



# Build a Multiplayer Real-time Game with Astra Streaming

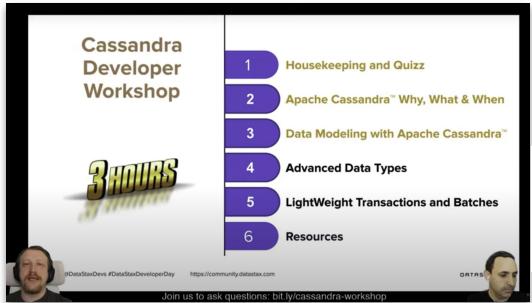


LEVEL  
**UP**  
with the

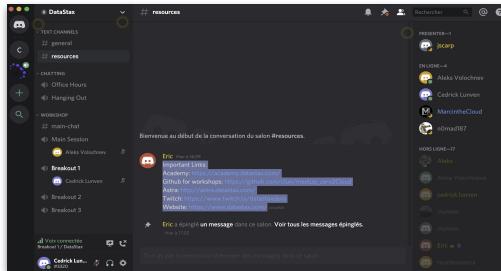
DataStax  
**Developers**

# Housekeeping #1: Attending the workshop

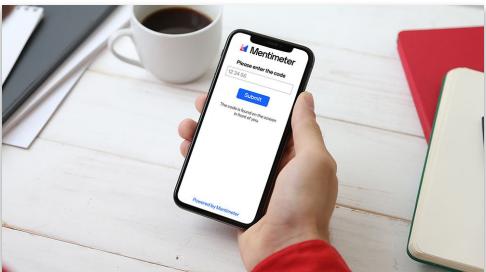
**Livestream:** [youtube.com/DataStaxDevs](https://youtube.com/DataStaxDevs)



**Questions:** <https://dtsx.io/discord>



**Games** [menti.com](https://menti.com)



Nothing to install !

# Housekeeping #2: Doing Hands-On

Source code + exercises + slides

The screenshot shows a GitHub repository page for 'DataStax-Examples / todo-astra-jamstack-netlify'. It displays a list of code contributions and releases. Contributions include 'gh-pages' (code), 'functions' (code), 'public' (code), 'src' (code), 'env-template' (code), 'gh-pages' (code), and 'global.yaml' (code). Releases include 'Update for CI/CD' (code) and 'Create a new release' (code). The repository has 197 commits ahead of 'master' and 239 commits behind it.

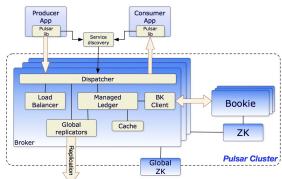


IDE

The screenshot shows an IDE interface with a code editor displaying Java code for a 'SpringBootDemoApplication.java' file. The code imports org.springframework.boot.SpringApplication and org.springframework.boot.autoconfigure.SpringBootApplication. The main method is annotated with @SpringBootApplication. The code editor also shows other files like 'README.md' and 'Dockerfile'. Below the code editor are tabs for PROBLEMS, OUTPUT, TERMINAL, and DEBUG CONSOLE.



Messaging system (based on Pulsar)



# Get your Badge for today !

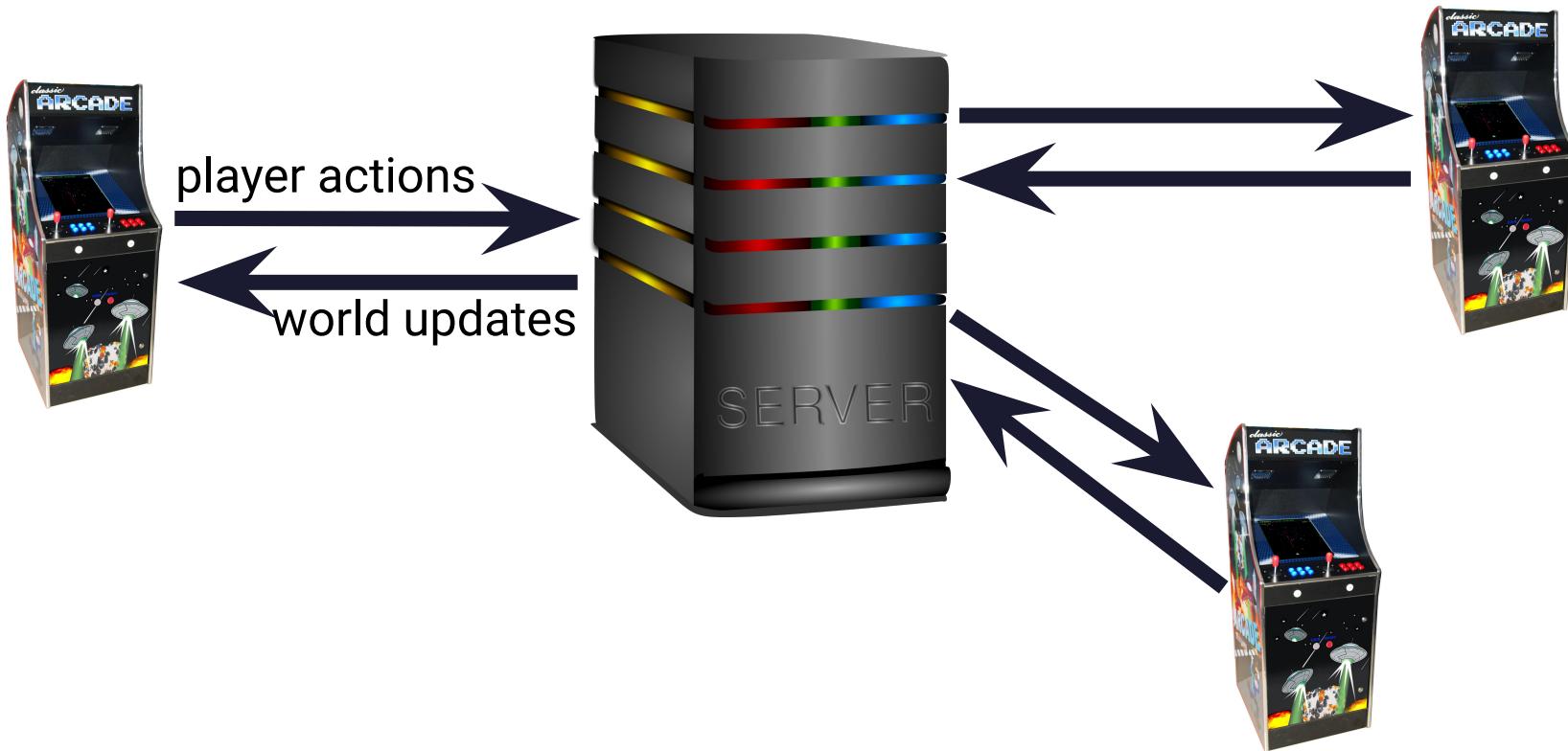


DataStax Developers

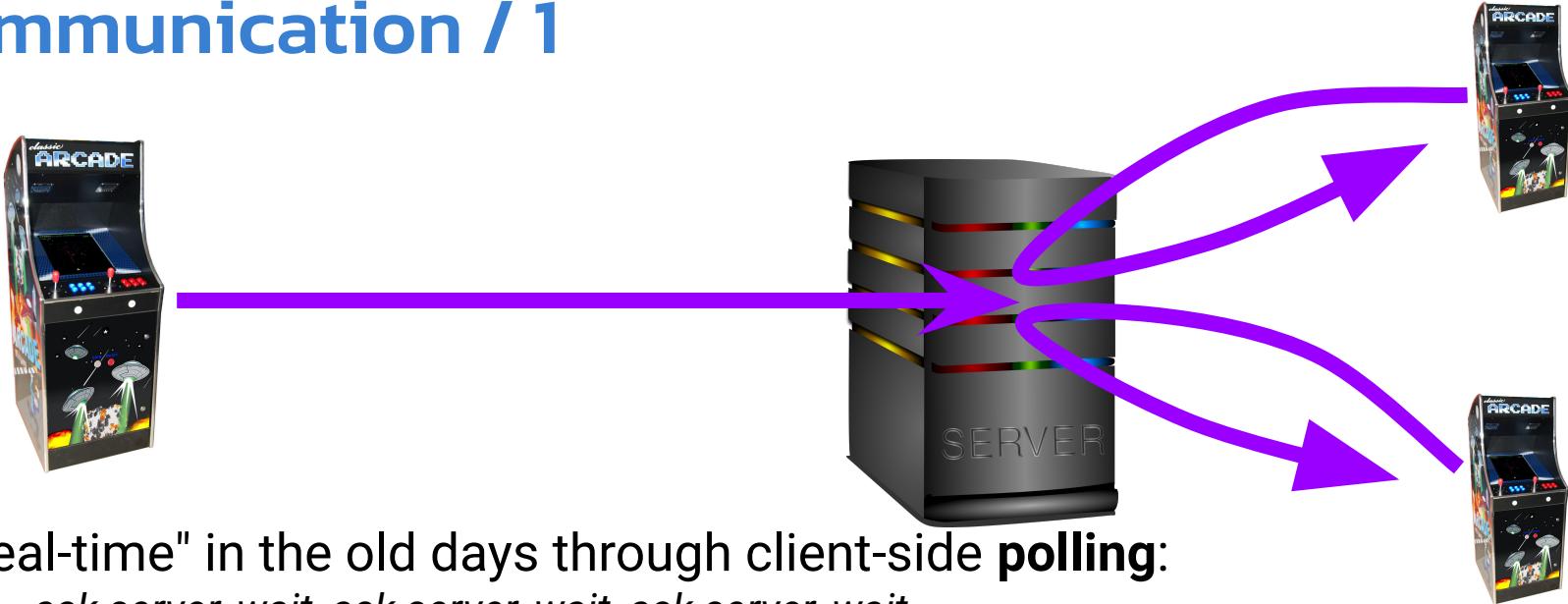
# Let's start!



