

RF AMI/DR Network Overview

May 11th, 2023

Eaton Introductions

- William Corbalis – Firmware Engineer
- Shashikant Chowdhary – Firmware Engineer
- Rena Wang – Training Manager

Node Detail Page

Node Details

INFO

Node Serial Number : 4210
Node Type : Electric node
Sensor Info : 3211 (ITRN , C2SX-SD) [3/22/2023 10:50:48]
Product Number : RFN420CL
Hardware Version : RFN420CL
Software Version : R11.3.4.S1Kp
Node Names :
Groups :
Commissioned ? : Yes
Commissioned Time :
In Network ? : Yes
In Network Time : 11/1/2019 17:12:53
Latitude : 41.586149
Longitude : -84.595198
GPS Source : RF Node

NODE VERSIONS

Backup Eka Software Version : R10.2.1.S1Kp

COMMUNICATIONS

Node Address : 00:14:08:
Primary Gateway : **Gateway**
Communication Status : Ready
Communication Status obtained at : 4/13/2023 18:17:52
Number of Hops to Gateway : 1
Current Number of Neighbors : 19
Current Primary Neighbor : **00:14:08:**
Link Cost to Primary Neighbor : 1.0 (ETX band: 1)
Current Link Rate to Primary Neighbor : 2x
Current Link Power to Primary Neighbor : 0.5 Watt
Current Neighbor Data Timestamp : 4/13/2023 17:51:07
Number of Associations : 1

Menu Options

Refresh Node Details

Show Node Logs
Show Node Routes
Show Node Neighbors
Show Node Visible Neighbors
Show Node Data Points
Show Node Status Points
Show Node Events
Show Node Alarms
Set Channel Configuration
Get Channel Configuration
Get Current Meter Reading
Get Node Information
Get Communication Status
Add to Group
Generate Report

Show Node.. Logs, Routes, Neighbors, etc.

- What are these?
 - Logged data pertaining to RF node's interactions and radio communication (RFN Meter, RFN Relay, etc.)
- When to review?
 - Deeper dive if warranted after utilizing Yukon resources, mapping features
- Why use?
 - **Comprehensive review** of a node's connectivity behavior from multiple angles
 - **Identify patterns** from behavior over time

Node Logs

- **About Node Logs**
 - Each RF Gateway logs certain interactions with subscribed RF Nodes
 - When user accesses Node Logs, Network Manager filters RF Gateways for applicable logs over specified time period
 - If multiple Gateways log interaction with an RF node, Node Logs will include the logs from each
- **Why Review?**
 - Helps build understanding of node circumstances

Node Logs – Normal Output

Row	Log Timestamp	Log	Log Level	Gateway Name
4210460469				
1	4/14/2023 15:47:30	Updated formatID 1281 index for node 4210460469: StartSeq 8734, EndSeq 8744	Information Log	VCGW228
2	4/14/2023 15:47:30	Received formatID 1281 report from node 4210460469: StartSeq 8734, EndSeq 8744	Information Log	VCGW228
3	4/14/2023 10:25:44	Received routing table from 4210460469	Information Log	VCGW228
4	4/14/2023 10:25:43	Requested routing table for 4210460469	Information Log	VCGW228
5	4/14/2023 10:09:44	Received visibility table from 4210460469	Information Log	VCGW228
6	4/14/2023 10:09:44	Received neighbor table from 4210460469	Information Log	VCGW228
7	4/14/2023 10:09:43	Requested visibility table for 4210460469	Information Log	VCGW228
8	4/14/2023 10:09:43	Requested neighbor table for 4210460469	Information Log	VCGW228
9	4/13/2023 23:50:42	Received routing table from 4210460469	Information Log	GW218
10	4/13/2023 23:50:41	Requested routing table for 4210460469	Information Log	GW218

Node Route Table

- **About Node Route Table**
 - Nodes typically report route data to RF Gateway **daily**
 - One row per day
 - Illustrates connection quality of node's reliant route for reaching RF Gateway
- **Why Review?**
 - Helps build understanding of node route connections, over time
- **What to look for**
 - Hop count, route cost and '**Count to Cost**' ratio
 - 1:1 is GOOD,
 - 1:2 can be problematic
 - Gaps in data entry

