Dear reader,

Time flies! This is already the fourth issue of Blueprint, our annual skyguide Technology Outlook. Yet if we stop to consider what has changed in the ATM technology field since that first issue of 2010, it’s a somewhat sobering conclusion that we must come to.

The pace of innovation in the ATM sector compared to other industry segments is rather slow.

And, as a result, ATM today remains based on technologies that lag substantially behind the present-day potential. The consequent discrepancy between what ATM can provide and what the aviation sector expects and demands is a major problem that needs to be addressed with all possible priority.

What none of our various stakeholders would dispute is that the technology required to modernize our present ATM already exists in tried-and-tested form. Yet we still seem to be unable to take the innovative steps desired within a reasonable timeframe.

The reasons for this might become a little clearer if we view the whole issue within a broader context. The projected increases in European air traffic volumes seem lower than expected and the states are very much occupied solving more urgent issues. The ‘tools’ created to ensure that the Single European Sky’s objectives are achieved have not yet fulfilled expectations and opportunities seem not to be strong enough at present to prompt any abandonment of the existing structures and systems. There is a tendency to regard today’s ATM as ‘good enough’ for today, the question is: is it good enough to meet tomorrow’s demands, too?

We do currently have two new initiatives that are bringing fresh impetus to the ATM debate: the Virtual Centre (VC) and the Central Services (CS) approach.

Both of these, especially when combined, offer considerable potential for initiating the necessary amount of change we will need for tomorrow’s ATM.

But the path to adopting them is far from easy: besides the problems to be solved in the field of technology, there will be also a sizeable amount of ‘non-technical problems’ to be addressed. New roads must be taken and new means adopted.

Given the current frequency of the ATM innovation cycle, we will need to do all of this very soon. So let’s take a positive attitude towards change and bear the challenge.

Sincerely,

Robert Stadler
The air transport sector is in considerable difficulties right now, especially in Europe. Traffic volumes are declining, despite all the projections of the past few years. The economic crisis is certainly a major factor here. And the present state of affairs could easily sway the industry’s participants to delay or even totally abandon the kind of developments within the sector that are already overdue. As a brief survey of the last few decades shows, however, aviation has gone through several such crises of falling volumes in the past, only to subsequently recover and return to traffic growth.

We must assume that the present traffic declines, too, will be followed by such a recovery. That’s why our industry needs to press on with its applied research and development and its adoption of new systems and technologies today if it is to master the challenges of tomorrow. This approach is further borne out by the success of a number of technology providers which have taken advantage of an economic downturn in the past to put their reserves into innovation and further staff training, with impressive results and returns.

A further challenge is posed by the European Commission and its own ambitious objectives. By 2025, the EC wants to see Europe’s airspace capacity tripled, costs halved, safety improved tenfold and emissions reduced by 10%. And the creation of a Single European Sky (SES) is the means by which all these aims should be achieved. Various tools from SES ATM Research (SESAR) to regulatory Implementing Rules (IRs) have been created to this end, sizeable funds are being provided and extensive legal foundations laid. But the question of whether sufficient numbers of skilled personnel will be available to make such radical system changes has hardly been addressed. And the key issue here is: can the present education system deliver the human resources required?

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**Education: the «software» for tomorrow’s technology**

Maurizio Scaramuzza, Head of CNS Expert Group, skyguide

The aviation industry faces sizeable challenges ahead. And the air traffic services sector in particular must address the industry’s future needs and expectations now if it is to continue to ensure safe and smooth flight operations in a few years’ and decades’ time. New technological advances are the means by which it can do so. But maximizing their potential will also require skilled and qualified personnel who can both design the new systems and operate them, too. So is our current education system adequately suited to this vital task?
Ask a small child what they would like to be when they grow up, and “a pirate” or “a princess” is often the reply. At this young age, we make little connection between what we wish to become and what being so will actually entail. As we get older, our professional dreams take on a more rational form. Young boys will tend to dream of being an engine driver, a pilot, a policeman or a footballer (with the first two chosen more for the status than for their technical nature); and young girls will tend to opt for more caring professions: teacher, vet or nurse.

Our education system today is primarily designed to meet the needs of society and our economy – not least through the numbers of apprenticeships it offers, which are directly influenced by the business sector. If a youngster elects to go on to further education, however, this can have a major impact on their choice of subsequent career. Broader economic considerations may play only an indirect role (if at all) in their choice of study course, which is far more likely to reflect the student’s own genuine interests. And such interests can be readily tracked by following the numbers of students in tertiary education and the studies they elect to pursue.

