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re:Invent
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ROB202

How Lockheed Martin uses AWS and Boston Dynamics to deliver tools

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Agenda

Introductions

Working Backwards

Advanced manufacturing technology

- Initial landscape
- Objectives

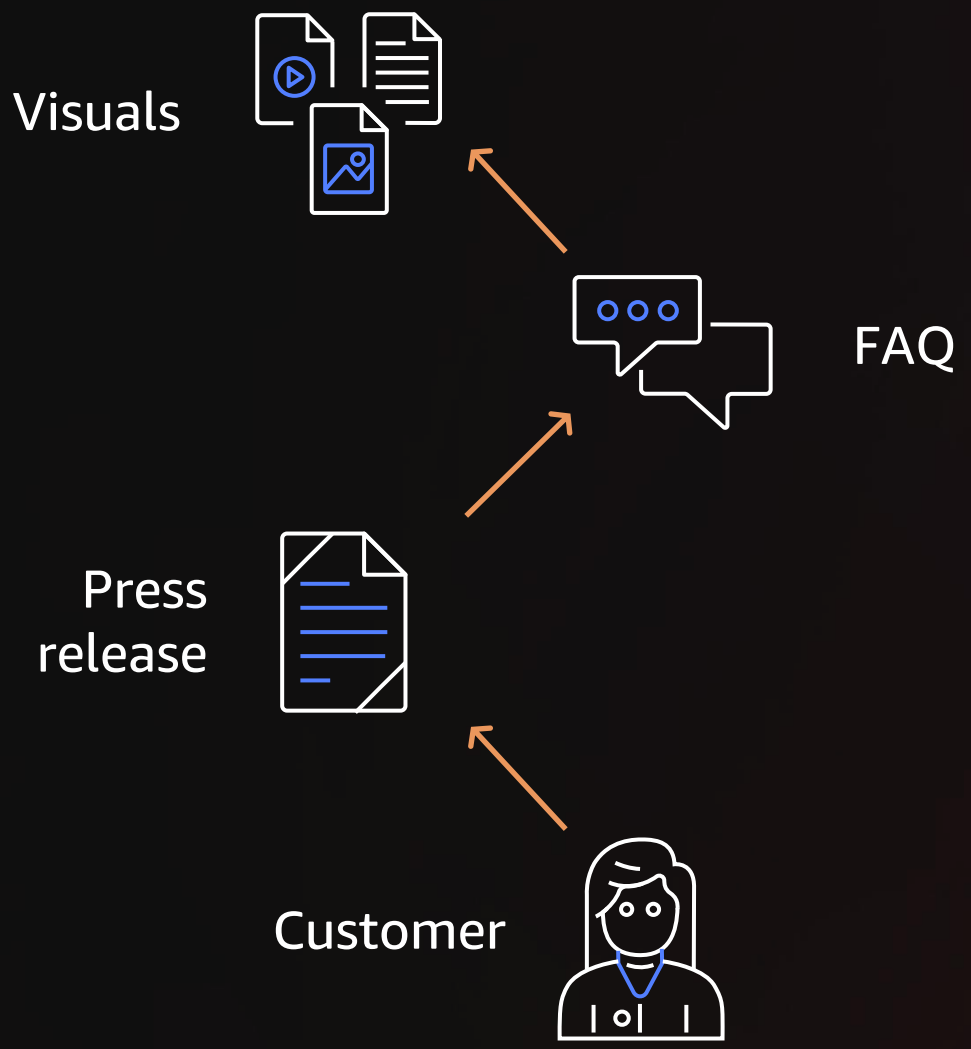
Digital shop floor

Solution architecture

Partners

Demo

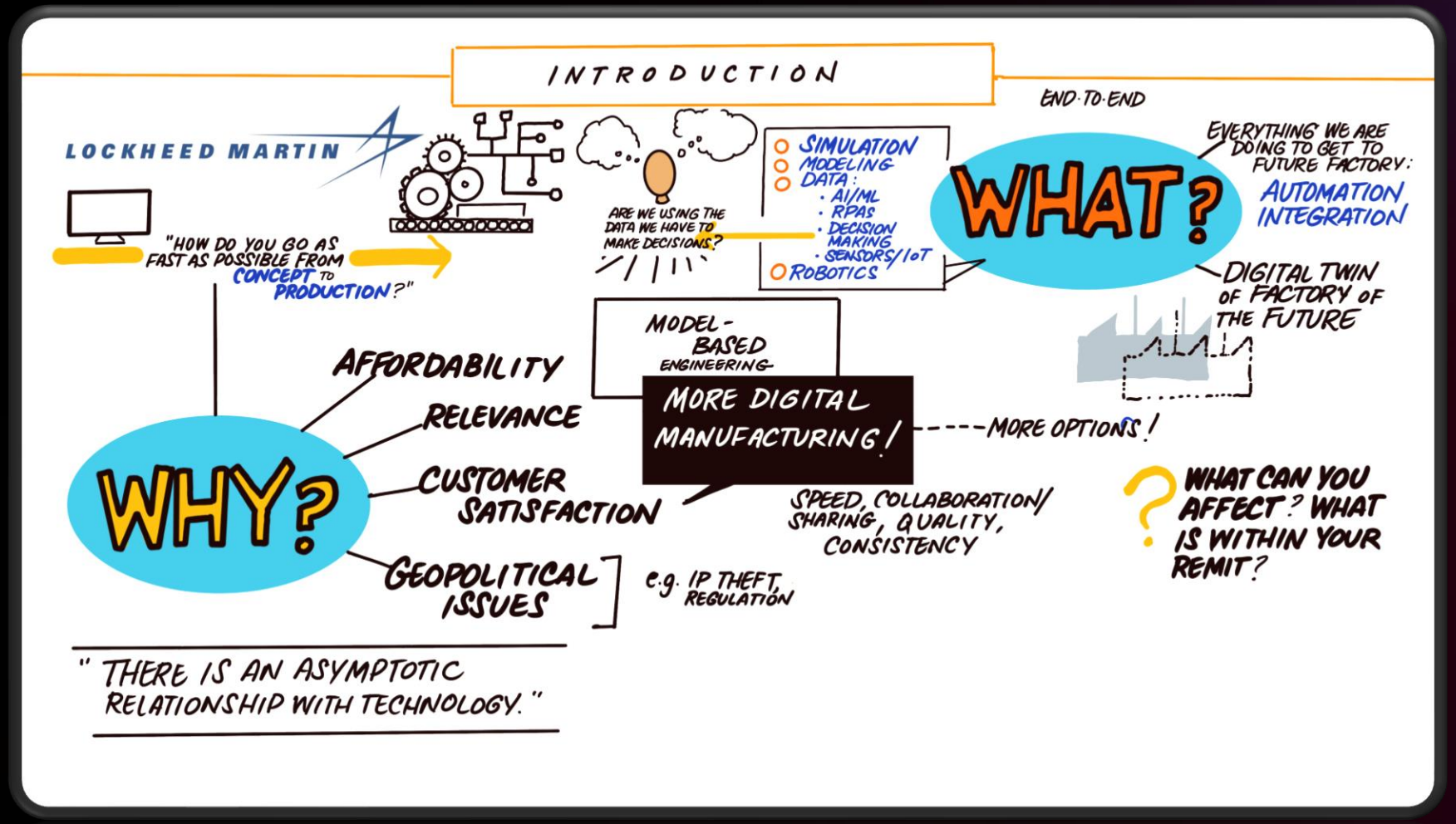
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Working Backwards is a process

