



Twelve Patterns for Hypermedia Microservices

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API Academy / CA
@mamund

Drawings by Diogo Lucas
@diogoelucas

Introduction



Mike Amundsen
@mamund

http://apiacademy.co

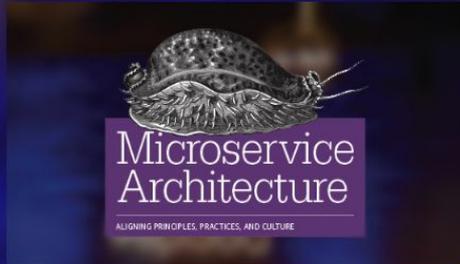
MENU



SERVICES

EVENTS

EBOOK



MICROSERVICE ARCHITECTURE: ALIGNING PRINCIPLES, PRACTICES & CULTURE

DESIGN AND APPLY MICROSERVICES TO EMBRACE CONTINUAL
CHANGE IN THE DIGITAL ECONOMY

READ MORE



Building

Hypermedia
APIs with
HTML5 & No

O'REILLY®

Mike

O'REILLY®



Designing APIs
for the Web

Mike Amundsen

VIDEO

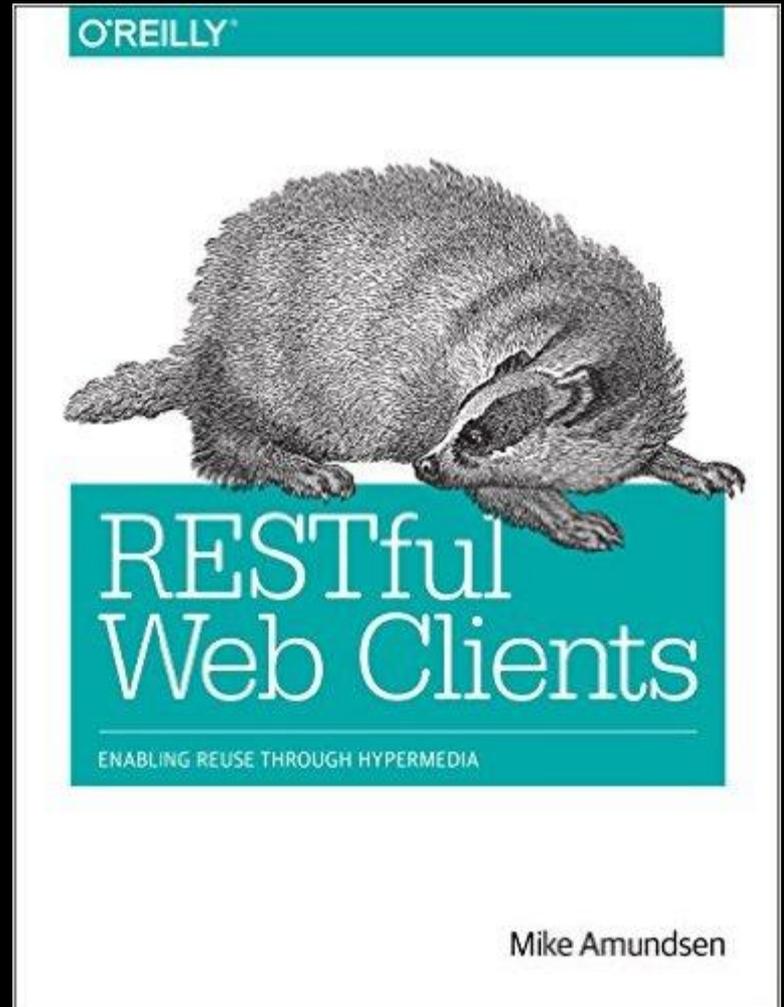
RESTful
Web APIs



LLY®

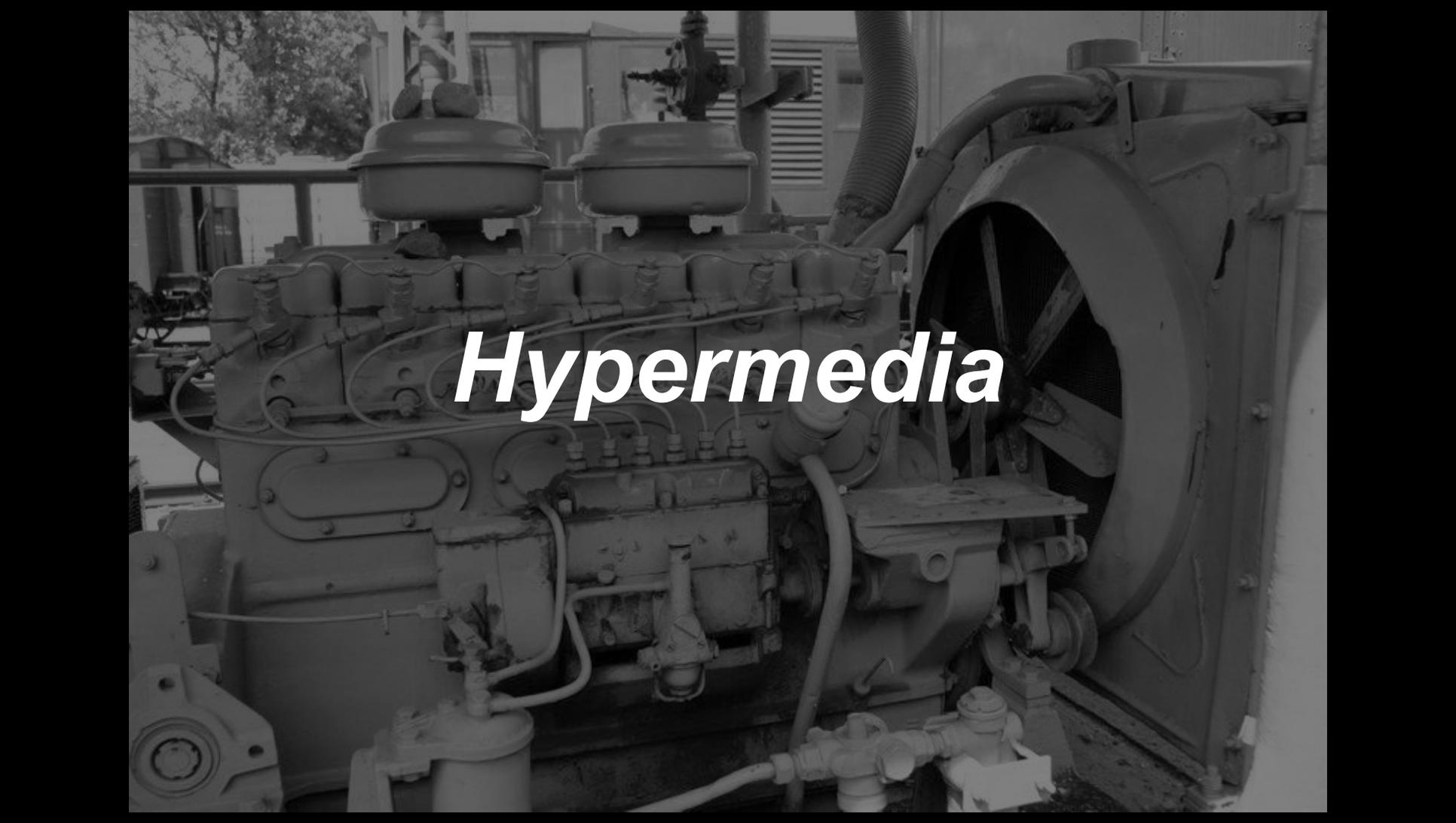
Leonard Richardson,
Mike Amundsen & Sam Ruby

@RWCBook



Outline

- Hypermedia
- Messages
- Patterns
- 4+4+4
- Summary



Hypermedia

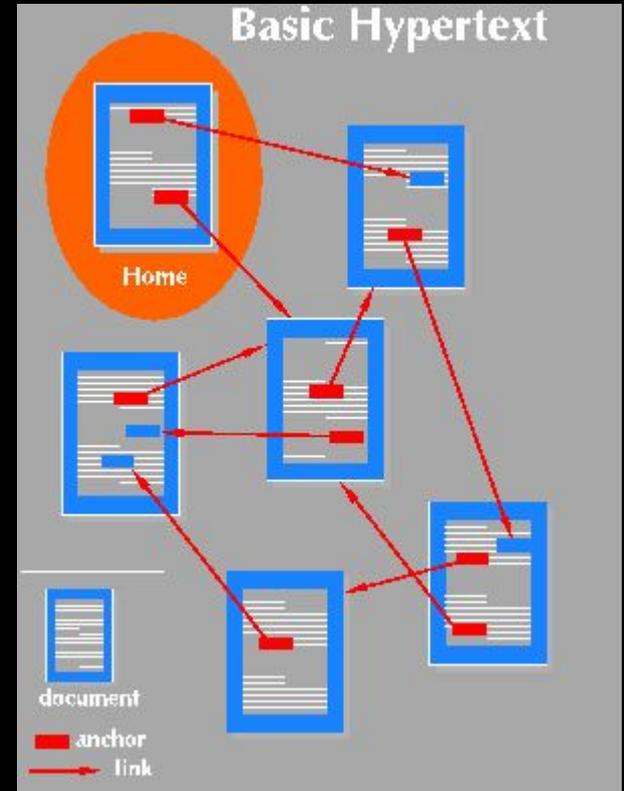
What is Hypermedia?

Hypertext is text which is not constrained to be linear.

Hypertext is text which contains links to other texts.

The term was coined by Ted Nelson around 1965.

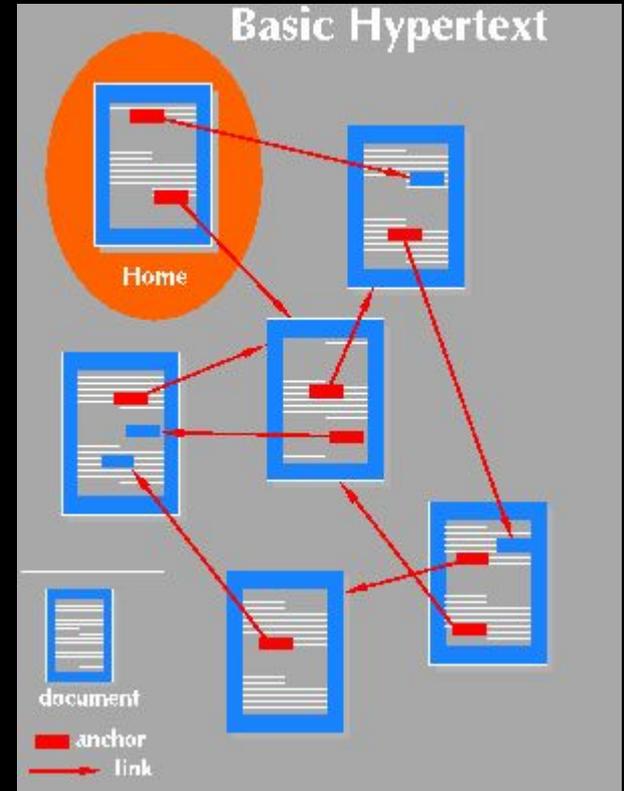
<https://www.w3.org/WhatIs.html>



What is Hypermedia?

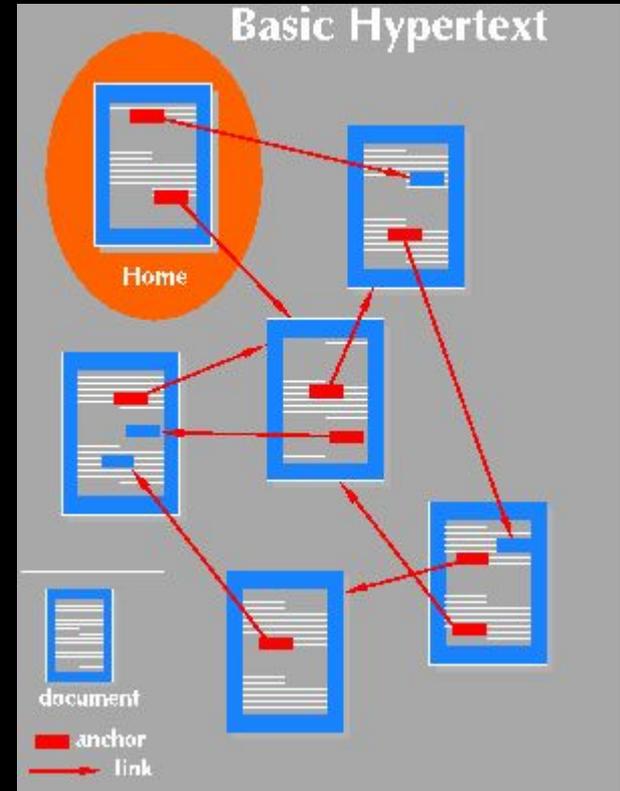
Hypermedia is a term used for hypertext which is not constrained to be text: it can include graphics, video and sound, for example.

