AWS re:Invent

NOV. 29 – DEC. 3, 2021 | LAS VEGAS, NV

LFS306

How Baxter has innovated digital health connectivity with AWS

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AWS

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Sr. Director, Digital Products IT
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Agenda

1. Baxter overview
2. Baxter’s digital transformation
3. Design challenges
4. Solution architecture deep dive
5. Key takeaways & learnings

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Introductions



Shehryar Abbasi

Sr. DevOps Cloud Architect,
Professional Services

AWS



Mike Butler

Sr. Director, Digital Products IT

Baxter Healthcare Corporation

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Baxter overview

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90-year heritage of saving and sustaining lives



STRONG global business with great people





ONE OF THE MOST trusted brands in medical products



ADVANCING transformative healthcare innovation

Working to bring smarter, more personalized care to the world

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"Baxter colleagues around the world are focused on our mission **to save and sustain lives.** Whether they are making life-saving products, working with healthcare providers, or bringing innovation to life, I am proud of how our team embraces our mission with passion and determination."

Joe Almeida
Baxter Chairman & CEO

#Our mission

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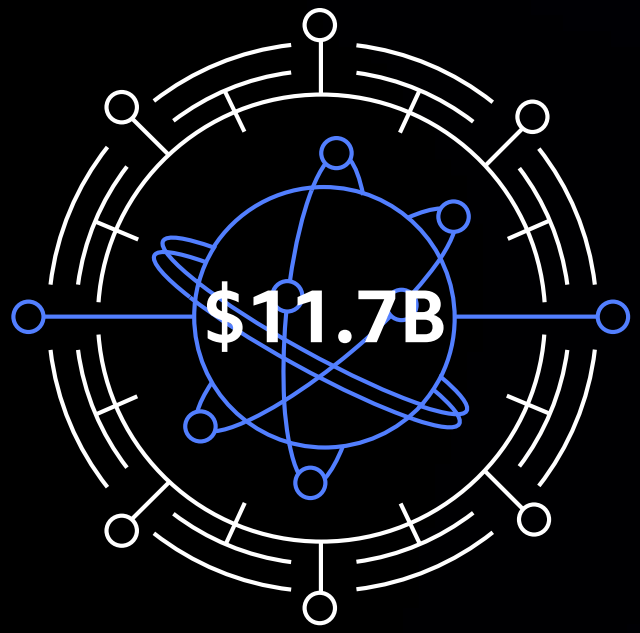
Our impact

~75M patients treated annually

Products in **100+** countries

~50,000 employees worldwide

2020 GLOBAL SALES



REVENUE BY REGION



Americas: 54%
North, Central & South America



APAC: 21%
Asia Pacific



EMEA: 25%
Europe, Middle East & Africa

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Advancing healthcare: Our businesses



Acute therapies

Innovative products and therapies that treat life-threatening conditions in the ICU



Advanced surgery

Enabling surgeons to act with precision and speed to minimize complications and increase efficiency



Biopharma solutions

Providing scientific expertise, contract manufacturing, parenteral delivery systems and customized support services



Clinical nutrition

leading nutrition solutions formulated to help patients maintain or regain their health



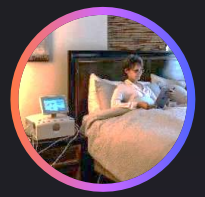
Medication delivery

Advanced infusion systems and solutions to help ensure the right treatment is delivered safely and efficiently



Pharmaceuticals

Providing generic injectables and inhaled anesthetics that are critical to patient care across the globe



Renal care

Pioneering therapy options for people with kidney disease, including peritoneal dialysis and hemodialysis

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Baxter’s digital transformation

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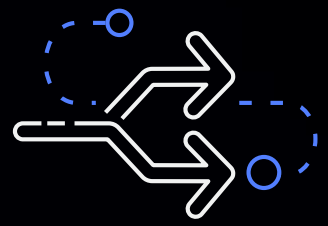
The drive for digital transformation