It makes interesting reading. The numbers of students enrolled in Switzerland’s «Fachhochschulen» (universities of applied sciences) and graduating – following the Bologna reforms – with a bachelor’s or master’s degree has expanded over the past ten years. The trend can be attributed at least in part to the fact that the grants these institutions receive rise in proportion to their student numbers far more substantially than the associated costs. As a result, the institutions have a clear economic incentive to maximize their student numbers. This in turn can jeopardize the quality of the education offered, which may suffer as a result of these strong business pressures.

Student numbers have also been increasing at Switzerland’s universities and institutes of technology, though at a far lower rate. What is interesting here is that twice as many students opt for arts and social sciences courses as those who choose the «hard science» (science, technology, engineering and mathematics, or ‘STEM’) options. And business and industry have also voiced alarm at the shortage of specialists emerging from tertiary education in these latter fields.

One key criterion in the choice of study course seems to be: what line of study will enable me to earn the most money in the shortest possible time? Here STEM students tend to fare less well than their colleagues studying in financial or administrative fields. The salaries of 30-year-old employees in research and development are on average between 10 and 20% lower. The discrepancy increases with age, particularly for those who take on management functions, and can be as much as 30 to 40% by age 45, or well over 50% for the highest salary
earners. With discrepancies of this scale, it is understandable that many students elect to pursue courses offering the greater financial rewards.

The reasons for the decline in STEM specialists are more multifaceted than this. But the following three factors seem to play a particular role.

Subject ratings. The present Swiss school system rates language subjects more highly than mathematical ones. This has two prime effects: it can shift the student’s interests towards arts subjects in general; and it can cause those students with a flair for maths to achieve less favourable overall scores, creating a tougher starting point for their further development.

Recognition. Pilot over engineer, teaching over IT: just as they do in their early dream jobs, the respect and recognition a profession seems to command in society can be a key factor in a child’s study interests all the way through to their working career.

Pay: The statistics clearly show that the professions requiring STEM specialists are less attractive financially in both the short and the longer term than other professions demanding the same education levels. This, too, has a clear impact on people’s choice of career – not least because salary levels are a further way in which society expresses its appreciation of the work performed.

The question of whether sufficient ranks of suitably-skilled personnel are available on the market cannot, however, be reduced to student numbers alone. The quality of those graduating must also meet the needs of the economy and the demands of the tasks to be performed. The risk of a decline in quality at educational institutions as a result of the business pressures they are exposed to has already been mentioned above. At the same time, more and more tertiary education establishments are coming to offer courses culminating in a «Master of Advanced Studies». Such courses tend to require a minimum of students before they can be held; and this in turn can sometimes prompt the admission criteria to be lowered, with a concomitant effect on course and student quality.

All these trends are far from conducive to meeting and mastering the many industry challenges ahead, particularly in the air transport field. And let’s be under no illusions here: we cannot simply change the present education system to suit the needs of aviation and other technical sectors. What the companies affected can do, though, to help avert future staff shortages is raise the attractiveness of their technical professions. At the same time, these same companies must also press for optimum quality in the study courses offered in the STEM field. After all, work tasks and duties are becoming harder, not easier in today’s increasingly complex and networked world.
GALILEO is the pan-European initiative to develop a global satellite-based navigation system. GALILEO is under civilian control, and will be 100% interoperable with the military-controlled GPS and GLONASS systems. The system set-up is now well under way, with partial operation planned for 2016 and full system capability expected to be available by 2020. GALILEO will not only enhance the robustness of satellite-based navigation; it will also permit the adoption of further challenging aviation applications.

Description
It was back in 2003 that the European Space Agency’s member states launched the GALILEO project to develop a global satellite-based navigation system. Since then, major progress has been made, though the venture has seen a few setbacks, too. This is not uncommon with a complex and innovative project of this kind: similar experiences were (and are still being) reported in the development of the GPS system.

The first GALILEO test satellite, GIOVE-A, was launched in December 2005. The second, GIOVE-B, followed in April 2008. Following the successful completion of the initial tests, the project has now moved on to the «in-orbit validation» phase, which involves four new GALILEO satellites. The first two of these were launched in October 2011, and the second two in October 2012.

The setting-up of the full GALILEO constellation should commence with the launch of two satellites later this year. These will be followed from 2014 onwards by several launches per year, each with two to four satellites. This should produce an initial operational capability (IOC) of 18 satellites (including the four in-orbit validation satellites) by the end of 2014. The 30 GALILEO satellites required for full operational capability (FOC) should be provided by 2020.

