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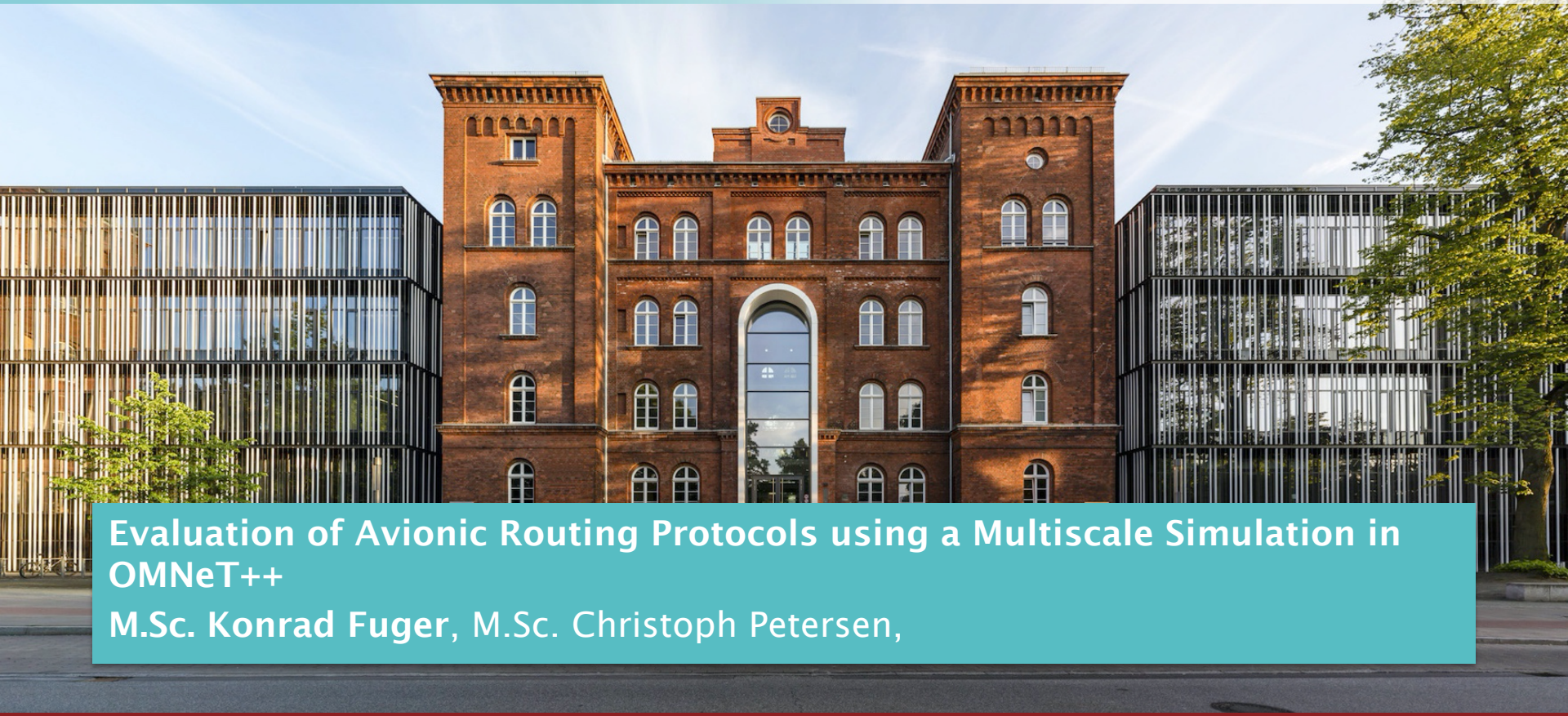

