Open Software in a Changing World: How to Sustain and Accelerate Business and Societal Impact while Addressing Current Challenges?

University of Skövde, Sweden

Implementing Technical Standards in Open Source Software – Challenges and Practicalities of Royalty-Free Standards

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Professor Jorge L. Contreras
University of Utah, Salt Lake City, Utah, USA

S.J. QUINNEY
COLLEGE OF LAW
THE UNIVERSITY OF UTAH

Greetings from Utah!
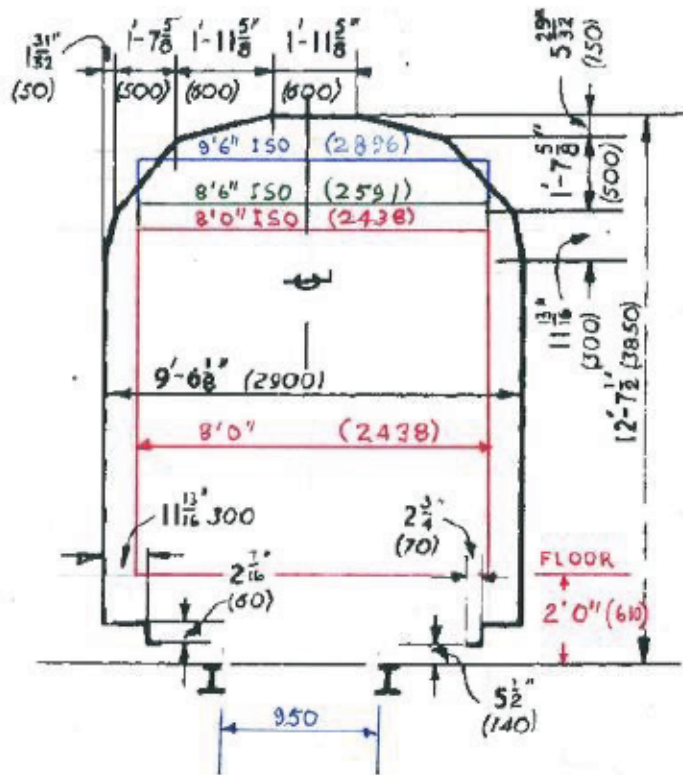

The ARPANET in December 1969

SALT LAKE 2002

Outline

1. Software and Standards
2. Patents and Standards
3. FRAND Licensing and OSS
4. OSS and RF Licensing
5. Outsider Claims and RF
6. Quest for an RF Codec
7. The Attack on Reciprocity

1. Software and Standards: Background

Interoperability Standards (physical)

Braking Mode—T_e range (s)	Wagon Type	Command Equipment	Load	Requirement for running speed at 100km/h	
				Maxi	Mini
Braking mode "P" - $1,5 \le T_e \le 3$ s	All	All	EMPTY	$S = 480m$ $\lambda = 100\%^a$ $\gamma = 0,91 \text{ m/s}^2$ a	Case A — composite blocks: $S = 390$ m, $\lambda = 125\%$, $\gamma = 1,15 \text{ m/s}^2$ Case B — other cases: $S = 380$ m, $\lambda = 130\%$, $\gamma = 1,18 \text{ m/s}^2$
	"S1"[b]	Empty/ Load Device	Intermediate Load	$S = 810$ m $\lambda = 55\%$ $\gamma = 0,51 \text{m/s}^2$	Case A — composite blocks: $S = 390$ m, $\lambda = 125\%$, $\gamma = 1,15 \text{ m/s}^2$ Case B — other cases: $S = 380$ m, $\lambda = 130\%$, $\gamma = 1,18 \text{ m/s}^2$
			LOADED (Maximum = 22,5 t/axle)	$S = 700$ m $\lambda = 65\%$ $\gamma = 0,6 \text{ m/s}^2$	Case A — Brake only on wheels (Brake blocks): $S = $ greater of ($S = 480$ m, $\lambda = 100\%$, $\gamma = 0,91 \text{ m/s}^2$) or (S obtained with a mean retardation force of 16,5 kN per axle [e]. Case B — Other cases: $S = 480$ m, $\lambda = 100\%$, $\gamma = 0,91 \text{ m/s}^2$

Railroad gauge standards

Interoperability Standards

IETF - Long History of Software in Standards (i.e., long before ETSI…)

The ARPANET in December 1969

Internet Standards and Software

· *IETF RFC 1 "Host Software" (7 Apr 1969), Steve Crocker, ed.*

Messages

Information is transmitted from HOST to HOST in bundles called messages. A message is any stream of not more than 8080 bits, together with its header. The header is 16 bits and contains the following information:

- Destination   5 bits
- Link   8 bits
- Trace   1 bit
- Spare   2 bits

The destination is the numerical code for the HOST to which the message should be sent. The trace bit signals the IMPs to record status information about the message and send the information back to the NMC (Network Measurement Center, i.e., UCLA). The spare bits are unused.

Error Checking

We propose that each message carry a message number, bit count, and a checksum in its body, that is transparent to the IMP. For a checksum we suggest a 16-bit end-around-carry sum computed on 1152 bits and then circularly shifted right one bit. The right circular shift every 1152 bits is designed to catch errors in message reassembly by the IMPs.

