

Europe's new opening for Cognitive Radio: *ASA/LSA*

ROBERT HORVITZ

Stichting Open Spectrum



2012 Wireless Innovation Forum European
Conference on Communications Technologies
and Software Defined Radio
(SDR'12 – WInnComm – Europe)



27 - 29 June • Brussels, Belgium

Phasing out untethered “dumb” license exempt radios?

ROBERT HORVITZ

Stichting Open Spectrum



2012 Wireless Innovation Forum European
Conference on Communications Technologies
and Software Defined Radio
(SDR'12 – WInnComm – Europe)

27 - 29 June • Brussels, Belgium



Open Spectrum

... is based on the realization that by making radios “smarter,” technology can reduce or eliminate the need for governments to micro-manage wireless communication.

Open Spectrum can be considered:

- an ideal of freedom in the use of radio;
- a critique of traditional spectrum management;
- a possibility arising from trends in radio design.

Cognitive Radio is the key enabling technology for Open Spectrum.

The Internet & Open Spectrum have a common origin



Paul Baran
(1927-2011)

openspectrum.info

Authorized Shared Access (ASA)

First proposed by Nokia & Qualcomm in their joint response to an RSPG consultation on cognitive technologies (January 2011).

Subsequently presented to the CEPT Working Group on Frequency Management, which is drafting a report on ASA with recommendations for the European Commission.

Authorized Shared Access (ASA)

Nokia & Qualcomm initially described the idea as a way for a cellular operator (for example) to get earlier access to spectrum assigned to an incumbent who might be gradually phasing out his use of the band as part of a “re-farming” process.

An agreement between the incumbent(s) and the newcomer(s) will have been previously negotiated, setting conditions for the access (perhaps including compensation to the lender, and perhaps guaranteeing the borrower a certain minimum availability).

Cognitive techniques – beacons, geo-databases, sensing, etc. - would be used to alert the borrower to the imminent availability of the spectrum in certain locations, and to provide a warning of when access will be suspended.

Authorized Shared Access (ASA)

ASA differs from “white space device” (WSD) proposals in that the opportunistic users are licensed, limited in number, their identities are known & they are subject to the terms of an explicit agreement with the incumbent(s).

Under WSD rules, there are no negotiations with incumbents. The number of opportunistic users is unpredictable, & because they are unlicensed, the identities & locations of the WSD owners are unknown.

Thus, ASA is designed to give incumbents more control over the details of the sharing, and an incentive to share in the form of compensation for loaning “their” spectrum.

The resistance incumbents have shown to proposals for WSD access to the UHF band suggested a need for such a scheme.

Licensed Shared Access (LSA)

But our research also showed that ASA would not be legal in EU member states that do not allow the subletting of licensed spectrum (*e.g.*, the Czech Republic, Ireland, Lithuania, Malta, Slovenia, etc.). If the lender receives compensation, ASA must be considered a sublet.

So the Commission took the idea of ASA and re-focused it, emphasizing the need for regional harmonization and for regulatory approval of subletting arrangements based on cognitive radio techniques. That is now called LSA, to distinguish it from the Nokia/Qualcomm proposal.

A public consultation on ASA and LSA is expected in few months. If either or both are recommended, the re-farming of many frequency bands could be accelerated, and now-exclusive government bands opened to sharing.

PCAST

The (US) President's Council of Advisors on Science & Technology (PCAST) will soon issue a report on ways to improve the management of federal spectrum.

We spoke with the report's lead author, Mark Gorenberg, for several hours last month. He had read our shared spectrum report to the European Commission & he quizzed us about ASA, LSA & unlicensed access to spectrum using cognitive techniques & geo-databases.

The next PCAST meeting is 19 July. It is possible that his spectrum report will be approved then for public release.

FCC proposed opening TV white spaces to unlicensed devices

“Additional Spectrum for Unlicensed Devices below 900 MHz and in the 3 GHz Band - Notice of Inquiry,” ET Docket 02-380 (December 2002)

WSDs are *not* cognitive radios

According to the ITU definition, a “cognitive radio” can “**autonomously** adjust its operational parameters and... **learn** from the results obtained.” (Report ITU-R SM.2152)

WSDs are *database slaves*. They do not make independent assessments of channel availability.

Under Part 15.711 of the FCC’s rules, WSDs must check in with the database every day and whenever they move more than 100 meters. If a day passes without a check in, the WSD must cease operating by midnight the following day.

