November 1st, 2021

California Energy Commission
Dockets Office,
Re: Docket # 20-FDAS-01
1516 Ninth Street
Sacramento, CA 95814

Regarding: Request for Comments on California Energy Commission's Flexible Demand Appliance Standards [Docket Number 20-FDAS-01]

e-Radio USA, Inc. (e-Radio) supports and appreciates the work being performed by the California Energy Commission (CEC) and the opportunity to provide comments on Senate Bill 49 Flexible Demand Appliance Standards (FDAS).

e-Radio is a communications technology company specializing in broadcast-based systems. We are pleased to have the opportunity to share our decades of work related to flexible demand appliances and to comment on the FDAS draft language via the 20-FDAS-01 docket.

Background

California Senate Bill 49 authorizes the California Energy Commission to adopt standards for appliances to facilitate the deployment of flexible demand technologies. The objective of the standards is to reduce greenhouse gas emissions by scheduling, shifting, or curtailing appliance operations with consumer consent, under standards that are feasible and cost-effective.

The goal of the standards is to require flexibility services in future devices, to support the achievement of a carbon free grid, in concert with the 2018 California 100% Clean Energy Act (SB 100). A diagram depicting the CEC's vision for load flexibility is presented in Figure 1.

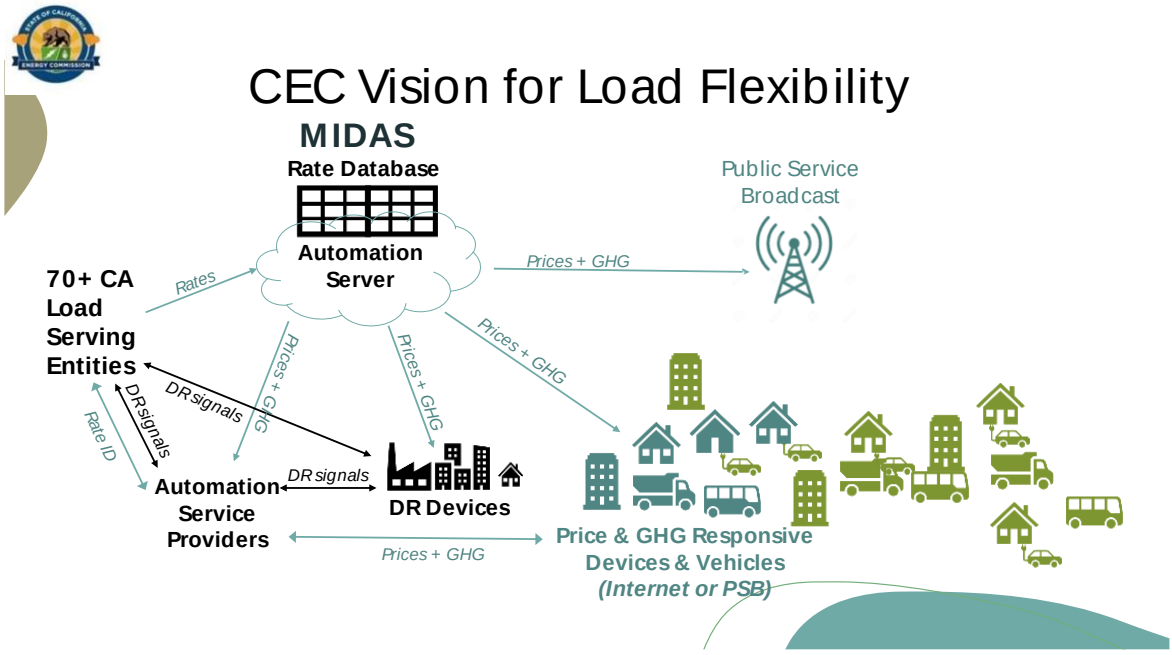

Figure 1. CEC Vision for Load Flexibility through Load Management Standards[1]

The CEC also addresses load flexibility in the Building Standards Section 110.12, which requires demand responsive controls in non-healthcare buildings be:

- *A certified OpenADR 2.0a or OpenADR 2.0b Virtual End Node (VEN), as specified under Clause 11 in the applicable OpenADR 2.0 Specification; or certified by the manufacturer as being capable of responding to a demand response signal from a certified OpenADR 2.0b Virtual End Node by automatically implementing the control functions requested by the Virtual End Node for the equipment it controls.*
- *Capable of communicating using one or more of the following: Wi-Fi, ZigBee, BACnet, Ethernet, or hard-wiring.*

Multiple challenges intrude on this vision. Simple solutions must be brought to bear against the traditional roadblocks of capital investment for unbuilt communications networks, control technologies, and the costs and the complexities of installation, enrollment, and equity. To this yin is the yang of customer value: simplicity, privacy, security, reliability, and effectiveness, to form a complementary dynamic system. The optimal solution must provide efficiency via simplicity and focus on technical solutions that can realistically scale to the mass market.

