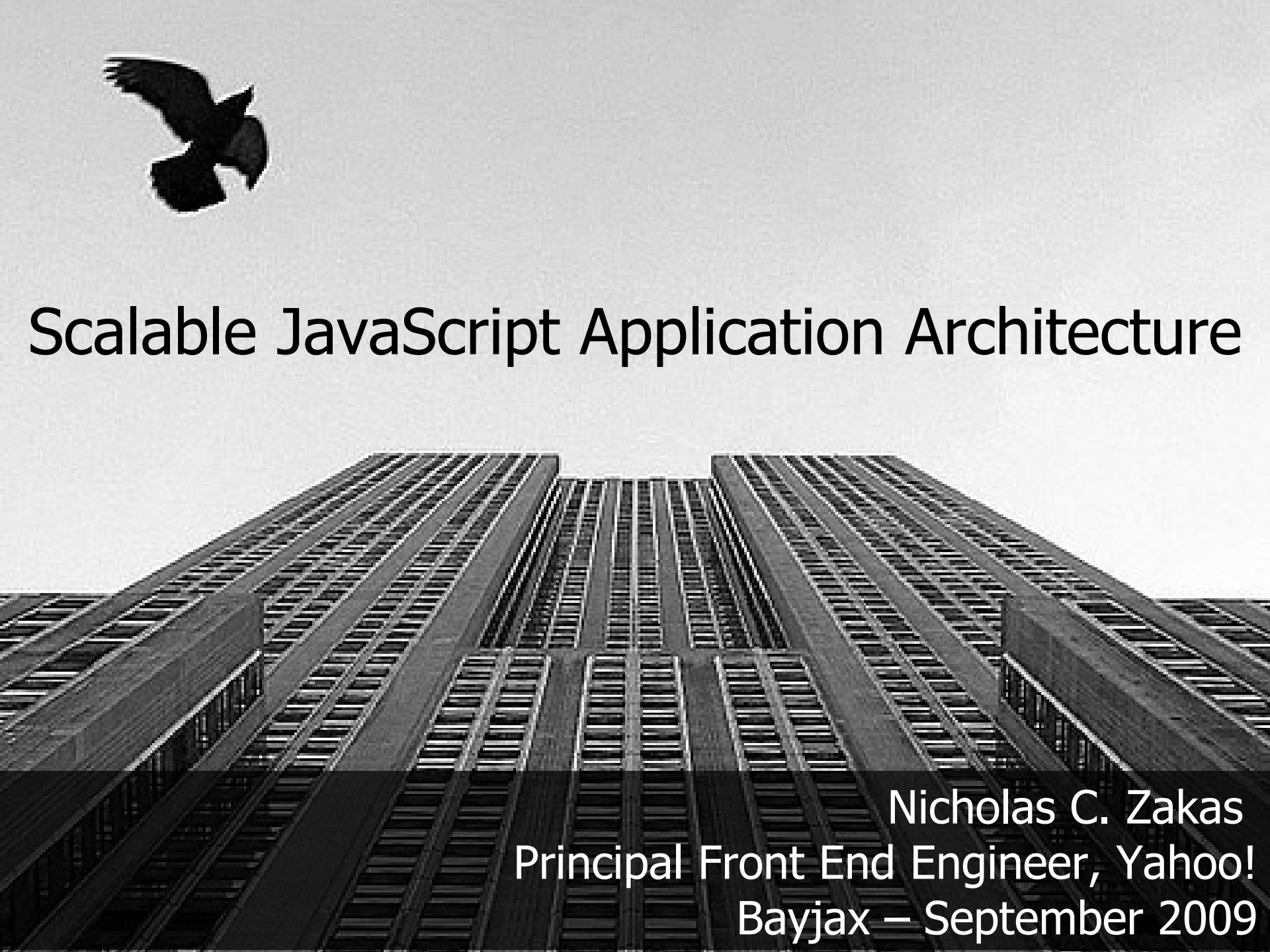

Scalable JavaScript Application Architecture

Nicholas C. Zakas
Principal Front End Engineer, Yahoo!
Bayjax – September 2009

Who's this guy?

- Principal Front End Engineer, Yahoo! Homepage
- YUI Contributor
- Author

Visibility
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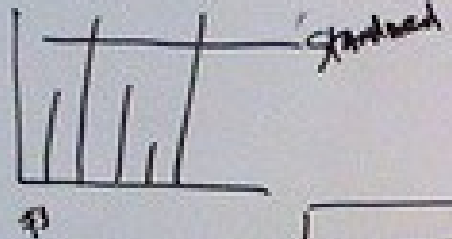
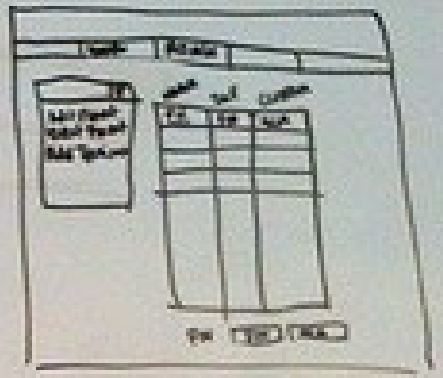
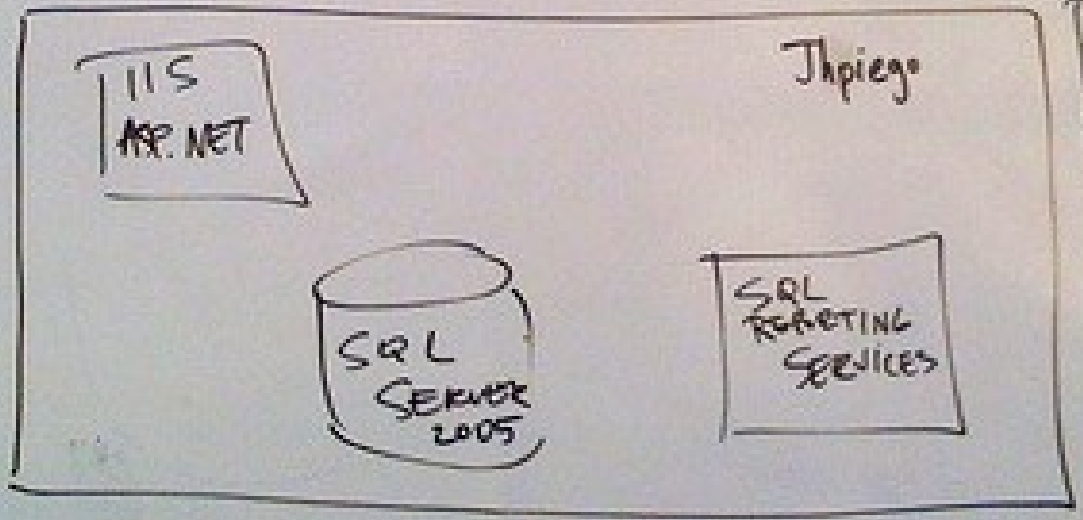
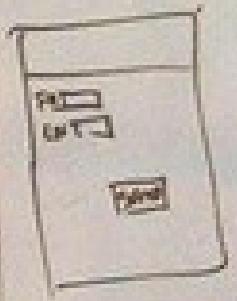
Admin	✓	✓	✓	X	X
SuperUser	X	All	All		X
User	X				X
Manager	X				X



SIFo







Building an application framework

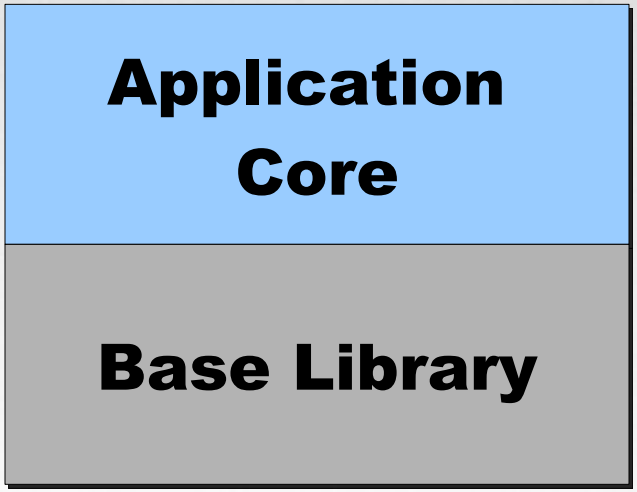
An application framework is like a playground for your code

Provides structure around otherwise unrelated activities

Isn't that what JavaScript libraries do?

A JavaScript library is like a toolbox

You can build any number of things using the tools


Application Core
Base Library

Module Theory

Everything is a module

module (*n*)
1 : a standard or unit of measurement
2 : the size of some one part taken as a unit of measure by which the proportions of an architectural composition are regulated
3 a : any in a series of standardized units for use together: as (1) : a unit of furniture or architecture (2) : an educational unit which covers a single subject or topic **b :** a usually packaged functional assembly of electronic components for use with other such assemblies
4 : an independently operable unit that is a part of the total structure of a space vehicle
5 a : a subset of an additive group that is also a group under addition
b : a mathematical set that is a commutative group under addition and that is closed under multiplication which is distributive from the left or right or both by elements of a ring and for which $a(bx) = (ab)x$ or $(xb)a = x(ba)$ or both where a and b are elements of the ring and x belongs to the set

Source: Merriam-Webster Dictionary

module (*n*)

1 : a standard or unit of measurement

2 : the size of some one part taken as a unit of measure by which the proportions of an architectural composition are regulated

3 a : any in a series of standardized units for use together: as (1) : a unit of furniture or architecture (2) : an educational unit which covers a single subject or topic **b :** a usually packaged functional assembly of electronic components for use with other such assemblies

4 : an independently operable unit that is a part of the total structure of a space vehicle

5 a : a subset of an additive group that is also a group under addition **b :** a mathematical set that is a commutative group under addition and that is closed under multiplication which is distributive from the left or right or both by elements of a ring and for which $a(bx) = (ab)x$ or $(xb)a = x(ba)$ or both where a and b are elements of the ring and x belongs to the set

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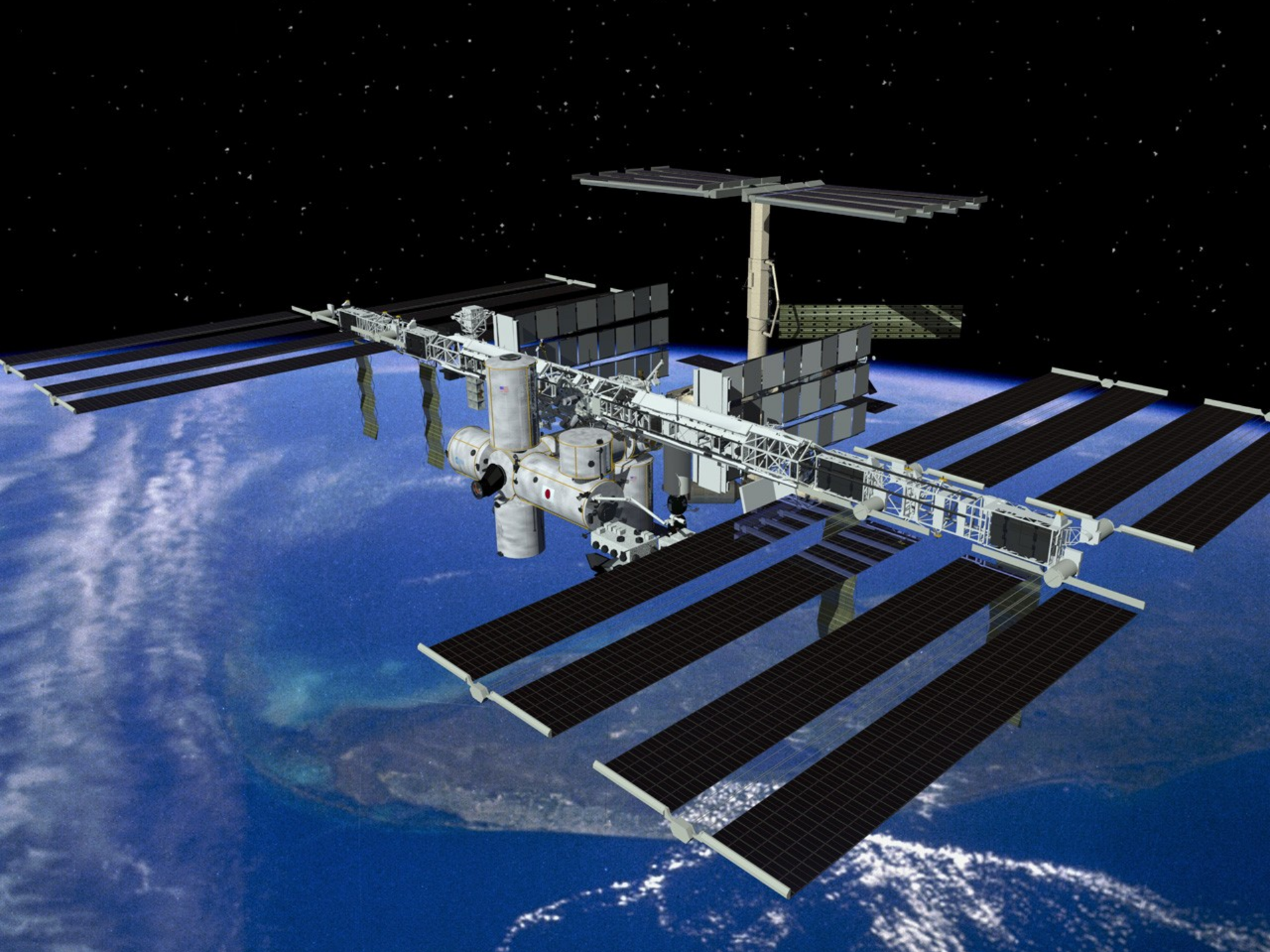

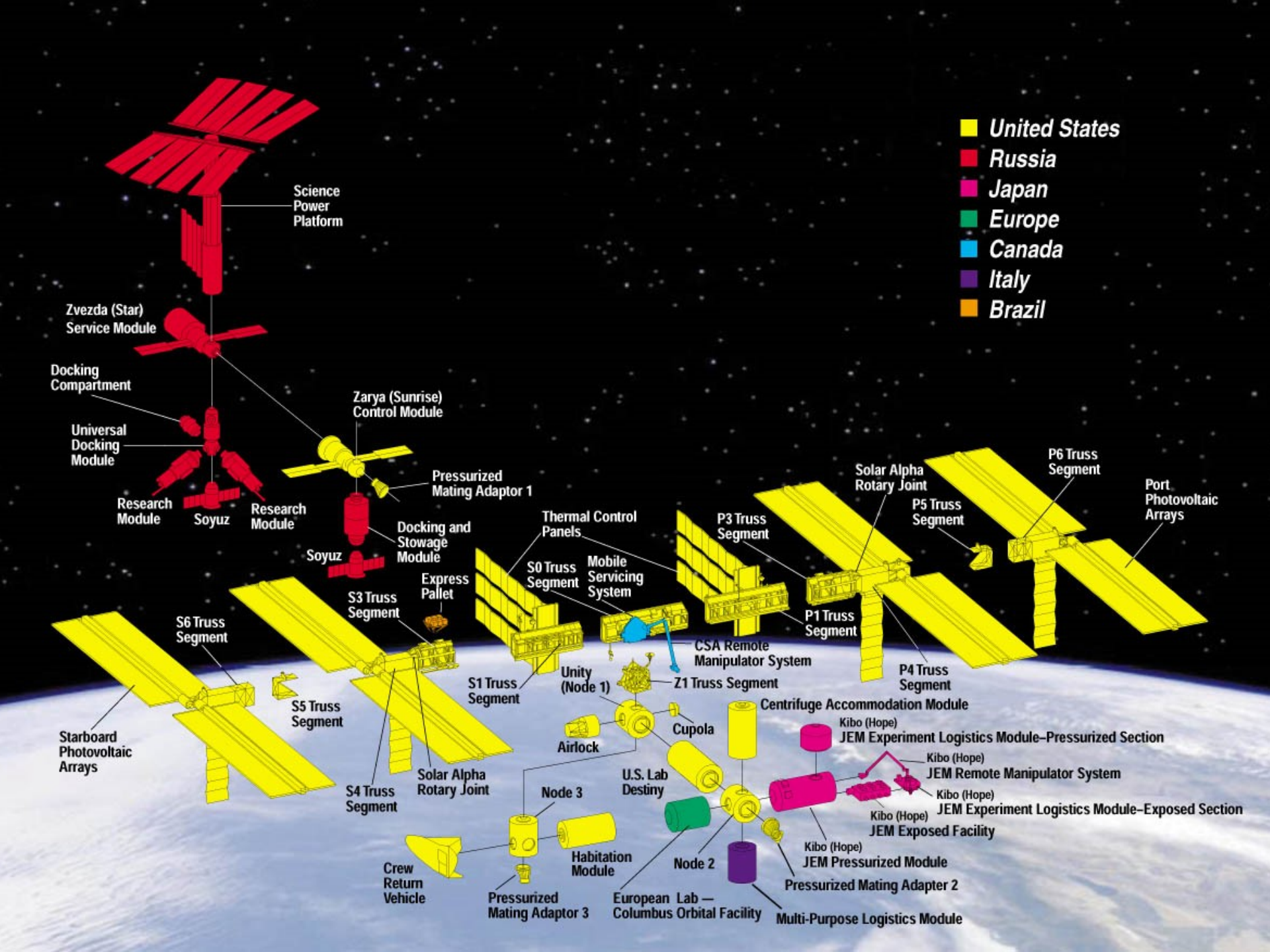
United States
Russia
Japan
Europe
Canada
Italy
Brazil
Science Power Platform
Zvezda (Star) Service Module
Docking Compartment
Universal Docking Module
Research Module
Soyuz
Research Module
Zarya (Sunrise) Control Module
Pressurized Mating Adaptor 1
Docking and Stowage Module
Soyuz
Thermal Control Panels
S0 Truss Segment
Mobile Servicing System
P3 Truss Segment
Solar Alpha Rotary Joint
P6 Truss Segment
P5 Truss Segment
Port Photovoltaic Arrays
Express Pallet
S3 Truss Segment
S6 Truss Segment
P1 Truss Segment
CSA Remote Manipulator System
S1 Truss Segment
Unity (Node 1)
Z1 Truss Segment
P4 Truss Segment
Centrifuge Accommodation Module
Kibo (Hope)
JEM Experiment Logistics Module–Pressurized Section
Cupola
Airlock
S5 Truss Segment
Starboard Photovoltaic Arrays
Kibo (Hope)
JEM Remote Manipulator System
Kibo (Hope)
JEM Experiment Logistics Module–Exposed Section
Kibo (Hope)
JEM Exposed Facility
U.S. Lab Destiny
Solar Alpha Rotary Joint
S4 Truss Segment
Node 3
Kibo (Hope)
JEM Pressurized Module
Habitation Module
Node 2
Pressurized Mating Adapter 2
Crew Return Vehicle
Pressurized Mating Adaptor 3
European Lab — Columbus Orbital Facility
Multi-Purpose Logistics Module

How does this apply to web applications?

web application module (*n*)
1 : an independent unit of functionality that is part of the total structure of a web application

Source: Me

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My Yahoo! Blog: How green are you?

