

UQ&M, past, present, future ?



The presentation in a nutshell

- UQ&M has become a must-have topic for the last 10 years in engineering BUT it still requires « something » to be deployed!
- We will present the current trends in this area in two steps:
 - Part I: Wake-up session
 - Part II: A bit of maths before the 2 days

Let's analyse a striking use-case ...



... with these two brilliant characters ;-) !



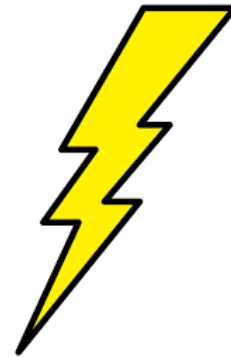
Comics 1 « The great hope »

Epoch1 « The simulation rises »
Simulate locally, communicate then
decide thanks to various expert views
1985-2005
a success...

Disciple, we need to **protect** the Xcraft against **lightning** strike !



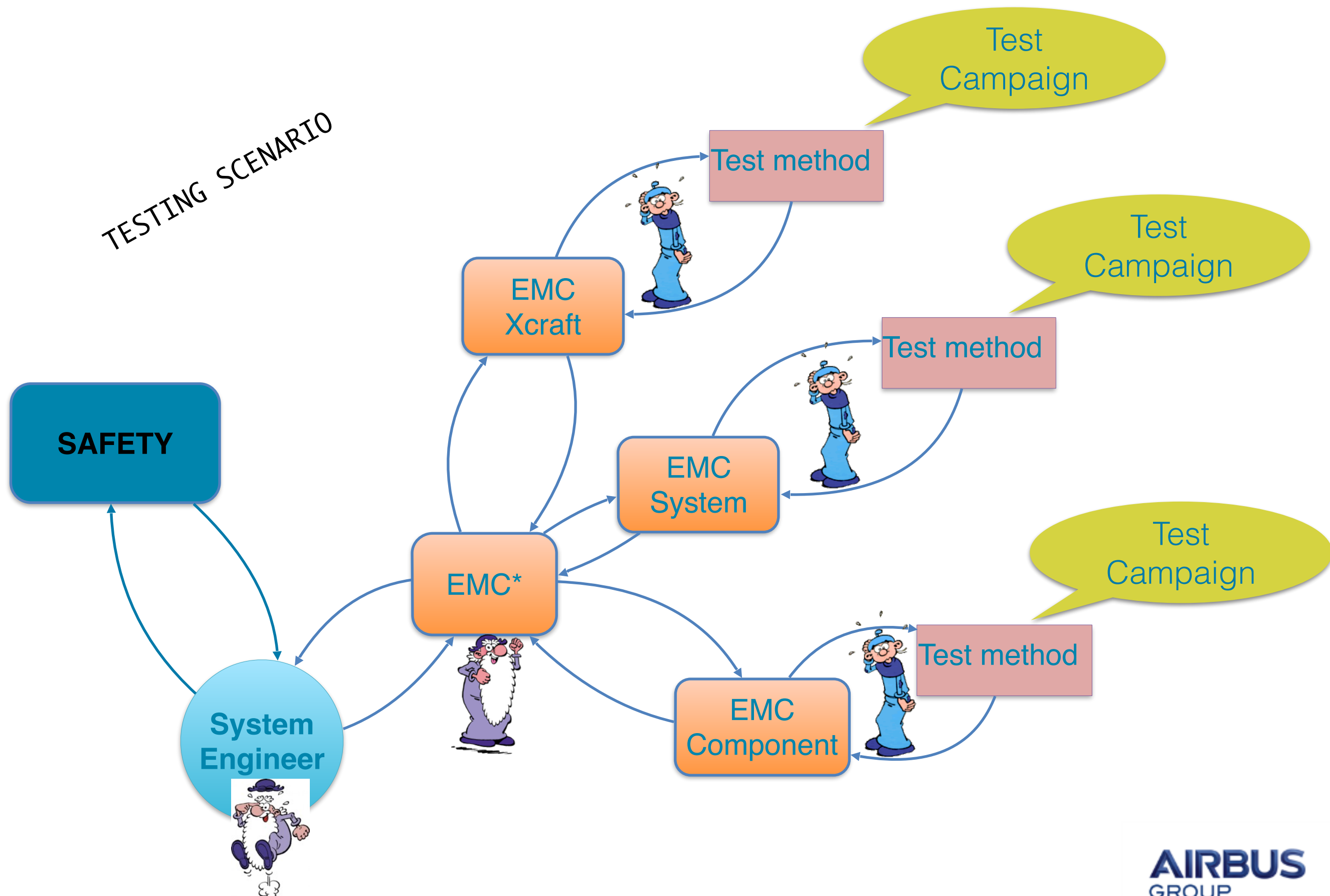
Requirements



Genius needs to protect his Xcraft against lightning strike !?!

Let's break the complexity by decomposing the problem and do a few **physical tests** thanks to Maxwell laws...





*EMC stands for ElectroMagnetic Compatibility

Your tests are too long
and not flexible!

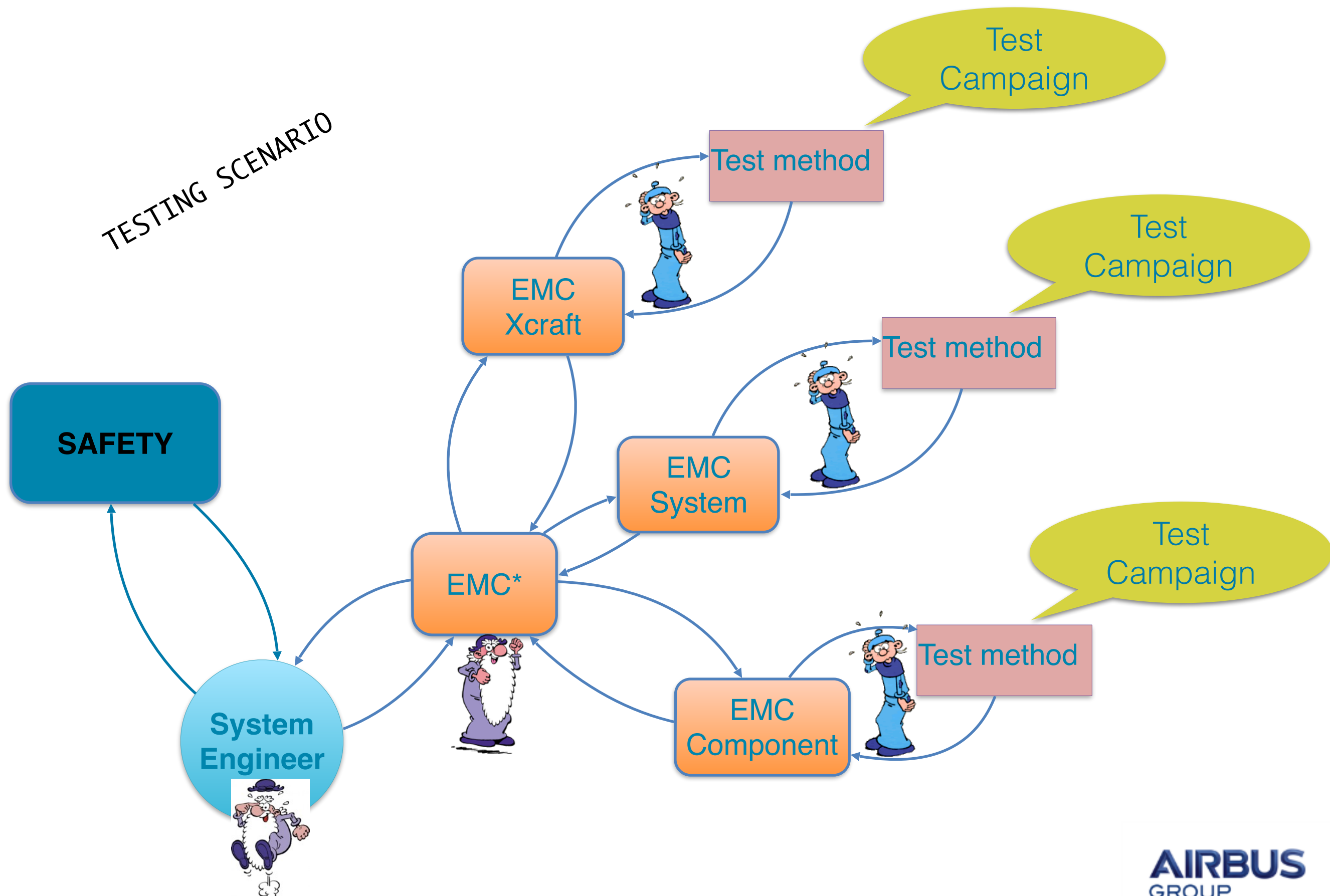
Go and prepare better
tests !

