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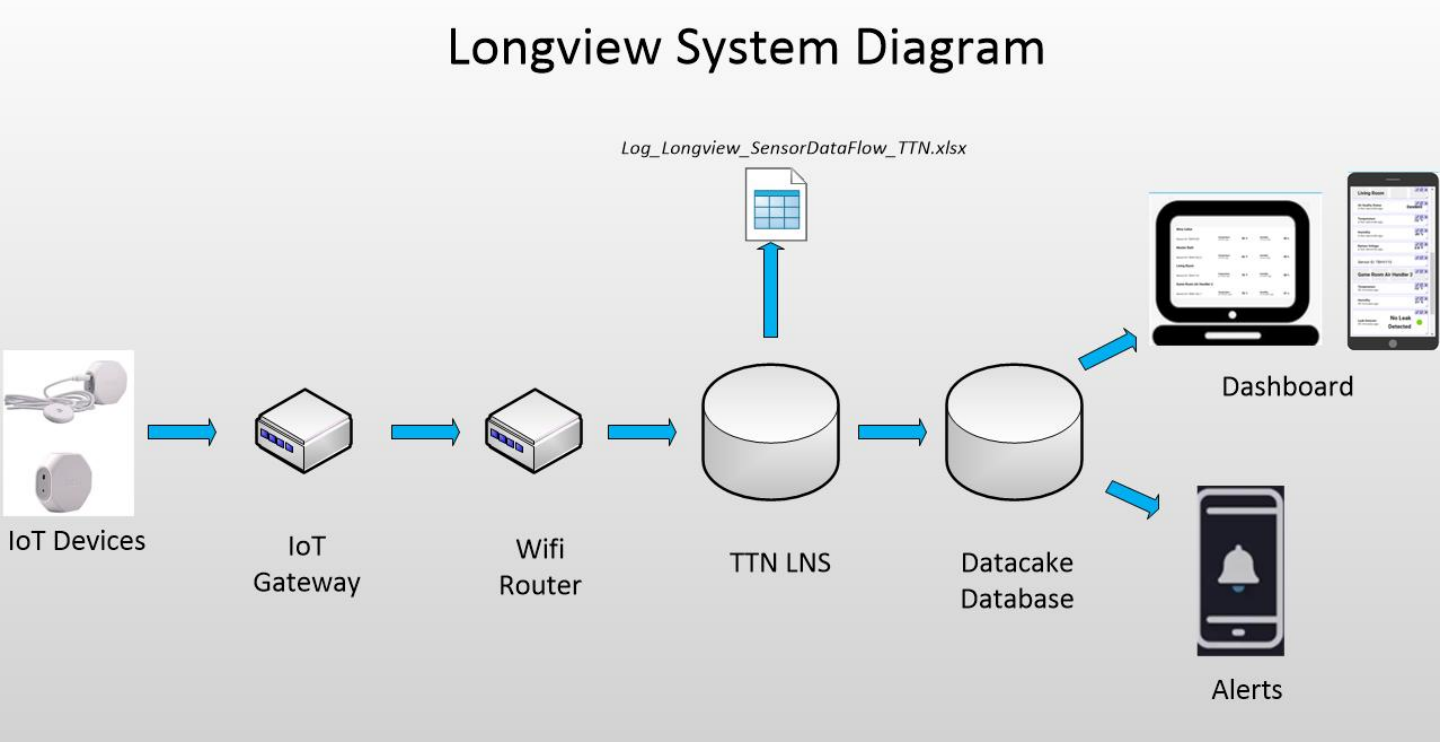
System Overview

Longview is a LoRaWAN IoT system with 7 devices and 1 IoT gateway. The Longview system is in Starkville, Mississippi and uses The Things Industries (TTN) as a LoRaWAN Network Server (LNS).

The IoT gateway is a model RAK7268C that uses a Wi-Fi connection for data backhaul.
The 7 IoT devices in the Longview are listed below

- TBHV110-11 – this is a Browan indoor air quality sensor that measures temperature, humidity, estimated C02 and VOC levels
- TBHH100_8 – this is a Browan indoor temperature and humidity sensor
- TBHH100_10 – this is a Browan indoor temperature and humidity sensor
- TBWL100_7 – this is a Browan indoor water leak sensor that also measures temperature and humidity
- TBWL100_8 – this is a Browan indoor water leak sensor that also measures temperature and humidity
- TBWL100_9 – this is a Browan indoor water leak sensor that also measures temperature and humidity
- TBWL100_10– this is a Browan indoor water leak sensor that also measures temperature and humidity

The diagram below shows a system-level view of the components in the Longview IoT system.