<https://www.w3.org/WhatIs.html>



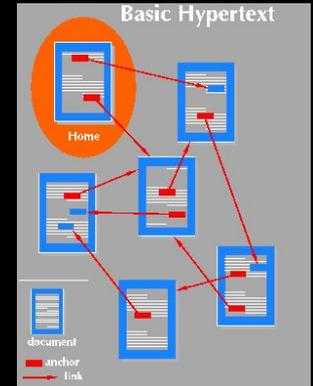
What is Hypermedia?

Hypertext and Hypermedia are concepts, not products.



<https://www.w3.org/WhatIs.html>

Hypermedia is the language of the WWW



Why Hypermedia?

***Why Hypermedia?
Affordances!***

Affordances

"The affordances of the environment are what it offers ... what it provides or furnishes, either for good or ill.



James Gibson, 1977

Affordances

“The term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used.”



Donald Norman, 1988

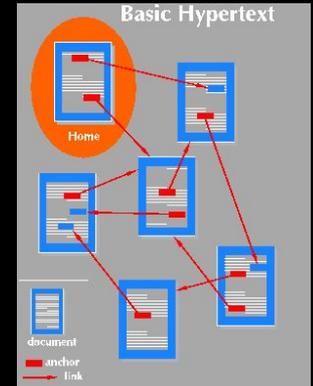
Affordances

“When I say Hypertext, I mean the simultaneous presentation of information and controls such that the information becomes the affordance through which the user obtains choices and selects actions.”

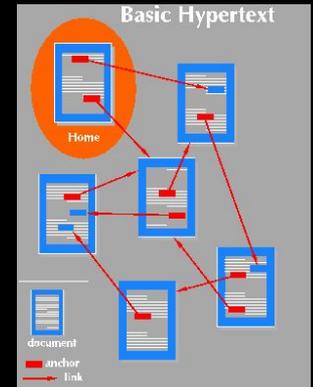


Roy Fielding, 2008

***Affordances are the
reason for hypermedia***



So, what does it look like?



HTML

```
1 <title>Hypertext Links</title>
2 <h1>Links and Anchors</h1>
3 A link is the connection between one piece of
4 <a href=whatIs.html>hypertext</a> and another.
5
```

Atom

```
<?xml version="1.0" encoding="utf-8"?>
<feed xmlns="http://www.w3.org/2005/Atom">

  <title>Example Feed</title>
  <link href="http://example.org/" />
  <updated>2003-12-13T18:30:02Z</updated>
  <author>
    <name>John Doe</name>
  </author>
  <id>urn:uuid:60a76c80-d399-11d9-b93C-0003939e0af6</id>

  <entry>
    <title>Atom-Powered Robots Run Amok</title>
    <link href="http://example.org/2003/12/13/atom03" />
    <id>urn:uuid:1225c695-cfb8-4ebb-aaaa-80da344efa6a</id>
```

CCXML

```
1 <?xml version="1.0" encoding="UTF-8"?>
2 <ccxml version="1.0" xmlns="http://www.w3.org/2002/09/ccxml">
3   <eventprocessor>
4     <transition event="connection.alerting">
5       <var name="MyVariable" expr="'This is a CCXML Variable'"/>
6       <log expr="'Hello World. I just made a variable: ' + MyVariable"/>
7       <log expr="'Lets hang up on this incoming call.'"/>
8       <exit/>
9     </transition>
10  </eventprocessor>
11 </ccxml>
```

HAL

```
{
  "_links": {
    "self": { "href": "/orders" },
    "curies": [{ "name": "ea", "href": "http://example.com/docs/rels/{rel}" },
    "next": { "href": "/orders?page=2" },
    "ea:find": {
      "href": "/orders {?id}",
      "templated": true
    },
    "ea:admin": [{
      "href": "/admins/2",
      "title": "Fred"
    }, {
      "href": "/admins/5",
      "title": "Kate"
    }
  ]
},
"currentlyProcessing": 14,
"shippedToday": 20,
"_embedded": {
```

Siren

```
"actions": [
  {
    "name": "add-item",
    "title": "Add Item",
    "method": "POST",
    "href": "http://api.x.io/orders/42/items",
    "type": "application/x-www-form-urlencoded",
    "fields": [
      { "name": "orderNumber", "type": "hidden", "value": "42" },
      { "name": "productCode", "type": "text" },
      { "name": "quantity", "type": "number" }
    ]
  }
],
"links": [
  { "rel": [ "self" ], "href": "http://api.x.io/orders/42" },
```

<https://github.com/kevinswiber/siren>

Collection+JSON

```
{ "collection" :  
  {  
    "version" : "1.0",  
    "href" : "http://example.org/friends/",  
  
    "links" : [  
      {"rel" : "feed", "href" : "http://example.org/friends/rss"},  
      {"rel" : "queries", "href" : "http://example.org/friends/?queries"},  
      {"rel" : "template", "href" : "http://example.org/friends/?template"}  
    ],  
  
    "items" : [  
      {  
        "href" : "http://example.org/friends/jdoe",  
        "data" : [  
          {"name" : "full-name", "value" : "J. Doe", "prompt" : "Full Name"},  
          {"name" : "email", "value" : "jdoe@example.org", "prompt" : "Email"}  
        ],  
        "links" : [  
          {"rel" : "blog", "href" : "http://examples.org/blogs/jdoe", "prompt" : "Bl"},  
          {"rel" : "avatar", "href" : "http://examples.org/images/jdoe", "prompt" :  
        ]  
      }  
    ]  
  }  
}
```

<http://amundsen.com/media-types/collection/>

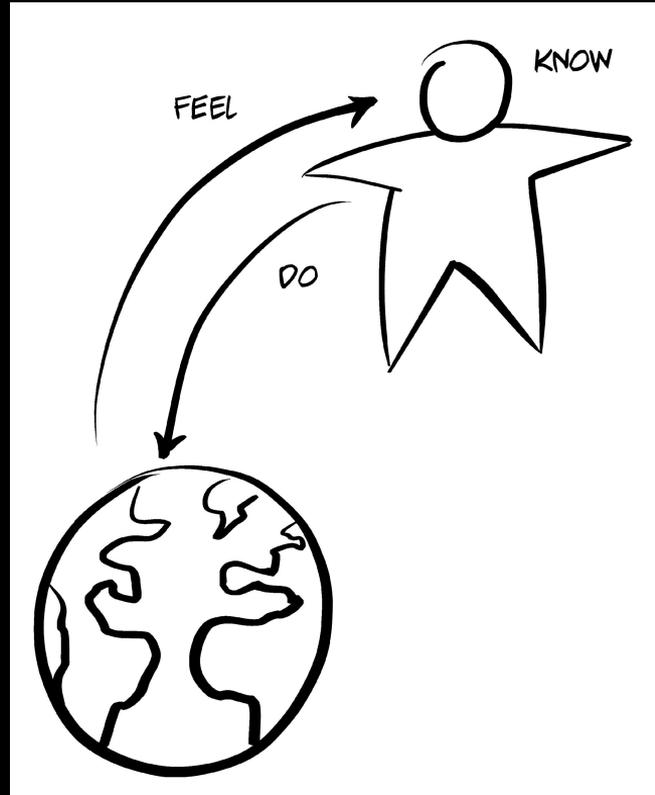
***Hypermedia Types are the
programming language
of the WWW***

```
{ "collection" :  
  {  
    "version" : "1.0"  
    "href" : "http://  
  
    "links" : [  
      {"rel" : "feed"  
      {"rel" : "queri  
      {"rel" : "templ  
    ],  
  
    "items" : [
```