The first GALILEO services will deliver added value to global navigation satellite system (GNSS) users from 2015 onwards. The GALILEO open service will partially complement GPS to ensure the higher accuracy, greater availability and enhanced robustness of satellite-based navigation.

As soon as full operational capability is achieved, a full GALILEO open service will allow either navigation without GPS or enhanced performance while using both systems. The public-related service (for government purposes) and the commercial service will also offer robust encrypted navigation with continuous availability. Last but not least, the search-and-rescue service will provide a return link to a rescue organization for emergency purposes.

The safety-of-life service, which adds integrity to the open service, will be provided in a similar way to that of today’s GPS, i.e. via an advanced RAIM functionality and augmentation through the existing EGNOS.

Applications
With its various frequencies, GALILEO will enhance the robustness of satellite-based navigation in general, and for aviation applications in particular. This will allow the aviation sector to further rationalize its conventional ground navigation aids. An interoperable GPS and GALILEO will also provide the dual GNSSs required to develop further challenging aviation applications.

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Description
Network design today must adapt to ever-changing service requirements and user needs. In the past, a simple point-to-point connection would usually do the job. Today, by contrast, there are a vast number of factors to consider – not only changed and changing user requirements, but also the products and technologies offered by network manufacturers.

Today’s service providers are under enormous cost pressures, and must also be able to respond quickly to any technological developments. At the same time, they are facing increasing demands on the availability of the services they provide; and the structures of their redundancies today extend far beyond the boundaries of a single company, and are not restricted to single systems, either.

There are many further considerations, too, which can influence a network’s design: network security, to name just one. All these various factors inevitably bring additional complexity. And the sheer range of the manufacturers’ and providers’ portfolios may also put restrictions on, or even entirely rule out, some of the features desired.

Network design today is also a multidisciplinary activity. The technology involved is still largely in the hands of the engineer; but many further players are rising in importance, too. And this shift in design responsibilities must be cemented by contracts that are well defined by the network engineer.

With all these various trends, strong central coordination has never been more vital. An in-depth knowledge of the users’ work and needs is a further key prerequisite to effective network design, while experience in different technologies and a familiarity with the market will both be a major help in the choice of equipment.

Another key aspect here which is often neglected is the human factor: both the customer and the network maintenance team can be overwhelmed by all the technical applications. This is especially true when problems or failures occur in a technical environment. And here, safe and simple diagnostics are a further hallmark of good network design.

Applications
Virtual services and a network that is optimally designed for this purpose can only be realized if their design, their service quality, the use of cost-efficient devices and the necessary coordination with ATC neighbours are all entrusted to a central unit within the ATM provider.

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Virtualization offers the ATM sector a range of options and degrees of flexibility that were previously inconceivable. It does mean, though, that many networks which have performed reliably in the past now have to be replaced. And doing so poses some major challenges, especially if the technologies used are no longer supported by their manufacturers.
Virtualization is not new to networking. From early on, standardisation bodies included protocol features that permitted logically-separated services on the same infrastructure. Traditional networks, however, have evolved in a context of stationary end systems. Today’s dominant network protocol stack, Internet Protocol (IP) over Ethernet, will reroute traffic around failures, but is not well equipped to handle roaming endpoints.

Scalability demands make it impossible for a network device to keep track of all the unique station identifiers (Ethernet MAC addresses), so IP addresses are overlaid. Like postal addresses, their assignment is based on network topology. Intermediate sorting stations – routers – read the IP address to forward packets to the next hop, a knowledge of MAC addresses is only required for local recipients.

Needless to say, this concept breaks down when a virtual machine moves from one point in the network to another. Routing efficiency would require an IP address change, but usability prohibits this.

At present, network best practices become violated through the creation of extended Ethernet domains across redundant data centres. Scalability issues aside, this creates new problems. Ethernet was born on a broadcast medium. It requires packets to be flooded everywhere, if a recipient’s location is unknown. This is a minor issue if and only if domains remain small and local.

It gets worse, though. Redundant links would cause packets to loop. So all but one of the redundant links are blocked, resulting in a tree with only one path from any node to another. Once again, this is acceptable with small Ethernet domains. With extended ones, however, it wastes expensive resources and creates significant detours for network traffic to neighbouring nodes that do not sit on the same tree branch.

In view of all this, network suppliers are now rolling out new technology that brings routing to the Ethernet layer. Their latest solutions enable the concurrent use of redundant links and provide forwarding of traffic along the shortest path.

