

Performance analysis of routing algorithms in AANET with realistic access layer

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Outline

- 1 Aeronautical Ad-hoc NETWORK (AANET)
- 2 Routing protocol assessment
- 3 Conclusions and perspective

Outline

- 1 Aeronautical Ad-hoc NETWORK (AANET)
 - What is an AANET
 - Challenges
- 2 Routing protocol assessment
- 3 Conclusions and perspective

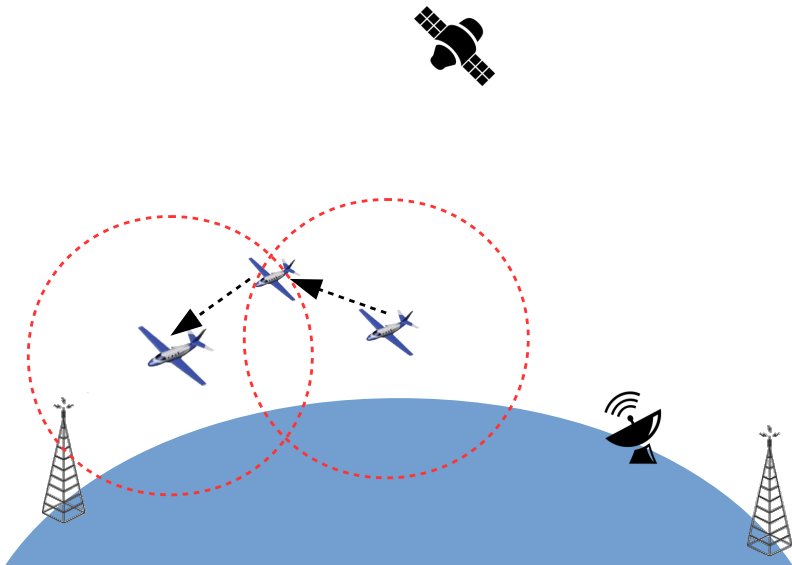
Definition

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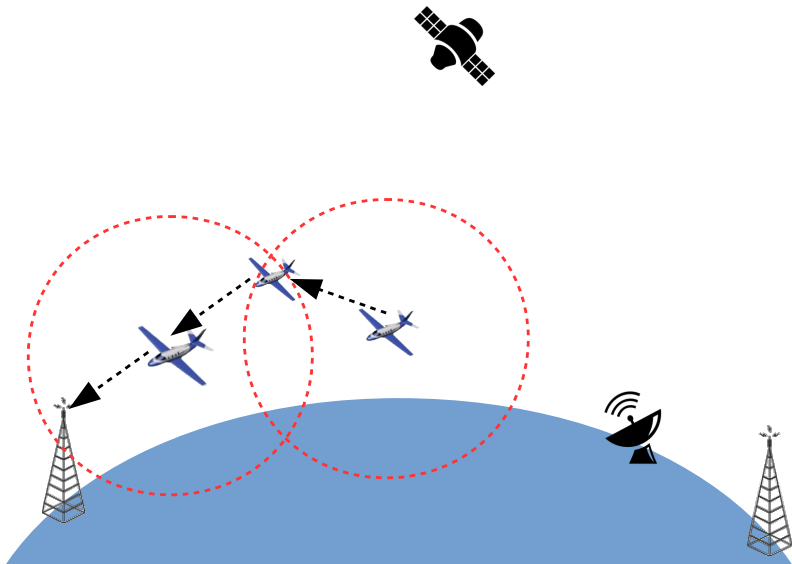
AANET : Aeronautical Ad-hoc NETWORK

- Ad-hoc network in which nodes are inflight aircraft
- Subset of MANET, similarities with VANET
- Provides a digital communication service between aircraft or between aircraft and the ground

Aeronautical ad-hoc networks (AANET)



Aeronautical ad-hoc networks (AANET)



Challenges

- Radio technology:
- Channel access protocol:
- Routing protocol:

¹Frederic Besse. "RESEAUX AD HOC AERONAUTIQUES". . PhD thesis. Toulouse: ISAE, Feb. 2013.