Standards and copyright

- As a "work of authorship", standards documents are protected by copyright
  - Often owned by SDO
  - May be "sold" or released as open access
  - Issues arise from incorporation by reference (IBR) into legal regulations and codes

- But most standards text is not machine executable…
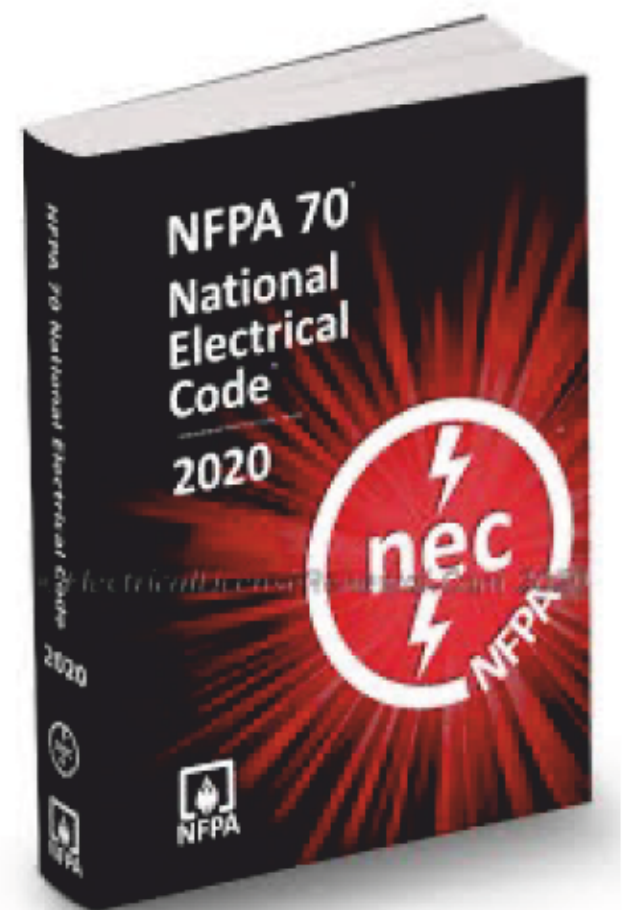
Software in/as standards

IETF BCP 78, Rights Contributors Provide to the IETF Trust and IETF Trust Legal Provisions 5.0, § 4(c)

Code components* included in IETF RFCs are licensed under BSD 3-paragraph license

  *components intended to be directly processed by a computer

Code component examples:
  ABNF definitions
  ASN.1 modules
  ASN.1 structures
  Management Information Base (MIB) modules
  TLS presentation syntax
  eXternal Data Representation (XDR)
  Extensible Markup Language (XML) Schemas
  XML DTDs
  XML RelaxNG definitions
  tables of values
  classical programming code
  Policy Information Base (PIB) module
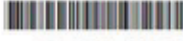 YANG modeling language
  JSON
  CBOR

BSD

2. Patents and Standards

Products infringe, Standards don't

- Patents give owner the exclusive right to **make, use or sell** a product or perform a process

- Standards are <u>documents</u> that describe how to make products interoperable.
  - They can't infringe.
  - SDO is not an infringer.

- Products that "implement" a standard can infringe a patent.

- If a patent will necessarily be infringed by implementing a standard, it's a "standards-essential patent" (SEP)

Patent Issues in Standard Setting

Patent stacking

- Many independent patent holders each require a royalty

Patent "hold up"

- Patent holders use leverage to demand excessive royalty
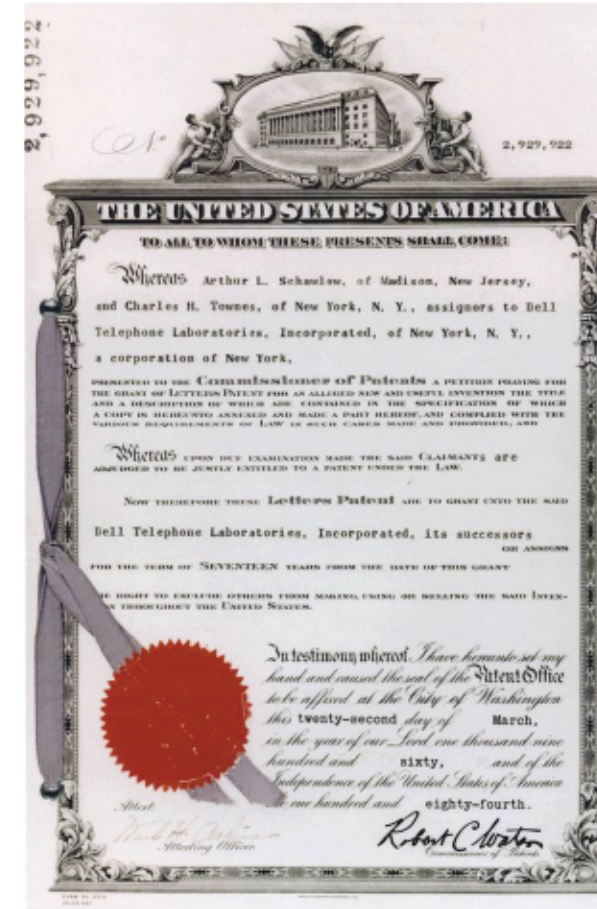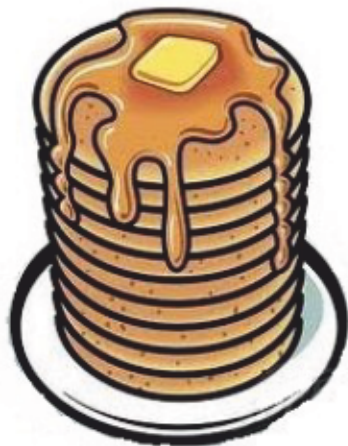
Patent families and Standards

