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Distribution systems of the future: Novel ICT solutions as the backbone of Smart Distribution

Developing novel high performance computing and messaging solutions for smart distribution network operation

Presented by

Gary Taylor

Coordinator – **HiPerDNO** Project

Presentation Outline

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- Project Overview
  - Funding and consortium: **interdisciplinary**
- Future Electricity Distribution Network Operation
  - **Novel Distribution Management System functionality**
    - Real-time On-line Condition Monitoring
    - Intelligent system restoration ...
  - **Distribution System State Estimation (DSSE**)
- ICT Frameworks and Platforms
  - Communications Technology
  - Information Technology
- Concluding Remarks

HiPerDNO - Future Networks

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In future distribution networks…

Millions of smart meters + **Smart sensors & instrumentation** = **Vast amounts of data**

Requires High Performance ICT for:

- **Large-scale state estimation**
- **Intelligent condition monitoring**
  - **Feature extraction**
  - **Scalable data mining ...**

Scalable High Performance computing + **State-of-the-art data communications** = **Smart Grid functionality**

Project & Consortium Overview

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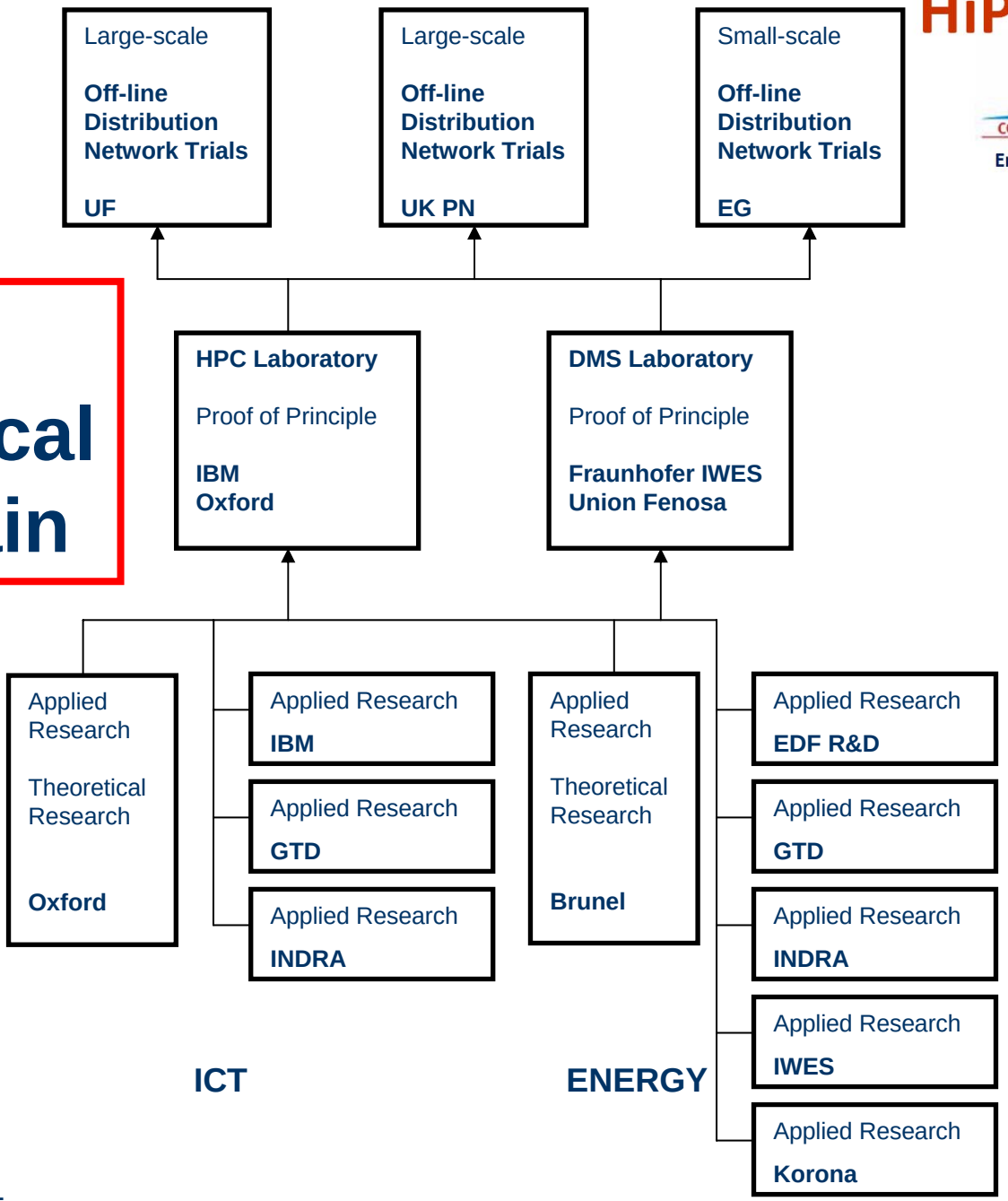
- HiPerDNO Collaborative Project
  - Three year project started **1st February 2010**
  - HiPerDNO project web site: **www.hiperdno.eu**

