Resource-Controlled Remote Execution to Enhance Wireless Network Applications

Travis Newhouse, Joseph Pasquale

{newhouse,pasquale}@cs.ucsd.edu

Wireless Applications Can Benefit From Wired Computational Resources

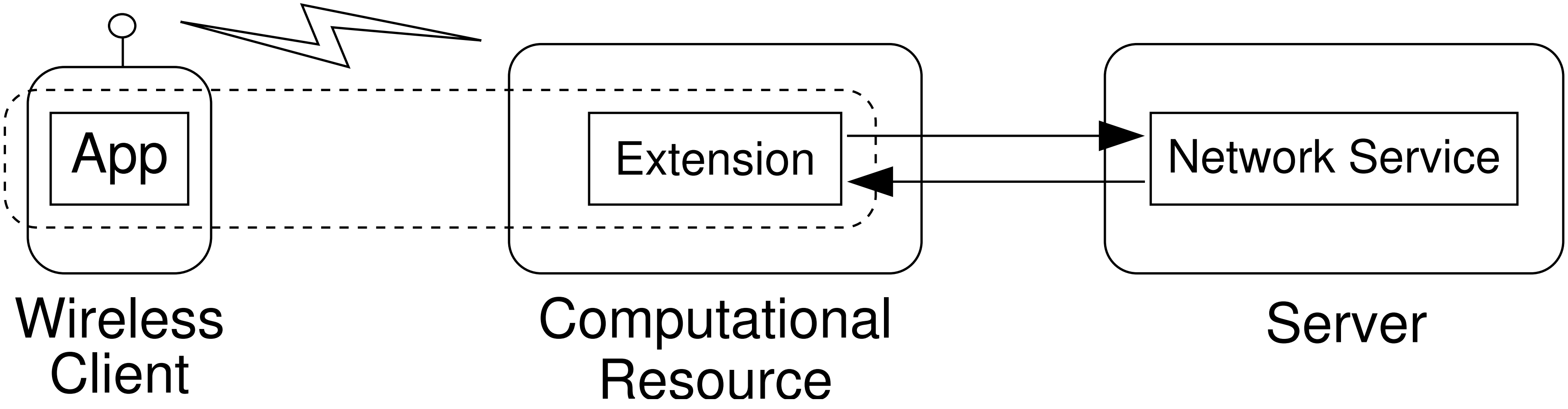
Goal:

- Enhance wireless applications without requiring additional resources on mobile device

Benefits:

- Reduce effects of Internet’s “best effort” design
- Transform data “designed for the desktop” to suit mobile device platforms
- Supplement mobile device hardware resources (e.g. processor, memory, battery life)

The Extension Model for Remote Execution



Extension is code that implements application-specific functionality to extend control of an endpoint

Extension is loaded on demand by the remote node

Non-extended endpoint need not be modified

Java Active Extensions System

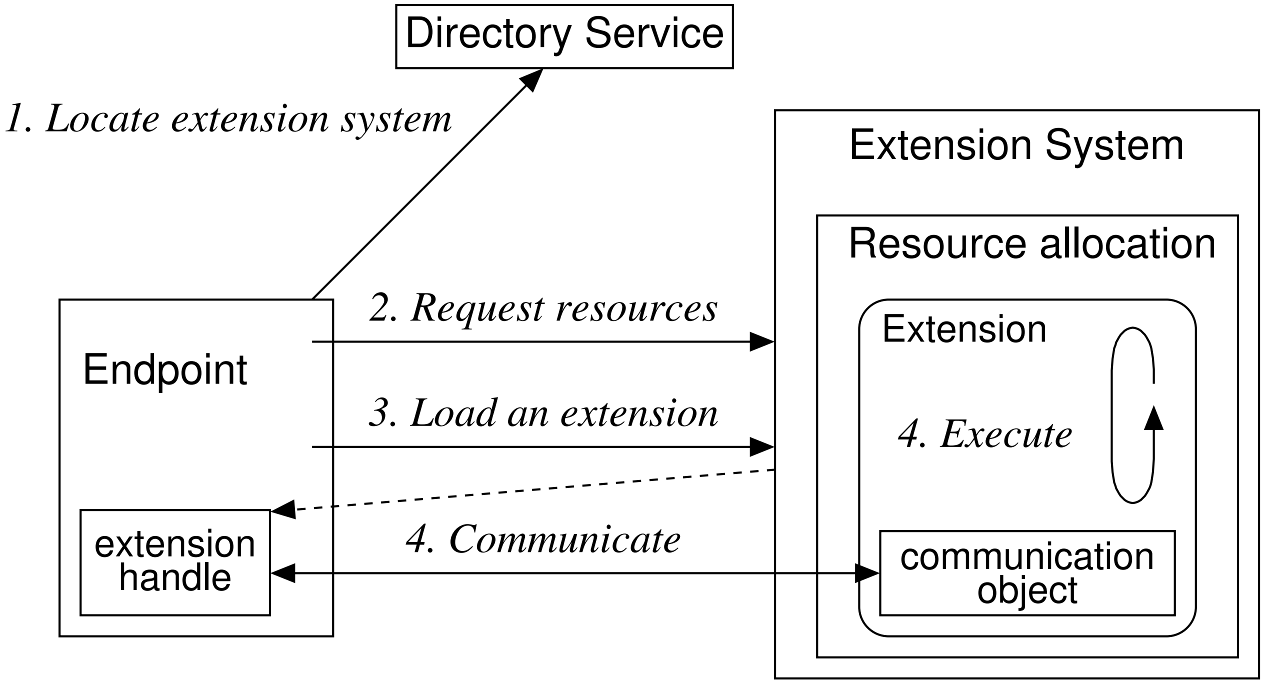
A user-level system for remote execution

