Advanced REST

Oxford University
Software Engineering Programme
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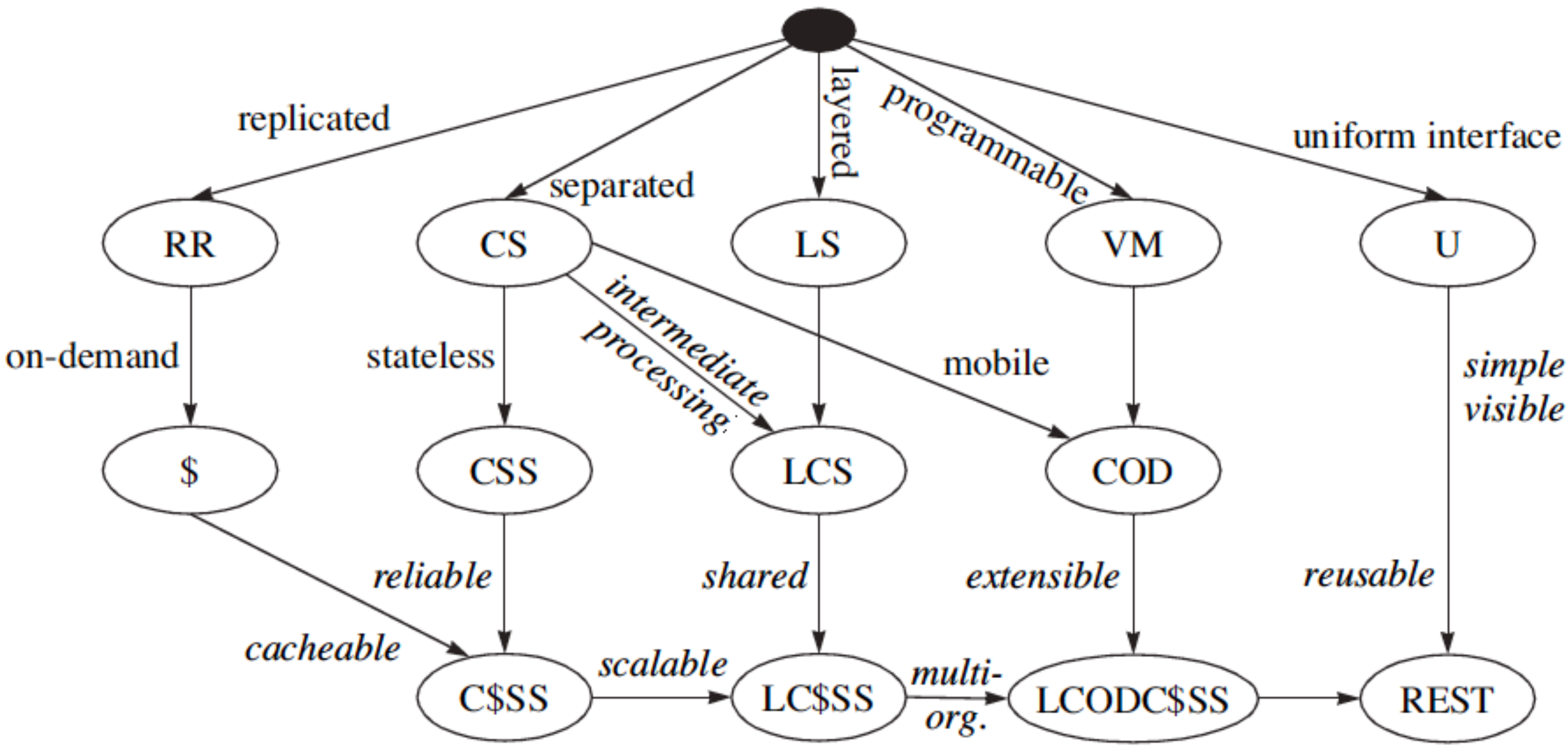
Another way of looking at REST

Taking HTTP seriously

REST

- **Roy Fielding**, a principal author of HTTP
- PhD thesis *Architectural Styles and the Design of Network-based*
- Subsequent article *Principled Design of the Modern Web Architecture* (ACM TOIT 2:2, 2002)
- Richardson & Ruby, *RESTful Web Services* architectural patterns of the web

REST Derivation from Style Constraint



Key concepts

- Client Server
- Cacheing
- Replicable
- Stateless
- Layered
- Uniform interface

Cacheing

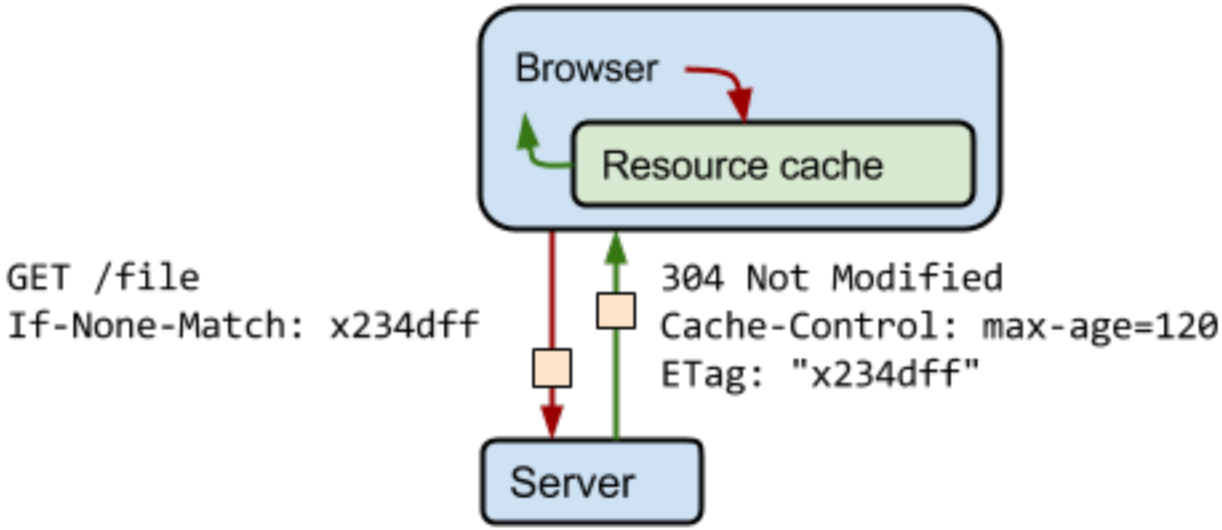
- Large scale network systems often rely on cacheing
  - Reduce traffic
  - Localised access
  - Reduced processing
    - **Akamai** and others make the web work effectively
- Caching relies on differentiating between cacheable and not cacheable traffic
  - Also understanding the lifetime and status of cacheable objects

