STANDARD INTERFACES: PREREQUISITE FOR KEY GLOBAL INFRASTRUCTURES

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Interfaces: fire hydrants

- 1904 John E. Hurst fire (Baltimore)
  - destroyed 1,500 buildings
- Reinforcements from DC, Philadelphia, NYC, …
- but: fire hoses did not fit hydrants
  - 600 different versions
- National standard 1905

3

Role of standards

- Widespread use of technology requires standards
  - railroad gauges, nuts & bolts, Morse code, phone system
    - industrial age = interchangeable parts
- Particularly for network technology
  - many mid-size actors
  - "network effect" = utility increases with number of users
    - e.g., cars have *inverse* network effects
    - chess game vs. email and word processor
  - DECnet, SNA, ARCnet ⇒ Ethernet, IP
  - "hypermedia" ⇒ HTML, HTTP

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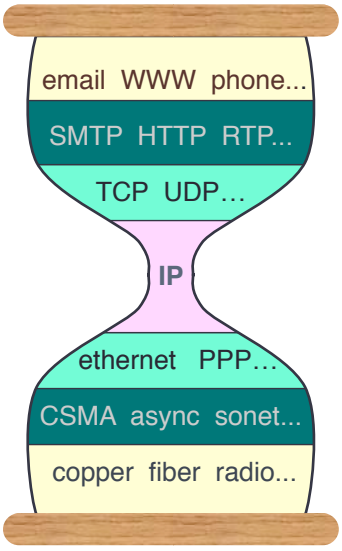
The Internet Protocol Hourglass (S. Deering)



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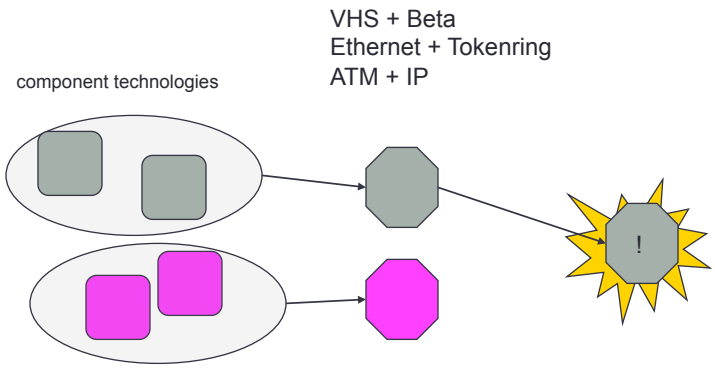
Standards

- Tanenbaum: *"The nice thing about standards is that you have so many to choose from."*



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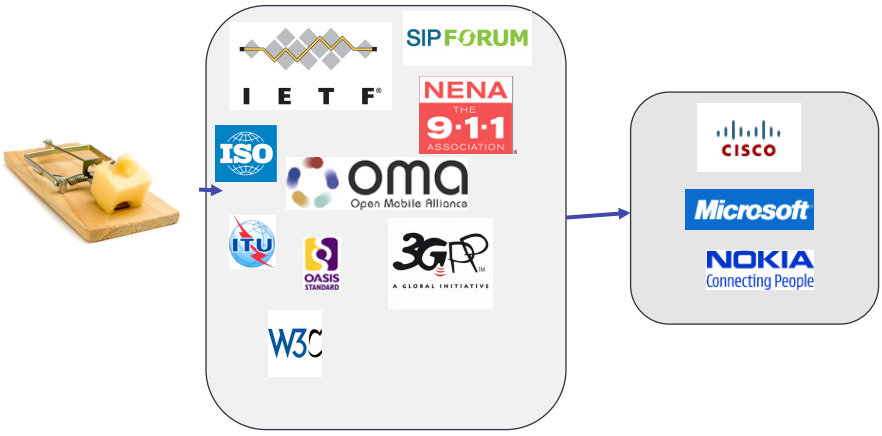
The standards route



Standards as barrier to entry

- Theodore Vail & E. J. Hall: AT&T standards for interconnection
  - state regulators enforced
  - company-wide standardization
- China: LTE TDD, WiFi security, …

Nevertheless, in a number of sectors, concern has grown that China has pursued the development of unique national standards as the basis for its technical requirements, despite the existence of well- established international standards. Reliance on national standards could serve as a means of protecting domestic companies from competing foreign standards and technologies. The sectors affected include: automobiles, automotive parts, telecommunications equipment, wireless local area networks (see the "WAPI" section below), radio frequency identification technology, audio and video coding, fertilizers, food products, and consumer products, such as cosmetics. These China-specific standards, which sometimes appear to lack a particular technical or scientific basis, could create significant barriers to entry into China's markets, because of the high cost of producing products that comply with the China-specific standards.

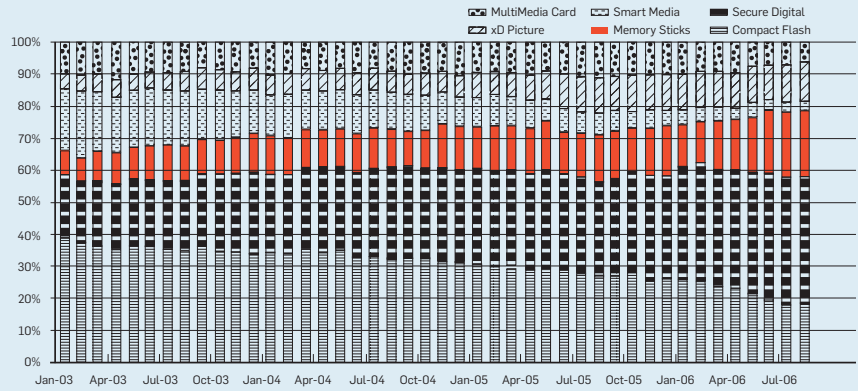
Winner-take-all vs. winner-take-some

- Complete substitute vs. overlapping
  - Beta vs. VHS & Blue-ray vs. HD-DVD
  - XM and Sirius
  - Image file formats: JPEG for photographic images (lossy), GIF for rendered images (lossless)
- Cost of adopting multiple standards
  - e.g., low cost for image and video file rendering
  - perfect format conversion?
- Need for interoperation
  - unknown destination
  - e.g., Powerpoint vs. Apple Keynote
  - but: flash memory mostly used locally
  - role of DRM in restricting content mobility