Evaluation of Avionic Routing Protocols using a Multiscale Simulation in OMNeT++

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Outline

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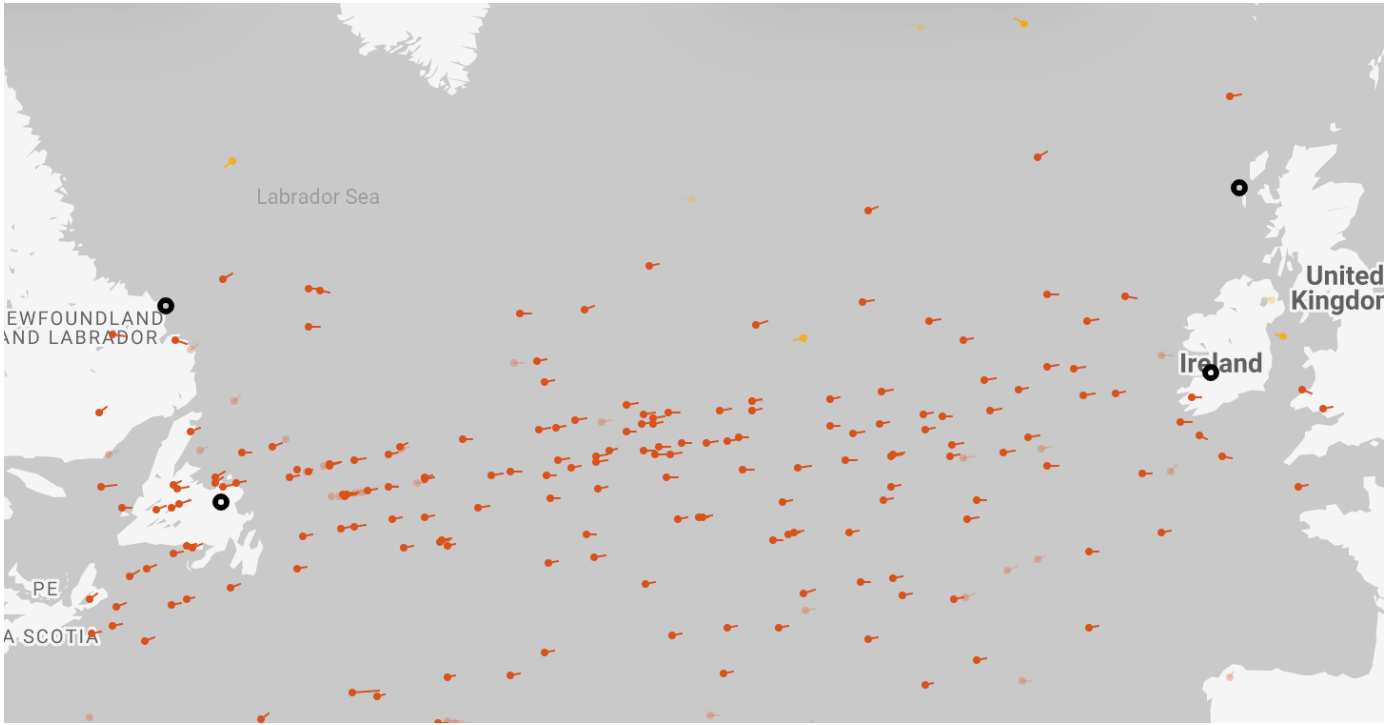
1. Simulation Scenario
2. Avionic Routing Protocol (AODV-LD)
3. Multiscale Simulation Architecture
4. Performance Results
5. Closing Remarks

