

Scaling UI @ Xero

Josh Barr



Beautiful
accounting
software



Architect at Xero

Before that, Tech Director at Springload

Before that, Graphic Designer



“It’s just the navigation,
how hard can it be?”



A distributed product team is hard to wrangle!

~2000 staff

~900 people work in product

4 time zones for product development



We had a bug with this widget...

You're using a demo of Xero. When you're ready, set up an organisation with real data.

Add an organisation

Demo Company (NZ)

Josh Barr

Dashboard Accounts Payroll Projects Reports Adviser Contacts Settings + 📁 📧 🔍 ?

Business Bank Account
12-0102-0345678-000

Reconcile 28 items Balance in Xero 11,273.22 Statement balance (Nov 28) 18,214.67

No notifications

Future

YTD

xero

The screenshot shows the Xero dashboard for 'Demo Company (NZ)'. A blue bar at the top displays the company name and a message about using a demo. On the right, there's a user profile for 'Josh Barr' and a 'Add an organisation' button. Below the bar, a navigation menu includes 'Dashboard', 'Accounts', 'Payroll', 'Projects', 'Reports', 'Adviser', 'Contacts', 'Settings', and several icons. A blue box highlights the 'Notifications' icon (an envelope). A modal window titled 'Notifications' is open, showing the message 'No notifications' and a 'Future' section. The main dashboard area shows two bank accounts: 'Business Bank Account' and 'Business Savings Account', both with transaction history and reconciliation status. A large orange vertical rectangle highlights the entire right side of the screen, from the user profile down to the bottom of the page, indicating a visual bug where content is partially obscured by the sidebar or modal.

Releasing the fix took 2 months.

It involved raising PRs to twelve projects.

We had to coordinate 20 people in 3 countries.

To change a few lines of JS.



#Beautiful is one of our values.

This doesn't feel very #Beautiful.



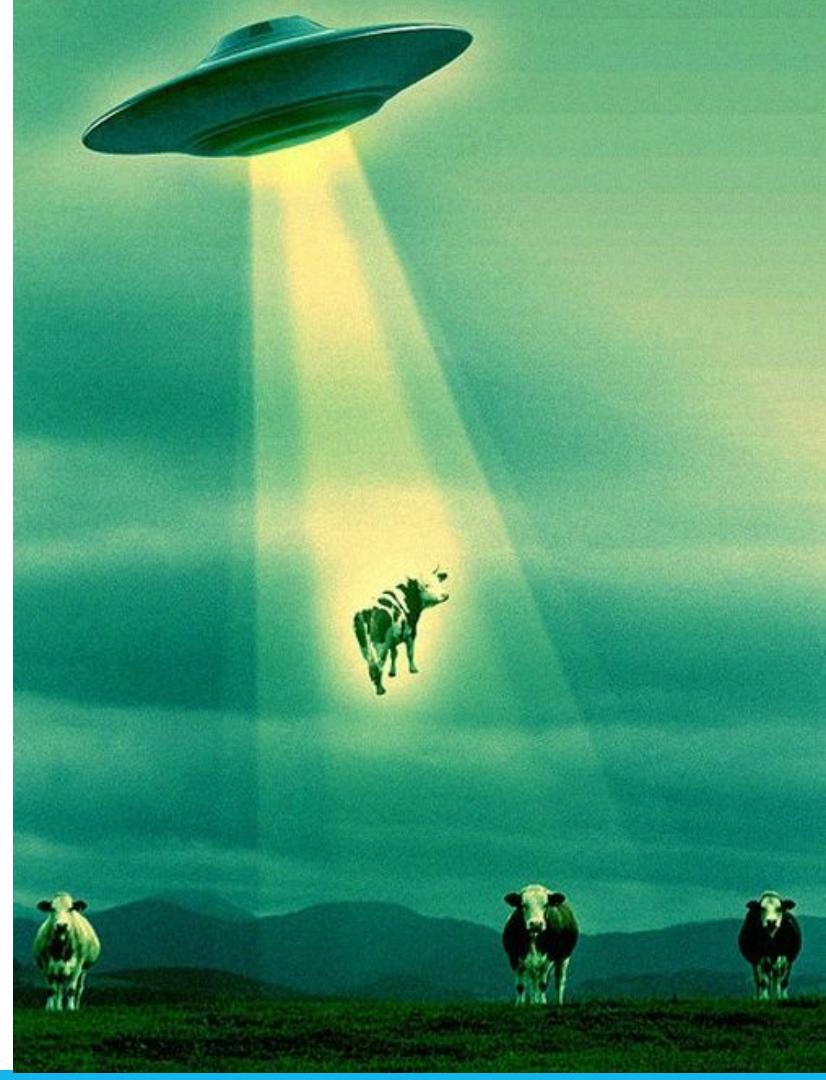
The big blue app

Xero has lots of web applications.

Some acquired (Payroll, Workflow Max)

Many of them built in house

About 16 in the “blue” product.



Teams run independent stacks for their apps

This screenshot shows the Xero Payroll Overview page. It displays basic payroll metrics: Total Wages Last Month (\$0.00), Upcoming Tax Obligations (\$0.00), and Next Pay Run Date (21 May). Below this is a 'Pay Runs' section with two tables: one for a weekly period ending 01 Jan 2017 (Total Amount \$15.63, Payment Date 04 Jan 2017, Status Draft) and another for a monthly period ending 30 Apr 2017 (Total Amount \$5,099.71, Payment Date 18 Feb 2017, Status Draft). At the bottom is a 'Leave to Approve' section.

