TornadoVM: Dynamic Optimisation of Heterogeneous Java Acceleration

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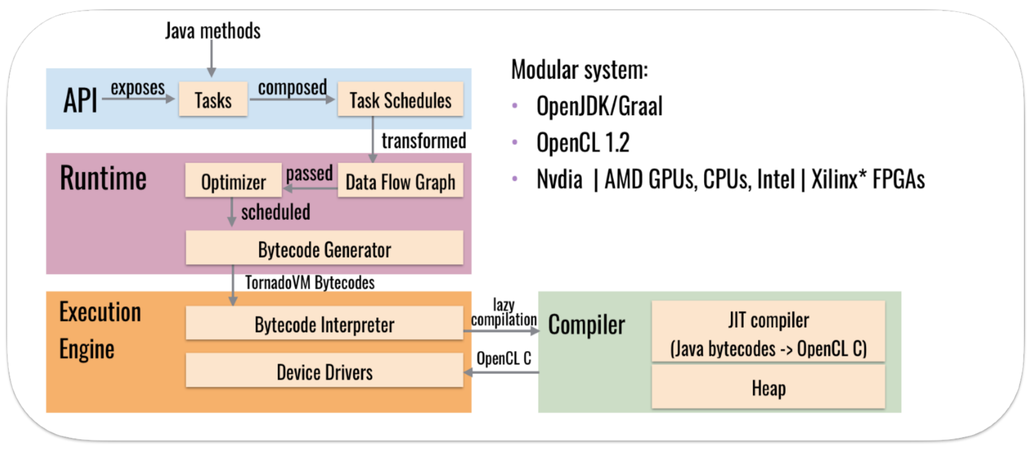
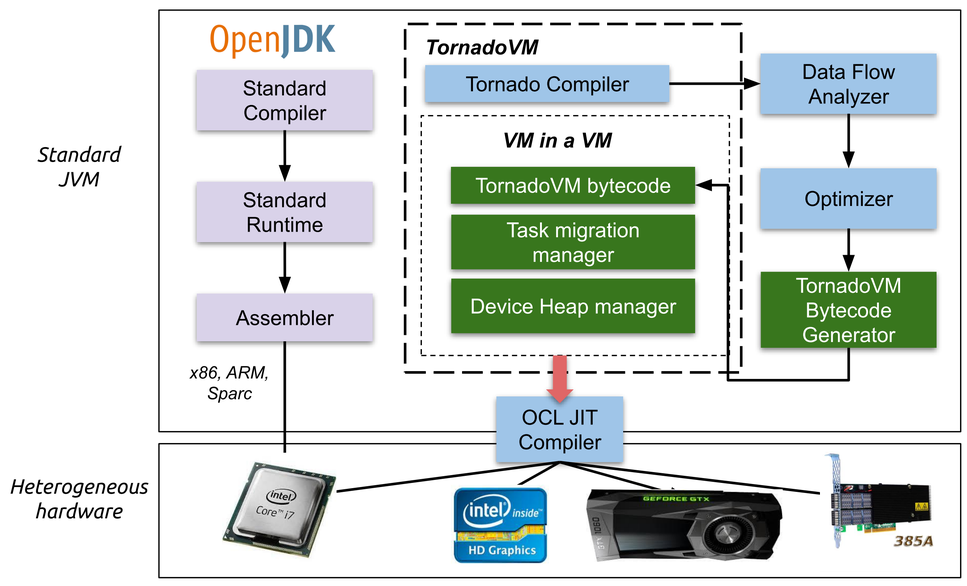
Problem

Heterogeneous hardware (GPUs, FPGAs) can dramatically increase performance and reduce energy. However, key questions persist:
1) Which accelerator is more suitable for each code?
2) Can we find the optimal software/hardware mapping automatically and dynamically?

Proposed Solution: TornadoVM



Project Overview: "VM in a VM"



References

[1] Juan Fumero, Michail Papadimitriou, Foivos Zakkak, Maria Xekalaki, James Clarkson, Christos Kotselidis. **Dynamic Application Reconfiguration on Heterogeneous Hardware. *VEE 2019***
[2] James Clarkson, Juan Fumero, Michalis Papadimitriou, Foivos S. Zakkak, Maria Xekalaki, Christos Kotselidis, Mikel Lujan (The University of Manchester) **Exploiting High-Performance Heterogeneous Hardware for Java Programs using Graal**. ManLang 2018.

