

Comments on Throughput Comparison for 16m Relay Frame Structure Options

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Venue:

SDD, in response to Call for Comments/Contributions (IEEE 802.16 #57 Kobe, Japan)

Re:

IEEE 802.16m-08/033: Call for Contributions and Comments on Project 802.16m System Description Document (SDD), Target topic: “SDD Session 56 Cleanup, Call for PHY details”.

Base Contribution:

C80216m-08_1058r1.pdf (Intel)

Purpose:

For discussion about the above mentioned contribution on throughput comparison of Relay Frame Structure options in 16m SDD

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Comments on Throughput Comparison for 16m Relay Frame Structure Options

LG Electronics

Outline

- Throughput, in terms of what?
 - A single-hop network and a multi-hop network have different meaning of “throughput” in terms of the actual average throughput the users can experience.
 - A tree network and a mesh network have different level of asymmetry between UL and DL.
 - In tree networks, each node (e.g., RS) still has the traffic asymmetry that the two end nodes (e.g., BS and MS) have.
 - As far as the asymmetry comes, the throughput in nature has an important bottleneck, which needs to be considered to examine the throughput performance of a given FS.
 - Related contribution(s): C80216m-08_1058r1.pdf (Intel)

Adaptation Capability for Traffic Asymmetry (1/2)

- Asymmetry b/w Traffic Volume Demands in UL and DL
- Why is “Adaptation Capability” important?
 - Traffic asymmetry between UL and DL is an inherent characteristic of a tree network (whether multihop or not).
 - With a limited number of subframes in a single radio frame for DL-A, DL-R, UL-A, and UL-R zones, the actually experienced level of throughput is completely upper-bounded by the one (either UL or DL) that is saturated first.
 - This is the same problem even when both UL and DL are saturated/overloaded because the utility (value of resource utilization) still falls into a non-optimal situation.

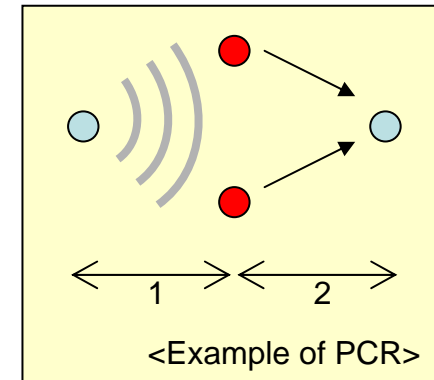
Adaptation Capability for Traffic Asymmetry (2/2)

- Comparison
 - Option 1:
 - No substantial adaptation capability but changing the number of subframes for each zone
 - Option 2:
 - Better adaptation capability through bidirectional zones

Capability of Cooperative Diversity (1/4)

- Parallel Cooperative Relaying (PCR)

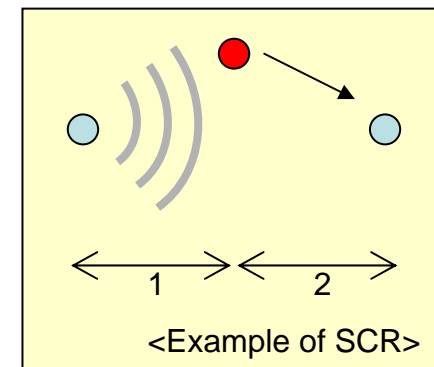
- min. # (required) RS's = 2
- What if # RS's <2, no PCR gain
 - In Option 1, no SCR gain, either
- Probability perspective:



- $\Pr\{\# \text{ RS's } \geq 2\} = 1 - \Pr\{\# \text{ RS's } = 1\} - \Pr\{\# \text{ RS's } = 0\}$
- Example (Poisson): $\Pr\{PCR\} = 1 - \exp(-\lambda) - \lambda \exp(-\lambda)$

- Single Cooperative Relaying (SCR)

- min. # (required) RS's = 1
- What if # RS's <2, still SCR gain (if ≥ 1)
- Probability perspective:



- $\Pr\{\# \text{ RS's } \geq 1\} = 1 - \Pr\{\# \text{ RS's } = 0\}$
- Example (Poisson): $\Pr\{SCR\} = 1 - \exp(-\lambda)$
 $= \Pr\{PCR\} + \lambda \exp(-\lambda)$

