Itron

RF Safety Compliance and Duty Cycle for OpenWay CENTRON 4G-LTE Meters

December 2015

WHITE PAPER

EXECUTIVE SUMMARY

As a world-leading technology and services company that manufactures products that utilize wireless communications, Itron is committed to delivering safe products that meet or exceed all applicable safety standards. With that, we are also committed to providing accurate and complete product safety information to our utility customers and the customers they serve.

To this end, and to supplement the FCC and Health Canada certifications for the meters, Itron recently completed a detailed study of radio frequency (RF) transmissions and duty cycles for OpenWay® CENTRON® smart meters operating on the 4G LTE wireless cellular network.

Results from the study show the RF wireless communication from the OpenWay meters meet all applicable safety standards established by government agencies, such as Health Canada and the Federal Communications Commission (FCC) in the U.S.

SMART METERING AND CELLULAR TECHNOLOGY

Itron is an industry leading provider of smart metering solutions that utilize cellular communications technology. Utilities across the U.S. and Canada have been replacing old-style electromechanical meters with digital communicating smart meters for the past decade. Industry research groups estimate that today approximately 50 percent of the 180 million electricity meters in the U.S. and Canada are now smart, with the vast majority of those smart meters – approximately 95 percent or more – using RF wireless and/or cellular communication to send data back to the utility. Installation of digital smart meters continues to accelerate and it is estimated that by 2020, virtually all electricity meters in the U.S. and Canada will be smart.

SMART METERING AT BC HYDRO

BC Hydro is seeking to implement OpenWay CENTRON with an LTE Itron Cellular Module (ICM), which includes the OpenWay Collection Engine (SR 6.6) with enhanced security. This includes deployment of approximately 25,000 Itron electric OpenWay CENTRON meters with 4G LTE Itron Cellular Modems (ICM) using local cellular network as a backhaul.

BC Hydro is already using Itron's OpenWay Advanced Metering Infrastructure (AMI) solution, which includes the OpenWay Collection Engine (SR 6.6), OpenWay Reporting System (ORS) SR5.1, Cisco Grid Network Management System V2.1.3 (CG-NMS), Cisco Connected Grid Router (CGR) and RFMESH to read approximately 1.8M Itron electric OpenWay CENTRON meters with enhanced security.

The addition of the ICM equipped meters to BC Hydro's existing solution is to be seamless to current operations. ICM will be utilized to capture data from meters that do not have RF Mesh coverage as a cost effective alternative to further network build out of Range Extenders and CGRs.

CELLULAR TECHNOLOGY AND SMART METERING SOLUTIONS

Cellular communications for smart meters offer utilities and their customers flexibility and advantages in a number of strategic deployment scenarios, such as:

- Areas where RF mesh communications may not be practical from either a cost or reliability standpoint
- Support for customer opt-in programs that require smart metering capabilities, such as time-of-use pricing, pre-payment, and in-home energy management programs;
- A full-scale cellular deployment where cellular solution is the preferred communications network.

BCH plans to deploy the cellular solution as an alternative to offset remote area network pockets that have challenging network connections to the RF mesh network; in these cases cellular meters are a more economical solution to provide consistent and reliable performance from these locations.

OPENWAY CENTRON CELLULAR 4G LTE METERS

In early 2015, Itron announced the availability of its new OpenWay CENTRON Cellular LTE electricity meter, which features the latest in cellular communication capabilities for use with the OpenWay solution.

The LTE product, which uses the fastest 4G LTE technology available today, offers several advantages, including broad territory coverage, low latency, and network longevity. Because of its high data rate and throughput, the CENTRON LTE cellular electricity meter also exhibit a very low duty cycle (the total time the meter transmits during a given 24-hour period), reducing even further the wireless emissions from smart meters.

In fact, under normal operating conditions the OpenWay CENTRON Cellular LTE meter will transmit, on average, about 2.65 seconds per day. For the purposes of this study, we have defined normal daily operations to include meter data for a three interrogations per day, network status checks, network connections, management connections. The meter configuration for the test results included two interval channels and two billing registers.

CELLULAR COMMUNICATIONS AND PUBLIC HEALTH

Itron's products are stringently evaluated for RF safety and meet all FCC, Health Canada, and Institute of Electrical and Electronic Engineers (IEEE) standards. We consistently evaluate key factors for exposure risk, including the total duration of the transmission (duty cycle), the power output and the distance from the public.

These key factors ensure that Itron OpenWay meters (both RF mesh and cellular) emit RF/wireless exposure levels that are not only well below the legal limits, but minimal when compared to other devices people use every day.

From a duty cycle viewpoint, the OpenWay CENTRON Cellular 4G LTE transmits for only 0.003% of a day. That is about 2.65 seconds per day. This transmit duty cycle represents an extremely low percentage compared to Health Canada and FCC safety limits and standards for RF exposure.

