MAP Multiplexing in IEEE 802.16 Mobile Multi-Hop Relay

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林咨銘

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tmlin@itri.org.tw

Outline

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- Overview of IEEE 802.16 MMR
- Proposed MAP Multiplexing Approach
- Performance Evaluations
- Conclusions

Introduction

- IEEE 802.16 is a candidate for achieving high-speed fixed-wireless/mobile access services
- IEEE 802.16 employs AMC (Adaptive Modulation and Coding) to convey data transmissions
- For service area expansion and throughput enhancement, IEEE 802.16 MMR (Mobile Multi-Hop Relay) is proposed
  - Based on IEEE 802.16 PMP (Point-to-Multi-Point) mode
  - RS (Relay Station) is introduced for relaying services between BS and SS

Introduction

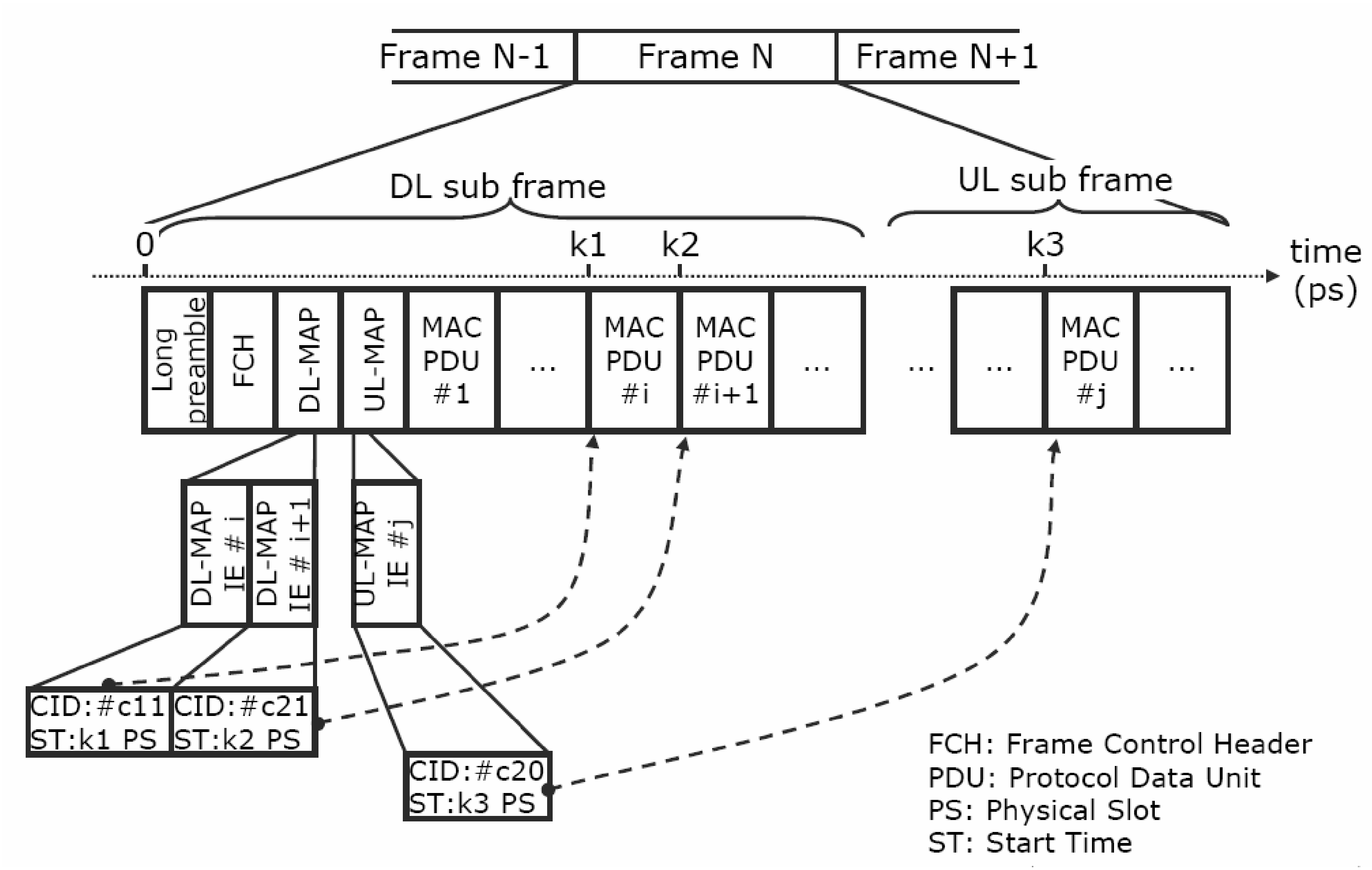
- Efficiency of radio resource utilization could be degraded under IEEE 802.16 MMR circumstances
  - BS and RS simply take turns to use radio resource
  - Only one station can transmit a packet on a frequency/sub-carrier at one time

- To improve the efficiency of radio resource utilization, a basic concept of MAP Multiplexing approach is proposed
  - Enable stations to transmit packet simultaneously

