Collaboration Bus: An Infrastructure for Supporting Interoperating Collaborative Systems

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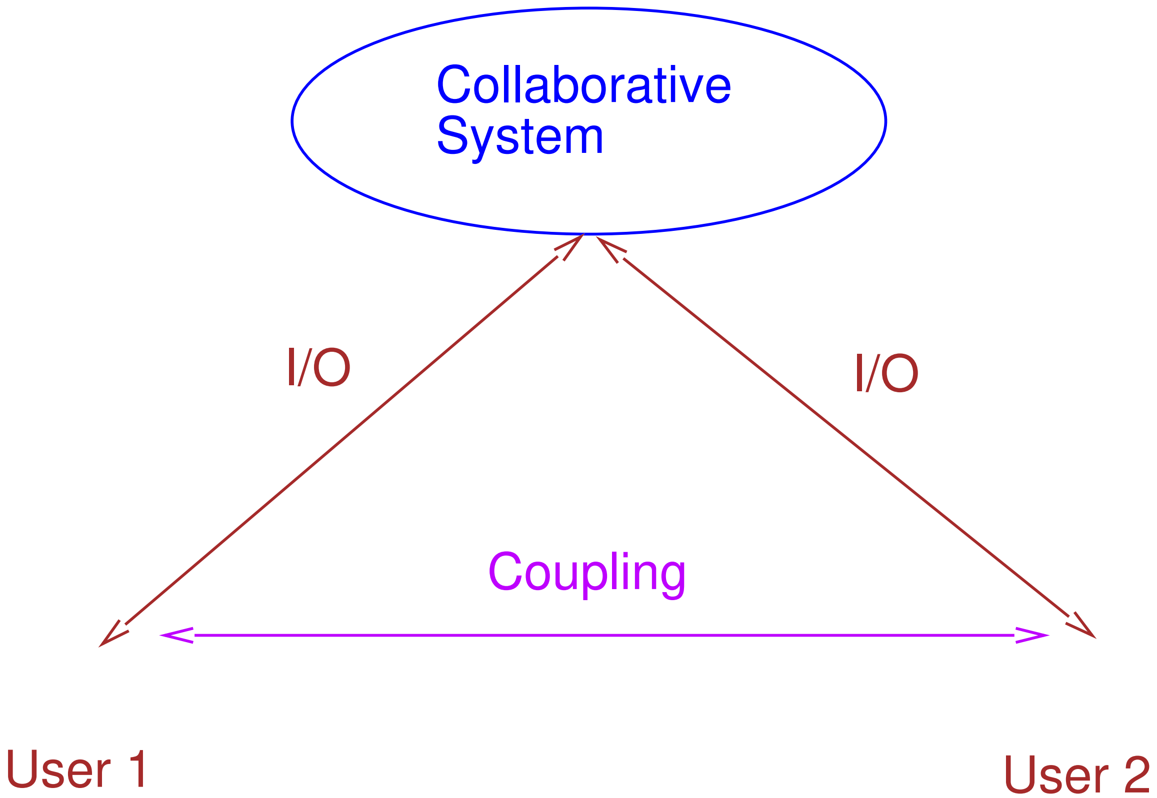
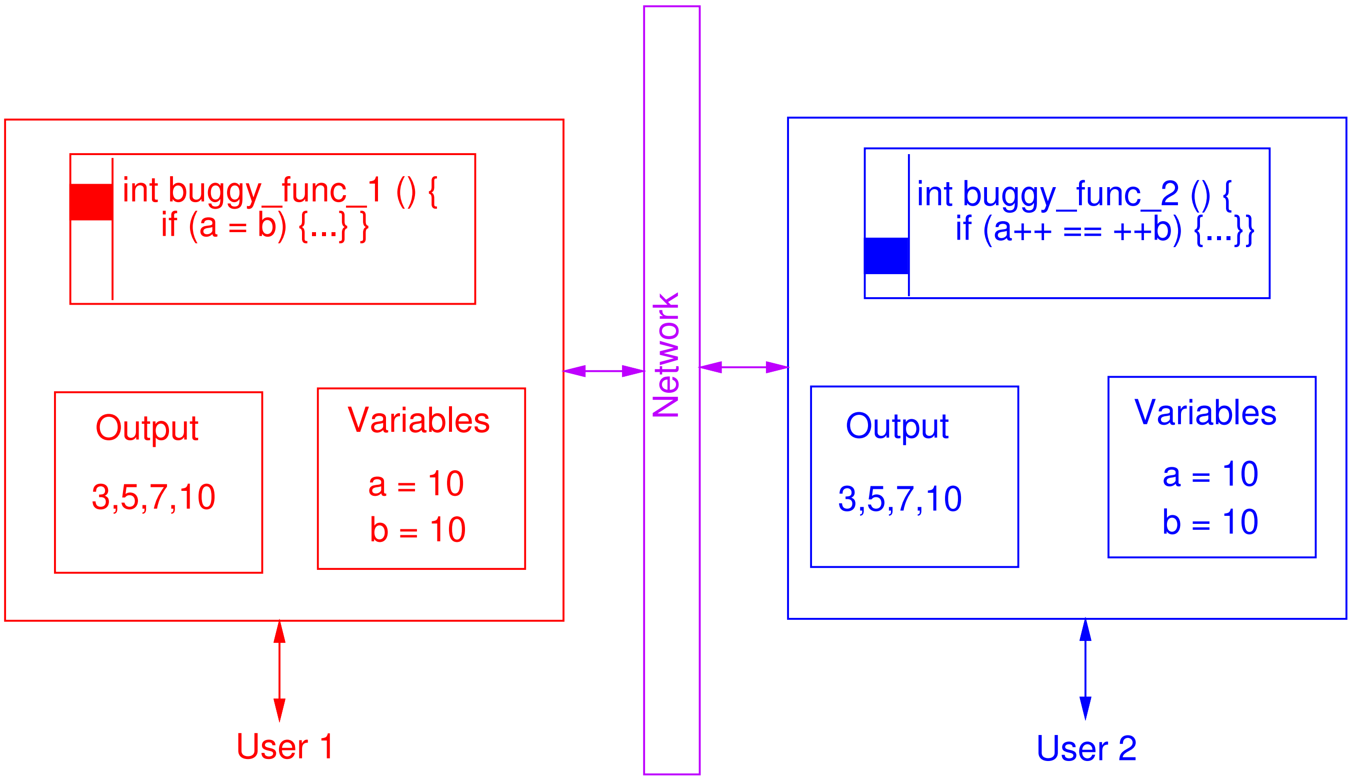
Definition



Motivation: Distributed Collaboration



Example Collaborative Applications

Traditional Database, Mail and Talk Applications

Hypermedia Applications

Structured Mail (Malone '87, Winograd '92)

Active Mail (Goldberg '92, Borenstein '92)

Awareness Sytems (Mantei '91, Dourish & Bly '92)

Spreadsheet (Greif '92)

Coauthoring System (Fish '88, Neuwirth '90)

Proposal Reviewing System (Olson & Atkins '90)

Real–Time Calendaring System (Sarin & Greif '85)

Real–Time Document Editor (Greif '86)

Real–Time Text Editor (Prakash '90, Newman–Wolfe '91, Aspects '92)

Real–Time Outline Editor (Stefik '87, Ellis '91)

Real–Time Code Inspector (Brothers '90, Johnson '90, Riedl '93)

Real–Time Drawing Tools (Bly & Minneman '90, Greenberg '92)

Real–Time Instrument Monitoring (Prakash '94)

Air Traffic Control (Benteley '92)

Collaborative Virtual Reality (Curtis '90, Fahlen '93)

Video Walls (Abel '90)

Example Collaboration Infrastructures

Traditional DOS and DBMS

Shared Window Systems (Lantz ’86, Abdel–Wahab ’88,
Ensor el al ’88, Garfinkel et al ’94,
Jeffay et al ’94, Menges & Jeffay ’94,
Chung & Dewan ’96)

Group Toolkits (Crowley et al ’90,
Roseman & Greenberg ’92 & ’94,
Abdel–Wahab ’96)

Multiuser Languages (Stefik et al ’87, Patterson et al ’90,
Dewan & Choudhary ’91, Graham & Urnes ’94,
Tou et al ’94, Prakash & Shim ’94,
Trevor et al ’94, Feiner ’96)

Process/Workflow Support (Stotts & Furuta ’89, Kaplan et al ’92,
Kaiser et al ’92, Medina–Mora et al ’93)

