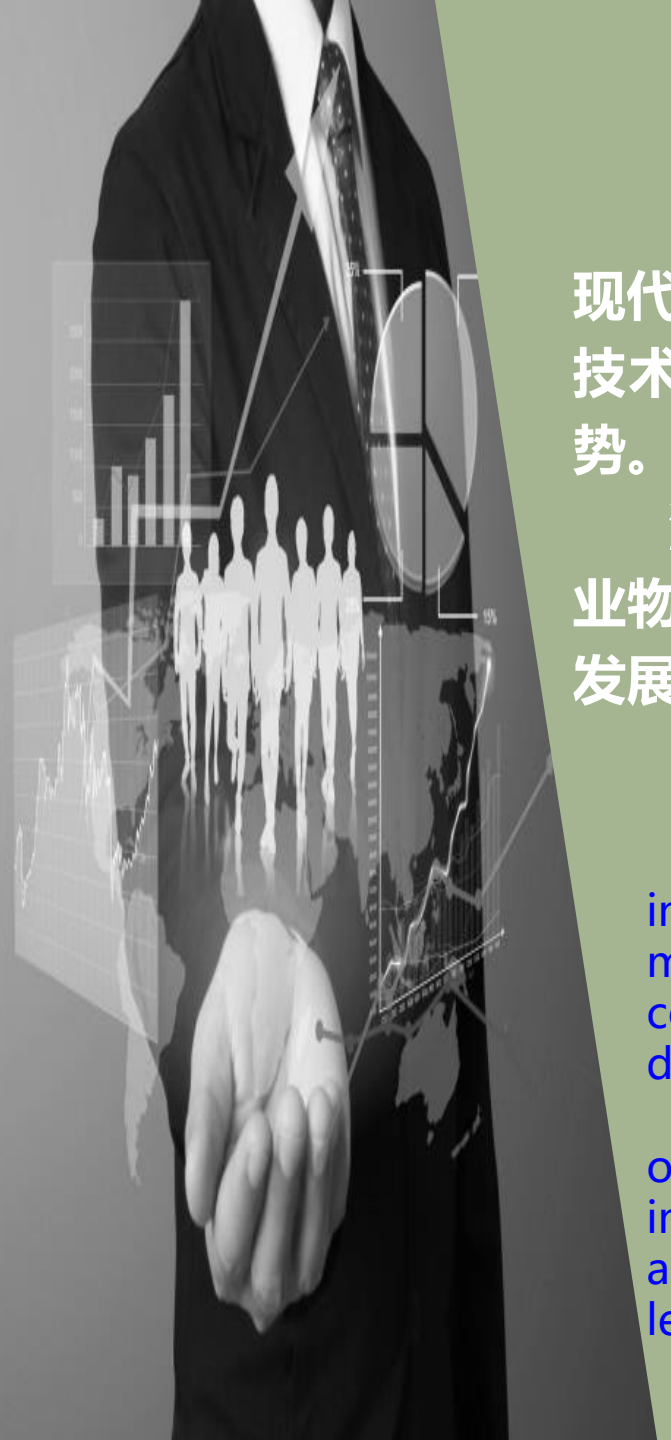
潞安集团 LU'AN GROUP



前言

随着矿山绿色开采和智能化开采技术的不断发展，将现代网络通信技术、操作系统平台、软件定义网络等核心技术融入异构网络统一化平台，是实现智慧矿山的必然趋势。

潞安矿业集团下辖各主体矿创新性的建设基于智能工业物联网技术的矿山异构网络融合平台，符合智慧矿山的发展趋势，技术水平同行业领先。

Background

With the continuous development of green mining and intelligent mining technology, the inevitable trend of realizing smart mine system is integrating the core technologies of modern network communication technology, operating system platform and software defined network into the heterogeneous network integration platform.

Innovative constructions of each main mine under the jurisdiction of Lu'an Group are based on the mine heterogeneous network integration platform of intelligent industrial Internet technology, that are in line with the development trend of smart mines and have the leading technology of the industry.

智慧矿山异构网络融合平台

Heterogeneous network integration platform of smart mine system

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潞安集团介绍

Lu'an Group Introduction

Lu'an Group, one of the five largest coal enterprises in Shanxi, is the country's important production base of high grade heating coal and injection coal. Since the 13th five-year plan, Lu 'an has deeply implemented the decision and deployment of supply-side structural reform promoted by the central and provincial government, and has established the "1+3" industrial development layout focusing on the clean and efficient use, high-end transformation and deep transformation of coal. This study, taking the main mine of Lu'an Group as research samples and innovation research as the starting point, deeply analyzed the technical bottlenecks encountered in the development of information technology, had given the overall design, and ultimately built a high performance system platform that can realize heterogeneous network integration of smart mine system .

