Case Finavia:

Optimal airport

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FINAVIA
21 Airports
25 million pax
HEL the biggest

FINAVIA

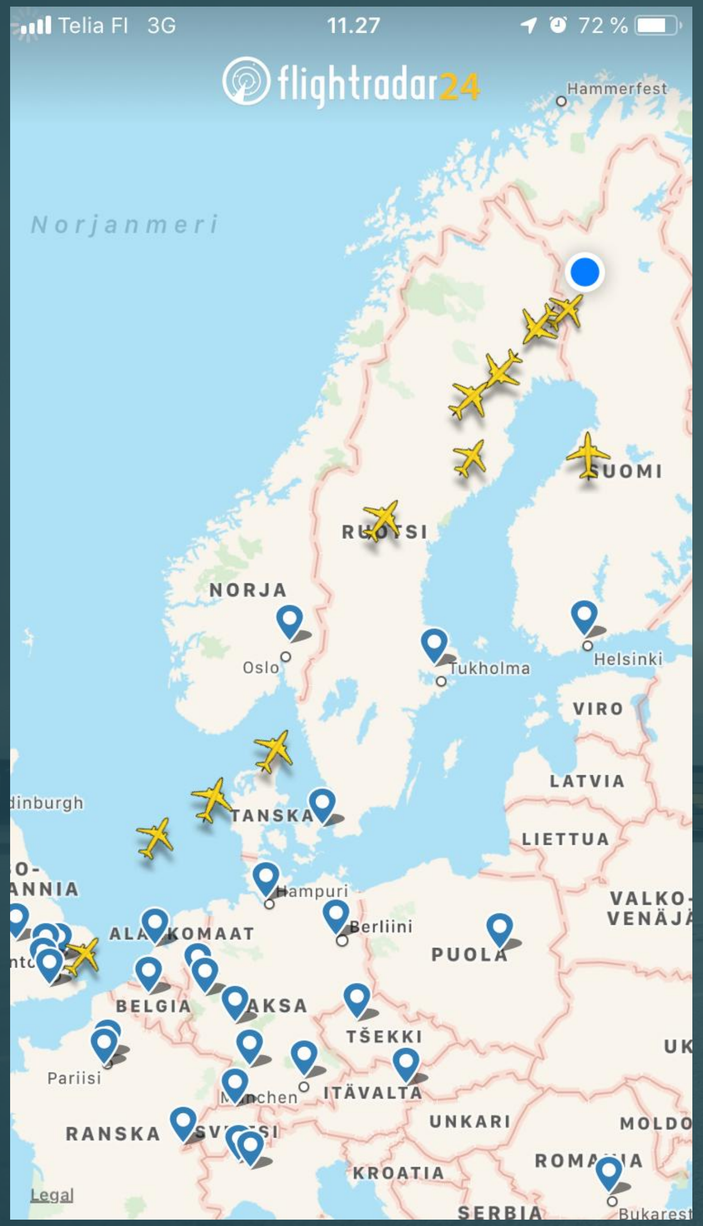
KITTILÄ

(Home of Santa Claus)

Crazy peak times

Very limited capacity

Pen & Paper


Telia FI 3G
11.27
72 %
flightradar24
Hammerfest
Norjanmeri
SUOMI
RUOTSI
NORJA
Oslo
Tukholma
Helsinki
VIRO
LATVIA
TANSKA
LIETTUA
Hampuri
Berliini
PUOLA
VALKO-
VENÄJÄ
BELGIA
TŠEKKI
Pariisi
ITÄVALTA
RANSKA
UNKARI
KROATIA
SERBIA
Legal

Airports' operations are built around **parking plans**

CASE KITTILÄ:

How do you assign 58 flights to 12 parking stands?

Parking planning is manual expert work.

In Kittilä, the next day's plan is done the night before which takes about 3 hours during the peak season.

Challenge #1:

Rules and regulations

Bigger airports use dedicated rule-checking software,
smaller airports handle everything manually.

Challenge #2:

Restricted resources

Stands, buses, check-in counters, staff, …

Challenge #3:

Preferences

Transfers, walking distances, efficient use of resources,
airlines' wishes, ...

