



Outbound Punctuality Sequencing by Collaborative Departure Planning

MSc. Ing. Eugène Tuinstra

*R&D Engineer Validation & Concepts
ATM & Airports Department*

6th USA / Europe ATM 2005 R&D Seminar

Eurocontrol / FAA conference, Baltimore

28 June 2005

Introduction

- **CDM and Departure Management**
- **Simulation Environment**
- **Objectives**
- **OPS Methodology**
- **Runway Queuing**
- **Runway Punctuality**
- **OPS DMAN Properties**
- **Conclusions**
- **Future steps**

CDM and Departure Management

CDM enables Flow Management

Flight Trajectory basic data to exchange

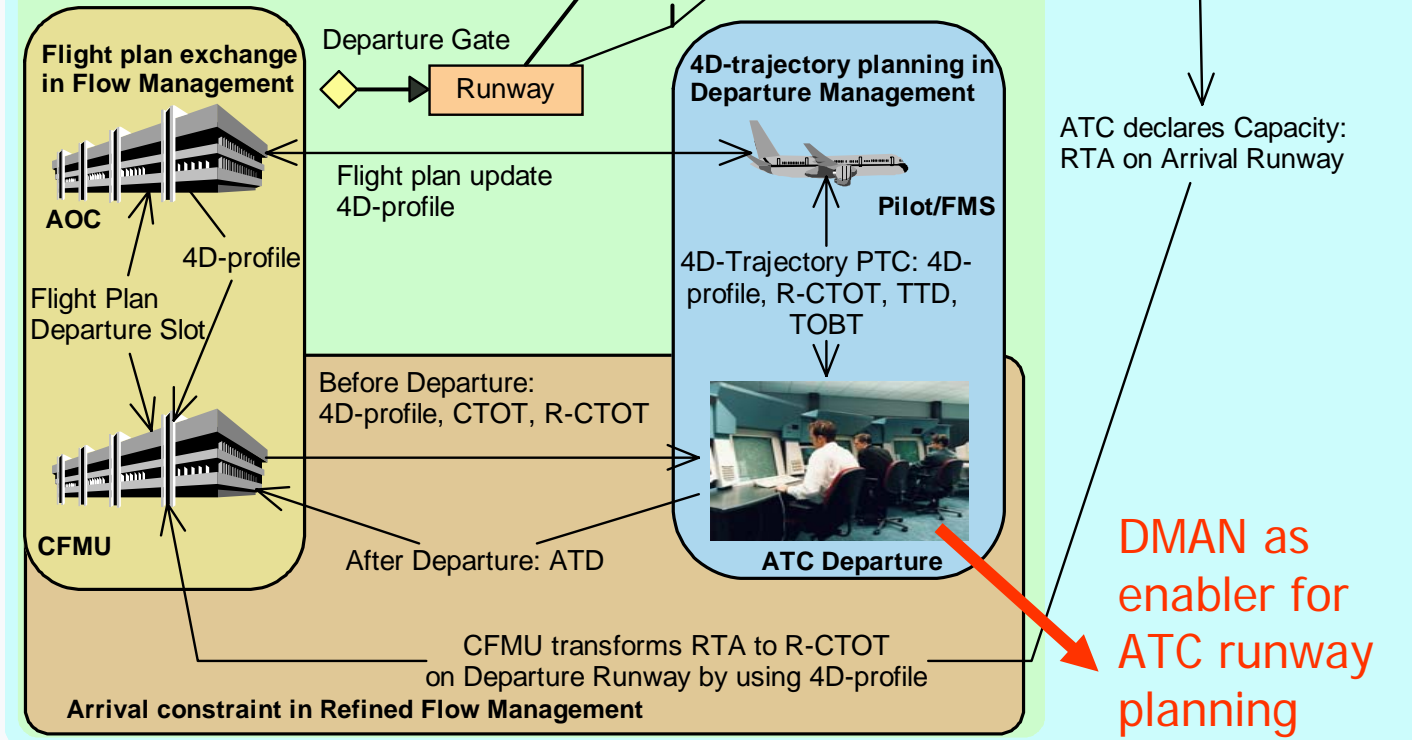
Add constraints or preferences from CFMU, pilot and Airline