- GSM (2G)
  - 2,200 Baron & Pohlman, 2018)
- UMTS (3G)
  - 9,400 (Baron & Pohlman, 2018)
- LTE (4G)
  - 11,600 (Baron & Pohlman, 2018)
- 5G
  - 32,000 (Buggenhagen & Blind, 2022)

251 Standards

(Biddle et al. 2010)

Top Holders of 5G patents

Current family assignee	5G patent family shares
Huawei (CN)	15.33%
LG Electronics (KR)	11.58%
ZTE (CN)	10.13%
Qualcomm (US)	9.34%
Samsung Electronics (KR)	8.71%
Nokia (FN)	6.31%
Ericsson (SE)	5.18%
Oppo (CN)	4.38%
NTT Docomo (JP)	3.62%
Sharp (JP)	3.41%
CATT Datang Mobile (CN)	2.52%
Vivo (CN)	2.49%
Xiaomi (CN)	2.08%
Apple (US)	1.83%
Institute Of Telecommunication Science (US)	1.55%
Intel (US)	1.14%
Lenovo (CN)	0.95%
Fg Innovation Company (CN)	0.91%
InterDigital (US)	0.91%
MediaTek (CN)	0.78%

(Buggenhagen & Blind, 2022)

How SDOs attempt to address hold-up and stacking

- **Disclosure Policies**
  - SDO participants must <u>disclose</u> essential patents prior to approval
    - Allows workaround
    - Notice of licenses needed

- **Licensing Policies**
  - SDO participants commit to <u>license</u> essential patents on terms that are royalty free (<u>RF</u>) or Fair, Reasonable and Nondiscriminatory (<u>FRAND</u>)

3. FRAND Licensing and OSS

FRAND, RF and Pool Licensing Structures

251 Standards in a Laptop

- FRAND — 75%
- RF — 22%
- Pool — 3%
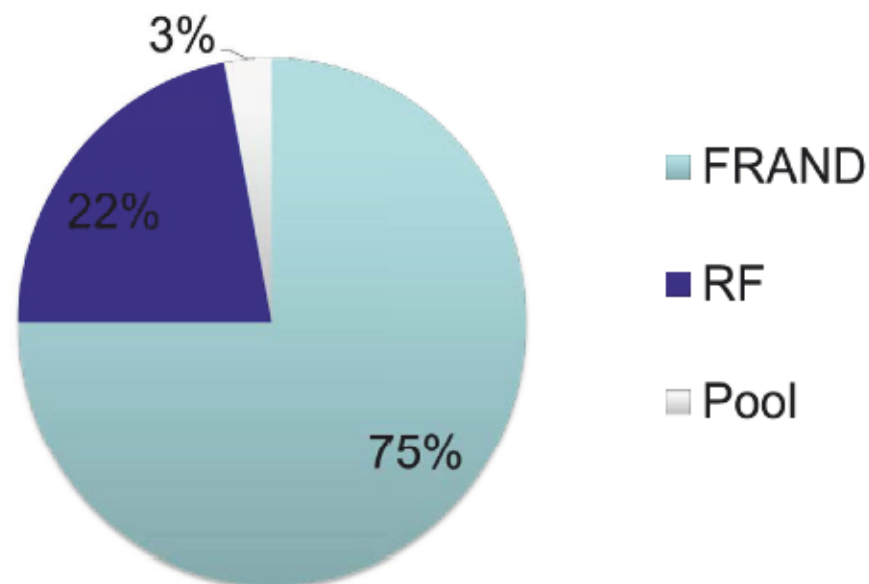
Biddle, White & Woods 2010

FRAND Commitments

A holder of standards-essential patents must offer all implementers of the standard "reasonable terms and conditions that are demonstrably free of any unfair discrimination"

ANSI Essential Requirements, 3.1.1.b

"the Director-General of ETSI shall immediately request the owner to give within three months an irrevocable undertaking in writing that it is prepared to grant irrevocable licences on fair, reasonable and non-discriminatory ("FRAND") terms and conditions"

ETSI IPR Policy 6.1

SEP/FRAND Disputes

- Availability of injunctions
  - Willingness of licensee

- FRAND royalty rates
  - SSPPU v. EMVR
  - Comparable licenses
  - Ex ante value
  - Incremental value