Messages

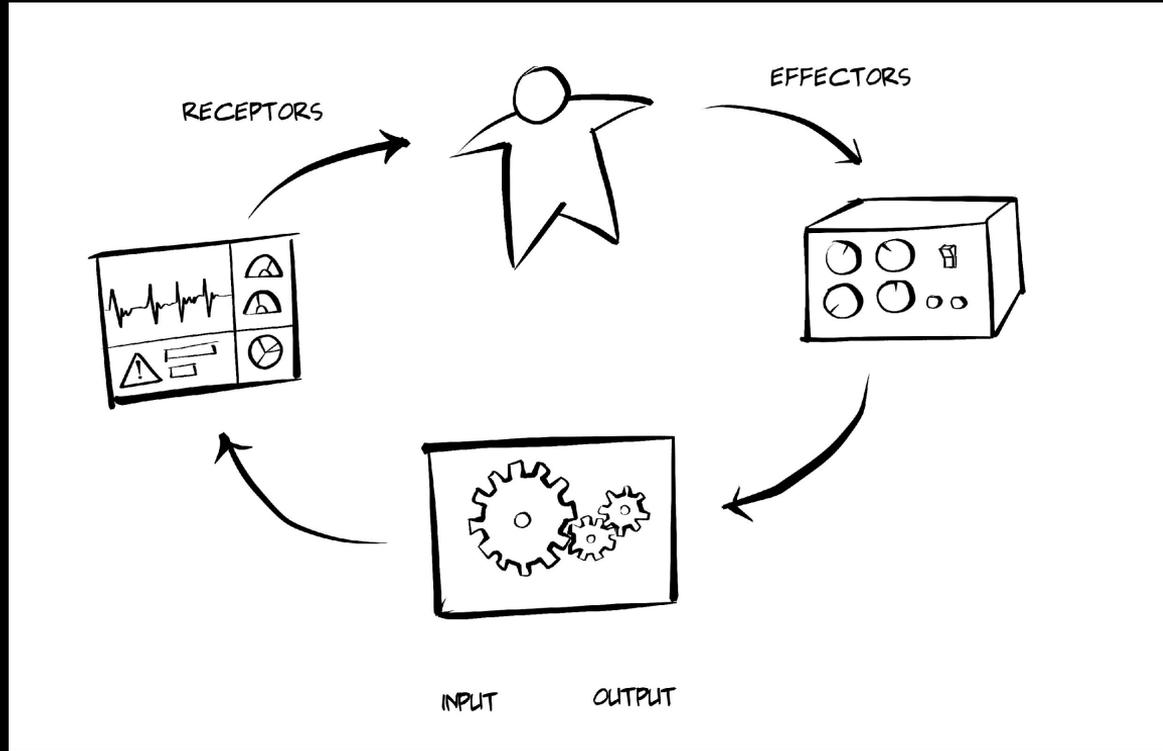


Messages are how we communicate

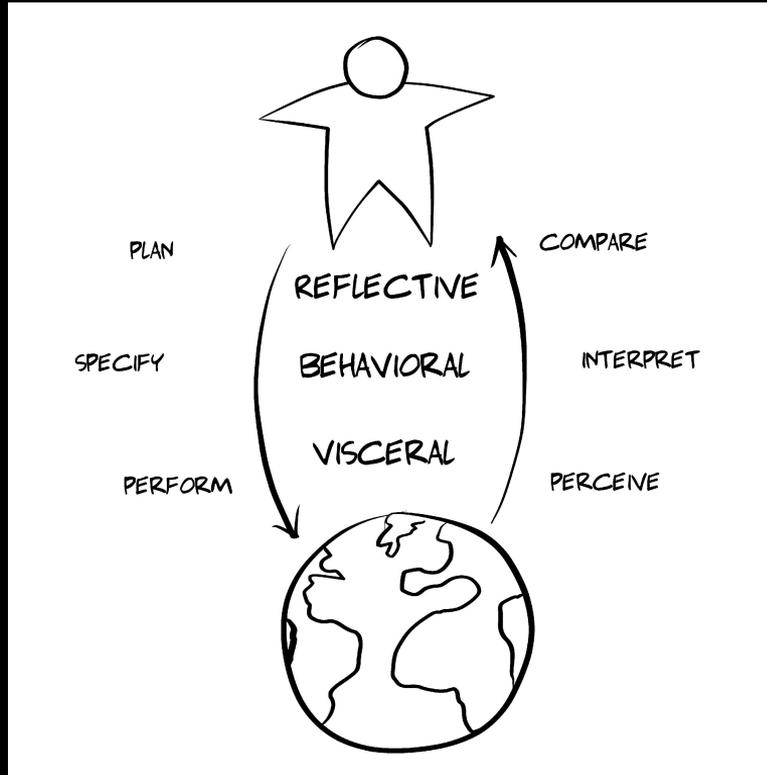


Bill Verplank

Messages are how we manipulate

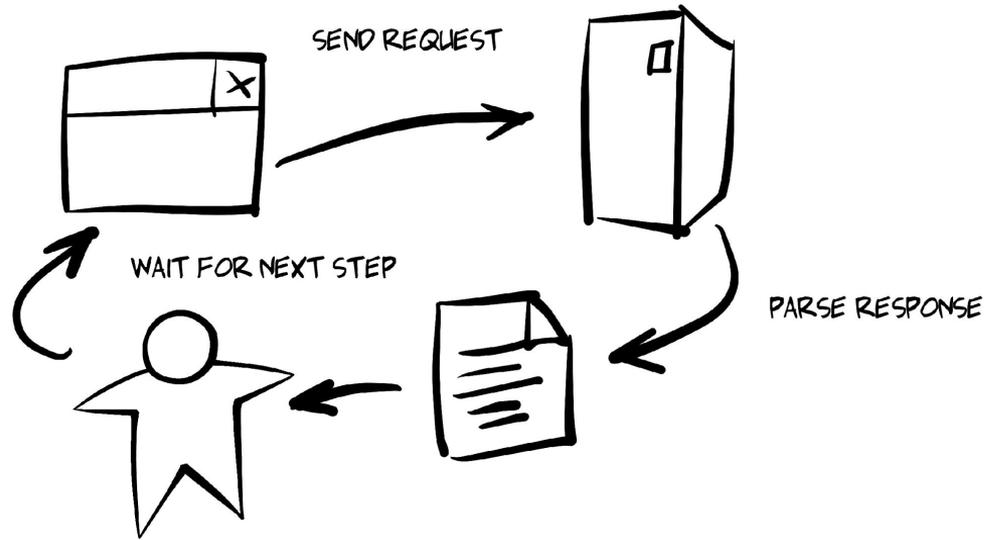


We manipulate via affordances



Donald Norman

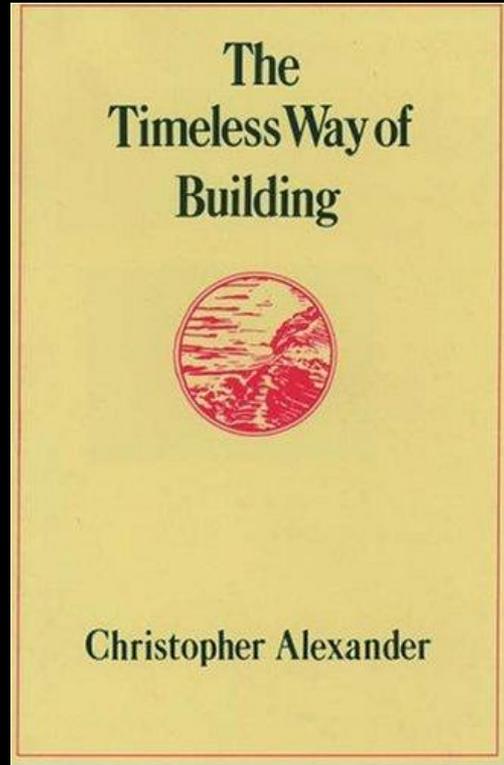
Hypermedia affords communication



A black and white photograph of a steam locomotive engine on tracks. The image is a close-up, focusing on the intricate mechanical parts of the engine, including the large flywheel, various pipes, and the complex arrangement of rods and pistons. The locomotive is positioned on a set of railway tracks, with some concrete blocks visible in the foreground. The overall scene is industrial and historical. Overlaid on the center of the image is the text "Patterns for Hypermedia" in a bold, white, italicized serif font.

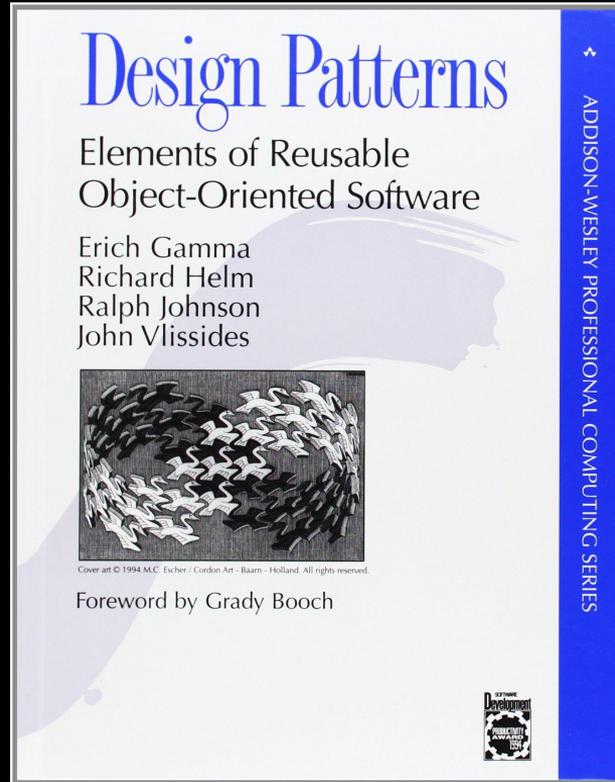
Patterns for Hypermedia

Architectural Patterns



Christopher Alexander, 1977

Patterns are typically applied to code



Gang of Four, 1994

Applying patterns to messages

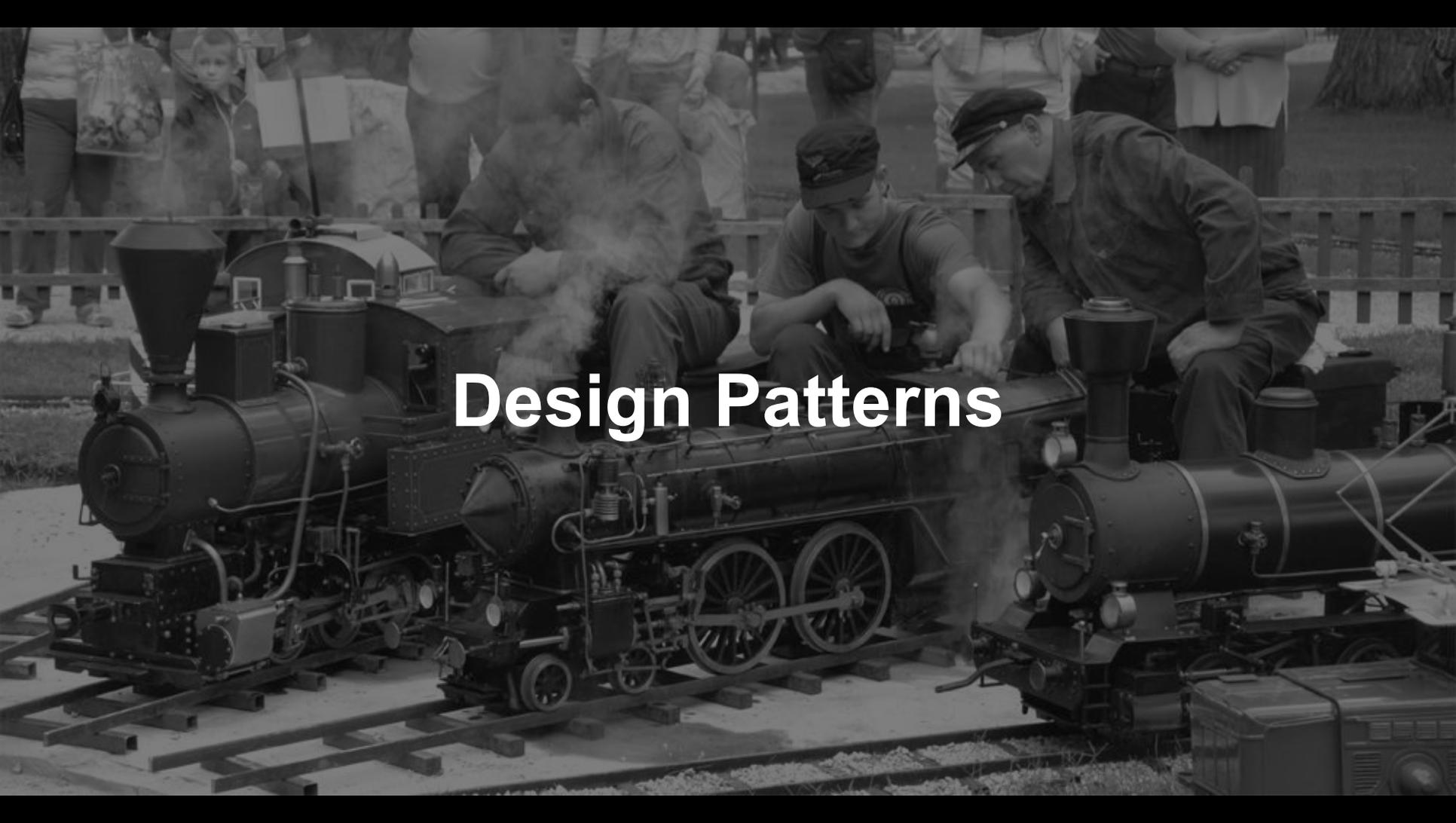


Twelve Patterns for Adaptable Apps

Four Design Patterns

Four Basic Principles

Four Shared Agreements



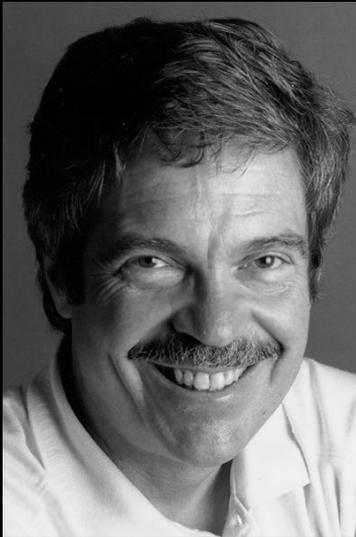
Design Patterns



pass MESSAGES, not OBJECTS.

Pass Messages, Not Objects

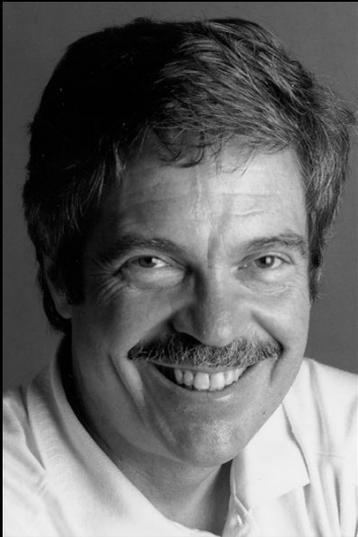
"I'm sorry that coined the term 'objects' for this topic. The big idea is 'messaging'."



Alan Kay, 1998

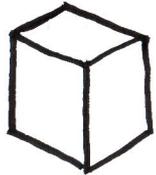
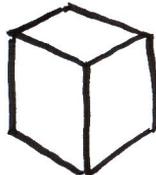
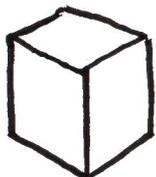
Pass Messages, Not Objects

"I'm sorry that coined the term 'objects' for this topic. The big idea is 'messaging'."

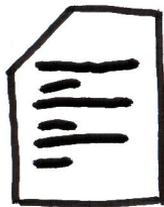


Alan Kay, 1998

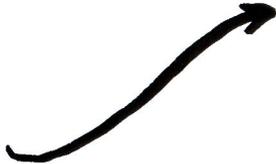
OBJECTS



MESSAGE



CLIENT



Pass Messages, Not Objects

Use a Registered Hypermedia Type

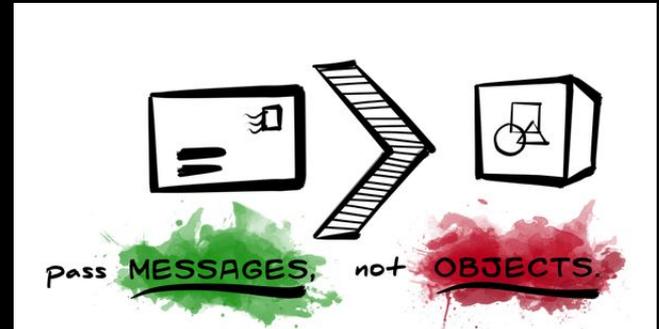
HAL

Collection+JSON

Siren

UBER

Atom

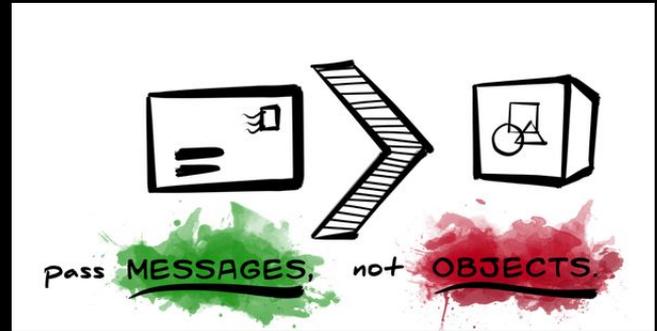


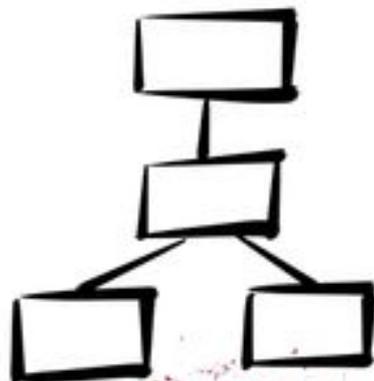
Pass Messages, not Objects

What problem does this solve?

