Single Value SRS (SV-SRS) Feedback Control Method for LTE Uplink Transmission

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Abstract**—**LTE and LTE-Advance communication are based on the uplink reference signals to estimate the channel characteristics. A split transmission of sounding and demodulation signaling will cause many constraints; such as layers and reference signal symbols interferences, increase in delay and reduction in the overall throughput of the LTE uplink transmission. In this paper, we propose an energy efficient LTE uplink transmission by eliminating the demodulation reference signal (DM-RS) information from the LTE uplink resource grid. Initially, the DM-RS signaling data is eliminated from the data resource grid to provide spare capacity for data to increase the data rate within the same energy consumption. After that, the DM-RS signaling information within SRS signaling symbols is amalgamate. Finally, the model of single value sounding reference signal (SV-SRS) is designed to merge the DM-RS features in SRS symbols, which are helpful to estimate the fine channel parameters for LTE downlink transmission. SV-SRS also overcomes the symbols and channel interference to enhance the overall throughput and reduces the BER of LTE uplink system. The simulation results of proposed strategy show that the SV-SRS improvement in the LTE uplink data by eliminating the DM-RS symbols.

Index Terms**—**MU-MIMO, LTE uplink reference signals, SV-SRS, CSI.

I. Introduction

Your goal is The multi-input multi-output (MIMO) and multi user MIMO (MU-MIMO) are state-of-the-art inventions of wireless networks due to the ability of augmented diversity, elevated capacity, considerable spatial gain and capability of interfering repression [1], [2]. In recent years, MU-MIMO has gotten great concentration in terms of downlink/uplink channel systems for higher cellular technologies, like WIMAX and LTE [3]. These technologies are based on pre-coded transmission to avoid the recipient noise and multi-user interference. Channel state information (CSI) is usually required at transmitter side that can measure Information flow at the receiver and also send feedback of quantized information about CSI to the transmitter in both frequency and time duplex schemes [4].

Some research work has been done to improve the throughput of LTE uplink by reducing symbols and channel interference of reference signals (RSs). The RSs (such as sounding reference signal (SRS) and demodulation reference signal (DM-RS)) are generally utilized in the support of measuring the channel value of planned frequency perceptive and parameter arrangement of unscheduled subscribers [5]. They are also useful for demodulation and decoding data systems, power management and periodical data transmission. SRS carries information for an evolved node B (eNodeB), to select a suitable pre-coder for the data channel; the uplink SRS transmission based on conventional non-precoding scheme in which information transmits without pre-coding [6]. As DM-RS and data channel transmits along common pre-coding method, it is difficult to select pre-coding through a DM-RS signaling. The SRS also supports the orthogonal transmission for different users [7].

Intensive research work has been done through different prospectives (i.e. SRS, DM-RS, cyclic shifting, layer interference and delay control etc.), in the domain of imperfect CSI estimation for optimizing the performance of beamforming systems in the LTE Uplink. Specifically, the major enhancement is done through improvement of SRS and DM-RS in LTE Uplink network to improve the system performance. A scheme of multiple-input single-output (MISO) was discussed in [8] to increase the SNR through uplink time interval (UPTI) in TDD beamforming. The throughput consequence was investigated in [9] by channel assessment error and quantization error in the performance of partial feedback beamforming, with a limited coherence period. In [10], a channel estimation technique was proposed to measure the interference level through the SRS signaling to enhance the network throughput. The constant power RS was proposed for the MU-MIMO in LTE uplink network to reduce the power allocation limitation of cyclic shift in multi-user RSs [11]. A constant power allocation of code-division multiplexing (CDM) and frequency-division multiplexing (FDM) based on RS was investigated in [12], by utilizing the typical characteristics of Zadoff-Chu sequence, with zero sequence of cyclic shift. The DM-RS is forwarded orthogonally through multiple transmit antennas and maximum ration combining scheme used at receiver sites to get diversity gain [13]. The uplink DM-RS and data channel information are transmitted by similar pre-coding schemes to achieve pre-coding gains of link assessment [14].

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To remedy the above mentioned RS problems, the LTE uplink transmission method is proposed based on the uplink reference signaling. In a single value SRS (SV-SRS) of the uplink feedback information system, subscribers send solitary symbol information about RS via the uplink sub-frames to estimate channel characteristics at eNodeB, for the assistance of downlink beamforming transmission. The basic theme of the proposed method is to eliminate the DM-RS signaling. The spare capacity of DM-RS is used for uplink data to enhance the overall uplink capacity. The DM-RS signaling information is aligned with SRS signaling by SV-SRS proposed system design. The SV-SRS can eliminate the layer interference issues and enhance the overall throughput of the Uplink LTE network through the elimination of some DM-RS data from the resource grid. Throughput is enhanced using the full capacity of DM-RS for user data within the same transmission power. The proposed strategy is useful to overcome the layers, symbols, channel interference to improve the overall throughput and reduce the BER of LTE uplink system.

The rest of the paper is organized as follows. Section II describes the proposed system model. The features of key technology used in proposed scheme are conferred in Section III. The methodology of the proposed solution is briefly explained in Section IV, simulation results are explained in Section V and finally conclusion is presented in Section VI.

II. System Model

The SISO and MISO system models are considered with M_{Tx} and N_{Rx} antenna at the eNodeB and receiver, respectively. The channel is modeled according to the independently and identically distributed (i.i.d) rayleigh fading, spatial unrelated, smooth frequency and periodic alteration. Here, $\boldsymbol{h} = [\boldsymbol{h}_1,\boldsymbol{h}_2,\ldots,\boldsymbol{h}_M]$ is channel vector between transceivers. In addition, the power block adds the pre-coding block to increase the total transmit power p to an assured level.

