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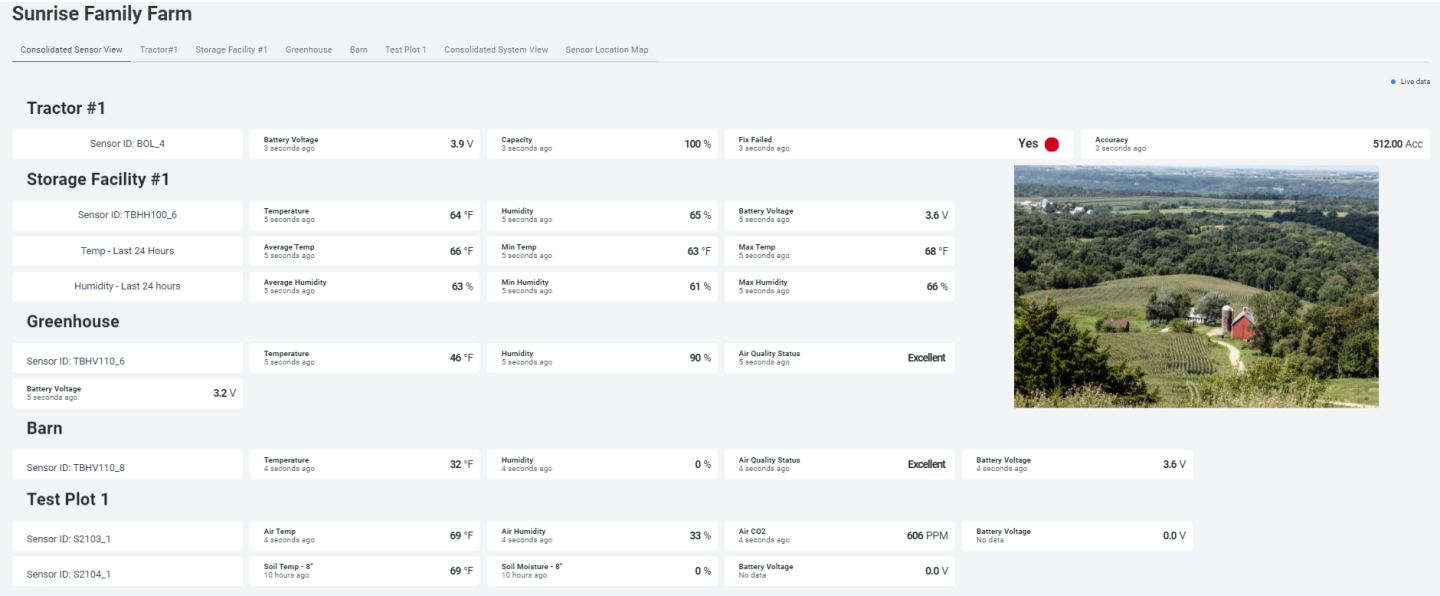
Title: Lessons Learned - Transitioning a Smart Farm IoT System from the Helium to The Things Network (TTN) for its LoRaWAN Network Server
Tags: #IOT, #Helium, #TTN, #Datacake

Executive Summary

This article outlines lessons learned from transitioning a Smart Farm prototype IoT system from the Helium VIP Console to The Things Network (TTN) for its LoRaWAN Network Server component. Initially, it provides an overview of the prototype system and the reasons for the change. Subsequently, the article details the steps undertaken for the transition and the outcomes. Finally, it shares crucial insights gained from this endeavor.

System Overview

Sunrise Family Farm is a smart farm prototype equipped with 6 IoT sensors. The main sensor dashboard is shown in the screenshot below.



