



# ***Maintenance Programme Evolution (MPE) demonstrator***

**F. VINIACOURT - EADS-CCR  
J. NEVEUX - AIRBUS**



## *Introduction*

**EASA** and **FAA** require the A/C Type Certificate holder to prepare and revise the **initial minimum scheduled maintenance requirements** that are applicable to a dedicated aircraft family.

This document is called the **Maintenance Review Board Report (MRBR)**, and provides the **scheduled maintenance tasks and their frequencies (intervals)** for the aircraft systems, powerplant and structure.

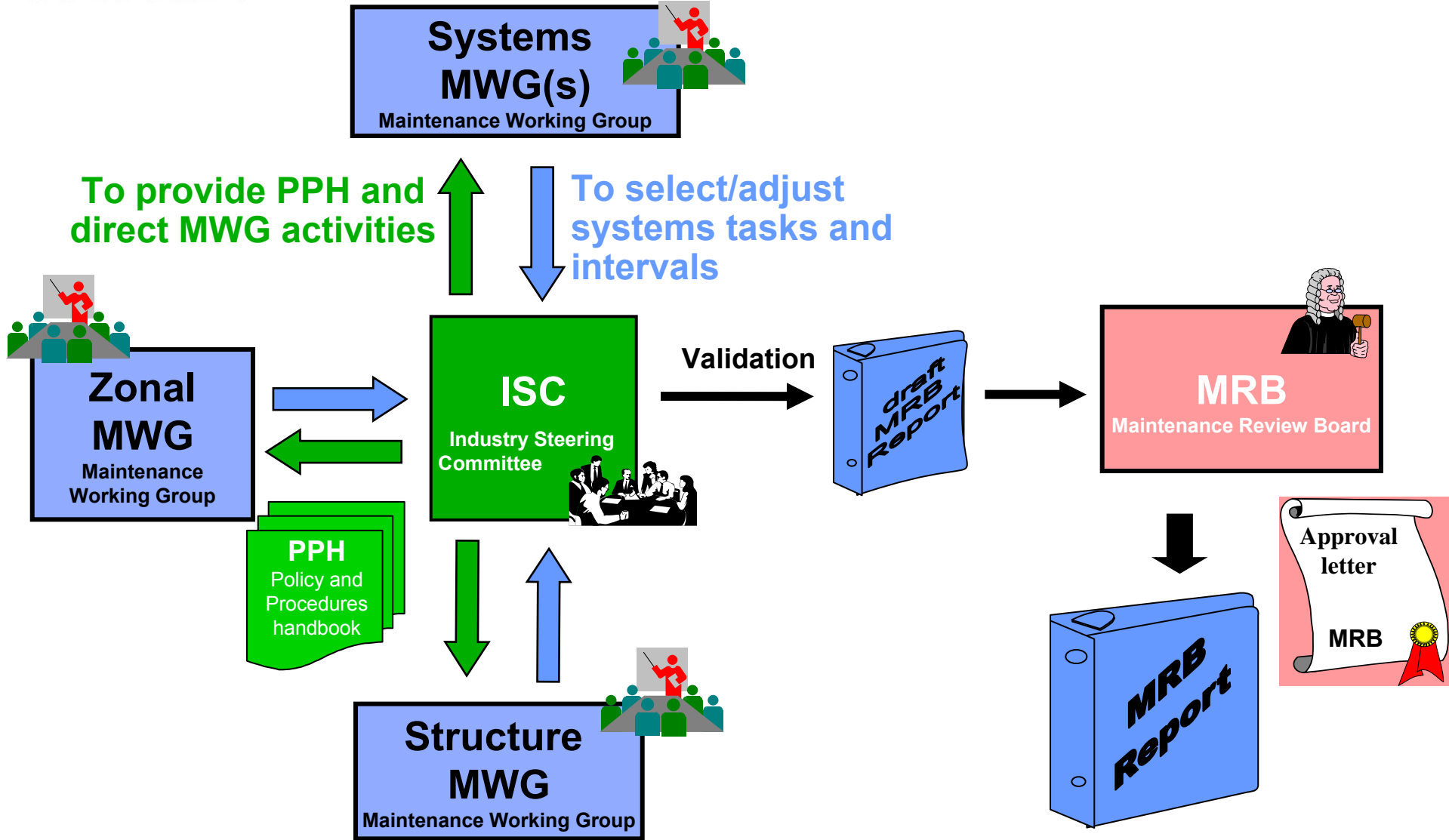
MRBR development is based on the MSG-3 method

Note: The MRBR is the main source document of the Maintenance Planning Document (MPD)

**The MRBR requirements form part of the instructions considered essential for proper maintenance as required by certification requirements CS 25.1529 Appendix H - “Instructions for Continued Airworthiness”**



