How new Technology for Runway Weather Detection can reduce Risks in Take-off and Landing Performance Assessment

Whitepaper

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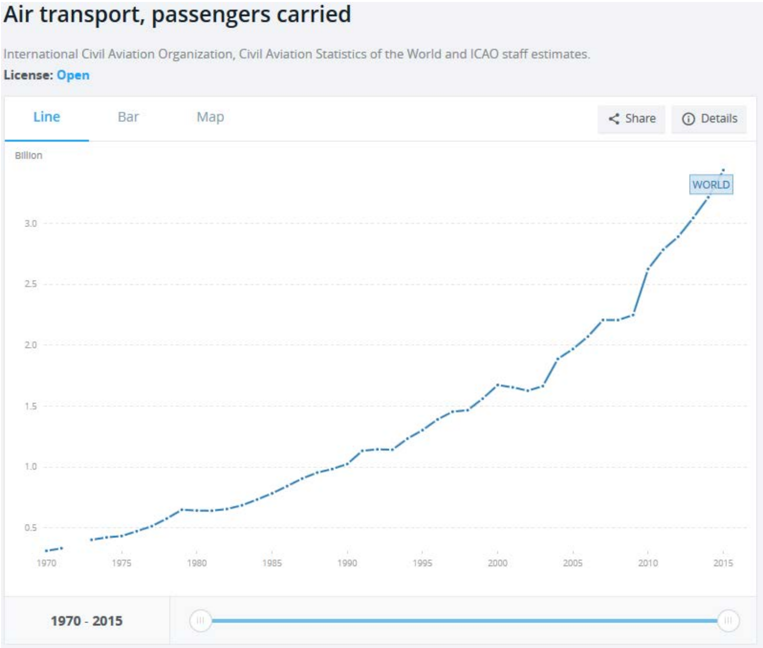
Every day, pilots, air traffic controllers and airport operators do their best to make air travel more secure and efficient, and safely bring the 2,246,004 passengers per day – meaning 7,000 aircrafts in the sky per minute[1] - from A to B. However, flight security also depends on external factors we can hardly influence, especially referring to risky weather conditions: strong winds, freezing temperatures, or heavy precipitation can have serious consequences. Combined with increasing air transport, as shown in figure 1, the need for safety measures grows in parallel.



1: Air transport, passengers carried, © International Civil Aviation Organization of the World and ICAO staff estimates

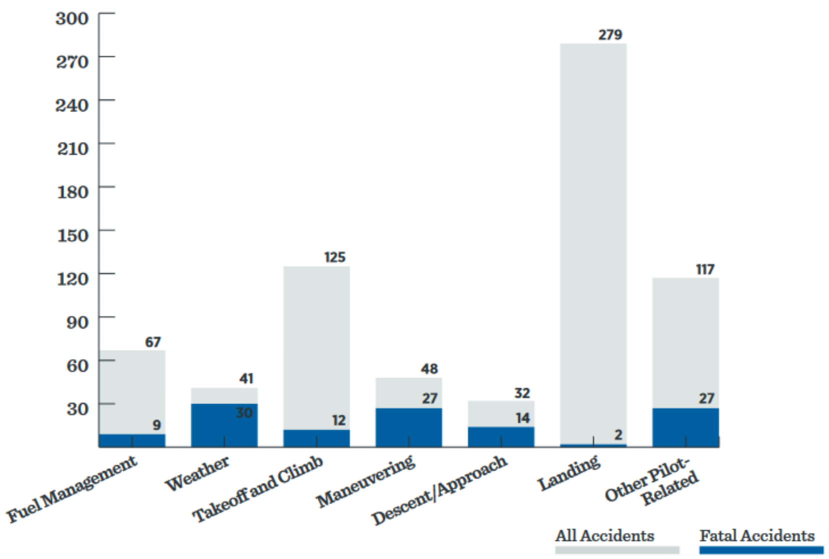
Takeoff and Landing Performance Assessment

To provide the necessary information to ensure the required safety level especially for takeoffs and landings, the TALPA (Takeoff and Landing Performance Assessment) was introduced, defining the process of assessing runway conditions, based on contaminant type and depth. This provides effective means to anticipate the airplane braking performance for airport traffic managers[2].

