| Question | Answer |
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| Flight centric operations using VHF will be difficult for extended airspace. It will have some limitations. Digital voice would be beneficial in these cases. | Olivia Nunez<br>Indeed, but we first need to clarify what the operational requirements for this voice service. The current flight-centric concept being researched by SESAR assumes that we have communication party-line/broadcast , which is what Radek said would be technically very challenging. If we are going to use point-to-point voice, this would be a big operational change, that would need to be researched. |
| To all in general: which is the key point or the missing piece to accelerate the implementation of these solutions? | Bill Holtzman<br>For geometric altimetry, I would say it's awareness of the problem. There is very little written documentation both of how difficult it is to sustain barometric altimetry and of how satellite-based altimetry might be used as a replacement, including work on transition and implementation. As I mentioned in my talk, this kind of change will take a generation and will require an enormous amount of foundational work.<br><br>Joan Manuel Cebrian<br>This is a very difficult question depending on many factors and very likely there is not a unique response for different solutions. But maybe the key point is the Cost Benefit result of each solution for each of the key stakeholders, as ANSPs and airlines. As mentioned during the webinar, a key cost is the one coming from modifications on board the aircrafts. Solutions that do not represent any change or limited changes may potentially be better prepared to become a reality. |
| Question for Radek: According to indications the flight centric operations using VHF will not be feasible for extended airspace due to inability to operate offset function with 8.33 channel spacing. How improvement could be achieved by introducing digital communication? | Olivia Nunez<br>Hi, for the cases when the flight-centric area is larger than what be covered with a VHF frequency, SESAR is developing a solution called "Wide Area Communications over VHF" (within the same project researching flight-centric): you have two antennas, and the ATCO clicks on the screen to indicate which aircraft he is transmitting to, and the communication is routed to the appropriate antenna. |
| How do you manage air traffic during the transition period? I recall the intro of RVSM and that had so many exemptions and exceptions whilst fleet upgrade or withdrawal took place that it was hard work. State aircraft were even worse as their exemptions went on for an even more extended period. | Olivia Nunez<br>My thought is there would be a slow transition starting at the very high altitudes. There would be a second transition altitude for some period of time, between the Flight Levels and geometric altimetry about, say, FL 500. That transition level would incrementally move down over time until it ultimately reached the ground. That process could take many years (Reply from Bill) |

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| Why SBAS is not the answer to geometric increased precision? | Bill Holzman<br>Yes, it may be.<br>I think a global solution is best, not a regional one. If you look at some of the coverage maps here (https://www.nstb.tc.faa.gov/24Hr_WaasLPV200.htm) you'll see that there are gaps and the coverage is lost beyond the continent. A solution is required everywhere if the altitude structure worldwide is to change. |
| Is it really only an issue of barometric precision, to reduce RVSM down to 500ft? What is about the necessary safety margin for ACAS/TICAS RA maneuvres? Jumping just into the 500ft gap? | Olivia Nunez<br>There is indeed more to moving to 500 ft separation than having geometric precision in the altimetry. SESAR project R-WAKE investigated this in detail; they had very promising results, reaching partial V1 maturity. You can check it out at: http://www.rwake-sesar2020.eu<br><br>Bill Holzman<br>Currently there is a standard for VFR traffic of just 500 ft. But obviously you wouldn't want to fly 500 ft under an A380 in a C172. As I mentioned during the call, wake turbulence issues would become very significant with decreased vertical separation so there would have to be a plan to manage that. It doesn't seem unreasonable to expect on-board avionics to use ADS-B In and wind readings to enable pilots to anticipate adverse wake turbulence conditions and avoid them. An icnremental approach to narrowing vertical standards seems appropriate. |
| Most drones which are using geo alt are not reporting any baro alt and most manned aircraft using baro alt are not reporting any geo alt (even the DL formats can use both fields). Why? | Olivia Nunez<br>This is a very interesting question. The simple answer is that we do not yet have a defined concept on how to address this interoperability issue. There is interesting EUROCONTROL paper on this topic: https://www.eurocontrol.int/publication/uas-atm-common-altitude-reference-system-cars. In SESAR, we have an ongoing project looking at the development of a U-space service to increase interoperability of altimetry: https://www.u-spaceicarus.eu<br><br>Bill Holzman<br>Not sure this is entirely accurate. Drones do have pressure altimeters because the GNSS signals often provide quite a bit of variation over small periods of time. The drones use a combination of pressure and GNSS altimetry to enable them to hover at a constant height, averaging out variations in the GNSS-derived altitude over a period of time. Meanwhile more and more aircraft do report geometric altitude. This site shows you live ADS-B tracking and you can see both the barometric and geometric altitude reports: https://globe.adsbexchange.com/ |

