CASCADE
Pioneer Airlines & Monitoring Projects

Joint WG49/SC-209 Meeting
23rd August 2007
EUROCONTROL HQ, Brussels

Jörg Steinleitner
CASCADE Infrastructure WP Leader

ADS-B Pioneer Airlines Project

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Objectives

- Key: “ADS-B out” certification
- Matching CRISTAL ANSPs’ activities
- Towards operational approval
- Strong stakeholder co-op
- System anomalies

ADS-B Pioneer Airlines

AEGEAN AIRLINES

Phase 1 (now):
11 Airlines
> 350 Aircraft
500.000 Flights/Year

AirEuropa

CYPRUS AIRWAYS

AIRBUS TRANSPORT INTERNATIONAL snc

SAS Scandinavian Airlines

BRITISH AIRWAYS

Hapagfly

Lufthansa

CCM Airlines

NIKI DOUBLE SATISFACTION

Phase 2 (contract establishment underway)
bring total to: 20 Airlines - 450 Aircraft

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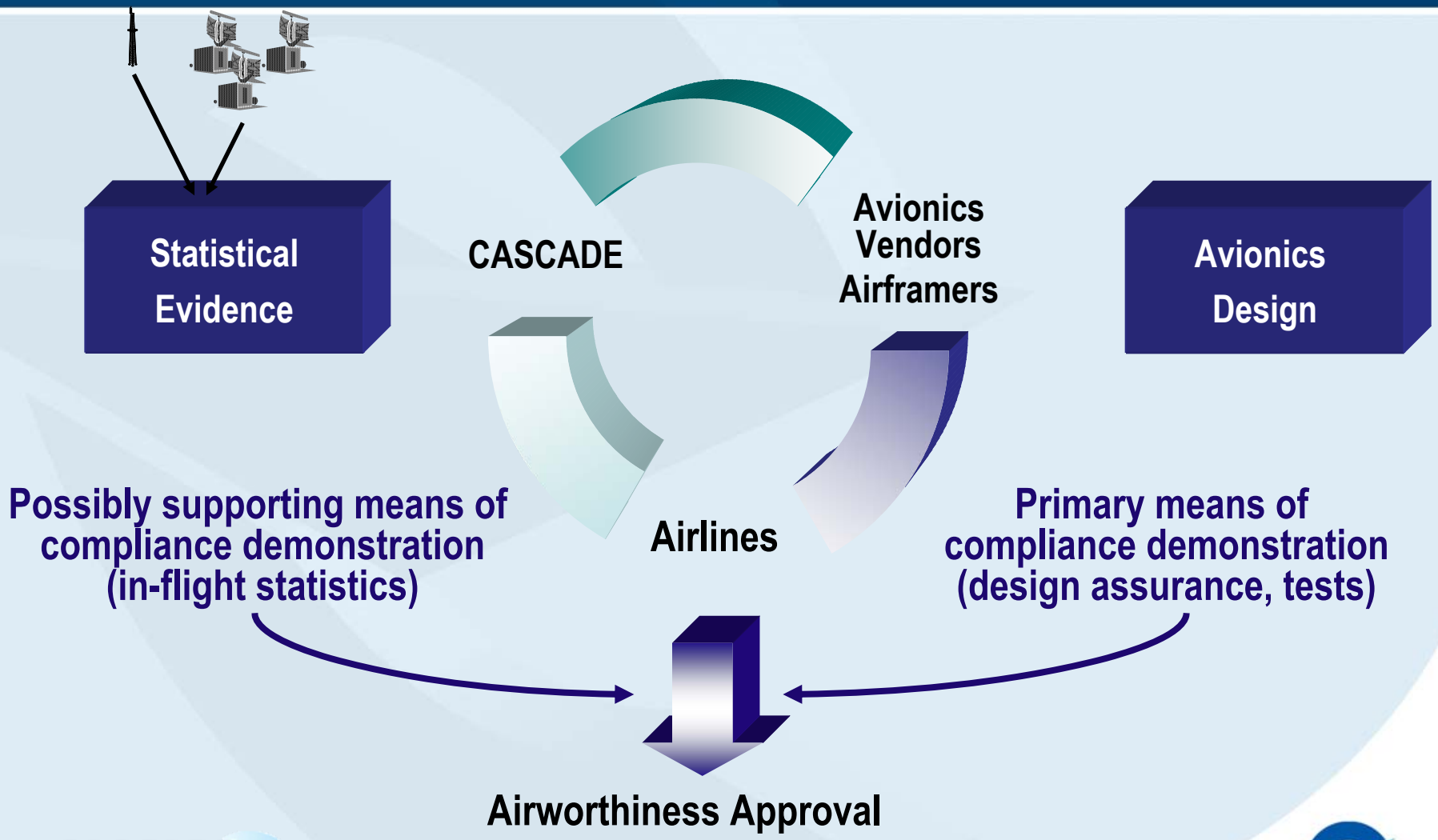
Pioneer Airline Project Monitoring & Certification



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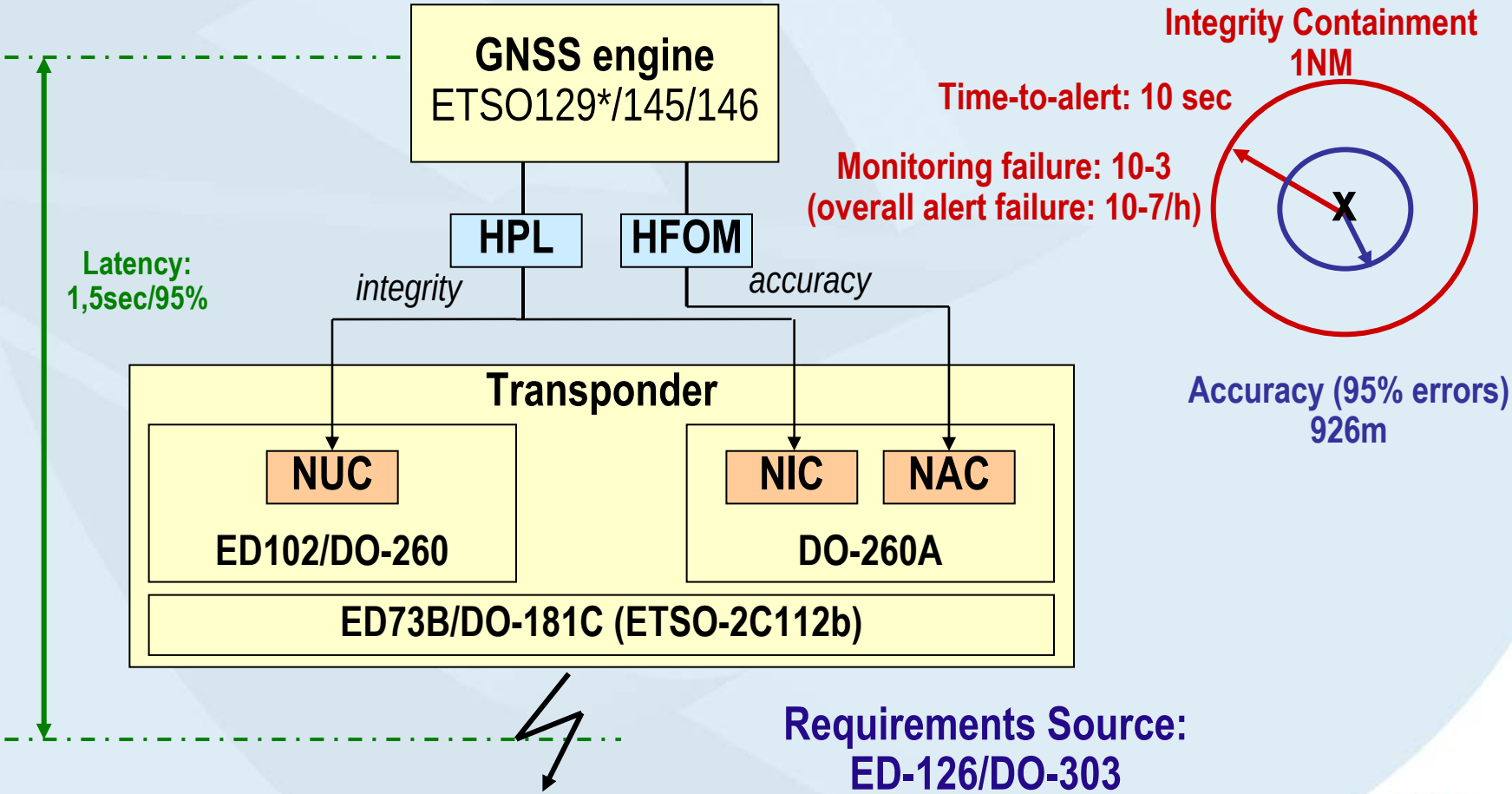
ADS-B-NRA Horizontal Position Requirements
Accuracy, Integrity & Latency

