CS 525M – Mobile and Ubiquitous Computing Seminar

Fan Wu

IEEE 802.11 Wireless Local Area Networks

- Attributions
  - Title: “IEEE 802.11 Wireless Local Area Networks”
  - Authors: Brian P.Crow, The MITRE Corporation
    Indra Widjaja, Fujitsu Network Communications
    Jeong Geun Kim, University of Arizona
    Prescott T. Sakai, Cypress Semiconductor
  - Pubilshed in “IEEE Communications Magazine”, Sep. 1997

Why WLAN?

- Providing high bandwidth to users in a limited area
- Physical and environmental necessity
- The operational environment may not accommodate a wired network

Challenges and Constraints of WLAN

- Frequency Allocation
- Interference and Reliability
- Security
- Power Consumption
- Human Safety
- Mobility
- Throughput

Two WLAN standards

- High-Performance European Radio LAN
  - European Telecommunications Standards Institute(ETSI)
  - Transmission data rates up to 23.529 Mb/s
- IEEE 802.11 WLAN
  - IEEE
  - Transmission data rates 1 Mb/s with optional support for 2Mb/s

IEEE 802.11 WLAN (MAC Schemes)

- Distributed Coordination Function (DCF)
  - Similar to traditional legacy packet networks.
  - Support asynchronous data transmission: email, file transfer etc.
- Point Coordination Function(PCF)
  - Based on polling that is controlled by access point (AP)
  - Support delay-sensitive data transmission: packetized voice and video

Architecture

- Ad hoc Network (DCF)

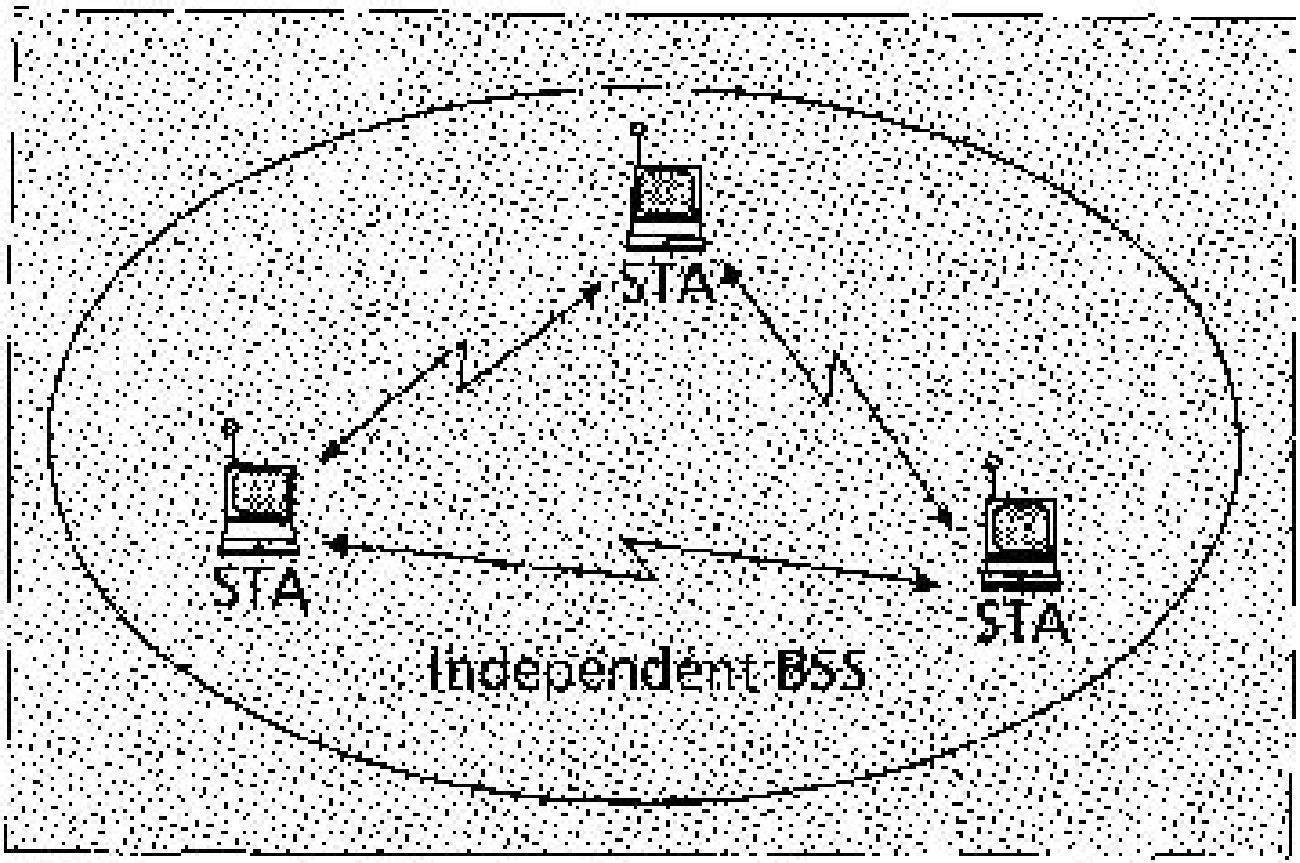
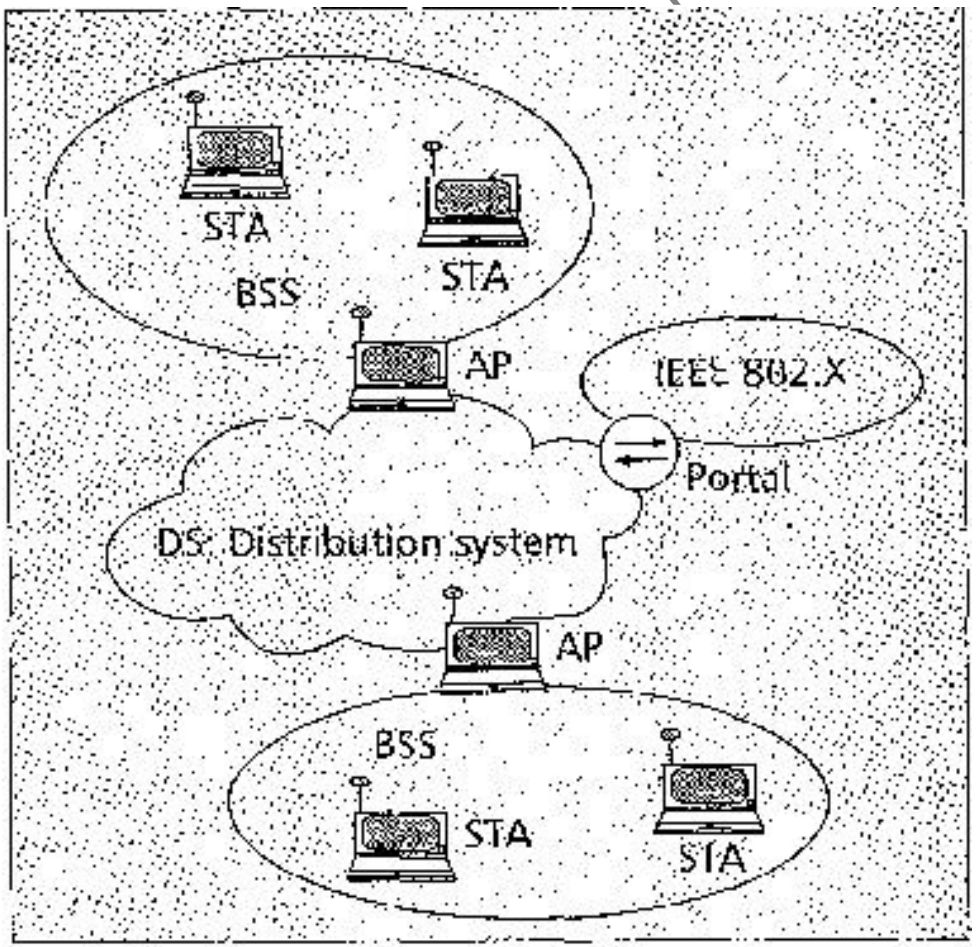


Figure 1. *Sketch of an ad hoc network.*

Architecture Cont.

