



A Flight Delay Reporting and Analysis Platform Through Secure Information Sharing

Guney Guner, Baris Baspinar, Emre Koyuncu, Gokhan Inalhan,
Massimiliano Zanin†, Vaishali Mirchandani, Alberto Enrich
Gonzalez, Julio Cesar Triana Castillo, Emilio Alvarez Pereira and
Cengiz Pasaoglu



The problem of trust in AT / ATM

Many situations require collaborative computation ...

Slot market mechanisms

CO₂ allowance trading

Airline ranking

Analysis of safety records

... but information is mostly private

Slot and CO₂ bids

Safety records

Business information



Secure Multi-party Computation

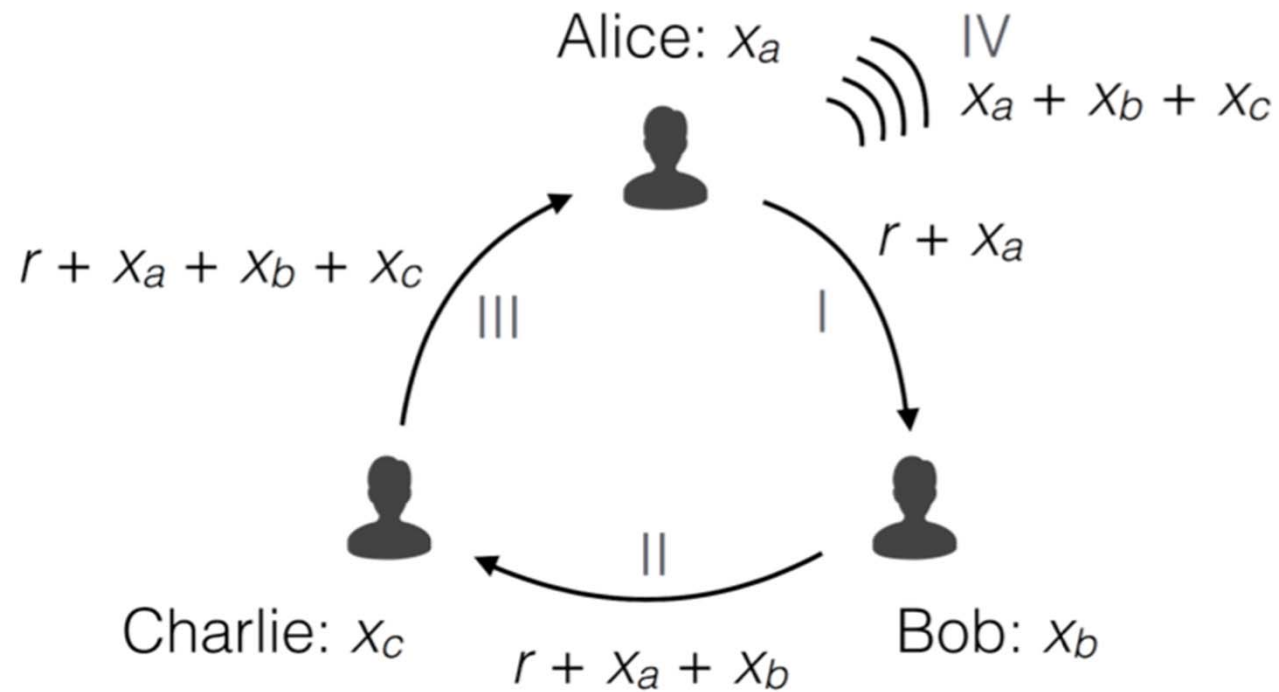
Set of cryptographic techniques

Perform a computation over private data

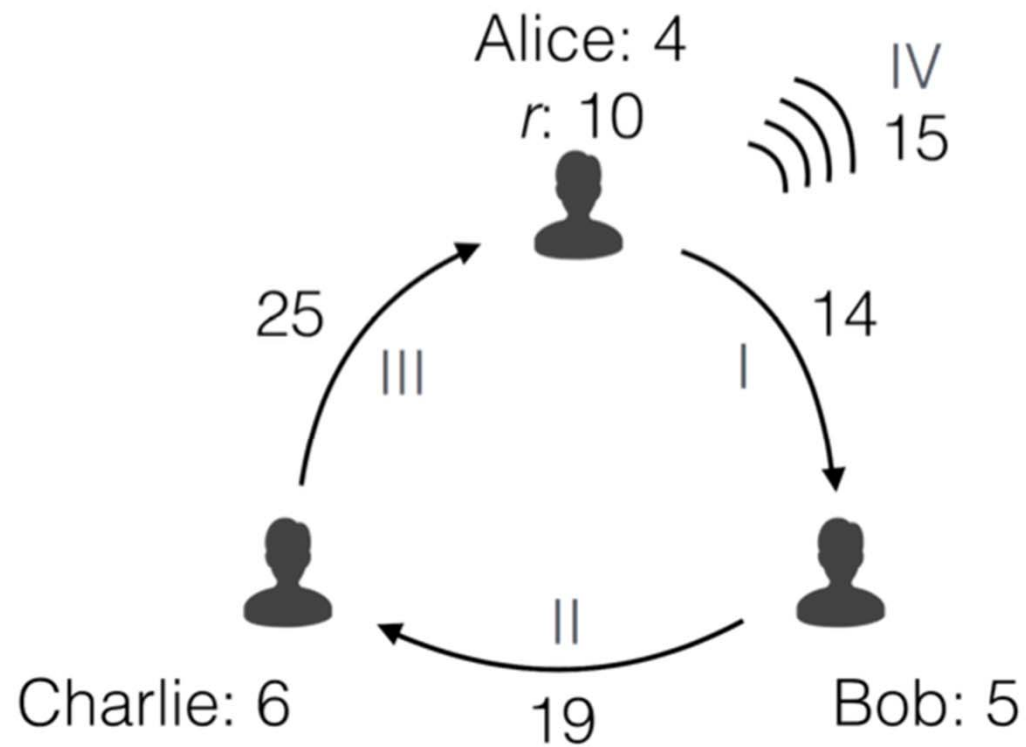
No party should get information about other parties' inputs



Secure Multi-party Computation



Secure Multi-party Computation



Secure Multi-party Computation

What can we do with it?

Simple mathematical operations (*e.g.* averages)

Benchmarking of financial information

Secure analysis of biomedical records

Sorting

Secure auctions of sugar bids

Secure procurements

More complex operations

Satellite collision avoidance

Supply chain optimization



SCLOUD vision



Secure Data Cloud

Demonstrate the usefulness of SMC in AT / ATM

In terms of business relevance and associated costs

Validating technical solutions to requirements

Provide the community with a set of ready-to-deploy SMC libraries

To solve real ATM business needs

Define a high level operational Architecture for a Cloud implementation.

Highly distributed computing environment

No central authority with all the data

Fault-tolerant and scalable, but “low-cost”?

Apply SMC to two AT related case studies



Simulation Models for Results for Business Cases

We have developed simulation models for
Slot Trading and Dynamical Landing Queues