# So you want a multiplayer real-time game ... ?



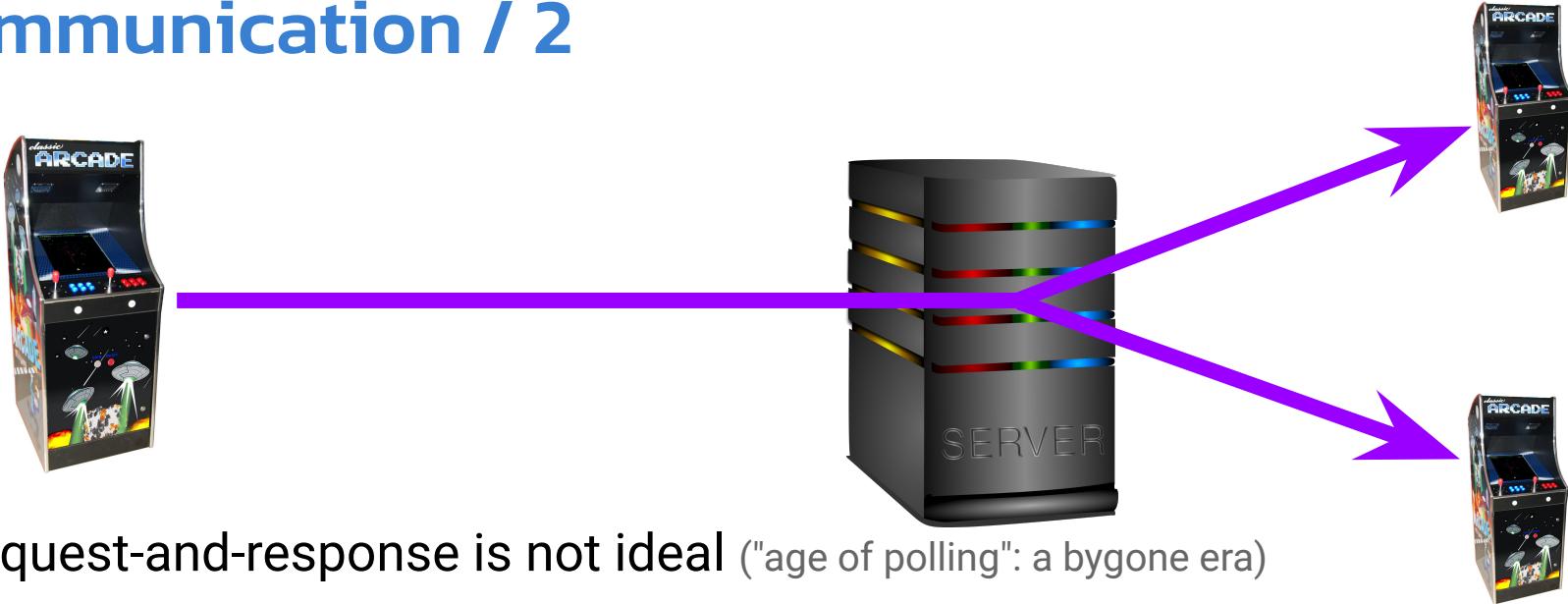
# Communication / 1



"Real-time" in the old days through client-side **polling**:  
ask server, wait, ask server, wait, ask server, wait ...

- ✗ A flood of request-and-responses (overhead!)
- ✗ Not really real-time (latencies)
- ✗ Waste of server resources
- ✗ Sometimes a mess to handle in the application

# Communication / 2



Request-and-response is not ideal ("age of polling": a bygone era)

Rather: server pushing data to clients at once.

⇒ We need a messaging platform

⇒ And server-initiated communication

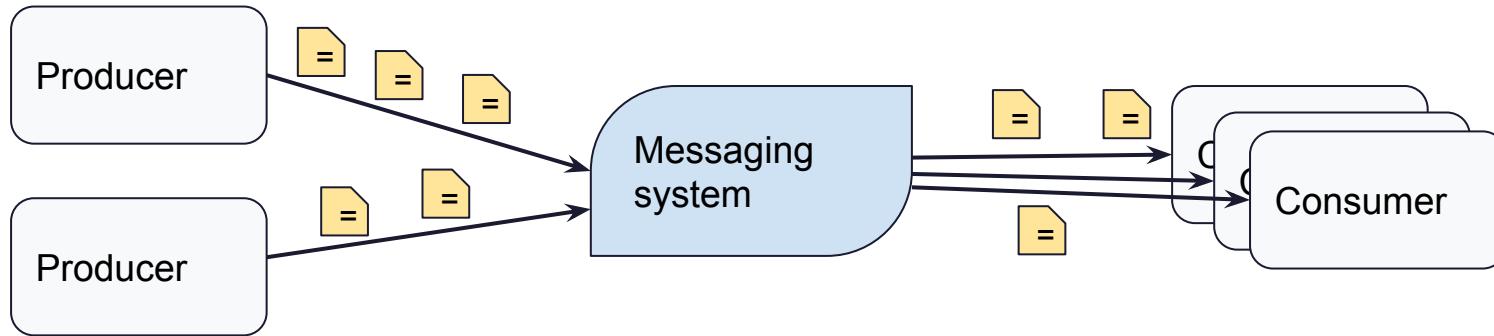
# Messaging systems

- **Born out of the need for:**
  - non-blocking communication
  - "push, not pull"
  - decoupling
  - faster response to new data
- **Good match with modern microservice architectures**
- **Receive and deliver "messages"**
  - decouple sending and receiving (also: cross-language)
  - Act as a "buffer" for communication
  - various messaging patterns (queue, pub/sub)
  - (optional) Message schemas: JSON, Avro, ...

# Messaging systems

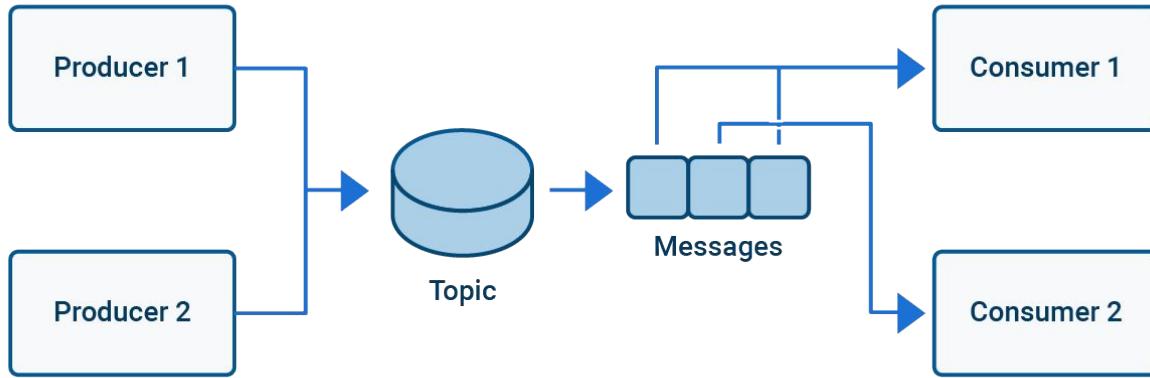
- **We live in a "golden age for messaging services"**  
RabbitMQ 2007, Apache Kafka 2009, Apache Pulsar 2016
- **Use cases for messaging:**
  - the dataset is never complete
  - continuous stream of events/datapoints
  - shared queues (items to process)
  - ...
- **In practice:** IoT, social media, car automation, finance, online gaming, ...

# Messaging at a glance



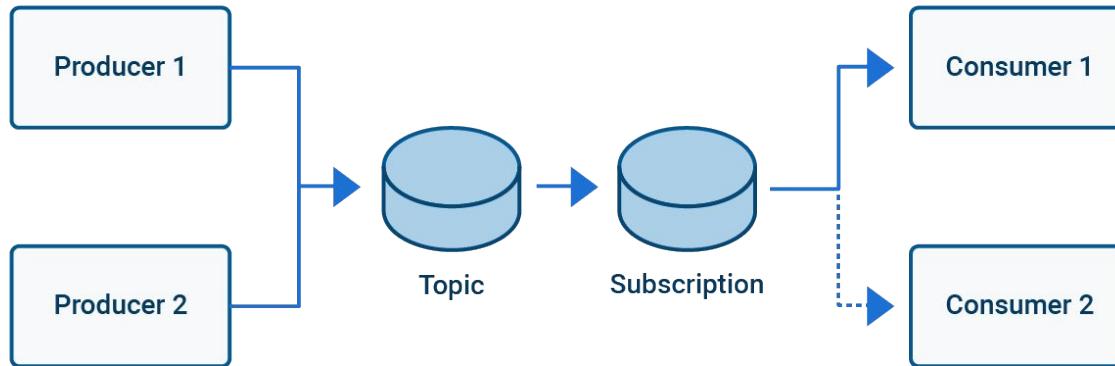
- **Asynchronous ⇒ messages retained**
- **Delivery semantics ⇒ receipt acknowledgement**  
(the hard part is correct delivery)

# Message Consumption – Queuing



- Exactly-once semantics
- Backlog of messages
- Distributed processing
- Out-of-order possible
- Message failover
- Easy to scale

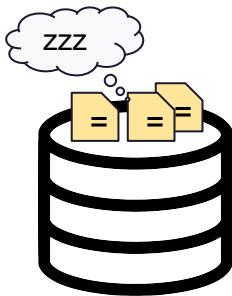
# Message Consumption - Pub/Sub



- Producers publish to Topic
- Consumers subscribe to Topic
- Multiple consumers
- Easy to extend

"**Each** player shall receive **all updates** to the game world"

# Messaging != databases



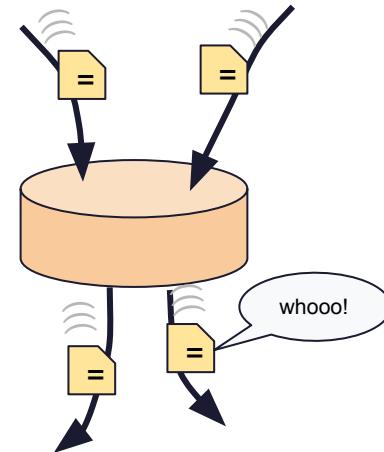
Databases  
*data at rest*

(in "tables/collections")



Messaging  
*data in transit*

(through "topics")



**But: blurred boundaries**

Most messaging systems offer some *persistence*

Some databases equipped with *CDC* ("change data capture")

Mixing the two: a very common pattern anyway

# Storage (?)



This workshop is "messages only", no DB!

*(a richer game will need some persistent storage...)*

# A tricky business

High-performance, correct delivery, failover, replication, scaling...

