Knowledge Driven Risk Management

DSAC Symposium –Novembre 24th, 2011

“From event processing to risk management”

Andrew Rose – on behalf of UK CAA

Data verses Knowledge

We have huge amounts of data that has the potential to tell us how our ‘system’ is performing

but we use it in a piecemeal way

so what it tells us through its individual parts is nothing compared to what it would tell us as part of a **homogenous picture**

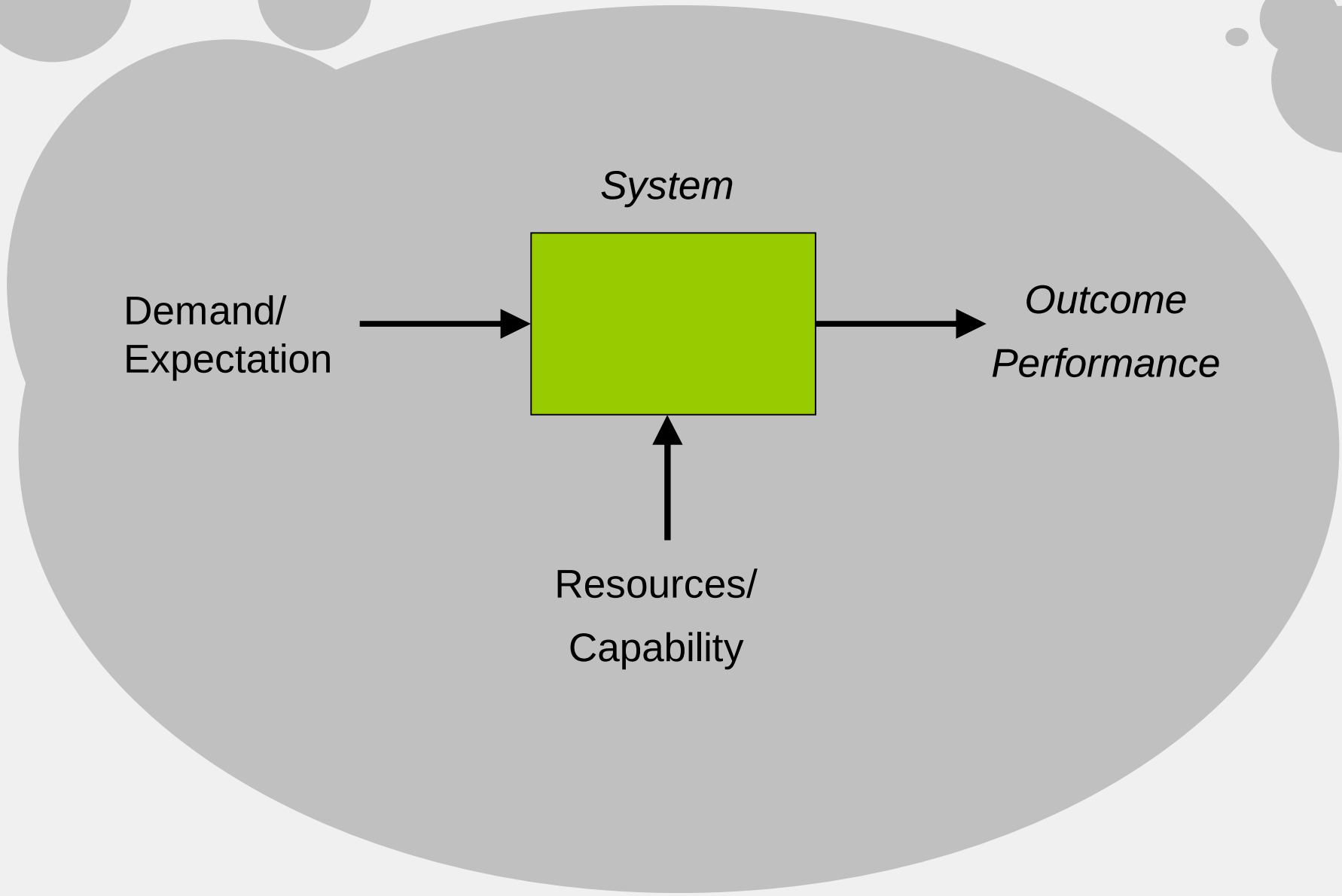
Effective Risk Management

Effective risk management requires us to monitor the performance of our system

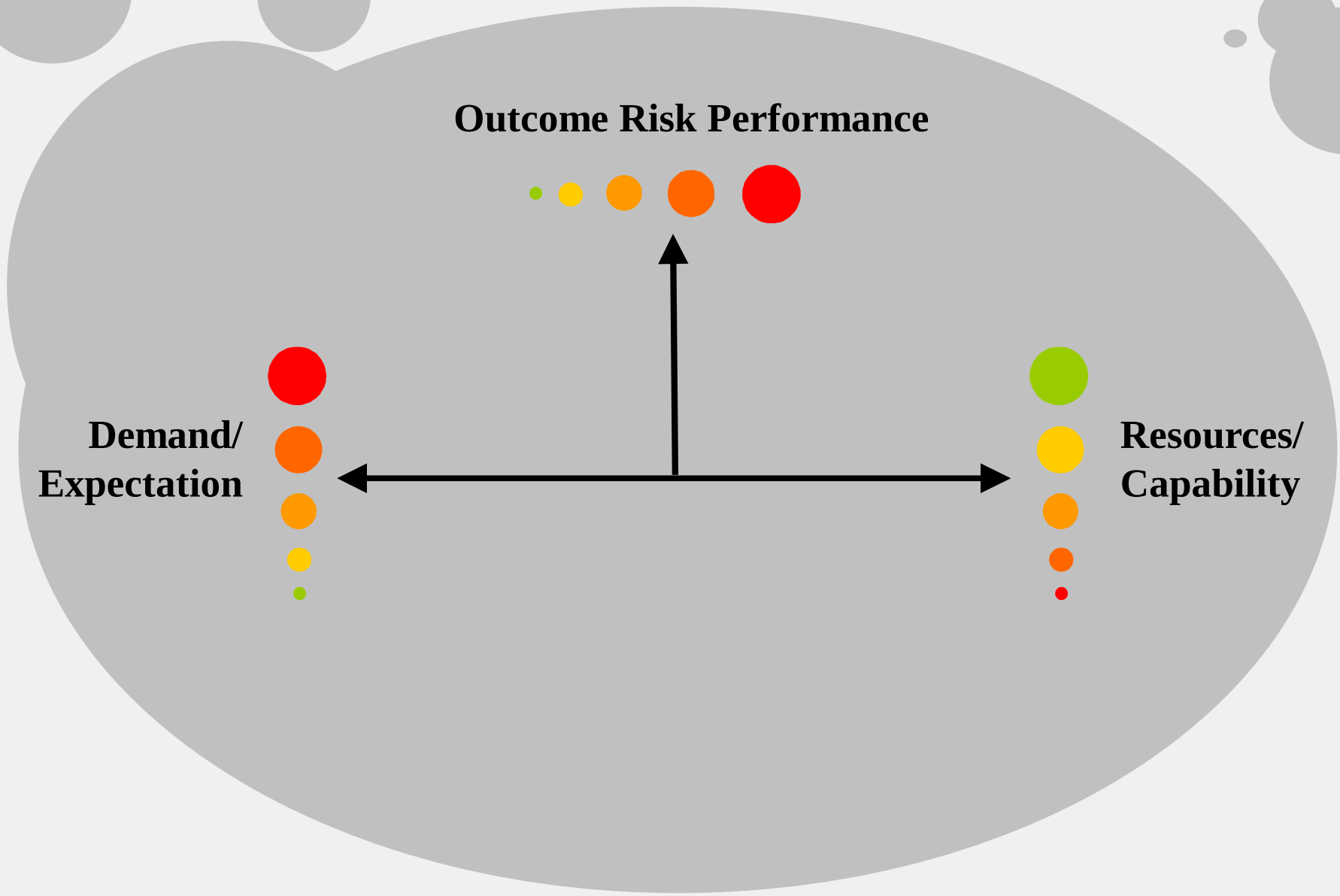
But it also requires us to understand what affects that performance and how we can influence it