and

Analysis of Delay Reports

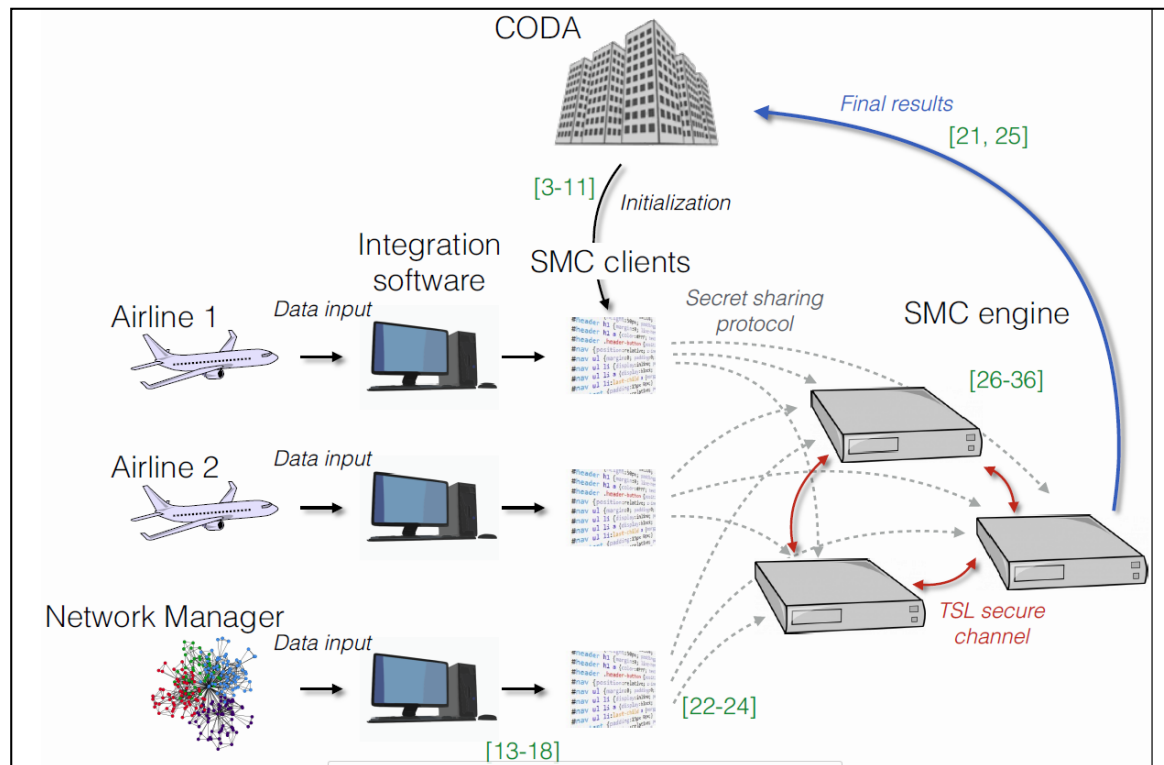
Capabilities

- *Complete Bidding process*
- *Complete Delay Benchmark process:*
 - *Delay statistical data*
 - *Cause of delay statistical data*
 - *Airline ranking per delay*



Analysis of Delay Reports

A system of delay reports using cleared information coming from different parties, securely merged in order to achieve additional knowledge about causes of delays and their evaluation through time.



SMC Library for Analysis of Delay Reports

The following statistical analyses are performed via SMC:

- Statistical indicators* related to the delay per flight
- Statistical indicators* related to the delay per cause
- Airlines ranking by means of total delay minutes in a route

*mean, median, standard deviation and max value



Flight Operations and Crewing			
61	FP	FLIGHT PLAN	Late completion of or change to flight plan
62	FF	OPERATIONAL REQUIREMENT	Late alteration to fuel or payload
63	FT	LATE CREW BOARDING OR DEPARTURE PROCEDURES	Late flight deck, or entire crew, other than standby; late completion of flight deck crew checks
64	FS	FLIGHT DECK CREW SHORTAGE	Sickness, awaiting standby, flight time limitations, valid visa, health documents, etc.
65	FR	FLIGHT DECK CREW SPECIAL REQUEST	Requests not within operational requirements
66	FL	LATE CABIN CREW BOARDING OR DEPARTURE PROCEDURES	Late cabin crew other than standby; late completion of cabin crew checks
67	FC	CABIN CREW SHORTAGE	Sickness, awaiting standby, flight time limitations, valid visa, health documents
68	FA	CABIN CREW ERROR OR SPECIAL REQUEST	Requests not within operational requirements
69	FB	CAPTAIN REQUEST FOR SECURITY CHECK	Extraordinary requests outside mandatory requirements

IATA DELAY CODES

Others		
8	OA	NO GATE/STAND AVAILABLE
9	SG	SCHEDULED GROUND TIME
Passenger and baggage		
11	PD	LATE CHECK-IN
12	PL	LATE CHECK-IN
13	PE	CHECK-IN ERROR
14	PO	OVERSALES
15	PH	BOARDING
16	PS	COMMERCIAL PUBLICITY /PASSENGER CONVENIENCE
17	PC	CATERING ORDER
18	PD	BAGGAGE PROCESSING
Cargo and Mail		
21	CD	DOCUMENTATION
22	CP	LATE POSITIONING
23	CB	LATE ACCEPTANCE
24	CI	INADEQUATE PACKING
25	CO	OVERSALES
Aircraft		
27	GE	DOCUMENTATION, PACKING
28	CL	LATE POSITIONING
29	CA	LATE ACCEPTANCE
Aircraft and Ramp Handling		
31	GD	LATE / INACCURATE AIRCRAFT DOCUMENTATION
32	GL	LOADING / UNLOADING

33	GE	LOADING EQUIPMENT
34	GS	SERVICING EQUIPMENT
35	GC	AIRCRAFT CLEANING
36	GF	FUELLING / DEFUELLING
37	GB	CATERING
38	GU	ULD
39	GT	TECHNICAL EQUIPMENT
Technical and Aircraft Equipment		
41	TD	TECHNICAL DEFECTS
42	TM	SCHEDULED MAINTENANCE
43	TN	NON-SCHEDULED MAINTENANCE
44	TS	SPARES AND MAINTENANCE
45	TA	AOG SPARES
46	TC	AIRCRAFT CHANGE
47	TL	STANDBY AIRCRAFT
Damage to Aircraft		
51	DF	DAMAGE DURING FLIGHT OPERATIONS
52	DG	DAMAGE DURING GROUND OPERATIONS
EDP / Automated Equipment Failure		
55	ED	DEPARTURE CONTROL
56	EC	CARGO PREPARATION DOCUMENTATION
57	EF	FLIGHT PLANS

83	AE	ATFM DUE TO RESTRICTION AT DESTINATION AIRPORT	Airport and / or runway closed due to obstruction, industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights
84	AW	ATFM DUE TO WEATHER AT DESTINATION	

