ICSA 2017 Tutorial: Study Foundations

Architecture Styles and Evolution
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Schedule of Events

09:00 – 09:10	Welcome and General Introduction
09:10 – 09:40	**Study Foundations**
09:40 – 10:00	Model-based Software Application Monitoring
10:00 – 10:30	Runtime Architecture Modeling and Visualization
10:30 – 11:00	Coffee Break
11:00 – 12:15	Introduction to the ExplorViz, Palladio, and iObserve Approaches with following Tool / Visualization Demos
12:15 – 12:30	Study Setup
12:30 – 14:00	Lunch
14:00 – 15:30	Comprehensibility Study
15:30 – 16:00	Coffee Break
16:00 – 16:30	Live Database Trace Visualization in Large Software Landscapes
16:30 – 17:00	Feedback and Open Discussion

Running Example Scenarios

SCENARIOS

Change Scenarios

Given an existing software system

- Insert new component “database persistence”
- Create new functionality “add billing”
- Update GUI “red → blue button”

ARCHITECTURE PATTERNS

Design vs. architectural patterns

- Design pattern
  - Small-scale / low-level solution
  - Usually a number of design patterns is “mixed”
- Architectural pattern
  - Large-scale / high-level solution (== balance design forces)
  - Dominate the structure of a whole software-system
- Architectural patterns and design patterns usually are combined

Architecture Patterns

- Layers
- Client-Server
- Pipe & Filter
- Shared Data
- PAC

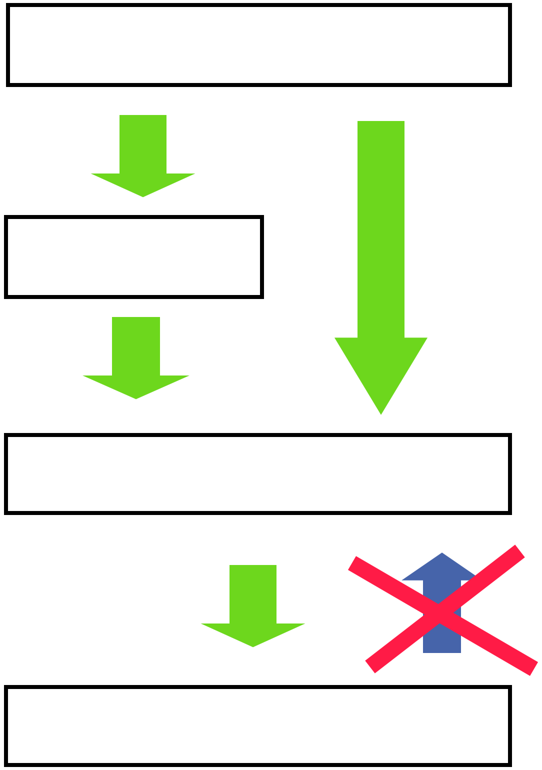
- Referred to as “architecture style”
- Single architecture style applied to a whole system

Architecture Patterns

LAYERS

Layers

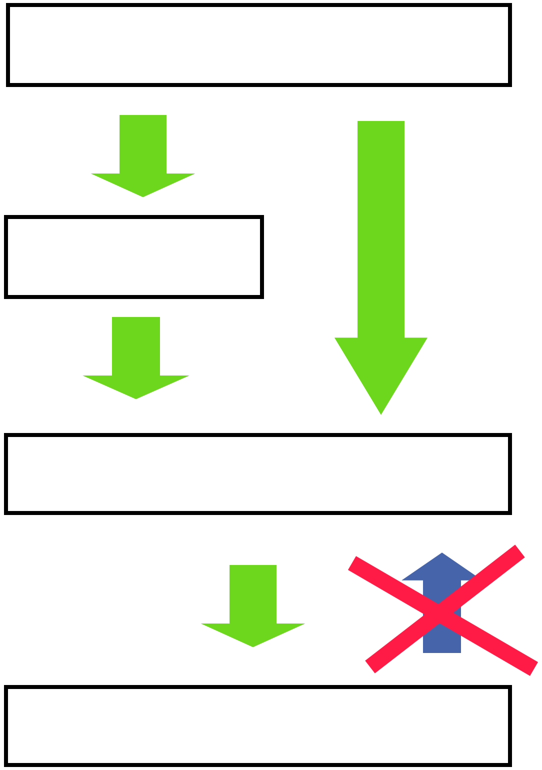
- Expresses is-allowed-to-use relation
- Each layer consists of one or several modules
- Any piece of software is allocated to exactly one layer
- A lower layer cannot use a higher layer!
  - ("There is more to layers diagrams than the ability to draw separate parts on top of each other!" [1], p. 78)
  - No call-backs
  - Forwarding is OK
- Information hiding
  - Better changeability