Node Routes – Reliable Routes

Row	Data Timestamp	Dest. Address	Next Hop Address	Hop Count	Cost
4110032890					
1	4/21/2023 03:39:14	00:14:08:03:E2:AB	00:14:08:03:E2:AB	1	0
2	4/20/2023 03:38:48	00:14:08:03:E2:AB	00:14:08:03:E2:AB	1	0
3	4/19/2023 03:52:00	00:14:08:03:E2:AB	00:14:08:03:E2:AB	1	0
4	4/18/2023 03:37:58	00:14:08:03:E2:AB	00:14:08:03:E2:AB	1	0
5	4/17/2023 03:37:33	00:14:08:03:E2:AB	00:14:08:03:E2:AB	1	0
6	4/16/2023 03:37:11	00:14:08:03:E2:AB	00:14:08:03:E2:AB	1	0
7	4/15/2023 03:36:46	00:14:08:03:E2:AB	00:14:08:03:E2:AB	1	0
8	4/14/2023 03:36:22	00:14:08:03:E2:AB	00:14:08:03:E2:AB	1	0
9	4/13/2023 03:35:55	00:14:08:03:E2:AB	00:14:08:03:E2:AB	1	0
10	4/12/2023 03:35:30	00:14:08:03:E2:AB	00:14:08:03:E2:AB	1	0

Row	Data Timestamp	Dest. Address	Next Hop Address	Hop Count	Cost
4110173772					
1	4/21/2023 05:14:12	00:14:08:04:B5:4B	00:14:08:04:B5:4B	1	1
2	4/20/2023 05:13:57	00:14:08:04:B5:4B	00:14:08:04:B5:4B	1	1
3	4/19/2023 05:13:42	00:14:08:04:B5:4B	00:14:08:04:B5:4B	1	1
4	4/18/2023 05:13:22	00:14:08:04:B5:4B	00:14:08:04:B5:4B	1	1
5	4/17/2023 05:13:11	00:14:08:04:B5:4B	00:14:08:04:B5:4B	1	1
6	4/16/2023 05:12:56	00:14:08:04:B5:4B	00:14:08:04:B5:4B	1	1
7	4/15/2023 05:12:42	00:14:08:04:B5:4B	00:14:08:04:B5:4B	1	1

Node Neighbor Table

- **About Node Neighbor Table**
 - Nodes typically report neighbor data to RF Gateway **every 3 days**
 - 0-to-many rows per day -> however many neighbors are present!
 - Illustrates connection quality of RF mesh resources which are accessible to node in question
- **Why Review?**
 - Helps build understanding of node's accessible RF neighbor resources, over time
- **What to look for**
 - Link Cost, ETX Band, and 'PF' Flag
 - PF = Primary Forward; reliable connection to PF is impactful
 - Gaps in data entry