Apply stakeholder preferences into runway sequence

Use DMAN tool for automation

Gate to Gate Refined Flow Management and 4D Trajectory Planning enabled by CDM

Collaborative Decision Making



DMAN as enabler for ATC runway planning

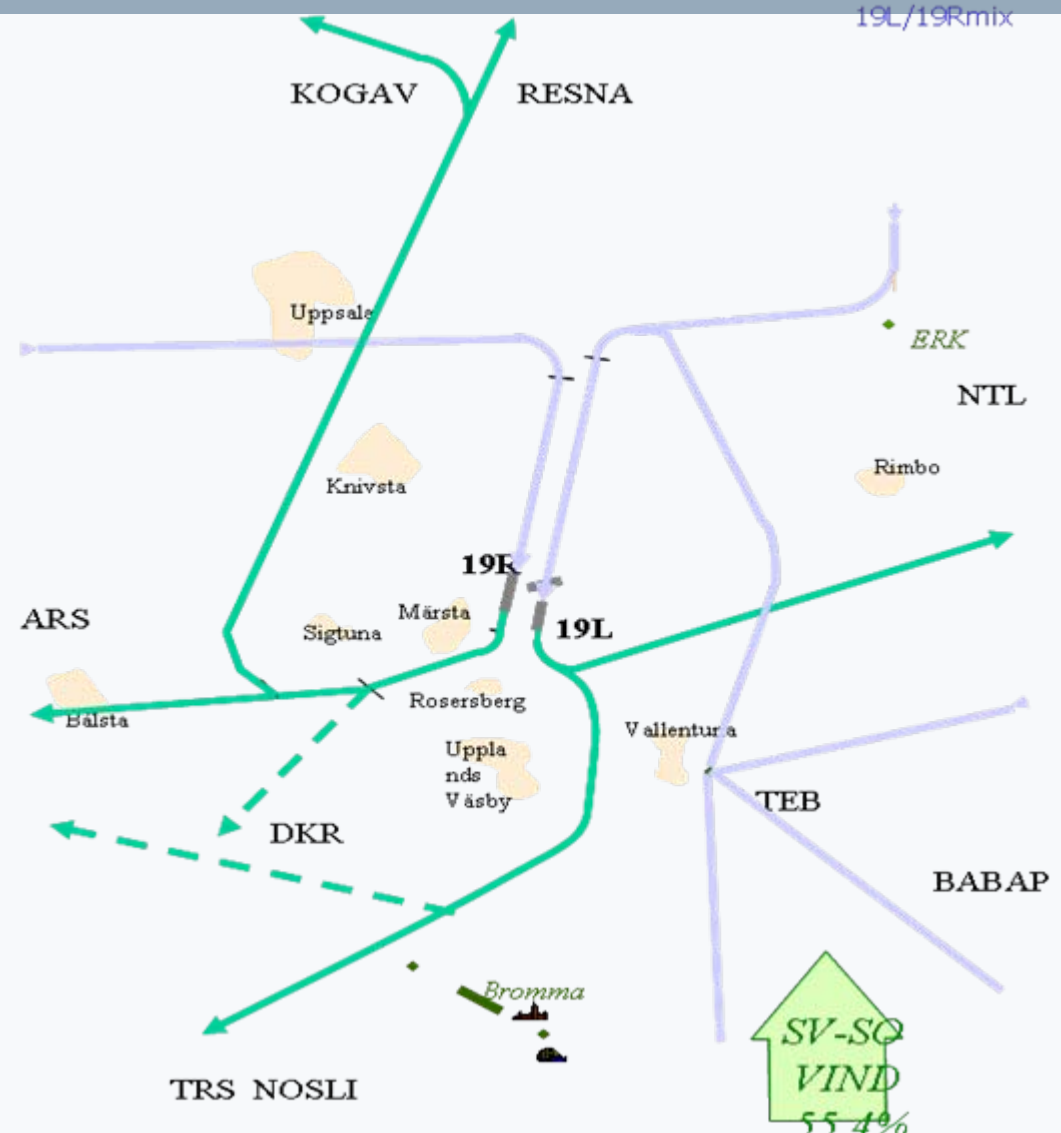
Simulation Environment

**Stockholm Arlanda
Airport and Terminal
Maneuvering Area**

**2004 busiest day
scenario (404
departure flights)**

**Scenario converted to
parallel runways in
mixed mode: 19L+R**

**FTS and RTS
experiments coupled
to verify results**



Objectives

- **Regulate taxi traffic to runway**
 - Reduce runway queuing and controller workload
- **Create Pre-tactical Runway and Off-block planning**
 - to support Ground and Runway controllers
- **Achieve a Punctual Outbound Sequence**
 - optimised for stakeholder preferences (CDM)

