



# Call for Proposal 11<sup>th</sup>

Brussels, Jan 19<sup>th</sup> 2011

*JTI-CS-2012-1-ECO-02-013*

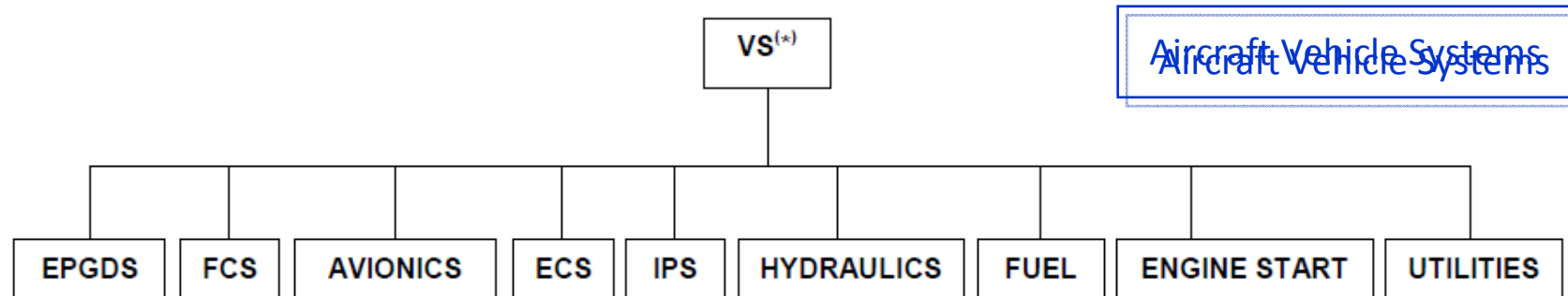
*Electrical Test Bench Generic Configuration  
Behavioral Electrical Network Analysis Model*

[www.cleansky.eu](http://www.cleansky.eu)

# EDS Modeling Activities Background

## ❖ EDS Modeling Computer Platform

- ▶ Within EDS modeling activities framework, each **Vehicle Systems** (VS) architecture will be *evaluated and optimized by means of iterative loops at aircraft level to take into account the impact of the aircraft sizing around the VS architecture* (snowball effect).
- ▶ The a/c level iterative loops involve the exploitation of *numerical models and data* defining the **Virtual Aircraft Demonstrator** (or *Virtual Test Bench*).

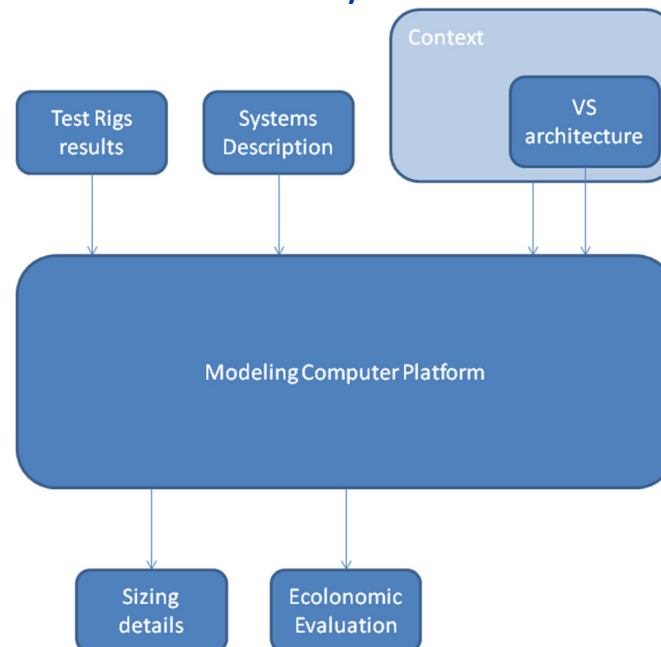


An aircraft level VS architecture is a selection of solutions for each module/subsystem

# EDS Modeling Activities Background

## ❖ EDS Modeling Computer Platform

- ▶ The Virtual Test Bench will run on the EDS **Modeling Computer Platform** (MCP), providing a computer environment in order to achieve EDS objectives in terms of modeling activities. They can be divided in two main objectives:
  - Defining and validating methods for the development of models without a corresponding test rig, i.e., for each selected VS architecture electrical network and thermal environment models;
  - Assembling and simulating a Virtual Test Bench for different a/c architectures and optimizing them in terms of “ecolonomical” efficiency.

