Industrial Internet:

The next age of productivity for European gas turbine based plants

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10 October 2018

Introduction – ETN perspective

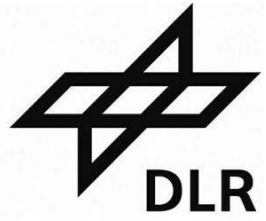
- Improvements in plant performance
  - Hardware based – many improvements in recent years, reaching area of diminishing returns
- New focus using digital technologies
  - Accelerate productivity
  - Reduce inefficiency and waste
  - Enhance human work experience
- ETN 2016 project board R&D report highlighted ICT (information and communication technology) as an enabler to achieve targets for GT industry.
  - Predictive performance algorithms
  - Risk based maintenance
  - Grey box models
  - New instrumentation
  - Big data storage and management

Introduction

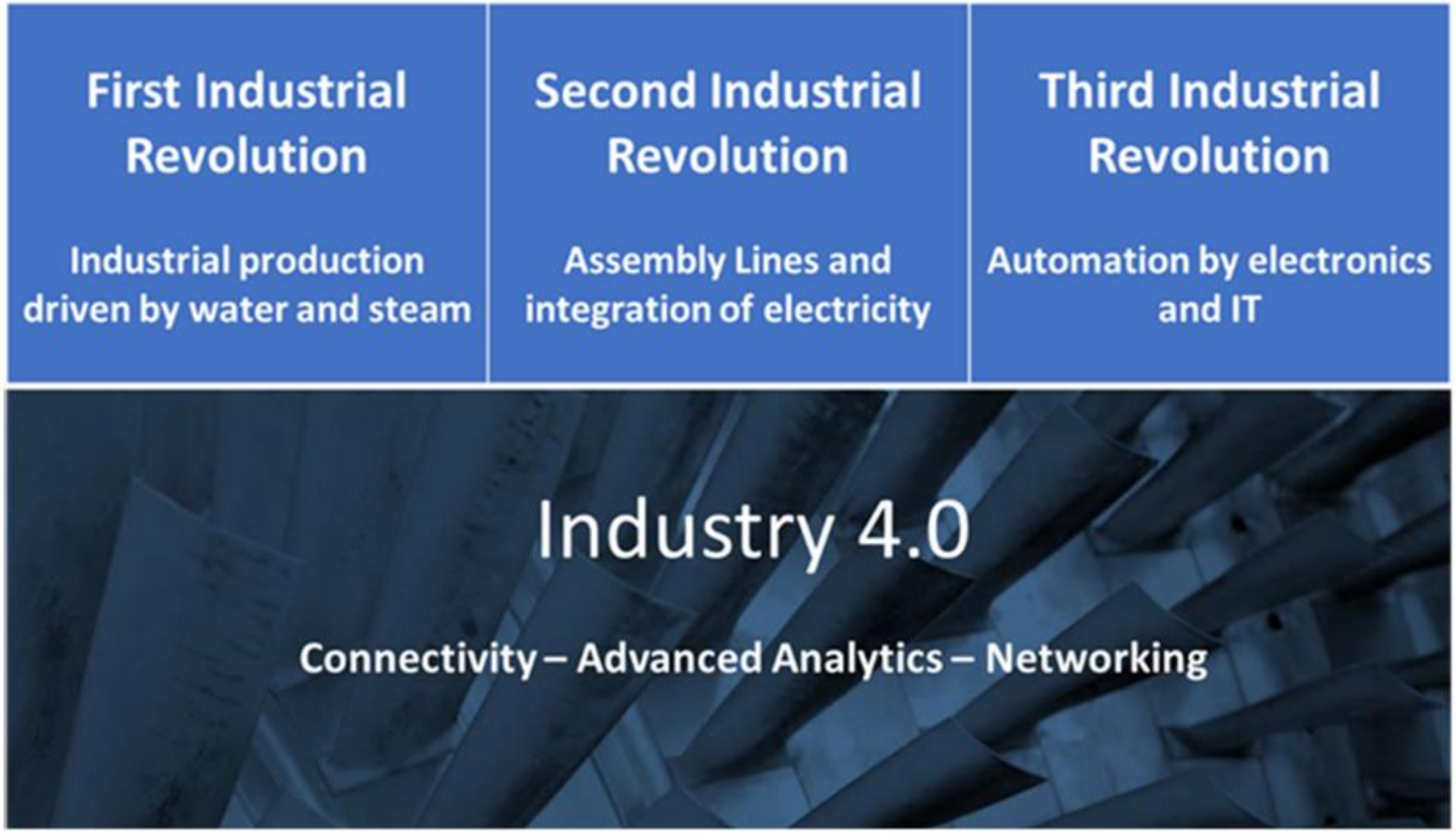
- 2014 industrial internet consortium (IIC) formed
  - To enable accelerative growth of industrial internet of things (IIoT)
- EPRI project I4Gen, insight through integration of information for intelligent generation (2016)
- Other industries benefiting from digital transformation