Example Scenarios

- “database persistence”
  - Where to add?
  - Which interface?
- “add billing”
  - All data accessible?
  - GUI + Business Layer + Persistence?
- “red → blue button”
  - 1. Which layer?
  - 2. Which component(s)?

→ Right layer, interfaces between layers, cycle avoidance



Architecture Patterns

CLIENT SERVER

Client Server Architecture

- Distributed system model which shows how data and processing is distributed across a range of components
- Set of stand-alone servers which provide specific services such as printing, data management, etc.
- Set of clients which call on these services
- Network which allows clients to access servers

Client Server: Example

Film and picture library

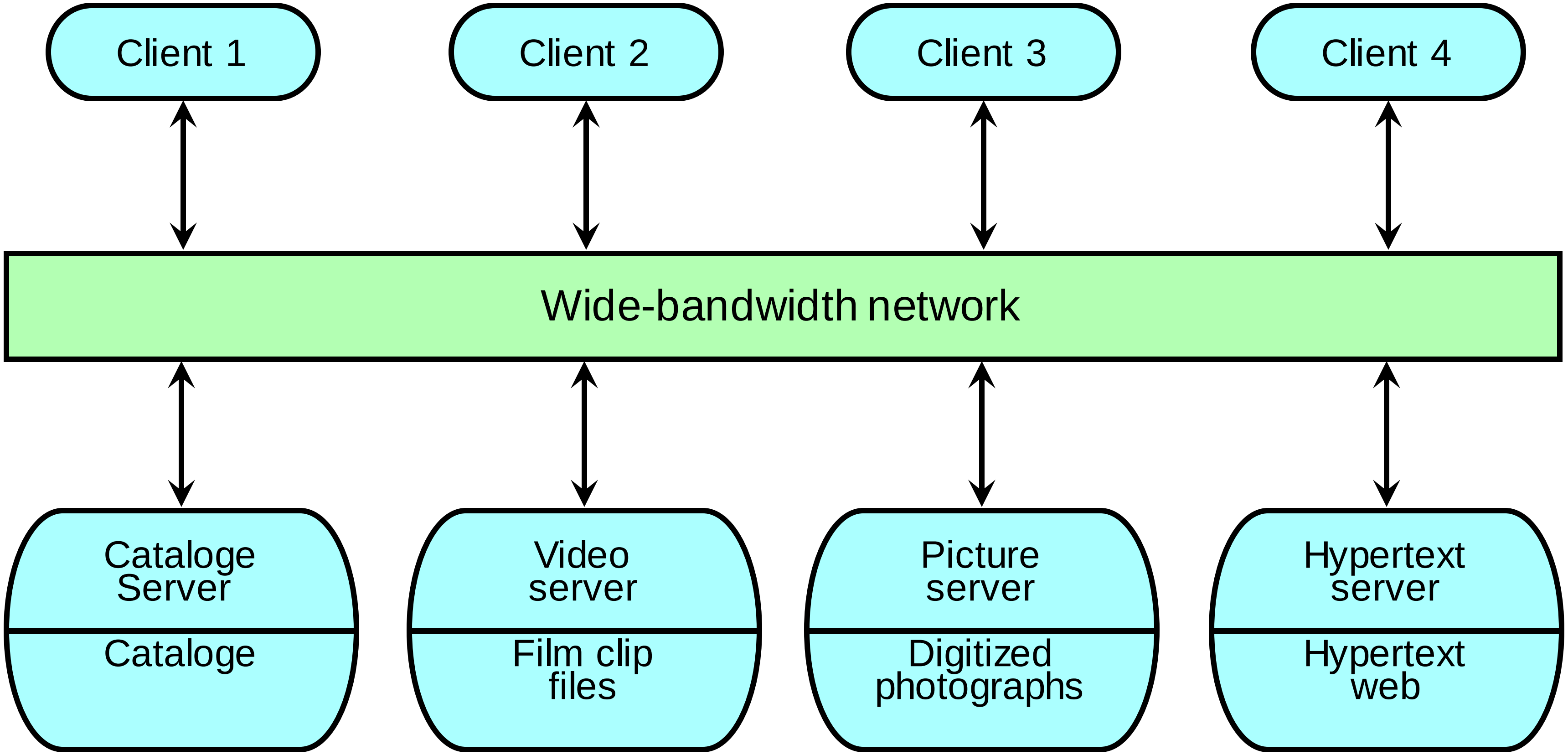


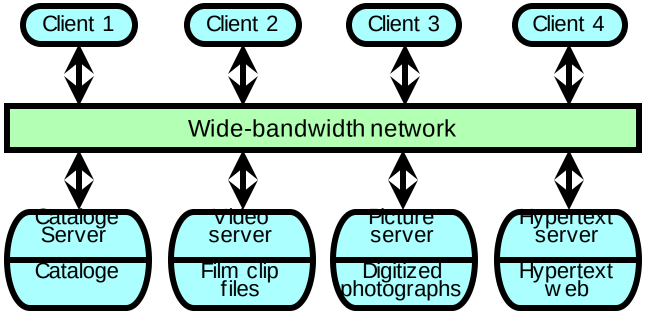
Figure: [2]

Client Server Characteristics

- Advantages
  - Distribution of data is straightforward
  - Makes effective use of networked systems.
    - May require cheaper hardware
  - Easy to add new servers or upgrade existing servers
- Disadvantages
  - No shared data model so sub-systems use different data organisation.
    - Data interchange may be inefficient
  - Redundant management in each server
  - No central register of names and services
