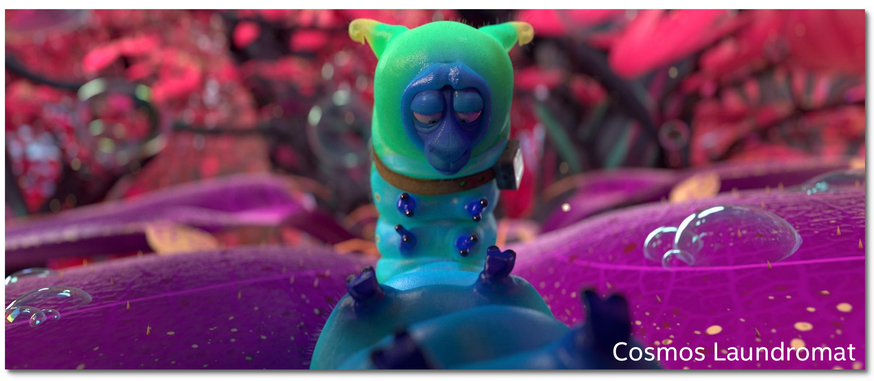
Interactive and offline rendering in Blender Cycles using MPI and Intel® Xeon Phi™ Offload

Milan Jaros milan.jaros@vsb.cz | Lubomir Riha | VŠB-Technical University of Ostrava, IT4Innovations, Czech Republic

IT4Innovations national supercomputing center

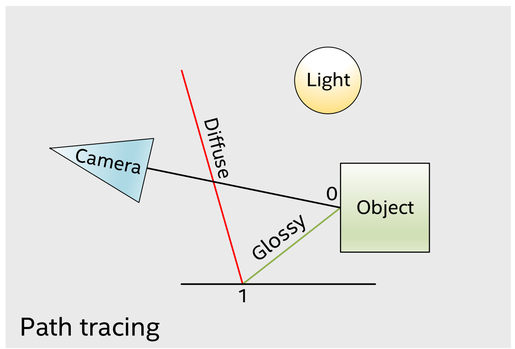
Blender & Cycles

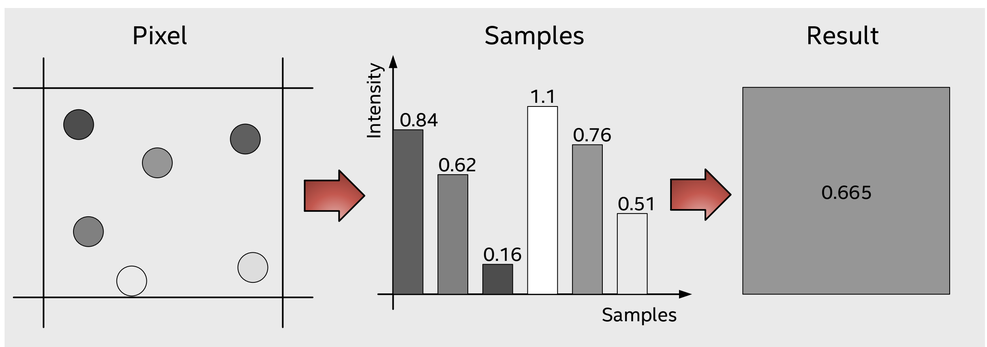
- **Blender** is an open source 3D creation suite. It has two render engines: Blender Internal and Cycles.
- **Cycles** is a raytracing based render engine with support for interactive rendering, shading node system, and texture workflow.



Algorithm for image rendering

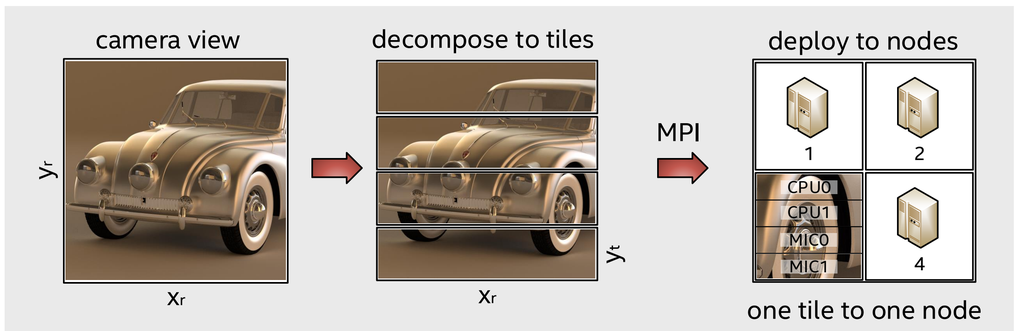
- For each pixel, a ray is cast into a scene.
- A ray from a camera hits a glossy surface (0), then a diffuse surface (1), and it bounces into a random direction.
- The color of the ray is calculated depending on all materials of the surfaces.
- This process is repeated by the value of samples.
- In the end, the mean value of all samples is used for the color of the pixel.





