空地一体化运行提升机场运行效率

Integrated Air-Ground Operations to Improve Operational Efficiency of Airports

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空地一体化提升效率的现实需求

Practical Needs for Enhancing Efficiency through Integrated Air-Ground Operation

痛点一：无法精确感知空中航空器运行态势，无法动态获取航班精确预达时刻和异常状态

Bottleneck 1: Inability to precisely sense the real-time operational situation of aircraft in flight, resulting in difficulties to dynamically obtain accurate flight arrival time and abnormal status

空管通告报文、无线电播报实时性与交互性较差

Poor real-time performance and interactivity of ATC notification and messages and radio broadcasting

缺少对航班异常状态的分析和提示

Lack of analysis and warning of flight abnormalities

痛点二：缺乏航班运筹规划能力，航空器地面滑行时间过长

Bottleneck 2: Lack of flight arrangement and planning capabilities, leading to extended ground taxiing time for aircraft

等待时间长

Long waiting time

滑行时间长

Long taxi time

痛点三：“机-车-场道-设施”协同能力差，场面冲突风险居高不下

Bottleneck 3: Poor collaboration among aircraft, vehicles, pavements, and facilities, resulting in persistent and high risks of ground conflicts

场面交通复杂，冲突因素多

Complicated surface traffic with multiple parties

场面冲突风险大

High risk of conflicts at the airports

痛点四：缺乏智慧化保障资源调度手段，资源配置和保障能力不稳定

Bottleneck 4: Lack of intelligent resource allocating approaches, leading to unstable resource allocation and support capabilities

人工任务排班调度效率低

Low efficiency of manual task scheduling

保障节点数据人工录入，误报漏报多，数据不准确

Manual data input，false reporting，inaccurate data

02

航科院助力空地一体化的创新实践

Innovative Practices in Integrated Air-Ground Operation by CAST

1. 全球航班实时监控预警，解决空中态势感知问题

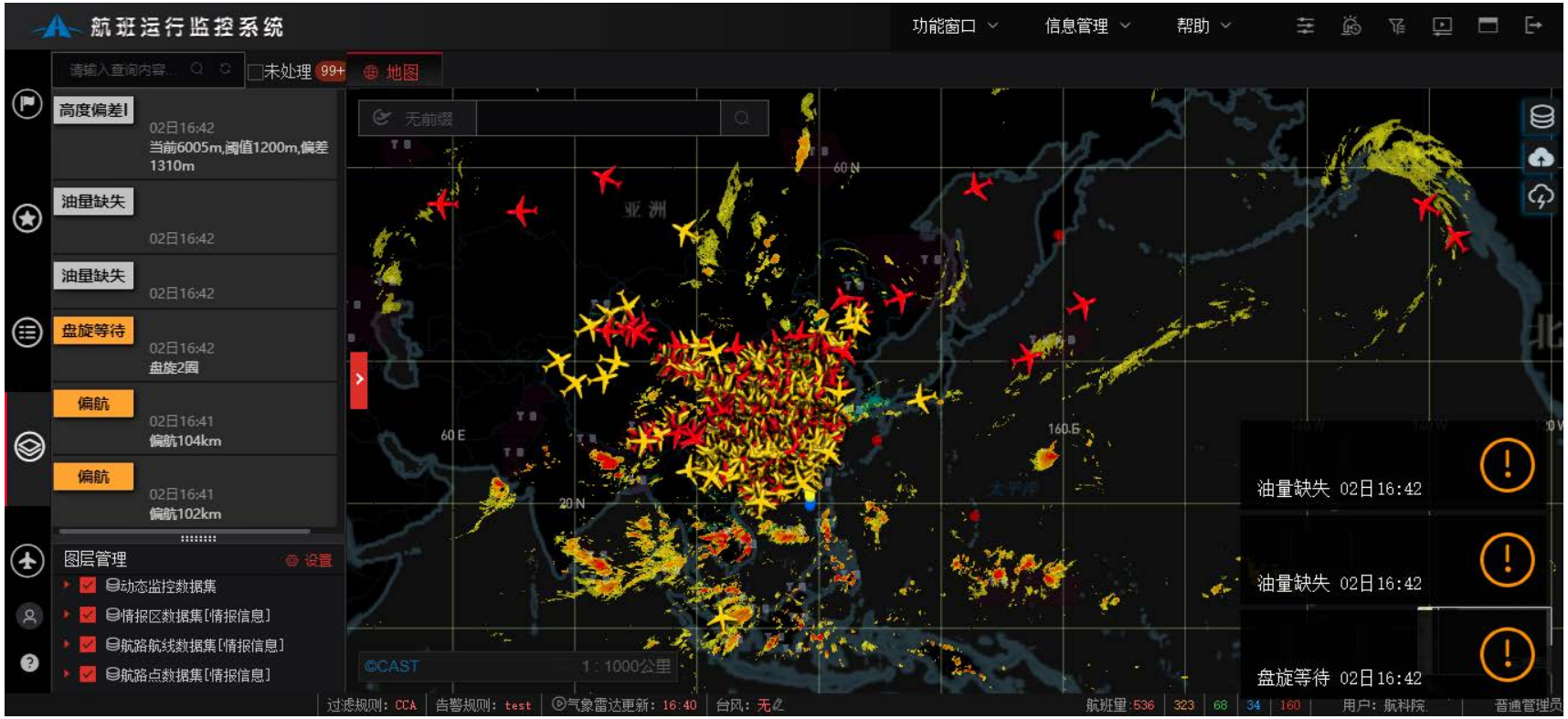
1. Global real-time monitoring and alerting of flights to solve in-flight situational awareness

