Universität Würzburg - Lehrstuhl für Informatik III

4. Würzburger Workshop - 27/28 July, 2004

„IP Netzmanagement, IP Netzplanung und Optimierung“

Performance Comparison of Reservation MAC Protocols

Dr.-Ing. Halid Hrasnica

Chair for Telecommunications, Dresden University of Technology

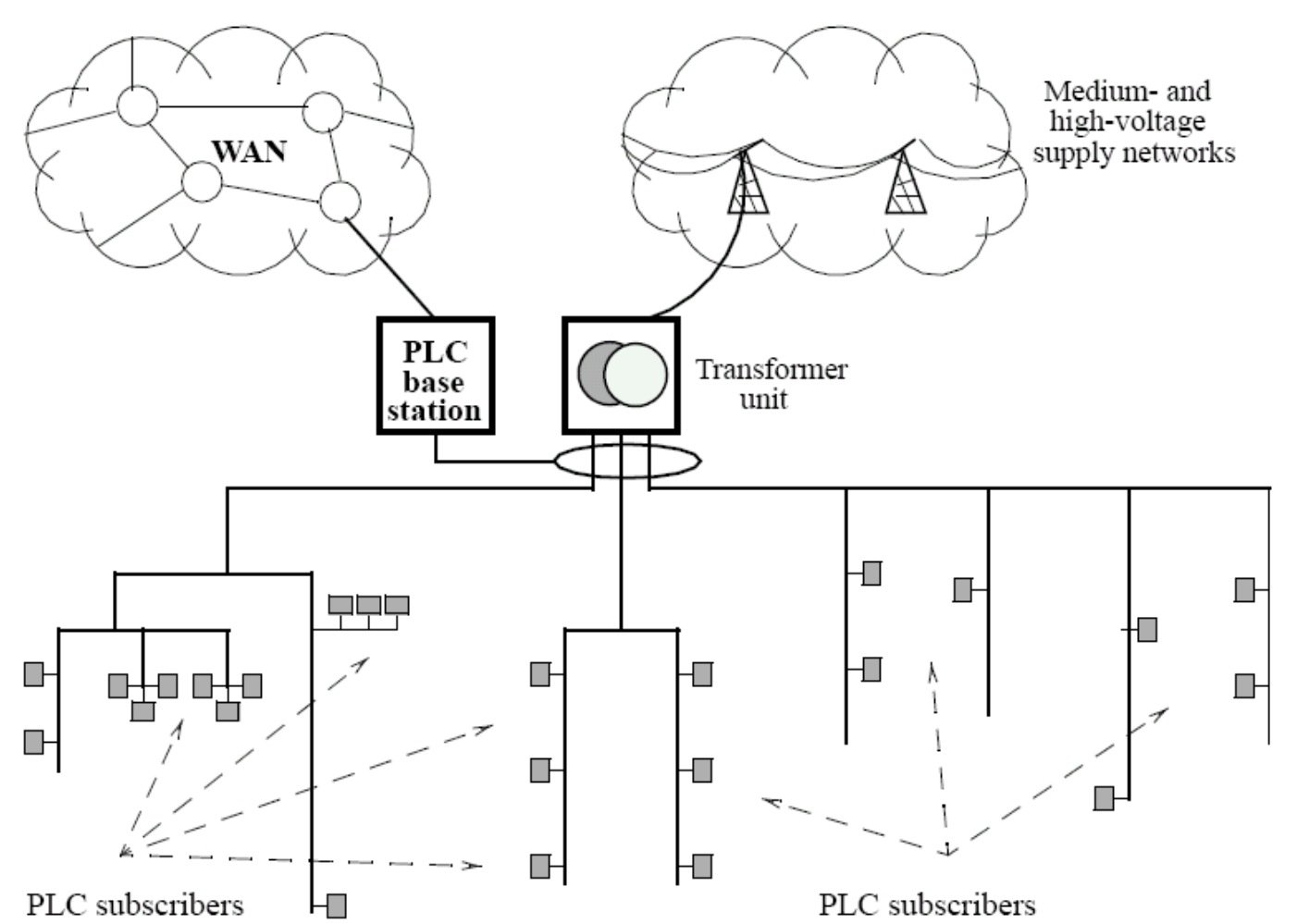
D-01062 Dresden, Germany

E-mail: hrasnica@ifn.et.tu-dresden.de

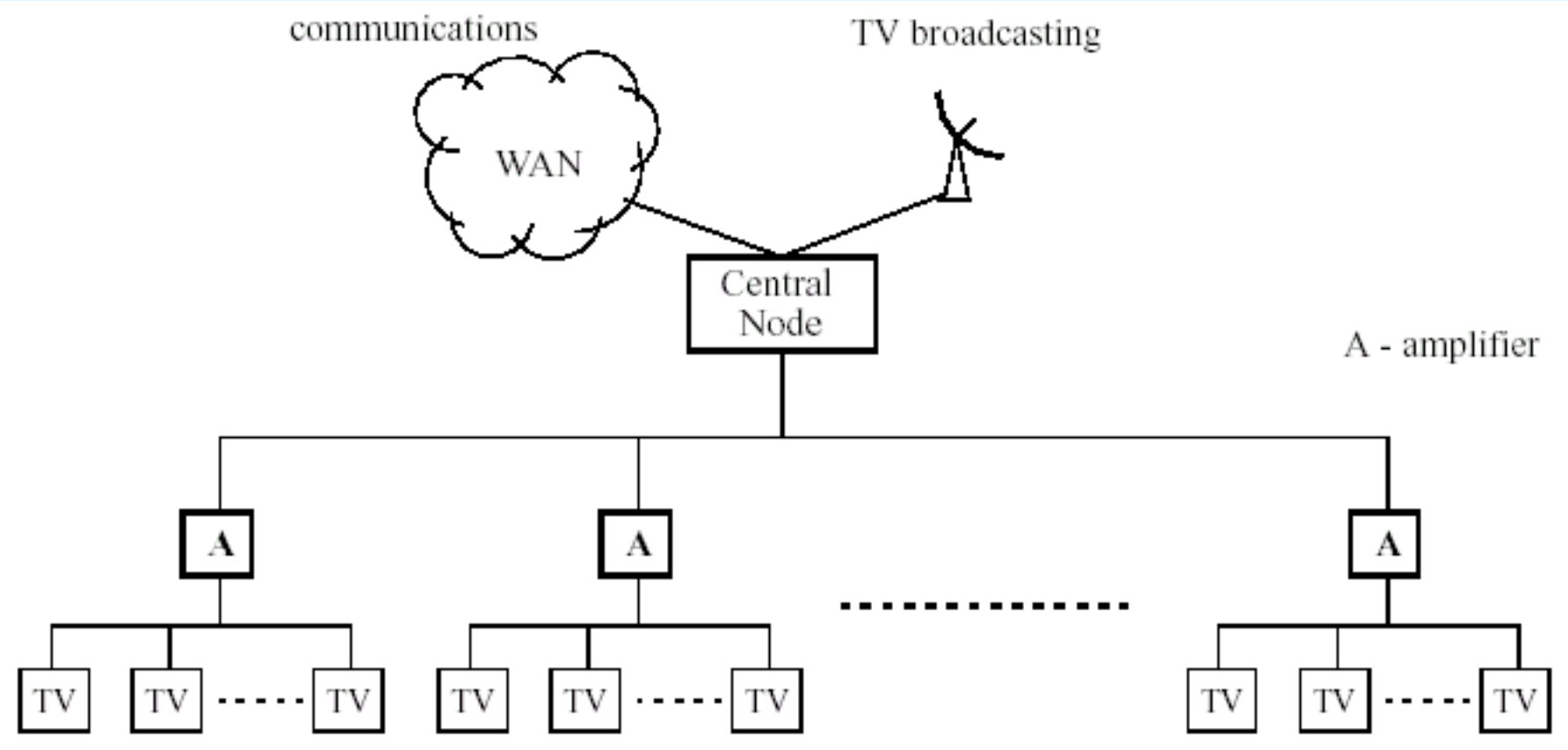
Motivation

- Reservation MAC protocols are very often used in modern telecommunications networks
- Features of the reservation protocols
  - Make possible transmission of different traffic mixtures, ensuring so-called multimedia services
    - QoS guarantees for different service/traffic classes
    - Good network utilization
- Application
  - **Broadband PLC access networks**
  - CATV networks for broadband access
  - Wireless networks