Not flexible, too long]:-> !!!

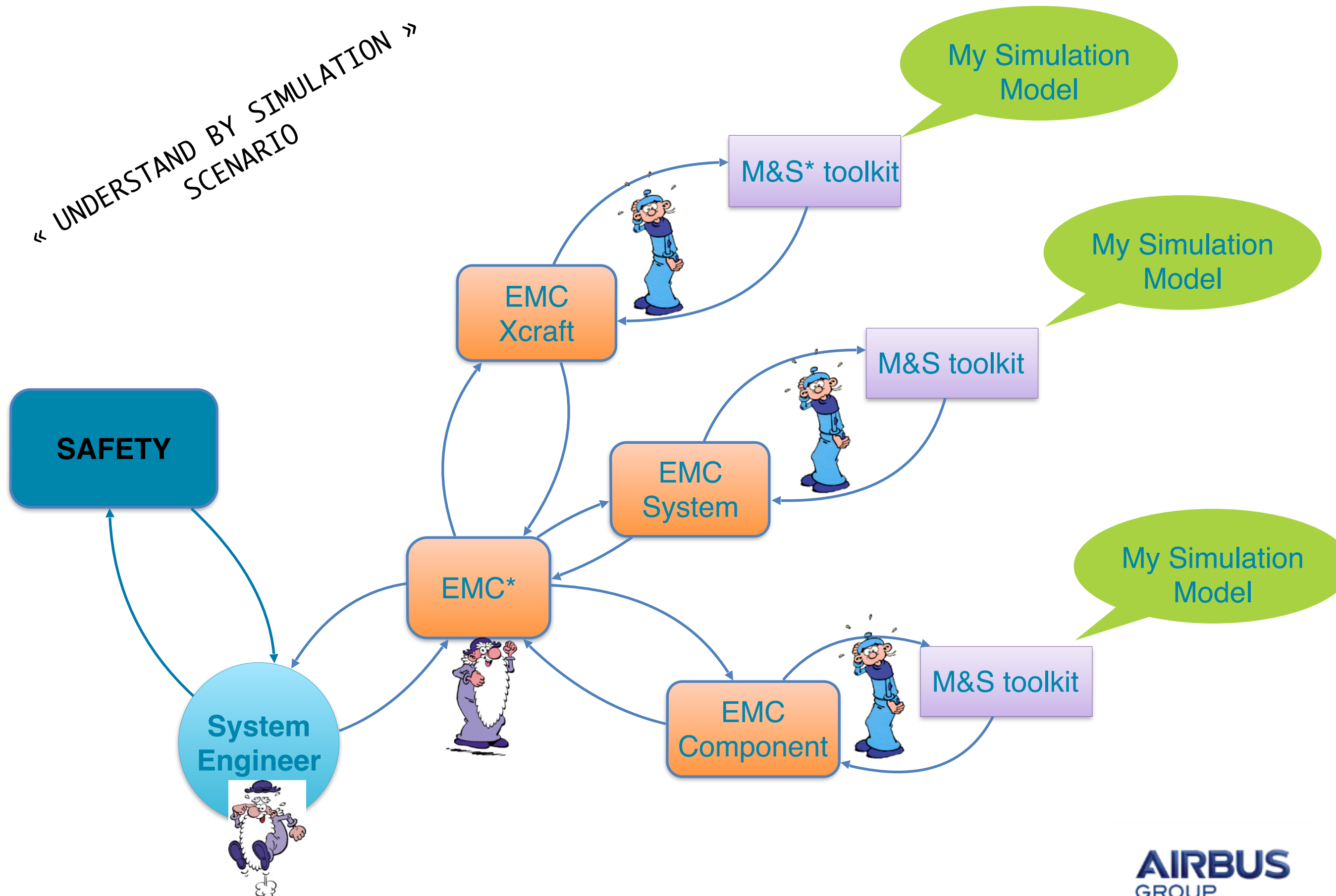
OK, I will prepare my tests
by simulations !



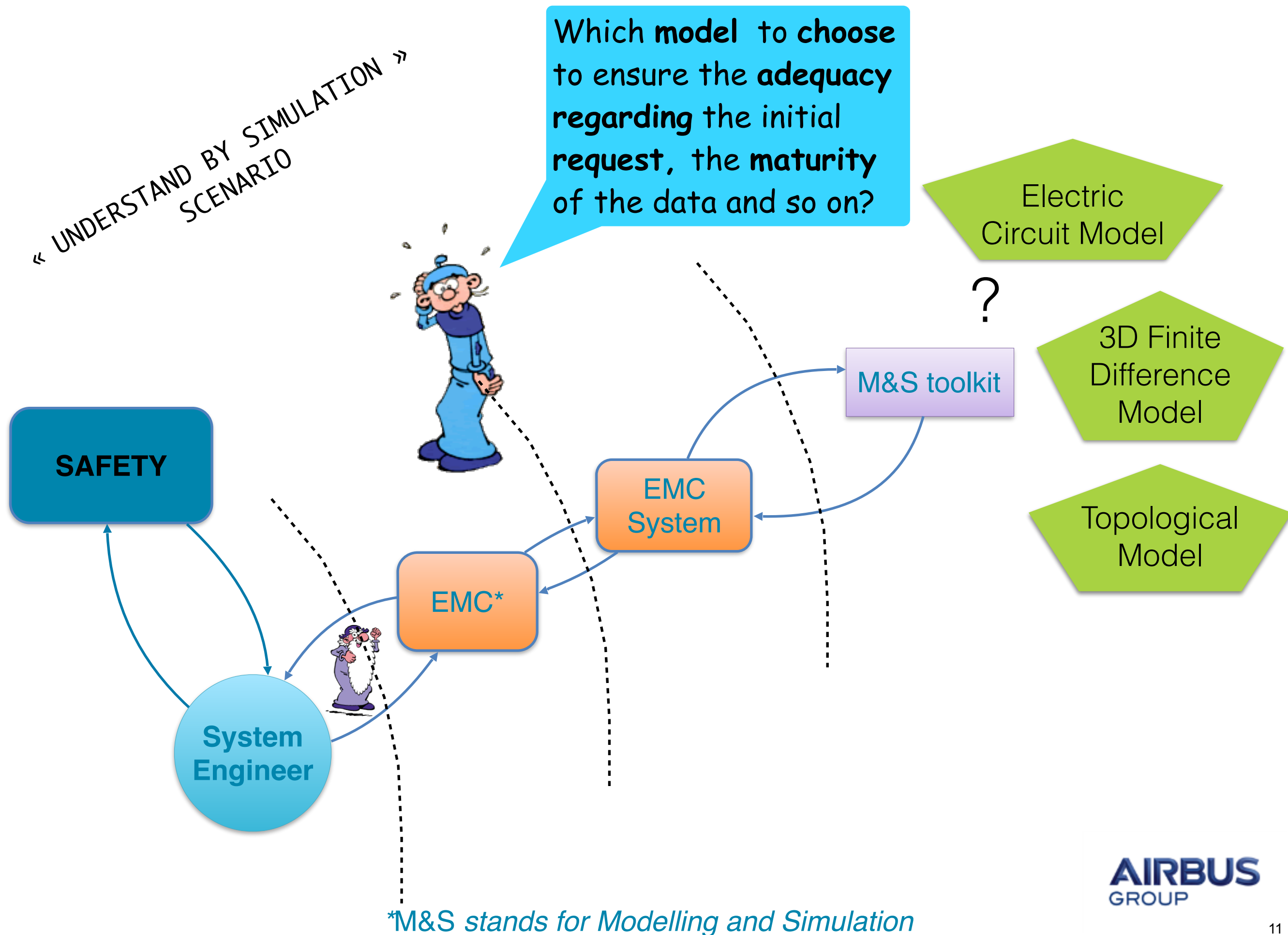
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*EMC stands for ElectroMagnetic Compatibility



