Supplemental Material
RelEx: Visualization for Actively Changing Overlay Network Specifications

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Abstract

The following supplemental material provides additional screenshots of the tool RelEx, meant for further clarification of visual encodings and linked-view interaction. Figures S1 and S2 describe the basic visual encodings. Figure S3 introduces the differences between intra- and inter-bus communication. Figure S4 shows an example of intra-bus communication, and Figures S5-S7 show an example of inter-bus communication.
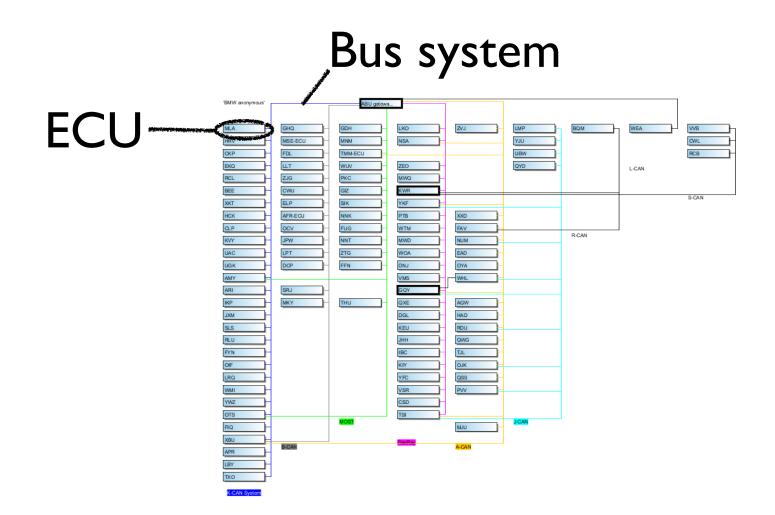
Figure S1: Topology View: The basic visual encodings are the rectangles for *ECUs*, and color-coded lines for *bus systems*.
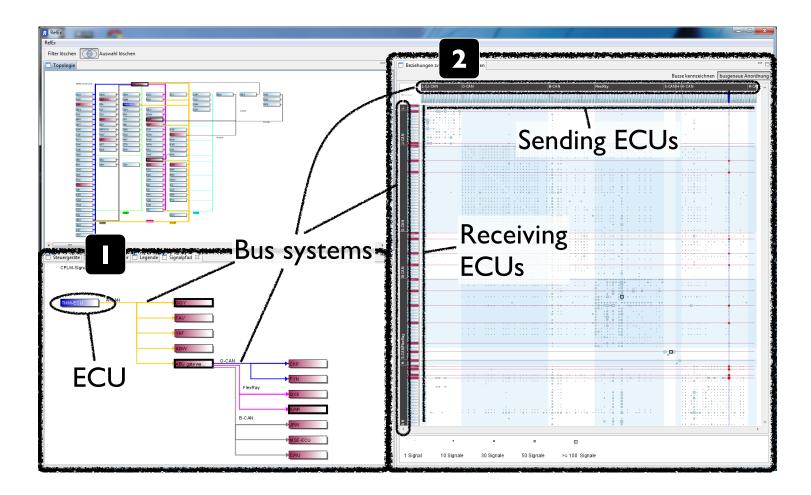
Figure S2: RelEx: (1) The SignalPath View uses the same visual encodings as the Topology View; that is, rectangles for ECUs, and color-coded lines for bus systems. (2) The Matrix View also uses rectangles for ECUs; sending ECUs are positioned at the top of the matrix, and receiving ECUs at the left side. As shown here, the matrix can be sorted by bus system. In this mode, bus names are indicated with white labels in grey boxes that span the periphery of the adjacent rectangles representing the ECUs for each bus system. ECUs connected to multiple buses are shown redundantly; within the matrix alternating groups of bus systems have light blue backgrounds to create visually distinguishable stripes. At each crossing of an ECU's send column and an ECU's receive row the total number of signals exchanged between that pair of ECUs is represented by a size-coded square called a communication-box.