This screenshot shows the Xero Fixed Assets page. It features a heading 'Track business assets to manage their depreciation and disposals' and a sub-section 'Import your existing asset registry to Xero via CSV or manually add assets'. Below this is a table listing three assets:

Asset Name	Asset Number	Asset Type	Purchase Date	Purchase Price
Deals, chairs, reception furniture for ...	FA-0004	Office Equipment	29 Nov 2016	\$3,000.00
Laptop (Tracy)	FA-0001	Computer Equipment	29 Nov 2016	\$1,699.99

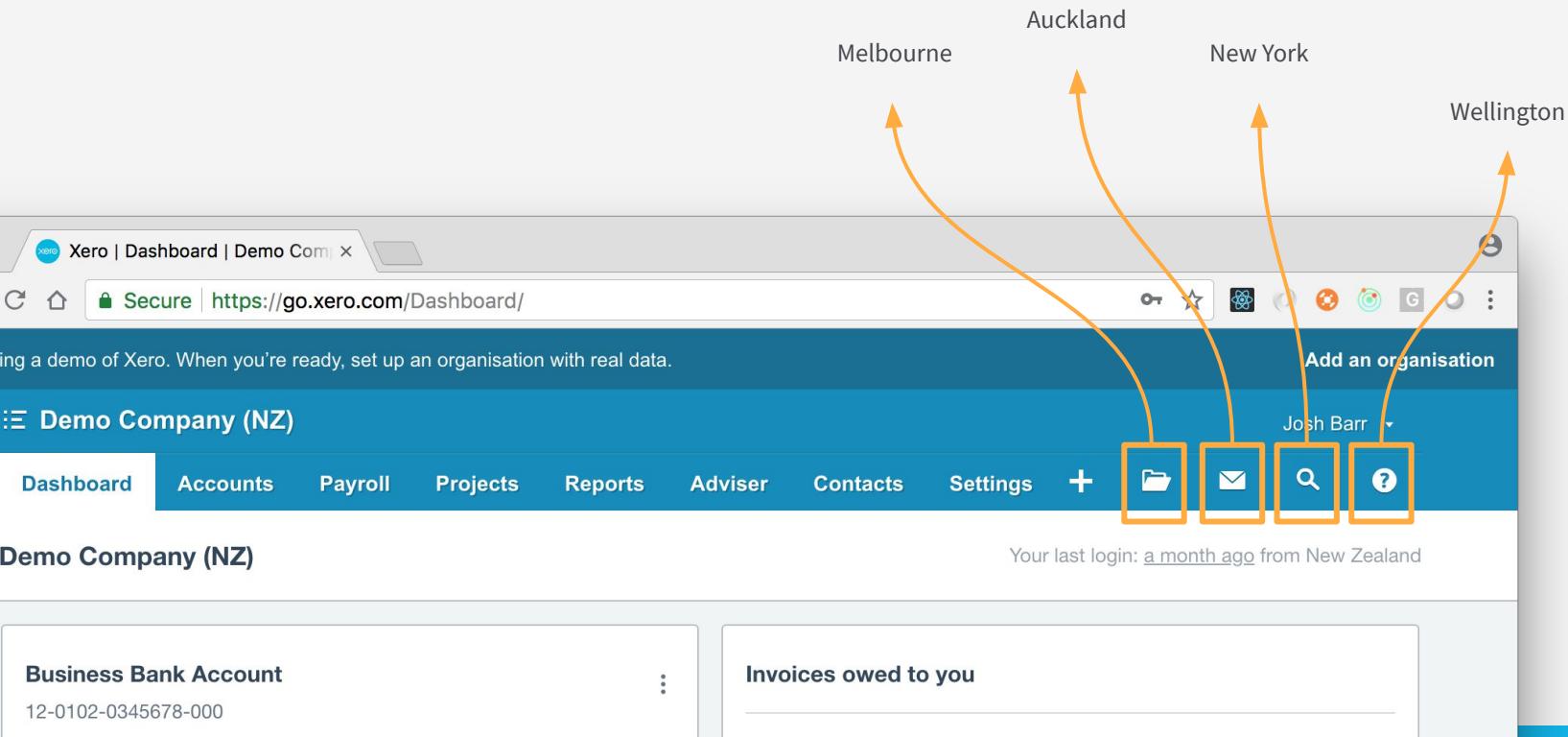
This screenshot shows the Xero Reports page. It has tabs for 'Summary', 'Custom', 'Adviser', 'Drafts', 'Published', and 'Archived'. On the left is a 'Financial' sidebar with links like Balance Sheet, Cash Summary, Profit and Loss, etc. On the right is a 'Sales' sidebar with links like Aged Receivables, Cash Detail, Customer Invoice Report, etc. Below these are sections for 'Tax' and 'Purchases'.

This screenshot shows the Xero Dashboard page. It includes a 'Business Bank Account' summary (12-0102-0345678-000) with a 'Reconcile 28 items' button, a 'Balance in Xero' of \$11,273.22, and a 'Statement balance (Nov 28)' of \$18,214.67. Below this is a chart showing bank activity from Jun 17 to Jul 15. To the right is an 'Invoices owed to you' section with a 'New sales invoice' button and a table of outstanding invoices:

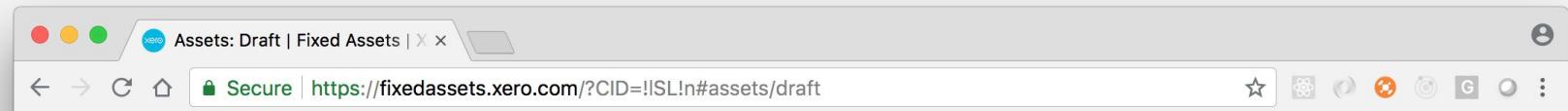
Type	Description	Amount
4 Draft invoices	1,151.69	
12 Awaiting payment	9,244.06	
12 Overdue	9,244.06	

This screenshot shows the Xero Projects page. It has tabs for 'Dashboard', 'Accounts', 'Payroll', 'Projects', 'Reports', 'Adviser', 'Contacts', 'Settings', and a 'Get started' button. The main content area features a heading 'Run your projects in Xero' and a paragraph encouraging users to enter time and costs, invoice, and track financial performance. At the bottom are 'Learn more' and 'Get started' buttons.

In-page widgets built in different cities



It's textbook Conway's law - right up to the DNS!



