

Health Risks from RFR of Emerging Wireless Communications

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Technology Overview

- Brief history
- Smart-Phones
- Smart-Meters
- Smart-Appliances

Regulation Overview

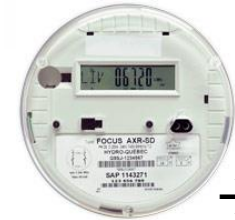
- Safety Code 6
- Health Canada
- Recommendations

Summary of Paper Reviews

Conclusion



Smart Planet



→ PLC

1G
Analog AMPS
1983

2G
GSM/Edge
1991

3G
CDMA/HSPA
2004

3.5G
HSPA
2010

4G
LTE
2012

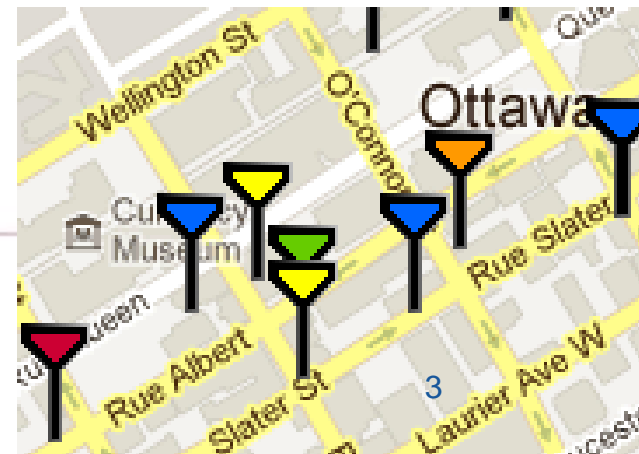
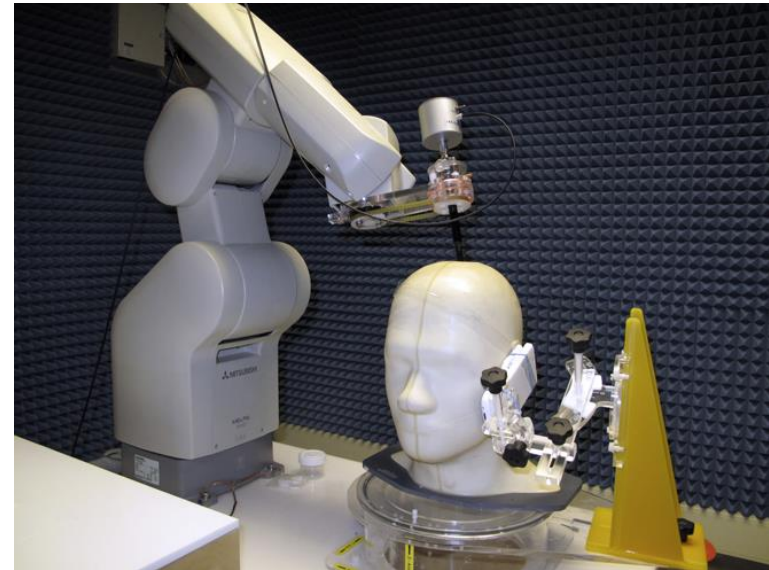
700MHz
ITS



Smart-Phones



- Cell Phone → Local RF radiation at head
 - 0.25-2 Watt EIRP
 - 1.6W/Kg in Safety Code 6/FCC
 - WIFI, BT, and ...?
 - Vendor: "SAR may exceed FCC if less than 25mm from body"
 - Classified 2B by IARC based on possible risk of glioma cancer
- Cell Tower → Long Term Exposure
 - 16-300 Watt EIRP
 - Power Density Regulation
 - Directive Antenna
 - Spectral Mask Compliance



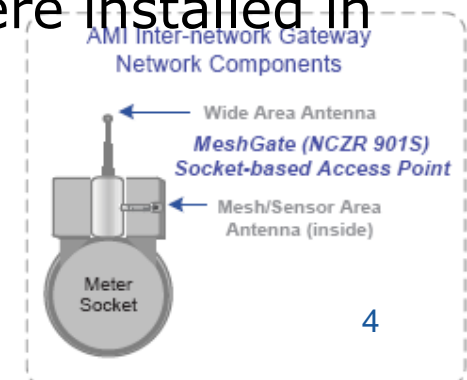
Smart-Meters

- **NOT standardized!**

- Smart meters, when teamed with Time-of-Use prices, are new energy management tools to help customers manage their electricity use and costs.

