

Edge Bundling for Visualizing Communication Behavior

Ronny Brendel, Michael Heyde, Holger Brunst, Tobias Hilbrich and Matthias Weber
Presenter: Jens Domke
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Contents

- Introduction & Motivation
- Test Cases
- Edge Bundling
 - Time-based Visualization
 - Summary Visualization
- Conclusion & Future Work
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Slides and supplemental material:

<https://github.com/hydroo/sc16-vpa-edge-bundling-for-visualizing-communication-behavior>

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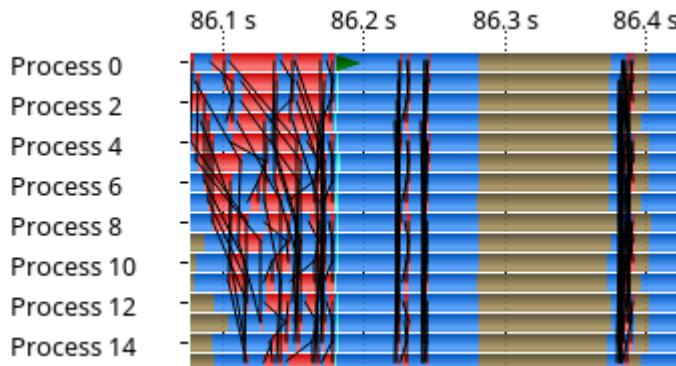
Introduction & Motivation

- Utilize today's computers → concurrency
- HPC uses distributed memory → inter-process communication (e.g. Message Passing)
- Analysis and Visualization of IPC supports developers in their debugging and performance optimization workflows

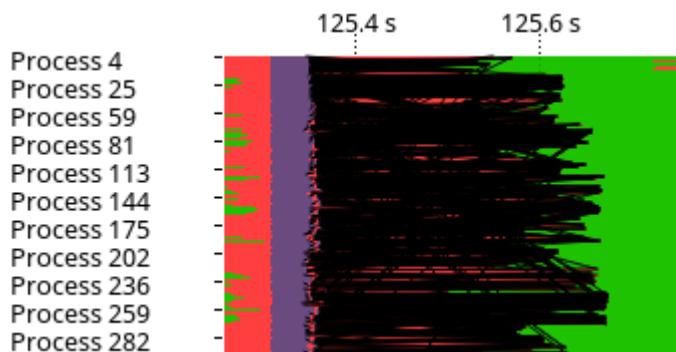


Introduction & Motivation

- Timeline visualizations [1] (Paraver [2], ITA [3], Vampir [4])



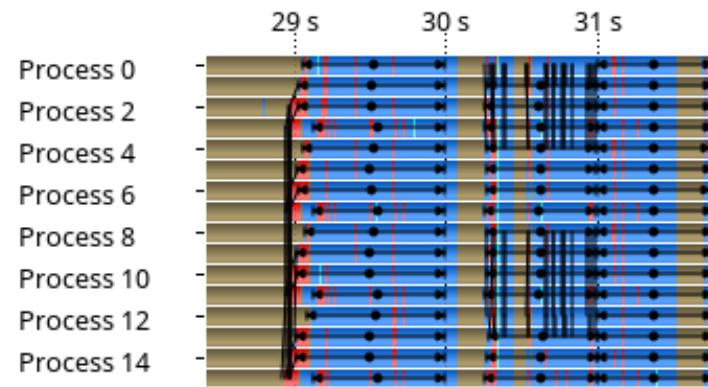
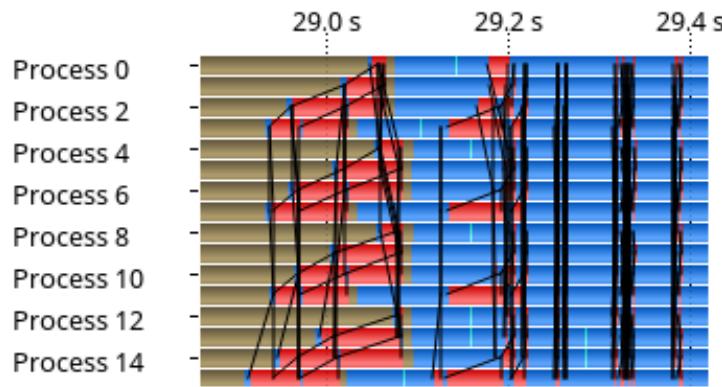
- Helpful message visualization