- Infrastructure Network (DCF and PCF)



■ **Figure 2.** *Sketch of an infrastructure network.*

Physical Layer

- Frequency hopping spread spectrum(FHSS)
  - 2.4 GHz ISM Band
  - Two level Gaussian frequency shift keying for 1Mb/s
    Four level Gaussian frequency shift keying for 2Mb/s
- Direct sequence spread spectrum(DSSS)
  - 2.4 GHz ISM Band
  - Differential binary phase shift keying for 1Mb/s
    Differential quadrature phase shift keying for 2Mb/s
- IR
  - Wavelength range from 850 to 950 nm
  - 16-pulse position modulation for 1Mb/s
    4-pulse position modulation for 2Mb/s

Medium Access Control Sublayer

- Management Frame

  Station Association and disassociation with AP, timing and synchronization and so on

- Control Frame

  Handshaking during Contention period(CP), end the contention- free period(CFP)

- Data Frame

Medium Access Control Sublayer

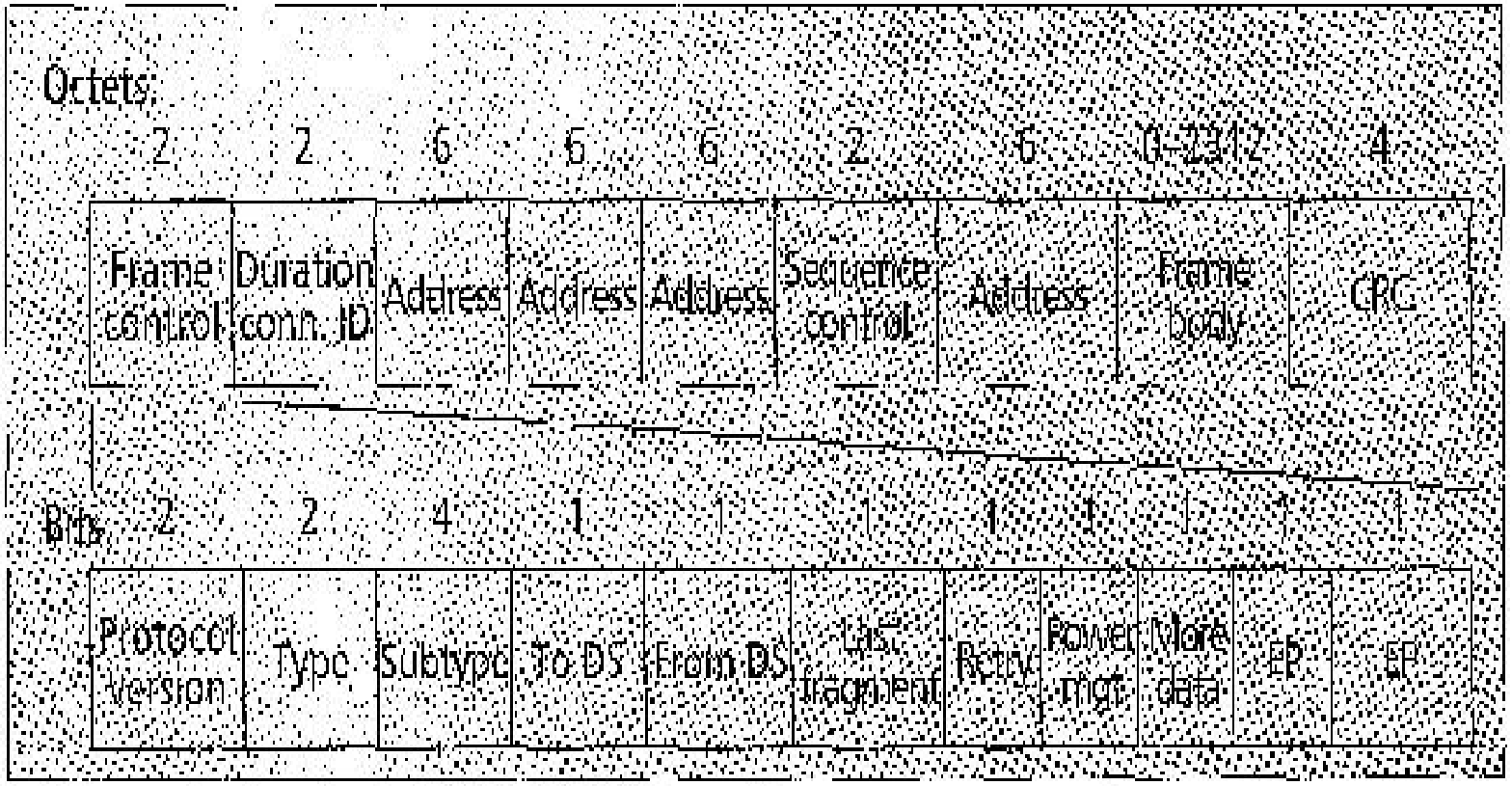
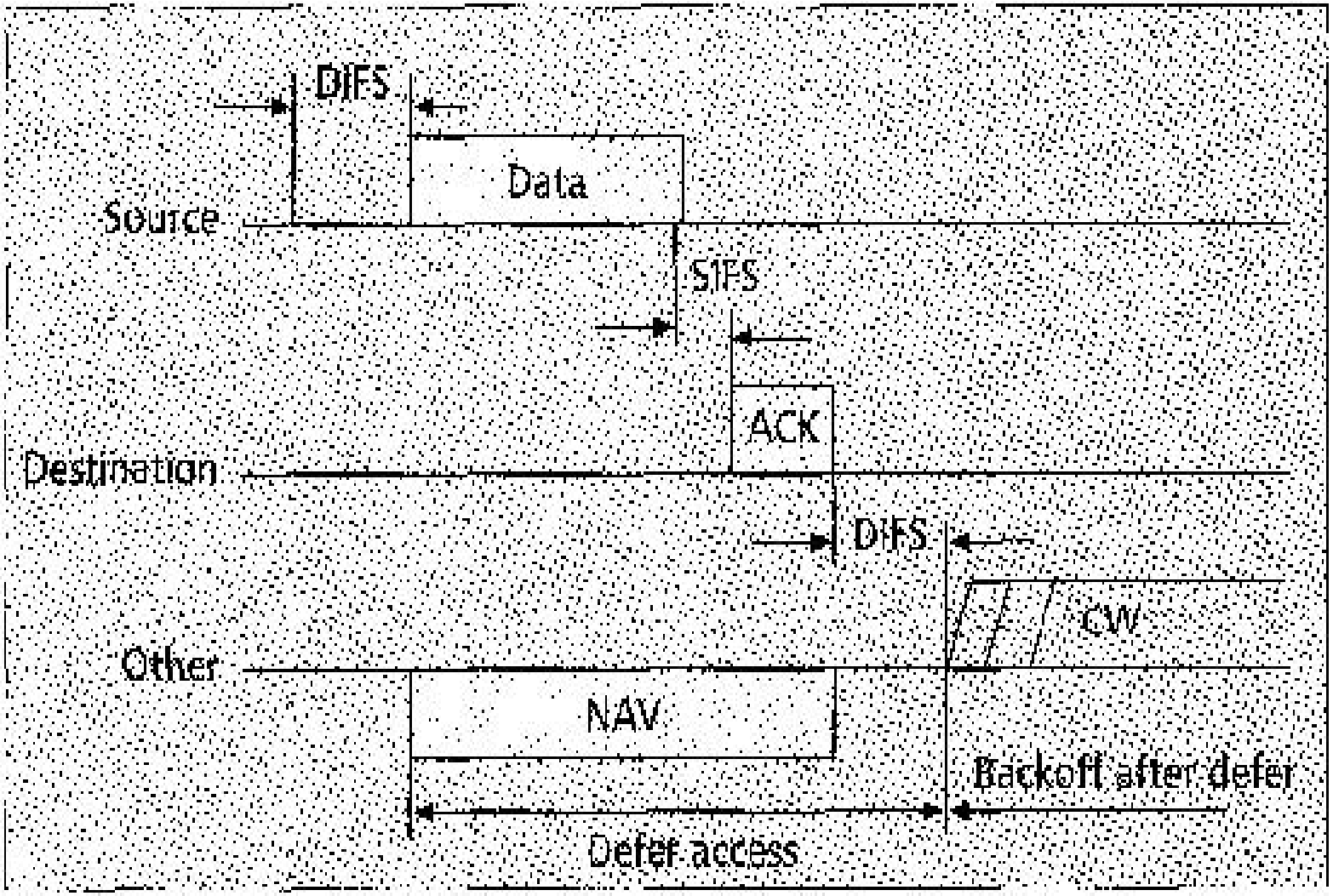


Figure 3. *Standard IEEE 802.11 frame format.*

Distributed Coordination Function(DCF)



■ Figure 5. *Transmission of an MPDU without RTS/CTS.*

Distributed Coordination Function(DCF)

