Enabling a Data-Centric Model on the Open Community Runtime

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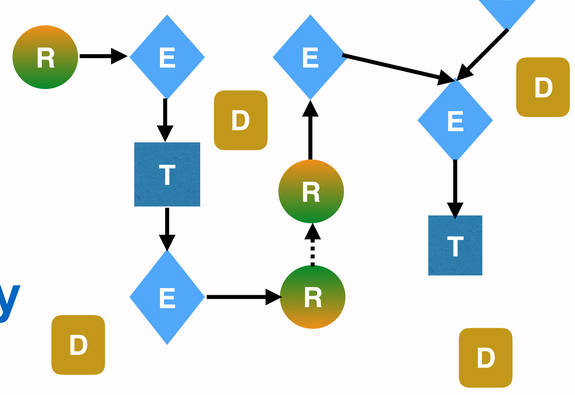
Legion-OCR Motivation

- **Exascale challenges**
  - **Hierarchy of processor and memory**
  - **Power constraints**
- **High-level programming models are required**
  - **Legion - data-centric programming model**
- **Bridge gap between high-level programming models and complex exascale hardware**
  - **Open Community Runtime(OCR) - low level task based runtime**
- **Use OCR as a low-level runtime on top of which high-level programming models can be built on**

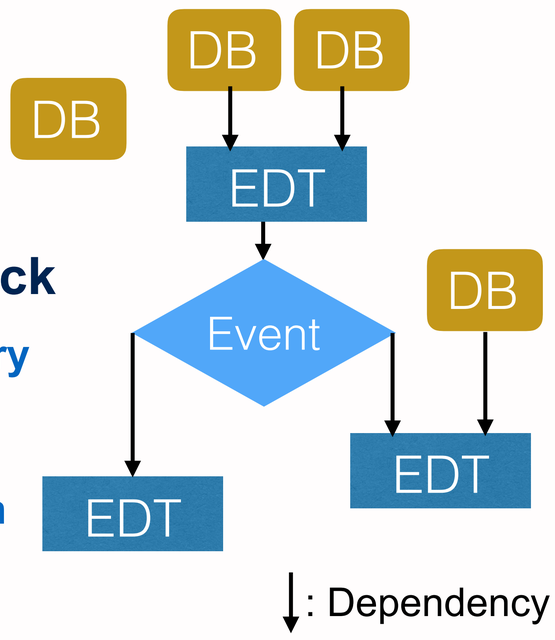
Legion

- **High-level parallel programming model**
- **Uses a low-level task-based runtime: Realm**
- **Realm Components**
  - **Tasks(T): Computation**
  - **Events(E): Dependency**
  - **Regions(D): Data**
  - **Reservations(R): Synchronization**

