A usage scenario and frame structure for out-of-band relay

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Purpose:
. Some correction for our base contribution

A usage scenario and frame structure for out-of-band relay in IEEE 802.16j

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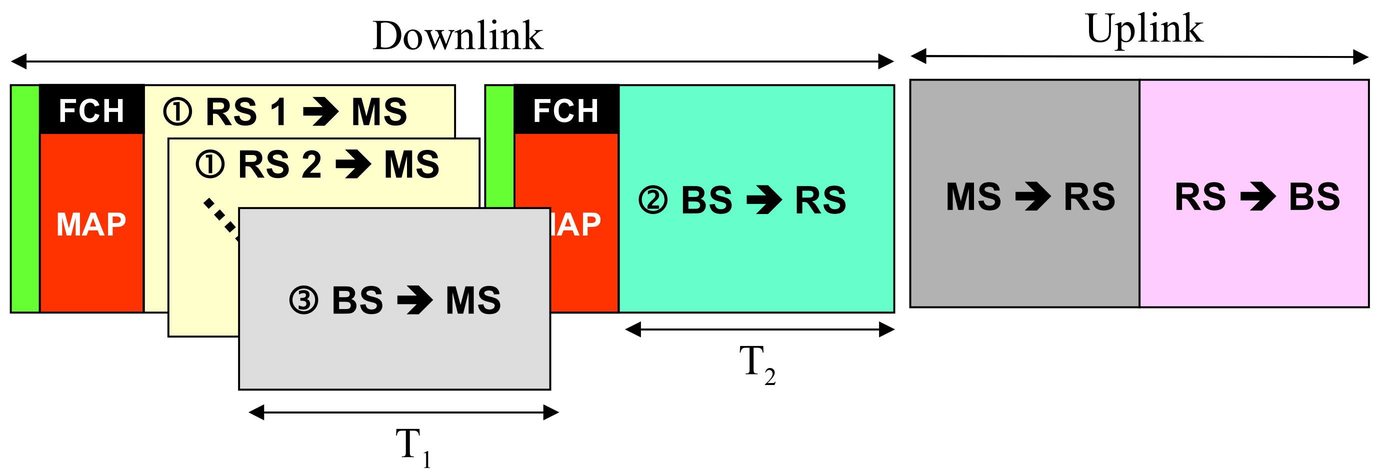
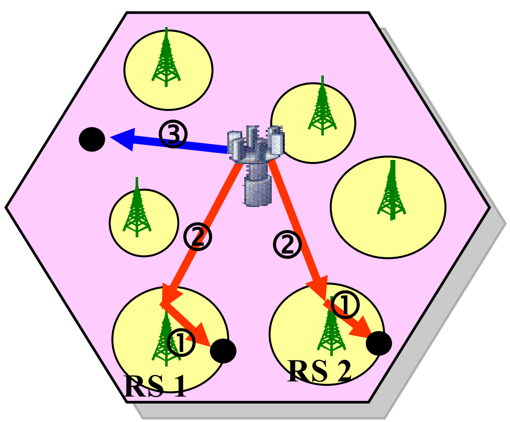
Outline

- Network capacity expansion scenarios
- Proposed frame structure for out-of-band relay operation
- Simulation results
- Text contribution
- Summary

Network Capacity Expansion Scenario (1)