Challenges

- Radio technology:
 - 350 km radio range ensures 95% connectivity over the North Atlantic Tracks (NATs)¹
 - Direct-Sequence Spread Spectrum Code Division Multiple Access (CDMA)
- Channel access protocol:
- Routing protocol:

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 - RP-CDMA
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- Radio technology:
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 - Direct-Sequence Spread Spectrum Code Division Multiple Access (CDMA)
- Channel access protocol:
 - RP-CDMA
- Routing protocol:
 - Several propositions for MANET, VANET and AANET
 - Assessment done in various conditions, sometimes lack a reference
 - Standardized protocols have not been assessed with real aircraft positions and a realistic access layer model

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 - Access layer
 - Routing protocols
 - Methodology
 - Results
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RP-CDMA

- Random Packet CDMA
 - Based on CDMA²
- Contention-based access
 - Non-persistent CSMA³

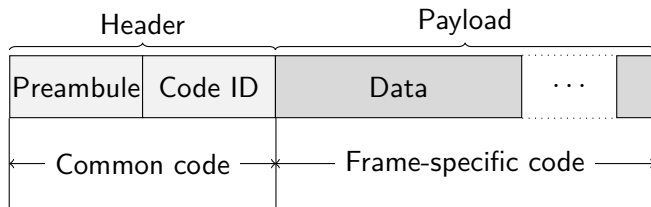
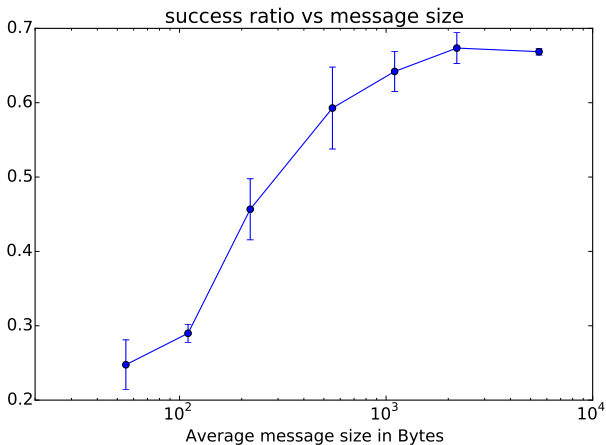


Figure: Base structure of a RP-CDMA frame.

²Kempler. "Modeling and evaluation of throughput, stability and coverage of RP-CDMA in wireless networks". PhD thesis. University of Utah, 2006.

³Todd Mortimer. "A mac Protocol for Multihop RP-CDMA Ad-Hoc Wireless Networks". MA thesis. University of Alberta, Edmonton, 2012.

RP-CDMA (cont.)



RP-CDMA (cont.)

- Modifications:
 - Packet aggregation
 - p -persistence
- parameters:
 - Probability p
 - Time between two access
 - Maximum size of the aggregated frame
 - Retransmission timer
- Tuning:
 - Simulation
 - Simplified topology

