

A Performance Evaluation Model for Effective Job Scheduling in Global Computing Systems

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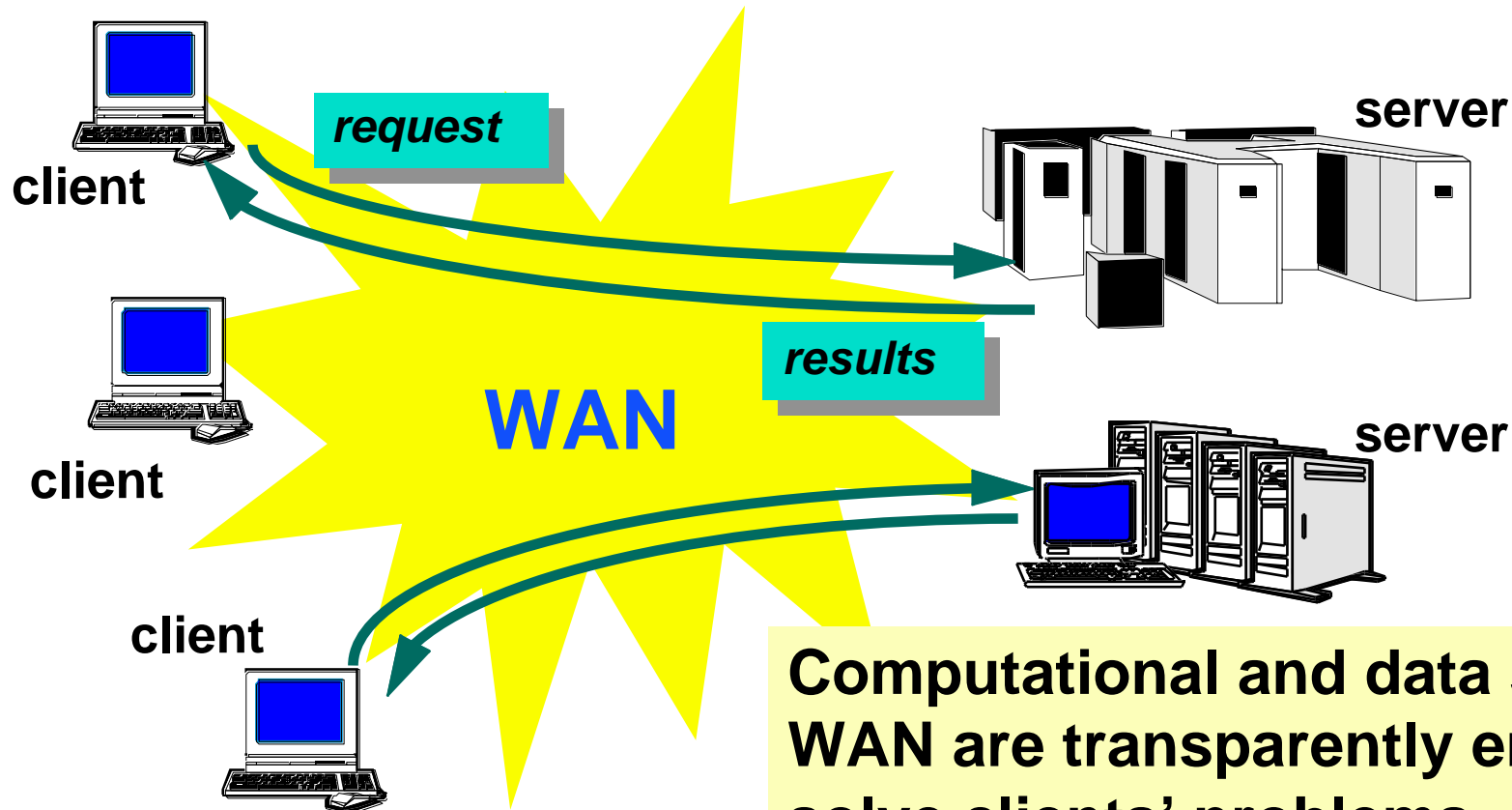
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Global Computing System