We use it to get clarity, not to document what we have already decided to do

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Working Backwards

- Discovery process to determine the **why** and the **what**
- Deemphasizing the **how**

Real-time customer input

- Virtual workshop to capture customer stream of consciousness … in real time

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Current state?

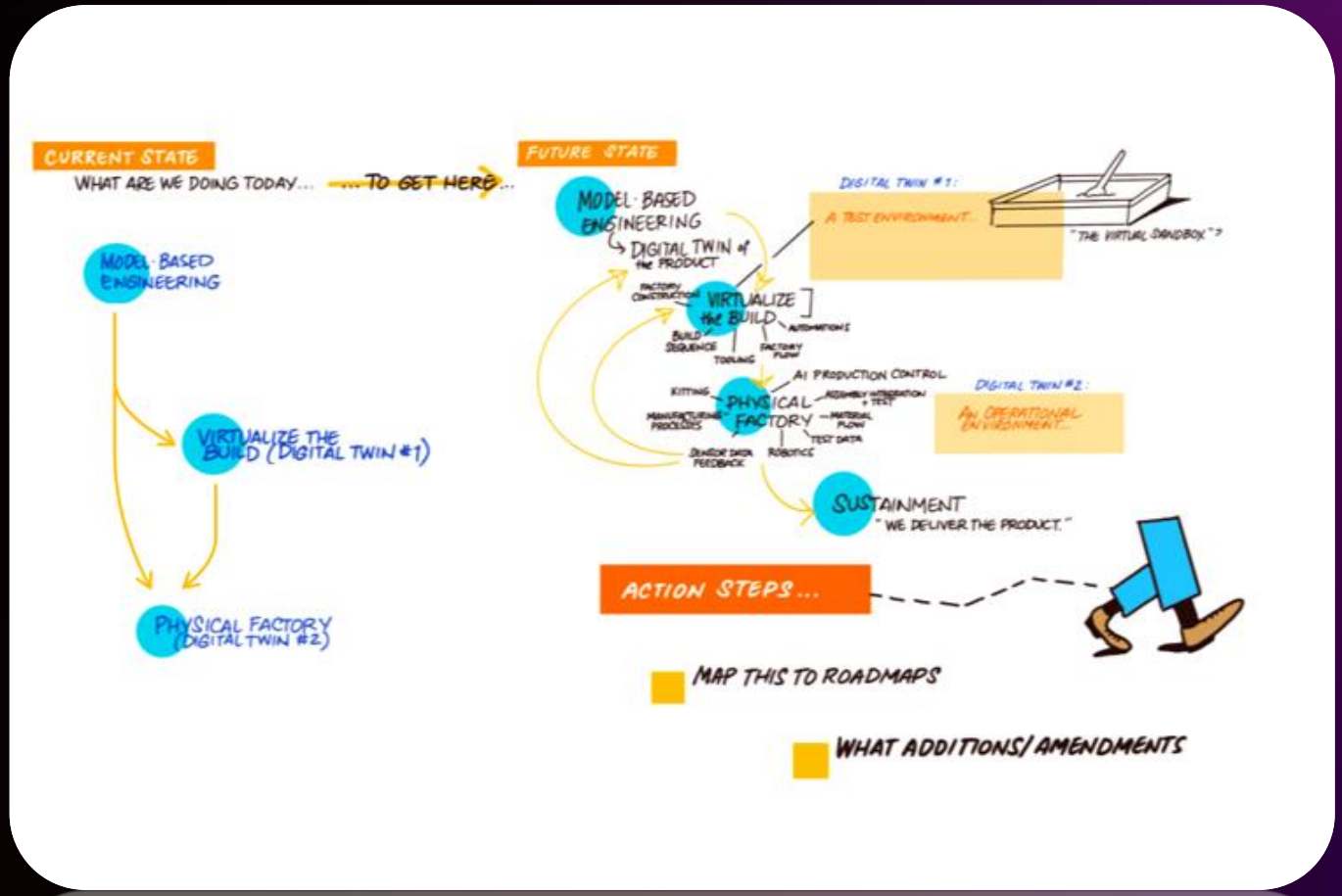
- We created a baseline from which we can move forward

Future state?