- Nondiscrimination
  - Level discrimination
  - Similarly situated

- Jurisdictional competition
  - Antisuit[n] injunctions
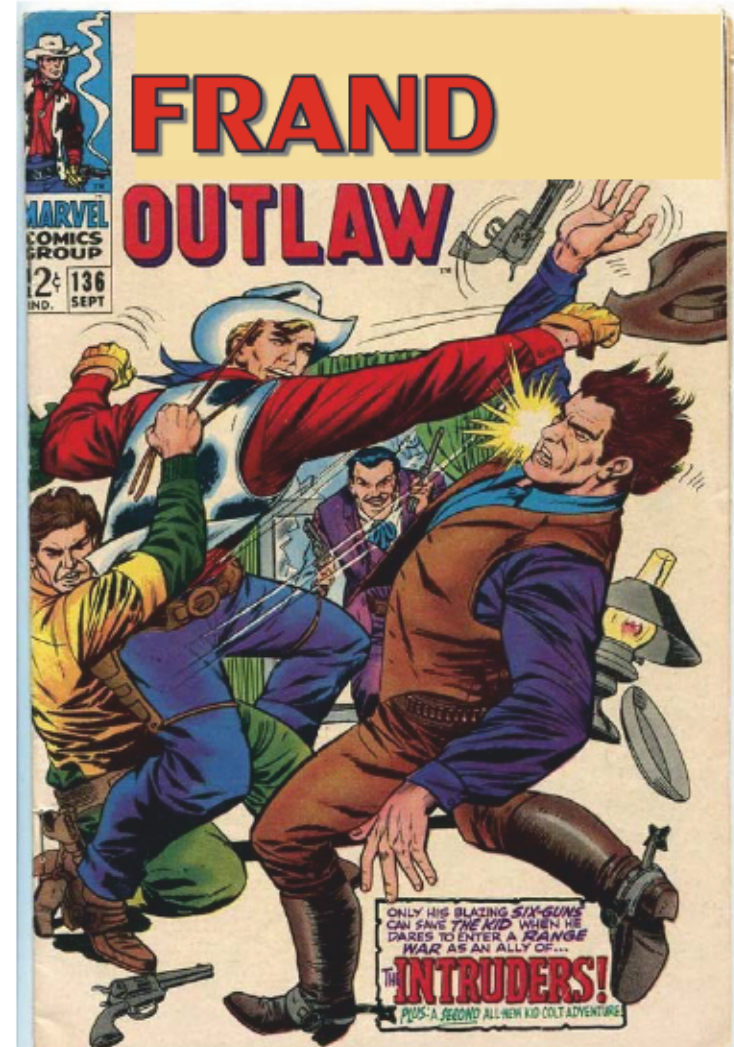
Can OSS accommodate FRAND?

- **Copyright-only OSS licenses**
  - BSD, LGPL, MIT
  - If code does not itself implement full standard, <u>maybe</u> no license required for code writing/distribution. BUT
  - Making, using or selling a <u>product</u> incorporating code implementing standard requires SEP license
  - This includes software
  - Even if "legally" compatible, many (most) OSS developers can't afford to pay a royalty on every copy of software that they distribute (usually for free)
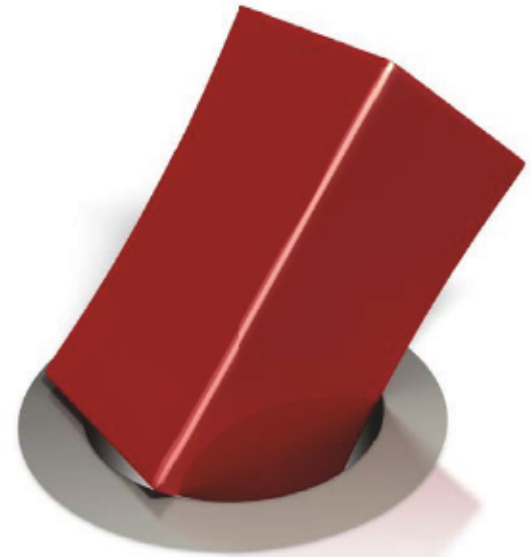
Patent-inclusive OSS licenses and FRAND

- GPL
  - Requires licensing of <u>Licensor's</u> SEPs to recipients
    - Does not implicate 3rd party SEPs
    - Does not require RF
  - Recipients must re-license code on same terms
    - Patent license only applies to recipient's SEPs

- Apache, PERL
  - Requires licensing of <u>Licensor's</u> SEPs to recipients on RF basis (i.e., precludes FRAND licensing)
  - But does not apply to third party SEPs
  - And not prevent third party SEP holders from seeking royalties
  - Even if third party SEPs were covered, this does not stop Licensor from licensing them to recipients RF, so long as Licensor pays the royalty to the SEP holder

→Not all OSS licenses technically inconsistent with FRAND
→**But, practically, very inconsistent**

4. OSS and RF Licensing

Efficiencies of RF

- **Implementer**
  - No cost to implement
  - Reduced recordkeeping and accounting burden

- **SEP holder**
  - Reduced disclosure obligation
  - Less risk of pre-emptive invalidation action (PTAB, Opposition)

- **Both**
  - No negotiation cost/delay
  - No (or little) litigation risk

- **Potential drawbacks**
  - Less incentive for SEP-only players to participate

W3C and RF

- **1999** - Microsoft, Sun and InterMind all disclose patents covering W3C standards

- **2002** - W3C adopts RF policy with PAG process and universal reciprocity

- **2003** - PAGs formed for VoiceXML and HTML patent threats
  - USPTO invalidates HTML patent

Growth of RF Standards

- RF consortia (Bluetooth, USB, W3C, OASIS)

- Armstrong, Mueller, Syrett (2014)
  - of 44 standards embodied in a smartphone, 18 of these (41%) were RF