Individual devices or all devices of a certain type can be de-registered by the database: **unregistered devices cannot operate.**

WSDs in Europe

ECC Report 159: Technical and Operational Requirements for the Possible Operation of Cognitive Radio Systems in the 'White Spaces' of the Frequency Band 470-790 MHz (January, 2011)

EC mandate to Project Team SE43 (which produced the report) was to “ensure the protection of the incumbent radio services [and] investigate the... amount of spectrum potentially available as white space.”

Most important conclusion: geo-databases are sufficient to protect the incumbent systems. Spectrum sensing by individual WSDs is unreliable and unnecessary.

WSDs in Europe

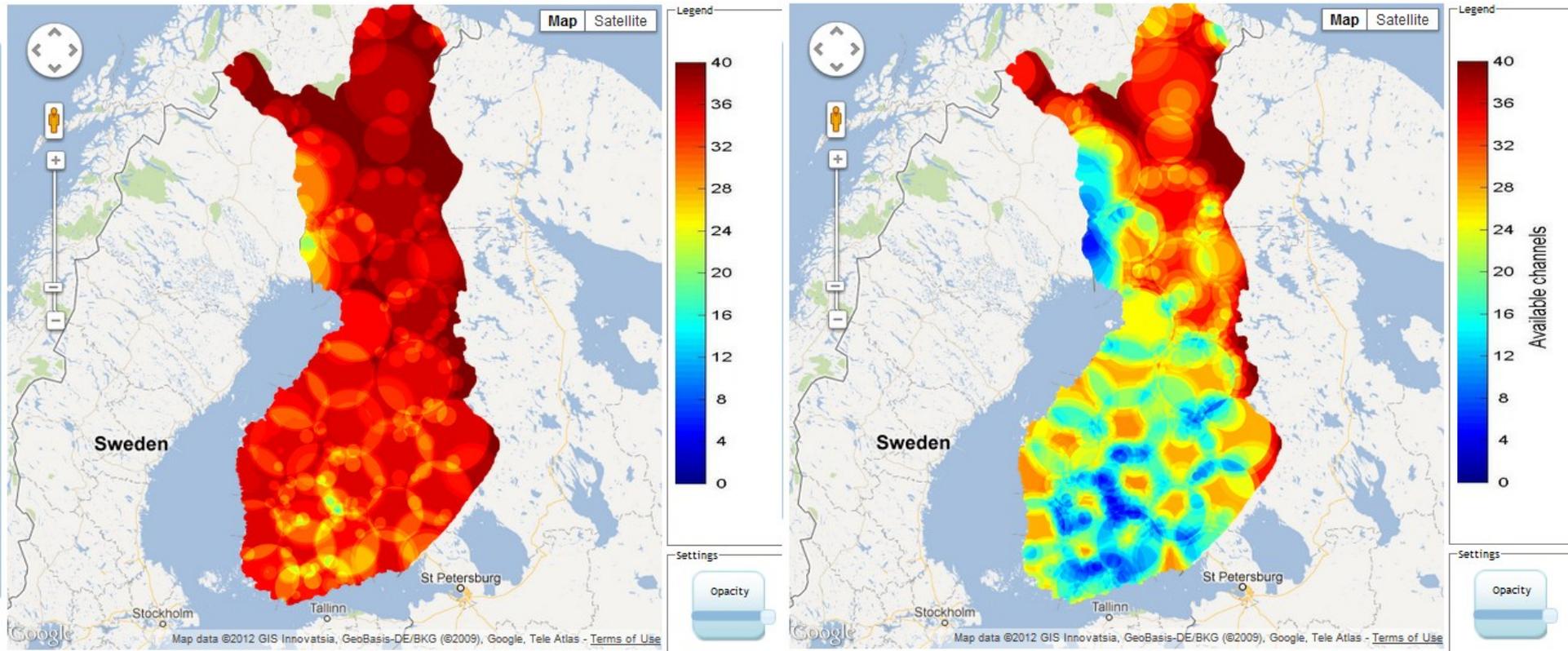
Best feature of *ECC Report 159*:

- ◆ Set no maximum permitted EIRP for WSDs which must be “baked” into hardware. The geo-database algorithms can calculate the power limit necessary for the protection of incumbent services at any given locale (this is good for remote & sparsely populated regions).

Worst features of *ECC Report 159*:

- ◆ The project team did not test any prototype WSDs or measure the interference susceptibility of any DTT receiver.
- ◆ Broadcasters influenced the calculation of the signal detection sensitivity said to be needed to protect DTT from WSD interference. Result: a recommended detection threshold of **-140 to -155 dBm** (for mobile WSDs), which was declared insufficiently reliable anyway.

