Leibniz Universität Hannover

SOFTWARE ENGINEERING

Teaching Old Services New Tricks: Adding HATEOAS Support as an Afterthought

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- Service Example
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Motivation

- Problem with web service communication: Client needs to know *exactly*, what a request has to look like
- Many sources for errors
  - Coding errors
  - Invalid requests
- Idea: Server includes request-information in response messages
  - Which requests allowed next
  - What they look like
- HATEOAS
- But: not many services conform to this principle

Motivation

Example:

Service response without HATEOAS:

```
HTTP/1.1 200 OK
Last-Modified: Wed, 01 Dec 2010 17:36:
Content-Type: application/xml
<task>
  <id>208</id>
  <name>create GUI</name>
  <status>inprogress</status>
  <parentStoryId>04</parentStoryId>
</task>
```

What can the client do next?

No idea. The client has to know by itself.

Motivation

Example:

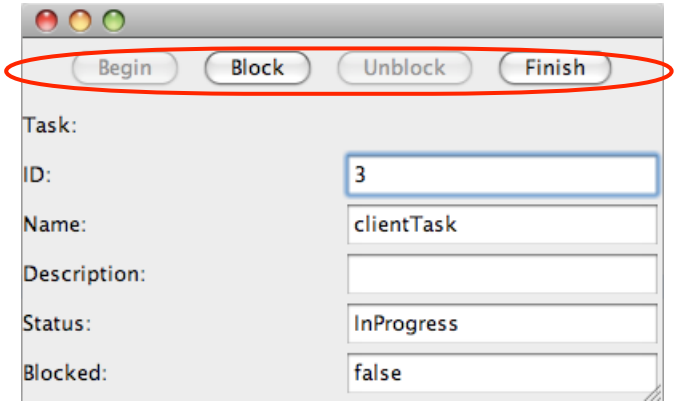
Service response with HATEOAS:

```
HTTP/1.1 200 OK
Last-Modified: Wed, 01 Dec 2010 17:36:02 GMT
Content-Type: application/xml
Link: <stories/04/tasks/208/finish>; rel="finish"
Link: <stories/04/tasks/208/block>; rel="block"
<task>
  <id>208</id>
  <name>create GUI</name>
  <status>inprogress</status>
  <parentStory>/stories/04</parentStory>
</task>
```

Control elements directly present in response message.

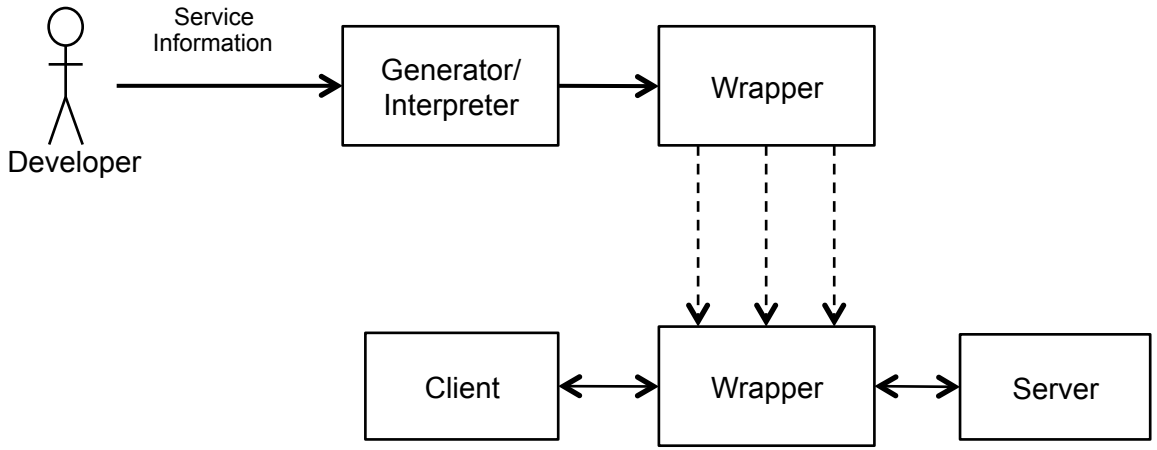
Now client can see following requests and how to make them