The transmission is carried out as

$$Z = hwS + g \tag{1}$$

where, Z is baseband transmission, w is pre-coder, S refers to the data symbols and $\mathbf{g}$ is the receiver AWGN noise vector;

where, the symbols extracting is defined as

$$\hat{S} = c^h Z \tag{2}$$

The equalizer c^h is applied on grounded with the association of SRS in non-codebook based pre-coding.

A general equalizer, by channel estimation of single SRS information, can be produced according to Eq.(2) for single layer transmission of solitary user. The w_p vector defines the SRS weight for multi antennas allied with single antenna port and the channel estimation for single antenna port represented as $\boldsymbol{h}\hat{w}_p = \boldsymbol{h}w_p+g_p$,

The equalizer is defined as [15]

$$c^h = (\mathbf{h}\hat{w}_p)^h \tag{3}$$

Here, the instant SNR maxima and BER minima are expressed as pursues.

Instant SNR

$$\hat{S} = (\mathbf{h}\hat{w}_p)^h \mathbf{h}wS + (\mathbf{h}\hat{w}_p)^h g \tag{4}$$

Afterward the instant SNR is habituated with $\mathbf{h}$, *it* can be moulded as [15]

$$SNR = E_{\mathbf{g}_p}\left[\frac{E_S[((\mathbf{h}\hat{w}_p)^h \mathbf{h}wS)((\mathbf{h}\hat{w}_p)^h \mathbf{h}wS)^h]}{E_{\mathbf{g}}[((\mathbf{h}\hat{w}_p)^h \mathbf{g})((\mathbf{h}\hat{w}_p)^h \mathbf{g})^h]}\right]$$

$$= \{E_S[SS^*] = p \;\&\; E_{\mathbf{g}}[\mathbf{g}\mathbf{g}^h] = N_o\mathbf{I}\}$$

$$= \frac{p}{N_o} E_{\mathbf{g}_p}\left[\frac{(\mathbf{h}\hat{w}_p)^h \mathbf{h}w((\mathbf{h}\hat{w}_p)^h \mathbf{h}w)^h}{(\mathbf{h}\hat{w}_p)^h(\mathbf{h}\hat{w}_p)}\right]$$

$$= \frac{p}{N_o} E_{\mathbf{g}_p}\left[\frac{w^h \mathbf{h}^h (\mathbf{h}\hat{w}_p)(\mathbf{h}\hat{w}_p)^h \mathbf{h}w}{(\mathbf{h}\hat{w}_p)^h(\mathbf{h}\hat{w}_p)}\right] \tag{5}$$

In the case of optimum channel information at the receiver (CSIR) supposition, $\boldsymbol{h}\hat{w}_p = \boldsymbol{h}w_p$.

the SNR specified with $\mathbf{h}$ is defined as

$$SNR = \frac{p}{N_o}\frac{w^h \mathbf{h}^h (\mathbf{h}w_p)(\mathbf{h}w_p)^h \mathbf{h}w}{(\mathbf{h}w_p)^h(\mathbf{h}w_p)} \tag{6}$$

The instant BER expressions were investigated in detailed by Metha et al. [16]. The mean vector μ is delimitated as

$$\mu = \frac{E_{|\mathbf{h}}[Z^h \mathbf{h}\hat{w}_p]}{\sqrt{E_{|\mathbf{h}}[Z^h Z] E_{|\mathbf{h}}[(\mathbf{h}\hat{w}_p)^h \mathbf{h}\hat{w}_p]}} \tag{7}$$

where $Z = \mathbf{h}wS + \mathbf{g}$.

To reduce BER conditioned on $\mathbf{h}$ is corresponding to maximize

$$\mu\mu^* = \frac{E_{|\mathbf{h}}[Z^h \mathbf{h}\hat{w}_p]}{\sqrt{E_{|\mathbf{h}}[Z^h Z] E_{|\mathbf{h}}[(\mathbf{h}\hat{w}_p)^h \mathbf{h}\hat{w}_p]}} \frac{(E_{|\mathbf{h}}[Z^h \mathbf{h}\hat{w}_p])^*}{\sqrt{E_{|\mathbf{h}}[Z^h Z] E_{|\mathbf{h}}[(\mathbf{h}\hat{w}_p)^h \mathbf{h}\hat{w}_p]}}$$

$$= \{E_{\mathbf{g}_p}[\mathbf{g}_p \mathbf{g}_p^h] = N_p I\} \tag{8}$$

$$= \frac{w^h \mathbf{h}^h (\mathbf{h}w_p)(\mathbf{h}w_p)^h \mathbf{h}w}{p w^h[\mathbf{h}^h \mathbf{h} + \frac{N_o}{p}\mathbf{I}]w} \frac{1}{w_p^h \mathbf{h}^h \mathbf{h} w_p + N_p}$$

III. LTE Uplink Reference Signals

LTE uplink reference signals accomplish certain provisions for a better transmission. The amplitude must be constant and equally divided between owed sub-carriers for an impartial channel calculation. To keep the constant power amongst the sub-carriers, the time domain Low Cubic Metric (CM) is used [17]. The CM has similar characteristics as the Peak-to-Average Power Ratio (PAPR). Autocorrelation for accurate channel estimation and cross correlation to reduce the RS interferences are considered. Additionally orthogonal transmission of RSs sequence grouping with cyclic time shifts is used to resolve the correlation issues.