**Technically it's a tough challenge**

**Consider also operations/management**

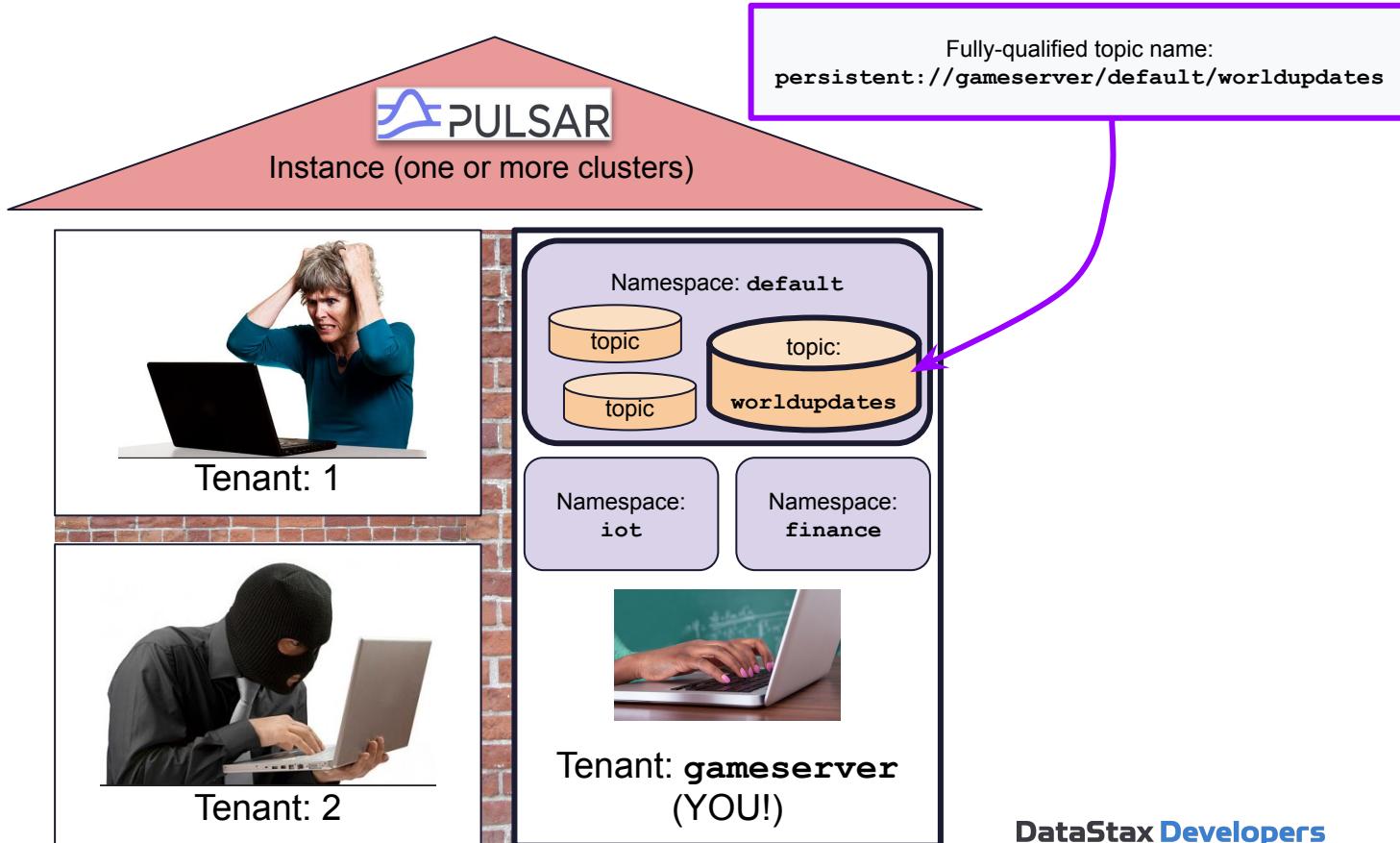
... that's why today we rely on a managed solution!

# Apache Pulsar ⇒ Astra Streaming



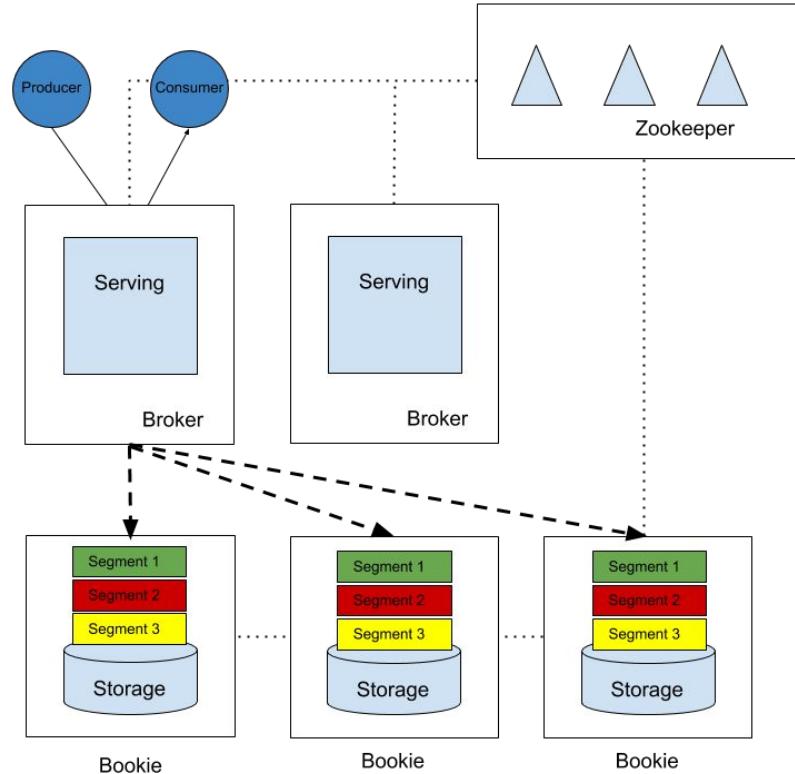
- Yahoo ⇒ Apache Foundation
  - Supports **pub/sub** and queueing
  - Split compute from storage
  - Modern features:
    - Multi-tenancy
    - Horizontal scalability
    - High performance / Low latency
    - Geo-replication
- + schemas, functions, Pulsar SQL, deduplication, IO (sinks/sources) ...
- Managed Pulsar in the cloud currently **FREE open beta**
  - Create ready-to-use streaming topics
  - Tight integration with Astra DB available (as between Pulsar and Cassandra)

# Pulsar messaging, logical structure



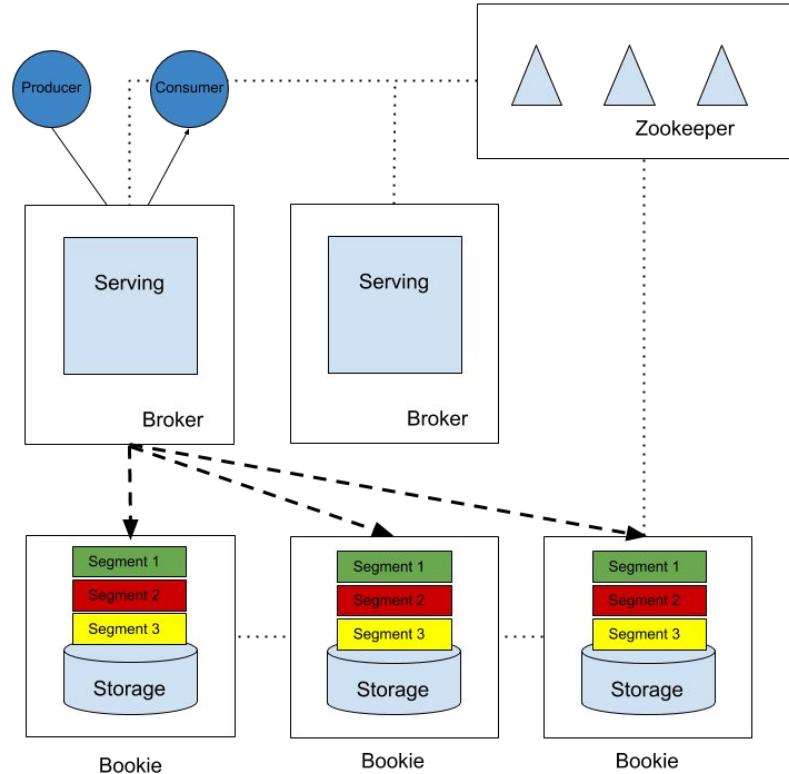
# Pulsar architecture

- Distributed, tiered architecture
- Separates compute from storage
- Zookeeper holds metadata for the cluster
- Stateless Broker handles producers and consumers
- Storage is handled by Apache Bookkeeper



# Pulsar architecture (cont'd)

- BookKeeper (“bookies”) distributed, append-only log
- Data is broken into ledgers and segments written to multiple bookies
- Producer acknowledged when quorum of bookies acknowledge
- No single bookie holds entire log