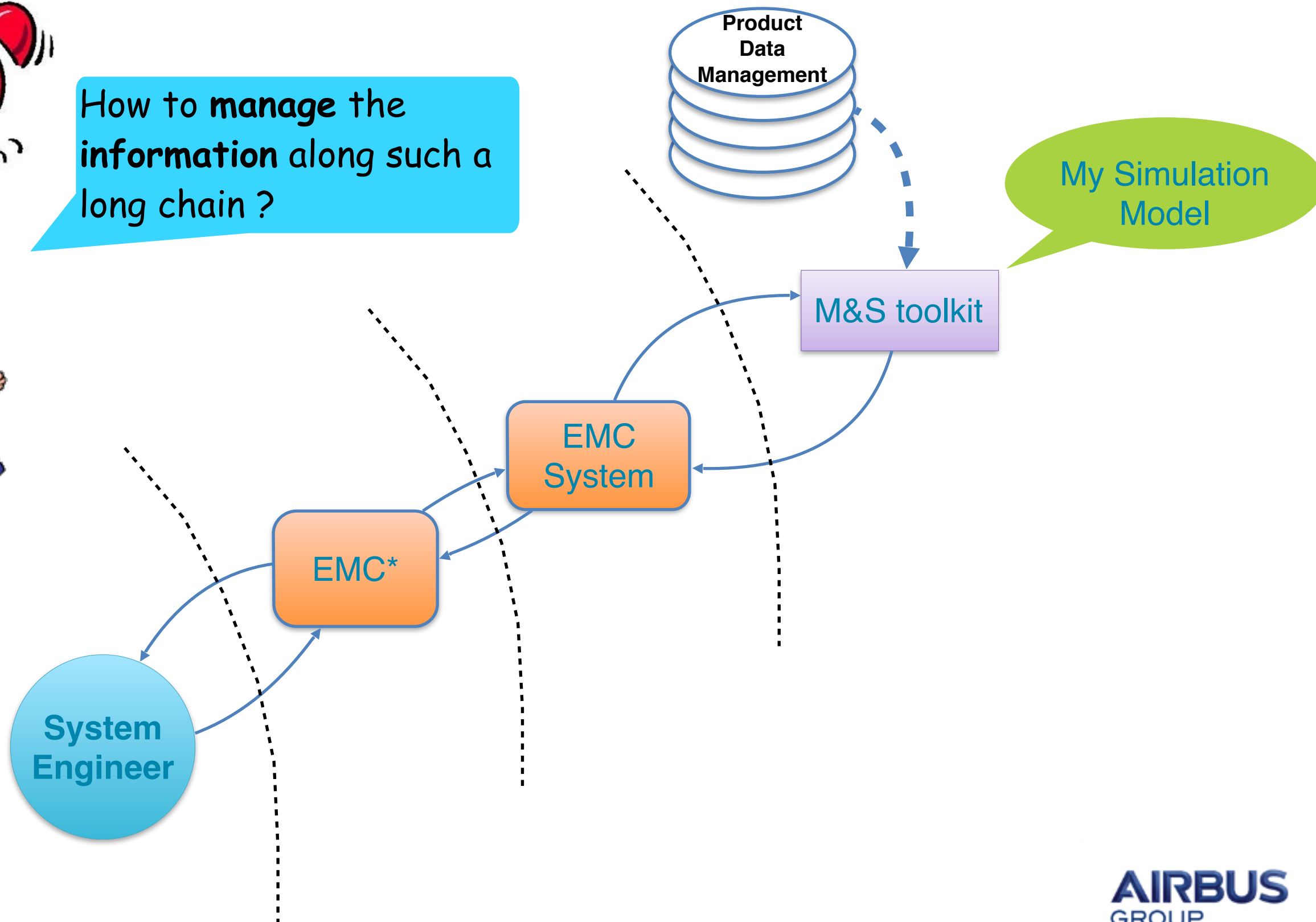
*M&S stands for Modelling and Simulation



Creation of simulation models to answer the engineering needs



How to manage the information along such a long chain ?



Comic: album 1 “The great Hope”

Epoch1= 1985-2005 “the simulation rises”

WORST-CASE

- Method: System Engineering (V-cycle)
- Tool: Understanding & tests aided by Simulation
- Results: focus on *simulation affordability*
- Key Actors: *mono-Discipline* Expert(s)
- Mandatory skills for Simulation: Numerical Analysis +
Linear Algebra + Geometry idealization + Scientific
Programming

And finally..... it flies !

BUT... Disciple...
Are you confident in
the overall process
including simulations?

Yes I am, and now, **YOU GO**
and **TEST** your Xcraft !



To be continued...

COMICS 2 « Simulate for others »

Epoch2

simulate locally, collaborate globally then decide
2005-2020
we miss a simulation architect...

NEW material composite !



WHAT IF I change metallic parts by composite parts? This will decrease the mass...



Well, From a **Manufacturing** perspective, the quality and cost of the composite have to be managed...

WHAT IF composite? This will decrease the mass...

Well, From an **ElectroMag** perspective, the structure has to recover a Faraday box effect and ensure a ground...



Composite materials induce other fatigue criteria for **structural** sizing...

Hep! From a **Thermal** perspective, the structure will isolate the interior of the fuselage...