Drive cost savings



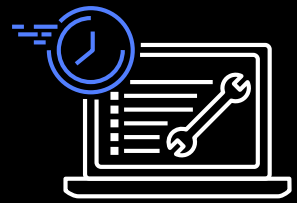
Security



Enterprise agility



Speed of innovation & time to market

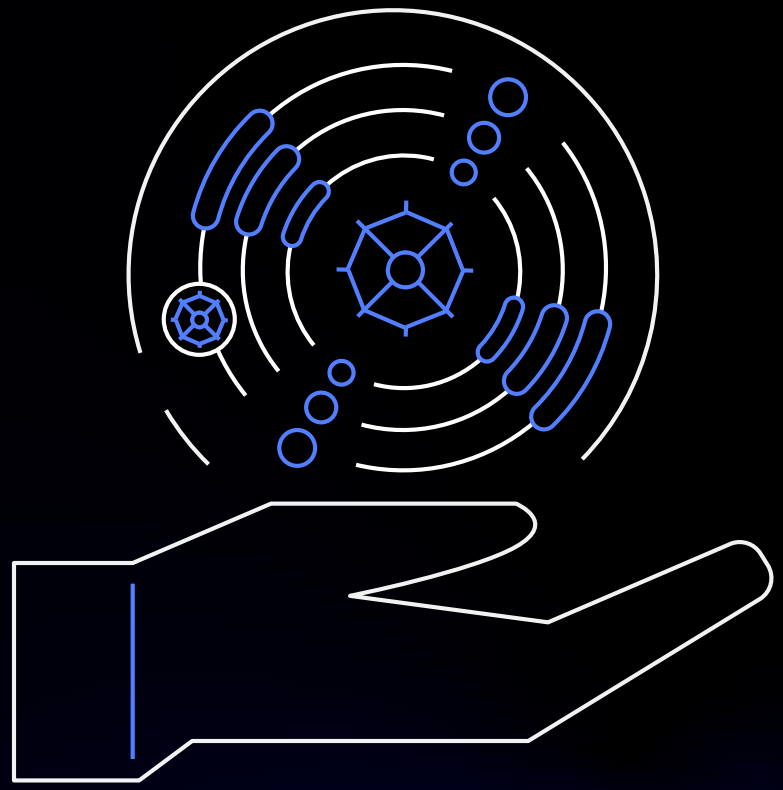


Aging legacy tech

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Our North Star for the digital transformation

"Empowering our people and our customers to reach their full potential by driving data, insights, and deep partnerships to advance our mission of saving and sustaining lives."



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The journey started with IT transformation and modernization

Digital transformation

Transform products, customer experiences, and internal operations through digital





IT transformation

Achieve scalable IT service delivery through optimizing, retraining, and strategic workforce sourcing

Force multiplier value levers

Data-driven organization

Transform how we do business through data and advanced analytics





Standardize & modernize

Standardize and upgrade technologies to streamline business operations and improve performance

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The journey evolved . . .



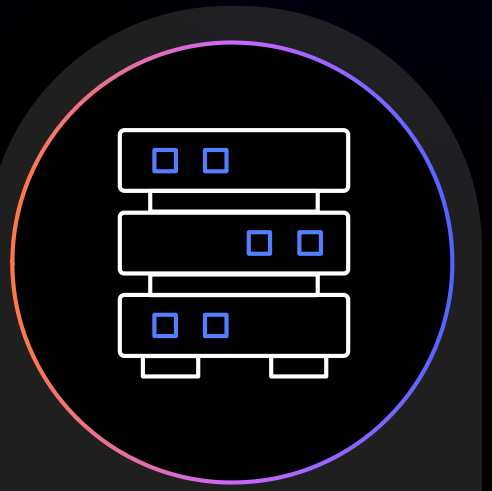
Team development

- Continue to evolve cloud culture
- Continue to support and enhance training
- Mandatory certifications for access
- Specialty certifications
- Complete transition of operations and deployment teams

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As did the mindset . . .



Data center mindset

Backup & recover to restore state	Make services stateless
Security via isolation	Security via best practices
Application + infrastructure	Code + configuration
Functional silos	Reusable scripts
Practice deployment before prod	Practice deployment everywhere
Perfect it upfront	Make it easy to refine



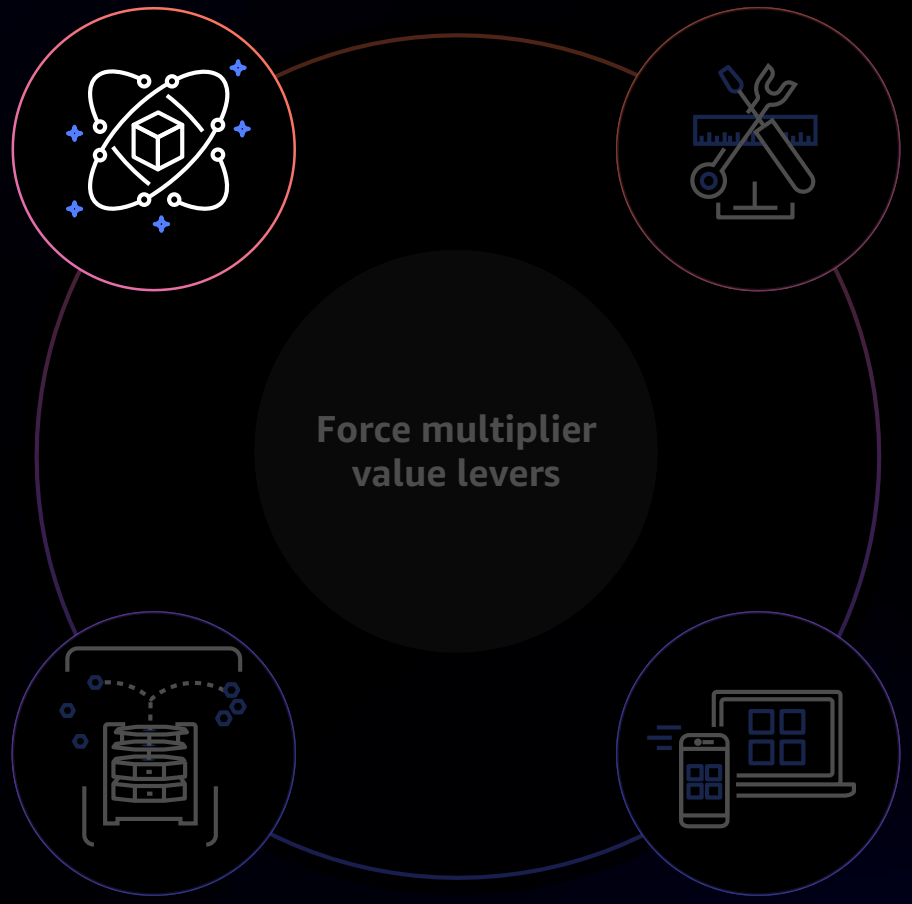
Cloud mindset

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Allowing us to focus on a broader transformation focus