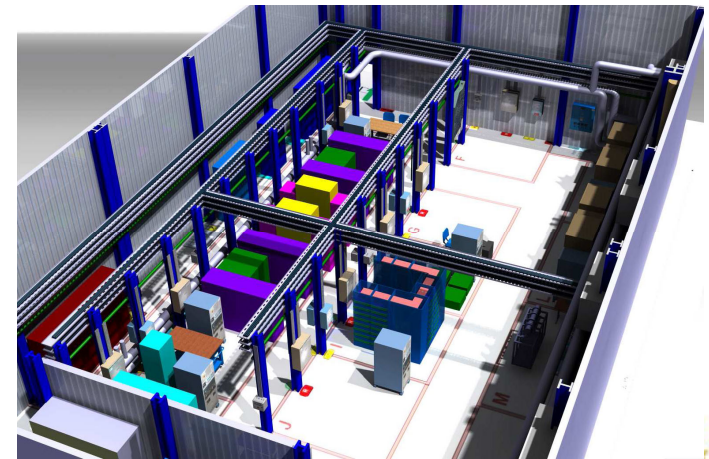


**Modeling Computer Platform**  
(general view)

# EDS Electrical Test Bench Activities Background

## ❖ EDS Electrical Test Bench Objectives

- ▶ Within EDS ITD framework, test activities will be performed mainly. *to validate the methodology and associated models to optimize complete a/c vehicle systems architecture for an all/more-electric aircraft*
- ▶ The tests will be performed on a ground **Electrical Test Bench** (ETB, namely “Copper Bird”) (in Hispano-Suiza from POA Project), partially representing the **Generic Architecture** as defined by the air-framers from the architecture down-selection.
- ▶ The ETB will comprise *electrical and electronic technologies for power generation, distribution and users’ consumption.*

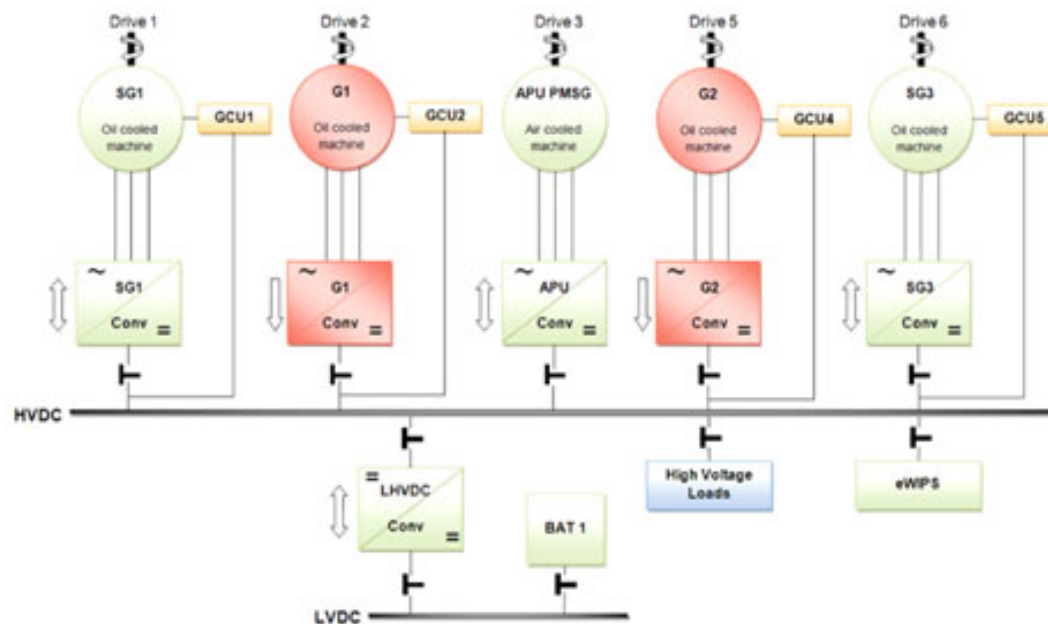


[www.cleansky.eu](http://www.cleansky.eu) 

# Electrical Network Analysis Model (ENAM)

## ❖ ENAM Main Objectives

- ▶ On a future all/more-electric a/c, “electricity” will be major (maybe the only) media for the management of aircraft energy. As a consequence, the power level and the interaction between subsystems through the electrical network will be very high. In addition the single energy media increases the common mode failure risk.
- ▶ Within EDS ITD, the **Electrical Network Analysis Model (ENAM)** is a representation of the electrical test rig. The main objective of the Electrical Network Analysis Model (ENAM) is **to validate a VS architecture with respect to electrical network quality through short term transient analysis.**