Above – Longview System Diagram

Sept. 28, 2025

System performance is measured by counting the number of messages sent by each device per week and comparing that to the number of messages received by the LoRaWAN Network Server (LNS) for each device per week. The ratio of packets received over packets sent is called Packet Completion Rate or PC Rate.

The file, *20250910_Weekly System Performance Tracker.xlsx*, contains the PC Rate performance data for the 7 sensor devices for the first 9 months of 2025. The screenshot below is taken from that file.

	A	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ
1	Date	TBHV110_11 Frame Count	Packet Count	#PKTS RCVD - 24 HOURS	#PKTS SENT - 24 HOURS	#PKTS RCVD - 7 Days	#PKTS SENT - 7 Days	24 Hour PC Rate	Weekly PC Rate	TBHH100_8 Frame Count	Packet Count	#PKTS RCVD - 24 HOURS	#PKTS SENT - 24 HOURS	#PKTS RCVD - 7 Days	#PKTS SENT - 7 Days	24 Hour PC Rate	Weekly PC Rate	TBHH100_10 Frame Count	Packet Count	#PKTS RCVD - 24 HOURS	#PKTS SENT - 24 HOURS	#PKTS RCVD - 7 Days	#PKTS SENT - 7 Days	24 Hour PC Rate	Weekly PC Rate	TBWL100_10 Frame Count	Packet Count	#PKTS RCVD - 24 HOURS	#PKTS SENT - 24 HOURS	#PKTS RCVD - 7 Days	#PKTS SENT - 7 Days	24 Hour PC Rate	Weekly PC Rate
28	6/23/2005	49154	50541	288	288	2008	2025	100.0%	99.2%	24469	25194	23	24	166	175	95.8%	94.9%	1769	1721	36	37	249	269	97.3%	92.6%	23674	25264	25	25	174	175	100.0%	99.4%
29	6/30/2005	51192	52570	288	288	2016	2025	100.0%	99.6%	24643	25360	23	24	165	174	95.8%	94.8%	2023	1945	32	34	222	252	94.1%	88.1%	23850	25439	24	24	174	175	100.0%	99.4%
30	7/7/2005	53231	54604	288	288	2020	2025	100.0%	99.8%	24816	25525	23	24	164	172	95.8%	95.3%	2256	2169	29	30	222	231	96.7%	96.1%	24027	25615	25	25	174	175	100.0%	99.4%
31	7/14/2005	55242	56599	288	288	2009	2025	100.0%	99.2%	24995	25695	24	25	170	179	96.0%	95.0%	2455	2357	27	28	188	199	96.4%	94.5%	24200	25787	24	24	173	174	100.0%	99.4%
32	7/21/2005	57255	58575	286	288	1988	2025	99.3%	98.2%	25180	25871	23	24	177	186	95.8%	95.2%	2671	2561	29	30	205	217	96.7%	94.5%	24374	25956	24	24	169	174	100.0%	97.1%
33	7/28/2005	59285	60589	287	289	2009	2025	99.3%	99.2%	25354	26038	23	24	165	172	95.8%	95.9%	2887	2770	29	30	208	215	96.7%	96.7%	24550	26131	23	23	173	174	100.0%	99.4%
34	8/4/2005							#DIV/0!	#DIV/0!							#DIV/0!	#DIV/0!							#DIV/0!	#DIV/0!							#DIV/0!	#DIV/0!
35	8/11/2005	60694	61982	0	0	0	0	#DIV/0!	#DIV/0!	25482	26159	0	0	0	0	#DIV/0!	#DIV/0!	3034	2910	0	0	0	0	#DIV/0!	#DIV/0!	24672	26251	0	0	0	0	#DIV/0!	#DIV/0!
36	8/18/2005	65387	62697	97	292	714	1974	33.2%	36.2%	25875	26312	22	24	152	160	91.7%	95.0%	3535	2952	9	24	41	195	37.5%	21.0%	25078	26300	7	22	48	179	31.8%	26.8%
37	8/25/2005	67450	63472	111	289	774	2049	38.4%	37.8%	26054	26482	23	24	169	178	95.8%	94.9%	3766	3029	12	34	76	224	35.3%	33.9%	25269	26368	10	25	67	183	40.0%	36.6%
38	9/1/2005	69518	64265	113	288	787	2054	39.2%	38.3%	26229	26648	23	24	164	173	95.8%	94.8%	3974	3100	10	25	69	202	40.0%	34.2%	25459	26434	7	20	65	183	35.0%	35.5%