I don't need to share your object model to interact with you.

Machines can now manage their own internal models independently.





share VOCABULARIES, not MODELS.

Share Vocabularies, Not Models

"It is easier to standardize representation and relation types than objects and object-specific interfaces."

-- Roy Fielding

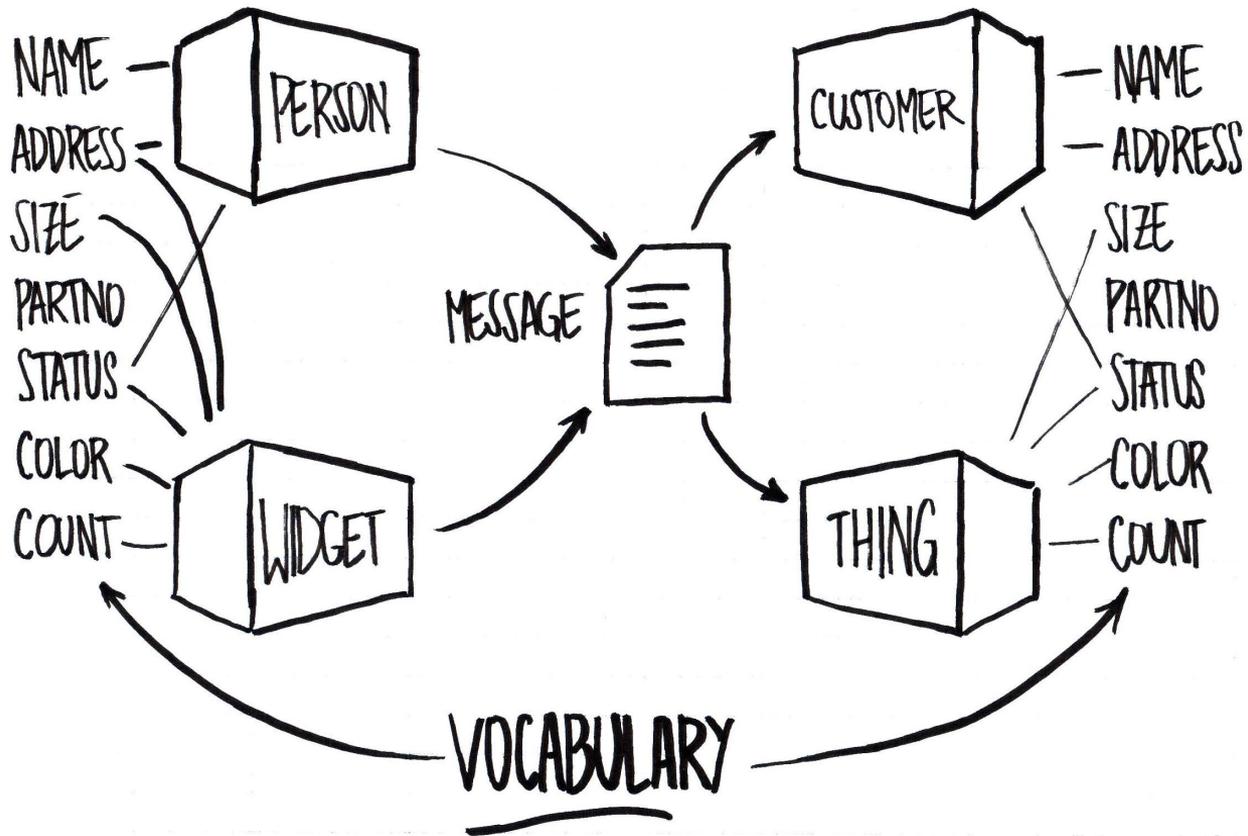


Share Vocabularies, Not Models

*"It is easier to standardize **representation** and **relation** types than objects and object-specific interfaces."*

-- Roy Fielding





SHARE VOCABULARIES

Share Vocabularies, Not Models

Use Existing Shared Vocabularies

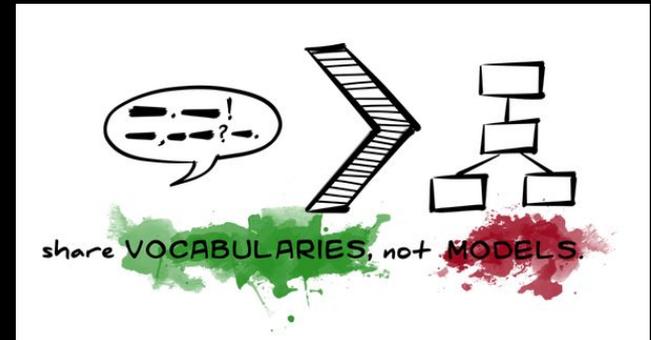
IANA Link Relation Values

Schema.org

Microformats

Dublin Core

Activity Streams

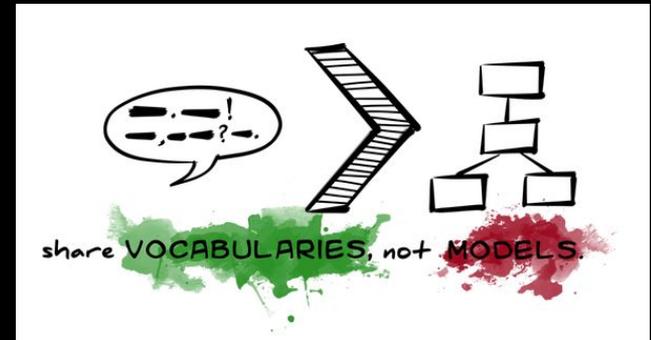


Share Vocabularies, Not Models

What problem does this solve?

Vocabulary is how we “evaluate and select”

Machines can now
evaluate and select without
direct human interaction.





on behalf of...

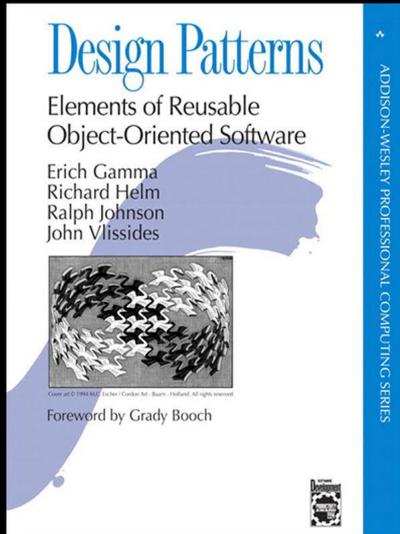
use

REPRESENTER

Use the Representor Pattern

"The Strategy Pattern lets the algorithm vary independently of the clients that use it."

- Gamma, et al.

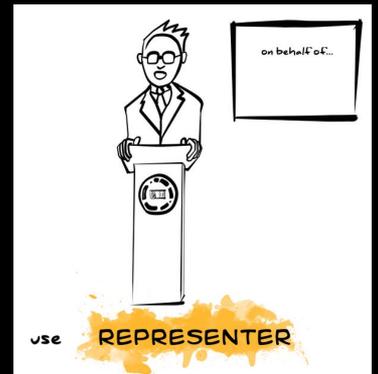


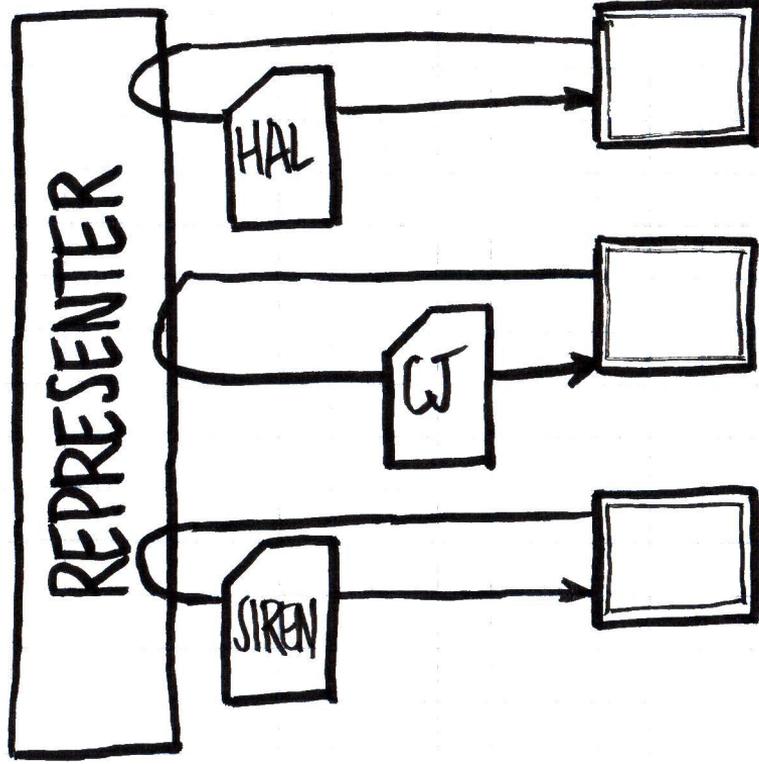
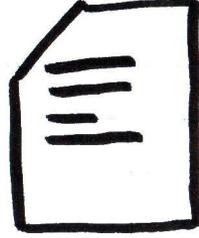
Use the Representor Pattern

Implement a Representor/Strategy Pattern

Standard Internal Resource Model

Strategy Messages Format Dispatch



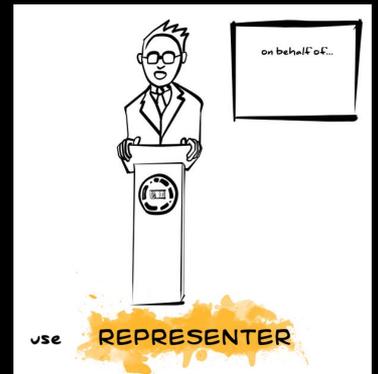


Use the Representor Pattern

Implement a Representor/Strategy Pattern

Standard Internal Resource Model

Strategy Messages Format Dispatch



Use the Re

Implement a

Standard Inte

Strategy Mes

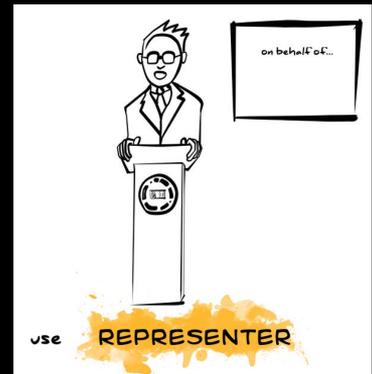
```
// dispatch to requested representor
switch(mimeType.toLowerCase()) {
  case "application/json":
    doc = json(object, root);
    break;
  case "application/vnd.collection+json":
    doc = cj(object, root);
    break;
  case "application/hal+json":
    doc = haljson(object, root);
    break;
  case "application/vnd.uber+xml":
    doc = uberxml(object, root);
    break;
  case "text/html":
  case "application/html":
  default:
    doc = html(object, root);
    break;
}

return doc;
```

n

Pattern

ch

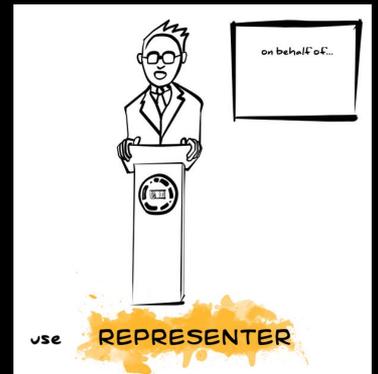


Use the Representor Pattern

What problem does this solve?