Kemmerer/Liu/Smith, *CACM* 5/2013

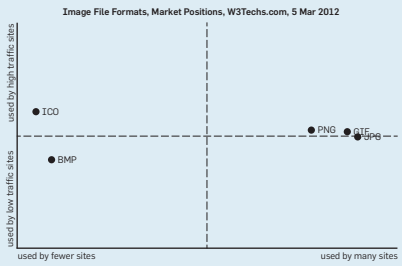
Flash memory

Figure 1. Flash memory card market share, January 2003–August 2006; data source: NPD Group[11]



Digital image formats

Figure 2. Adoption of digital image formats by market position and Web traffic; data source: http://w3techs.com/technologies/market/image_format

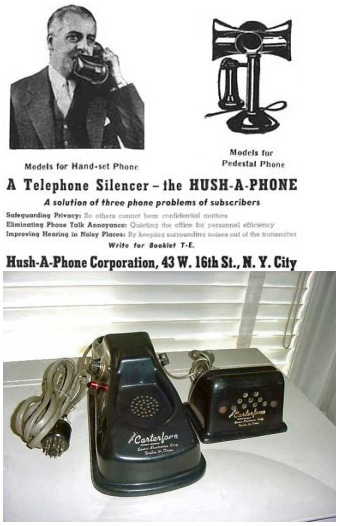


Digital-image formats use, November 2011–April 2012, top one million websites; data source: http://w3techs.com/technologies/history_overview/image_format/all

Digital Image Format Used	November 2011	April 2012
JPG	71.8%	72.4%
GIF	69.9%	67.3%
PNG	50.9%	55.6%
BMP	0.8%	0.7%
ICO	0.2%	0.2%
None	9.9%	9.4%

FCC & standards

- Carterfone decision (1968)
- Part 68 rules
- FCC Computer Inquiries
- 1983-1988: avoid direct standards setting
- 1983: approved T1 industry committee
  - voluntary consensus standard
- 1988: declines to define digital standard
- "safe harbor"



Example: GSM

- Analog standards national
  - no roaming, no economies of scale
- 1982: Groupe Spécial Mobile in CEPT
- 1987: 15 representatives from 13 European countries
- 1989: GSM migrates to ETSI
- 1990: Phase I spec
- 1992: first SMS
- 80% of global market

GSM vs. multi-standard: consequences

GSM advantages

- roaming: "native" or swapping SIM cards
- interchangeable handsets
  - earlier pre-pay market?
- earlier SMS development
  - vs. in-network-only messaging
- lead in developing 3G as follow-on

US

- Qualcomm?

Example: Open Internet

Standard Practices. The conformity or lack of conformity of a practice with best practices and technical standards adopted by open, broadly representative, and independent Internet engineering, governance initiatives, or standards-setting organizations is another factor to be considered in evaluating reasonableness. Recognizing the important role of such groups is consistent with Congress's intent that our rules in the Internet area should not "fetter[]" the free market with unnecessary regulation, and is consistent with broadband providers' historic reliance on such groups. We make clear, however, that we are not delegating authority to interpret or implement our rules to outside bodies.

Broadband providers' practices historically have relied on the efforts of such groups, which follow open processes conducive to broad participation. *See, e.g.*, William Lehr et al. Comments at 24; Comcast Comments at 53–59; FTTH Comments at 12; Internet Society (ISOC) Comments at 1–2; OIC Comments at 50–52; Comcast Reply at 5–7. Moreover, Internet community governance groups develop and encourage widespread implementation of best practices, supporting an environment that facilitates innovation. *See supra* Part II.A (discussing the benefits of edge providers having access to a uniform service interface, consisting of a core set of Internet standards and conventions); CDT Comments at 43–44.

Telecom standards

- Telecommunications and networking always focus of standardization
  - 1865: *International Telegraph Union* (ITU)
  - 1956: International Telephone and Telegraph Consultative Committee (CCITT)
- First Internet RFC in 1969
- First IETF meeting 1986

Telecom standards

Standards: technology translator

- Similar in some ways to text books
- "accepted technology"
  - lower/known risks ("vetted")
  - infrastructure ("eco system")
    - libraries, test tools, text books, certification, …
  - reduce cost of picking among roughly equal choices
  - sometimes reduce IPR risks ("patent pool", RAND)
- requires expertise and broader training
  - many CS standards don't have either
    - example: HTTP/1.0, HTML 1.0, 802.11 WEP

Types of Standards

- Mandatory vs. voluntary
  - Allowed to use vs. likely to sell
  - Example: health & safety standards →UL listing for electrical appliances, fire codes
- Types of standards
  - performance standards
    - "must survive fire for 30 minutes"
  - *interoperability standards*
  - system profiles
    - "use option A, C and M"

OMB circular A-119 (1998)

- (1) Common and repeated use of *rules, conditions, guidelines or characteristics for products or related processes and production methods*, and related management systems practices.
- (2) The definition of terms; classification of components; delineation of procedures; specification of dimensions, materials, performance, designs, or operations; measurement of quality and quantity in describing materials, processes, products, systems, services, or practices; test methods and sampling procedures; or descriptions of fit and measurements of size or strength.

OMB A-119: Performance vs. prescriptive

- "*Performance standard*" … requirements in terms of required results with criteria for verifying compliance but without stating the methods for achieving required results.
- A performance standard may define the functional requirements for the item, operational requirements, and/ or interface and interchangeability characteristics.
- juxtaposition to a *prescriptive standard* which may specify design requirements, such as materials to be used, how a requirement is to be achieved, or how an item is to be fabricated or constructed.