Digital transformation

Transform products, customer experiences, and internal operations through digital



IT transformation

Achieve scalable IT service delivery through optimizing, retraining, and strategic workforce sourcing

Data-driven organization

Transform how we do business through data and advanced analytics

Standardize & modernize

Standardize and upgrade technologies to streamline business operations and improve performance

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Enabled by 3 pillars and our technology backbone



Digital health

Data-driven **products,** personalized care



Digital customer experience

Connected and simplified experiences



Digital core

Streamlined **processes,** trusted, understood, available, and protected **data**



Digital enablers

Backbone (including AWS technology), training, and culture

Our outcomes

- Efficient, agile processes
- High customer loyalty
- Digital revenue
- Data-driven decisions
- Employee's future fit

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Design challenges

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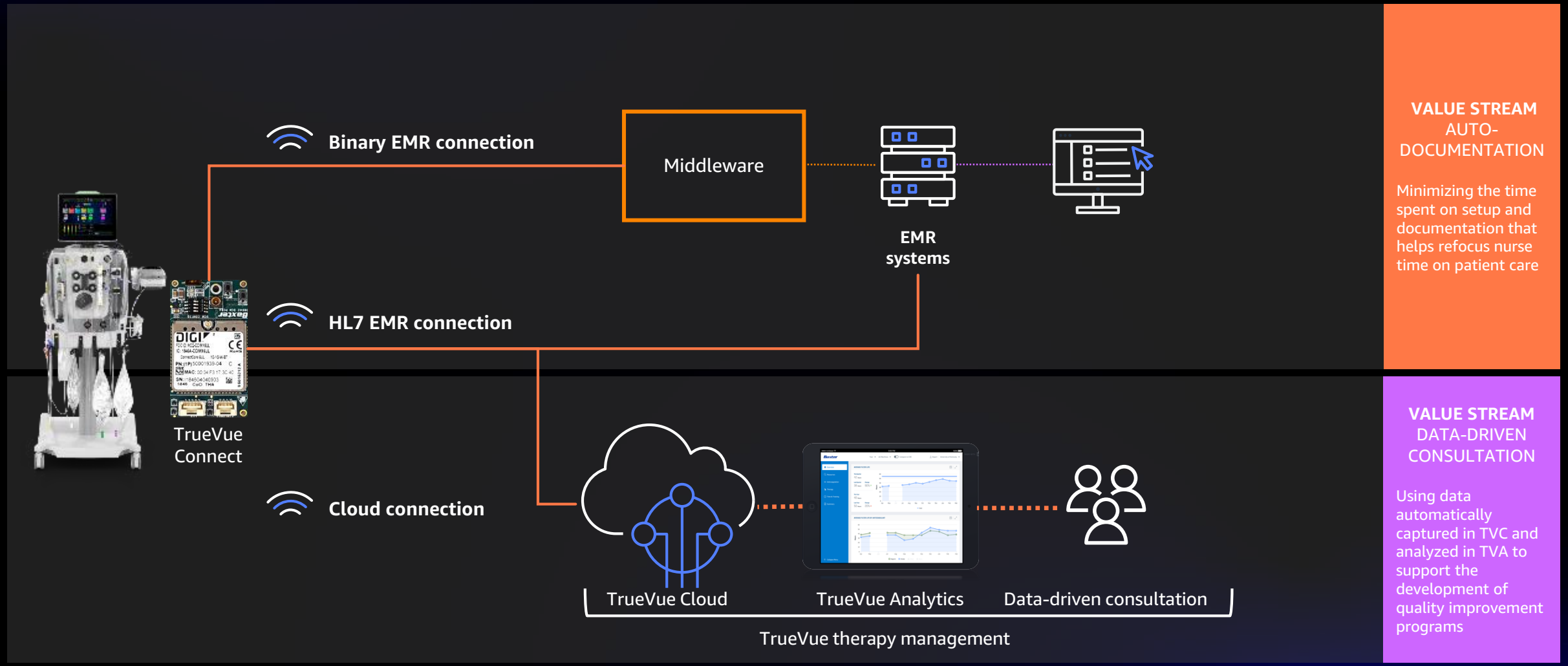
Empowering data-driven decision-making for clinicians

- Deliver a complex life-saving therapy
- Innovate within a highly regulated space
- Give customers control and gain insights from data



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TrueVue offers two value streams



VALUE STREAM
AUTO-DOCUMENTATION

Minimizing the time spent on setup and documentation that helps refocus nurse time on patient care

VALUE STREAM
DATA-DRIVEN CONSULTATION

Using data automatically captured in TVC and analyzed in TVA to support the development of quality improvement programs

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The challenge of connecting equipment and data to benefit patients and clinicians

TRUEVUE CONNECT
DATA MANAGEMENT PROCESS

TRUEVUE CONNECT
Network and configuration settings managed through TrueVue Connect portal

