TCP Splice Benefits for Web Proxy Servers

Marcel C. Rosu

Daniela Rosu

IBM T.J. Watson

Server ‘in-the-middle’

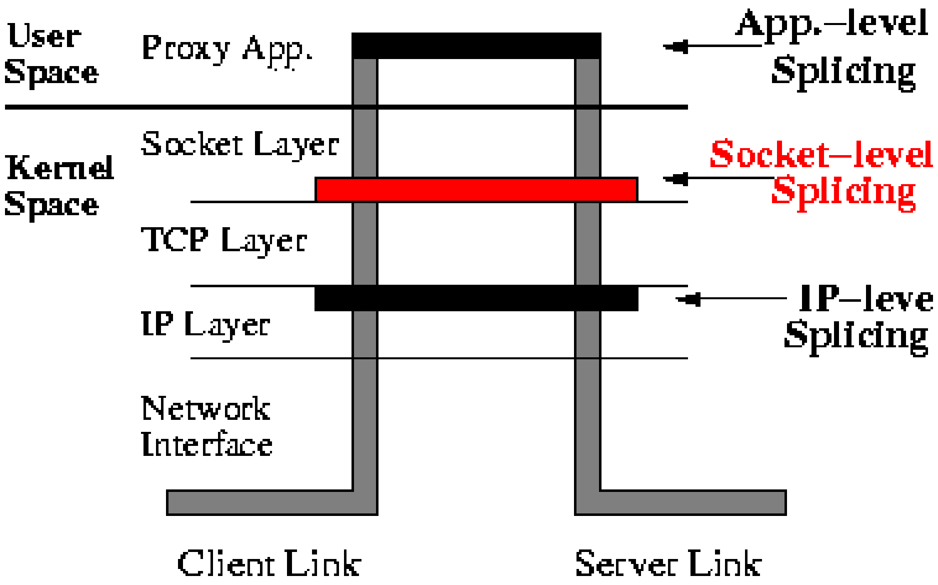
- Web proxies, CDN nodes, Edge Servers...
- Act as caches for Web content
  - Hit rates are 50% or lower
- Relay data between end nodes
  - Process small fraction of data (headers)
  - Handle a very large number of connections
- **Our target**
  - Reduce overheads of data relay

Our Approach

- Use a General-Purpose Platform
  - Large servers vs. dedicated appliances
- Improve the data-forwarding path
  - Lower CPU overheads and packet latencies
- Restrict OS & app changes to a minimum
  - Improves chances of being deployed

- **In-kernel connection splicing**

TCP Connection Splicing



Related Work

- IP-level Splice [Maltz et al., Spatcheck et al.]
  - For firewalls, mobile gateways
  - Restricts splicing to connections with identical characteristics
- Socket-level Splice [Balakrishnan et al.]
  - Evaluated for throughput implications
  - Mobile gateways
- **Our work**
  - Use socket-level splice for Web Proxies
  - Evaluate for overhead reductions

Outline

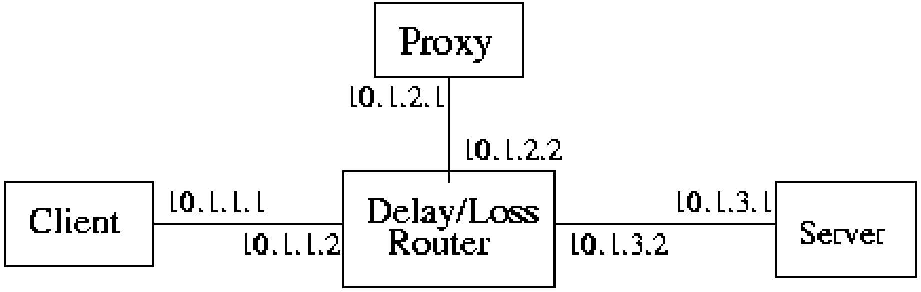
- Implementation
- Experimental Testbed
- Experimental Evaluation
    - Forwarding overheads and latencies
        - GET requests and SSL Tunnels
    - Interaction with serving from proxy cache
- Conclusions and Future Work