Challenge #4:

Uncertainty

Passenger amounts are not usually known beforehand

Challenge #5:

Unpredictable changes

Flights may be (usually are) delayed or arrive too early
which may snowball into chaos

Challenge #6:

Problem dimensions

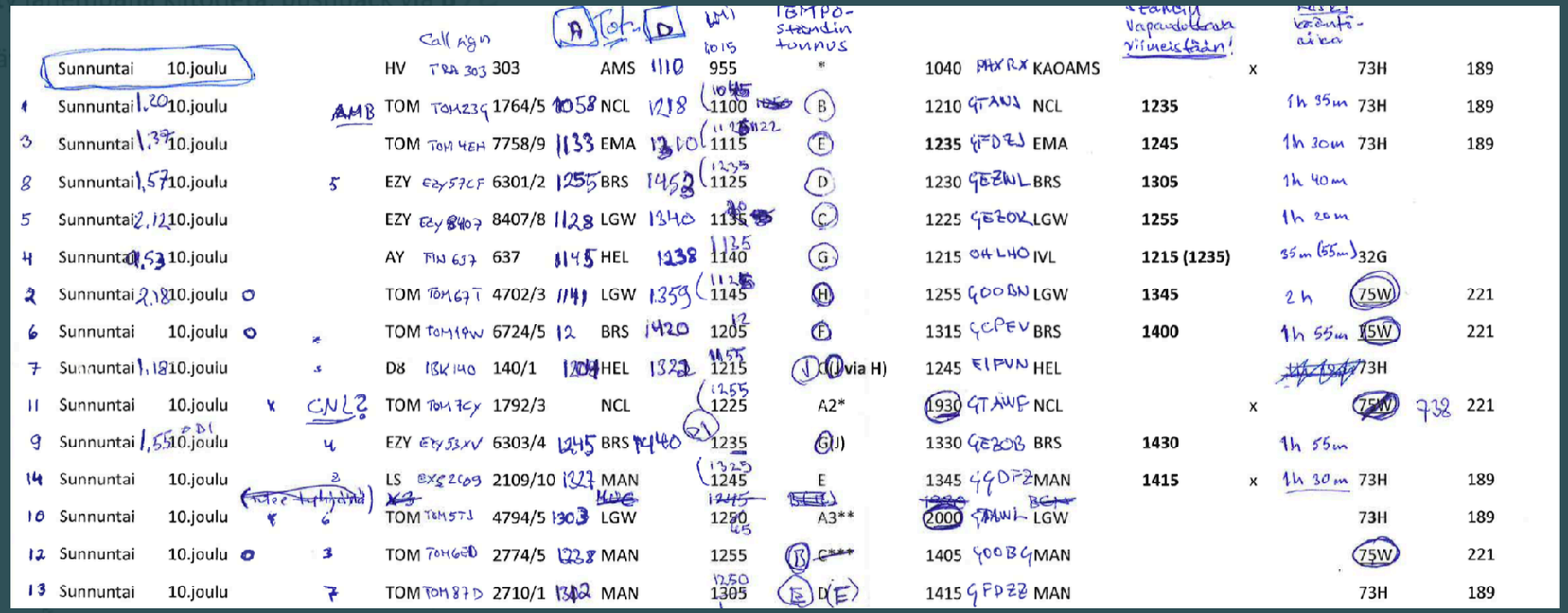
Even mere 58 flights assigned to 12 stands leads to

10^{31} possible plans

To compute all the alternatives would take billions of years
even with a supercomputer