Weather

Options

Compact | Classic | Full

102°F
Partly Cloudy

Location	Today	Tomorrow	Monday
Pleasanton, CA * Partly Cloudy	102° / 60°	87° / 55°	82° / 55°

* Severe weather alert

City or ZIP Go

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Options

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Suite101: South...

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Options

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Example Portfolio

Symbol	Price	Change	
DJIA	9,544.20	-36.43	-0.38%
NASDAQ	2,028.77	+1.04	+0.05%
S&P 500	1,028.93	-2.05	-0.20%
10 Yr Bond	3.45	-0.01	-0.32%
GE	14.08	-0.11	-0.78%
T	26.21	-0.21	-0.79%
YHOO	14.85	-0.08	-0.54%
Total (USD)	$0.00	0.00	0.00%
Cumulative		0.00	0.00%

get quotes Go

Quotes Delayed: NYSE & AMEX 20 min, NASDAQ 15 min.

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Featured | World | Local | Finance

As of 04:37 pm PDT

- Throughout history, Kennedys have grieved losses in public
- Japan votes in election, opposition tipped to win
- GOP senator strikes blow to chances of health compromise
- 7 found slain at Ga. mobile home, 2 badly hurt
- Firefighters in California wage fierce wildfire battles
- Eco-friendly German city functions without cars
- Fans mark the would-have-been 51st birthday of 'King of Pop'

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MLB

All games

Chi White Sox	0	Final
NY Yankees	**10**	

NFL

All games

Saturday, August 29, 2009

San Francisco	5:00pm PDT
Dallas	

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Options

- Why f/2.8? - 5 days ago
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- Photoshop Working (Space) Behind the Scenes - 2 weeks ago

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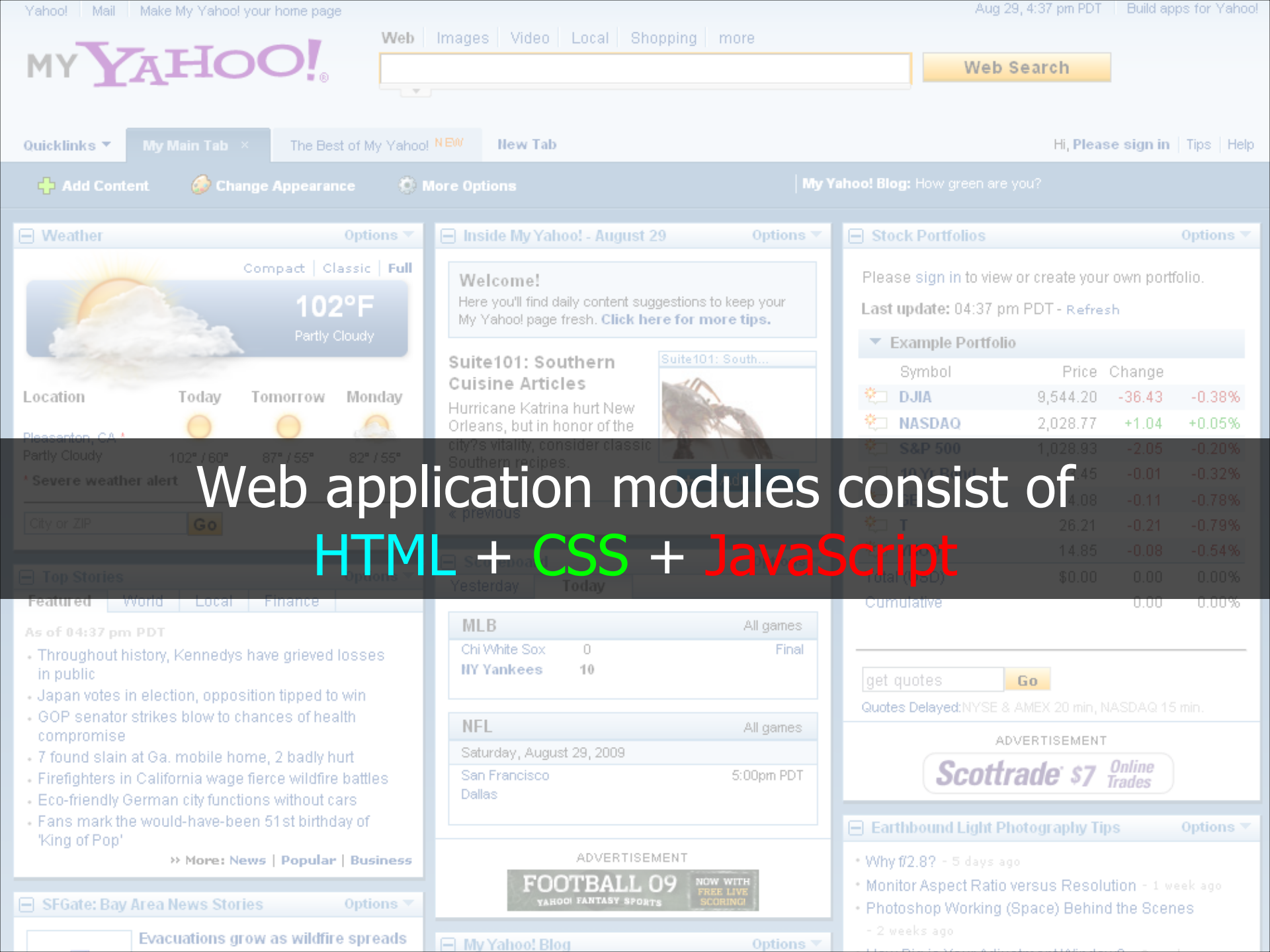
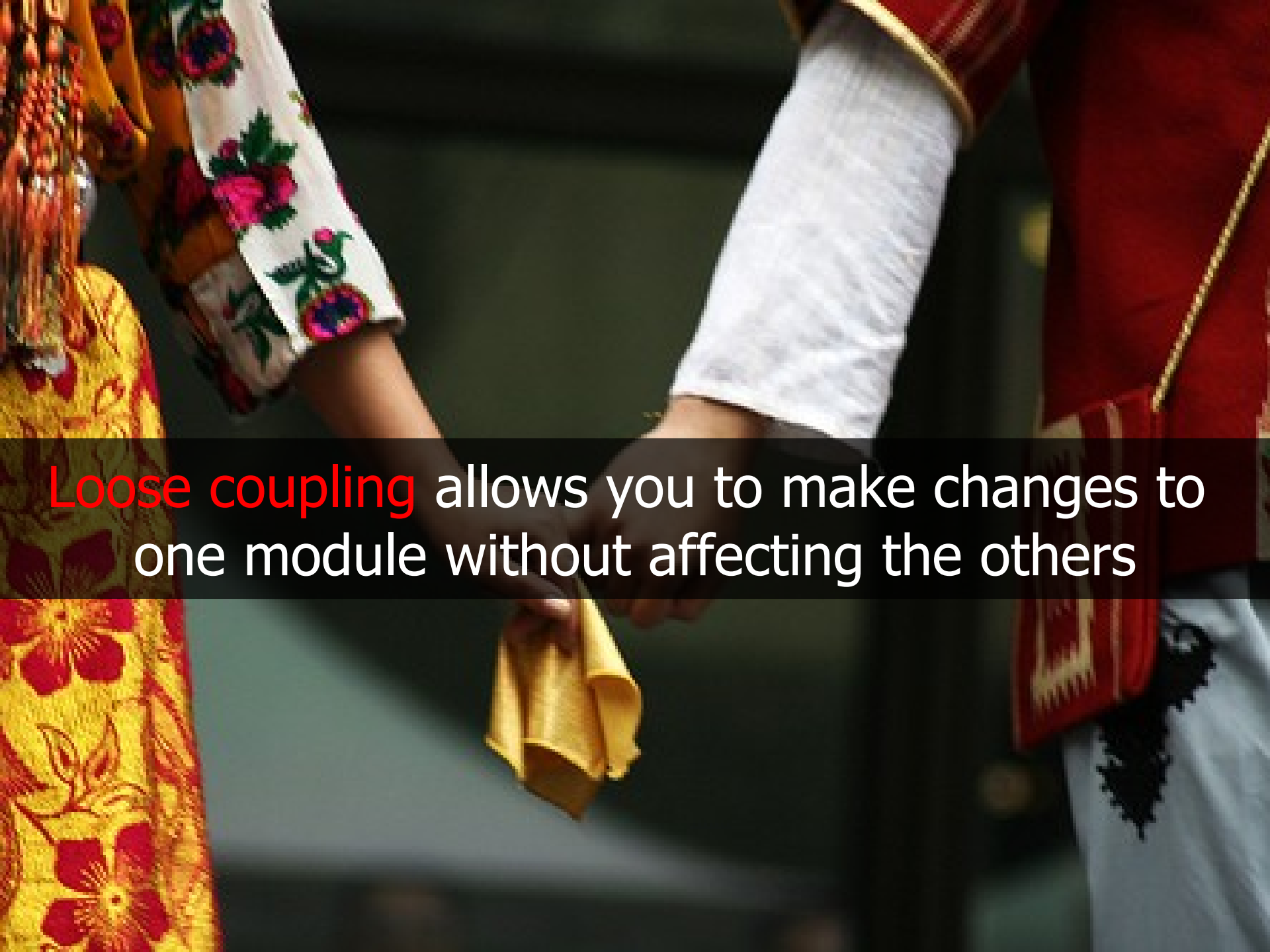
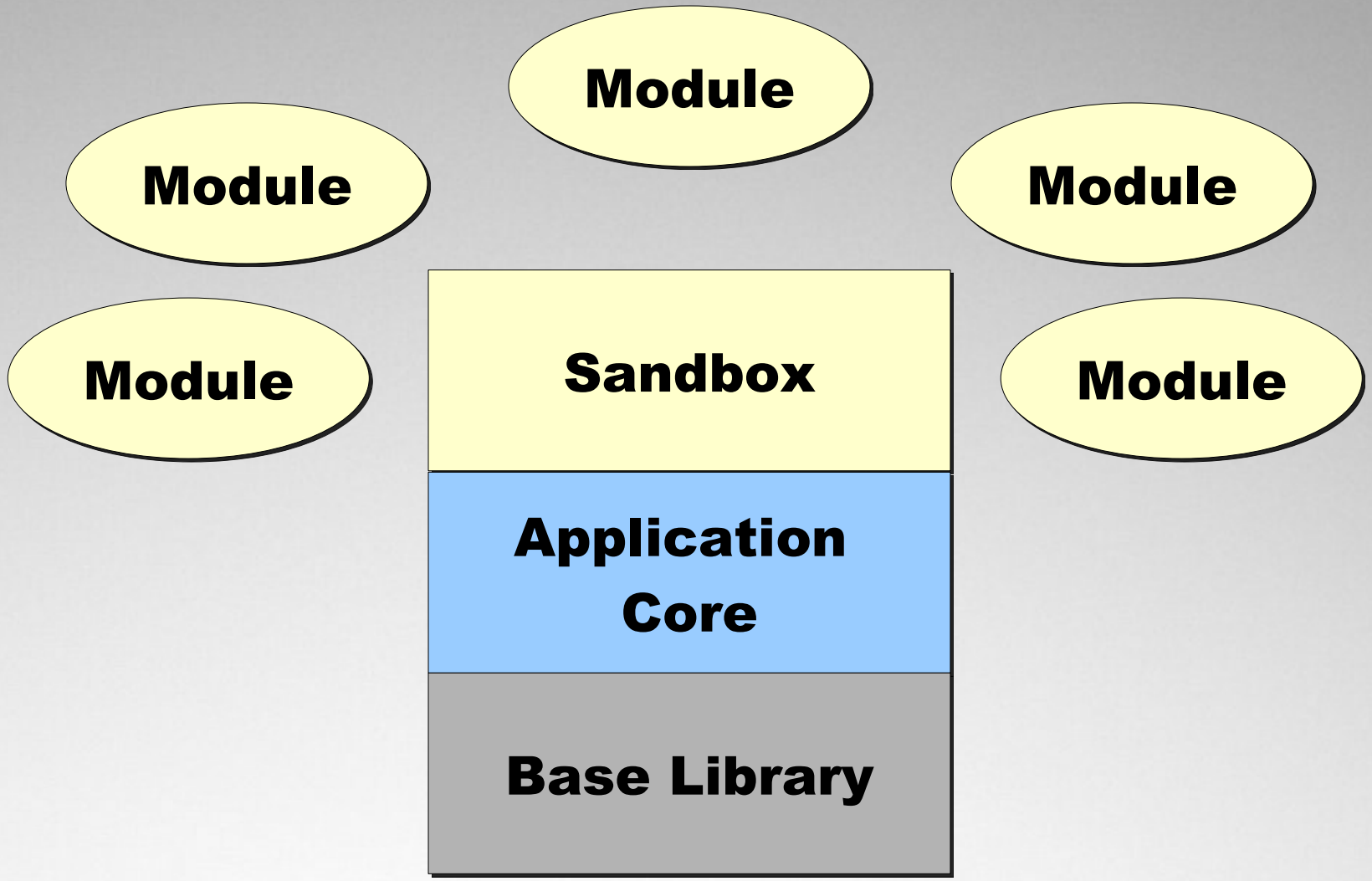

Web application modules consist of
HTML + CSS + JavaScript

Any single module should be able to live on its own


Loose coupling allows you to make changes to
one module without affecting the others