…and also indicate this



Main Goals

- Create HATEOAS support using *state charts*
  - Automatically generate a wrapper

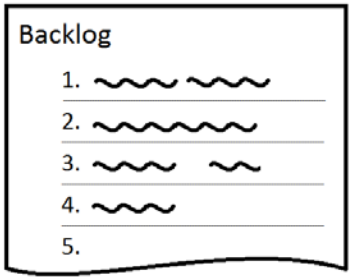


- Prerequisite: Clear way to model network-based applications
  - State Charts
  - Terminology

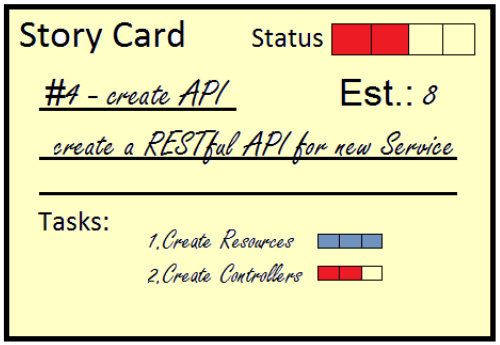
Service Example

Backlog service: support agile development projects

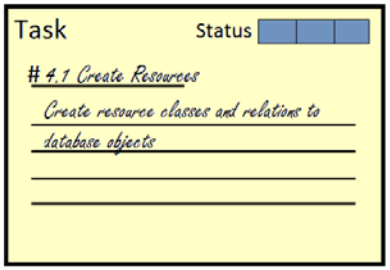
- Backlog
  - contains story cards



- Story Card
  - One particular topic
  - Different states
    - „definde“, „in progress“, „blocked“,…
    - Depend on included tasks



- Task
  - Story Card divided into tasks
  - Different states
    - Changed by user



