Persistence

SWE 432, Fall 2017

Design and Implementation of Software for the Web

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Today

- Demo: Promises and Timers
- What is “state” in a web application?
- How do we store it, and how do we choose where to store it?

Demo: Promises and Timers

What is “state” in a web app?

Application State

- All data in an application
- What kinds of data are we concerned about?
  - What user is logged in?
  - What interactions have they had with us before?
  - What data have they given us?
  - What data have others given us?
- Where do we store all of these things?

State: Example

Amazon.com…

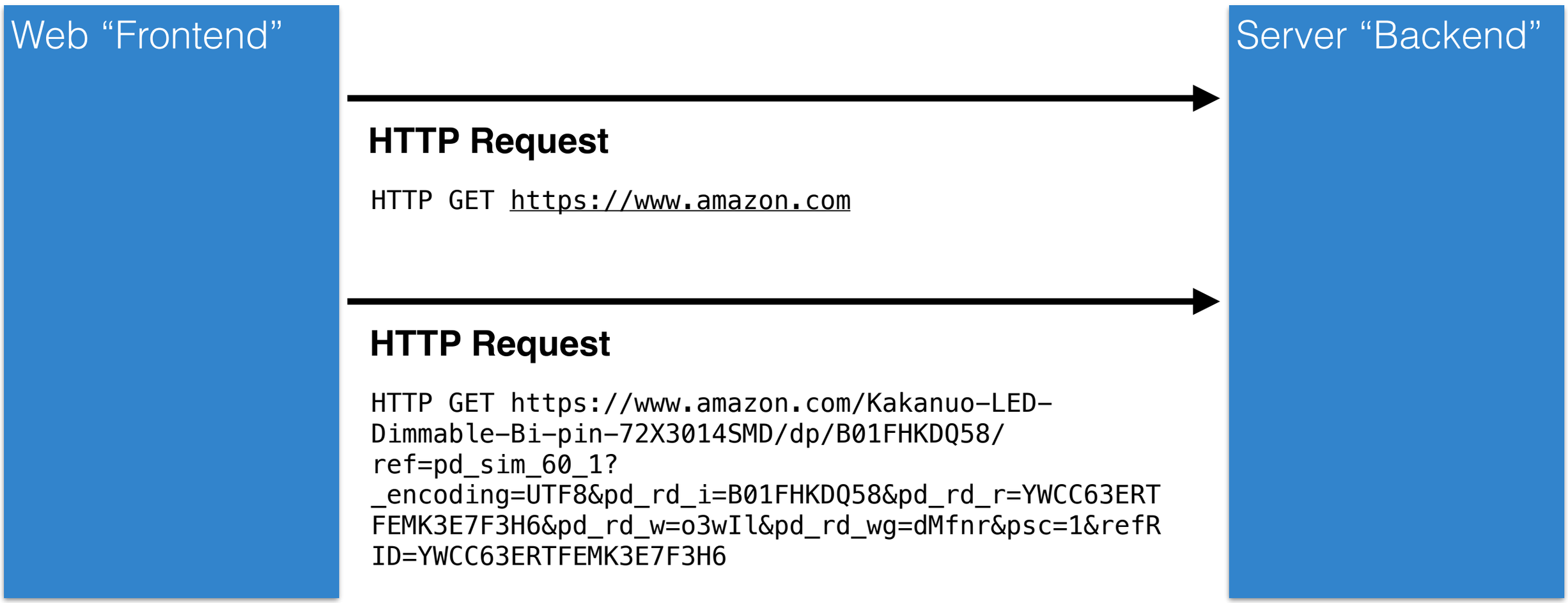
Home page | Login | Browse | Add to cart | visit amazon.com

Still logged in

Still logged in

Still logged in, still have cart…

HTTP is stateless



- Each request / response pair is independent of previous request / response pair
- Frontend cannot assume that it is making request to the same server.
  - Might be load balanced, crash, ...

Where to persist application state?

- Many options
- Goals:
  - Cost
  - Efficiency
  - Stability

Web “Front End”

Our Node Backend

Storage provider

Where to persist application state?