**) incl. Integrity Monitoring*



Requirements Source:
ED-126/DO-303
Requirements Focus Group (RFG)
➔ EASA NPA/AMC

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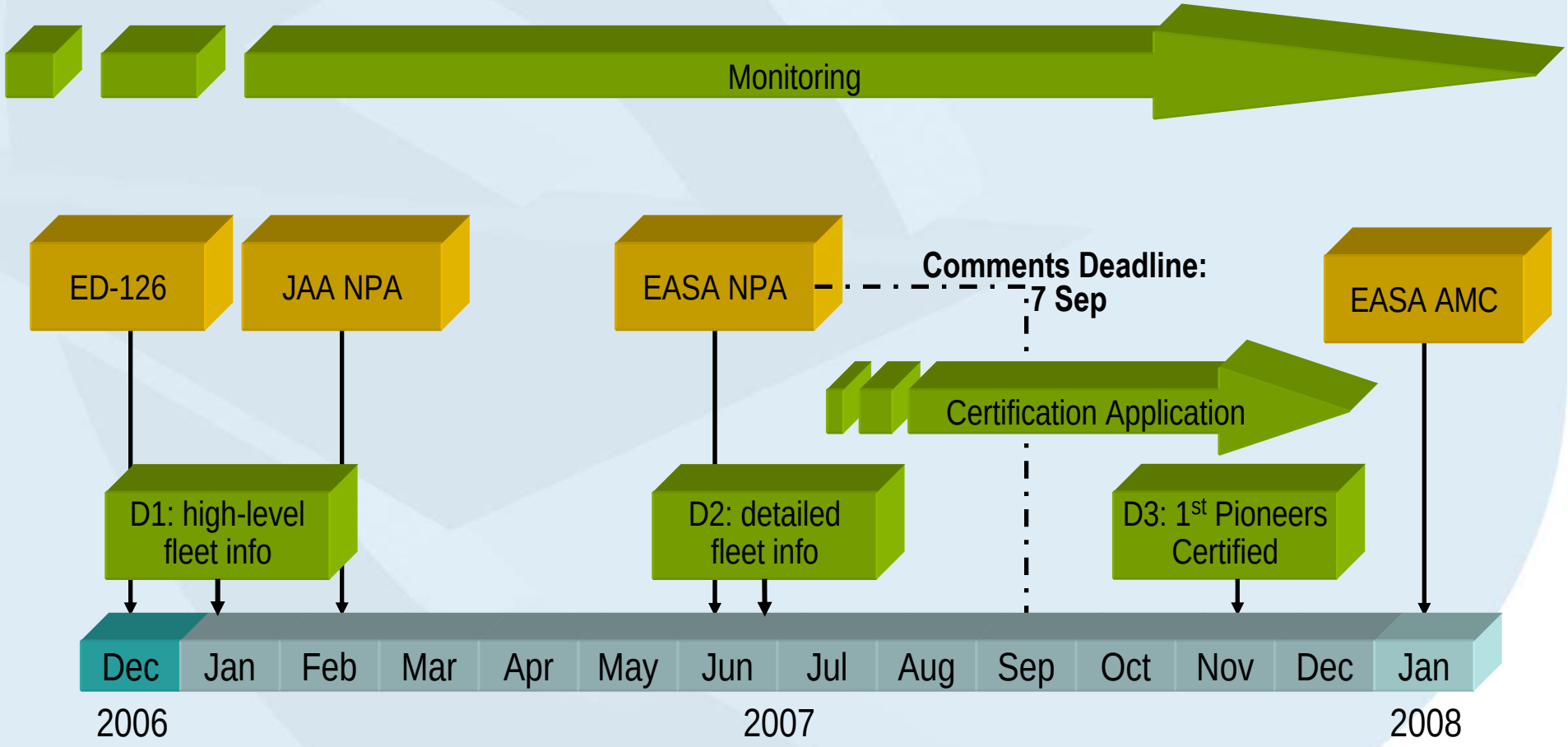
Timeline



NPA: Notice of Proposed Amendment
AMC: Acceptable Means of Compliance

Phase 1: Aircraft Types

Aircraft Make	Aircraft Type	Number
Airbus	A319	16
Airbus	A320, A321	42
Airbus	A330	4
Airbus	A3ST	5
ATR	ATR72	6
Boeing	B737-600, -800	178
Boeing	B747-400	57
Boeing	B777-200	43
		351

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Phase 1: Equipment – Transponder

Transponder Make	Transponder Type	No
Honeywell	TRA-67A	225
Rockwell Collins	TDR-94	6
Rockwell Collins	TPR-901	56
L3-com (ACSS)	XS-950	64
		351

all ED-102/DO-260 except for TDR-94 (DO-260A)

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Phase 1: Equipment - GNSS

GNSS Make	GNSS Type	No
Honeywell	RMA-55B	161
Honeywell	GPSSU (H)	2
Honeywell	HT1000	6
Honeywell	GNSSU	5
~~Litton (Northrop/Grumman)~~	~~GPSSU (L)~~	~~6~~
Rockwell Collins	GLU-920	136
Thales	TLS 755	35
		351

all (E)TSO-129: RAIM/Fault Detection (& Exclusion)

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ADS-B Airborne Monitoring Project

