

## *Retraction*

# **Retracted: English Education Translation System Based on 5G Network Virtualization**

### **Journal of Sensors**

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### **References**

- [1] M. Hou, "English Education Translation System Based on 5G Network Virtualization," *Journal of Sensors*, vol. 2022, Article ID 8763849, 12 pages, 2022.

## Research Article

# English Education Translation System Based on 5G Network Virtualization

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In order to improve the effect of English education translation, this paper improves the 5G network virtualization algorithm and uses the typical correlation analysis method in data mining to extract the correlation relationship between the data content contained in the massive English translation user equipment. Furthermore, this paper adopts the similarity-based clustering method to realize the self-organization construction of English translation virtual community. On this basis, this paper proposes a spectrum allocation algorithm based on convex optimization, which effectively solves the problem of spectrum allocation in virtual cells. Finally, this paper constructs the functional architecture of the English education translation system based on 5G network virtualization and conducts experimental research. The experimental research results show that the English education translation system based on 5G virtualization constructed in this paper can play an important role in smart English teaching.

## 1. Introduction

With the introduction of the concept of “smart earth,” under the research and development of artificial intelligence, cloud computing, and other technologies, the concept of “smart” has penetrated into all fields of society. In the field of education, researchers have conducted theoretical and practical discussions and research on smart classrooms, smart campuses, and smart education [1].

The emergence of smart teaching tools provides a full range of smart teaching environments for college teaching. Among them, the intelligent assistant Yu Class, developed by the Online Education Office of Tsinghua University, has powerful functions in the teaching process before, during, and after class. In particular, the application in classroom teaching is more obvious. Its “screen projection function” can not only project the content of learning to the student’s mobile phone but also stimulate students’ enthusiasm for learning through functions such as “barrage” [2].

In the context of smart education, the optimization of English translation classroom teaching ecology can analyze students, teachers, teaching organization, and teaching envi-

ronment from the perspective of ecology and build an ecological teaching model for English translation classrooms in a smart education environment. According to ecological theory, English translation teaching can be regarded as an organic, complex, and unified system [3].

In traditional translation teaching, due to the influence of a fixed teaching environment (such as classrooms), the teaching content is generally based on theory and exercises, and students lack sufficient practice and knowledge input and application. In the process of teaching, students often lack interest due to the limitations of the language in the textbooks. However, the ecological translation teaching model in the context of smart education breaks through the limitations in this respect, and the forms of teaching organization present a trend of diversification. With the help of smart teaching tools, teachers can strengthen the learning content in three links before class, during class, and after class, so that the input of knowledge presents a natural ecological inheritance, and the degree of internalization of students’ knowledge is more effective. In addition, it also balances the learning of basic English knowledge and professional knowledge. English translation teaching and learning

involve the basic knowledge of English as well as the professional knowledge. If you do not handle the relationship between each other, you may lose sight of one another. The three aspects of learning before class, during class, and after class effectively avoid this problem. Teachers can choose the way of teaching according to the difficulty of knowledge. For example, the basic knowledge of English such as vocabulary, grammar, and sentence patterns is relatively easy, but it is difficult to grasp quickly. Then, in the preclass session, teachers can set tasks for students through video commentary, audio commentary, or article reading. Students can have a deeper understanding of certain knowledge points by watching or reading repeatedly. As for the more difficult parts, you can analyze in depth through classroom discussion and solve such problems in the classroom. For the problem of insufficient translation practice, students can be organized to gradually improve through activities such as translation workshops and translation companies to observe knitting internships. Teaching and learning before class, during class, and after class is an organic whole, and the three are independent of and complementary to each other.

Based on the above analysis, this article studies an English education translation system based on 5G network virtualization, which provides a theoretical reference for improving the wisdom of subsequent English education.

## 2. Related Work

In the edge computing network system, the network architecture that combines network function virtualization and software-defined networking transforms traditional network functions from dedicated hardware devices to virtual network function software running on standardized commercial server virtual machines [4]. On the one hand, virtual machine-based software network functions use underlying virtualization technology to bring benefits that traditional networks do not have, such as accelerating time to market, reducing hardware and operating costs, and improving security and scalability [5]; on the other hand, the use of standardized programmable interfaces that separate the data plane and the logically centralized control plane can effectively simplify maintenance operations and reduce network management costs. It is an important means to provide network flexibility [6]. Sun and Li [7] put the network function of compressing the data stream at the front and the network function of augmenting the data stream at the back, thereby reducing the bandwidth overhead of the physical link between the front and rear network functions. However, they do not take into account the computational resource overhead required by the network functions that process the data flow. Literature [8] designed a corresponding buffer for the service chain. When the buffer data packet volume exceeds the threshold, the NFVnic will appropriately limit the data flow rate to avoid the downstream virtual network function from becoming the bottleneck of the entire service chain; when it is lower than the threshold, it will appropriately increase the data rate. Literature [9] proposes to place network functions with strong processing capabilities in front of the service chain and network functions with weak

processing capabilities behind the service chain to avoid performance degradation of the service chain and to sacrifice resources in exchange for performance. How to find the proportional relationship between the data flow rate and the service chain deployment resources and directly determine the resource allocation based on the data flow rate is a very difficult problem [10]. In addition, the network architecture based on software-defined networking and network function virtualization is more flexible than traditional network architectures, but this flexibility also makes the state of edge computing networks constantly change and service chain updates occur frequently. Network operators must not only ensure that the update process of the service chain is correct and consistent but also avoid loopholes in the network update process, resulting in network performance degradation or even crash [11]; faster update speed means that the time occupied by resources at the same time will be reduced, and the use of network resources will be avoided. The rate is further reduced [12]. Literature [13] chooses to wait for the current data stream to be processed before routing the new data stream to process it, but this increases the time and cost of updating. Literature [14] replicates and transfers the state of network functions in a fine-grained manner to ensure consistent properties during the update process. At the same time, in order to avoid network performance degradation, they will cache data packets in the controller during the update process. Avoid packet loss or error handling. Literature [15] arranges the update sequence between service chains under the consideration of network resource constraints, so as to complete the update of the entire network state. Literature [16] uses an OpenNF or Split/Merge update mechanism to realize the update of a single service chain. Literature [17] is too coarse-grained to study the update sequence of the service chain, and it is difficult to minimize the update time of the network state. At the same time, because their update of a single service chain relies on the OpenNF or Split/Merge update mechanism, there is no further analysis of a single service chain. The update mechanism of the service chain is optimized.

## 3. 5G Network Virtualization Processing

Next, this article defines the relevant concepts and elements in the English education translation system network.

*Definition 1.* The base station set  $S = \{s_m, m = 0, 1, 2, \dots, N_s\}$  under the coverage area of the macro base station is composed of one macro base station and  $N_s$  small base stations, where  $s_0$  is the macro base station and  $s_1, \dots, s_{N_s}$  represents the small base station [18].

*Definition 2.* A large number of user equipment are randomly distributed in the area,  $U = \{s_m, m = 0, 1, 2, \dots, N_U\}$  is the set of user equipment, and  $N_U$  is the number of users.

