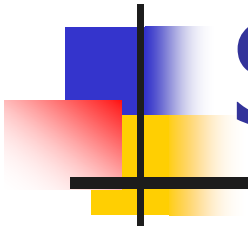

State Is Not Evil

Dan Johnsson

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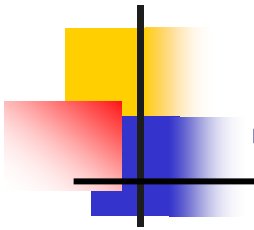
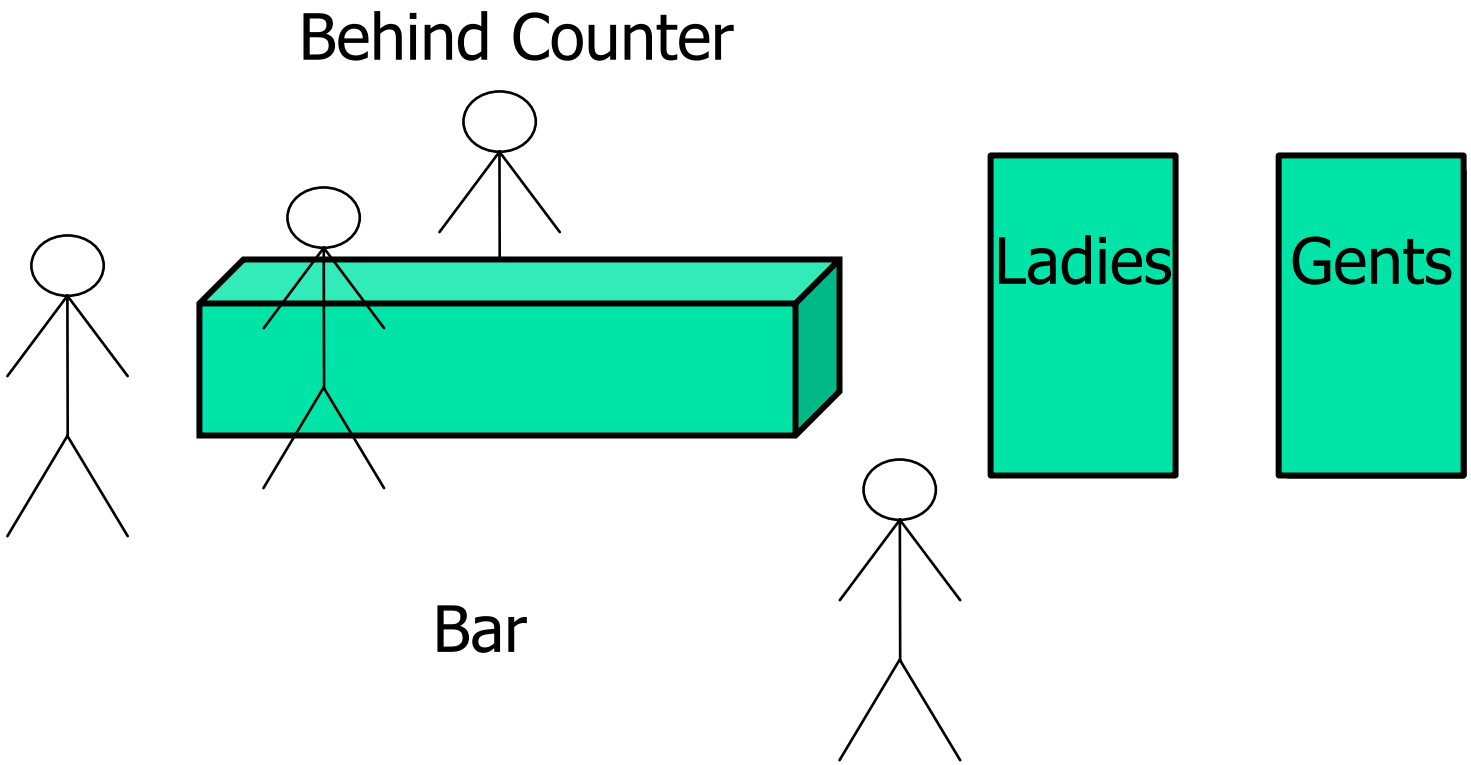
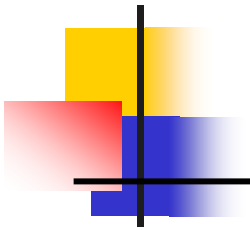


Some Opinions on State

- State is not evil, it is just misunderstood
  - Carl Jung
- State is not evil, it is the love of state that is evil
  - Book of Job
- The peoples' right to bear state must not be infringed upon
  - Constitution of the United States
- If state is outlawed, only outlaws will carry state
  - Librarian party
- There is something rotten in the state …
  - Shaxbeard
- "I'll be back!"
  - Governor of the state …

Silly Example - Bar

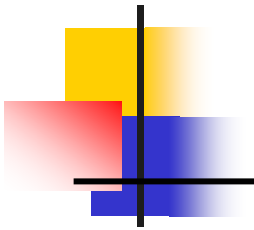




Bar Activities

- Move around
  - Bar area
  - Behind counter
  - Ladies
  - Gents
  - Home
- Buy Drinks
  - only in bar are
- Take money from cash register
  - only behind counter

Where am I?
What can I do?

