Proposed: an international standard data model and encoding for electromagnetic field (EMF) data

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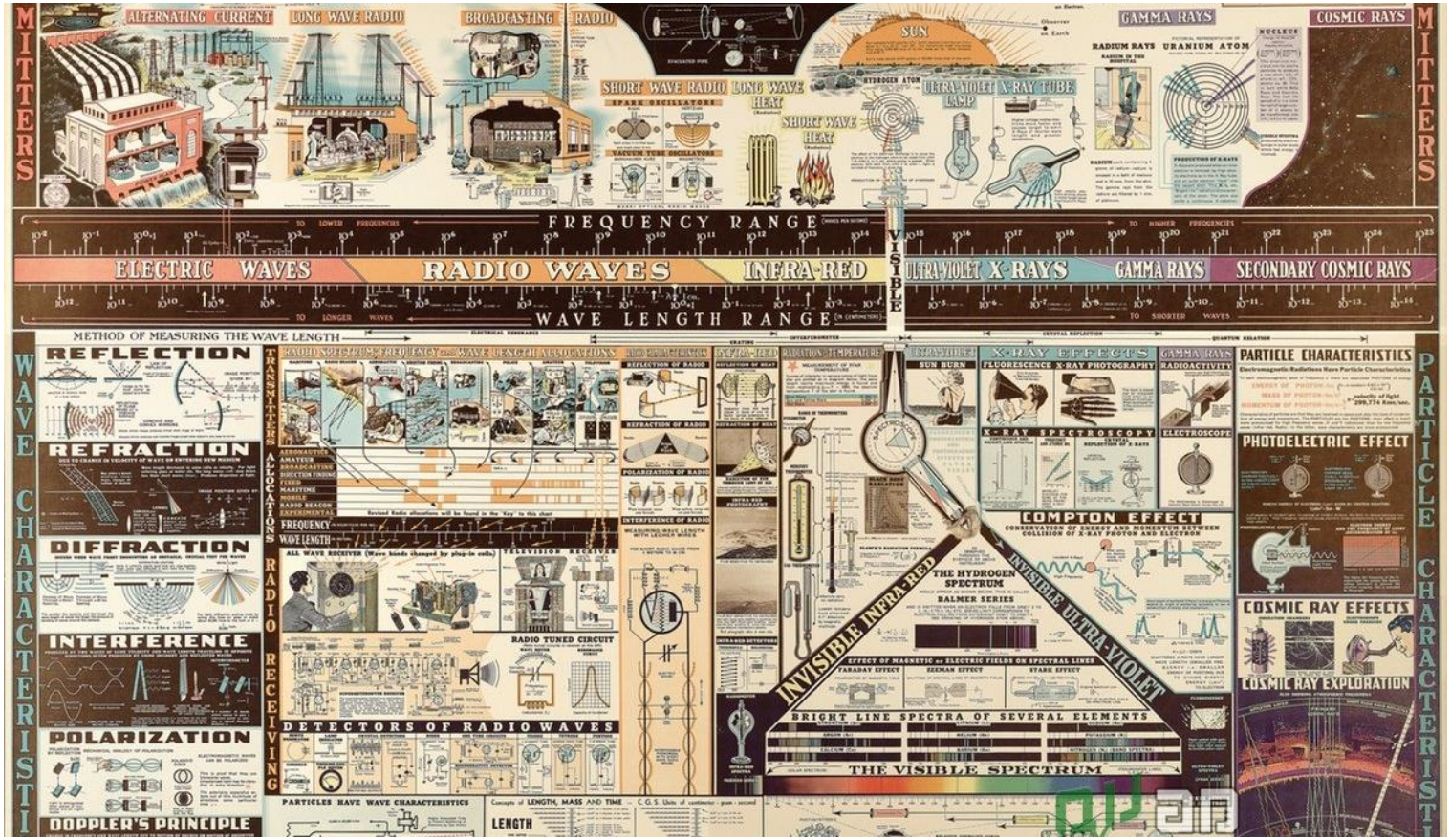
- Expertise: Standards Development
- Associate Procurement Engineer, State of California, Dept. of General Services
- Collaborative for High Performance Schools (CHIPS), chair of the indoor environmental quality committee since 2006.
- Co-coordinator, Collaborative on Health Environment – Electromagnetic Fields (CHE EMF)
- I am an Advisor on the FDA's Technical Electronic Product Radiation Safety Standards Committee
- Research and Development Engineer for 7 years at GE
- PhD funded by EPRI