Overview of IEEE 802.16

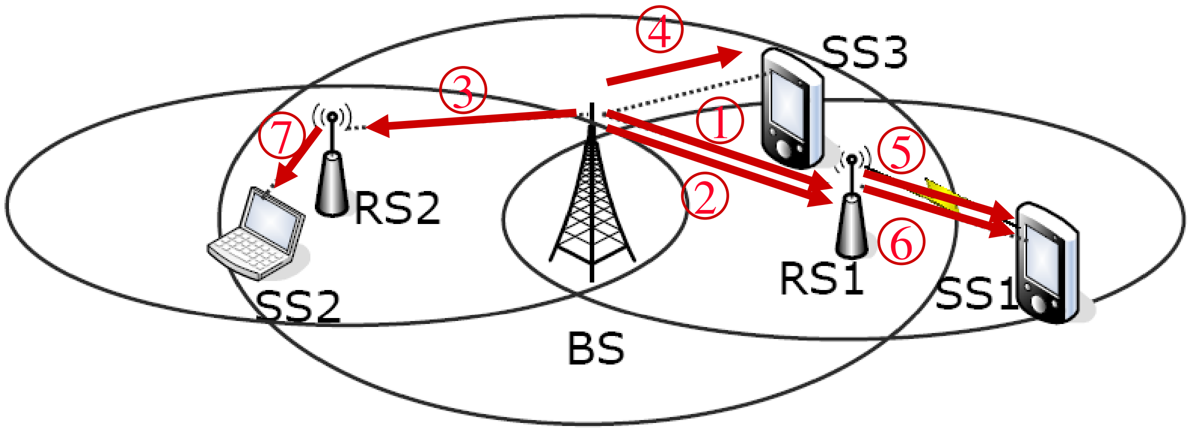
- In the PMP mode, BS arranges all the transmission timing both from BS and SS using the broadcast message called MAP
  - DL-MAP / UL-MAP
- Each SS receives the traffic destined to itself and sends traffic BS at a timing specified by MAP
- CID (Connection Identifier) is used for connection identification between BS and SS
- The MAP message has IEs (Information Elements) that include CID and the start timing of traffic

IEEE 802.16 Frame Structure

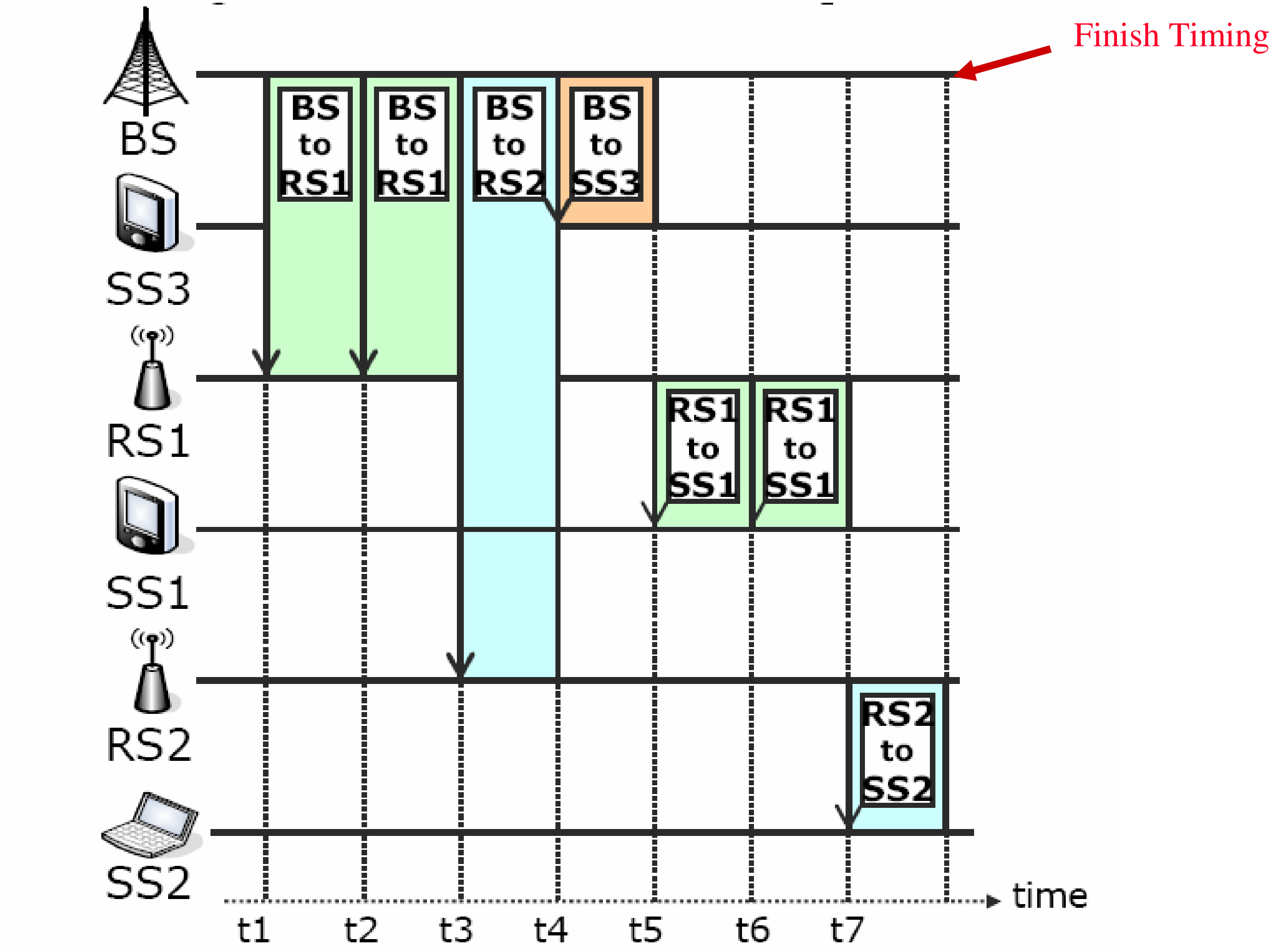


Overview of IEEE 802.16 MMR

- In IEEE 802.16 MMR, RS relays traffic between BS and SS for
  - Throughput enhancement
  - Coverage extension
- Because the MAP of IEEE 802.16 has no IEs in which the start timing overlaps the start timing of another IE, the BS and SS simple take turns to use the frequency

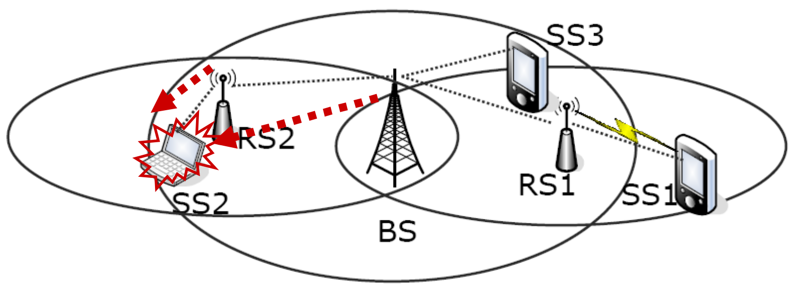


Downlink data transmission (IEEE 802.16 MMR)