Sunrise Family Farm – Consolidated Sensor View Dashboard

Details of the 6 sensors are in the following table:

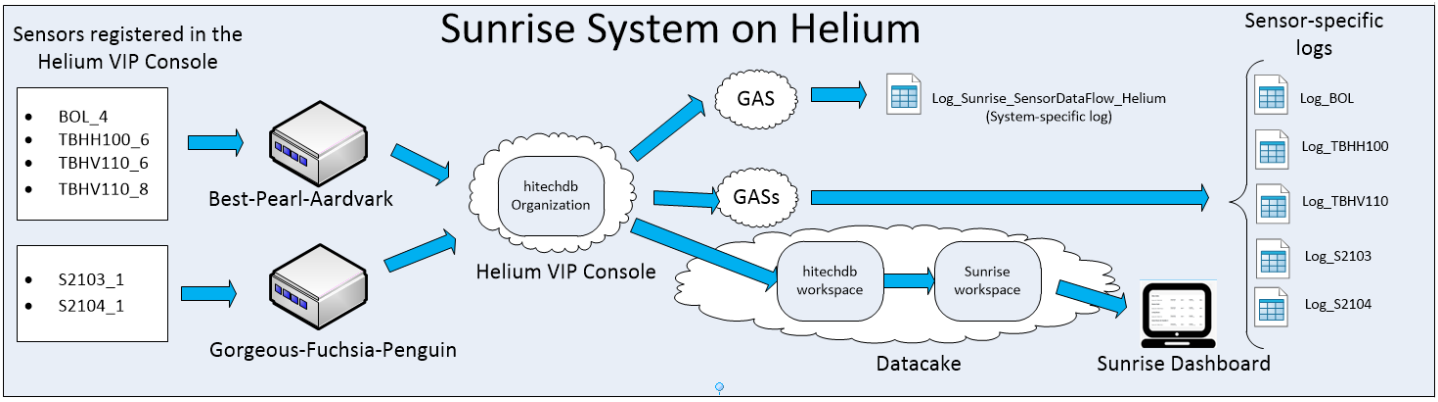
Sunrise Family Farm Sensors

Sensor Model	Description	System Sensor ID	Location
Browan Tabs Object Locator	GPS Tracker	BOL_4	Davis, California
Browan Healthy Home Sensor IAQ	Indoor Air Quality Sensor	TBHV110_6, TBHV110_8	Davis, California
Browan TBHH100	Temperature & Humidity Sensor	TBHH100_6	Davis, California
SenseCAP S2103	Outdoor CO2, Temperature, and Humidity Sensor	S2103_1	Atlanta, Georgia
SenseCAP S2104	Outdoor Soil Moisture and Temperature Sensor	S2104_1	Atlanta, Georgia

The Sunrise Family Farm System, established in 2022, utilized the Helium VIP Console for the LoRaWAN Network Server (LNS) and Datacake for sensor data visualization. A custom logging solution involving Google Application Scripts (GAS) and Google Sheets was employed for recording sensor and system data.

Sunrise System on Helium

The system diagram below illustrates the components of the Sunrise Family Farm system on Helium.



(above) System Diagram – Sunrise System on Helium

Key characteristics of this Helium-based system include:

- Sensors in California connecting through the Helium hotspot, Best-Pearl-Aardvark
- Sensors in Georgia connecting through Helium hotspot, Gorgeous-Fuchsia-Penguin
- Both hotspots using Wi-Fi for backhaul
- Sensor-specific logs for analyzing environmental conditions
- Log_Sunrise_SensorDataFlow_Helium storing undecoded messages from all 6 sensors for a health check on the LoRaWAN system

- Integration of logging data from the Helium Console to Google Sheets via Google Application Scripts

totals.