- Typical frame structure for a single FA scenario



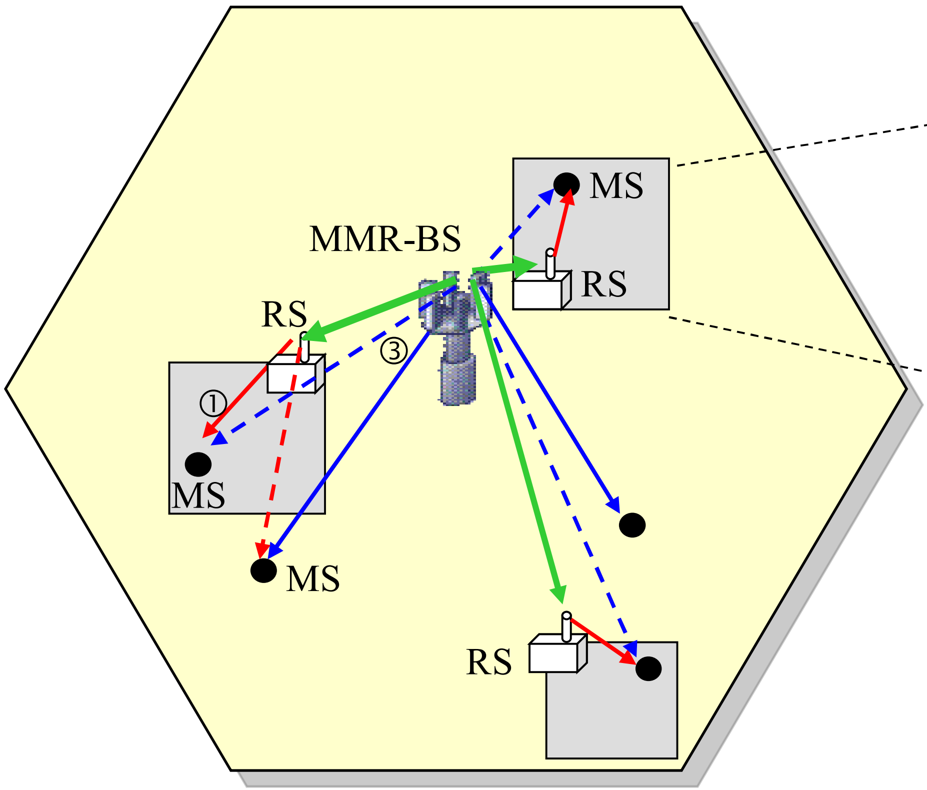


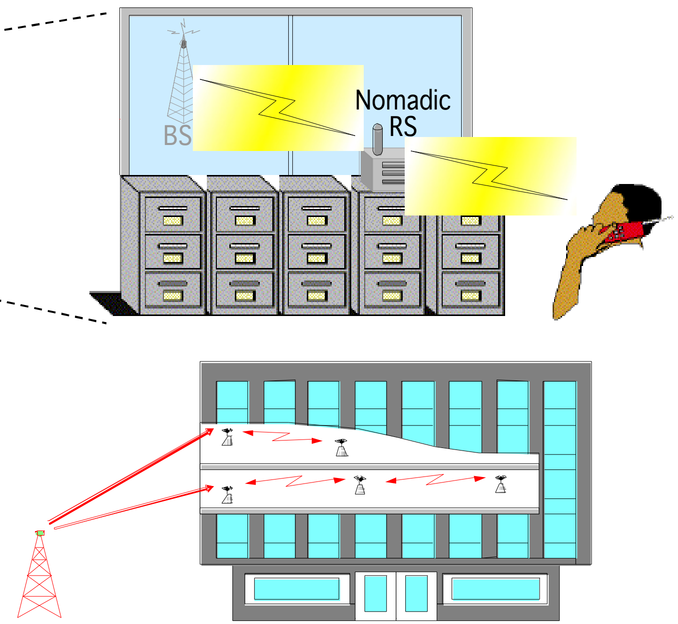
✓ RS-MS link ① interferes with BS-MS link ③
➔ *Inter-hop interference problem*

✓ What if we use two FA's for capacity expansion?

Network Capacity Expansion Scenario (2)

• Usage scenario for indoor coverage extension



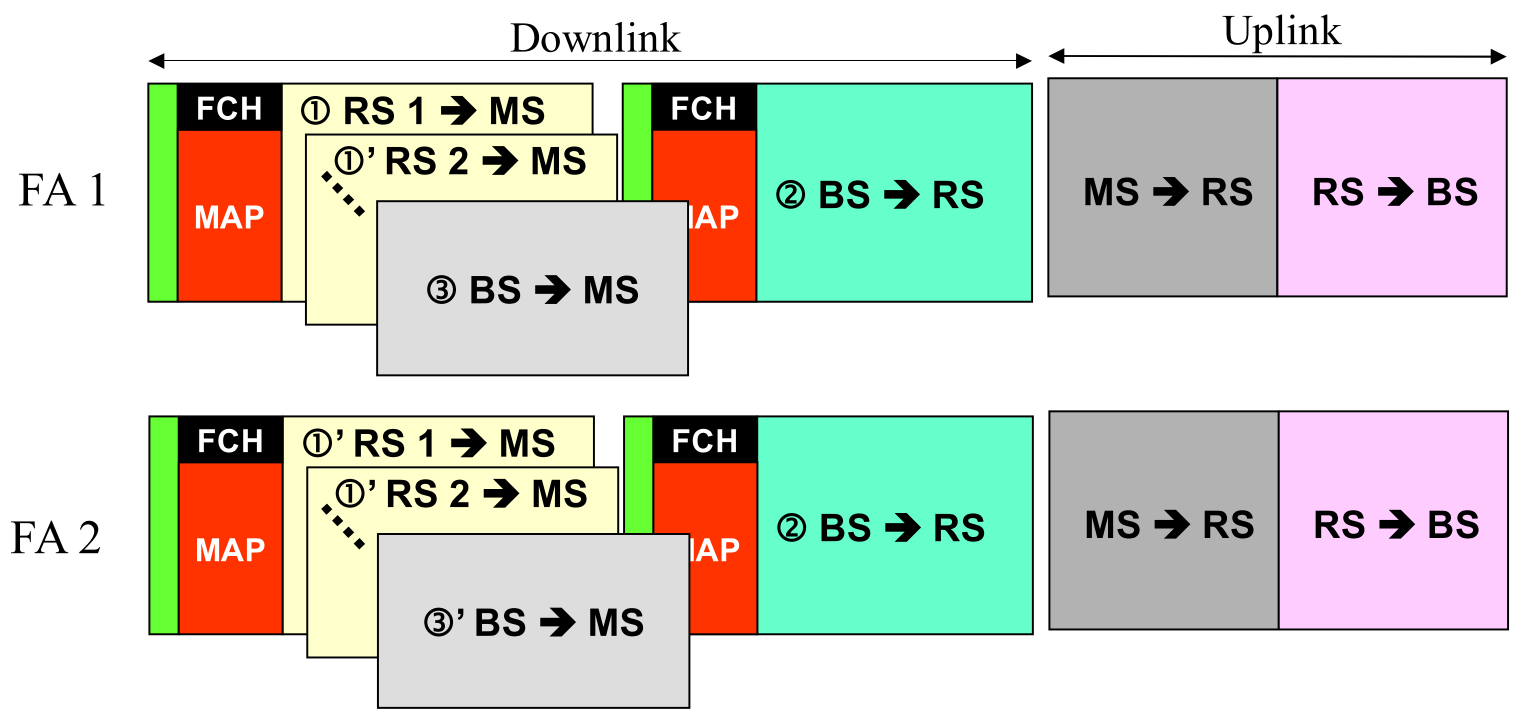


✓ Severe inter-hop interference problem expected in the indoor coverage extension scenario, especially for the buildings very close to MMR-BS

Network Capacity Expansion Scenario (3)

- Additional FA is deployed for capacity expansion as the traffic demand increases
  - ✓ Two Tx/Rx's required for each RS, one for FA 1 and the other for FA 2, incurring additional implementation cost