潞安集团是山西五大煤炭企业集团之一，是国家重要的优质动力煤和喷吹煤生产基地。进入“十三五”以来，潞安集团深入落实中央及省委省政府推动供给侧结构性改革的决策部署，围绕煤炭的清洁高效利用和高端转型、深度转型，确立了“1+3”产业发展布局。本研究以潞安矿业集团下辖各主体矿为样本和创新研究为起点，深度剖析潞安矿业集团下辖各主体矿信息化发展中遇到的技术瓶颈，给出了整体设计方案，并最终搭建一个能实现矿山异构网络智能融合的高性能系统平台。

为什么矿山信息化过程中会产生大量异构网络和异构数据信息？

Why is there a large number of heterogeneous networks and heterogeneous data information produced in the process of mine informatization?

原因一：企业建设的各类综合自动化系统、管理信息系统及工程数字化系统等，由于开发商不同，采用的开发技术、编码规则、数据命名和数据描述不同，“数字鸿沟”和“信息孤岛”现象凸显，数据无法共享，信息无法分享，各系统产生的珍贵数据无法发挥作用。

原因二：潞安集团下属分（子）公司布局分散，矿井管理涵盖面大，各企业井下系统之间、井上系统之间及井上和井下系统之间、集团系统与下属公司系统之间都无法互联互通，难以形成统一的信息资源池，很难实现高效、统一、安全的综合系统管理。

Reason 1: Because of different developers, the integrated automation system, management information system and engineering digital system constructed by the enterprise use different development technique, code rule, data naming and data description; the phenomenon of "digital gap" and "information island" is prominent; data and information can not be shared, and the precious data produced by each system fail to work.

Reason 2: Branches of Lu'an Group are decentralized, mine management covers a large area, there is no interconnection between the downhole systems, the wellhead systems, the downhole and wellhead systems, the group system and the subordinate company system. It is difficult to form a unified pool of information resources, and difficult to achieve efficient, unified and safe integrated system management.

智慧矿山异构网络融合平台是基于RED-MOS®、RED-SDN®、RED-DDS®等组成的软硬件平台。

Heterogeneous network integration platform of smart mine system is a hardware and software platform based on RED-MOS®, RED-SDN®, RED-DDS®.

解决途径是采用如下技术：

① RED-MOS® 智慧矿山操作系统（Intelligent mining operation system）

② RED-SDN® 软件定义工业物联网（software defined industrial Internet of Things）

③ RED-DDS® 强实时传输控制技术（hard real-time transmission control）

RED-MOS®核心优势：

- 实现矿山应用程序的软件平台载体；
- 最小化开发人员管理系统扩展性和硬件的时间；
- 为研发和管理人员的统一生态系统提供基础，为工业物联网提供支持。

RED-SDN®核心优势：

- 硬件开源，智慧矿山系统升级通过软件直接升级；
- 矿山企业的信息化服务可以远程管理，降低人力成本，日常升级维护可以远程化（非本地化）。

RED-DDS®核心优势：

- 矿山多系统异构信息、异构网络融合的传输层解决方案；
- 矿山设备互操作、强实时、可扩展的解决方案。

RED-MOS® core advantages:

- Software platform carrier for realizing mine application program;
- Minimize the extensibility of developer management system and hardware time;
- Provide basis for the unified ecosystem of R & D and management personnel, and provide support for the industrial Internet of things;

RED-SDN® core advantages:

- Open source hardware, smart mine system system could be upgraded through software;
- The information service of mining enterprises can be managed remotely, which could reduce manpower cost, and daily maintenance can also upgraded remotely (delocalization).

RED-DDS® core advantages:

- Transport layer solutions for multisystem heterogeneous information and heterogeneous network integration of mine;
- Mine equipment interoperability, hard real-time, scalable solutions.

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智慧矿山异构网络融合平台研究内容

Heterogeneous network integration platform of smart mine system

矿山网络融合研究内容 Research contents of mine network integration

互联互通：运用软件工程学领域的操作系统技术、软件定义网络技术、高效数据分发传输队列等技术，实现人员、设备，环境的互通互联，实现系统间的横向联通和纵向集成。

智能融合： 在RED-MOS®操作系统平台上对数据进行深度挖掘以形成人工智能的基础，以及对知识智慧进行学习推理形成执行能力，是实现智慧矿山的主要特征之一。构建一个具备数据挖掘和学习推理的平台，支持集团公司、主体矿井等多层面网络的高效融合以及人工智能辅助的专家决策。

Interconnection: using the operating system technology, software defined network technology, efficient data distribution technology in the field of software engineering to realize the interconnection of personnel, equipment and environment, and the horizontal integration and vertical integration between systems.
Intelligent integration: It is one of the main characteristics of smart mine system to dig data deeply on RED-MOS® operating system platform forming the foundation of artificial intelligence, and learn knowledge wisdom forming executive ability. To construct a platform with data mining and learning reasoning, and support the efficient integration of multi-level networks, such as group company and main mine, as well as the expert decision-making of artificial intelligence.