1	Local Time (America/NewYork)	Reported At (Local Time)	From Device	Frame Count	Hotspot	Channel	Frequency	Hold Time	rssi	snr	Spreading	Hotspt Status	Board Temp	Battery (V)	Temp Ambient	Rel Humidity (%)	RH error	CO2	CO2 error	VOC	VOC Error	IAQ
320908	9-30-2023 7:36:53	9-30-2023 7:36:46	TBHV110_5	114515	dizzy-eggplant-corgi	1	904.1	0	-66	12.80	SF7BW125	success	71.6	3.6	69.8	57	FALSE	525	FALSE	0	FALSE	38
320909	9-30-2023 7:37:24	9-30-2023 7:37:16	TBHV110_6	150964	best-pearl-aardvark	4	904.7	0	-76	13.00	SF7BW125	success	64.4	3.6	62.6	80	FALSE	3254	FALSE	46	FALSE	250
320910	9-30-2023 7:37:50	9-30-2023 7:37:42	TBHV110_8	96137	best-pearl-aardvark	7	905.3	0	-26	12.80	SF7BW125	success	71.6	3.6	68	63	FALSE	616	FALSE	0	FALSE	91
320911	9-30-2023 7:37:57	9-30-2023 7:37:53	TBHV1110_2	37388	creamy-holographic-cat	0	903.9	0	-81	13.50	SF7BW125	success	75.2	3.6	75.2	44	FALSE	877	FALSE	1	FALSE	168
320912	9-30-2023 7:41:52	9-30-2023 7:41:46	TBHV110_5	114516	dizzy-eggplant-corgi	7	905.3	0	-64	13.20	SF7BW125	success	71.6	3.6	69.8	58	FALSE	523	FALSE	0	FALSE	37
320913	9-30-2023 7:42:24	9-30-2023 7:42:16	TBHV110_6	150965	best-pearl-aardvark	0	903.9	0	-77	13.00	SF7BW125	success	64.4	3.6	62.6	80	FALSE	3243	FALSE	46	FALSE	249
320914	9-30-2023 7:42:50	9-30-2023 7:42:42	TBHV110_8	96138	best-pearl-aardvark	3	904.5	0	-25	13.20	SF7BW125	success	71.6	3.6	68	63	FALSE	629	FALSE	0	FALSE	98
320915	9-30-2023 7:42:58	9-30-2023 7:42:53	TBHV1110_2	37389	silly-golden-baboon	2	904.3	0	-73	10.20	SF7BW125	success	75.2	3.6	75.2	44	FALSE	857	FALSE	1	FALSE	164
320916	9-30-2023 7:46:53	9-30-2023 7:46:46	TBHV110_5	114517	dizzy-eggplant-corgi	3	904.5	0	-65	13.20	SF7BW125	success	71.6	3.6	69.8	58	FALSE	533	FALSE	0	FALSE	43
320917	9-30-2023 7:47:24	9-30-2023 7:47:16	TBHV110_6	150966	best-pearl-aardvark	2	904.3	0	-75	11.20	SF7BW125	success	64.4	3.6	62.6	80	FALSE	3264	FALSE	47	FALSE	250
320918	9-30-2023 7:47:50	9-30-2023 7:47:42	TBHV110_8	96139	best-pearl-aardvark	4	904.7	0	-26	13.20	SF7BW125	success	71.6	3.6	68	63	FALSE	660	FALSE	0	FALSE	116
320919	9-30-2023 7:47:57	9-30-2023 7:47:53	TBHV1110_2	37390	silly-golden-baboon	5	904.9	0	-76	13.00	SF7BW125	success	75.2	3.6	75.2	44	FALSE	860	FALSE	1	FALSE	164
320920	9-30-2023 7:51:54	9-30-2023 7:51:47	TBHV110_5	114518	dizzy-eggplant-corgi	4	904.7	0	-65	13.50	SF7BW125	success	71.6	3.6	69.8	58	FALSE	527	FALSE	0	FALSE	40
320921	9-30-2023 7:52:24	9-30-2023 7:52:17	TBHV110_6	150967	best-pearl-aardvark	5	904.9	0	-74	13.50	SF7BW125	success	64.4	3.6	62.6	80	FALSE	3264	FALSE	47	FALSE	250
320922	9-30-2023 7:52:50	9-30-2023 7:52:42	TBHV110_8	96140	best-pearl-aardvark	0	903.9	0	-26	13.00	SF7BW125	success	71.6	3.6	68	63	FALSE	633	FALSE	0	FALSE	101
320923	9-30-2023 7:52:58	9-30-2023 7:52:54	TBHV1110_2	37391	silly-golden-baboon	6	905.1	0	-74	14.00	SF7BW125	success	75.2	3.6	75.2	44	FALSE	887	FALSE	1	FALSE	170
320924	9-30-2023 7:56:53	9-30-2023 7:56:47	TBHV110_5	114519	dizzy-eggplant-corgi	0	903.9	0	-66	13.80	SF7BW125	success	71.6	3.6	69.8	58	FALSE	534	FALSE	0	FALSE	43
320925	9-30-2023 7:57:24	9-30-2023 7:57:17	TBHV110_6	150968	best-pearl-aardvark	6	905.1	0	-74	13.20	SF7BW125	success	64.4	3.6	62.6	80	FALSE	3296	FALSE	49	FALSE	250
320926	9-30-2023 7:57:50	9-30-2023 7:57:42	TBHV110_8	96141	best-pearl-aardvark	2	904.3	0	-25	11.80	SF7BW125	success	71.6	3.6	68	63	FALSE	693	FALSE	0	FALSE	126
320927	9-30-2023 7:57:58	9-30-2023 7:57:54	TBHV1110_2	37392	long-quartz-starfish	1	904.1	0	-111	-1.20	SF7BW125	success	75.2	3.6	75.2	44	FALSE	902	FALSE	1	FALSE	174
320928	9-30-2023 8:01:53	9-30-2023 8:01:47	TBHV110_5	114520	dizzy-eggplant-corgi	2	904.3	0	-66	10.20	SF7BW125	success	71.6	3.6	69.8	58	FALSE	520	FALSE	0	FALSE	36
320929	9-30-2023 8:02:25	9-30-2023 8:02:17	TBHV110_6	150969	best-pearl-aardvark	1	904.1	0	-76	13.00	SF7BW125	success	64.4	3.6	62.6	81	FALSE	3318	FALSE	51	FALSE	250
320930	9-30-2023 8:02:50	9-30-2023 8:02:42	TBHV110_8	96142	best-pearl-aardvark	5	904.9	0	-25	13.20	SF7BW125	success	71.6	3.6	68	63	FALSE	664	FALSE	0	FALSE	118
320931	9-30-2023 8:02:58	9-30-2023 8:02:54	TBHV1110_2	37393	silly-golden-baboon	7	905.3	0	-75	13.50	SF7BW125	success	75.2	3.6	75.2	44	FALSE	802	FALSE	1	FALSE	151
320932	9-30-2023 8:06:53	9-30-2023 8:06:47	TBHV110_5	114521	dizzy-eggplant-corgi	5	904.9	0	-65	14.00	SF7BW125	success	71.6	3.6	69.8	58	FALSE	532	FALSE	0	FALSE	42