The RSs sequence-grouping uses Zadoff-Chu sequence to raise a signal up to required constant amplitude signal level. In frequency-domain, the Zadoff-Chu sequence is defined as follows [18]:

$$a_q(n) = \exp\left[-j2\pi q \frac{n(n+1)/2}{N_{\mathrm{ZC}}^{\mathrm{RS}}}\right] \qquad (9)$$

where, q = 1, 2, . . . , $N_{\mathrm{ZC}}^{\mathrm{RS}}$ -1 is the sequence index, and n = 0, 1, . . . , $N_{\mathrm{ZC}}^{\mathrm{RS}}$ -1 is exponent based on the location of the index.

The exponent depends on the position index n and the sequence index q. When n or q increase, the exponential function has constant amplitude but the phase rotation become faster. There are 30 base sequences in the base RS sequences and sequence grouping. For $M_{\mathrm{sc}}^{\mathrm{RS}} \geq 3N_{\mathrm{sc}}^{\mathrm{RB}}$, where $N_{\mathrm{sc}}^{\mathrm{RB}}$ is the quantity of subcarriers for resource block and $M_{\mathrm{sc}}^{\mathrm{RS}} = mN_{\mathrm{sc}}^{\mathrm{RB}}$ is the length of the reference signal with $1 \leq m \leq N_{\mathrm{RB}}^{\mathrm{max.UL}}$.

The RS base sequences are distanced from the allotment of a Zadoff-Chu base sequence as

$$\bar{\gamma}_{u,v}(n) = a_q(n \bmod N_{\mathrm{ZC}}^{\mathrm{RS}}) \qquad (10)$$

The arrangement of n mod N_{ZC} is the representation of multiple subcarrier with repetition condition of sequence, that repeat the sequence as long as $n < N_{ZC}$ -1. At this juncture q is a utility of u and v as

$$q = \left[\bar{q} + 1/2\right] + \mathrm{v} \cdot (-1)^{2\bar{q}} \qquad (11)$$

$$\bar{q} = N_{ZC}^{RS} \cdot (\mathrm{u}+1)/31 \qquad (12)$$

where, $u \in \{0, 29\}$ is the number of sequence group, and $v \in$ 0, 1, is the index of base sequence, $N_{\mathrm{ZC}}^{\mathrm{RS}}$ is the length of Zadoff-Chu sequence according to the prime number like $N_{\mathrm{ZC}}^{\mathrm{RS}} < M_{\mathrm{sc}}^{\mathrm{RS}}$

A. LTE Uplink Demodulation Reference Signal (DM-RS)

The DM-RS information is for facilitating the articulate signal modulation at eNodeB. Normally, these types of signaling information are transmitted with the uplink data information, in the time multiplexed scheme. It is generally dispatched on the 3rd or 4th SC-FDMA symbol of a LTE uplink slot for the normal or extended cyclic prefix (CP) [19]. The demodulation reference signal sequence, $\gamma_{u,v}^{(\alpha)}(n)$, with the cyclic shift α of base sequence $\bar{\gamma}_{u,v}(n)$ is delimiting as

$$\gamma_{u,v}^{(\alpha)}(n) = e^{j\alpha n}\bar{\gamma}_{u,v}(n), \ 0 \leq n \leq M_{sc}^{RS} \qquad (13)$$

where, the length of DM-RS is $M_{\mathrm{sc}}^{\mathrm{RS}} = mN_{\mathrm{sc}}^{\mathrm{RB}}$, m is the resource block (RB) number and the subcarrier number within every RB is N^{RB}. The dissimilar base sequence groups are introduced into neighboring cells selection of DM-RS sequences to reduce the inter-cell interference. Additionally, the three hopping types (group hopping, sequence hoping and cyclic shift (CS) hopping) are distinct by the LTE Uplink for DM-RS. Further, the CS hooping method must be constantly enabled for each slot. The CS transfer α in slot n_s is specified as $\alpha = 2\pi n_{cs}/12$ amid

$$n_{cs} = \left(n_{DM-RS}^{(1)} + n_{DM-RS}^{(2)} + n_{PRS}\right)/12 \qquad (14)$$

where $n_{DM-RS}^{(1)}$ is the propagated significance, $n_{DM-RS}^{(2)}$ is comprised in the uplink forecast task and n_{PRS} is provided through a cell specific pseudo random sequence.

Every RB will restrain 12 sub-carriers, with 15 KHz sub-carrier bandwidth. The DM-RS is mapped to the 4th Single Carrier–Frequency Division Multiple Access (SC-FDMA) symbol of the slot, during normal cyclic prefix (CP) and to every 3rd SC-FDMA slot during extended cyclic prefix.

B. LTE Uplink Sound Reference Signal (SRS)

The SRS information is forwarded through the last SC-FDMA symbol of a LTE uplink slot [20]. The major advantage of SRS is frequency selection for uplink scheduling and channel impulse response. This type of information cannot be extracted from DM-RS because the DM-RS information is transmitted in a multiplexed format with data.