    - It may be hard to find out what servers and services are available

Example Scenarios

- “database persistence”
  - Which server?
  - Local / remote?
- “add billing”
  - Client or server?
  - New client type?
  - Common client functionality?
- “red → blue button”
  - Client!
  - Server-side colour schema?



→ interface between server/client, (de-) centralisation criteria

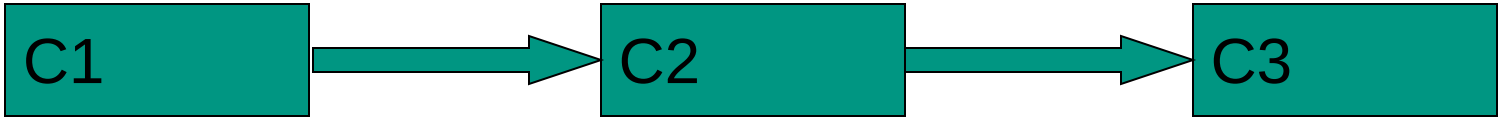
Architecture Patterns

PIPE AND FILTER

Pipe and Filter (1)

- Elements:
  - Components with in- and out-ports
  - Pipe-Connectors with data-in and data-out roles
- Attached-to relation
- Topology: acyclic
- Example:
  unix-pipes

```
ps efl |grep mozilla |wc -l
```



Pipe and Filter (2)

- Filter
  - Incrementally transform some amount of the data at inputs to data at outputs
    - Stream-to-stream transformations
  - Preserve no state between instantiations
- Pipe
  - Move data from a filter output to a filter input
  - Pipes form data transmission graphs
- Overall Computation
  - Run pipes and filters (non-deterministically) until no more computations are possible
- When transformations are sequential, this is a batch sequential model which is extensively used in data processing systems
- Not really suitable for interactive systems