WIRED AND WIRELESS CONNECTIVITY OPTIONS

- Setup and installation by Baxter
- Simple configuration management by your IT team
- No additional hardware or software required onsite
- Flexible support options available

HOSPITAL EMR/PDMS CONNECTIVITY

Enterprise-grade encryption		Optional enterprise-grade encryption	Hospital-managed security	
PrisMax SW 3.1 data received by TrueVue Connect	Treatment data sent to hospital middleware or EMR/PDMS (optional buffering if no connection)	Direct ethernet connection with configurable TLS 1.2 encryption Serial connection to gateway device Wi-Fi connection with multilayer security combining optional TLS 1.2 encryption and multiple secure Wi-Fi authentication protocols	EMR/PDMS Middleware **Data sent to hospital network**	Clinician data access

PrisMax SW 3.1 data received by **TrueVue Connect**	Patient ID anonymized using secure one-way hash key (HMAC-256)	Anonymized device data sent to **TrueVue Cloud**	Direct Ethernet connection with TLS 1.2 encryption Wi-Fi connection with multilayer security combining TLS 1.2 encryption and multiple secure W-Fi authentication protocols		Anonymized data collected, analyzed, and stored in **TrueVue Cloud**	Anonymized data sent to **TrueVue Therapy Management Team**

Anonymized data routed over hospital network to **TrueVue Cloud**. Secure mutual authentication protocol help ensure only authorized devices can communicate with **TrueVue Cloud.**

TrueVue Cloud environment is secure. Anonymized therapy data is encrypted at every step of storage, transmission, and analysis. Access to cloud data is highly limited and tightly controlled

Accessibility limited to authorized Baxter representatives

End-to-end enterprise-grade encryption

TRUEVUE CLOUD AND TRUEVUE THERAPY MANAGEMENT

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Solution architecture deep dive

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Approach to creating TrueVue platform



Focus on therapy rather than infrastructure



Serverless



Platform as a service



Pay per use



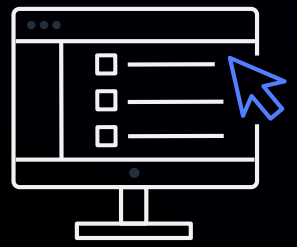
Scalable

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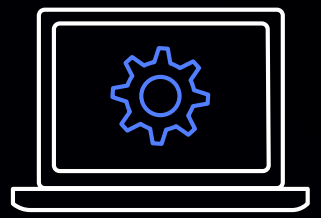
TrueVue requirements



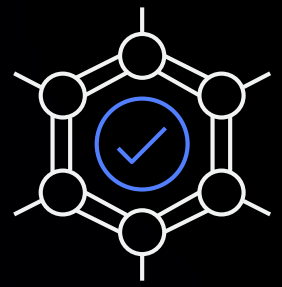
Secure device-to-cloud communication



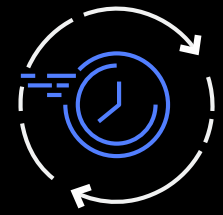
Data management and data analytics



Administration web portal



Integration with Baxter Enterprise Services



Agile development with CI/CD pipelines

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Device communication



Challenge

- No remote connectivity
- Physical access to hospital machine was needed
- Run analysis on laptop locally in the field

