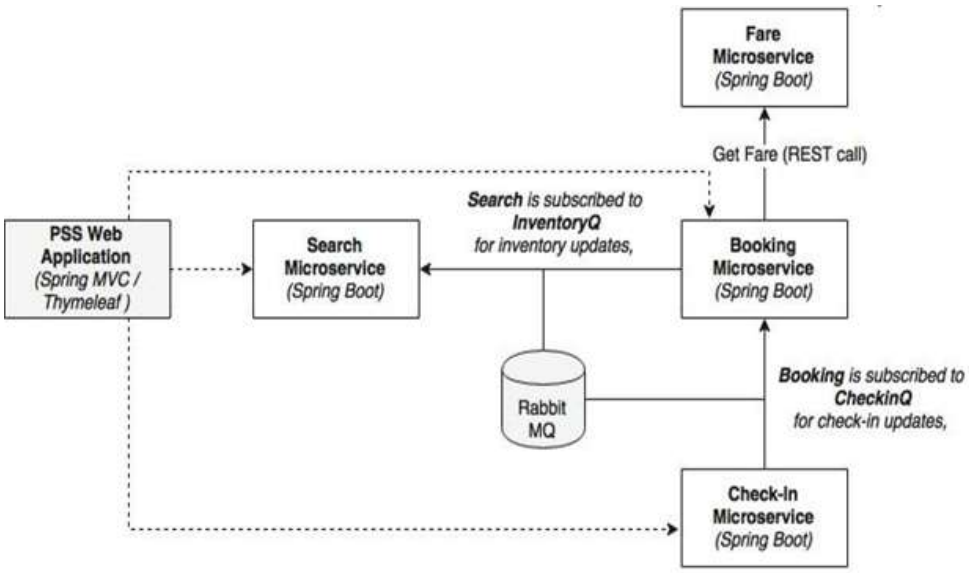
MICROSERVICES EVOLUTION – A CASE STUDY

We will understand the case study of BrownField Airline and their journey from a monolithic **Passenger Sales and Service** (PSS) application to a next generation microservices architecture by adhering to the principles and practices that were discussed before.

Reviewing the microservices capability model

We are about to implement four microservices such as Fare, Search, Booking and Check-in. In order to test the application, there is a website application developed using Spring MVC with Thymeleaf templates (needed for html pages). The asynchronous messaging is implemented with the help of RabbitMQ. In this implementation, the **Oracle database will be used with separate schema for each Microservice**.



The following steps are used to setup PSS Microservices project:

1) Create tablespaces, schemas, tables, sequences and insert data by referring 'Documents/Misc/ Airline_PSS_Schema.doc' file.
2) Download STS from https://spring.io/tools/sts/all. Start STS (Spring Tool Suite) and select '**MicroservicesWorkspace**' from the backup.
3) Start FaresFlightTickets by right click and Run as **Spring Boot App**.
4) Install **RabbitMQ** Server from Softwares folder. After installation check service status in start-> run -> services.msc
   Observation: Status: Running, Startup type: Automatic
   Note: The pre-requisite for RabbitMQ is **Erlang**. Hence Install OTP_win64_19.3.exe from Softwares folder.
5) Start SearchFlightTickets by right click and Run as **Spring Boot App**.
6) Start BookingFlightTickets by right click and Run as Spring Boot App.
7) Start CheckInCustomers by right click and Run as Spring Boot App.
8) Start FlightWebSite by right click and Run as Spring Boot App.

Each service has multiple packages and their purposes are explained as follows:

1. The entity package contains the JPA entity classes for mapping to the database tables.
2. The repository package contains repository classes, which are based on Spring Data JPA.
3. The component package hosts all the service components where the business logic is implemented.
4. The controller package hosts the **REST endpoints** and the **Messaging endpoints**. Controller classes internally utilize the component classes for execution.
5. The root package (com.brownfield.pss.fares) contains the default Spring Boot application.

