Strategic Planning for IT Support of Grant-funded Research

(http://www.esp.org/rjr/briite-01.pdf)

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Strategic Planning for IT Support of Grant-funded Research

Eh?

Strategic Planning: >= 5 years

Grant-funded: <= 5 years

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But what is the essence of generic support for IT support of grant-funded research?

How can you do strategic planning

Is it perhaps,

CENTRALIZED SUPPORT FOR
DISTRIBUTED COMPUTING

support for IT support of grant-
funded research?

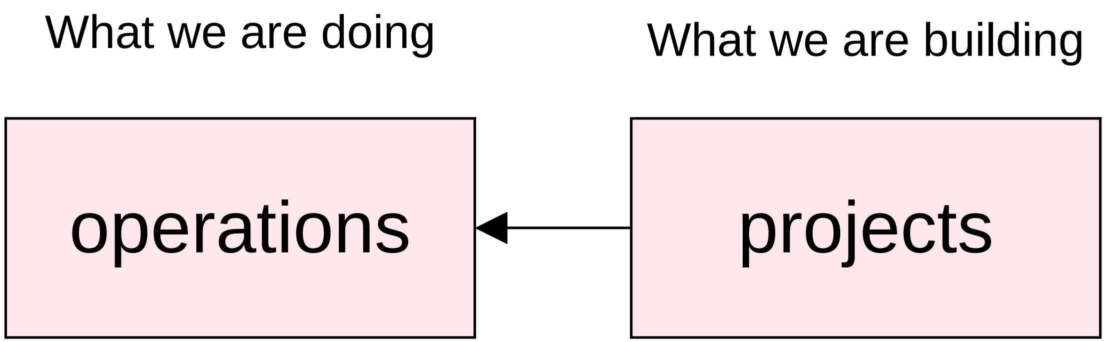
Strategic Planning for grant-funded research requires ***fourth-box*** thinking: a strategic architectural vision in response to some driving question.

Strategic Planning

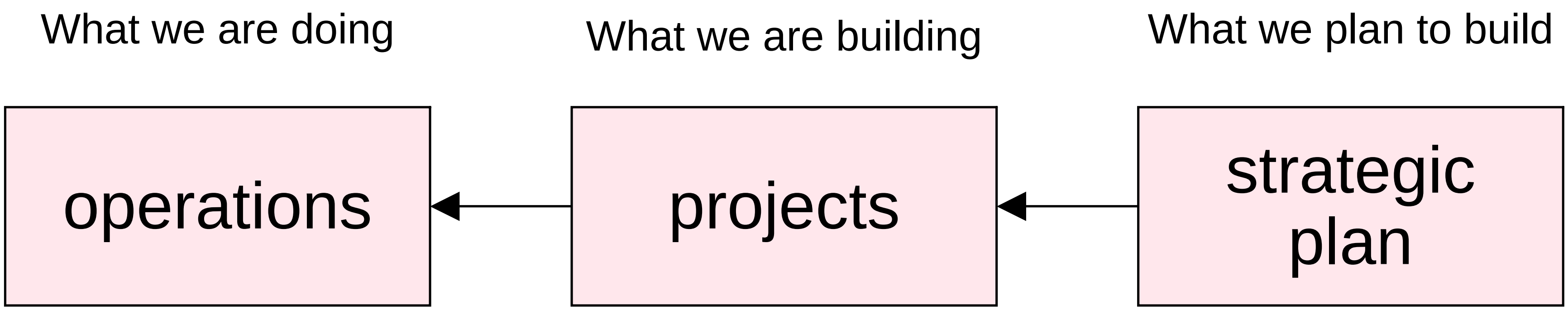
What we are doing

operations

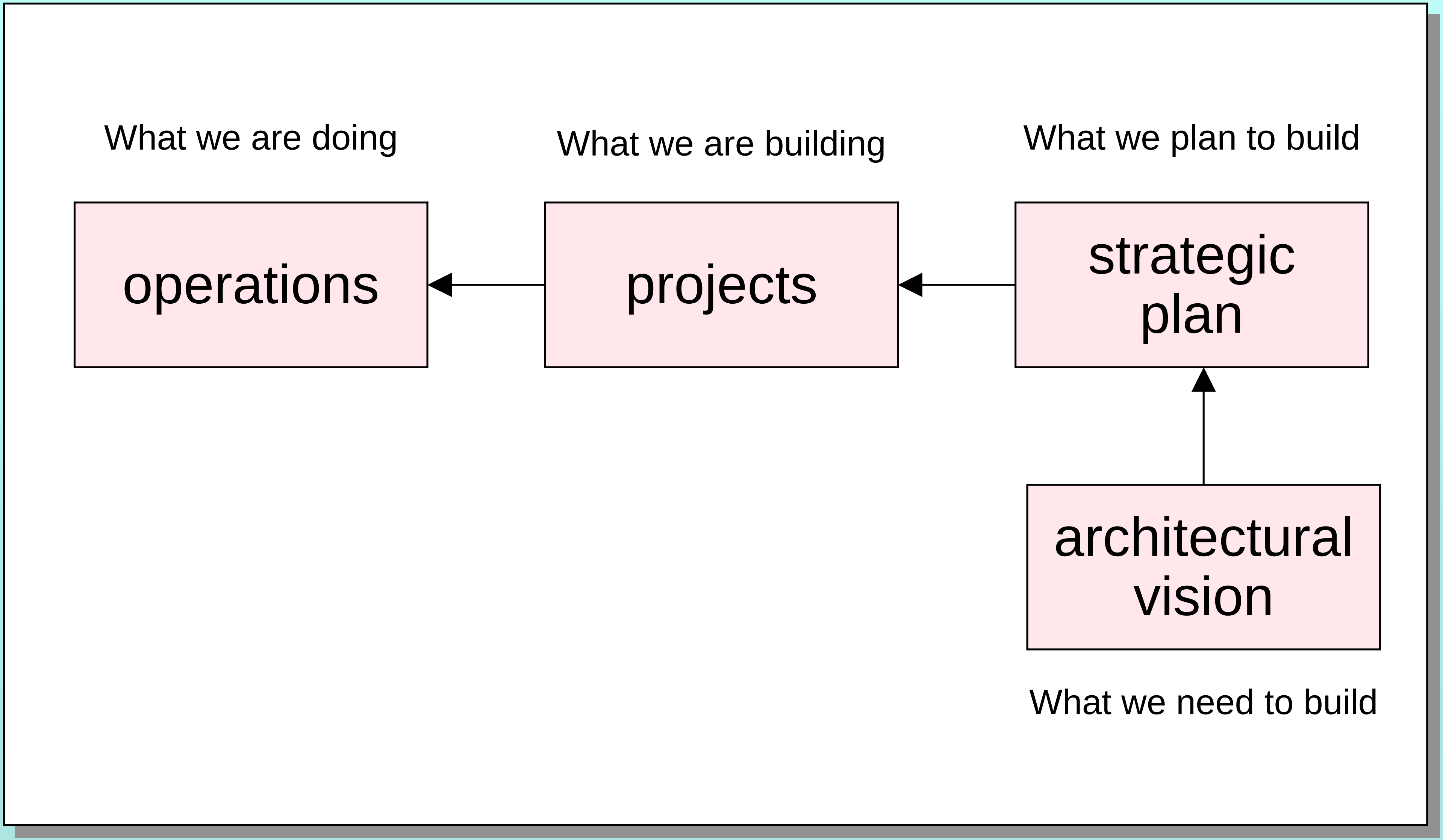
Strategic Planning



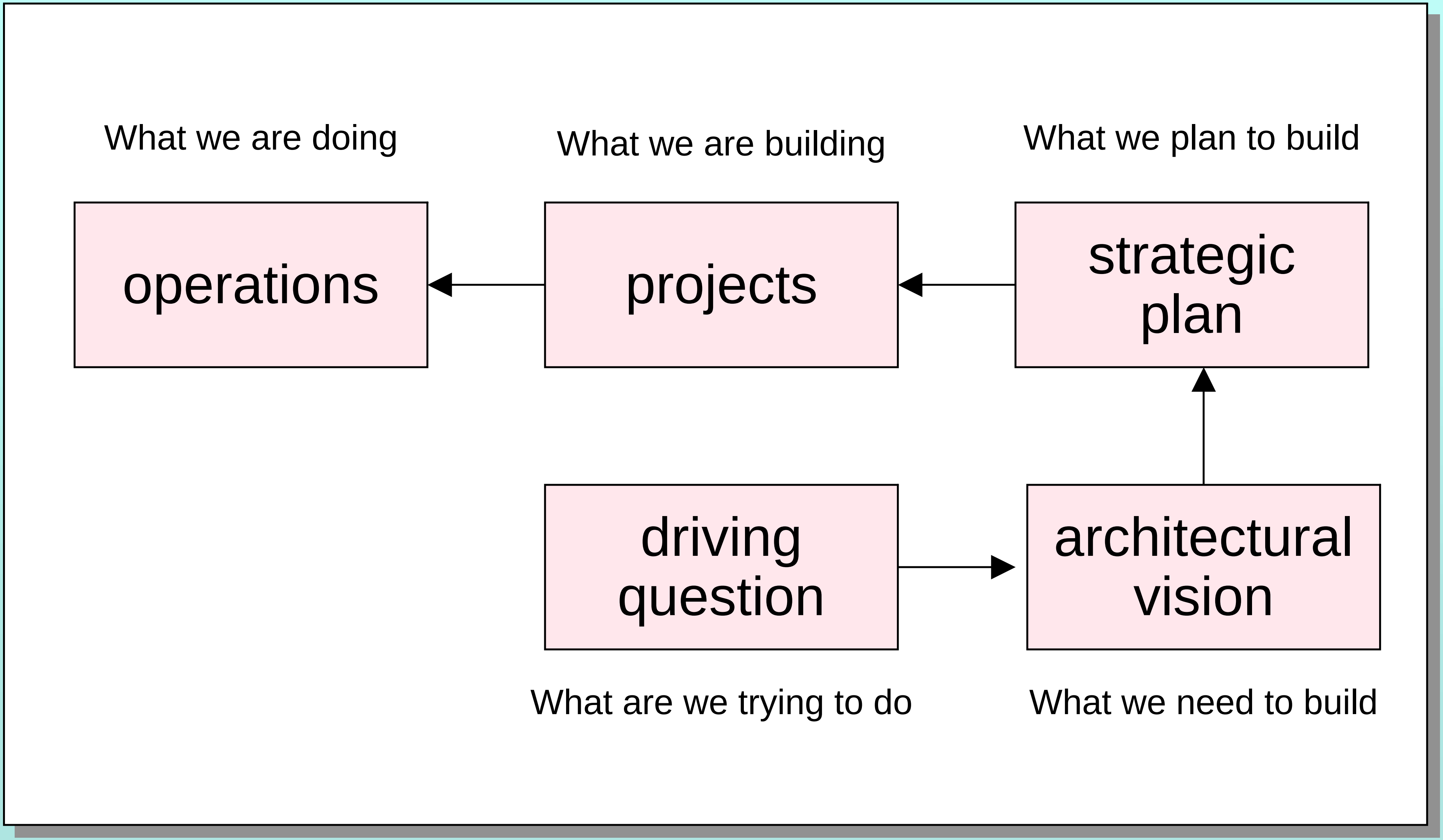
Strategic Planning



Strategic Planning



Strategic Planning



Strategic Planning

Example of important driving question:

Q: How could you design a communication system that will continue to function, even when pieces have been totally destroyed?

Strategic Planning

W uild

al

o build

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A: ARPANET packet-switched network

Strategic Planning

Example of important driving question:

Q: How can you get different networks, using different computers and different operating systems and different network protocols to interoperate?

Strategic Planning

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Q: How can you get different networks, using different computers and different operating systems and different network protocols to interoperate?

A: TCP / IP (the INTERNET)

Strategic Planning

Example of important driving question:

Q: How could you separate business logic from the technical manipulation of the contents of databases?

Strategic Planning

Example of important driving question:

Q: How could you separate business logic from the technical manipulation of the contents of databases?

A: The RELATIONAL MODEL of databases.

Strategic Planning

Example of important driving question:

Q: What can a biomedical institution do to maximize the effectiveness of IT at the level of individual grants?

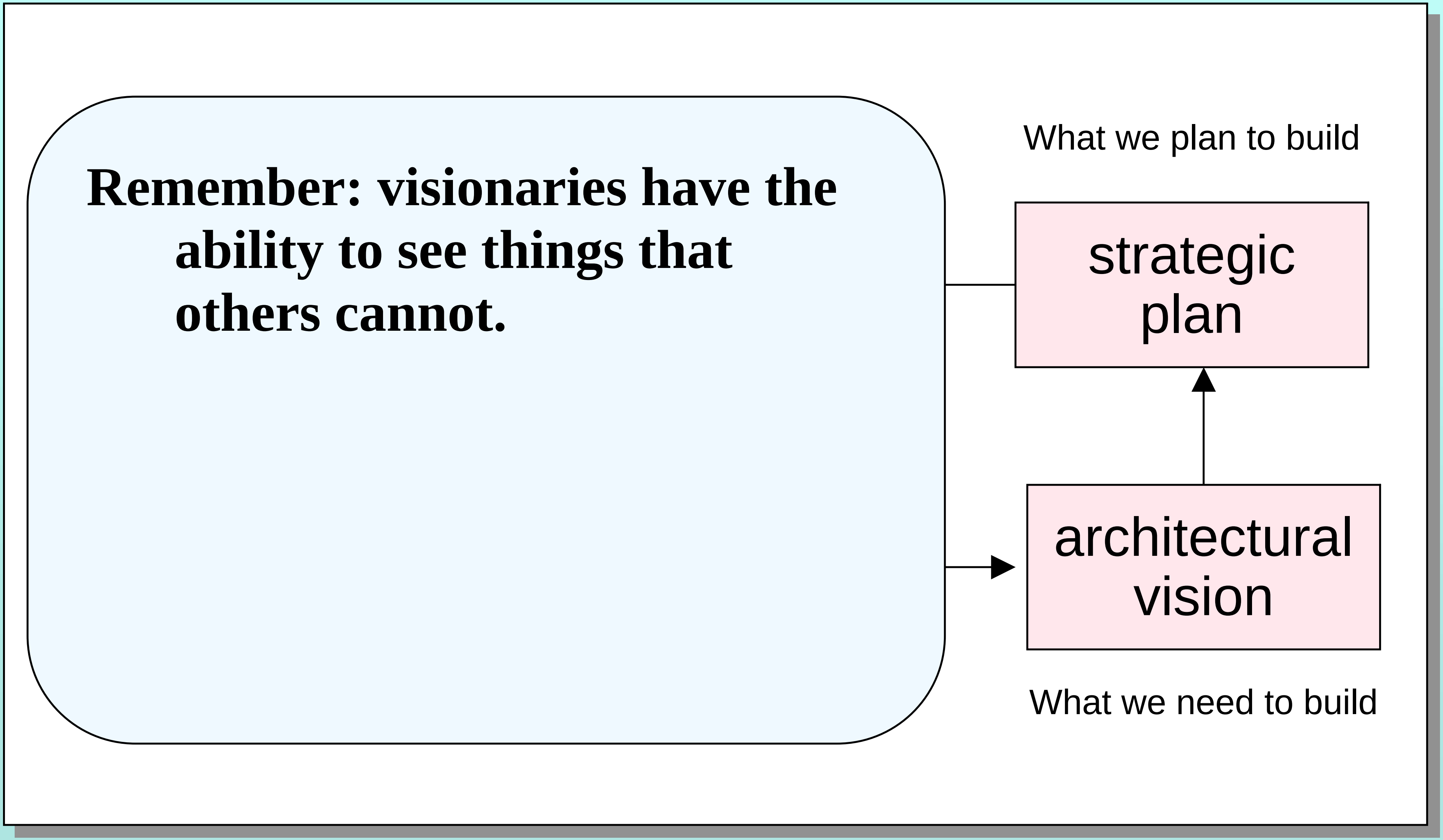
Strategic Planning

Example of important driving question:

Q: What can a biomedical institution do to maximize the effectiveness of IT at the level of individual grants?

A: That's the question for this meeting. A strong case can be made for centralized support of distributed computing.

Strategic Planning

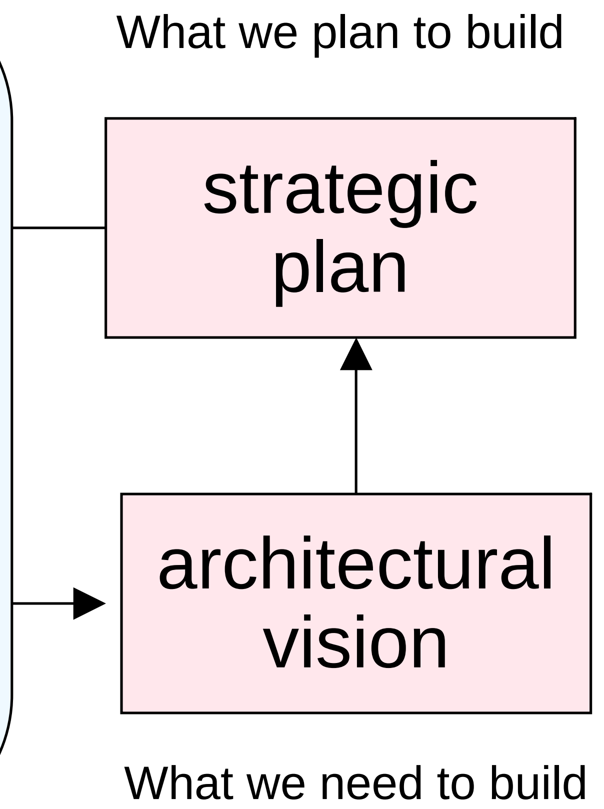


Strategic Planning

Remember: visionaries have the ability to see things that others cannot.

This is also true of those with various forms of dementia.

Expect some skepticism along the way…



Strategic Planning

TCP / IP networking and RDBMS are two of the most useful tools in the history of IT.

What can we learn from the history of their development?

Conclusions (Inferences)

- Truly valuable IT comes from a driving question, informing an architectural vision.

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Conclusions (Inferences)

- Truly valuable IT comes from a driving question, informing an architectural vision.
- You must know your GOAL and handle the trade-offs accordingly.
- The resulting architectural vision may have a NEWSPEAK flavor.
- Ultimately, the results are stunning in their power, flexibility, and extensibility.

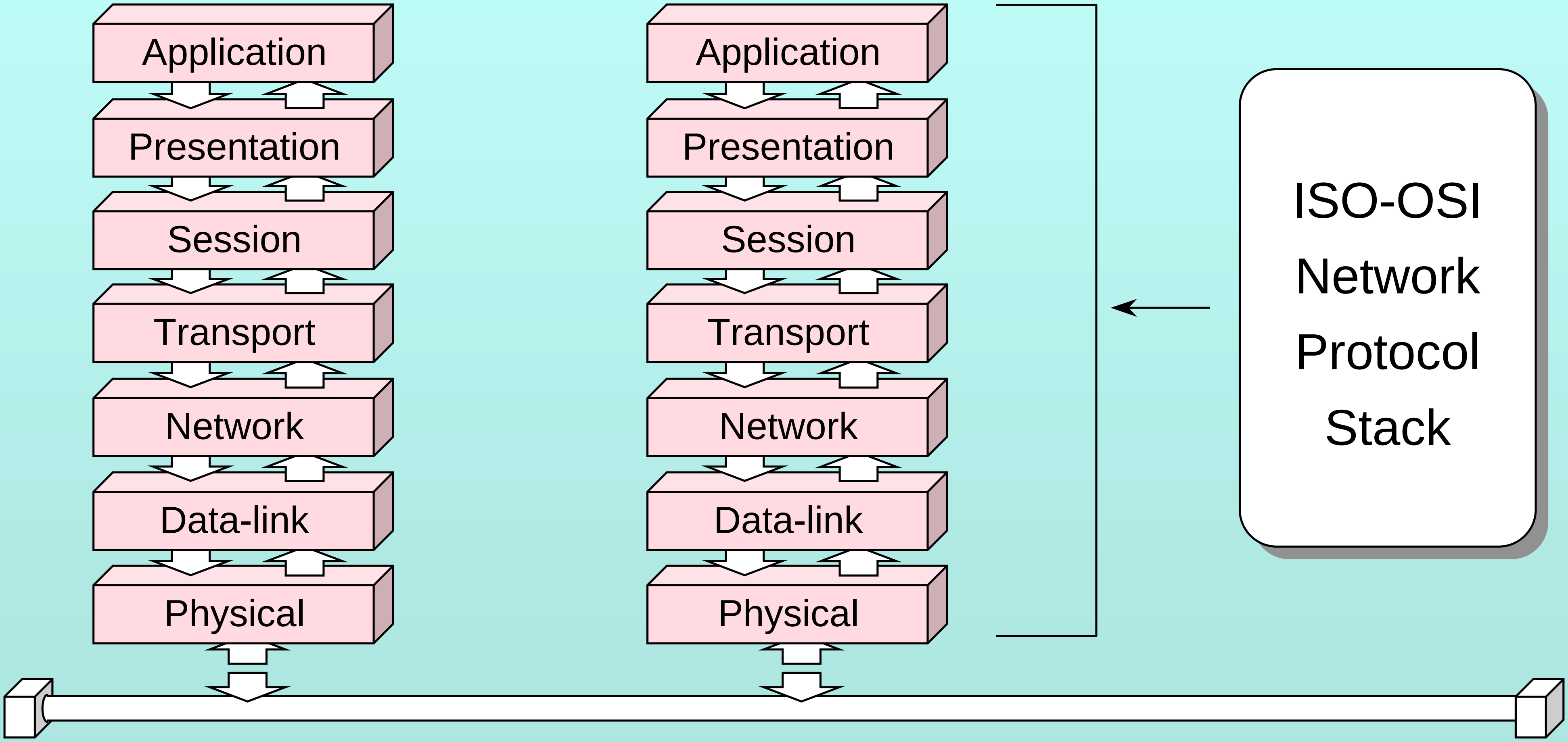
TCP/IP Network Model

Technology

Technical Attributes

- Highly abstracted components
- Layered architecture
- Modular construction
- Clearly defined interfaces
- No interactions except through interfaces
- Declarative user interface

