



# Industry 4.0 and Corn Production at Bayer Crop Science



## **Internet of Manufacturing**

Anu Raman - June 2019





# Crop Science Division at a glance

The world's leading agricultural company across product segments and geographies



Global  
*Footprint*



~€ 14 bn

generated in sales in 2018



€ 2,4 bn

Projected R&D budget 2019



>38K

Employees 2018



Active in

>143

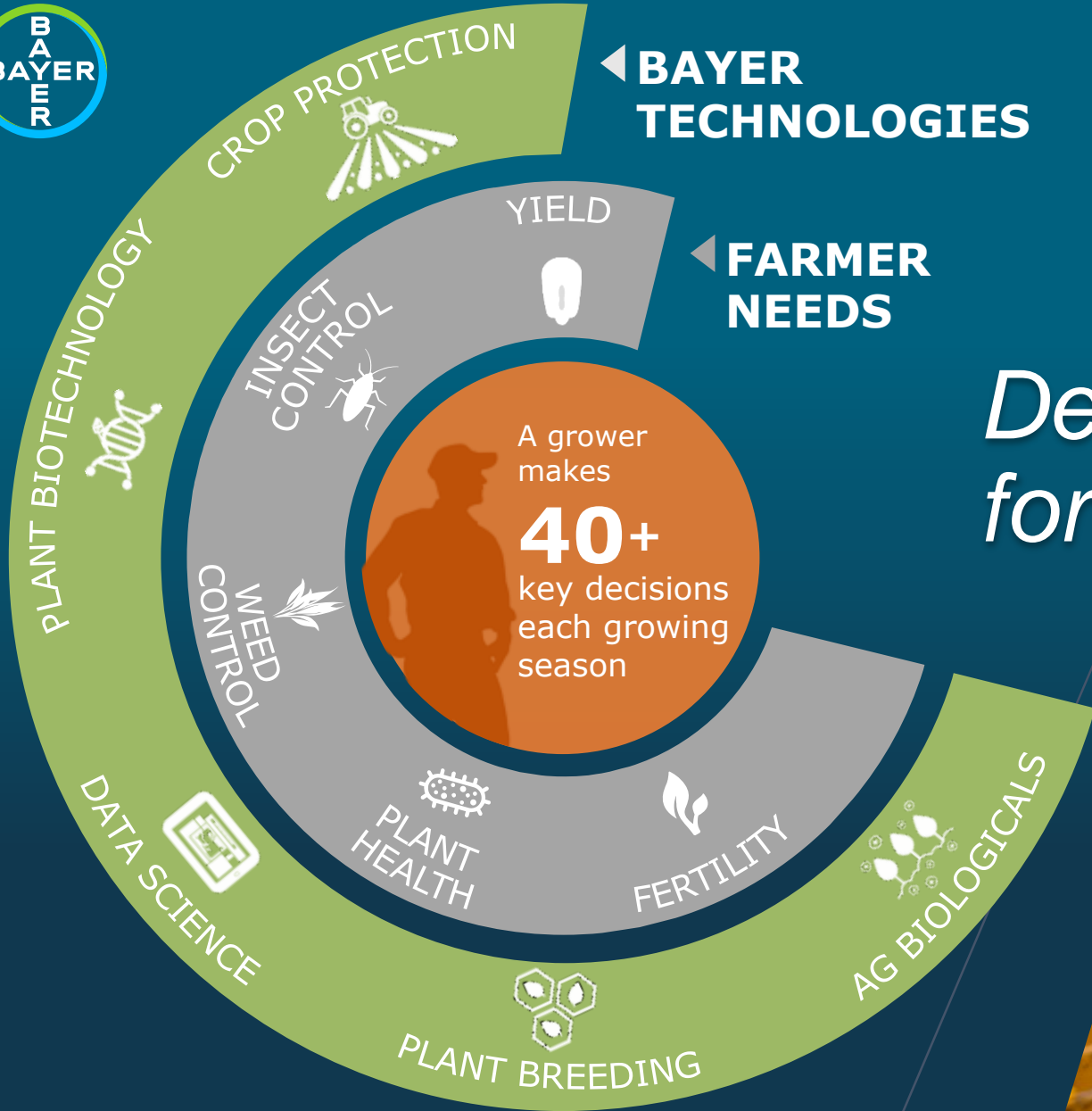
countries\*

Status: December 2018

*We bring innovation to the market through a wide range of chemical, biological, and service-based agricultural solutions*

