Methodologies for the initial design studies of an innovative community-friendly miniliner

Lorenzo Trainelli, Carlo E. D. Riboldi, Alberto Rolando, Francesco Salucci
Politecnico di Milano
September 2, 2020

SHORT HAUL REGIONAL ROUTE CONCEPT

Towards an **environmentally and community-friendly** short-haul air transportation service for door-to-door mobility

1. **Microfeeder** service (hub-and-spoke)
   - Feeding hub flights: carry people to international airports flying from small aerodromes (minor airports and grassy airstrips) scattered in the neighboring territory

town Typical Italian **road** travel time: **55 ÷ 100** min **international airport**

2. **Miniliner** service (point-to-point)
   - Serving town-to-town commuters: intercity service replacing car/train, "as easy as a bus"

SHORT HAUL REGIONAL MARKET

Requirements to design the UNIFIER19 aircraft for these services?

- Typically, requirements come from **market needs**
- Here, the market is not developed today, it must be **predicted**

Preliminary studies encompass several elements in the **future microfeeder and miniliner market definition**

1. Available aerodrome network
2. Mission analysis
3. Potential demand estimation
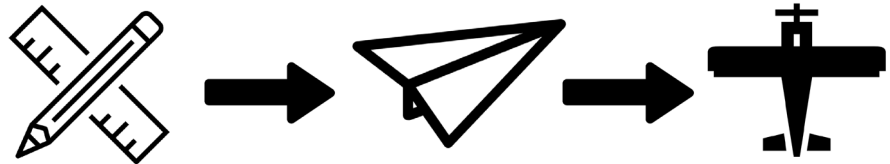
OUTLINE

1. Available aerodrome network
2. Mission analysis
3. Potential demand estimation
   - Microfeeder
   - Miniliner

OUTLINE

1. **Available aerodrome network**
2. Mission analysis
3. Potential demand estimation
   - Microfeeder
   - Miniliner

AERODROMES IN EUROPE

Nomenclature

1. **Airports**
   a. Primary airports or Hubs
   b. Secondary airports

2. **Airstrips**

Hubs (pax 2018 >5,000,000)	69
Secondary airports	1,928
Airstrips (no ICAO code)	1,101
Total	**3,098**

**Secondary Aerodromes (SA)**: secondary airports + airstrips

Data sources

- Aerodromes source: https://www.openaip.net/

- Countries considered: **EU 27**
  Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden

- Data about pax from Eurostat

- RWY length >= 100 m

AERODROME DISTRIBUTION
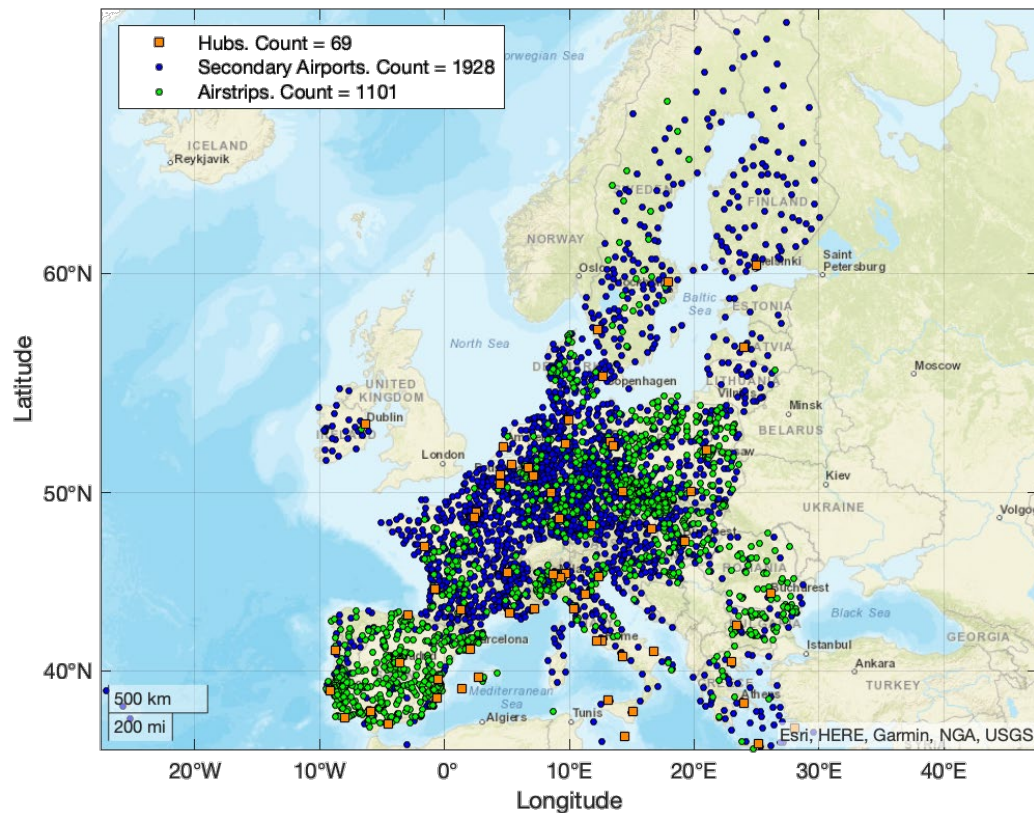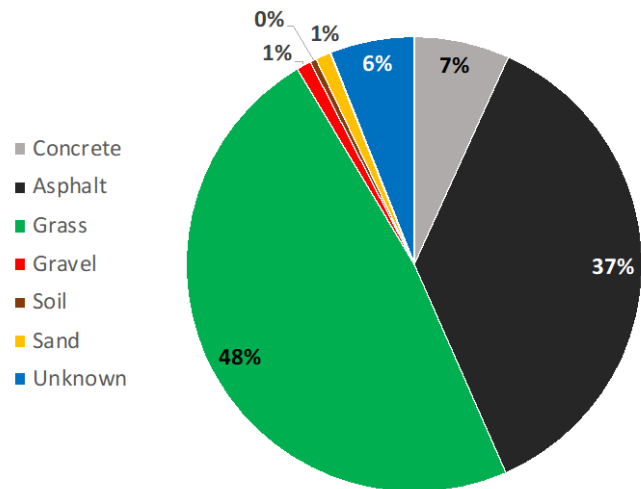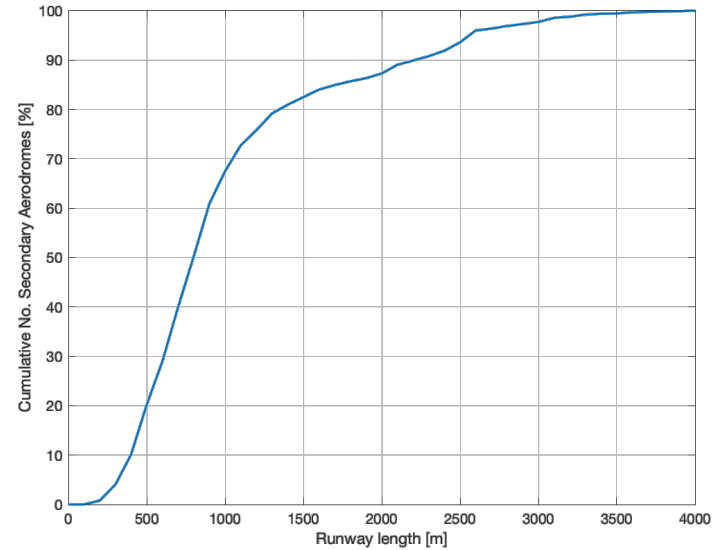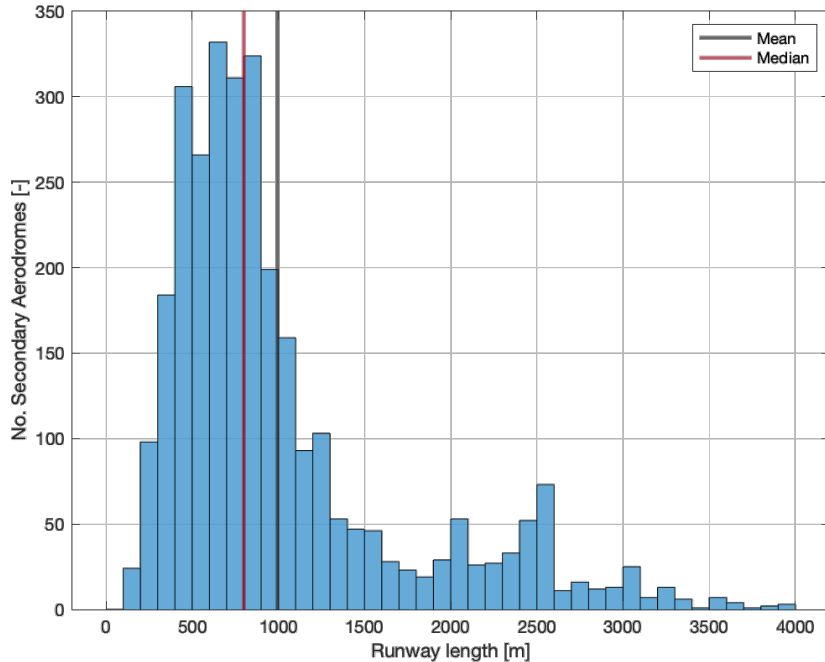
RUNWAY LENGTH

