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OCTOBER 11-14

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**2021 Fall
Technical Forum**
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Internet of Things, Home Networking, Smart Cities, and Emerging Services

Wireless IoT for Rural Use Cases

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Smart cities and communities is a concept that is gaining more attention because of its potential to enhance citizens' lives and make cities and communities more efficient. Rural America can also benefit from leveraging new technologies like IoT (Internet of Things) and Fixed Wireless Access (FWA) to achieve better operational efficiencies.

The primary goals of the Smart Farming use cases include:

- Providing early warning detection of potential illnesses in the horses on the farm through the use of a water intake monitoring solution.
- Improving security on the farm through LoRaWAN sensor monitoring and alerting and video surveillance.
- Providing Spectrum Internet[®] WiFi connectivity at the Farm

The Wireless Technologies R&D team at Charter is executing a PoC trial at a local Colorado Equestrian Farm (“Farm”) to ascertain the viability of IoT technology through a variety of Smart Farming use cases, using

Access technologies such as:

- LoRaWAN
- FWA in CBRS
- WiFi

Application technologies like:

- video surveillance
- license plate recognition.

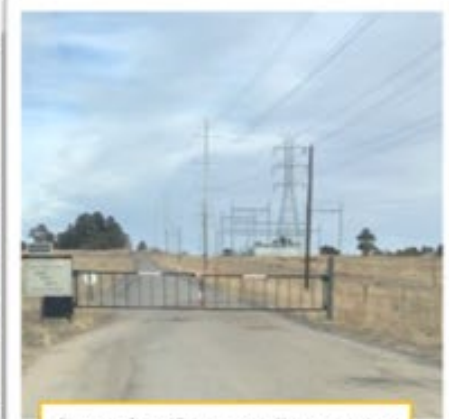


Wellsbridge Farm Parker

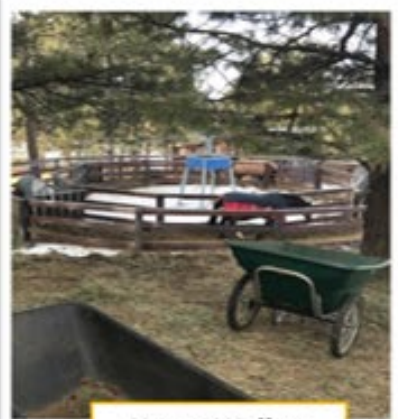
- 120 Acres
- 55 Horses
- 3 Barns (main barn attached to indoor training arena)
- Outdoor training arena
- Outdoor Horse Walker
- 4 Pastures
- Security gate at entrance with minimal security



