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Autonomous airports

The shift from manual to predictive operations

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Executive summary: The airport that runs itself is closer than you think

The aviation industry has spent four decades digitising the terminal. Biometric gates, mobile boarding passes, self-service kiosks, AI-powered flow management. Walk through any modern departure hall and the transformation is unmistakable.

Now walk onto the ramp.

The same belt loaders, the same tow tractors, the same manual turnaround choreography that existed in the 1960s. Stuart Holdstock of Lufthansa Group put a photo from 60 years ago next to one from today and challenged the audience: what is the major thing that changed? Almost nothing, except the container.

That asymmetry is about to collapse. The argument kept reasserting itself: the next wave of airport transformation will not happen at the check-in desk or the security lane. It will happen on the ramp, in the operations centre, and inside the AI systems that are quietly rewriting who makes decisions, when, and on what authority.

Three numbers frame the stakes. Over 40% of all airline delay originates from the turnaround process. Only 60% of the gate plan created the day before survives intact through the day of operation. And Schiphol, designed for 30 million passengers, now handles 68 million, and has moved from third to eighth in European passenger experience rankings over the same period.

The industry has ambition in abundance. The opportunity ahead lies in building the operational architecture to match it.

Key findings

- Over 40% of airline delay originates from the turnaround process, the single largest source of delay in the airport system.
- Only 60% of the gate plan created on D-1 survives through D-0. AI-generated turnaround predictions are now outperforming manual inputs.
- AI turnaround timestamping has reached TRL 9. The question is no longer “does it work” but “when do we deploy.”
- Berlin Airport is auto-overwriting airline-submitted TOBTs with AI predictions, a structural power shift in A-CDM governance.
- The ramp has barely changed in 60 years. Germany alone will lose 3 million workers by 2030. Ramp automation is now an existential prerequisite for airline growth.
- Technology can recover 20-30% more throughput from existing infrastructure, but beyond that, the industry faces a hard capacity ceiling.

1. The ramp: A six-decade constant now poised for change

The gap between terminal innovation and ramp stagnation is no longer a curiosity. It is a strategic priority.

Germany alone will lose 3 million workers from its employment market by 2030. That is not a projection buried in a whitepaper. It is the workforce reality that Lufthansa Group is already feeling, and it makes ramp automation an existential prerequisite for airline growth, not an efficiency initiative.

The Smart Ramp Innovation Program, a consortium of six organisations including IAG, KLM, ANA Japan, Schiphol, and Miami Airport, has completed 15 of 19 planned projects spanning technology readiness levels from TRL 3 to TRL 9. ANA Japan has achieved Level 4 autonomous cargo vehicle transport from warehouse to aircraft. KLM and Schiphol have tested a robot that autonomously connects and disconnects the GPU cable. Miami has deployed 5G cameras that simultaneously perform AI turnaround detection and foreign object debris identification.

The critical finding: AI turnaround timestamping has reached TRL 9. It is no longer a proof-of-concept technology. The question for the industry is not "does it work" but "when do we deploy." Yet deployment at scale remains blocked by structural barriers. Congested hubs have no spare gates for extended trials. Multiple ground handlers with different contracts and incentive structures resist standardisation. And large robotics companies still view aviation as a niche market.

"If a startup has proven its technology works in one airport, it still has to prove it works at your airport. The Smart Ramp program lets them skip that re-proof. We can go straight to the operational trial."

Manuel van Lijf, director - travel and transportation, NLMTD (Unlimited)

The ramp of 2035, as described in the program's concept of operations whitepaper, is a semi-autonomous environment where robots handle FOD detection, GPU connections, baggage loading, and stand guidance, with humans focusing on exception management. Getting there requires not just technology but a new model for testing automation in live, capacity-constrained environments.

What to watch: The first airport to deploy fully autonomous ramp vehicles without a safety driver will set the regulatory precedent for the industry. Every country currently requires its own approval process, a fragmentation problem that is the single largest drag on scaling.

2. The APOC question: From shared space to operational control

The Airport Operations Centre has become the prestige project of the 2020s. Big screens, comfortable chairs, and stakeholders co-located in one room.

