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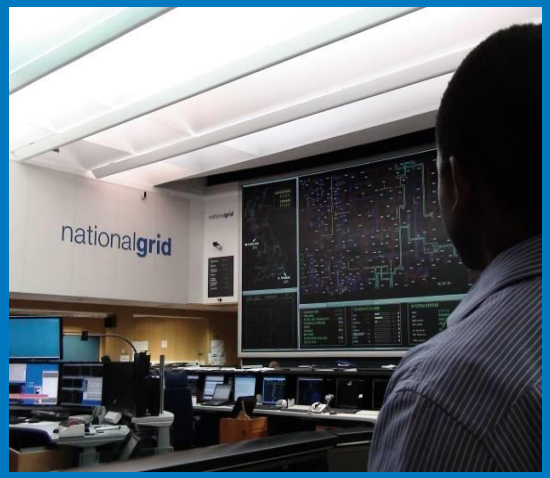
Purpose Driven Smarter Grid

-SGMITT'17 Weihai, China



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  - National Grid and GB Electricity Transmission
- Smart Grid Philosophy
  - What and Why?
  - Smarter Grid
- Smarter Grid within National Grid
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  - Smarter Transmission Initiatives
- Summary

Introduction

- National Grid and
- GB Electricity Transmission

National Grid & GB Electricity Transmission

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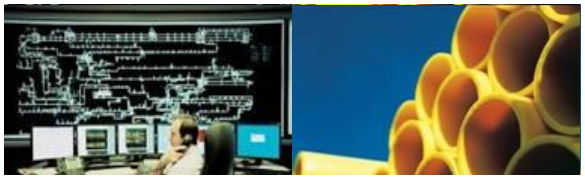
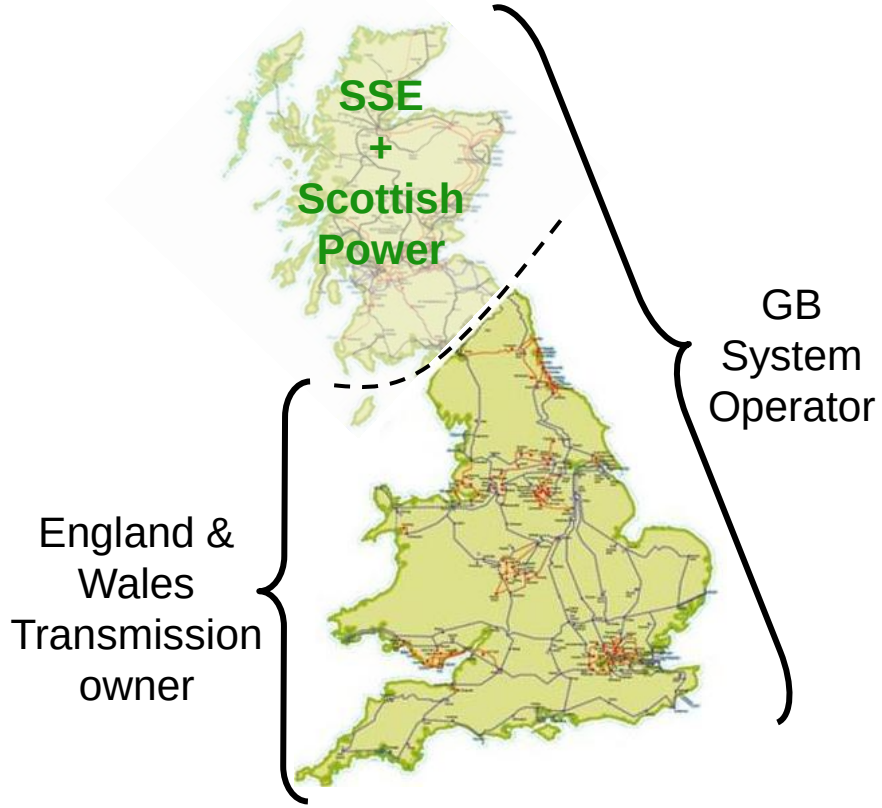
UK & US

Electricity & Gas

Transmission & Distribution





Revenue £15.bn, Operating profit £4.7 bn,

Employees 22,068 after sale of UK Gas distribution (2017)