# Maintenance Review Board Process





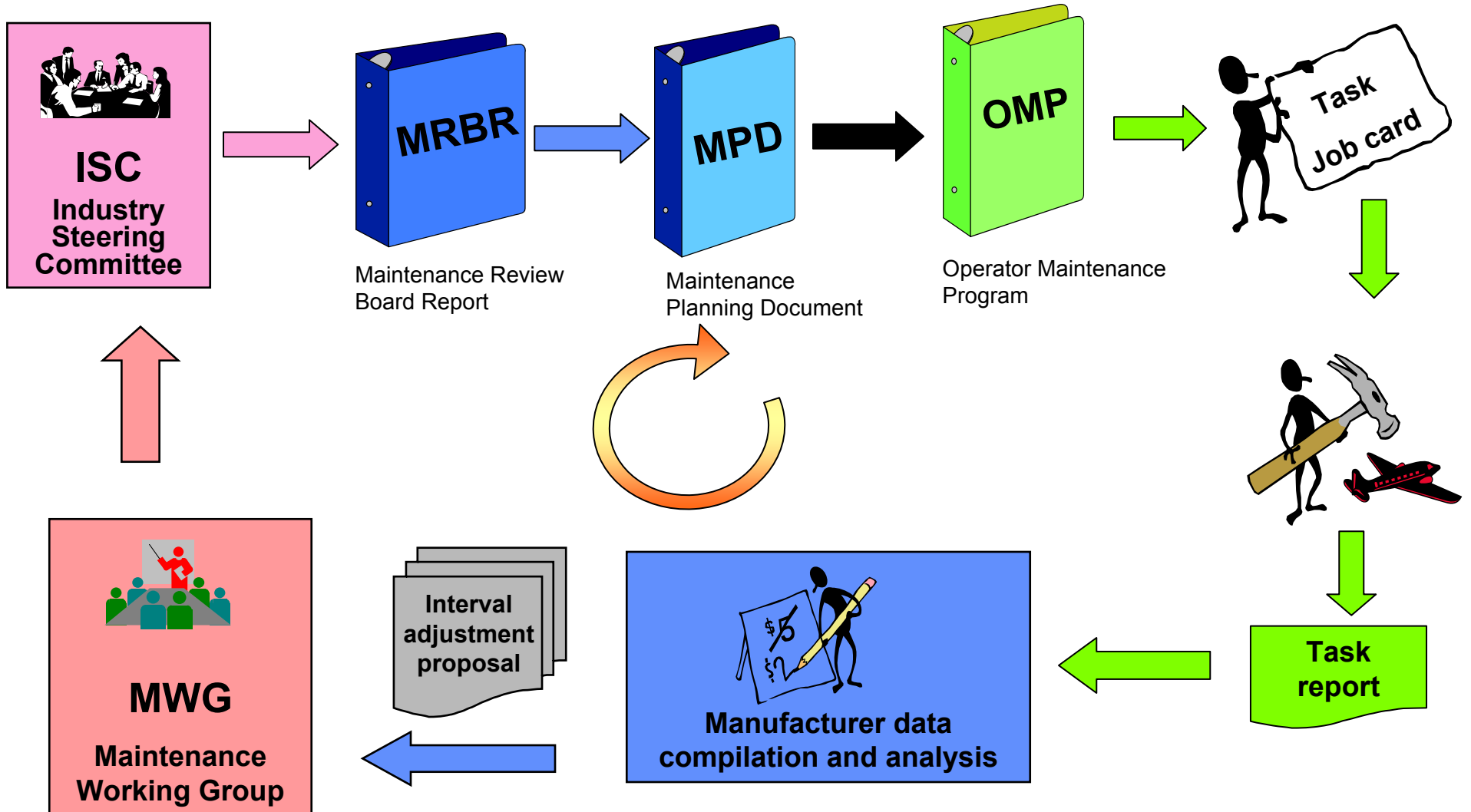
## *Maintenance Program evolution objective*

- Objective of Maintenance Program Evolution is to maintain **safety, reliability, at minimum cost.**
- Main means to achieve this is to **adjust the initial interval**
- Such exercise is launched when the A/C manufacturer and the ISC consider that sufficient **in-service experience is collected.**





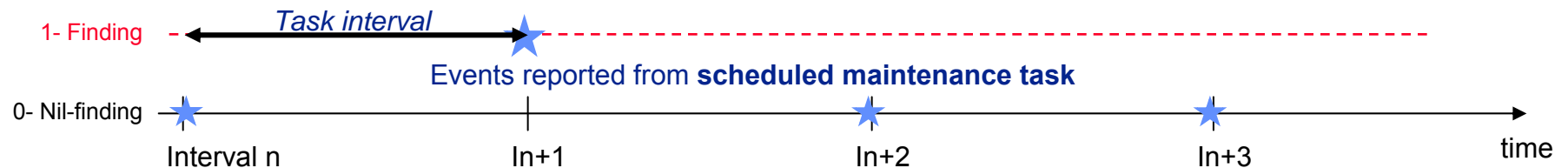
# Maintenance Program Evolution process





## Maintenance Program evolution process

- Airlines report in-service experience in the form of “Nil findings/details of findings” reports for each task.
- Tasks are reviewed individually in MWG meeting.





## ***GOAL of the Maintenance Program***

To develop an **innovative** methodology that **helps**, improves and **homogenises** “engineering judgement” for **system task interval adjustment** on commercial (& military) aircraft

