Five API Styles

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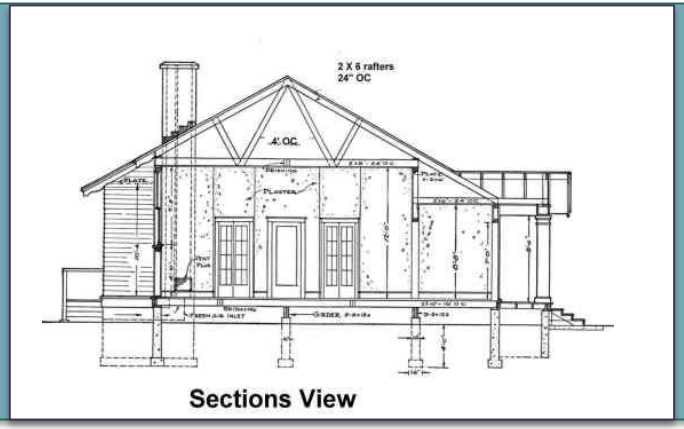
Why API Styles?

- Architects of networked/distributed applications have many decisions to make
- Technology changing quickly, new implementations every year:
  - graphQL, gRPC, Kafka, HAL+Forms
- Which *models* of component interaction work best?

The Value of Styles for the Designer

Design a House



Sections View

Design a *Victorian Style* House

Styles, Not Standards

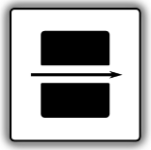
- Standards
  “Usually a formal document that establishes uniform engineering or technical criteria, methods, processes and practices.”

Standards

- **IETF** (HTTP, URI, Basic Auth, etc.)
- **W3C** (SOAP, HTML, RDF, etc.)
- **OASIS** (ebXML, DocBook, WS-Security, etc.)

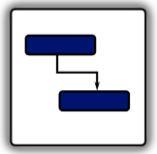
The Value of Styles for the Designer

- Styles describe:
  - Characteristics
  - Vocabulary
  - Constraints
- The style is a loose set of rules – the rules become a guide
- Styles help designers communicate



Tunnel Style

URI Style



Hypermedia Style

Query Style

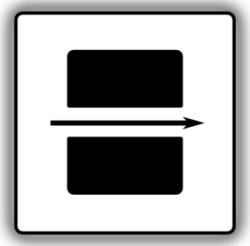
Event Driven Style

Style Implementation Considerations

Five properties to consider:

- Scalability
- Usability
- Changeability
- Performance
- Reliability

Tunnel Style



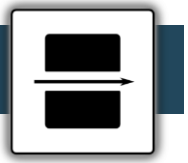
Tunnel Style: Overview

- Application Layer Protocol with a type system and operations
- HTTP is not usually required (protocol agnostic)
- RPC Interaction
- Examples:
  - XML-RPC (1998)
  - SOAP 1.0 (1999)
  - SOAP 1.2 (2003)
  - JSON-RPC (2005)
  - gRPC (2016)

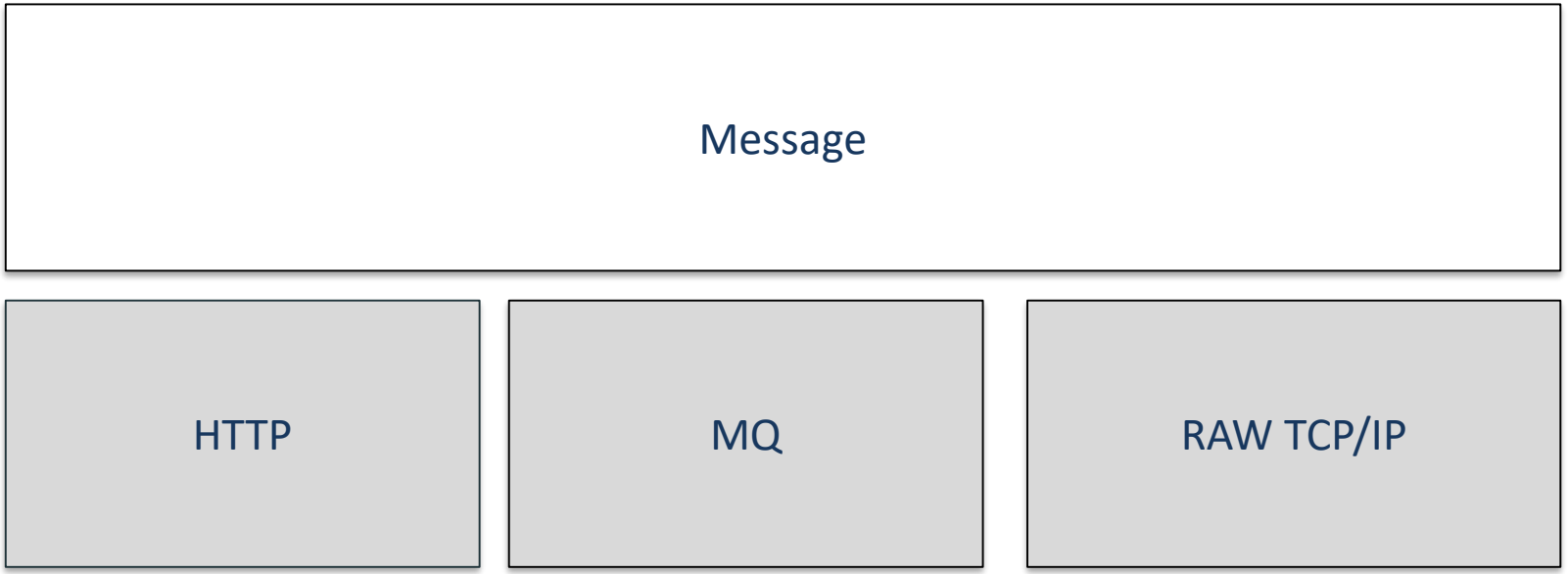
Tunnel Style: Characteristics

- Type and Specification Driven (XML-*, WS-*, Protocol Buffers)
- Procedure/Operation based design (“RPC”)
- Similar to imperative programming interfaces