以空管报文、ADS-B、雷达位置数据、航司ACARS数据等为基础，融合航空数字化地图、高精度机场平面图，实现航班的全球实时监控追踪、异常航班监控告警、航班预达时刻动态预测

Realize **global real-time monitoring and tracking of flights**, **monitoring and alarming of abnormalities**, and **real-time prediction of estimated time of arrival based** on ATC messages, ADS-B, radar position data and airline ACARS data，combined with digital aviation map and high-resolution airport map

1. 全球航班实时监控预警，解决空中态势感知问题

1. Global real-time monitoring and alerting of flights to solve in-flight situational awareness

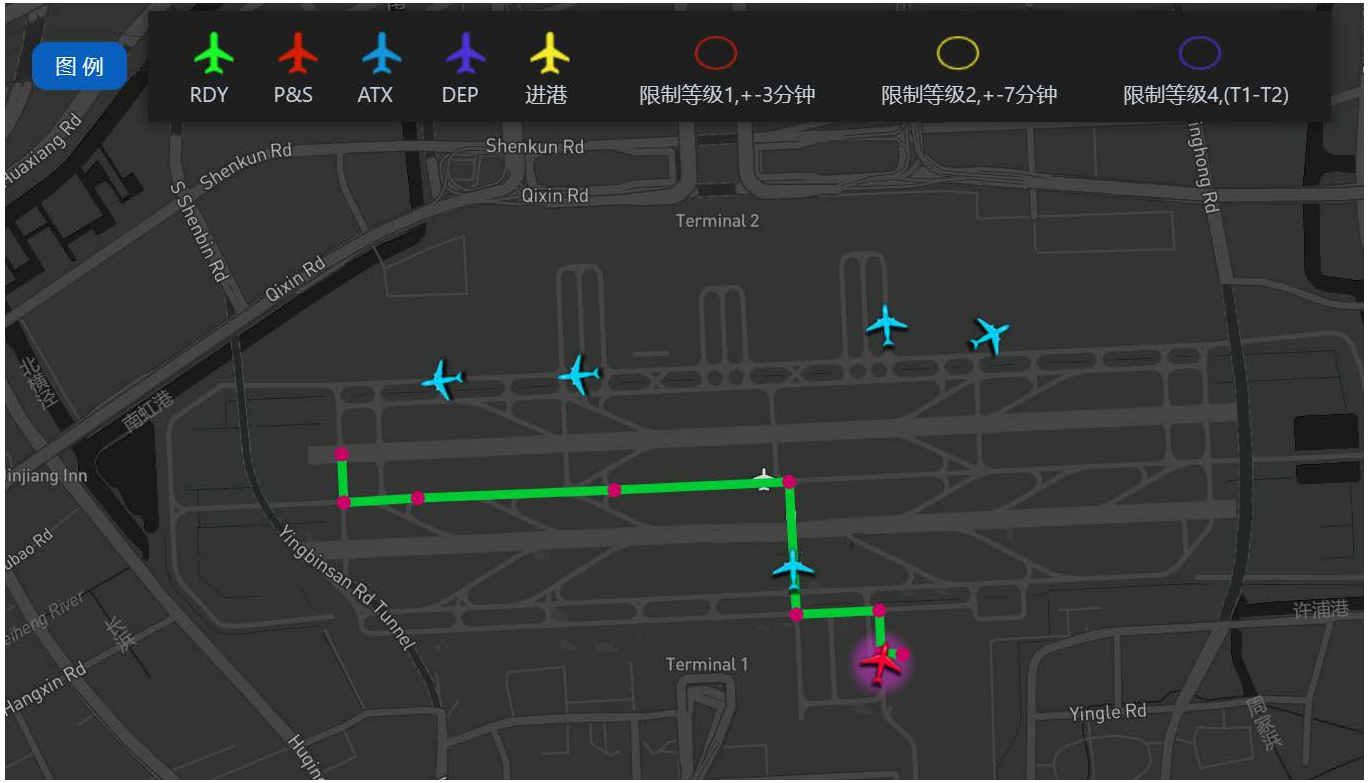


将落地前30分钟内的预测精度控制在3分钟以内；截至目前，全球航班追踪监控系统应用于50家航空公司和40多家机场，产生有效告警每天近2000次

The estimated time of arrival within 30 minutes before landing is **no more than 3 minutes**. The system is applied by 50 airlines and more than 40 airports, generating nearly 2,000 valid alarms per day.

2. 机坪管制智能辅助决策，有效降低滑行时间

2. Intelligent assistance in apron control decision-making to effectively reduce taxiing time



基于“就近起降，动态规划”原则，成功对进离港航班进行实时运筹规划，实现航空器管制指挥方案的“秒级”迭代优选，解决了离港航班推出时间智能排序、数字孪生大模型求解时间长的难题

Based on the principle of "proximity of takeoff and landing by dynamic arrangement", we developed an Apron Control Decision-Making Assistance System, which can optimize the taxiing path in seconds, and substantially reduce the taxiing time.