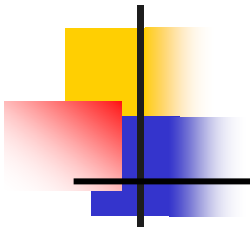


BarDweller - EJB Session

- Interface to clients

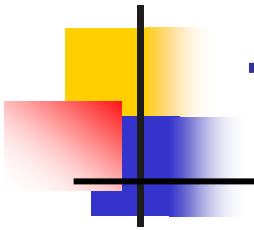
```
public interface BarDweller extends EJBObject {
    public void buyDrink() throws RemoteException;
    public void takeMoney() throws RemoteException;
    public void goBar() throws RemoteException;
    public void goBehindCounter() throws RemoteException;
    public void goLadies() throws RemoteException;
    public void goGents() throws RemoteException;
    public void goHome() throws RemoteException;
}
```

- Implementation will enforce state rules



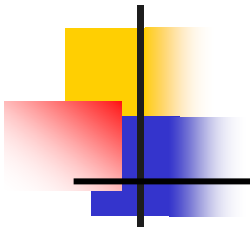
Realistic Example

- Dance school
  - Single (Tap, Hip Hop) and pair dances (Swing)
  - Single or couple registration
  - Quota for men/women
- Strategies for registration ("complex order")
  - Form strategy
    - Gather all info and try, and try again, and again ...
  - Personal service strategy
    - Search with fast fail and partial redo



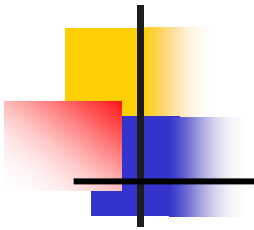
This Presentation

- Scope
  - Management of client state in enterprise systems
  - Session Enterprise JavaBeans
- Depth
  - Recognition
  - Rephrase
  - Apply
  - **Analysis**



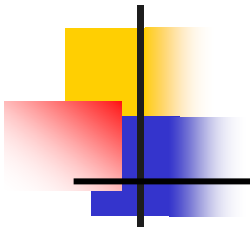
Outline

- **Philosophy - state *etc.***
- Technology - Session EJBs
- Myth - SFSB *vs.* SLSB
- Closer analysis
- Alternative architectures



Philosophy

- Enterprise Systems
- State - from where?
- The Cube
- Kinds of State



Enterprise Systems

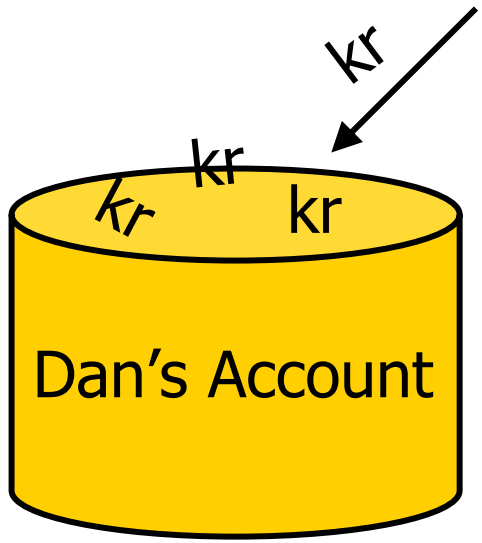
- Information system
  - Information = data *about* something
  - Manage data
    - Oppose: games, FEM-calculations
  - Producers and consumers
  - Consistency of data
  - Enterprise Logic = rules on data

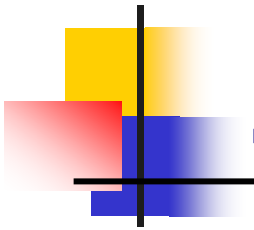
Large Scale Distributed Enterprise Systems

- Large Scale
  - Lots of users
  - Lots of kinds of users
  - Lots of functionality
- Distributed
  - No control of clients
  - Security challenges

All Computer Systems Are Simulations

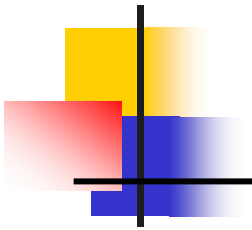
- Simulation of what is
  - Aerodynamics of airplane wing
- Simulations of what should have been
  - File cabinet w/ customer info in office
- Naive Model
  - Bank account = jar with money





