



Corporate Research - looking ahead

Frequentis develops highly reliable communication and information systems for safety-critical solutions in the key markets Air Traffic Management and Public Safety & Transport. Our mission has guided us in our journey related to digitisation of communication, be it on land, on sea, or in the air. In our research projects, we usually work together with key customers and top-level research partners.

In our cooperations, we pave the way for new technology by improving it through research work to reach higher Technology Readiness Levels (TRLs). As a result, such technology can enter operational scenarios at our customers. Often, we succeed in transforming successes of one market segment into other segments as well. For example, we consider our work on System Wide Information Management (SWIM) in ATM a valuable investment that also allows other segments to benefit from business-to-business information exchange solutions that have matured in a highly demanding field of application. This issue of the Research Bulletin highlights new developments in networks, be it voice communication related such as Mission Critical Push-To-Talk (MCPTT), or focusing on data exchange such as IPv6 mobility solutions for satellite-based communication or maturing L-band Digital Aeronautical Communications System (LDACS), the upcoming standard for air-ground communication in ATM. We also report on activities related to flying objects: advanced briefing concept for aircraft pilots or detection of drones in critical areas. As the human operator is finally in charge of most critical decisions, our systems need to be built in the best possible way to support these critical situations. We have various ongoing activities to analyse the work of those decision makers with the objective to figure out which obstacles need to be removed to guarantee a smooth work style for operators. With the amplex of topics covered, we believe there is something in it for everyone – we hope you enjoy reading. Feel free to contact us if you want to discuss topics of particular interest to you: our experts will be more than happy to exchange views and elaborate further.

Hannes Bardach, CEO

Georg Trausmuth, Director Corporate Research

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Safe integration of Unmanned Aircraft Systems (UAS) into the airspace

Author: Jan Patrick Ziegler

Many beneficial civilian applications of UAV have been proposed, from goods delivery and infrastructure surveillance, to search and rescue, and agricultural monitoring. The U.S. aviation safety agency predicts 1.6 million commercial and 3.5 million drones used by hobbyists by 2021. Currently, there is no established infrastructure to enable and safely manage the widespread use of low-altitude airspace and UAV operations, regardless of the type of UAV.



One of the attributes of the UTM system is that it would not require human operators to monitor every vehicle continuously. Therefore, the UAV must be equipped with obstacle detection and collision avoidance sensors for self-optimisation and self-protection. This technology is becoming more prevalent in both the consumer and professional sectors, but is limited to range.

The High-Tech companies COMSOFT Solutions GmbH and Knowtion UG, both homebased in Karlsruhe, Germany, are researching prototype technologies for an UAV Traffic Management (UTM) system that could develop airspace integration requirements for enabling safe, efficient low-altitude operations.

To overcome the limited range of currently available collision avoidance sensors, Knowtion UG integrated an additional lightweight sensor into an UAV to detect surrounding air traffic within a range of over 100 NM.

The data format complies with the EUROCONTROL surveillance information exchange protocol and can be used either for automatic conflict detection and avoidance during flight operations in the UAV flight management system or to be fed into a situational awareness display to provide human managers the necessary data to monitor low-altitude UAV operations and conformance.

The COMSOFT Solutions' Surveillance Data Display (SDD) tracks the UAV position and visualises the no-fly zones including airports, public authority buildings, temporary reserved airspaces, and incorporates dynamic geofencing. The combination of UAV track information and trustworthy aeronautical data facilitate re-routing, separation management, sequencing, and spacing in hazardous situations like severe weather, ground proximity, and conflicting tracks. This concept underlines the key factors of safety and interoperability to safely and efficiently manage unmanned/manned aerospace.

About COMSOFT Solutions GmbH:

COMSOFT Solutions GmbH, is an internationally active air traffic control and air traffic management provider, headquartered in Karlsruhe, Germany. As leading manufacturer in this domain for over 25 years, COMSOFT Solutions delivers systems and services to civil and military air traffic control authorities and organizations, and customers in every ICAO region.

