TAUPE

Aircraft Power Line Communications

- 19th October 2012 -

TAUPE presentation

LABINAL/SAFRAN Engineering Services

Thibaud LEBRETON

Project co-funded by the European Commission within the Seventh Framework Programme

SEVENTH FRAMEWORK PROGRAMME

Agenda

1. **Project Presentation**
2. Project Results
3. Project Conclusion

Project identity card

- Name: TAUPE (Transmissions in Aircraft on Unique Path wirEs)
- T_0: September 1st 2008
- Duration: 3.5 years
- Number of partners: 17
  - Skills distributed across Europe
- Number of nationalities represented: 6
- European framework: FP7
  - Theme 7: Transport (including Aeronautics)
- Overall budget: 5 465 K€
- Overall funding by the European Commission: 3 630 K€

TAUPE Transmissions in Aircraft on Unique Path wirEs

TAUPE logo

Partners involved in TAUPE

SAFRAN Labinal
SAFRAN Engineering Services

WP Leaders

SAFRAN Engineering Services

AIRBUS AN EADS COMPANY

EADS

Lucerne University of Applied Sciences and Arts
HOCHSCHULE LUZERN

NLR

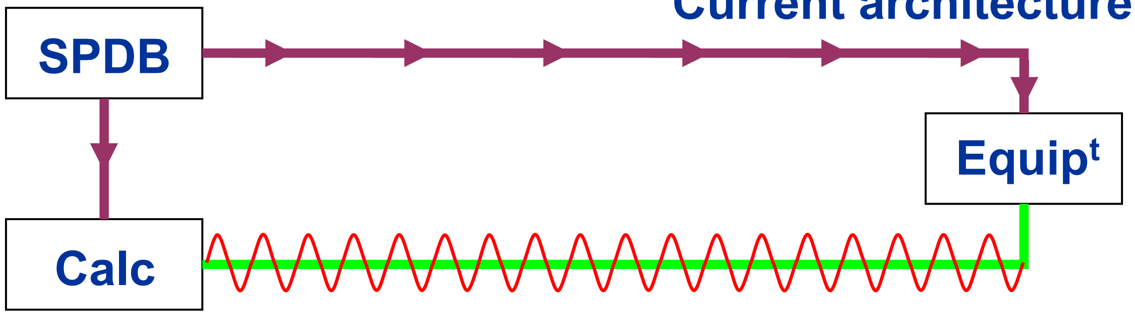
Coordinator

Other partners

ARTTIC INTERNATIONAL MANAGEMENT SERVICES
DIEHL Aerospace
DS2
ONERA THE FRENCH AEROSPACE LAB
EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
heig-vd Haute Ecole d'Ingénierie et de Gestion du Canton de Vaud
SAFRAN Hispano-Suiza
Hortec
ekis
Université Lille1 Sciences et Technologies
THALES
ascom

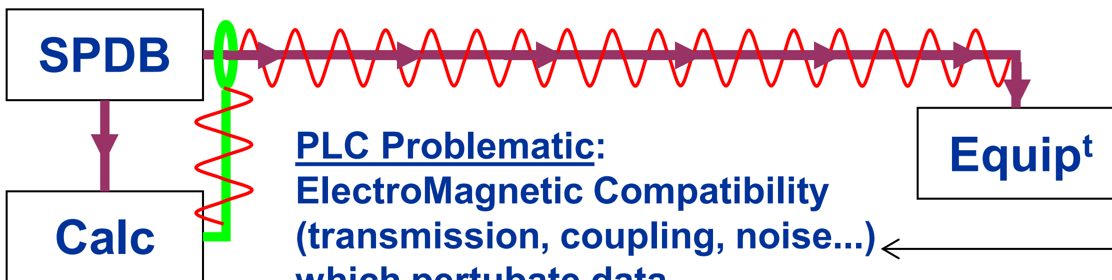
PLC and PoD, what is it?