- We created a set of high-level goals

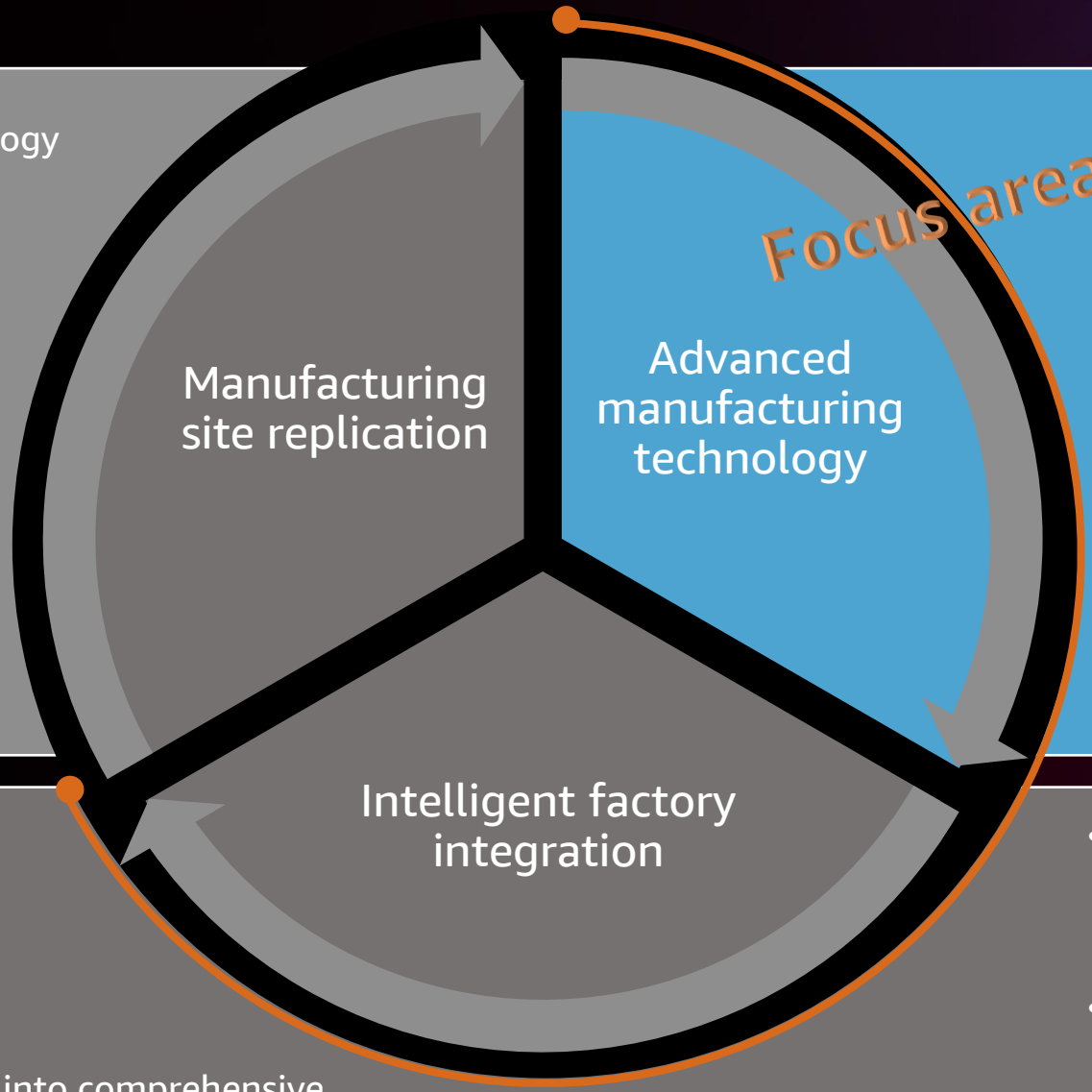
Action steps?

- Using the Think Big, Start Small axiom, we created the short-term next steps for action



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- **Identify** future site/LOB technology capability gaps
- Implement and **replicate** demonstrated solutions



- **Research** new manufacturing capabilities:
  - Robotics and automation
  - Materials and additive manufacturing
  - Manufacturing processes
  - Modeling and simulation
- **Demonstrate** new solutions and adapt emerging industry technologies
- Retain critical **SME skills** in core and emerging tech

- Drive **implementation** of future factory infrastructure
  - IFF infrastructure
  - Next gen WI
  - IIOT devices
- **Combine** DX and AMT capabilities into comprehensive future factory insertion strategy

- **Coordinate** technology implementation plans with manufacturing sites
- **Execute** intelligent factory environment roadmap

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Advanced manufacturing tech: Initial landscape

Across the 3 areas examined: 1 Shipping & receiving 2 MFG line 3 Machine shop

13 functional personas



15+ process workflows

- Sequential operations
- Welding operations
- Assembly operations
- Parallel operations
- Drill tap operations
- Quality inspection
- Shipping and receiving
- Material inspection
- Warehouse management
- Inter-building material movement
- Intra-building material movement
- Machine maintenance
- Machine operations
- Machine tool management
- Machine product QA

16+ software platforms

(PLM)	(S&R & QA)	(MES)
(Transport)	(Transport)	(S&R)
(Simulation)	(CAD/CAM)	(CMM/QA)
(Reporting)	(Reporting)	(Reporting)
(FAI/QA)	(PO Mgmt.)	(PR Mgmt.)
(Integration)	(WH Mgmt.)	

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Personas and MLP functional digital views



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Advanced manufacturing tech: Objectives



Remove data silos and liveliness of data

Integrate true shop floor process workflows with enterprise IT systems of record (SoR) and enforce SoR data integrity as single source of truth



Fill data gaps and remove blind spots

Digitally model activities and use robotics with analytics to drive predictive insights from both machine telemetry and manual shop floor process workflows



Improve quality and overall productivity

Deploy task-optimized shop floor apps simplifying workflows while removing sub-optimal error-prone multi-system use and workarounds

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The prioritization phase identified 4 transformation initiatives

Our understanding of MFC manufacturing strategic objectives

- Remove data silos and liveliness of data
- Fill data gaps and remove blind spots
- Improve quality and overall productivity

