Light-Weight Synthesis of Ptolemy Diagrams with KIELER

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During the development of Cyber-Physical Systems, Model-Driven Engineering is a common means to lower the development costs and time. Visual representations aid to preserve the manageability of large and complex models, however, they come with several challenges. Possibly hierarchical diagrams might exceed the size of a computer screen by several orders of magnitude, and great effort has to be made to position elements on a canvas manually. To preserve manageability and comprehensibility of large diagrams, concepts that address the *modeling pragmatics* are used [4]. Among these are automatic graph drawing and the dynamic expanding and collapsing of hierarchical elements to browse a diagram.

In the Kiel Integrated Environment for Layout Eclipse RichClient (KIELER)[1] we combine several concepts to facilitate the exploration of large, hierarchical models. The KIELER Infrastructure for Meta Layout (KIML) incorporates a variety of different algorithms for automatic graph drawing. It allows to configure these algorithms with certain properties (e. g., node spacing) and to apply different algorithms to different hierarchy levels. A specific type of diagram imposes specific requirements on the way it is drawn. Drawings of actor diagrams are often drawn *left to right* with orthogonal edge routing. Apart from that, the edges of state machines are drawn in the form of splines. The KLay Layered algorithm enhances the well-known and well-established layered approach, introduced by Sugiyama et al. [3], to support (hierarchical) ports and orthogonal edge routing [1]. The KLay Layered algorithm was integrated with the Ptolemy tool itself in 2009, providing automatic layout with results that are competitive with time-consuming manual layout.

Visual models are created at best once and are read many times. Contrary to the modeler itself, an engineer who has to understand the functionality of a model, developed by somebody else, has no initial perception of the model at all. Hence, a good readability and a seamless and responsive tooling support is even more important during browsing than during editing. We therefore propose the use of transient, on-the-fly generated views on semantic models with the focus on efficiency and interactivity [2]. This concept resulted in the KLighD project. To illustrate this approach of on-the-fly

[1] http://www.informatik.uni-kiel.de/rtsys/kieler

generated views, we developed an automatic model transformation from the MoML format, used by Ptolemy, to the KGraph format used in KIELER. This allows to view and browse complex Ptolemy models in a pleasant, responsive, and comprehensible fashion.

Therefore, we would like to propose a presentation on our enhanced, KLighD-based model browser for Ptolemy models. The traditional way to explore these models as well as two new ways are illustrated in Fig. 1.

1. The original Vergil editor with manual layout and every hierarchical node in a new editor window (Fig. 1a).

2. A KLighD-based desktop application with automatic layout and hierarchy directly embedded within the overall model (Fig. 1b).

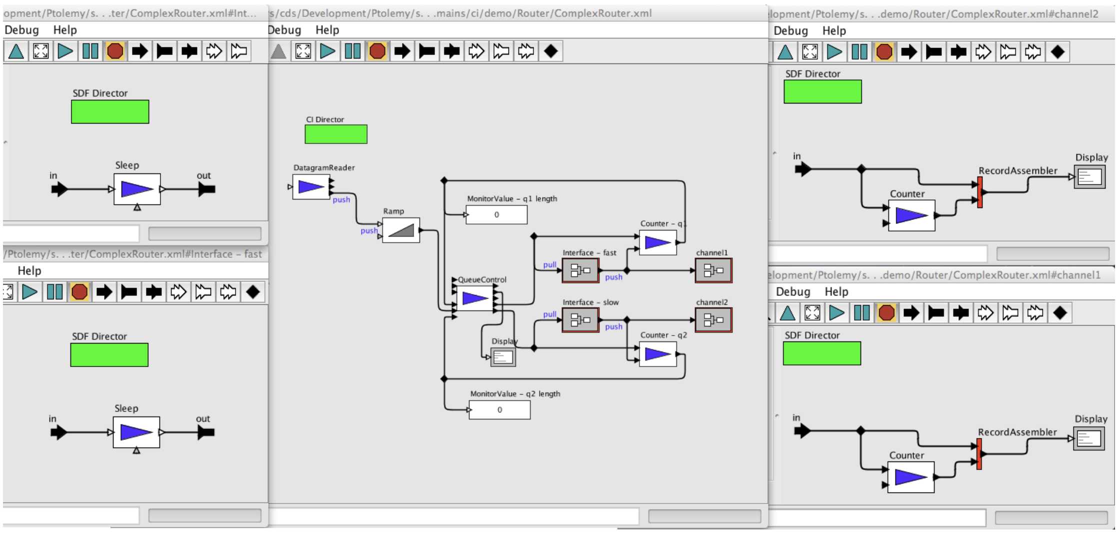
3. A browser-based viewer with automatic layout and embedded hierarchy that additionally allows collaboration (Fig. 1c). KLighD performs the diagram synthesis on a server, creates an SVG, and sends it to the browser for rendering.

[1] Lars Kristian Klauske, Christoph Daniel Schulze, Miro Spönemann, and Reinhard von Hanxleden. Improved layout for data flow diagrams with port constraints. In *Proceedings of the 7th International Conference on the Theory and Application of Diagrams (DIAGRAMS'12)*, volume 7352 of *LNAI*, pages 65–79. Springer, 2012.