\* countries in which business is performed with >100K€ sales performance





# Developing Solutions for Farmers







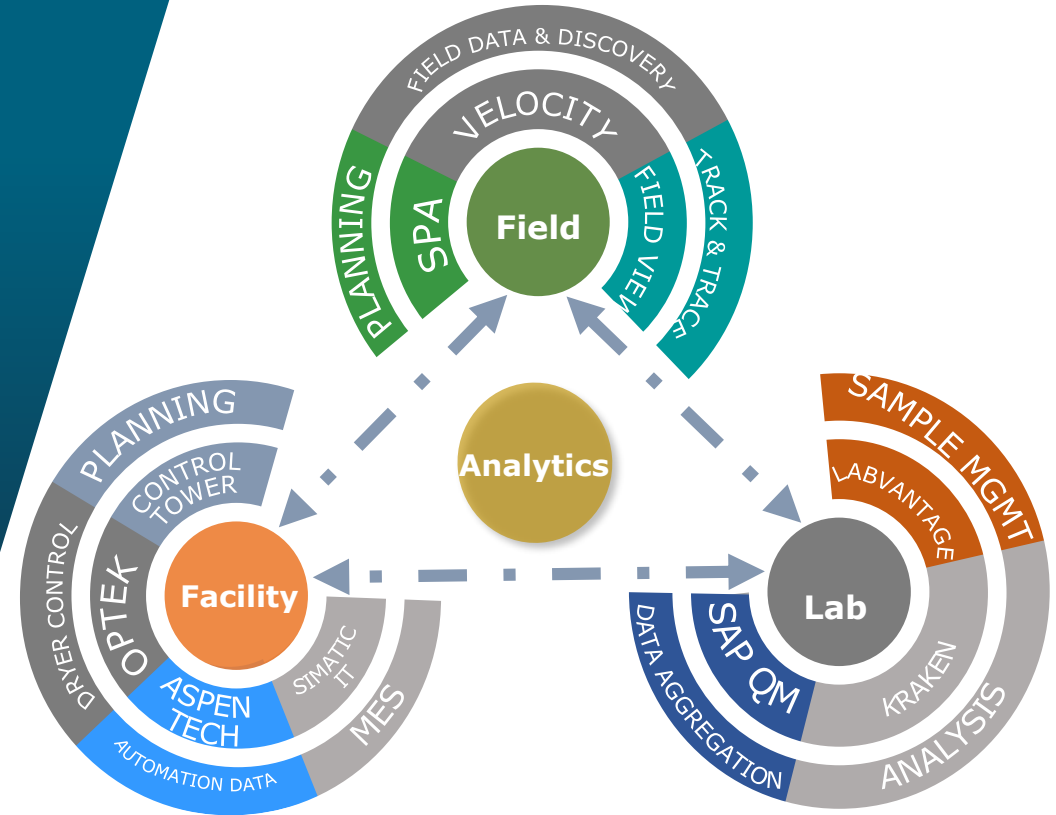




# Seed Production Requires Coordination

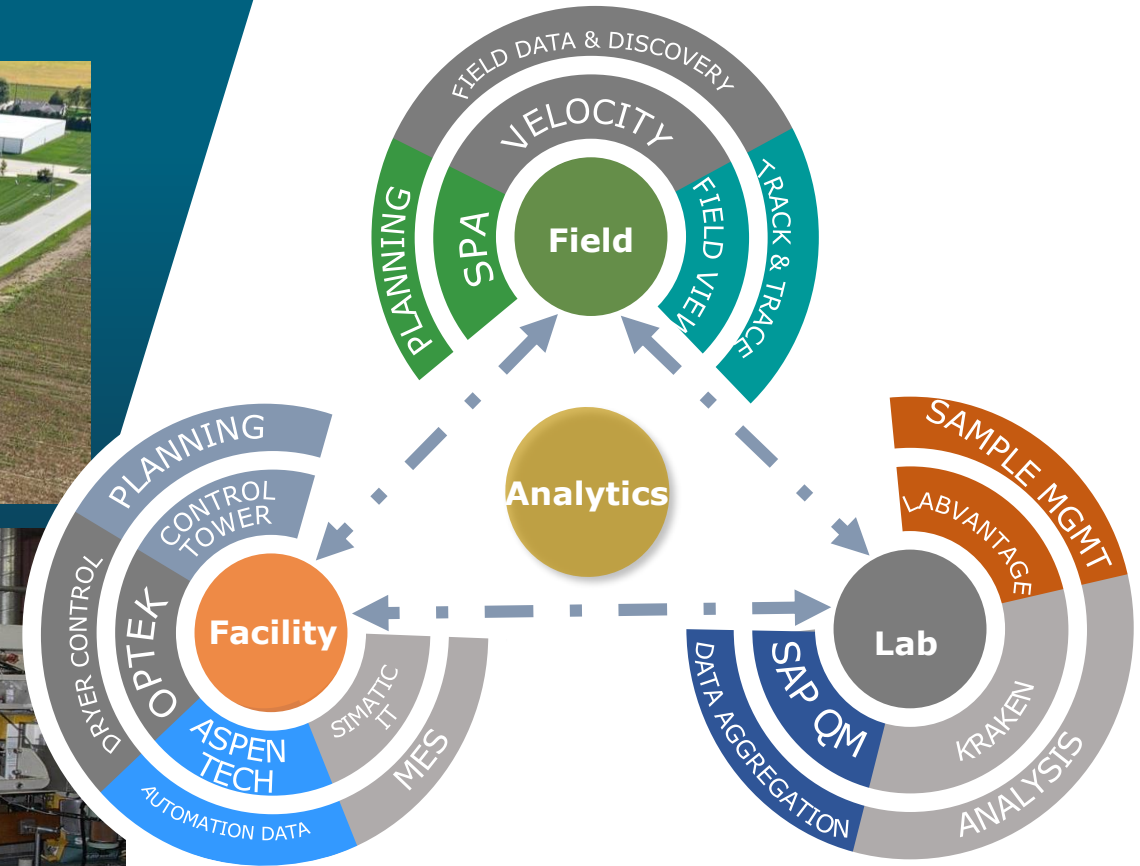


Hybrid Production Requires Cross-Pollination  
80% Product Quality Determined in the Field





# Seed Production Requires Coordination



Processing Facility is a Manufacturing Environment