OMB A-119: Voluntary Consensus Standard

- "Voluntary consensus standards bodies" are domestic or international organizations which plan, develop, establish, or coordinate voluntary consensus standards using agreed-upon procedures.
- Openness
- Balance of interest
- Due process
- An appeals process
- Consensus ("general agreement, but not necessarily unanimity")

Not all standards are equal

- Can I access the standard document?
- … for free?
- What about preliminary drafts?
- Who can contribute to the design of the standard?
  - only one company or organization
  - dues-paying members
  - anybody
- Do I have to pay to build a product based on the standard?
  - patent licensing

Open (and other) standards

- *proprietary* standard ("de-facto standard")
  - controlled by single company
  - may not be formally documented → reverse engineering
  - e.g., Microsoft Word (.doc)
- *industry* standard
  - industry consortium ("XYZ Forum")
- *open* standard
  - process requirements
  - possibly free access
  - well-defined patent policy

proprietary standards may be submitted for open standardization (e.g., ECMAscript, Java)

Open standards

2005 ANSI IPRPC Critical Issue Paper

- *consensus* by a group or "consensus body" that includes representatives from materially affected and interested parties;
- broad-based public review and comment on draft standards;
- consideration of and response to comments submitted by voting members of the relevant consensus body as well as by the public;
- incorporation of approved changes into a draft standard; and
- availability of an appeal by any participant alleging that due process principles were not respected during the standards-development process.

Standards and IPR

- Standards are attractors of patent issues
  - patent trolls ("non-practicing entities")
  - incumbents
- Four steps to fortune:
  1. Get proprietary technology into standard (secretly)
  2. file patent & claim IPR
  3. sue every implementer
  4. ka-ching!
- See Rambus case

IPR licensing for standards

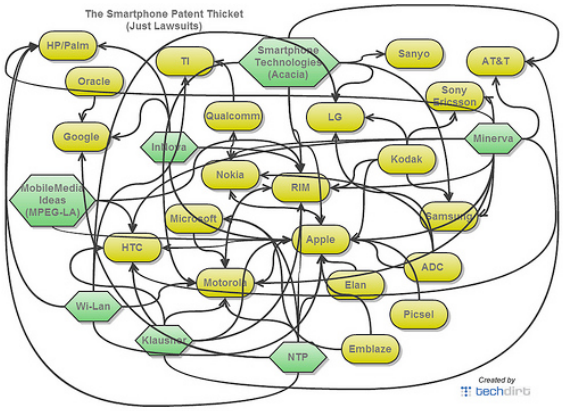
- Royalty Free (RF)
  - e.g., W3C
  - only applies to working group members
- Reasonable and non-discriminatory licensing (RAND)
  - e.g., one possible IETF approach
  - reasonable fees
    - one-time fee
    - unit fee (e.g., 20c/unit for H.264 video codec)
    - percentage of retail price
  - available on an equal basis to everybody
  - hard to define "reasonable"
- Mutual non-aggression licenses
  - "don't sue us and we won't sue you"
  - e.g., some Cisco licenses

IPR

- **patent stacking:** Taking out many patents for different aspects of a single innovation, thus forcing several royalty applications and payments
  - one cell phone, 250,000 patents
- **standard-essential patents (SEPs)**: see *Microsoft v. Motorola, 2013*

Patents

- Tend to come in waves
  - VoIP
  - Smart phones



Note Well

This summary is only meant to point you in the right direction, and doesn't have all the nuances. The IETF's IPR Policy is set forth in BCP 79; please read it carefully.

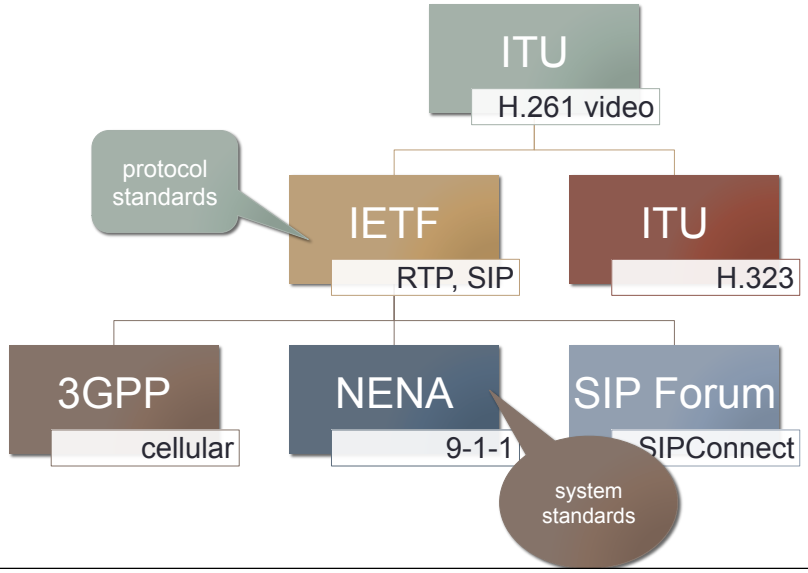
The brief summary:

- **By participating with the IETF, you agree to follow IETF processes.**
- **If you are aware that a contribution of yours (something you write, say, or discuss in any IETF context) is covered by patents or patent applications, you need to disclose that fact.**
- **You understand that meetings might be recorded, broadcast, and publicly archived.**

For further information, talk to a chair, ask an Area Director, or review the following:

BCP 9 (on the Internet Standards Process)
BCP 25 (on the Working Group processes)
BCP 78 (on the IETF Trust)
BCP 79 (on Intellectual Property Rights in the IETF)

Standards relationships



Internet Standardization

- International Telecommunications Union (ITU)
  - United Nations treaty organization
  - Transmission standards (e.g., modem: V.90)
  - Traditional telephone services, fax
- IEEE
  - anything electrical
  - generally, link layer (IEEE 802.11)
- Internet Engineering Task Force (IETF)
  - Core: Internet Protocol, transport (TCP)
  - Applications: email, HTTP, ftp, ssh, NFS, VoIP
  - Not: HTML, XML, APIs

