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Improving Services using Mobile Agents-based IoT in a Smart City

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Outline

- Introduction
- Proposed Approach
- Experiments
- Results
- Conclusion

Introduction

- Today's Mobile Devices:
  - Powerful Processors
  - Huge Storage Capacities
  - Always connected to the Internet
- How to tap this power?
  - Use them together
  - Make each device a part of bigger network.
  - Provide services on the fly

Smart City

- Millions of smart devices
- 24 x 7 Internet connectivity
- Needs to have better basic services

How?

- Internet of Things

Basic Services in a Smart City

- Medical
  - Ambulances
  - Hospitals
- Law and Order
  - Police Stations
- Gas Stations
- ATMs

...and many more

Problem Definition

- Improving the services
- Use Internet of Things
- A solution that is
  - Distributed
  - Robust
  - Scalable

Possible Solution

Mobile Agents
based Framework

Mobile Agents

- Autonomous piece of computer programs
- Can migrate anywhere in a network
- Can make decisions locally
- Asynchronous and Distributed
- Encompass features of static agents

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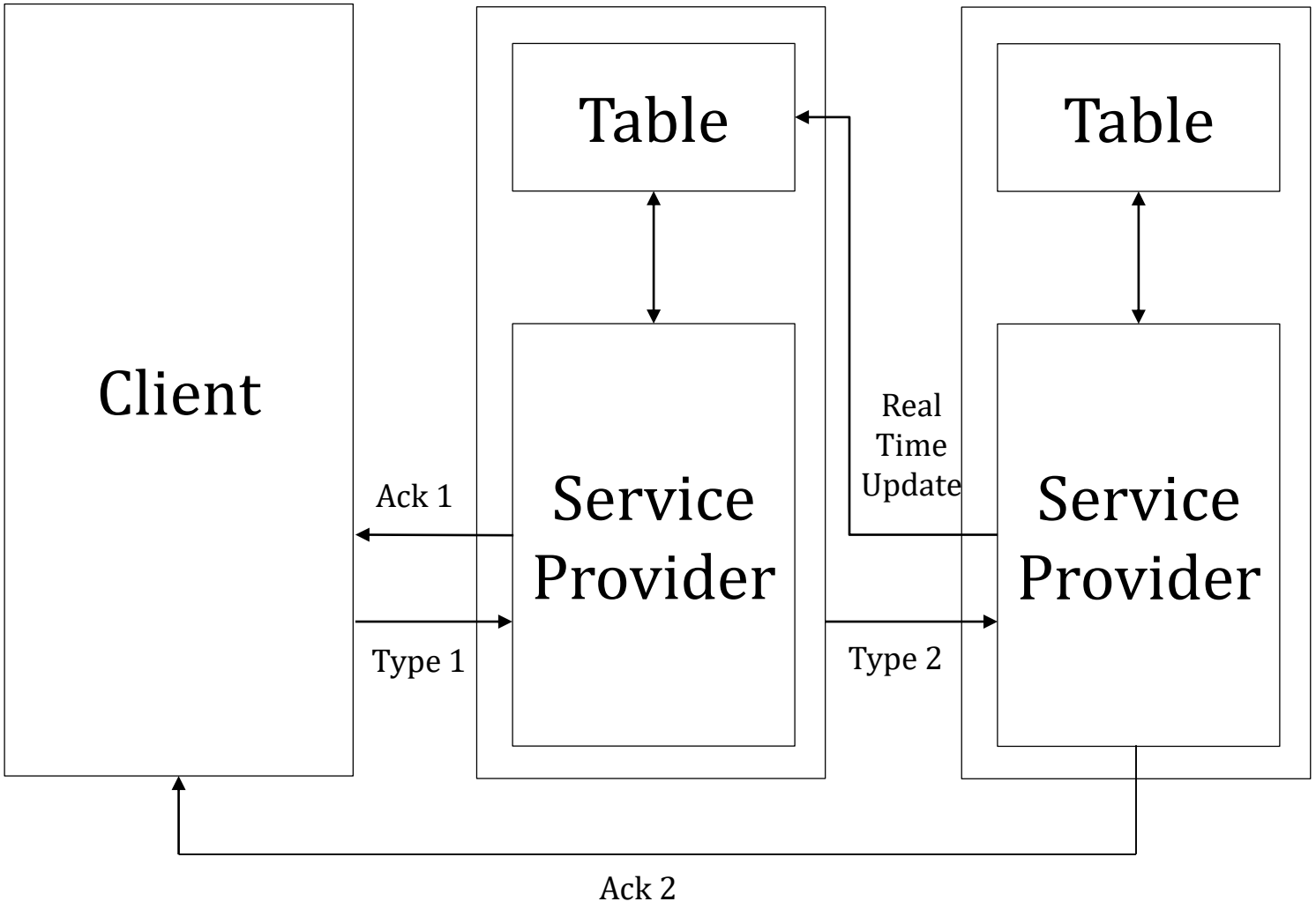
Proposed Approach