- Contreras (2013)
  - 59% of IETF patent disclosures (2007-12) are RF

- ETSI (2016)
  - MANO OSS project (Apache RF patent licensing)

Born-RF specifications

- Promoter group/consortium with RF policy develops spec

- Acquired by WFA, with FRAND policy

- Submitted to IEEE-SA (or ISO or ETSI) for standardization

5. Outsider Claims and RF

Outsiders: Not part of the gang…

- Patents may read on a standard, but the inventor is not part of the SDO process (no disclosure)

- **Not limited to FRAND (or RF) rates**

- **No limit on right to seek injunctions**
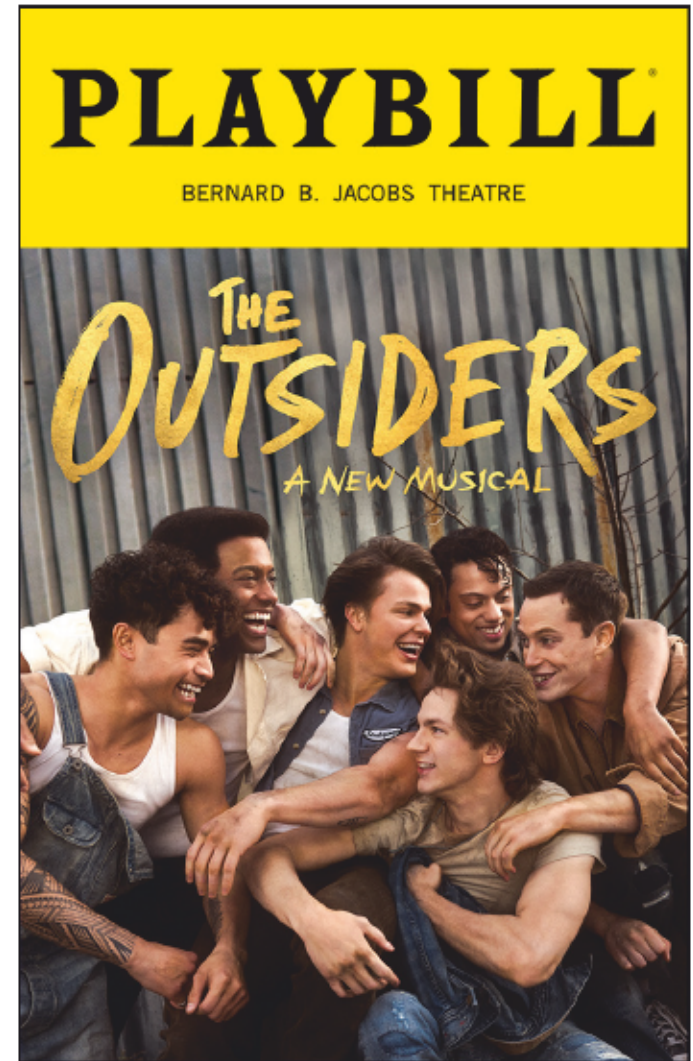
Types of RF Outsiders

	(A) SEP is Encumbered	(B) SEP is Unencumbered
(1) Outsider <u>acquired</u> SEP	Acquired from an SSO participant (e.g., divestiture, M&A, bankruptcy) [N-Data, Innovatio]	Acquired SEP from another Outsider [Rembrandt]
(2) Outsider <u>developed</u> SEP	Outsider was formerly an SSO participant [Rambus]	Outsider developed SEP independently of SSO [CSIRO]

Contreras (2016)