Vintage WSDL for getting menu

Custom renderer that only works with dotnet full framework

We have apps in node, python, dotnet core, etc.

```
<?wsdl:definitions xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/" xmlns:wsx="http://schemas.xmlsoap.org/ws/2004/09/wsdl/import-schema" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:tns="http://tempuri.org/" xmlns:soap="http://schemas.xmlsoap.org/soap/http" targetNamespace="http://tempuri.org/Imports">
    <?wsdl:import schemaLocation="http://xero.branch.navigation.xero-test.com/FixedAssetsHeaderBackChannel.svc?xsd1" />
    <?wsdl:import schemaLocation="http://xero.branch.navigation.xero-test.com/FixedAssetsHeaderBackChannel.svc?xsd2" />
    <?wsdl:import schemaLocation="http://xero.branch.navigation.xero-test.com/FixedAssetsHeaderBackChannel.svc?xsd3" />
    <?wsdl:import schemaLocation="http://xero.branch.navigation.xero-test.com/FixedAssetsHeaderBackChannel.svc?xsd4" />
    <?wsdl:import schemaLocation="http://xero.branch.navigation.xero-test.com/FixedAssetsHeaderBackChannel.svc?xsd5" />
    <?wsdl:import schemaLocation="http://xero.branch.navigation.xero-test.com/FixedAssetsHeaderBackChannel.svc?xsd6" />
    <?wsdl:types>
        <?wsdl:part name="parameters" element="tns:Ping"/>
    </?wsdl:types>
    <?wsdl:message name="IFixedAssetsHeaderBackChannel_Ping_InputMessage">
        <?wsdl:part name="parameters" element="tns:Ping"/>
    </?wsdl:message>
    <?wsdl:message name="IFixedAssetsHeaderBackChannel_Ping_OutputMessage">
        <?wsdl:part name="parameters" element="tns:PingResponse"/>
    </?wsdl:message>
    <?wsdl:message name="IFixedAssetsHeaderBackChannel_PingDependencies_InputMessage">
        <?wsdl:part name="parameters" element="tns:PingDependencies"/>
    </?wsdl:message>
    <?wsdl:message name="IFixedAssetsHeaderBackChannel_PingDependencies_OutputMessage">
        <?wsdl:part name="parameters" element="tns:PingDependenciesResponse"/>
    </?wsdl:message>
    <?wsdl:message name="IFixedAssetsHeaderBackChannel_GetHeaderModel_InputMessage">
        <?wsdl:part name="parameters" element="tns:GetHeaderModel"/>
    </?wsdl:message>
    <?wsdl:message name="IFixedAssetsHeaderBackChannel_GetHeaderModel_OutputMessage">
        <?wsdl:part name="parameters" element="tns:GetHeaderModelResponse"/>
    </?wsdl:message>
    <?wsdl:portType name="IFixedAssetsHeaderBackChannel">
        <?wsdl:operation name="Ping">
            <?wsdl:input wsaw:Action="http://tempuri.org/IDebug/Ping" message="tns:IFixedAssetsHeaderBackChannel_Ping_InputMessage"/>
            <?wsdl:output wsaw:Action="http://tempuri.org/IDebug/PingResponse" message="tns:IFixedAssetsHeaderBackChannel_Ping_OutputMessage"/>
        </?wsdl:operation>
        <?wsdl:operation name="PingDependencies">
            <?wsdl:input wsaw:Action="http://tempuri.org/IDebug/PingDependencies" message="tns:IFixedAssetsHeaderBackChannel_PingDependencies_InputMessage"/>
            <?wsdl:output wsaw:Action="http://tempuri.org/IDebug/PingDependenciesResponse" message="tns:IFixedAssetsHeaderBackChannel_PingDependencies_OutputMessage"/>
        </?wsdl:operation>
        <?wsdl:operation name="GetHeaderModel">
            <?wsdl:input wsaw:Action="http://tempuri.org/IFixedAssetsHeaderBackChannel/GetHeaderModel" message="tns:IFixedAssetsHeaderBackChannel_GetHeaderModel_InputMessage"/>
            <?wsdl:output wsaw:Action="http://tempuri.org/IFixedAssetsHeaderBackChannel/GetHeaderModelResponse" message="tns:IFixedAssetsHeaderBackChannel_GetHeaderModel_OutputMessage"/>
        </?wsdl:operation>
        <?wsdl:portType name="BasicHttpBinding_IFixedAssetsHeaderBackChannel" type="tns:IFixedAssetsHeaderBackChannel">
            <?wsdl:binding transport="http://schemas.xmlsoap.org/soap/http" />
            <?wsdl:operation name="Ping">
                <?wsdl:input>
                    <?soap:operation soapAction="http://tempuri.org/IDebug/Ping" style="document"/>
                    <?wsdl:input>
                        <?soap:body use="literal"/>
                    </?wsdl:input>
                    <?wsdl:output>
                        <?soap:body use="literal"/>
                    </?wsdl:output>
                </?wsdl:operation>
                <?wsdl:operation name="PingDependencies">
                    <?soap:operation soapAction="http://tempuri.org/IDebug/PingDependencies" style="document"/>
                    <?wsdl:input>
                        <?soap:body use="literal"/>
                    </?wsdl:input>
                    <?wsdl:output>
                        <?soap:body use="literal"/>
                    </?wsdl:output>
                </?wsdl:operation>
                <?wsdl:operation name="GetHeaderModel">
                    <?soap:operation soapAction="http://tempuri.org/IFixedAssetsHeaderBackChannel/GetHeaderModel" style="document"/>
                    <?wsdl:input>
                        <?soap:body use="literal"/>
                    </?wsdl:input>
                    <?wsdl:output>
                        <?soap:body use="literal"/>
                    </?wsdl:output>
                </?wsdl:operation>
            </?wsdl:binding>
            <?wsdl:service name="FixedAssetsHeaderBackChannel">
                <?wsdl:port name="BasicHttpBinding_IFixedAssetsHeaderBackChannel" binding="tns:BasicHttpBinding_IFixedAssetsHeaderBackChannel"/>
                <?soap:address location="http://xero.branch.navigation.xero-test.com/FixedAssetsHeaderBackChannel.svc"/>
            </?wsdl:port>
        </?wsdl:service>
    </?wsdl:definitions>
```