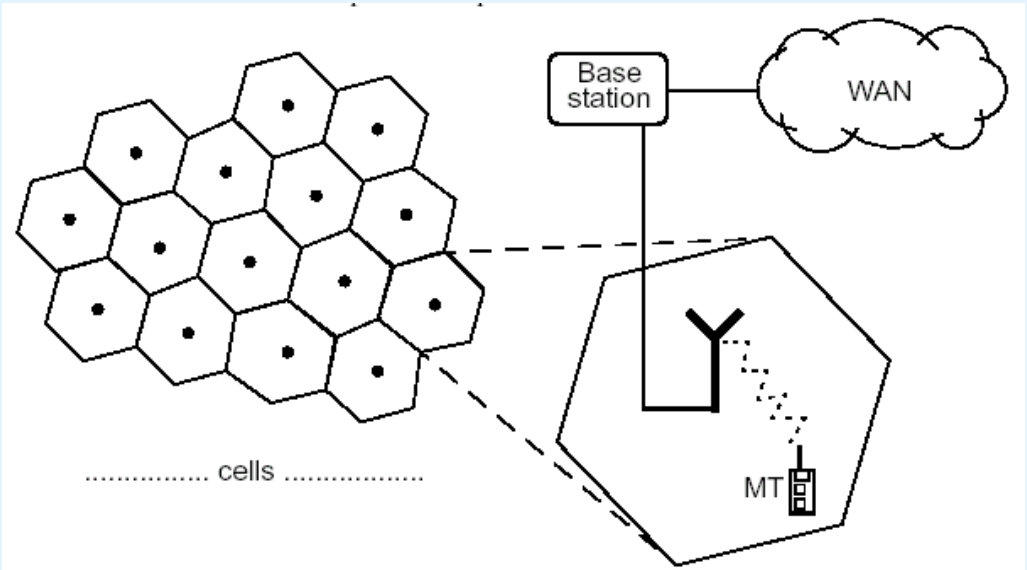
PLC Access Network



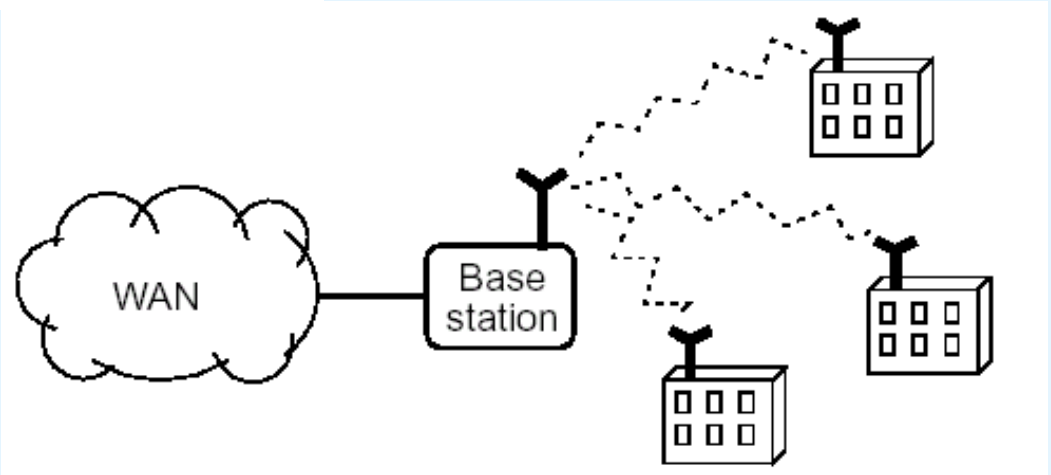
CATV Access Network



