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« NAMASTE »

DCNS

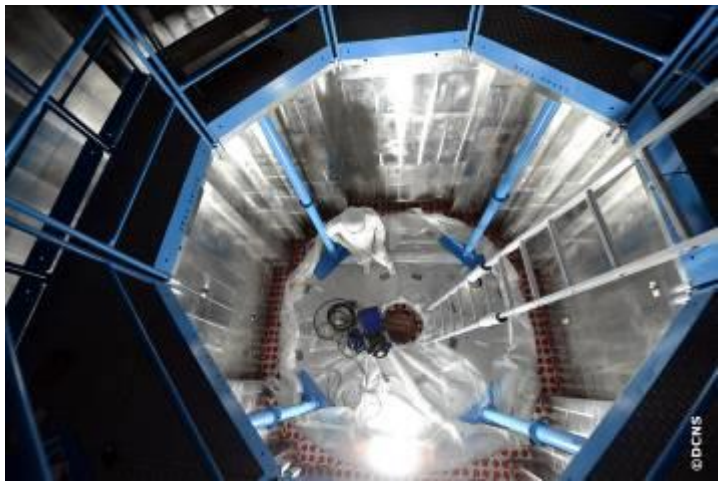
Propulsion systems for Aircraft Carrier

Vice Admiral (Rtd) Bertrand Aubriot

DCNS AT A GLANCE

- **Revenues** **€3.1 billion**
- **Group staff** **13,130**
- **50 Navy clients worldwide**
- **Designer, builder and maintainer of warships: SSBN, SSN, SSK, Fregates and Aircraft Carriers**
