Karlsruhe Institute of Technology

Fraunhofer IOSB

Real-time Visualization of Analyzed Industrial Communication Network Traffic

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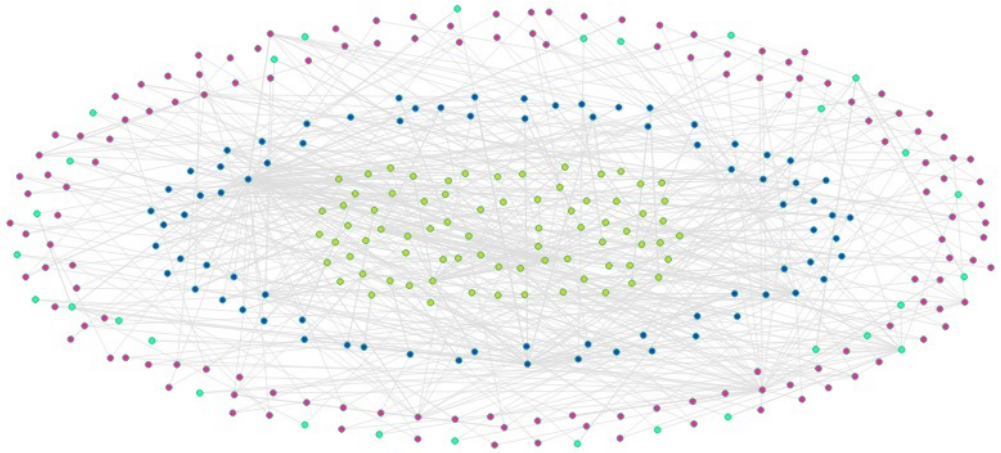


Background

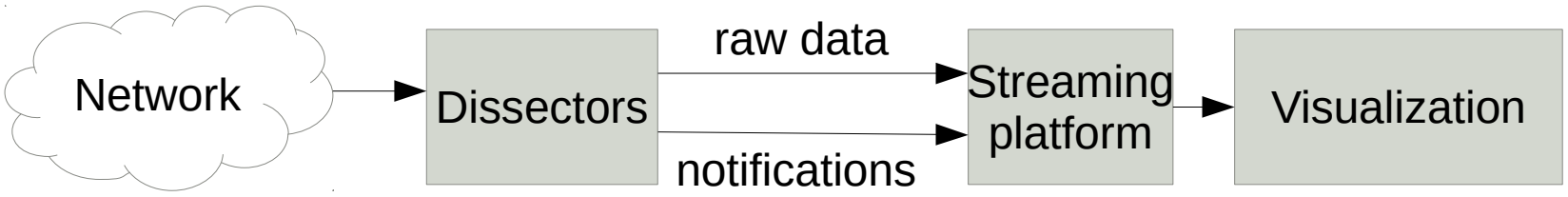
- Industrial Network Security aims to understand the traffic in industrial production systems
- Analysis of the traffic to find anomalies
- Real-time visualization to help the user understand
  - Communication behavior
  - Changes in the communication
- Incidents can be detected visually

Requirements

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

The Workflow

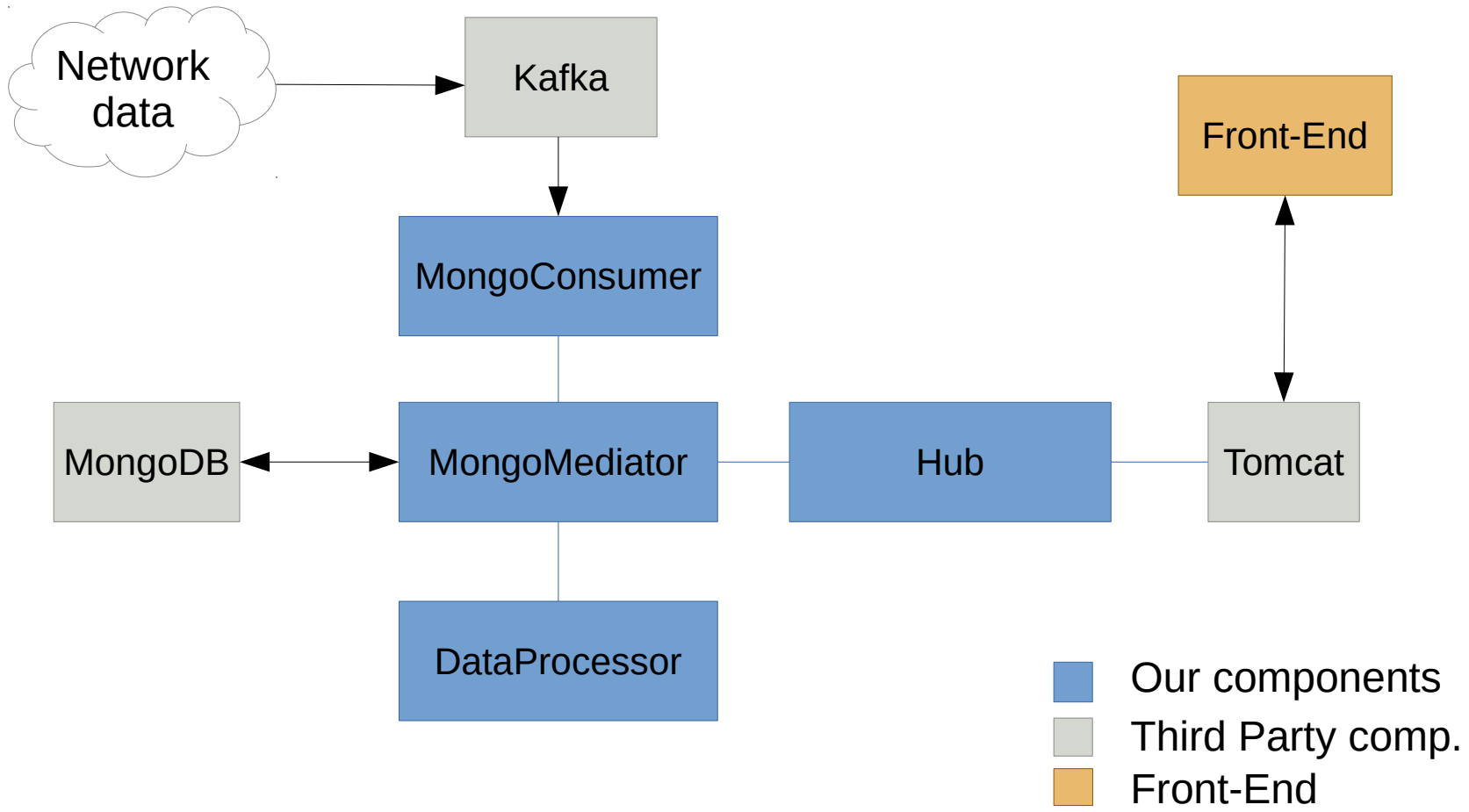
- Network traffic is recorded
- Traffic data is analyzed (dissected)
- Data is fed to a streaming platform (Kafka)
- A visualization tool displays data and analysis results