States

- OOA: data and usage objects
- Data - persistent data in system
- Usage - client sessions
- Both have state
- Our focus: session objects

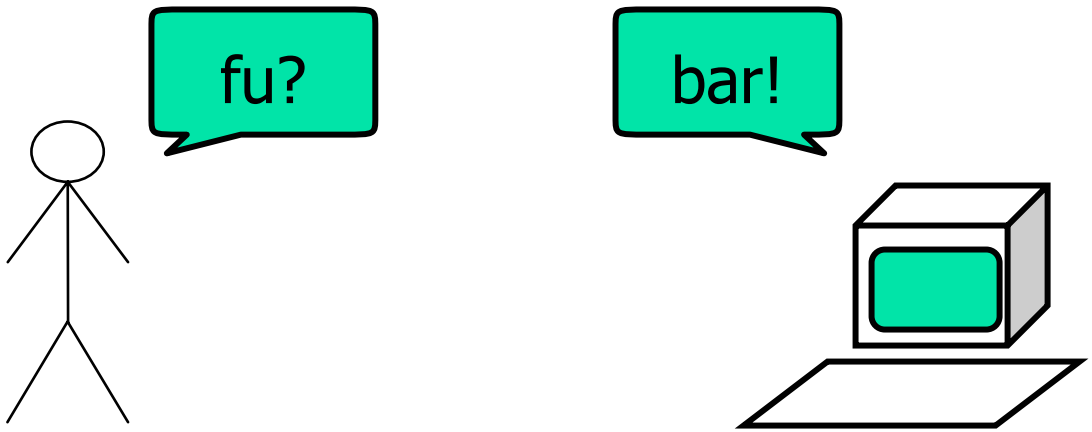


State - from Where ?

- Earlier: human interaction
  - Ex: dance class registration
  - Humans remember things
  - ”State of conversation”
- Now: system interaction
  - Want same user experience
  - Sessions with ”conversational state”
- State as we are humans

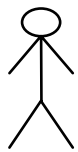
Conversational State

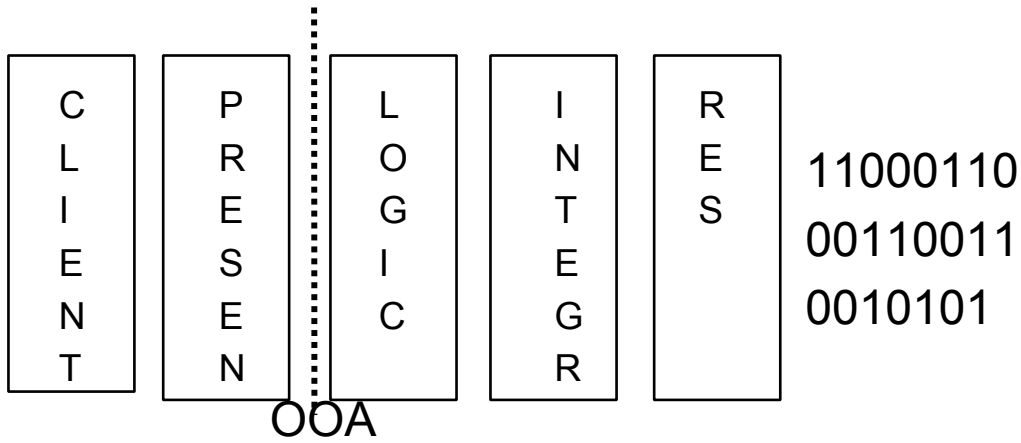
- Experienced by client
- Property of application



The Cube - Tiers

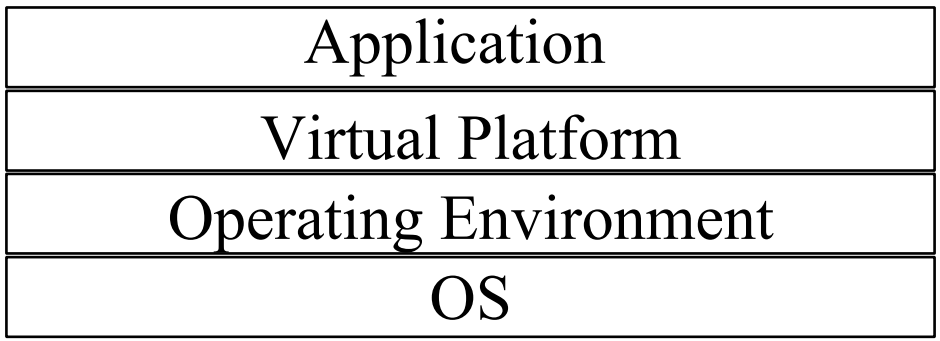
- Split system functionality
  - Client
  - Presentation
  - Enterprise/Business Logic
  - Integration
  - Resource