- **Functional and physical integrator of the whole warship, combat system and platform system**

DCNS Propulsion Center for nuclear and conventional warship



- 1,175 employees
- R & D
- Design
- Test
- Production
- Maintenance

Power and propulsion systems and equipment

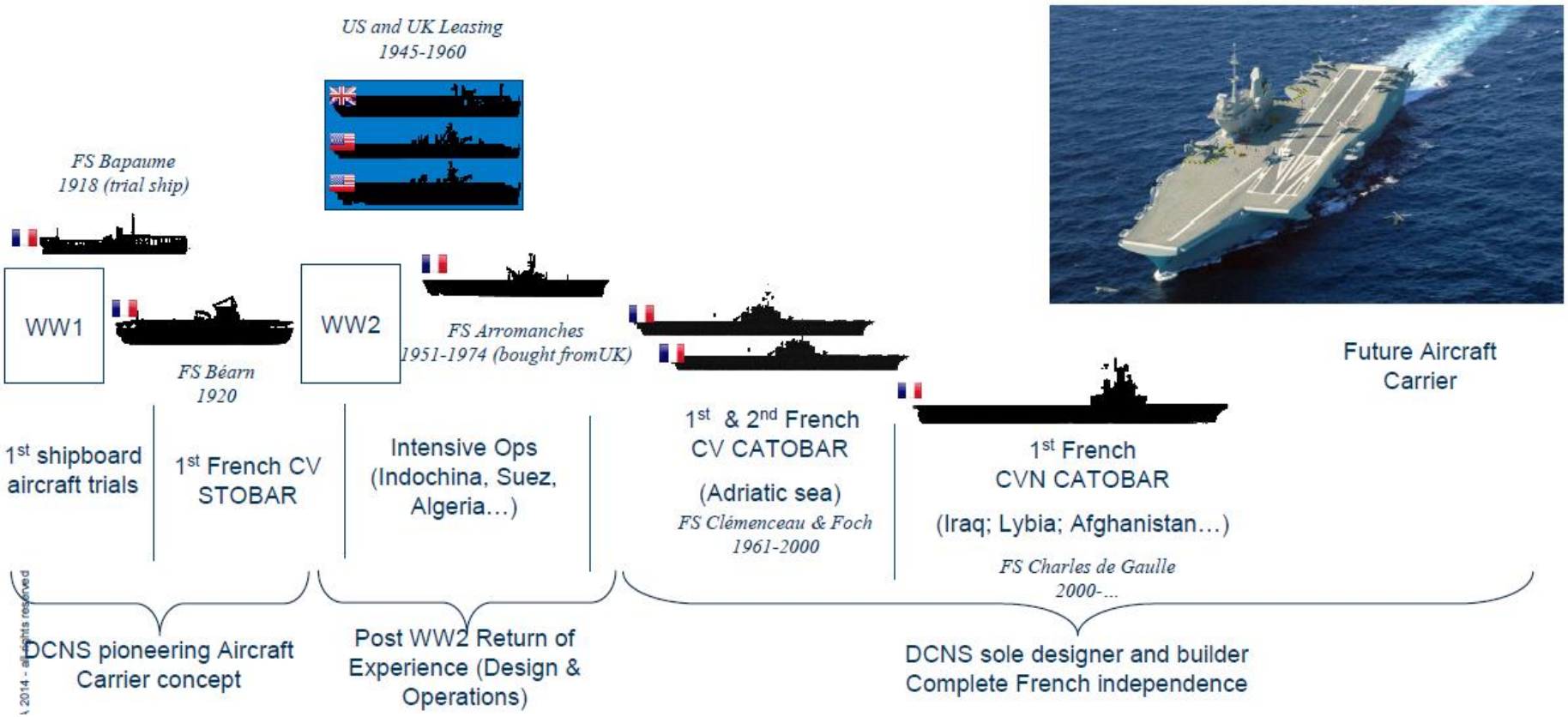
- Nuclear stokehold module for FR SSN
- 360t - 2,100 components