Proposed MAP Multiplexing Approach

- Assumption
  - BS arranges the transmission timing for all SS including SS under RS
- Approach
  - SS needs to inform BS of the BS/RS identification that can be the interference for the communication
  - RNG-REQ message is modified for interference report
    - Interference occurs at SS2 if BS transmits a packet while RS 2 transmits a packet to SS2



Proposed MAP Multiplexing Approach

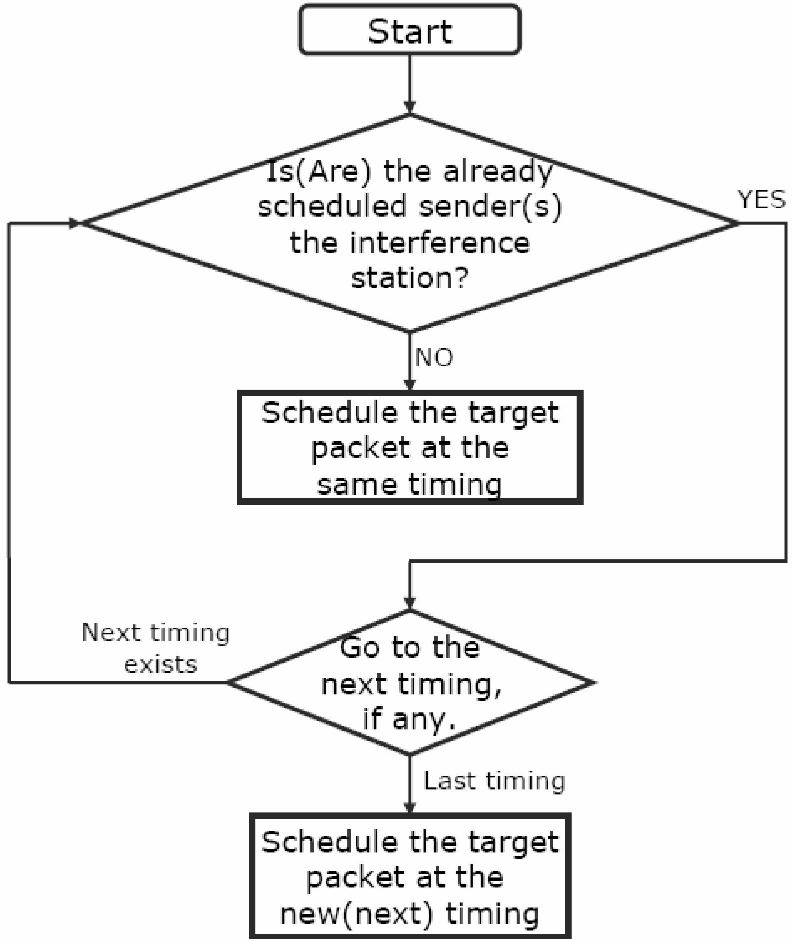
- Approach
  - SS management table is used to maintain the information on SS
    - Identification of SS
    - Point of attachment of SS
    - The interference stations informed by SS's RNG-REQ message

Table 1: SS-management table

SS	Point of attachment	Interference station
SS1	RS1	-
SS2	RS2	BS
SS3	BS	RS1
...	...	...

