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A Feasibility Study On C-RAN

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Abstract

Now a days the number of users of mobile phone are increasing exponentially, so it will cause jamming in the network and require large bandwidth So among promising technology candidates to overcome this problem, cloud radio access network (C-RAN) used. C-RAN, having one baseband unit (BBU) communicates with users through distributed Remote Radio Heads (RRHs) .RRH are connected to the BBU via high capability, low latency fronthaul links and performs soft relaying. The architecture of C-RAN imposes a shortage of fronthaul bandwidth because raw I/Q samples are exchanged between the RRHs and the BBU. In BBU different algorithms are used to improve the capacity, joint decompression and decoding (JDD) and wyner ziv coding.

Keywords: *Cloud radio access networks, joint decompression and decoding, BBU, RRH*

INTRODUCTION

Cloud radio access network (C-RAN) has been widely accepted as a new architecture for future mobile networks to sustain the ever increasing demand in data rate [2].simply speaking C-RAN is a centralized, cloud computing-based architecture for radio access networks that supports 2G, 3G, 4G and future wireless communication standards. C-RAN consists of one centralized Baseband Unit (BBU) and a variety of distributed Remote Radio Heads (RRHs), it serve users in a geographical region. The advantage of C-RAN over Traditional cellular, or radio access networks (RAN) includes system throughput improvement, high power efficiency, and dynamic resource management, which eventually result in the cost-saving on capital expenditure and operating expenditure [5].

Traditional cellular or Radio Access Networks (RAN), it consist of many complete base stations. Each base station covers a tiny space, where as a cluster of base stations provides coverage over a continual space. Each base station processes and transmits its own signal to and from the mobile terminal, and forwards the data payload to and from the mobile terminal and out to the core network via the backhaul. Each base station has its own cooling, backhaul transportation, backup battery, monitoring system, and so on. Because of restricted spectral resources, network operators 'reuse' the frequency among different base stations, which will cause interference between neighbouring cells [6]

Cloud computing is the hot topic for all information technology investors. C-RAN is used for boosting of data services and applications, in wireless system mainly used in voice, data e-mail, video .Now a days increasing demand of data services and users C-RAN is used, earlier traditional RAN was used. In traditional RAN each basestation connects to fixed number of antennas, the antenna cover small area and capacity is limited by interference. The main challenges are requirement of large base station, base station utilization rate is low, base station processing units power cannot be shared among other units and for faster data services upgrade the network. In future RAN should provide mobile broad band internet access to wireless users low bit cost, high spectral efficiency, energy efficiency, able to support multiple standards and platform for additional revenue generating services. C-RAN reduces the capital and operating expenses and maintains heterogeneous networks. C-RAN architecture consists of BBU, RRU, fronthaul. BBU is moved from base station to central unit and BS will upgrade as RU (Radio Unit) [1].

