Bayer Digital Farming: Enabling Hyper-Localized Decision-Making on AWS
The Bayer Digital Farming team in the company’s Crop Science division has a mission: to empower farmers to take smarter decisions and contribute to solving the challenge of feeding a growing world population and at the same time reduce the environmental footprint.

Bayer uses data from satellites, drones and ground sensing combined with proven agronomic logics to optimize crop protection, make every drop count and offer great convenience to growers.

Learn how Bayer leverages an AWS-based, cloud-only implementation approach to allow for highly scalable data management and processing as well as to serve a growing number of customers.

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On the way to digitalization: What is the situation for farmers today?
Meet highest expectations towards food and enable more sustainable farming

- **Consumers** expect more transparent and sustainable food production

- All of us are challenged to balance societal, agricultural and environmental needs

- **Farmers** want to meet those demands without losing productivity

- In fulfilling rising requirements, documentation workload for farmers is increasing

Digital Farming Solutions strongly support farmers to meet rising requirements, improve farming efficiency and reduce documentation workload.
Demand for Digital Farming Solutions is rising and the market potential is increasing fast

Connected hardware devices in agriculture are rapidly increasing.\(^1\)

\(25\%\) of all weather-related harvest damage can be prevented with prognostic weather modelling and precision agriculture techniques.\(^3\)

Already today, most new machinery is equipped with precision agriculture features.\(^2\)

Even with crop protection products, farmers suffer yield losses of up to \(40\%\).\(^4\)

Sources: 1 Machina Research; 2 CEMA; 3 IBM Research; 4 European Crop Protection
Bayer and Digital Farming: Agronomic expertise meets digitalization
Bayer...thinking agriculture one step further

Bayer’s Know-how

Expert in crop productivity and quality.

Digital Farming Solutions connect Bayer’s expertise with the opportunities offered by digitalization.

Motivation

Make agriculture more sustainable and efficient.

Support farmers to meet increasing challenges.

Digital Farming Solutions are a key element to improve conventional agriculture

Commitment

Collaborations in the development of digital solutions to create innovative technologies together with existing experts.

Current Focus

Optimization of crop protection, make every drop count and offer great convenience to growers.
How Digital Farming Solutions Work

**Mobile Products/Sensors**
- Capture data
  - Understand what happens locally!

**Command Centre**
- Agronomic Decision Engine
  - Analyze and plan agronomy! Keep the overview!
- Recommendation - Advice

**Crop Protection + field specific timing + variable application maps**
- Do!
Bayer is starting to offer first digital solutions in various geographies.
Bayer Digital Farming Solutions – Products 2017 / 18

Digital Farming SCOUTING
The Assistant In Your Pockets
Identify weeds, pests and diseases by image recognition app

Digital Farming TIMING
Use the Optimal Application Time
Field specific timing optimization of FUN and INS

Digital Farming FIELD MANAGER
Simply Smarter Crop Protection
Field-zone specific optimization of FUN and HER usage

Digital Farming JOB STEP SOLUTION
Selling Outcomes
Decoupling CP volume from economic success

COMING SOON
Simply Smarter Crop Protection
FIELD MANAGER currently comes with 3 core features

- Spray Timer
- Zone Spray
- Autopilot Beta

Don’t miss the **right time**
Use the **right dosage**
Count on the **right strategy**
Spray Timer
Don’t miss the right time for applications

- **Automatic notifications** when the right time for fungicide applications is approaching
- **Valuable insights** in the disease risk status of each field
- **Efficient prevention** of diseases
- **Field-specific maps** that are ready to use for terminals
- **Tried-and-tested disease risk model** as a basis

8 of the **most common diseases*** in winter wheat can be avoided by using the Spray Timer.

*(Eye spot, brown rust, yellow rust, septoria tritici, leaf mould, powders mildew, drechslera leaf spot & fusarium)
Zone Spray
Use the right product dosage zone by zone

- **Field zone-specific maps** for T2 applications that are ready to use for terminals
- Maps are based on current vegetation for each zone by frequently analyzing satellite images

**5** Number of different dosing rates in which fungicides can be applied field zone specific

(One field zone = 9 m²)
Rediscover your fields with SCOUTING

SCOUTING is a mobile application that enables you to...

...do fast and convenient scouting and document your results.

...recognize and identify in-field stress by simply taking a picture with your smartphone camera.

...share your insights within the SCOUTING community to react faster on spreading pests and diseases.
Using **DIGITAL FARMING SOLUTIONS**, farmers can...

