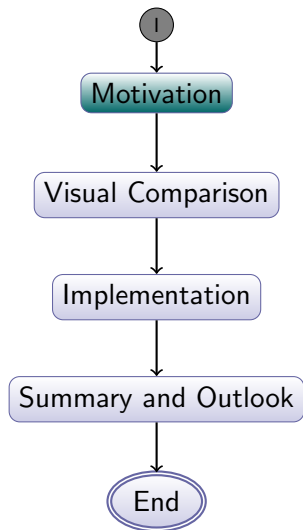# Visual Comparison of Graphical Models

Arne Schipper   Hauke Fuhrmann   Reinhard von Hanxleden

Real-Time Systems and Embedded Systems Group,
Department of Computer Science,
Christian-Albrechts-Universität zu Kiel

{ars,haf,rvh}@informatik.uni-kiel.de

UML&AADL'09
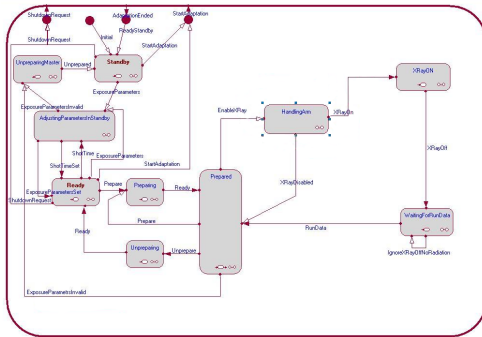
Outline

Motivation

Problem:

- ▶ Graphical models very often used, quite easy to create and browse, but pain to compare.

Motivation

Problem:

▶ Graphical models very often used, quite easy to create and browse, but pain to compare.
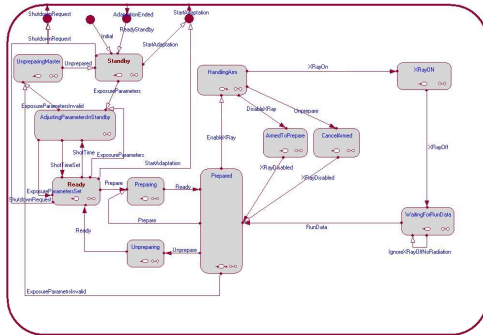

Screenshot of a real model from a project, Version 1

Motivation

Problem:

▶ Graphical models very often used, quite easy to create and browse, but pain to compare.
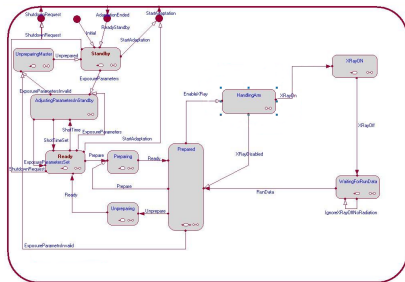

Screenshot of a real model from a project, Version 2
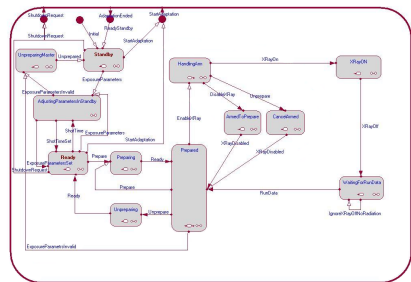
Motivation

Problem:

▶ Graphical models very often used, quite easy to create and browse, but pain to compare.

Screenshot of a real model from a project, Version 1

Screenshot of a real model from a project, Version 2

Motivation

Problem cont'd:

- ▶ Means exist to compare graphical models textually, but …
- ▶ User has to switch between different abstraction levels.

Motivation

Problem cont'd:

- ▶ Means exist to compare graphical models textually, but ...
- ▶ User has to switch between different abstraction levels.

Solution:

- ▶ Develop means to aid the user in performing a real **visual comparison** of graphical models.
- ▶ Some tools exist, but have drawbacks.

