

Collaboration-Based Design

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ADAP D04

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Agenda

1. Collaborations in UML
2. File system collaborations
3. Collaboration and class models
4. History and related concepts
5. The role object pattern

1. Collaborations in UML

Collaboration-Based Design

Collaboration-based design is

- An approach to modeling and implementing using collaborations

A **collaboration specification** (UML: Collaboration) is

- A model of how objects collaborate for a particular purpose

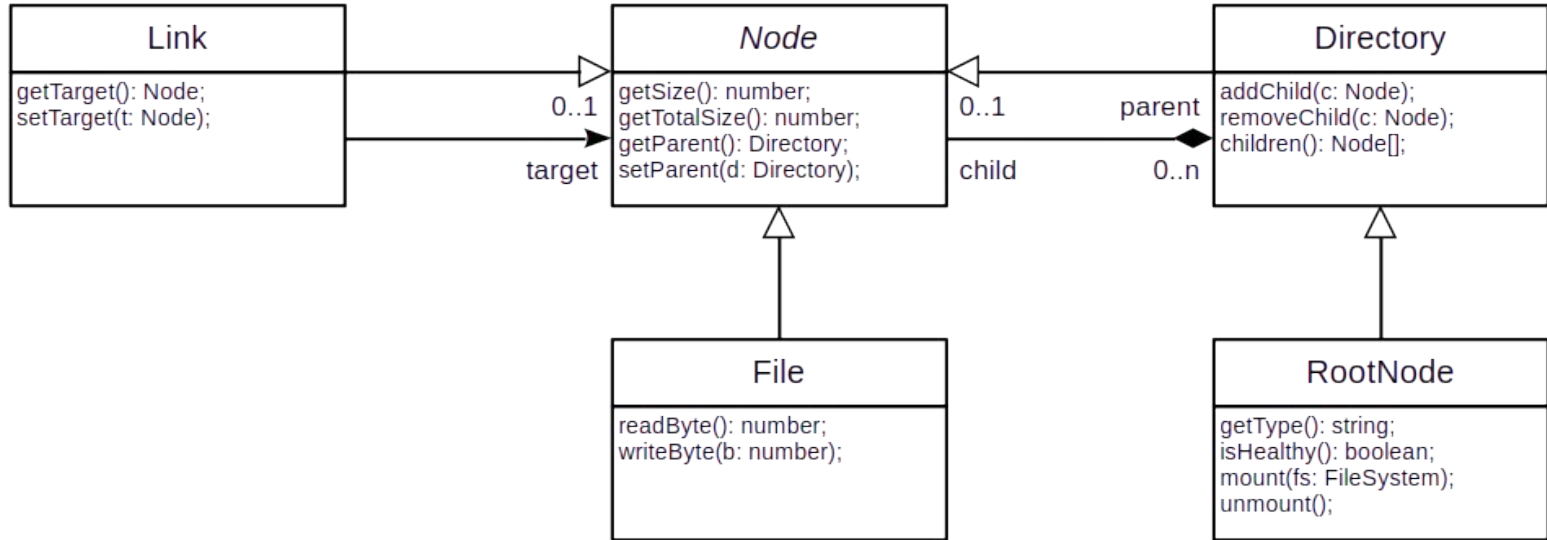
A **collaboration instance** (UML: Collaboration Use) is

- A set of objects collaborating according to a collaboration specification

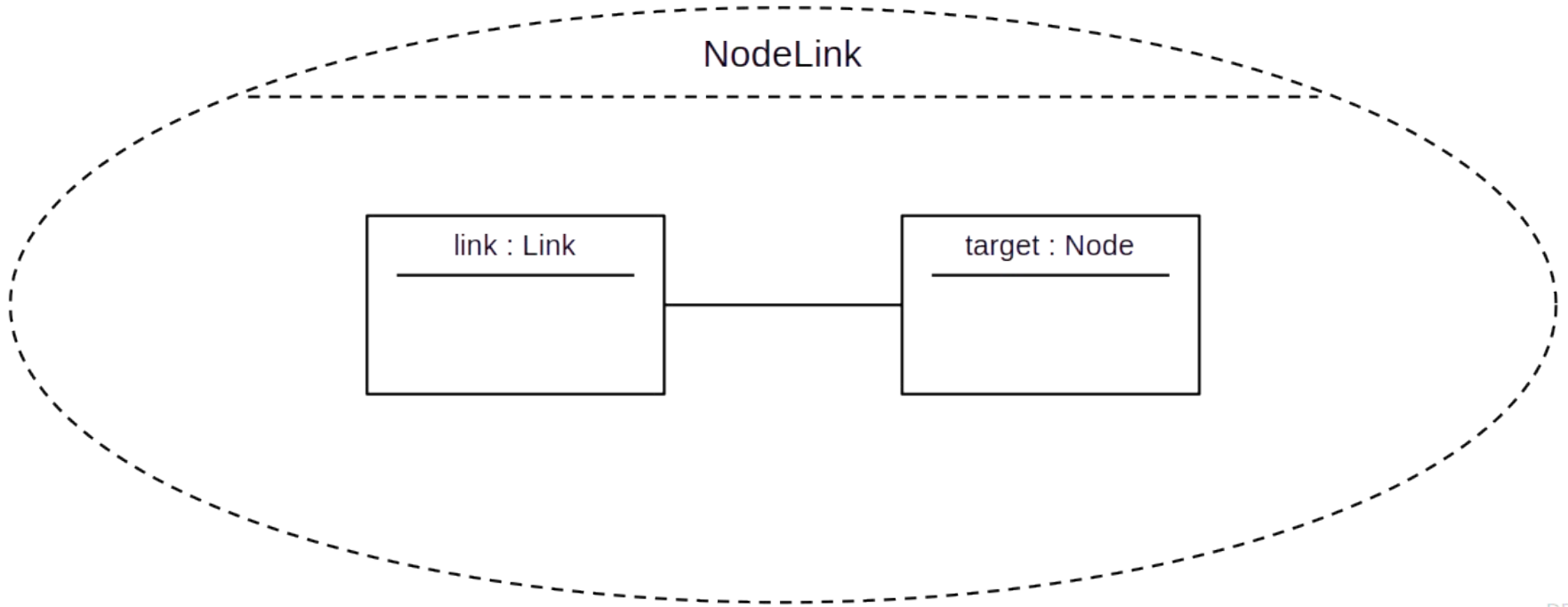
A **role specification** (UML: Role) is

- A model of the behavior of one object in a collaboration instance

File System Example Revisited



Collaboration Example (UML)