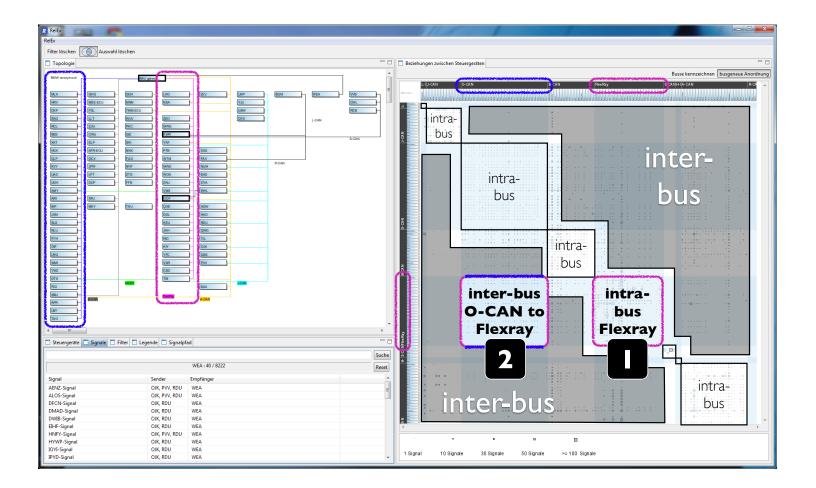
Figure S3: *Intra-bus communication* describes signals that are exchanged between ECUs that are connected to the same bus system. In the Matrix View all intra-bus communication lies on the diagonal intersection of bus stripes; that is, where bus stripes of the same type cross each other (indicated with rectangles). Signal communication that resides outside these rectangles needs to traverse multiple bus systems via Gateway ECUs (indicated as gray areas); in contrast, we call this pattern *inter-bus communication*. (1) shows the intra-bus communication within the pink Flexray bus. (2) shows an example of inter-bus communication: all signals that are sent from ECUs connected to the blue O-CAN bus to ECUs that are connected to the pink Flexray bus. Blue and pink colored rectangles indicate the two bus systems in the different views.
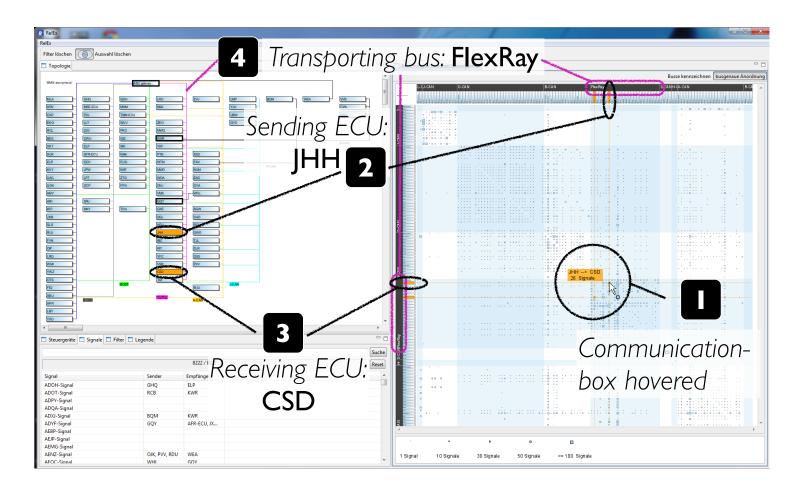
Figure S4: Example 1: Intra-bus communication. A user hovered over the communication-box (1) between the JHH and the CSD ECU in the Matrix View. The sending JHH ECU (2) is highlighted in orange in the Topology View and the Matrix View. The receiving CSD ECU (3) is also highlighted. In the Topology View, sending and receiving ECU are connected to the same bus system line, the pink Flexray (4). In the bus-sorted Matrix View they are thus within the same bus region, and the hovered communication-box resides within the intra-bus communication region on the matrix diagonal.
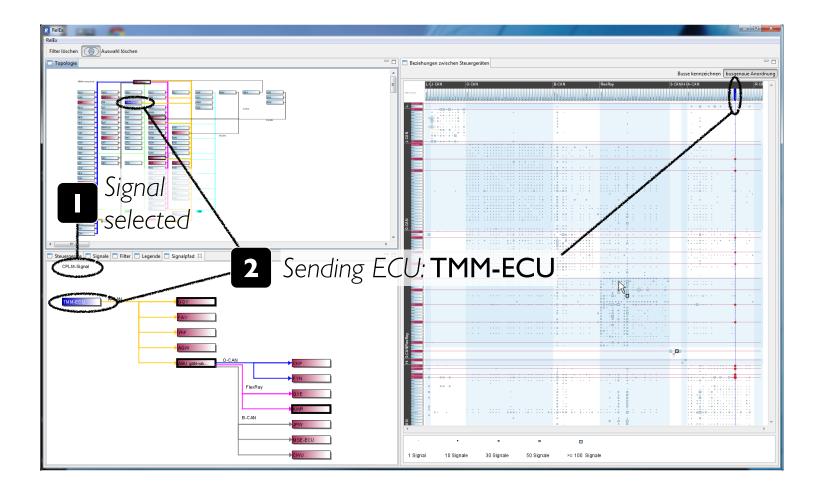
Figure S5: Example 2: Inter-bus communication. The user selected the CPLM-Signal (1). The sender of this signal is the TMM-ECU (2); it is highlighted in blue in the Topology View (upper left), the Matrix View (right), and the SignalPath View (lower left).