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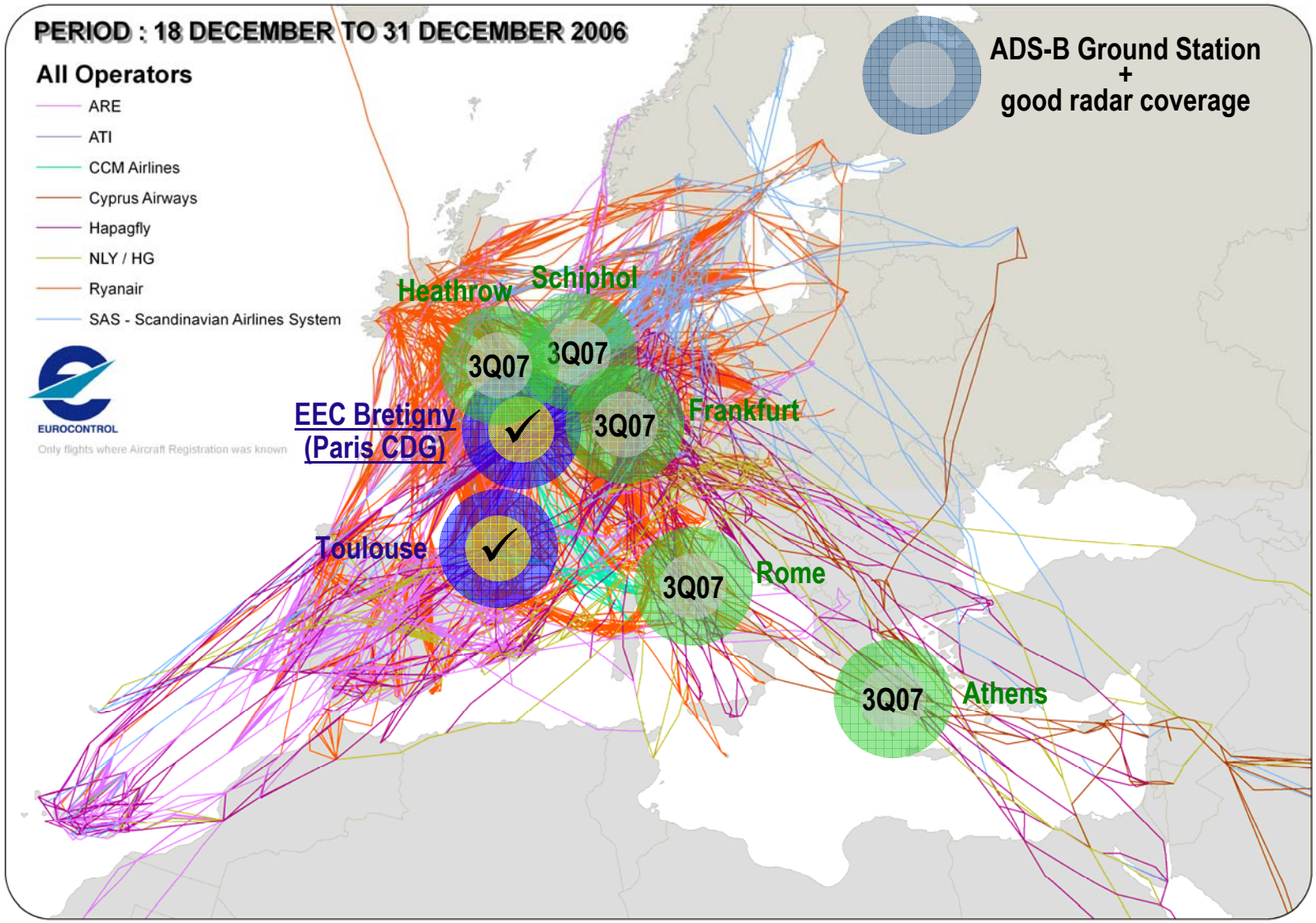
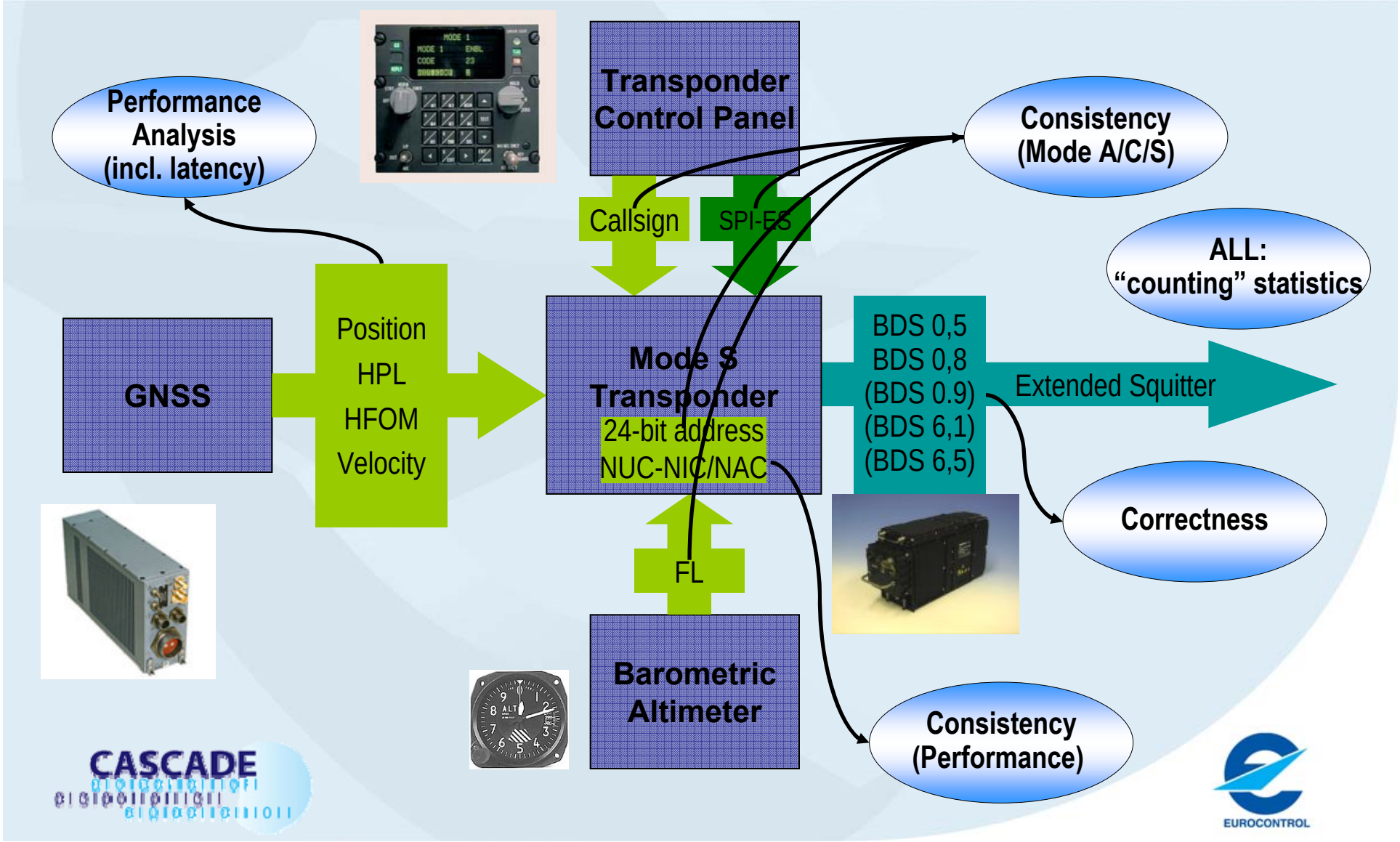
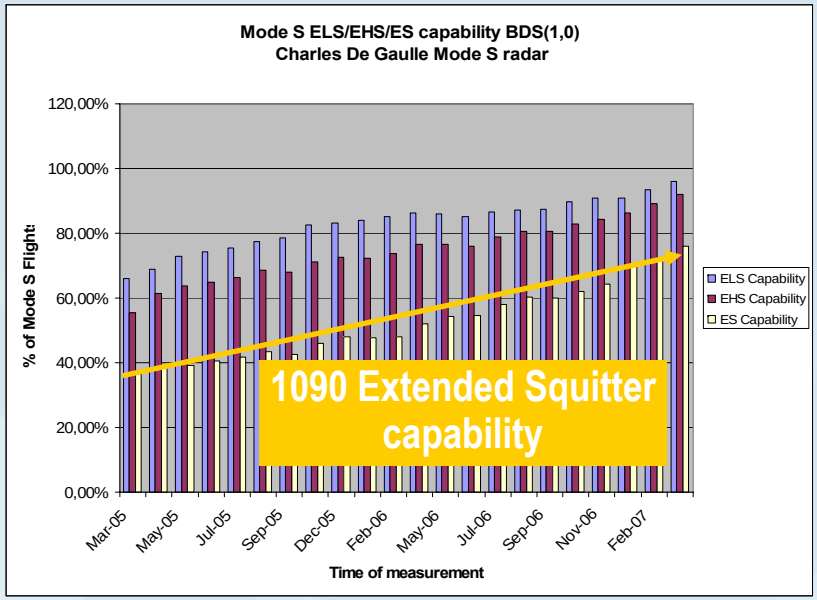
Current & Planned Monitoring Sites



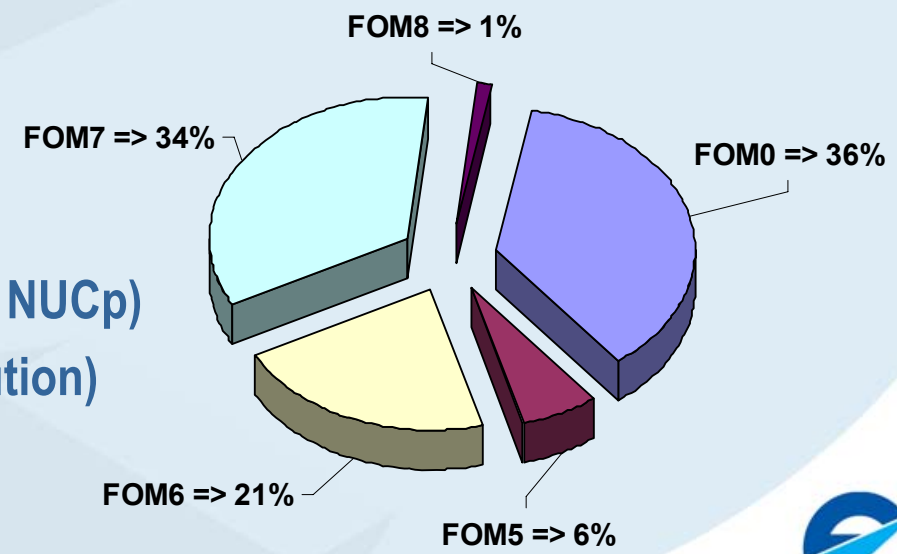
Scope of ADS-B Airborne Monitoring
1090 ES “ADS-B out“



“Counting” Statistics



Reported Transponder Capability (ELS/EHS/ES – per # of flights) (in co-op with Mode S Programme)



“Figure of Merit” (FOM ➔ NUCp) (per # of aircraft distribution)

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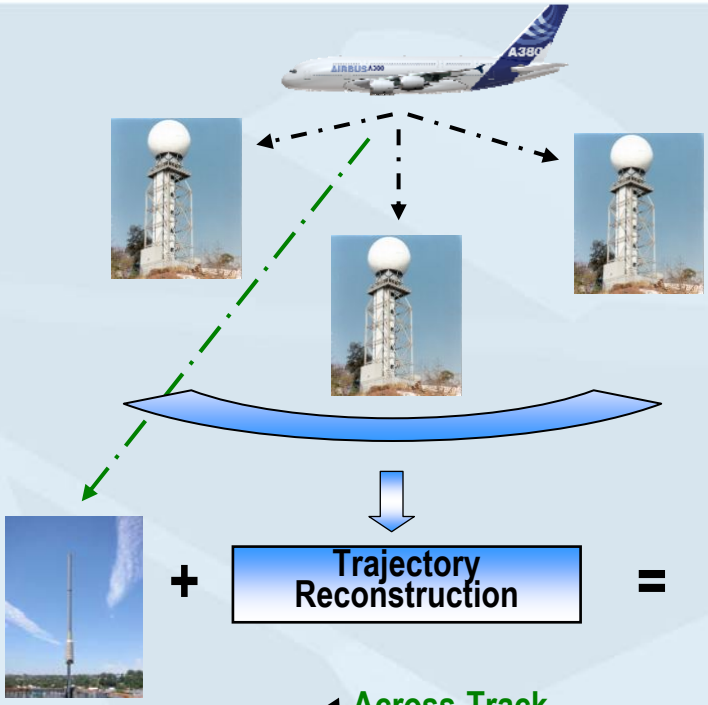
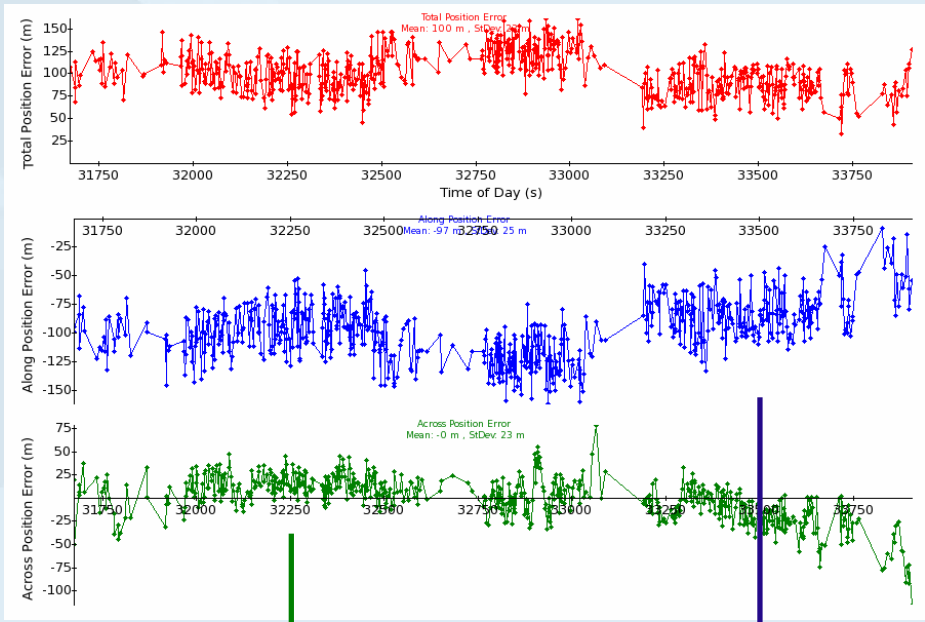
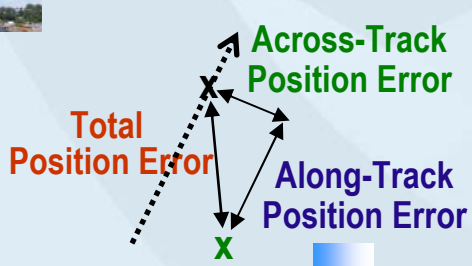
Horizontal Position Performance Analysis
"SASS-C" ADS-B Prototype