# Seed Production Requires Coordination

## A Day in the Life of a Quality Testing Scientist

41%

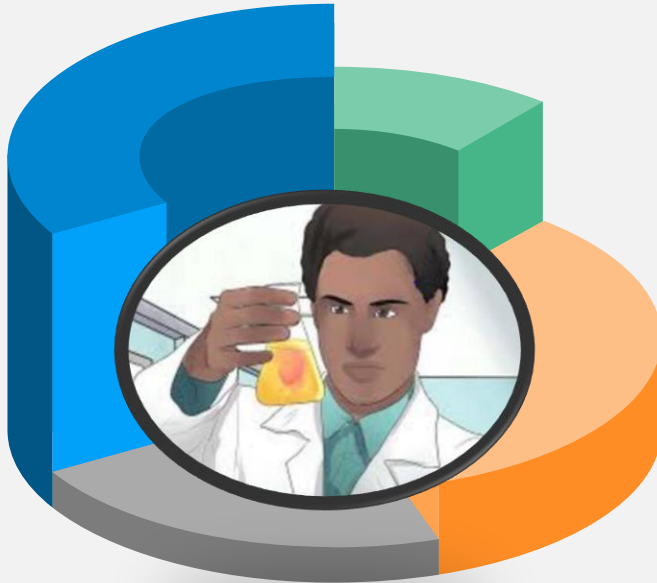
### Lab

- Sample Management
- Scoring/ Analysis
- Consumables Mgmt
- Equipment Mgmt
- Lab Reporting

12%

### Business Operations

- Budget Management
- Cost Management
- Vendor Management
- Supply/Purchase
- Requisitions
- Travel