Considering different runway lenghts

- From 600 m up – capture 75% of the total
- From 800 m up – capture 50% ot the total
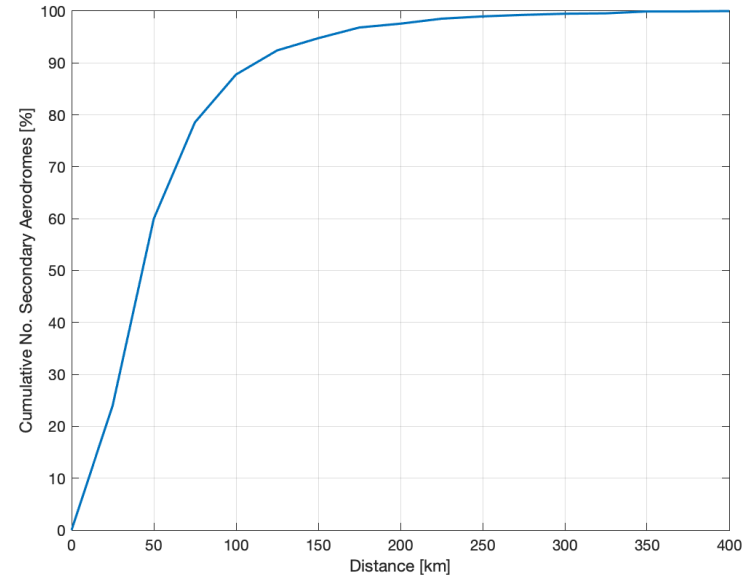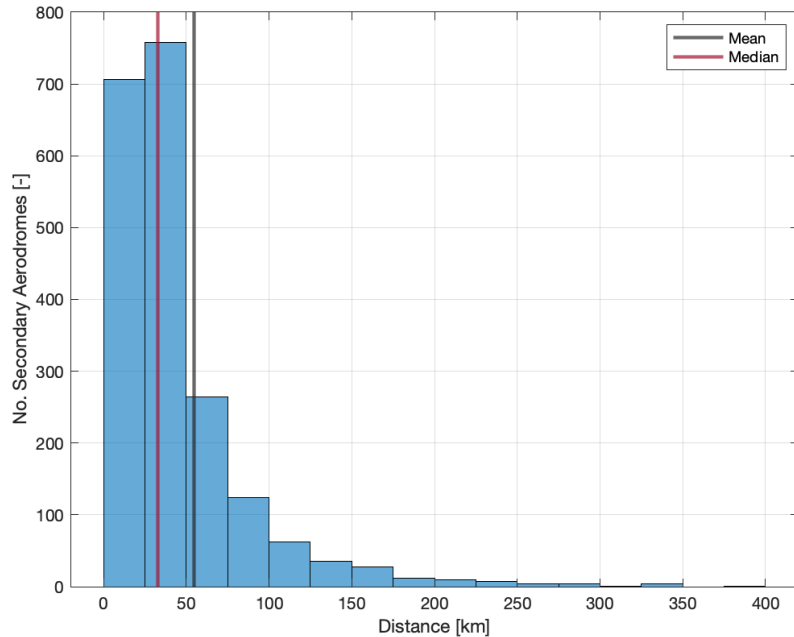- From 1,000 m up – capture 35% of the total

OUTLINE

1. Available aerodrome network
2. **Mission analysis**
3. Potential demand estimation
   - Microfeeder
   - Miniliner

DIVERSION NEEDS

- **RWY >=600 m**

- **1376 secondary. aerodromes**
  - 162 airstrip
  - 1214 sec. airports

- **80 %** of **secondary aerodromes** has an airport within **75 km**
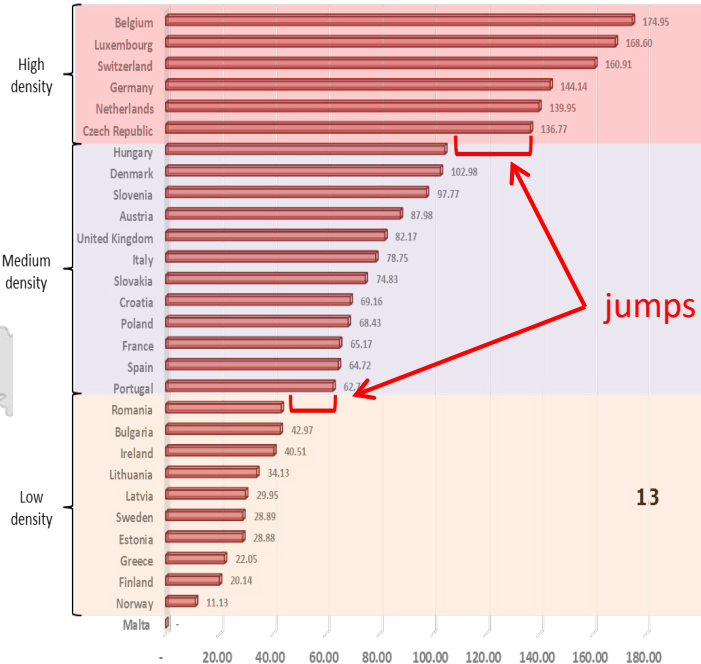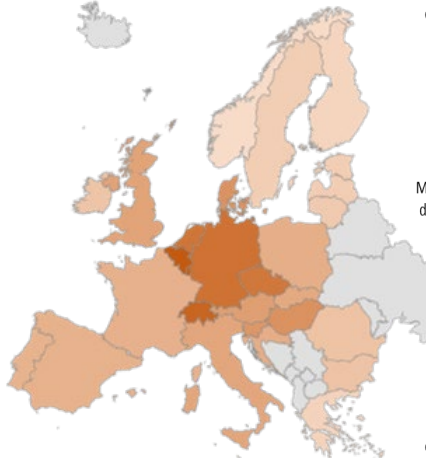
OUTLINE

1. Available aerodrome network
2. Mission analysis
3. **Potential demand estimation**
   - **Microfeeder**
   - Miniliner