Implementation

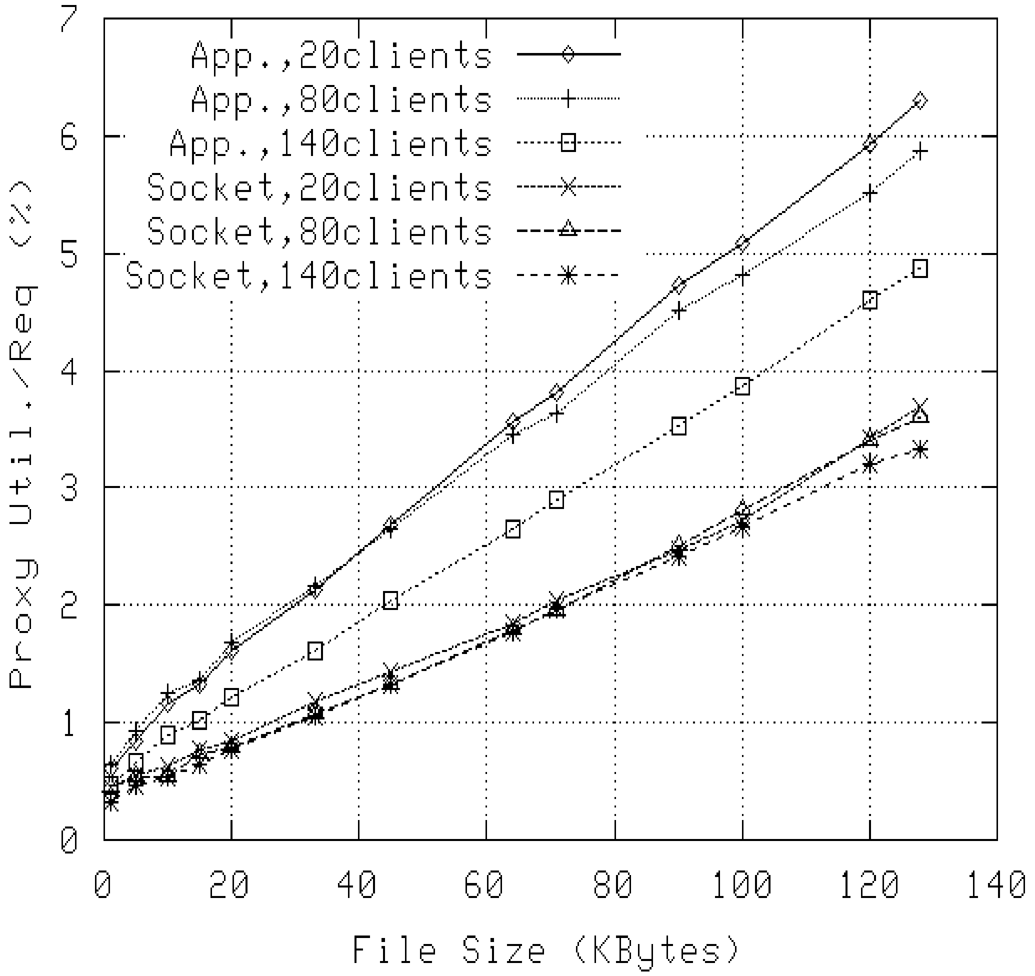
- New system call in AIX
  - Integrated with the TCP stack
- Data forwarding path
  - ≃100 lines C code
  - Executes in interrupt context

Experimental Testbed

- Platforms
  - AIX 5.10 on RS/6000s and Linux/Pentium
- Clients
  - s-client: generates concurrent request streams
  - best-effort workload
- Custom proxy
  - event-driven, minimal header processing
- HTTP server emulator
  - SSL handshake
- WAN emulation
  - enhanced Nistnet



