THINGWORX IIOT PLATFORM: A LOOK AHEAD

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PLATFORM INVESTMENT DRIVERS

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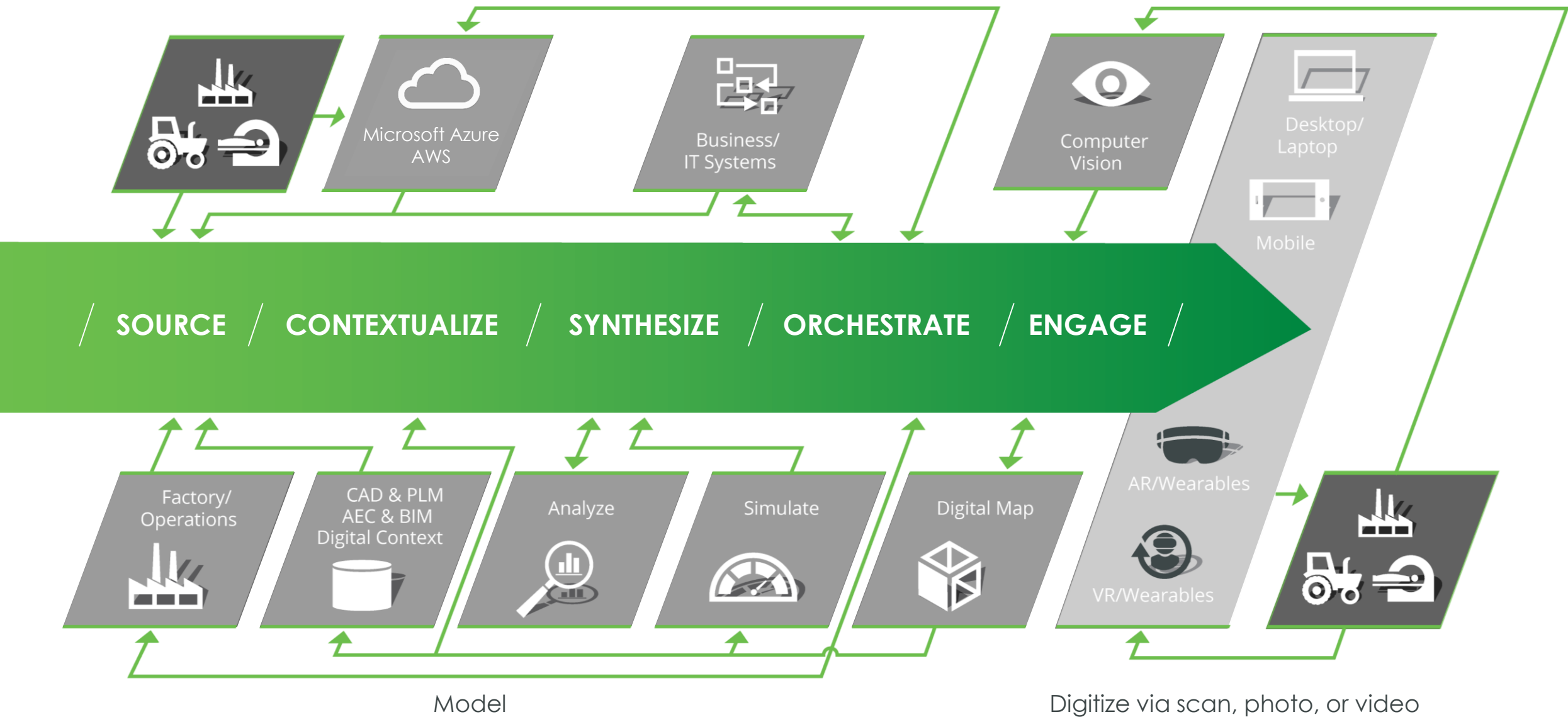|	
Solution Development	Efficiently build and extend solutions for connected operation and connected product use-cases.
High Scale, High Availability	Continue to stay ahead of market requirements for scaled-up IoT implementations.
Orchestration	IoT-enable enterprise systems with business process automation and integration.
Microsoft Azure	Expand the combination of Azure and ThingWorx technologies to bring market-leading capabilities.
Rockwell	Build out the Rockwell partnership with support for FactoryTalk MES and analytics.

INDUSTRIAL INNOVATION PLATFORM

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SOURCE / **CONTEXTUALIZE** / **SYNTHESIZE** / **ORCHESTRATE** / **ENGAGE**

Microsoft Azure AWS

Business/ IT Systems

Computer Vision

Desktop/ Laptop

Mobile

Factory/ Operations

CAD & PLM AEC & BIM Digital Context

Analyze

Simulate

Digital Map

AR/Wearables

VR/Wearables

Model

Digitize via scan, photo, or video

INDUSTRIAL INNOVATION PLATFORM

SOURCE / CONTEXTUALIZE / SYNTHESIZE / ORCHESTRATE / ENGAGE

Open Platform

Rockwell & Analytics

Device Management

Edge

Developer Enablement

Orchestration

Security

High Scale

Microsoft Azure AWS

Factory/ Operations

AEC & BIM Digital Context

Analyze

Simulate

AR/Wearables

VR/Wearables

Mobile

Model

Digitize via scan, photo, or video

THINGWORX RELEASE CADENCE

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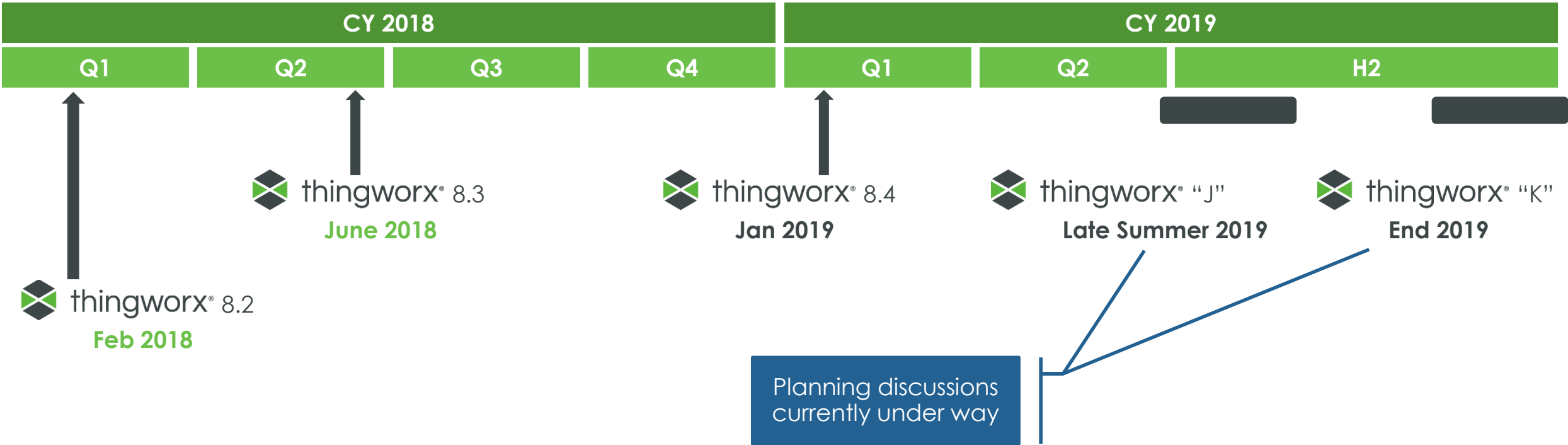
Developer Enablement

