# BBoxDB
A Key-Bounding-Box-Value Store

## BBoxDB Streams: Distributed Processing of Real-World Streams of Position Data

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# Outline

# BBoxDB Streams

### BBoxDB Streams. . .

- is a distributed stream processing system that supports *n*-dimensional *point* and *non-point data*.
- uses the key-bounding-box-value store BBoxDB as data storage.
- supports continuous range queries.
- **allows efficient continuous spatial joins between static *n*-dimensional big data and stream elements.**

# BBoxDB – A distributed key-bounding-box-value store

### BBoxDB. . .

- is a distributed *key-bounding-box-value store*.
- stores each value together with a *bounding box*. The bounding box determines the location of the value in the *n*-dimensional space.
- partitions the space dynamically and redistributes the data.
- stores data co-partitioned for efficient spatial joins.
- is freely available and licensed under the *Apache 2.0* license.

# Partitioning the space
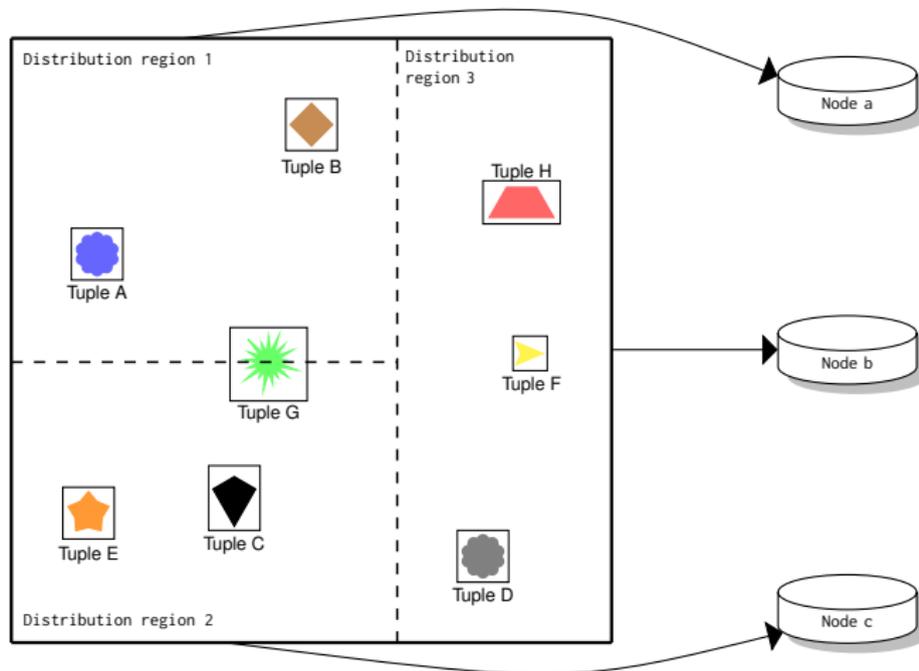
# Architecture

## Processing data with BBoxDB Streams
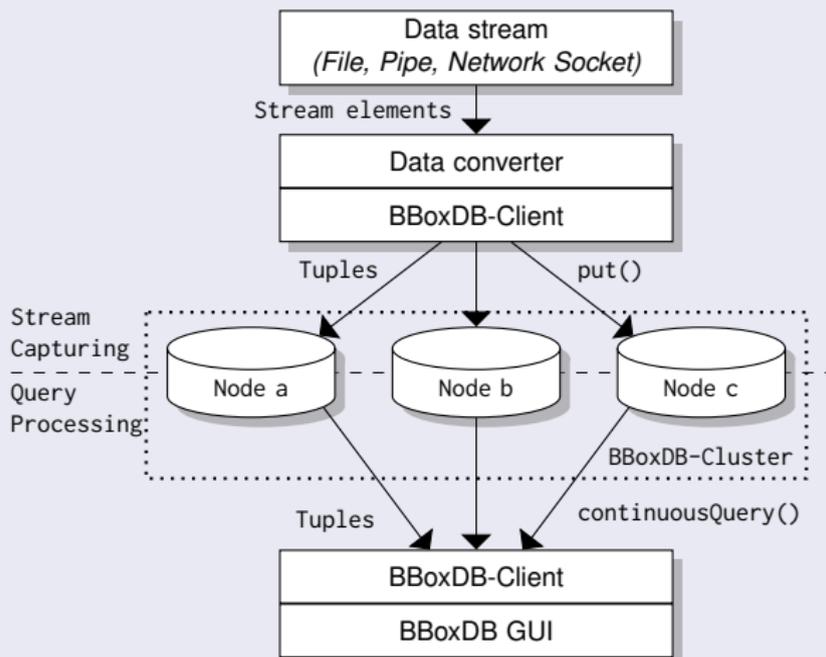
Figure: A USB-receiver which is capable of processing ADS-B (*Automatic Dependent Surveillance-Broadcast*) radio transmissions.
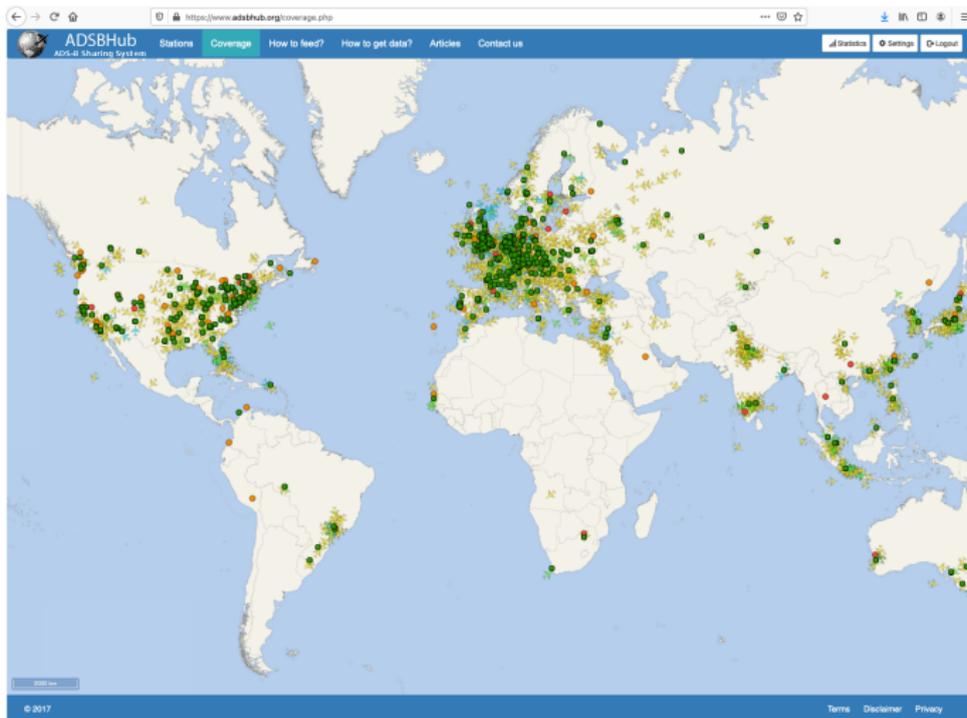
Figure: Aircraft position data fetched from the website `https://adsbhub.org/`

Figure: Public transport data in *GTFS real-time* format are fetched from the website https://opendata.transport.nsw.gov.au/

# Live Demonstration

# Summary

### BBoxDB Streams...

- is a stream processing extension of BBoxDB.
- can handle *n*-dimensional data streams (e.g., *position data*).
- is able to perform continuous queries such as range queries and spatial joins.
- **the spatial joins are performed between the dynamic stream elements and static *n*-dimensional big data.**
- is written in *Java* and licensed under the *Apache 2.0 license*.