2. 机坪管制智能辅助决策，有效降低滑行时间

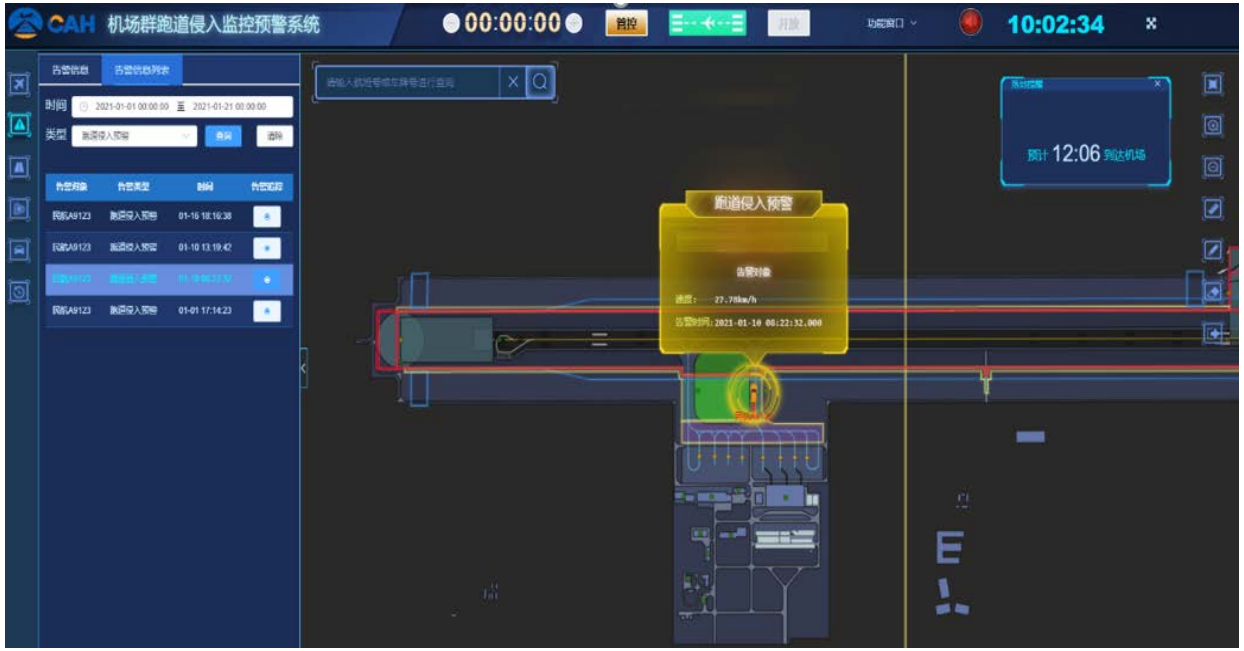
2. Intelligent assistance in apron control decision-making to effectively reduce taxiing time

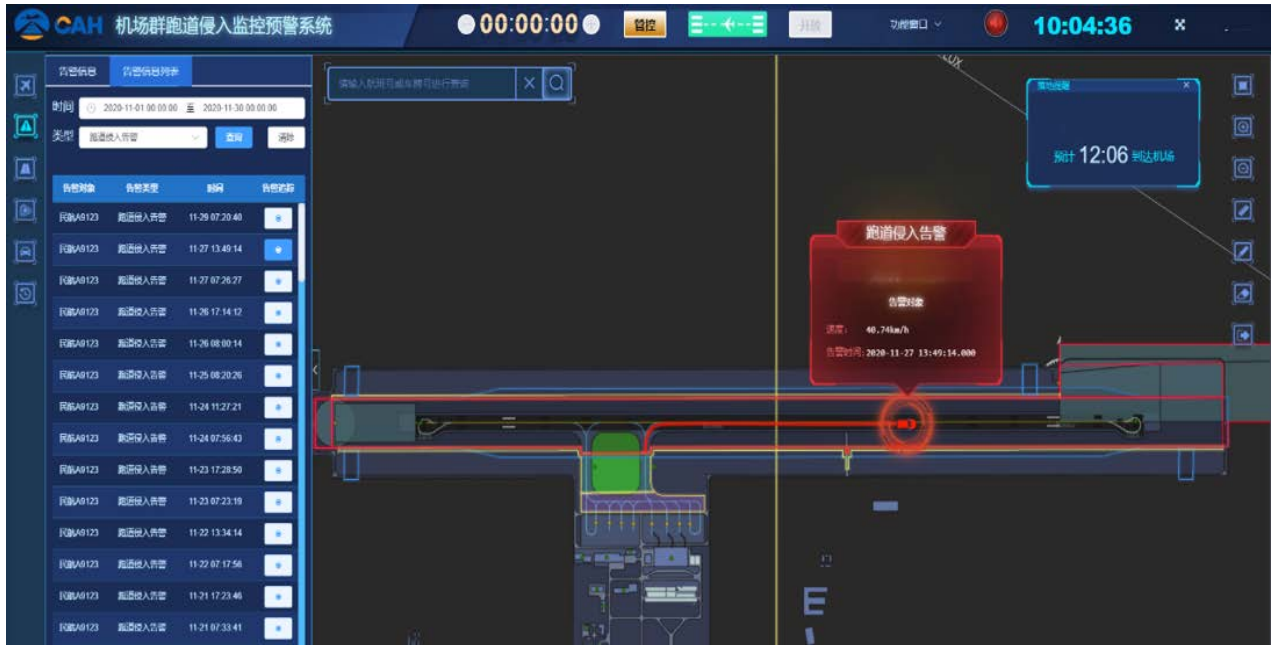
2023年，该系统在某机场应用后，航空器平均滑出时间缩短了15%，航班正常性提升约2.4%，CTOT符合率（代表空地协同能力）提升约9%，大幅减少了滑行过程中的冲突等待、机场碳排放和航空器燃油成本消耗。