[1] https://www.energy.ca.gov/sites/default/files/2020-02/2019_Part6_Section_110.12_and_Joint_Appendix5_ADA.pdf

Internet + FM Hybrid Communications

e-Radio USA has developed a communication architecture that reaches 99% of California homes by leveraging the existing FM broadcast network. This hybrid Internet Protocol (IP) plus FM architecture is compatible with all existing IP-based systems, including smart devices such as the Nest and Ecobee thermostats (Figure 2).

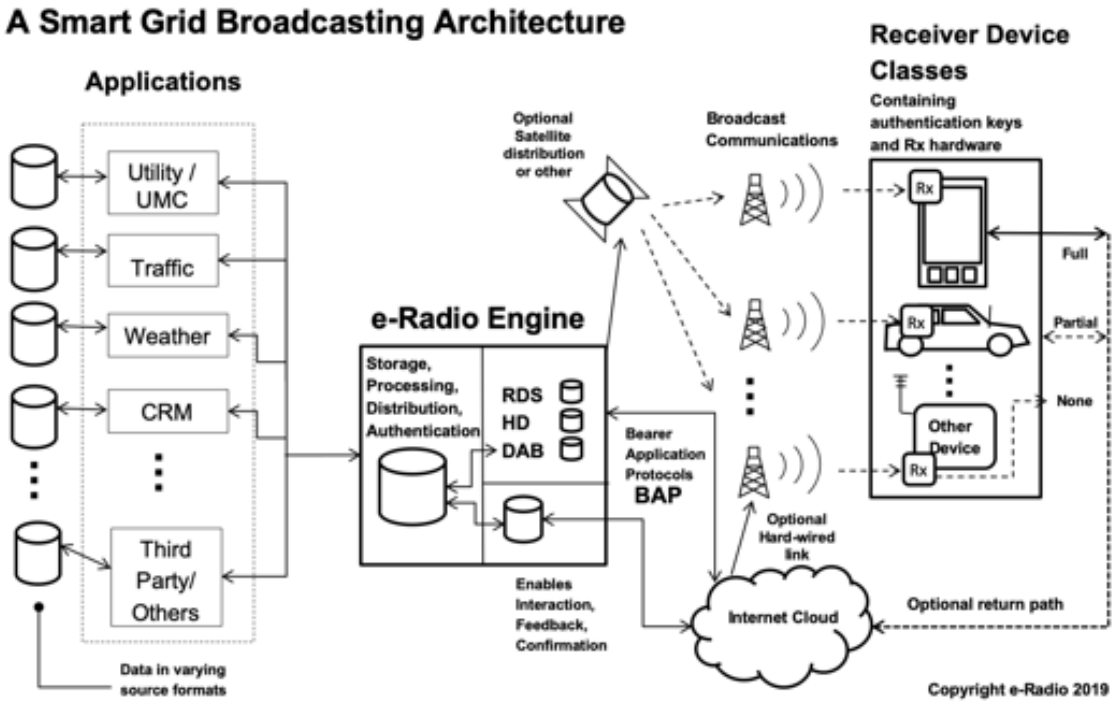

Figure 2. Hybrid IP+FM data architecture

Adding FM to a conventional IP solution provides the following benefits:

- reduces overall packet traffic and associated “server farms”
- reduces last mile wireless power consumption
- provides multi-factor authentication for improved security
- facilitates equitable access for low-income customers and disadvantaged communities, via the free-to-consumer system it has been for nearly a century.

The hybrid IP+FM communications system can broadcast prices and carbon emissions signals to millions of customers simultaneously. These signals can then be intercepted and used by devices to shift loads to the cheapest and cleanest hours of the day, thereby minimizing the financial and environmental costs of electricity use. A hybrid IP+FM system using price and emissions data from the CEC’s MIDAS database

can provide services like the recently announced Nest Renew service, which uses a similar signal from WattTime to enable real-time GHG response.[2]

Figure 3. Broadcast of WattTime emissions data to an EV via KUDL Sacramento, March 12, 2021.

Technical Considerations

OpenADR and CTA-2045 Compatibility

The e-Radio hybrid architecture is compatible with OpenADR as documented in the Lawrence Berkeley Lab's 2009 "Development and Demonstration of the Open Automated Demand Response Standard for the Residential Sector."[3] The integration of OpenADR and FM completed and demonstrated in the study enabled utilities to send hourly or sub-hourly electricity pricing information simultaneously to the residential, commercial and industrial sectors via FM broadcast.