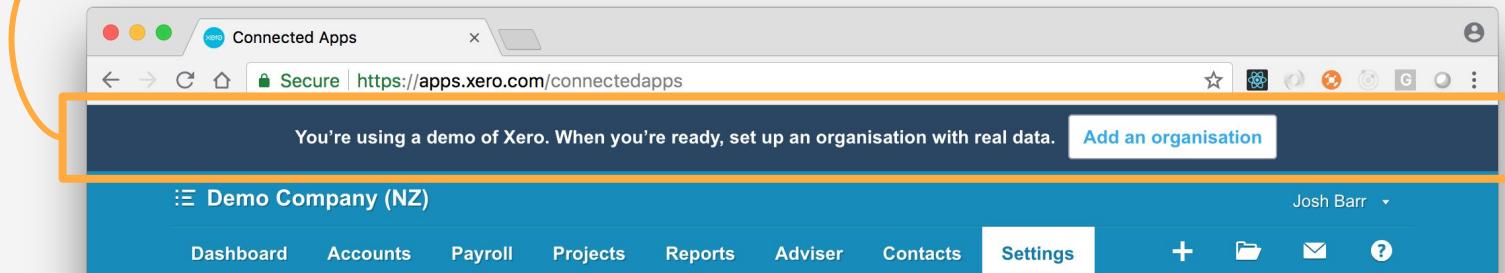
Can't easily iterate on our wayfinding system

Can't respond quickly to potential vulnerabilities

Teams can't choose their tech stack

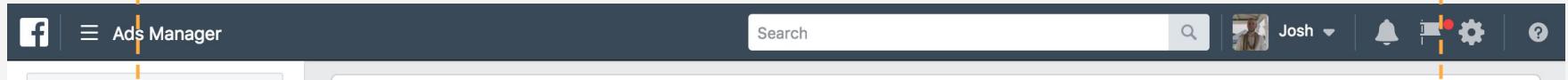
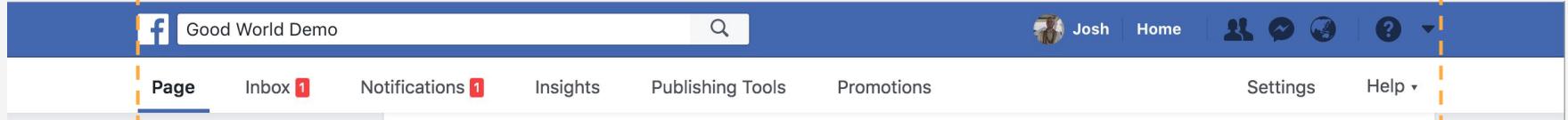
Apps are diverging (sometimes in subtle ways)

Why does this widget look different on this one page?

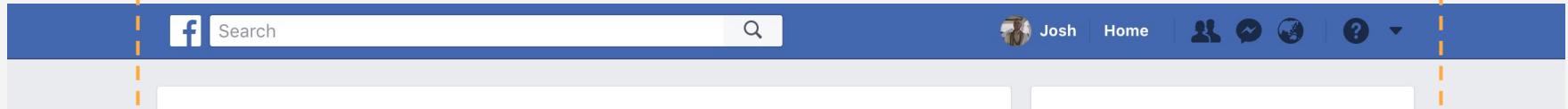


We're not the only ones to have
these kinds of challenges.





Different design!



Different width!



We want to:

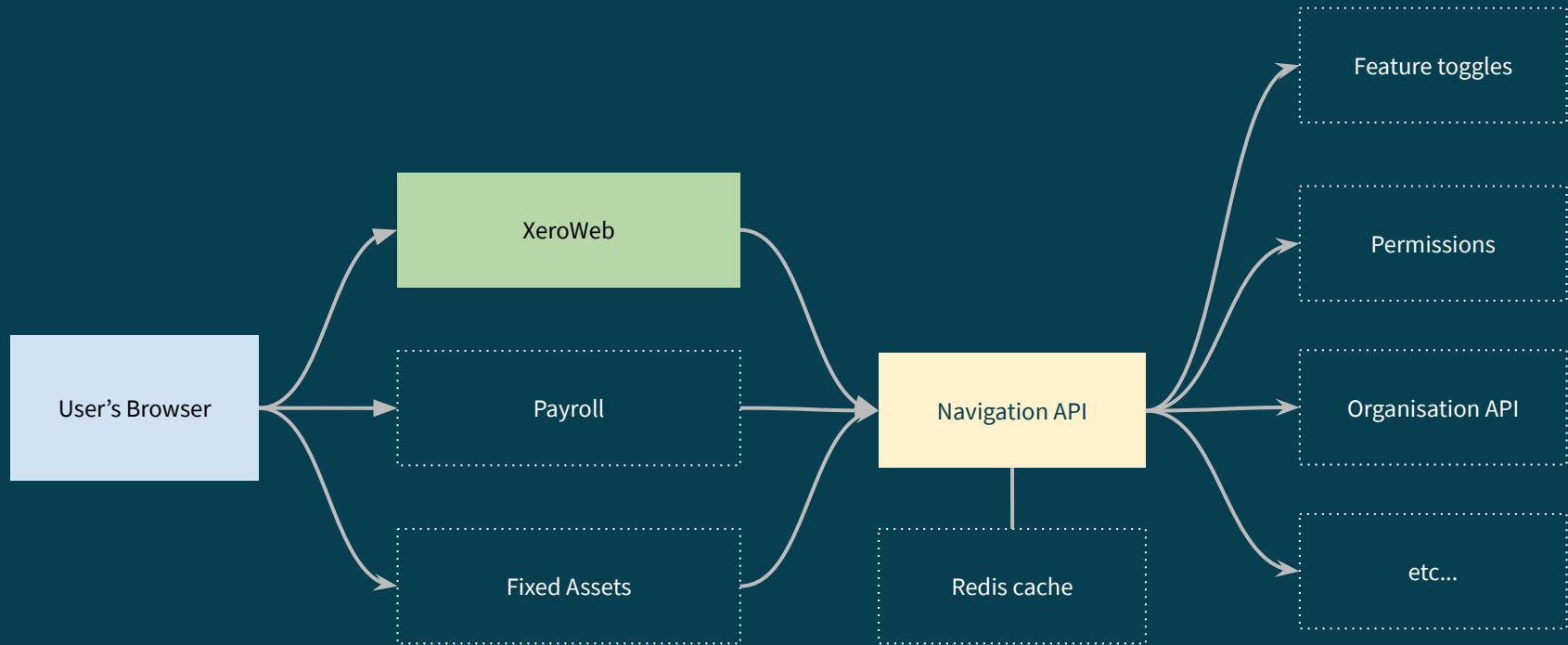
Change the wayfinding quickly

Show wayfinding experiments to different users

Ship cross-cutting UI features to all 16 apps



Aggregation API for Navigation



A really simple API contract

```
{  
  "header": "[a blob of JSON]",  
  "headerAssets": {  
    "js": {  
      "uri": "https://edge.xero.com/platform/header/3.2.0/scripts/header.min.js"  
    },  
    "css": {  
      "uri": "https://edge.xero.com/platform/header/3.2.0/stylesheets/all.css"  
    }  
  }  
}
```