**Work Package members:**

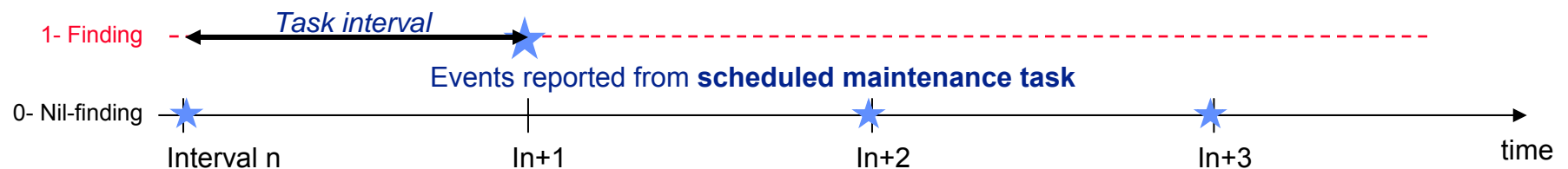
**AIRBUS, EADS-CCR, THALES**



## Model 1x assumptions

Statistical model developed with following assumptions

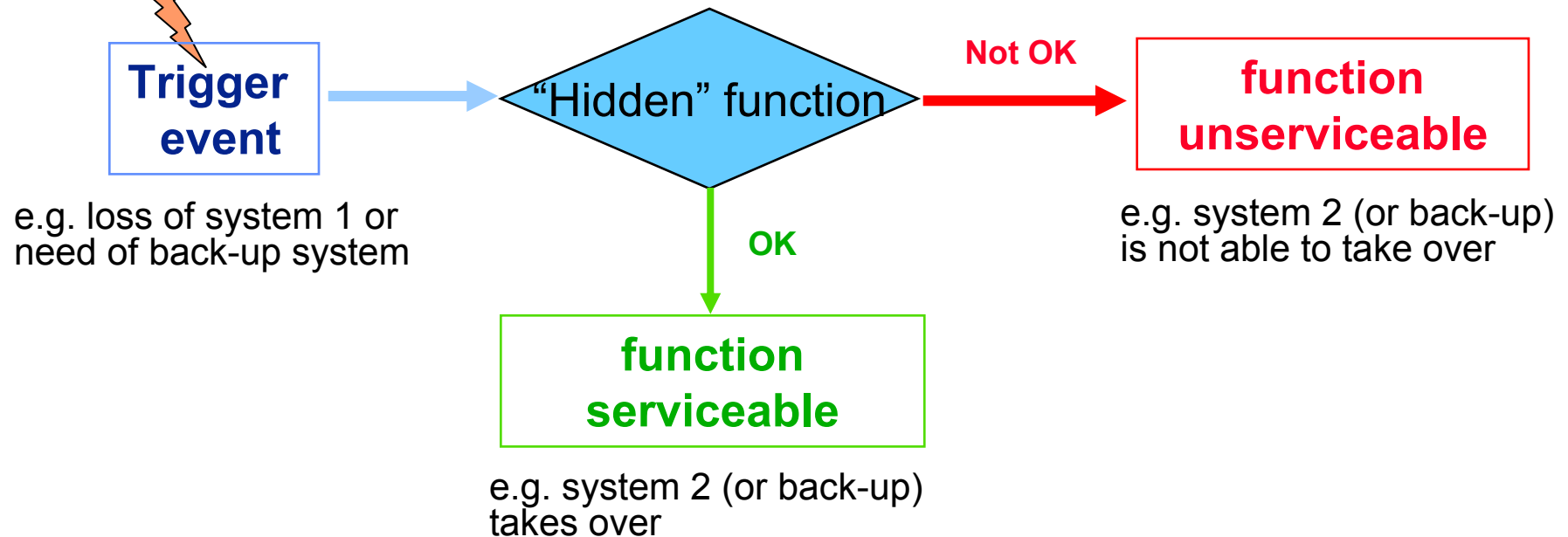
1. **Hidden functional failures only,**
2. **Constant failure rate (no ageing),**
3. **The order of magnitude of the initial interval is well chosen**



NOTE: Unscheduled maintenance is not taken into account in this model



## Model 1x definitions



**The model estimates serviceability (S) of hidden function = probability that the hidden function is serviceable when a trigger event occurs**

Nil finding reported on infinite fleet and number of checks  
= 100% serviceability of hidden function



## Model 1x principle

### INPUTS

- Number of task reported -  $N_T$
- Percentage of findings -  $\rho$

Mathematic Model  
Statistical risk  $\alpha$

### OUTPUTS

SU: Upper "Serviceability" of hidden function  
SL: Lower "Serviceability" of hidden function

Statistical risk  $\alpha$  is linked to the sampling error and introduces an uncertainty in the computation of "S"