- General purpose framework
- Provides services in a distributed network through the devices connected to the network
- The client application sends a request, which contains a request-type along with other details like GPS location

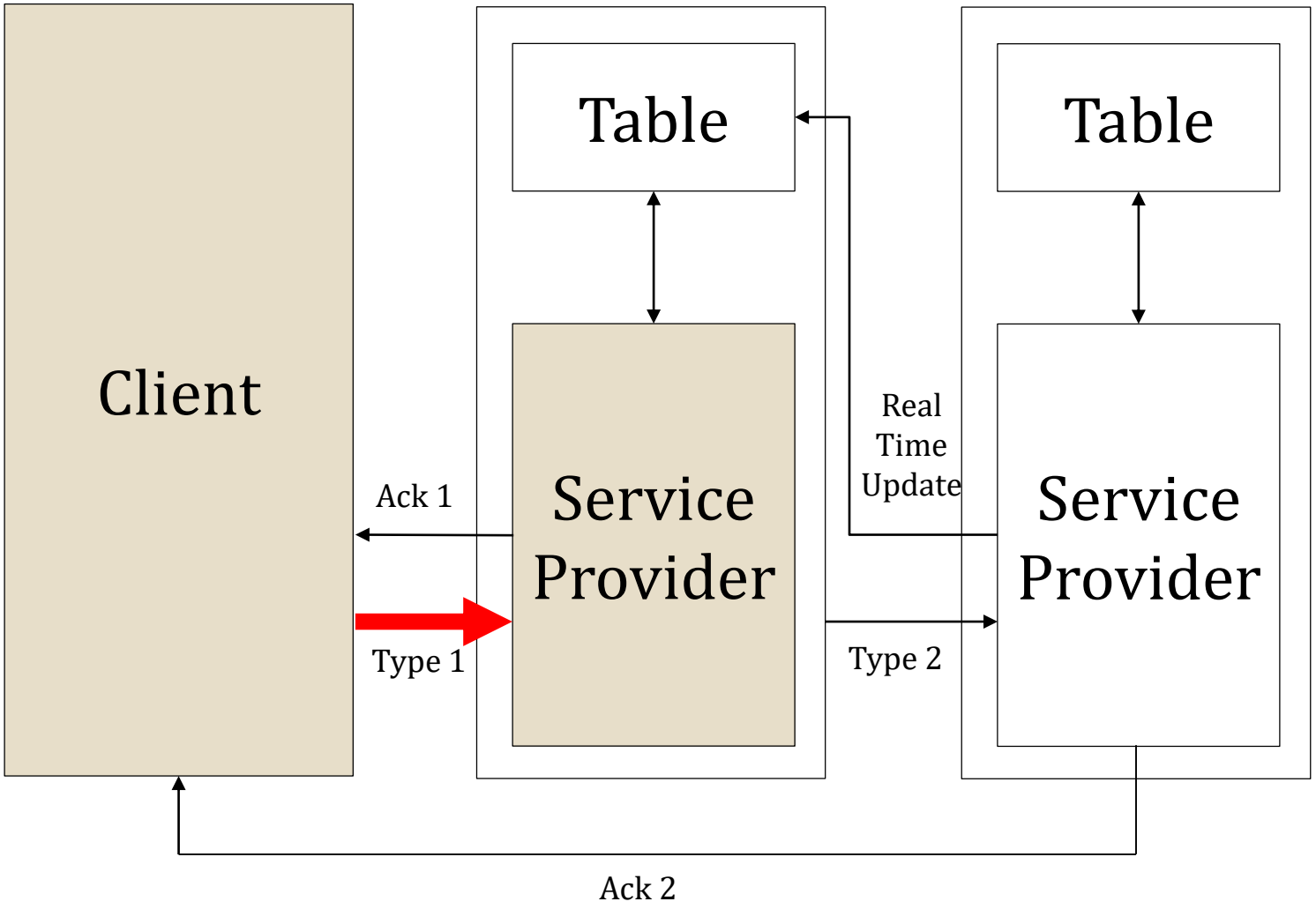
Proposed Approach

- The client knows the addresses of all the service providers present in the city
- This data is dynamic
- The client's request goes to one of the service providers, irrespective of the request type