Wireless Networks

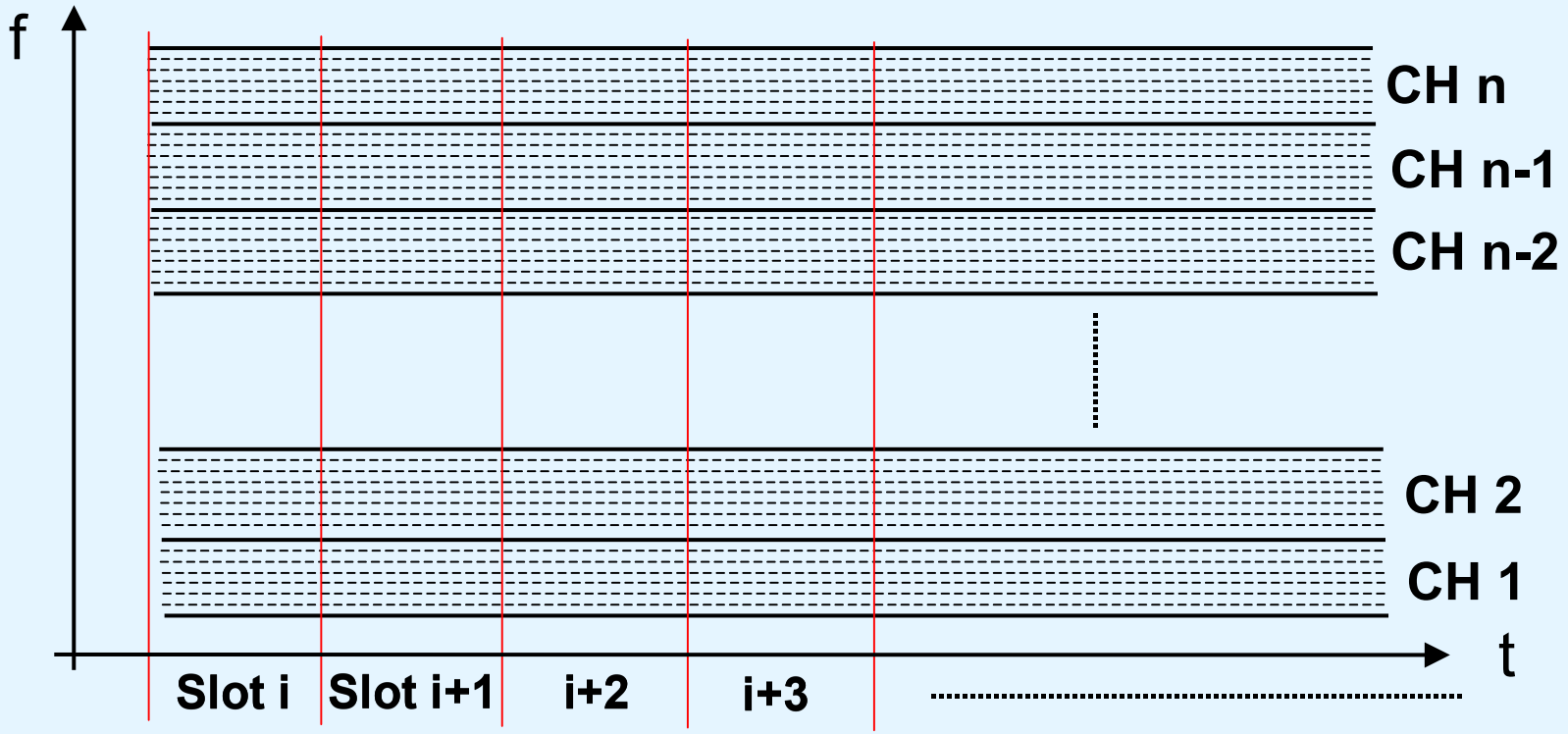


Mobile networks

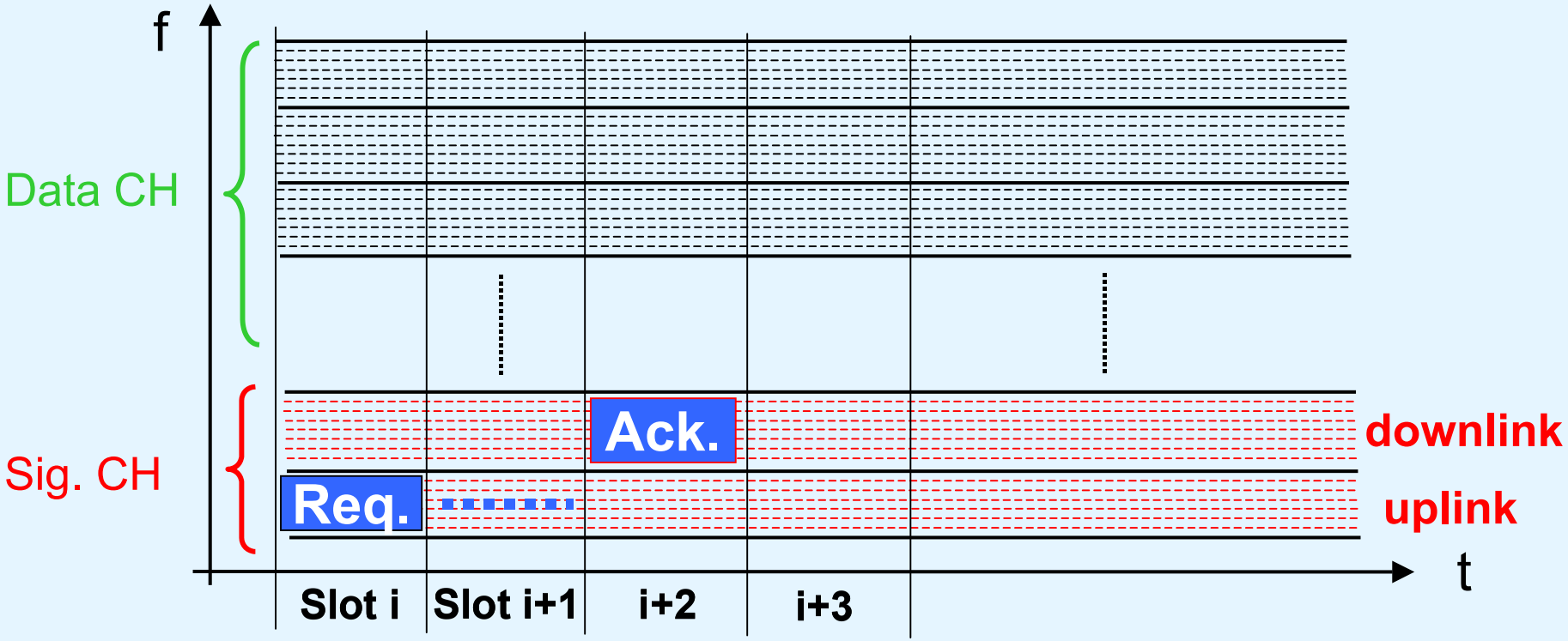


Fixed networks (WLL)