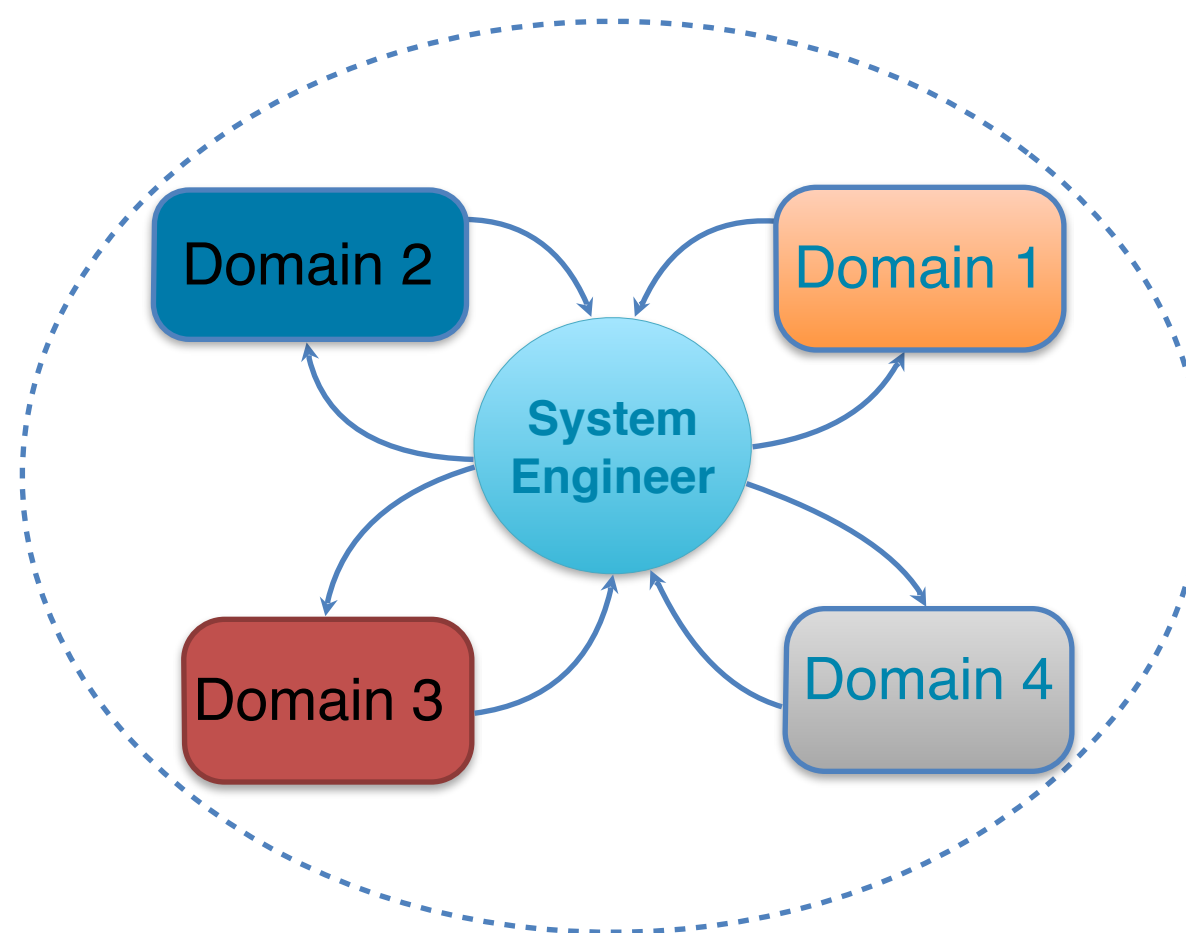
From mono domain to multi domain !