ISO-OSI Network Model



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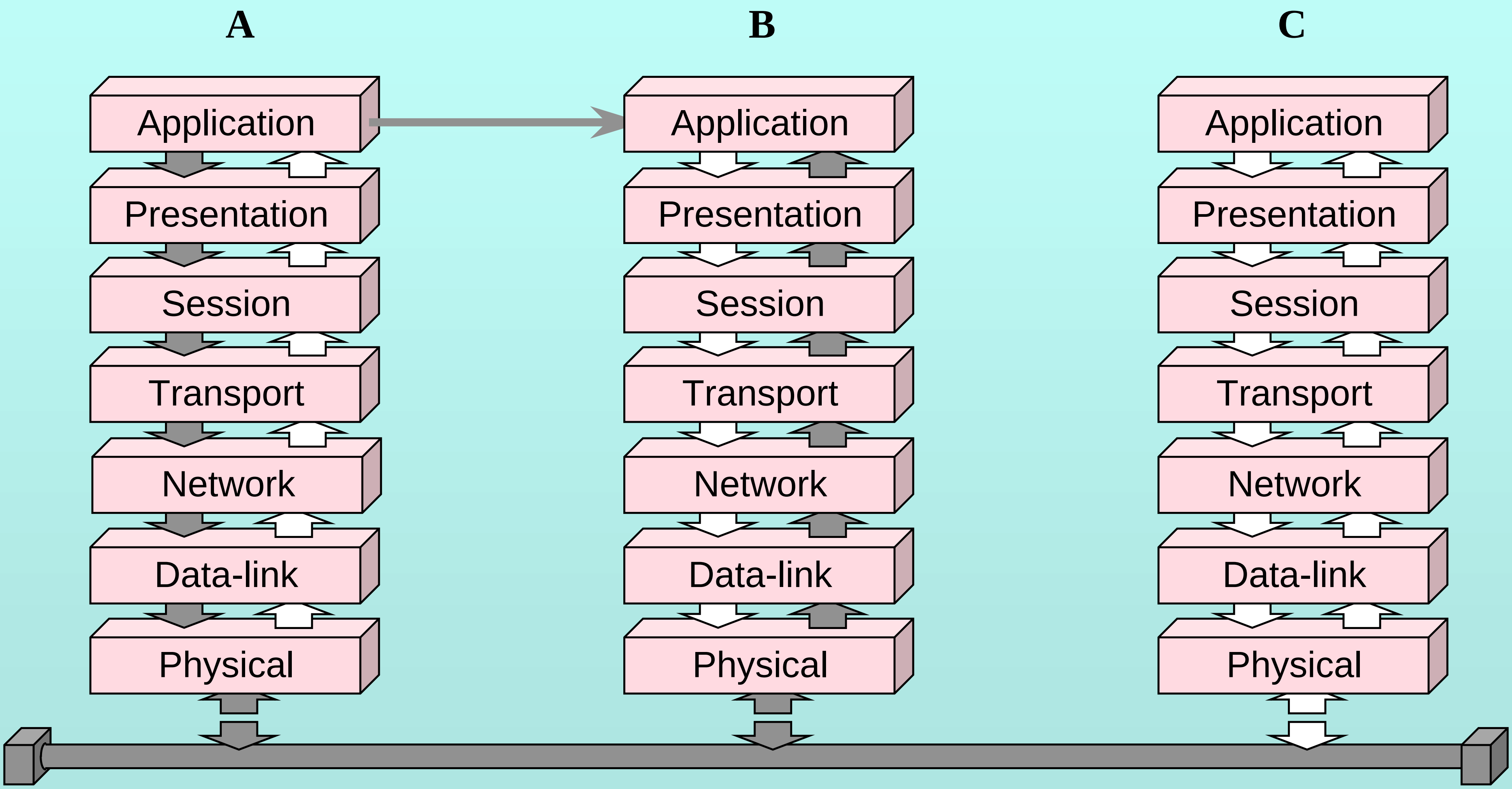
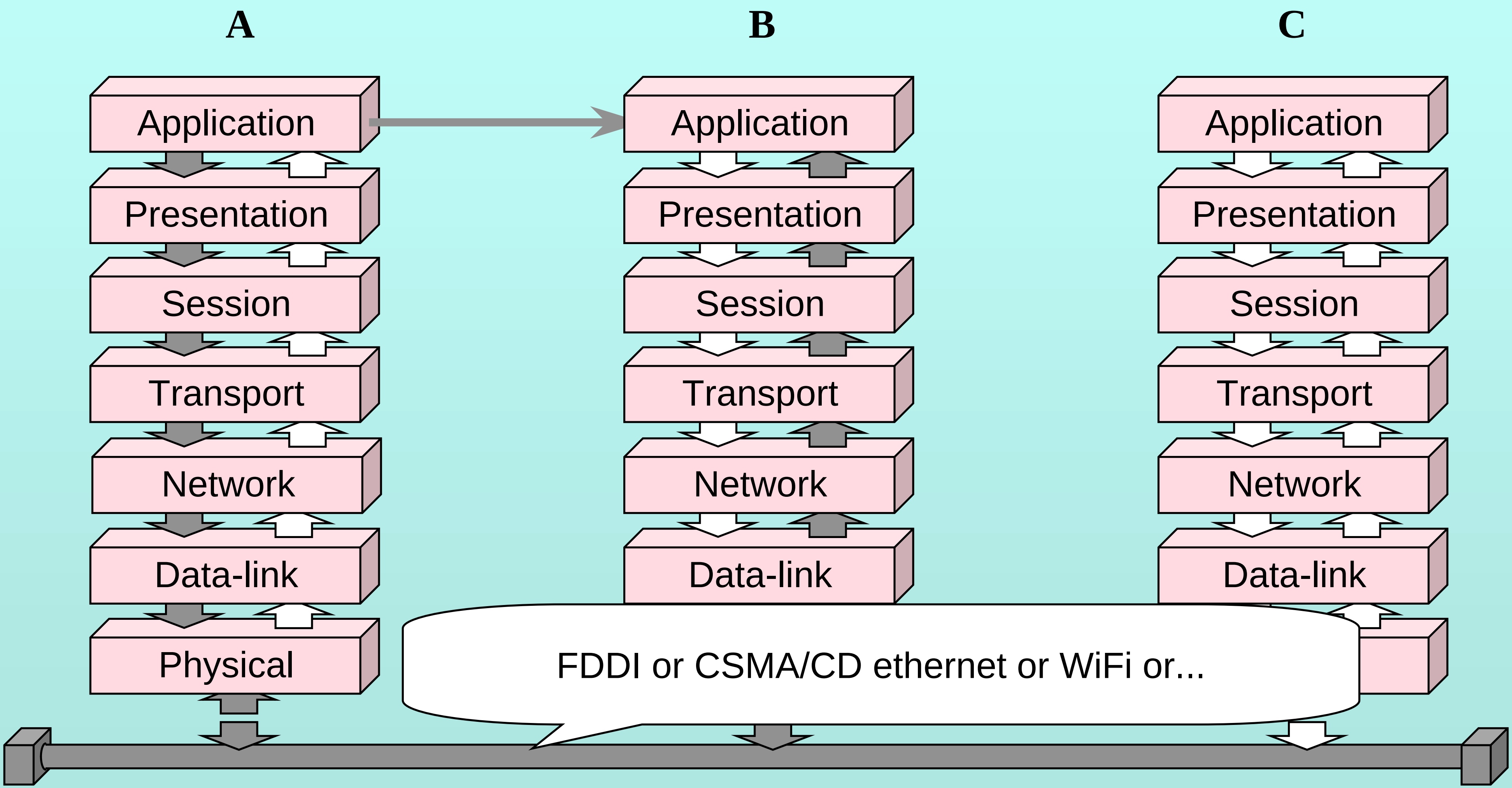
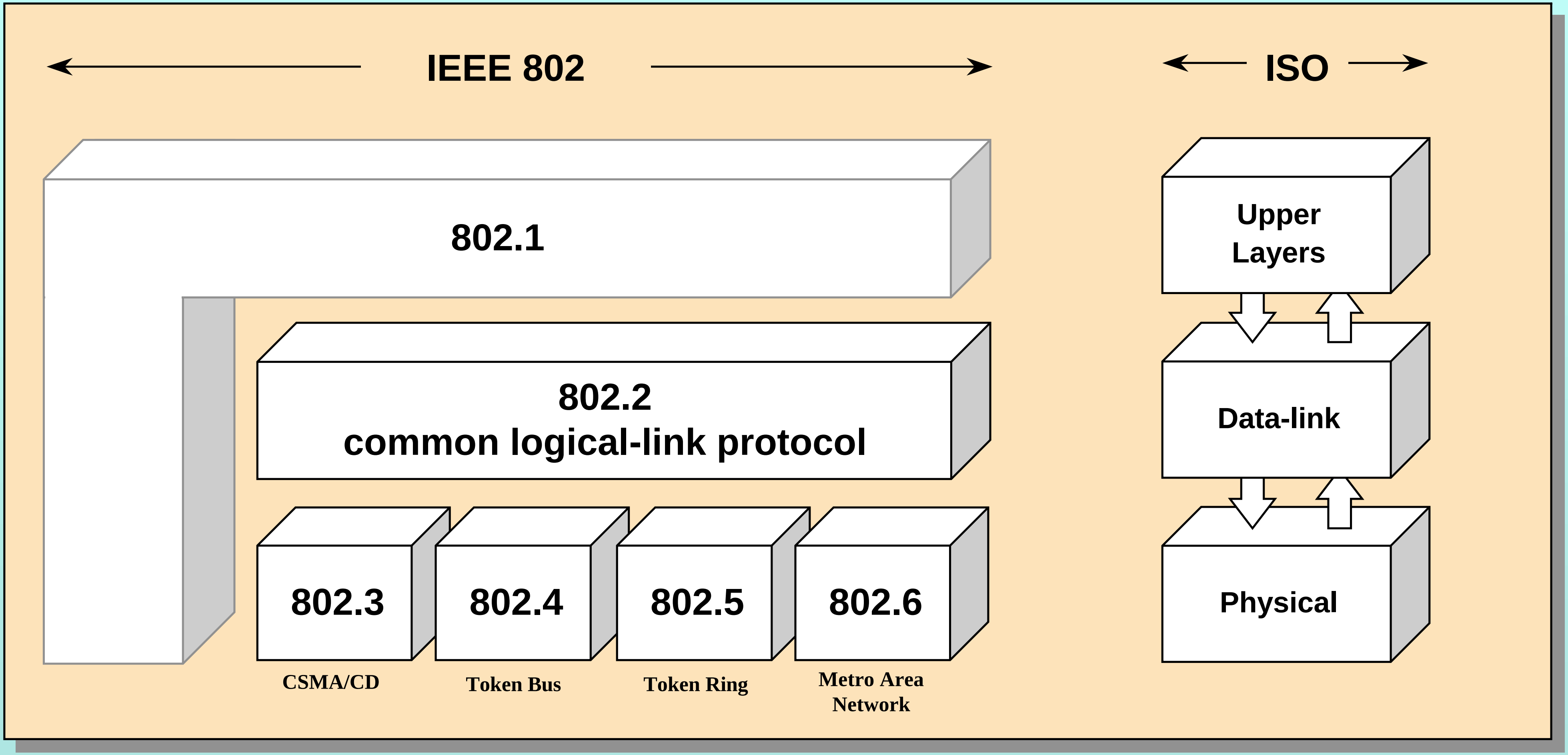


ISO-OSI Network Model



Physical Layer Protocols



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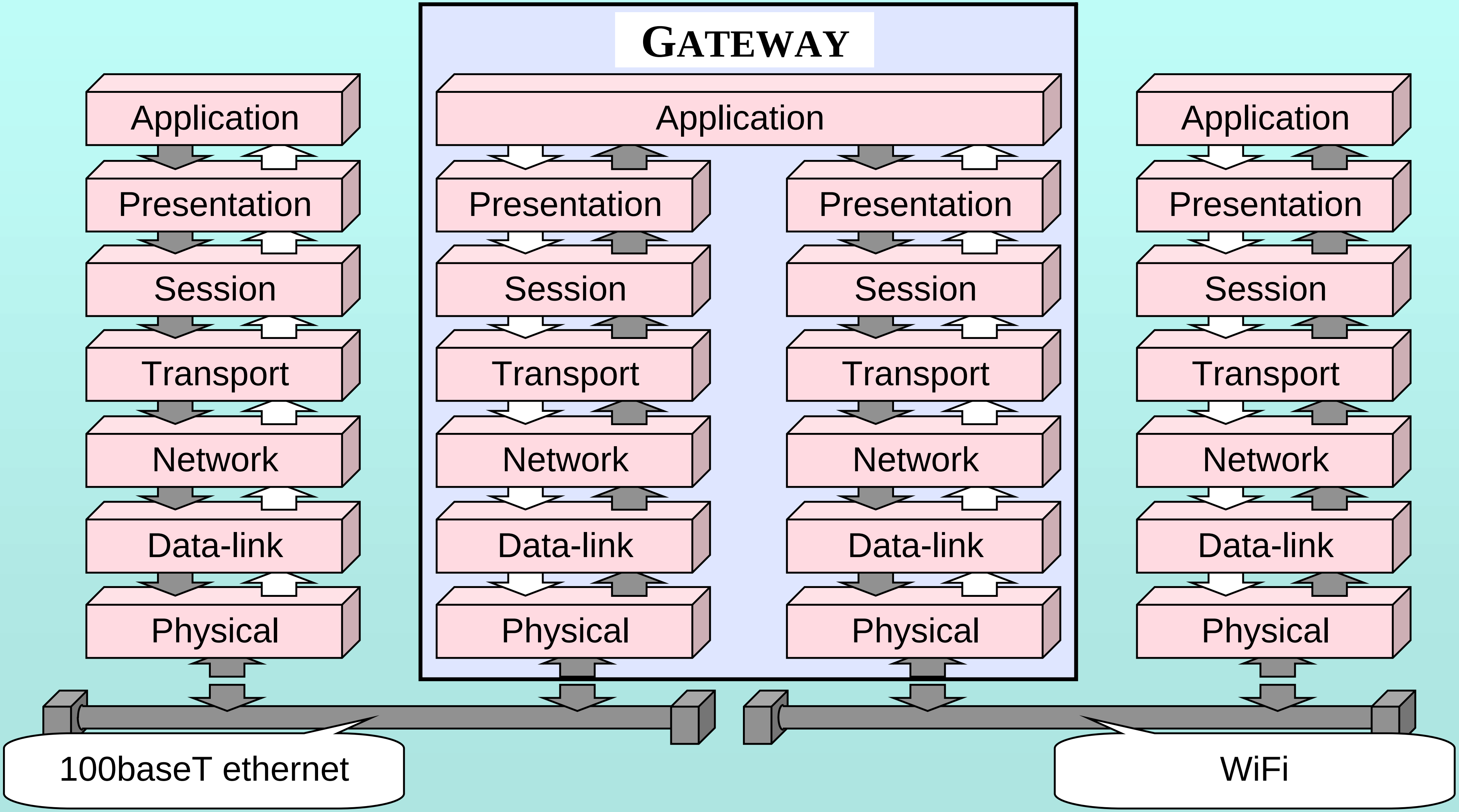

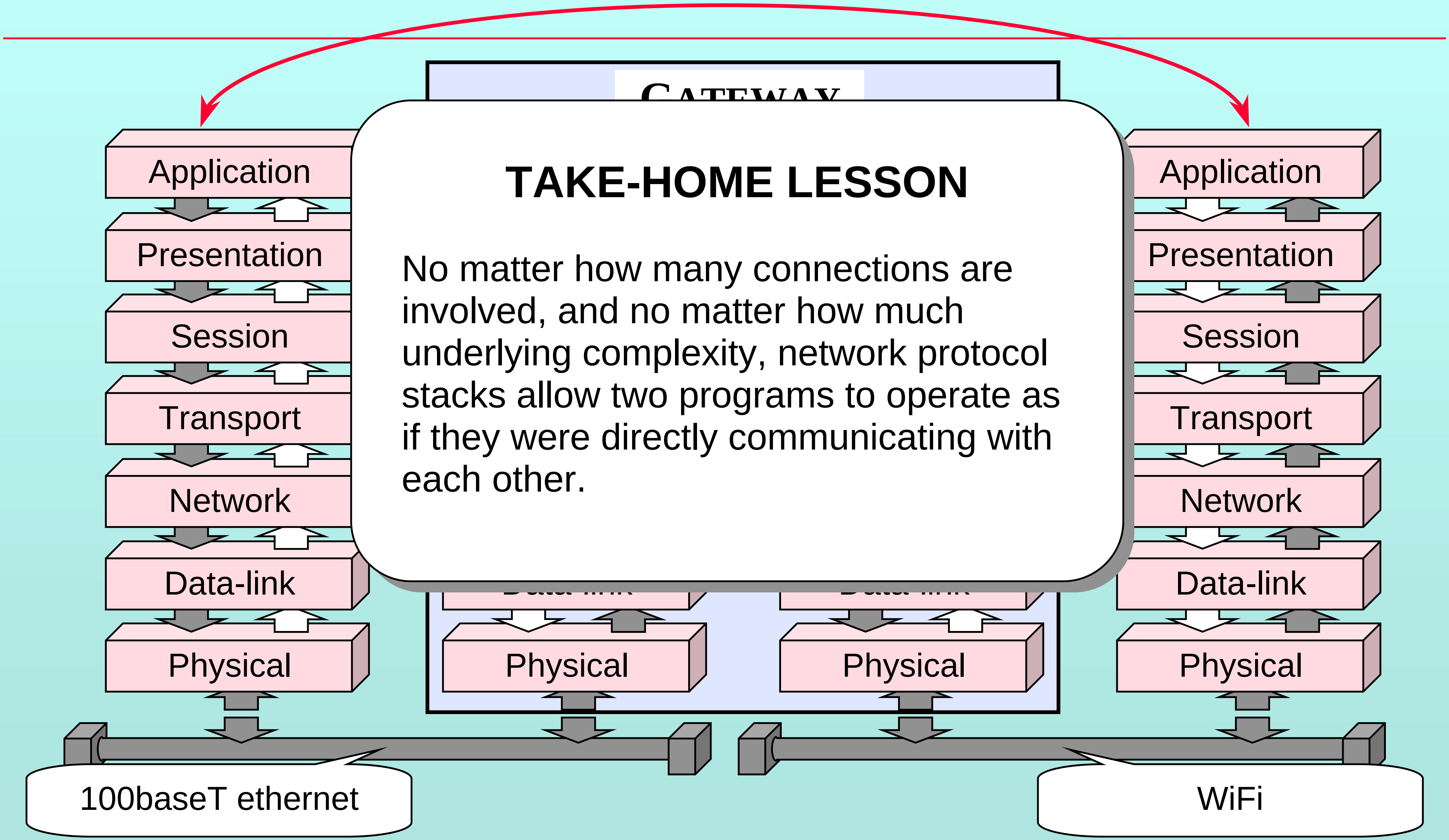

TAKE-HOME LESSON

No matter how many connections are involved, and no matter how much underlying complexity, network protocol stacks allow two programs to operate as if they were directly communicating with each other.

Network Protocol Stacks

layer	ISO	TCP / IP	SNA	DECNET
7	Application	User	End User	Application
6	Presentation	ftp, telnet	NAU Services	
5	Session	(none)	Data-flow Control	(none)
			Transmission Control	
4	Transport	Host-Host		Network Services
		Source to destination IMP		
3	Network		Path Control	Transport
2	Data-Link	IMP-IMP	Data-Link Control	Data-Link Control
1	Physical	Physical	Physical	Physical

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		MP	Data-Link Control	Data-Link Control
		cal	Physical	Physical

This automatically provides fine support for a rapidly changing environment.

TCP / IP protocols were developed to allow robust communication among distributed, heterogeneous computer systems, even under severely adverse conditions.

Network Protocol Stacks

add HTTP, create the WWW

layer	ISO	TCP / IP		ET
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6	Presentation	ftp, telnet, **http**	NAU Services	
5	Session	(none)	Data-flow Control	(none)
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Network Protocol Stacks

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7	Application	User		Application
6	Presentation	ftp, telnet, **http**	NAU Services	
5	Session	(none)	Data-flow Control / Transmission Control	(none)
4	Transport	Host-Host / Source to destination IMP	Transmission Control	Network Services
3	Network	Source to destination IMP	Path Control	Transport
2	Data-Link	IMP-IMP	Data-Link Control	Data-Link Control
1	Physical	Physical	Physical	Physical

It cannot get any more extensible than this: add a protocol, create an industry.

Declarative Interface

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With TCP/IP networking, the commands to connect to HOSTNAME via PROTOCOL are:

telnet snapple

ssh foobar

ftp shazbot

Declarative Interface

With TCP/IP networking, the commands to connect to HOSTNAME via PROTOCOL are:

telnet snapple

ssh foobar

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It cannot get any more declarative than this: there are two critical parameters and the command is just the concatenation of the parameters.

Good Sociology

Sociological Attributes

- No definitive center
- Community participation
- Optional usage
- Avoid premature standards
- Evolving/extensible standards
- . . .

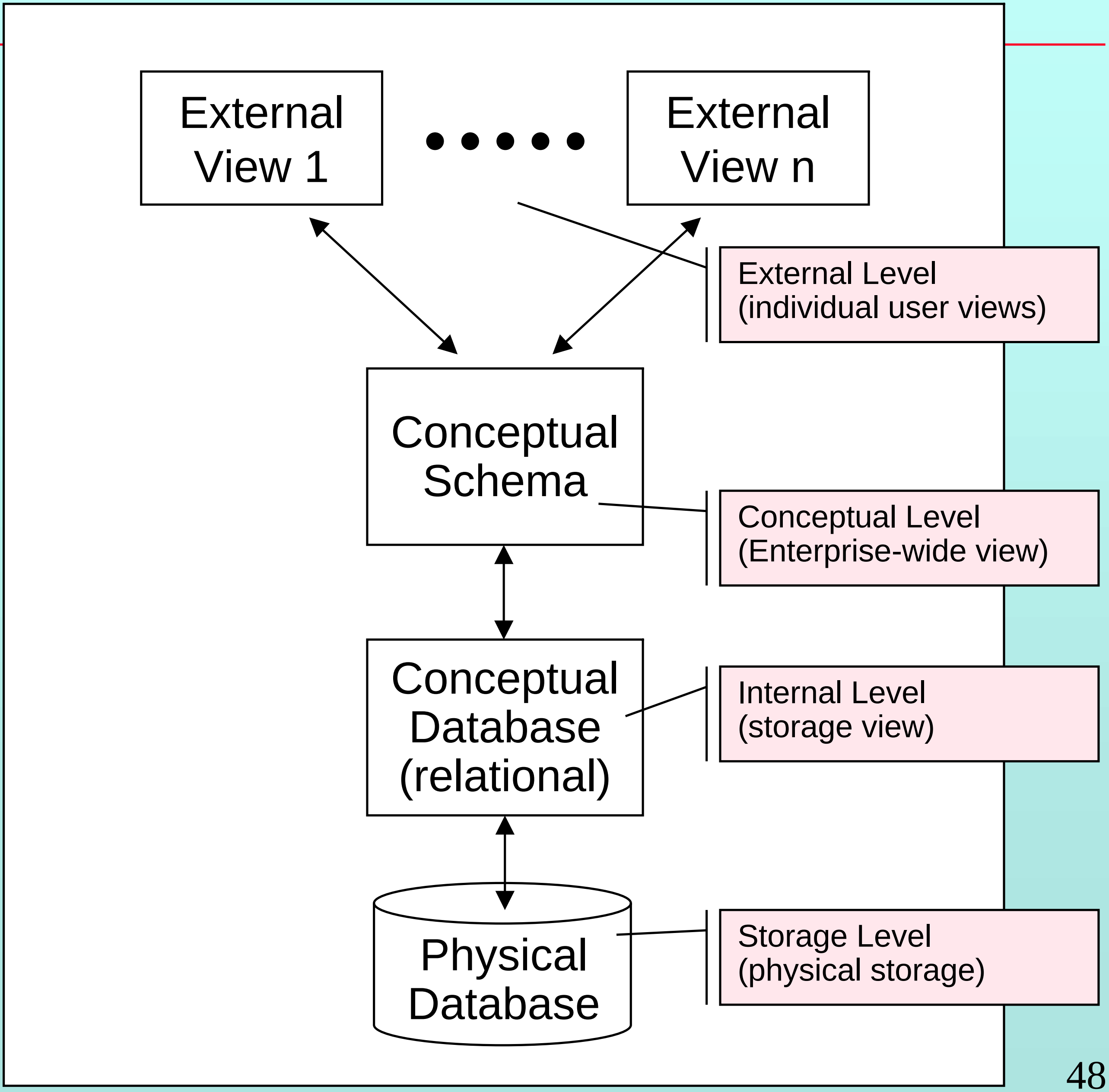
RDBMS Technology

Technical Attributes

- Highly abstracted components
- Layered architecture
- Modular construction
- Clearly defined interfaces
- No interactions except through interfaces
- Declarative user interface

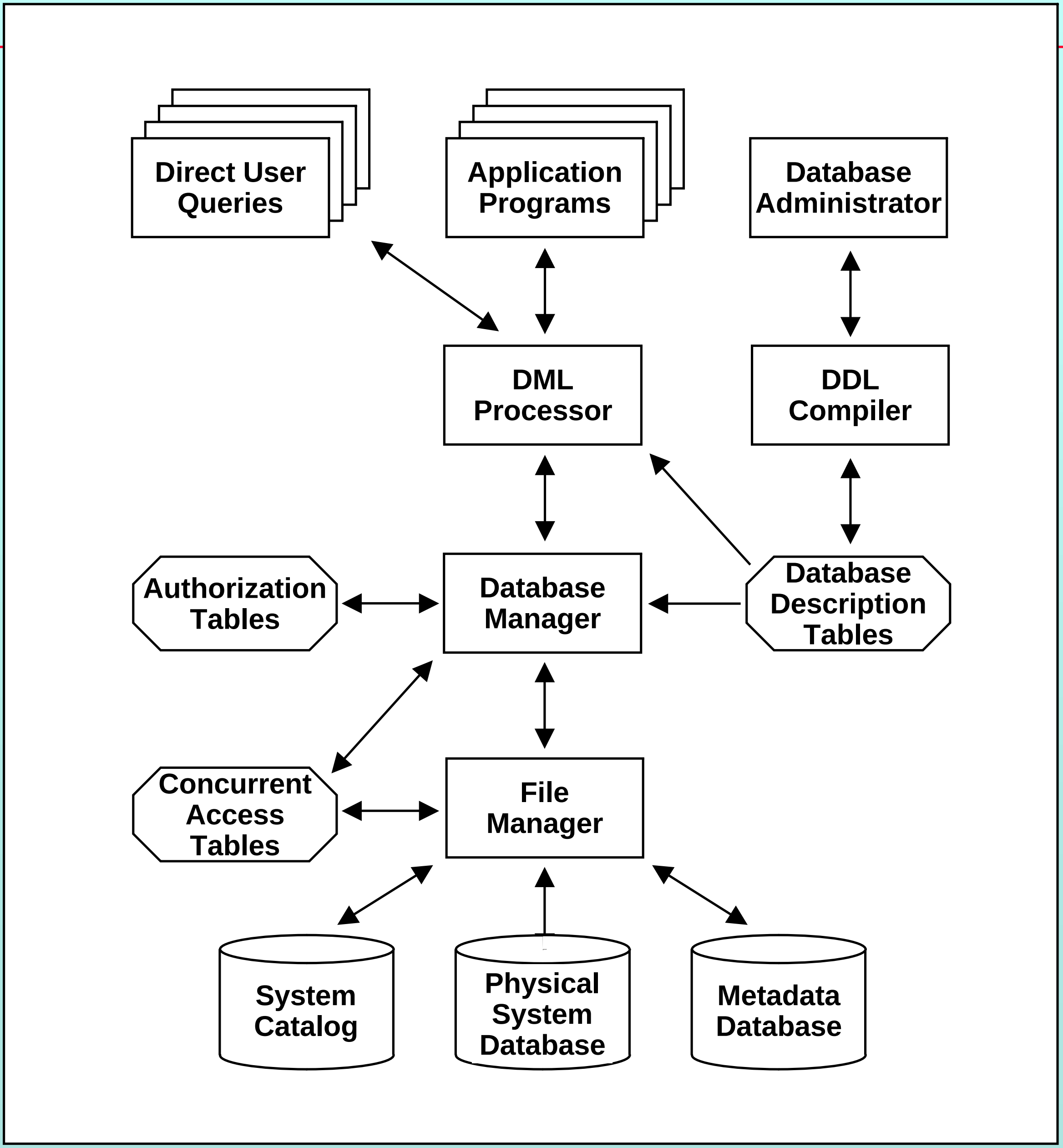
RDBMS

A database management system (DBMS) is a collection of programs that enables users to create and maintain a database. According to the ANSI/SPARC DBMS Report (1977), a DBMS should be envisioned as a multi-layered system:



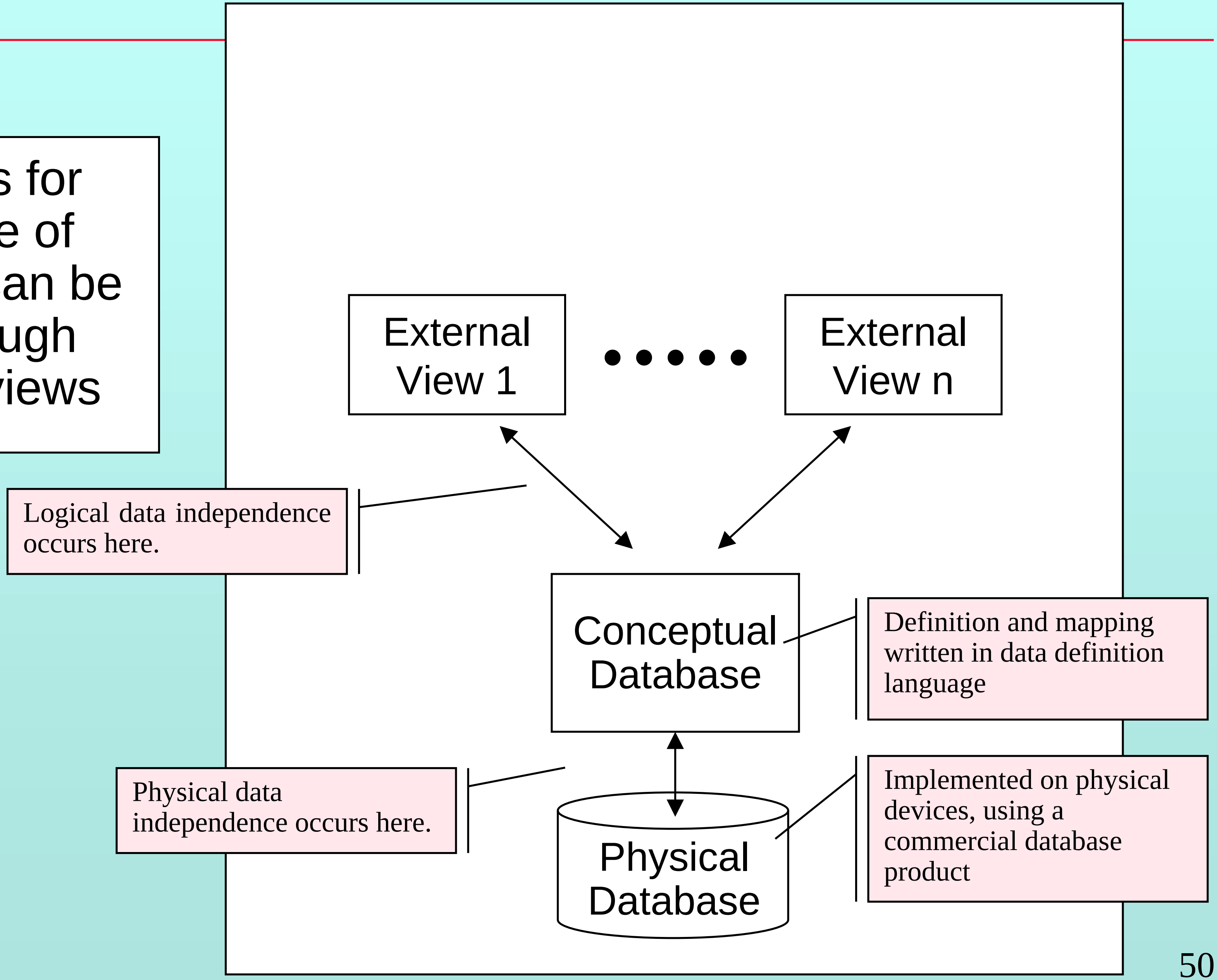
RDBMS

Many of the layers have identified, and separable sub-components…



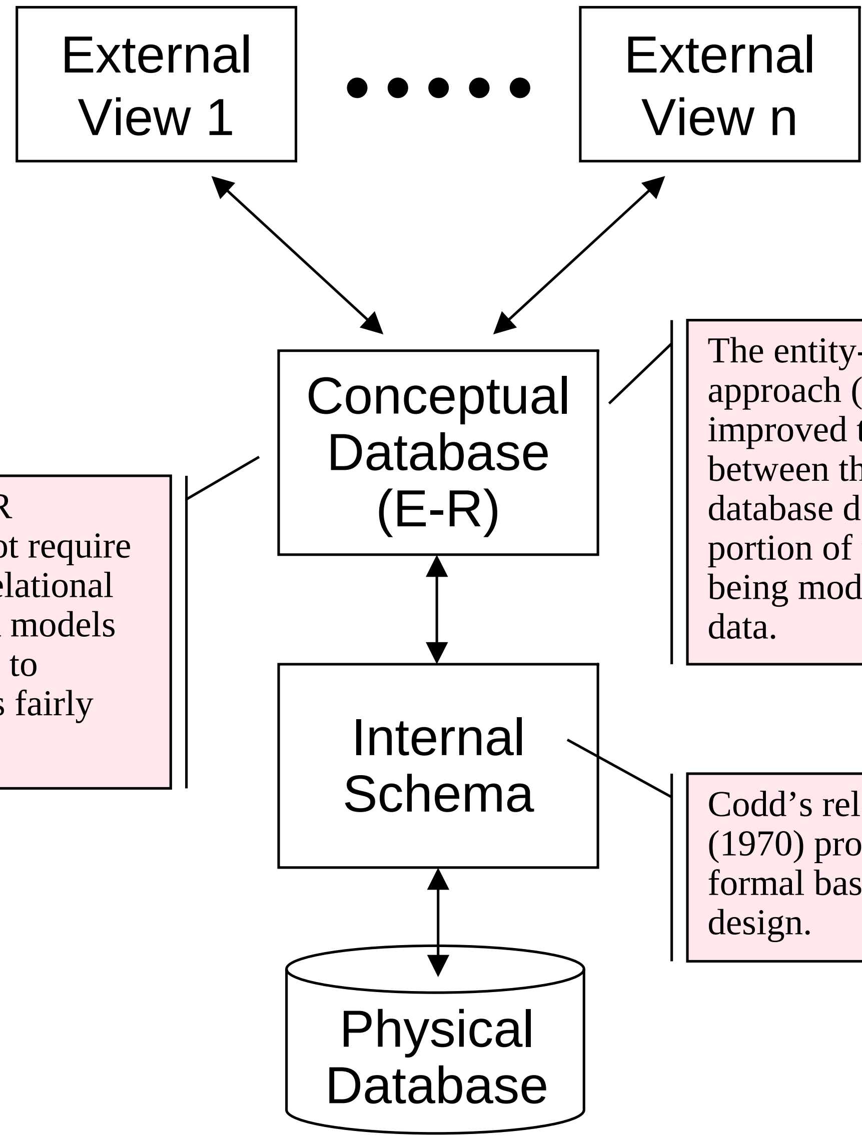
RDBMS

Different needs for access and use of the database can be supported through different user views



RDBMS

Layers may be added to a conceptual design in order to increase the semantic richness available at the top design level.



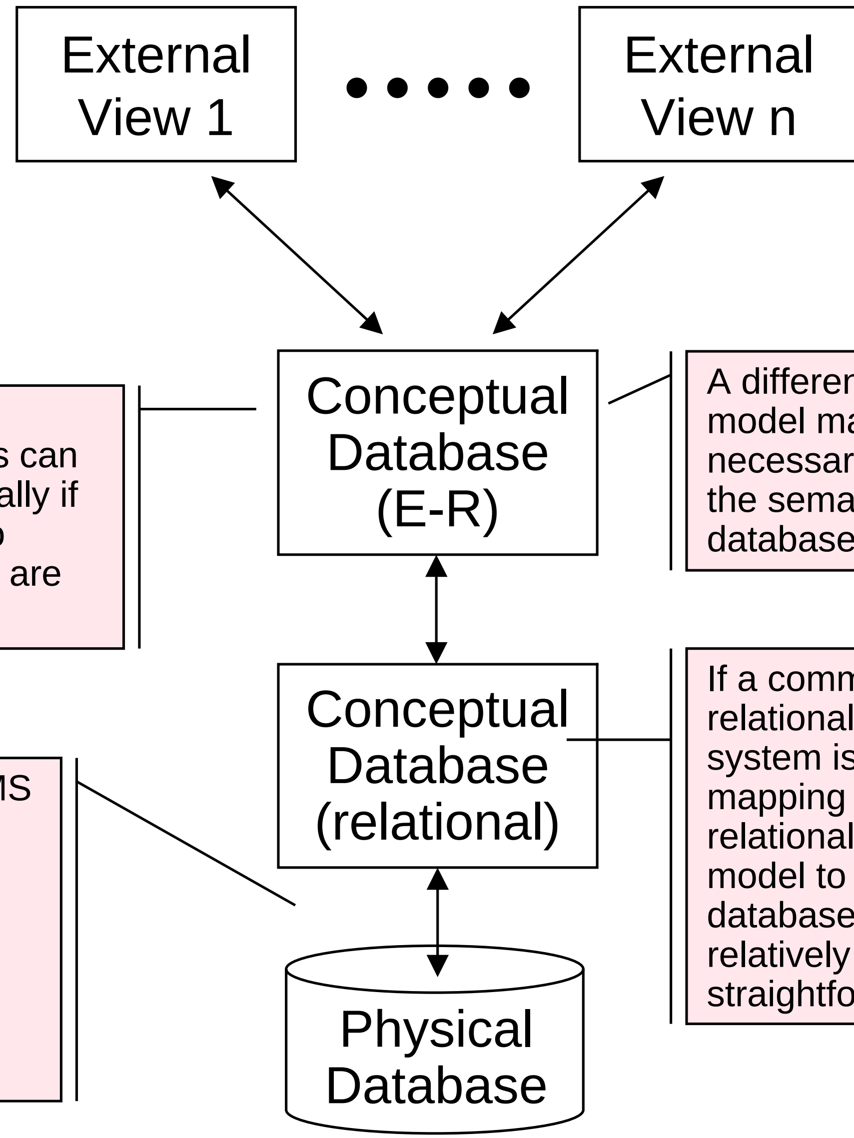
Although the E-R approach does not require an under-lying relational model, most E-R models can be converted to relational models fairly easily.

The entity-relationship approach (Chen, 1976) improved the mapping between the semantics of a database design and that portion of the real world being modeled with the data.

Codd's relational model (1970) provided the first formal basis for database design.

RDBMS

If layered conceptual models are used, the layering may be perceived differently by the system's users and developers. Users often see the database only in terms of the views that they employ. System analysts and designers may think primarily about the E-R schema, whereas the database administrator is likely to deal primarily with the relational schema and the physical system.



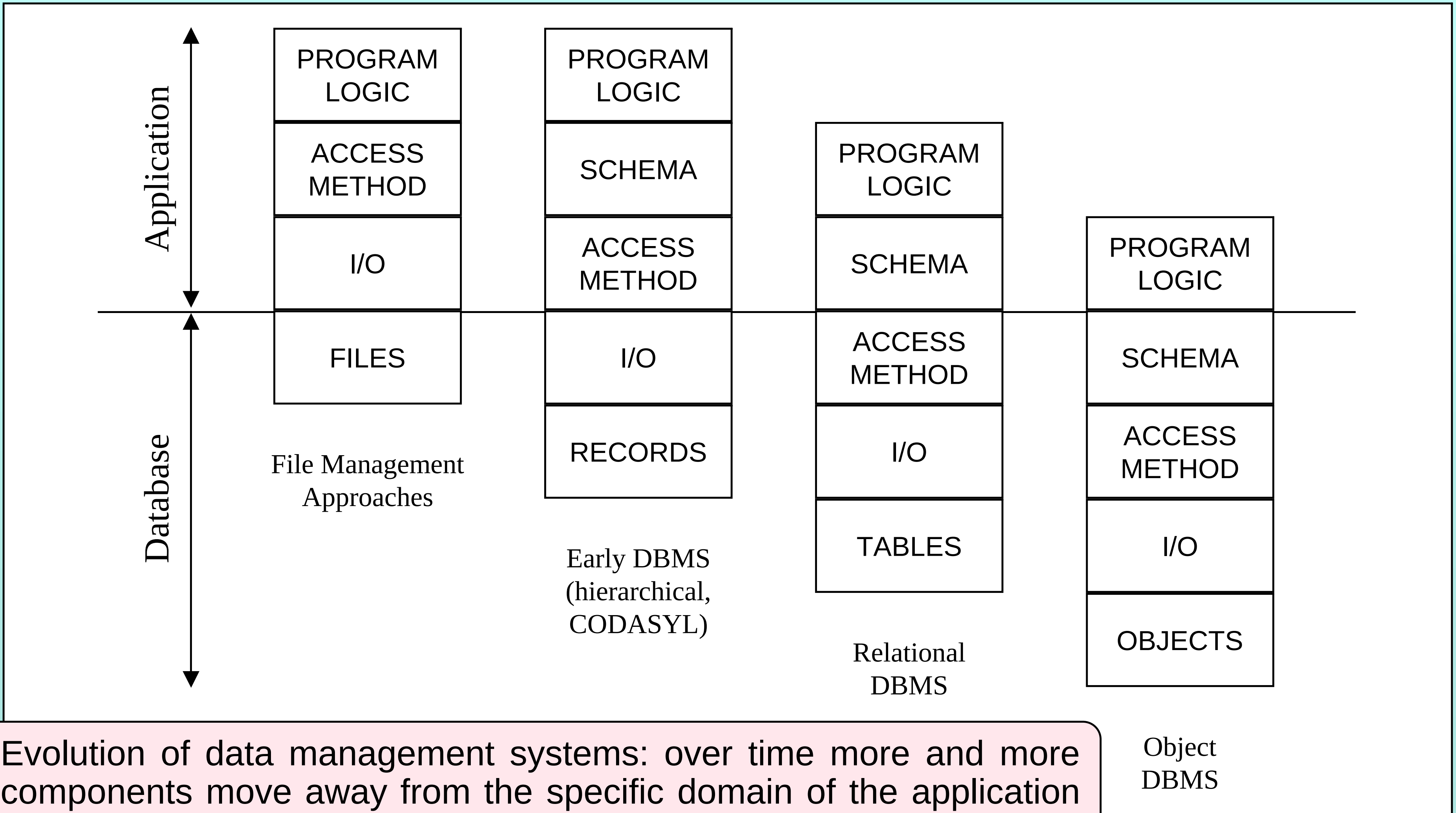
Moving between conceptual models can be difficult, especially if automated tools to facilitate the move are not available.

A different conceptual model may be necessary to capture the semantics of the database domain.

If a commercial relational database system is used, mapping from a relational conceptual model to the physical database should be relatively straightforward.

If a commercial RDBMS is used, a relational conceptual model provides a basis for designing and implementing an underlying physical database.

RDBMS



Evolution of data management systems: over time more and more components move away from the specific domain of the application and into the generic tools of the database management system

Declarative Interface

Declarative Interface

With RDBMS, the command to extract data from the system are generically:

SELECT data elements
FROM source tables
WHERE condition is true

It would be hard to get any more declarative than this: the syntax is pretty much limited to the minimum set of verbs, nouns, and logic.

TCP/IP & RDBMS
Patterns

TCP/IP & RDBMS Pattern

- Formulate driving question
- Develop vision of what might be
- Explore logical consequences of vision
- Prototype
- Expand/extend/revise vision
- Prototype
- Repeat…

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Expect lots of nay-sayers and skeptics along the way…

Patience is a Virtue

Internet Time:

- A sustained explosion of growth and technical innovation…
- after 35 years of patient, painstaking planning, testing, and development.

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Conceptually, packet-switched networking began in 1960; the idea of internetworking was created in the 1970s; the whole thing took off in 1995…

BRIITE Challenge

BRIITE Challenge

- Confirm driving question
- Begin to plan architectural vision
- Identify possible components
- Describe ideal functions of components
- Imagine how functions might be achieved
- Assess how design might affect function
- Consider how components might interact
- Repeat as necessary

Working Group Assignments

For each module:

Background
- The Problem
- Available Solutions
- Remaining Challenges
  - *To be Solved in Other Modules*
  - *To be Solved in This Module*

An Ideal Solution
- Requirements
- Black-box Attributes
- Interoperability Interfaces
- Other Necessary Components
- Possible Implementation Details

Summary and Overview

Possible Modules

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- Basic Infrastructure

Possible Modules

- Basic Infrastructure
- Authorization, Authentication, Auditing

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- Digital Publishing Support

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- Scientific Database I: Data Models & Design

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- Scientific Database II: Data Integration
- Scientific Database Support III: Community Databases
- Scientific Database Support IV: Public dB Integration

Possible Modules

- Clinical Research I: Research Access to Clinical Data

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- Laboratory Information Management Systems

Possible Modules

- Clinical Research I: Research Access to Clinical Data
- Clinical Research II: Research Trials
- Clinical Research III: Controlled Vocabularies
- Clinical Research IV: Specimen Management
- Clinical Research V: Tumor / Disease Registries
- Laboratory Information Management Systems
- Shared Resource Support

Possible Modules

- More …

Possible Methods

- Top down: ideal solutions

Possible Methods

- Top down: ideal solutions
- Bottom up: current problems

Possible Methods

- Top down: ideal solutions
- Bottom up: current problems
- Iterative: both, back and forth…

Top-down Example

Authorization, Authentication, etc.

Every administrator of a computer resource needs some way to identify users, to authorize them to access the resource, to authenticate them when they access the resource, and to log and audit them when they use the resource. In a typical academic environment, there are many, many different approaches to handling these tasks.

What if, once upon a time in the future, there were to be a system called GLAAAS…

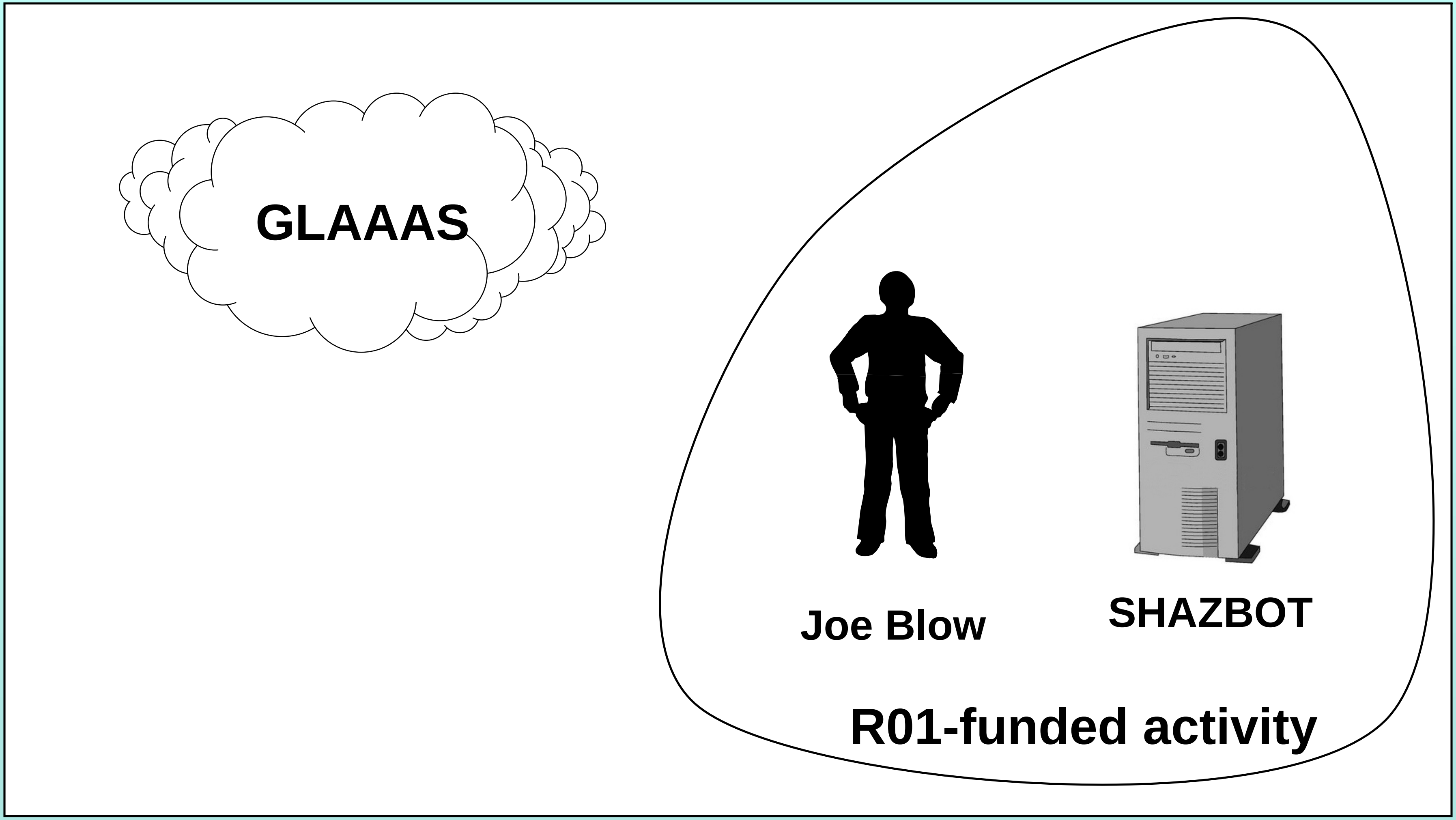
GLAAAS

GLAAAS is a GLobal Authorization, Authentication, and Auditing System that can be used to assign, track, and audit permissions to use IT resources on any server that participates in GLAAAS.

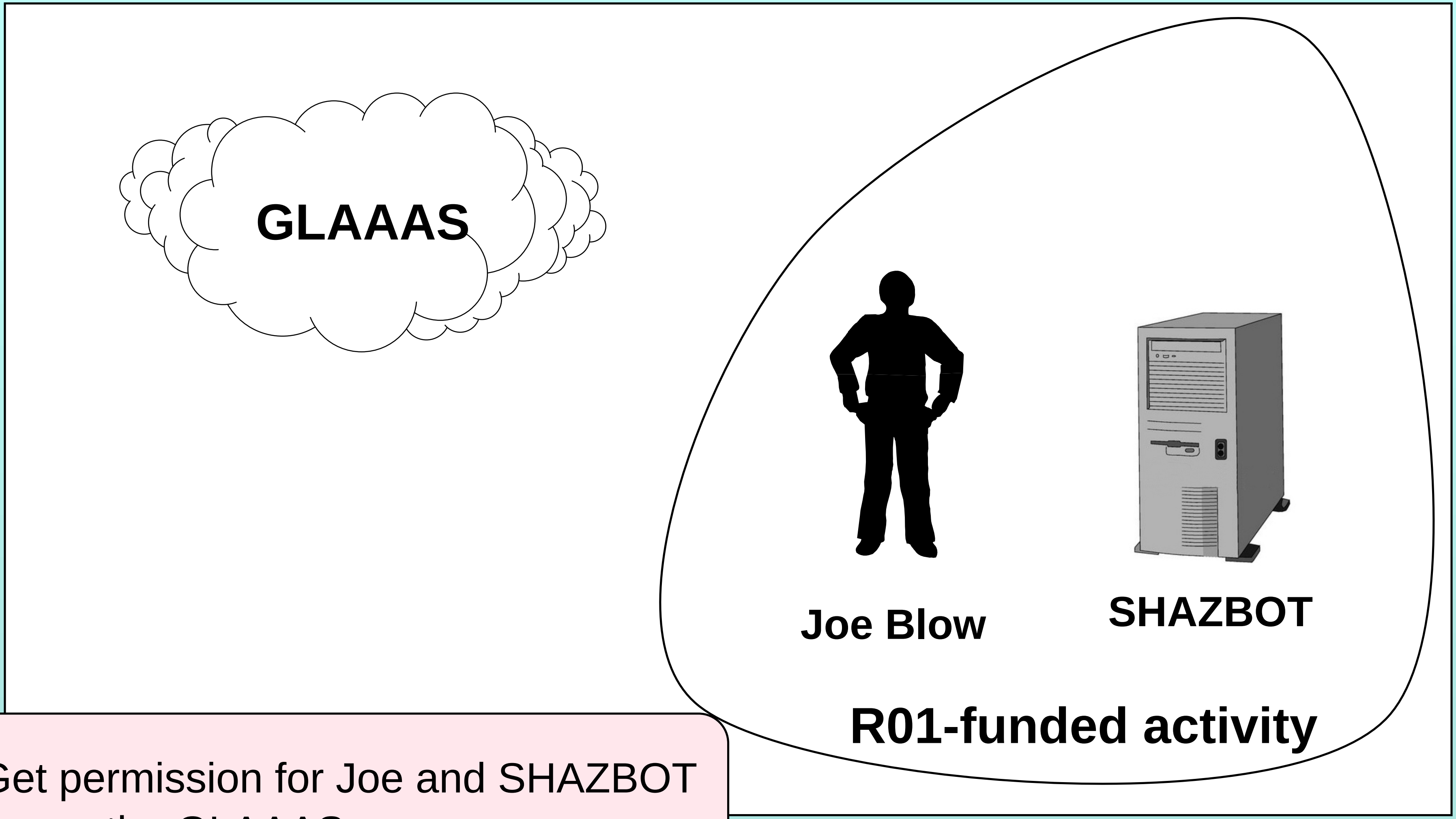
GLAAAS works with any operating system and makes almost no demands on the configuration of any participating server.

GLAAAS provides gPAMs (general pluggable authentication modules) and gPLMs (general pluggable logging modules) to all participating servers.