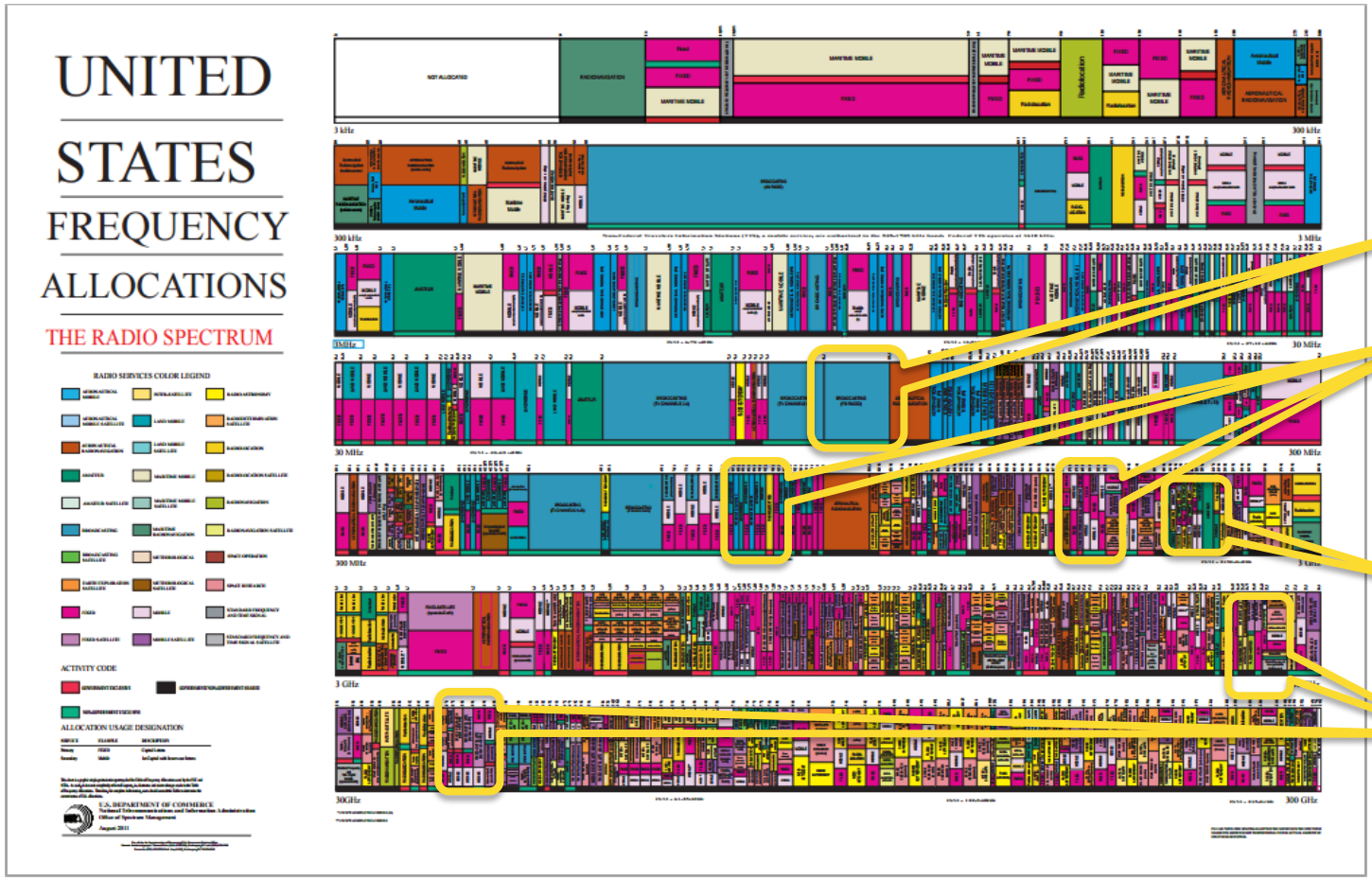
Electromagnetic spectrum = the full range of self-propogating oscillating electric and magnetic fields



Poster created in the late 1930s by Dwight Barr, a consultant for the W. M. Welch Scientific Company.