- Typical frame structure for a multiple FA scenario for capacity expansion

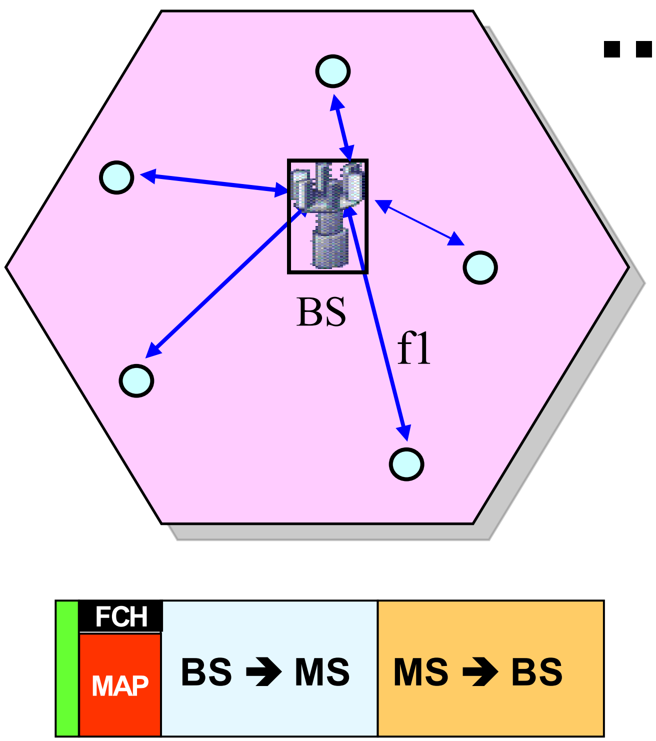


✓ The inherent inter-hop interference problem still exists in the multi-FA operation.

Network Capacity Expansion Scenario (4)

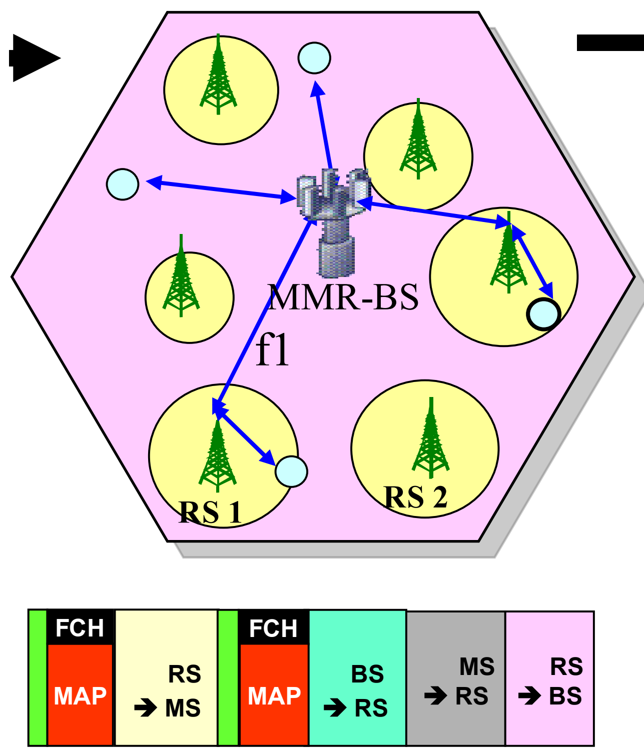
- Migration Scenario

✓ Legacy (802.16e) Network



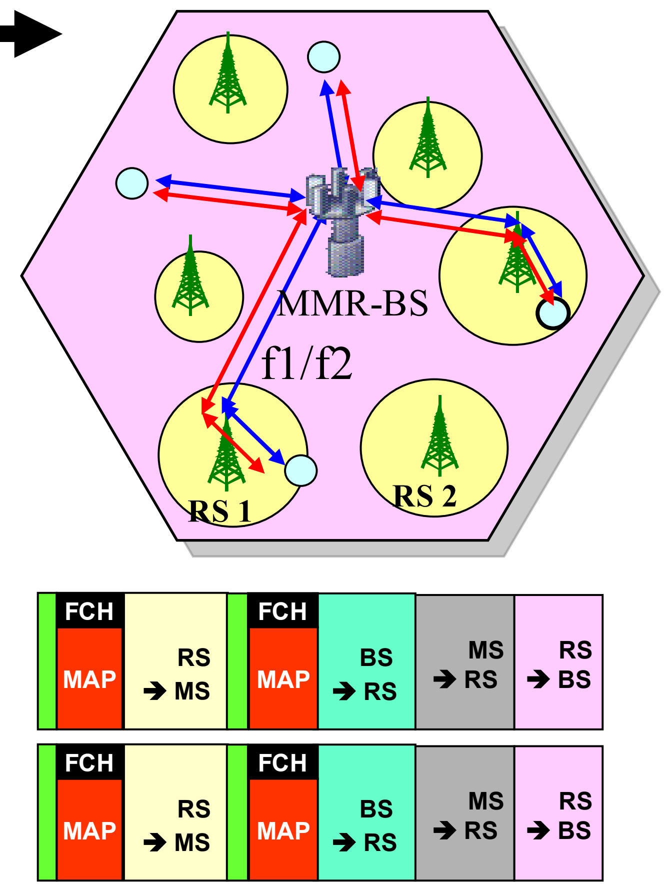
1 FA

✓ Legacy (802.16j) Network



1 FA

✓ Network Expansion (Dual Structure)