HTTP cacheing features

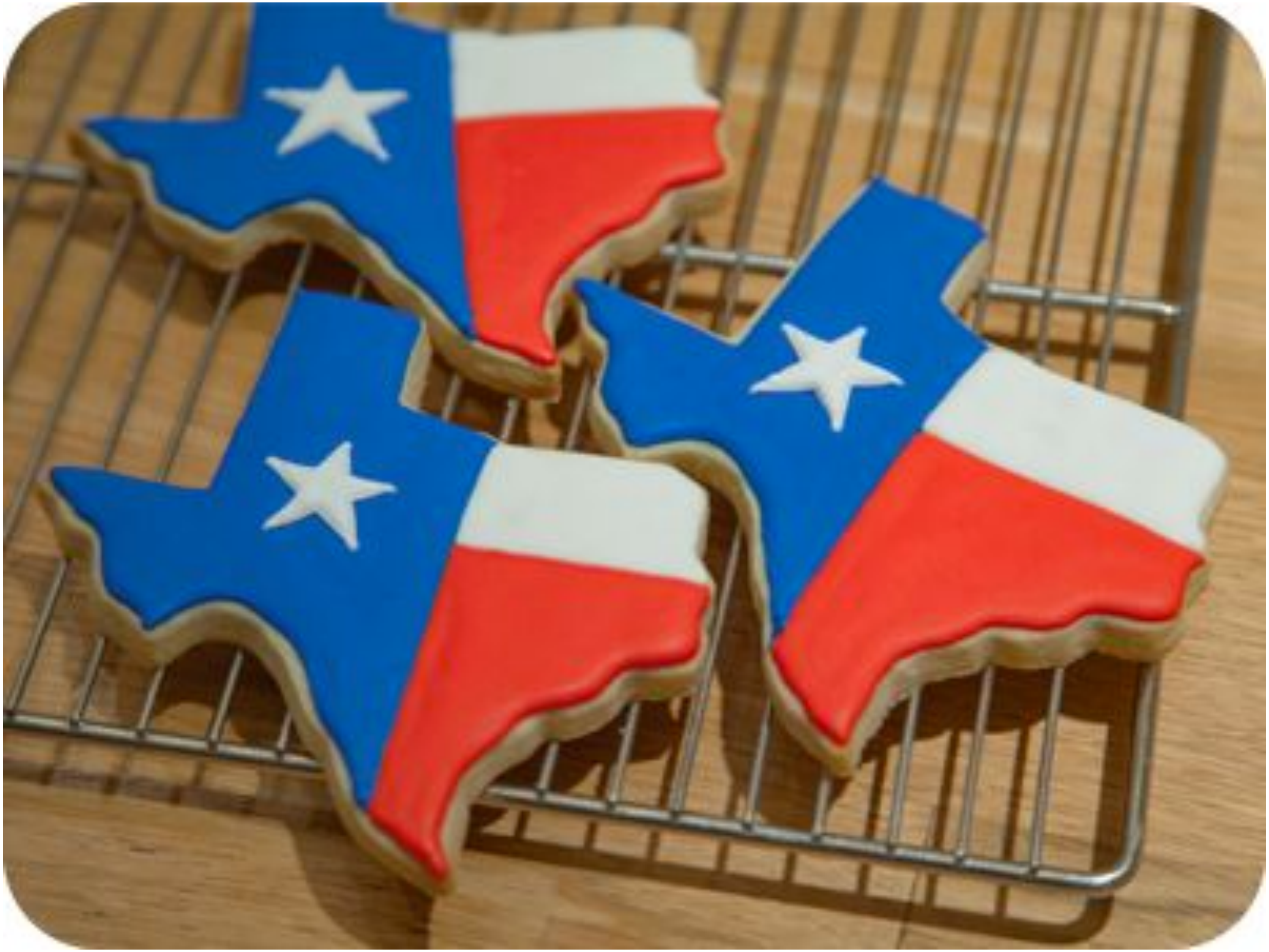
- Expires header
- Cache-control header
- If-modified-since / Not modified
- ETags (Entity Tags)
  – Uuids for content
  – Strong and Weak
- If None Match

- Unfortunately some websites are using Etags to track users instead of cookies!

ETags



https://developers.google.com/web/fundamentals/performance/optimizing-content-efficiency/images/http-cache-control.png



Statelessness

- Of course there is state!
- The only question is where the state is kept.
- Traditional CS systems required the client and server to be kept in sync
- The web uses cookies

scalability

/ˌskeɪləˈbɪlɪtɪ/

noun

1. the ability of something, esp a computer system, to adapt to increased demands

Collins English Dictionary - Complete & Unabridged 2012 Digital Edition

Speedup

- The **speedup** is defined as the performance of new / performance of old
  - e.g. move from 1 -> 2 servers
  - New system is 1.8 x faster than the old
    - In terms of transactions/sec (throughput)
  - Speedup = 1.8

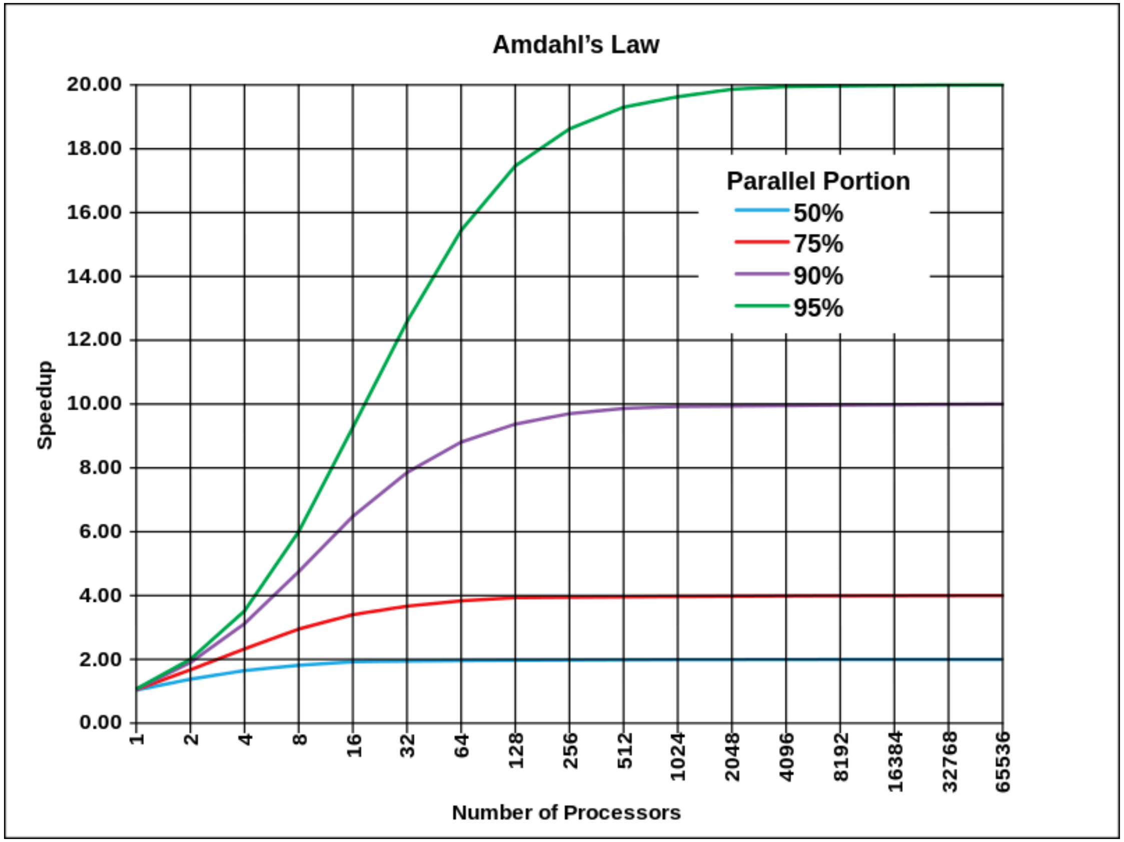
What inhibits speedup?