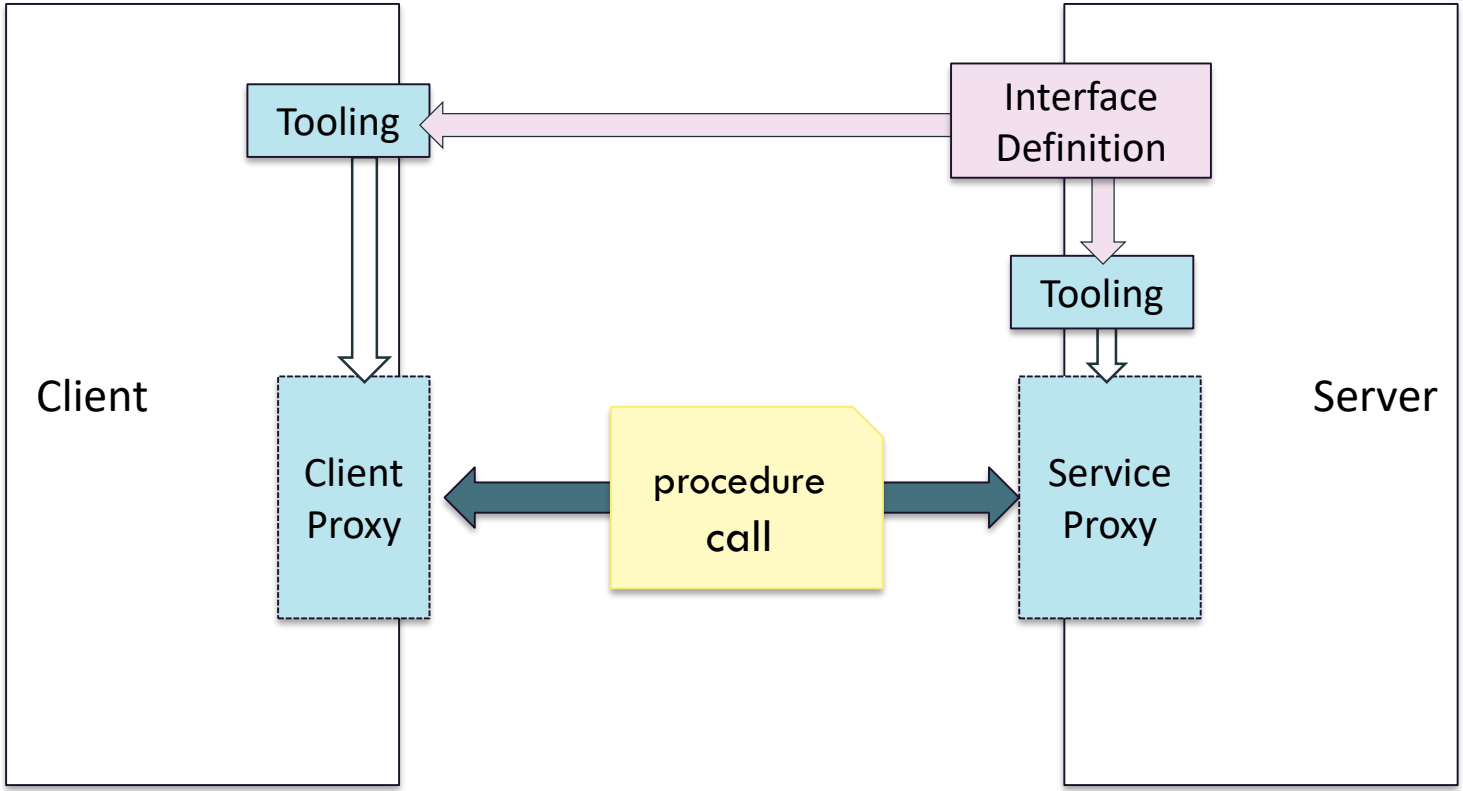
Tunnel Style: Primary Constraint



No dependencies on transport layer protocol



Tunnel Style: Common Implementation Model



Tunnel Style: Benefits

- RPC style is familiar to many developers and architects
- Support for heterogeneous networks
- Messages can be optimized for point-to-point performance (reduced size, reduced latency)

Tunnel Style: Limitations

- Ignores HTTP features (caching, etc.)
- Limited tooling in mobile and web stacks
- Change is often costly (highly typed, tightly-coupled)

URI Style

URI Style: Overview

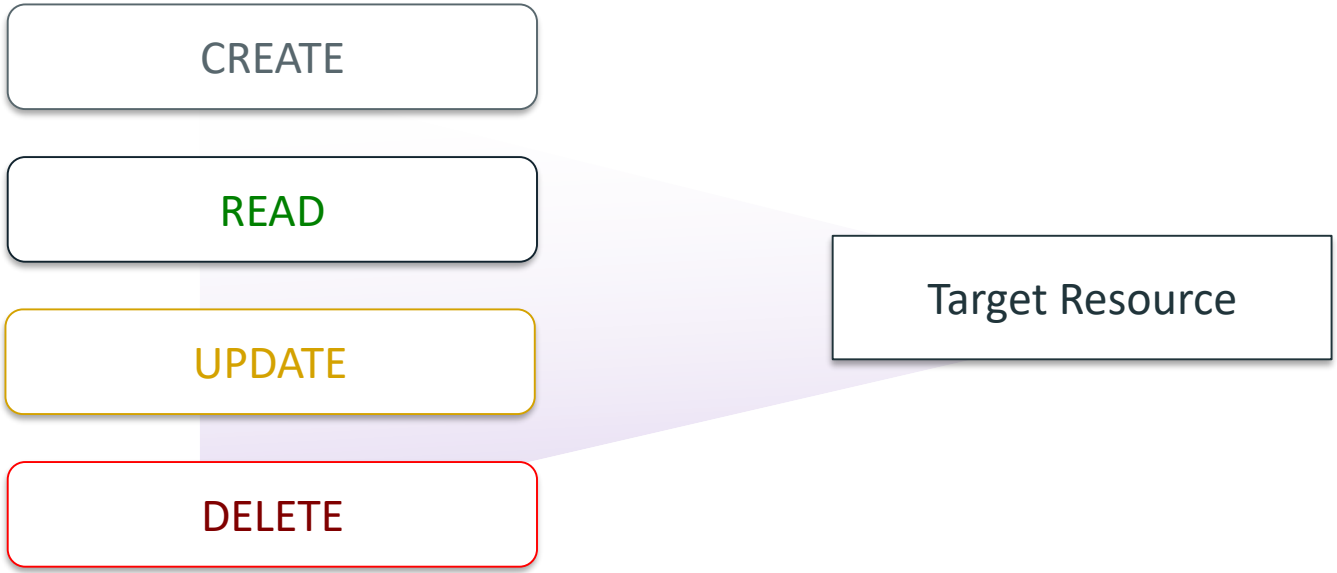
- Uses **C**reate, **R**ead, **U**pdate, **D**elete (CRUD) interaction pattern
- URI points to a target
- Uses HTTP only

URI Style: Characteristics

- Use HTTP standard
- **Object** first design
- **Convention** driven
- Similar to data object interactions (DAO)

URI Style: Primary Constraint

- Interactions must use the CRUD Pattern



URI Style: Example

GET `http://myapi.com/students`

- GET is used for Retrieval (Read)
- http://myapi.com/students points to a collection of student records
- This request means “retrieve a list of student records”

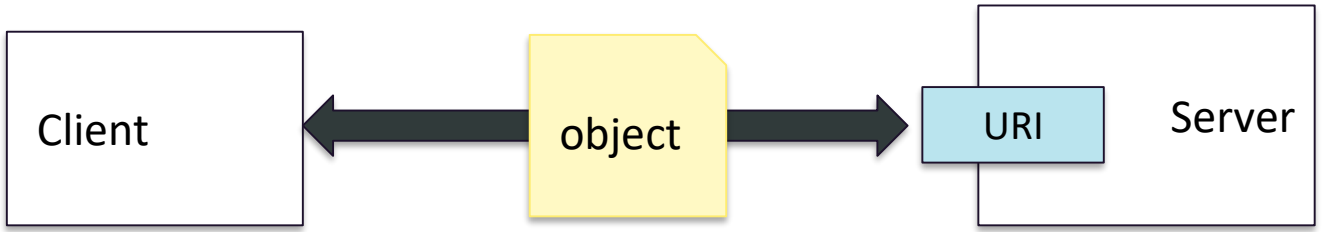
URI Style: Protocol Stack

MIME (for representation)
XML, JSON, CSV, etc…

URI (for identification)
RFC 3986

HTTP (transport)
RFC 7231 et al

URI Style: Common Implementation



URI Style: Ideal for Data-Centric APIs

Frontend
(client)

INPUT HANDLING

APPLICATION LOGIC

LAYOUT | IMAGES | TEXT

Backend
(server)

DATA-CENTRIC API

WEATHER DATA

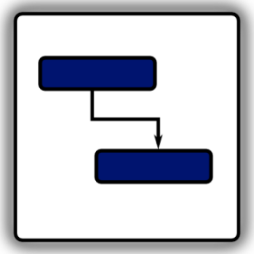
URI Style: Benefits

- HTTP path & query is a “well known” – improved usability for many developers
- CRUD pattern is simple and a good fit for “data service” pattern
- Large ecosystem of tools and frameworks today

URI Style: Limitations

- CRUD pattern is limited
- URI modelling is not standard – every API is a “snowflake”
  - Internal domains can benefit from a style guide
  - External domains (partner/public) may suffer
- Can be “chatty” (esp. when the object passing pattern is used)
- API changes usually require client changes, cost is magnified by scale of client components