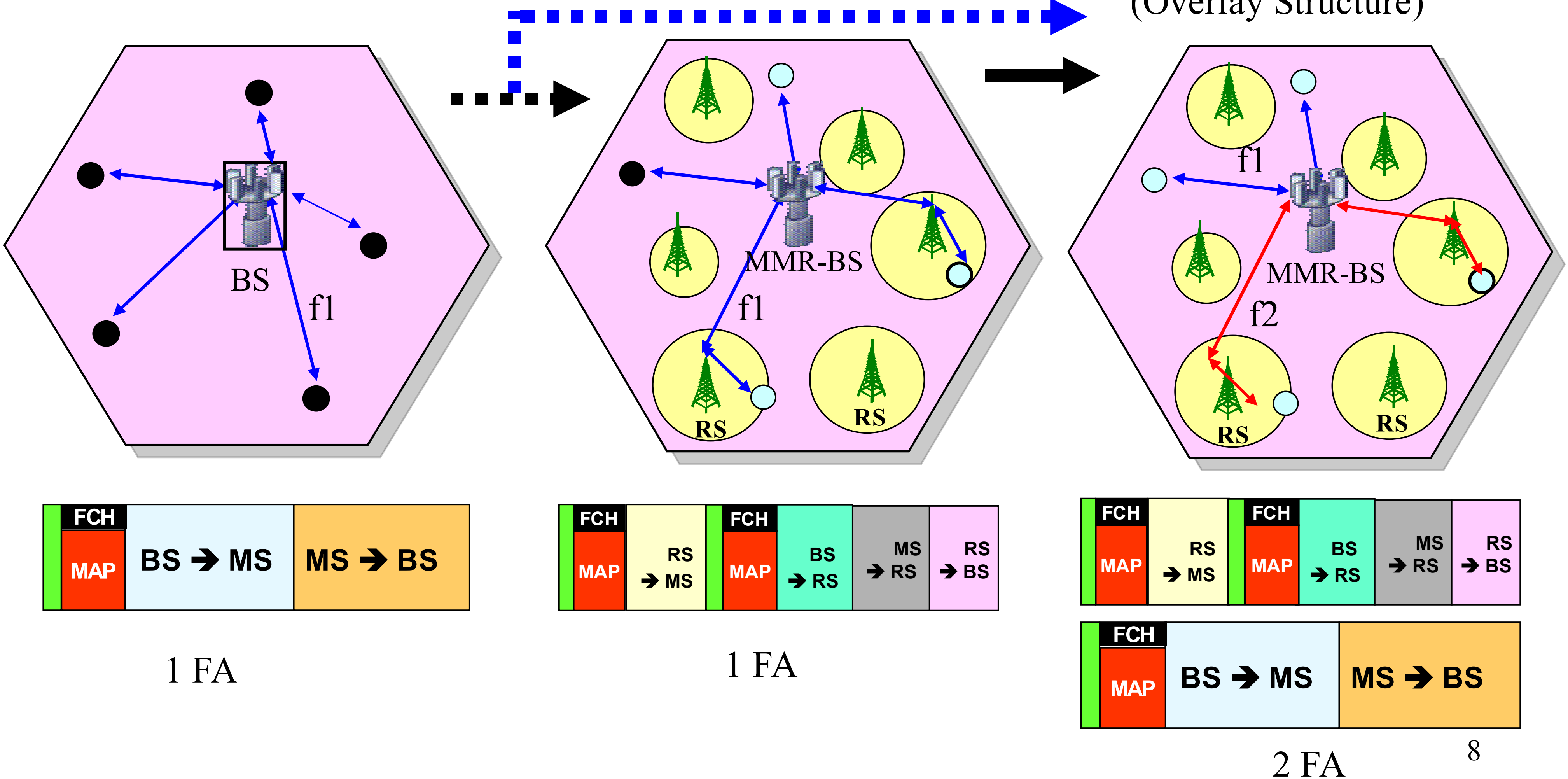


2 FA

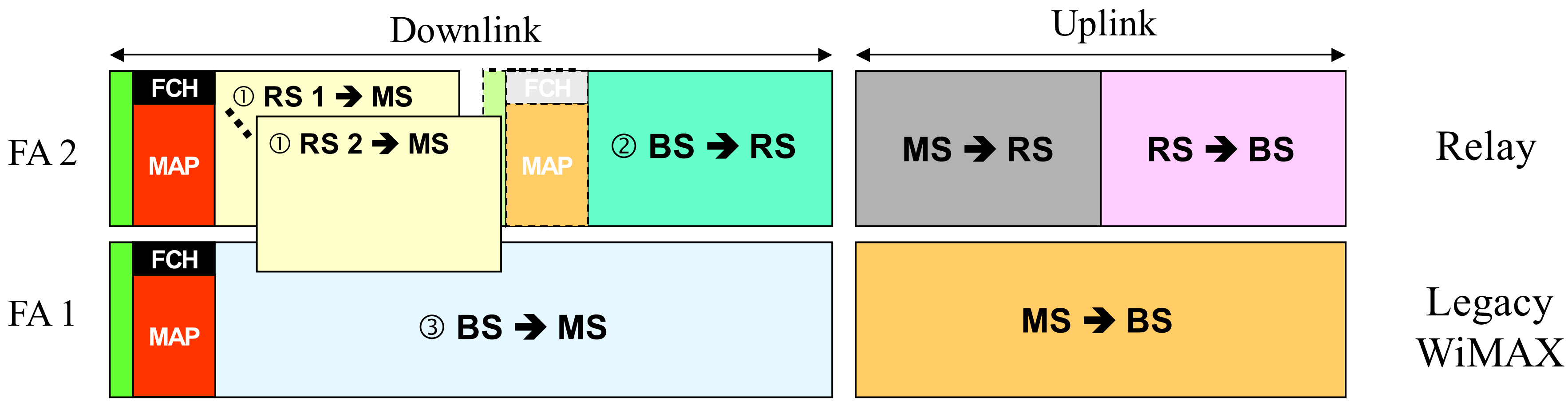
Network Capacity Expansion Scenario (5)

- Migration Scenario

✓ Legacy (802.16e) Network ✓ Legacy (802.16j) Network ✓ Proposed Network (Overlay Structure)



Proposed Frame Structure for Out-of-band Relay (1)



- Synchronous-broadcast MAP information
  - ✓ 1st FA: BS broadcasts MAP information to MS (in BS coverage)
  - ✓ 2nd FA: RS broadcasts it's own MAP information to MS (in RS coverage) at same time as MMR-BS
- Data burst transmission
  - ✓ 1st FA: MMR-BS schedules the relay link traffic and relay (MS Access) traffic (BS & RS share the same frame resource)
  - ✓ 2nd FA: MMR-BS schedules the relay link traffic and Relay (MS Access) traffic.