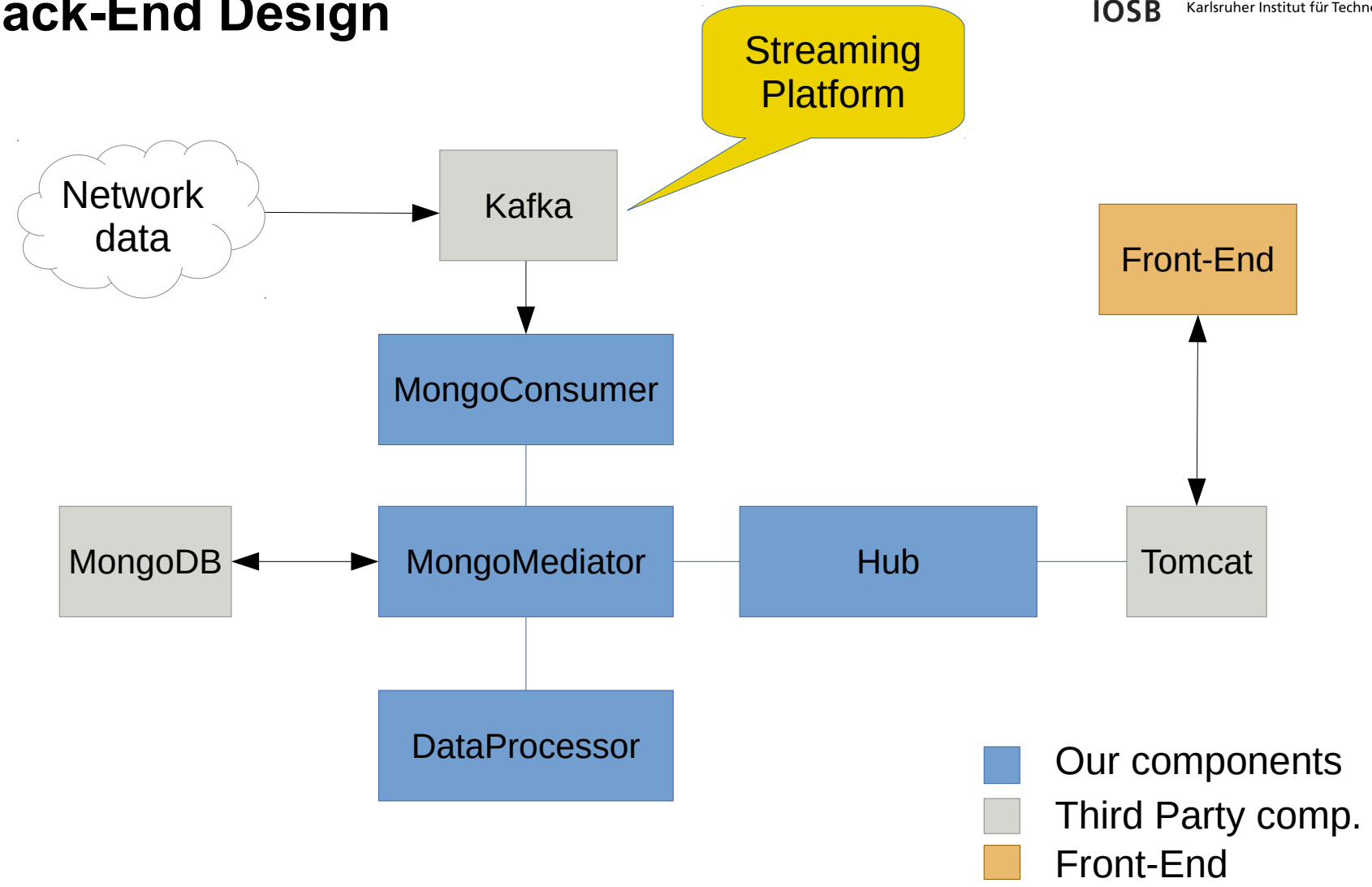
Architecture and Design

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

