Usage models and technical requirements for 802.16j

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Purpose:

To show how RS usage models enhance IEEE802.16e coverage and capacity.

To list the technical requirements in these usage models.

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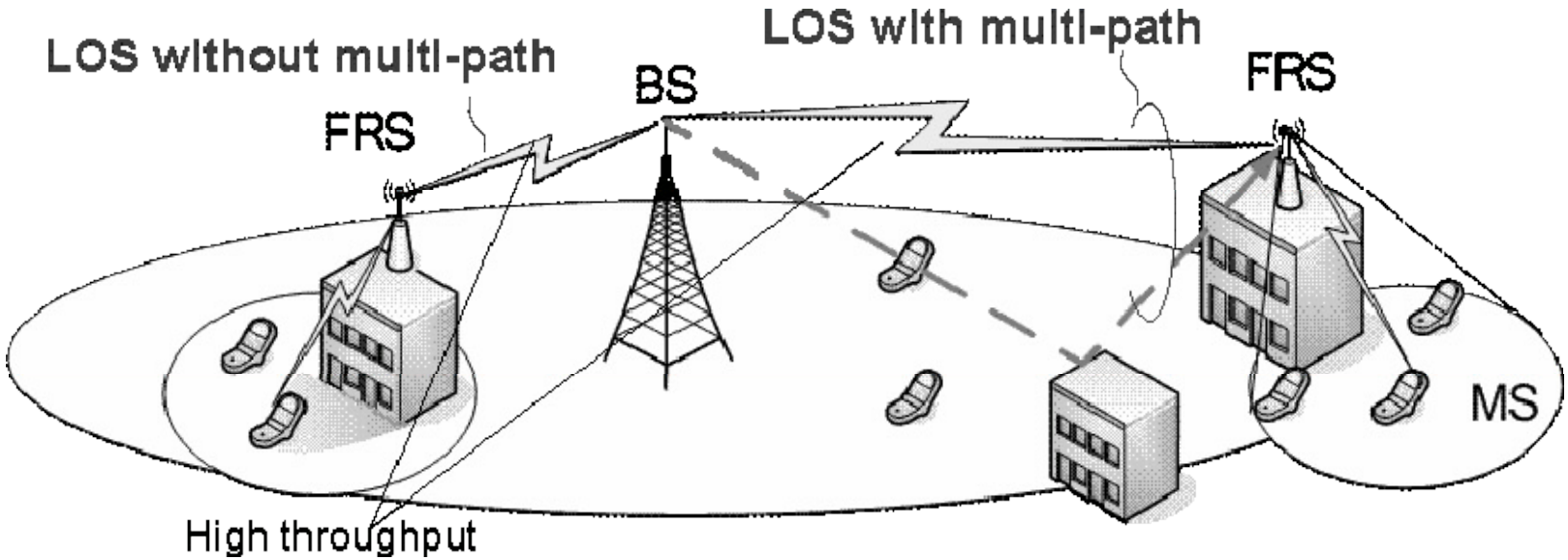
Outline

- Usage Scenario
  - ✓ Secnario1: Fixed RS (FRS)
  - ✓ Scenario2: Nomadic RS (NRS) in the room
  - ✓ Scenario3: Nomadic RS (NRS) in the field
- Technical challenges / Requirements
  - ✓ Our motivation and target for technical requirements
- Simulation results of 802.16 ARQ
- Analytical results of Turbo Coding for Hybrid ARQ
- Conclusion

Scenario 1: Fixed RS (FRS)