Motivation

Problem cont'd:

- ▶ Means exist to compare graphical models textually, but ...
- ▶ User has to switch between different abstraction levels.

Solution:

- ▶ Develop means to aid the user in performing a real **visual comparison** of graphical models.
- ▶ Some tools exist, but have drawbacks.

Method:

- ▶ Identify and improve those drawbacks.
- ▶ Implement as Eclipse plug-in using existing techniques where appropriate.
- ▶ Use generic approach to cope with various graphical languages.

Outline
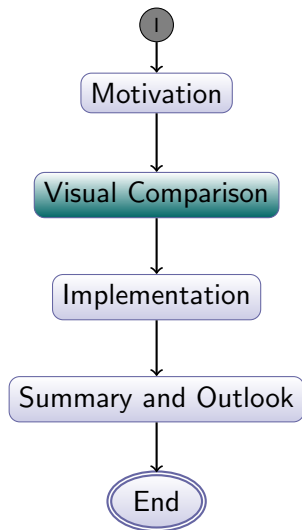
Visual Comparison

Textual diff/comparison:

- ▶ Known to everyone, compare texts side by side.
- ▶ One-dimensional or linear arrangement with *holes* in the texts.

Visual Comparison

Textual diff/comparison:

- ▶ Known to everyone, compare texts side by side.
- ▶ One-dimensional or linear arrangement with *holes* in the texts.

Figure: Two article versions in Wikipedia

Visual Comparison

Common comparison of graphical models:

- ▶ Generate a textual description of the changes.
- ▶ Is sometimes structured, but ...
- ▶ User has to find these changes in the graphical representation.

Visual Comparison

Common comparison of graphical models:

- ▶ Generate a textual description of the changes.
- ▶ Is sometimes structured, but ...
- ▶ User has to find these changes in the graphical representation.
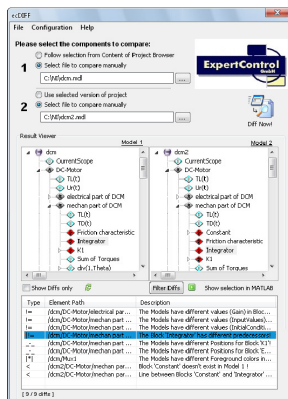
Figure: Model diff of Expert Control

Visual Comparison

Visual comparison:

- ▶ Show the changes in the graphical model itself.
- ▶ Prevents the user from switching between text and graphical model.

Visual Comparison

Visual comparison:

- ▶ Show the changes in the graphical model itself.
- ▶ Prevents the user from switching between text and graphical model.
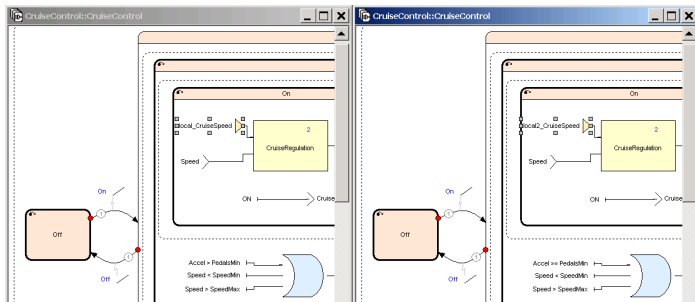
Figure: Scade model diff

Visual Comparison

Challenges:

- Graphical models at least two-dimensional, in contrast to text.

Visual Comparison

Challenges:

- Graphical models at least two-dimensional, in contrast to text.
- No trivial solution for *holes* like in textual diff.

Visual Comparison

Challenges:

- ▶ Graphical models at least two-dimensional, in contrast to text.
- ▶ No trivial solution for *holes* like in textual diff.
- ▶ Some models have information which is not shown visually.

Visual Comparison

Challenges:

- ▶ Graphical models at least two-dimensional, in contrast to text.
- ▶ No trivial solution for *holes* like in textual diff.
- ▶ Some models have information which is not shown visually.
- ▶ Large models.

