



Software Engineering In the Cloud

Mary Poppendieck
mary@poppendieck.com
www.poppendieck.com

Scale Out >> Scale Up



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Business Software:

1996

- Monolithic & Slow to change
- ERP Database ↔ Integration
 - On a Single Server

Why One Server?

CAP Theorem:

- Partitioned databases must choose between:
 - Availability
 - Consistency

How do you store 1.3 billion web pages on one server?

The Google logo is displayed in its classic multi-colored font: 'G' is blue, 'o' is red, 'o' is yellow, 'g' is blue, 'l' is green, 'e' is red, and '!' is blue. The letters have a slight 3D effect with shadows.

[c. 2001]

Search 1,326,920,000 web pages

Google Search

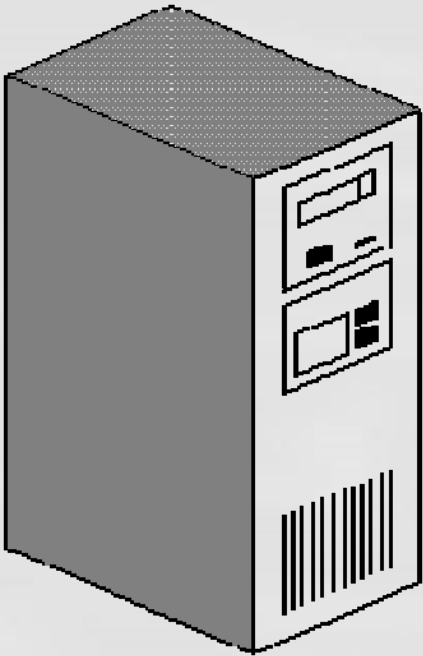


Software is Eating the World

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Option 1: Scale UP

Get a bigger computer.



If one ox could not do the job they did not try to grow a bigger ox, but used two oxen. When we need greater computer power, the answer is not to get a bigger computer, but...to build systems of computers and operate them in parallel.

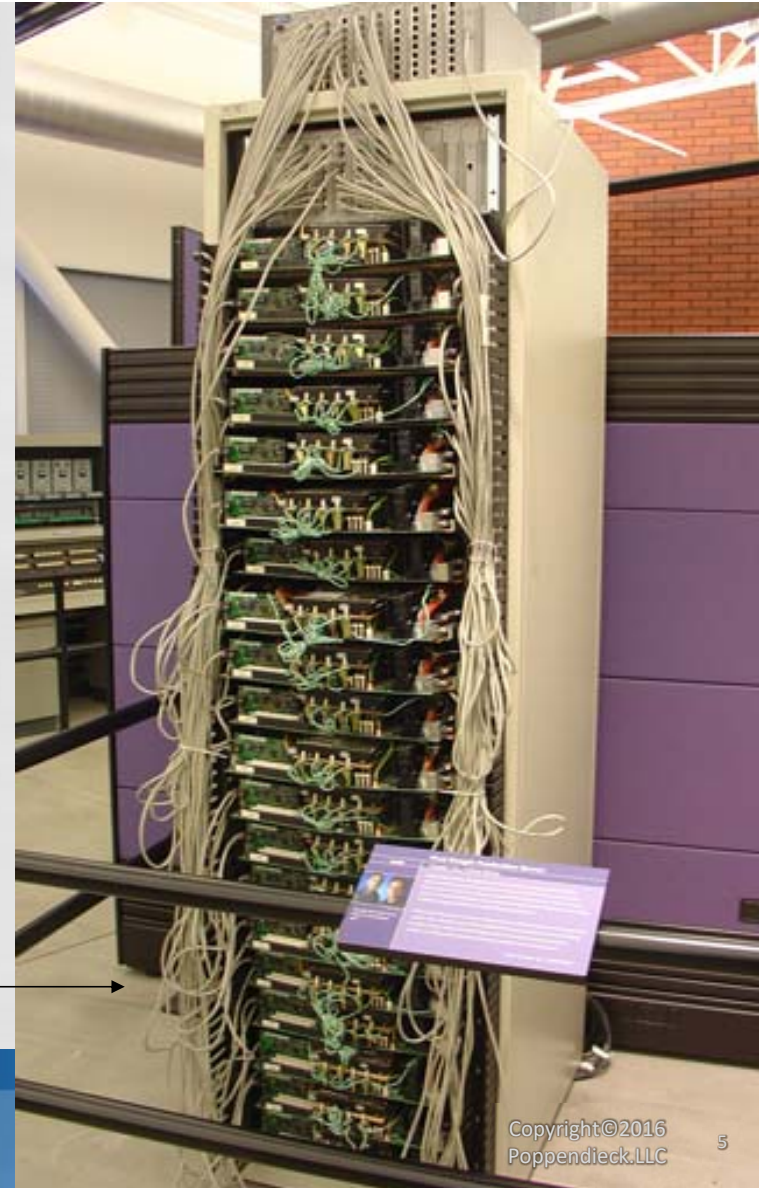
(Grace Hopper)

izquotes.com

Option 2: Scale Out

Get more computers.