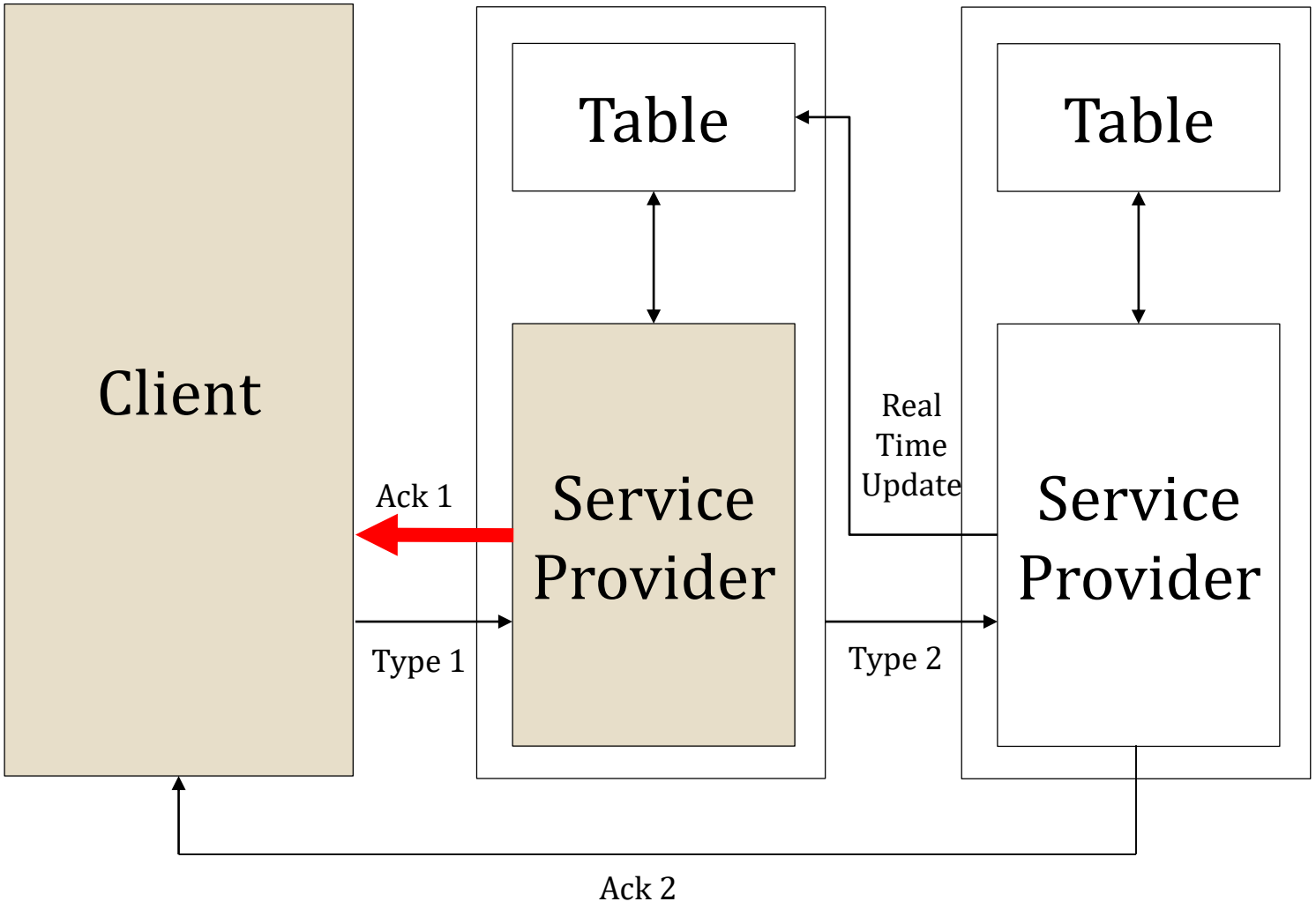
Proposed Approach



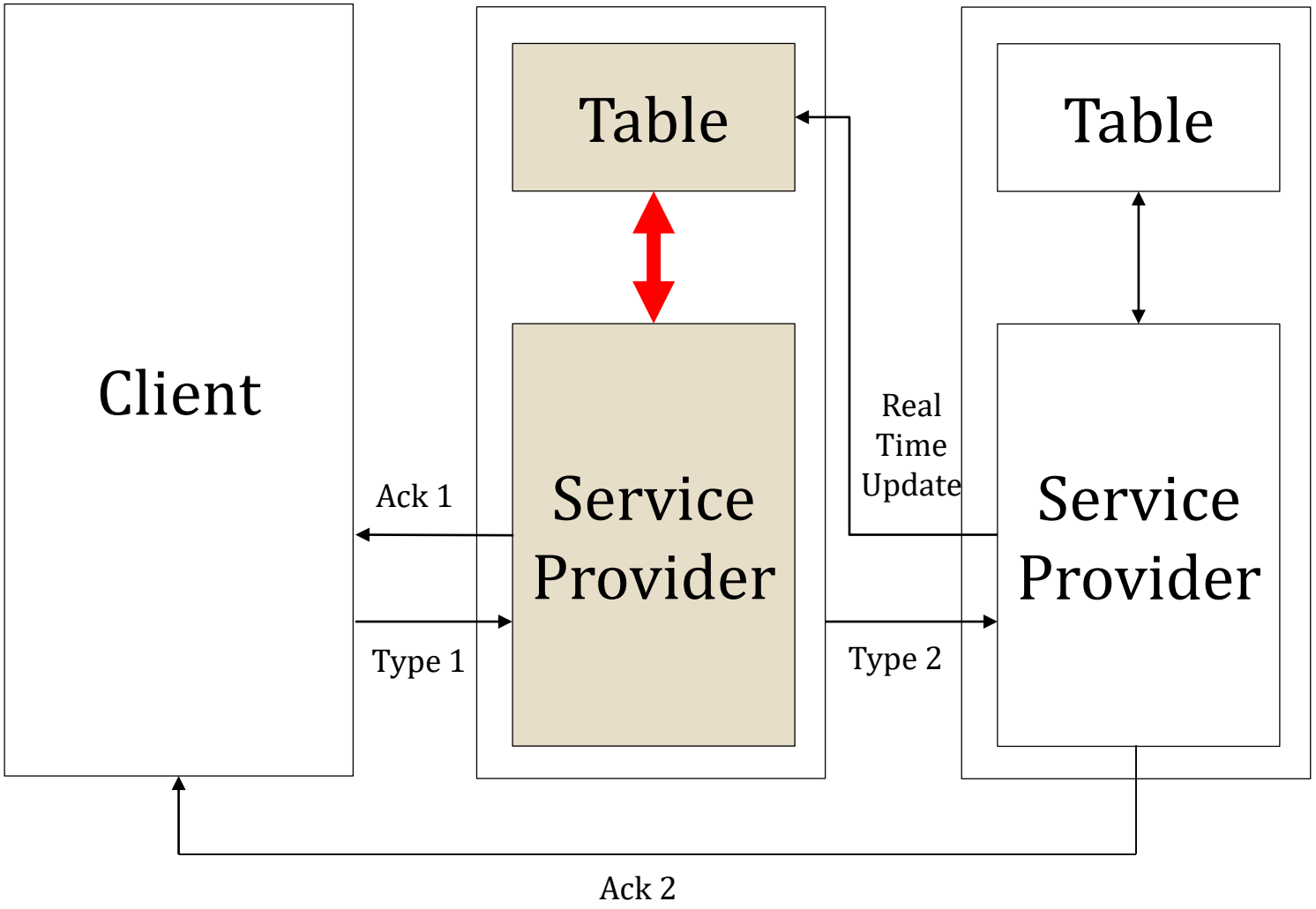