The physical-versus-virtual APOC debate consumed an entire panel at PTE World Conference 2026, and the conclusion was that the debate itself is the wrong question. The real question is whether the APOC exercises operational control or primarily provides a shared physical environment.

Helsinki's Finavia manages 20 airports with a virtual APOC model. The investment went into the systems that enable collaboration and communication, not the room. During COVID, Helsinki's virtual model proved its resilience while physical APOCs sat empty.

"We didn't want to bring all the units responsible for the baggage handling system to one room far away from their natural location where they handle the processes. And the investment for a physical APOC is really, really big. We've invested more in the system that makes collaboration and communication work."

Jani Ceder, head of APOC, Finavia

Orlando International, by contrast, operates 125 boarding bridges with 95% origin-destination traffic and no dominant hub carrier. Their position: at that scale, with that stakeholder complexity, you need both virtual tools and a physical environment. Hurricane recovery requires face-to-face decision-making.

Harvey at Gatwick offered the most practical framework: start with people and process, then systems, then infrastructure last. And limit the inputs. Five to six key variables are enough to run a high-performing APOC. The temptation to track everything is counterproductive.

The structural barrier that no APOC model has solved is data sharing. Airlines will not share pre-day operational data unless there is an active incident. Harvey named this explicitly as the biggest cultural barrier to proactive operations management. European regulation (CP1) will mandate Airport Operations Plans by 2027, which may force formalisation. But regulation cannot mandate trust.

The forward-looking question: If the APOC's value is in its decision authority rather than its physical form, how can airports best define the decisions a room will support before committing tens of millions to it?

3. How AI is reshaping the dynamics of A-CDM

The most quietly revolutionary experiment at PTE World Conference 2026 did not involve robots or digital twins. It happened at Berlin Airport, where the operations team began auto-overwriting airline-submitted Target Off-Block Times with AI-generated predictions, and transmitting those updated times directly to Eurocontrol.

The implications are structural. Under the current A-CDM framework, airlines own TOBT. They set the predicted pushback time. Berlin's position is that airports, having the best real-time view of what is actually happening during the turnaround, are better placed to make that call. Their system has 130,000 turnarounds in its prediction database, and when the AI-predicted End of Ground Handling Time diverges from the manual TOBT by more than five minutes, the system overwrites.

"Before we used the system, we didn't know if the jet bridge was connected or if unloading had started. Now after 7 minutes of I-block, we get an alert. If the jet bridge isn't connected, our team drives it. If unloading hasn't started at 25 minutes, we take over the turnaround."

Ralph Struck, senior vice president - facility management / technical director, BER Airport Berlin Brandenburg

After one week of the trial, ground handlers stopped manually overriding the AI-generated TOBT. They began to trust it.

Rome Fiumicino took a different approach to the same problem. Rather than overwriting airline data, ADR gave ground handlers and major airlines free access to the ACDM platform to create shared situational awareness. The theory: if everyone sees the same data, the quality of inputs improves organically.

Both approaches converge on the same insight: the traditional A-CDM model, where airlines submit predicted times and airports react to them, is becoming obsolete. AI does not just predict better than humans. It shifts the locus of operational authority toward whoever has the best data, and at the ramp, that is increasingly the airport.

The network-level implications are significant. Better predicted times at individual airports stabilise the entire European network. Eurocontrol benefits from every airport that replaces guesswork with prediction. But the legal and procedural frameworks have not caught up. Berlin's auto-overwrite is procedurally novel and not without risk.

The shift underway: A-CDM is evolving from a collaborative data-sharing framework into an AI-mediated decision system. The airports that move first will set the terms. The airlines that adapt early will help shape how this evolving framework is governed.

4. The turnaround: Where minutes become millions

Over 40% of delay originates from the turnaround process. No single party can fix that alone. Yet the "golden triangle" of turnaround management has historically faced coordination challenges, with responsibility distributed across three parties when delays occur.

Vancouver Airport is addressing this dynamic with technology that provides a shared, objective data source.

"Pasha was saying 'I have this information, you have that information, I'm right, you're wrong.' That's gone. It's just a camera that gets all the data, and that's the starting point for the three of us to start improving. Nobody can argue anymore."