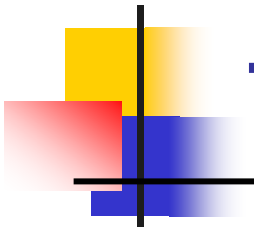




The Cube - Layers

- Layers of abstraction



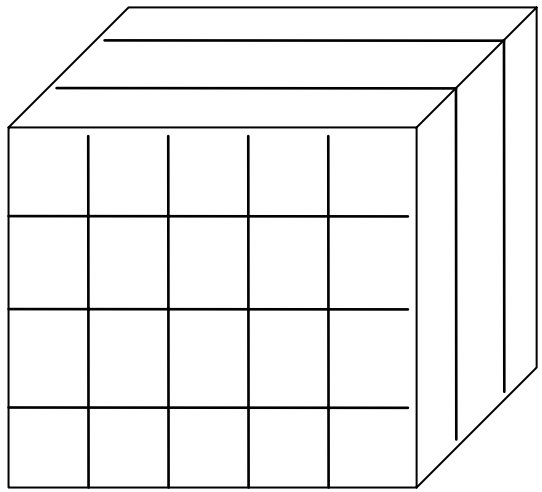


The Cube - 2D

check-date.js	seats.jsp	Ticket	SELECT … UPDATE …	bookings
JavaScript	Servlet 2.3 JSP 1.2	EJB 2.0	JDBC 2.0	SQL 92
Mozilla	Tomcat 4	JBoss	Connector/J	MySQL
OpenBSD	BeOS	Linux	Linux	Linux

The Cube - Capabilities

- Emergent properties
  - Performance
  - Availability
  - Security
  - Extensibility



- Not located in single component
- Discussing architecture - must consider entire system

Some Client State Is Presentation State

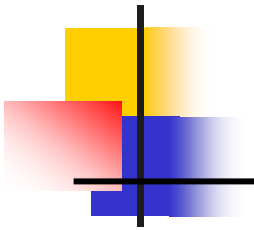
- Presentation logic is for info-gathering flow
- *e.g.* On-line registration
  - Alt 1: One massive registration
    - all info gathered in the same page
  - Alt 2: Wizard
    - same info gathered in steps (name, address, …)
    - can even have branches (US or Swedish address)
- No business logic difference!
  - one business logic call: "register(RegInfo)"

Some Client State Is Business State

- Business logic is for guaranteed consistency
- Stateful conversation can have branches
  - conversation can take different routes
  - consistency w model still guaranteed
    - *e.g.* cannot continue registration if course is full
- Course grained methods
  - course grained state changes

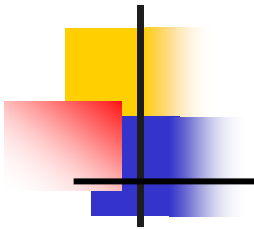
Are Not All Client States Presentation?

- PL for info-gathering flow
- BL for enforcing enterprise rules
  - guarantees consistency
- Distinction - BL if
  - Transaction support
  - Security constraint
  - Dependent on system state



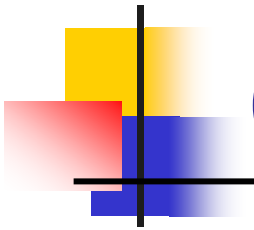
PL *vs.* BL ex: Dance School

- Presentation
  - Wizard
  - Name
  - Address
  - Phone
- Business
  - Choose activity
  - Register partner
  - Choose lead/follow



Recap

- Must consider entire system
- State property of system
- State as we are humans
- There are true business states



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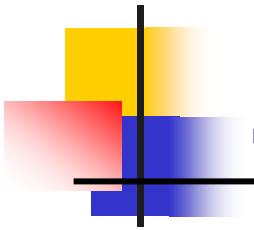
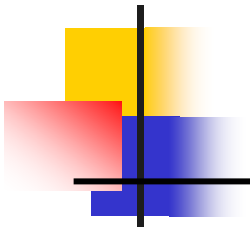


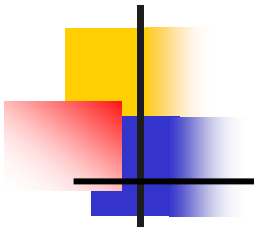
Session EJBs

- Enforce cross entity consistency
  - Ex: transaction between accounts
- Enforce business flow
  - Ex: payment info before shipping
- "Top level" services to user tiers
- Other uses
  - Infrastructure services: mail, log *etc.*
  - Not focus



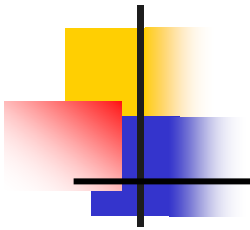
Stateful - Stateless

- Confusion
- All sessions have state
  - Bank accounts have balance, even if zero
- Conversational state property of code
- SFSB, SLSB are deploy options
- SLSB will only work for ∅-state beans