It's complex! Civilization has suddenly become dependent on it!
All waves are inherently spatial and temporal.

It’s complex! Fine differences separate signals.



FM radio

3G/4G LTE cellular

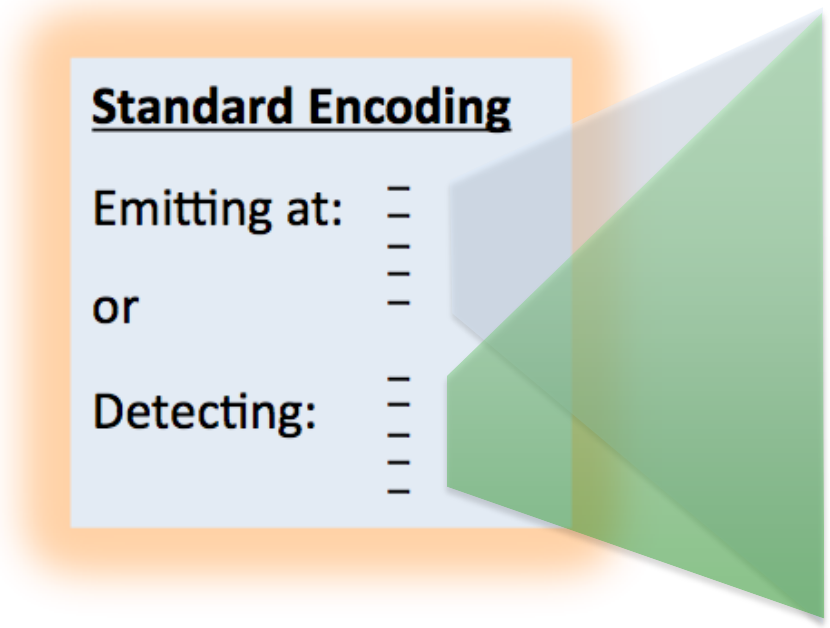
WiFi

5G cellular (not yet deployed)

This chart only shows <u>frequency</u> bands. There’s much more complexity!

EMF Parameters

EMF signals and noise can be measured, described and (if we had a standard) communicated.



- _ Frequency
- _ Modulation type & mode
- _ Polarity
- _ Energy intensity max/min.
- _ Energy intensity ave.
- _ Relative location & orientation of antennas and impacted biological elements
- _ Time
- _ Unique source ID?
- _ Emitter or sensor specifications, including antenna specifications
- _ etc. (to be determined by Standards working group)

We need a standard encoding because we need computers to help us with the complexity!

Rigorous characterization & communication of EMF data is important in many domains

Mitigation & study of EM Interence with electronic devices – to achieve EMC (EM compatility)

Defense & Intel: signals intelligence, EMP,

Bioelectro-magnetics Research – health risks & therapeutc uses of EMF

Wireless provider operations

Wireless technology R&D

Remote sensing operations and R&D

Physics & astronomy research

Government regulation of RF spectrum use

Others? Future uses …?

Resolve the controversy over EMF health risks

- Many studies show negative health effects of wireless signals (from cell phones, laptops, wireless smart meters, etc.), but often repeat studies using the “same” parameters yield different results. This creates disagreement among scientists and policy makers and leaves the public in doubt about safety.
- Non-reproducible results are quite likely due to the complexity of wireless communication protocols: Experiments (and experiments to test those experiments’ reproducibility) seldom account for all the details of modulation mode, pulsing, timing, polarity, spatial location and orientation, etc.
- The growing complexity of wireless signals requires more sophisticated bioinformatics tools for bioelectromagnetics research and environmental EMF data collection. Interoperability is a key requirement: Information systems need to work together within and across information communities, organizational boundaries and technology platforms.
- Faulty wiring exposes building occupants to extremely low frequency (ELF) but relatively strong magnetic fields – a “healthy buildings” issue.