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Collaboration as Code

```
export class Link extends Node {  
  
    protected target: Node | null = null;  
  
    constructor(bn: string, pn: Directory, tn?: Node) {  
        super(bn, pn);  
  
        if (tn !== undefined) {  
            this.target = tn;  
        }  
    }  
  
    public getTarget(): Node | null {  
        return this.target;  
    }  
  
    public setTarget(target: Node): void {  
        this.target = target;  
    }  
  
    ...  
}
```

```
export class Node {  
    ...  
}
```

Collaboration Role Binding Example (UML)



Collaboration Roles as Code

```
export interface NodeLinkLink {
  getTarget(): NodeLinkTarget | null;
  setTarget(target: NodeLinkTarget): void;
}

export class Link extends Node implements NodeLinkLink {
  protected target: NodeLinkTarget | null = null;

  constructor(bn: string, pn: Directory, tn?: Node) {
    super(bn, pn);

    if (tn !== undefined) {
      this.target = tn;
    }
  }

  public getTarget(): NodeLinkTarget | null {
    return this.target;
  }

  public setTarget(target: NodeLinkTarget): void {
    this.target = target;
  }

  ...
}
```

```
export interface NodeLinkTarget {
  // no methods
}

export class Node implements NodeLinkTarget {
  protected baseName: string = "";
  protected parentNode: Directory;

  constructor(bn: string, pn: Directory) {
    this.doSetBaseName(bn);
    this.parentNode = pn;
    this.initialize(pn);
  }

  protected initialize(pn: Directory): void {
    this.parentNode = pn;
    this.parentNode.addChild(this);
  }

  protected doSetBaseName(bn: string): void {
    this.baseName = bn;
  }

  ...
}
```

Collaboration as Code (as Language Construct)

```
export collaboration NodeLink {  
  
  role Link {  
  
    protected target: Target | null = null;  
  
    constructor(tn?: Target) {  
      if (tn != undefined) {  
        this.target = tn;  
      }  
    }  
  
    public getTarget(): Target | null {  
      return this.target;  
    }  
  
    public setTarget(target: Target): void {  
      this.target = target;  
    }  
  
  }  
  
  role Target {  
    // no methods  
  }  
  
}
```

```
import { NodeLink.Target } from "../NodeLink";  
  
export class Node implements NodeLink.Target {  
  ...  
}  
  
-----  
  
import * as NodeLink from "../NodeLink";  
  
export class Link extends Node implements NodeLink.Link {  
  
  protected target: NodeLink.Target | null = null;  
  
  ...  
  
  public getTarget(): NodeLink.Target | null {  
    return this.target;  
  }  
  
  public setTarget(target: NodeLink.Target): void {  
    this.target = target;  
  }  
  
  ...  
  
}
```

Semantics of Collaboration “Implementation”

```
export collaboration NodeLink {  
  
  role Link {  
  
    protected target: Target | null = null;  
  
    constructor(tn?: Target) {  
      if (tn != undefined) {  
        this.target = tn;  
      }  
    }  
  
    public getTarget(): Target | null {  
      return this.target;  
    }  
  
    public setTarget(target: Target): void {  
      this.target = target;  
    }  
  
  }  
  
  role Target {  
    // no methods  
  }  
}
```

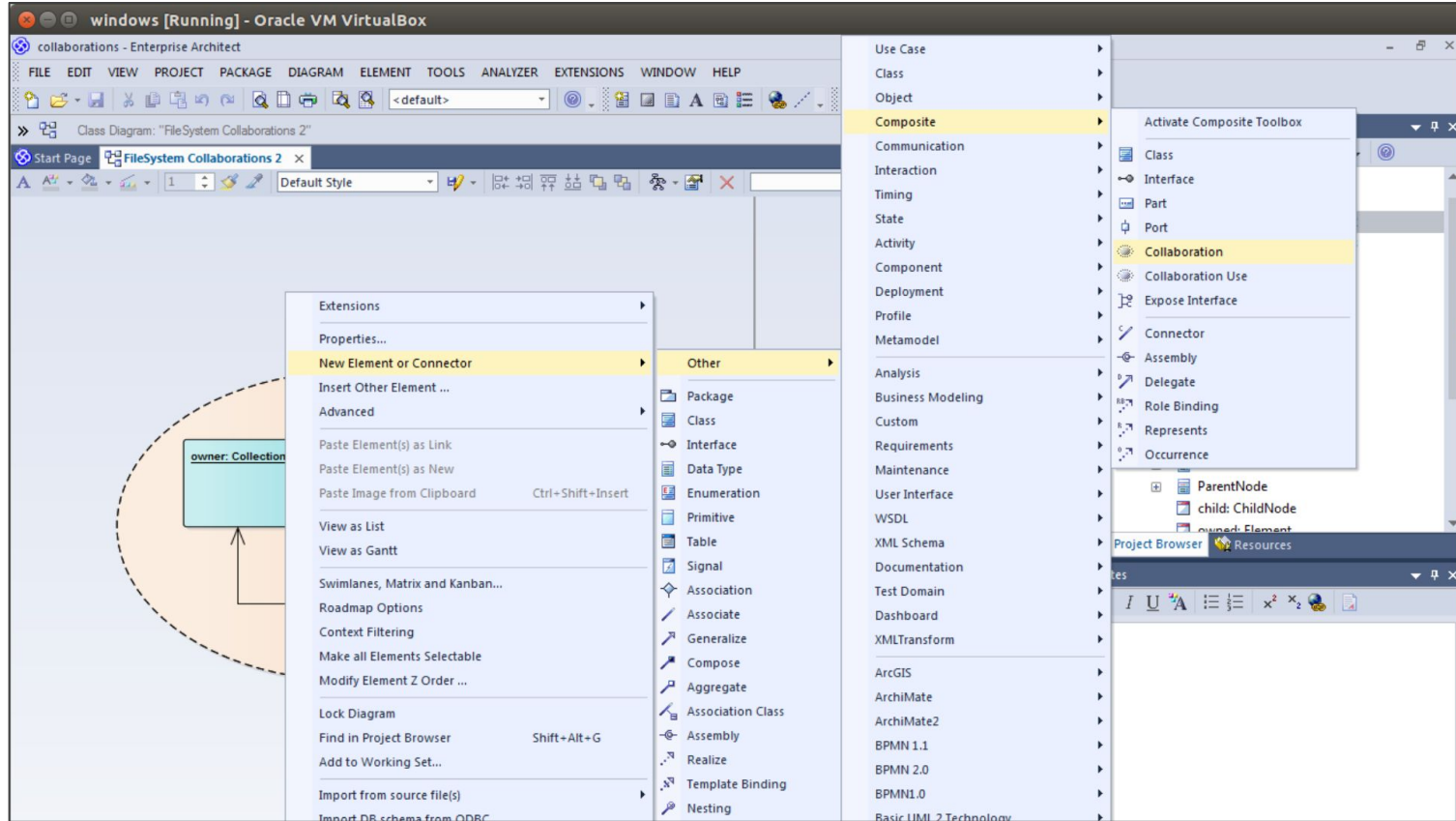


```
import { NodeLink.Target } from "../NodeLink";  
  
export class Node implements NodeLink.Target {  
  ...  
}  
  
-----  
  
import * as NodeLink from "../NodeLink";  
  
export class Link extends Node implements NodeLink.Link {  
  
  protected target: NodeLink.Target | null = null;  
  
  ...  
  
  public getTarget(): NodeLink.Target | null {  
    return this.target;  
  }  
  
  public setTarget(target: NodeLink.Target): void {  
    this.target = target;  
  }  
  
  ...  
}
```