A really simple API contract

```
{  
  "header": "[a blob of JSON]",  
  "headerAssets": {  
    "js": {  
      "uri": "https://edge.xero.com/platform/header/3.2.0/scripts/header.min.js"  
    },  
    "css": {  
      "uri": "https://edge.xero.com/platform/header/3.2.0/stylesheets/all.css"  
    }  
  }  
}
```



Supply everything a team needs to show the navigation in a single response



Minimum viable Xero page

```
<html>
  <head>
    <link href="{{ response.headerAssets.css.uri }}" rel="stylesheet" type="text/css">
  </head>
  <body>
    <div id="header"></div>
    <script type="application/json" id="header-data" data-render-to="#header">
      {{ response.header }}
    </script>
    <script src="{{ response.headerAssets.js.uri }}" type="text/javascript"></script>
  </body>
</html>
```



That was easy!

Push to master, deploy, profit ... right?



SCALE

OH NOES!



Xero handles a lot of web traffic

1000

Req/sec

1m+

Monthly active users



A central navigation API is a calculated risk:

Participates in every page request across the web platform

Sustained high load (50 million requests/day at peak)

Data from several sources (favourites, contacts, permissions, etc)

Needs to be very fault tolerant.

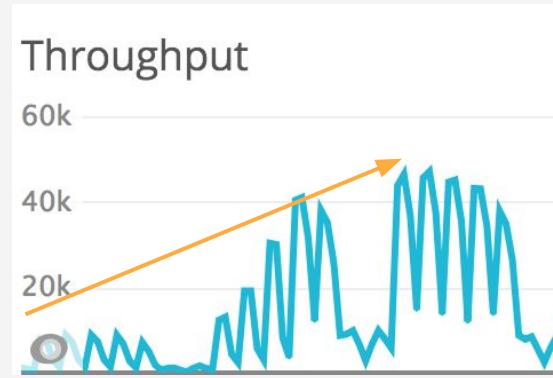


Migration strategy: Watch & learn.

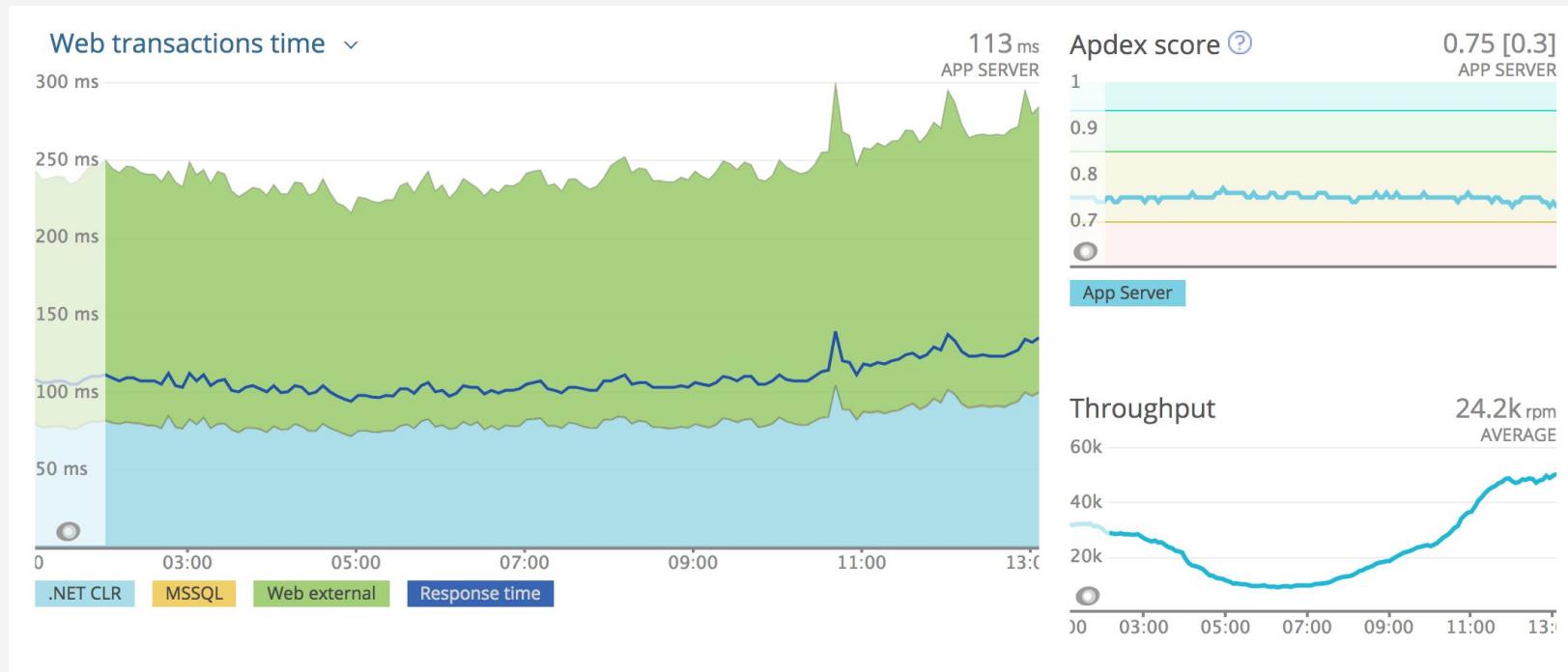
Pick an “off peak” time of the year.