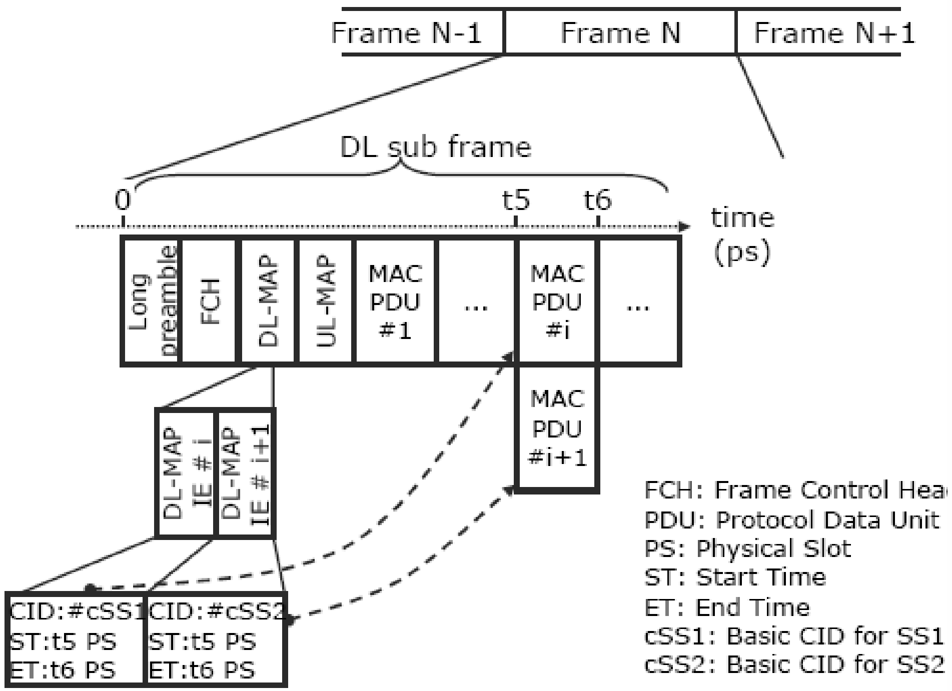
Proposed MAP Multiplexing Approach

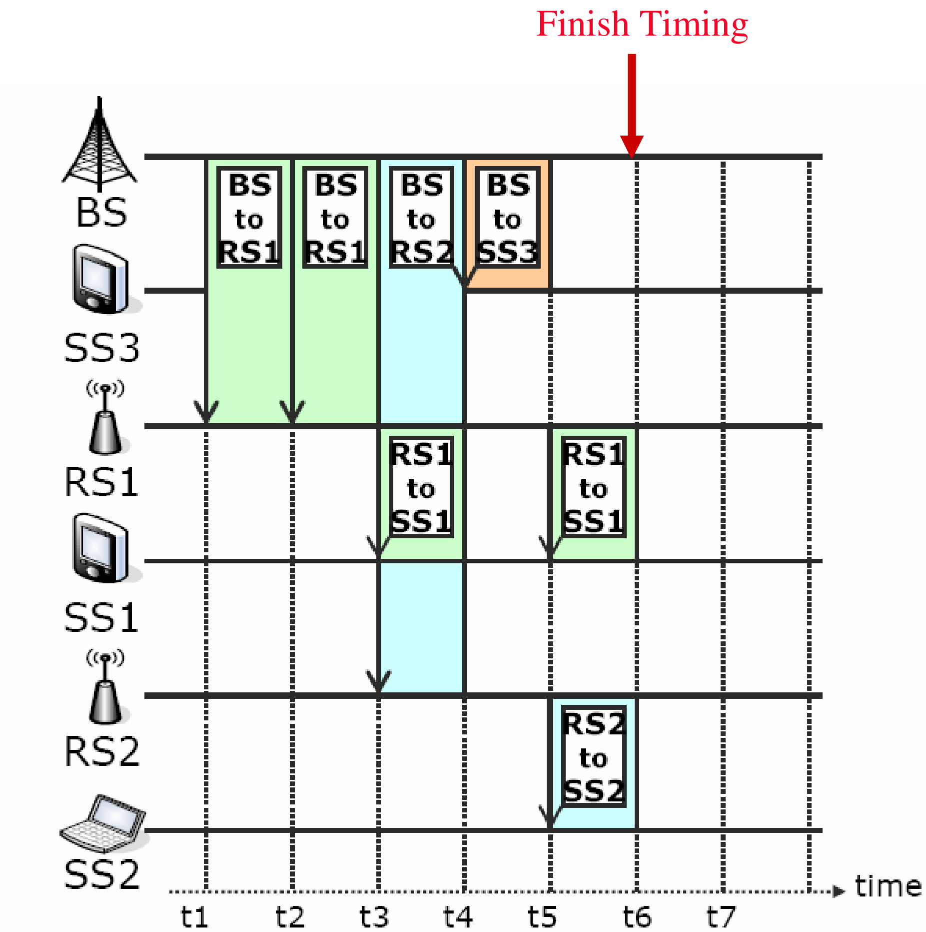
- When BS creates a MAP message
  - BS checks the SS management table and schedules packets unless interference occurs



Example algorithm

Proposed MAP Multiplexing Approach



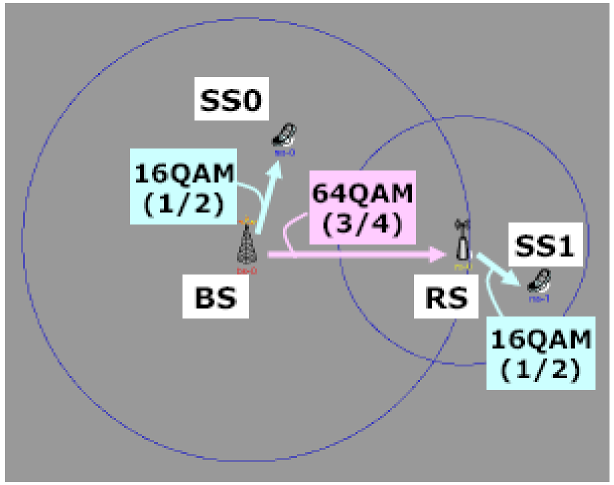


Performance Evaluation

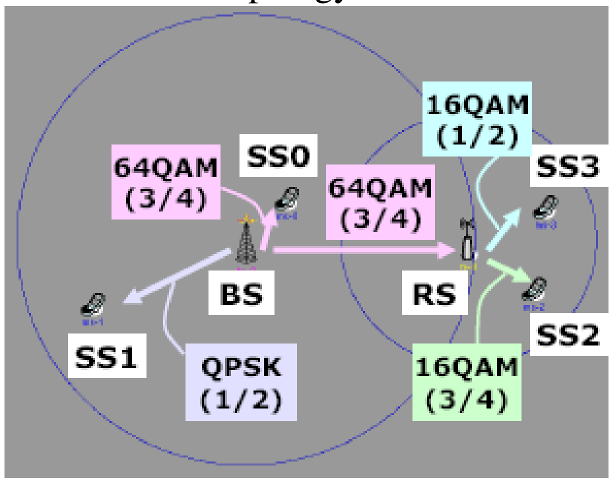
- Simulation Model

Table 2: Simulation parameters

System	IEEE 802.16-2004
PHY	OFDM
Frequency	2.5 GHz
Channel bandwidth	10 MHz
FFT size	256
Duplexing	TDD
Propagation model	Free space (BS-RS) Okumura-Hata
ANT height	30 m (BS, RS) 1.5m (SS)
PHY mode for broadcast	QPSK (1/2)
Offered traffic type	CBR/UDP
Offered traffic rate	2.8 Mbps/connection