MARKET STUDY FRAMEWORK

Ground Transportation Efficiency Index based **on railway + motorway** network (MAHEPA)

Categorization of EU countries by transport efficiency

Three case studies:

1. High-transportation-density countries: **Brussels (Belgium)**

2. Medium-transportation-density countries: **Venice (Italy)**

3. Low-transportation-density countries: **Riga (Latvia)**

- Secondary aerodromes organized in clusters (cluster max width: 50 km **road distance**)

- Only towns with more that 20,000 inhabitants involved

Route catchment area definition

- The catchment area for a route traced between a secondary aerodrome (airport or airstrip) and a hub is defined based on the positive evaluation
  of the **time advantage** represented by the following time constraints

3x45 parametric studies:

- Trip distance from 100 to 300 km
- Cruising speed from 150 to 250 KTAS
- Cruising altitude 4,000 ft (when possible)
- Runway length from 600 to 1,000 m
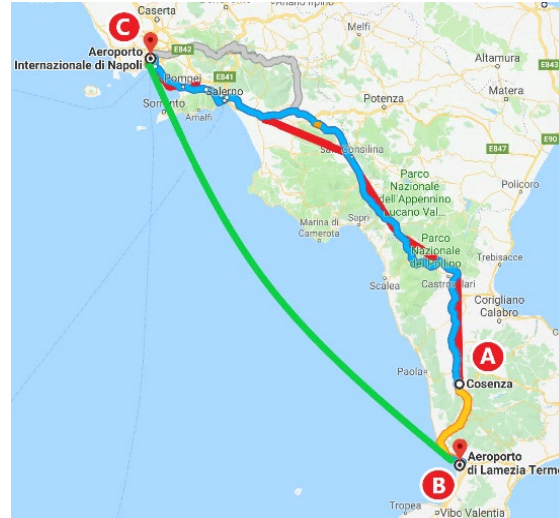
Catchment area example for the route between Lamezia Terme and Naples, in Italy

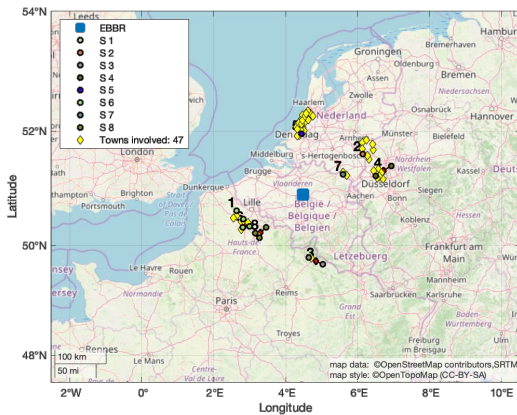$$t^{T-SA} + t^{mf} \leq \frac{t^{T-H}}{k}$$

$$t^{T-H} - \left(t^{T-SA} + t^{mf}\right) \geq t_{ref}$$
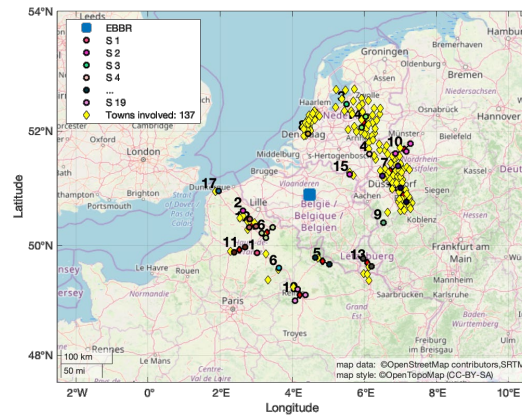
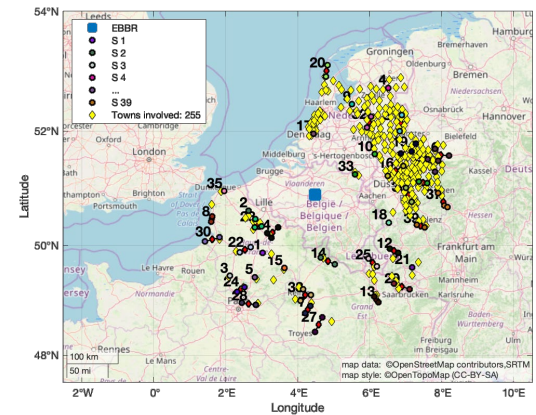| k	1.3
t_{ref}	30 min

MICROFEEDER MARKET STUDIES

- **Brussels Zaventem Airport (EBBR): effect of trip distance**
- Distribution of towns and secondary aerodromes involved in the case of **800 m long runways** and a **cruising speed of 200 KTAS**