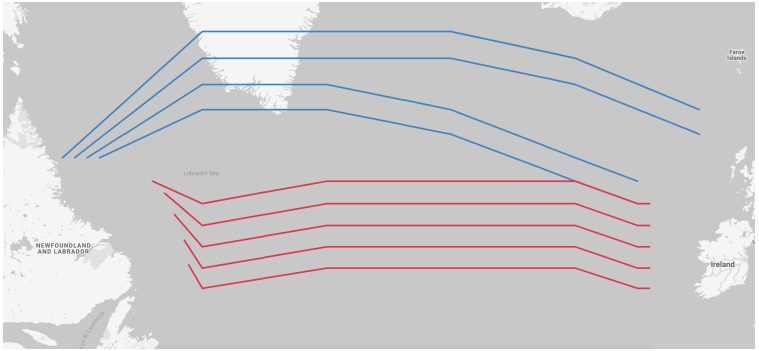
Simulation Scenario

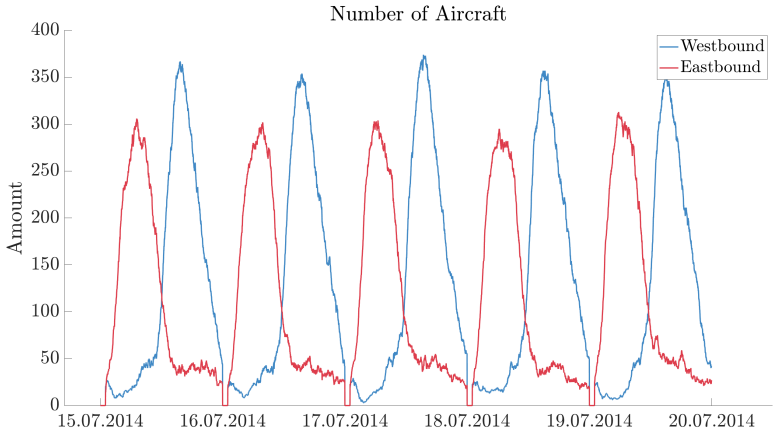


- **North Atlantic Corridor:** Oceanic airspace between Europe and North America

Simulation Scenario

- Aircraft form swarms crossing the NAC
- Eastbound and Westbound traffic is isolated in time and space
- Communication range: ~400km
- Up to 400 aircraft at the same time
- Duration of swarm: 5-6 hours





AODV-LD

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- Link duration based Ad-hoc On-Demand Distance Vector Routing Protocol (**AODV-LD**) is an adaption of AODV:
  - AODV is a common routing protocol for ad-hoc networks. It was selected for its reactive nature and an existing reference implementation
  - **Adaption**: Use expected path duration as routing metric instead of number of hops
    - Route Requests (**RREQs**) must carry additional information
    - Several RREQs must be evaluated in the IGW
    - Strategy to calculate the expected path duration is needed
- **Metrics**: Route duration, E2E delay, Route acquisition delay