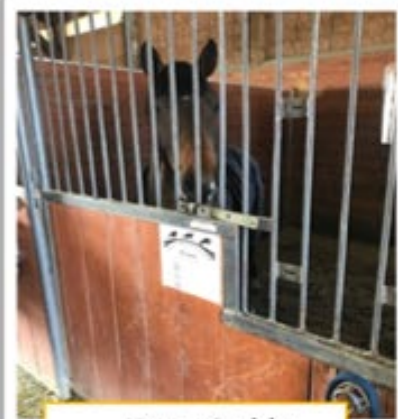
Outdoor Training Arena



Security Gate at Entrance



Horse Walker



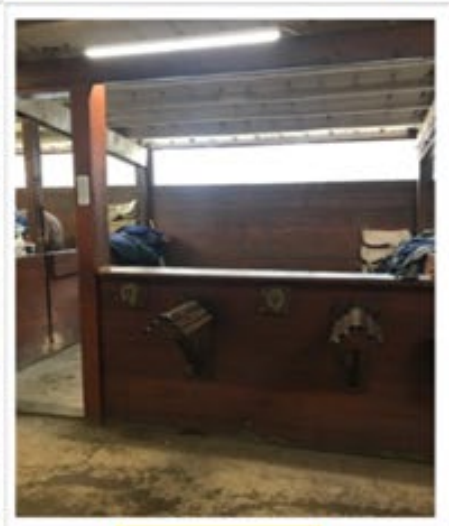
Horse Stable



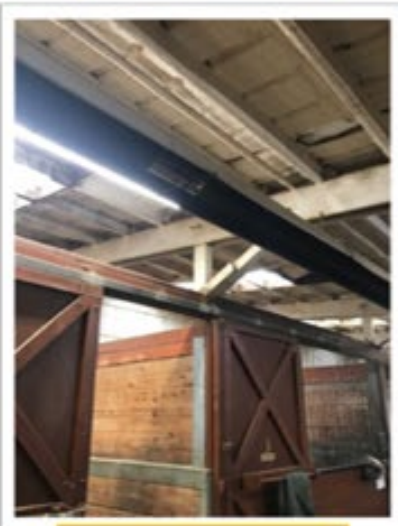
Manual Feed Tracker



Indoor Training Arena



Stall



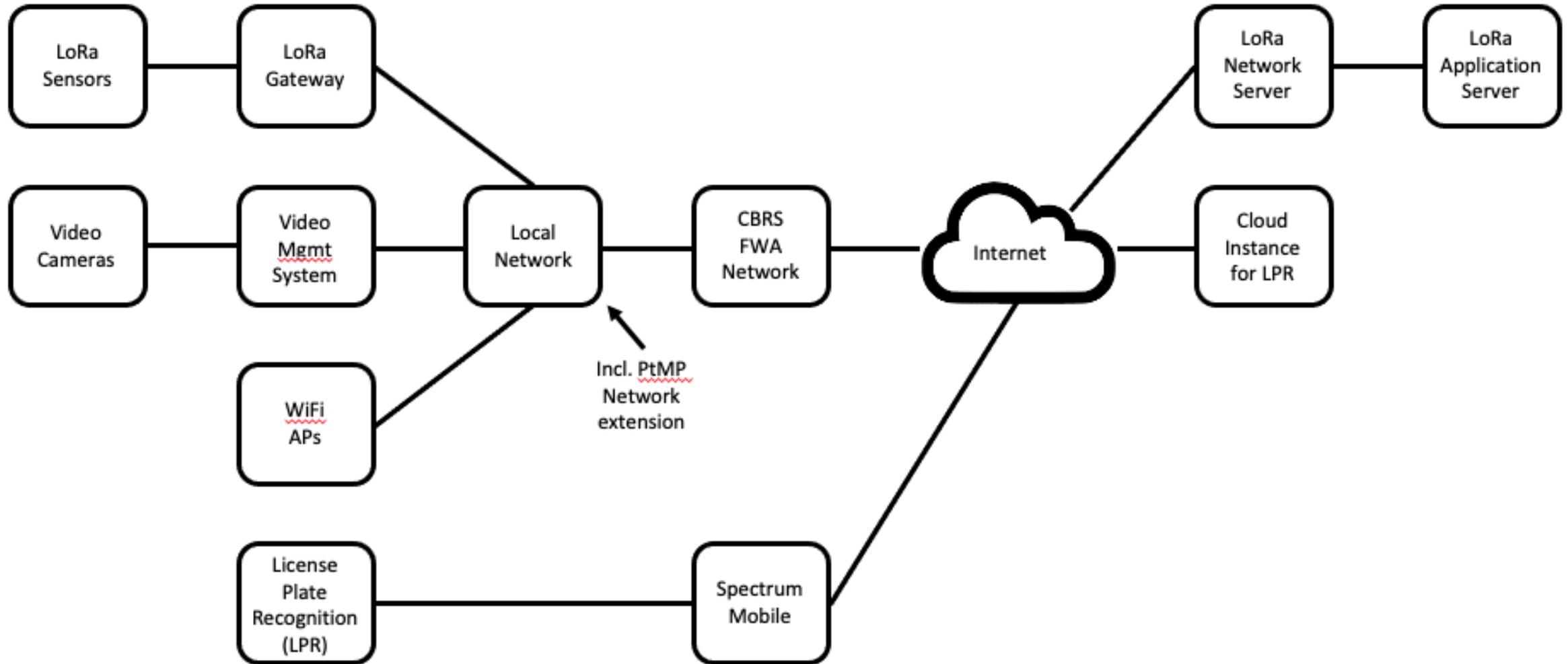
Stall Doors



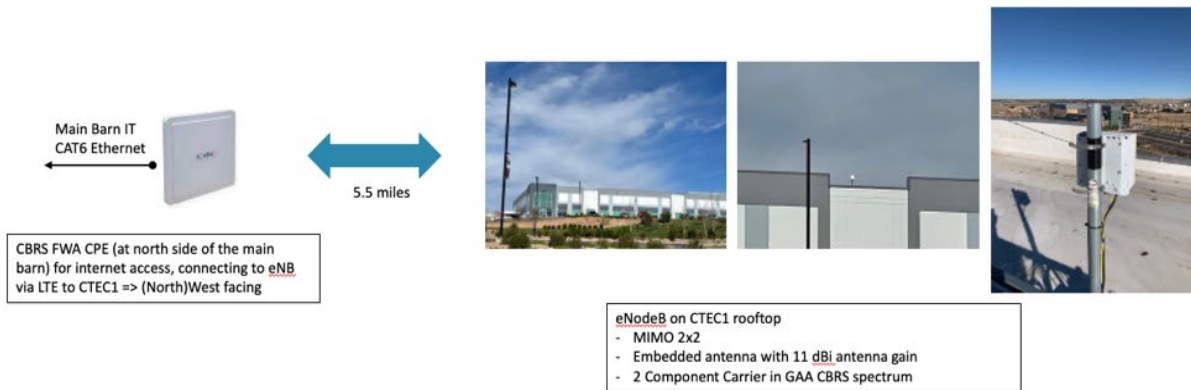
Outdoor Pastures



View of Downtown GW



CBRS Fixed Wireless Access



Main Barn to CTEC Tower					
PCI	Distance	SINR	RSRP	Download	Upload
120	5.5 Miles	26 dB	-92 dBm	240 Mbps	11 Mbps

- Cellular link using Fixed Wireless Access in CBRS band
- 5.5 miles between eNodeB at Charter CTEC2 building and CPE at farm
- Primary use:
 - End-user internet access via WiFi AP
 - LoRaWAN connectivity to Network/Application Server
 - Cloud Portals (LPR and others)
 - Remote



Horse Surveillance

Provides the farm owner/personnel with the ability to monitor the condition of select horses for improved welfare and security.

In the future, this could be extended to provide the same access to the horse owners.

Additionally, processing the captured and stored video feeds allows for implementation of further analysis and detection of unusual horse behavior via Artificial Intelligence and Machine Learning.



Indoor Training Facility Surveillance

Farm owners and personnel have the ability to detect abnormal behavior or 'not permitted' jumping based on time (after hours), in combination with installed LoRaWAN proximity sensors, and general remote monitoring of activities.



Horse Walker Surveillance

Farm owners and personnel have the ability to remotely monitor activities at the outside horse walker, in combination with LoRaWAN sensors, in order to detect equipment malfunctions, horses escaping or other general remote monitoring of activities.

License Plate Recognition at Gate Entrance



The purpose of the license plate recognition (LPR) is to provide: the Farm owner with the ability to monitor and track access, with dates and times, of visitors for potential later proof of entrance for those who entered the Farm area. As additional enhancement for the future, the LPR system could be linked to the gate control via a white/black list control.

The processing of the license plate recognition is done at the edge in a self-contained battery and solar powered system. The processed data is sent to a cloud portal via a cellular (using Spectrum Mobile service) link.