21%

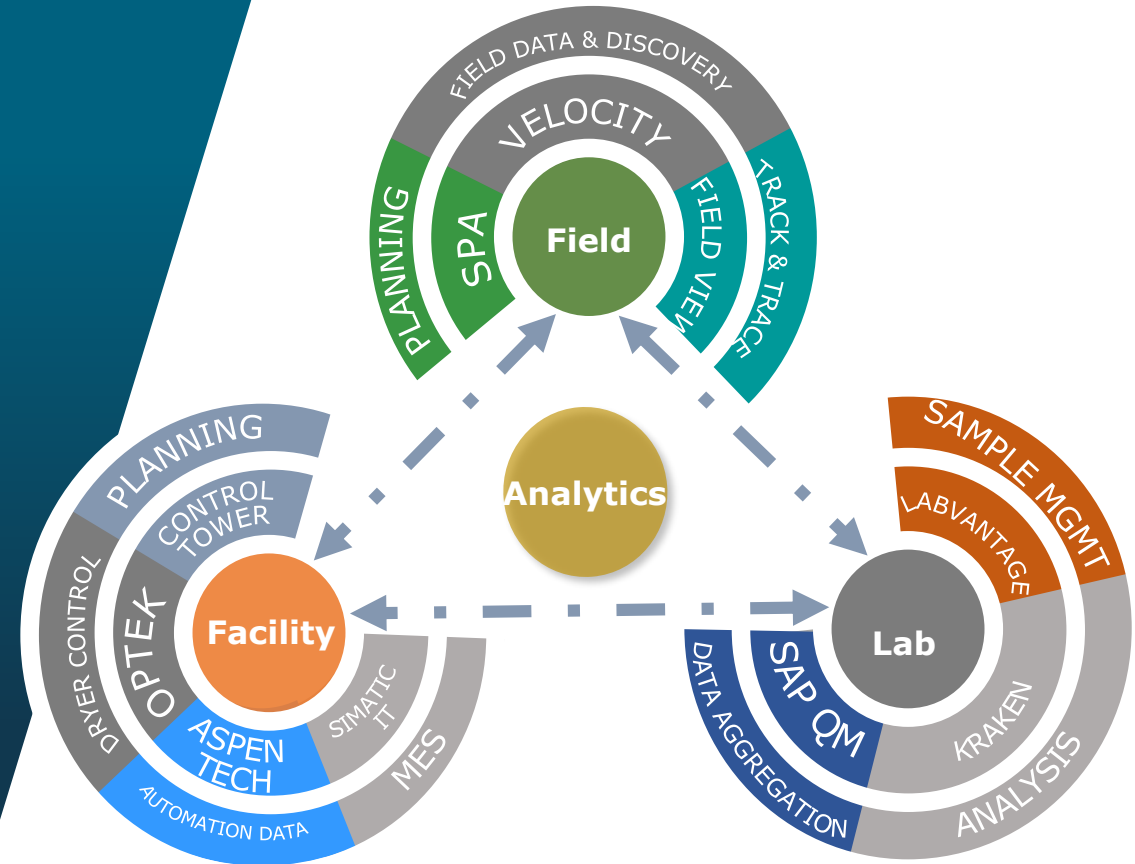
### Quality Management

- Continuous Improvement
- Traceability
- Corrective & Preventative Action
- Document Control
- Management of Change

15%

### Safety Needs

- Recording Near Misses
- Recording Incidents
- Recording First Aids
- Observation & Feedback



Quality Testing Labs “Manufacture” Product Data  
Regulatory and Internal Standards

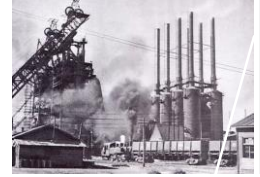


## Industry 1.0 (Agricultural Revolution)



- Large farms
- Plow, Reaper, Gin
- Mechanization
- Steam Power

## Industry 2.0 (Industrial Revolution)



- Agrichemicals
- Industrial Farming
- Mass Production
- Electricity

## Industry 3.0 (Digital Revolution)



- GMOs
- Automation
- Remote Sensing
- Compute Power

## Industry 4.0 (Cyber-Physical)



- CRISPR
- Connected Devices
- Local Control
- Augmented Reality
- Artificial Intelligence

- Novel design technologies such as Digital Twinning and 3-D printing unlock new ideation methods
- Virtual factory process simulations identifies inefficiencies and allows for informed decision making and process orchestration

- Human-Robot cooperation delivers safer facilities with higher throughput
- IoT will overcome connectivity barriers to become fully realized
- Imaging Analytics delivers dynamic, targeted decision making

- Systems (Velocity, MES, LIMS) allows operators to be more focused on product quality by enabling them more control of production runs
- Continuously streaming data provides the driver for orchestration

- 5G speed and edge computing will drive high performing networks and services
- Cyber and physical threats are more quickly identified and mitigated