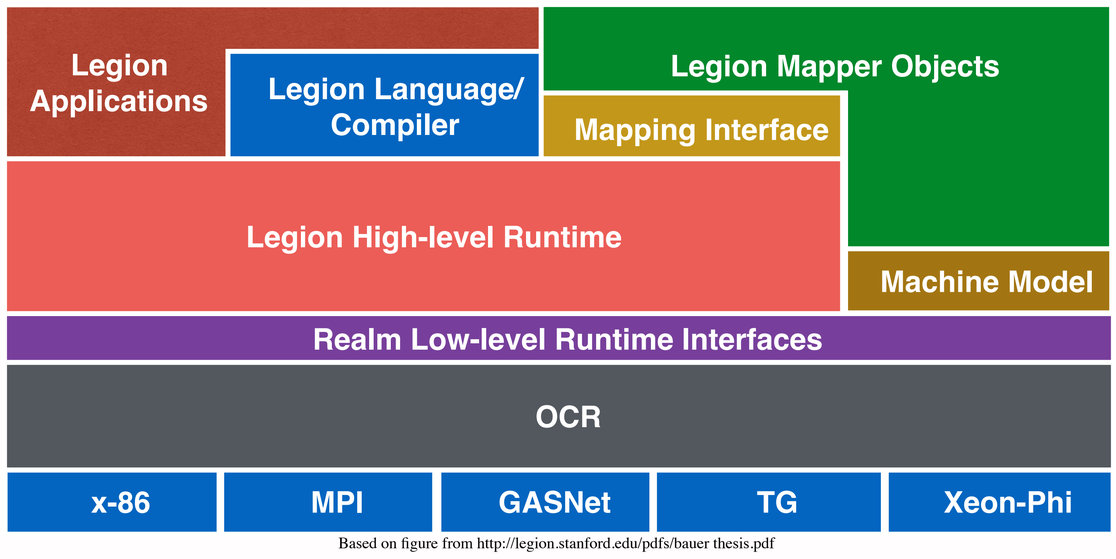


OCR

- **GUID: Globally visible unique ID**
  - **All objects have a GUID**
- **EDT: Event Driven Task**
  - **Basic computation unit**
- **DB: Relocatable Data Block**
  - **Consecutive block of memory**
- **Event: Synchronization**
  - **Enable dependency between tasks**



Legion-OCR software stack



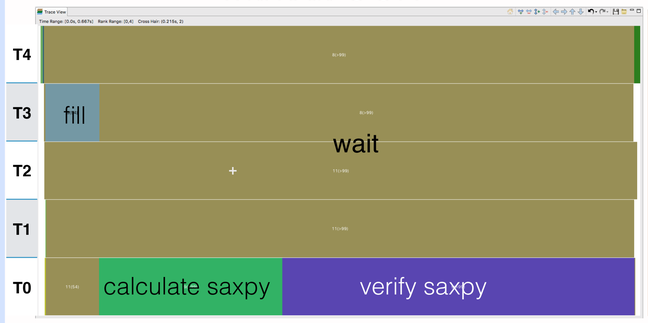
Based on figure from http://legion.stanford.edu/pdfs/bauer thesis.pdf

Mapping Realm to OCR

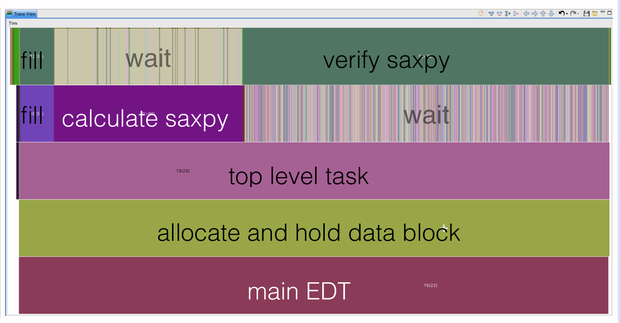
Realm	OCR
Task	EDT
Event	Sticky Event + Latch Event
Region	Data Block
Reservation	Channel Event

Results

Execution trace of realm_saxpy without OCR



Execution trace of realm_saxpy with OCR



Comparison of source code of hello_world Legion program without and with OCR

Listing 1: Original hello_world Legion program

```
1  int main(int argc, char **argv){
2  ..
3  HighLevelRuntime::register_legion_task<
       hello_world_task>(.., Processor::LOC_PROC
```

Listing 2: hello_world Legion program after integration of OCR

```
1  int legion_ocr_main(int argc, char **argv){
2  ..
3  HighLevelRuntime::register_legion_task<
       hello_world_task>(.., Processor::OCR_PROC
```

Future work

- **Extend single node Legion-OCR to run on a distributed environment**
- **Use a compiler to translate from Legion directly to OCR**
- **Use blocking rather than busy-wait to enable performance evaluation**

References

1. M. Bauer et al., “Legion: Expressing Locality and Independence with Logical Regions”, SC’12
2. T. Mattson et al., “The Open Community Runtime: A Runtime System for Extreme Scale Computing”, HPEC’16
3. S. Treichler et al., “Realm: An event-based low-level runtime for distributed memory architectures”, PACT’14