

RTDS Validation of a WAMPAC for BESS and HVDC Control in the Balearic Islands

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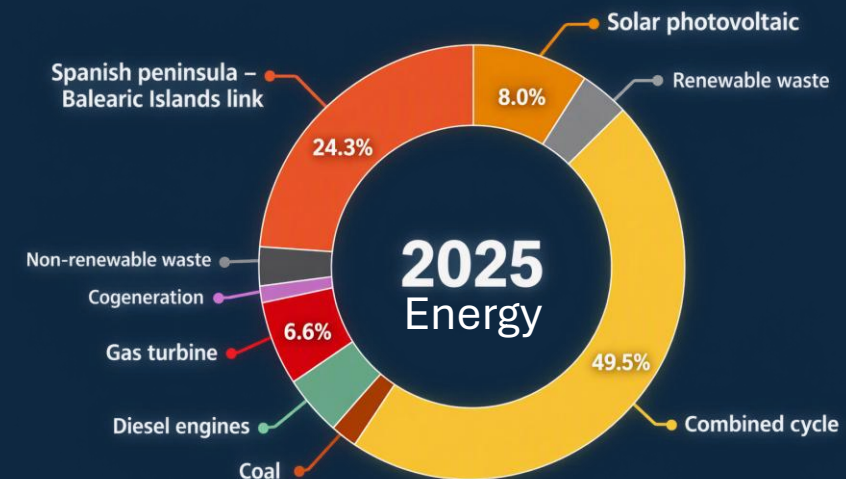
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Introduction

WAMPAC for BESS and HVDC in the Balearic Islands

Balearic Power System: Today

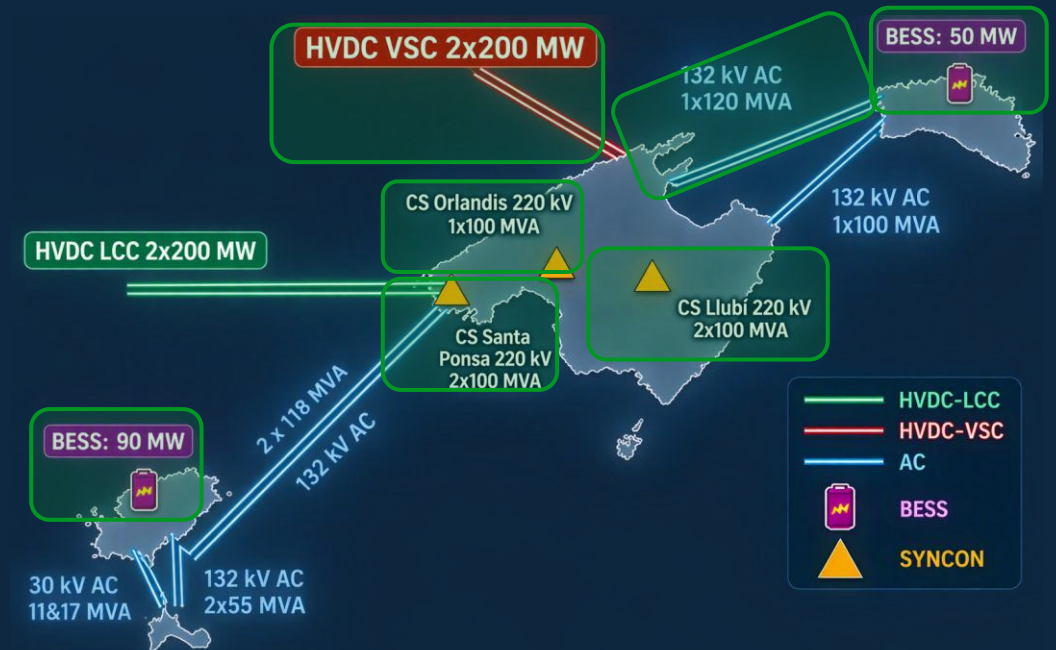
- The Balearic system is an isolated system connected to the peninsula by means of an HVDC-LCC link with a capacity of 2×200 MW
- It is made up of four islands interconnected by 132 kV AC links
- Combined cycle plants are the main source of energy, followed by the contribution of the peninsula through the HVDC link
- Peak demand varies significantly between winter (≈ 900 MW) and summer (≈ 1500 MW)