CTA-2045 has supported FM communications since its inception, as demonstrated in this 2011 video showing an early CTA-2045+FM project with EPRI.[4] We support the OpenADR Alliance's view on the

[2] https://www.watttime.org/news/nest-renew-from-google-harnesses-watttime-tech-to-help-nest-thermostat-users-to-prioritize-clean-energy-automatically/

[3] https://www.osti.gov/servlets/purl/1164902

[4] https://www.youtube.com/watch?v=RGy0GTMLdYQ

symbiotic relationship between OpenADR and CTA-2045, as documented in the following presentation by the OpenADR Alliance.[5]

As CTA-2045 is still an evolving protocol, now internationally recognized by the ISO, e-Radio regularly participates in various user group forums such as AWHI (advanced water heater initiative) as supported by the Northwest Energy Efficiency Alliance (NEEA) in the refinement and implementation of CTA-2045. A current List of CTA-2045+FM devices include the following:

- RDS and HD Radio™ capable modules with + LTE CTA-2045 EcoPort^{CM} are to be tested in FY 2022 via partners including XPERI Corporation of San Jose CA. These modules can be made available for testing with CEC's EPIC FlexHub for further empirical evidence of the feasibility and success of the IP+FM hybrid architecture in the field.
- The higher bandwidth afforded by HD Radio™ could potentially facilitate higher bandwidth features such as CRM (customer relations management) and even customer specific info via encrypted pointcast. We look forward to working with the CEC and others to demonstrate these capabilities.

Ubiquity, Reliability, and Cybersecurity

Signals sent via the national FM broadcast infrastructure reach some 300 million Americans and their devices in about 2 seconds with no potential for congestion. Low-cost FM repeaters and data translators (e.g., FM to HEM/LAN) ensure reliability and virtually full market coverage at all times.

In contrast, the cellular log jams experienced on September 11, 2001 in New York, and during the January 13, 2018 false missile attack warning in Hawaii highlight the limitation of cellular and IP-based communication in real-time high data traffic volume situations. The dynamics of Internet congestion are similar to sand in an hour glass at choke points. Caltrans uses Ramp Metering to help keep traffic volumes just below levels which can cause stop-and-go shock waves. In the same manner, off-loading packet traffic to FM broadcasting could improve internet traffic to reduce delays, power consumption and possibility of grid lock.

In addition to the creation of flexible loads, it is possible that a hybrid IP+FM architecture could mitigate the effects of internet cyber-attacks by provision of available multi-factor authentication inherent in having an independent FM channel. This would be useful in cases like the Colonial pipeline cyber-attack, wherein non-confidence in the operating network resulted in the temporary shutdown of critical infrastructure. Security via hybrid IP+FM broadcast with multi-factor authentication is built-in and implemented with minimal additional cost. The inherent security of broadcast infrastructure due to limited access points is well guarded and has 7/24 off-air and network monitoring of content as per FCC regulations.

The notion that an infinite number of devices can be powered by infinite bandwidth is not realistic. To reduce data traffic, the CEC can encourage the off-loading of flexibility signals information (such as MIDAS price, FlexAlert, and greenhouse gas emissions data) to FM broadcast. This concept is like the notion that public rail transit can greatly reduce single occupancy road traffic, resulting in a better

[5] https://register.gotowebinar.com/recording/7749450721965030407

experience for all. In the same way public transit can improve road traffic, FM broadcasting can make the internet more efficient and less likely to be grid locked.

