Complex Pairing Access Based on Network Coding with Interference Suppression

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CONTENT

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- Turbo multiple access interference Reducing approach based on network coding
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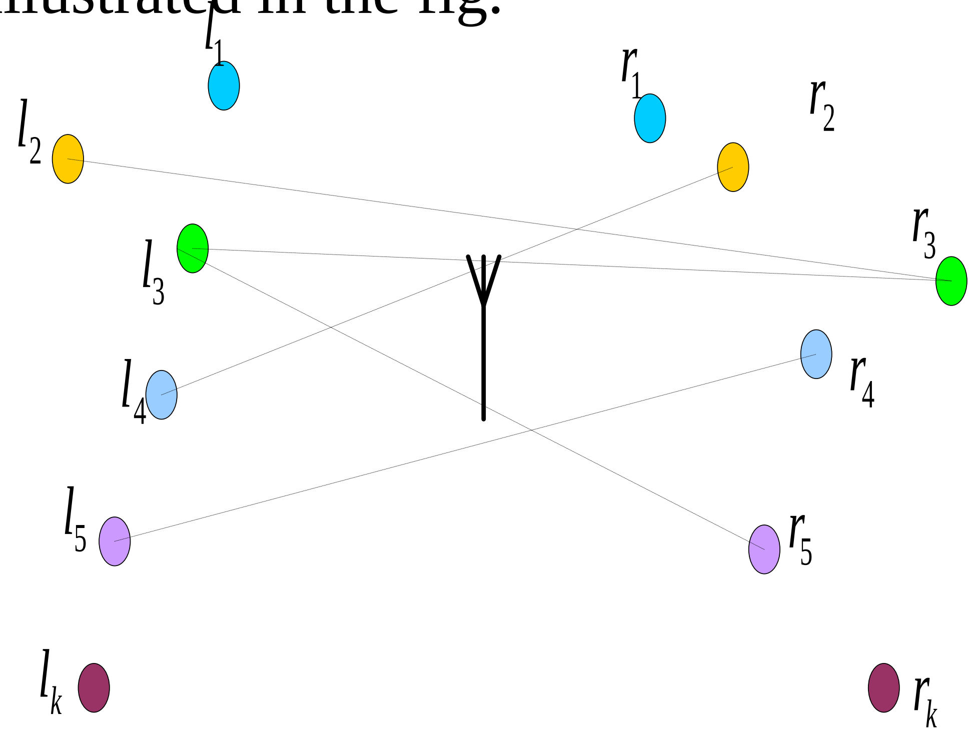
I. System Model of Complex Pairing Access

System Model:

The complex Pairing Access based on network coding mode is illustrated in the fig.



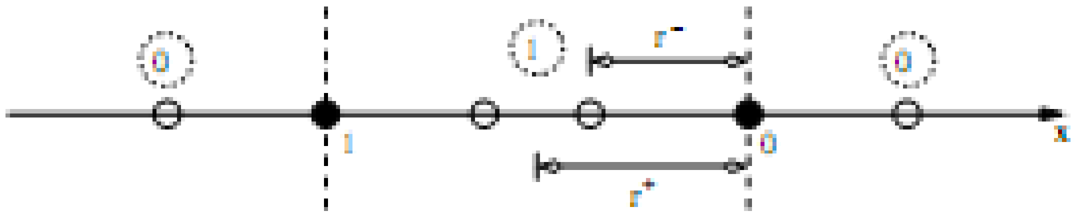
1.The whole information exchanging is completed in two time-slots:All paired users transmit their signals to the relay in time-slot 1, and the relay broadcasts the processed signals in time-slot 2.

2.The working form on relay is decoding-forwarding which is detailed following.

Decoding scheme at TWR

In time-slot 1:for simplicity, we assume all the user taking BPSK modulation and the multiple access scheme is CDMA. Specially one spreading code is allocated to one pair of users exchanging information with each other. so the one received by relay is their superposing form expressed as:

$$g_{up} = \left(\sqrt{\alpha_i p_{l_i}}\, l_i + \sqrt{\alpha_j p_{r_j}}\, r_j\right) c_{ij} + n_0 \quad (c_{ij} \neq 0)$$



From the diagram, we can observe the corresponding decision region in AWGN channel

Under fading channel, considering the instant channel coefficients, we have the decision region as:

$$\begin{cases} \text{the same bit polar}: d_{i'j'} = 1, & \text{when}: -I^{th} < m_{i'j'} < I^{th} \\ \text{the opposite bit polar}: d_{i'j'} = -1, & \text{when: others} \end{cases}$$

$$I^{th} = \max\left(\left|\sqrt{\alpha_{i'} p_{l_{i'}}} l_{i'}\right|, \left|\sqrt{\alpha_{j'} p_{r_{j'}}} r_{j'}\right|\right)$$

In time-slot 2, the decision result is broadcasted to the pairof users, then they can know the desired signal through comparing with its own signal

Communication scheme for multiplex pairing access based on network coding

	r_1	r_2	r_3	r_4	r_5	r_k
l_1	0	0	0	0	0	0
l_2	0	0	1	0	0	0
l_3	0	0	1	0	1	0
l_4	0	1	0	0	0	0
l_5	0	0	0	1	0	0
l_k	0	0	0	0	0	0

	r_1	r_2	r_3	r_4	r_5	r_k
l_1	0	0	0	0	0	0
l_2	0	0	C_{23}	0	0	0
l_3	0	0	C_{33}	0	C_{35}	0
l_4	0	C_{42}	0	0	0	0
l_5	0	0	0	C_{54}	0	0
l_k	0	0	0	0	0	0