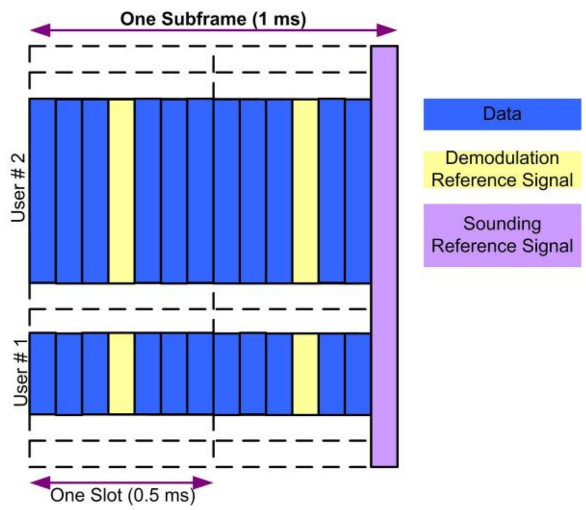

Fig. 1. LTE Uplink DM-RS and SRS placement in resource grid

The SRS sequences are defined as

$$\gamma^{SRS}(n) = S_{u,v}^{(\alpha)}(n) = \mathrm{e}^{j\alpha n}\gamma_{u.v}(n),\ \ 0 \le n \le M_{\mathrm{sc}}^{\mathrm{RS}} \quad (15)$$

where, $\gamma_{u,v}(n)$ is base sequence of Physical Uplink Control Channel (PUCCH), $u \in \{0,\ 29\}$ is the group sequence number, v = 0, 1 is sequence number inside the group for the RS. $M_{\mathrm{sc}}^{\mathrm{RS}}$ is the duration of RS sequence, and α is the cycle shift for a single base sequence. In the case of multiple RS, the value of α will differ accordingly. However, the SRS are mapped to every second subcarrier in the last symbol of a sub-frame. The detailed proof of above mentioned DM-RS and SRS measurements are defined in the 3GPP standard documents [18], [21]. The SRS and DM-RS symbols placement are shown in Fig. 1.

IV. SV-RS Method for LTE Uplink Reference Signals

The proposed strategy is based on the modified LTE reference signaling system. The strategy is divided in two steps. In the first step, a resource grid model is proposed in which the SRS and DM-RS information is transmitted by the Single Value-SRS (SV-SRS), format at the end of each sub-frame as shown in Fig. 2.

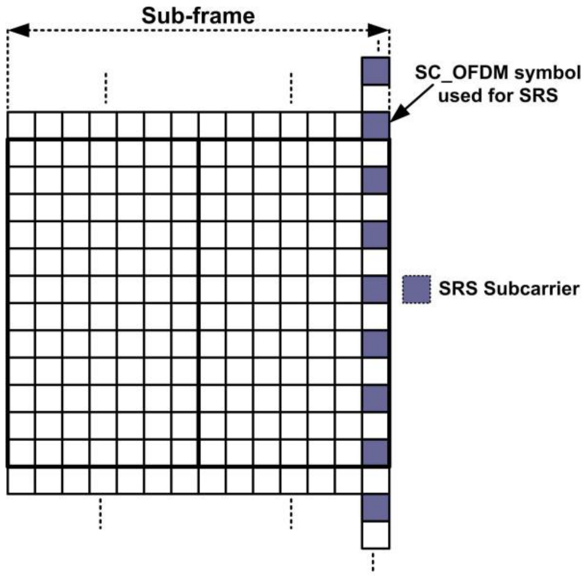

Fig. 2. SV-SRS resource grid structure

The SV-SRS symbols/resource elements (RE) are dispatched orthogonally for multi-user scheme to eliminate the symbol interferences. Both, SRS and DM-RS, are hauling the channel quality data with the same Zafoff-Chu sequences, to assists the eNodeB for LTE downlink beamforming transmission. As the DM-RS signaling is dispatched along with data information within similar RBs, it has effects on the consumption of data packet capacity and also on the signaling information in case the RBs are discards. The purpose of SRS data transition is differing with the DM-RS in the replica wisdom of sensitive channel quality information. It conveys through a dedicated RB with a periodic transmission behavior. The SV-SRS signaling information is used by eNodeB to project the downlink transmission with appropriate characteristics. The anticipated designed is based on the advantages of SV-SRS periodic signaling behavior, to increase the data throughput capacity by eliminating the DM-RS signaling. The proposed theme is designed to enhance the throughput and reduce the delay in such a way, that, all RS parameters are forwarded through the SV-SRS of LTE uplink scheme

The SV-SRS followed by the Zadoff Chu sequences is defined as

$$\gamma^{SVRS}(n) = \gamma_{u.v}^{(\alpha)}(n) \quad (16)$$

where, the SV-SRS sequence $\gamma_{u.v}^{(\alpha)}$ is distinct via a cyclic shift α of the base sequence $\overline{\gamma}_{u,v}(n)$.

$$\alpha = 2\pi \frac{n_{\mathrm{SVSRS}}^{\mathrm{cs}}}{8} \quad (17)$$

where, $n_{\mathrm{SVSRS}}^{\mathrm{cs}}$ is configured for each user by higher layers and $n_{\mathrm{SVSRS}}^{\mathrm{cs}}$ = 0,1,2,3,4,5,6,7.