- 2nd Generation Air Independent Propulsion with fuel cells
- Under testing

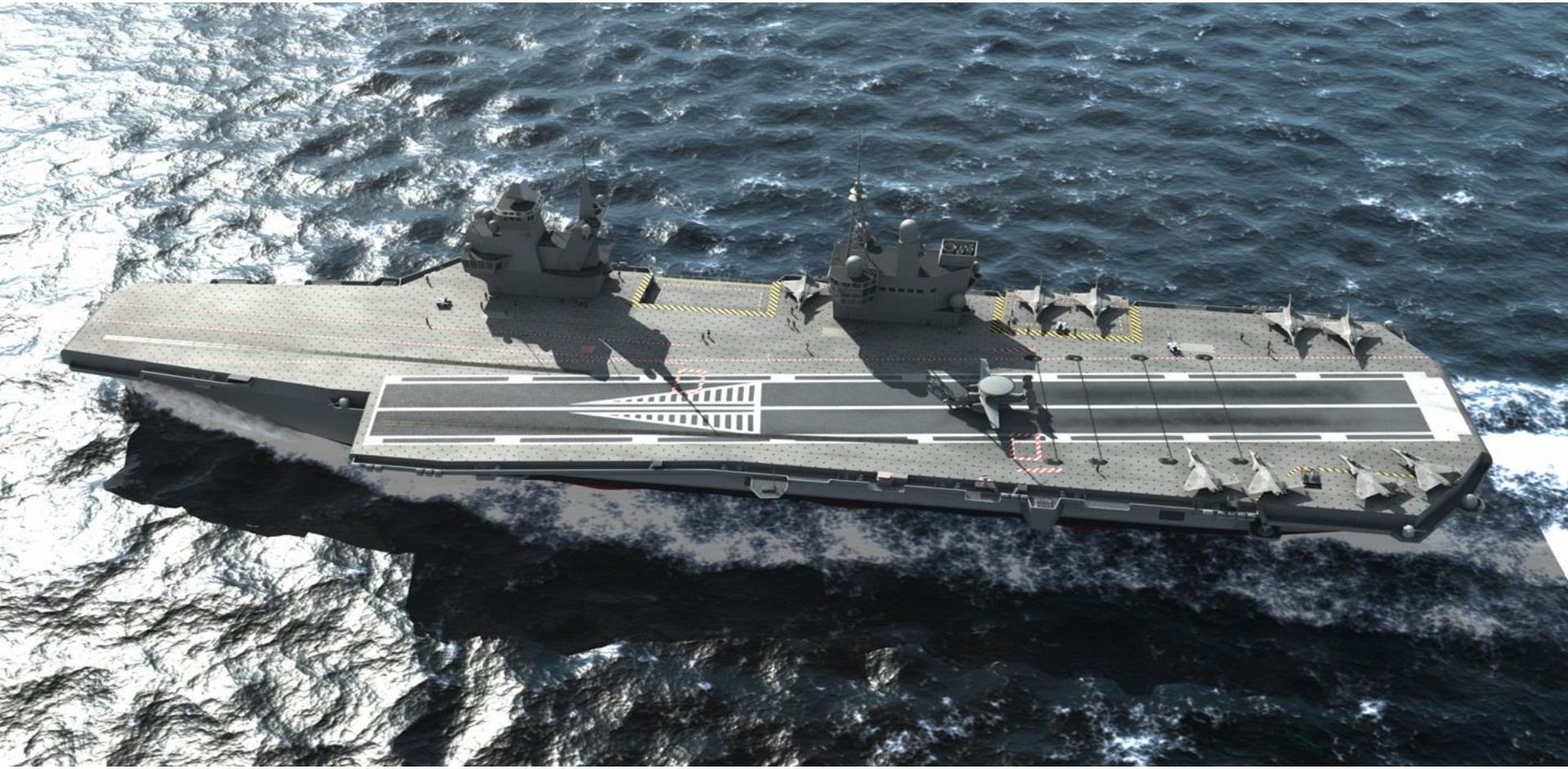
- Key components for nuclear steam supply systems

