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RESEARCH NOTE

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SUBJECT:	**M2M Applications: Agriculture and Oil & Gas**

Background:

This research note follows previous Catalyst research in the broader IoT/M2M space and highlights software that digests data gathered from distributed networked devices in the Oil & Gas and Agriculture industries.

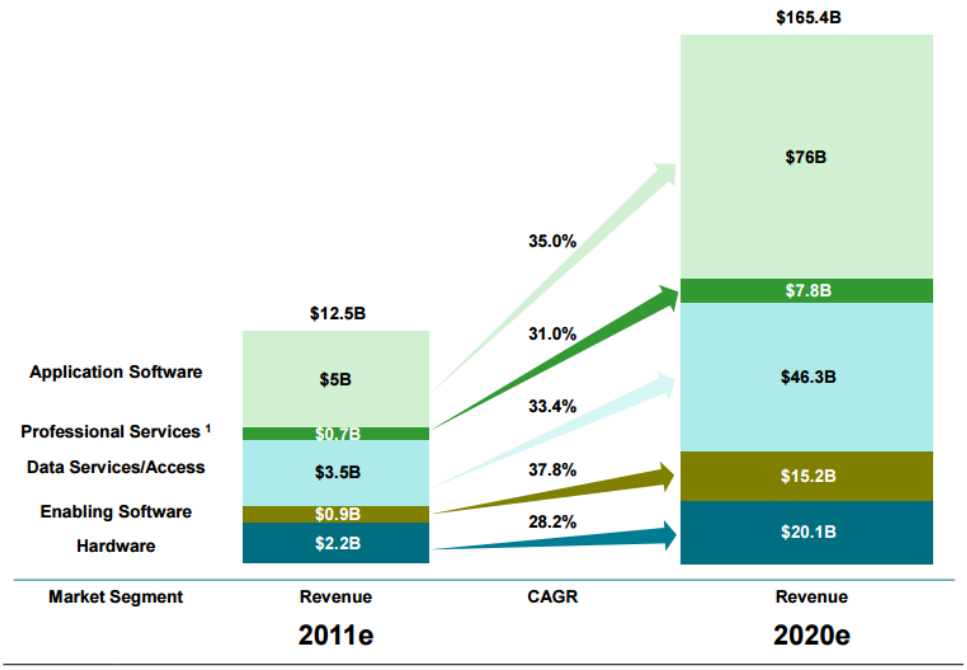
Defining the Market

- Machine-to-Machine ("M2M") describes technology that collects data from distributed sensors via cellular, satellite, or other networks to monitor, control, or analyze the operation of an environment, resource, or employee; it is the business application arm of the Internet of Things (IoT).
- In the Oil & Gas industry, these sensors are deployed on drills to measure pressure, depth, and heat in wells, pipelines and tanks to measure throughput and pressure, and in field service workers' trucks to capture location, speed, and other data for efficient deployment of workers, among other applications.
- In Agriculture, along with fleet and employee management, applications include soil and climate sensors to measure weather and subterranean conditions, as well as silo and processing facility monitors and irrigation system sensors to ensure efficient water use.
    - For crop farming, data analytics optimizes the processes of preparing the soil, planting and harvesting.
    - For livestock farming, it enhances monitoring of the condition of animals to inform judicious intervention.
- For both industries, key inputs in the value chain include:
    - Deployed sensors
    - Local wireless network
    - Local control unit and module (convert sensor signals into digital data)
    - Wide area network (i.e. cellular or satellite)
    - Back-end server applications
        - Software to store and present data for an operator/supervisory platform (real-time intelligence for an operator to direct resources)
        - Vertical application for business intelligence and analytics
- This report focuses on M2M-enabled "application software", which exploits the data from M2M deployments through processing, storing, analyzing, or presenting collected data to provide actionable business intelligence.
    - This excludes hardware/network-dependent "enabling software" that provides the underlying connectivity functionality.

Market Sizes

- Wide-area-wireless M2M (exchange of data using a wireless network to monitor or control remote assets) is predicted to grow at a 45%+ CAGR from 50 million connections in 2011 to 1.5 billion in 2020 (First Analysis).
    - Each connection generates payments for the hardware, software, data services, and support services that make up the M2M market.
    - The M2M software market is expected to grow at a 35% CAGR to $91 billion in 2020.
    - Within M2M software, M2M application software is projected to grow at a 35% CAGR to $76 billion 2020.

Estimated Wide-Area-Wireless M2M Market Size (2011, 2020)



Source: First Analysis estimates.

Notes: ¹ Includes Field Maintenance.

- In agriculture, M2M penetration is greatest in the U.S., but as of yet is limited to the largest farms, which experience increased ROI from scale benefits.
- In Oil & Gas, where the ROI is more measurable, penetration is higher than in agriculture.
    - However, organizations lack adequate applications to create actionable intelligence.
    - At the enterprise level, companies rely on antiquated ERP systems that are ill-equipped to manage large quantities of M2M data.