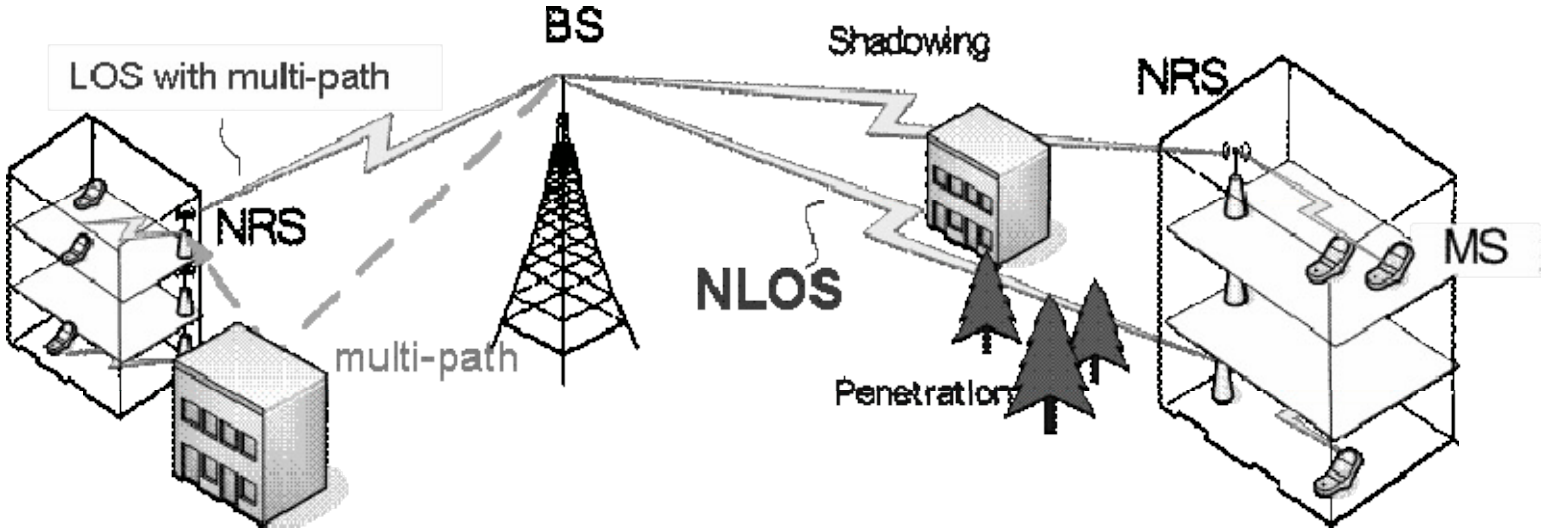
- FRS are deployed for coverage extension and reducing coverage holes,
  - ✓ The connection between BS and FRS requires high throughput in LOS environment w/wo multi-path
  - ✓ MSs in the FRS's sphere of influence can NOT communicate with BS directly, but only communicate via FRS
- As the result of the deployment of FRSs,
  - ✓ Reduce ACK delay under heavy traffic loading
  - ✓ MSs are physically nearer to the FRS and therefore reduced the UL Tx power



BS-RS(RS-RS) link requires "high reliability", "stable, moderate to high throughput", and "small delay and delay jitter" transmission.

Scenario 2: Nomadic RS (NRS) in the room

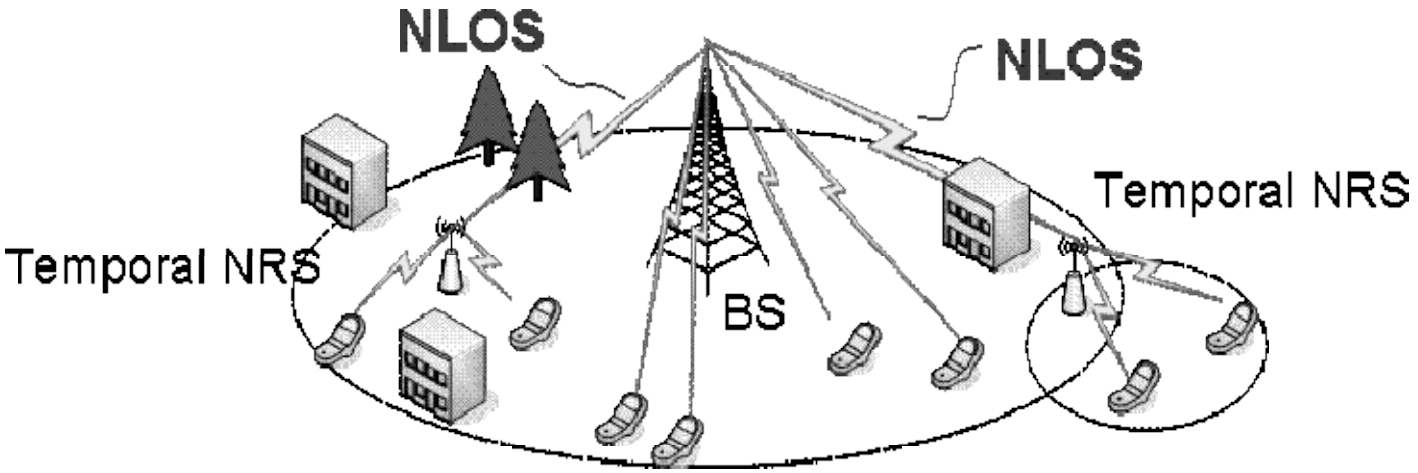
- NRSs are deployed for coverage extension into the room
  - ✓ The connections between BS and NRS requires high throughput in NLOS and LOS (w/wo multi-path) environment
  - ✓ NRS is deployed near the window in the building , and relays packets to the MSs in the room.
  - ✓ MSs in the NRS's sphere of influence can NOT communicate with BS directly, but only communicate via NRS
- As the result of the deployment of NRSs,
  - ✓ Reduce ACK delay under heavy traffic loading
  - ✓ MSs are physically nearer to the NRS and therefore reduced the UL Tx power