Proposed Frame Structure for Out-of-band Relay (2)

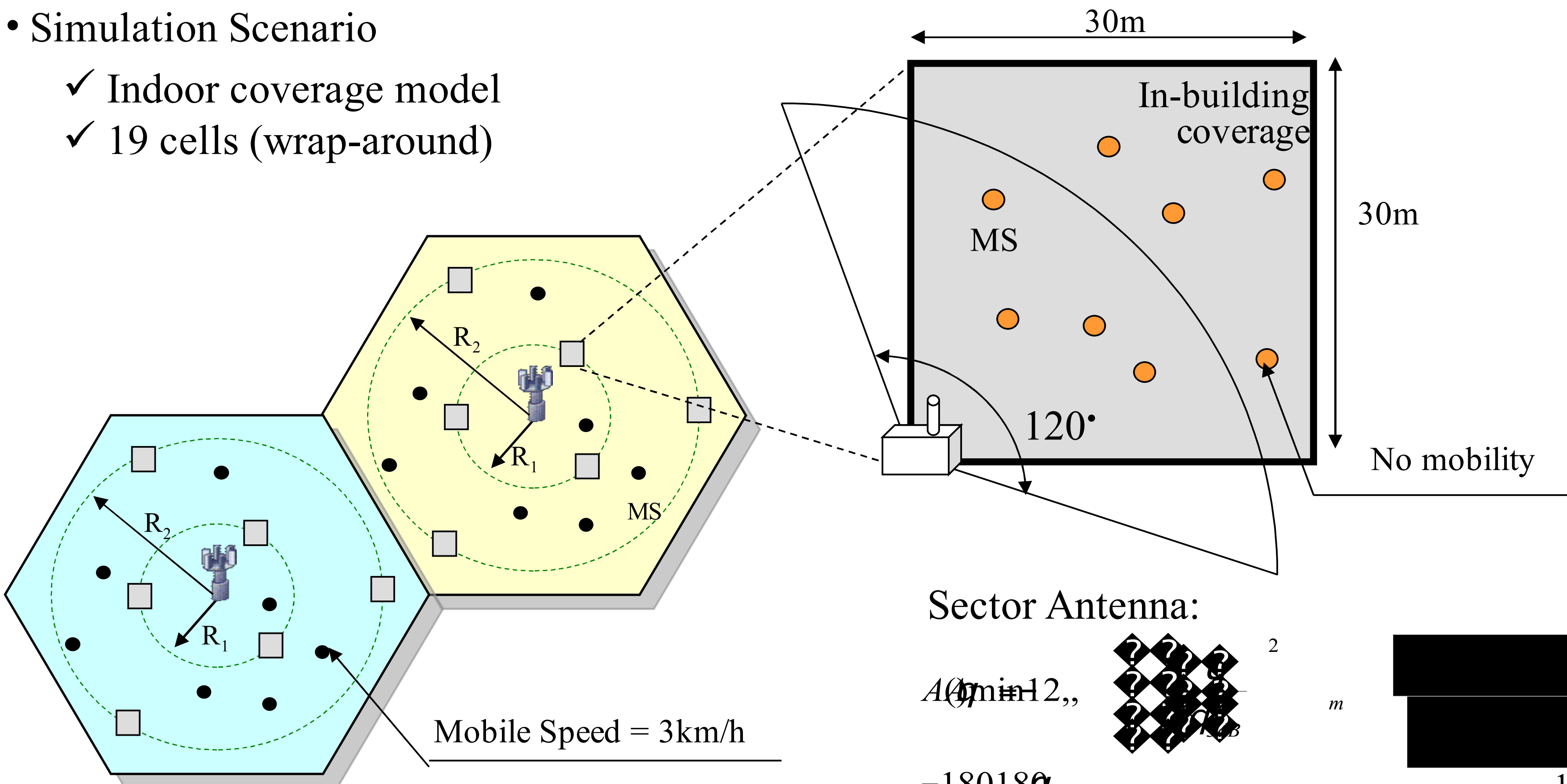
- Advantages
  - ✓ A solution to resolve relay link capacity enhancement.
    - The interference might be lower than conventional usage model (frequency sharing with BS & RS)
    - BS-RS link & Relay resource control may be flexible (BS is only needed to schedule MMR link & RS Access traffic.)
  - ✓ Support a smooth migration plan
    - MMR-BS support legacy WiMAX and MMR technology at the same time.
    - FA expansion can be a way to migrate MMR system.

- Disadvantages
  - ✓ MMR-BS should support multiple FA (more costly than a simple relay)
  - ✓ Inflexibility in load balancing (e.g., what if MMR Link(RS→MS) traffic is overloaded while BS Access (BS→MS) traffic is under-loaded ?)

Simulation Scenario (1)

- Objective
  - ✓ To compare the average throughput and outage performance for two different frame structures under 2-FA operation

- Simulation Scenario
  - ✓ Indoor coverage model
  - ✓ 19 cells (wrap-around)



Sector Antenna:

$A(\theta) = -\min$ 12,, ? 2 m [redacted]

$-180 \leq \theta \leq 180$

Simulation Scenario (2)

- Simulation Parameters

Model		Parameters
Cell Layout		• 19 cells – wrap around
RS Configuration		• 6 FRS's per cell with a radius of 1km - 3 RS's on a circle with a radius of R_1 - 3 RS's on a circle with a radius of R_2
Transmit Power		• BS Power = 20W; RS Power = 1W, 100mW
Antenna Height		• BS Antenna = 30m; RS Antenna = 20m; MS Antenna =2m
Channel Model	**BS-RS Link**	• LOS for 64-QAM with R = 5/6
	BS-MS Link (outdoor MS)	• Path-loss: NLOS (Type B) • Shadow fading: 9.6dB • Multi-path: ITU-R (M.1225)
	BS-MS Link (indoor MS)	• The same as outdoor MS with an additional loss of 10~20dB for building walls
	RS-MS Link (indoor MS)	• Path-loss: NLOS (Type G) with n = 3 • Shadow fading: 12dB
Resource Allocation		• Dual structure ➔ $T_1 : T_2 = 6 : 15$ • Overlay structure ➔ $T_1 : T_2 = 4 : 17$
Mobile Speed		• Outdoor MS: 3km/h • Indoor MS: 0km/h
Packet Scheduling		Round robin
Traffic Model		Full buffer