- **Smart Meters in Canada**

- **2016:** B.C. Hydro needs to remove more than 88,000 smart meters that are either faulty or may not meet Measurement Canada standards, public records show.
 - **2015:** Ontario's Electrical Safety Authority has ordered local hydro companies to remove 5,400 smart meters because they pose a safety risk.
 - **2014:** SaskPower has announced that they are removing all the smart meters that were installed in the province.



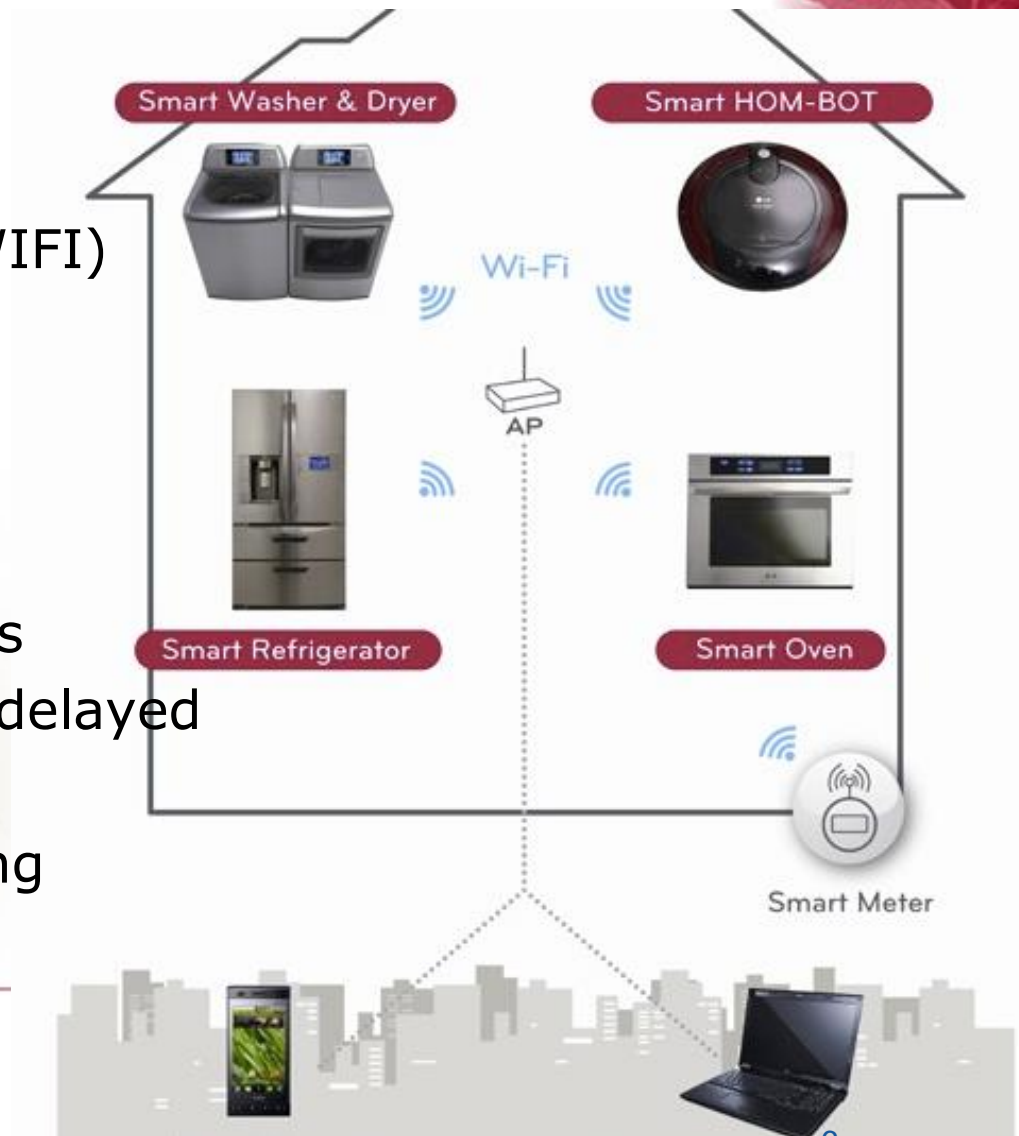


Connectivity

- A wireless smart meter has two radio transmitters for operating on networks.
- HAN: Connectivity to smart-appliances: next slide
- NAN: Connectivity to other smart-meters
 - Data transmission every hour
 - PG&E: Up to 190,000 overhead transmission per day
- WAN: connectivity to a “collector”
 - One house reports for its neighborhood
- World Wide: 250M..1B by 2020
- “Zero Energy Home” movement (2015)

Smart-Appliances

- Vendors (partial)
 - Honeywell: RedLink
 - GE: Brillion (ZigBee/WIFI)
 - LG: Thing links (WIFI)
- Features
 - Thermostat & sensors
 - Wash @low-cost hrs
 - Self-clean @hi-cost hrs
 - Defrost automatically delayed
 - Food Management
 - Remote troubleshooting





Emitted Power

- Most wireless smart meters are as powerful as a mobile phone, or sometimes more powerful.
- If the meter is in the cellar, under the stairs or in the centre of a house, or deep inside a block of flats and a long way from the nearest mast, it operates at higher levels of power than if the meter is outside and with an uninterrupted line to a mast nearby.
- A wireless HAN has to penetrate walls, floors and ceilings.
- The HAN may operate continuously. Some domestic appliances have built-in radio transmitters and receivers which cannot be turned off.



Hot Spots

- EM radiation may create interference patterns. Two factors may contribute to a “hot-spot” in a property:
- The constructive interference of two sources of radiation can create small areas in a house or outside with radiation much higher than the surrounding area. This is becoming increasingly common as different neighbours beam different sources of WiFi into a property and these interact, and also interfere with radiation from nearby sources operating at similar frequencies.
- The structure of a house, such as thick walls, steel beams or reflective metal sheeting in kitchen fittings, may significantly distort EM radiation patterns.

Smart-Appliances



- WIFI (802.11)
 - 100mW@2.4GHz
 - 200mW@5GHz
 - Short range
 - High data rate (600Mbps)
 - medium cost
- ZigBee (802.15)
 - 1mW-150mW @ 2.4GHz [[uniband](#)]
 - Short range
 - Low data rate (250kbps)
 - Low cost
- SEP-2.0 standard under development...