- Consortium (11 partners, 6 EU Member States)
  - UK: **Brunel University, University of Oxford (WP1)**, UK PN
  - France: **EDF R&D (WP2)** SA
  - Germany: Fraunhofer IWES
  - Israel: IBM Haifa
  - Slovenia: Korona, EG
  - Spain: **Union Fenosa (WP4)**, INDRA, GTD

HiPerDNO Technological Supply Chain



Distribution System State Estimation

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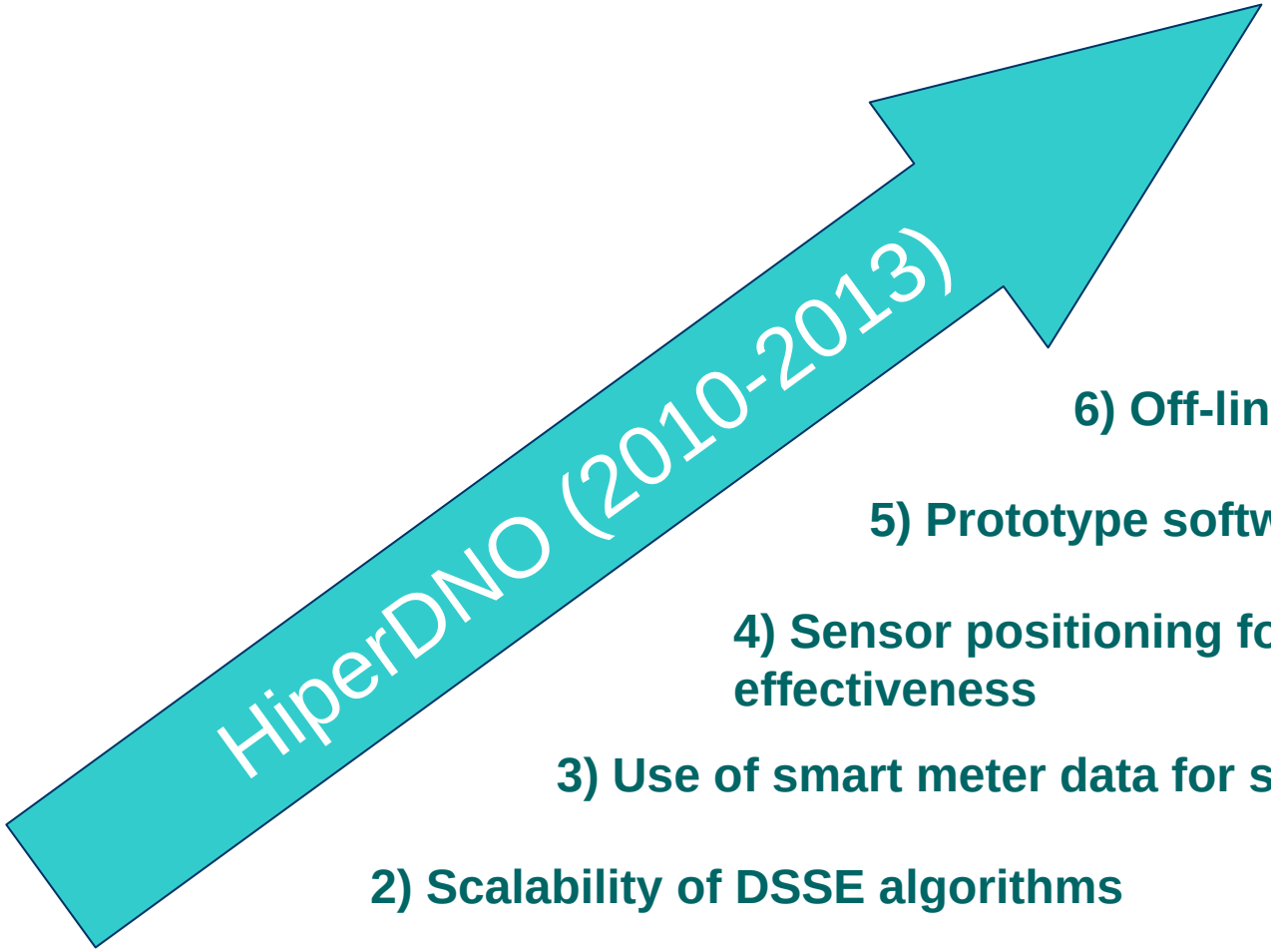
- Limited observability & monitoring in distribution networks (MV & **LV**)
- Most technical issues presently solved at off-line planning phase or through network reinforcement

- Transition from passive to active distribution networks:
  - **Operate distribution network assets with in narrower margins**
  - **Improve / maintain quality and reliability cost-effectively**
  - **Increase the capacity of the grid to host distributed generation and responsive load**
  - **Defer investments, and keep up with possible higher load demand**
- Make efficient use of sensors and new smart metering infrastructure (in terms of measurement data and communication architecture)

⇒ Distribution System State Estimation **(DSSE)** is a key enabler for smart grid functionality in distribution networks

HiPerDNO: DSSE R&D (1 of 2)



6) Off-line experiments

5) Prototype software

4) Sensor positioning for accuracy and cost effectiveness

3) Use of smart meter data for state estimation

2) Scalability of DSSE algorithms

1) Develop algorithms for distribution networks state estimation

HiPerDNO: Develop future DSSE (2 of 2)