# HandsOn: Streaming topic



**Astra**  
**STREAMING**

**Get your instance here:**

- <https://astra.dev/11-17>



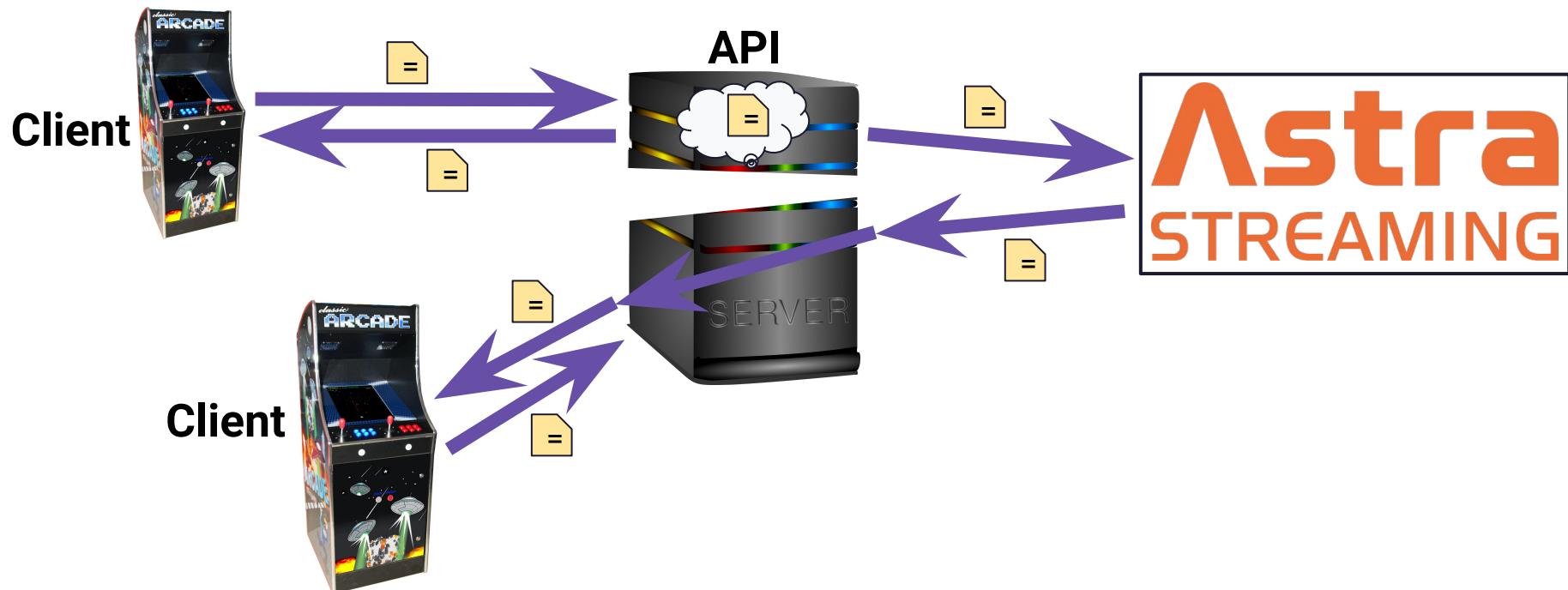
**GitHub**

**Repository:**

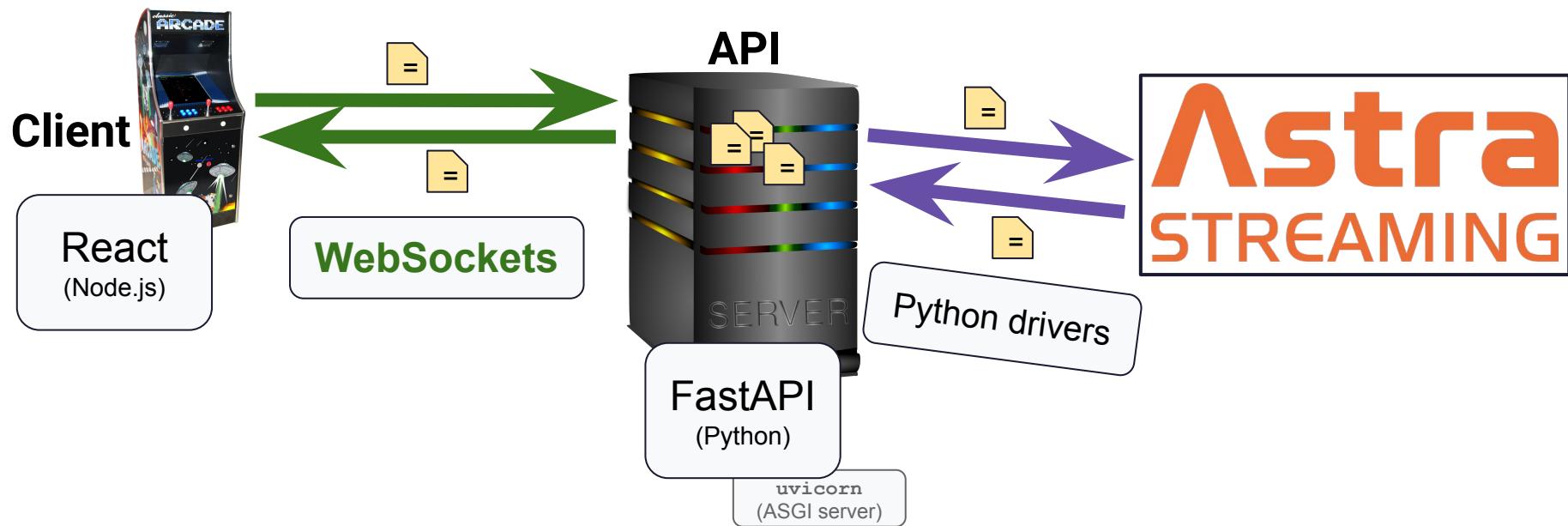
- <https://github.com/datastaxdevs/workshop-streaming-game>



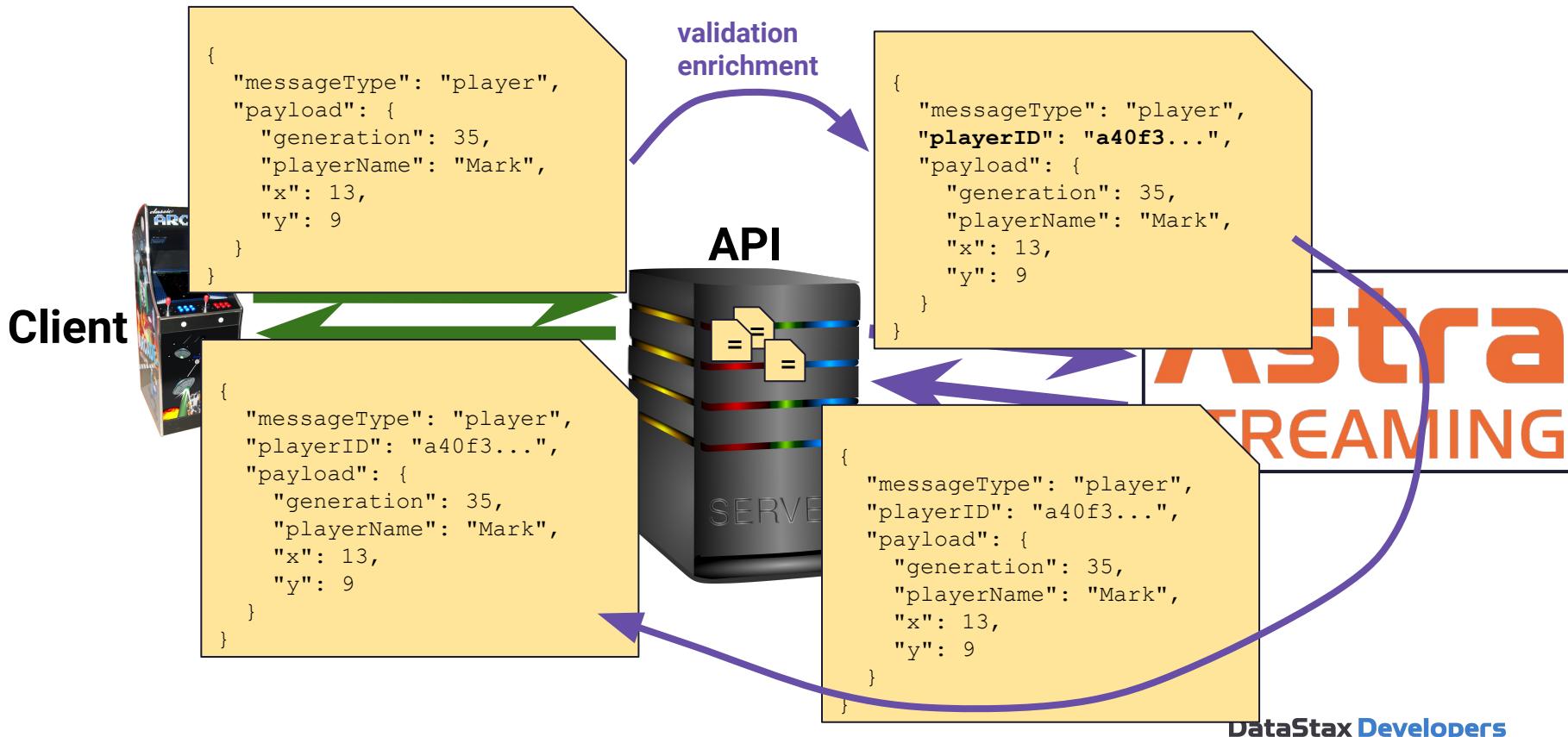
# Game architecture, revisited



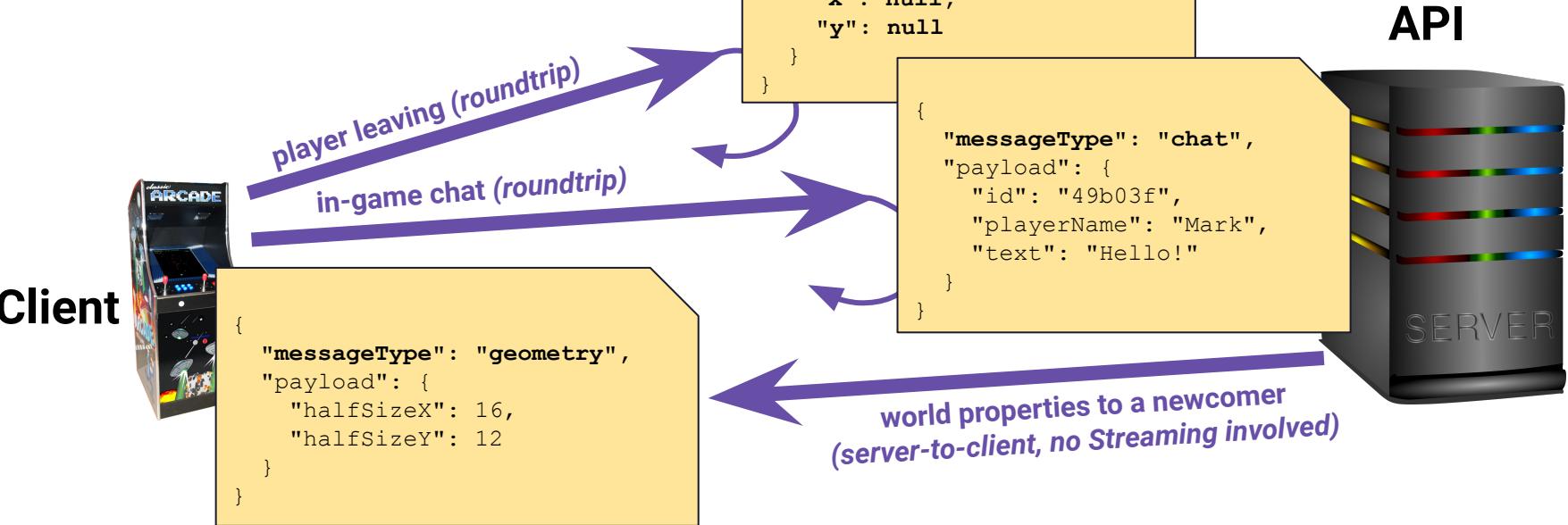
# Technologies

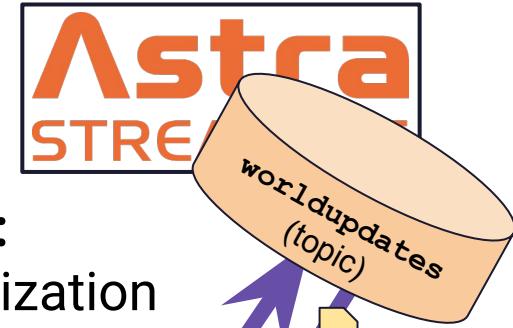


# Messaging protocol



# Other messages





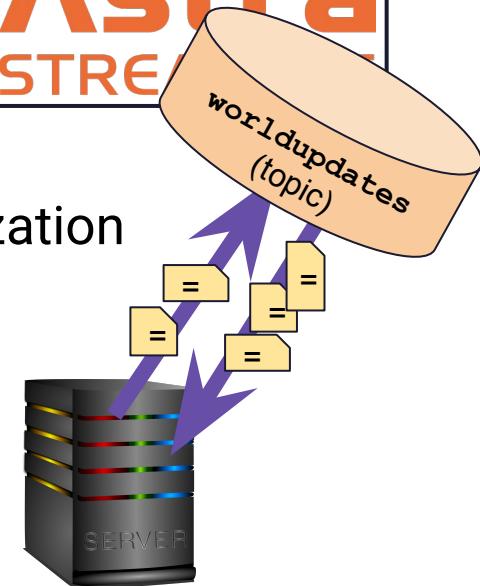
# Architectural choices

## All messages through a single Streaming topic:

- no schema, just (JSON) message serialization
- simplified setup, focus on core concepts
- in a real-life app: several topics

