ACCELERATING BIG DATA AND IOT FOR FARM SOLUTIONS

July 29, 2015
ACCELERATING
MARKETS AND ACCELERATED ADOPTION

**Grow**
- DSS
- Healthcare
- Workforce Automation
- Public Sector
- Gaming
- Retail Market

**Innovate**
- E2E Video
- Remote Health
- 3D Scan
- 3D Print

**Incubate**
- Agriculture
- Drones
- Wearables

Scan through Ecosystem across All Segments
LAW EVOLUTION

Network Value

Metcalf’s Law
Value = N^2

Productivity

Power of 1% Efficiency

Downtime

Moore’s Law

Intelligence Everywhere

CISCO

GE

Motorola
CONNECTED THINGS DRIVE MASSIVE GROWTH INFRASTRUCTURE, ECOSYSTEM AND COMPUTE AT EVERY NODE

- Volume
- Velocity
- Variety
- Veracity

IBM Infographic
FUNDAMENTAL TRENDS
Driving Big Data & IOT
TREND 1: CUSTOMERS BUY OUTCOMES

Agriculture: 6% of GDP
15%-40% of Cost of Living

Malaysian Rice Paddy
Increase Output by 50%
Reduce Implementation Cost by 75%

Healthcare: 21% Readmission
$26B in Economic Waste

3x ROI, 40% lower readmission
Affordable Care: $100 per month
Orchestrate OpEx based service
TREND 1: CUSTOMERS BUY OUTCOMES

- Integrated
- Frictionless
- Whole Solution
- Business Model
TREND 2: SCARCE TALENT

“Shortage of Engineers Threaten Growth”
– Financial Times

Shortage by Industry *

- Manufacturing: 30%
- Agriculture: 28%
- Business Services: 28%
- Transport and Communications: 26%
- Community, Social and Personal Services Activities: 24%
- Electricity, Gas and Water: 23%

EngineeringUK 2015
“If the rate of change on the outside exceeds the rate of change on the inside, the end is near.”
Internet of Things

ENABLING INFORMATION TO DO A JOB WELL
WHAT IS THE INTERNET OF THINGS

Inputs from machines, sensors, people, animals, maps, video, newsfeeds and more is digitized and placed on networks integrating people, devices, processes, and content to enable collective awareness.
WHERE IS IOT HAPPENING?

IoT World Forecast Model Venue Map

Healthcare
- Doctors Surgeries & Outpatient Clinics
  - Blood Glucose Monitors
  - Electro-Cardiogram Monitors
  - Pulse Oximeters
- Hospitals & Facilities
  - Energy Mgmt
  - Entertainment
  - Lifestyle Devices
  - Fixed Patient Monitoring
  - Patient Care
  - Patient Diagnostic
- Research Laboratories
  - Research Equipment
  - Research Instruments
- Home Office & Infrastructure
  - Enterprise IT
  - Networking
  - Telecom Equip
- Mobile
  - Comm's Devices
  - Enterprise IT
  - Home IT
  - Infotainment
  - Lifestyle
- Office
  - Comm's Devices
  - Enterprise IT
  - IT Ancillary
  - Support
- Home
  - Appliances
  - Infotainment
  - Lifestyle Devices
  - Small Appliances
- Retail / Commercial
  - Home IT
  - IT Ancillary
- Industrial
  - Research Laboratories
- Transportation

Resources
- Agriculture
  - Farming Plant
  - Irrigation Systems
  - Soil Preparation
- Mining, Oil & Gas
  - Resource Extraction Equip
  - Oil, Gas Production Plant & Equipment
- Utilities & Water
  - Gas Distribution
  - Water Distribution
  - Water Production Plant & Equipment
  - Resource Extraction Equip
- Alternative Power
  - Co-Generation Equipment
  - Solar Farms Equipment
  - Wind Farm Equipment
- Demand & Supply Side Power
  - Electrical Distribution Equipment & Devices
  - Electrical Distribution Equipment & Devices
  - Electricity Transmission
  - Generation Plant & Equipment
- Utilities
  - Civilian Aircraft
  - Military Aircraft
- Aerospace
  - Construction
  - Material Handling
  - Ground Works Plant
- Construction
  - Commercial Vehicles
  - Consumer Vehicles
  - Military Vehicles
  - Recreational Vehicles
- On-Road & Off-Road
  - Cargo Ships
  - Fishery Craft
  - Military Ships
  - Recreational Craft
  - Freight & Passenger Trains
- Marine & Railways
  - Bus, Rail & Highway Infrastructure
  - Commercial Service Equipment
  - Surveillance Systems
- Transportation Infrastructure