Since the associated traffic flows change from a tree pattern to interwoven paths, the marketing names here often contain the word «fabric». Alas, it’s not only the names that differ. The IEEE’s «Shortest Path Bridging» standard competes with mutually incompatible proprietary solutions. Which will prevail? Only time will tell…
The legacy platforms have reached the end of their life-cycle, and the new technologies like Carrier Ethernet Services (CES) have been mature and in service with the world’s various telecom operators for some years now. ATM services will be migrated to these new technologies in the next decade. And doing so poses a real challenge.

Description
The combination of legacy networks being replaced by packet networks and legacy equipment reaching the end of its life-cycle is presenting skyguide with a major challenge. The corresponding technology change was initiated at our company with a mandate to increase the bandwidth at various regional airports.

We currently have point-to-point 2 MBit/s leased lines in operation between these locations and our main Geneva and Dübendorf sites. One possible way of increasing this bandwidth is to lease more lines from the telecom operator. This is not the best solution, though: it would entail higher costs, and 2 MBit/s services are soon likely to be terminated by the various telecom operators.

In view of this, skyguide has been considering how its networks could otherwise evolve, in a way that would provide more bandwidth for the same cost and would continue to carry the legacy services. The question is: what technology is mature enough to transport both the legacy services and the future IP-based services?

There is currently no means available of migrating all the existing services to a new technology, since some services (radio, phone, applications) are not available on IP. In view of this, the choice of the new technology and the equipment for the future will be a key decision that must meet the three requirements of improving performance, offering scalability and keeping down costs.

Having listened carefully to their requirements, we are now well aware of our internal customer’s current and future needs (among which reducing and subsequently controlling operational costs is of particular importance). And, after analyzing the various scenarios, we have decided to proceed with an evaluation of Carrier Ethernet Services (CES) as the transport service delivered by a Telecom operator. We have also decided to evaluate various candidate MPLS hardware suppliers, and to take a final decision on our partner here by the end of this year.

Conclusion
Our legacy services will continue to be used for the next five to ten years. During this period, new IP-based services will be introduced in parallel to the existing services. This life-cycle extension and the evolution in technology offer us a real chance to provide all the services needed by our customers via a new platform during the next few years. And the Ethernet interfaces will also help us propose a smooth means of migrating to the new IP-based services envisaged for tomorrow’s ATM world.

Applications
We plan to put our new Packet Switched Network into operation by the end of 2014, and to have the network fully operational by the following year. The new network should provide various types of shared computed data – radar, weather/environment, flight, voice and more – for our customers at our regional airports.

Impact
Radio Quality of Service, or high-fidelity «skyguiding»

Fabien Mann, CHIPS Specialist, skyguide

The first-ever CNS system, which is still in use today, was AM radio communications. Like road traffic, the population of the sky has massively increased over the last few decades; and so have the associated radio communications. To maintain both safety and capacity, air navigation service providers now have to ensure a high «quality of service» in terms of their radio communications — especially in Switzerland, where the topography can also be a nightmare for radio propagation.

Description

Any user or customer will want (or need) to have a clear idea of the quality of the services they are using. This is especially true in civil aviation, where thousands of lives are placed in the hands of a small group of specialists and their equipment every single day.

On the user side, pilots can often be heard comparing the relative quality of radio communications in different regions. On the provider side, meanwhile, skyguide is fortunate in having specialists who are fully familiar with the strengths and weaknesses of its equipment, installations and radio sites. But, while this knowledge may be sufficient internally to provide a good service, it may not be enough to give the user a guarantee of safety and a good quality report.

This is where skyguide’s «Quality of Service» (QoS) comes into play. We want users to have an objective assurance of the quality of the radio services within the airspace areas under skyguide’s control and — ultimately — a complete real-time radio quality map of the sky.

Skyguide’s QoS is based on various criteria, such as signal levels, signal-over-noise ratio, interference rates, mean time before failure or interruption, (which lead to the availability), channel occupancy and more. Some of these metrics and measures are described in standards deriving from such sources as ICAO, the ISO, the ITU and EUROCAE; others are not, and must be described from scratch.

Several voice communication systems already perform part of the job here at skyguide’s Dübendorf and Geneva facilities, obtaining real-time or delayed data on the state of the sites and their equipment, and even collecting measurements straight from the installations. The MATRIX system, for instance, has been running for ten years displaying various quality indicators; but it now has to be used at its full capacity. And these systems as a whole now need to be improved and completed, and used to confirm skyguide’s reputation as a quality radio communications provider.