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Novel DSSE algorithmic procedures

WEIGHTED ERROR MODULUS (WEM)

OBJECTIVES

- Feasible for high data volumes
- Capability to overcome gross error
- Most accurate estimation with the least data
- Scalability
- Combines benefits of WLS and WLAV

DSSE as part of Distribution Management System

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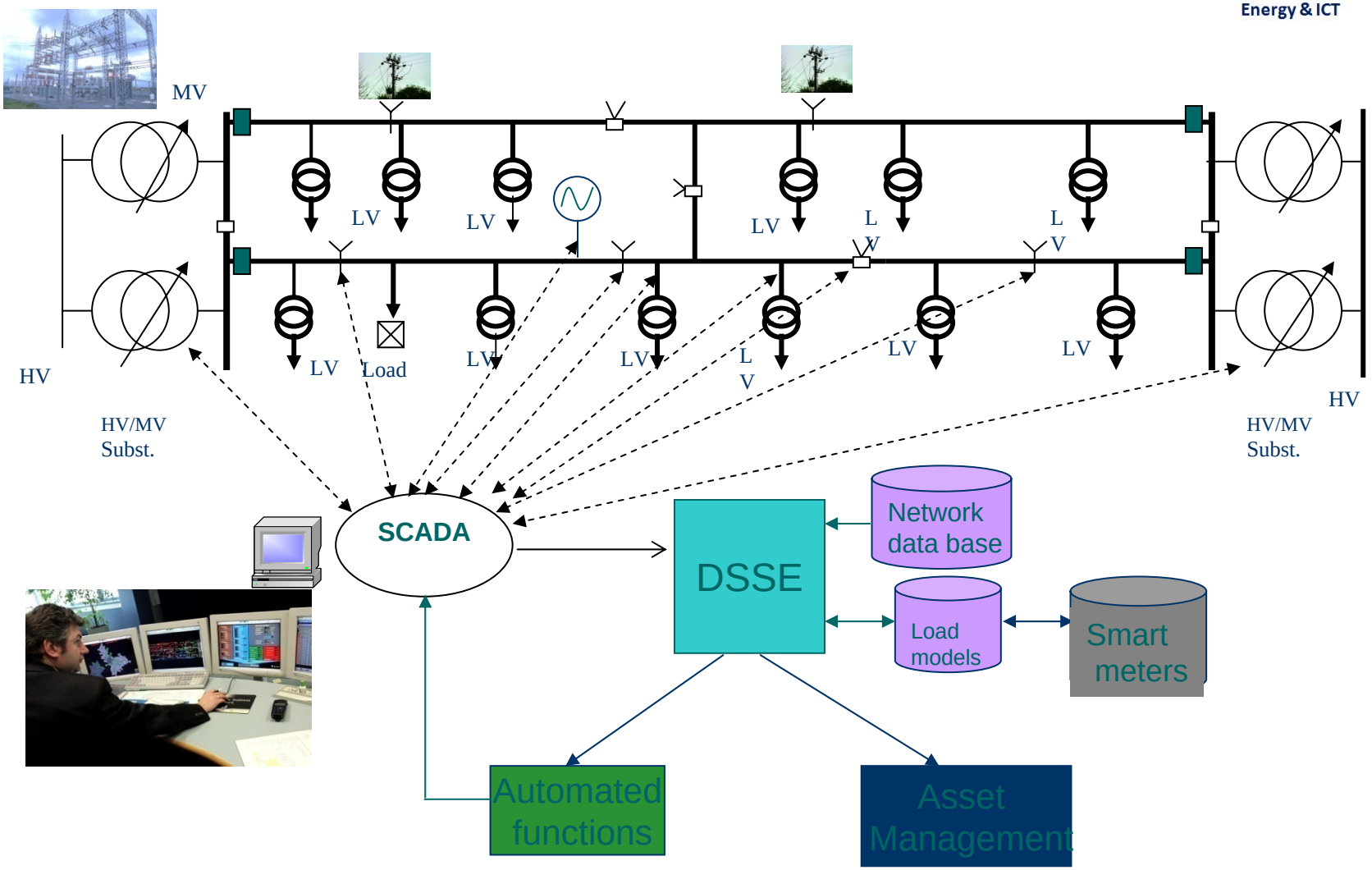

Figure courtesy of EDF R&D

Communication Technology

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- Novel High Speed Messaging middleware to provide the following :
  - Support for differentiated Quality of Service and near real-time data transfer
  - Data aggregation or conflation
  - Scalability