One step of the TALPA is the so-called NOTAM (Notice to Airmen) - a crucial encoded report for airmen, which is determined by national authorities. The code is usually sufficiently self-evident allowing a fast recognition of hazards or obstacles[3].

[1] © Air Transport Passengers, FAA (2017), https://www.faa.gov/air_traffic/by_the_numbers/
[2] © European Organization for Safety of Air Navigation (EUROCONTROL) (2016), URL: skybrary.aero/bookshelf/books/3593.pdf
[3] © European Organization for Safety of Air Navigation (EUROCONTROL) (2016), URL http://www.skybrary.aero/index.php/NOTAM

FIGURE 10. TYPES OF PILOT-RELATED ACCIDENTS



2: Types of pilot related accidents in 2013 – 41 of 709 accidents were weather-related, © AOPA

SNOWTAM is understood as a special form of the NOTAM notifying the presence, or removal, of hazardous conditions due to snow, ice, slush, or standing water in a specific format[4].

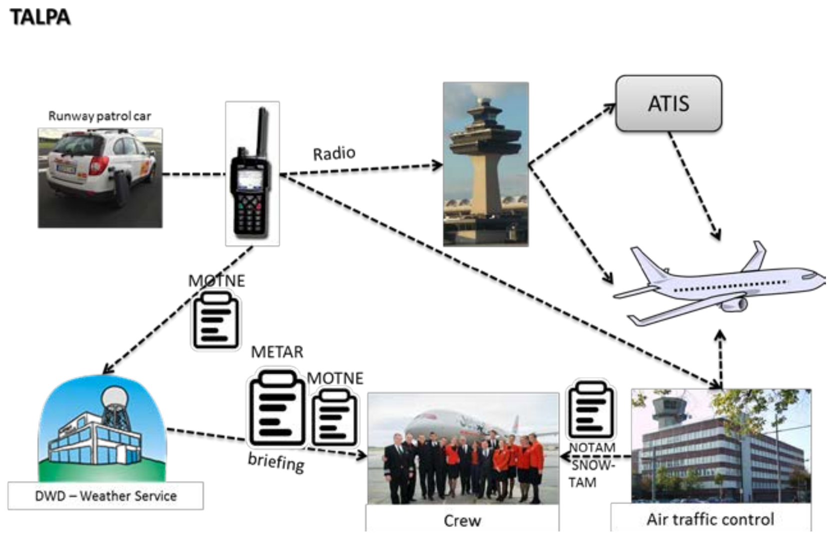
From 2020 onwards, the TALPA and SNOWTAM will become mandatory on airports replacing the so-called μ-value measured by grip testers. The Runway Condition Code (RCC) is an important part of the TALPA. The trigger of this change was a Southwest Airline Boeing-737 overrunning the Chicago-Midway Airport runway in December 2005.

But what are the needed parameters and how are they delivered?

Landing safety depends, among other factors, on the runway grip or friction. It is mainly influenced by different kinds of layers on the runway surface. Grip on dry surfaces can be measured by a grip tester, which has already been used on airports for many years. But most of the friction level estimations depend on experienced airport traffic managers who are responsible for informing airmen on the runway conditions via radio communication or via printed reports for pilot briefings. “Normally the first step of a runway assessment is done visually from a patrol car. In case of apparent frost, ice, or other dangerous conditions, runway technicians sometimes use a mechanic μ-Meter, Skidometer, or a GripTester issuing the data on a protocol printout”, explains Michael Eberling, transport manager at Airport Saarbrücken, Germany.

[4] © European Organization for Safety of Air Navigation (EUROCONTROL) (2016), URL: http://www.skybrary.aero/index.php/SNOWTAM

Air traffic controllers record the runway weather message onto an ATIS (Automatic Terminal Information Service), which is a recorded tape retrieved by aircraft crews via a known radio frequency. The ATIS is updated for every significant change of (weather) conditions. The airport operators also feed the MOTNE (Meteorological Operational Telecommunication Network Europe). The latter is an appendix of the METAR (Meteorological Aviation Routine Weather Report) distributed by the national aviation weather service, such as the DWD in Germany, informing on current data on the runway (RWY) designator (e.g. R27), type of deposit, extent of contamination, depth of deposit and estimated braking conditions. The MOTNE is part of a briefing package every airplane crew must read before the start of a flight. In turn, the pilot gives his or her feedback on the landing conditions back to the tower (see workflow in picture 3).