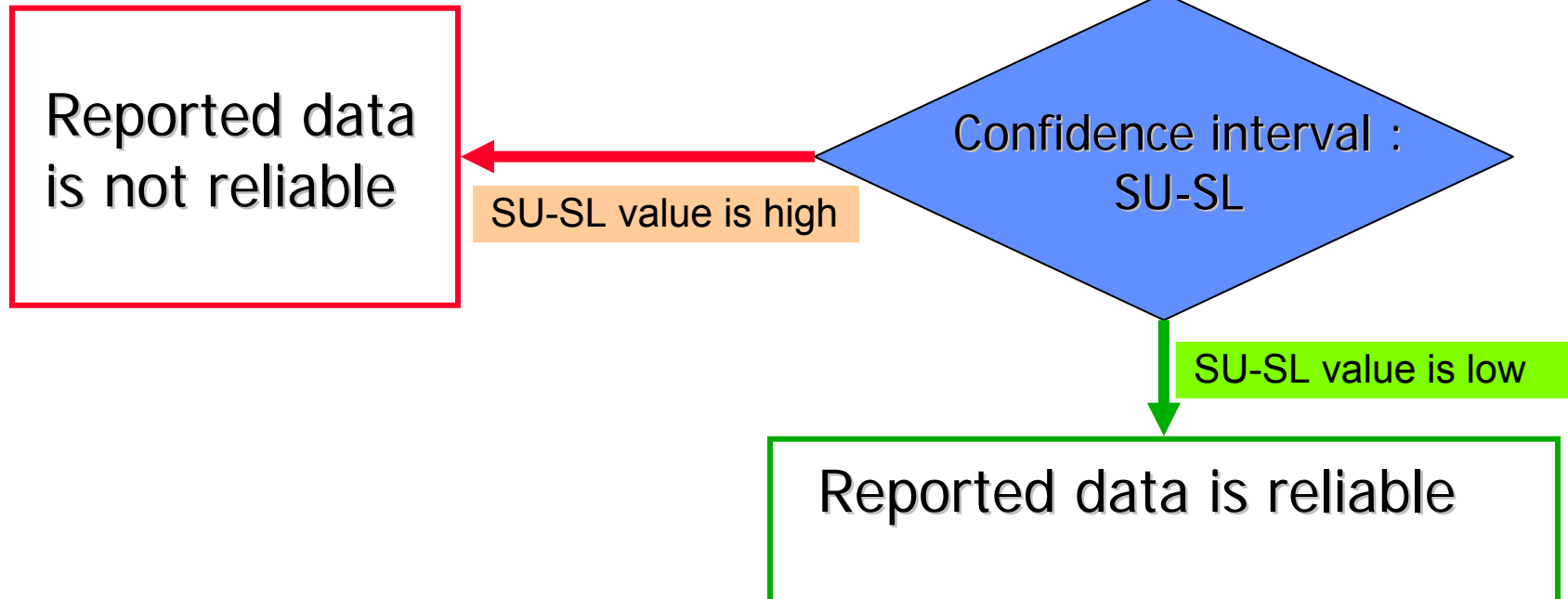
SU= high probability that the hidden function is serviceable when a trigger event occurs

SL= low probability that the hidden function is serviceable when a trigger event occurs



# Confidence interval

SU = Upper "Serviceability"  
SL = Lower "Serviceability"



SU-SL=0 means that the number of reported checks is infinite  
(i.e. SU=SL)



# Evolution guidance table

- Number of task reported -  $N_T$
- Percentage of findings -  $\rho$

## INPUTS

Synthesis table		Number of task reported			
		1	2	3	etc
$\rho$ % of relevant findings	0%	SU	SU	SU	SU
		SL	SL	SL	SL
	1%	SU	SU	SU	SU
		SL	SL	SL	SL
	etc	SU	SU	SU	SU
		SL	SL	SL	SL