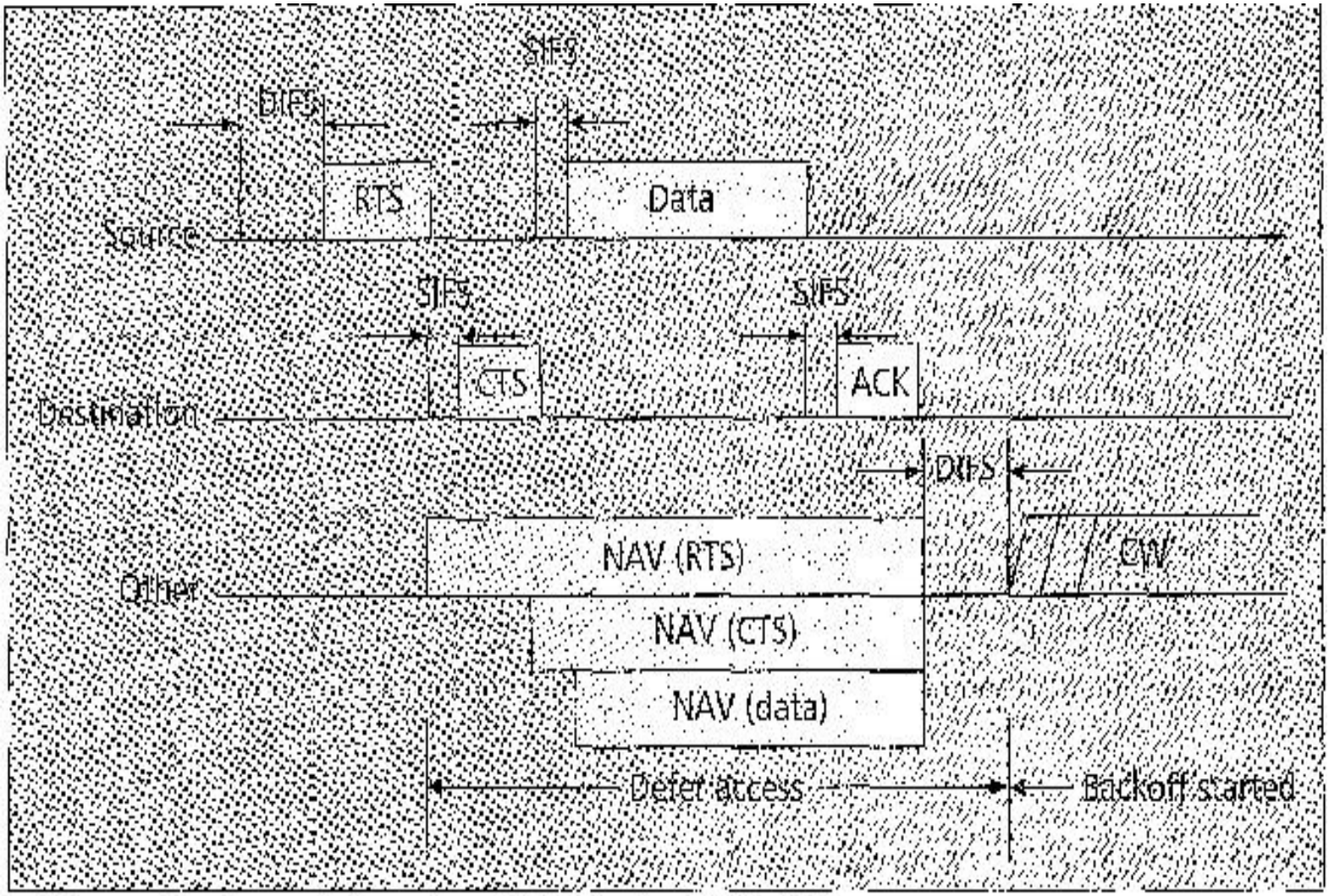


Figure 6. *Transmission of an MPDU using RTS/CTS.*

Distributed Coordination Function(DCF)

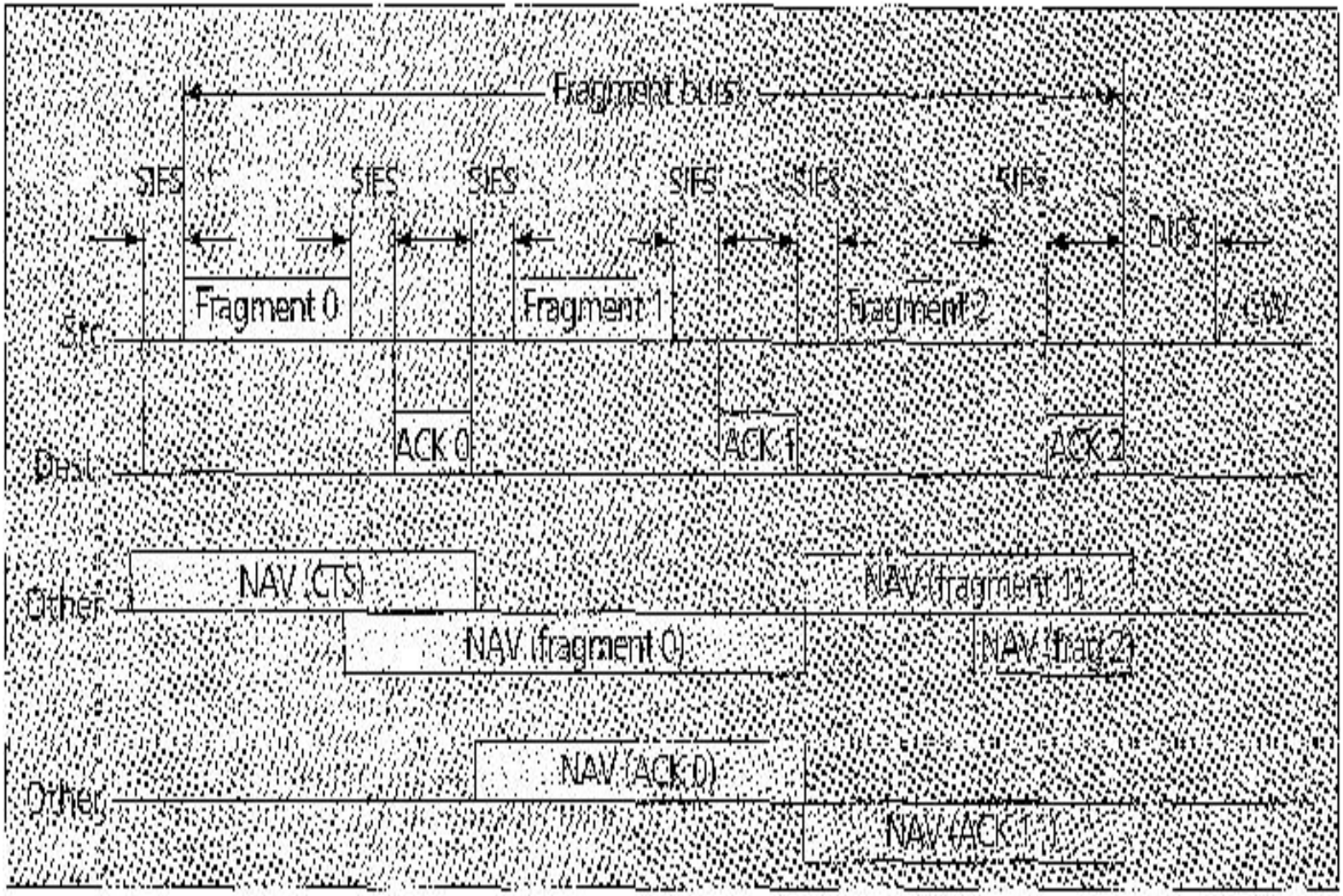


Figure 7. *Transmission of a fragmented MPDU.*

Point Coordination Function(PCF)

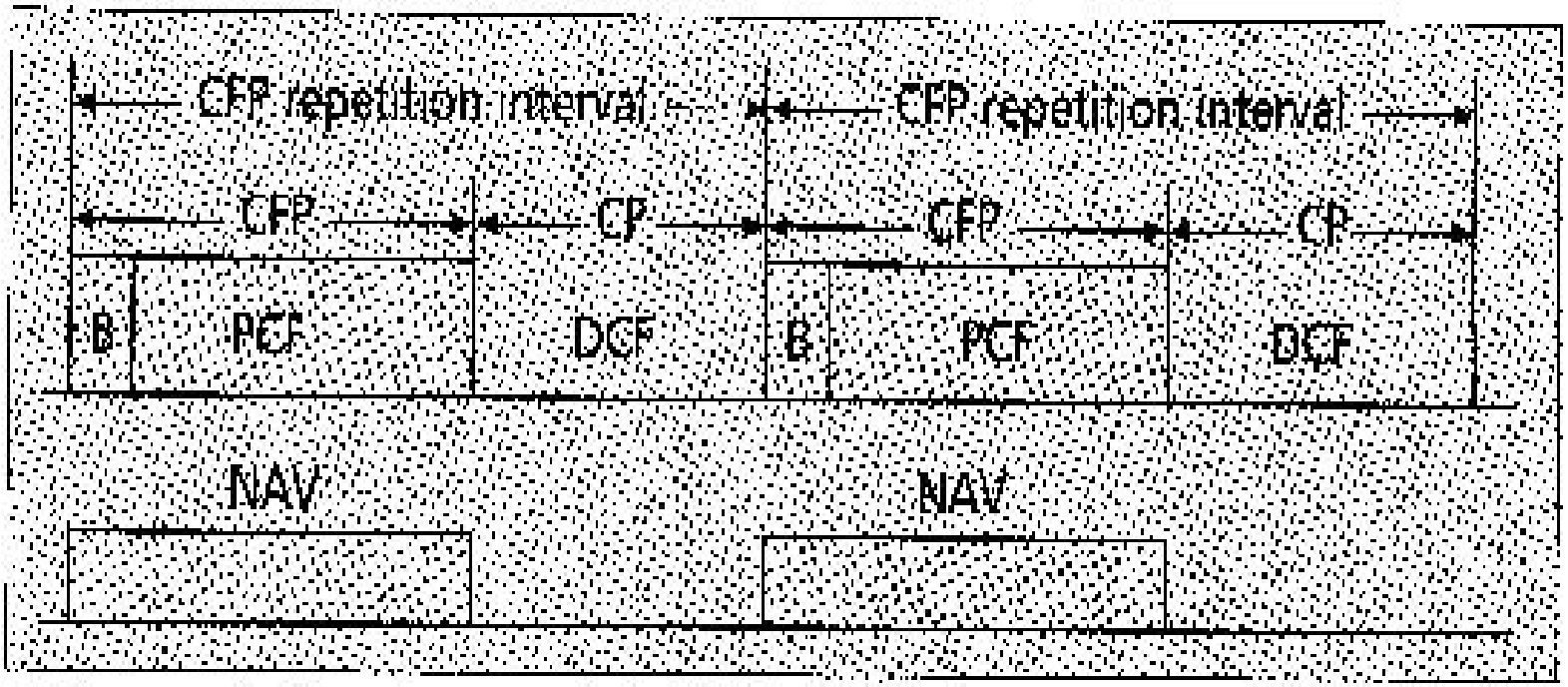


Figure 8. *Coexistence of the PCF and DCF.*

Point Coordination Function(PCF)