Application Areas

Software Engineering

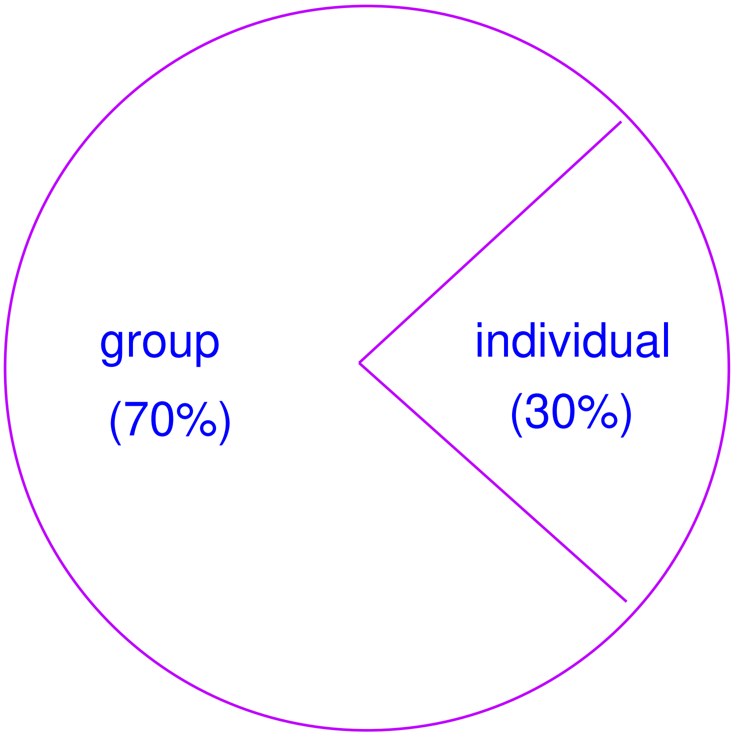
Training/Simulations

Design/Planning

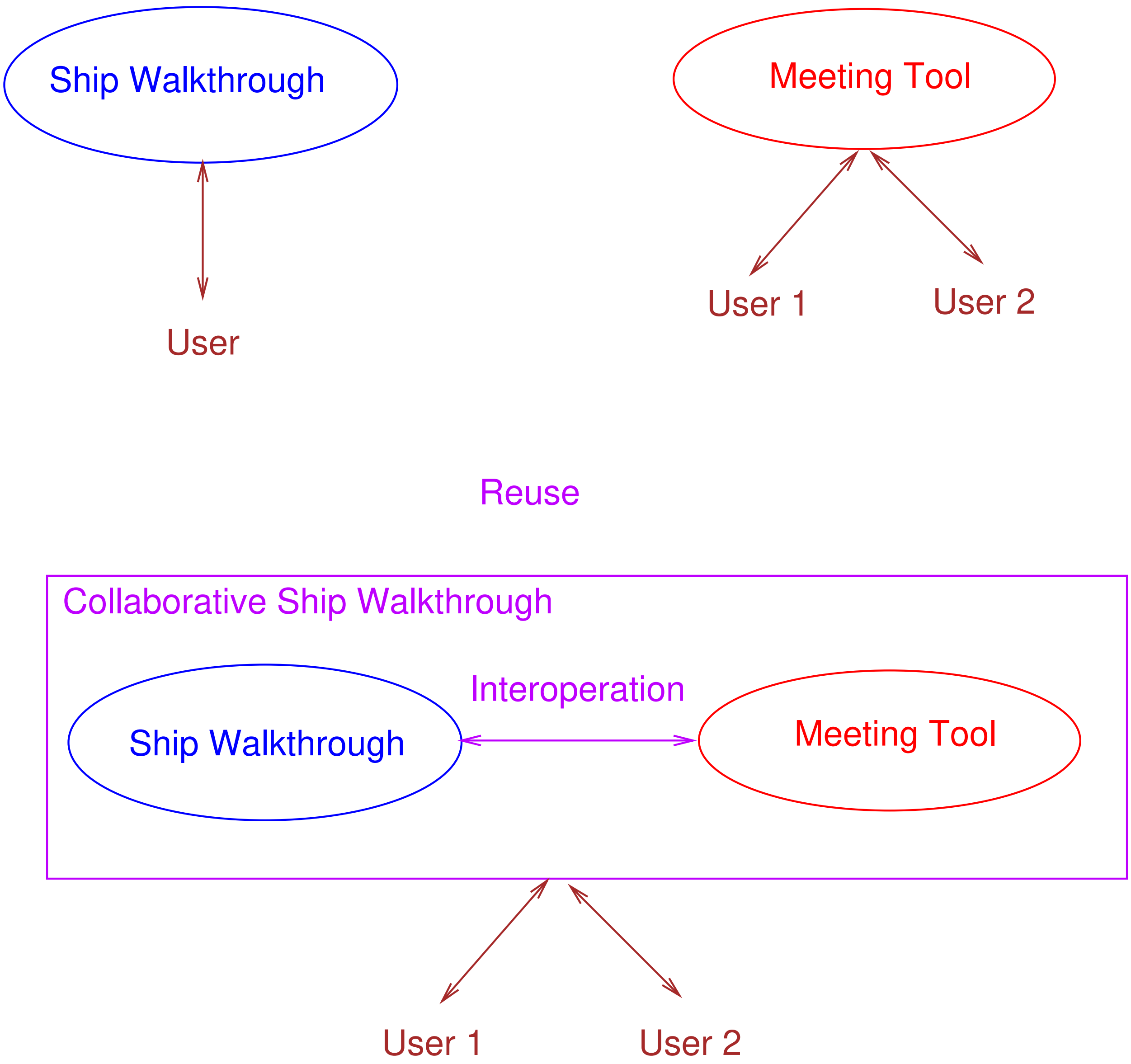
Writing

Air Traffic Control

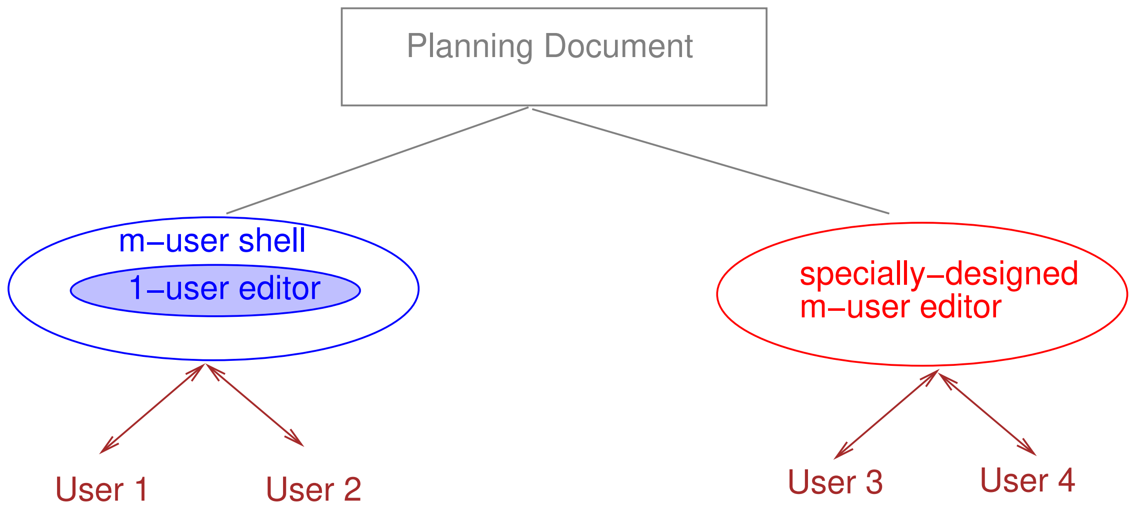
Casual Interaction



Inter-Service Interoperability

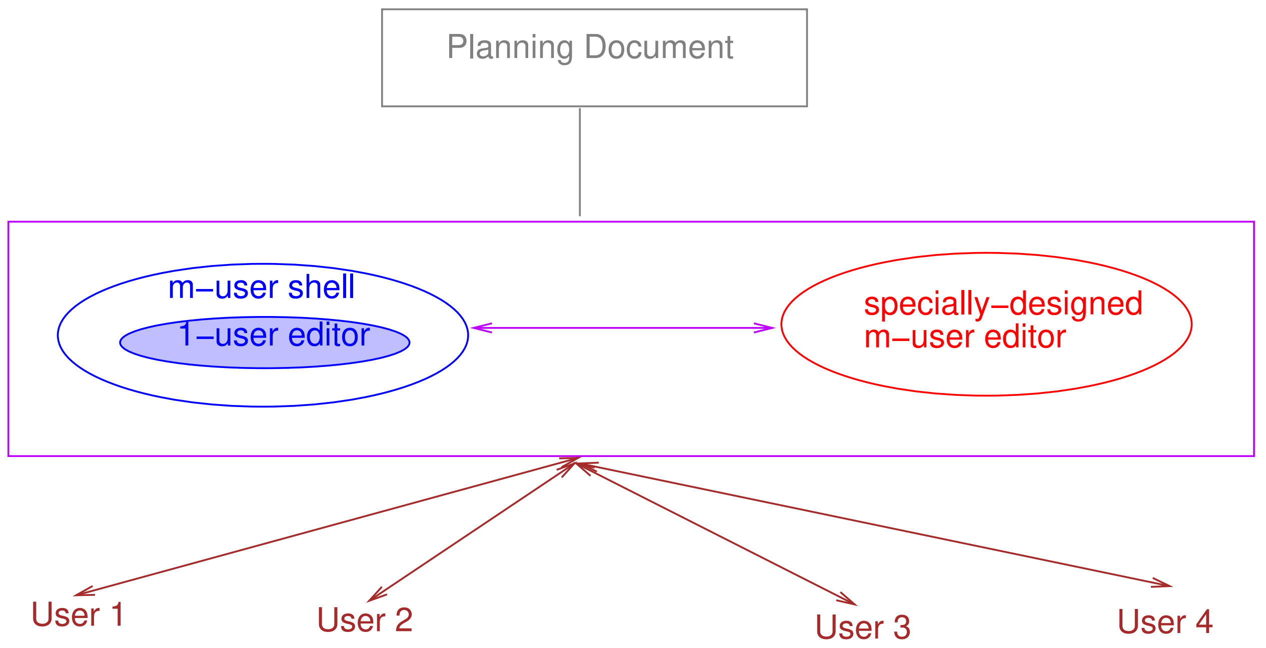


Intra-Service Interoperability



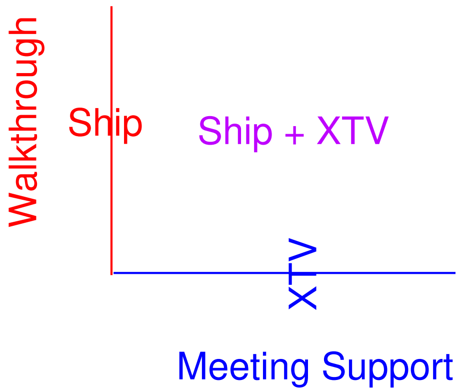
Coexistence

Composing Global Functions from Local Functions

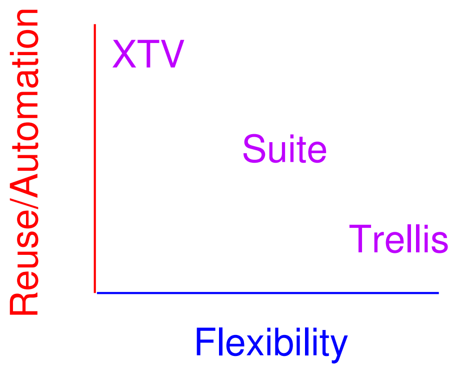


Interoperability vs Standardization

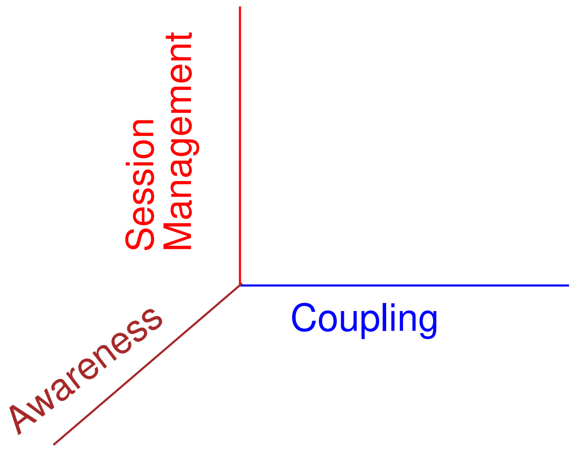
Service Composition



Different Tradeoffs

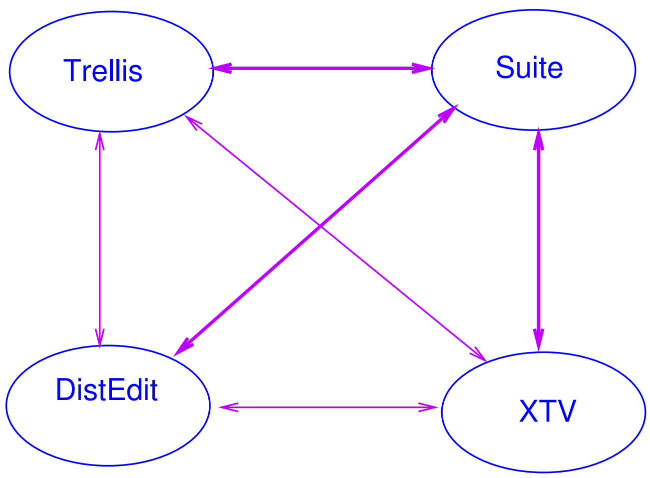