智慧矿山异构网络融合平台系统设计核心理念

The core design concept of heterogeneous network integration platform system of smart mine system

智慧矿山异构网络智能融合平台包括两部分，第一部分是硬件设备，包括网络通信设备，数据存储设备，监测设备以及其他辅助硬件设备。第二部分是智能融合的RED-MOS®（智慧矿山操作系统）、RED-SDN®（软件定义工业物联网）、RED-DDS®（强实时传输控制技术），这是整个智慧矿山系统智能融合平台运行的基础。

Heterogeneous network integration platform of smart mine system includes two parts, the first part is hardware devices, including network communication equipment, data-storage equipment, monitoring equipment and other auxiliary equipment. The second part is intelligent-fusion RED-MOS® (Intelligent mining operation system), RED-SDN® (software defined industrial Internet of Things), RED-DDS® (hard real-time transmission control), which is the basis of intelligent integration platform for smart mine system system.

软件与硬件解耦
Software and hardware decoupling

开放性平台设计
Design based on known details

系统分层化
Hierarchical system

系统配置和升级简易化
Simplification of system configuration and upgrade

数据传输队列化
Data transmission queue

基于已有应用实例标准
Standards based on existing application examples

基于所有已知细节设计
Open platform design

关注基础服务和用户体验
Focus on basic services and user experience

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智慧矿山异构网络融合平台方案设计及关键技术

Heterogeneous network integration platform program design and key technologies of smart mine system