Proposed Approach



Proposed Approach



Proposed Approach



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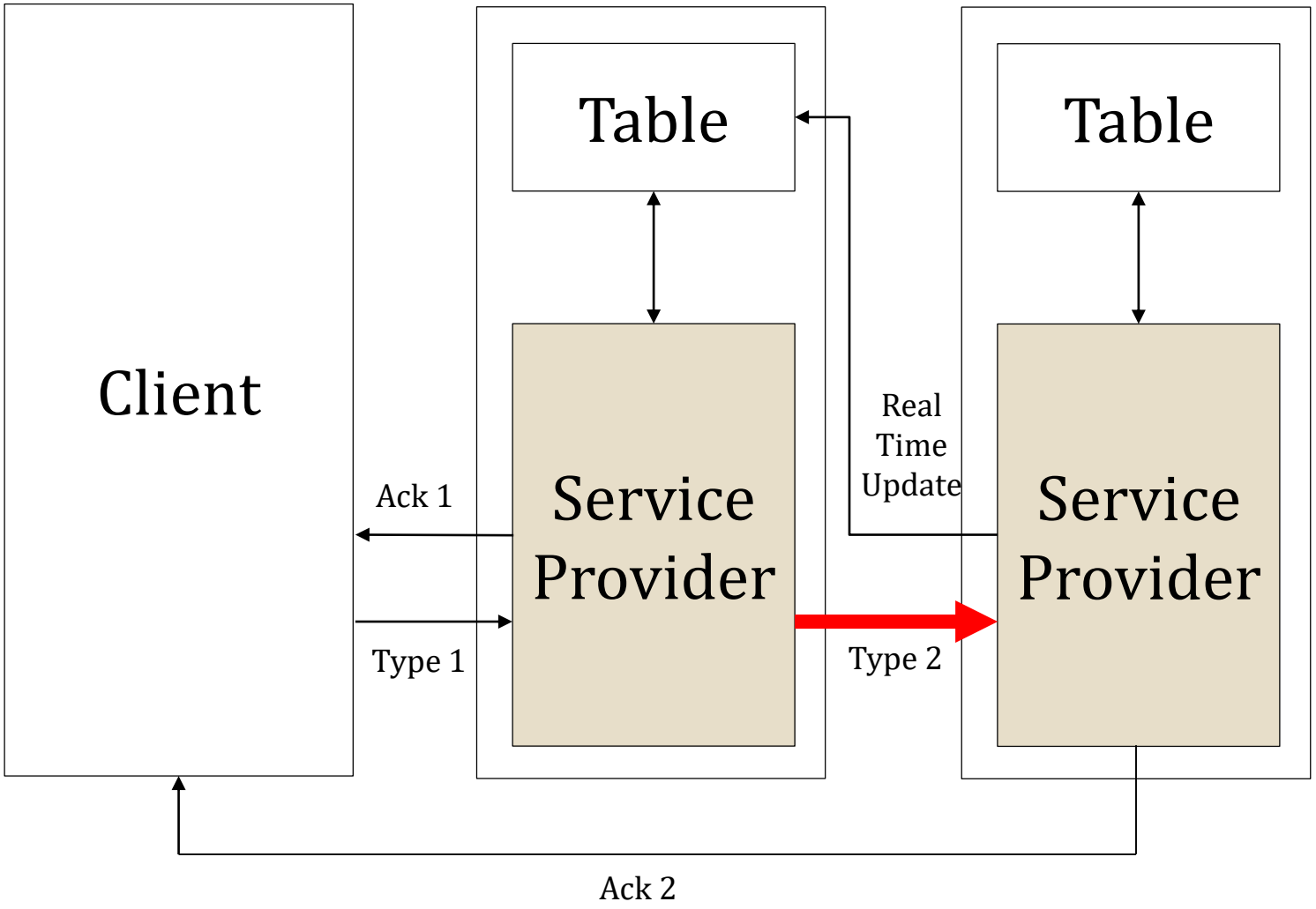