Understanding Colab. Design Space



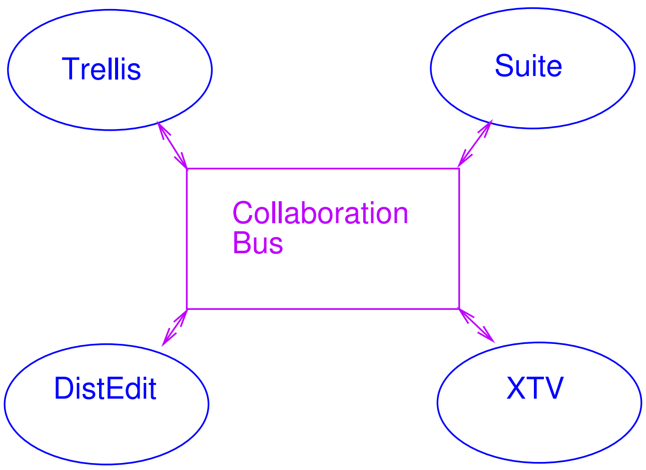
Interoperability Approaches

Direct Connection



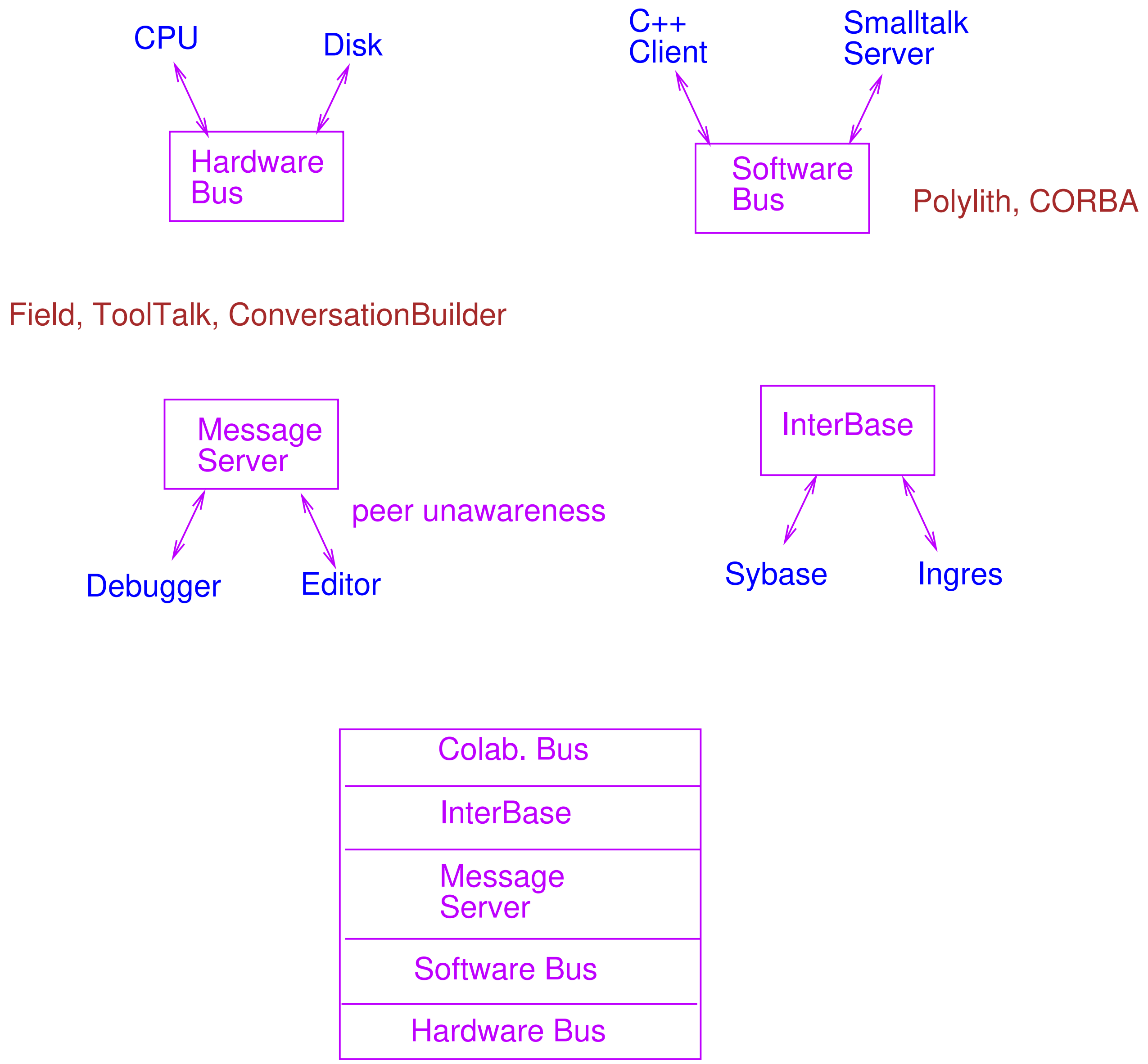
O (n^2) Translations

Bus-based Connection

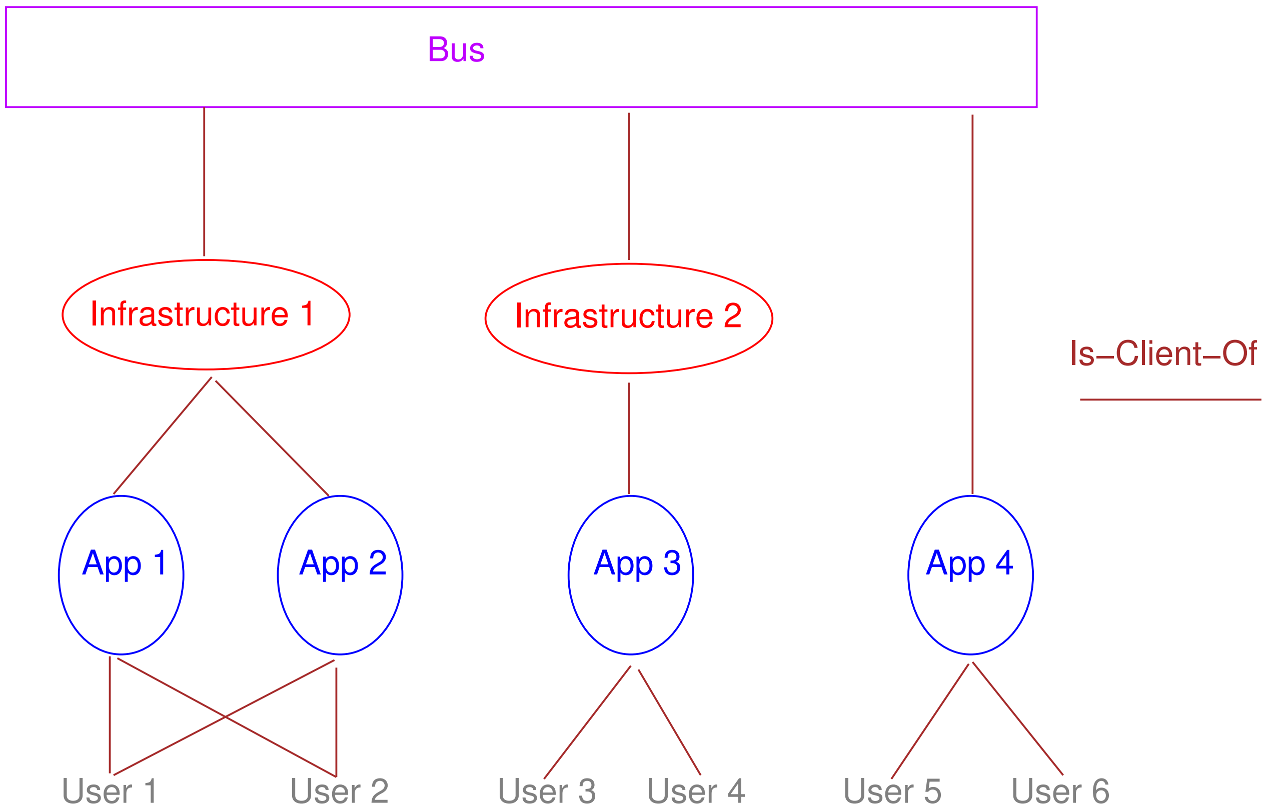


O (n) Translations

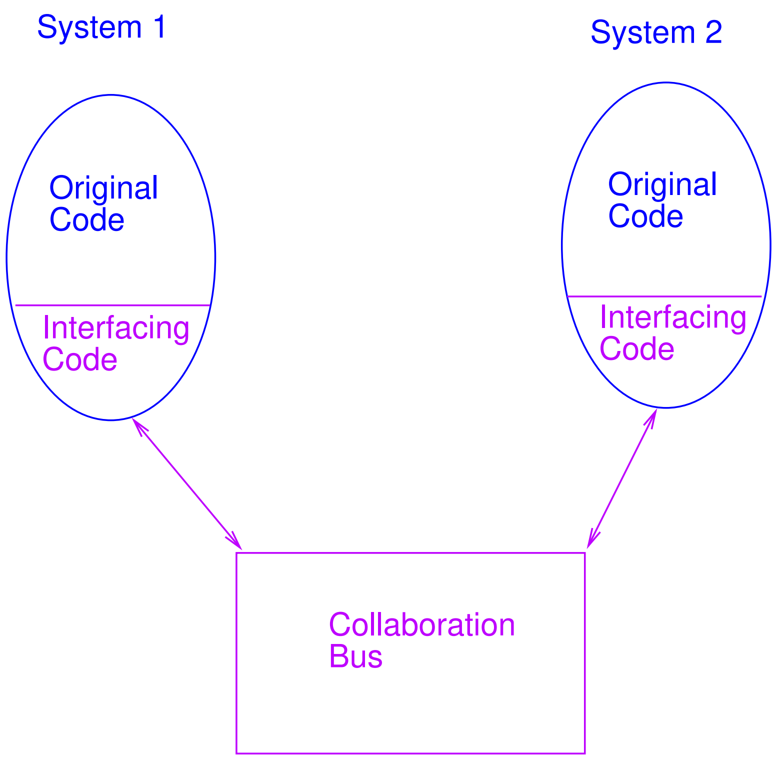
Relationship with other Bus Software



Relationship with other Collaboration Software



Requirements



Generality

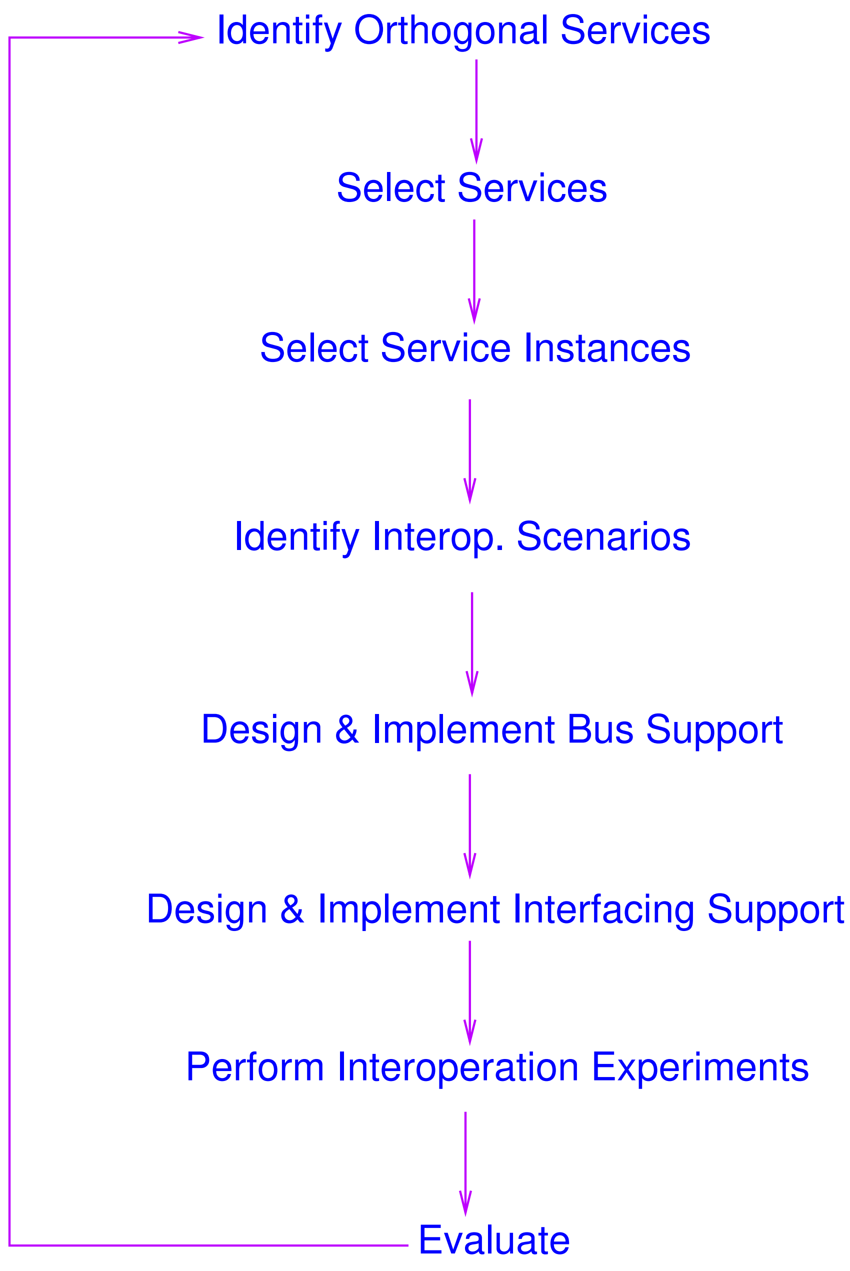
Semantics Preservation

Security

Automation

Efficiency

Incremental, Iterative Approach



Collaboration Services

1–User Services (Data + Semantics + User–Interface)

