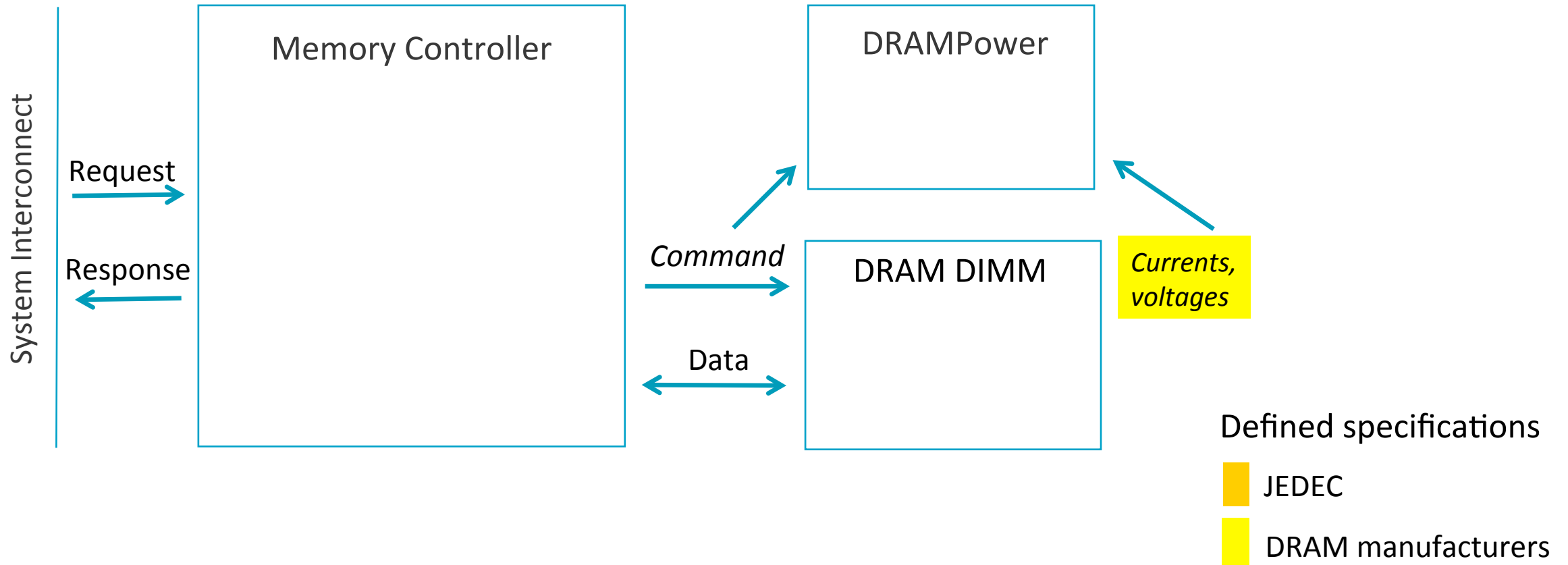# arm

DRAM Power-Down States in gem5

gem5 workshop at Arm Research Summit
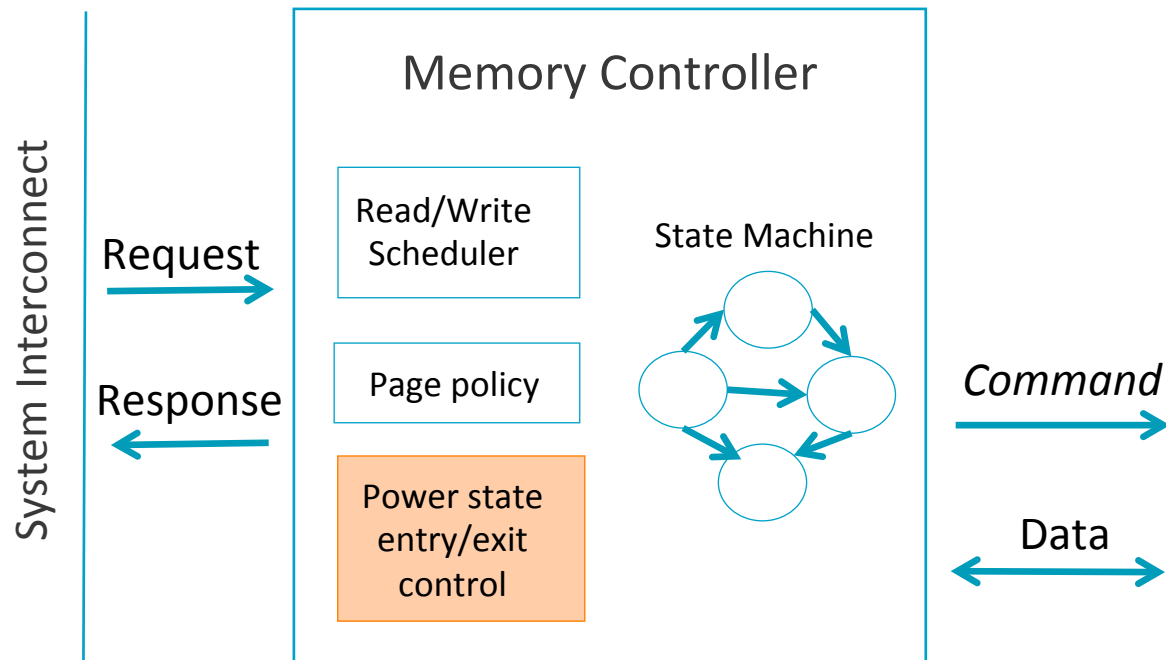
Radhika Jagtap, Senior Research Engineer, Arm Ltd.

