

Tickets and Currencies Revisited: Extensions to Multi-Resource Lottery Scheduling

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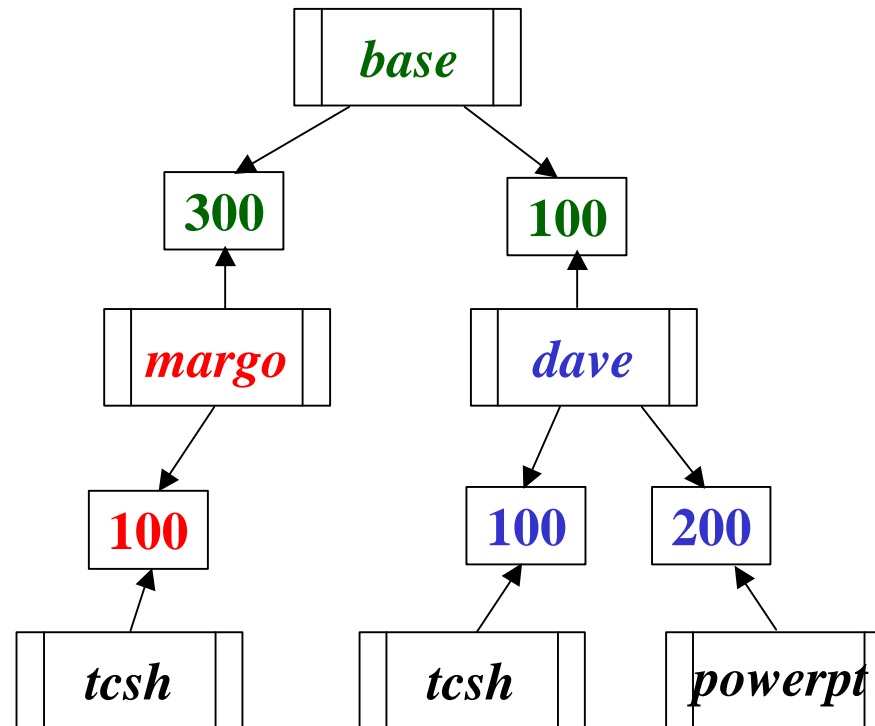
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Resource Management Problem is *Not* Solved!

- Two observations:
 - applications have different resource needs
 - isolation is useful
 - central service providers
 - single-user systems running multimedia applications
- Two conflicting goals:
 - flexible, application-centered resource management
 - give applications more control
 - secure isolation
- *How can we meet both goals?*

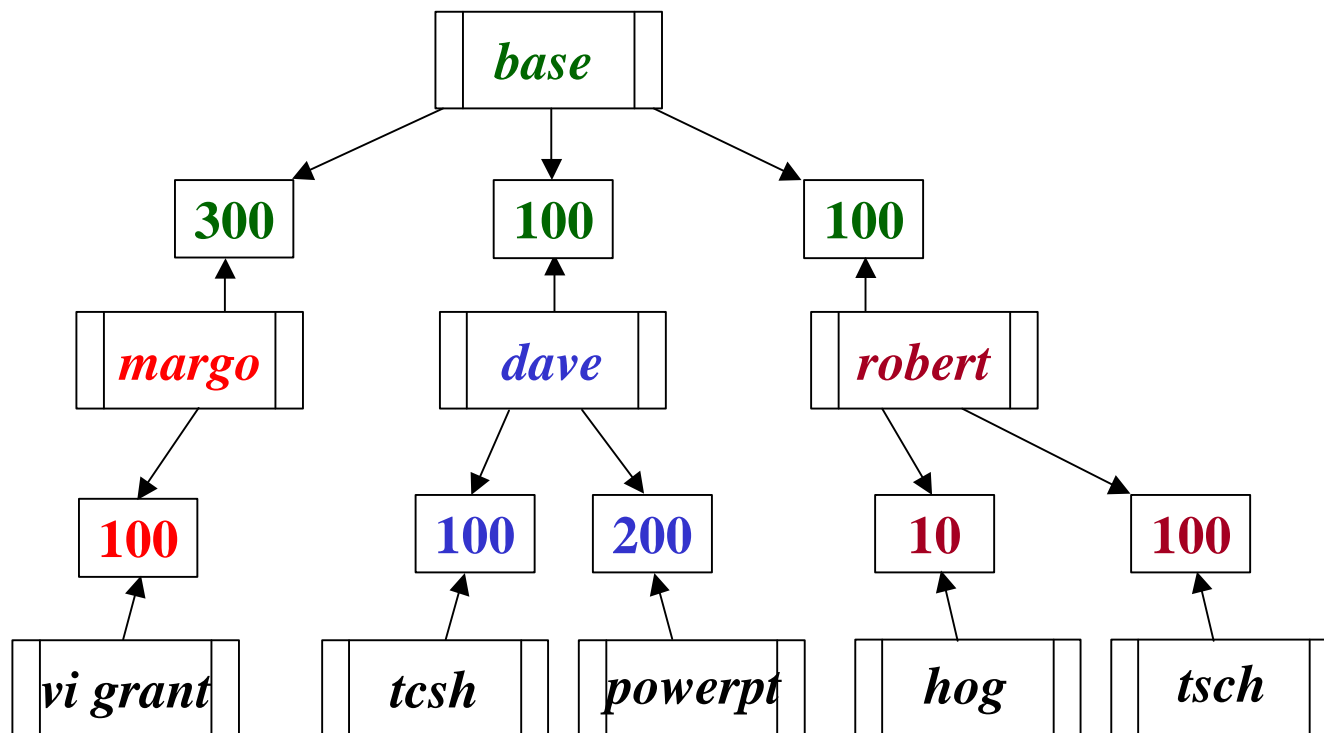
Lottery Scheduling Framework [Waldspurger & Weihl]