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Balearic Power System: Tomorrow

- Several grid developments will support decarbonization of the Balearic power system
- One synchronous condenser is already being installed to ensure, among other functions, sufficient short-circuit power at the HVDC-LCC link terminals. Four additional synchronous condensers are planned
- Two BESS are already being installed in Menorca and Ibiza to maximize use of inter-island links and the connection to the mainland
- Medium-term plans include commissioning a new HVDC-VSC link to the mainland with grid-forming technology
- A new AC 132 kV link between Menorca and Mallorca is also planned for the medium term



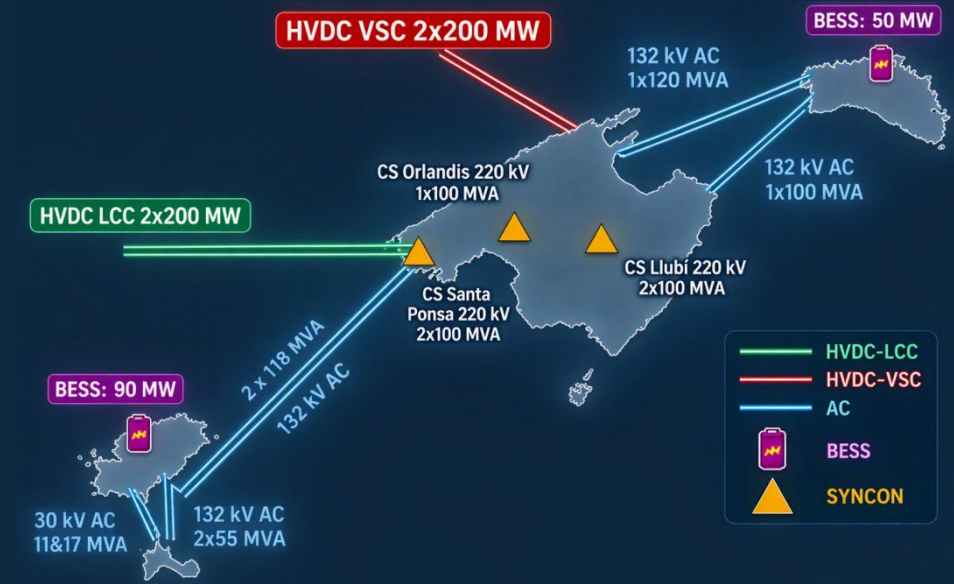
BESS & WAMPAC (HERMES)

WAMPAC for BESS and HVDC in the Balearic Islands

BESS: Objectives and Key Features

- New BESS: Ibiza, 90 MW / 67.5 MWh, and Menorca, 50 MW / 37.5 MWh, fully integrated into the transmission grid
- BESS increase both security and link utilization, enabling higher mainland–Balearic and inter-island transfers
- After a circuit outage, they support the lost power flow until restoration or alternative action, such as starting generation
- They remain with no energy injection or absorption in normal operation
- Frequency services are outside the scope of this system