- Developer efficiency & productivity
- Faster time-to-value
- Fast iteration with changing requirements
- Code re-use
- For citizen and professional developers

8.3 — June 8 2018

8.4 — Jan 2019

"J" — Late Summer 2019

"K" — End 2019

Next Generation Composer

- New capability for User & Group administration, authorization and permissions
- Localized for German and French

Mashup Builder

- Modern UI for all widgets
- New widgets – phase I
- Responsive layout
- Template support
- Mashups and widgets design preview
- Widgets/components SDK – phase I

Mashup Builder

- New/Updated widgets – phase II
- Navigation & routing between mashups
- Localization enhancements
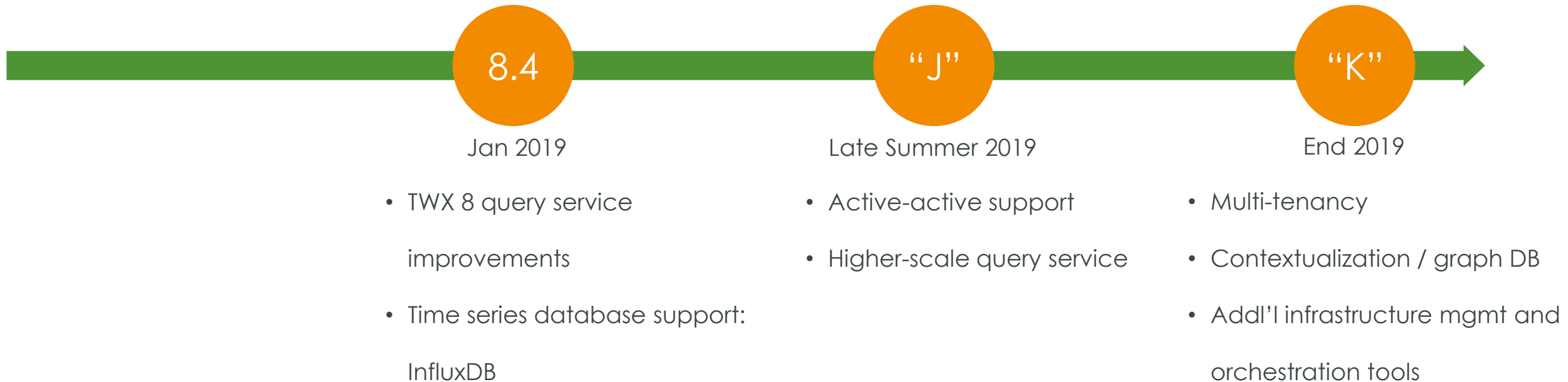- Role based support
- Widgets/components SDK – phase II

Mashup Builder

- New/Updated widgets completion
- Debugging/Tracing improvements
- Change and version management
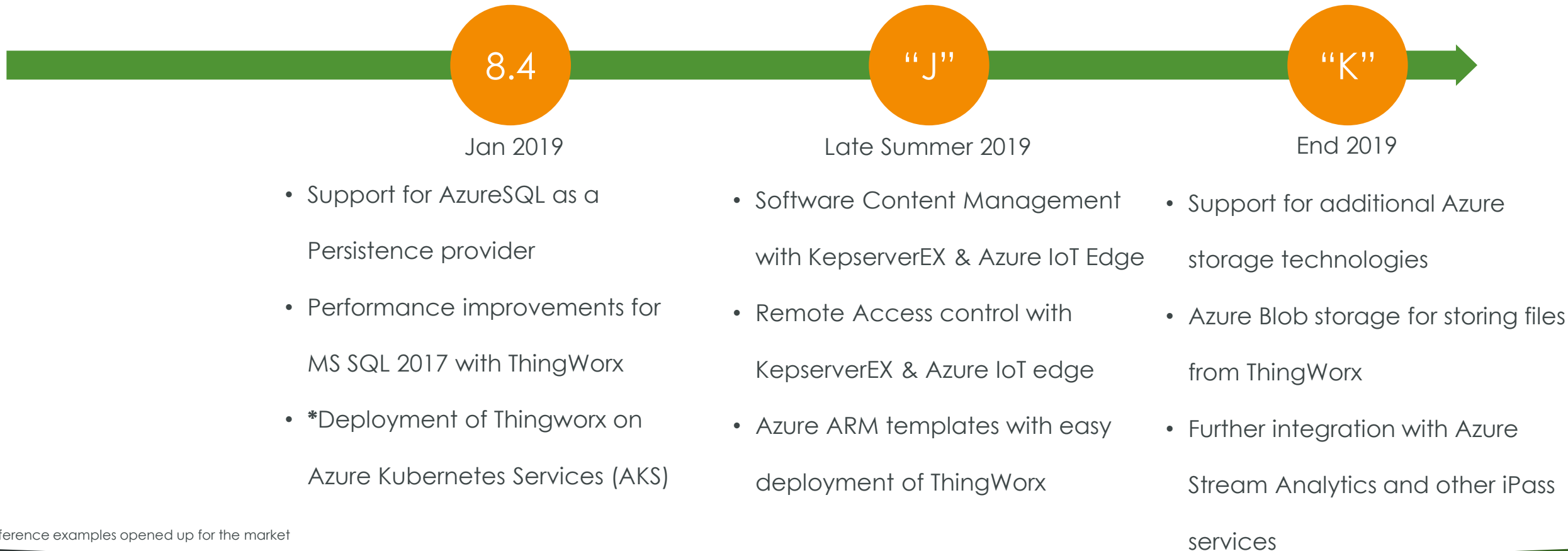- Marketplace and Community ecosystem

High-Scale / High-Availability

- **Continued platform evolution supporting exponential projections of device growth**
- **Active-active support for greater reliability, easier upgrading**
- **Horizontal scalability**

8.4
Jan 2019
- TWX 8 query service improvements
- Time series database support: InfluxDB

"J"
Late Summer 2019
- Active-active support
- Higher-scale query service

"K"
End 2019
- Multi-tenancy
- Contextualization / graph DB
- Addl'l infrastructure mgmt and orchestration tools

Microsoft Azure Integration

- **Support deeper integration of ThingWorx with Azure Services to benefit joint PTC- Microsoft customers with easy interoperability**
- **Achieve cloud-like scalability and resiliency with Azure-optimized version of ThingWorx**

8.4
Jan 2019

- Support for AzureSQL as a Persistence provider
- Performance improvements for MS SQL 2017 with ThingWorx
- *Deployment of Thingworx on Azure Kubernetes Services (AKS)

"J"
Late Summer 2019

- Software Content Management with KepserverEX & Azure IoT Edge
- Remote Access control with KepserverEX & Azure IoT edge
- Azure ARM templates with easy deployment of ThingWorx