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Beehive lab

github.com/beehive-lab/tornado

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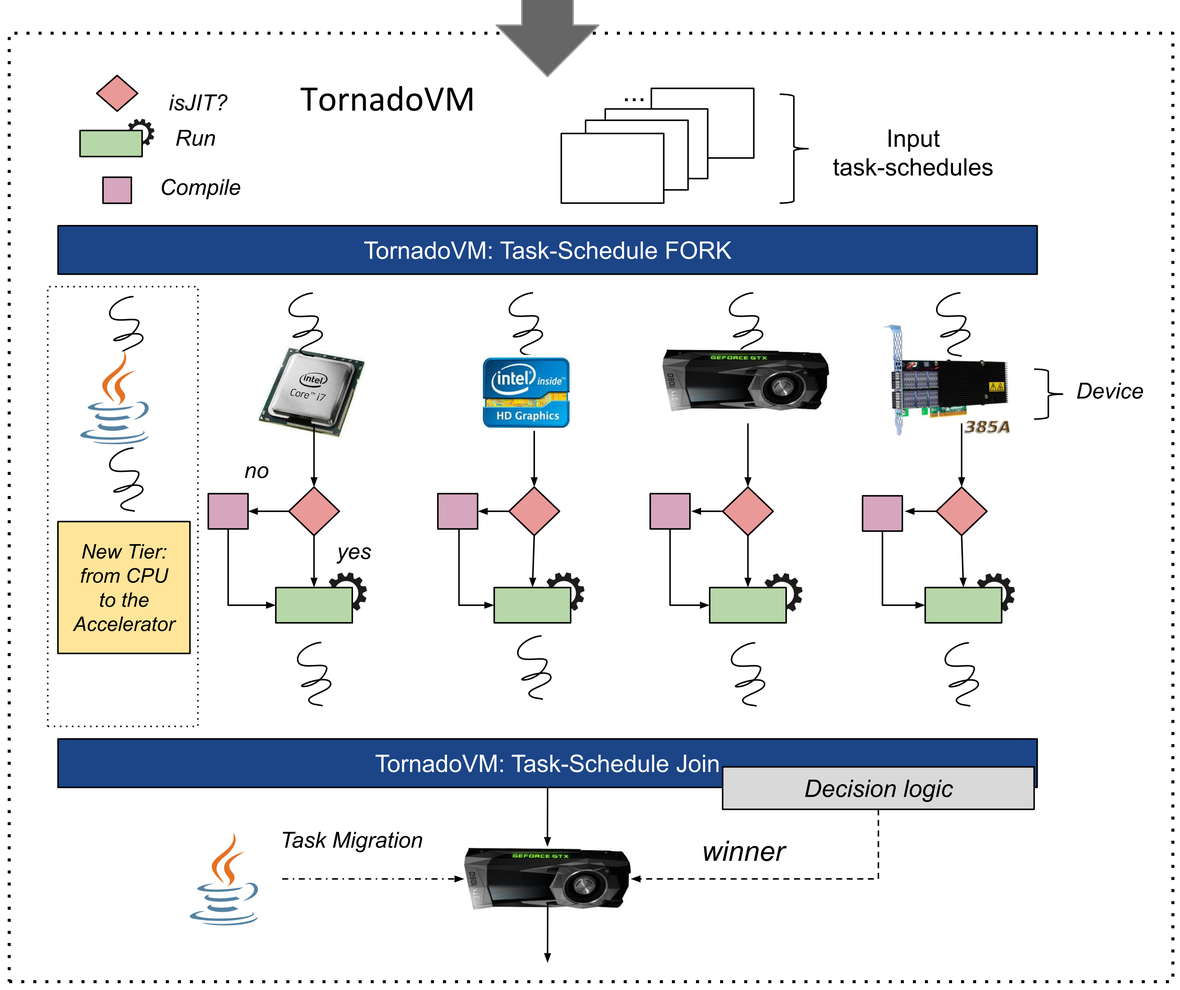
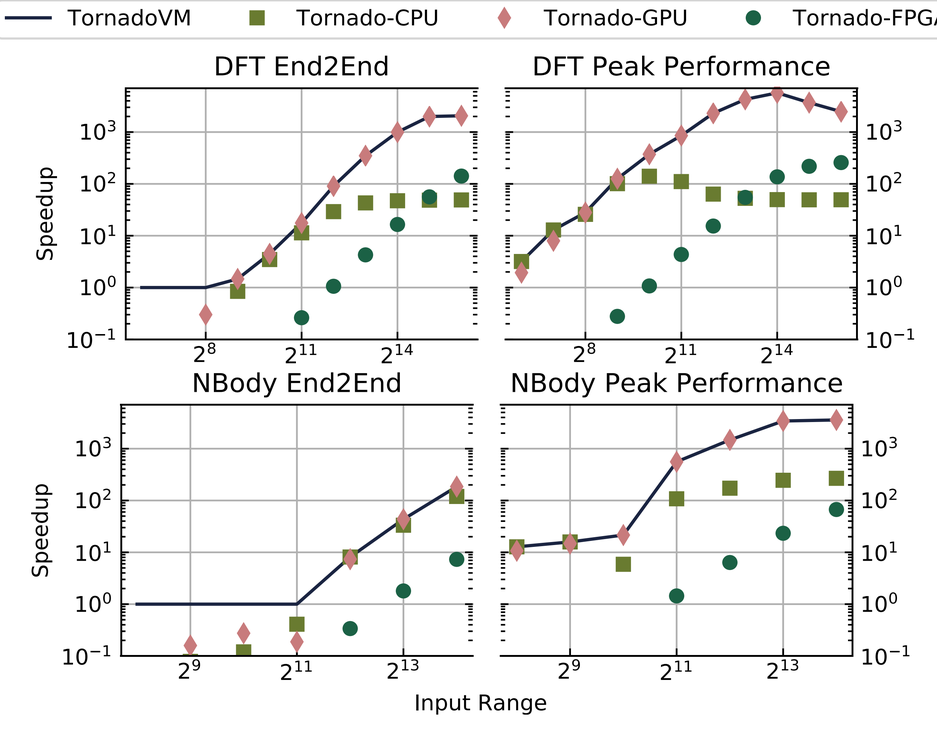
How does it work?

```
public void dft(float[] inreal, float[] inimag,
                float[] outreal, float[] outimag) {
  for (@Parallel int k = 0; N < n; k++) {
    float sumreal = 0;
    float sumimag = 0;
    for (int t = 0; t < M; t++) {
      // computation
      sumreal += ...;
      sumimag += ...;
    }
    outreal[k] = sumreal;
    outimag[k] = sumimag;
  }
}
public void compute() {
  new TaskSchedule("s0")
    .task("t0", this::dft, inReal, inImag, outReal, outImag)
    .streamOut(outReal, outImag)
    .execute(Profiler.PERFORMANCE);
}
```

javac



Results



TornadoVM performs up to 7.7x over the best static device, and up to 4000x over Java sequential