Pipe and Filter: Example

Invoice processing system

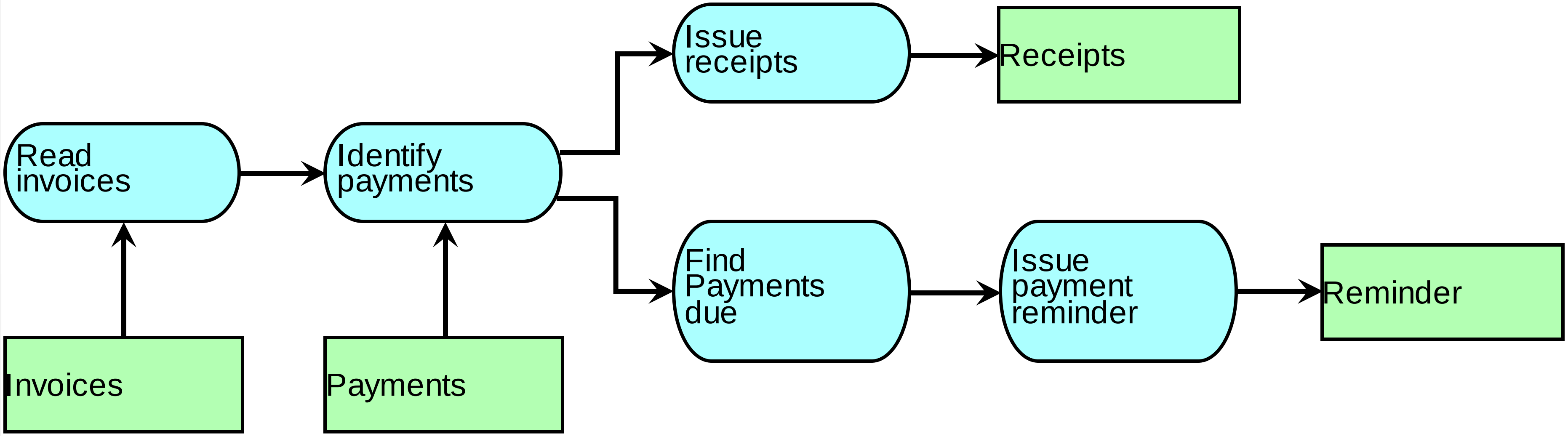
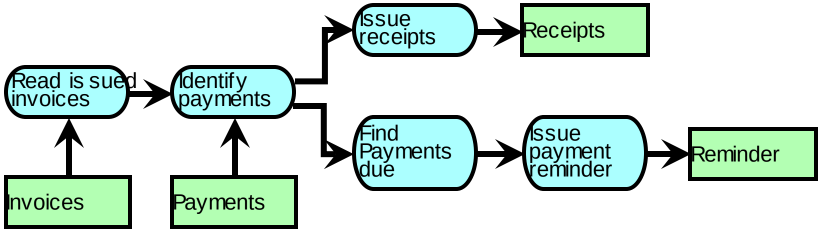


Figure: [2]

Example Scenarios

- “database persistence”
  - Data source or data sink?
  - What are input / output steps?
- “add billing”
  - Which processing steps inside billing?
  - In which sub-chain to add?



- “red → blue button”
  - Suitable architecture?
  - Which are interactive nodes?

→ interface between steps, thinking in terms of clear input / output relation, distinct locations during processing

