Real World LoRa Challenges

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Water Management Key to Farmer’s Success

- Cannot “see” water held in the soil
- Precipitation runs off, evaporates, or moves into soil
- When should you water?
- Important for both Dryland and Irrigated land
Realtime Fertility Info Missing to Make Decisions

- What nutrients are available and how much?
- Soil test taken during off season
- Must wait for results
- How much to apply?
- Is data valid when crop is actively growing?
Teralytic Wireless NPK + Moisture Probes

**Microclimate Head**
- Air Temp
- Humidity
- Light

**Gas Sensors 6”, 18”**
- Aeration (O₂)
- Respiration (CO₂)

**Soil Sensors 6”, 18”, 36”**
- Nitrate
- Potassium
- Phosphorus
- pH
- Soil Moisture
- Salinity
- Soil Temp
LoRa Solution Solves Many Issues

- Low data rate, a perfect fit
- Transmission distance measured in miles/kilometers
- Low power allows longer battery life
- Costs shared by all connected devices
- Worldwide acceptance
- Many LoRa gateway options, networks, and equipment to choose from

<table>
<thead>
<tr>
<th>LPWAN</th>
<th>Low Powered Wide Area Network</th>
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</thead>
<tbody>
<tr>
<td>DATA RATE</td>
<td>~10kbps</td>
</tr>
<tr>
<td>RANGE</td>
<td>Long</td>
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<tr>
<td>BATTERY LIFE</td>
<td>Long</td>
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<tr>
<td>COST</td>
<td>Best</td>
</tr>
<tr>
<td>MARKET</td>
<td>55% of IoT Market</td>
</tr>
</tbody>
</table>
Product Goals

- Simple to install
- Simple to operate
- Long term power by internal battery
- No exterior wires or solar panels
- Long distance communication
- Low data transmission costs
- Universal protocols
LoRa Completes Data/Management Loop

Data from probes sent via LoRa network to gateway

Gateway sends data to the cloud where it is analyzed and processed by servers

Results sent to farmers and their agronomists so they can make management decisions

Teralytic soil sensors monitor 26 data points in real-time

Management decisions implemented, results can be measured, and the cycle repeats
Our First Year with LoRa

• 100s of probes connected to our server network worldwide
But not Without Challenges

• LoRa configuration decisions
• Gateway installations issues
• Integrating with other networks
• Troubleshooting
LoRa Configuration Decisions

- NB-IoT: more expensive modem (most on the market combined with LTE-M), coverage still developing, higher power
- SigFox: more radio options, but network controlled by them
- Custom radio allows more flexibility, but off the shelf modems allow faster time to market
- Lack of common frequency plan around the world causes challenges
- LoRa modem interfaces not standardized and sometimes buggy
Gateway Installations Issues

• Infrastructure Development

• Rural areas are often sparsely populated
• Power supply hard to find
• Internet access unreliable
• Tall structures not always available
• Each gateway can only cover a limited area
Gateway Installations Issues

• Topography – Land is not always flat
Gateway Installations Issues

- Biomass
- Trees
- Crops
Gateway Installations Issues

Professional Installs

• More reliable
• Generally better range
• Professional support

Amateur Installs

• Less expensive to implement
• Faster implementation
• Install in any area
Gateway Installations Issues

- Gateway Density
  - 70 x 50 mile area
  - 1 gateway / 10 miles
  - Find high locations
  - Try to overlap

- 16 towers to cover
  - 1.4 million square miles in US
  - 6500 gateways
Integrating with other networks

- Theoretically conforming to the LoRaWAN regional parameters guarantees compatibility
- Must test integrations with partner networks before going into field
- Network operators can implement commands around data rate and channel configuration differently
- Managing shared device keys with partner network providers is logistically challenging
- Custom integrations need to be built with each network provider to bring data back into our cloud
- Roaming in LoRaWAN 1.1 will solve many of these issues but is not widely implemented
Troubleshooting

• Failure to Communicate
• Where is the failure?
  • Device to gateway
  • Gateway to LoRa Server
  • LoRa Server to Backend Servers
  • Backend Servers to Customer
• Most difficult for Service is the first link