Forwarding Overheads: GET



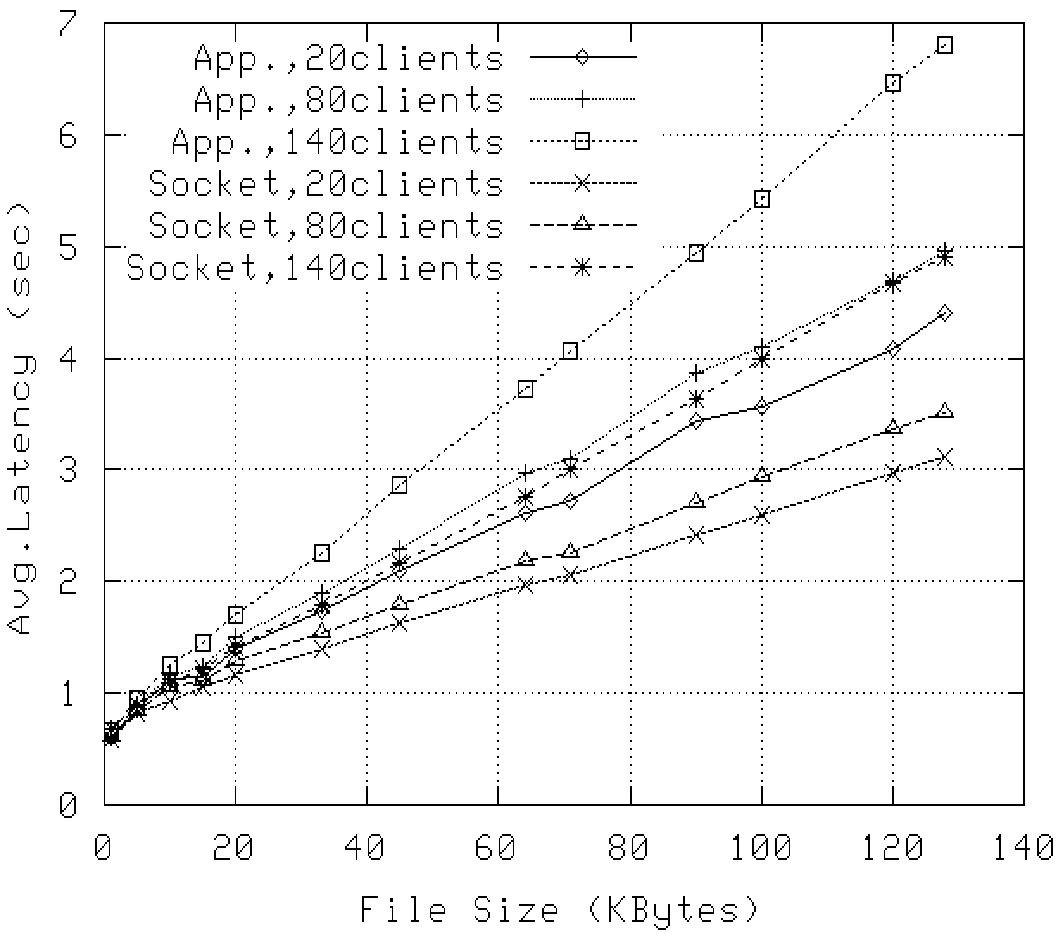
Proxy utiliz./req

- 25-50% reductions
- Proxy overloaded for 140 clients, app-level splicing

WAN conditions

- C-P: 10ms, loss 0.1%
- P-S: 90ms, loss 1.0%

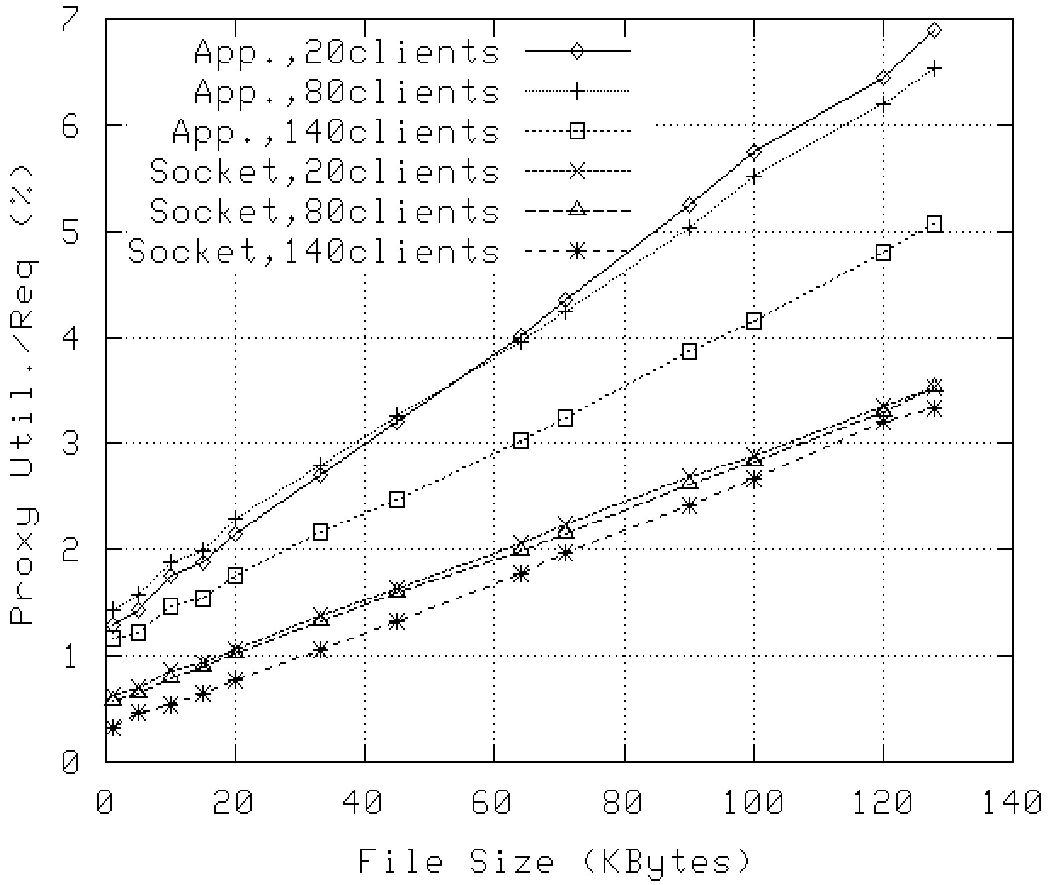
Forwarding Latency