- Unfavorable visualization

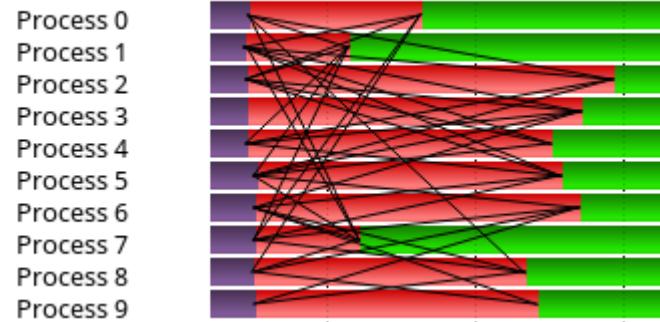
Introduction & Motivation

- Current Solution in Vampir: Message Burst 
 - Start + End with the number of exchanged messages encoded
 - Sender-oriented

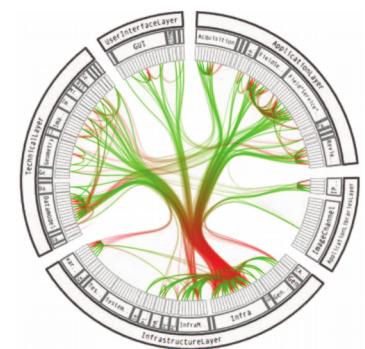


Introduction & Motivation

- No obvious patterns



- **Goal:**
 - Alleviate message clutter and information occlusion
 - Preserve interesting information
 - Highlight/Amplify communication patterns
- Approach based on ideas from edge bundling [5]

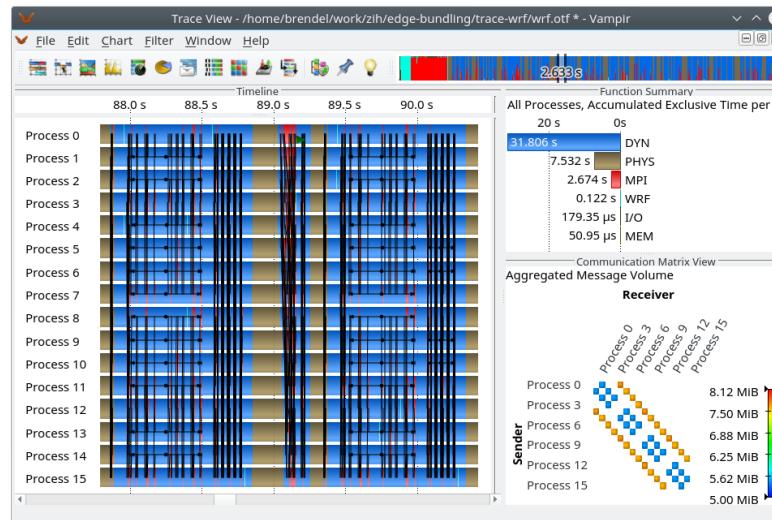
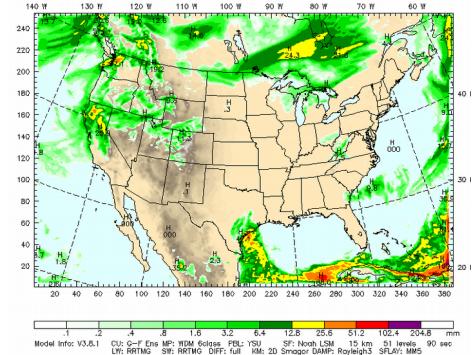