- This paper will review
  - Opportunities IIoT provide
  - Associated risks
  - Benefits to GT plant in the Oil and Gas and Power Generation industries
  - Understanding the value creation process
  - How business can take advantage of digital transformation

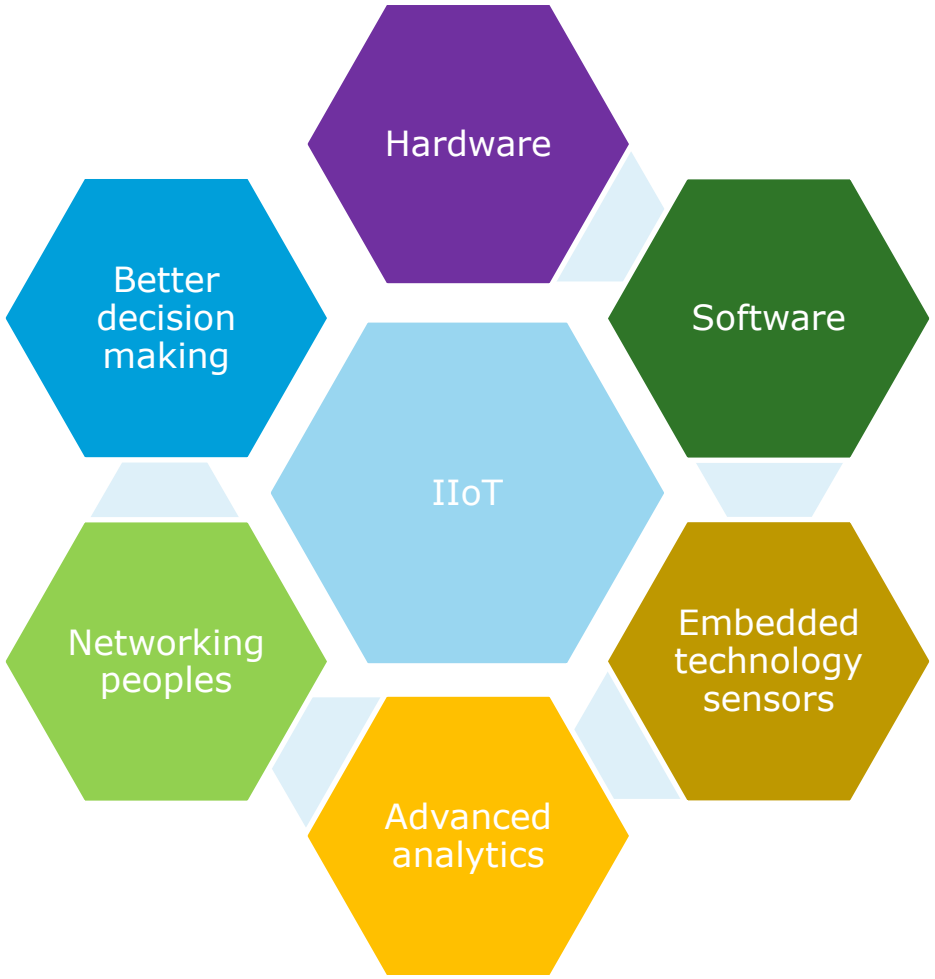
Acknowledgements



Industry 4.0 and the industrial internet



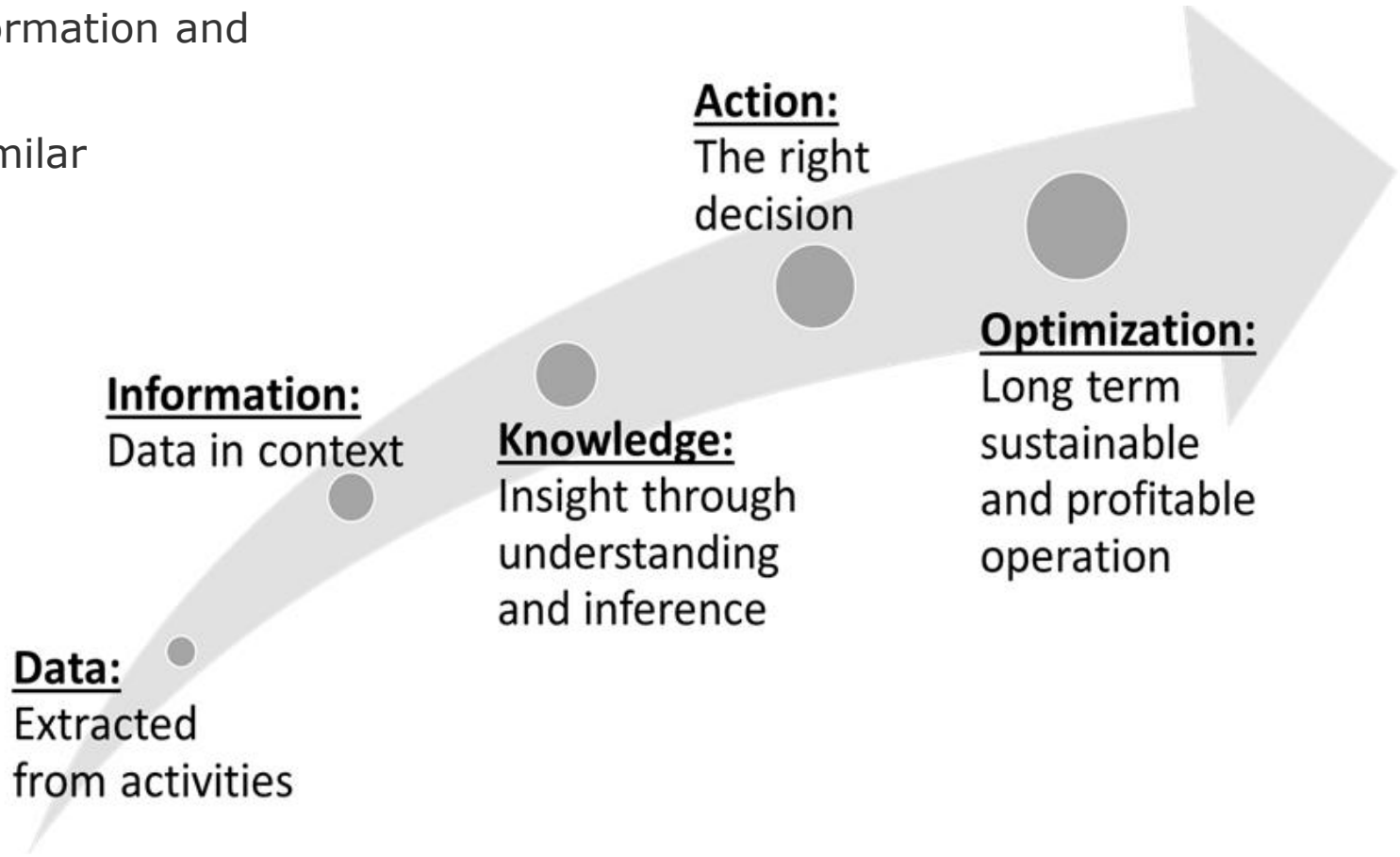
Industrial Internet of Things (IIoT)