OFDMA/TDMA based System

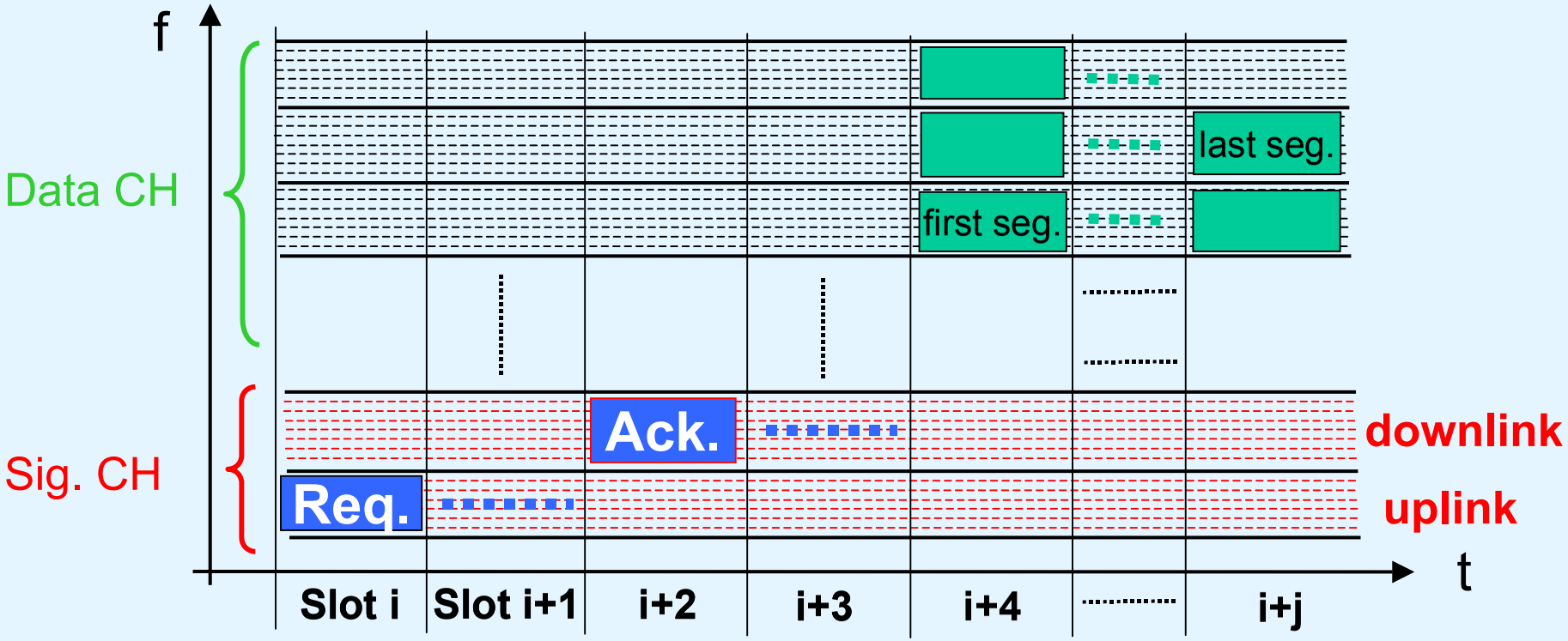


Reservation MAC Protocols



- Requesting procedure over signaling channel

Signaling MAC Protocols



- Per-packet reservation – good network utilization

Features of Basic Protocols

- Contention protocols – slotted ALOHA
  - Good for low loaded networks
  - In highly loaded networks
    - High collision probability, Performance collapse
- Arbitration protocols - polling
  - Not efficient in low loaded networks
- Protocol improvements:
  - Reduction of the collision probability (ALOHA)
  - Insertion of a random access component (Polling)

Protocol Extensions

- Piggybacking
  - Improvement in highly loaded networks
- Extended signaling over free data channels
  - Improvement in low loaded networks
- Dynamic backoff mechanism
  - Dynamical change of contention window size
  - Reduction of the collision probability
  - Performance stabilization (for random access)