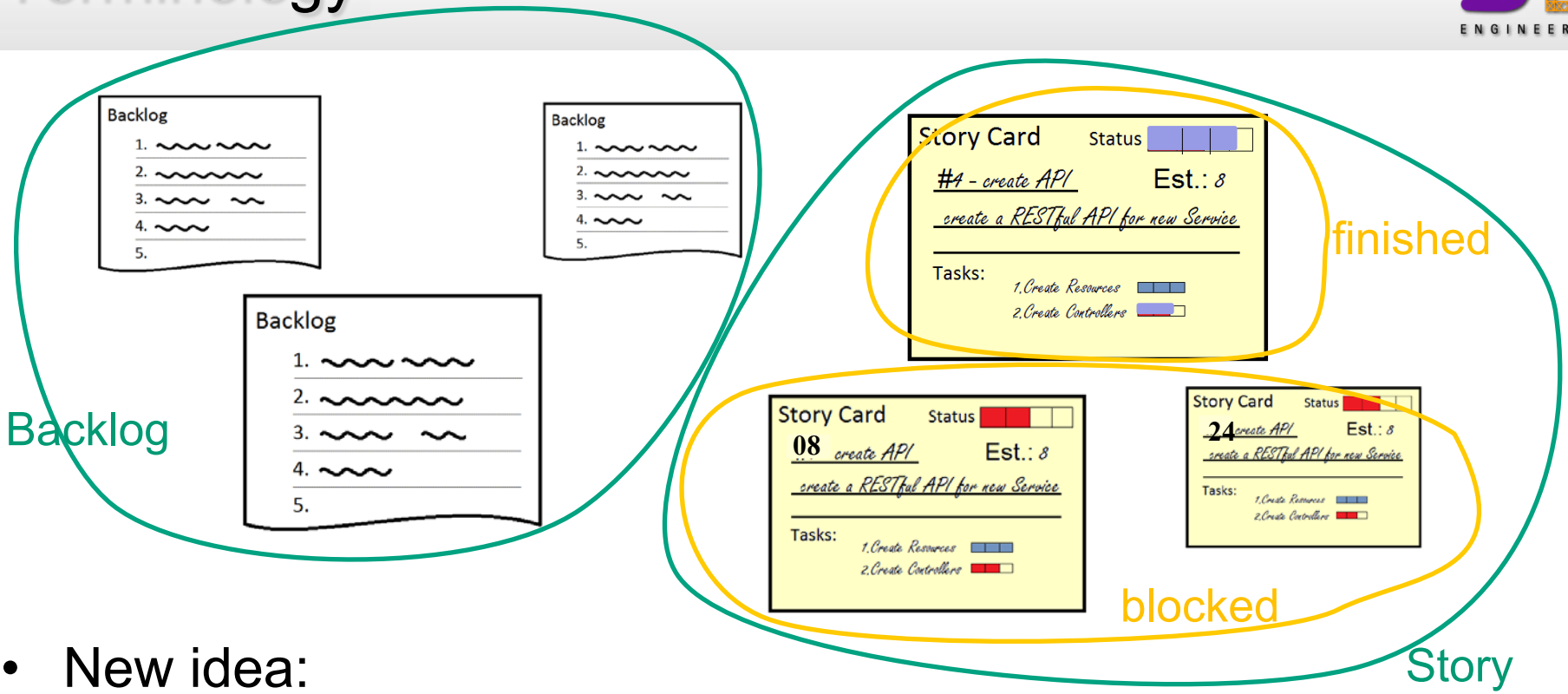
1 Modelling Network-Based Applications

Terminology

- Valid requests depend on current application state
- What exactly is application state?

- Relevant terminology:
  - application
    - „representation of the business-aware functionality of a system“ (Fielding)
  - resource state
    - Values of a resource‘s attributes
  - application state
    - Requests, responses and the processing of those
    - E.g.: „process detail view of a story card“

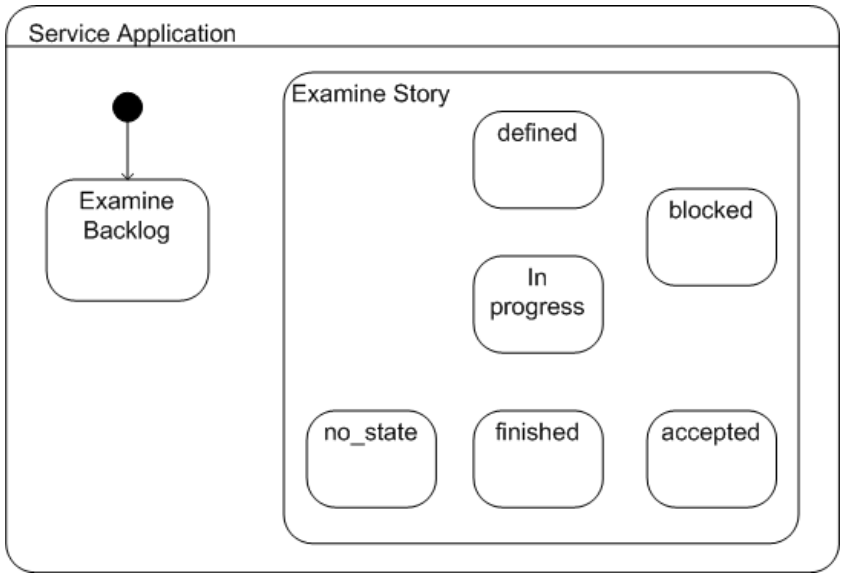
Terminology



- New idea:
  - Equivalence classes of application states
    - Combine „similar“ states
    - Determined by *resource class* and *resource state*

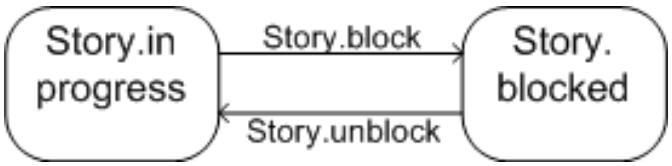
State Chart

- States
  - Equivalence classes of application states
  - Composite States combine states with same resource class