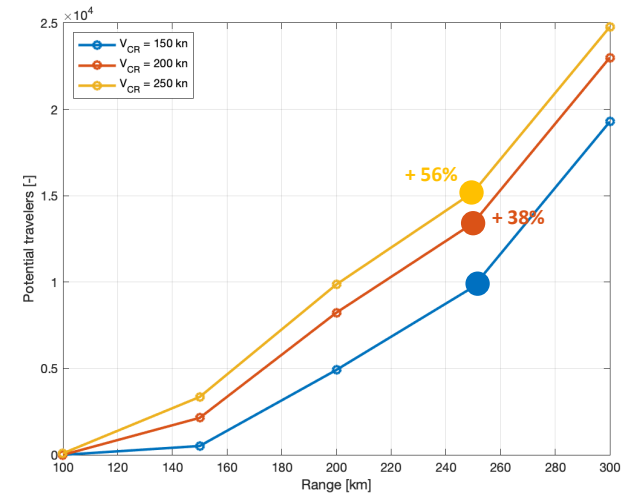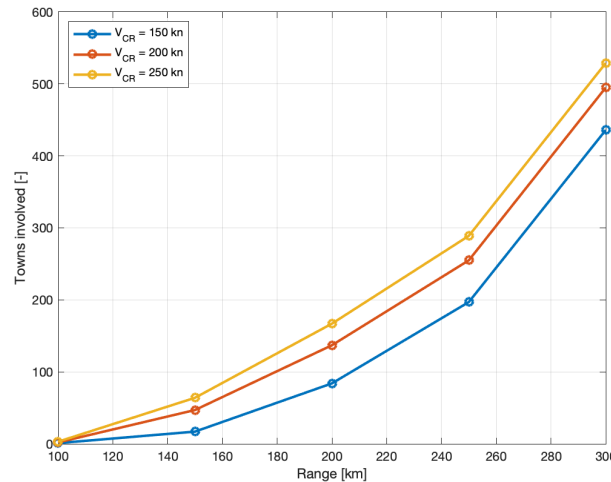Maximum trip distance of 150 km   Maximum trip distance of 200 km   Maximum trip distance of 250 km

MICROFEEDER MARKET STUDIES

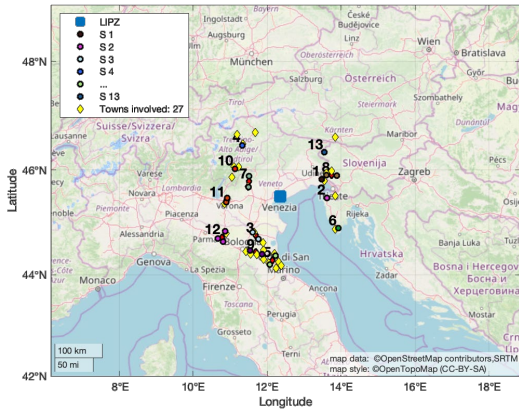**Brussels Zaventem Airport (EBBR): effect of cruise speed and trip distance**

- Secondary aerodromes and potential travelers as functions of cruise speed and trip distance (RWY >= 800 m)

- Moderate changes observed in the potential demand with respect to cruise speed.

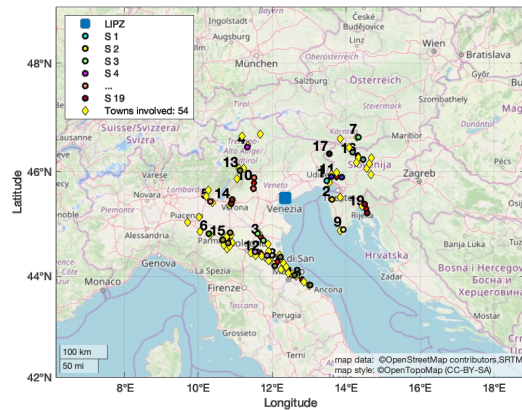- Exponential growth with respect to trip distance
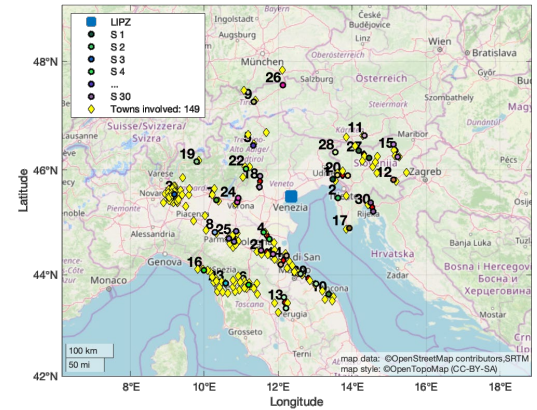
MICROFEEDER MARKET STUDIES

- **Venice Marco Polo Airport (LIPZ): effect of trip distance**
- Distribution of towns and secondary aerodromes involved in the case of **800 m long runways** and a **cruising speed of 200 KTAS**

