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Tetyana Petrenko, PhD, Associate Professor
Anton Zadorozhnyi, PhD student
Ukrainian State University of Railway Transport, Kharkiv

CLIMATE FORECASTING SYSTEM DISTRIBUTED ARCHITECTURE

Climate forecasting has received considerable attention due to its critical importance for decision-making in areas such as agriculture, natural resource management, and disaster preparedness. In recent years, the use of distributed architectures for Internet of Things (IoT)-based climate forecasting systems has emerged as an effective approach to provide scalable and resilient solutions. This thesis provides an overview of distributed architectures as applied to climate forecasting systems and explores how these systems can improve climate forecasting skills while overcoming key challenges of scalability, heterogeneity, and data security.

With the growing impact of climate change, there is an increasing demand for accurate climate forecasting systems. Recent advancements in distributed systems, combined with the rise of the IoT, have paved the way for advanced architectures capable of effectively predicting climatic events. IoT-based systems enable the collection of large volumes of environmental data, but they require distributed and scalable approaches to manage the heterogeneity and complexity of the data.

Distributed generation [1] is gaining attention for its role in supporting climate resilience through decentralized systems. This distributed approach aligns well with climate forecasting needs, as it enhances the reliability of data collection across different geographical areas.

Distributed systems [2] integrated with emerging technologies like Artificial Intelligence (AI), are crucial for improving the accuracy of climate forecasting models. Such distributed architectures provide scalability, adaptability, and robustness, which are essential for addressing the growing challenges posed by climate change.

Recent research has highlighted the use of distributed architectures that incorporate both IoT devices and distributed computing paradigms such as Fog and Peer-to-Peer (P2P) networks to create effective climate forecasting systems. The article [3] proposes a hybrid and distributed architecture based on CoAP that combines fog computing with P2P overlay networks to facilitate the seamless integration of smart objects. Such systems make climate data readily available for real-time forecasting while ensuring efficient use of resources. In addition, distributed architectures [4] address key issues related to heterogeneity, scalability, and interoperability using a multi-tiered model. This model provides different levels of abstraction, simplifying data management and integration of new IoT devices.

Integrating AI models with traditional forecasting systems is another way to improve climate forecasts. Hybrid methods of hydroclimatic forecasting combine data-driven AI models with physical models to achieve more accurate predictions of climate events [5]. This integration allows for improved forecasting skills by taking advantage of machine learning, which can cope with the inherent errors of numerical models and learn efficiently from large data sets. In addition, the combination of AI and climate models allows forecasts to be made over a wide range of time scales, from short-term weather forecasts to long-term climate forecasts.

The introduction of distributed IoT systems raises several security concerns due to their large-scale deployment and potential vulnerability to cyberattacks. The article [6] addresses this problem by proposing a blockchain-based architecture that provides a secure and scalable IoT network. Blockchain combined with AI improves the reliability of climate forecasting systems by adding layers of data integrity and security, which is crucial given the sensitivity of the data being processed. Anomaly detection based on machine learning at the gateway level further protects against malicious activity, providing a solid foundation for a secure climate forecasting system.

The development of distributed climate forecasting systems involves a few challenges, such as the integration of diverse data sources, the need for secure communication protocols, and the high computational requirements for processing complex models. However, the opportunities are significant. By using a distributed architecture, the system can achieve high scalability and fault tolerance, allowing for real-time climate forecasts over large geographical areas. Furthermore, the development of exascale computing [7] and advances in artificial intelligence offer enormous potential to overcome current limitations in climate forecasting capabilities, making distributed systems a critical component of future climate forecasting solutions.

Distributed architectures represent a promising approach to addressing the challenges associated with climate forecasting. By integrating IoT devices, Fog computing, blockchain, and AI models, it is possible to create a scalable, secure, and efficient climate prediction system that meets the growing demand for timely and accurate forecasts. Future work should focus on overcoming existing limitations related to interoperability, security, and computational requirements to unlock the full potential of these advanced distributed systems in climate forecasting.

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д.т.н., професор, А.В. Прохорченко
аспірант, Д.Р. Харченко
Український державний університет залізничного транспорту (м. Харків)

ПІДВИЩЕННЯ ПРОПУСКНОЇ СПРОМОЖНОСТІ ЗАЛІЗНИЧНОЇ ІНФРАСТРУКТУРИ В УМОВАХ ПЕРЕВАНТАЖЕННЯ НА ОСНОВІ ПРІОРИТЕЗАЦІЇ РУХУ ПОЇЗДОПОТОКІВ

Зростання обсягів вантажних і пасажирських перевезень створює значний тиск на залізничну інфраструктуру України. Особливо гостро дана проблема виникла під час широкомасштабного російського вторгнення в Україну – залізнична інфраструктура піддається руйнівним ракетним ударам, що створює так звані “вузькі місця” в мережі – залізничні дільниці, які мають дефіцит пропускної спроможності та стають перевантаженими. Перевантаження дільниць призводить до затримок, зниження ефективності та підвищення експлуатаційних витрат. В умовах обмежених ресурсів та неможливості швидкого розширення інфраструктури актуальним стає питання оптимізації руху поїздів на залізничній мережі України шляхом пріоритезації поїздопотоків. Додаткової актуальності завдання встановлення пріоритетів руху поїздів набуває в умовах лібералізації ринку залізничних перевезень, де важливим є вірно розподілити обмежену пропускну спроможність між декількома перевізниками.

Планування руху поїздів на перевантажених дільницях мережі здійснюються шляхом встановлення певного механізму визначення порядку проходження поїздів через дільницю на основі пріоритерізації. Створення ефективного механізму управління залізничним рухом на основі його пріоритерізації є досить складним питанням, так як в умовах функціонування залізничного ринку за принципом відкритого доступу (англ. open access) він повинен забезпечувати вирішення міжпоїзних конфліктів у графіку руху поїздів щодо порядку проходження перевантаженої залізничної дільниці на основі недискримінаційнойсті для всіх учасників перевезень. Незважаючи на наявність у АТ “Укрзалізниця” встановлених правил пріоритетності