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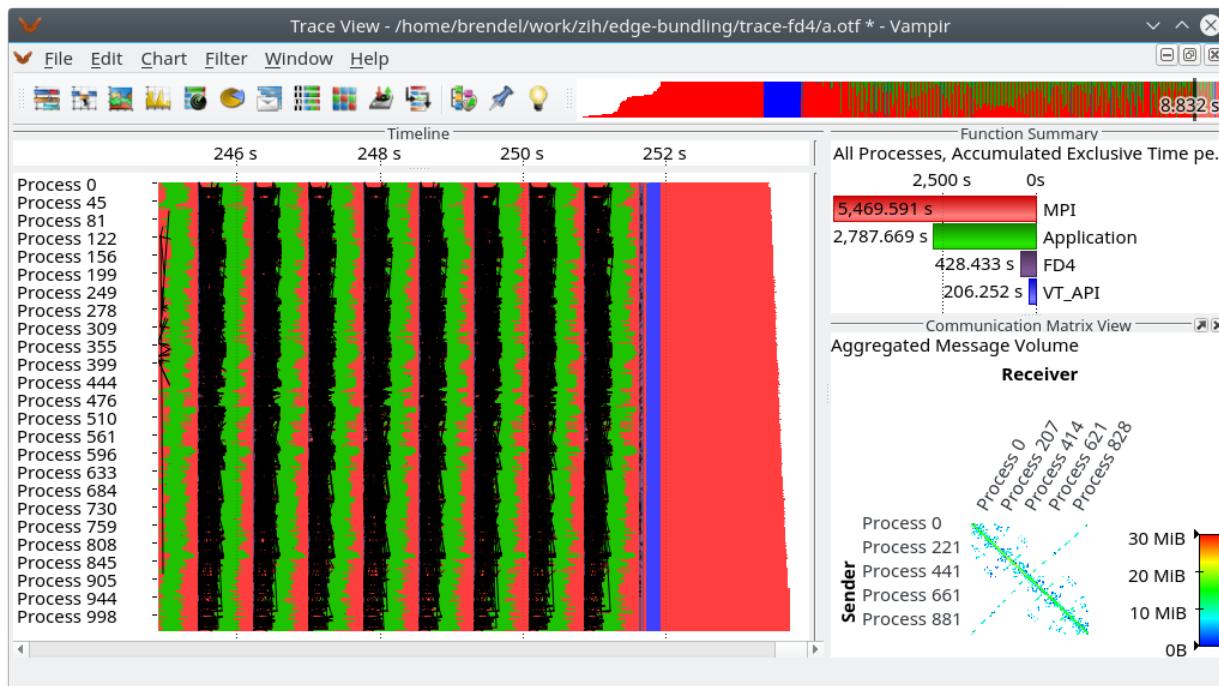
Test Cases

- (1) WRF [6]
 - 16 processes
 - 4 minutes
 - 160k point-to-point messages
 - <https://www.vampir.eu/public/files/tracefiles/Large.zip>