An open EMF data encoding standard would open up bioelectromagnetics research opportunities.

Accelerated and more rigorous laboratory research

Standard Encoding

Emitting at: _ _ _ _ _

or

Detecting: _ _ _ _ _

- _ Frequency
- _ Modulation type & mode
- _ Polarity
- _ Energy intensity max/min.
- _ Energy intensity ave.
- _ Relative location & orientation of antennas and impacted biological elements
- _ Time
- _ Unique source ID?
- _ Emitter or sensor specifications, including antenna specifications
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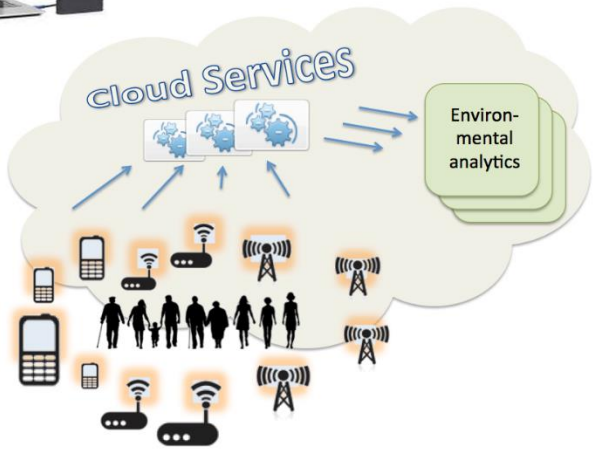
More widespread and effective environmental monitoring (ELF & RF)

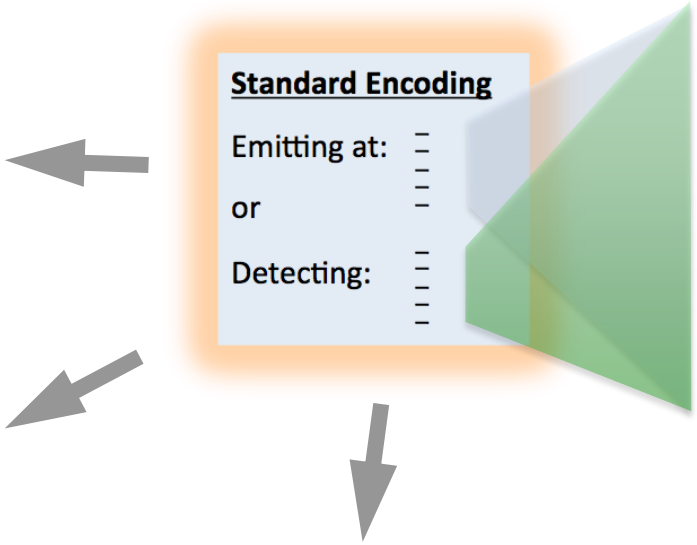
Improved epidemiological research, with potential for data sharing, access to vast quantities of environmental EMF data, and new bioinformatics tools.



Ultimately, improved wireless devices, communications policy, management, operations, energy efficiency, monitoring and oversight.

EMF data encoding standard would open up opportunities for utilizing scarce spectrum.

With such a standard, schemes like the [FCC's proposed 3.5 GHz spectrum database] would have a common way of describing signals and digitally communicating and integrating information about signals.



Model would include:

- Frequency
- Modulation type & mode
- Polarity
- Energy intensity max/min.
- Energy intensity ave.
- Relative location & orientation of send/receive antennas
- Time
- Unique source ID?
- Emitter or sensor specifications, including antenna specifications
- etc. (to be determined by Standards working group)