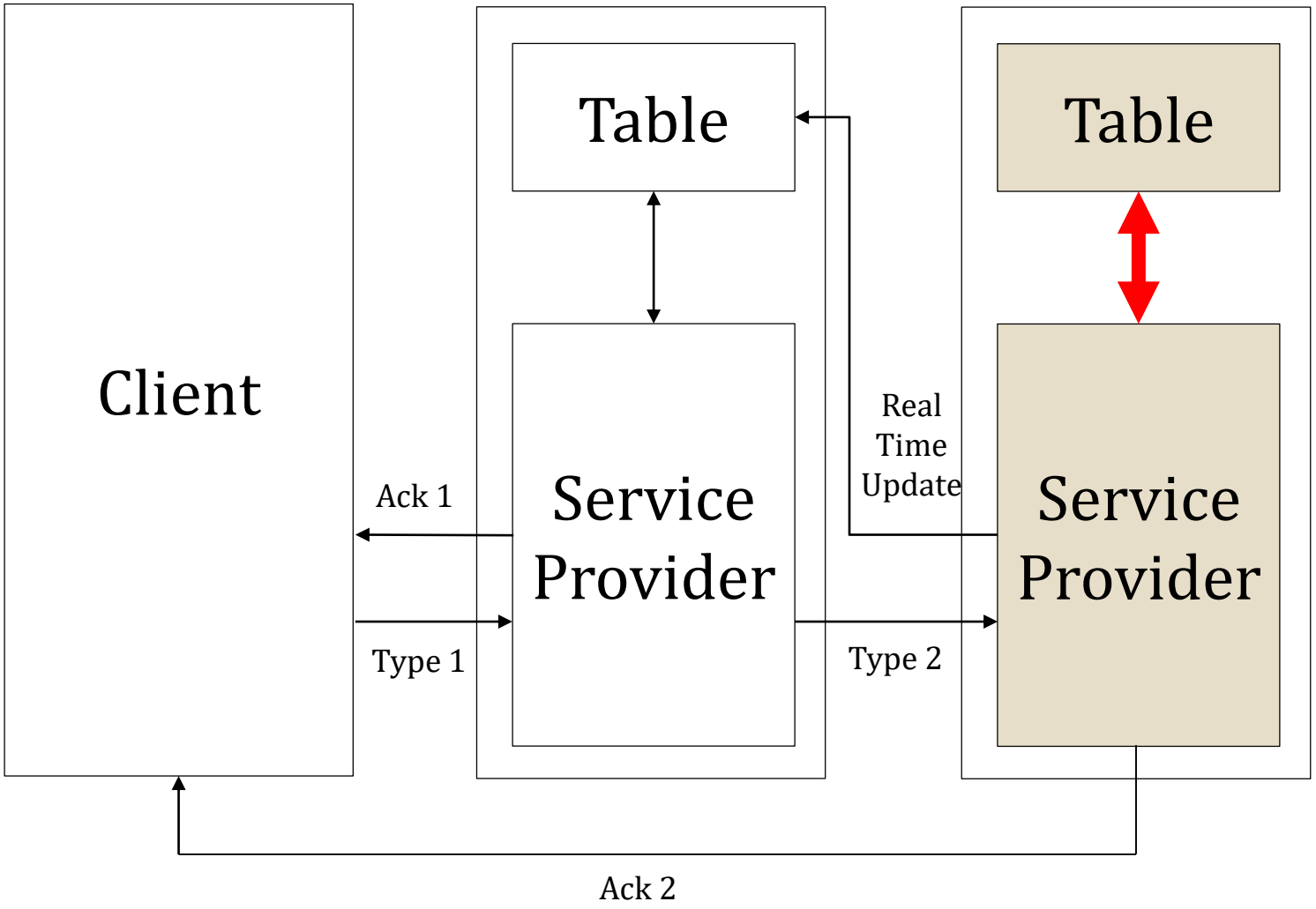
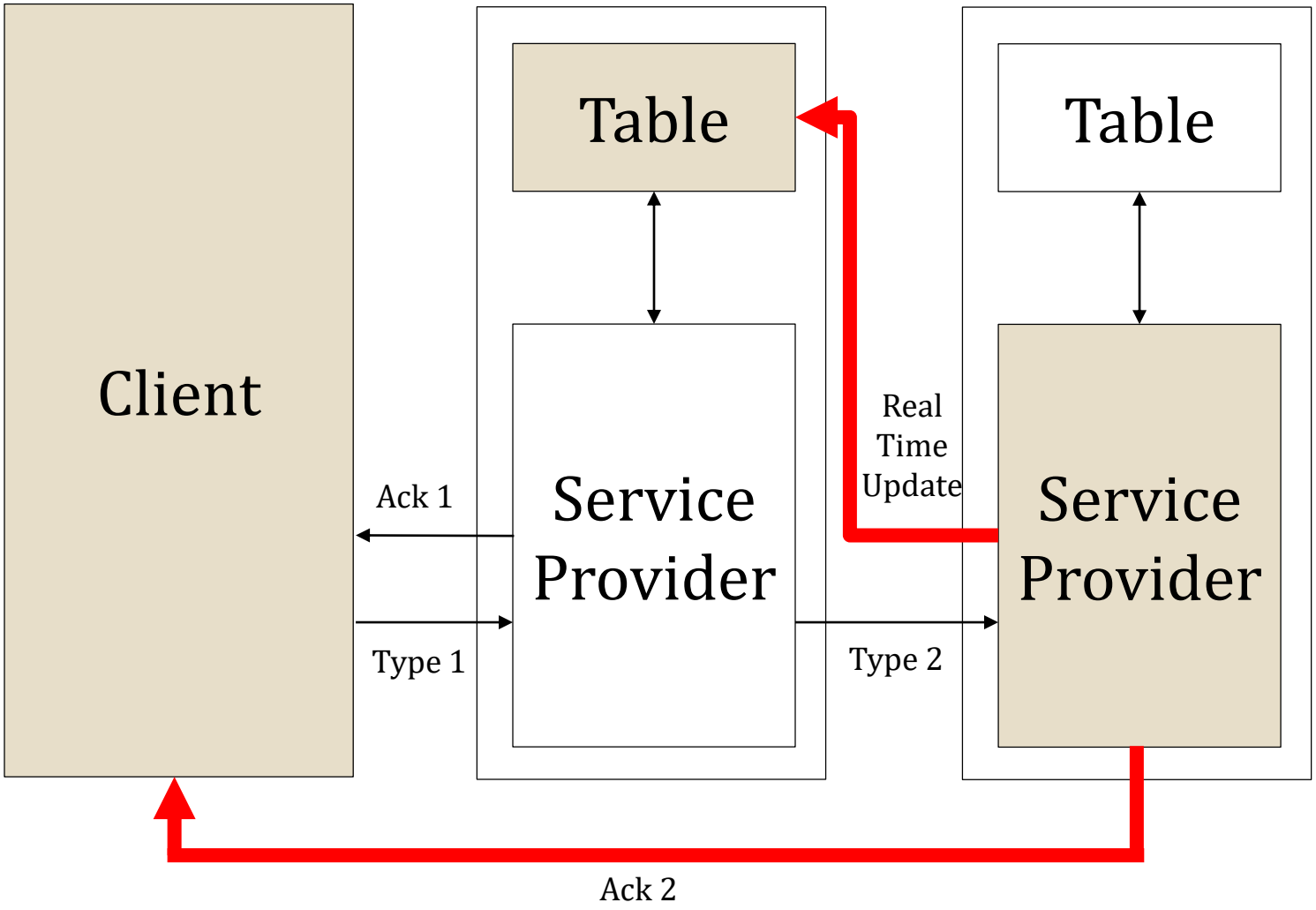