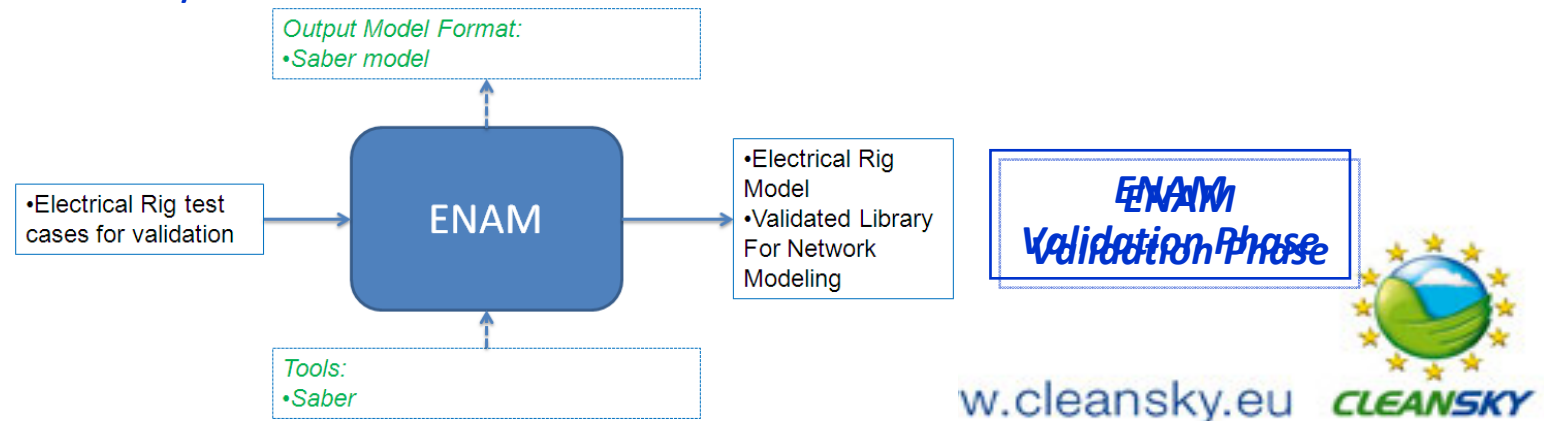
Example of a typical electrical network to be modelled



# Electrical Network Analysis Model (ENAM)

## ❖ ENAM Main Objectives

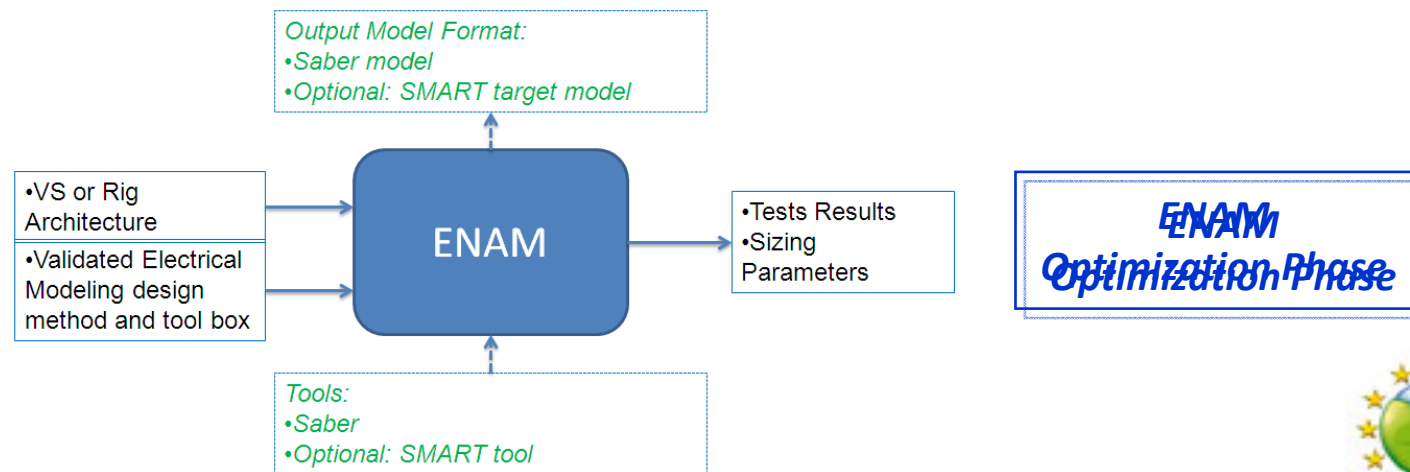
- ▶ The objectives of the ENAM with respect to the *definition of modeling methods* can be listed in the following way:
  - **Modeling electrical components of the Electrical Test Bench before integration**; the ENAM will demonstrate the capability to anticipate problems on the test bench;
  - **Modeling the Electrical Test Bench**; the ENAM will be a representation of the electrical test rig, where the ENAM and the ETB both contribute to the same goals (the rig extends the model into physical phenomena which are not modelled, the model extends the rig into configurations or parametric changes which cannot be physically performed on the rig);
  - **Validate the methodology for electrical modeling**, in order to model the electrical network of the studied VS architecture and validate it with respect to electrical network quality through short term transient analysis.



