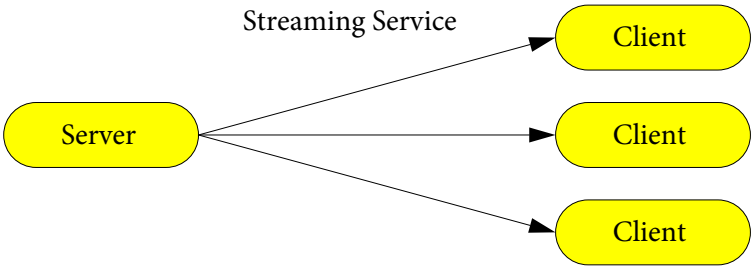
H.1 FORMI: An RMI Extension for Adaptive Applications

- Motivation
- The Fragmented-Object Approach
- Java RMI
- Fragmented Objects in Java RMI
- Conclusions

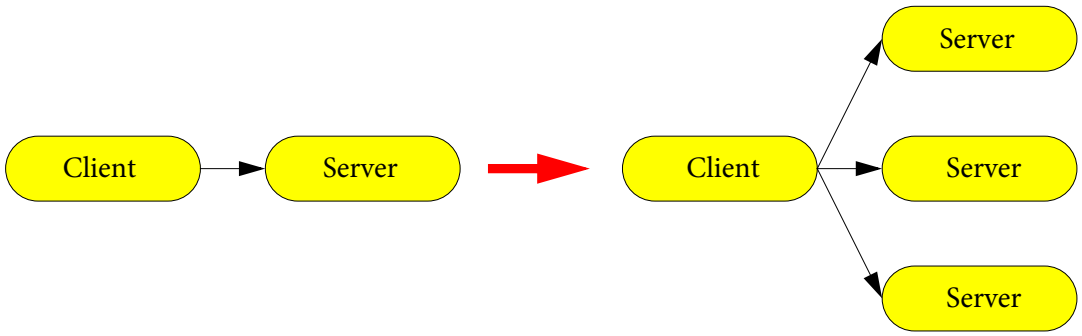
1 Motivation

- Distributed object-oriented applications supported by middleware
  - CORBA, .NET-Remoting
  - Java Remote Method Invocation (RMI)
- Rising number of applications require non-functional requirements
  - Soft real-time conditions
  - Fault-tolerance
  - High availability



1 Motivation

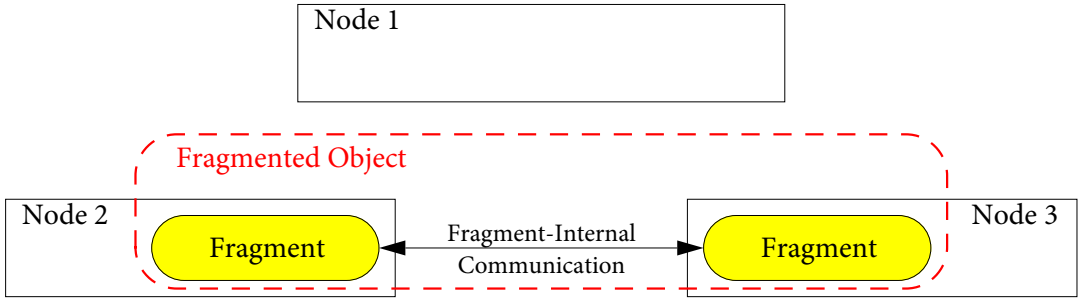
- Java RMI framework provides extension points
  - New call semantics, transport protocols
  - Used to introduce the object group paradigm



- No general adaption of the interaction patterns and the internal structure
  - Solution: fragmented-object approach [Shapiro94]

2 Fragmented-Object Approach

- Extension of the traditional concept of stub-based distributed objects
  - Object with unique identity distributed among different nodes (fragments)
  - Distribution of state and functionality and arbitrary internal communication
  - Fragments offer the whole FO's interface (distribution transparency)
  - Support for adaptive applications (e.g. state migration, replicas, etc.)
  - Implicit binding (passing reference creates object-specific fragment)