- Hybrid propulsion system

DCNS AIRCRAFT CARRIER LEGACY



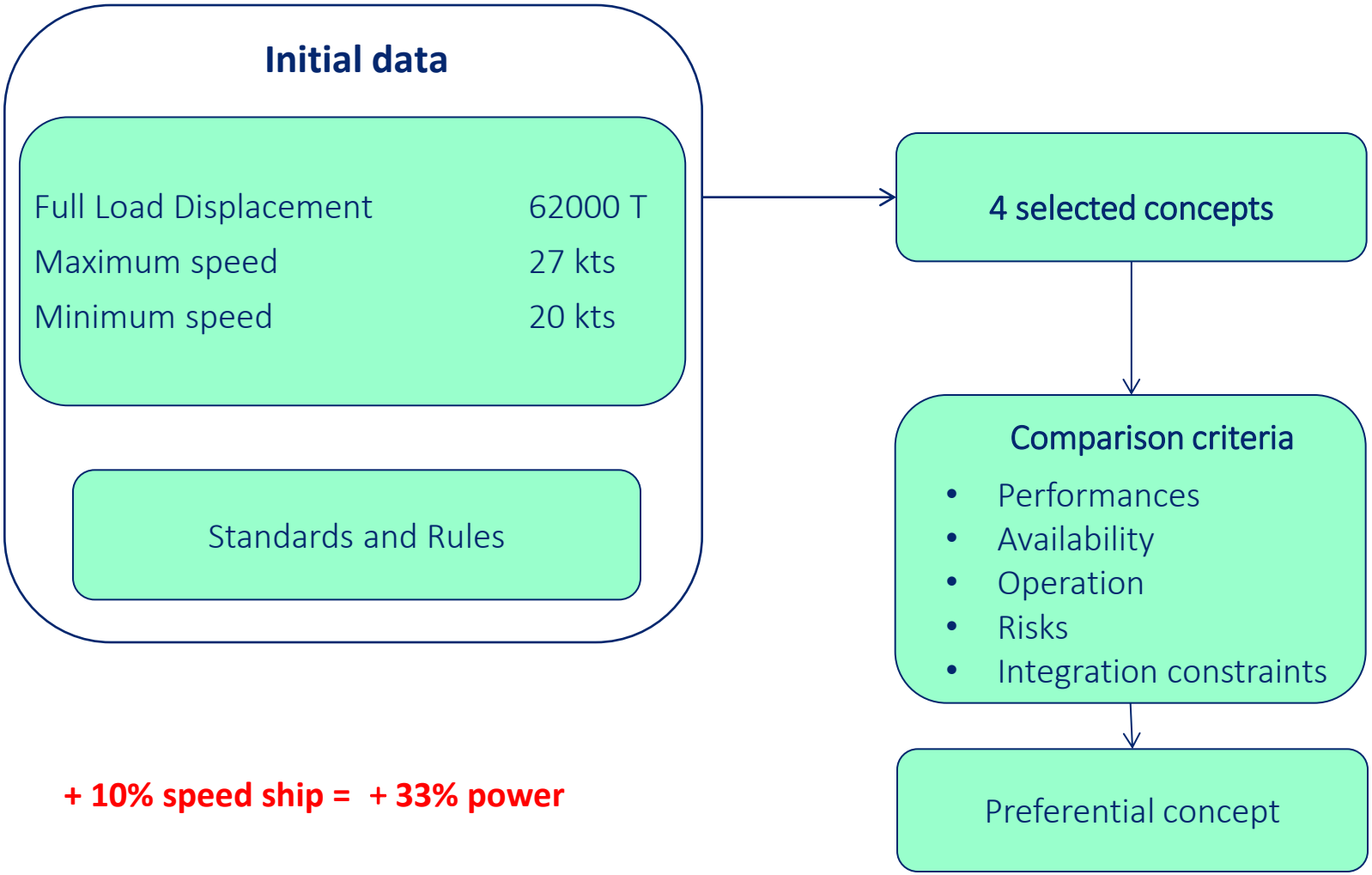
FUTURE CV PROPULSION STUDIES



FUTURE CV PROPULSION STUDIES
Operational drivers

- FOR LAUNCH AND RECOVERY, AIRCRAFT SPEED MAY NOT BE SUFFICIENT TO FLY ACCORDING TO THE WEIGHT OF THE AIRCRAFT DUE TO ITS CONFIGURATION
- THE ONLY WAY TO HELP THE AIRCRAFT TO FLY IS TO ADD RELATIVE WIND SPEED
- RELATIVE WIND SPEED = TRUE WIND SPEED + SHIP SPEED
- IF NO TRUE WIND THEN THERE IS A NEED FOR HIGH SHIP SPEED (UP TO ABOUT 30 KNOTS)
- AND A MINIMUM SPEED HAS TO BE GUARANTED (ABOUT 20 KNOTS) TO RECOVER AIRCRAFT IN CASE OF DEGRADATION OF THE PROPULSION
- PROPULSION HAS TO BE REACTIVE TO COMPENSATE VARIATIONS OF TRUE WIND