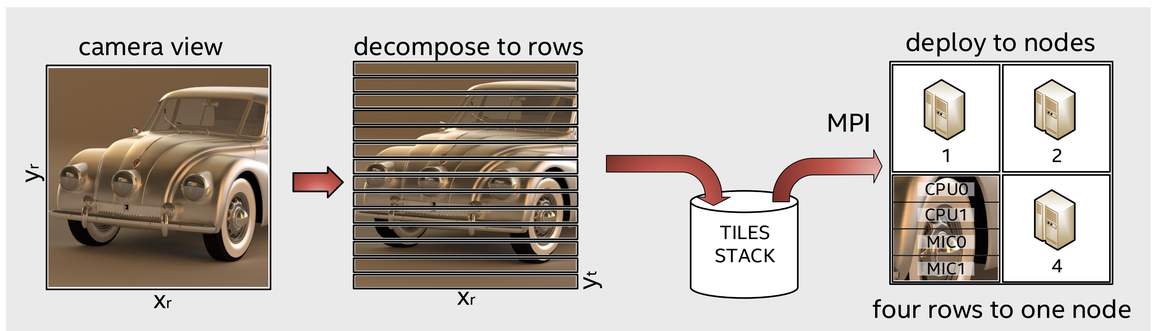
Task decomposition (interactive)

- The synthesized image with resolution x(r) x y(r) is decomposed into tiles by number of compute nodes.
- The tile is sent to one node using MPI.
- The tile x(r) x y(t) is divided by the number of devices on one node.
- In our cases, there are four devices: CPU (12+12 cores), Intel Xeon Phi / MIC (61+61 cores).

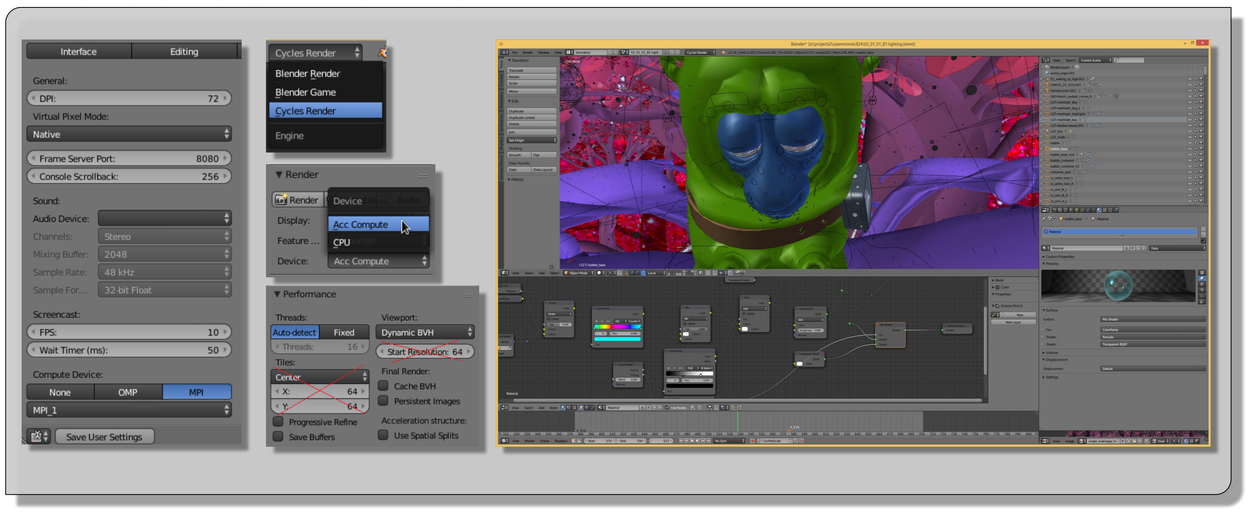


Task decomposition (offline)