*Definition 3.* The user equipment is running various types of applications and needs to transmit various modal data, and the vector  $X = \{x_1, x_2, \dots, x_n\}$  representing the modal data is obtained through the data analysis method.

**Definition 4.** Similarity  $\text{sim}(u, v)$  refers to the similarity between user equipment  $u$  and  $v$  that needs to transmit data when communicating.

**Definition 5.** This article introduces a “user-centered” virtual cell, breaking the concept of traditional access network centered on base stations. The cell is no longer associated with the base station. However, it is associated with the user. At the same time, it realizes the decoupling of signal transmission and base station ID and further supports network virtualization management.

**Definition 6.** This article assumes that the defined macro base station area is allocated logically continuous spectrum resources; that is, the available spectrum resource is  $C$ . The spectrum allocation strategy among macro base stations is beyond the scope of this article, so this article will not discuss it.

There are a large number of user equipment in the network, and a large amount of data of various modalities needs to be transmitted in real time. As shown in Figure 1, each user equipment needs to transmit multiple modal data, and there is a certain correlation between modal data blocks describing the same or similar objects.

In this paper, two modal data blocks are represented as vectors  $X = \{x_1, x_2, \dots, x_n\}$  and  $Y = \{y_1, y_2, \dots, y_n\}$ , respectively. The canonical correlation analysis extracts a linear combination of a set of variables from each vector representing the data to form two canonical vectors  $w_X^T X$  and  $w_Y^T Y$ . Then, we use these two typical vectors to calculate the Pearson coefficient describing the correlation, as shown in the following formula [19]:

$$X\rho(X, Y) = \rho(w_X^T X, w_Y^T Y) = \frac{\text{cov}(w_X^T X, w_Y^T Y)}{\sqrt{\text{var}(w_X^T X) \text{var}(w_Y^T Y)}}. \quad (1)$$

In order to fully discover the correlation relationship between the data, the typical correlation analysis objective selects the optimal  $w_X$  and  $w_Y$  to maximize the value of formula (1), thus forming an optimization problem, as shown in the following formula:

$$\begin{aligned} \max \quad & \frac{\text{cov}(w_X^T X, w_Y^T Y)}{\sqrt{\text{var}(w_X^T X) \text{var}(w_Y^T Y)}} \\ \text{s.t.} \quad & \text{var}(w_X^T X) = \text{var}(w_Y^T Y) = 1. \end{aligned} \quad (2)$$

The Lagrangian multiplier method is usually used to solve this problem, and the Lagrangian equation is constructed:

$$\begin{aligned} L = \text{cov}(w_X^T X, w_Y^T Y) - \frac{\lambda}{2} (\text{var}(w_X^T X) - 1) \\ - \frac{\theta}{2} (\text{var}(w_Y^T Y) - 1). \end{aligned} \quad (3)$$

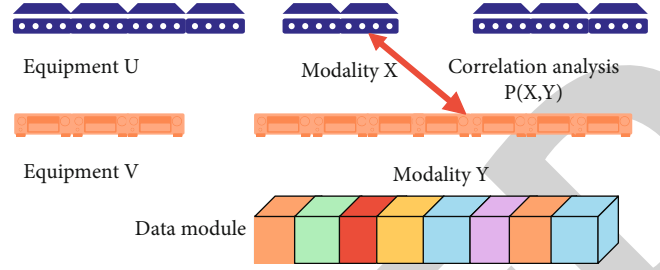


FIGURE 1: Modal data model.

By deriving and calculating the Lagrangian equation, we obtain [20]

$$w_Y = \frac{1}{\lambda} \sum_{yy}^{-1} \sum_{yx} w_x, \quad (4)$$

$$\sum_{xy} \sum_{yy}^{-1} \sum_{yx} w_x = \lambda^2 \sum_{xx} w_x.$$

Among them,  $\sum_{xy}$  is the covariance matrix,  $\sum_{xx}$  and  $\sum_{yy}$  are the variance matrices, and the goal is to find the maximum  $\lambda$ , that is, the canonical correlation coefficient. When the maximum  $\lambda$  is obtained, it corresponds to  $w_X$  and  $w_Y$  is a typical vector.

We assume that two user equipment  $u$  and  $v$  and the data sets formed by transmitting data of multiple different modalities are  $\Phi(u) = \{X_1^u, X_2^u, \dots, X_{N_\phi}^u\}$  and  $\Phi(v) = \{X_1^v, X_2^v, \dots, X_{N_\phi}^v\}$ , respectively. Using the data correlation discovery method introduced in the previous section, the correlation  $\lambda(X_a^u, X_b^v)$  between any two pieces of different modal data  $X_a^u$  and  $X_b^v$  of two user equipment can be obtained. Thus, the similarity  $R(u, v)$  between user equipment can be obtained, as shown in the following formula [21]:

$$R(u, v) = \sum_{a=1}^{N_\phi^u} \sum_{b=1}^{N_\phi^v} \lambda(X_a^u, X_b^v) \theta_{a,b}. \quad (5)$$

Among them,  $\theta_{a,b}$  is determined according to the application type and the importance of the data in the user equipment, and the weight between these different associated data is obtained.

This research mainly focuses on the coverage area of the macro base station. Therefore, only the user equipment within the coverage of the same macro base station is clustered. And when two user devices are far apart, even if they have a strong similarity, it is difficult for the collaborative operation and data sharing between the devices to occur. In addition, it is not conducive to the optimization of virtualized spectrum resource allocation if devices that are far apart are divided into the same cluster. Therefore, the distance factor needs to be considered in the process of user equipment clustering and division, and the distance between the equipment is defined as

$$D(u, v) = \sqrt{(x_u - x_v)^2 + (y_u - y_v)^2}. \quad (6)$$

Among them,  $(x_u, y_u)$  and  $(x_v, y_v)$  are the location information of user equipment  $u$  and  $v$ , respectively. In the process of clustering, this study defines the distance threshold  $D_{\max}$ . When the distance between two user equipment exceeds the threshold, that is,  $D(u, v) > D_{\max}$ , the similarity between the two user equipment is considered to be zero. The distance threshold  $D_{\max}$  is dynamically adjusted according to the coverage area of the macro base station, the distribution of small base stations, and the supply and demand of spectrum resources.

