Real-time Visualization of Analyzed Industrial Communication Network Traffic

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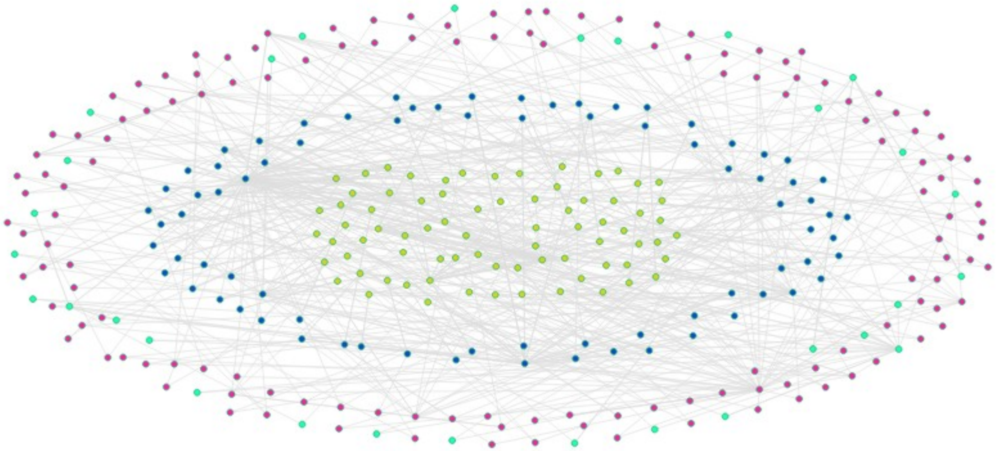


Background

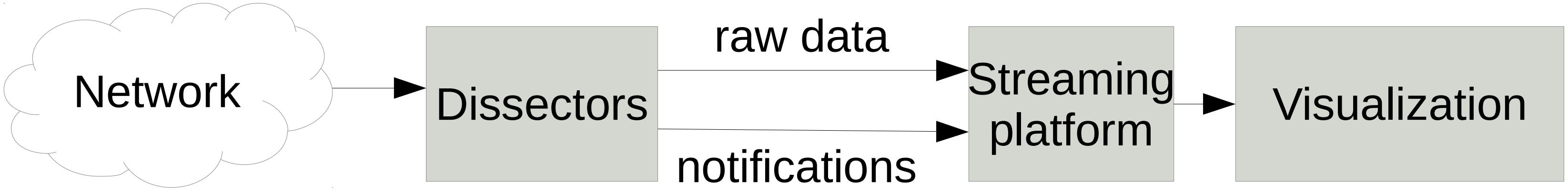
- Industrial Network Security aims to understand the traffic in industrial production systems
- Analysis of the traffic to find anomalies
- Real-time visualization to help the user understand
    - Communication behavior
    - Changes in the communication
- Incidents can be detected visually

Requirements

- 24 Functional Requirements
  - User access control, security roles
  - Three different diagram types
  - Brushing
  - Data filter
- 12 Non-Functional Requirements

