Multi-path Channel Modeling and Analysis of Embedded LTE Wireless Communication Network Under Cloud Computing

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Abstract. The multi-path channel modeling analysis of conventional communication network can analyze the modeling of multi-path channel in communication network. However, for the multi-path channel modeling analysis of embedded LTE wireless communication network under cloud computing, there is a shortage of high analysis error rate. To this end, the multi-path channel modeling analysis of embedded LTE wireless communication network under cloud computing is proposed. The LTE multipath channel modeling and analysis program structure is built, and the single-frequency signal is subjected to time-varying channel technology, and the digital signal is designed by multipath time-varying channel technology to complete the key technology design of multipath channel modeling and analysis. The multipath channel modeling and analysis program is used to determine the multi-path channel modeling Rayleigh distribution and Rice distribution, and the related characteristics analysis to realize multi-path channel modeling analysis of embedded LTE wireless communication network under cloud computing. The experimental data show that the proposed multipath channel modeling analysis is more than the conventional multipath channel modeling analysis, and the analysis error rate is reduced by 14.35%, which is suitable for multi-path channel modeling analysis of embedded LTE wireless communication networks under cloud computing.

Keywords: Embedded LTE · Wireless communication · Network multipath channel · Modeling and analysis

1 Introduction

The multipath channel modeling analysis of conventional communication network can analyze the multipath channel modeling of communication network. However, when modeling and analyzing multipath channel in embedded LTE wireless communication network, the key technology of multipath channel modeling and analysis is limited. Literature [1] proposes a multipath channel modeling and analysis method for wireless communication networks based on improved subgradient algorithm. To transfer process of communication signals, on the basis of the instantaneous signal to noise ratio

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will repair network port priority selection problem is transformed into the constraint optimization problems, according to the network port repair choice optimization criterion, combined with the gradient algorithm, at the same time to determine the network port repair priority selection of the optimal solution, wireless communication network modeling analysis of multipath channel. Simulation results show that the method takes longer time and has lower precision. Literature [2] proposes a multipath channel modeling and analysis method for wireless communication networks based on multipath fading channel. By using the energy differential function of the received signal and the primary synchronization signal, the precise symbol timing synchronization and fractional carrier frequency deviation are obtained respectively in the time domain, and the multipath channel analysis of wireless communication network is completed. Experimental results show that the accuracy of this method is low and the practical application effect is poor. Therefore, the multipath channel modeling analysis of embedded LTE wireless communication network is proposed. Based on the LTE physical layer protocol and OFDM modulation, the LTE multipath channel modeling and analysis program structure is built, the single frequency signal passing through the time-varying channel technology is constructed, and the digital signal passing through the multipath time-varying channel technology is designed. The key technologies of multipath channel modeling and analysis are designed; The multipath channel modeling and analysis program is used to analyze the Rayleigh distribution and Rice distribution, and the proposed multipath channel modeling analysis for embedded LTE wireless communication network is completed. In order to ensure the effectiveness of the multipath channel modeling and analysis of the designed communication network, the simulation of the embedded LTE wireless communication network environment is carried out, and two different communication network multipath channel modeling and analysis are used to simulate the error rate analysis. The experimental results show that the proposed multipath channel modeling analysis is highly effective.

2 System Objectives and Analysis

Cloud computing is an Internet-based computing model that distributes computing tasks across resource pools of large numbers of computers. Consumers can acquire computing power, storage space, and various software services as needed, and pay for usage. Cloud computing has caused another innovation in the computer field, and has brought many new security problems. To this end, the multi-path channel model of embedded LTE wireless communication network under cloud computing is designed.

Multi-path channel modeling and analysis of embedded LTE wireless communication networks under cloud computing mainly includes:

(1) Analysing the signal processing flow of LTE physical layer protocol and FDM modulation, builds the LTE multipath channel modeling and analysis program structure, and designs the single frequency signal and digital signal through time-varying channel technology.