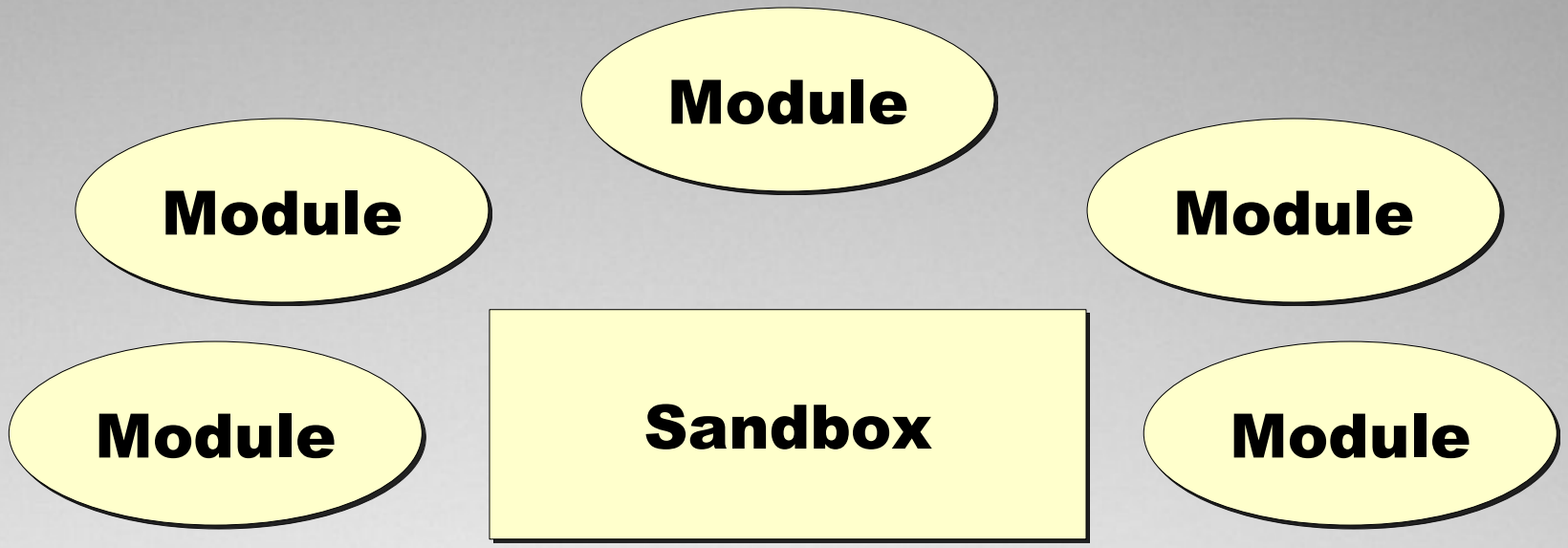
Each module has its own sandbox

An interface with which the module can interact to ensure loose coupling


Module
Module
Module
Module
Module
Sandbox
Application Core
Base Library

Application Architecture

- Modules
- Sandbox
- Application Core
- Base Library



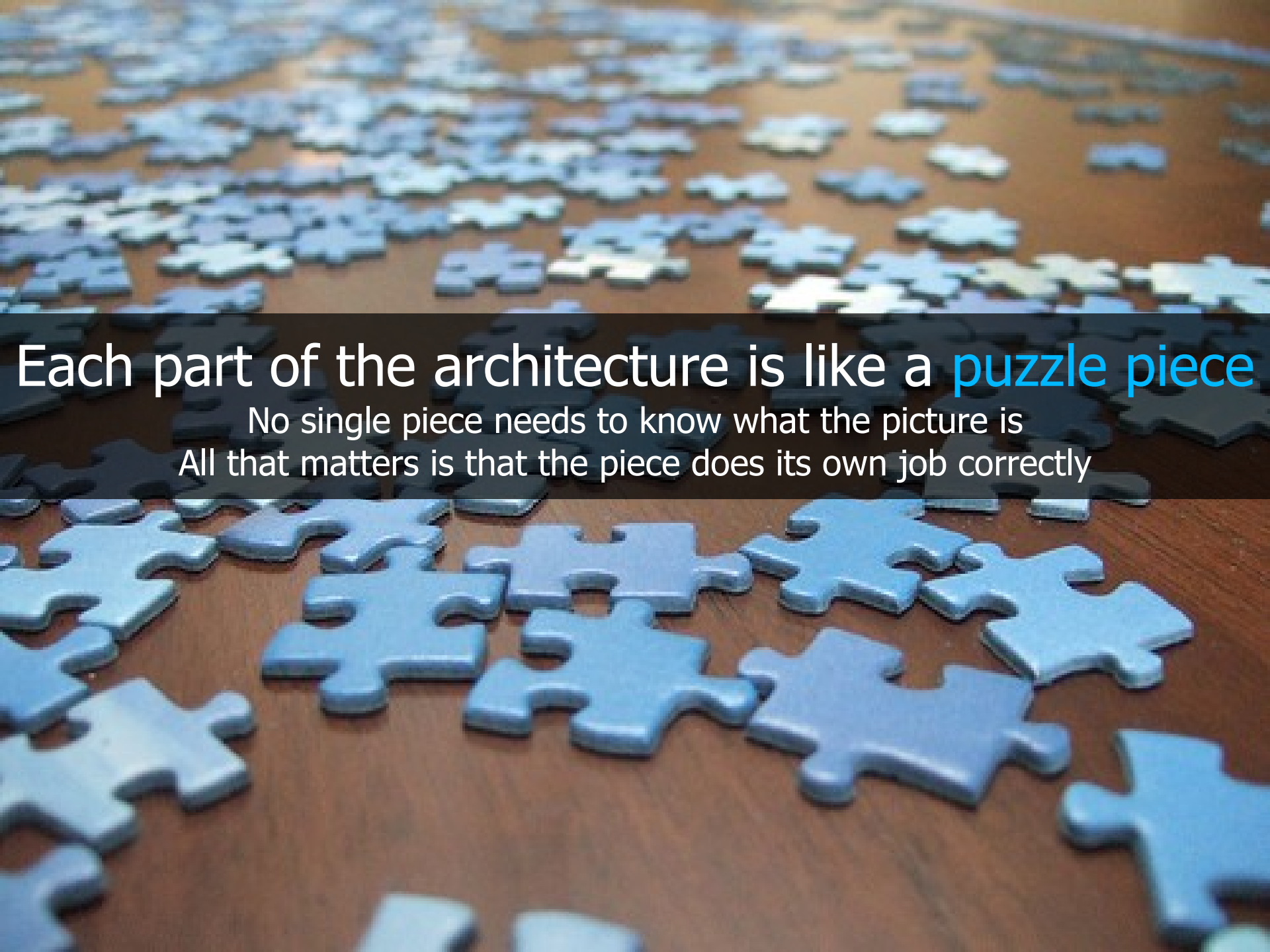
Modules have limited knowledge

Each module knows about their sandbox and that's it

```
Core.register("module-name", function(sandbox){

    return {
        init: function(){
            //constructor
        },

        destroy: function(){
            //destructor
        }

    };

});
```

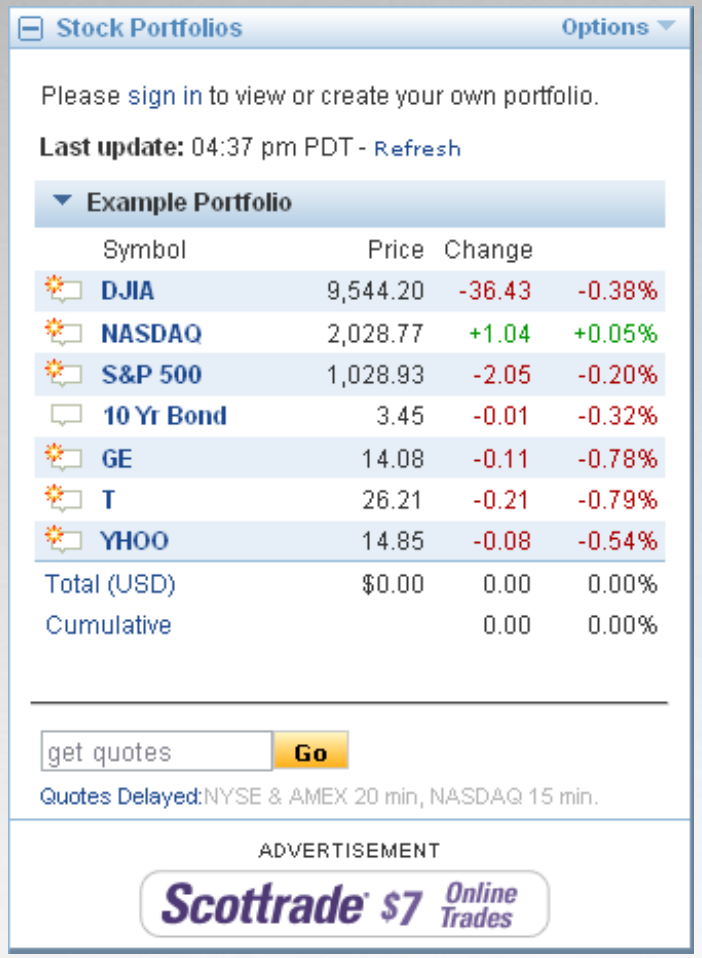
Which parts know about the web application being built?

None of them


Each part of the architecture is like a puzzle piece
No single piece needs to know what the picture is
All that matters is that the piece does its own job correctly

What is a module's job?

Hello, I'm the weather module.
It's my job to tell you the weather.



Hello, I'm the stocks module. It's my job to tell you about the stock market.

Each module's job is to create a meaningful user experience

The web application is created
as a result of all parts doing their job

This doesn't mean modules can do whatever they want to do their job


Modules are like little kids
They need a strict set of rules so they don't get into trouble

Module Rules

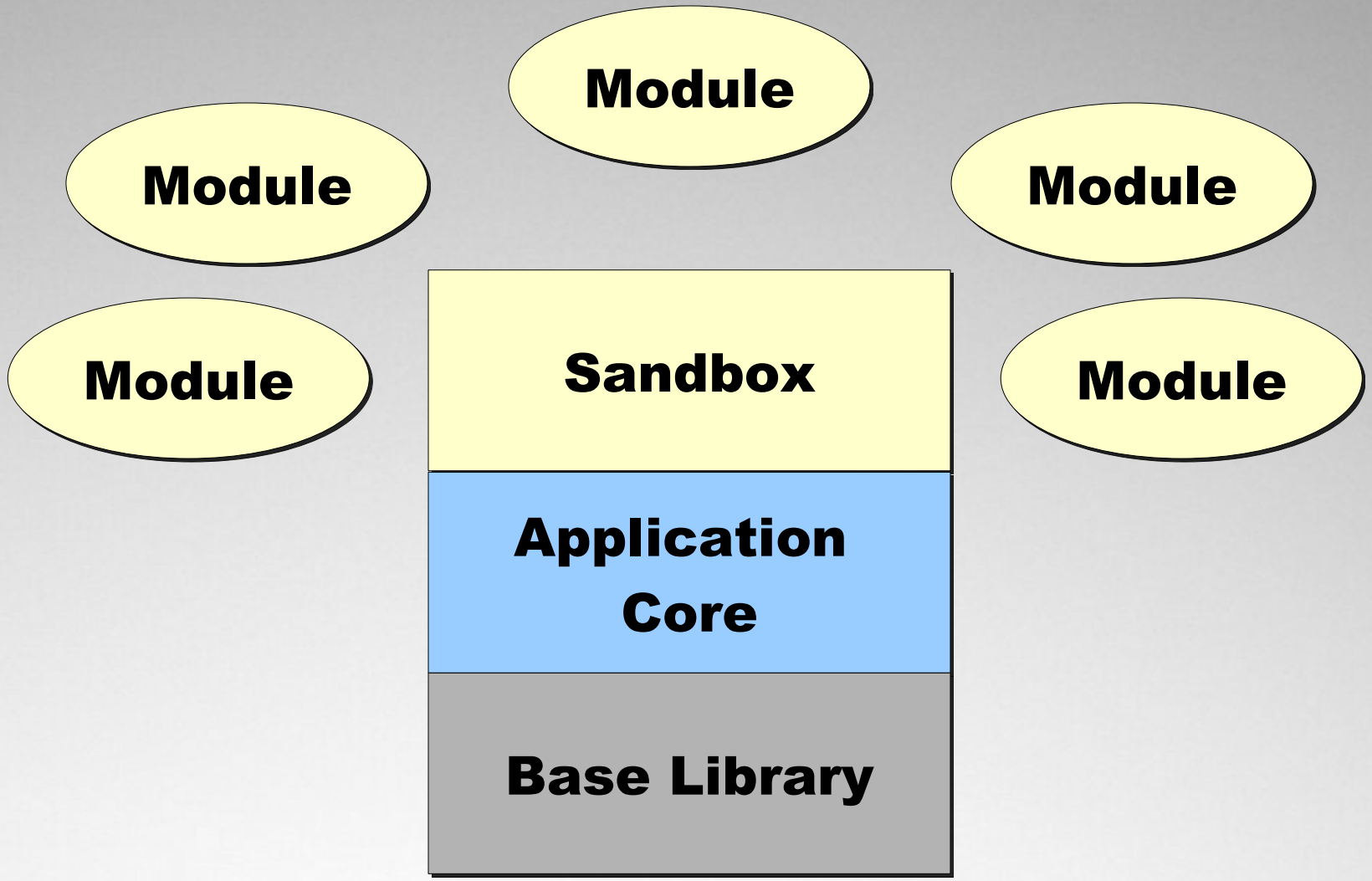
- **Hands to yourself**
  - Only call your own methods or those on the sandbox
  - Don't access DOM elements outside of your box
  - Don't access non-native global objects
- **Ask, don't take**
  - Anything else you need, ask the sandbox
- **Don't leave your toys around**
  - Don't create global objects
- **Don't talk to strangers**
  - Don't directly reference other modules

Modules must stay within their own sandboxes

No matter how restrictive or uncomfortable it may seem

Application Architecture

- Modules
- Sandbox
- Application Core
- Base Library


Module
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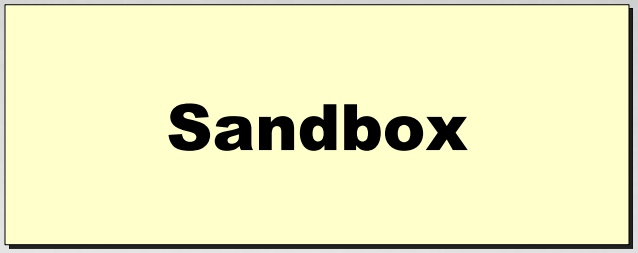
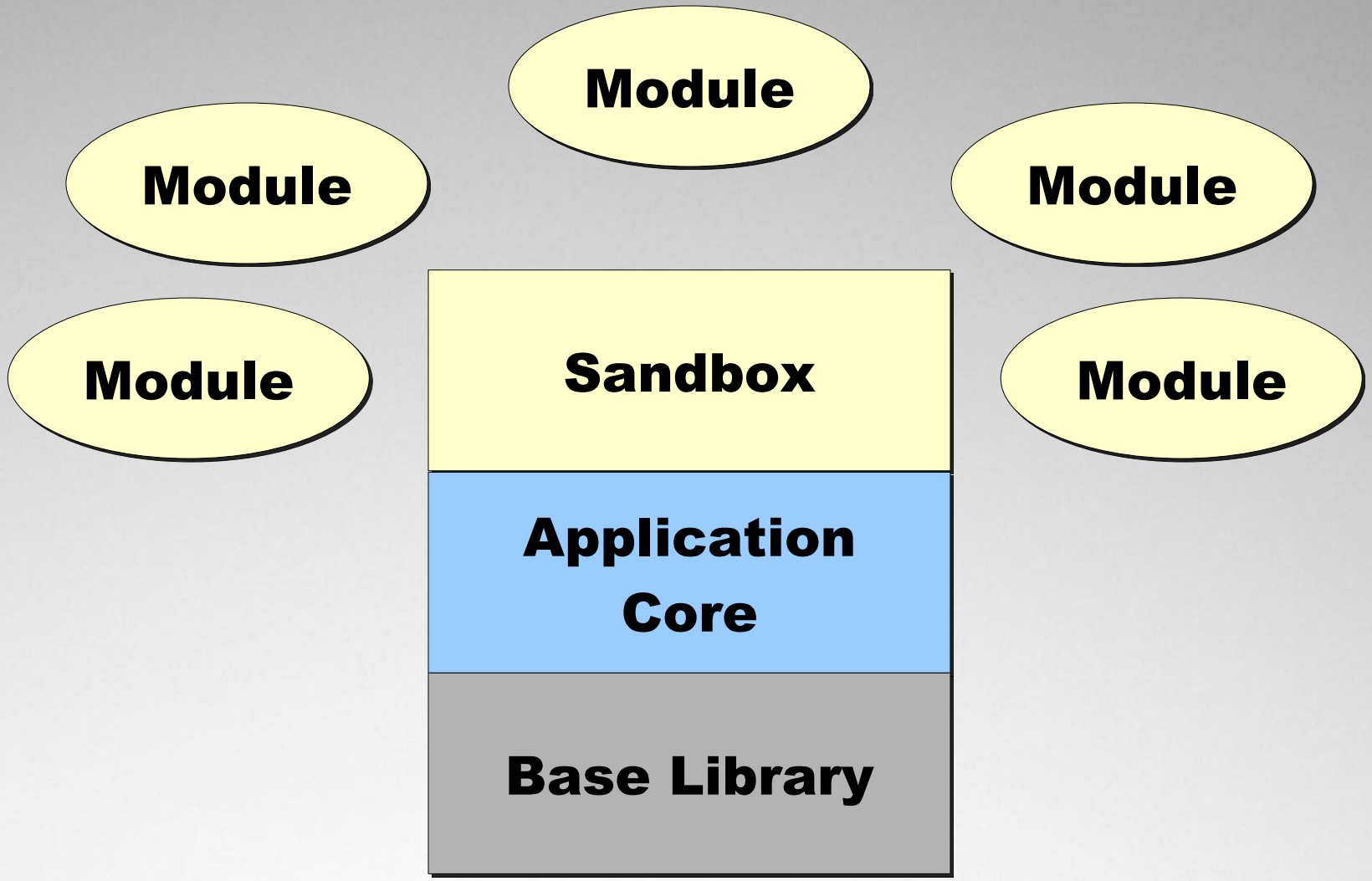
Module
Module
Sandbox
Application Core
Base Library



