Practical Persistent Memory Programming

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Aims

- Understand persistent memory hardware and software
- Understand the different aspects that can impact performance, and the shared/private nature of the resources
- Learn how to program persistent memory
- Get hands on with persistent memory hardware

Aims cont

- Understand data movement and think about application data requirements
- Understanding I/O and data movement, particularly persistence requirements, is hard
- Thinking about different ways you can do I/O or storing data

Format

- Lectures and practicals

- Slides and exercise material available online:
  - https://github.com/NGIOproject/PMTutorial
  - Exercises will be done on remote machine (NEXTGenIO prototype)
  - We will give you accounts on these

Timetable

- 08.30 Introduction
- 08.45 Practical: IOR and Streams
- 09.00 Hardware, I/O and storage
- 09.30 Practical: Using different mount points
- 09.45 Persistent thinking
- 10.00 Break
- 10.30 Low-level persistent memory programming
- 10.45 Practical: Persistent memory programming
- 11.00 Higher-level persistent memory programming
- 11.15 Persistent Memory Programming with PyCOMPSs
- 12.00 Finish

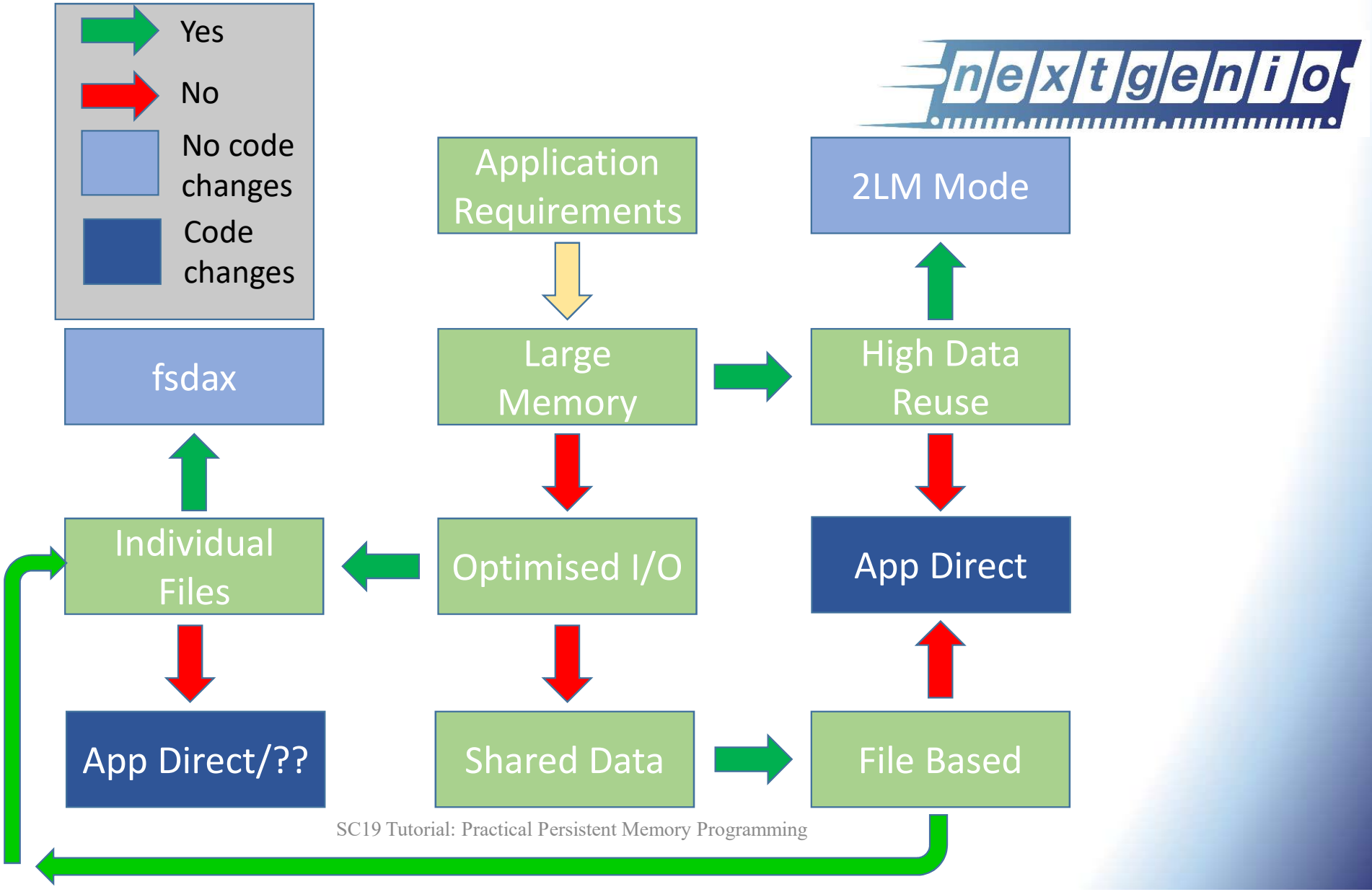
Programming persistent memory

Programming persistent memory


```
double *a, *b, *c;
pmemaddr = pmem_map_file(path, array_length,
                         PMEM_FILE_CREATE|PMEM_FILE_EXCL,
                         0666, &mapped_len, &is_pmem)
a = pmemaddr;
b = pmemaddr + (*array_size+OFFSET)*BytesPerWord;
c = pmemaddr + (*array_size+OFFSET)*BytesPerWord*2;

#pragma omp parallel for
for (j=0; j<*array_size; j++){
   a[j] = b[j]+scalar*c[j];
}
pmem_persist(a, *array_size*BytesPerWord);
```

Programming persistent memory


Yes
No
No code changes
Code changes
Application Requirements
2LM Mode
fsdax
Large Memory
High Data Reuse
Individual Files
Optimised I/O
App Direct
App Direct/??
Shared Data
File Based

Programming persistent memory

- Design and performance considerations are the challenge
  - Programming the memory is easy
- Design for functionality
  - What is persistent, when is it persistent, what failures can you tolerate, etc..
- Design for performance
  - Memory size, I/O, data access costs, etc…
- Design for hardware configurations
  - NUMA, filesystems, storage, etc…

Summary

- Please don’t hesitate to ask questions!
- We are doing practicals
  - But if you’re not confident in programming we have other options
- We are aiming at different experience levels so if it’s too easy/you know it already/it’s too difficult let us know

Practical

- Take IOR and STREAMS source code
- Run on the prototype
- Prototype is available at:

```
ssh hydra-vpn.epcc.ed.ac.uk
```

- Then

```
ssh nextgenio-login2
```

- Using your guest account
- Practical source code is available at:

```
/home/nx01/shared/pmtutorial/exercises
```

- Using slurm as the batch system
  - `pm` partition for this course

```
sbatch -p pm scriptname.sh
```

ssh ngguest01@hydra-vpn.epcc.ed.ac.uk

ssh nextgenio-login2