(2) Using the discrete multipath analysis and scattering multipath analysis, analyze the finite number of multipath components and multipath components, and determine the multipath channel modeling and analysis program.
(3) The characteristics of multipath time-varying channel, Rayleigh distribution and Rice distribution are analyzed by using multipath channel modeling and analysis program, and the shortcomings of modeling and analysis of multipath channel in conventional communication network are solved.

3 Key Technology Design of Multipath Channel Modeling and Analysis for Embedded LTE Wireless Communication Network Under Cloud Computing

3.1 Building a LTE Multipath Channel Modeling and Analysis Program Structure Under Cloud Computing

The emerging "cloud computing" technology is the most noteworthy technological revolution in the world in the next few years. It is designed with the concept of dynamic resource allocation and on-demand service, and is valued and promoted by the scientific and technological community and more and more commercial giants. However, while cloud computing is rapidly developing, it also brings many new security threats. Among them, multipath channel transmission is affected. Wireless channel is the most complex channel. The wireless propagation environment is the basic factor that affects the wireless communication system. During the process of signal propagation, the signal will be reflected, diffracted and scattered under the influence of various environments, so that the signal arriving at the receiver is the superposition of many path signals [3]. Therefore, the superposition of these multipath signals in the case of no line-of-sight propagation obeys the Rayleigh distribution. When the multipath signal contains a line-of-sight propagation path, the multipath signal is distributed from Rice. In the channel with multipath transmission, due to the different transmission time of each path, the transmission characteristic is not ideal, and the influence of the channel noise, received signal is widened in time, which extends to adjacent symbol. Such channels can cause inter-symbol interference.

LTE uses OFDMA (Orthogonal Frequency Division Multiple Access) as the downlink multiple access mode. OFDM is a transmission technology of multi-carrier modulation. The signal processing flow of OFDM modulation is as follows: the data stream is transformed into a multi-channel sub-data stream (N-channel) after series-parallel transformation, and then they are used to modulate the N-channel subcarriers respectively, and finally to transmit in parallel. OFDM signals have a strong ability to resist multipath fading and pulse interference, because the rate of sub-data stream becomes 1/N, the symbol period becomes NT times as long as the symbol period after serial-parallel transformation. The designer can divide a wideband frequency selective channel into N narrow band flat fading channels by designing the symbol period much longer than the delay spread of the channel [4]. This process is a simplification of channel equalization operation, because of its simple implementation, it is especially

suitable for high-speed wireless data transmission. The signal processing flow of LTE downlink OFDM modulation is shown in Fig. 1.

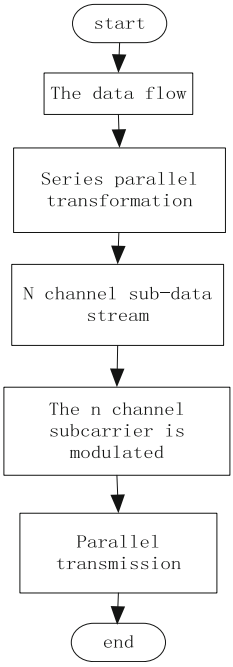

Fig. 1. Signal processing flow of LTE downlink OFDM modulation

3.2 Design of Single Frequency Signal Passing Through Time-Varying Channel

The effect of multipath propagation on signal is called multipath effect, which has great influence on the quality of signal transmission. When a single frequency signal is input and transmitted through a multipath time-varying channel, the waveform envelope of the received signal fluctuates randomly with time, and the output is not a single frequency signal, it is a narrow band signal, and the bandwidth is determined by speed of upper variable factor. After multipath time-varying channel transmission, delay and attenuation of multipath channel are different, which leads to different amplitude and frequency of received signal. A single frequency signal with a amplitude of 1 and a frequency of 10 Hz is transmitted by 20 paths to obtain the waveform and spectrum. The attenuation of the 20 paths is the same, but the time delay varies with time. Time delay variation of each path is sinusoidal. The frequency of the change is extracted from 0–2 Hz randomly. After multipath propagation, the different path delays are different at the same time. The superposition of delay signal causes the time domain graphics to no longer be single sinusoidal, and other frequencies appear. (because of the sampling frequency, it looks like a smooth curve) burrs appear in frequency domain, that is diffusion in frequency domain [5].