Our responsibility is to ensure that we make best use of the data available to enable ***optimum risk management decisions***

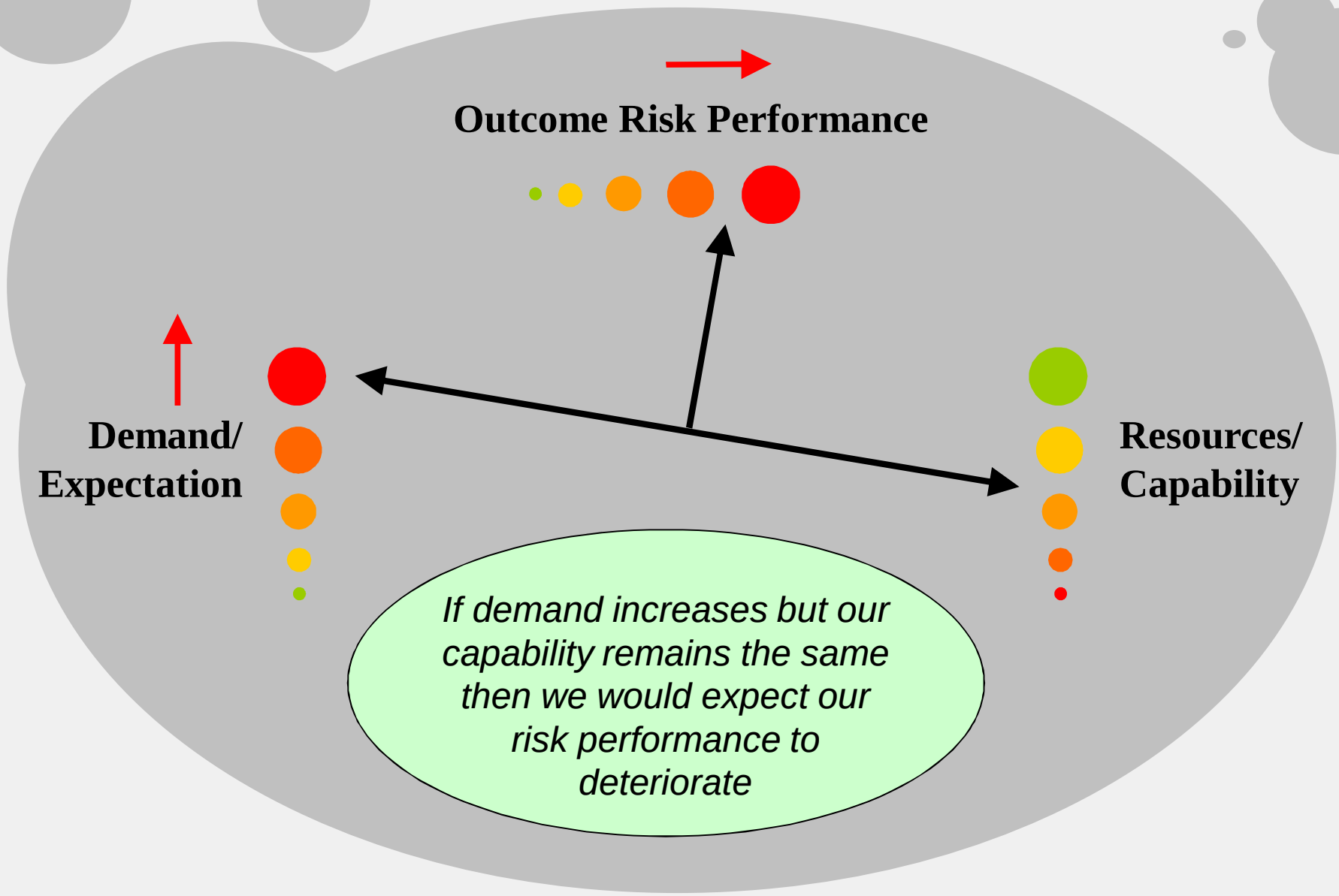
A Systems Perspective



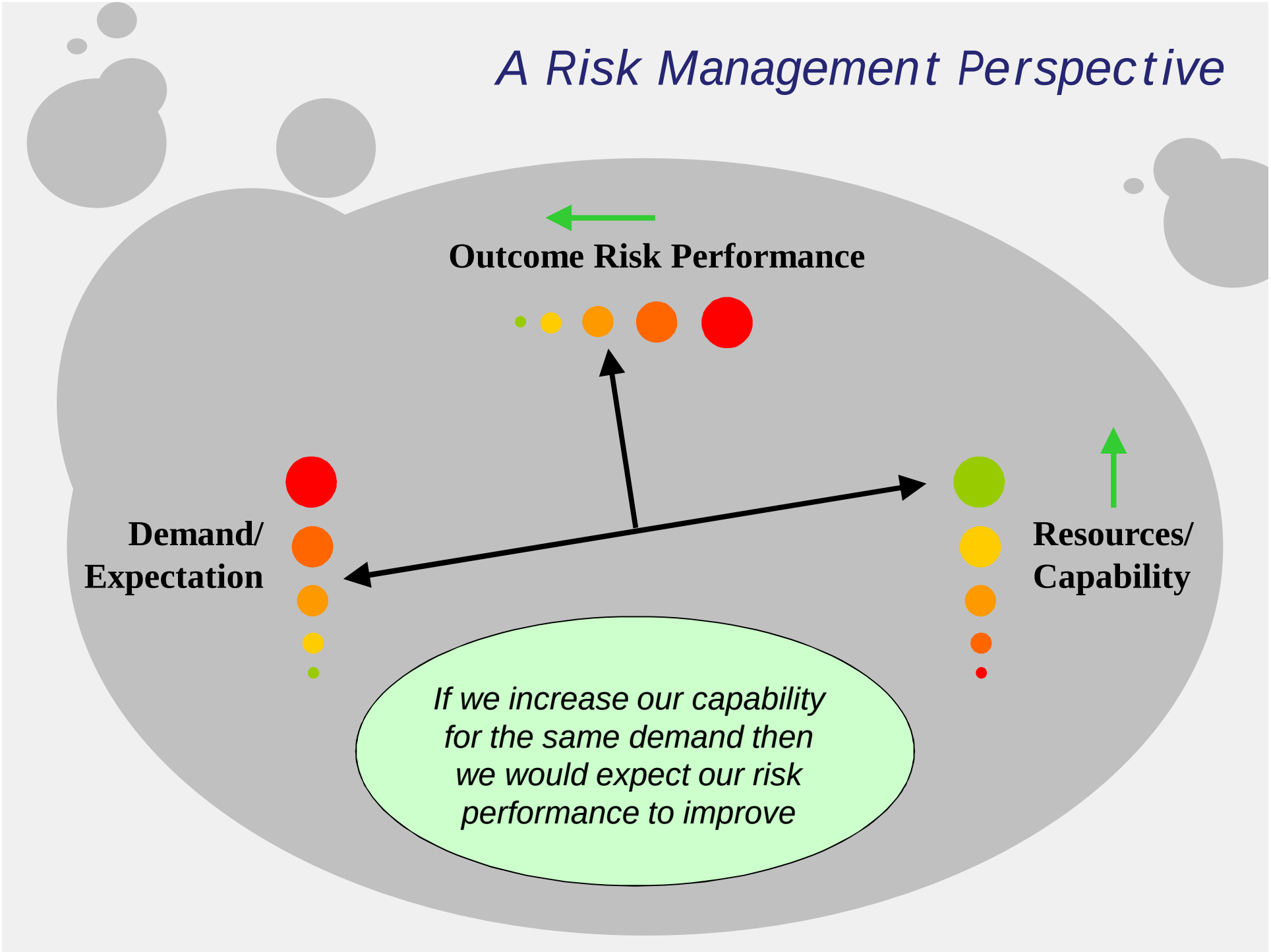
A Risk Management Perspective



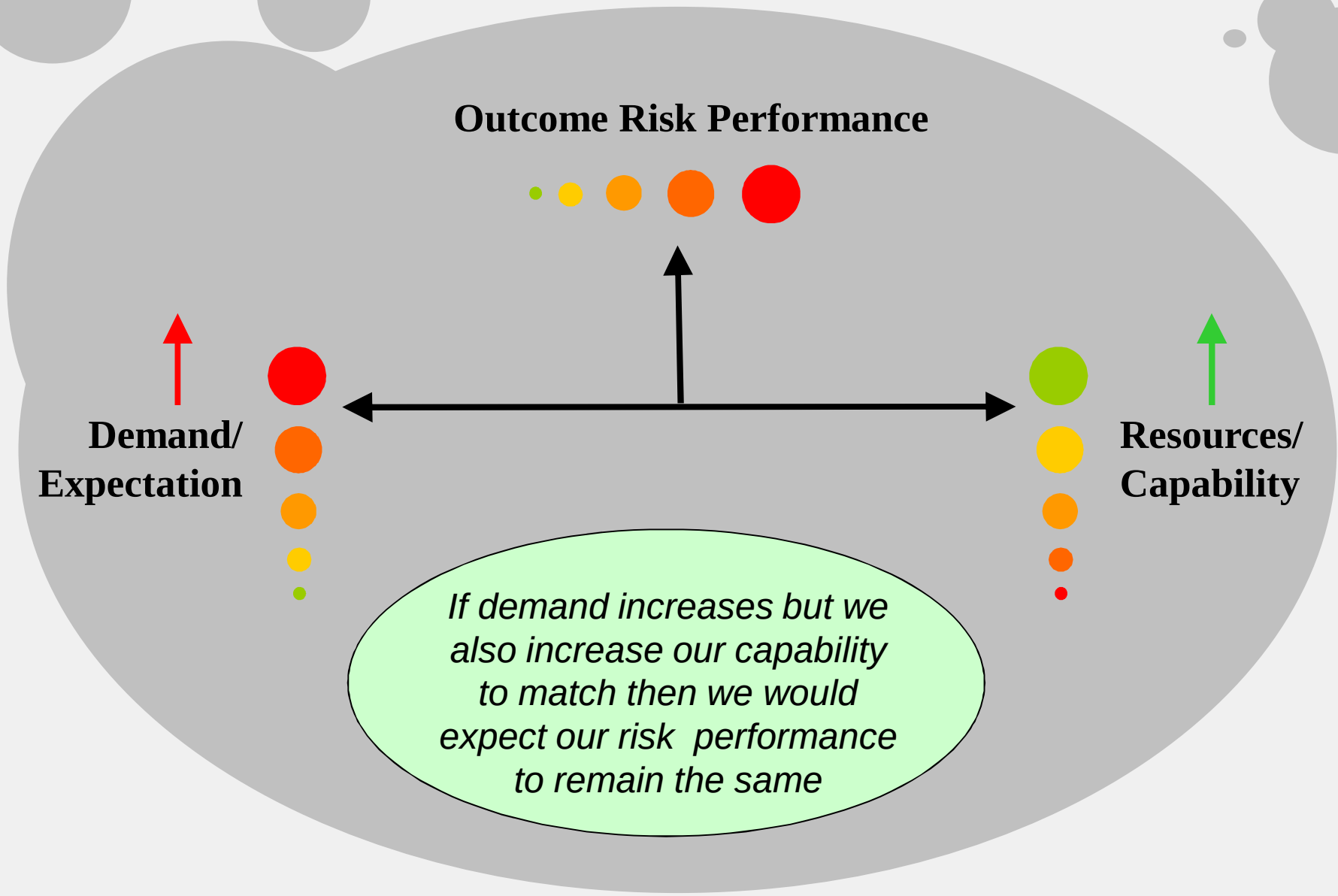
A Risk Management Perspective



A Risk Management Perspective



A Risk Management Perspective

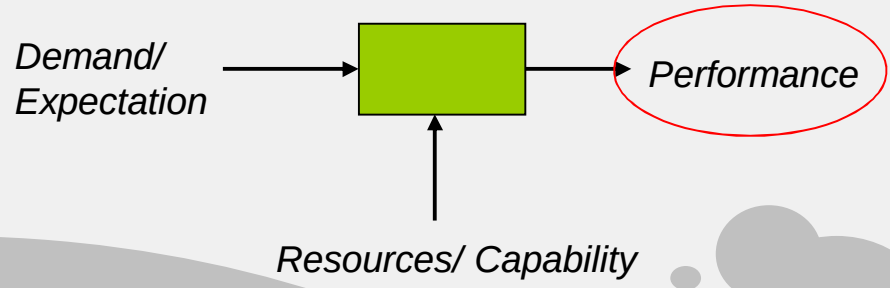


Consolidated Risk Picture

By identifying data and measures to support each of these three variables in the system we can bring them together to form a Consolidated Risk Picture

Enabling really effective risk management at any level*

** The concept is scalable from the individual right up to the global system level*



Historically, as an industry, we have spent most of our time, and effort, in the 'outcome' performance area

and within that we have concentrated further still on using employee reporting data