Knowtion UG was founded in 2011 and has been active for more than eight years in the research and development of algorithms for sensor fusion and machine learning in a wide-range of domains. Specifically, applications for localization and tracking of moving targets (e.g. aircraft) had been deployed in the air traffic management domain.

LDACS development & standardisation update

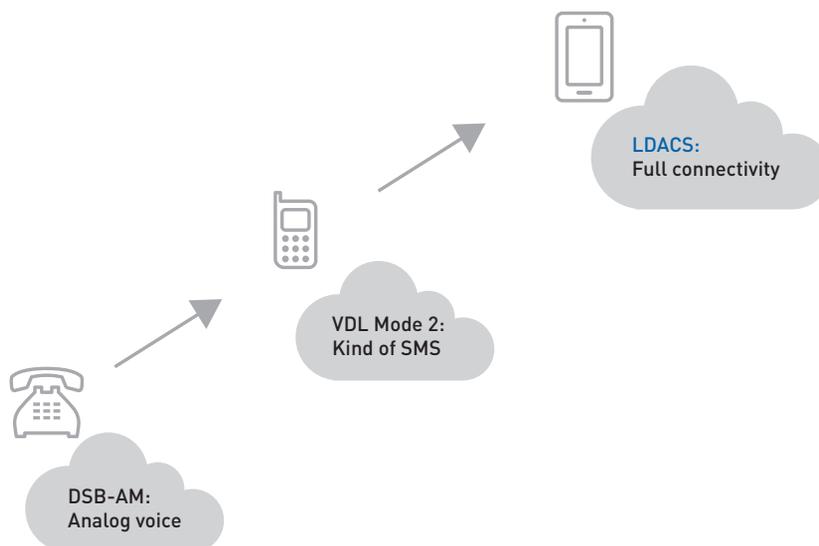
Author: Christoph Rihacek

For nearly 15 years Frequentis has been working on the detailed design, development and standardisation of the L-band Digital Aeronautical Communications System (LDACS). This is the future data link for terrestrial-based aeronautical communications and a major element of the Future Communication Infrastructure (FCI). It meets all the requirements imposed on time-critical communications in continental airspace (airports, terminal manoeuvring areas and en-route). LDACS is targeted for deployment in the lower part (960–1164 MHz) of the aeronautical L-band.

LDACS will enable the ATM modernisation and paradigm changes promoted by the SESAR Programme such as trajectory-based operations. These new concepts foresee that increasingly more communication will be performed via the exchange of data. As a result, there is a vital need for powerful broadband data link technology that can support the migration from analogue voice to digital data communications.

LDACS is the solution to overcome the existing shortcomings as it is a future proof and scalable data link technology making very efficient use of the scarce spectrum in the L-band.

Frequentis is one of the major players collaborating in several European and national research projects all of which are contributing towards achieving a common goal - to operationally deploy LDACS in Europe by 2028.



A virtual world to evaluate IPv6 based mobility solutions for ATM

Author: Richard Prinz

<https://artes.esa.int/iris> | https://en.wikipedia.org/wiki/Proxy_Mobile_IPv6

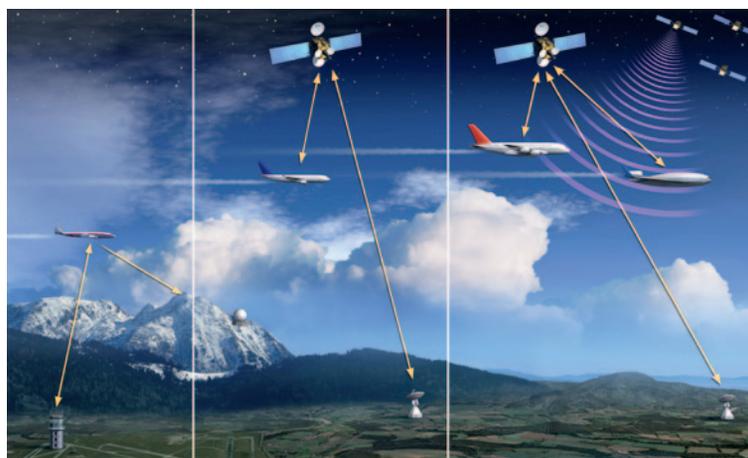
https://en.wikipedia.org/wiki/Locator/Identifier_Separation_Protocol | <https://tools.ietf.org/html/draft-templin-aerolink-75>

Frequentis Corporate Research (CR) has accumulated significant experience in the areas of simulation and virtualisation through its work supporting various European Space Agency (ESA) projects (further information available in 2016 CR Bulletin).