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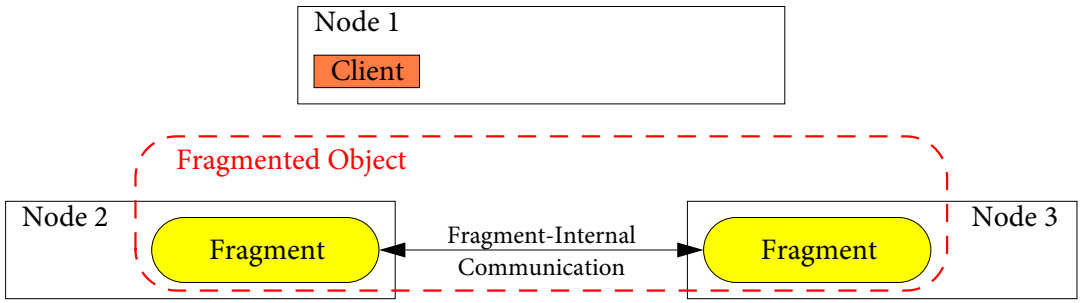

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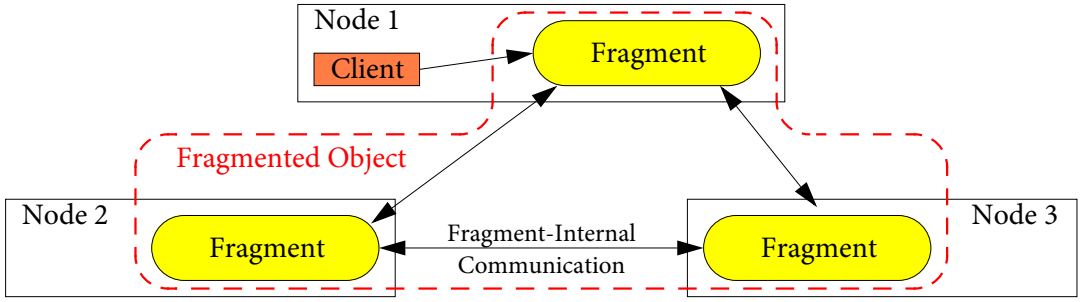
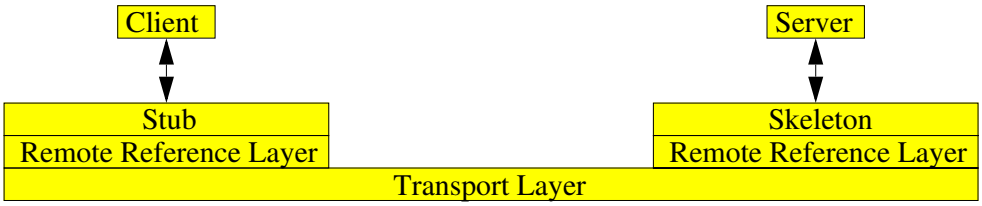


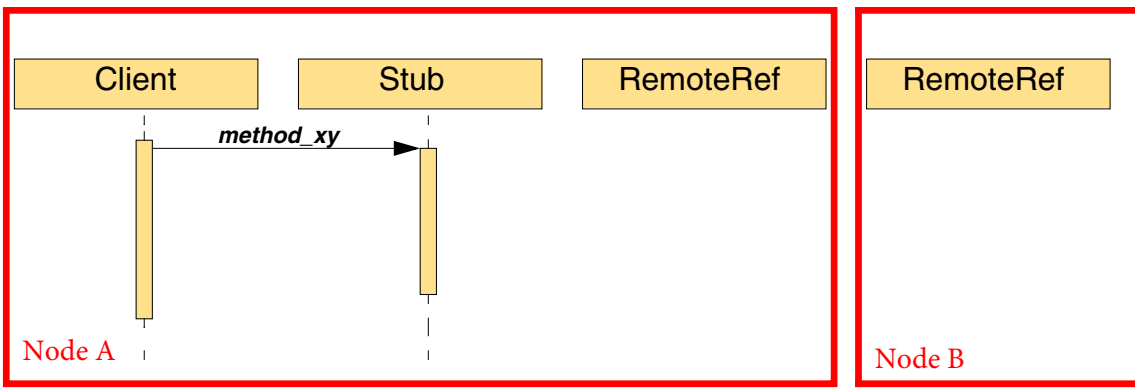
3 Java RMI

- Remote Method Invocation in Java
  - Maintaining semantics of the Java object model in a distributed environment
- Semantics for object-passing
  - Primitive values, Java objects, not exported RMI-objects: call-by-value
  - Exported RMI-objects: call-by-reference
- Architecture