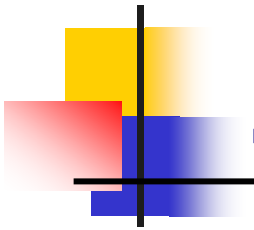
Lifecycle of Session EJB

- Two deploy options
  - SFSB - for all session
  - SLSB - for ∅-state sessions



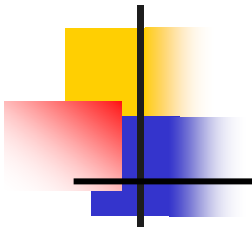
SFSB - Deploy Option

- Clients have private instances
- Full memory - swap to disk
- Penalty: swap time delay
- Instances = simultaneous sessions



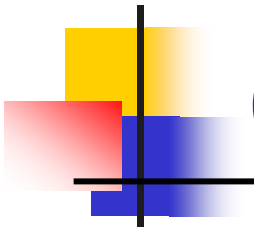
SLSB - Deploy Option

- EJB container allowed party trick
- Instance not occupied between calls
- Instance is occupied during calls
  - Cf. servlets are truly multi-threaded
- Pool size = simultaneous calls



Recap

- Session EJBs represent top level services
- State is property of code
- SFSB and SLSB are deploy options
- SFSB have swap mechanism
- SLSB does not need swap



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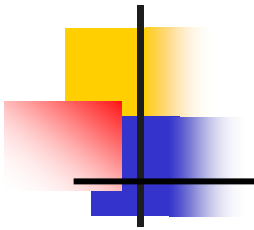
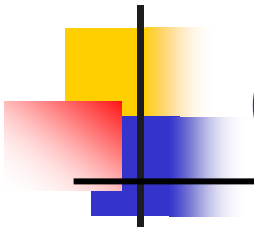


Myth

- "Thou shalt always use SLSB"
- Take up less resources
  - True: Less memory on EJB server
- Higher performance
  - True: No swapping overhead



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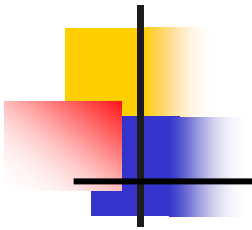
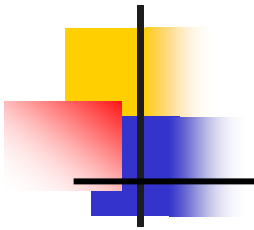


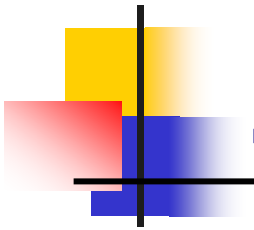
Closer Analysis

- Myth simplifies
  - Misses system view (remember "entire system")
  - When are SFSB troublesome?
  - How big is the problem?
- Nuisances
  - Memory consumption
  - Swap-time delay



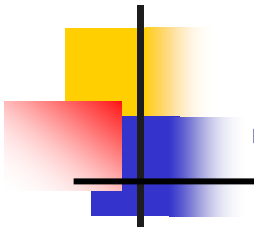
How Big Is the Problem?

- Intensity of penalty
  - Not every time - only on misses
  - 125 % memory usage - miss in 20 % of calls
  - 200 % memory usage - miss in 50 % of calls
- Size of penalty
  - one passivate + one activate + some admin
  - *i.e.* two disc accesses w/ serialisation < 100 ms



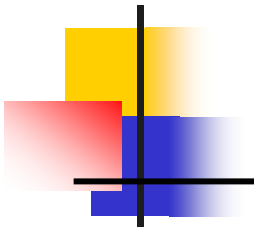
Some Bar-Scenarios

- Different bar patrons
  - Fast party animals
  - Shanti bar dwellers
- Few animals running around - OK
- Many dwellers moving slowly - OK
- Extremely many dwellers - Crowded!
- Many dwellers and few animals - OK
- Many animals - Gahd! Get out of here!



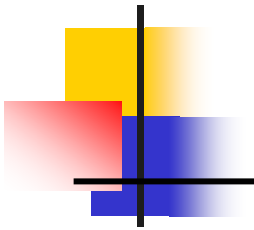
Some Scenarios

- Different client characteristics
  - Few fast sessions
  - Many slow sessions
  - Extremely many slow sessions
  - Many slow and few fast
  - Many fast
- What does the client experience?