Hypermedia Style



Hypermedia Style: Overview

- An API with hypermedia features
- A **browser-like** experience for machines
- Implemented with links and forms
- Example:
  - REST (Roy Fielding dissertation)

Hypermedia Style: Characteristics

- Focus on transitions
- URI is not an object key
- Messages are self-documenting

Hypermedia Style: Primary Constraint

- Uniform Interface
  - Identification of resources
  - Manipulation of resources through representations
  - Self-descriptive messages
  - Hypermedia as the engine of application state

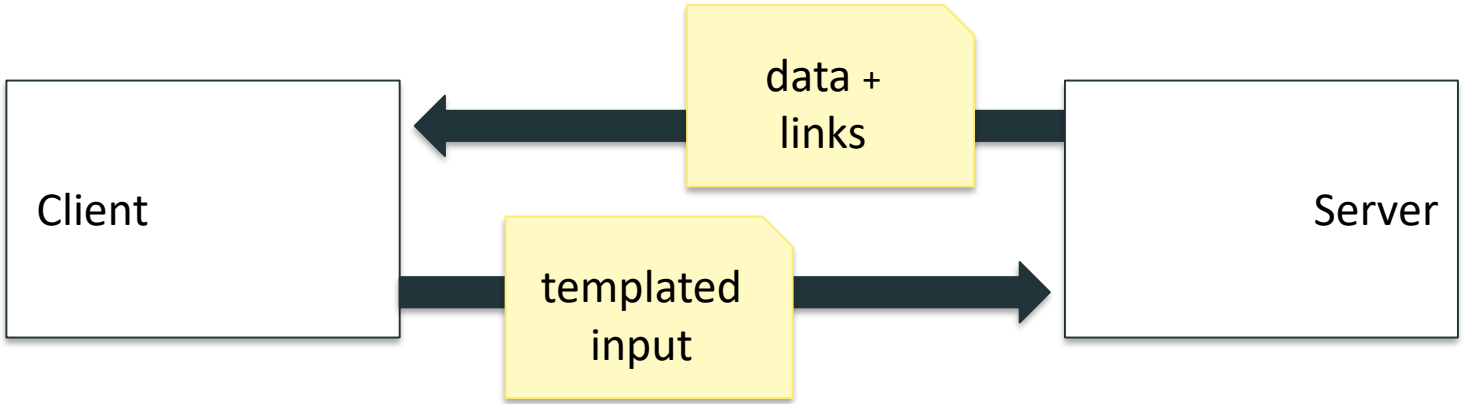
Hypermedia Style: Protocol Stack

Profiles and Link Relations
hCard, next, prev, etc..

Media Type
HTML, ATOM, HAL+JSON, Collection+JSON, etc..

Transport Protocol
HTTP, COAP, etc…

Hypermedia Style: Common Implementation



Hypermedia Style Example: Links

- Links tell the client what it can do next

```
<html>
<body>
<h1>Student Records</h1>
<a href=“/detail?id=3”>Ronnie Mitra</a>
</body>
</html>
```

Hypermedia Style Example: Links in JSON

```
{
   “name”: “Ronnie”,
   “enrollment-year”: “2014”
}
```

A URI Style JSON Response

Hypermedia Style Example: Links in JSON

```
{
   “name”: “Ronnie”,
   “enrollment-year”: “2014”
}
```

A URI Style JSON Response

```
{
   “name”: “Ronnie”,
   “enrollment-year”: “2014”,
   “_address_details”: “/student/ronnie/address”
}
```

A Hypermedia Style JSON Response

Hypermedia Style Example: Generic Data

```
{
   “name”: “Ronnie”,
   “enrollment-year”: “2014”,
   “_address_details”: “/student/ronnie/address”
}
```

Hypermedia Style Example: Generic Data

```
{
   “data”: [
    {“name”: “student-name”, “value”: “Ronnie”},
    {“name”: “enrollment-year”, “value”: “2014”}
    ],
   “_address_details”: “/student/ronnie/address”
}
```

Hypermedia Style Example: Generic Links

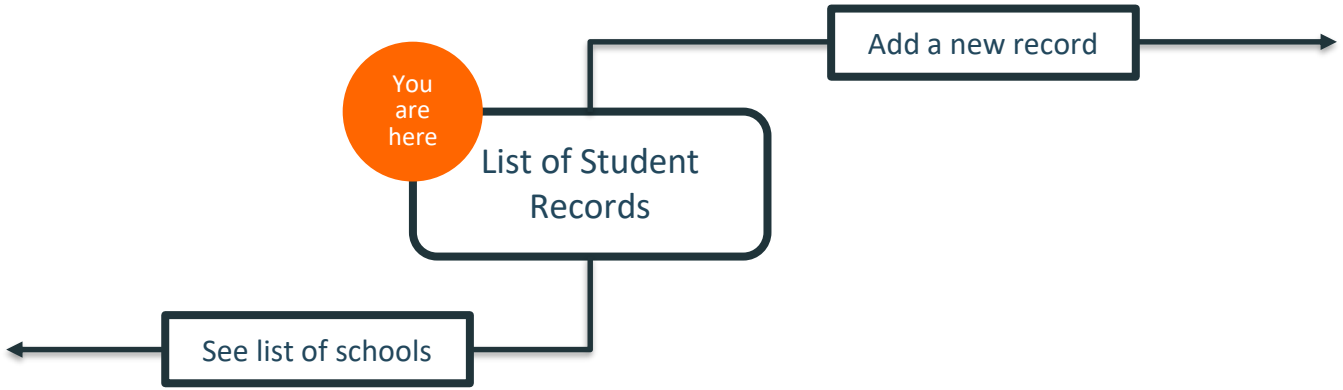
```
{
   “data”: [
    {“name”: “student-name”, “value”: “Ronnie”},
    {“name”: “enrollment-year”, “value”: “2014”}
    ],
   “_address_details”: “/student/ronnie/address”
}
```