W3C, OASIS, ATIS, ANSI, ISO

- W3C
  - HTML, XML, schema, SOAP, JavaScript APIs, semantic web, …
- OASIS
  - XML schema for specific applications
  - Lots of other organizations: component vs. system engineering
- ATIS, ANSI, ISO, …
  - telecom standards
  - operational standards

ITU

- Initially, national delegations
- Members: state, sector, associate
  - Membership fees (> 10,500 SFr)
- Now, mostly industry groups doing work
- Initially, mostly (international) telephone services
- Now, transition from circuit-switched to packet-switched universe & lower network layers (optical)
- Documents cost SFr, but can get three freebies for each email address

Who makes the rules? - ITU

- ITU = ITU-T (telecom standardization) + ITU-R (radio) + development
  - http://www.itu.int
  - 14 study groups
  - produce Recommendations:
    - E: overall network operation, telephone service (E.164)
    - G: transmission system and media, digital systems and networks (G. 711, G.723)
    - H: audiovisual and multimedia systems (H.323)
    - I: integrated services digital network (I.210); includes ATM
    - V: data communications over the telephone network (V.24)
    - X: Data networks and open system communications (X.509)
    - Y: Global information infrastructure and internet protocol aspects

Example: IEEE balloting

- IEEE-SA members only
- Producers, users, general interest
  - no group more than 50%
- 75% vote + 75% yes
- 30 to 60 days
- Ballot comments: technical or editorial

Example: IETF

- Consensus mechanisms:
  - the “working group hum”
  - IESG DISCUSS: single DISCUSS holds up the document
    - override with 2/3 yes votes

IETF

(based partially on slides by Lars Eggert, 2009/2010 and Scott Bradner, 2012)

A quick overview of the IETF

The Internet Engineering Task Force is a loosely self-organized group of people who contribute to the engineering and evolution of Internet technologies.
It is the principal body engaged in the development of new Internet standard specifications.

RFC4677

The IETF

- Internet Engineering Task Force
- formed in 1986
  - evolved out of US ARPANET-related government activities
  - Internet Configuration Control Board (ICCB) (1979) and Internet Activities Board (1983)
- was not considered important for a long time - good!!
- not "government approved" (US or other) - great!!
  - although funding support from U.S. Government until 1997
- people not companies
- *"We reject kings, presidents and voting. We believe in rough consensus and running code"* Dave Clark (1992)

The Internet Engineering Task Force – IETF

- The IETF is an open, international community
  - Network designers, operators, vendors and researchers
- Goal: evolution of the Internet architecture and smooth operation of the Internet
- Open to any interested individual
  - "people, not companies"
- Produces Internet standards (and other documents)

"We reject kings, presidents and voting. We believe in rough consensus and running code."

Dave Clark (1992)

The Role & Scope of the IETF

- "Above the wire and below the application"
  - IP, TCP, email, routing, IPsec, HTTP FTP, SSH, LDAP
  - SIP, MobileIP, PPP, RADIUS, Kerberos secure email
  - Streaming video & audio
  - …
- But wires are getting fuzzy
  - MPLS, GMPLS, PWE3, VPN, ...
- Hard to clearly define the IETF scope
  - Constant exploration of the edges

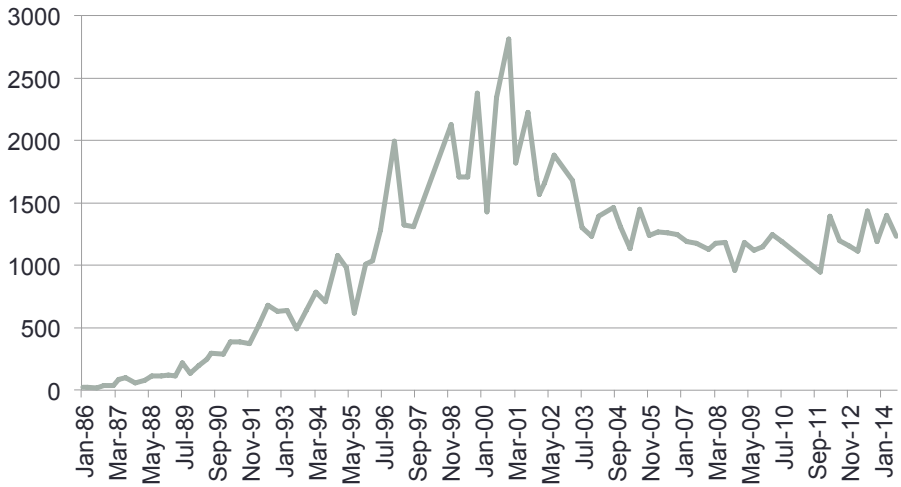
"Since attendees must wear their name tags, they must also wear shirts or blouses. Pants or skirts are also highly recommended."

RFC4677, The Tao of IETF: A Novice's Guide to the Internet Engineering Task Force

IETF

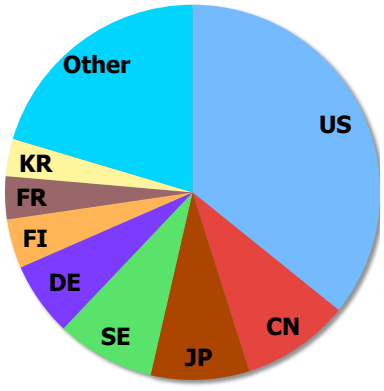
- Supposed to be engineering, i.e., translation of well-understood technology → standards
  - make choices, ensure interoperability
  - reality: often not so well defined
- Most development work gets done in working groups (WGs)
  - specific task, then dissolved (but may last 10 years…)
  - typically, small clusters of authors, with large peanut gallery
  - open mailing list discussion for specific problems
  - interim meetings (1-2 days or phone calls) and IETF meetings (few hours)
  - published as Internet Drafts (I-Ds)
    - anybody can publish draft-somebody-my-new-protocol
    - also official working group documents (draft-ietf-wg-*)
    - versioned (e.g., draft-ietf-avt-rtp-10.txt)
    - automatically disappear (expire) after 6 months