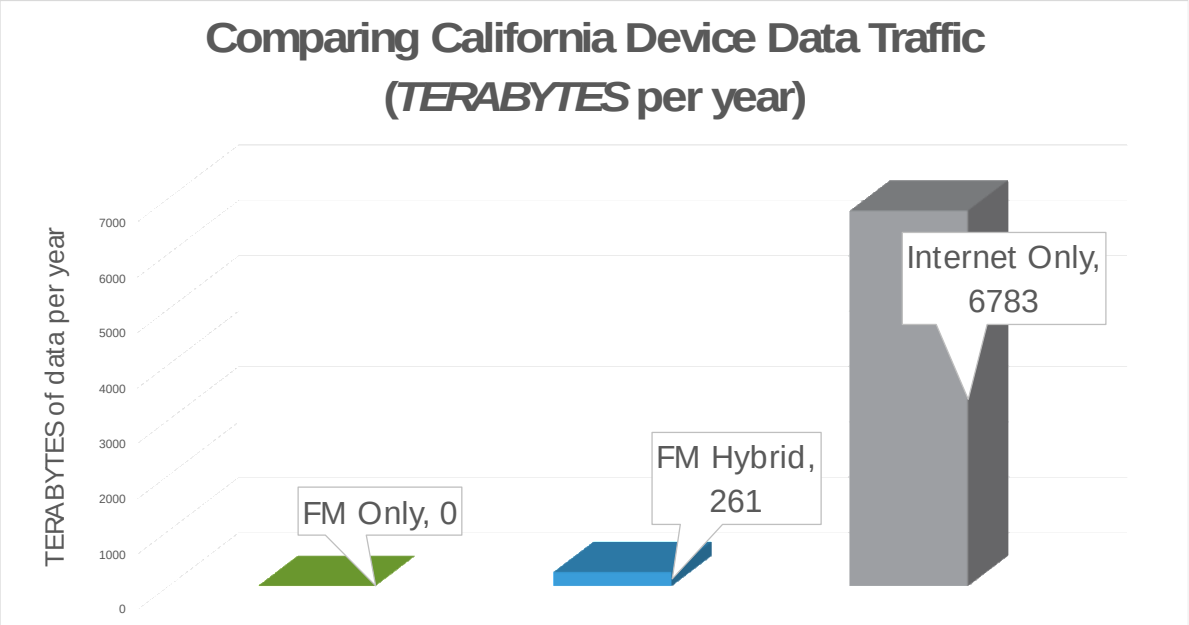

Figure 4. Estimate of FM, Hybrid, and Internet server traffic for PCT, WH, HVAC [6]

Energy Considerations

"Server Farms" currently consume some 2% of the entire US electricity generation before FDAS IOT is scaled.[7] A proportional increase in the amount of packet traffic will logically add to the need to build and cool the server infrastructure - not to mention data hops and last mile wireless with associated power consumption of systems and devices.

On a global scale, data center power consumption has been estimated to be about 200-400 terawatts or as much as 3% percent of all electricity generated on the planet. US Data centers are one of the most energy-intensive building structures, consuming 10 to 50 times the energy per floor space of a typical commercial office building. Collectively, these spaces account for approximately 2% of the total U.S. electricity use.[8] Each major data center requires approximately 100MW of electrical power, the output of a nominal sized gas-fired peaker plant.

---

[6] Assuming 11.5M California homes with 3 devices each on average with required latency (response time) of 5 minutes and 10 randomly timed "events" per day, and 2048 bytes required for each secure "call home" to the cloud

[7] https://www.energy.gov/eere/buildings/data-centers-and-servers

[8] https://www.energy.gov/eere/buildings/data-centers-and-servers

Data centers are not the only infrastructure components consuming energy. There are 3 other major components:

- Internet data hop facilities or networks
- *Production* of ICT (information and communication technology) devices
- Consumer devices

Each of the 4 components is estimated to be in the same order of magnitude with respect to energy use. Some estimates have put total ICT consumption to grow to double digit % of all electricity generated in the future.

FM receivers typically use just 1/10 peak power of cellular transceivers. For the hybrid FM/LTE modules the figures are FM: 50mA and LTE:500mA @ 3V. Furthermore, FM transmitters consume no additional energy as device population scales, whereas 2-way communication systems will experience increases in server traffic and associated power consumption proportional to the number of devices in the field.

See presentation previously presented on Jan 15 2020 to the CEC as TN 231535[9] in docket 19-OIR-01.[10]

Proven Feasibility

Over the past two decades, field studies have proven the feasibility of load flexibility using the hybrid IP+FM broadcast system. The devices and architecture described here are consistent with the CEC's 2008 draft Load Management Standards specifications.

FM-Flexible Thermostats

In 2007, the CEC funded an LBNL study to test the effectiveness of FM enabled smart thermostats for demand response, energy, and bill savings in the small commercial sector. The study found that, on a 100 degree Fahrenheit reference day, peak load reduction of all participants during events averaged 14%, while peak load reduction of office and retail buildings averaged 20%. Pilot participants including restaurants had summer energy savings of 20% and bill savings of 30%. When the study was over, about 80% of participants said that the program met or surpassed their expectations." [11]

[9] https://efiling.energy.ca.gov/GetDocument.aspx?tn=231535&DocumentContentId=63348

[10] https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-OIR-01

[11] https://eta-publications.lbl.gov/sites/default/files/LBNL-2742E.pdf

Figure 5. 2007 FM-OpenADR Thermostat

FM-Flexible Dishwasher and Refrigerator

In response to the CEC's 2008 Load Management Standards, a major appliance manufacturer developed several large flexible appliances that were compatible with an IP+FM hybrid communications (Fig. 6). This particular dishwasher is a live example of the Delay Start feature requested by Stefanie Wayland in her comments to docket 20-FDAS-01 on May 4, 2021 (TN 237375). This dishwasher is still in use today.

The flexible FM refrigerator auto selects the best time to run various power consumption modes, including the main compressor, defrost cycle, and the small air pump between freezer and main compartment.