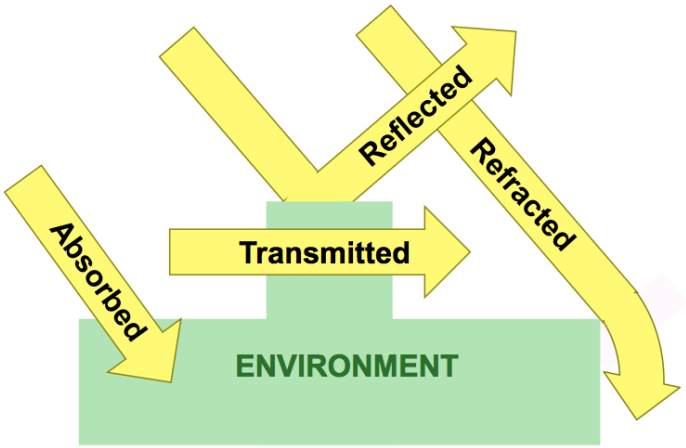
Spectrum sharing in urban and indoor spaces requires modeling those spaces. Standards for integrated indoor/outdoor spatial modeling are being developed. Those standards could be a critical enabler for advanced spectrum sharing methodologies and small cell communications. (Small cell approaches might be safer!)

With growing spectrum usage, wireless communications policy, management, operations, energy efficiency, monitoring and oversight will depend on having standard ways of modeling signals in spaces.

Why the focus on "spatial"?

1. **Electromagnetic fields are inherently spatial and temporal.** All **…**
   - have a point or region of origin.
   - are affected by the media they travel through.
   - are absorbed, reflected, refracted by objects and phenomena they impinge upon.
   - have effects on objects and phenomena they impinge on, including other electromagnetic fields (interference). Dynamic magnetic fields induce currents in conductors.

1. **Good fit into the OGC standards that focus on spatial and temporal encoding and interface standards.**
   - Historically, OGC's focus was solely *geo*spatial.
   - Now, OGC members are working with other standards organizations on convergence of indoor and outdoor.
   - Basic principles of modeling macrospatial and mesospatial features and phenomena can be extended to microspatial and nanospatial (and nanotemporal) cellular and molecular features and phenomena important in bioelectromagnetics research.



Collaboration is needed to address complexity.

Complexity makes data integration and communication difficult.
Collaboration makes data integration and communication possible.

EMF is complex:

- Modulation type (very complex mix of parameters!)
- Frequency
- Polarization
- Energy intensity max/min.
- Energy intensity ave.
- Location & orientation
- Time
- Unique source ID?
- Emitter or sensor specifications, including antenna dimensions
- etc. (to be determined by SWG)

EMF domain experts would bring this expertise to the working group.

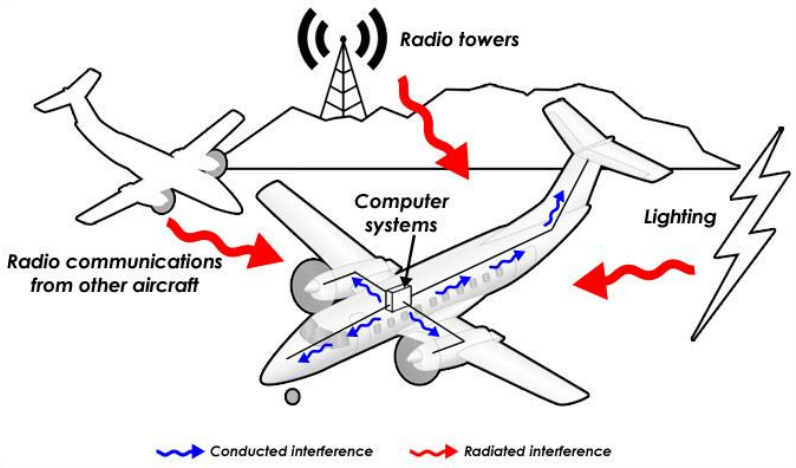
Spatial data is complex:

- Vector, raster, point clouds and other types data
- Diverse Earth coordinate reference systems & Earth shape models (geodesy)
- 2D, 3D, 4D and nD
- Many spatial phenomena are time-varying
- Conflating semanticly different data
- Conflating precise and imprecise data
- Harmonizing with other standards for spatial features and phenomena
- Navigating IT trends, e.g. database > services > linked data