GLAAAS

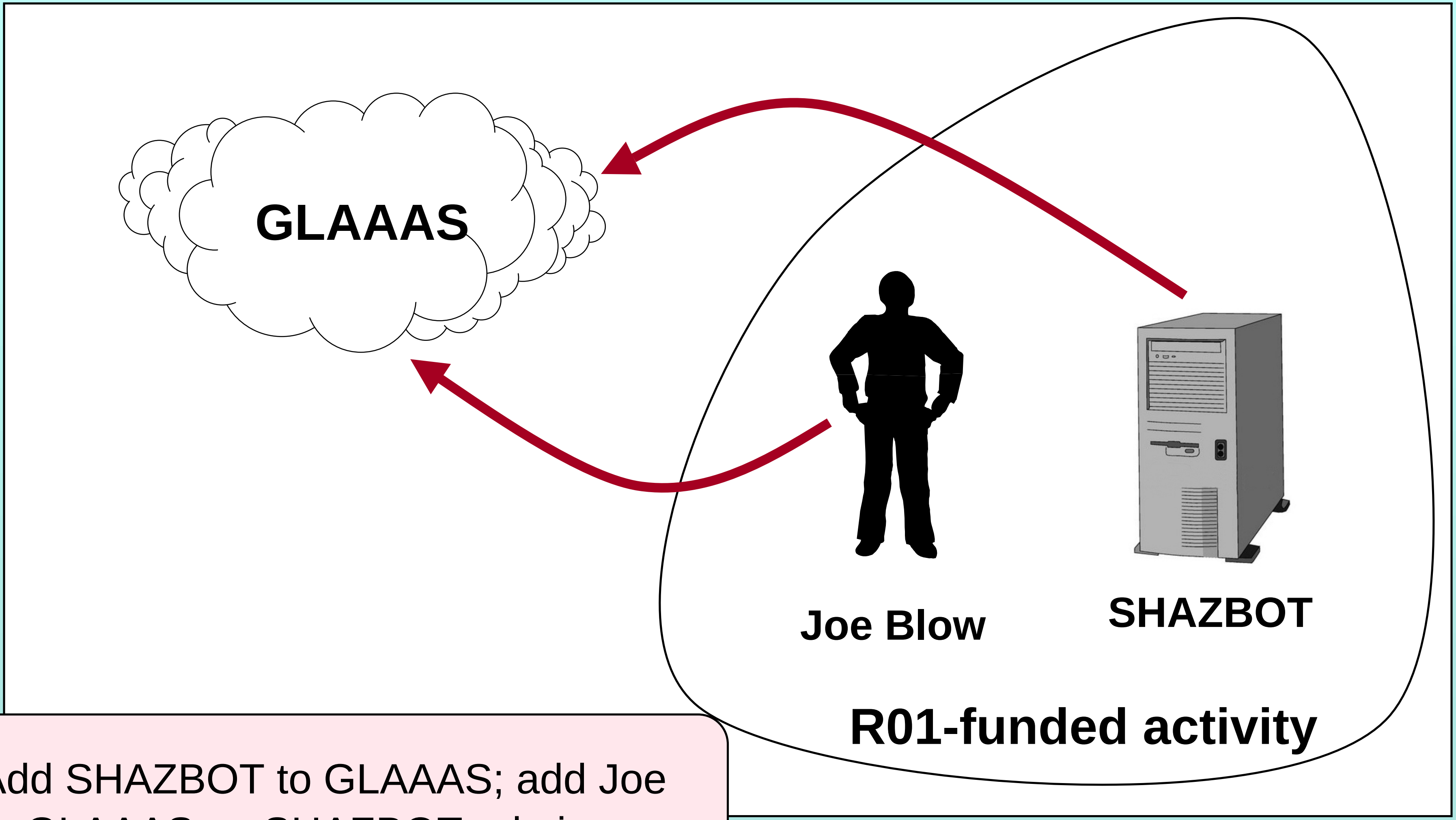


GLAAAS



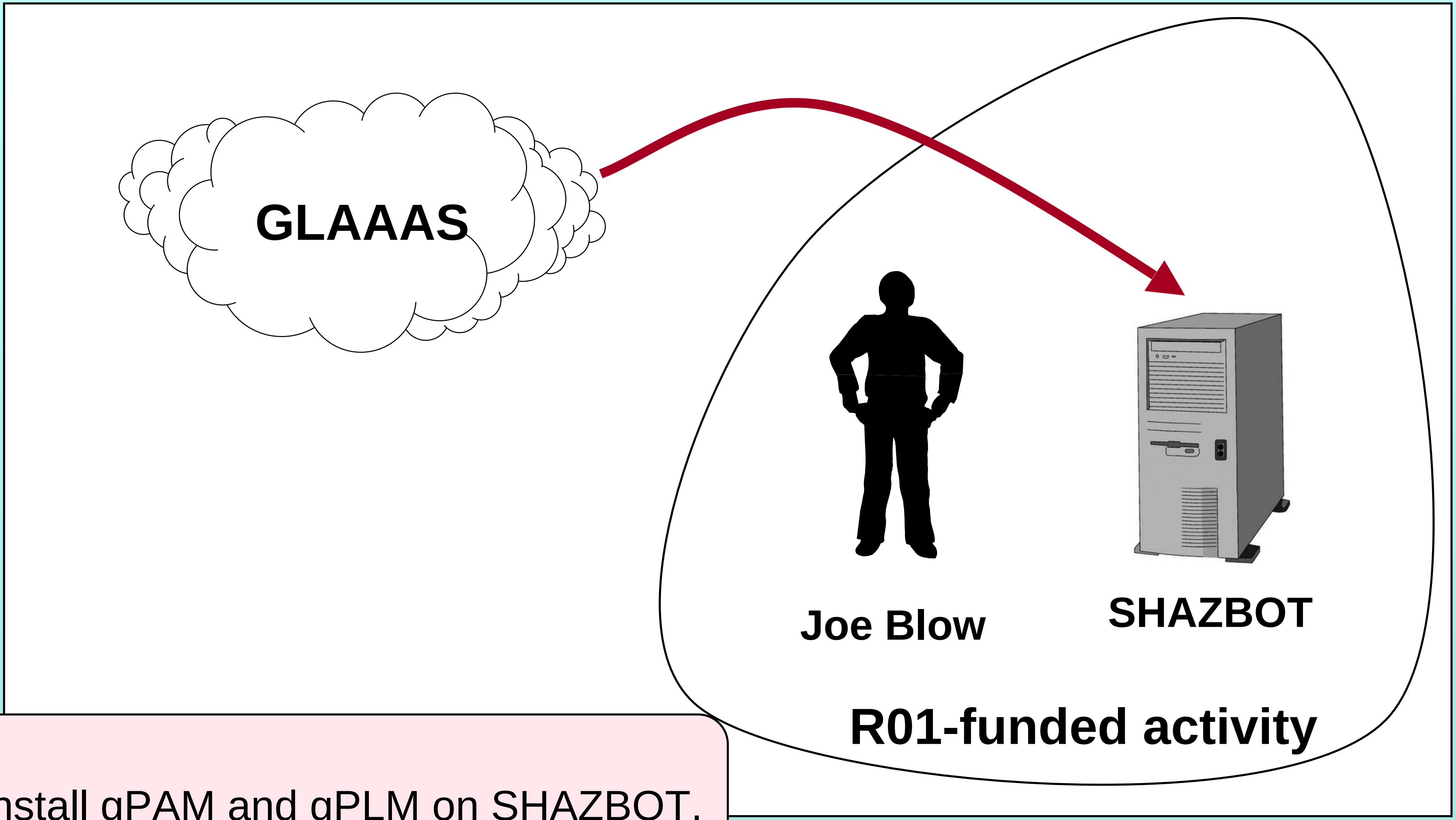
Get permission for Joe and SHAZBOT to use the GLAAAS.

GLAAAS



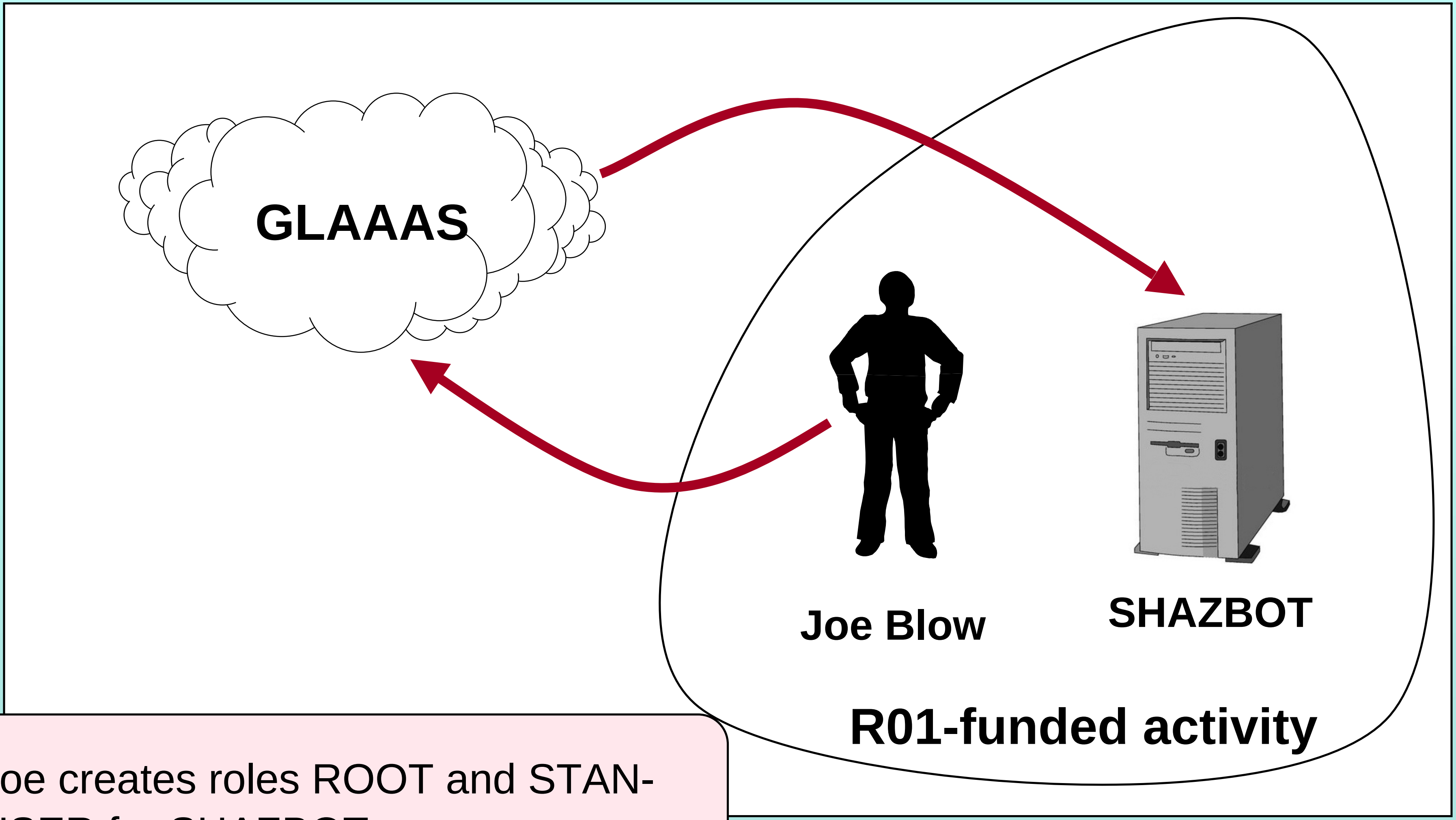
Add SHAZBOT to GLAAAS; add Joe to GLAAAS as SHAZBOT admin.

GLAAAS



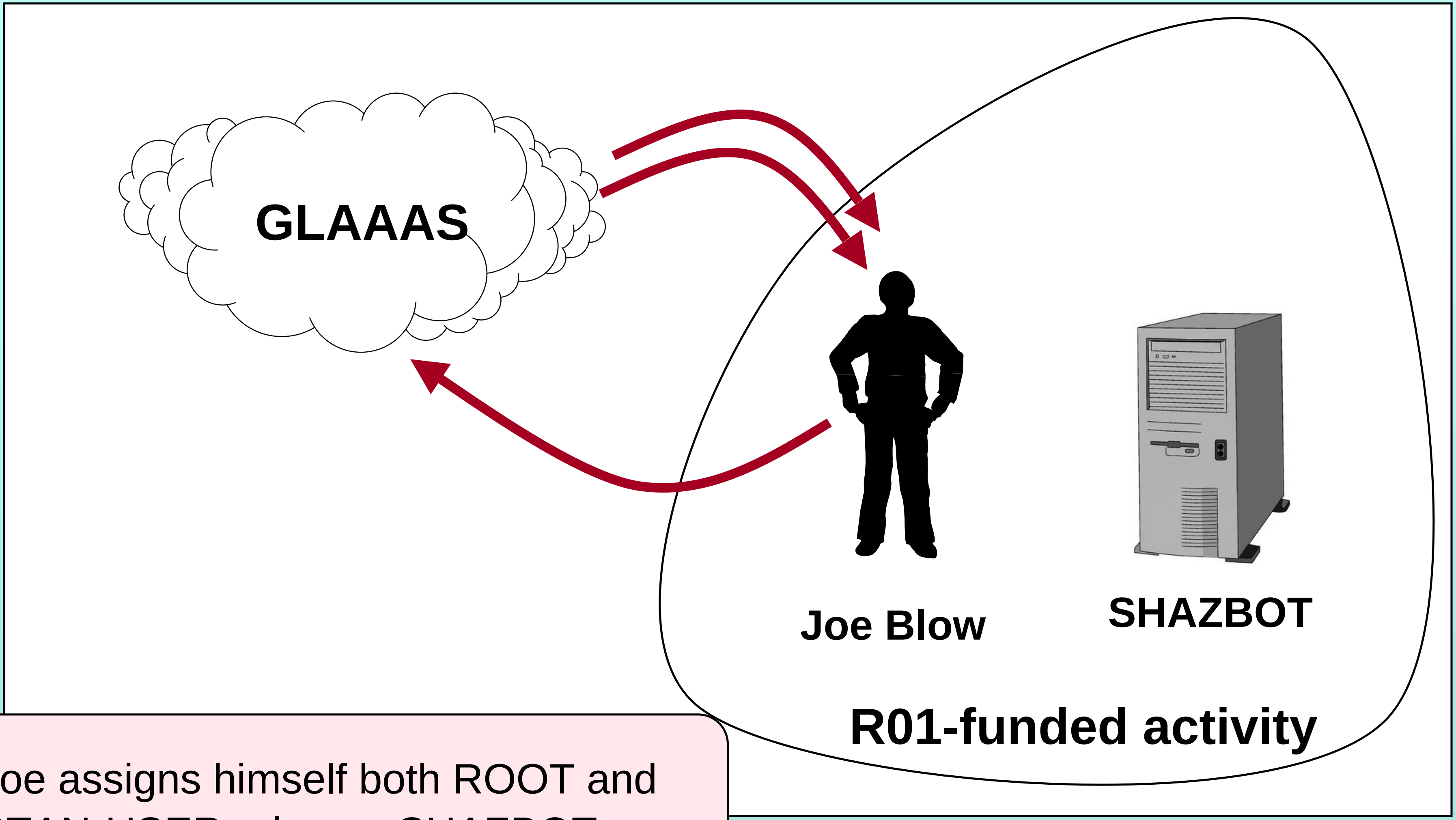
Install gPAM and gPLM on SHAZBOT.

GLAAAS



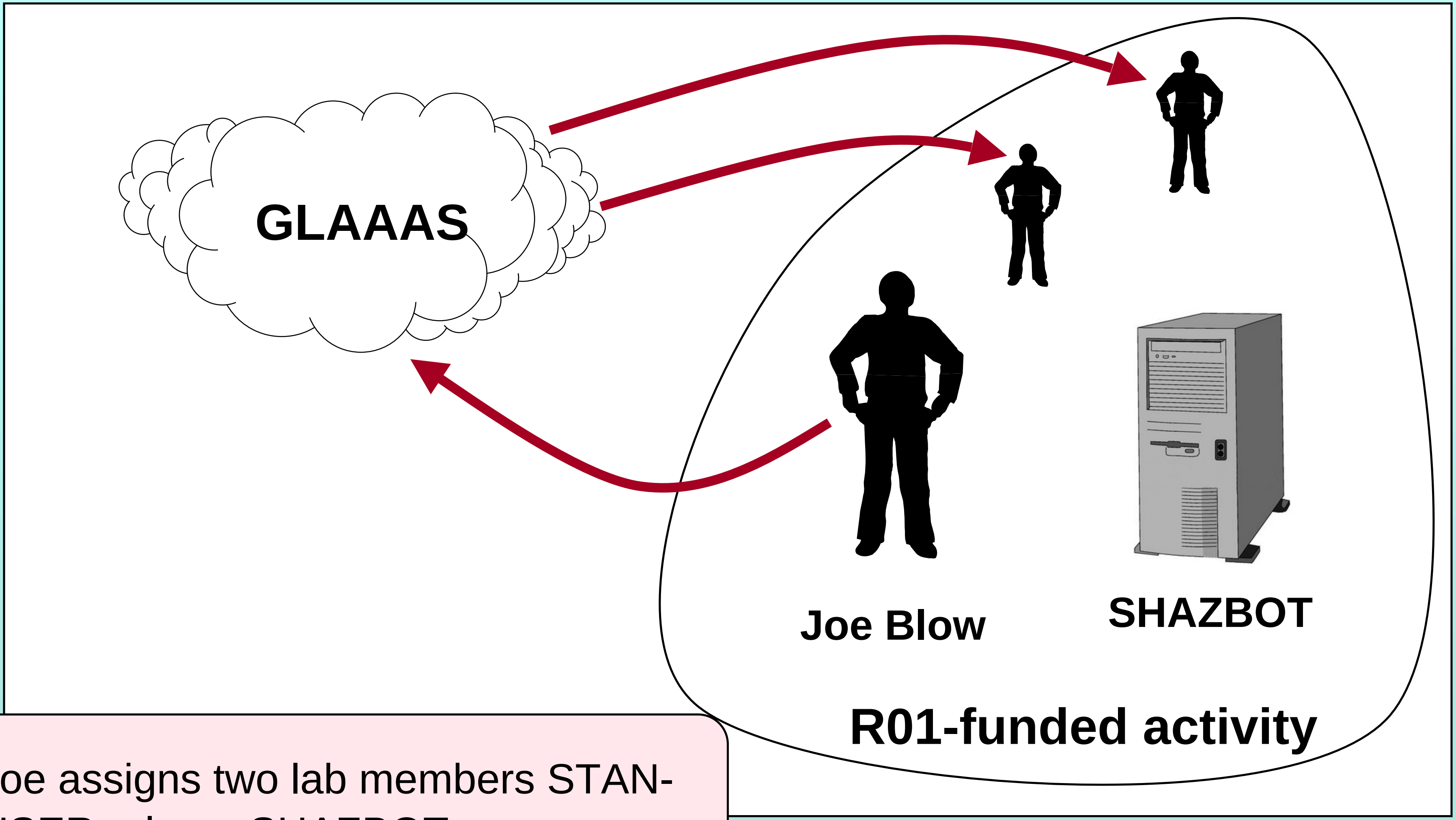
Joe creates roles ROOT and STAN-USER for SHAZBOT.

GLAAAS



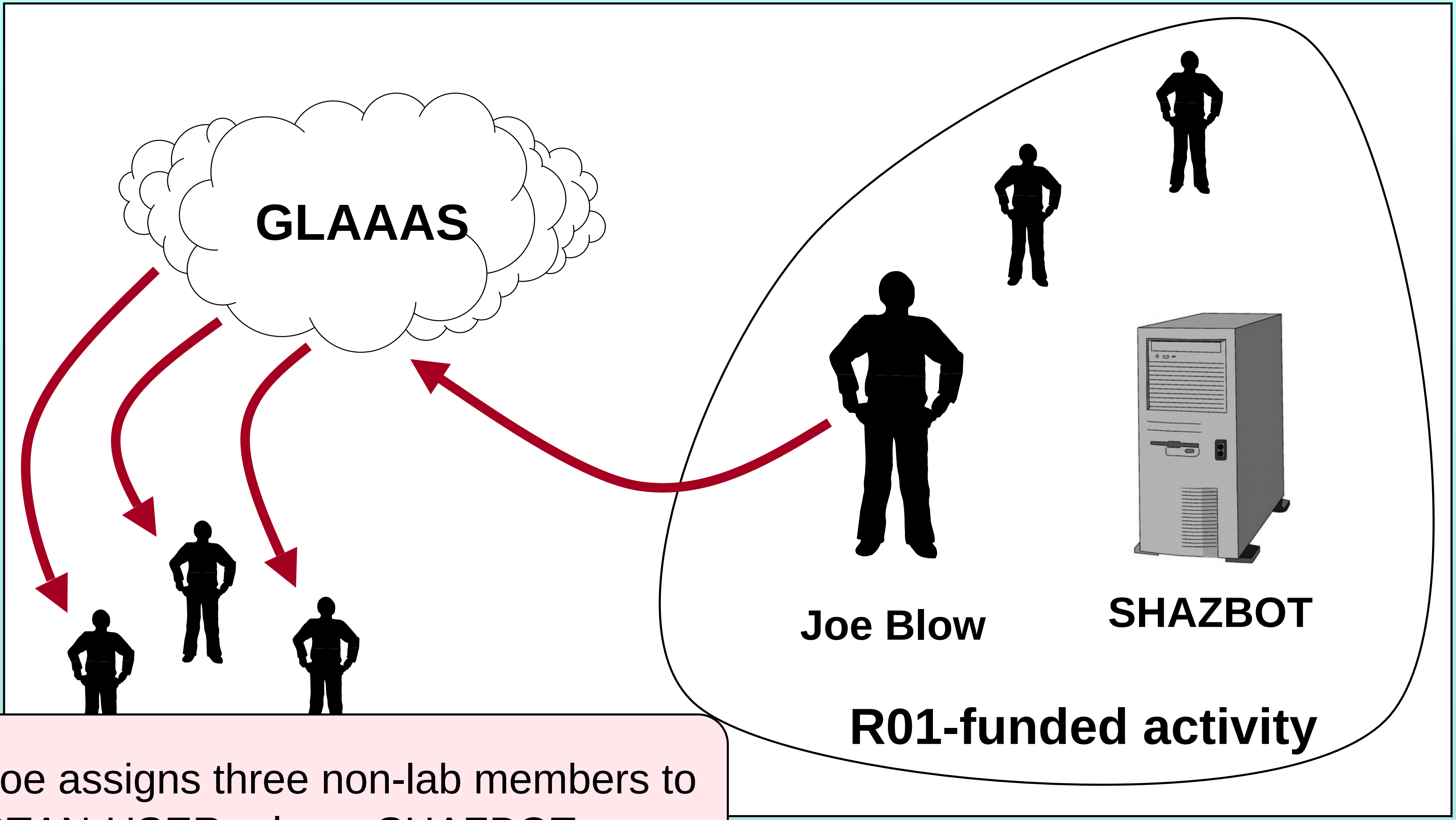
Joe assigns himself both ROOT and STAN-USER roles on SHAZBOT.

GLAAAS



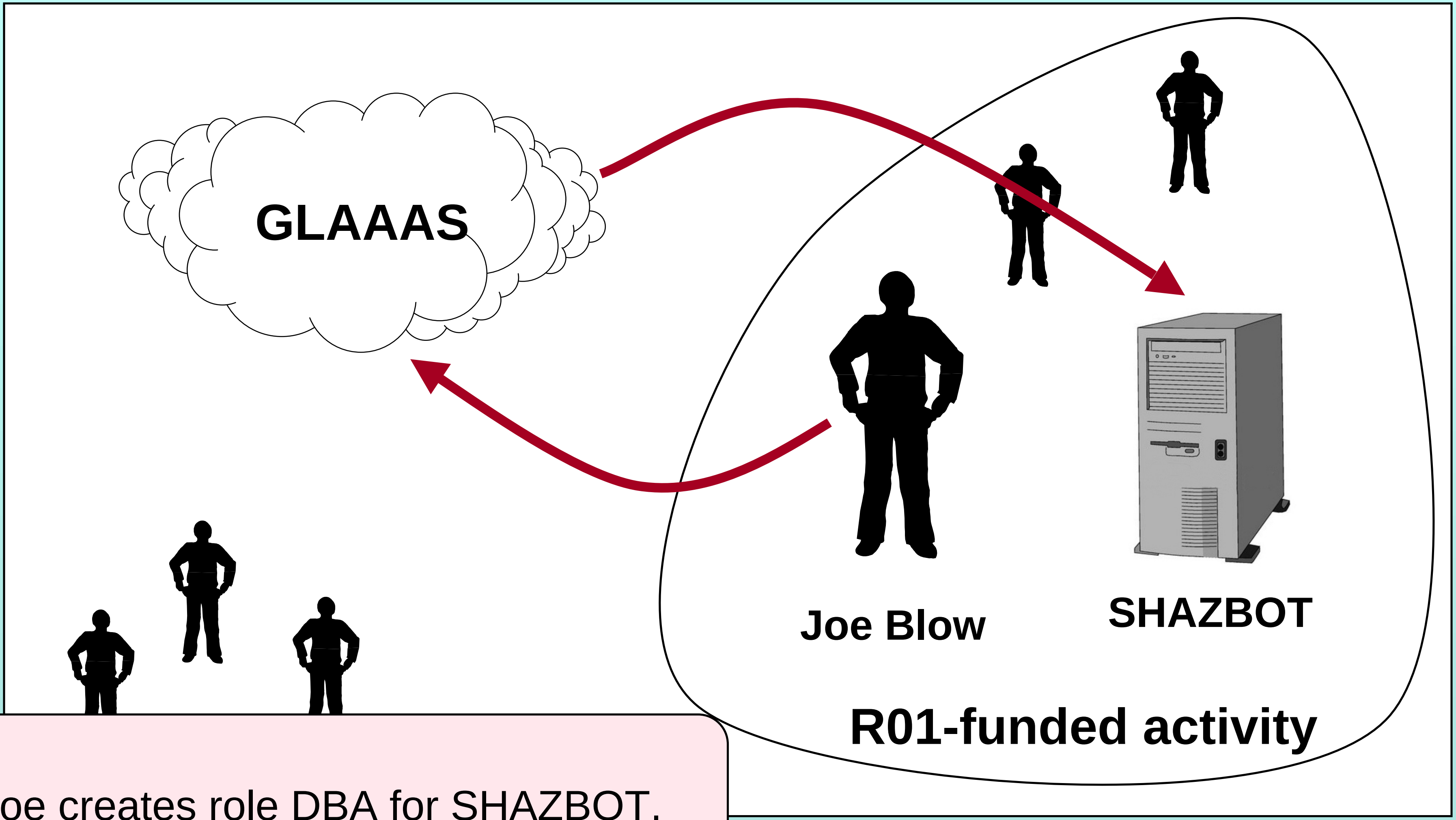
Joe assigns two lab members STAN-USER role on SHAZBOT.

