VoIP Over 802.16e

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12/16

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802.16e Additions

- **Mobility Support Features:**
  - Licensed Band Only: 2 to 6 GHz
  - Handoff: HO, SHO, FBSS (Fast BS Switching)
  - BS Classifications: Neighbor, Serving, Target, Active
  - Active Set: List of BSs available to MS, maintained by BS and MS
  - The BSs arranged in geographically contiguous *paging groups*
  - Network Topology Advertisement: Each BS transmits its own and neighbor's channel info.

802.16e Additions

- **Improved PHY and MSS Features**
  - Low Density Parity Check Codes(Error-Correcting Codes) at the Physical Layer
  - Enhanced MIMO setup functions
  - New States for MS operation: Sleep Mode (reduces MS power, and optimizes BS air interface capacity), Parameter defined Power Saving Classes of Mobiles
  - Enhanced FFT sizes for Scalable OFDMA: 2048, 1024, 512, 128 Bandwidth flexibility

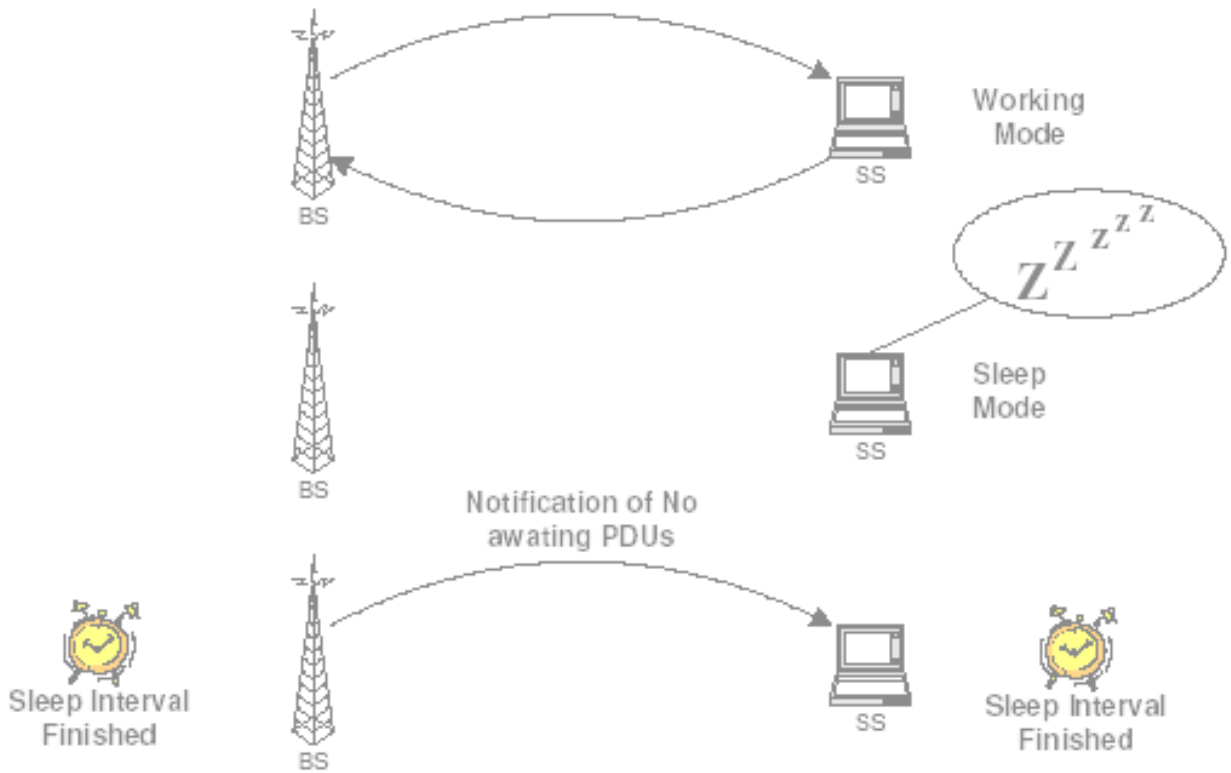
802.16e Additions

- **MAC and QoS Features:**
  - Global Service Flows defined for operation over varying topologies with mobility
  - 4 New MAP headers defined to help in PHY Channel reporting, feedback, combined
  - bandwidth-power requests ...
  - QoS - ErtPS: The ErtPS adds to rtPS support real-time service flows that generate variable size data packets on a periodic basis, e.g.VoIP with silence suppression.

