Digitalization in Downstream of JSC NC "KazMunayGas"

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Definition of Digitalization*:

Digitalization is the profound transformation of business, processes, competencies and business models **by full involvement and use of digital technologies** during the entire entity cycle (both at the strategy and at daily operations level).

Levels of plant Digitalization:

Automatic process and financial **data collection**
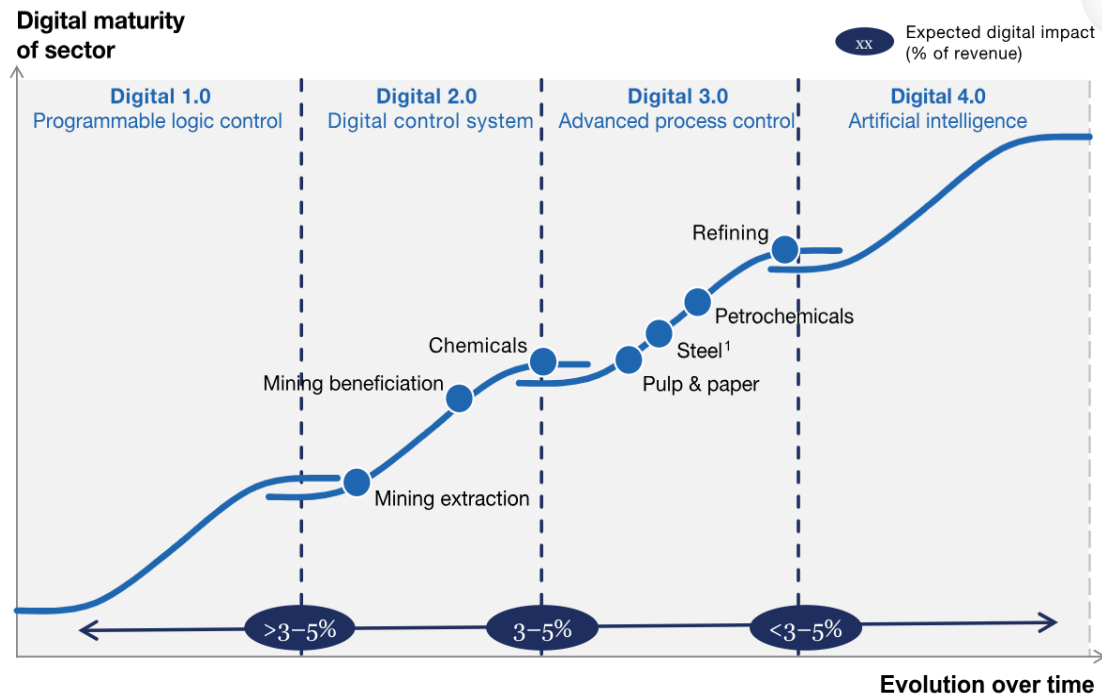
Computerized **data analysis**

Fully automated **process control**

Decision-making based on digital analytics, in the future - using artificial intelligence

*www.i-scoop.eu/digital-transformation, AVEVA

4 levels of digital maturity in heavy industries

Digital maturity of sector

| Digital 1.0 | Digital 2.0 | Digital 3.0 | Digital 4.0 |
| Programmable logic control | Digital control system | Advanced process control | Artificial intelligence |

Refining

Petrochemicals

Steel[1]

Pulp & paper

Chemicals

Mining beneficiation

Mining extraction

Expected digital impact (% of revenue)

>3−5% 3−5% <3−5%

Evolution over time

[1] We estimate that other metals fall between chemicals and steel on the maturity curve. .

Digitalization 1.0
Programmable logical control (PLC)

- The beginning of the digital journey.
- immediate control and decision making.
- Sensors installed on equipment and connected to local PLCs to automate basic functions

Digitalization 3.0
Advanced process control

- Use highly sophisticated automation using APC and RTO
- **LP**: use modelling and analytics to optimize the performance
- **MES**: manufacturing executive system monitoring

Digitalization 2.0
Digital control system

- Extensive automation including DCS (distributed control system) technology
- Connected to an ERP at corporate
- Historian infrastructure in place for operations data

Digitalization 4.0
Artificial intelligence

- Using machine learning and AI.
- Real-time flows automatically across industrial sites, enabling all decisions to be centralized and data-driven.
- Automated management tasks,
- Brute-force optimization

Digitalization for KMG

Approach to Digitalization:

1. Assess, **at what stage of digital maturity KMG downstream is now**: business-models, processes, systems, competencies (point A).
2. Decide, **how digitalized KMG downstream needs to be**, in order to achieve its strategic and business goals (point B)
3. Develop **a road map**, how to get from point A to point B
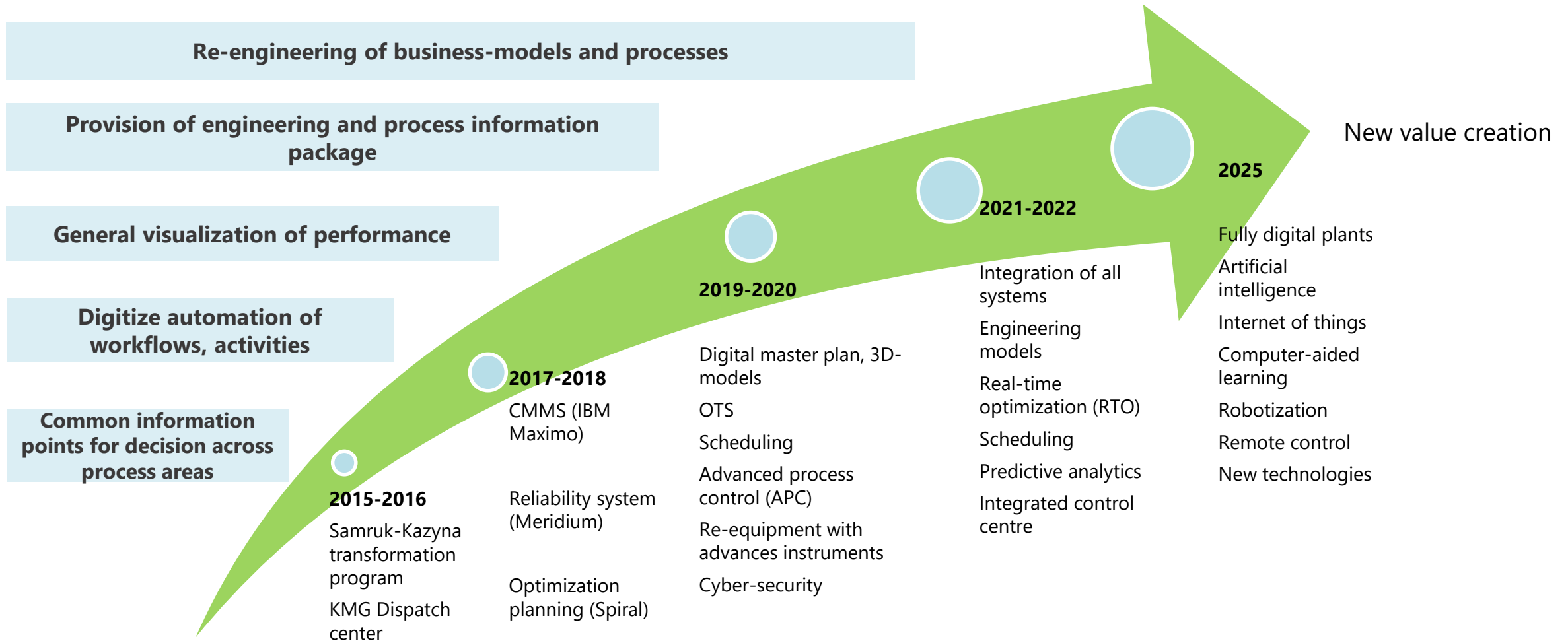4. **Execute** this road map

Benefits:

- **Productivity improvement**
  - Better products yield and quality
  - Less personnel at the site
  - Use of capacity potential
  - Operation flexibility

- **Improved return on assets**
  - Early anomaly detection
  - Predictive maintenance
  - Downtime reduction

- **Safe operations**
  - Prevention of incidents
  - Wireless instruments, drones
  - Automatic star-up / shutdown of equipment

- **Better business solutions**
  - Based on data-based insights
  - Enterprise-wide view with ability to drill down into specific plants/assets/processes