CR is currently implementing a real-time testbed as part of the ESA ARTES programme 'Satellite Communications for Air Traffic Management' (ATM) element (IRIS). This is the largest testbed developed to date by CR and consists of approximately 30 routers, switches, and servers.

It enables the emulation of future Aeronautical Telecommunication Network that will use the Internet Protocol Suite (ATN/IPS) based mobility management solutions and multilink concept embedded in the European Air Traffic Management satellite and terrestrial ATM communications. The testbed is based exclusively on IPv6 and supports Proxy Mobile IPv6 (PMIP), Locator/Identifier Separation Protocol (LISP) and Asymmetric Extended Route Optimization (AERO) mobility solutions.

To test and evaluate these concepts, it is necessary to create a complete 'virtual world' incorporating multiple virtual aircraft objects, each hosting Airline Operational Control, Air Traffic Service hosts as well as mobile routers. The testbed needs to present realistic situations and so uses only COTS hardware and includes a fully-fledged ground ATN/IPS network comprising AOC and ATS on-ground entities, local, global, and regional mobility management entities and an emulated ATN/IPS gateway. The testbed also emulates the movement of aircraft flying over different regions using various mobile link technologies and providers.



Drone detection and defence - countering emerging air threats

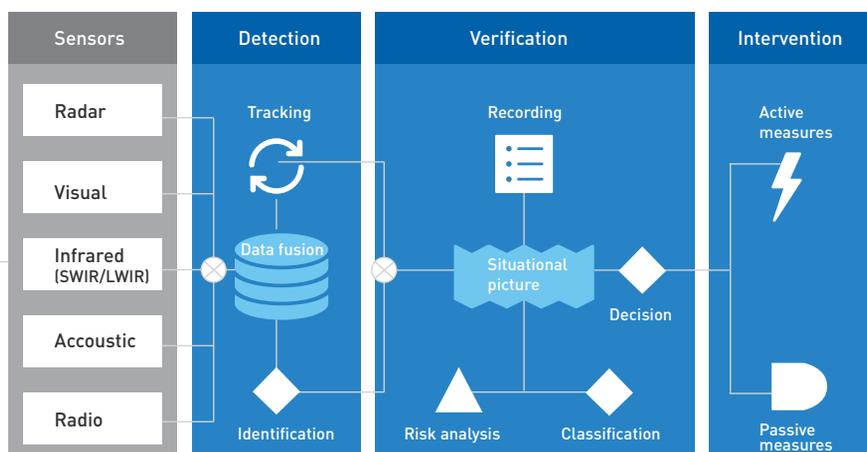
Author: Michael Strobl

Military and public services are currently reacting to heightened threat scenarios from a variety of drone technologies including remotely piloted and autonomous vehicles.

The asymmetric threats from extremism and terrorism, industrial espionage, and criminality pose a significant risk to both events and critical infrastructure such as airports. As a result, Frequentis and its subsidiary CNS, together with several industry, research and governmental partners, are undertaking research into the area of drone detection and defence.

Frequentis and CNS activity focuses on the display of the 3D location of cooperative and non-cooperative (unmanned) drones in a situational picture, combined with a proven Incident & Crisis Management (ICM) solution. Additionally, the system allows optical validation via a Pan Tilt Zoom camera directly accessed via the ICM. The key challenge is to establish how many cooperative and non-cooperative aircraft systems are flying in a given area by determining their speed, direction, and altitude in order to calculate the time it will take them to reach point X. Information from a sensor mix, adaptable for different scenarios and areas, meaning urban and rural areas, and including radar, electro optical, and acoustic, is fused together. This is analysed to create a validated track and displayed in the situational picture. Workflow handling and checklists support the risk analysis and classification of the drone to aid the 'human in the loop' decision maker. This approach increases situational awareness and enhances communication and collaboration.