Back-End Design



Back-End Design



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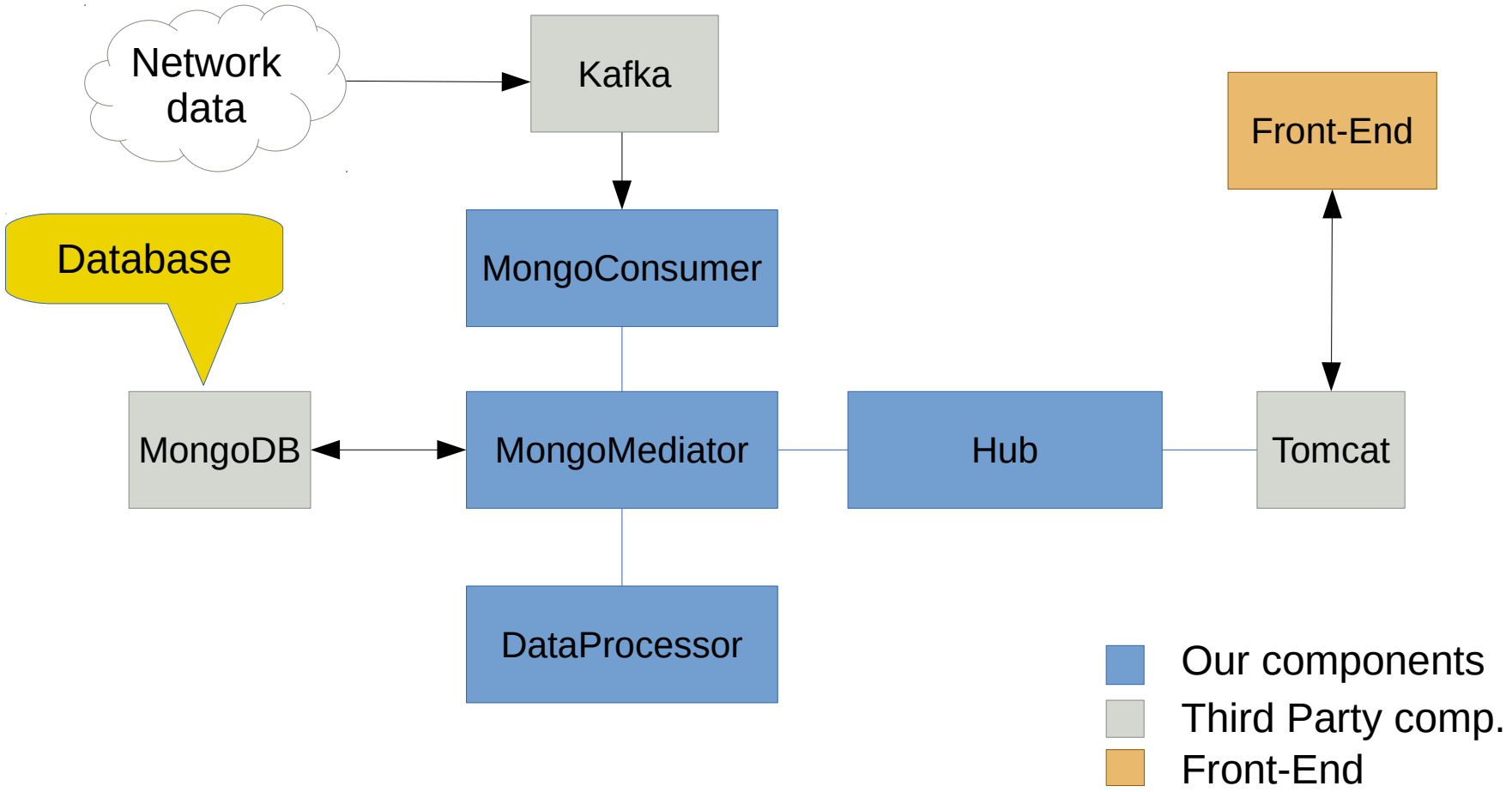
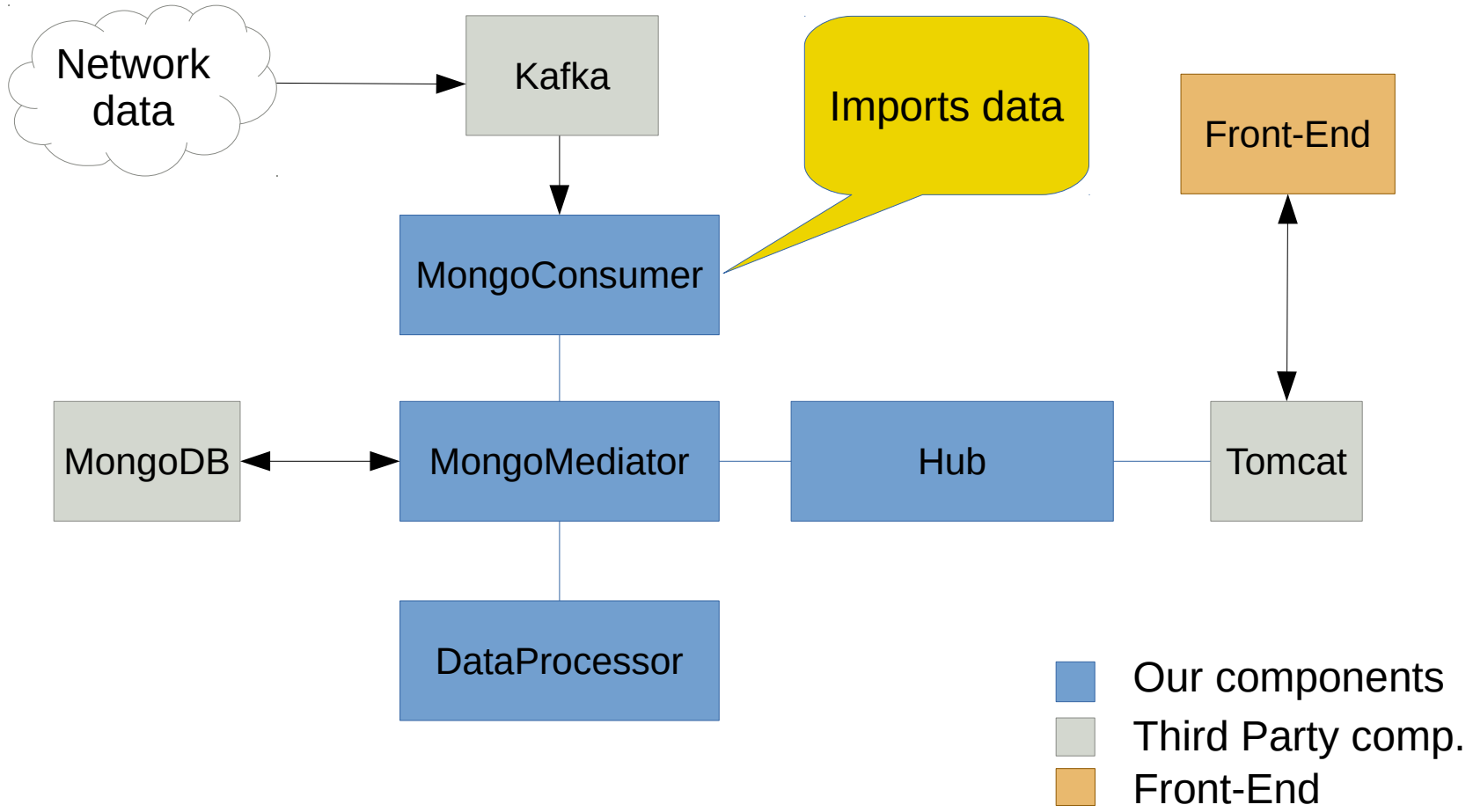
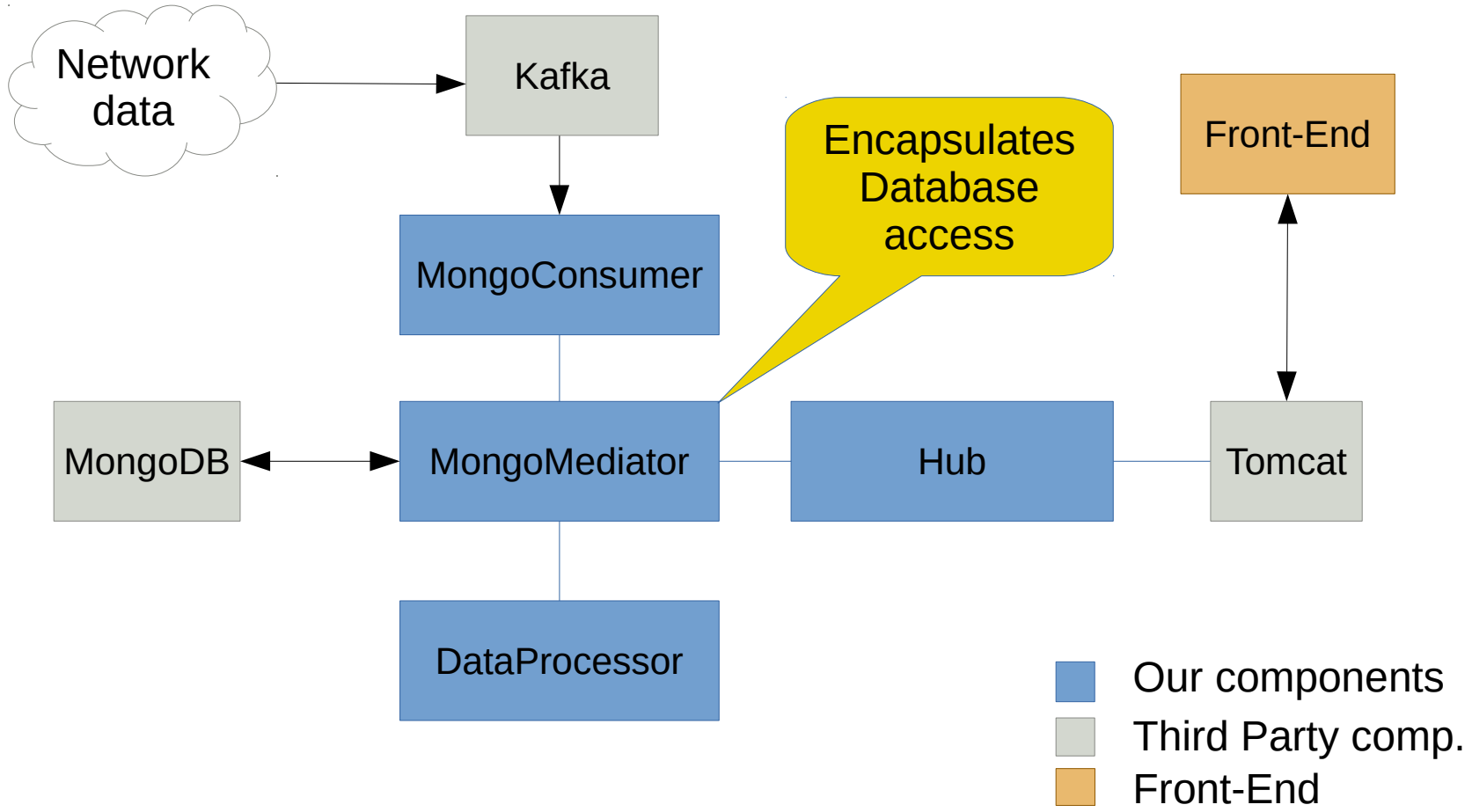