Visual Comparison

Challenges:

- ▶ Graphical models at least two-dimensional, in contrast to text.
- ▶ No trivial solution for *holes* like in textual diff.
- ▶ Some models have information which is not shown visually.
- ▶ Large models.
- ▶ *Mental map* of the user.

Visual Comparison

Challenges:

- ► Graphical models at least two-dimensional, in contrast to text.
- ► No trivial solution for *holes* like in textual diff.
- ► Some models have information which is not shown visually.
- ► Large models.
- ► *Mental map* of the user.
- ► Difference detection. However, solved by an existing engine and we focus on graphical presentation

Questions:

Visual Comparison

Challenges:

- ▶ Graphical models at least two-dimensional, in contrast to text.
- ▶ No trivial solution for *holes* like in textual diff.
- ▶ Some models have information which is not shown visually.
- ▶ Large models.
- ▶ *Mental map* of the user.
- ▶ Difference detection. However, solved by an existing engine and we focus on graphical presentation

Questions:

- ▶ Use just the structure of the graphical model or also the layout information of the elements?

Visual Comparison

Challenges:

- ▶ Graphical models at least two-dimensional, in contrast to text.
- ▶ No trivial solution for *holes* like in textual diff.
- ▶ Some models have information which is not shown visually.
- ▶ Large models.
- ▶ *Mental map* of the user.
- ▶ Difference detection. However, solved by an existing engine and we focus on graphical presentation

Questions:

- ▶ Use just the structure of the graphical model or also the layout information of the elements?
- ▶ Use one model or both versions to display the changes?

Visual Comparison

Challenges:

- ▶ Graphical models at least two-dimensional, in contrast to text.
- ▶ No trivial solution for *holes* like in textual diff.
- ▶ Some models have information which is not shown visually.
- ▶ Large models.
- ▶ *Mental map* of the user.
- ▶ Difference detection. However, solved by an existing engine and we focus on graphical presentation

Questions:

- ▶ Use just the structure of the graphical model or also the layout information of the elements?
- ▶ Use one model or both versions to display the changes?
- ▶ Alter the layout or leave it intact?
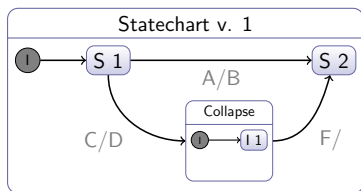
Visual Comparison

Challenges:

- ▶ Graphical models at least two-dimensional, in contrast to text.
- ▶ No trivial solution for *holes* like in textual diff.
- ▶ Some models have information which is not shown visually.
- ▶ Large models.
- ▶ *Mental map* of the user.
- ▶ Difference detection. However, solved by an existing engine and we focus on graphical presentation
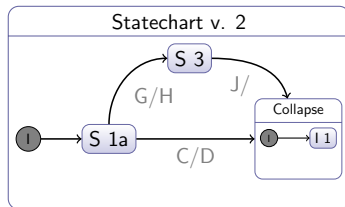
Questions:

- ▶ Use just the structure of the graphical model or also the layout information of the elements?
- ▶ Use one model or both versions to display the changes?
- ▶ Alter the layout or leave it intact?
- ▶ Does a readable automatic layout help?

Visual Comparison

The two versions of the model:
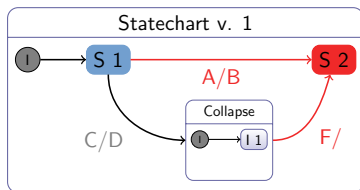

(a) Version 1   (b) Version 2

Figure: The two original versions of the example diagram.