Google Hardware c. 1999



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Scale Out: Files

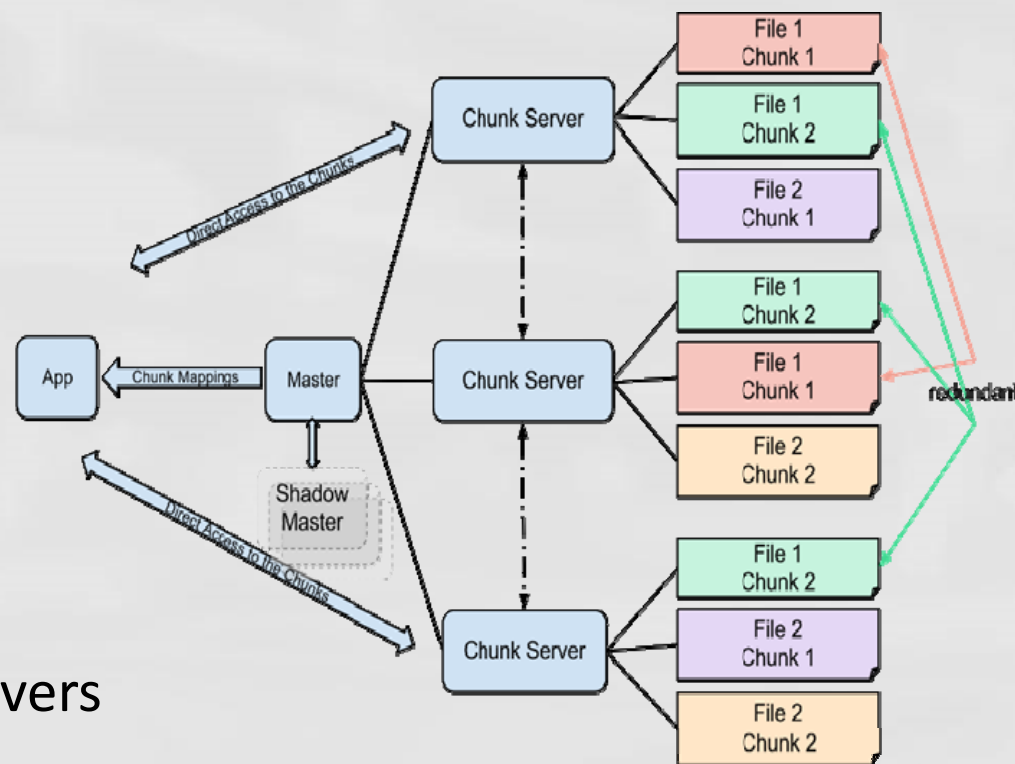
Google's Problem:

- Search the entire Internet
- Instantly

Response:

Horizontal Scaling

- Break files into small pieces
 - Make three copies of each piece
 - Spread the pieces across many servers
- Manage the pieces with software



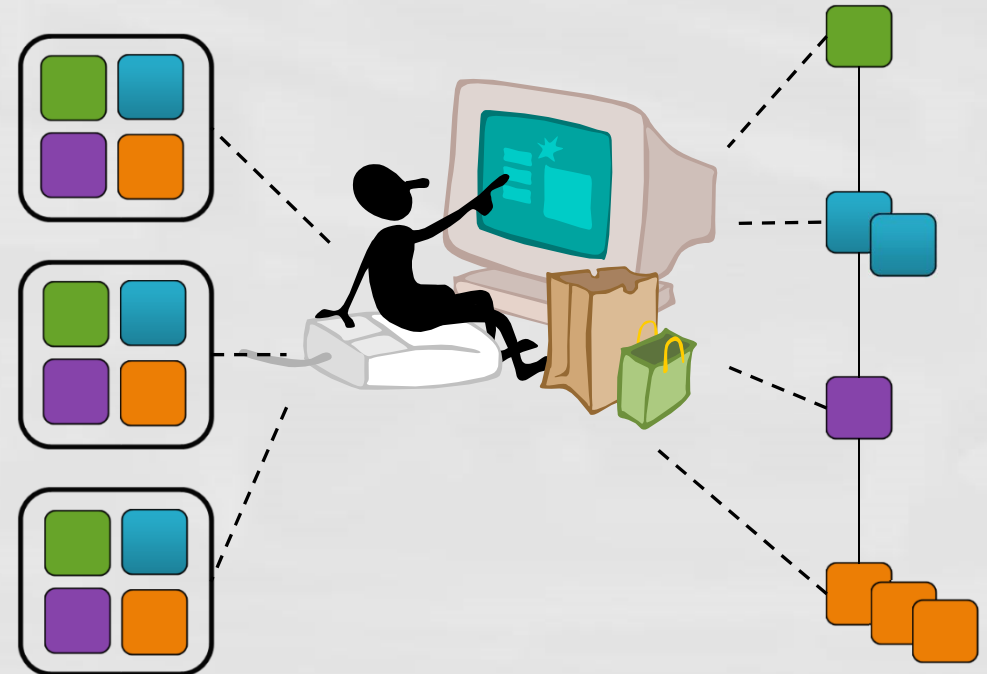
Scale Out: Architecture

Amazon ~ 2001

- Handle a gazillion transactions
- All at once

What Amazon Did:

- Break transactions into services
 - Replicate bottleneck services
- Each service owned by a semi-autonomous “two pizza” team



Option 1:
Scale Up

Option 2:
Scale Out



Scale Out: Databases

2001 

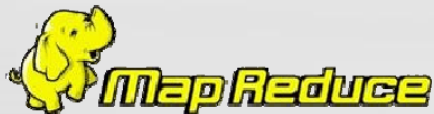
Doug Cutting, joined by Mike Cafarella



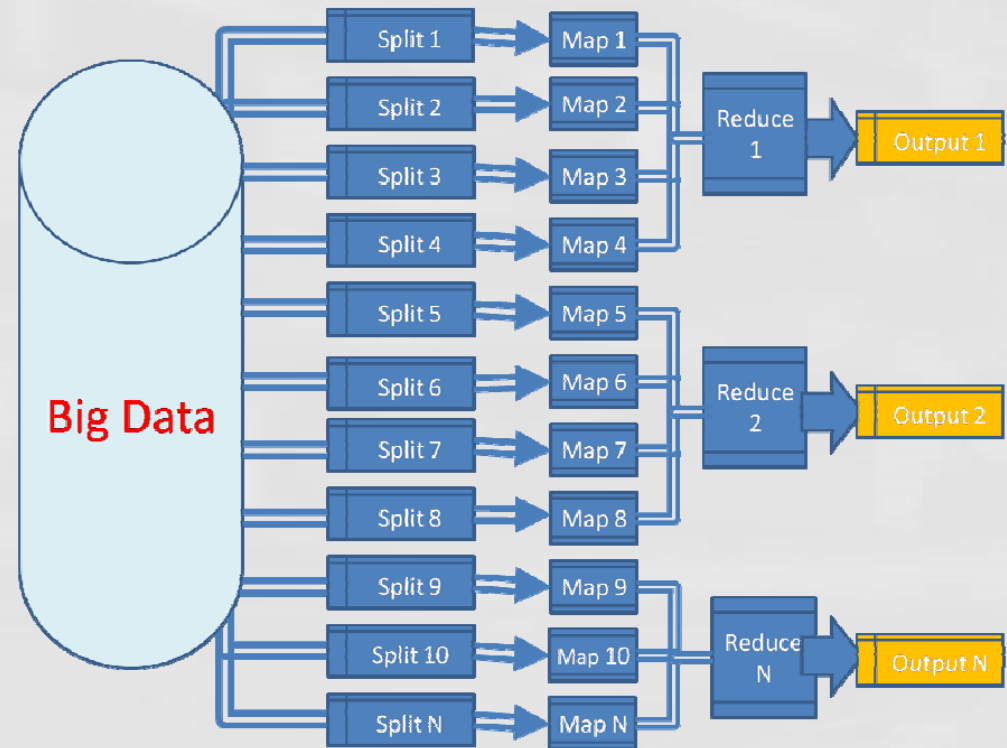
2003 Google File System Paper



2004 Google MapReduce Paper



2006-2012 Hadoop Grows Up



Infrastructure

as Code



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How Conway's Law Brought us the Cloud



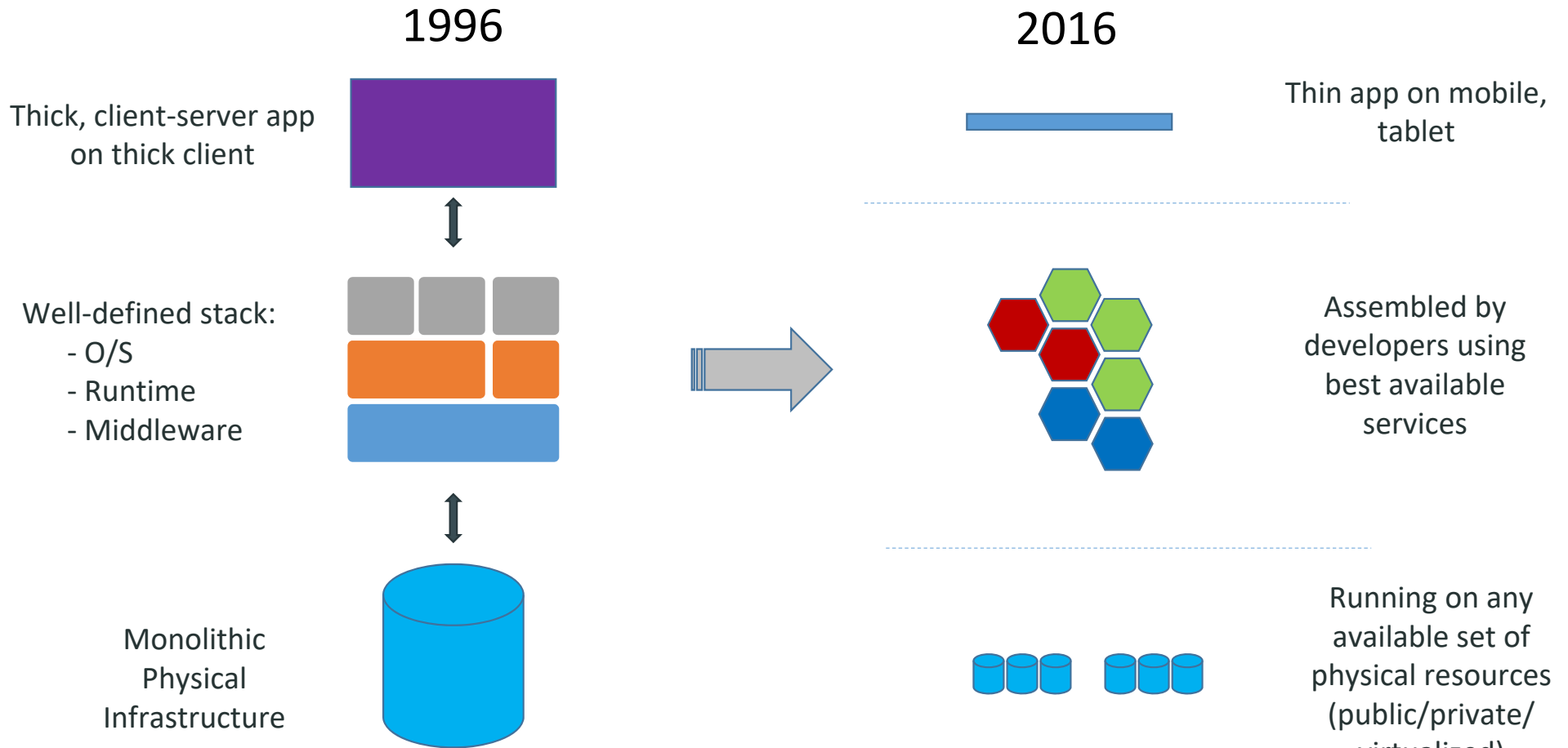
Autonomous Services \Rightarrow
Autonomous Service Teams
 \cong Independent Deployment
 \Rightarrow Much Stress in Operations