The amplitude scaling factor β_{SVSRS} should be multipliewith sequence, and mapping of preliminary sequence wit $r^{\mathrm{SVSRS}}(0)$ to resource element (frequency-domain index k and time-domain index l) concord as

$$a_{2k'+k_0,l} = \begin{cases} \beta_{\mathrm{SVSRS}} r^{\mathrm{SVSRS}}(k'), & k' = 0,1,\ldots,\ M_{\mathrm{sc,b}}^{\mathrm{RS}}\text{-}1 \\ 0, & \text{otherwise} \end{cases} \quad (18)$$

The frequency domain preliminary location of the SVRS

k_0 is defined as

$$k_0 = k_0' + \sum_{b=0}^{B_{\mathrm{SVSRS}}} 2M_{\mathrm{sc,b}}^{\mathrm{RS}} n_b \quad (19)$$

with the length of the sounding reference signal sequence$b$ and $M_{sc,b}^{RS}$.

$$M_{sc,b}^{SVSRS} = \frac{1}{2} m_{SVSRS,b} N_{sc}^{RB} \quad (20)$$

where, each uplink bandwidth N_{RB}^{UL} is already specified in the structure of $m_{SVSRS,b}$ [21]. The normal uplink sub-frames k_o' and n_b frequency position index are further expressed as

$$k_0' = \frac{1}{2}\left(\left\lfloor N_{\mathrm{RB}}^{\mathrm{UL}} \right\rfloor - m_{\mathrm{SVSRS,0}}\right) N_{\mathrm{SC}}^{\mathrm{RB}} + k_{\mathrm{TC}} \quad (21)$$

where, the parameter transmission-Comb provided via higher layer for the users is $k_{TC} \in \{0,1,2,3\}$. The number of subcarriers $N_{\mathrm{sc}}^{\mathrm{RB}}$ is defined in the resource as frequency domain. N_{RB}^{UL} is repressing the arrangement of uplink bandwidth in terms of multiples of N_{sc}^{RB}.

$$n_b = \begin{cases} \lfloor 4n_{RRC}/m_{SVRS,b} \rfloor \bmod N_b, & \text{SRS hopping enabled} \\ \{\lfloor 4n_{RRC}/m_{SVRS,b} \rfloor \bmod N_b, & \\ \{F_b(n_{SVRS}) + \lfloor 4n_{RRC}/m_{SVRS,b} \rfloor\} \bmod N_b, & \text{Otherwise, SRS hopping disable} \end{cases} \quad (22)$$

where, the parameter frequency-Domain-Position n_{RRC} is prearranged through the upper layers for users. Each uplink bandwidth N_{RB}^{UL} is already specified in the structure of $m_{SRS,b}$ and N_b [18]. F_b is defined as carrier frequency

In the second step, the SV-SRS scheme is described in such a way that all parameters of SRS and DM-RS congregate in a SV-SRS format. The purpose of SRS and DM-RS in LTE uplink RS is to carry the calculated information of channel characteristics such as frequency, time, modulation scheme, signal strength and beamforming layer. The proposed SV-SRS is used to manage all the essentially required in-formation of channel estimation, through the single value information.

The SV-SRS carries x information, that contains the following information about channel characteristics for eNodeB: Frequency = $F1$, Time = T_1 (for scheduler assistance) Modulation scheme = M, Transmission power = P_t, and Transmission layer = B of each layer. Here, $x_{1,2\&3}$ describe the channel information of different beamforming layers information within maximum beamforming strength, as shown in Fig. 3.

The following data is contained by

$$x_{(n)} = F_n T_n M_n B_n P_{t_n}, \quad n = 1,2,3,\ldots,m \quad (23)$$

The x information are aggregated as the weight of SV-SRS for uplink transmission. x is planned as a single value base, that can easily extract the information at eNodeB, to provide assistance in the designing process of downlink beamforming transmission. The association between the rudiments of the channel matrix is falling slower than the time relationship between $w_{t_{UL}}$ and $\mathrm{w}_{t_{DL}}$. It is concluded by the uplink and downlink delay that the $\mathrm{w}_{t_{UL}}$ and $\mathrm{w}_{t_{DL}}$ have major variation, but the channel elements of $\mathbf{h}_{t_{UL}}$ and $\mathbf{h}_{t_{DL}}$ are tranquil and intimately associated. Therefore, it can only be true in the case with a dumb time deviation channel, where $\mathbf{h}_{t_{UL}} \approx \mathbf{h}_{t_{DL}}$. The SRS weight models are described as $\mathrm{w}_{P_1}, \ldots, \mathrm{w}_{P_{Mtx}}$.

The proposed scheme is based upon a single row of the channel matrix assessment at BS such as $\mathbf{h}_{t_{UL}}$ (1,:). It is acquired via uplink SV-SRS.

In this phase, the BS will calculate the $\mathbf{h}_{t_{UL}}$ and estimate the pre-coder $\mathrm{w}_{t_{UL}}$ acquired via users. Subsequently, the pre- coder extracts the signal information form $\mathrm{w}_{t_{UL}}$.

Afterwards, a downlink signal is generated according to $t_{DL} = t_{UL} + \tau$. Where, the SNR Maxima being

$$\mathrm{w}_{t_{UL}} = \begin{cases} \max\limits_{\mathrm{w}_{t_{UL}}} [\mathrm{w}_{t_{UL}}^h \mathbf{h}_{t_{UL}}(1,:)^h \mathbf{h}_{t_{UL}}(1,:) \mathrm{w}_{t_{UL}}] \\ \text{s.t.} \mathrm{w}_{t_{UL}}^h \mathrm{w}_{t_{UL}} = 1 \end{cases} \quad (24)$$

and, single antenna power manage

$$w_{t_{ULi}} = \frac{w_{t_{ULi}}}{\sqrt{M_{tx}} \left| w_{t_{ULi}} \right|}, \quad i = 1, 2, \ldots, M_{tx} \quad (25)$$