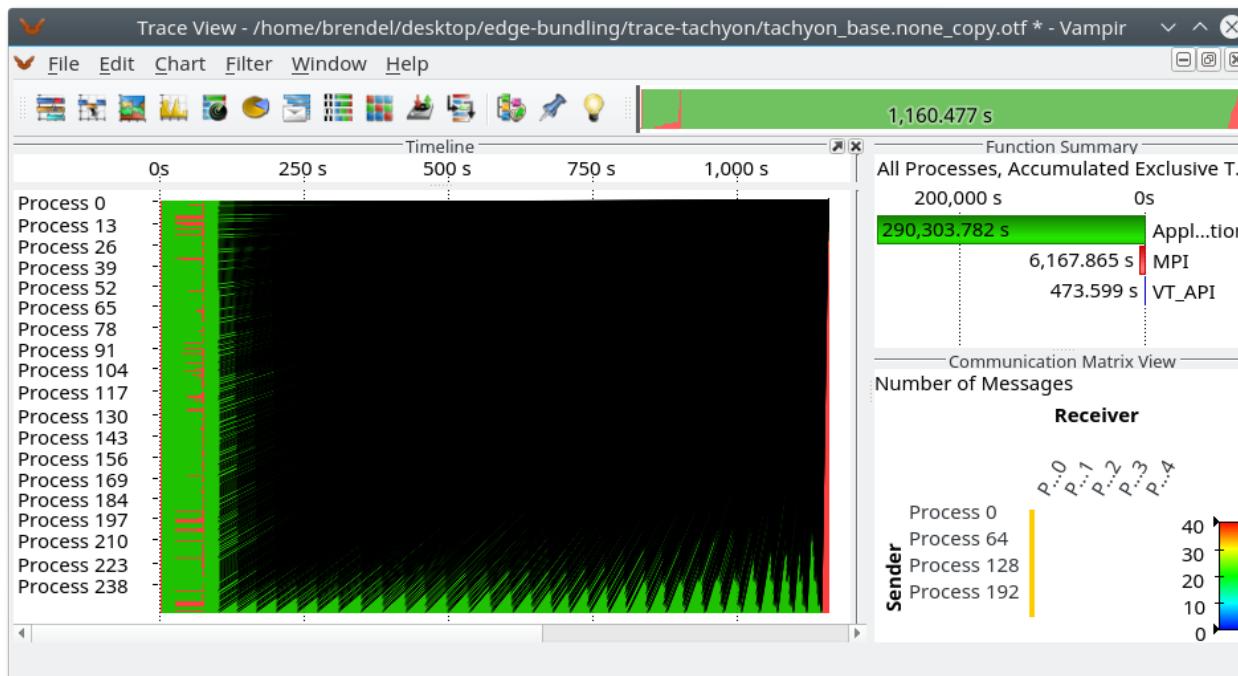
Test Cases

- (2) FD4 [7]
 - 1,024 processes, 5 minutes, 2,2M messages



Test Cases

- (3) Tachyon [8]
 - 256 processes, 20 minutes, 8000 messages

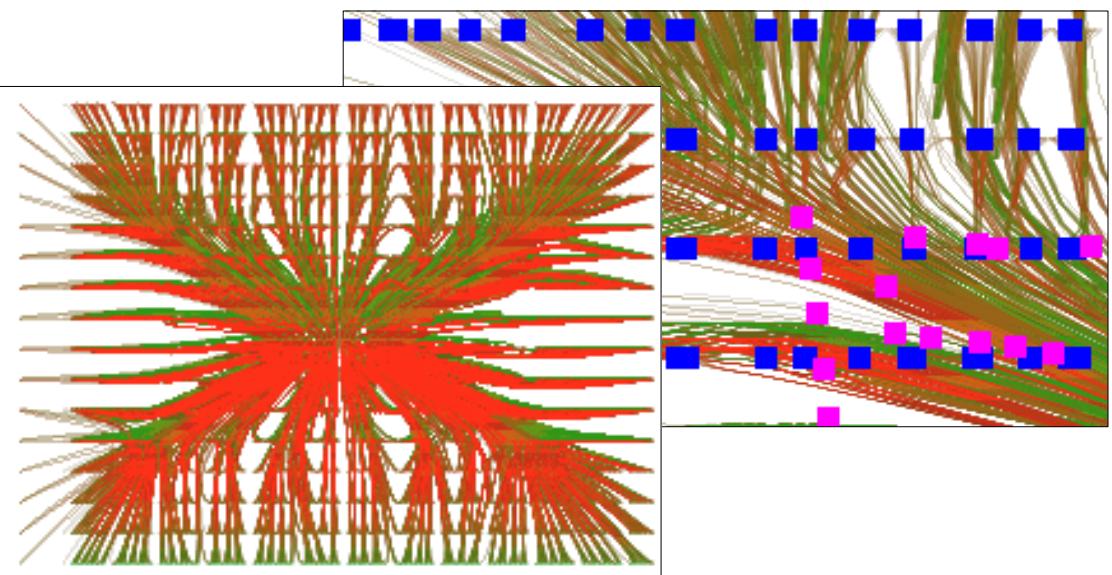
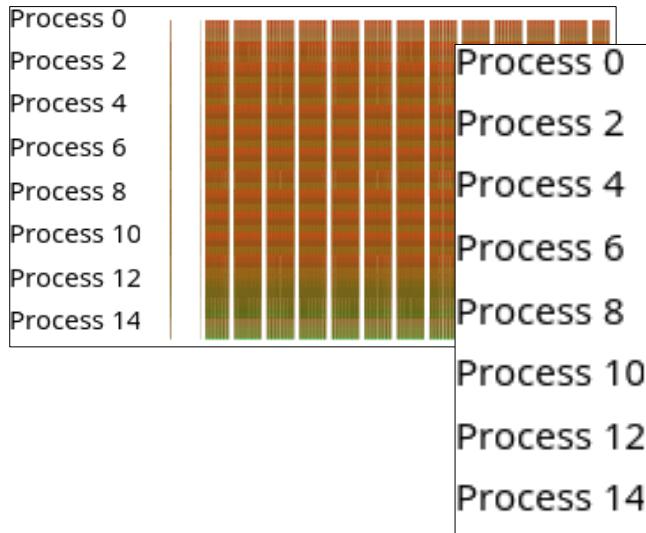