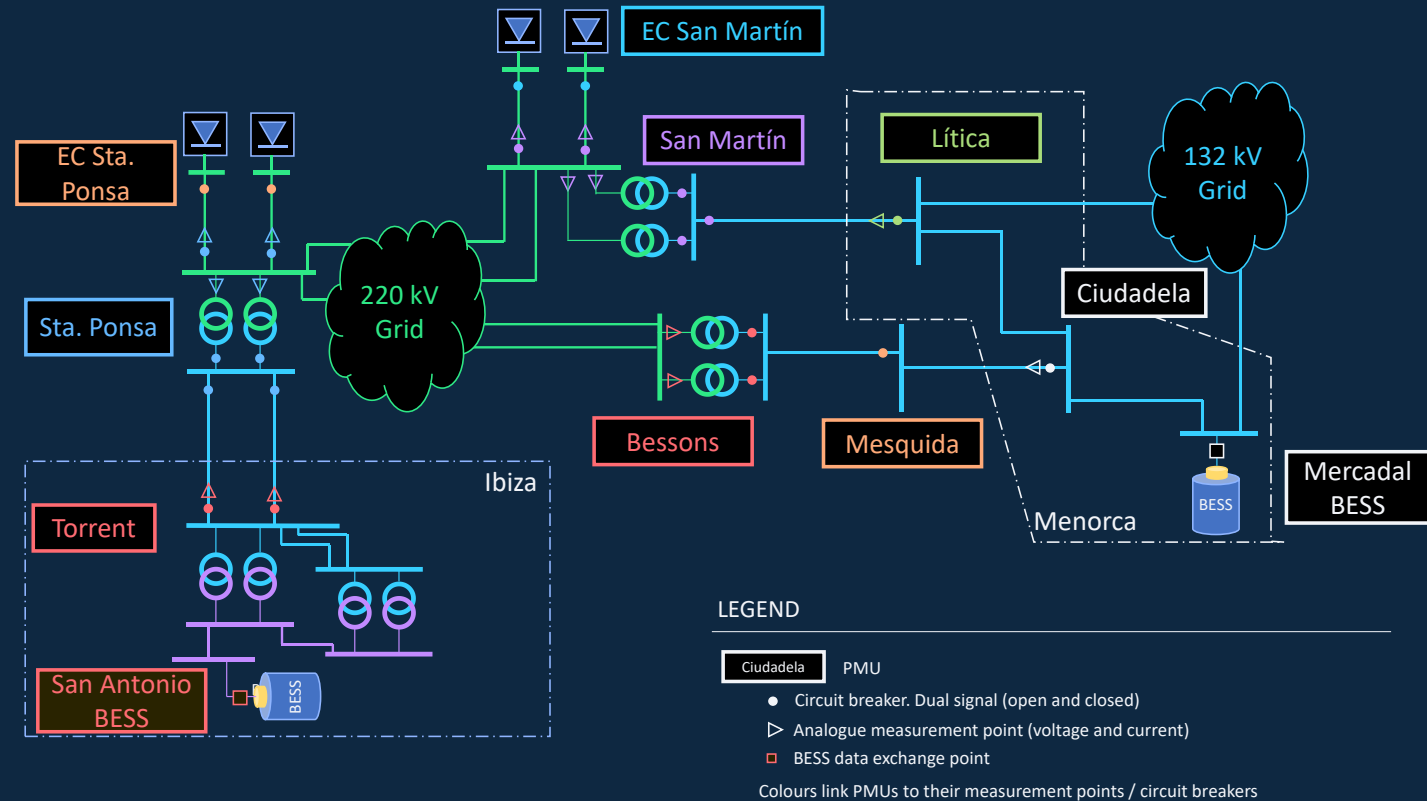
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