# Questions?

## Further information

- Web: `https://bboxdb.org`
- GitHub: `https://github.com/jnidzwetzki/bboxdb`
- Twitter: `@bboxdb`
- Google Groups: `https://groups.google.com/forum/bboxdb`

# Backup Slides

# ADS-B data

## ADS-B data in SBS format

```
MSG,1,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,MSR681,,,,,,,,,
MSG,3,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,30525,,,29.562973,33.627777,,,,
MSG,4,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,,,477.000000,0.000000,,,-448,,,,


MSG,1,0,0,100DD,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,MSR914,,,,,,,,,
MSG,3,0,0,100DD,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,,25200,,,29.792269,32.485603,,,,
MSG,4,0,0,100DD,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,,,434.000000,99.000000,,,1792,,,,


MSG,1,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,NMA6389,,,,,,,,,,
MSG,3,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,,424,,,52.379501,13.527200,,,,
MSG,4,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,,,6.000000,150.000000,,,-510,,,,
```

# ADS-B data

## ADS-B data in SBS format

```
MSG,1,0,0 100A4 0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,MSR681,,,,,,,,,
MSG,3,0,0 100A4 0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,,30525,,,29.562973,33.627777,,,,,
MSG,4,0,0 100A4 0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,,,477.000000,0.000000,,,-448,,,,

MSG,1,0,0 100DD 0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.0
MSG,3,0,0 100DD 0,2021/02/01,07:07:39.000,2020/02/01,07:07:39                    2.485603,,,,,
MSG,4,0,0 100DD 0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.0            00000,,,1792,,,,

MSG,1,0,0 10140 0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,NMA6389,,,,,,,,,
MSG,3,0,0 10140 0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,,424,,,52.379501,13.527200,,,,,
MSG,4,0,0 10140 0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,,,6.000000,150.000000,,,-510,,,,
```