Sept 2017, Cambridge, U.K.

Background - DRAM in gem5

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Memory controller function

Memory Controller

Read/Write Scheduler

Page policy

Power state entry/exit control

State Machine

System Interconnect

Request

Response

Command

Data

Reference for gem5 DRAM controller:
A. Hansson, N. Agarwal, A. Kolli, T. Wenisch, and A.N. Udipi, *Simulating DRAM controllers for future system architecture exploration*, ISPASS 2014

JEDEC defined states

- Active
- Idle
- Active Power-Down
- Precharge Power-Down
- Self-Refresh

Code committed, paper in MEMSYS Conference '17

Controller designers implement their own power state entry and exit control

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Scheduling power-down (PD) state transitions

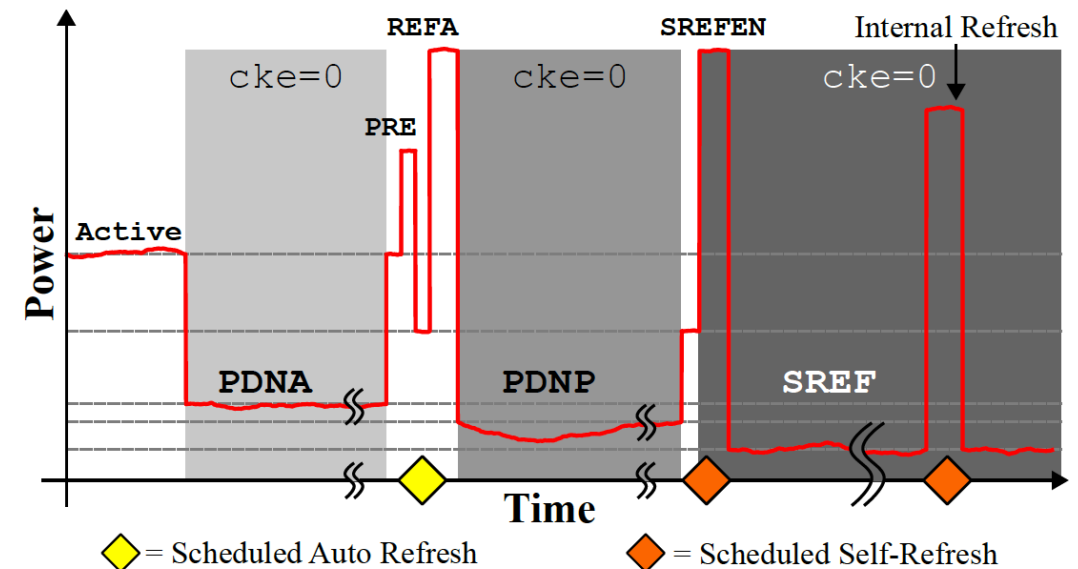## Conditions to enter power-down state

Enter power-down (PD) state if:

- There are no requests in the queue AND

- There are no pending events

Which PD state depends on:

- At least one bank open -> Active PD (PDNA)

- All banks closed -> Precharge PD (PDNP)

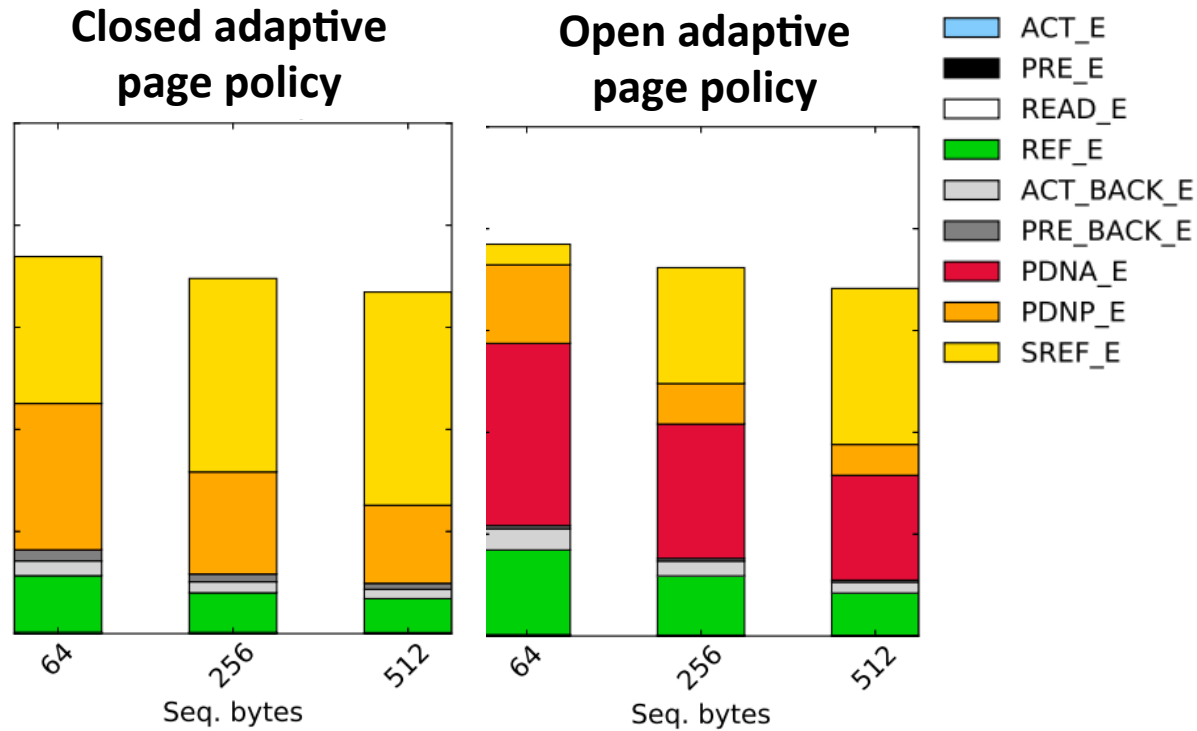- Previous state was Precharge PD -> enter Self-Refresh (SREF)