- ... use crop protection products more accurately and sustainably and thus unleash the potential of their fields.
- ... identify field-specific stresses by simply taking a picture.
- ... comply better with official regulatory requirements.
Digital Farming IT
Engineering and Operations based on AWS platform
DF embedded IT and engineering team
Langenfeld and Münster, Germany
Sao Paulo, Brazil

Responsible for:
- Requirements Management
- System Development
- System Operations
- Platform Operations
  ➔ for commercial products as well as internal and R&D systems

Driving new Cloud approach inside Bayer together with Corporate IT
(Business Services @ Bayer)..

Digital Farming IT Engineering
Setup

AWS

cloud only
All in AWS

24
end user & analytics solutions

36
Countries served

3
major AWS locations

~250
server

4
tiers incl dev, integration, qa and prod

~150 TB
storage, rapidly growing

end user & analytics solutions

~250
server

3
major AWS locations

~150 TB
storage, rapidly growing
Digital Farming Schematic
How it works

1. Discover
   Remote Sensing

   Field Sensors and mobile

2. Analyze
   Models

   $r = \frac{\sum_{i=1}^{N} x_i y_i - \frac{\sum_{i=1}^{N} x_i \sum_{i=1}^{N} y_i}{N}}{\sqrt{\left(\sum_{i=1}^{N} x_i^2 - \frac{\left(\sum_{i=1}^{N} x_i\right)^2}{N}\right) \left(\sum_{i=1}^{N} y_i^2 - \frac{\left(\sum_{i=1}^{N} y_i\right)^2}{N}\right)}}$

3. Act
Digital Farming (Big) Data Technology
From Geospatial and Temporal Datasets to Insights

Data Gathering (federated)
- Pre-processing
- Mapping, Curation
- Data Gathering (federated)

INFORMATION
- Analytics
- Visualization

INSIGHTS

Satellite images
- Weather images + data
- Drone images
- Machinery data
- Sensor data
- Elevation data
- Run off data
- Soil data
- Yield data

RAW DATA
- Structured data
- Real-time data

IMAGE DATA
- Pre-processing
- Annotation
- Mapping, Curation
- Data Gathering (federated)

5cm ... global, hours ... 30 years

Amazon S3
Amazon RDS
PostgreSQL + PostGIS
iRODS
R
RStudio Shiny
Amazon EMR
**Digital Farming IT Approach**

**Design Paradigms**

- Flexible, highly scalable and secure infrastructure for global and regional setup
- Serving customer facing and internally used systems
- Compute where data is located
- Agile and user centric development
- Rely on open standards, use Bayer shared services where appropriate
- Data protection / privacy aware

**Decision Drivers to select AWS**

- High scalable data management and processing for exponential growing number of external customers
- Production ready services and infrastructure, speed to market
- Mature DevOps support for agile scrum based software development and delivery
- Access to high volume open data sets (e.g. satellite imagery from NASA and ESA) and crowd sourced data with compute power where the data is located
Digital Farming on AWS
Cloud-only approach

From embedded IT to corporate IT responsibility

AWS Services used:
- EC2 / Systems Mgr
- S3
- RDS (Postgres/Postgis)
- DynamoDB, EMR
- VPC
- Route53 / ELB
- CloudWatch
- CloudFormation
- CloudFront
- CertificateManager
- IAM
- SQS
- SNS
Digital Farming and AWS
Lessons learnt and next steps

Lessons learnt

• AWS offers stability, reliability and scalability to offer solutions to our customers
  ➔ Scaling on demand?
  ➔ Quota exist, locations like Frankfurt do not offer all services (e.g. Database Aurora, EFS)
• AWS services have their price
  ➔ realize savings through optimizing payment options (pre-paid)
• From IaaS and Open Source Frameworks to AWS PaaS services (e.g. AI)
  ➔ requires a new way of system design and architecture to fully leverage the server-less paradigm
• AWS Cloud Platform becomes complete toolbox
  ➔ high agility and speed to market, crucial in new digital business models
• Data Privacy requirements demand data hosting in several defined global locations
  ➔ well supported by AWS regions

Next steps

- ECS based Docker container and auto scaling
  - EFS, Aurora for Postgres / Postgis
- Lambda, API Gateway serverless architectures
- Check AI: Machine Learning and Rekognition

Based on own scientific and software development competence in key areas on top of AWS services we can generate competitive advantage for society and shareholders.
http://www.digitalfarming.bayer.com
Thank you