Initial transformation initiatives identified during prioritization

Priority 1

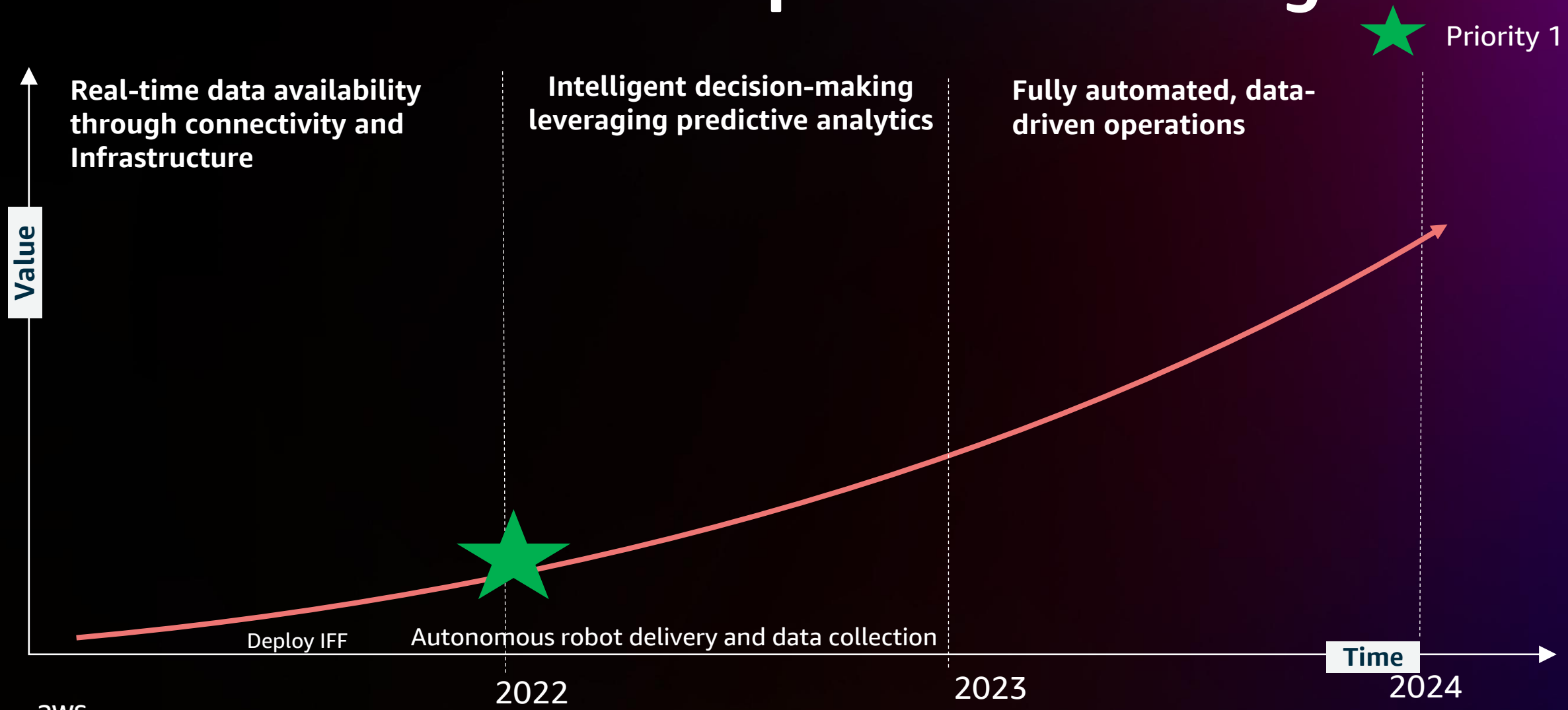
- CNC machine optimization

Future

- Paperless shipping and receiving process
- Robotic factory floor data collection
- Value realization framework

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In Priority 1, the goal is to target an initial robotics use case for operators' tooling



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CNC machine optimization



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Machine shop floor



Handheld Digital Station (existing devices)

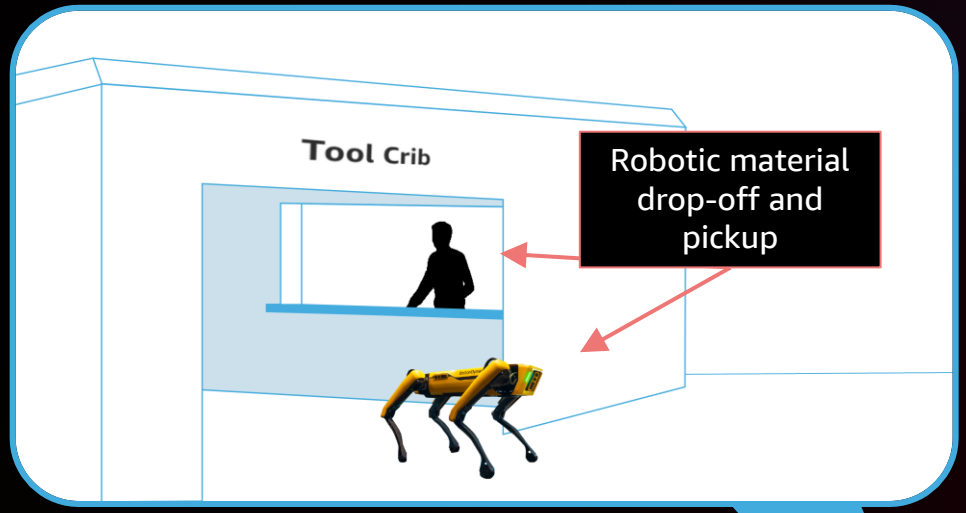
Workcenter Digital Station (existing PCs)

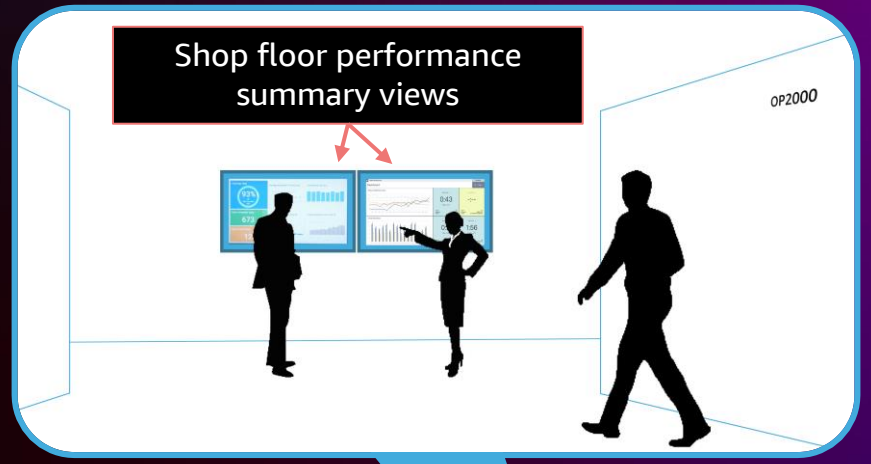
Material Drop Off (Robotic & Humans)