Benefits of Collaboration-Based Design

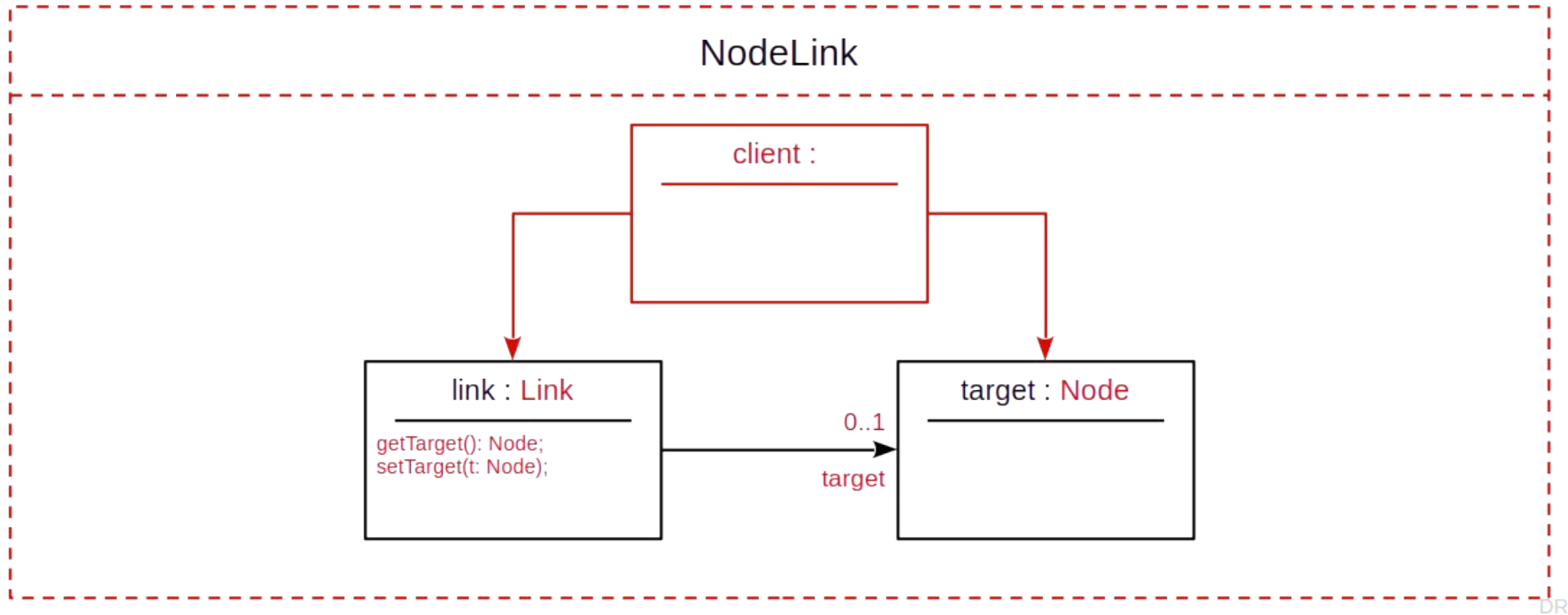
1. Separation of concerns
2. Better reusable models (potentially)

Reality Check: UML Collaboration in Sparx EA



2. File System Collaborations

Node Link Collaboration (Riehle's UML Extension)