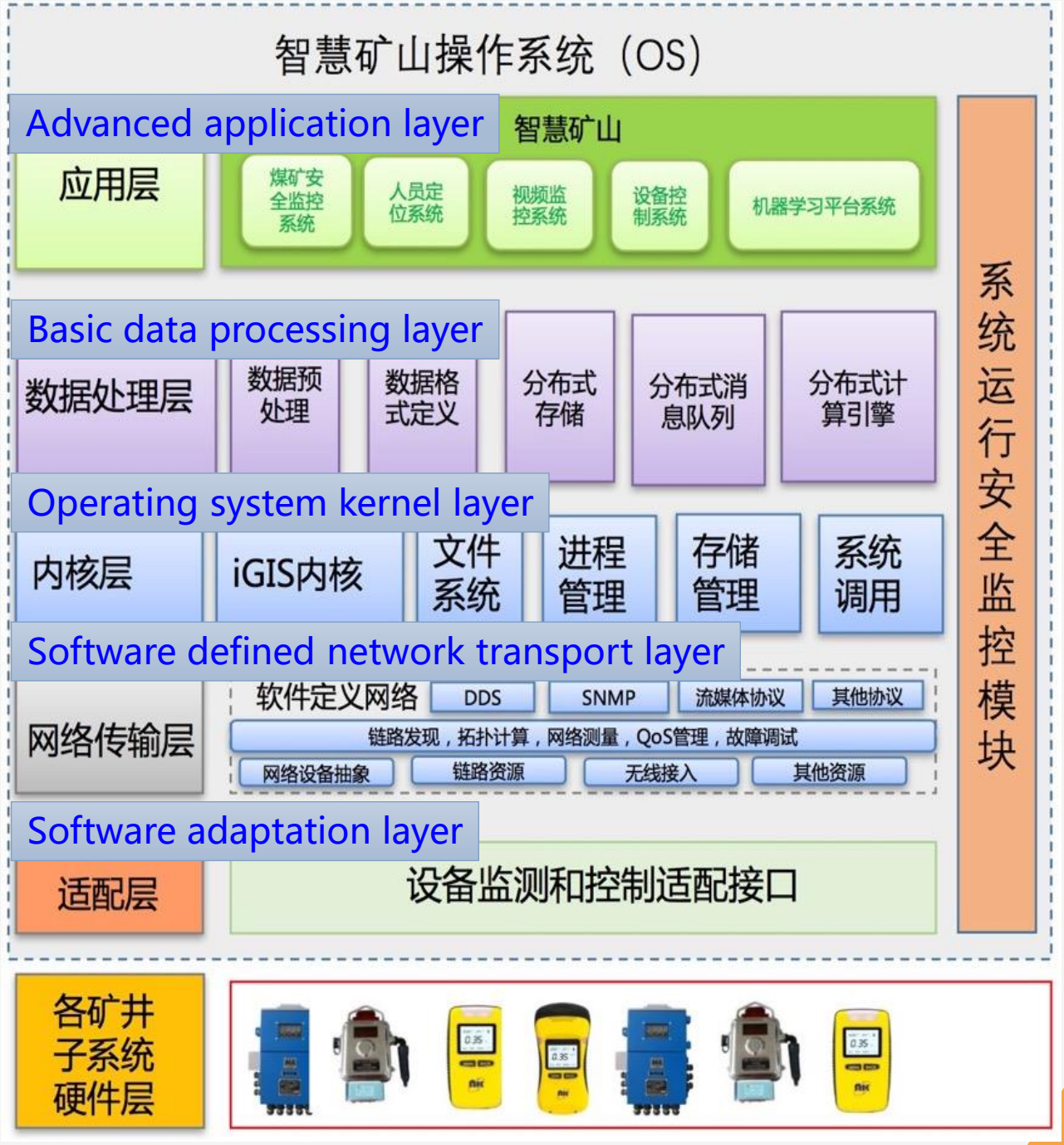
RED-MOS®系统

RED-MOS®操作系统包括多个适用于不同硬件设备的订制化操作系统。总体上如图所示，RED-MOS®操作系统可以分为以下几个层次：

1、软件适配层
2、软件定义的网络传输层
3、操作系统内核层
4、数据处理基础层
5、高级应用层

RED-MOS® operating system includes a number of customized operating systems suitable for different hardware devices. As shown in the figure, RED-MOS® operating system can be divided into the following levels:

1. Software adaptation layer
2. Software defined network transport layer
3. Operating system kernel layer
4. Basic data processing layer
5. Advanced application layer