3.3 Design of Digital Signal Over Multipath Time-Varying Channel

Multipath time-varying channels generate time domain dispersion for digital signals. Intersymbol interference occurs when the digital signal passes through a multipath time-varying channel. Due to the different delay of each path, the attenuation of each path is different, and the signal reaches the receiving end through multiple paths to form inter-symbol interference. A three-path transmission channel:

$$s(t) = \sum_{i=1}^{3} u_i b(t - \tau_i) \tag{1}$$

In the formula, $u_1 = 0.5, u_2 = 0.707, u_3 = 0.5; \tau_1 = 0, \tau_2 = 1, \tau_3 = 2$, the waveform of the output signal in the transmission channel is closer to that of the input signal. Because the channel amplitude characteristic is not very ideal, will cause the input signal distortion. Analog signal is reflected in waveform distortion and digital signal is reflected in inter-symbol interference.

Relying on the LTE multipath channel modeling and analysis program structure, the single-frequency signal undergoes time-varying channel technology, and the digital signal is designed through multi-path time-varying channel technology to realize multipath channel modeling and analysis of embedded LTE wireless communication network under cloud computing. Key technology design.

4 Multi-path Channel Modeling and Analysis of Embedded LTE Wireless Communication Network Under Cloud Computing

4.1 Determination of Multipath Channel Modeling and Analysis Program

There are two main programs for analyzing multipath channel models, discrete multipath analysis (finite number of multipath components)and scattering multipath analysis (continuum of multipath components). In mobile wireless channels, the first model is usually used to simulate the waveform level of mobile wireless channels, while the second model is usually used in narrowband modulated tropospheric channels. In the two case, the channel is modeled as a linear time-varying system with complex low pass equivalent response $c(\tau, t)$. If there are N discrete multipath components, the channel output is the sum of five delayed and fading input signals. So $y(t) = \sum_{k=1}^{N(t)} a_k(t)x(t - \tau_k(t))$ impulse response $c(\tau, t)$ is:

$$c(\tau, t) = \sum_{k=1}^{N(t)} a_k(t)\delta(\tau - \tau_k(t)) \tag{2}$$

In the formula, $N(t)$ is the number of multipath components, $a_k(t)$ and $\tau_k(t)$ are the complex fading and delay of the K path at the moment.

4.2 Analysis of Rayleigh Distribution and Rice Distribution

In practice, for digital communication systems, the period of modulation symbols is larger than the delay spread caused by multipath propagation, so all frequency components in a symbol period will undergo the same attenuation and phase shift [6]. The channel is flat for all frequency components, so this kind of channel is defined as flat fading channel. The theoretical analysis and experimental results show that the amplitude of flat fading is consistent with Rayleigh distribution or Rice distribution in most cases. Because of the complexity of the mobile communication channel, the simulation is usually based on the flat fading channel modeling, and then on this basis, the frequency selective channel is modeled and simulated. The characteristics of Rayleigh distribution and Rice distribution are deduced and simulated [7, 8].

When there is a line-of-sight propagation signal, the line-of-sight component of the received signal is described by a generic time-varying component as:

$$m(t) = m_1(t) + jm_2(t) = \rho e^{j(2\pi f_\rho + \theta_\rho)} \tag{3}$$

In the formula, ρ, f_ρ, and θ_ρ are the amplitude of the stadia signal component, the Doppler frequency of the stadia signal component and the phase respectively of the stadia signal component.

The envelope of the received signal is expressed as:

$$\xi(t) = \sqrt{(\mu_1 + \rho)^2 + \mu_2^2} \tag{4}$$

It is distributed from Rice distribution, where μ_1 and μ_2 are two independent and dependent real Gao Si processes with normal distribution, it is satisfy $\mu_1, \mu_2 \in N(0, \sigma_0^2)$.