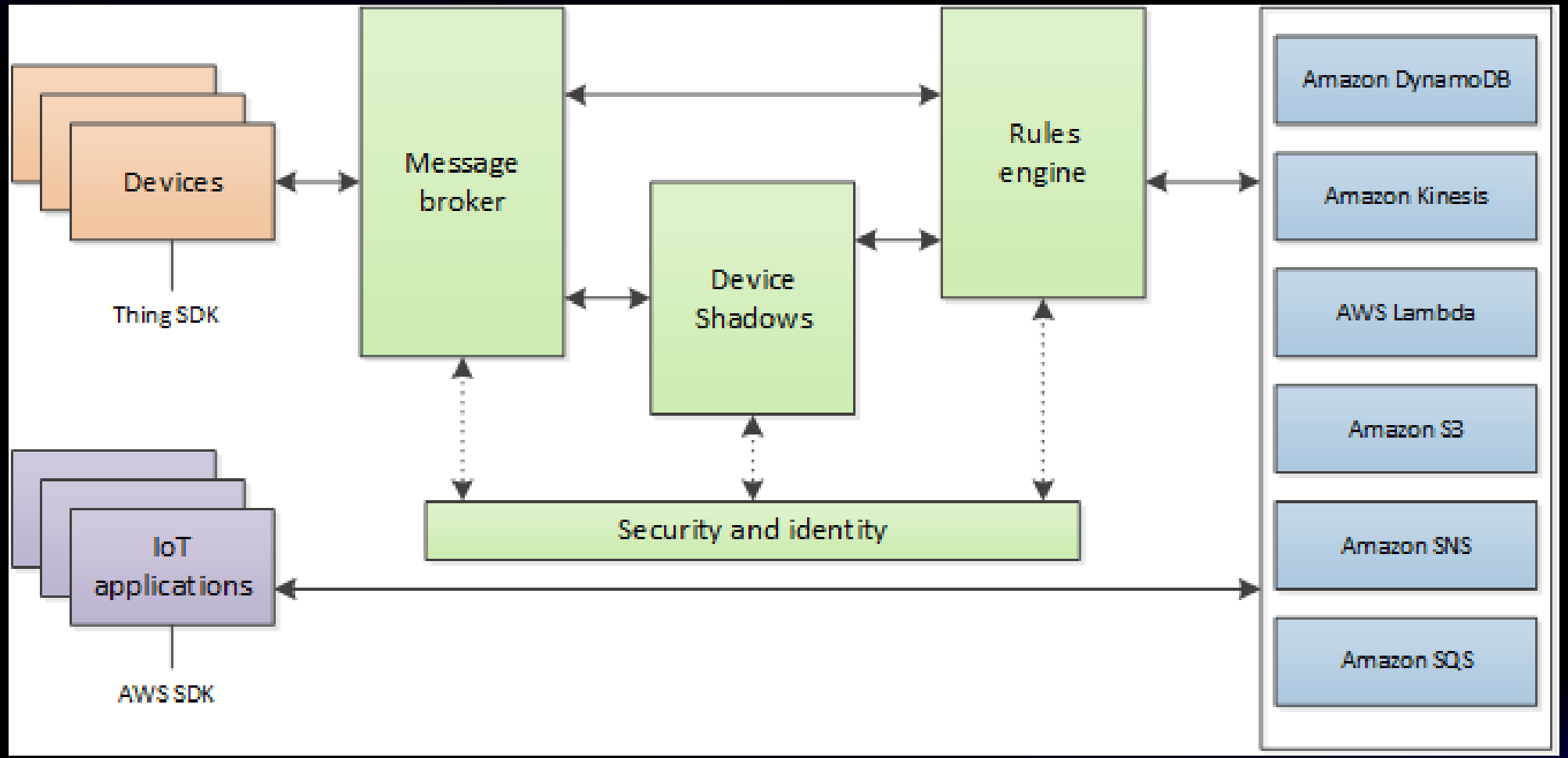
Solution

- Added remote connectivity by integrating a digital communication board
- TLS-based mutual authentication
- AWS IoT SDK C++
- Enabled connection to AWS IoT Core on AWS
- Allowed gathering of near-real-time metrics
- Enabled proactive monitoring of machines
- Physical device access was no longer necessary

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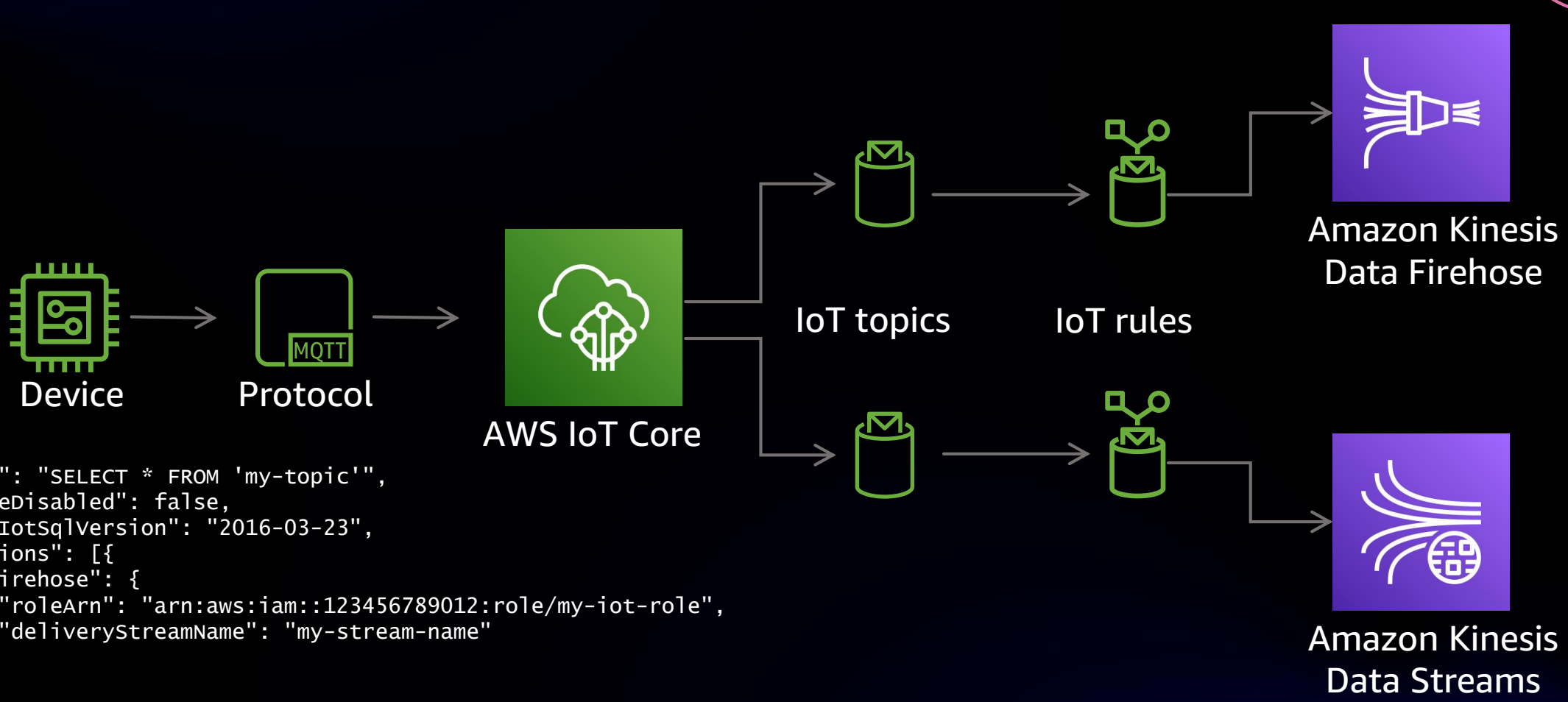
Device communication



