

An Efficient Relaying Scheme for Multiple Users in Spectral Efficient Cooperative Networks

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Introduction

- **User cooperation is an efficient way to exploit the benefits of multiple antenna systems in wireless communication systems.**
 - Spatial diversity gain, Higher bit-rates
- The Relay forwards the Source's overheard signal to "act" as a new antenna.
- The Forwarding strategy of the Relay affects the performance of the cooperation significantly.
- In this work, a new forwarding strategy based on the existing schemes is developed.
- The new scheme can be applied to multiple relays and used with higher order modulations. The removal of feedback necessity makes the scheme easily applicable to practical systems.

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Existing Schemes: AF and CC

- **Amplify and Forward [1]:** $\frac{S \rightarrow D}{N \text{ bits}} + \frac{R \rightarrow D}{N \text{ bits}}$ $\frac{T}{2} + \frac{T}{2}$

$x_R(t) = \beta x_S(t-T/2)$ $x_S(t)$: Source signal β : Amplification constant

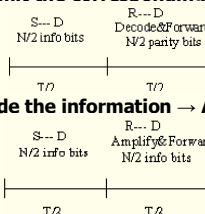
$\frac{S \rightarrow D}{N/2 \text{ info bits}} + \frac{R \rightarrow D}{N/2 \text{ parity bits}}$ $\frac{S \rightarrow D}{N/2 \text{ info bits}} + \frac{R \rightarrow D}{N/2 \text{ parity bits}}$
- **Coded Cooperation [2], [3]:**
 - Relay decodes the source's info bits and sends the parity bits only.
 - If it cannot decode, sends feedback to the Source, and Source transmits in the second half, too.

	BENEFITS	DRAWBACKS
AF	<ul style="list-style-type: none"> Always two-level of diversity is achieved (For one relay case) Low Complexity, more flexible to synchronization constraints No feedback requirement 	<ul style="list-style-type: none"> Relay also amplifies the interuser channel noise. Destination receives the simple repetition coding.
CC	<ul style="list-style-type: none"> Relay forwards the exact source information. Various coding schemes can be applied. Best performance among all forwarding strategies. 	<ul style="list-style-type: none"> Feedback is required between Relay and Source. High complexity.

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New Scheme: Hybrid Decode&Forward

- **Intuition:** Combine the benefits of AF and CC to obtain an efficient user cooperation scheme.
 - No feedback requirement
 - At least the same error performance as the best scheme among the existing ones: Coded Cooperation
 - More flexible synchronization constraints : Should be possible to apply more than 1 relay cooperative networks.
- **How it works:** Relay tries to decode the source's information correctly:
 - If it can → Transmit the corresponding bit (either parity or info. bits)
 - If it cannot decode the information → Amplify the received signal.



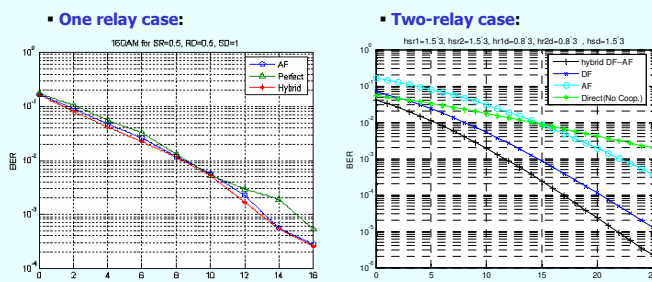
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Coded System Example:

- **Coded System:** Rate 1/4 Convolutional Code [15,17,13,15]
- **Direct Transmission:** 1 info. Bit (Source) → [15,17,13,15] → 4 coded bits $\frac{M\text{-ary Mod.}}{T}$
- **Hybrid DF:** 1 info. Bit (S) → [15,17] → 2 coded bits $\frac{M\text{-ary Mod.}}{T/2}$ (S→D, S→R)
- **If R decodes:** R → [13,15] → 2 coded bits $\frac{M\text{-ary Mod.}}{T/2}$ (S→R)
- **If R cannot decode:** Amplify → [15,17] → 2 coded bits $\frac{M\text{-ary Mod.}}{T/2}$ (R→D)

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Simulation Results



- Each user transmit 16 QAM symbols
- Packet size: 512 bits
- Interleaver size: 32*32

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Conclusion and Future Work

- The proposed scheme, Hybrid-DF, outperforms existing schemes especially for bad source-relay channels.
- The feedback necessity between the cooperating terminals is removed. Additional relays can easily join the cooperative network.
- Higher-order modulation techniques can be used with Hybrid-DF scheme. For spectral efficient systems, Hybrid-DF provides substantial gains to the existing schemes.
- The performance comparisons the schemes will be done for the fast fading channels.
- For better error performance in high spectral efficient systems, TCM based cooperation will be investigated.

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[1] J. N. Laneman, D. N. C. Tse and G. W. Wornell, "Cooperative Diversity in Wireless Networks: Efficient Protocols and Outage Behaviour." IEEE Trans. Inform. Theory, vol. 50, no. 12, Dec. 2004
 [2] A. Stefanov and E. Erkip, "Cooperative coding for wireless networks." IEEE Transactions on Communications, vol. 52, no. 9, pp. 1470-1476, September 2004.
 [3] T. E. Hunter and A.Nosratinia, "Cooperative diversity through coding," in Proc. IEEE Int. Symp. Inform. Theory, Lausanne, Switzerland, 2002, p.220