"K"
End 2019

- Support for additional Azure storage technologies
- Azure Blob storage for storing files from ThingWorx
- Further integration with Azure Stream Analytics and other iPass services

* Reference examples opened up for the market

Orchestration

- **Connect and integrate systems to extract value from enterprise data for IoT use cases**
- **Quickly build and modify interactions with systems & system data to create orchestrated data flows in visual, no-code environment**

8.4	"J"	"K"
Jan 2019	Late Summer 2019	End 2019

Initial Release: Deployment options
- On-premise; PTC-managed Azure Cloud Service

Connectors
- On-premise Systems: SAP, Windchill, Integrity and more
- Cloud: Salesforce, Dynamics 365, Jira, Box, Dropbox, Twilio
- Custom connector SDK & standard-based connectors

Connected App support
- Azure services connectors (event hub, event grid, execute service)
- Federated search and cloud to cloud and cloud to on-premise flows

Scale
- Dynamically scale flow execution with Azure Function as a service
- Automatic retry and checkpointing
- Pause and resume flows while waiting on events

Human task support
- Define flows with integrated human tasks/mashups; system & device data flow elements

Digital Twin Support
- Enable population of digital twin models through flows
- Enable consumption of digital twin models in context of flows

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Rockwell & Analytics

- **Building out Rockwell FactoryTalk partnership**
- **Predictive modeling based on machine learning algorithms**
- **Real-time monitoring for improved asset performance and reliability**

8.3 — June 8 2018

- Out-of-box standard calculations for statistical process control
- New descriptive services to apply logic to and derive insights from streaming data

8.4 — Jan 2019

- Initial integration between Thingworx Analytics + Rockwell FactoryTalk
- Analytics Upgrades to AI infrastructure (Improved transforms, metadata handling)
- "Codeless" authoring of property transforms and statistical monitoring calculations for SPC solution
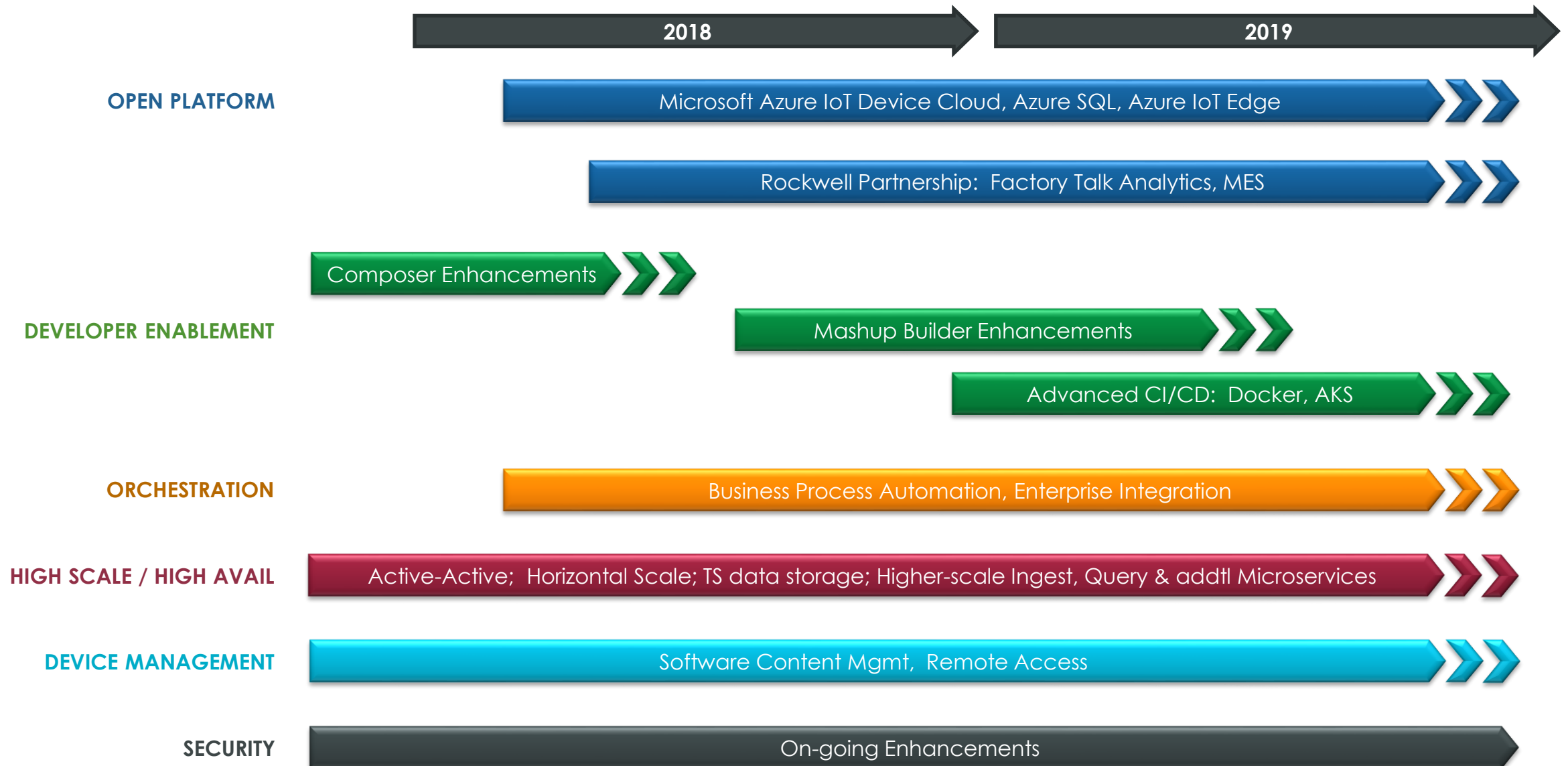
"J" — Late Summer 2019

- Advanced integration between ThingWorx Analytics and Rockwell FactoryTalk Analytics
- Advanced AI integrations with our strategic partners
- Domain-specific frameworks and offerings

"K" — End 2019

- Diagnostic Analytics widgets
- Improved AI features
- Enhanced frameworks and offerings

THINGWORX PLATFORM ROADMAP

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	2018	2019

OPEN PLATFORM
- Microsoft Azure IoT Device Cloud, Azure SQL, Azure IoT Edge
- Rockwell Partnership: Factory Talk Analytics, MES

DEVELOPER ENABLEMENT
- Composer Enhancements
- Mashup Builder Enhancements
- Advanced CI/CD: Docker, AKS

ORCHESTRATION
- Business Process Automation, Enterprise Integration

HIGH SCALE / HIGH AVAIL
- Active-Active; Horizontal Scale; TS data storage; Higher-scale Ingest, Query & addtl Microservices

DEVICE MANAGEMENT
- Software Content Mgmt, Remote Access

SECURITY
- On-going Enhancements

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KEPWARE AND THINGWORX EDGE: A LOOK AHEAD