The parking of airplanes is
a constant battle against time

Kittilä: Old way of working



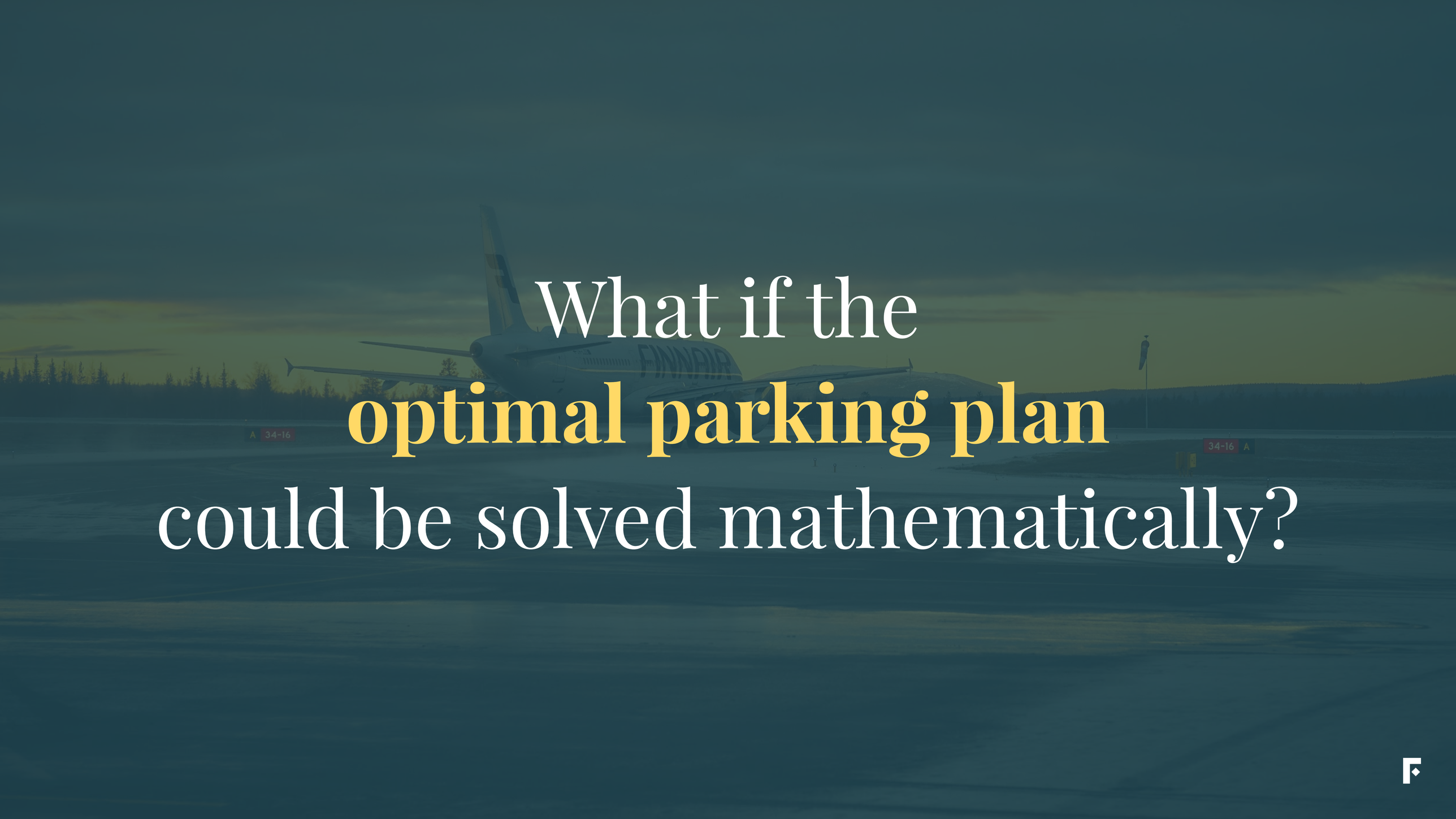
	Sunnuntai	10.joulu			HV	TRA 303	303		AMS	1110	955	*	1040	PHXRX	KAOAMS		x	73H	189
1	Sunnuntai	10.joulu		AMB	TOM	TOM23G	1764/5	1058	NCL	1218	1100	B	1210	GTANJ	NCL	1235		1h 35m 73H	189
3	Sunnuntai	10.joulu			TOM	TOM 4EH	7758/9	1133	EMA	1310	1115	E	1235	GFDZJ	EMA	1245		1h 30m 73H	189
8	Sunnuntai	10.joulu		5	EZY	EZY57CF	6301/2	1255	BRS	1453	1125	D	1230	GEZWL	BRS	1305		1h 40m	
5	Sunnuntai	10.joulu			EZY	EZY 8407	8407/8	1128	LGW	1340	1135	C	1225	GEZOK	LGW	1255		1h 20m	
4	Sunnuntai	10.joulu			AY	FIN 637	637	1145	HEL	1238	1140	G	1215	OHLHO	IVL	1215 (1235)		35m (55m) 32G	
2	Sunnuntai	10.joulu	o		TOM	TOM67T	4702/3	1141	LGW	1359	1145	H	1255	GOOBN	LGW	1345		2h 75W	221
6	Sunnuntai	10.joulu	o	*	TOM	TOM19W	6724/5	12	BRS	1420	1205	F	1315	GCPEV	BRS	1400		1h 55m 75W	221
7	Sunnuntai	10.joulu		*	D8	IBK140	140/1	1204	HEL	1322	1215	J C(J via H)	1245	EIPVN	HEL			73H	
11	Sunnuntai	10.joulu	x	CNL?	TOM	TOM7CY	1792/3		NCL		1225	A2*	1930	GTAWF	NCL		x	75W 738	221
9	Sunnuntai	10.joulu		4	EZY	EZY53XV	6303/4	1245	BRS	1440	1235	G(J)	1330	GEZOB	BRS	1430		1h 55m	
14	Sunnuntai	10.joulu		8	LS	EXS2609	2109/10	1327	MAN		1245	E	1345	GGDFZ	MAN	1415	x	1h 30m 73H	189
10	Sunnuntai	10.joulu		6	TOM	TOM5TJ	4794/5	1303	LGW		1250	A3**	2000	GTAWL	LGW			73H	189
12	Sunnuntai	10.joulu	o	3	TOM	TOM6ED	2774/5	1238	MAN		1255	B C***	1405	GOOBG	MAN			75W	221
13	Sunnuntai	10.joulu		7	TOM	TOM87D	2710/1	1312	MAN		1305	E D(E)	1415	GFDZZ	MAN			73H	189

How much staff is needed?