BS-RS(RS-RS) link requires "high reliability", "stable, moderate to high throughput", and "small delay and delay jitter" transmission.

Scenario 3: Nomadic RS (NRS) in the field

- NRSs are deployed for tentative coverage extension
  - ✓ The connections between BS and NRS requires moderate to high throughput in NLOS environment
  - ✓ NRS is nomadic (on the emergency vehicle for example), and relays packets to the MSs around the NRS.
  - ✓ NRS is deployed at a special location temporarily (event spots for example)
- As the result of the deployment of NRSs,
  - ✓ It is possible to fill the coverage hole and increase the number of MSs served
  - ✓ Reduce ACK delay under heavy traffic loading
  - ✓ MSs are physically nearer to the NRS and therefore reduced the UL Tx power



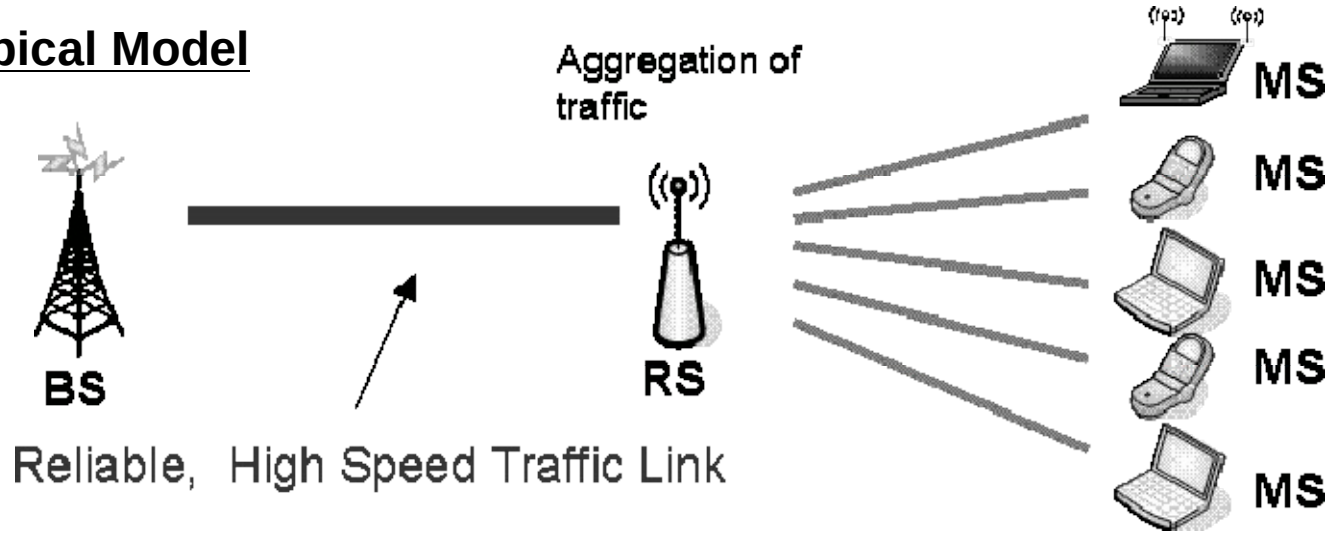
BS-RS(RS-RS) link requires “high reliability”, “stable, moderate to high throughput”, and “small delay and delay jitter” transmission.