The sandbox ensures a consistent interface

Modules can rely on the methods to always be there


Module
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Module
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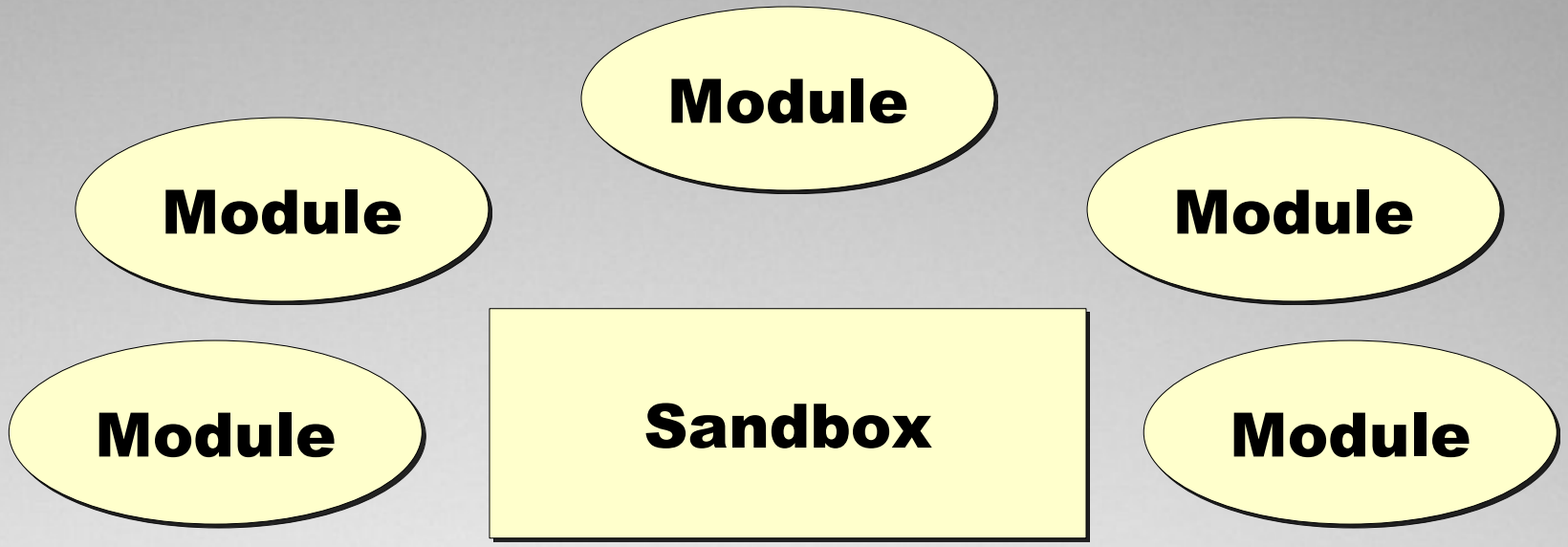
Base Library



Modules only know the sandbox

The rest of the architecture doesn't exist to them

The sandbox also acts like a security guard

Knows what the modules are allowed to access and do on the framework

```
Core.register("module-name", function(sandbox){

    return {
        init: function(){

            //not sure if I'm allowed...
            if (sandbox.iCanHazCheezburger()){
                alert("thx u");
            }
        },

        destroy: function(){
            //destructor
        }

    };

});
```

Sandbox Jobs

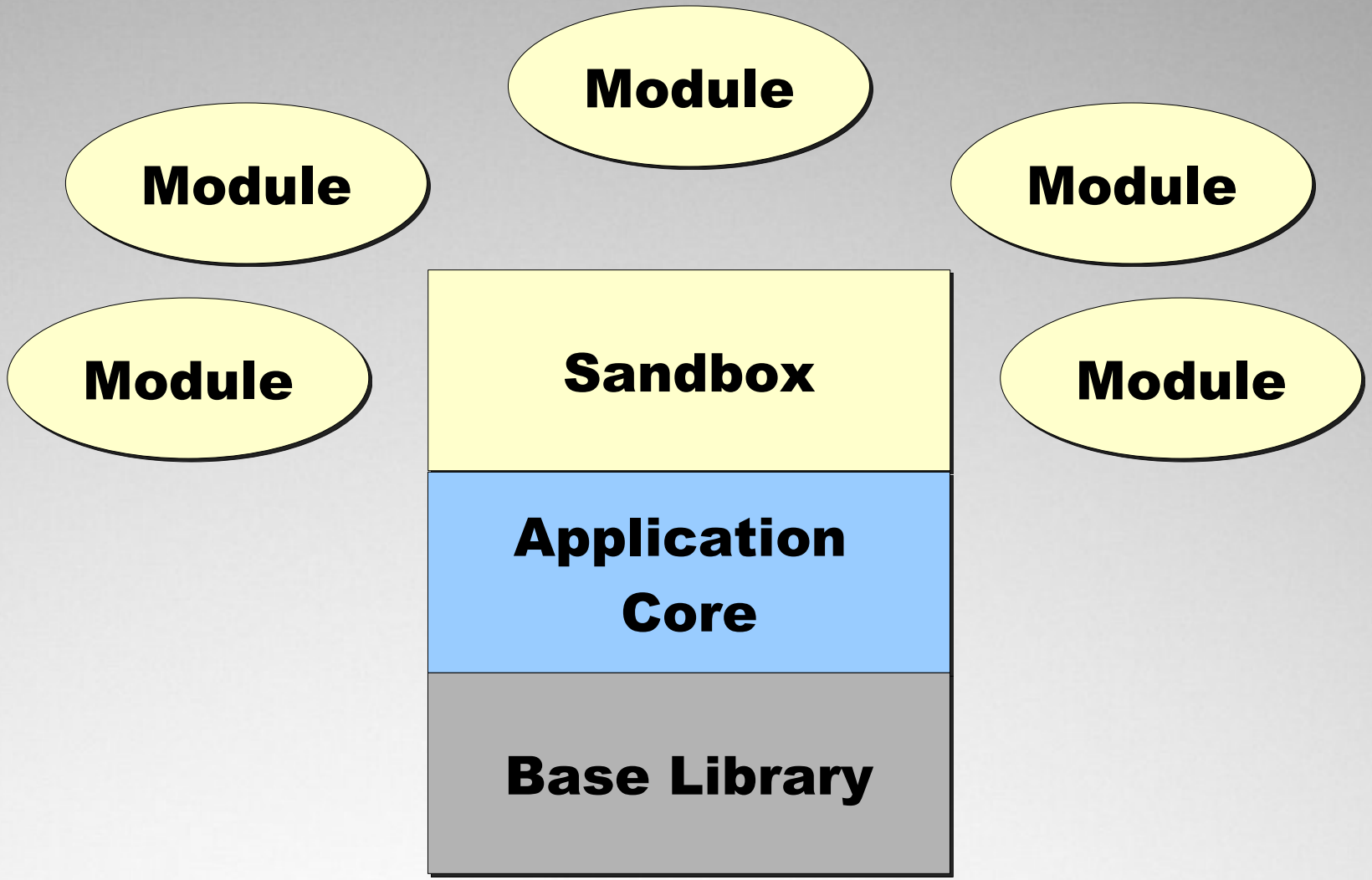
- **Consistency**
  - Interface must be dependable
- **Security**
  - Determine which parts of the framework a module can access
- **Communication**
  - Translate module requests into core actions

Take the time to design the correct sandbox interface

It can't change later

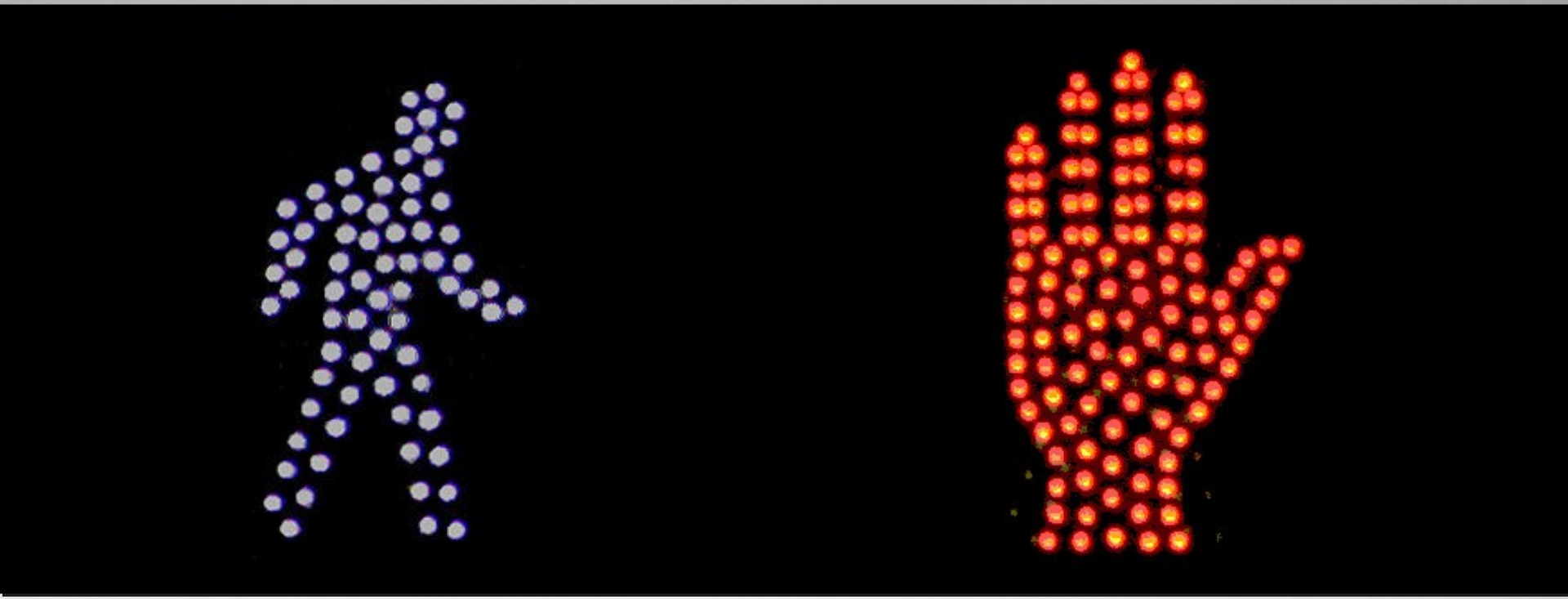
Application Architecture

- Modules
- Sandbox
- Application Core
- Base Library


Module
Module
Module
Module
Module
Sandbox
Application Core
Base Library

The application core manages modules

That's it



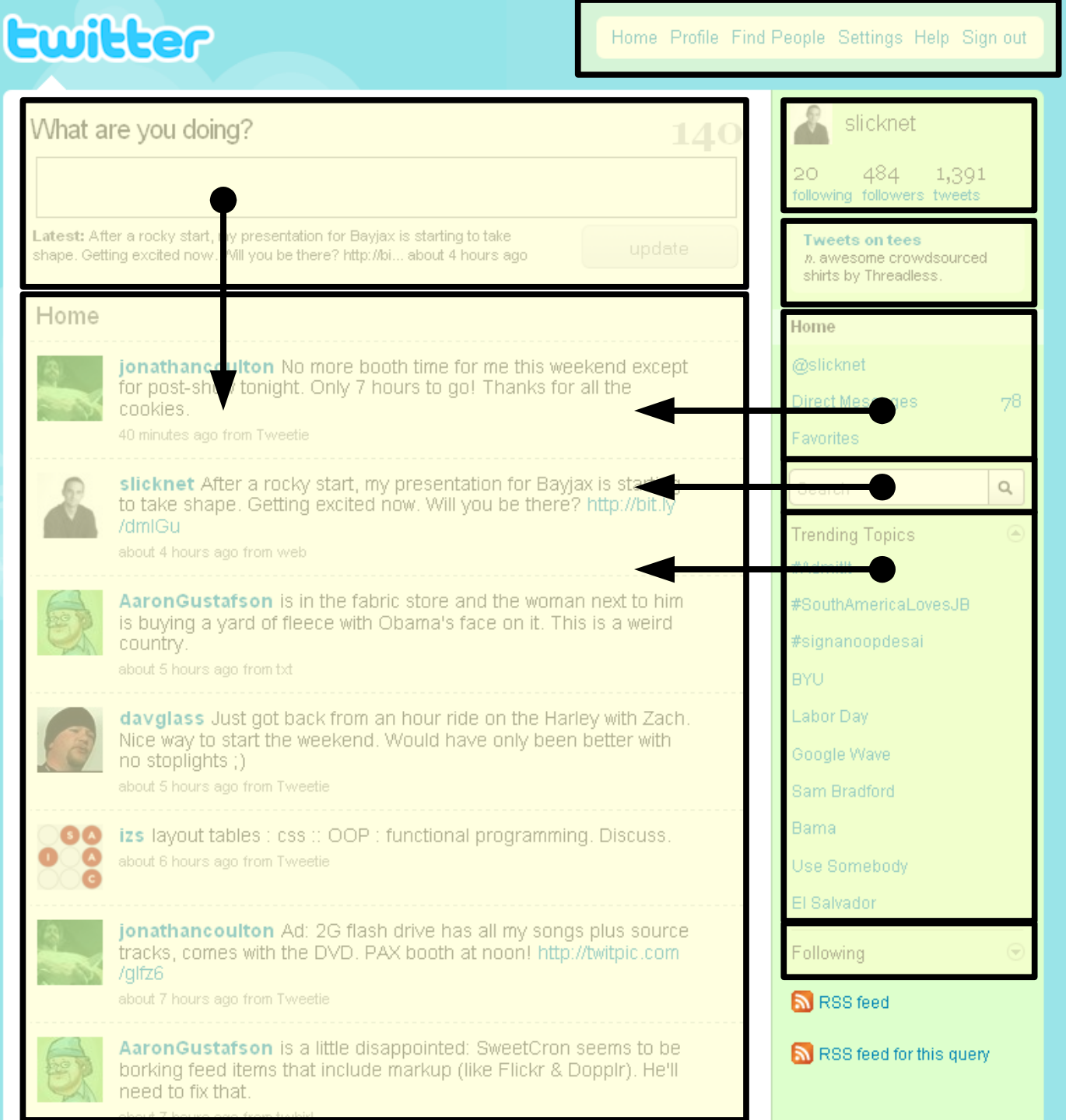
The application core tells a module when it should initialize and when it should shutdown

```
Core = function(){
  var moduleData = {};

  return {
      register: function(moduleId, creator){
        moduleData[moduleId] = {
          creator: creator,
          instance: null
        };
      },

      start: function(moduleId){
        moduleData[moduleId].instance =
            moduleData[moduleId].creator(new Sandbox(this));
        moduleData[moduleId].instance.init();
      },

      stop: function(moduleId){
        var data = moduleData[moduleId];
        if (data.instance){
            data.instance.destroy();
            data.instance = null;
        }
      }
  }
}();
```

```
Core = function(){

  return {
    //more code here...

    startAll: function(){
      for (var moduleId in moduleData){
        if (moduleData.hasOwnProperty(moduleId)){
          this.start(moduleId);
        }
      }
    },

    stopAll: function(){
      for (var moduleId in moduleData){
        if (moduleData.hasOwnProperty(moduleId)){
          this.stop(moduleId);
        }
      }
    },

    //more code here...
  };
}();
```

```
//register modules
Core.register("module1", function(sandbox){ /*...*/ });
Core.register("module2", function(sandbox){ /*...*/ });
Core.register("module3", function(sandbox){ /*...*/ });
Core.register("module4", function(sandbox){ /*...*/ });

//start the application by starting all modules
Core.startAll();
```

The application core manages communication between modules


twitter
Home Profile Find People Settings Help Sign out
What are you doing?
140
Latest: After a rocky start, my presentation for Bayjax is starting to take shape. Getting excited now. Will you be there? http://bi... about 4 hours ago
update
Home
jonathancoulton No more booth time for me this weekend except for post-sh tonight. Only 7 hours to go! Thanks for all the cookies.
40 minutes ago from Tweetie
slicknet After a rocky start, my presentation for Bayjax is st to take shape. Getting excited now. Will you be there? http://bit.ly /dmlGu
about 4 hours ago from web
AaronGustafson is in the fabric store and the woman next to him is buying a yard of fleece with Obama's face on it. This is a weird country.
about 5 hours ago from txt
davglass Just got back from an hour ride on the Harley with Zach. Nice way to start the weekend. Would have only been better with no stoplights ;)
about 5 hours ago from Tweetie
izs layout tables : css :: OOP : functional programming. Discuss.
about 6 hours ago from Tweetie
jonathancoulton Ad: 2G flash drive has all my songs plus source tracks, comes with the DVD. PAX booth at noon! http://twitpic.com /glfz6
about 7 hours ago from Tweetie
AaronGustafson is a little disappointed: SweetCron seems to be borking feed items that include markup (like Flickr & Dopplr). He'll need to fix that.
slicknet
20 following
484 followers
1,391 tweets
Tweets on tees
awesome crowdsourced shirts by Threadless.
Home
@slicknet
Direct Mes ges 78
Favorites
Trending Topics
#SouthAmericaLovesJB
#signanoopdesai
BYU
Labor Day
Google Wave
Sam Bradford
Bama
Use Somebody
El Salvador
Following
RSS feed
RSS feed for this query

```
TimelineFilter = {
    changeFilter: function(filter){
        Timeline.applyFilter(filter);
    }
};

StatusPoster = {
    postStatus: function(status){
        Timeline.post(status);
    }
};

Timeline = {
    applyFilter: function(filter){
        //implementation
    },
    post: function(status){
        //implementation
    }
};
```

