Cooperative relaying system

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Information

Cooperative relaying system

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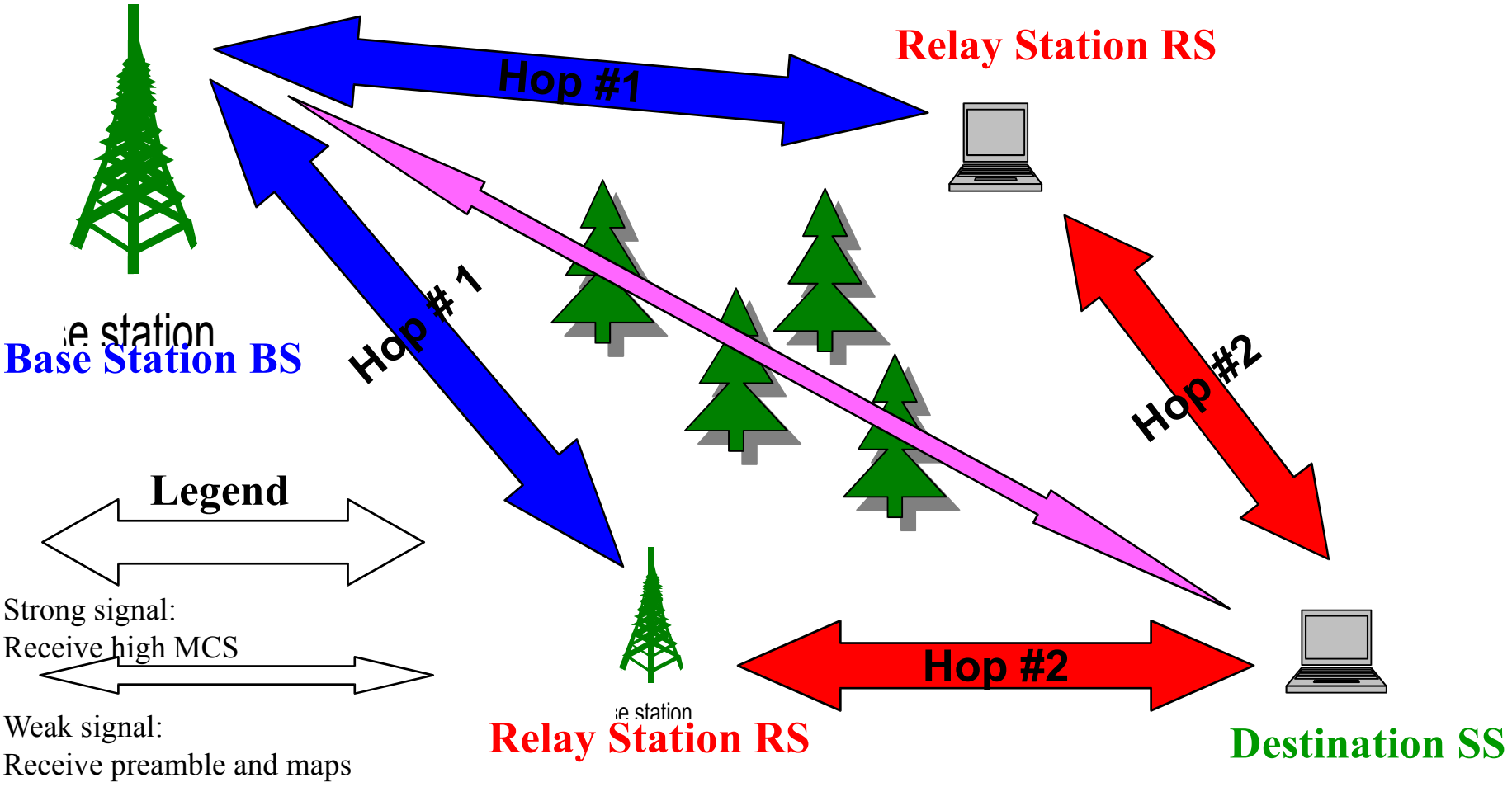
Cooperative relaying accelerates 802.16 networks

