Airbus Aircraft Development for Ground Operations
To display an Airport moving Map with Aircraft position providing the flight crew with improved situational awareness on the airport surface.
OANS Onboard Airport Navigation System

Functional overview

Approaching Runway Alert

5 ranges 5Nm to .2Nm

3 modes

Other interactions with map - Drag, Flags, search….
OANS: a first step for Ground Operations

• OANS is part of the avionics
  • Avionic computer: OANC (380/SA/LR)
  • Partition of CDS on 350
  • Avionic display: ND
  • To be compared to 3rd party EFB solution

• OANS Provide the basis for next steps
  • Display braking cues (Brake To Vacate)
  • Display airport information via Datalink (Notam, Atis)
  • Display ATC Taxi Clearance via Datalink
  • D-TAXI
  • SURF-IA
Onboard Airport Navigation System
Approaching Runway Advisory

OANS displayed on ND (Zoom)

- To provide Visual indications to the crew that the aircraft is approaching a runway
- Advisory based on:
  - Aircraft position
  - Aircraft dynamic behavior
  - OANS database

OANS not displayed on ND or Wrong mode
Onboard Airport Navigation System

Approaching Runway Advisory

- To provide Visual indications to the crew that the aircraft is approaching a runway
- Advisory based on:
  - Aircraft position
  - Aircraft dynamic behavior
  - OANS database

OANS displayed on ND (Zoom)  OANS not displayed on ND or Wrong mode
Brake To Vacate - BTV
Current Situation

An evolving environment

Airports with heavy traffic need to increase available slots
- By reducing Runway Occupancy Time at Landing
- Or speeding up Takeoff clearance

Current situation of Runway Capacity
- Not optimised & directly correlated to the Runway Occupancy Time (ROT), which depends on:
  - Pilot performance
  - Aircraft performance
  - Airport/Runway/Taxiway layout
- Saving seconds per movement has the potential to increase capacity (source: NATS, EUROCONTROL)
- In low-visibility conditions, runway capacity is drastically reduced
Current Situation
Current situation of Auto-Brake System at Landing

- Pilot selects deceleration levels
  - LO / MED or LO / 2 / 3 / 4 / HI

- Braking starts at roughly nose landing gear impact down to full stop.

- **Full open-loop vs. exterior world (blindness)**
  - controls only a preset deceleration level, whatever A/C speed, position on runway and desired exit

- No possibility to know where the A/C will stop
BTV  Brake to vacate

Objectives

Brake to Vacate system is a « mission oriented » Autobrake mode.

When an exit taxiway is selected by the pilots, BTV will actively adapt braking to reach target exit.

- System « closed loop » to permanently manage A/C deceleration
A380 BTV Operation
1- Runway selection
A380 BTV Operation
2- Exit selection
A380 BTV Operation
3- AUTO BRAKE BTV arming
## A380 BTV Operation - APPROACH

<table>
<thead>
<tr>
<th>SPEED</th>
<th>LAND</th>
<th>CAT 3</th>
<th>AP1 + 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTV</td>
<td>DUAL</td>
<td>DH 20</td>
<td>1FD2</td>
</tr>
</tbody>
</table>

**Diagram:**

[A380 BTV Operation Diagram]
A380 BTV Operation - LANDING
Implementation on A350
A350 BTV Cockpit Installation Overview

RWY condition matrix on WHEEL page to assist pilots in contaminated runway conditions.
A350 BTV - Selecting Runway Conditions

Pilot input for Runway State information into BTV/ROPS:
• Allows to actively protect every runway state & trigger red alerts
• Allows optimisation of BTV and ROPS laws and protections.

Push-Pull to display the matrix on System Display (SD)

Inner ring to change the selection

Outer ring to switch between both references

Display on Navigation Display (ND) upper part

<table>
<thead>
<tr>
<th>RWY CONDITION</th>
<th>BRAKING ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRY – 6</td>
<td>DRY – 6</td>
</tr>
<tr>
<td>GROOVED WET – 5</td>
<td>GROOVED WET – 5</td>
</tr>
<tr>
<td>WET – 5</td>
<td>GOOD – 5</td>
</tr>
<tr>
<td>COMP SNOW – 4</td>
<td>GOOD TO MED – 4</td>
</tr>
<tr>
<td>SNOW/SLIP – 3</td>
<td>MEDIUM – 3</td>
</tr>
<tr>
<td>WATER/SLUSH – 2</td>
<td>MED TO POOR – 2</td>
</tr>
<tr>
<td>ICE – 1</td>
<td>POOR – 1</td>
</tr>
</tbody>
</table>
A350 BTV - Quick Landing Assessment

- landing distance line is before the runway end ND messages
  
  FOR BTV: SELECT EXIT

- landing distance line is beyond the runway end ND messages

- landing assessment synthesis for all runway conditions
  
  On SD WHEEL PAGE

nominal situation
Runway Overrun Prevention System – ROPS
Runway Overrun Prevention System
Short final and landing