Tight Coupling

Tight Coupling

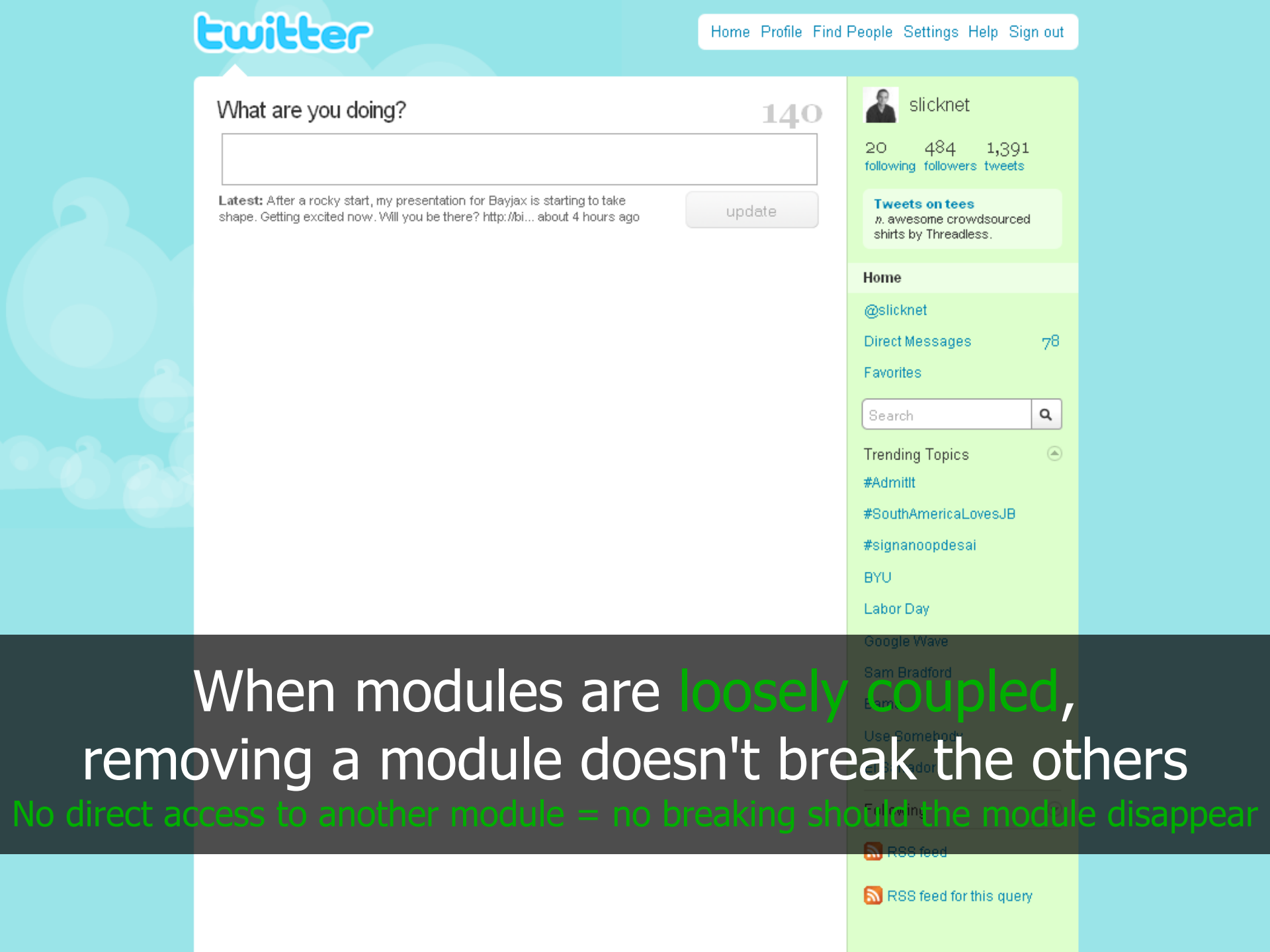
```
Core.register("timeline-filter", function(sandbox){

    return {
        changeFilter: function(filter){
            sandbox.notify({
                type: "timeline-filter-change",
                data: filter
            });
        }
    };
});

Core.register("status-poster", function(sandbox){

    return {
        postStatus: function(statusText){
            sandbox.notify({
                type: "new-status",
                data: statusText
            });
        }
    };
});
```

Loose Coupling

Loose Coupling

```
Core.register("timeline", function(sandbox){

    return {
        init: function(){
            sandbox.listen([
                "timeline-filter-change",
                "post-status"
            ], this.handleNotification, this);
        },

        handleNotification: function(note){
            switch(note.type){
                case "timeline-filter-change":
                    this.applyFilter(note.data);
                    return;
                case "post-status":
                    this.post(note.data);
                    return;
            }
        }
    };
});
```

Loose Coupling


twitter
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update
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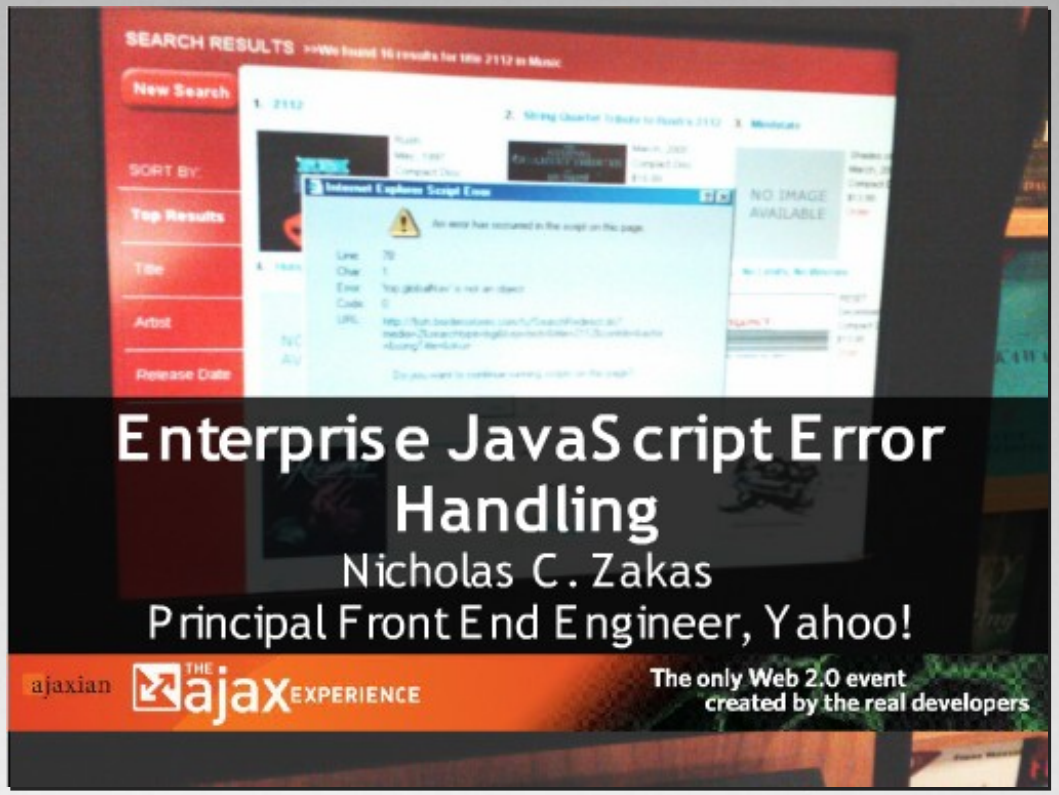
n. awesome crowdsourced shirts by Threadless.
Home
@slicknet
Direct Messages 78
Favorites
Search
Trending Topics
#AdmitIt
#SouthAmericaLovesJB
#signanoopdesai
BYU
Labor Day
Google Wave
Sam Bradford
RSS feed
RSS feed for this query
When modules are loosely coupled,
removing a module doesn't break the others
No direct access to another module = no breaking should the module disappear

The application core handles errors

Uses available information to determine best course of action

```
Core = function(){

  var moduleData = {}, debug = false;

  function createInstance(moduleId){
    var instance =
      moduleData[moduleId].creator(new Sandbox(this)),
      name, method;

    if (!debug){
      for (name in instance){
        method = instance[name];
        if (typeof method == "function"){
          instance[name] = function(name, method){
            return function(){
              try { return method.apply(this, arguments);}
              catch(ex) {log(1, name + "(): " + ex.message);}
            };
          }(name, method);
        }
      }
    }

    return instance;
  }

  //more code here

}();
```



Learn more

http://www.slideshare.net/nzakas/enterprise-javascript-error-handling-presentation

Application Core Jobs

- **Manage module lifecycle**
  - Tell modules when to start and stop doing their job
- **Enable inter-module communication**
  - Allow loose coupling between modules that are related to one another
- **General error handling**
  - Detect, trap, and report errors in the system
- **Be extensible**
  - The first three jobs are not enough!

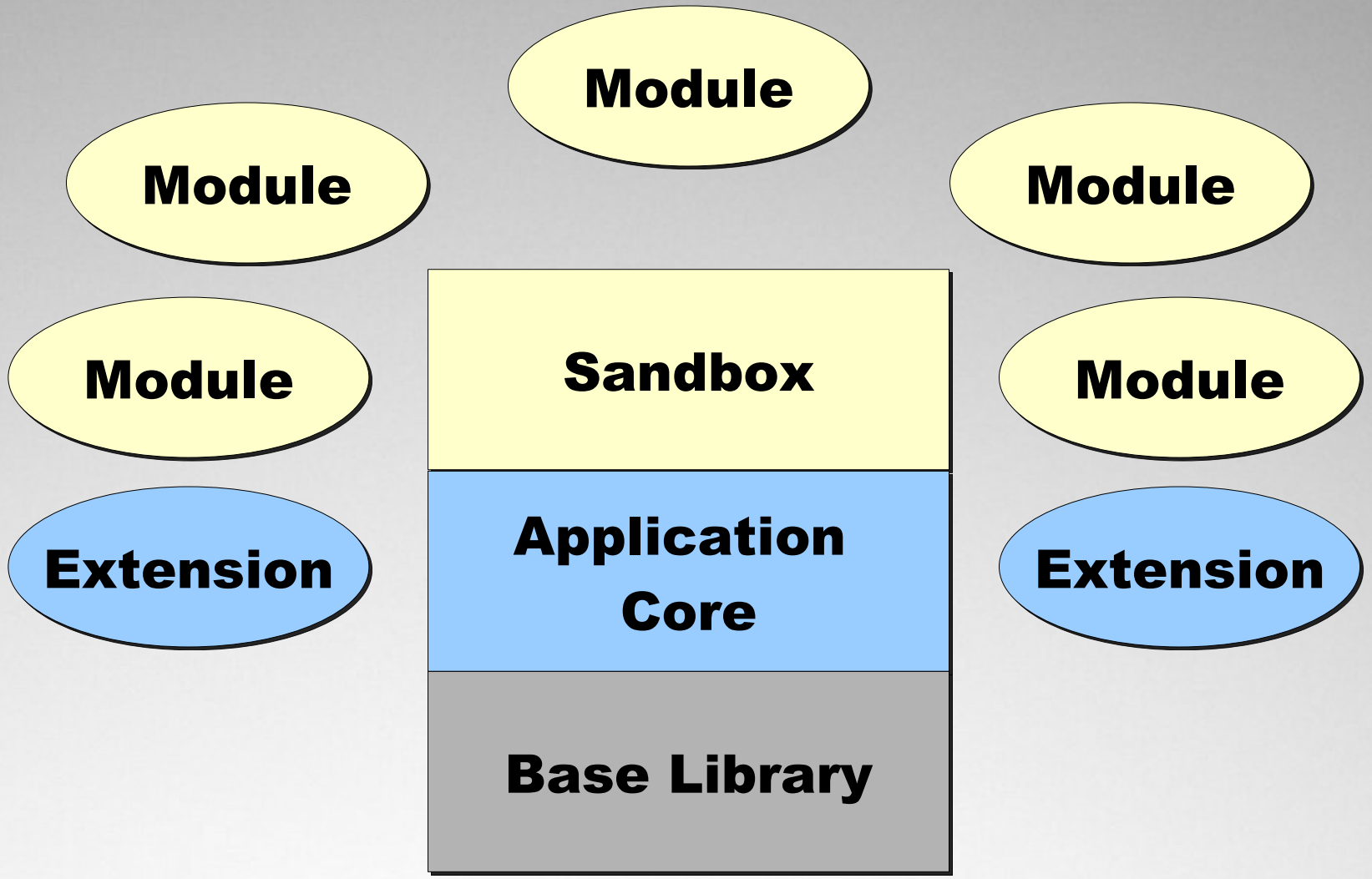
Why not?

Web applications change

Often in ways that you couldn't possibly anticipate

Plan for extension


Anything built for extension can never be obsolete
Extensions augment the capabilities of the core to keep it relevant and useful


Module
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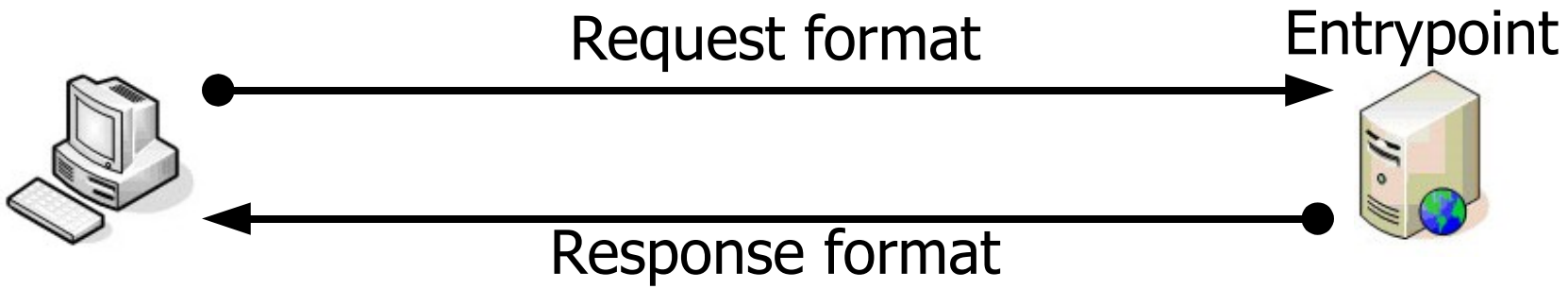
Module
Module
Extension
Extension
Sandbox
Application Core
Base Library

What Extensions?

- Error handling
- Ajax communication
- New module capabilities
- General utilities
- Anything!