Session Management

Coupling

Concurrency Control

Process Control

Access Control

Undo/Redo

Merging

Awareness

Function

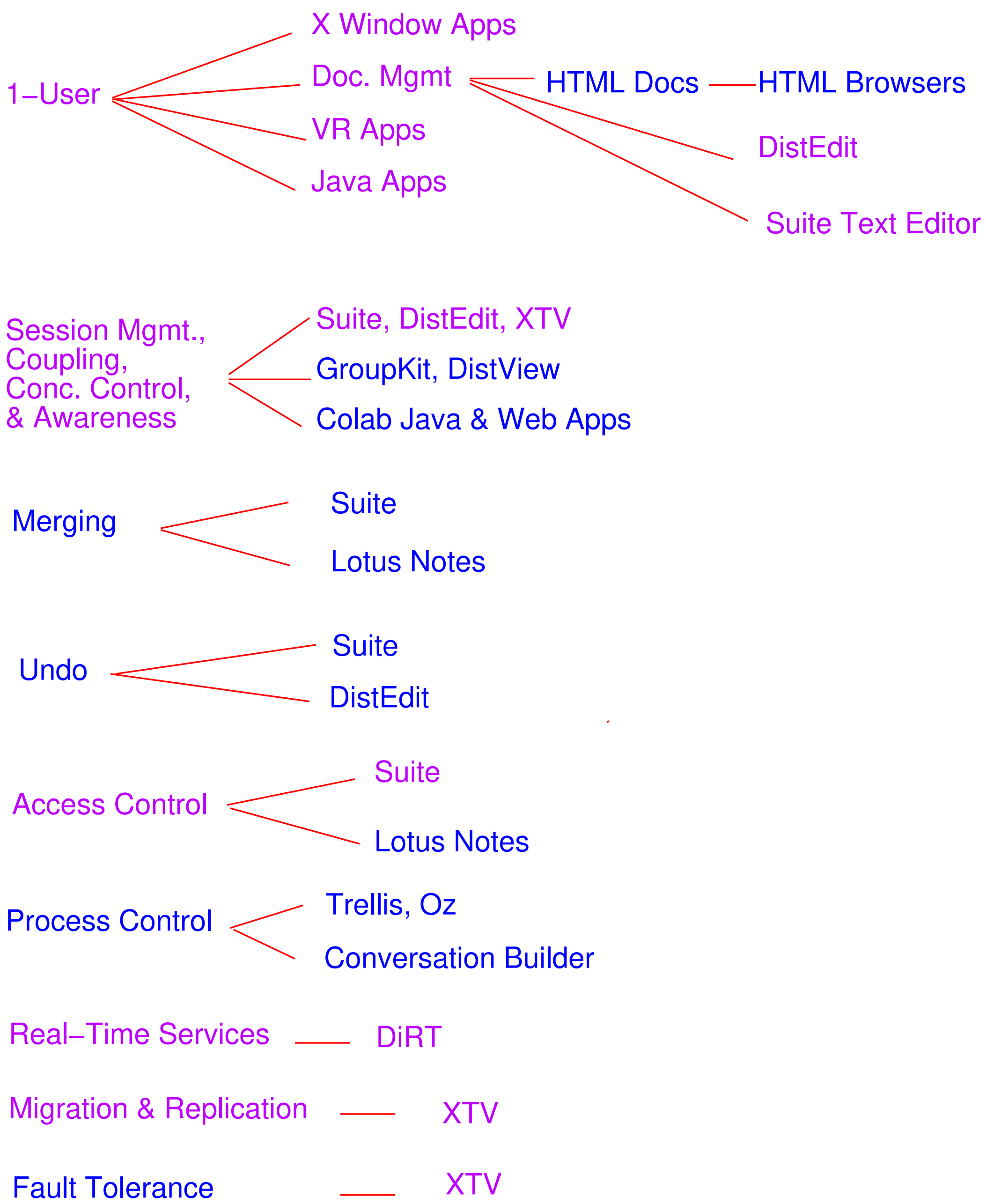
Real–Time (Scheduling + Networking) Support

Replication & Migration

Fault Tolerance

Implementation

Services and Instances



Scenarios

Session Management 1 + Session Management 2

Session Management + Coupling

Coupling1 + Coupling 2

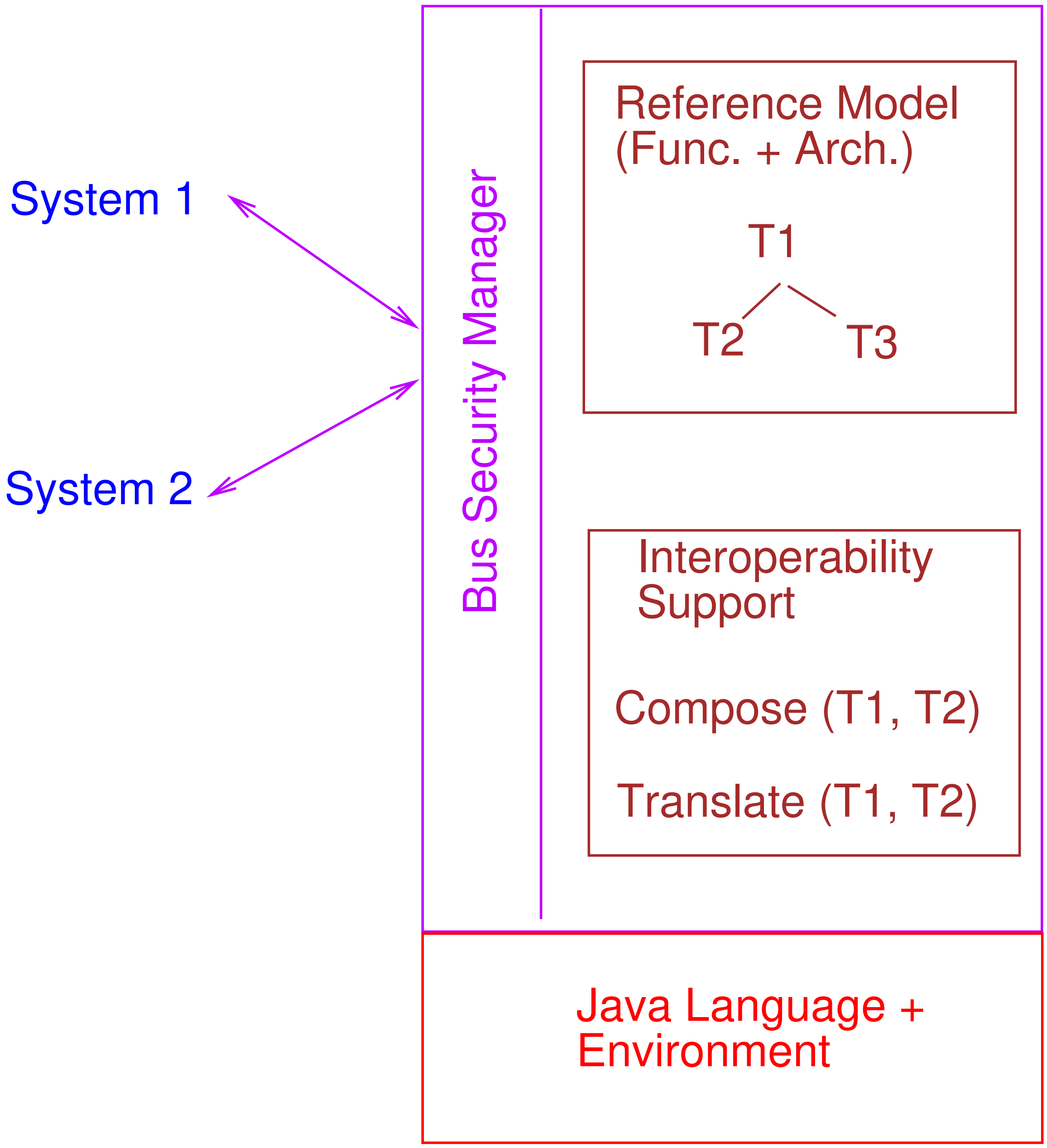
VE + (Flexible) Coupling + Real–Time Services

