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Application of Cross Platform Integration Technology in Modern Communication Systems

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Abstract: Cross platform integration technology plays an indispensable role in modern communication systems, effectively addressing the challenges of data interaction and compatibility between different systems, and providing efficient solutions by utilizing middleware, APIs, and microservice architecture for seamless integration and real-time data transmission. By using middleware technology, application API design and microservice architecture, the seamless combination of multi terminal support, real-time data transmission, cloud services and edge computing is realized. This technology improves the integration and compatibility of heterogeneous systems, and enhances the adaptability of communication systems under changing network conditions. This article focuses on the key technologies of cross platform integration, and deeply analyzes their specific application effects in improving communication efficiency, controlling development costs, and enhancing system scalability. Research has shown that cross-platform integration significantly enhances the compatibility and stability of modern communication systems, providing a solid foundation for the innovative development of the industry.

Keywords: cross platform integration; modern communication systems; middleware technology; microservice architecture; heterogeneous system integration

1. Introduction

In the modern technological environment, achieving efficient collaboration and information exchange across devices and operating systems is crucial for modern communication networks [1]. With the rapid development of cloud computing, edge computing and the Internet of Things technology, the complexity of communication systems and the demand for timeliness and compatibility of data processing are constantly increasing. By utilizing cross platform integration technologies such as middleware, APIs, and microservice architecture, data integration and system integration between different operating systems have been effectively facilitated. This type of technology not only addresses the challenges of diverse system interconnection, but also promotes the improvement of communication efficiency and flexible expansion of system scale [2].

2. Key Technologies for Cross Platform Integration

2.1. Middleware Technology

As a key technology that connects various platforms, programming languages, and hardware facilities, middleware plays a crucial role. It ensures the smooth transmission of data and effective calling of functions in heterogeneous systems through standardized interfaces and conventions, thereby promoting harmonious collaboration between different platforms. There are various types of middleware, including message middleware, database middleware, and transaction processing middleware. Message middleware relies on stable information queues to facilitate information exchange between systems. Database middleware is dedicated to integrating and enhancing distributed database resources. Transaction processing middleware ensures transaction consistency across platforms. By utilizing middleware technology, developers can avoid the complex details at the bottom and focus on developing business logic. This technology enhances the interoperability of the system and significantly reduces the difficulty of software development and maintenance [3].

2.2. API and Microservice Architecture

API and microservice architecture are important technical means for cross platform integration. API, as a standardized bridge, promotes functional calling and data exchange between different systems, ensuring smooth information sharing. RESTful and GraphQL are two typical types of APIs that have been optimized for resource management and diverse query scenarios, respectively. Microservice architecture, on the other hand, decomposes a massive system into multiple independent and single responsibility service units, which interact with each other through efficient and convenient API interfaces, greatly enhancing the adaptability and scalability of the entire system. In microservice architecture, the calling relationship of services can be represented as:

$$R = n \times (n - 1) \tag{1}$$

Among them, R is the total number of possible calls between services, and n is the number of microservices. As n increases, the communication complexity of the system grows exponentially. Therefore, with the help of API gateways and service registration and discovery mechanisms, it is possible to efficiently coordinate and improve the interaction efficiency between services, ensuring smooth and stable integration between different platforms.

3. Application of Cross Platform Integration Technology in Modern Communication Systems

3.1. Multi Terminal Support and Unified User Experience

In the field of contemporary communication technology, multi terminal support has become an important function in multiple industries such as video conferencing, real-time information exchange, and multimedia resource dissemination [4]. Relying on multi-platform integration technology, users can achieve efficient interaction between different devices such as computers, mobile phones, and smart home appliances. Taking video conferencing systems as an example, with flexible interface design and multi-platform development frameworks such as Flutter and React Native, the interface can automatically adapt to different screen sizes, ensuring that users can enjoy the same visual and operational experience on multiple terminals. In real-time communication software, a unified API interface can achieve synchronous updates of information, documents, and video materials between devices, allowing users to maintain communication continuity when changing devices. Unified user experience requires dynamic adjustment of interface layout based on device resolution and characteristics, and its adaptation rules can be described through formulas:

$$S = L \times \frac{R_d}{R_b} \tag{2}$$

Among them, S represents the adjusted layout size, L is the basic layout size, R_d is the actual resolution of the device, and R_b is the reference resolution. By calculating S, multiple terminal devices can be dynamically adapted to meet the usage habits of different users.