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| SSR, MSSR and ADS-B are compliant to report QNE (baro alt) with accuracy 25ft only. Some drones are already carrying test equipment which measures baro alt already with 11 cm accuracy. How to use such different sources in common airspace? | Olivia Nunez<br>Increasing interoperability with drones is indeed an additional argument to investigate how manned aviation could transition to geometric altitude.<br><br>Bill Holzman<br>It would be interesting to learn more about barometric altimeters that provide 11 cm accuracy. |
| How can IRIDIUM constellation defined as non-ATM focussed? They are certified for safety of life operations, using ITU protected spectrum. And Aireon is even certified by EASA... please clarify at it is a wrong statement | Joan Manuel<br>We meant that Iridium was designed to provide a broad set of services, many of them non safety, but for sure in addition to those services it also provides certified safety services as you mention, both communicatinos and surveillance |
| Move to geometric - great idea.<br>What about moving to true tracks, instead of magnetic tracks?<br>(Has Sesar adopted this already?) | Olivia Nunez<br>This is also a very interesting idea, but we do not (yet) have any SESAR project researching it. |
| Are there voice solutions based on call-setup suitable for Controller - Pilot communication? | Radek Zaruba<br>Yes for the procedural (oceanic, remote) airspace. Nevertheless this is far from acceptable for continental communication if VHF-like experience is needed. (I.e. practically real time conversations.) So I believe for continental the answer is "no". |
| To add questions (to your questions) :<br>Party line<br>A/C to A/C coms<br>Virtual operator | Radek Zaruba<br>Good questions indeed - particularly the air-to-air adds another level of complexity (but also opportunities). Party line is I thin covered by what I called "teleconferencing" in my presentation. |
| Most of current Com systems are simplex in voice mode ( ie Transmit , then receive), even for Satcom which is full duplex, same principle apply using Push to Talk to not confuse crew. So what will be the trend ? | Radek Zaruba<br>I think this is operational question. As you say SATCOM can give you full duplex (i.e. normal conversation). So technically full duplex is certainly possible. In fact it is likely even more "natural" solution for most digital systems. So if digital voice becomes reality for continental airspace, simplex would only be used if pushed by operational needs.<br><br>Joan Manuel Cebrian<br>A new solution has been approved in SESAR to define a digital voice over LDACS having as input the operational concept of the VHF voice. One of the objectives will be if such PTT scheme can be supported. |

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| JM: The life cycle of satellite constellation includes the end of life of the satellites, that has to be taking into account from the beginning in their design . This is mandatory to be allowed to deploy it. Q: is this regulated at global or european level? Or just recommendations? | Joan Manuel<br>I am not an expert on space debris, but there are standards at european and international level, You can find more information in:<br>https://www.iso.org/standard/72383.html<br>https://ecss.nl/standard/ecss-u-as-10c-adoption-notice-of-iso-24113-space-systems-space-debris-mitigation-requirements-2/ |
| In future fully automated 4D trajectory operations - how often will aircraft exchange messages with the ground automation systems? Could it be almost every second ? | Olivia Nunez<br>SESAR projects are researching this topic in depth, looking for a balance between load on the data communications channel and performance. The answer will depend on the specific needs for each airspace, and it is likely to be more like every few minutes, rather than every few seconds. |
| How flight centric can be based on VHF when there is no longer Climax | Olivia Nunez<br>First of all, in some cases the flight-centric area is larger than a current sector, but still within the coverage of a VHF antenna. For the cases when the flight-centric area is larger than what can ve covered with one antenna, SESAR is working on a solution to provide extended coverage with VHF without CLIMAX; it is called Wide Area Communication over VHF. The concept is that there is a connection between SUR and COMM , so each ATCO transmission is routed though the appropriate antenna. |
| How may countries cooperate to use common satellites to reduce space debris Ron Ogan Major USAF Civil Air Patrol USA | Joan Manuel Cebrian<br>I am not an expert on space debris, but there are standards at european and international level, You can find more information in:<br>https://www.iso.org/standard/72383.html<br>https://ecss.nl/standard/ecss-u-as-10c-adoption-notice-of-iso-24113-space-systems-space-debris-mitigation-requirements-2/<br><br>Bill Holzman<br>https://spacenews.com/u-s-space-command-announces-improvements-in-space-debris-tracking/#:~:text=The%2018th%20Space%20Control%20Squadron,on%20approximately%2025%2C000%20space%20objects.&text=Most%20of%20the%20objects%20now,are%20active%20satellites%2C%20Sorice%20said. |
| Did someone studied and showed feasibility of LDACS business case? How will LDACS costs be shared between users? I see mainly the focus only on technological/standardization aspects. | The costs are like the VDLM2 costs, same coverage, higher bandwidth but more costs due to security means and due to higher availability in the access network. What it costs for the different end-users, will depend more on the different business plans of the CSPs! |