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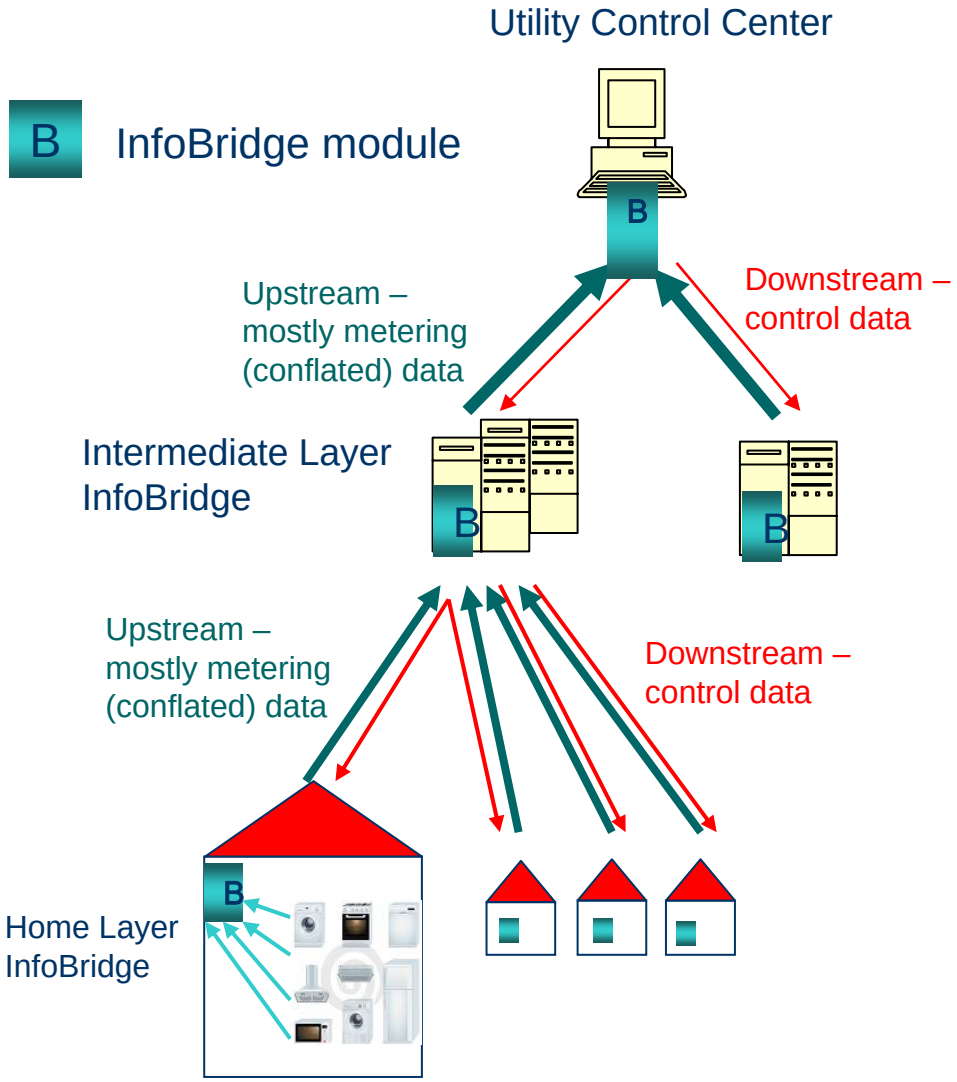
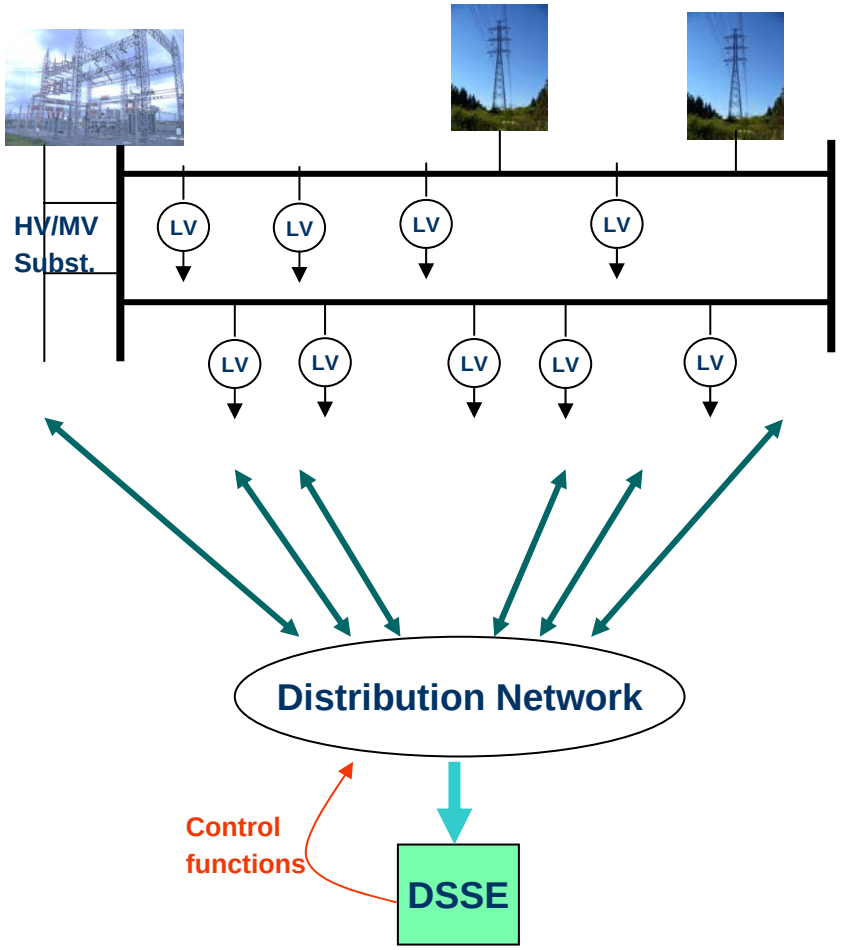
1. Advanced Metering Infrastructure