3.2. Real Time Data Transmission and Interconnection

Real-time data transmission technology is widely adopted in the fields of intelligent transportation, online gaming, and industrial Internet of Things. In the field of intelligent transportation, this technology mainly facilitates the real-time exchange of information between vehicles and infrastructure, such as transmitting road conditions and providing navigation guidance [5]. Thanks to cross platform integration technology, various devices including cars, mobile phones, and traffic signal control devices can rely on common protocols such as MQTT and WebSocket to complete real-time data communication. In the field of online games, real-time feedback of player actions is synchronized with servers, relying on the efficiency of cross platform integration technology to ensure consistency and coherence among players on different platforms. In the Industrial Internet of Things, numerous sensors and devices report their status through gateways in real time and receive control instructions to ensure the efficiency and stability of the production process. The calculation of real-time data transmission efficiency can be expressed as:

$$T = \frac{P}{B} + L_{enc} + L_{route} \quad (3)$$

Among them, T is the total delay of data transmission, P is the packet size, B is the network bandwidth, L_{enc} is the delay of data encryption processing, and L_{route} is the delay of routing processing. By optimizing the communication protocol and using lightweight encryption algorithms, the total delay (T) can be effectively reduced to meet the low latency requirements of real-time applications.

3.3. Integration of Cloud Services and Edge Computing

In modern communication systems, the strategy of combining cloud services with edge computing is widely deployed in multiple scenarios, such as industrial automation, intelligent city construction, and video security monitoring. Especially in the field of industrial automation, various edge devices, including sensors and controllers, are responsible for real-time collection of various data in the manufacturing process, and use edge processing technology for preliminary data anomaly screening and other operations. Then, the preliminary processed data is sent to the cloud for more in-depth data mining and model construction. This process greatly improves both the efficiency and intelligence of manufacturing operations. In the process of building intelligent cities, edge nodes distributed in public infrastructure such as lighting systems and monitors can instantly process traffic flow, environmental data, etc., and transmit these important data to remote servers in a timely manner, providing global decision support for city managers and ensuring the timeliness of road traffic efficiency and environmental supervision. In the video security monitoring system, the edge computing device is responsible for real-time detection of abnormal behavior in the video stream and sending an alarm, while sending all video data to the cloud for backup, providing data support for subsequent abnormal behavior prediction and inter regional information linkage. With the cooperation between the cloud and the edge, edge computing mainly deals with tasks that require high timeliness, while ECS is responsible for in-depth data analysis and long-term preservation of data. This synergy improves the overall performance of the system and reduces the burden of network bandwidth. Table 1 shows the specific functions of the two in different application scenarios.

Table 1. Function Comparison of Cloud Service and Edge Computing in Different Application Scenarios.

Application scenarios	Cloud service function	Edge computing function
Intelligent Manufacturing	Large scale data storage and model training	Real time processing of production data and anomaly detection

smart city	Comprehensive data analysis and long-term trend prediction	Real time data collection, local event response
Video surveillance	Video stream storage, deep behavioral analysis	Abnormal behavior detection and real-time event alerts
Remote healthcare	Historical case analysis and auxiliary diagnostic support	Real time physiological data monitoring and emergency warning
Intelligent Transportation	Global traffic flow optimization and path recommendation	Real time monitoring of road conditions and dynamic adjustment of traffic lights

3.4. Integration and Compatibility of Heterogeneous Systems

In modern communication technology, the integration and compatibility of heterogeneous systems play an indispensable role, especially in key industries such as smart transportation management, industrial Internet of Things, and smart healthcare. Taking smart transportation as an example, monitoring devices, vehicle tracking systems, and traffic signal management systems provided by different manufacturers must be able to seamlessly exchange data. Using data normalization tools, the video information, global positioning system data, and operation instructions generated by these devices are uniformly converted into standard formats, and then efficiently transmitted through message middleware such as Kafka or RabbitMQ, ultimately achieving event monitoring and signal control in the traffic command system. In the application of the industrial Internet of Things, the traditional PLC controller on the production line and advanced intelligent devices, such as robots and sensors, are mutually compatible through OPC-UA protocol, and the data is real-time transmitted to the cloud through edge computing devices for preventive maintenance analysis. As for the field of smart healthcare, the data generated by medical devices from different manufacturers, such as magnetic resonance imaging equipment and electrocardiogram instruments, often have inconsistent formats. Through middleware and protocol conversion tools, these data are integrated into the hospital information system (HIS), allowing doctors to view patients' complete diagnostic information on a unified platform. The real-time monitoring system is responsible for monitoring the operation status of the equipment. Once an abnormality is detected, the maintenance process will be immediately initiated to ensure the stability of the system. Figure 1 shows a typical process for heterogeneous system integration:

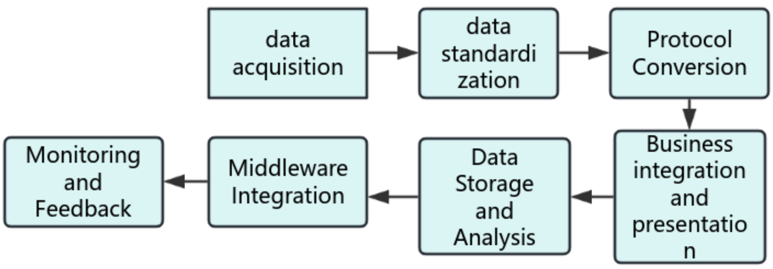

Figure 1. Flowchart of Heterogeneous System Integration and Compatibility.

4. The Application Effectiveness of Cross Platform Integration Technology in Modern Communication Systems

4.1. Enhance System Compatibility and Flexibility

The compatibility and flexibility of contemporary communication systems have been greatly enhanced, and collaboration between various devices and systems has become more efficient, thanks to the widespread application of cross platform integration technology. In enterprise resource planning (ERP) systems, there are often technical differences in the business systems used by various departments, involving multiple aspects such as operating systems, database types, and interface specifications. By utilizing middleware technology, these heterogeneous systems can be seamlessly integrated and data can be exchanged, ensuring smooth information transmission. For example, the financial management system and inventory management system are integrated through application programming interfaces (APIs) to achieve automatic data synchronization, thereby reducing errors and delays caused by manual operations. In the construction of intelligent cities, environmental monitoring, traffic control signals, and emergency response information need to be standardized through specific protocol converters, and then widely distributed through integrated middleware systems to achieve real-time interaction between different systems. The flexibility of the system is mainly manifested in the ability of the communication network to dynamically expand its functions or flexibly configure resources according to actual needs. With the help of microservice architecture, system design can be modularized, allowing for on-demand addition or removal of service nodes without interfering with the normal operation of other parts. During peak communication hours, additional message processing nodes can be added to cope with the increase in communication traffic. The improvement of system compatibility and flexibility can be expressed by the formula:

$$C_{eff} = \frac{S_{int}+R_{dyn}}{E} \quad (4)$$

Among them, C_{eff} represents system compatibility and flexibility, S_{int} is the number of interfaces between systems, R_{dyn} is the ability to dynamically adjust resources, and E is the resource consumption for system expansion. By improving S_{int} (the number of interfaces between systems) and R_{dyn} (the ability to dynamically adjust resources), and optimizing E (the resource consumption for system expansion), the compatibility and flexibility of the communication system can be significantly enhanced.

4.2. Optimize Communication Efficiency and Real-Time Performance

Cross-platform integration technology has achieved significant results in various fields such as remote video communication, intelligent transportation management, and industrial Internet of Things applications due to its efficient protocol design and real-time information processing capabilities. Taking the remote video communication system as an example, this technology adopts protocols such as WebRTC to achieve efficient and low latency transmission of audio and video data between multiple terminals, ensuring smooth switching for users between different devices and greatly enhancing the user experience. Through adaptive bandwidth adjustment and data compression technology, the efficiency of information transmission has been further improved. In the field of intelligent transportation, cross platform integration technology has promoted the real-time data exchange between sensors, surveillance cameras and traffic signal systems. Traffic information is preliminarily processed through edge computing gateways, and important data is uploaded to the cloud for global regulation, effectively reducing delays and accelerating response speed. As for the industrial Internet of Things, sensors and controllers on the production line can report the status in real time through a unified interface. Edge computing nodes are responsible for on-site analysis of data and uploading key information to the cloud to achieve predictive maintenance and prevent downtime during production. These applications significantly improve the speed of data transmission, shorten response time, enhance the real-time response performance of the system, and provide solid support for situations that require extremely high communication efficiency.