How many buses are needed?

When should the check-ins begin?

How robust is this plan?



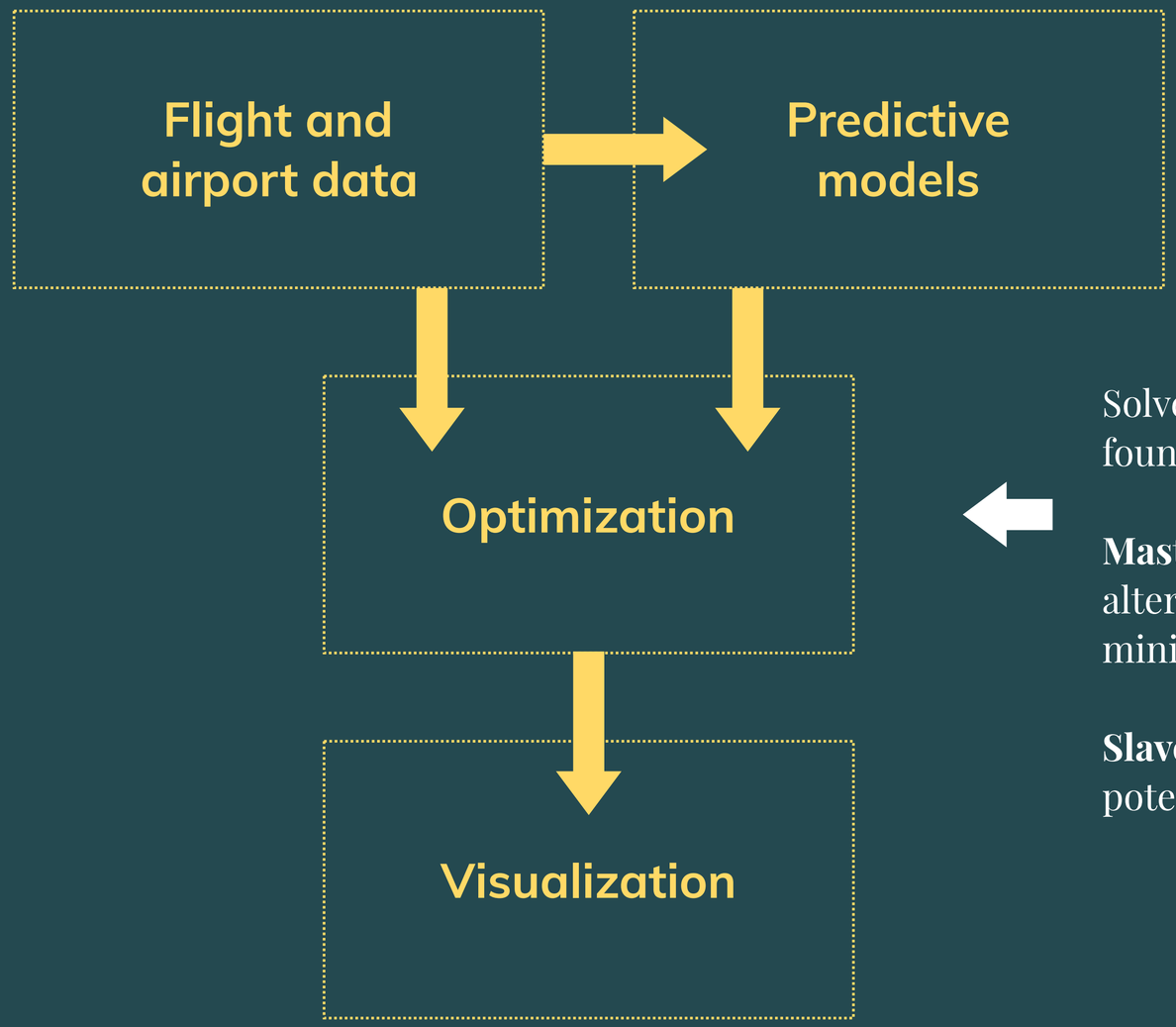
What if the
optimal parking plan
could be solved mathematically?