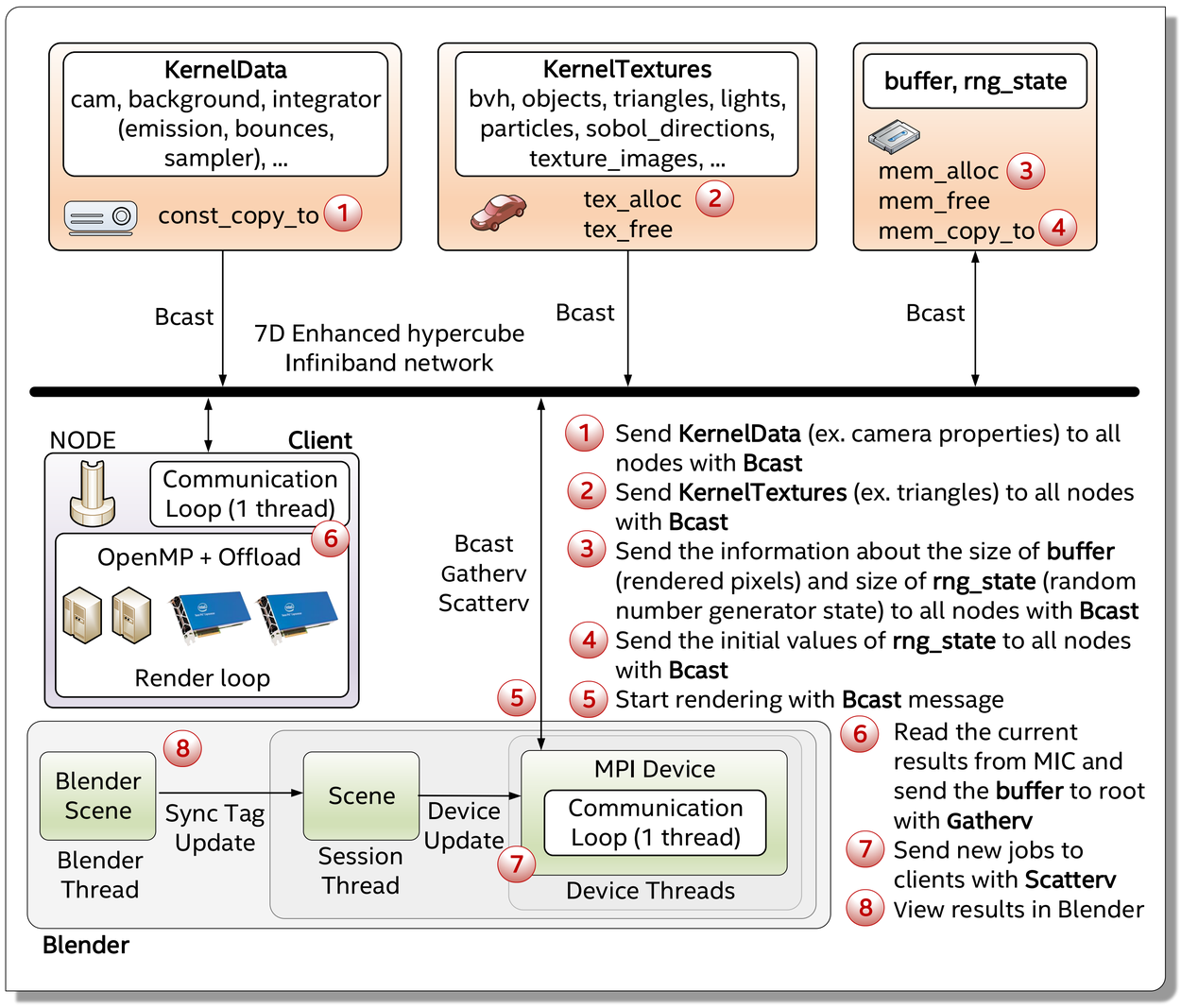
- The synthesized image with resolution x(r) X y(r) is decomposed to rows (y(t) = 1).
- In our cases, there are four devices: CPU (12+12 cores), Intel Xeon Phi / MIC (61+61 cores).
- One node reads the stack and gets four rows (each row for one device).
- The Load Balancing is provided by the stack.