The Workflow

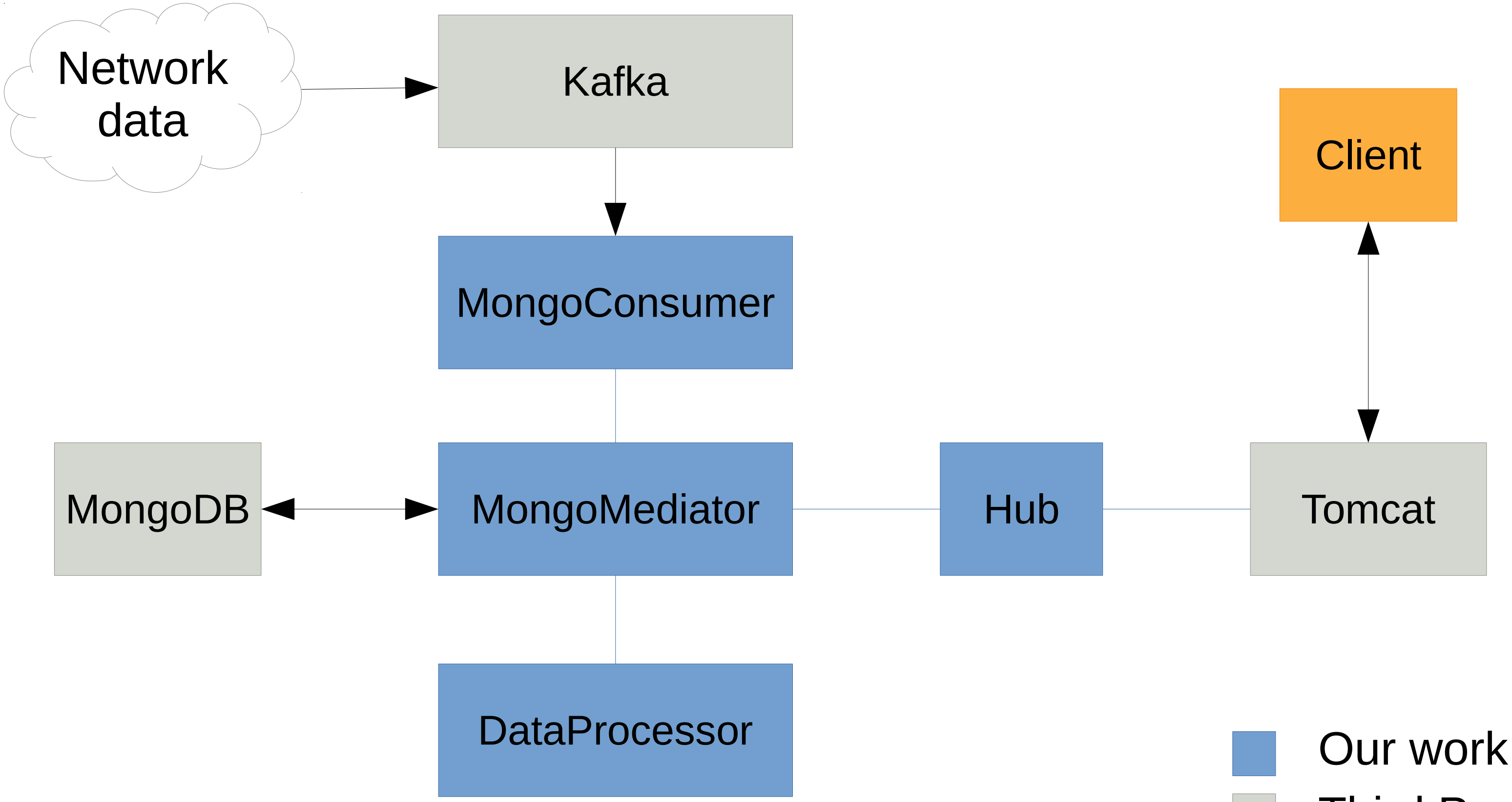
- Network traffic is recorded
- Traffic data is analyzed (dissected)
- Data is fed to a streaming platform (Kafka)
- A visualization tool displays data and analysis results



Architecture and Design

- Client-Server Architecture
- Back-End:
  - Mediator pattern
  - Strategy pattern
- Front-End:
  - Model-View-Controller
  - Observer