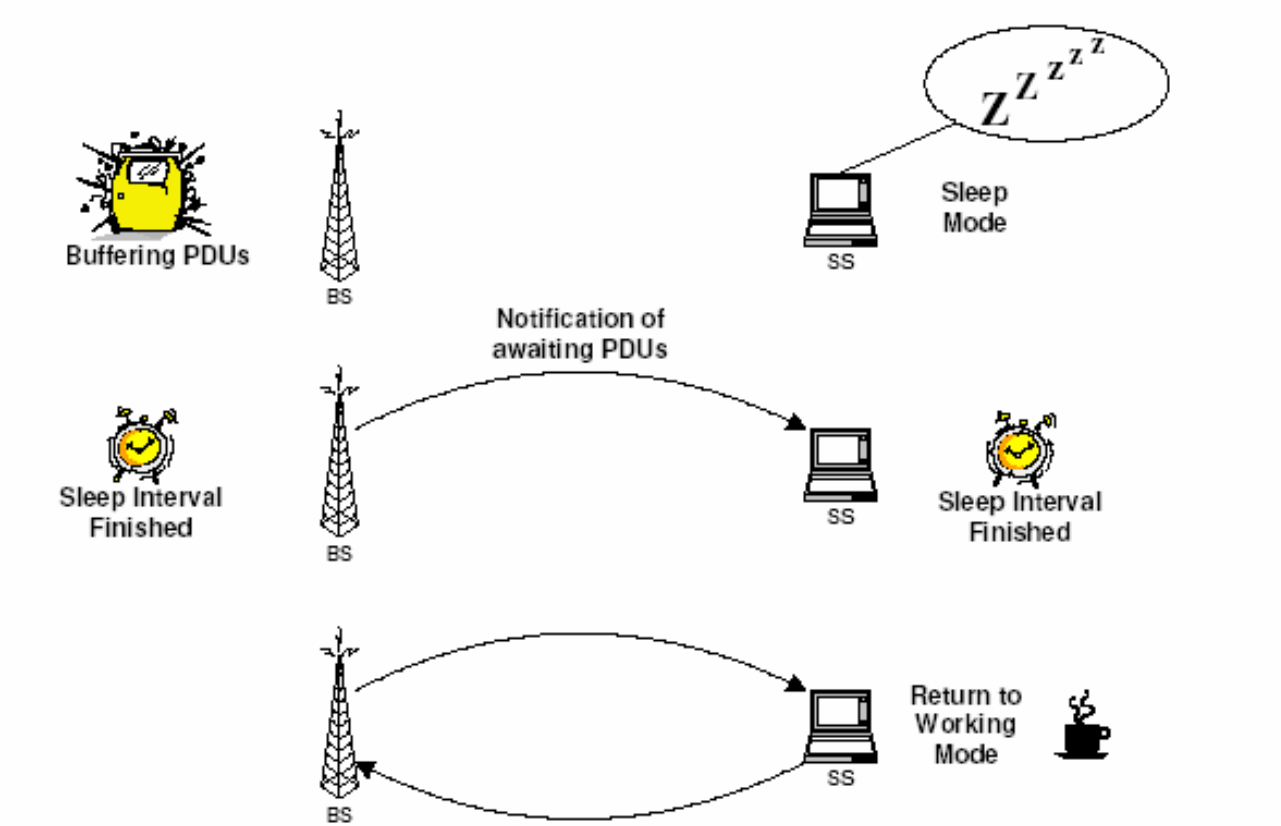
802.16e Additions

- **Service Features:**
  - Enhanced Multicast Broadcast Service

example of the Sleep Mode



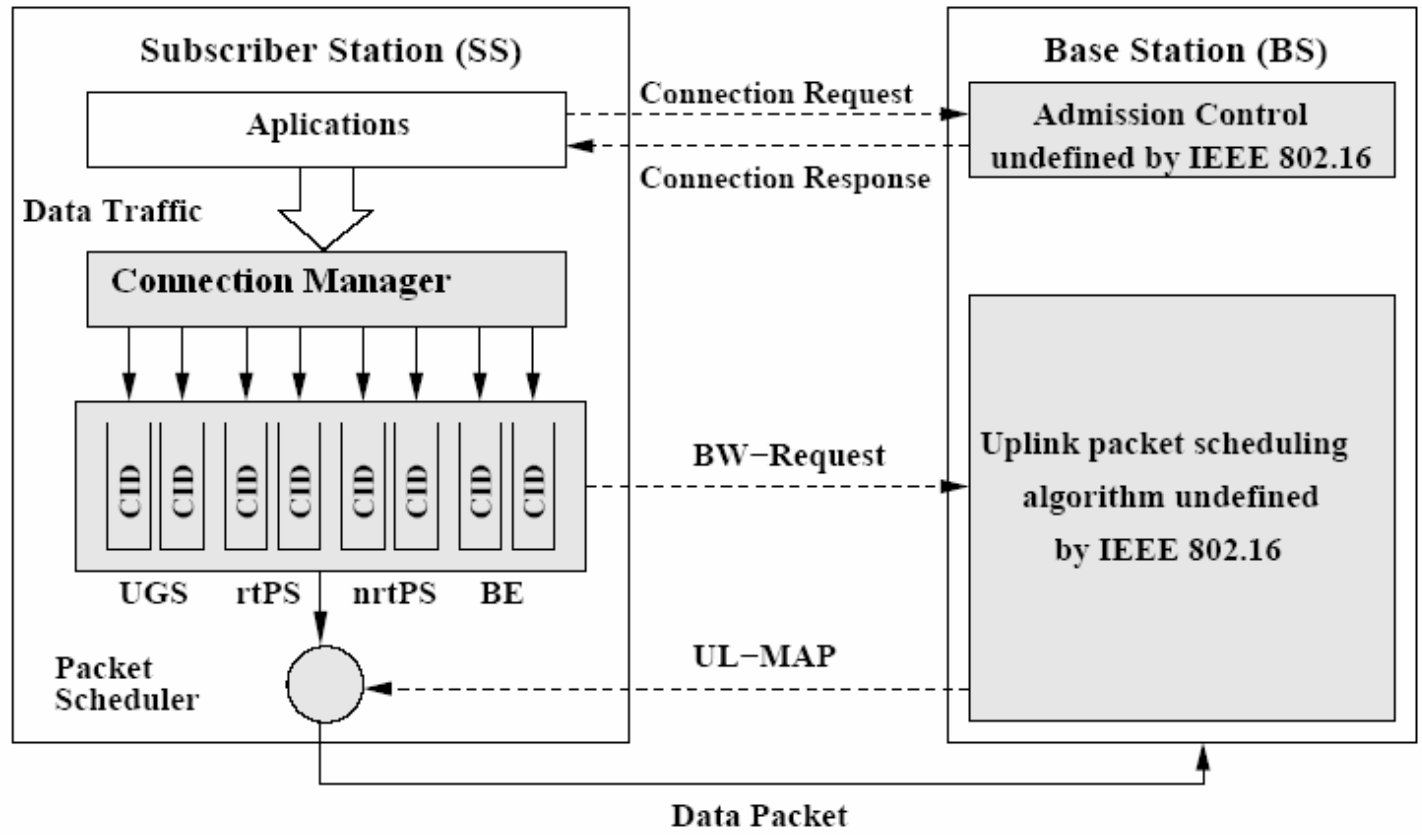
example of the Sleep Mode



4 types of Scheduling Service in 802.16-2004

- Unsolicited Grant Service (UGS)
- Real-Time Polling Service (rtPS)
- Non-Real-Time Polling Service (nrtPS)
- Best Effort Service

QoS architecture of IEEE 802.16



Real-Time Service Flows

- **Unsolicited Grant Service (UGS)**:
  - Supports real-time traffic (Voice over IP).
  - Offers fixed size unsolicited data grants (transmission opportunities) on a periodic basis.
- **Real-Time Polling Service (rt-PS)**:
  - Supports real-time flows that generate variable size data packets on a periodic basis (MPEG).
  - Offers periodic unicast request opportunities. The SSs specify the size of the desired data grants.

Non Real-Time Service Flows

- **Non Real-Time Polling Service (nrt-PS)**:
  - Supports flows that require variable size data grants on a regular basis (high bandwidth FTP).
  - Offers infrequent unicast polls plus contention and piggybacking.
- **Best Effort (BE)**:
  - The SS uses contention and piggybacking only.