- Should consider how often we need to show it to the user, and how permanently we need to store it
- Examples:
  - What user is logged in? (Transient, relevant to user and backend)
  - What's in my shopping cart? (Semi-transient, relevant to user and backend)
  - What products am I looking at? (Transient, relevant to user)
  - What are all of the products (Long-term, parts are relevant to users)

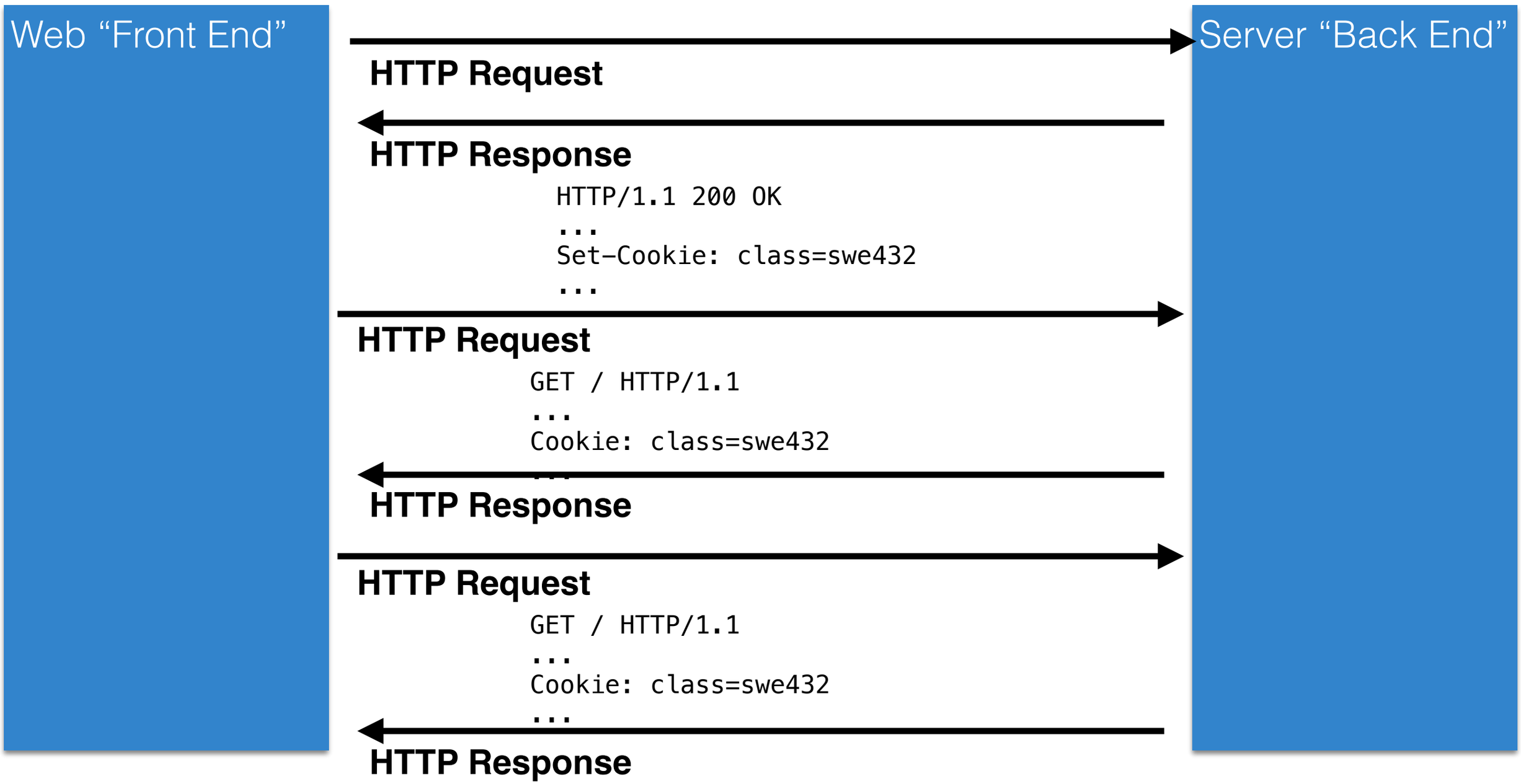
Where to persist application state

- URL and query parameters
  - Really small amounts of data
  - Data that should be changed through forward/back buttons in browser
- Frontend
  - Data we might need to show again soon
  - Fairly small (KB's or few MBs, not 100 MB's or GB's)
  - Data we don't care about going away or being maliciously manipulated
- In memory on backend
  - Data that we are working with that will fit in memory (MB's probably not GB's)
  - Transient data that can disappear if the server crashes
  - Cache or index of data stored on backend disk, database, or storage provider
- On backend disk or database
  - Data we need persisted "permanently"
  - Data that only needs to be used by single server
- Storage provider
  - Data we need persisted "permanently"
  - Data that we need to share across multiple servers

Frontend State: Cookies

- String associated with a name/domain/path, stored at the browser
- Series of name-value pairs, interpreted by the web application
- Create in HTTP response with *"Set-Cookie: "*
- In all subsequent requests to this site, until cookie's expiration, the client sends the HTTP header *"Cookie: "*
- Often have an expiration (otherwise expire when browser closed)
- Various technical, privacy and security issues
  - Inconsistent state after using "back" button, third-party cookies, cross-site scripting, …

Cookies and Requests



Cookies & NodeJS

- cookie-parser enables reading and writing cookies
  - npm install cookie-parser
  - let cookieParser = require('cookie-parser');

- Stateful Hello World

```
const express = require('express');
const cookieParser = require('cookie-parser');
const app = express();

app.use(cookieParser());

app.get('/', (req, res) => {
