Optimal Scheduling Policies for Broadcast Information Delivery Systems

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Broadcast Delivery is an efficient way of delivering popular Information (news, weather, stocks, traffic, WWW cache, …) to a large number of users.

PULL broadcast delivery:

- The scheduler receives all the requests for the packages and schedules the broadcast based on that information.
- Heuristic policies have been proposed but the optimal policy is not characterized (Su, Franklin, …).

Problem Setup:

- N stored packages with lengths $L_1,\ldots,L_N$.
- K(<N) broadcast channels.
- Request arrival process for each package is Poisson with rate $\lambda_1, \ldots, \lambda_N$.

Goal:

- Finding the optimal policy for scheduling the broadcast of packages to get the minimum weighted average delay over all users.
- Can serve as benchmark for evaluating other heuristic policies.
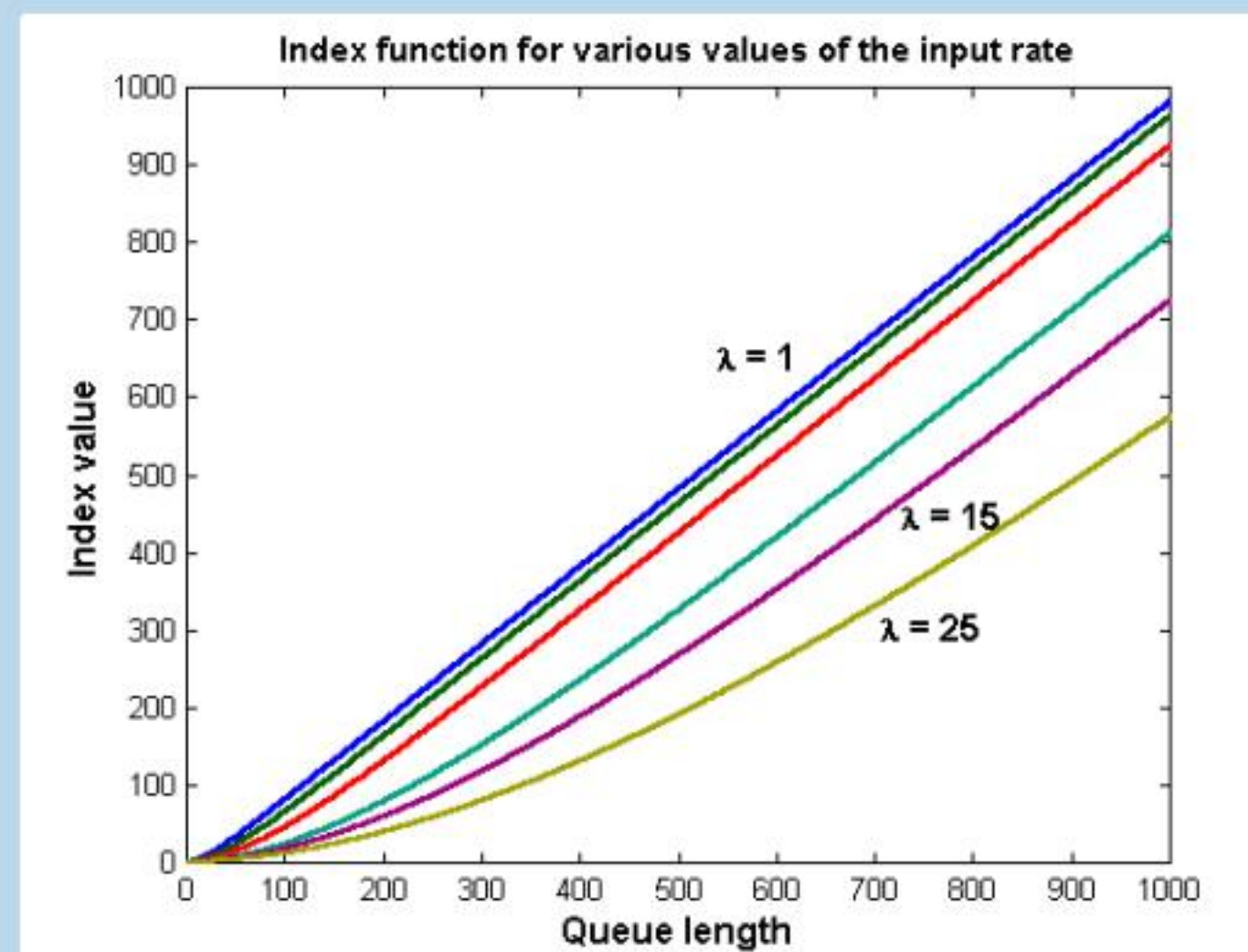
NOC