- In general you can split work into
  - Parallelizable and
  - Serial parts
- The serial parts stop you from scaling

Amdahl's Law

Theoretical speedup given a fixed data size

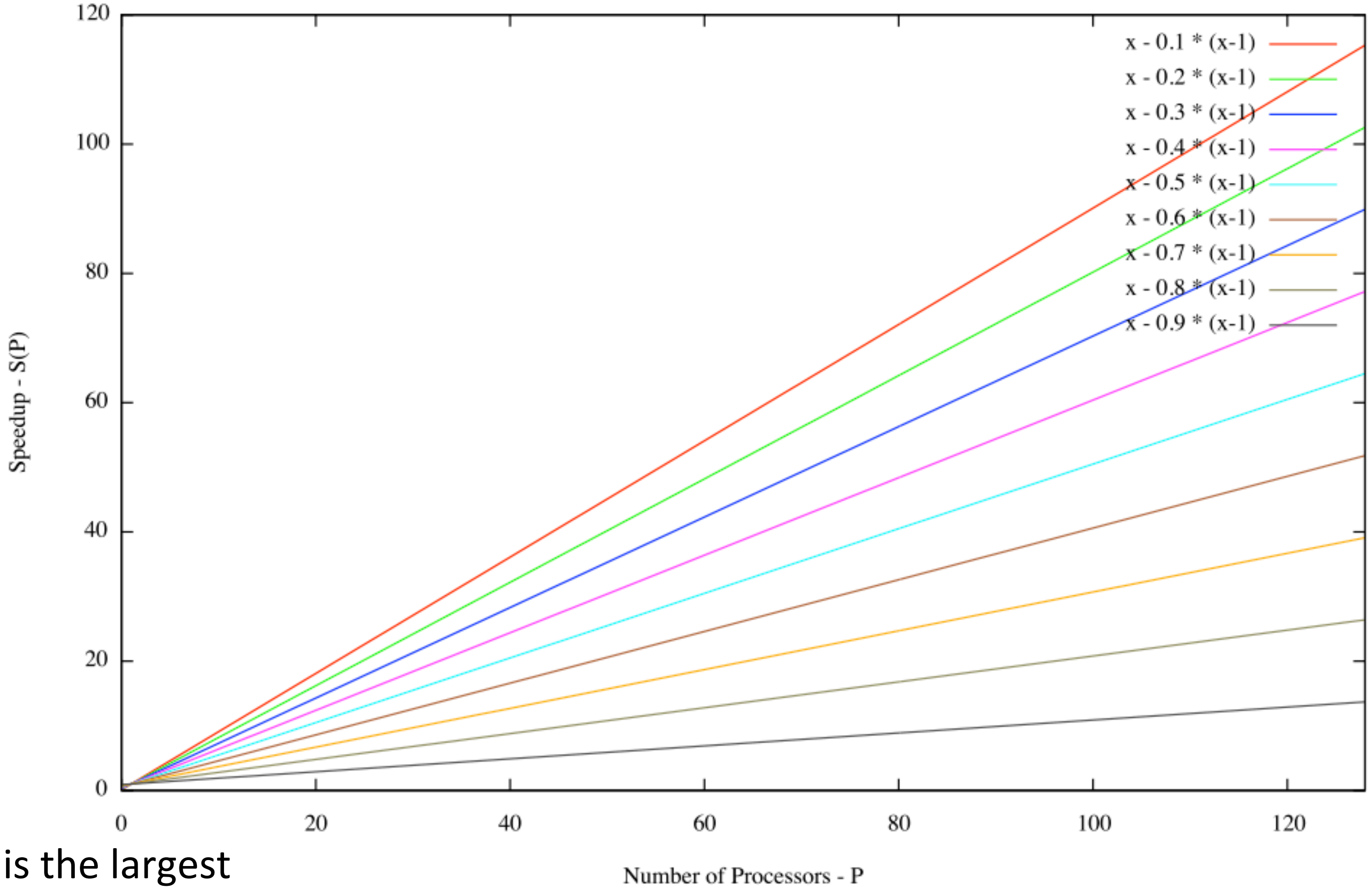
The speedup of a program using multiple processors in parallel computing is limited by the time needed for the serial fraction of the program, given a fixed size of data



Gustafson's Law

What if the data increases too?

