Application Scheduling

Richard Lagerstrom

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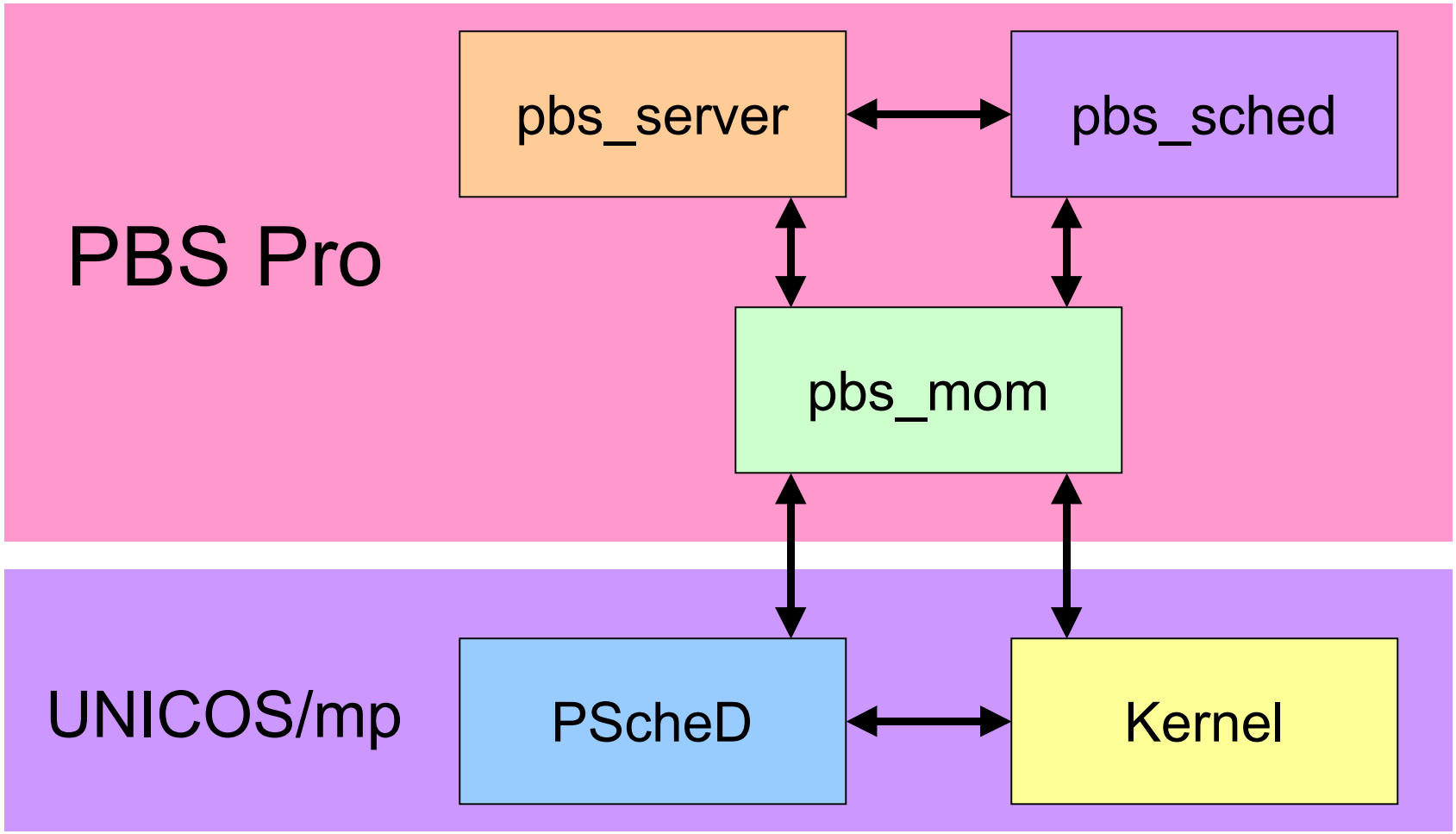
Scheduling Hierarchy and Scope

Name	Scope	Example
Grid	Global	Globus
Batch	Organizational, Departmental, or Cluster	PBS Pro
Placement	Single System, Multinode	PScheD
Process	Single Node, Multiprocessor	UNICOS/mp