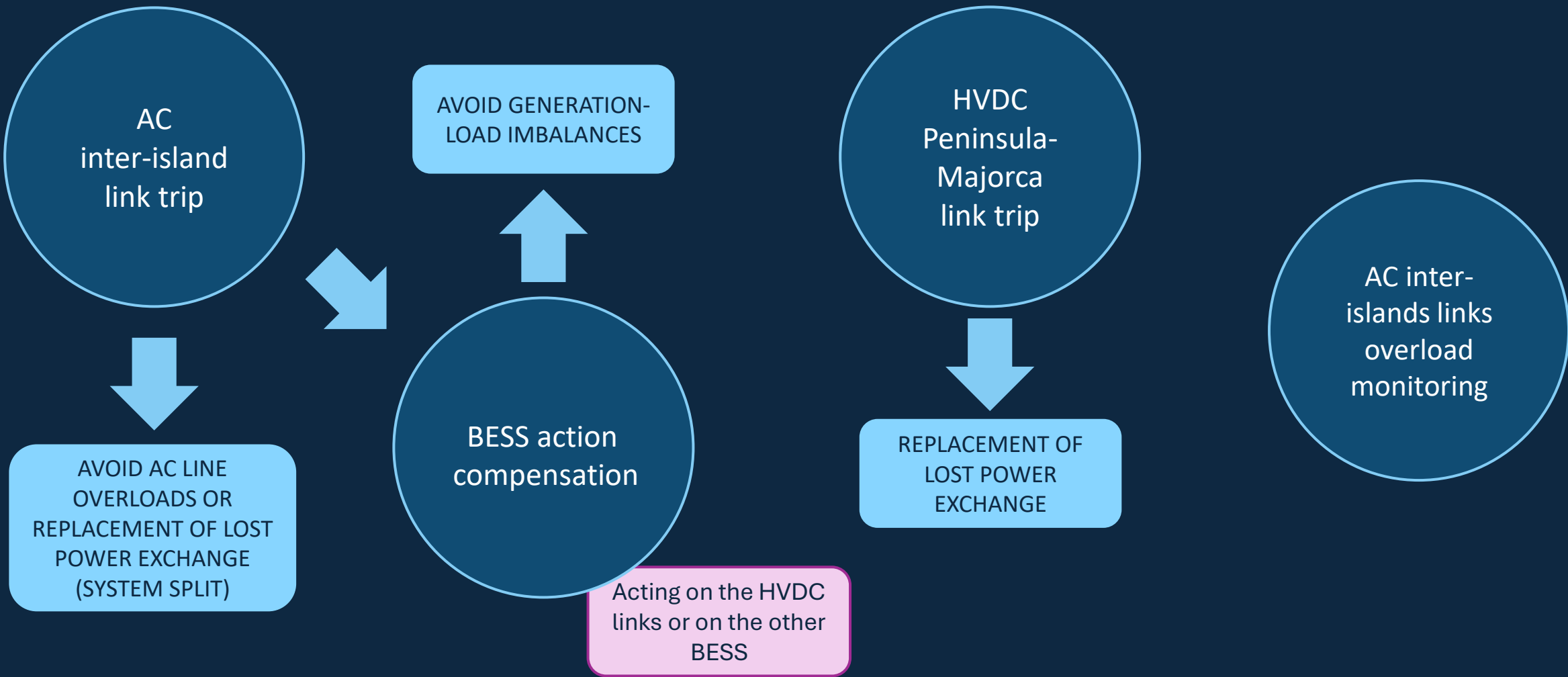
WAMPAC (HERMES): design