- Shared View VEs
- Position Coupled VEs
- Shared Model VEs

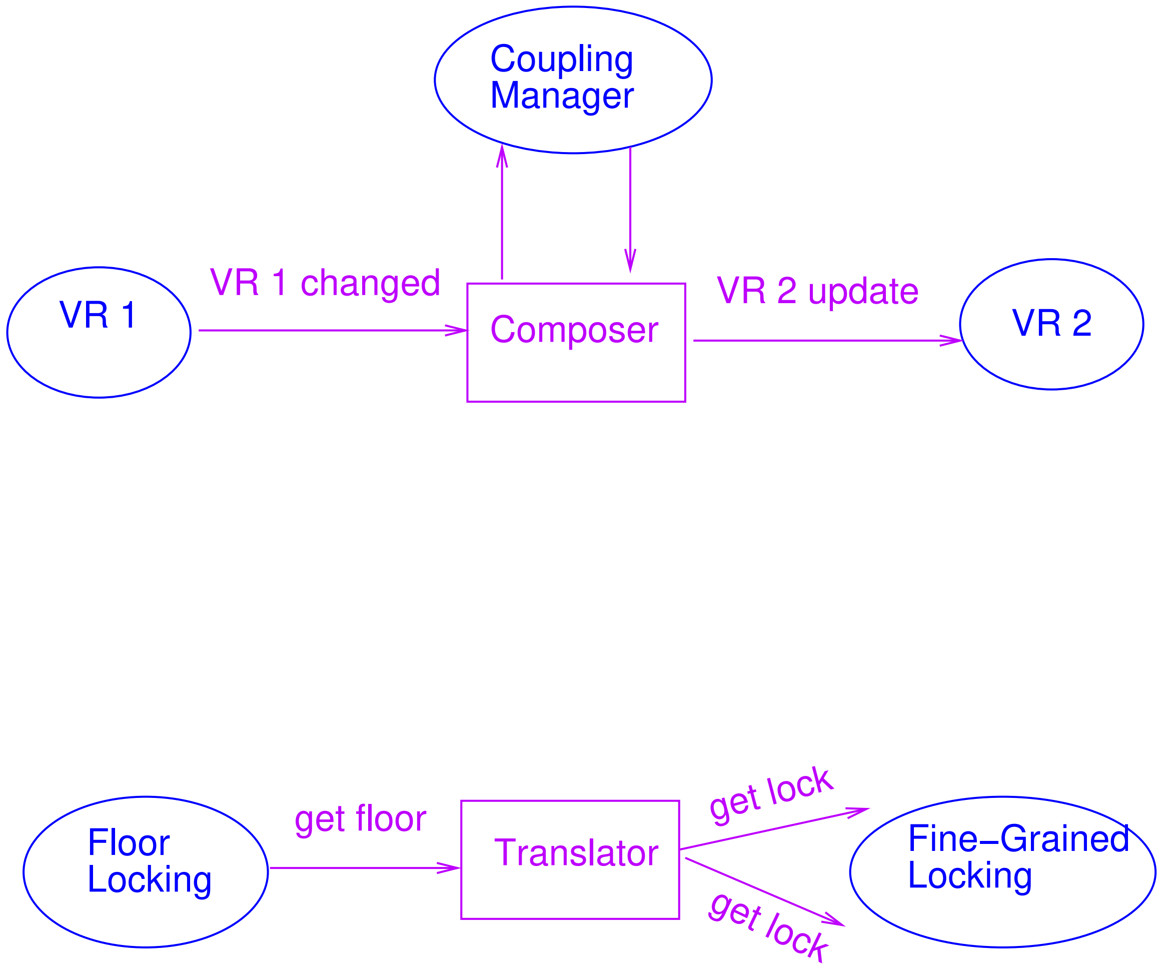
VE + Non–VE + Coupling

VE + VE + Concurrency/Access Control

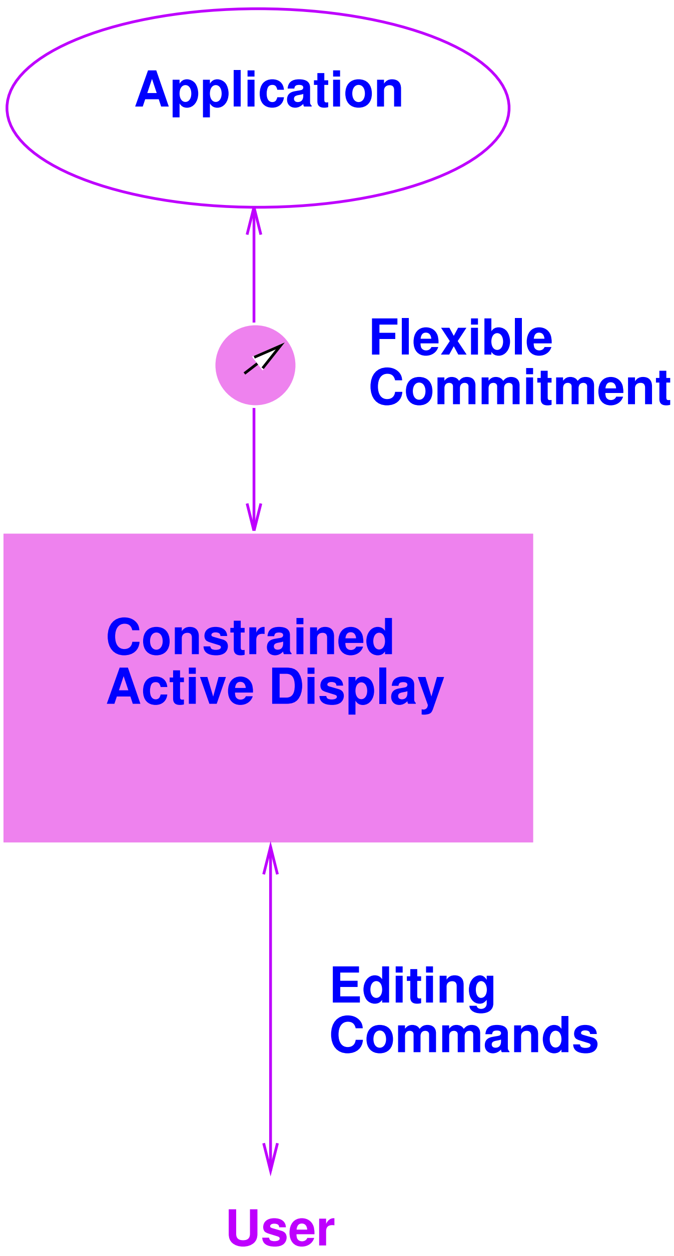
Bus Architecture



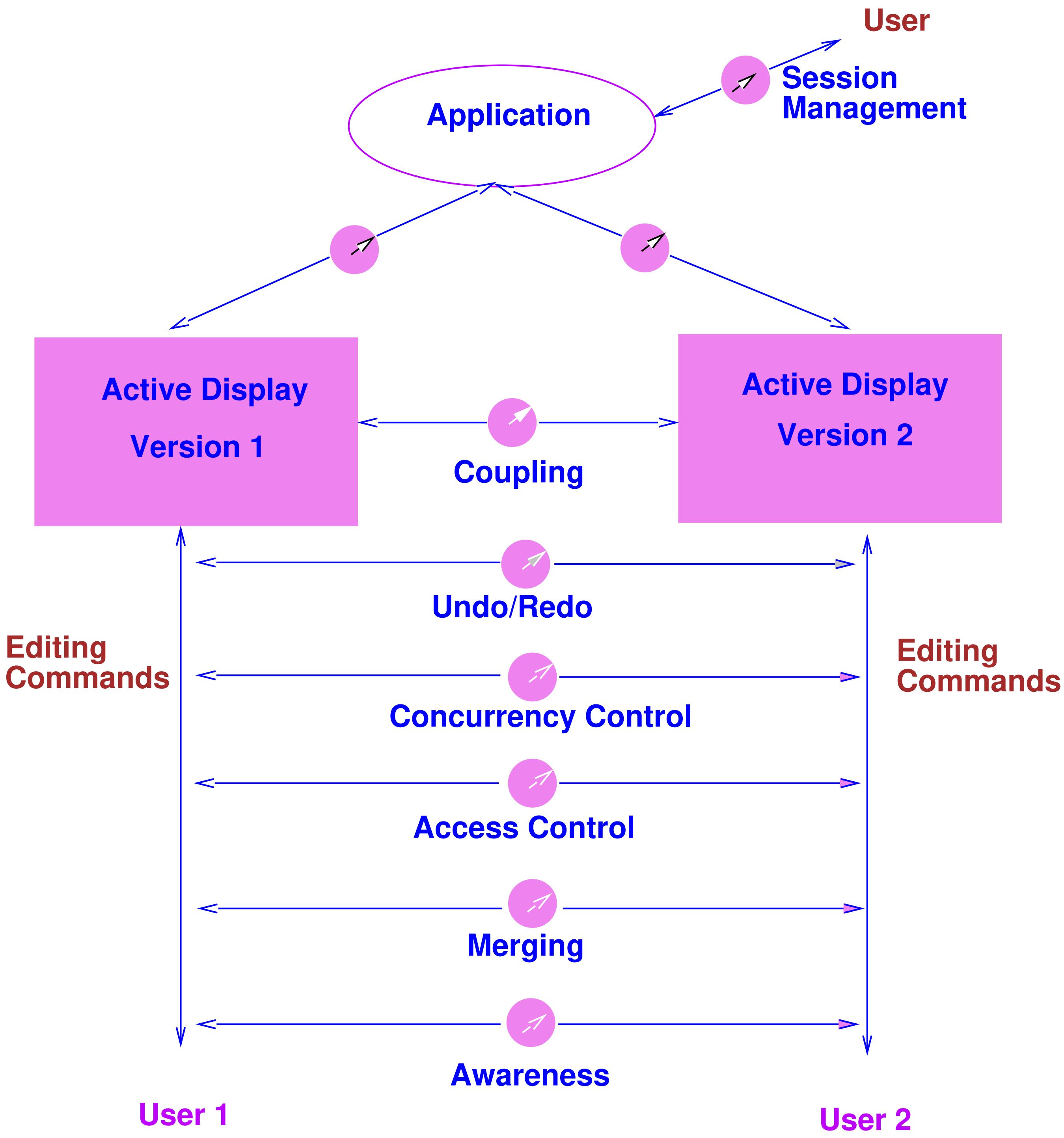
Intra- and Inter- Service Interoperability