However we are increasingly interested in 'system generated' data but in the context of 'another view'

We should be striving for a better picture: *a cohesive picture…*

Data verses Knowledge

Employee reporting data is a rich source of information but is narrow in its scope

System generated data is often lacking in detail but wide in its coverage

combined they become a powerful source of system performance knowledge

"The whole is greater than the sum of its parts." - Aristotle

A BIG Picture

But there is more...

If we are really interested in a ‘big picture’ then we not only need to look ***deeper*** within our domains but also ***wider*** across the functional and global aviation domain

A truly integrated aviation system needs an integrated view of risk performance

"The whole is greater than the sum of its parts." - Aristotle

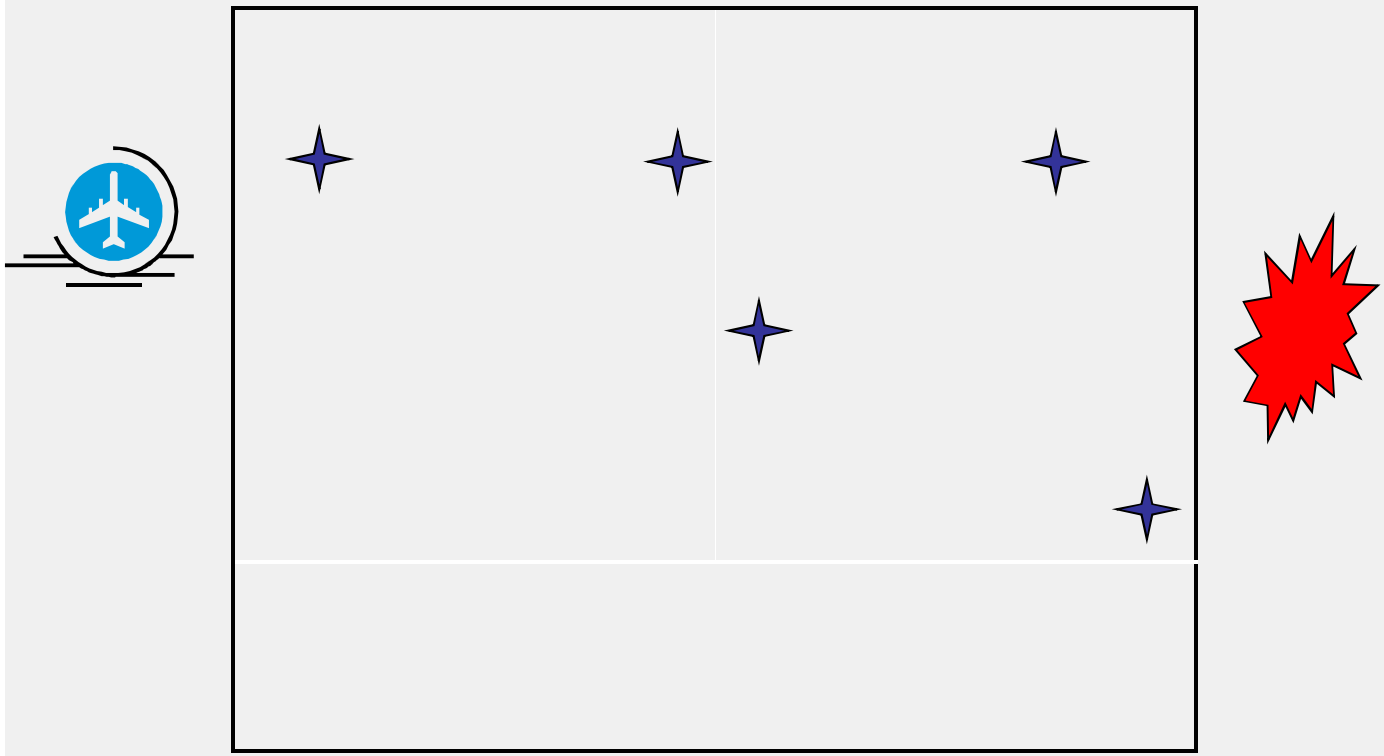
Understanding Risk

The key to bringing these wide sources of data together is a common understanding:

all these adverse events allude to **risk**;
risk in terms of the likelihood of an accident outcome occurring

Hence they share a commonality that allows us to place them in a common 'risk space'

The shared Risk Space



ARMS Event Risk Classification (ERC) Framework

What was the effectiveness of the remaining barriers between this event and the accident scenario?

EFFECTIVE	LIMITED	MINIMAL	NOT EFFECTIVE
2	20	200	2000
1	10	100	1000
0.1	1	10	100
0.01			

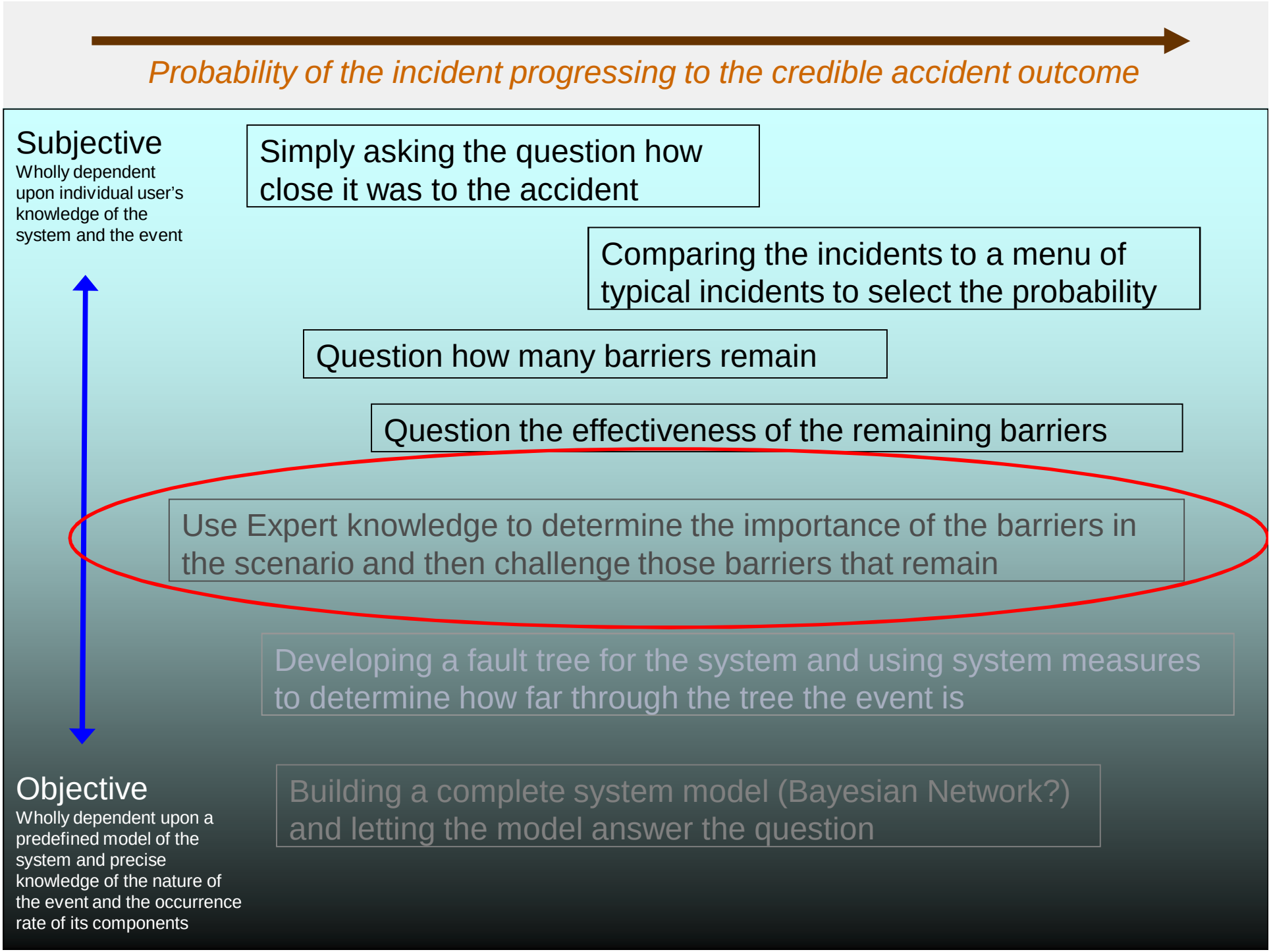
If this event had escalated into an accident, what would have been the most credible accident outcome?

Catastrophic accident with multiple fatalities >8

1-8 fatalities, multiple serious injuries, major damage/loss to the aircraft

Minor injuries, minor damage to aircraft

No potential damage or injury could occur


Probability of the incident progressing to the credible accident outcome
Subjective
Wholly dependent upon individual user's knowledge of the system and the event
Simply asking the question how close it was to the accident
Comparing the incidents to a menu of typical incidents to select the probability
Question how many barriers remain
Question the effectiveness of the remaining barriers
Use Expert knowledge to determine the importance of the barriers in the scenario and then challenge those barriers that remain
Developing a fault tree for the system and using system measures to determine how far through the tree the event is
Building a complete system model (Bayesian Network?) and letting the model answer the question
Objective
Wholly dependent upon a predefined model of the system and precise knowledge of the nature of the event and the occurrence rate of its components

ECAST – Common Risk Classification Framework

Barrier models provide an ‘accessible’ way to evaluate the probability of an event progressing to an accident (*Safety Margin*)

Q. *What barriers stopped this event progressing?*

What other barriers could also have stopped this event progressing?

How reliable are those barriers?

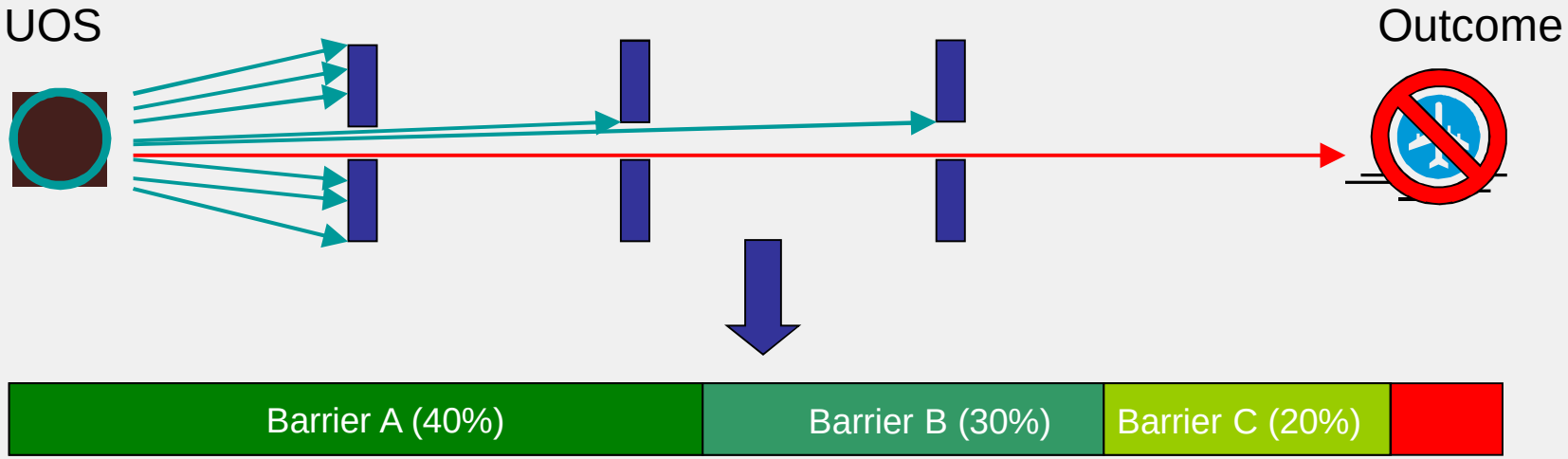
Building upon:

Risk Analysis Tool (RAT)

Analytical Hierarchy Process from the APF

Formulating a Barrier Model

- Scenario – system has three barriers and a $Prob_{OUTCOME}$ of 10%, thus the barriers stop 90% of all undesirable operational states becoming an undesired outcome



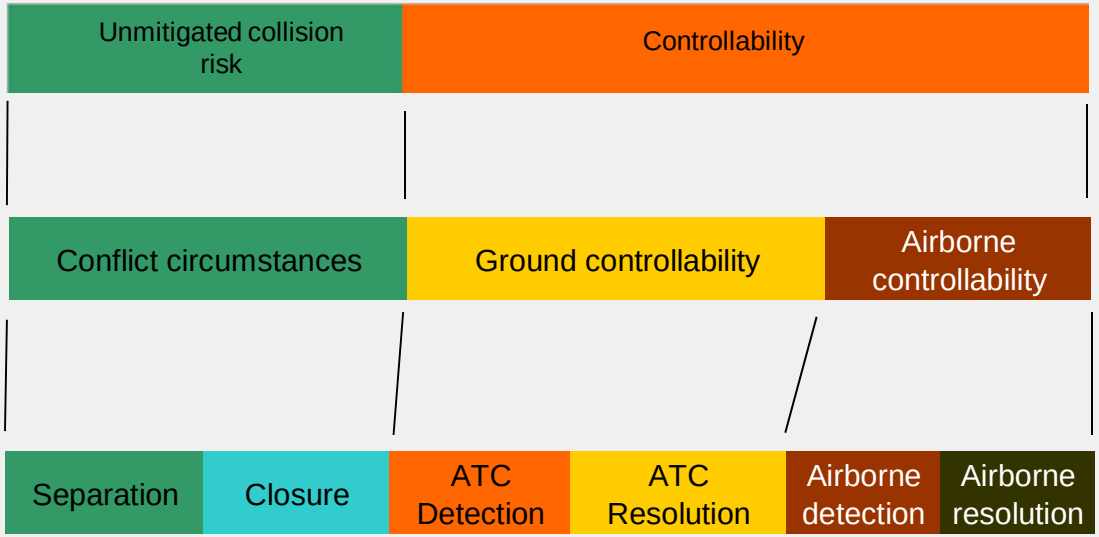
So what happens if Barrier A is eroded or does not exist?

The Eurocontrol ‘RAT’

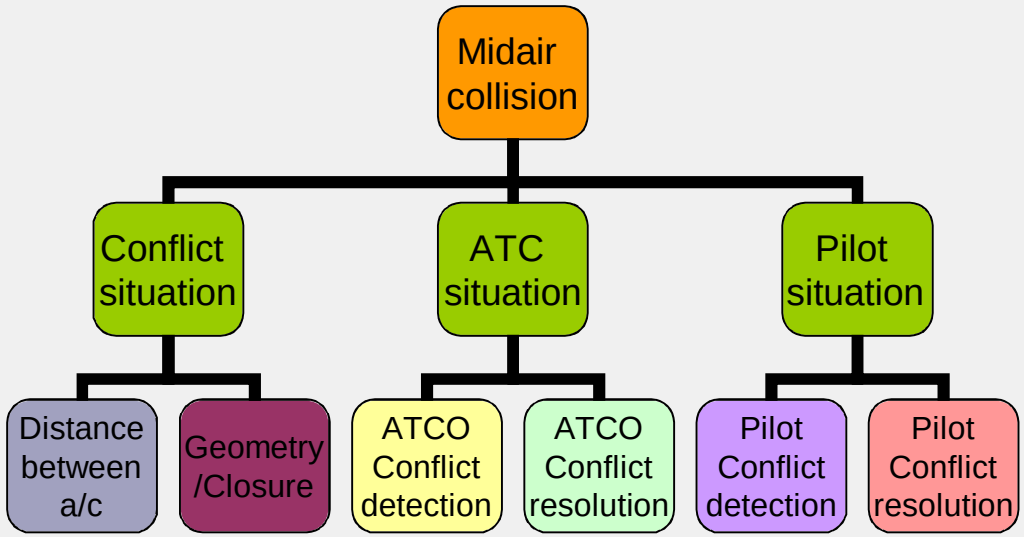
1. Risk of collision	ATM ground	ATM airborne
Minimum separation achieved	0	0
Separation < 75% minimum	1	1
Separation > 50%, <= 75% minimum	3	3
Separation > 25%, <= 50% minimum	7	7
Separation <= 25% minimum	10	10
Total separation (a)		
Rate of closure NONE	0	0
Rate of closure LOW (<= 85knots, <= 1000ft/mn)	1	1
Rate of closure MEDIUM (> 85 and <= 205 knots, > 1000 and <= 2000 ft/mn)	2	2
Rate of closure HIGH (> 205 and <= 700 knots, > 2000 and <= 4000 ft/mn)	4	4
Rate of closure VERY HIGH (> 700knots, > 4000ft/mn)	5	5
Total rate of closure (b)		

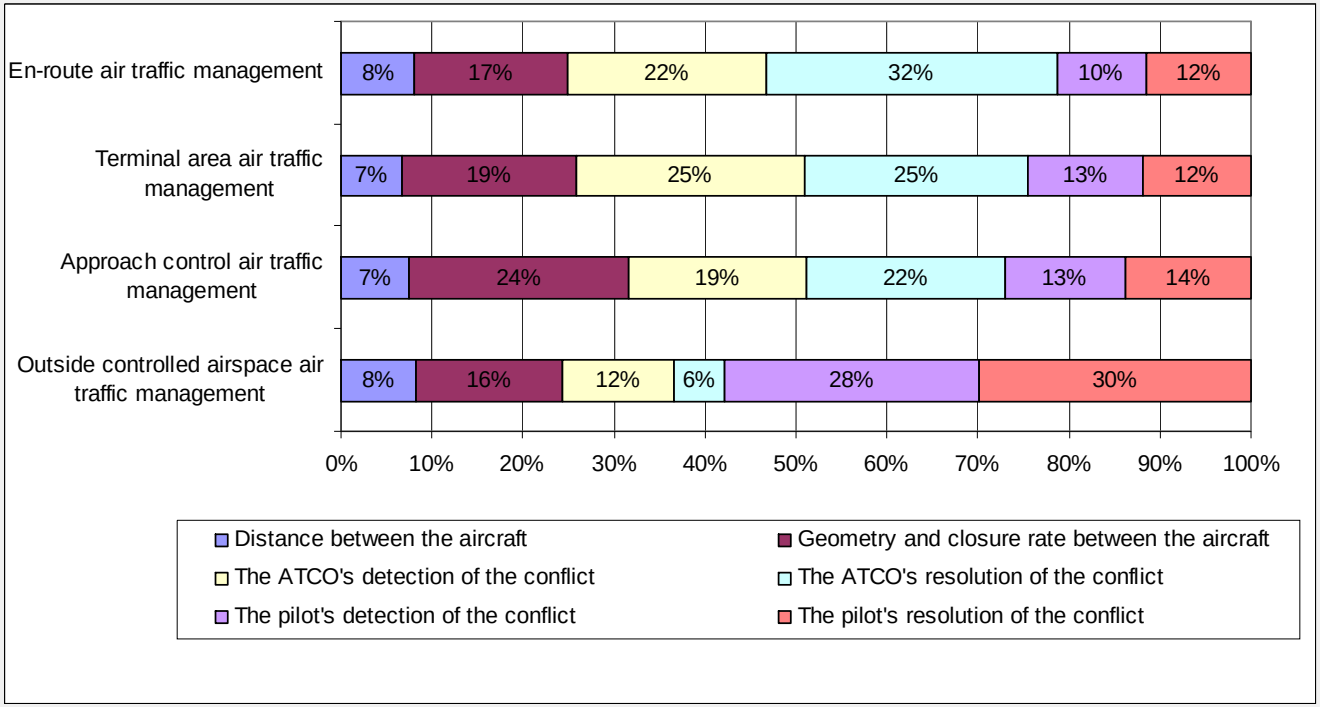
TOTAL (1-ATM) Risk of Collision (a)+(b)	0
TOTAL (1-ATM Ground) Risk of Collision (a)+(b)	0