3: TALPA Workflow

Is the visual estimation of the runway conditions sufficient for the high safety requirements on airports? The figures speak against it: On average, 14.4% (see figure 2) of all aircraft accidents in 2013[5] (Source: AOPA, see figure 2) and 63.1% of aviation system delays in the US between 2003 and 2017 (source: FAA[6]) were weather-related - but how can this be prevented?

[5] Types of pilot related accidents, AOPA (2015), URL: https://www.aopa.org/-/media/files/aopa/home/pilot-resources/safety-and-proficiency/accident-analysis/nall-report/15-fn-0022-1-24th-nall-v6.pdf
[6] Airline On-Time Statistics and Delay Causes, United States Department of Transportation (2017), URL: https://www.transtats.bts.gov/OT_Delay/ot_delaycause1.asp?type=4&pn=1

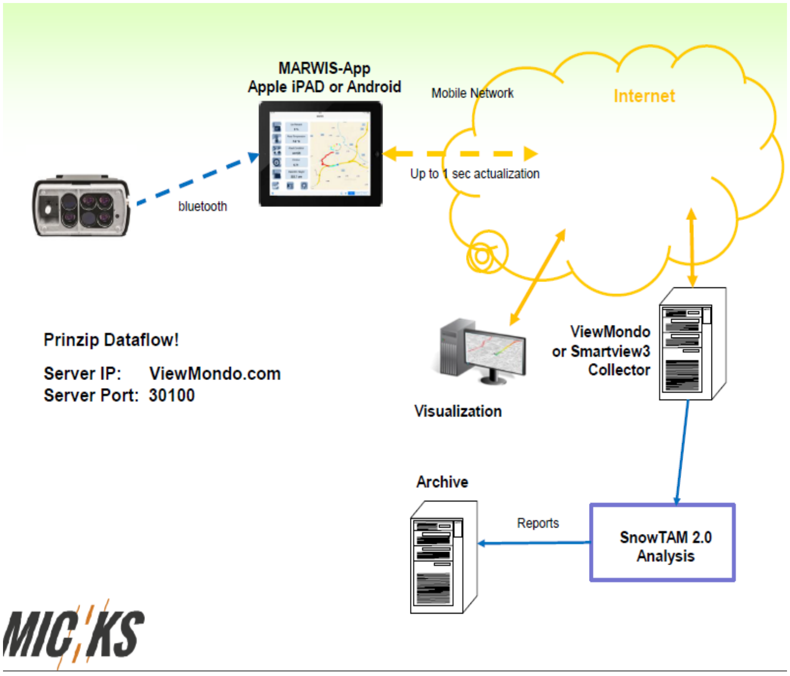
New technology for runway weather assessment

4: MARWIS Sensor Description

One answer to improve aircraft takeoff and landing safety is new technology in form of the mobile runway weather sensor MARWIS (see figure 4). As an addition to the usual RWIS (Runway Weather Information Systems) equipment such as embedded runway surface sensors and stationary weather sensors, it improves the determination of runway conditions and digitalizes the handling of runway condition codes of traffic managers, pilots and towers. It thus offers a new toolbox to digitalize airport workflows for processing and transferring the runway conditions in the right future-proof coding as required by the new TALPA standards. How exactly does this change the landing preparation?