Simulation Scenario (3)

- Path Loss Channel Model [1]
  - ✓ BS-MS Link (outdoor MS): Type B

    where

  - ✓ RS-MS Link (indoor MS): Type G

    where

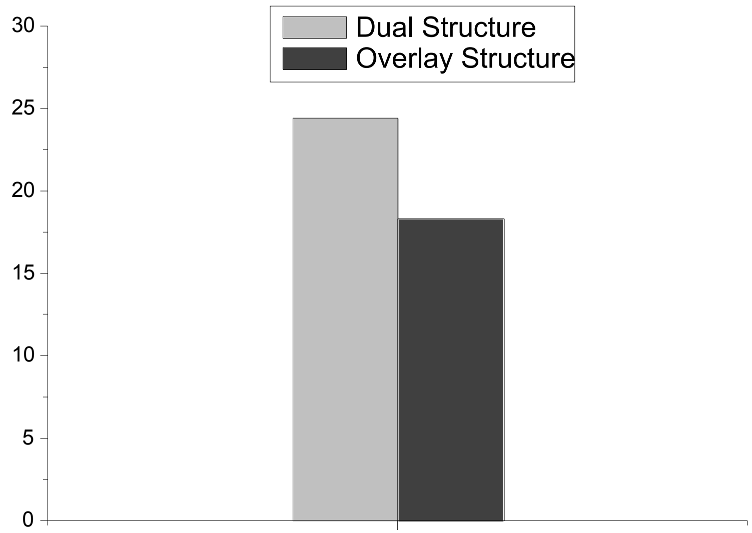
[1] Gamini Senarath, et al., “Multi-hop System Evaluation Methodology (Channel Model and Performance Metric),” document IEEE C802.16j-06/013, 5 September 2006.

Simulation Result (1)

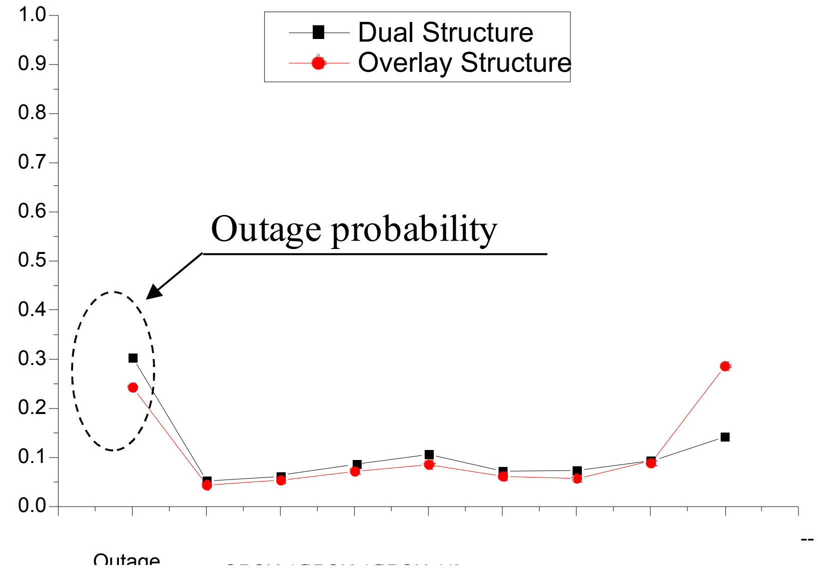
- Overall System Performance

- R_1 = 289m; R_2 = 866m
- The number of MS in each building = 4
- RS power = 200mW