Hypermedia Style Example: Generic Links

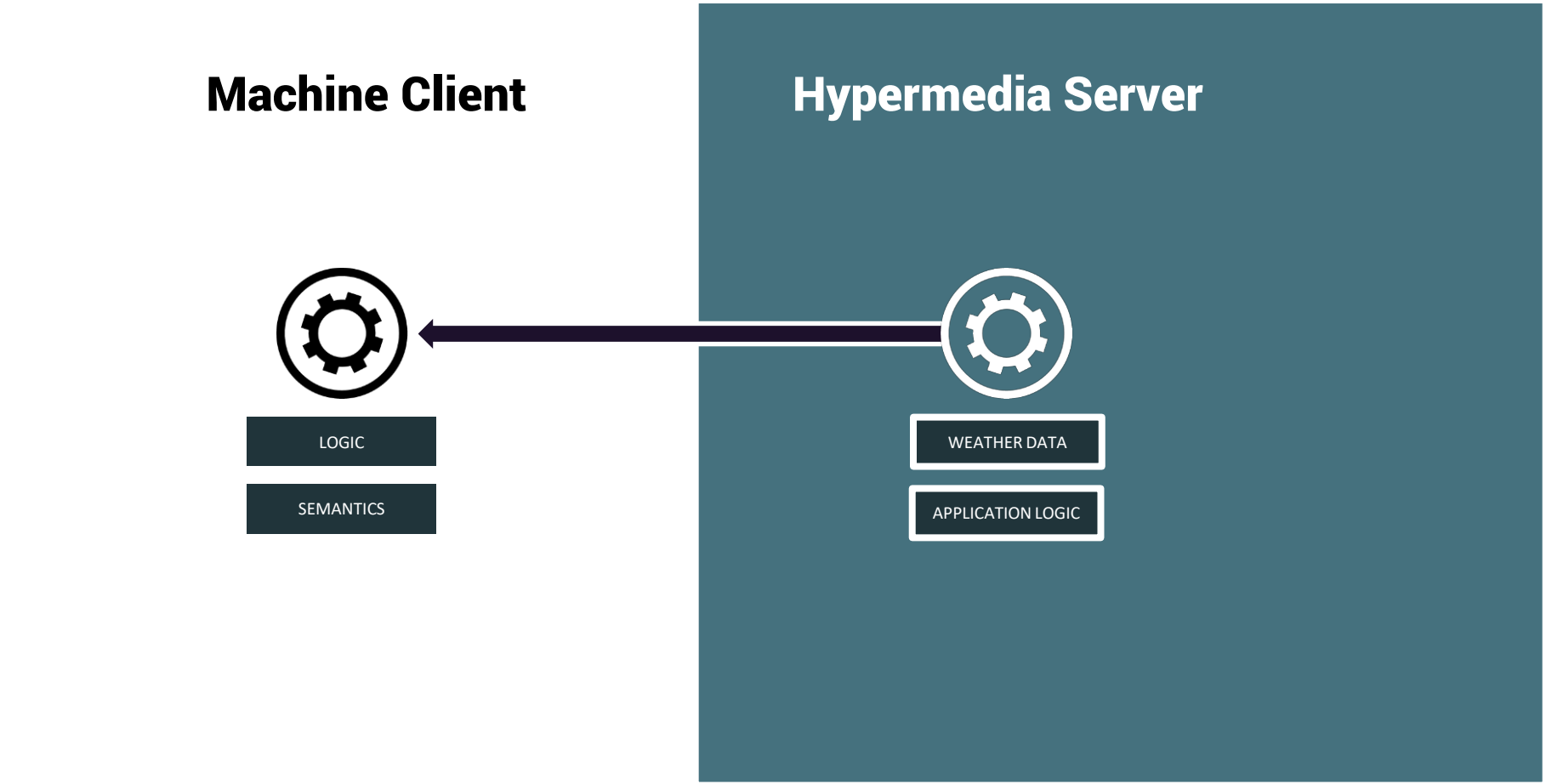
```
{
   “data”: [
    {“name”: “student-name”, “value”: “Ronnie”},
    {“name”: “enrollment-year”, “value”: “2014”}
    ],
   “_links”: [
      {“rel”: “address”, “href”: “/student/ronnie/address”}
   ]
}
```

Hypermedia Style: State Machine

- Each message represents the *current* state of the application
- Links tell the client what it can do *next*
- The client *changes* application state by following links



Hypermedia Style: Server to Server



Hypermedia Style: Mobile Client

Human Facing Client

INPUT HANDLING

LAYOUT | IMAGES | TEXT

SEMANTICS

Hypermedia Server

WEATHER DATA

APPLICATION LOGIC

Hypermedia Style: “Browser” Client

Human Facing Client

INPUT HANDLING

Hypermedia Server

WEATHER DATA

APPLICATION LOGIC

LAYOUT | IMAGES | TEXT

Hypermedia Style: Benefits

- Applications are easier to change (less client code changes required)
- Favours long running and large scale applications
- Takes advantage of the WWW architecture

Hypermedia Style: Limitations

- Short-term benefits are limited – big up front cost today
- Assumed “esoteric”, “too hard”, etc.
- Clients are non-trivial to build
- Messages are verbose – not optimized for message size

Query Style

Query Style: Overview

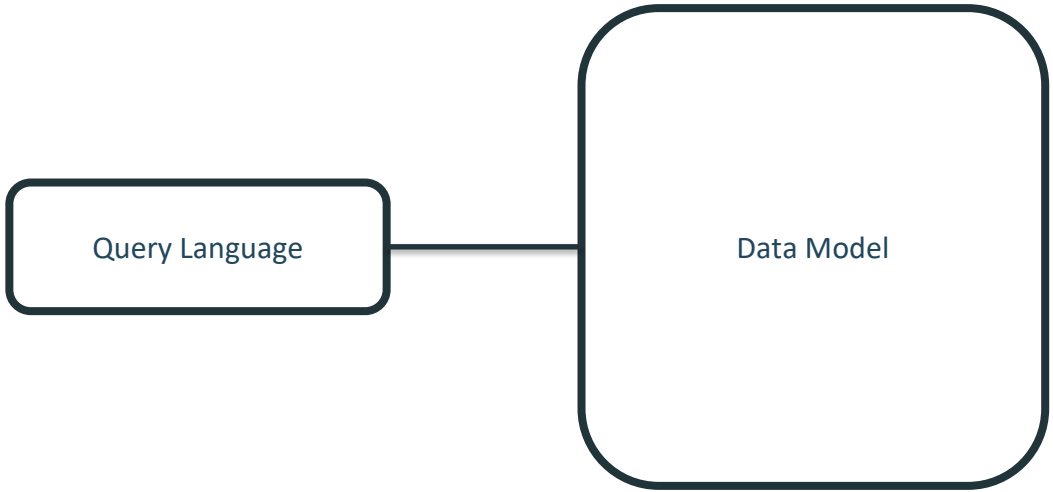
- Interaction optimized and standardized for *querying* functions
- Learn the location of API and run queries against the data
- Suitable for any transport protocol that supports client-server interactions (usually supports HTTP)
- Examples:
  - graphQL
  - sparQL
  - ODBC
  - ql.io

Query Style: Characteristics

- Treats the API as a *data source*
- A *Query Language* is defined and standardized (not just generic support)
- Focus is on reading and writing data

Query Style: Primary Constraint

- Interactions and data model are constrained by the *query language*



Query Style Example: GraphQL

POST http://myapi.com/graphql

```
{
 “query”: “
    {
      student {
        name
        age
      }
    }
  ”
}
```

Query Style: Protocol Stack

Query Interface Language
X, Y, etc…

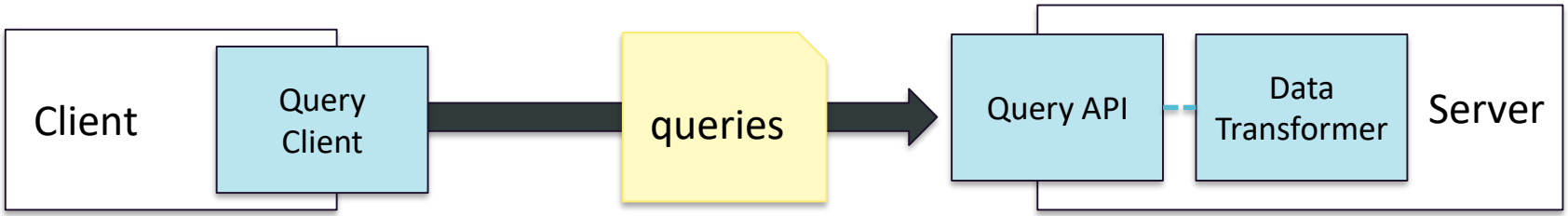
Data Model
Relational, CRUD, etc…

Client-Server Transport Protocol

Query Style: Common Implementation

?