- Communication performance breakthrough
- Longer battery lifetime
- Quick implementation
- Low cost solution

Cooperative relaying characteristics

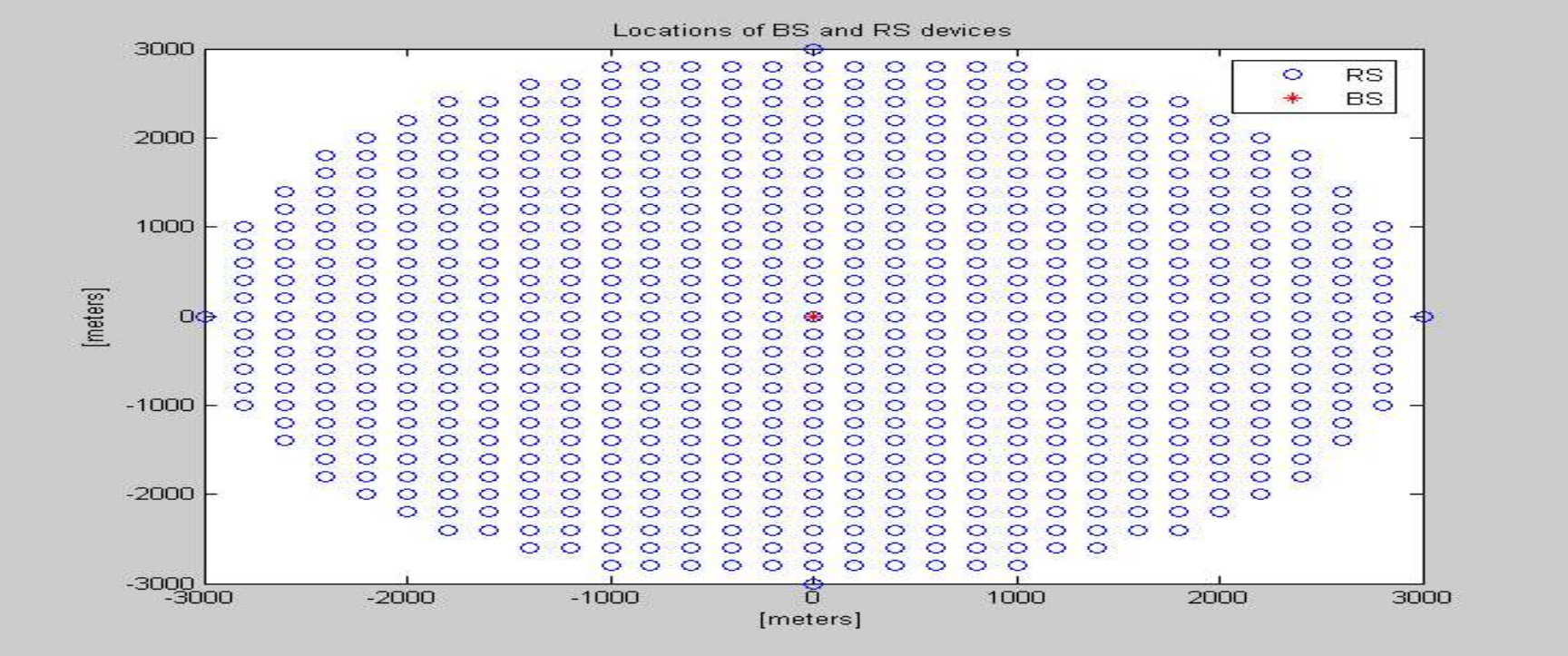
- Relaying stations forward received physical layer information towards the destination
- Multiple synchronized transmissions from spatially distributed relaying stations on the uplink or downlink
- Known to combat effectively wireless channel conditions

Example: two RS serving a SS with 2-hop relaying



Performance breakthrough illustration

- Infrastructure relay stations in a 3km radius cell
- Deployment of relays is 200m grid at 3 meter above roof tops
- Pedestrian speed indoor: 2.5Ghz model from ITU-R
- Uplink performance is examined