✓ Average cell throughput

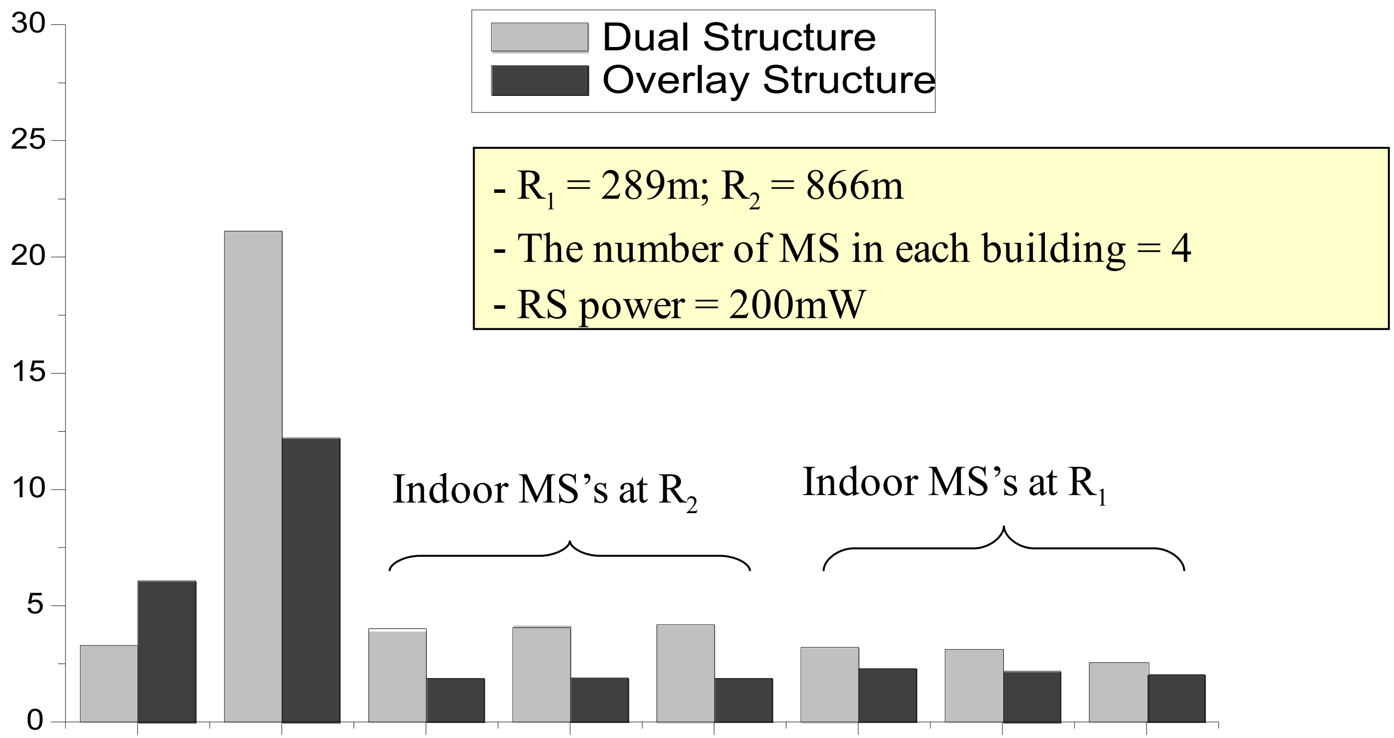


✓ Distribution of AMC levels



Simulation Result (2)

• Throughput per cell in each link

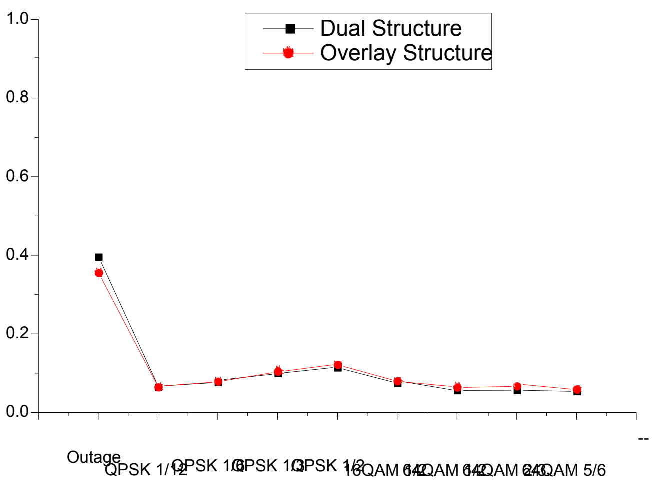


Simulation Result (3)

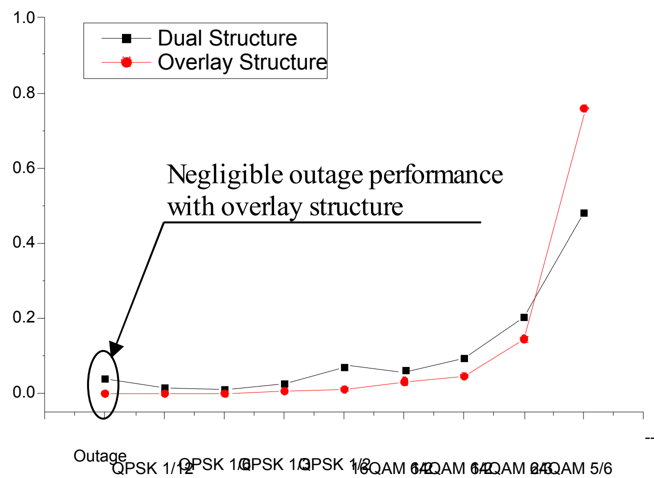
- Distribution of AMC Levels: R_1 = 289 m & R_2 = 866 m

> - R_1 = 289m; R_2 = 866m
> - The number of MS in each building = 4
> - RS power = 200mW

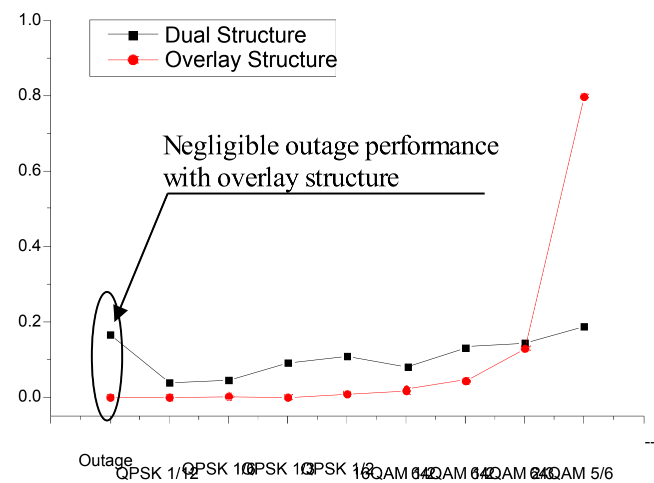
✓ Outdoor MS



✓ Indoor MS in RS at R_2 = 866m



✓ Indoor MS in RS at R_1 = 289 m

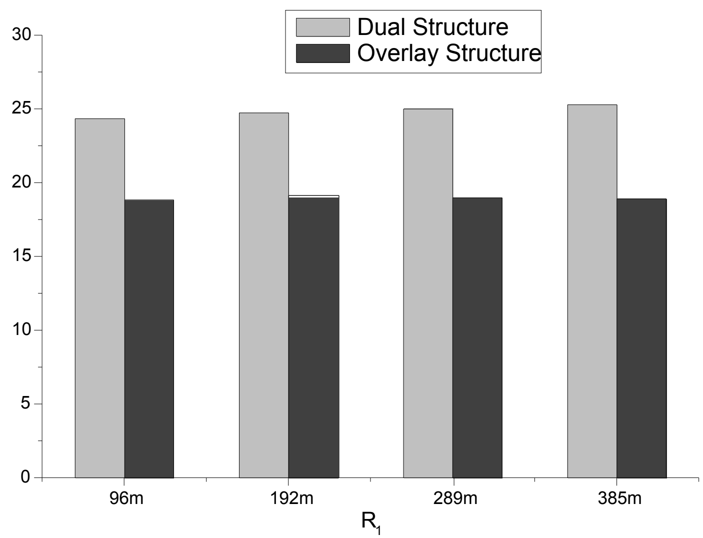


Simulation Result (4)