National Grid Electricity Transmission

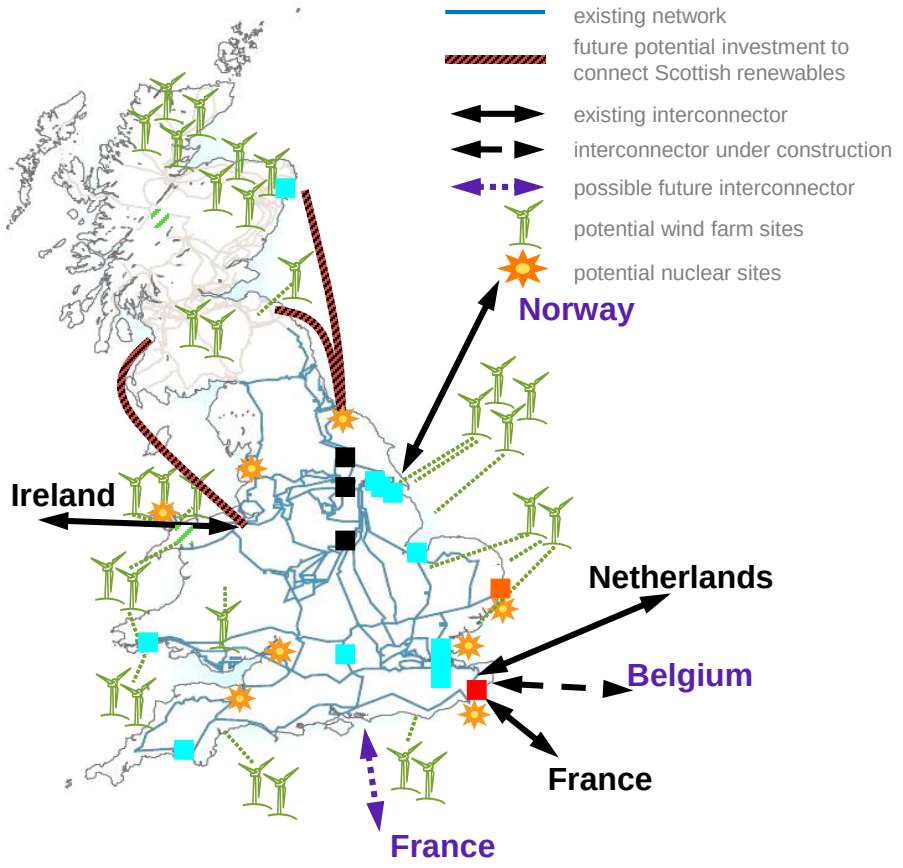
- An evolving network

132kV, 275kV & 400kV (50Hz)
GB Demand ≈ 60 GW Peak

337 Substations
7,200km OHL
690km underground cable

Interconnectors with
Scotland (AC),
Holland (DC), France (AC)
Ireland (EWIC-DC)

In construction:
Western HVDC Link
NSN HVDC Link (Norway)
NEMO HVDC Link (Belgium)



GB Transmission - Regulated

Interconnectors with Europe - Unregulated

Challenges & Business Strategy

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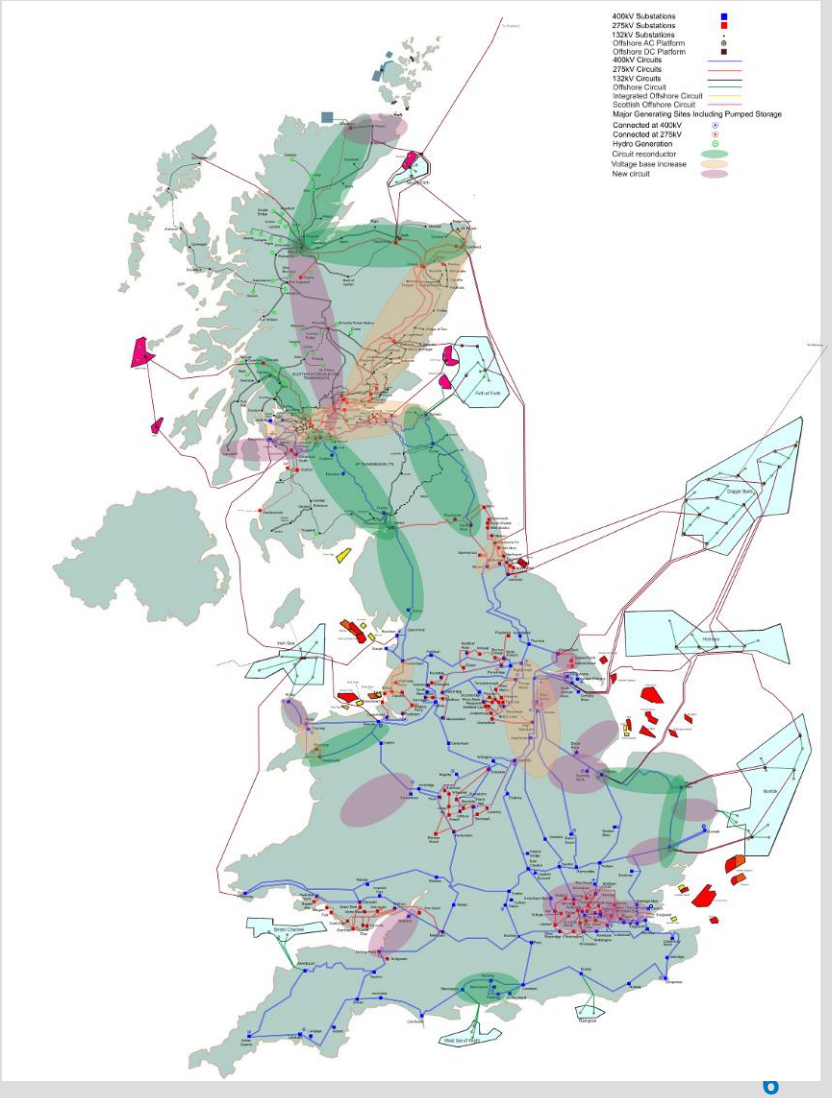
PERFORM
- New regulatory regime (RIIO)
- Large investment program
    - Aging infrastructure + New Conns
- ‘Fit for Purpose’ Network
- System access