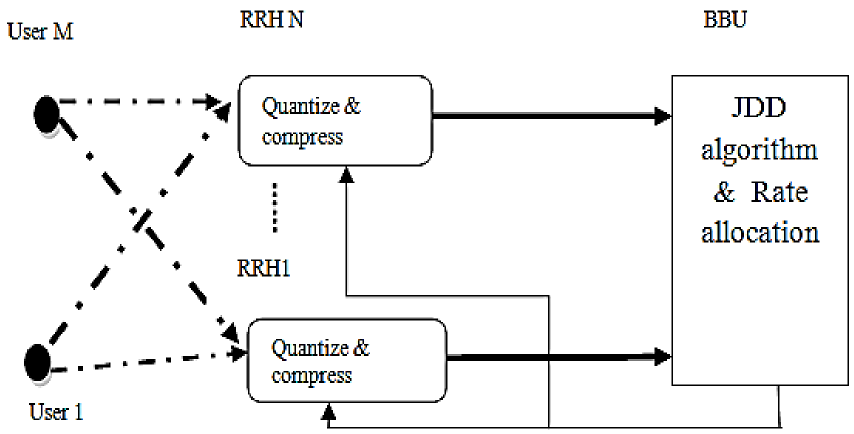

Fig: 1. *General Block Diagram*

LITERATURE SURVEY

Karl F. Nieman et.al describes the compression methods that exploit the temporal and spectral structure of LTE signals for achieving high compression with limited impact on end-to-end communication performance. This includes design of a low-complexity compression technique for LTE and validation of this technique victimization an LTE link-level simulation. Also this technique achieves up to 5× compression for transmission and downlink signals[7].orthogonal frequency division multiple access (OFDMA) are used to modulate LTE downlink signals are and single carrier frequency-division multiple access (SC-FDMA) is used to modulate uplink signals. In OFDMA (downlink) subcarrier symbols are drawn from an M-QAM. And for SC-FDMA, symbol set is pre coded using a length-12 discrete Fourier transform (DFT) and is scaled by the channel. LTE is designed to operate in different bandwidths. Compression of LTE uplink and downlink signals can be achieved by exploiting redundancies in the signal structure [7] and use time-domain compression techniques for baseband signals [8].

First the samples are converted to block floating point illustration and rate regenerate. Dithering is used across parallel links to scale back compression error and there by achieving mixture rate reduction of 3×. Lloyd-Max quantizers, which takes the advantage of the statistical structure of the baseband signals [9]. Quantization which minimizes mean squared error (MMSE) using a potentially non-uniform spacing depending on the PDF of the amplitude. Distributed compression is achieved for baseband uplink signals using the conditional Karhunen-Loeve transform [9]. In

OFDMA, a vector of allocated subcarriers area unit encoded as M-QAM symbols, in SCFDMA, these symbols are pre coded exploitation a DFT. Central Limit Theorem (CLT), is used for a sufficiently large IFFT length N, the resulting amplitude statistics of the real and imaginary component converge to a circular Gaussian amplitude distribution. For sufficient IFFT length, OFDMA samples can be modeled as a Gaussian process. The LTE samples are not i.i.d so LTE signals are oversampled which means correlation exists in the time-domain. Minimum mean squared error (MMSE) sense for samples with a given amplitude PDF [11].The filter are designed to reshape noise power to LTE guard bands and use fifth-order Chebychev Type II IIR filter. Block scaling is performed before the quantizer stage and gain factor can be added to a block of samples to ensure in range values for a fixed quantizer.

The uplink simulator was changed to include compression/decompression blocks when the channel and the downlink simulator was changed to include compression/decompression blocks at intervals the base station before transmission[7]. Two performance metrics are used in evaluation of the compression methods. First, record coded bit error rates (BERs) to measure the impact on end-to-end link level performance. Second, error vector magnitude (EVM), the most sensitive (highest SNR) channel quality index (CQI) is used for both uplink and downlink simulations. Both non-uniform quantization and noise shaping reduce one bit in word length for similar BER performance. After quantization, reduction in rate via cyclic prefix removal and rational rate change reduces the rate by an extra one.78×, resulting in an overall reduction of 5.3×. Further compression is potential for lower CQIs because of higher code rate and modulation [7].

Here a combination of non-uniform quantization, rescaling, resampling and noise-shaping error feedback to compress LTE uplink and downlink signals. Low complexity, time-domain methods achieve up to five time compression versus standard 15-bit complex-baseband representation and it can be easily implemented in digital logic. Current CPRI links have insufficient capability to support twenty megahertz bandwidth LTE for a base station with 3 sectors and four antennas per sector. To overcome these eight antennas per sector and up to 5× system bandwidth, LTE-A will require substantial increases in CPRI capacity is used. Further spatial compressibility can exploit for multiple antennas.