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Device communication






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{
 "sql": "SELECT * FROM 'my-topic'",
 "ruleDisabled": false,
 "awsIotSqlVersion": "2016-03-23",
 "actions": [{
   "firehose": {
     "roleArn": "arn:aws:iam::123456789012:role/my-iot-role",
     "deliveryStreamName": "my-stream-name"
   }
 }]
}
```

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Data management and data analytics framework



Challenge

- Manual workflows for data ingestion and reporting
- Limited way to gain intelligent insights with big data analysis immediately

Solution

- Data lake strategy with Amazon S3
- Added purpose-built data stores with Amazon Redshift, Amazon RDS
- Enabled ETL workflows and data analysis with Amazon EMR
- Automation through event-driven workflows

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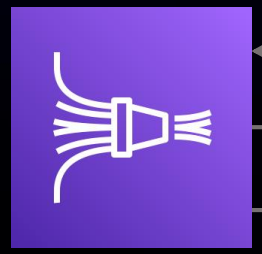
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Data management and data analytics framework





IoT rules



Kinesis Data Firehose



Lambda function for ETL



Amazon S3



Amazon Redshift





Kinesis Data Streams

splunk>



Amazon EMR



Lambda function on CRON

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Web services and administration web portal



Challenge

- Delays in updating software applications on laptops
- Difficult to manage day-to-day access

Solution

- Created reactive web and mobile applications
- Allowed iterating on UI/UX rapidly
- Added a unified Amazon API Gateway endpoint to integrate with data stores
- Secured with custom authentication and authorization logic

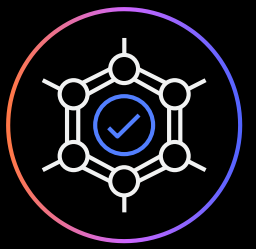
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Web services and administration web portal



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Integrate with Baxter Enterprise Services



Challenge

- The existing field-distributed laptops needed improvements on logging, monitoring, identity management
- Difficult to improve quickly and integrate centrally