FUTURE CV PROPULSION STUDIES

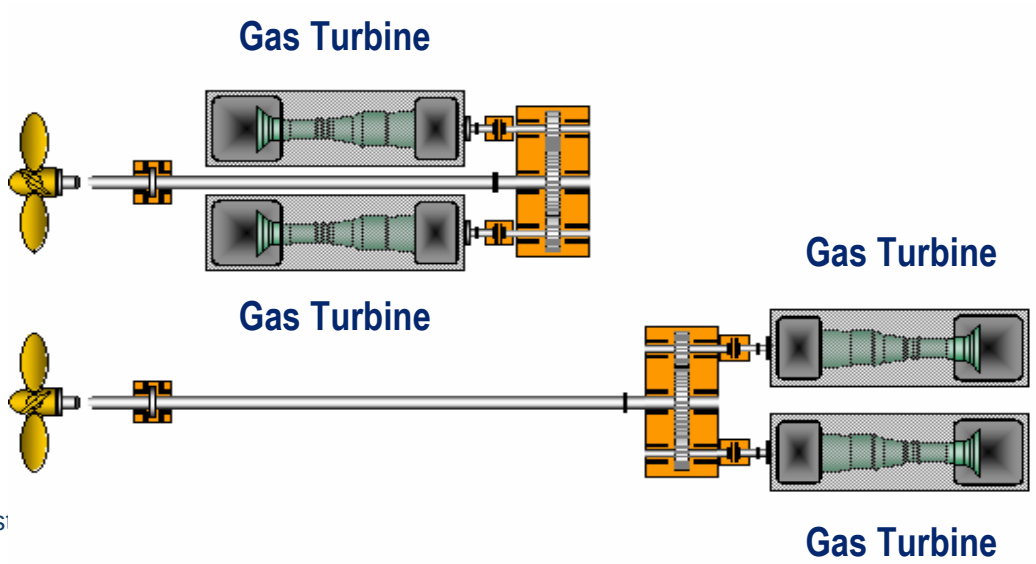


+ 10% speed ship = + 33% power

FUTURE CV PROPULSION STUDIES

Combined Gas and Gas concept with 2 Shaft lines

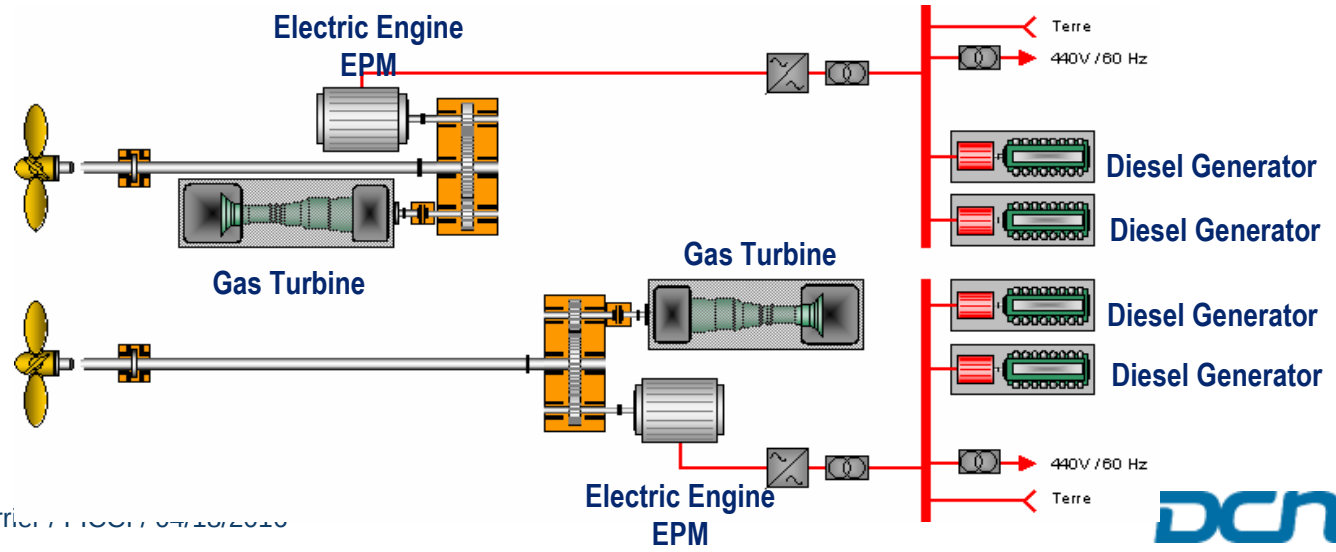
- **Advantages**
  - Good power-to-weight ratio
  - Good high speed
- **Disadvantages**
  - High fuel consumption at low speed
  - Heavy turbines integration constraints (suction and exhaust)
  - Variable pitch propeller
  - Complex Gearbox