Node Neighbors – Reliable Connection

Row	Data Timestamp	Neighbor Address	Link Cost	ETX Band	Current Rate	Current Power	Samples	Flags
1	4/23/2023 04:46:07	00:14:08:03:E2:A	5.0	2	1x	1 Watt	0	S1
2	4/23/2023 04:46:07	00:14:08:03:E2:A	5.0	2	1x	1 Watt	0	S1
3	4/23/2023 04:46:07	00:14:08:00:00:2	5.0	2	1x	1 Watt	0	S1
4	4/23/2023 04:46:07	00:14:08:03:73:0	2.7	2	1x	1 Watt	8	S1
5	4/23/2023 04:46:07	00:14:08:03:E2:9	5.0	2	1x	1 Watt	0	PF
6	4/23/2023 04:46:07	FF:FF:FF:FF:FF:AC	5.0	2	1x	1 Watt	0	
7	4/23/2023 04:46:07	00:14:08:0A:72:5	5.0	2	1x	1 Watt	0	S1
8	4/20/2023 04:45:20	00:14:08:03:E2:A	5.0	2	1x	1 Watt	0	S1
9	4/20/2023 04:45:20	00:14:08:01:D8:7	1.0	2	1x	1 Watt	6	PF
10	4/20/2023 04:45:20	00:14:08:00:00:2	5.0	2	1x	1 Watt	0	S1
11	4/20/2023 04:45:20	00:14:08:03:73:0	2.7	2	1x	1 Watt	8	S1
12	4/20/2023 04:45:20	00:14:08:03:E2:9	5.0	2	1x	1 Watt	0	S1
13	4/20/2023 04:45:20	FF:FF:FF:FF:FF:AC	5.0	2	1x	1 Watt	0	
14	4/20/2023 04:45:20	00:14:08:0A:72:5	5.0	2	1x	1 Watt	0	S1
15	4/17/2023 04:44:38	00:14:08:03:E2:A	5.0	2	1x	1 Watt	0	S1
16	4/17/2023 04:44:38	00:14:08:01:D8:7	1.0	2	1x	1 Watt	6	PF
17	4/17/2023 04:44:38	00:14:08:00:00:2	5.0	2	1x	1 Watt	0	S1
18	4/17/2023 04:44:38	00:14:08:03:73:0	2.7	2	1x	1 Watt	8	S1
19	4/17/2023 04:44:38	00:14:08:03:E2:9	5.0	2	1x	1 Watt	0	S1
20	4/17/2023 04:44:38	FF:FF:FF:FF:FF:AC	5.0	2	1x	1 Watt	0	
21	4/17/2023 04:44:38	00:14:08:0A:72:5	5.0	2	1x	1 Watt	0	S1
22	4/14/2023 04:43:59	00:14:08:03:E2:A	5.0	2	1x	1 Watt	0	S1
23	4/14/2023 04:43:59	00:14:08:01:D8:7	5.0	2	1x	1 Watt	0	S1
24	4/14/2023 04:43:59	00:14:08:03:5F:1	5.0	2	1x	1 Watt	0	F
25	4/14/2023 04:43:59	00:14:08:00:00:2	5.0	2	1x	1 Watt	0	S1
26	4/14/2023 04:43:59	00:14:08:03:73:0	5.0	2	1x	1 Watt	0	S1
27	4/14/2023 04:43:59	00:14:08:03:E2:9	1.6	1	1x	1 Watt	26	PF
28	4/14/2023 04:43:59	FF:FF:FF:FF:FF:AC	5.0	2	1x	1 Watt	0	

Gateway Information

Gateway Details

- Similar page in Network Manager
- Gateway Software Version
 - Software – Interface to Network Manager
 - Upper Stack – The RF Network Interface
 - Radio – Firmware on the radio daughter board
 - Release – Typically firmware available to spread to RF Nodes
- Location
 - Useful for displaying network topology overlaid on a physical map

Home / Gateways / GW222

★ GW222

Actions ▾

Gateway Information

Name: GW222
Type: GWY-800
Serial Number: 10106171222
Hardware Version: GW2.0
Software Version: R_9_5_0
Upper Stack Version: R_9_5_0_0_1
Radio Version: R5.5.0qp
Release Version: 9.5.1
Version Conflicts: None
Application Mode: Normal
Streaming Capacity: 0% [View History](#)

Edit

Notes

Note Text (255 characters max)

+ Create

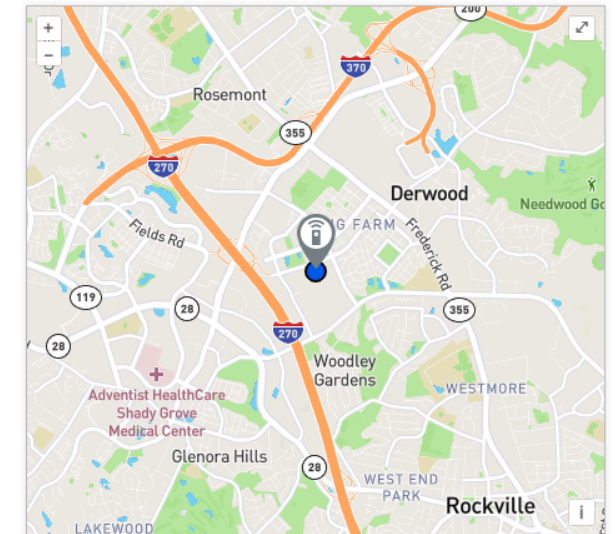
No notes to display.

[All Notes](#)

Location ?