General Conclusion

- **Departure Management proven to contribute significantly to all high level objectives Capacity, Environment, Efficiency, Safety**

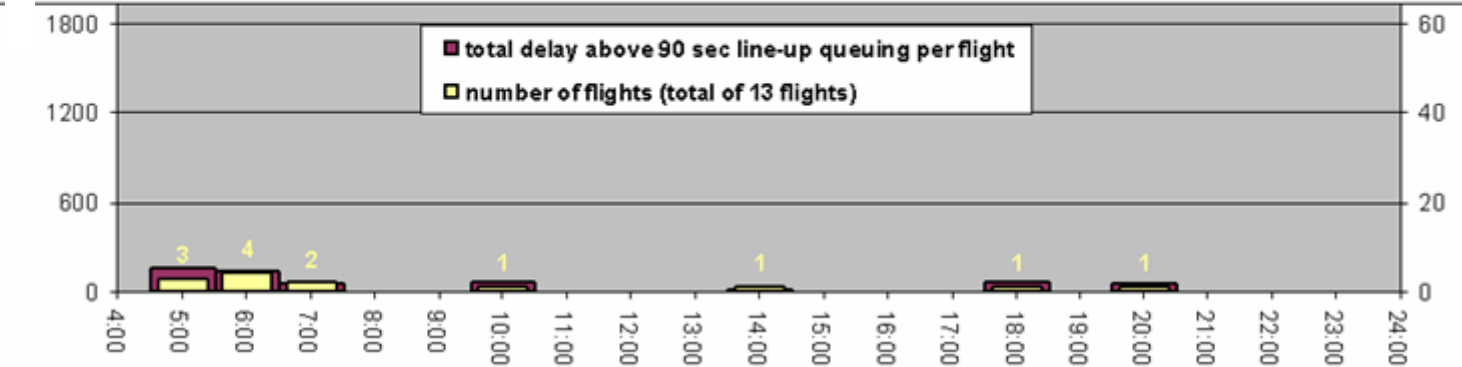
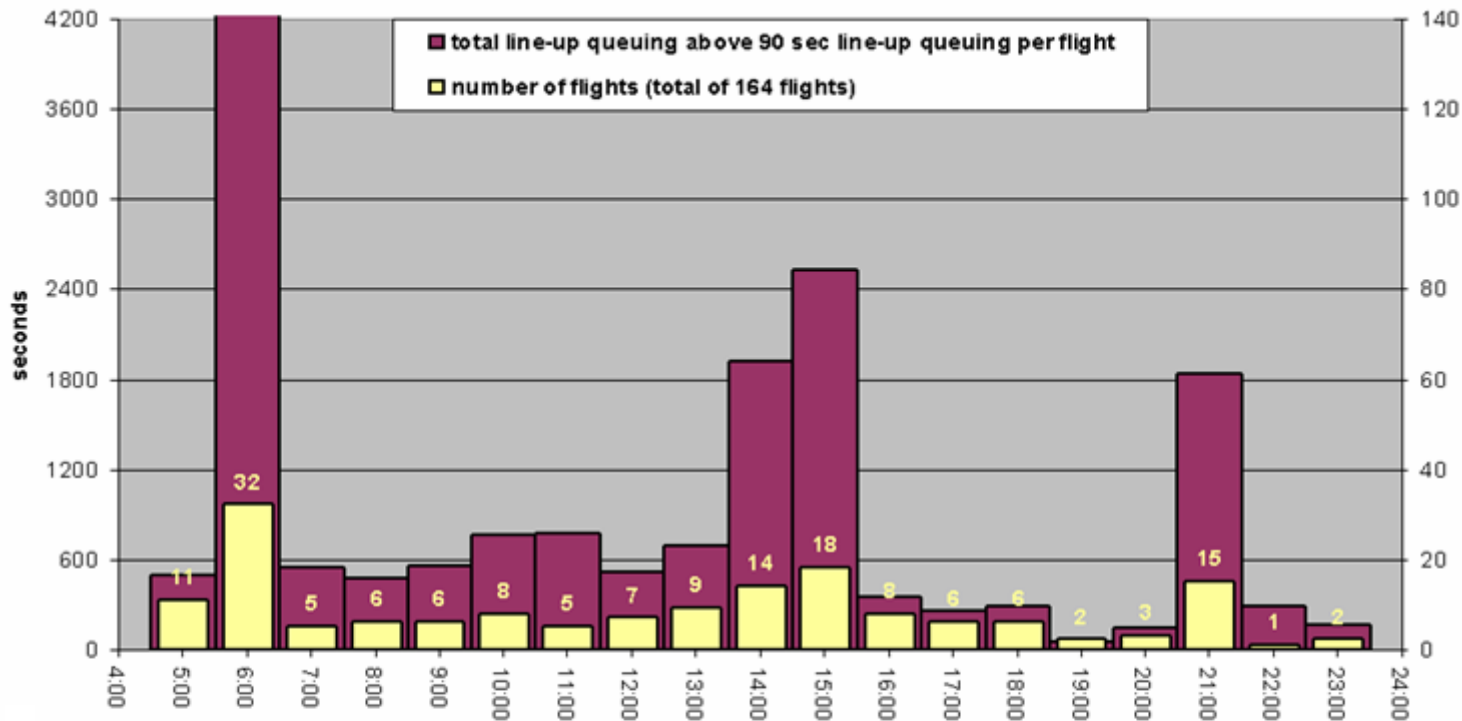
OPS Methodology