Well it can:

we created a linear optimization model for parking, making Kittilä

the world's first AI-optimized airport

SOLUTION:



Solved iteratively until better alternatives can no longer be found:

Master problem: From the already generated set of alternatives, find the best possible combination by minimizing the total cost

Slave problem: Find new alternatives that have the greatest potential of reducing the total cost of the master problem

KTT - Kittilä
Sun 23 December
Flights
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16
7
8
9
10
11
12
13
14
15
16
17
18
U
LS2109/EXS211M
TOM4702/23C
OR157/TFL158
TOM2774/99P
QS2404/T
IBK
FIN7PK
EZY8409/
FIN571
FPO841/2
EZY630
FIN658/
OR151/2
HV303/TRA30
SN1025/BEL1026
HV545/6
EZY6301/2
LS2173/EXS2
EZY8407/43QN
TOM6724/1JC
TOM1764/HP
TOM3730/8AP
Bus Numbers
Schengen
Non-Schengen
Callsign
Flight number
Flights
Arrival
Departure
A321
13
OHLZA
HEL FIN571
08:35
AY571
PAX 208
Landed
HEL FIN7TP
09:15
AY572
PAX 69
Departed
-
14
OOTUX
AMS
09:45
OR151
PAX 92
Landed
IVL
10:35
OR152
PAX N/A
Final call
B738
15
PHHSG
AMS
10:15
HV545
PAX 136 ± 35
Estimated
AMS
11:00
HV546
PAX 92
Boarding (GTO)
B733
13
FGZTA
CDG
10:29
FPO841
PAX 141
Estimated
CDG
~~11:30~~ 11:55
FPO842
PAX 144
B738
11
AMS
10:36
AMS TFL158
11:55

Solution #1:

Rules and regulations

Incorporated as optimization constraints that are inherently taken into account

Solution #2:

Restricted resources

Incorporated as optimization constraints that are inherently taken into account

Solution #3:

Preferences

Incorporated as additional costs affecting
the plan optimality

Solution #4:

Uncertainty

Predictive models of the uncertain variables for data-driven decisions instead of a hunch

Solution #5:

Unpredictable changes

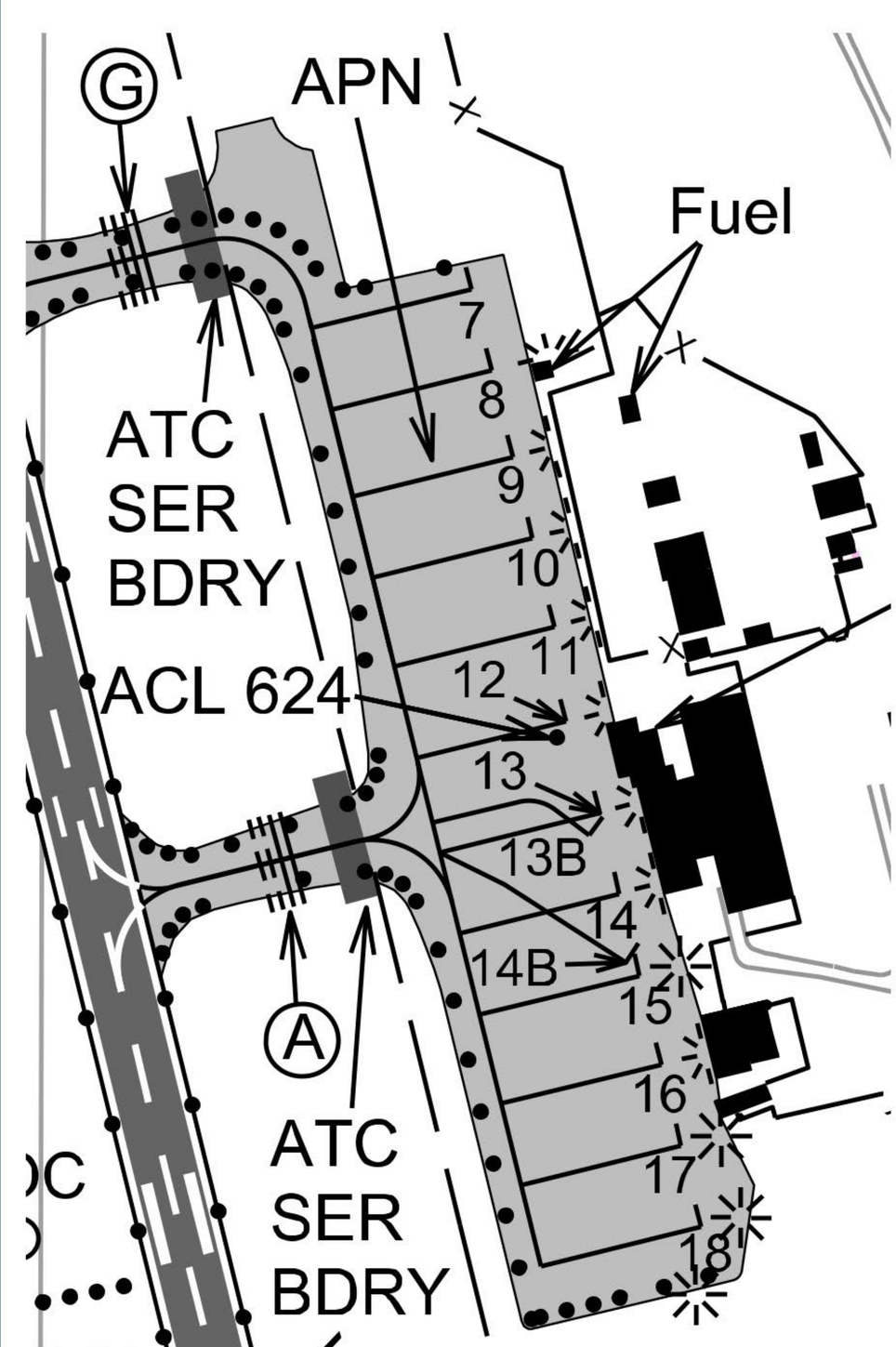
Inherent robustness against changes by using it as an optimality criterion