(above) Excerpt from Log_TBHV110 with decoded sensor data highlighted in red

1	A UTC Time	B (America/NewYork	C (Local Time)	D From Device	E Frame Count	F Hotspot	G Channel	H Frequency	I Hold Tiime	J RSSI	K SNR	L Spreading	M Hotspt Status	N Payload	O Payload Size	P Port	Q Reported At
356188	10-18-2023 4:34:31	10-18-2023 0:34:31	10-18-2023 0:34:28	TBHV110_8	101235	best-pearl-aardvark	4	904.7	0	-29	13.50	SF7BW125	success	AAs3NkgFAgDsADc=	11	103	1.6976E+12
356189	10-18-2023 4:34:47	10-18-2023 0:34:47	10-18-2023 0:34:44	TBHV110_6	156062	best-pearl-aardvark	2	904.3	0	-78	10.20	SF7BW125	success	AAs3Oj4FAgDuADY=	11	103	1.6976E+12
356190	10-18-2023 4:39:31	10-18-2023 0:39:32	10-18-2023 0:39:28	TBHV110_8	101236	best-pearl-aardvark	0	903.9	0	-29	13.50	SF7BW125	success	AAs3NzwFAgDqADY=	11	103	1.6976E+12
356191	10-18-2023 4:39:47	10-18-2023 0:39:48	10-18-2023 0:39:44	TBHV110_6	156063	best-pearl-aardvark	5	904.9	0	-78	13.50	SF7BW125	success	AAs3OqAFAwD6ADY=	11	103	1.6976E+12
356192	10-18-2023 4:44:04	10-18-2023 0:44:04	10-18-2023 0:44:01	S2104_1	9371	clever-orange-mustang	4	904.7	0	-66	13.20	SF7BW125	success	AQYQBEIAAAEHEAwwA	16	2	1.6976E+12
356193	10-18-2023 4:44:31	10-18-2023 0:44:32	10-18-2023 0:44:28	TBHV110_8	101237	best-pearl-aardvark	2	904.3	0	-28	11.20	SF7BW125	success	AAs3NlgFAgDwADY=	11	103	1.6976E+12
356194	10-18-2023 4:44:47	10-18-2023 0:44:48	10-18-2023 0:44:44	TBHV110_6	156064	best-pearl-aardvark	6	905.1	0	-78	13.00	SF7BW125	success	AAs3Om4FAgDxADY=	11	103	1.6976E+12
356195	10-18-2023 4:49:31	10-18-2023 0:49:32	10-18-2023 0:49:29	TBHV110_8	101238	best-pearl-aardvark	5	904.9	0	-28	14.00	SF7BW125	success	AAs3N3QFAgD2ADY=	11	103	1.6976E+12
356196	10-18-2023 4:49:49	10-18-2023 0:49:49	10-18-2023 0:49:44	TBHV110_6	156065	best-pearl-aardvark	1	904.1	0	-78	13.50	SF7BW125	success	AAs3OtcFAwD6ADY=	11	103	1.6976E+12
356197	10-18-2023 4:54:32	10-18-2023 0:54:32	10-18-2023 0:54:29	TBHV110_8	101239	best-pearl-aardvark	6	905.1	0	-28	13.80	SF7BW125	success	AAs3N00FAgDwADY=	11	103	1.6976E+12
356198	10-18-2023 4:54:48	10-18-2023 0:54:49	10-18-2023 0:54:45	TBHV110_6	156066	best-pearl-aardvark	7	905.3	0	-78	12.80	SF7BW125	success	AAs3OqEFAwDwADU=	11	103	1.6976E+12
356199	10-18-2023 4:59:32	10-18-2023 0:59:32	10-18-2023 0:59:29	TBHV110_8	101240	best-pearl-aardvark	1	904.1	0	-29	13.50	SF7BW125	success	AAs3NyYFAgDpADY=	11	103	1.69761E+12
356200	10-18-2023 4:59:48	10-18-2023 0:59:48	10-18-2023 0:59:45	TBHV110_6	156067	best-pearl-aardvark	3	904.5	0	-78	12.80	SF7BW125	success	AAs3OtAFAwD6ADU=	11	103	1.69761E+12