(divided by) velocity → Latency

Across ≈ Reconstruction + GNSS

Along ≈ Reconstruction + GNSS + Latency

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SASS-C Basics
Reference Trajectory Reconstruction

- Estimation of systematic errors for each radar in the data set
- Using spline fitting & mode-of-flight techniques
- Production of smooth reconstructed trajectories
  - Eliminating systematic errors (e.g. azimuth bias, transponder latency)
  - Minimising random range and azimuth errors
- At least 3 radars with good overlapping coverage required
- Certain filter criteria to be met
- Reconstruction accuracy in the order 30 meters:
  - Similar to GNSS Positioning Performance
  - Similar to small ADS-B on-board latency

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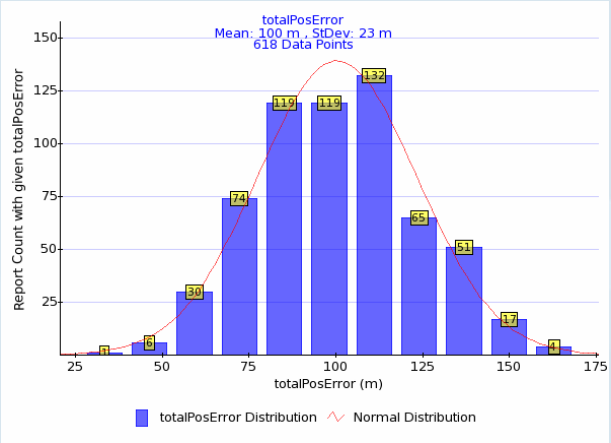
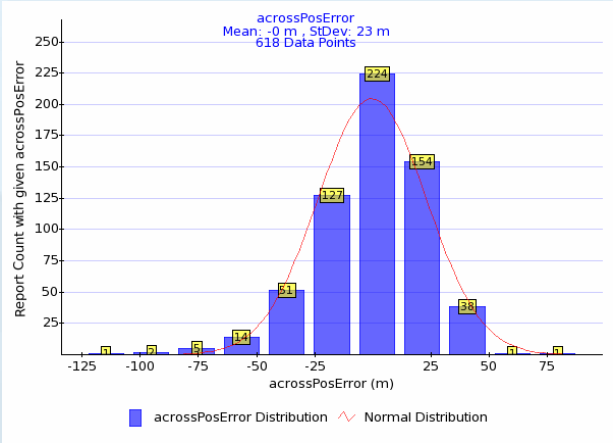
Horizontal Position Error & Latency Example



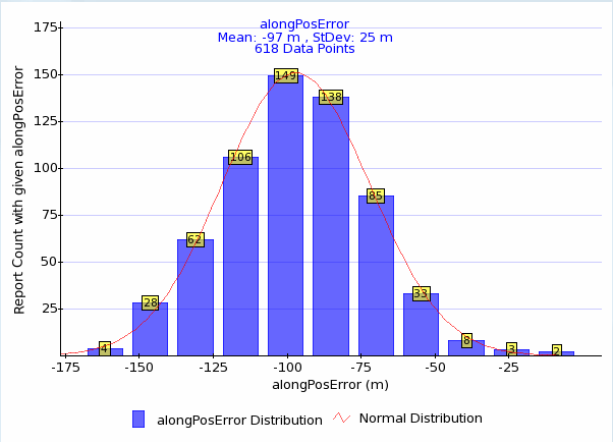
Total Error

split



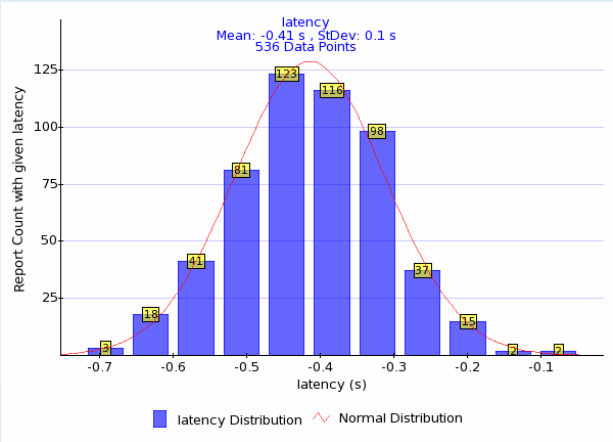
Across-Track Error

split



Along-Track Error

% speed



Latency

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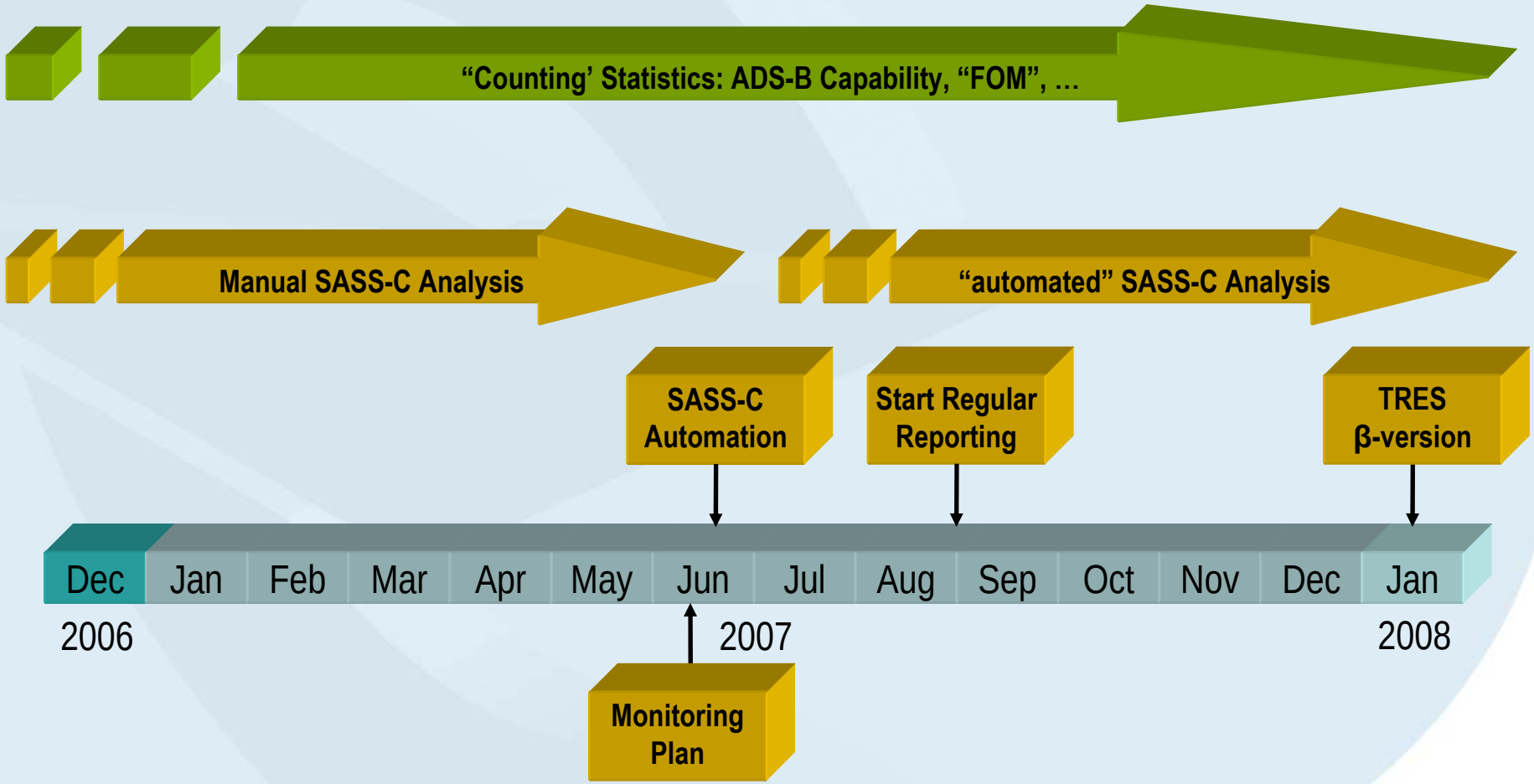
Timeline