Sometimes we need to translate our conversations in order to communicate.

Machines can now “negotiate” the language of a conversation.





publish **PROFILES**

Publish Profiles

"Profiles provide a way to create a ubiquitous language for talking about APIs (resources) for both humans and machines."

-- Mark Foster



Publish Profiles

Use a Profile like ALPS to share vocabularies

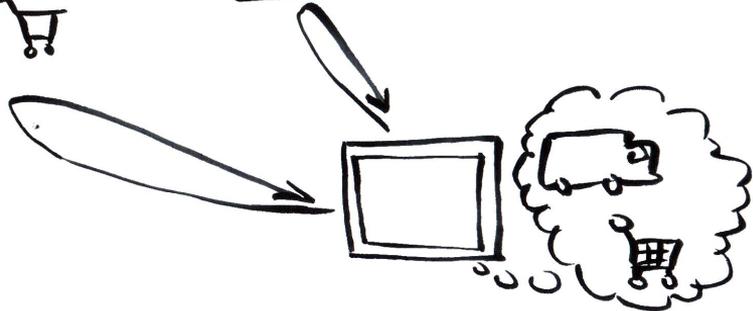
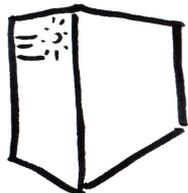
Define all possible data and actions

Publish using Profile Standard (RFC6906)

Servers emit profile URI

Clients validate profile URI





Publish Profiles

Use a Profile like ALPS to share vocabularies

Define all possible data and actions

Publish using Profile Standard (RFC6906)

Servers emit profile URI

Clients validate profile URI



Publish

Use a Pr

Define a

Publish u

Servers

Clients v

products-alps.xml

```
1 <alps version="1.0">
2   <link rel="help" href="http://example.org/documentation/products.html" />
3   <doc>
4     This is a prototype product API.
5   </doc>
6
7   <!-- transitions -->
8   <descriptor id="item" type="safe" rt="#product">
9     <doc>Retrieve A Single Product</doc>
10  </descriptor>
11
12  <descriptor id="collection" type="safe" rt="#product">
13    <doc>Provides access to all products</doc>
14  </descriptor>
15
16  <descriptor id="search" type="safe" rt="#product">
17    <doc>Provides access to all products</doc>
18    <descriptor href="#id" />
19  </descriptor>
20
21  <descriptor id="edit" type="idempotent" rt="#product">
22    <doc>Updates A Product</doc>
23    <descriptor href="#product" />
24  </descriptor>
25
26  <descriptor id="create" type="unsafe" rt="#product">
27    <doc>Allows the creation of a new product</doc>
28    <descriptor href="#product" />
29  </descriptor>
```

ularies

06)



ublish **PROFILES**

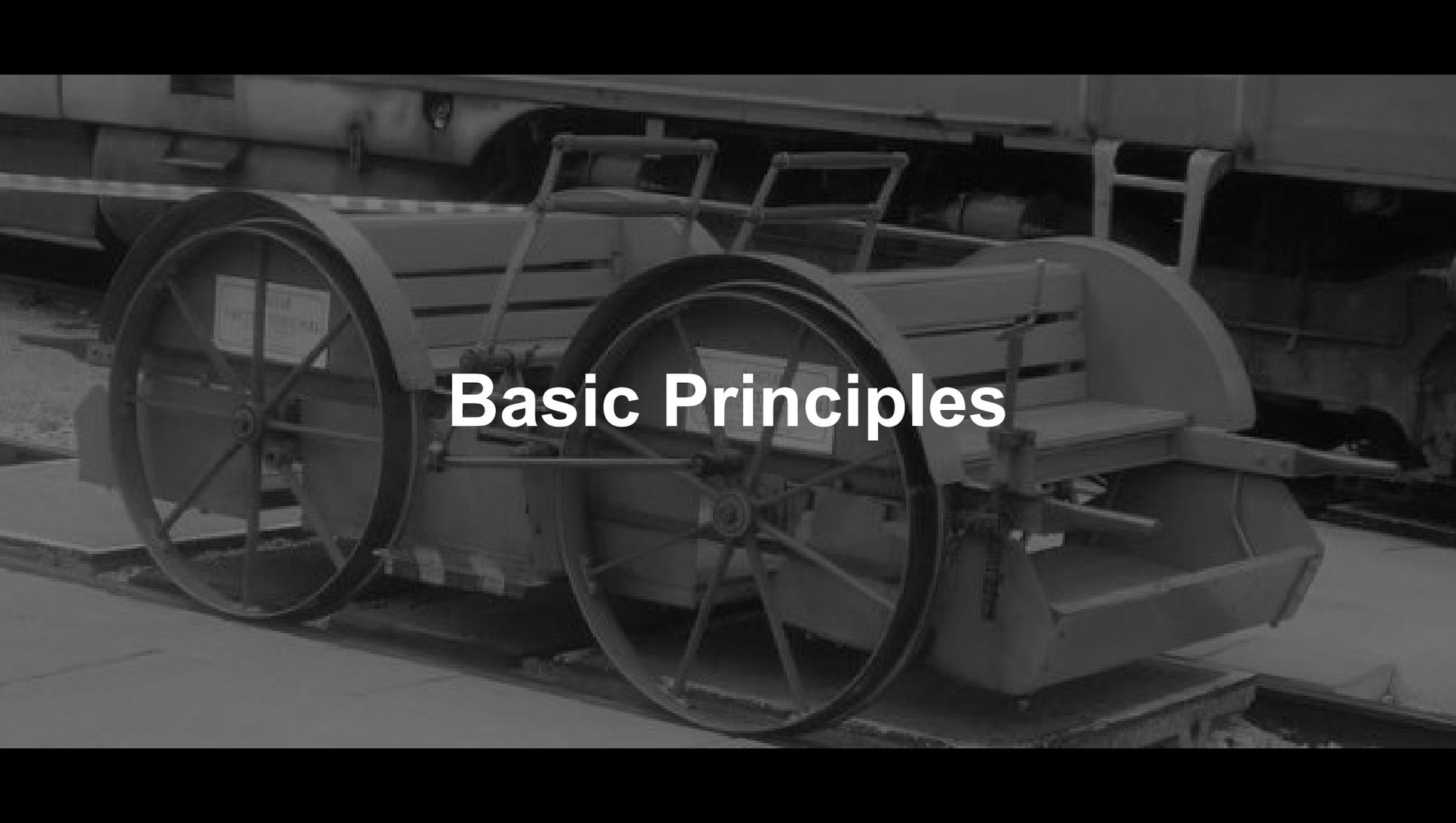
Publish Profiles

What problem does this solve?

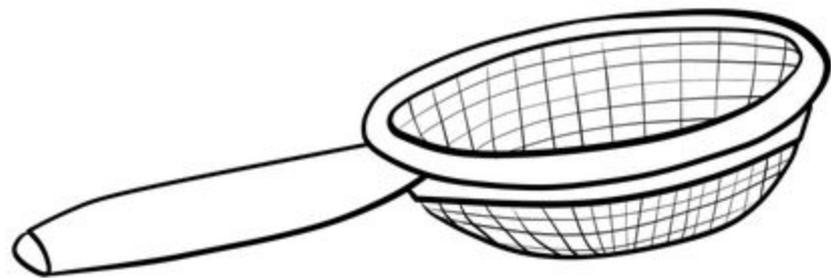
I need to know what we're talking about.

Machines can now
validate domain topics easily



A black and white photograph of a vintage passenger rail car, possibly a trolley or streetcar, with large spoked wheels and a curved roof. The car is positioned on tracks. The text "Basic Principles" is overlaid in the center of the image in a bold, white, sans-serif font.

Basic Principles



must IGNORE

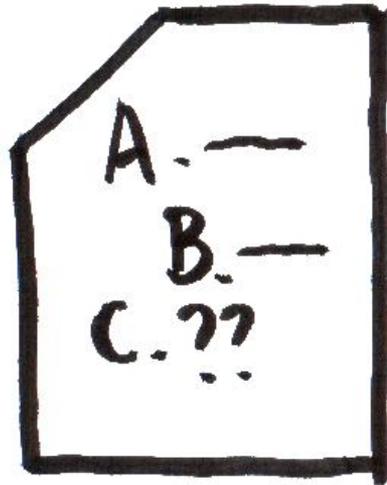
Must Ignore

“The main goal of the MUST IGNORE pattern of extensibility is to allow backwards- and forwards-compatible changes.”

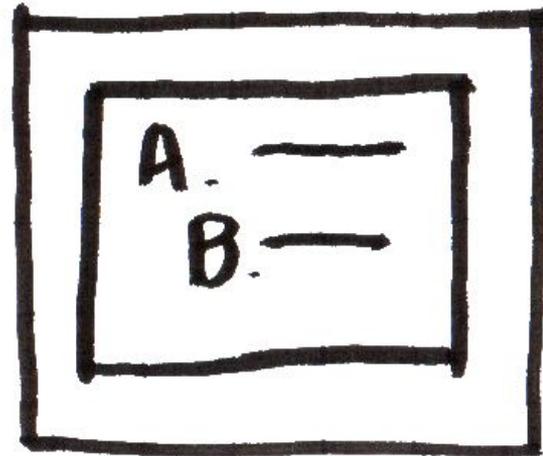
- David Orchard



MESSAGE



CLIENT



Must Ignore

Clients **MUST IGNORE** any data/inputs that the client does not understand.

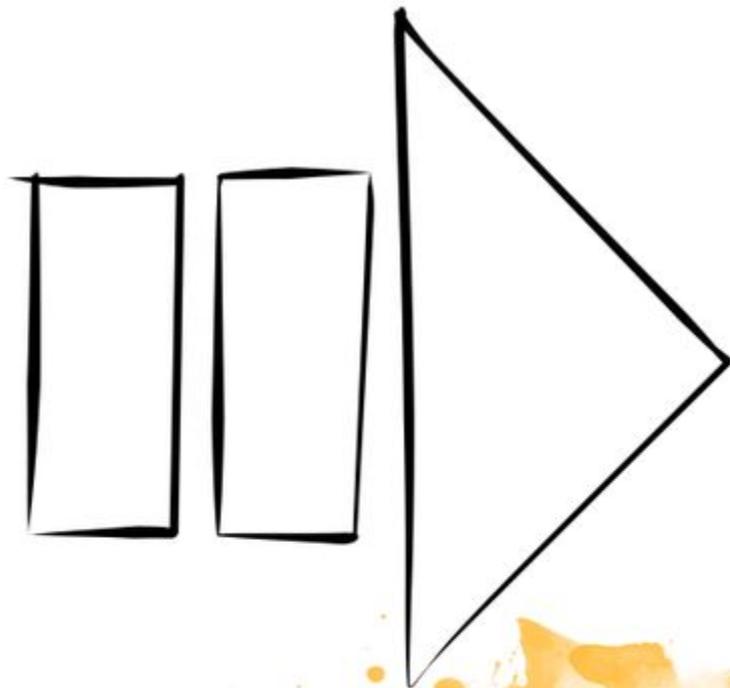
Must Ignore

What problem does this solve?

Ignoring what we don't understand lets us “do our own thing” w/o knowing everyone's job

Machines can now focus on their own job, not everyone's job.





must

FORWARD

MUST FORWARD

“A proxy MUST forward unrecognized header fields...”
-- RFC 7230

[\[Docs\]](#) [\[txt\]](#) [\[pdf\]](#) [\[draft-ietf-httpbi...](#)] [\[Diff1\]](#) [\[Diff2\]](#) [\[Errata\]](#)

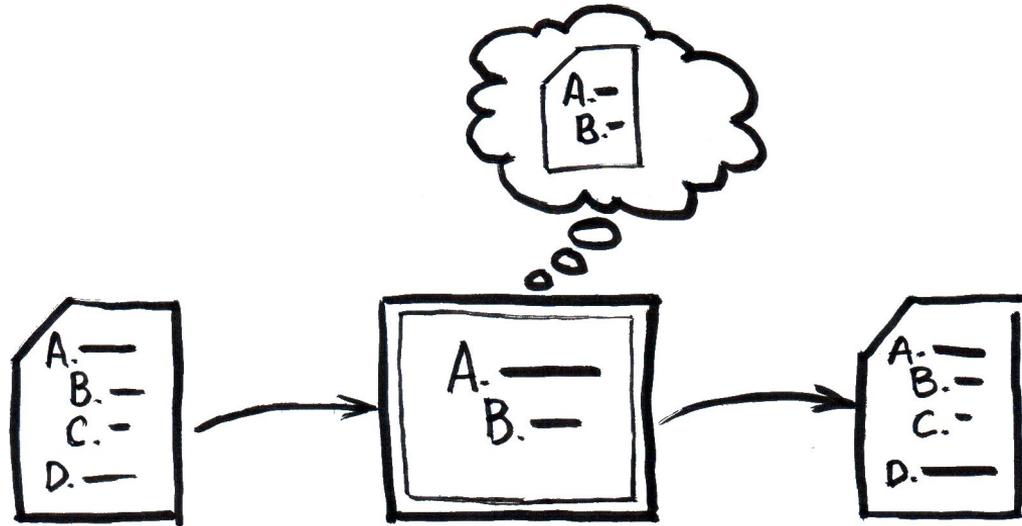
	PROPOSED STANDARD
	Errata Exist
Internet Engineering Task Force (IETF)	R. Fielding, Ed.
Request for Comments: 7230	Adobe
Obsoletes: 2145 , 2616	J. Reschke, Ed.
Updates: 2817 , 2818	greenbytes
Category: Standards Track	June 2014
ISSN: 2070-1721	

Hypertext Transfer Protocol (HTTP/1.1): Message Syntax and Routing

Abstract

The Hypertext Transfer Protocol (HTTP) is a stateless application-level protocol for distributed, collaborative, hypertext information systems. This document provides an overview of HTTP architecture and its associated terminology, defines the "http" and "https" Uniform Resource Identifier (URI) schemes, defines the HTTP/1.1 message syntax and parsing requirements, and describes related security concerns for implementations.