FUTURE CV PROPULSION STUDIES

Combined Diesel Electric and Gas concept with 2 Shaft lines

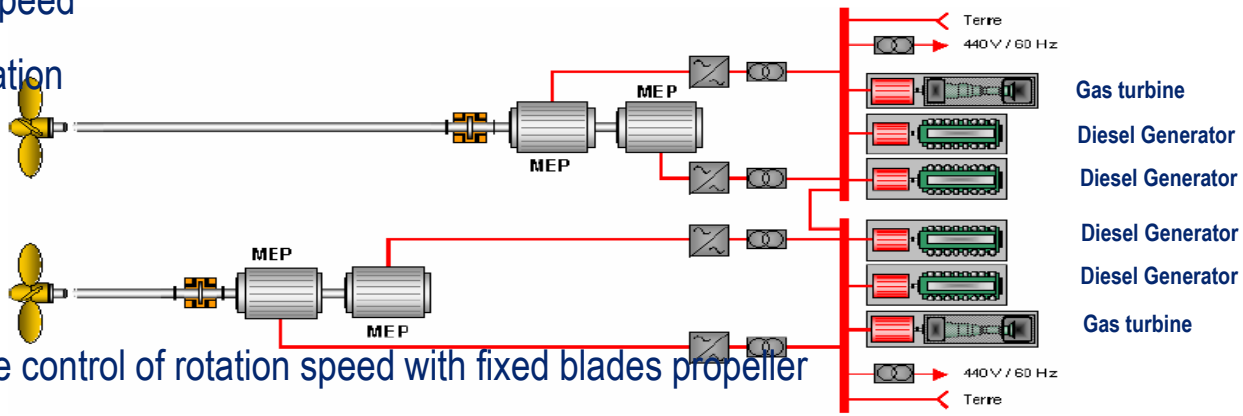
- **Advantages**
  - Single electrical power plant for propulsion and ship consumption
  - Precise and progressive control of rotation speed with fixed blades propeller and EPMs
- **Disadvantages**
  - Gearbox presence
  - Harmonic pollution to be treated
  - Crew training requested in power electronics, automation…
  - Minimum speed if one of the two shaft lines is locked



FUTURE CV PROPULSION STUDIES

Integrated Full Electric Propulsion concept with 2 Shaft Lines

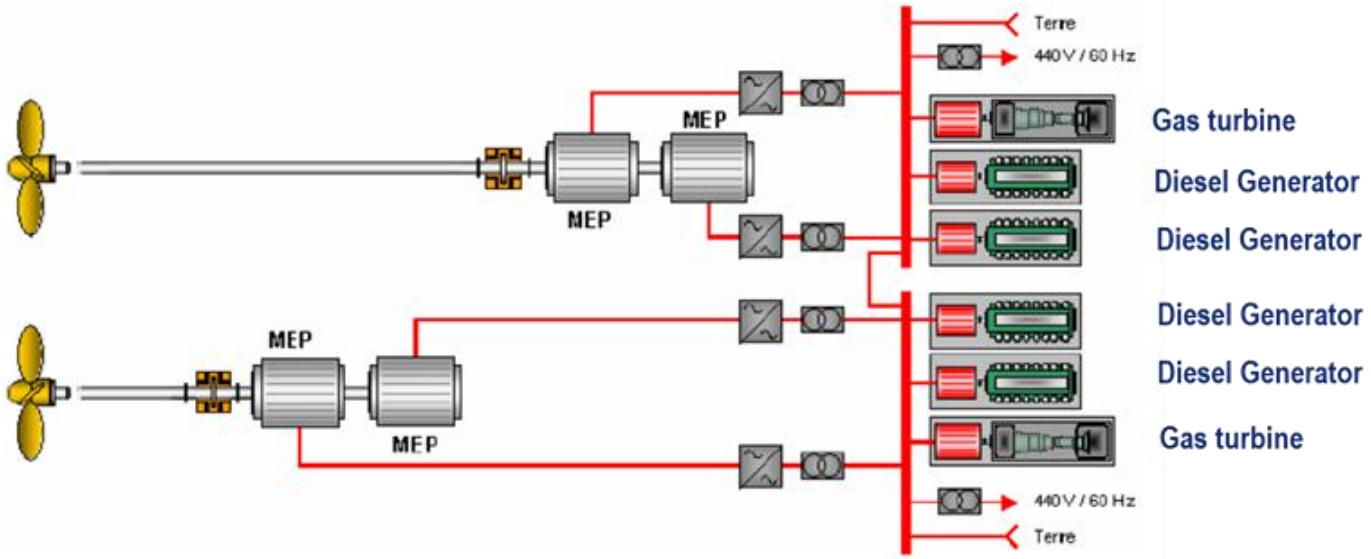
- **Advantages**
  - **No gear box**
  - **Single electrical power plant for propulsion and ship consumption**
  - **Optimization of the load rate of generators**
  - **Reduced maintenance costs on diesels:**
    - Operating at constant speed
    - Working Hours optimization
  - **Maneuverability**
    - Precise and progressive control of rotation speed with fixed blades propeller
    - Maximum torque on the whole range speed
  - **4 Static converters easy to maintain**
  - **Electric generation redundancy**
  - **Propulsion redundancy**