Performance Tracker README +

Above – Screenshot from *20250910_Weekly System Performance Tracker.xlsx*

Each week, *20250910_Weekly System Performance Tracker.xlsx* is manually updated with data read from a Datacake system performance dashboard. A screenshot of that dashboard is shown below. The column headers are as follows: Location/Sensor ID, Current Frame Count, Current Packet Count, Packets received last 24 hours, Packets sent last 24 hours, Packets received last 7 days, Packets sent last 7 days, Datarate, Gateway ID.

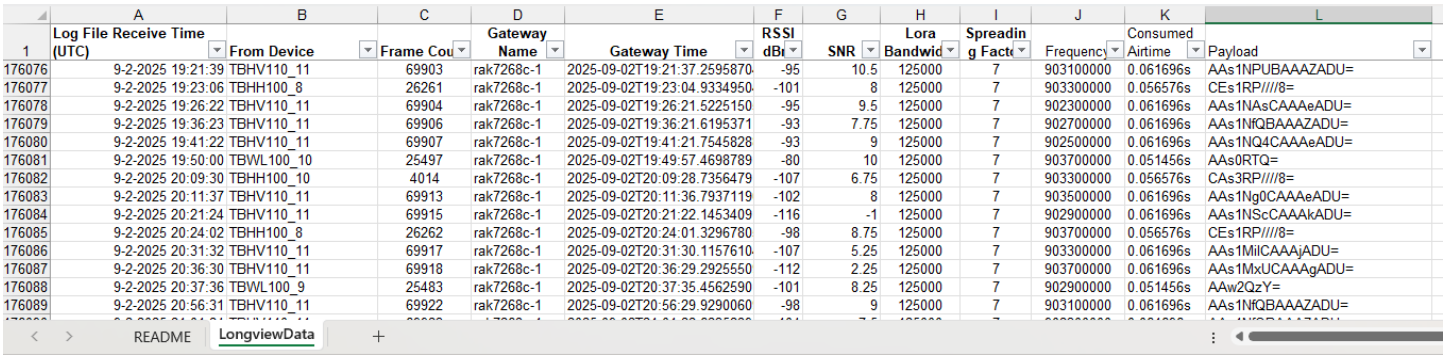
Mercy Hospital								
CO Detector / RA02C-2	2,533	1,985	+23	+36	+167	+252	SF7BW125.0	4 seconds ago rak7268c-2
Vaccine Refrigerator #1 / TBHH100	105,320	197,602	+237	+241	+1,928	+1,958	SF7BW125.0	7 seconds ago rak7268c-2
Tissue Freezer #1 / LHT65_1	112,538	93,088	+73	+73	+502	+505	SF10BW125	6 seconds ago gorgeous-fuchsia-pengui
Nurses Station 6th Floor / TBHH100_2	29,404	33,357	+24	+24	+169	+169	SF7BW125	23 minutes ago precise-frost-aphid
Third Floor Lab / TBHV110_2	126,432	322,631	+288	+288	+2,014	+2,015	SF7BW125	7 seconds ago creamy-holographic-ca
2nd Floor Mechanical Room / TBWL100_1	27,283	32,933	+23	+23	+171	+174	SF7BW125.0	5 seconds ago rak7268c-2
Dietary Walk-In Refrigerator / LDS01	5,909	76,467	+50	+50	+402	+402	SF10BW125	17 minutes ago gorgeous-fuchsia-pengui
Security Vehicle #2 / Gary's BOL	981	41,714	+3	+3	+27	+27	SF10BW125.0	2 hours ago rak7268c-5
Longview								
Great Room / TBHV110-11	77,487	67,304	+111	+290	+787	+2,065	SF7BW125.0	9 minutes ago rak7268c-1
East Cabin / TBHH100_8	26,900	27,288	+22	+24	+167	+176	SF7BW125.0	9 minutes ago rak7268c-1
North Cabin / TBHH100-10	4,868	3,398	+9	+25	+75	+223	SF7BW125.0	3 hours ago rak7268c-1
Workout Room Air Handler / TBWL100_10	26,211	26,697	+9	+23	+69	+200	SF7BW125.0	3 hours ago rak7268c-1
Attic West Air Handler / TBWL100_7	15,663	15,812	+11	+11	+127	+128	SF7BW125.0	30 minutes ago rak7268c-1
Attic East Air Handler / TBWL100_9	26,178	26,600	+8	+23	+67	+184	SF7BW125.0	5 hours ago rak7268c-1
Attic Dehumidifier / TBWL100_8	26,619	27,467	+10	+27	+75	+213	SF7BW125.0	6 seconds ago rak7268c-1
Sunrise Family Farm								
Tractor #1/ BOL_4	3,987	9,031	+3	+3	+31	+31	SF10BW125.0	3 hours ago rak7268c-4
Storage Facility #1/ TBHH100_6	5,160	34,698	+24	+25	+183	+190	SF7BW125.0	22 minutes ago rak7268c-4
Greenhouse/ TBHV110_6	2,008	333,881	+290	+290	+2,015	-50,639	SF7BW125.0	5 seconds ago rak7268c-4
Barn/ TBHV110_5	2,235	82,746	+287	+289	+2,013	+2,025	SF7BW125.0	5 seconds ago rak7268c-4
Test Plot #1/S2103_1	77,138	75,824	+96	+191	+684	+1,359	SF7BW125.0	5 seconds ago rak7268c-2
Test Plot #1/S2104_1	93,913	103,973				+1,213	SF10BW125	5 seconds ago rak7268c-2