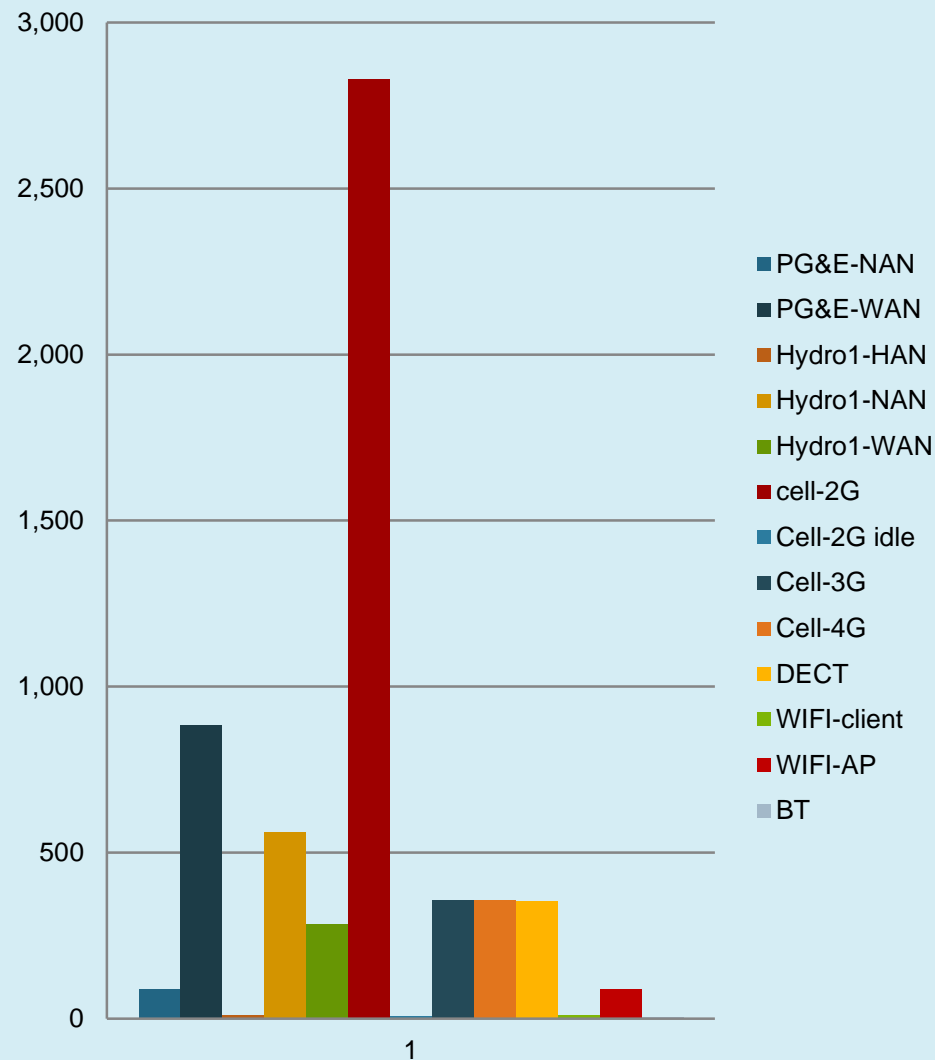
Power Density Estimation

- **Peak RF Radiation**
 - Phones and BT at 7.5 cm, 30cm for other devices
 - 100% duty cycle
- **Average Exposure**
 - phones/BT: 3 in (7.5cm) distance as per CCST report.
 - Cell phone average usage at ear: 469min per month
 - Cell phone signaling overhead: calculated from cell reselection
 - WiFi: 90 cm is used for AP; 30cm is used for laptop
 - WiFi and BT: assuming 8hr exposure per day
 - SM: 100% reflection as per FCC OET 65 bulletin
 - SM: 30cm distance; Loss through wall is not considered
 - SM WAN radio power corrected to 2.5W
 - PG&E SM duty cycle as per CCST reports (not corrected)
 - HydroOne SM duty cycle as per Trilliant report
 - Smart-Appliance: all day at 10ft average distance