$$S(P) = P - \alpha \cdot (P - 1)$$



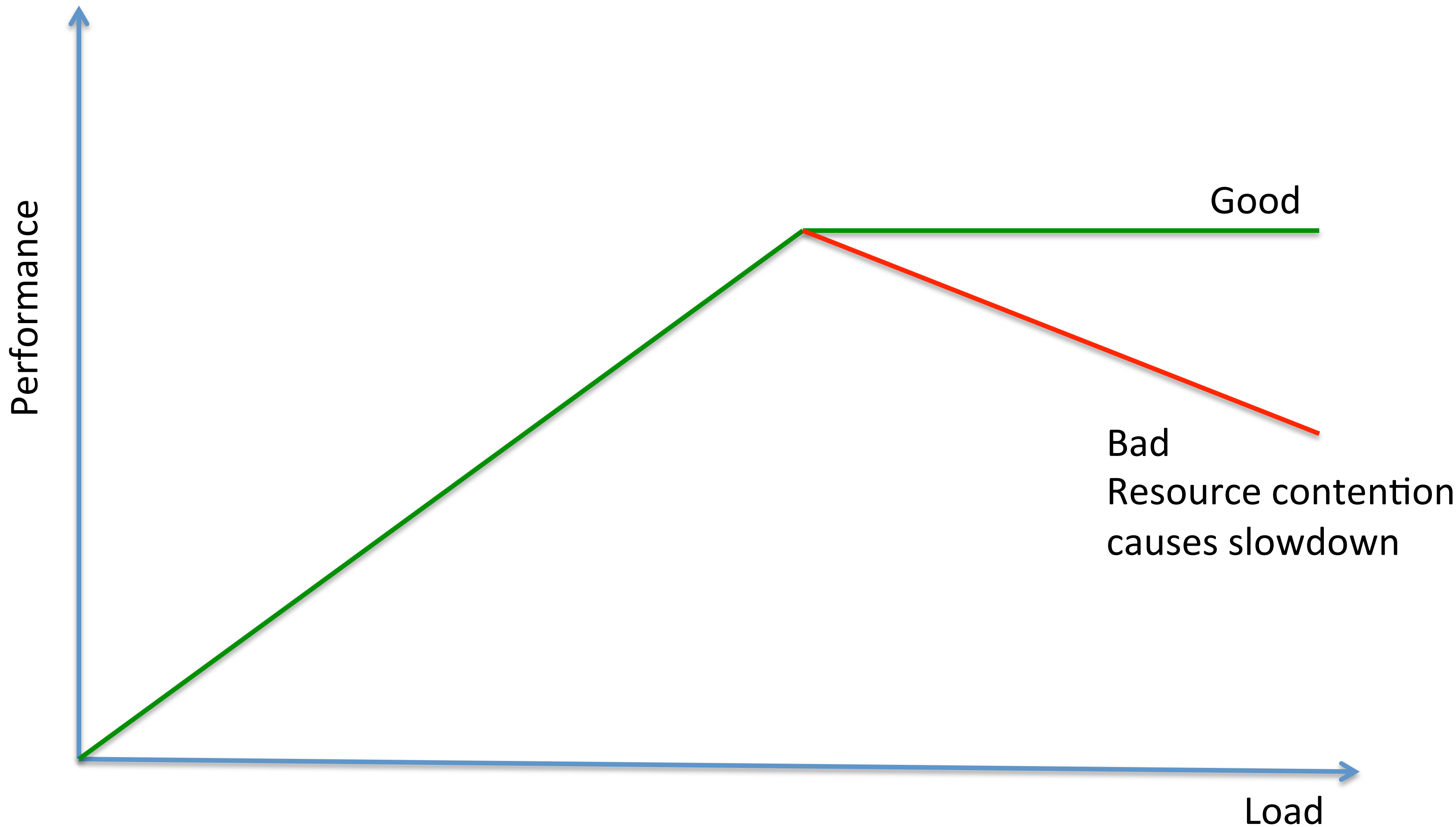
α is the largest non-parallelizable fraction

A driving metaphor

- **Amdahl's Law**
  - You are travelling to London (60 miles)
  - 30 miles in you have spent one hour
  - You can never average > 60 mph
- **Gustafson's Law**
  - You are travelling across the US
  - You've spent an hour at 30 mph
  - You can achieve any average speed given enough time and distance