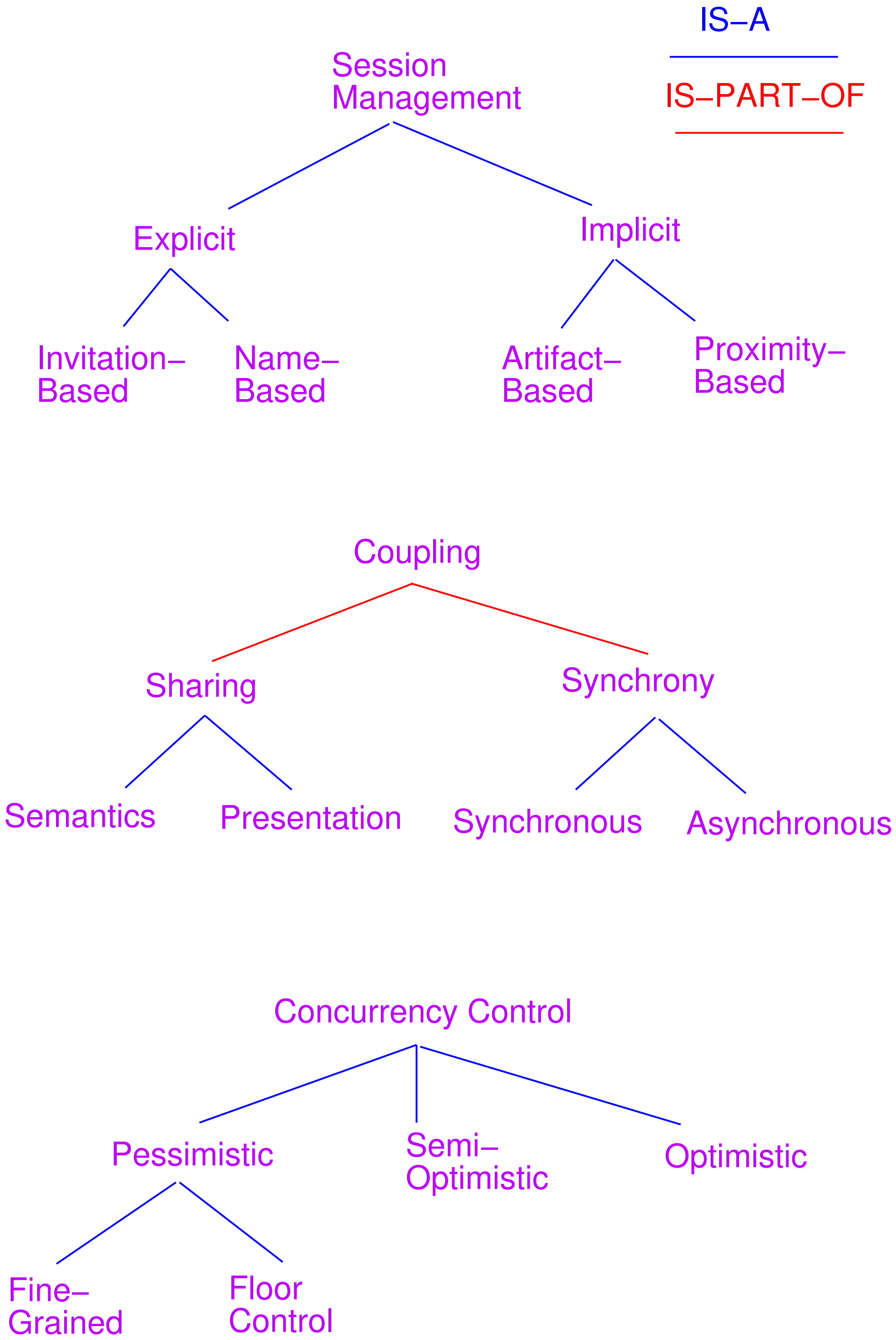
Generalized Single-User Editing



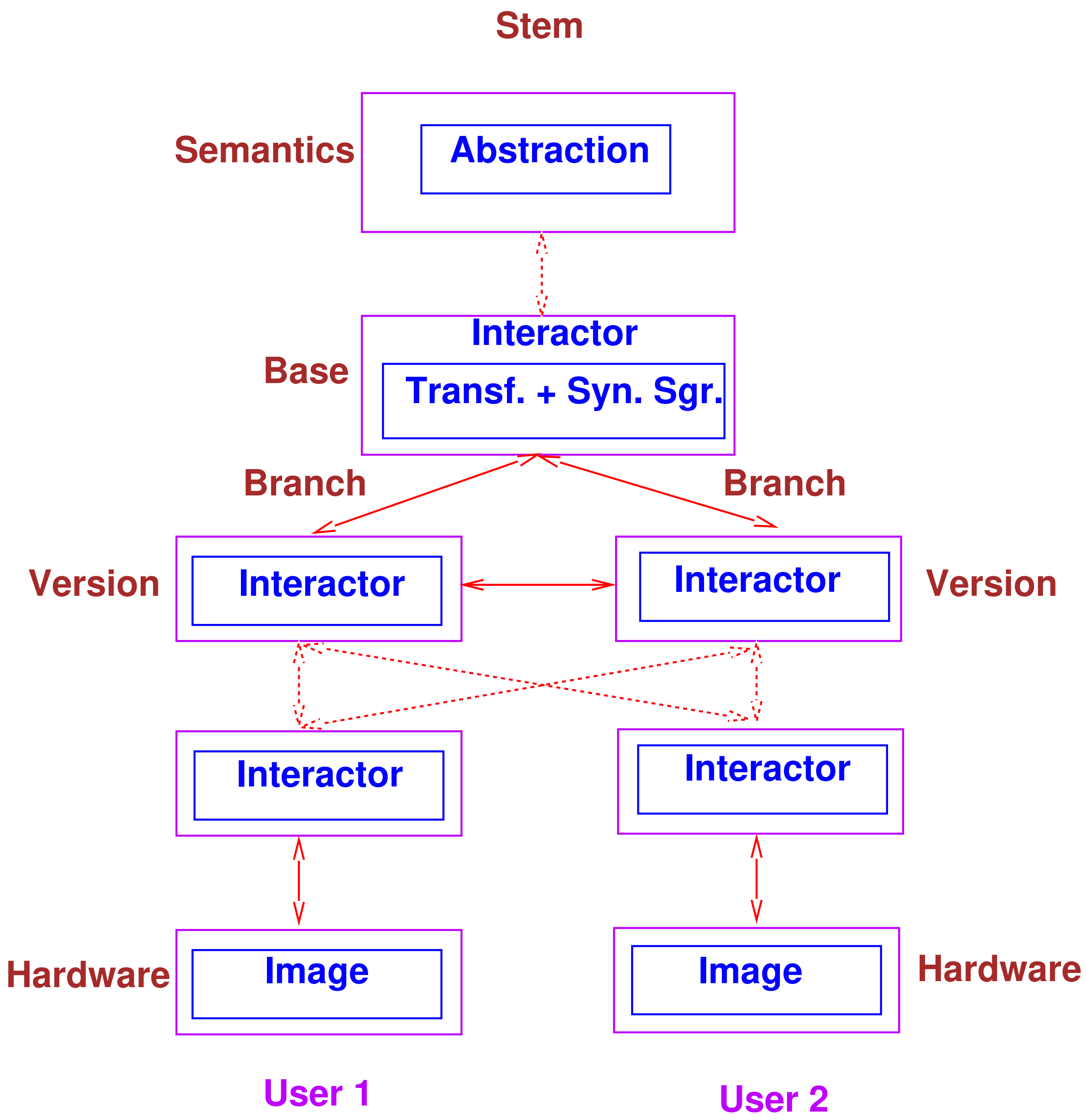
Collaboration Model



Individual Design Spaces



Generic Architecture



Architecture Dimensions

1–User Layering

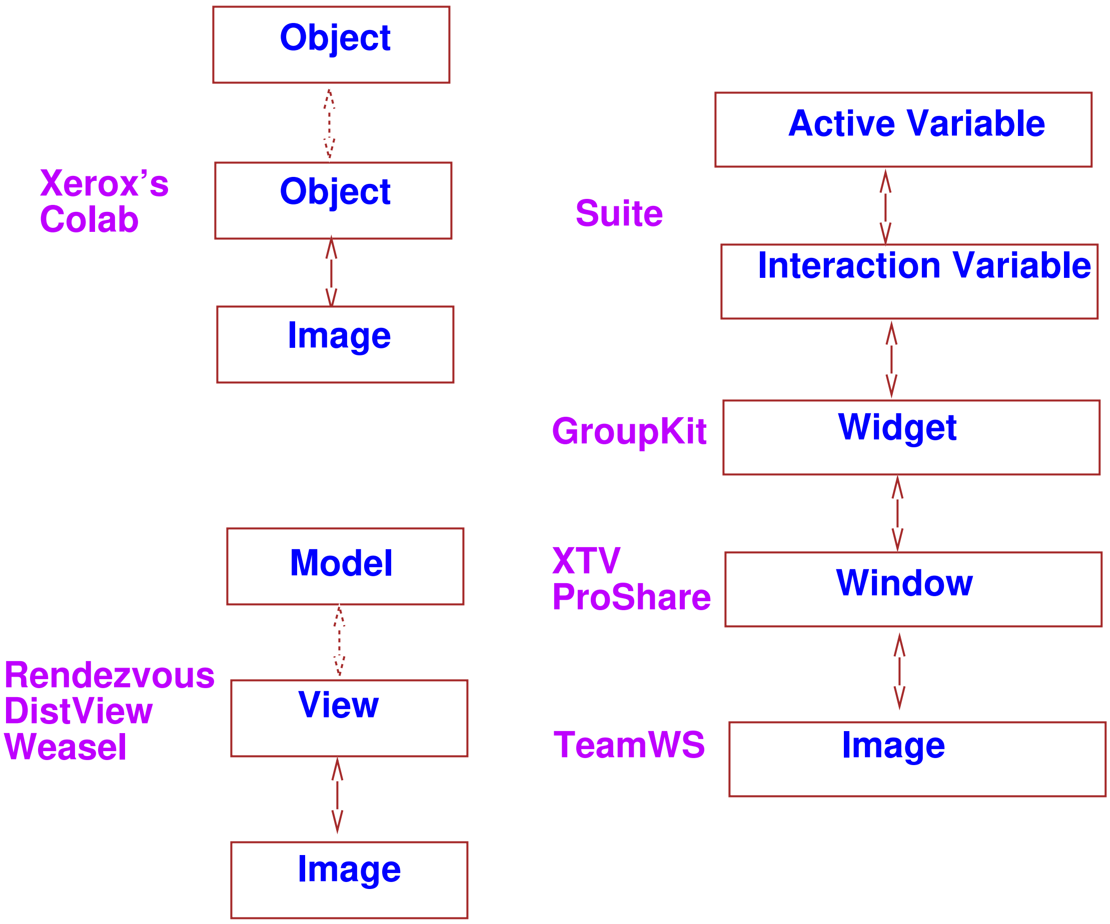
Replication/Versioning

Concurrency/Threading

Distribution

Collaboration Awareness

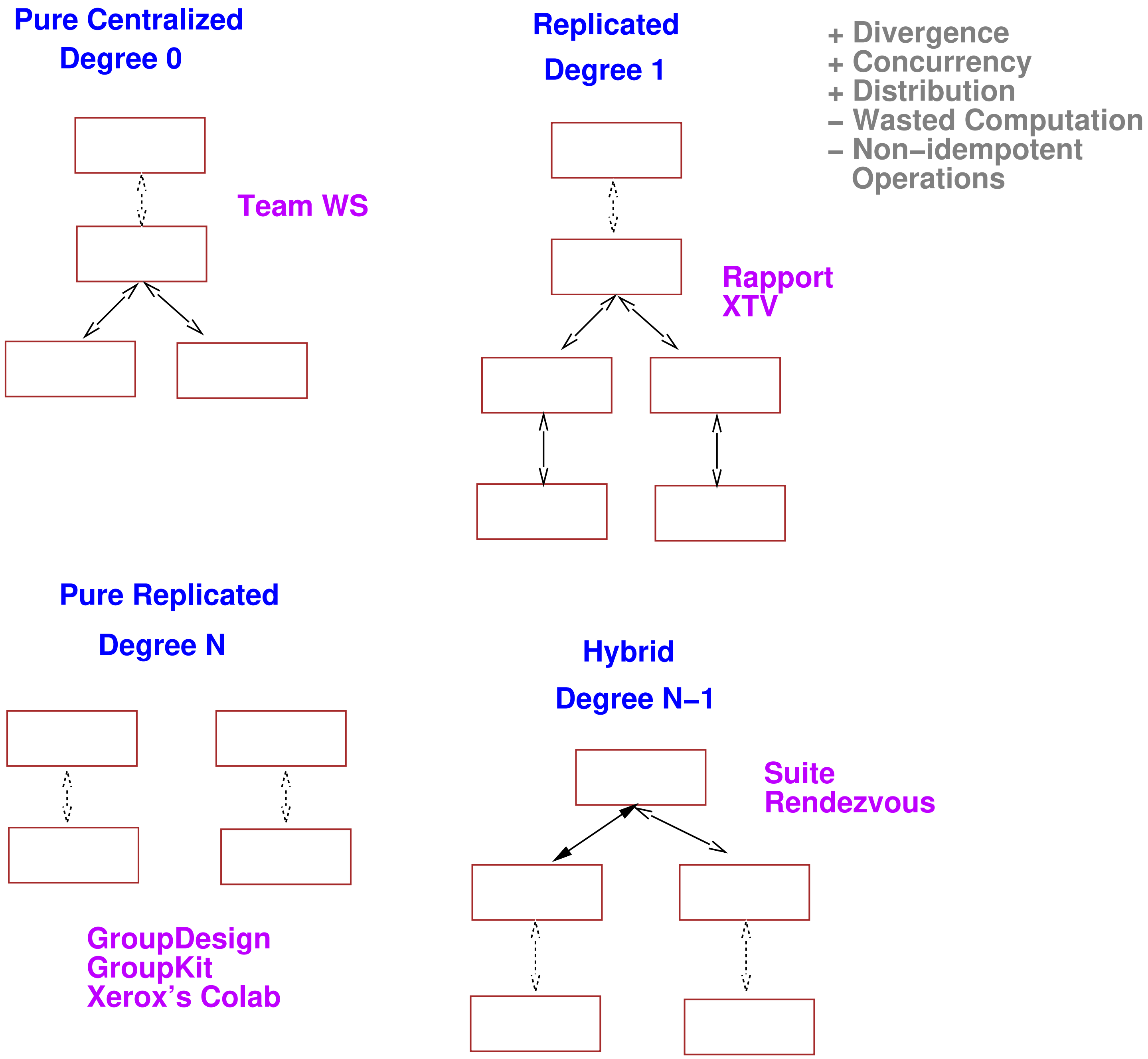
Single-User Layering



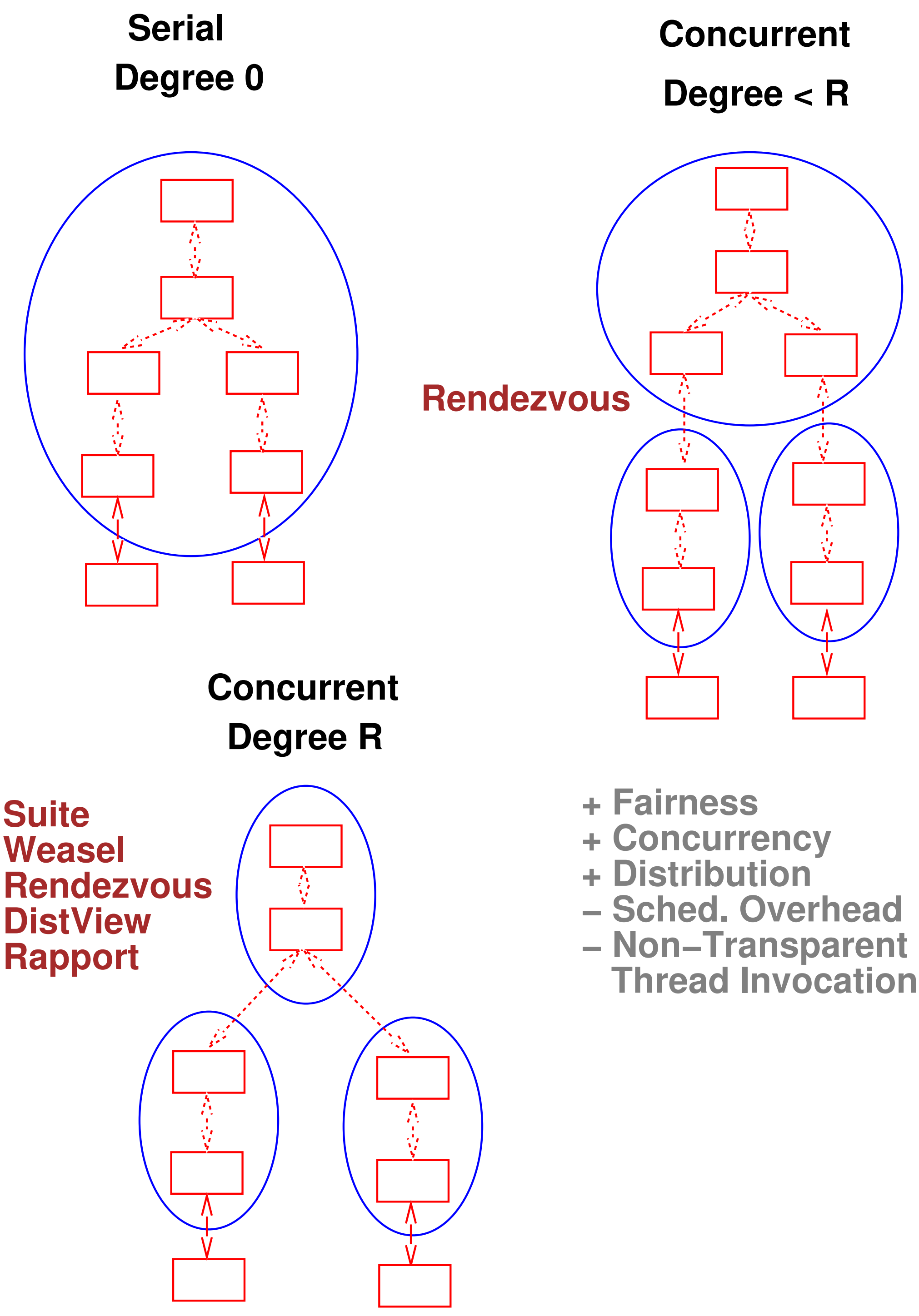
+ Greater
  Replication
  Concurrency
  Distribution
  Awareness