2. Controllability	ATM ground	ATM airborne
Conflict detected	0	0
Conflict detected late	3	0
Conflict NOT detected	5	0
Plan CORRECT	0	0
Plan INADEQUATE	3	0
NO plan	5	0
Execution CORRECT	0	0
Execution INADEQUATE	3	5
NO execution	5	10
Current STCA triggered	3	0
NO STCA warning	5	0
Recovery CORRECT	0	0
Recovery INADEQUATE	5	6
NO recovery or the ATM ground actions for recovery have worsen the situation or ATM airborne has worsen the situation	10	15
TCAS triggered (useful RAs only to be considered) or see and avoid pilot decision (in the absence of TCAS)	10	0
NO TCAS RA	0	10
Pilot(s) followed RA (or, in absence of RA, took other effective action, as a result of see and avoid decision)	0	0
Pilot(s) INSUFFICIENTLY followed RA	0	10
Pilot(s) INCORRECTLY followed RA (or, in the absence of RA, took other inadequate action)	0	15
	TOTAL (2-ATM Ground)	TOTAL (2-ATM Airborne)
	0	0



Example output from Midair collision work





ARMS ERC and the Common Risk Classification Framework

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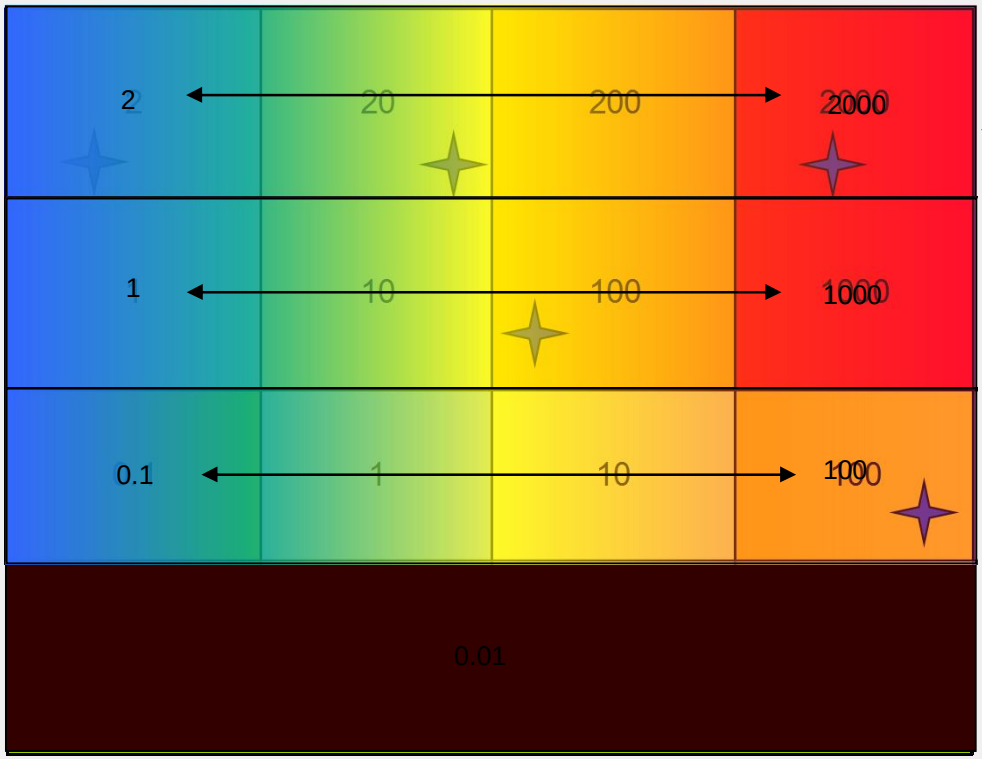

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The Output

A common way to assess outcome probability: CRCF barrier model approach

+ application to the ERC risk space

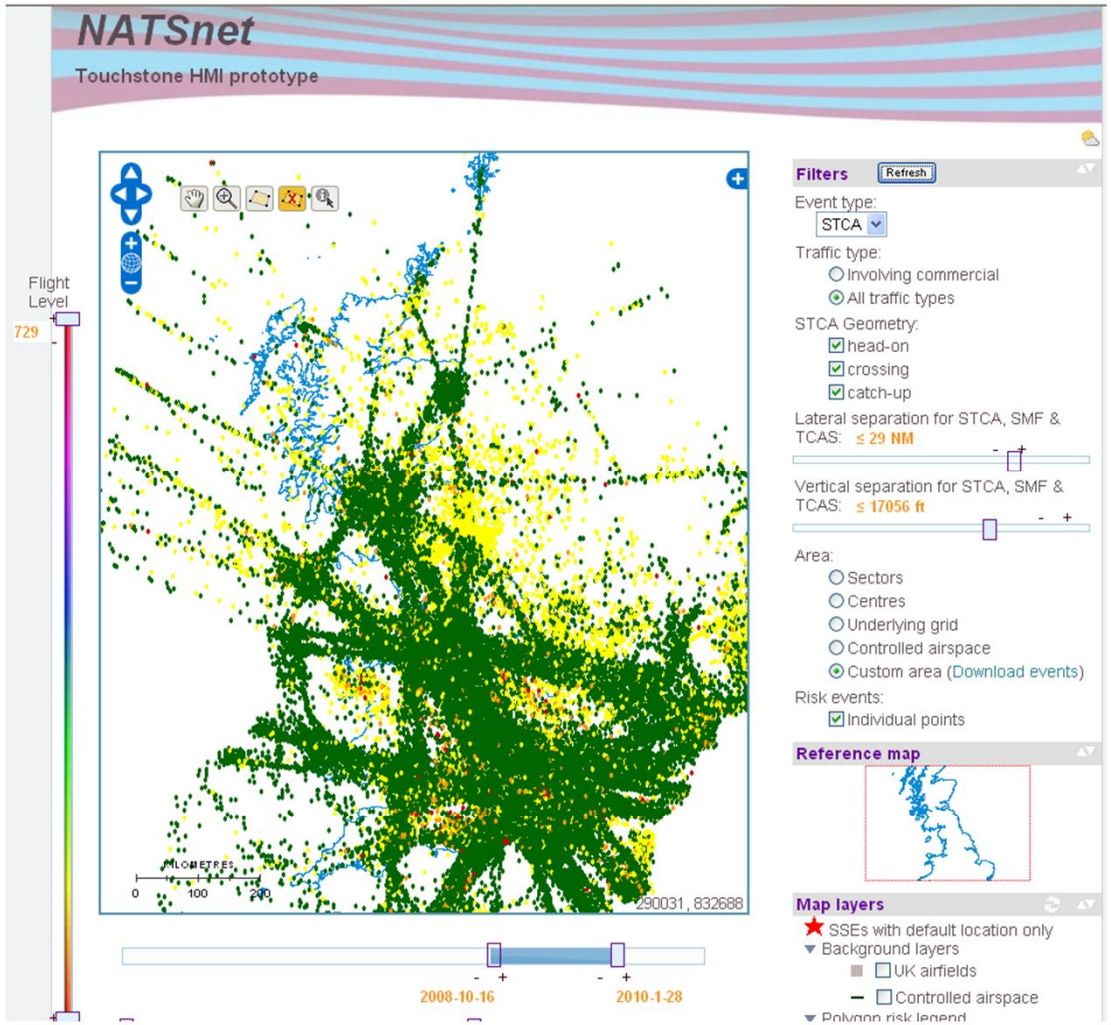
= a comparable and combinable output in terms of risk with which…

Aerospace Performance Factor type tracking

European Safety Performance Indicators

. . .