Buildings
- Commercial & Institutional
  - Electrical
  - HVAC
  - Lighting
  - Safety
  - Security
  - Transit
- Government & Institutional
  - Airport Systems
  - CCTV
  - ID Systems
  - Intruder Detect
  - Radar & Sonar
  - Surveillance
- Residential
  - Appliances
  - Electrical
  - HVAC
  - Lighting
  - Safety
  - Security
- Advertising & Financial Services
  - Commercial Service Equipment
  - Signage Devices
- POS & Vending & Professional
  - Commercial Service Equipment
  - Cleaning Appliances
  - Cold Storage Appliance
  - Cooking Appliances
  - Laundry Appliances
- Hotels, Venues & Restaurants
  - Cleaning Appliances
  - Commercial Service Equipment
  - Stage, Venue, Hotel Entertainment
- Supply Chain, Garage & Gas Stn
  - Ind / Professional Maintenance
  - Commercial Service Equipment
  - Surveillance Sys
- Discrete Manufacturing
  - Handling / Processing Sys
  - Machine Control
  - Test / Inspection
- Electronics Manufacturing
  - Silicon Fabrication
  - Assembly, Test & Inspection Equip
- Processing & Converting
  - Process Control Systems
- Supply Chain & Mobile Systems
  - Handling / Processing Sys
  - Ind / Professional Maintenance Equip
THE MARKET IS EMERGING…
IT’S STILL EARLY IN THE AGRICULTURE GAME

Simple Applications
Remote support-driven applications to monitor/upgrade installed base of machines in the field – such as motors, instruments, machines, etc.
- Tracking
- Product Support
- Diagnostics / Monitoring

Compound Applications
Multiple collaborating [peer-peer] devices or significant interactions between devices, systems and people.
- Multi-Party Equipment Support
- Complex Equipment and Field Integration Automation
- Maintenance Support & Collaboration

Complex Applications
Drive interactions between devices, sub-systems and people. Can extend/expand values from third party collaboration and large scale data integration/analytics
- Multi-Vendor Brokered Services
- Integrated Real Time Pricing for Electricity
- Multi-vendor Maintenance Collaboration

Simple
- Equipment Monitoring
- Maintenance Dispatch
- Alerts & Alarms

Compound
- Integrated Automation, Condition Monitoring & Asset Management
- Managed Yield Services

Complex
- Crowd-Sourced Content for Soil, Weather, Machine Troubleshooting
- Brokerage / Auction for Ag Services

Connections

Time
EARLY ADOPTER FARM
MOVING FROM SIMPLE TO COMPOUND APPLICATIONS

CONNECTED FUTURE FARM

- Equipment
- Seed and Crop Protection
- Planting and Application
- Soil and Irrigation Management
- Imagery
- Scouting
- Transportation
- Storage
- Finance & Record Keeping
- Insurance and Bank Relationships
- Commodities Trading
OEMS ARE DOMINANT SMART SERVICES ADOPTERS

- Adoption Ease
- Ease of Use
- Design Transparency
- Collect Customer Intelligence
  - Use
  - Configuration
  - Management
- Next Gen Product Designs

Diagram:
- Design & Engineer
- Build & Integrate
- Sell
- Operate
- Maintain

Key Processes:
- Connected Designs
- Connected Sales
- Connected Supply
- Connected Support

- Pre-Sales Insights
  - Understand installed device states – usage, issues, end of life

- Supply Chain
  - Track product through supply chain

- Design for [remote] Servicing
IoT will drive digitization of the agricultural value chain ... over time, all systems will inevitably become integral to the whole ecosystem.
KEY FORCES IMPACTING ADOPTION

- Interactions and optimization between humans and devices
- Systems & equipment awareness via monitoring, location/presence
- Safety and security concerns encourage optimization
- Devices enable new customer experiences and operations enhancements
- Competition for customer attention becomes digitized
- Go-To-Market Confusion
- Business Model Uncertainty
- Deployment of Technology Standards
- Supplier Models And Fragmentation
- Invested Capital & “Sunk Cost”

Overall Demand For Device & Sensor Networking
## OPPORTUNITY
### DATA ANALYTICS, OPTIMIZATION

<table>
<thead>
<tr>
<th>Category</th>
<th>Benefits</th>
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| Operations Management & Business Analytics    | • Cost Optimization  
• Process Optimization  
• Service Quality |
| Application Performance & Analytics           | • Analytic Tools to Optimize Metrics; Soil Moisture Capacity, GDD, Crop Yield, Equipment | Systems Perf., Capacity Planning, Availability, etc. |
| System Performance & Analytics                | • Analyze and Optimize Systems  
• Build Data-Driven Decisions  
• Volume, Variety, Velocity, Veracity. |
| Equipment / Machine and Ag Infrastructure     | • Centralize and Optimize Access  
• Software, Sensors, Instruments  
• Gain Visibility To Crop-Related Data |
| Monitoring & Analytics                        | • Agronomic Data  
• Plant Traits  
• Soil Analysis |