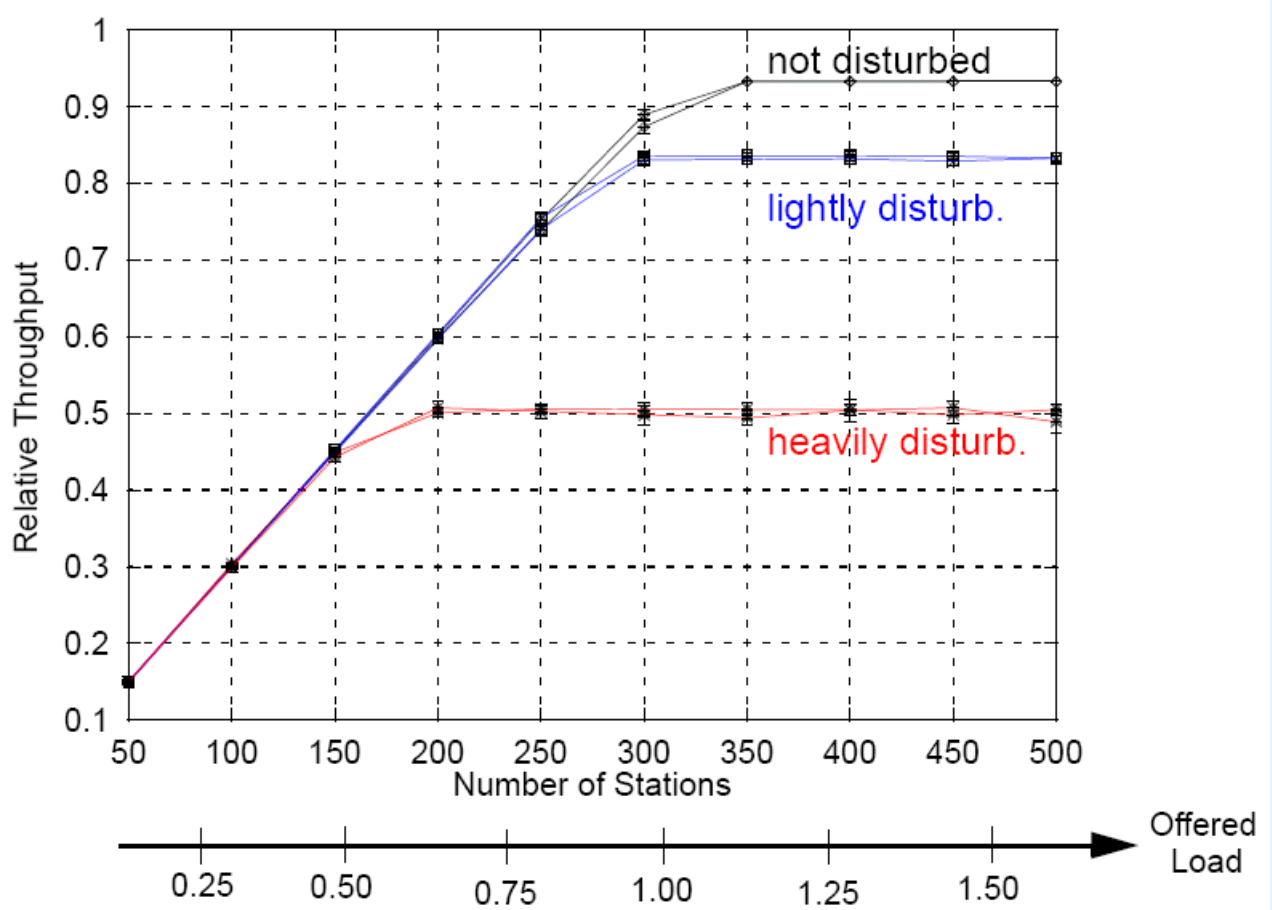
Model Parameters

- 15 transmission channels (64 kbps)
  - One signaling channel
  - Slot duration: 4 ms
  - Segment size 32 bytes (28 payload + 4 header)
- Disturbance modeling
  - Mean interarrival time of impulses
    - 200 ms for **lightly** disturbed network
    - 50 ms for **heavily** disturbed network
  - Mean impulse duration: 100 µs
  - Both random variables - geometrical distribution

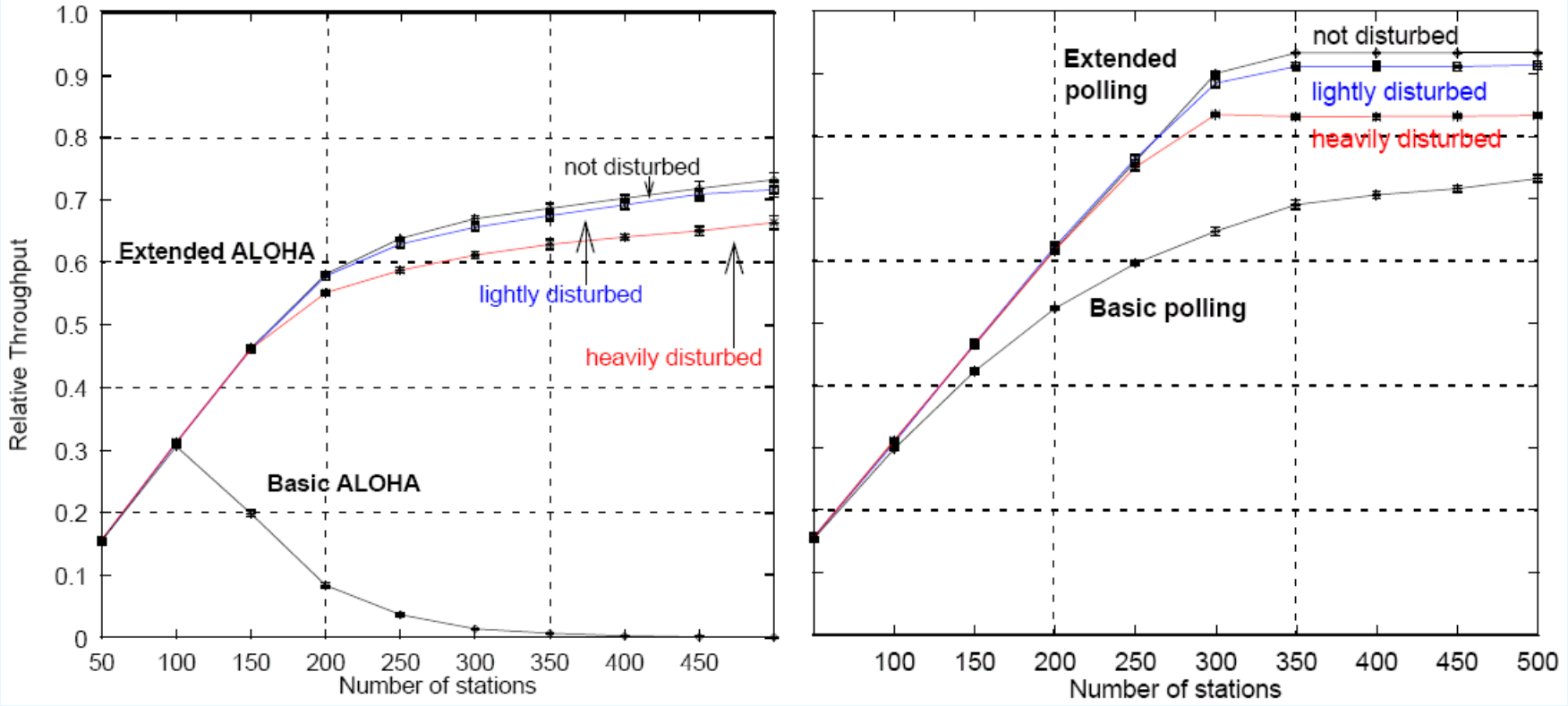
Simple Traffic Model

- Representing Internet traffic
- Mean interarrival time
  - 4.8 s – **Rare** transmission requests
  - 0.96 s – **Frequent** requests
- Mean packet size
  - 1500 bytes
  - 300 bytes
- Resulting data rate per user – 2.5 kbps
- Both random variables - geometrical distr.