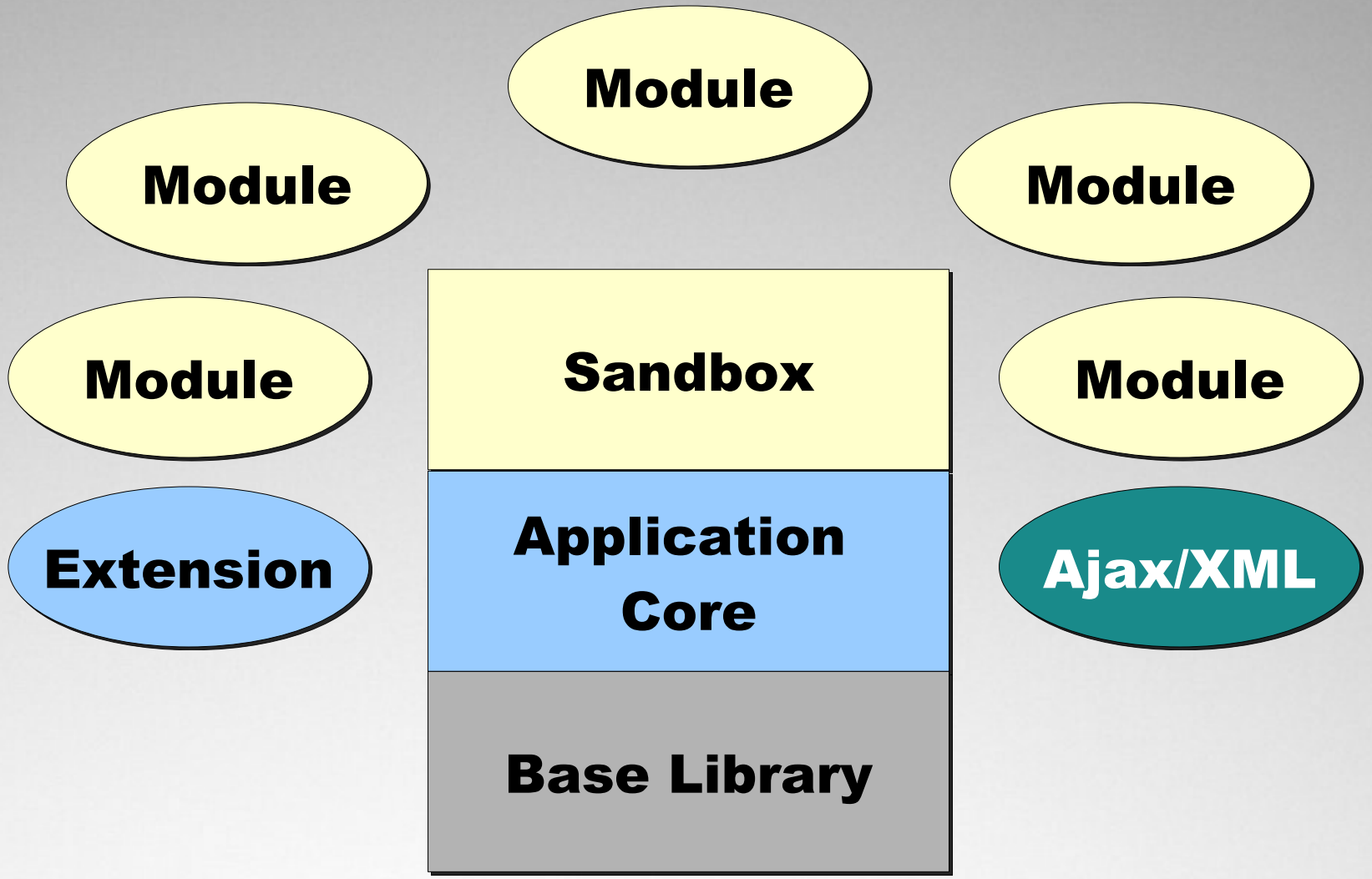
Ajax communication comes in different forms

Tends to be tied to something available on the server



Three parts must be in sync for Ajax to work

Modules shouldn't know anything about any of this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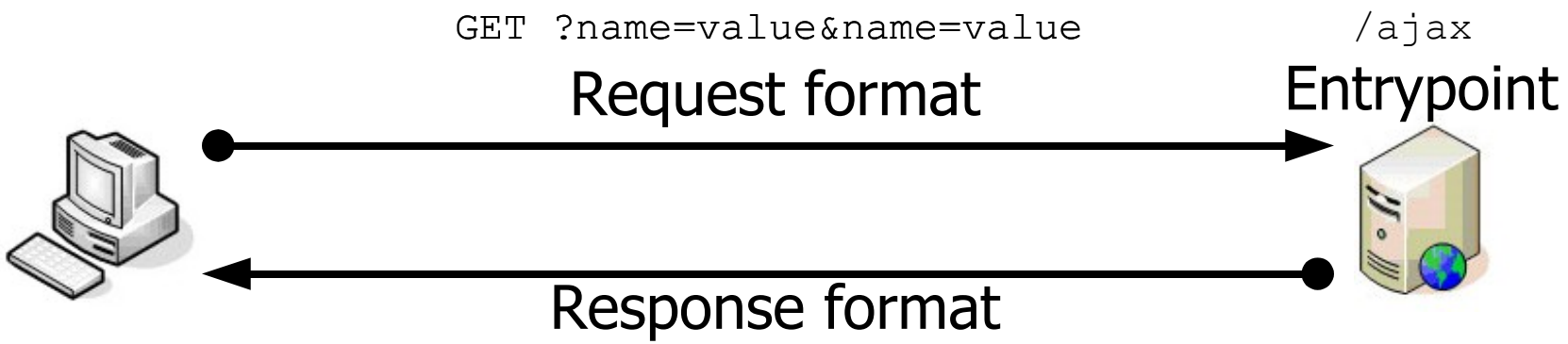
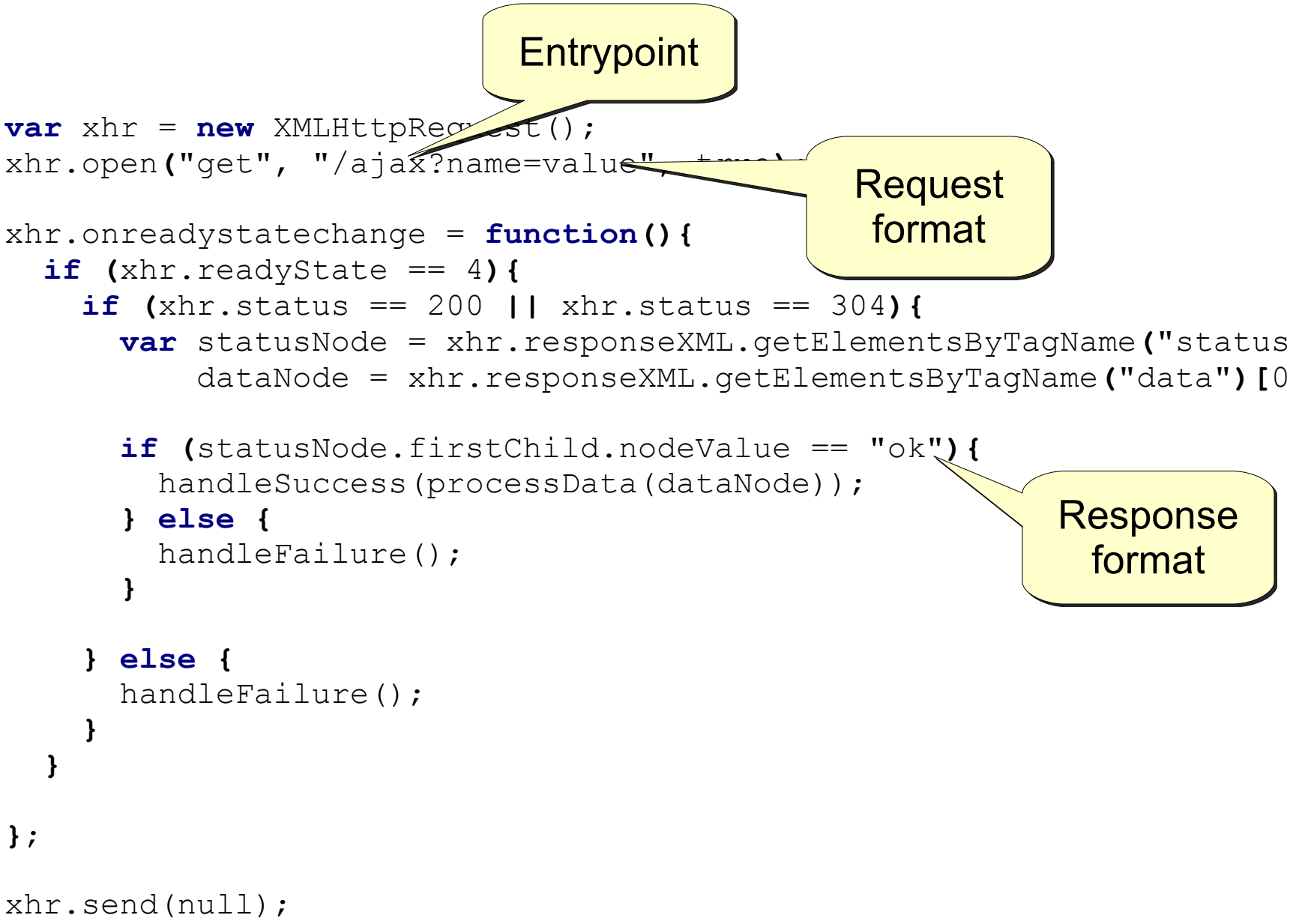
Sandbox
Application Core
Base Library
Ajax/XML

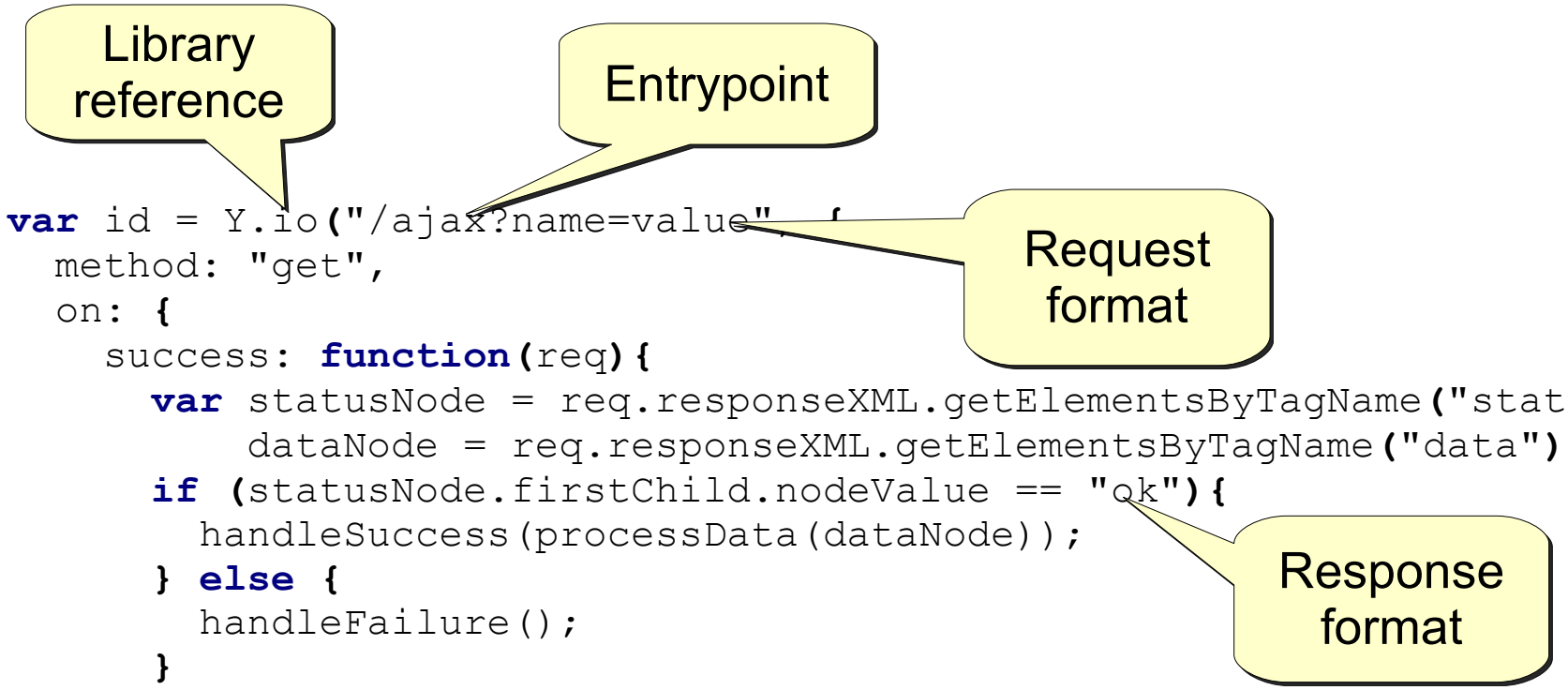



```
<response>
   <status>ok|error</status>
   <data>
      <results>
          <result name="..." />
          <result name="..." />
      </results>
    </data>
</response>
```



Basic implementation

Lowest-level Ajax with XMLHttpRequest



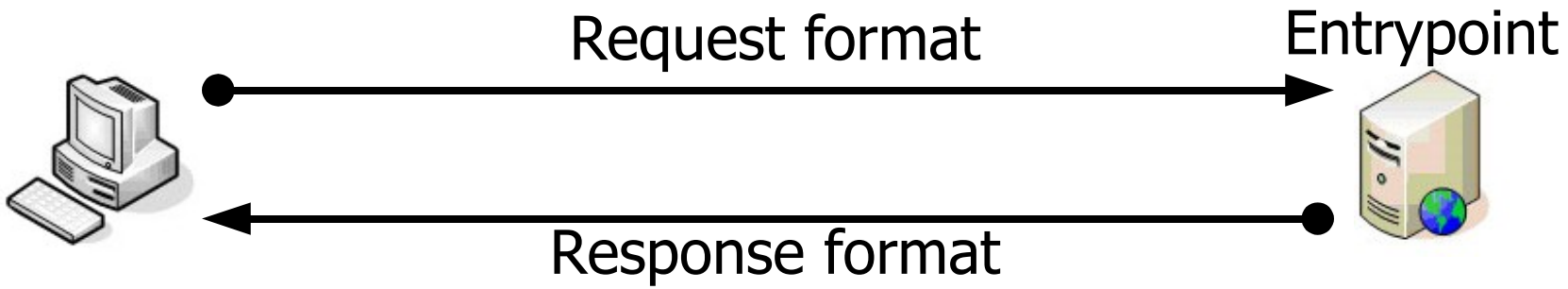
Implementation using a library

Hides some of the ugliness but still tightly coupled to Ajax implementation

```
var id = sandbox.request({ name: "value" }, {
  success: function(response){
    handleSuccess(response.data);
  },
  failure: function(response){
    handleFailure();
  }
});
```

Implementation using sandbox

Passes through to core - hides all Ajax communication details



Ajax extension encapsulates all details

Any of these three can change without affecting modules

GET ?name=value&name=value

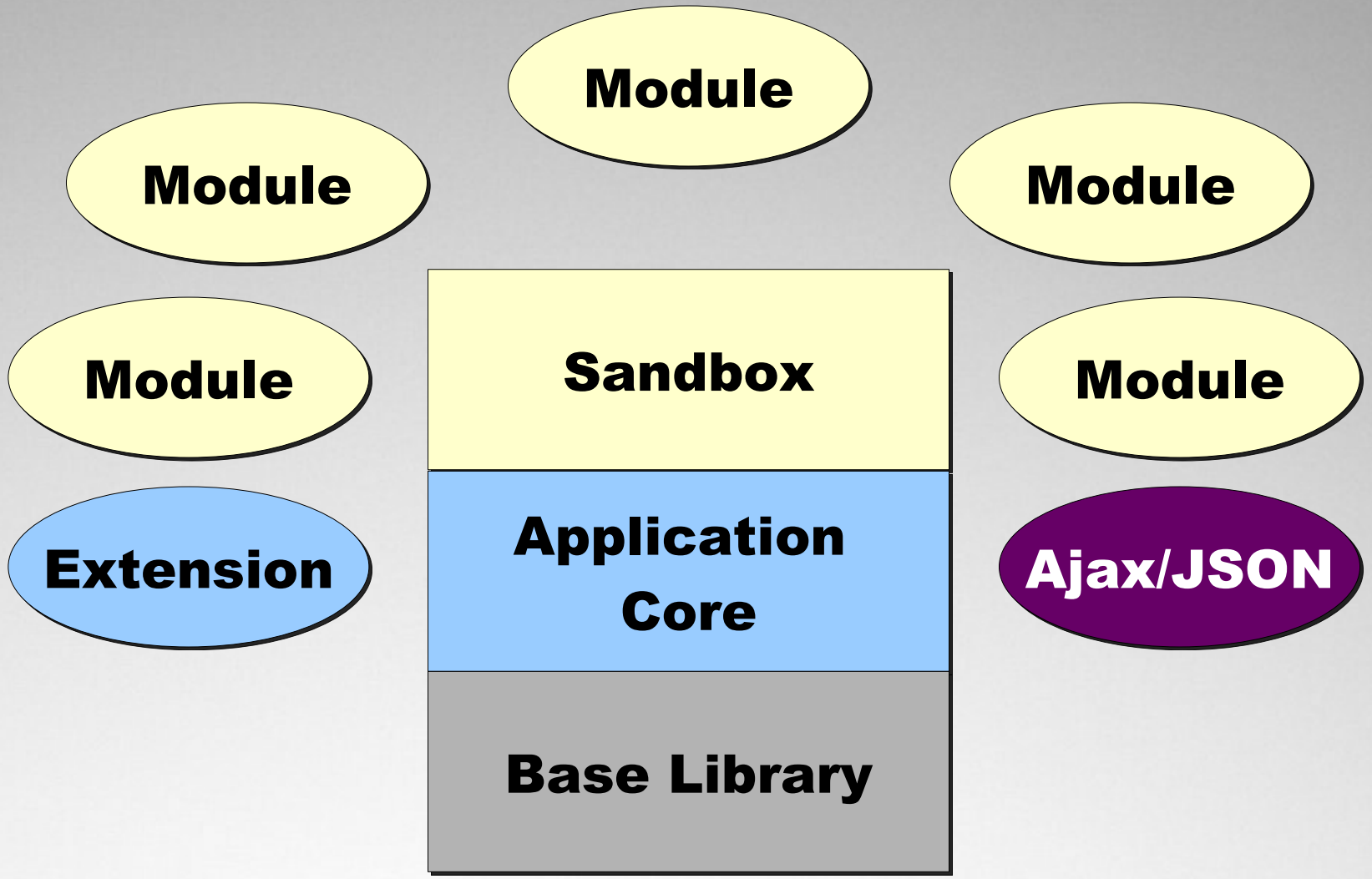
/request

Request format

Entrypoint

Response format

```
{
  status: "ok|error",
  data: {
    results: [
      "...",
      "..."
    ]
  }
}
```