For the purpose of monitoring conditions and environments in the Farm area, a LoRaWAN network setup consists of various sensors and an outdoor gateway, interconnecting via the internet to a network and application server. Sensors that are part of the solution include:

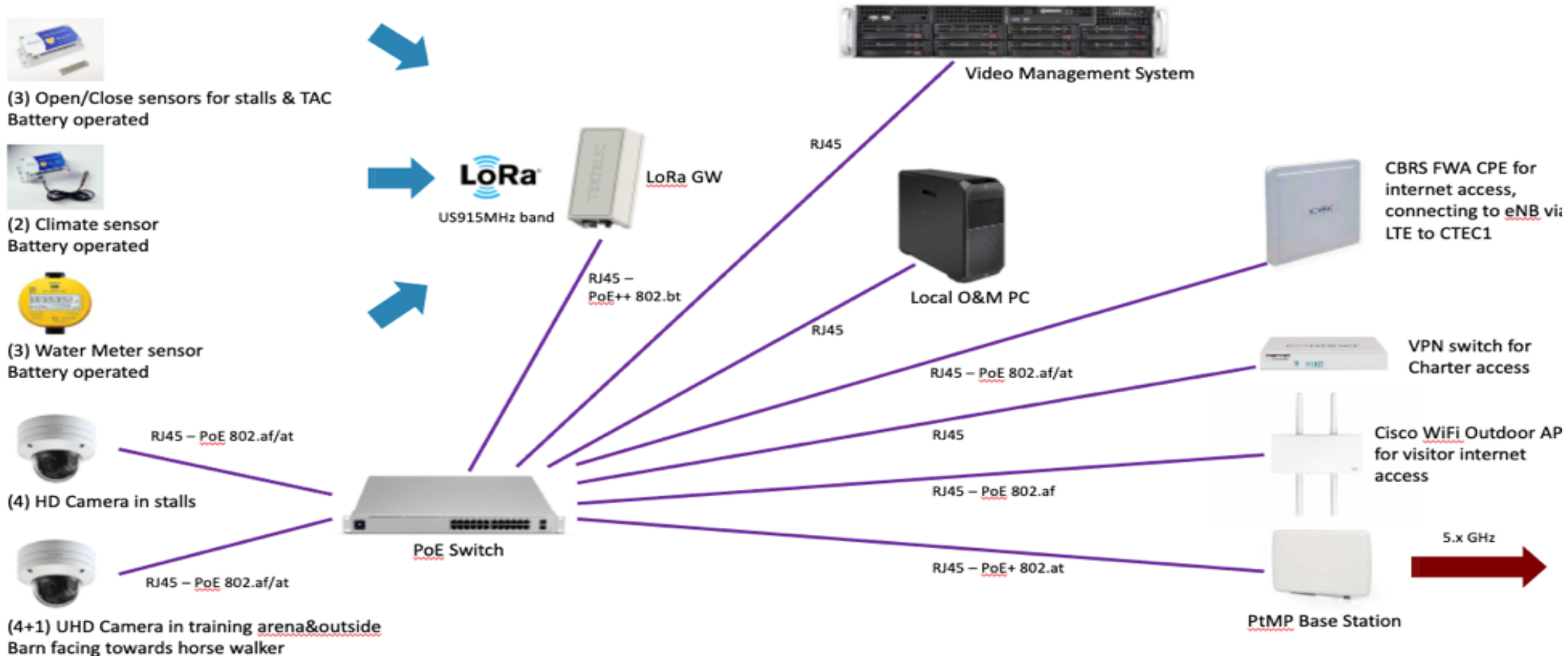
- Open/close door for monitoring the selected horse stalls
- Temperature and humidity in main, upper and lower barns and TAC room (contains equipment for the solution)
- Proximity sensors for training facility and outdoor horse walker (use cases described earlier)
- Water consumption monitoring. This sensor solution is consisting of a water meter, which is in line with the water supply and the water bucket for the horse (automatically refilled via a floating valve) and connected to a LoRaWAN pulse sensor.



Water meter and LoRa pulse sensor solution

- Water bucket for the horses with floating valve
- Water Meter with 1/10 per Gallon reporting via LoRaWAN pulse sensor
- Data is presented in the application server for observing 'healthy' water intake by the horse
- Alarm threshold allow for proactive horse monitoring

Connectivity Diagram



The proof of concept activities have already demonstrated that the use of hybrid wireless technologies combined with data processing at the edge and in the cloud is extremely helpful in a rural farm environment for its day-to-day activities. The trial will continue and learnings from the end users - farm owners and personnel - will be used to improve the overall solutions. Additionally, other use cases or enhancements to the existing use cases will be made as needed.



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Thank You!

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