Technical Challenges / Requirements

Our Motivation

The aggregation of traffic is supported in the RS. The throughput requirement between BS and RS is therefore higher. So efficient and reliable data transmissions are very important when the RS system is introduced.

Our Typical Model



The Link between BS and RS (including RS-RS)

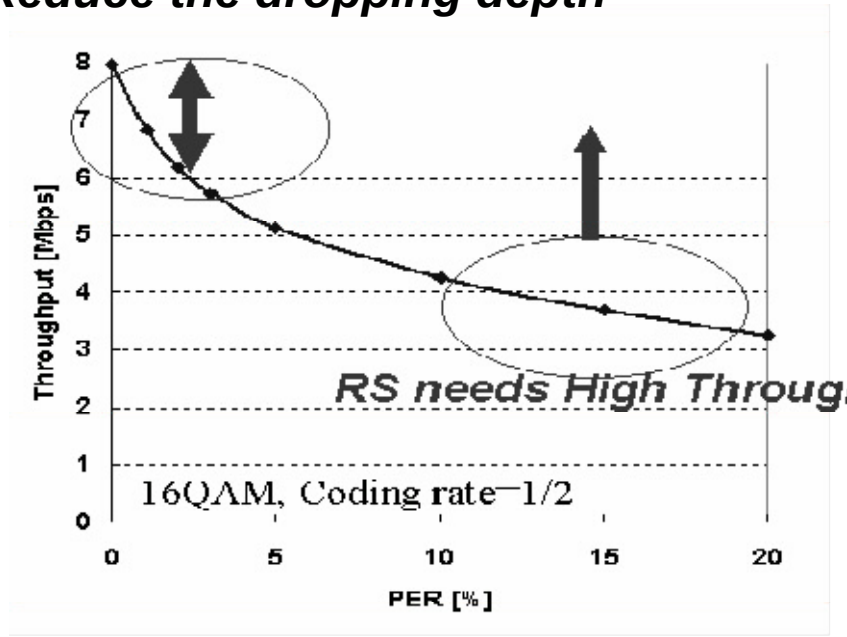
The link between BS-RS (including RS-RS) is reliable and provide stable, moderate to high throughput while minimizing delay and delay jitter. Efficient data transmission is required to realize these requirements.

Simulation Results – 802.16 ARQ

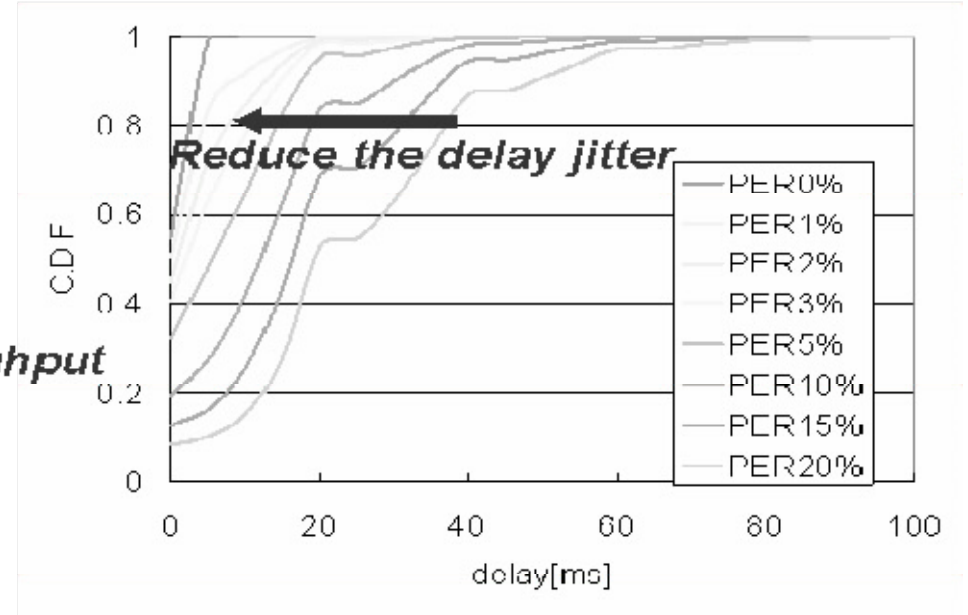
The throughput between BS and RS (or RS-RS) is relatively higher than BS-MS. Throughput and delay of a link (BS-RS for example) using 802.16 ARQ are sensitive functions of PER (see figures). As the link (PER) quality changes, throughput value of the link may become volatile and the delay jitter would also increase. These quality and reliability of the link are not acceptable to the BS-RS or RS-RS. A new transmission scheme is required to address these challenges.