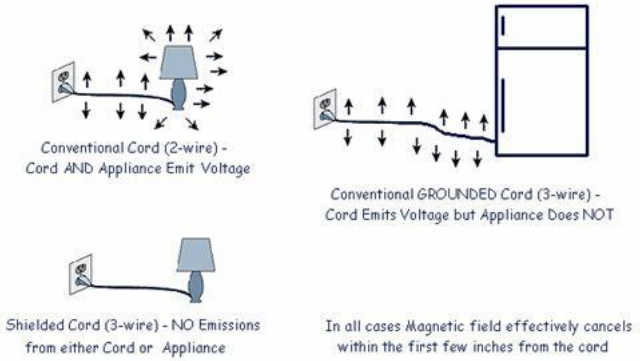
OGC staff and OGC members who are spatial technology experts would bring this expertise.

EMF interference: Radiated and Conducted Sources

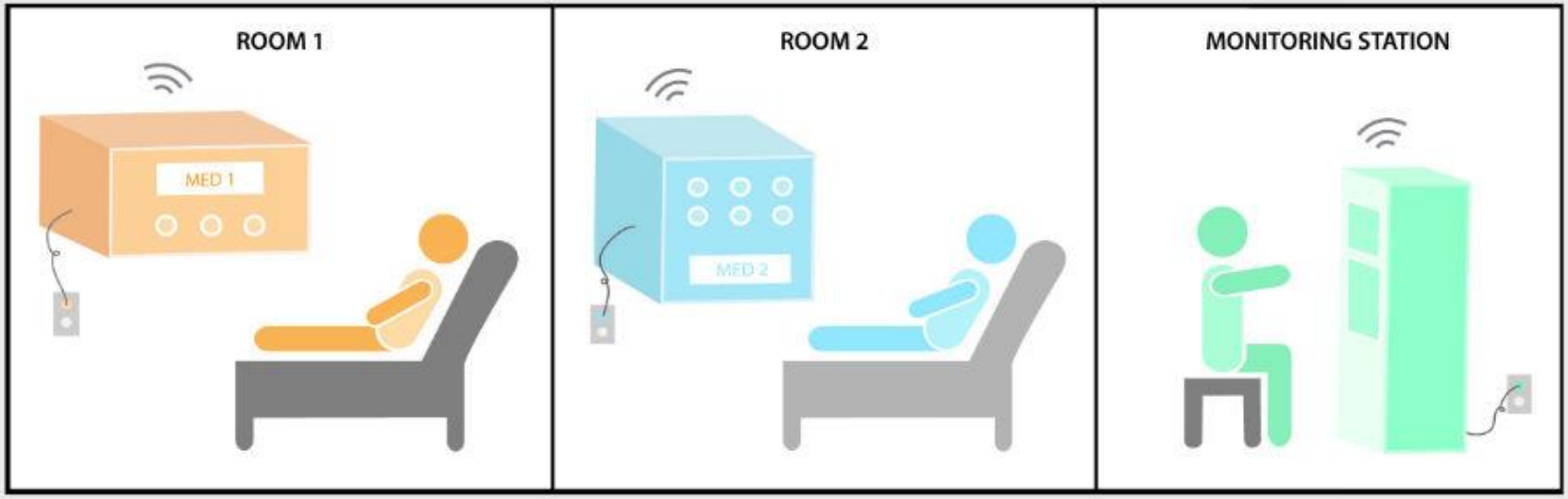
Many sources of EMF.



FAA (http://lessonslearned.faa.gov/ll_main.cfm?TabID=4&LLID=45&LLTypeID=2)



Risks of Using Wireless Devices in a Healthcare Setting



POTENTIAL RISKS	ADDRESSED BY
1. Potential interference between the devices and ambient noise	IEC 60601-1-2
2. Immunity of the devices to wireless RF	NEW Standard
3. Wireless coexistence	FDA Guidance Document

POTENTIAL CONSEQUENCES OF ELECTROMAGNETIC INTERFERENCE

- Device Breakdown
- Data Signal Distortion/Interruption
- Transmission Delay
- Negative effect on patient outcomes

http://www.mdtmag.com/articles/2013/09/new-regulations-minimize-risk-electromagnetic-interference

Call to action:

Tell me if you're interested. Join a discussion about drafting an OGC Standards Working Group charter.

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