<http://quasar.netlab.hut.fi/>



White space channels available in Finland under *ECC Report* 159 rules (left) vs. *FCC 2nd Memo Opinion & Order* rules (right), both assuming a 2km WSD cell radius

Restricting the use of TV channels *adjacent* to those occupied reduces white space availability by ~50%

From van de Beek, *et al.*, "TV White Space in Europe," *IEEE Trans. Mob. Comms.* (2012)

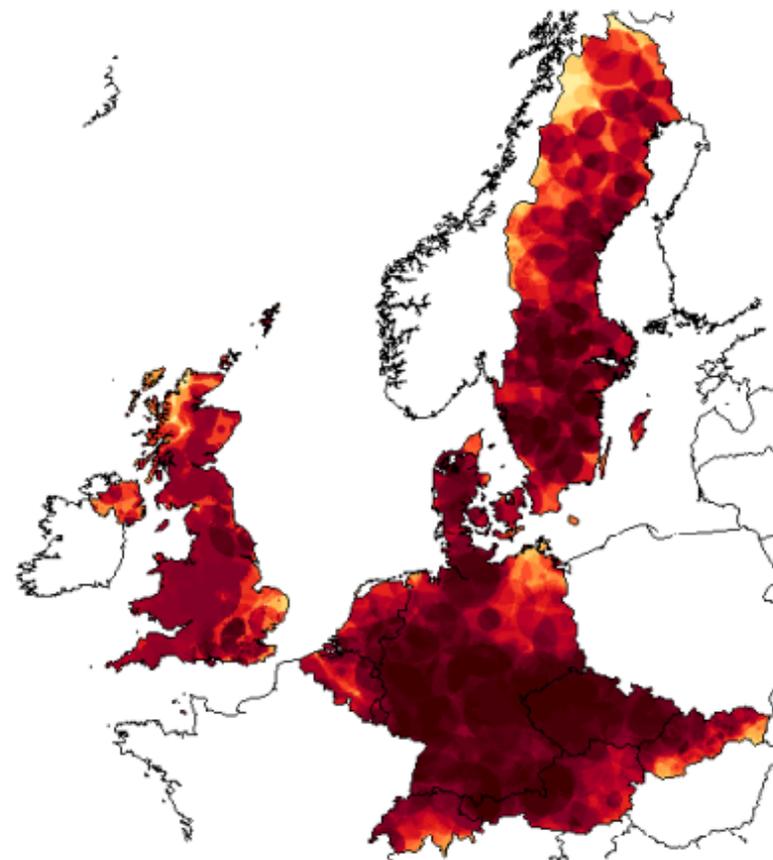
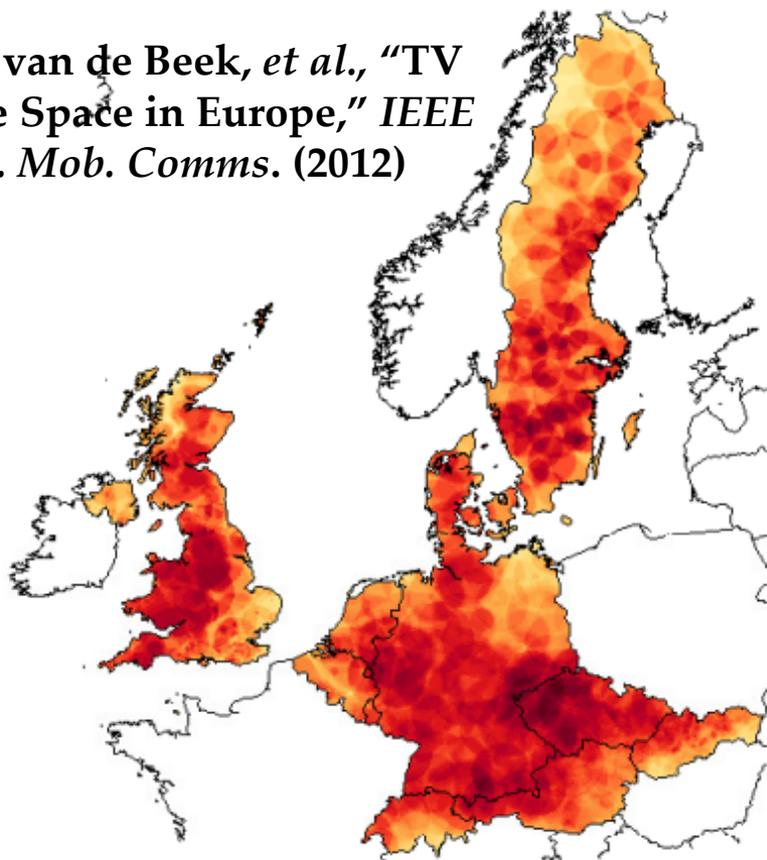
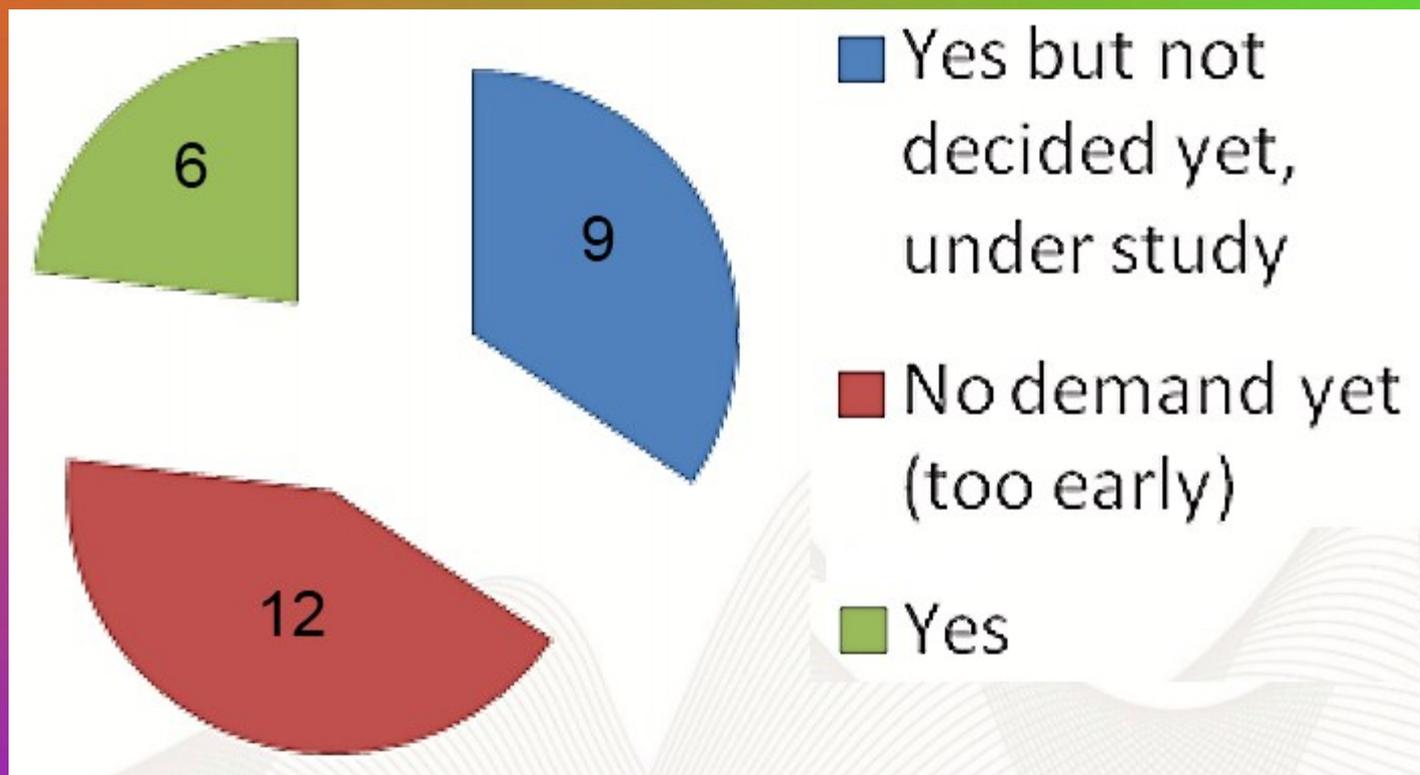