- Chris Pinkham (VP Infrastructure)
 - Proposes self-service deployment for development teams
 - Maybe sell the capability?

Time Passes....

- Pinkham moves to South Africa
 - Asked to pursue project there
 - Assembles and leads a team
 - Develops EC2 in 2 years
- EC2 Launches in 2006
- 10 Years Later:
The Cloud is cheaper, more stable, more secure, and more expandable than most on-premises data centers.

The Evolution of IT



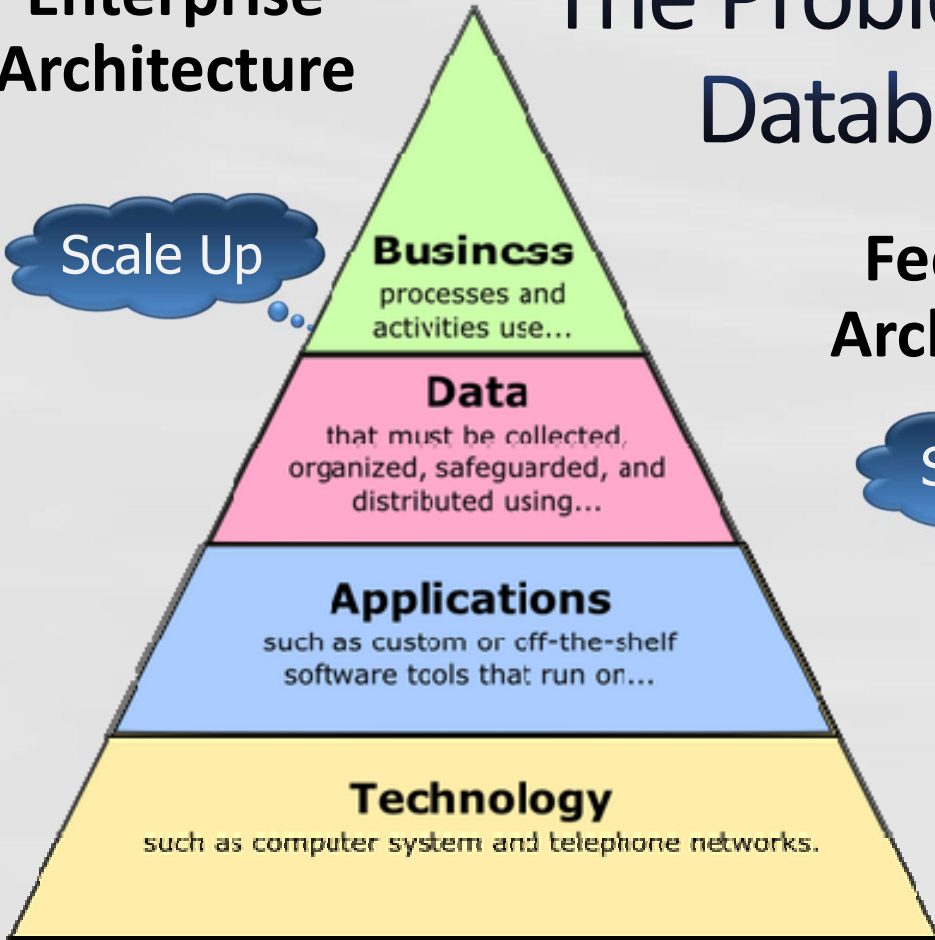
www.docker.io



Enterprise Architecture

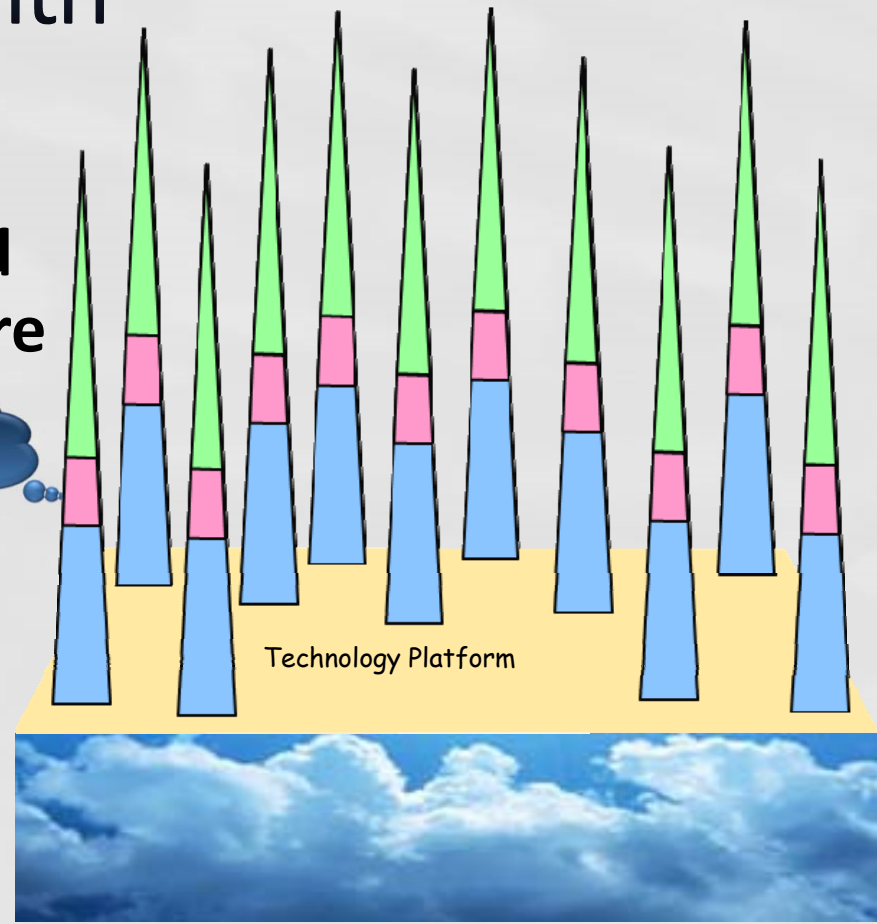
The Problem with Databases

Scale Up



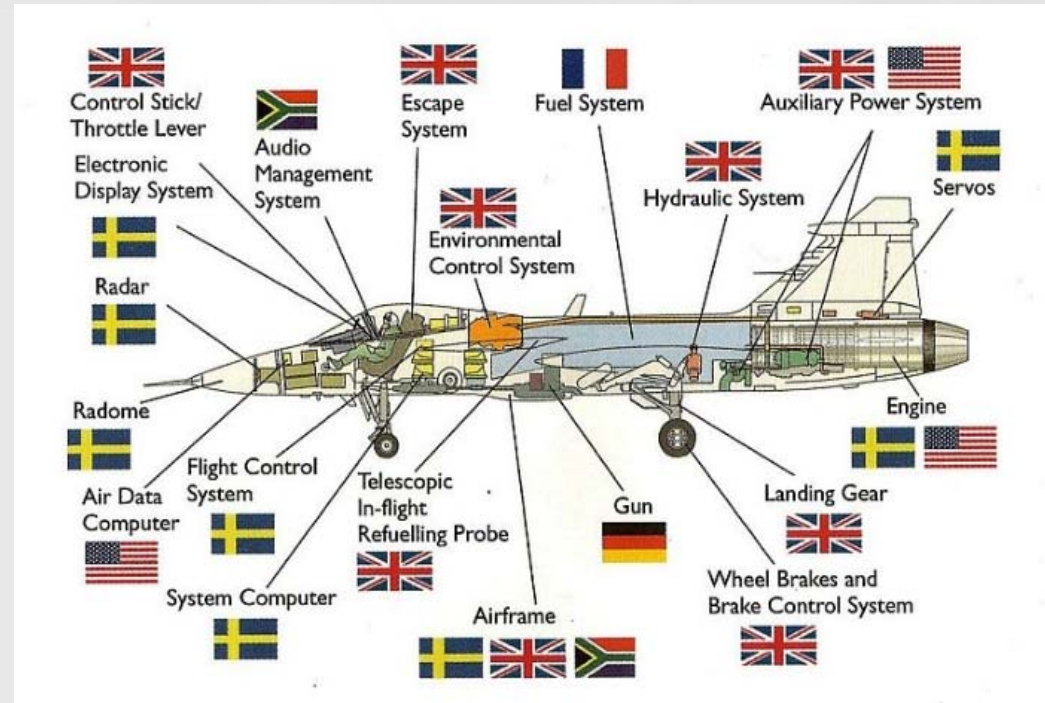
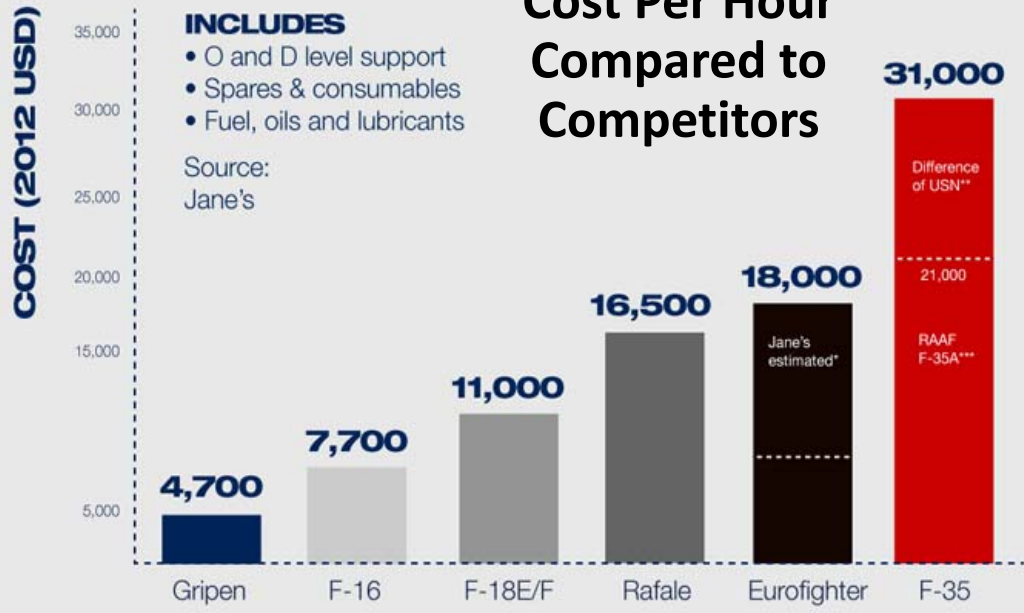
Federated Architecture