Latitude: 39.10906 Longitude: -77.17672

Infrastructu... ▾



Miles: 1.0 ▾

Nearby

Neighbors



Gateway Details (cont'd)

- Communication
 - Connection Status
- Gateway Metrics/Gateway Node Information
 - Hovering over the green bars will show a breakdown.
 - Total count can be seen under “Nodes with Serial Numbers”
- Infrastructure Alarms/Gateway Events
 - Yukon derived
 - Events directly from Gateway

Communication

Admin: admin
Super Admin: super
Connection Type: TCP/IP
IP Address: Port: 32030
NM IP Address: Port: 32030
EkaNet 915 MHz
MAC Address: FF:FF:FF:FF:FF:FF
Version: V_13_33_5
Radios: EkaNet 915 MHz
MAC Address: 00:14:08:08:84:9C
Version: V_13_63
Connection Status: ■ Connected 04/14/2023 18:25:39
Last Communication: ■ Successful 04/14/2023 18:25 EDT

Gateway Metrics

Ready Nodes: 12 Counts 05/10/2023 09:36:59
Streaming Capable Device Count: 6 Counts 05/10/2023 09:37:27
Streaming Active Device Count: 0 Counts 05/10/2023 09:37:27

Gateway Node Information

Cellular Capable Count: 0
Wi-Fi Capable Count: 0
Ready Nodes: 92.31%
Nodes with Info: 92.31%
Nodes with Serial Numbers: 92%

Infrastructure Warnings

04:24 PM 05/13/2021 Gateway detecting AC power failure.
10:58 AM 07/05/2022 Duplicate color 20 configured into gateway.
07:16 PM 08/29/2022 Gateway's total ready node count (12) is lower than the warning threshold (25).
04:24 PM 05/13/2021 Gateway security alarm, SSH service enabled.
04:25 AM 11/10/2021 Gateway detecting low voltage on UPS battery.


Gateway Events

Timestamp	Event	State
03/04/2023 12:43:43	Power Failure	■ Cleared
03/04/2023 12:43:41	Power Failure	■ Active
11/28/2022 00:05:50	Time Sync Failed	■ False
11/27/2022 23:05:51	Time Sync Failed	■ True
11/27/2022 23:04:17	Power Failure	■ Cleared
11/27/2022 17:28:08	Power Failure	■ Active
11/20/2022 06:37:27	Power Failure	■ Cleared
11/20/2022 05:46:34	AC Power Failure	■ Active
11/20/2022 05:46:32	AC Power Failure	■ Cleared
11/20/2022 05:41:44	Power Failure	■ Active

Gateway Details (penultimate)

- Data Collection
 - Data Completeness – How synchronized Yukon/NM are with the Gateway
 - If less than 100%, there is data pending on Gateway
 - Sensor Data – Metering/Billing data, events
 - Node Alarms – Outage alarms








Data Collection

Data Completeness:  100%

Collection Schedule: Custom, 2 17 */1 * * ? *

[Edit](#)

Sequencing

Data Type	Sequence Start	Sequence End	Completeness
Gateway Alarms	0	177	 100%
Gateway Logs	0	10693	 100%
General Purpose Data	0	22236	 100%
Node Alarms	0	10323	 100%
Node Data	0	126371	 100%
Node Logs	0	204717	 100%
Sensor Data	0	197830	 100%

Gateway Details (Network Manager)

Nodes
Search Results
Neighbors
Visible Neig...
Gateway Details

[Menu Options](#)
Legend +

INFO

Name : GW222
Gateway Type : Energy Management
Maximum No. of Nodes :
User Access ID :
Administrator Access ID : admin
Product Number : 2.0
Serial Number : 10106171222
Hardware Version : GW2.0
Software Version : R_9_5_0
Upper Stack Version : R_9_5_0_0_1
Radio Version : R5.5.0qp
Release Version : 9.5.1
Version Conflicts : None
Application Mode : Normal Mode
Groups :
Route Color : 20
GW IPv6 Prefix :

COMMUNICATIONS

Connection Type : TCP/IP
IP Addresses : 10.106.171.222 Port: 32030 EkaNet (TCP + SSL)

Connection Status : ■ (Connected)
Communication Status : ■ Last connected at: 4/14/2023 18:25:39
Radios : EkaNet 915 MHz MAC Address: 00:14:08:08:84:9C [7/9/2019 14:40:13]
EkaNet 915 MHz MAC Address: FF:FF:FF:FF:FF:FF [1/17/2020 16:58:00]
Radio Stack Revision : V_13_63,V_13_33_5

GATEWAY NODE SUMMARY

Row	Data Type	Value
1	Total Nodes	13
2	Total Ready Nodes	12
3	Total Not Ready Nodes	1
4	Total Nodes With SN	12
5	Total Nodes With Info	12
6	Total Nodes Without Info	1