The below table contains service endpoints and communication styles:

Microservice Name	**REST endpoints (synchronous)**	**Messaging Endpoints (asynchronous)**	**Used By**
FareFlightTickets	http://localhost:8081/fares/get		Booking microservice
SearchFlightTickets	http://localhost:8090/search/get		Website
SearchFlightTickets		@RabbitListener(queues = "**SearchQ**")	Search microservice itself subscribed to **SearchQ** for inventory updates.
BookingFlightTickets	http://localhost:8060/booking/create		Website
BookingFlightTickets	http://localhost:8060/booking/get/{id}		Checkin, website
BookingFlightTickets		template.convertAndSend("**SearchQ**", message);	Search Microservice
BookingFlightTickets		@RabbitListener(queues = "**CheckINQ**")	Booking service subscribed to **CheckINQ** for check-in updates.
CheckInCustomers	http://localhost:8070/checkin/create		Website
CheckInCustomers	http://localhost:8070/checkin/get/{id}		Not used
CheckInCustomers		template.convertAndSend("**CheckINQ** ", message);	Booking Microservice

We have accomplished the following items in our microservice implementation so far:

1. Each microservice exposes a set of REST/JSON endpoints for accessing business capabilities
2. Each microservice implements certain business functions using the Spring framework.

3. Each microservice has its own schema in Oracle database.
4. Microservices are built with Spring Boot, which has an embedded Tomcat server as the HTTP listener.
5. RabbitMQ is used as an external messaging service. Search, Booking, and Check-in interact with each other through asynchronous messaging.
6. An OAuth2-based security mechanism is developed to protect the Microservices.

DataBase Design

CREATING FARE SCHEMA

Step 1: Connect to database
C:\>sqlplus system/manager@xe

Step2: Create tablespace

```
CREATE TABLESPACE tbs_fareuser DATAFILE 'tbs_fareuser.dat' SIZE
1M AUTOEXTEND ON;
```

Note: alter session set "_ORACLE_SCRIPT"=true; This is required in Oracle 12c

Step3: Create a new user in Oracle

```
CREATE USER fareuser IDENTIFIED BY aspire123 DEFAULT TABLESPACE
tbs_fareuser QUOTA unlimited on tbs_fareuser;
```

Note: In oracle, a schema is created when a user is created.

Step4: Grant permissions

```
GRANT create session TO fareuser;
GRANT create table TO fareuser;
GRANT create sequence TO fareuser;
```

Step5: Disconnect from system account and connect to fareuser `Sql>exit`

```
C:\>sqlplus fareuser/aspire123@xe
```

Step6: Create tables and sequences

```
drop table fare cascade constraints;
drop sequence fare_seq;
```

```
create table fare (id number(19) primary key, fare
varchar2(255), flight_date varchar2(255),
flight_number varchar2(255));

create sequence fare_seq start with 1 increment by 1;
```

Step7: Insert records

```
insert into fare(id, fare, flight_date, flight_number)
values (fare_seq.nextVal, '100', '22-JAN-16', 'BF100');
insert into fare(id, fare, flight_date, flight_number)
values (fare_seq.nextVal, '101', '22-JAN-16', 'BF101');
insert into fare(id, fare, flight_date, flight_number)
values (fare_seq.nextVal, '102', '22-JAN-16', 'BF102');



insert into fare(id, fare, flight_date, flight_number)
values (fare_seq.nextVal, '103', '22-JAN-16', 'BF103');
insert into fare(id, fare, flight_date, flight_number)
values (fare_seq.nextVal, '104', '22-JAN-16', 'BF104');
insert into fare(id, fare, flight_date, flight_number)
values (fare_seq.nextVal, '105', '22-JAN-16', 'BF105');
insert into fare values (fare_seq.nextVal, '106', '22-JAN-16',
'BF106');

commit;
```