To implement similarity-based clustering, firstly, it is necessary to define the similarity between user devices. This study uses data correlation and location information to define similarity as follows:

$$\text{sim}(u, v) = \frac{\sigma R(u, v)}{D(u, v)}. \quad (7)$$

Among them,  $\delta$  is the balance factor used to coordinate the relationship between the distance between the equipment and the degree of association. And  $\text{sim}(u, v) \in [0, 1]$ . The greater the similarity, the greater the value of  $\text{sim}(u, v)$ . When the data of two devices are not correlated,  $\text{sim}(u, v) = 0$ . This article defaults that the similarity between the user equipment and itself is 1, that is,  $\text{sim}(u, u) = 1$ . Then, the similarity matrix of user equipment in the network can be obtained, and it is shown in the following formula:

$$M_{N_U \times N_U} = \begin{bmatrix} \text{sim}(u_1, u_2) & \cdots & \text{sim}(u_1, u_{N_U}) \\ \vdots & \ddots & \vdots \\ \text{sim}(u_{N_U}, u_1) & \cdots & \text{sim}(u_{N_U}, u_{N_U}) \end{bmatrix}. \quad (8)$$

The elements on the main diagonal of the matrix are all 1, and  $\text{sim}(u, v) = \text{sim}(v, u)$ , so the similarity matrix is a symmetric matrix. In this case, we only need to store the upper triangular part of the matrix. This effectively reduces storage space and reduces computing costs. Then, an undirected graph  $G = (U, E)$  is constructed according to the user equipment similarity matrix, where the node set  $U = \{u_1, u_2, \dots, u_{N_U}\}$  describes the user equipment in the network and the edge set  $E = \{(u_i, u_j) \mid u_i, u_j \in U\}$  describes the similarity between the user equipment. The boundary value is defined as the similarity of two user devices. The larger the boundary value, the greater the similarity.

When the user equipment clusters are formed, it is necessary to judge the pros and cons of the cluster division. It mainly considers the similarity of user equipment in clusters and the similarity between user equipment in different clusters. The modularity is usually used to measure the quality of the clustering structure, that is,  $Q = \sum(e_{ii} - a_i^2) = \text{Tre} - \|e^2\|$ , where  $\text{Tre} = \sum e_{ii}$ . It describes the proportion of the number of connections between each user equipment in the cluster to the total number of connections, and  $a_i = \sum e_{ii}$  represents the proportion of the number of connections between the

user equipment in the cluster and the user equipment outside the cluster in the total number of connections. However, the measurement standard based on modularity has certain limitations, such as being not applicable to the situation where the cluster size difference is too large and the problem of inaccurate discovery of small-scale clustering. This paper studies the use of module density to measure the clustering structure, and as the exit condition of the clustering process, it is defined as follows:

$$\rho = \sum_{i=1}^{N_\Omega} \frac{L(V_i, V_i) - L(V_i, \bar{V}_i)}{|V_i|}. \quad (9)$$

Among them,  $\bar{V} = V - V_i$  and  $N_\Omega$  are the number of user equipment clusters,  $L(V_i, V_i)$  is the number of internal connections in cluster  $i$ ,  $L(V_i, \bar{V}_i)$  is the number of connections to other clusters,  $\Omega_k$  is the number of user equipment in cluster  $i$ , and  $N_\Omega$  is the number of user equipment clusters formed.

In the research of this article, this article considers that each user equipment participates in the cluster division and is divided into only one cluster; then, the user equipment in the network will eventually form  $N$ , nonoverlapping user equipment clusters; that is, it will satisfy

$$\begin{aligned} U &= \bigcup_{k=1}^{N_\Omega} U(\Omega_k), \\ \Omega_k &\neq \emptyset, \quad k = 1, 2, \dots, N_\Omega, \\ \Omega_i \cap \Omega_j &= \emptyset, \quad i, j = 1, 2, \dots, N_\Omega, i \neq j. \end{aligned} \quad (10)$$

Among them,  $U$  is the user equipment set in the network and  $U(\Omega_k)$  is divided into the user equipment set of cluster  $\Omega_k$ .

Through the abstract management of user equipment information, the clustering method based on similarity is used to divide the user equipment in the coverage area of the macro base station online to form  $N$  user-centric virtual cells, forming a virtual cell set  $G = \{g_1, g_2, \dots, g_{N_g}\}$ . As shown in Figure 2, each user equipment participates in the formation of a virtual cell. Through the construction of virtual cells, the data center conducts abstract management of user equipment distributed in various locations in the network. At the same time, in the process of constructing a virtual cell, by sensing the data content transmitted by the user equipment and then predicting the data flow information of each user equipment, the spectrum resource demand of the user equipment in the network is finally determined.

Within the coverage area of a certain macro base station, various types of user equipment form a user equipment set  $U = \{u_n, n = 0, 1, 2, \dots, N_U\}$ . Through the self-organizing construction of virtual cells, the user equipment forms multiple virtual cells to form a virtual cell set  $G = \{g_1, g_2, \dots, g_{N_g}\}$ . At the same time, collect and analyze various valuable user information in the network. Furthermore, the abstract and unified global information in the data center is used to perform virtualized management of spectrum resources in units of virtual cells.

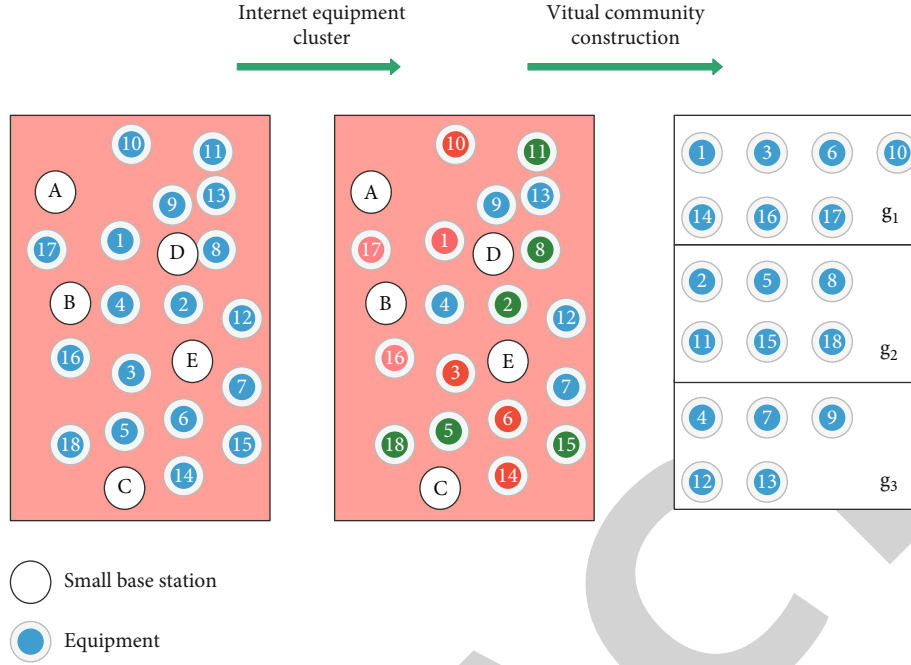


FIGURE 2: Virtual cell formation process.