GLAAAS



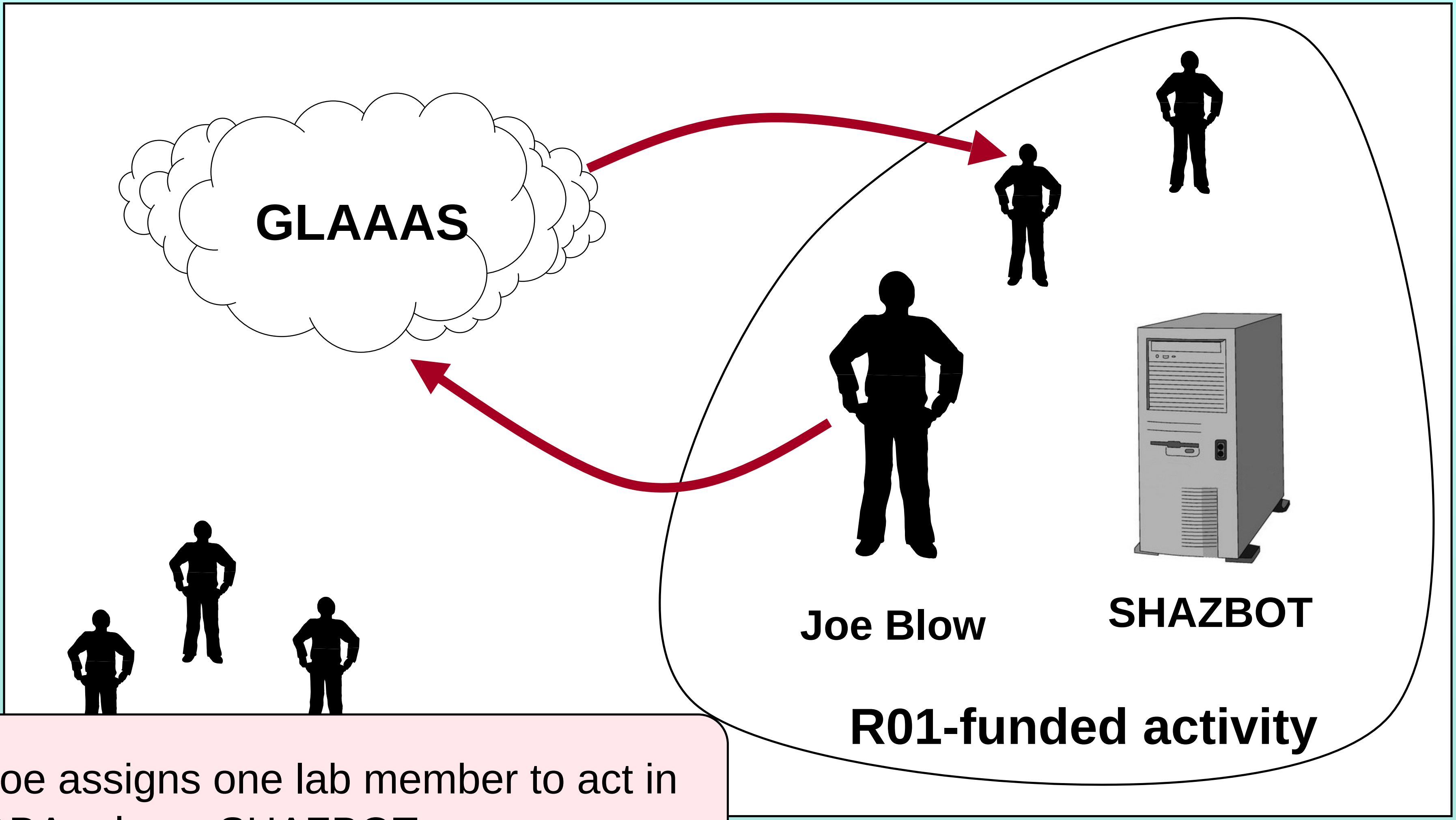
Joe assigns three non-lab members to STAN-USER role on SHAZBOT.

GLAAAS



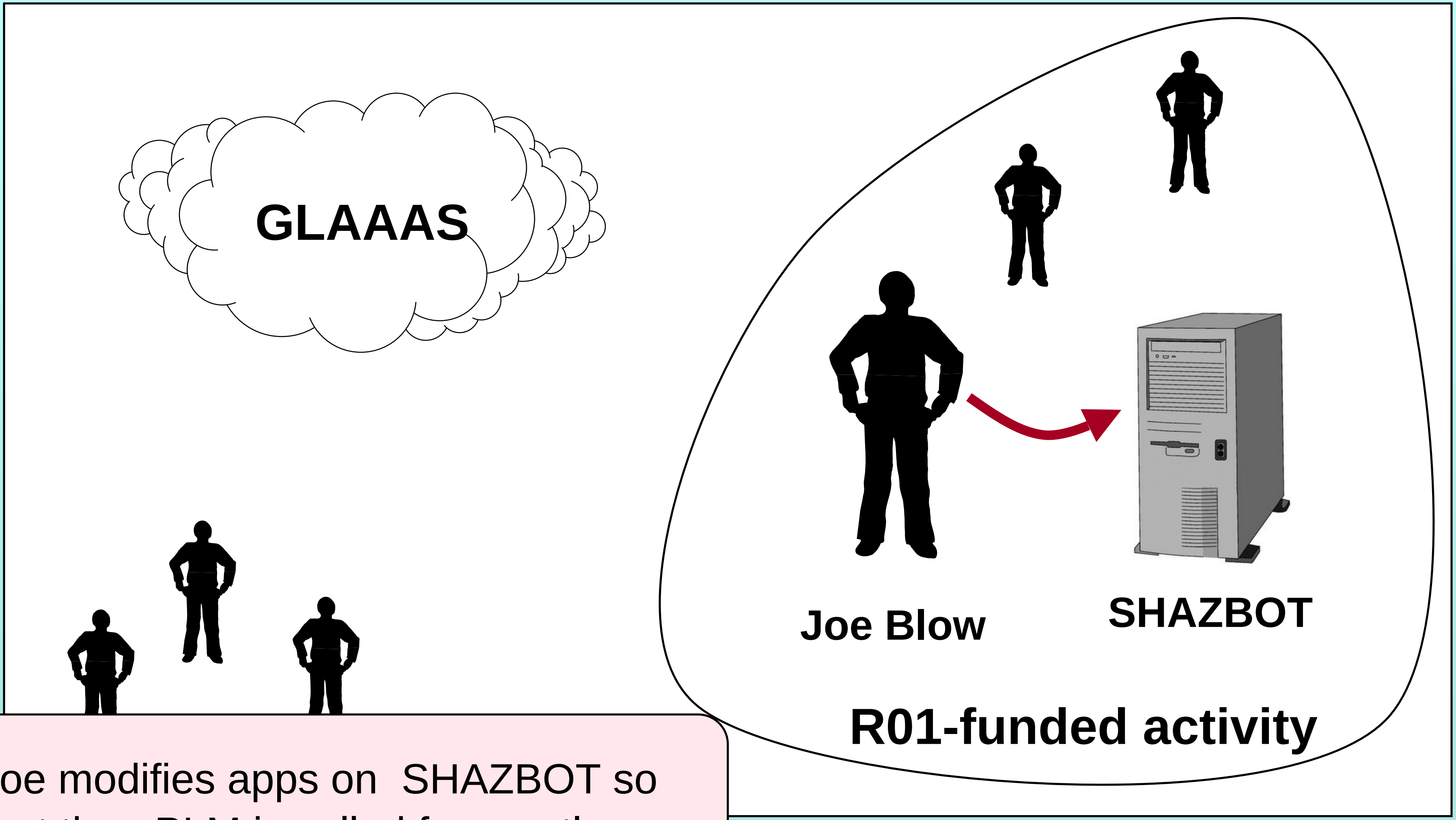
Joe creates role DBA for SHAZBOT.

GLAAAS



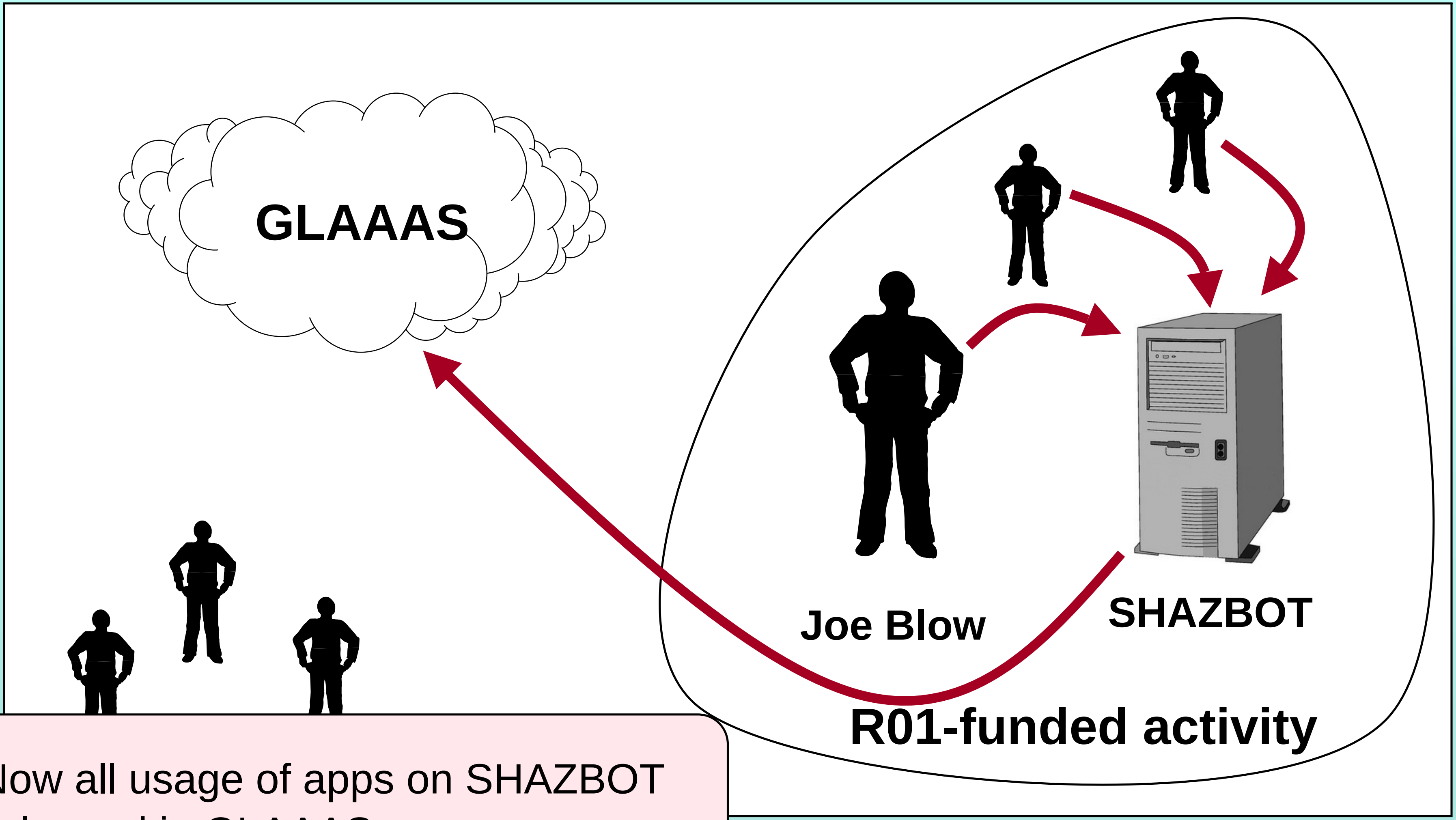
Joe assigns one lab member to act in DBA role on SHAZBOT.

GLAAAS



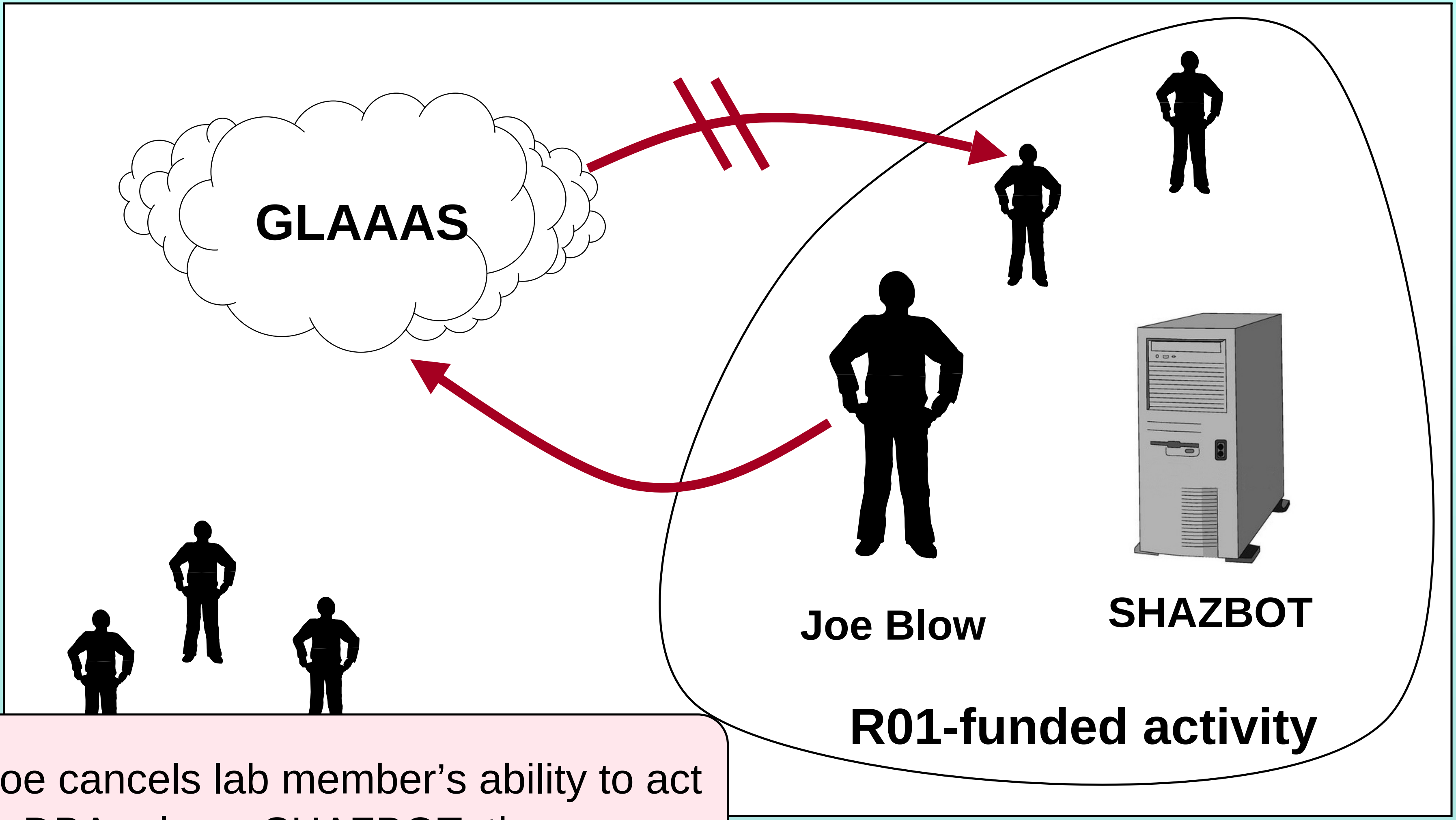
Joe modifies apps on SHAZBOT so that the gPLM is called frequently.

GLAAAS



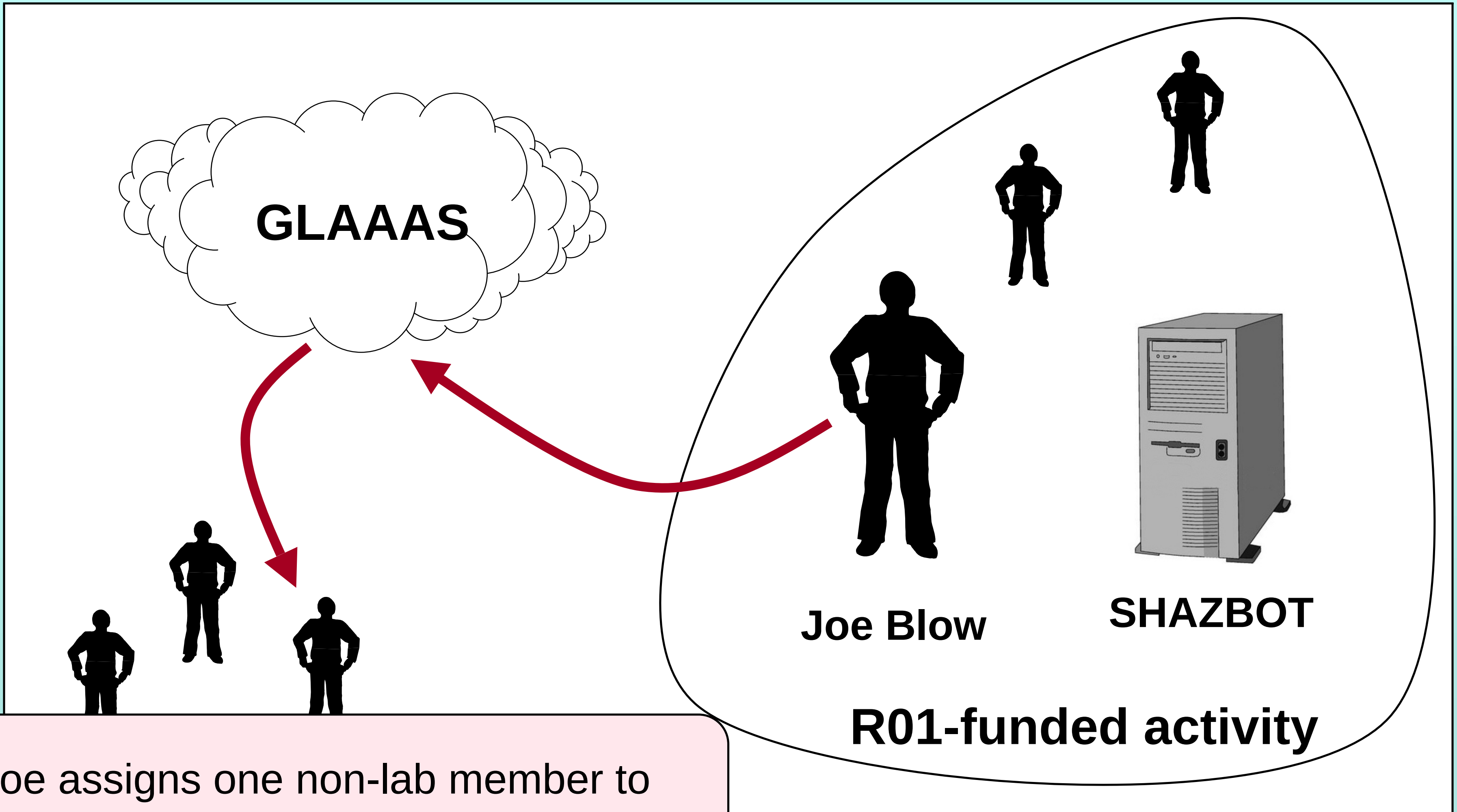
Now all usage of apps on SHAZBOT is logged in GLAAAS.

GLAAAS



Joe cancels lab member's ability to act in DBA role on SHAZBOT, then …

GLAAAS



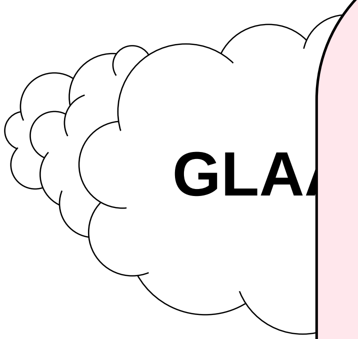
Joe assigns one non-lab member to act in DBA role on SHAZBOT.

GLAAAS

All of these changes in authorization, authentication, and logging for SHAZBOT occur without any USER having to make any changes to his/her account and without any effect on the user's permissions or access on any other system.

USERs assigned multiple roles on a machine can request a change to a different authorized role at any time, without having to reauthenticate. USERs can be simultaneously connected in multiple roles, if needed.

GLAAAS



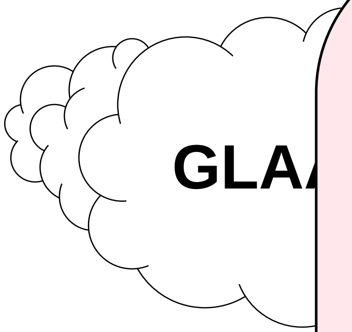
What else might GLAAAS do?

Provide truly GLOBAL support, by working with similar systems at other campuses?

Support the management of GROUPS of people, so that permission could be granted to the right group, but the responsibility for maintaining the group is no longer the system administrator's?

....?

GLAAAS



Technically, how might GLAAAS actually work?

....?

Bottom-up Example

Database Issues

Relational Databases

Business Databases:

- FACTS
- REAL OBJECTS
- CLOSED UNIVERSE
- DEDUCTIVE REASONING

Relational Databases

Business Databases:	Scientific Databases:
• FACTS	• OBSERVATIONS
• REAL OBJECTS	• HYPOTHETICAL OBJECTS
• CLOSED UNIVERSE	• OPEN UNIVERSE
• DEDUCTIVE REASONING	• INDUCTIVE REASONING

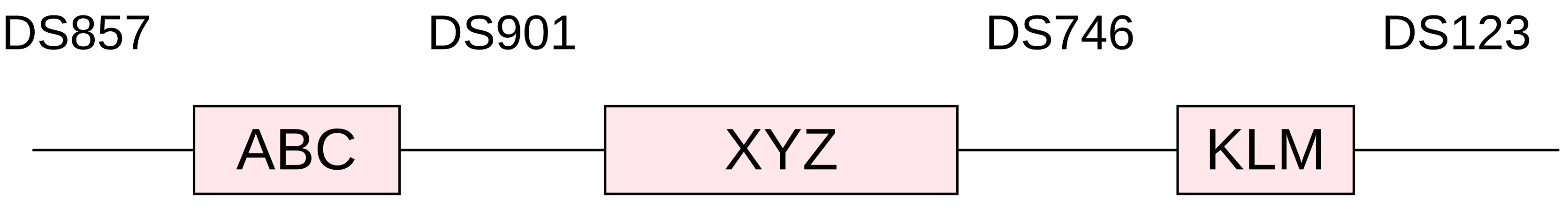
Relational Databases

Facts:	Observations:
• SOLID	• SOFT
• STABLE	• CONSTANTLY CHANGING
• GLOBALLY CONSISTENT	• MUTUALLY INCONSISTENT

Relational Databases

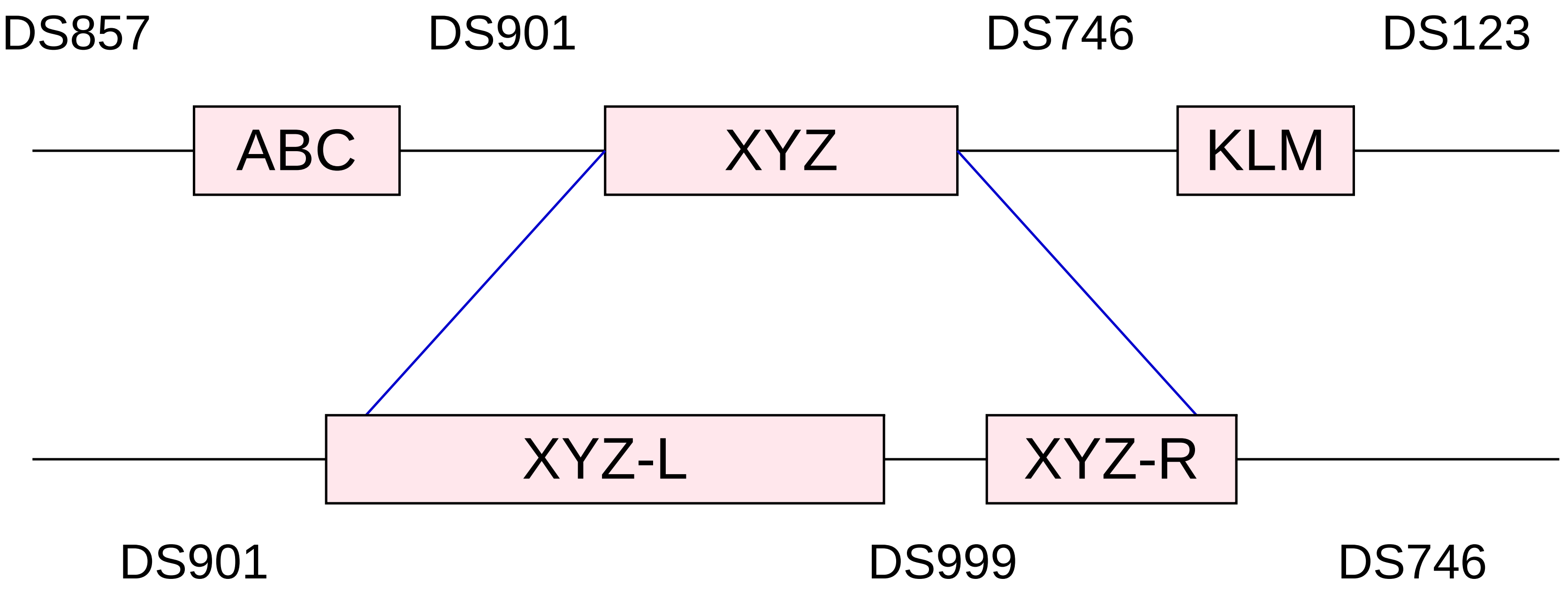
Real Objects:	Hypothetical Objects:
• CONCRETE	• INSUBSTANTIAL
• STABLE (or known instability)	• UNSTABLE
• IMMUTABLE (more or less)	• HIGHLY MUTABLE (lumping and splitting)

GDB Example:



In principle, the completed genome should consist of alternating coding regions (genes) and non-coding regions (D-segs). Each map object (gene or D-seg) is an individual object, with a primary key and with foreign keys pointing to it.

GDB Example:



But while the genome is being completed, the HYPOTHETICAL genes and D-segs may undergo lumping or splitting, creating challenges for the maintenance of referential integrity.

Relational Databases

Closed Universe:	Open Universe:
Who, of the registrants for BRIITE, came to the meeting?	

Relational Databases

Closed Universe:	Open Universe:
Who, of the registrants for BRIITE, came to the meeting? Who, of the registrants for BRIITE, did not come to the meeting?	