The weight is further processed of downlink beamforming pattern.

$$\mathrm{w}_{UL} = \arg_{\mathrm{w}} \max \left[\mathrm{w}_{UL}^h \mathbf{h}^h \mathbf{h} \mathrm{w}_{UL} \right]$$

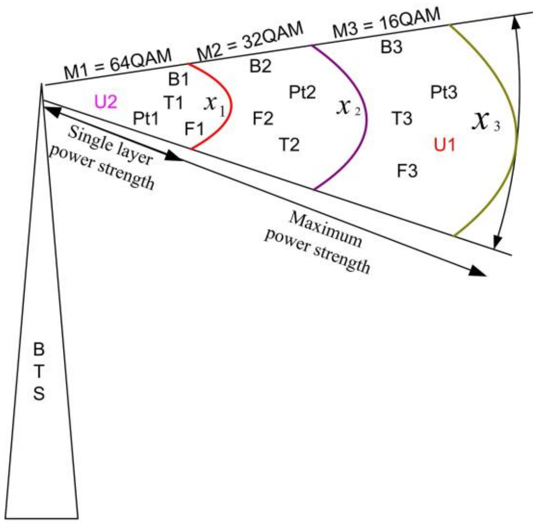

Fig. 3. Single value information gathering

$$\text{s.t.} \left| \mathrm{w}_{ULi} \right| \le \frac{1}{\sqrt{M_{tx}}}, i = 1, \ldots, M_{tx} \quad (26)$$

$$\Re\{(\mathbf{h}\mathrm{w}_{ptUL})^h \mathbf{h}\mathrm{w}_{tUL}\} > 0$$

$$\Im\{(\mathbf{h}\mathrm{w}_{ptUL})^h \mathbf{h}\mathrm{w}_{tUL}\} = 0$$

In case of feedback information mismatch or channel performance degrade, the periodic and orthogonal SVSRS signaling process will upgrade the destructed portion of the downlink beamforming transmission. This SV-SRS value is dispatched to eNodeB through last symbols/resource elements (RE) of each sub-frame, to select the appropriate downlink transmission method at enodeB.

Algorithm

Step 1

a). Eliminate the DMRS information to resource grid

$$\gamma_{u,v}^{(\alpha)}(n) = e^{j\alpha n}\bar{\gamma}_{u,v}(n),$$

b). Allocate the DMRS spare space for user data.

c). Align SRS symbols with DMRS features to form SVSRS

$$\gamma^{SVRS}(n) = \gamma_{u.v}^{(\alpha)}(n)$$

Step 2

a). The SV-SRS carries *x* information, that contains the information about channel characteristics for eNodeB

$$w = x_{(n)} = F_n T_n M_n B_n P_{t_n}, \quad n = 1,2,3,\ldots,m$$

b). Weight forward to enodeB for maximum SNR adjustment

$$w_{t_{UL}} = \begin{cases} \max\limits_{w_{t_{UL}}} [w_{t_{UL}}^{h} \mathbf{h}_{t_{UL}}(1,:)^{h} \mathbf{h}_{t_{UL}}(1,:) w_{t_{UL}}] \\ s.t. w_{t_{UL}}^{h} w_{t_{UL}} = 1 \end{cases}$$

$$w_{t_{ULi}} = \frac{w_{t_{ULi}}}{\sqrt{M_{tx}}\left|w_{t_{ULi}}\right|}, \quad i = 1, 2, \ldots, M_{tx}$$

c). The weight is further processed for downlink beamforming shape

$$w_{UL} = \arg_{w}\max\left[w_{UL}^{h}\mathbf{h}^{h}\mathbf{h}w_{UL}\right]$$

$$\text{s.t. } \left|w_{ULi}\right| \le \frac{1}{\sqrt{M_{tx}}}, i = 1,\ldots, M_{tx}$$

If, Channel performance degrade, the periodic and orthogonal SVSRS signaling process will upgrade the destructed portion of the downlink beamforming transmission.

The existing system throughput and proposed method throughput are articulated below as

The Uplink resource grid consists of 168 units between time and frequency domains as:

12 (subcarriers) × 7 (symbols in one slot) × 2 (slots in one sub-frame) = 168 symbols

In one resource unit, the control overheads are gathered in form of SRS and DM-RS such as

12 <subcarriers> × (2<DM-RS> + 1<SRS>) = 36 symbols

The total number of symbols available for data transmission in existing LTE uplink scheme are 132(168-36). As in some cases, the SRS is considered as an optional feature, and it is turned off to reduce the overheads of uplink data. The total data symbols thus available without SRS option, are 144 (168-24). The proposed methodology enhances the data rate and throughputs through increasing data symbols in the uplink transmission scheme. As our scheme is based on single value-SRS, in which control overheads are dispatched via SV-SRS symbols. Now, the total available symbols for data rate are 156 (168-12) symbols. The advantage of the proposed strategy is to improve the overall throughput within same power consumption, through enhancing data resource elements in sub-frames and also reducing the symbol interference and layer interference issues.