COMPETE
- CATO – Onshore competition
- TO/SO separation
- Efficiency –
- Resource & Skills

GROW
- Energy Landscape changes
- New Tech/Opportunitiy-Storage, MicroGrid etc.
- Integrating renewable energy
- Quick Power flows changes and control



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Smart Grid Philosophy

- What and Why?
- Smarter Grid

Smart Grid Philosophy
- What and Why?

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- **Definitions:**

  - *"Smart grid" generally refers to a class of **technology** people are using to bring utility **electricity delivery systems** into the 21st century, using computer-based remote **control and automation**.* ***-Department of Energy, UK***
  - *A smart grid is a **modernized** electrical grid that uses analogue or digital information and communications **technology** to gather and act on information, such as information about the behaviours of suppliers and consumers, in an **automated** fashion to **improve the efficiency, reliability, economics, and sustainability** of the **production and distribution of electricity**.* ***-Wikipedia***
  - *The "smart grid" has come to describe a next-generation electrical power system that is typified by the **increased use** of communications and information **technology in the generation, delivery and consumption of electrical energy**.* ***-IEEE***

"Intelligent way to design, build, operate and manage ESI* for a defined benefit or purpose"

- **Purposes:** efficiency, reliability, economics, and sustainability …..

***ESI**: Electricity Supply Industry (Generation, Distribution & Transmission)*

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Smart Grid Philosophy

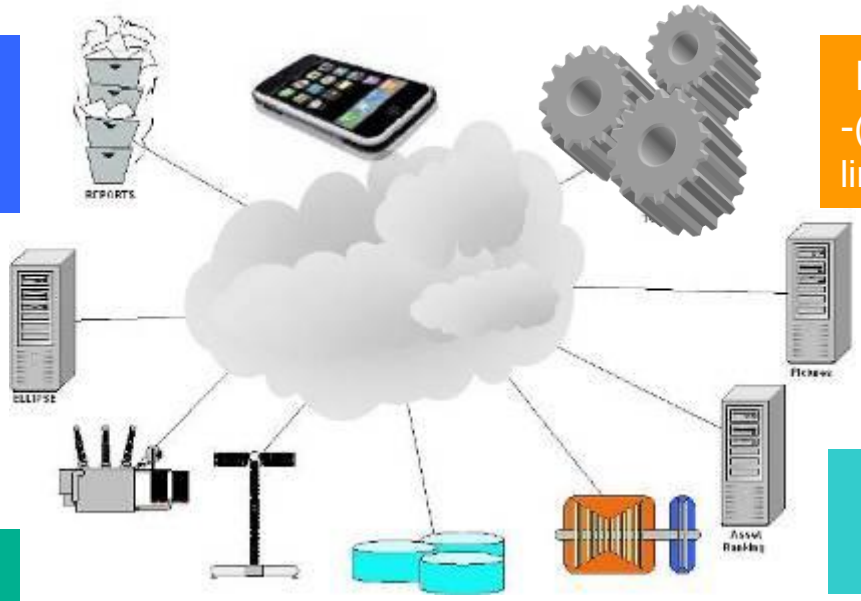
-Is the Current System Smart?

Condition monitoring

"Whole Life Value"
-Asset Management Strategy

Protection Systems
-Detect & Clear faults in 140ms

SCADA/EMS
-Remote Control & Unmanned Substations



Delayed Auto Reclose
-(**DAR)** to recover tripped lines by transient faults

Auto-Switching
-Hot Standby Schemes

Auto Volt Control
-ATCC/ARS/SVC

Quad Booster
- Optimise Power Flow

FACTS
-HVDC & Series Comp

Operational Tripping Schemes (OTS)
- Thermal /Stability protection

RAMM system
-Remote access function

Smarter Grid
-Purposes and Benefits

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- *Question 1:*
  - *Could we make our Grids even Smarter?*
- *Question 2:*
  - *What is Smarter Grid for?*