It is assumed that the logically continuous spectrum resource obtained in the coverage area of the macro base station is  $C$ . In order to effectively reduce the interlayer interference, the spectrum resources are divided into two parts  $C_M$  and  $C_G$  orthogonally, and an appropriate spectrum guard band  $C$  is added between the two to reduce the adjacent channel interference between the macro base station and the small base station. Then, there are  $C = C_M \cup C_G \cup C_p$  and  $C_M \cap C_G \cap C_p = \emptyset$ . Among them, the macro base station exclusively occupies the spectrum resource  $C_M$ , while the small base stations in the virtual cell use the spectrum resource  $C_G$  together. Furthermore, using the global user equipment distribution and resource demand information, the available spectrum resources are allocated to the virtual cell during the construction of the virtual cell. Using the data mining method, the data flow of each user equipment is obtained as  $f(u)$ . At the same time, the real-time demand  $r(u)$  of user equipment communication is predicted. Furthermore, in the data center, the load information of the user equipment is obtained by calculation, and it is as follows:

$$D(u) = \psi(f(u), r(u)). \quad (11)$$

In order to determine the allocation ratio of  $C_M$  and  $C_G$ , it is necessary to calculate the load situation of the macro base station and the small base station in each virtual cell. First, this study uses global information to determine the base station selection situation of the user equipment, that is, which base station to choose to communicate with. Furthermore, the load generated by the user equipment on the base station is determined. This study defines  $D(u, s_0)$  and  $D(u, s)$  to describe the load situation of the user equipment on the macro base station and the small base station. Then, the load generated by the user equipment communicating

with the macro base station in each virtual cell is calculated, and the total load of the macro base station is obtained as  $D_M = \sum_{g \in G} \sum_{u \in U^g} D(u, s_0)$ . At the same time, the load generated by the user equipment communicating with the small cell in the virtual cell is calculated, and the total load of the small cell in the network is calculated as  $D_S = \sum_{g \in G} \sum_{s \in S^g} \sum_{u \in U^g} D(u, s)$ ,  $s \neq s_0$ , where  $U^g$  is the set of user equipment in the virtual cell and  $S^g$  represents a set of small base stations that provide communication services to the virtual cell  $g$ . Furthermore, this solution can dynamically adjust the size of  $C_M$  and  $C_G$  using the global load distribution, as shown below:

$$\frac{C_M}{C_G} = \sigma \frac{D_M}{D_S}. \quad (12)$$

Among them,  $\sigma$  is the distribution ratio factor to control the fairness of distribution. The spectrum resource  $C$  obtained by all small base stations is allocated to each virtual cell as needed according to the load condition of the virtual cell in the network and when the spectrum resource is sufficient. At the same time, in order to reduce interference,  $C_G$  is orthogonally divided into  $|G|$  parts; then, the small base stations in the virtual cell  $h$  obtain spectrum resources as

$$C_h = \frac{\sum_{g \in G} \sum_{u \in U^g} D(u, s)}{\sum_{g \in G} \sum_{s \in S^g} \sum_{u \in U^g} D(u, s)} \cdot C_G, \quad h \in G, s \neq s_0. \quad (13)$$

Therefore, this solution allocates corresponding spectrum resources to each virtual cell through the virtualized management of user equipment information and spectrum resources.

Specifically, spectrum resources need to be allocated to user equipment in the virtual cell. In the allocation process, the user's spectrum requirements and interference control

are mainly considered. First, communicating with the macro base station in the virtual cell  $g$  occupies the spectrum resource  $r_1$  ( $eCx$ ). Whether the device  $g$ , communicating with the small cell in the virtual cell  $u$ , occupies the spectrum resource  $r_2$  ( $eCa$ ) is expressed as  $\delta_{i,0,k}^{r_1}$  ( $g, eG, s, cS8, s, \neq u$  EU).

$$x_{i,0,k}^{r_1} = \begin{cases} 1, & \text{if UE } u_k \text{ in MBS is assigned resource } r_1, \\ 0, & \text{otherwise.} \end{cases} \quad (14)$$

In the same way,  $x_{i,j,k}^{r_2}$  has a similar definition. In this study, the macro base station equipment and the small base station equipment use orthogonal spectrum resources  $C_M$  and  $C_G$ , respectively. And by setting a spectrum guard band, the problem of adjacent channel interference between the

macro base station and the small base station is overcome. Then, there is no interference between the macro base station equipment and the small base station equipment under the same macro base station coverage area. When the macro base station equipment and the small base station equipment use spectrum resources to communicate, the interferences they suffer are as follows:

$$\begin{cases} I_{i,0,k}^{r_1} = \sum_{\pi \in \text{neigh}} P_{\pi,0}^{r_1} \varphi_{\pi,k}^{r_1} + \sum_{\pi \in \text{neigh}} \sum_{s_j \in S^{\pi}} P_{i,0}^{\xi} \varphi_{i,0,k}^{\xi}, \\ I_{i,j,k}^{r_2} = \sum_{\xi \in \psi_{r_2}} \sum_{g_i \in G} \sum_{s_j \in S^{g_i}} P_{i,j}^{\xi} \varphi_{i,j,k}^{\xi}. \end{cases} \quad (15)$$

When the macro base station equipment and the small base station equipment occupy resources, the SINR, respectively, meets

$$\begin{cases} \delta_{i,0,k}^{r_1} = \frac{P_{i,0}^{r_1} \varphi_{i,0,k}^{r_1}}{\sum_{\pi \in \text{neigh}} P_{\pi,0}^{r_1} \varphi_{\pi,k}^{r_1} + \sum_{\pi \in \text{neigh}} \sum_{s_j \in S^{\pi}} P_{\pi,j}^{r_1} \varphi_{\pi,j,k}^{r_1} + \sum_{\xi \in \psi_{r_1}} P_{i,0}^{\xi} \varphi_{i,0,k}^{\xi} + \sigma^2}, \\ \delta_{i,j,k}^{r_2} = \frac{P_{i,j}^{r_2} \varphi_{i,j,k}^{r_2}}{\sum_{\xi \in \psi_{r_2}} \sum_{g_i \in G} \sum_{s_j \in S^{g_i}} P_{\pi,j}^{\xi} \varphi_{\pi,j,k}^{\xi} + \sigma^2}. \end{cases} \quad (16)$$

Among them,  $\delta^2$  is the noise power. This study assumes that different channels have the same noise.  $\text{neigh}$  is the set of macro base stations that interfere with the macro base station. Therefore, in the virtual cell  $g_j$ , when the macro base station equipment and the small base station equipment occupy resources, the data transmission rates obtained are, respectively,

$$\begin{cases} R_{i,0,k}^{r_1} = W_{i,0,k}^{r_1} \log(1 + \delta_{i,0,k}^{r_1}), \\ R_{i,j,k}^{r_2} = W_{i,j,k}^{r_2} \log(1 + \delta_{i,j,k}^{r_2}). \end{cases} \quad (17)$$

Among them, according to the load information of the user equipment,  $W_{i,0,k}^{r_1}$  and  $W_{i,j,k}^{r_2}$  are the calculated resources, respectively. In addition, the data transmission rate needs to ensure that the user equipment successfully completes the communication. The transmission rate limitation of macro base station equipment and small base station equipment meets

$$\begin{cases} R_{i,0,k}^{r_1} \geq Y(D(u_k, s_0), t), \\ R_{i,j,k}^{r_2} \leq Y(D(u_k, s_j), t). \end{cases} \quad (18)$$