NPE v. Producer SEP assertions

Contreras (2016)
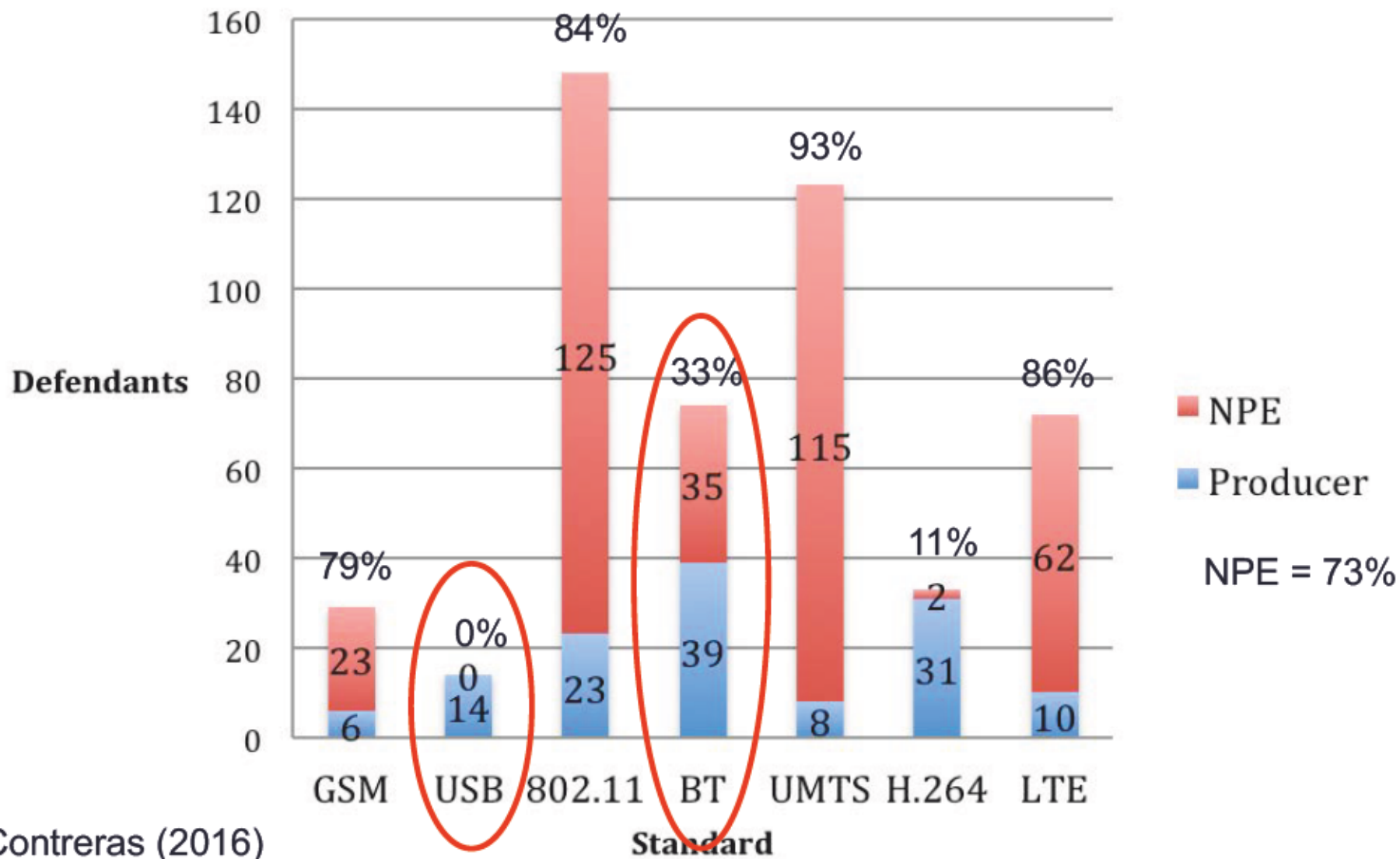
6. Quest for an RF Codec

IETF RFC 6569 "Guidelines for Development of an Audio Codec within the IETF" § 5 (Mar. 2012)

a codec that can be widely implemented and easily distributed among application developers, service operators, and end users is preferred. Many existing codecs that might fulfill some or most of the technical attributes listed above are encumbered in various ways. For example, patent holders might require that those wishing to implement the codec in software, deploy the codec in a service, or distribute the codec in software or hardware need to request a license, enter into a business agreement, pay licensing fees or royalties, or adhere to other special conditions or restrictions. Because such encumbrances have made it difficult to widely implement and easily distribute high-quality codecs across the entire Internet community, the working group prefers unencumbered technologies … The working group cannot explicitly rule out the possibility of adopting encumbered technologies; however, the working group will try to avoid encumbered technologies that require royalties or other encumbrances that would prevent such technologies from being easy to redistribute and use.

In cases where no royalty-free license can be obtained regarding a patent, BCP 79 suggests that the working group consider alternative algorithms or methods, even if they result in lower quality, higher complexity, or otherwise less desirable characteristics.

Competing Codec Development

Gen.		ISO/IEC, ITU-T	Google/ AOM	Huawei, Samsung, Qualcomm
1a	1993	MPEG-1 Part 2		
1b	1994	MPEG-2 (H.262)		
2	2003	MPEG-4 (H.264, **AVC**)		
3	2013	MPEG-H Part 2 (H.265, **HEVC**)	2013: VP9 2018: AV1	
4	2020	MPEG-I Part 6 (H.266, **VVC**)	AV2?	MPEG-5 (EVC)

Gen 3 Codec Patent Groups

HEVC	**MPEG-LA/Via** (Apple, MIT, Fujitsu, KAIST, NEC, NTT, Orange, [Samsung], etc.)	**Access Advance** (AT&T, Microsoft, Nokia, Motorola, Technicolor, Samsung, Panasonic, Sony)	**[Velos Media/Marconi*** (AT&T, Microsoft, Nokia, Motorola, BlackBerry, Ericsson, Panasonic, Qualcomm, Sharp, Sony.)
AV1	**AOM- RF** (Amazon, Apple, Cisco, Google, Huawei, Intel, Meta, Microsoft, Mozilla, Netflix, NVIDIA, Samsung, Tencent)	**Sisvel** (Dolby, Ericsson, IDC, KAIST, Philips, NTT, Orange, Toshiba)	

*Discontinued in Dec. 2022

AV1 Outsider Litigation

Technology Developer	SEP Asserter (PAE)	Implementer (Defendant)
Panasonic, Nokia, Openwave, Siemens	VideoLabs	Netflix
DivX	DivX	LG, Realtek
Alcatel-Lucent	Brasos	ZTE
JVC, Victor	Advanced Coding	Samsung, LG
Technicolor	InterDigital	Lenovo