Back-End Design

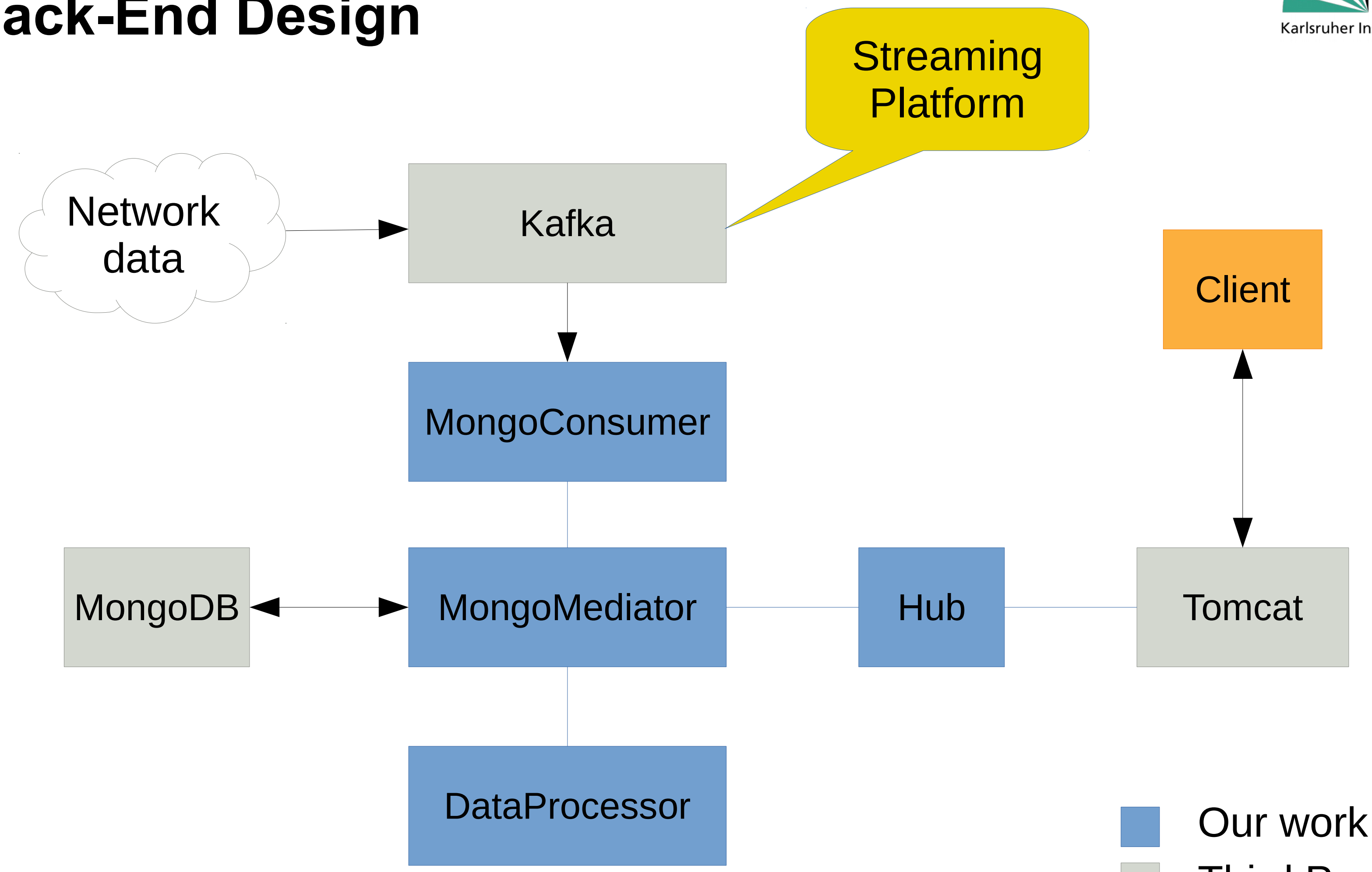


🟦 Our work

⬜ Third Party

🟧 Front-End