**Aircraft ID**

# ADS-B data

## ADS-B data in SBS format

```
MSG,1,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,MSR681,,,,,,,,,
MSG,3,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,,3052,,,29.562973,33.627777,,,,
MSG,4,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,,,477.000000,0.000000,,,-448,,,,

MSG,1,0,0,100DD,0,        000,2020/02/01,07:07:39.000,MSR914,,,,,,,,,
MSG,3,0,0,100DD,0,   Call-Sign   000,2020/02/01,07:07:39.000,25200,,,29.792269,32.485603,,,,
MSG,4,0,0,100DD,0,        000,2020/02/01,07:07:39.000,,,434.000000,99.000000,,,1792,,,,

MSG,1,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,NMA6389,,,,,,,,,
MSG,3,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,,424,,,52.379501,13.527200,,,,
MSG,4,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,,,6.000000,150.000000,,,-510,,,,
```

# ADS-B data

## ADS-B data in SBS format

```
MSG,1,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,MSR681,,,,,,,,
MSG,3,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,30625,,29.562973,33.627777,,,,
MSG,4,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,,,477.000000,0.000000,,,-448,,,,

MSG,1,0,0,100DD,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,MSR914,,,,,,,,
MSG,3,0,0,100DD,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,25200,,29.792269,32.485603,,,,
MSG,4,0,0,100DD,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,,,434.000000,99.000000,,,1792,,,,

MSG,1,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,NMA6389,,,,,,,,
MSG,3,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,22,,52.379501,13.527200,,,,
MSG,4,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,,,6.000000,150.000000,,,-510,,,,
```

**Height**
(Foot)

# ADS-B data

## ADS-B data in SBS format

```
MSG,1,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,MSR681,,,,,,,,,
MSG,3,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,30525,,,29.562973,33.627777,,,,,,
MSG,4,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,477.000000,0.000000,,,-448,,,,
```

```
MSG,1,0,0,100DD,0,         000,2020/02/01,07:07:39.000,MSR914,,,,,,,,,,
MSG,3,0,0,100DD,0,         000,2020/02/01,07:07:39.000,25200,,,29.792269,32.485603,,,,,
MSG,4,0,0,100DD,0,         000,2020/02/01,07:07:39.000,434.000000,99.000000,,,1792,,,,
```

**Speed**
(Knots)

```
MSG,1,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,NMA6389,,,,,,,,,
MSG,3,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,424,,,52.379501,13.527200,,,,,
MSG,4,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,.000000,150.000000,,,-510,,,,
```

# ADS-B data

## ADS-B data in SBS format

```
MSG,1,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,MSR681,,,,,,,,,
MSG,3,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,3052[29.562973,33.627777],,,,
MSG,4,0,0,100A4,0,2021/02/01,07:07:39.000,2020/02/01,07:07:39.000,,,477.000000,0.000000,,,-448,,,,

MSG,1,0,0,100DD,0,            000,2020/02/01,07:07:39.000,MSR914,,,,,,,,,
MSG,3,0,0,100DD,0,    Position    000,2020/02/01,07:07:39.000,,25200[29.792269,32.485603],,,,
MSG,4,0,0,100DD,0,   (WGS84)      000,2020/02/01,07:07:39.000,,,434.000000,99.000000,,,1792,,,,

MSG,1,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,NMA6389,,,,,,,,,
MSG,3,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,,424[52.379501,13.527200],,,,
MSG,4,0,0,10140,0,2021/02/01,07:07:39.000,2020/02/01,07:07:38.000,,,6.000000,150.000000,,,-510,,,,
```

# GTFS real-time data

### GTFS real-time data of a bus in GeoJSON format

```
{
 "geometry":{
  "coordinates":[151.17762756347, -33.92598342895],
  "type":"Point"
 },
 "type":"Feature",
 "properties":{
  "Speed":"19.2",
  "TripStartDate":"20200121",
  "TripScheduleRelationship":"SCHEDULED",
  "OccupancyStatus":"MANY_SEATS_AVAILABLE",
  "TripStartTime":"02:00:00",
  "RouteID":"2437_N20",
  "Timestamp":"1579530867",
  "TripID":"883447",
  "Bearing":"77.0",
 }
}
```

# Demonstration

### Our demonstration...

- performs continuous queries on real-world data streams.
- visualizes the results interactively on a map.
- performs spatial joins between *OpenStreetMap* data and a data stream.

### Performed continuous queries

- *Which aircraft is currently in the area of Berlin?*
- *Which bus drives currently through a forest?*