Throughput – Rare Requests



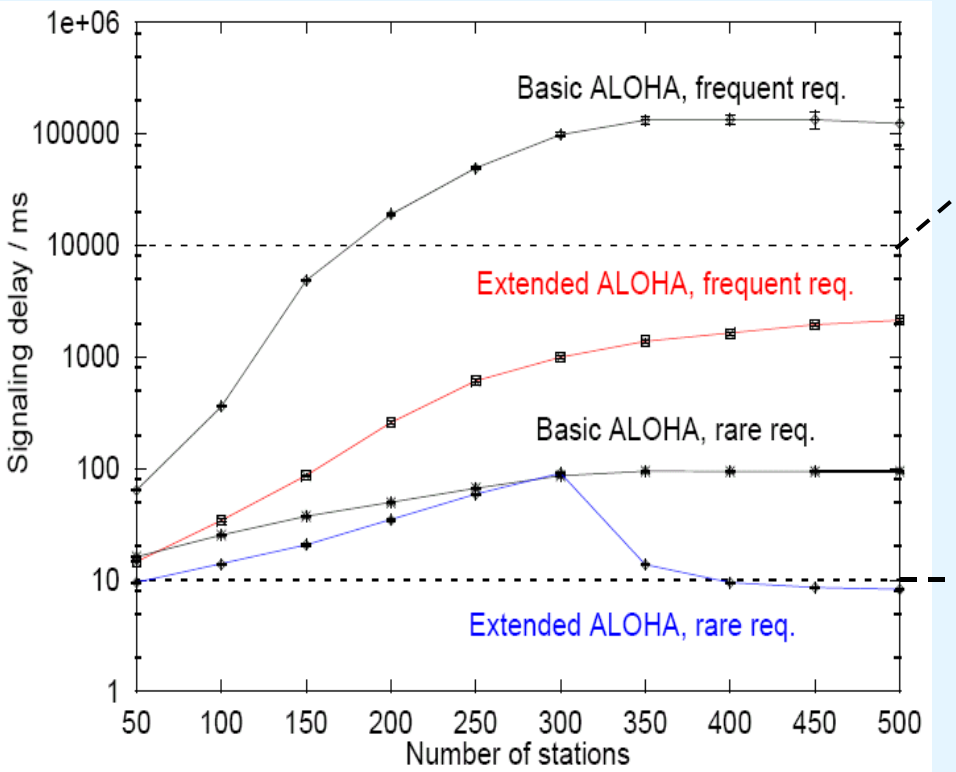
Throughput - Frequent Requests

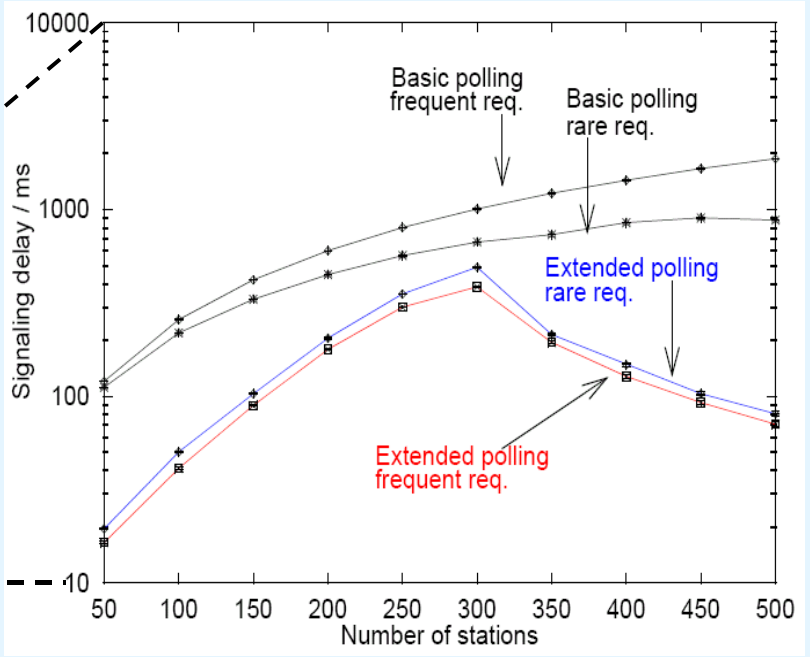


ALOHA protocols

Polling protocols

Signaling Delay





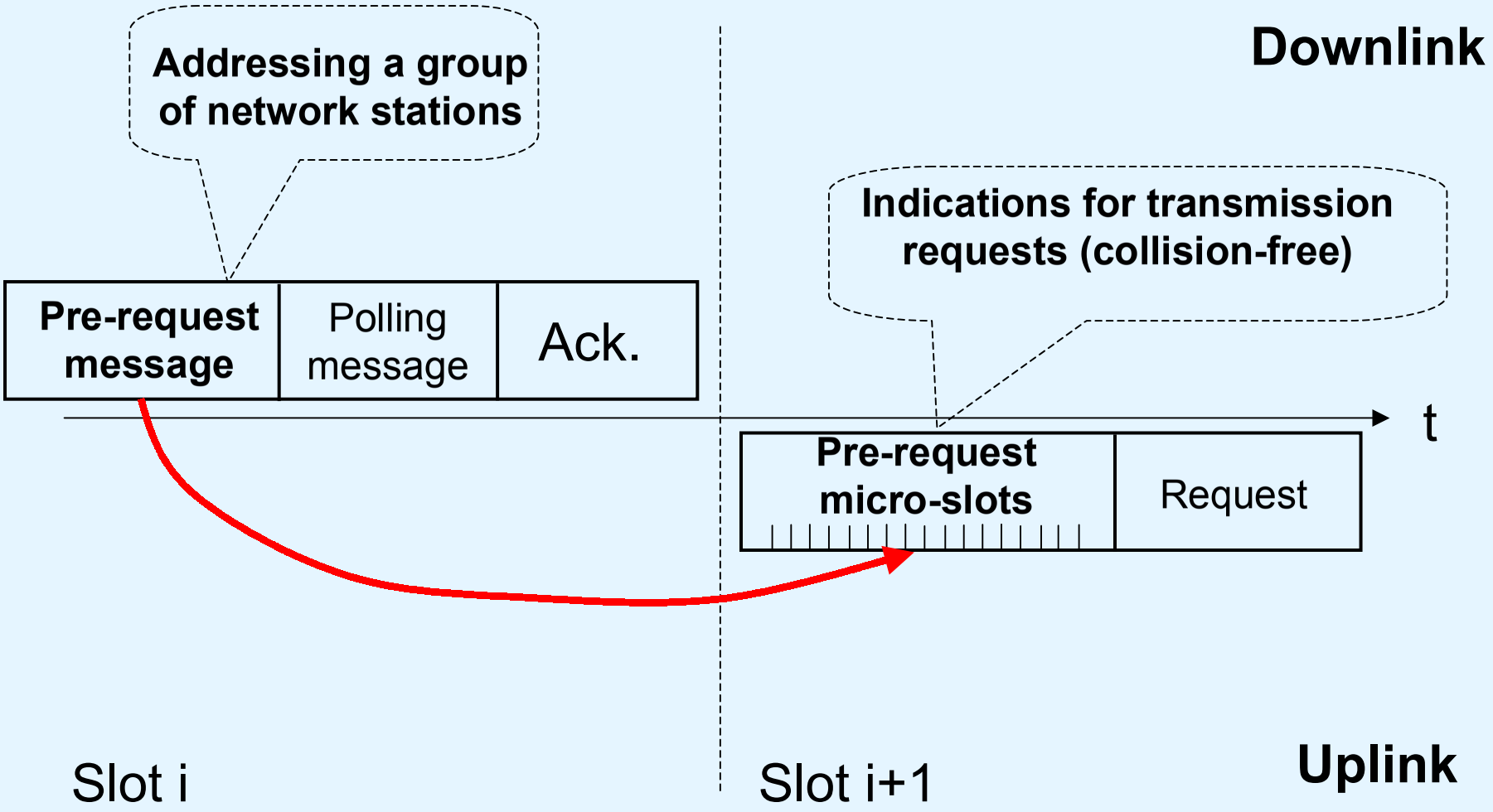
ALOHA protocols

Polling protocols

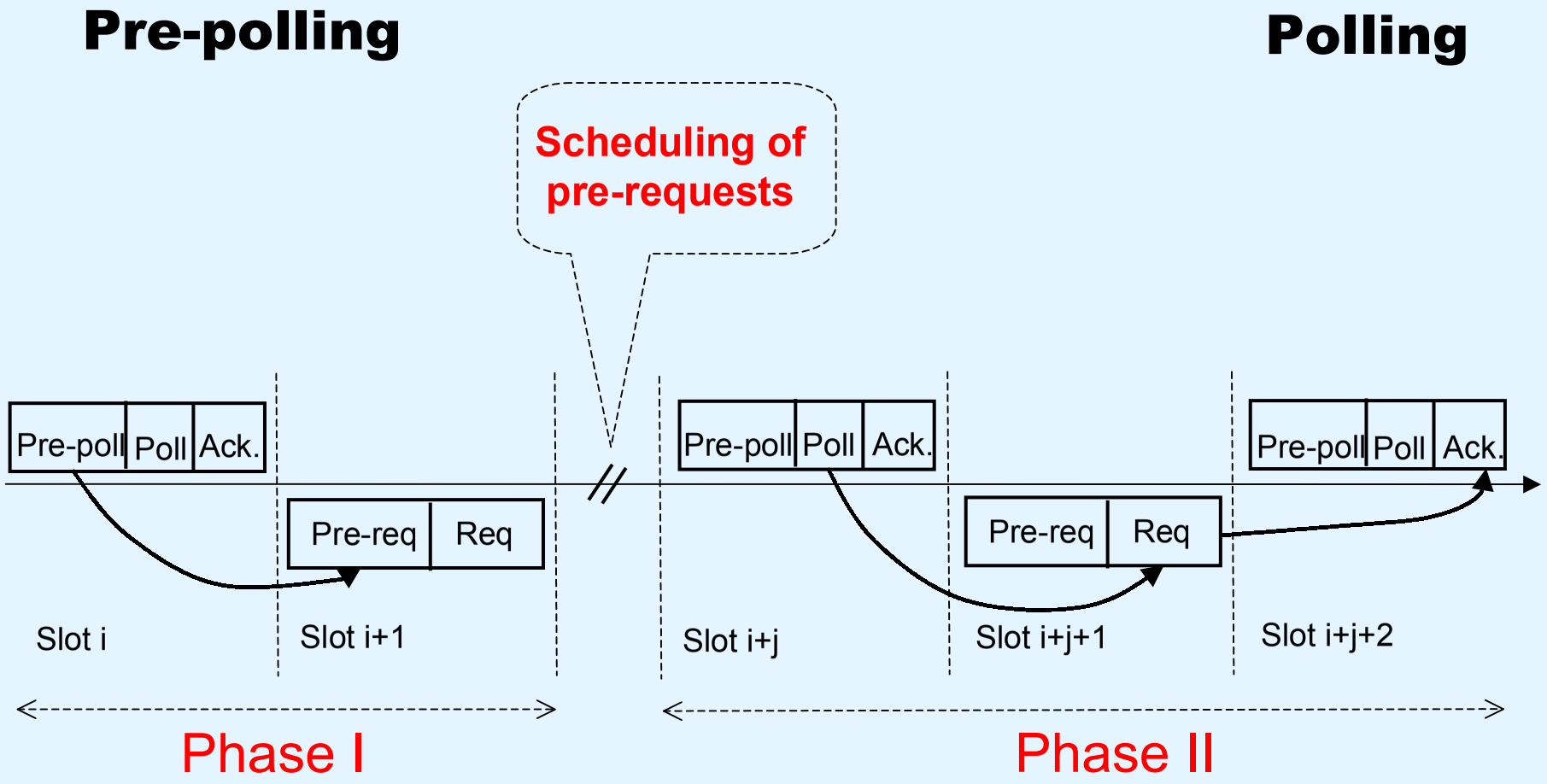
Polling Based Protocols

- Extended polling
  - Still too long signaling delays in middle load area
- Active polling
  - Only so-called active network stations are polled
  - Reduction of round-trip time of polling messages
  - Slightly improvement in the middle load area
- Two-step reservation MAC Protocol
  - Pre-polling phase: estimation of active stations
  - Standard polling procedure