# Electrical Network Analysis Model (ENAM)

## ❖ ENAM Main Objectives

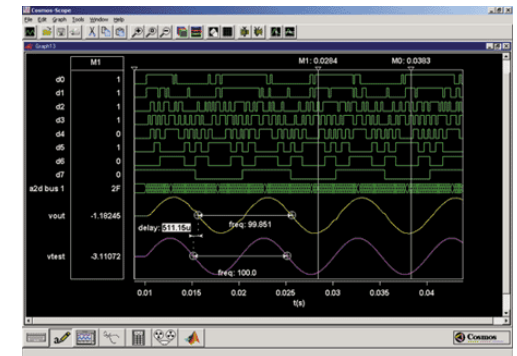
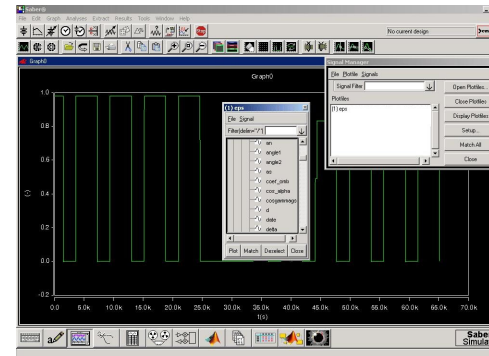
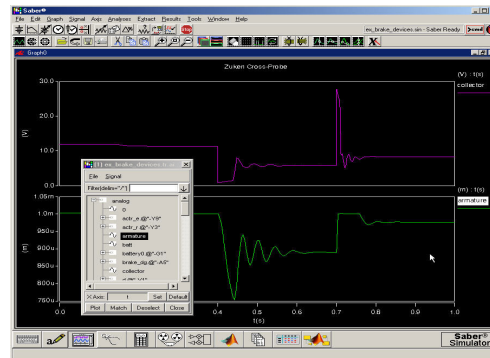
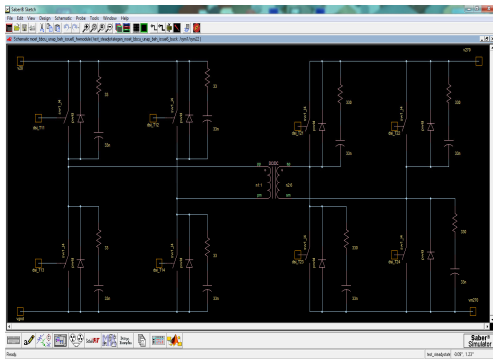
- ▶ Once the modeling methodologies and tool boxes have been developed and validated, they will be used for the **virtual optimization** of the different selected VS candidate architectures:
- ▶ ENAM will concur to the above process. In particular, ENAM objectives with respect to the virtual architecture optimization process are:
  - **Model the Electrical network of the studied Architecture;**
  - **Perform Stability and Quality Analysis;**
  - **Provide sizing parameters for the electrical parts of systems included in the model (mass of filters...).**



# Electrical Network Analysis Model (ENAM)

## ❖ ENAM Main Objectives

- ▶ The level of ENAM modeling will be at **behavioral level**, including but not limited to:
  - **Power Quality & Stability Analysis (Switchings included)**,
  - **Failure Mode and Selectivity Analysis (Reliability)**,
  - **Power & Weight Behaviour.**
- ▶ ENAM shall be delivered in **SABER** format (version 2009.12).



- ▶ Equipment suppliers will provide models of the electrical interfaces of equipment and subsystems, at the level of detail required to reach the goals of the rig and models.

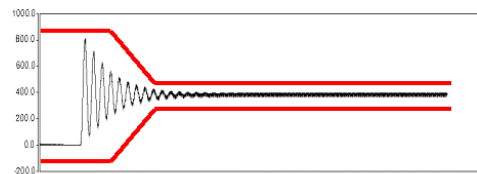
# Electrical Network Analysis Model (ENAM)

## ❖ CFP Main Requirements

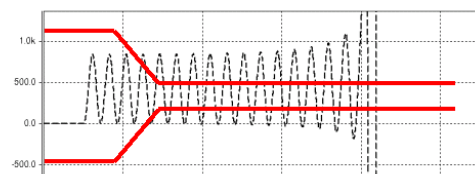
- ▶ Given the depicted scenario, the selected Candidate shall **design, implement, verify and validate** the behavioral level computer implementation of the Electrical Network Analysis Model for the Electrical Test Bench Generic Configuration.