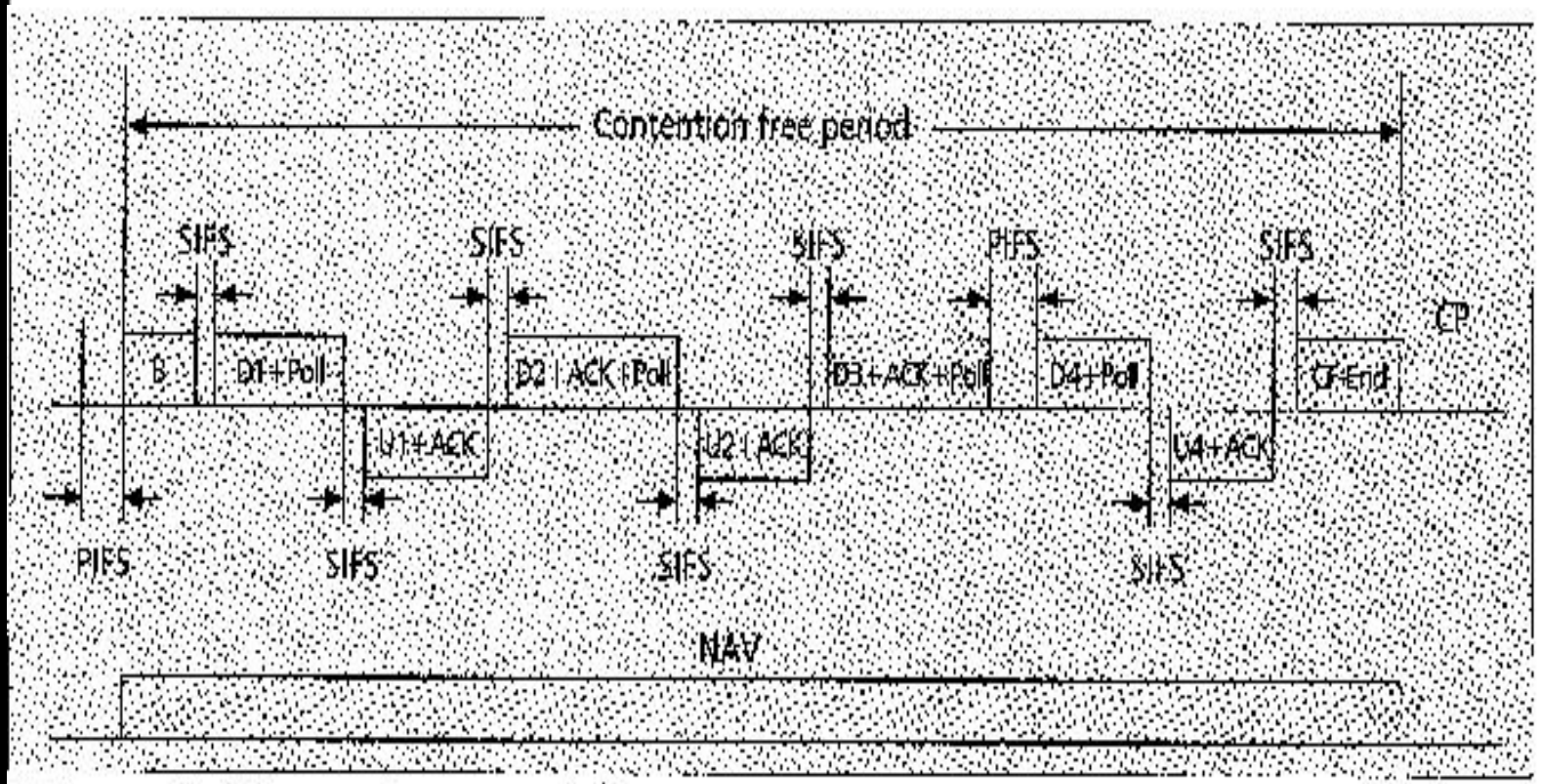
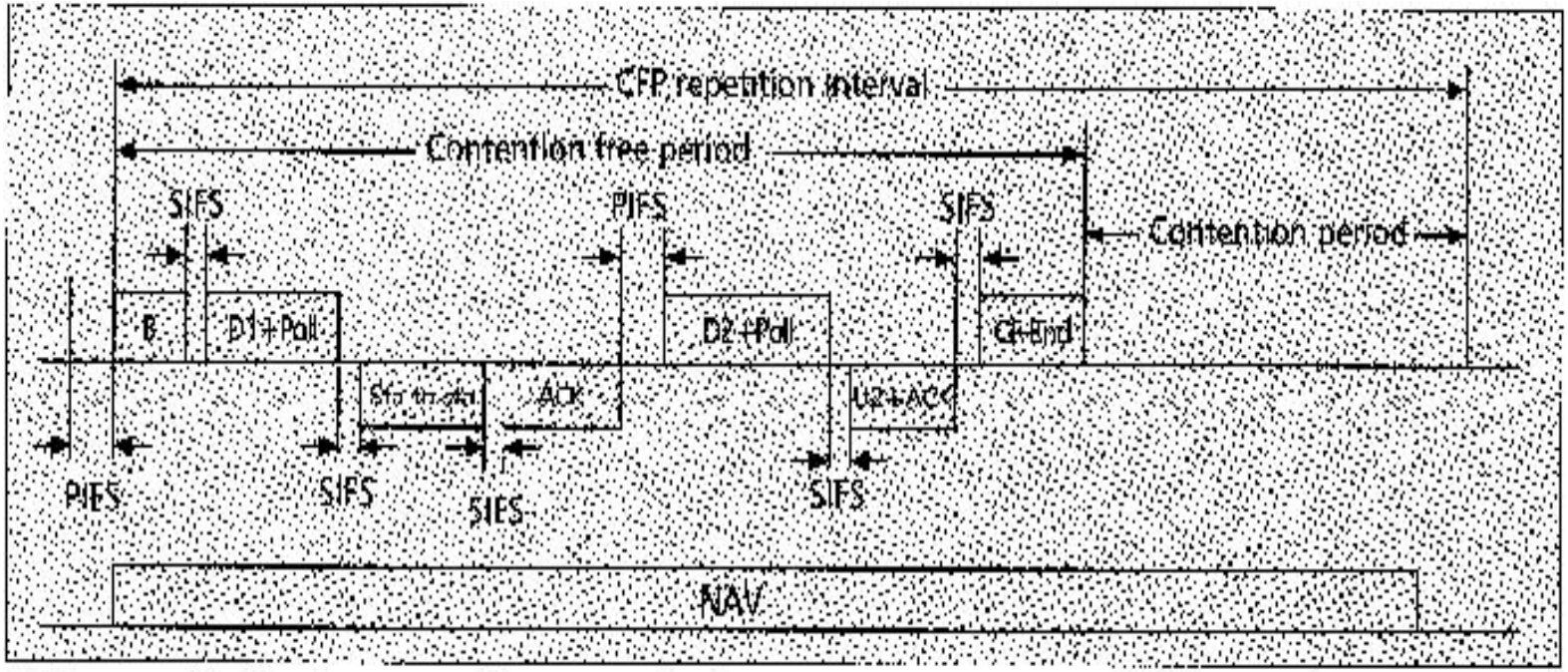


Figure 9. *PC-to-station transmission.*

Point Coordination Function(PCF)