If needed, an updated optimal plan can be generated with the click of a button

Solution #6:

Problem dimensions

Convergence to the best solution in less than 30 sec on a desktop computer through a tailored optimization algorithm

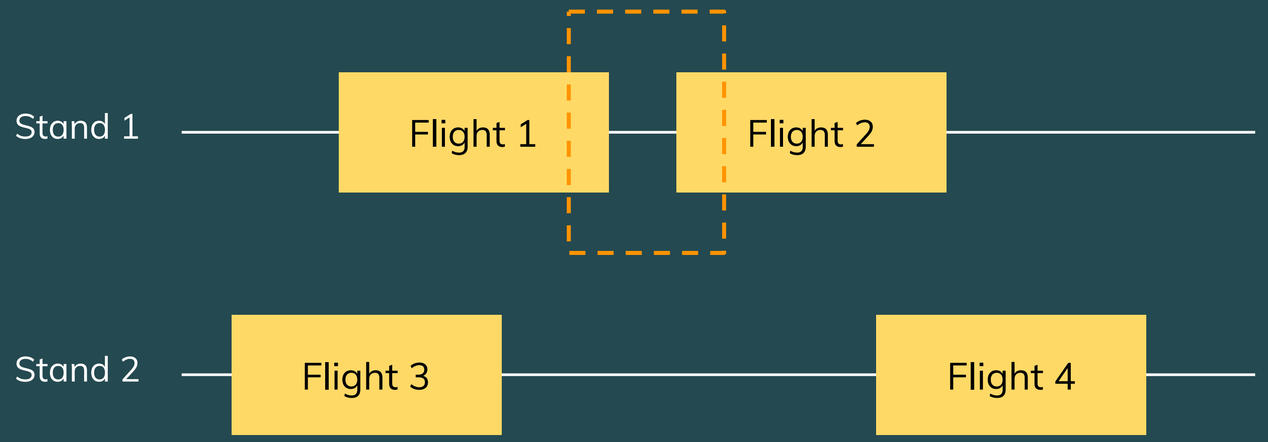


Optimization criteria:

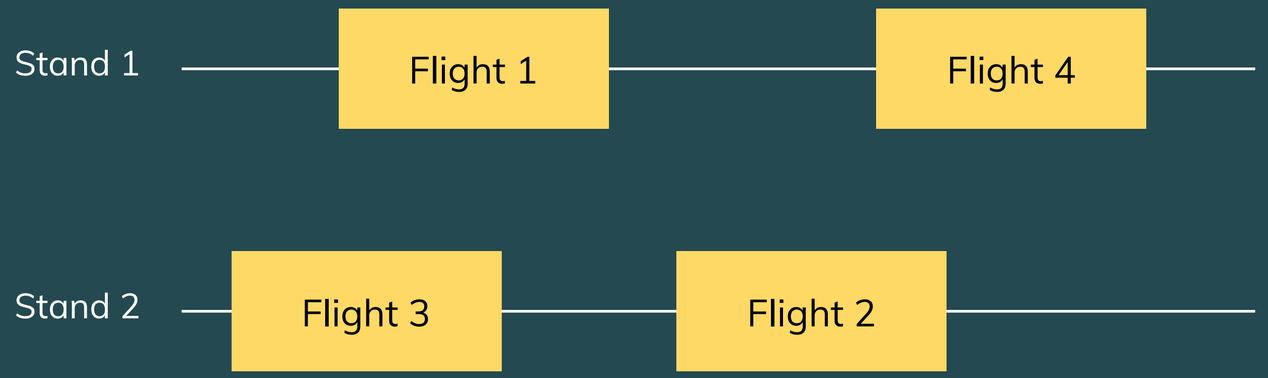
Robustness
&
Minimal number of bus transportations