Status of This Memo



MUST FORWARD

Must Forward

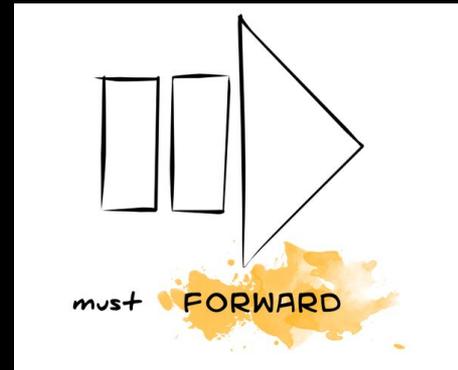
Clients **MUST FORWARD** (unchanged) any input fields (URL or FORM) that the client does not recognize.

Must Forward

What problem does this solve?

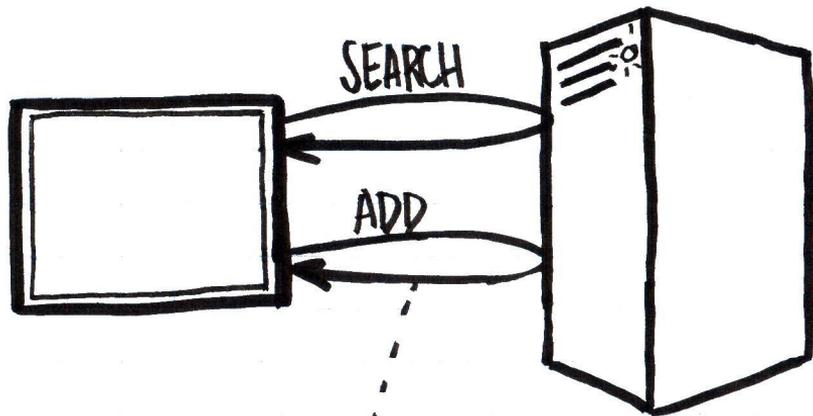
We don't edit for others around us.

Machines can now co-operate w/o
full understanding of other's work





provide MRU



RESULTS
+ ADD -
+ SEARCH -

USE
MRU

Provide MRU

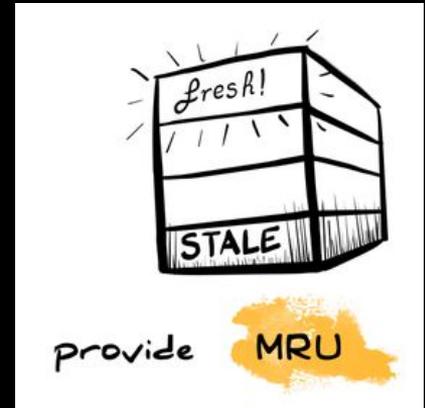
Services SHOULD return the most recently-used (MRU) LINKS and FORMS in all responses.

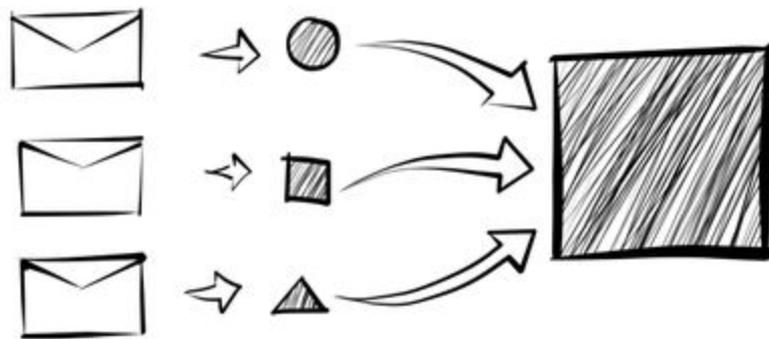
Provide MRU

What problem does this solve?

We need most-used tools close at hand

Machines can now find most-used affordances easily





use

IDEMPOTENCY

Use Idempotence

“Can be applied multiple times without changing the result beyond the initial application.”
-- Wikipedia

4.2.2. Idempotent Methods

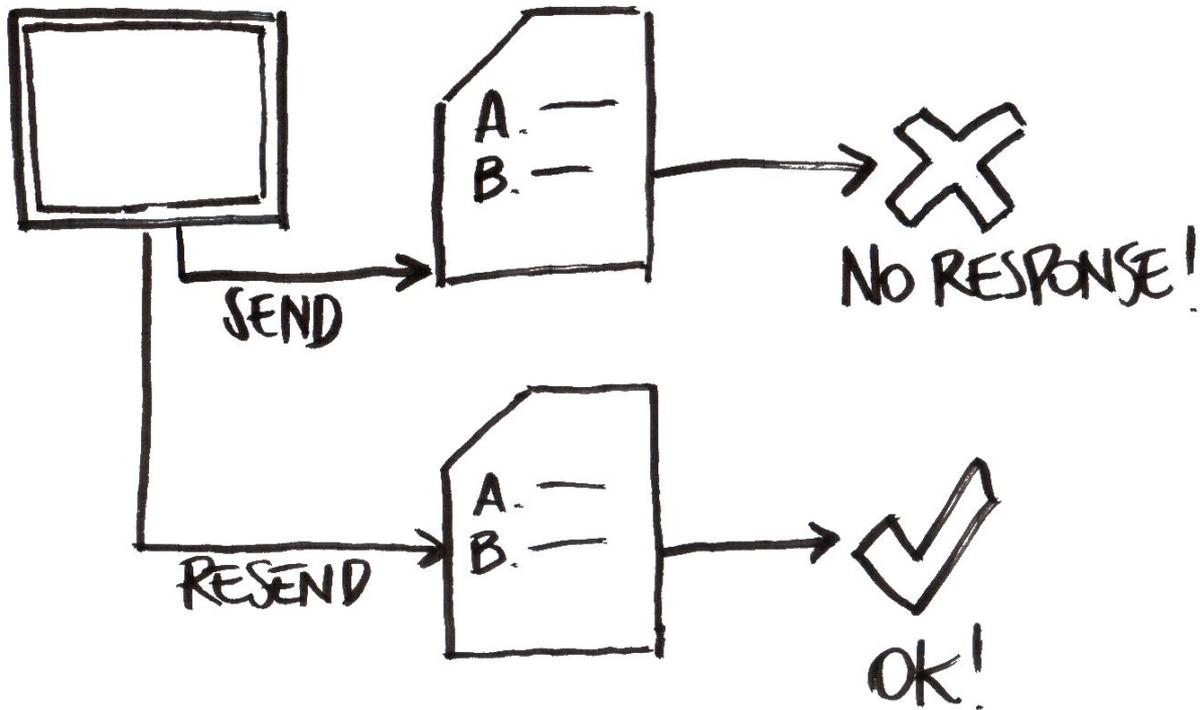
A request method is considered "idempotent" if the intended effect on the server of multiple identical requests with that method is the same as the effect for a single such request. Of the request methods defined by this specification, PUT, DELETE, and safe request methods are idempotent.

Fielding & Reschke Standards Track [Page 23]

[RFC 7231](#) HTTP/1.1 Semantics and Content June 2014

Like the definition of safe, the idempotent property only applies to what has been requested by the user; a server is free to log each request separately, retain a revision control history, or implement other non-idempotent side effects for each idempotent request.

Idempotent methods are distinguished because the request can be repeated automatically if a communication failure occurs before the



Use Idempotence

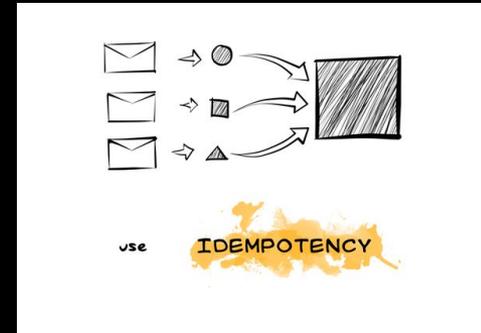
All network requests SHOULD be idempotent in order to allow clients to safely repeat them when response is unclear.

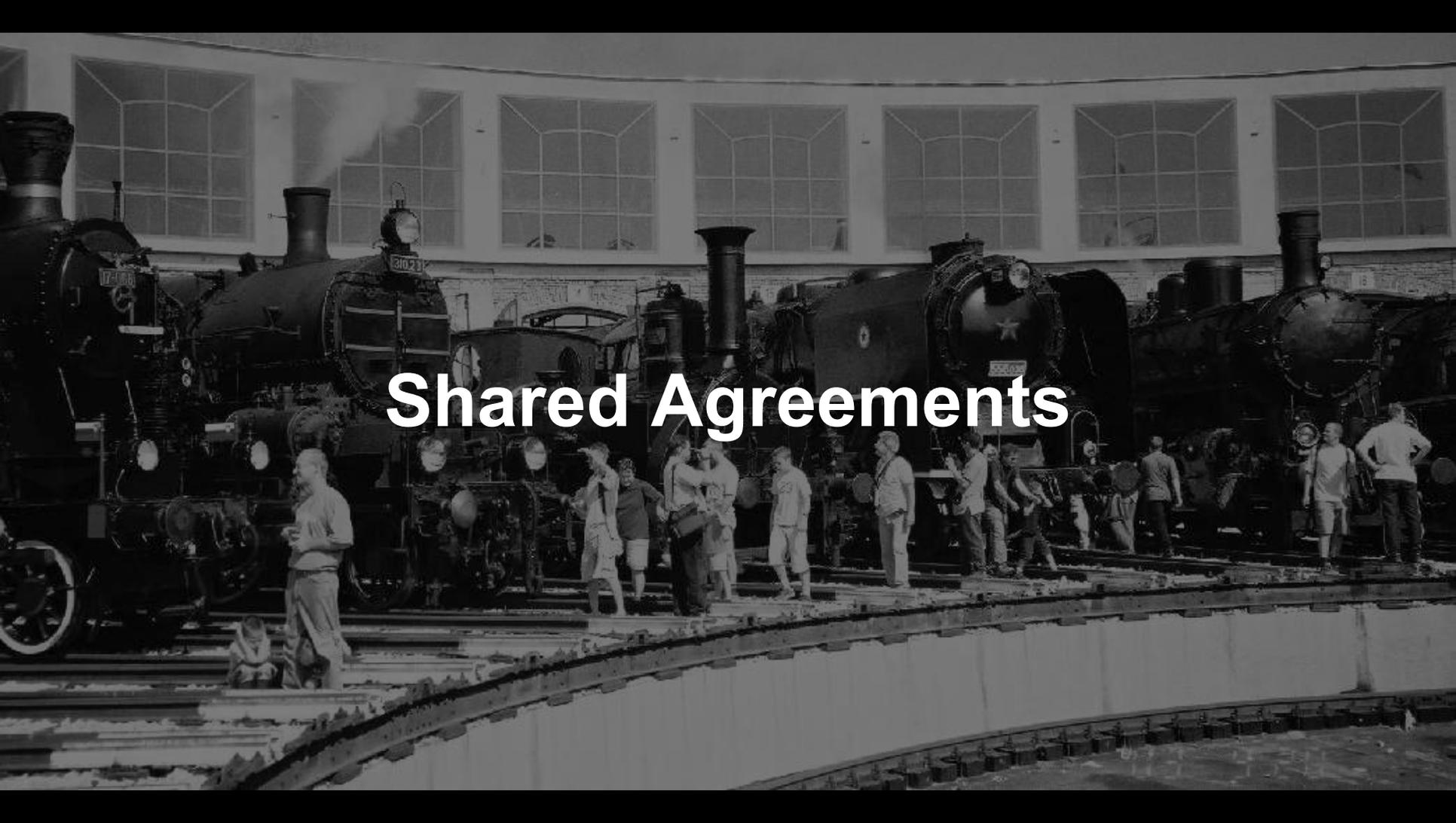
Use Idempotence

What problem does this solve?