3 Java RMI

- Remote invocation in Java RMI



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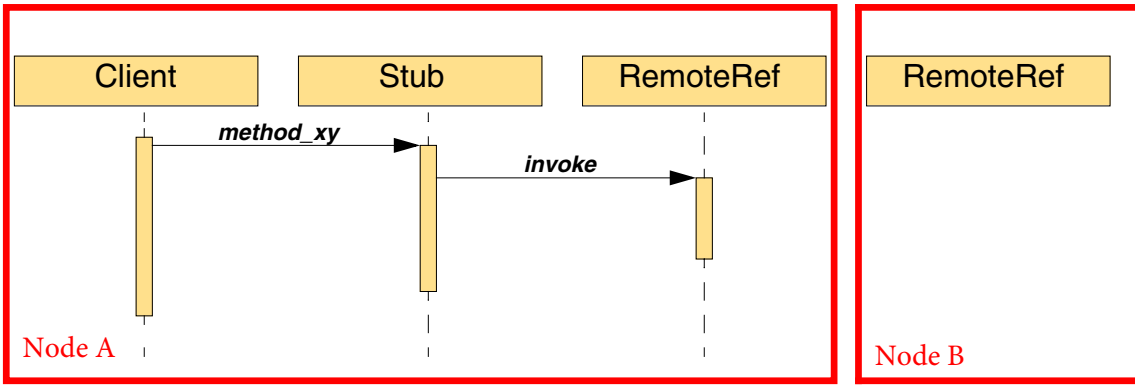

3 Java RMI

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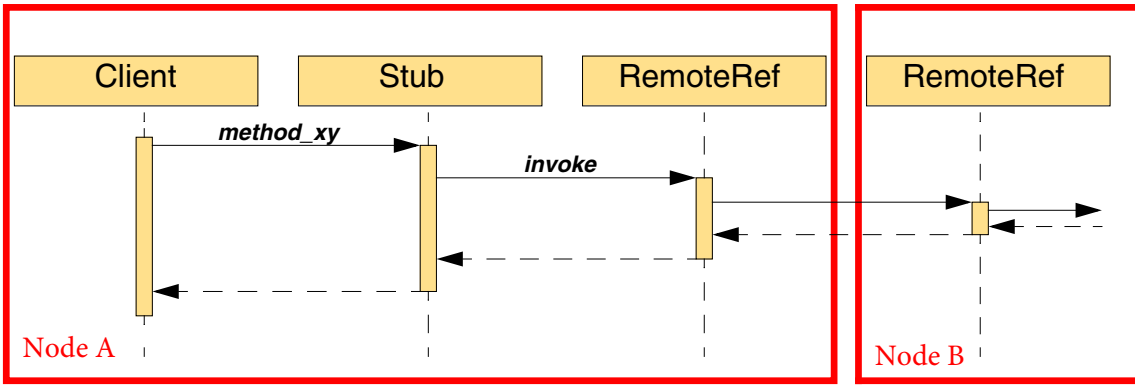
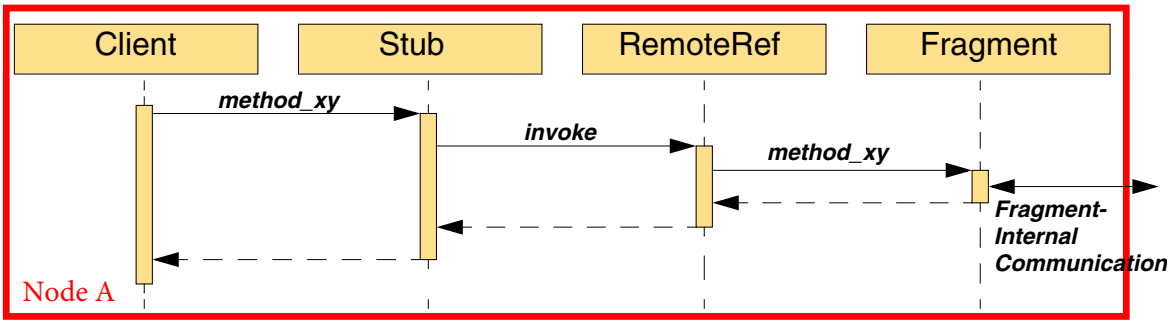