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ADS-B Airborne Monitoring Project
Some Initial Results

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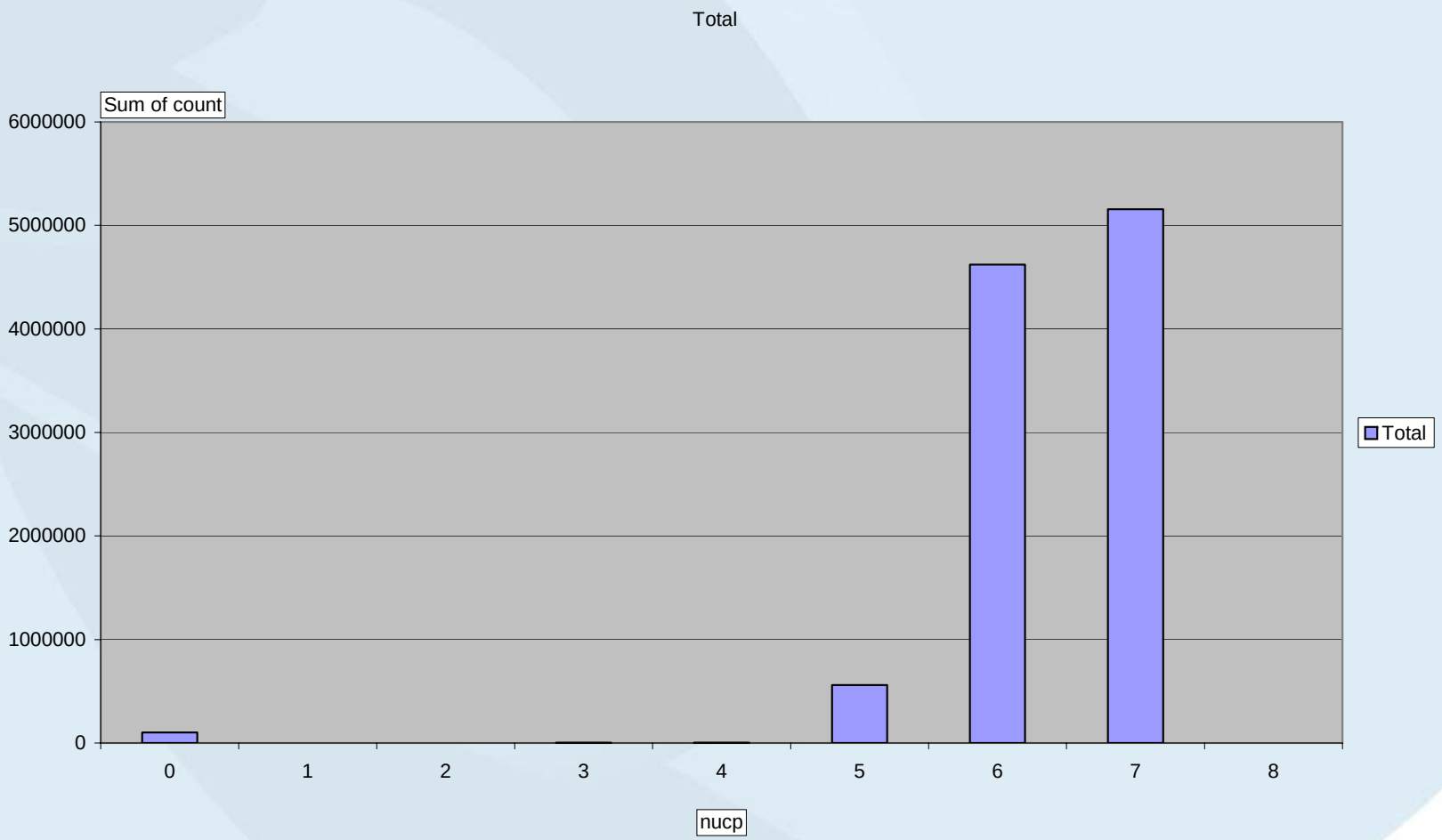
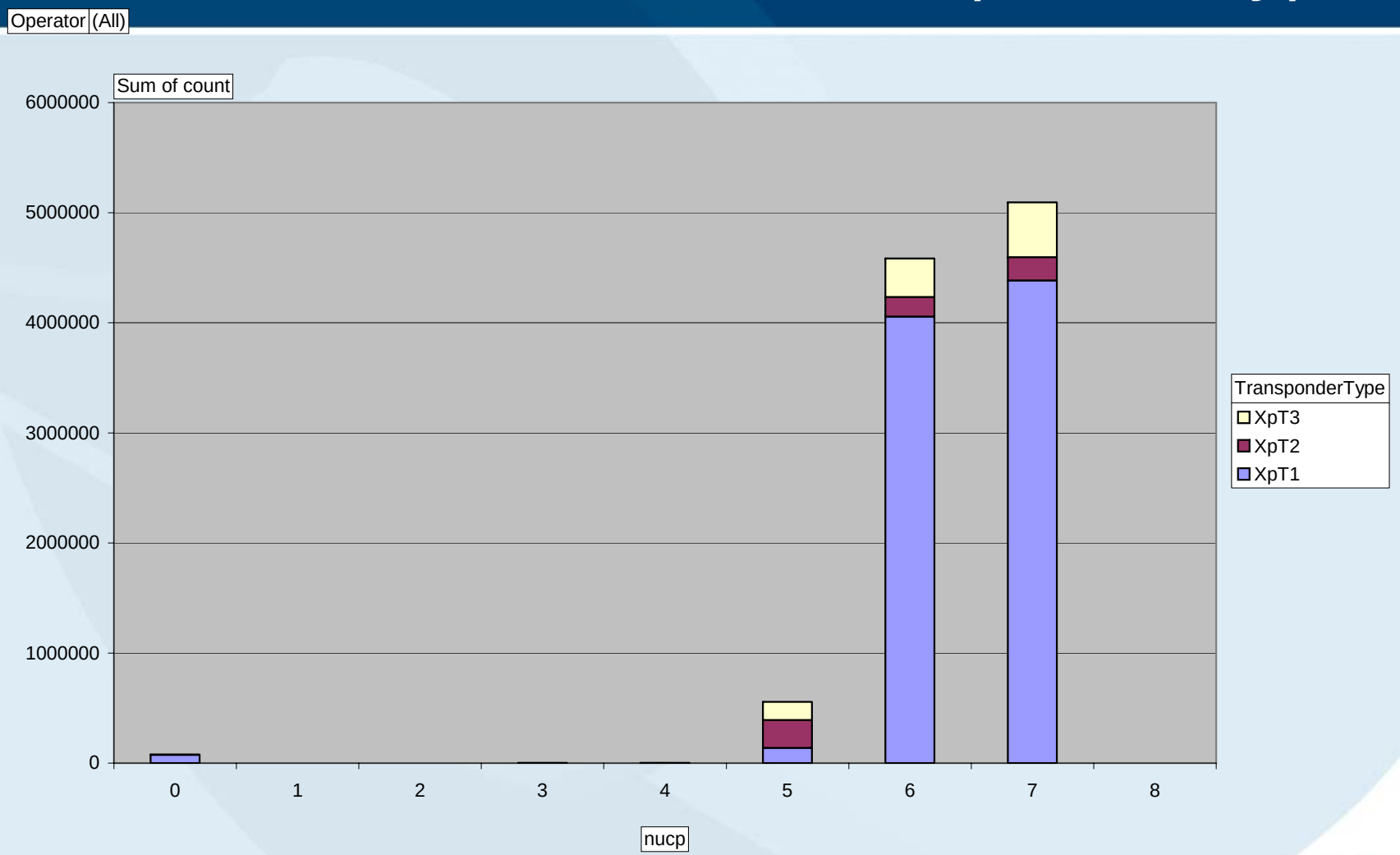
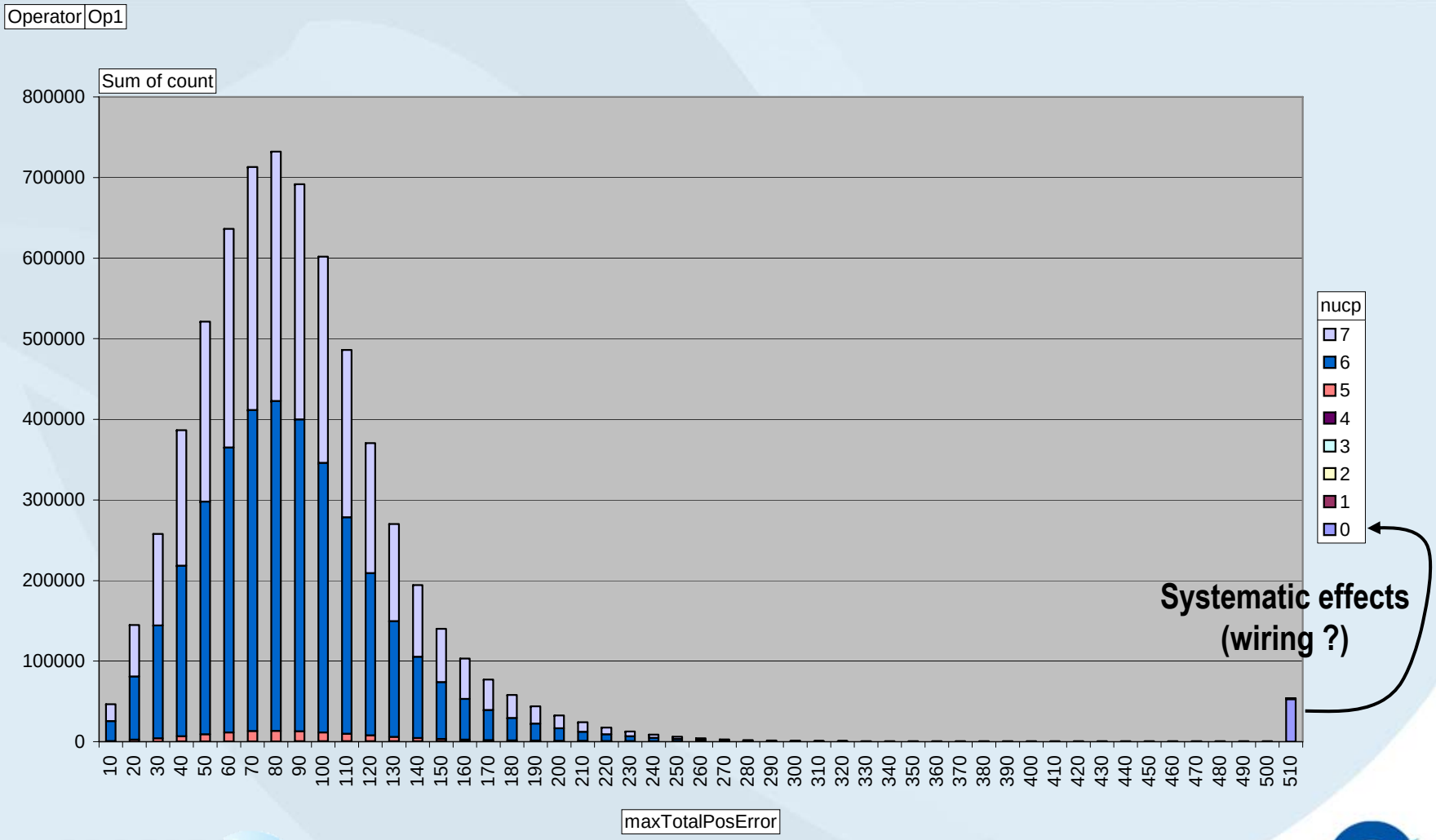
NUCp Distribution