Plan robustness

Non-robust:



Robust:



Kittilä 2018/12/23

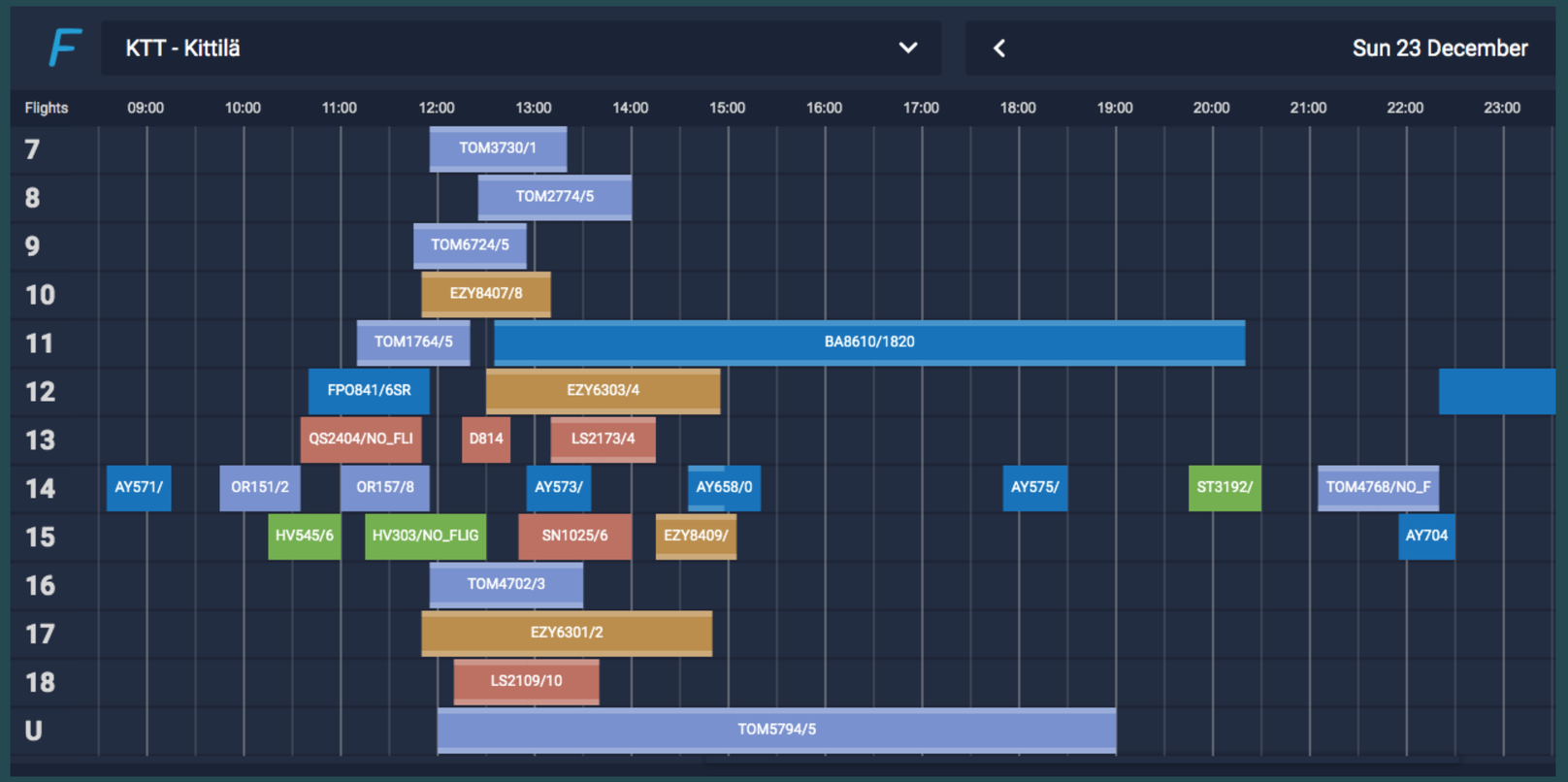
Optimized with respect to **robustness**