Step8: Read data from FAREUSER schema

```
SELECT * FROM "FAREUSER"."FARE";
```

ID	FLIGHT_NUMBER	FLIGHT_DATE	FARE
1	BF100	22-JAN-16	100
2	BF101	22-JAN-16	101
3	BF102	22-JAN-16	102
4	BF103	22-JAN-16	103
5	BF104	22-JAN-16	104
6	BF105	22-JAN-16	105
7	BF106	22-JAN-16	106

CREATING SEARCH SCHEMA

Step 1: Connect to database (ignore if already connected)
C:\>sqlplus system/manager@xe

Step2: Create tablespace

```
CREATE TABLESPACE tbs_searchuser DATAFILE 'tbs_searchuser.dat'
SIZE 1M AUTOEXTEND ON;
```

Note: alter session set "_ORACLE_SCRIPT"=true; This is required in Oracle 12c

Step3: Create a new user in Oracle

```
CREATE USER searchuser IDENTIFIED BY aspire123 DEFAULT
TABLESPACE tbs_searchuser QUOTA unlimited on tbs_searchuser;
```

Note: In oracle, a schema is automatically created when a user is created.

Step4: Grant permissions

```
GRANT create session TO searchuser;
GRANT create table TO searchuser;
GRANT create sequence TO searchuser;
```

Step5: Disconnect from system account and connect to searchuser

```
Sql>exit
C:\>sqlplus searchuser/aspire123@xe
```

Step6: Create tables and sequences

```
drop table fare cascade constraints; drop
table inventory cascade constraints; drop
table flight cascade constraints;

drop sequence fare_seq;
drop sequence flight_seq;
drop sequence inventory_seq;

create sequence fare_seq start with 1 increment by 1;
create sequence flight_seq start with 1 increment by 1;
create sequence inventory_seq start with 1 increment by 1;

create table fare (fare_id number(19) primary key, currency
varchar2(255), fare varchar2(255));

create table inventory (inv_id number(19) primary key,
count number(10) not null);

create table flight (id number(19) primary key, origin
varchar2(255), destination varchar2(255), flight_number
varchar2(255), flight_date varchar2(255),
fare_id number(19) references fare(fare_id), inv_id
number(19) references inventory(inv_id));

Step7: Insert records
insert into fare (currency, fare, fare_id) values ('USD',
100, fare_seq.nextVal);
insert into fares (currency, fare, fare_id) values ('USD', 101,
fare_seq.nextVal);
insert into fare (currency, fare, fare_id) values ('USD',
102, fare_seq.nextVal);
insert into fare (currency, fare, fare_id) values ('USD',
103, fare_seq.nextVal);
insert into fare (currency, fare, fare_id) values ('USD',
104, fare_seq.nextVal);
insert into fare (currency, fare, fare_id) values ('USD',
105, fare_seq.nextVal);
```

```
insert into fare (currency, fare, fare_id) values ('USD',
106, fare_seq.nextVal);

insert into inventory (count, inv_id) values
(100, inventory_seq.nextVal);
insert into inventory (count, inv_id) values
(100, inventory_seq.nextVal);
insert into inventory (count, inv_id) values
(100, inventory_seq.nextVal);
insert into inventory (count, inv_id) values
(100, inventory_seq.nextVal);
insert into inventory (count, inv_id) values
(100, inventory_seq.nextVal);
insert into inventory (count, inv_id) values
(100, inventory_seq.nextVal);
insert into inventory (count, inv_id) values
(100, inventory_seq.nextVal);

insert into flight (id, flight_number, origin, destination,
flight_date, fare_id, inv_id) values (flight_seq.nextVal,
'BF100', 'SEA', 'SFO', '22-JAN-16', 1, 1);
insert into flight (id, flight_number, origin, destination,
flight_date, fare_id, inv_id) values (flight_seq.nextVal,
'BF101', 'NYC', 'SFO', '22-JAN-16', 2, 2);
insert into flight (id, flight_number, origin, destination,
flight_date, fare_id, inv_id) values (flight_seq.nextVal,
'BF102', 'CHI', 'SFO', '22-JAN-16', 3, 3);
insert into flight (id, flight_number, origin, destination,
flight_date, fare_id, inv_id) values (flight_seq.nextVal,
'BF103', 'HOU', 'SFO', '22-JAN-16', 4, 4);
insert into flight (id, flight_number, origin, destination,
flight_date, fare_id, inv_id) values (flight_seq.nextVal,
'BF104', 'LAX', 'SFO', '22-JAN-16', 5, 5);
insert into flight (id, flight_number, origin, destination,
flight_date, fare_id, inv_id) values (flight_seq.nextVal,
'BF105', 'NYC', 'SFO', '22-JAN-16', 6, 6);
insert into flight (id, flight_number, origin, destination,
flight_date, fare_id, inv_id) values (flight_seq.nextVal,
'BF106', 'NYC', 'SFO', '22-JAN-16', 7, 7);

commit;
```