Current architecture:



- A cable for power
  ↳ large size, not shielded…
- A cable for data
  ↳ bifilar, shielded…

PowerLine Communication (PLC) architecture:



PLC Problematic:
ElectroMagnetic Compatibility (transmission, coupling, noise…) which pertubate data transmission

A unique cable, initially designed to transmit power transports

- power (low freq < kHz)
- data (high freq ~ MHz) with a new protocol

Power Over Data (PoD) architecture:

PoD Problematic:
To transmit power with low voltage drop and no overheating

A unique cable, initially designed to transmit data transports

- data with an existing protocol
- power (low freq < kHz)

Main objectives of the project

- Main project objectives:
  - Demonstrate a **TRL of 4** *(Component and/or breadboard validation in laboratory environment)*, using:
    - The Cabin Lighting and Communication System (Diehl Aerospace) on a Cabin Mock-up (EADS-IW) ⇒ PLC
    - The Cockpit Display System (Thales Avionics) on the A380 CDS test bench (Thales Avionics) ⇒ PoD
  - Optimize the architecture of the system for power and data transmission in terms of topologies, EMC, safety and integrity of data, etc

RTD Workpackages

- The project can be seen as constituted by 2 parts:
  - WP1 + WP2:
    - The requirements are established, the architectures defined and the solutions modeled and simulated
    - Regarding the modeling and simulation activities, 2 aspects are considered and taken into account:
      - The noise aspect
      - The propagation channel performance
    - Measurements are performed on benches and on a real aircraft
  - WP3 + WP4 + WP5:
    - This part was focused towards the actual demonstration of the feasibility
    - The COTS components and the benches are adapted in WP3; specific interfaces are also developed
    - In WP4 additional components for benches integrations are developed when required
    - WP5 is developing the V&V test plan and tests will be performed on the benches