Back-End Design



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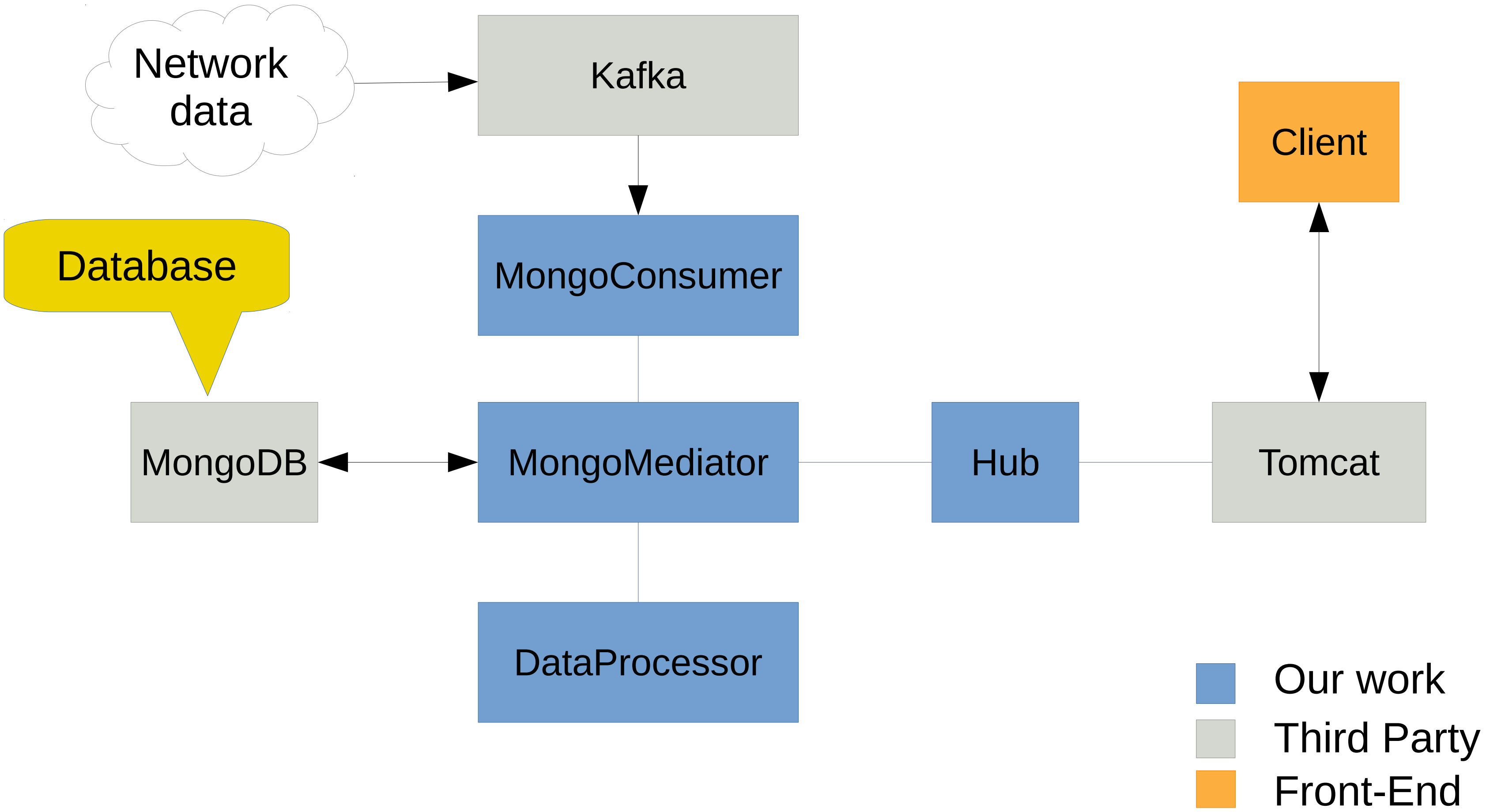