Tom Gaudet
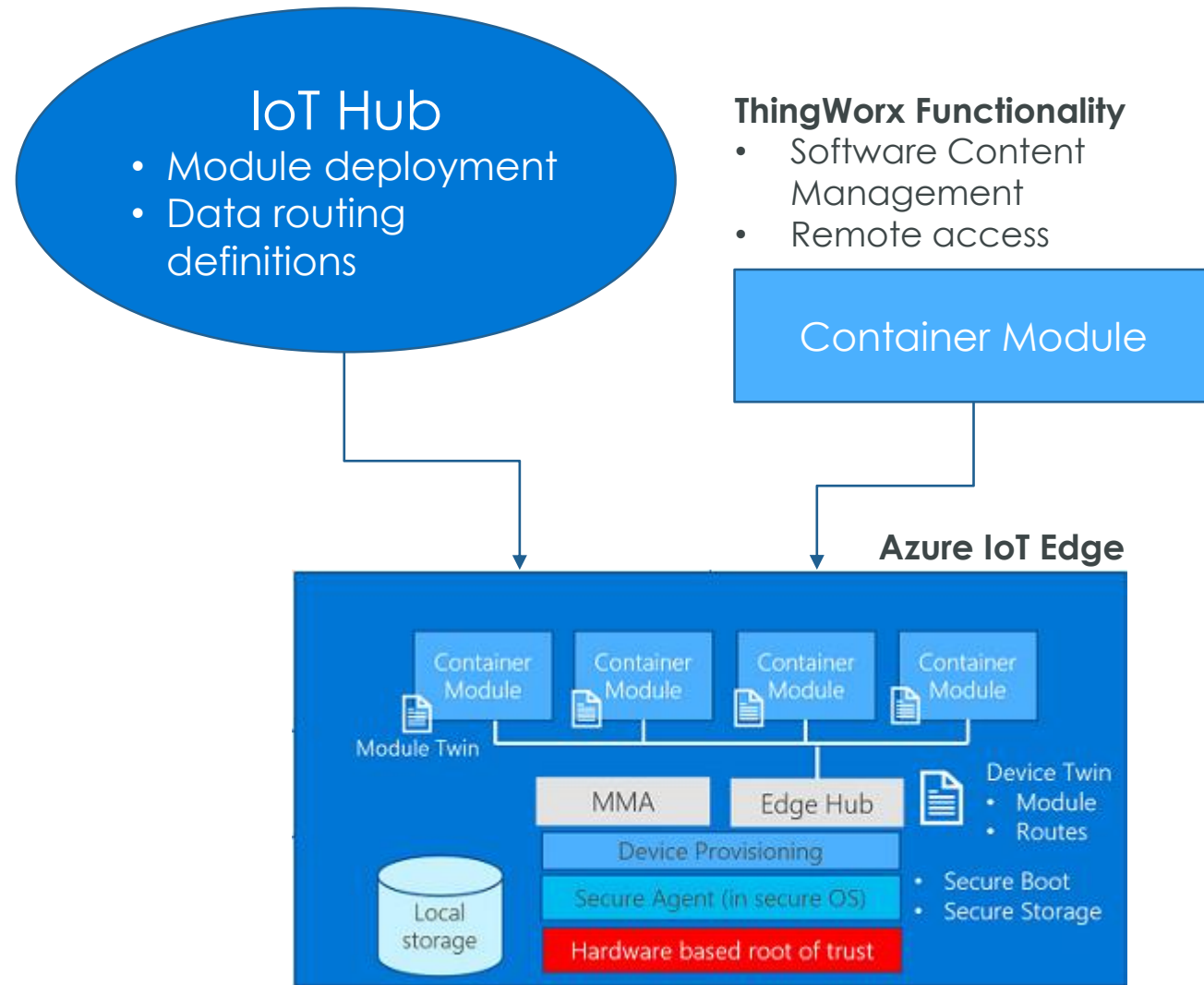Product Manager

ptc | forum europe

KEPWARE AND EDGE ROADMAP*

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	Calendar Year 2018		Calendar Year 2019				FUTURE
	Q3	Q4	Q1	Q2	Q3	Q4	

	"I" release	**Feb/Mar release**	**Jun/Jul release**	**Future Direction**	
KEPSeverEX	• Security • New Driver • CNC driver enhancement • Oil & Gas driver enhancement	• Security • Remote configuration enhancements • High value customer requests	• Security • OPC UA Security (https transport layer) • High value customer requests	• Security • Enhanced business logic at the edge • High value customer requests	• Enhanced redundancy • Configuration from ThingWorx • New drivers and enhancements • Interface enhancements
"Kepware on Linux"	• Beta	• Initial drivers & interfaces • Security & user access • Diagnostic tools • OEM licensing	• Additional drivers	• Additional drivers • Extensible Connectivity • Additional remote configuration enhancements	
Edge SDKs	• SCM for C SDK (off-cycle) • SCM for .NET SDK (off-cycle)	• Android support for Java SDK		• Java SDK store and forward • Java SDK edge extensions • Edge extensions phase 2	
Partner Enablement	• OEM versions of KEPServerEX for Rockwell	• Azure IoT Edge integration	• Improvements to FactoryTalk integration	• Azure integration • Rockwell integration	

Forward looking information – Does not indicate commitment – Subject to change without notice