Proposed Approach



Proposed Approach



Proposed Approach

- Additional information like image, audio clip, etc. may be needed as well
- Problem: Large Size, unreliable network
- Solution:
  - The text message should go first
  - Multimedia message sent next as a payload

Proposed Approach

- Maintain a key to inform the server that a particular image or sound clip belongs to a previously routed Type 1 request
- Key can be a combination of the client id, GPS location and request timestamp

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Experiments

- Used *LPA Prolog* and *Typhon* - A Mobile Agents Framework
- Several instances of Prolog running, denoting service providers
- 4 types of service providers used:
  - Hospital
  - Police Station
  - Transportation
  - Fire Brigade

Experimentation

- When Client requests for a service:
  - Type of request, location (GPS) added to payload of agent
  - A service provider chosen at random
  - Request sent

Experiments

- When service provider receives a request:
  - Type of request is checked.
  - If “Type 1”, request forwarded to correct service provider with type changed to “Type 2”
  - If “Type 2”, service is provided to client.

Experiments

- Whenever a message is sent or received, the timestamp also gets displayed
- Response Time:

Response Time	=	Ack2 received by client	- Type 1 request sent by client

Experiments

- Along with a text-based input, we have also used a speech-based interface
- Developed using HTK, which is a standard toolkit for speech processing tasks
- Speech subsystem is used only to collect the input from the user
- Its accuracy does not influence the performance of the proposed architecture

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Results

No. of Clients	Service Time (milliseconds)		
	Minimum	Maximum	Average
1	235	235	235
5	262	469	388.2
10	423	460	446.4
20	302	662	492.1
40	334	2089	716.5
60	437	2330	952.2
85	295	25699	1442.8

TABLE 1: VARIATION IN SERVICE TIMES TAKEN FOR DIFFERENT NUMBER OF CLIENTS USING 10 SERVICE PROVIDERS

Results

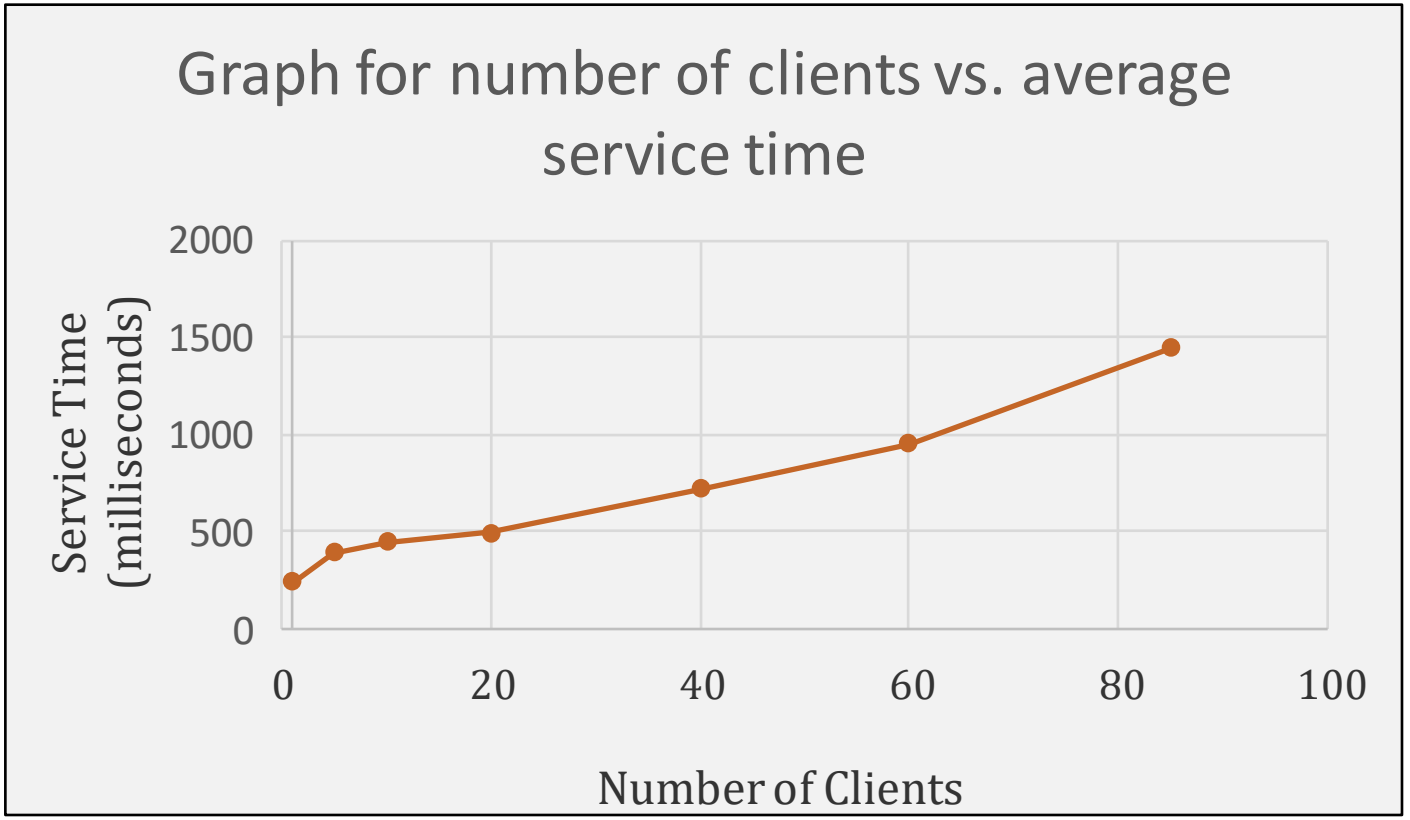

Figure 1: Graph for number of clients vs. average service time

Results

- Service time increases almost linearly with increase in the number of clients

Results

No. of Service Providers	Service Time (milliseconds)		
	Minimum	Maximum	Average
1	517	1696	1008.6
5	516	2985	1332.2
10	585	3115	1389.9
15	577	1953	976.6
20	279	2076	1049.4