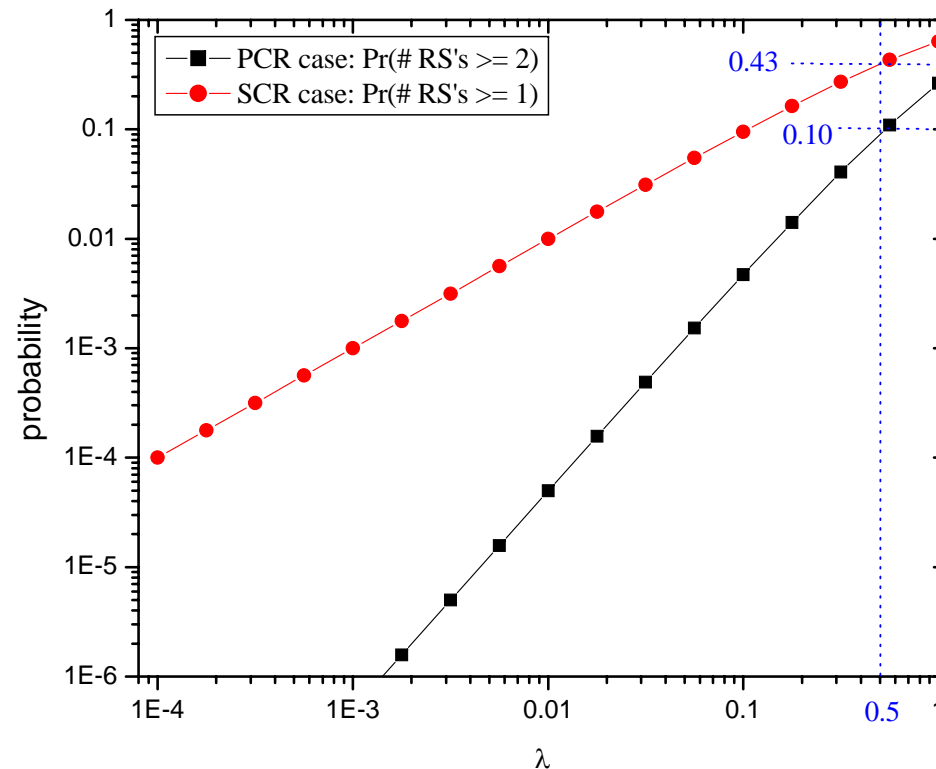
Capability of Cooperative Diversity (2/4)

- Comparison of Probability
 - Probability for having min. # required RS(s): for PCR (>1), for SCR (>0)
 - Option 1: PCR gain with low probability, no SCR gain at all times
 - The even-numbered are transmitting while the odd-numbered are receiving: grandparent cannot hear grandchild (both in Tx)
 - Option 2: PCR gain with low probability, SCR gains with higher probability

# RS's that can hear from MS	Option 1	Option 2
0	No PCR gain No SCR gain	No PCR gain No SCR gain
1	No PCR gain No SCR gain	No PCR gain with SCR gain
2 or more	possible PCR gain No SCR gain	possible PCR gain with SCR gain