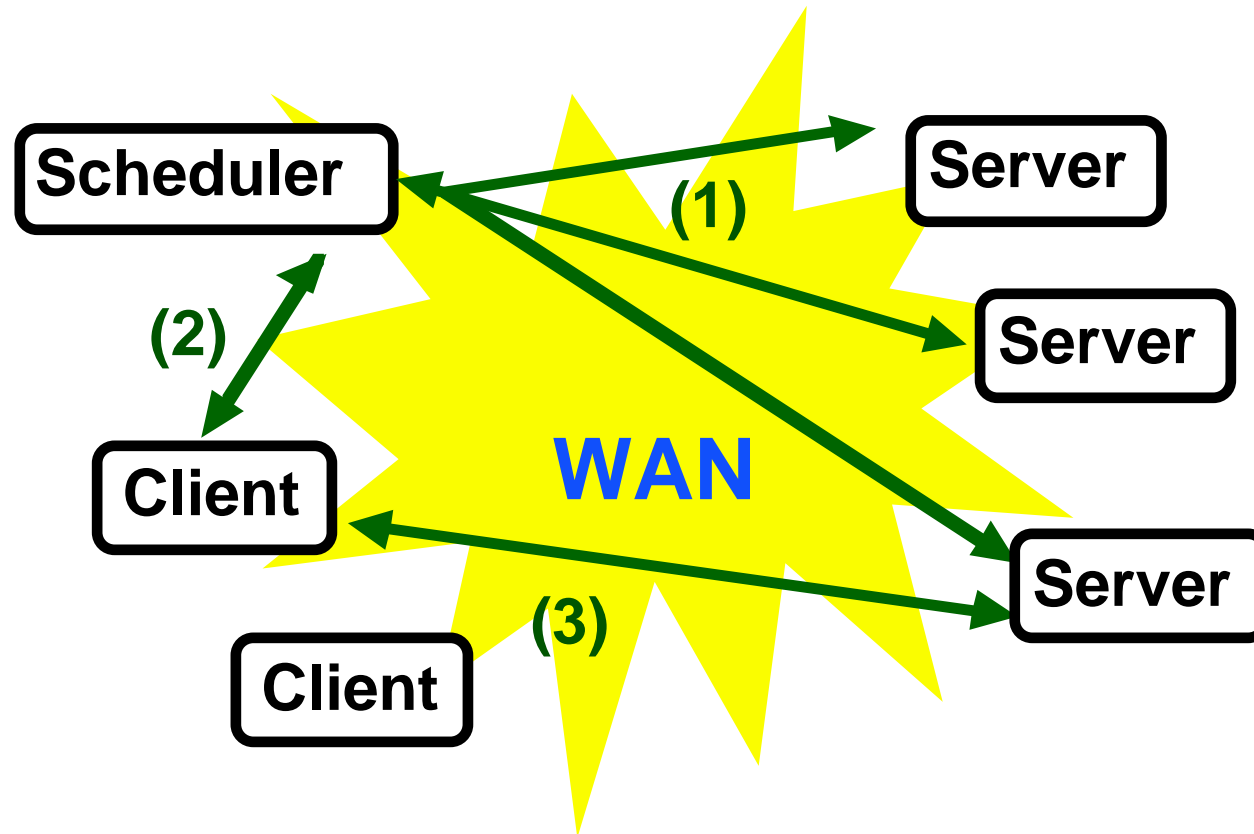


Computational and data servers in WAN are transparently employed to solve clients' problems.

Proposed Global Computing Systems:

- **Globus, Netsolve, Ninf, Legion, RCS, etc.**

Job Execution in Global Computing



- (1) Scheduler collects load information.
- (2) Client queries Scheduler about the suitable server.
- (3) Client requests execution of the job, transmits data to the designated server, and receives results.

Job Scheduling for Global Computing

An effective job scheduling scheme is required to achieve high-performance global computing!

Software Systems for Job Scheduling

- AppLes, Netsolve agent, Nimrod, Ninf metasever, Prophet, etc.

Scheduling Algorithm

- Effective algorithm has not been proposed.
- The performance of algorithm has not been evaluated sufficiently.

Performance Evaluation Model

Model for Locally Distributed System

- well studied
- embody only **computational servers**

Model for Global Computing System

- not established
- should embody both **computational servers** and **networks** between clients and servers

A performance evaluation model for job scheduling in global computing systems is required!