Functional Organization



History

- Psched was ported from Cray T3E
- Enhanced to do initial placement
- Modified to support multi-CPU nodes
- User and admin. displays through `psview`
- More displays with `apstat`
- Cray X1 kernel cannot initiate applications without the assistance of psched

Introduction

- Placement strategies
- Placement requirements
- Starting an application
- Gang scheduling
- Migration
- The PBSpro interface

Placement Strategies

Many configurable options

- Equalize node workload
- Minimize node fragmentation
- Maximize processor utilization

Placement Requirements

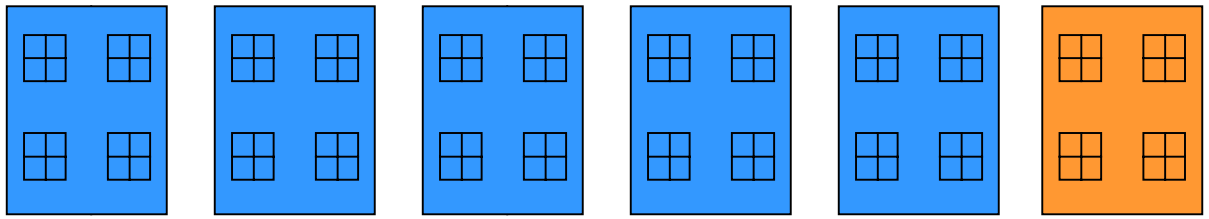
- Power-of-2 MSP/SSP per node
- Memory loaded when executing

Accelerated applications need:

- Global address space ID (GASID) for off-node accelerated memory references
- Node contiguity

Six-node Example

- Each node has 4 MSPs and 16GB memory
- Five with application flavor
- One with operating system and support flavors

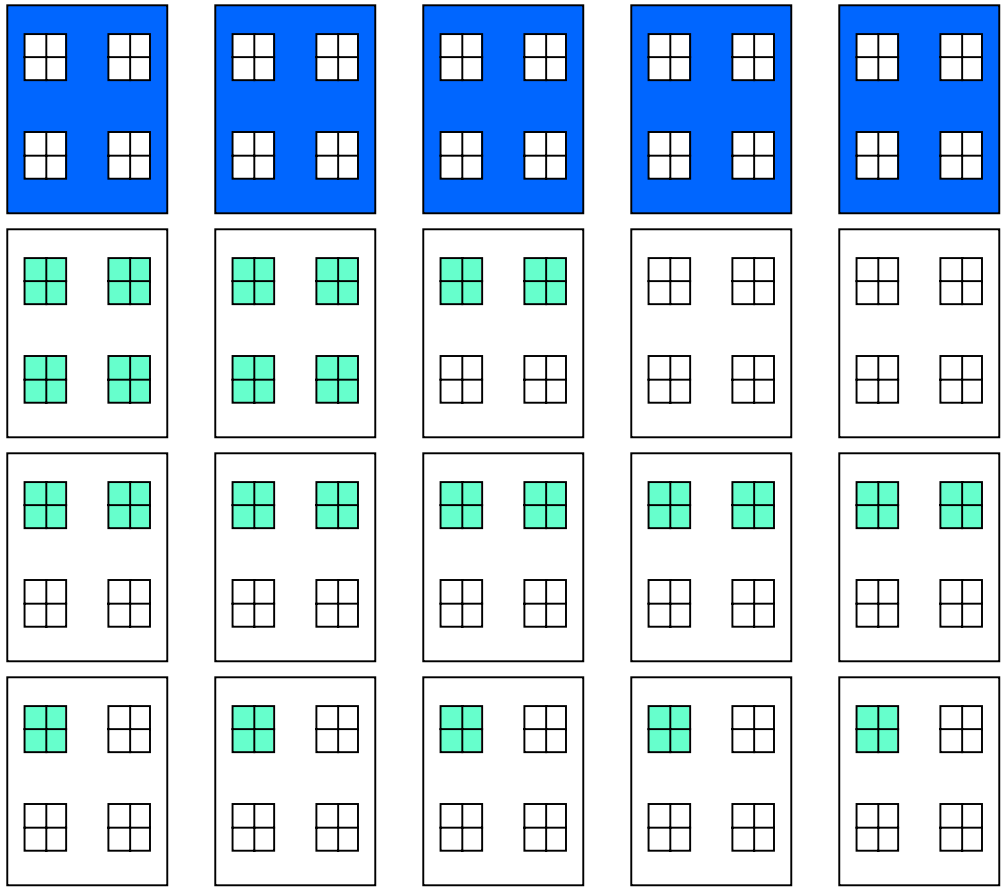


Application Mapping

How many PEs are allocated to a node?