Channel model

•Pedestrian speed indoor model for 2.5 GHz

Transmit power	**20dBm**
Noise power	-174dBm/Hz + 10log10(240e3) + NF = -174+54+6 **= -114dBm**
Shadowing [dB]	~N(0,8)
Building Penetration [dB]	~N(10,8) for BS and 0 for RS
Fast fading taps [dB]	ChanA:[0, -9.7, -19.2, -22.8 -100 -100] ChanB:[0 -0.9 -4.9 -8.0, -7.8 -23.9]
Path loss [dB]	40*(1-4e-3*h)*log10(R) - 18*log10(h) + 80 + 21*log10(f)

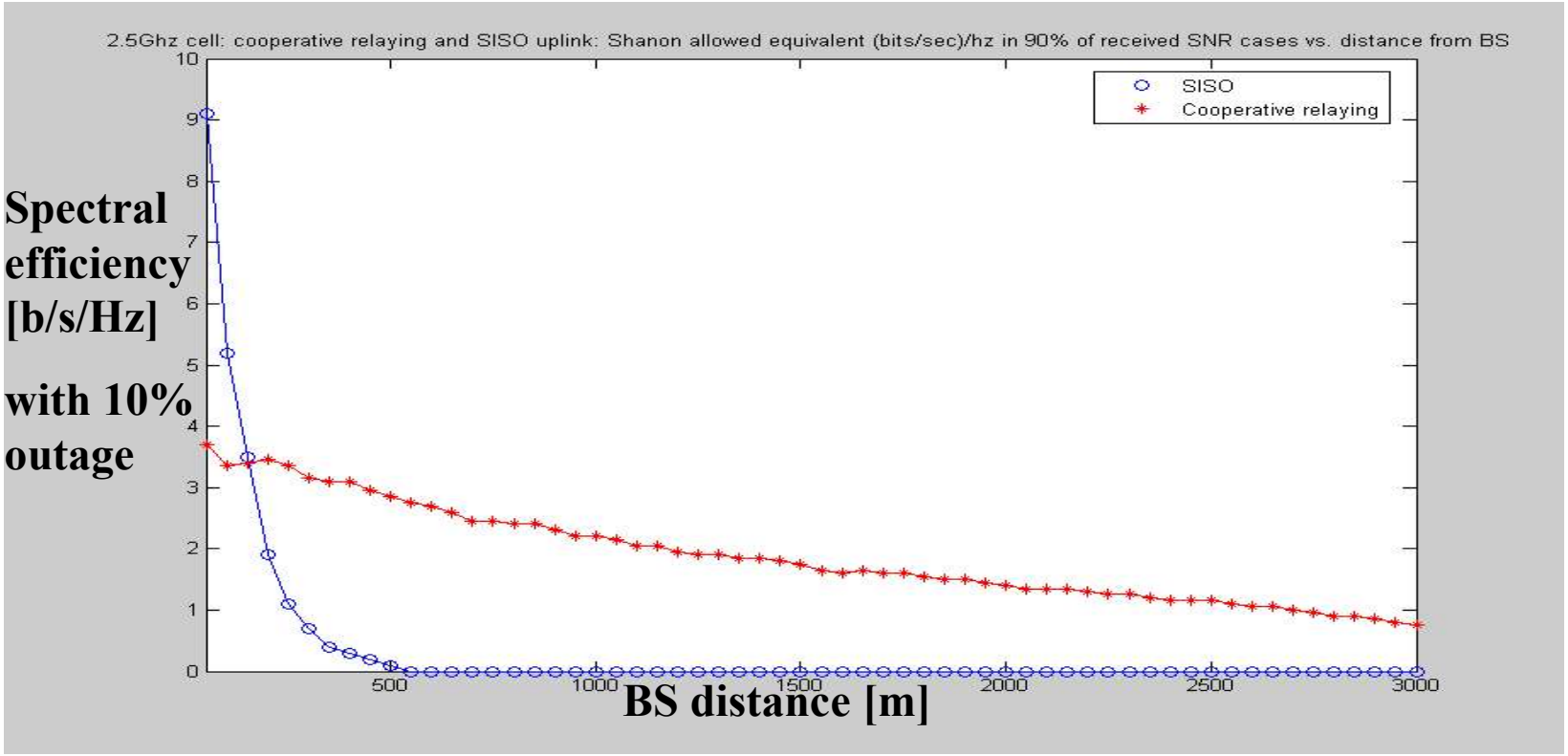
h = Height above roof top of BS and of RS in meters, BS=15 and RS=3