TABLE 2: VARIATION IN SERVICE TIMES TAKEN FOR DIFFERENT NUMBER OF SERVICE PROVIDERS USING 60 CLIENTS

Results

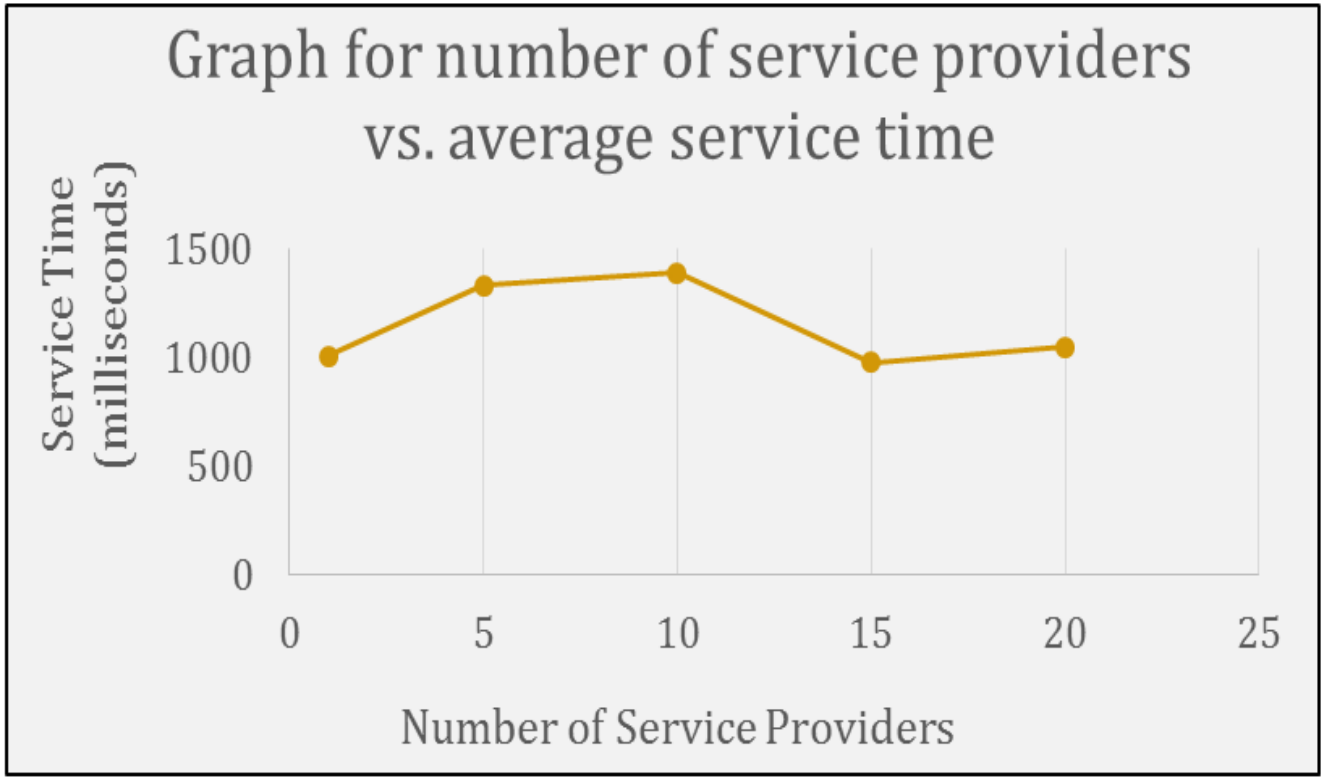

Figure 2: Graph for number of service providers vs. average service time

Results

- Service time decreases when the number of service providers is increased
- As the service providers increase in number, the load tends be distributed across more nodes
- For single service provider there is no need to route the packets anywhere else

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Conclusion

- Proposed a framework for IoT which uses mobile agents for providing services
  - Better service time for requests
  - Fault Tolerant / Robust
  - Scalable
  - Distributed and Decentralized

Future Work

- Can be extended for controlling devices remotely.
- If multiple requests are received from a location, they may be for the same incident or different ones.
- Real-time services like traffic updates can also be implemented using a slightly complex version of this design.

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Thank You

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