Latency

- Significant reductions
  - 5k+ files: 5-25%
- Small increases (< 5%)
  - small files, many clients
- Most important contribution:
  - Congestion window opens faster

SSL Tunneling



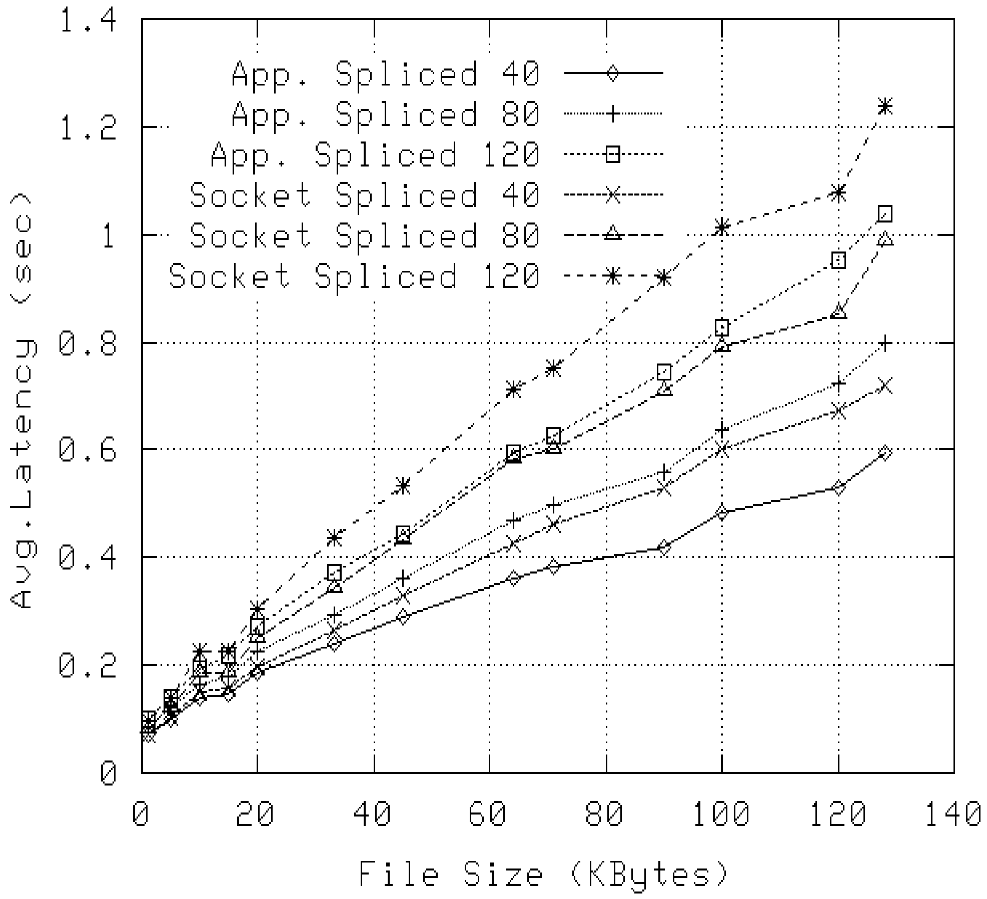
Proxy utiliz./req

- 25-50% reductions

SSL Handshake (full)