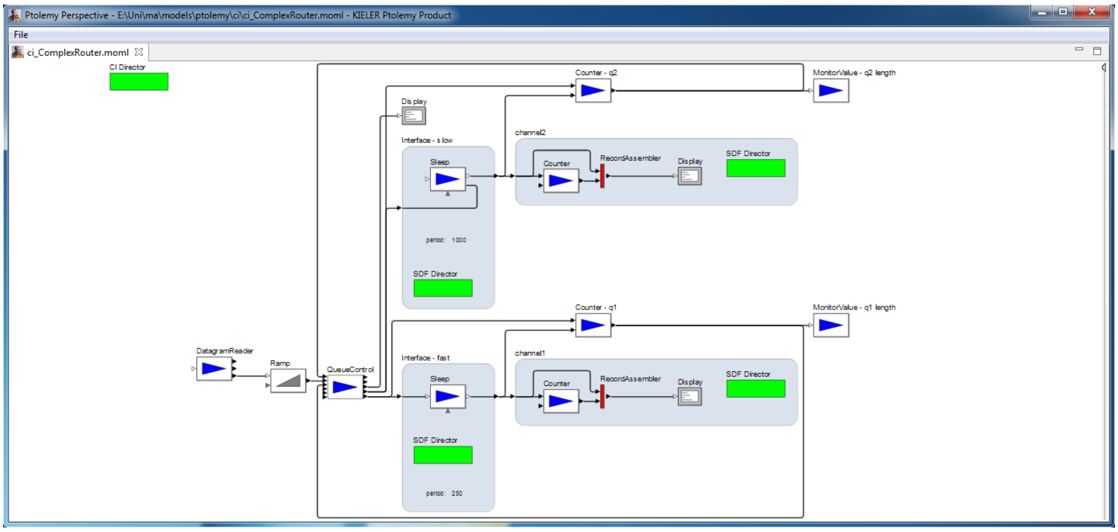
[2] Christian Schneider, Miro Spönemann, and Reinhard von Hanxleden. Just model! – Putting automatic synthesis of node-link-diagrams into practice. In *Proceedings of the IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC'13)*, San Jose, CA, USA, September15–19 2013.

[3] Kozo Sugiyama, Shojiro Tagawa, and Mitsuhiko Toda. Methods for visual understanding of hierarchical system structures. *IEEE Transactions on Systems, Man and Cybernetics*, 11(2):109–125, February 1981.

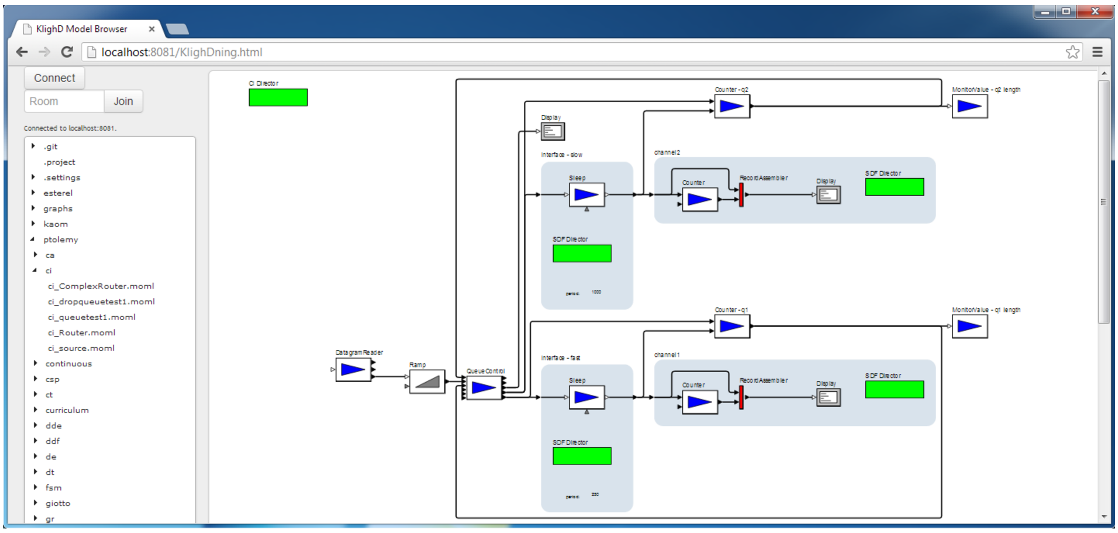
[4] Reinhard von Hanxleden, Edward A. Lee, Christian Motika, and Hauke Fuhrmann. Multi-view modeling and pragmatics in 2020 — position paper on designing complex cyber-physical systems. In *Proceedings of the 17th International Monterey Workshop on Development, Operation and Management of Large-Scale Complex IT Systems, LNCS*, volume 7539, Oxford, UK, December 2012.



(a) The original Vergil editor, where each hierarchical level is displayed in its own window.



(b) A KLighD-based desktop application with embedded hierarchy.



(c) A KLighD-based web-client for collaborative viewing of models within the browser.

Figure 1: The `complexRouter` Ptolemy model within different viewers.