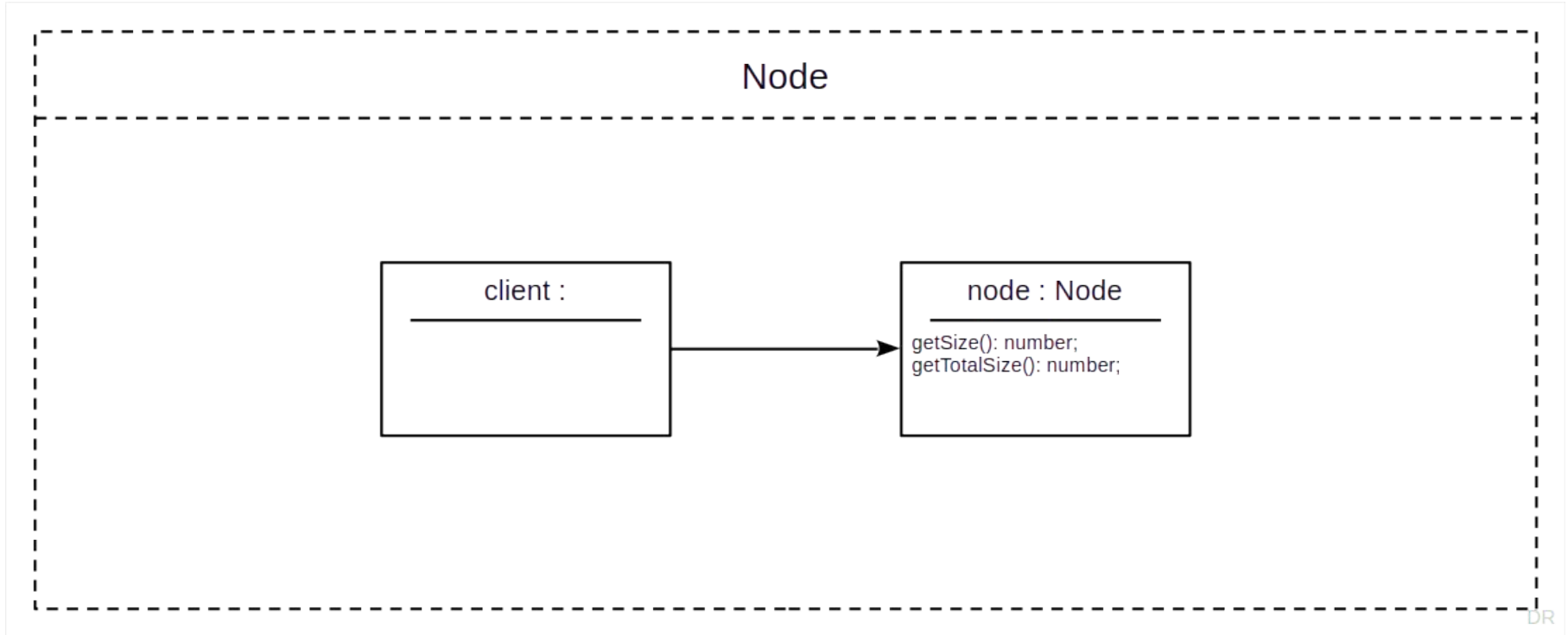


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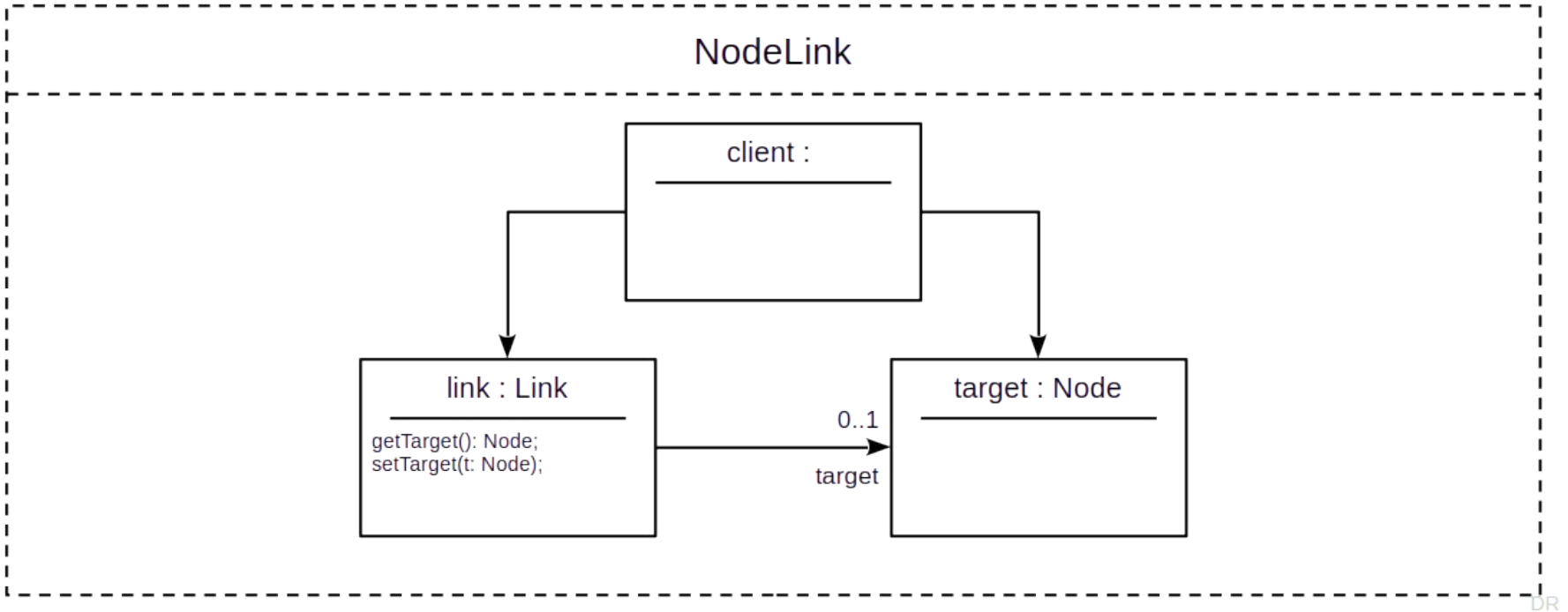
Collaborations in File System Example

1. Node collaboration
2. NodeLink collaboration
3. File collaboration
4. ParentChild collaboration (a.k.a. Composite pattern)
5. RootNode collaboration