    if(req.cookies.helloSent == "true")
        res.send("I already said hello to you!");
    else
        res.cookie("helloSent","true").send('Hello World!');
});

app.listen(3000);
```

Persisting more complex state

- The most cookies you can have: 4KB (TOTAL per DOMAIN)
- Old solution
  - Cookie is a key to some data stored on server
  - When client makes a request, server always includes this "extra data" being stored on server
- What's wrong with this old solution?
  - Really slow
  - For every request
    - Client passes key to server using cookie
    - Server loads data corresponding to key
    - Client downloads data as part of HTTP response

Frontend State with LocalStorage

- HTML5 added support for persisting larger data on the frontend

  `localStorage` (Persists forever)
  `sessionStorage` (Persists until tab is closed)

- To use localStorage and sessionStorage

```
setItem(“key","value");
getItem(“key”);
```

```
var id = localStorage.getItem(“userID”);
```

  - Can store any string
  - All pages in the same domain see the same localStorage and sessionStorage
  - Alternatively: SQLite (SQL DB) that you can use in JS

Persisting state on the backend

Storing state in a global variable

- **Global variables**

```
var express = require('express');
var app = express();
var port = process.env.port || 3000;

var counter = 0;
app.get('/', function (req, res) {
    res.send('Hello World has been said ' + counter + ' times!');
    counter++;
});

app.listen(port, function () {
    console.log('Example app listening on port' + port);
});
```

- Pros/cons?
  - Keep data between requests
  - **Goes away** when your server stops
    - Should use for transient state or as cache

What forms of data might you have

- Key / value pairs
- JSON objects
- Tabular arrays of data
- Files

Options for backend persistence

- Where it is stored
  - On your server or another server you own
    - SQL databases, NoSQL databases
    - File system
  - Storage provider (not on a server you own)
    - BLOB store
    - NoSQL databases: Next time

Blobs: Storing uploaded files

- Example: User uploads picture
  - … and then?
  - … somehow process the file?

How do we store our files?