- The connection of all hardware and software within an industrial environment
- Mixing of industry with open computing and communications as part of the Internet Revolution
- Brings machinery and smart data together
- Allows for real time adjustments and insights for smarter business decisions.
- Advanced sensors, better control
- Analytics, machine learning
- Improvements in operation efficiency

Historic Roadblocks

- When asked ETN members agreed industry is between information and knowledge
- EPRI survey came to similar conclusion



Brain storming sessions

- ETN work groups conducted brain storming sessions with its members
- Held at ETN meetings
  - Prague 2016
  - Oberhausen 2017

- Covering
  - Data access and connectivity
  - System/platform management
  - Data management
  - Data security
  - Analysis and analytics

Brain storming session

Data access and connectivity

- Data islands
- Time continuity
- Incomplete data model
- Data resolution
- Data browsing limitations
- Physical limitations
- Data ownership

System/platform management

- Hardware or software update issues
- Obsolescence
- Hardware limitations
- Different data formats

Data management

- Incomplete data
- Data validation

Data security

- Access limitations
- Risk associated with 3rd part access

Analysis and analytics

- Modelling limitations
- Effort and cost involved with maintaining models
- Expertise
- Risk management
- Economic evaluation
- Human factors
- Uncertaincies related to cost-benefit

What's new?

- Onset of IIoT helps to address may historical challenges
- Reviewed during ETN meeting Genoa, Italy, October 2017

What's New

Data access and connectivity	System/platform management and maintenance	Data management and maintenance	Data security	Analytics and analysis	Sensors
• Cloud database • Single source access point • Integrate data islands • Difference access and connection technologies can be used • Access through mobile and remote devices	• Software as a service (SaaS), shift in responsibility • Improved reliability, disaster recovery, maintenance • Handling of different data types • Data from different sources • Scalability • Technology advancements not industry specific • Open platform • Reduced costs • Cost of devices	• Improved data quality – easier maintenance • Short term storage • Improved HMI	• Remote data reduces risk of direct access • Secure data storage • Data encryption • Data diode • Viewing data "on device" more secure than hardcopy • Central version control • Still a risk of single location	• Advanced analytics software more available • Code sharing standards • Virtual plants or digital twin • Increased visualization opportunities • Management of data access • Breakdowns operational silos • Virtual power plants • Faster fault analysis as access to data better	• Improved sensors • Faster processing technologies • Lower cost of technologies • Wireless technology

Pitfalls and risks

- Cyber Security
  - Hackers
  - More security but only access to data not plant
  - Convergence of OT (operational technology) and IT systems, could make a plant more vulnerable to acts of sabotage
  - Competitor insight, can happen already with printed documents and email, can be managed better
- Skills
  - IT skills, reduced through SaaS
  - OT skills, plant reliability requires OT qualified people, required for operation and maintenance of systems, remote support can help here
  - Training on new systems and technology

Pitfalls and risks

- Abundant data solves nothing
  - Leadership and process are part of the implementation.
  - Project teams need to ensure their expertise is used
  - Connecting the right data sources

- Ownership
  - Data access to historic data
  - Licence agreements need to be in place
  - In IIoT software is a service and owned by the service provider, subscriptions need to be in place.