2. DNO Architecture



Figures courtesy of IBM Haifa

InfoBridge – publish/subscribe middleware

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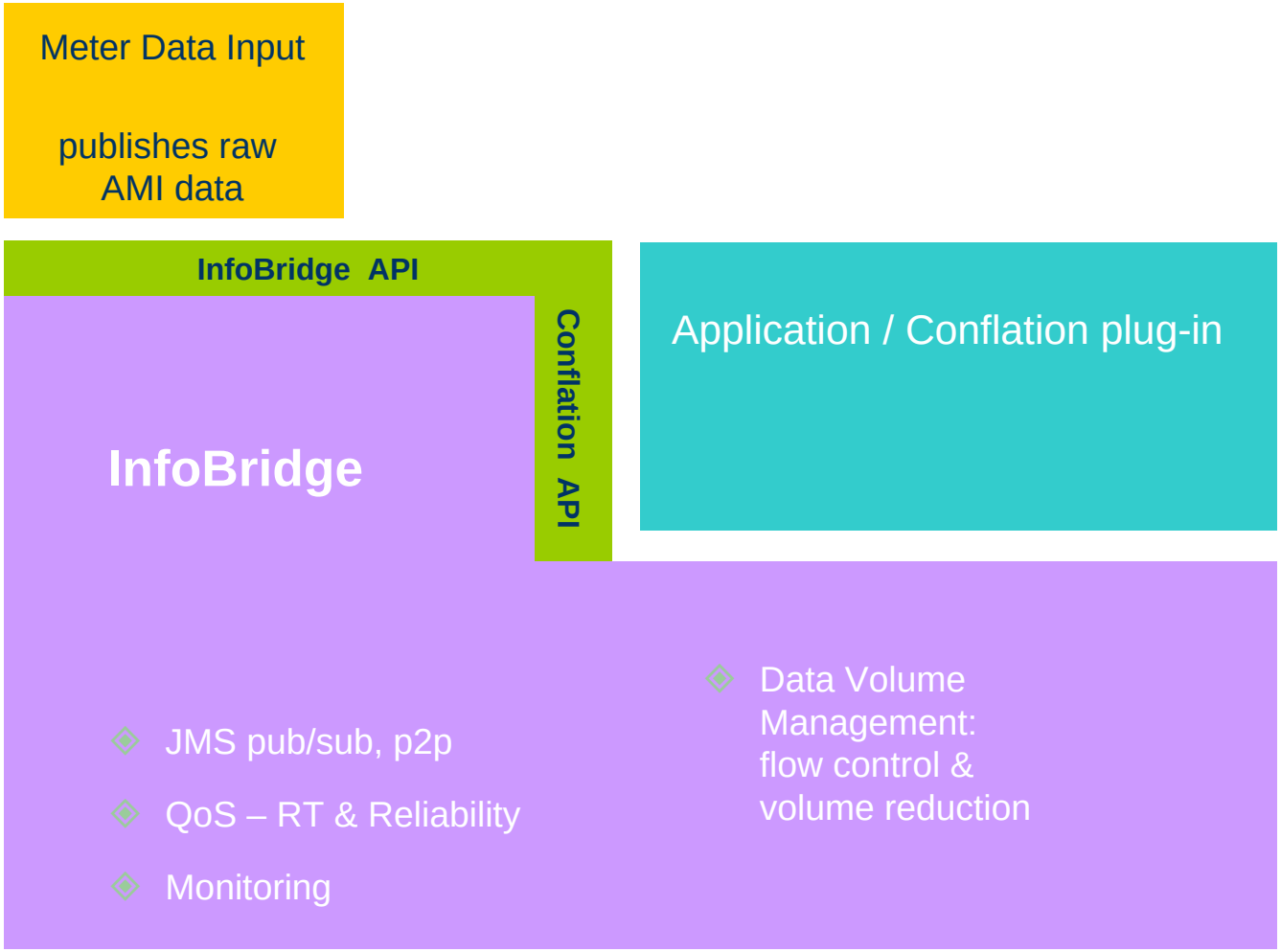

Figure courtesy of IBM Haifa

Information Technology

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- Enterprise computing platform to support interoperability
- Scalable architecture to support integration of multiple services – eg offline and online
- Data visible at different levels of granularity (temporal and spatial)
- Real-time on-demand resource scaling depending on requirements
- Potential high performance computing platforms
  - Cluster: Local Area Networks
  - Cloud: Private or enterprise computing; utility computing
  - Grid: Virtual organisations managed over Wide Area Networks