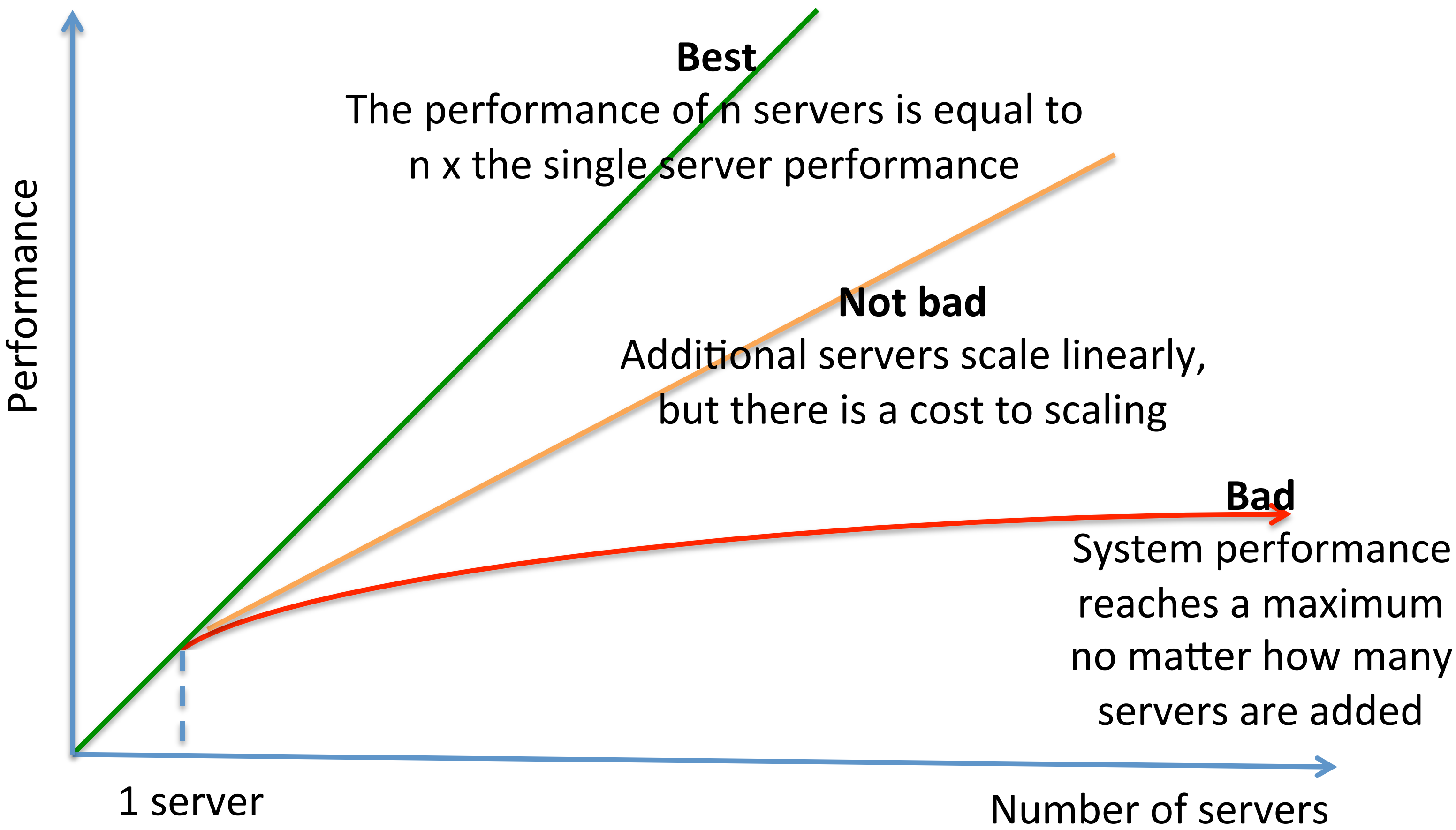
Performance

Single system under increasing load



Performance

Scaling servers when fully loaded



Karp-Flatt Metric

e is the Karp-Flatt Metric

ψ is the speedup

p is the number of processors

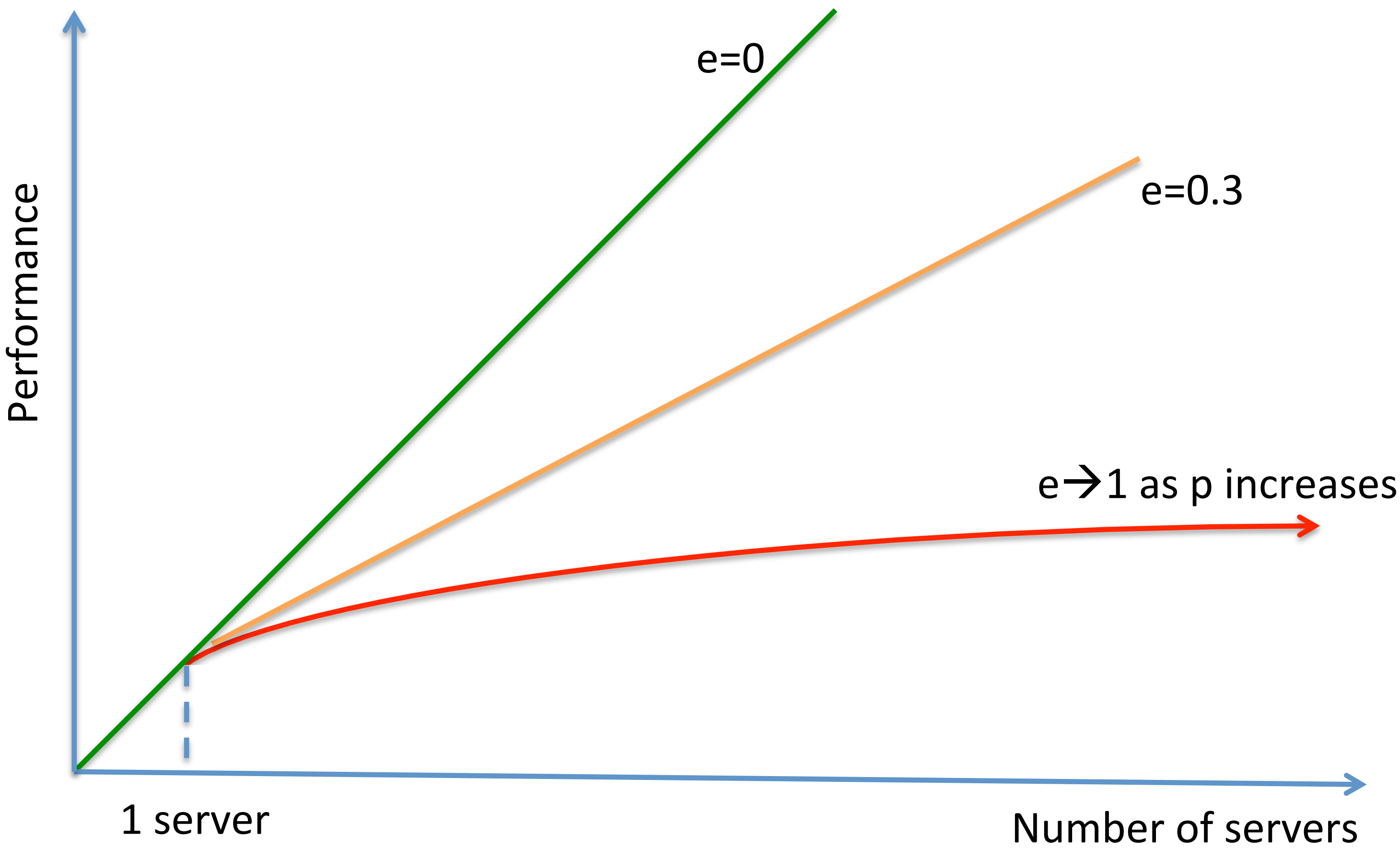
$$e = \frac{\frac{1}{\psi} - \frac{1}{p}}{1 - \frac{1}{p}}$$

e = 0 is the best

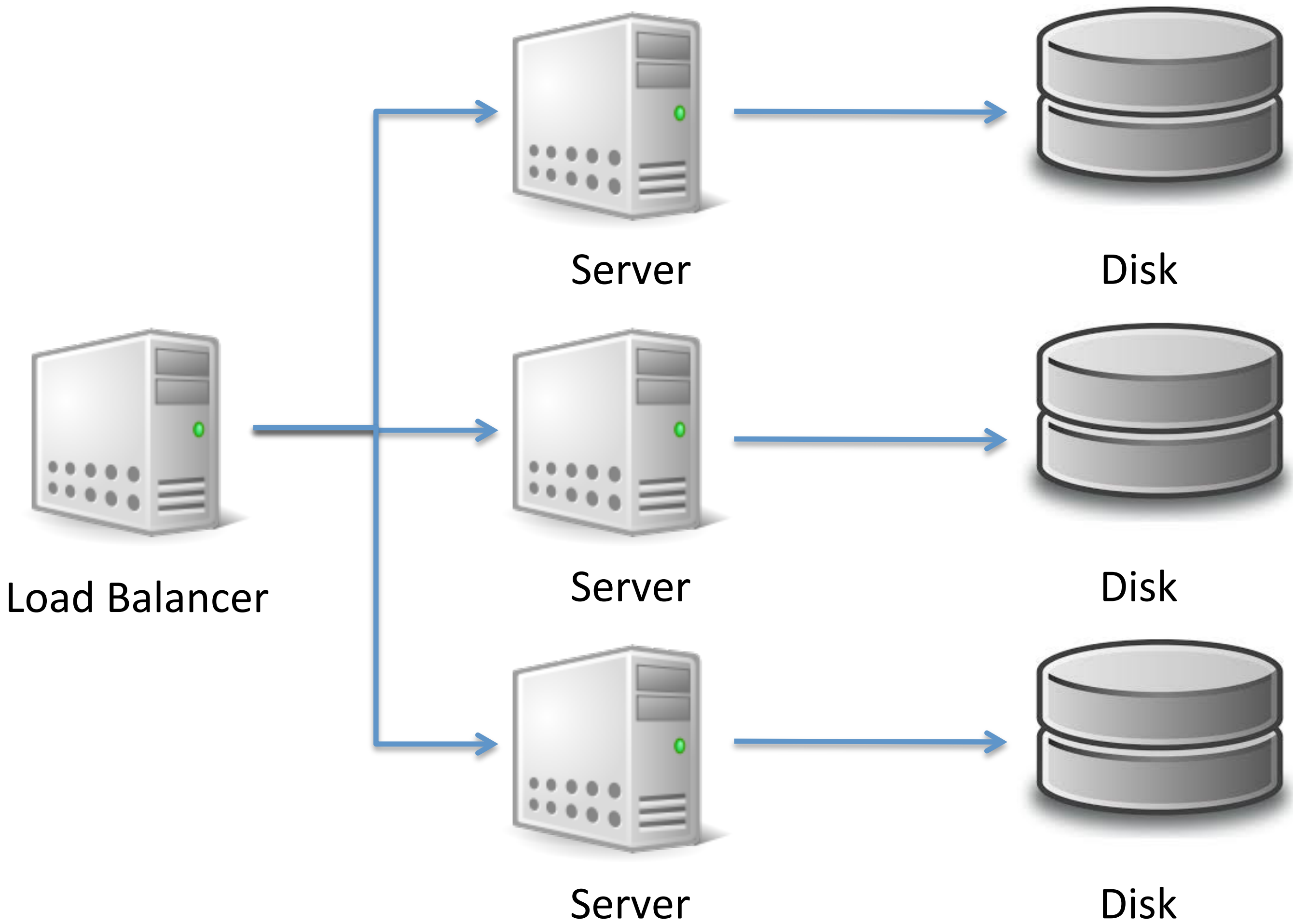
e = 1 indicates no speedup

e > 1 indicates adding processors slows down the system!!!