SOFTWARE CONTENT MANAGEMENT IN C & .NET SDK
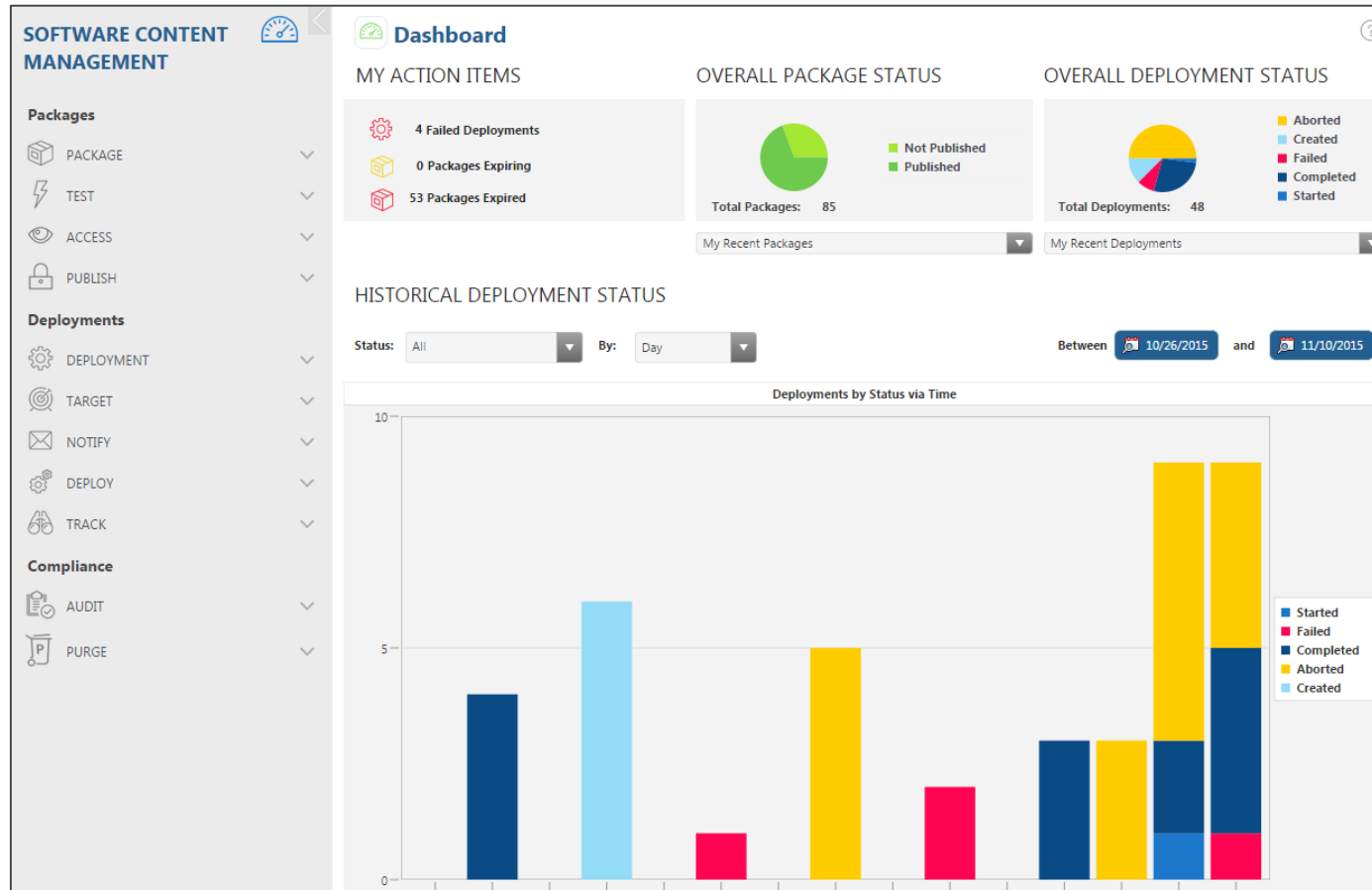
- Enables custom connectivity applications with SCM:
  - Content update
  - Configuration updates
  - Firmware upgrade

- Developers can now build SCM directly into their applications

- Security features built in
 - Digital signing of packages

AZURE IOT EDGE INTEGRATION

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IoT Hub
- Module deployment
- Data routing definitions

ThingWorx Functionality
- Software Content Management
- Remote access

Container Module

Azure IoT Edge

Container Module | Container Module | Container Module | Container Module

Module Twin

MMA | Edge Hub

Device Twin
- Module
- Routes

Device Provisioning

Secure Agent (in secure OS)

Local storage

- Secure Boot
- Secure Storage

Hardware based root of trust

EUROMAP 63 DRIVER

- Injection molding machines are a critical piece of factory machinery
  - IMMs are generally unconnected today

- First out-of-the-box connectivity in this market:
  - To date, there is no other IMM vendor-agnostic connectivity software.

- Provides personas across the enterprise visibility into IMM production

POTENTIAL EUROMAP 63 THIRD-PARTY DEPENDENCIES
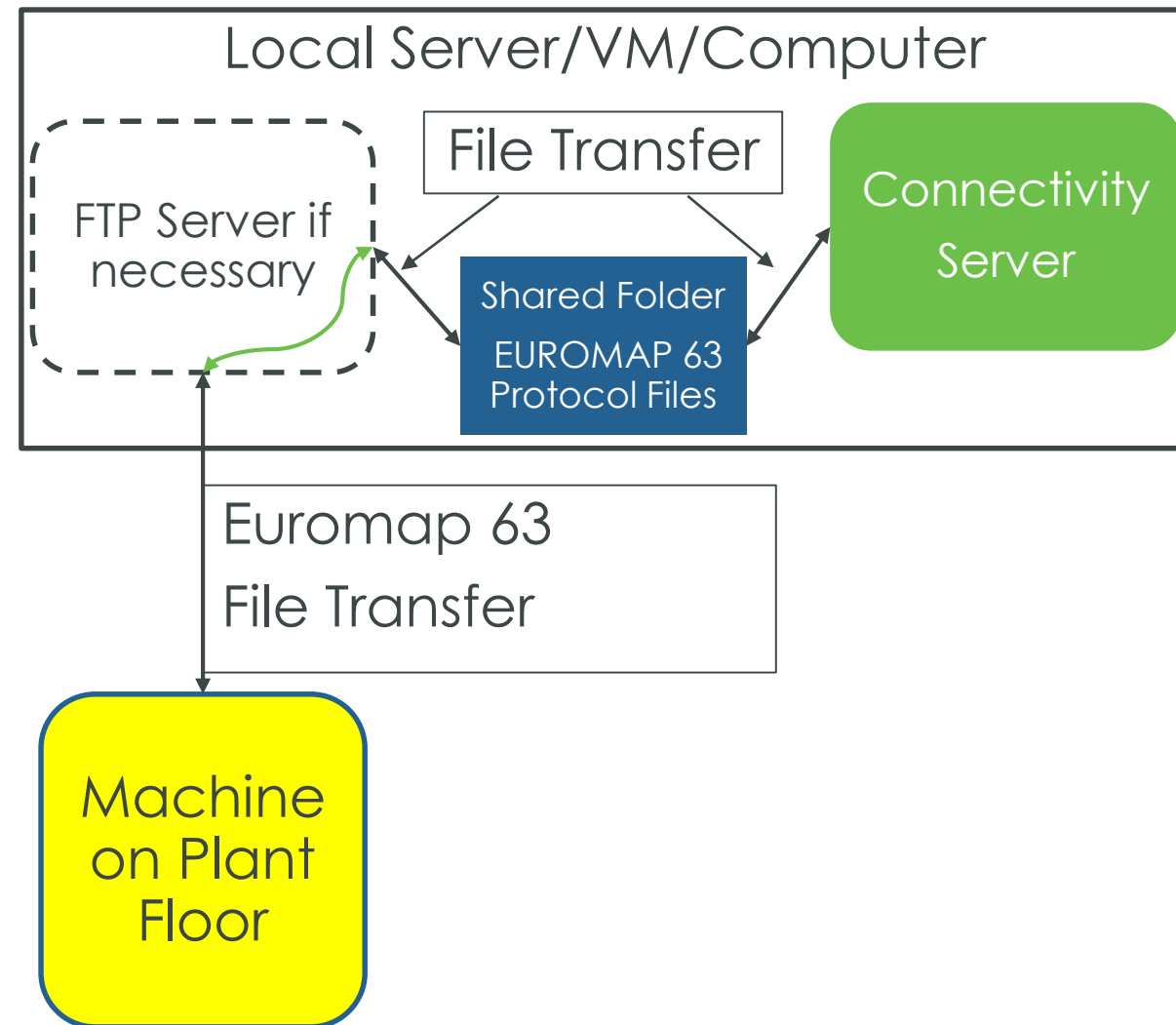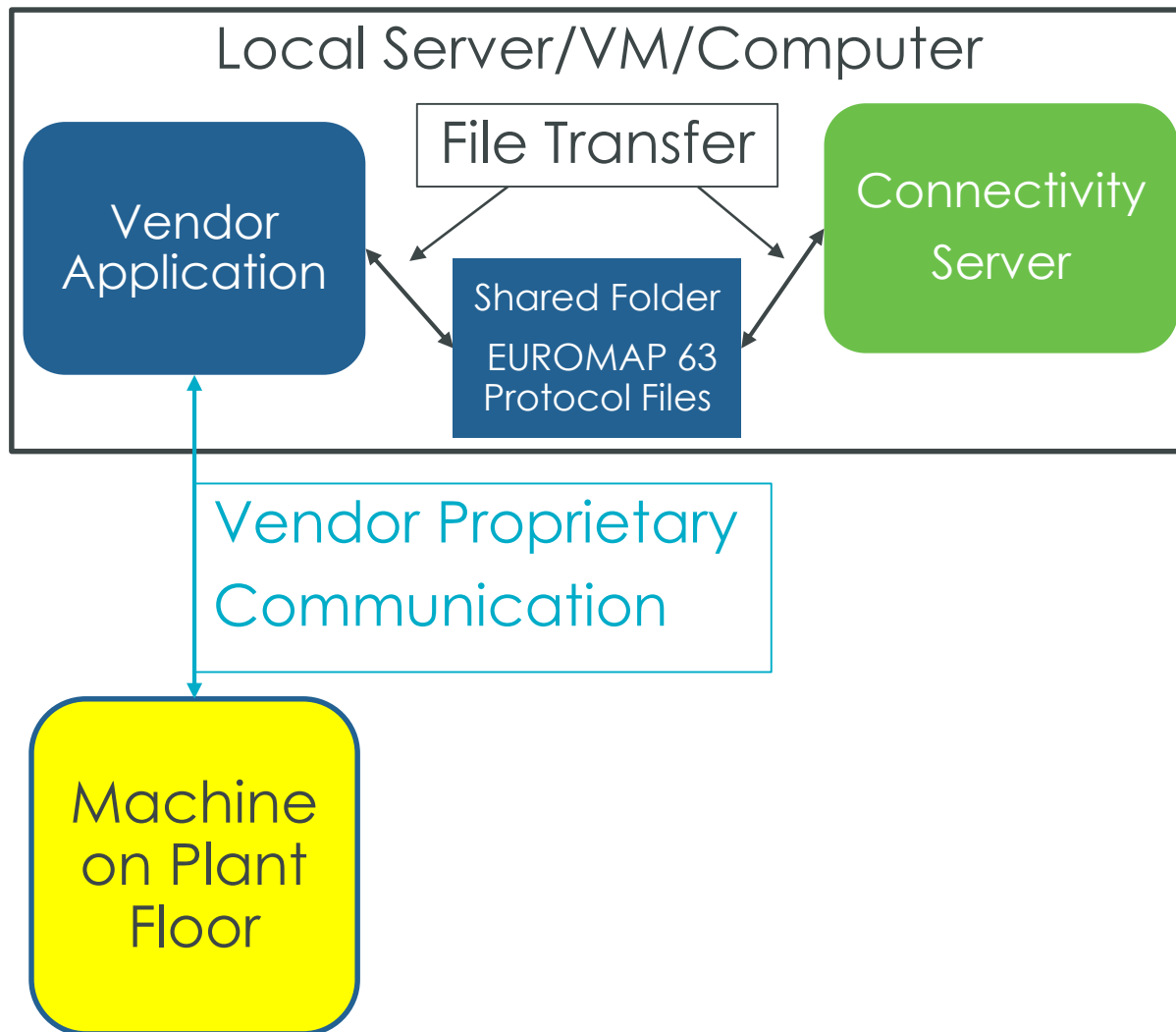
Server must have permissions to read/write/create/delete files