Airport and Government Authorities			
85	AS	MANDATORY SECURITY	Passengers, baggage, crew, etc.
86	AG	IMMIGRATION, CUSTOMS, HEALTH	Passengers, crew
87	AF	AIRPORT FACILITIES	Parking stands, ramp congestion, lighting, buildings, gate limitations etc.
88	AD	RESTRICTIONS AT DESTINATION AIRPORT	Airport and / or runway closed due to obstruction industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights
89	AM	RESTRICTIONS AT AIRPORT OF DEPARTURE	Including air traffic services, start-up and pushback, airport and / or runway closed due to obstruction or weather (restriction due to weather in case of ATFM only) industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights

Reactionary			
91	RL	LOAD CONNECTION	Awaiting load from another flight
92	RT	THROUGH CHECK-IN ERROR	Passenger or baggage check-in error at originating station
93	RA	AIRCRAFT ROTATION	Late arrival of aircraft from another flight or previous sector
94	RS	CABIN CREW ROTATION	Awaiting cabin crew from another flight
95	RC	CREW ROTATION	Awaiting flight deck, or entire crew, from another flight
96	RO	OPERATIONS CONTROL	Re-routing, diversion, consolidation, aircraft change for reasons other than technical

Miscellaneous			
97	MI	INDUSTRIAL ACTION WITHIN OWN AIRLINE	
98	MO	INDUSTRIAL ACTION OUTSIDE OWN AIRLINE	Industrial action (except Air Traffic Control Services)
99	MX	MISCELLANEOUS	No suitable code; explain reason(s) in plain text

SMC Library for Analysis of Delay Reports

The data library for this project includes:

- ALLFT+: historical flight data from the DDR2 repository (EUROCONTROL);
- Capacity reports: reported airport capacities from the DDR2 repository (EUROCONTROL);
- NOP – Network Operation Portal: Air traffic network headline news from Europe (provides some news for the events causing delay);
- Other online weather reporting portals providing METAR Data.



Delay Causes for Analysis of Delay Reports

- Observable subset of the IATA delay causes library through the available dataset

Weather
71(WO) DEPARTURE STATION (NM + AOC)
72(WT) DESTINATION STATION (NM + AOC)
73(WR) EN ROUTE OR ALTERNATE (NM + AOC)
75(WI) DE-ICING OF AIRCRAFT, removal of ice and/or snow, frost prevention excluding unserviceability of equipment (AOC)
Air Traffic Flow Management Restrictions
81(AT) ATFM due to ATC EN-ROUTE DEMAND/CAPACITY, standard demand/capacity problems (NM)
82(AX) ATFM due to ATC STAFF/EQUIPMENT EN-ROUTE, reduced capacity caused by industrial action or staff shortage, equipment failure, military exercise or extraordinary demand due to capacity reduction in neighboring area (NM)
83(AE) ATFM due to RESTRICTION AT DESTINATION AIRPORT, airport and/or runway closed due to obstruction, industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights (NM)
84(AW) ATFM due to WEATHER AT DESTINATION (NM)
Airport And Governmental Authorities
88(AD) RESTRICTIONS AT AIRPORT OF DESTINATION, airport and/or runway closed due to obstruction, industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights (NM + AOC)
89(AM) RESTRICTIONS AT AIRPORT OF DEPARTURE WITH OR WITHOUT ATFM RESTRICTIONS, including Air Traffic Services, start-up and pushback, airport and/or runway closed due to obstruction or weather, industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights (NM + AOC)
Reactionary
93(RA) AIRCRAFT ROTATION, late arrival of aircraft from another flight or previous sector (AOC)
Miscellaneous
97(MI) INDUSTRIAL ACTION WITH OWN AIRLINE (NM + AOC)
98(M) INDUSTRIAL ACTION OUTSIDE OWN AIRLINE, excluding ATS (NM)

NM : Network manager

AOC: Airline Operation Centers



Delay Causes for Analysis of Delay Reports

Reference (actual) data

Predictive Model for Flight Delays																		
Flight ID	Calculated Delays					Binary Features												
	PBD Delay	TOD Delay	ERD Delay	ARD Delay	Total Delay	71 WO	72 WT	73 WR	75 WI	81 AT	82 AX	83 AE	84 AW	88 AD	89 AM	93 RA	97 MI	98 M

Weather
71(WO) DEPARTURE STATION (NM + AOC)
72(WT) DESTINATION STATION (NM + AOC)
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98(M) INDUSTRIAL ACTION OUTSIDE OWN AIRLINE, excluding ATS (NM)