356201	10-18-2023 5:04:30	10-18-2023 1:04:30	10-18-2023 1:04:29	TBHV110_8	101241	best-pearl-aardvark	7	905.3	0	-29	13.20	SF7BW125	success	AAs3Nz0FAgDuADY=	11	103	1.69761E+12
356202	10-18-2023 5:04:48	10-18-2023 1:04:48	10-18-2023 1:04:45	TBHV110_6	156068	best-pearl-aardvark	4	904.7	0	-78	13.80	SF7BW125	success	AAs3OmoFAgDoADU=	11	103	1.69761E+12
356203	10-18-2023 5:09:32	10-18-2023 1:09:32	10-18-2023 1:09:29	TBHV110_8	101242	best-pearl-aardvark	3	904.5	0	-28	13.50	SF7BW125	success	AAs3N1sFAgD1ADY=	11	103	1.69761E+12
356204	10-18-2023 5:09:48	10-18-2023 1:09:48	10-18-2023 1:09:45	TBHV110_6	156069	best-pearl-aardvark	0	903.9	0	-79	13.20	SF7BW125	success	AAs3O5QFAgDwADU=	11	103	1.69761E+12
356205	10-18-2023 5:14:32	10-18-2023 1:14:32	10-18-2023 1:14:29	TBHV110_8	101243	best-pearl-aardvark	4	904.7	0	-29	13.80	SF7BW125	success	AAs3N/YEAgDiADY=	11	103	1.69761E+12
356206	10-18-2023 5:14:48	10-18-2023 1:14:48	10-18-2023 1:14:45	TBHV110_6	156070	best-pearl-aardvark	2	904.3	0	-80	10.20	SF7BW125	success	AAs3O4kFAgDvADU=	11	103	1.69761E+12
356207	10-18-2023 5:19:32	10-18-2023 1:19:32	10-18-2023 1:19:29	TBHV110_8	101244	best-pearl-aardvark	0	903.9	0	-29	13.50	SF7BW125	success	AAs3N0IFAgDxADY=	11	103	1.69761E+12
356208	10-18-2023 5:19:48	10-18-2023 1:19:48	10-18-2023 1:19:45	TBHV110_6	156071	best-pearl-aardvark	5	904.9	0	-78	13.50	SF7BW125	success	AAs3O+4FAwD6ADU=	11	103	1.69761E+12
356209	10-18-2023 5:20:52	10-18-2023 1:20:52	10-18-2023 1:20:49	S2103_1	9563	wild-glossy-swallow	6	905.1	0	-112	-7.80	SF7BW125	success	AQQQOIULAAEBEOgcA/	23	2	1.69761E+12
356210	10-18-2023 5:24:32	10-18-2023 1:24:32	10-18-2023 1:24:29	TBHV110_8	101245	best-pearl-aardvark	2	904.3	0	-28	10.80	SF7BW125	success	AAs3NzQFAgDvADY=	11	103	1.69761E+12
356211	10-18-2023 5:24:48	10-18-2023 1:24:48	10-18-2023 1:24:45	TBHV110_6	156072	best-pearl-aardvark	6	905.1	0	-75	13.20	SF7BW125	success	AAs3O3wFAgDmADU=	11	103	1.69761E+12
356212	10-18-2023 5:29:32	10-18-2023 1:29:33	10-18-2023 1:29:29	TBHV110_8	101246	best-pearl-aardvark	5	904.9	0	-28	13.20	SF7BW125	success	AAs3N88EAgDcADY=	11	103	1.69761E+12
356213	10-18-2023 5:29:48	10-18-2023 1:29:49	10-18-2023 1:29:45	TBHV110_6	156073	best-pearl-aardvark	1	904.1	0	-75	13.20	SF7BW125	success	AAs3OzQFAgDaADU=	11	103	1.69761E+12
356214	10-18-2023 5:34:27	10-18-2023 1:34:28	10-18-2023 1:34:24	TBHH100_6	8578	best-pearl-aardvark	7	905.3	0	-67	14.00	SF7BW125	success	CAs1QP////8=	8	103	1.69761E+12