OPC UA BINARY OVER HTTPS

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* OPC UA supports three "protocol bindings:"
  – UA binary
  – XML-SOAP (WebSocket)
  – UA binary via HTTPS

* ThingWorx Industrial Connectivity currently supports UA binary
  – Requires port 4840
  – Unfamiliar to most IT organizations

* Makes OPC UA more IT friendly

UA binary over HTTPS

UA binary only

443

4840

THREAT LANDSCAPE – TRADITIONAL ICS

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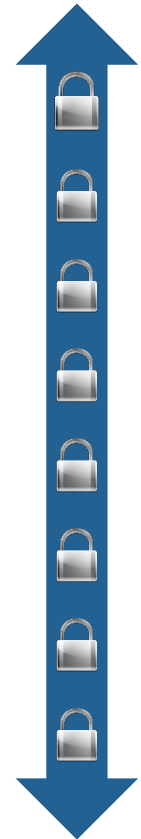
- Legacy security methods:
  - Air gaps
  - Security by Obscurity

11 operations-to-enterprise connections

110% increase in ICS attacks from 2015 to 2016

71% manufacturers reporting >2 ICS attacks
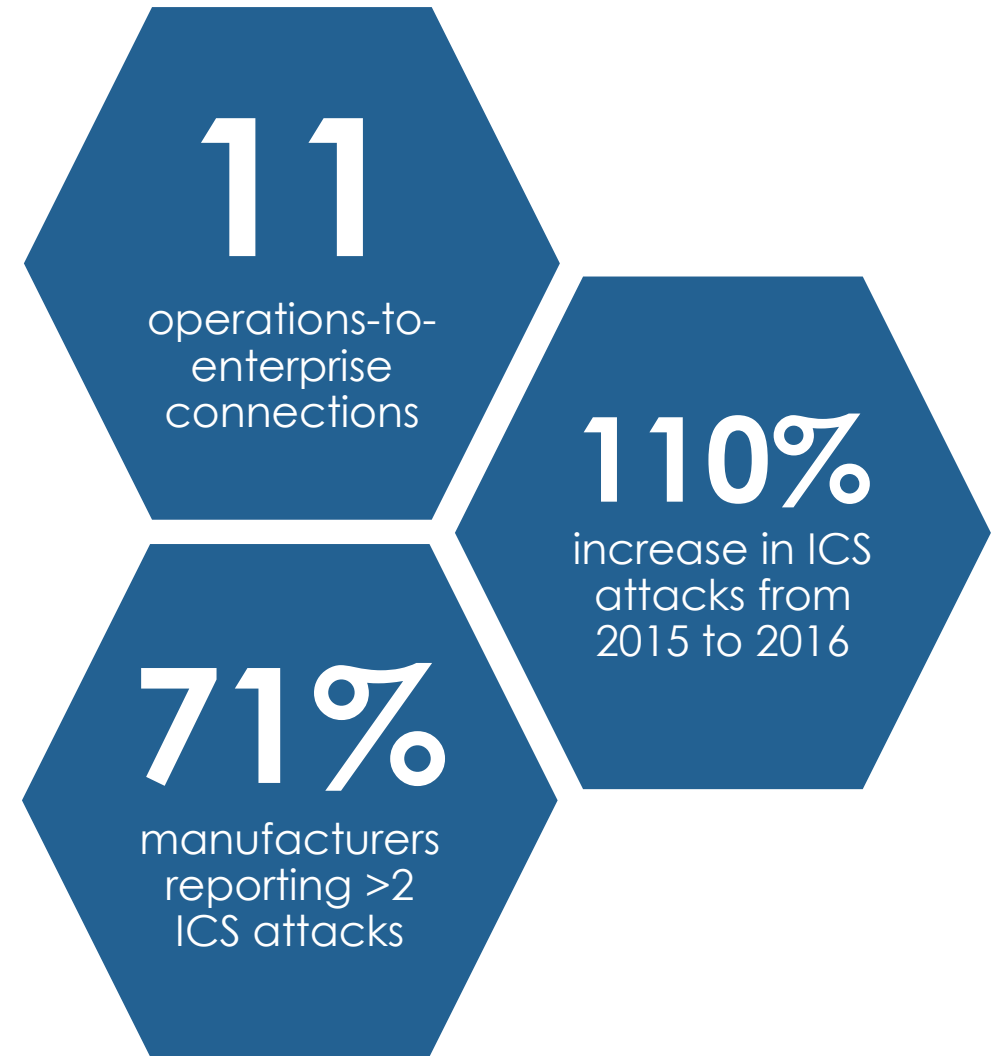
- Dedicating significant resources to security enhancements
  – 30% of some teams