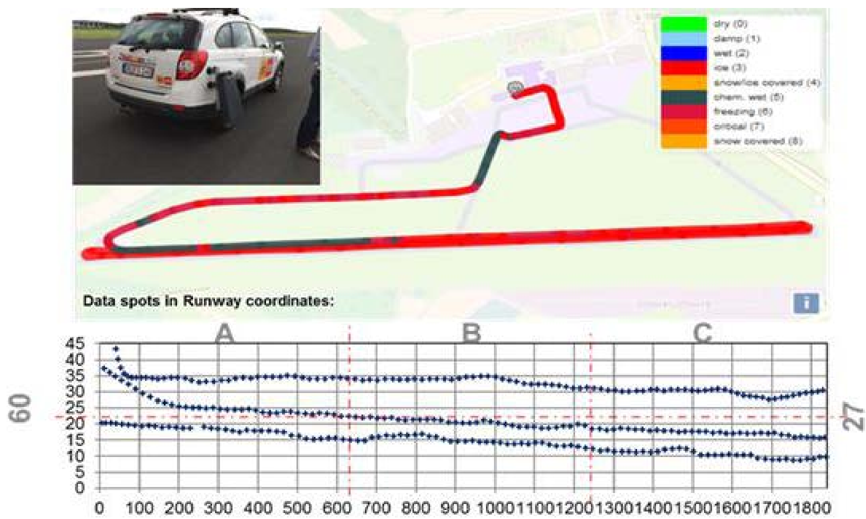
Fast and digital

The **compact** MARWIS **can be mounted on all kinds of airport patrol vehicles** and directly delivers the runway conditions dry, moist, wet, snow, slush, ice, chemically and critically wet. It issues this data both on mobile devices, such as a tablet, and stationary output devices, such as in a control center (TWR). Therefore, it supports the traffic manager in the patrol car during the runway assessment without detours. Moreover, MARWIS issues a weather-related **friction value** between 0.1 and 0.82 (low to high) which is similar to the CRFI (Canadian Runway Friction Index). This means, that the smart sensor detects the friction for the different runway contamination levels from dry to water, ice or snow covered and feeds them directly into the MDSS (Maintenance Decision Support System) software ViewMondo in the right format of SNOWTAM – and this with a **notably large number of local high-resolved measuring points** along the runway thanks to the high data transfer rapidity of 1.0 Hz.



5: Principle data flow: runway condition monitoring

Using MARWIS for the assessment is linked with two decisive advantages: Airmen get **considerably more information for their decision-making, and the workflow takes less time, because by retrieving the data automatically the runway is blocked for a shorter period**. This frees **precious time** for the TALPA workflow, which must not exceed 10 minutes. However, airport traffic managers **still hold the reigns of the data, as the View-Mondo software allows any modification** of the issued TALPA/SNOWTAM parameters, which are used to calculate the RCC, directly on the mobile output device in the patrol car, in case the observations require it, or the feedback of the pilots calls for a level downgrade. The SNOWTAM and RCC/ RCAM reports can be **printed, or sent by e-mail,** e.g. directly from the patrol vehicle to the tower (see data flow process in image 5).



6: Runway division and assessment per SNOWTAM in a test, © Karl

To define the corner points of the three runway segments, they must previously be set/stored in the software so that it can determine whether a measurement point is on the runway and, if so, in which segment. This is especially important for the TALPA, where the runway states need to be reported for each of the three sections (see figure 6).

More efficient de-icing

Within one week, one of the first airport users in Europe was able to save more than 10,000 Euro with the help of MARWIS, achieved by a **more efficient output of de-icing chemicals**. By using the new mobile sensor, the airport operators were able to recognize **chemically wet** runway spots, where de-icing chemicals were still active and needed less, whereas especially **critical spots** needed more treatment. Moreover, under certain conditions, the residual de-icing chemical density can be estimated quantitatively. This is not only **decreasing costs** but also **increasing the landing safety** even more.

Outlook on future aviation tasks

As shown above, many ways to assess and maintain runways are prevailing in the airport business, meaning that there are no officially valid international standards yet. The introduction of the TALPA will be one step forward to a global settlement. For the estimation or measurement of runway conditions there is also no standard available, forcing airport technicians to choose the best method to go with individually.

The mobile sensor MARWIS from Lufft, issuing weather-related friction values, water film heights, runway conditions, ice percentages, and dew points as well as surface and air temperatures at once, is the **most versatile and future-proof equipment** for a successful TALPA performance according to ICAO and FAA standards.

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For further details visit the MARWIS product page www.lufft-marwis.com
or contact us at www.lufft.com/contact/