Time between flights is distributed as evenly as possible

Plan requires 64 bus transportations

Kittilä 2018/12/23

Optimized with respect to required **bus transportations**

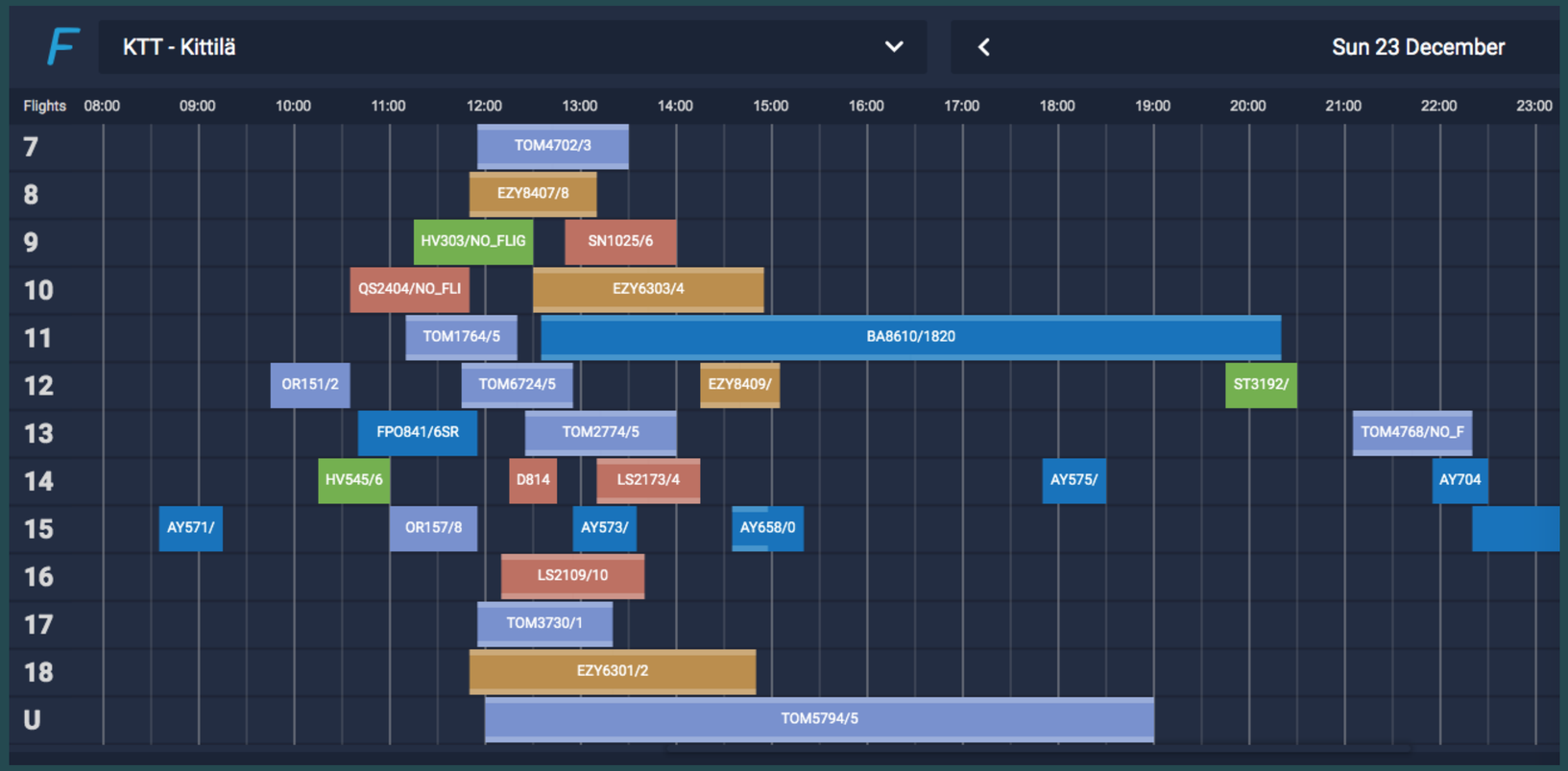


Plan requires 38 bus transportations

Plan is sensitive to changes!

Kittilä 2018/12/23

Optimized with respect to **robustness and bus transportations** (weights 50%-50%)



Requires 42 bus transportations

Results

The solution was deployed in December 2018. When comparing December 2018 with December 2017:

The number of flights increased by **12 %**

The decrease in delays resulted in an estimated **500 000 €** cost savings

Duration of average airport-related flight delay decreased by **66 %**

The share of airport-related flight delays decreased by **61 %**

The airport's NPS score increased by **20 points**

More information:

fourkind.com/work/finavia-optimal-airport/