Source: IAM, 9/11/2023

Codec royalty burdens

Large OEM - Without Velos Media

- AV1 Royalties 17%
- AVC Royalties 12%
- VP9 Royalties 13%
- HEVC Royalties 27%
- VVC Royalties 31%
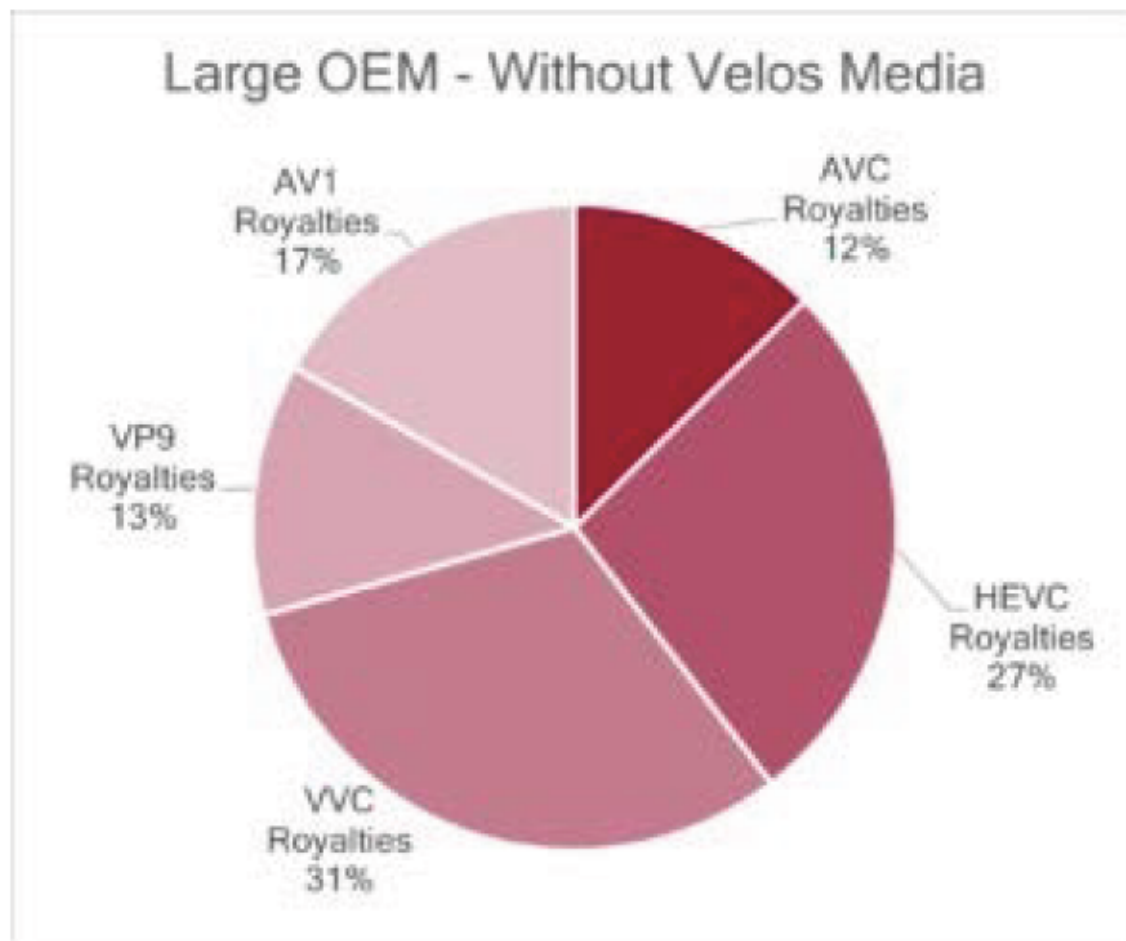
$241M on $150B sales

[$1B w/ Velos]

Source: Alex Davies, ReThink, 24 Mar 2022

AV1 Patent List

Sisvel has the right to grant non-exclusive licenses under the AV1 patents owned or controlled by some of the world's leading technology companies: B1 Institute of Image Technology, Inc., Dolby Electronics, Electronics and Telecommunications Research Institute (ETRI), GE Video Compression LLC, Godo Kaisha IP Bridge 1, IDEAHUB Inc., Intellectual Discovery, JVCKENWOOD Corporation, Korea Advanced Institute of Science and Technology (KAIST), Korean Broadcasting System (KBS), Koninklijke Philips N.V., Nippon Telegraph and Telephone Corporation (NTT), NTT Docomo Inc., Orange S.A., RAI - Radio Televisione Italiana S.p.A., Sejong University, SK Planet Co. Ltd., SK Telecom Co. Ltd., Toshiba Corporation (previously Toshiba IPR Solutions) and Xylene Holdings S.A. (patents held by Xylene Holding include patents previously held by Mitsubishi Electric Corporation). The Patent Owners have appointed independent accredited third parties to evaluate the patents and confirm their use when implementing AV1 technology. The third party evaluation process is still ongoing and to date there are 1774 patents listed, including third-party evaluated patents and their related family members. This list will be updated on a regular basis and supplemented to include new evaluations as soon as available.