For clarity, we introduce matrix for registration:
Left users is represented by the rows and the right ones by columns.
So the superposing signals, after despreaded with the corresponding spreading codes, are:

$$
\begin{cases}
m_{i'j'} = \dfrac{g_{up} c_{i'j'}^T}{L_c} = \dfrac{\sum_{i=1}^{m}\sum_{j=1}^{n}\left(\sqrt{\alpha_i p_{l_i}}\, l_i + \sqrt{\alpha_j p_{r_j}}\, r_j\right) c_{i'j'}^T c_{ij} + c_{i'j'}^T \mathbf{n_0}}{L_c} = \left(\sqrt{\alpha_{i'} p_{l_{i'}}}\, l_{i'} + \sqrt{\alpha_{j'} p_{r_{j'}}}\, r_{j'}\right) + \inf + \mathbf{n_0} \\
\inf = \dfrac{\sum_{i=1}^{m}\sum_{j=1}^{n}\left(\sqrt{\alpha_i p_{l_i}}\, l_i + \sqrt{\alpha_j p_{r_j}}\, r_j\right) c_{i'j'}^T c_{ij}}{L_c} \qquad (c_{ij} \neq c_{i'j'})
\end{cases}
$$

Interference reducing on the relay

The decision results, after despreading by relay, are broadcasted then. However the interference, which has been shown in the previous expression, can be reduced before decoding decision.

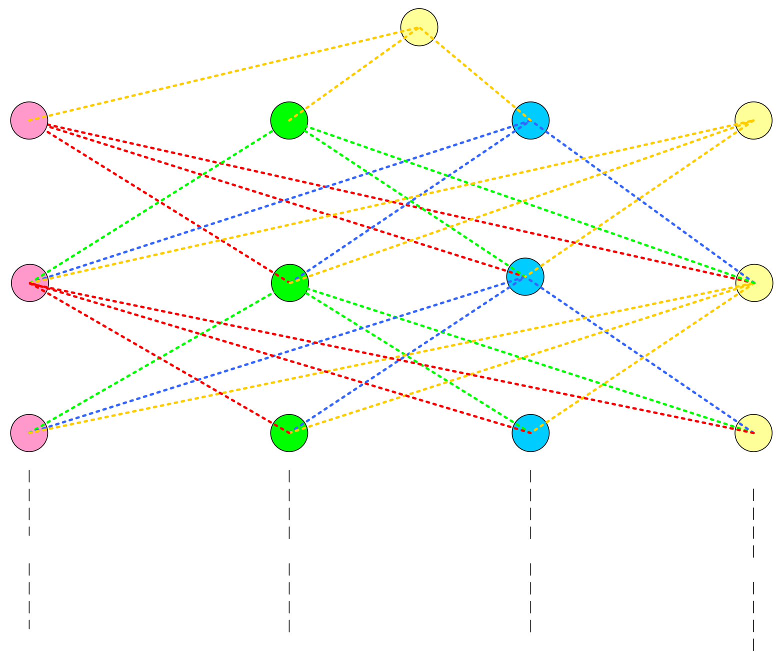
As we know, in this system, the interference is due to the quasi orthogonality of spreading codes. And the corresponding interference to the pair of users taking c_{ij} can be expressed as :

$$-\frac{\sum_{i=1}^{m}\sum_{j=1}^{n}\left(\sqrt{\alpha_i p_{l_i}}\, l_i + \sqrt{\alpha_j p_{r_j}}\, r_j\right)\ c_{i'j'}^{T} c_{ij}}{L_c} \quad \left(c_{ij} \neq c_{i'j'}\right)$$

After interfere reducing, the signal is theoretically expressed as:

$$\frac{\mathbf{g}_{up}\mathbf{c}_{ij}^{T}}{L_c} - \frac{\sum_{c_{vw}\neq c_{ij}}\left(\sqrt{\alpha_v p_{l_v}}\,\mathbf{l}_v + \sqrt{\alpha_w p_{r_w}}\,\mathbf{r}_w\right)\mathbf{c}_{ij}^{T}\mathbf{c}_{vw}}{L_c}$$
$$= \sqrt{\alpha_i p_{l_i}}\,\mathbf{l}_i + \sqrt{\alpha_j p_{r_j}}\,\mathbf{r}_j + \mathbf{n}_0$$

Unfortunately, the term $\left(\sqrt{\alpha_v p_{l_v}}\,\mathbf{l}_v + \sqrt{\alpha_w p_{r_w}}\,\mathbf{r}_w\right)$ also is interfered. So we should first get pure $\left(\sqrt{\alpha_v p_{l_v}}\,\mathbf{l}_v + \sqrt{\alpha_w p_{r_w}}\,\mathbf{r}_w\right)$ that is also solved by this interference reducing schedule. So the interfere process is a iterative procedure, which can be explained through the diagram:



Beyond all questions, the interference can also be compatible with the receivers in time-slot 2 for broadcasted signals.

Conclusion

We design a efficient interference reducing scheme against MAI of CDMA due to the network coding. Here opening all the spreading codes to every user is safe because the receiver need its own information to decode the desired information. That would make our reducing operation more accurately.

And so we introduce the MAI reducing scheme of turbo mode. That means we can operate the process iteratively to get a satisfactory result.

Of course the performance will not have obvious improvement after certain loops just like turbo decoding.

Thank you