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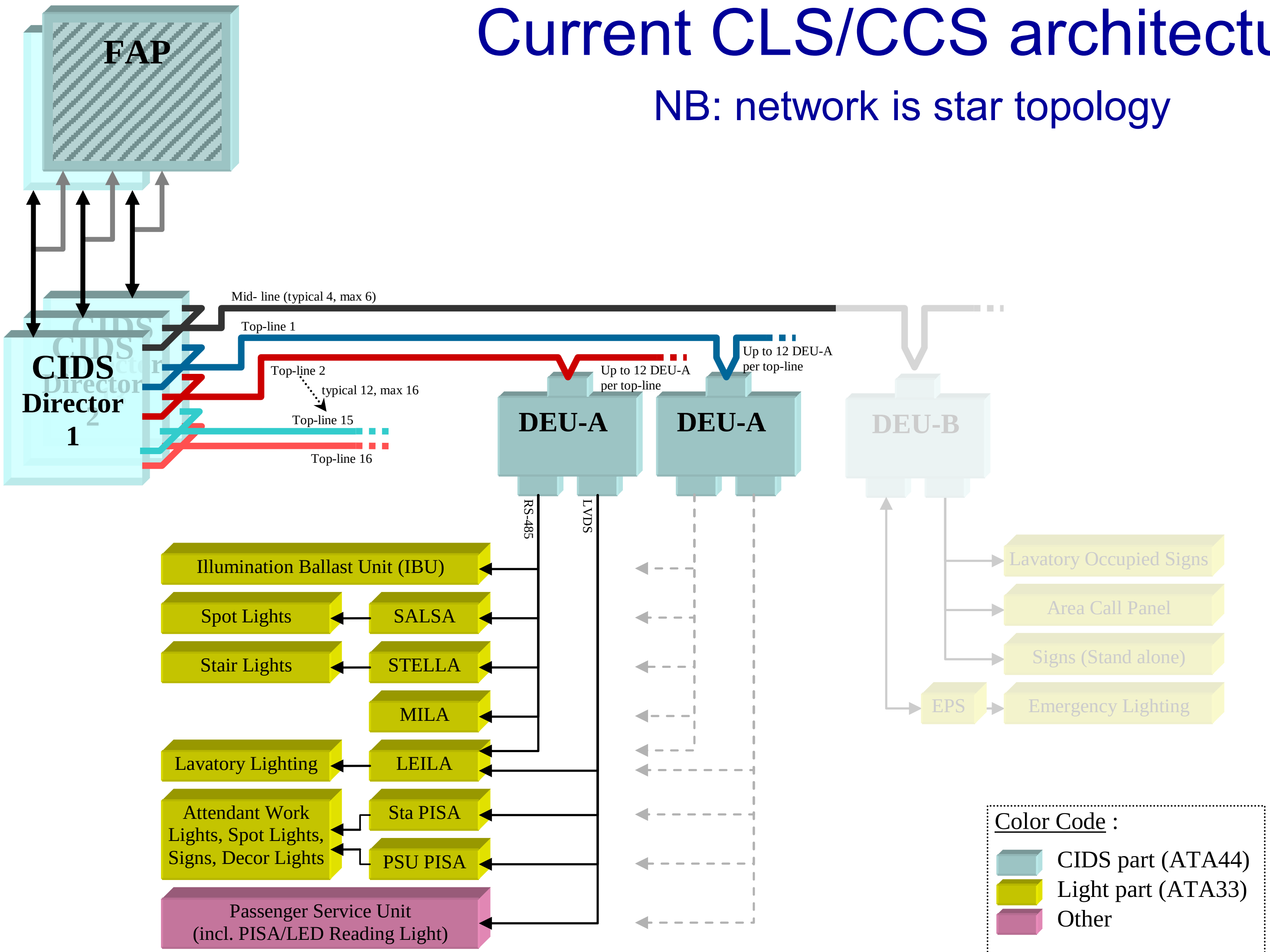