- Stakeholders constraints transformed into preference functions
- Combine stakeholder functions into flight profile
- Algorithm: optimize **overall** punctuality using profiles
- Verify OPS with FCFS sequence



Runway Queuing

Time in queue in [s]



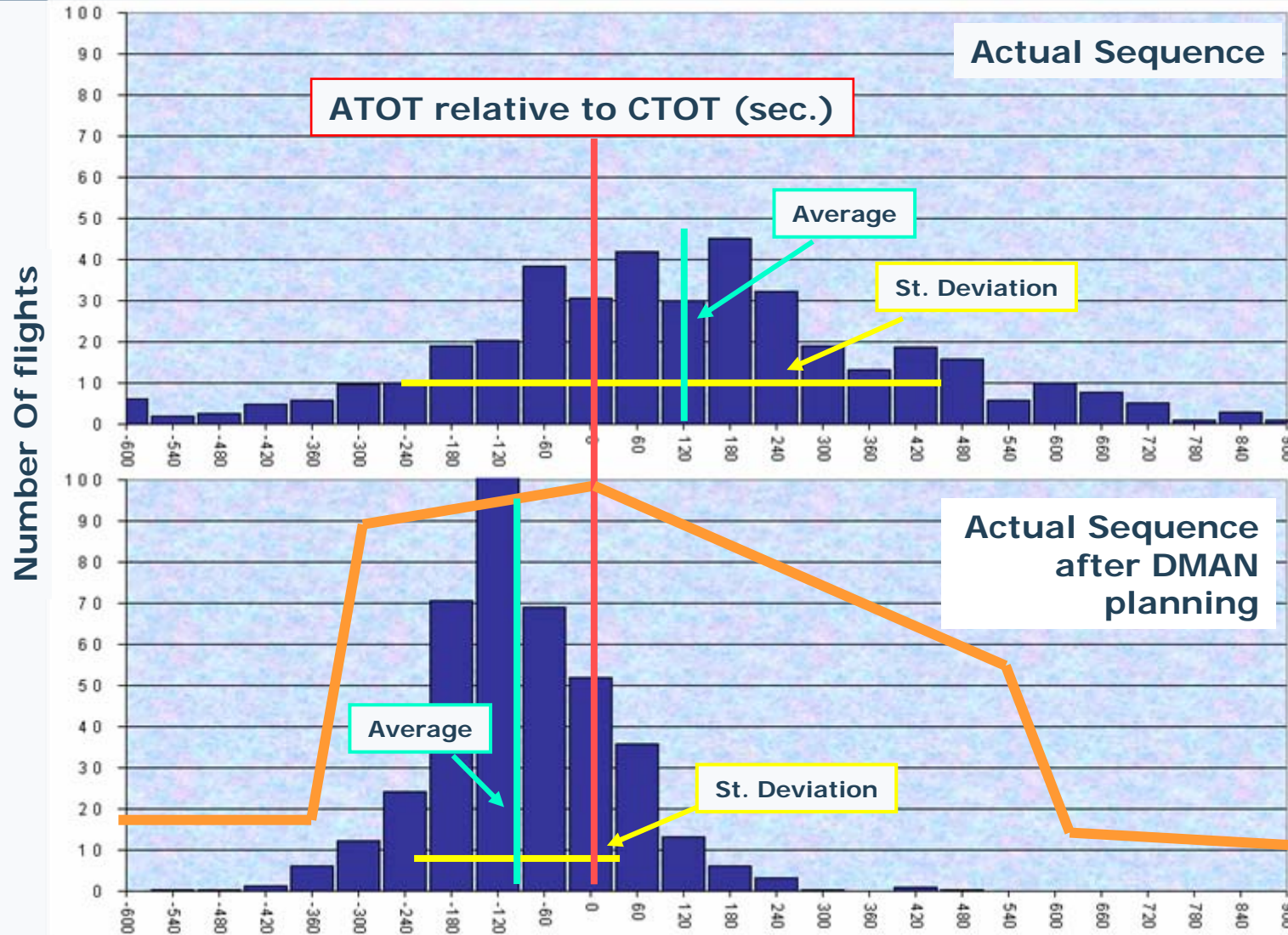
**24 hour sample:
404 departures**

**Departure
sequence:
FCFS versus OPS**

**FCFS: 4200 [s]
for 32 flights
between 6-7 hr**

**OPS: 2,5 hour
less time spend
in runway queue**

Runway Punctuality



Punctuality at Arlanda over 24 hours 404 flights sample

Average CTOT deviation reduced from 124 [s] to -88 [s]

Standard deviation reduced from 320 [s] to 120 [s]

Depending on shape Preference Function: plan as early possible in CFMU slot

OPS DMAN Properties

Highly **Configurable** DMAN-prototype

Algorithm is **Flexible** to sudden events, or additional information

DMAN used as **Decision Support Facility**

Enables **Collaborative Decision Making** in Departure Planning

Algorithm optimises **Punctuality**

Algorithm solutions are **Transparent**

Departure Manager Planning Analysis					
Overall Planning Quality					99%
RWY	#dep	#fix	#arr	#slot	
19R	24	0	0	0	99%
19L	19	0	0	0	99%
Optimisation Runway 19R					
ID	CTOT	FOBT	Score	ETD	