Topology-1



Topology-2

Performance Evaluation

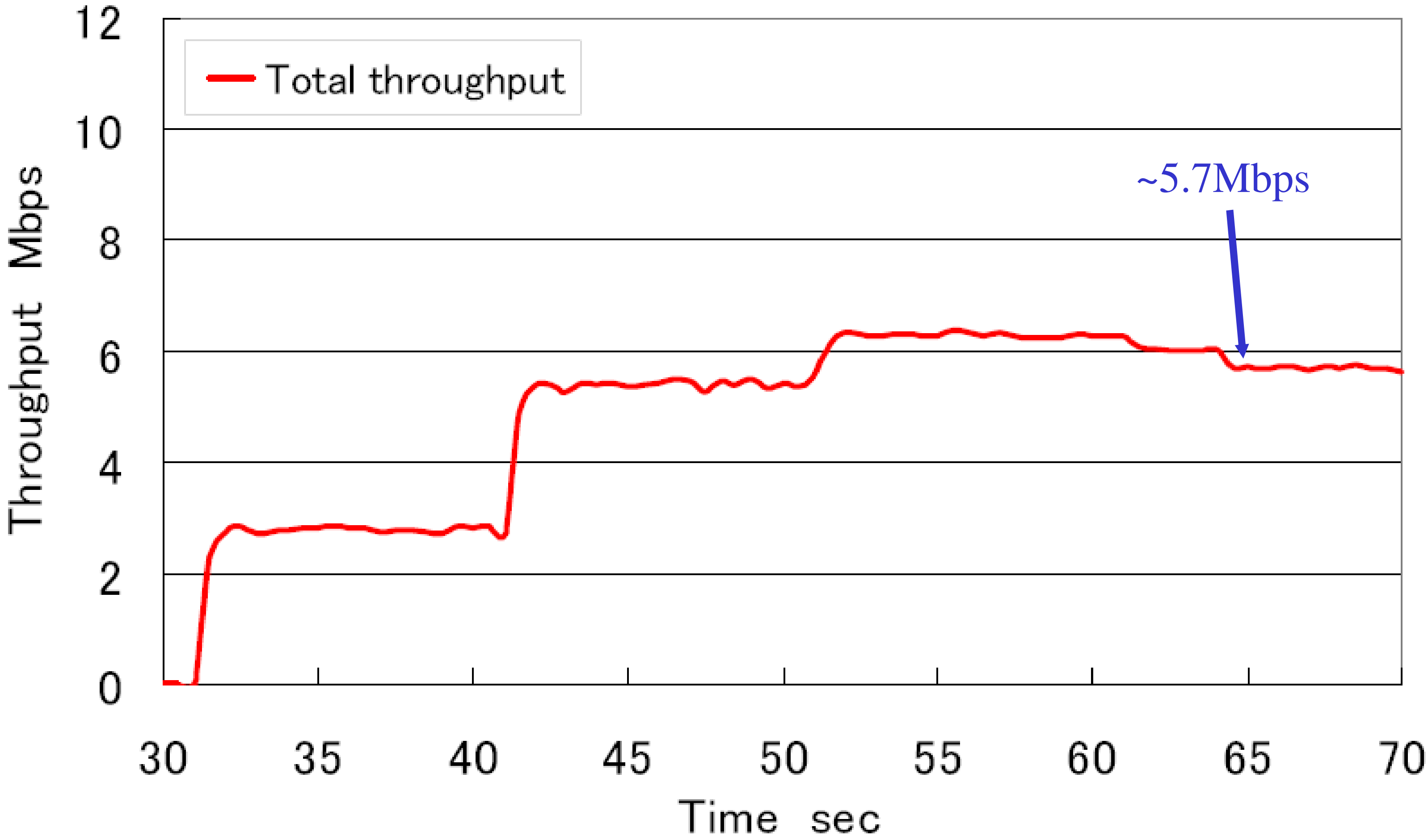
Table 3: Traffic pattern (topology-1)

Time (sec)	Connection name	Destination
30 – 70	CBR-0_1	SS0
40 – 70	CBR-0_2	SS0
50 – 70	CBR-1_1	SS1
60 – 70	CBR-1_2	SS1

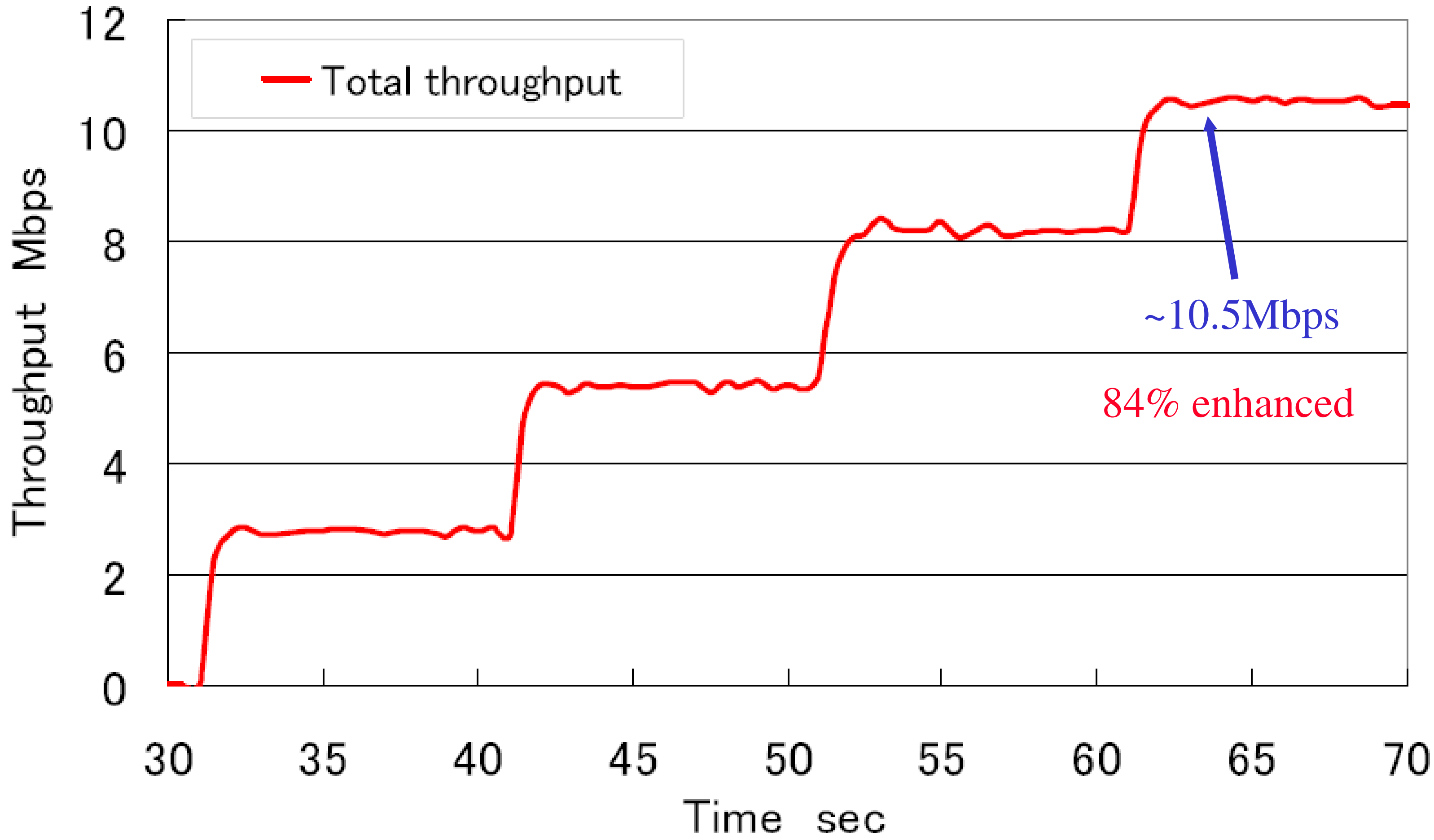
Table 4: Traffic pattern (topology-1)