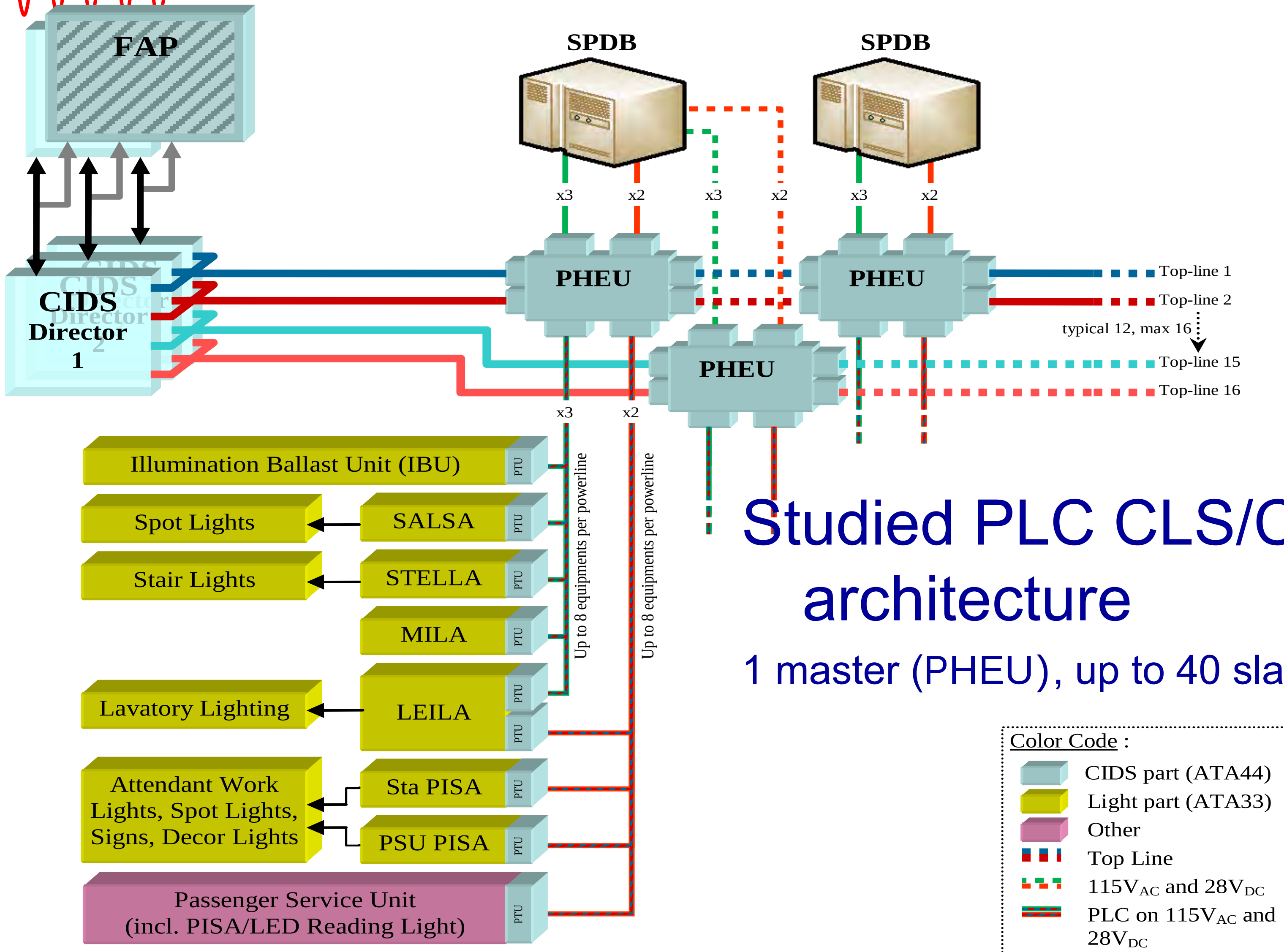
Current CLS/CCS architecture