- Location-dependent Performance

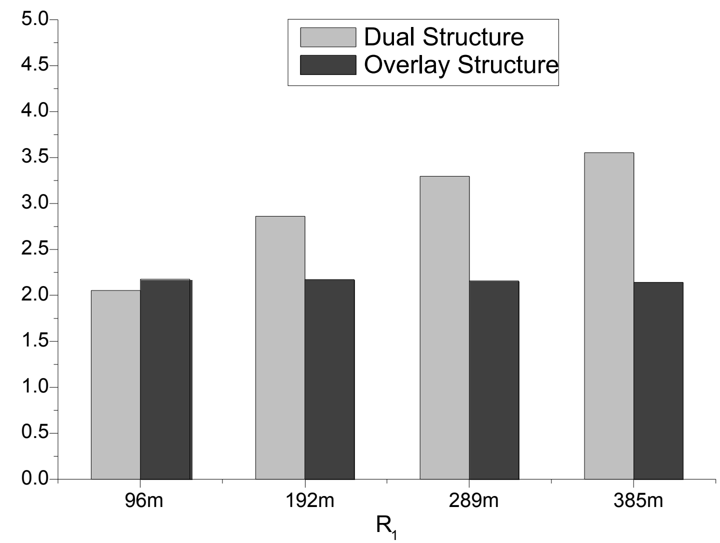
- The number of MS in each building = 4
- RS power = 1W

✓ Overall average cell throughput



- Distance of RS from BS does not much affect overall average cell throughput

✓ Indoor MS in RS at R_1



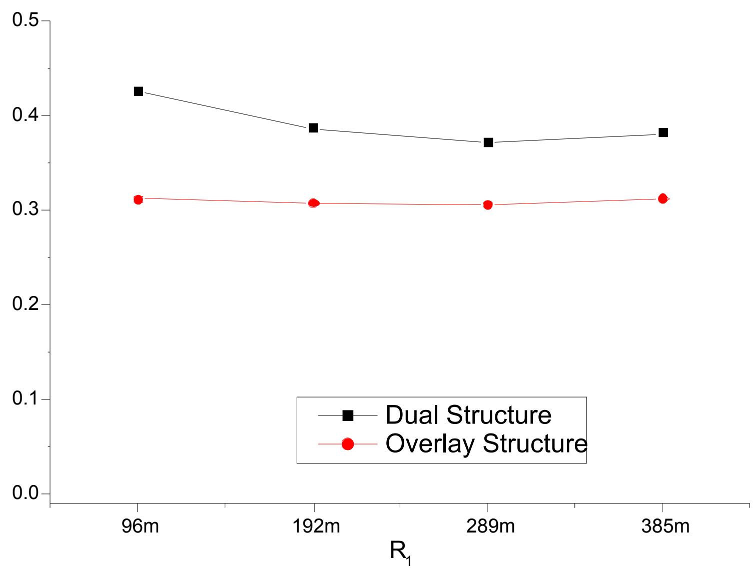
- Performance of indoor MS is not significantly affected by distance of RS from BS for the overlay structure as opposed to the dual structure

Simulation Result (5)

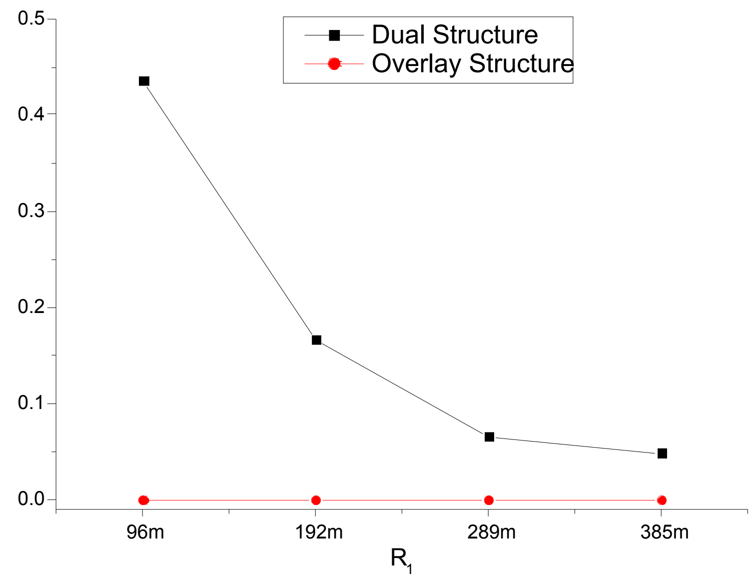
- Outage Performance for Different Locations

- The number of MS in each building = 4
- RS power = 1W

✓ Overall Outage Probability



✓ Outage Probability for Indoor MS



Text Contribution

8.4.4.8 Relaying frame structure

…………………………..

Insert the following text in the subclause:

When a multiple number of FA's are employed for capacity expansion, two different frame structures, the relaying frame structure and the existing frame structure, can be used at the same time, each of which is using the different FA so as to isolate the interference between RS-MS link from BS-MS link. In other words, *out-of-band relay* can be introduced with two different frame structures to facilitate an efficient migration from the existing infrastructure to MMR system.

…………………………..

Summary

- A new frame configuration with *overlay structure* is introduced for a multiple number of FA's as a network capacity is expanded.
  - ✓ To allow a more economical migration toward a MMR-based network without incurring additional hardware burden
  - ✓ To provide a reliable and effective means of indoor coverage extension

    (more effective as there are a large number of buildings to be covered by RS, especially those close to BS)

- Additional MAC management procedure might be required to support the overlay structure for out-of-band relay under consideration (for example, multiple frequency operation of MS entry for out-of-band relay)
  - ✓ To be further discussed