NUCp Distribution Per Transponder Type



Total Position Error
Example for one Operator



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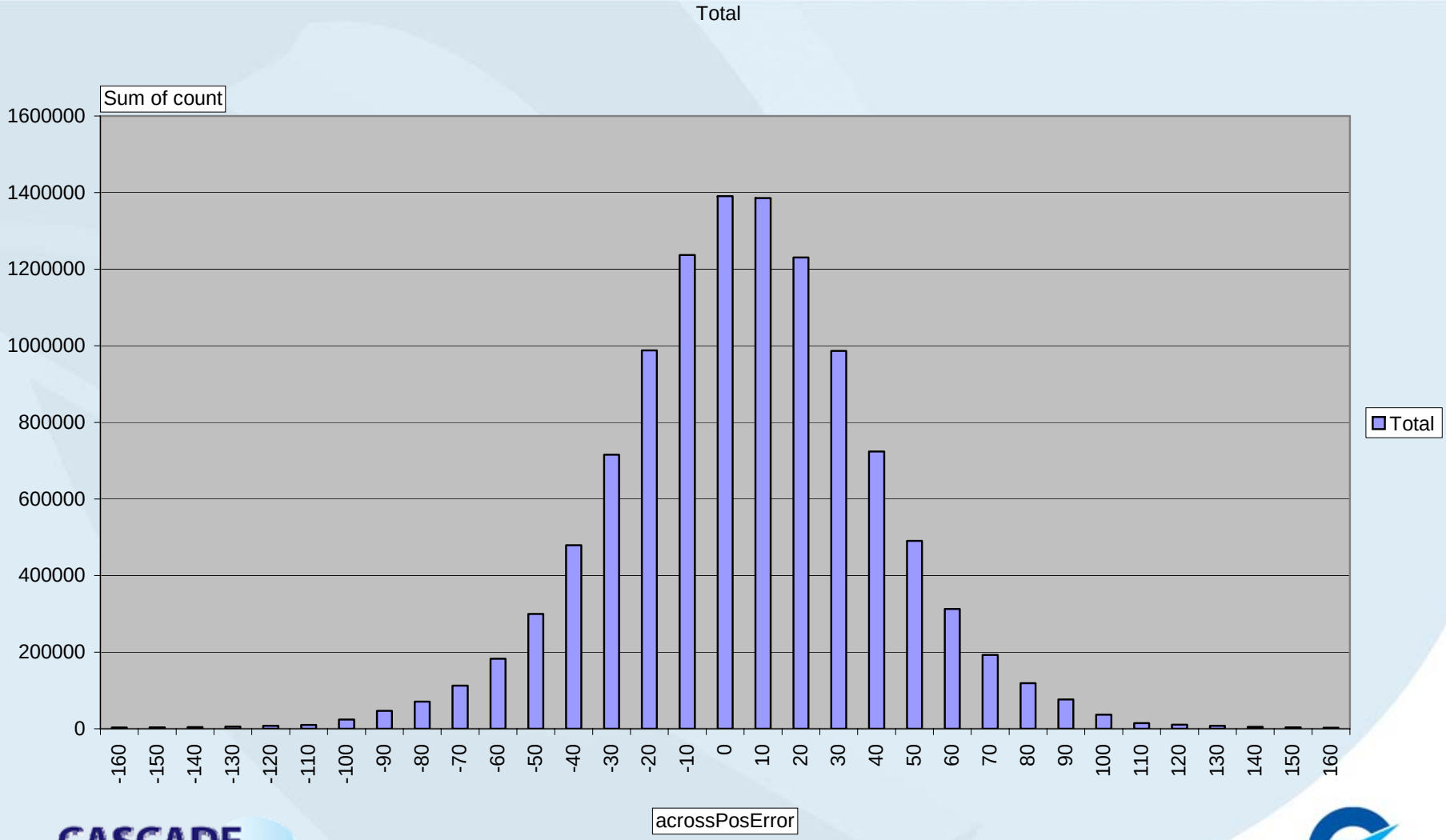
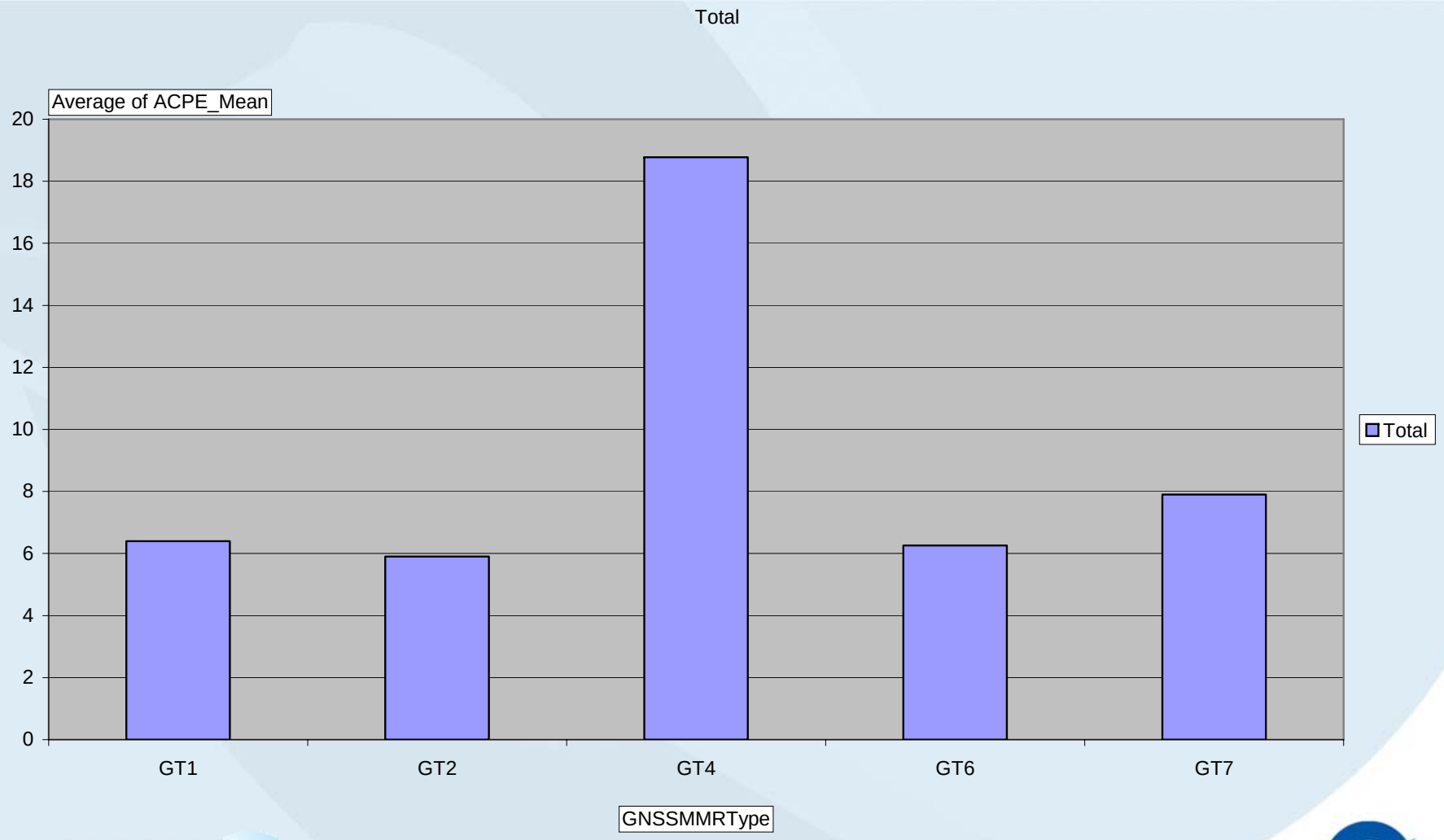