- *Tickets* encapsulate resource rights.
- *Currencies* isolate users, processes and threads.
- Use resource-specific tickets (CPU, memory, disk,...).

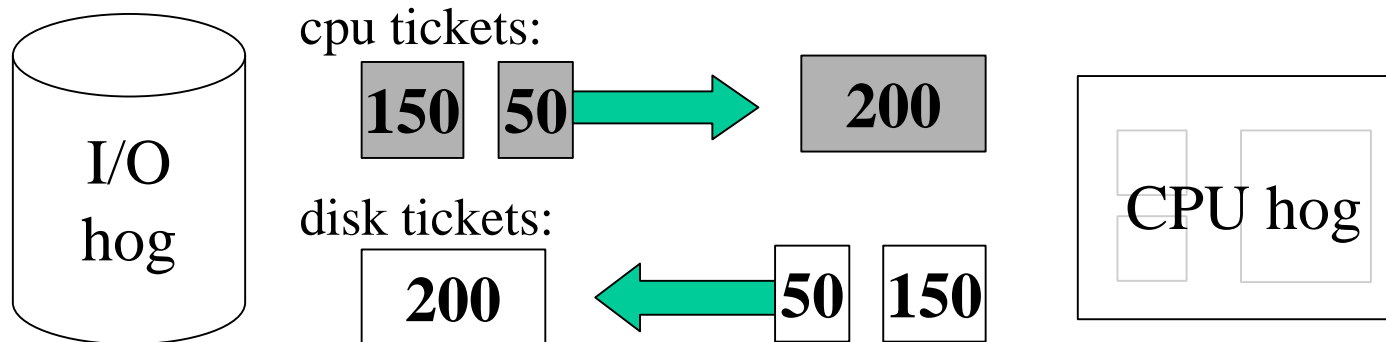
Flexible Allocation vs. Secure Isolation

- Currencies impose upper *and* lower limits on flexible allocation.



Ticket Exchanges

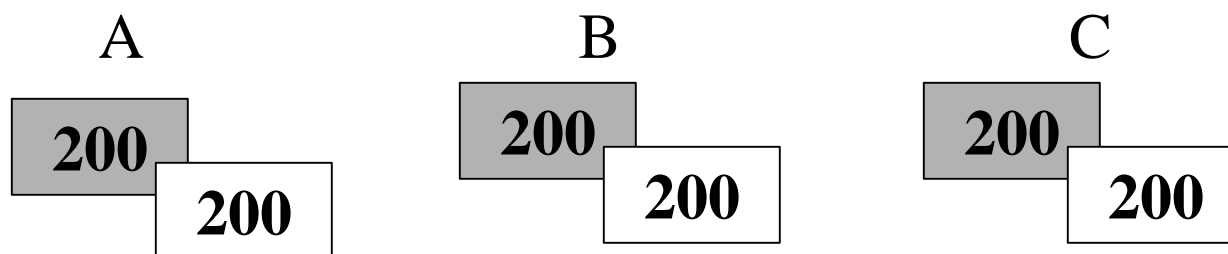
- Allow applications to safely modify their resource rights.