A follow-up project will commence in mid 2018. This will explore intervention methods to identify the most effective countermeasures for future deployment. In tandem, faster decision making will be facilitated as Frequentis focuses on communication and coordination of ground forces.



This project has received funding from the Austrian research promotion programme "KIRAS". KIRAS is an initiative of the Federal Ministry of Transport, Innovation and Technology (BMVIT), managed by the Austrian Research Promotion Agency (FFG).

Improving civil-military interoperability

Author: Gregor Berger

In most countries, a significant natural or man-made disaster will necessitate the involvement of a variety of organisations in all phases of the disaster management cycle. Invariably this poses huge challenges in terms of major information exchange and activity coordination.

The INTERPRETER project aims to improve civil-military interoperability between the Austrian Armed Forces and governmental bodies through the introduction of IT-supported information exchange without the risk of media discontinuities.

In the event of a crisis, the effectiveness and efficiency of the aid delivered can therefore be increased on the basis of information provided by a common overview of the situation.

Building on current research findings, this project will use state-of-the-art software design methods to enable fully automated data exchange between civil and military management information systems, thus ensuring their semantic integrity. Furthermore, the modular structure of INTERPRETER allows for generic expandability of the system, which is regarded as a basic pre-requisite for its sustainable usability.

The Austrian Federal Armed Forces and national warning centres use IT systems to process data. INTERPRETER offers the potential to electronically compare an overview of the situation between these highly secure systems by defining a common semantic model for data exchange. Should a crisis occur, a shared situational overview can be generated and maintained. This would allow for data exchange in near-real time between responders of military and civil organisations, thereby increasing their collective effectiveness and efficiency.

This project has received funding from the Austrian research promotion programme "KIRAS". KIRAS is an initiative of the Federal Ministry of Transport, Innovation and Technology (BMVIT), managed by the Austrian Research Promotion Agency (FFG).



Control Room Consulting's way to ensure user acceptance

Author: Bettina Arendt

The work of Control Room Consulting (CRC) within Frequentis focuses on a user centric design process that follows international standards and places humans at the centre of any solution. This helps to achieve the goal of evaluating, defining, and designing a safe, performing, and resilient working environment where human limitations and health are important considerations.

We compare the control room to a production area where humans and machines work in optimised symbiosis to deliver the appropriate and agreed Key Performance Indicators (KPIs). Humans will remain central in future systems and so continued operational refinement and resultant user acceptance are critical in achieving improved productivity within control room environments.

CRC puts the human in the centre by utilising four principles:



Following these principles, compliant to ISO9241, we can ensure:

- a fit for purpose design
- the application of a user-centred design in the development of the system
- the required effectiveness and efficiency of human performance for all users
- the identification and management of human factors, threats, and errors

Our customers have demonstrated that our user-centric design process works. National carrier Air New Zealand has contracted Frequentis CRC to help develop Human Performance measures for a new Air Traffic Management (ATM) system for New Zealand. This is a key element of the airline's move to transform its services and work as one centre from two locations. The new system will be operational from 2020 ON and will include new desks and displays housed in two new buildings in Auckland and Christchurch.

SASR supports situational awareness in a multi-remote tower environment

Author: Michael Poiger

In the world of Air Traffic Control (ATC), the integration of Automatic Speech Recognition (ASR) into ATC training started in the late 1980s [2]. Today, ASR applications have transformed controller productivity by reducing key strokes, adding integral safety net functionality, and improving situational awareness.



However, the evolution of ATC ASR continues and with over 10 years' R&D experience in this area, Frequentis is now working with DFS to address the requirements of SESAR funded solutions PJ.16-04 and PJ.05.03.