RED-SDN®技术介绍

RED-SDN® Technology Introduction

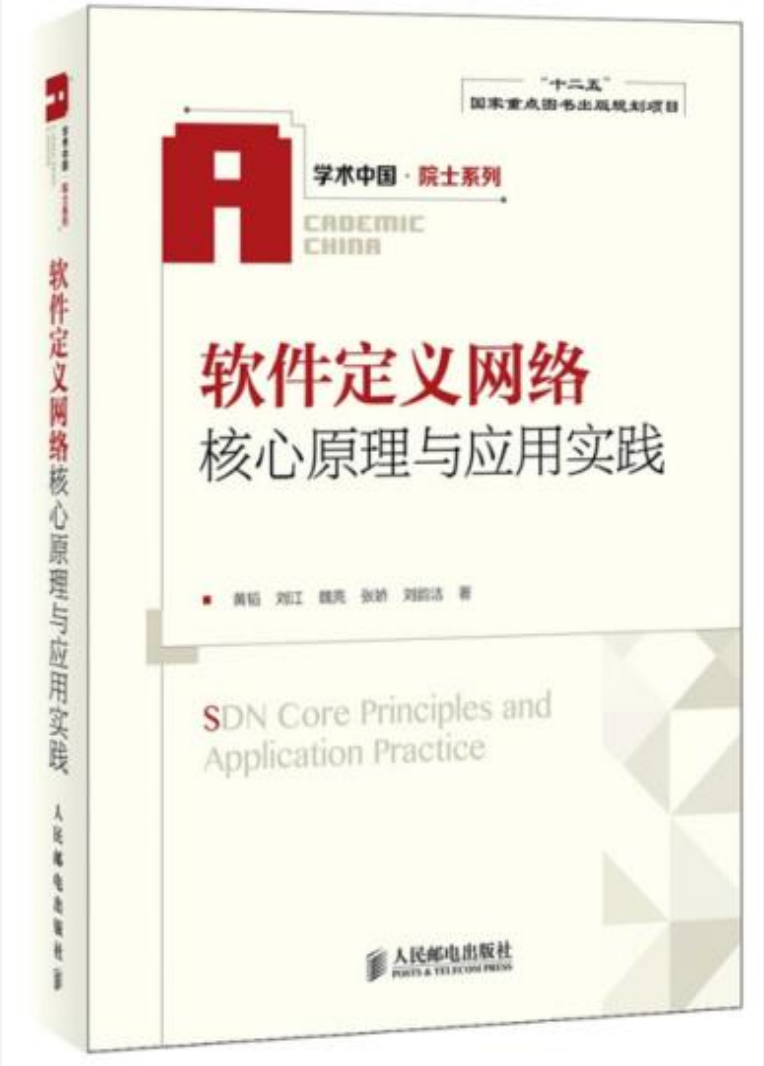
SDN是Software Defined Network 的缩写。

Network而非networking
表明是一种框架，一种网络设计理念。

SDN is short for Software Defined Network

Network, not networking

Indicating a framework, a network design concept

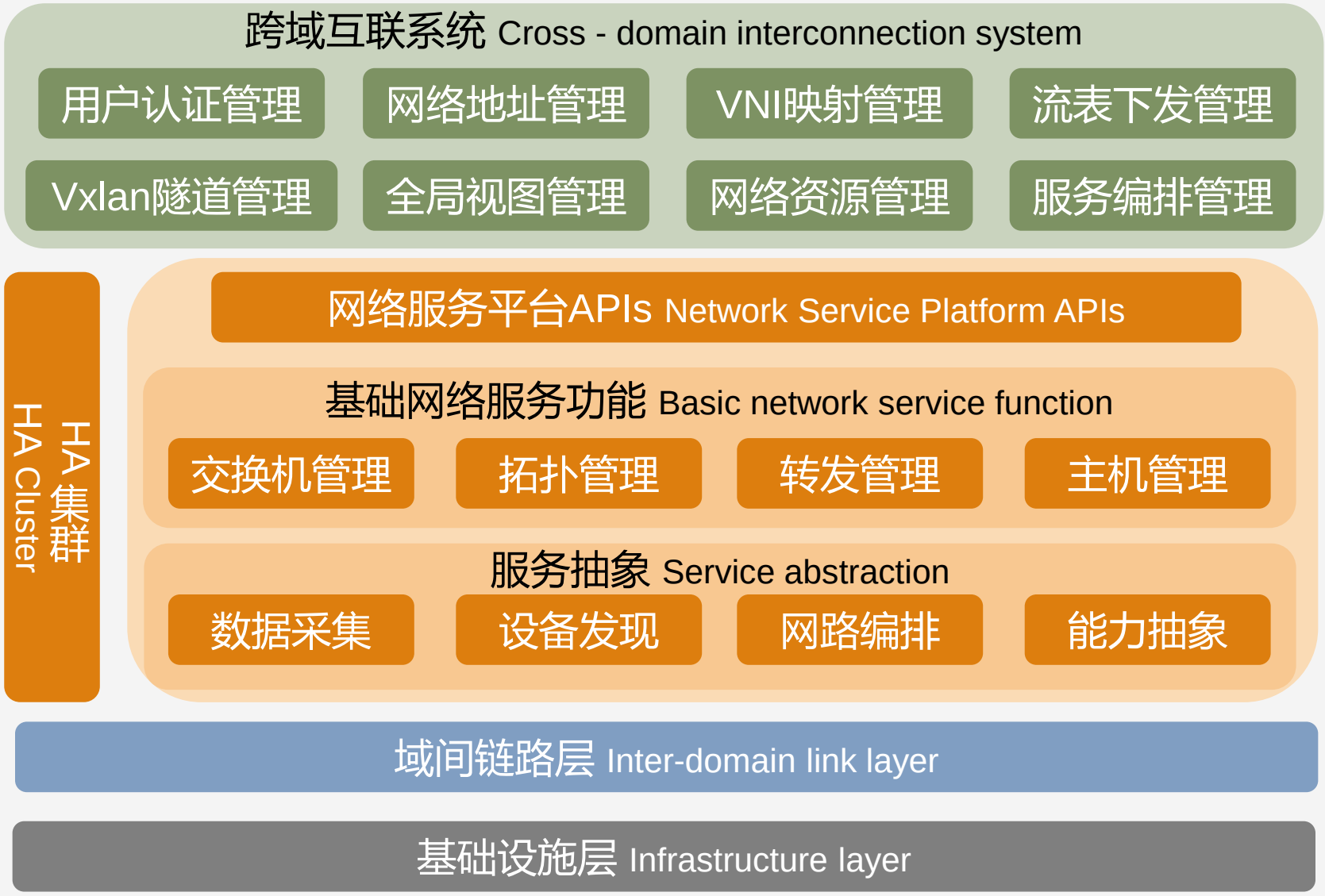


“软件开源”→“软件开源、硬件开源”

Open source software, →Open source software, Open Source Hardware

基于RED-SDN®技术的网络传输层

Network transport layer based on RED-SDN®



SDN网络传输层设计架构主要是解决不同系统（视频监控系统，瓦斯监控系统等）之间的跨域互联问题。通过软件与硬件分离，数据层与转发层分离。使得上层应用可以很好的协调不同域，不同系统间的跨域互联互通。

SDN network transmission layer design architecture is mainly to solve cross-domain connectivity issues between different system (video surveillance system, gas monitoring system, etc.) through the separation of hardware and software, data layer and forwarding layer, that can enable the upper level applications to well coordinate the cross-domain interoperability between different domains, and different systems.

RED-DDS® 实时可靠安全的数据分发服务技术协议

RED-DDS® Real-time, reliable and secure data distribution service technology protocol

RED-DDS®采用的通信模型是以数据为中心的发布/订阅模型

RED-DDS® The communication model adopted is data centered publish/subscribe model

基于全局数据空间的概念，网络中的数据对象用域或主题做标识

The concept of global data space, the data objects in the network are marked by domain or topics