Delay Causes for Analysis of Delay Reports

Delay report for NM representative

Flight ID	Total Delay	71 WO	72 WT	73 WR	75 WI	81 AT	82 AX	83 AE	84 AW	88 AD	89 AM	93 RA	97 MI	98 M
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Weather
71(WO) DEPARTURE STATION (NM + AOC)
72(WT) DESTINATION STATION (NM + AOC)
73(WR) EN ROUTE OR ALTERNATE (NM + AOC)
75(WI) DE-ICING OF AIRCRAFT, removal of ice and/or snow, frost prevention excluding unserviceability of equipment (AOC)
Air Traffic Flow Management Restrictions
81(AT) ATFM due to ATC EN-ROUTE DEMAND/CAPACITY, standard demand/capacity problems (NM)
82(AX) ATFM due to ATC STAFF/EQUIPMENT EN-ROUTE, reduced capacity caused by industrial action or staff shortage, equipment failure, military exercise or extraordinary demand due to capacity reduction in neighboring area (NM)
83(AE) ATFM due to RESTRICTION AT DESTINATION AIRPORT, airport and/or runway closed due to obstruction, industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights (NM)
84(AW) ATFM due to WEATHER AT DESTINATION (NM)
Airport And Governmental Authorities
88(AD) RESTRICTIONS AT AIRPORT OF DESTINATION, airport and/or runway closed due to obstruction, industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights (NM + AOC)
89(AM) RESTRICTIONS AT AIRPORT OF DEPARTURE WITH OR WITHOUT ATFM RESTRICTIONS, including Air Traffic Services, start-up and pushback, airport and/or runway closed due to obstruction or weather, industrial action, staff shortage, political unrest, noise abatement, night curfew, special flights (NM + AOC)
Reactionary
93(RA) AIRCRAFT ROTATION, late arrival of aircraft from another flight or previous sector (AOC)
Miscellaneous
97(MI) INDUSTRIAL ACTION WITH OWN AIRLINE (NM + AOC)
98(M) INDUSTRIAL ACTION OUTSIDE OWN AIRLINE, excluding ATS (NM)



Delay Causes for Analysis of Delay Reports

- Delay report for **Airline** representative
 - may act biased on **red** colored causes

Flight ID	Total Delay	71 WO	72 WT	73 WR	75 WI	81 AT	82 AX	83 AE	84 AW	88 AD	89 AM	93 RA	97 MI	98 M
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Reactionary
93(RA) AIRCRAFT ROTATION, late arrival of aircraft from another flight or previous sector (AOC)
Miscellaneous
97(MI) INDUSTRIAL ACTION WITH OWN AIRLINE (NM + AOC)



Simulation Data Analysis of Delay Reports

Simulation model provides specific examples for each group of delay causes;

- Weather caused delays,
 - ATM related news are searched and related METAR data is obtained to identify cause
- Demand Capacity problem caused delays,
 - ATM headlines are searched and related NOP notification is obtained to identify cause
- Restrictions, Industrial Actions and Special Event caused delays, and
 - ATM headlines are searched and related NOP notification is obtained to identify cause
- Aircraft Rotation caused delays.
 - ALLFT+ data is processed and late arrivals-late departures are identified



Example Simulation Data for Analysis of Delay Reports

Tactical update 1450 UTC

Details

History

20/05/2015 14:47

Airports:

LOWW (Vienna) arrivals

regulated with reduced rate due to weather (TS).
Rate further reduced, delays are high.

LTFJ (Istanbul Sabiha Gokcen) arrivals

regulated with reduced rate due to weather (heavy rain).
High delays.

LTBA (Istanbul Ataturk)

Regulated with reduced rate due weather (heavy rain).
Delays are high.

Heavy rain and storm in Vienna
and Istanbul Airports in 20 May
2015

delay causes refer to codes 71(WO) [for
departure] or 72(WT), 84(AW) [for
arrival] in the IATA code table

fl_ID	date	org	dest	TtOff	Tland	dep_dly	arr_dly	13 delay causes													
NLY711D	20150520	LFPG	LOWW	19:19	20:52	21	16	0	1	0	0	0	0	0	0	1	0	0	0	0	0
AUA416D	20150520	LFPG	LOWW	15:13	16:40	16	14	0	1	0	0	0	0	0	0	1	0	0	0	0	0
AUA462R	20150520	EGLL	LOWW	14:39	16:22	0	37	0	1	0	0	0	0	0	0	1	0	0	0	0	0
BAW706V	20150520	EGLL	LOWW	18:30	20:15	0	6	0	1	0	0	0	0	0	0	1	0	0	0	0	0
VLG6687	20150520	LOWW	LIRF	14:20	15:31	31	34	1	0	0	0	0	0	0	0	0	0	0	0	0	0
AZA191	20150520	LOWW	LIRF	16:12	17:24	41	48	1	0	0	0	0	0	0	0	0	0	0	0	0	0
THY6431	20150520	LOWW	LTBA	19:37	21:29	75	77	1	1	0	0	0	0	0	0	1	0	0	0	0	0
THY9QR	20150520	LOWW	LTBA	21:52	23:47	39	38	1	1	0	0	0	0	0	0	1	0	0	0	0	0
THY5GT	20150520	LTBA	LOWW	17:19	19:00	37	54	1	1	0	0	0	0	0	0	1	0	0	0	0	0



Example Simulation Data for Analysis of Delay Reports

Tactical Update 1105 UTC

Details
History

23/04/2015 11:05

Airports.