The goal of PJ.16-04 Controller Working Position Human Machine Interface (CWP HMI) is to further improve controller productivity by analysing the operational concepts applicable for ASR and standardising the ontology for the transcription of transmissions. The solution to PJ.05.03 addresses the Multi-Remote Tower Environment through the development of a Speech Recognition service

supporting the multi remote tower concept to improve the situational awareness of the controller operating multiple remote towers. This is particularly critical in situations with parallel operations as there must be a complete overview of the on-going communications between controller and pilot, those between airports, and the ability for all parties to clearly distinguish between each other.

To best support the operator, particular focus is given to integrating the recognised information in a user-friendly way within the HMI. To get the best results it is very important to extract the relevant information from the actual voice transmission and this task will be eased by the developed ontology.

Speech Recognition applications are now commonplace in daily life. Products such as Apple's Siri is in global use and companies like Amazon and Google are constantly developing technology to enhance the customer experience. Frequentis is proud to play its part in this ever-evolving tech revolution by remaining at the forefront of ATC R&D developing solutions to support operators as they maintain safety in the sky.

References

- [1] SRI International "Siri-based virtual personal assistant technology," <http://www.sri.com/engage/ventures/siri>, n.d.
- [2]. C. Hamel, D. Kotick, and M. Layton, "Microcomputer System Integration for Air Control Training," Special Report SR89-01, Naval Training Systems Center, Orlando, FL, USA, 1989.

Common Information Space – an enabler for collaboration in disaster management

Author: Gerhard Zuba

<https://episecc.eu/>

The provision of accurate information is vital for successful collaboration between all parties involved in disaster management.



The main objective of the project EPISECC is to develop a Common Information Space (CIS) enabling seamless information exchange between stakeholders involved in European crisis and disaster management.

The concept of CIS ensures that the organisations participating in the information processes can continue to use their proprietary IT tools applied for crisis management. Unobstructed information interoperability can be realised by mapping the information to common standard formats and developing one adaptor per involved IT tool, which links the tool to the CIS.

It is possible to set up sub-groups of participating organisations to manage different classes of information. This ensures that messages are only shared between the organisations involved in a specific event and sensitive information is protected from unauthorised access.

The EPISECC Taxonomy and Semantic Services support the comprehension of information shared between organisations and tools which use different language, terms or abbreviations. A successful EPISECC CIS Proof of Concept exercise took place in Palmanova, Italy, in May 2017 and involved the participation of First Responders and civil protection agencies.

EPISECC is funded from the European Community's Seventh Framework Programme FP7/SEC 2013.5.1-1 under the grant agreement no. 607078.

Semantic data containers realise full potential of SWIM

Author: Eduard Gringinger

<http://project-best.eu/index.html>

The BEST* project aims to unleash the full potential of System Wide Information Management (SWIM) by utilising the semantic container approach to shield developers from the complexities of data provisioning in Air Traffic Management.



When combined with SWIM, semantic containers can facilitate the emergence of a marketplace of value-added information services and allow for complex derivation chains of data sets. Existing data is intelligently filtered along these derivation chains, prioritised, combined, and annotated with additional information.

BEST facilitates the organisation of data from various origins relevant to the operational scenario into semantic containers and keeps track of associated metadata. An Ontology-based description of information needs and semantic container contents facilitate automated data discovery. This makes it possible to re-use already prepared data collections, avoiding the need to redundantly implement further data collection and preparation. As a result, the number of query request will drop and relieve the whole SWIM network performance wise.

Employing the semantic container approach in SWIM makes scalability a key achievable. A first feasibility study showed that with an adequate Ontology-based representation of information needs and semantic container membership conditions, automated data discovery is possible in a large-scale setting.

*BEST (achieving the BENefits of SWIM by making smart use of Semantic Technologies)

BEST has received funding from the SESAR Joint Undertaking under grant agreement No 699298 within the framework of the European Union's Horizon 2020 research and innovation programme.

Spatially aware Service Registry for Maritime Connectivity Platform

Author: Josef Jahn

<http://efficiensea2.org/>

<http://stmvalidation.eu/>

EfficienSea2, led by the Danish Maritime Authority, is a first generation e-navigation project that has brought together 32 maritime-related partners from 12 countries to develop a Maritime Connectivity Platform (MCP).