Among them,  $Y(D(u_k, s_0), t)$  and  $Y(D(u_k, s_j), t)$ , respectively, represent the data transmission rate requirements of the macro base station equipment and the small base station equipment, that is, the transmission rate requirements for

completing the data volume transmission within the effective time  $t$ . At the same time, considering the overall performance of the system, before spectrum allocation, by calculating the data transmission rate of each user equipment, the minimum data transmission rate limit  $R_{\min}$  of the user equipment can be determined. According to the above description, this research builds a virtualized spectrum allocation model based on virtual cells. On the premise of effectively coordinating interference and maximizing system capacity, the virtualized spectrum allocation model can be expressed as

$$\begin{aligned} & \max \sum_{m=1}^2 \sum_{i=1}^{N_G} \sum_{j=0}^{N_S} \sum_{k=1}^{N_U} x_{i,j,k}^{r_m} R_{i,j,k}^{r_m} \\ & \text{s.t. } C1: \sum_{i=1}^{N_G} \sum_{k=1}^{N_U} x_{i,0,k}^{r_1} W_{i,0,k}^{r_1} \leq C_M \\ & \quad C2: \sum_{i=1}^{N_G} \sum_{j=0}^{N_S} \sum_{k=1}^{N_U} x_{i,j,k}^{r_2} W_{i,j,k}^{r_2} \leq C_G \\ & \quad C3: \sum_{m=1}^2 \sum_{i=1}^{N_G} \sum_{j=0}^{N_S} x_{i,j,k}^{r_m} R_{i,j,k}^{r_m} \geq R_{\min}, \quad \forall k = 1, 2, \dots, N_U \\ & \quad C4: W_{i,j,k}^{r_2} \geq 0, \quad \forall m = 1, 2, i = 1, 2, \dots, N_G, \forall j = 1, 2, \dots, N_S, \\ & \quad \quad \quad \forall k = 1, 2, \dots, N_U. \end{aligned} \quad (19)$$

In addition, while maximizing system capacity, focusing on user fairness, this article rewrites the optimization goal as  $\max \sum_{m=1}^2 \sum_{i=1}^{N_G} \sum_{j=0}^{N_S} \sum_{k=1}^{N_U} x_{i,j,k}^{r_m} \log(R_{i,j,k}^{r_m})$  to achieve user fairness in virtualized spectrum allocation.

For the problem of virtualized spectrum allocation based on virtual cells, the data center obtains the load information of the user equipment in the network through perception and calculation. Therefore, for the spectrum allocation model based on virtual cells, this research introduces a convex optimization method to realize virtual spectrum allocation.

**Theorem 7.** *The virtualized spectrum allocation problem is a convex optimization problem; that is, there is an optimal spectrum allocation scheme to enable the system to obtain the maximum capacity.*

*Proof.* For the objective function  $\max \sum_{m=1}^2 \sum_{i=1}^{N_G} \sum_{j=0}^{N_S} \sum_{k=1}^{N_U} x_{i,j,k}^{r_m} \log(R_{i,j,k}^{r_m})$ , first of all, the method of slack variables is used to make  $x_{i,j,k}^{r_m}$  become a continuous value in the range of 0 to 1. Then, after calculation, it is proven that  $Sx_{i,j,k}^{r_m} \log(R_{i,j,k}^{r_m})$  is a concave function. Therefore, the problem of virtualized spectrum allocation is equivalent to the following optimization problem:

$$\min \left( - \sum_{m=1}^2 \sum_{i=1}^{N_G} \sum_{j=0}^{N_S} \sum_{k=1}^{N_U} x_{i,j,k}^{r_m} \log(R_{i,j,k}^{r_m}) \right). \quad (20)$$

At the same time, it is easy to determine that the constraints of formula (19) constitute a convex set. Furthermore, the virtualized spectrum allocation problem is proven to be a convex optimization problem with constraints on the variable  $W_{i,j,k}^{r_m}$ . Therefore, there is a globally optimal allocation scheme for the virtualized spectrum allocation problem, which can obtain the maximum system capacity.  $\square$

Next, this research transforms the optimization goal into  $\min (-\sum_{m=1}^2 \sum_{i=1}^{N_G} \sum_{j=0}^{N_S} \sum_{k=1}^{N_U} x_{i,j,k}^{r_m} \log(R_{i,j,k}^{r_m}))$ . Then, the Lagrangian duality method and KKT (Karush-Kuhn-Tucker) conditions are used to solve the virtualized spectrum allocation problem. First, construct the Lagrangian function of the virtualized spectrum allocation problem as follows:

$$\begin{aligned} L(W_{i,j,k}^{r_m}, \lambda^m, \lambda_k, v_{i,j,k}^{r_m}) \\ = - \sum_{m=1}^2 \sum_{i=1}^{N_G} \sum_{j=0}^{N_S} \sum_{k=1}^{N_U} x_{i,j,k}^{r_m} \log(R_{i,j,k}^{r_m}) \\ + \sum_{m=1} \lambda^m \left( \sum_{m=1}^2 \sum_{i=1}^{N_G} \sum_{j=0}^{N_S} \sum_{k=1}^{N_U} x_{i,j,k}^{r_m} W_{i,j,k}^{r_m} - C_M \right) \\ + \sum_{m=2} \lambda^m \left( \sum_{m=1}^2 \sum_{i=1}^{N_G} \sum_{j=0}^{N_S} \sum_{k=1}^{N_U} x_{i,j,k}^{r_m} W_{i,j,k}^{r_m} - C_C \right) \end{aligned}$$

$$\begin{aligned} + \sum_{k=1} \lambda^m \left( R_{\min} - \sum_{i=1}^{N_G} \sum_{j=0}^{N_S} \sum_{k=1}^{N_U} x_{i,j,k}^{r_m} R_{i,j,k}^{r_m} \right) \\ - \sum_{m=1}^2 \sum_{i=1}^{N_G} \sum_{j=0}^{N_S} \sum_{k=1}^{N_U} v_{i,j,k}^{r_m} W_{i,j,k}^{r_m}. \end{aligned} \quad (21)$$

Among them,  $\lambda^m$ ,  $\lambda_k$ , and  $v_{i,j,k}^{r_m}$  are Lagrange multipliers. Then, the dual function of the virtualized spectrum allocation problem is

$$g(\lambda^m, \lambda_k, v_{i,j,k}^{r_m}) = \inf_{W_{i,j,k}^{r_m}} L(W_{i,j,k}^{r_m}, \lambda^m, \lambda_k, v_{i,j,k}^{r_m}). \quad (22)$$

**Theorem 8.** *The optimal solution  $W_{i,j,k}^{r_m}$  of the virtualized spectrum allocation problem has a corresponding relationship with the optimal solution  $(\lambda^m, \lambda_k, v_{i,j,k}^{r_m})$  of the dual problem.*

*Proof.* According to the literature, for any feasible Lagrangian multiplier  $(\lambda^m, \lambda_k, v_{i,j,k}^{r_m})$ , the dual function value is the lower limit of the spectrum allocation optimization function  $p$ , that is,  $p \geq g(\lambda^m, \lambda_k, v_{i,j,k}^{r_m})$ . In addition, the spectrum allocation problem is a convex optimization problem, which usually has a strong duality. Then, the optimal value  $p$  of the original problem is equal to the optimal value  $a$  of the dual problem, that is,  $p' = a'$ . Therefore,  $W$  has a corresponding relationship.  $\square$

Therefore, the optimal solution of the virtualized spectrum allocation problem can be obtained by solving the following dual problem:

$$\begin{aligned} \max g(\lambda^m, \lambda_k, v_{i,j,k}^{r_m}) \\ \text{s.t. } \lambda^m \geq 0, \lambda_k \geq 0, v_{i,j,k}^{r_m} \geq 0. \end{aligned} \quad (23)$$

Solving the above problems has greater complexity. This paper uses the interior point method to solve the problem and finally obtains the maximum value of  $g(\lambda^m, \lambda_k, v_{i,j,k}^{r_m})$ . At this time, the optimal Lagrangian multiplier value is  $\lambda^m$ ,  $\lambda_k$ ,  $v_{i,j,k}^{r_m}$ .