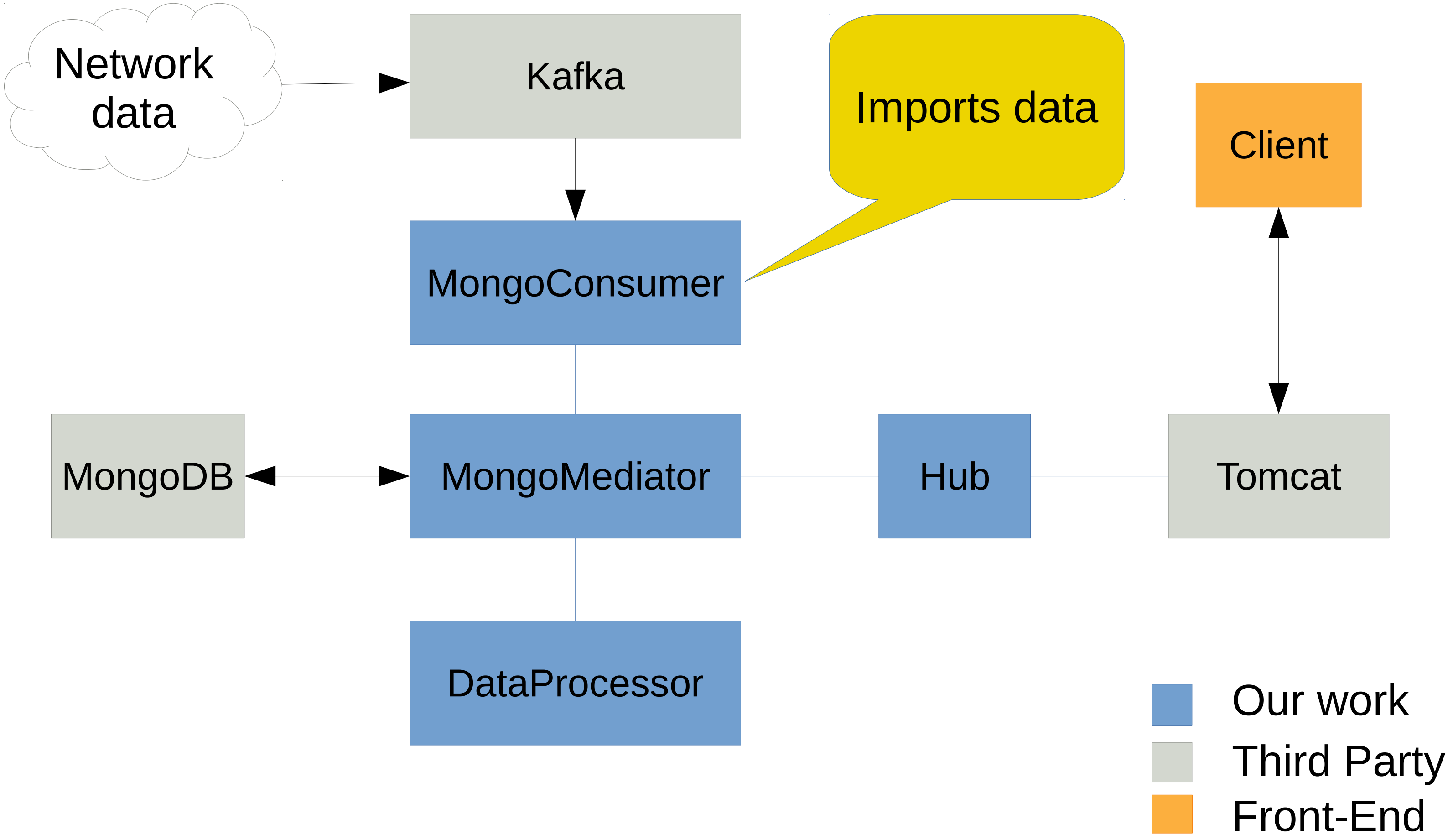
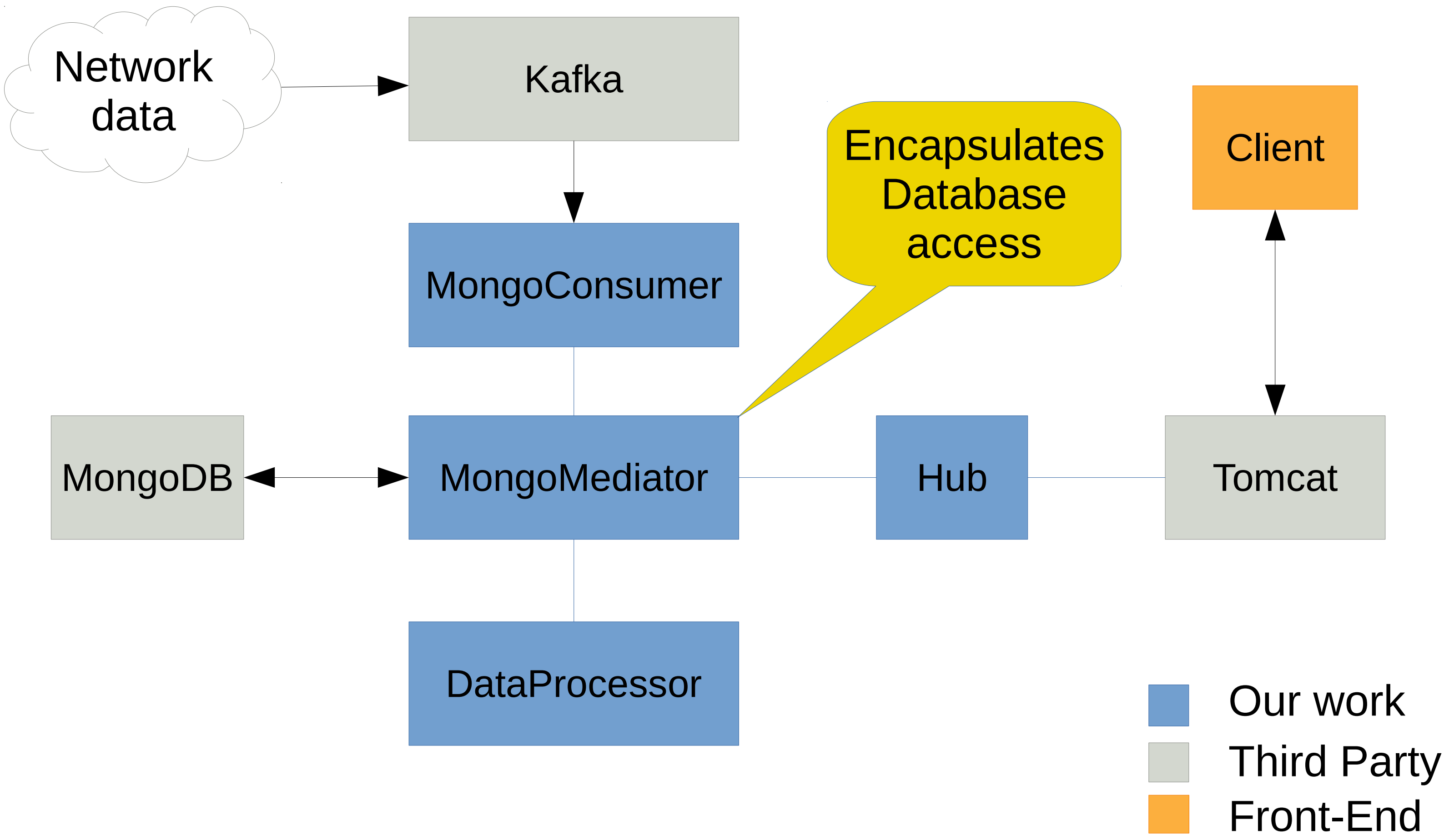