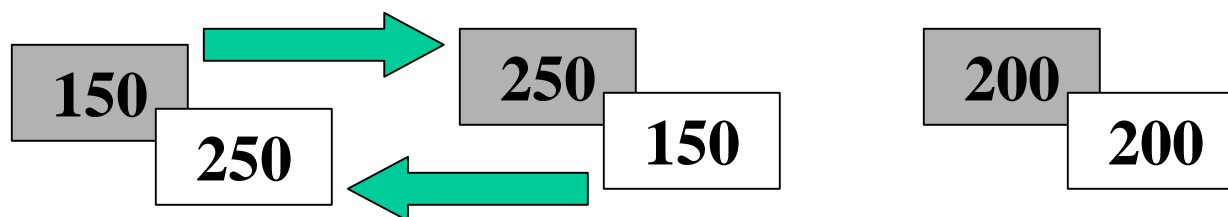
- Exchanges enable coordination among applications.
- Applications can install *resource negotiators* to initiate exchanges based on their QoS and the state of the system.

Exchanges Insulate Non-Participants

- Before:

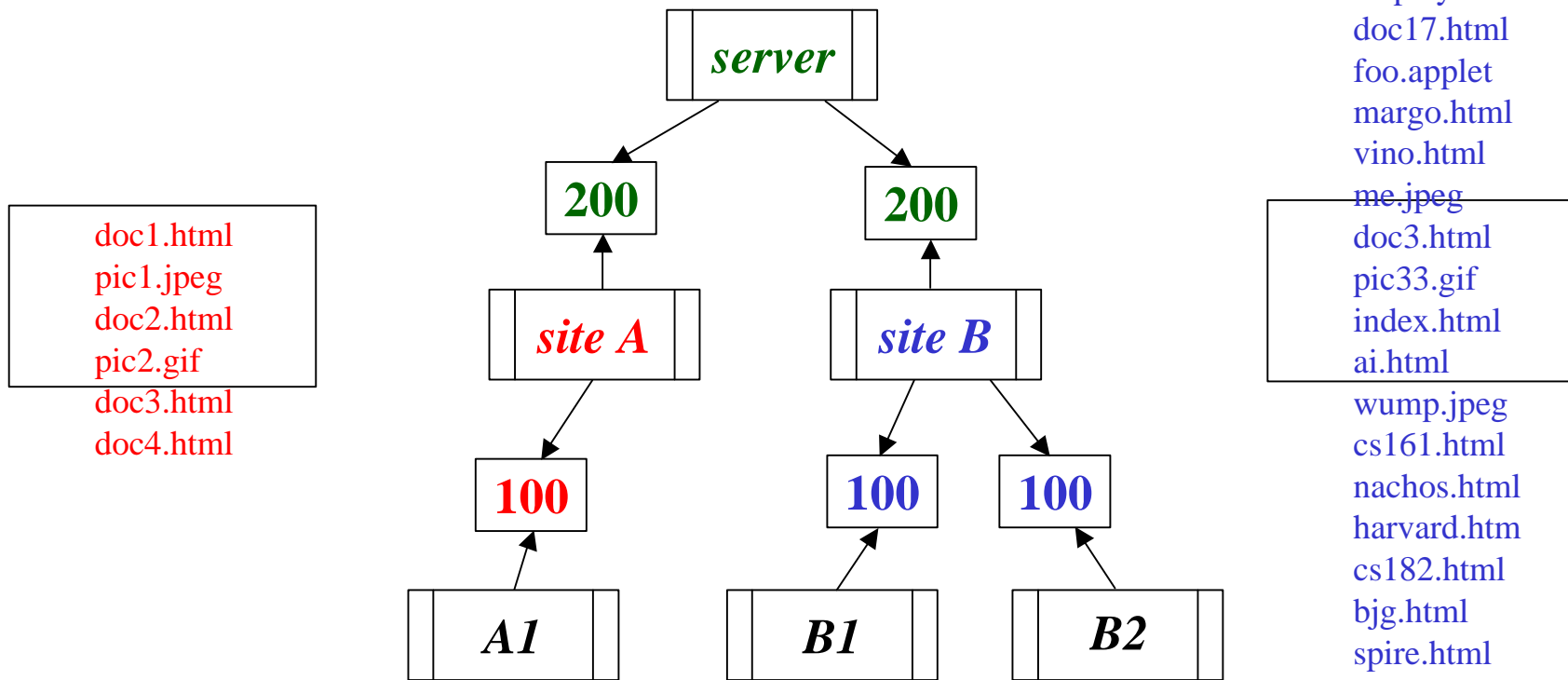


- After:



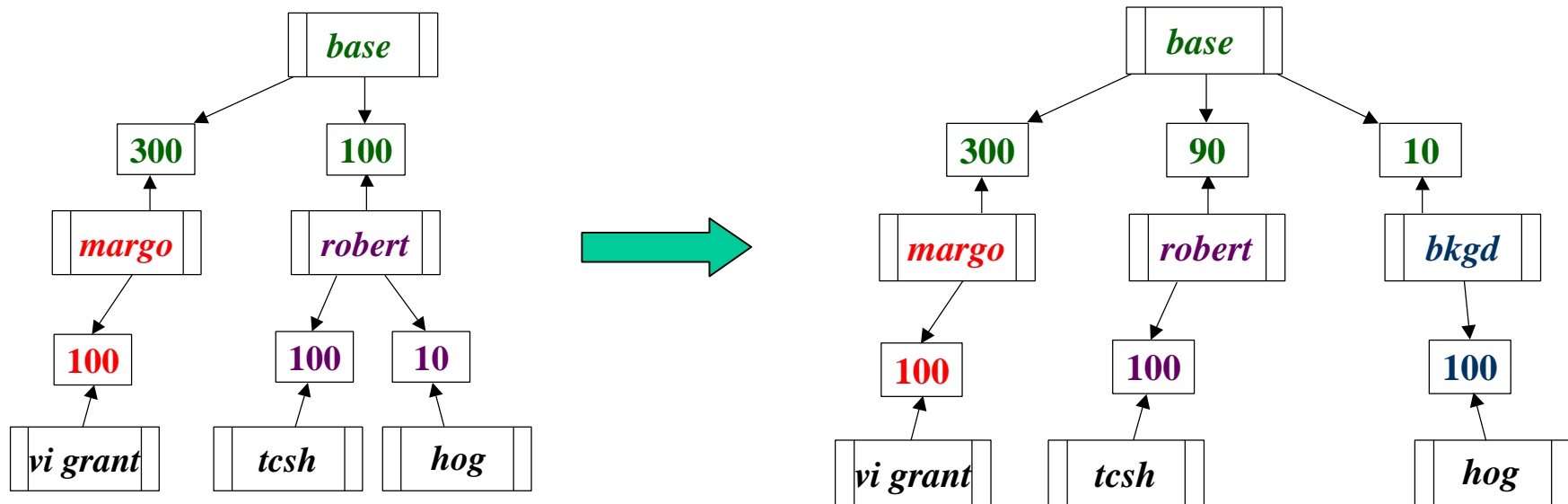
- Client C has the same relative resource rights ($200/600$) after the exchange as it did before.

Ticket Exchange Example: Web server for virtual hosting



Extensible Currency Brokers

- Brokers provide access controls to currencies.
- Extensibility makes them flexible.
- They allow us to overcome the lower limits imposed by currencies.



Conclusions

- Goals: flexible allocation *and* secure isolation
- Currencies, like any isolation mechanism, impose limits on possible allocations.
- Ticket exchanges safely circumvent the upper limits.
 - allow applications to take advantage of their differing resource needs
 - protect the resource rights of non-participants
- Extensible brokers overcome the lower limits by enabling flexible access controls.
- We *can* and *should* provide application-centered resource management that is both flexible and secure.