Requirements



Requirements



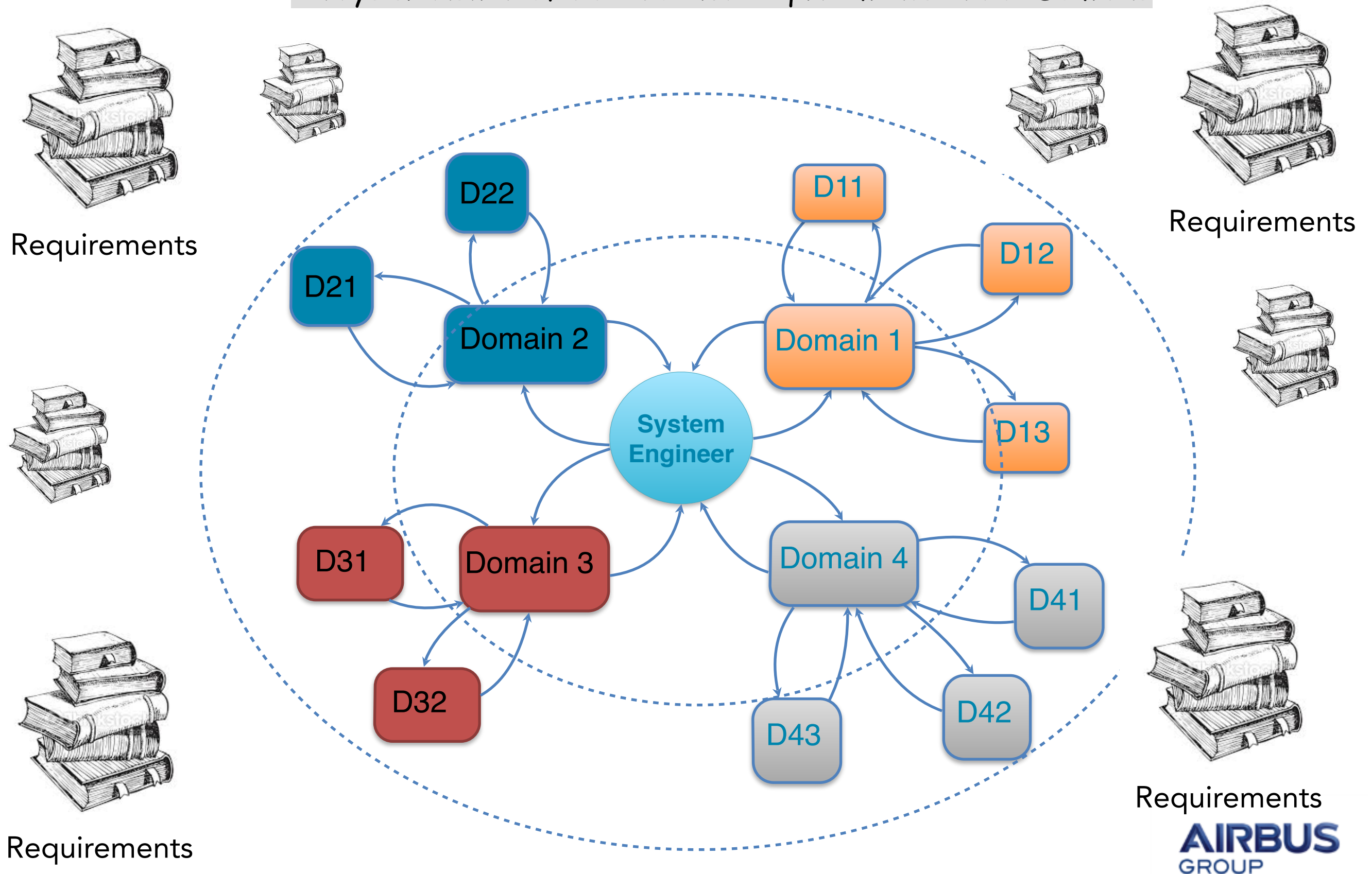
Requirements



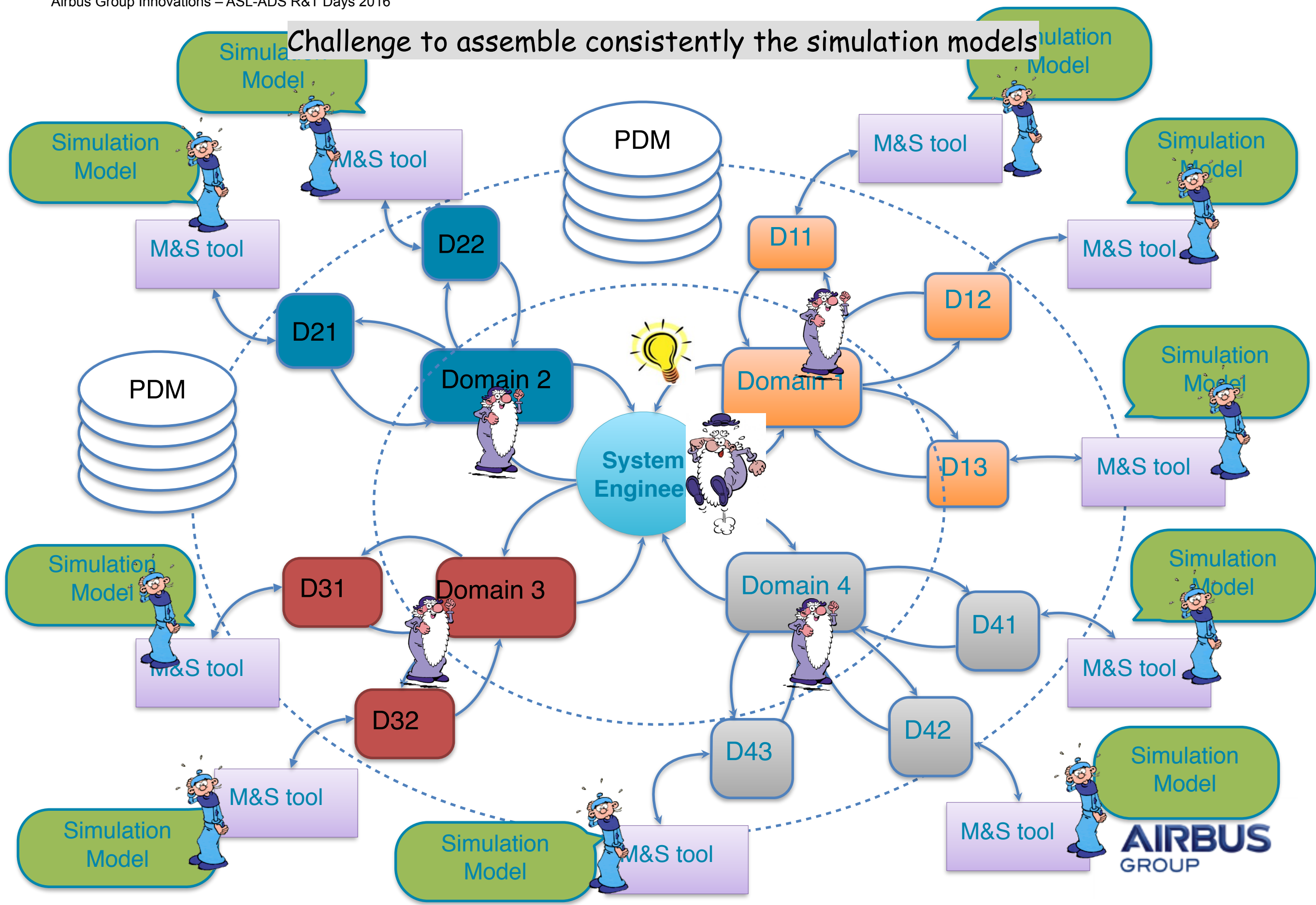
Requirements

AIRBUS
GROUP

Analysis/answer of the Product Requirements in the Domains



Challenge to assemble consistently the simulation models



PAUSE

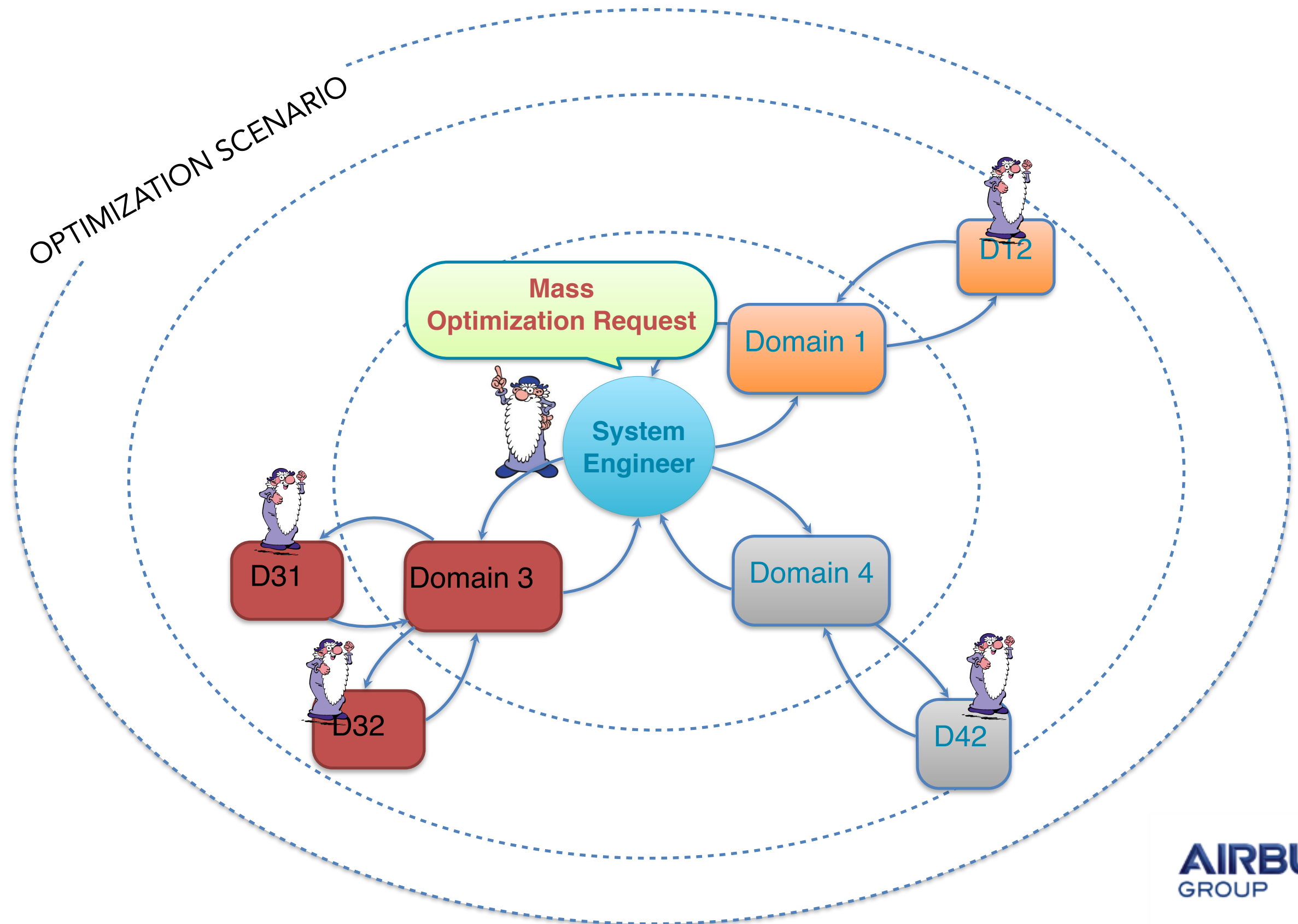


Disciple **Architect**, let see if it works: we need to optimize **GLOBALLY** the mass to go further!