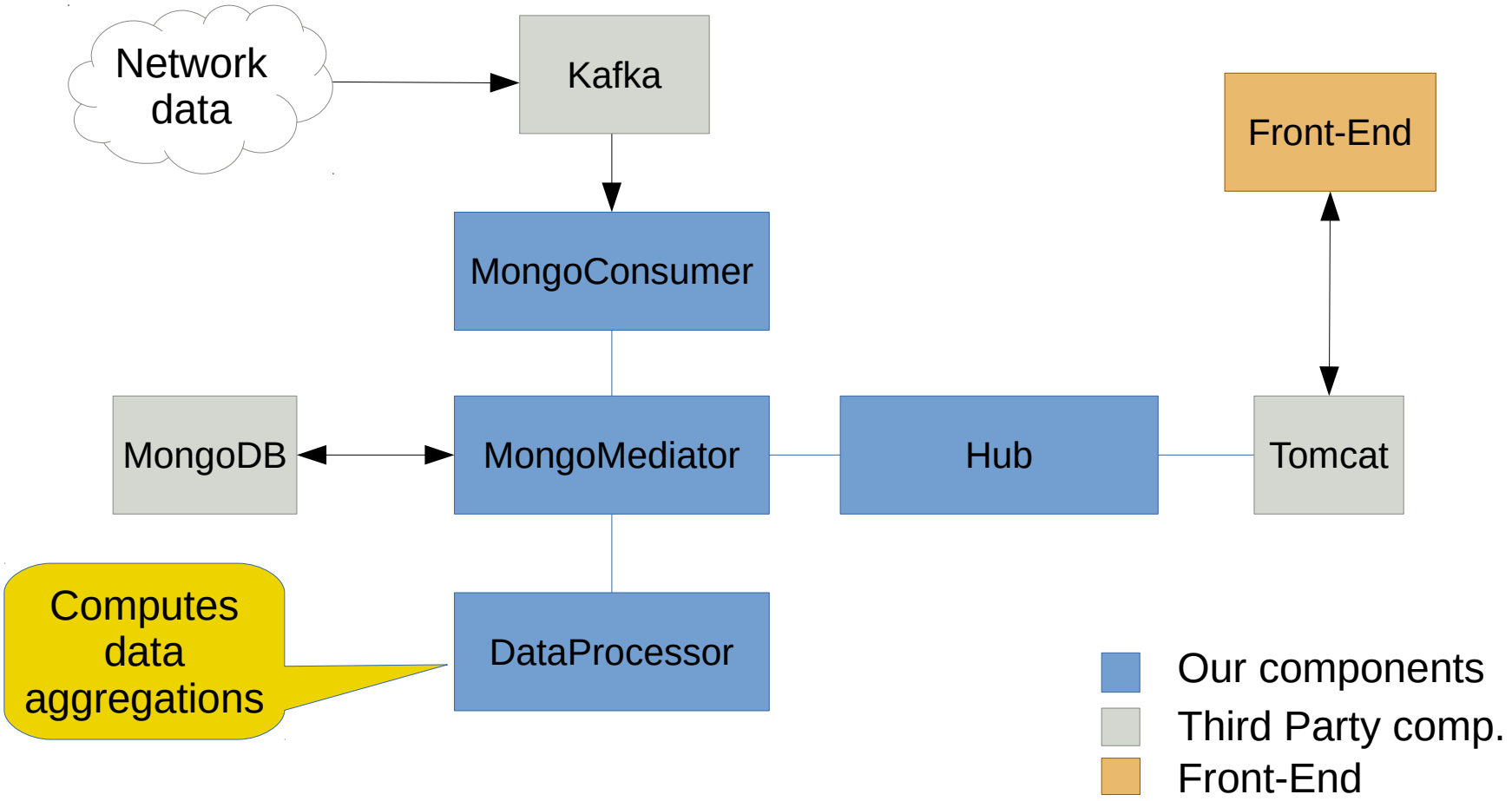
Back-End Design



Back-End Design



Back-End Design