Enterprise Computing Platform
Supporting Real-time Analysis

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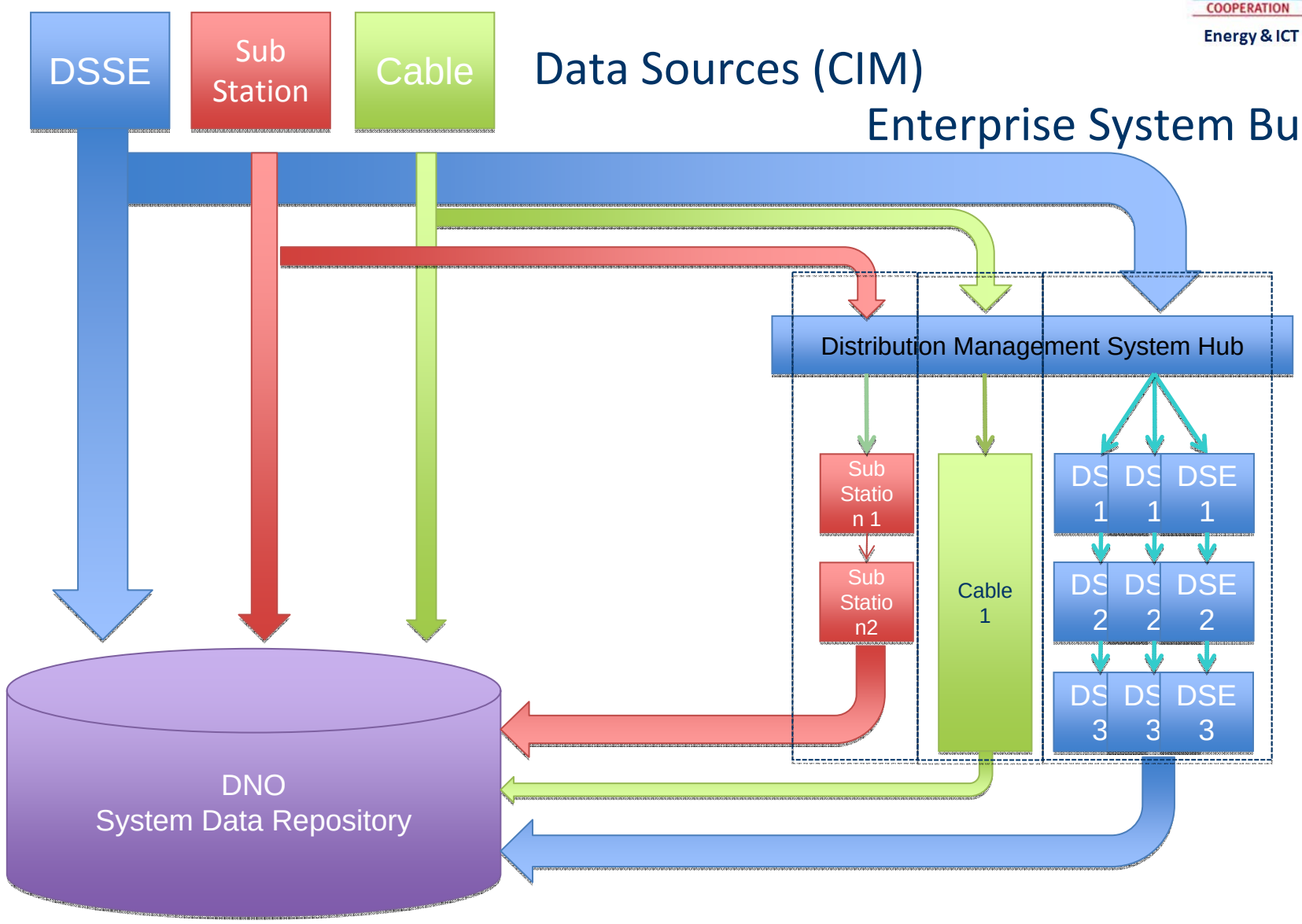

Figures courtesy of Oxford e-science Research Centre (OeRC)