AODV-LD

Multiscale Simulation

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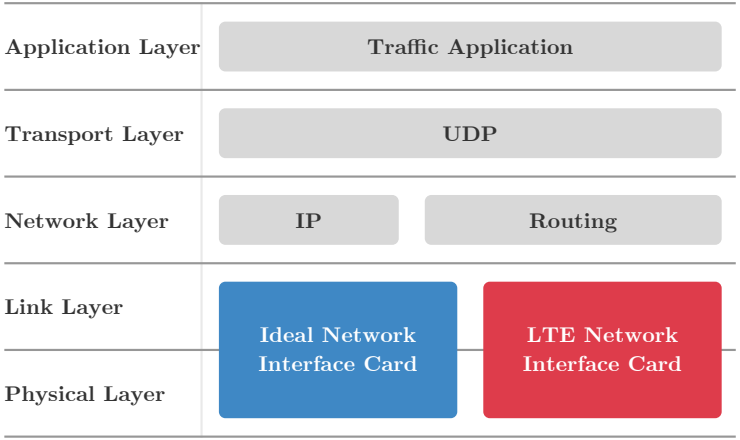
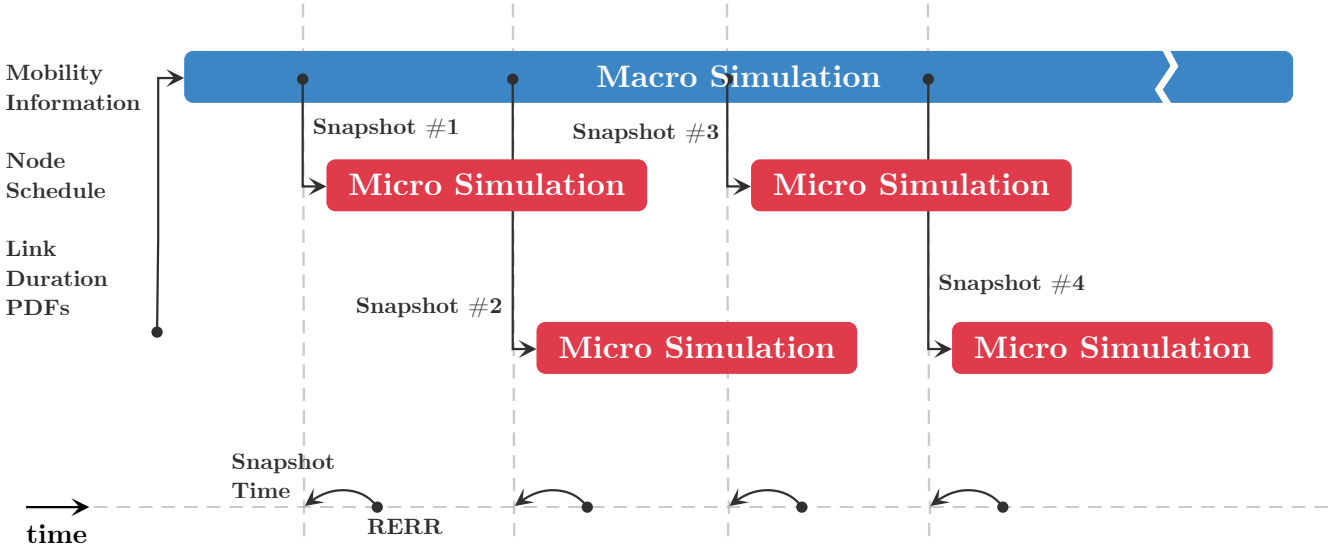
- LTE-like Link/PHY layer technology
- **Challenge:** LTE is very computing intensive, Aircraft fly for several hours
- **Solution:** Multiscale Simulation
  - **Macro** simulation captures routing behavior
  - **Micro** simulation captures link layer timinigs



Multiscale Simulation



- Macro simulation runs twice: To collect timestamps and to creates snapshots
- Micro simulation started from snapshots

Multiscale Simulation

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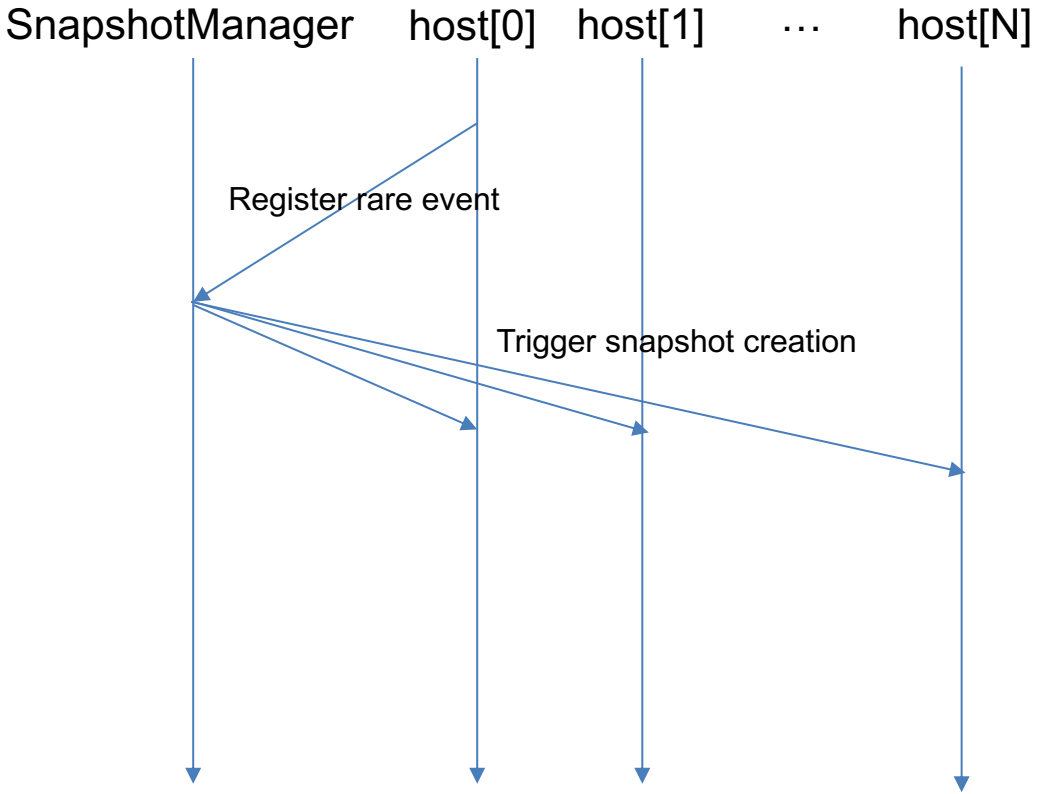
- SnapshotManager
  - Global Module
  - Orchestrates snapshot creation
- SnapshotModule
  - One module per host
  - Serializes state into snapshot and vice versa