Proposed Performance Evaluation Model

Queueing Network

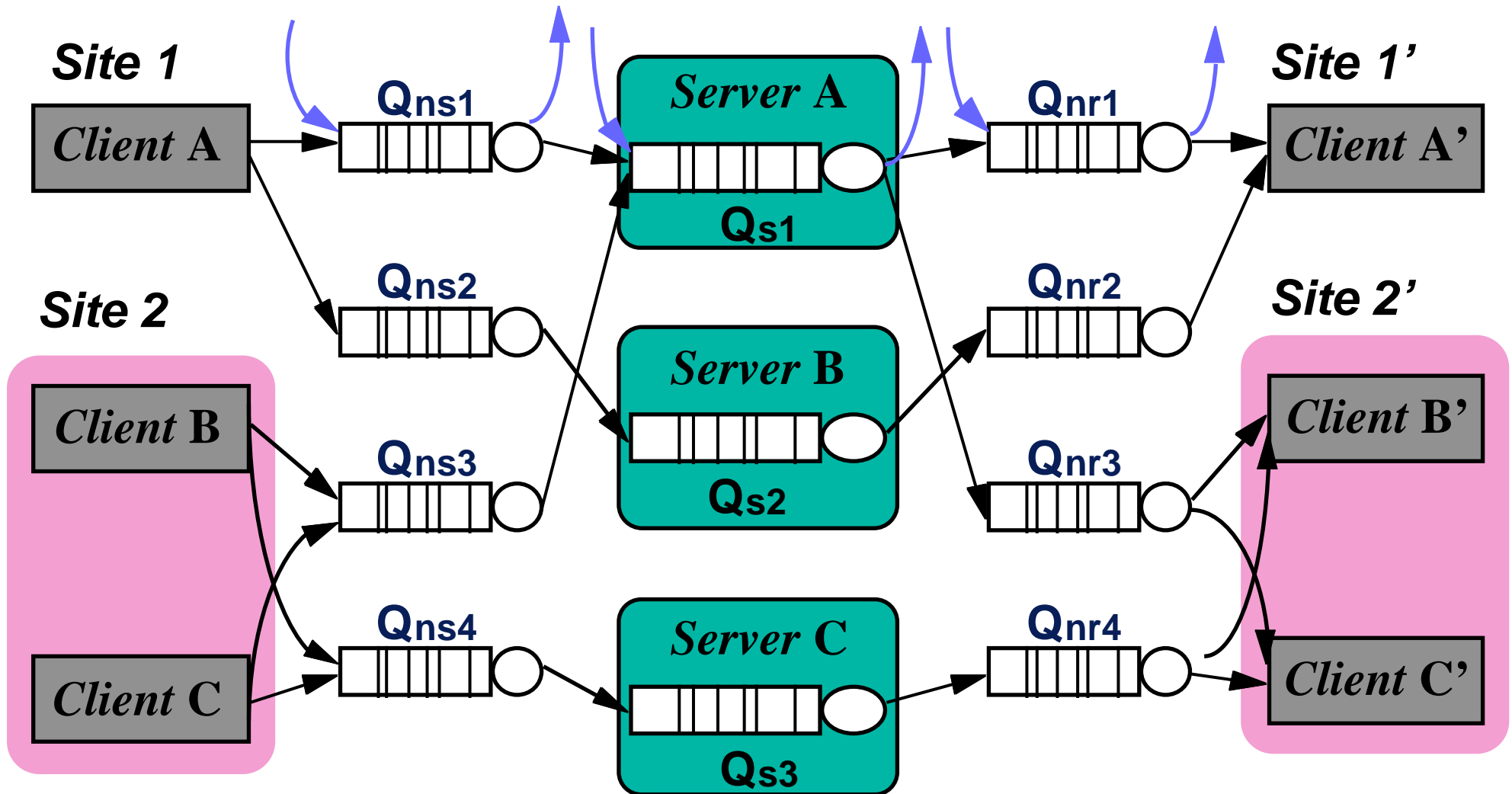
Global Computing System

- Q_s computational servers
- Q_{ns} network from the client to the server
- Q_{nr} network from the server to the client

Congestion on Servers and Networks

- other jobs
 - jobs which are invoked from other processes and enter Q_s
- other data
 - data which are transmitted from other processes and enter Q_{ns} or Q_{nr}