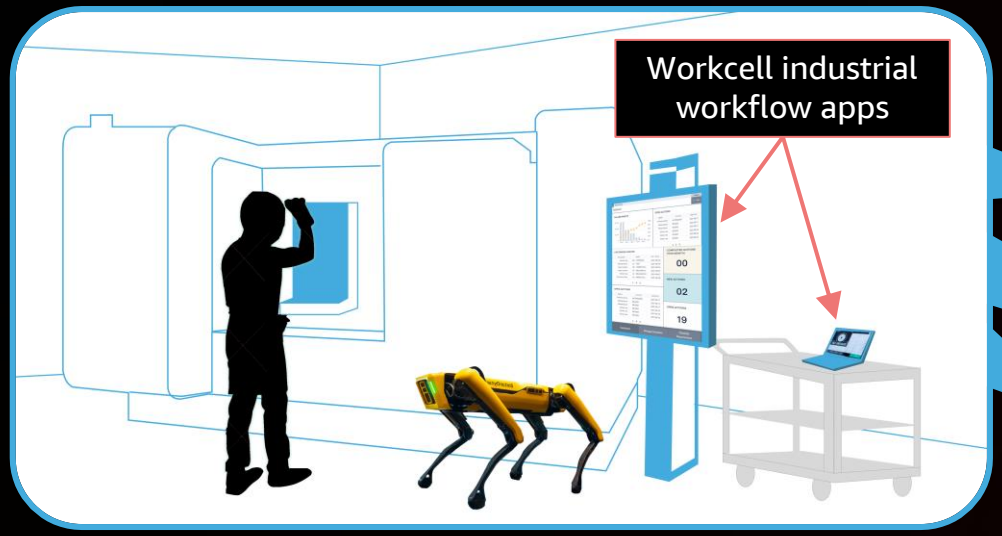
Material Pick Up (Robotic & Humans)

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Machine shop floor digital transformation









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Example digital shop floor

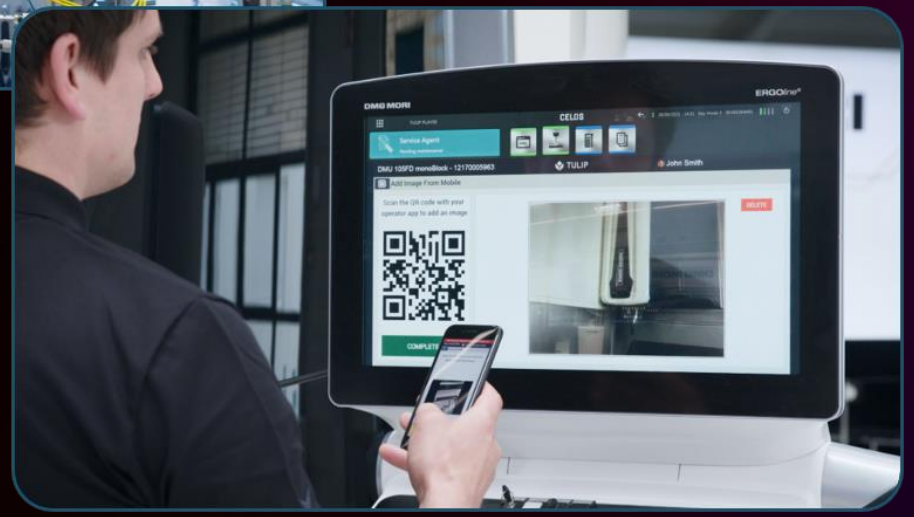
Production line



Shipping and receiving



Machine shop



Workcenter stations:

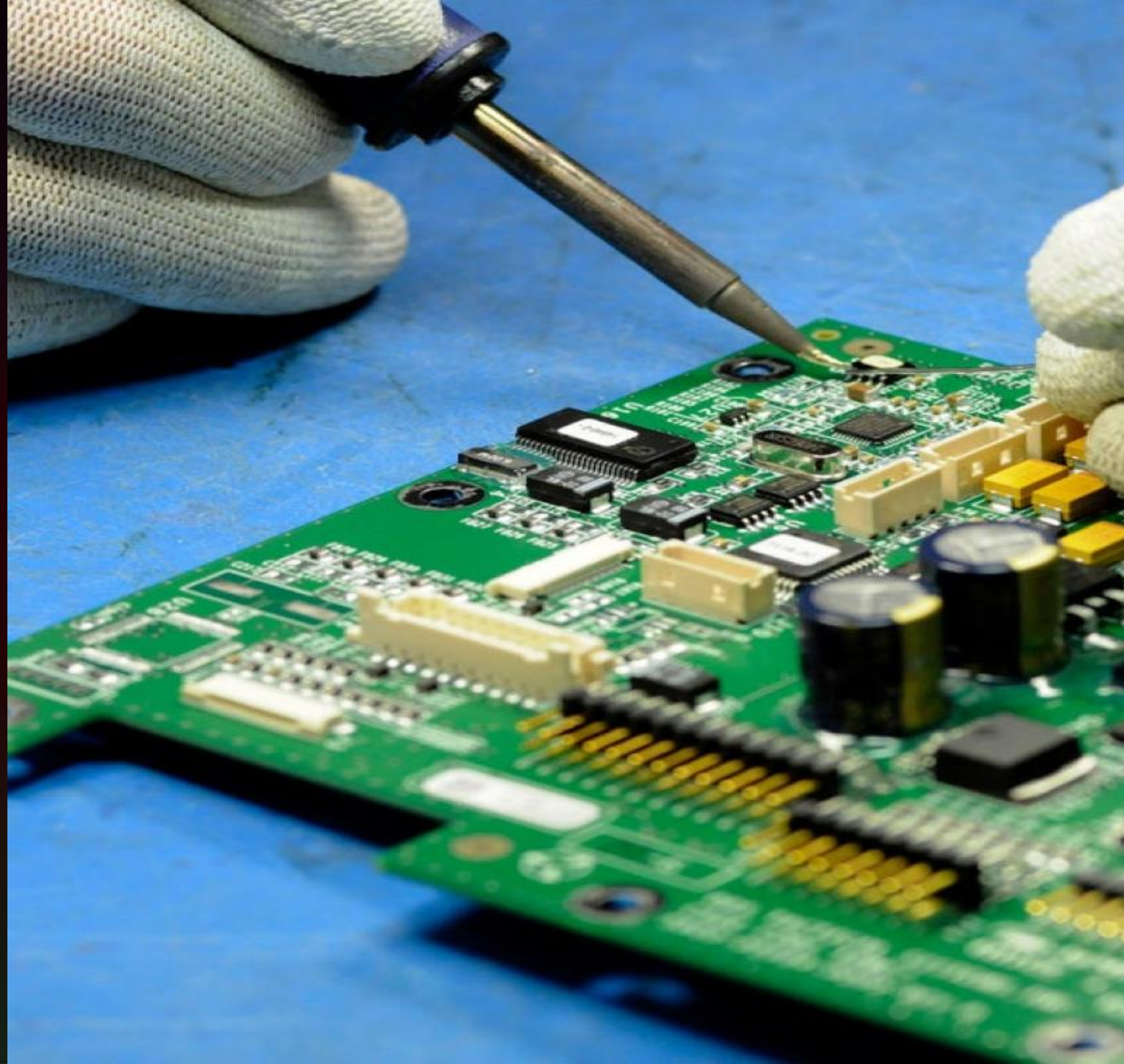
- Human digital interface
- Work check-in/out
- View workcenter status
- View work order
- View work instructions & mBoM
- Materials check-in/out
- View/set materials status
- View materials handling instructions
- Dispatch material handlers
- Andon to unblock issues