Throughput

Reduce the dropping depth



Delay C.D.F.



Analytical Results – Turbo coding

In the high speed Link, Turbo Coding needs larger size memory and bigger size of logic circuitry, depending on the number of parallel processing modules required. RS is required to be low cost in comparison with BS. So we develop a new coding scheme of Hybrid ARQ to address this challenge.

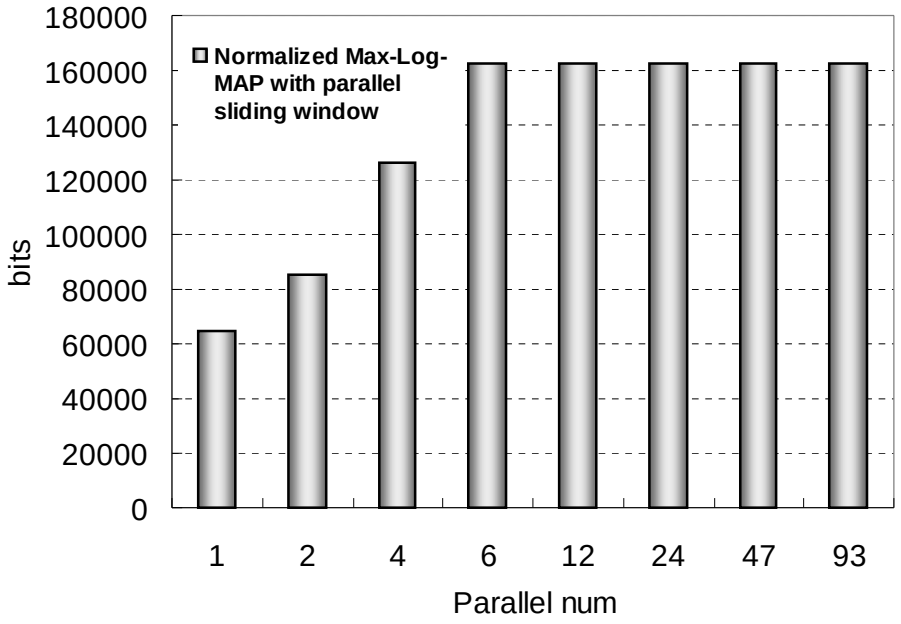


Fig1. The memory size of Turbo Code in the parallel processing

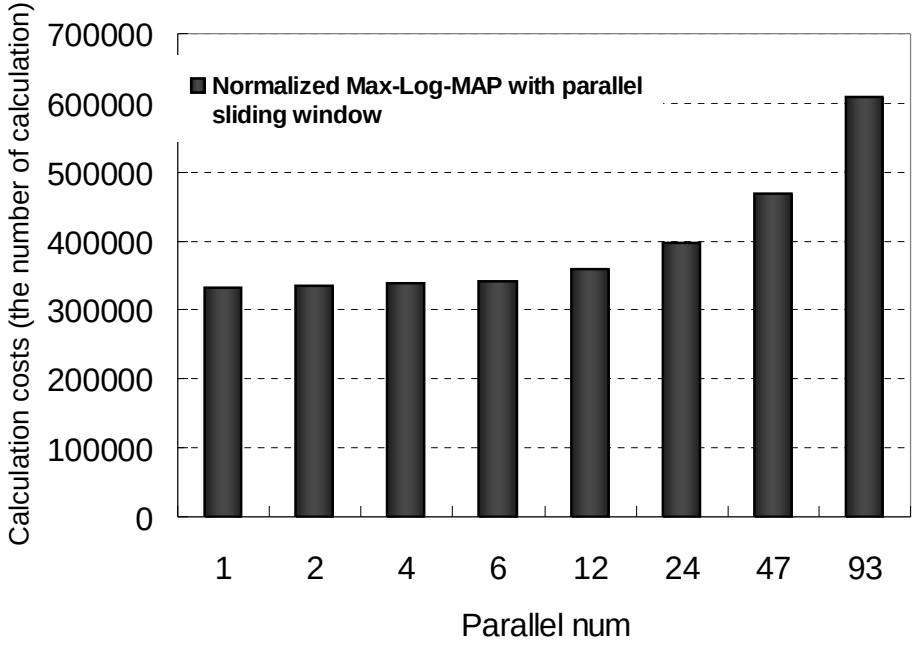


Fig2. The calculation costs of Turbo Code in the parallel processing

Conclusions

- The benefits of RS deployment are as follow:
  1. A reliable way to extend and improve coverage of a cell
  2. Reduce the terminal Tx power