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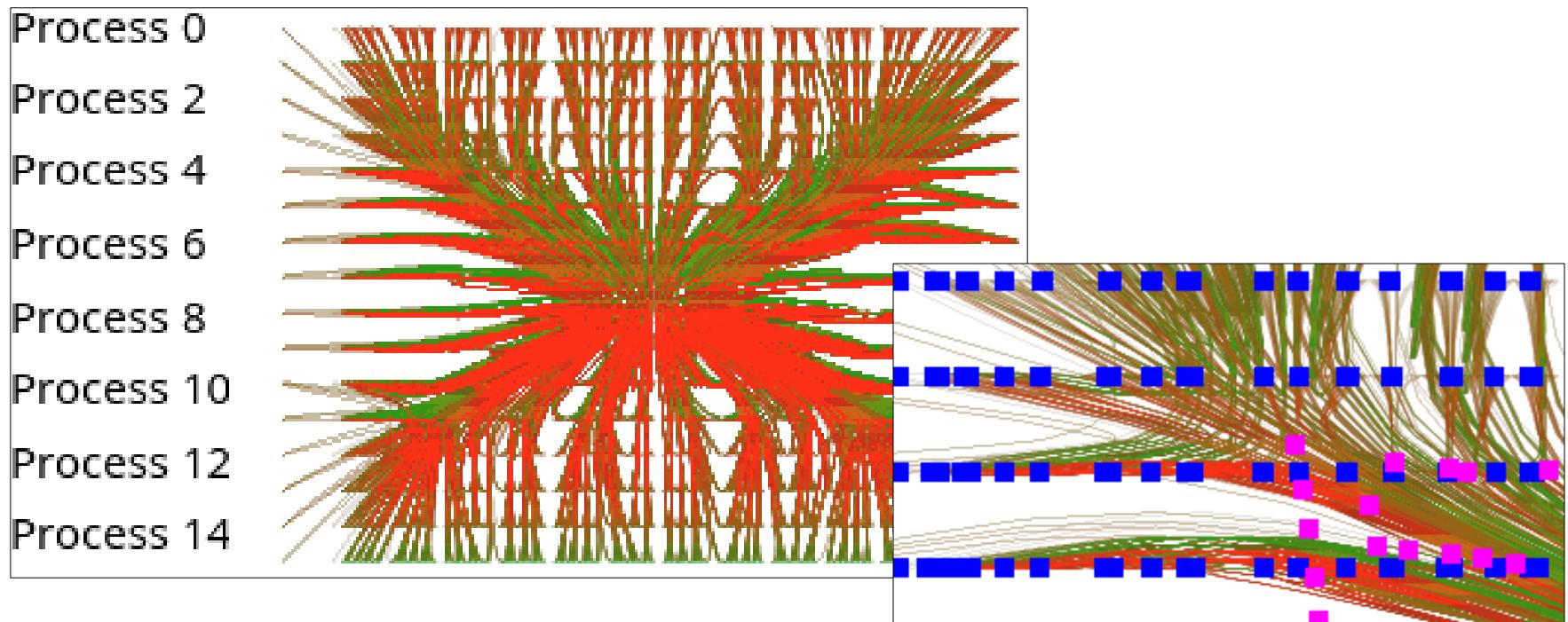
Edge Bundling > Time-based Vis.

- **Hierarchical** edge bundling [5]
- B-Splines
- Send/receive event points + mean shift clustering = hierarchy
- **Sender, Receiver** (gradient)
- WRF



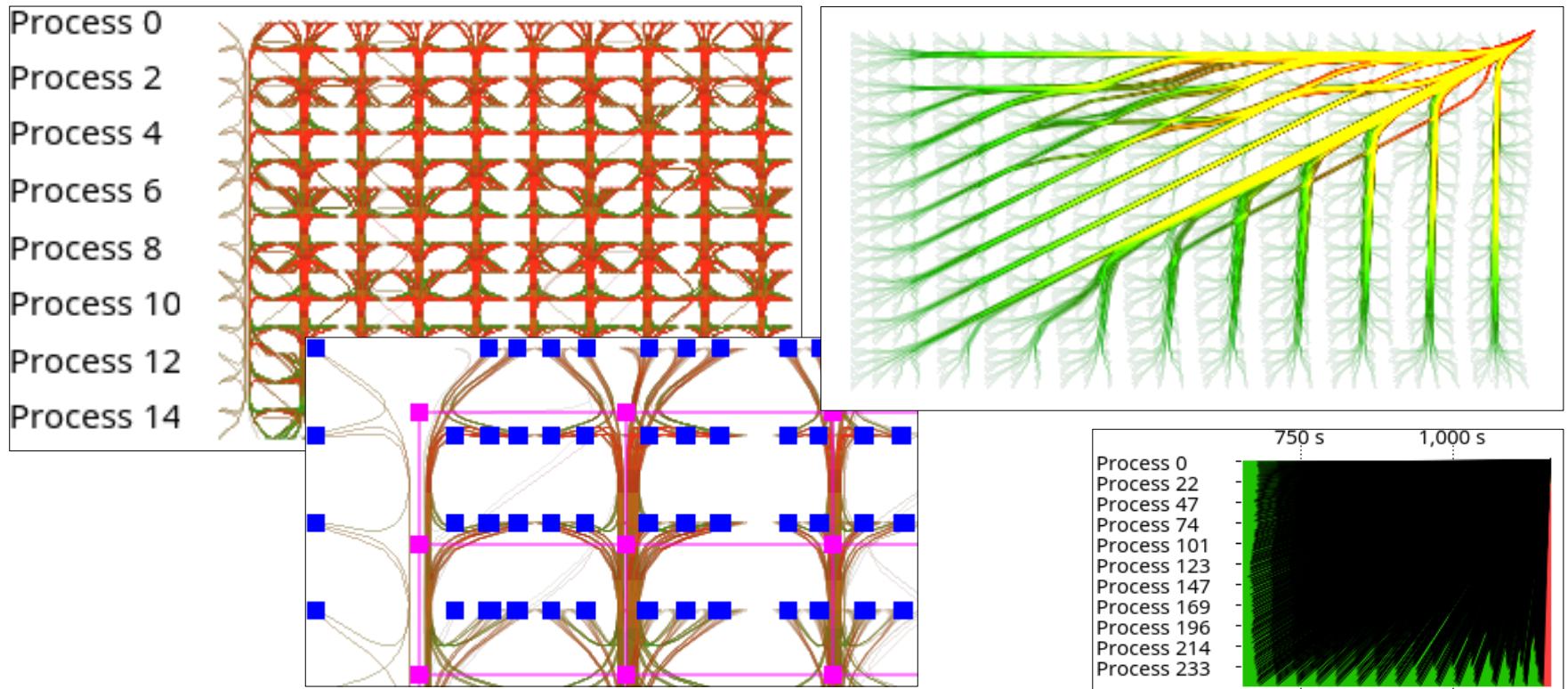
Edge Bundling > Time-based Vis.