- **Enhanced competitiveness in domestic & international markets**

Architecture of KMG digital downstream asset
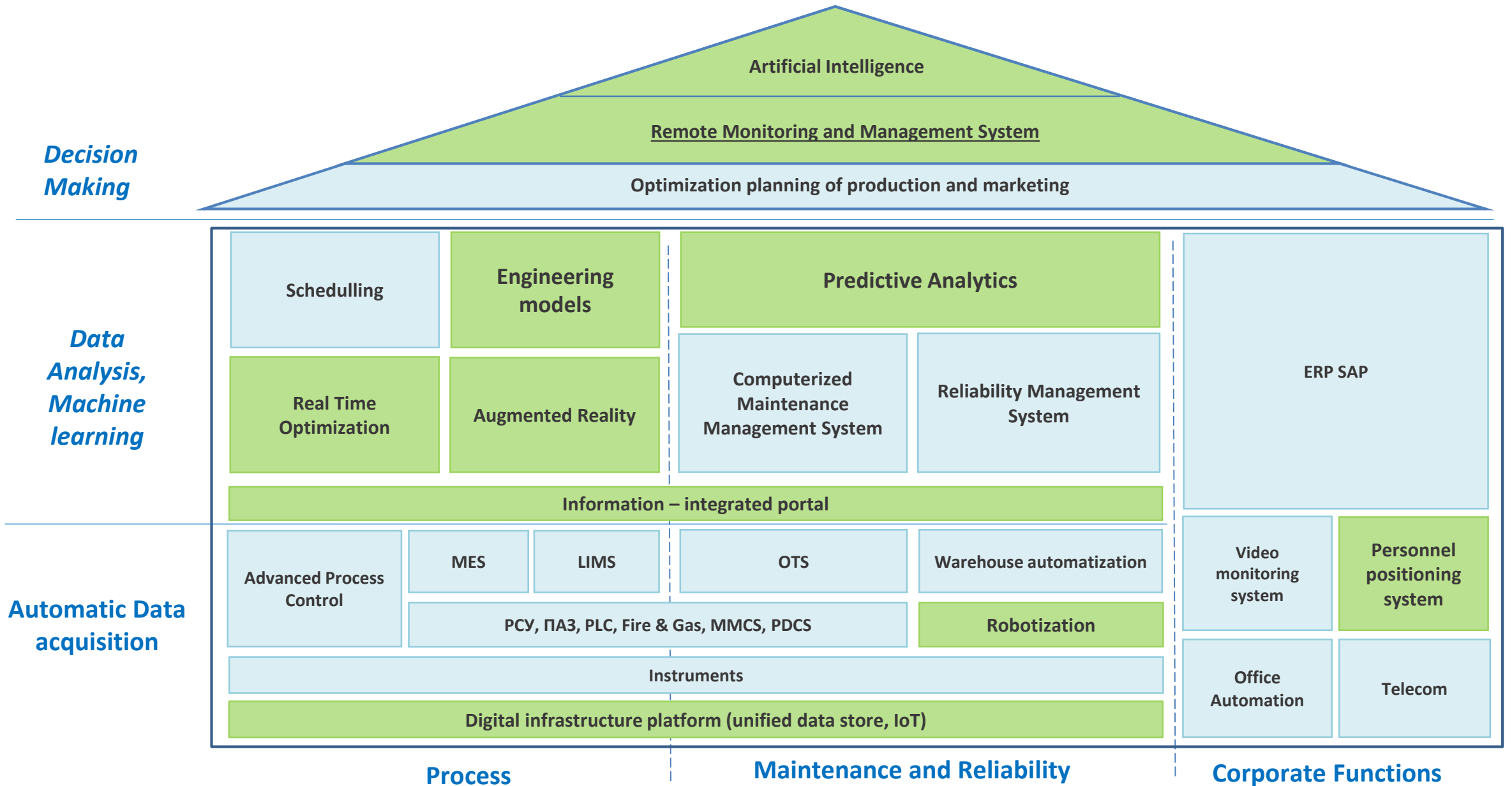
KMG downstream Digitalization route

Goal: increase in productivity, operation efficiency and security

Re-engineering of business-models and processes

Provision of engineering and process information package

General visualization of performance

Digitize automation of workflows, activities

Common information points for decision across process areas

2015-2016

Samruk-Kazyna transformation program

KMG Dispatch center

2017-2018

CMMS (IBM Maximo)

Reliability system (Meridium)

Optimization planning (Spiral)

2019-2020

Digital master plan, 3D-models

OTS

Scheduling

Advanced process control (APC)

Re-equipment with advances instruments

Cyber-security

2021-2022

Integration of all systems

Engineering models

Real-time optimization (RTO)

Scheduling

Predictive analytics

Integrated control centre

2025

New value creation

Fully digital plants

Artificial intelligence

Internet of things

Computer-aided learning

Robotization

Remote control

New technologies

Individual KMG downstream Digitalization projects

Project pre-requisites:

- Modernization and added complexity of the refinery processes
- Need for equipment reliability and mechanical integrity increase (in terms of maintenance) during transition to extended mean time between turnarounds
- Transition to best practices of refining industry sector in terms of assets management

Solution:

Implementation of CMMS systems providing the required level of maintenance, reliability and mechanical integrity to operate the equipment under the conditions of at least 3-years turnaround circle according to the best practices of global majors (Honeywell, Shell, ExxonMobile, PetroChina, Dupont, Reliance, etc.)