■ Figure 10. *Station-to-station transmissions.*

Simulation Model

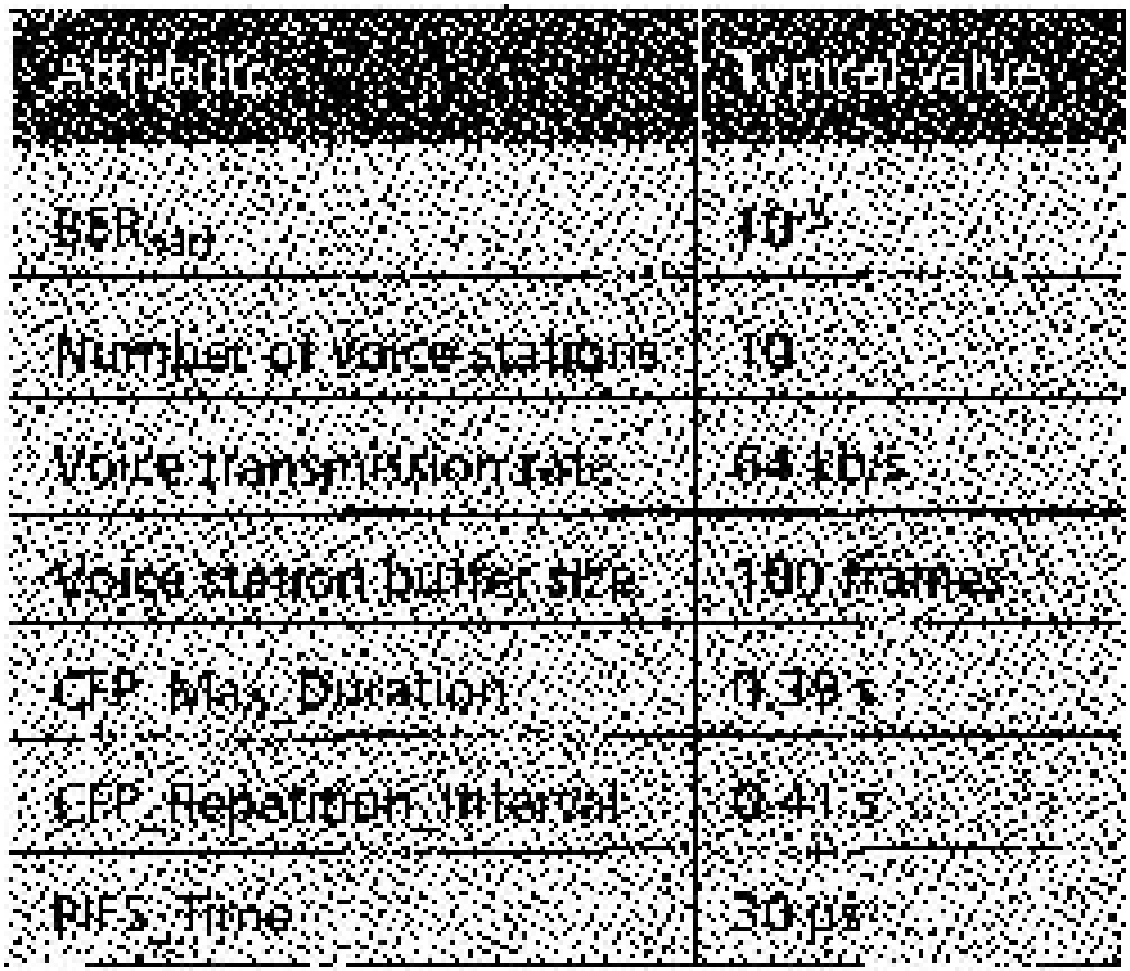
- The effect of propagation delay on the model are neglected
- The basic rate of 1Mb/s was simulated for the DSSS.
- No stations operate in the “power-saving” mode
- No interference is considered from nearby BSSs reusing the same DSSS spreading sequence

Ad hoc network model

Attribute	Typical value
Data stations	10
Average MSDU length	1000 octets
Channel rate	1 Mb/s
BER used	10^{-5}
α	$30\ s^{-1}$
β	$10\ s^{-1}$
RTS Threshold	250 octets
Fragmentation Threshold	2000 octets
Short Retry Limit	5
Long Retry Limit	7
DSSS preamble	144 bits
DSSS header	48 bits
Station buffer size	300 frames
Slot Time	20 μs
SIFS Time	10 μs
DIFS Time	50 μs

Table 1. *Default attribute values for the ad hoc network unless otherwise specified.*

Infrastructure network model



Attribute	Typical value
BER_{av}	10^{-6}
Number of voice stations	19
Voice transmission rate	64 kb/s
Voice station buffer size	100 frames
CFP_Max_Duration	0.39 s
CFP_Repetition_Interval	0.41 s
PIFS_Time	30 μs

Table 2. *Default attribute values for the infrastructure network unless otherwise specified.*

Ad hoc network

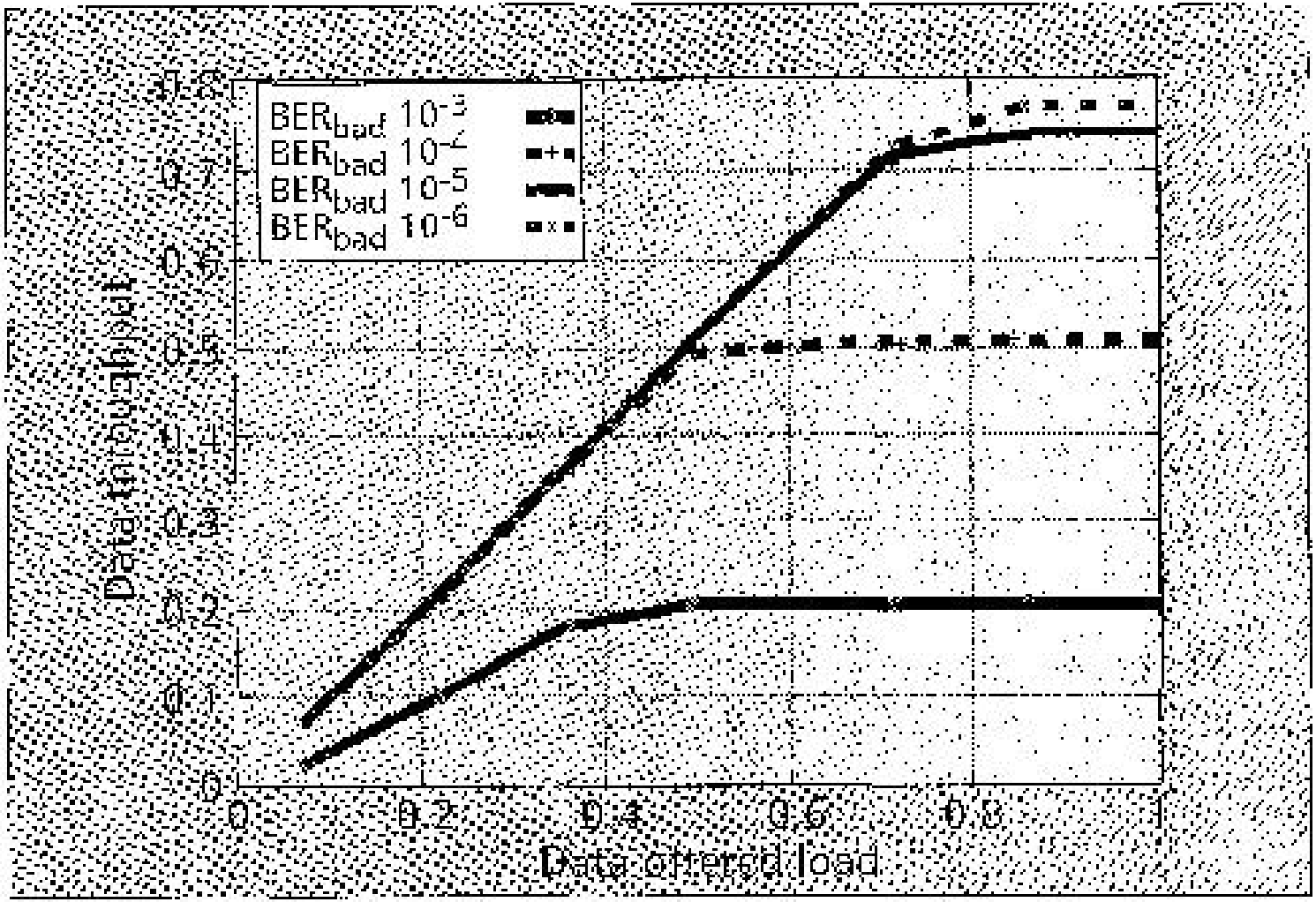
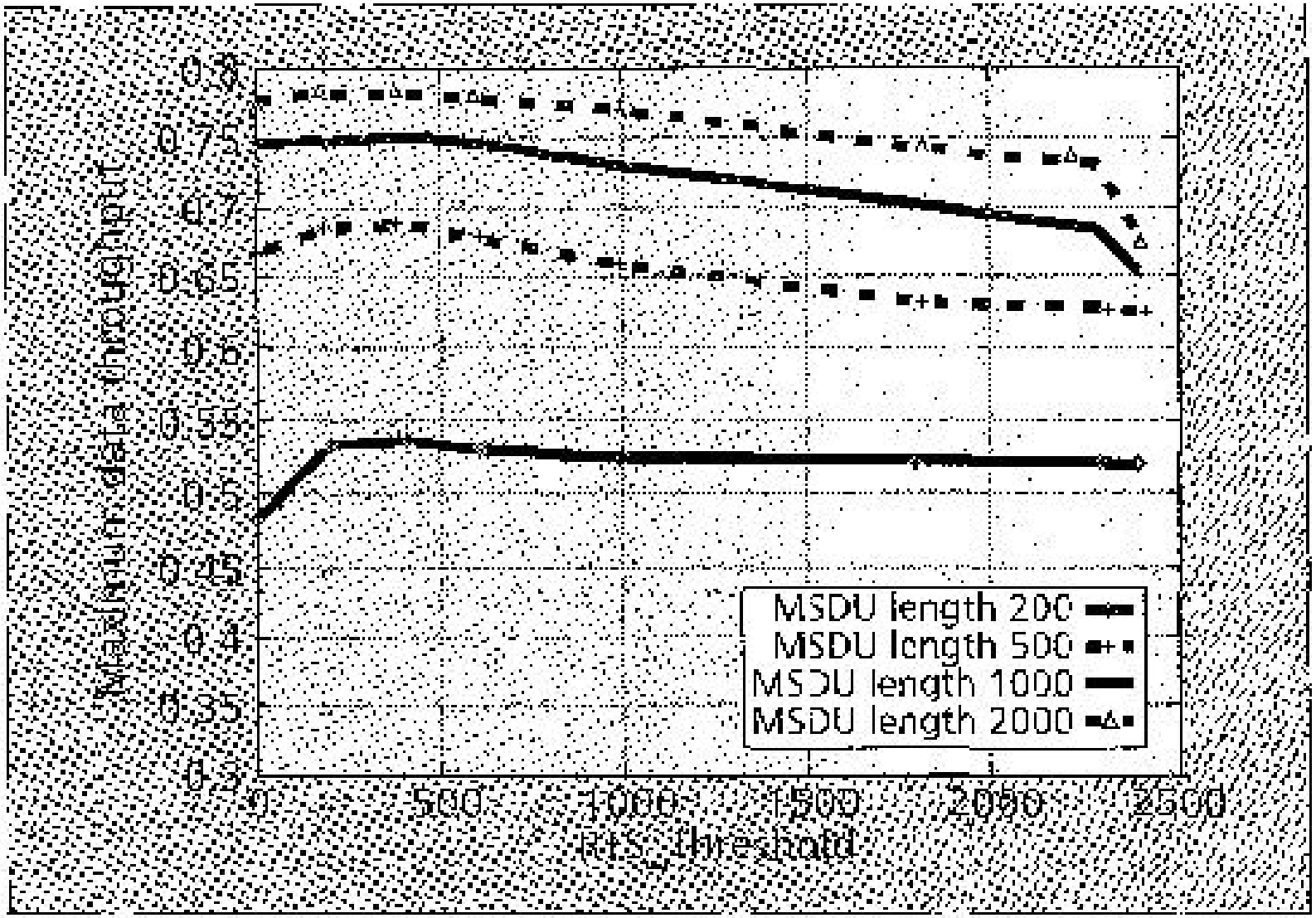