Infrastructure Warnings/Events

- Power Failure – All power lost, running on internal capacitors
- Time Sync Failed – Gateway is not synchronizing with NTP and will stop syncing the RFN
- Disk Space – Gateway at 80% disk usage, abnormal condition and there is some fault to address
- Radio – If standing, implies RF comms have been lost
- Node Counts – Low indicates GW radio or antenna issue, high may indicate GW has low capacity for incoming devices

Gateway Routes

Row	Data Timestamp	Dest. Address	Next Hop Address	Hop Count	Cost	Flags
GW214						
1	5/9/2023 22:37:42	00:14:08:0D:F5:B6	00:14:08:0D:F5:B6	1	1	
2	5/9/2023 22:37:42	00:14:08:16:49:17	00:14:08:16:49:17	1	1	PR
3	5/9/2023 22:37:42	00:14:08:08:84:A2	00:14:08:16:49:17	2	2	PF
4	5/9/2023 22:37:42	00:14:08:03:CA:EA	00:14:08:03:CA:EA	1	2	
5	5/9/2023 22:37:42	00:14:08:16:D0:13	00:14:08:16:D0:13	0	0	PF

- Full routing table, will display all descendants in the segment
- “PR” Primary Reverse – Gateway believes the node is using it, path to a destination meter/relay/lcr/etc.
- “PF” Primary Forward – Path to a gateway
 - PF with 0 cost and 0 hops – Seed route, route from gateway to itself
- No Flag – Neighboring device but not using this gateway

Gateway Logs

Row	Log Timestamp	Log	Log Level
GW222			
1	4/2/2023 20:22:09	Gateway time adjusted: Sun Apr 2 23:46:33 UTC 2023: 151.110.126.15: 0.180742 sec	Information Log
2	4/2/2023 14:22:12	Gateway time adjusted: Sun Apr 2 17:46:33 UTC 2023: 151.110.126.15: 0.145872 sec	Information Log
3	4/2/2023 08:22:15	Gateway time adjusted: Sun Apr 2 11:46:03 UTC 2023: 151.110.126.15: 0.156891 sec	Information Log
4	4/2/2023 08:20:42	Sequence Upgrade: Network Evaluation - USN = 376	Information Log
5	4/2/2023 07:22:16	Gateway time fail	Alarm Flag Lower
6	4/2/2023 07:20:43	Application started, Version R_9_5_0	Information Log
7	4/2/2023 07:20:43	Gateway has valid time	Information Log
8	4/2/2023 07:18:35	Trigger activated: SYSTEM_WARNING Message: GatewayWatchdog.performHealthCheck(): Not sending pulse	Error Log
9	4/2/2023 07:18:35	Trigger activated: SYSTEM_WARNING Message: GatewayWatchdog.performHealthCheck(): SensorProtocolManager has not checked in for 150009ms	Error Log
10	4/2/2023 07:18:05	Trigger activated: SYSTEM_WARNING Message: GatewayWatchdog.performHealthCheck(): Not sending pulse	Error Log
11	4/2/2023 07:18:05	Trigger activated: SYSTEM_WARNING Message: GatewayWatchdog.performHealthCheck(): SensorProtocolManager has not checked in for 119997ms	Error Log
12	4/2/2023 02:15:10	Gateway time adjusted: Sun Apr 2 05:46:03 UTC 2023: 151.110.126.15: 0.631748 sec	Information Log
13	3/4/2023 19:20:48	Gateway time adjusted: Sat Mar 4 23:37:03 UTC 2023: 151.110.126.15: 0.103097 sec	Information Log
14	3/4/2023 13:20:51	Gateway time adjusted: Sat Mar 4 17:37:03 UTC 2023: 151.110.126.15: 0.513897 sec	Information Log
15	3/4/2023 12:43:43	Power restored	Alarm Flag Lower
16	3/4/2023 12:43:41	Power failure	Alarm Flag Raise
17	3/4/2023 07:20:55	Gateway time adjusted: Sat Mar 4 11:37:03 UTC 2023: 151.110.126.15: 0.651015 sec	Information Log
18	3/4/2023 01:20:58	Gateway time adjusted: Sat Mar 4 05:37:03 UTC 2023: 151.110.126.15: -0.604391 sec	Information Log

- “Application Started” - Gateway has restarted
- “Gateway time adjusted” – Indicates successful time sync (expect 4/day)
- Several alarms are reflected in the logs
- Gateway will automatically restart every 24 hours if it does not receive a message from the RFN

RF Node Issues

RF Network Troubleshooting

- Yukon has added features to display Network Information.
- If provided with GPS Coordinates, Yukon also provides mapping of the network topology overlaid on the physical location.