Step8: Read data from SEARCHUSER schema

```
SELECT * FROM "SEARCHUSER"."FARE";
```

FARE_ID	FARE	CURRENCY
1	100	USD
2	101	USD
3	102	USD
4	103	USD
5	104	USD
6	105	USD
7	106	USD

```
SELECT * FROM "SEARCHUSER"."INVENTORY";
```

INV_ID	COUNT
1	100
2	100
3	100
4	100
5	100
6	100
7	100

```
SELECT * FROM "SEARCHUSER"."FLIGHT";
```

ID	FLIGHT_NUMBER	FLIGHT_DATE	ORIGIN	DESTINATION	FARE_ID	INV_ID
1	BF100	22-JAN-16	SEA	SFO	1	1
2	BF101	22-JAN-16	NYC	SFO	2	2
3	BF102	22-JAN-16	CHI	SFO	3	3
4	BF103	22-JAN-16	HOU	SFO	4	4
5	BF104	22-JAN-16	LAX	SFO	5	5
6	BF105	22-JAN-16	NYC	SFO	6	6
7	BF106	22-JAN-16	NYC	SFO	7	7

CREATING BOOKING SCHEMA

Step 1: Connect to database (ignore if already connected)
C:\>sqlplus system/manager@xe

Step2: Create tablespace

```
CREATE TABLESPACE tbs_bookinguser DATAFILE 'tbs_bookinguser.dat'
SIZE 1M AUTOEXTEND ON;
```

Note: alter session set "_ORACLE_SCRIPT"=true; This is required in Oracle 12c

Step3: Create a new user in Oracle

```
CREATE USER bookinguser IDENTIFIED BY aspire123 DEFAULT
TABLESPACE tbs_bookinguser QUOTA unlimited on tbs_bookinguser;
```

Note: In oracle, a schema is created when a user is created.

Step4: Grant permissions

```
GRANT create session TO bookinguser;
GRANT create table TO bookinguser;
GRANT create sequence TO bookinguser;
```

Step5: Disconnect from system account and connect to bookinguser

```
Sql>exit
C:\>sqlplus bookinguser/aspire123@xe
```

Step6: Create tables and sequences

```
drop table booking_record cascade constraints;
drop table inventory cascade constraints; drop
table passenger cascade constraints;

drop sequence booking_seq;
drop sequence inventory_seq;
drop sequence passenger_seq;

create sequence booking_seq start with 1 increment by 1;
create sequence inventory_seq start with 1 increment by 1;
create sequence passenger_seq start with 1 increment by 1;

create table booking_record (id number(19) primary key,
booking_date timestamp, destination varchar2(255), fare
varchar2(255), flight_date varchar2(255), flight_number
varchar2(255), origin varchar2(255), status varchar2(255));

create table inventory (id number(19) primary key, available
number(10) not null, flight_date varchar2(255), flight_number
varchar2(255));

create table passenger (id number(19) primary key, first_name
varchar2(255), gender varchar2(255), last_name varchar2(255),
booking_id number(19) references booking_record(id));
```