Albert Van Veen, vice president of innovation and chief information officer, Vancouver Airport Authority

The AI-powered turnaround camera has become the neutral arbiter of truth. It timestamps every event, from jet bridge connection to cargo door closure, and makes the data available to all three parties simultaneously. Coordination improves when all parties share the same visible facts.

Vancouver's ambition goes further: a 25% increase in turnaround capacity without building new infrastructure, achieved through biometrics, AI turnaround monitoring, and a digital twin. Biometric boarding has already reduced boarding time from 20 minutes to 17, with a target of 15. At 70% adoption with Air Canada, it is no longer a pilot.

"It's a little bit like a pit stop. F1 is the best. That's what we need to do at the airport. And solutions like deep turnaround are super helpful to get more data points about that turnaround, to really nail the pit stop."

Albert Van Veen, vice president of innovation and chief information officer, Vancouver Airport Authority

The reframing of biometrics as a turnaround tool, not just a passenger experience tool, is significant. Faster boarding means airlines can recover time on late inbound aircraft. Three minutes saved at the gate compounds across every connection window, every crew rotation, every evening schedule recovery.

Munich Airport is pursuing the same goal through shared data architecture. The MUC-Lufthansa NUC 2030 program is creating a joint data environment, not data sharing into separate models, but a new shared layer built together.

The ground handler perspective was present at PTE World Conference 2026. Menzies Aviation in Amsterdam added the uncomfortable truth: ground handlers have their own contracts, incentives, and risk profiles that do not automatically align with efficiency goals set by airports or airlines. The golden triangle only works when commercial structures reward collaboration rather than punish it.

The numbers that matter: If 40% of delay starts at the turnaround, and AI cameras plus biometrics can recover 15-25% of turnaround time, the aggregate network benefit across European aviation runs into billions of euros annually. The technology exists. The commercial alignment does not.

5. Self-service and the commercial model inherited from 1984

SITA introduced Common Use Terminal Equipment in 1984. The check-in desk, the kiosk, the workstation, all connected through a shared platform that allowed multiple airlines to use the same physical infrastructure. It was revolutionary. It is now, by the industry's own assessment, due for modernisation.

"It's probably one of the only technologies that hasn't moved with the times. We haven't changed the technology, but we also haven't changed the costing model. The commercial model of CUTE hasn't evolved since 1984."

Tracie Baldock, senior technology manager, easyJet

EasyJet achieves 98-99% online check-in rates. The agent sitting behind a fixed desk is there for 1-2% of edge cases. The airline has deployed a Ground Crew App with SITA at Gatwick that turns every agent into a mobile check-in desk, paired with portable printers. The fixed-desk model becomes optional.

Why does a kiosk look like a kiosk and why today is it only used by a passenger? Why is a workstation located behind a check in desk and only used by an agent? At the end of the day, both are just a set of the same devices, one in a box and one not. Why does a kiosk have to look like it does today? Why cant both workstation and kiosk be used by both agent and passenger alike?

Drew Wilby, senior business development manager, SITA

Athens International Airport's experience illustrates what can happen when self-service technology is deployed without first redesigning the process. Their first self-bag-drop trial ended with agents assigned one-to-one to each machine. Their second attempt starts with governance, then workflow, then technology. The airport funds the infrastructure, sets the rules, and handlers operate it.

Swedavia's off-airport bag drop trial at Stockholm Arlanda tested the frontier: bags checked in at hotels, libraries, and convention centres. Roughly 70% of surveyed passengers said they would pay around ten euros for the service. Zero security incidents. The concept works. But the commercial model remains unresolved.

A deeper dynamic is that every self-service innovation reshapes someone's revenue stream. Mobile agents reduce desk fees. Off-airport bag drops reduce terminal footfall. Untethered check-in reduces CUTE transaction charges. The technology is ready. The commercial architecture is still catching up.

The forward-looking question: COVID demonstrated that the phone is increasingly the terminal. Three years later, many airports still bill airlines for desks that around 98% of passengers do not use. The commercial model is likely to evolve. The question is whether it evolves by design or by disruption.