Architecture Patterns

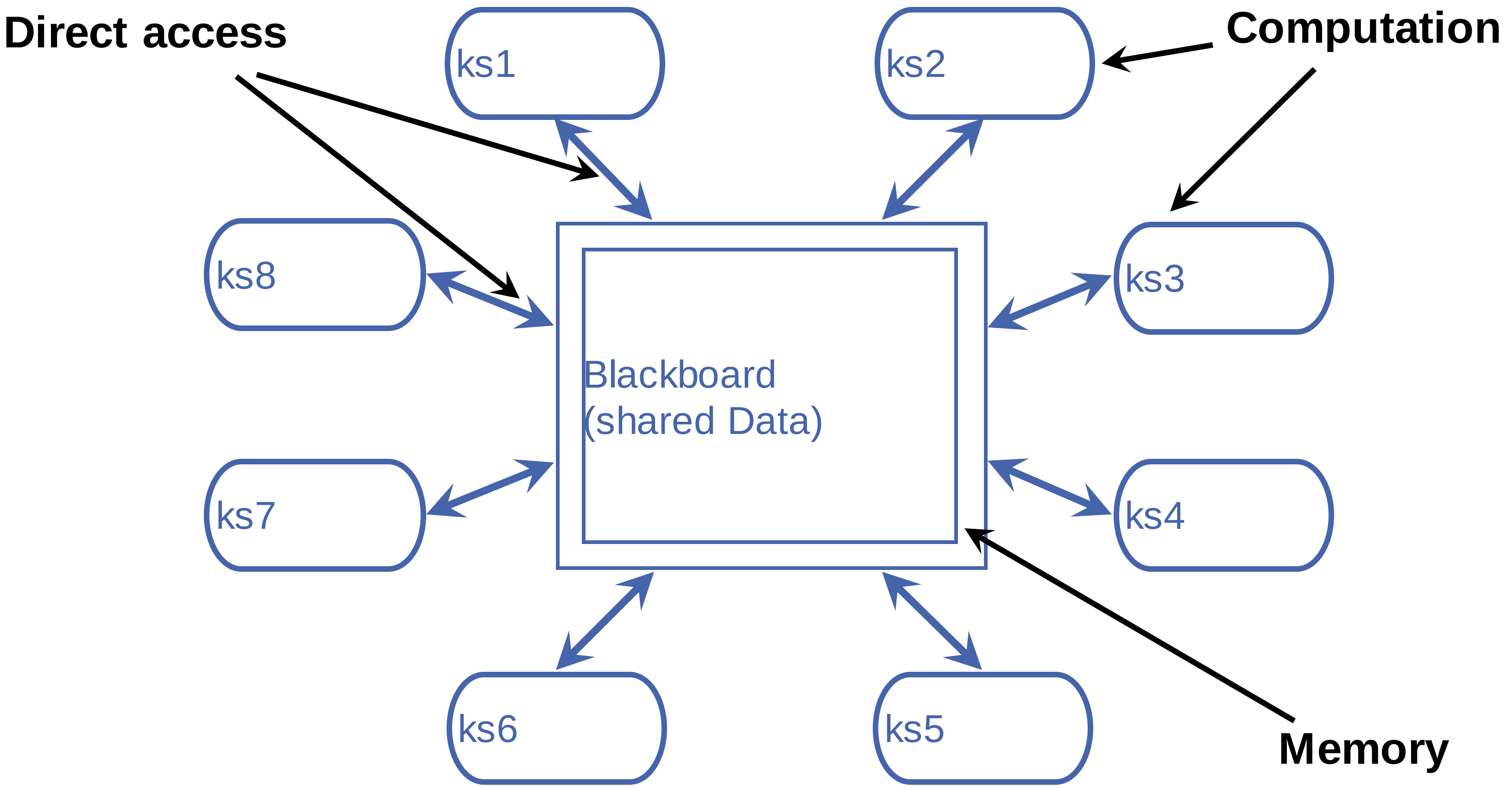
SHARED DATA

Shared Data (1)

- Elements:
  - Component types:
    - Shared data repositories
    - Data accessors (sinks and sources)
  - Connector types: data reading and writing
- Attached-to relation
- Topology: star (bus) or connected stars