Return channel
(Pull system only)
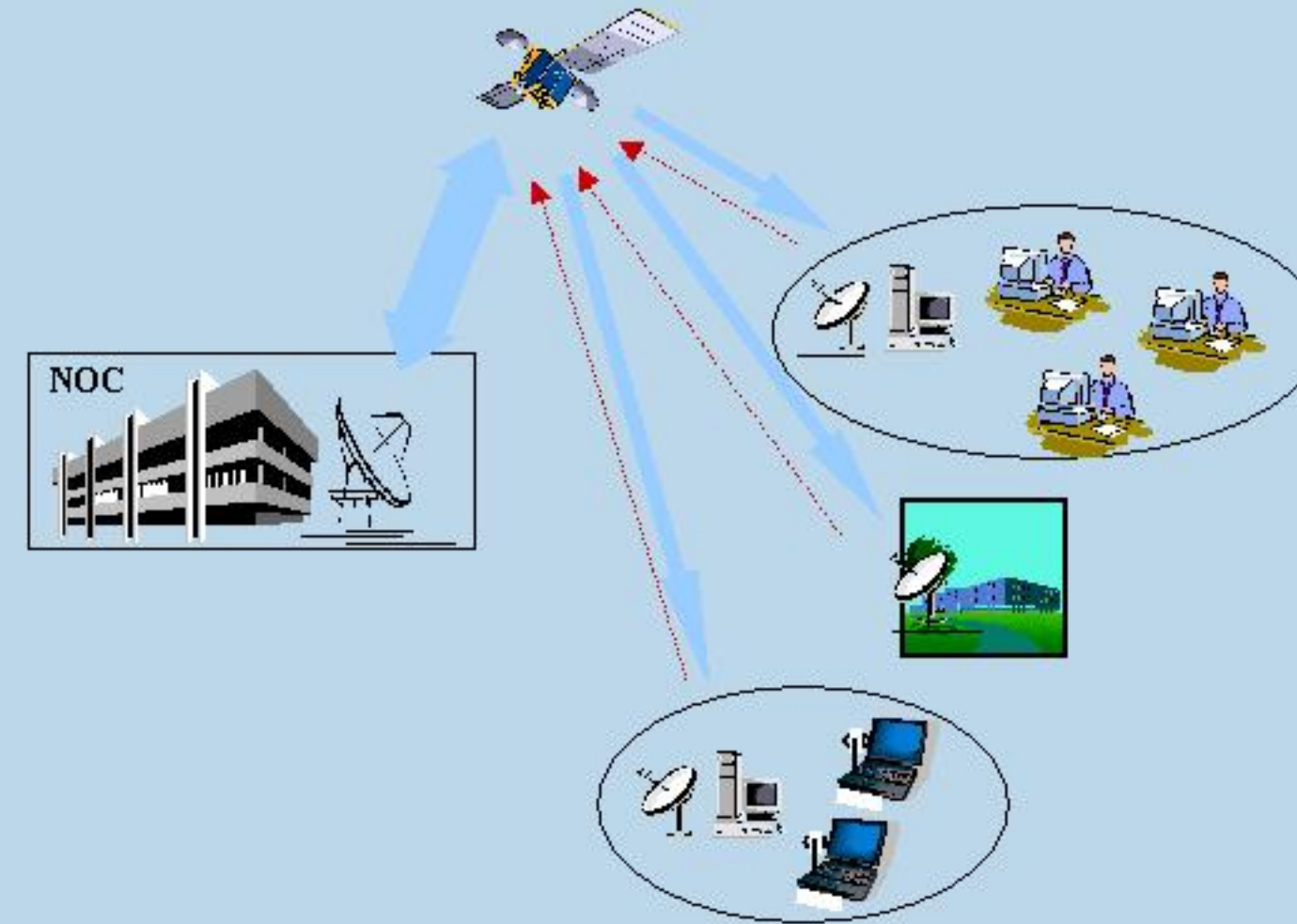
Satellite package delivery system

Wireless package delivery system

Our approach:

- A system of N competing queues with bulk service.
- Problem is formulated as a Markov Decision Process.
- We have found an index policy using the dynamic optimization approach.
- **Policy:** Broadcast the packages with K largest indices.
- Index function:

Index function for various values of the input rate

$\lambda = 1$

$\lambda = 15$

$\lambda = 25$

Queue length

Index value

Results:

- Our policy (NOP)
- Maximum Request First (MRF)
- First Come First Serve (FCFS)
- Priority Index Policy (PIP)
- Average delay results:

average delay for different scheduling policies

MRF

FCFS

PIP

NOP

Total # pages: 100

avg # arrivals per time slot

avg delay (slots)