各个节点具有完全的独立性和自主性，在逻辑上无主从关系

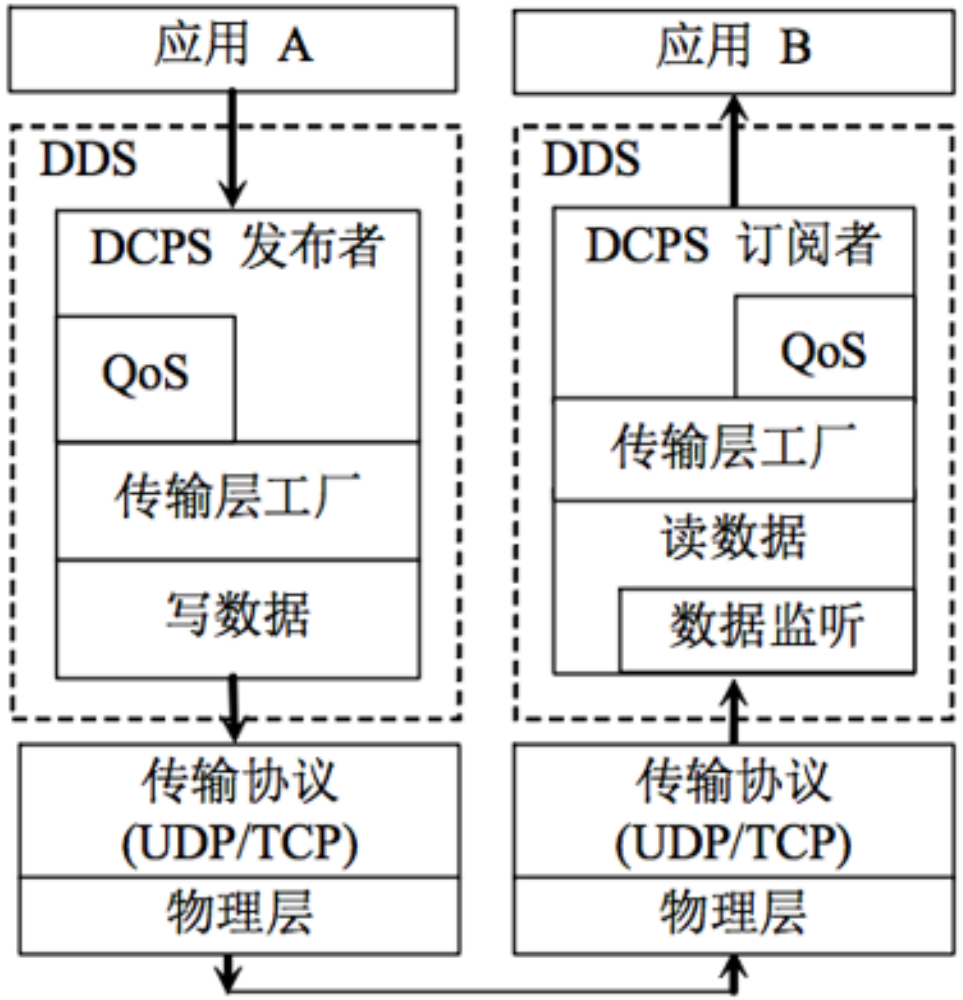
The scriptable Qos strategy can meet the requirements of customers for communication quality

可编写的Qos策略满足客户对通信质量的要求

Each node has complete independence and autonomy, and no subordinate relation in logic.

RED-DDS®数据通信应用模型

RED-DDS® Data communication application model



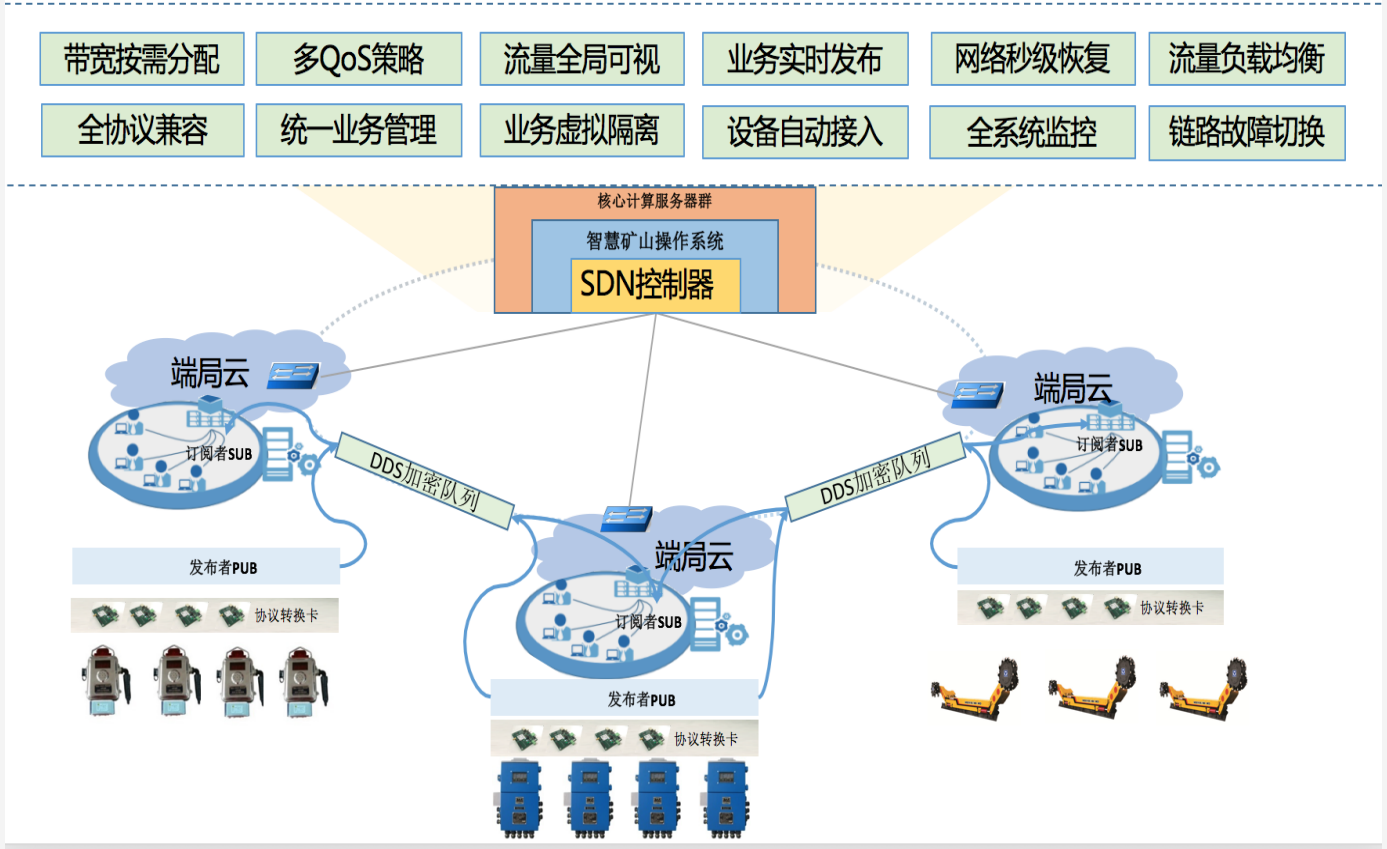
RED-DDS®使用接口定义语言描述服务，实现了独立于平台的数据交换方式，可以映射到多种操作系统、适应多种编程语言的编程规范。因此，**RED-DDS®**可以支持不同的处理器体系结构、编程语言和操作系统的组合。目前，本项目开发的**RED-DDS®**解决方案可采用多种编程语言(主要是C，C++和Java)用于多种操作系统，如VxWork，QNX，Lynx，Windows和Unix/Linux等。