Company	AV1 Family	.	Pat.Nr	Claim	Illustrative section(s) of the AV1 specification
B1 Institute of Image Technology, Inc.	AV1-187	Exemplary Patent/s	US11539979	1	2, 4.10.1, 4.10.9, 5.11.4, 5.11.5, 5.11.6, 5.11.7, 5.11.18, 5.11.20, 6.10.4, 7.1, 7.2, 9.3
		Family members	US18/363,949		
Dolby International AB	AV1-003	Exemplary Patent/s	US10499058	1	2, 4.7, 4.8, 5.5.1, 5.5.2, 5.11.35, 5.11.39, 6.4.1, 6.4.2, 6.4.5, 6.10.33, 6.10.34, 7.12, 7.12.1, 7.12.2, 7.12.3, E,
			US10728554	1	2, 4.7, 5.5.1, 5.5.2, 5.11.35, 5.11.39, 6.4.1, 6.4.2, 6.10.33, 6.10.34, 7.1, 7.2, 7.12, 7.12.1, 7.12.2, 7.12.3
			US10951893	1	2, 4.7, 5.5.1, 5.5.2, 5.11.35, 5.11.39, 6.4.1, 6.4.2, 7.1, 7.2, 7.12, 7.12.1, 7.12.2, 7.12.3

- Claims 1774 AV1 patents as of Feb.19, 2024

7. The Attack on Reciprocity

RF Licensing Models (and reciprocity)

- **Non-assertion covenant**
  - Common, e.g., at IETF

- **RF license**
  - Includes other terms
    - Defensive suspension
    - Reciprocity

- **Reciprocity**
  - Bilateral
  - Universal (copyleft)

EC's AOM Investigation

AOM adopts RF with universal reciprocity for AV1

Complaint: "As a condition to the grant of rights to Licensee to make, sell, offer for sale, import or distribute an Implementation … Licensee must **make its Necessary Claims available under this License**, and must reproduce this License with any Implementation…"

July 2022 - EC opens Case AT.40805

• AOM + Members engaged in horizontal arrangement

• Limits ability of FRAND codecs to compete with AV1

• Eliminates incentives for competitors to innovate

PRESERVING THE ROYALTY-FREE STANDARDS ECOSYSTEM

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Jorge L. Contreras
University of Utah S.J. Quinney College of Law

Rudi Bekkers
Eindhoven University of Technology,
Netherlands

C. Bradford Biddle
Sandra Day O'Connor College of Law, Arizona
State University

Enrico Bonadio
The City Law School, City, University of London

Michael A. Carrier
Rutgers Law School

Bernard Chao
University of Denver Sturm College of Law

Charles Duan
American University Washington College of Law

Richard Gilbert
University of California, Berkeley

Joachim Henkel
Technical University of Munich

Erik Hovenkamp
USC Gould School of Law

Martin Husovec
London School of Economics and Political
Science

Kai Jakobs
RWTH Aachen University

Dong-hyu Kim
University of Glasgow

Mark A. Lemley
Stanford Law School

Brian J. Love
Santa Clara University School of Law

Luke McDonagh
London School of Economics and Political
Science

Fiona Scott Morton
Yale School of Management

Jason Schultz
New York University School of Law

Timothy Simcoe
Boston University Questrom School of Business

Jennifer M. Urban
University of California, Berkeley, School of Law

Joy Xiang
Peking University, School of Transnational Law

* Affiliations are listed for identification purposes only.

Procompetitive Benefits of Universal RF

1. accelerates diffusion of standardized technology
2. facilitates decentralized follow-on innovation
3. promotes market entry and competition
   - Esp. by SMEs
4. equalizes benefits
   - Applies to implementers whether or not they have their own SEPs to license
5. lowers consumer prices
6. reduces transaction costs (negotiation, litigation)
7. supports growth of innovative communities (e.g., OSS)
8. reduces international tensions (re. judicial competition)
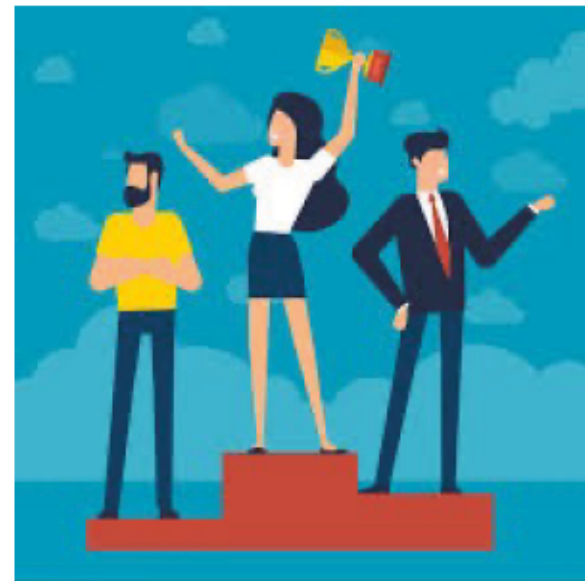
Conclusions

- Despite protestation, FRAND patent licensing isn't compatible with OSS (or at least its intent)
  - FRAND isn't free
  - FRAND has high transaction costs
- RF licensing is a better fit for OSS
- But RF has challenges
  - Outsider patent assertions
  - Legal challenges to reciprocity
  - Is RF oligopsonistic?
- Increased mainstream use of RF licensing with OSS projects will establish stronger norms and make legal challenges more difficult

Further Reading (in addition to Lundell Group)

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Thank you!

Jorge L. Contreras

University of Utah

Salt Lake City, UT

jorge.contreras@law.utah.edu

SSRN page: http://ssrn.com/author=1335192