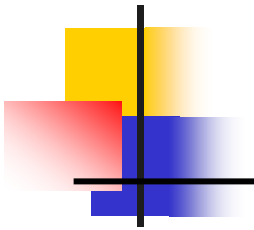
Few Fast

- *e.g.*: clerks within a company, other systems
- Can stay in memory
- No swapping
- No problem



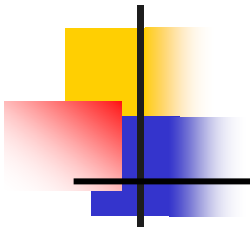
Many Slow

- *e.g.*: human Web users
- Memory consumption
  - Swapped out
- Swap time delay
  - Marginal
  - Swap circle < 100 ms
  - Roundtrip time >1 s
- No Problem



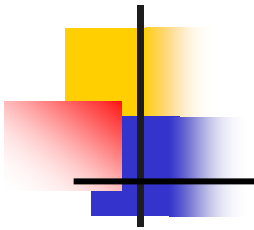
Extremely Many Slow

- *e.g.*: under dimensioned system
- Swap admin becomes heavy
- Less time for real work
- Downwards spiral
- Problem!



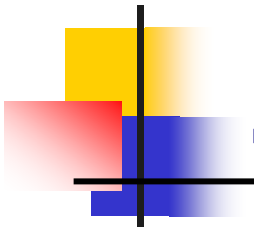
Many Slow and Few Fast

- *e.g.*: Other subsystems, B2B integration
- Memory consumption
  - Majority swapped out
- Swap time delay
  - Eager sessions never swapped out
  - (sound implementation)
- No Problem



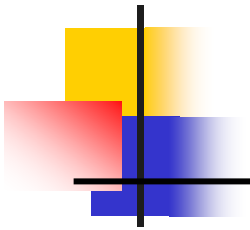
Many Fast

- *e.g.*: lots of connected subsystems
- Very fast swaps needed
- Swap admin becomes heavy
- Similar to "Extremely Many Slow"
- Problem!



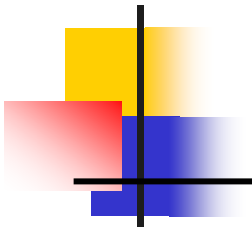
Summary of Scenarios

- Few Fast - OK
- Many Slow - OK
- Extremely Many Slow - Problem
- Many Slow and Few Fast - OK
- Many Fast - Problem



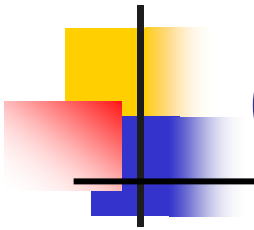
Solutions to Problem Scenarios

- Changing architecture
  - Let's investigate options
  - Expensive
    - To do
    - To keep
- Changing operating environment
  - More memory
    - reduces intensity
  - Faster I/O
    - reduces penalty



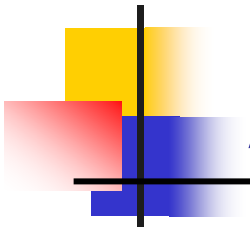
Recap

- Myth takes too narrow view
  - Misses system view - does not consider clients
  - Not swap all the time
  - Swap is not extremely expensive
- SFSB no problem in several usual scenarios



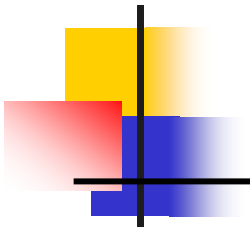
Outline

- Philosophy - state *etc*.
- Technology - Session EJBs
- Myth - SFSB *vs*. SLSB
- Closer analysis
- **Alternative architectures**



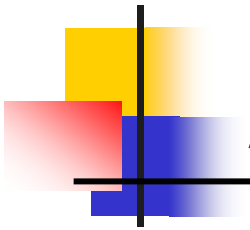
Alternative Architectures

- Cannot remove state
  - State property of application
  - Like it or not - it's still there
- Can push state elsewhere
  - Into database
  - Onto web server
  - Onto client
    - GUI client
    - Web client



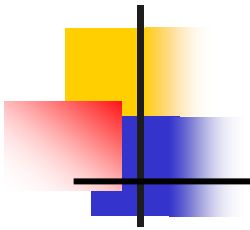
Capabilities

- Performance
  - Response time
- Capacity
  - Simultaneous usage
- Scalability
  - To increase capacity
- Reliability
  - Consistency of behaviour
- Exensibility
  - Add functionality
- Security
  - Fulfil security policy
- Architecture is always a trade-off
  - Change architecture: Buy one, pay with another



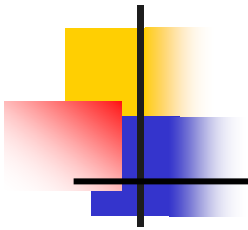
Architectural Transformation

- Change architecture
  - Gain capability
  - Will effect other capabilities
- No way of knowing result (too complex)
  - Measure
  - Transform
  - Measure again



Some Transformations

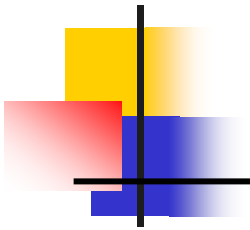
- Optimisation
  - gain performance
  - lose extensibility
- Optimistic locking
  - gain performance
  - lose reliability
- Clustering
  - gain availability
  - lose manageability
- Encryption
  - gain security
  - lose performance and capacity
- Architecture is always a trade-off