Node Collaboration

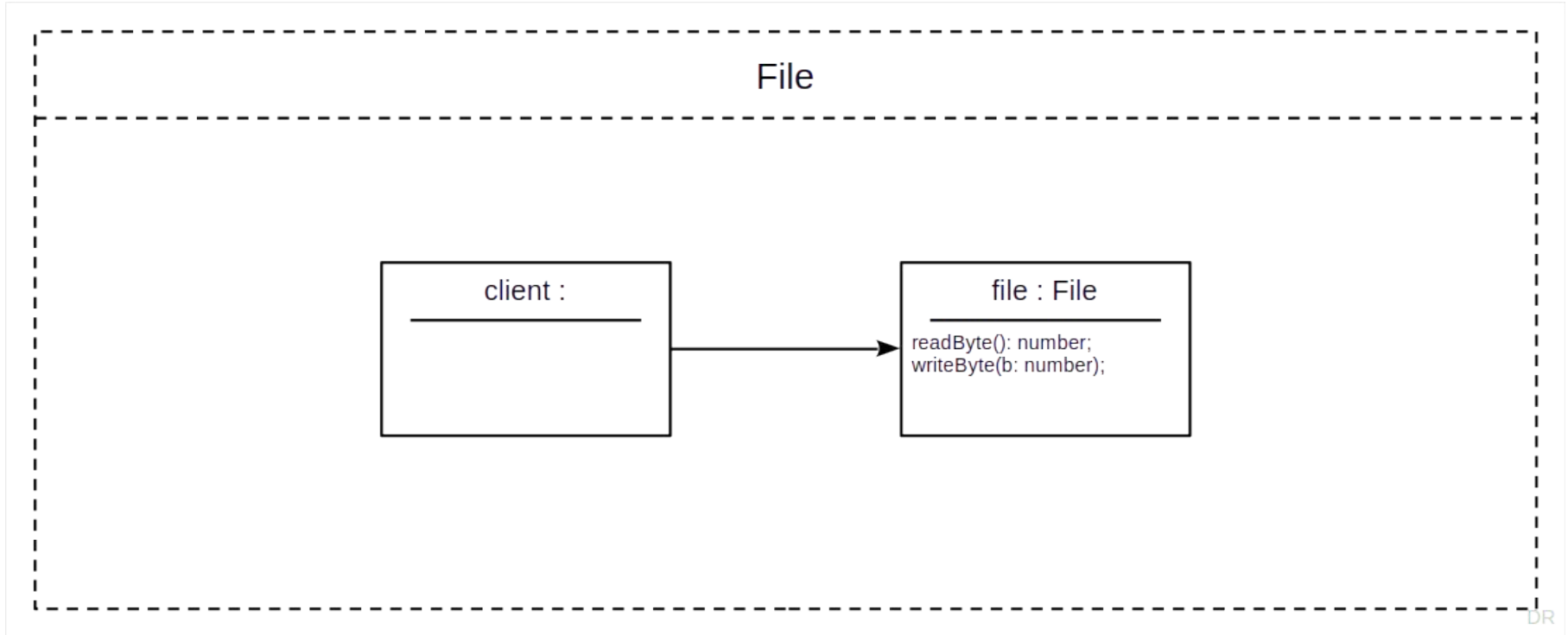


NodeLink Collaboration



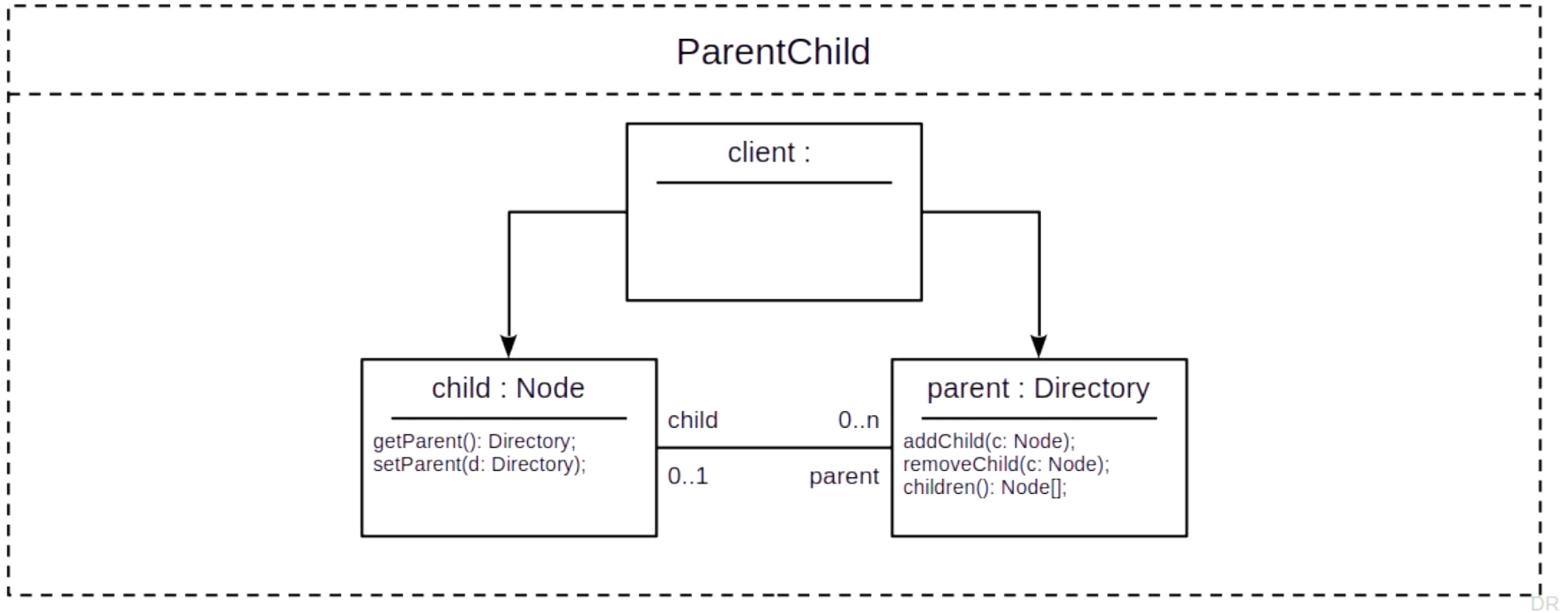
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File Collaboration



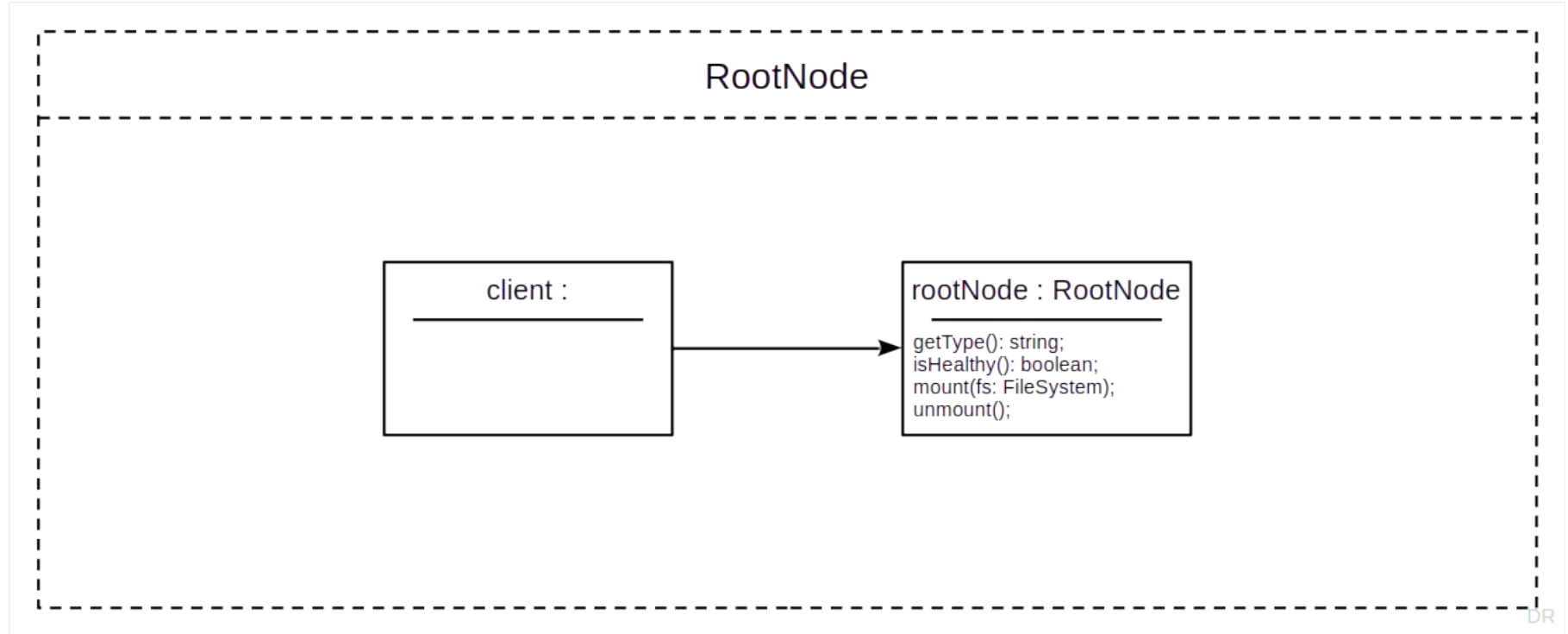
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Parent / Child Collaboration