There is a lot of work still to do. But with the collaboration between the CHIPS programme and skyguide’s radio communications experts, and with the equipment renewal project that is currently under way, we see strong prospects of having full monitoring of the quality of skyguide’s radio communications in the foreseeable future.

Applications

With the growing consolidation in European civil aviation, skyguide must guarantee the quality of its technical services. This is already done in its network, surveillance and navigation services; and it’s now time for its radio communications to receive similar such assurance, so all users know that they are paying for a high-fidelity radio service.

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ATSAW: helping enhance traffic situational awareness

Jörg Neubert, Flight Operations Engineering, SWISS

Flight efficiency and CO₂ emissions over the North Atlantic would both be improved if optimum cruise levels could be reached more frequently. The new Airborne Traffic Situational Awareness (ATSAW) applications enabled by «ADS-B In» will enhance the situational awareness of flight crews by displaying information of the surrounding traffic on their cockpit displays, and could also help identify situations where the flight level can be changed. This should result in both enhanced safety and improved efficiency.

Description

It was in preparation for the operational deployment of «ADS-B In» applications that the EUROCONTROL CASCADE Programme launched its «ATSAW Pioneer Project». Its aim: to help airlines equip their aircraft with certified ATSAW equipment and participate in trial operations, later transitioning to regular operations. Five airlines were selected worldwide for the project. SWISS was one of them, and installed the new equipment required on three of its Airbus A330-300s.

The ATSAW concept includes several applications that are optimized for each flight phase:

• ATSA-AIRB (enhanced traffic situational awareness during flight operations)
• ATSA-ITP (in-trail procedure in procedural airspace)
• ATSA-VSA (visual separation on approach)
• ATSA-SURF (application on airport surfaces).

ATSAW supplies enhanced traffic information to pilots by showing surrounding traffic on their cockpit displays and on specific pages of the Multipurpose Control and Display Unit. This enriched information is available for surrounding aircraft with «ADS-B Out» capability within at least 100 nautical miles longitudinally and 30 nautical miles on either side of the ATSAW-capable aircraft.

The ATSAW Pioneer Project flight trials, accompanied by evaluation and reporting, began in February 2012. In addition to the ATSA-AIRB application, the main focus for SWISS here was on flight trials within North Atlantic airspace using the in-trail procedure (ITP).

Any aircraft operating in oceanic airspace will, at times, be flying at less-than-optimal flight levels, owing to conflicting traffic either at the desired flight level or at flight levels between the existing level and the optimal level. The ITP procedure permits flight levels to be changed by allowing temporarily-reduced separations to climb or descend through blocking traffic. The procedure is currently being trialled in the Shanwick and Reykjavik FIRs.

For SWISS, the “active” part of the ATSAW flight trials ended last March, and attention has now switched to an analysis of the potential fuel savings. SWISS is confident of showing clear benefits in the form of reduced fuel burn and lower emissions for aircraft using the ITP procedure.

Applications

The ATSAW Pioneer Project addresses two «ADS-B In» applications within the airborne domain:

• (ATSA-AIRB)
• (ATSA-ITP)

While the ATSA-AIRB application can be used worldwide, the ATSA-ITP application is currently restricted to trials in the Shanwick and Reykjavik FIRs.

Impact

At a glance, the CNS, ATM, and AIM levels are rated as follows:

CNS: high
ATM: medium
AIM: high
We are confronted with remote systems every day of our lives: TV remote controls, remotely-controlled aircraft and remotely-controlled trains, to name just a few. But when it comes to air traffic control, the idea of a «remote tower» sounds somehow strange. How could air traffic controllers possibly manage and monitor the traffic at and around an airport far away from where they are sitting? In fact, today’s technology already permits such an innovative approach.

**Description**
With the associated financing becoming increasingly tight, many countries – developed ones included – are facing tough business decisions on the infrastructure of their regional airports. Air navigation service providers also have difficulty staffing their control towers in less attractive locations; and the general pressure on ATC costs is growing, too. «Remote tower» technology is seen as a promising response to many of these challenges.

On the technology side, the remote tower is based on sensors (including high-definition cameras) located on a mast covering 360 degrees, along with microphones and possibly infrared cameras. A high-speed network then transmits the data between the remote airport and the central facility. In this building, which can be located a sizeable distance away, an air traffic controller will operate a remote tower covering one to four airports. The visuals with which the controller is provided for this purpose can range from a couple of screens to a more sophisticated TOSIM-like 360° perspective.