4 Fragmented Objects in Java RMI

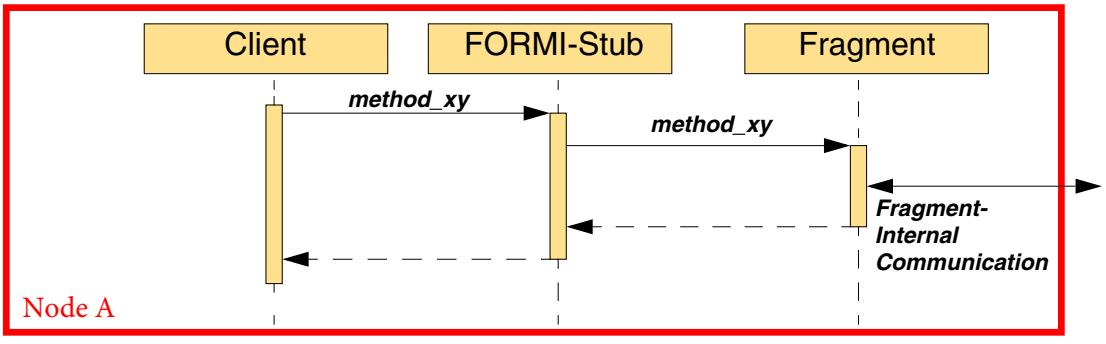
- Goal: transparent integration of fragmented objects into Java RMI

- Naive approach: Extending the Remote Reference Layer
  - Well-known approach to integrate own call semantics (e.g., JGroup system)
  - `RemoteRef` forwards invocations to the local fragment
  - **Problem:** Local calls treated like remote ones (marshalling uses Java serialization and reflection)



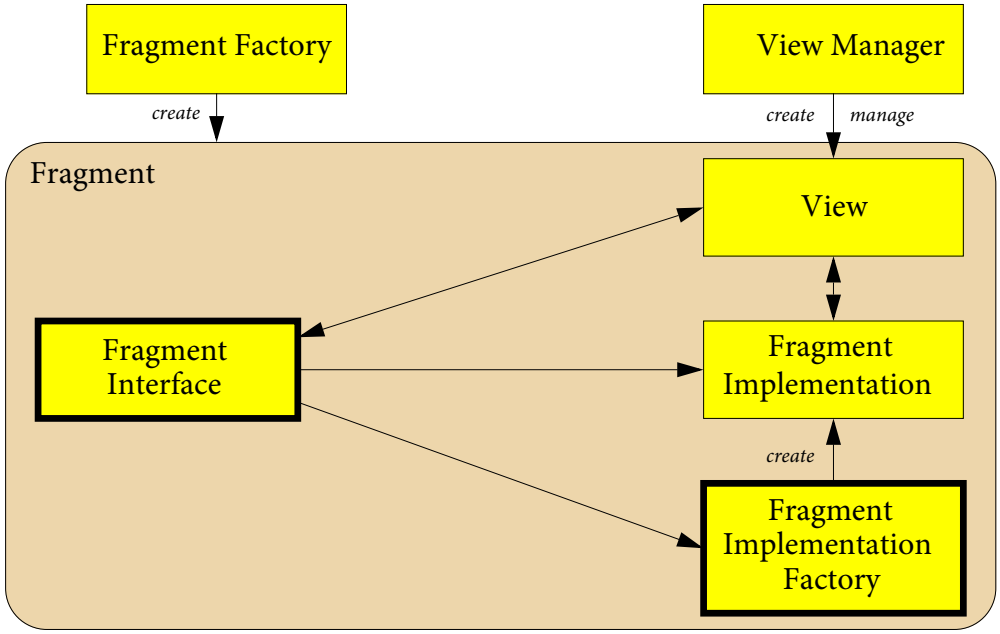
4 Fragmented Objects in Java RMI

- FORMI approach
  - FORMI stub: merge of reference layer and stub layer
  - Marshalling of stubs possible
  - Calls processed faster