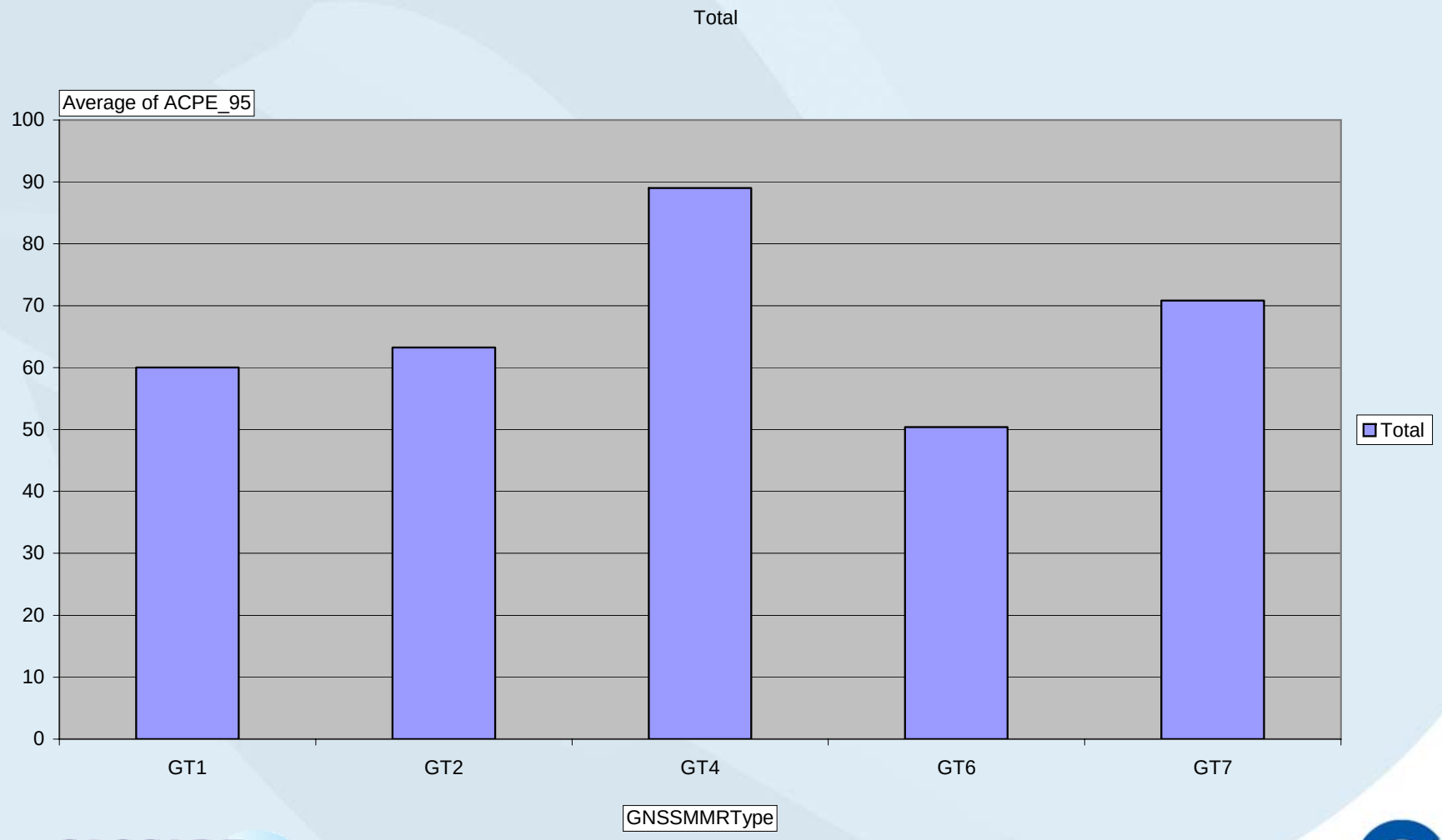
Overall Across-Position Error



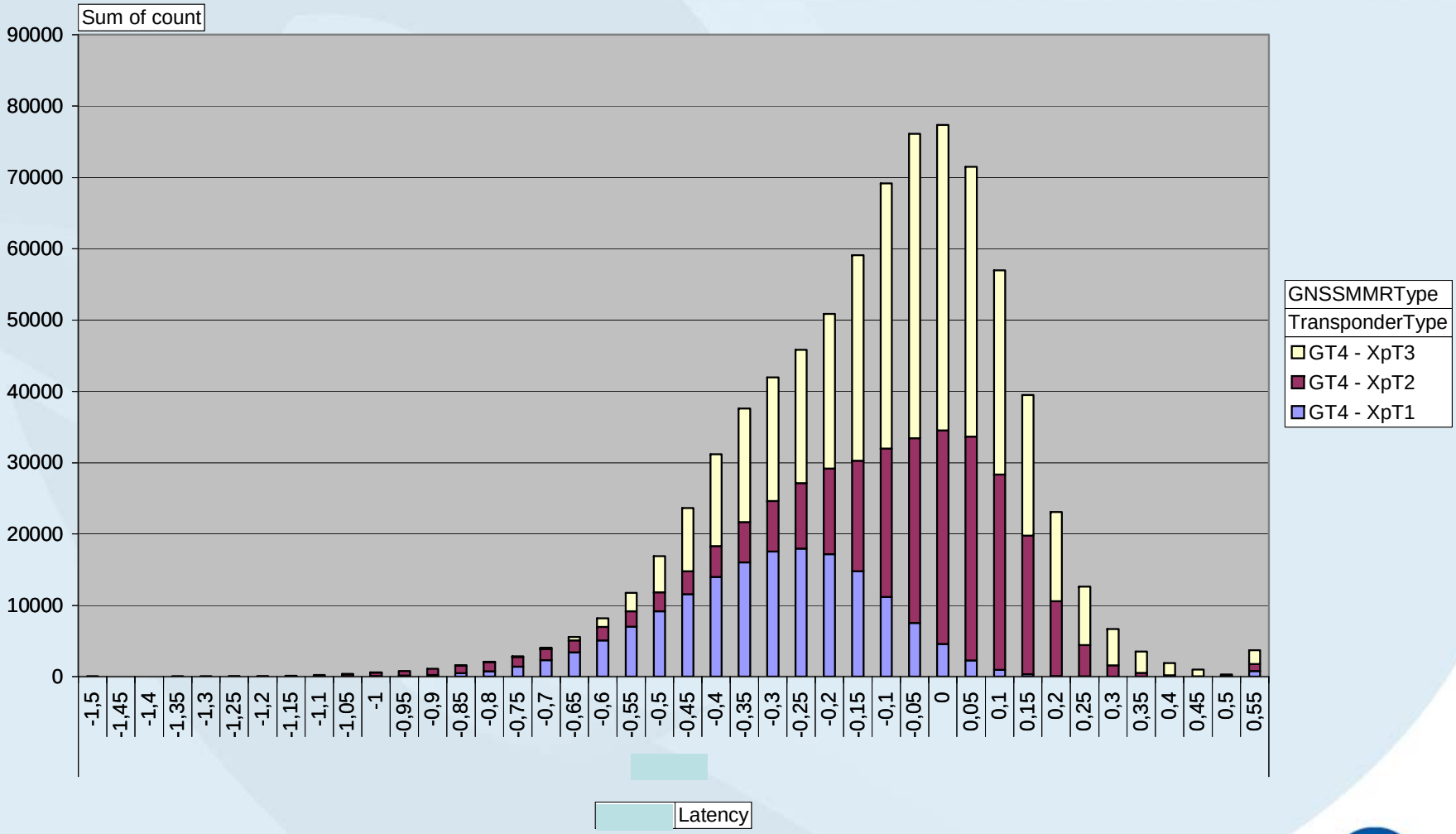
Across-Track Position Error (Mean Average) Variation per GPS Engine Type