NB: network is star topology



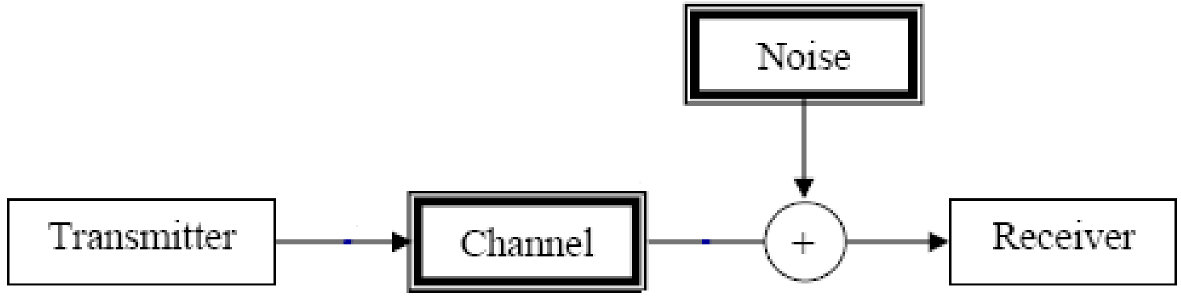
WP1, Architecture



Studied PLC CLS/CCS architecture

1 master (PHEU), up to 40 slaves

WP2, Modeling, Simulation



- The propagation channel (attenuation versus frequency
- The noise present on the line

Both influence performances (BER & datarate)

The knowledge of those 2 aspects are the key to predict PLC feasibility. It justifies the role of LABINAL/SEngS as leader of the project thanks to its EMC expertise