- User option to choose PEs/node
- Psched will pick a mapping by default
- Memory usage per PE is the major reason for user specified mapping

Mapping Examples



-n 10 –N 4

-n 10 –N 2

-n 5 –N 1

Posting an Application

Support node phase

- Run `aprun -n x -N y a.out`
- aprun checks for option errors
- aprun sends an RPC request to psched to post the app for placement
- aprun waits for a signal to continue
- Psched gets PBSpro queue limits
- Psched creates an apteam and joins aprun

Placing an Application

- Psched generates placement information
- Psched sends placement information to the kernel
- On the next time slice psched sends a start signal to aprun to exec( ) PE 0 of the app

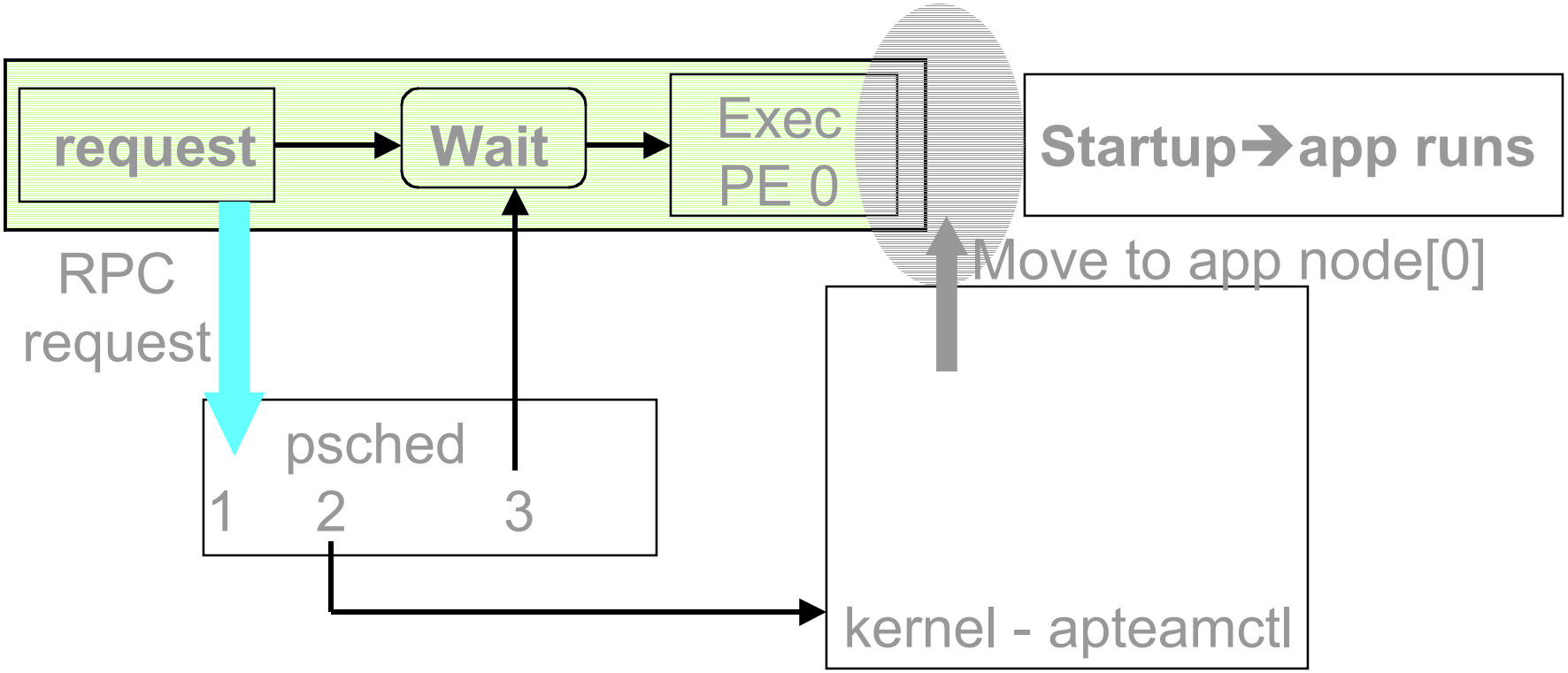
Application Startup

Application node(s) phase

- Execution begins in `startup()` which sets up the shared memory environment
- All PEs of the app are created with a *placed* `fork()`
- App execution begins in `main()`