4 Fragmented Objects in Java RMI

- Architecture of local fragments



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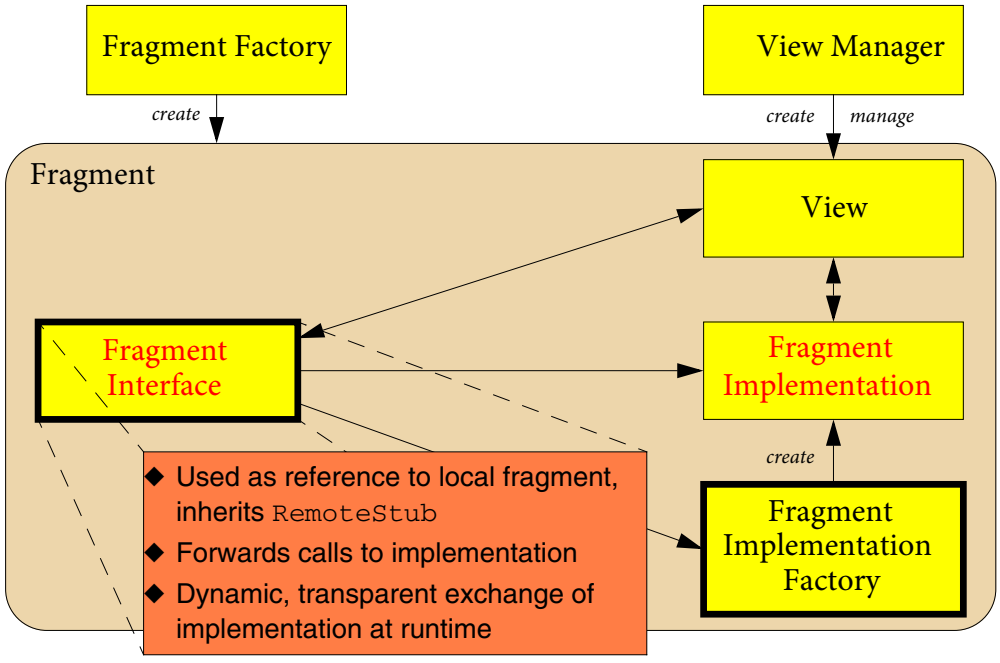

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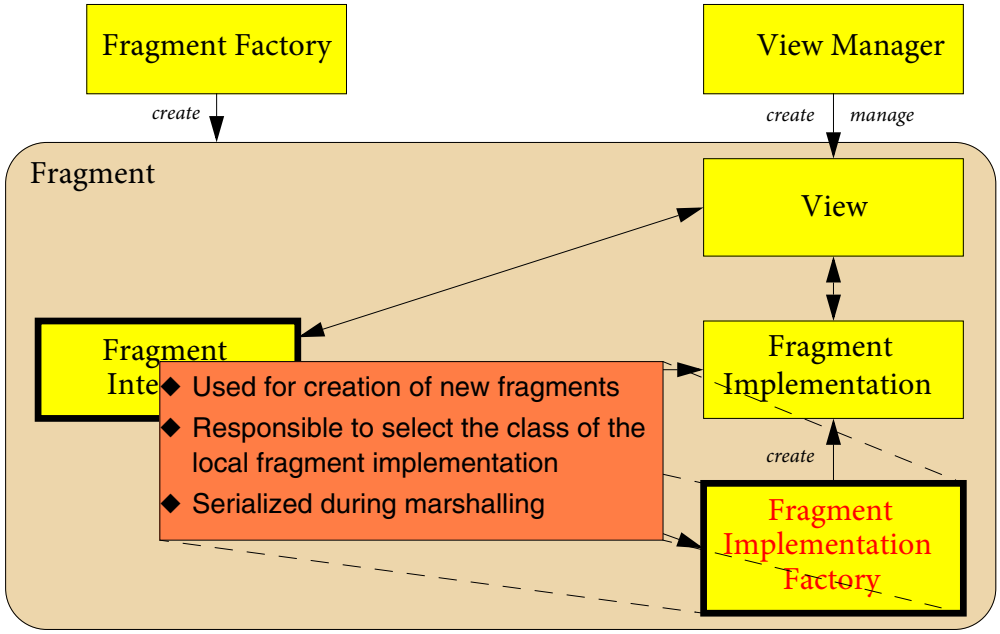