FUTURE CV PROPULSION STUDIES

Integrated Full Electric Propulsion concept with 2 Shaft Lines

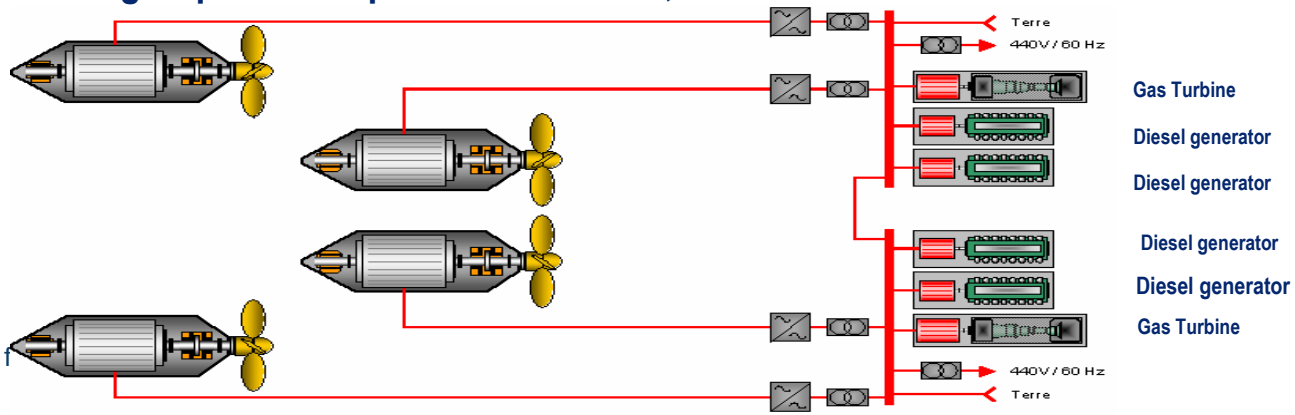
- **Disadvantages**
  - Harmonic pollution to be treated
  - Complex Control and Command system
  - Crew training requested in power electronics, automation…
  - Minimum speed if one of the two shaft lines is locked



FUTURE CV PROPULSION STUDIES

Integrated Full Electric Propulsion concept with 4 Pods

- **Advantages**
  - 20 kts with N-1 propeller
  - Space gain: no shaft line nor gear box, EPMs outside hull
  - Excellent maneuverability: 360° steerable POD
  - Less mounting operations: no shaft Line, no gear box, no rudder
  - Possible late installation of the PODs
  - Reduced noises and vibrations inside ship
- **Disadvantages**
  - Mechanical stress between PODs and hull
  - More important draft
  - Harmonic pollution to be treated
  - Crew training requested in power electronics, automation