Shipping companies, sea and port authorities, equipment manufacturers, service providers, and other stakeholders have contributed to the development of this connectivity platform which allows service users and providers to discover each other, validate identities, and facilitate the flow of information.

A key part of the platform is the Maritime Service Registry developed by Frequentis. The company is currently operating and hosting the Registry which stores both service connectivity information as well as geographic service coverage information and even machine- and human-readable service specifications.

Approximately 200 services are currently registered and used every day by in excess of 300 vessels - from small barges to large container ships – as part of the Sea Traffic Management (STM) project which guides and monitors vessels in a similar way to ATM. Bridge equipment on the ships automatically queries the registry with its current location and planned voyage route. The architecture of the Maritime Connectivity Platform makes it extremely resilient, failure-tolerant and easy to discover thereby ensuring there is always a service reachable for a ship; and so it can play a part in supporting operational efficiency and safety at sea.

This project drew heavy inspiration from SESAR*, applying principles like a service-oriented approach and the use of open standards.

The concepts and technologies used by Frequentis are now being applied in other domains like Air Traffic Management.

Parts of these activities have received co-funding from the European Union's Horizon 2020 research and innovation programme and the Connecting Europe Facility (CEF).

*SESAR (Single European Sky ATM Research)

Network status knowledge with NWOK

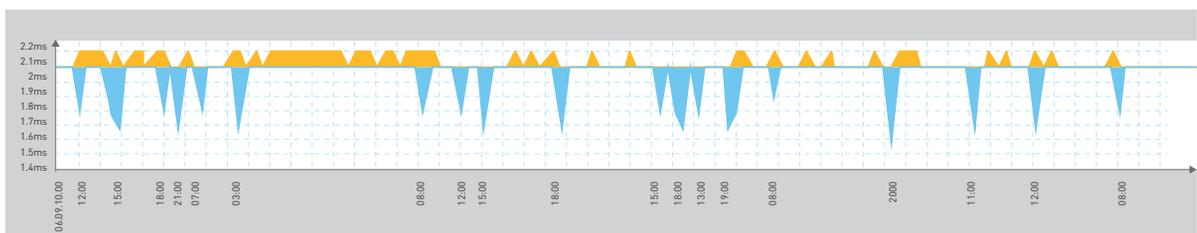
Author: Wolfgang Kampichler

With cyber threats becoming increasingly sophisticated, this places even more importance on the need to protect high quality voice communication in mission-critical domains. As a direct result, the ability to establish the exact status of a network, at any given time, is an invaluable aspect of protecting its integrity.

Frequentis Corporate Research has developed a network monitoring tool that actively measures the network using probes – for example, traffic typically arising from VoIP sessions. The tool - NWOK ('is your NetWork OK?') - is a client server application sending traffic to a remote service for the evaluation of data received where it creates similar traffic being returned to the client. The client receives statistics such as information on packet loss, delay, and inter-packet delay variation from the server side and calculates its own statistics based on the traffic received. Periodically generated reports of time-window averaged values for inbound and outbound traffic are further used by monitoring platforms such as Zabbix.

NWOK is a command line tool with some mostly client side configuration parameters. To get constant statistics, it can run automatically as a service or simply be initiated manually should a field engineer wish to obtain a snapshot of the network status. For in-depth investigations, a manual configuration may extend statistical values with measurement results taken from each sample received.

NWOK can be utilised as the first level of security for a network as it provides a picture of what 'normal' performance should look like and therefore makes it easy to spot anything out of the ordinary.



