significant extra factor in acceleration of the rare event MC simulations. A third direction of research is to evaluate operational concepts that are mixtures of ground-based and airborne self separation TBO.

VIII. DISCLAIMER

Opinions expressed in this work reflect the authors' view only and EUROCONTROL and/or the SJU shall not be considered liable for them or for any use that may be made of the information contained herein.

IX. REFERENCES

[1] SESAR, "Concept of Operation, Sesar definition phase, Task 2.2.2, Milestone 3", Report DLT-0612-222-02-00, Version 2.0, October 2007.

[2] SESAR-JU, Preliminary OSED_2, Final V2 OSED_1, November 2013.

[3] H.A.P. Blom, G.J. Bakker, Safety of advanced airborne self separation under very high en-route traffic demand, Proc. SESAR Innovation Days, ENAC, Toulouse, 29 November-1 December 2011.

[4] H.A.P. Blom & G.J. Bakker (2012). Can airborne self separation safely accommodate very high en-route traffic demand? 12th AIAA Aviation Technology, Integration, and Operations (ATIO) Conference. Indianapolis, Indiana: AIAA, Inc.

[5] H.A.P. Blom, G. J. Bakker (JAIS2015), Safety Evaluation of Advanced Self-Separation Under Very High En Route Traffic Demand, Journal of Aerospace Information Systems, Vol. 12, No. 6 (2015), pp. 413-427. doi: 10.2514/1.I010243

[6] EMERGIA (2013), Project plan, web site http://emergia.nlr.nl , 2013.

[7] H.A.P. Blom, G.J. Bakker (2013). In search of positive emergent behaviour in Trajectory Based Operations. Proceedings of the Third SESAR Innovation days. Stockholm.

[8] EMERGIA D2.2 (2014), Emergent behaviour of simulation model, EMERGIA report D2.2, December 2014.

[9] H.A.P. Blom, G.J. Bakker, G. (ATIO2015). Can ground-based separation accommodate very high en route traffic demand as well as advanced self-separation? Proc. 12th AIAA Aviation Technology, Integration, and Operations (ATIO) Conference, Dallas, 22-26 June 2015, AIAA 2015-3180, pp. 1-15.

[10] EMERGIA D3.1 (2015), Report on the proposed improvements of the A3G ConOps, EMERGIA report D3.1, March 2015.

[11] G. Cuevas, I. Echegoyen, J. García, P. Cásek, C. Keinrath,, F. Bussink, A. Luuk (2010), iFly Deliverable D1.3, Autonomous Aircraft Advanced (A3) ConOps, January 2010. Available on iFly website http://ifly.nlr.nl/

[12] NASA (2004), "DAG-TM Concept element 5 en-route free maneuvering for user-preferred separation assurance and local TFM conformance operational concept description", NASA, Washington D.C., 2004.

[13] D.J. Wing, W.B. Cotton, "For spacious skies: self-separation with "Autonomous Flight Rules" in US domestic airspace", Proc. 11th AIAA ATIO Conference 2011, Virginia Beach, VA, USA, September 2011.

[14] E. Gelnarová, P. Cásek (2009), iFly report D9.1, "Operational Services and Environmental Description (OSED) of Airborne Self-Separation Procedure (SSEP)", August 2009.

[15] P. Fiorini, Z. Schiller (1998), "Motion planning in dynamic environments using velocity obstacles", *The International Journal of Robotics Research*, Volume 17 (1998), pp. 760–772.

[16] Y. Abe, M. Yoshiki (2001), "Collision avoidance method for multiple autonomous mobile agents by implicit cooperation", Proc. IEEE/RSJ Int. Conf. Intelligent Robots and Systems (IROS 01), pp. 1207–1212.

[17] N. Durand, N. Barnier (2015), Does ATM need centralized coordination? Autonomous conflict resolution analysis in a constrained speed environment, Proc.11th USA/Europe ATM Seminar, Lisbon, 2015.

[18] iFly report D7.1b (2009), Hazard Identification and Initial Hazard Analysis of A3 ConOps based operation, by H.A.P. Blom, G.J. Bakker, M.B. Klompstra and F.J.L. Bussink, 2009.

[19] EMERGIA D4.1 (2016), Improved Simulation Model, EMERGIA report D4.1, April 2016.

[20] M.H.C. Everdij, M.B. Klompstra, H.A.P. Blom, B. Klein Obbink (2006), Compositional specification of a multi-agent system by stochastically and dynamically coloured Petri nets, Eds: H.A.P. Blom, J. Lygeros (eds.), Stochastic Hybrid Systems: Theory and safety critical applications, Springer, 2006, pp. 325-350.

[21] D.C. Rapaport, "The art of molecular dynamics simulation", Cambridge University Press, 2004

[22] J.W. Andrews, H. Erzberger, J.D. Welch, "Safety analysis for advanced separation concepts", Air Traffic Control Quarterly, Vol. 14, 2006, pp. 5-24.

[23] H.A.P. Blom, B. Klein Obbink, G.J. Bakker, "Simulated Safety Risk of an Uncoordinated Airborne Self Separation Concept of Operation", Air Traffic Control Quarterly, Volume 17 (2009) Number 1, pp. 63-93.

[24] M. Consiglio, S. Hoadley and B.D. Allen, "Estimation of Separation Buffers for Wind-Prediction Error in an Airborne Separation Assistance System", Proc. 8th USA/Europe ATM Seminar, Nappa, CA, 2009.

[25] M. Paglione, H. Ryan (2007), "Aircraft conflict probe sensitivity to weather forecast errors", Proc. 26th IEEE/AIAA Digital Avionics Systems Conference, 2007, pp. 3.D.1.1-10.

[26] EMERGIA D4.2 (2016), Emergent behaviour of improved simulation model, EMERGIA report D4.2, June 2016.

ABREVIATIONS

4D = Four dimensional
A3 = Advanced airborne self-separation
A3G = Ground-based version of A3
a/c = aircraft
ADS-B = Airborne Derived Surveillance – Broadcast
ANP = Actual Navigation Performance
ASAS = Airborne Separation Assistance System
ATC = Air Traffic Control
ATCo = Air Traffic Controller
ATCo-P = ATCo-Planning
ATCo-T = ATCo-Tactical
ATM = Air Traffic Management
ConOps = Concept of Operations
FMS = Flight Management System
ft = foot
GNC = Guidance Navigation and Control
GNSS = Global Navigation Satellite System
iA3G = improved version of A3G
IRS = Inertial Reference System
LPN = Local Petri Net
MC = Monte Carlo
MTCR = Medium Term Conflict (detection and) Resolution
MTCR-IIS = MTCR Internal Iteration System
Nm = Nautical mile
OSED = Operational Services and Environmental Description
PBC = Periodic Boundary Condition
PF = Pilot Flying
RBT = Reference Business Trajectory
SDCPN = Stochastically and Dynamically Coloured Petri Net
SSR = Secondary Surveillance Radar
STCR = Short Term Conflict (detection and) Resolution
STCR-IIS = STCR Internal Iteration System
SWIM = System Wide Information Management
TBO = Trajectory Based Operations
TCP = Trajectory Change Point
VO = Velocity Obstacle