## Two WebSockets per client:

"player": client-to-server messages  
"world": server-to-client messages



# HandsOn: Gitpod setup



**Astra**  
**STREAMING**

**Get your instance here:**

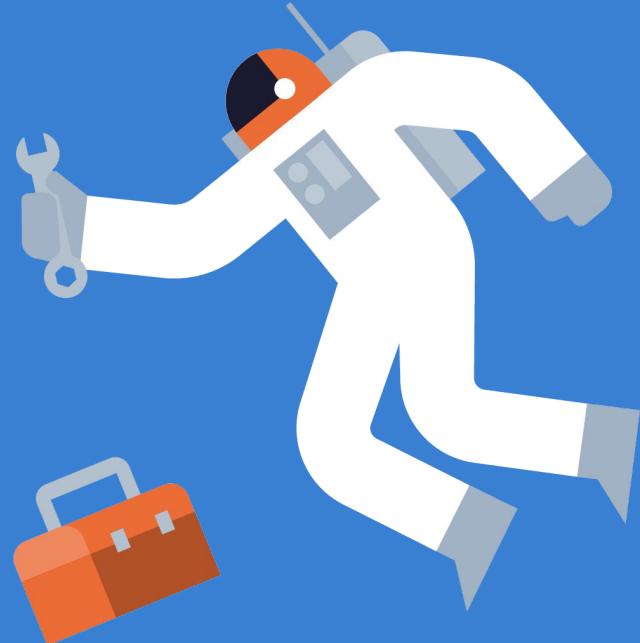
- <https://astra.dev/11-17>



**GitHub**

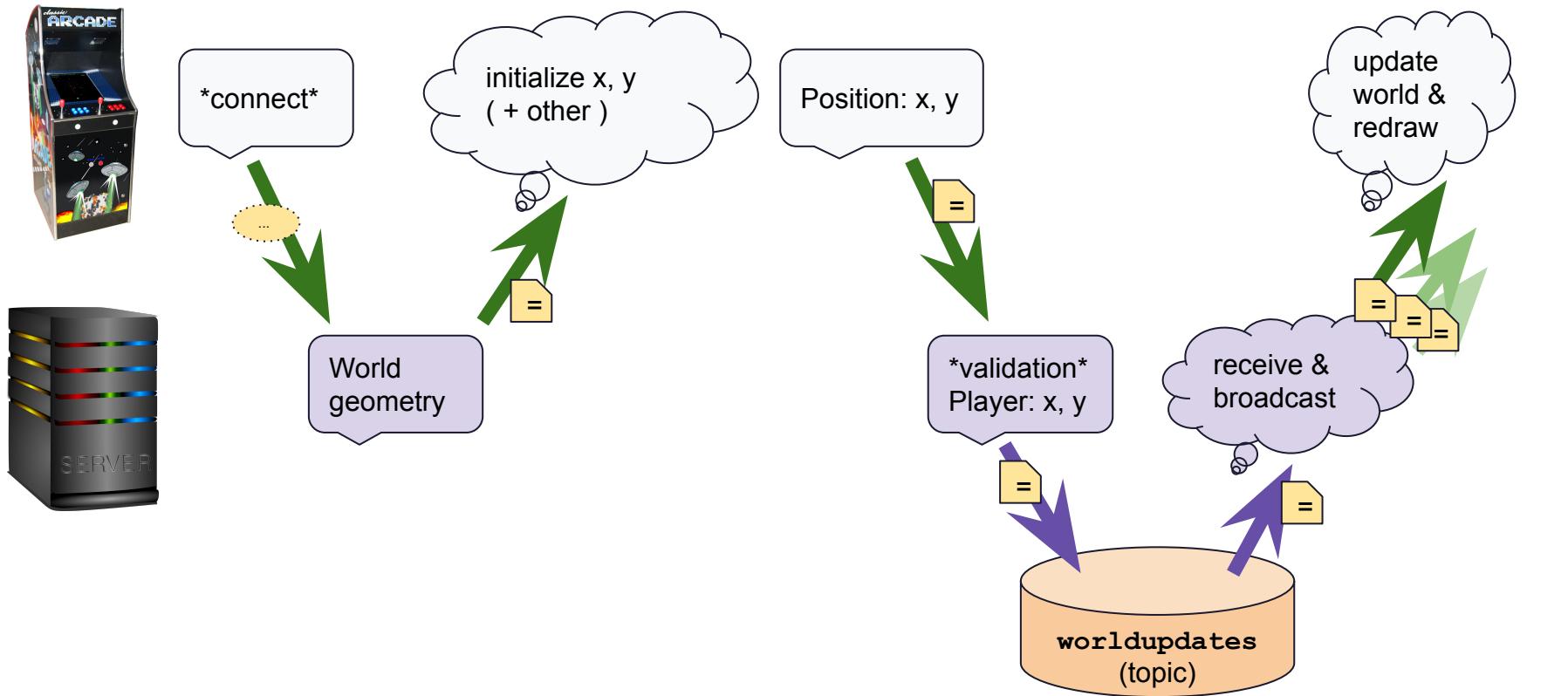
**Repository:**

- <https://github.com/datastaxdevs/workshop-streaming-game>



# When the client starts...

time



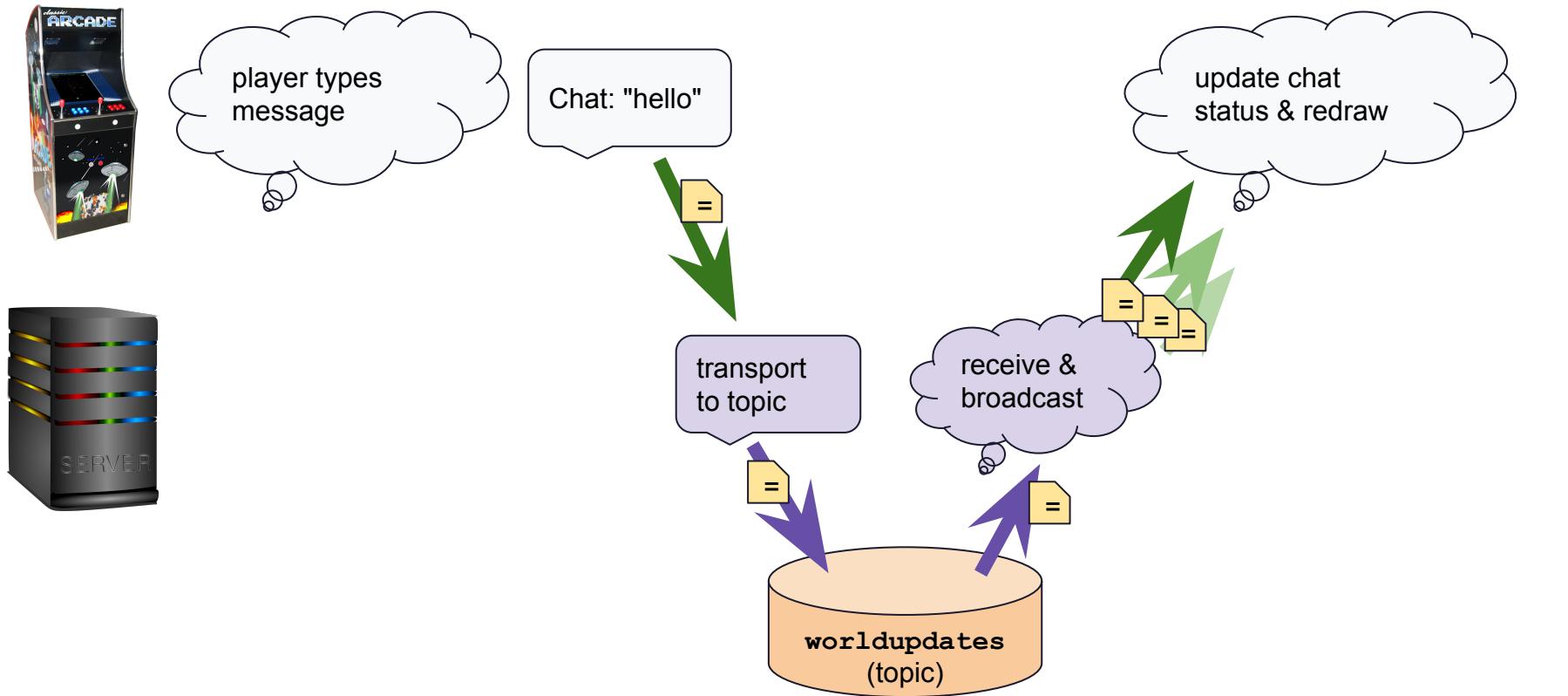
# Gameplay

*time*



# In-game chat

*time*