If things didn't work right the first time, we need to try again.

Machines can now safely “try again”





Shared Agreements



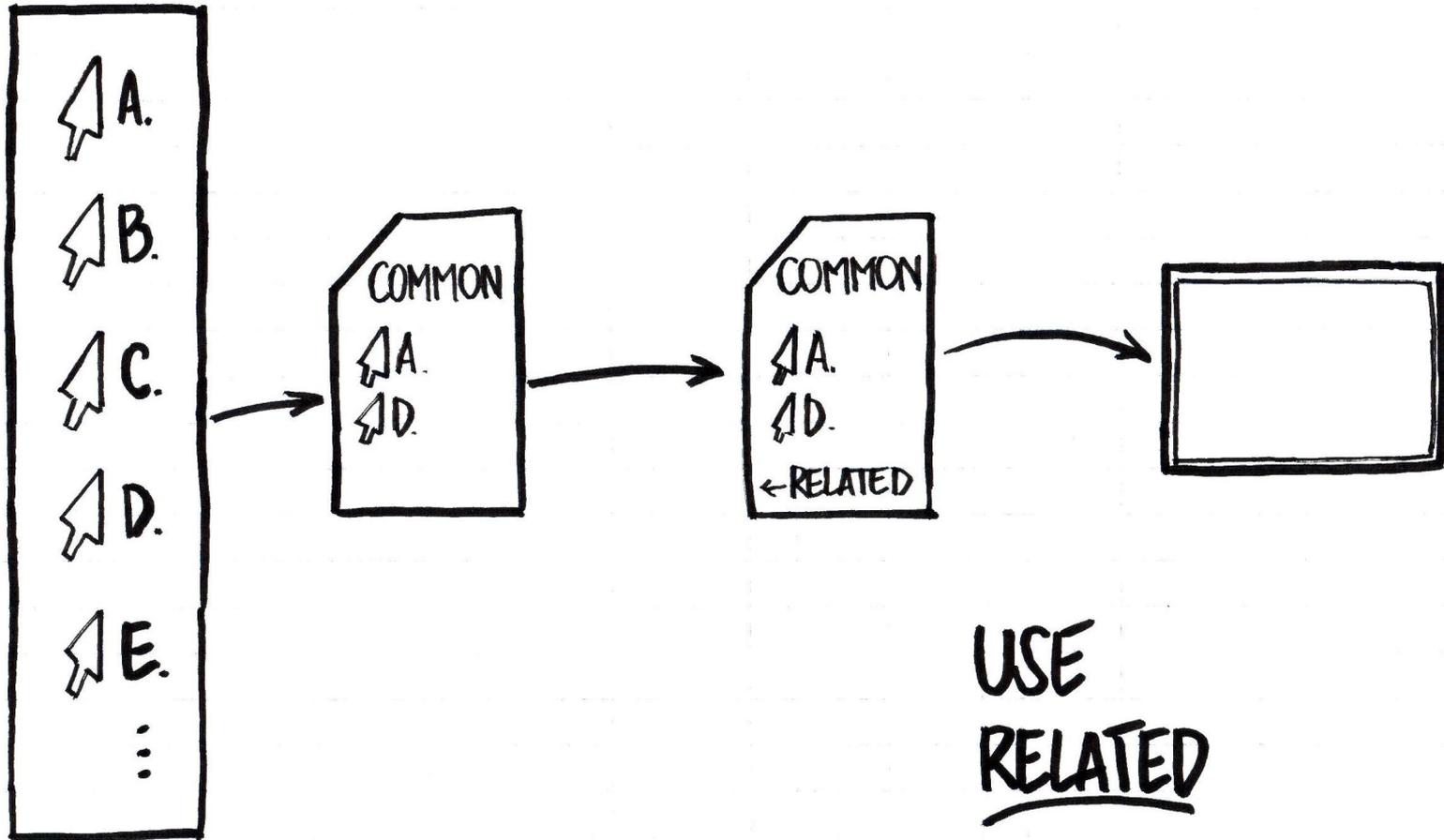
use

RELATED

Use Related

“By watching what you click on in search results, Google can learn that you favor particular sites.” – Danny Sullivan, 2009





Use Related

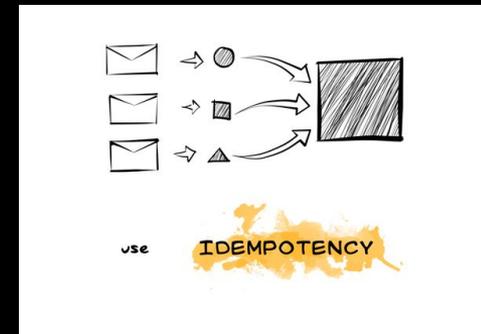
Services SHOULD return a RELATED LINK that responds with ALL the possible actions for this context.

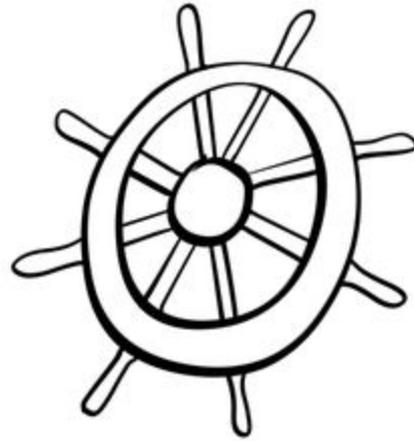
Use Related

What problem does this solve?

I can't remember everything, need an easy way to look up instructions.

Machines can now “look up”
the available affordances.





next



previous



done



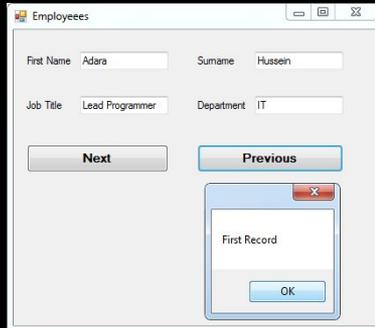
cancel

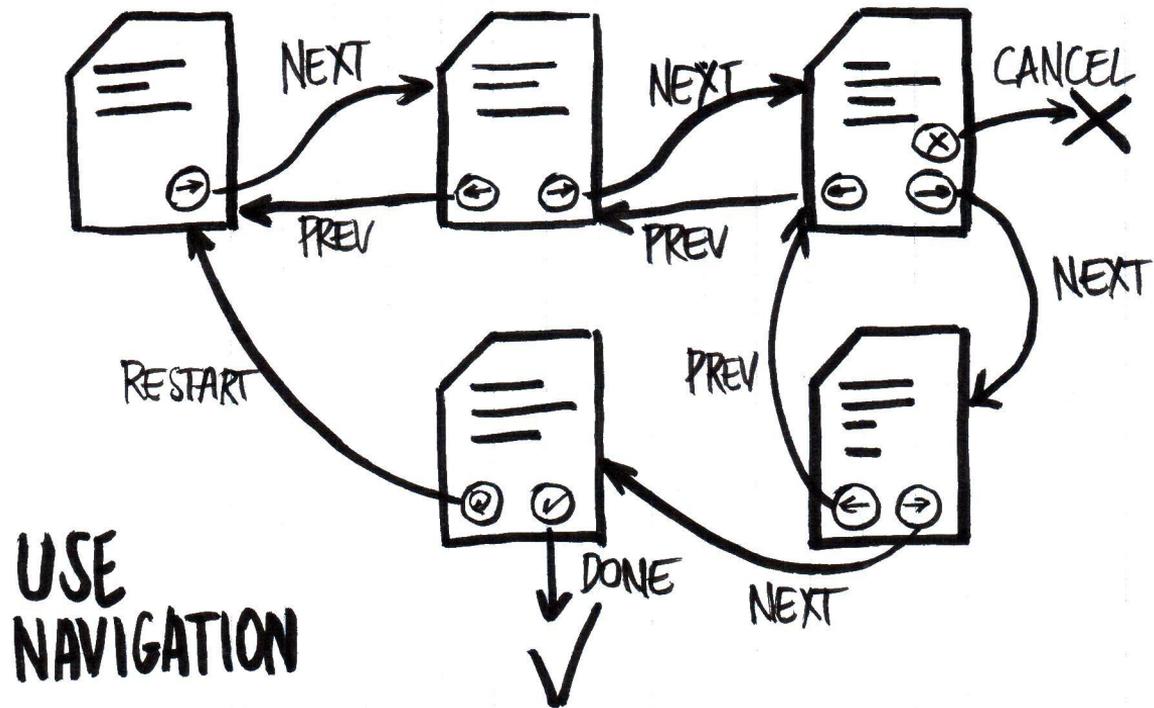
use

NAVIGATION

Use Navigation

*“To achieve a single goal which can be broken down into dependable sub-tasks.”
-- Design Patterns (@uipatterns)*





Use Navigation

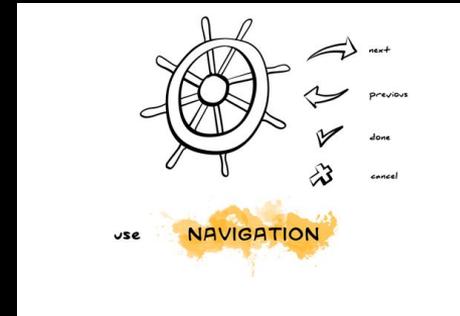
Services SHOULD provide "next/previous" LINK to handle multi-step workflow with "cancel", "restart", & "done."

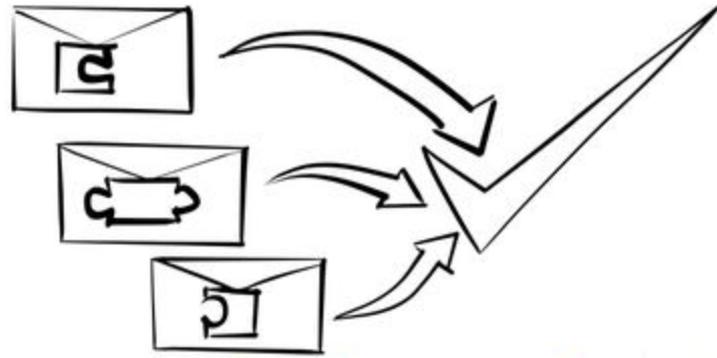
Use Navigation

What problem does this solve?

I can't keep all the steps in my head

Machines can now navigate through a long series of steps safely.





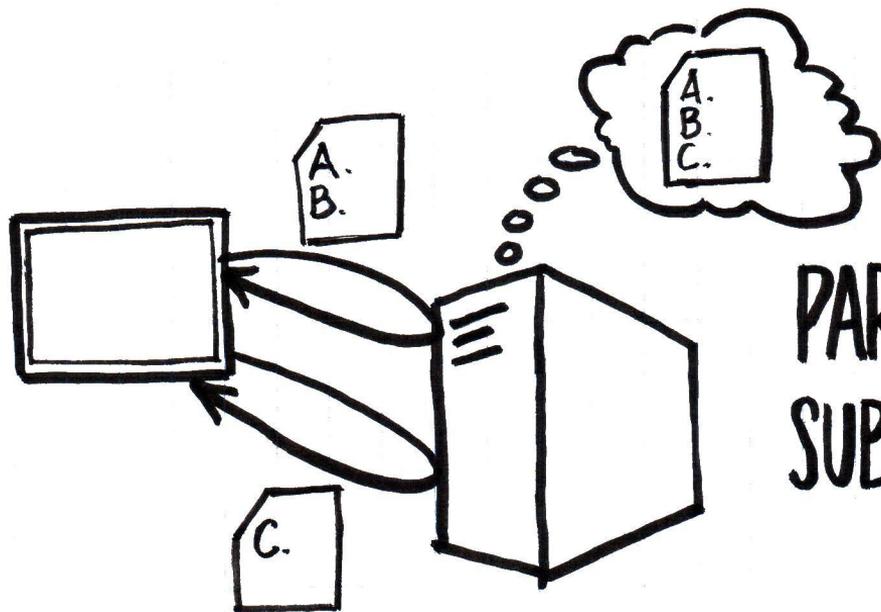
PARTIAL SUBMIT

Partial Submit

*“Think of the actions as approximations of what
is desired.”*

-- Donald Norman





PARTIAL
SUBMIT

Partial Submit

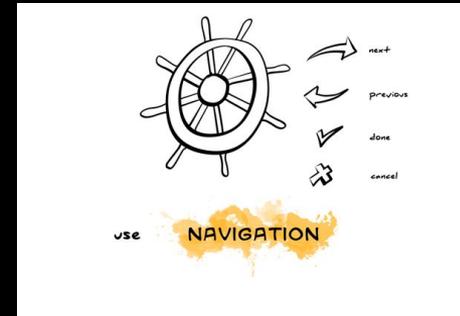
Services SHOULD accept partially filled-in FORM and return a new FORM with the remaining fields.