The technology here is not limited to a simple visualization tool, though. A wide range of further data such as radar information and flight plan data can also be integrated to support the controller’s work. In fact, with these supplementary facilities, too, the remote-tower controller may even end up with a better situational overview than they would have in a normal tower, especially in poor weather conditions. At the same time, some special functions such as runway check and runway incursion detection can be automated and run continuously, further enhancing safety.

As several pilot projects have demonstrated, the technology here is already mature. Sweden is in the process of certifying the technology for operational use. This should be done by the end of this year, when two regional airports will begin to be controlled from one remote location. Australia is also currently considering controlling Alice Springs Airport from Adelaide, some 1500 kilometres away.

The technology itself is not the only issue, though, and there are still many more challenges to overcome if we are to deploy remote-tower technology in our operations: standardization, certification, controller licensing and more. And, as is always the case with new technology, end-user acceptance will also be a key success factor.

**Applications**
The remote-tower approach can be adopted to control groups of airports in remote regions with a low traffic density, or during non-peak hours. The remote tower could further serve as a low-cost alternative to a back-up tower in any contingency concept. And flight information services could also be provided using the same «remote» philosophy.
In 2006, wide area multilateration (WAM) was declared ready for use. After several years, we now have a more nuanced understanding of its advantages and disadvantages. Although putting a WAM-system into operation may present a challenge, there are reasons for using this technology now and in the future.

**Description**

At a Eurocontrol workshop in 2006, industry specialists declared wide area multilateration (WAM) ready for use. They expected it to be easy to transfer the successful use already implemented at airports to wider expanses of airspace. However, as airports have clearly defined borders, they require only two-dimensional coverage.

When installing a WAM-system to cover three-dimensional airspace volume without natural borders, certain unexpected issues may arise. For instance, the system around Frankfurt in Germany covers 128 NM x 80 NM, but it receives reports inter alia from the North Sea 300 NM away. Additional calculations are required to establish that the report is not within the specified coverage area.

Besides technological challenges, the cost savings promised have not always been achievable. Rental cost for property and communication lines may increase the life cycle costs of a WAM-system making it more expensive than radar. However, a positive cost benefit ratio can be achieved with alternate applications. Within the Frankfurt area, for example, the WAM-system with its one-second update rate prolongs the use of normal approach and departure separation under poor weather conditions. Benefits are not directly for the ANSP, but for aviation as a whole.

Measurable benefits directly for an ANSP may arise when phasing out one aging radar and closing a potential gap with a small WAM. Another beneficial application of the technology is when coverage needs to be provided behind obstacles. A small WAM may be more cost efficient than a radar which may not get approval anyhow. In the future, it will become increasingly difficult to get approval for new CNS sites. In such cases, WAM provides an acceptable alternate solution.

Finally, choosing to implement a WAM may be a strategic decision with the goal of deploying ADS-B. The experience with airborne Mode-S equipment has shown quite a lot of unexpected shortcomings in onboard implementations which decreased the performance of the ground system. Using the same receivers, WAM could be an independent backup system for ADS-B to cope with such shortcomings. In the long term, lower performance might even be acceptable if ADS-B were operated as the main surveillance system.

**Applications**

PAM FRA went into operation in April 2013. The whole WAM system (34 ground stations) covers an area of 128 NM x 80 NM. It runs with a one-second update rate displayed to the controller working positions for Frankfurt Approach and Departure. For the rest of the area, it contributes to the multi sensor tracker as one sensor, but with one-second update rate instead of four, five or twelve seconds as is the case with radars.
The aviation world is seeing itself increasingly confronted with various environmental issues: over noise, emissions, flights over built-up areas and general airspace structures.

With airspace becoming an increasingly rare commodity both in Europe and worldwide, these issues are particularly sensitive when it comes to airport approaches and departures. One possible solution here is the radius-to-fix (RF) application envisaged by ICAO. And Switzerland is playing a pioneering part in developing this new technology.

**Description**

In the past, aircraft have navigated from point to point along a defined route. With RF legs, by contrast, flights will follow a defined radius arc. The «Dübendorf Curved Approach» CHIPS project has set itself the objective of studying such RF legs and their impact, to acquire concrete knowledge for use in future developments and applications.

As a key part of this project, the Swiss Air Force has been performing a number of flights involving RF legs with a Super King Air T-721. This particular aircraft was chosen for such trials in view of its advanced cockpit and the fact that it also has an additional GPS receiver installed for its further deployment on Swisstopo survey and calibration flights.