802.16-2004 real-time services

- There are two scheduling types for real-time services in IEEE 802.16-2004
  - UGS
  - rtPS.
- **However, UGS and rtPS are not efficient in supporting VoIP service because these methods don’t consider ON/OFF property of voice traffic.**

Problems

- In case of UGS, the BS always assigns fixed-size grants that are sufficient to send voice packets.
  - This method causes a waste of uplink resources, especially in silence - off - duration.
- In case of rtPS, the SSs comply with a bandwidth request process – polling process
  - the polling process always causes unnecessary MAC overhead and access delay.

Proposed method

- This document* propose an efficient uplink scheduling method considering the voice on/off property for VoIP services and add changes that let the scheduler know codec type and coding rate.

Proposed method

- Firstly, the SS informs the BS of its voice status information using Grant Management subheader in case that the size of the voice data packet is decreased.
- Secondly, the SS informs the BS of its voice status information using Bandwidth request header in case that the size of the voice data packet is increased.

Proposed method

- In this case, the BS assigns uplink resources according to the requested size periodically, until the SS requests another size of the bandwidth.

Proposed method

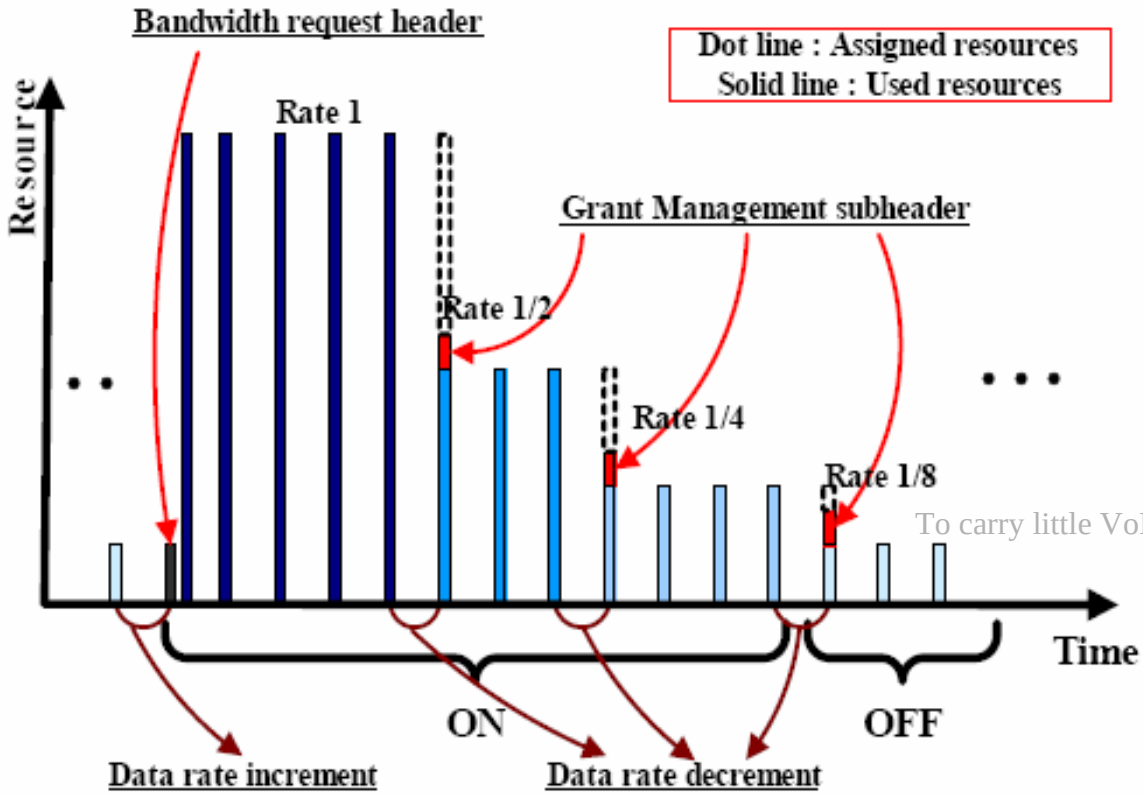


Fig. 1 Operation of the proposed method

Performance Analysis

- A voice codec characteristic parameter and a voice on/off duration can be shown in Table 1 and Table 2, respectively.