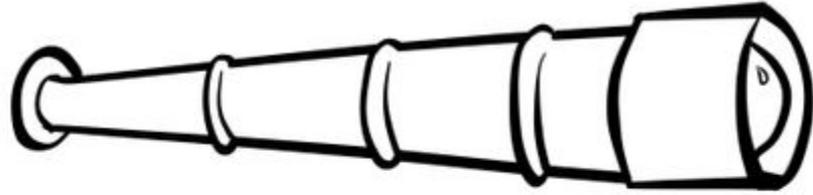
Use Navigation

What problem does this solve?

I sometimes only know part of the story.

Machines can now interact in small parts and not always be perfect.





STATE WATCH

State Watch

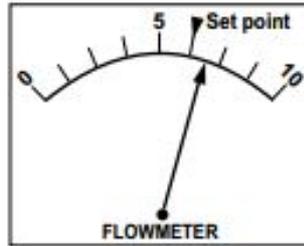
“Data representing variables in a dynamical system...”

-- Jens Rasmussen



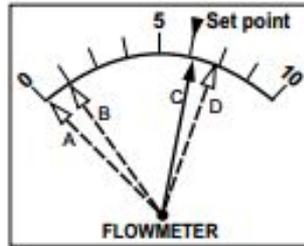
State Watch

“Data rep



SIGNAL

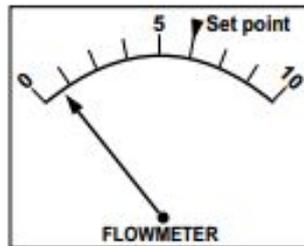
- Keep at set point
- Use deviation as error signal
- Track continuously



SIGN

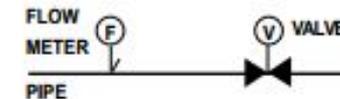
Stereotype acts

If	If C, ok
Valve	If D, adjust flow
Open	
If	If A, ok
Valve	If B, recalibrate
Closed	meter

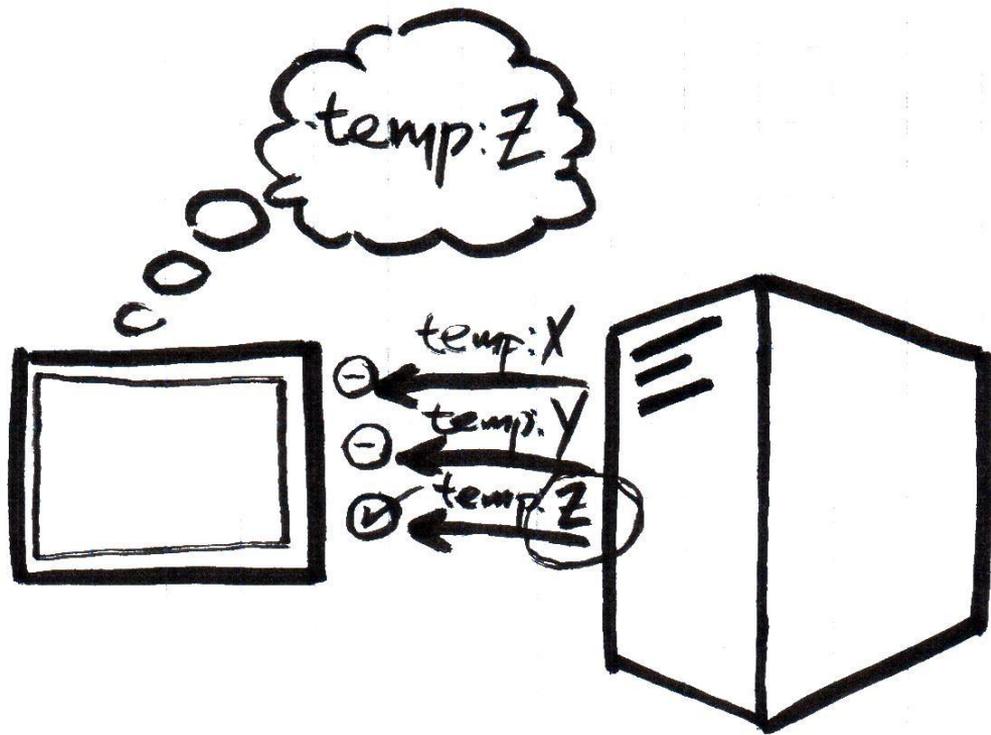


SYMBOL

If, after calibration, is still B, begin to read meter and speculate functionally (could be a leak)



a dynamical
system...”
passmussen



STATE
WATCH

State Watch

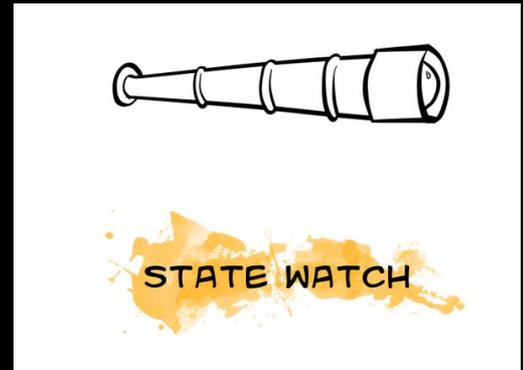
Services SHOULD allow clients to subscribe to WATCH VALUES so that clients can determine "done."

Use State Watch

What problem does this solve?

My boss doesn't always set my goals.

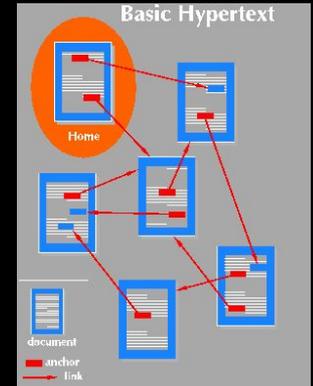
Machines can now set their own goals and act accordingly.



A black and white photograph of a circular railway yard. Numerous small steam locomotives are lined up on tracks that curve around a central area. In the background, there are houses and trees. The word "Summary" is overlaid in white, italicized text in the center of the image.

Summary

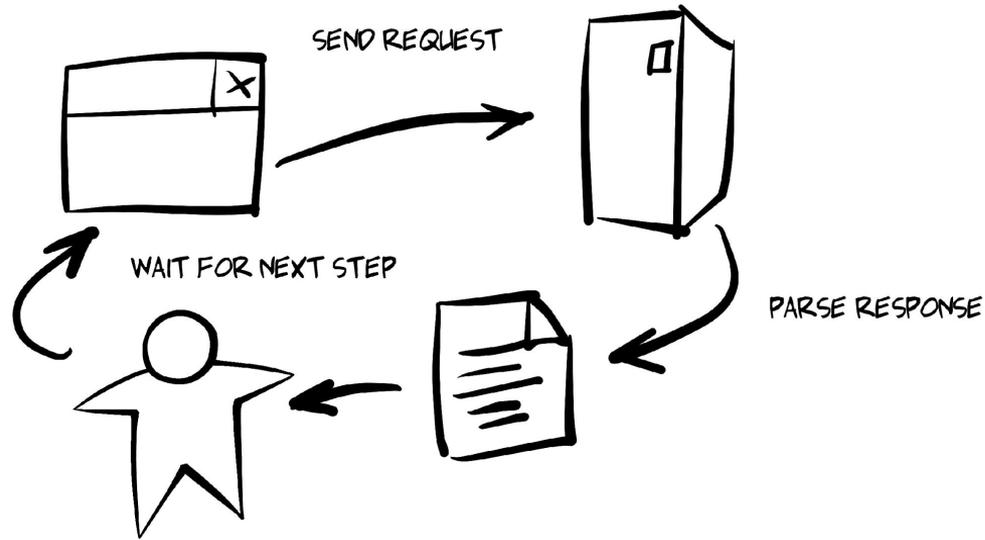
Hypermedia is the language of the WWW



***Hypermedia Types are the
programming language
of the WWW***

```
{ "collection" :  
  {  
    "version" : "1.0"  
    "href" : "http://"  
  
    "links" : [  
      {"rel" : "feed"  
      {"rel" : "queri  
      {"rel" : "templ  
    ],  
  
    "items" : [
```

Hypermedia affords communication



Apply patterns to messages

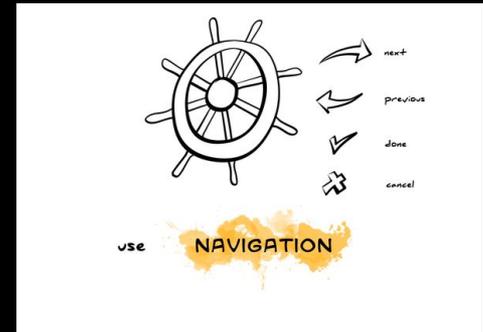
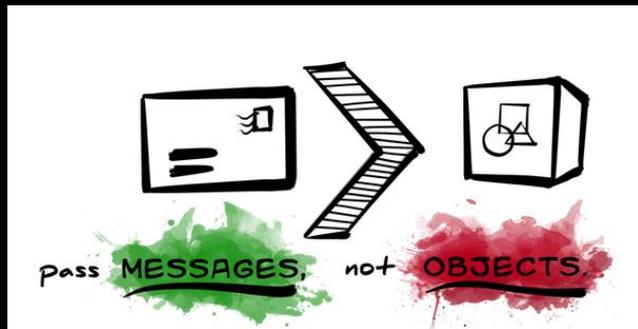


Twelve Patterns for Adaptable APIs

Four Design Patterns

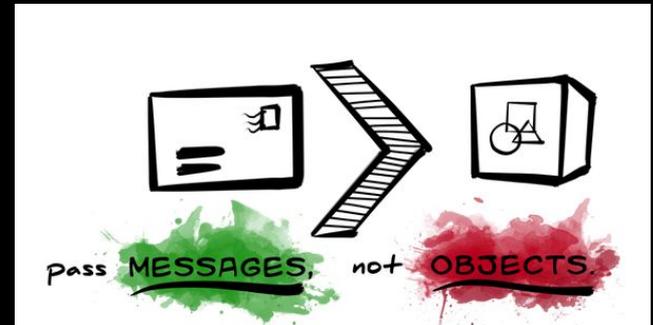
Four Basic Principles

Four Shared Agreements



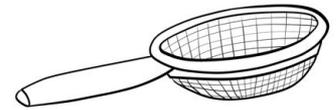
Design Patterns

1. PASS MESSAGES, NOT OBJECTS
2. SHARE VOCABULARIES, NOT MODELS
3. THE REPRESENTOR PATTERN
4. PUBLISH PROFILES



Basic Principles

5. MUST IGNORE
6. MUST FORWARD
7. PROVIDE MRU
8. USE IDEMPOTENCE



must IGNORE

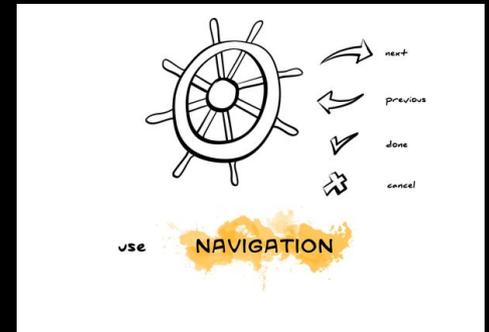
Basic Agreements

9. USE RELATED

10. USE NAVIGATION

11. PARTIAL SUBMIT

12. STATE WATCH



The Best Software Architecture

"The best software architecture 'knows' what changes often and makes that easy."

- Paul Clements



Twelve Patterns for Hypermedia Microservices

Mike Amundsen
API Academy / CA
@mamund

Drawings by Diogo Lucas
@diogoclucas