- Dealing with text is easy - we already figured out firebase
  - Could use other databases too… but that's another class!
- But
  - What about pictures?
  - What about movies?
  - What about big huge text files?
- Aka…Binary Large OBject (BLOB)
  - Collection of binary data stored as a single entity
  - Generic terms for an entity that is array of bytes

Working with Blobs

- Module: express-fileupload

- Simplest case: take a file, save it on the server

```
app.post('/upload', function(req, res) {
    var sampleFile;
    sampleFile = req.files.sampleFile;
    sampleFile.mv('/somewhere/on/your/server/filename.jpg', function(err) {
        if (err) {
            res.status(500).send(err);
        }
        else {
            res.send('File uploaded!');
        }
    });
});
```

- Long story... can't app.use(body-parser) when you are handling file uploads. Instead:

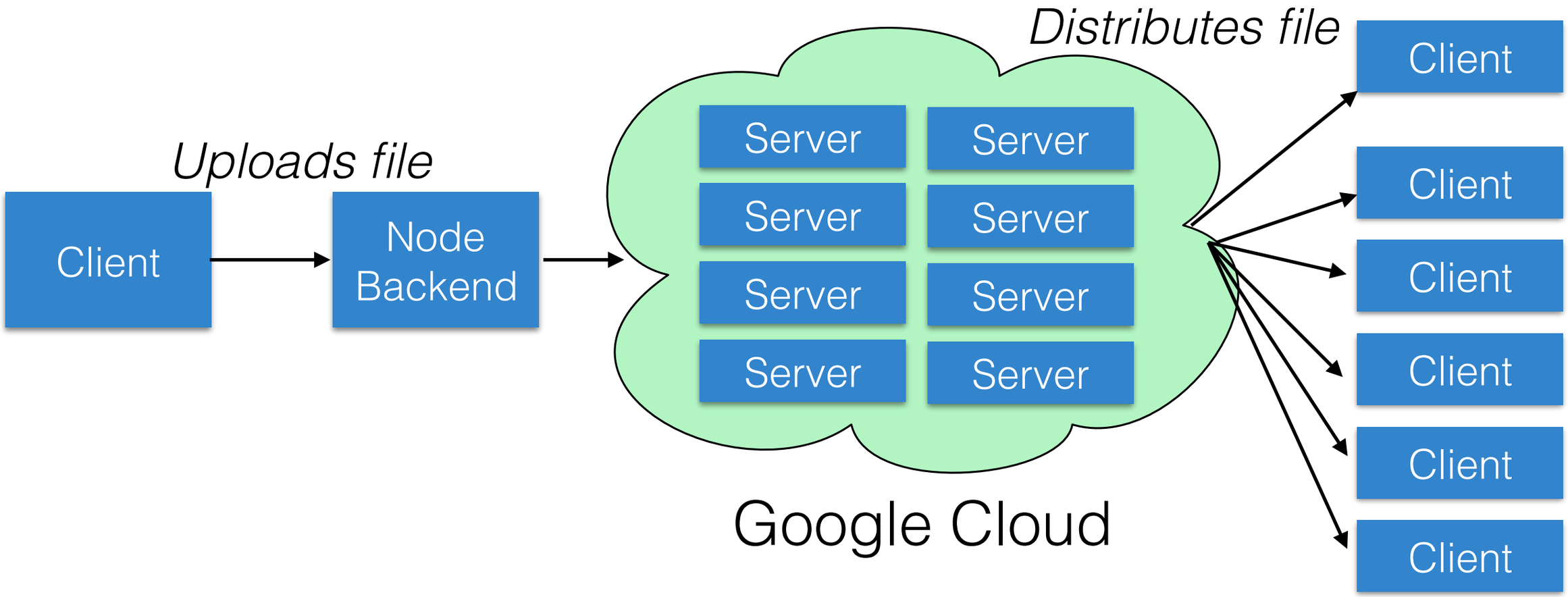
```
app.use(express.json())
   .use(express.urlencoded());
```