Since its implementation an airport in 2023, 15% reduction in average taxi-out time, 2.4% increase in flight regularity, 9% increase in CTOT. These improvements have significantly reduced holding time during taxiing, airport carbon emissions and aircraft fuel consumption.

3.机-车位置实时监测，保障跑道运行安全

3. Real-time monitoring of aircraft-vehicle positions to ensure runway operational safety





将传统的人工监管模式转化为“机器监控预警、人为处置”的智能管控模式；实时监控车辆与跑道、车辆与航空器的安全运行状态，一旦发现跑道侵入风险，自动向车辆驾驶员和空中交通管制员告警

The intelligent monitoring and early warning system for runway incursion can monitor runways, vehicles and aircrafts in real time, and automatically alert drivers and controllers once the runway incursion risk is detected.

3.机-车位置实时监测，保障跑道运行安全

3. Real-time monitoring of aircraft-vehicle positions to ensure runway operational safety

2023年，系统在国内18个机场部署投运。已外理航班数据2千万条，车辆数据2亿条，有效预警130次，所有投运机场全年未发生跑道侵入事件。

In 2023, this system has been deployed to operate at 18 airports. The system has processed over 20 million flight records and 200 million vehicle records. It has issued 130 valid alerts, and there have been zero runway incursion incidents at any of the deployed airports throughout the year.

4. 地面保障智能化，提升保障效能

4. Intelligent ground support to enhance effectiveness and efficiency


电动客梯

电源车

远机位

利用人工智能及先进算法，对资源分配、保障任务进行智能调度和合理分配；采用多种技术方法对航班地面保障节点进行自动采集，实现关键保障状态的自动感知

Leveraging on AI and advanced algorithms, we intelligently schedule resource allocation and support task operations based on factors such as task nature, priority, and resource requirements. Tasks are allocated properly to respective operational staff. Meantime, various technological approaches are employed to achieve the automatic collection of ground support node data.