Scale Out





Integrated Federated Architecture



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Software Engineering for Big Data Systems

Distribution, Data, Deployment: Software Architecture Convergence in Big Data Systems

Ian Gorton, John Klein, Software Engineering Institute Carnegie Mellon University, May 2014

“Big data applications are pushing the limits of software engineering It is essential that the body of software architecture knowledge evolves to capture this advanced design knowledge for big data systems.”

Designing for scale:

- Big Data systems are inherently distributed; their architectures must explicitly handle:
 - partial failures
 - concurrency
 - consistency
 - replication
 - communications latencies

Resilient Architectures:

- Replicate data to ensure availability in the case of failure.
- Design components to be
 - stateless
 - replicated
 - tolerant of failures of dependent services



What Could Possibly Go Wrong?



Photograph © Tom Poppendieck

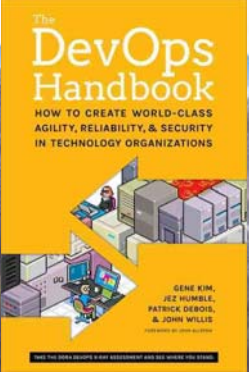
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One Thing We Know for Sure

For Complex Systems
This does not work

Smash!

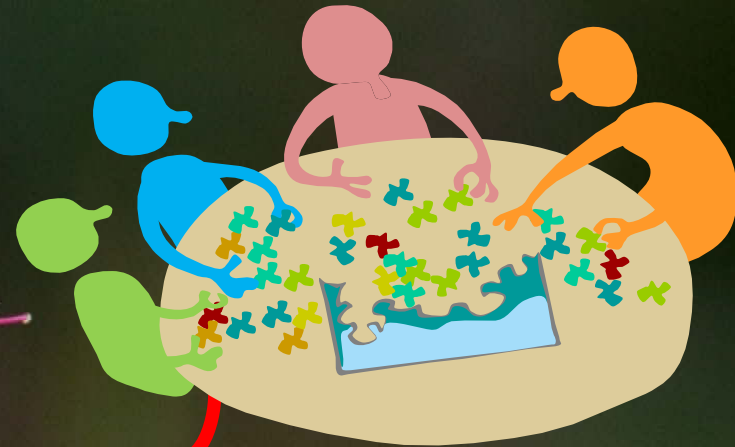




Build a Deployment Pipeline



Specification as Code



Designers SMEs Testers Engineers

Feature: User trades stocks

Scenario: User requests a sell before close of trading

Given I have 100 shares of MSFT stock

And I have 150 shares of APPL stock

And the time is before close of trading

When I ask to sell 20 shares of MSFT stock

Then I should have 80 shares of MSFT stock

And I should have 150 shares of APPL stock

And a sell order for 20 shares of MSFT stock should have been executed

From Martin Fowler.com

Specification
[by Example]