- WAMPAC uses PMUs to monitor all inter-island AC links, mainland HVDC links and BESS outputs
- Measurements come from 11 substations across three islands
- Setpoint commands use IEC 61850 analogue GOOSE messages for both BESS and the future HVDC-VSC link
- The HVDC-LCC link receives hardwired run-up and run-back commands
- HVDC power flows must be adjusted to compensate for the generation-demand imbalance following BESS activation when one or more AC-link elements trip



WAMPAC for BESS and HVDC in the Balearic Islands

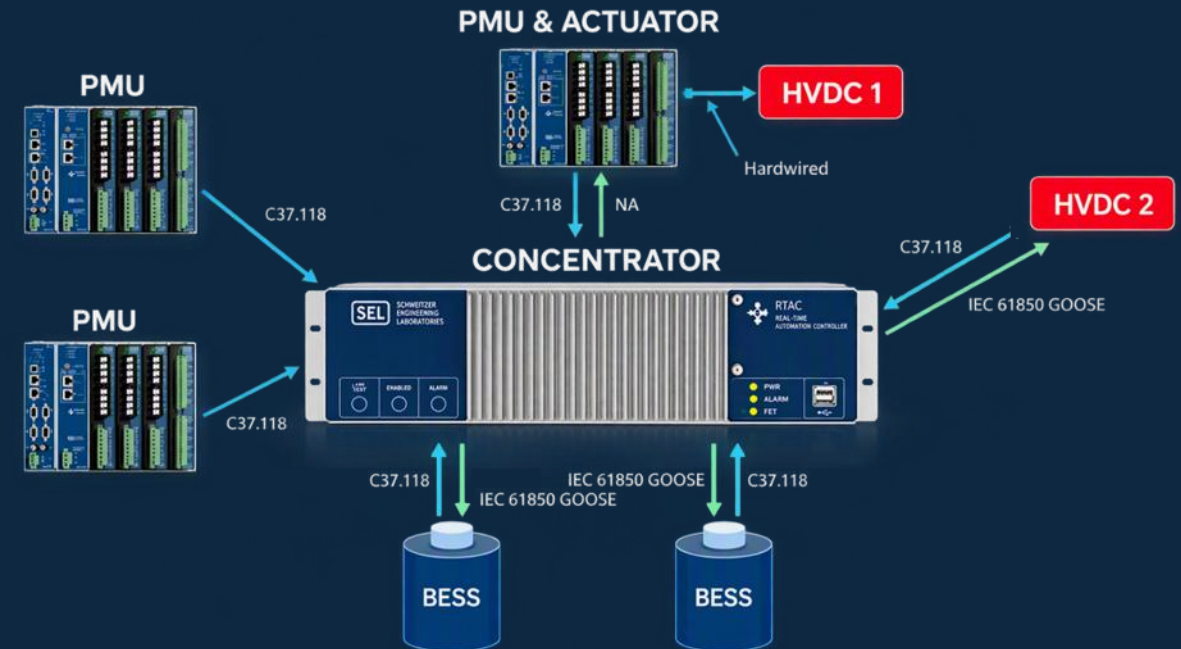
WAMPAC (HERMES): main functions



WAMPAC for BESS and HVDC in the Balearic Islands

WAMPAC (HERMES): implementation

- WAMPAC comprises two fully independent, redundant systems operating in an active-active configuration
- Both systems continuously transmit setpoints
- The BESS implement a logic to handle setpoints received from both systems
- To support this logic, each system sends both its setpoint and the remaining additional transfer capacity in both directions on the AC links, calculated in real time