Figure 11. *Burst error effects on data throughput.*

Ad hoc network



■ Figure 12. *RTS_Threshold effects on data throughput.*

Ad hoc network

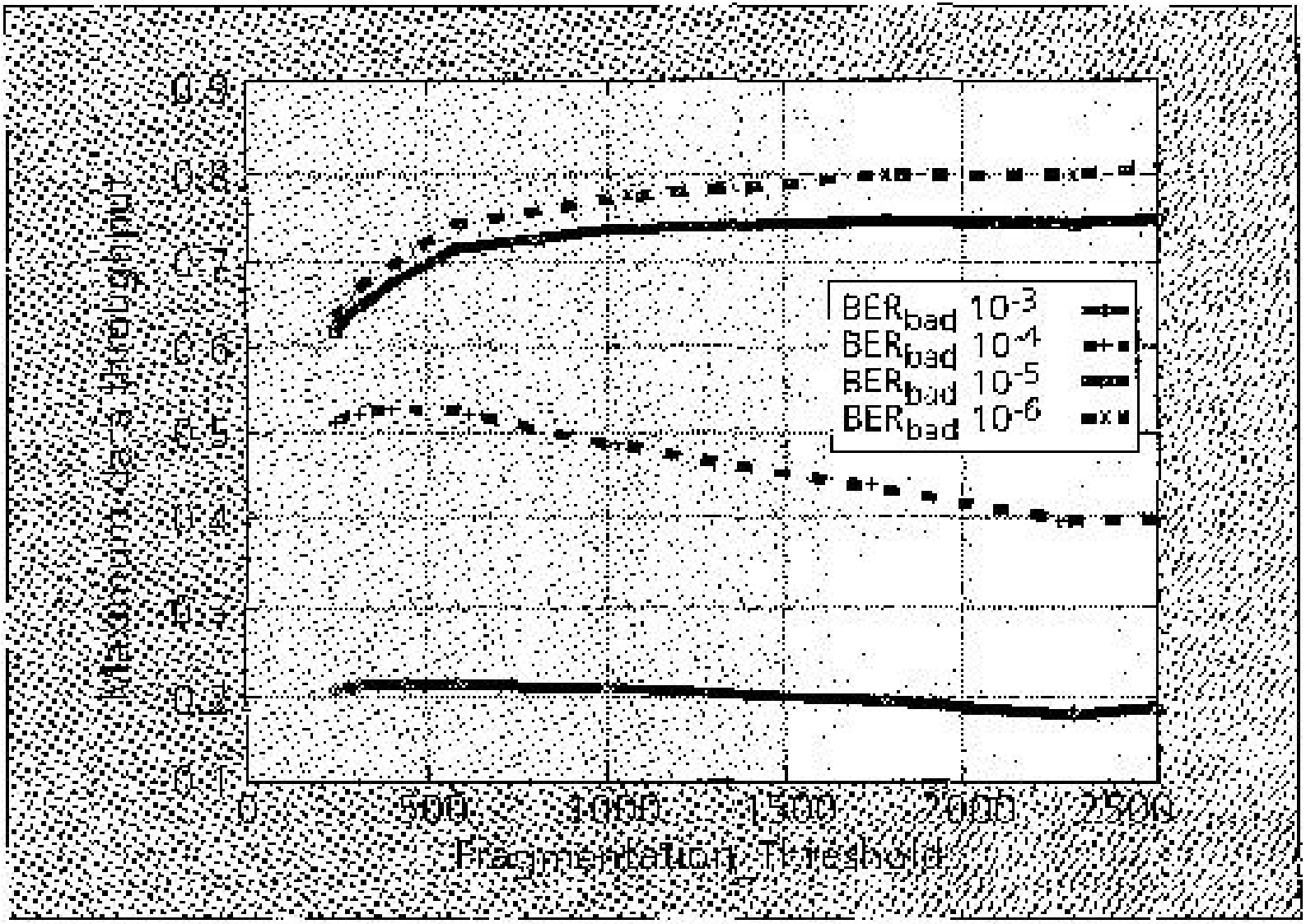


Figure 13. *Fragmentation_Threshold effects on data throughput.*

Infrastructure network

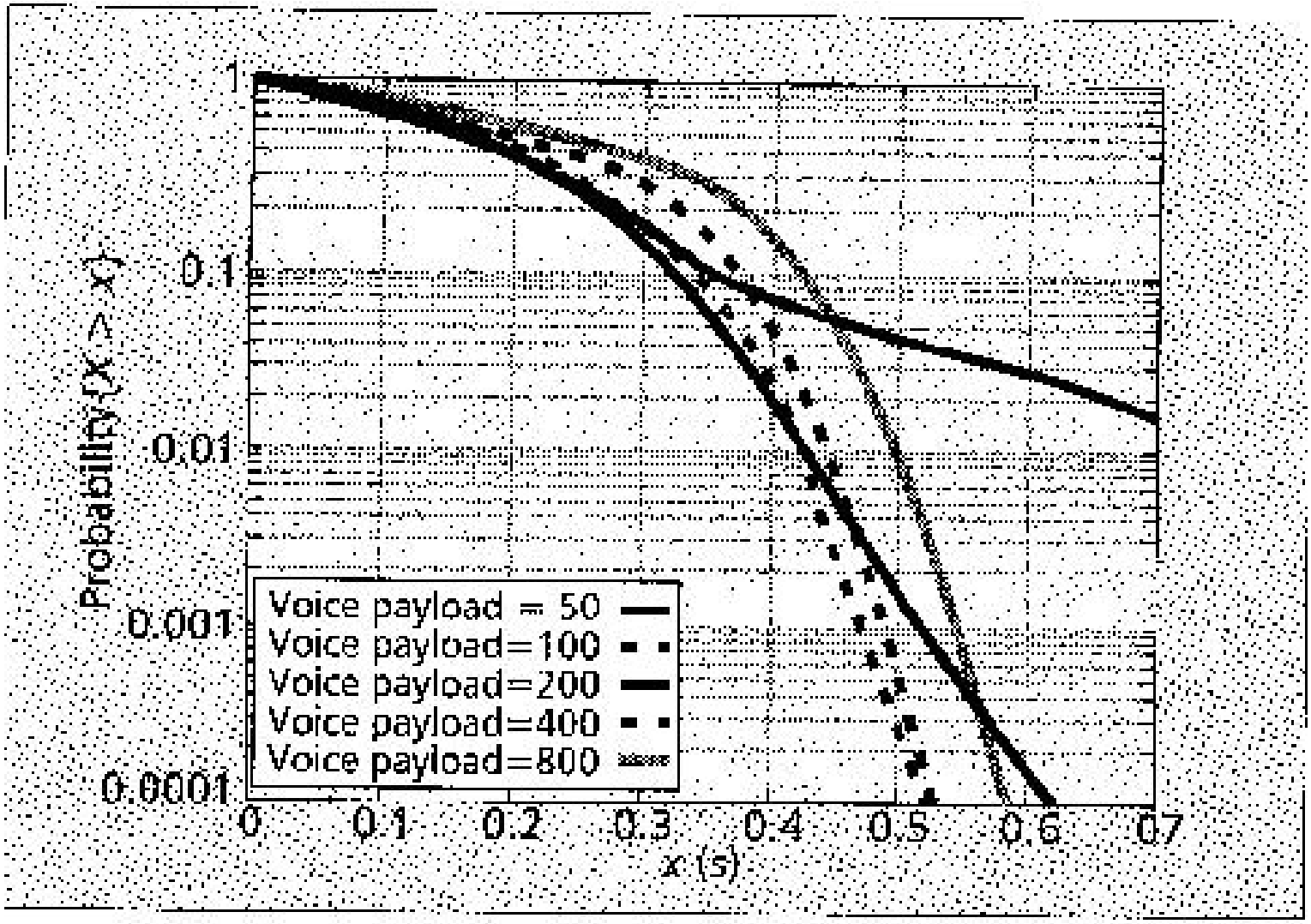


Figure 15. *Complemenary cumulative distribution for voice delay.*

Infrastructure network