Test
Tool

Test
Report

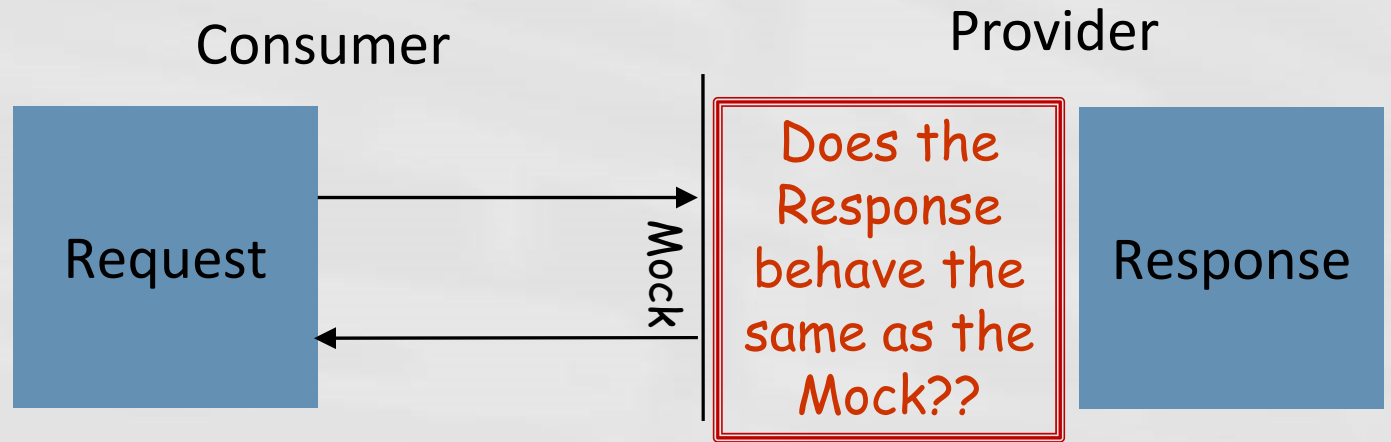
Fixture

Functional Layer
of Application

Configuration
Management

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Smart Test Automation

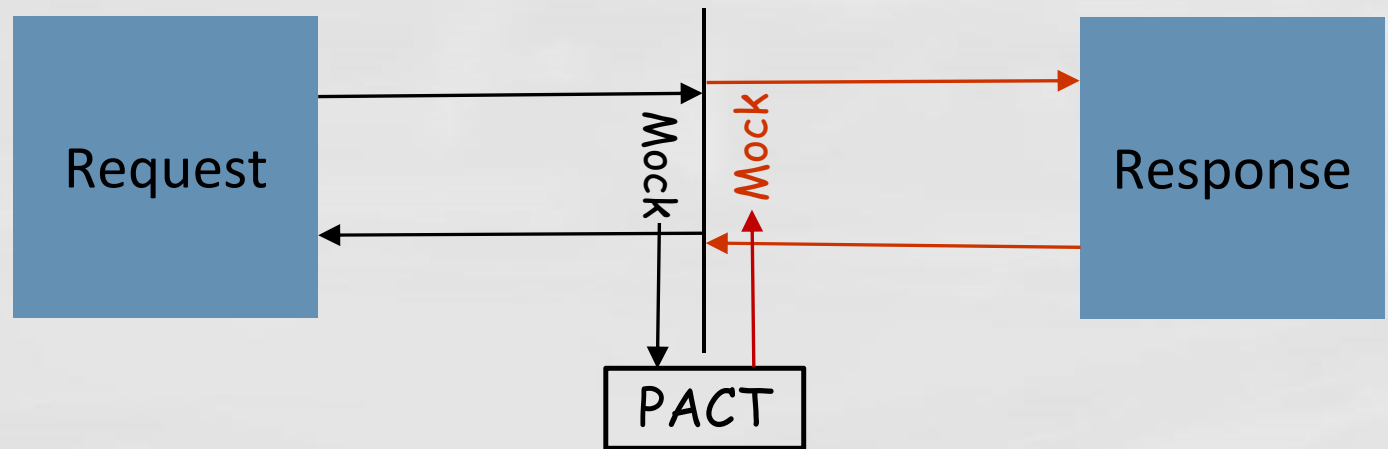


Martin Fowler

<http://martinfowler.com/articles/consumerDrivenContracts.html>

Beth Skurrie

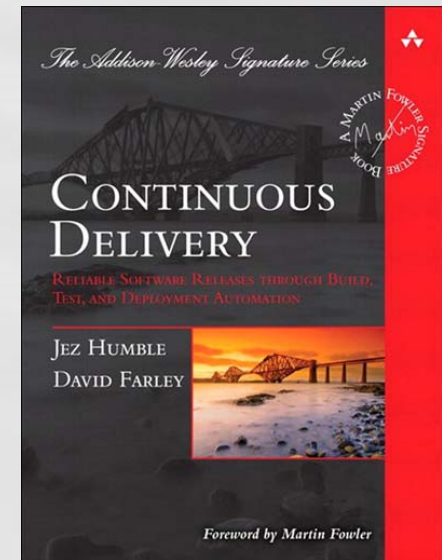
<https://github.com/realestate-com-au/pact>



Continuous Delivery

Software Engineering for the Cloud

- Acceptance test driven development process
- Cross-functional teams include Product, QA and Ops
- Automated build, testing, db migration, and deployment
- Incremental development *on the mainline* with continuous integration
- Software always production ready, or everything stops until it is
- Deploy constantly, release by switch





Full Stack Teams

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Build Strong Teams

IBM's Agile Principles

- Clarity is more important than Certainty
- Course Correction is more important than Perfection
- Self-directed Teams work better than Control Structures
- Collective Wisdom outweighs Individual Insights
- Full Stack Teams of 8-10 do the whole job: design, build, deploy
- Leadership Role:
 - Build Strong Teams
 - Create Clarity of Purpose
 - Create a Productive Environment
 - Inspire People to do Great Things
 - Measure (only) what matters



Jeff Smith, IBM CIO



Collective Wisdom Outweighs Individual Insights



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Half the Time the Product Manager is Wrong.