Example of Proposed Model



Clients

Job Invoked by a Client

- data transmitted to the server (D_{send})
- computation of the job
- data transmitted from the server (D_{recv})

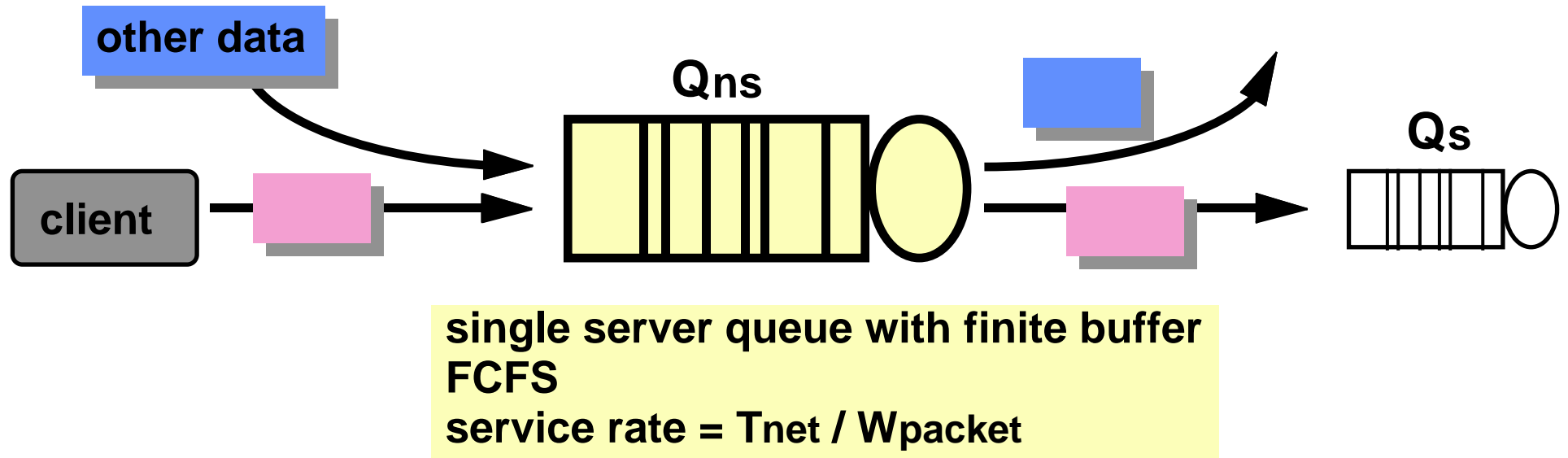
Procedure to Transmit Associated Data

- decompose D_{send} into logical packets
- transmit packets to Q_n

Procedure to Receive Execution Results

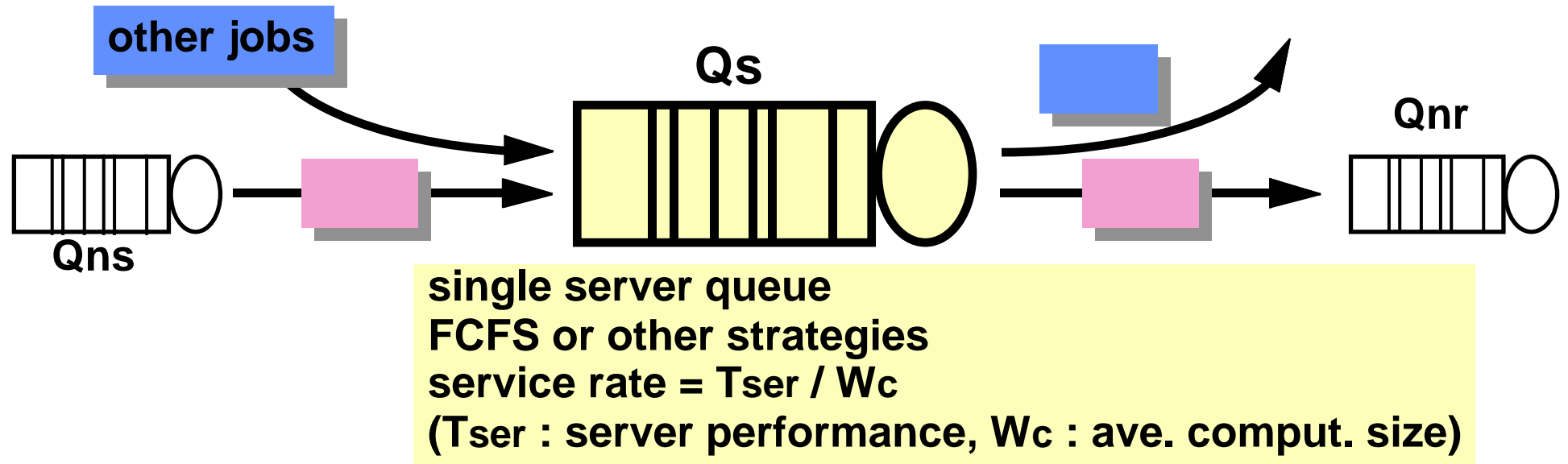
- receive D_{recv} from Q_n

Queue as a Network (Q_{ns})



- A packet transmitted from the client enters Q_{ns} .
 - A packet is retransmitted when buffer is full.