Enterprise Computing Platform
Supporting Historical Analysis

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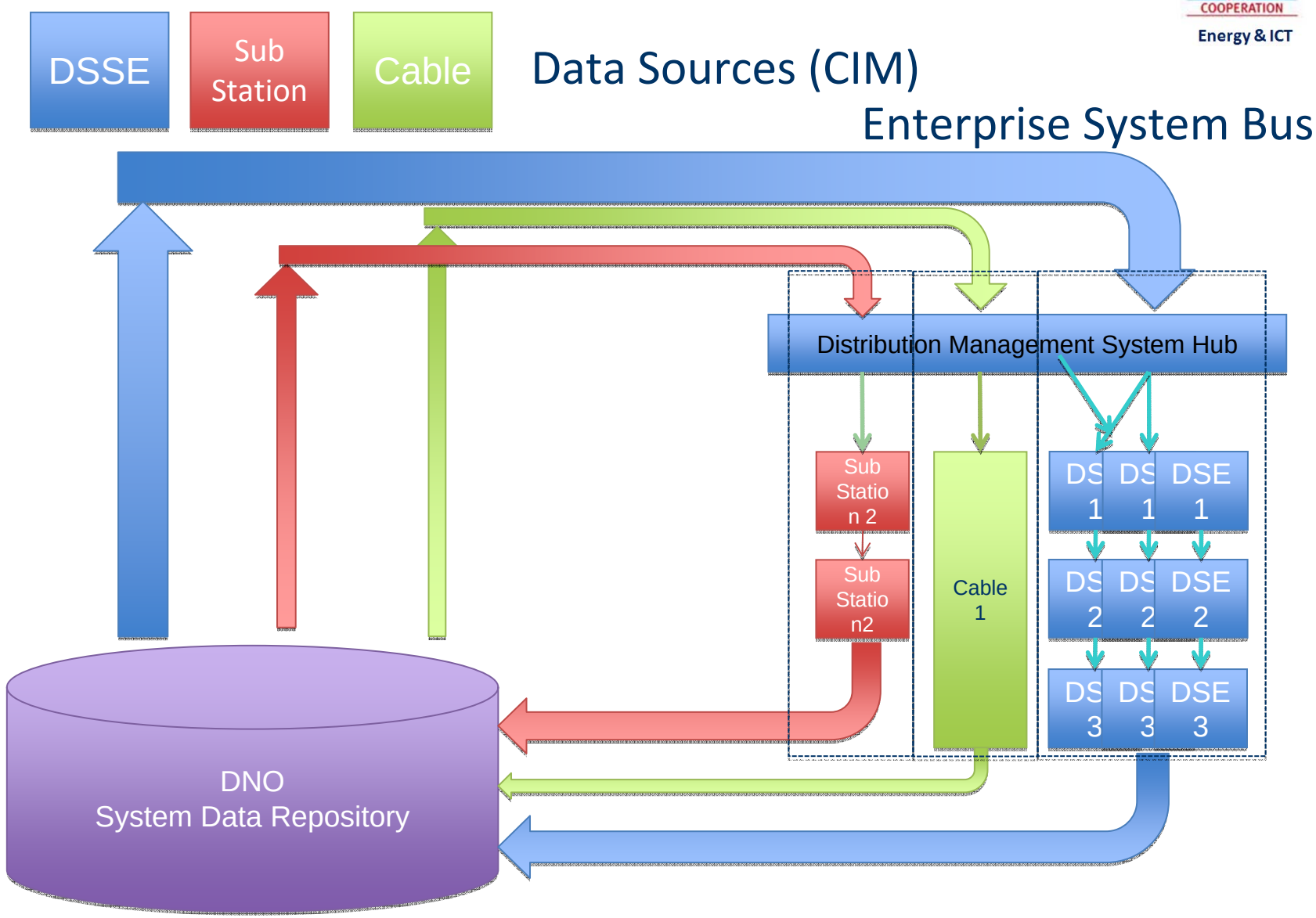