The probability density function of the envelope of the received signal is:

$$P_\zeta(x) = \frac{x}{\sigma_0^2} \exp\left[-\frac{x^2 + \rho^2}{2\sigma_0^2}\right] \cdot I_0\left[\frac{x\rho}{\sigma_0^2}\right], (x > 0) \tag{5}$$

In the formula, $I_0(x)$ is a modified Bessel function of the first kind [9]. The ratio K between the reflected signal power and the dispersive signal power is called the Rice factor, it is can be expressed as:

$$K = \frac{\rho^2}{2\sigma^2} \tag{6}$$

When there is no line-of-sight propagation signal, $\rho = 0$ (K = 0, $I_0 = 1$), the envelope of the received signal is represented as:

$$\zeta(t) = |u(t)| = \sqrt{u_1^2(t) + u_2^2(t)} \tag{7}$$

It takes the Rayleigh distribution, and its probability density function is:

$$P_{\xi}(x) = \frac{x}{\sigma_0^2} \cdot \exp\left[-\frac{x^2}{2\sigma_0^2}\right], (x > 0) \tag{8}$$

So Rayleigh channel can be regarded as a special case of Rice channel with K factor 0 and no line-of-sight propagation path [10].

4.3 Characteristic Analysis of Multipath Time-Varying Channel

Time-varying channel refers to the channel in which the channel parameters change with time. Its characteristic is that the transmission attenuation of the signal changes with time, and the transmission delay of the signal also changes with the time, and the signal passes through multiple paths to the receiving end. And the length and decay of each path vary over time. The influence of time-varying channel on signal transmission diffuses the frequency of input signal.

In multipath channel, the input signal is transmitted by more than one path, and the receiver receives the signal from multiple transmission paths at the same time. These signals may be Co direction addition, or reverse phase subtraction. The effect of multipath propagation on the signal is called multipath effect, which can greatly affect the signal transmission quality.

For the multipath signal of mobile station at different positions, the initial distance from the mobile station to the base station is set to r0 = 1000, r0 = 9000, r0 = 14000. When other conditions remain unchanged, the condition of receiving the signal is such as to make the mobile station static. Because of the reflection path, the received signal is weaker than the signal without the reflection path, and the fading occurs. Signals of different frequencies pass through the multipath channel f = 3e8, f = 9e8, f = 27e8, if f increases gradually and some frequencies are weakened and f is sufficiently large, the synthesis signal is weakened. Those frequency ranges that are affected are basically consistent, called coherent bandwidth. At the same location, because of the presence of the mirror signal, the frequency at which different signals are transmitted, the signals received at the receiver are either strengthened or weakened. This is called frequency selective fading.

The multipath signal of different speed signal of mobile station is changed, and the signal of different speed of mobile station passes through the multipath channel v = 0, v = 300. When other conditions are invariant, the mobile station has velocity, even at the same frequency, the same position, at different time points, the intensity of the composite signal is different, some local signal attenuation, some local signal enhancement. When the velocity increases from 0 to 300, the direct path signal weakens, the reflection path signal increases, and the composite signal weakens.

Based on the key technology design of multi-path channel modeling and analysis of embedded LTE wireless communication network under cloud computing, and the multipath channel modeling analysis program, the characteristics analysis, Rayleigh distribution and Rice distribution of multipath time-varying channel are completed. Analysis and analysis of multi-path channel modeling of embedded LTE wireless communication network under cloud computing.

5 Experiment and Result Analysis

In order to ensure the effectiveness of multi-path channel modeling and analysis of embedded LTE wireless communication network under cloud computing proposed in this paper, simulation simulation analysis is carried out. In the course of experiment, different embedded LTE wireless communication networks are used as experimental objects to simulate the error rate. Simulation and simulation of different structure, data volume and so on of embedded LTE wireless communication network are simulated. In order to ensure the effectiveness of the experiment, the multipath channel modeling and analysis of conventional communication network is used as the comparison object, the results of the two simulation experiments are compared, and the experimental data are presented in the chart.

5.1 Parameter Setting

In order to ensure the accuracy of the simulation experiment, the parameters of the test are set. In this paper, different embedded LTE wireless communication networks are used as experimental objects, and two kinds of multipath channels are used to model and analyze the simulation results. Because the analytical results and the analytical methods obtained by different methods are different, it is necessary to ensure the consistency of the experimental environment parameters in the experiment process. The results of the experimental data set in this paper are shown in Table 1.