Relational Databases

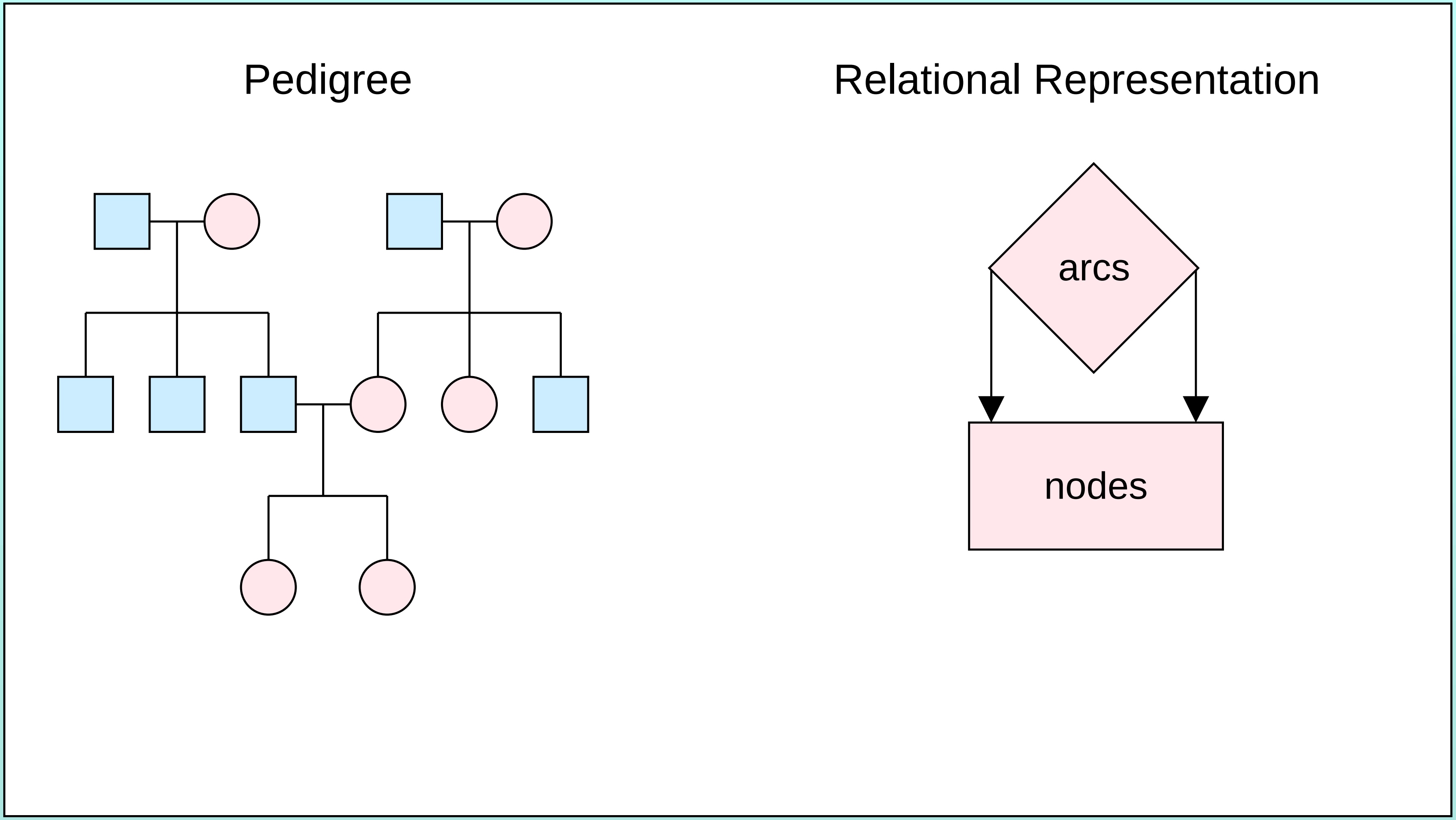
Closed Universe:	**Open Universe:**
Who, of the registrants for BRIITE, came to the meeting? Who, of the registrants for BRIITE, did not come to the meeting?	Who else did not come to the meeting?

Relational Databases

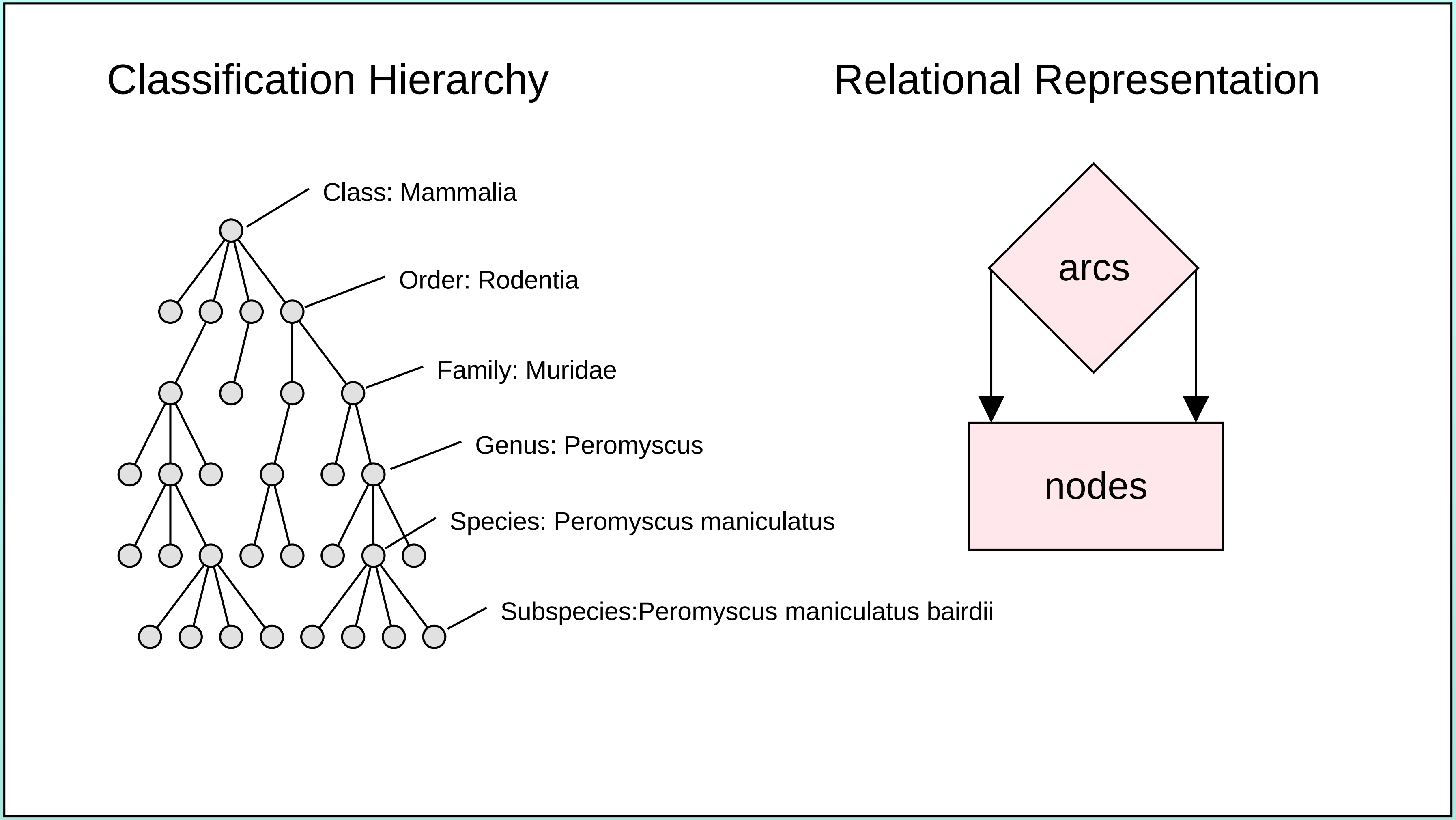
Deductive Reasoning:	Inductive Reasoning:
• DETERMINISTIC	• PROBABALISTIC
• WELL ESTABLISHED ALGORITHMS (formal logic)	• METHODS STILL DEBATED (almost at the metaphysical level)

Data Model Problems

Graph Challenges

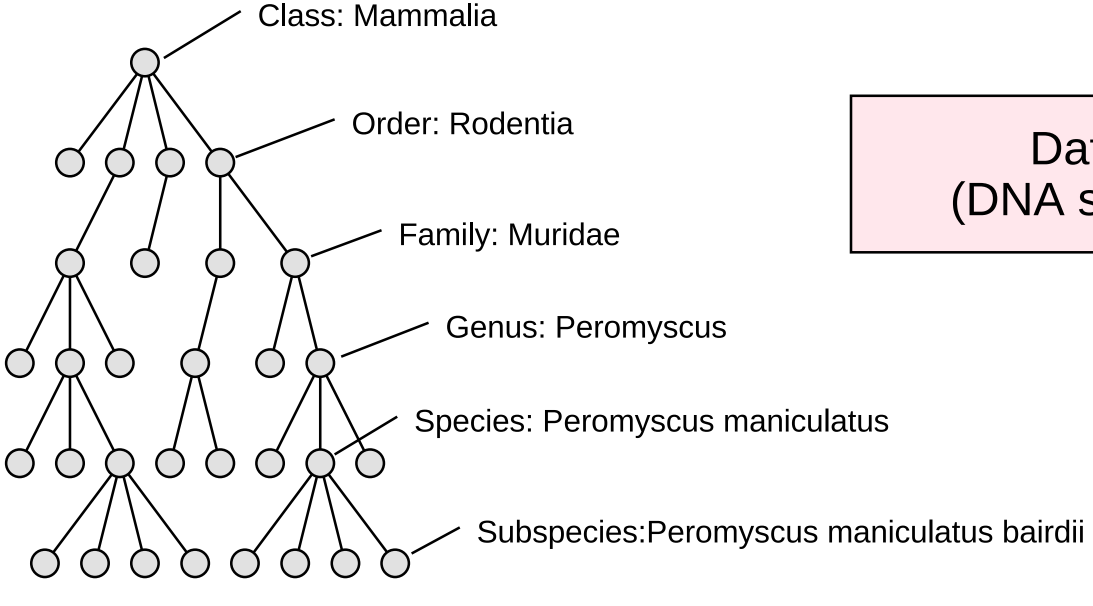


Graph Challenges



Classification Challenges

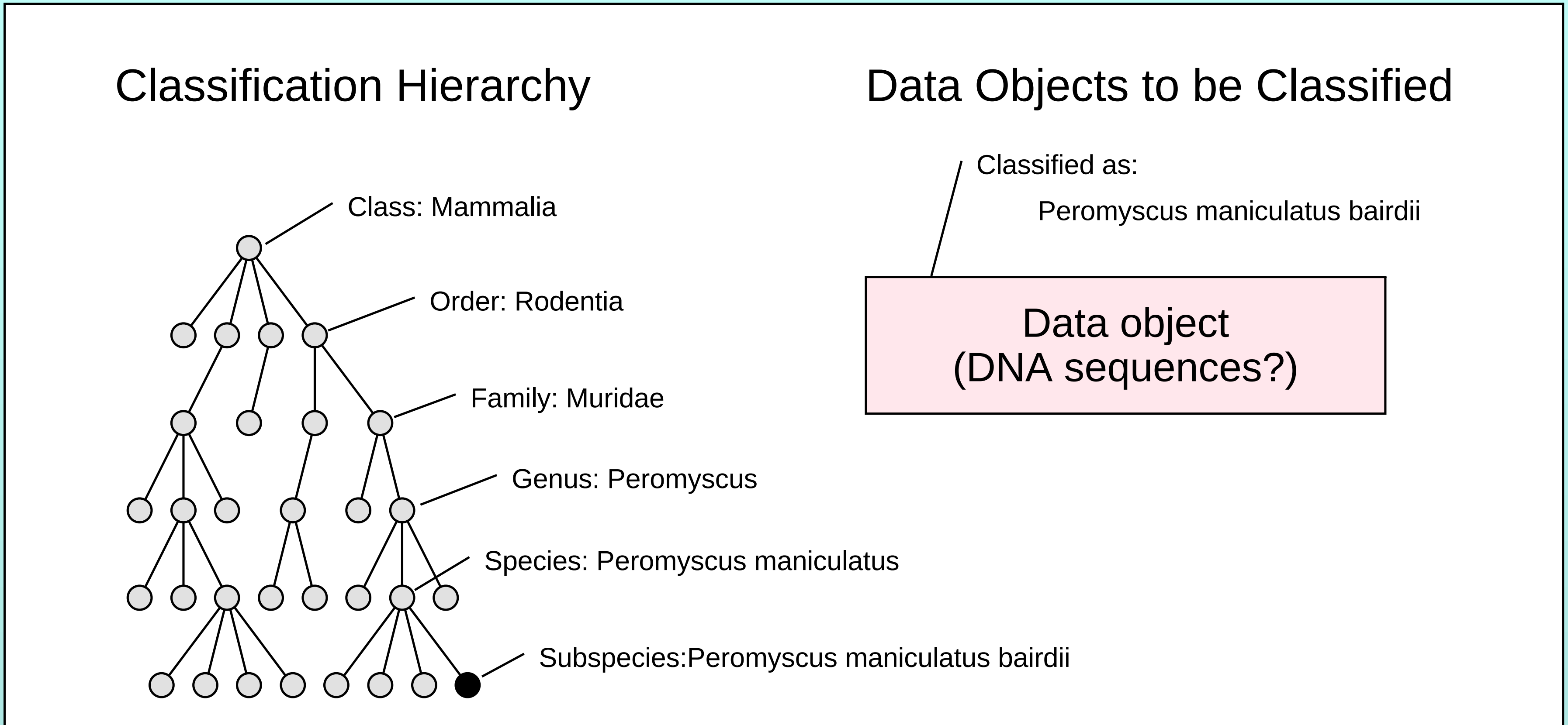
Classification Hierarchy



Data Objects to be Classified

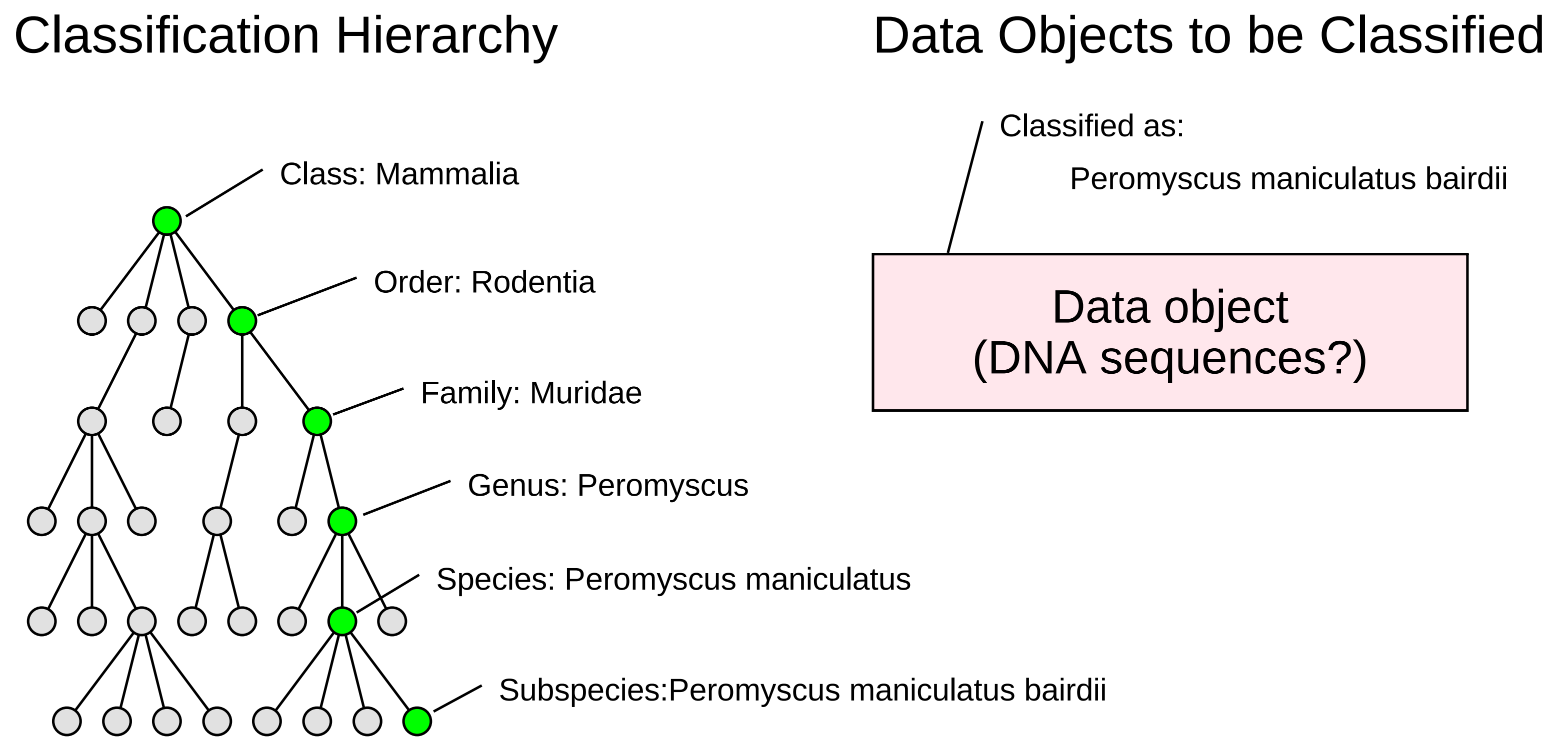
Data object
(DNA sequences?)

Classification Challenges



Suppose we permit querying at any level, but require classification of objects at leaf level.

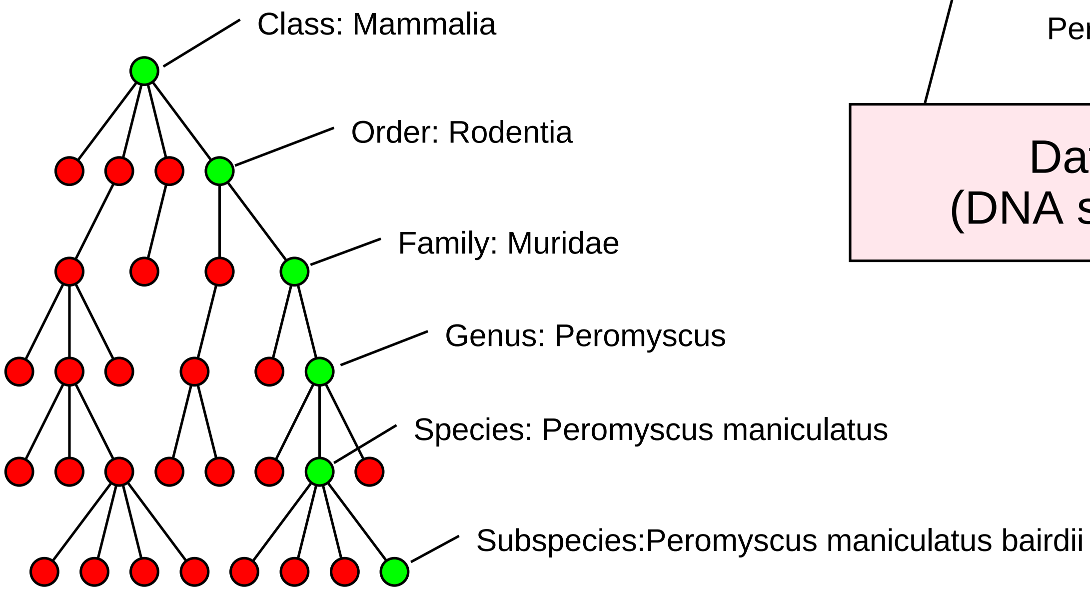
Classification Challenges



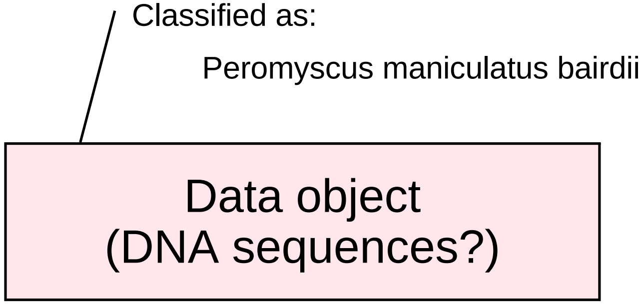
Suppose we permit querying at any level, but require classification of objects at leaf level. Then all questions referring to nodes on the path from the classification point to the top return **TRUE**,

Classification Challenges

Classification Hierarchy

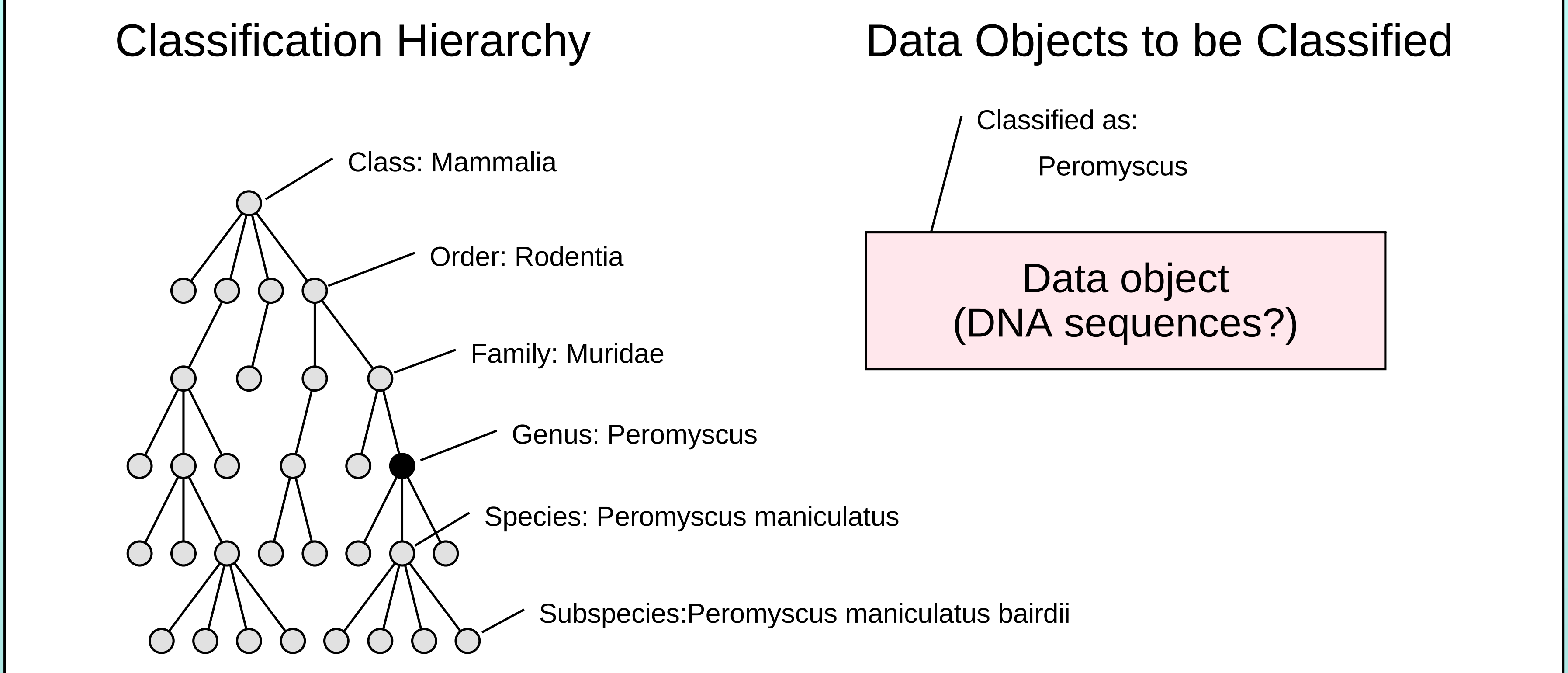


Data Objects to be Classified



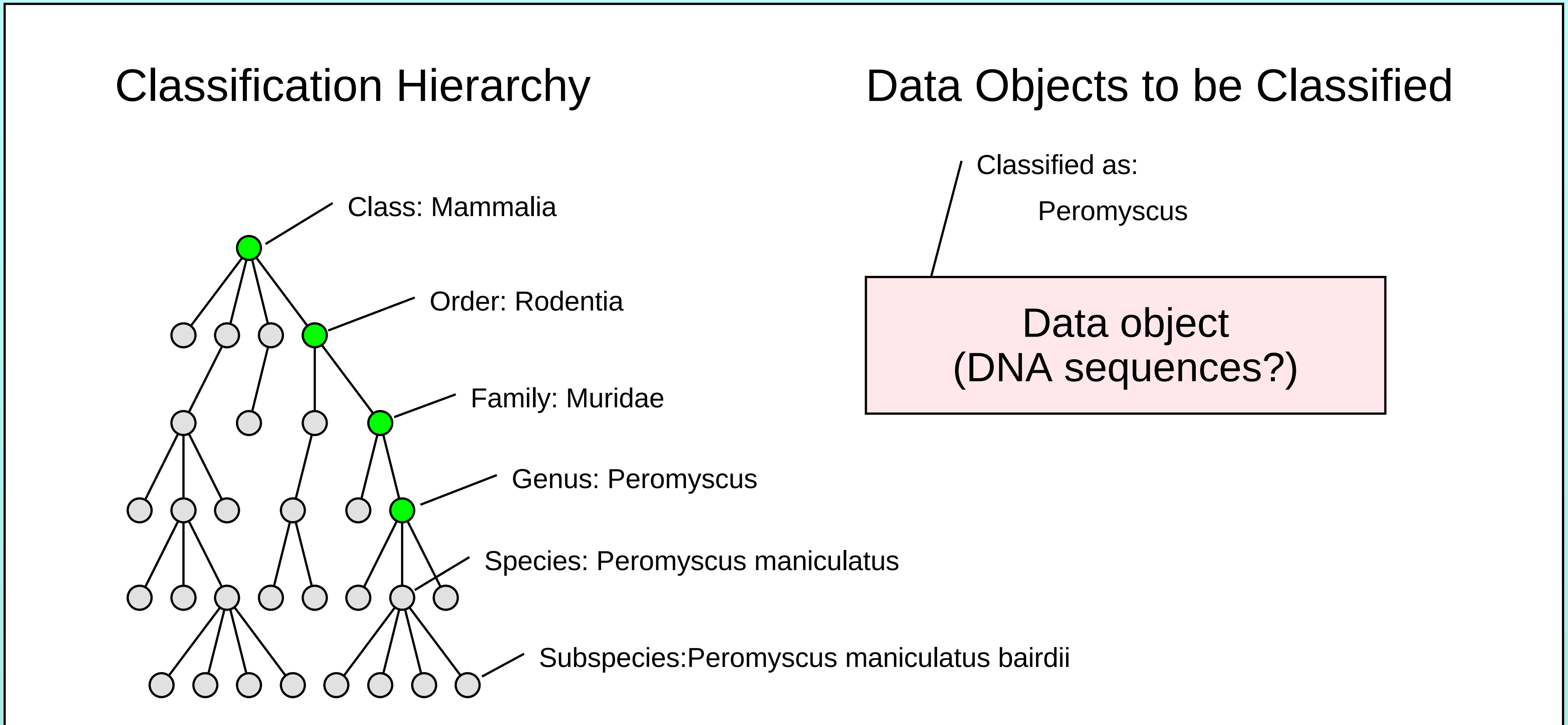
Suppose we permit querying at any level, but require classification of objects at leaf level. Then all questions referring to nodes on the path from the classification point to the top return **TRUE**, all others **FALSE**.

Classification Challenges



Now, suppose the we permit querying at any level, and also that we allow classification of objects at any level.