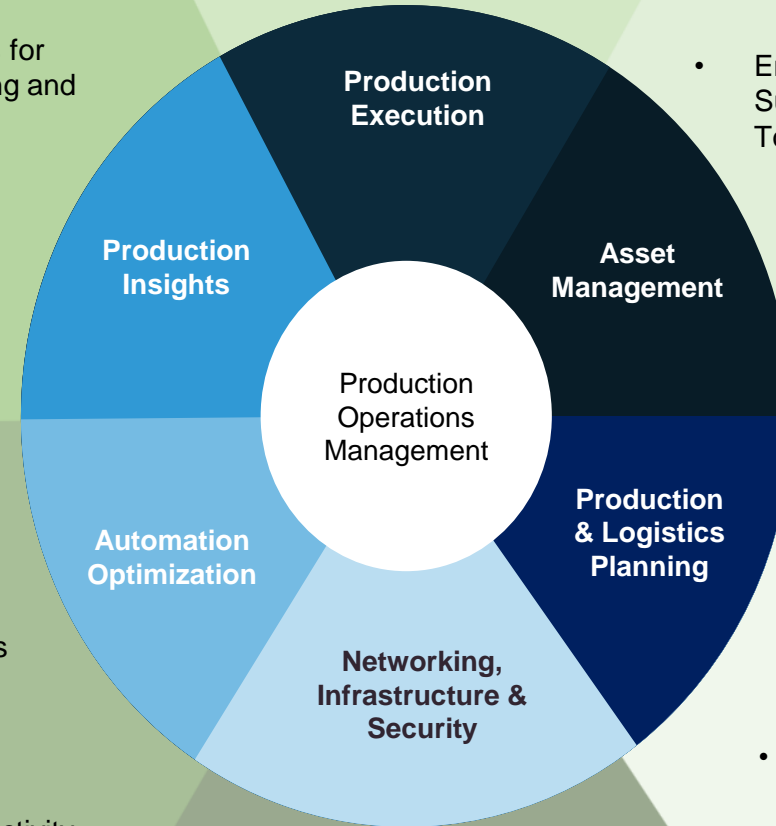
- Augmented Reality revolutionizes maintenance of equipment
- Artificial Intelligence can open the way to micro-calibration

- Energy Monitoring & Resource Sustainability enhances Freedom To Operate

- Detailed Scheduling reacts more quickly and completely to operational constraints

- Digitally enabled logistics efficiencies drive down cost, carbon footprint and delivery times

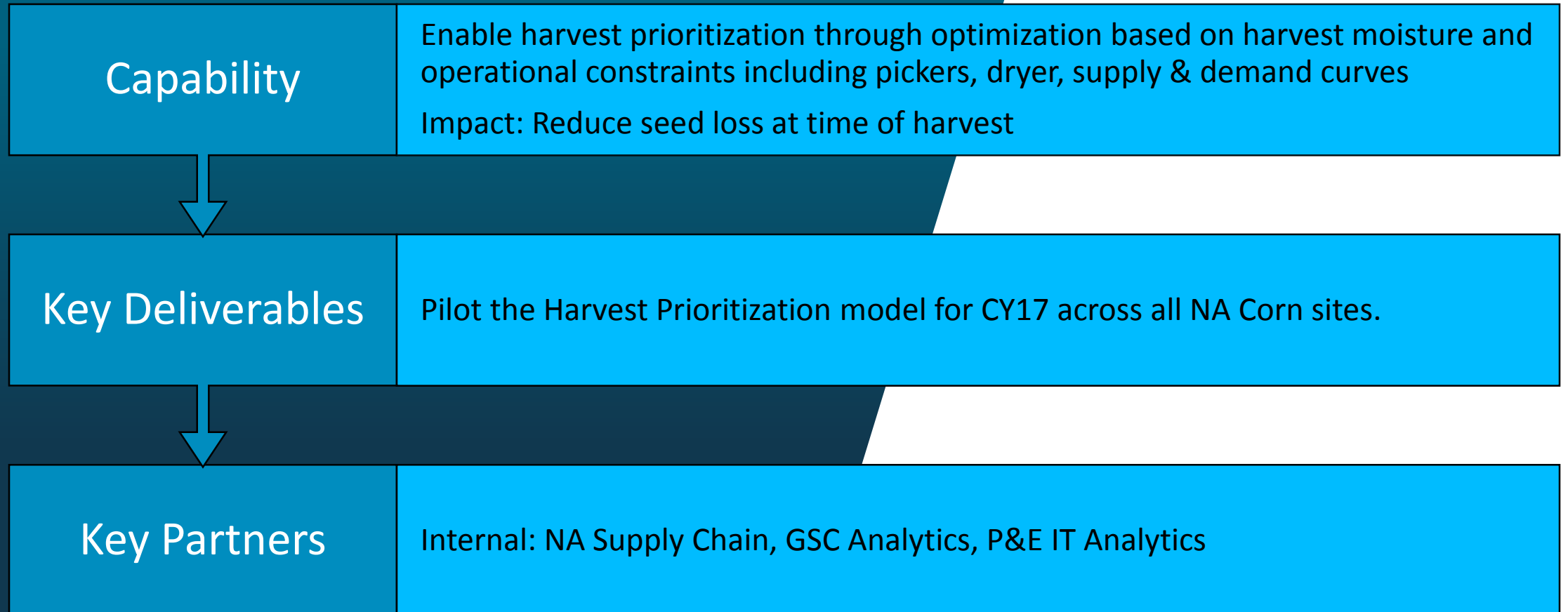
- Predictive modeling allows warehouse footprint optimization