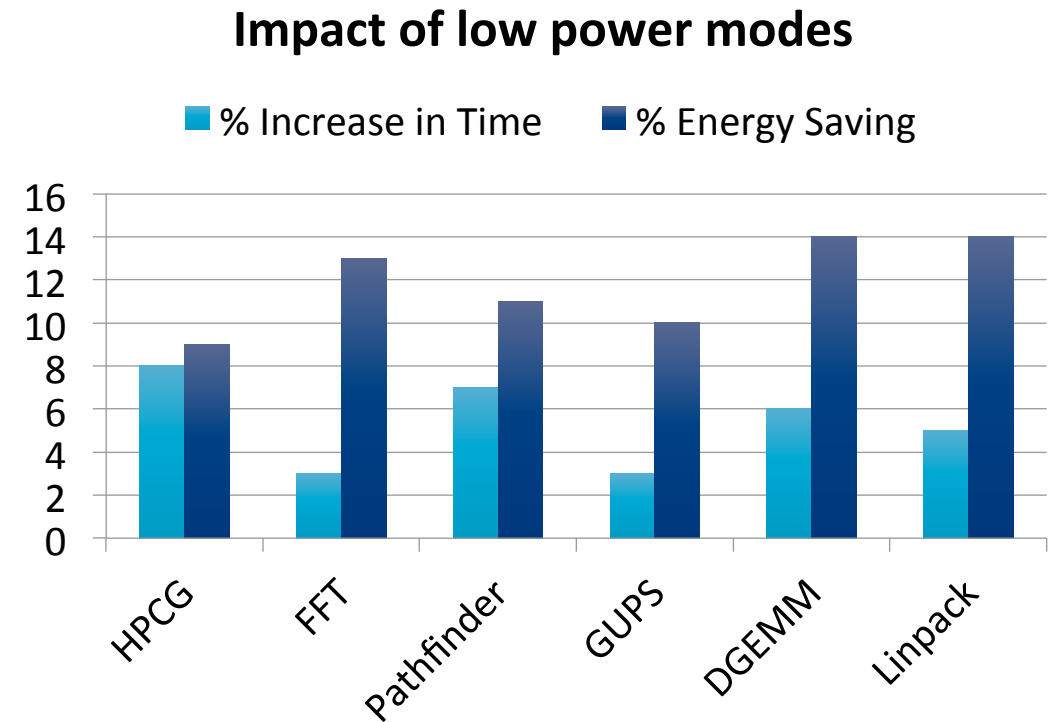## Staggered power-down strategy

Reference: M. Jung, C. Weis, N. Wehn, M. Sadri, and L. Benini. 2014. Optimized active and power-down mode refresh control in 3D-DRAMs, VLSI-SoC 2014

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Do the PD modes work? What is their impact?

Breakdown of energy per state

Closed adaptive page policy

Open adaptive page policy

Legend:
- ACT_E
- PRE_E
- READ_E
- REF_E
- ACT_BACK_E
- PRE_BACK_E
- PDNA_E
- PDNP_E
- SREF_E

Seq. bytes: 64, 256, 512

Performance / energy trade-off

Impact of low power modes

- % Increase in Time
- % Energy Saving

Categories: HPCG, FFT, Pathfinder, GUPS, DGEMM, Linpack

Memory part is based on 2 rank Micron DDR4-2400 8 Gbit datasheet

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Modeling details and validation results in MEMSYS '17 paper

DRAM is a major energy consumer and DRAM power-down modes are
now integrated to enable richer full-system energy-efficiency studies

Integrating DRAM Power-Down Modes in gem5 and Quantifying their Impact

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Thank You!
Danke!
Merci!
谢谢!
ありがとう!
Gracias!
Kiitos!

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