IETF Meeting Attendance



IETF by Numbers

- 1K-2K people at 3 meetings/year
  - from ca. 40-50 different countries
  - Many, many more on mailing lists
- ~130 Working Groups (WGs)
  - ~2 WG chairs each
- 8 Areas with 15 Area Directors (ADs)
- More than 6,300 RFCs published
  - Internet Standards and informational documents
- More than 50,000 Internet Draft revisions submitted

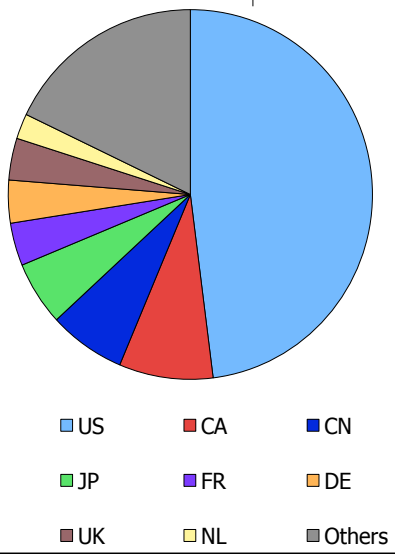


Participants at IETF-75
Stockholm, July 2009
1084 total, 50 countries

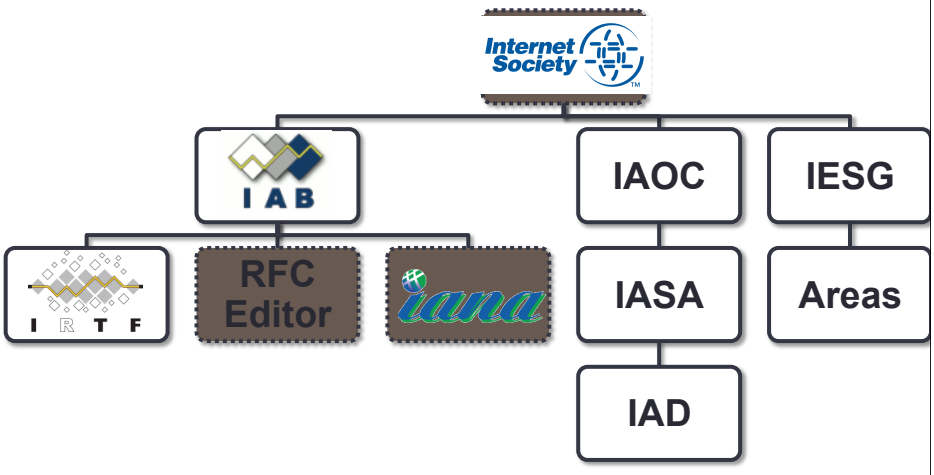
IETF 90 Participants

- 1175 people onsite
  - 153 newcomers
  - IETF 87 had 1435 people onsite
- 53 countries
  - IETF 87 was 62 countries

IETF 87 was held in Berlin, Germany



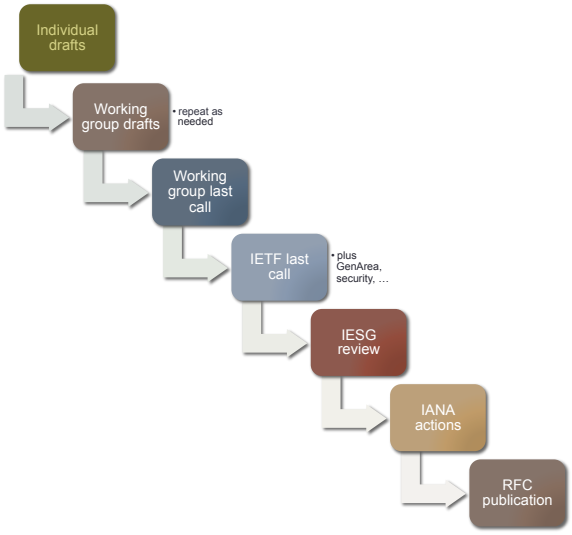
Top-Level Organizational View



ICANN

- Internet Corporation for Assigned Names and Numbers
  - manages IP address space (at top level)
  - DNS top-level domains (TLD)
    - ccTLD: country codes (.us, .uk, …)
    - gTLDs (.com, .edu, .gov, .int, .mil, .net, and .org)
    - uTLD (unsponsored): .biz, .info, .name, and .pro
    - sTLD (sponsored): .aero, .coop, and .museum
  - protocol constants
    - port numbers, enterprise numbers, …
- actual domains handled by registrars

From protocol to RFC

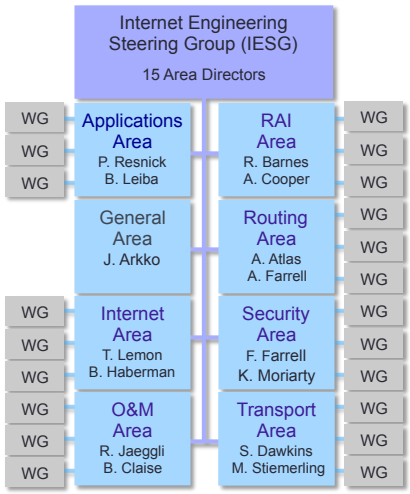


Standards Track RFCs:

- Best Current Practices (**BCP**)
  - policies or procedures (best way we know how)
- 2-stage standards track (changed Oct 2011 - RFC 6410)
  - Proposed Standard (**PS**)
  - good idea, no known problems
  - Internet Standard (**STD**)
  - PS + stable + "benefit to Internet community"
  - multiple interoperable implementations to prove document clarity
  - note: **interoperability** not conformance