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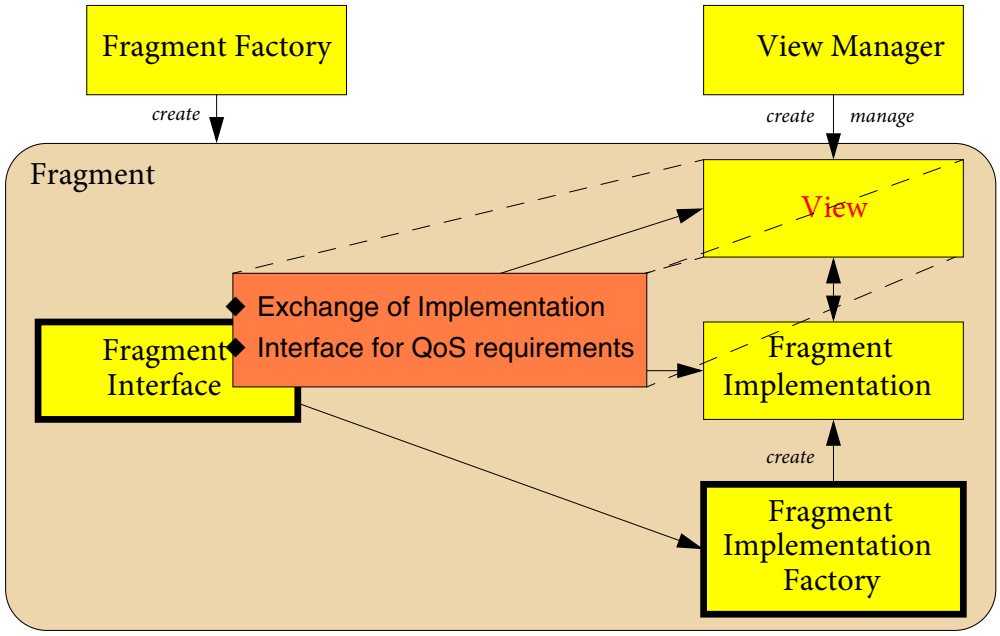

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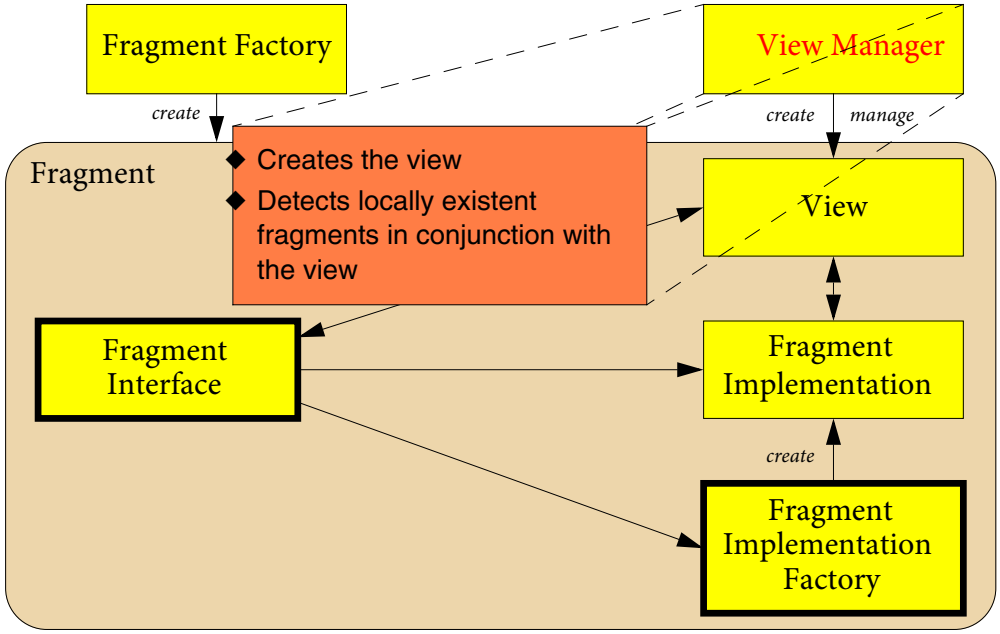