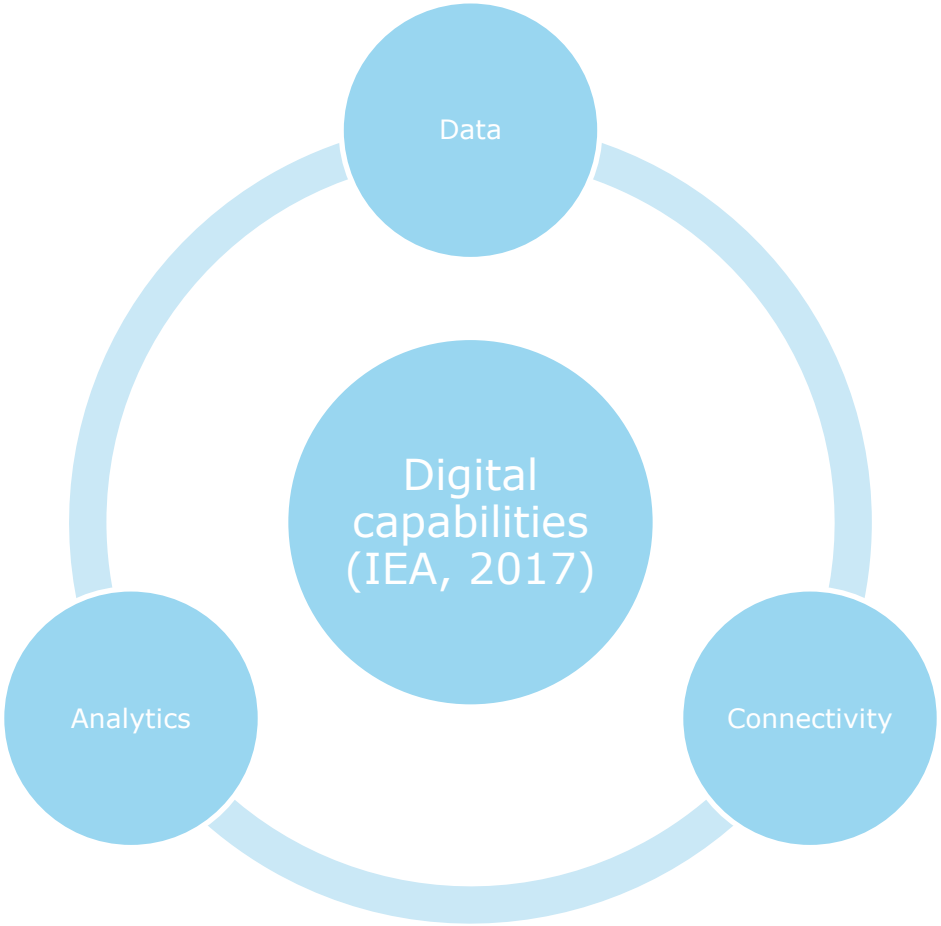
How can the industrial internet provide value?

Accelerate productivity	• Closer to equipment limits • Better forecasting • Trade offs between market and life consumption
Reduce inefficiency	• Off design tuning for part load • Predict and avoid failures • Reduce life cycle costs • Fleet benchmarking • Better alignment across organisation
Enhance the human work experience	• Mobile worker, ease of access, better reporting • Robotic inspection technologies • Virtualization/minimize risk

Maturity model

- Industry 4.0 – The smart factory, relies on Cyber-physical systems which link the physical and virtual worlds.
- The smart factory manages itself using data
- Requires real-time data and cross enterprise collaboration.
- Most companies will not start from zero
- It is important to understand your starting point
- Digital mastery requires not only technology but also governance to manage the transformation