## Harvest Prioritization – NA Pilot/POC





### IoT Enablement

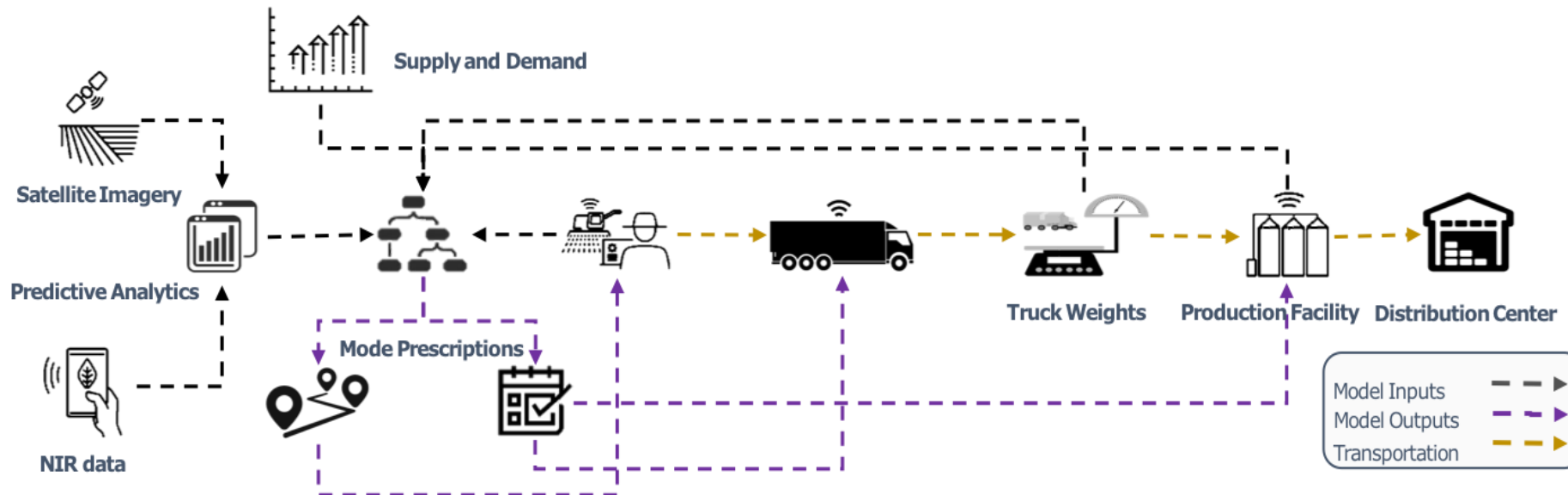
- Imagery, NIR readings
- Trucks
- Sites