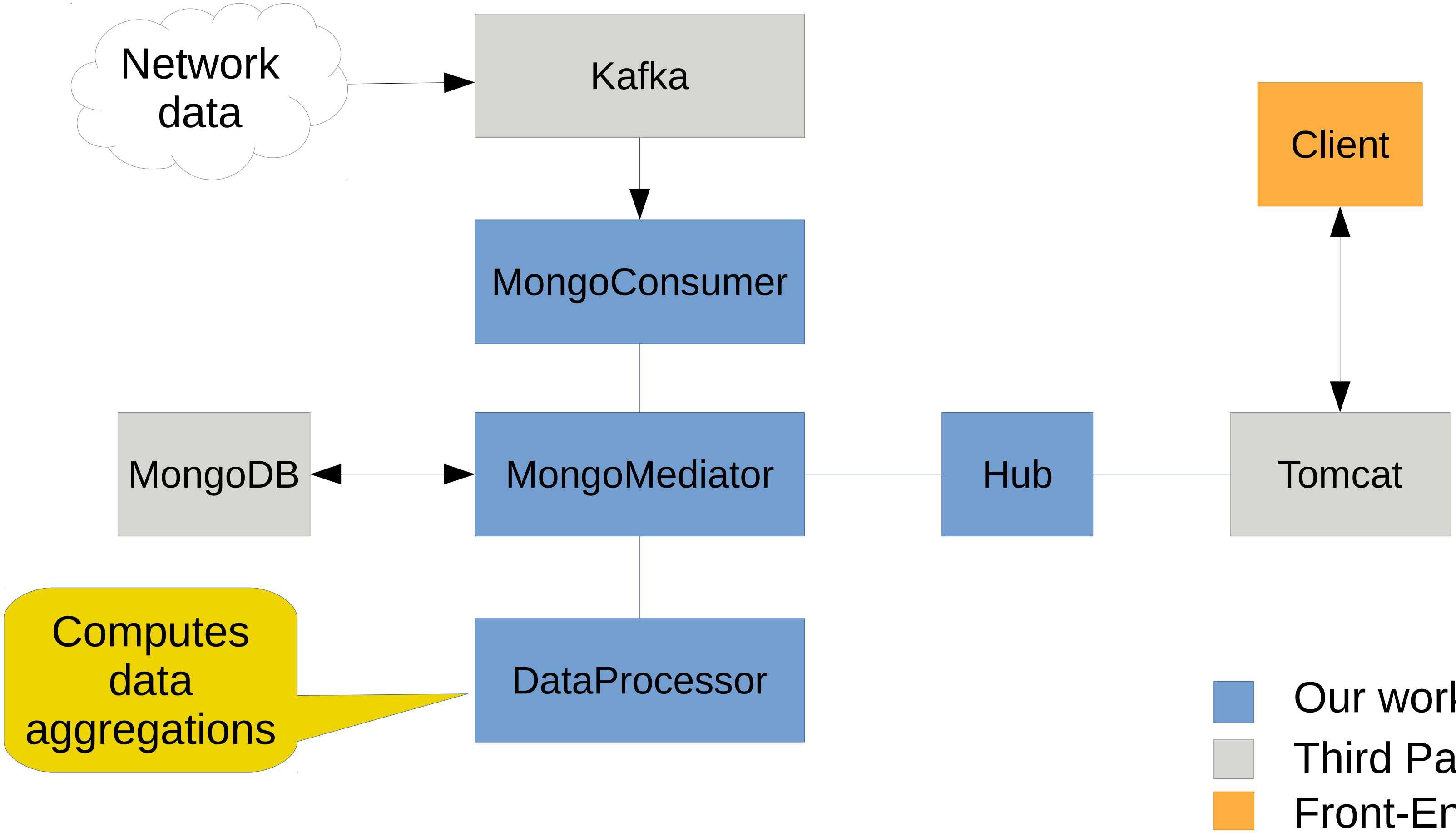
Back-End Design



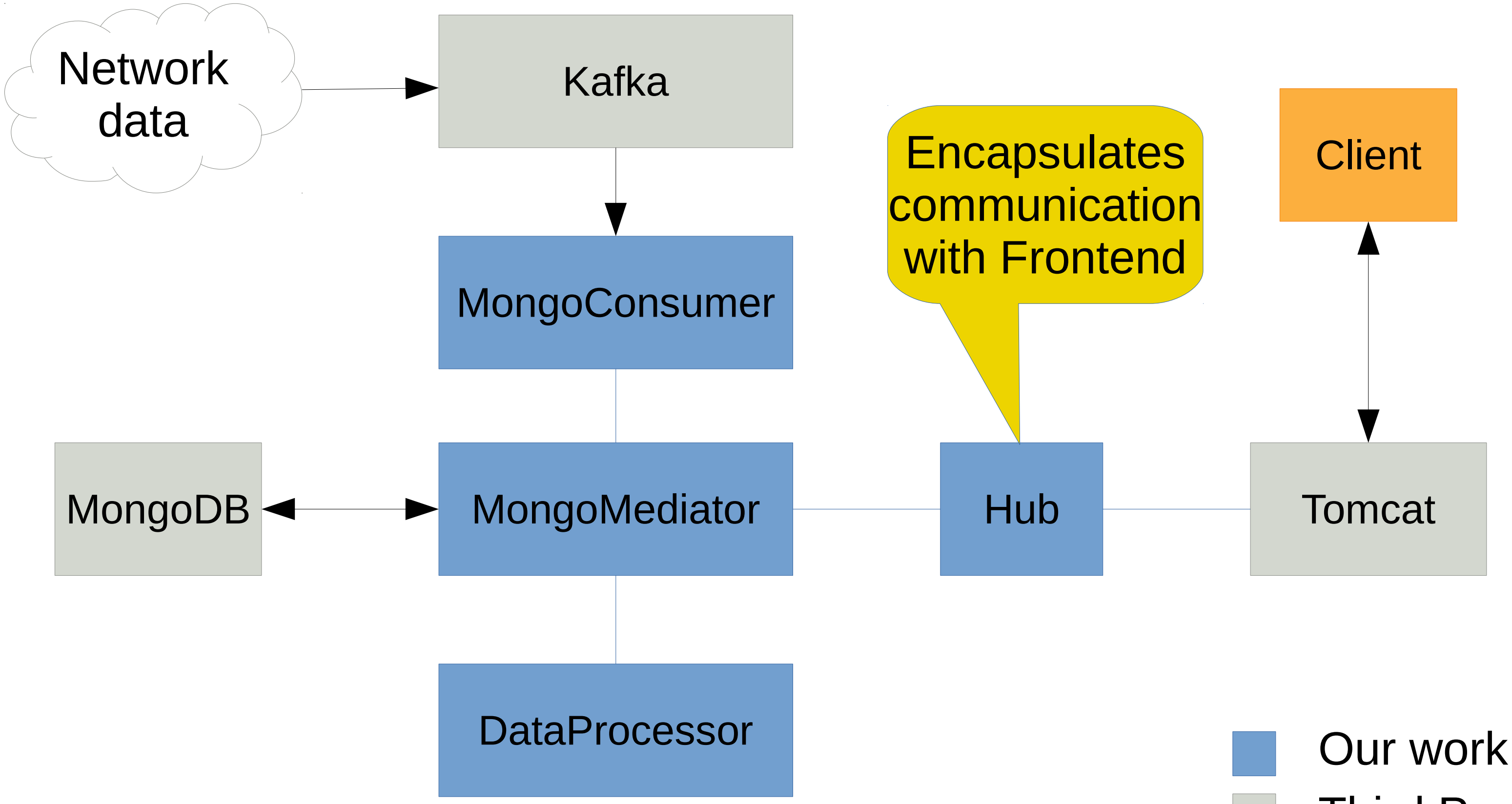
Back-End Design



Back-End Design