- communication throughput**
- A packet transmitted from the client leaves for Q_s .
 - Arrival rate of other data indicates congestion of the network.

Queue as a Server (Qs)

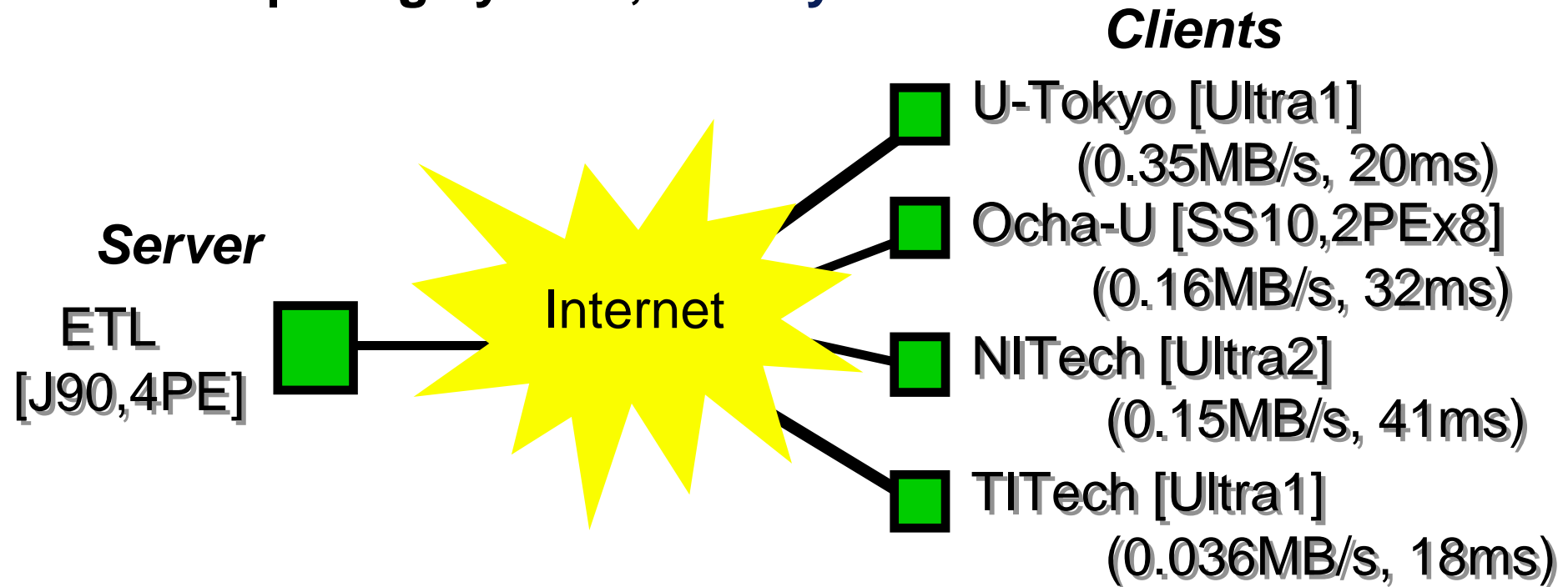


- The computation of the job enters **Qs** after all associated data arrive at **Qs**.
- Queued job waits for its turn. **response time**
- Data of results are decomposed into logical packets and these packets are transmitted to **Qnr**.
- **Arrival rate of other jobs indicates congestion on the server.**