Across-Track Position Error (95% Average) Variation per GPS Engine Type



Latency
Variation per Transponder Type



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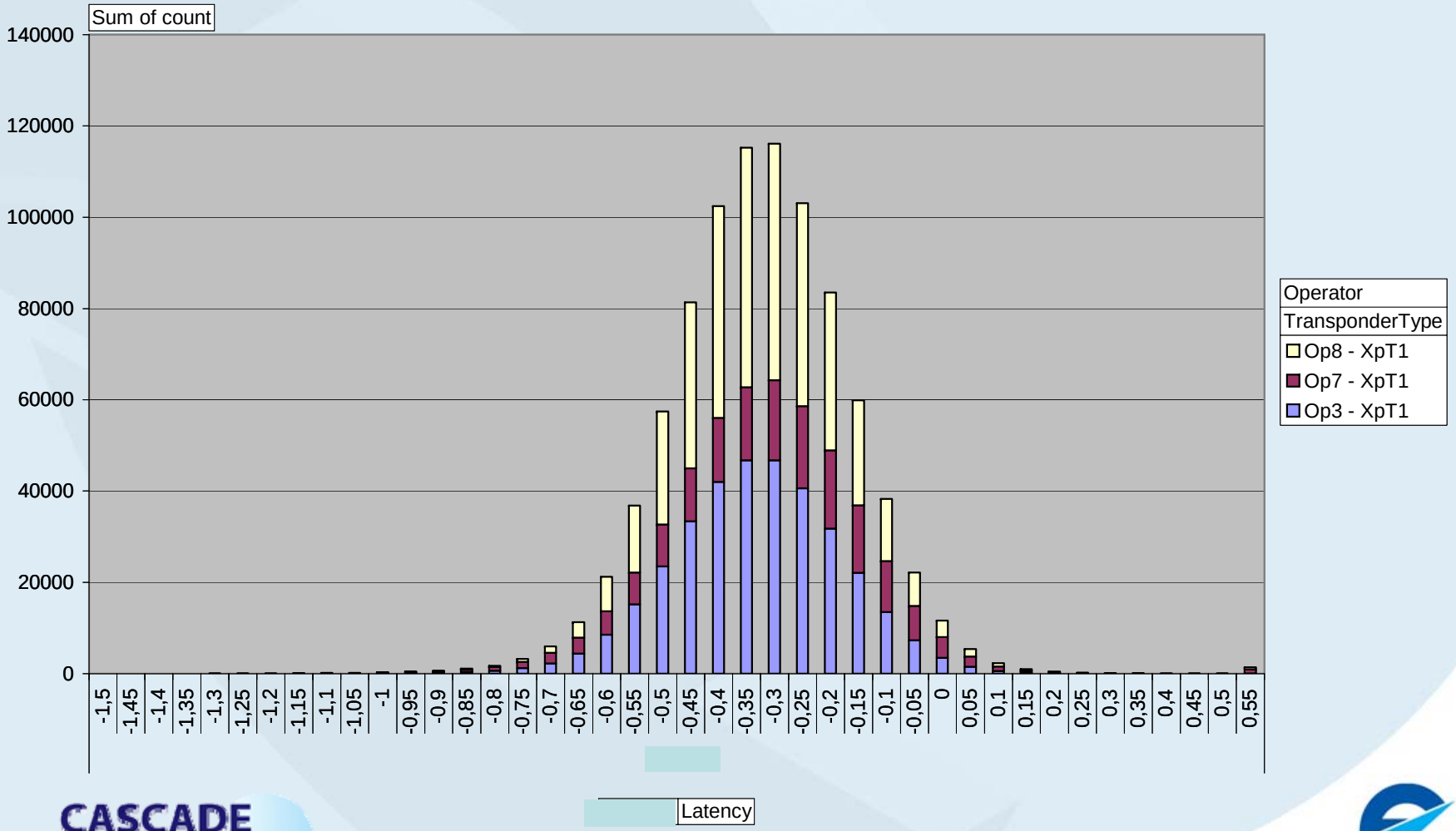
Latency Variation per Operator



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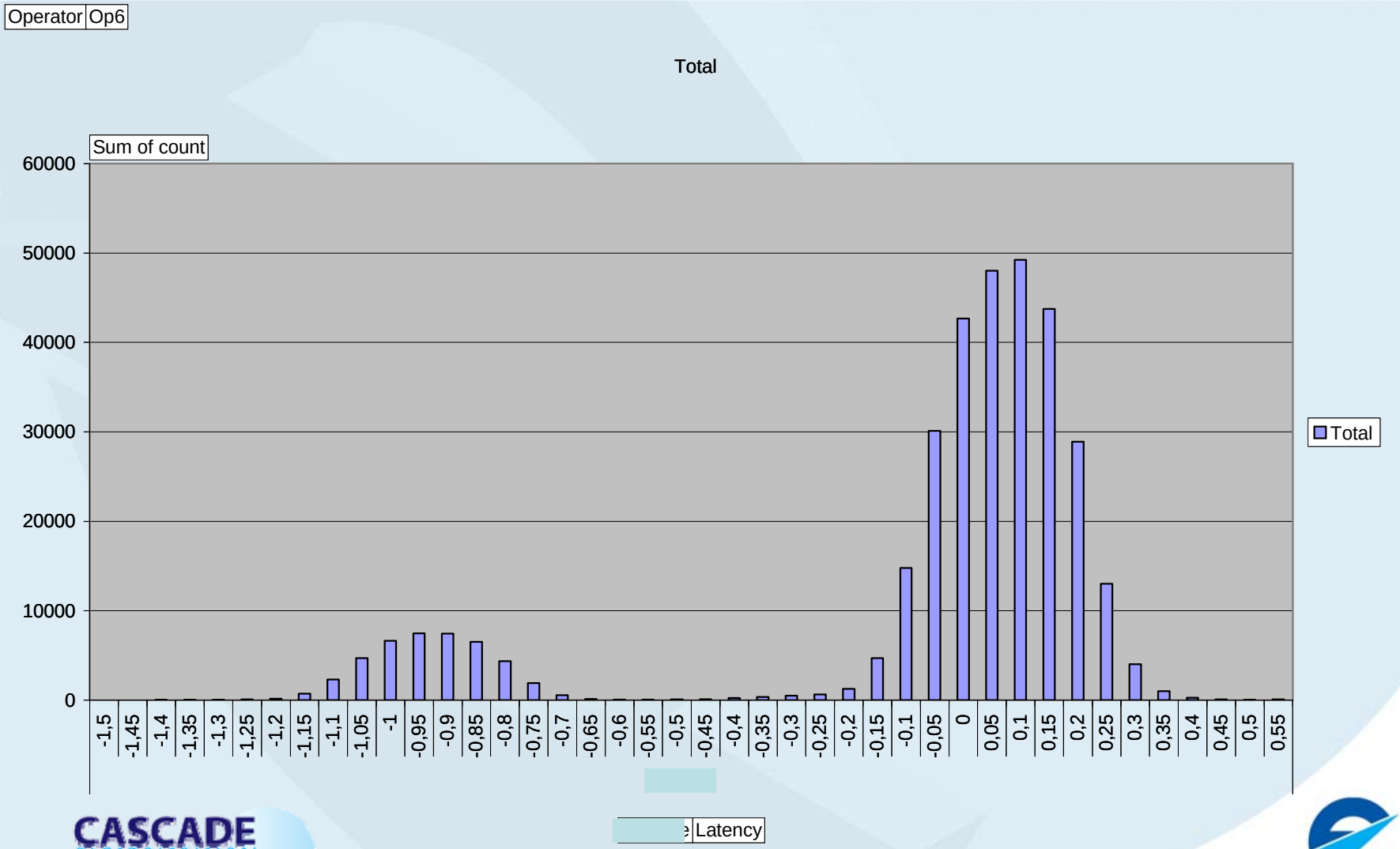
Latency
“Backward Jumps”



Summary

ADS-B Monitoring established as a key activity …

… in support of certification & beyond

Large live data set from wide aircraft mix

Deep insights into ADS-B avionics

Regular reporting to start soon

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Contacts

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- Stelios Adamopoulos Lead Airborne Monitoring Project
- Johan Martensson Secretariat Pioneer Project

Thank You !