f = carrier frequency (MHz), 2500 used

R = distance between BS and mobile (km)

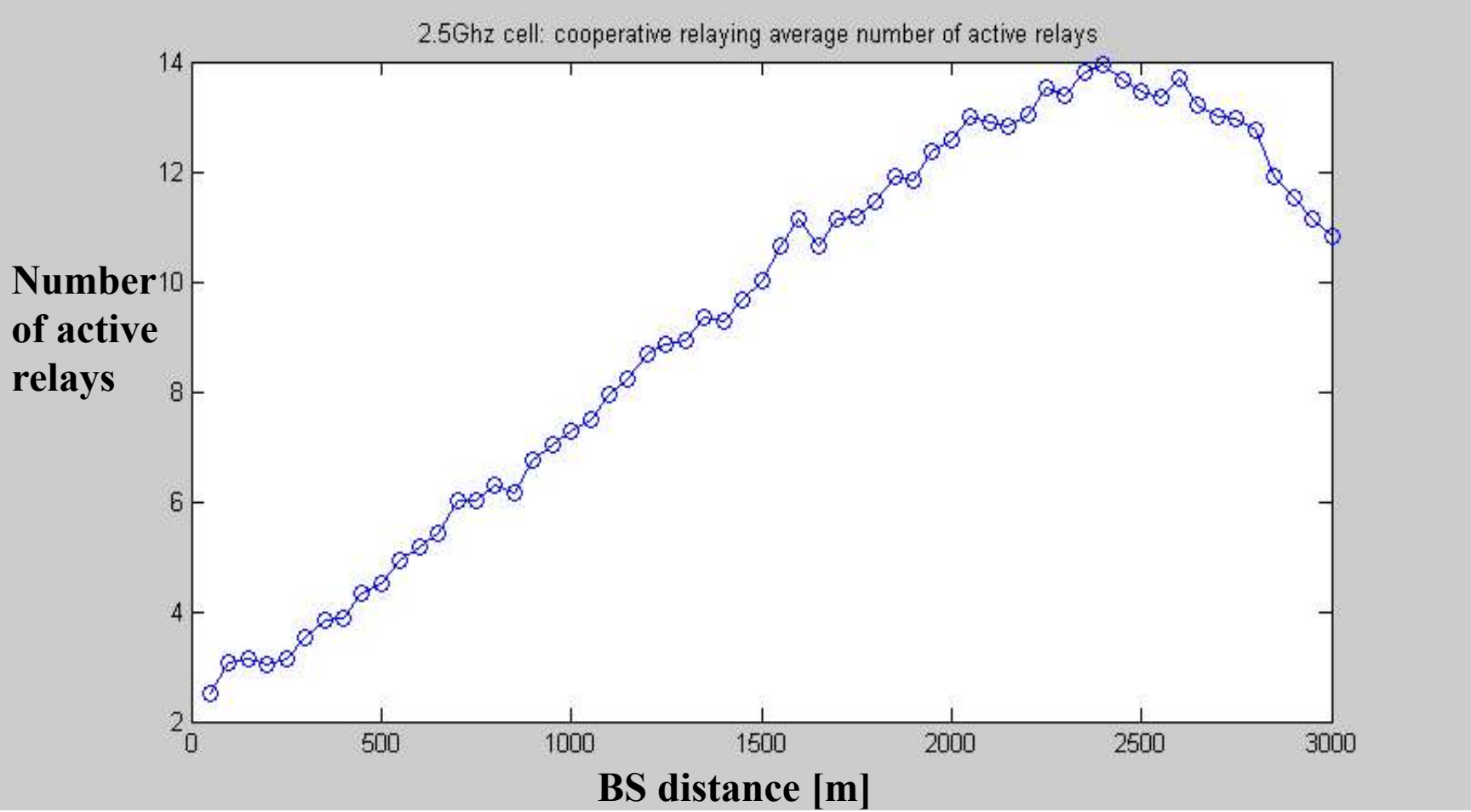
Performance : increase in spectral efficiency