Karp-Flatt metric



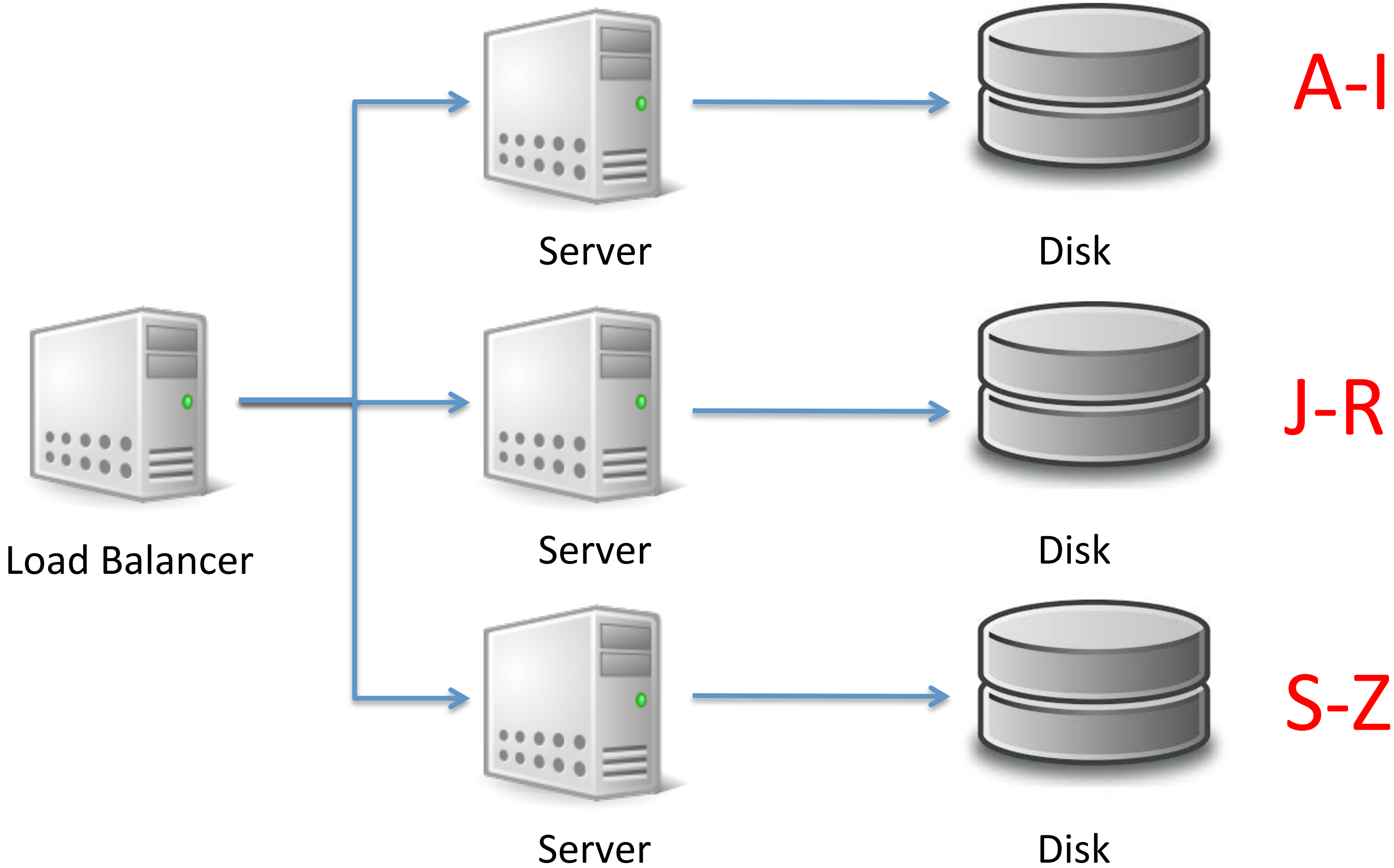
Shared Nothing Architecture



Shared Nothing Architecture

- Implies there is no serial part to the computation
- Karp-Flatt Metric of 0
  - Assuming 100% efficient load balancing
- In practice, this is difficult!