SKX1595	100%	0%	1.000	00:05:00	
SWN487	95%	100%	0.960	00:12:30	
SAS052	98%	0%	0.977	00:13:50	
SKX307	100%	0%	0.997	00:15:10	
NVR5522	97%	0%	0.970	00:16:30	
BT1108	100%	0%	1.000	00:25:00	
Optimisation Runway 19L					
ID	CTOT	FOBT	Score	ETD	
SAS421	100%	0%	1.000	00:15:00	
SAS673	98%	30%	0.922	00:26:00	
JKK106	96%	59%	0.943	00:33:00	
SAS1127	100%	0%	0.997	00:34:50	
SAS123	92%	100%	0.939	00:36:10	
SAS2139	98%	100%	0.987	00:39:10	

Conclusions

- Minimised separation by optimising punctuality of ALL flights → increased Capacity
- Improved punctuality by CDM and preference functions → enhanced Predictability
- Regulated queuing and taxi movements → reduced controller workload

OPS Departure Management by **CDM** leads to



- **Economic** benefits for Airlines, ATC, Airports
- **Safety** and **Capacity** improvements for Airport, ATC & CFMU
- **Efficiency** and **Environment** gains for Airports, Passengers

Future steps

➤ Integrate pre-tactical **OPS DMAN** to tactical **DLR DMAN**

➤ Extend functionality to coupling with

- AMAN
- A-SMGCS
- Gate Assignment
- Taxi-Planner



➤ Incorporate **Airline Preferences** into **ATC Runway Planning**

- Enhance CDM levels

➤ **Tactical and Pre-Tactical DMAN** into Live Operations

Any Questions ??