- Performance metric: Shannon capacity at 10% outage
- Two-hop relaying with same rate supported on both hops
- Compare direct rate and relayed rate [b/s/Hz] vs. BS distance [m]



Performance : average number of active relays

- Average amount of active relays vs. BS distance



Cooperative relaying – cost effectiveness

- Relay stations are low cost
  - No MAC functions are required
  - Transmitted power as of regular subscribers
- Subscriber cost unchanged
- Increased cell size
  - Quantities of relay stations can be used
- Allows low cost 5-6Ghz frequency networks
  - More relays should be deployed

Suggested cooperative relaying mechanism

- Decode-and-forward at the relaying stations according to reception reliability (e.g. CRC)
- The BS schedules relaying transmissions
- Dedicated uplink and downlink zones
- The relaying stations may be SS with relaying capability or dedicated relay stations

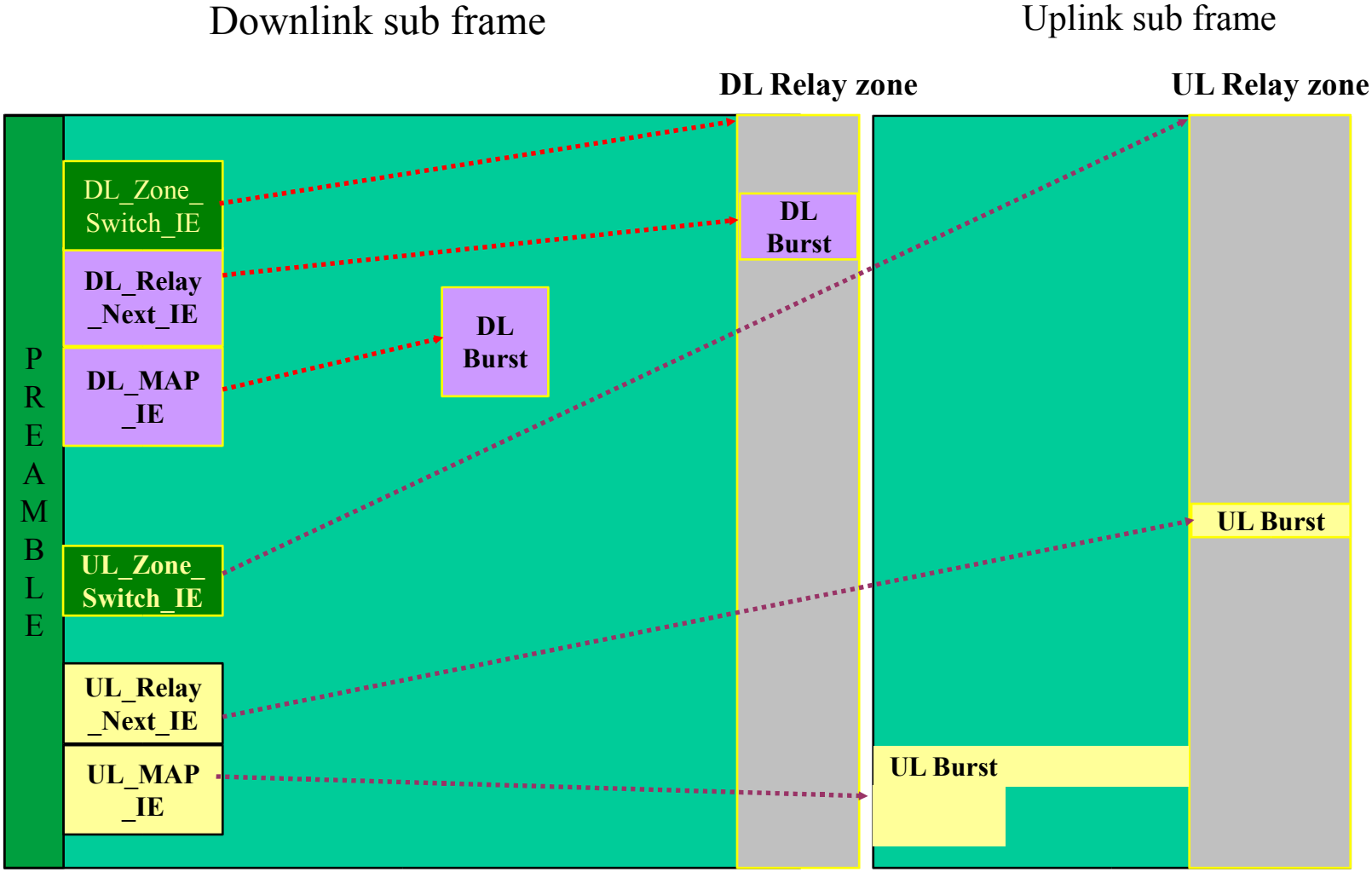
Suggested cooperative relaying implementation