Migrated lower traffic apps first, over a week

Migrated main app incrementally over the second week

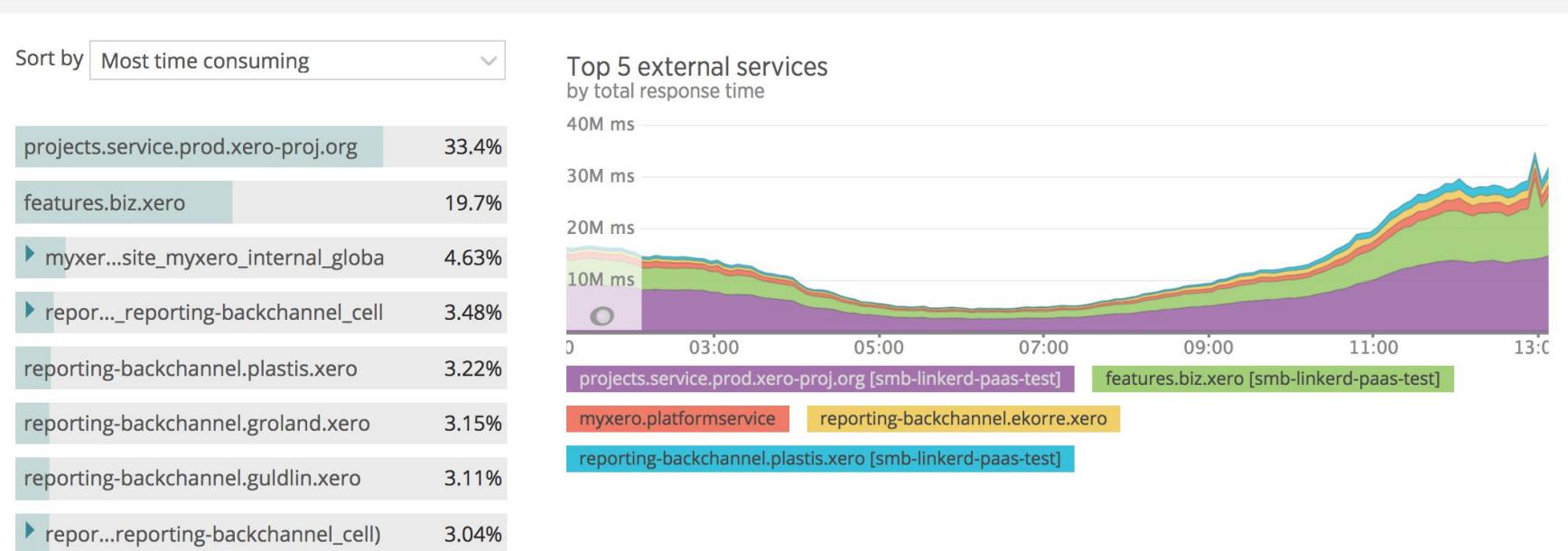


NewRelic APM has been our eyes and ears



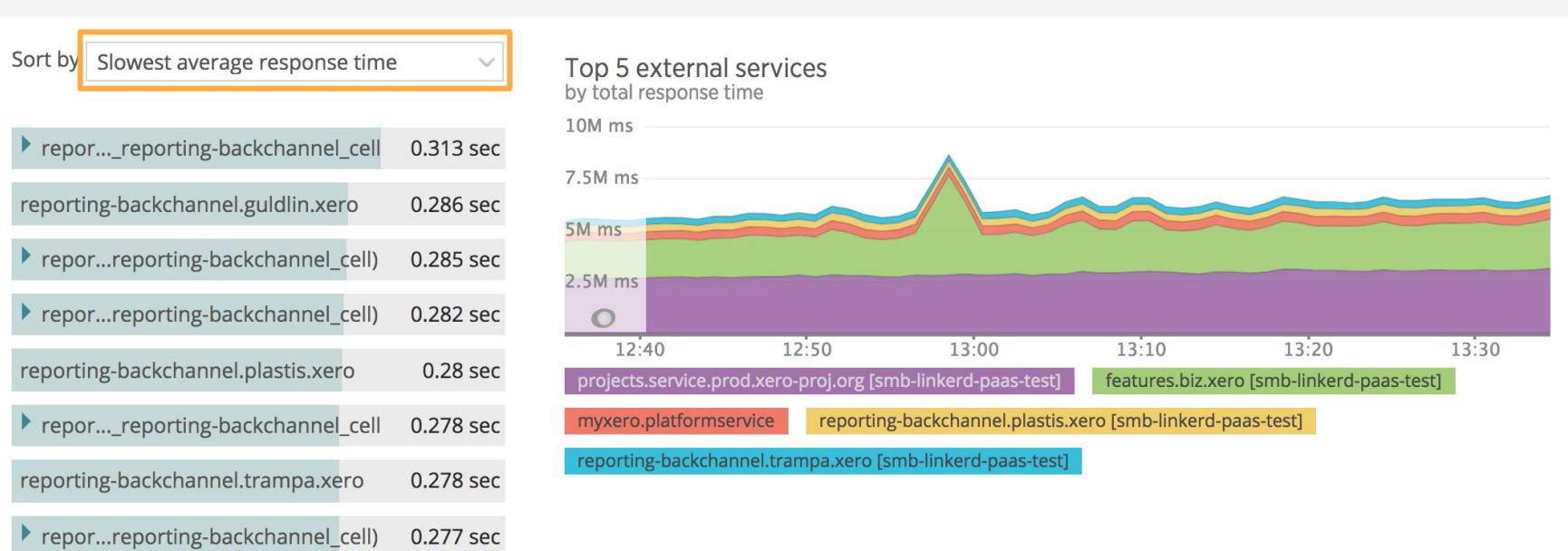
Debugging slowness in External Services

APM is really, really good at this!