Supports processor quality of service

User-level implementation supports incremental deployment

System design supports scalability of hardware resources

Resource-Controlled Remote Execution



4 phases:

- Discovery – locate an extension system in the network
- Resource allocation – request processor resources for execution
- Deployment – load extension(s)
- Execution – extension runs and communicates with endpoint

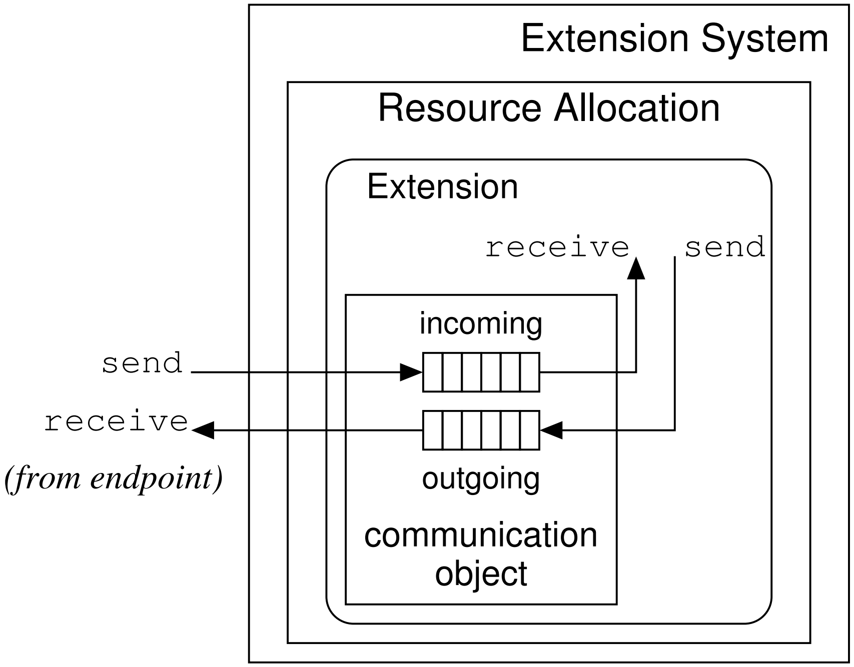
Quality of Service

Resource requests are made in the form: $\langle quanta, period \rangle$