Smarter Grid

-Technologies & Techniques

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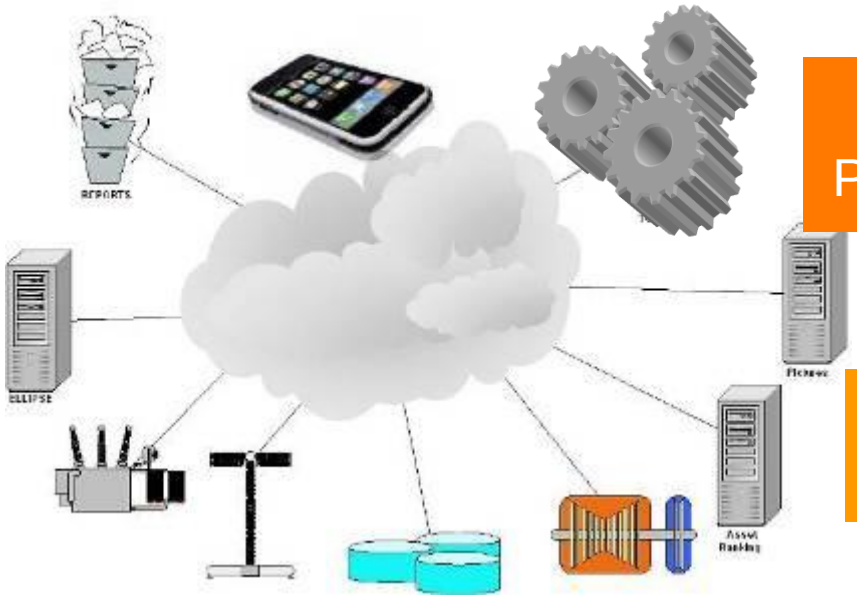
Smart Metering & Energy Storage

PMUs - Phasor Measurement Units

Risk Based Asset Management

Wireless Comm & Secure Data Exchange



Wider Area Protection & Control

Co-ordinated Regional Control

Dynamic Line Rating (DLR)

System Integrity Protection

IEC61850 Digital Substations

Congestion Management

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Smarter Grid within National Grid

- Smarter Transmission Strategy
- Smarter Transmission Initiatives

Smarter Transmission Strategy

-to deal with business challenges

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Smarter Build

- **“No-build” solutions- Innovations to enhance asset utilisation & capacity**
- **“Corrective system design”**
- **Better network modeling and prediction**
- **Stronger system resilience**

Smarter Asset Management

- **“Whole Life Value” philosophy**
- **“Risk & Criticality” based maintenance to Improve system availability & access**
- **Asset life ext- “Refurbish than replace”**
- **Cost-effective specifications**

Smarter System Operation

- **Flexible network & system automations**
- **Intelligent system balancing tools**
- **ICT skills & resources for Energy**
- **Demand side management**

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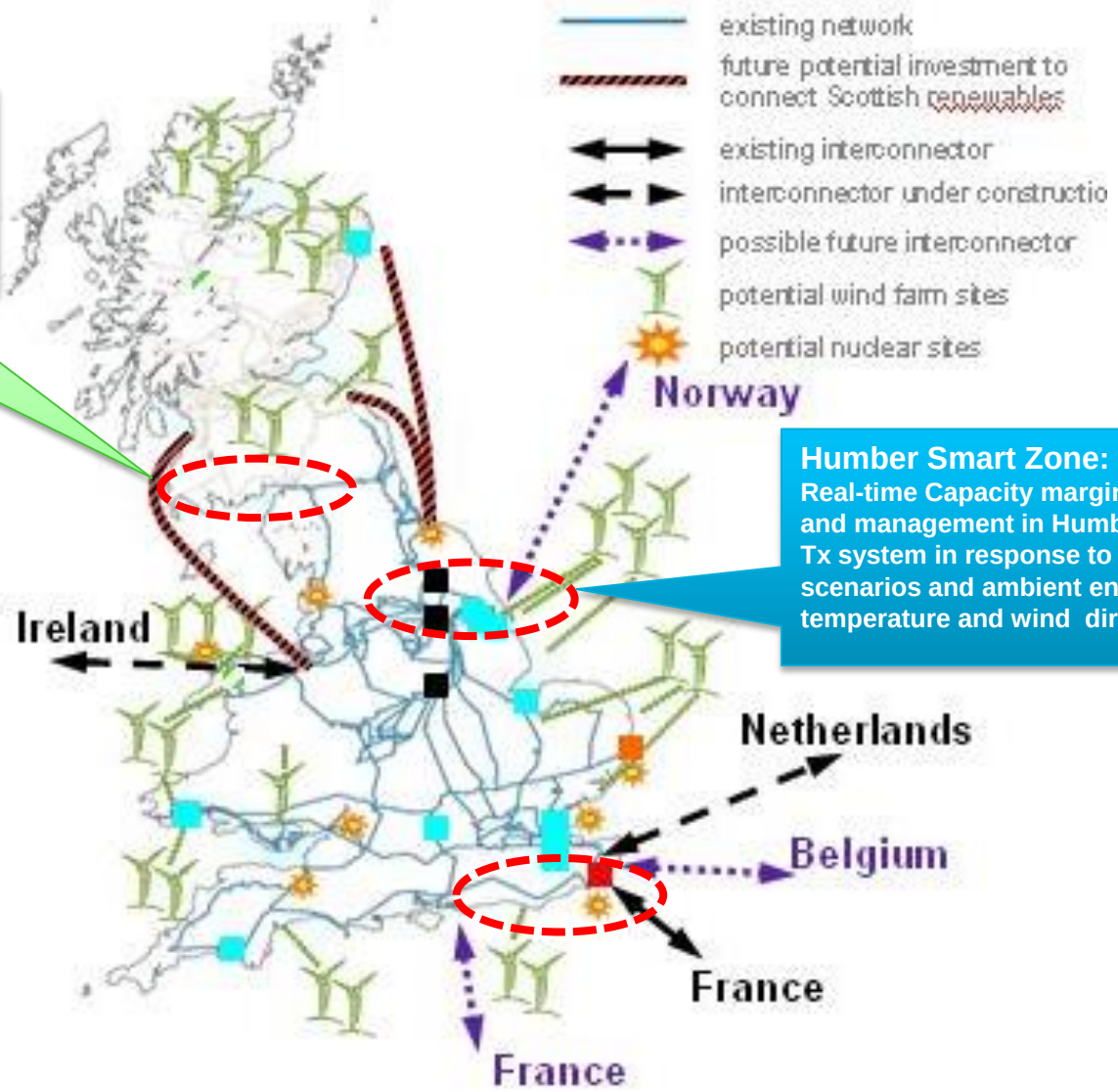
Smarter Transmission Initiatives