Top-Level IESG & WG Structure

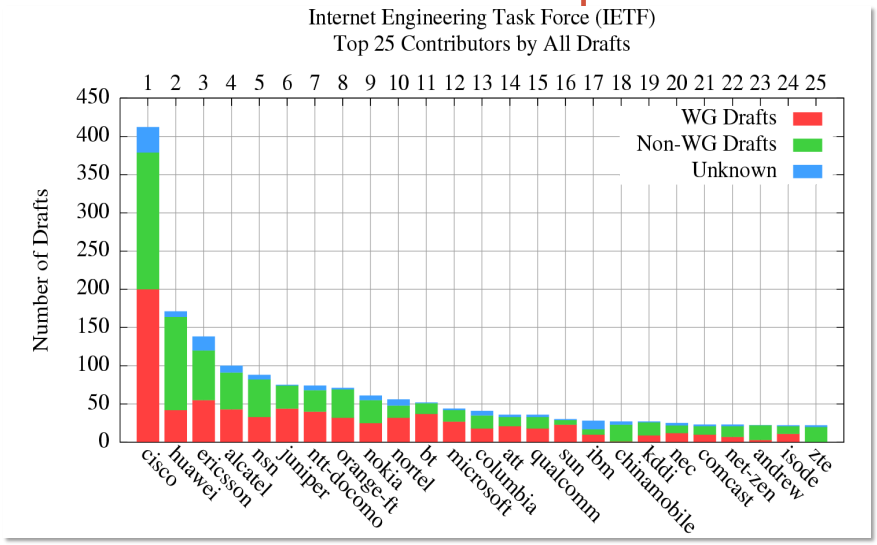
- IETF is structured into Areas
  - Each with Area Directors (ADs)
- Areas are structured into Working Groups (WGs)
  - Each with WG Chairs
- Internet Engineering Steering Group (IESG) = all ADs
  - Approves all Internet Standards
  - Manages technical work
  - Starts/ends WGs
  - Assigns WG Chairs



IETF WGs with regulatory impact

Regulatory issue	Area or WGs
Emergency calling	ECRIT, GEOPRIV
Emergency alerting	ATOCA
Universal service/intercarrier compensation	RAI
VoIP (numbering, caller ID spoofing)	TERQ, STIR
PSTN transition	RAI
Accessibility, video relay services	RAI
White spaces, spectrum	PAWS
Cybersecurity	DNSEXT
Competition	IPv6, MIF
Open Internet (network neutrality)	MPLS, DiffServ, email operations
Network measurement	IPPM

Most Active IETF Participants



IETF Documents – Two Types

Internet Draft (ID)

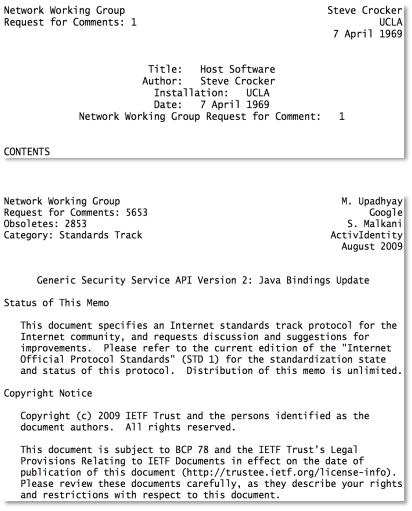
- Active working documents
- Not finalized! Not stable!
- Anyone can submit
  - draft-yourname-...
- Only some IDs are WG documents!
  - draft-ietf-wgname-...

Request for Comment (RFC)

- Archival publications
  - Never change once published
- Not all RFCs are standards!
  - Standards track:
    - Proposed Standard
    - Draft Standard
    - Full Standard
  - Other types:
    - Informational
    - Experimental
    - Best-Current-Practice (BCP)

IETF Document Format

- English if the official language of the IETF; ASCII is the mailing list and document format
- Various tools exits (xml2rfc, etc.)
- Constant discussion of alternate formats
  - IETF seen as “behind the times”
  - (Almost) no drawings
  - But no consensus on alternative
- Note that the current format is still readable after 40+ years…



Network Working Group
Request for Comments: 1

Steve Crocker
UCLA
7 April 1969

Title: Host Software
Author: Steve Crocker
Installation: UCLA
Date: 7 April 1969
Network Working Group Request for Comment: 1

CONTENTS

Network Working Group
Request for Comments: 5653
Obsoletes: 2853
Category: Standards Track

M. Upadhyay
Google
S. Malkani
ActivIdentity
August 2009

Generic Security Service API Version 2: Java Bindings Update

Status of This Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

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IETF Organization – Areas

- 8 Areas to structure the technical work:
  - Applications (APP)
  - Transport Services (TSV)
  - Security (SEC)
  - Routing (RTG)
  - Operations & Management (O&M)
  - Real-Time Applications and Infrastructure (RAI)
  - Internet (INT)
  - General (GEN)

IETF Organization – ADs

- Area Directors (ADs)
  - Each Area has 2, except for the General Area
- ADs are responsible for:
  - Setting direction in their Area
  - Managing process in their Area
    - Starting and closing Working Groups (WGs)
    - Approving the scope of technical work
  - Reviewing Working Group documents

IETF Organization – IESG

- Internet Engineering Steering Group (IESG)
  - Formed by all 15 ADs
- The IESG is the process management and RFC approval body
  - Approves all WG creations
  - Provides technical review
  - Approves publication of IETF documents
  - Reviews and comments on non-IETF submissions

IETF Organization – IAB

- Internet Architecture Board (IAB)
- IAB provides overall architectural advice & oversight
  - Provides “oversight” of IETF standards process
  - Deals with IETF external liaisons to other SDOs
  - Sponsors the Internet Research Task Force (IRTF)
  - Write documents stating the IAB’s technical opinion
  - Community & IESG review
  - Participate in WG discussions