Extension systems advertise quantum length

Endpoints specify the period over which resources are guaranteed

Endpoint-Extension Communication



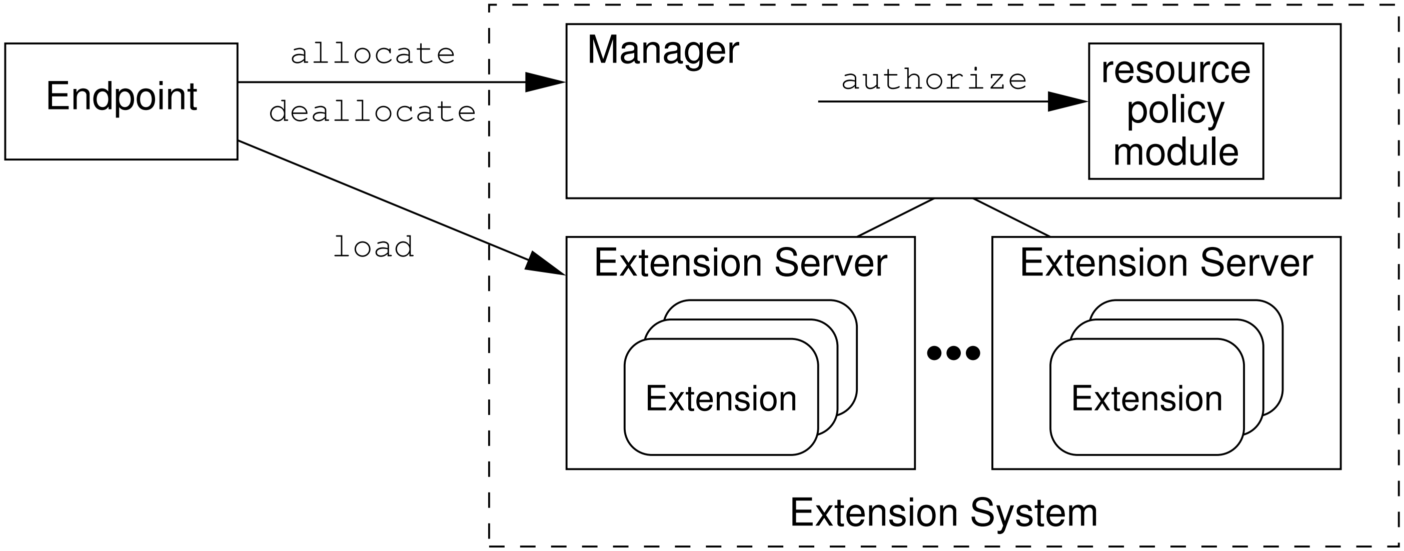
Message passing mechanism provided by extension system

Intended for bootstrapping application-specific communication

Messages are arbitrary, application-formatted sequences of bytes

Message delivery follows in-order and at-most-once semantics

Extension System Architecture



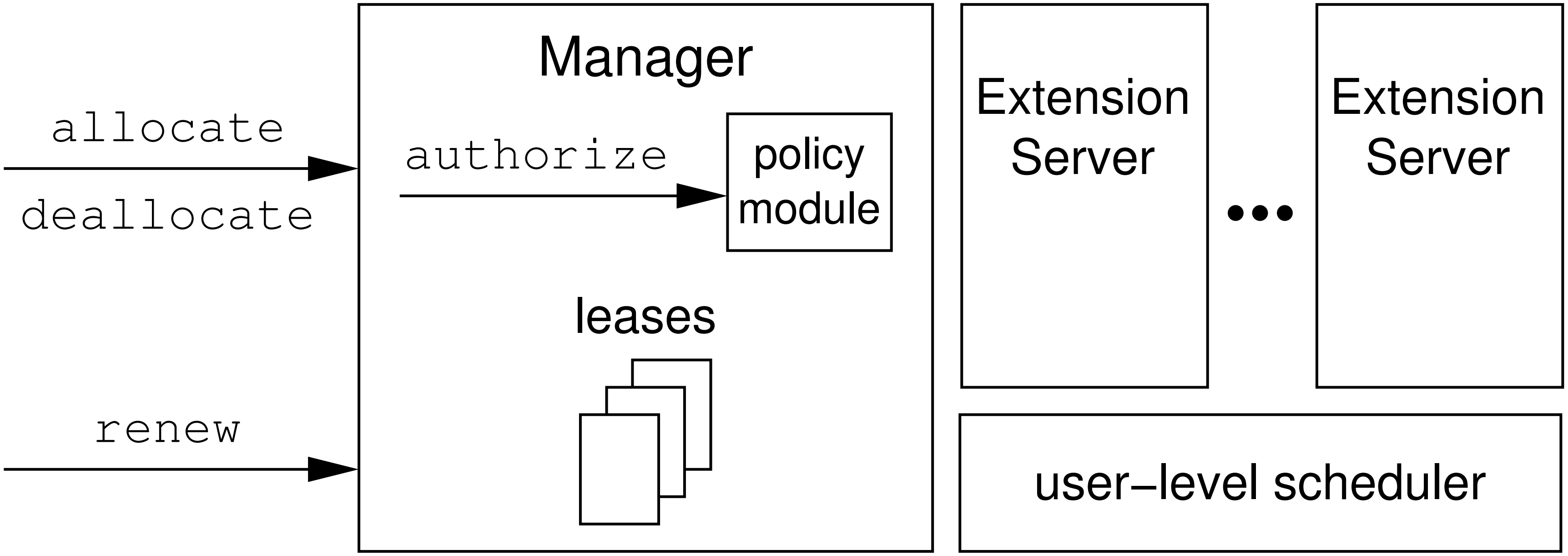
Extension Server provides execution environment