- Implement data transformation components on the server to support the standardized *Data Model*
- Bind a *Query Language* API to the data transformation
- Client implements a client query library
- Client uses query client to work with data (in RPC fashion)



Query Style: Benefits

- All clients and servers that support query standard can interact easily
- Standardizing on language makes tooling possible:
  - Data inspection tools
  - Frameworks and libraries for clients and servers
- Ideal choice for data-centric apps (e.g. mobile apps)

Query Style: Limitations

- Features are limited to query language functions
  - How do you mutate data?
  - What is the performance profile?
  - How can you perform non-query operations?
- Difficult to use if data model doesn’t match the client’s needs
- Changes to data model may require client code changes

Event-Driven Style

Event-Driven Style: Overview

- Fire and receive “events”
- Asynchronous interactions (one-way)
- Sender/Receiver instead of Client/Server
- Examples:
  - Message Oriented Middleware (e.g. MQ)
  - Reactive Programming
  - Service Mesh

Event-Driven Style: Protocol Stack

Event
Custom Design

Transport Protocol
HTTP, MQ, TCP/IP, etc…

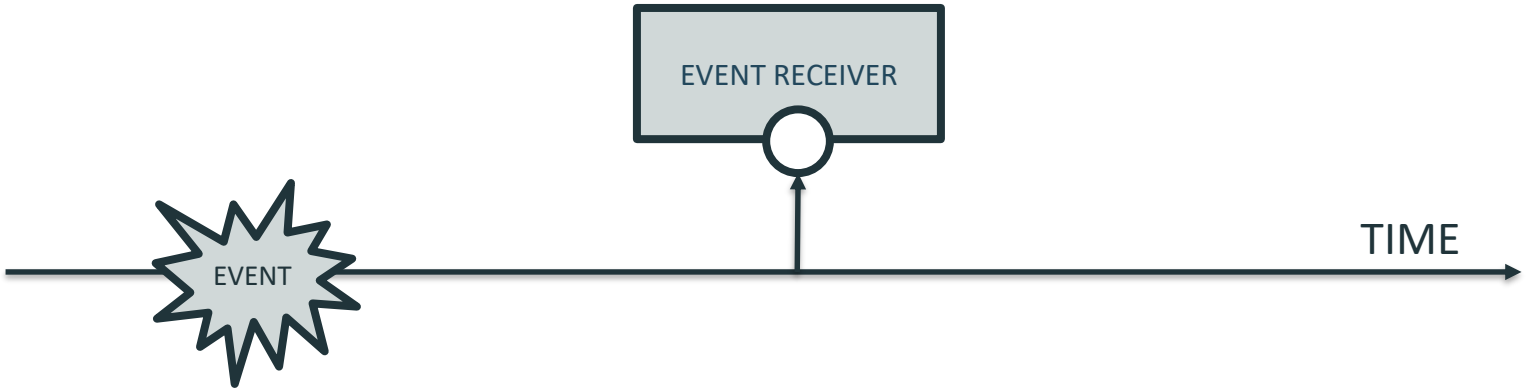
Event Infrastructure

Event-Driven Style: Constraints and Characteristics

- Senders have no knowledge of receivers (e.g. write to queue or publish to topic)
- Event receivers “react” to events
- Events represent change to a state
- Events can have multiple receivers (subscribers)

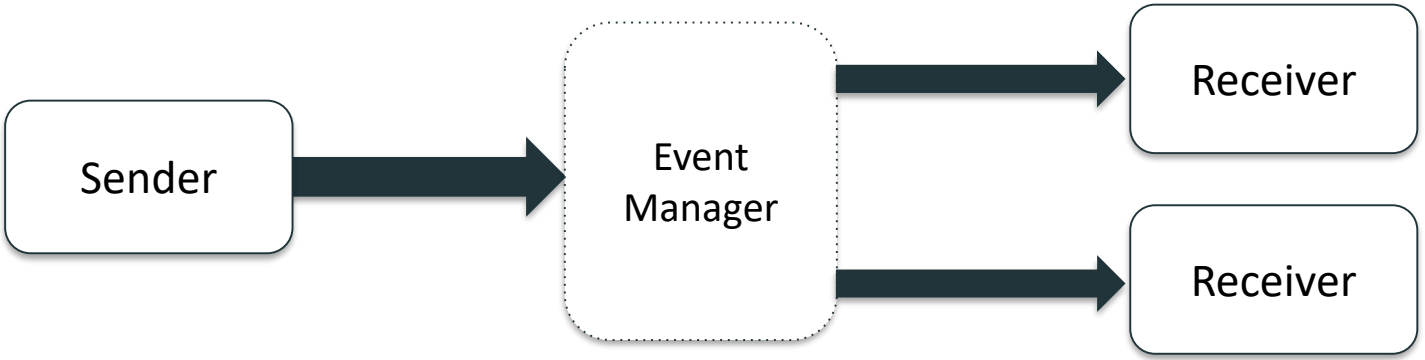
Event-Driven Style: Primary Constraint

- Events occur in the past
- You can't change the past!



Event-Driven Style: Common Implementation

- Identify state change events
- Register event listener(s)
- Sender sends notification when state changes
- Event manager transmits notifications
- Receiver(s) handle events



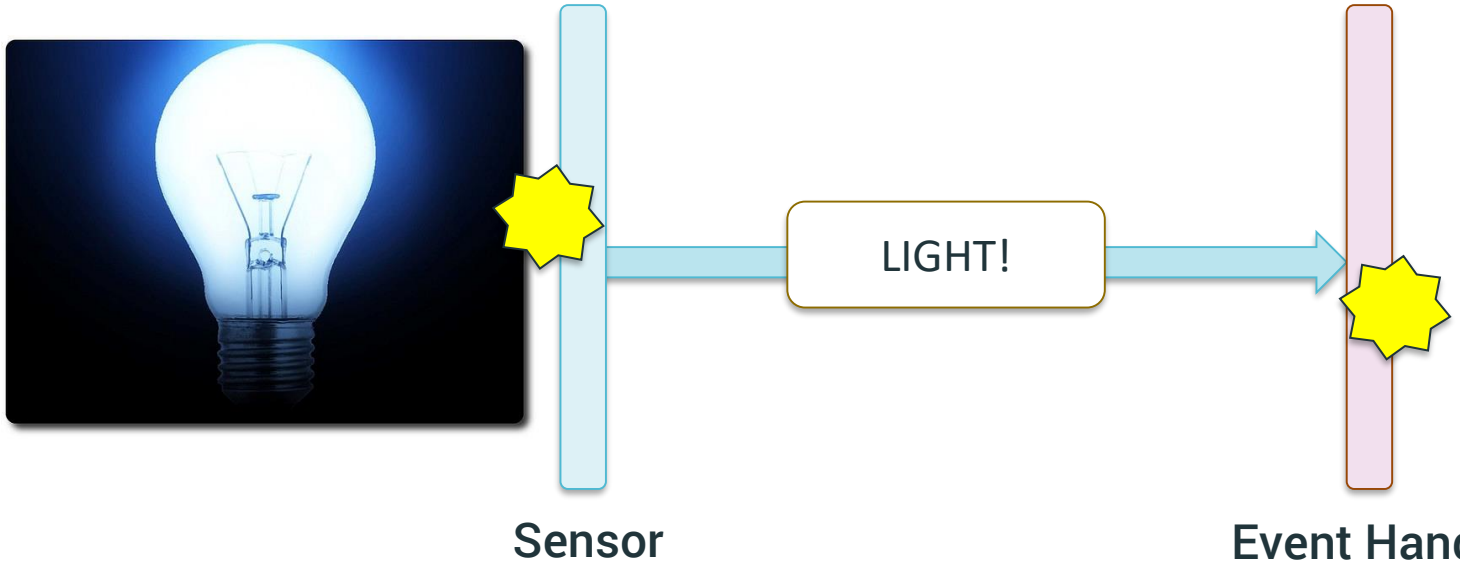
Event-Driven Style: Notification Design

- Event data may include:
  - Target or source of event
  - Type of event
  - Event details
  - Contextual information

```
{
  “event” : {
  “name”: “RecordAdded”,
  “source”: “StudentRecords”,
  “location” : “/students/1883”,
  “editing” : “true”
  }
}
```