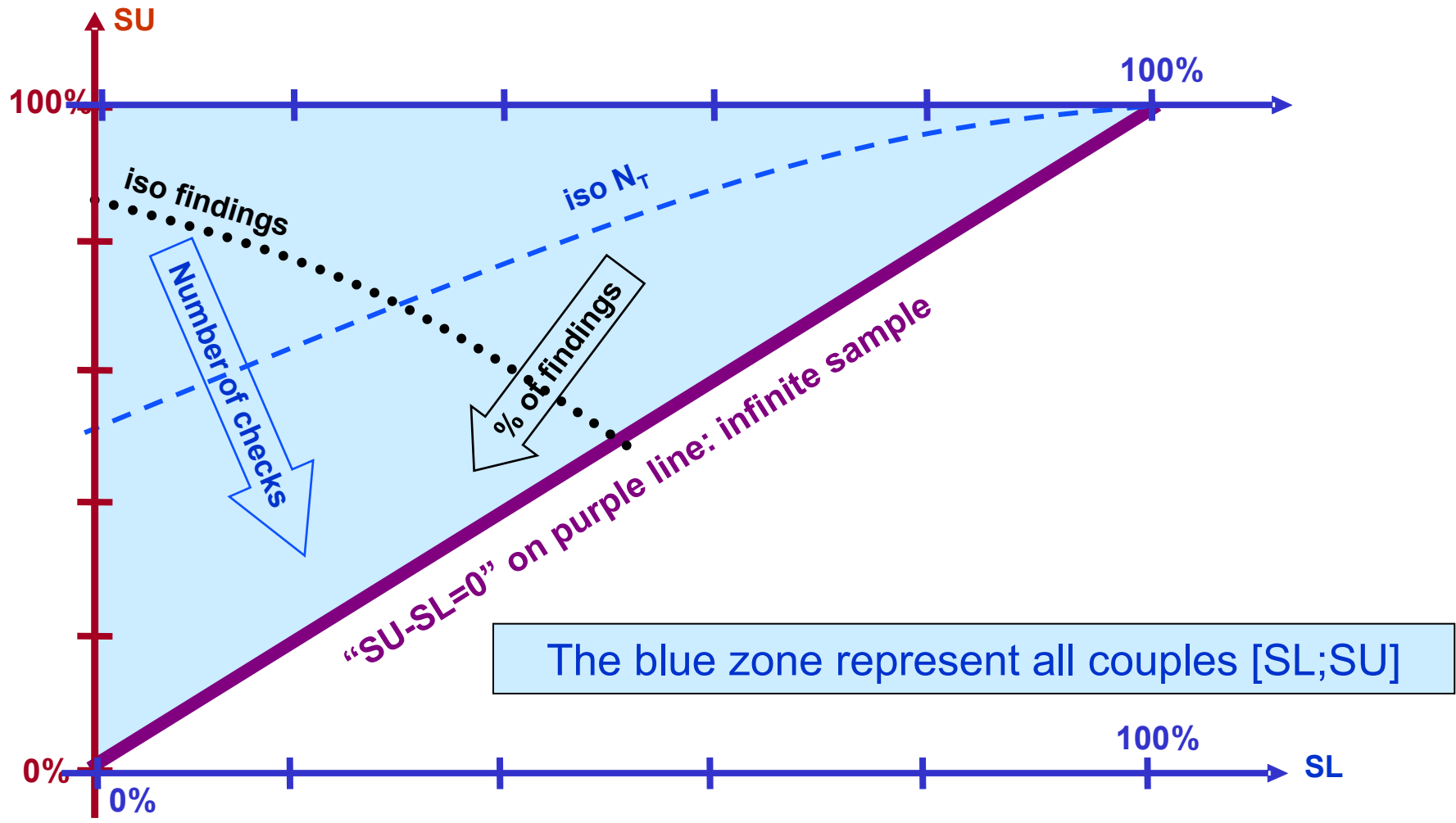
## OUTPUTS

**SU** : Upper "Serviceability" of hidden function  
**SL** : Lower "Serviceability" of hidden function

These couples [SL;SU] can be visualized on 2D

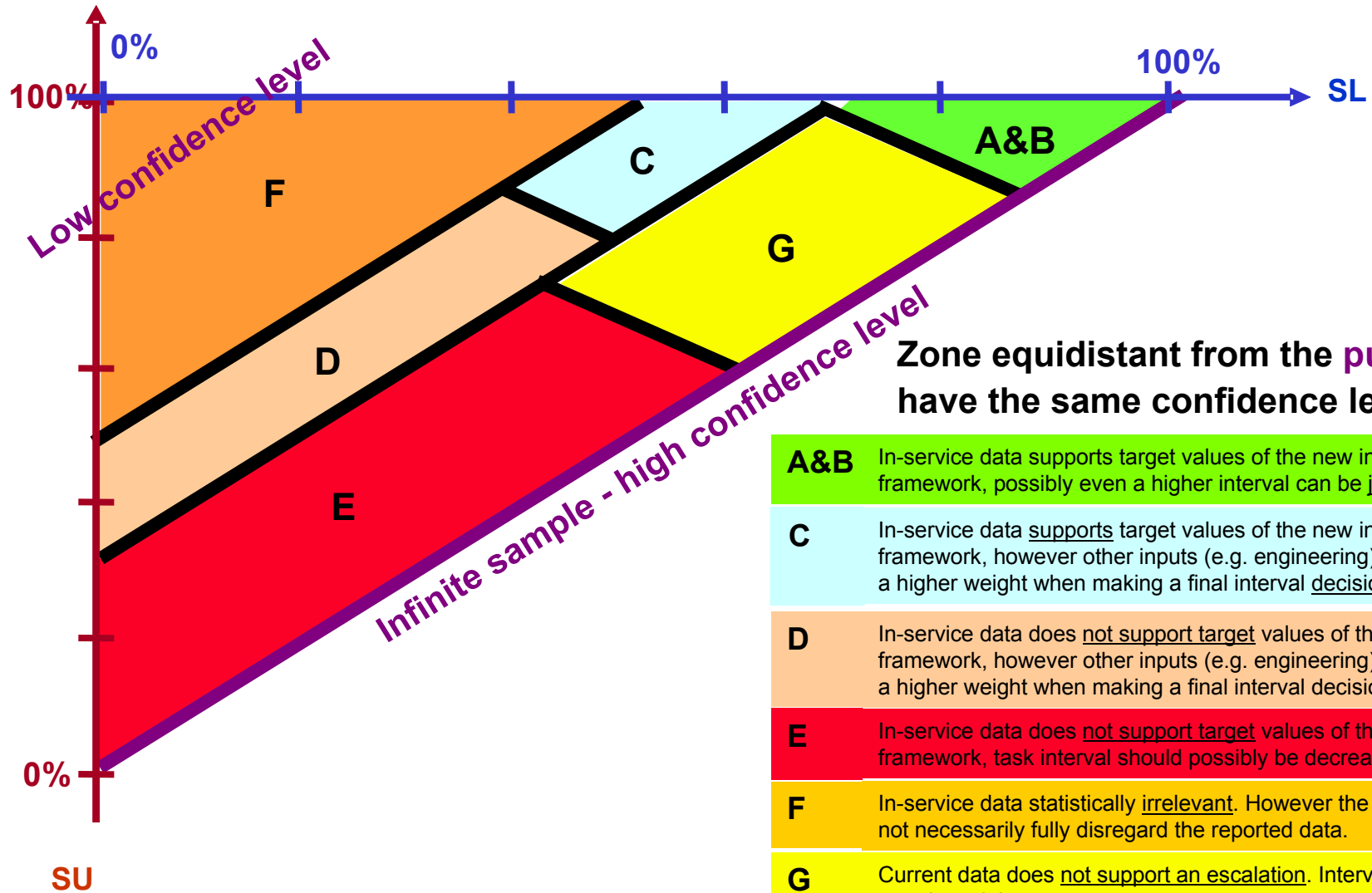


# Definition of zone on SU/SL diagram





# Definition of zone shape on SU/SL diagram

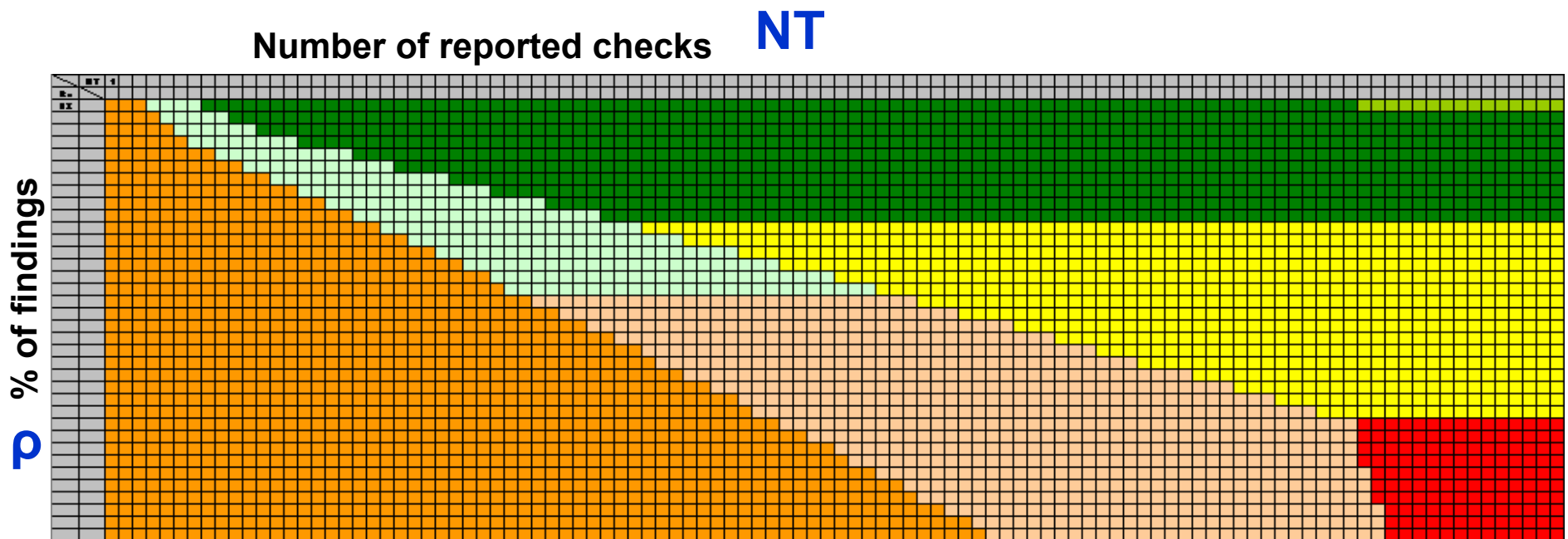


<b>A&amp;B</b>	In-service data supports target values of the new interval framework, possibly even a higher interval can be <u>justified</u>
<b>C</b>	In-service data <u>supports</u> target values of the new interval framework, however other inputs (e.g. engineering) should have a higher weight when making a final interval <u>decision</u>
<b>D</b>	In-service data does <u>not support target</u> values of the new interval framework, however other inputs (e.g. engineering) should have a higher weight when making a final interval decision