- Stabilised?
- Runway conditions?
  - Dry
  - Wet
  - Contaminated

Aircraft Energy vs Landing Distance Available?
Current situation

Touchdown points are scattered
### Landing: n°1 Air Transportation Safety Issue

#### Can we reduce fatalities at landing?

<table>
<thead>
<tr>
<th>Flight Phase</th>
<th>Incident Count</th>
<th>Passenger Fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>En Route (Cruise)</td>
<td>287</td>
<td>3,766</td>
</tr>
<tr>
<td>Ground - Taxi</td>
<td>301</td>
<td>24</td>
</tr>
<tr>
<td>Landing - Approach</td>
<td>1,120</td>
<td>8,718</td>
</tr>
<tr>
<td>Landing - Go Around</td>
<td>107</td>
<td>1,324</td>
</tr>
<tr>
<td>Landing - Initial Descent</td>
<td>178</td>
<td>2,450</td>
</tr>
<tr>
<td><strong>Landing - Landing Roll</strong></td>
<td><strong>2,587</strong></td>
<td><strong>1,261</strong></td>
</tr>
<tr>
<td>Take Off - Climb to Cruise</td>
<td>298</td>
<td>5,250</td>
</tr>
<tr>
<td>Take Off - Initial Climb</td>
<td>541</td>
<td>3,936</td>
</tr>
<tr>
<td>Take Off Aborted</td>
<td>113</td>
<td>146</td>
</tr>
<tr>
<td>Take Off Run</td>
<td>407</td>
<td>725</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5,939</strong></td>
<td><strong>27,600</strong></td>
</tr>
</tbody>
</table>

Source: Ascend Database
AIRBUS-WILLIS Analysis on 1985-2010

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Landing: n°1 Air Transportation Safety Issue

Airline and Airport operational losses

<table>
<thead>
<tr>
<th>Flight Phase</th>
<th>Hull Loss USD m</th>
<th>Liability USD m</th>
</tr>
</thead>
<tbody>
<tr>
<td>En Route (Cruise)</td>
<td>1,576</td>
<td>2,727</td>
</tr>
<tr>
<td>Ground (Taxi)</td>
<td>473.89</td>
<td>76.74</td>
</tr>
<tr>
<td>Landing - Approach</td>
<td>2,937.49</td>
<td>3,316.70</td>
</tr>
<tr>
<td>Landing - Go Around</td>
<td>511.22</td>
<td>498.68</td>
</tr>
<tr>
<td>Landing - Initial Descent</td>
<td>442.46</td>
<td>948.56</td>
</tr>
<tr>
<td><strong>Landing Roll - Excursions</strong></td>
<td><strong>5,429.54</strong></td>
<td><strong>1,133.26</strong></td>
</tr>
<tr>
<td>Landing – Landing Roll Others</td>
<td>1,139.66</td>
<td>186.05</td>
</tr>
<tr>
<td>Take Off - Climb to Cruise*</td>
<td>1,324.16</td>
<td>6,976.04</td>
</tr>
<tr>
<td>Take Off - Initial Climb</td>
<td>1,231.18</td>
<td>1,860.20</td>
</tr>
<tr>
<td>Take Off Aborted</td>
<td>352.43</td>
<td>61.55</td>
</tr>
<tr>
<td>Take Off Run</td>
<td>1,237.67</td>
<td>989.55</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16,655.69</strong></td>
<td><strong>18,774.32</strong></td>
</tr>
</tbody>
</table>

Excursions have cost the industry $6.5 Billion over 25 years plus indirect costs, lost revenue and brand

Source: Ascend Database
AIRBUS-WILLIS Analysis on 1985-2010

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To improve the current situation by protecting actively against runway overrun situation at landing.

- Automatically detects the current landing runway
  - using Airport navigation database

- Displays in real time DRY/WET predicted and estimated distances-to-stop

- Triggers clear visual and audio messages to flight crew
  - In case of detected runway overrun situation
Aircraft energy monitoring to assist in decisions

**ROW**
Runway Overrun Warning
Target: go around

**ROP**
Runway Overrun Protection
Target: Stopping

Transition Point
Runway Overrun Prevention System
Alerts, Call outs, Displays and Actions required

PFD (Below 500 ft) | Audio (Below 200 ft) | Actions (Below 500 ft)
--- | --- | ---
None | None | Go-Around Decision If Runway Condition not DRY (Pilots)

Transition Point

ROW Runway end Overrun Warning
Go around
Runway Overrun Prevention System
Alerts, Call outs, Displays and Actions required

PFD (Below 500 ft) | Audio (Below 200 ft) | Actions (Below 500 ft)
--- | --- | ---
![PFD Image] | A repetitive audio “RWY TOO SHORT” | Go-Around Decision (Pilots)
### Runway Overrun Prevention System

#### Alerts, Call outs, Displays and Actions required

<table>
<thead>
<tr>
<th>PFD</th>
<th>Audio</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="PFD Image" /></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **If Max Braking applied and Max Reverse not selected,**
  - "SET MAX REVERSE"
  - "KEEP MAX REVERSE"
  
  *Below 80 KIAS*

- **Max Braking**
  - (Automatic)

- **Max Reverse** (Pilots)

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Runway Overrun Prevention System
Demonstration on a Real Accident Scenario (1/4)

- Runway Threshold
- Touchdown
- Runway Very Wet
- Runway End
As runway was WET, Go-Around decision
Runway Overrun Prevention System

Demonstration on a Real Accident Scenario (3/4)

- IF WET, RWY TOO SHORT
- RWY TOO SHORT
- Slow Wind Shift
- Go-Around decision

Runway Threshold ---- Touchdown ---- Runway Very Wet ---- Runway End
Runway Overrun Prevention System
Demonstration on a Real Accident Scenario (4/4)

- Immediate Full pedals application
- Max reverse selection
- Down to full stop

- Touchdown
- Runway Very Wet
- Runway Threshold
- Runway End

Slow Wind Shift
Conclusion

ROPS
An AIRBUS Technology
to reduce Runway Excursion Risk at Landing

• Energy monitoring on Dry and Wet runways
  • Easy-To-Retrofit
  • Lever to negotiate reduced insurance fees
  • Worldwide coverage