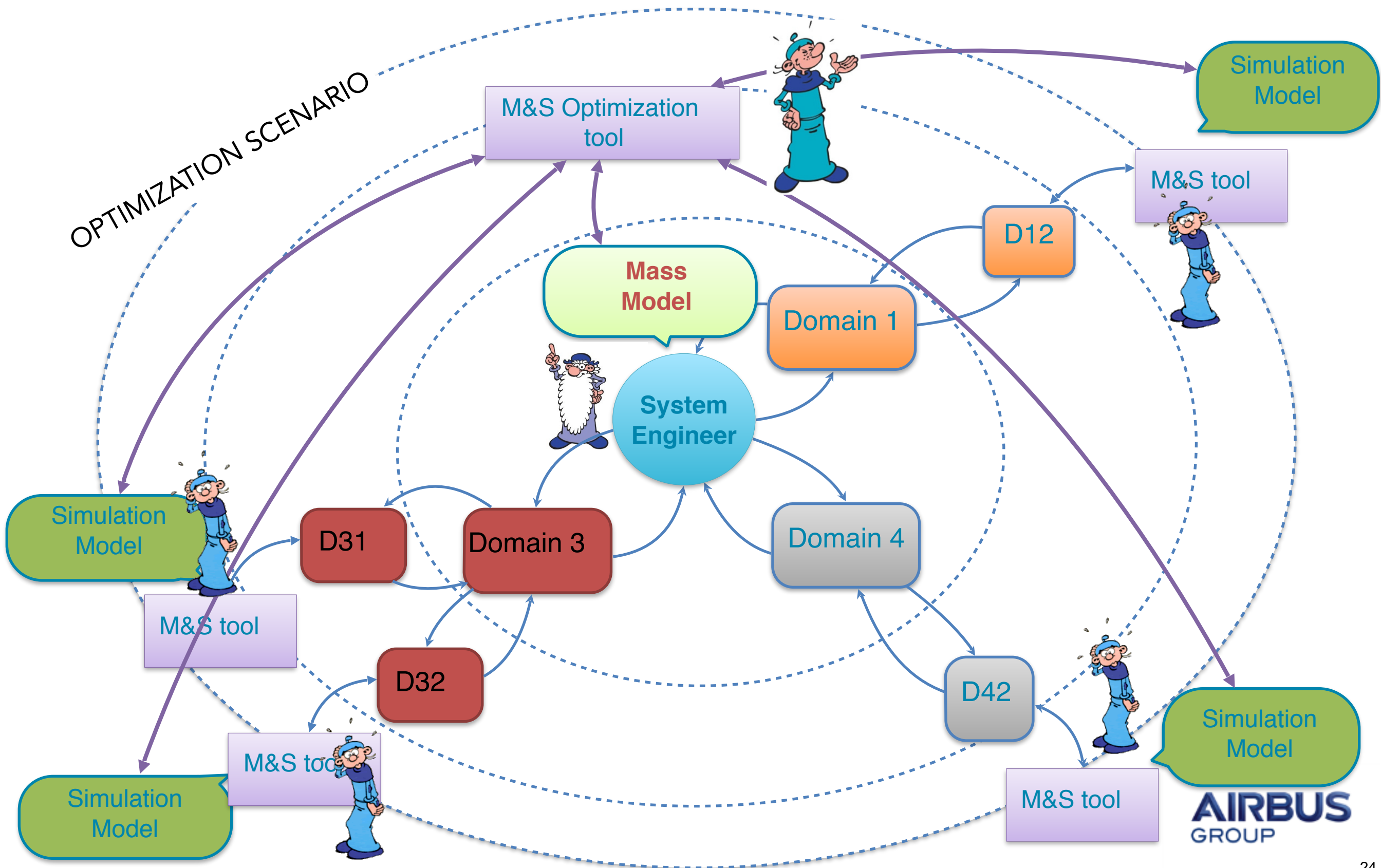
I have never optimized anything before!



New simulation scenarios are required



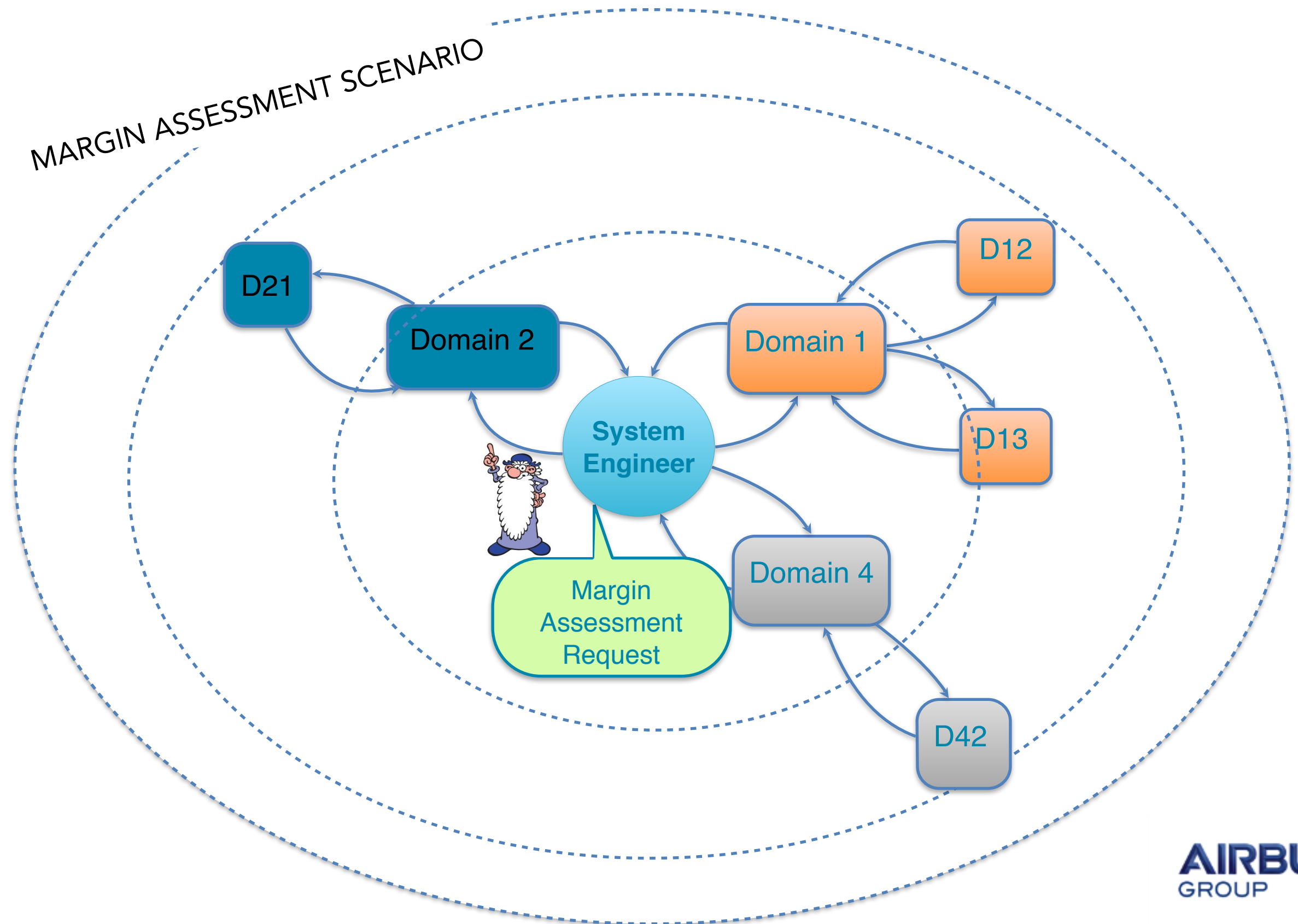
The assembly of models has to be consistent for this scenario!