Verification of the Proposed Model

Comparison

- results in simulation on the proposed model
- results in experiments on the actual global computing system, **Ninf system**

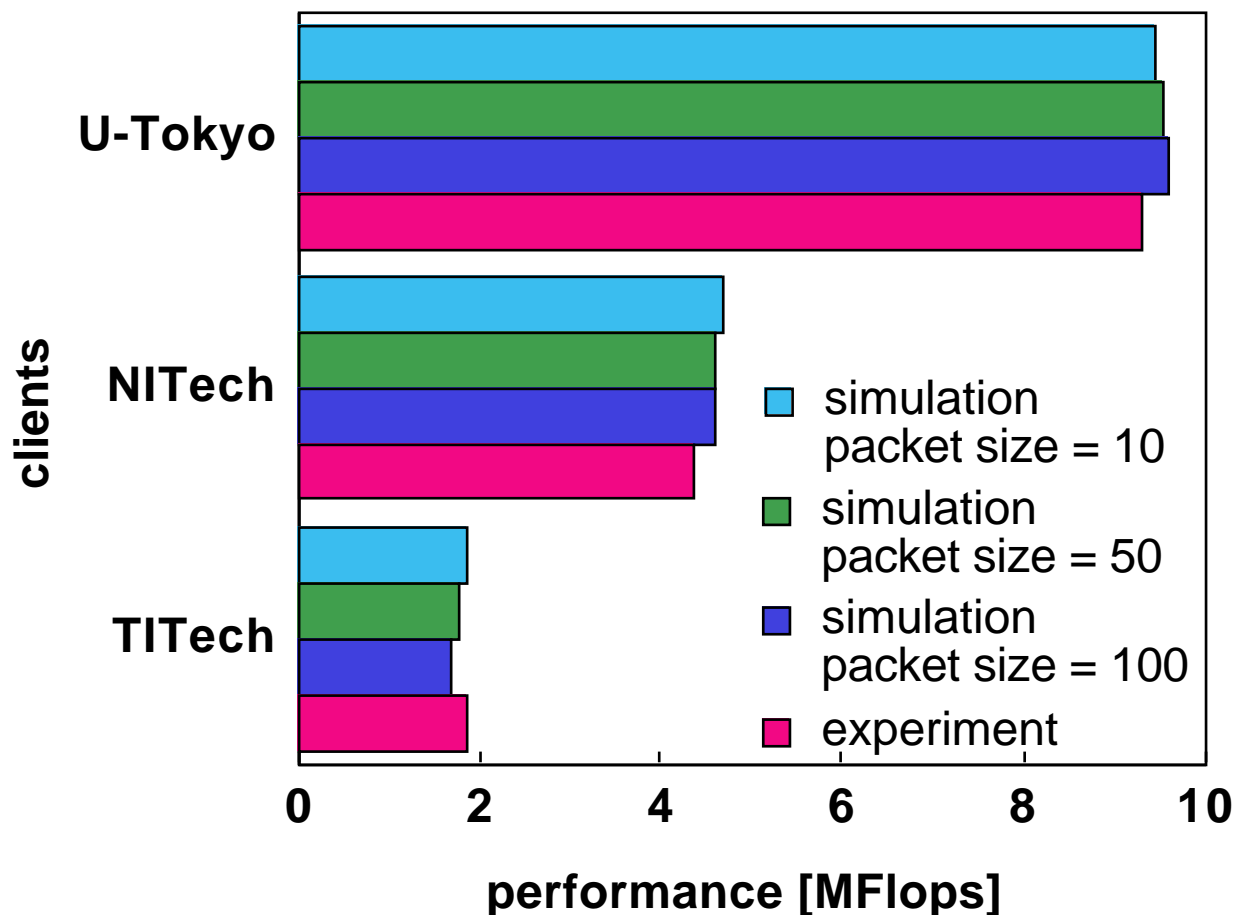


Performance of Clients' Jobs

clients : WS in U-Tokyo, NITech and TITech, server : J90 in ETL

clients' jobs :

-Linpack (Comput. = $O(2/3n^3 + 2n^2)$, comm.= $8n^2 + 20n + O(1)$)



- The performance of jobs invoked by multiclients in the simulation closely matches experimental results.