Peak Demand: 0.000 kW 04/30/2023 02:00:00 Archived Usage Data HTML | CSV
Demand: 0.000 kW 04/30/2023 02:00:00 Daily Usage Data HTML | CSV
Voltage: 240.1 Volts 04/30/2023 02:00:00

View All | Quick View

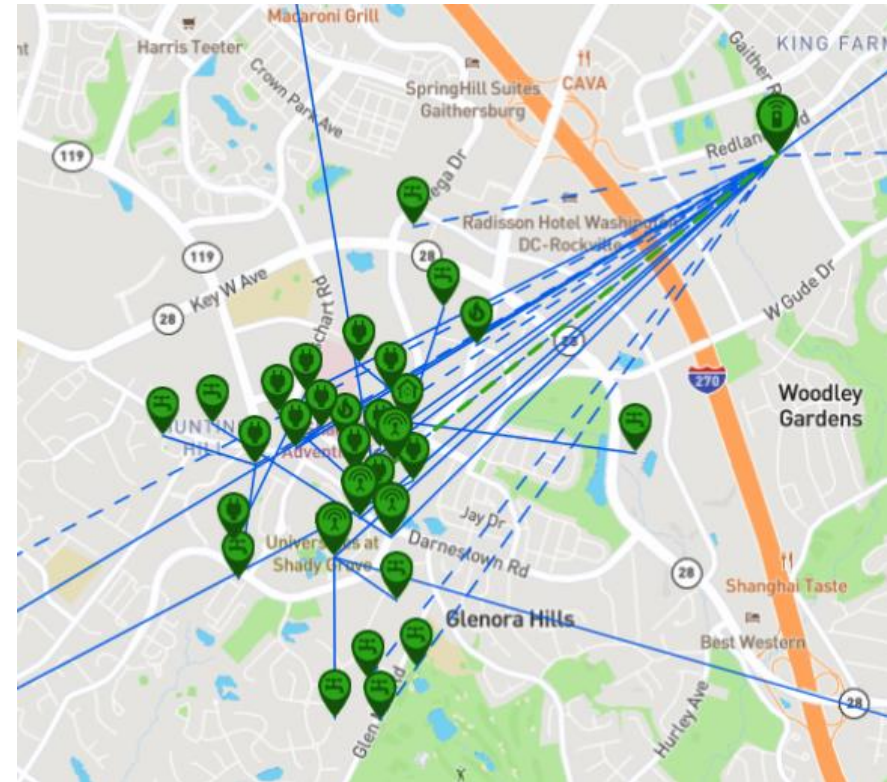
Network Information

Battery Node Associations:	0
Boot Loader Version:	2
Comm Status:	Ready
Comm Status Obtained At:	05/01/2023 00:17
Groups:	915rollback-gw211
Hardware Version:	RFN420CL
Hop Count:	1
Joined Network At:	05/27/2022 10:06
MAC Address:	00:14:08:04:DE:40
Neighbor Count:	12
Node Firmware Version:	R11.5.11.S1Kp
Node Serial Number:	4210031347
Node Type:	Electric node
Primary Forward:	GW211
Primary Neighbor:	00:14:08:09:65:08
Primary Neighbor Data Timestamp:	04/29/2023 23:59
Primary Neighbor Link Cost:	1.0
Product Number:	RFN420CL
Reverse Lookup:	GW211

Show All

Notes

Note Text (255 characters max)



RF Network Troubleshooting

- Node Details screen gives a lot of information about the node (Node S/N, fw version, comms status, link cost, power, data rate...)