- Humber Smarter Zone
- VISOR: Visualisation of Real-time System Dynamics
- EFCC – Enhanced Frequency Control
- AS^3 Architecture: IEC61850 Based P&C systems
- SAM - Smarter Asset Management
- MSB - Mobile Substation Bay

Smarter Transmission Initiatives

-Overview

VISOR :
Interactions between generator-side in Scotland and GB Tx system area B6 in terms of both real-time SSO and transient stability monitoring and constraints management.



Humber Smart Zone:
Real-time Capacity margin monitoring and management in Humber Zone of GB Tx system in response to generation scenarios and ambient environment e.g. temperature and wind directions.

Humber Smart Zone

- Using QB, DLR and OTS to enhance circuit capacity

Phase 1: Enhance Trans capacity

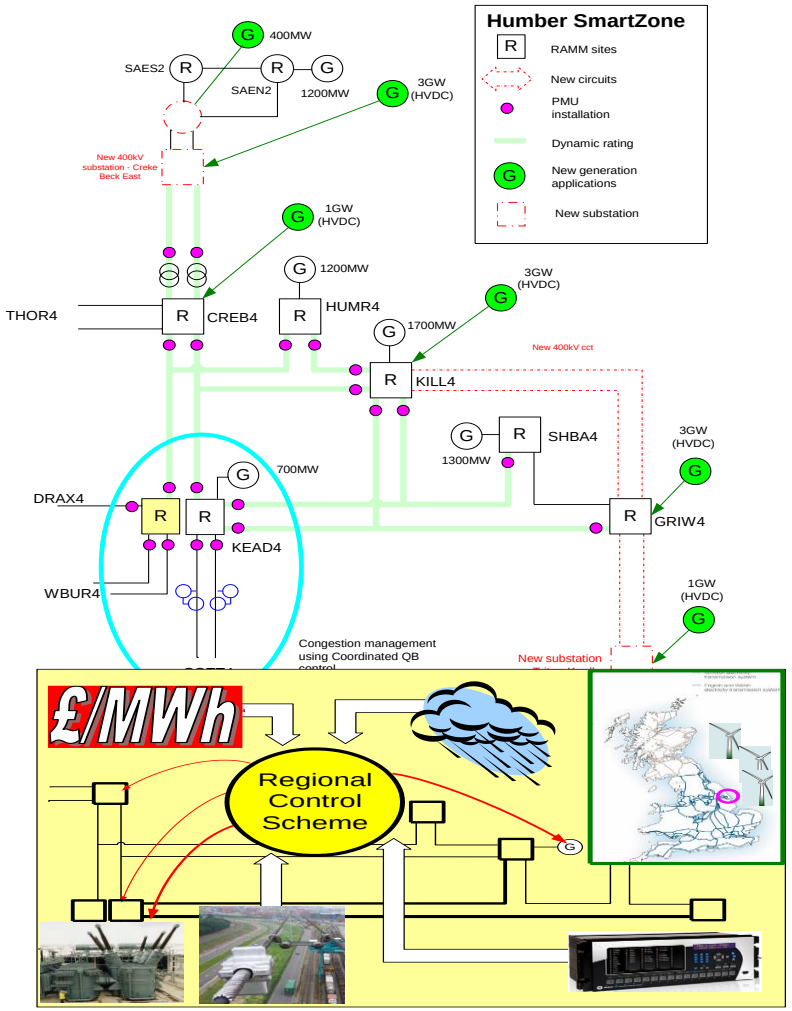
01/11 -03/14

- Optimise circuit capacity using QB, dynamic line ratings and OTSs
- Dynamic rating controlled Operational Tripping Schemes (OTS);
- DLR modules for real time monitoring.