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Solution architecture



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The Intelligent Factory



- ✓ First Partner in the AWS IOT Greengrass, AWS GovCloud US Pipeline.
- ✓ Extensible design, strong security architecture, elasticity and modularity
- ✓ Successful machine connection and data collection agents in production environments
- ✓ Standardized data format that includes metadata tags, observation and semantic attributes
- ✓ First time MT Connect pipeline aligned to data model
- ✓ Data Flows to the cloud in milliseconds
- ✓ Amazon S3 batching and secure broker routing

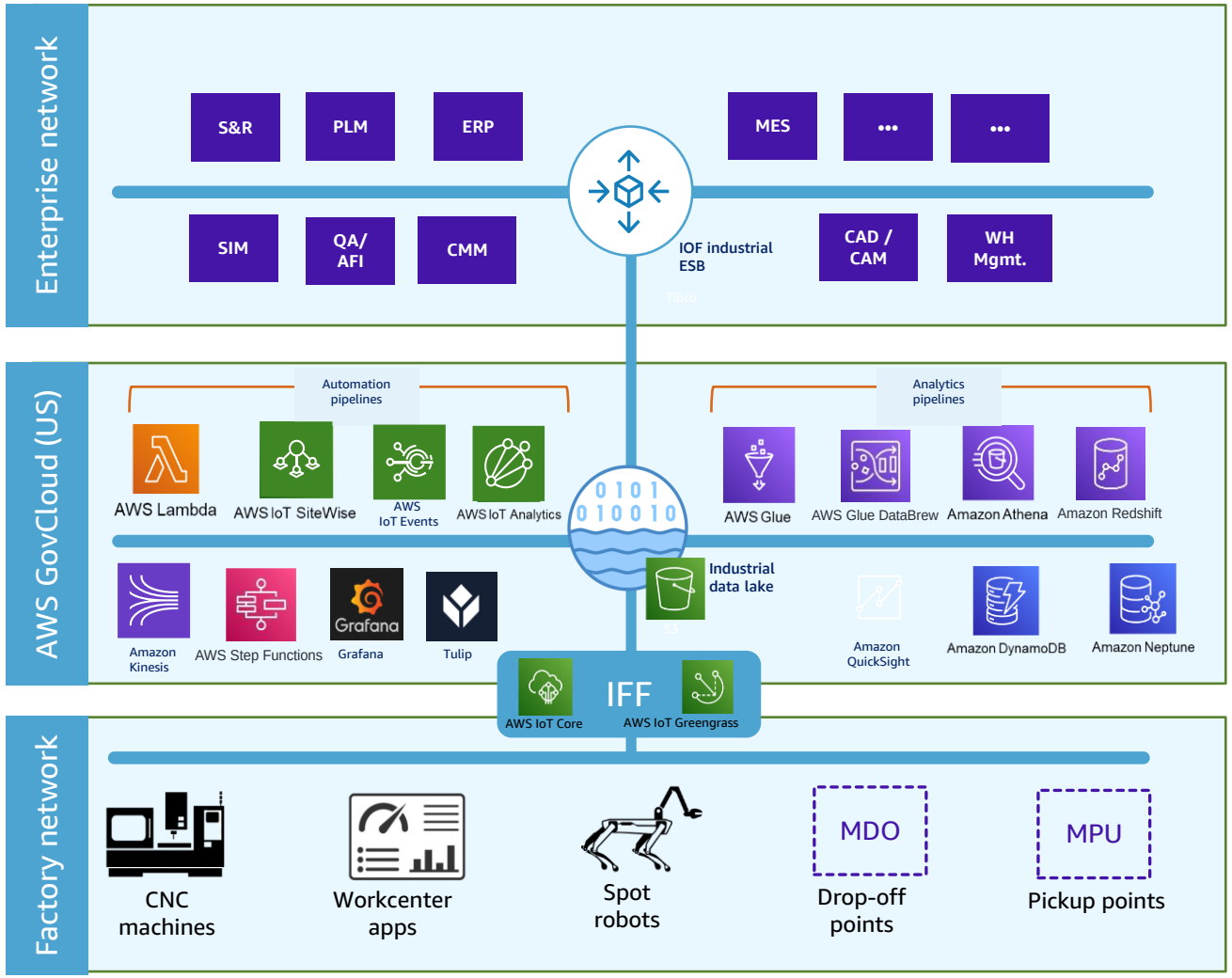
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Solution architecture (high-level)