What is Touchstone?



ASMT Workshop - Belgocontrol

27th-28th October 2011

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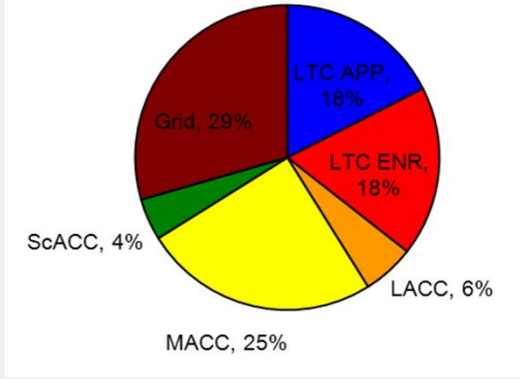
Touchstone concept

'Big Picture' in terms of outcome/system performance

Centre	Sector Number	Sector Name	Rank (05-08)
Approach	SN=A5	HEATHROW APPROACH	1
Approach	SN=A6	GATWICK APPROACH	2
Approach	SN=A1+A2	ESSEX RADAR	3
Approach	SN=A3	THAMES RADAR	4
TC	SECTOR 58E	NORTH - NE+LAM	5



Expert knowledge

Risk ref. data (SSR codes etc)

ATM Risk Data sources

Report Data

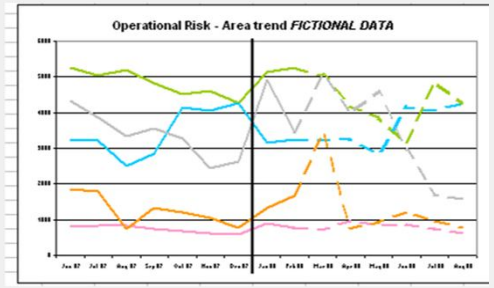
Conflict Data

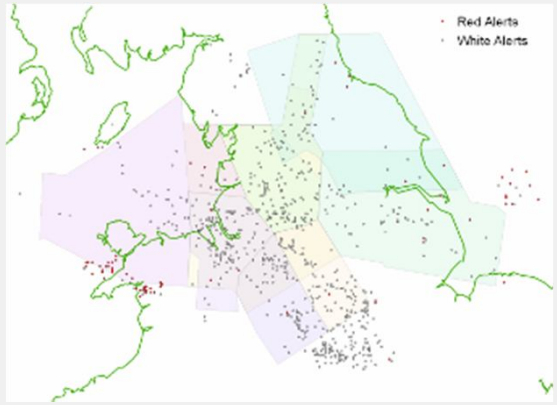
TCAS events

Separation

…. ?

Risk Inference Model





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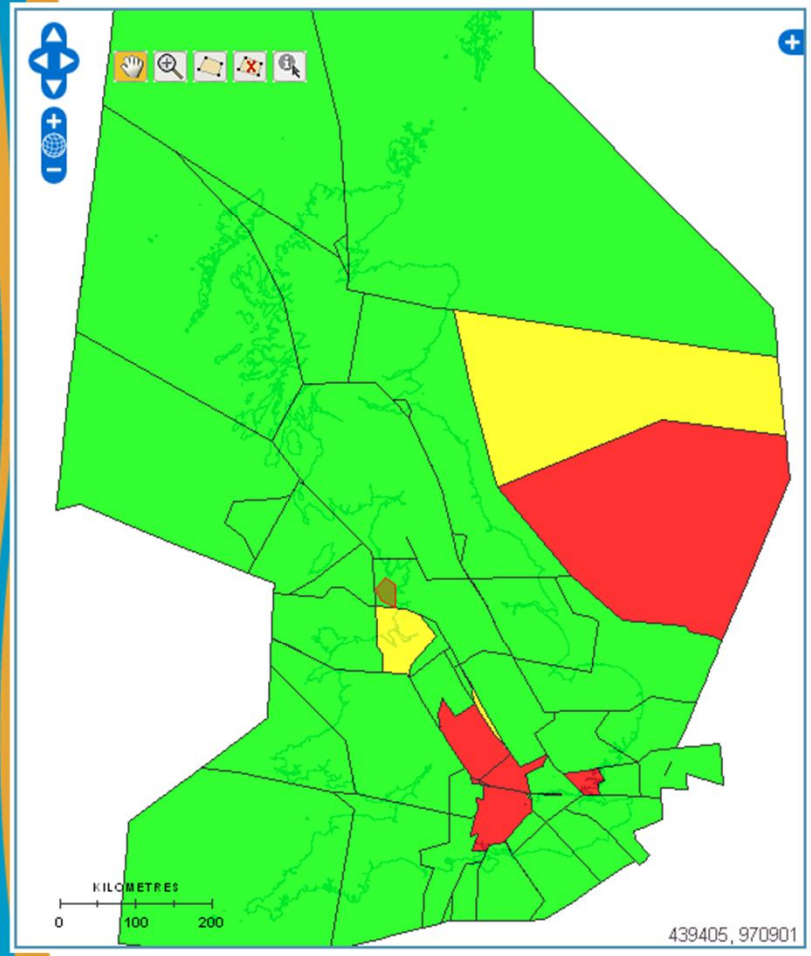
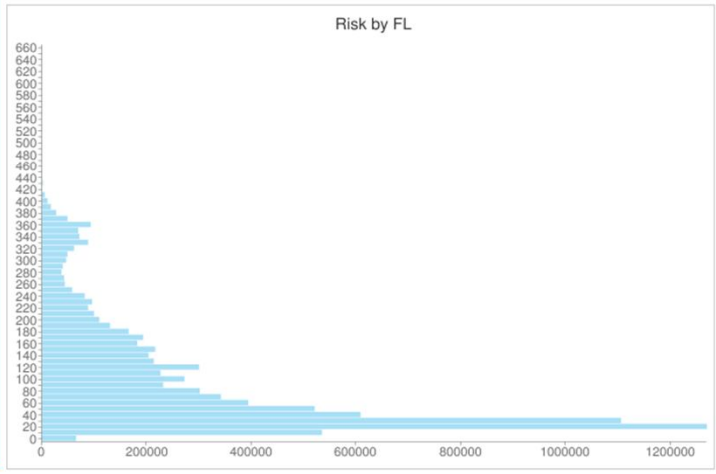
Understanding the Past
Business-level: Easy Access to Information