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| How does the integrated CNS system LDACS consider especially non-cooperative UAS (non-ADS-B equipped)? | Christoph Rihacek<br>Not different than other systems. Currently there are no plans to integrate non-cooperative systems. |
| It is already confirmed by many WAM/MLAT manufactures that UAT signals and DME signals are not good source for multilateration - position accuracy is alway less than in case of 1090MHz. Is it different for LDACS signals? | Christoph Rihacek<br>Yes because of the dedicated channel. It is guaranteed that each aircraft is transmitting every 240ms. The synchronization requirements are accurate enough to achieve a similar performance here, but further research is needed. |
| Thanks, very interesting. Can you elaborate on the statement that there is no need for new antenna or avionics ???. What is the status of EUROCAE and SESAR to develop LDCAS MOPS and prototypes ? what ara the plans from FAA and US manufturering industry to implement LDACS ? | Christoph Rihacek<br>No additional radio nor antenna would be required, but of course it is needed to replace the existing radio and antenna with equipment which can support the new requirements (multimode radio and exchange VHF antenna with a combined VHF-/L-band antenna that has the same footprint)<br>EUROCAE standardisation is planned to start next year. Flight trials with LDACS prototypes are planned to be executed in SESAR in 2022. |
| Can LDACS be used for CNS for urban air mobility? If yes as a primary means? | Christoph Rihacek<br>In principle yes; there are currently some discussions ongoing about the specific needs (use cases) for such an iCNS system when used for urban air mobility |
| you mentioned a possible combined LDACS/VDL2 antenna. Is a Satcom/LDAS combined antenna also possible ? | Christophe Rihacek<br>In principle yes, but the SAT Antenna is directing into the space, while the LDACS antenna should direct to the ground. |
| The impression is that LDACS is driven by ground-based stations. Will it be also feasible over satellite networks? Also, could you please provide some more details about the dedicated channel it uses? | Christoph Rihacek<br>Currently not considered. The DC is a channel reserved for one aircraft, which is designed to send keep-alive signals, transmission requests or ACKs |
| LDACs may capable of providing CNS componets. However, do we need to consider system resilience? | Christoph Rihacek<br>Yes, it is needed to consider resilience and therefore LDACS should be only used as an alternative solution. |
| Without financial incentive for operators (board part) , clear return of investment and even associated mandates, nothing will change and we will still suffer VHF congestion at | Christoph Rihacek<br>The return of investment would be higher, considering the additional services available only by having a broadband data link. Without that ATM will stay at it is and no improvements on efficiency and automation. |