- Hosts the execution of one or more extensions
- Executes extensions with pre-allocated share of processor resources

Manager enforces locally-defined policy for resource sharing

- Responds to endpoints' resource requests by creating extension servers
- Schedules processor resources among extension servers

Enforcing Processor Shares



Each extension server implemented as a separate JVM

User-level scheduler operates on UNIX-like operating system

Groups of processes scheduled by the user-level scheduler

Kernel makes fine-grained scheduling decisions

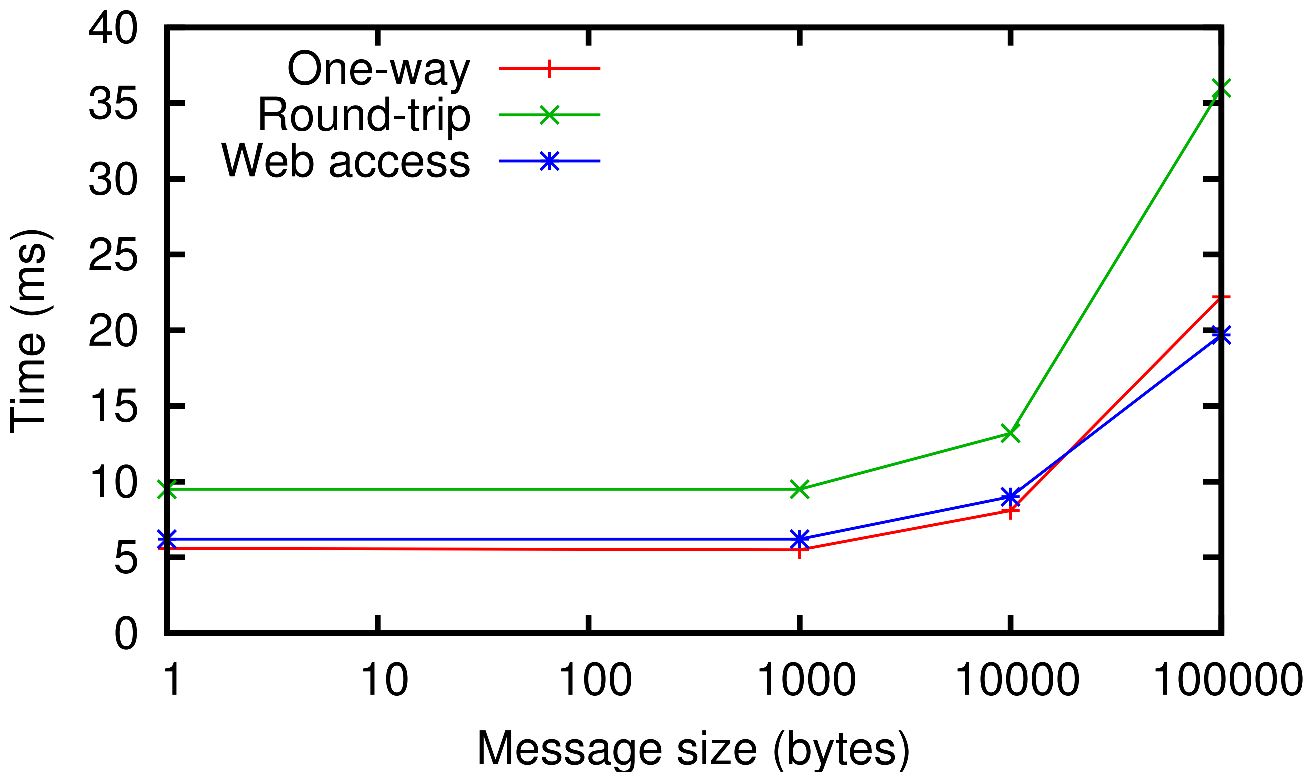
Cost of Basic Operations

Operation	Mean (ms)
Discover manager using Jini	770 ± 1
Discover manager using socket	542 ± 1
Allocate extension server	764 ± 4
Load extension	315 ± 3