- Effect of different packet sizes is almost negligible.

Evaluation of Job Scheduling Schemes

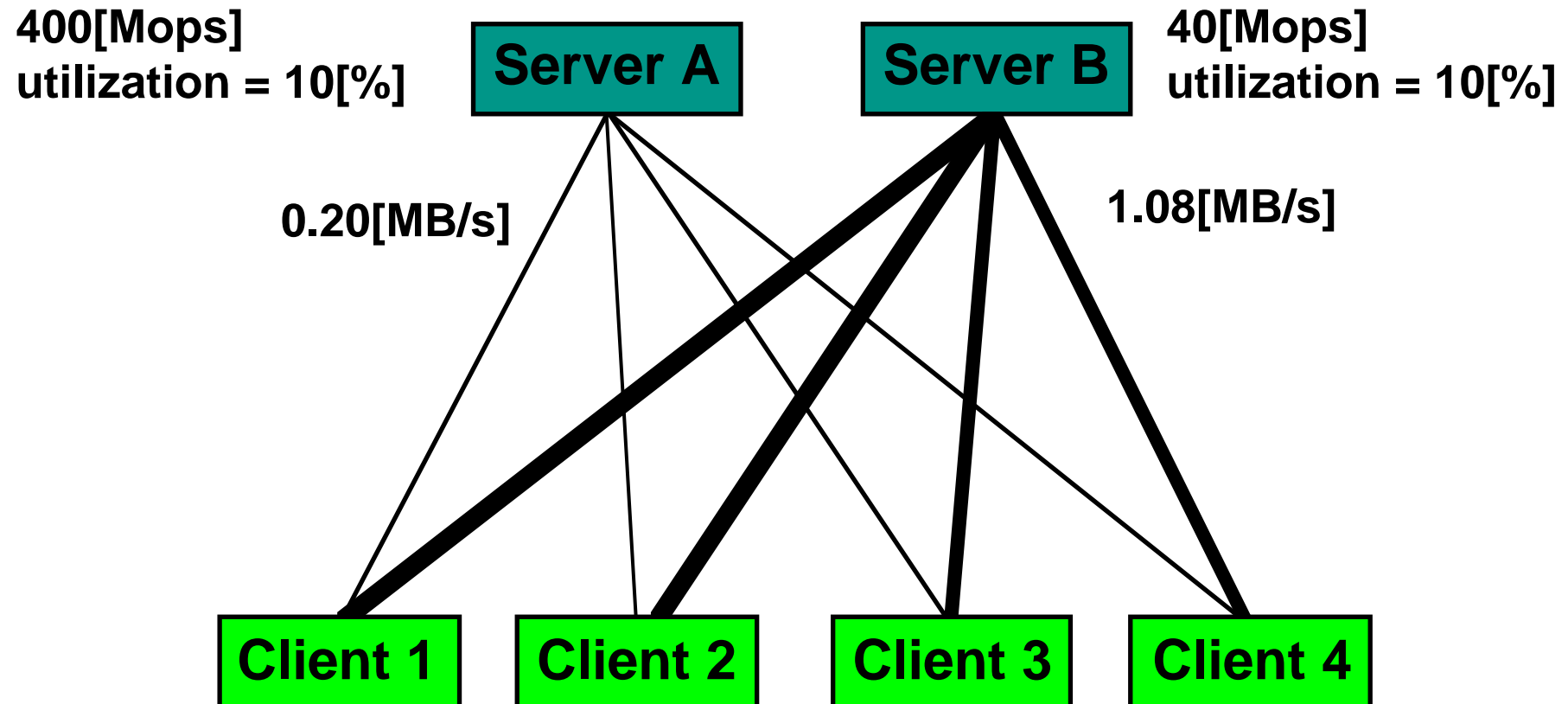
Evaluation

- Evaluation of job scheduling schemes on imaginary environment in the simulation on the proposed model

Job Scheduling Schemes

- **RR** round robin
- **LOAD** server load
- **LOTH** server load + network load