TABLE I: SIMULATION PARAMETERS AND VALUES

Parameters	Values
Number of User Equipments(UEs)	1
System Bandwidth	1.4 MHz
Subcarrier spacing	15 kHz
Sub-frames duration	1 ms
CP length	normal (7)
Channel type	Flat Rayleigh
Receiver types	MMSE and ZF
Simulations Period	5000 subframes
Transmit modes	SU-SISO (1x1) and SU-MISO (2x1)

V. SIMULATION RESULTS AND DISCUSSION

The simulation results of the proposed theme are discussed in this section. The LTE uplink transmission is based on SC-FDMA characteristic along 15 KHz subcarrier spacing, bandwidth 1.4 to 20 MHz, QPSK, 16-QAM & 64-QAM modulation scheme and stumpy PAPR consume less power for subscriber transmission as shown in Fig. 4.

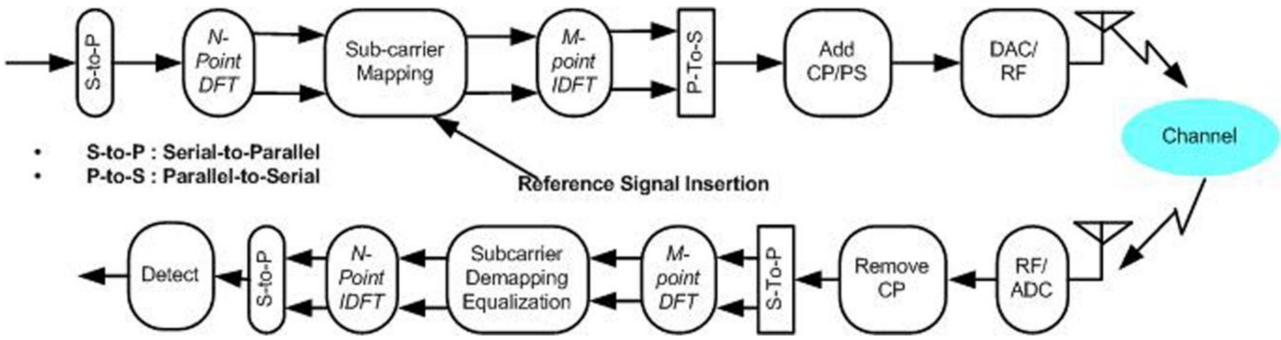

Fig. 4. Transmitter and receiver structure of a SC-FDMA

The comparison of outcomes is divided in two parts: The contribution of the first step is based on the data symbols and reference signal symbols utilization in Tr-Scheme (traditional scheme) and Pr-Scheme (proposed scheme) of LTE uplink transmissions. In the second step, the numerical results are compared on user scenarios, such as SU-SISO (Single User Single input Single output) and SU-MISO (Single User Multi input Single output) of overall BER (Bit Error Rate) and throughput amongst Tr-Scheme and Pr-Scheme of LTE uplink transmission. Simulation parameters are set, as shown in Table. I.

A. Evaluation Step: Data and Reference signal symbols measurements

The total number of received symbols, data symbols and reference signal utilization is driven in results. In the traditional uplink transmission consequence chart, illustrated in Fig. 5, the usage of total number receive symbols is shown; in which the resource elements are used as 39% of data symbols and 11% for RSs (DM-SR and SRS).

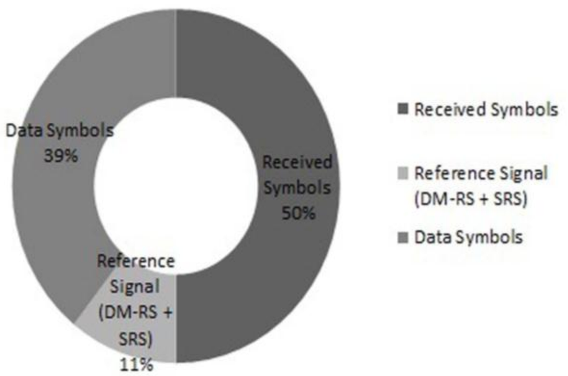

Fig. 5. Tr-Scheme allocation of data symbols and reference signal symbols

The main focus of our proposed strategy is to enhance the LTE uplink data rate with the same energy consumption, through reducing the resource elements of RS. The RS utilization is reduced up to 4% and the data symbols are increased till 46% from total received symbols as demonstrated in Fig. 6. The impact of the decrease in RS and the increase in data symbols enhances the overall LTE uplink transmission data rate.

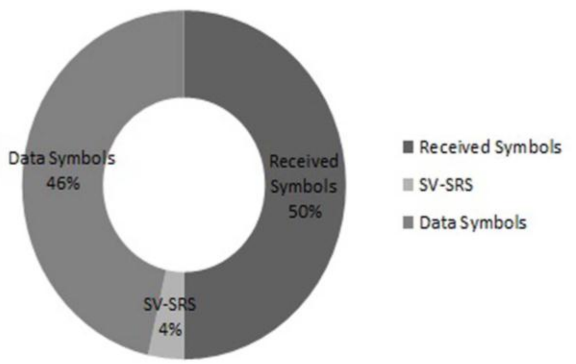

Fig. 6. Pr-Scheme allocation of data symbols and reference signal symbols

B. Assessment Step: dimensions of BER and Throughput of LTE uplink Transmission

The second assessments are further alienated in two scenarios, of SU-SISO and SU-MISO performance of BER and throughput of LTE uplink transmissions with MMSE (Maximum mean square error) and ZF (Zero forcing) data receiving technique.

1) Scenario 1: SU-SISO for BER and throughput with MMSE and ZF

MMSE and ZF receive data processing technique with the BER performance of SU-SISO are shown in Fig. 7. According to the simulation outcomes, the proposed strategy has a better performance of up-to 32% to 35% in both MMSE and ZF respectively, than the traditional uplink transmission scheme.