6. Autonomous systems: From wheelchairs to docking to ramp bots

The word "autonomous" appeared in more PTE World Conference 2026 session titles than any previous year. What is new is not the ambition but the specificity: these are no longer concept videos. They are operational deployments with measurable results and defined scaling paths.

Frankfurt Airport handles 4,000 PRM service requests per day with 750 employees. Walking distances in the Schengen zone reach 20-25 minutes one way, meaning a single wheelchair escort is a 45-minute round trip. DAO Switzerland's autonomous wheelchair uses LIDAR sensors only, making it GDPR-compliant by design.

"If you have autonomous wheelchairs handling certain passengers, our staff can focus on those who need more personal assistance. It reduces physical workload. Pushing a wheelchair for 45 minutes round-trip, multiple times a day, is a serious physical strain."

Verena Dollberg, program director corporate strategy and digitalization, Fraport

The reframe is significant. Autonomous wheelchairs do not replace human care. They give PRM passengers something they have never had: independent mobility within the airport.

Incheon Airport has been deploying robots continuously since 2018 and is rolling out its next generation: multifunctional guide-and-patrol robots, cultural docent robots, and mobile self-check-in robots where the desk comes to the passenger. Fleet management runs on a 5G-based digital twin platform.

Autonomous docking systems represent the closest technology to full deployment. CLX Engineering has deployed autonomous bridge docking at gates in Atlanta. The four-level maturity model provides a clear scaling path: Remote Drive, Prepositioning, Semi-Autonomous (Agent Assist), and Fully Autonomous.

"The joke is: if we can make it work in Atlanta, we can make it work anywhere."

Max Kling, lead automation technician, Delta Air Lines Inc.

Prepositioning alone reduces the manual docking step to 3-6 inches of travel, capturing most of the efficiency benefit while keeping a human in the loop.

What to watch: Incheon's three-phase model (Introduction, Assistance, Personalized Care) is the clearest roadmap for robot integration in airports. The airports that follow it will treat robots not as isolated projects but as embedded nodes in the operational ecosystem.

7. The capacity ceiling: When technology cannot substitute for infrastructure

Every session on operational optimisation at PTE World Conference 2026 carried an implicit caveat that the most candid speakers made explicit: technology has limits.

Schiphol processes 68 million passengers through infrastructure designed for 30 million. The airport's response, a 180-day planning horizon with D-60 and D-7 handover points, severity categorisation, and demand-capacity balancing, can recover significant throughput.

Heathrow operates 84 million passengers on two runways in a 14-15 square kilometre footprint. A landing or takeoff every 45 seconds. Istanbul achieves similar numbers with five runways.

Time-based separation, live for ten years at Heathrow, has squeezed additional capacity from headwind conditions. But Terminal 4 sits south of the southern runway, meaning every T4 movement requires a runway crossing. That is a hard ceiling no algorithm can remove.

Geneva's AODB replacement illustrates the fragility underneath the operational surface. A digital heart transplant that took 2.5 years, 3,000 IT mandates, and a cutover with essentially no Plan B.

"If your airport operating system goes wrong, you can't really use your airport anymore. It's like your computer's operating system."
Gilles Brentini, head of airport systems and projects, Geneva Airport (GVA)

ACI projects that global passenger traffic will double in 20-25 years. The aggregate message from PTE World Conference 2026 is that technology can recover 20-30% more throughput from existing infrastructure. Beyond that, the industry faces a hard capacity problem. The airports that acknowledge this candidly are the ones planning most effectively.

"When you've got lots of capacity, optimize for retail maximization and passenger experience. When you're in a disruption capacity position, optimize for on-time performance and turning aircraft as fast as possible. The priority you optimize against has to be dynamic."
James Williamson, CEO, Veovo

The strategic reality: The $2 trillion infrastructure gap cannot be closed by software alone. AI, automation, and predictive operations are necessary but not sufficient. The industry needs both the algorithms and the concrete.