Fig. 2. TV white space map of $S(x)$ for 11 European countries (adjacent channel use is unrestricted).

Fig. 3. TV white space map of $S'(x)$ for 11 European countries (adjacent channel use is restricted).

ECC questionnaire to EU regulators (May 2011): “Do you envisage the introduction of white space devices in the 470-790 MHz band”?



From “Deployment of TV White Space Devices: A survey among European Regulators 2011,” by Thomas Weber (ECC), presented at two workshops in November 2011

*Perspectives on the Value of Shared Spectrum Access:
Final Report for the European Commission
(Forge, Horvitz & Blackman, February 2012)*

“Our survey of national regulatory authorities found a great deal of professional interest in the policy questions posed by WSDs, but limited support for authorizing them. Only Belgium, Denmark, Finland, Latvia, Poland, Slovakia, and the UK said they now plan to authorize WSDs, although Bulgaria, Portugal and Spain remain undecided.”

All work so far has been on ways to manage the emissions of WSDs

Assuming the worst-case interference scenario does not maximize spectrum's socioeconomic benefit.

Geo-databases protect broadcasters' whole authorized coverage area, even where & when there are no active receivers. Such overprotection is spectrally inefficient – it denies access to safely usable resources.

Another option: register the locations of *receivers* in a protection database

Proposed by Hemdan Bezabih in her master's thesis (University of Oslo, 2010).

- In most parts of Europe, broadcast receiver owners pay an annual license fee, so their locations are already registered.
- In the 1st quarter of 2012, 36% of all new TVs sold in western Europe – and 27% of all new TVs sold worldwide – were designed for connection to the Internet (according to the NPD Group). Strategy Analytics predicts that *80% of all flat-panel TVs sold in 2016 will have Internet connection capability.*

Another option: register the locations of *receivers* in a protection database

- ◆ Interference is a *reception* problem which transmitters have traditionally borne the burden of solving.
- ◆ Receiver owners have a strong incentive to register – to gain protection against interference – and the procedure can be automated.
- ◆ More detailed audience measurement data is sought by broadcasters & advertisers. The protection database could gather data about receivers' current frequency use, for real-time audience data & to enable the temporary re-purposing of spectrum within broadcast coverage areas.

Governments see many new applications for Internet “tethering” & database control

- ◆ To prevent interference to 5 GHz radars by WAS/RLANs.
- ◆ To enable location-variable power limits for WAS/RLAN deployments (rural, urban).
- ◆ To open federal spectrum for sharing without revealing protected sites’ frequency use or location.
- ◆ Solves the problem of “refarming” an unlicensed band for future licensed use.
- ◆ In a security crisis, net access can be restricted – selectively, for individuals or areas, or for all.

PCAST: Extending the US TVWS database to federal bands

On 25 May 2012, the President's Council of Advisors on Science & Technology (PCAST) adopted recommendations in a forthcoming report on improving the management of federal spectrum.

One recommendation calls on NTIA to authorize access to up to 1000 MHz of federal spectrum on a secondary basis or as license exempt subject to control by a geo-location database (supplemented, where appropriate, with sensing).

The 3550-3650 MHz band (used by military radars) was proposed as the initial opening, by extending the TVWS geo-location database system authorized by the FCC.

CSMAC

On 1 March 2012, the US Commerce Department's Spectrum Management Advisory Committee (CSMAC) considered recommendations from its Unlicensed Subcommittee on conditions for access to new shared frequency bands:

“...the Committee recommends that NTIA, in coordination with the FCC, require that **in all new unlicensed bands, or in shared Federal bands designated for unlicensed access, that devices should be ‘connected devices’ that are required periodically to ‘call home’ to renew the authorization to operate in the band (e.g., via a certified database, or directly to the manufacturer)...**”

More from the CSMAC report:

“The Committee generally recommends that in the future ‘unconnected’ devices should be restricted to certain bands of spectrum where they are already prevalent (e.g., 900 MHz, 2.4 GHz). *Policymakers should consider whether such devices should even be further restricted in the future, phasing out their access to very high-quality bands over an appropriate time period.*”

Phasing out “dumb” untethered devices globally

CSMAC: “...since the demand for spectrum is arising from the explosion of smart devices that need to communicate, we should use those same ‘smarts’ to enable safer sharing scenarios... the continued decrease in product costs makes this approach feasible even for very low end or low cost devices. Finally, note that if this approach to primarily allowing sharing via smart devices is to take hold, the US may need to take a leadership position in the international community to advance this more holistic approach to sharing..”

Context of the CSMAC report

These recommendations grew out of discussions about unlicensed use of *federal* frequencies (*e.g.*, garage-door openers & automobile keyfob problems in military bands, interference to doppler radars at 5 GHz).

But the Subcommittee believes it is right to have consistency in the rules for federal & non-federal band sharing, so they proposed these new policies to apply generally, not just in federal bands.

Realizing that billions of unlicensed devices will be deployed in the coming years, they decided it is better to increase our reliance on *technical prophylaxis* from the beginning of market entry, and less on enforcement responses after interference occurs (*e.g.*, penalties, instructions to users, confiscation of equipment).

“Opinion 13/2011 on Geolocation services on smart mobile devices”

Adopted 16 May 2011 by the European Union’s ARTICLE 29 Data Protection Working Party.

They see two central issues:

- 1. Can location information for a particular device be reliably associated with an “identifiable natural person”?** If it can, then the data is considered personal and more demanding privacy protection standards apply.
- 2. Is the information collected for use in an infrastructural or a value added service?** If the former, there is no “opt out.”