Assessed routing protocols

Reactive algorithms

- AODV
- DYMO

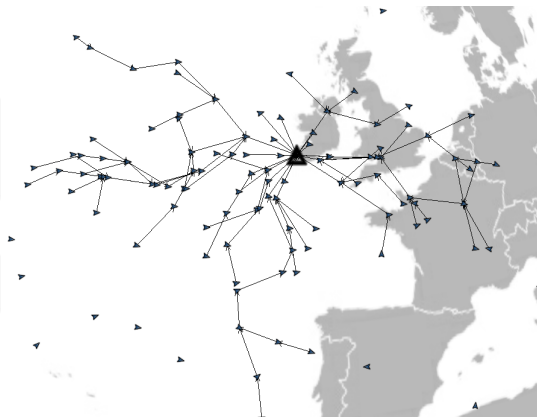
Proactive algorithm

- BATMAN

AODV : Ad-hoc On demand Distance Vector

DYMO : DYnamic Manet On demand routing protocol

BATMAN : Better Approach To MANet routing

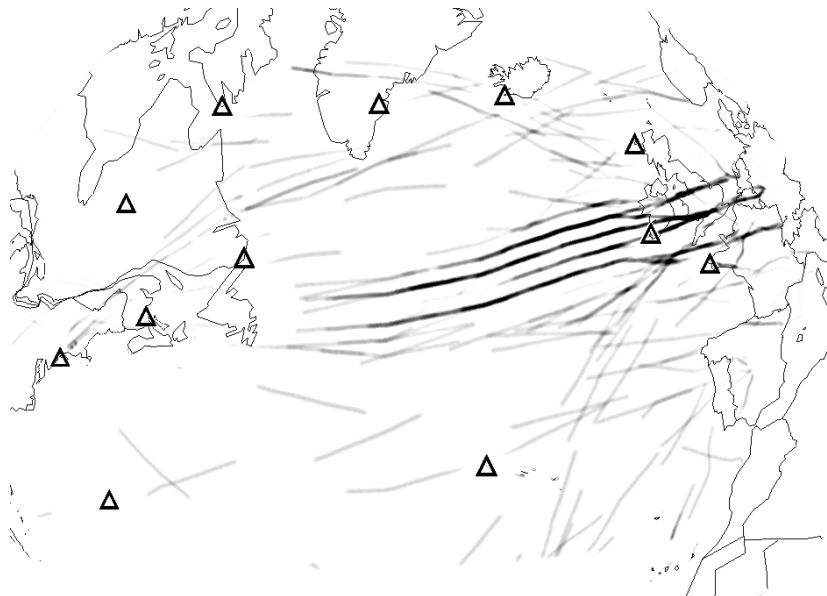


Example of routing tables for AODV

Network simulation

- Omnet++ simulator
- Node characteristics:
 - real aircraft trajectories
 - Radio model:
 - 350 km range
 - 800 kbits/s capacity
 - Simplified collisions model
 - Data generation:
 - Sporadic probe packets
 - Mimics air-ground communications