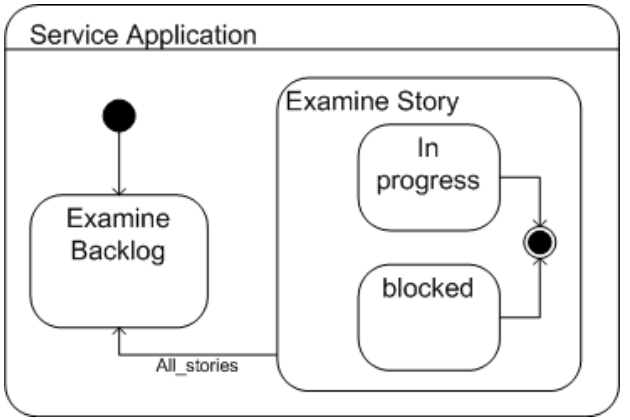
State Chart

- Transitions
  - Possible change of application state
    - triggered by new client request
  - Target state reached in case of success
- Transitions between Simple States

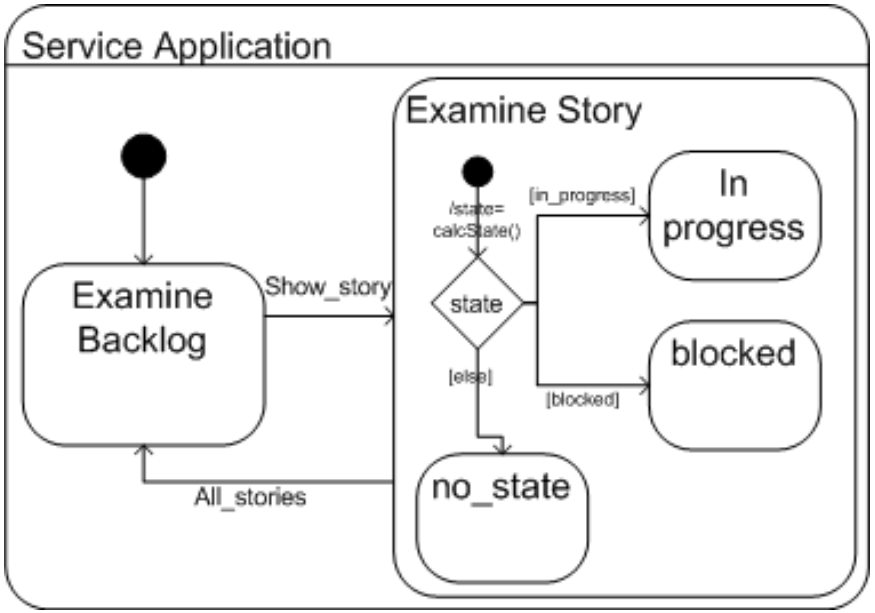


State Chart

- Transitions between Composite States
  - More precise information about control flow necessary
  - Outgoing transition:
    - Transition possible from all sub-states