Classification Challenges

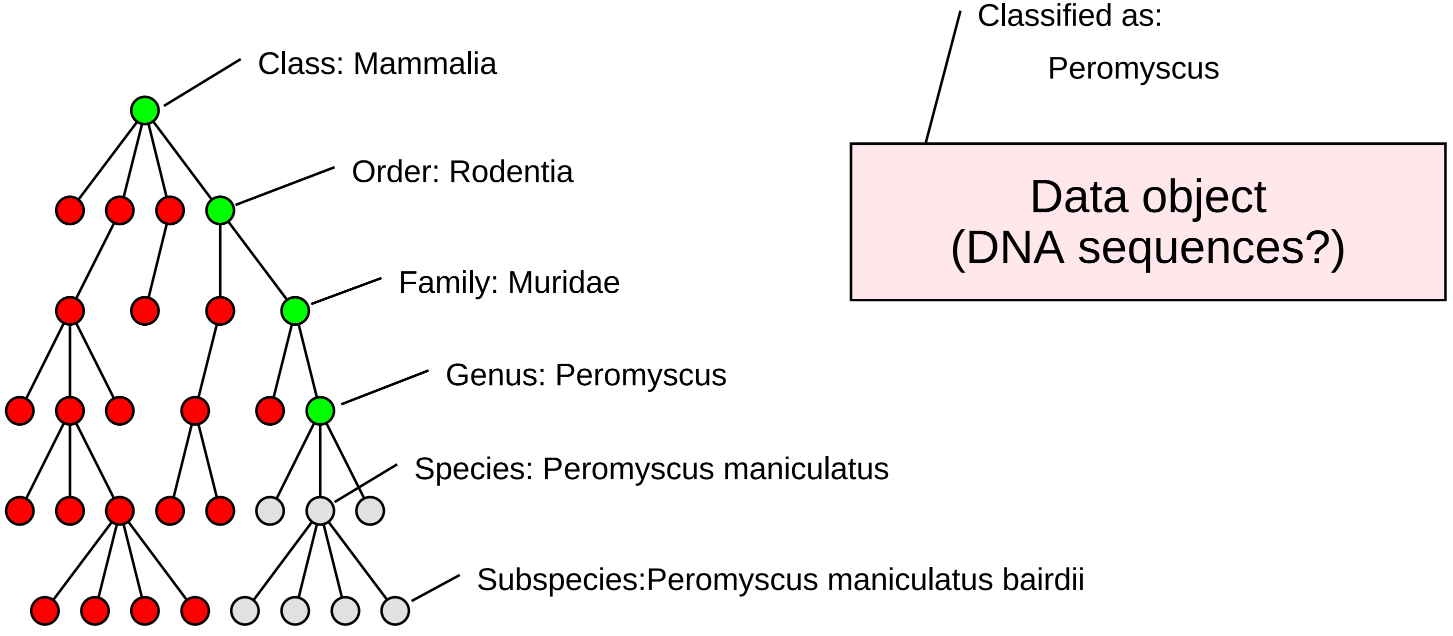


Now, suppose the we permit querying at any level, and also that we allow classification of objects at any level. Then all questions referring to nodes on the path from the classification point to the top return **TRUE**,

Classification Challenges

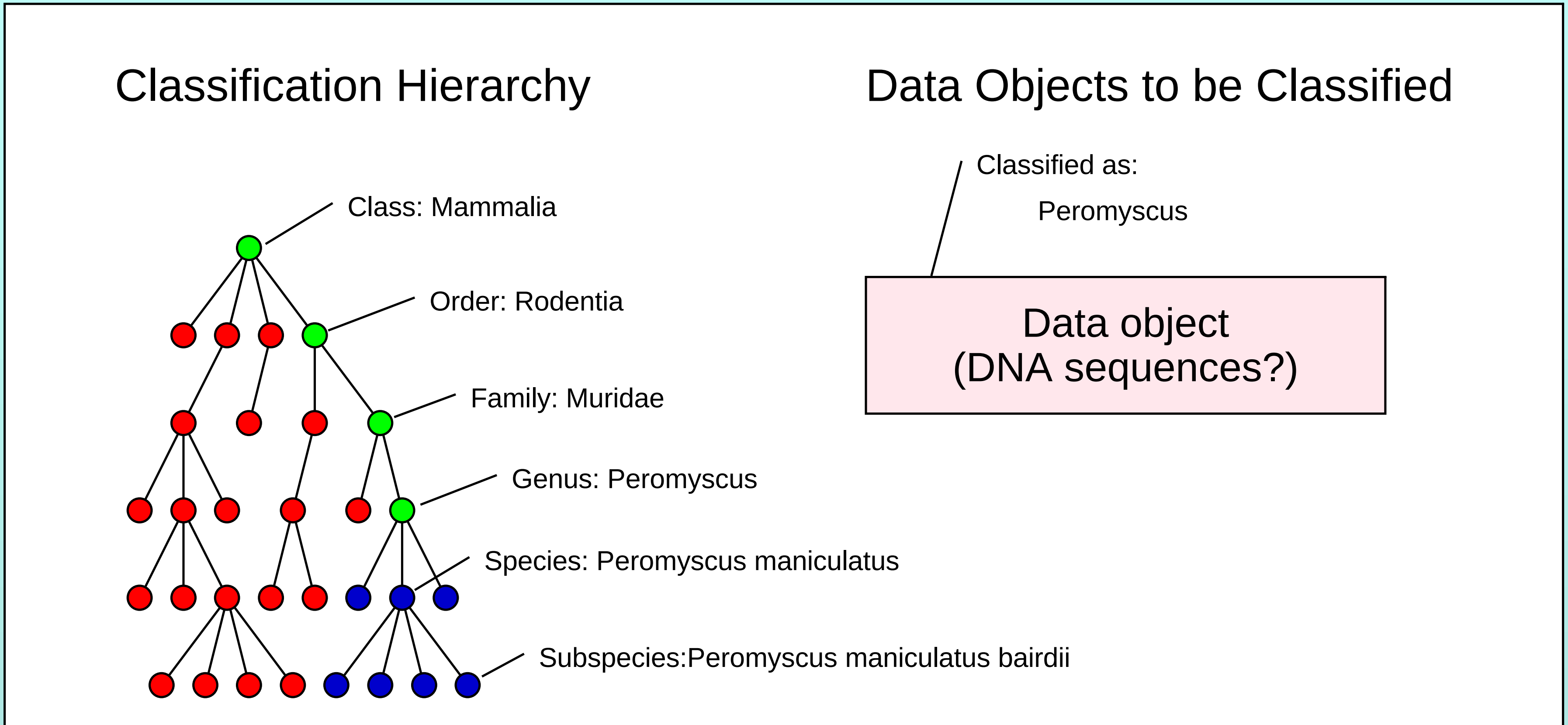
Classification Hierarchy

Data Objects to be Classified



Now, suppose the we permit querying at any level, and also that we allow classification of objects at any level. Then all questions referring to nodes on the path from the classification point to the top return **TRUE**, all questions referring to nodes lateral to this path return **FALSE**,

Classification Challenges



Now, suppose the we permit querying at any level, and also that we allow classification of objects at any level. Then all questions referring to nodes on the path from the classification point to the top return **TRUE**, all questions referring to nodes lateral to this path return **FALSE**, and all questions referring to nodes below the classification point return **MAYBE**.

Data Integration

Data Integration Crisis

Adequate connections among data objects in different databases do not exist.

Without adequate connectivity, much of the value of the data will be lost.

Data Integration Goals

Achieve conceptual integration of biomedical data.

Provide technical integration of both data and analytical resources to facilitate conceptual integration.

Data Integration Impediments

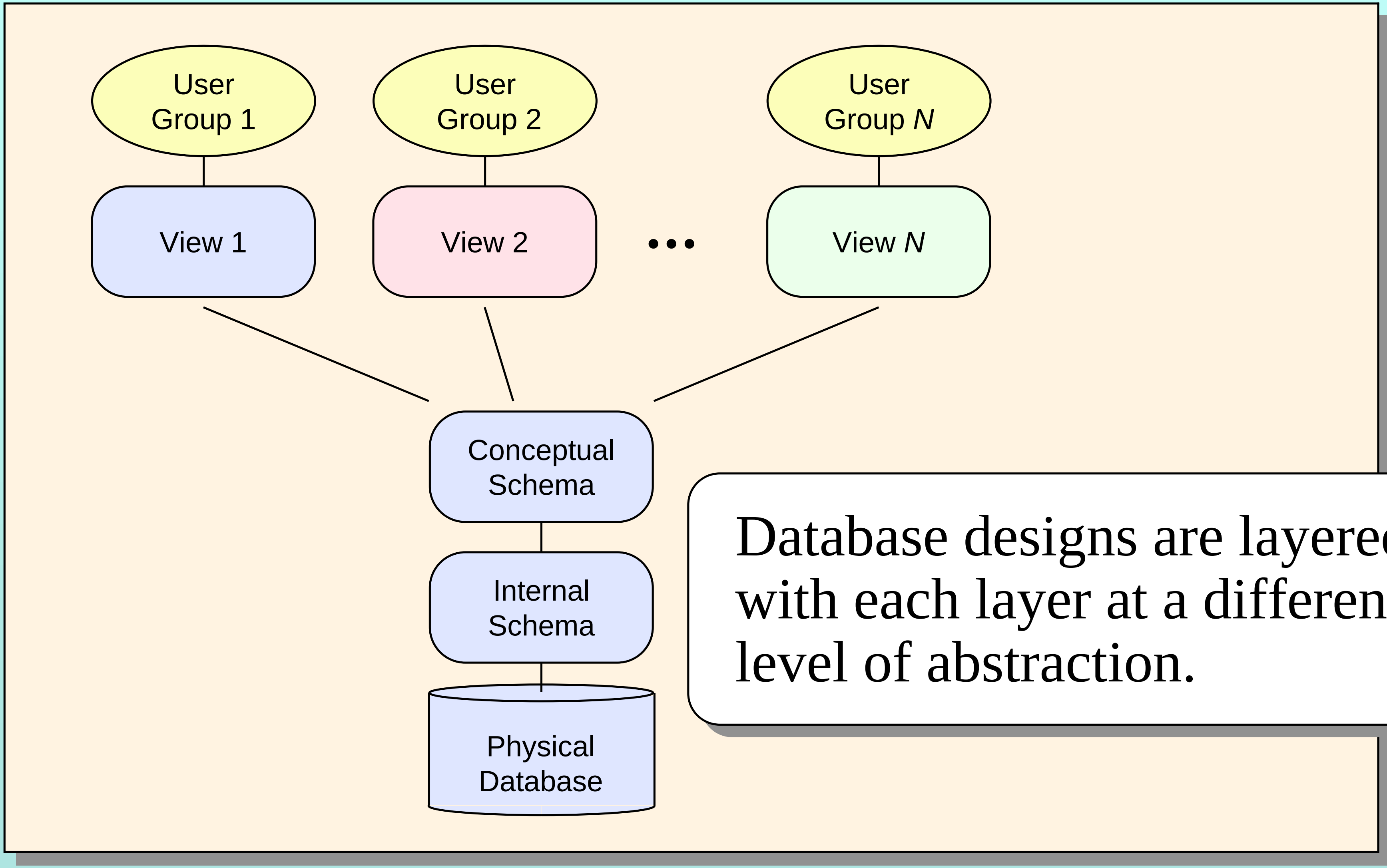
Technical: Integrating distributed, heterogeneous databases is not easy.

Sociological: Local incentives encourage competition, not cooperation.

Conceptual: Semantic mismatches exist among databases.

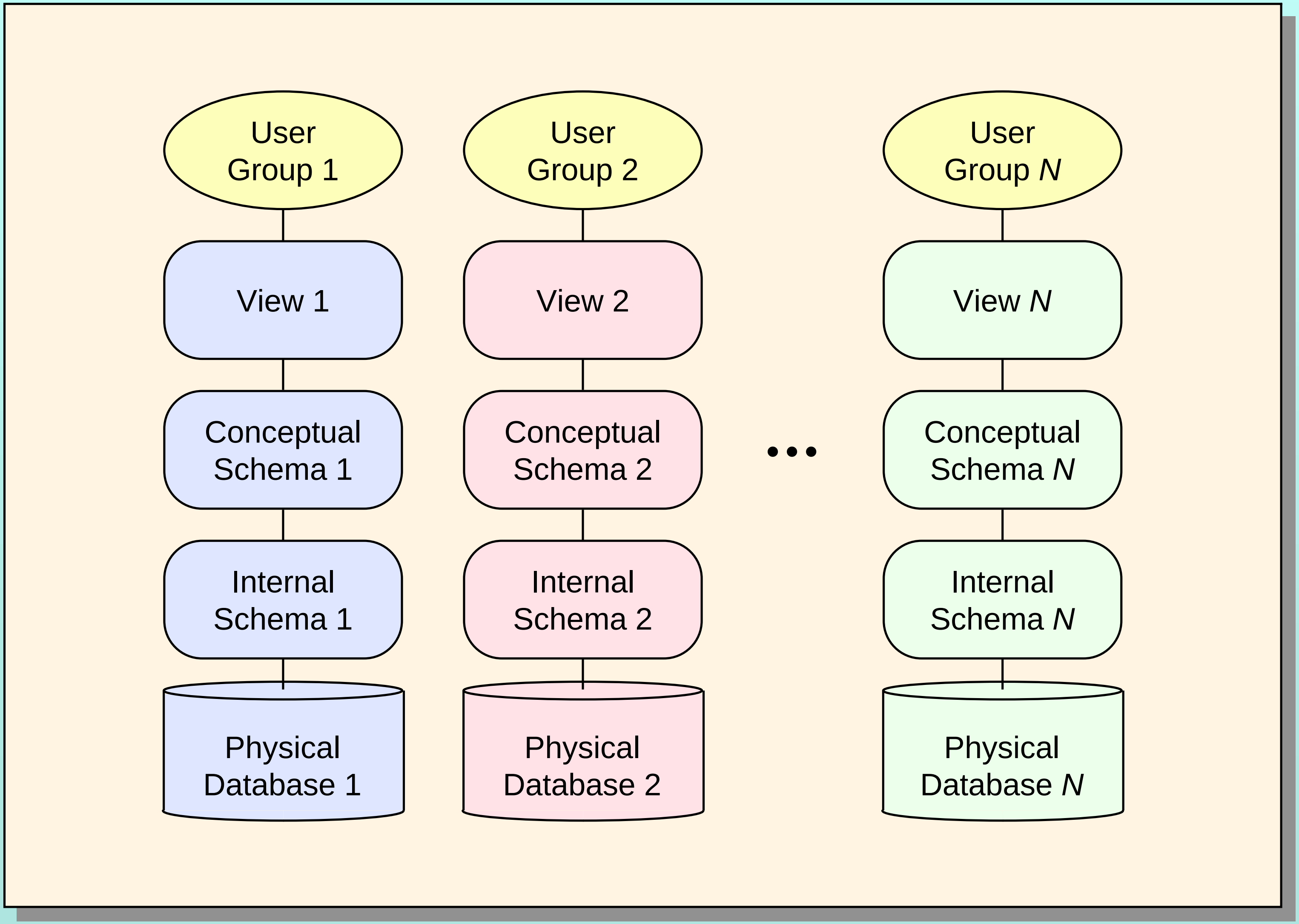
Technical Impediments

Multiple Views

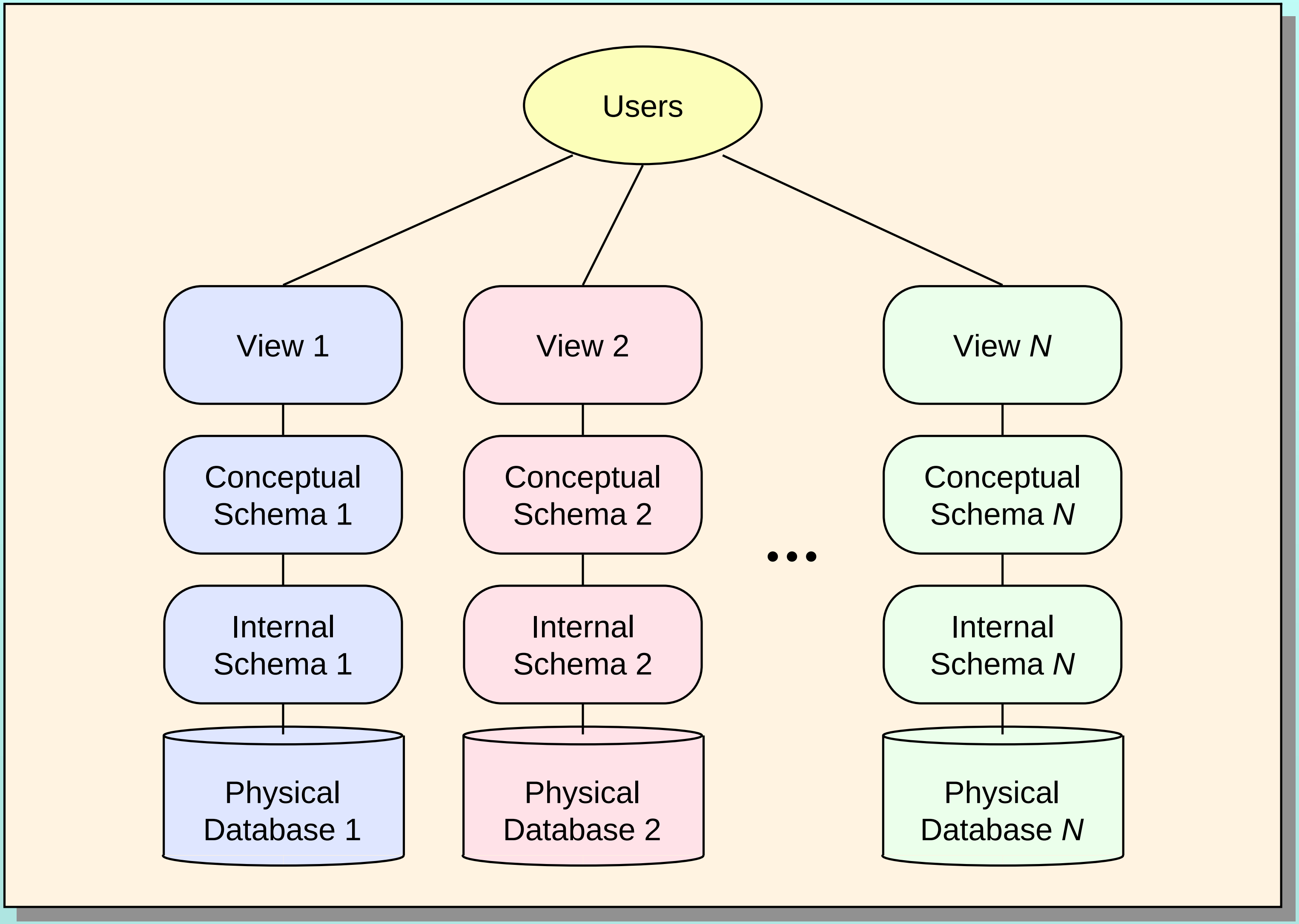


Database designs are layered, with each layer at a different level of abstraction.

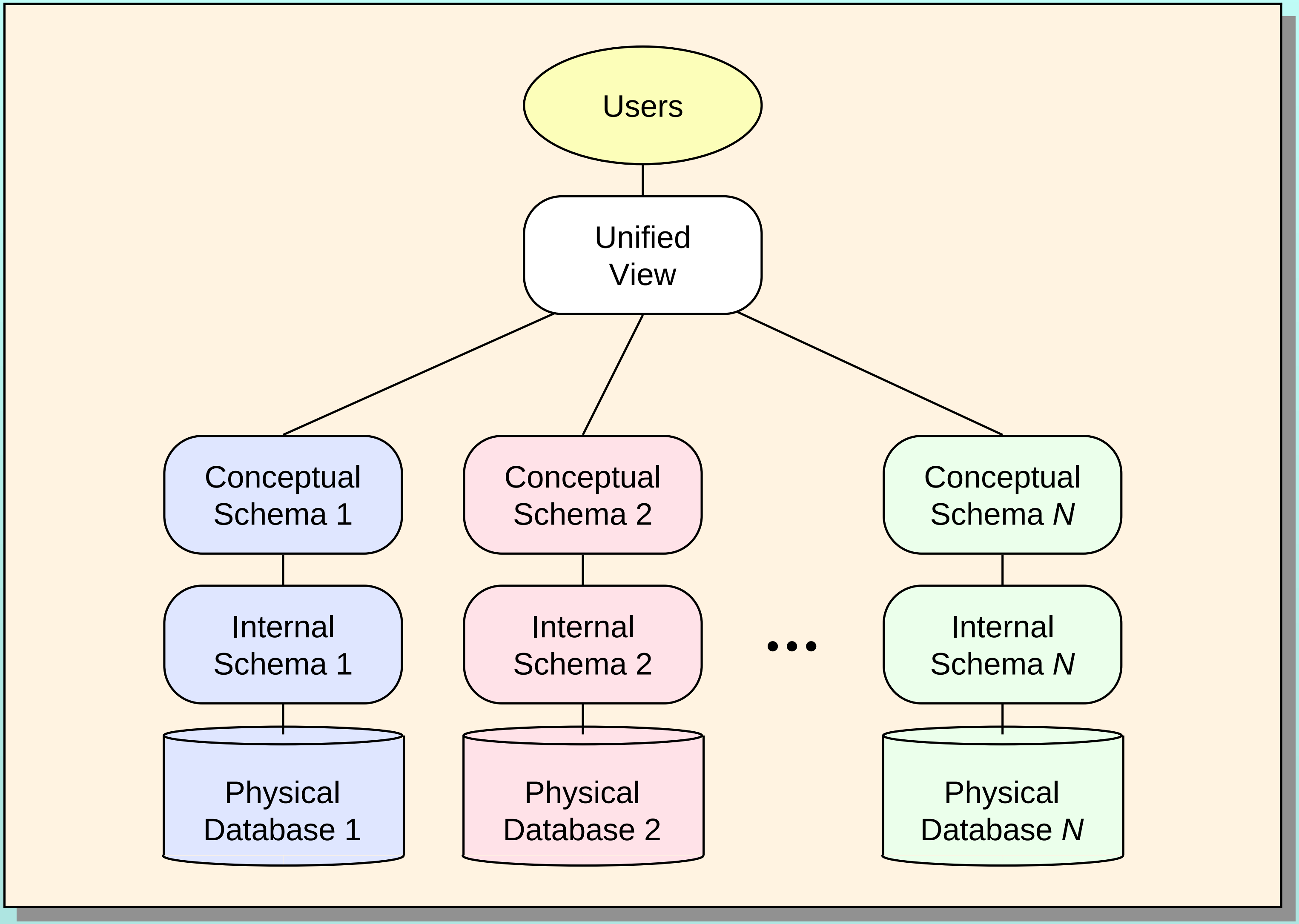
Multiple Databases



Current Situation



Desired Situation

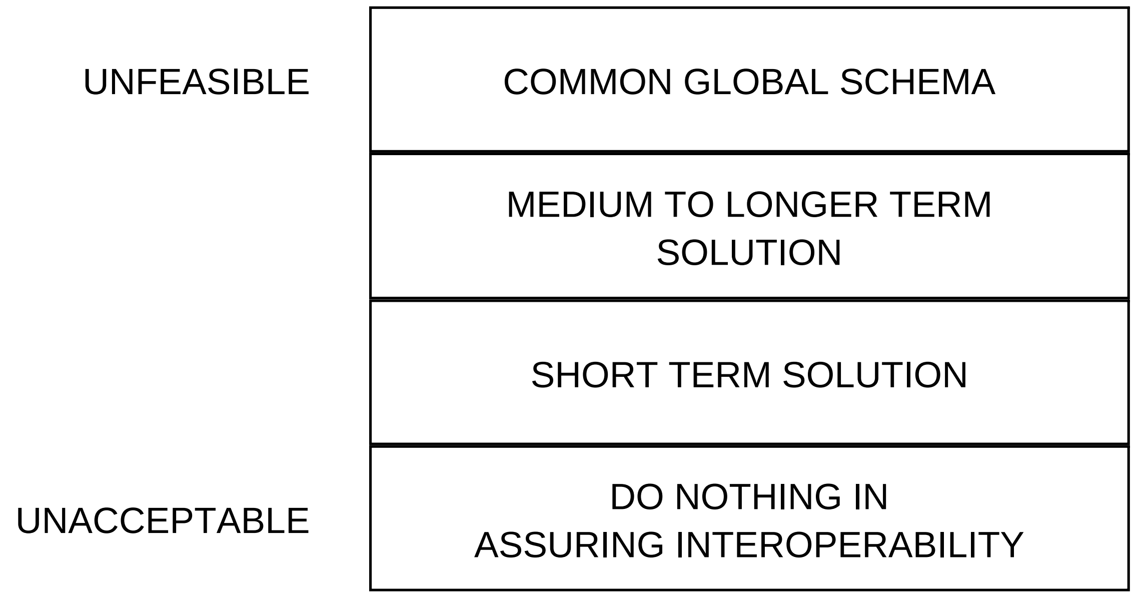


The Vision

We must begin to think of the computational infrastructure of genome research as a federated information infrastructure of interlocking pieces.

Report of the Invitational DOE Workshop on Genome Informatics, 26-27 April 1993, Baltimore, Maryland

Taxonomy of Multidatabase Systems



Options for integrating networked databases (adapted from Chorafas and Steinmann, 1993).