What this means for the next five years

Six structural shifts are reshaping airport operations:

1. The ramp will be the primary theatre of automation.

Terminal-side innovation is mature. Ramp-side innovation is 10-15 years behind. Demographic pressures, TRL 9 technologies, and airline growth ambitions are converging to make ramp automation the highest-priority investment of the next decade.

2. AI is shifting operational authority from airlines to airports.

Berlin's TOBT auto-overwrite is the leading edge of a structural power shift in A-CDM. Airports with better real-time data will increasingly set the terms of turnaround management, regardless of legacy governance frameworks.

3. The APOC must earn its authority.

Co-location is not collaboration. The airports that invest in decision-making processes before rooms, and in five key variables before dashboards of hundreds, will outperform those that build physical spaces before establishing operational substance.

4. Commercial models are the binding constraint.

From CUTE pricing unchanged since 1984 to ground handler incentive misalignment to APOC investment cases, the technology is consistently ahead of the commercial architecture needed to deploy it.

5. Autonomy will arrive incrementally, not as a revolution.

Autonomous docking at Agent Assist level, autonomous wheelchairs for independent PRM mobility, AI turnaround timestamping at TRL 9: these are deployable today. Full ramp autonomy is a decade away. The airports that deploy the incremental steps now will compound their advantage.

6. Technology cannot substitute for infrastructure.

The 20-30% throughput recovery that better operations can deliver from existing terminals is real and valuable. It is also finite. The airports operating at 2-3x their design capacity need both smarter operations and more physical capacity.

The autonomous airport is not a destination. It is a direction. The airports moving fastest are the ones that have stopped debating whether automation works and started solving the harder problems: who decides, who pays, and who adapts when the AI turns out to be better at the job than the human was.

Appendix: Sessions referenced

REPORT SECTION	SESSIONS
The Ramp Has Not Changed in 60 Years	Introducing automation on the ramp (Deutsche Lufthansa); The Smart Ramp innovation program: reinventing ramp operations (NLMTD (Unlimited); IAG; KLM Royal Dutch Airlines; Narita International Airport Corporation; Amsterdam Airport Schiphol; Miami International Airport)
The APOC Paradox	Panel discussion: APOC physical vs virtual? Which wins? (Finavia; Airport Intelligence; TotalCDM; Greater Orlando Aviation Authority; London Gatwick); 180 days ahead: orchestrating the airport ecosystem by DCB (Royal Schiphol Group)
AI Is Rewriting A-CDM Power Dynamics	Panel discussion: Harnessing AI-driven insights to optimize POBT and enhance A-CDM collaboration (Aeroporti di Roma; Assaia International; Flughafen Berlin Brandenburg); AI-powered airport operations: transforming gate planning and passenger flow at Schiphol (Royal Schiphol Group)
The Turnaround: Where Minutes Become Millions	Panel discussion: Turnaround wins – how empowering the golden triangle drives real change (Royal Schiphol Group; Vancouver Airport Authority; easyJet; Menzies Aviation); Rewiring the airport mindset: building a brain for MUC operations (Munich Airport)
Self-Service Is Stalling	Empowering airlines to achieve digital passenger processing (easyJet; SITA); Developing a multi-player self-bag drop environment at Athens International Airport (Athens International Airport); Swedavia's off-airport bag-drop journey (so far) (Swedavia)
Autonomous Systems	Integrating autonomous wheelchair services into airport operations at Frankfurt Airport (Fraport; DAAV); Panel discussion: Transforming gate operations through autonomous docking systems (Greater Orlando Aviation Authority; Delta Air Lines Inc.; CLX Engineering); Where robots meet passengers: ICN's AI-powered airport of the future (Incheon International Airport Corporation)
The Capacity Ceiling	The schedule never flies: extraordinary journeys in capacity constrained environments (Heathrow; NATS); 180 days ahead: orchestrating the airport ecosystem by DCB (Royal Schiphol Group); Panel discussion: The future operational challenges of airports (Copenhagen Airports AS; Geneva Airport); AODB transplant: replacing the beating heart of an airport (Geneva Airport (GVA))

Additional sessions

- Growing together: a validated cross-partner framework for data-driven airport operations (Zurich Airport)
- Transitioning from lagging to leading performance management at airports (Royal Schiphol Group)

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