RED-DDS® Uses interface definition language to describe services, which achieved platform-independent data exchange method and programming specifications that can be mapped to a variety of operating systems, adapt to a variety of programming language. At present, the solutions based on RED-DDS® can use a variety of programming languages (mainly C, C++ and Java) for many operating system, such as VxWork, QNX, Lynx, Windows and Unix/Linux, etc.

RED-DDS®技术与RED-SDN®技术融合

The fusion of RED-DDS® technology and RED-SDN® technology

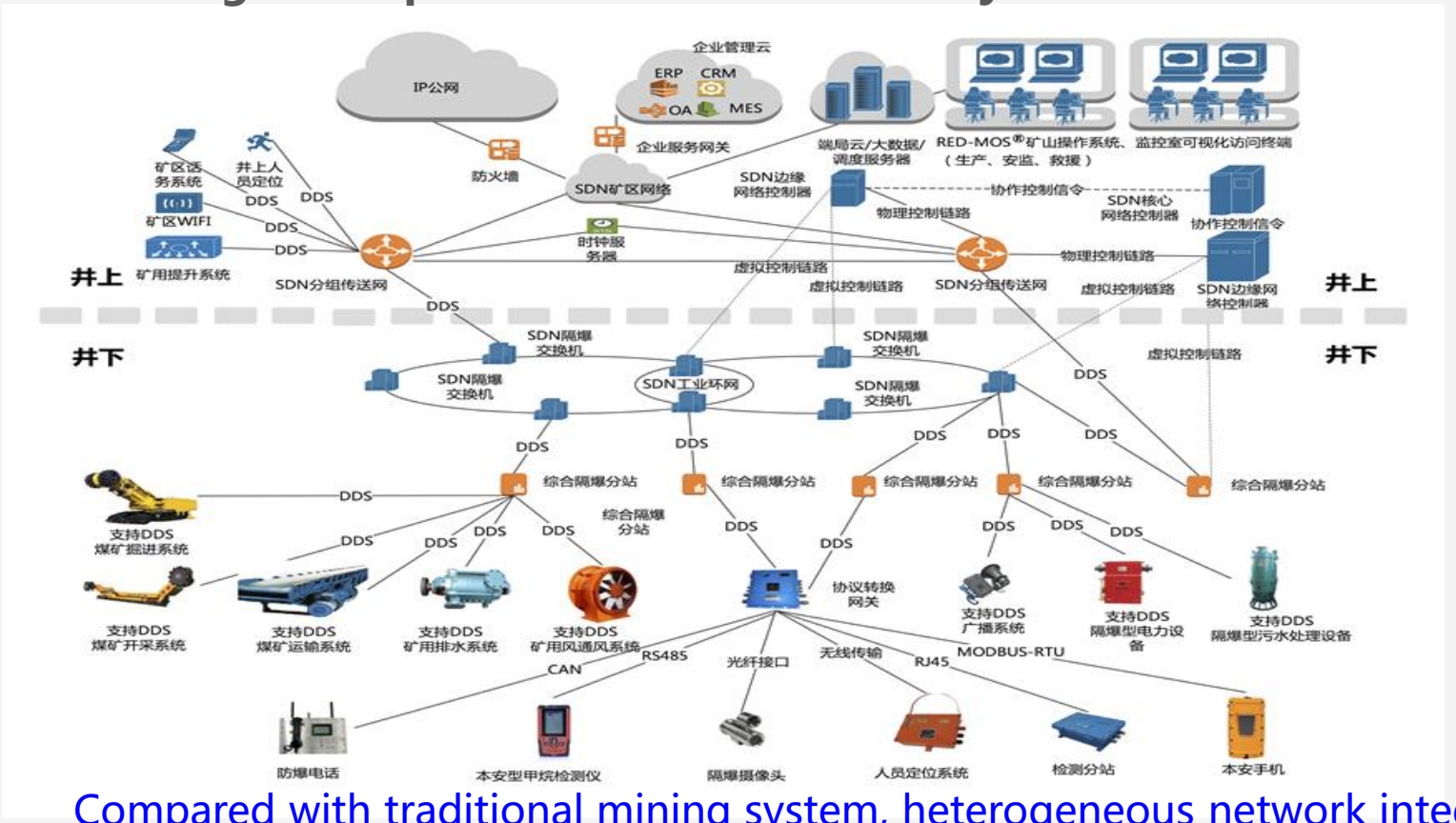
每个端局云是一个分布在不同区域的子计算系统。通过统一的SDN控制器集群通过全局视角控制网络中数据的流向。 RED-DDS®作为一种应用层数据传输协议，在SDN控制器的指导下选择性的向所维持的队列系统中添加数据，删除数据。在队列的两侧，各个端局云支撑的设备和系统则根据需求来发送和获取数据包。所有的发送获取策略由SDN控制器预先规划好，并下发到端局云计算平台。