# HandsOn: PLAY!



**Astra**  
**STREAMING**

**Get your instance here:**

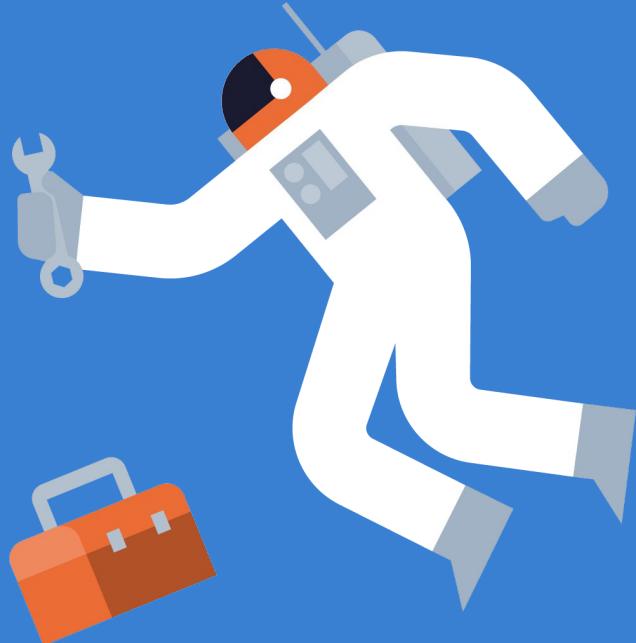
- <https://astra.dev/11-17>



**GitHub**

**Repository:**

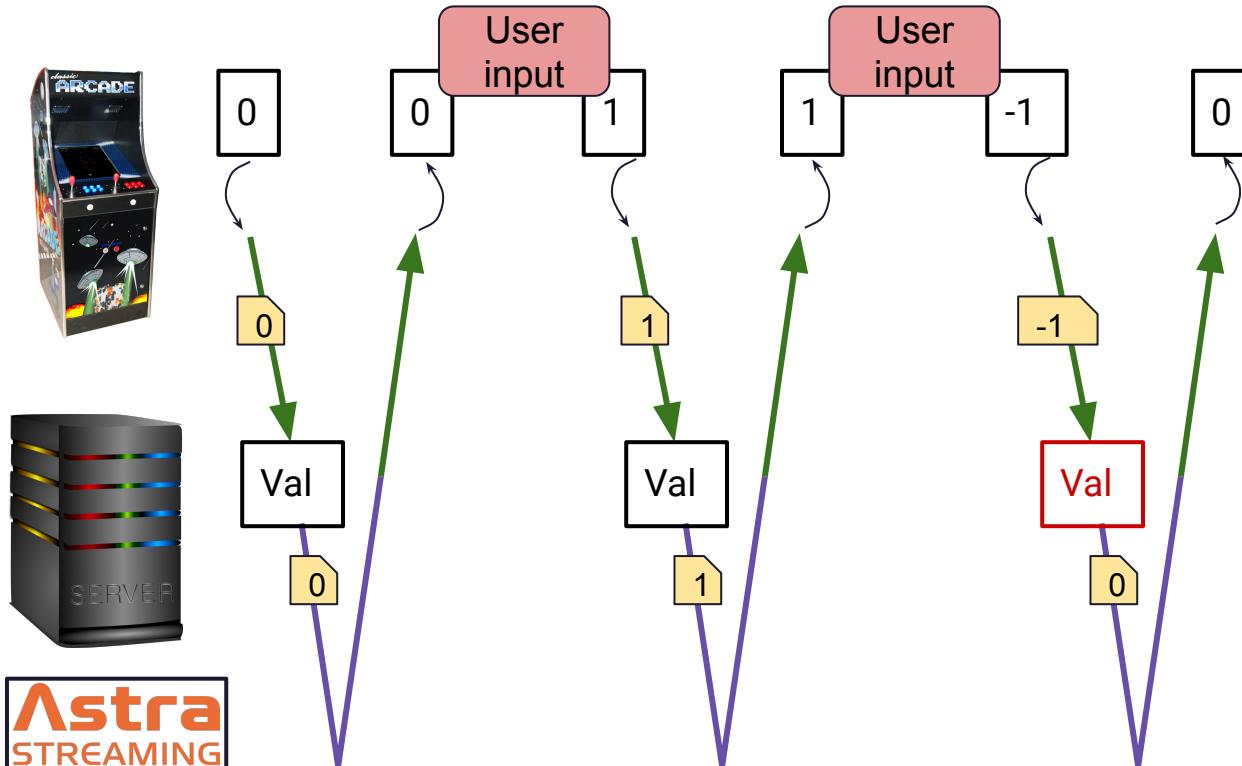
- <https://github.com/datastaxdevs/workshop-streaming-game>



# Async and server-side validation

*time* 

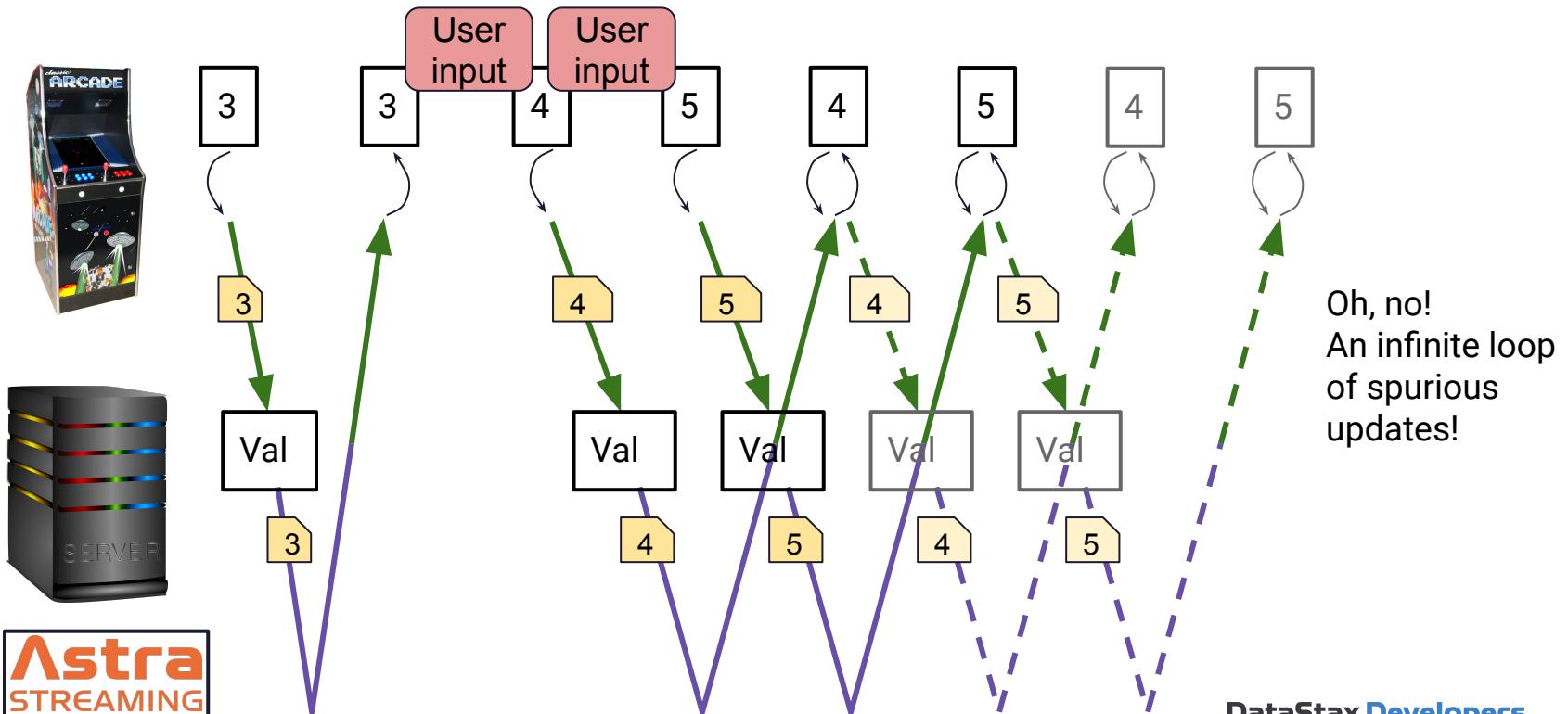
Position is in client memory and validated by the API



# Async and server-side validation / 2

time →

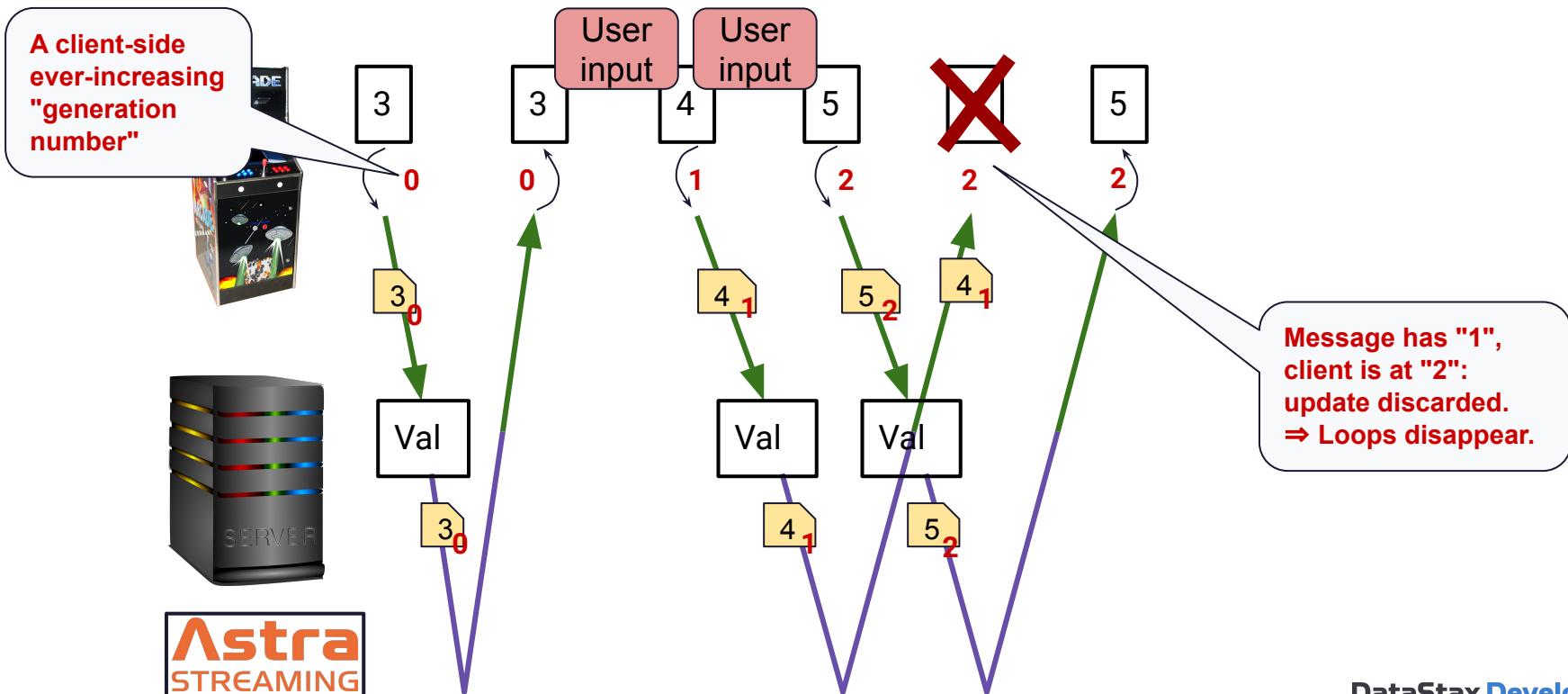
Client receives position updates (and may fire new updates)