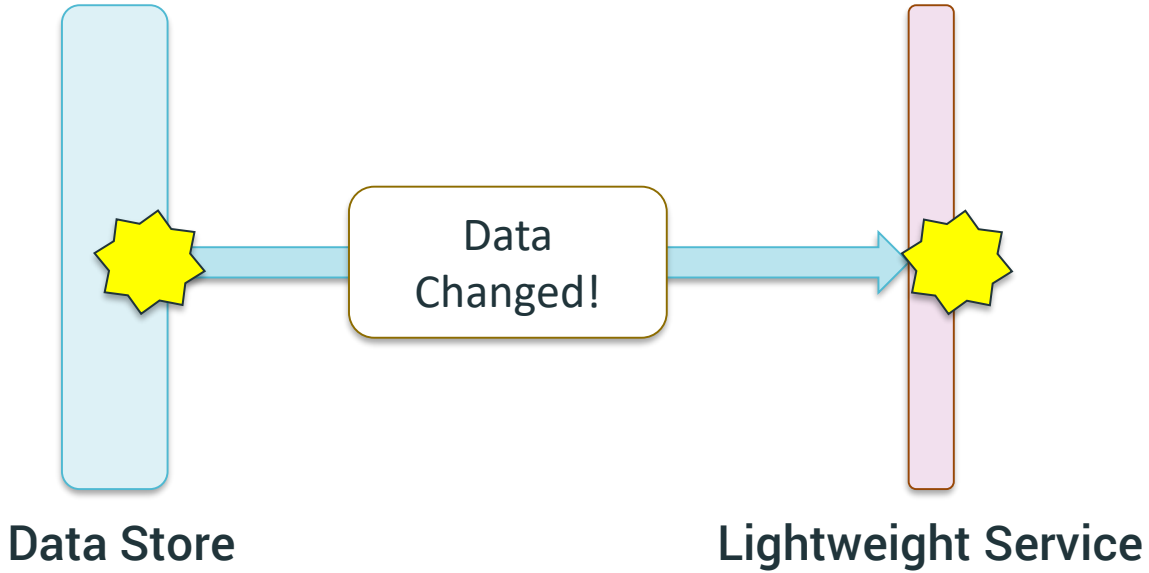
Event-Driven Style: Internet of Things

- Increased use of event driven style in IoT
- The real world is based on events
- Pervasive technology is primarily event based



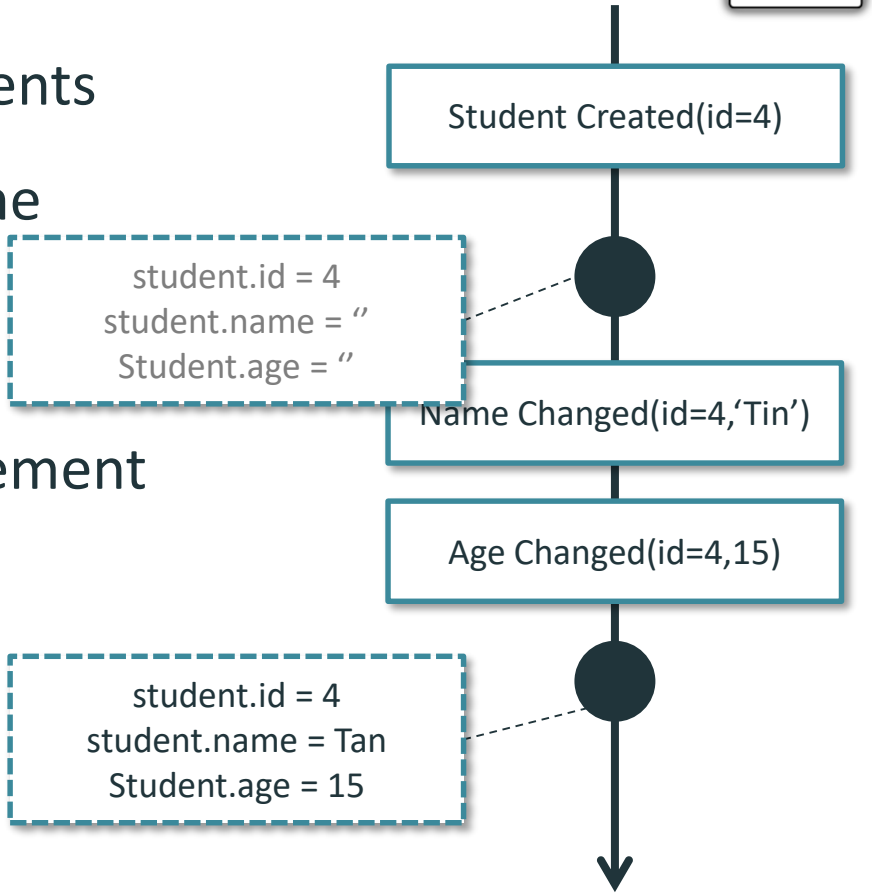
Event-Driven Style: Microservices

- Inter-Service communication (behind firewall)
- Cache freshness
- Data synchronization / eventual consistency



Event-Driven Style: Event Sourcing / Event Store

- Persist data state change events
- The history of all events is the "present" state of data
- Makes *distributed data* architectures easier to implement



Event-Driven Style: Benefits

- Components and data can be *de-coupled* and *de-centralized*
- Ideal for transmitting many changes continuously over time (e.g. streaming)
- De-centralized messaging system offers added reliability
- “Reactive” event style offers improved perceived UI performance

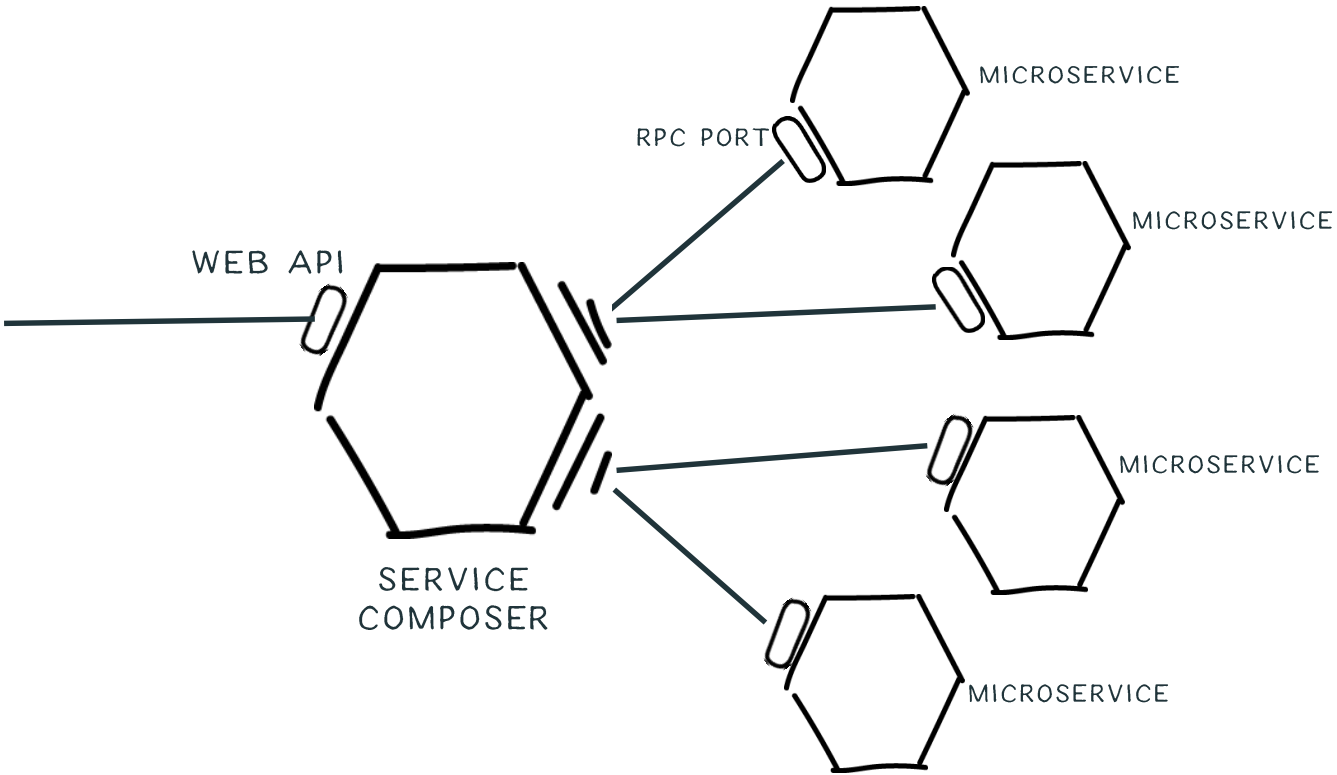
Event-Driven Style: Limitations

- Can only record what has *already* happened (e.g. how do you perform validation?)
- Increases the complexity of the architecture and infrastructure
- Performance, scalability and reliability limited by event infrastructure