In addition to the duty cycle testing, two other factors can greatly limit the wireless emissions exposure from OpenWay CENTRON Cellular LTE meters:

- Low power: The cellular modem inside OpenWay CENTRON Cellular LTE meter operates very much like a regular cell phone that people use every day, with comparable signal strength, but far less usage time. The meter has a very limited duty cycle that amounts to only a tiny fraction of a cell phone's typical usage.
- Limited proximity to humans: Itron electric smart meters are typically installed outside the home or office building. Because RF energy falls off very quickly with distance, smart meters typically represent much lower exposure than other RF devices located within the home. Basically, the wireless exposure decreases exponentially with distance - at twice the distance, the exposure level is reduced to a quarter or less of the original.

SUMMARY OF DUTY CYCLE

Cellular LTE Advanced networks (4G LTE specifically) are designed to support high throughput while maximizing efficiency. The data rate for each cellular connection will vary based on the cellular network quality between the meter and the cell tower.

The data rate ranges from 1.16 Mbps to 67.5 Mbps. For the analysis, Itron used the minimum data rate because this will result in the highest duty cycle. This provides a worst case result instead of selecting the highest data rate and best case results.

The data transmissions occur in short time slots of 0.5 msec duration. For the lowest data rate links, the number of bits of data that can be sent in each time slot will be 578 payload bits (accounting for overhead).

CALCULATING DUTY CYCLE

To determine the transmission duty cycle for an OpenWay CENTRON Cellular LTE meter, Itron measured the transmission time from a sample meter set up to the daily read profile BC Hydro is planning to utilize.

CONTRIBUTORS TO DAILY TRANSMIT TIME

Daily Data Reads: A read from a single phase residential cellular meter typically accounts for about 5kB or 40,960 bits per day in data transmission. Considering the worst case throughput for a connection to meter (highest daily usage), a 5kB read requires 71 time slots of transmission at 0.5 msec each. This results in 35.5 msec of actual transmission time necessary to transfer the read. BC Hydro currently plans for up to 3 reads per day (a typical maximum) which results in ~106 msec of transmission time per day for the daily reads.

Network Overhead and Connection Maintenance: In addition to the daily reads there is network overhead and connection maintenance. The cellular modem itself checks the network status every 54 minutes. Finally, to confirm continued device access, the application reestablishes the connection every two hours. To determine the amount of transmissions for network overhead and connection maintenance, actual measurements from a sample meter were utilized.

MEASURED DUTY CYCLE RESULTS

In order to get a better understanding of the actual transmit time used in a 24-hour period a meter was instrumented to time real transmission events. The meter was configured for the expected (and typical) daily read profile: two channel load profile data on one-hour intervals with reads occurring three times a day. Each read brought back eight hours of data.

The measured transmit time for each of the three data reads was 38 msec. This is consistent with what was expected considering that there is overhead data in each read.

Actual measured network maintenance transmit time excluding the three intentional daily data reads totaled nearly 2.5 seconds per day. The 2.5 seconds of transmit time is split up throughout the 24 hours of a day. Some hours may only see a single network status check of 5-12 msec, while other hours see as much as 200 msec of transmit activity.

From a duty cycle viewpoint, the OpenWay CENTRON Cellular 4G LTE typically transmits about 2.65 seconds out of 86,400 seconds in a day. This calculates to a transmit duty cycle of about 0.003%.

VARIATIONS IN DUTY CYCLE

As previously mentioned, the cellular network relies on meters in certain areas of BC Hydro's service area to act as direct cellular connections to the Rogers cellular network where RF Mesh meters experience connectivity challenges. For this reason, duty cycles for cellular meters will, to a degree, be more consistent than RF Mesh meters depending on their position in the Rogers network and proximity to cellular towers.

Typically, meters located closer to cellular network towers tend to have a lower duty cycles than meters located farther away from the cellular network, as meters closer to the tower are able to utilize higher data rate connections. Despite these dynamics, duty cycles remain consistently much lower compared to the vast majority of meters throughout the network and as compared to other cellular devices such as smartphones.

POWER DENSITY RESULTS

The transmit duty cycle is a factor in research and testing scenarios to determine the amount of RF exposure present in a typical day's meter interrogations and to ensure it meets acceptable health and safety standards.

Both Health Canada (HC) and Federal Commination Commission (FCC) use a Reference Period (RP) to calculate exposure limits. HC uses a 6 minutes and the FCC uses 30 minutes for their Reference Periods.