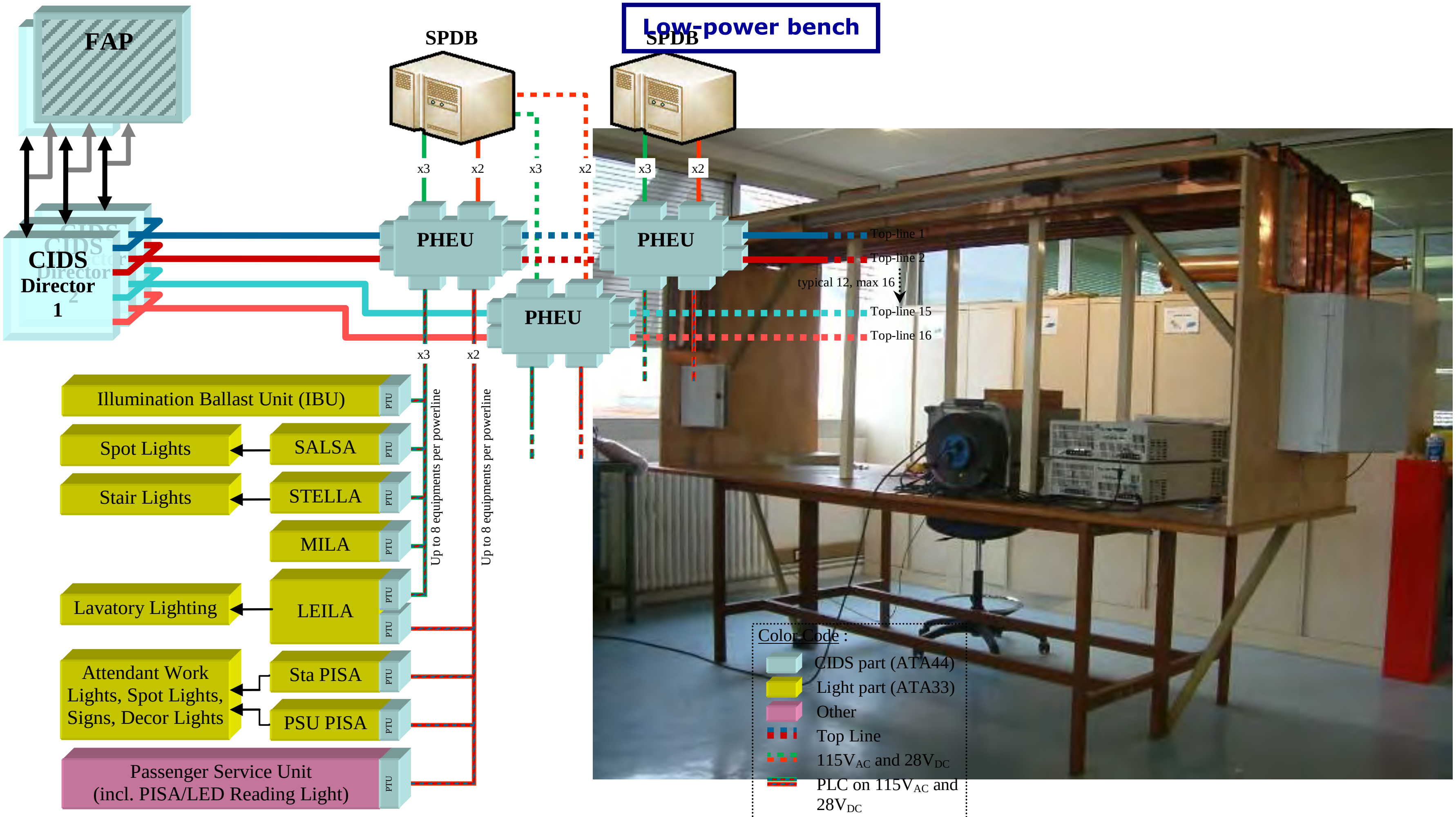
WP2, Modeling, Simulation

CLS & CDS architectures

Typical CLS lines modelling

Recommendations

Low-power bench



WP2, Modeling, Simulation

CLS & CDS architectures

Typical CLS lines modelling

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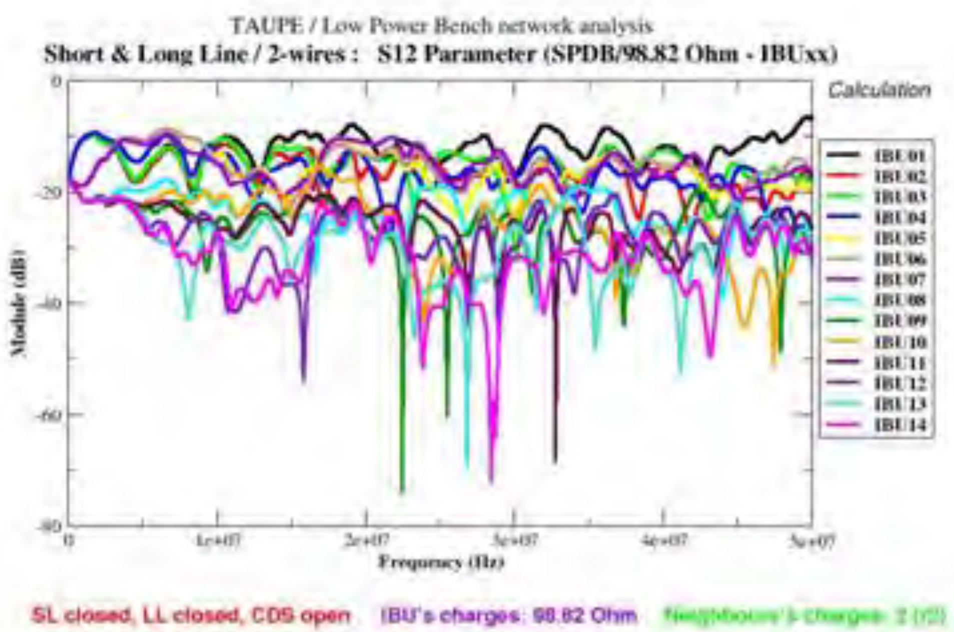
Low-power bench