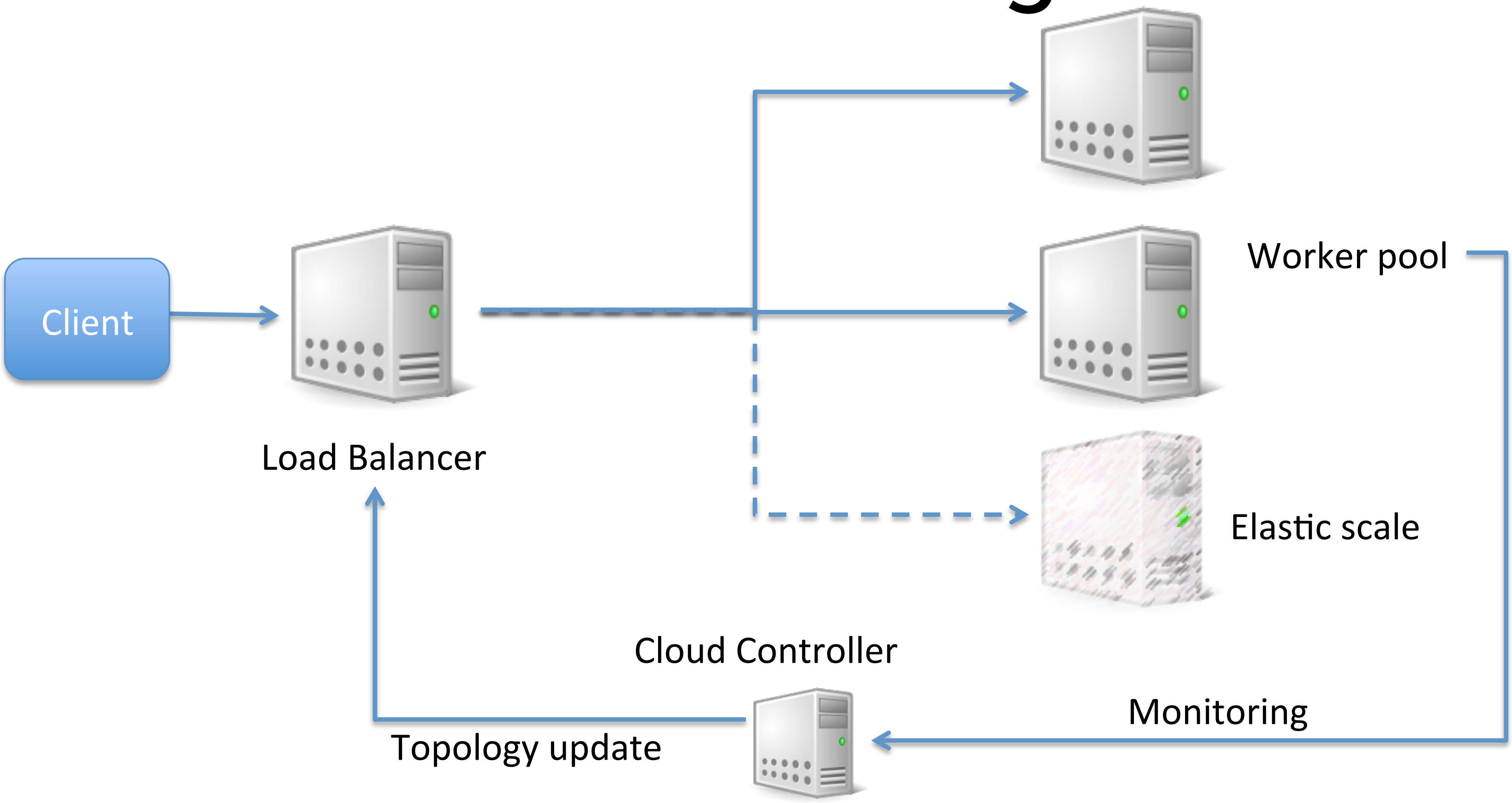
Partitioning / Sharding



Problems with Sharding

- Imbalance
  - Fewer S-Z's than A-I's
- Failover
- Adding new servers requires a re-balance
  - Is this automatic or manual?!

Load Balancer-based elastic scaling



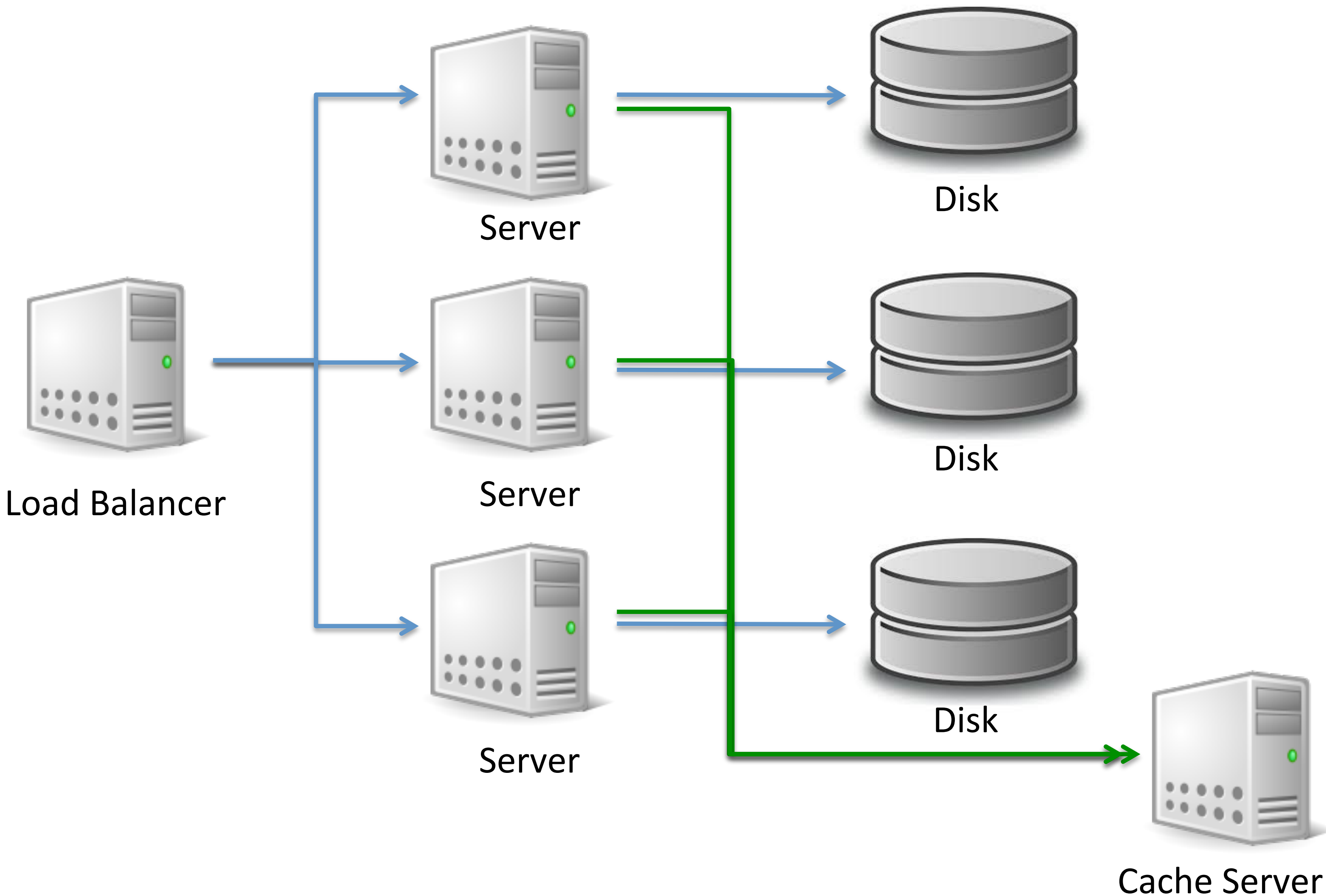
Statelessness is hard

- There is a lot of intermediate calculation in most web systems that needs to be stored between transactions.
- The exemplar is the shopping cart

Intermediate state storage

- In-memory
  - Breaks statelessness, limits scalability
- In the client
  - OK for some APIs but can be slow and hard to program
- In the database
  - Slow and expensive
- Cache servers:
  - The client keeps a cookie, which is the key to the datastore
  - The usual practise
  - Redis, memcached, Hazelcast, Infinispan

Cache



Server
Disk
Load Balancer
Server
Disk
Server
Disk
Cache Server

Layered systems

- Reverse proxies
- Composable
  - E.g. my business process is a service that exposes a REST interface and co-ordinates other services
- Compare with web scraping

Principles of REST Architecture

- REST isn't protocol specific, but in practice means the RESTful usage of HTTP
  - CoAP is an example of a non-HTTP restful interface
- HTTP is very rich:
  - Content negotiation
  - Distributed caching.
- HTTP verbs nicely map to CRUD operations of data
- RESTful web services
  - Try to use all of HTTP as an application protocol