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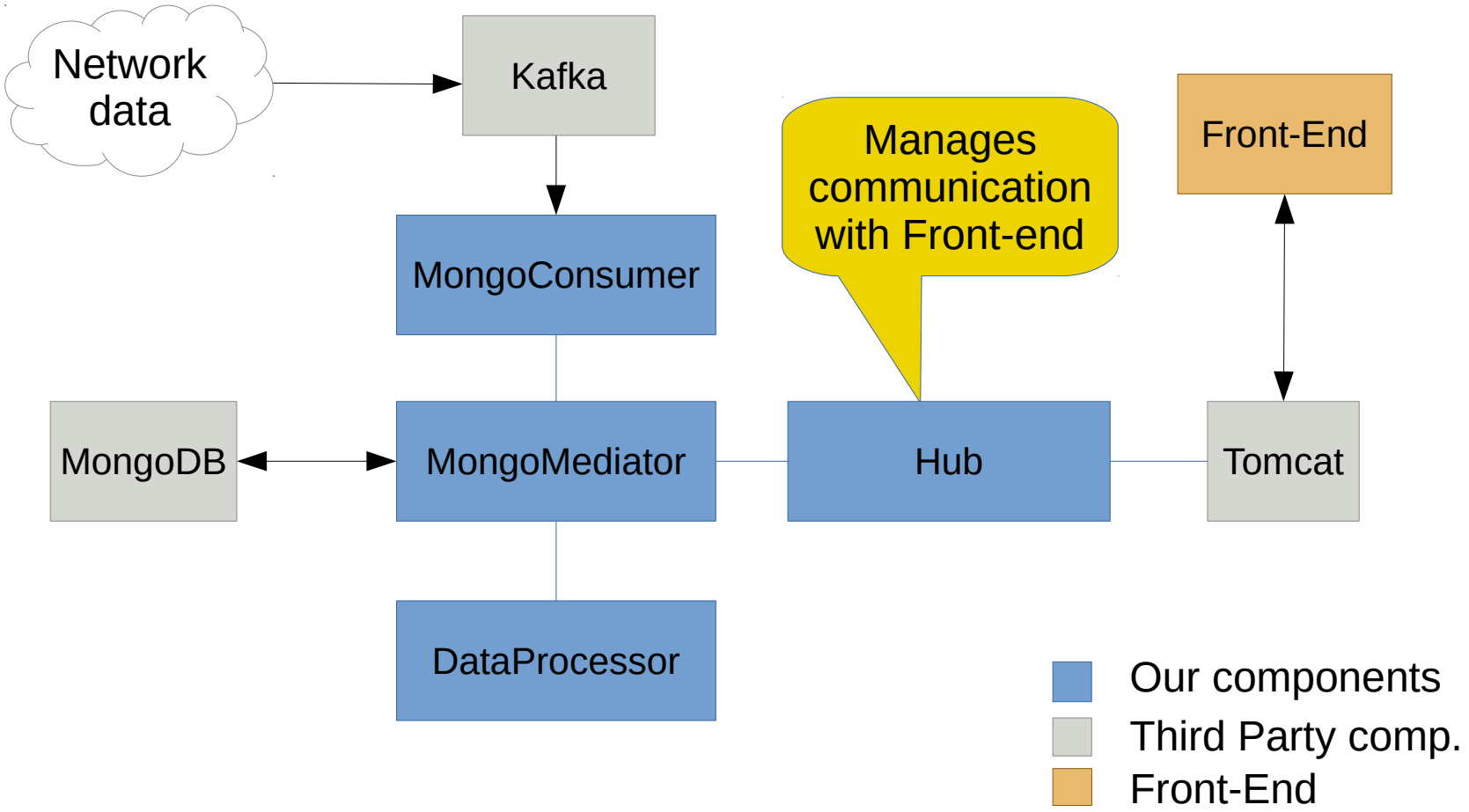