Online Experimentation at Microsoft
by Kohavi , Crook, & Longbotham
Presented at KDD 2009
(Knowledge Discovery & Data Mining)
<http://exp-platform.com/expMicrosoft.aspx>
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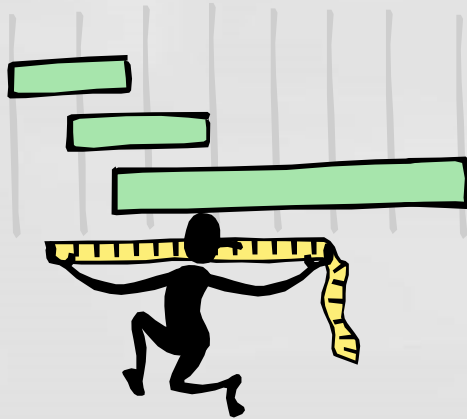
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Two Thirds of the features and functions
in a specification are unnecessary.

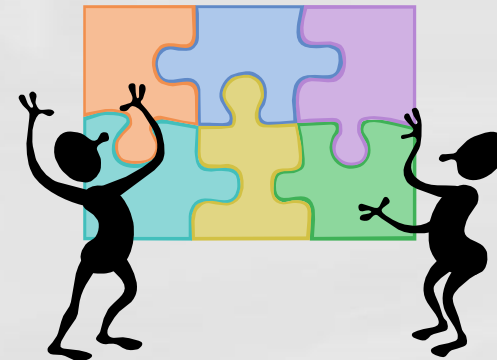
Be Lazy!

From Delivery Teams To Problem Solving Teams

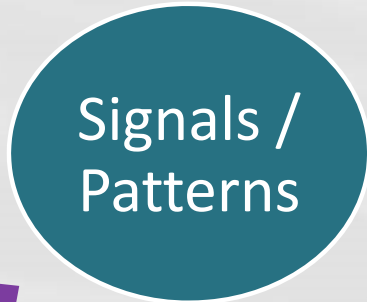
Delivery



Problem Solving



Start with Signals
Focus on Problems
Plan with Hypotheses



Not Requirements
Not Features
Not Estimates



The Engineering Process



Do Multiple
Experiments
Use Data
to Decide



Not a Backlog
of Stories
Don't Guess at
a Solution



Software Engineering Moves to Profit Centers

From The IT Mindset*

- Focus on “The Business”
- Project Manager
- Order-taking Development Team
- Success = Cost, Schedule, Scope
- Tough Tradeoffs are Made During the Planning Process
- Cost Center Mentality: Constantly Reduce Costs

To The Product Mindset

- Focus on Customers
- Entrepreneur
- Problem-solving Engineering Team
- Success = Delighted Customers
- Tough Tradeoffs are Made Often, Based on Market Realities
- Profit Center Mentality: Spend Money to Make Money

*Thanks to Marty Cagan

Jeff Immelt, Ceo, GE

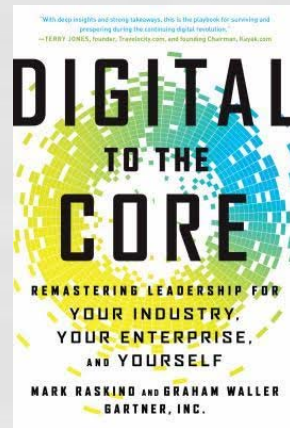
- Our competitive advantage is **Digital Productivity.**
- Winning requires simpler organizations.
- Change requires new business models that are leaner, faster, more decentralized.
- Complex centralized bureaucracies are obsolete. Annual processes are too slow.
- Push capability to local teams who are empowered to take risks.
- If you are joining GE in your 20's you're going to learn to code. It doesn't matter whether you are in sales, finance or operations. You may not be a programmer, but you will know how to code.



Digitizing General Electric

The Industrial Internet of Things
Use Data to Increase Asset Productivity

- Critical Skills: Science, Security
- Critical Challenge: Attract and challenge talented people



Software is Eating the World

Highly Successful Digital Organizations

Don't do

- Monolithic Architecture
- Testing at the End
- Periodic Releases
- Five Nines
- Projects
- Features
- Estimates
- IT
- Outsource Development

Do

- Federated Architecture
- Tests as Specification
- Continuous Delivery
- Fault Tolerance
- Constantly Evolving Products
- Problems
- Hypotheses
- Full Stack Teams
- Outsource Infrastructure





Thank you!

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