IETF Organization – IRTF

- Internet Engineering Research Task Force (IRTF)
- Focused on long-term research problems in Internet

ASRG	Anti-spam
CFRG	Crypto forum
DTNRG	Delay-tolerant networking
HIPRG	Host identity
ICCRG	Internet congestion control
MOBOPTS	IP mobility optimizations
NMRG	Network management
P2PRG	Peer-to-peer
RRG	Routing
SAMRG	Scalable adaptive multicast
TMRG	Transport modeling
VNRG	Virtual networks

IETF Organization – WGs

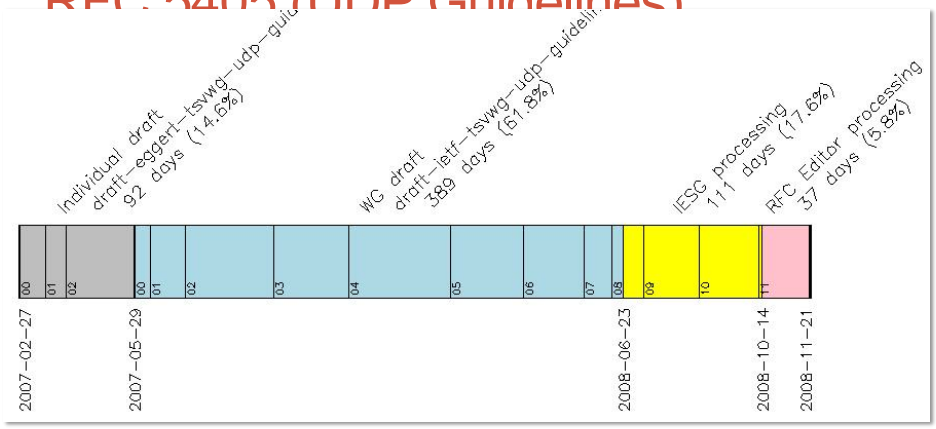
- Where the IETF get its work done; belong to one Area
  - Discussions on mailing list + meetings focused on key issues (ideally)
- WG is focused by charter agreed between WG Chairs and ADs
  - Restrictive charters with milestones – WGs close when their work is done
  - No defined membership, just participants
- "Rough consensus and running code"
  - No formal voting - cannot define constituency
  - Consensus does not require unanimity; disputes resolved by discussion

IETF WGs

Internet Research Task Force A. Falk	Applications Area	Transport Area	Security Area	Routing Area	O&M Area	RAI Area	Internet Area
asrg	core	alto	abfab	bfd	6renum	atoca	6lowpan
cfrg	eai	behave	dane	ccamp	adslmib	avtcore, ext	6man
dtnrg	ftpext2	cdni	dkim	forces	armd	bliss	ancp
hiprg	httpbis	conex	emu	idr	bmwg	clue	autoconf
iccrg	hybi	dccp	hokey	isis	dime	codec	csi
mobopts	iri	decade	ipsecme	karp	dnsop	dispatch	dhc
nmrg	marf	fecframe	kitten	l2vpn	eman	drinks	dna
p2prg	paws	ippm	krb	l3vpn	grow	ecrit	dnsext
rrg	precis	ledbat	msec	manet	ipfix	enum	hip
samrg	sieve	mptcp	nea	mpls	mboned	geopriv	homenet
tmrg	urnbis	nfsv4	oauth	ospf	netconf	mediactrl	l2tpext
vnrg	vcarddev	pcn	pkix	pce	netmod	mmusic	lisp
	websec	rmt	tls	pim	opsawg	p2psip	lwig
	yam	rohc		pwe3	opsec	payload	mext
		storm		roll	radext	rtcweb	mif
		tcpm		sidr	v6ops	simple	mip4
				vrrp		sipclf	multimob
						sipcore	netext
						siprec	ntp
						soc	pcp
						speechsc	pppext
						speermint	savi
						splices	shim6
						vipr	softwire
						xcon	tictoc
						xmpp	trill
						xrblock	

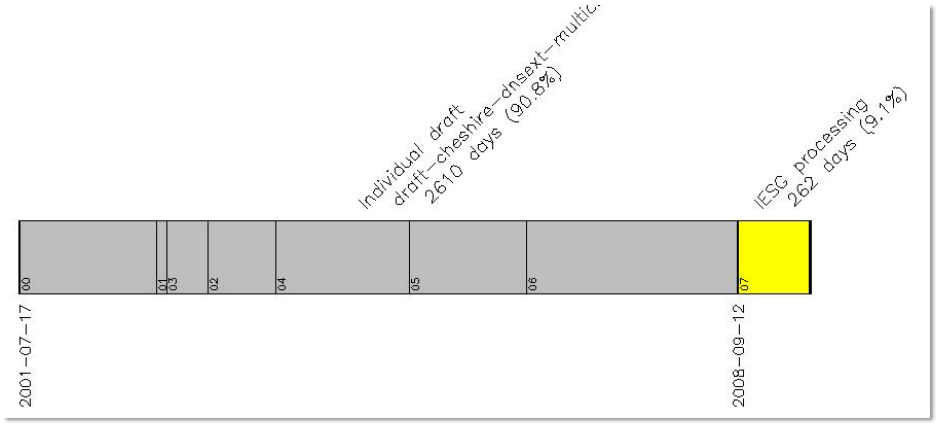
…bis = second (revision)

RFC 5405 (UDP Guidelines)



- Document was in individual and WG process for 481 days, and in IESG/RFC Editor process for 148 days, 629 days in total.
- This is 1 years and 8 months.

draft-cheshire-dnsext-multicastdns



- Document was in individual process for 2610 days, and in IESG/RFC Editor process for 262 days, 2872 days in total.
- This is 7 years and 10 months. (And it's not published yet…)

The role of 3GPP

3GPP
A GLOBAL INITIATIVE

- GSM, GPRS, W-CDMA, UMTS, EDGE, HSPA and LTE are all [RAN] Technologies specified by 3GPP
- Core network and Systems architecture evolution have kept pace
- Backward compatibility is a key element of each new 3GPP Release