- + Occupies less space
- Extreme Bending towards the center of the diagram



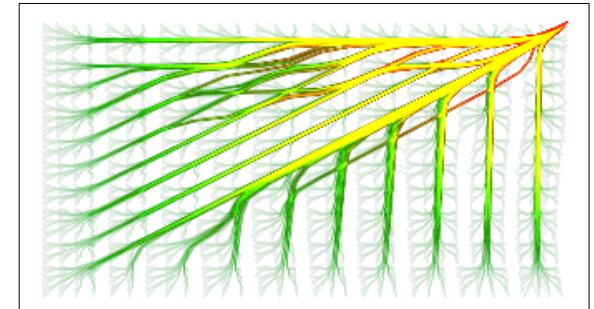
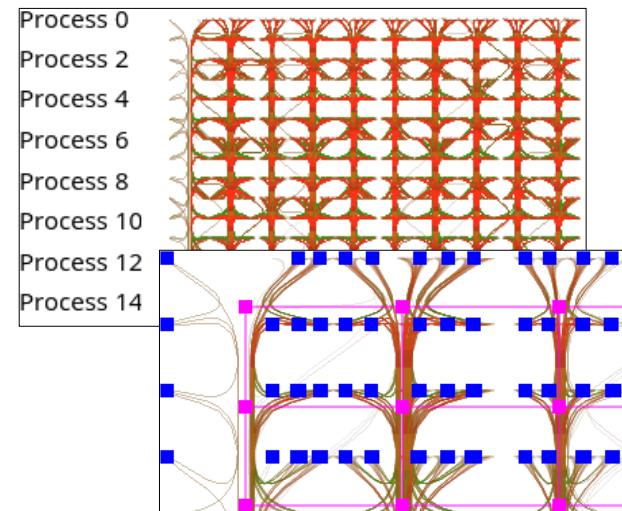
Edge Bundling > Time-based Vis.

- Grid-based Routing [9] + diagonals: WRF, Tachyon



Edge Bundling > Time-based Vis.

- + Less horizontal bending
- + More tidy
- + More intuitive
- Fixed position and size grid
- Still some horizontal bending