- **Build with Specialists via Alliances**
- **Managed Services will be Key**
- **Enable Rich Integration of Data from Constantly Evolving Sources**
- **Make Systems Easy to Use**
ROBUST MARKET SOLUTIONS DEPEND ON ALLIANCES AND ECOSYSTEM DESIGNS

More services and content drive more customers to purchase and interact

<table>
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<tr>
<th>Drive Participation</th>
<th>Expand Partnerships</th>
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<tr>
<td>Develop Core Platform and Means of Collaboration</td>
<td>New Tools &amp; Services For Brokering and Integrating Value Marketplace</td>
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Near Term

Medium - Longer Term

More interactions & participation leads to higher value & profitability

Broader scope and better economics attract better offers

Customer Value and Choice

Organic Maneuvers
Partner Maneuvers
TRENDS
WHAT’S GOING ON?
NOT TOO DISTANT FUTURE

Kilometers

Fields

Plants
FARMER NEEDS COMPLEX INFORMATION

CONTROL
- Equipment
- Seed choice
- Crop Protection
- Irrigation
- Land Preparation
- Workforce

NO CONTROL
- Weather
- Pests
- Input costs
- Commodity Prices
- Regulatory
- Water Availability

www.Farms.com/PrecisionAgriculture
PHYSICS & BIOLOGY
DRIVING EFFICIENCY & YIELD

Equipment produces 98% of crop production data
4 HOURS+
TIME FOR AGRONOMIST TO BUILD A FIELD PRESCRIPTION
TODAY – PEOPLE INTENSIVE

AGRONOMIC CHOICES
• Made by Human Brain
• Field Experience
• Farm Size

TOOLS PREDICTIVE
• Not in Farmer’s Toolbox
• Incompatible Data Input
• Limited Analytics Success
CRYSTAL BALL
PREDICTING WITH CROP MODELS
TOMORROW - DECISION SUPPORT SYSTEMS

AGRONOMIC CHOICES
• Cost vs. Quality Decisions
• Historic Field Analytics
• Plant Level Optimization

PREDICTIVE TOOLS
• Workflow Priority
• Fully Integrated
• Rapid Response and Alerts
WHERE TO NEXT?
US MILITARY—GROUND SENSOR NETWORK

- Anomaly Detection
- Perpetually Powered
- Wireless
- Self-organizing
- Self-learning
- Self-healing
LPWAN – LONG RANGE INTERNET OF THINGS

- 10 Years
- 10+ Miles
- Billions
- AES128

Source: DARPA
“SMART DUST”

- Sense and monitor environment
- 20 meter range, 5mm
- Base station or other motes
- One week life in continuous operation
- 2 years with 1% duty cycling
- Cisco and IBM leading investment
- Application: Forest Fire Detection

Source: Professor Kris Pister University of California Berkeley, 1997, Rice University 2014 iteration
“SYNTHETIC BIOLOGY IS THE NEW DIGITAL”

Sensors: Programmable Behavior in Biology

Source: MIT Labs Jiochi Ito, Charles Fracchia
THE END GAME

THE BIG DATA PLATFORM
TOO MANY?

PLATFORMS
GROWING NUMBER OF PLATFORMS
THE FARMER’S DATA
SECURITY & PRIVACY
DATA PRINCIPLES: PRIVACY & SECURITY

PURPOSE

Make farmers comfortable about their data while encouraging innovation in precision agriculture solutions

1. Ownership
2. Collection, Access and Control with Consent
3. Notification of Third-party Access and Use
4. Transparency and Consistency
5. Choice
6. Portability
7. Data Availability
8. Market Speculation
9. Liability & Security Safeguards
GROWERS WANT
GROWERS WANT
SIMPLIFY OPERATIONS AND INCREASE FARM PROFIT

• Share Choice
• Frictionless
• Secure Central Storage [CLOUD]
• Use Data to Make Smart Decisions
THANK YOU!
STANDARDS
OPEN AG DATA ALLIANCE

PURPOSE
To help farmers access and control their data by building an open source framework and a community of commercial vendors, farmers, academics, and developers upon which the emerging ag data market can rapidly grow.
Ag Gateway
Point-to-Point
AG GATEWAY

PURPOSE
Non-profit consortium of businesses serving the agriculture industry, with the mission to promote, enable and expand eBusiness in agriculture.

Long-term vision is to become the recognized international source for enabling the use of information and communication technologies for agriculture.

More than 225 member companies working on projects in 8 segments:

- Ag Retail
- Allied Providers (systems & software developers and service providers)
- Crop Nutrition
- Crop Protection
- Feed
- Grain
- Precision Agriculture
- Seed