What might that mean in practice?

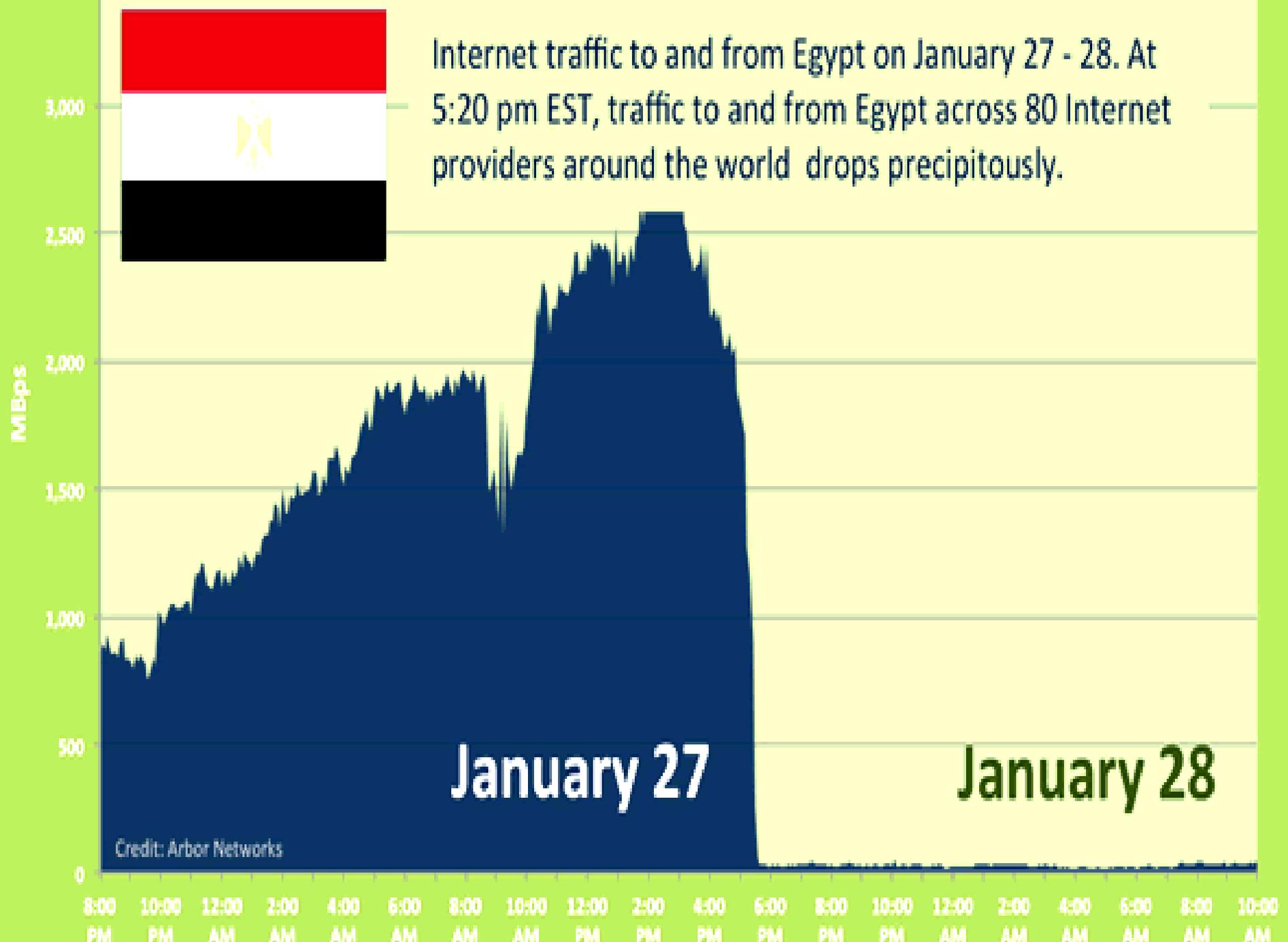
Note that Opinion 13/2011 is **a recommendation, not a law**, and it does not specifically address WSDs. So applying its arguments to a new application requires a new interpretation. That means there is still room to argue about the applicability of certain policies since WSDs are – or are not – like other location-based services.

Since many countries are likely to emulate the FCC's rules, which require WSDs to have a unique identifier built in – like a MAC address! – WSDs might be considered analogous to Wi-Fi. (Super Wi-Fi?)

Therefore, the opinion that EU member states should treat Wi-Fi locations as personal data (thus deserving privacy protection) might encompass WSDs as well.