Knowledge-based SWIM service for enhanced digital briefing

Author: Eduard Gringinger

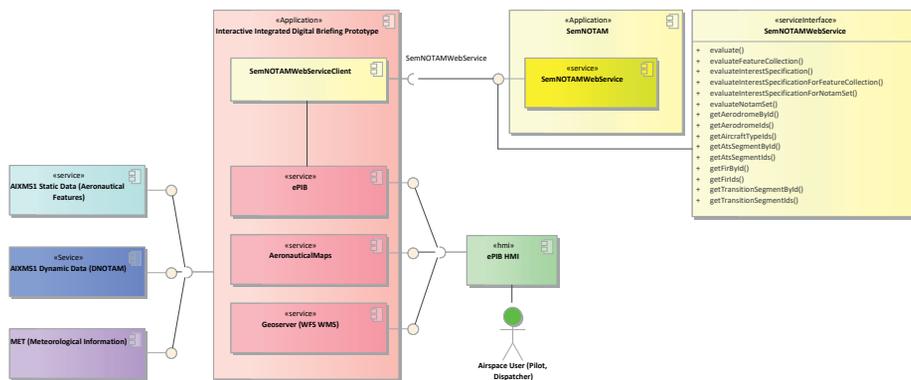
<http://semnotam.frequentis.com/>

The general aim of the SemNOTAM*** project was to investigate the potential for using a knowledge-based approach to fully exploit the benefits of DNOTAMs** by providing complementary intelligent query and notification support. This would involve the use of a wide range of criteria based on event types, types of aircraft, location in space and progress in time. Specifically, the goal was to develop the necessary semantic techniques for intelligent DNOTAM filtering and their application in a proof-of-concept prototype knowledge base framework.



SemNOTAM is a rule-based system. DNOTAMs are filtered and annotated based on rules. A rule describes a NOTAM* situation for which a specific classification is assigned. For example, a rule can state that relevant NOTAMs regarding apron ground markings are informative but not flight critical.

Prototype tests showed that a knowledge-based approach for DNOTAM filtering and annotation is feasible. Evaluation for a sample flight showed that if information about currently defined Event Scenarios is published as DNOTAMs, the currently defined small set of business rules can be used to reduce the set of displayed DNOTAMs by around 35%. This can be achieved by hiding non-essential ones. Current Event Scenarios cover about 65% of the NOTAMs in the sample flight for which importance can be determined.



- * NOTAM (Notice to Airmen)
- ** DNOTAM (Digital Notice to Airmen)
- *** SemNOTAM (Ontology-based Representation and Semantic querying of Digital Notices to Airmen)

This project has received funding from Take Off, the Austrian Research, Technology and Innovation Funding Programme of the Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT). The Austrian Research Promotion Agency (FFG) has been authorised for the Programme Management.

*SESAR (Single European Sky ATM Research)

Unite Crowd Com – a new cloud service

Author: Kuno Skach, Managing Director, Control Center Apps GmbH



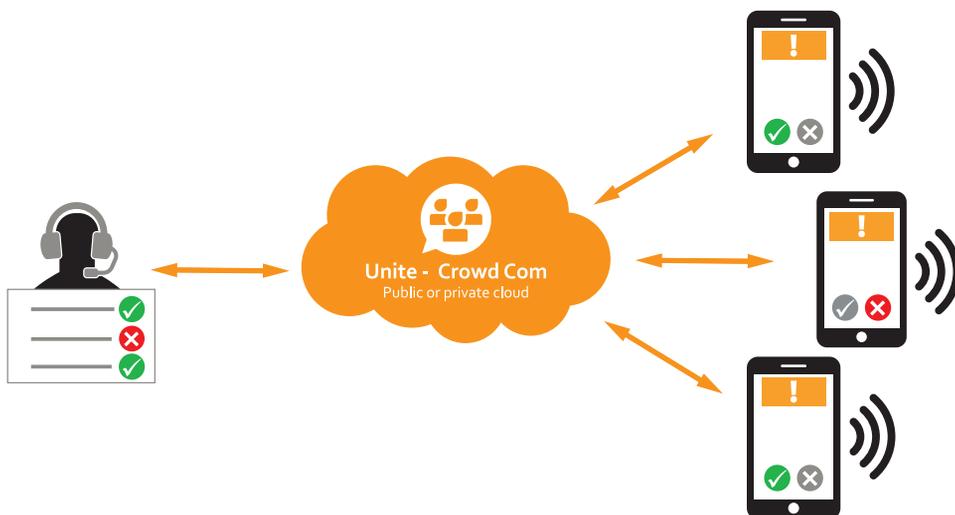
Imagine the scenario: there is a severe flood. The local authorities require the help of volunteers and NGOs to tackle its impact on people and the immediate environment. So, in the interests of best coordination, they share a Crowd Com activation code via Facebook and volunteers install and activate the Crowd Com app.