Project implementation stages:

1. Adjustment of the **regulatory framework**

2. Rearrangement of the **equipment range**

3. Implementation of **new business processes** and **organizational structure** at the refineries

4. Implementation of individual refinery **equipment repair and replacement programs**

5. **Implementation** of CMMS

6. Personnel **training**

7. **Commissioning**

8. **Transferring control over all maintenance process to the system** (after sufficient data generation)

Project perimeter :

- 2016-2019: Atyrau refinery and Pavlodar refinery – **implementation completed**

- 2019-2020: Shymkent refinery

Implementation of optimization planning system at refineries (Spiral)

Project pre-requisites:

- planning priority – production focus on market demands
- need to increase refinery yield, control and reduction of losses
- after modernization, the refinery process operations became more complex

Solution:

Transformation of the production planning process by implementation of new business processes and specialized software (Spiral)
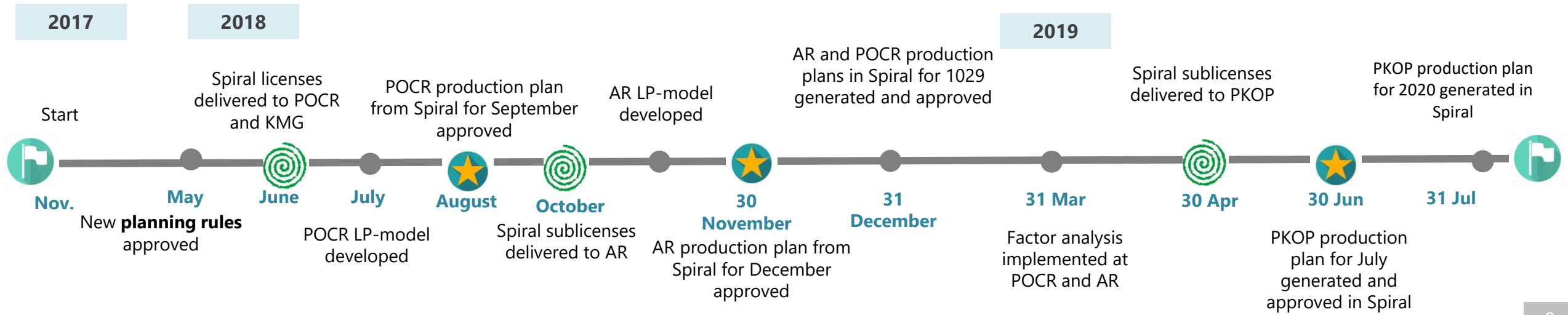
Benchmarking (best practices):

Similar business process and software are used in companies such as BP, SHELL and represent the standard in the global downstream

Project perimeter:

2018: POCR LLP, AR LLP, KMG (implemented)

2019: PKOP LLP

2017

2018

2019

Start

Spiral licenses delivered to POCR and KMG

POCR production plan from Spiral for September approved

AR LP-model developed

AR and POCR production plans in Spiral for 1029 generated and approved

Spiral sublicenses delivered to PKOP

PKOP production plan for 2020 generated in Spiral

Nov.

May

June

July

August

October

30 November

31 December

31 Mar

30 Apr

30 Jun

31 Jul

New **planning rules** approved

POCR LP-model developed

Spiral sublicenses delivered to AR

AR production plan from Spiral for December approved

Factor analysis implemented at POCR and AR

PKOP production plan for July generated and approved in Spiral

Project pre-requisites :

- Integrated gas chemical complex (IGCC) is being constructed in Karabatan, away from the city. That is why it is reasonable to optimize the number of personnel who will work at this plant

- KPI is a new industrial facility and there is an opportunity to construct it as an all-digital asset from the early stage
- Implementation of ERP-systems in KMG group was always partial that is why the maximum gains potential was not achieved

Solution:

- Implementation of automation systems of all entity business processes: **production** processes, **CMMS and reliability**, **corporate** (ERP):
  - ✓ Automatic process and financial data collection
  - ✓ Computerized data analysis
  - ✓ Fully automated control over production processes
  - ✓ Decision-making based on digital analytics, in the future – using artificial intelligence

Benchmarking (best practices):

The majority of the largest downstream and chemical companies (BASF, BP, ADNOC) have been digitalizing their assets stage by stage for a long time. In Kazakhstan there has as yet been no examples of fully digitized entities.