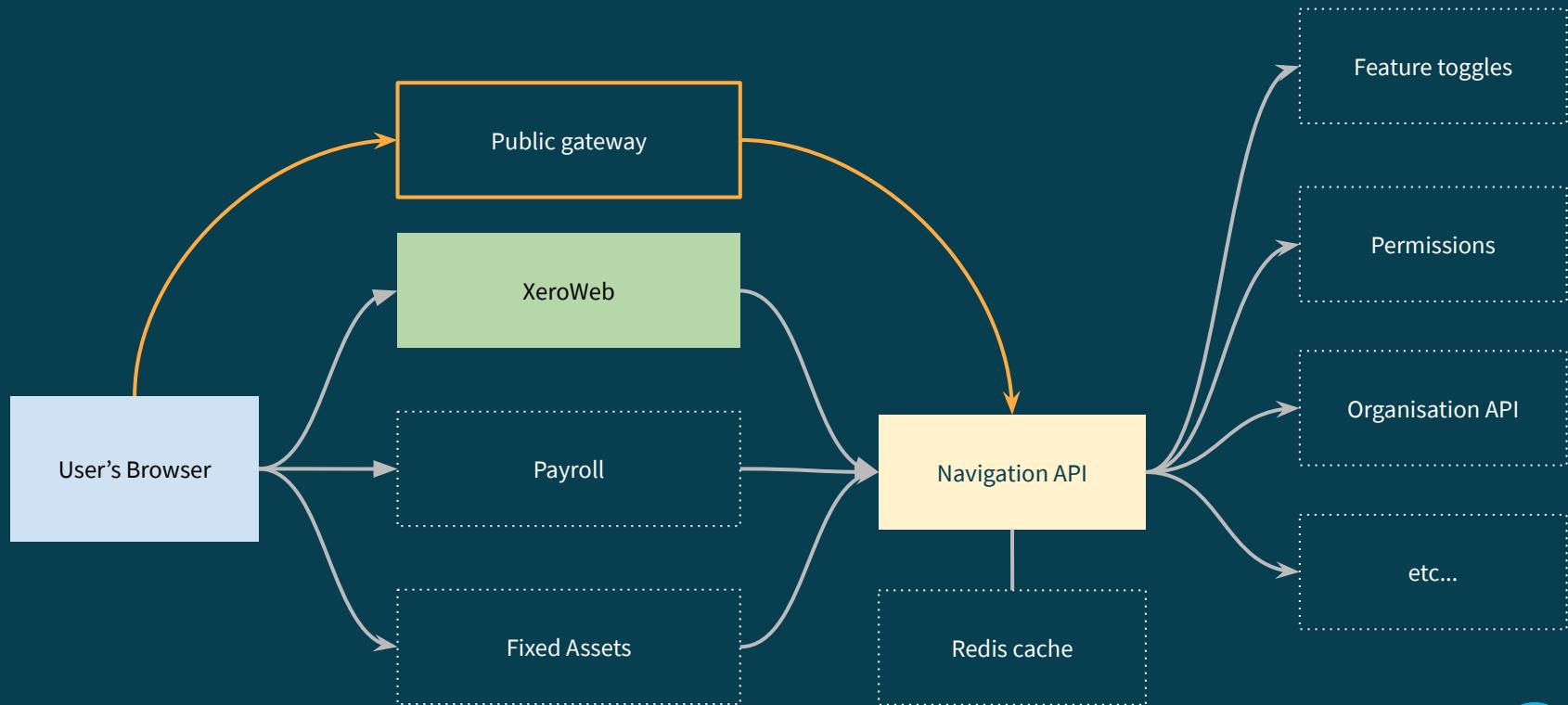


Sometimes, things just take the time they take.

We couldn't make some dependencies any faster



Back to the drawing board



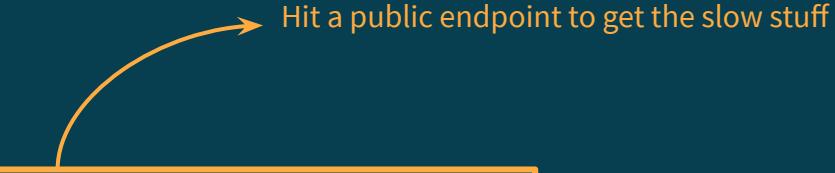
Splitting the workload into fast and slow queries

```
{  
  "header": {  
    "fast-stuff": "goes here..."  
  },  
  "endpoints": {  
    "groups": {  
      "url": "https://go.xero.com/api/navigation/public/v3/groups",  
      "authorization": "AfDJ8Lp9aDvXkVIqhpKUrZdiPrs7Qh1F0dKJ...."  
    }  
  }  
}
```



Splitting the workload into fast and slow queries

```
{  
  "header": {  
    "fast-stuff": "goes here..."  
  },  
  "endpoints": {  
    "groups": {  
      "url": "https://go.xero.com/api/navigation/public/v3/groups",  
      "authorization": "AfDJ8Lp9aDvXkVIqhpKUrZdiPrs7Qh1F0dKJ...."  
    }  
  }  
}
```



Favourites are fetched asynchronously after page load

```
Name x Headers Preview Response Timing  
preview?userId=d7611330-435c...  
xui.min.css  
all.css  
header.js  
_70x70.jpg  
header-2x-s9dd413a45b.png  
groups  
app.js  
help.js  
mixpanel-loader.min.js  
organisations  
styles.css  
mixpanel-2.2-XERO.min.js  
?data=eyJldmVudCI6ICJtcF9wY...  
▼ {...}  
  ▼ navGroups: [{navigationId: "reports", groups: [{label: "Favourites",...}]}]  
    ▶ 0: {navigationId: "reports", groups: [{label: "Favourites",...}]}  
      ▼ groups: [{label: "Favourites",...},...]  
        ▶ 0: {label: "Favourites",...}  
          id: "report-favourites"  
          label: "Favourites"  
        ▼ menuItems: [{label: "Aged Payables",...}, {label: "Aged Receivables",...}, {label: "Balance Sheet",...}, {label: "Cash Summary",...}, {label: "GST Return",...}, {label: "Profit and Loss",...}]  
          ▶ 0: {label: "Aged Payables",...}  
          ▶ 1: {label: "Aged Receivables",...}  
          ▶ 2: {label: "Balance Sheet",...}  
          ▶ 3: {label: "Cash Summary",...}  
          ▶ 4: {label: "GST Return",...}  
          ▶ 5: {label: "Profit and Loss",...}  
        ▶ 1: {label: "Adviser Favourites", menuItems: [], id: "adviser-report-favourites", label: "Adviser Favourites", menuItems: []}  
          navigationId: "reports"  
        ▶ 1: {navigationId: "contacts",...}  
        ▶ 2: {navigationId: "settings",...}
```



The “shell” of the navigation is delivered quickly (35% under 10ms)