Wei Yuet.al describes the uplink of a cloud radio access network where ever the cell sites are connected to a cloud computing-based central processor with noiseless backhaul links with finite capacities. It formulates the problem of optimizing the quantization noise levels. It deals with the capability limits and system level optimization of transmission C-RAN underneath sensible finite capacity backhaul constraints. C-RAN taking advantage of the high-capacity backhaul links between the BSs and the CP, The BSs are connected to the CP via quiet backhaul links with a finite add capability constraint. The sum backhaul capacity constraint considered in this paper is suitable the sequence of events where the backhaul is put in to action in a wireless shared medium. The wireless backhaul links are start using an orthogonal access scheme such as TDMA/FDMA. Here uses a compress and forward scheme in that the basestations quantize the received signals and mistreatment Wyner-Ziv coding or single-user compression and it transmit the compressed bits to the CP through the quiet backhaul links. Hence the Wyner-Ziv compression is used to attain higher compression potency and to better utilize the restricted the capacities of backhaul than per-link single-user compression. However Wyner-Ziv coding represents a better utilization of the backhaul and to implement in practice is very complex. In this part Wyner-Zivcoding is replaced by using single-user compression. It considers a compress and forward relay over all aim in which the base stations send compressed version of their received signals to the control processor through the backhaul and the control processor jointly or successively decodes all the user messages. Determining on the different compression used at base stations Wyner-Ziv coding or with single-user compression and the coding over an all aim is VMAC-WZ or VMAC-SU that is virtual media access contolwynerziv and virtual media access control single user respectively. The optimal quantization noise levels are achieved by using VMAC-WZ, it can achieve the total capacity by successive decoding and VMAC-SU achieves the maximum capability of a channel diagonal underneath dominant condition.

Here the Wei Yu et .al studies the uplink C-RAN model it achieves through noiseless backhaul links of limited sum capacity , it uses two virtual media access control schemes where the base stations uses Wyner-Ziv compression or single-user compression to quantize the received signals and send the compressed bits to the cental processor. In quantization codewords are first decoded at the cental processor and the user messages are decoded the users of a virtual multiple-access channel [3].

KatsuyaSutoet.al proposed that the traditional RAN network architecture uses distributed resources. A base-band unit manages the resources and interference connection. C-RAN locates BBU in the CO to manage numerous RRHs. This method effectively manages RRHs multiple and complex functions. That functions include multiple input multiple output (MIMO), handover and coordinated multipoint (CoMP). The CO controls the C-RAN optical components. The CO determines allocation of the optical source and OLT transmission power. PON construct a fronthaul between RRHs and OLTs. OLT connected to RRHs has two functions. First provide communication of data between RRHs and OLT. And provide input supply to the RRHs. Wavelength division multiplexing (WDM) which provides resource allocation. RRH having three modules antenna module, optical network unit (ONU) module and battery module. In downlink communication, the OLT it receives a data from CO. laser diode (LD) convert the received data to optical signal it is transmitted to ONU. The RRH it converts the optical signal into electric signal, is then transmitted to the users through antenna module. In case of unnecessary received data, the converted electrical power is stored in the battery module.

This method minimizes each OLTs transmitted power. Power efficient network operation is provided by QoE. The CO executes this procedure in each time slot. RRHs transmission range and QoE value are initially set by the operator. QoE value depends on region, time and user context. This operation performs two functions, first is distance threshold decision function (DTDF) and sleep and power control function (SPCF). For the required QoE value, DTDF decides distance threshold for guaranteeing, the state of RRHs is controlled by SPCF. First CO executes DTDF then, the CO executes SPCF. Then CO constructs a set of candidate RRHs. This step will continue upto it finishes the state decision the CO first chooses the RRH which has the maximum amount of power. And performance effectiveness is based on the comparison of performance between this method and the conventional method.

Disadvantage of this method is that distance threshold change based on the guaranteed QoE level. The challenge of this method is PON exploiting PoF. To overcome this derived mathematical model to evaluate the performance of envisioned C-RAN [4]

Thang X. Vu et.al describes a joint decompression and detection (JDD) algorithm for detection and decompression in a single step and effectively exploits the correlation between the RRHs. Also it achieves improvement in information-theoretic sense. It consider both compression and fadingin single decoding step and the block error rate (BLER) is analyzed by using a pair-wise error probability analysis after that analyze BLER. Adaptive compression is used to minimize the fronthaul transmission rate. Also propose a new scheme to minimize the signal distortion. This method achieves a compression ratio. First uniformly quantized the received signal at the RRH. Then convert it into bits sequence by using ADC then transmitted it to the BBU through fronthaul links. Compression ratio is controlled by changing resolution of the ADC. This compression scheme can be applied to time domain and in frequency domain with a small modification. First aim l is to minimize the transmission rate on the fronthaul links with a minimum attenuation in the decompressed signal. There by BBU can support a maximum number of RRHs also fully occupying the fronhaul link capacity. Next goal is to reduce the signal distortion for a fronthaul constraint.