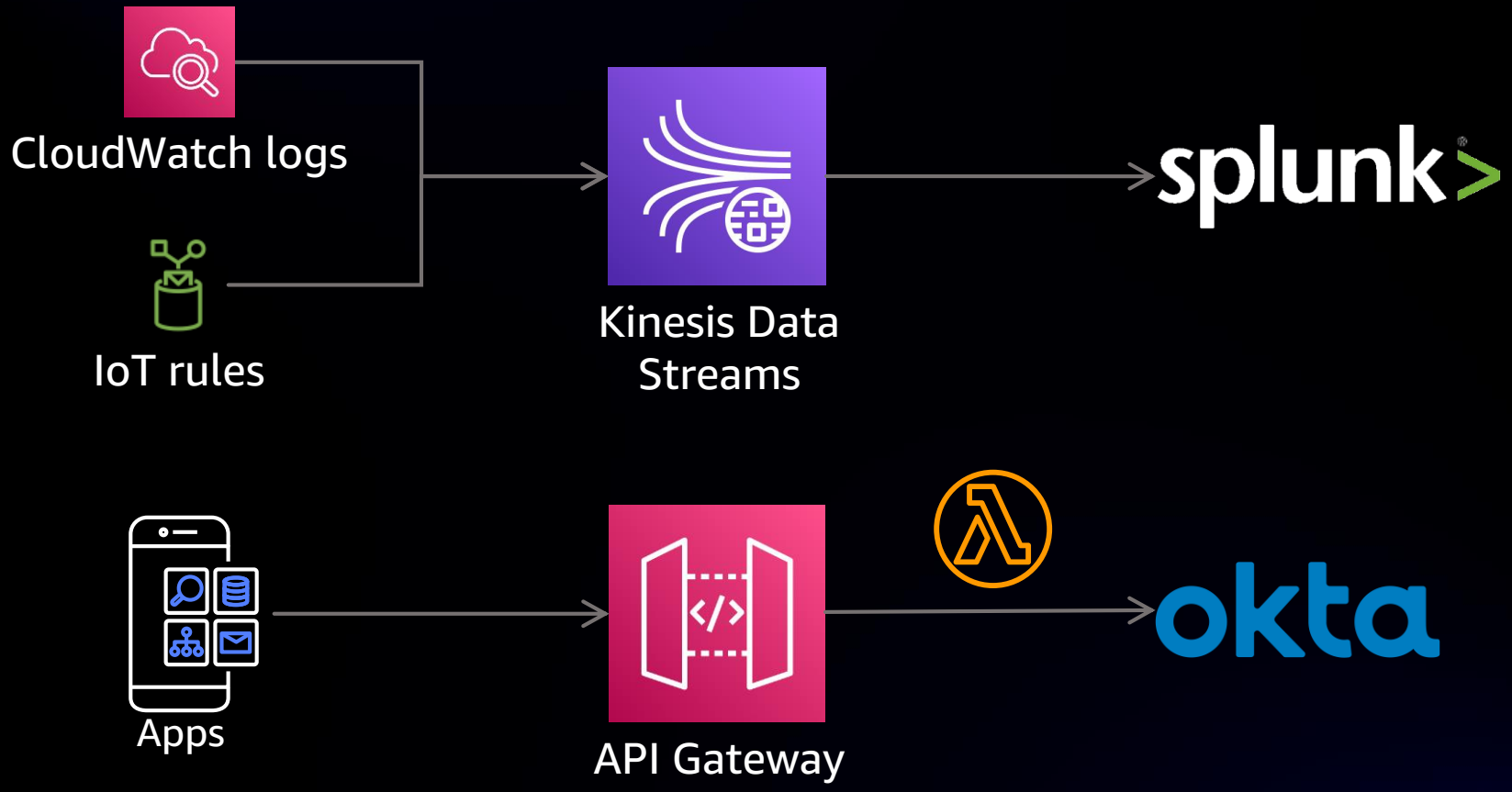
Solution

- Web and mobile applications use SSO (identity provider: Okta)
- Unified Amazon API Gateway layer with custom authorizer Lambda
- Integration with Splunk for data aggregation of logs (IoT device + AWS services)
- Note: Device data stored in the AWS data lake and AWS services logs in Amazon CloudWatch enabled taking action quickly

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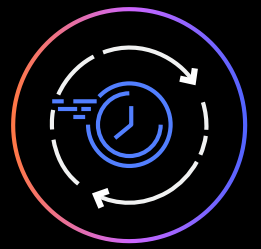
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Integrate with Baxter Enterprise Services



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CI/CD pipelines



Challenge

- Avoiding monoliths when developing and deploying both infrastructure and application code
- Difficult to deploy to multiple environments, multiple regions
- Current processes and systems required manual intervention and were difficult to repeat precisely, adding several days

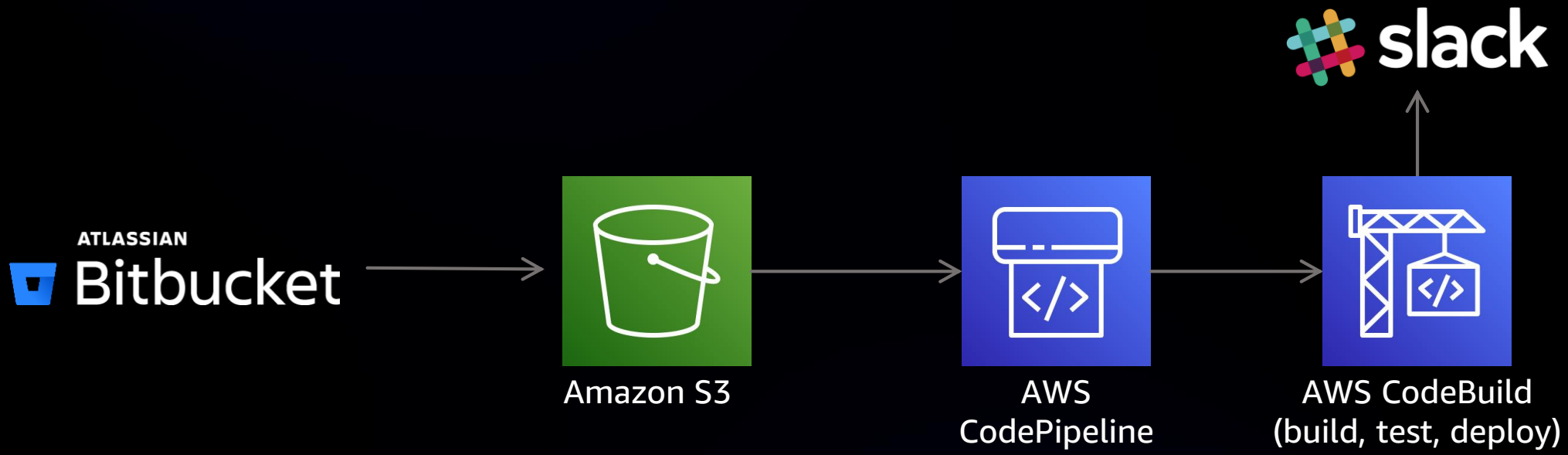
Solution

- Integrated Bitbucket with AWS CI/CD tooling
- Added agile methodologies and ownership
- Allowed for infrastructure and apps to be separately developed and deployed
- Integrated best-fit tool for the solution, AWS CDK and Boto3 for infra, AWS SAM for APIs

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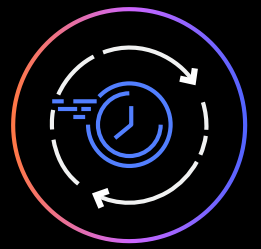
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CI/CD pipelines



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Journey to success

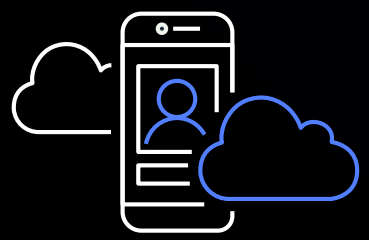


- Teamed with AWS ProServe for strategy and foundational work
- Used the AWS Well-Architected Framework's IoT Lens
- Built native, modular, managed infrastructure with near $0 for both OpEx and COTS, and >50% annual run-rate savings
- Added 78% integration testing automation
- Gained the benefit of automatic scaling for infrastructure and connected devices, including a petabyte-scale data warehouse
- Achieved global application deployment capability of less than 2 hours
- Added 250+ AWS Certifications

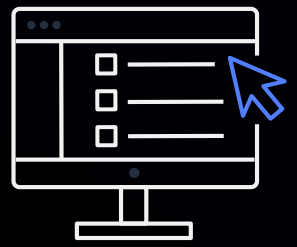