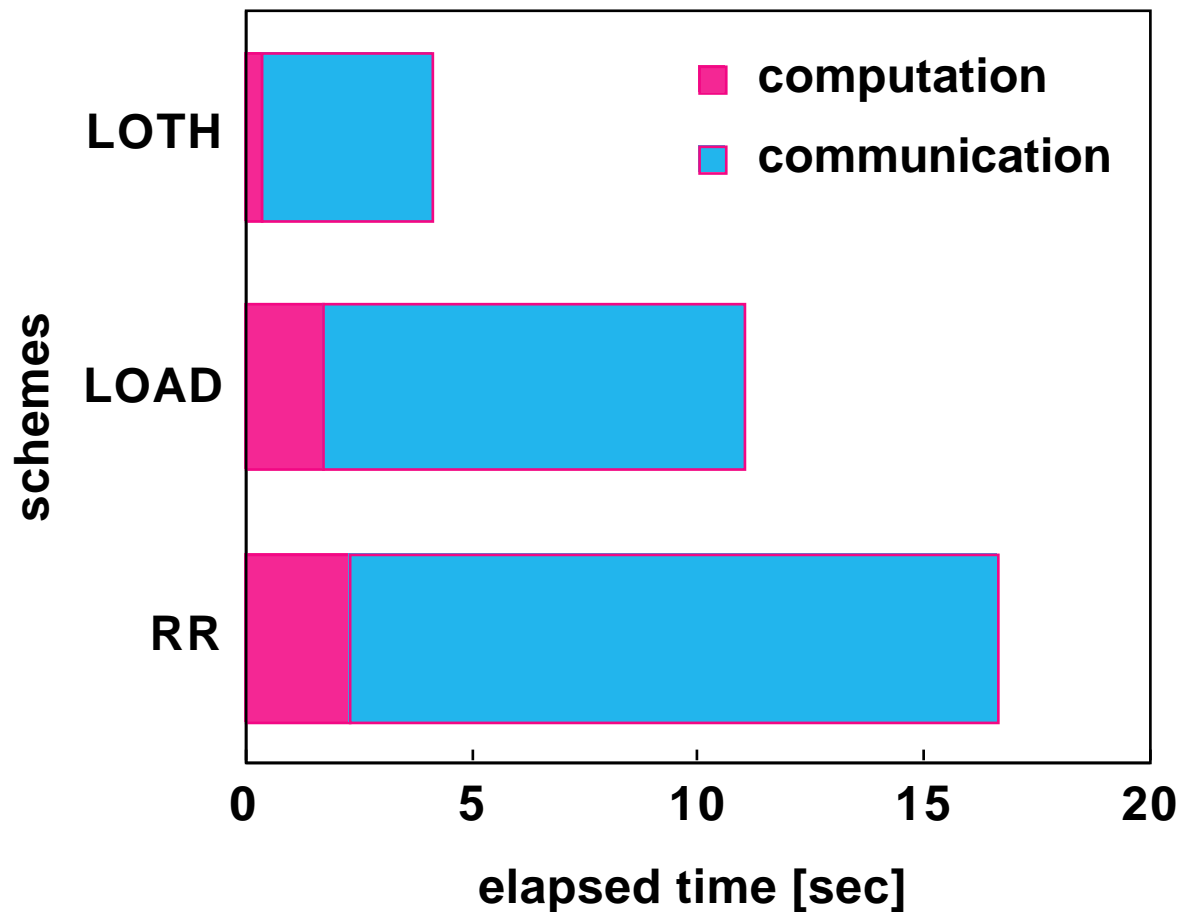
Imaginary Environment



Job Scheduling Performance

clients' jobs

-Linpack (Comput. = $O(2/3n^3 + 2n^2)$, comm.= $8n^2 + 20n + O(1)$)



LOAD causes network congestion and degrades the performance.

LOTH shows best performance.

Both a server load and a network load should be employed.

Conclusions

Proposal

- performance evaluation model for effective job scheduling in global computing systems

Verification and Evaluation of the Model

- The proposed model could effectively simulate the performance of clients' jobs in simple setup of the actual global computing system, **Ninf system**.
- Dynamic information of both servers and networks should be employed for job scheduling.

Future Work

- better modeling of changeability of network congestion