Styles as Metaphors

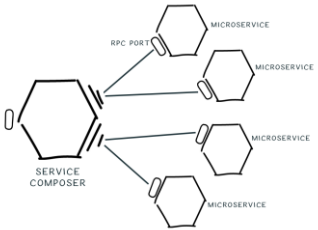
Style	Metaphor
Tunnel Style	Procedural programming
URI Style	Data Access Objects
Hypermedia	Browsing the web
Query	Database Query Languages
Event Based	Event based programming (e.g. GUI)

A Tunnel Style Example: Microservices Composition

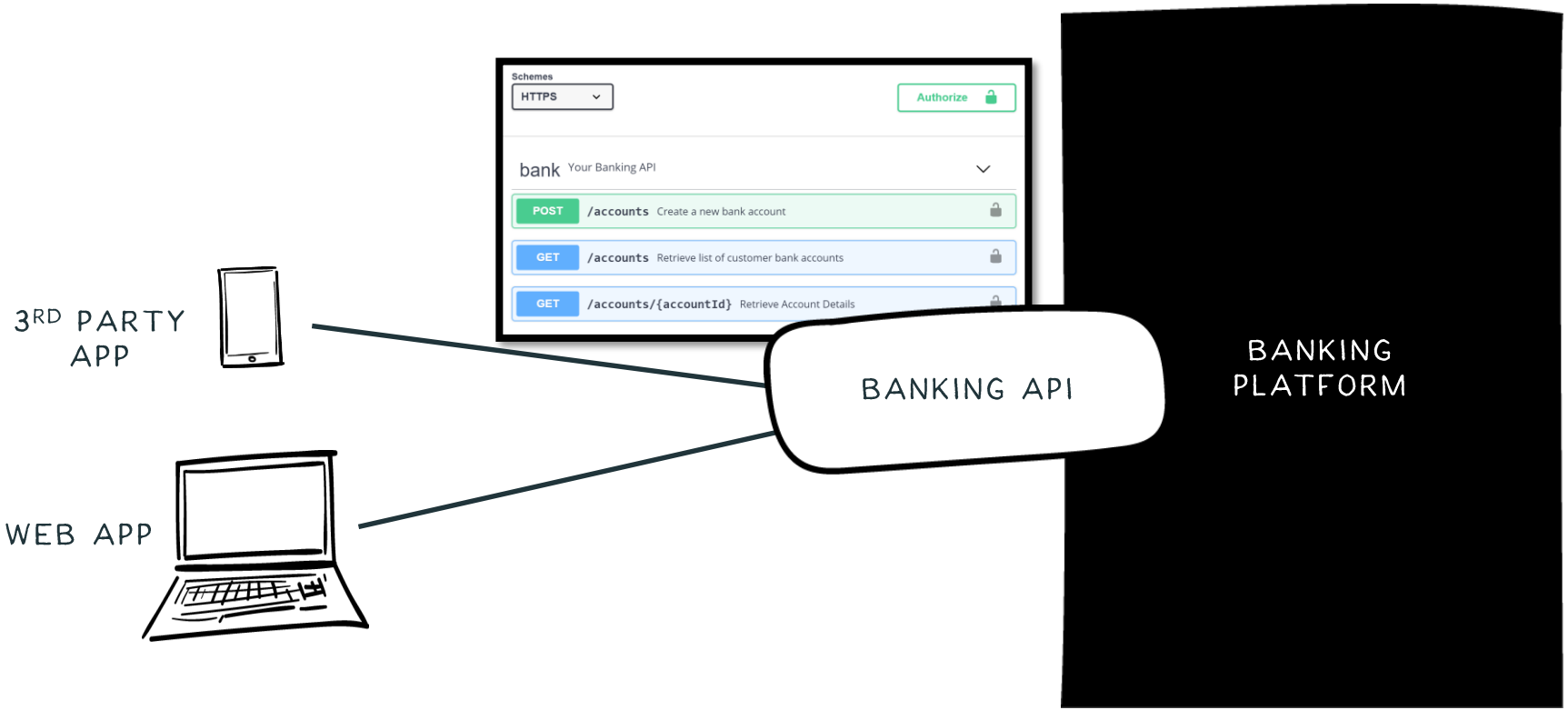


A Tunnel Style Example: Microservices Composition

- Publishing new interfaces is cheap and easy for service teams
- Service composer team is only client and prepared to rebuild their component after any service changes (warning: potential bottleneck)
- External component is shielded from change
- RPC implementation can be chosen for optimized messaging speed (e.g. GRPC/Thrift)