Back-End Design



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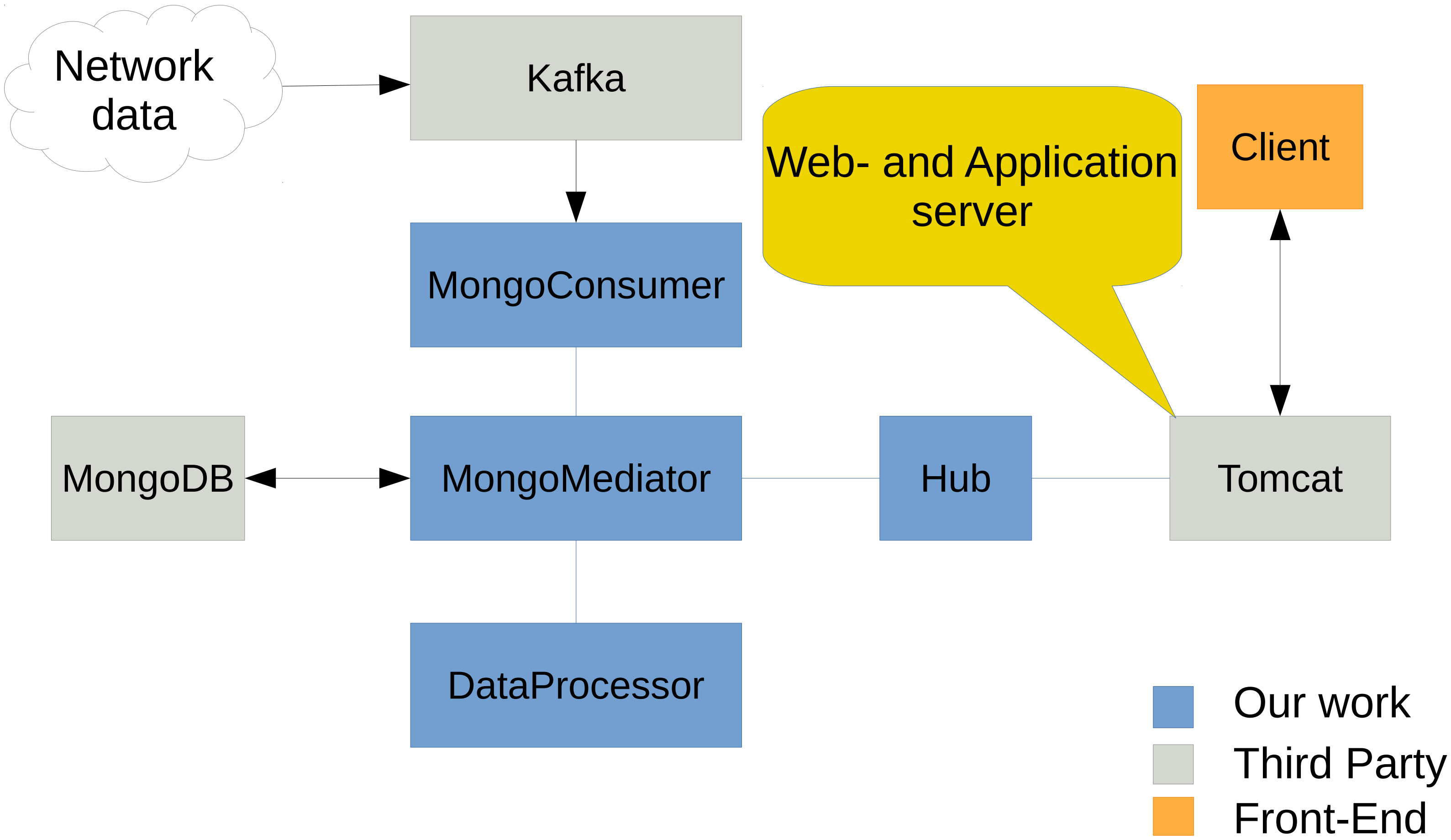
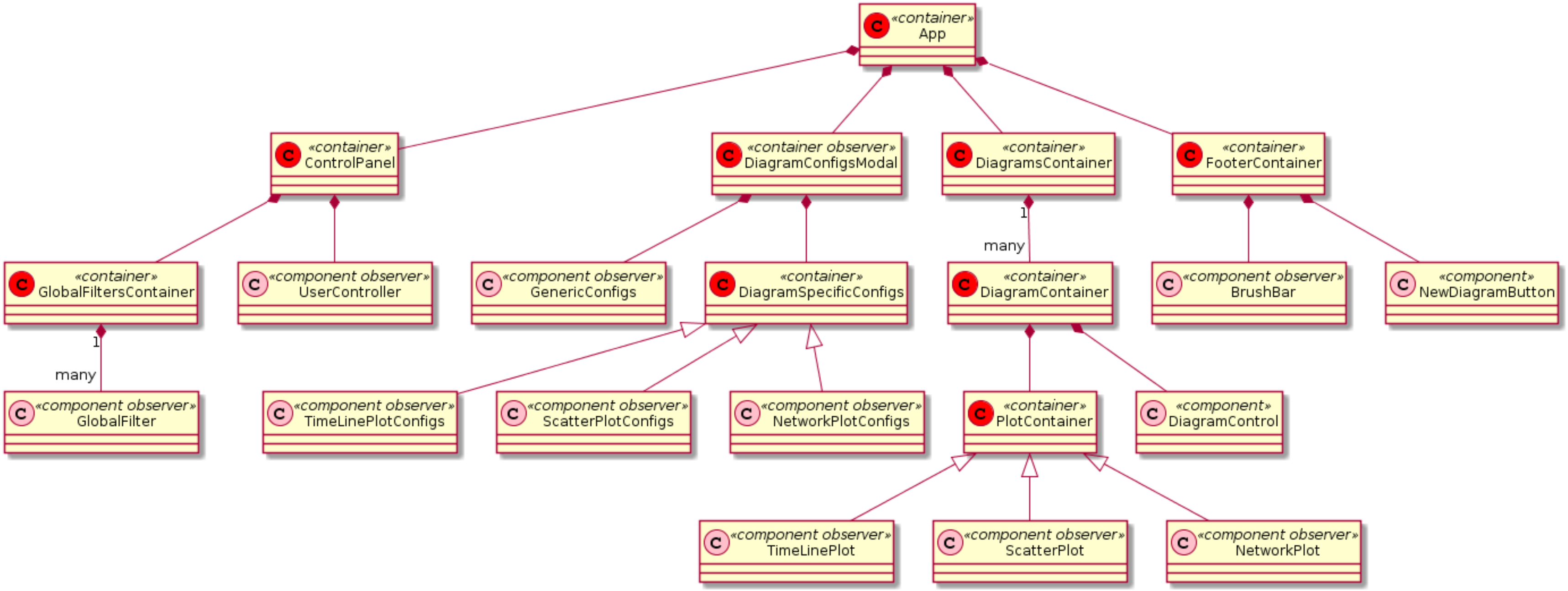