  3. Reduce delay by distributing and reducing the Up link load

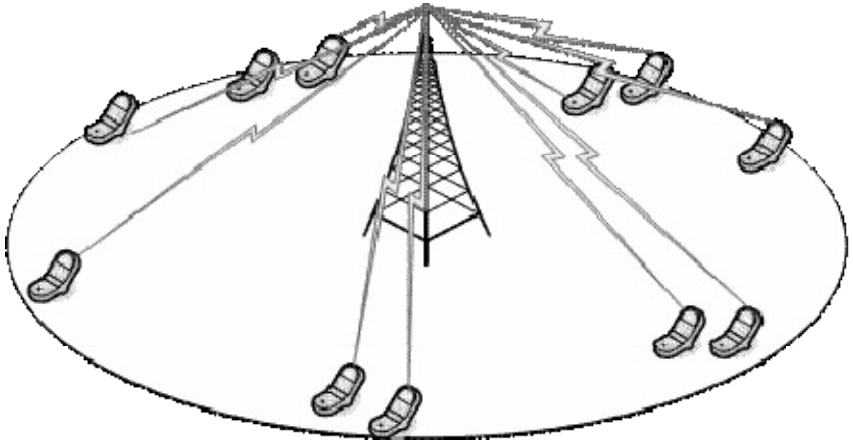
- We propose to improve the following data transmission scheme in order to achieve an efficient, stable and reliable data transmission link with low delay and delay jitter between BS-RS or RS-RS:
  - ✓ ARQ
  - ✓ High Speed FEC for Hybrid ARQ
  - ✓ Aggregation of Traffic

Appendix

Reduction of ACK delay using RSs

- RSs reduce delay in ACK signaling under heavy traffic loading

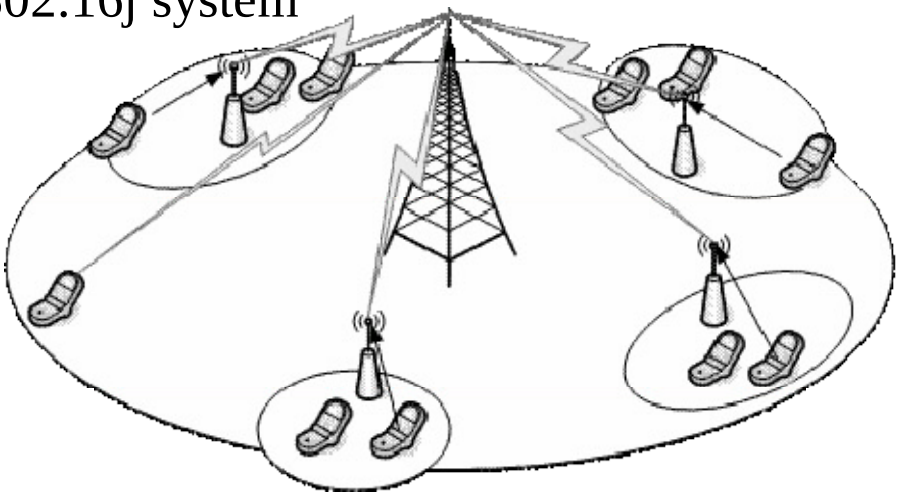
Conventional system (w/o RS)



UL traffic

-Separate UL ACK traffic for each connection
-Inefficient usage of UL bandwidth

802.16j system



-Aggregate UL ACK traffic
-Efficient usage of UL bandwidth