Enterprise IT and systems of record

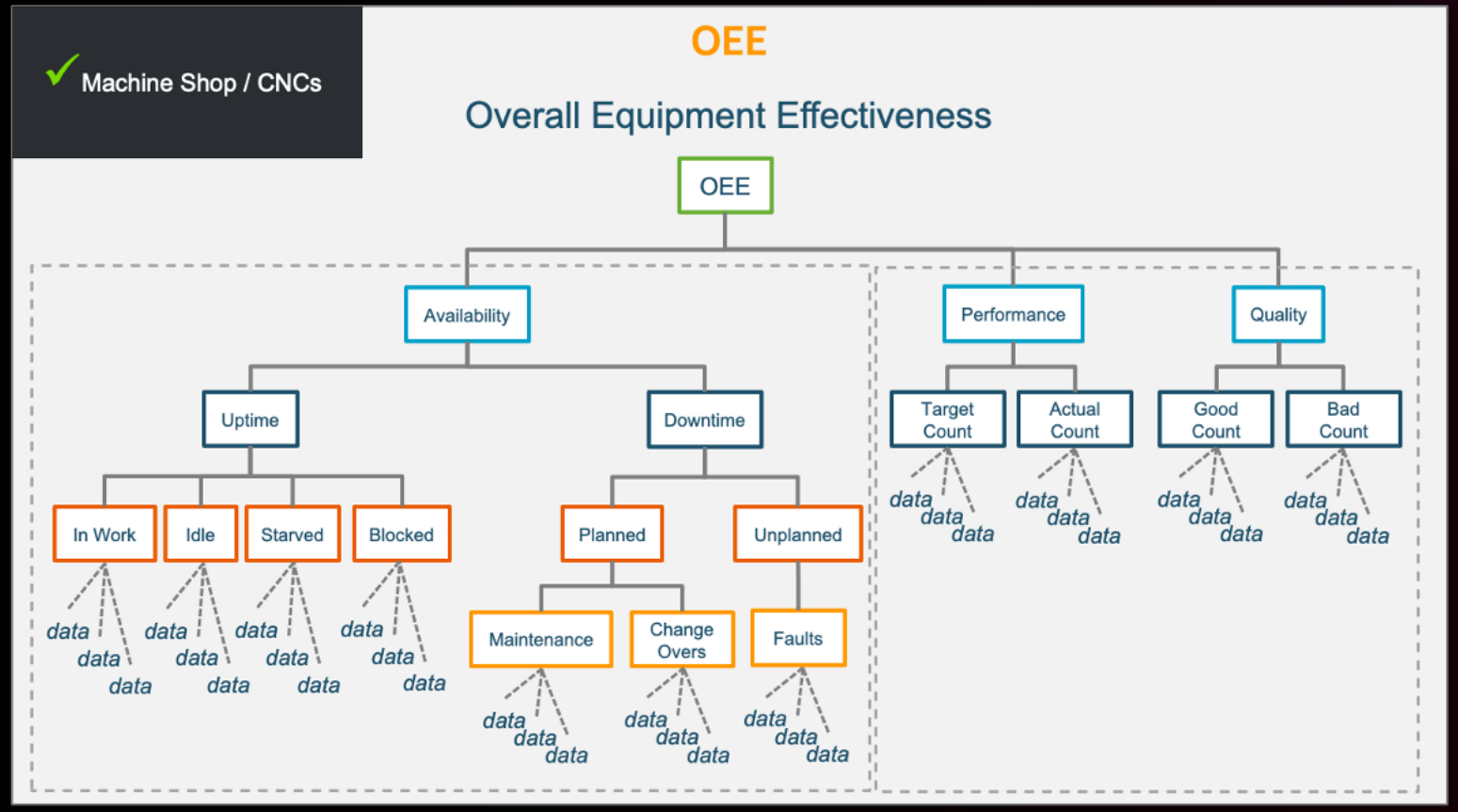
Cloud/IIoT data and analytics

Edge/shop floor



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North Star technical KPIs/OEE



What is OEE?

- Industry-standard KPI for overall semi-automated and fully automated machine operational processes
- Used to determine **asset utilization** and **optimize maintenance**
- Mature metric model proven in real-world operations at Amazon FCs

How do we make it real?

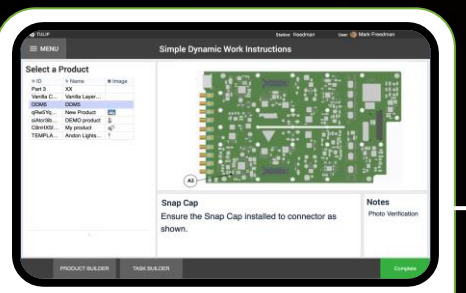
- Top-level KPI metric model and formulas provided by AWS
- Joint exercise per machine type to map low-level data sources to top-level feeder metrics
- Feed resulting KPI and feeder data metrics to functional digital views

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Build apps, or systems of apps, as comprehensive as you need them

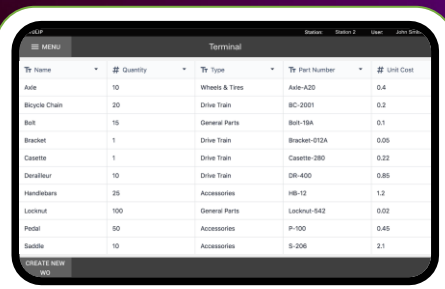


Process data and insights
Improve visibility and analysis for process optimization

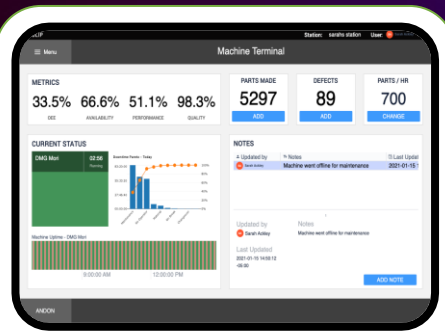


Guided workflows
Provide dynamic work instructions, connect data, show real-time info





Back-end processes
Work orders, connections to ERPs, BOMs, etc.



Real-time metrics
Collect data from machines, sensors, cameras, etc.

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AWS and Spot

Boston Dynamics



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AWS IoT Greengrass

AWS IoT Greengrass extends AWS services onto your devices, so that they can act locally on the data they generate, while still taking advantage of the cloud