Analysis is based on BLER and PEP. BLER is derived from pair-wise error probability (PEP) analysis, is a function of the non-linear quantization methods. Based on BLER 2 adaptive compression method with quality of service (QoS) are considered to maximize the compression ratio if satisfying given BLER target. Also use a JDD method which minimizes the distortion in a predefined fronthaul rate.

The users communicate with the RRHs through wireless medium. RRHs connected to the BBU by using fiber, known as fronthaul links. The users and RRHs are equipped with a single antenna. The multiple antennas of RRH used as a band of single-antenna RRHs because of all central processing performance are acts as BBU. The fronthaul link has limited capacity so the inphase /quadrature signals need to be compressed before sending through the baseband unit, then the BBU decompresses the received signal from the RRHs and further processing performs. Here assume all nodes are synchronous and the all wireless channels are blocking Rayleigh fading. The BBU is assumed to know all the channel state information (CSI) within the network. Upon receiving analogue signals from the users, the RRHs quantize and compress them into digital bits and then forward these bits to the BBU.

Uniform compression is used to cut back the fronthaul links transmission rate and also the received signal at each RRH is compressed before causing to the BBU. This compression method is flexibly tuning the resolution of ADCs. Therefore a target compression ratio achieved by changing the resolution of the ADC. Then compression method performed by truncating the some least important bits in the output of ADCs. The JDD algorithm that performs decompressing and detecting for the source codeword and at the same time exploiting the structure of the quantizer and the codeword. The BBU is assumed to know the CSI of all wireless links. The CSI can be obtained through channel estimation with pilot transmission in training period. Given the compressed bit sequences, the BBU optimally estimates the source codeword by using the maximum a posteriori (MAP) receiver compare the proposed JDD algorithmic program with2 references: Separate decompression and detection (SDD) and minimum mean square error (MMSE) receivers. The Separate decompression and detection receiver detects the source symbols just primarily based on the Hamming distance between the received signal and also the trial codeword and the MMSE receiver separates the received signal vector into M orthogonal sub-streams which takes into throughout result of quantization noise, achieves the best performance compared with the references. Such expected gain results from the searching over all mixtures of the source symbols of the proposed algorithm. The proposed JDD algorithmic program yields larger gain over SDD receiver in non-uniform fronthaul bandwidths. This is as a result of quantization noise in this case, which is unheeded in SDD receiver, has more impact on the overall system performance [12].

Thang X. Vu et al. proposed a fronthaul in C-RAN transmission by compression and optimization in fronthaul uplinks. First derive the system block error rate (BLER) under Rayleigh fading channels then obtained closed-form. From these obtain bounds gain insight in terms of diversity order and limits of the BLER. Next propose adaptive compression scheme which minimize the fronthaul compression rate subject to a BLER constraint. A fronthaul rate allocation which minimize the system BLER. It is shown that the uniform rate allocation approaches the optimal scheme as the total fronthauls' bandwidth increases. Here mainly study the compression and the corresponding performance of C-RAN uplinks in Rayleigh fading channels. At first to derive the performance metrics for C-RAN systems based on the channel statistics. The two adaptive compressions which maximize the compression efficiency while satisfying a predefined BLER. This criterion is different from that in [3], which aims to fully utilize the fronthaul link capacity. Such overhead reduction becomes more important in C-RAN systems which are designed to support a large number of users.

Due to limited fronthaul links capacity in phase/quadrature signals need to be compressed The BBU decompress the signals received from the RRHs and then performs further processing. Fronthaul rate allocation is proposed to minimize the system BER. In this paper discuss about only the performance of block error rate and not mentioned about any other errors. This paper can be extended for the study of error vector magnitude which is also an important performance measurement [13].

CONCLUSION

In this Paper we are comparing different compression schemes used in the cloud radio access networks, among those all compression scheme we find out that adaptive compression scheme is better than the others. According to Thang X. Vu compression efficiency of 350% is optimized according to the proposed scheme, Wei Yu et.al efficient algorithms for optimizing the quantization noise levels two schemes are proposed VMAC-WZ and VMAC-SC, Nei Kato et.al to reduce the transmission power while satisfying the quality of service value. Sumei Sun et.al proposed two adaptive compression method to minimize fronthaul transmission rate subject to a BLER constraint.

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