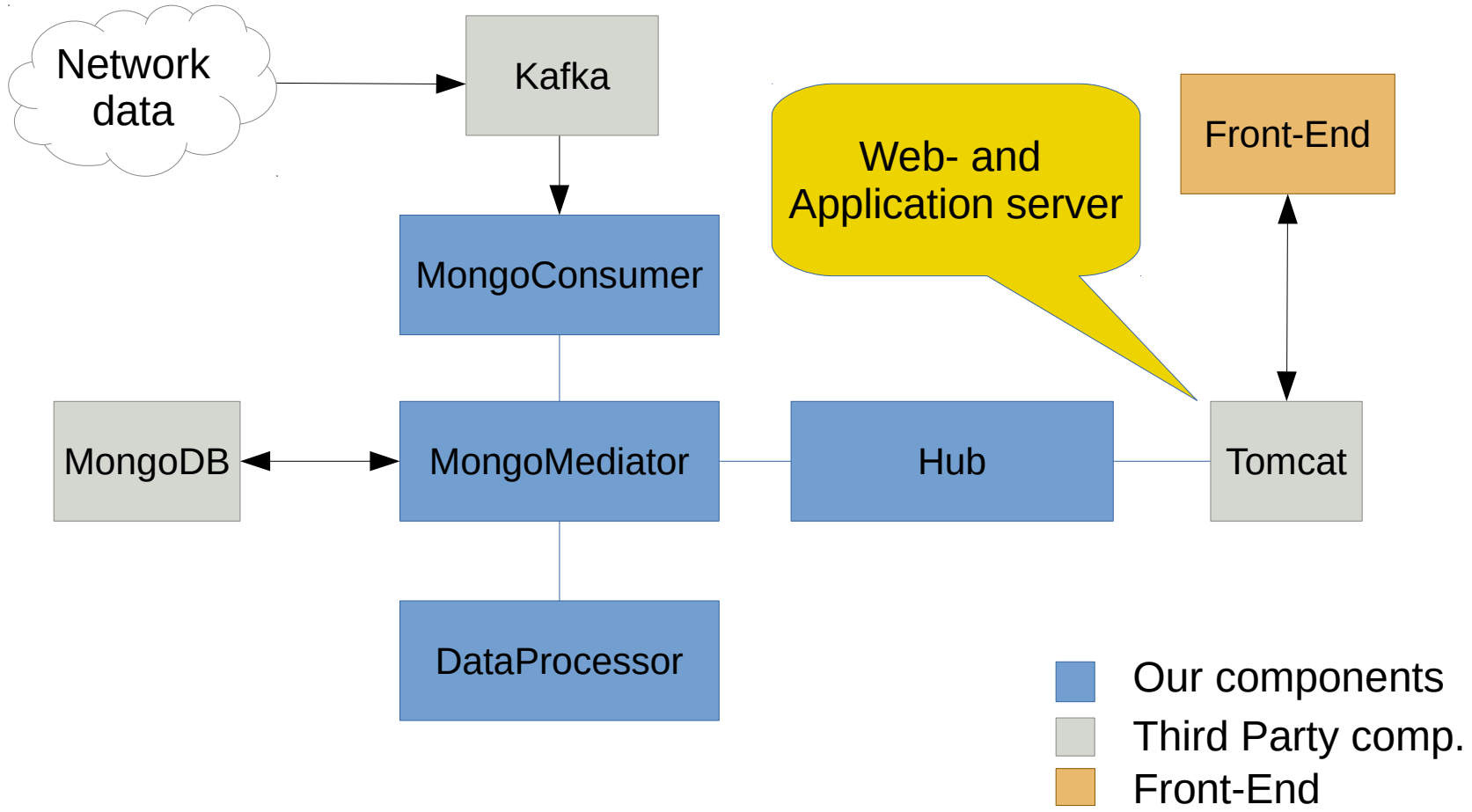
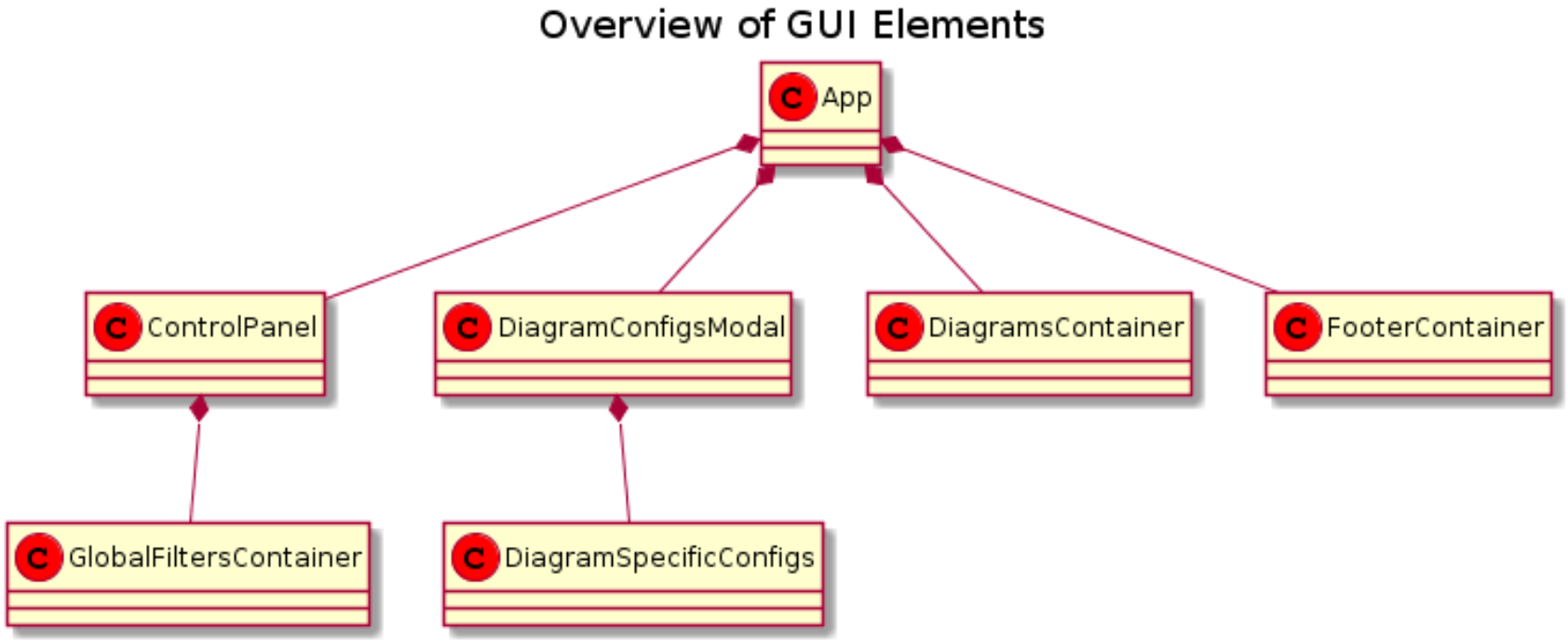