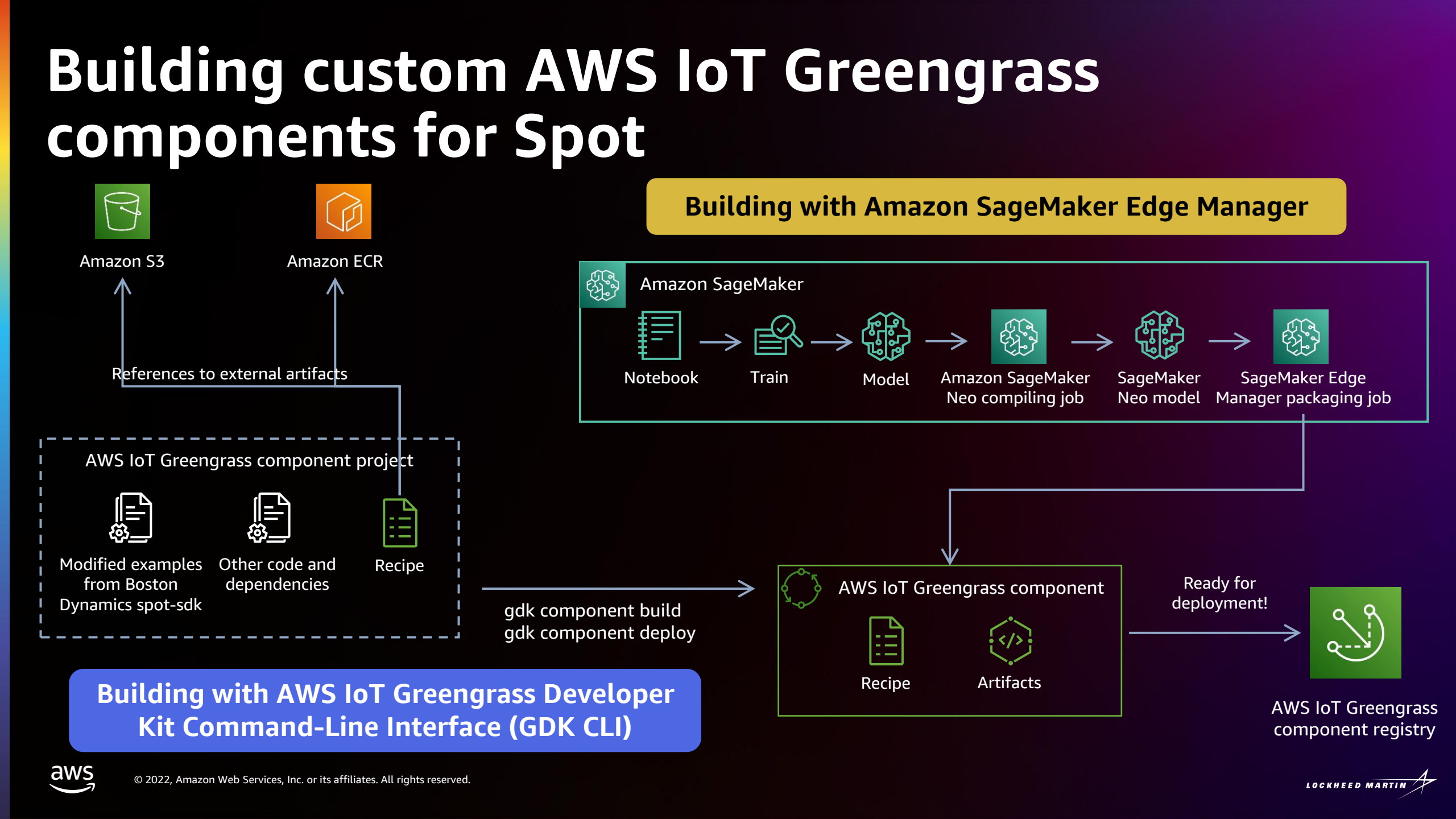




Local messaging | **Local actions** | **Container support** | **Data and state sync** | **Stream manager** | **ML inference** | **Secrets manager** | **Over-the-air updates** | **Security**

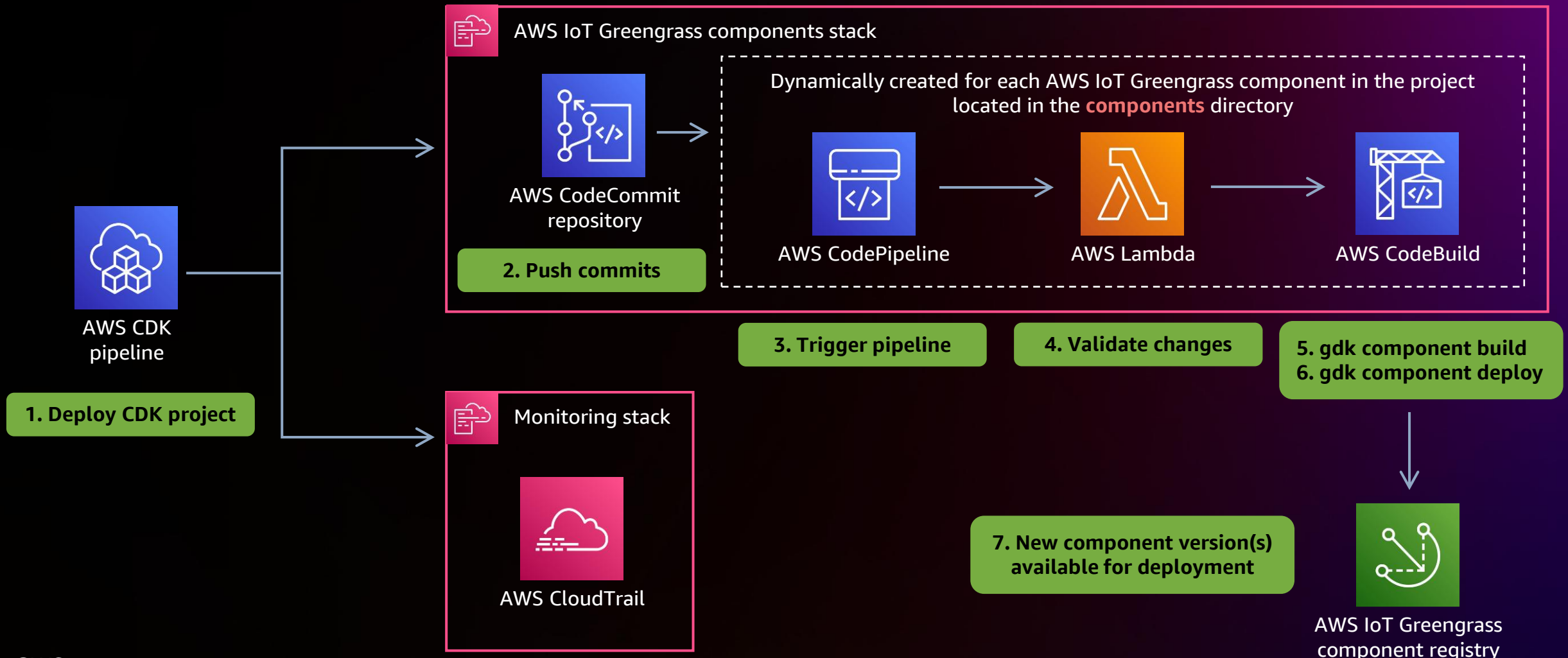
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Building custom AWS IoT Greengrass components for Spot



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Automating AWS IoT Greengrass component builds with CDK



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