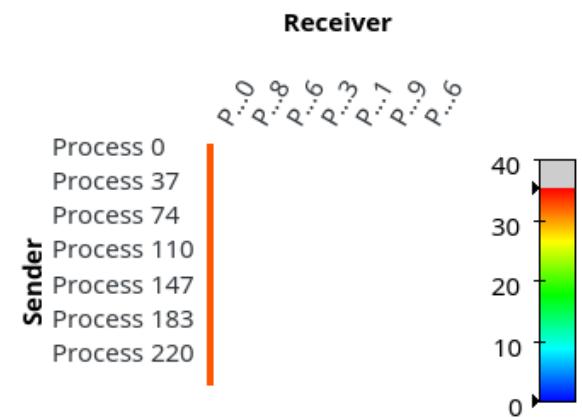
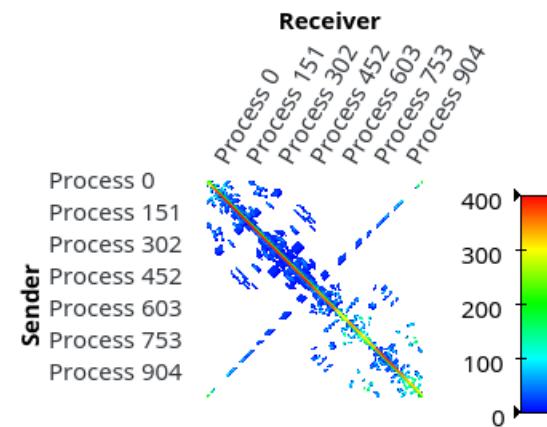
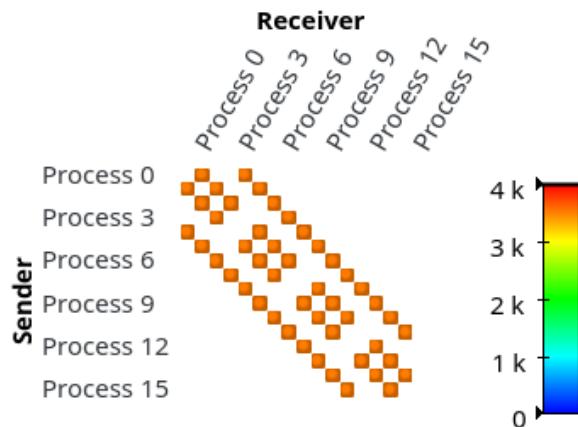


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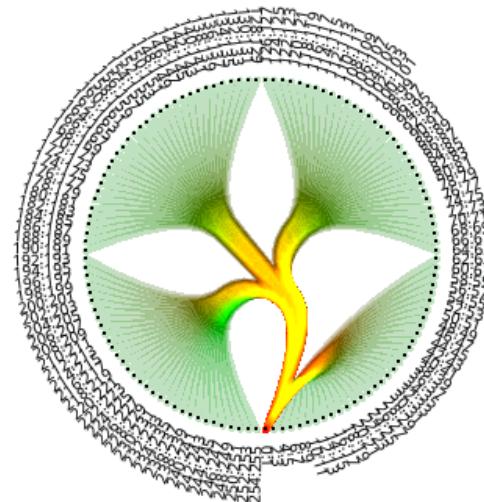
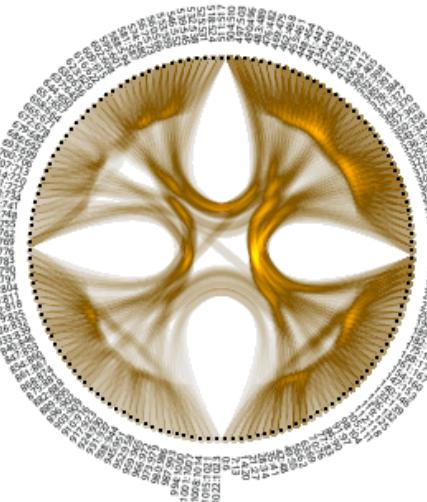
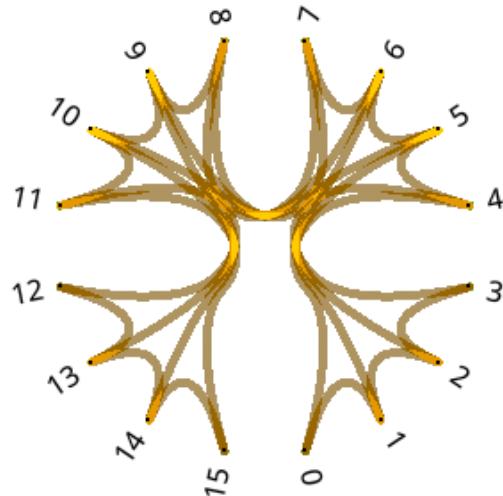
Edge Bundling > Summary Vis.

- Existing: *Communication Matrix*: WRF, FD4, Tachyon
 - Encode quantity into the points in color (here number of messages exchanged)