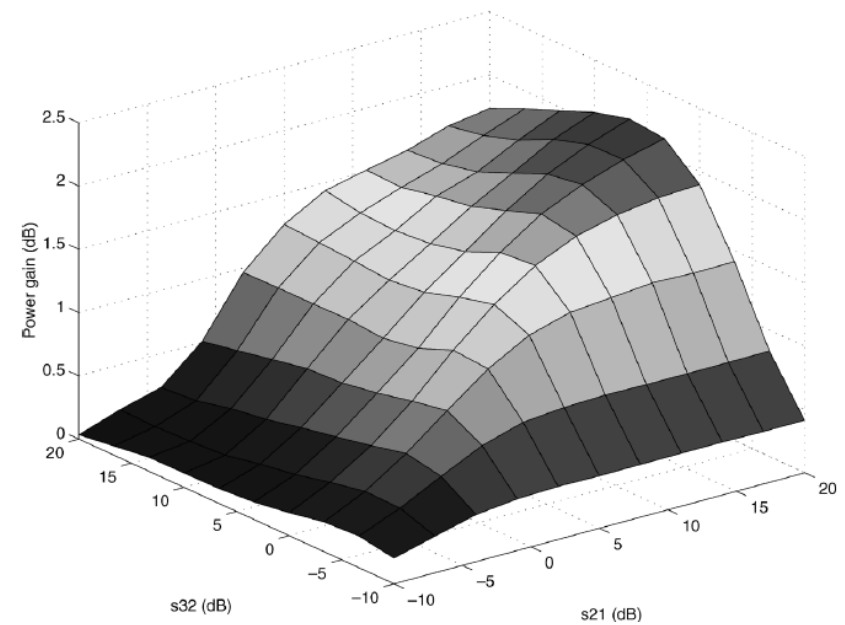
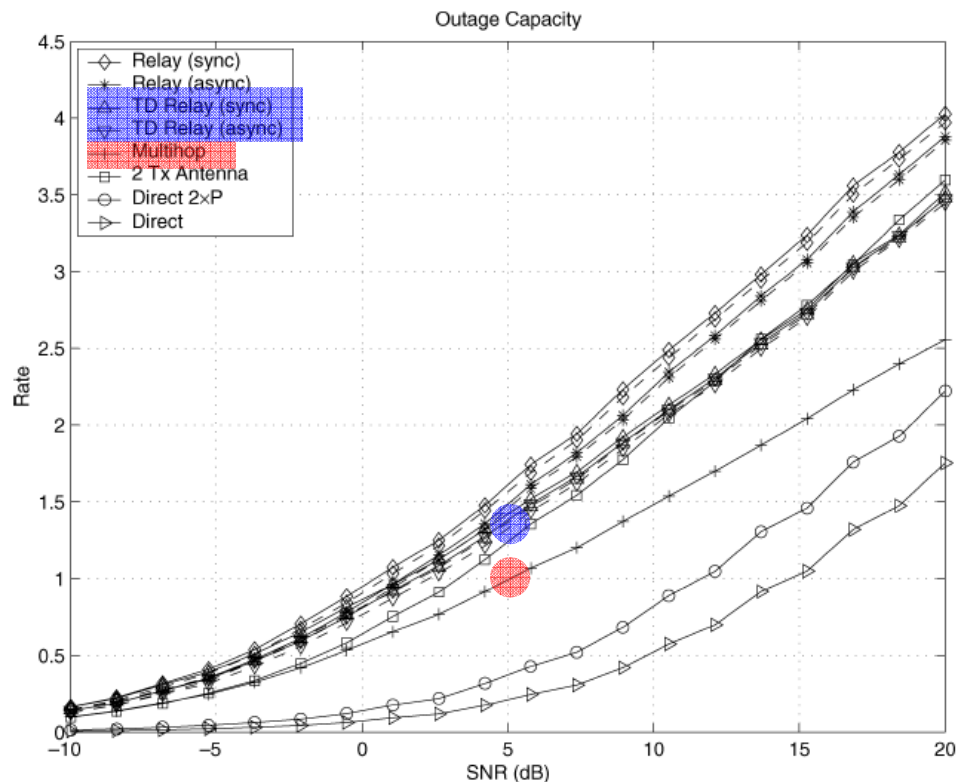
Capability of Cooperative Diversity (3/4)

- Toy example for Probability Comparison: PCR and SCR cases
 - Setup:
 - BS coverage radius: 2km; RS coverage radius: 0.5km
 - # RS's in BS coverage area (near cell boundary): 8
 - Binomial approximation ($N=8, p=1/16$); Poisson approximation ($\lambda=N*p=1/2$)
 - Result:



Capability of Cooperative Diversity (4/4)

- How much is SCR gain?
 - 30% in rate; 1.2dB in power



<Source: "Capacity Bounds and Power Allocation for Wireless Relay Channels," *IEEE Trans Info. Theory*, Vol. 51, No. 6, June 2005>

Comparison: Different Types of Cooperative Relaying (CR) in Option 1 and Option 2

- PCR: (not always possible for both UL and DL in both Options)
 - (to achieve PCR gain, two parallel RS's must be able to decode)
 - if parent schedules, it requires significant control signaling overhead b/w two parallel RS's for synchronized resource assignment (in both UL and DL);
 - if grandparent schedules, no extra overhead
- DL SCR: (possible in both Options but requires more control overhead than UL SCR)
 - if grandparent schedules, the MS must know where grandparent and parent will send (extra overhead: need to know where to hear from grandparent)
 - if parent schedules, the MS must know where grandparent and parent will send (extra overhead: where to hear from grandparent)
- UL SCR: (not possible in Option 1)
 - when parent signals resource assignment to MS, grandparent can also hear without additional signaling overhead
- Summary:
 - For UL CR, only Option 2 with SCR is feasible