Application-Specific Hierarchical Power Management for Multicast High Efficiency Video Coding

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Introduction and Problem Definition

- **Reduced transistor size** has enabled us to realize high workload applications by executing parallel threads on many-core systems.
- Widespread integration of video applications like video encoding/compression.
- **Power cap** of the many-core chip and the quality of service constraint (frame rate) must be respected.
- To sustain video encoding workload, trends have moved towards exploiting thread-level parallelization using Video Frame Tiles.
- Multicast video encoding with multiple, independent HEVC encoders with varying requirements (resolution, frame rate in fps) on the many-core system.
- Under constraints of power and quality of service.

**Challenges**
- Satisfy throughput requirements (fps) for each encoder
- Allocate the available PEs to every encoder
- Distribute power to each PE (respecting the power cap)

An adaptive scheme for resource and power distribution is required to satisfy throughput requirements of all video encoder, each processing independent video sequence with diverse features.

Our Novel Contributions and System Overview

- **Runtime allocation of PEs (cluster size)** to video encoders
  - Depends upon the resolution of the video frame and throughput requirement (fps) of an encoder.
- Closed-loop inter-cluster power allocation to video encoders
  - Depends upon the total power budget available for the many-core system.
  - Accounts for the history of power consumption, the mispredictions in video encoders’ workload, and the cluster-size.
- **Adaptive intra-cluster power allocation of video encoder**
  - Adjustment of PEs’ frequencies such that the total power budget allocated to the encoder is not violated.
- Content-adaptive adjustment of a PE’s workload
  - Difference between allowable and required number of Sum of Absolute Differences (SADs) is used to adjust frequency (and hence the power) of the PE.

Experimental Setup and Evaluations

- **Sniper x86 based many-core simulator**
- **ces265**: In-house, open-source, C++ based multithreaded next-generation High Efficiency Video Encoder (HEVC)
  - State of the art video encoder released in 2013 by JCT-VC.
  - Light weight, fast and low memory footprint with Tile based parallelism.
  - One thread is ~13.2× faster than the reference encoding software.

Conclusion

- Runtime adaptive resource and power allocation for multicast HEVC video encoders
  - Application-specific, content-adaptive, quality-of-service constrained, runtime resource and power distribution scheme on a many-core system.
  - Adjustment of PEs’ frequency and workload, in order to utilize the power budget and increase the video quality at the same time.

Download our ces265 software at http://ces.itec.kit.edu/ces265