Time (sec)	Connection name	Destination
30 – 70	CBR-0	SS0
40 – 70	CBR-1	SS1
50 – 70	CBR-2	SS2
60 – 70	CBR-3	SS3

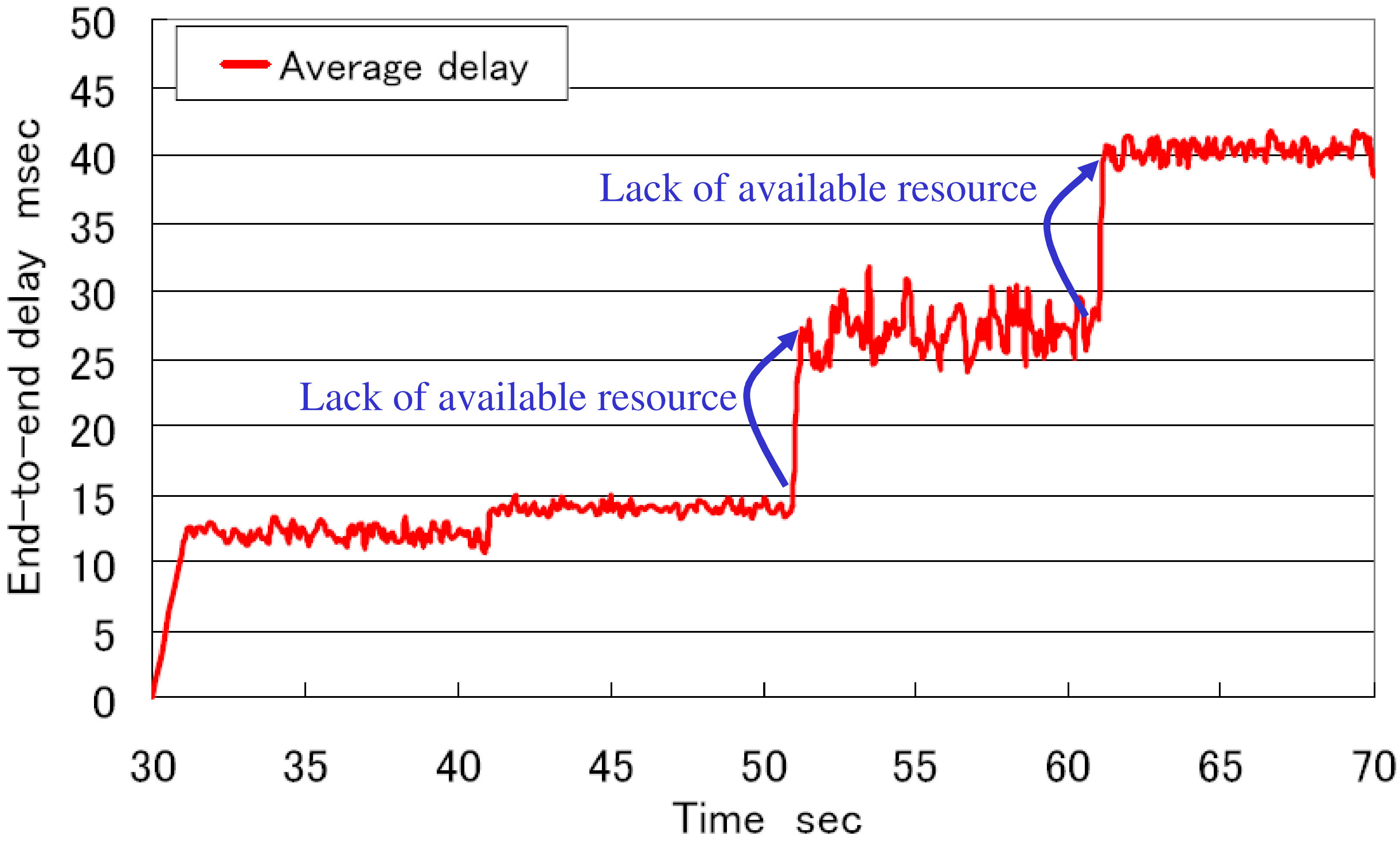
Total Throughput in topology – 1 (Normal MAP)