- New Chief Security Officer

- Investment in Application Security Team

- Coordinated vulnerability disclosure program

- Shared responsibility whitepaper

Shared Responsibilities Stack

Operators

Developers/OEMs/SIs

Platform Provider
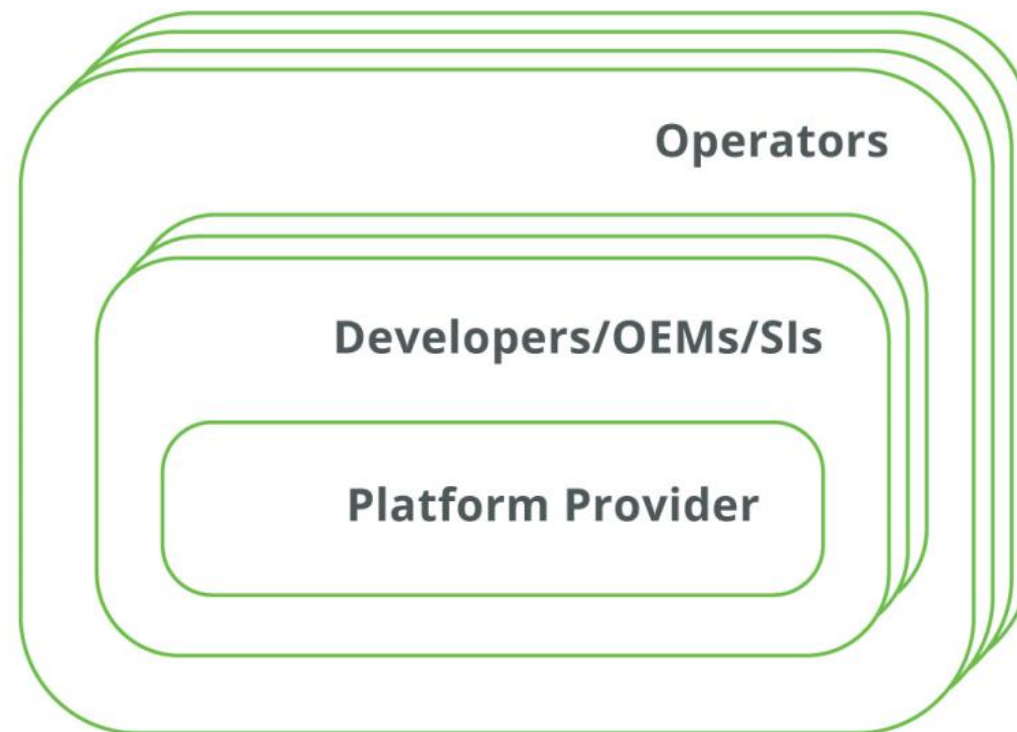
KEPWARE RESPONSE

- Product improvements

- Secure Deployment Guide

- Security collateral

IMPORTANCE OF MAINTENANCE

- Critical to PTC that customers update KEPServerEX
  - Safety critical software
  - Evolving threat landscape

- Updates are critical to security
  - Security is an arms race

- Customers are increasingly adopting this mindset

- Updates to ICSs are difficult
  - Benefits outweigh the risks

ICS-CERT
INDUSTRIAL CONTROL SYSTEMS CYBER EMERGENCY RESPONSE TEAM

2.6.1 Patch and Vulnerability Management

Applying patches to ICS components presents a challenge to system administrators, because system updates and patches can interfere with the ICS function. A patch to an ICS component could change the way it works, resulting in component failure or loss of functionality. System administrators should test all patches off-line in a test environment that contains the same model and type of ICS to determine whether the patch has unintended consequences. Also, many ICSs utilize older OS versions, which the vendor may not support.

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System designers should separate any process for applying ICS patches from the corporate patch management solution, and the application of patches to ICS should occur only during planned outages. Organizations should develop a systematic patch and vulnerability management approach for ICS and ensure that it reduces the exposure to system vulnerabilities while ensuring ongoing ICS operations.

Administrators should schedule software upgrades and patch management procedures at routine intervals. The development of procedures to incorporate security patches promptly and current software recommendations on a regular basis can substantially limit opportunities for hostile parties to target newly discovered vulnerabilities, which receive wide and immediate publicity. Organizations should institute practices to protect themselves without granting ample time for would-be intruders to apply the new knowledge against critical systems.[3]

DevOps & CI/CD

- Enable strong DevOps & CI/CD pipelines with improved platform support
- Reduce time to install and deploy ThingWorx for application development use cases
- Use Docker containers and Orchestrators (such as Kubernetes) to improve infrastructure management

8.3

June 8 2018

- Dockerfiles to enable building of ThingWorx docker container images
- Deployment example of Docker container images on Kubernetes using Helm charts and Docker-compose

8.4

Jan 2019

- Click and easy to install ThingWorx Foundation Installer
- Additional persistence provider such as InfluxData to support Dockerfiles
- Guidelines on developing and Deploying enterprise solutions

"J"

Late Summer 2019

- Deployment example of Docker container images on OpenShift environment

"K"

End 2019

- DevOps infrastructure for managing production deployment and advanced CI/CD

Device Management

- Expanding Software updating capabilities for improved asset performance and security
- More secure and flexible Remote Access and Control
- Increased visibility and control of remote activity for end users

8.3 — June 8 2018

- SW content mgmt enhancements:
  o instruction-based packages

8.4 — Jan 2019

- Remote access enhancements:
  o New secure tunnel
  o Remote Desktop via VNC/RDP
  o Remote access via ssh & http
  o multi-session mgmt

"J" — Late Summer 2019

- SW content mgmt enhancements:
  o property dependencies,
  o complex instruction set
- ThingWorx Global Access Server

"K" — End 2019

- SW content mgmt enhancements:
  o auto deployment
  o scale refactoring
- ThingWorx Policy Server
- Remote access:
  o session recording, auditing