Figure 6. Pre-production Dishwasher and refrigerator (2008) responsive to FM broadcast

FM-Responsive Electric Vehicles

In 2012, a major U.S. automaker successfully developed an automotive bus architecture to optimize electric vehicle charging using reception of signals via the car's built-in FM receiver.[12] An infographic describing the project is provided in Figure 7.

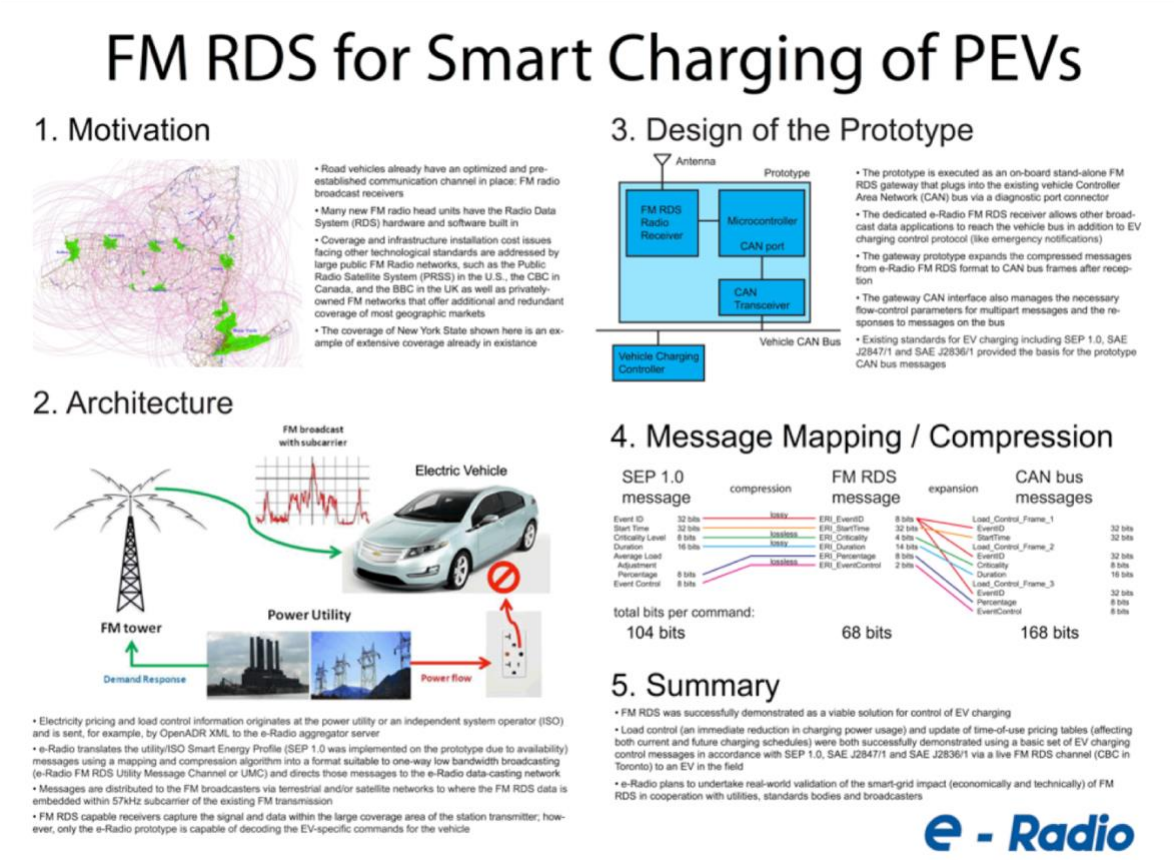

Figure 7. June 2012 IEEE ITEC paper with major US automotive OEM [13]

[12] http://e-radioinc.com/news/itec2012

[13] A legible copy of this poster can be found at http://e-radioinc.com/files/ITEC-2012-Poster.pdf

FM-Flexible Water Heater (via CTA-2045)

On July 7th 2021, a live demonstration of FM RDS broadcast was performed in Sacramento for the CEC Flex team. The demonstration involved the reception of FM event signals and corresponding responses by an FM-flexible thermostat, a CTA-2045 heat pump water heater (Figure 8), and FM-flexible electric vehicle charger.

Figure 8. HPWH responsive to KUDL FM in Sacramento, July 7th 2021

Additional live testing was also performed in Pleasanton, CA to responsive and highly instrumented heat pump water heater for calibration testing. Results of the testing showed significant possible daily cost savings under TOU and RTP rates paired with FM-flexible control.