Multiscale Simulation

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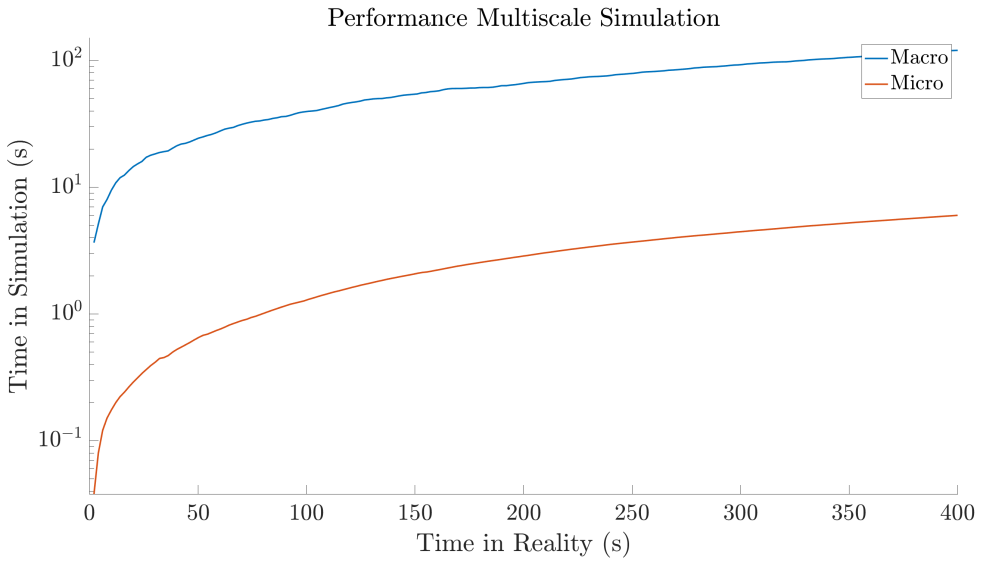
- Content of a snapshot:
  - IP address
  - Link lifetime of encountered neighbors
  - Routing table + AODV specific route data

Performance

- Macro:
  - 31282 events / simsecond
  - Runtime: ~8h
- Micro:
  - 823583 events / simsecond
  - Runtime: ~5min



Closing Remarks

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- Multiscale simulation enables full system investigation
  - Over long times
  - In high detail

- Multiscale simulation only possible when simulation state can be derived from a simpler model

- Multiscale simulation requires tailor made snapshots

Thank you for your attention!

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