For convex optimization problems, the KKT condition is a sufficient and necessary condition for the optimal solution; that is, the specific value that meets the KKT condition is the optimal solution of the virtualized spectrum allocation problem and its dual problem. Next, this study combines the calculated best Lagrangian multiplier  $(\lambda^m, \lambda_k, v_{i,j,k}^{r_m})$  and uses the KKT condition to calculate  $W_{i,j,k}^{r_m}$ . For KKT conditions, according to the virtualized spectrum allocation problem,



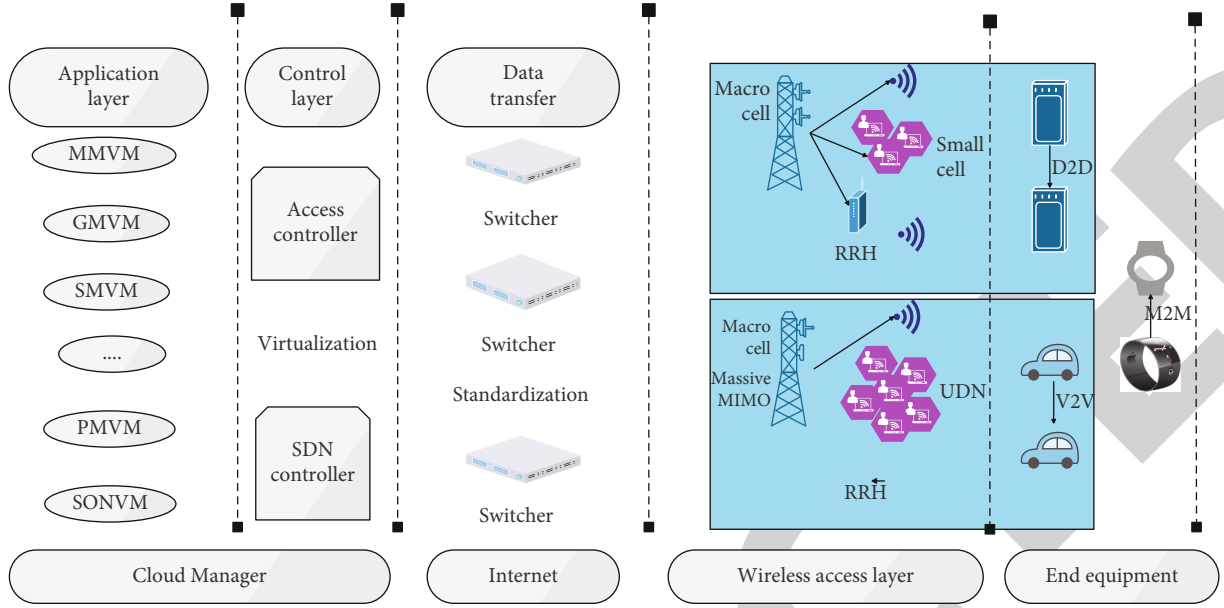


FIGURE 3: Schematic diagram of 5G network architecture of the English education translation system.

the feasibility conditions are determined as follows:

$$\begin{aligned}
 & \sum_{i=1}^{N_G} \sum_{k=1}^{N_U} x_{i,0,k}^{r_1} W_{i,0,k}^{r_1} - C_M \leq 0, \\
 & \sum_{i=1}^{N_G} \sum_{k=1}^{N_U} \sum_{k=1}^{N_U} x_{i,j,k}^{r_2} W_{i,j,k}^{r_2} - C_G \leq 0, \\
 & R_{\min} - \sum_{i=1}^{N_G} \sum_{k=1}^{N_U} \sum_{k=1}^{N_U} x_{i,j,k}^m R_{i,j,k}^m \leq 0, \quad \forall k = 1, 2, \dots, N_U, \\
 & -W_{i,j,k}^{r_2} \leq 0, \quad \forall m = 1, 2, i = 1, 2, \dots, N_G, \forall j = 1, 2, \dots, N_S, \\
 & \quad \quad \quad \forall k = 1, 2, \dots, N_U.
 \end{aligned} \tag{24}$$

Then, it is ensured that the optimal solution  $W_{i,j,k}^{r_m*}$  of the original problem is reachable. By analyzing the relationship between the virtualized spectrum allocation problem and the dual problem, the conditions for the complementary slack relationship are as follows:

$$\begin{aligned}
 & \lambda^{m*} \left( \sum_{i=1}^{N_G} \sum_{k=1}^{N_U} x_{i,0,k}^{r_m} W_{i,0,k}^{r_m} - C_M \right) = 0, \\
 & \lambda^{m*} \left( \sum_{i=1}^{N_G} \sum_{k=1}^{N_U} \sum_{k=1}^{N_U} x_{i,j,k}^{r_m} W_{i,j,k}^{r_m} - C_G \right) = 0, \\
 & \lambda_k^* \left( R_{\min} - \sum_{m=1}^2 \sum_{i=1}^{N_G} \sum_{j=0}^{N_S} x_{i,j,k}^{r_m} R_{i,j,k}^{r_m} \right) = 0, \\
 & \quad \quad \quad v_{i,j,k}^{r_m*} W_{i,j,k}^{r_m*} = 0.
 \end{aligned} \tag{25}$$

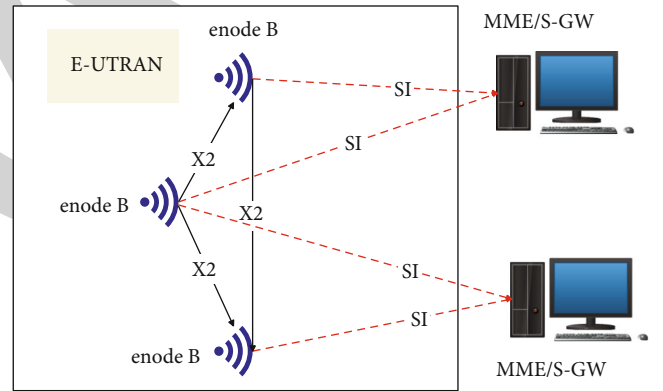


FIGURE 4: Schematic diagram of LTE architecture of the English education translation system.