Selected Use Cases: Oil & Gas

- Upstream – Exploration and Production – operational insights to decrease time to production or increase well productivity
    - Remote well monitoring to optimize production and safety
    - Drill and pump health data
    - Production volume data
- Midstream – Pipelines and Storage – data-enabled infrastructure
    - Pressure sensing
    - Flow rate monitoring of fluid movement in pipelines
    - Humidity sensors to monitor integrity of pipelines and identify areas where moisture collects
    - Sensors measuring the rate of pipeline corrosion
    - Pipeline vibration monitors to predict damage
    - Tank measurement of oil or gas levels
- Downstream – Petroleum Products Refiners and Retailers – supply chain visibility
    - Monitoring custody transfer of substances when passed from one entity to another
    - Sensors to monitor hazardous gas leaks at refineries

Selected Use Cases: Agriculture

- Precision Livestock Farming – Monitoring animal health and inputs
    - Body temperature, movement, tissue resistivity, pulse, location, and breeding alerts
    - Feed lot controls
- Precision Agriculture – Monitoring crop health and inputs
    - Crop disease detection and prevention
    - Irrigation management
    - Fertilizer and pesticide application
    - Soil moisture, leaf wetness, and atmospheric humidity level monitoring
    - Air and soil temperature monitoring
    - Wind speed, humidity, and solar radiation monitoring
- Other Use Cases
    - Fleet management for farm vehicles
    - Water and fuel tank monitoring
    - Remote sensor monitoring for pivot irrigation
    - Intelligent monitoring and control systems for fish farming

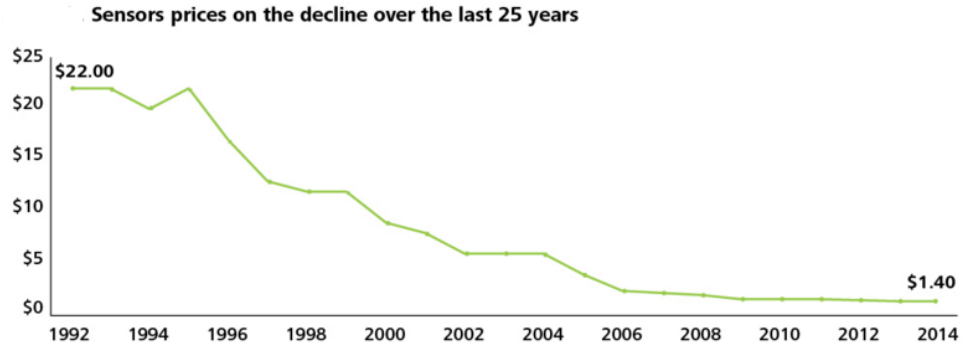
Today:

Industry Trends / Investment Themes

- Declining Connectivity Costs
    - For cellular-based M2M operations, most of the lifetime cost of the deployment is cellular communications expenses.
        - According to M2MHub, in 2011 a typical M2M deployment requiring 1 MB of data traffic cost $5.00+ monthly.

        - As of 2014, a deployment with 1 MB of data traffic cost only $1.50 to $2.00 monthly.
    - This decrease in costs resulted from carriers' expansion of network capacity by upgrading their networks to 3G and 4G technologies.
        - Expansion capacity on these consumer networks leaves more bandwidth for M2M applications on the lower-capacity 2G network.
        - Also, carriers seeking subscription growth have become more competitive in pursuing M2M business, reducing prices for M2M services.
    - Development of low-power, low-bandwidth networks dedicated to M2M connectivity, such as Ingenu's RPMA network enables the following:
        - Connects devices for ~10% of the cost of a cellular network using unlicensed 2.4 GHz spectrum
        - Frees Oil & Gas and Agriculture industries from cost limitations of satellite and coverage limitations of cellular and short-range wireless technologies
        - Breaks the cycle of cellular network upgrades that require hardware replacement in each cellular generation cycle – IoT deployments require longevity to drive ROI
    - New connectivity hardware products incorporate traditional serial and Ethernet interfaces, with wireless networking capabilities including WiFi in remote locations.
        - Hybrid systems reduce costs by using one endpoint with monthly fees and piggy-backing onto that network connection locally – saving the cost of connecting multiple spoke devices to a cellular or satellite network.
    - The price of cellular radio modules, another high-cost input, has also declined, according to M2M Hub.
        - Typical 2G cellular radio modules cost $26-$30 each in 2011, and 3G radio modules were 2x-3x the cost of 2G modules.
        - Today 3G radio modules cost $25-$30 (a decrease of two-thirds).
            - 3G cellular modules are the preferred radio modules today and low frequency 1xRTT modules have proliferated.