Modelling

Measurements on prop. channel



WP2, Modeling, Simulation

CLS & CDS architectures

Typical CLS lines modelling

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Modelling

Measurements on prop. channel

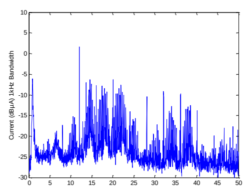
Aircraft A340-600

Noise measurement

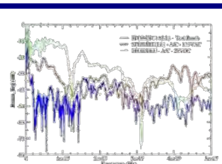
Prop channel measurement

Comparison

Validate CRIPTE models



Statistical Analysis



WP2, Modeling, Simulation

CLS & CDS architectures

Typical CLS lines modelling

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Low-power bench

Aircraft A340-600

Modelling

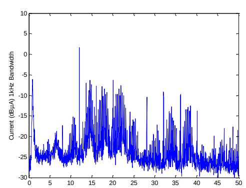
Measurements on prop. channel

Noise measurement

Prop channel measurement

Measures conducted EMC

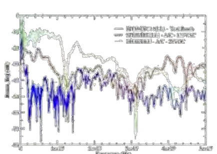
Comparison



Validate CRIPTE models

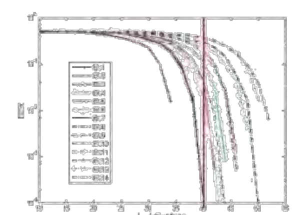
Statistical Analysis

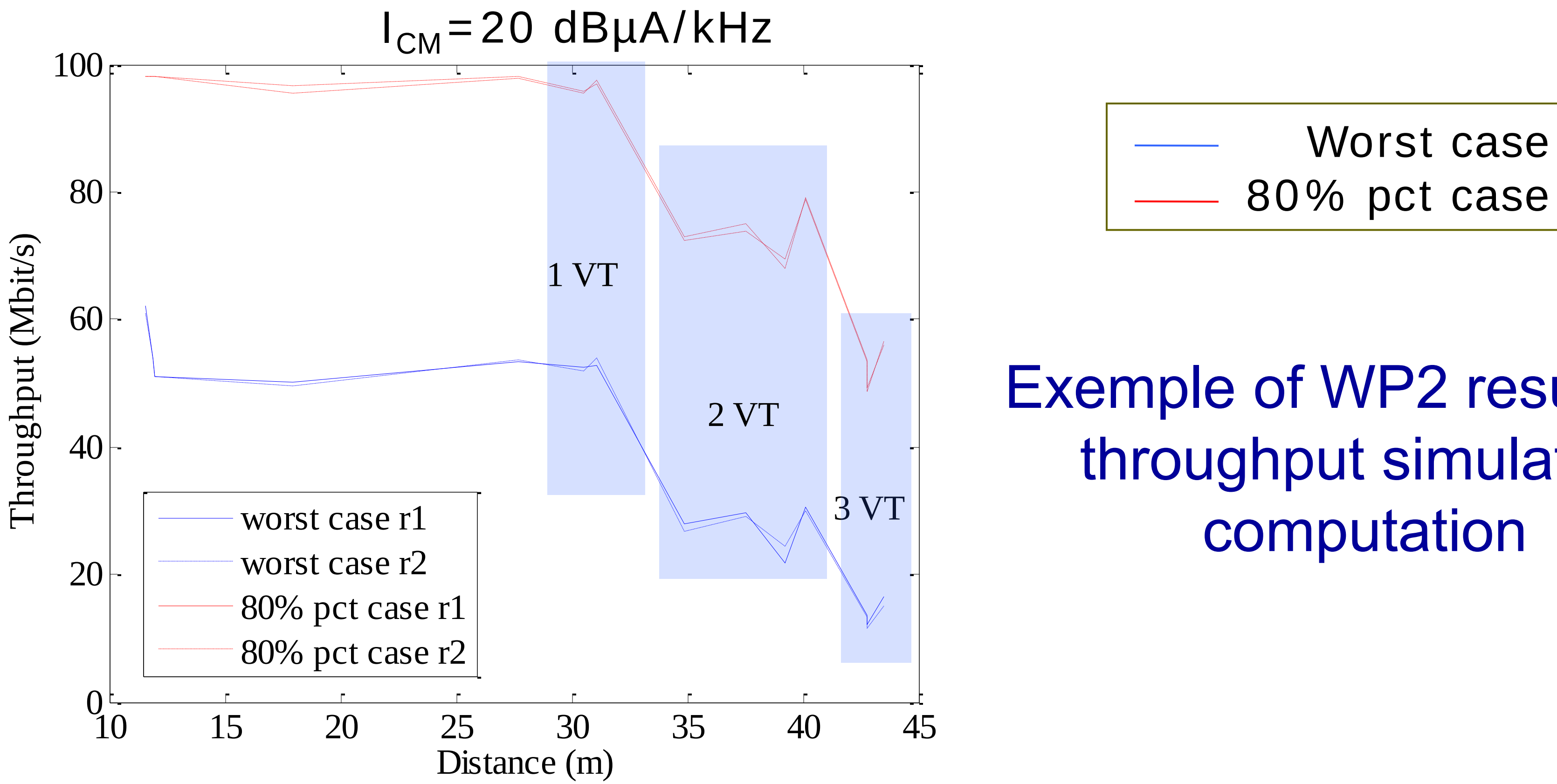
Conducted EMC Studies



TOOL

Simulation runs





Exemple of WP2 results: throughput simulation computation

Influence of the distance but also on the number of VTs

WP3&4: PLC CLS/CCS Mock-up

- Both Demonstrators have been developed and integrated

Cabin Mock-up (EADS-IW)

CDS test bench (Thales Avionics)

WP5: V&V

- A safety analysis was performed according to “classical” safety process and method carried out in the aeronautic domain. At TRL4 step, it did not show showstopper.

- A V&V test plan has been followed. Some requirements were not successfully passed
  - ❑  throughput, frame loss and latency performance
  - ❑  setup time, jitter, deterministic scheduling

Main V&V conclusion at TRL4 level :

1) There is no ‘showstopper’ for further development of the PLC and PoAFDX technology

2) Some points need technological improvement/adaptation to comply with aeronautical constraints

Results and Benefit

TAUPE study showed high weight saving potential.

System level	PLC (CLS/CCS perimeter)	PoAFDX (CDS perimeter)
Weight	-85 kg ⇔-29%	-2,8 kg ⇔ -14%
Length	-36%	-60%

A/C level extrapolated (A380)	PLC	PoAFDX
Weight	359 kg	49 kg
Length	36670 m	2866 m

Note: Assumption for max weight saving potential computation:
- A dedicated network (as AFDX) is kept for backbone communication
- Discrete are kept
- Other protocols using shielded bifilar are replaced (CAN, ARINC 429 etc…)

The simplification objectives (maintenance, installation, retrofit) was harder to compute and quantify. Study shall be refined before getting accurate figures.

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Conclusion

- **System concepts** have been investigated, optimized and simulated (WP1 and WP2). Requirements have been established.

- Basic technological **components** for both PLC and PoAFDX technology have been developed:
  - PLC components: master and slave modems on 115V and 28V
  - PoAFDX components: PoAFDX Injector and PoAFDX Receiver

- **Integration** of these components in two test benches:
  - The Cabin Mockup for the PLC technology
  - The CDS A380/A320 System Bench for the PoAFDX technology

- Formal **testing** in a laboratory environment at EADS-IW and THALES Avionics by using a Test Plan and detailed Test Procedures has been achieved