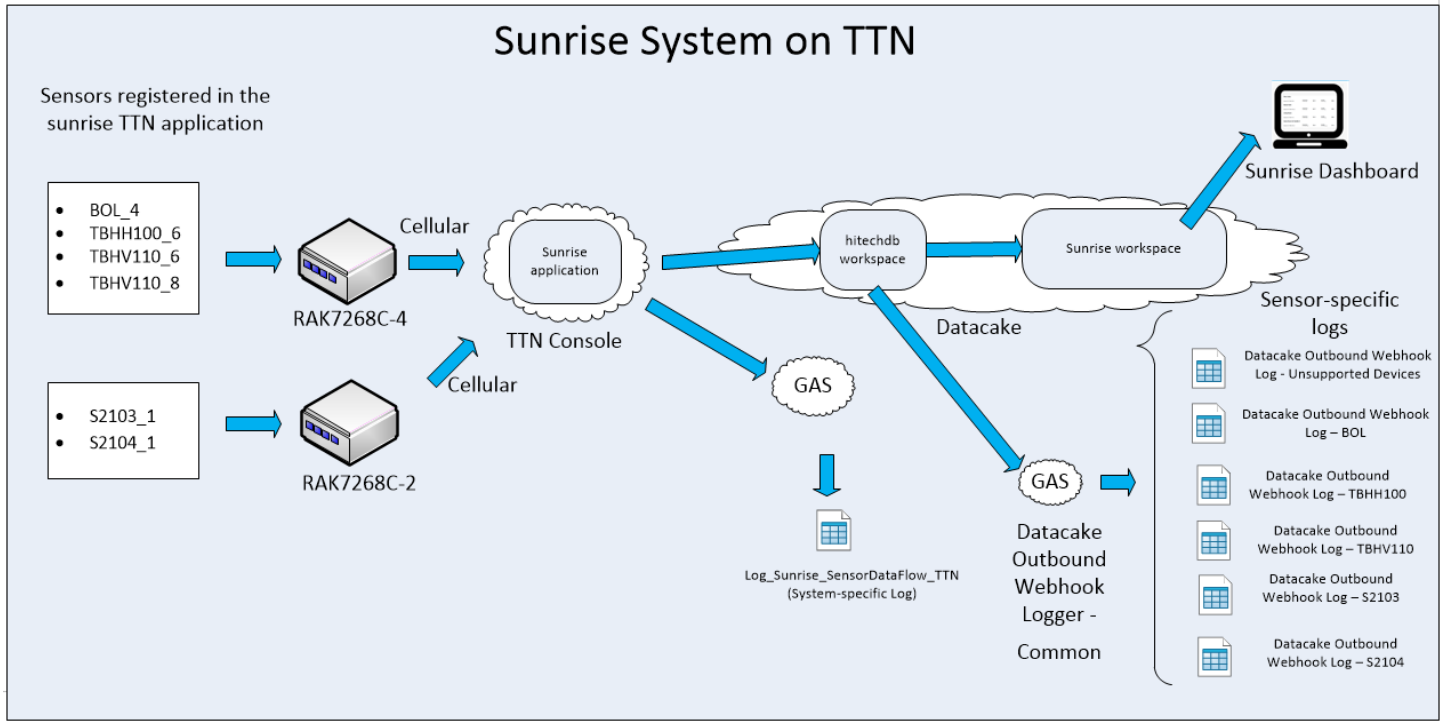
(above) Excerpt from Log_Sunrise_SensorDataFlow_Helium