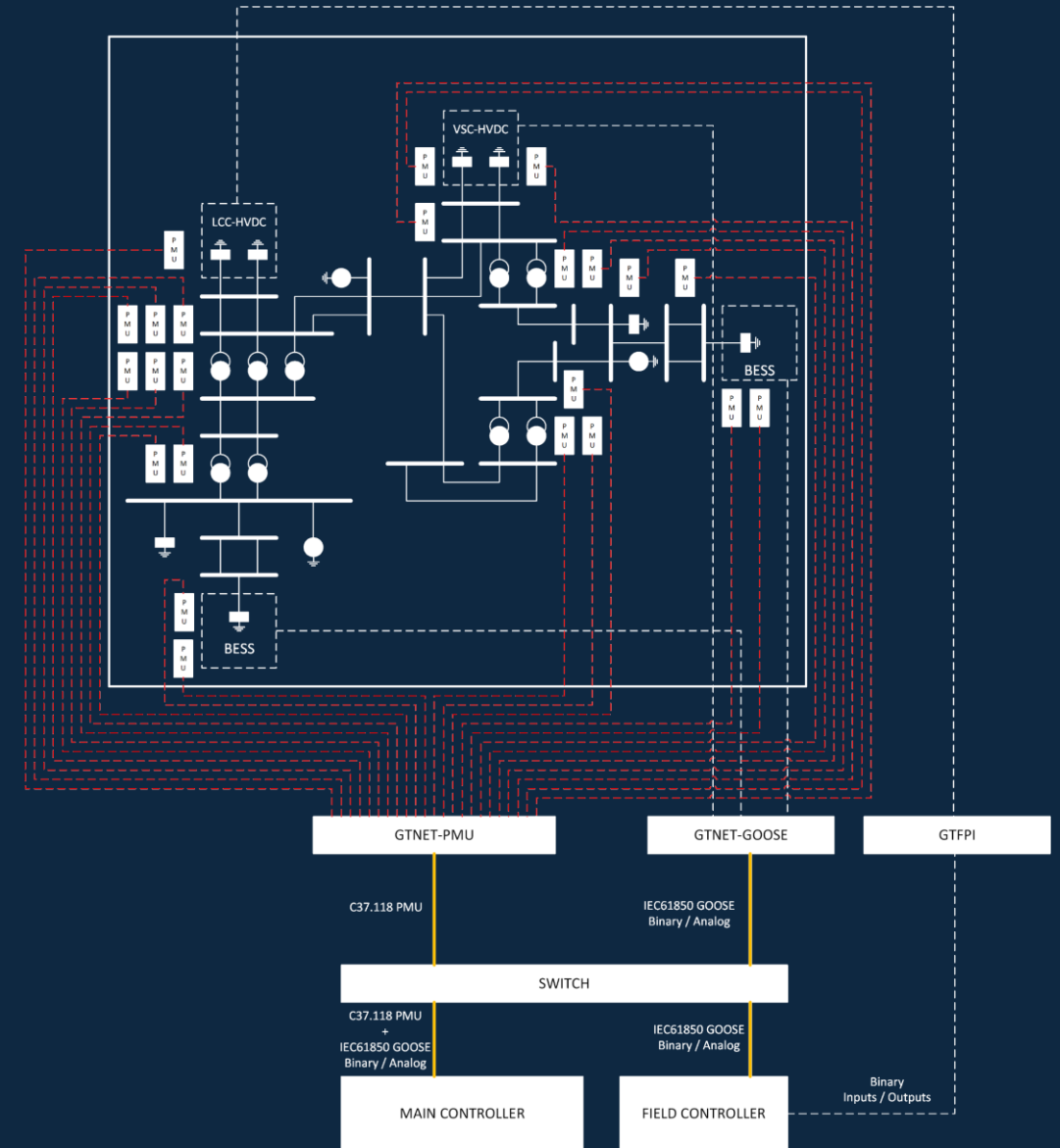
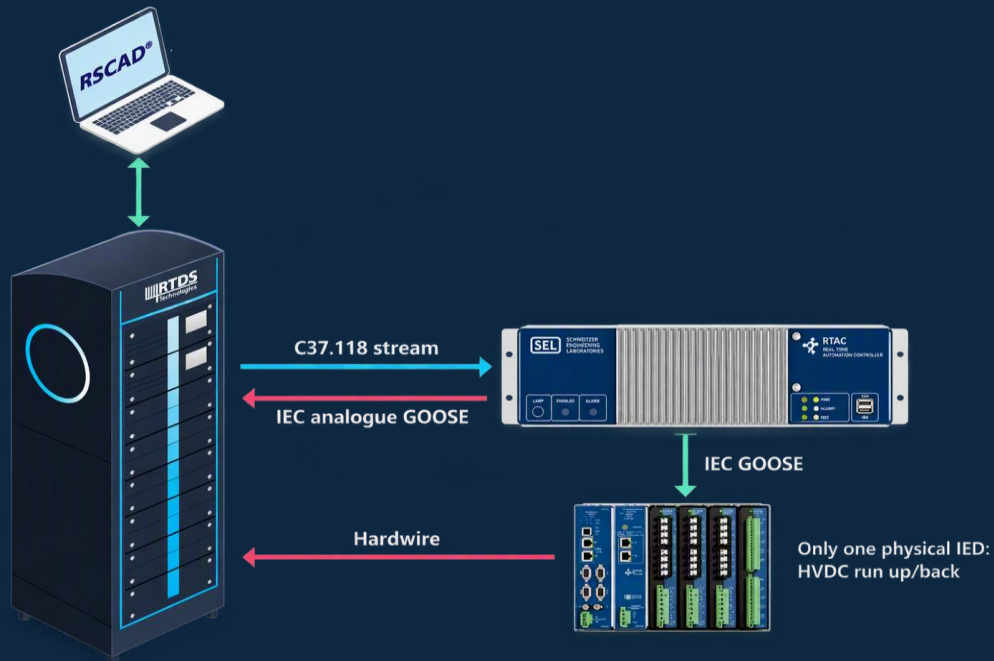
RTDS Implementation

WAMPAC for BESS and HVDC in the Balearic Islands

RTDS implementation

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- A large model was implemented with 1 Main controller and 1 physical field controller; the rest of controllers were simulated:

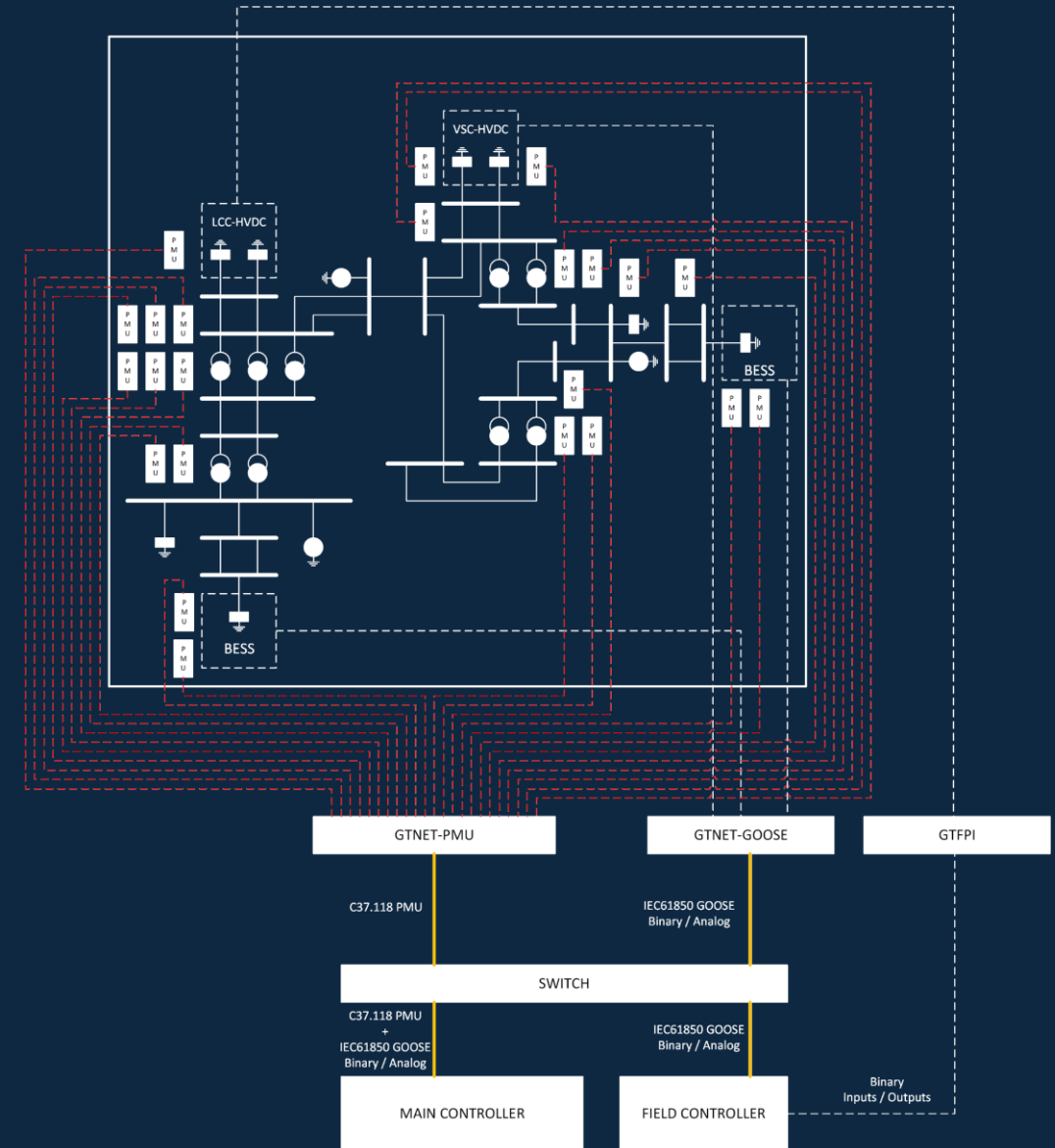


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RTDS implementation

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- The model included:
 - 24 Tlines (Bergeron for long distances and PI for short distances).
 - 9 Power Transformers and Autotransformers.
 - 5 Controlled PQ Loads and 3 Sources.
 - HVDCs simulated as controlled PQ Sources.
 - BESS simulated as controlled PQ Sources.
 - GOOSE communication both with Digital and Set Points (for BESS and HVDC).
 - Analog Measurements based on C37.118 PMUs. (23 Measuring points) with CB Positions included in the Binary frame.
 - GTFPI to validate outputs of the field controller.



Final remarks

Final remarks

- Ibiza and Menorca BESS maximize the utilization of existing transmission grid assets
- Achieving this requires fast and reliable WAMPAC systems
- These systems require rigorous and extensive testing
- Hardware-in-the-loop testing provides an efficient way to validate systems that span multiple substations and perform multiple control functions



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Valuing the essentials

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