Where to store blobs

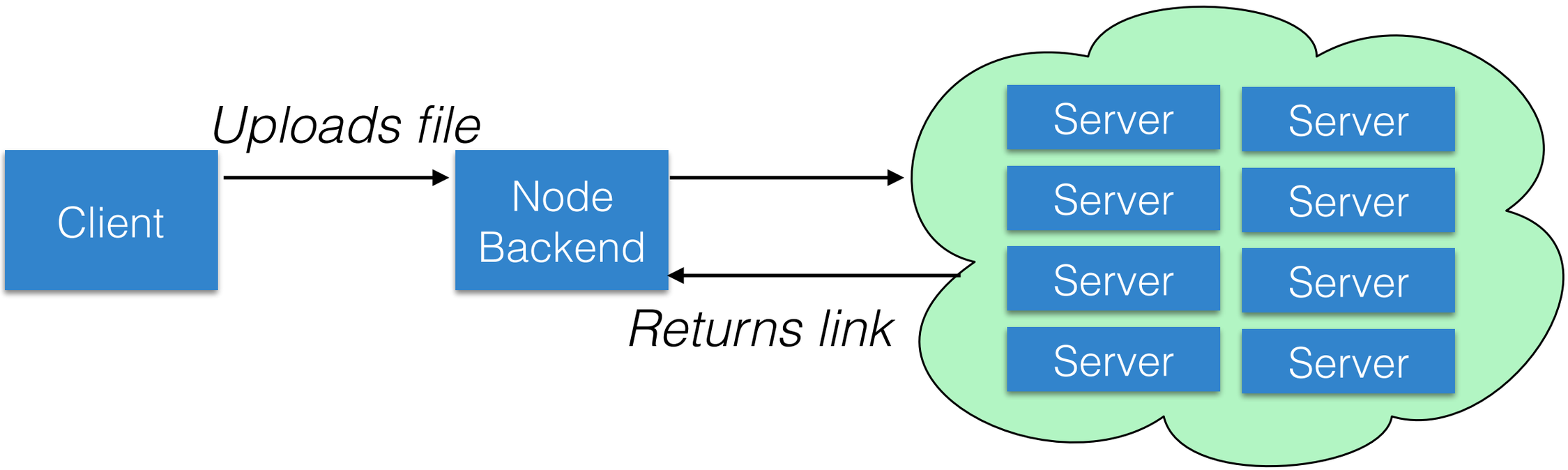
- Saving them on our server is fine, but…
  - What if we don't want to deal with making sure we have enough storage
  - What if we don't want to deal with backing up those files
  - What if our app has too many requests for one server and state needs to be shared between load-balanced servers
  - What if we want someone else to deal with administering a server

Blob stores

- Amazon, Google, and others want to let you use their platform to solve this!



Blob Stores



Typical workflow:

Client uploads file to your backend

Backend persists file to blob store

Backend saves link to file, e.g. in Firebase

Google Cloud Storage

- You get to store 5GB for free
- Setup

```
npm install --save @google-cloud/storage
```

```
var storage = require('@google-cloud/storage');

var fs = require('fs');

// Authenticating on a per-API-basis. You don't need to do this if you auth on a
// global basis (see Authentication section above).

var gcs = storage({
  projectId: 'grape-spaceship-123',
  keyFilename: '/path/to/keyfile.json'
});

// Create a new bucket.
gcs.createBucket('my-new-bucket', function(err, bucket) {
  if (!err) {
    // "my-new-bucket" was successfully created.
  }
});
```

- https://www.npmjs.com/package/google-cloud

Google Cloud Storage

```
// Reference an existing bucket.
var bucket = gcs.bucket('my-existing-bucket');

// Upload a local file to a new file to be created in your bucket.
bucket.upload('/photos/zoo/zebra.jpg', function(err, file) {
  if (!err) {
    // "zebra.jpg" is now in your bucket.
  }
});

// Download a file from your bucket.
bucket.file('giraffe.jpg').download({
  destination: '/photos/zoo/giraffe.jpg'
}, function(err) {});
```

Exercise: Where to Persist

- You are building a news aggregator site and want to recommend articles based on past articles the user has clicked on. Where should you persist this?

Exercise: Where to Persist

- You are building a shopping app and need to track a shopping card. How might you persist this?

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Readings for next time

- Firebase Get Started
  - https://firebase.google.com/docs/database/web/start
- Firebase Structure Data
  - https://firebase.google.com/docs/database/web/structure-data
- Firebase Read and Write Data
  - https://firebase.google.com/docs/database/web/read-and-write