- Backwards compatible
- Several new information elements
- Data bursts relaying
  - Extended throughput with higher modulation-coding schemes
  - Sufficient for SS that can communicate maps and initial ranging directly with the BS
- Preamble, maps and initial ranging relaying
  - Required for extended range and coverage

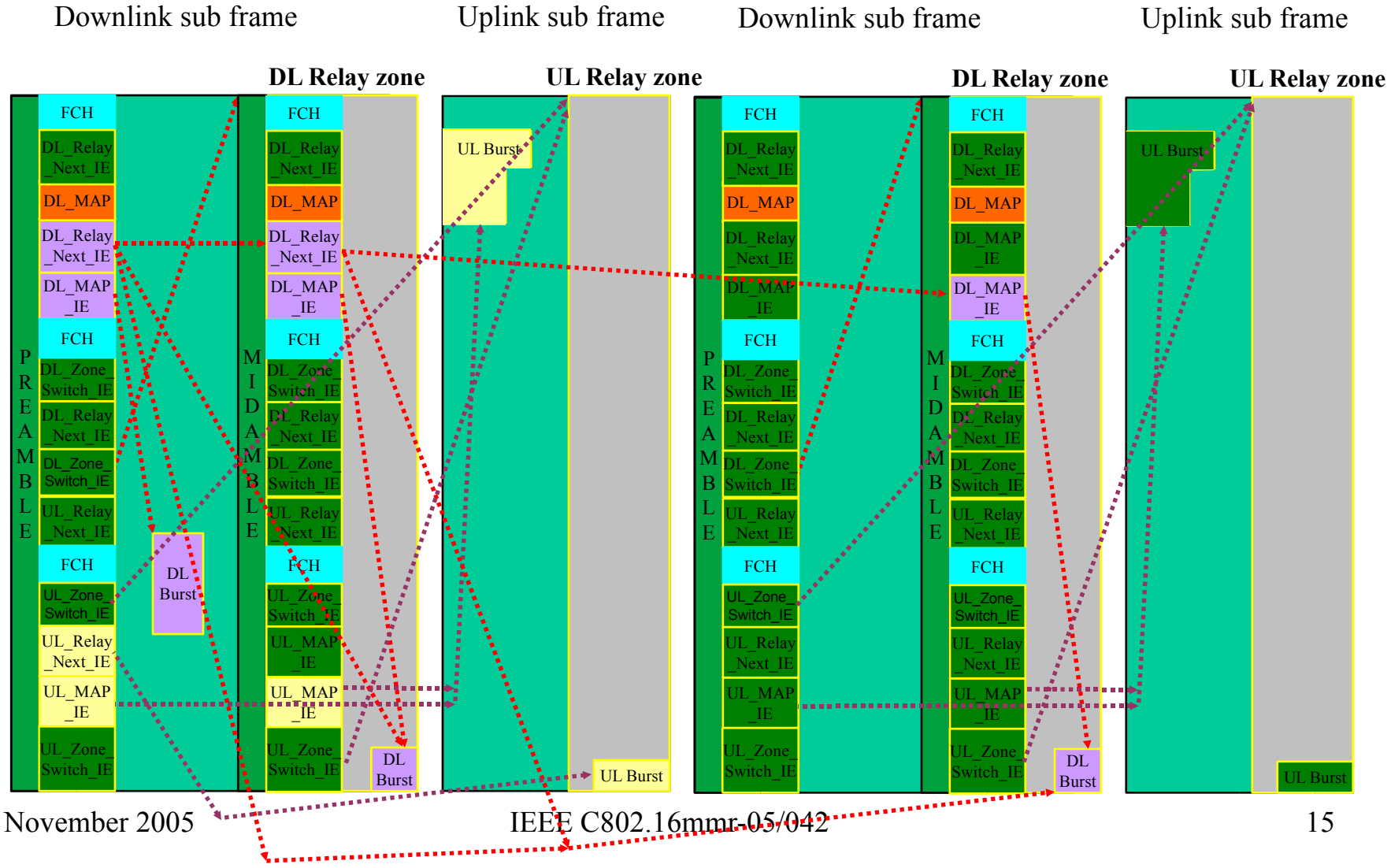
Information elements for cooperative relaying