Unlike the RF Mesh product, whose transmissions are evenly distributed throughout the day, an ICS device transmits in very discrete time windows. Therefore, rather than using the calculated duty cycle across an entire day, the duty cycle within the six minute reference period (HC requirement) is utilized to determine the level of RF exposure. The worst case scenario within a six minute time window would contain the following: one interrogation (71 messages), one status check (1 message), one connection (2 messages), one management connection (1 message), and nine additional messages for a power up or daily events and exceptions. That is a total of 84 messages for a total time of 0.042 seconds for a single phase meter.

For a polyphase meter, the payload size was increased to 15 kB. Again, accounting for payload overhead, the total messages for a polyphase meter would be 226. This results in a total transmission time per Reference Period of 0.113 seconds for polyphase meter.

COMPARISON TO HEALTH CANADA LIMITS

The high data throughput of LTE communication technology and the resulting low duty cycle, coupled with other factors, mean that the wireless emissions from OpenWay CENTRON Cellular LTE meters are well within all applicable Health Canada safety limits, and amount to only a tiny fraction of the RF/wireless exposure that people are exposed to in their everyday lives.

See table below for comparison of results:

ITRON CELLULAR MODULE (ICM) METERS AND HEALTH CANADA(HC) EXPOSURE LIMITS – SINGLE PHASE METER

LTE Band	Band Frequency (Mhz)	HC Reference Period (RP) (minutes)	ICM Transmit Time per RP (seconds)	ICM Power Density1 (W/m^2)	ICM RP Power Density2 (W/m^2)	HC Limits (W/m^2)	ICM Percentage of Limit (%)
17	710	6	0.042	0.518	0.000060	2.326	0.0026
5	829	6	0.042	0.347	0.000040	2.586	0.0016
4	1745	6	0.042	0.749	0.000087	4.301	0.0020
2	1905	6	0.042	0.772	0.000090	4.567	0.0020

Notes: Distance to device for calculations is 20 cm or 0.2m
Power Density determined for Uncontrolled Environment
Health Canada (HC) Safety Code 6 (2015) for Limits
1) Power Density during transmission
2) Power Density with Reference Period accounting for transmit duty cycle

ITRON CELLULAR MODULE (ICM) METERS AND HEALTH CANADA(HC) EXPOSURE LIMITS – POLYPHASE METER

LTE Band	Band Frequency (Mhz)	HC Reference Period (RP) (minutes)	ICM Transmit Time per RP (seconds)	ICM Power Density1 (W/m^2)	ICM RP Power Density2 (W/m^2)	HC Limits (W/m^2)	ICM Percentage of Limit (%)
17	710	6	0.113	0.703	0.000221	2.326	0.0095
5	829	6	0.113	0.665	0.000209	2.586	0.0081
4	1745	6	0.113	1.264	0.000397	4.301	0.0092
2	1905	6	0.113	1.348	0.000423	4.567	0.0093

Notes: Distance to device for calculations is 20 cm or 0.2m
Power Density determined for Uncontrolled Environment
Health Canada (HC) Safety Code 6 (2015) for Limits
1) Power Density during transmission
2) Power Density with Reference Period accounting for transmit duty cycle

USE OF EXTERNAL ANTENNAS

The Itron Polyphase LTE meter supports an optional external antenna. Itron has tested and certified an omnidirectional antenna for this purpose. This antenna has a higher gain than the standard internal meter antennas. However, after factoring in power loss in the cables and electrical isolation circuit, the overall total radiated power of the external antenna is nearly identical (within 1 dB) to the internal antenna solution. In addition, the external antenna selection also has no appreciable effect on the transmit duty cycles. Hence the power density calculations in previous sections apply to both the internal antennas and the Itron certified external antenna.

It's also important to note that the external antenna is not intended to improve performance in areas of general poor LTE coverage. Instead the external antenna is for use when the meter may be enclosed in a metal cabinet or may be located in a room with little to no coverage. The external antenna can then be located outside of the enclosure, or in another nearby room that has overall better coverage to mitigate these connectivity challenges.

COMPARISON TO HEALTH CANADA LIMITS CONCLUSION

The RF exposure to people from OpenWay CENTRON Cellular LTE meters amounts to a fraction of the maximum permissible exposure levels and safety standards set by Health Canada. This study shows that the total maximum time meters are transmitting in a given 24-hour period is less than 3 seconds. That translates into a maximum duty cycle of ~0.003 percent. This means the OpenWay cellular meters, on average, are not transmitting radio signals for more than 99.99.9 percent of a typical day. Using the worst case transmissions within the Reference Periods and comparing the short term power density to the HC limits indicates that the OpenWay CENTRON Cellular LTE meters represent only a small fraction of the established limits.

Also, these meters utilize low-power transmissions and typically operate at a significant distance away from people, especially compared to other common wireless devices such as cellular smartphones.

In conclusion, the exposure from OpenWay CENTRON Cellular LTE Meters is a fraction of the established limits and very low in comparison to other common wireless devices used every day.

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