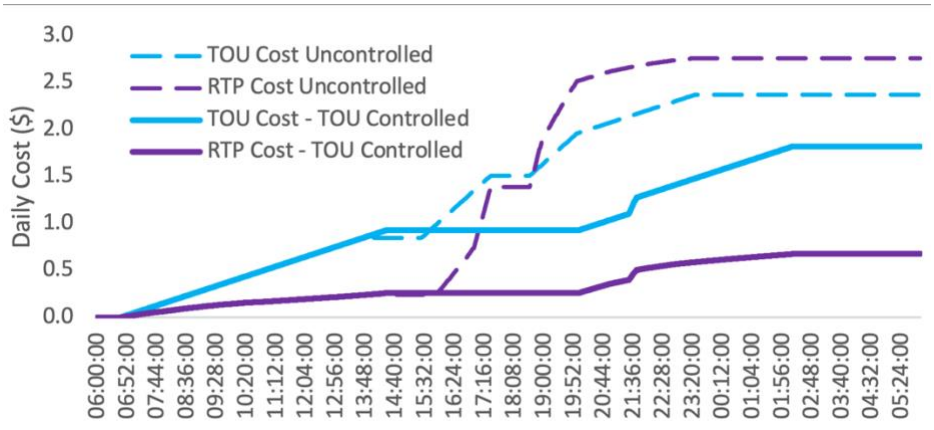

Figure 9. Cost of HPWH responsive to KKIQ FM in Pleasanton, March 3rd, 2021

International Efforts

Greenhouse gas emissions have no borders. The CEC is a highly respected global leader on energy issues and therefore expected to think globally in developing standards, with a view to facilitating scalable solutions that can be readily replicated in the rest of the world. Global scalability was also one of the key reasons for the creation of the global RDS forum.[14]

Like California, the European Union (EU) is also considering the use of FM broadcast for electric grid signaling. Initial testing is underway in an EU project called "Fleximax", which makes use of an IP+FM hybrid architecture (Figure 10). Since GHG emissions are correlated to gross domestic product (GDP), we can estimate that advanced flexibility capabilities in North America and Europe could affect directly and indirectly upwards of 50% of GHG emissions worldwide, on par with their combined GDP. This can be achieved by sharing proven technical knowhow, international standards, and co-operative products and services with the rest of the world.