Yukon
Network Manager

Network Manager Welcome Administrator | Log out

Gateway Node Primary Gateway GW223 GO

Node Details Menu Options

INFO

Node Serial Number : 421000058
 Node Type : Electric node
 Sensor Info : 88638034 (ITRN , C25X) [2/2/2016 00:08:00]
 Product Number : RFN420CL
 Hardware Version : RFN420CL
 Software Version : R9.0.0.S1Kp
 Node Names :
 Groups : Next Gen 2 Water Packet-9.6, All_7.0_Nodes, 9.6 Meters
 Commissioned ? : Yes
 Commissioned Time :
 In Network ? : Yes
 In Network Time : 2/2/2016 00:08:00

NODE VERSIONS

Backup Eka Software Version : Q9.0.0.28Kp

COMMUNICATIONS

Node Address : 00:14:08:00:00:11
 Primary Gateway : **GW221**
 Communication Status : Ready
 Communication Status obtained at : 10/21/2016 17:50:06
 Number of Hops to Gateway : 1
 Current Number of Neighbors : 11
 Current Primary Neighbor : **00:14:08:08:84:A8 (Gateway 10106171221)**
 Link Cost to Primary Neighbor : 1.0 (ETX band: 1)
 Current Link Rate to Primary Neighbor : 1/2x
 Current Link Power to Primary Neighbor : 1 Watt
 Current Neighbor Data Timestamp : 10/21/2016 07:21:30

Click [here](#) to update node location.

DATA COLLECTION CONFIGURATION

Row	Channel Number	Units	Enabled ?	Recording Frequency	Reporting Frequency
1	1	Wh Quadrant 1, Quadrant 4	Yes	1 hr	1 day
2	2	Wh Quadrant 2, Quadrant 3	No	1 hr	1 day

Neighbor Table Details

- **PF** – Primary Forward
- **PR** – Primary Reverse
- **S1** – Secondary neighbors, serving GW
- **S2** – Secondary neighbors, alternate GW
- **F** - Float Neighbor
- **BN** – Battery neighbor
- **IN** – Ignored neighbor (Field- tool)

Nodes	Search Results	Neighbors	Visible Neig...					
Row	Data Timestamp	Neighbor Address	Link Cost	ETX Band	Current Rate	Current Power	Samples	Flags
4210123395								
1	5/8/2023 22:41:52	00:14:08:0A:72:4A	1.0	1	1x	0.5 Watt	39	F
2	5/8/2023 22:41:52	00:14:08:09:9B:C3	1.0	1	1/2x	0.5 Watt	144	S1
3	5/8/2023 22:41:52	00:14:08:09:9B:BB	1.0	1	1/2x	0.5 Watt	264	S1
4	5/8/2023 22:41:52	00:14:08:04:66:79	1.0	1	1x	0.5 Watt	28	S1
5	5/8/2023 22:41:52	00:14:08:09:6B:51	21.3	6	1/2x	0.5 Watt	9	
6	5/8/2023 22:41:52	00:14:08:03:CB:03	1.0	1	1x	1 Watt	48	S1
7	5/8/2023 22:41:52	00:14:08:04:35:BE	1.0	2	1/2x	0.5 Watt	8	F
8	5/8/2023 22:41:52	00:14:08:04:35:B9	1.0	1	1/2x	0.5 Watt	32	F
9	5/8/2023 22:41:52	00:14:08:0A:BF:0C	1.0	1	1/2x	0.5 Watt	192	S1
10	5/8/2023 22:41:52	00:14:08:04:66:59	1.0	1	1/2x	0.5 Watt	72	F
11	5/8/2023 22:41:52	00:14:08:0A:72:49	1.0	1	1/2x	0.5 Watt	72	F
12	5/8/2023 22:41:52	00:14:08:01:49:19	1.0	1	1x	0.5 Watt	75	F
13	5/8/2023 22:41:52	00:14:08:03:9B:E6	1.1	2	1/2x	0.5 Watt	8	F
14	5/8/2023 22:41:52	00:14:08:0A:72:5B	1.0	1	1/2x	0.5 Watt	40	F
15	5/8/2023 22:41:52	00:14:08:0A:72:48	1.0	1	1/2x	0.5 Watt	24	F
16	5/8/2023 22:41:52	00:14:08:04:66:83	1.0	1	1/2x	0.5 Watt	48	F
17	5/8/2023 22:41:52	00:14:08:06:4A:6E	1.0	1	1/2x	1 Watt	167	F
18	5/8/2023 22:41:52	FF:FF:FF:FF:AC	5.0	2	1/2x	1 Watt	0	
19	5/8/2023 22:41:52	00:14:08:0E:D7:16	1.0	1	2x	250 mWatt	62	PF