# PTC PORTFOLIO TO ENABLE INDUSTRIAL INNOVATION

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PARTNER SOLUTIONS

Microsoft ANSYS Capgemini accenture Hewlett Packard Enterprise

Rockwell Automation Deloitte Digital McKinsey&Company InVMA vodafone

SOLUTIONS

thingworx asset advisor

thingworx navigate

thingworx production advisor

INDUSTRIAL INNOVATION PLATFORM

thingworx kepware vuforia

PRODUCT LIFECYCLE MANAGEMENT

creo windchill integrity servigistics

CLOUD | HYBRID | ON-PREM

PTC + MICROSOFT ROADMAP

Bringing intelligent cloud, intelligent edge, and AI to manufacturer's critical workflows
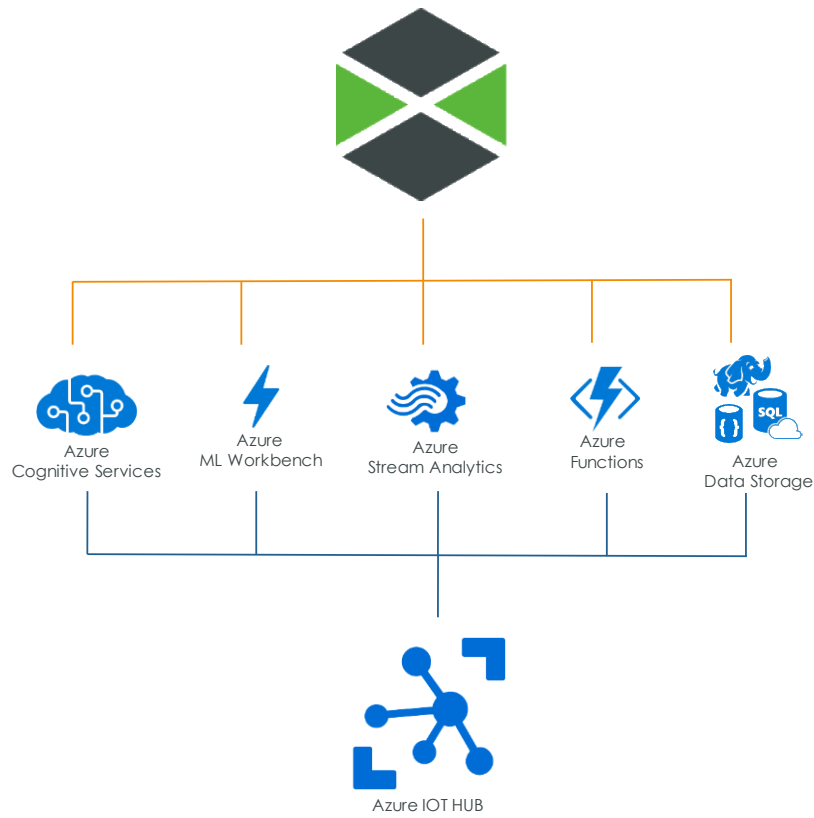
Market Ready

architecture
IoT Hub Connector 2.0
Support telemetry and events, device twin

offering
ThingWorx on Azure
Deployment of ThingWorx solutions on Azure cloud with **Azure PostgreSQL**

architecture
Kepware → IoT Hub
Kepware industrial connectivity connected to IoT Hub

offering
Vuforia Studio for Hololens
Advanced mixed-reality for enterprise users

interop
Azure AI / PaaS Recipes
API – API integration with Azure serverless compute features e.g. Functions and ASA

Near Term

architecture
IoT Hub Connector 3.0
Advanced content management and remote access through IoT Hub, jobs

interop
IoT Edge Integration
SCM, RAC, and Kepware as Edge Container Modules

interop
AzureSQL Integration
Metadata and configuration data in AzureSQL

interop
Time Series Insights
Access TSI data from ThingWorx and inclusion of TSI widgets in solution UIs

offering
Windchill on Azure
PLM solution to support deployment on Azure Azure with **AzureSQL**

Future

architecture
Azure-as-Core
Optimize ThingWorx on core Azure PaaS services: Event Grid, AKS, etc.

architecture
Native Serverless
Automatically configure Functions, ASA jobs, and utilization of cognitive services through ThingWorx applications

opening the market
Plug and Play
Metadata and configuration data in AzureSQL

opening the market
Digital Twin
feed the Digital Twin with the relevant product data and use the DT to power complete solutions for product manufacturers

opening the market
AI for PLM
Decorating product design data with semantic links and knowledge graph for intelligent recommendations and insights

opening the market
Optimized MR Rendering
Utilizing GPU streaming and Spatial Graph to deliver rich CAD models in the context of MR experiences

opening the market
MR + AI / Cognitive
Weaving AI into the MR experience for enterprise use cases. LNP, Knowledge,

opening the market
CAD rendering Cloud
Utilizing the elastic compute of the cloud to drive advanced rendering, FAE and simulation

opening the market
CDM for Manufacturers
Collaborate on a CDM for manufacturing data and content to semantically link to relevant IoT and enterprise data, through ODI

opening the market
Blockchain for Mfg.
Tracking lifecycle events across a distributed value chain

Azure
Cognitive Services

Azure
ML Workbench

Azure
Stream Analytics

Azure
Functions

Azure
Data Storage

Azure IOT HUB

THINGWORX 8.4

Target general availability: Q1 2019

Primary investments:

1. Developer Enablement
    *   Mashup Builder Phase 1 enhancements

2. Open Platform
    *   Microsoft Azure SQL support

3. Scalability
    *   High-scale query microservice

4. Orchestration
    *   Initial release

5. Device Management
    *   Remote Access: additional tunneling support

6. Axeda
    *   eMessage and IDM connector updates

7. Analytics
    *   Statistical process control

8. On-going investment
    *   Security
    *   Install
    *   Documentation

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THINGWORX "J" PLATFORM INVESTMENT THEMES

Target GA: TBD

➔ Continue **security** investment

➔ Continue **Mashup Builder** improvements to address product shortcomings and improve the developer experience

➔ Deliver **Microsoft** partnership co-sell enablers: Azure SQL, CosmosDB, Azure IoT Edge, Azure IoT Hub

➔ Deliver platform capabilities for **enterprise deployment** for efficient multi-site factory implementations

➔ Continue investment in **high-availability and high-scale** capabilities to meet increasing market requirements for large-enterprise implementations

➔ Deliver **remote access** and **software content management** enhancements to support Axeda customer transition to ThingWorx

➔ Deliver **install** improvements with common installer and user friendly front-end

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Orchestration

- **Connect and integrate systems to extract value from enterprise data for IoT use cases**
- **Enable broad set of skill levels to quickly build, modify and repurpose interactions with systems & system data to create orchestrated data flows in visual, no-code environment**

Low fuel

salesforce

Schedule refuel service

Deliver service notification by email

Alert

Identify asset info

thingworx

End

Connected devices
(electric generators)

High Engine Temperature

salesforce

Create urgent service order

Notify operator to shut down generator