Mean operation time with a 99% confidence interval over 1000 trials

Test machine is dual 600 MHz Pentium III, 1 GB memory, Solaris 8

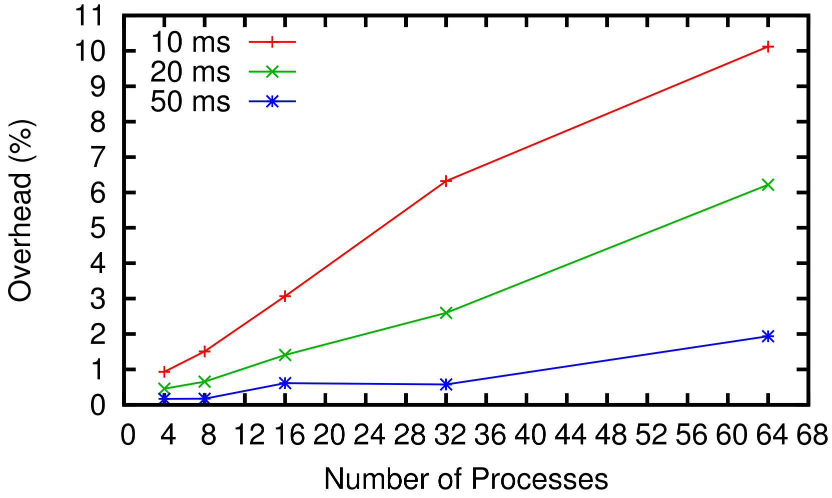
Message Passing Time

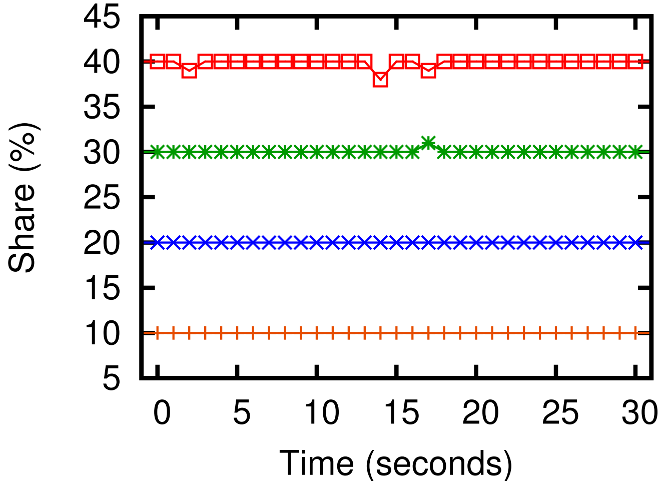


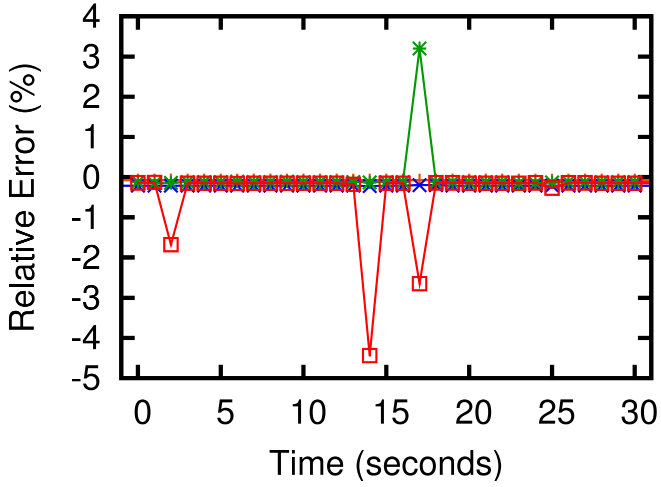
1000 trials performed over a local 100 Mbps Ethernet

Sending a message is comparable to a retrieving a local Web object

Overhead and Accuracy of User-Level Scheduler







Conclusions

The extension model for remote execution can enhance wireless network applications

Java Active Extensions system provides remote execution with processor quality of service

The system architecture supports scalable hardware resources

The user-level implementation supports ease of deployment and abstracts hardware details