– Less interaction flexibility

Replication

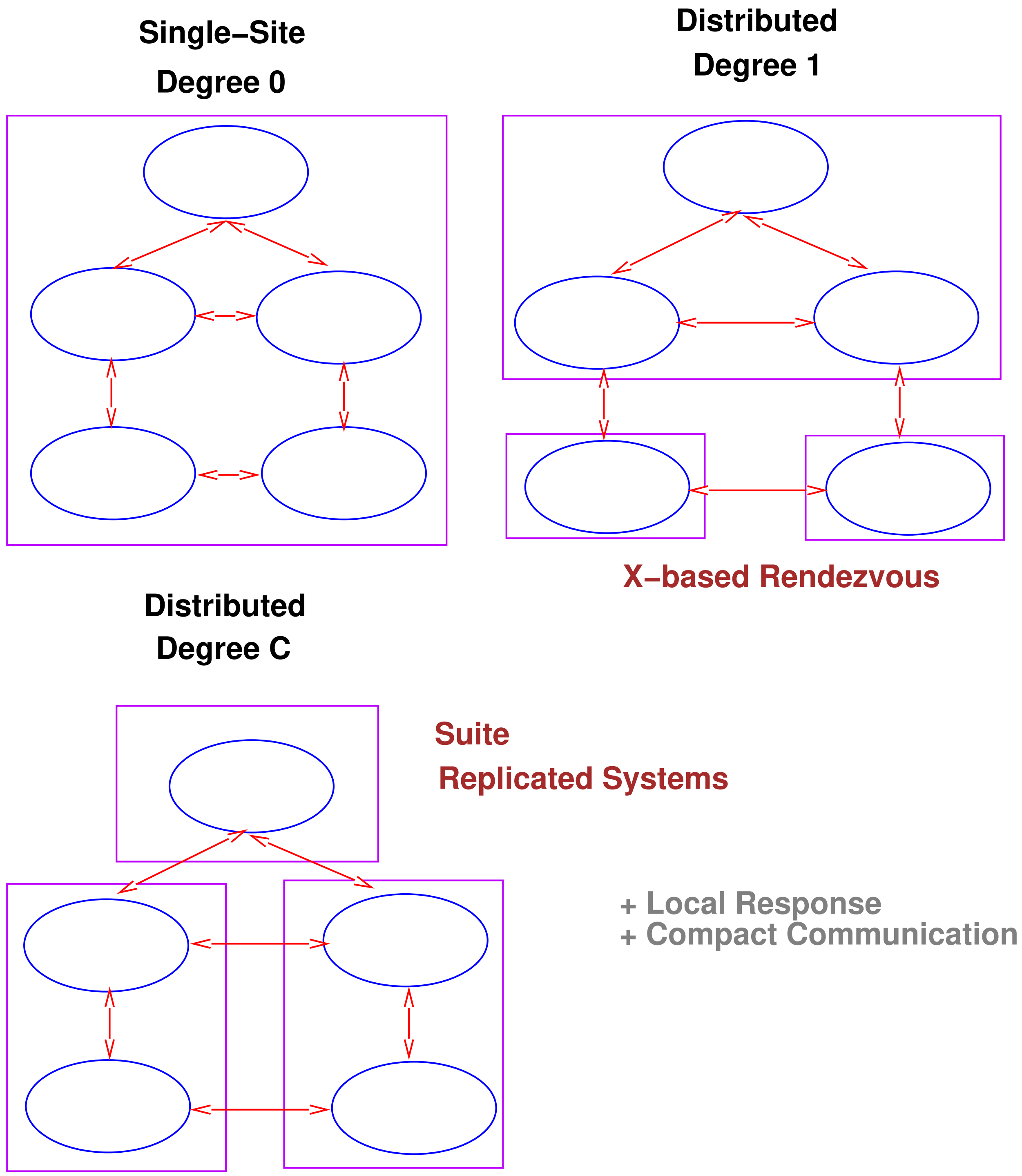


Concurrency

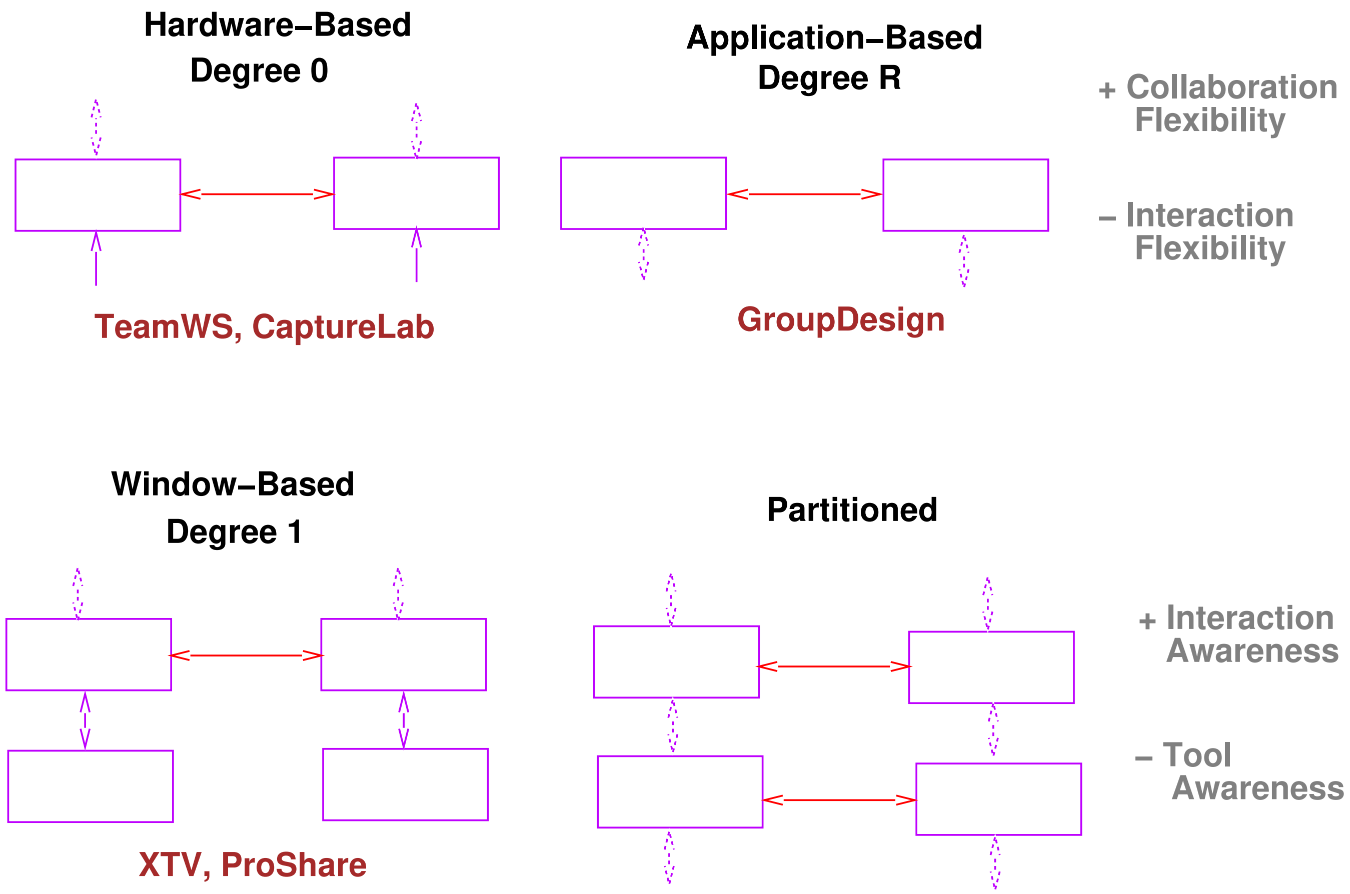


+ Fairness
+ Concurrency
+ Distribution
– Sched. Overhead
– Non–Transparent Thread Invocation