### Truck Scheduling

- Availability
- Temperature, Moisture

### Processing Site Scheduling

- Capacity
- Changeovers



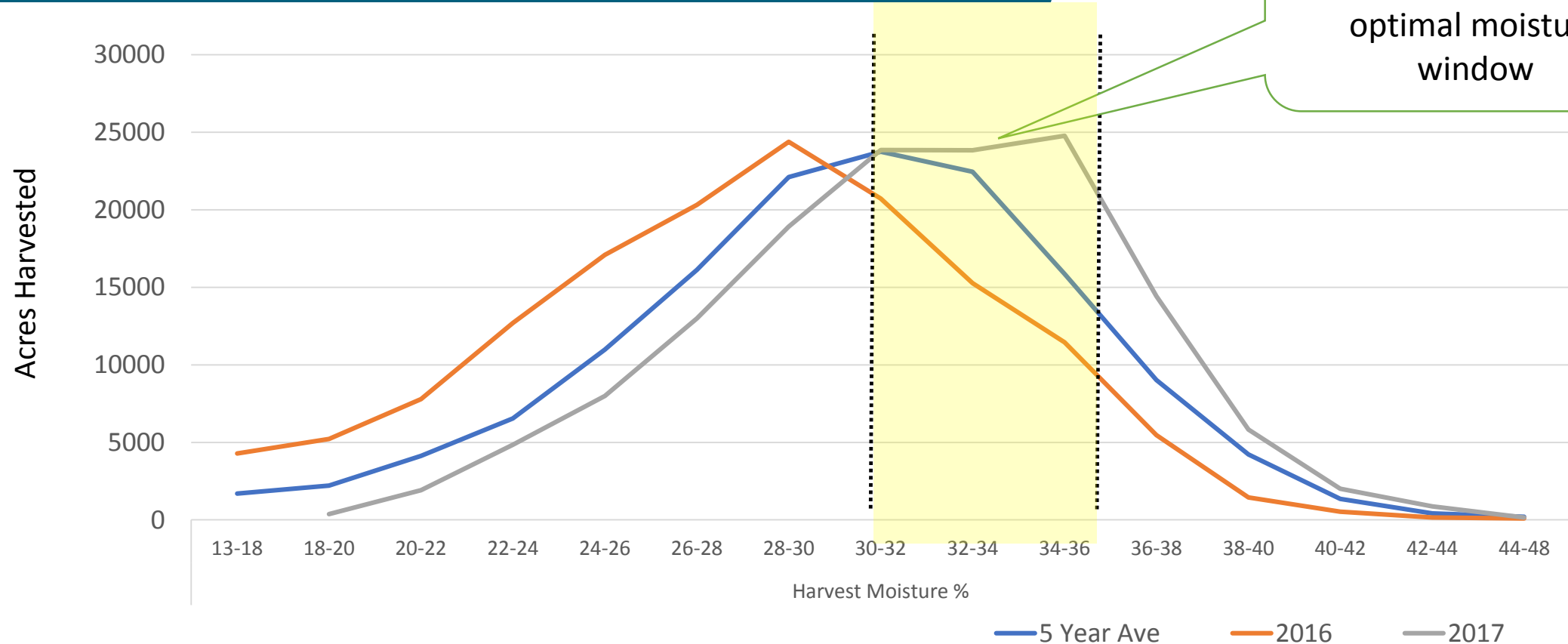
*Powered by Machine Learning, IOT and Optimization*





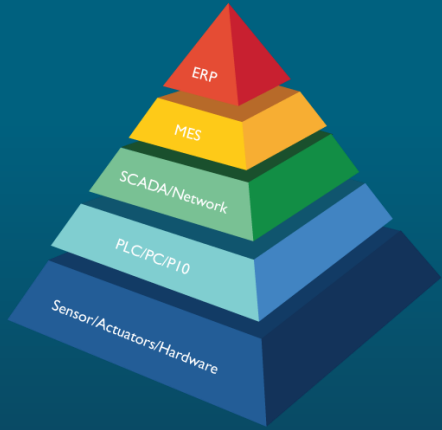
# Harvest Prioritization 2017 Pilot Results

## Harvested Acres by Moisture

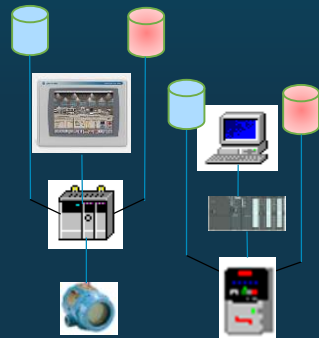
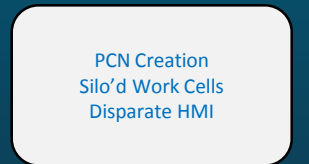




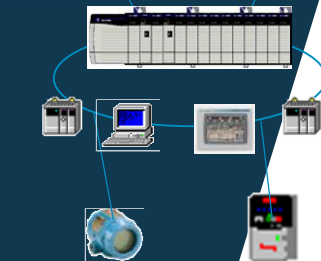
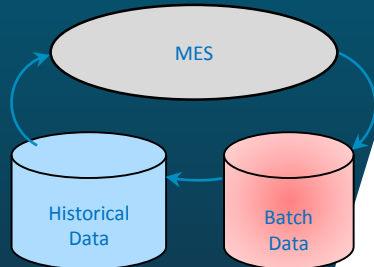
# Manufacturing Technology Maturity Model



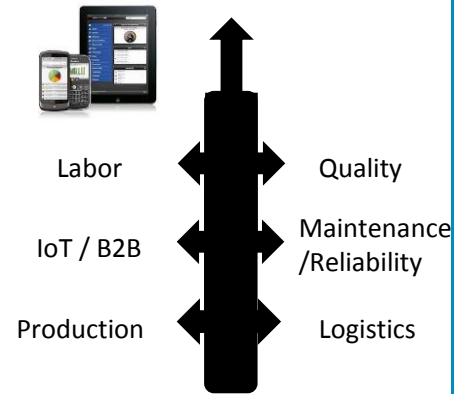
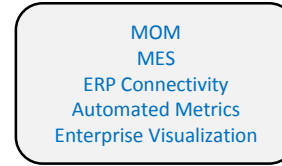
Islands of Automation