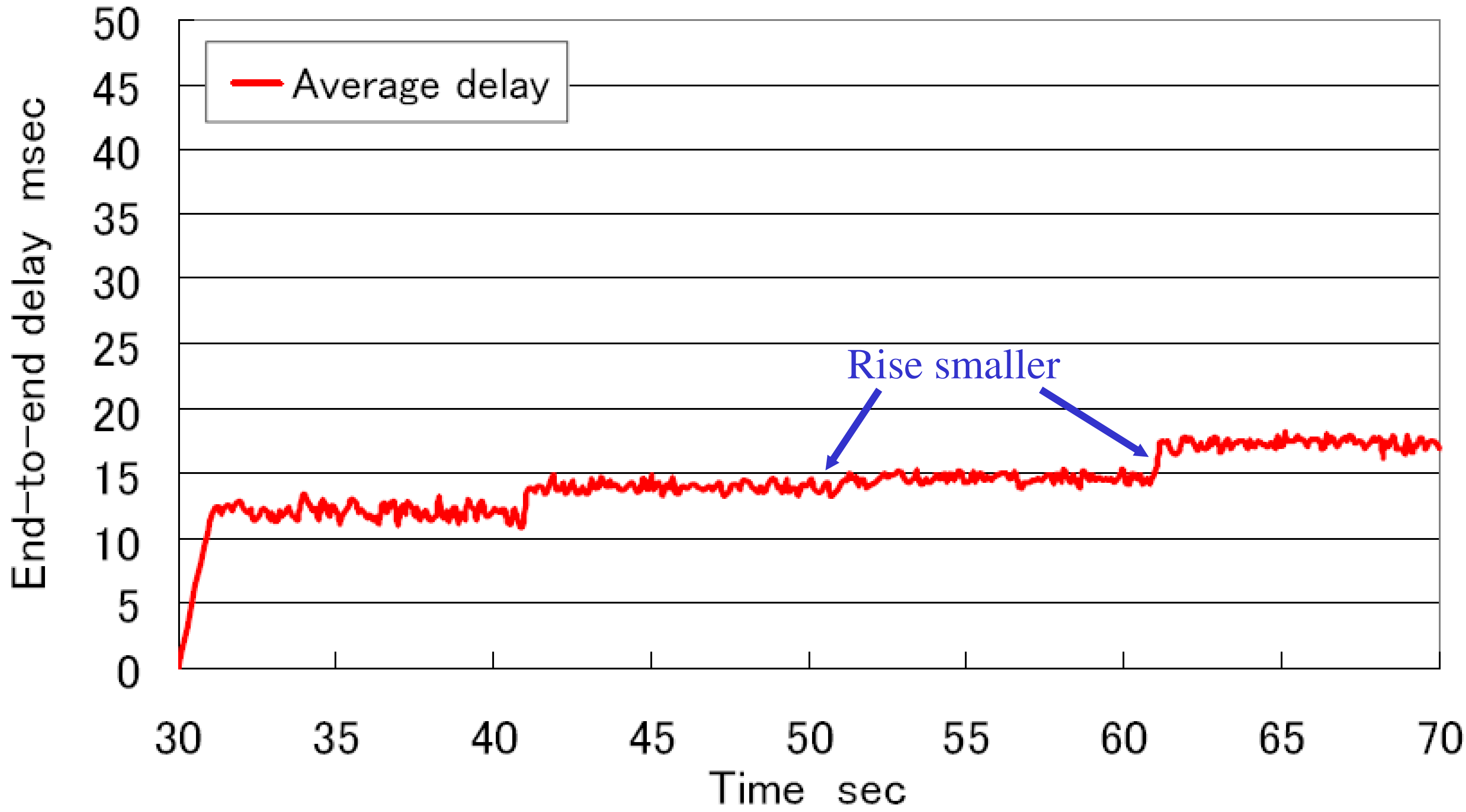
Total Throughput in topology – 1 (MAP Multiplexing)



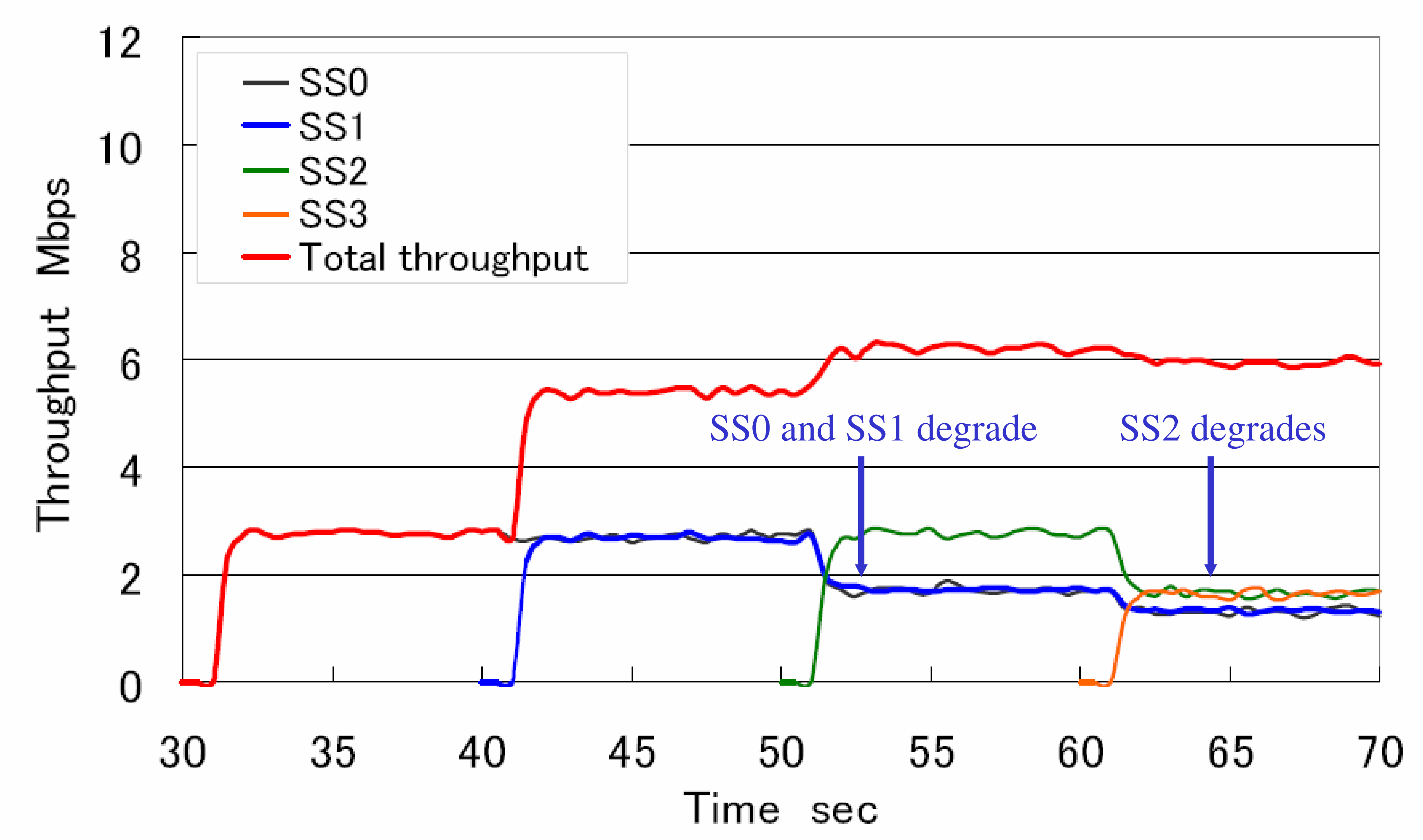
Average end-to-end delay in topology-1 (Normal MAP)