4.3. Reduce Development and Operation Costs

Through unified interface design and a standardized development framework, costs across multiple stages from development to operation and maintenance are significantly reduced, highlighting the advantage of cross-platform integration technology. In the development phase, cross platform frameworks such as Flutter are utilized React Native, Developers are able to achieve one code for multiple devices, greatly saving labor and resources for coding various types of hardware. The mobile instant messaging system can develop functions such as message push, document transmission, and voice communication through a unified API, eliminating the tedious development of iOS, Android, and web versions, greatly reducing the development time required. The application of componentization and microservice architecture allows development teams to focus on improving a single functional module, reducing system complexity and improving development efficiency. As for the operation and maintenance phase, utilizing middleware and a unified monitoring system has become a key means of reducing costs and improving efficiency. The middleware function of log monitoring and fault diagnosis helps operation and maintenance engineers quickly identify and lock in fault points, thereby compressing the time required for fault troubleshooting and reducing the economic burden of system downtime. In the enterprise resource planning system, its modular architecture enables the operations team to independently update or maintain specific modules without interfering with the overall system operation, thereby preventing financial losses caused by overall shutdown. Cross platform integration technology, with standardized development processes, component-based updates, and automated management, significantly reduces human resources, time consumption, and economic investment, providing an efficient and economical solution for the long-term stable operation of communication systems.

4.4. Enhance System Scalability and Reliability

The scalability and reliability of communication systems have been greatly enhanced through modular construction, flexible resource allocation, and fault-tolerant design, all of which are supported by cross-platform integration technology. In multimedia transmission platforms, user traffic fluctuations are common. Cross-platform integration technology ensures flexible adjustment of service capabilities by dynamically increasing or decreasing content distribution servers. This system can expand or reduce nodes based on real-time data traffic requirements, which not only saves costs but also speeds up user access response time. In the process of building a smart city, the coordinated operation of transportation, environmental monitoring, and public safety systems is crucial. By utilizing universal interfaces and middleware technology, the system can quickly integrate new devices and add new functions. For example, the traffic monitoring system can quickly deploy additional monitoring cameras or traffic signal control devices based on regional traffic congestion, ensuring the system's ability to respond quickly to sudden demands. Cross-platform integration technology improves system reliability through load balancing and backup design, enhancing stable operation. By distributing network requests across multiple server nodes, load balancing technology effectively mitigates the risk of a single point of failure.

5. Conclusion

Cross-platform integration technology plays a crucial role in modern communication systems by relying on unified interface design, standardized development frameworks, and modular architecture. It greatly improves system compatibility, flexibility, and scalability, while reducing development and operational costs and enhancing communication efficiency and reliability. The practical application of this technology in multiple fields, such as smart transportation, industrial Internet of Things, and smart healthcare, has shown excellent adaptability and technological advantages. With growing communication demands and technological advancements, cross-platform integration technology will further promote the intelligence, automation, and efficiency of communication systems, providing solid support for various application scenarios. These technological innovations have laid a solid foundation for modern communication systems and continue to drive the industry's innovative development.

References

1. L. Zhi, S. Liu, H. Dai, M. Liu, and J. Wang, "Algorithm for data format conversion and compatibility guarantee in technical platforms for cross-platform application integration," in *Proc. 2024 IEEE 4th Int. Conf. Data Sci. Comput. Appl. (ICDSCA)*, Nov. 2024, pp. 893–897, doi: 10.1109/ICDSCA63855.2024.10860147.
2. I. Rasheed, M. Asif, A. Ihsan, W. U. Khan, M. Ahmed, and K. M. Rabie, "LSTM-based distributed conditional generative adversarial network for data-driven 5G-enabled maritime UAV communications," *IEEE Trans. Intell. Transp. Syst.*, vol. 24, no. 2, pp. 2431–2446, 2022, doi: 10.1109/TITS.2022.3187941.
3. C. Goumopoulos, "Smart city middleware: A survey and a conceptual framework," *IEEE Access*, vol. 12, pp. 4015–4047, 2024, doi: 10.1109/ACCESS.2023.3349376.
4. M. AlKaldi and A. AlShehri, "Dynamic middleware for interoperable federated learning: Enabling cross-framework communication," in *Proc. 2024 2nd Int. Conf. Federated Learn. Technol. Appl. (FLTA)*, Sep. 2024, pp. 267–273, doi: 10.1109/FLTA63145.2024.10839910.
5. X. Li, C. C. Kang, Z. N. Ng, and K. Nisa'Minhad, "Advances and challenges in automated agriculture: Integrating 5G wireless technology with IoT, cloud computing and robotics," in *Proc. 2024 Int. Conf. Electr. Commun. Comput. Eng. (ICECCE)*, Oct. 2024, pp. 1–5, doi: 10.1109/ICECCE63537.2024.10823580.