Made with DATACAKE

Above – Screenshot of the System Performance Dashboard with the Longview System Highlighted in Red

Sept. 28, 2025

The log file, *20250911_Log_Longview_SensorDataFlow_TTN.xlsx*, is a log of device messages received by the TTN LNS between 2022 and Sept 2025. The screenshot below is taken from that file.



	A	B	C	D	E	F	G	H	I	J	K	L
1	Log File Receive Time (UTC)	From Device	Frame Cou	Gateway Name	Gateway Time	RSSI dBi	SNR	Lora Bandwid	Spreadin g Fact	Frequency	Consumed Airtime	Payload
176076	9-2-2025 19:21:39	TBHV110_11	69903	rak7268c-1	2025-09-02T19:21:37.2595870	-95	10.5	125000	7	903100000	0.061696s	AAs1NPUBAAAZADU=
176077	9-2-2025 19:23:06	TBHH100_8	26261	rak7268c-1	2025-09-02T19:23:04.9334950	-101	8	125000	7	903300000	0.056576s	CEs1RP////8=
176078	9-2-2025 19:26:22	TBHV110_11	69904	rak7268c-1	2025-09-02T19:26:21.5225150	-95	9.5	125000	7	902300000	0.061696s	AAs1NAsCAAAeADU=
176079	9-2-2025 19:36:23	TBHV110_11	69906	rak7268c-1	2025-09-02T19:36:21.6195371	-93	7.75	125000	7	902700000	0.061696s	AAs1NfQBAAAZADU=
176080	9-2-2025 19:41:22	TBHV110_11	69907	rak7268c-1	2025-09-02T19:41:21.7545828	-93	9	125000	7	902500000	0.061696s	AAs1NQ4CAAAeADU=
176081	9-2-2025 19:50:00	TBWL100_10	25497	rak7268c-1	2025-09-02T19:49:57.4698789	-80	10	125000	7	903700000	0.051456s	AAs0RTQ=
176082	9-2-2025 20:09:30	TBHH100_10	4014	rak7268c-1	2025-09-02T20:09:28.7356479	-107	6.75	125000	7	903300000	0.056576s	CAs3RP////8=
176083	9-2-2025 20:11:37	TBHV110_11	69913	rak7268c-1	2025-09-02T20:11:36.7937119	-102	8	125000	7	903500000	0.061696s	AAs1Ng0CAAAeADU=
176084	9-2-2025 20:21:24	TBHV110_11	69915	rak7268c-1	2025-09-02T20:21:22.1453409	-116	-1	125000	7	902900000	0.061696s	AAs1NScCAAAkADU=
176085	9-2-2025 20:24:02	TBHH100_8	26262	rak7268c-1	2025-09-02T20:24:01.3296780	-98	8.75	125000	7	903700000	0.056576s	CEs1RP////8=
176086	9-2-2025 20:31:32	TBHV110_11	69917	rak7268c-1	2025-09-02T20:31:30.1157610	-107	5.25	125000	7	903300000	0.061696s	AAs1MilCAAAjADU=
176087	9-2-2025 20:36:30	TBHV110_11	69918	rak7268c-1	2025-09-02T20:36:29.2925550	-112	2.25	125000	7	903700000	0.061696s	AAs1MxUCAAAgADU=
176088	9-2-2025 20:37:36	TBWL100_9	25483	rak7268c-1	2025-09-02T20:37:35.4562590	-101	8.25	125000	7	902900000	0.051456s	AAw2QzY=
176089	9-2-2025 20:56:31	TBHV110_11	69922	rak7268c-1	2025-09-02T20:56:29.9290060	-98	9	125000	7	903100000	0.061696s	AAs1NfQBAAAZADU=