Phase 2: Development and trial

04/14 to 03/17

- Develop a “capacity margin management “tool to define tenhanced flexible capacity
- Identify technical challenges
- Assess performance;
- Develop specs and guidance



VISOR (NIC Project 2013)

-Visualising Real-time System Dynamics using Enhanced Monitoring

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Partners: **SPTL (Lead), SHETL 12/13 to 03/17**

WP1: Enhanced system oscillation monitoring

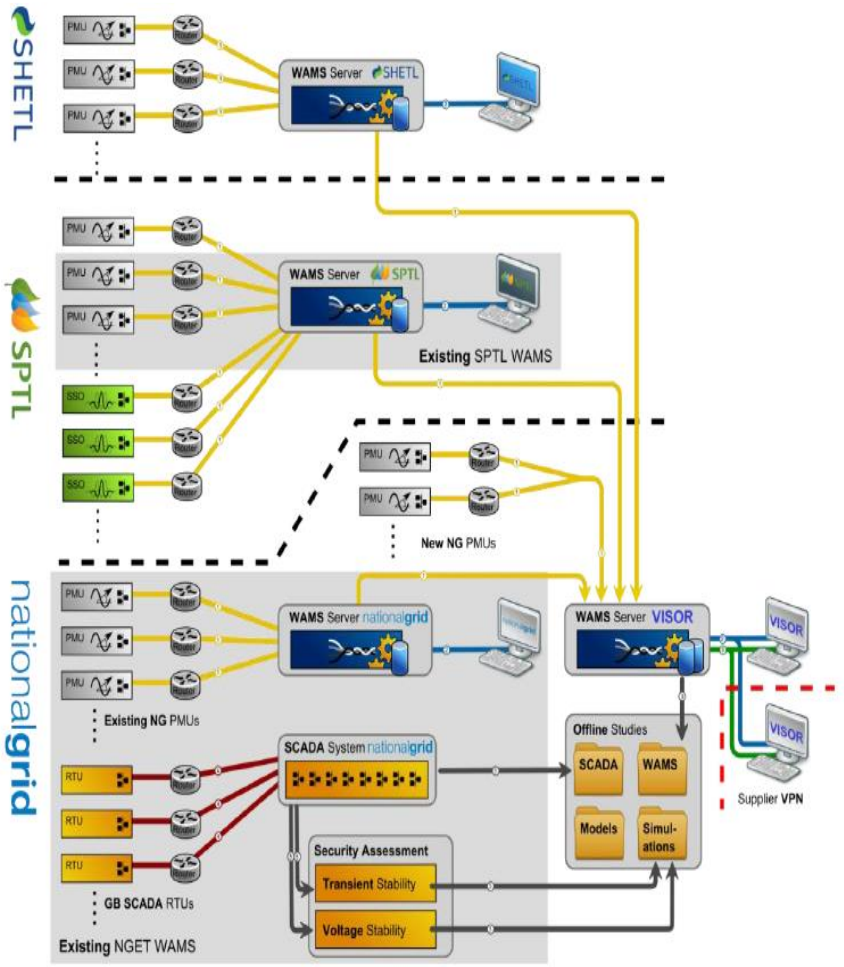
- Wide-area monitoring of SSO;
- Proactive actions against instability;
- Oscillation detection and source location.

WP2: System model validation

- Improved line parameter estimation algorithm;
- Oscillation analysis validation using continuous dynamic analysis of phasor measurements;
- Transient stability simulations;
- Generator model validation via plant-system interaction.

WP3: Improvement of transient stability

- Quantify transient stability limit margin;
- Quantify benefits of WAMS on management of stability limit uncertainty;
- Visualising power-angle operating point and stability limits



EFCC (NG NIC Project 2014)

- Enhanced Frequency Control Capability

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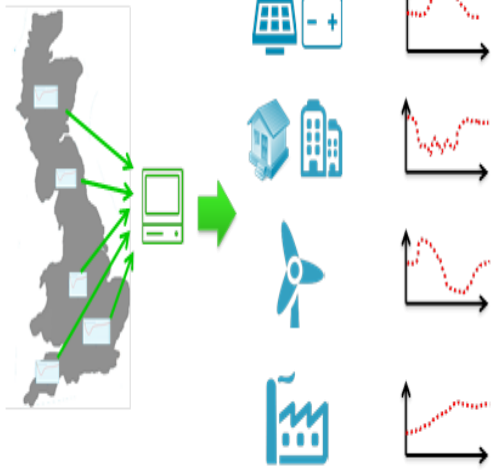
RIIO NIC NETWORK INNOVATION COMPETITION



Resources Trialled

Individual Response

Wide Area Measurement

Optmise Response Providers

January 2015

Other Providers (not trialled)

Send control signal

Roll-out

Commercial Development

Technical Developments

New Commercial Service

Interaction with existing services (i.e. STOR, Primary Response etc.)