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RootNode Collaboration



Types of Collaborations

Primary service collaborations

- Typically simple client / service collaborations
- The client role often has no methods
- Are visible to the outside (use-clients)

Maintenance collaborations

- Maintain the domain logic within the model
- Often follow design pattern logic
- Often not visible to the outside (no use-clients)

3. Collaboration and Class Models

Collaborations / Roles vs. Class Models / Classes

Collaborations

- Focus on behavior

Roles

- Are part of collaborations
- Compose classes from parts
- Use use-client interface

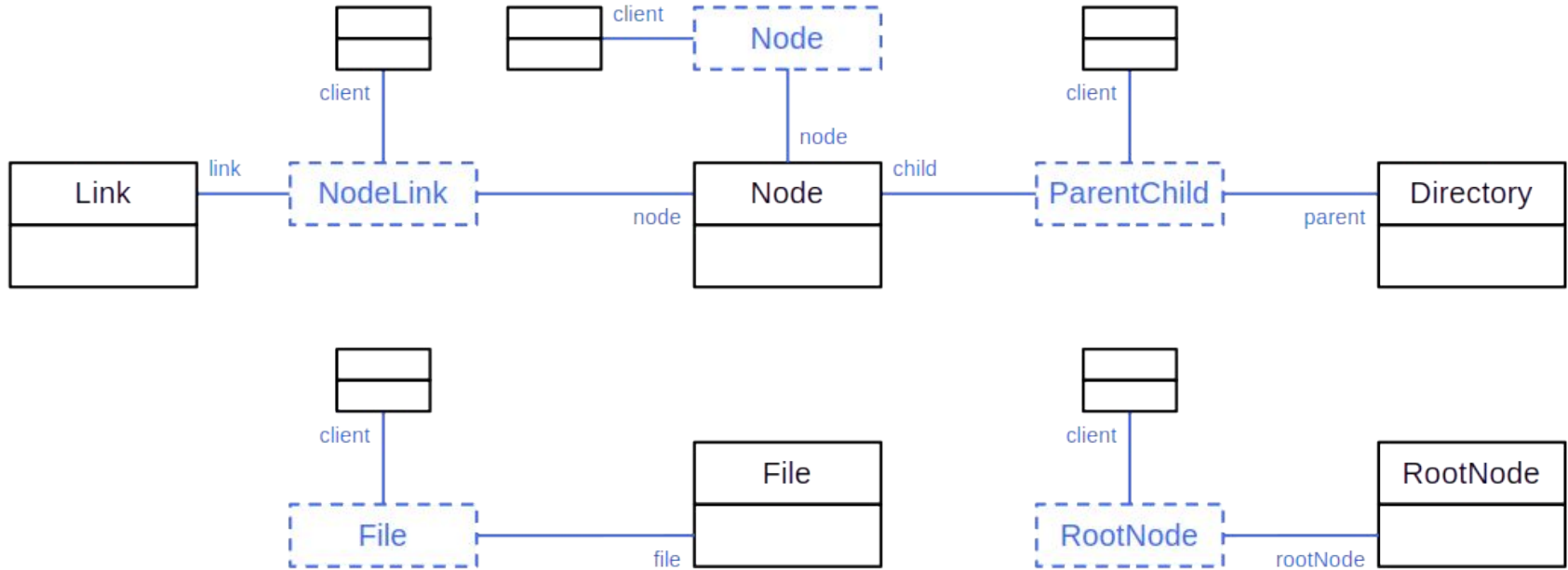
Class models

- Focus on structure

Classes

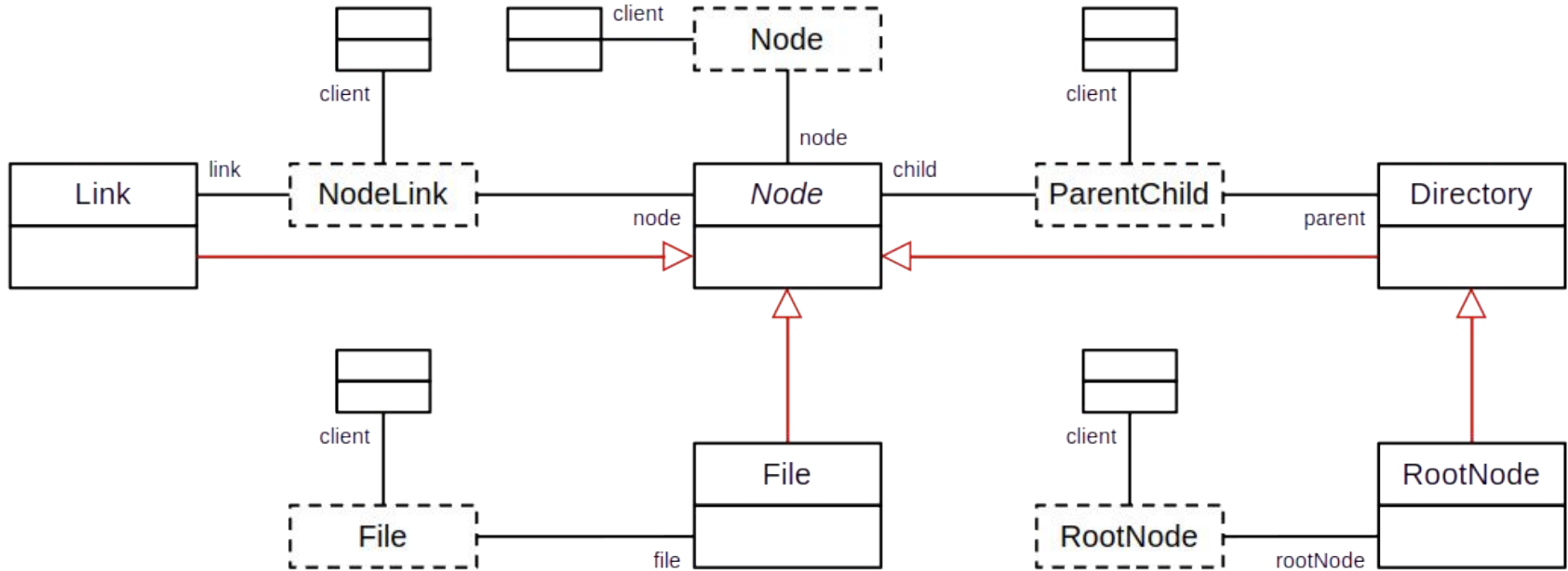
- Are part of class hierarchies
- Compose classes by inheritance
- Use inheritance interface