Shopping Cart

- Criticised Example
  - Carts in reality are transient
  - Carts in e-stores are persistent
- Simple and standard

- This version
  - transient
  - keeps client name
  - items represented by int:s
  - ‘add’ checks inventory
  - fast fail
  - ‘buy’ makes persistent

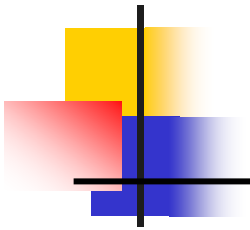


State in Session EJB - Client

- Client
  - state
    private Cart cart;
  - init
    cart = carthome.create(name);
  - add-action
    cart.add(item);
    int sum = cart.sum();
  - buy-action
    cart.buy();
    cart.remove();
- CartHome
  - public Cart create(String name)…
- Cart
  - public void add(int item)…
  - public int sum()…
  - public void buy()…

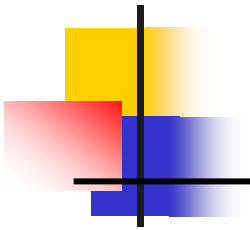
State in Session EJB - Bean

- CartEJBean
- private String name;
  private List items;
- public void ejbCreate(String name){
  this.name = name;
  this.items = new ArrayList();
  }
- public void add(int item) {
  items.add(new Integer(item));
  }
- public int sum() {
  int result = 0;
  // items iteration
  return result;
  }
- public void buy() {
  // commit items
  this.items = null;
  }



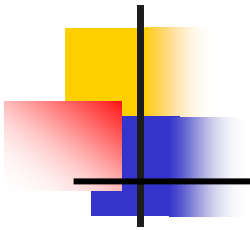
State in Session EJB - Analysis

- Performance
  - OK, as long as swapping under control
- Capacity
  - Craves memory for many sessions, least swapping
- Extensibility
  - Easy to understand
  - Truthful to model
- Reliability
  - No problem
- Security
  - Easy to verify



State in Database

- Pass client ID to SLSB
- SLSB updates state in DB
- BL still in BL tier
- Client must handle ID
- Client must initialize
- Client must remove explicitly
  - Session EJB has timeout - can give orphan data

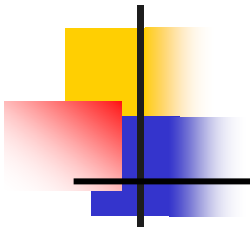


State in Database - Client

- Client
  - state
    private Cart cart;
    private int id;
  - init
    cart = carthome.create();
    id = cart.createCart(name);
  - add-action
    cart.add(id, item);
    int sum = cart.sum(id);
  - buy-action
    cart.buy(id);
    cart.removeCart(id);
    cart.remove();

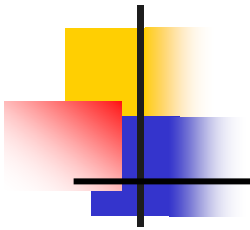
- CartHome
  - public Cart create()…

- Cart
  - public int createCart(String name)…
  - public void removeCart(int id) …
  - public void add(int id, int item)…
  - public int sum(int id)…
  - public void buy(int id)…



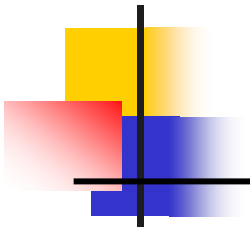
State in Database - Bean

- CartEJBean
- public void ejbCreate() {}
- public int createCart(String name) {
  // JDBC: INSERT INTO session
  return id;
  }
- public void removeCart(int id) {
  // DELETE FROM session
  // DELETE FROM sessionitem
  }
- public void add(int id, int item) {
  // INSERT INTO sessionitem
  }
- public int sum(int id) {
  // SELECT sum(item)
  // FROM sessionitem WHERE id=?
  }
- public void buy(int id) {
  // SELECT name FROM session …
  // SELECT … FROM sessionitem…
  // commit items
  }



State in Database - Analysis

- Performance (-)
  - swap
  - DB access
    - memory cache
- Capacity +
  - Lot less memory
- Extensibility -
  - Less natural interface
    - create does not start a session
    - createCart does
- Reliability
- Security
  - BL still protected



State in HttpSession

- Business logic in Web tier code?
  - Effect: no session logic in EJB tier
  - EJB tier no longer guarantees consistency
  - Problems with transactions (*e.g.* atomic 'buy')
- Just keep state in Web tier
  - Send state to EJB for state changes
  - EJB perform state change actions
  - Updated state as return value