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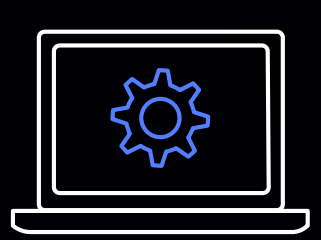
Satisfying TrueVue requirements with AWS



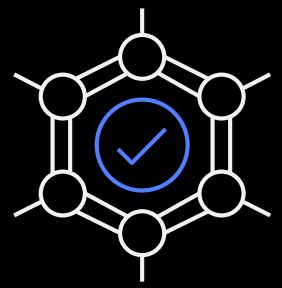
Secure device-to-cloud communication



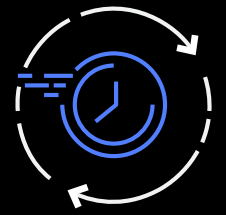
Data management and data analytics



Administration web portal



Integration with Baxter Enterprise Services



Agile development with CI/CD pipelines

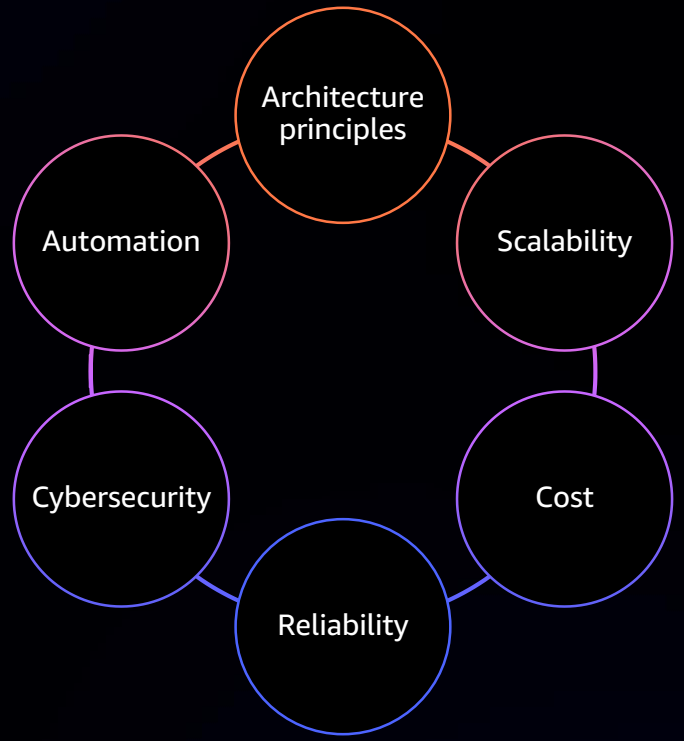
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Key takeaways & learnings

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Results

Cloud | Digital-native architecture (DNA), modular, pay per use
Data | Near-real-time streaming data



78% test automation with integration testing
~80% can be tested from HOME
Automation of cybersecurity wireless protocols

Automatic scaling for # of connected devices
Therapy/device data velocity workloads – 5 MB/hour
Data warehouse scalability at petabytes of data

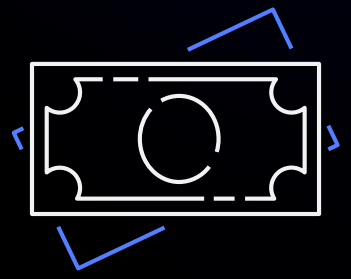
WS Enterprise security standards **| AWS**
TLS certificate **| Manufacturing**
UL 2900 certificate, secure kernel boot, TLS **| Device connections**
Data at rest, data in transit **| Data encryption**
Encryption between services **| Cloud services**

Less moving parts, less maintenance, less operational cost
$0 enterprise infrastructure cost for OS patches and upgrades
Enterprise software licence cost → $0
Application deployment time <2 hours
Data residency | Lower cost to expand to new markets with data residency needs

AWS enterprise infrastructure SLA >99.9%
End-to-end reliability with PrisMax to EMR to cloud

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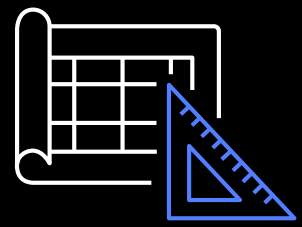
Key takeaways



Spend up-front time on your pipelines for consistency and compliance



Use the AWS services for speed



Design for change at the appropriate layer (medical device, connectivity, cloud)

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Thank you!

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