# Async and server-side validation / 3

time →

Solution: discard **obsolete** server updates



# HandsOn: Multiplayer



**Astra**  
**STREAMING**

**Get your instance here:**

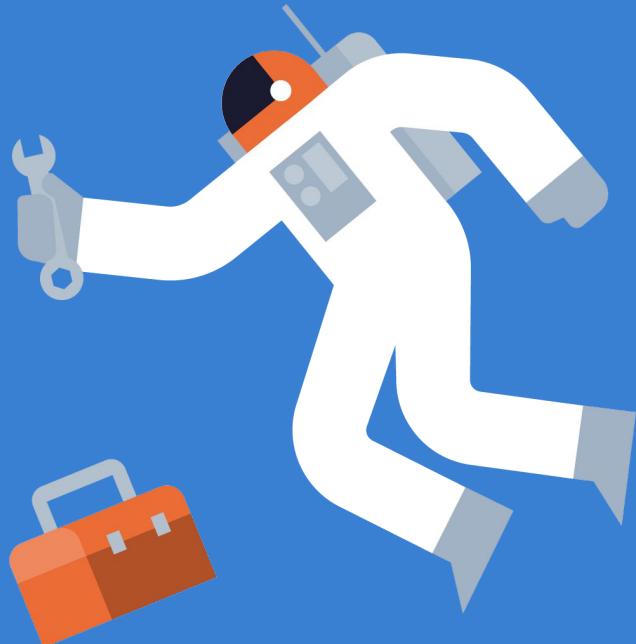
- <https://astra.dev/11-17>



**GitHub**

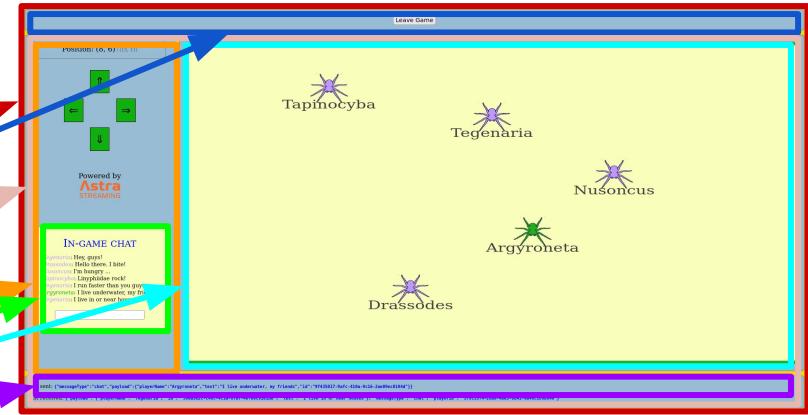
**Repository:**

- <https://github.com/datastaxdevs/workshop-streaming-game>



# Client app structure

```
1 | let pws = null
2 | let wws = null
3 |
4 | const App = () => {
5 |   React_States = useState(....)
6 |   React_References = useRef(....)
7 |
8 |   keyDown_Handler = ...
9 |
10 |   useEffect( () => {
11 |     if(inGame) {
12 |       if ( both_Websockets === null ) {
13 |         both_Websockets = new Websocket(apiAddress)
14 |         wws.onmessage = evt => {
15 |           parse_and_interpret(evt ...)
16 |           // check messageType (player/geometry/chat)
17 |           // HERE WE MODIFY REACT STATE AND NEED REFERENCES
18 |         }
19 |       } else {
20 |         pws.send(goodbyeMessage)
21 |         both_Websockets.disconnect()
22 |         both_Websockets = null
23 |       }
24 |     }, [inGame])
25 |
26 |     useEffect( () => {
27 |       pws.send(myPlayerUpdate ... )
28 |     }, [coordinates, etc])
29 |
30 |     return (
31 |       App
32 |       PlayerForm
33 |       GameArea // if inGame
34 |       sidebar
35 |       GameInputs
36 |       buttons, etc
37 |       ChatArea
38 |       GameField
39 |       statusbar
40 |     )
41 |   }
42 | }
```



# React & WebSockets: useRef

WebSocket on client side: **subscription to events**

**Problem: we're closing over a React state**

```
import { useState } from "react"

const [generation, setGeneration] = useState(0)

// WebSocket event subscription
wws.onmessage = evt => {
  // Stale value because of closure!
  console.log(generation)
}
```

```
import { useState, useRef } from "react"

const [generation, setGeneration] = useState(0)

const generationRef = useRef()
generationRef.current = generation

// WebSocket event subscription
wws.onmessage = evt => {
  // This is what we want!
  console.log(generationRef.current)
}
```

**Solution: useRef to access a state within a closure!**



A modern, high-perf Python library to create APIs

- WebSockets support
- native `async/await` support in route functions
- Minimal boilerplate
- Sophisticated route dependency handling
- Asynchronous post-response task support
- Well documented ([fastapi.tiangolo.com](https://fastapi.tiangolo.com))

# FastAPI, code layout

Routes = functions, return value = response (etc etc...)

What about WebSockets?

```
app = FastAPI()

@app.websocket('/ws/world/{client_id}')
async def worldWSRoute(worldWS: WebSocket, client_id: str):
    await worldWS.accept()
    #
    pulsarClient = getPulsarClient()
    pulsarConsumer = getConsumer(client_id, pulsarClient)
    #
    try:
        geomUpdate = makeGeometryUpdate(HALF_SIZE_X, HALF_SIZE_Y)
        await worldWS.send_text(json.dumps(geomUpdate))

        while True:
            worldUpdateMsg = receiveOrNone(pulsarConsumer, RECEIVE_TIMEOUTS_MS)
            if worldUpdateMsg is not None:
                await worldWS.send_text(worldUpdateMsg.data().decode())
                pulsarConsumer.acknowledge(worldUpdateMsg)
            await asyncio.sleep(SLEEP_BETWEEN_READS_MS / 1000)

    except WebSocketDisconnect:
        pulsarConsumer.close()
```

WebSocket decorator

function definition

once-per-client part

the function runs for a long time ...

notify successful processing

detect client-side disconnect

# Pulsar drivers for Python

```
# pip install pulsar-client==2.7.3
import pulsar

client = pulsar.Client(
    SERVICE_URL,
    authentication=pulsar.AuthenticationToken(ASTRA_TOKEN),
    tls_trust_certs_file_path=TRUST_CERTS,
)

streamingTopic = 'persistent://gameserver-0123/default/worldupdates'

# consume messages
consumer = client.subscribe(streamingTopic, 'this-subscription-id')
receivedMessage = consumer.receive(timeout)
# (process message ...)
consumer.acknowledge(receivedMessage)

# alternatively: client.subscribe(... message_listener=myListenerFunction)

# produce messages
producer = client.create_producer(streamingTopic)
pulsarProducer.send('{"message":"hello!"}'.encode('utf-8'))
```

# Python quickstart on Astra Streaming UI

The screenshot shows the Astra Streaming UI interface. On the left, there's a sidebar with navigation links for Dashboard, Databases (listing hemidactylus, techblog, measurements, workshops, multics), and Streaming (listing stefano, og1, snktest). Below these are Sample App Gallery and Other Resources. The main content area is titled "Dashboard / snktest". It has tabs for Quickstart, Try Me, Connect, Topics, Functions, Sinks, Sources, Namespaces, and Settings. Under "Connect", the Python tab is selected, showing Python Code Samples. It explains that Astra Streaming is powered by Apache Pulsar and provides links for PyPi documentation and client documentation. It also notes that Astra Streaming runs Pulsar version 2.7.2. Below this, there are tabs for PIP, PRODUCER, CONSUMER (which is selected), and READER. Under CONSUMER, there's a "Simple Consumer" example with fields for Cluster (pulsar-gcp-europewest1), Namespace (default), Topic (jsnktopic), and Subscription (my-subscription). At the bottom, there's a code editor window displaying Python code for connecting to a Pulsar topic:

```
import pulsar, time

service_url = 'pulsar+ssl://pulsar-gcp-europewest1.streaming.datastax.com:6651'

# Use default CA certs for your environment
# RHEL/CentOS:
trust_certs='/etc/ssl/certs/ca-bundle.crt'
# Debian/Ubuntu:
# trust_certs='/etc/ssl/certs/ca-certificates.crt'

token=''
```

# Python: Pulsar+WebSockets

```
try:  
    # first we tell this client how the game-field looks like  
    geomUpdate = makeGeometryUpdate(HALF_SIZE_X, HALF_SIZE_Y)  
    # Note: this message is built here (i.e. no Pulsar involved)  
    # and directly sent to a single client, the one who just connected:  
    await worldWS.send_text(json.dumps(geomUpdate))  
    while True:  
        worldUpdateMsg = receiveOrNone(pulsarConsumer, RECEIVE_TIMEOUT_MS)  
        if worldUpdateMsg is not None:  
            # We forward any update from  
            # for all clients out there:  
            await worldWS.send_text(worldUpdateMsg)  
        await asyncio.sleep(SLEEP_BETWEEN_UPDATES)  
    except WebSocketDisconnect:  
  
def receiveOrNone(consumer, timeout):  
    """  
    A modified 'receive' function for a Pulsar topic  
    that handles timeouts so that when the topic is empty  
    it simply returns None.  
    """  
    try:  
        msg = consumer.receive(timeout)  
        return msg  
    except Exception as e:  
        if 'timeout' in str(e).lower():  
            return None  
        else:  
            raise e
```