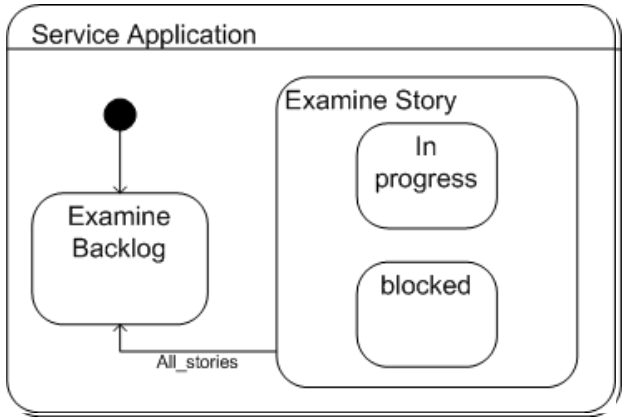


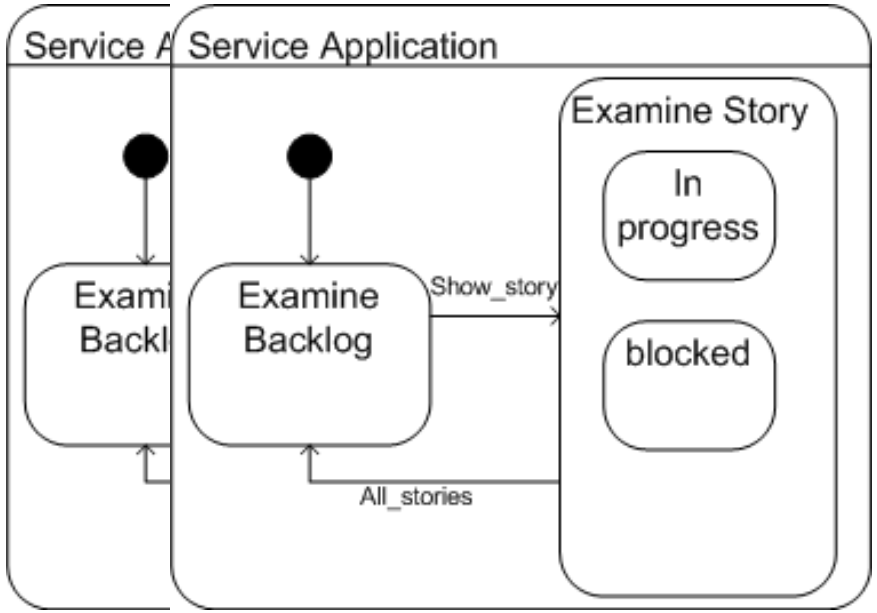
  - Incoming transition:
    - Client requests a resource of particular *class*
    - Sub-state can only be determined at runtime