LEMG (Malaga) arrivals
Regulated due ATC equipment failure (radar).
Rate reduced.
High delays.

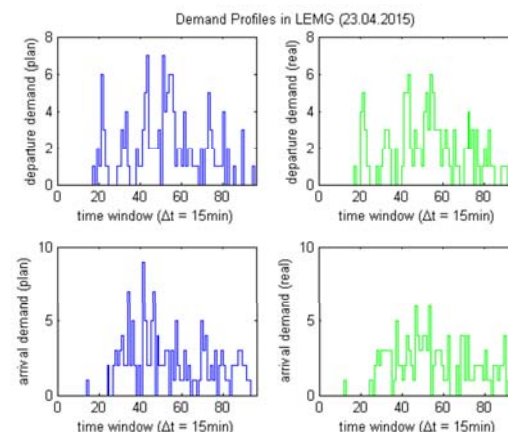
EFHK (Helsinki) arrivals
Regulated due to weather, strong wind, single rwy ops.
Moderate to high delays.

LTFJ (Istanbul/ S.Gokcen) arrivals
regulated due to aerodrome capacity between 1400-1700 UTC.
Moderate to high delays for flights arriving after 1500 UTC.

LTBA (Istanbul/ Ataturk) arrivals
regulated due to aerodrome capacity until 1720 UTC.
Moderate to high delays.

This delay cause refers to code 88(AT) in the IATA code table, thus the binary indicator associated with 88(AT) is set 1.

Capacity reduction issue in Malaga Airport due to ATC equipment failure on 23 April 2015.



fl_ID date org dest TtOff Tland dep_dly arr_dly — 13 delay causes —

```

DLH62W 20150423 EDDF LEMG 7:33 10:06 6 11 0 0 0 0 0 0 0 1 0 0 0 0
DLH31J 20150423 EDDF LEMG 11:35 14:05 3 4 0 0 0 0 0 0 0 1 0 0 0 0
VLG6211 20150423 LIRF LEMG 13:50 16:10 8 13 0 0 0 0 0 0 0 1 0 0 0 0
DLH42K 20150423 LEMG EDDF 15:05 17:45 6 5 0 0 0 0 1 0 0 0 1 0 0 0 0
DLH66N 20150423 LEMG EDDF 11:05 13:44 11 -3 0 0 0 0 1 0 0 0 0 0 0 0 0
VLG8366 20150423 LEMG EHAM 13:50 16:22 13 9 0 0 0 0 1 0 0 0 0 0 0 0 0
TRA118K 20150423 LEMG EHAM 18:40 21:14 6 11 0 0 0 0 1 0 0 0 0 0 0 0 0

```

Example Simulation Data for Analysis of Delay Reports

ATCEUC INDUSTRIAL ACTION

Accs

SOCIAL ACTION HAS BEEN ANNOUNCED BY ATCEUC FOR THE 30TH JAN.

THE FOLLOWING STATES HAVE ANNOUNCED THAT THEIR ATC PERSONNEL WILL BE INVOLVED TO SOME EXTENT.

INDUSTRIAL ACTION IN FRANCE IS DETAILED BELOW.

EDDF CANNOT BE FILED AS AN ALTERNATE UNTIL AFTER 2200 ON 31ST JANUARY. NOTAM A0279/14 REFERS.

EGKK WILL ONLY ACCEPT EMERGENCY DIVERSIONS BETWEEN 29TH 0500 AND 31ST 0500. NOTAM A0293/14 REFERS.

FRANCE INDUSTRIAL ACTION IS ANNOUNCED:

(A0503/14 NOTAMN

Q) LFXV/QXXXX/V/NBO/E /000/999/4504N00053E999

A) LFRR LFEE LFFF LFMM LFBF B) 1401291800 C) 1401310500

E) DUE TO EUROPEAN INDUSTRIAL ACTION (EUROPEAN TRANSPORT WORKERS FEDERATION), SOME DISTURBANCES MIGHT AFFECT FRENCH ATS,AIS AND COM SERVICES:

1-A MINIMUM SERVICE WILL BE ENSURED IN ACCS AND AT LFPG/LFPO/LFSB/LFST/LFLA/LFCL/LFMN/LFML/LFKB/LFKC/LFKJ/LFBD/LFBV/LFBL /LFBO/LFRG/LFRS AND OVERSEAS

AIRPORTS. ACTUAL ATC CAPACITY WILL BE DETERMINED ACCORDING TO AVAILABLE STAFF.