State in HttpSession - Client

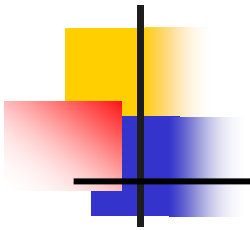
- Client
  - state
    private Cart cart;
    private CartState state;
  - init
    cart = carthome.create();
    state = cart.create(name);
  - add-action
    state = cart.add(state, item);
    int sum = cart.sum(state);
  - buy-action
    state = cart.buy(state);

- CartHome
- public Cart create()…

- Cart
- public CartState create(String name)…
  - BL: customer verification
- public CartState add(CartState state, int item)…
  - BL: check inventory
- public int sum(CartState state)…
  - BL: discounts
- public CartState buy(CartState state)…

State in HttpSession - Bean

- CartEJBean
- public void ejbCreate() {}
- public CartState
  create(String name) {
    return new CartState(name);
  }
- public CartState
  add(CartState state, int item) {
    return state.add(item)
  }
- public int sum(CartState state) {
  int result = 0;
  for(Iterator iter =
  state.items();…) {
    Integer item = …
    result += item.intValue();
  }
  return result;
  }
- public CartState buy(CartState
  state) {
  for(Iterator iter = state.items();…)
  {
    Integer item = …
    // commit items
  }
  return state.empty();
  }

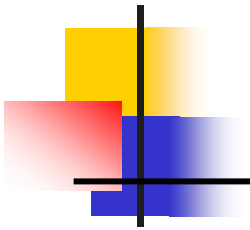


State in HttpSession - State

- CartState - data holder
- private String name;
  private List items = new ArrayList();
- public CartState(String name) {
  this.name = name;
  }
- public CartState add(int item) {
  items.add(new Integer(item));
  return this;
  }
- public Iterator items() {
  return items.iterator();
  }

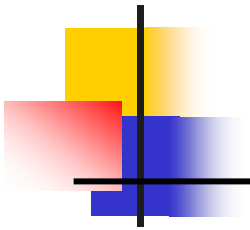
State in HttpSession - Analysis

- Performance
- Capacity (+)
  - Same amount of memory
  - HttpSession might be more lightweight
- Extensibility -
  - have to pass state
- Reliability -
  - no guarantee of data consistency
- Security -
  - State managed outside server
  - Malicious client could change state



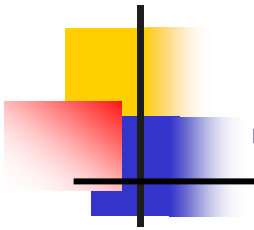
State in GUI Application

- State completely pushed from server
- Code = HttpSession case
- Business logic
  - still server round-trip
  - (BL in GUI/HttpSession => EJB meaningless)



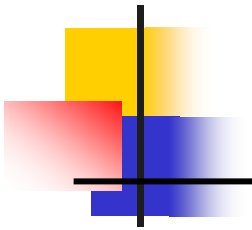
State in GUI - Analysis

- Performance -
  - State transferred over slow cable
- Capacity ++
  - No trace of state on Web- or EJB-server
- Extensibility -
- Reliability
- Security --
  - State exposed on client deployed "elsewhere"



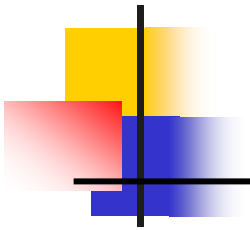
State in Cookie

- State pushed completely off server in Web environment
- State has to be encoded as String
  - String encode(CartState)
  - CartState decode(String)



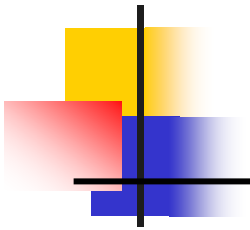
State in Cookie - Analysis

- Performance --
  - Really slow to ship full text-encoded state
- Capacity ++
- Extensibility -
- Reliability
- Security --
  - Cookies can very easily be manipulated



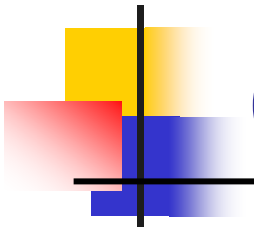
Summary - Alternatives

- State in database
  - + capacity, (-) performance, - extensibility
- State in HttpSession
  - (+) capacity, - extensibility, - security
- State in GUI application
  - ++ capacity, - performance, -- security
- State in Cookie
  - Forget that! Perhaps small, trivial state



How to Know? Test!

- Check out sample code
  - pserver:cvs.frobozz.se:/repository/public
  - module: css2003state
  - username: css2003, password: kovsky
- Test it on your app server (laptop?)
- Enhance (Web tier, profiling scripts, *etc*.)
- Share your work! Commit!
- Licence: completely unrestricted (both ways)



Conclusion

- No alternative obviously better
  - However: architecture is always a trade-off
- State in session EJB first alternative
- Investigate alternatives
  - Measure
  - Make architectural transformation
  - Measure again
- However: State is Not Evil!