FUTURE CV PROPULSION STUDIES

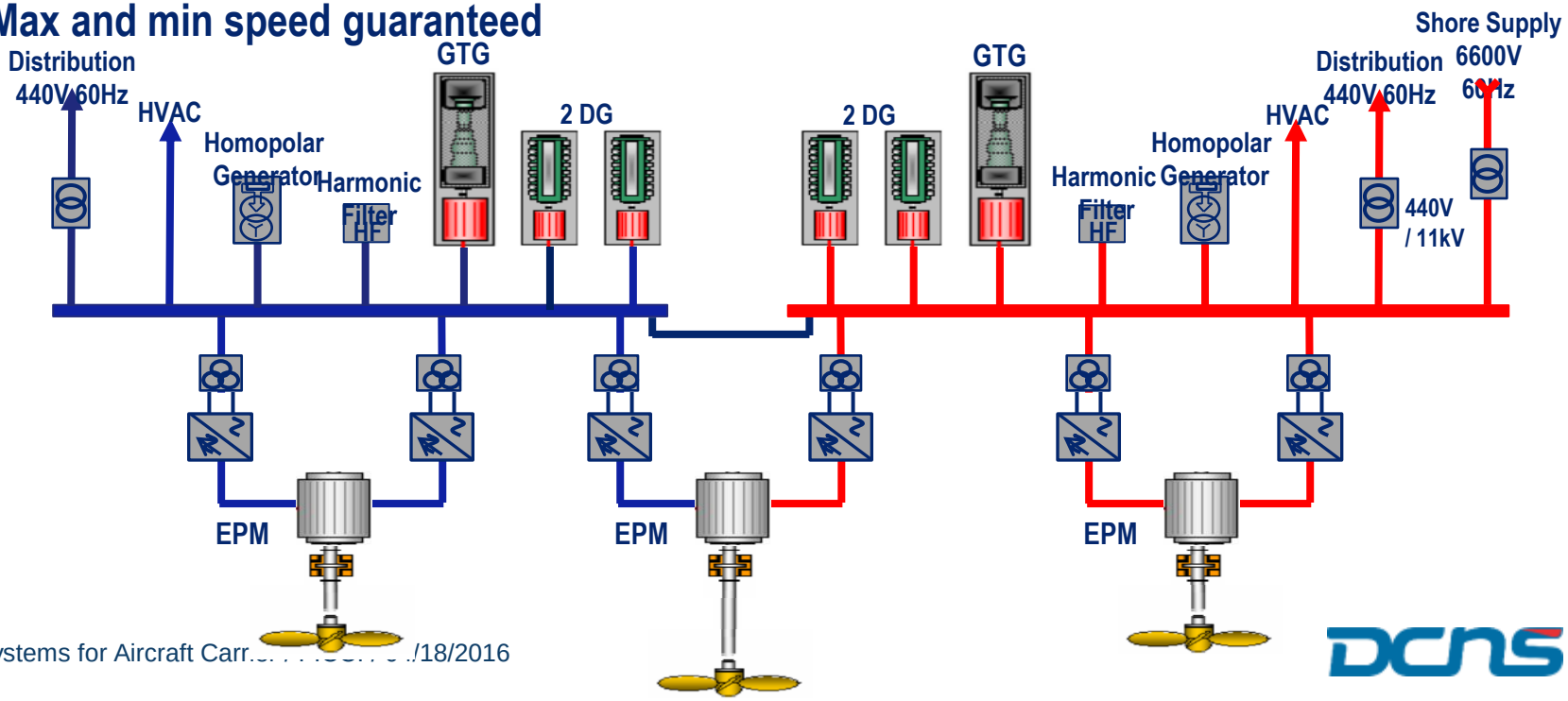
Preferential concept

- New assumption : increase of the Full Load Displacement at the end of life of the ship up to 75 000 tons,
- New technical risks identified:
  - Too high density of power on the Propellers
  - Too high propeller thrust
- More PODs or more powerful PODs not possible
- Preferential solution : IFEP with 3 Shaft Lines

FUTURE CV PROPULSION STUDIES

Integrated Full Electric Propulsion concept with 3 shaft lines

- 3 electrical propulsion motors (EPM)
- 2 variable speed drives for each EPM
- 1 transformer for each variable speed drive
- Central EPM supplied by the two main switchboards
- 50% motor maximum torque powered by only one variable speed drive
- Max and min speed guaranteed



DHANYAVAD ! THANK YOU !

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