Back-End Components

- Written in Java and using open source components

Front-End Design

Overview of GUI Elements


«container» App
«container» ControlPanel
«container observer» DiagramConfigsModal
«container» DiagramsContainer
«container» FooterContainer
«container» GlobalFiltersContainer
«component observer» UserController
«component observer» GenericConfigs
«container» DiagramSpecificConfigs
«container» DiagramContainer
«component observer» BrushBar
«component» NewDiagramButton
«component observer» GlobalFilter
«component observer» TimeLinePlotConfigs
«component observer» ScatterPlotConfigs
«component observer» NetworkPlotConfigs
«container» PlotContainer
«component» DiagramControl
«component observer» TimeLinePlot
«component observer» ScatterPlot
«component observer» NetworkPlot
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Front-End Components

- Written in Javascript
- Additional third party components (open source):
  - React library
  - D3 graphics library
  - nivo diagram components
  - MobX state management

Implementation

- User access control
- Data source selection
- Multiple diagram types
- Brushing
- Modular structure
- 19 of 24 functional requirements

- 🟨 Node-link diagram (partial)
- 🟨 Filtering (partial)
- ✖ Data selection

Development Tools Used

- Tools for Back-end development:
  - Eclipse
  - Maven
  - Junit
- Tools for Front-end development:
  - Visual Studio Code
  - Parcel.js
  - Netlify (CD)
- Git, Github
- Slack
- Latex

Unexpected Difficulties and Challenges

- Only four team members
- Larger Scope than expected
- Many different technologies
  - Javascript and the libraries make use of multiple programming paradigms
  - Complexity of D3
  - Nivo components have inconsistent features
  - MongoDB idiosyncracies

Lessons Learned

- Design more thoroughly
  - Especially data structures
- Plan and schedule more strictly
- Evaluate third party components more thoroughly
- Waterfall model didn‘t work.

Best Practices

- Overall design was viable
- Good commit practices
- Frequent team communication
- Flexibility
- Learning from each other

Conclusion

- We produced a working system
- Usable as a good and extensible base for future work
- Underestimated the amount of work required
- Gained experience with teamwork
- Gained understanding of technologies