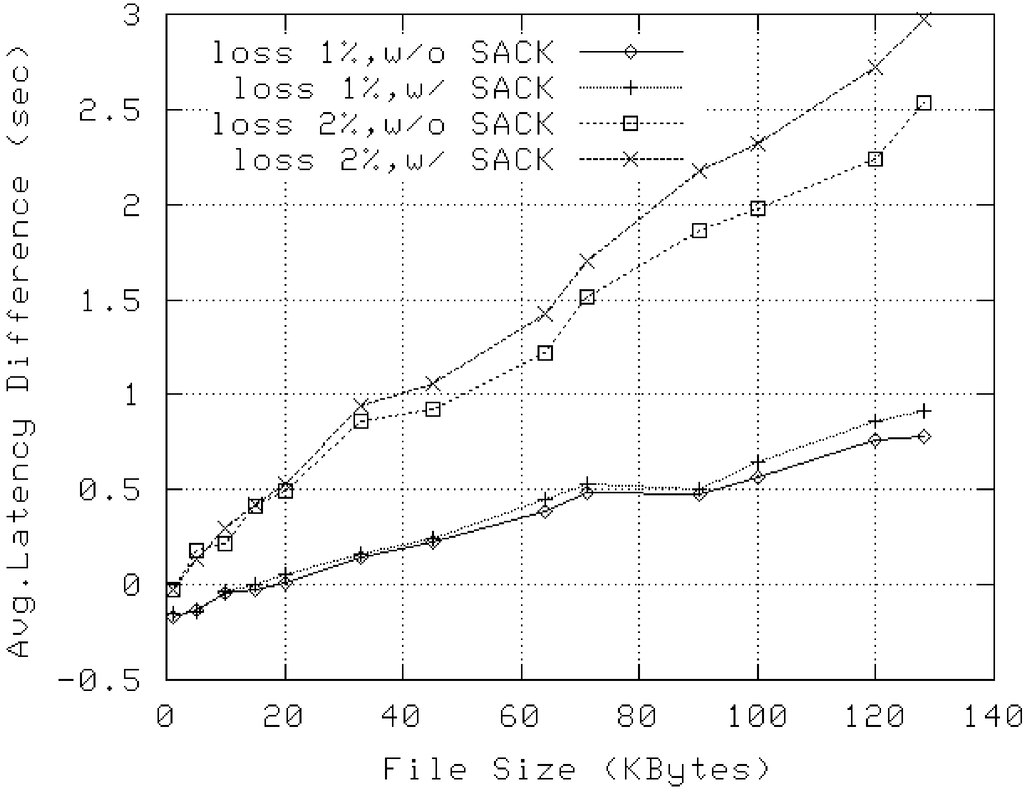
- Client: 98 bytes
- Server: 2239 bytes
- Client: 73 bytes
- Server: 6 bytes
- Client: 67 bytes
- Server: 61 bytes

Mixed Traffic: Cache & Server



- Workload mix:
  - 40 clients to cache
  - 40/80/120 to server
- Performance
  - Rates – similar for app- and socket-level splicing
  - Latencies – higher for socket-level splicing

Comparing to IP-level Splice



Faster loss recovery

- Independent loss recovery on the two TCP connections
- Lower RTTs and loss rates

WAN conditions

- C-P: 50ms, loss 0.1%, 56k modem
- P-S: 90ms, loss 1-2%

Conclusions

- Socket-level Splicing in proxy servers
  - Enables substantial overhead reductions
    - for medium and large data transfers
  - Requires small/few kernel & app changes
- Future Work
  - Extend splicing interface
    - HTTP/1.1, handle cacheable content
  - Control resource allocation (memory, CPU)
    - kernel vs. application