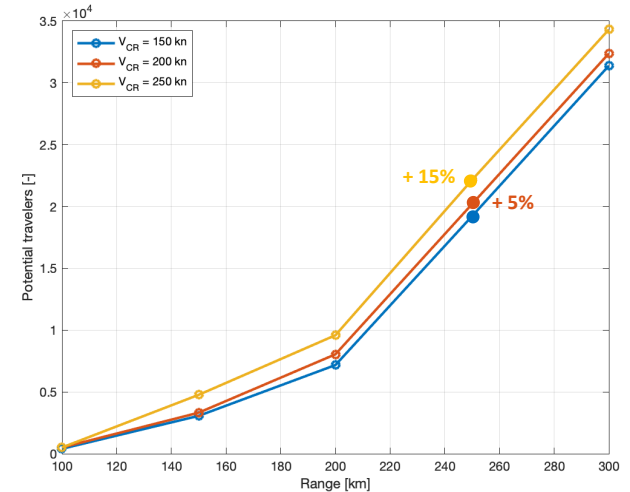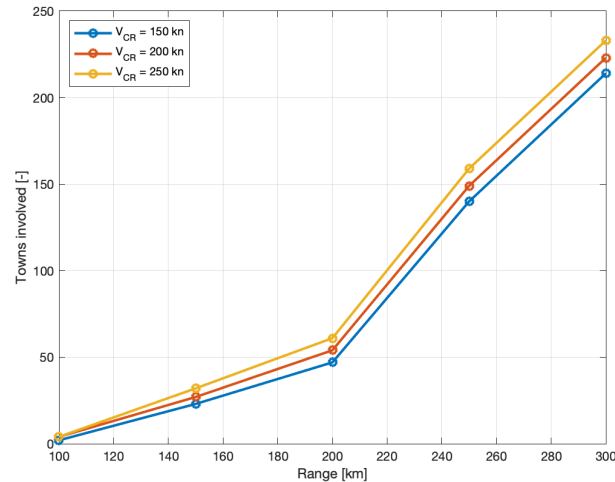Maximum trip distance of 150 km   Maximum trip distance of 200 km   Maximum trip distance of 250 km

MICROFEEDER MARKET STUDIES

Venice Marco Polo Airport (LIPZ): effect of cruise speed and trip distance

- Secondary aerodromes and potential travelers as functions of cruise speed and trip distance (RWY >= 800 m)

- Relatively small changes observed in the potential demand with respect to cruise speed,

MICROFEEDER MARKET STUDIES

- **Riga International Airport (EVRA): effect of trip distance**
- Distribution of towns and secondary aerodromes involved in the case of **800 m long runways** and a **cruising speed of 200 KTAS**

Maximum trip distance of 150 km

Maximum trip distance of 200 km

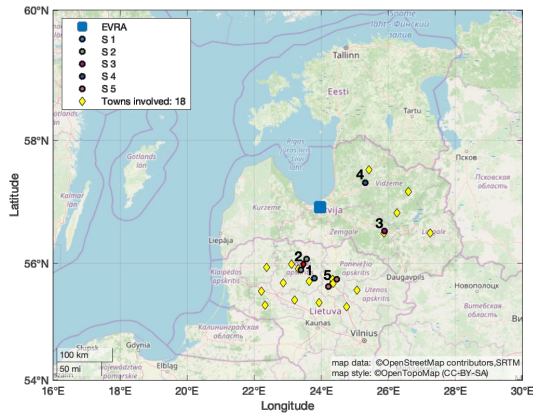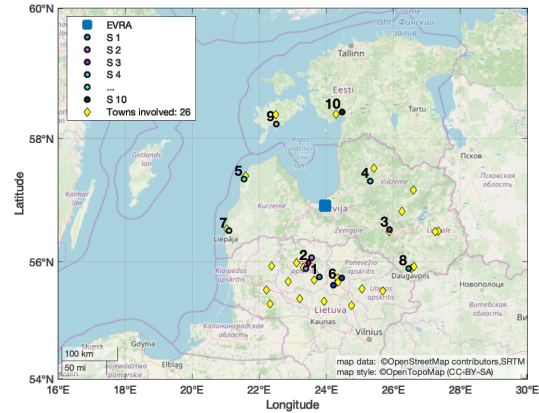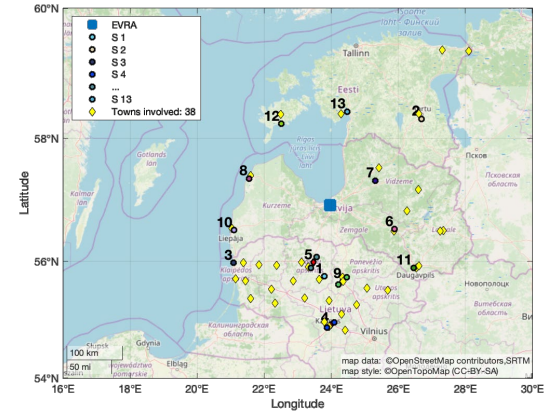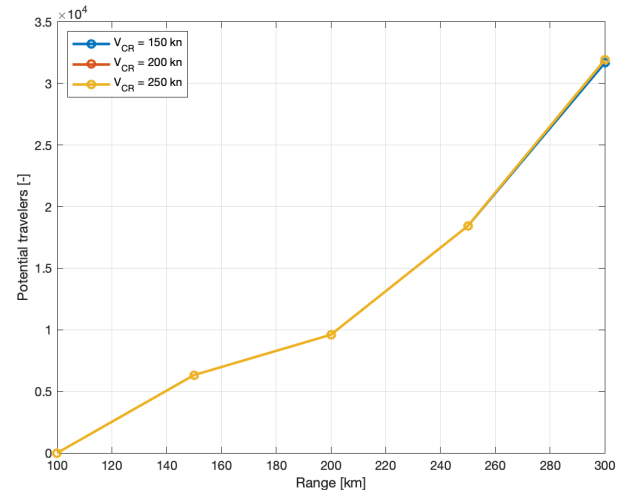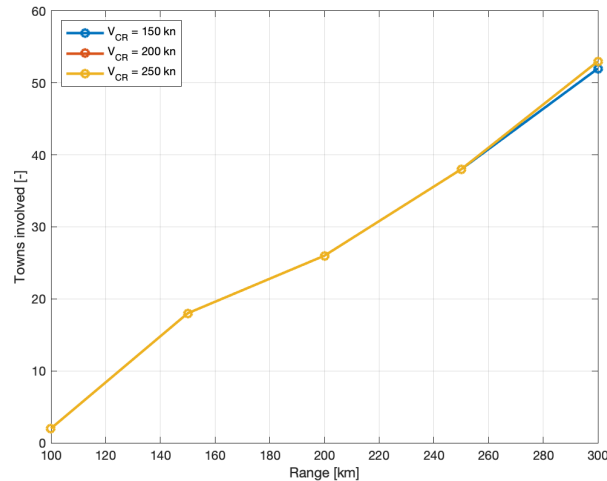Maximum trip distance of 250 km