The optimal value of  $L(W_{i,j,k}^{r_m*}, \lambda^{m*}, \lambda_k^*, v_{i,j,k}^{r_m*})$  is obtained at  $W_{i,j,k}^{r_m*}$ ; when the derivative is 0, the first-order constraint is satisfied:

$$\nabla \left( W_{i,j,k}^{r_m*}, \lambda^{m*}, \lambda_k^*, v_{i,j,k}^{r_m*} \right) = 0. \tag{26}$$

Among them, the feasible solution satisfies  $W_{i,j,k}^{r_m*} \geq 0$ ,  $\lambda^{m*} \geq 0$ ,  $\lambda_k^* \geq 0$ ,  $v_{i,j,k}^{r_m*} \geq 0$ . The above formulas (24)–(26) are KKT conditions. Then, combine the obtained best Lagrangian multiplier  $(\lambda^{m*}, \lambda_k^*, v_{i,j,k}^{r_m*})$  and KKT condition calculation:

$$\frac{\partial L \left( W_{i,j,k}^{r_m*}, \lambda^{m*}, \lambda_k^*, v_{i,j,k}^{r_m*} \right)}{\partial W_{i,j,k}^{r_m}} = 0. \tag{27}$$

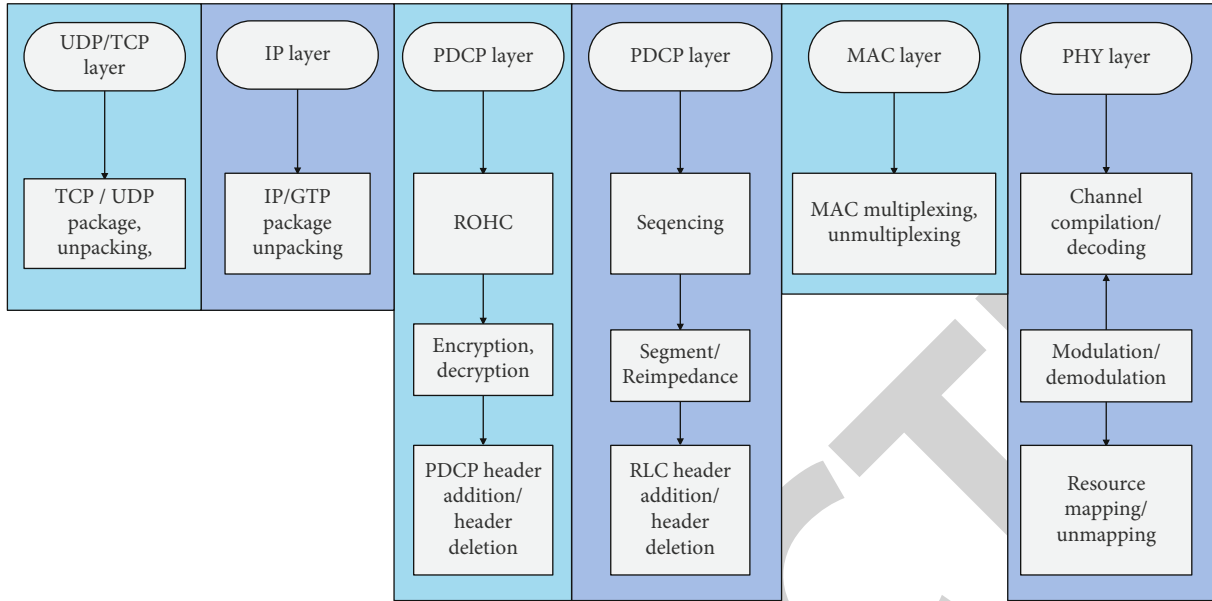


FIGURE 5: Schematic diagram of each functional module of the data plane.

Finally, the optimal solution to the virtualized spectrum allocation problem is

$$W_{i,j,k}^r = \frac{x_{i,j,k}^r}{\lambda^{m*} (x_{i,j,k}^r + x_{i,0,k}^r) - \lambda_k^* x_{i,j,k}^r \log(1 + \delta_{i,j,k}^r) - v_{i,j,k}^r}. \quad (28)$$

#### 4. English Education Translation System Based on 5G Network Virtualization

The English education translation system network will introduce more communication modes, such as D2D (device-to-device), M2M (machine-to-machine), and V2V (vehicle-to-vehicle). To maintain an optimal user experience in such a complex network environment, RAT selection and management must be done on the network side and the device terminal side at the same time. Heterogeneous networks are still the development direction of future communication networks. Therefore, flexible deployment and cost have become important factors for 5G networks. This requires 5G systems to be based on software implementation and virtualization technology to enable them to build different virtual core networks to meet the needs of specific applications. As shown in Figure 3, it briefly describes the diversified services, application scenarios, different network integration modes, and cloud-based layered architecture ideas of the wireless network of the English education translation system.

The continuous evolution of the English education translation system has put forward stricter delay requirements for the LTE system, especially the delay requirements of the control plane and the user plane. Therefore, the LTE system not only optimizes the radio frame length and transmission time interval (TTI) but also adjusts the network

architecture. The current LTE system architecture is mainly composed of two parts, namely, the evolved core network EPC and the evolved access network E-UTRAN, as shown in Figure 4.

Figure 5 shows the functional division of the data processing module in the English education translation system eNB-D. As shown in the figure, some sublayers have control logic tightly coupled with data, such as HARQ in the MAC layer and ARQ in the RLC layer. Here, these control functions are still attributed to the data plane.

The 5G network will not only adjust the access network architecture but also improve the forwarding plane. Moreover, it uses a distributed gateway with a sinking user plane to realize distributed deployment. Through the local cloud service system, the streaming media services originally obtained from the service center through the complicated Internet network can be cached to the local cloud server. Figure 6 shows the business flow network transmission model of the English education translation system.

As shown in Figure 7, a service chain flow needs to update its internal network functions VNF1, VNF4, and VNF5 from the old routing path to the new routing path based on performance optimization reasons. The update time required for each network function can be obtained according to the time prediction model in the previous section. If we use OpenNF's update mechanism to update the service chain in the figure, we first start from the data flow, and the data packets flow along the old deployment path of the service chain. It is found that the source network function "Old VNF1" needs to be updated, so it is updated.

Figure 8 is the hardware composition of this intelligent translation system, which is mainly composed of a database server, gateway server, client, and human-computer interaction terminal, including information processing module, AD module, and controller module. When translating English

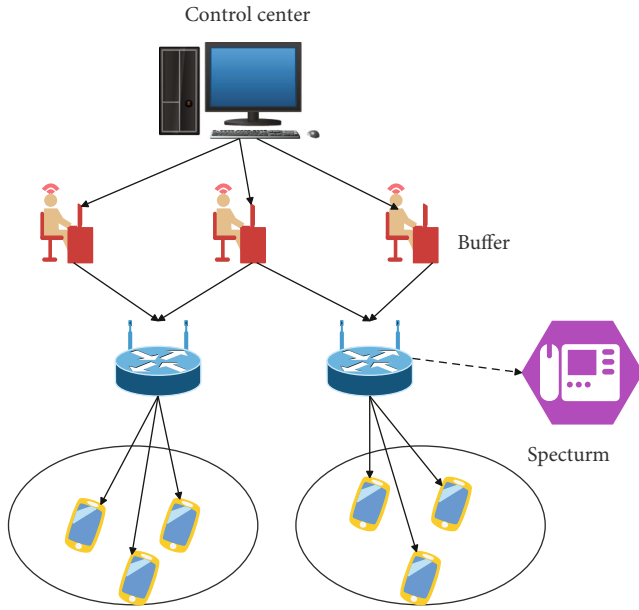


FIGURE 6: The new network service transmission model of the English education translation system.