Visual Comparison

Possible representation of the changes 1:

(a) Version 1
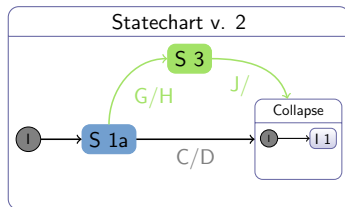
(b) Version 2

Figure: Plain visual diff. Color legend: green/additions, red/deletions, blue/changes.

Visual Comparison

Possible representation of the changes 3:
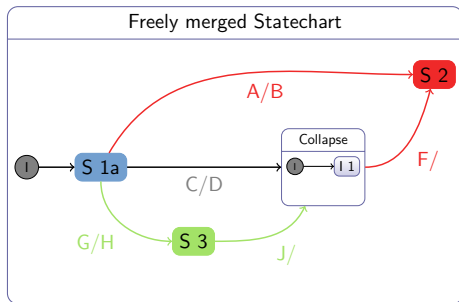
Figure: Freely merged visual diff.

Visual Comparison

Which representation?

- Manual tests showed that *plain* visual diff is best.

Visual Comparison

Which representation?

- ▶ Manual tests showed that *plain* visual diff is best.
- ▶ Additional textual description of changes is also given.

Visual Comparison

Which representation?

- ► Manual tests showed that *plain* visual diff is best.
- ► Additional textual description of changes is also given.
- ► No problems with/recomputation of layout, but a good layout of the original models is helpful.

Visual Comparison

Which representation?

- Manual tests showed that *plain* visual diff is best.
- Additional textual description of changes is also given.
- No problems with/recomputation of layout, but a good layout of the original models is helpful.
- Mental map of user is preserved.

Visual Comparison

Which representation?

- Manual tests showed that *plain* visual diff is best.
- Additional textual description of changes is also given.
- No problems with/recomputation of layout, but a good layout of the original models is helpful.
- Mental map of user is preserved.
- Additional means like panning, zooming and folding needed to cope with large models.

Visual Comparison

Which representation?

- Manual tests showed that *plain* visual diff is best.
- Additional textual description of changes is also given.
- No problems with/recomputation of layout, but a good layout of the original models is helpful.
- Mental map of user is preserved.
- Additional means like panning, zooming and folding needed to cope with large models.

Other issues:

- The diff is performed just against the structural/domain model.

Visual Comparison

Which representation?

- Manual tests showed that *plain* visual diff is best.
- Additional textual description of changes is also given.
- No problems with/recomputation of layout, but a good layout of the original models is helpful.
- Mental map of user is preserved.
- Additional means like panning, zooming and folding needed to cope with large models.

Other issues:

- The diff is performed just against the structural/domain model.
- Non graphical changes (e.g. of properties) are also displayed; blue in the previous slides.

Outline
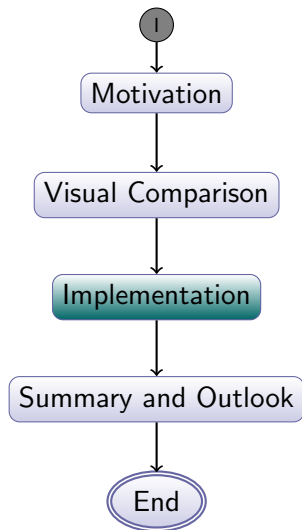
Implementation

Developed as Eclipse plug-in within a project called KIELER (Kiel Integrated Environment for Layout, for Eclipse RCP).

- ▶ EMF to create the domain models.

Implementation

Developed as Eclipse plug-in within a project called KIELER (Kiel Integrated Environment for Layout, for Eclipse RCP).

► EMF to create the domain models.

► GMF to build the corresponding graphical editor.

Implementation

Developed as Eclipse plug-in within a project called KIELER (Kiel Integrated Environment for Layout, for Eclipse RCP).

- ▶ EMF to create the domain models.
- ▶ GMF to build the corresponding graphical editor.
- ▶ EMF Compare to compute the differences of the EMF model.

Implementation

Developed as Eclipse plug-in within a project called KIELER (Kiel Integrated Environment for Layout, for Eclipse RCP).