Visibility Table

- **S1** – Secondary neighbors, serving GW
- **S2** – Secondary neighbors, alternate GW
- **V1** – Visible neighbors, serving GW
- **V2** – Visible neighbor, alternate GW

Row	Data Timestamp	Visible Neighbor Address	Color	Path Cost	Link Cost	Link Cost Eval.	Hop Count	Flags	Idle Count
4210123395									
1	5/8/2023 22:41:53	00:14:08:04:35:B9	10	1	4	1	2	V1	0
2	5/8/2023 22:41:53	00:14:08:03:E2:9B	10	2	2	0	3	V1	0
3	5/8/2023 22:41:53	00:14:08:0A:BF:54	10	1	2	0	2	V1	0
4	5/8/2023 22:41:53	00:14:08:0A:72:4A	10	1	2	1	2	V1	0
5	5/8/2023 22:41:53	00:14:08:03:CB:03	10	1	2	1	2	S1,V1	0
6	5/8/2023 22:41:53	00:14:08:01:17:69	10	1	2	0	2	V1	0
7	5/8/2023 22:41:53	00:14:08:04:35:BE	10	1	2	0	2	V1	0
8	5/8/2023 22:41:53	00:14:08:01:49:19	10	1	2	1	2	V1	0
9	5/8/2023 22:41:53	00:14:08:0A:BF:03	10	1	2	0	2	V1	0
10	5/8/2023 22:41:53	00:14:08:04:66:79	10	1	2	1	2	S1,V1	0

Meter Not Joining Network

- Multiple step process:
 1. Perform a current meter reading Over The Air (OTA) using Field Tool to verify the meter is operational
 2. Retrieve neighbor table from the node using Field Tool
 3. Check if this node appears as a neighbor of a nearby node that's already in the network. If not go to Step 6
 4. Verify ETX Band for this node at all neighbors
 5. If ETX Band is 4 or above with all neighbors, go to Step 6
 6. Reinforce infrastructure for this node

Communications Status “Not Ready”

- Backhaul connection may be down
- Not Ready may be a temporary condition because a node is in the process of switching to a new Gateway.
- If node continues to be Not Ready for 24 hours or more:
 - Check Node logs:
 - If data reports are being sent, node can communicate with its neighbors
 - Original route to Gateway is reforming or has an issue

“Not Ready” Node Not Reporting In

- Check if there are no data reports from the node for 3 days:
 - Check Routing table of Node to determine last known Primary Forward Node
 - Locate the Primary Forward in the node’s neighbor table and check its link cost.
 - Review the link cost history of this node in the Primary Forward node’s neighbor table
 - If the link cost has degraded, the node may be in the process of switching to another Primary Forward.
 - Review the problem node’s neighbor table to verify link costs with other neighbors
 - If all neighbors have degraded link cost, visit the node to verify OTA connect with a Field Tool

Interval Data Not Received

Issue: Node data intervals not received

- Nodes report their interval data periodically (usually every 24 hours) with each Interval Record (usually 15 minutes)
- Data points can be seen from the Network Manager Node Details -> Data Points for a selectable date range
- If the node is in “Ready” state and interval data is received with missing dates (i.e. gaps)
 - Network may be busy and RFN Gateway may be gap filling. It will catch up and fill the missing intervals

Interval Data Not Received (cont'd)

Issue: Node data intervals not received (cont'd)

- If the node is in “Ready” state and no reports are received for more than several days then it should be diagnosed for other root causes:
 - Check the NTP configuration at the Gateway. Nodes will not report interval data if they haven't received time sync from the gateway
 - RF Network manager and gateway communications can be checked from NM
- If the node is in “Not Ready” state then diagnose the “Not Ready” cause

All of the Above

Node not joining or NOT-READY, missing data

- Check if Gateways are running within capacity
 1. From NM, list nodes under the gateway and verify that the total number of nodes is not too close to its maximum capacity (configured parameter during deployment. Ask Customer Service for your network's setting)
 2. Gateway logs in NM having too many entries of 'Received Message from Unknown Node' – is another indication of Gateway running out of capacity
 3. If gateway capacity issue is verified, evaluate infrastructure, and decide on gateway addition or relocation.

RF Network Troubleshooting

Issue: Water node not in network

1. Check if the water node is in ship mode using a Field-Tool and swiping the node with magnet.
2. Check the neighbor table of nearby Electric meters, if the MAC address does not appear in neighbor tables, reinforce infrastructure by adding relays.