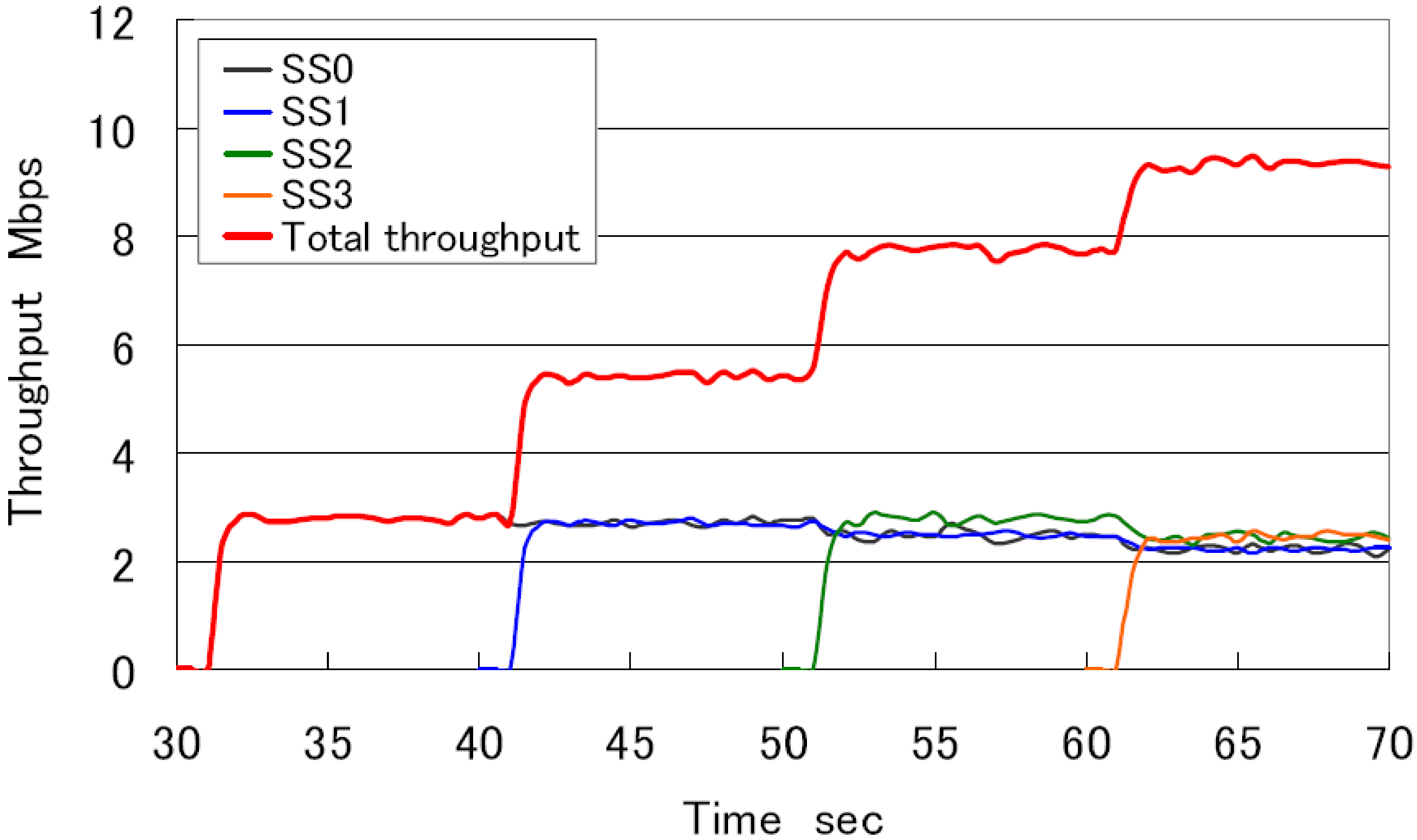
Average end-to-end delay in topology-1 (MAP Multiplexing)



Throughput of each connection (Normal MAP)



Throughput of each connection (MAP Multiplexing)



Conclusion

- The paper introduces a MAP Multiplexing approach to enhance the radio resource utilization under IEEE 802.16 MMR
  - Gathering proper interference information by SS is necessary MAP multiplexing
- MAP multiplexing reduces the end-to-end delay and the improves radio resource utilization
- Spatial Diversity