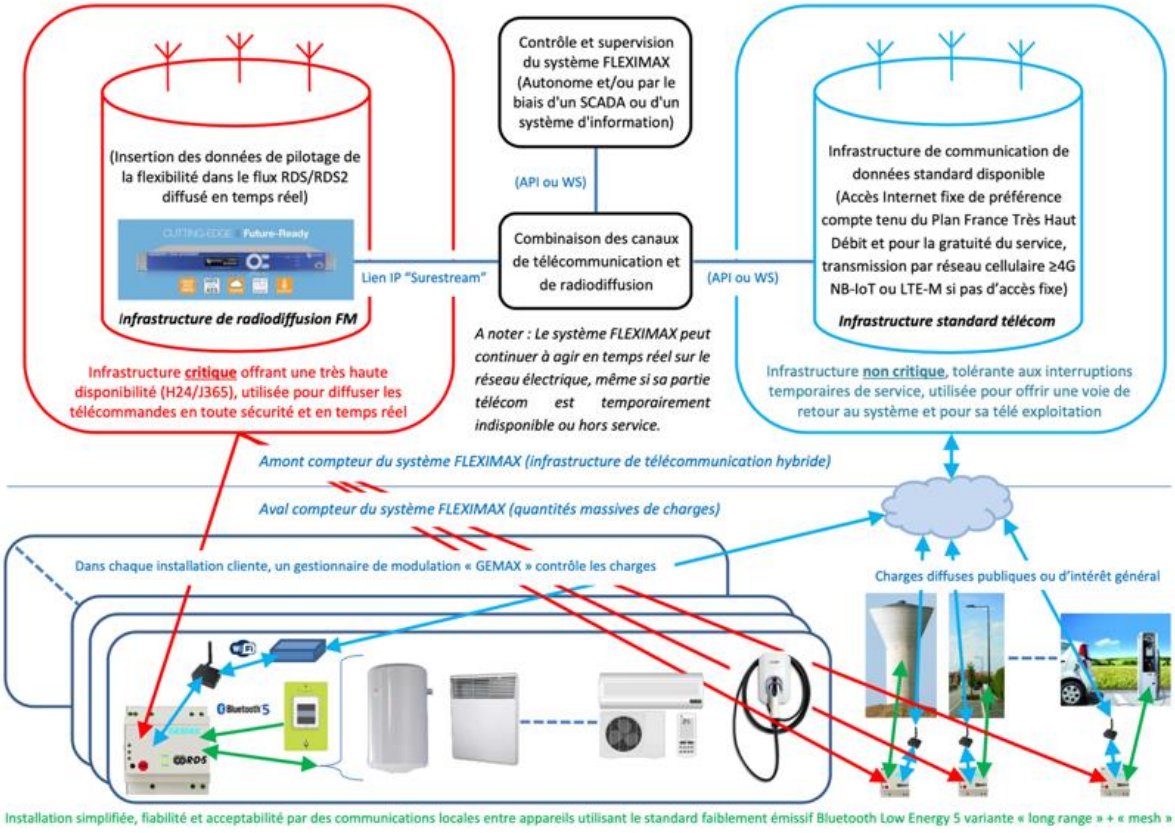

Figure 10. Fleximax Project, European Union

[14] https://www.rds.org.uk/2010/RDS-UMC.htm

A further example of international co-operation was found with UK comments by Laura Schade to the FDAS docket 20-FDAS-01 (TN 239948). It appears that UK seeks similar goals and philosophies including the use of flexible appliance standards to lower costs and expand reach with a desire to enable participation from and benefits to low income and disadvantaged communities.

Consumer Consent, Ease of Use, and Health Considerations

Typical FM devices are the simplest of all electronic devices to install: simply turn it on. The intelligent software automatically finds the local carrier frequency and locks on the strongest authenticated signal. OEM devices must incorporate a highly usable consumer interface; consumer consent and ability to override at any time is key to scaled adoption.

The rapid expansion of RF transmitters for Internet reception is the result of ever-increasing desire for higher internet bandwidth, which in practice requires higher and higher frequency carriers. Consumers may or may not be aware that ultra-high RF energy can be a health issue.

5G cellular frequencies are subdivided into two frequency bands, FR1 (below 6 GHz) and FR2 (24–54 GHz). These higher frequency signals have been shown to get absorbed more readily by materials such as glass, metal, wood, concrete and human skin. The long-term effects of prolonged and relentless exposure to ultra-high frequency transmissions in close proximities is yet unknown.

Fig 11. Sample cellular repeater station atop of a residential building

FM towers broadcast at 100 MHz – some 50 times lower than 5 GHz and 540 times lower than 54 GHz. These towers have been in operations since the 1930s with no evidence of deleterious health effects.

The main issue here is the *unprecedented* use of bands *above* ultra-high frequencies, especially those above 5GHz, and the lack of "weak field" long term exposure medical studies. The current FCC “heat” limits akin to microwave oven heating is not sufficient. Biological systems such as human skin exposure limits are typically a function of an integral of intensity and duration. Imagine 724 UV exposure to sunlight, how would the skin cell recover? *Relentless* weak field exposure is an issue that needs more study prior to government mandates that increase such exposure.

For some, a nightly shutoff of the residential Wifi router is a daily ritual. However, the latest 80211 hardware with 2.4 & 5 Ghz dual band transmitters do not easily provide that option. Anyone using dual band routers will notice that the 2.4 GHz signal goes where 5 GHz does not. Professional installers of fibre television cables will routinely advise the resident that the 5 GHz carrier requires close proximity for it to work; .i.e., the 5 GHz signal which is only 2 times higher than 2.4 (or 50 times higher than 100Mhz FM) is more readily absorbed by the items between the transmitter and the TV. Some consumers would place the Wifi router in the basement in the hopes that natural building material attenuation as well as the distance inverted squared law helps. However, it is important to design the router placement so that no Wifi repeaters are necessary.

The inadvertent building of a national infrastructure akin to the lead-lined Roman Empire aqueducts would be tragic. In the concluding remarks from an expert on this topic, Dr. Tim Schoechle stated: "Consumers are entitled to informed consent to risk. The public should be educated about the real risks involved in using cellphones and being near cell antennas big or small as well as the risks of being exposed to RF radiation in general. It is the responsibility of the FCC to inform the public openly and accurately. The FCC has not done so in this proposed rulemaking." (Dr. Tim Schoechle's Comments on FCC 19-226 Human Exposure to Radiofrequency Electromagnetic Fields–A Proposed Rule by the FCC)

Financial and Operational Metrics

FM signals already reach essentially all California and most of the free world. It is not 5% as stated in table 3 of TN 239571.The origins of the $40 incremental cost cited in table 3 of TN 239571 of 20-FDAS-01 are unclear. The current FM receiver/processor module in our CTA-2045 universal communication module (UCM) is about 25% of the module cost. The total module cost is targeted to be $20 or less at mature volumes.

Our calculations indicate that the projected additional cost to add FM to the existing Internet network is roughly $1 per household per year plus $1 per receiver in costs at scale. This compares favorably to the estimated benefits, which easily exceed $1 per household per day. These rough numbers are based on the following calculations:

1. Full FM coverage of California can be achieved by some 60 to 100 FM stations
2. FM broadcast costs around $10,000 per station per month
3. Robust statewide coverage using 100 stations would cost $12 million per year
4. The entire statewide FM network could be fully activated in FY 2022
5. There are approximately 12 million households in California
6. $12 million per year for 12 million homes is $1 per household per year

Note that FM signals can also be used in the commercial and industrial sectors. Using the above calculation, the cost to the C&I sector is just the extra $1 per radio receiver. The planned new $1 FM receiver with advanced processing and security measure at mature volumes has been collaborated as proxy by many silicon experts in California.