Step7: **Insert records**

```
insert into inventory (flight_number, flight_date, available,
id) values ('BF100', '22-JAN-16', 100, inventory_seq.nextVal);
insert into inventory (flight_number, flight_date, available,
id) values ('BF101', '22-JAN-16', 100, inventory_seq.nextVal);
insert into inventory (flight_number, flight_date, available,
id) values ('BF102', '22-JAN-16', 100, inventory_seq.nextVal);
```

```
insert into inventory (flight_number, flight_date, available,
id) values ('BF103', '22-JAN-16', 100, inventory_seq.nextVal);
insert into inventory (flight_number, flight_date, available,
id) values ('BF104', '22-JAN-16', 100, inventory_seq.nextVal);
insert into inventory (flight_number, flight_date, available,
id) values ('BF105', '22-JAN-16', 100, inventory_seq.nextVal);
insert into inventory (flight_number, flight_date, available,
id) values ('BF106', '22-JAN-16', 100, inventory_seq.nextVal);

commit;
```

Step8: Read data from BOOKINGUSER schema

```
SELECT * FROM "BOOKINGUSER"."INVENTORY";
```

ID	FLIGHT_NUMBER	FLIGHT_DATE	AVAILABLE
1	BF100	22-JAN-16	100
2	BF101	22-JAN-16	**99**
3	BF102	22-JAN-16	100
4	BF103	22-JAN-16	100
5	BF104	22-JAN-16	100
6	BF105	22-JAN-16	100
7	BF106	22-JAN-16	100

```
SELECT * FROM "BOOKINGUSER"."BOOKING_RECORD";
```

ID	BOOKING DATE	ORIGIN	DESTINATION	FARE	FLIGHT DATE	FLIGHT NUMBER	STATUS
1	2017-06-06 20:46:01	NYC	SFO	101	22-JAN-16	BF101	**BOOKING_CONFIRMED**

```
SELECT * FROM "BOOKINGUSER"."PASSENGER";
```

ID	FIRST_NAME	LAST_NAME	GENDER	BOOKING_ID
1	Gean	Franc	Male	1

CREATING CHECKIN SCHEMA

Step 1: Connect to database (ignore if already connected)
C:\>sqlplus system/manager@xe

Step2: Create tablespace

```
CREATE TABLESPACE tbs_checkinuser DATAFILE 'tbs_checkinuser.dat'
SIZE 1M AUTOEXTEND ON;
```

Note: alter session set "_ORACLE_SCRIPT"=true; This is required in Oracle 12c

Step3: Create a new user in Oracle

```
CREATE USER checkinuser IDENTIFIED BY aspire123
DEFAULT TABLESPACE tbs_checkinuser QUOTA unlimited on
tbs_checkinuser;
```

Note: In oracle a schema is created when a user is created.

Step4: Grant permissions

```
GRANT create session TO checkinuser;
GRANT create table TO checkinuser;
GRANT create sequence TO checkinuser;
```

Step5: Disconnect from system account and connect to checkinuser

```
Sql>exit
C:\>sqlplus checkinuser/aspire123@xe
```

Step6: Create tables and sequences

```
drop table check_in_record cascade
constraints; drop sequence checkin_seq;

create sequence checkin_seq start with 1 increment by 1;

create table check_in_record (id
number(19)primary key, booking_id number(19) not
null, check_in_time timestamp, first_name
varchar2(255), flight_date varchar2(255),
flight_number varchar2(255), last_name
varchar2(255), seat_number varchar2(255));
```

Step7: **Insert records**

No need to insert data manually

Step8: Read data from CHECKINUSER schema

```
SELECT * FROM "CHECKINUSER"."CHECK_IN_RECORD";
```

ID	BOOKING_ID	CHECK_IN_TIME	FIRST_ NAME	LAST_NAME	FLIGHT_DATE	FLIGHT_NUMBER	SEAT_NUMBER
1	1	2017-06-06 21:18:46	Gean	Franc	22-JAN-16	BF101	**28A**

Other useful commands

DROP TABLESPACE tbs_testuser INCLUDING CONTENTS AND DATAFILES;

DROP USER testuser;