Internet traffic to and from Egypt on January 27 - 28. At 5:20 pm EST, traffic to and from Egypt across 80 Internet providers around the world drops precipitously.



Credit: Arbor Networks

“...the President, if he deems it necessary in the interest of national security or defense, may... cause the closing of any station for radio communication, or any device capable of emitting electromagnetic radiations... [or] cause the closing of any facility or station for wire communication...”

---United States Code, Title 47 Chapter 5 §606

FCC GN Docket No. 12-52

“In this Public Notice [released 1 March 2012], we seek comment on the legal constraints & policy considerations that bear on an intentional interruption of wireless service by government actors for the purpose of ensuring public safety...

“We are concerned that there has been insufficient discussion, analysis, and consideration of the questions raised by intentional interruptions.”

NOTE: This FCC inquiry was limited to licensed services.

Unfortunately, ubiquitous connectivity seems to be incompatible with personal privacy & device autonomy.

Robert Horvitz

bob@openspectrum.info

STICHTING OPEN SPECTRUM

Amsterdam/Prague

<http://www.openspectrum.info/>

openspectrum.info

References (1)

- Article 29 Data Protection Working Party, “Opinion 13/2011 on Geolocation services on smart mobile devices,” WP 185 (16 May 2011), Directorate General Justice - http://ec.europa.eu/justice/policies/privacy/docs/wpdocs/2011/wp185_en.pdf
- P. Baran, “Is the UHF Frequency Shortage a Self Made Problem?” Marconi Centennial Symposium, Bologna, Italy (23 June 1995) – <http://wireless.oldcolo.com/course/baran2.txt>
- P. Baran, “The Beginnings of Packet Switching: Some Underlying Concepts,” *IEEE Communications Magazine*, Vol. 40, Issue 7 (July 2002), pages 42-48 - <http://www.friends-partners.org/glosas/Origin%20of%20P-S%20Tech./Baran%20Papers%20copy/Given%20by%20Paul/Baran-IEEE/Baran-IEEE-color/Baran-IEEE.pdf>
- J. van de Beek, J. Riihijarvi, A. Achtzehn & P. Mahonen, “TV white space in Europe,” *IEEE Transactions on Mobile Computing*, vol. 11, no. 2 (Feb. 2012), pages 178-188 - <http://dx.doi.org/10.1109/TMC.2011.203>

References (2)

- H. Bezabih, *TV receiver registration to utilize unused frequencies in the TV broadcasting band*, master's thesis, Dept. of Physics, University of Oslo (2010) - <http://www.duo.uio.no/publ/fysikk/2011/133895/master.pdf>
- H. Bezabih, B. Ellingsaeter, J. Noll & T. Maseng, "Digital Broadcasting: Increasing the Available White Space Spectrum Using TV Receiver Information," *IEEE Vehicular Technology Magazine*, vol. 7, no. 1 (Mar. 2012), pages 24-30 - <http://dx.doi.org/10.1109/MVT.2011.2179344>
- A. J. Blumberg & P. Eckersley, "On Locational Privacy, and How to Avoid Losing it Forever," Electronic Frontier Foundation (August 2009) - <https://www.eff.org/wp/locational-privacy>
- M. Cazy, "Asia heads connected TV sales rates for 2012," *World TV PC* (14 June 2012) - <http://www.worldtvpc.com/blog/asia-heads-connected-tv-sales-rates-for-2012/>

References (3)

Commerce Spectrum Management Advisory Committee (CSMAC),
“Recommendations on Enforcement, Submitted for Adoption,” US
Department of Commerce, National Telecommunications &
Information Administration, Unlicensed Subcommittee (1 March,
2012) - http://www.ntia.doc.gov/files/ntia/meetings/csmac_unlicensed_comm_enforcement_adoptiondraft_final_022412.doc

Electronic Communications Committee, “ECC Report 159: Technical
and Operational Requirements for the Possible Operation of
Cognitive Radio Systems in the ‘White Spaces’ of the Frequency
Band 470-790 MHz” (January, 2011) - <http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP159.PDF>

FCC, “In the Matter of Additional Spectrum for Unlicensed Devices
Below 900 MHz and in the 3 GHz Band: Notice of Inquiry,” ET
Docket 02-380 (Dec. 2002) - <http://ecfsdocs.fcc.gov/filings/2002/12/11/5508555784.html>

References (4)

FCC, “In the Matter of Promoting More Efficient Use of Spectrum Through Dynamic Spectrum Use Technologies - Notice of Inquiry,” ET Docket 10-237 (Nov. 2010) - http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-10-198A1.pdf