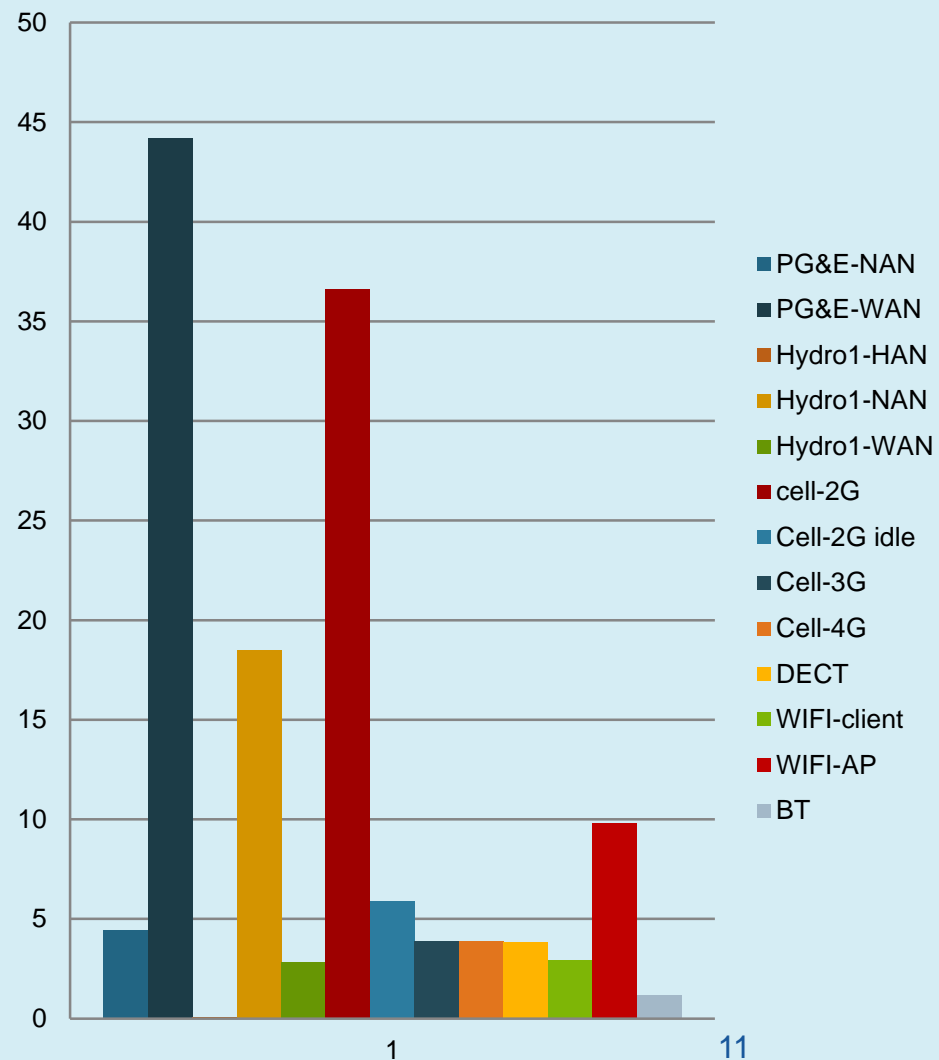
Power Density Estimation



Peak Power Density (uW/cm²)



Average Power Density



Safety Code 6 (1999, 2009)



- Predominant adverse health effects of 3kHz-300GHz RF energy
 - Tissue heating (1° C with SAR = 4W/Kg)
 - SAR regulation of 1.6W/Kg adds a safety margin
- Evaluation of the potential effects
 - Human cancer
 - Rodent Lifetime mortality
 - Tumor
 - DNA damage
 - EEG activity, memory, behavior, cognitive functions
 - Gene and Protein expression
 - Cardiovascular function
 - Immune response
 - Reproductive outcomes
 - Perceived electro-hypersensitivity (EHS)
- At present, there is no scientific basis for the premise of chronic and/or cumulative health risks from RF energy at levels below the limits

Health Canada Recommendations



- Some epidemiological studies that have shown brain cancer rates may be elevated for long-term/heavy users, while other studies have not supported this association
- In 2011, IARC classified RF energy as “possibly carcinogenic to humans”
 - “Some limited evidence exists” while “vast majority... does not support a link”
 - additional research is warranted
- Recommendations
 - Limiting length of calls
 - Using hands-free devices
 - Using text messaging

Biological Effect Paper Review



- Based on the double blind testing with DECT phones, some population have significant HRV reaction.
- **Based on the EEG testing with WIFI, gender may have a significant impact on RFR test results.**
- Some reports indicates that modulation type may influence test results; No study papers using newer modulations.
- **Very few studies on long term cumulative effects.**
- The reported number of electro-sensitive population has been steadily increasing since it was first documented in 1991 (EMF in general, not only RF radiation)
- **Several authors suggest that children may need to be considered in the regulation**

Conclusion – Smart-Phone



- Phone vendor documentation warning: SAR measurement may exceed FCC is positioned less than 25-15 mm from body.
- **Vendor documentation suggests that SAR test procedure does not consider the combined radiation from all the radios now in modern phones.**
- **SAR measurement procedure is based on homogenous tissue heating in a SAM head phantom, which may not model current induced in nerve cells (antenna model)**

Conclusion – Smart-Meter



- Comparing Smart Meter (SM) averaged RF radiation at a distance with cell phone peak power at ear does not seem relevant.
- Smart-Grid technology is not standardized, not/poorly publicly documented
- Installation is not regulated nor certified
- Pushed by complains, California state regulators and PG&E (CA) have decided to offer the population to opt-out.
- **There is little research on long term cumulative effects of RF radiation, which would apply to SM technology**
- Considering the EHS population, RF radiation should not be imposed.
- **The FCC/IC regulation does not consider combination of RF radiation from multiple sources (as in a smart house)**