Table 1 Example of voice codec parameter

	Frame Size (ms)	Data Size (bits)	
		Talk-spurt	Silence
TIA-IS-127 (EVRC) Enhanced Variable Rate Coder	20	171 (Rate 1, 29%) 80 (Rate 1/2, 4%) 40 (Rate 1/4, 7%)	16 (Rate 1/8, 60%)

Table 2 Example of Voice on/off duration

Talk-spurt (on) Duration (ms)	0.352
Silence (off) Duration (ms)	0.650

1s ON
1.35s OFF

UGS

Average assigned uplink resources / voice codec frame / user
= (171 bits + 48 bits (Generic MAC header size)) * 100%
= **219 bits/frame/user**

rtPS

- Average assigned uplink resources / voice codec frame / user

  = (171 bits + 48 bits (Generic MAC header size)) * 29% + (80 bits + 48 bits (Generic MAC header size)) * 4% + (40 bits + 48 bits(Generic MAC header size)) * 7% + (16 bits + 48 bits (Generic MAC header size)) * 60% + (16 bits + 48 bits) * 40% (Polling size in talk-spurt (on) duration)

  = **138.79 bits/frame/user**

Only Waste the downlink bandwidth in silence duration ON/OFF

Proposed method

- Average assigned uplink resources / voice codec frame / user

  = (171 bits + 48 bits (Generic MAC header size)) * 29% + (80 bits + 48 bits (Generic MAC header size)) * 4% + (40 bits + 48 bits (Generic MAC header size)) * 7% + (16 bits + 48 bits (Generic MAC header size)) * 60%

  = **113.19 bits/frame/user**

Average assigned uplink resources

Table 3 Average assigned uplink resources

	Average assigned uplink resources / voice codec frame (MAC frame) / user
UGS	219 bits/frame/user
rtPS	138.79 bits/frame/user
Proposed method	113.19 bits/frame/user

Compared with UGS and rtPS

Table 4 Average saved resources compared with UGS

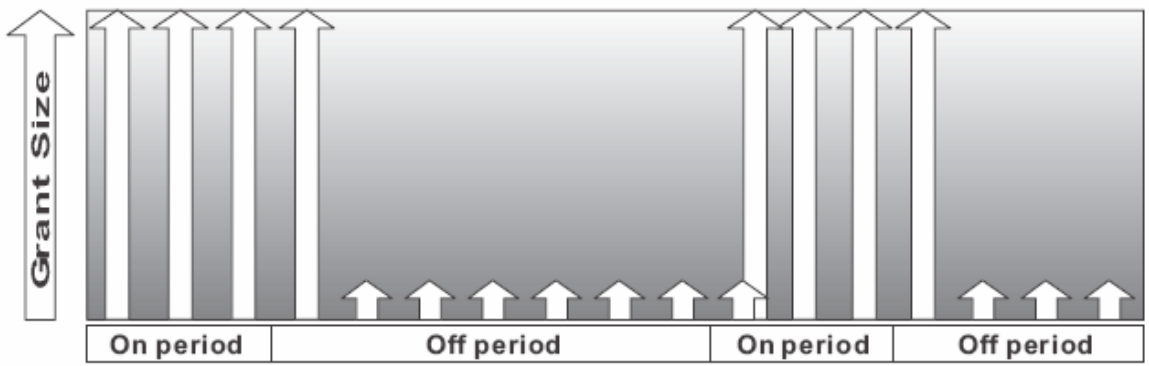
User	Average saved resources in our proposed method / voice codec frame (MAC frame)	
	Downlink (bits/frame)	Uplink (bits/frame)
1	0	105.81
10	0	1058.1
20	0	2116.2
30	0	3174.3
40	0	4232.4

Table 5 Average saved resources compared with rtPS

User	Average saved resources in our proposed method / voice codec frame (MAC frame)	
	Downlink (bits/frame)	Uplink (bits/frame)
1	36	25.6
10	360	256
20	720	512
30	1080	768
40	1440	1024

Conventional Algorithm

- Two type bandwidth allocation ON/OFF.
  - Don’t need the Grant Management subheader
  - Used the reserved bit
    - ON 1
    - OFF 0



Operation of BS according to GM bit in proposed algorithm

Conclusion

- Voice + Data
- Flexible Resource Allocation

References

- **Extended rtPS for VoIP services:IEEE 802.16 Broadband Wireless Access Working Group**
- **An enhanced uplink scheduling algorithm based on voice activity for VoIP services in IEEE 802.16d/e system**
  Howon Lee; Taesoo Kwon; Dong-Ho Cho;
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  Supervised by Professor Hamid Aghvami

  November 2004

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