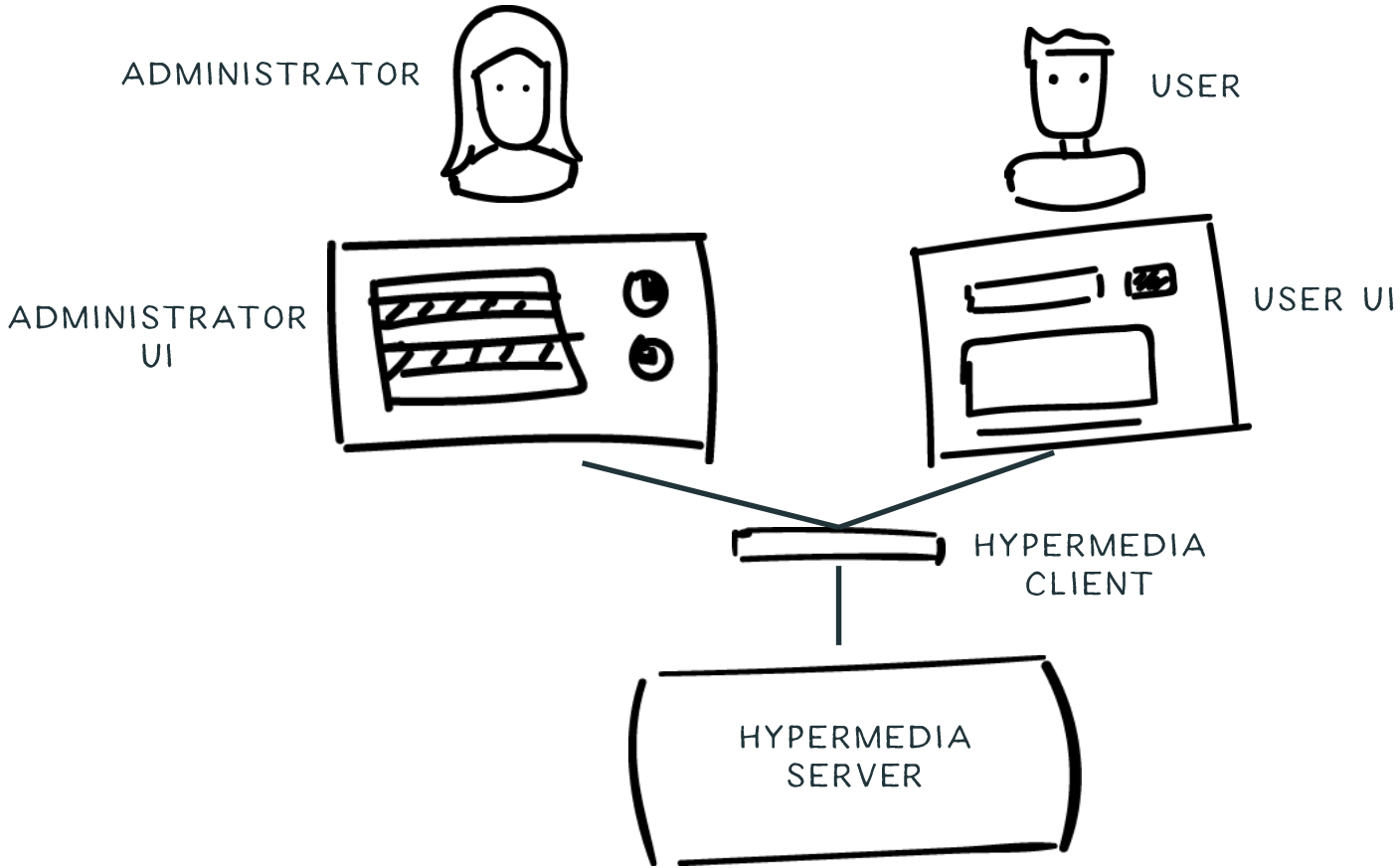
URI Style Example: Public Banking API



URI Style Example: Public Banking API

- Developers outside the bank will find the URI style *familiar*
- Many of the interactions are well suited for the CRUD pattern
  - View transactions
  - View balance
  - Create payment
- Little commercial motivation to make it easy to change API providers

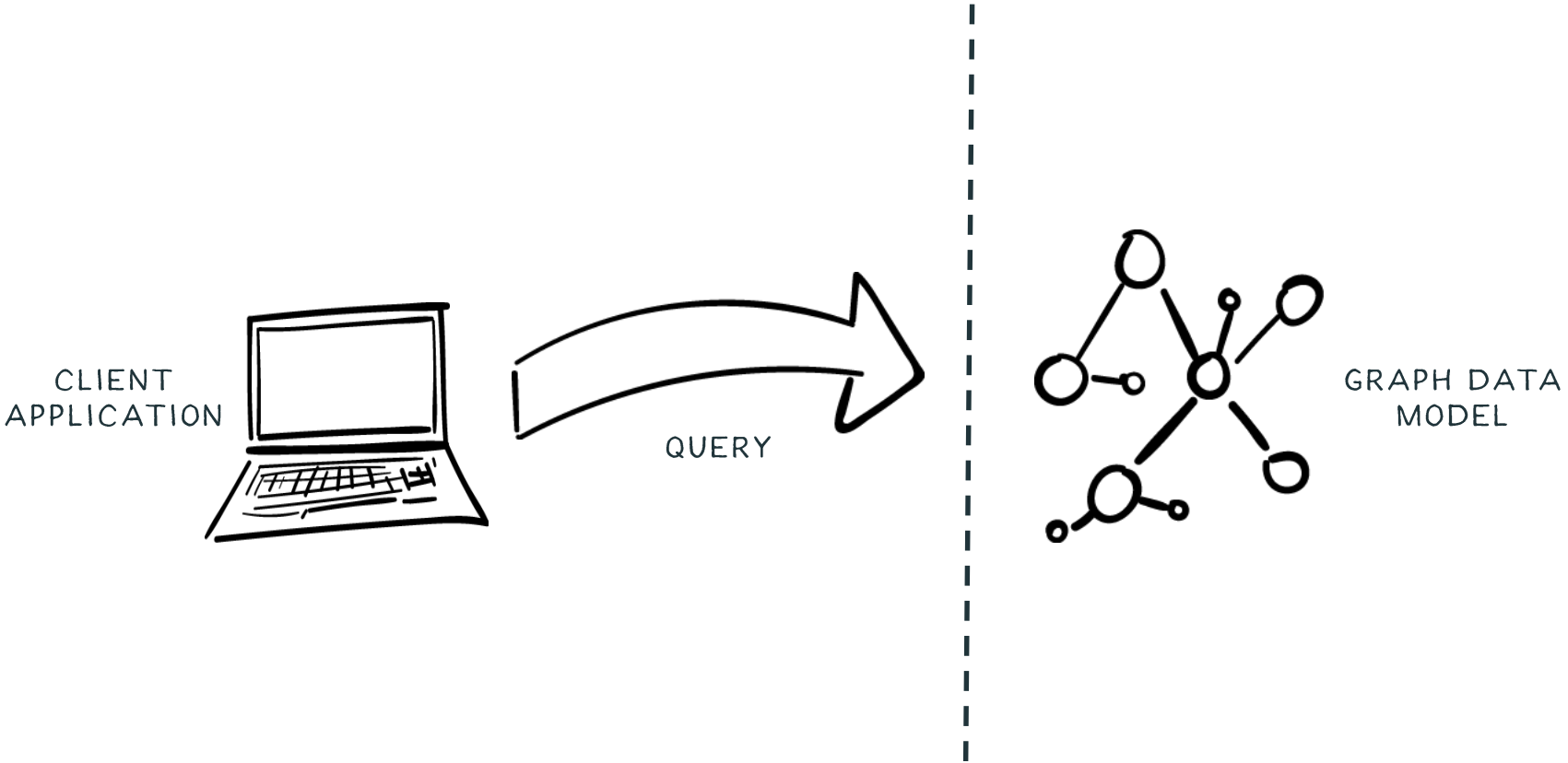
Hypermedia Style Example: UX Fragmentation



Hypermedia Style Example: UX Fragmentation

- Manage and deploy a single client application
- Change UI and workflow without re-deploying client
- Works best when client development owned by organization
- Works best when cheap UX generation is a market differentiator

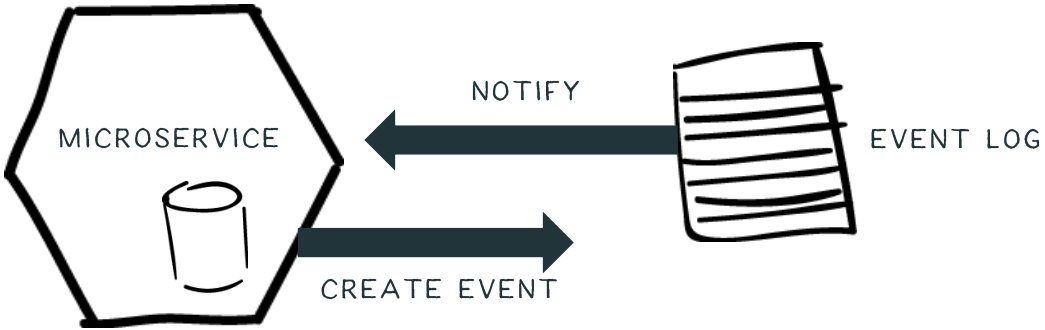
Query Style Example: Social Graph Data



Query Style Example: Social Graph Data

- Query language optimized for data type
- Client development is easier
- Backend is optimized for fast reads and complex queries

Event Driven Example: Decentralized Data



Event Driven Example: Decentralized Data

- Makes it easier to manage and deploy services independently
- Distance between components is small (intranet, not internet)
- Data can be “stale”
- Libraries/SDK/Sidecars are provided to reduce dev. cost

General Advice for Styles

Tunnel Style	▪ Typed interaction, gRPC gaining popularity for internal use
URI Style	▪ The default style for web based APIs
Hypermedia Style	▪ Most scalable and change-friendly, but least conventional
Query Style	▪ Gaining popularity, ideal for internal, data-centric apps
Event Driven Style	▪ Loose coupled, centralized – good for internal use, not a good choice for public APIs

Use Your Head

- Implementations may borrow from multiple styles
- Your system will probably contain more than one API style and needs will change over time
- Start with a style that makes sense for your situation – not necessarily the one you are “supposed” to use

Five API Styles

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