README LongviewData +

Above – Screenshot from *20250911_Log_Longview_SensorDataFlow_TTN.xlsx*

For each message received by the LNS, the following information is recorded:

- **Log File Receive Time (UTC)** – The UTC timestamp at which the message was received by the logging application. A webhook from the LNS sends each device message to a Google Application Script which logs the message to a Google Sheet file.
- **From Device** – The name of the sending device
- **Frame Count** – The frame count value in the message data. The frame count increments by 1 each time a device sends a message. Gaps in frame count indicate when messages sent from a device were not received by the gateway.
- **Gateway Name** – The name of the IoT gateway. In the Longview system, there is only 1 IoT gateway.
- **Gateway Time** - A timestamp indicating when the gateway received an uplink message from an end device
- **RSSI dBm** – This is a measurement of the power level of the radio signal received by the gateway from the end device.
- **SNR** – This is a measurement of the ratio of the power of the received signal to the power of the background noise. It is a more accurate indicator of signal quality than RSSI alone.
- **Lora Bandwidth** – This is the frequency range a LoRa signal occupies when transmitting. It is a critical radio parameter that defines the channel width used by the device and gateway to communicate. The bandwidth directly affects the trade-offs between data rate, range, and energy consumption. A log entry will typically show one of the standard bandwidth values used in LoRaWAN, which include 125 kHz, 250 kHz, and 500 kHz, depending on the region and the specific data rate being used. A lower bandwidth "spreads" the signal over a narrower frequency range. This makes it more resilient to noise and improves the receiver's sensitivity, which in turn increases the communication range. The longest-range transmissions use the narrowest bandwidths.
- **Spreading Factor** – This is the LoRa spreading factor used for the message transmission from the device. The LoRa spreading factor (SF) is a key parameter that indicates the trade-off made between communication range and data rate for each transmitted message. The SF influences how data is sent and is a defining characteristic of LoRa's Chirp Spread Spectrum (CSS) modulation. The values range from 7 to 12.
- **Frequency** - Refers to the specific radio channel in Hertz (Hz) used by the device to transmit message to the gateway
- **Consumed Airtime** - The actual duration (in milliseconds) that a radio transmission occupied the airwaves. This is calculated by the end device or network server based on the message's size, spreading factor (SF), and bandwidth (BW). This value is used to ensure compliance with duty cycle regulations, which limit the total time a

device can transmit on a particular frequency band. It also helps estimate device battery consumption. This value varies based on the spreading factor and payload size. A higher spreading factor or larger payload increases consumed airtime.

- **Payload** – The is the base64-encoded string of the binary message sent by the device. This payload contains the measurement and other device-specific data.

Problem Statement

Between 8/2/2025 2:52am ET and 8/11/2025 1:30pm ET, the IoT gateway was offline, resulting in no message transfer from the devices to the LNS. Before the gateway went offline, PC Rate was near 94% for all 7 sensors. When the IoT gateway came back online after 9 days of being offline, only 2 of the sensors (TBHH100_8 and TBWL100_7) returned to a near 94% PC Rate. The other 5 sensors have been running at a PC Rate in the 34% range since the gateway came back online.

Challenge

Using the information in the logs:

1. Figure out what is causing the drop off in PC Rate for devices TBHV110-11, TBHH100-10, TBWL100_8, TBWL100_9, and TBWL100_10 after the gateway outage and why there was no drop-off in PC Rate for TBHH100_8 and TBWL100_7
2. Figure out how to fix the poor PC Rates without having to do a physical reset (battery pull and terminal short) of the devices