A first project phase saw the aircraft’s hardware and software modified to enable it to fly the RF legs envisaged. It also saw recording equipment such as ADSB-OUT installed, to permit the subsequent evaluation of the flights performed.

So far, a total of 13 trial approaches have been flown on the existing Dübendorf approach procedure using RF legs. And the data collected have already been analyzed to reveal how such curved approaches are flown in more challenging conditions such as strong winds, a right-hand turn followed immediately by a left-hand turn, or high-speed operations.

The results of these trial flights have been very encouraging, and show no deviation from traditional point-to-point navigation. The parameters for designing such RF legs are currently being developed; and the findings of these Dübendorf flights will play a major part in establishing future criteria here, and are thus of invaluable benefit to the entire aviation sector.

In a further development, an EASA Supplement Type Certification (STC) for radius-to-fix (RF) applications has also been devised in a close collaboration among the Swiss Federal Office of Civil Aviation, Skyguide, Armasuisse, Jet Aviation and the Swiss Air Force.

For the pilots themselves, RF legs do not require any special training, and are comparable to point-to-point navigation in flying terms.

**Applications**

The technical requirements for RF flying have now been established, and approaches to Dübendorf will soon be flyable using RF legs. We will then be able to see what impact the new technology will have in environmental and traffic-flow terms.
The Virtual Centre Model
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The Virtual Centre Model is a concept that enables a group of air traffic control centres to act both internally and towards the customer as one single centre, using the same data services, procedures and tools to perform their control function. As a result, the centres involved are able to share their ATM capacity and their data centre infrastructure. Air navigation service providers (ANSPs) who adopt the Virtual Centre Model are therefore able to both reduce their costs through infrastructure sharing and enhance their responsiveness to changing capacity demand. This article outlines the key elements of the Virtual Centre Model and the beneficial impact it can have on the ANS industry. For illustration purposes, it also uses analogies based on past developments during the airline industry's deregulation.

The need for action
For over two decades now, governments both throughout Europe and farther afield have been showing a strong commitment to improving the effectiveness and efficiency of aviation markets, and have taken the corresponding (de-)regulatory measures. In its efforts to adapt to these new market rules, the aviation industry has been steadily growing more effective and more cost-efficient, predominantly by achieving economies of scale and concentrating on its core business, but also by cutting jobs and pushing salaries down.

This trend can be particularly well seen among the industry's airlines, where a formerly-fragmented industry structure has been replaced by a few big alliances whose members pool their resources to gain the critical mass they need to effectively compete. At the same time, most of the airlines have been unbundling their value chain: many have spun off their aircraft maintenance, their ground services or their catering into separate companies.

As well as concentrating on their core business, the remaining airline companies are also increasingly sourcing their supplier services not only from their own subsidiaries or from companies within their own alliance system, but also – in their constant efforts to remain competitive – by taking the best offers in the market in cost and quality terms.

The changes within the airline sector over the last two decades have resulted in significant improvements for their customers and for the entire economy, in the form of lower ticket fares and a denser network of flight connections.
In comparison, the ANS industry – insofar as it can be regarded as an industry today – is lagging far behind. Even though the industry’s ANSPs have been largely able to both fulfill safety requirements and meet the growing airline industry’s demand for more capacity, there have been few improvements in efficiency in the ANS world.

Some ANSPs have striven to work on their cost structures by consolidating their facilities to a smaller number of locations; but many of the attempts to do so have failed because of the resistance from unions, authorities or the political world. Socially and politically, it has just not been feasible to bring these consolidation plans forward, especially across national borders. So to cover their costs, the ANSPs are still basing their fees on full cost budgets, as the airlines did it in the past when they were mainly state-owned. And so far there has been little pressure on ANSPs to reduce their unit costs and fees.

In the face of growing pressure from airspace users and their associations, however, the European Commission (EC) is now showing an increasing determination to change this situation. With the EC’s Single European Sky programme, clear targets have been set for each state and its ANSP in efficiency, capacity, environmental impact and safety terms. And it is only a matter of time before regulatory changes are made that will force any ANSPs which fail to meet such targets to significantly change or partially disappear.

**The ANSP industry’s main levers for achieving the SES targets**

If they are to ensure that these SES targets are achieved, Europe’s ANSPs will need to address all the main improvement levers available. These levers are depicted in the diagram above. The left-hand column shows the improvements that can result from defragmentation of the airspace, while the right-hand column relates to the new technology expected from the Single European Sky ATM Research (SESAR) programme.