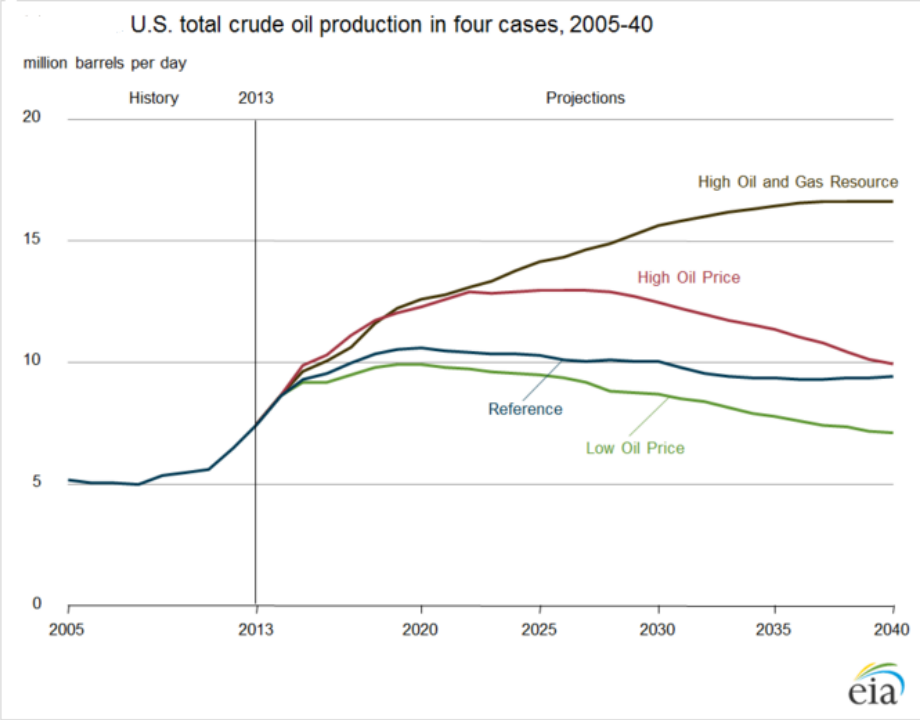
- Declining Device Costs
    - Data from Deloitte using image sensors and accelerometers as a proxy for the broader sensor market implies that prices have fallen significantly.
        - A typical accelerometer now costs $0.40, versus to $2.00 in 2006.
    - Many are now cheap enough to support common business use cases.



Source: Rob Lineback, IC Insights Inc. "The market for next-generation microsystems: More than MEMS!," http://itac.ca/uploads/events/execforum2010/rob_lineback_10-6-10-2.ppt, June 10, 2010, accessed January 28, 2015; Lee Simpson and Robert Lamb, *IoT: Looking at sensors*, Jeffries Equity Research, February 20, 2014, p. 4.

Note: Prices shown above are average selling prices for image sensors and accelerometers.

- Declining Energy Prices Driving Focus on Efficiency
  - Hardware monitors and software analytics are required to maintain profitability at lower prices.
  - Long-term cost reduction is a primary driver for M2M implementation in Oil & Gas.
  - Reduced exploration frees up Capex budgets for efficiency investments.
  - Despite the dip in oil prices the 2015 Annual Energy Outlook from the U.S. Energy Information Administration projects growth in US energy production led by crude oil and natural gas through 2020.



  - New M2M deployments are driven by the establishment of new well sites, which require automated operations and business processes.

- Rise of Smart Farming
  - Managers are able to observe, measure, and react to growing conditions and patterns with real-time data.
  - Farmers collect massive quantities of data from crop yields, soil mapping, fertilizer applications, weather data, machinery, and animal health.
  - Accelerant in farm automation is the growth in Big Data and the applications it serves:
    - Mobile apps used to assist in decision-making in the field
    - Unmanned aerial vehicles (UAVs) used for surveying and location purposes
    - Site- and crop-specific management zones

In Summary:

- The Oil & Gas and Agriculture industries, which have seen lower penetration of connected devices due to the number and geologic disbursement of assets and environments requiring tracking, are poised to experience an acceleration in IoT connection deployments. These new connections will feed the growth of IoT-enabled BI applications.
  - Inexpensive devices to collect and transmit data, analytic software tools, and optimized storage capabilities allow farmers and oil producers to capture more detailed data in real time and at lower costs from previously inaccessible areas.
- Application software presents the strongest opportunity for differentiation within the M2M value chain. The number of devices monitored, depth of reporting features, and data complexity present young companies a chance to define a defensible niche with highly integrated and sticky products and services.
  - Companies that address vertical-specific processes will lead with credibility over ERP software providers edging into the space.

Going Forward:

Key Outstanding Questions

- **Sales Strategy** – What channels offer the most efficient means of contacting geographically dispersed farm operators and field service managers?
  - Various stakeholders (integrators, VARs, connectivity providers, sensor and router manufacturers, incumbent ERP software vendors, and others) influence the buying decision.
  - The product's complexity may require long sales and implementation cycles.
- **Timeframe** – The continued fall in connectivity and sensor prices, plus broader belief in IoT efficacy will lead to widespread adoption in the medium term (if not sooner).
- **Implementation ROI** – Does the payback on an M2M investment justify prioritizing an implementation over other Capex investments?
  - Thin margins in agriculture and depressed energy prices could extend the payback period for M2M projects.