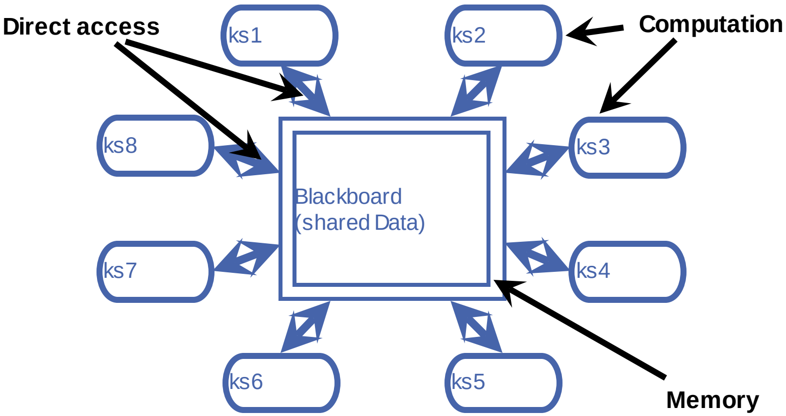
Shared Data: Example

Data Oriented Repository (Blackboard)



Example Scenarios

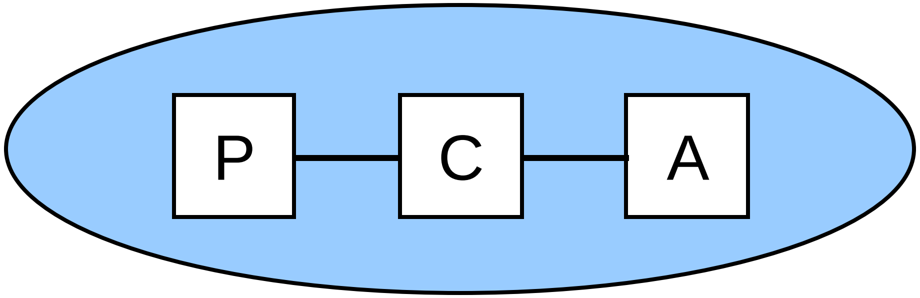
- “database persistence”
  - Blackboard!
  - Which subcomponent of the blackboard?
- “add billing”
  - New node operating on blackboard?
  - New data structure for blackboard?
- “red → blue button”
  - Which are interactive nodes?



→ interface between nodes and blackboard, hierarchical data storage, strict separation of storage and processing/calculation/import/export, guide for new processing/input/output steps