Running an Application

User types `aprun -n20 a.out`

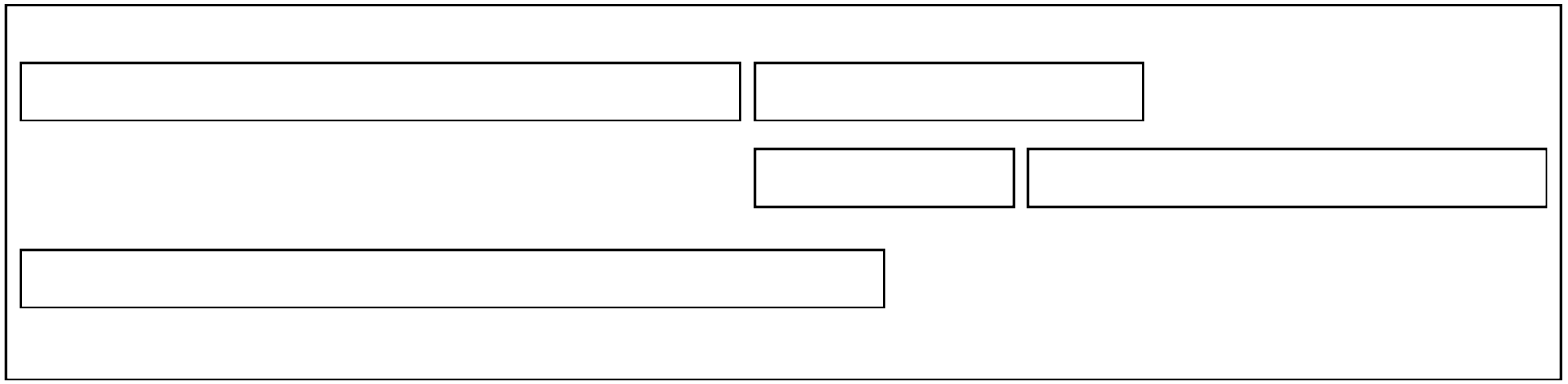


Application Execution

- Apps are time sliced by psched
- Memory of inactive apps may page out
- Memory of active apps is locked in