<b>E</b>	In-service data does <u>not support target</u> values of the new interval framework, task interval should possibly be decreased
<b>F</b>	In-service data statistically <u>irrelevant</u> . However the MWG should not necessarily fully disregard the reported data.
<b>G</b>	Current data does <u>not support an escalation</u> . Interval should remain as it is.



## Definition of zone shape on matrix

All coloured [SL;SU] couples are then visualized in a  
**Number of reported checks/ Percentage of findings**  
table

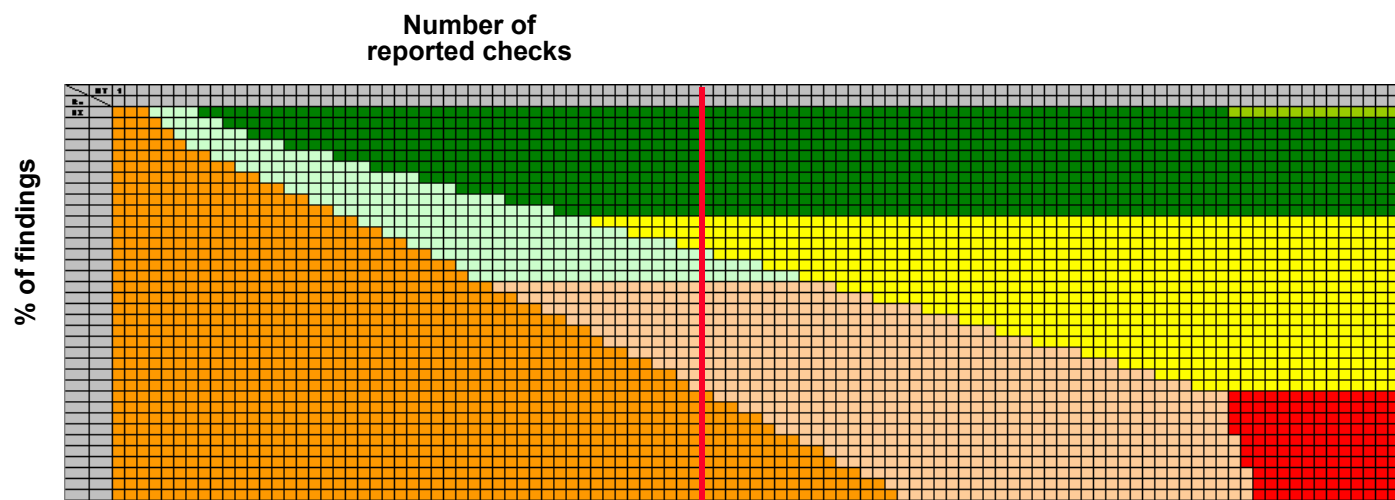




## Definition of zone shape on matrix

The graph shows that for the same number of reported check results, the confidence is higher with a low % of findings and may be statistically irrelevant (low confidence level) with a high % of findings.