- The 3GPP Organizational Partners are Regional and National Standards Bodies;
- Companies participate through their membership of one of these 6 Partners

3GPP Membership

A GLOBAL INITIATIVE

371 Organisations (September 2010)

Where the work is done

A GLOBAL INITIATIVE

TSG Structure

Project Co-ordination Group (PCG)

TSG GERAN	TSG RAN	TSG SA	TSG CT
GSM EDGE Radio Access Network	Radio Access Network	Service & Systems Aspects	Core Network & Terminals
GERAN WG1 Radio Aspects	RAN WG1 Radio Layer 1 spec	SA WG1 Services	CT WG1 MM/CC/SM (lu)
GERAN WG2 Protocol Aspects	RAN WG2 Radio Layer 2 spec Radio Layer 3 RR spec	SA WG2 Architecture	CT WG3 Interworking with external networks
GERAN WG3 Terminal Testing	RAN WG3 Iub spec, Iur spec, Iu spec UTRAN O&M requirements	SA WG3 Security	CT WG4 MAP/TAP/CAP/SS
	RAN WG4 Radio Performance Protocol aspects	SA WG4 Codec	CT WG6 Smart Card Application Aspects
	RAN WG5 Mobile Terminal Conformance Testing	SA WG5 Telecom Management	

Meeting Delegates* by region (June 2010):

* Participants in TSG and WG meetings over the last year

- Plenary meetings every 3 months, approve specifications and the Freezing of 3GPP Releases
- The 50th TSG Plenary will be in Istanbul in December 2010

Spanning the Generations...

GSM 1G
Analog technology. 1980s.

GSM 2G
Digital Technology - 1990s. New services such as SMS and low-rate data. IS-95 CDMA, GSM.

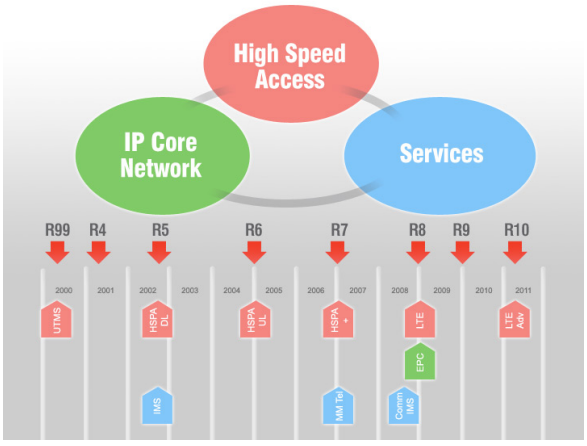
3G ITU's IMT-2000
required 144 kb/s mobile, 384 kb/s pedestrian, 2 Mb/s indoors; CDMA2000 1X/EVDO, WiMAX, and UMTS-HSPA.

4G ITU's IMT-Advanced
operate in up to 40 MHz radio channels and with very high spectral efficiency. No technology meets requirements today. IEEE 802.16m and LTE Advanced being designed to meet requirements.

- 3GPP Specified Radio Interfaces
  - 2G radio: GSM, GPRS, EDGE
  - 3G radio: WCDMA, HSPA, LTE
  - 4G radio: LTE Advanced
- 3GPP Core Network
  - 2G/3G: GSM core network
  - 3G/4G: Evolved Packet Core (EPC)
- 3GPP Service Layer
  - GSM services
  - IP Multimedia Subsystem (IMS)
  - Multimedia Telephony (MMTEL)
  - Support of Messaging and other OMA functionality
  - Emergency services and public warning
  - Etc.

Text adapted from 3G Americas White Paper. September 2010

Building on Releases



Release 99: Enhancements to GSM data (EDGE). Majority of deployments today are based on Release 99. Provides support for GSM/EDGE/GPRS/WCDMA radio-access networks.

Release 4: Multimedia messaging support. First steps toward using IP transport in the core network.

Release 5: HSDPA. First phase of Internet Protocol Multimedia Subsystem (IMS). Full ability to use IP-based transport instead of just Asynchronous Transfer Mode (ATM) in the core network.

Release 6: HSUPA. Enhanced multimedia support through Multimedia Broadcast/Multicast Services (MBMS). Performance specifications for advanced receivers. Wireless Local Area Network (WLAN) integration option. IMS enhancements. Initial VoIP capability.

Release 7: Evolved EDGE. Specifies HSPA+, higher order modulation and MIMO. Performance enhancements, improved spectral efficiency, increased capacity, and better resistance to interference. Continuous Packet Connectivity (CPC) enables efficient "always-on" service and enhanced uplink UL VoIP capacity, as well as reductions in call set-up delay for Push-to-Talk Over Cellular (PoC). Radio enhancements to HSPA include 64 Quadrature Amplitude Modulation (QAM) in the downlink DL and 16 QAM in the uplink. Also includes optimization of MBMS capabilities through the multicast/broadcast, single-frequency network (MBSFN) function.

Release 10 LTE-Advanced meeting the requirements set by ITU's IMT-Advanced project.

Also includes quad-carrier operation for HSPA+.

Release 9: HSPA and LTE enhancements including HSPA dual-carrier operation in combination with MIMO, EPC enhancements, femtocell support, support for regulatory features such as emergency user-equipment positioning and Commercial Mobile Alert System (CMAS), and evolution of IMS architecture.

Release 8: HSPA Evolution, simultaneous use of MIMO and 64 QAM. Includes dual-carrier HSPA (DC-HSPA) wherein two WCDMA radio channels can be combined for a doubling of throughput performance. Specifies OFDMA-based 3GPP LTE.

Defines EPC.

Text adapted from 3G Americas White Paper, September 2010

Summary

- No networks (and non-network interfaces) without standards
- Different types of standards organizations
  - component vs. system
  - protocols vs. data formats
- Important part of technology evolution
- Interaction with IPR