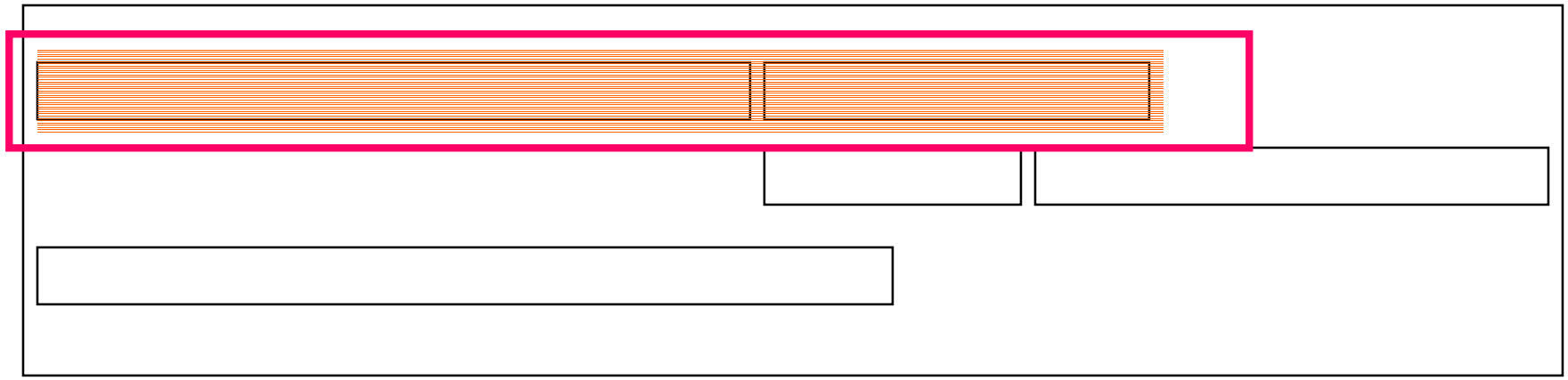
Gang Scheduling

Five gangs – three parties



Three time slice example

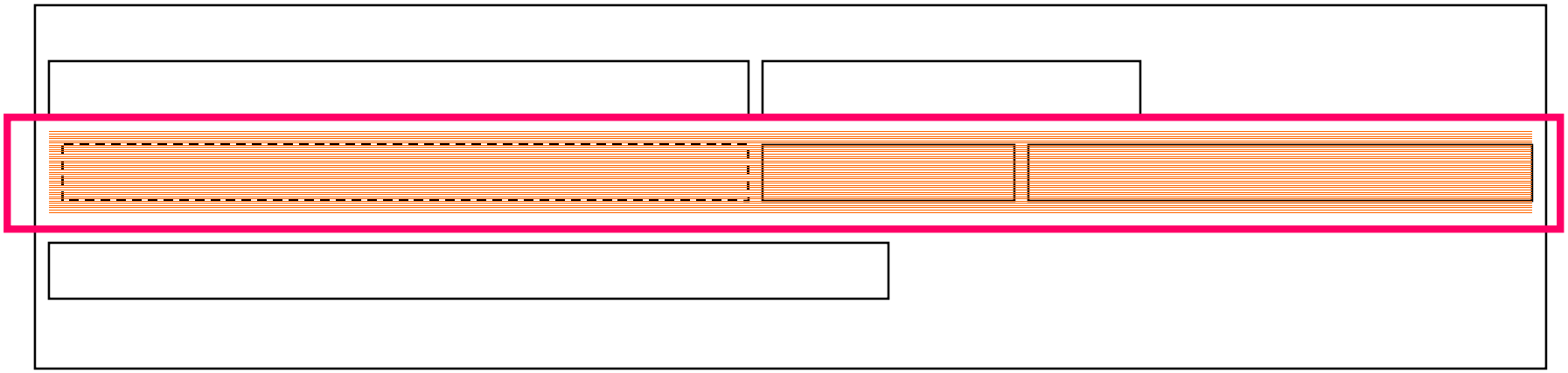
Gang Scheduling 1



Five gangs – three parties

First time slice

Gang Scheduling 2

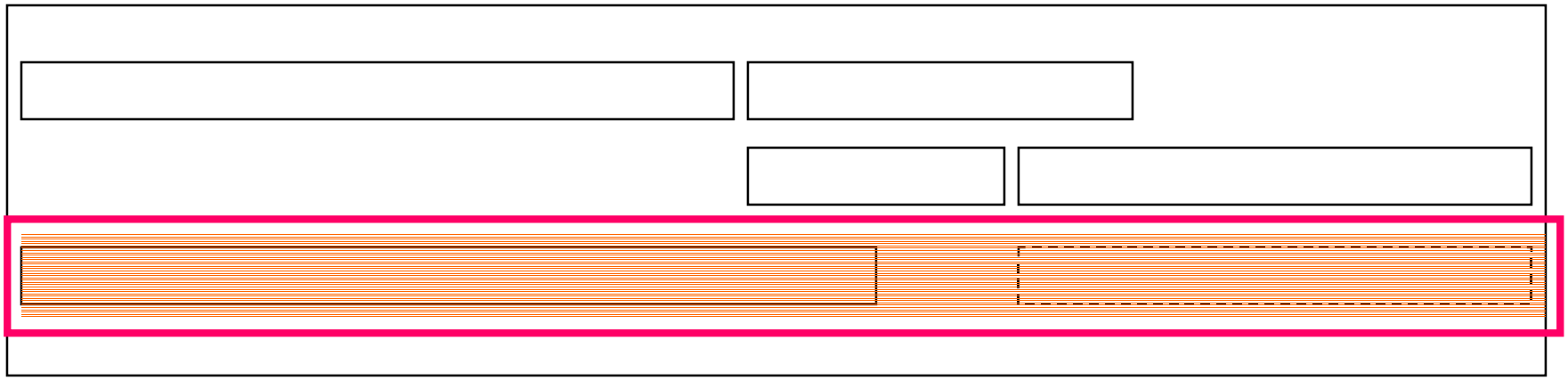


Five gangs – three parties

Second time slice

Gang Scheduling 3

Five gangs – three parties



Third time slice

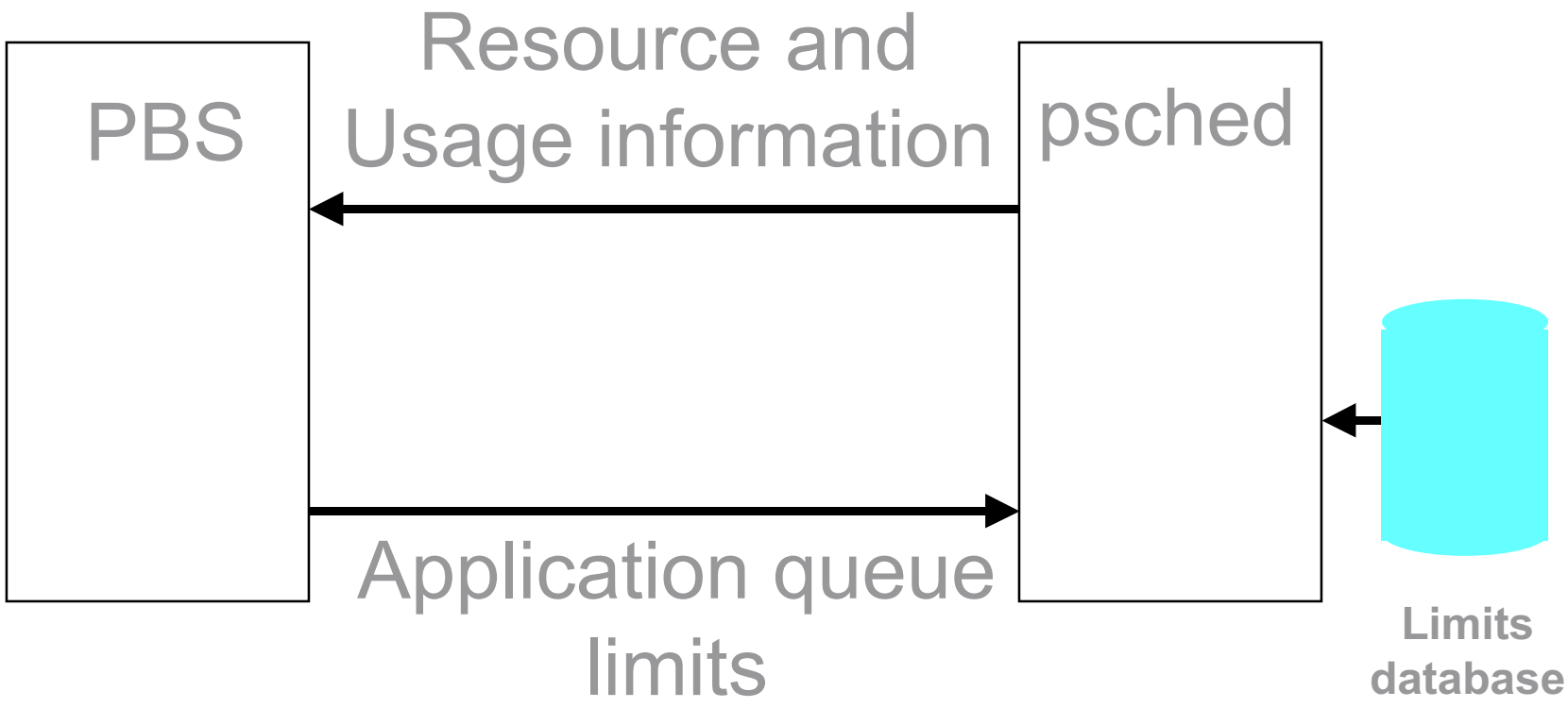
Application Migration

- A target place list is generated
- The app is disconnected to stop execution and unlock its memory pages
- The target place list is given to the kernel
- The app is connected
- Memory pages are moved from the origin nodes or disk to the target nodes
- Execution begins on the target nodes

Application Exit

- Each PE exits
- PE 0 waits for all other PEs to exit
- When PE 0 exits the kernel detects the PE count is zero
- The kernel sends psched the app exit signal
- Psched deletes the kernel's apteam entry and its internal information about the app

PBSpro/Psched Interface

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