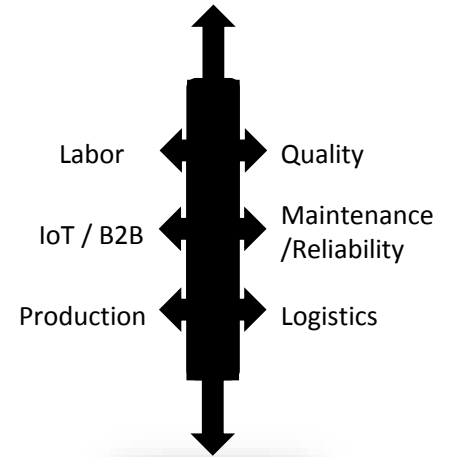
Connected



Integrated



Optimized

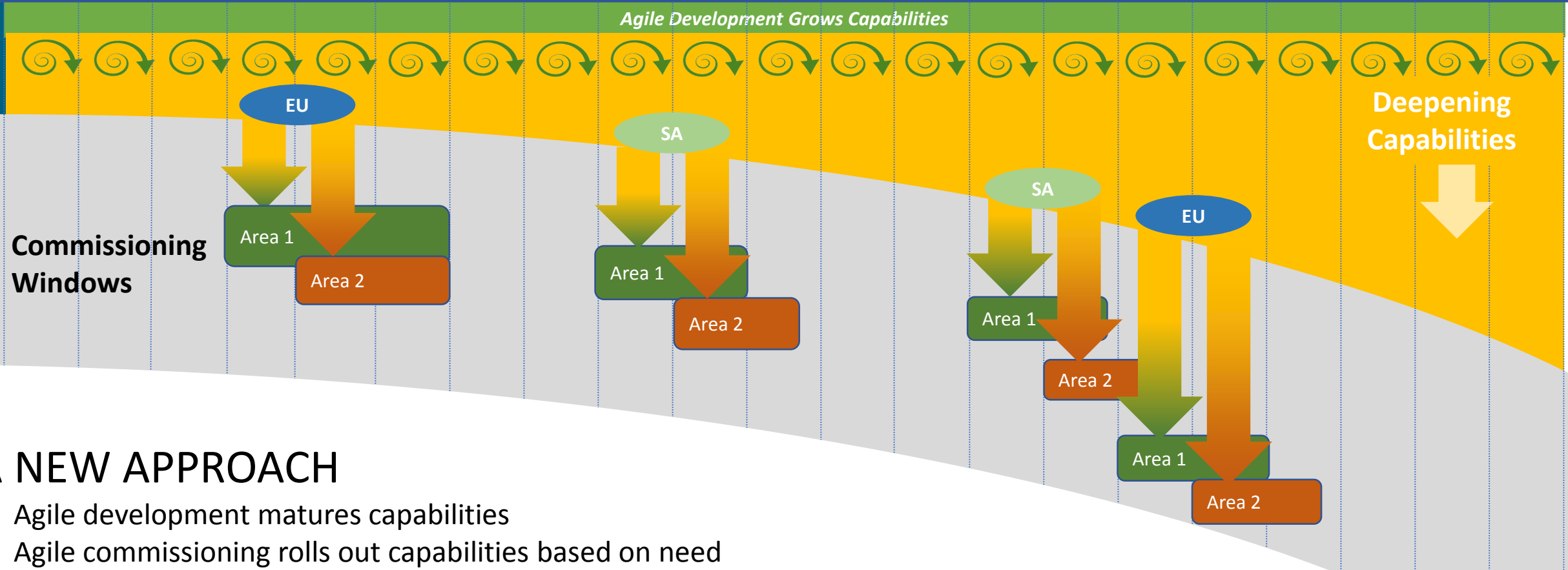


Orchestrated





# Global Opportunities to Deliver Functionality



## A NEW APPROACH

- Agile development matures capabilities
- Agile commissioning rolls out capabilities based on need and site readiness; start small and build over time



## Conclusions

- Industry 4.0 is a journey that requires a multi-pronged approach
- Technologies, resources and products must align to strategic drivers
- Fail early and mindfully

*Thank you!*

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