Taxonomy of Multidatabase Systems

Tightly Coupled: single organizational entity overseeing information resources relevant to genome research

•

•

•

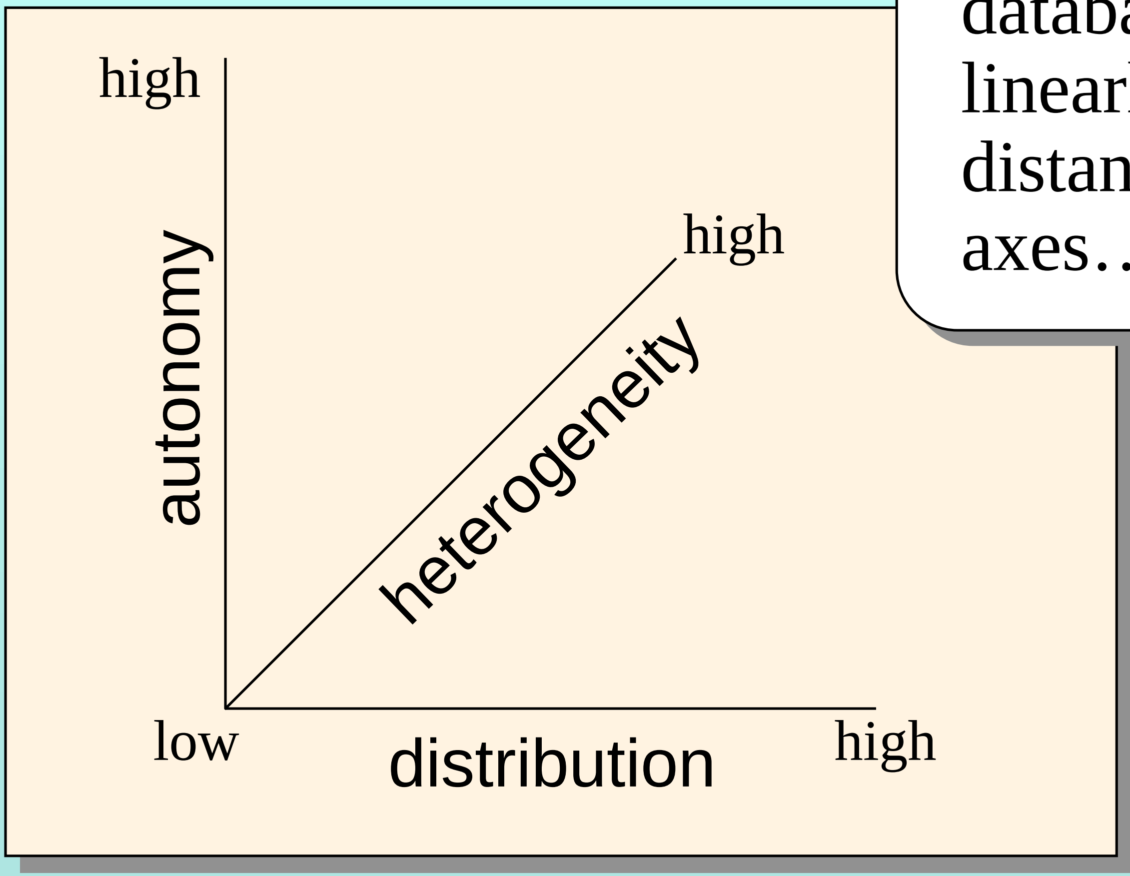
adoption of common DBMSs at participating sites

shared data model across participating sites

common semantics for data publishing

Loosely Coupled: common syntax for data publishing

Difficulty Dimensions

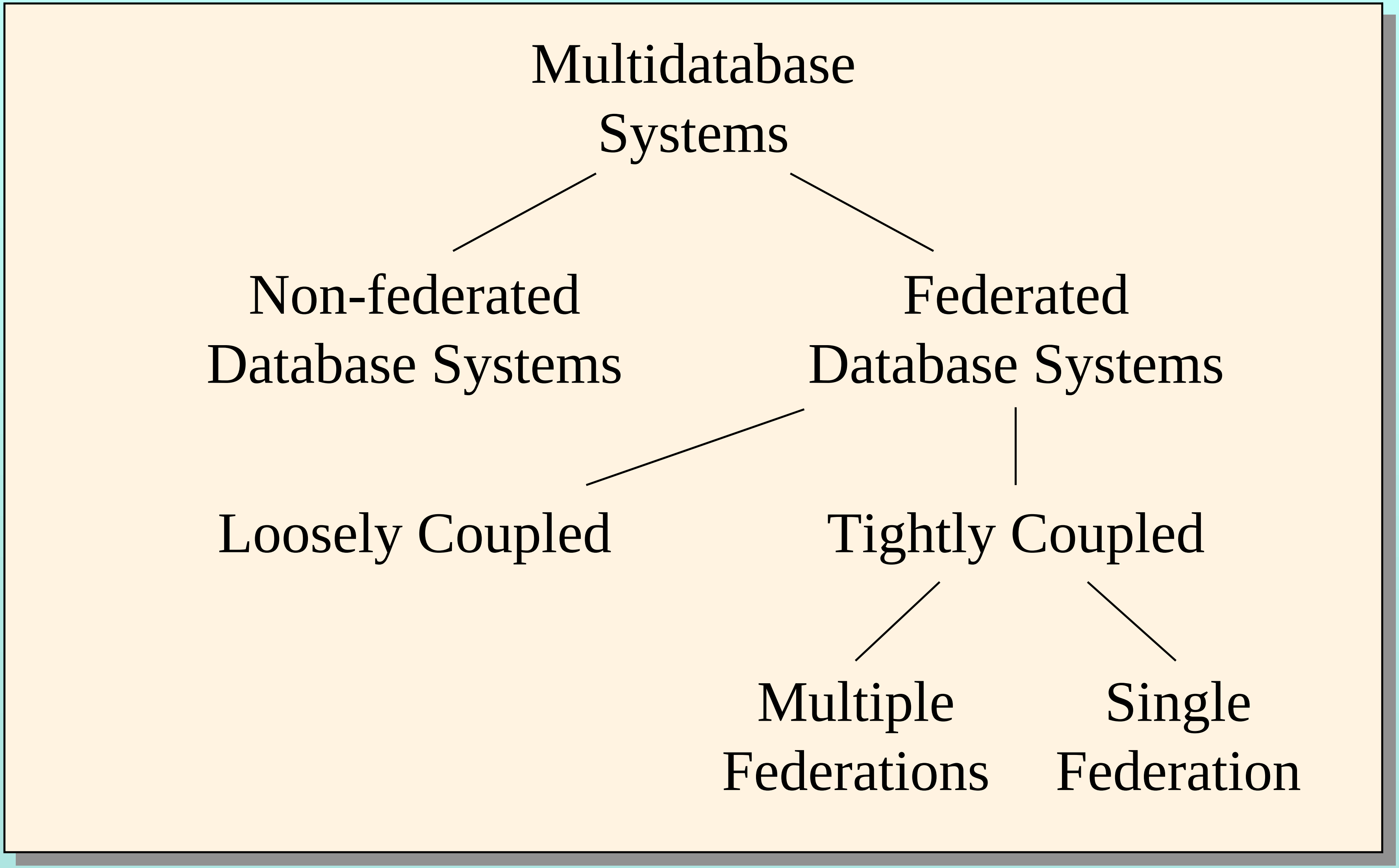


Difficulty in connecting databases scales non-linearly as a function of distance along all three axes…

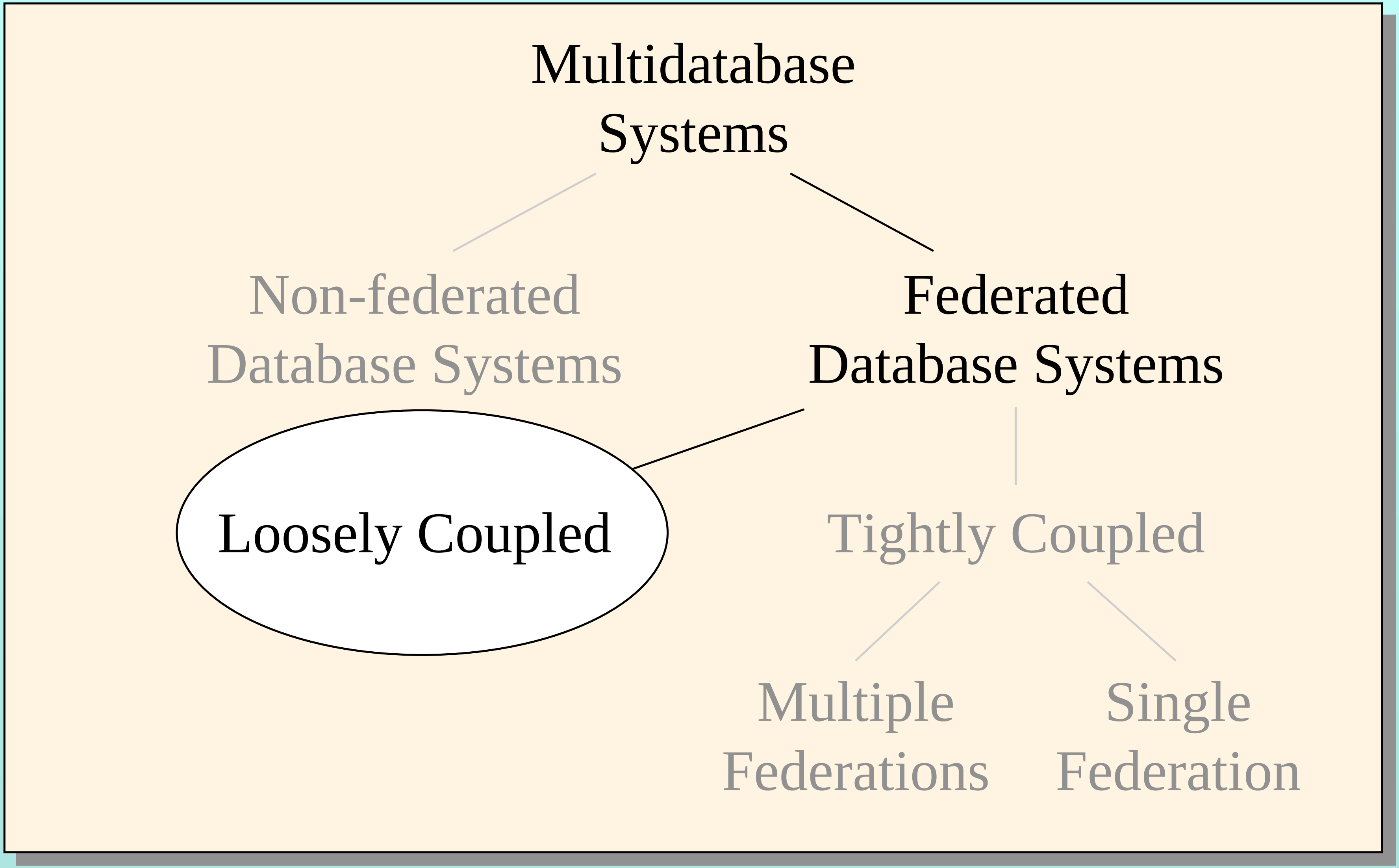
Taxonomy of Multidatabase Systems

A ***multidatabase system*** (MDBS) supports simultaneous operations on multiple (perhaps different) component databases. A ***federated database system*** (FDBS) has autonomous components, whereas ***non-federated database systems*** are unitary. A federated system with no strong central federation management is considered ***loosely coupled***. One with strong central management and with federation database administrators controlling access to the components is ***tightly coupled*** . A ***single federation*** allows only one centrally managed federated schema; a ***multiple federation*** allows multiple centrally managed schemas.

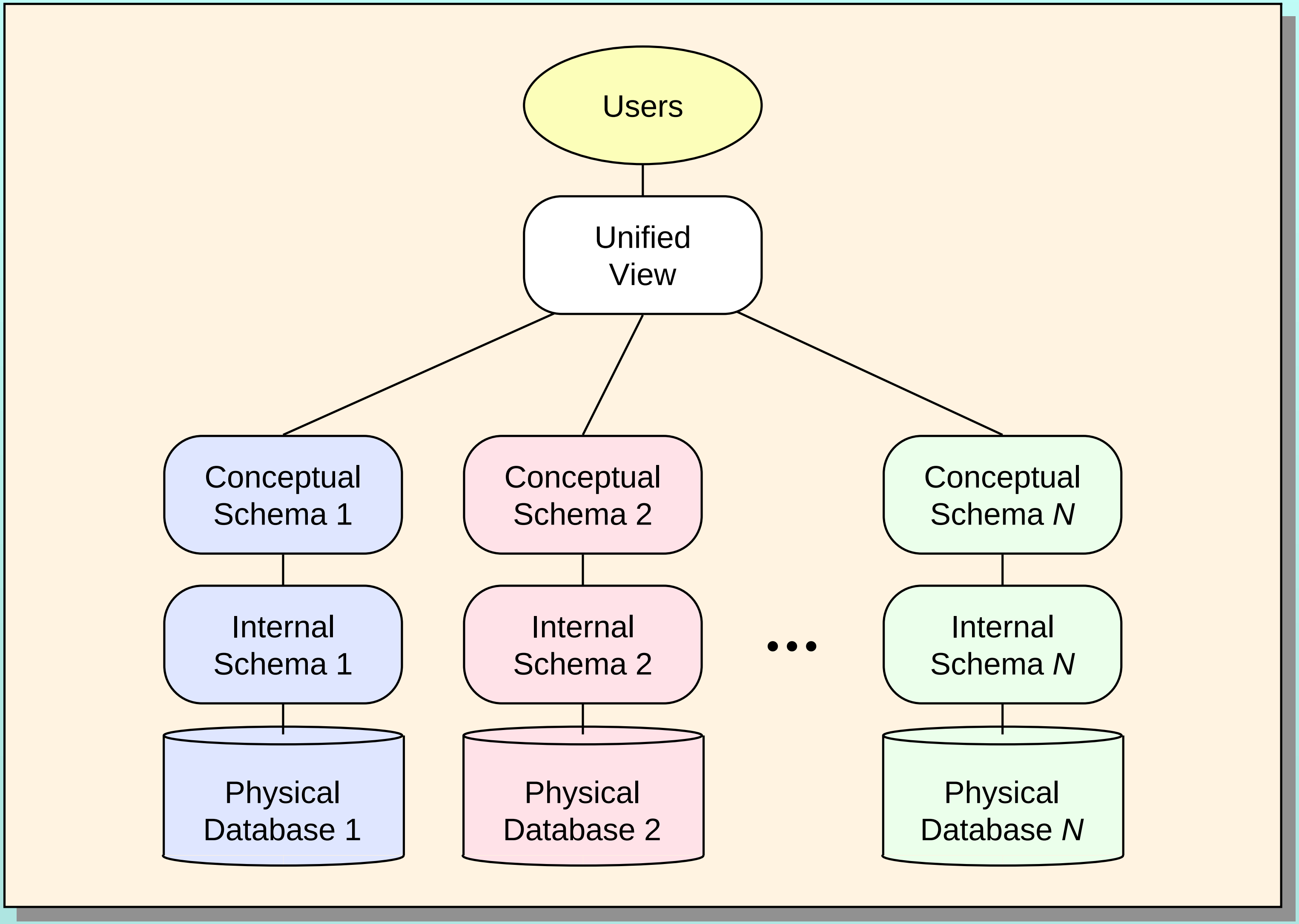
Taxonomy of Multidatabase Systems



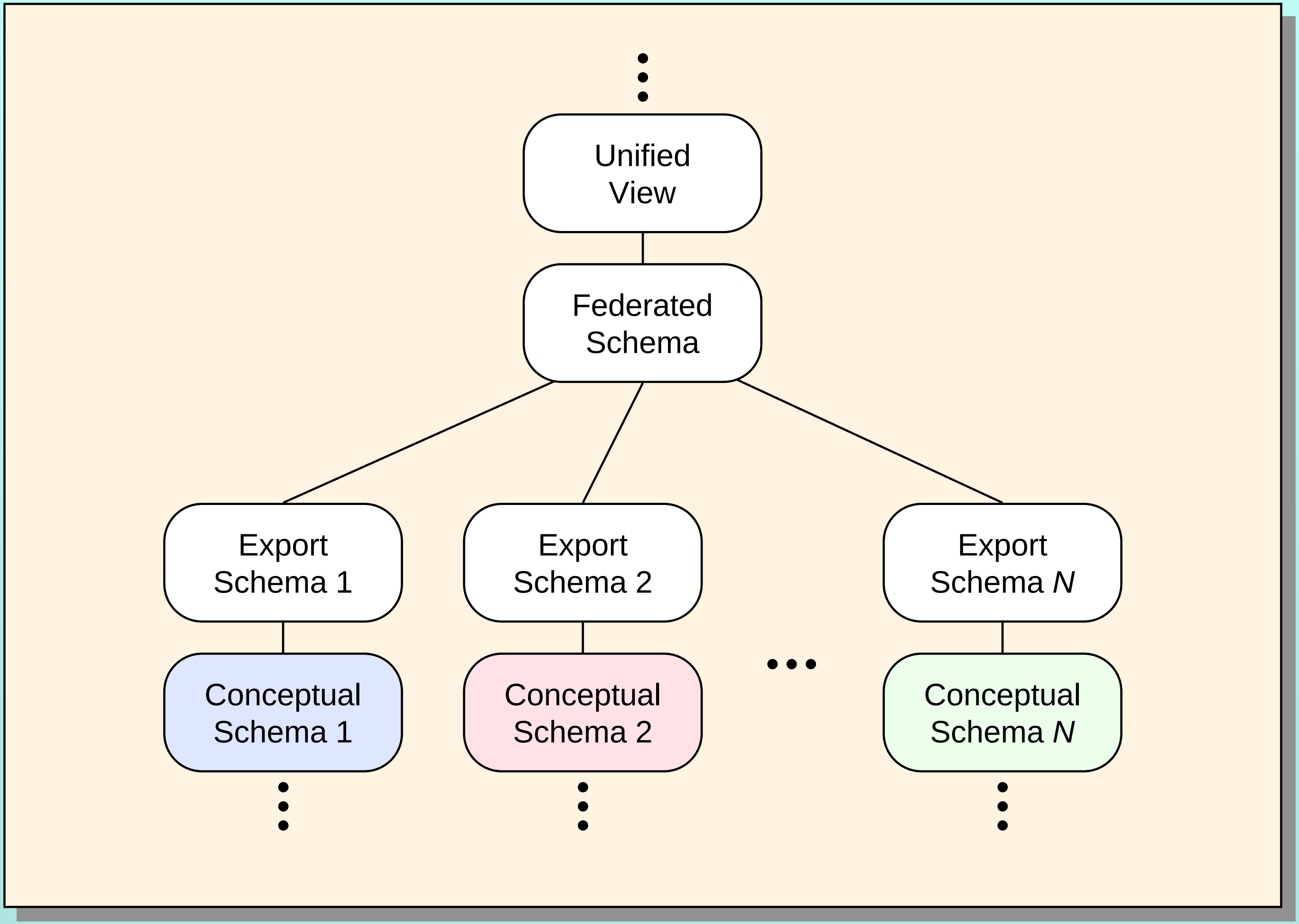
Taxonomy of Multidatabase Systems



Desired Situation

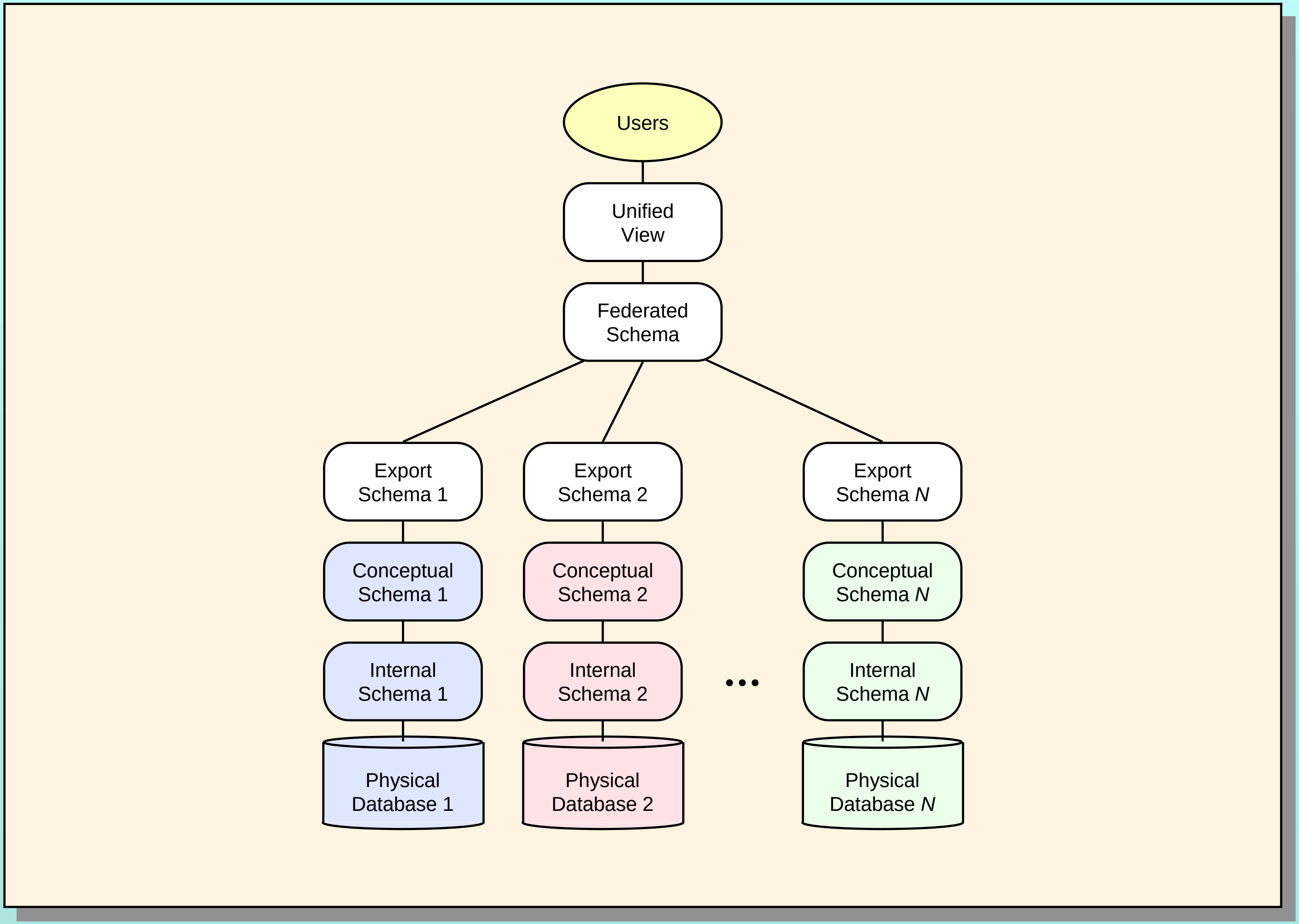


More Layers

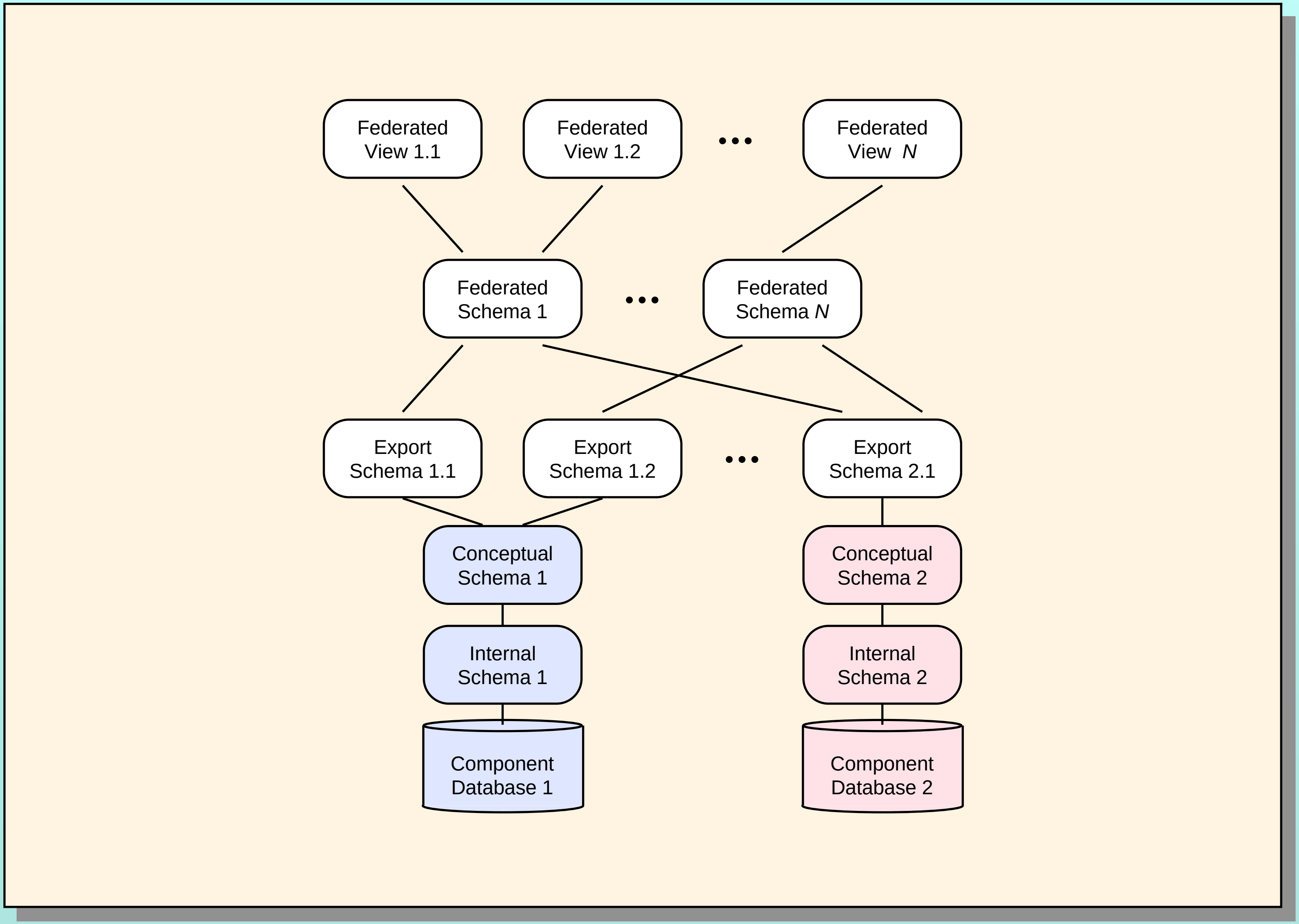


Unified View
Federated Schema
Export Schema 1
Export Schema 2
Export Schema *N*
Conceptual Schema 1
Conceptual Schema 2
Conceptual Schema *N*

Federated Schema



Multiple Federations



Federated Information Infrastructure

Public Funding of Databases

Stand-alone Criteria:

- Is there a need?
- Will this meet the need?
- Can they do it?
- Is it worth it?

Public Funding of Databases

Global Criteria:

- Does it adhere to standards?
- Will it interoperate?
- Is there commitment to federation?
- Is it worth it?

Information Resources and the GII

Guiding Principles:

- Global value explosion
- Componentry
- Anonymous interoperability
- Technical scalability
- Social scalability
- Value additivity

Enough Examples!

Let’s Get to Work

Working Group Assignments

For each module:

Background
- The Problem
- Available Solutions
- Remaining Challenges
  - *To be Solved in Other Modules*
  - *To be Solved in This Module*

An Ideal Solution
- Requirements
- Black-box Attributes
- Interoperability Interfaces
- Other Necessary Components
- Possible Implementation Details

Summary and Overview

Slides:

http://www.esp.org/rjr/briite-01.pdf