Evaluation of Communication and compliance requirement

IS Infrastructure

October 2016

January 2017

Package of new services

March 2018

Control System

Technology trials

Commercial Service & IS Comms

Recommendations & Closure

BELECTRIC

centrica

Flexitricity

GE

MANCHESTER 1824 The University of Manchester

University of Strathclyde Glasgow

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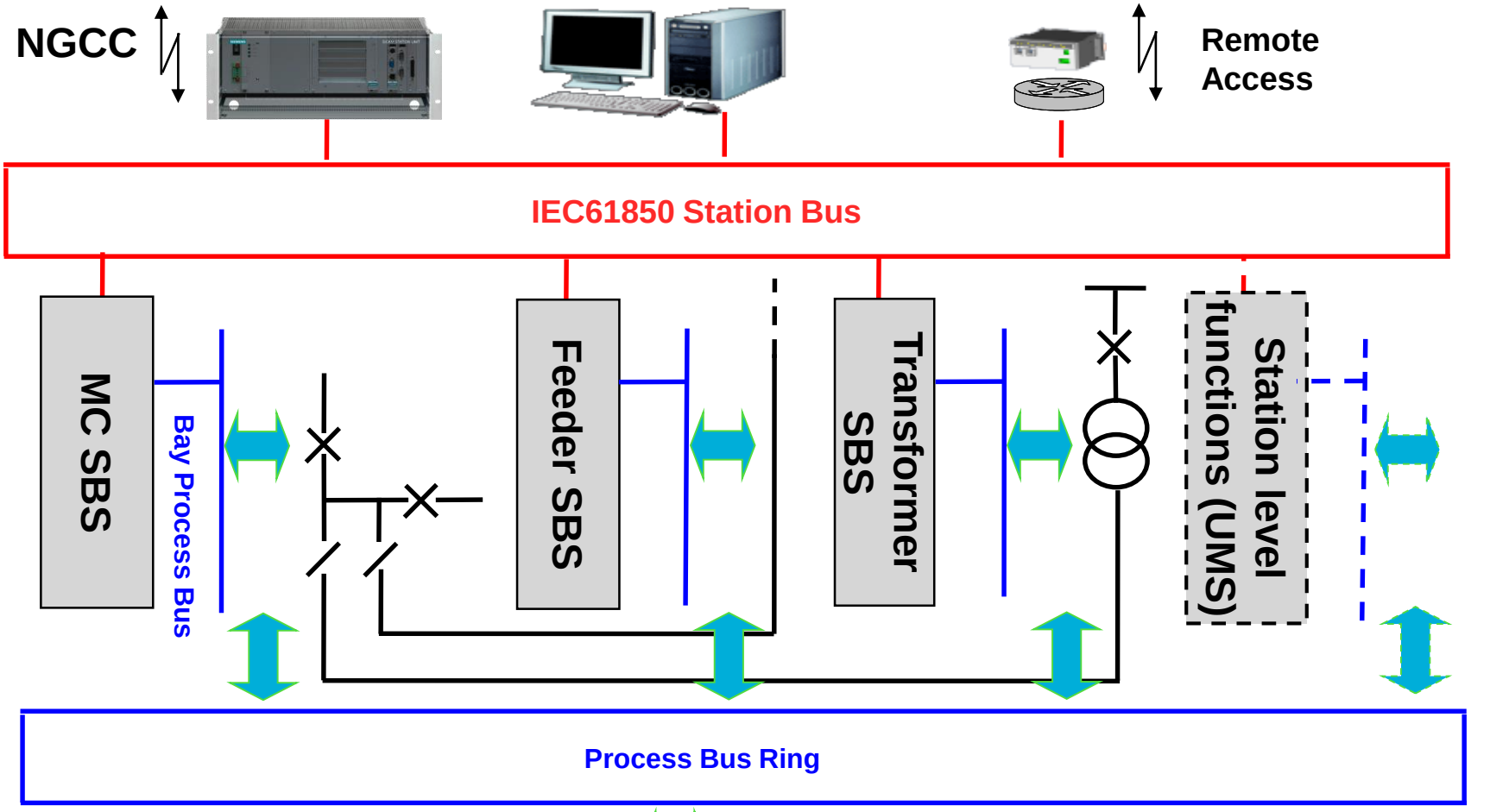
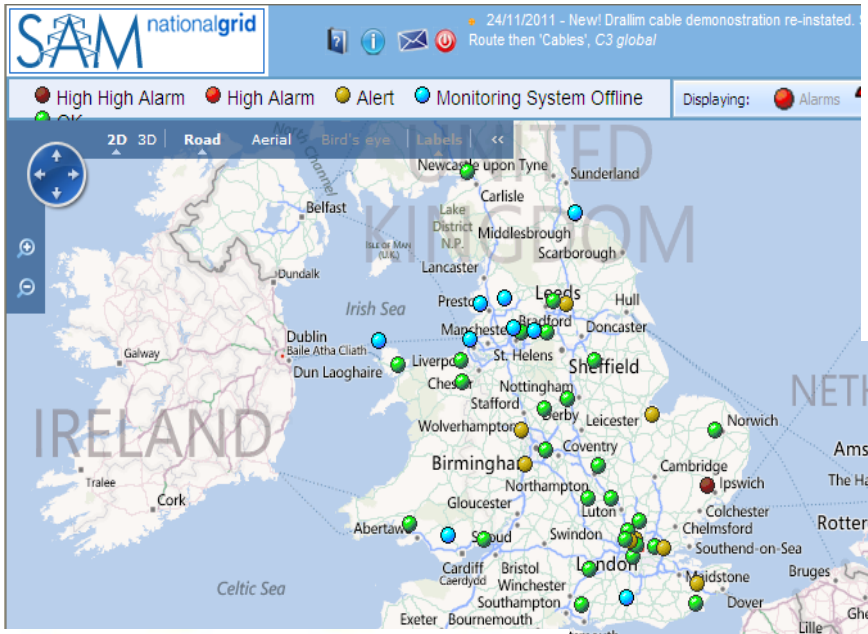
IEC61850 based P&C Systems