Distribution



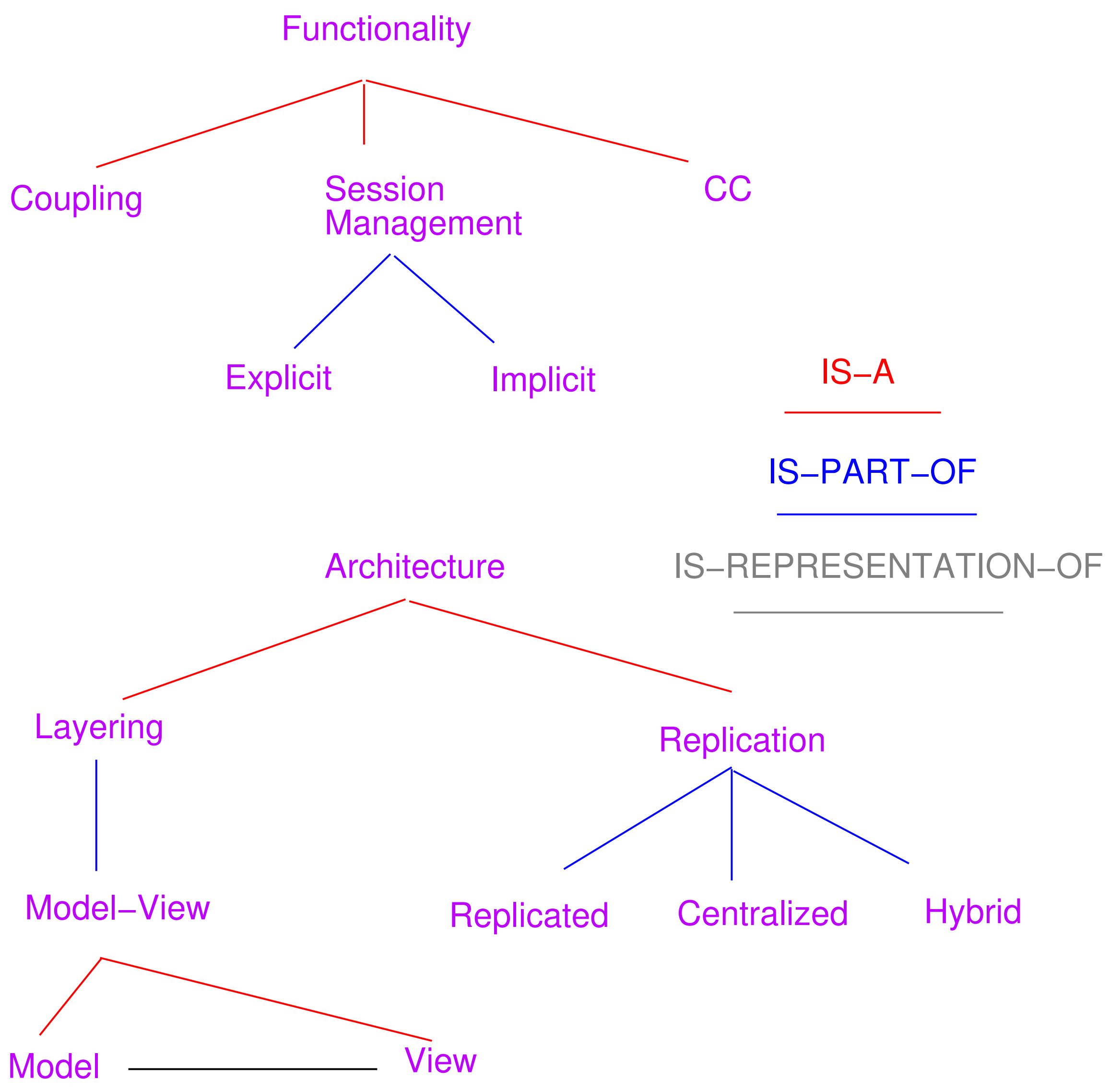
Collaboration-Aware Layers



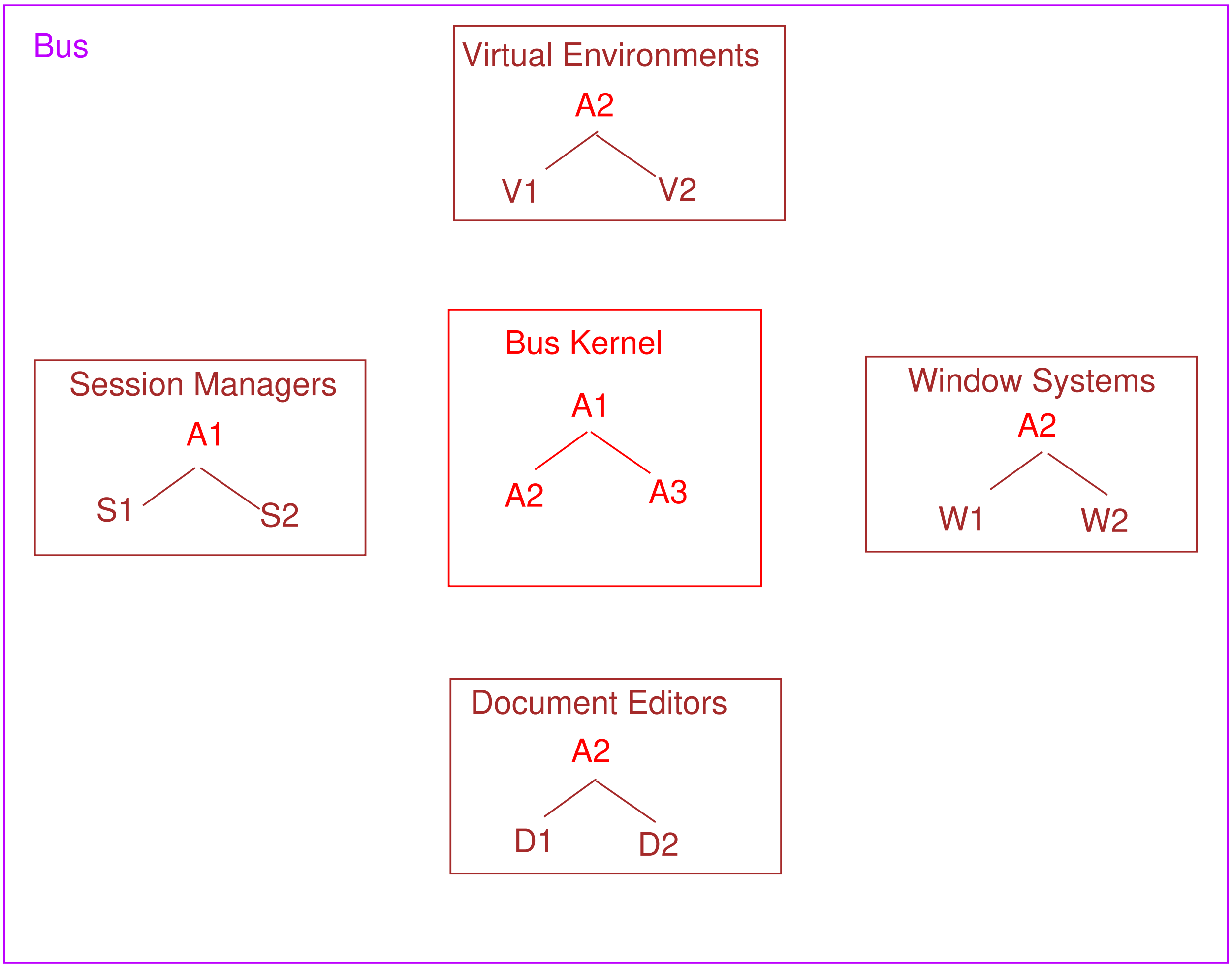
Shared Interactor => Shared Abstraction

Shared Abstraction ≠> Shared Interactor

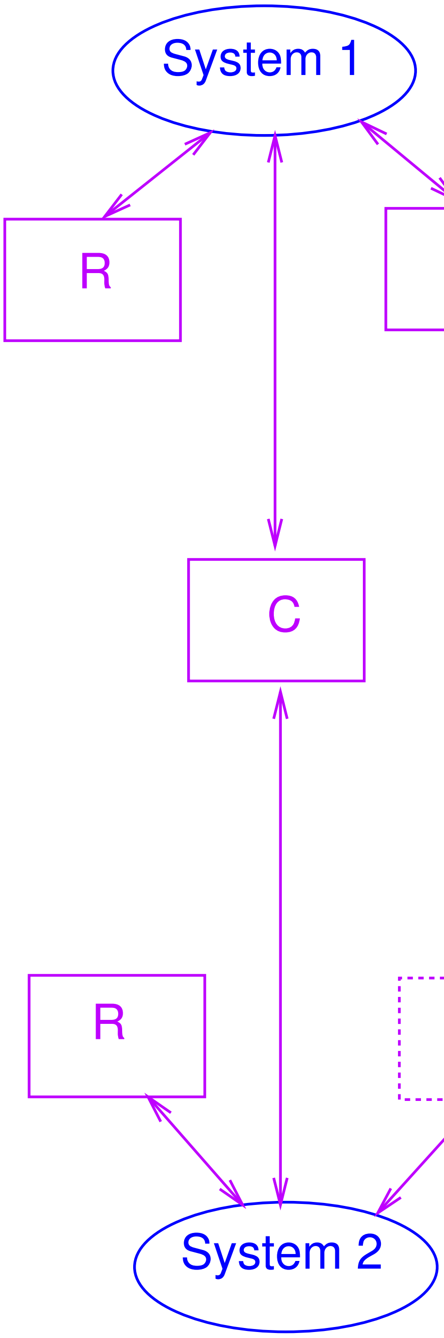
Bus Types


Functionality
Coupling
Session Management
CC
Explicit
Implicit
IS–A
IS–PART–OF
IS–REPRESENTATION–OF
Architecture
Layering
Replication
Model–View
Replicated
Centralized
Hybrid
Model
View

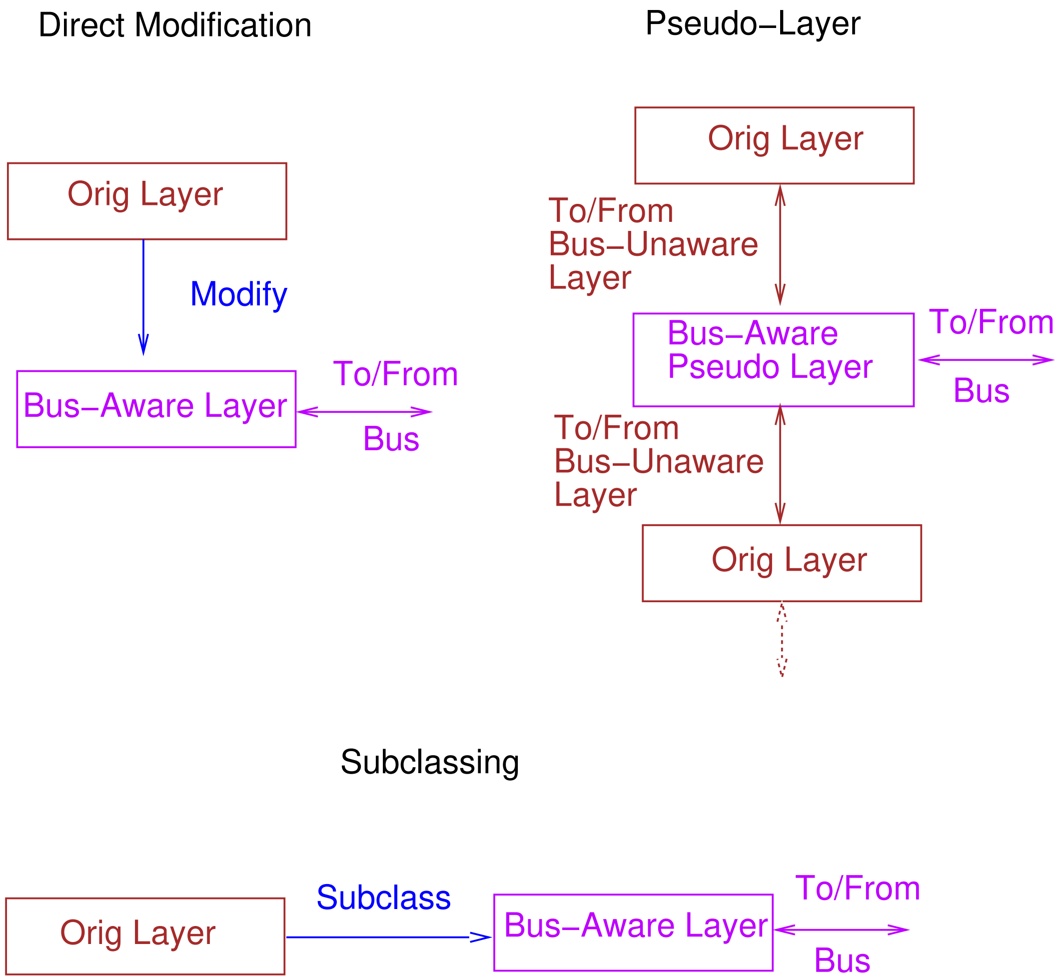
Bus Decomposition



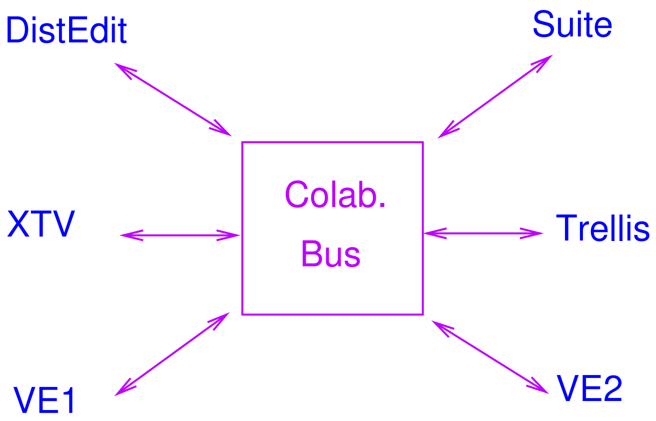
Bus Physical Architecture



Interfacing to the Bus



Experiments and Evaluation



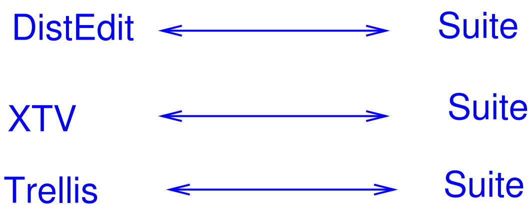
Interfacing Code

Performance

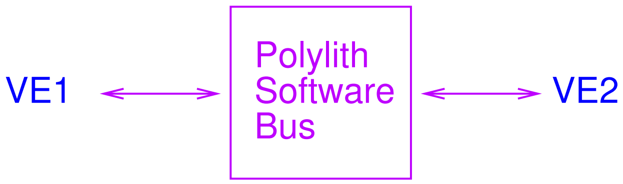
Compromises

Mismatches

Comparison with Direct Interconnection



Comparison with Lower−Level Bus Interconnection



Milestones & Schedule

Milestone	Date
Identification of Bus Clients & Interoperation Scenarios	2/97
Design of Bus Version 1: Support for Session Management, Coupling, VE, and associated Reference Models Characterization of Real–Time requirements of Colab. VEs based on initial experiments	9/97
Implementation of Bus Version 1	2/98
Interconnection experiments with Version 1 Design of Bus Version 2: Version 1 extension with support for Awareness, Concurrency & Access Control, Real–Time Services, Replication/Migration and Security & associated Reference Model	9/98
Implementation of Bus Version 2	2/99
Interconnection experiments with Bus Version 2	9/99