Assessing the impact of novel aircraft configurations on runway capacity

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The DLR Institute of Flight Guidance is one of the leading establishments in the field of air traffic management (ATM) research worldwide. Its activities include validation and verification of new systems and procedures, such as airport infrastructure, routes, or assistance systems for air traffic controllers and pilots. Research is supported by a number of different simulation environments. Real-time human-in-the-loop simulators as well as several fast-time simulation tools focus on different parts of air traffic and help to examine various aspects of the air traffic environment (e.g. controller view, pilot view, general traffic situation, etc.).

As a number of institutes within DLR focus on research in the domain of aircraft design, from aerodynamics to structures and aircraft engines, DLR has collaboratively developed a design environment that encompasses analysis tools based on physical models and has applied it to various aircraft configurations. This paper describes the development and application of a tool that looks beyond the physical vehicle design and assesses the impact of a novel aircraft configuration on the surrounding air traffic environment with a focus on airport runway capacity. At least in Europe runway capacity will be a scarce resource in midterm and long term temporal horizons according to the Challenges of Growth studies of Eurocontrol. Therefore it is essential to know how the introduction of new aircraft configurations will influence this important performance indicator.

Runway capacity is the capability of a runway system to process a given number of landing and take-off events within a certain time frame. It is dependent on a number of factors like aircraft performance, separation rules and execution, layout of runway and arrival/departure routes. Additionally the distribution of demand numbers and demand attributes over time influence the possible spread of capacity values.

If a novel aircraft configuration differs e.g. in performance, separation requirements or applicable routes from conventional aircraft designs, this may impact the capacity of a runway where a mix of conventional and novel configurations is operated. This paper concentrates on approach and landing flight phases where speeds and separations are major factors in determining runway capacity, but the method developed and implemented is equally well suited for departure or mixed-mode runway operations.

Runway capacity for a scenario is determined using the *Simmod PLUS!* fast-time simulation tool. Simmod is based on a node-link network representing the air and ground infrastructure, supplemented by a complex set of procedures and parameters to enable realistic modelling of a real-world environment, and a number of flight plans which are simulated along given trajectories on the node-link network. Simulation of a whole day of traffic for a major airport typically takes only a few seconds. Simulation output parameters include traffic flow and delay.

The tool named FACE (FrEACs Airport Capacity Estimation) was developed for the internal DLR project FrEACs (Future Enhanced Aircraft Configurations) to facilitate the assessment of novel aircraft configurations on runway capacity. Within FrEACs two novel aircraft configurations were designed: a blended wing-body and a strut-braced wing. The results of the capacity assessment for the two configurations are presented based on a generic single-runway scenario.

FACE is integrated into DLR's preliminary design tool chain. It receives vehicle performance data from other tools and performs capacity analyses for a generic airport based on a configurable traffic mix. Performance data is parsed and converted for usage within Simmod, and multiple simulations are performed using a configurable range of traffic demand. Delays are then plotted against the resulting traffic flows to determine practical and saturation capacities of the runway for arbitrary traffic mixes of conventional and novel aircraft configurations. As a number of input parameters are actually stochastic distributions each simulation is performed in multiple iterations in order to achieve statistical significance. The complete process is automated and results are fed back into the aircraft design tool chain for further use by other tools.