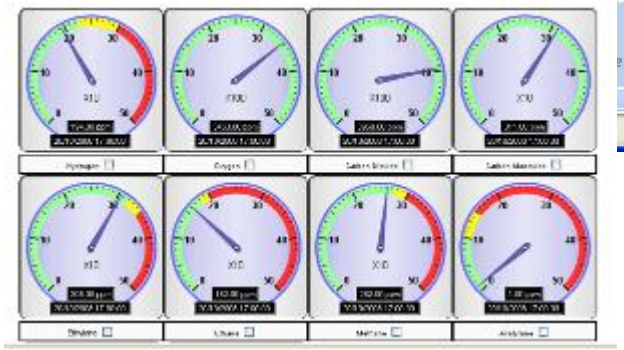
-AS^3 Architecture for Sub Secondary Systems

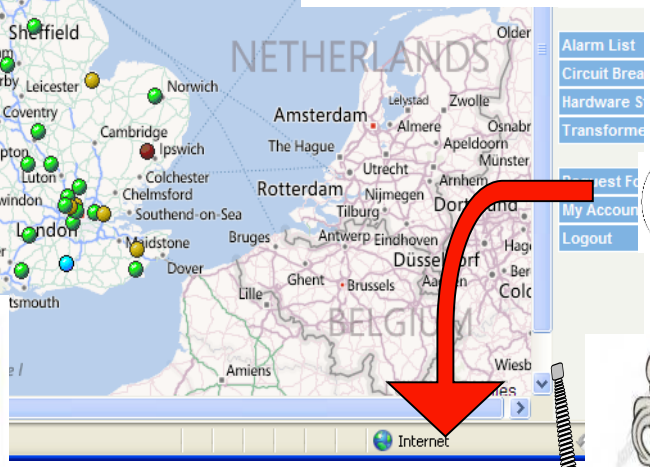


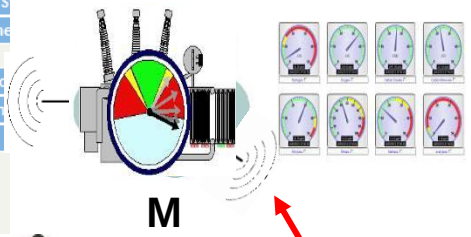
Smarter Asset Management (SAM) System

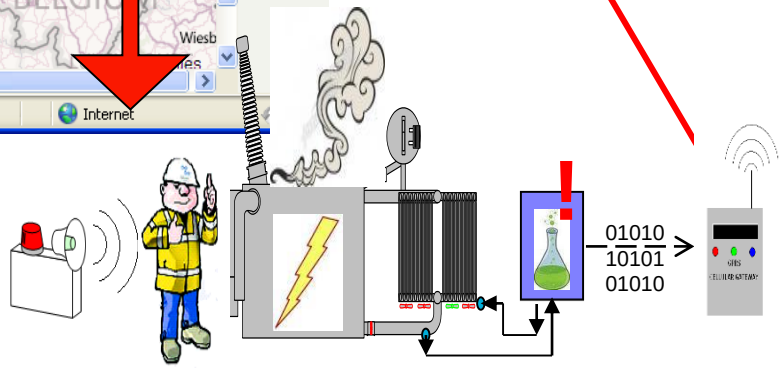
-A holistic method to share data across business











- Quick visual check on assets
- Mobilise & Visualise live data
- DGA, SF6, PD Monitoring
- Maintenance/business planning

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Mobile Substation Bays (MSB)

- **MSB:**
  - Primary plant with switching and protection & control facilitates on a mobilised unit for quick deployment
- **Scope of development**:
  - Technology
  - Deployment methodology
- **Apps/Benefits**:
  - Quick connections
  - In situ sub replacement
  - ‘Replace on Fail’
  - Enhance outage flexibility
  - Transformer maintenance
  - Pre-Fault Mitigation/Post-Fault Management

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Summary

- **Smart Grid**
  - A philosophy
  - Purpose driven
- **Smarter Grid**
- **Lessons learned so far!**
  - Be clear objectives, not “a solution looking for a problem”
  - Identify costs and value (it will vary between different utilities)
  - Consider a pilot/trial prior to roll out, 1st deployment will always unearth new issues
  - Doing nothing might be the “right choice! “
- **Significant risks to be managed**
  - Commercial, Technology & Security
  - Power Networks - “Critical National Infrastructures (CNI)”

Questions?

- Thank you for listening!