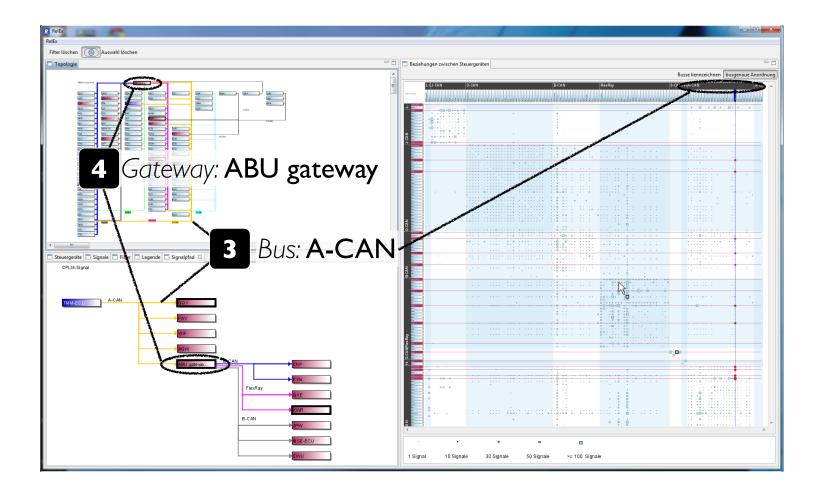
Figure S6: Example 2, continued. Red boxes indicate ECUs that are receiving the CPLM-Signal. From the TMM-ECU the signal is directly transferred onto the yellow A-CAN bus system (3). Five ECUs receive the signal directly from the A-CAN. One of them, the ABU gateway (4), is a gateway that repacks and forwards the message to three other bus systems. This forwarding behavior can easily be inspected in the SignalPath View by noting the three different colors of highlighted links leaving the gateway. It is also visible in the Matrix View by noting the highlighted communication boxes in three different off-diagonal blocks, and in the Topology View by inspecting the bus connections of all highlighted receiver ECUs.
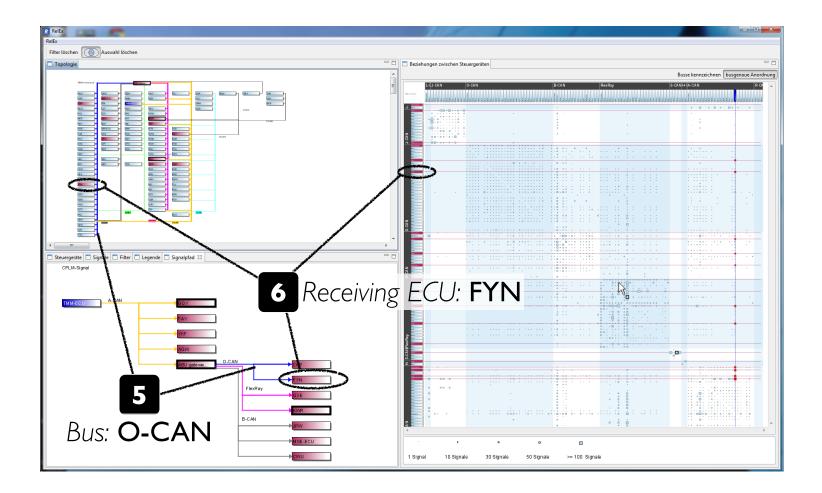
Figure S7: Example 2, continued. One of the bus systems also connected to the ABU gateway is the blue O-CAN (5), transferring the signal to two receiving ECUs: CKP and FYN (6). The communication between the sender TMM-ECU and the receiver ECU FYN is thus an example of inter-bus communication.