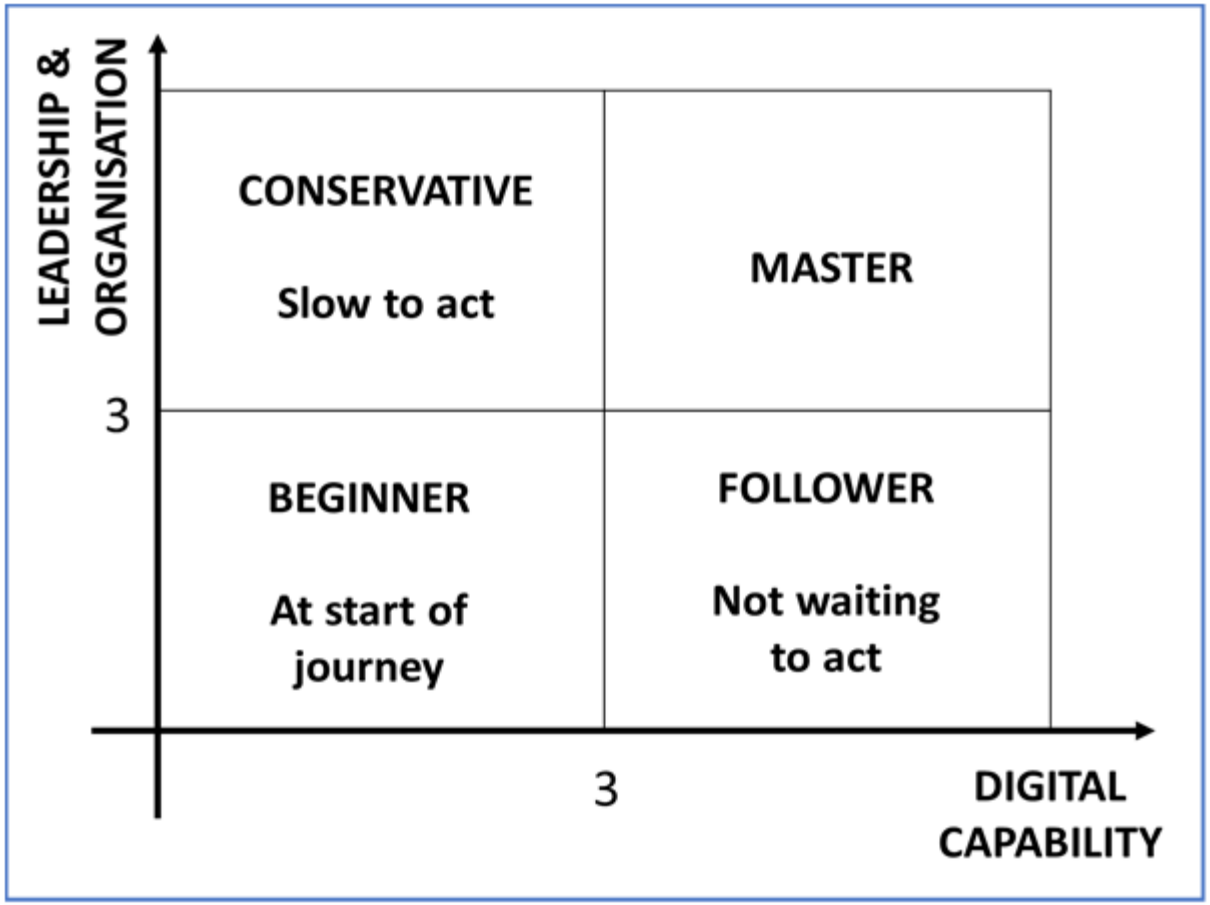
Assessing your maturity level, two main dimensions



- leadership and organizational aspects (Westerman et al, 2014).
  - Management:
    Is there a clear vision, plan and KPI's linked to the expected business outcomes.
  - Organization and implementation of digital capabilities:
    How is the adoption? How is the relationship with the IT department? How is training for users organized?