Blender´s environment



Collective communication routine



References

- Jaros Milan, et al.: *Acceleration of Blender Cycles Path-Tracing Engine Using Intel Many Integrated Core Architecture*, CISIM 2015, Warsaw, Poland, p. 86-97, September 2015
- Frederik Steinmetz, Gottfriend Hofmann: *The Cycles Encyclopedia*
- https://wiki.blender.org/index.php

- Source available at: **git@code.it4i.cz:blender/cyclesphi.git**

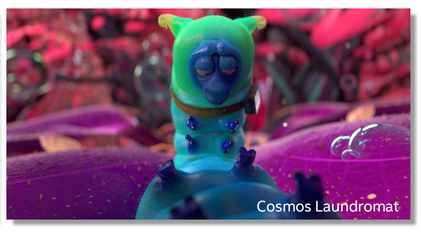
Salomon (IT4Innovations)

Computational Nodes With MIC Accelerator
- 432 nodes
- 10,368 cores in total
- two Intel Xeon E5-2680v3, 12-core, 2.5GHz processors per node
- 128 GB of physical memory per node
- MIC accelerator 2x Intel Xeon Phi 7120P per node, 61-cores,
- 16GB per accelerator

Computational Nodes Without Accelerator
- 576 nodes

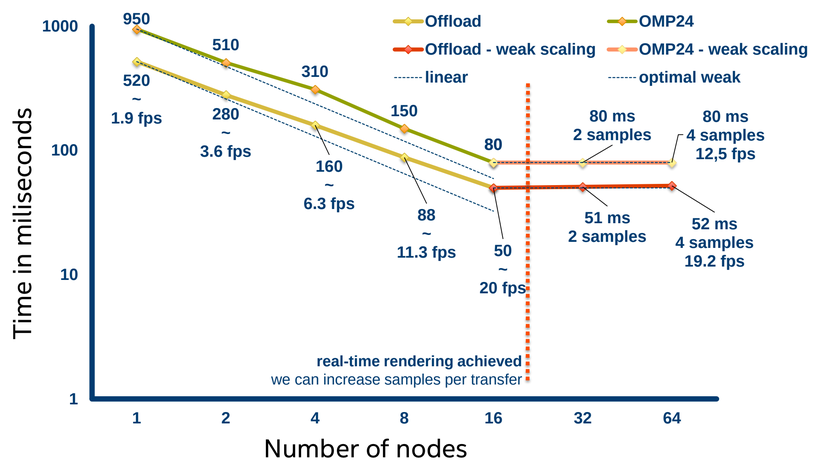
Benchmark (Tatra T87, Worm)

- **The benchmark** was run on 1-64 computing nodes of the Salomon supercomputer equipped with two Intel Xeon E5-2680v3 CPUs and two Intel Xeon Phi 7120P.
- **Tatra T87** scene has 1.2 million triangles and uses the HDRI lighting (Interactive rendering, Resolution: 1920x1080, Samples: 1).
- **Worm** scene has 13.2. million triangles (Offline rendering, Resolution: 4096x2048, Samples: 1024).



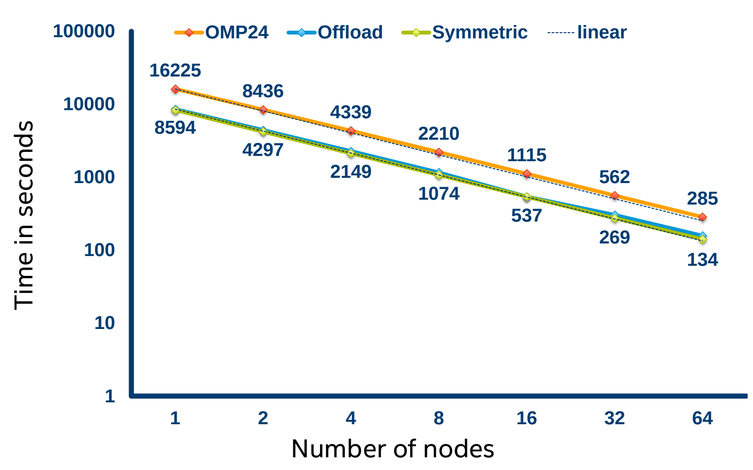
Strong Scalability Test (interactive)

- **Benchmark (Tatra T87):** The comparison of OpenMP CPU (OMP24) and hybrid (CPU+MIC Offload) implementations.



Strong Scalability Test (offline)

- **Benchmark (Worm):** The comparison of OpenMP CPU (OMP24) and hybrid (CPU+MIC Offload/Symmetric) implementations.



Acknowledgements

This work was supported by The Ministry of Education, Youth and Sports from the National Programme of Sustainability (NPU II) project "IT4Innovations excellence in science - LQ1602" and from the Large Infrastructures for Research, Experimental Development and Innovations project "IT4Innovations National Supercomputing Center - LM2015070" and by Intel Corporation from the project "Xeon Phi coprocessors: Test Cases on Image Rendering Curriculum - Grant Number: 23469721".