Resources and Uniform Interface

- Addressable Resources. Every “object” on your network should have a unique ID.
- An important aspect is that each “object” or resource has its own specific URI where it can be addressed
- The URI should have a lifetime equivalent to the resource it represents
  - (I’ve had the same bank account for 20+ years)

Representation

- State of resource captured and transferred between components
- Might be current or desired future state
- Represented as data plus metadata (name–value pairs)
- Metadata includes control data, media type
- The **Content-Type** of the resource should be useful and meaningful (self-description)
- One resource might have several representations
- Selected via separate URIs, or via content negotiation

Uniform Interface

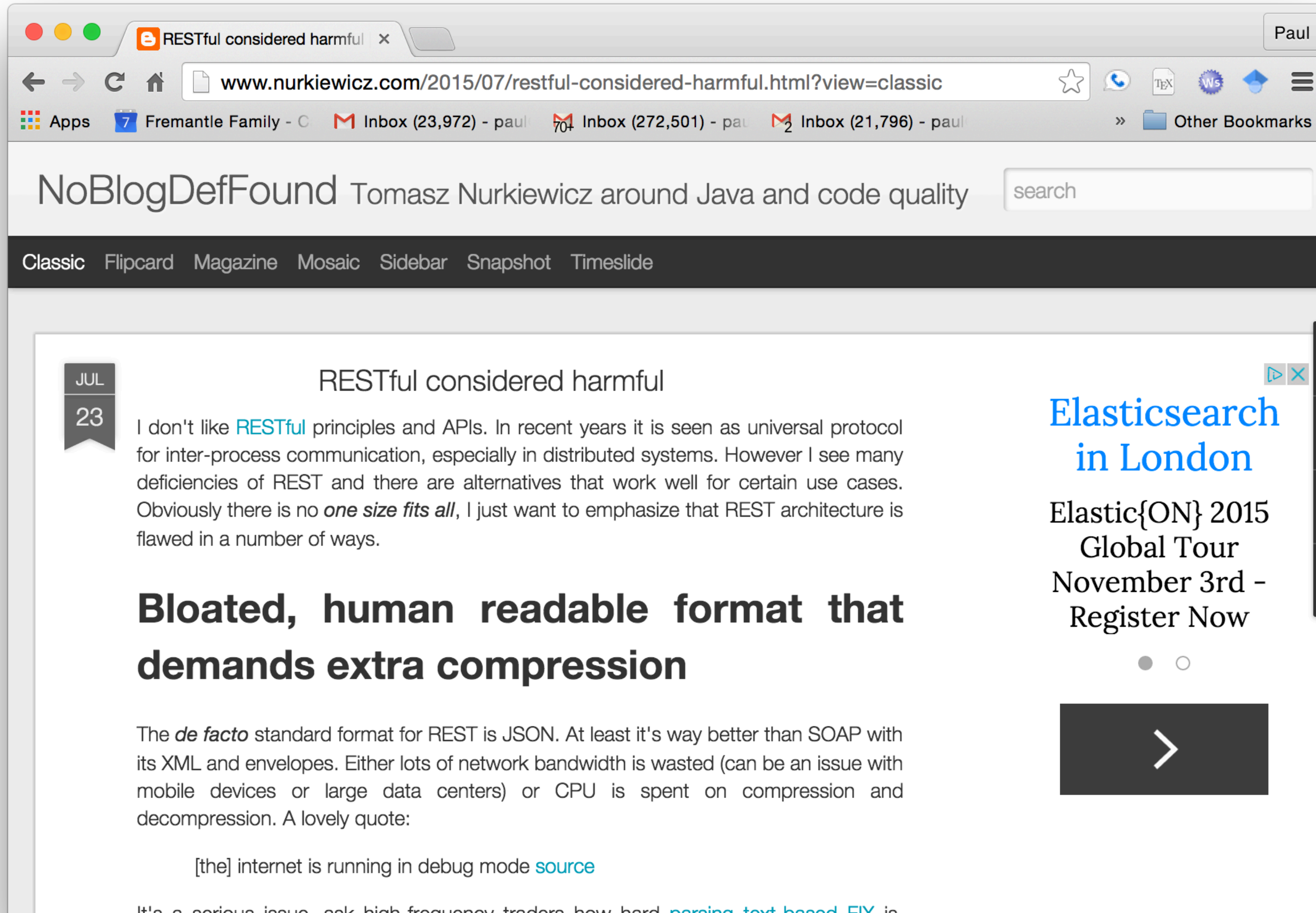
- A Uniform, Constrained Interface. When applying REST over HTTP, stick to the methods provided by the protocol
  - GET, POST, PUT, and DELETE.
- These should be used properly
  - GET should have no side effects or change on state
  - PUT should update the resource “in-place”

REST Standards

- **HTTP 1.1**
- URI
- URI Template
- **WebSockets**
- **XML, JSON, etc**
- Atom/AtomPub
- OData
- OpenId
- **OAuth 1 / 2**
- **SAML/SAML2**
- JSON Web Tokens
- WADL
- Swagger
- Json Home
- Json Web Encryption
- Json Web Signature
- Json Patch
- SPDY
- HTTPbis
- HTTP Link Header
- Microformats
- RDDL
- …

Not everyone agrees:

http://www.nurkiewicz.com/2015/07/restful-considered-harmful.html



Anti-REST concerns

- Bloated formats (equally applies to SOAP)
- Neither Schema nor Contract
- APIs and discovery instead of clear published machine-readable documentation
- No inbuilt batching, paging, sorting, etc
- CRUD only
- HTTP Status codes mixed with business replies
- Temporal Coupling
- Not clear enough what is REST and what isn't!
- Backwards compatibility

Why REST Keeps Me Up At Night

News, Mobile

May. 15 2012 By Guest Author

This guest post comes from Daniel Jacobson (@daniel_jacobson), director of engineering for the Netflix API. Prior to Netflix, Daniel ran application development for NPR where he created the NPR API, among other things. He is also the co-author of APIs: A Strategy Guide and a frequent contributor to ProgrammableWeb and the Netflix Tech Blog.

With respect to Web APIs, the industry has clearly and emphatically landed on REST as the standard way to implement these services. And for good reason... REST, which is generally implemented as a one-size-fits-all solution, is an excellent choice for a most companies who wish to expose their content to third parties, mobile app developers, partners, internal teams, etc. There are many tomes about what REST is and how best to implement it, so I won't go into detail here. But if I were to sum up the value proposition to these companies of the traditional REST solution, I would describe it as:

> *REST APIs are excellent at handling requests in a generic way, establishing a set of rules that allow a large number of known and unknown developers to easily consume the services that the API offers.*

http://www.programmableweb.com/news/why-rest-keeps-me-night/2012/05/15

Questions?