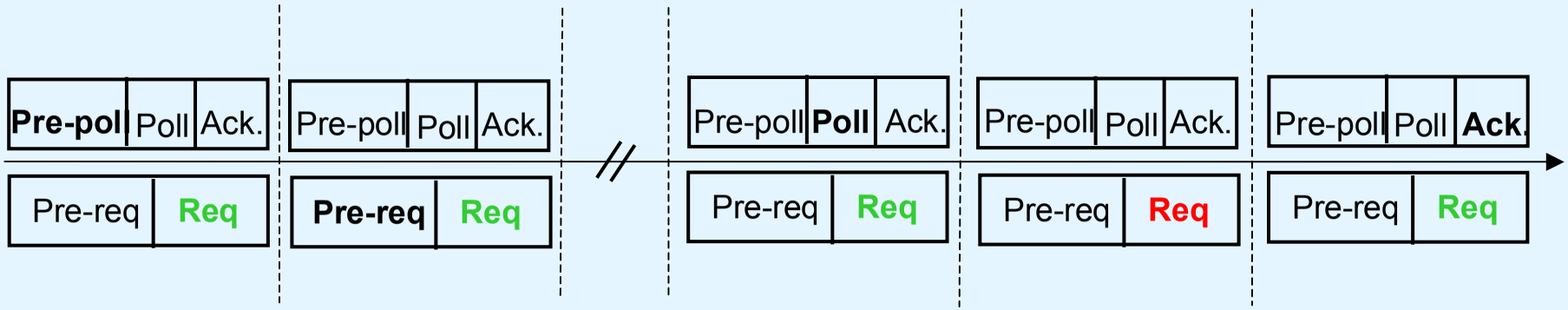
Two-step Protocol: Phase I



Two-step Procedure



Hybrid Two-step Protocol



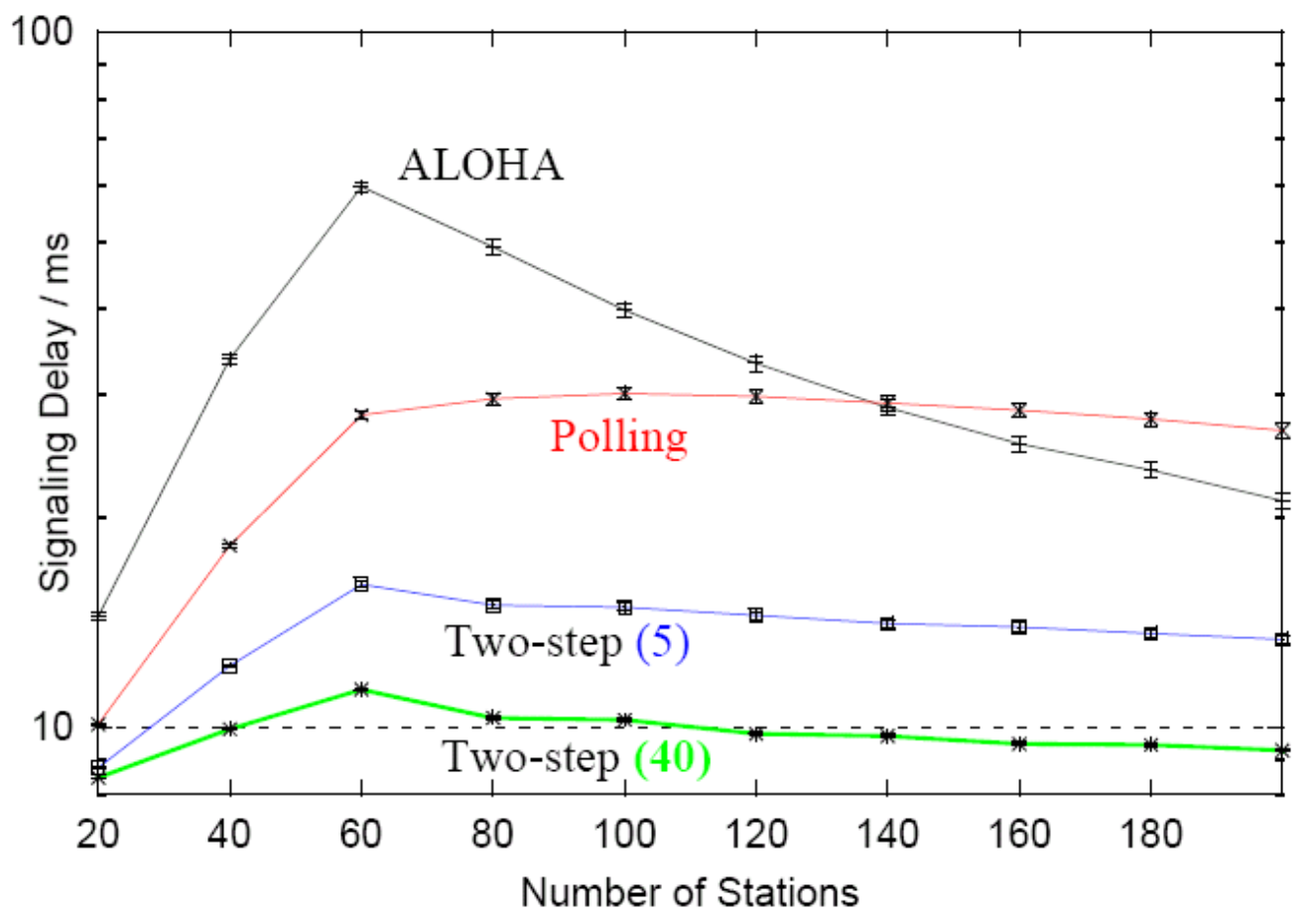
- Free request slots can be randomly accessed
- Protocol robustness against disturbances
  - Ensured due repetition of pre-requests
- Protocol performance
  - Depends on number of pre-request micro-slots

Protocol Comparison

- **Extended** ALOHA, Polling, and Two-step
  - 4 request fields per time-slot for ALOHA & polling
  - 1 request field, 5 and 40 pre-requests for two-step
- Traffic mix (using multimodal models)

	Model	Mean interarrival time of packets / s	Mean packet size / bytes	Average data rate / kbps	Share / %
M1	Uplink	3,55	332,5	0,75	40
M2	Uplink	1,06	332,5	2,5	20
M3	Uplink	0,35	332,5	7,5	10
M4	Downlink	0,88	822,33	7,5	10
M5	Downlink	0,26	822,33	25	10
M6	Downlink	0,07	822,33	100	10
	Average:	1,788	-	14,8	-

Signaling Delay



Summary

- Investigation of signaling MAC protocols
  - Basic protocols (slotted ALOHA and polling)
    - Dedicated access not efficient in low network load area
    - Random access collapses in higher network area
  - Protocol extensions
    - piggybacking, extended signaling, adaptive and hybrid protocols, active polling – for **extended protocols**
- Polling based reservation MAC protocols
  - Generally better performance
  - In some cases random protocols better
- Two-step protocol
  - The best performance in different load areas