### Power Quality & Stability Analysis

- ▶ Based on MIL-STD-704F standard, this analysis shall study the interaction between sources and loads on electrical power quality, filtering, the interaction between subsystems, *all with short term transient analyses* (behavioral modeling).
- ▶ Unlike the stability definition in the control theory, the *stability criterion in the industrial standard* is usually formalized with the *ability of a system to keep a certain system variable of interest within desired limits* (i.e., keep the voltage at PoR within limits specified by the relevant standard, in either steady-state or transient operation, and either normal or abnormal condition).



STABILITY



INSTABILITY

*Stability criterion in the industrial standard*



[www.cleansky.eu](http://www.cleansky.eu) CLEANSKY

# Electrical Network Analysis Model (ENAM)

## ❖ CFP Main Requirements

### Failure Mode and Selectivity Analysis

▶ This analysis shall include:

- **Protection strategy in case of failure mode detection;**
- **Operational management of the electrical system** (i.e., switching of bus bar contactors for normal and abnormal system operation);
- **Innovative/intelligent load management model** (i.e., algorithms for shedding and/or degrading of non-essential loads in cases of electrical system degradation);
- **Reliability of the system** (i.e., to compute the reliability of voltage and power supply to a single or several bus-bars in various operating modes (normal, degraded and failure behavior)).

### Power & Weight Behaviour

▶ By simulating a system model, the maximum load / power / current to be carried by each component of the electrical system shall be determined. This will lead to a sizing of the components and to an estimation of their weights.

(dependency of the component weight on sizing parameters)



[www.cleansky.eu](http://www.cleansky.eu) CLEANSKY

# Electrical Network Analysis Model (ENAM)

## ❖ CFP Other Requirements

- ▶ The winning Candidate will receive **as an input the behavioral electrical models of all the available equipment** composing the Generic Configuration of the ETB and provided by the equipment suppliers (in SABER format).

All the components models which will not be available by the suppliers shall be covered by the Candidate through a *dedicated electrical system library*, containing models of different complexity:

- *interfaces* (plugs, data-buses etc.),
  - *basic electrical components* (wiring, switches, bus-bars etc.),
  - *more integrated electrical components* (generators, rectifiers, converters etc.),
  - *power users* (motor drives, heaters etc.) and *entire system architectures*.
- 
- ▶ An adequate **signal analysis and measurement tool** of aircraft electrical power system shall be required, with following features:
    - *User-friendly graphical interface;*
    - *Powerful signal processing* (including power quality and stability analysis);
    - *Advanced functionality of plot* (zoom, export, comparison, etc.);
    - *Stand-alone software* (no third party license required).

# Electrical Network Analysis Model (ENAM)

## ❖ Major Deliverables and Schedule

| Deliverable | Title                       | Description (if applicable)                                                                                                                                                                | Due date       |
|-------------|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| D1          | Analysis                    | Detailed study of single equipment models and associated standalone validation tests. Single models integration in a specified ETB ENAM.                                                   | T0 + 3 months  |
| D2          | Development                 | Development of possible missing models. Power quality, stability and reliability tests arrangement. Development of post-processing tool in a simulation environment (SABER or equivalent). | T0 + 12 months |
| D3          | Verification and Validation | Power quality, stability and reliability tests performing. Analysis and verification of tests results for ETB ENAM validation.                                                             | T0 + 16 months |
| D4          | Optimization                | User feedbacks analysis and optimization of ETB ENAM for requirements accommodation.                                                                                                       | T0 + 18 months |



# Electrical Network Analysis Model (ENAM)

## ❖ Candidate Special Skills

- ▶ Expertise in electrical system design (power generation, power conversion, power network, power consumer);
- ▶ A well recognized experience in system simulation methods;
- ▶ Knowledge of Industrial/Aeronautical field constraints and procedures;
- ▶ Availability of basic simulation tools: at least a full SABER code license;
- ▶ Good practice in English language.

The Candidate shall preferably rely on a certified background in *development and validation of SABER models for aeronautical electrical equipment*, particularly for research (national and/or European) projects.

*Theoretical research centers and universities* are preferred due to their attitude to operate in a formal framework for modeling activities.

Duration: **18 months**

Topic value: **250 k€**