This is because the confidence level is directly proportional to the % of findings.





## ***Conclusion on model 1x***

This model

- proposes to use several categories (A, B, C...) for interval adjustment
- indicates how to choose between these categories, using a [ $\rho$ , NT] table
- is easy-to-use and homogeneous for MWG activities.
- provides the shapes of categories zones on the [ $\rho$ , NT] table.
- does not provide the shape boundaries.
  - It remains the a/c manufacturer and operators decision to select them, according to their in-service experience and engineering judgement. This decision should take into account the targeted percentage of escalation.

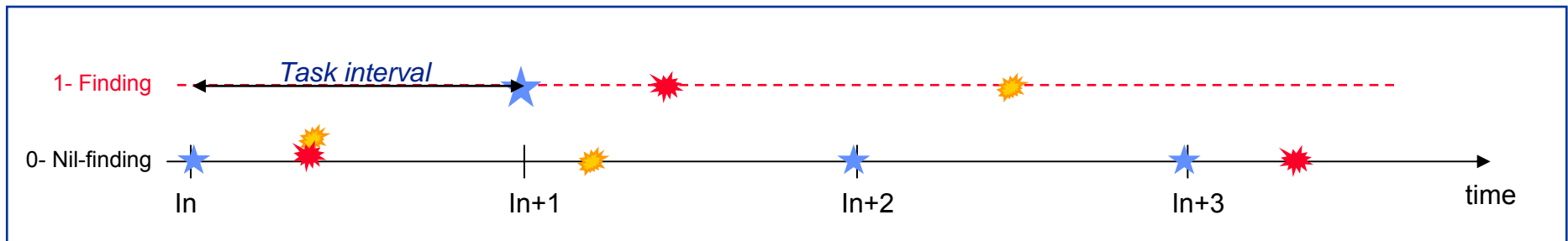
**This confirms that engineering judgement is still necessary to make the final interval adjustment**



## Next steps - model 2x

### 1. Impact of unscheduled maintenance

- “hidden” Functional Failure may become evident.
  - To the flight crew: upon multiple failures
  - To the ground personnel: during a line maintenance check



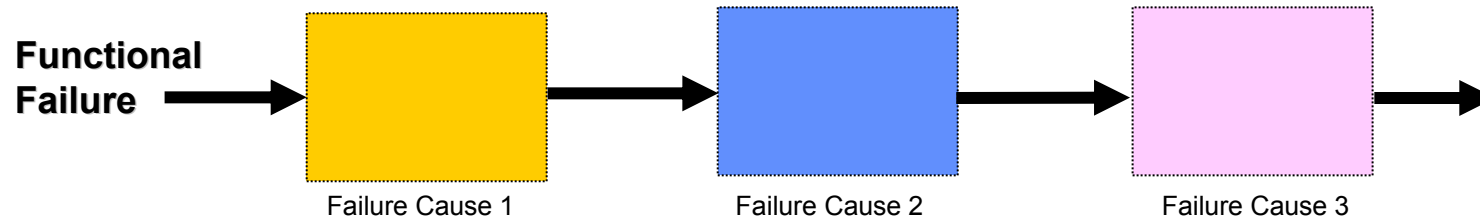
★ Events reported from scheduled maintenance task

★ Events reported from **Operational Interruptions**

★ Events reported from **Removals**

### 2- Modelling of MSG3 functional failure

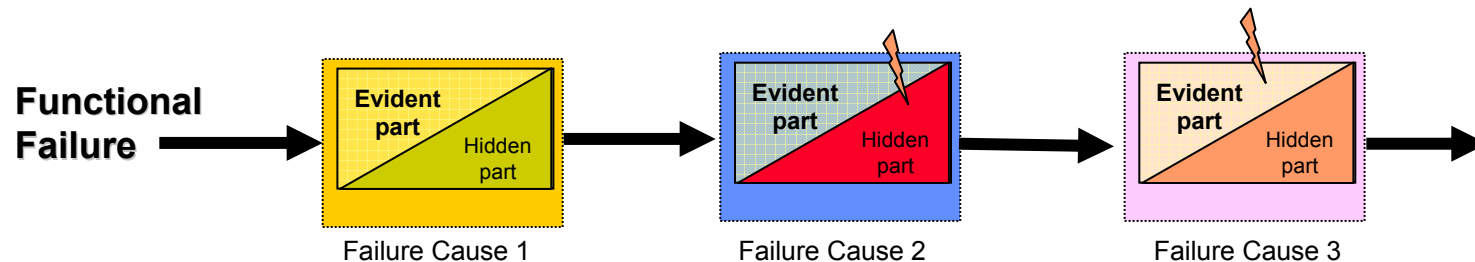
- which is defined as a series of Failure Cause
- Failure of any cause implies the failure of the function.
- MSG3 method does not list failure due to multiple causes