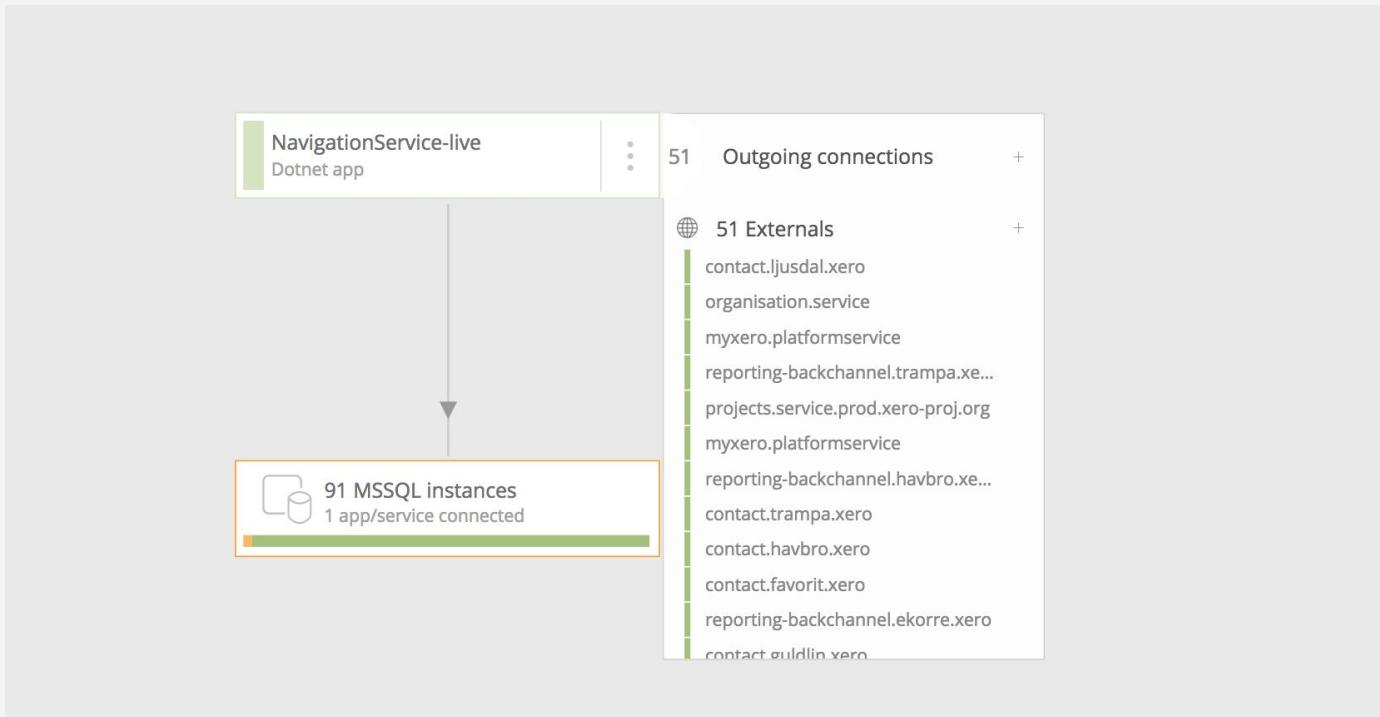
Expensive queries don’t block the page load

We can keep making this faster!



What about when things go wrong?

We depend on lots of other stuff.

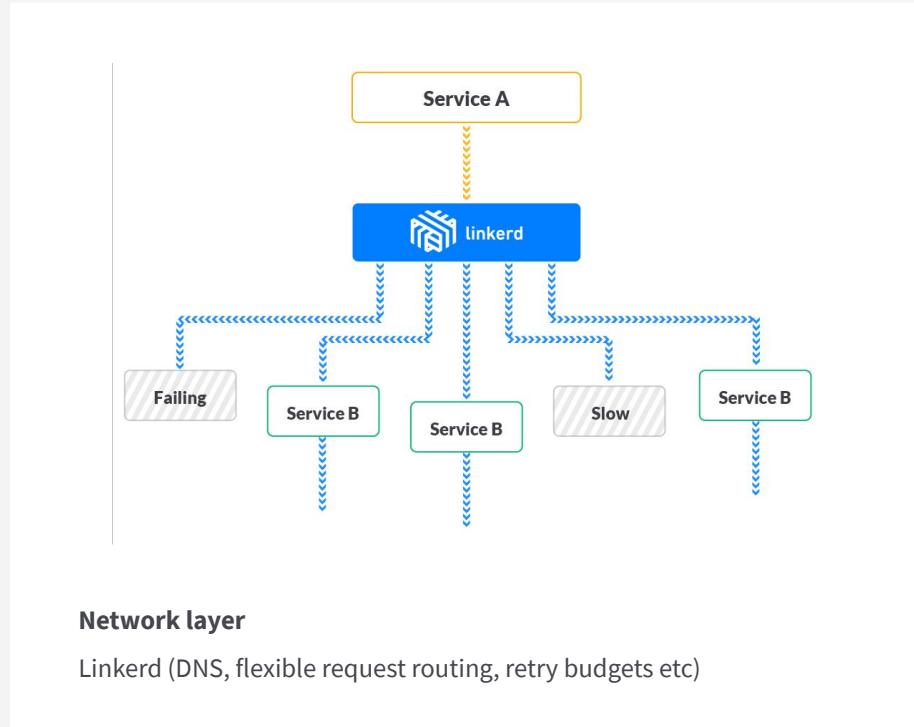


Fault tolerance in HTTP



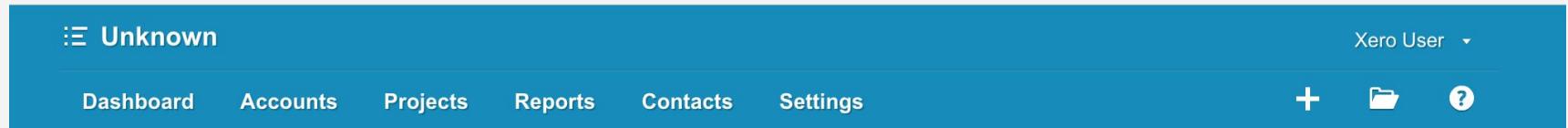
In process:

Polly (retries, timeouts, circuit breaker)



Keep the lights on!

Do everything we can to avoid returning 500



Handling 50 million requests/day

8

c5.xlarges

25

Docker containers

1

t2.small Redis



This isn't perfect – but it's a huge step forward for managing our super-distributed product UI.

Now that we've built the plumbing, we can start exploring Service Workers, adding Local Storage caching, etc.



I'll be writing something for our dev blog about this.

There's lots more to cover off (Service meshing with linkerd,
optimised logging, dotnet core deployments)

<https://devblog.xero.com/>