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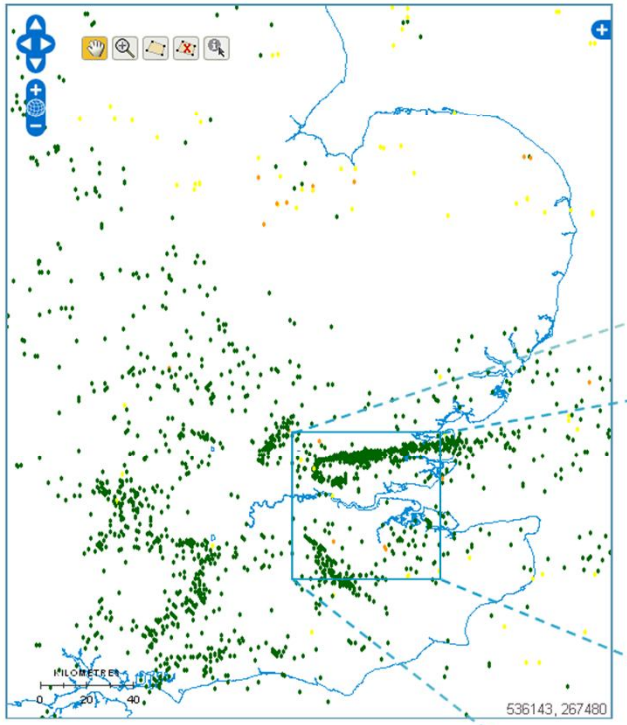
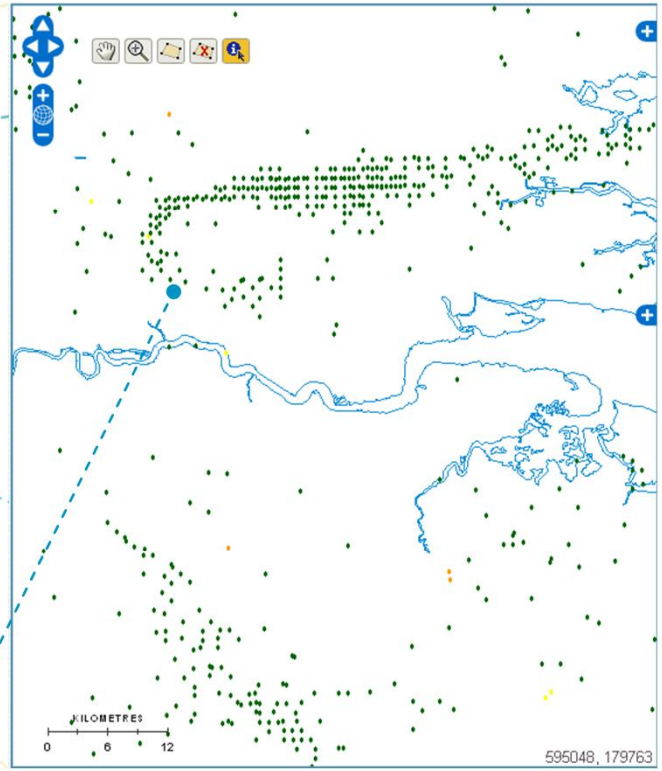
Understanding the Past
Unit-level: Easy Access to Data



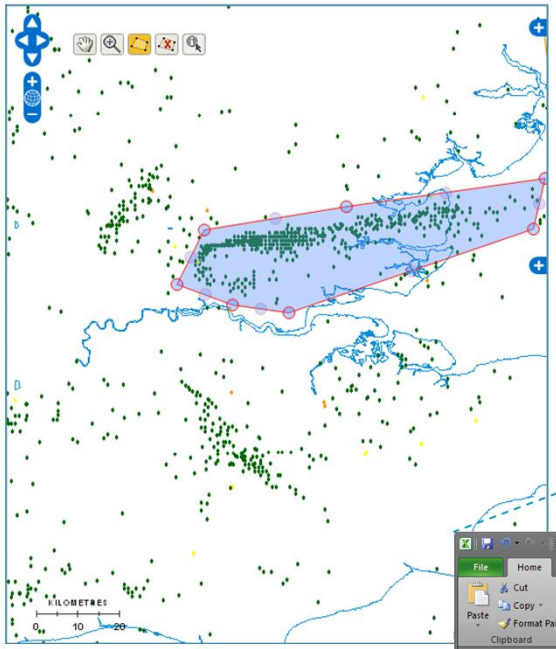


Query results

Risk events
Centre: LACC | **Pair:** 575 | **Letter:** D | **Altitude:** 126
SSR 1: 1136 | **SSR 2:** 1374 | **Intruder:** 0 | **Reg.:** 2
Lateral separation: 0.3 | **Vertical separation:** 1274
Angle: 0.999219239 | **S.value:** 1.275412083 | **Vclos:** 22
Strtcycl:2 | **x1:**64 | **y1:**-30 | **h1:**133 | **x2:**64 | **y2:**-30 | **h2:**120
Strtsev: 3 | **Wrstsev:** 3 | **Durn:** 24 | **FF:** L | **Delayip:** 0
Lmdl: 0.3 | **Tmla:** 0 | **Tca:** 75 | **Tov:** 44 | **Lateral:** C
Vertical: D L | **Sumstrtsev:**3 | **Sumwrstev:**3 | **Sumdurn:**23
Final centre: TC | **Final sector number:** SN=58E
Group CAT - CAT | **Timestamp:** 2009-12-07 18:26:36

NATS

Understanding the Past
Unit-level: Easy Access to Data



Filters Refresh

Event type:
STCA

Traffic type:
- Involving commercial
- All traffic types

STCA Geometry:
- head-on
- crossing
- catch-up

Lateral separation for STCA, SMF & TCAS: ≤ 6 NM

Vertical separation for STCA, SMF & TCAS: ≤ 2500 ft

Area:
- Sectors
- Centres
- Underlying grid
- Controlled airspace
- Custom area (Download events)

Risk events:
- Individual points

Reference map

download [Read-Only] - Microsoft Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	date	centre	pair	letter	cat	ssr1	ssr2	intruder	time	reg	strtcycl	ff	delaylp	strtsev	wrstsev	durn	x1	y1	h1
2	01/10/2009	LACC	1908	E	0	6263	7413	0	17:52:12	1	4	L	0	3	1	42	83	-22	200
3	01/10/2009	LACC	2256	E	0	6263	4420	0	17:57:24	1	0	L	-1	3	3	54	93	-24	185
4	01/10/2009	LACC	2530	E	0	6263	7413	0	18:02:12	2	2	L	0	3	3	12	73	-23	167
5	01/10/2009	LTCC	204	-	0	7413	6263	0	17:52:10	3	30	I	0	3	3	32	44	13	215
6	01/10/2009	LTCC	206	-	0	7413	6263	0	18:02:02	3	30	I	0	3	3	16	33	11	182
7	02/10/2009	LACC	3387	E	0	5446	3561	0	18:23:00	2	4	L	0	3	3	18	66	-24	132
8	02/10/2009	LACC	5705	E	0	2517	4145	0	19:03:36	2	2	L	0	3	3	12	69	-25	132
9	02/10/2009	LACC	7250	F	0	4137	606	0	07:44:00	2	7	L	0	3	3	12	69	-26	130
10	02/10/2009	LTCC	195	-	0	4304	766	0	18:03:22	12	29	LI	0	3	3	32	21	10	110
11	03/10/2009	LACC	3837	B	0	6625	4422	0	12:27:06	2	2	L	0	3	3	18	73	-24	120
12	03/10/2009	LACC	4183	C	0	4356	4403	0	15:56:54	1	4	L	0	3	2	96	91	-21	174
13	03/10/2009	LACC	6751	A	0	731	627	0	10:40:06	2	4	L	-1	3	3	12	72	-27	144
14	03/10/2009	LTCC	41	-	0	6625	4422	0	12:29:15	12	29	L	2	3	3	40	26	11	110
15	03/10/2009	LTCC	60	-	0	2534	7726	0	15:42:07	12	30	I	0	3	3	28	21	9	112
16	03/10/2009	LTCC	61	-	0	4356	4403	0	15:56:55	3	29	I	0	3	3	84	52	14	173
17	04/10/2009	LACC	4450	D	0	7334	773	0	17:56:24	2	2	L	0	3	3	42	82	-24	180
18	04/10/2009	LTCC	173	-	0	6016	6273	0	17:23:46	3	30	I	0	3	3	16	30	11	159
19	04/10/2009	LTCC	179	-	0	773	7334	0	17:54:22	3	30	L	0	3	3	44	51	13	206

Conclusion

The key to effective Risk Management is *knowledge* of how our system functions and how it is performing

We need a better, and bigger, *Risk Picture*
for outcome performance: bigger means both depth (data) and breadth (industry)

The ECAST CRCF work is an enabler to a common risk performance space that will facilitate that bigger picture

Questions and Further Information

Questions

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