MICROFEEDER MARKET STUDIES

Riga International Airport (EVRA): effect of cruise speed and trip distance

- Secondary aerodromes and potential travelers as functions of cruise speed and trip distance (RWY >= 800 m)

- No effect of the cruise speed

- Less pronounced growth wrt trip distance than EBBR and LIPZ

OUTLINE

1. Available aerodrome network
2. Mission analysis
3. **Potential demand estimation**
   - Microfeeder
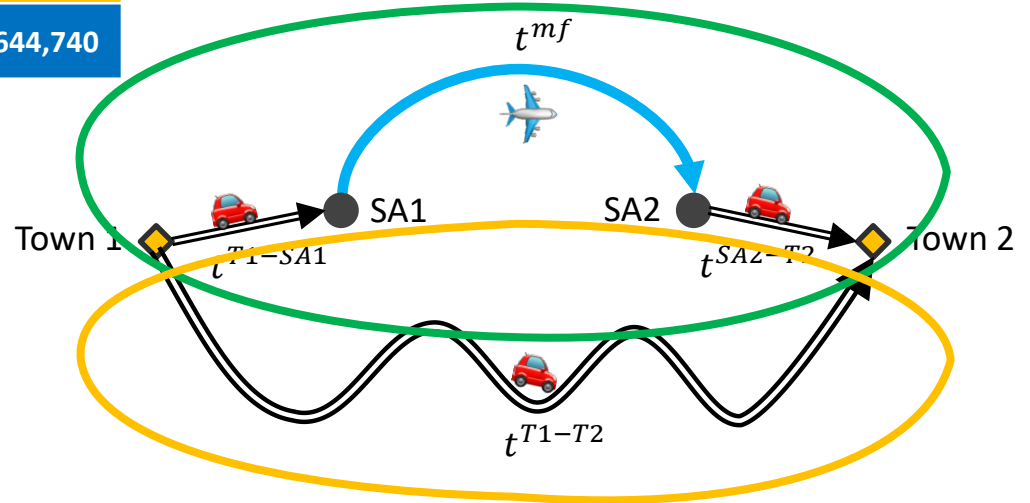   - **Miniliner**

MINILINER MARKET STUDIES

Italian scenario

Towns	521
Total commuters	13,644,740

Framework:

- Entire Italian territory
- Commuter matrix from 2011 census
- Only towns with more that 20,000 inhabitants involved
- Secondary aerodromes organized in clusters (cluster max width: 50 km road distance)

Route catchment area definition

- Time advantage criterion (with same parameters than the microfeeder)

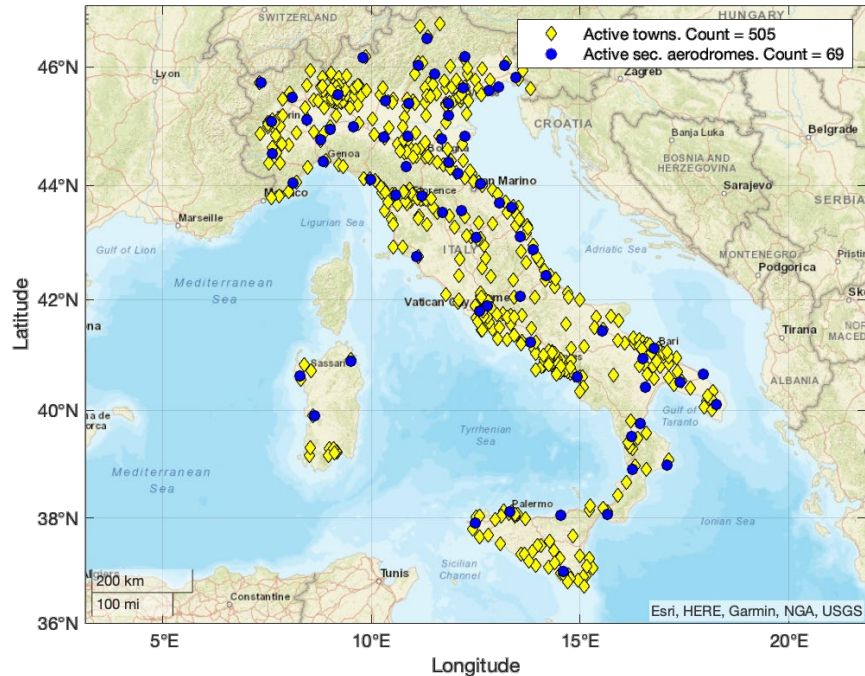$$t^{T1-SA1} + t^{mf} + t^{SA2-T2} \leq \frac{t^{T1-T2}}{k}$$