Inputs: Aircraft Trajectories



Reachability

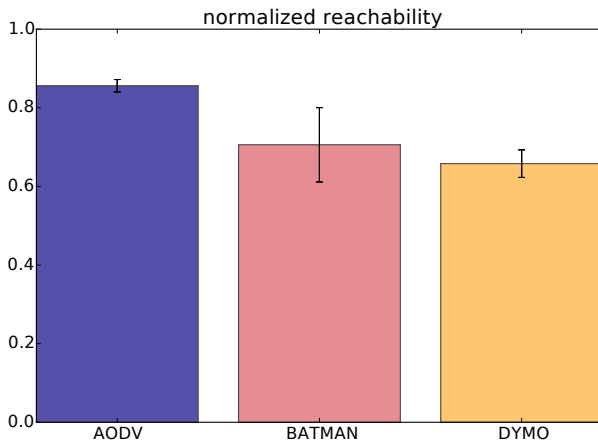


Figure: Reachability with ideal access layer

Reachability

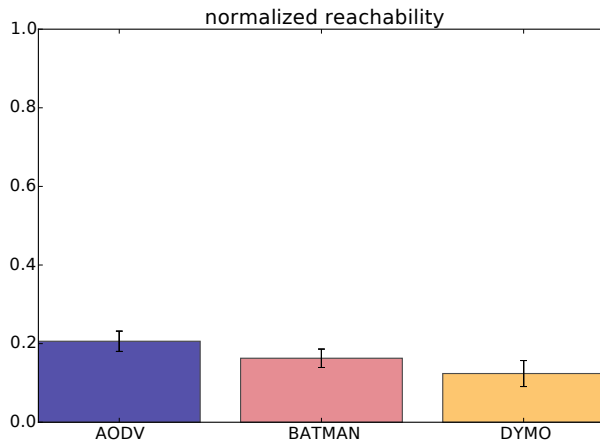


Figure: Reachability with base RP-CDMA

Reachability

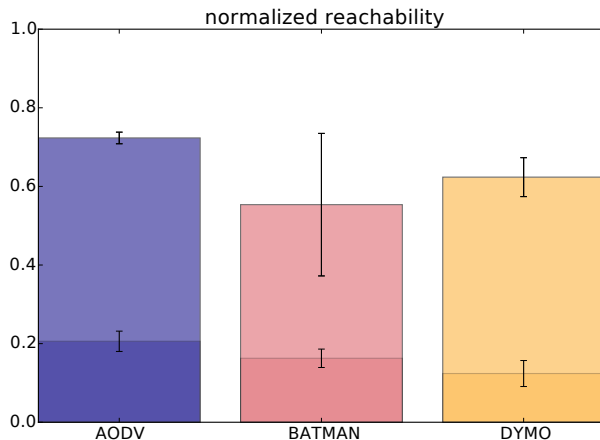


Figure: Reachability with aggregation

Reachability

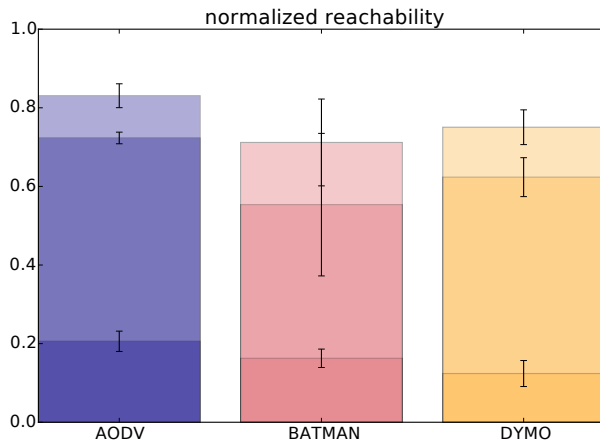
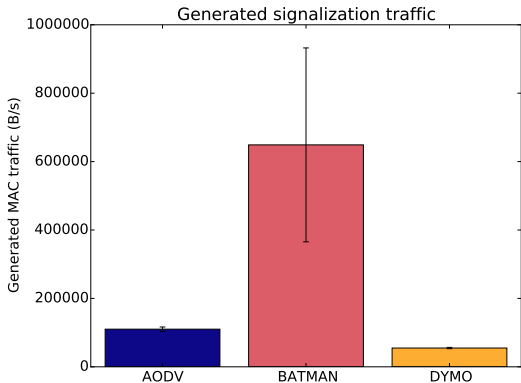


Figure: Reachability with p-persistence and aggregation

Generated signaling

- AODV :
 - Reactive protocol
- BATMAN :
 - Proactive protocol
- DYMO
 - Reactive protocol
 - Improvements over AODV visible



Delay

Table: Maximum one-way delay for 95% of the received messages.

Protocol name	D_{95}
AODV	699 ms
BATMAN	733 ms
DYMO	633 ms

Outline

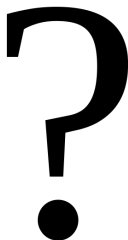
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Conclusions

- Performances of well-known routing algorithms have been evaluated in an AANET with real aircraft positions and a realistic access layer
- AODV has the best performances in an AANET
- Proposed modifications makes RP-CDMA suitable for use in AANETs
- Provides a frame of reference for future studies.

- Future work:
 - Assessment with higher load:
 - More aircraft
 - More generated traffic
 - Development of a new routing protocol based on the actual aircraft density : NoDe-TBR

Thank you for your attention



Any questions ?

Back-up slides

NoDe-TBR

- New routing algorithm
- Based on Trajectory-Based Routing (TBR)
- Takes into account actual aircraft density to generate a geographic path for the data

Hop count

- Over 80% of the packets were received after more than 1 hop transmissions.