- ▶ EMF to create the domain models.
- ▶ GMF to build the corresponding graphical editor.
- ▶ EMF Compare to compute the differences of the EMF model.
- ▶ **KiViK** (Kieler Visual Comparison) to get EMF Compare output into GMF.

Implementation

Developed as Eclipse plug-in within a project called KIELER (Kiel Integrated Environment for Layout, for Eclipse RCP).

- ▶ EMF to create the domain models.
- ▶ GMF to build the corresponding graphical editor.
- ▶ EMF Compare to compute the differences of the EMF model.
- ▶ **KiViK** (Kieler Visual Comparison) to get EMF Compare output into GMF.
    - ▶ Use original layout of diagrams and display them side by side.

Implementation

Developed as Eclipse plug-in within a project called KIELER (Kiel Integrated Environment for Layout, for Eclipse RCP).

- ▶ EMF to create the domain models.
- ▶ GMF to build the corresponding graphical editor.
- ▶ EMF Compare to compute the differences of the EMF model.
- ▶ **KiViK** (Kieler Visual Comparison) to get EMF Compare output into GMF.
  - ▶ Use original layout of diagrams and display them side by side.
  - ▶ Annotate the structural changes with different colors.

Implementation

Developed as Eclipse plug-in within a project called KIELER (Kiel Integrated Environment for Layout, for Eclipse RCP).

- ▶ EMF to create the domain models.
- ▶ GMF to build the corresponding graphical editor.
- ▶ EMF Compare to compute the differences of the EMF model.
- ▶ **KiViK** (Kieler Visual Comparison) to get EMF Compare output into GMF.
  - ▸ Use original layout of diagrams and display them side by side.
  - ▸ Annotate the structural changes with different colors.
  - ▸ Use third panel on top to display just the structural changes textually (like EMF Compare).
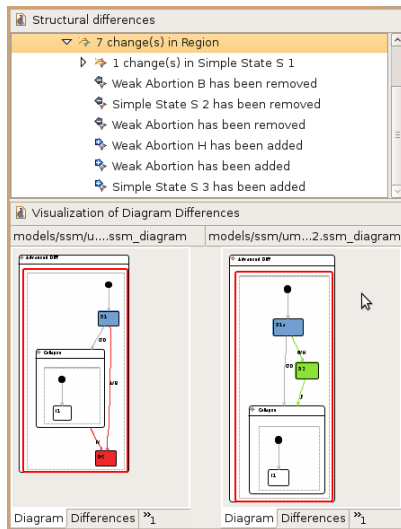
Implementation

Developed as Eclipse plug-in within a project called KIELER (Kiel
Integrated Environment for Layout, for Eclipse RCP).

- ▶ EMF to create the domain models.
- ▶ GMF to build the corresponding graphical editor.
- ▶ EMF Compare to compute the differences of the EMF model.
- ▶ **KiViK** (Kieler Visual Comparison) to get EMF Compare
  output into GMF.
  - ▸ Use original layout of diagrams and display them side by side.
  - ▸ Annotate the structural changes with different colors.
  - ▸ Use third panel on top to display just the structural changes
    textually (like EMF Compare).
  - ▸ Equip the comparison view with means to navigate and zoom.

Implementation

Developed as Eclipse plug-in within a project called KIELER (Kiel Integrated Environment for Layout, for Eclipse RCP).