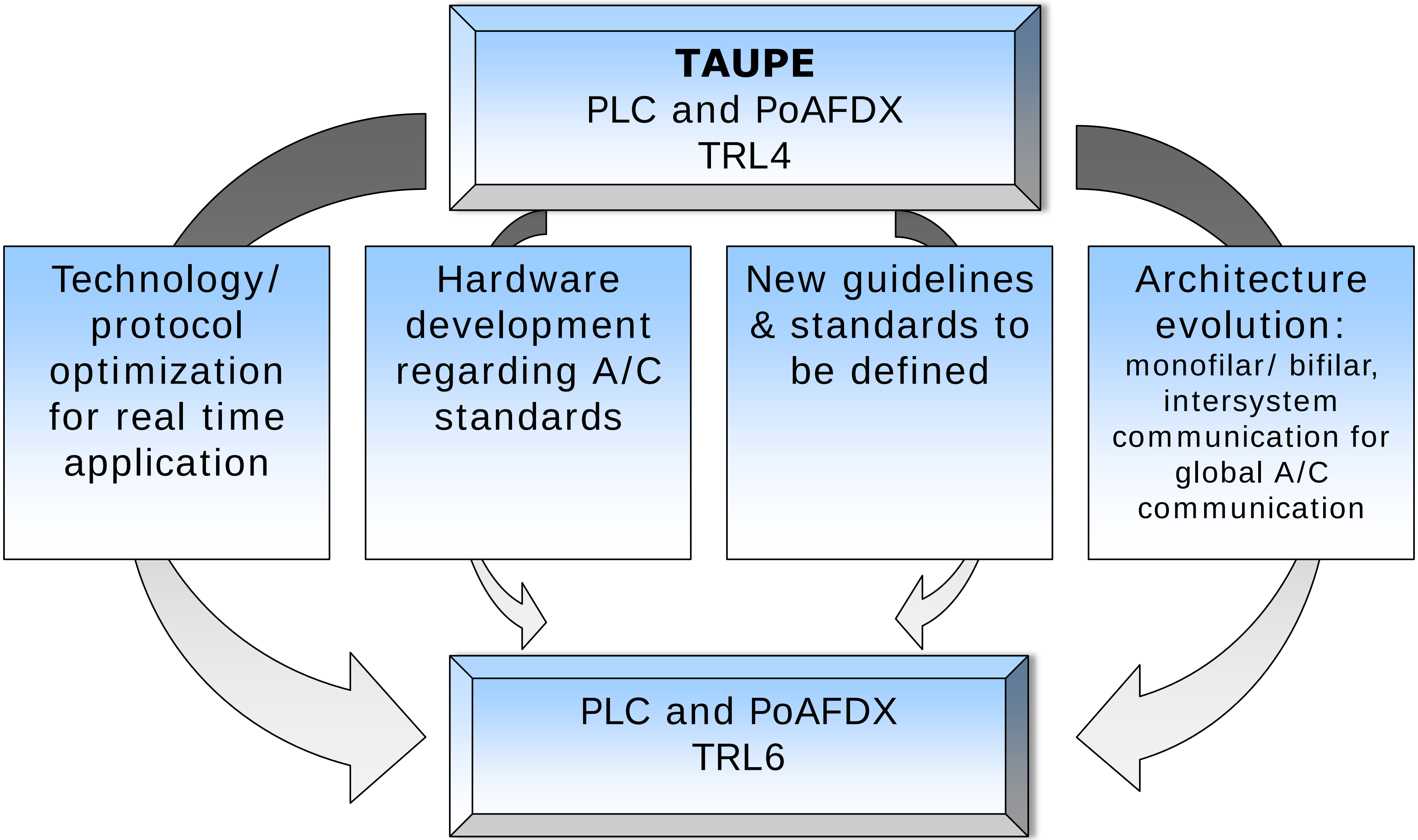
Way forward

TAUPE studies showed at TRL4 for PLC technology:

- Awaited benefice
  - Weight (leading to fuel consumption) reduction
  - Cabling reduction
  - Cabling simplification (maintenance, installation, retrofit)
  - Architecture rationalization

- Awaited difficulties
  - Technological improvement need
  - Architecture global change, to be uniformed and standardized
  - System complexity raise and role sharing
  - PLC techno will probably be complex (development + industrialization)

Maturing the technology



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Some interesting public consortium publications:

Power Line Communication in Aircraft: Channel Modelling and Performance Analysis: V. Dégardin, IEEE Conf on Devices, circuits and systems ICCDCS

Numerical assessment of propagation channel characteristics for future application of power line communication in aircraft, I. Junqua, International Symposium on Electromagnetic Compatibility

The application of commercial power line communications technology for avionics systems, Stephen Dominiak, 2012 Digital Avionics Systems Conference (DASC)

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