Table 1. Parameter setting

Parameter	Scope of implementation	Remarks
Communication network load	1–10^4 GHz	Analysis under variable load using two different analytical methods
Embedded LTE wireless communication network environment	good	Within the rated range, two different design methods are used to analyze the design in an ideal environment
Simulation system	DJX-2016-3.5	Windows terrace

5.2 Analysis of Experimental Results

In the process of experiment, two different modeling and analysis methods of multipath channel in communication network are used to analyze the change of error rate in

simulation environment. At the same time, because two different communication network multipath channel modeling and analysis, its analysis results can not be compared directly, so the third party analysis recording software is used to record and analyze the experimental process and results. The results are shown in the curve of the experiment. In the simulation experiment result curve, the function of the third-party analysis recording software is used to eliminate the uncertainty caused by the operation of the personnel in the simulation laboratory and the factors of the simulation computer equipment, and only for different embedded LTE wireless communication networks. Modeling and analysis of multipath channels in different communication networks. The contrast curve of the experimental results is shown in Fig. 2. According to the results of the test curve, the third-party analysis and recording software is used to analyze the multi-path channel of the proposed communication network, and the arithmetic error rate of the analysis error rate of the multi-path channel modeling analysis of the conventional communication network is processed.

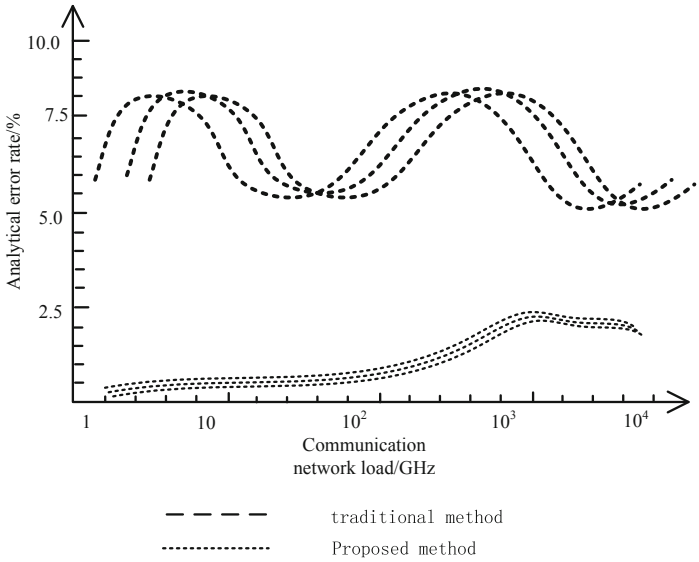

Fig. 2. Experimental result contrast curve

According to the test curve in Fig. 2, the arithmetic error rate of the bit-error rate analysis of the multipath channel modeling analysis method of traditional communication network is between 5.5 and 8.5, while the arithmetic error rate of the method in this paper is only between 0.1 and 2.5. The lower the error rate, the better the accuracy of the method and the better the application effect. It can be proved that the method in this paper is more suitable for multi-path channel modeling and analysis of embedded LTE wireless communication network under cloud computing. This is because the method in this paper establishes the LTE multipath channel modeling and analysis program structure, and combines time-varying channel technology or multi-path

time-varying channel technology to realize the key technology design of multipath channel modeling and analysis, so as to effectively improve the accuracy of analysis.

6 Conclusion

This paper proposes multi-path channel modeling and analysis of embedded LTE wireless communication network under cloud computing. The key technology design of multi-path channel modeling and analysis based on cloud computing embedded LTE wireless communication network, and the determination of multipath channel modeling and analysis program. The characteristics analysis, Rayleigh distribution and Rice distribution of multipath time-varying channels are analyzed to realize the research of this paper. The experimental data shows that the method designed in this paper is extremely effective. It is hoped that the research in this paper can provide a theoretical basis for multi-path channel modeling and analysis of communication networks.

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