PAC – HIERARCHICAL SOFTWARE ARCHITECTURE

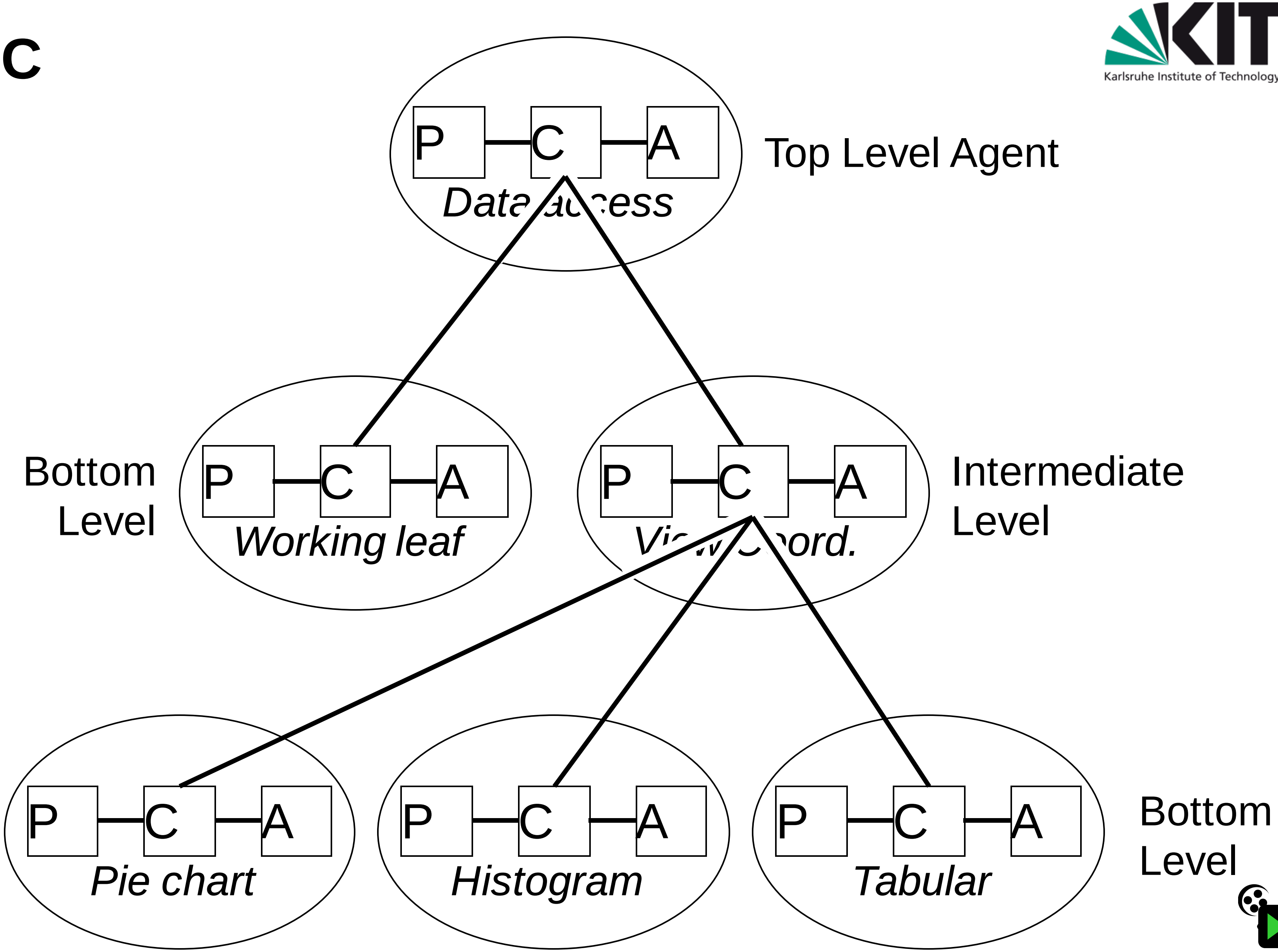
PAC - Overview



PAC-Agent

- Presentation: View + Control
- Abstraction: Model
- Control
  - Communication not only via **`update()`** (like in Model View Control, MVC)
  - Mediator

PAC



Top Level Agent

P C A

Data access

Bottom Level

P C A

Working leaf

Intermediate Level

P C A

View coord.

P C A

Pie chart

P C A

Histogram

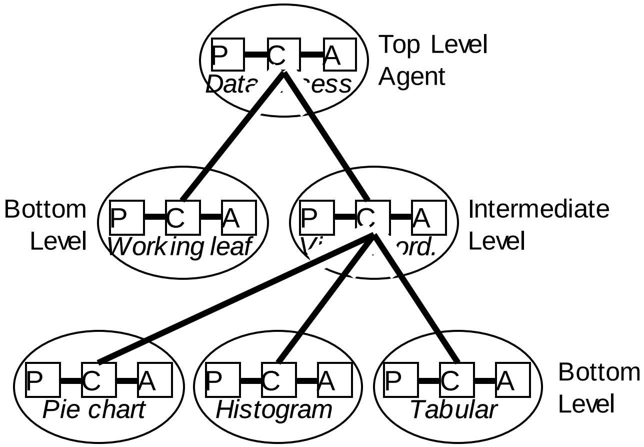
P C A

Tabular

Bottom Level

Example Scenarios

- “database persistence ”
  - Which level?
  - New Agent!
  - Abstraction node!
- “add billing”
  - Which agent?
  - P, C, and A!
- “red → blue button”
  - Which agent’s P?



→ Clear hierarchy, strict interfaces between levels and inside agents, repeating interaction patterns, unified extensions via new agents

CONCLUSION

Architecture Patterns

- Layers
- Client-Server
- Pipe & Filter
- Shared Data
- PAC

References

[1] Clements et al. “Documenting Software Architectures”, Addison Wesley, 2003

[2] Ian Sommerville “Software Engineering”, 7th edition, Pearson Education, 2004