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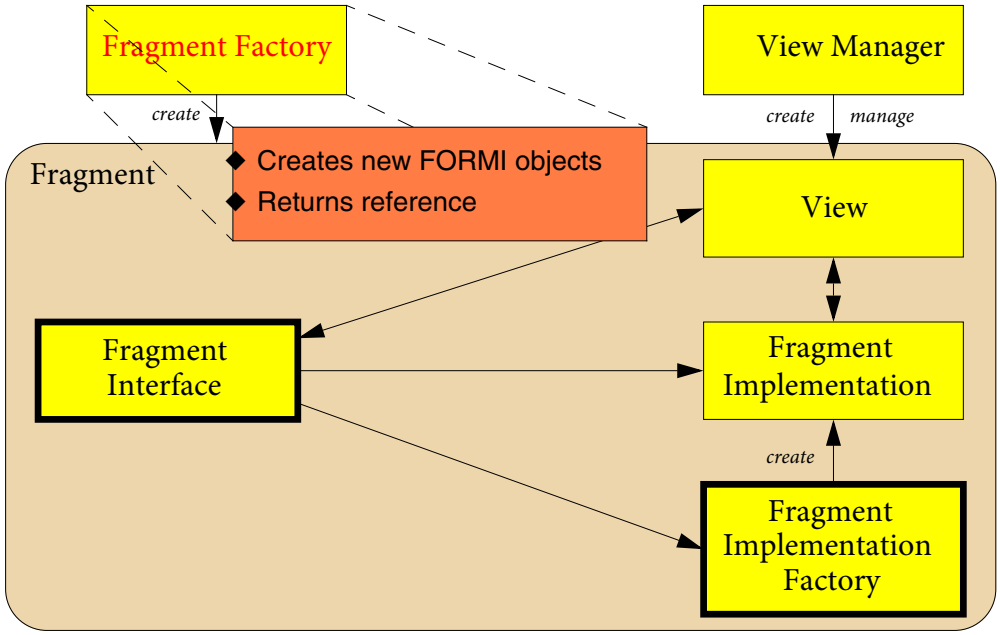
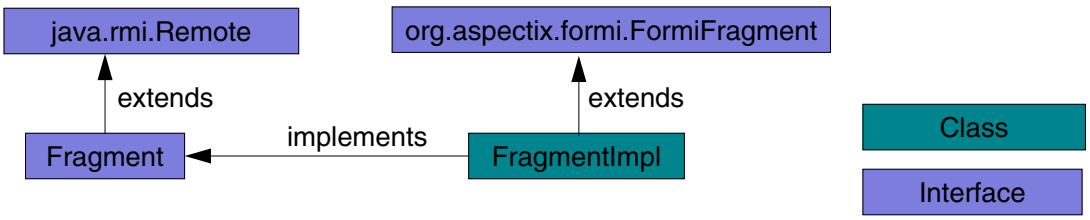


5 Conclusion

- Novel approach of integrating the concept of fragmented objects into Java RMI
  - Support for adaptive applications
  - Dynamic distribution of state and functionality
  - Arbitrary internal communication
  - Compatibility with standard RMI clients

H.2 Aufgabe #5

- Fragmented IM



1 Aufgabe #5

- Fragment Implementierung
  - `public interface Fragment extends Remote {}`
  - `public class FragImpl extends FormiFragment implements Fragment {}`

- Fragment Initialisierung und Erzeugung remote Referenz
  - Erzeugen einer eindeutigen Objekt ID

    ```
    GUID guid = new GUID();
    ```

  - Erzeugen einer remote Referenz

    ```
    Fragment frag = (Fragment) FragmentedObjectFactory.createObject
        (FragImpl.class, DefaultFragImplFactory.class, guid, null, null);
    ```

  - Veroeffentlichen der Referenz an einem Namensdienst (z.B. RMIRegistry)

    ```
    Naming.rebind("rmi://localhost/frag", frag);
    ```

- Referenz auf fragmentiertes Objekt
  - `Fragment frag = (Fragment) Naming.lookup("rmi://localhost/frag");`

2 Aufgabe #5

Questions?