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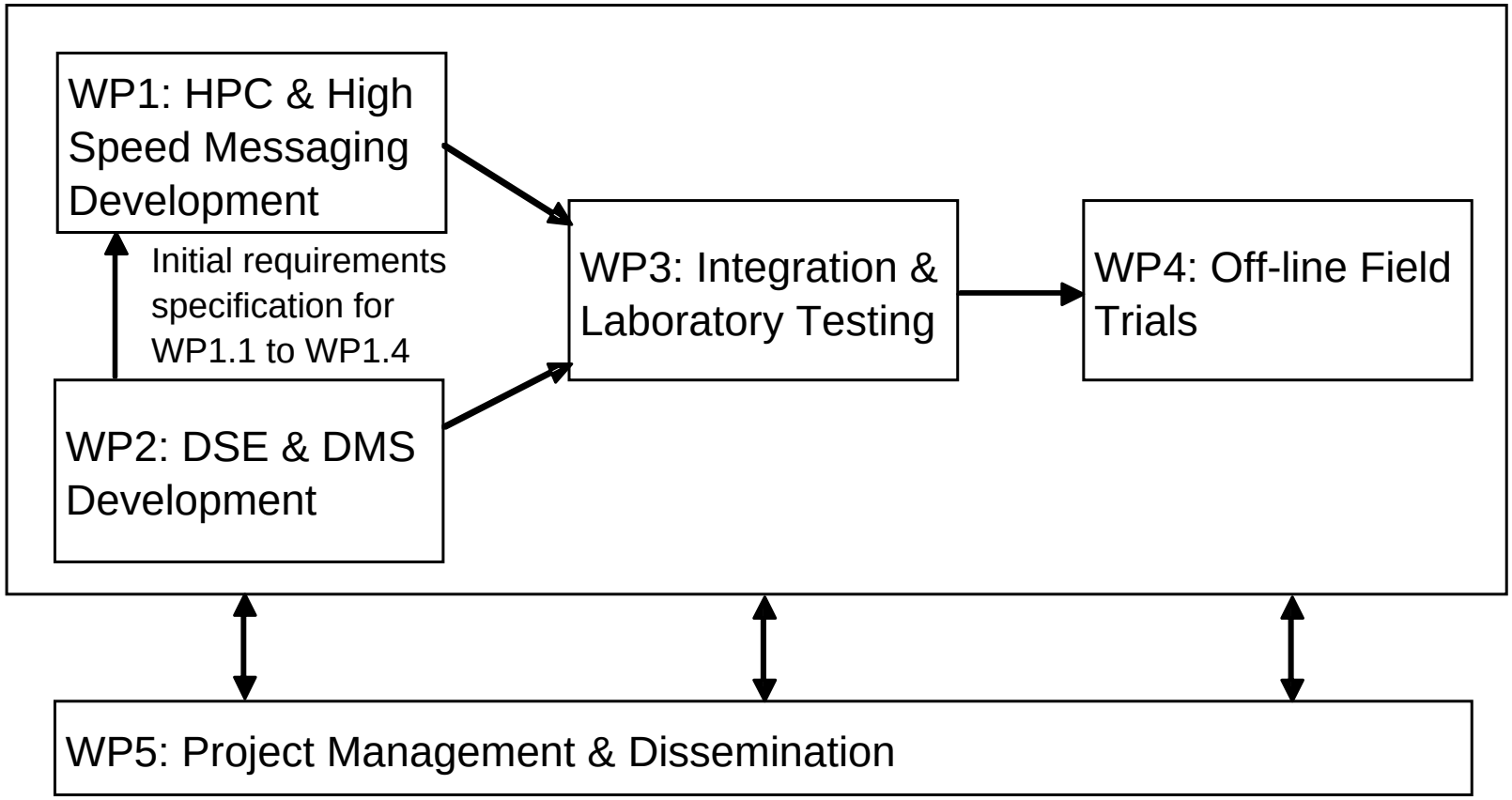
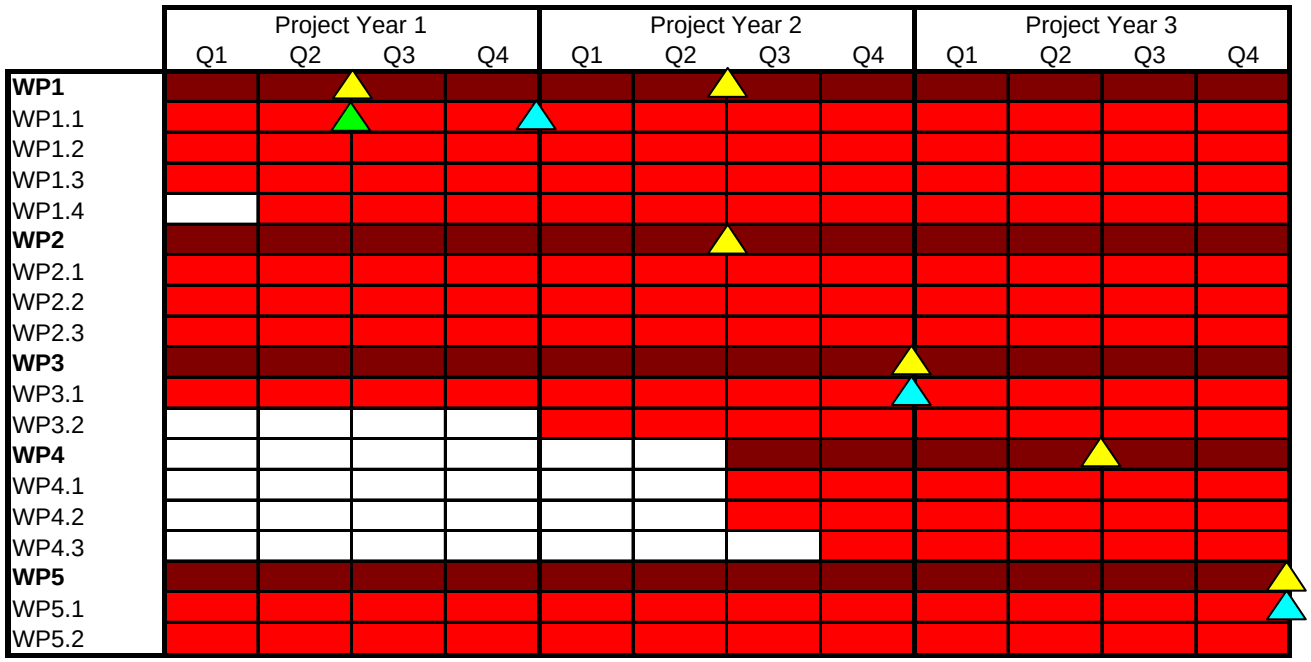
High Level Overview – Work Package Components



HiPerDNO Gantt Chart



Milestones	**M-WP1-M6**	**Initial Requirements & System Specification for HPC Tools & Messaging Layer**	
	M-WP1-M18	**Beta Versions of HPC Tools & Messaging Layer (M24)**	
	M-WP2-M18	**Beta Version of Real-Time State-Estimator**	
	M-WP3-M24	**Integration of New DMS Functionality**	
	M-WP4-M30	**Specified Off-line Field Trials Underway & Near Completion**	
	M-WP5-M36	**Project Results Evaluated and Disseminated**	
External Project Reviews	**EPR-Y1**	**Year 1: WP1 WP2 WP3 WP5**	
	EPR-Y2	**Year 2: WP1 WP2 WP3 WP4 WP5**	
	EPR-Y3	**Year 3: WP1 WP2 WP3 WP4 WP5**	
Internal Project Review	**IPR-M6**	**Year 1: WP1 WP2 WP3 WP5**	

Concluding Remarks

- Fully achieved objectives and technical goals for the period
  - All internal and external deliverables have been completed in accordance with Description of Work
- Demonstration phase of project is scheduled to start in M18 (August 2011)
- Project website is active and up-to-date
- Novel ICT Solutions for Smart Distribution Networks 1 day event is being scheduled at the UPEC 2012
  - 4th September 2012

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