While some significant improvements should be achieved through these levers, however, it is unlikely that they alone will deliver sufficient benefits for the ANS industry to reach its SES targets. The main contributions to doing so will need to come from an efficient and effective industry structure, and a business model that allows the achievement and the exploitation of economies of scale.

The Virtual Centre Model offers a transformation into such an industry structure, by initiating a virtual consolidation of air traffic control centres and a physical consolidation of ANS data centres.

**The key elements of the Virtual Centre Model**

A Virtual Centre (VC) is a group of affiliated Air Traffic Services Units (ATSUs) utilizing the same Common Operational Concept (COC), using the same Controller Working Positions (CWP) and acting as a single ATM service centre. The VC procures its data services from ANS Data Service Providers (ADSPs), and the data involved are exchanged through a Wide Area Network (WAN).

An ATSU provides a defined portfolio of ATM services and is assigned an Area of Responsibility (AoR). This portfolio can relate to en-route traffic, departure/approach traffic or a tower. The services are provided in accordance with the COC, and...
all data are exchanged through the WAN.

An ADSP provides data services to requesting ATSU’s, airspace users and other ADSPs.

The WAN is a network connecting ATSU’s, airspace users and ADSP’s through non-proprietary standard interfaces for each single data service type.

The COC is a set of rules and procedures that are mandatory for all ATSU’s inside the VC. It is their sharing of this COC that enables ATSU’s to dynamically delegate each other to provide ATM services for their AoR (or parts thereof).

The term CWP describes the standardized workstations that each ATSU of a Virtual Centre has for its air traffic controllers and support personnel. These workstations are equipped with the full range of control and communications functions and consist of hardware and software components with standardized interfaces, including a standardized human/machine interface (HMI).

In a virtual centre every participating ATSU is equipped with the same CWPs and follows the procedures of the COC. Since all ATSU’s are using harmonized procedures and HMIs, and since all ATSU’s are able to receive the data services required through the WAN, there are no technical or operational obstructions to temporarily delegating ATM service provision among participating ATSU’s. As a result, the ATSU’s concerned can jointly plan and dimension their capacity, and can temporarily take facilities «off-line» while still providing their full range of ATM services. In addition, a Virtual Centre can provide business continuity in contingency cases or in the event of the breakdown of an ATSU’s service.

The data services in a Virtual Centre environment are completely unbundled and are made available via a standardized interface for procurement by every ATSU that is connected to the WAN. These data services are certified and are offered by ADSP’s on an open and competitive market. This means that such data service provision can be largely consolidated, and redundancies can be reduced towards the minimum required.

The service-oriented architecture is a prerequisite for unbundling data services and thus for the physical consolidation of the data service provision.

All interfaces connecting ATSU’s and ADSP’s with the WAN need to be standardized.

There also needs to be a standard interface for each type of data service on both the supplying and the receiving side. These standards need to be open, too, since proprietary standards may prevent access to the services concerned and thus hinder the exploitation of economies of scale.

The WAN is needed to ensure a fully reliable, safe, real-time and multidirectional connection between the ATSU’s of a Virtual Centre and the ADSP’s. And at all the ATSU’s the controllers need to be equipped with a harmonized CWP that enables them to operate in accordance with the COC. This CWP must also have a common interface with the WAN and with each data service.

Conclusions and outlook
Just as its airlines have done over the past few decades, our industry’s ANSP’s now need to join forces and achieve critical mass. The ANSP’s also need to unbundle their own value chain to enable the procurement of data services, which will lead in turn to physical consolidation within this sector and will reduce the associated costs. The Virtual Centre Model offers a means of using both these levers to help shift the ANS sector towards an effective and efficient industry structure in a politically and socially feasible way.

Within the framework of the SESAR programme and at Eurocontrol, development activities are currently under way which are preparing the ground for the Virtual Centre Model. Within SESAR, for instance, the work packages around System-Wide Information Management (SWIM) will deliver the functions required by the WAN of the Virtual Centre Model. Eurocontrol’s Centralized Services initiative, meanwhile, is intended to centralize a set of ANS services, most of which are data services that would support the Virtual Centre Model and could thus also expedite the model’s deployment.

The interest in further exploring the Virtual Centre Model and its potential is steadily rising among Europe’s ANSP’s, regulators and multinational associations. It should soon become clearer, too, what the precise costs and benefits are, what the transition path might be and how the current initiatives within SESAR and Eurocontrol can be further aligned to the model. As well it will become clear what kind of (de)regulation will be needed to ensure the timely adoption of this immensely promising way forward for Europe’s ANS community.