$$t^{T1-T2} - \left(t^{T1-SA1} + t^{mf} + t^{SA2-T2}\right) \geq t_{ref}$$

k	1.3
t_{ref}	30 min

MINILINER MARKET STUDIES
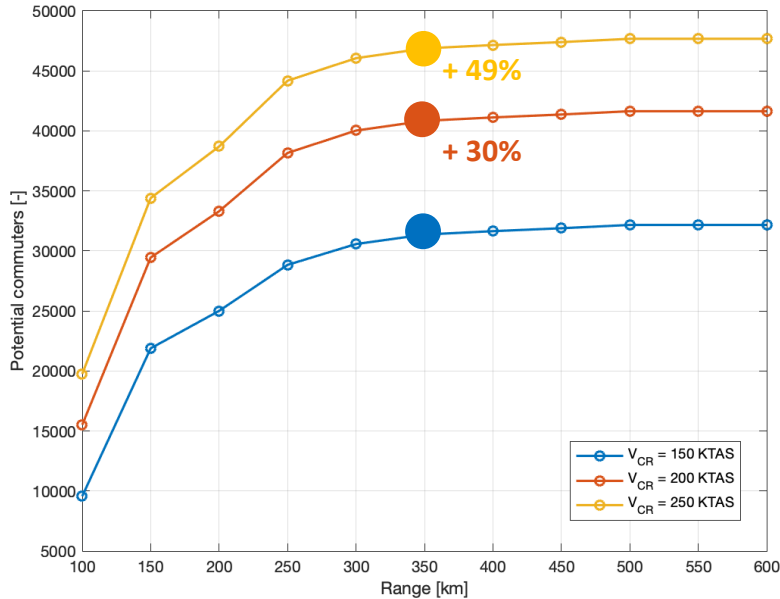
99 parametric studies:

- Trip distance from 100 to 600 km

- Cruising speed from 150 to 250 KTAS

- Cruising altitude 4,000 ft (when possible)

- Runway length from 600 to 1,000 m
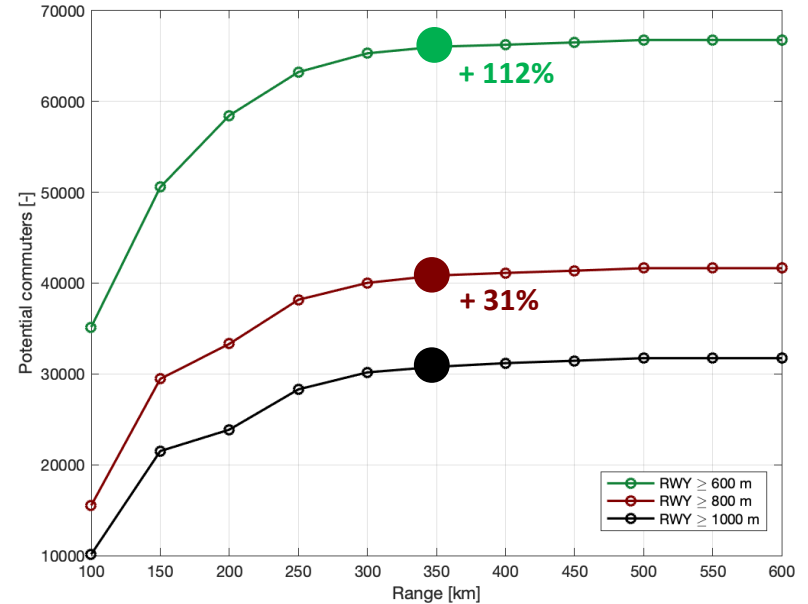

Italian scenario example.
Trip distance 200 km, cruising speed 200 KTAS and RWY >=800 m

MINILINER MARKET STUDIES

RWY>= 800 m with varying range and cruising speed

Cruising speed 200 KTAS with varying range and runway length

CONCLUSION

Miniliner and **Microfeeder** service
- **Lots of usable secondary aerodromes**
- Possibility to TO/LND on **grassy surfaces**
- **Alternate distance <75 km** for 80% of routes
- **New market** → NO **past data** → **potential demand** estimation:

  - **Microfeeder:** In high transport density areas, **cruise speed** must be high to compete with ground transportation. **Runway length** has a **low impact**. **Potential demand increases** exponentially with **trip distance**

  - **Miniliner:** Reducing the **runway length** can double the potential demand. **Cruise speed** has a **moderate effect**. **Saturation** of the potential demand at high **trip distances**.

THANK YOU FOR YOUR ATTENTION

Francesco Salucci, PhD candidate
francesco.salucci@polimi.it

Flight Mechanics & Flight Systems Laboratory
Department of Aerospace Science and Engineering
Politecnico di Milano