- Indicating bursts to be relayed
- Relaying allocations and conditions
- Source and destination of the burst
- Relaying transmission characteristics
- Provisioning for diverse algorithms of multi-hop relaying scheduling
- Provisioning for virtual MIMO

Example of only data bursts relaying



Example of preamble, maps and data relaying



Considerations

- Inter-cell Interference
  - Conditioning downlink relaying by proximity to destination strongly decreases Inter-cell Interference
- Inter Symbol Interference from the spatially diverse relaying stations
  - Cooperating relays are close and relaying transmissions power is low and controlled.
- Limitations on deployment of relay stations
  - Relays transmission power may be similar to SS's.

The bottom line: "Cooperative relaying ASAP, improvements later"

- Quick and low cost usage of cooperative relaying is crucial and achievable
- Allows breakthrough in 802.16 networks
- Accelerated market penetration
- Provisioning diverse future algorithms without waiting for them

BACKUP

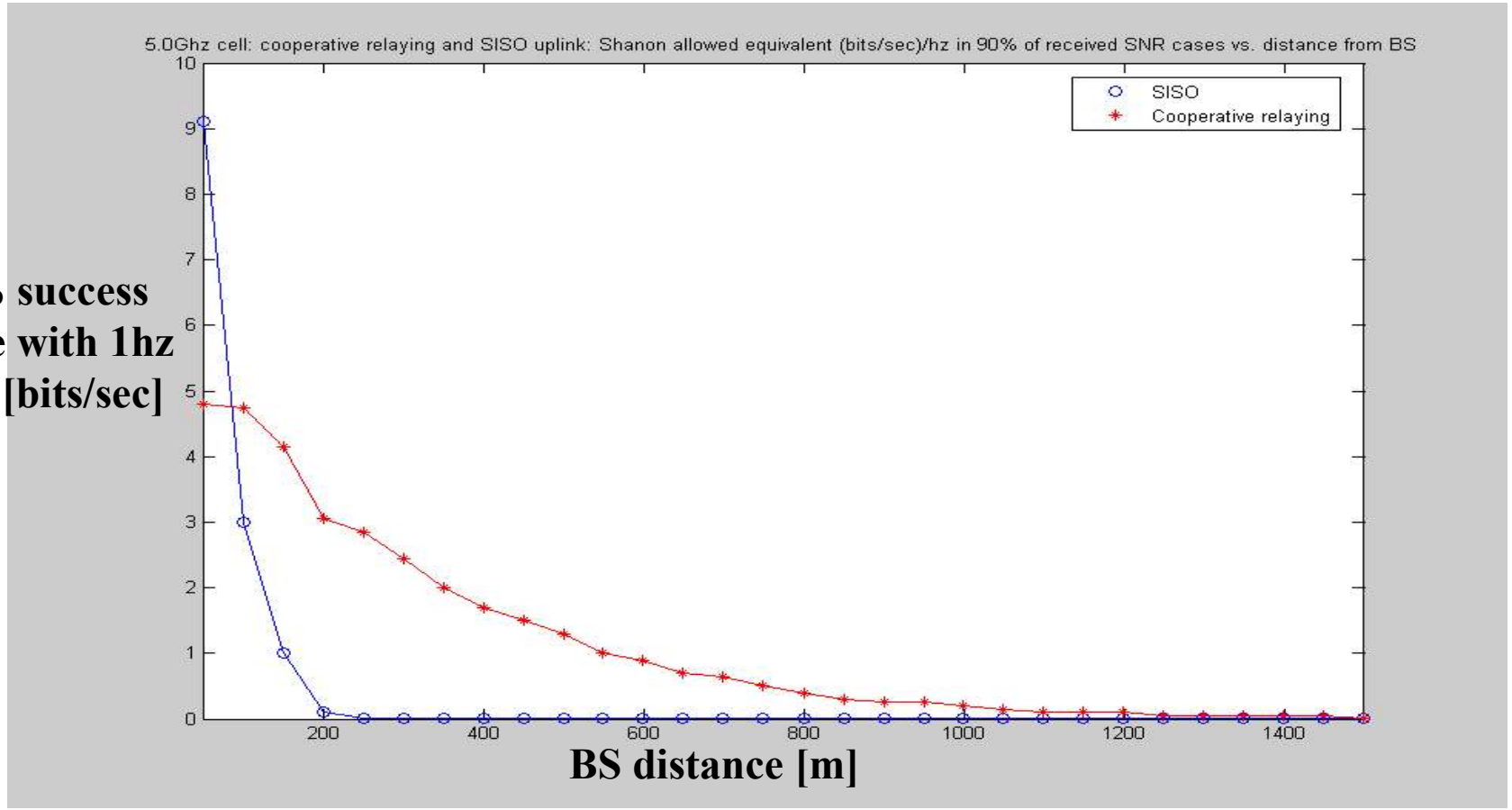
Reference: channel model

- Pedestrian speed indoor model at 5GHz
  - From:"IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 20, NO. 3, APRIL 2002 507, Propagation Characteristics for Wideband Outdoor Mobile Communications at 5.3 GHz,Xiongwen Zhao, Jarmo Kivinen, Pertti Vainikainen, Member, IEEE, and Kari Skog"

Transmitted power	**20dBm**
Noise power Bandwidth = 240kHz	-174dBm/Hz+10log10(240e3)+NF= -174+54+6**=-114dBm**
Shadowing [dB]	~N(0,4)
Building Penetration [dB]	~N(16,8)
Fast fading taps [dB]	ChanA:[0, -9.7, -19.2, -22.8 -100 -100] ChanB:[0 -0.9 -4.9 -8.0, -7.8 -23.9]
Path loss [dB]	58*log10(R)-16.9

Performance : 5 GHz

- Direct and relayed rate [bits/sec] with 1hz BW vs. BS distance [m]
  - –Relayed value is half of original and relayed rate
- Rates in graph allow 90% success ratio with Shanon limited receiver



Performance : 5 GHz

- Average amount of active relays vs. BS distance