    - choice-pseudostate



State Chart

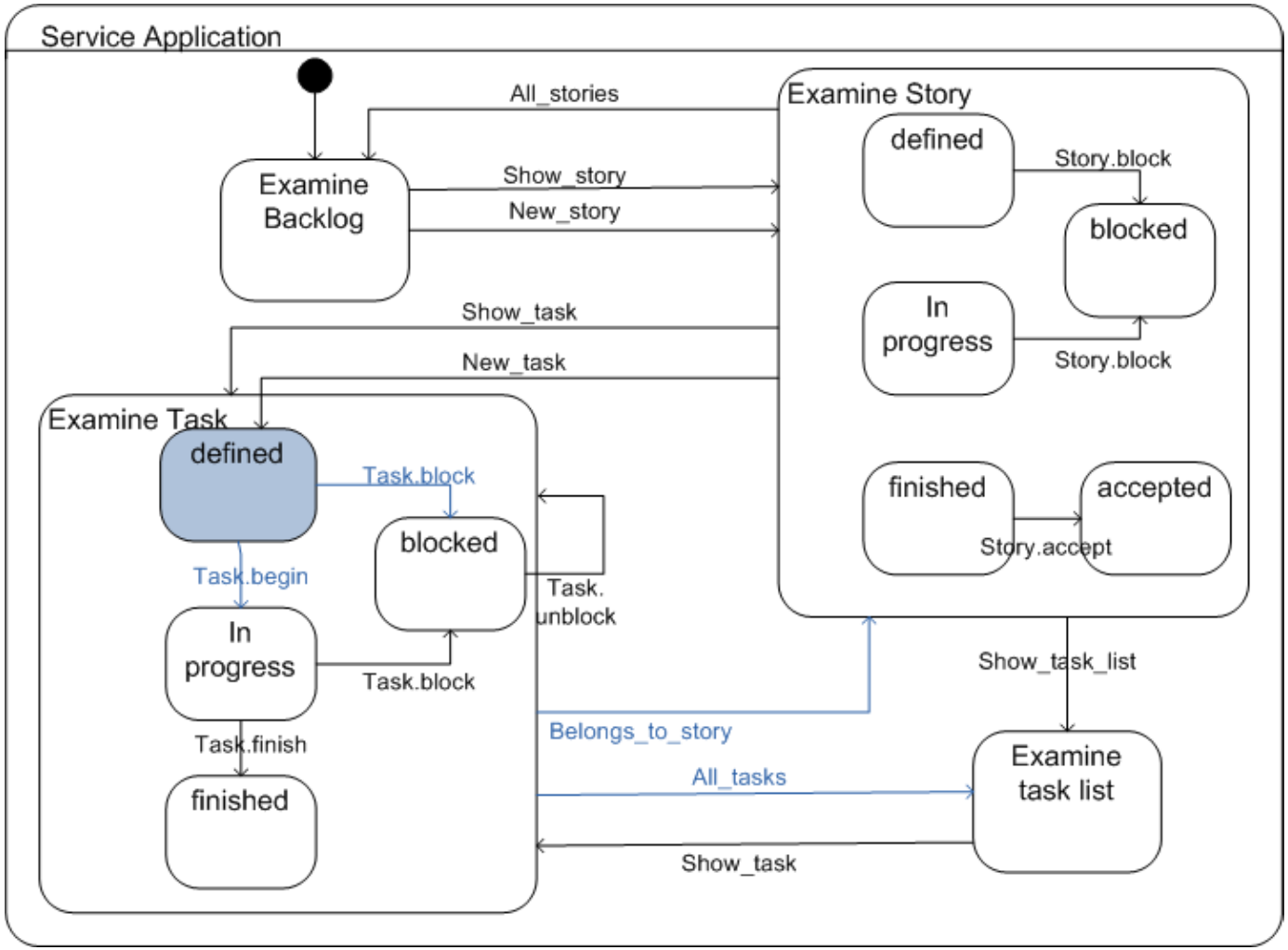
- Simplified notation
  - Remove end vertex
  - Remove choice pseudostate construct