Trigger for Change

On August 31, 2023, Helium announced the transition of the VIP Console to a paid service, 1663, effective December 7, 2023. This necessitated a decision to either continue with Helium's 1163 service, migrate the system to a different LNS, or shut down the system. We chose to move the Sunrise system to TTN, leveraging our previous experience with a similar LNS transition.

Sunrise System on TTN

The system diagram below depicts the Sunrise Family Farm system on TTN.



(above) System Diagram – Sunrise System on TTN

Key characteristics of the TTN-based system include:

- California sensors connecting through a new gateway, RAK7268C-4
- Georgia sensors connecting through an existing gateway, RAK7268C-2
- Both gateways using Cellular for backhaul
- Sensor-specific data logging from Datacake to Google Sheets via GAS
- System level logging originating from the Sunrise application in TTN

Main differences between the Helium and TTN systems:

1. Use of cellular instead of Wi-Fi for data backhaul
2. System level logging initiation point
3. Device level logging initiation point

Moving the System from Helium to TTN

Below are the high-level steps undertaken for the transition:

1. Purchase of a new gateway and a SIM card for cellular backhaul
2. Provisioning of the SIM card and gateway on TTN
3. Validation of sensor data flow through the gateway to TTN
4. Creation of a new TTN application for Sunrise sensors and integration with Datacake
5. Deployment of the gateway at the customer site
6. Transition of each sensor from Helium to TTN
7. Re-engineering the system and individual sensor logging solutions

Lessons Learned

Total Time Spent The project took 52 hours from October to December, including the development of a detailed transition plan. Prior experience with a similar project reduced potential unknowns, expediting the process.

Cellular VS Wi-Fi Backhaul Cellular connection for gateways simplifies remote deployment but incurs monthly costs. The primary advantage is ease of deployment without network configuration requirements. The primary downside is the expense of cellular data.

Provisioning a Gateway Correctly Before Remote Deployment Ensuring correct gateway settings before customer deployment is crucial. Proper configuration of both LoRa and Wi-Fi settings is essential to avoid unnecessary complications.

The Importance of a Well-Planned Approach A well-thought-out plan is instrumental in minimizing system downtime and customer involvement.

Expecting Unknown-Unknowns Even with a comprehensive plan, unexpected challenges can arise, necessitating flexibility and problem-solving skills. For this project, the Unknown-Unknown was unexpected trouble getting 3 of the sensors to join TTN.

Conclusion

Transitioning Lora Network Servers (LNS) is challenging and can impact system performance. For critical operations like real farms, minimal disruption strategies like sticking with the existing service might be preferable.

About Mike

Mike possesses a diverse and progressive career trajectory, having evolved from an electrical engineer to a software engineer, and ultimately to a project, program, and product manager. His experience spans across designing, constructing, and deploying innovative systems and solutions within the Telecom, Mobile, Healthcare, and IoT sectors. Fueled by a passion for leveraging the latest advancements in sensors, IoT, and AI/ML technologies, Mike is dedicated to creating cutting-edge products and services aimed at enhancing the quality of life for individuals and communities.