Each end of the cloud is a sub computing system distributed in different regions. The centralized SDN controller cluster will control the network data flow through the global perspective. RED-DDS®, as an data transmission protocol at application layer, could selectively add data and and delete data to the maintained queue system under the guidance of SDN controller. On both sides of the queue, the supported equipment and systems of each cloud end will send and retrieve data packets according to requirements. All the sending acquisition strategies are pre-programmed by the SDN controller and then sent to the end cloud computing platform.

智慧矿山异构网络融合平台示意图

The diagrammatic sketch of the heterogeneous network integration platform of smart mine system



智慧矿山异构网络融合平台相对于传统矿山系统更为纷繁复杂，数量庞大的多样化设备的矿山环境下成本递减的程度是非常显著的。

其中包括底层设备层（分站，隔爆摄像头，工业环网交换机，矿区广播设备等），通信链路（包括物理控制链路，虚拟控制链路还有数据传输链路），核心服务器及上层应用（SDN控制器，ERP，MES，CRM，矿区WIFI服务等）。整个智慧矿山异构网络融合平台依靠RED-MOS操作系统，RED-SDN网络以及RED-DDS传输协议来构建。

Compared with traditional mining system, heterogeneous network integration platform of smart mine system is more complex. The cost decline is very significant in mine with a large number of diverse equipment.Including the bottom equipment layer (substation, explosion-proof camera, industrial ring network switch, mine radio equipment, etc.), communication link (including physical link control, virtual control link and data transmission link), the core server and applications at upper layer (SDN controller, ERP, MES, CRM, mining WIFI services, etc.). The heterogeneous network integration platform of the who smart mine system is constructed relying on RED-MOS operating system, RED-SDN network and RED-DDS transport protocol.

04

结论

Summary

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Summary

潞安集团智慧矿山异构网络融合平台RED-MOS®操作系统平台为上层业务数据的人工智能深度挖掘，多源异构信息的深度学习提供了重要基础。

基于RED-SDN®和RED-DDS®架构下的异构网络智能融合平台实现了物理硬件资源的高效利用，接入网络设备灵活配置及异构信息的互联互通，是矿山系统实现智能化绿色开采的重要平台基础。通过异构网络的智能融合平台的建设，为智慧矿山绿色开采的目标更进一步。

The heterogeneous network integration platform of smart mine system RED-MOS® operating system of Lu'an Group provides an important basis for the artificial intelligence deep mining of upper-level business data and the deep learning of multi-source heterogeneous information.

The heterogeneous network integration platform based on RED-SDN® and RED-DDS® architecture achieved the efficient utilization of physical hardware resources, the flexible configuration of access network equipment and interconnection of heterogeneous information, which is an important platform foundation for realizing intelligent and green mining. The construction of heterogeneous network integration platform makes the goal of green mining for smart mine system s more further.

谢谢观看

Thanks！

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