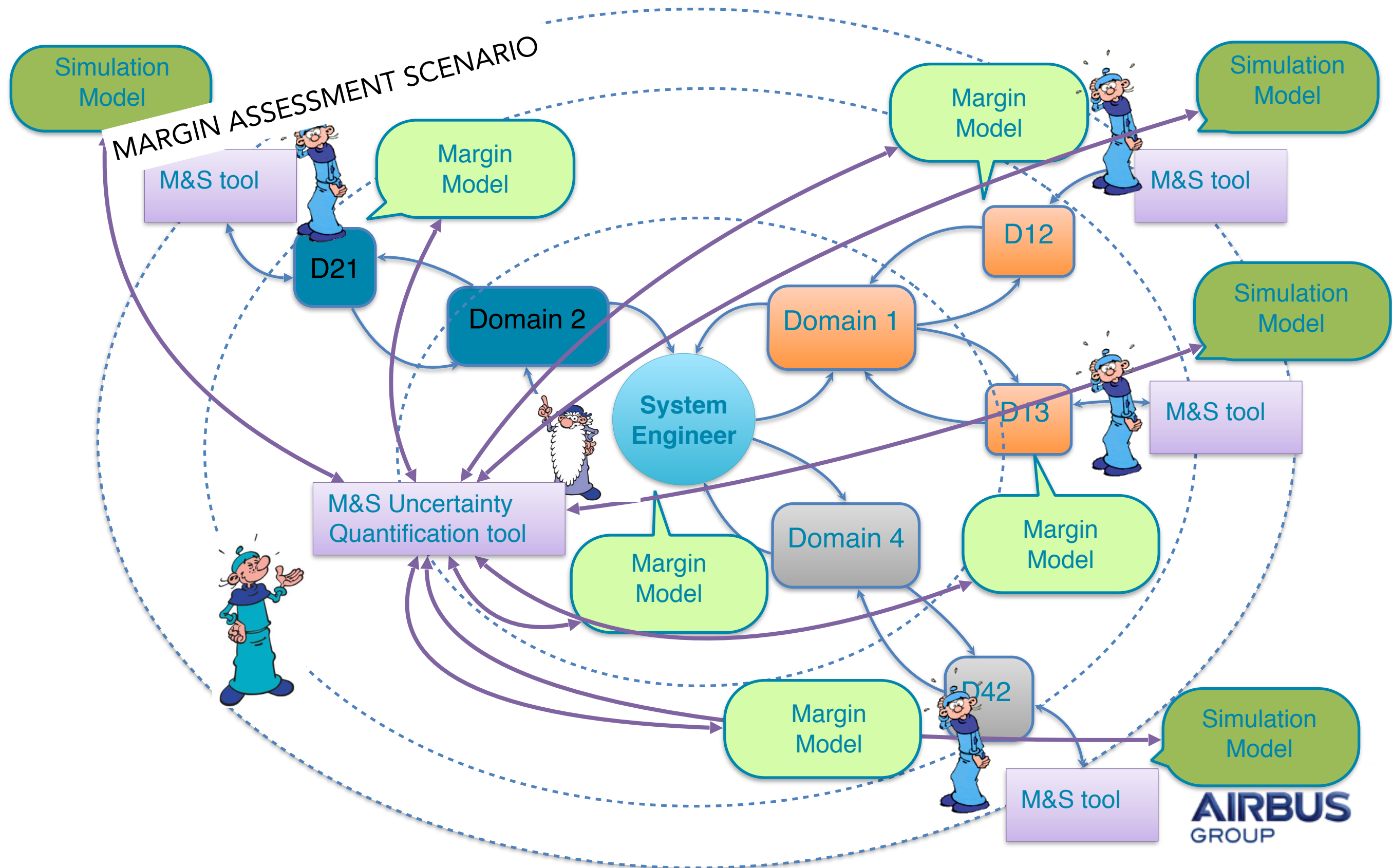
There are many uncertainties when we manage performances. How to define a margin policy & keep flexibility ?



New simulation scenarios are required



The assembly of models has to be consistent for this scenario (again)!



Epoch2= 2005-2020: scenario vs platforms

FROM WORST-CASE TO RISK-INFORMED

- Method: MBSE linked to Concurrent Engineering
- Tool: local platform centric (vendors, standards)
- Results: variety of simulation scenarios (optimization, uncertainty quantification, multi disciplinary)
- Key Actors: Discipline *simulation* experts + transverse scenario experts **Simulation Architect**
- Emerging mandatory skills: **Probability + Optimization** on top of numerical analysis background + Linear Algebra+

And it keeps on flying !

Disciple architect, I remind you that I relied on all your models to take decisions... But it is not a virtual aircraft!

Yes Genius, I just speeded up the process, but the process and the decisions were still yours!



To be continued...

COMICS 3 « Simulation is a serious Game » (under preparation)

Epoch3

collaborate to simulate globally,
decide based on simulation results

2020+

the age of simulation architects?

Bouhouhouhou...
Genius has now been
contaminated by the BIG
DATA virus...

Disciple, I have measured
the real data, you were
too conservative, I want
your margin BACK !



NEW models based on data arise !