Module
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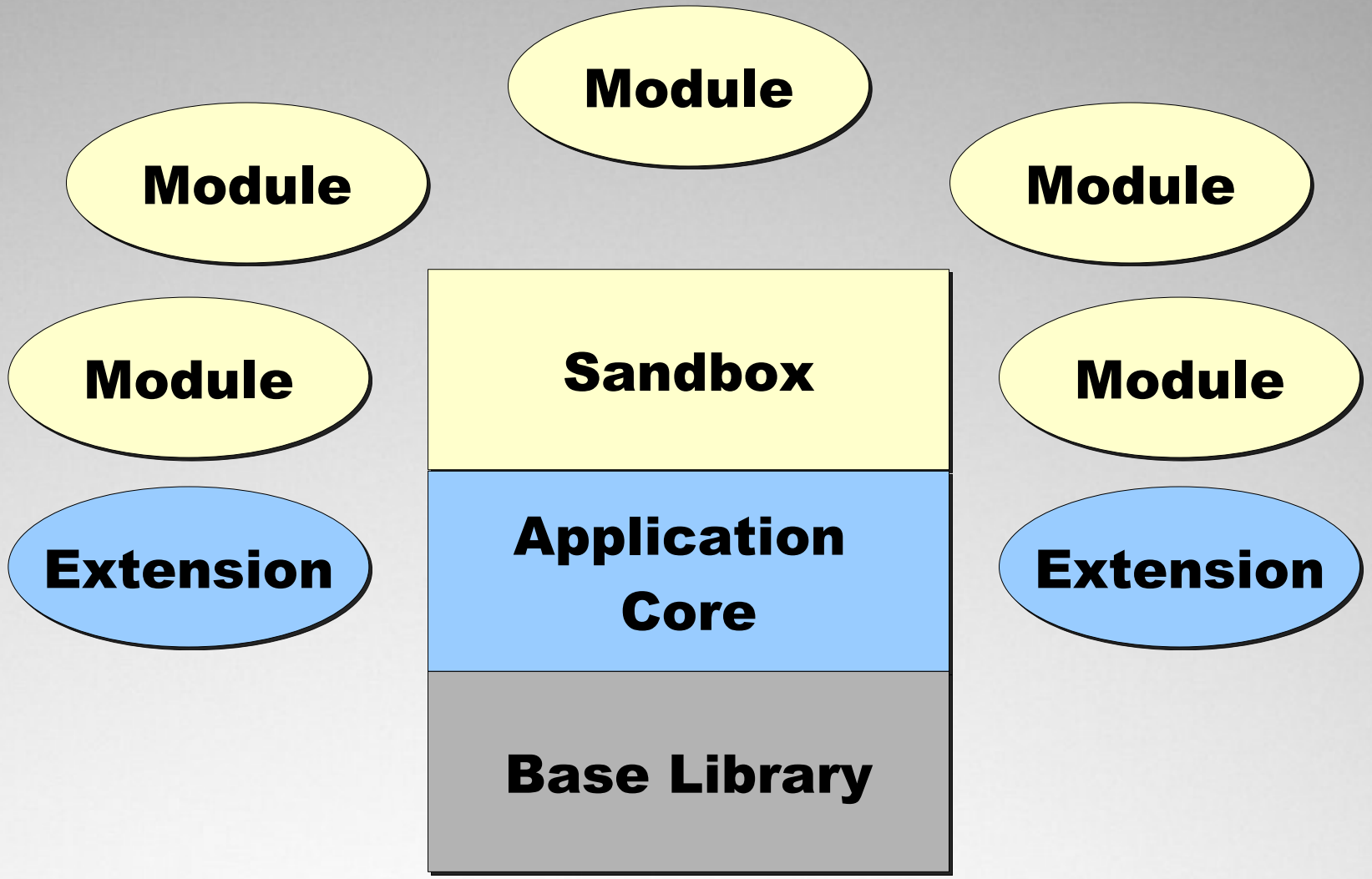
Module
Module
Extension
Sandbox
Application Core
Base Library
Ajax/JSON

Ajax Extension Jobs

- **Hide Ajax communication details**
  - Modules don't need to know any of it
- **Provide common request interface**
  - Modules use this interface to specify data to send to the server
- **Provide common response interface**
  - Modules use this interface to retrieve data from the response
- **Manage server failures**
  - Modules only care if they got what they wanted or not, don't care why

Application Architecture

- Modules
- Sandbox
- Application Core
- Base Library


Module
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Extension
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Sandbox
Application Core
Base Library

The base library provides basic functionality

Ironic, huh?


jQuery
write less, do more.


mootools


dojo
great experiences
...for everyone


prototype


Y
U
I
LIBRARY

Most applications are too tightly coupled to the base library

Developers get upset when they can't touch the base library directly

O'REILLY OSCON Open Source Convention

Be Lazy: Nothing is faster than doing nothing

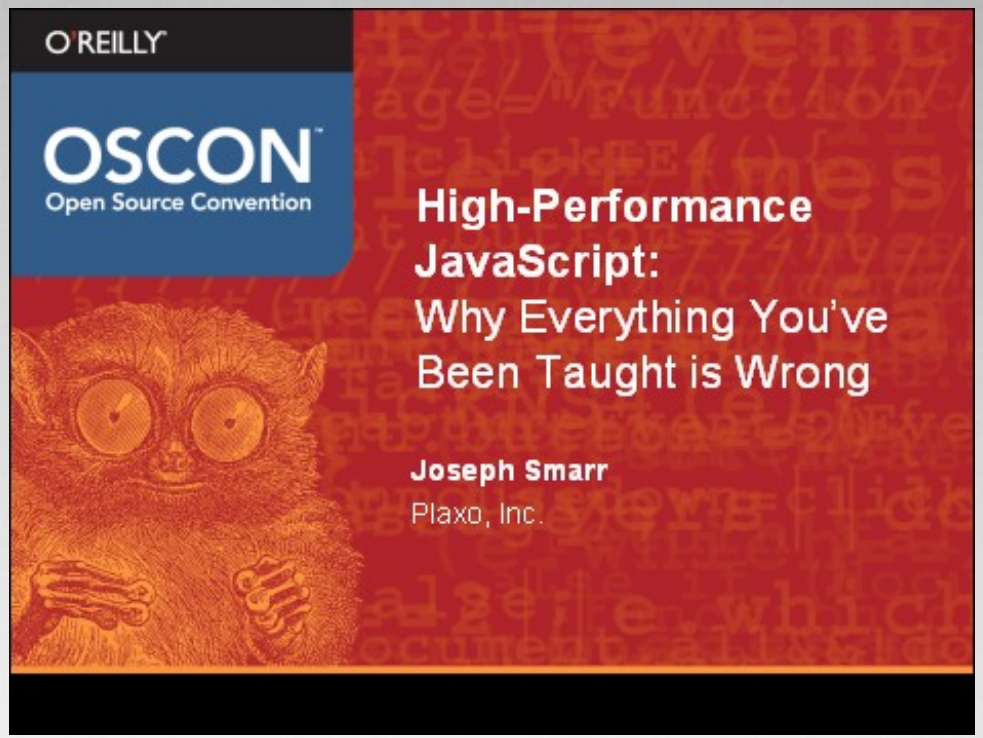
Write less code

- **Minimize the JavaScript code you send down**
  - Minify = good, obfuscate = not much better
  - Strip debug / logging lines (don't just set log-level = 0)
  - Remove unnecessary OOP boilerplate
    - Get/Set functions don't actually protect member vars! etc.
- **Minimize dependency on third-party library code**
  - Lots of extra code comes along that you don't need
  - Libraries solve more general problems → use like scaffolding

Joseph Smarr, Plaxo, Inc.

High-Performance JavaScript, OSCON 2007

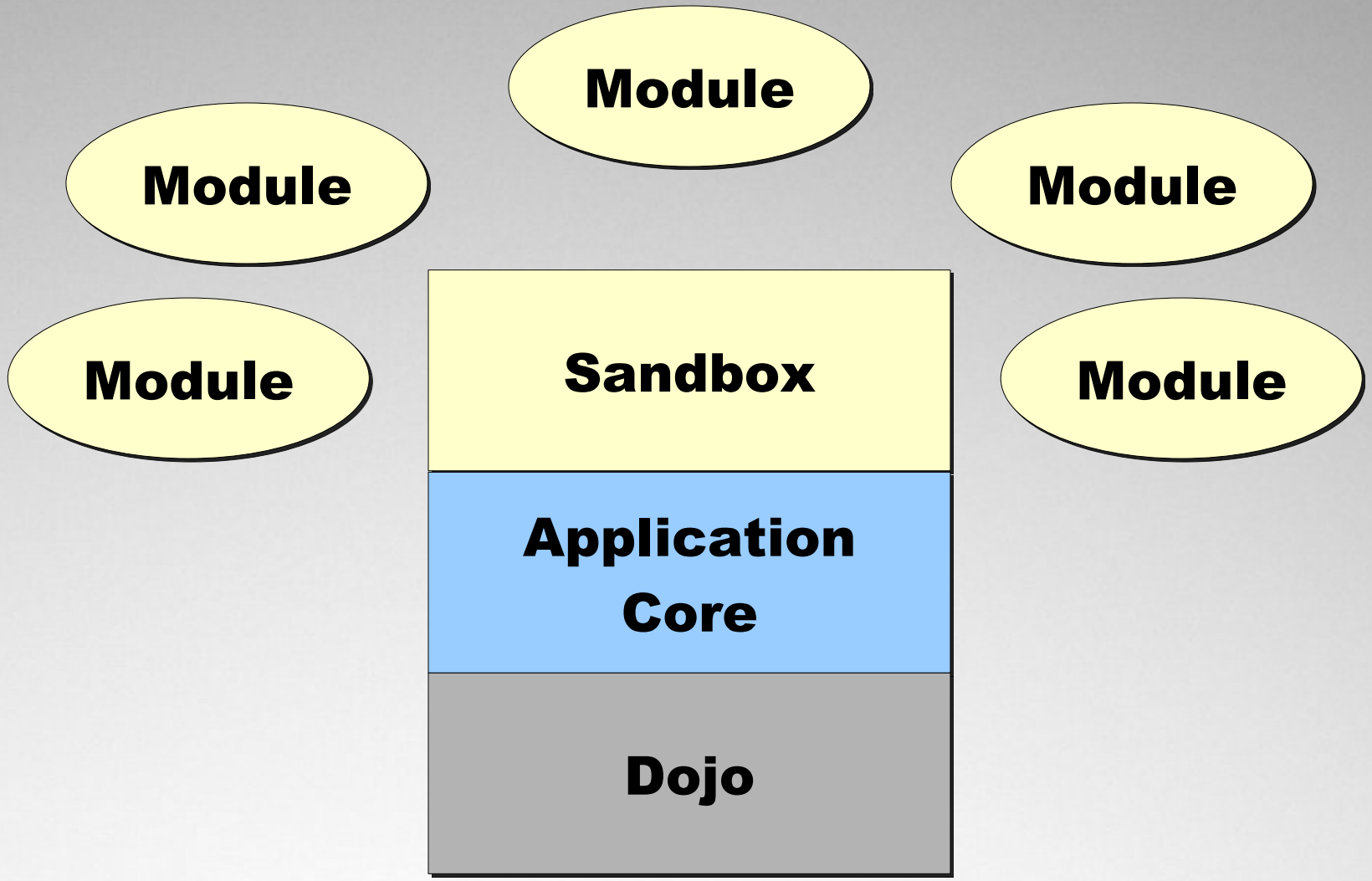
Joseph Smarr, Plaxo, Inc.



Learn more

http://josephsmarr.com/2007/07/25/high-performance-javascript-oscon-2007/

Ideally, only the application core has any idea what base library is being used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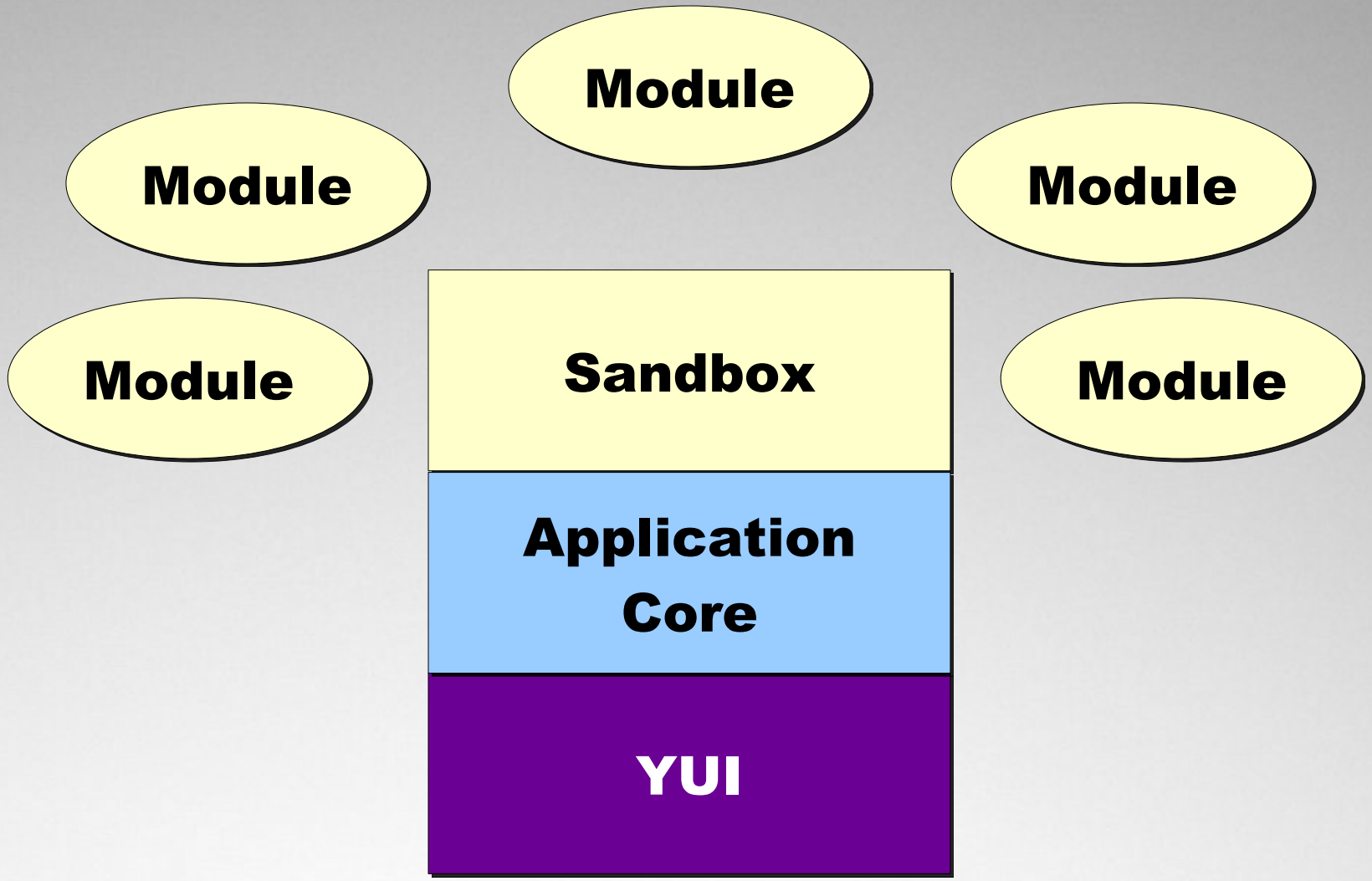
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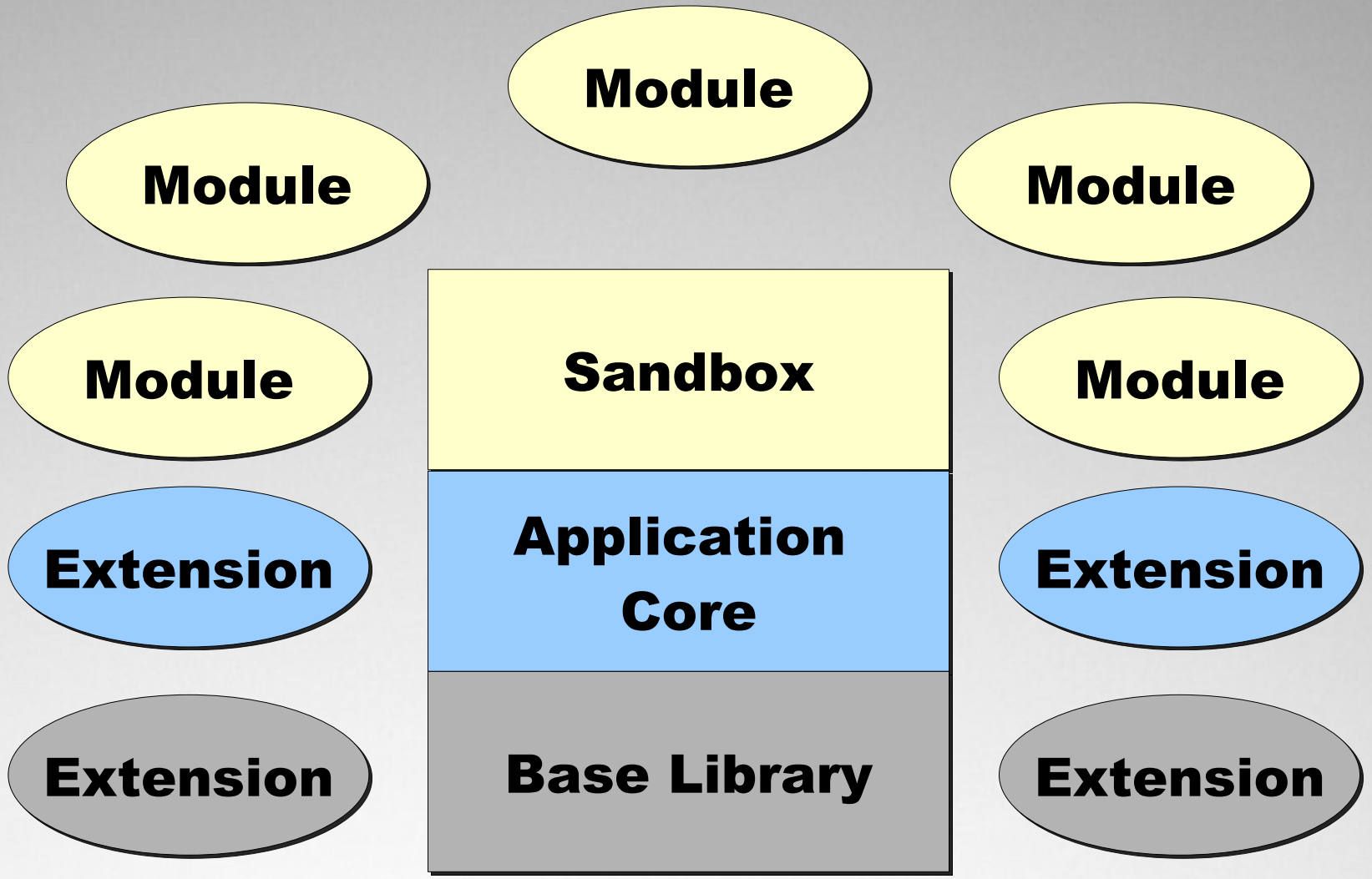
Sandbox
Application Core
YUI