- ▶ EMF to create the domain models.
- ▶ GMF to build the corresponding graphical editor.
- ▶ EMF Compare to compute the differences of the EMF model.
- ▶ **KiViK** (Kieler Visual Comparison) to get EMF Compare output into GMF.
  - ▸ Use original layout of diagrams and display them side by side.
  - ▸ Annotate the structural changes with different colors.
  - ▸ Use third panel on top to display just the structural changes textually (like EMF Compare).
  - ▸ Equip the comparison view with means to navigate and zoom.
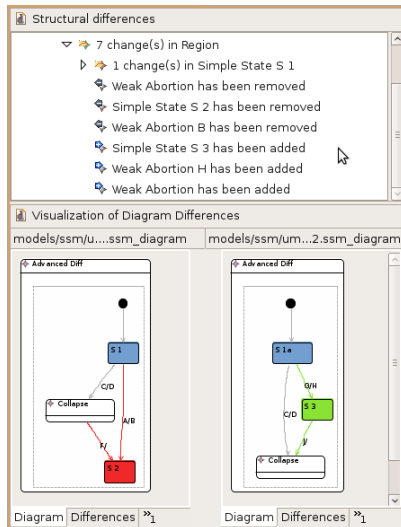 - ▸ Collapse composite items with no changes inside (a layout algorithm is needed then) .
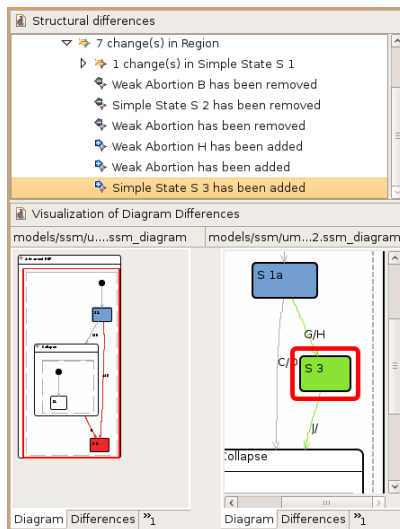
Implementation

General implementation:

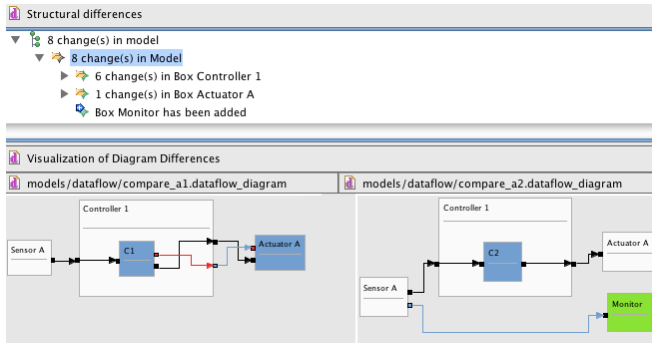# Implementation

Example of collapsing:

Implementation

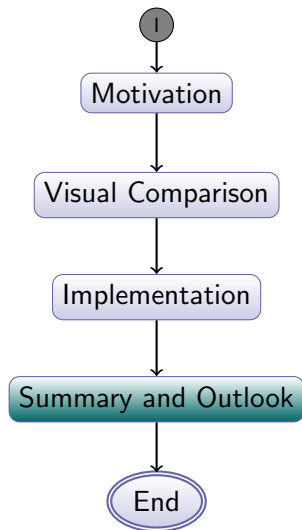Example of automatic zoom:

Implementation

## Comparison of Dataflow models:

Outline

Summary and Outlook

Feedback:

- ▶ Students and professionals gave an overall positive feeback for this approach.
- ▶ Representation directly in the diagram seen as benefit.
- ▶ Visualization of small (or invisible) changes very useful.
- ▶ User interface with collapsing, panning and zooming intuitive.
- ▶ Generic approach enables support for various diagrams with none or little adaption.
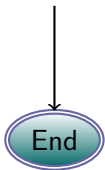
Summary and Outlook

Outlook:

- ▶ Large models are still challenging; time for comparison as well as navigation.
- ▶ Next step would be to support merging graphically.
- ▶ Maybe implement also the other approaches presented to see how they perform.
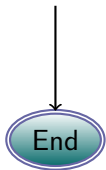
Visual Comparison of Graphical Models

Visual Comparison of Graphical Models

Thanks!