Self Assessment

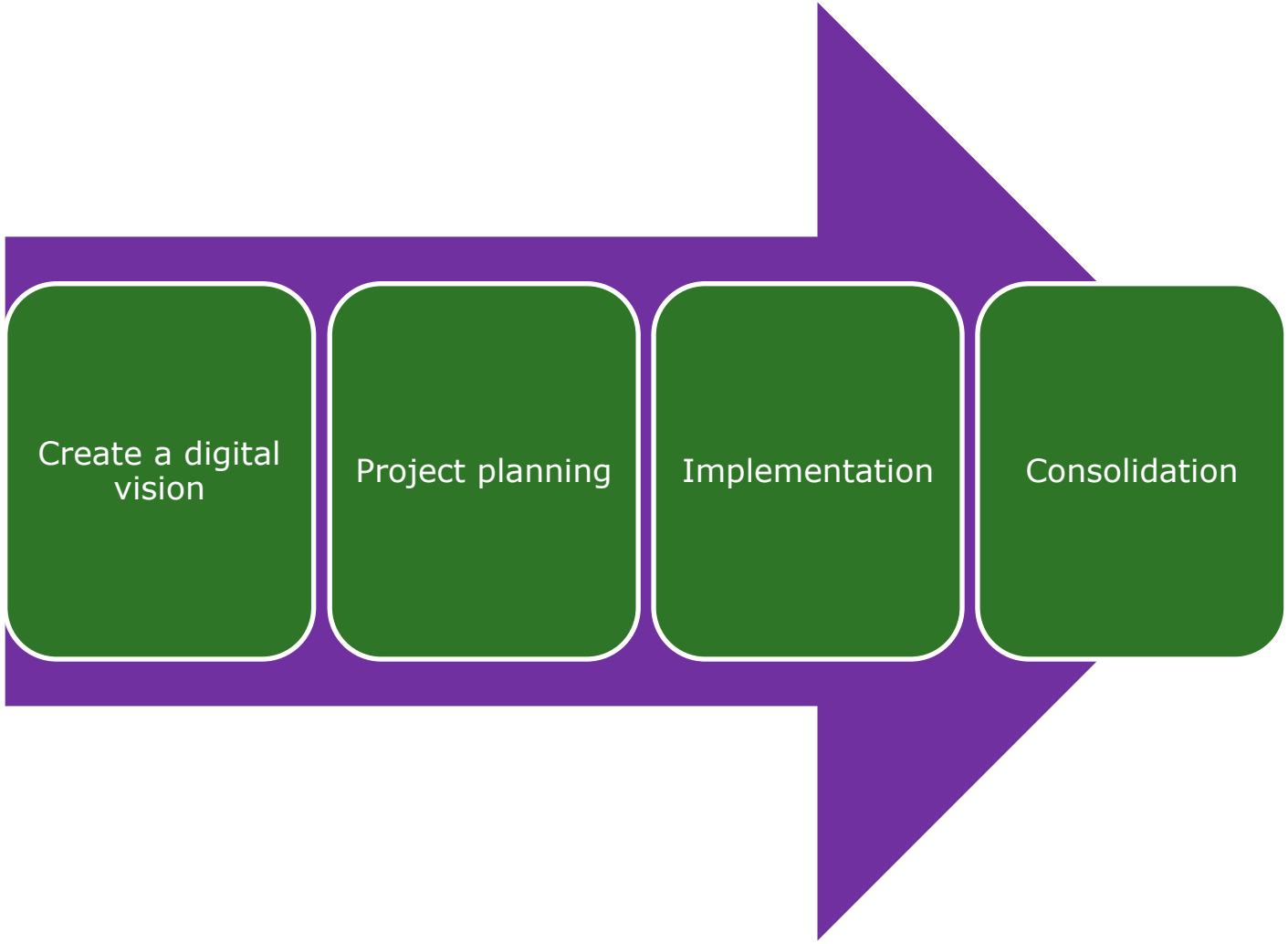
- List of questions develoed to perform self-assessment (Decoussemaeker / Dagnall 2018)
  - 1 strongly disagree / not at all;
  - 3: neutral / partly;
  - 5: strongly agree / fully in place.
- Results can then be average in each category.
- The results of the different categories can be averaged according to the two main dimensions and plotted on a XY graph (Westerman et al, 2014).



Implementation Model

- New technologies and methods need to be merged with existing technologies and processes.
- A successful implementation needs a business to consider both technology and leadership/organisation development
- A two speed approach is recommended
  - Build a digital backbone with interfaces to existing systems, old IT processes need to continue to receive full support.
  - Once backbone in place new capabilities can be developed in a fast and agile manner. Continuous deployment ensures rapid feedback of users and business

Implementation – Four phases



Case Study

- Old CCGT plant challenged with providing economic and reliable power as demand and fuel prices fluctuated.
- Management understood data from their plants could help informed decisions.
- Sensor data was collected and analytics applied to create insight for informed decisions
- M&D centre created to drive KPI for reliability, thermal performance and operational flexibility.
- Plant achieved the top quartile for heat rate and reduced fuel costs during startup
- Reliability improved by 1%
- Pilot system successful and roll out being planned for the future

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