# React & SVG graphics

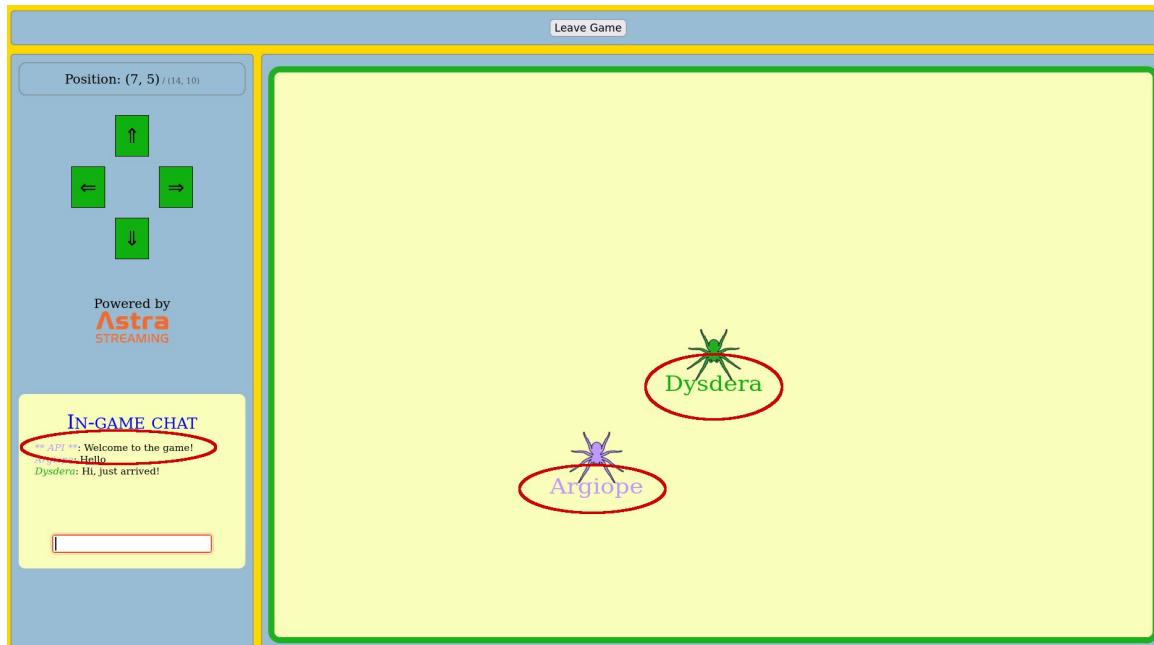
```
const GameField = ({playerMap, playerID, boardWidth, boardHeight}) => {

  return (
    <svg className="game-field" width="100%" height="700" preserveAspectRatio="none"
      viewBox={`0 0 ${100 * boardWidth} ${100 * boardHeight}`}>
      <defs>
        <pattern id="lyco_other" x="50" y="50" width="100" height="100" patternUnits="userSpaceOnUse">
          <image x="0" y="0" width="100" height="100" href="lyco_other.svg"></image>
        </pattern>
        <pattern id="lyco_self" x="50" y="50" width="100" height="100" patternUnits="userSpaceOnUse">
          <image x="0" y="0" width="100" height="100" href="lyco_self.svg"></image>
        </pattern>
        <pattern id="hearts" x="65" y="40" width="100" height="100" patternUnits="userSpaceOnUse">
          <image x="20" y="10" width="60" height="60" href="hearts.svg"></image>
        </pattern>
      </defs>
      <rect width={100 * boardWidth} height={100 * boardHeight} style={{fill: '#f9ffbb'}} />
      { Object.entries(playerMap).map( ([thatPlayerID, thatPlayerInfo]) => {
        const playerName = thatPlayerID === playerID ? 'lyco_self' : 'lyco_other'
        const playerClassName = thatPlayerID === playerID ? 'player-self' : 'player-other'
        return (<g key={thatPlayerID} transform={`translate(${thatPlayerInfo.x * 100}, ${thatPlayerInfo.y * 100})`}>
          <g transform='translate(50,50)'>
            <rect x="-50" y="-50" height="100" width="100" fill={`${url(${patternName})}`}></rect>
            {thatPlayerInfo.h && <rect x="-50" y="-50" width="100" height="100" fill='${url(#hearts)}'></rect>}
            <g transform={`translate(0,${thatPlayerInfo.y + 1} >= boardHeight ? -70 : 70)`)`}>
              <text className="player-name" textAnchor='middle' fontSize='40'>
                {thatPlayerInfo.playerName}
              </text>
            </g>
          </g>
        </g>
      ))}
    </svg>
  )
}
```

# Ideas for improvement

- **schemaful** messages at Pulsar level ( ⇒ several topics)
- a **sink** to Astra DB: persisted game-world representation
- player-player and player-world **interactions**

# Homework



# How to submit Homeworks

Link to submission form in the README

The screenshot shows a web page with a blue header containing the text "DataStax Developers". Below the header, there is a large white area with the text "Thank you!" in bold. At the bottom of this area, there is a blue button labeled "Submit". A pink circle highlights this "Submit" button. To the right of the "Submit" button, there is a green progress bar with a small green dot indicating progress. Below the progress bar, the text "Page 4 of 4" is visible. On the far right of the page, there is a "Clear form" button.

TikTok

Welcome to the DataStax Developers community! We're excited to have you here.

"Build your own DataStax application in just 4 pages!"

In case of any issues, please email us at [developers@datstax.com](mailto:developers@datstax.com).

- Workshops

- Discussions

\* Required

The name and phone number are required to file and submit the homework.

\* Required

Your Homework

In this section you have to upload your homework. Please follow the README file for instructions.

Compress

The name and phone number are required to file and submit the homework.

\* Required

Astra D

Deployed app info

Upload a screenshot (if included)

Email

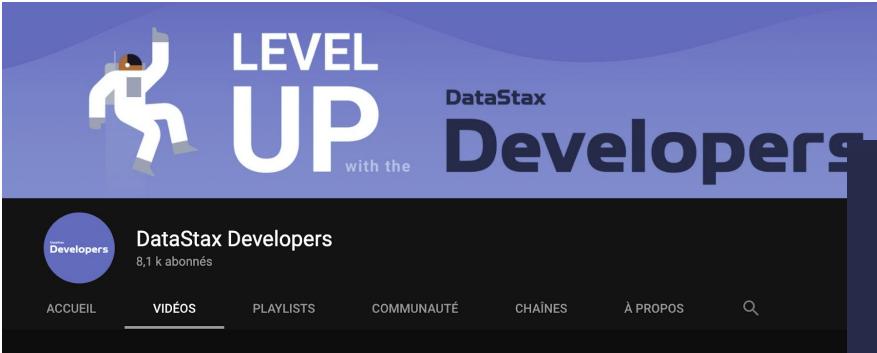
an N

Add file



# Weekly Workshops

[datastax.com/workshops](https://datastax.com/workshops)



LEVEL UP with the DataStax Developers

8,1 k abonnés

ACCUEIL VIDÉOS PLAYLISTS COMMUNAUTÉ CHAÎNES À PROPOS

Vidéos mises en ligne ▾ TOUT REGARDER

Hands-on live workshop Microservices with Cassandra + Spring 1:23:56 ADVANCED TOPIC	Hands-on live workshop Advanced Data Modeling with Aleksey Volkov 2:41:51 INTERMEDIATE TOPIC	LIVE hands-on workshop An Introduction to Apache Cassandra™ with Aleksey Volkov 1:28:14 INTERMEDIATE TOPIC	Hands-on live workshop Streaming to C* with Apache Pulsar! with Cedrick Lumeau 2:11:40 INTERMEDIATE TOPIC	A
Building Microservices with Cassandra + Spring 1,1 k vues • Diffusé il y a 20 heures	Advanced Data Modeling in Apache Cassandra™ 1,3 k vues • Diffusé il y a 1 semaine	Polska DataOps Meetup: Introduction to Apache... 151 vues • Diffusé il y a 1 semaine	Bring Streaming to Cassandra with Apache... 703 vues • Diffusé il y a 2 semaines	Introduction Cassandra™ 1,6 k vues • Diffusé il y a 3 semaines
Taking your K8s app to the Cloud! 1 k vues •	RESTful Data Access from a Spring Boot App 215 vues • il y a 1 mois	Ask Me Anything Hackathon Special 667 vues • Diffusé il y a 1 mois	Connecting Apache Cassandra™ & Kubernetes 1,1 k vues • Diffusé il y a 1 mois	An Easy Backend API with Apache... 2,3 k vues • D

SUBSCRIBE

for weekly content on building modern applications

Subscribe

Upcoming Live Events

LIVE hands-on workshop </>

Apache Cassandra™ Certification Preparation

MULTIPLE DATES | NoSQL | Beginner

LEVEL UP with the DataStax Developers

CERTIFICATION EXAM PREPARATION WORKSHOP

Register Now

LIVE hands-on workshop </>

Build Microservices with Apache Cassandra™!

FEB 17 or FEB 18 | NoSQL | Beginner

LEVEL UP with the DataStax Developers

CLOUD-NATIVE WORKSHOP: BUILD SPRING MICROSERVICES WITH APACHE CASSANDRA™

Register Now

LIVE hands-on workshop </>

Learn how to build a Serverless Game!

FEB 24 or FEB 25 | GAME DEVELOPMENT | Beginner

LEVEL UP with the DataStax Developers

START

CLOUD-NATIVE WORKSHOP: BUILD A SERVERLESS GAME WITH THE JAMSTACK!

Register Now

LIVE hands-on workshop </>

Build Microservices with Cassandra & Quarkus

MARCH 11 | Microservices | Beginner

LEVEL UP with the DataStax Developers

CLOUD-NATIVE WORKSHOP: BUILD MICROSERVICES WITH APACHE CASSANDRA™ + QUARKUS!

Register Now

# Next events:

[datastax.com/workshops](http://datastax.com/workshops)

Monday, November 22nd

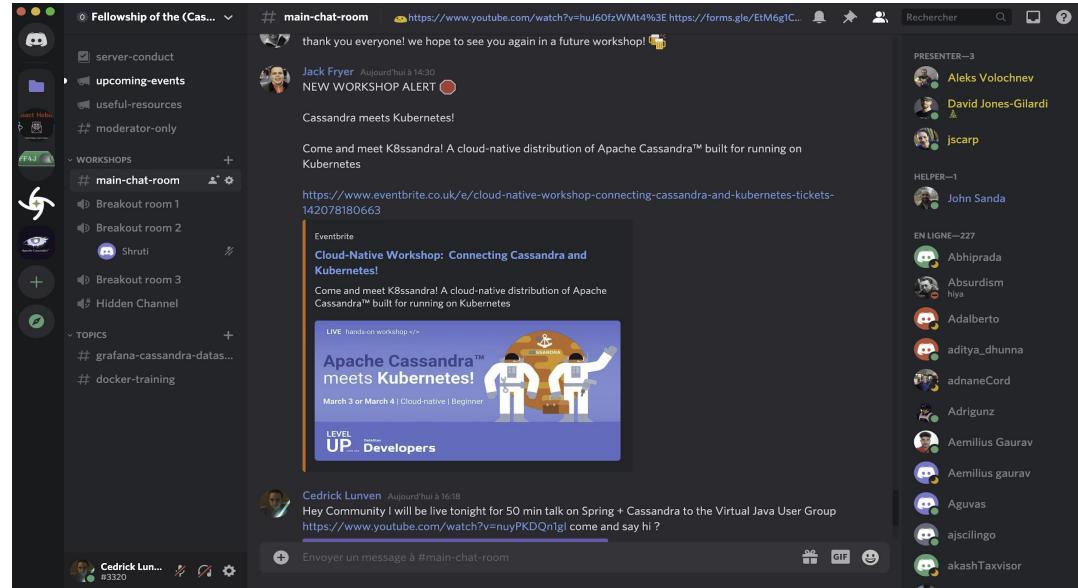
**Build an appointment scheduling application  
within the Java Spring Petclinic**

Wednesday, December 1st

**Build a Vast Digital Library (Netflix Clone)**

# Join our 17k Discord "DataStax Developers" Community

[dtsx.io/discord](https://dtsx.io/discord)



# Thank you!

Subscribe



Subscribe



# Thank you!

# DataStax Developers

Thank you!



Subscribe