Base Library Jobs

- **Browser normalization**
  - Abstract away differences in browsers with common interface
- **General-purpose utilities**
  - Parsers/serializers for XML, JSON, etc.
  - Object manipulation
  - DOM manipulation
  - Ajax communication
- **Provide low-level extensibility**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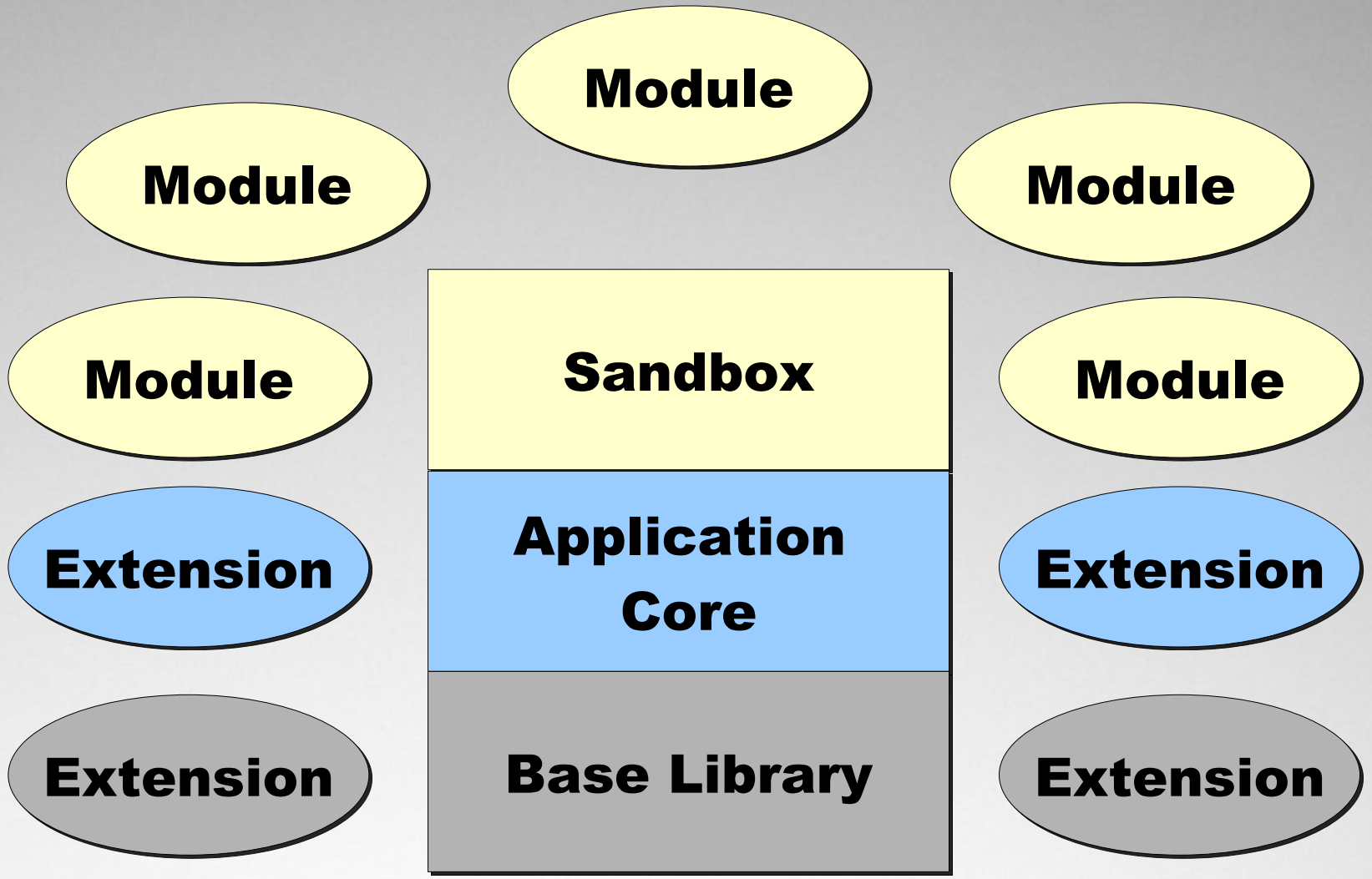
Sandbox
Application Core
Extension
Extension
Base Library
Extension
Extension

Architecture Knowledge


Module
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Sandbox
Application Core
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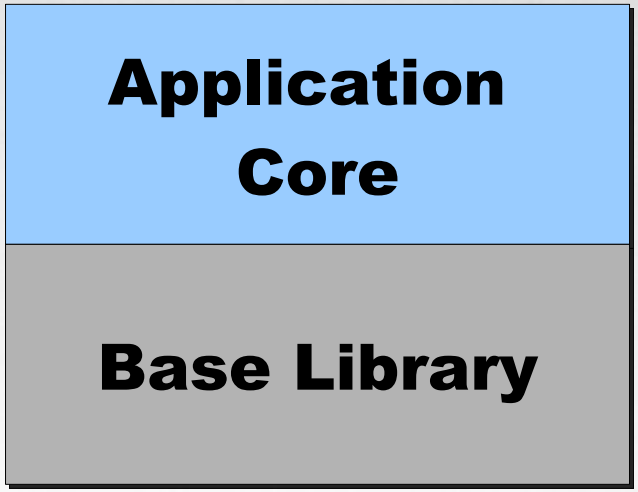
Extension
Base Library
Extension
Extension

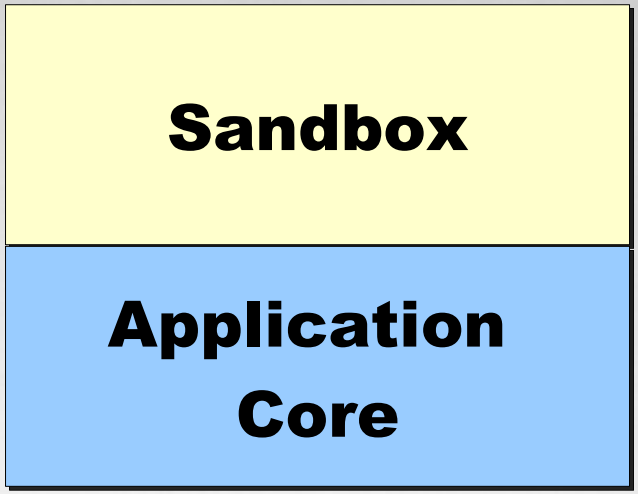
Only the base library knows which browser is being used

No other part of the architecture should need to know

Only the application core knows which base library is being used

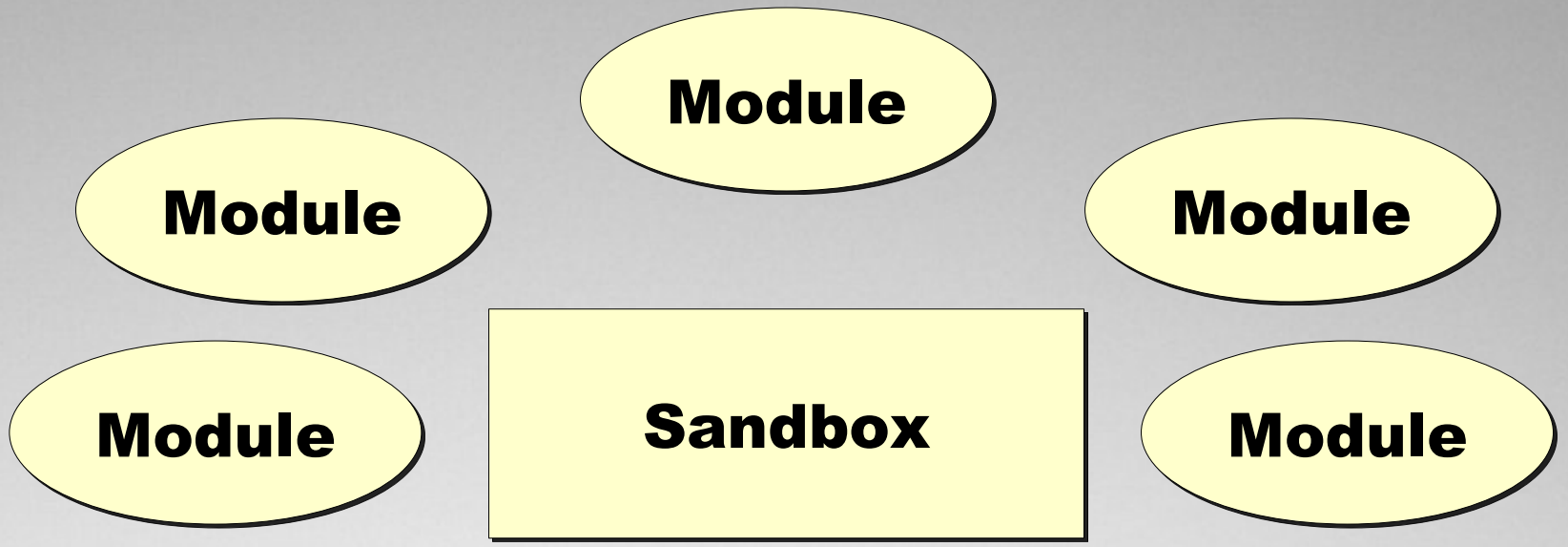
No other part of the architecture should need to know





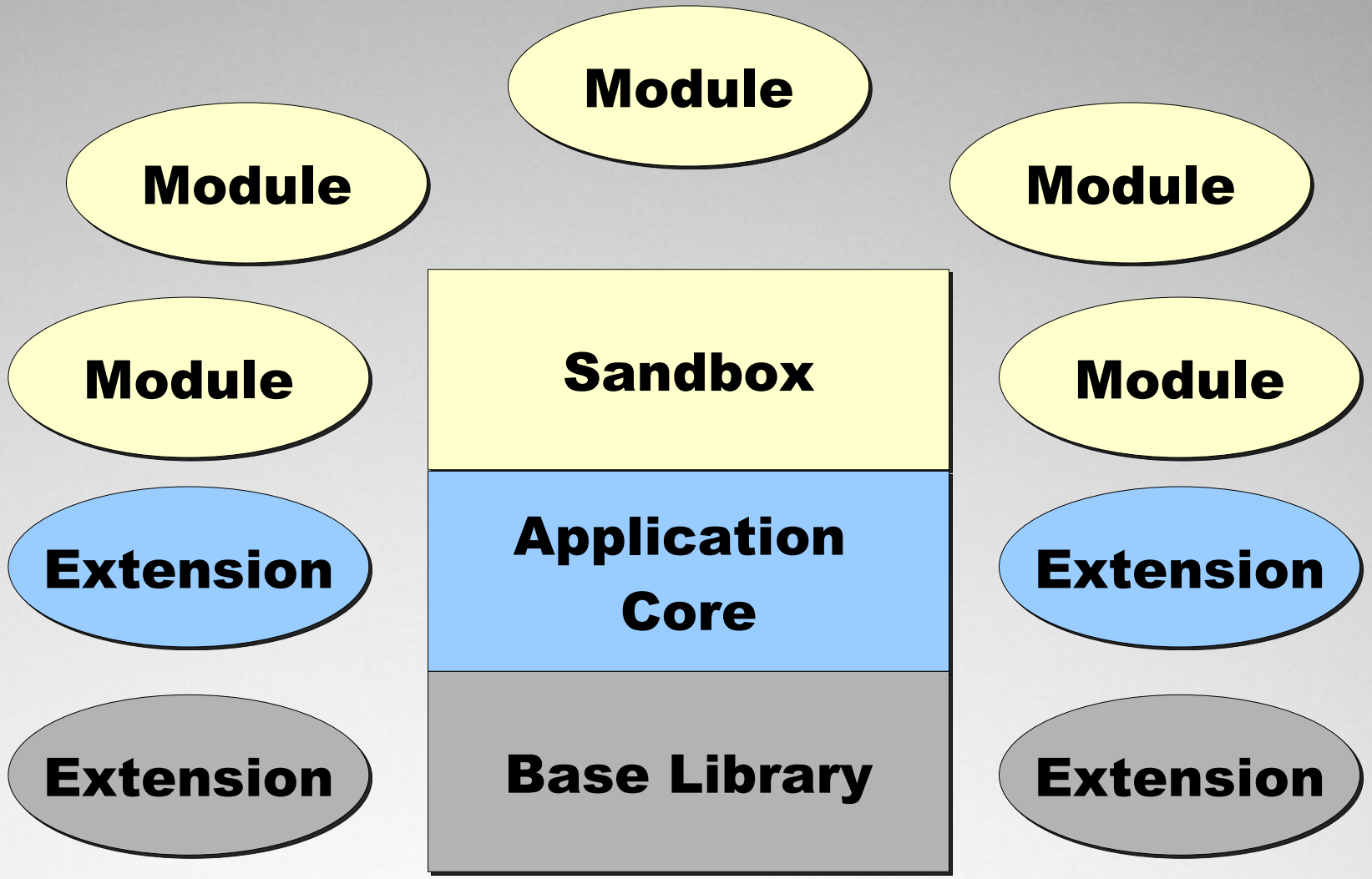
Only the sandbox knows which application core is being used

No other part of the architecture should need to know



The modules know nothing except that the sandbox exists

They have no knowledge of one another or the rest of the architecture



No part knows about the web application

Advantages

Multiple different applications can be created with the same framework

Minimize ramp-up time by reusing existing components

Each part can be tested separately

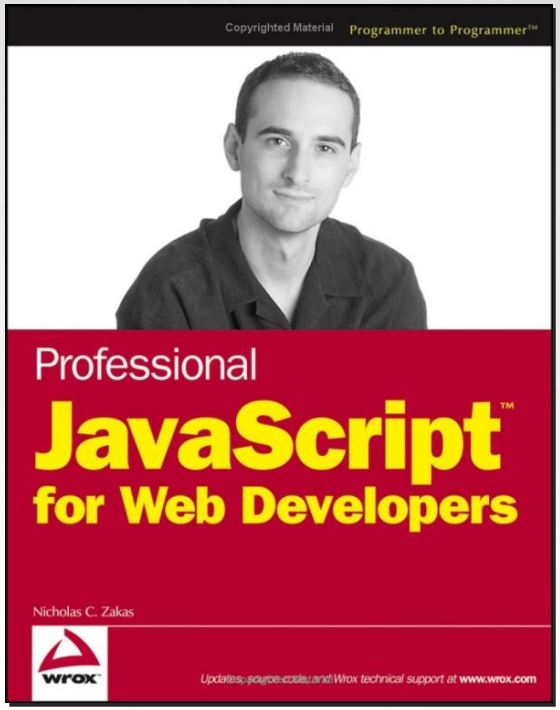
You just need to verify that each is doing it's unique job

A scalable JavaScript architecture allows you to replace any block without fear of toppling the tower

Questions?

Etcetera

- My blog: www.nczonline.net
- My email: nzakas@yahoo-inc.com
- Twitter: @slicknet



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