Now they can receive spoken instructions and announcements directly on their smartphones. Perhaps it is cold and still raining heavily and the volunteers do not have free hands. It is therefore extremely helpful that announcements are played automatically through their smartphone speaker or earphones – the recipient needs to take no further action in order to receive them.

The authorities have deployed several small control centres to coordinate local operations. Using laptops with Internet access, they send announcements to the volunteers in their respective areas. They can also monitor the coverage of each announcement within the control centres and, where the instructions are extremely important, they can request that volunteers confirm receipt of an announcement. Crowd Com then shows a map of the locations indicating where these confirmations have been received. To channel enquires, a call back number is transmitted along with each announcement.

Apart from the scenario above, there are a multitude of further uses. For example, it can be deployed during large-scale events or for communication on a railway or within airports where common, meaning same message communication, is required for transmission to internal or external staff.

Unite Crowd Com has been available since June 2017 and was designed and developed by Control Center Apps GmbH, a sister company of Frequentis.



Mission Critical Communication

Author: Wolfgang Kampichler

The introduction of MCPTT (Mission Critical Push-To-Talk) as a new global standard to ultimately replace legacy group communication systems prompted Frequentis Corporate Research to launch an initiative to demonstrate the key advantages of this promising technology.



MCPTT is based on LTE and will be available for both, public safety (government) as well as commercial users via a shared network infrastructure, where public safety will have priority over commercial users.

Frequentis and its technology partners - Austrian mobile radio provider A1, Italian LTE mobile core network provider Athonet and Spanish MCPTT application provider Nemergent – created a live demonstration in Austria involving a scenario where a flood crisis occurred in the vicinity of a power plant.

Different terminals and LTE networks made up the solution. This consisted of an LTE network from A1 and a 5G-ready complete LTE mobile core network including IMS (IP Multimedia Subsystem) from Athonet. Nemergent provided a core element in the form of the MCPTT client and server components and Frequentis, the control room solution. The Multimedia-Collaboration Platform 3020 LifeX enabled cross-coupling (LTE, TETRA, Emergency Telephone Calls) and mixing media as well as tacking the resources onto the embedded Geographical Information System (GIS).

During the demonstration, mobile broadband network coverage was combined with a deployable micro system. This allowed private and group calls to be established between professional field units and the dispatcher, which provided tracking and location information.

Emergency teams wearing helmet mounted cameras were able to stream live HD video to the control room and this enabled the command teams to direct personnel and resources more effectively and efficiently in response to events on the ground.

Frequentis experts and authors of this edition

indicating their main fields of research



Christoph Rihacek
Mobile Aeronautical
Communications
respectively Maritime
Information Sharing



Richard Prinz
Geographic Information
Systems and Protocols
(GIS) and Satellite
Mobility Protocols



Michael Strobl
Detection, Tracking
and Management of
Unmanned Aircraft
Systems



Gregor Berger
Control Centre Solutions



Bettina Arendt
Human Performance



Michael Poiger
User Productivity and
Human Performance
methodology



Gerhard Zuba
Crisis and disaster
management and
Software Engineering



Eduard Gringinger
ATM Data and
Services Models



Josef Jahn
SESAR, Enterprise
Integration, Microservice
Container, Security



Kuno Skach
Rail 4.0 / Industry 4.0
with focus on Internet of
People (IoP)



Wolfgang Kampichler
Architectures and
Standardisation for VoIP
based Control Centre
Solutions



Jan Patrick Ziegler
ADS-B, Multilateration,
Air Traffic Management
Systems

FREQUENTIS