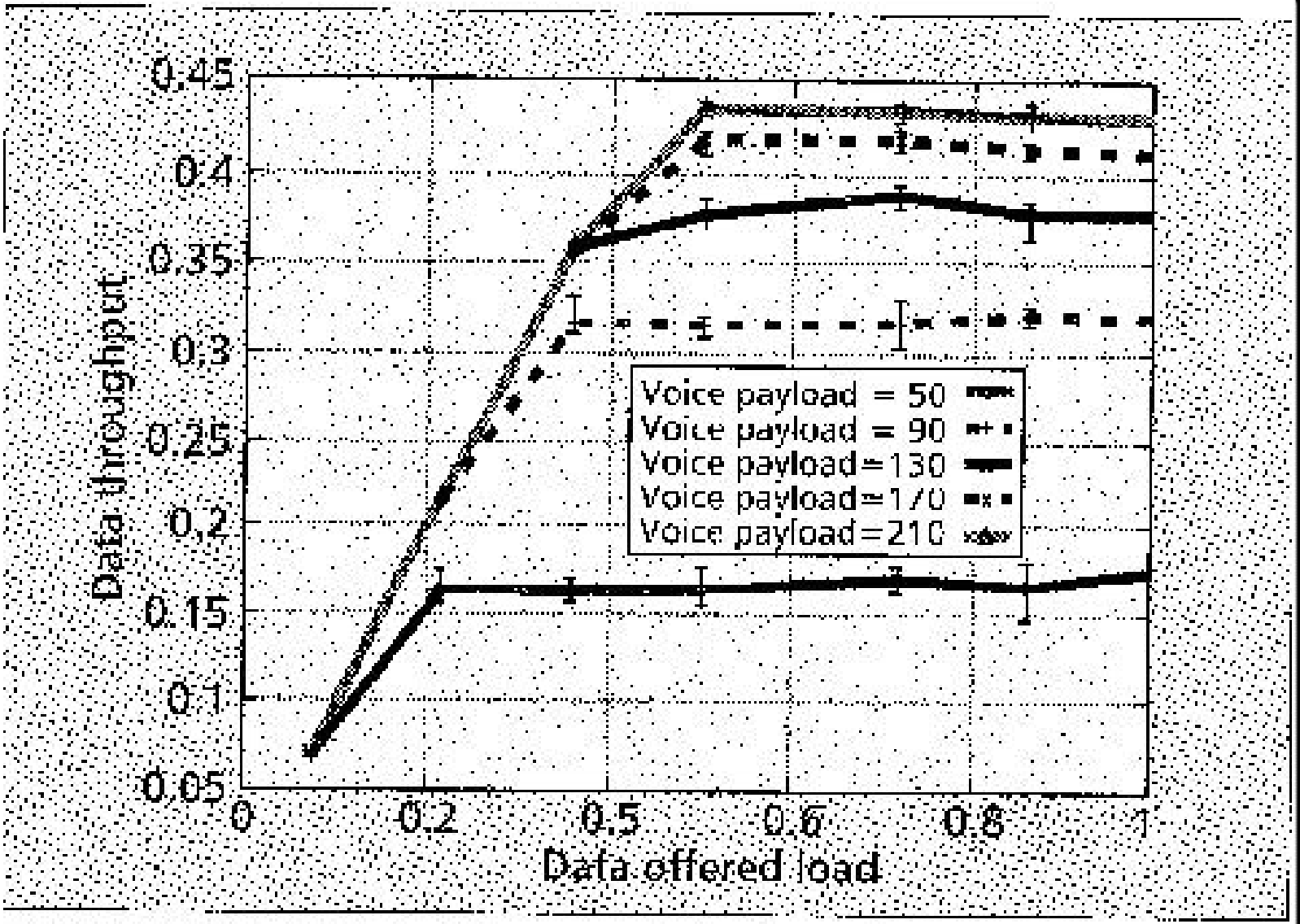


Figure 16. *Effect of* 1_{voice} *on data throughput.*

Infrastructure network

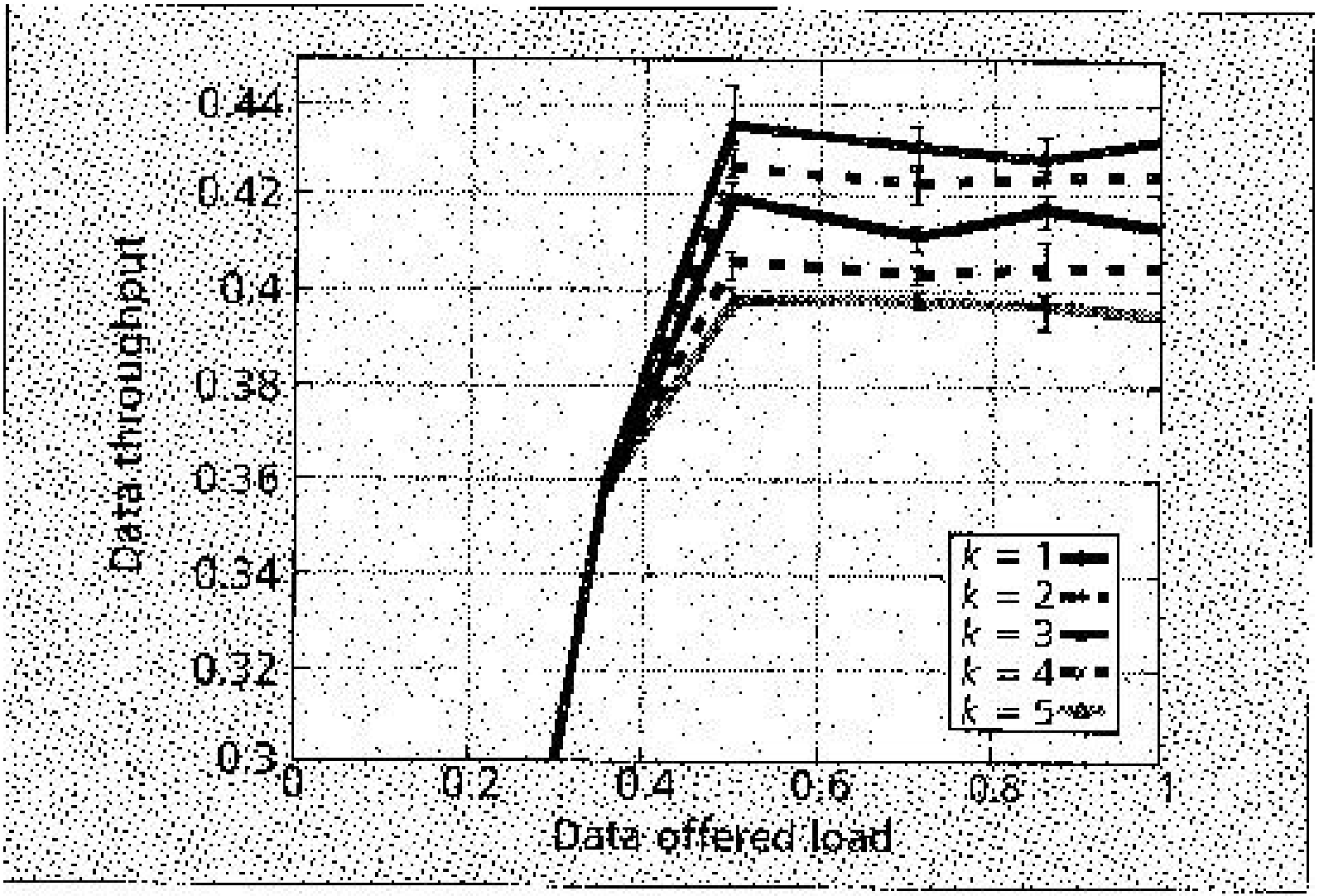


Figure 17. *Data throughput vs. offered load for several values of k.*

Infrastructure network

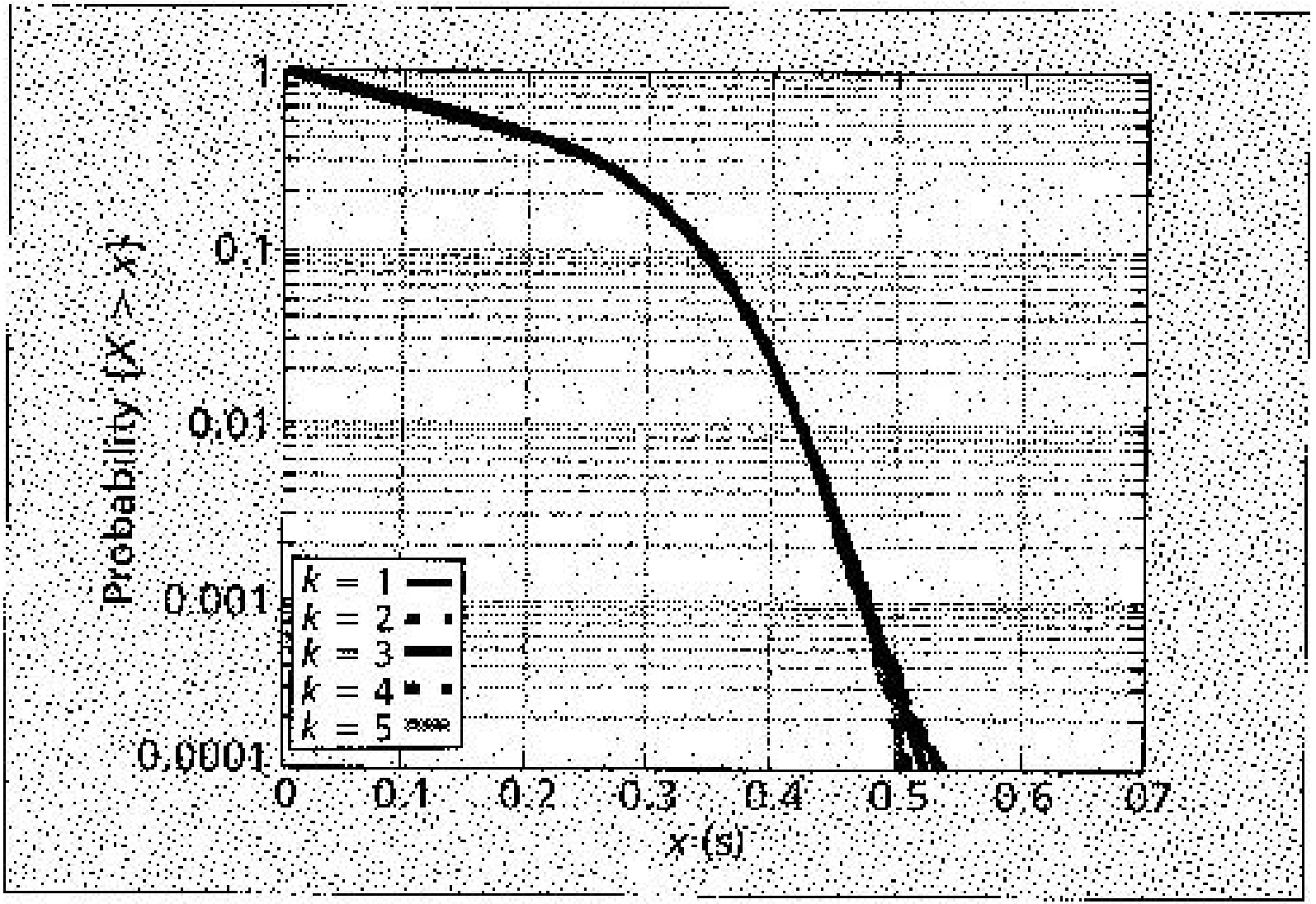


Figure 18. *Effect of k on voice delay.*

Infrastructure network

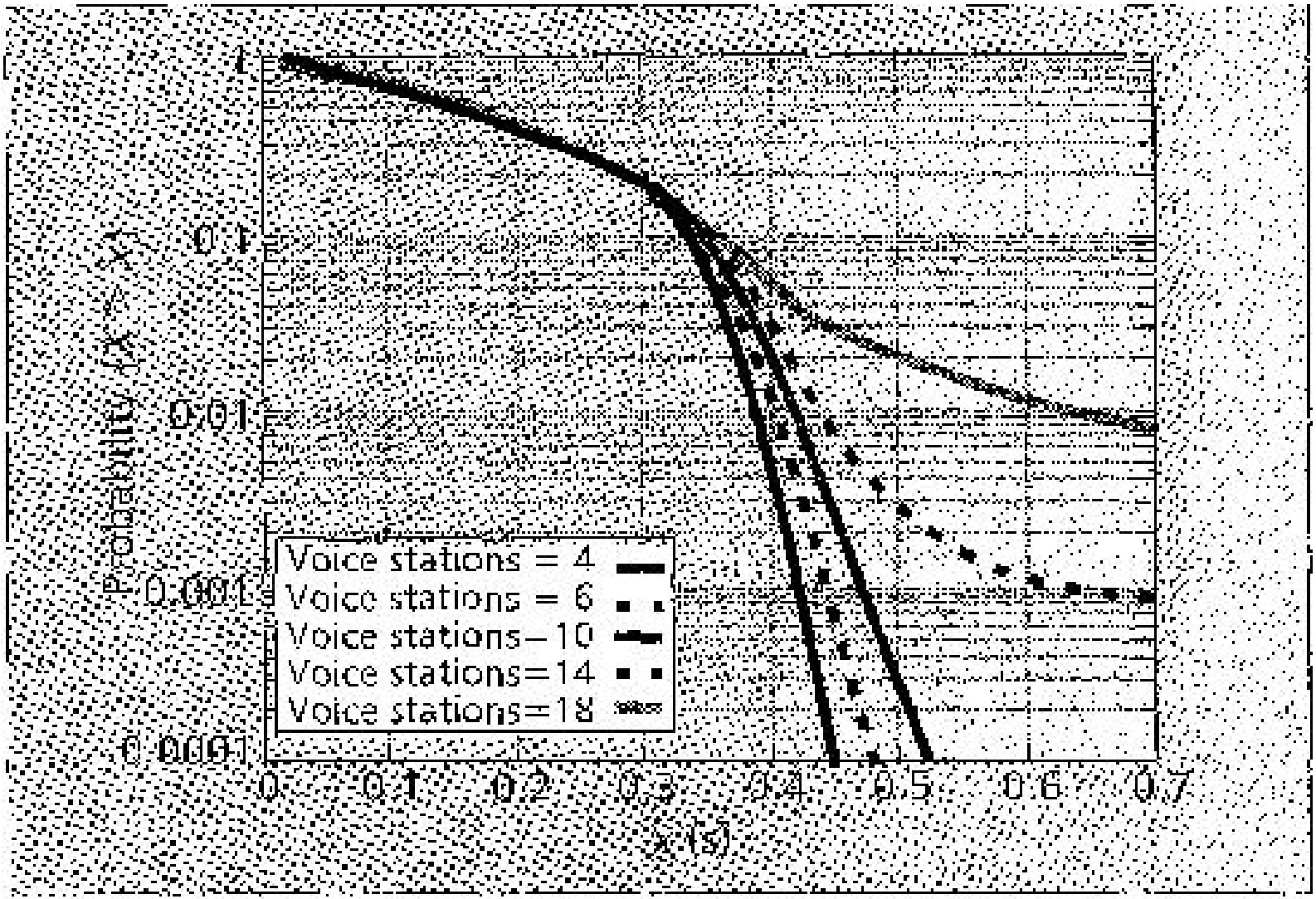


Figure 19. *Effect of voice stations on voice delay.*

Conclusion

- The MSDU length is set to 800 octets, the RTS_Threshold is set to 250 octets
- Pack voice systems must employ an echo canceler
- Compromised performance for both data and voice payload length is approximately 200 octets long.
- When a voice does not have any data to receive and transmit during a poll, the station should be dropped from the list immediately (k=1)