FCC, “Chairman Genachowski announces approval of first television white spaces database and device,” press release (22 December 2011) - http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-311652A1.pdf

FCC, “Public Notice: Commission Seeks Comment on Certain Wireless Service Interruptions,” GN Docket No. 12-52 (1 March 2012) - http://transition.fcc.gov/Daily_Releases/Daily_Business/2012/db0301/DA-12-311A1.pdf

References (5)

- S. Forge, R. Horvitz & C. Blackman, “Perspectives on the Value of Shared Spectrum Access: Final Report for the European Commission,” SMART 2011/0017, SCF Associates Ltd. (February 2012) - http://ec.europa.eu/information_society/policy/ecomm/radio_spectrum/_document_storage/studies/shared_use_2012/scf_study_shared_spectrum_access_20120210.pdf
- J. Gruenwald, “Panel Sympathetic to Geolocation Privacy Concerns,” *National Journal*, 17 May 2012 - <http://news.yahoo.com/panel-sympathetic-geolocation-privacy-concerns-152237035.html>
- V. Heinonen, P. Pirinen & J. Iinatti, “Capacity gains through inter-operator resource sharing in a cellular network,” *Proc. IEEE Wireless Personal Multimedia Communications* (2008) – http://www.ee.oulu.fi/~pekkap/WPMC08_VH_PP_JI.pdf

References (6)

- ITU, “Definitions of Software Defined Radio (SDR) and Cognitive Radio System (CRS),” Report ITU-R SM.2152 (Sept. 2009) - http://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-SM.2152-2009-PDF-E.pdf
- P. Margie, “Efficiency, Predictability and the Need for an Improved Interference Standard at the FCC,” Telecommunications Policy Research Conference, 19 September 2003 - <http://morse.colorado.edu/~timxb/spectrum/MargieHarmfulInterference.pdf>
- “Qualcomm and Nokia Corporation Joint Response,” Radio Spectrum Policy Group Consultation (January 2011) – http://rspg.groups.eu.int/consultations/consultation_cognitiv_2010/qualcomm_nokia_0114.pdf

References (7)

President's Council of Advisors on Science & Technology, "Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth," presentation (May 25, 2012) - http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_may25.pdf

QUASAR Project, "TV whitespace availability visualization tool," Department of Communications & Networking, Aalto University, Finland - <http://quasar.netlab.hut.fi/>

Radio Spectrum Policy Group, "Report on Collective Use of Spectrum (CUS) and other spectrum sharing approaches," RSPG11-392 Final (November 2011) - http://rspg.groups.eu.int/_documents/documents/meeting/rspg26/rspg11_392_report_CUS_other_approaches_final.pdf

References (8)

- R. Singel, "Egypt Shut Down Its Net With a Series of Phone Calls," *Wired Magazine's Threat Level* blog (28 January 2011) - <http://www.wired.com/threatlevel/2011/01/egypt-isp-shutdown/>
- Strategy Analytics, "China will overtake US in connected TV sales in 2012," press release (26 April 2012) - <http://www.strategyanalytics.com/default.aspx?mod=pressreleaseviewer&a0=5209>
- Title 47, Part 15.711, Subpart H: "Interference avoidance mechanisms: Television Band Devices," *Code of Federal Regulations* (2012) - <http://cfr.vlex.com/vid/15-interference-avoidance-mechanisms-300251090>
- UK Ministry of Defence, "Statement: Sharing Defence Spectrum," <http://www.mod.uk/DefenceInternet/AboutDefence/WhatWeDo/ScienceandTechnology/Spectrum>

References (9)

- UK Office of Communications, “Draft final regulatory requirements for white space devices in the UHF TV band” (June 2012) - <http://www.ietf.org/mail-archive/web/paws/current/pdfzJ6ceKZrN8.pdf>
- US National Security Telecommunications Advisory Committee, “Termination of Cellular Networks During Emergency Situations,” in *2009-2010 NSTAC Issue Review*, pages 155-156 - [http://www.ncs.gov/nstac/reports/2009%20-%202010%20Issue%20Review%20\(FINAL\).pdf](http://www.ncs.gov/nstac/reports/2009%20-%202010%20Issue%20Review%20(FINAL).pdf)
- W. Webb, “White space databases: A guidance note for regulators and others” (January 2012) - <http://www.pdf-searcher.org/White-space-database.html>
- T. Weber, “Deployment of TV White Space Devices: A survey among European Regulators 2011,” Workshop on Software Defined Radio and Cognitive Radio Standardisation, JRC, ISPRA, Italy (17-18 November 2011) - <http://ebookbrowse.com/sdr-weber-pdf-d240768200>