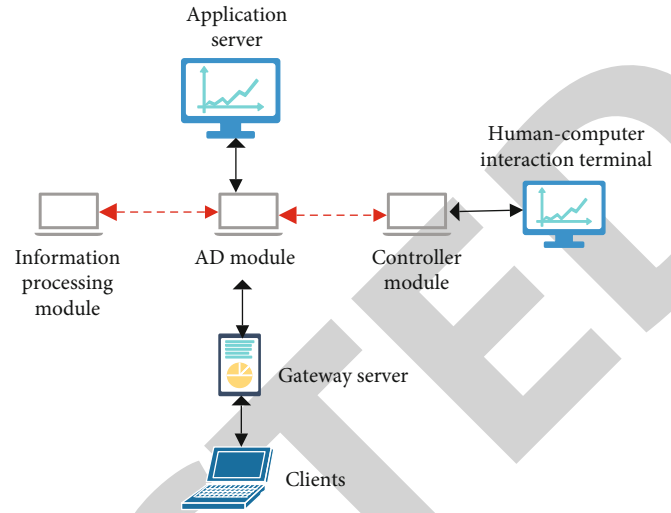


FIGURE 8: The hardware structure of the English education translation system.

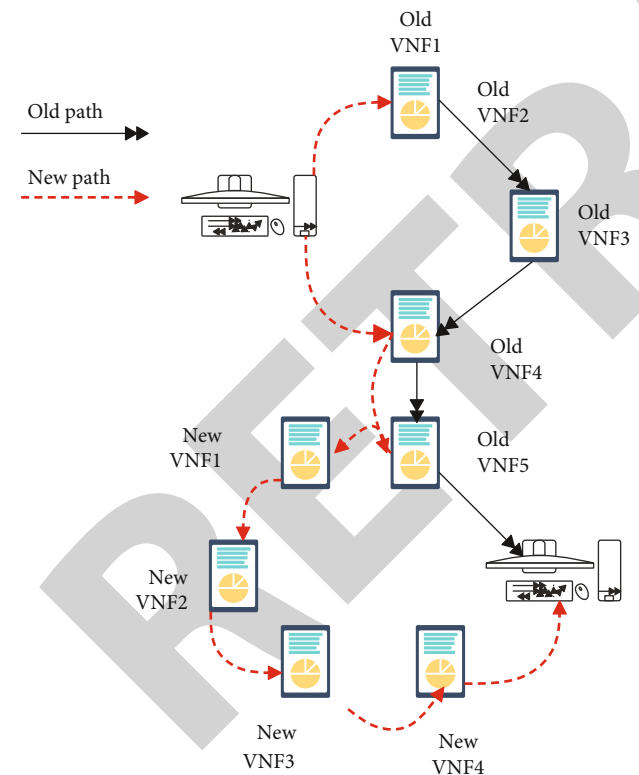


FIGURE 7: An example of updating the service chain of the English education translation system.

literary works, the user inputs the content to be translated from the client and uploads it to the database server through the gateway server for information processing. When encountering ambiguity judgments, the interpersonal interaction mode is turned on, and the human-computer interaction terminal is used for manual judgment, and the

TABLE 1: Data processing and transmission effect of the English education translation system based on 5G virtualization.

Number	5G data processing	Number	5G data processing	Number	5G data processing
1	89.09	17	89.92	33	90.06
2	89.91	18	88.65	34	93.82
3	86.08	19	92.38	35	85.87
4	85.88	20	91.46	36	86.60
5	90.67	21	89.74	37	86.76
6	85.86	22	92.39	38	87.28
7	85.78	23	86.59	39	88.43
8	87.34	24	85.87	40	88.68
9	92.17	25	91.89	41	89.94
10	92.01	26	88.91	42	93.01
11	93.30	27	86.70	43	89.39
12	90.24	28	85.32	44	87.12
13	89.91	29	91.14	45	90.43
14	85.27	30	88.43	46	92.14
15	93.01	31	89.08	47	88.79
16	85.60	32	89.94	48	86.09

judgment results are fed back to the client and server at the same time.

On the basis of the above research, this article studies the English education translation system based on 5G virtualization built in this article. This paper conducts experimental research by inputting multiple sets of English data and counts the experimental data, evaluates the system's 5G data transmission and the translation effect of the English education translation system, and obtains the results shown in Tables 1 and 2.

From the above research, it can be seen that the English education translation system based on 5G virtualization constructed in this paper can play an important role in smart English teaching.

TABLE 2: Translation effects of the English education translation system based on 5G virtualization.

Number	Translation evaluation	Number	Translation evaluation	Number	Translation evaluation
1	83.92	17	82.05	33	84.74
2	85.12	18	89.50	34	78.86
3	88.96	19	82.28	35	82.54
4	78.98	20	88.93	36	86.54
5	91.89	21	79.08	37	84.60
6	89.10	22	79.95	38	86.06
7	82.10	23	80.33	39	86.34
8	83.66	24	88.90	40	90.51
9	89.40	25	86.03	41	87.49
10	87.79	26	87.05	42	79.52
11	85.83	27	83.05	43	82.47
12	83.33	28	86.89	44	78.72
13	86.33	29	79.34	45	84.56
14	79.25	30	91.98	46	82.30
15	82.01	31	83.60	47	89.96
16	82.52	32	80.33	48	87.69

## 5. Conclusion

With the advent of the 5G era and the continuous development of computer technology, many technologies are affecting and improving the quality of people's lives. At the same time, it also affects the teaching mode of college classrooms. In particular, the gradual popularization and improvement of virtual reality technology under 5G networks have enabled immersive classroom teaching to be realized. The traditional classroom teaching centered on the knowledge imparted by teachers will gradually be replaced by immersive classroom teaching based on virtual reality technology with the popularization of 5G networks. The application of virtual reality technology is very extensive. In the future, classroom teaching has a broader platform and a more open environment. How to combine the advantages of 5G in the construction of classroom teaching in colleges and universities to better serve education has become a very important and urgent research topic. Based on the above analysis, this article studies an English education translation system based on 5G network virtualization and provides theoretical references for improving the effect of smart teaching in subsequent English education. The experimental research results show that the English education translation system based on 5G virtualization constructed in this paper can play an important role in smart English teaching.

## Data Availability

The labeled dataset used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The author declares no competing interests.

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