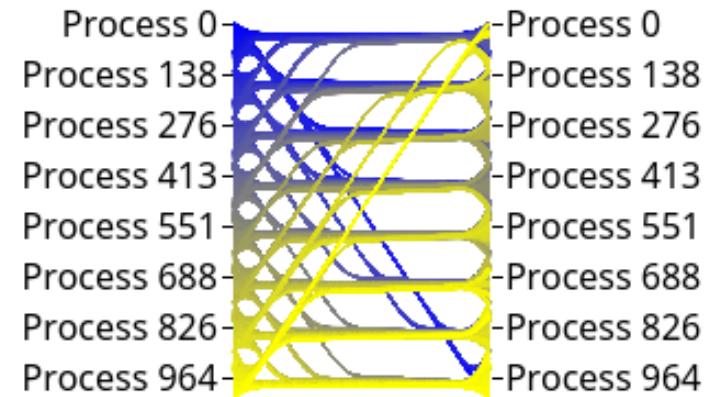
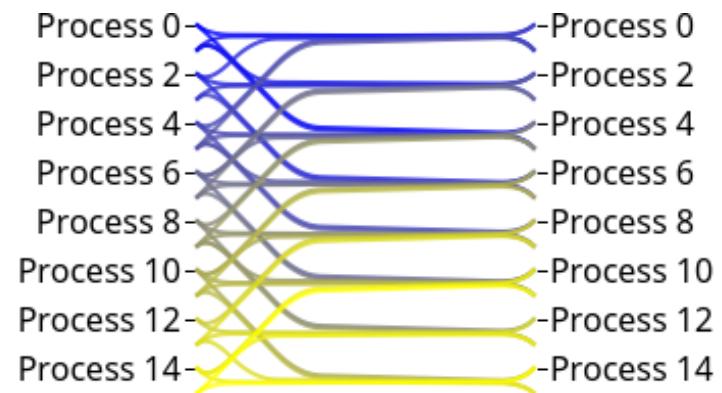
Edge Bundling > Summary Vis.

- Alternatively, use chord diagrams
 - Sender, Receiver
- Additive color mixing: Not always helpful, but sometimes



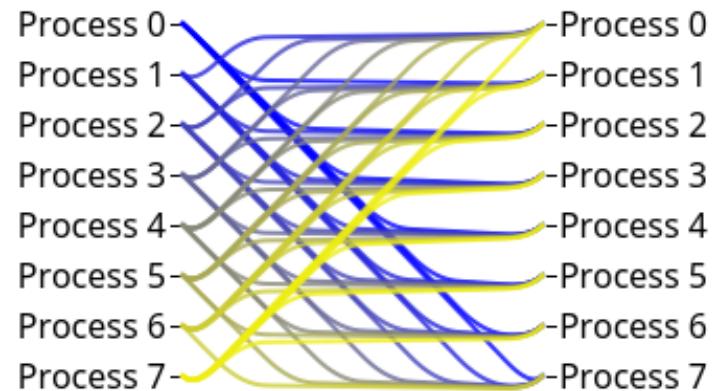
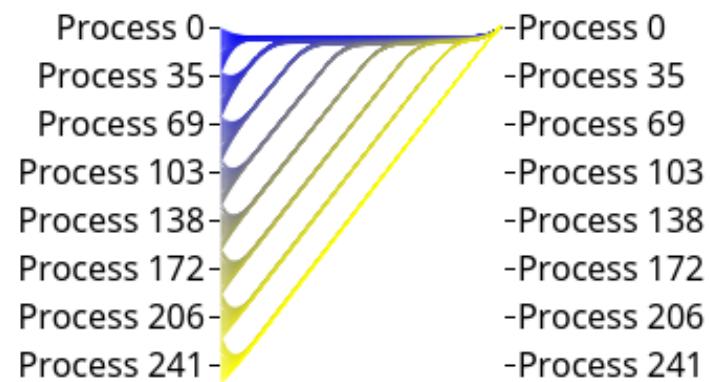
Edge Bundling > Summary Vis.

- *Sender/receiver diagram*
 - Sending process left, receiver right
 - Grid with diagonals
 - YX-Routing preferring diagonals
 - One color for each sender
- WRF: Near communication only
- FD4: Mostly near communication, some farther away receivers



Edge Bundling > Summary Vis.

- Tachyon: all-to-one
- LULESH [10]: all-to-all



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Conclusion

- Presented investigation into using edge bundling for time-based and summary inter-process communication visualization
- Time-based Visualization:
 - Hierarchical produces unintuitive results
 - Grid-based approach yields better diagrams
- Introduced the Sender/receiver diagram:
 - Simpler and faster
 - Improved ability to highlight communication patterns over other summary based visualizations
- For us, using edge bundling proved challenging

Future Work

- Improve visual outcome of the sender/receiver diagram
- Encode quantities into edges
- Alternative ways to obtain control polygons
- Make edge bundling viable for time-based visualizations
 - Reduce message number via filtering
 - Flexible grid
- Explore alternative edge bundling techniques, e.g. force-directed edge bundling [11]



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Tachyon with Hierarchical Edge Bundl.