2-AT OTHER AERODROMES ATS SERVICES MIGHT BE UNAVAILABLE DURING CERTAIN PERIODS NOTIFIED BY NOTAMS.

3-AIRCRAFT OPERATORS ARE REQUESTED TO REDUCE THEIR SCHEDULED FLIGHTS BY 20 PER CENT ALL TOGETHER ON PARIS ONLY, PARIS CDG AND BEAUVAIS PLATFORMS.

4-AIRCRAFT OPERATORS SHALL SEND REMAINING PROGRAM AND CANCELLED FLIGHTS BEFORE WEDNESDAY 29 JANUARY 11H00UTC TO DGAC/DTA BY MAIL TO PROGRAMMES-

COMPAGNIES.DTA(AT)AVIATION-CIVILE.GOUV.FR

5- FLIGHT PLANS EXCEEDING THOSE LIMITATIONS COULD BE REJECTED.

6-TERRITORIAL CONTINUITY FLIGHTS (CORSICA AND DOM-TOM), PUBLIC SERVICE OBLIGATIONS, ARE NOT CONCERNED BY THIS REQUEST 7-AIRCRAFT OPERATORS MUST

SYSTEMATICALLY CANCEL ALL PLN, RPL OR FPL FOR THE FLIGHTS NOT PERFORMED RMK : INFORMATION ON REAL TIME SITUATION WILL BE AVAILABLE ON THE FOLLOWING

INTERNET WEBSITE HTTP://DSNADO.CANALBLOG.COM DSNADO/2UM)

PLANNED REGULATIONS APPLIED AS FOLLOWS:

LFRR: REGULATION APPLIED FOR FLIGHTS DESTINATION LFPG/LFPT, 0000-0630 - LOW IMPACT PREDICTED.

LFRR: EN-ROUTE REGULATIONS APPLIED 0000-0600 - LOW IMPACT PREDICTED

LFMM - REGULATIONS APPLIED FOR LFMM + LFMM ARRIVALS AND LFML + LFCL TMAS OVERNIGHT.

Locations LFRRCTA, LFLCFIS, LFMLTMA, LFPB, LFPT, LFMM, LFML, LFBD, LFBOTMA

Social action issue in both Paris Charles de Gaulle and Paris Orly Airports at 20 January 2014.

delay causes refer to codes 82(AX), 89(AM) [for departure] or 82(AX), 83(AE), 88(AD) [for arrival] in the IATA code table.

fl_ID	date	org	dest	TtOff	Tland	dep_dly	arr_dly	13 delay causes												
KLM15P	20140130	EHAM	LFPG	11:33	12:22	10	14	0	0	0	0	0	1	1	0	1	0	0	0	0
KLM19P	20140130	EHAM	LFPG	15:33	16:21	13	14	0	0	0	0	0	1	1	0	1	0	0	0	0
AFR1141	20140130	EHAM	LFPG	18:03	18:54	8	12	0	0	0	0	0	1	1	0	1	0	0	0	0
AFR1019	20140130	EDDF	LFPG	6:43	7:36	18	17	0	0	0	0	0	1	1	0	1	0	0	0	0
MOIWA	20140130	EDDF	LFPG	9:24	10:16	3	6	0	0	0	0	0	1	1	0	1	0	0	0	0
AFR1119	20140130	EDDF	LFPG	18:18	19:12	4	4	0	0	0	0	0	1	1	0	1	0	0	0	0
KLM38P	20140130	LFPG	EHAM	9:35	10:16	22	22	0	0	0	0	0	1	0	0	0	1	0	0	0
KLM12P	20140130	LFPG	EHAM	8:54	9:35	9	8	0	0	0	0	0	1	0	0	0	1	0	0	0
AFR1140	20140130	LFPG	EHAM	16:03	16:47	8	10	0	0	0	0	0	1	0	0	0	1	0	0	0
DLH3F	20140130	LFPG	EDDF	10:11	11:04	6	5	0	0	0	0	0	1	0	0	0	1	0	0	0
FDX27	20140130	LFPG	EDDF	16:38	17:23	20	18	0	0	0	0	0	1	0	0	0	1	0	0	0
DLH5J	20140130	LFPG	EDDF	18:59	19:52	14	6	0	0	0	0	0	1	0	0	0	1	0	0	0