If any of FC1, FC2, FC3, FC4 or FC5 fails, then the function fails

### 3- Complex Failure Cause

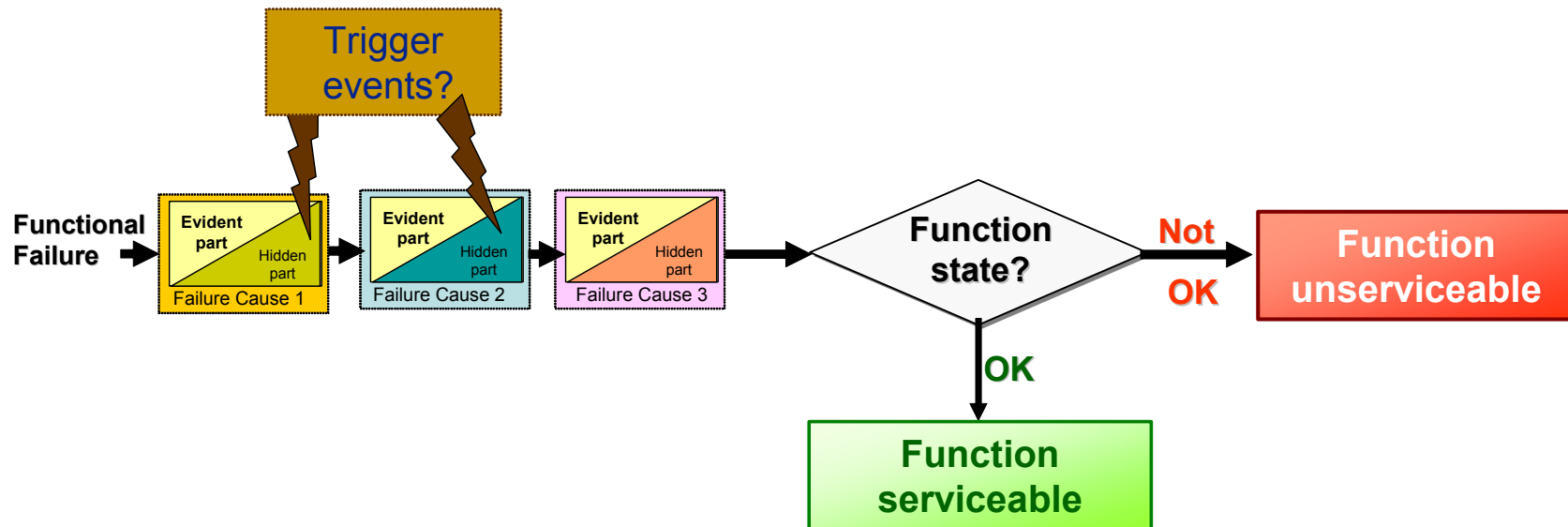
- Complex equipment, performing many functions, may be a failure cause of both hidden and evident functional failure
- Concept of Mixed failure causes
- Several trigger events



## Principle & Assumptions

Statistical model developed with following assumptions:

1. Constant failure rate (no ageing)
2. equipment is instantaneously restored upon evident failure

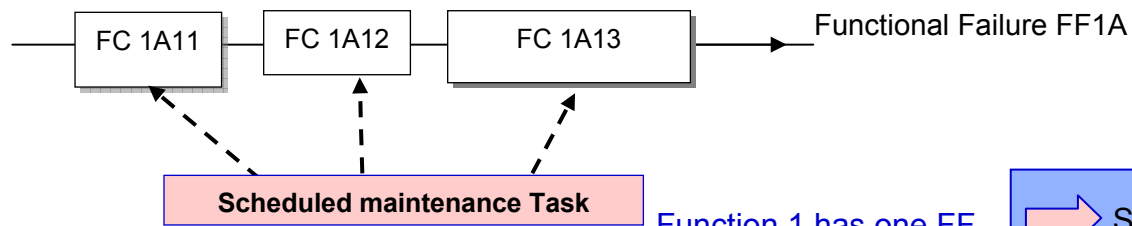


The model estimates serviceability (S) of the function = probability that the function is serviceable when needed



# Model2x summary

## Calculation



Function 1 has one FF

$$S_{F1} = SH_{FC1A11} \times SH_{FC1A12} \times SH_{FC1A13}$$

	INPUTS	
	EVIDENT FC	HIDDEN FC
Scheduled maintenance	Number of maintenance tasks reported	
	Percentage of relevant findings	
	Maintenance task Interval	
	Number of findings E	Number of findings H
Unscheduled maintenance	MTBURE	MTBURh
	NFFRe	NFFRh
	Nfuse	Nfush

	OUTPUTS	
	EVIDENT FC	HIDDEN FC
	serviceability e	serviceability h
	serviceability mixed	
	Number of findings e	Number of findings h
Unscheduled maintenance	Number of total findings	



## *MPE perspective*

- **VIVACE MPE models 1x and 2x will be disseminated by end of 2006 - end of the MPE task**
- **Final objective have been reached because**
  - **Model 1x has been tested and helps to homogenise “engineering judgement”**
  - **Model 2x is innovative, very close to the MSG3 methodology**
- **TATEM health monitoring and management systems could help to collect in-service data for maintenance program evolution**
- **Final step: to test and evaluate model 2x thru representative uses-cases**



## Questions