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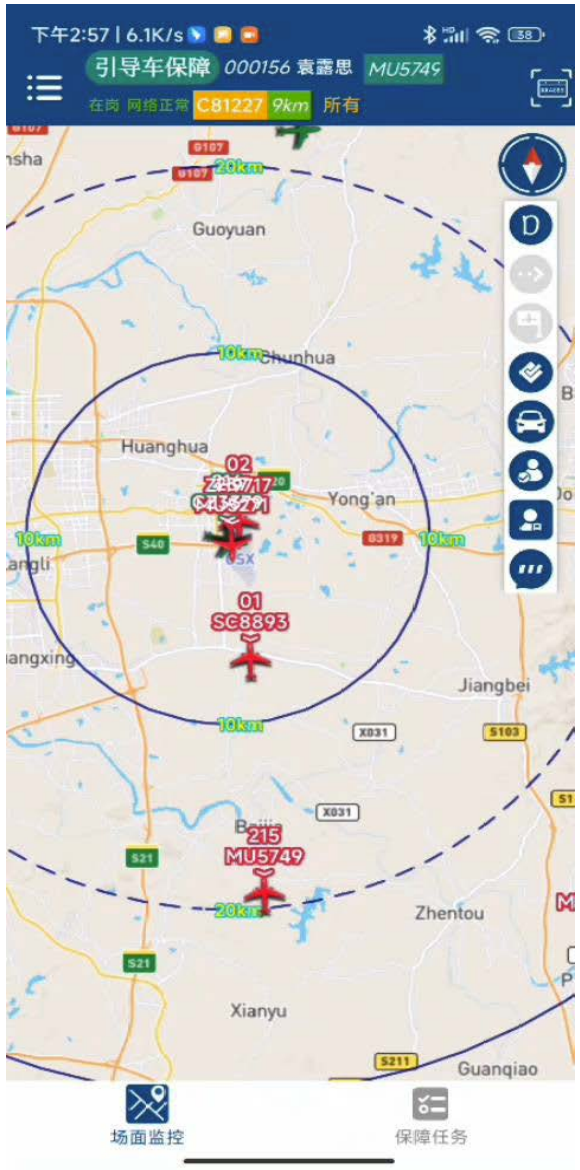
4. Intelligent ground support to enhance effectiveness and efficiency



人工排班由以前的2小时缩短到10分钟，语音对讲通话减少70%，将关键节点采集的准确性和完整性提高到95%以上

This system has been applied at some airports. Since its implementation, the time for manual scheduling was reduced from 2h to 10min, voice communication decreased by 70%, and the accuracy and integrity of critical node data collection exceeded 95%.