Collaboration Role to Class Assignments



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Collaborations with Class Hierarchy



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Role and Class Duality

A role specification ties a class into a collaboration context

- Control flow enters and leaves through a role

A class composes behavior in multiple contexts into one unit

- Role implementation is mapped onto implementation state

Levels of Abstraction

Design patterns

- No modeling support

Design templates

- UML Collaboration

Class models

- UML Class Model

4. History and Related Concepts

History of Collaboration Modeling Methods

1. Trygve Reenskaug, Role Modeling [1]
2. Dirk Riehle, Framework Design [2]
3. OMG, UML 2.0 Specification [3]

- [1] Reenskaug, T., Wold, P., & Lehne, O. A. (1996). Working with Objects. Manning.
- [2] Riehle, D. (2000). [Framework Design: A Role Modeling Approach](https://profriehle.com/publications/framework-design). Dissertation, no. 13509. Swiss Federal Institute of Technology at Zurich (ETH Zurich), Zurich, Switzerland.
- [3] OMG (2005). [Unified Modeling Language 2.0](https://www.omg.org/spec/UML/2.0). OMG.

Related Concepts from Programming Language History

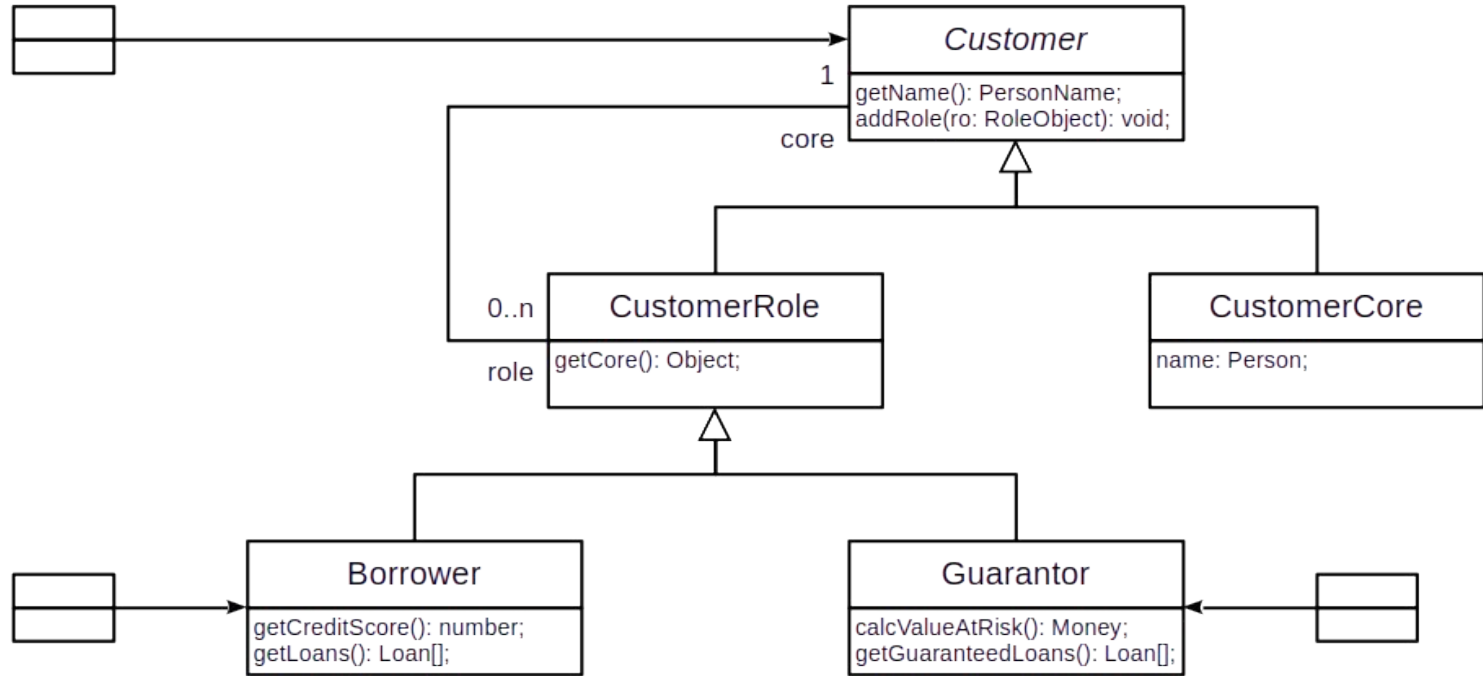
Past attempts

- Interfaces
- Protocols
- Mix-ins
- Traits

Common to all is that they ignore the collaboration, focus only on roles

5. The Role Object Pattern

Role Object Example



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Role Object Pattern

Context

- A large modular system with core domain concepts and varied applications

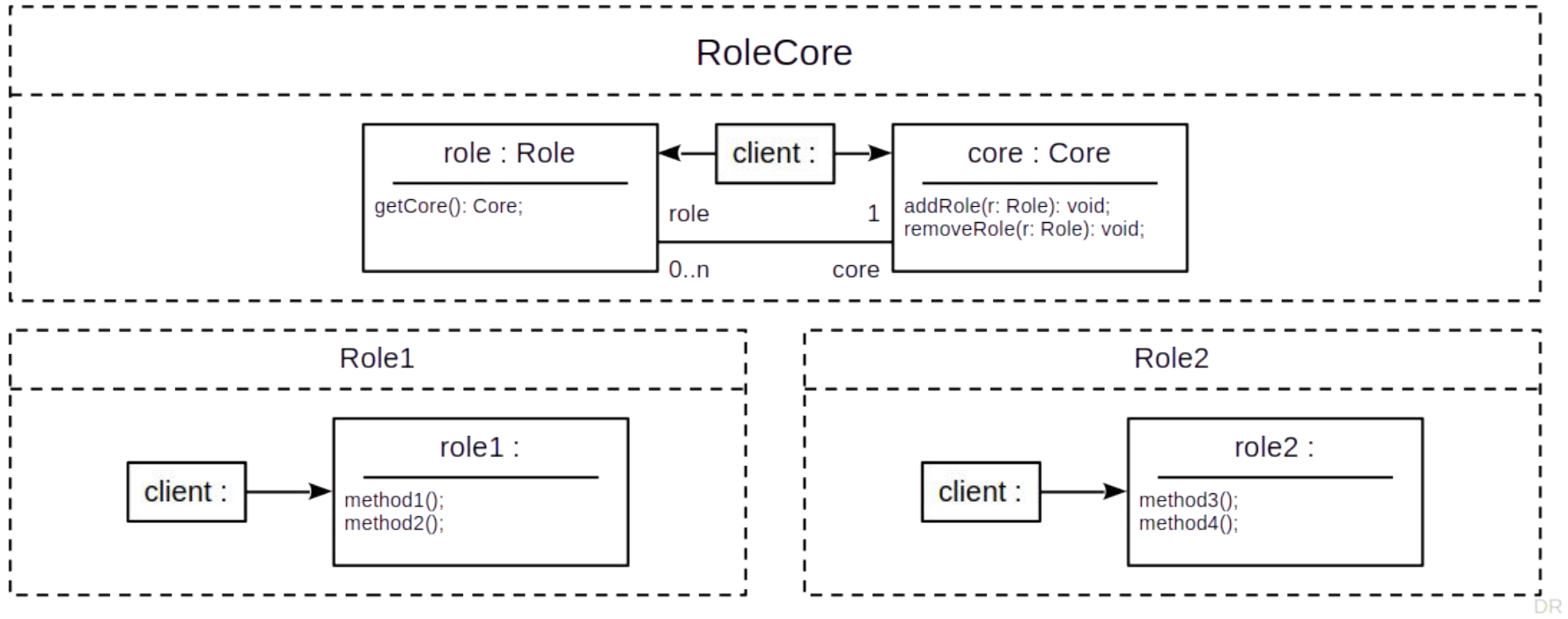
Problem

- A core concept needs to show a different face in each application

Solution

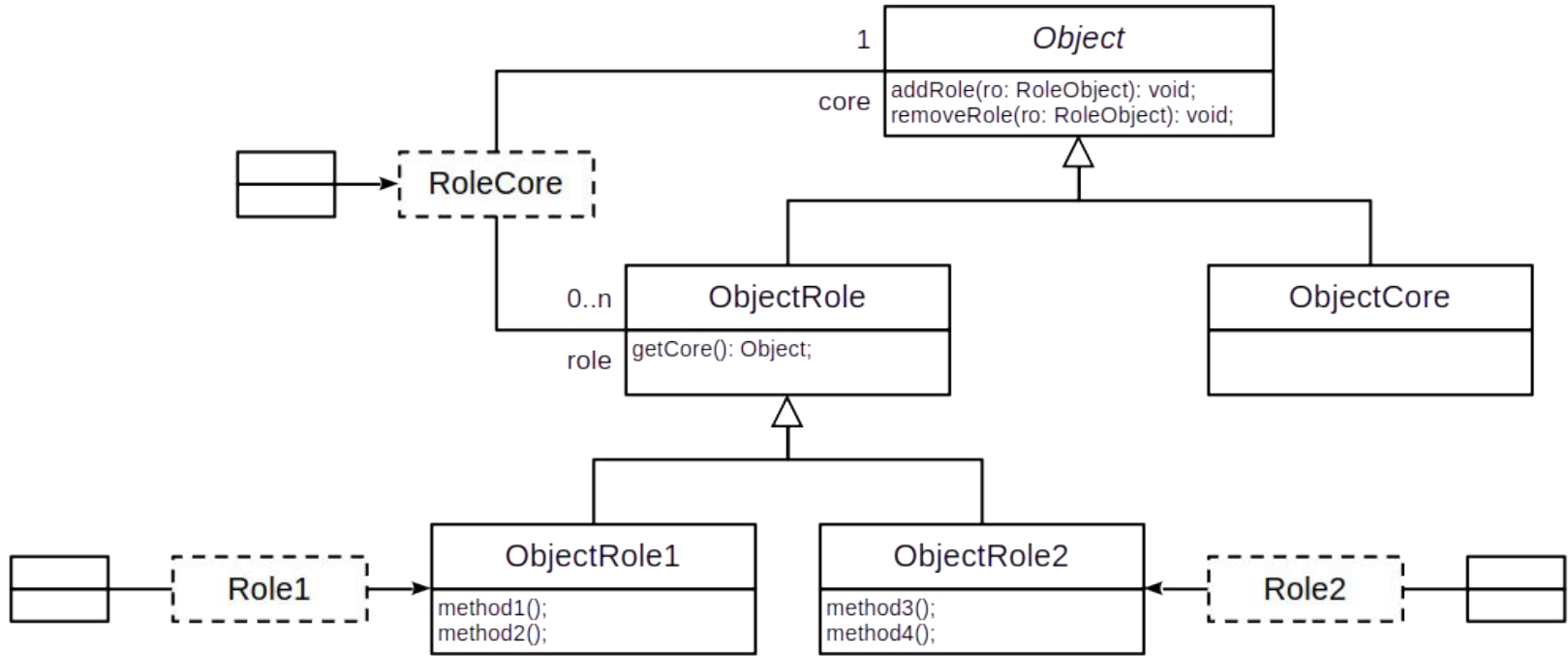
- Extend the core concept with separate role objects facing the application

Role Object Collaborations



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Role Object Structure Diagram



Role Objects vs. Collaborations

The role object pattern

- Can be described using collaborations
- Allows for dynamic role playing
- Simplifies persistence

Summary

1. Collaboration in UML
2. File system collaborations
3. Collaboration and class models
4. History and related concepts
5. The Role Object pattern

Thank you! Any questions?

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