Example Simulation Data for Analysis of Delay Reports

Callsign	Day	Dep	Arr	FTFM takeOff	FTFM landing	CTFM takeOff	CTFM landing	Dep delay	Arr delay
WIF709	2013-03-19	ENBO	ENST	18:25	19:01	18:40	19:11	15	10
WIF709	2013-03-19	ENST	ENVA	19:10	20:07	19:28	20:15	18	8
WIF722	2013-03-19	ENVA	ENBN	20:45	21:26	20:49	21:24	4	-2

Sorting the aircrafts according to their tail numbers enables to evaluate the late arrivals coming from previous leg (which is seen as a (93) RA IATA delay code).

```

fl_ID date org dest TtOff Tland dep_dly arr_dly — 13 delay causes —
-----
RJR6072 20130318 LIRA LICT 11:10 11:50 21 28 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0
WIF709 20130319 ENST ENVA 19:10 20:07 18 8 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0
AFL1006 20130319 UUEE UMKK 15:15 16:43 27 32 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0
WIF932 20130320 ENMH ENBV 11:37 11:46 20 21 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0
WIF985 20130320 ENVD ENTC 13:32 14:40 22 14 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0
WIF944 20130320 ENVD ENTC 07:38 08:47 22 11 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0

```



Analysis of Delay Reports

Analysis by routes

aggregates all the information about flight delays, and at generating a set of statistical descriptors (including average, median and standard deviation)

Ranker

compares total delays one by one and sorted in a secure way.

Analysis by causes of delays

analyzes the delay data as a function of the cause of the delay. The objective is to know the total delay introduced by each cause



Analysis by Routes

Enter Information Here	
Analysis Route	Select ▾
Responsible	Select ▾
End Time	
Flights on Selected Route	Route not selected...
Privacy Peers	Select ▾
Submit	Reset

Enter Information Here	
Analysis Route	LTBA-EGLL ▾
Responsible	Network Manager Pe ▾
End Time	28.08.2015
Flights on Selected Route	☒ THY8UN ☒ BAW677 ☒ THY1SX ☒ THY5UX ☒ THY4BV ☒ THY4EA ☒ BAW677
Privacy Peers	9 ▾
Submit	Reset

Aims to aggregate flight delay inputs, and generates a set of statistical descriptors (including average, median and standard deviation) about those flight delays.

Selected Analysis

ID	Route	DLH914	DLH6JA	Execute
18	EDDF-EGLL	10	17	Send Delay Report

ID	Route	Number Of Flights	Results
21	EDDF-EGLL	2	[38.0, 18.0, 2.5495097567963922]
22	EDDF-LTBA	11	[74.0, 68.0, 35.58600337722172]
23	EDDF-EHAM	2	[23.0, 7.5, 8.514693182963201]
24	EDDF-LIRF	5	[18.0, 13.0, 5.813776741499455]



Airline Ranking

[Trader](#) [Delay Per Flight](#) [Delay Per Causes](#) [Ranker](#)

[Start a New Ranker](#)

List of Available Rankers

ID	Ranking Name	Apply	Result
1	Airline Ranker	End Ranker	Computation Not started
2	Airline Ranker 2	End Ranker	Computing
3	Airline Ranker 3	End Ranker	Computing
4	Airline Ranker 4	End Ranker	[peer04, peer05, peer03, peer02, peer01]
5	Airline Ranker 5	End Ranker	[peer04, peer03, peer01, peer02]
6	Airline Ranker 6	End Ranker	Computation Not started

Evaluates ranking of the participants, comparing the total delays. All total delays are compared one by one and sorted through SMC.

9	EDDF-LTBA		[MNB, THY, OHY, DLH]
13	EDDF-LFPG		[AFR, MOIVA]
14	EDDM-EGLL		[BAW, DLH]
15	EDDM-LTBA		[THY, DLH]
16	EDDM-LEMD		[AEA, DLH, IBE]



Conclusions

Analysis of Delay Reports

delay report gathering from different stakeholders and analysing has been simulated through Secure Multiparty Computation (SMC) library.

web-based Simulation Portal have been added, enabling participants to see the open questionnaire and introduce their inputs.

many real-world examples through the ALLFT+ data analysis, exemplifying the kind of use one can make of the Simulation Portal. Experts and students have been used as reporters for both airlines and network managers.

We have conceptually demonstrated the feasibility of such web-based reporting and secure analysis.

we have observed that manipulating the results, of course, is easy if one intentionally acts in a biased manner.

- For example, when we have asked airline representatives to "care their businesses", they have assigned relatively small values to 93(RA) [delay due to aircraft rotation] and 97(MI) [delay due to industrial action in own airline], thus, this lead to biased outputs. Therefore, it can be said that, instead of asking report for delay through the secure information sharing, essential information sharing could be more effective in analysis of delay.