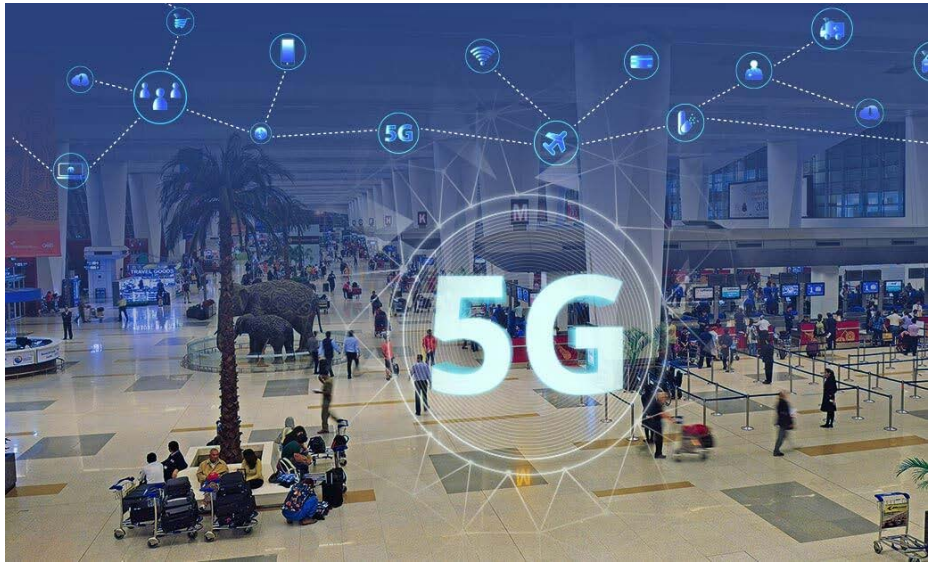
03

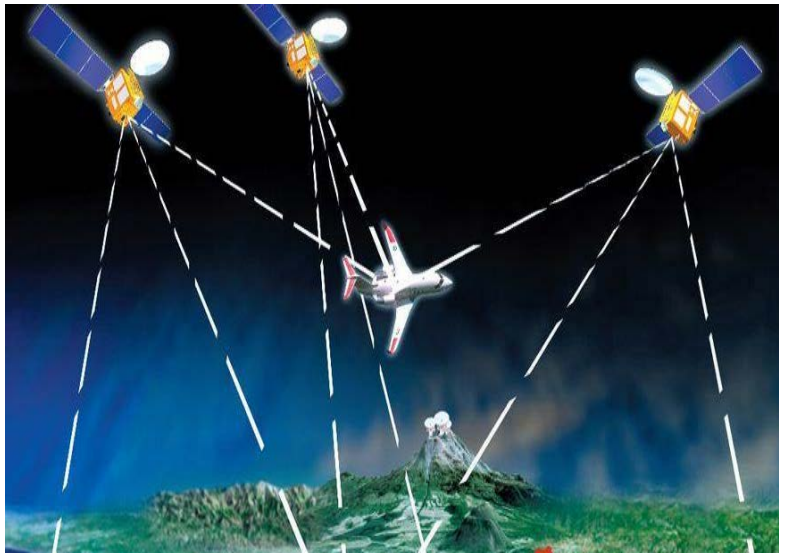
进一步提升空地一体化效率展望

Prospects for Further Enhancing the Efficiency of Integrated Air-Ground Operation

1. 下一代通信技术的应用

1. Application of next generation communication technology





5G在“机-车-场道-设施”互联中的应用

Application of 5G in

aircraft-vehicle-airport-facility

卫星互联网在旅客服务、态势感知、应急保障中的应用

Application of satellite network in

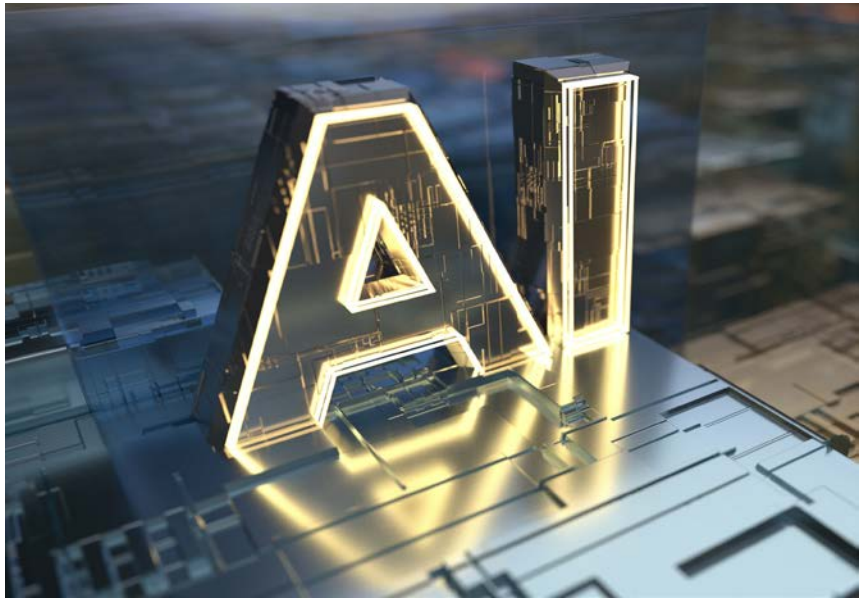
in-flight Internet services, air situational awareness and emergency

2. 新一代信息技术的应用

2. Application of new information technology

大数据分析在航班预测/航线优化/效率提升中的应用

Apply big data analysis to accurately predict flight traffic, optimize route networks, improve operational efficiency



人工智能在民航中广泛应用

NLP for passenger inquiries and complaints, RL to optimize aircraft taxiing routes and stand allocation, and MML to improve situational awareness

3. 民航引领综合交通运输

3. A Comprehensive Transportation System Led by Civil Aviation

“空地水联运”一体化出行运输服务

civil aviation will be combined with ground and water transportation, and realizes a seamless, efficient, integrated, interconnection transportation

无人/有人交通运输的融合

unmanned transportation will gradually integrate with current transportation, and eventually be dominant

谢谢！

Thank you!