DESIGN

IN-SERVICE

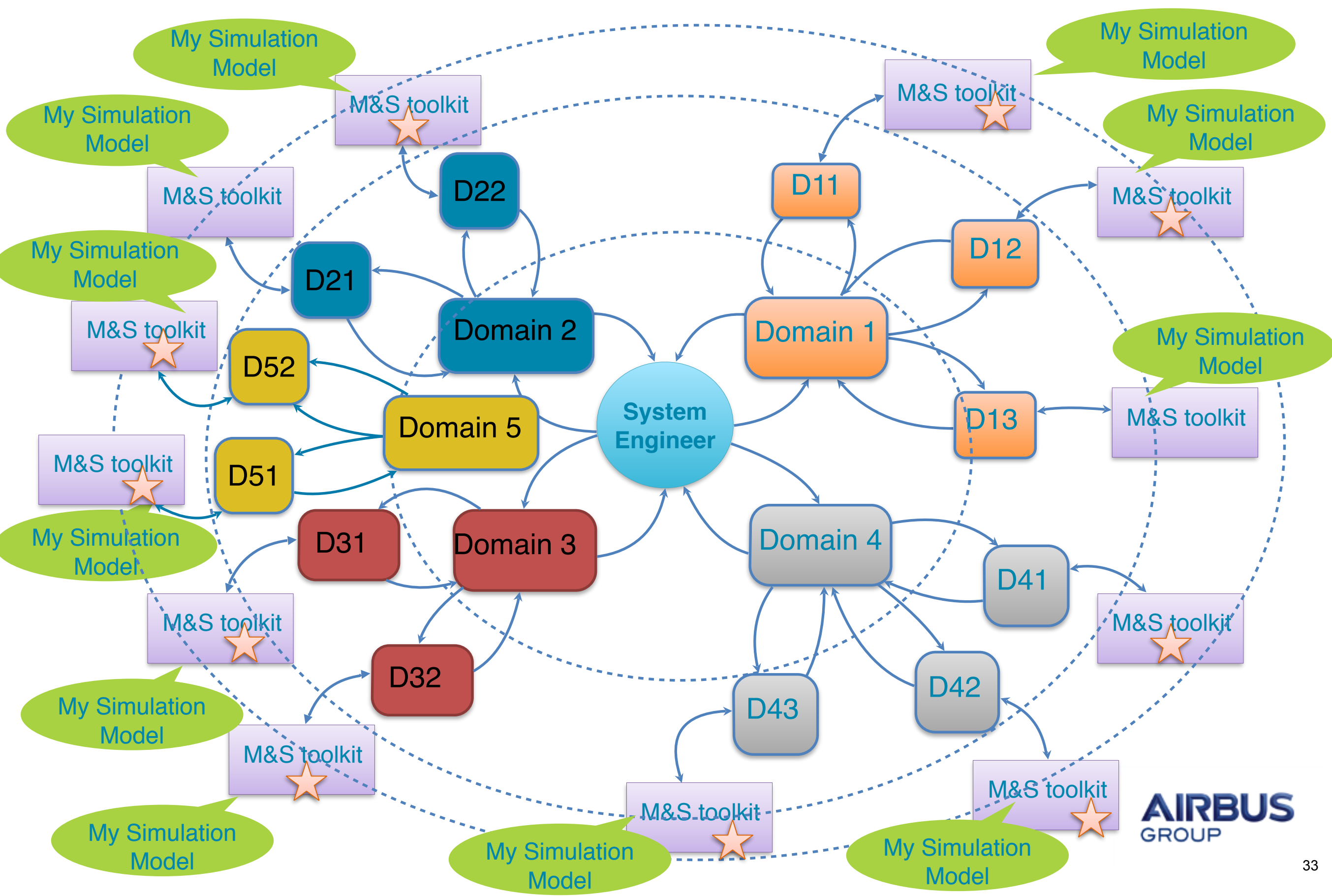
My Simulation
Model

My Simulation
Model

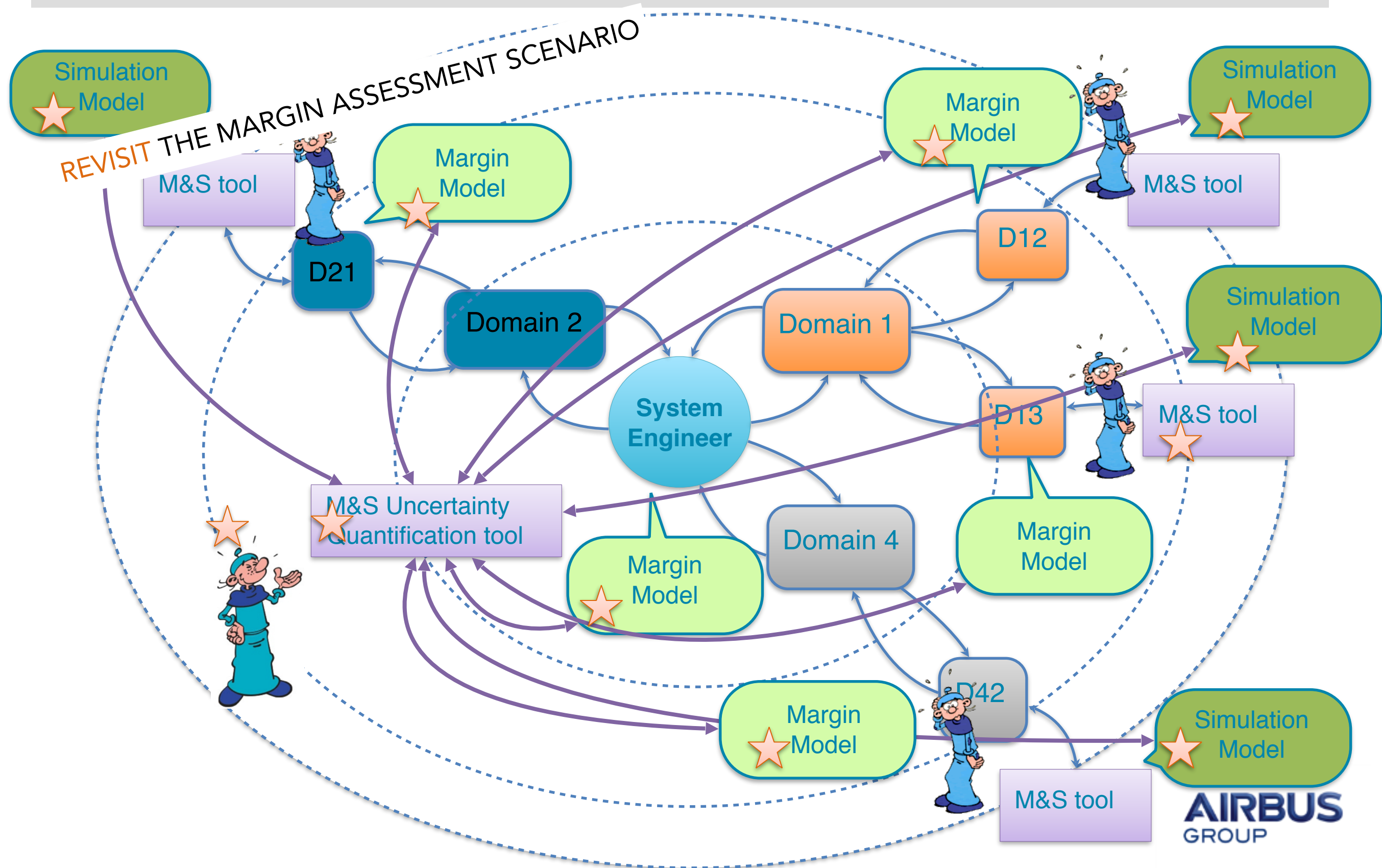
MODELS BASED
ON TECHNICAL
DOMAIN KNOWLEDGE

MODELS BASED ON
MEASURED DATA

NEW models based on operational data enrich the toolkits



New models based on data should enable the revisit scenarios



Comic: album 3 “simulation is a serious game”

Epoch3 = 2020+ “Digitalization tsunami on us”

- Method: “Agile” Engineering
- Tool: Simulation + reconfigurable platform on-demand
- Mandatory skills: Statistics, Game theory to support on-line decision on top of previous ones!
- People: Model makers + simulation community
- Results: To be...

MOVE TO MATHEMATICAL FORMALIZATION ?



*Genius & disciple are characters coming
from Editions du Lombard (Dargaud)*