State Chart

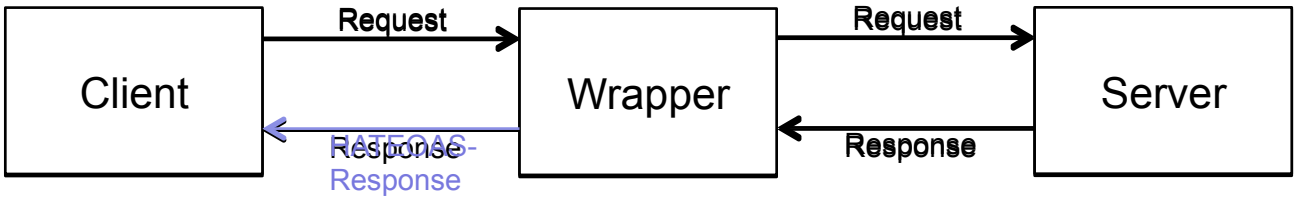
- Use State Chart as a static *map*



2 Constructing A Wrapper

Wrapper - Conception

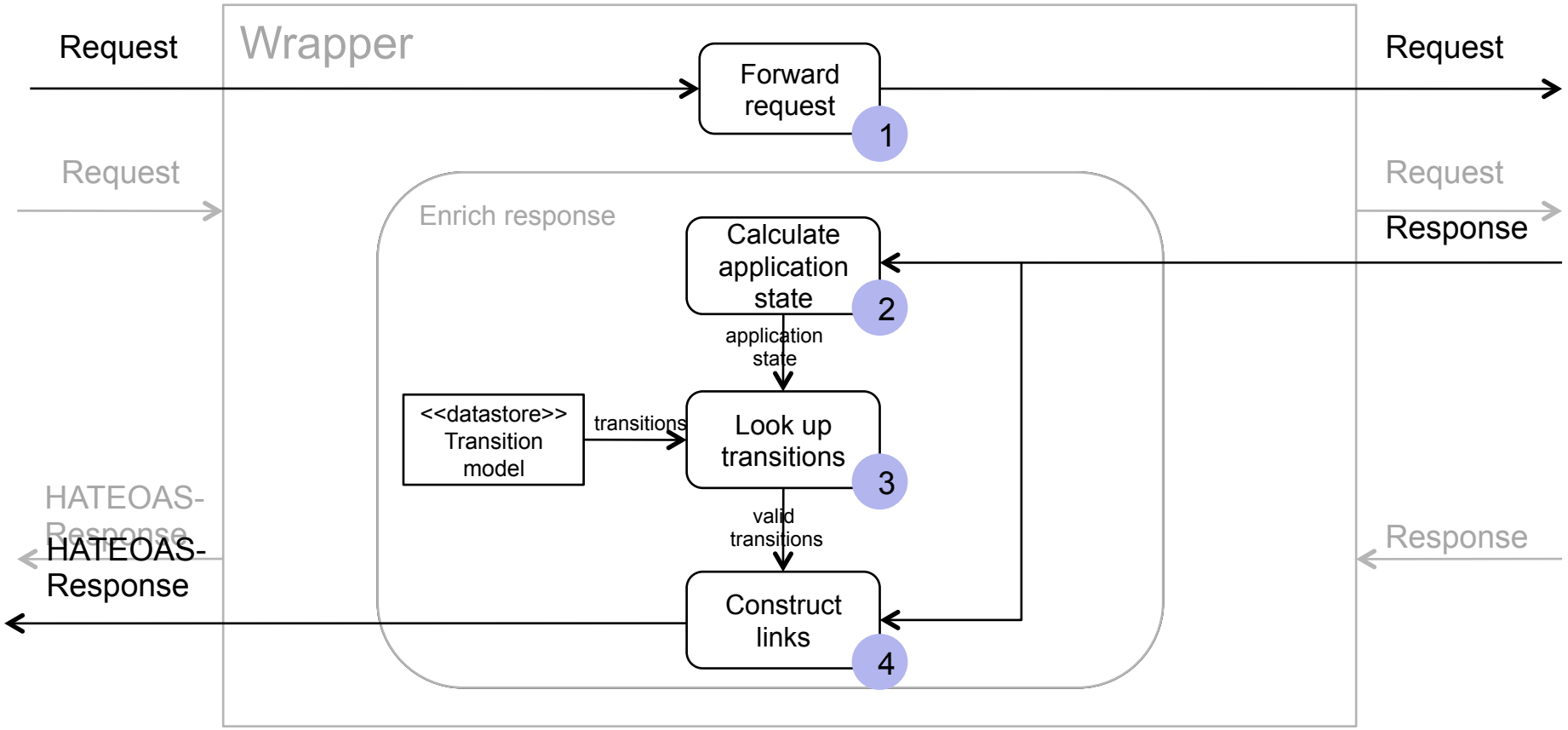
- Top-Down view
  - Wrapper at first as black-box
- Insert wrapper between client and server



  - Request forwarded
  - Response enriched with transitions
    - But not changed further