Conclusions

In these comments, e-Radio is advocating for the logical and prudent reduction not elimination of internet packet traffic. This, to avoid increased data congestion, power consumption, cyber security issues and potential adverse health effects related to high-frequency RF exposure associated with a mandated increase in the internet of things (IOT). The hybrid IP+FM architecture is a natural fit. It is compatible with all existing internet systems and can scale quickly to meet the program objectives of SB49 and SB100 in reducing GHG, while providing new levels of human safety, efficiency, reliability, consumer privacy, and cybersecurity.

FDAS standards should, at the least, be compatible with the hybrid FM broadcast architecture that simultaneously satisfies technical feasibility and cost effectiveness, provides enhanced cyber security and the simplest most inclusive type of consumer engagement and ease of use.

The broadcast service and provision of receiver chips/modules could be sponsored by the state, by utilities, or by a 3rd party with a mandate and requirement for public good (e.g., nonprofit or Benefit Corporation). Global NGO (non-government organization) may be such a vehicle.

Finally, had the CEC Title 24 draft building code of 2008, requiring FM receivers, been implemented, there would be Gigawatts of flexible loads in California today to help fulfill SB49 & SB100.

Questions for CEC Staff

1. What are the expected effects of the proposed standards on internet data traffic and systemwide energy consumption, including standby power use of IP devices?
2. Using only internet standards, will it be possible to overcome the barriers to international standards to quickly achieve global GHG reduction?
3. Requirements for WiFi or cellular communications run the risk of greatly increasing local RF exposure, especially in low income and disadvantaged communities. Has the commission considered the effects of near weak field long term radiation in its deliberations? What are the expected effects of the proposed standards on consumer health?
4. How is the CEC mitigating the threat of cyber-attacks from a growing population of internet connected devices and therefore points of attack at residential homes?

Suggested wording for thermostat standards (phase 1)

Based on the 2007 Title 24 draft wording for communicating thermostats:

Thermostats - All heating and/or cooling systems including heat pumps shall have a thermostat that meets the following requirements:

1. Scheduling Capabilities - All thermostats shall have a clock mechanism that allows the building occupant to program the temperature set points for at least six periods within 24 hours corresponding to Wake, Away, Precool, Offset, Home, and Sleep periods.

2. Communicating Capabilities – All thermostats shall be distributed with a non-removable FM Radio communications device in conformance with CFR 47 Part 73 of the FCC rules. Specifically, this radio communications device will support the FM Radio Data System (RDS), and optionally the higher data rate of an FM-band HD Radio™ receiver (as described in NRSC-5) to facilitate receiving timely information from the default statewide MIDAS system, which can be used by utilities, CCAs, and the CAISO to send price and emergency signals. Thermostats shall be capable of receiving and responding to the signals indicating price and emergency events as follows

A. Price Events – Thermostats shall be shipped with default price-event offsets of up to +3°F for cooling and -2°F for heating. Customers shall be able to change the offsets and thermostat settings at any time. Upon receiving a price-event signal, the PCT shall adjust the thermostat setpoint by the number of degrees indicated in the offset for the duration specified in the signal of the price event.

B. Emergency Events – Upon receiving an emergency signal, the thermostat shall respond to commands contained in the emergency signal, including changing the setpoint by any number of degrees or to a specific temperature setpoint. The thermostat shall allow customer changes to thermostat settings during emergency events.

3. Other Required Capabilities

A. Provide user information regarding communications system connection status, type of event (price or emergency), and other maintenance-related information.

B. Standard terminal mapping of terminal numbers 1-9 that support 24-volt power supply, heat pumps with resistance heat strips, and reversing valves in residential and small commercial packaged units.

C. Include the capability to randomize, over a 30-minute period after the end of an event, the time at which the thermostat returns to the programmed setpoint.

D. Be capable of addressability at the substation level or finer including individual thermostat.

EXCEPTION 1: Gravity gas wall heaters, gravity floor heaters, gravity room heaters, non-central electric heaters, room air conditioners, wood stoves, and room air-conditioner heat pumps.

EXCEPTION 2: Other devices within the heating and cooling system, other communications systems or methods, or utility specific devices determined to be capable of providing equivalent flexibility described in this section that are approved by the Executive Director.

Thank you for your consideration.

Jackson Wang, P.Eng.

CEO

e-Radio USA, Inc.

www.e-radiousa.com