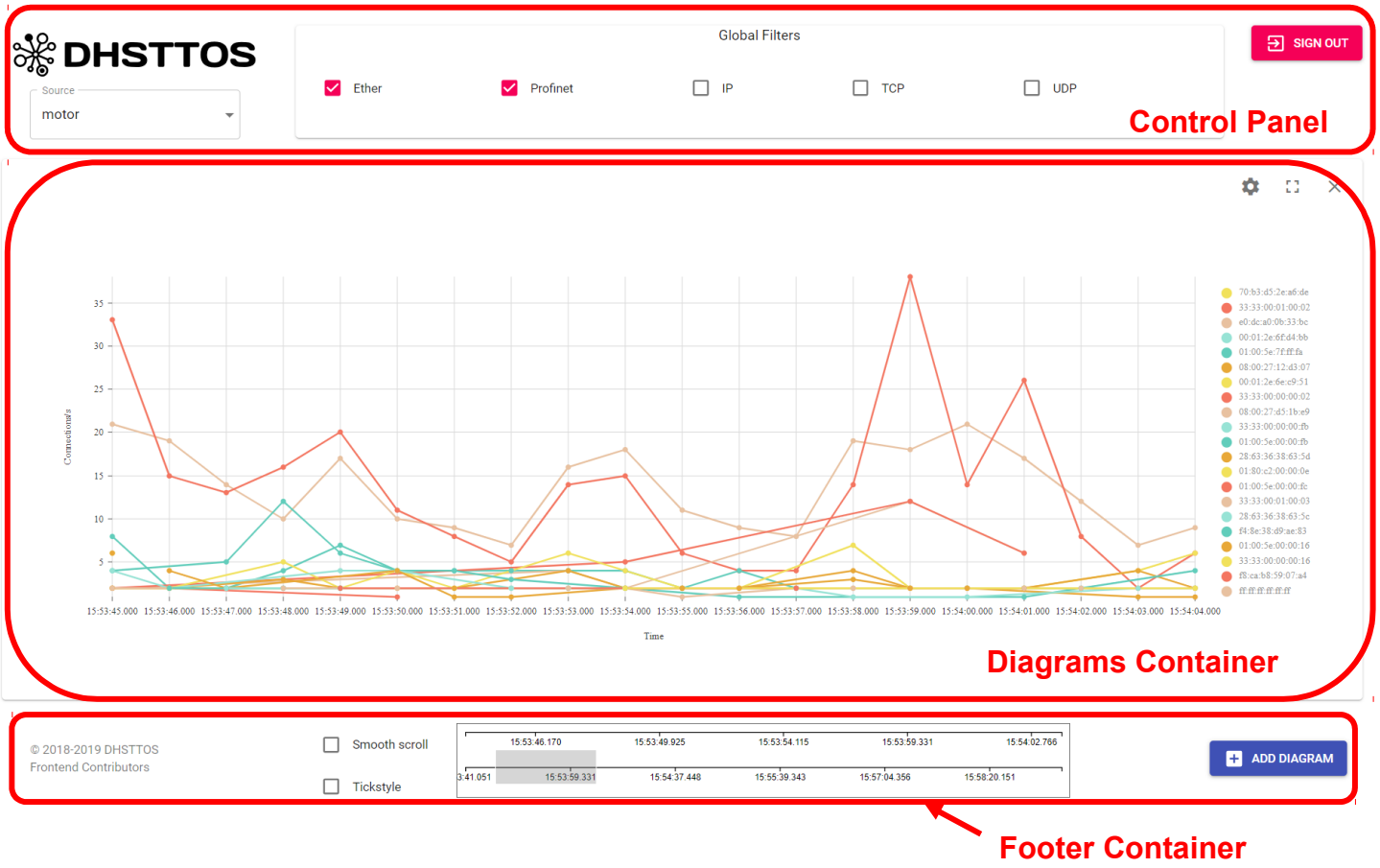
Back-End Design



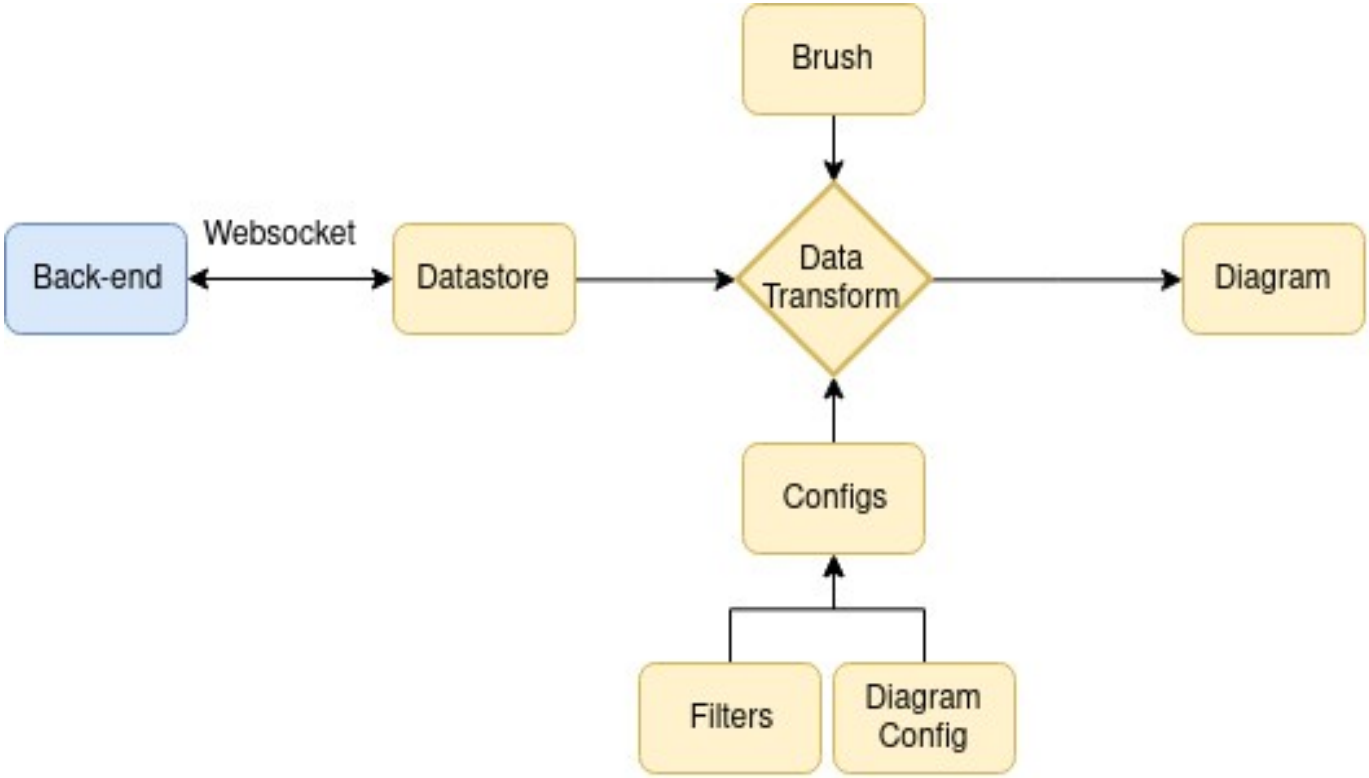
Front-End Design



Front-End Design



Front-End Data Flow



Front-End Components

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

Development Tools Used

- Back-end development:
  - Eclipse
  - Maven
  - Junit
- Front-end development:
  - Visual Studio Code
  - Parcel.js
  - Netlify (CD)
- Common tools:
  - Git
  - GitHub
  - Slack
  - Latex

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
- Display notifications

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 and protocolls
- 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