The throughput based simulation assessments are illustrated in Fig. 8, with MMSE and ZF scheme. The simulation results show that the proposed scheme has better performance, around 15 % to 20%, in both MMSE and ZF correspondingly, than the traditional LTE uplink scheme.

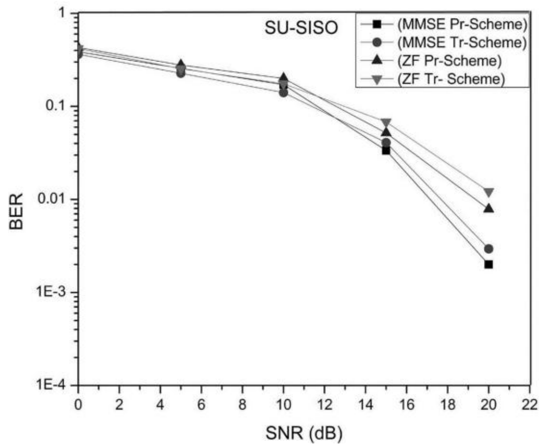

Fig. 7. BER performance of SU-SISO

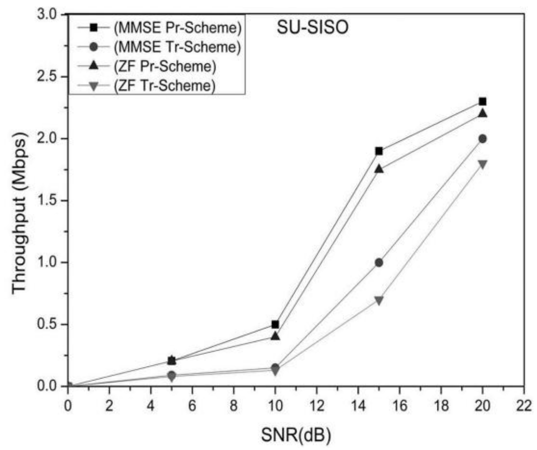

Fig. 8 Throughput performance of SU-SISO

2) Scenario2: SU-MIMO for BER and throughput with MMSE and ZF

In Fig. 9, the BER performance of SU-MISO with MMSE and ZF receiving data processing technique is presented. The simulation results demonstrate that the efficiency of the proposed strategy is from 35% to 38% in both MMSE and ZF correspondingly, than the traditional uplink transmission scheme.

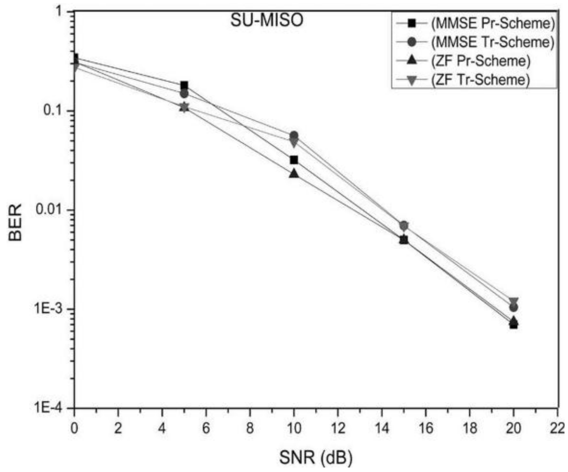

Fig. 9. BER performance of SU-MISO

The throughput based simulation assessments are illustrated in Fig. 10, with MMSE and ZF scheme. The simulation results show that the proposed scheme has a better recital, around 20 % to 25%, in both MMSE and ZF respectively, than the traditional LTE uplink scheme. Further, the patterns of almost all graph patterns for our proposed scheme demonstrate that it has an overall best performance, when compared to the traditional scheme of LTE uplink Transmissions.

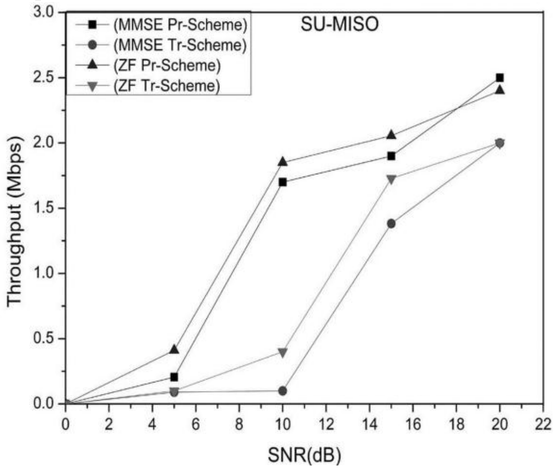

Fig. 10. Throughput performance of SU-MISO

VI. CONCLUSION

The reference signals are used in LTE transmission as pilot symbols for channel state information. The SRS and DM-RS reference signals are used to measure resource allocation, channel behavior, coherent demodulation and also to control information at the eNode-B. In this paper, we propose SV-SRS reference signal and channel estimation of LTE uplink transmission design to assist the LTE downlink beam-forming transmission. The model has the capability to reduce DM-RS overhead and probably of gathering the channel estimation information from SV-SRS. Simulation results in SU-SISO and SU-MISO scenarios show that the proposed strategy outperforms other traditional methods. The reduction of DM-RS overheads is useful to increase the data symbols of LTE uplink transmissions within the same power consumptions, which is effective to increase the throughput and decrease the BER for LTE uplink communication. As a future work, an extensive research can be carried out on SIMO and MIMO scheme.

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