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| least in Europe. I fear LDACS will go into the same direction as MLS | |
| @Christoph: what is the typical or achievable peformance of LDACS in terms of positioning? | Christoph Rihacek<br>The accuracy depends of course on many parameters, like the synchronization accuracy of the ground stations and the constellation (location of aircraft compared to ground stations, and other parameters). During the flight tests 2019 an accuracy of 2-40m was measured. |
| The first presentation was on moving from ground to space. It looks like LDACS is only designed as a ground based system. Are there any plans to make it space based ? | Joan Manuel Cebrian<br>Currently LDACS is planned for ground, to replace VDL2 in the end, so there are no plans to use it from satellite. However, this may be a very interesting solution equivalent to the idea presented now to use VHF from space. |
| in terms of the cyber security of LDACS, is there ongoing work in place or planned to ensure continuing cyber security over the years? The threats continue to evolve so in theory what is cyber secure in 2020 may not be by 2025. | Christoph Rihacek<br>Yes, this is required. But there is a need to define a process for the whole community, how upcoming threats can be considered timely. |
| How will LDACS profit from further developments such as 5G? | Christoph Rihacek<br>In principle, LDACS could benefit from LTE developments, but it should be noted that LTE 5G is mainly moving towards high data rate, low mobility and small cells, while ATC has completely different requirements. In addition, the feature/technology update rate in mobile communications is much shorter than in the aviation community. LTE is feature driven while aeronautical communication is safety driven. |
| Is it possible to make nano-satellite in low orbit to cover oceanic area without interconnecting them? | Joan Manuel Cebrian<br>you need intersatellite links to be able to achieve the perfromances, especially latency, in a similar way as Iridium is doing |
| If all CNS is space based how do we ensure we have a resilient service | Joan Manuel Cebrian<br>the idea is not all services via satellite, ground infrastructue will be used, primary in continental, and space based system will be complementary. In oceanic, satellites will be primary |
| There are some studies about public acceptance related to drones UAS deployment.<br>Are there similar studies about public acceptance of such numerous | Joan Manuel Cebrian<br>I am not aware of this type of studies for LEO constellations, but I found some information on the impact to optical astronomy that may be relevant. See for the case of Starlink: "Mega-Constellations of LEO Satellites |

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| LEO satellites deployments (even though, they are less visible)? | and Optical Astronomy" Patrick Seitzer, Department of Astronomy, University of Michigan |
| I will be curious to understand how an ADS-B payload mounted on nanosatellites can provide reliable layer of ATS Surveillance so to be compliant with ED129B and certified by EASA... good luck | Joan Manuel Cebrian<br>Our view is that in case the constellation is dedicated to ATM services, it can be dimensioned to be compliant with safety requirements |
| All new LEO constellations are not supporting Safety of Life frequencies allocation, so how do you ensure safety demonstration if the intent is to use them for CNS funtions ? | Radek Zaruba<br>This is a really big topic. But from my perspective the use (or non-use) of aviation protected spectrum is not directly impacting safety. All we get from protected spectrum is, that it's difficult to take away that spectrum from the safety services and use it for some other (perhaps commercially more attractive) services. So it does give long term guarantees that once deployed, the safety systems will be able to operate there for a long time, but by itself it does not improve immediate safety. |
| Is there any provision dealing with the interruptions of GNSS already recorded? Please be reminded that during 2018 almost 850 interruptions and more in 2019 were recorded, (some of them with duration of more than 15 minutes) in EVAIR database, for the area of Mediterranean only. | Bill Holzman<br>One of the requirements of the US WAAS is it must be available 99.999% throughout the service area, a downtime of just over 5 minutes per year. |
| Do cubesat based constellations meet performance requirements set by EASA to deliver ATM (certified) services ? | Joan Manuel Cebrian<br>They have to be designed to fullfill these requirements, for example with a number of satellites that overdimension the constellation and margins to be compliant with availability |
| @ JuanManuel: what happens to abandoned satelites and satelite launchers? Is there a green agenda? | Joan Manuel Cebrian<br>The life cycle of satellite constellation includes the end of life of the satellites, that has to be taking into account from the beginning in their design . This is mandatory to be allowed to deploy it |
| Why do you consider Satcom Iridium and Inmarsat are not ATM ? | Radek Zaruba<br>I think this must be misunderstanding. Both Inmarsat and Iridium clearly are ATM systems being used already for many years in procedural (oceanic, remote) airspace for both ATM voice and data. Both are now also evolving to become enablers for continental ATM. |

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| What is the present situation of Galileo? | Joan Manuel Cebrian<br>Galileo is in operation offering the initial services. See https://www.gsc-europa.eu/galileo/services/galileo-initial-services |