Wrapper - Conception

Main process

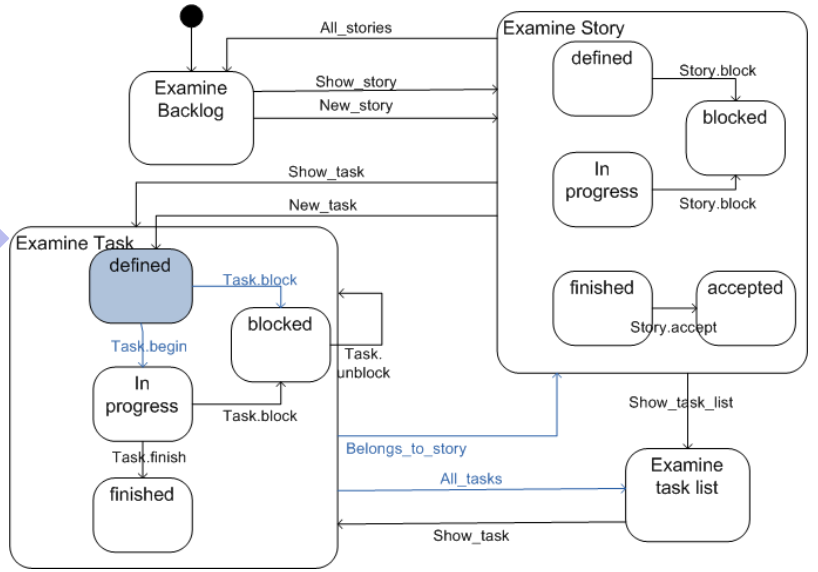


Wrapper - Concrete Process Steps

Full process cycle

```
HTTP/1.1 200 OK
Last-Modified: Wed, 01 Dec 2010
Content-Type: application/xml
<task>
  <id>04</id>
  <name>Update Database</name>
  <status>defined</status>
  <parentStory>08</parentStory>
</task>
```

Local-name(/*[1]) = **task**
/task/status/text() = **defined**



URI-Templates

/task/id/text() = **04**
/task/parentStory/text() = **08**

Task.block: </stories/08/tasks/04/block>
Task.begin: </stories/08/tasks/04/begin>
Task.allTasks: </stories/08/tasks>
Belongs_To_Story: </stories/08>

```
HTTP/1.1 200 OK
Last-Modified: Wed, 01 Dec 2010
Content-Type: application/xml
Link: </stories/08/tasks/04/block>;rel="Task.block"
Link: </stories/08/tasks/04/begin>;rel="Task.begin"
Link: </stories/08/tasks>; rel="Task.allTasks"
Link: </stories/08>; rel="belongs_to_story"
<task>
  <id>04</id>
  <name>Update Database</name>
  <status>defined</status>
  <parentStory>08</parentStory>
</task>
```

Comparison

- Implementation of backlog service
- Automated generation of wrapper (from transition model)
- Develop 2 clients to test concepts
  - With wrapper <-> without wrapper

```
List links =
      response.getHeaders().get("Link");
  for(String link : links){
    if(link.contains("story.start")){
      String uri = extractUri(link);
      this.startButton.setUri(uri);
      this.startButton.setEnabled(true);
    }//...
  }
```

```
if(story.getStatus().equals(StoryStatus
        .Defined)){
    this.startButton.setEnabled(true);
    this.startButton.setUri("/stories/"+
        story.getId() + "/start");
    this.blockButton.setEnabled(true);
    this.blockButton.setUri("/stories/"+
        story.getId() + "/block")
  }
```

Conclusions

- Creation of theoretical concepts
- Development of wrapper process
- Check the concept

- Is working
- Generic
- Improves development and maintainance of clients

- Errors in model lead to invalid/missing links
- Input data is complex

Outlook

- Further research on input of data
  - Project environment
  - Interface descriptions (e.g. WADL) as additional source
- Allow changes of whole service API
  - Can improve more REST aspects
- Use state charts for creation of *services* (not only wrappers)

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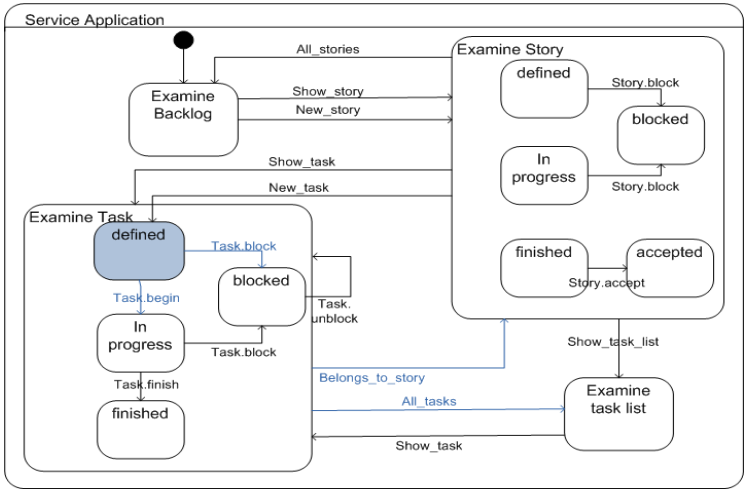

Questions?