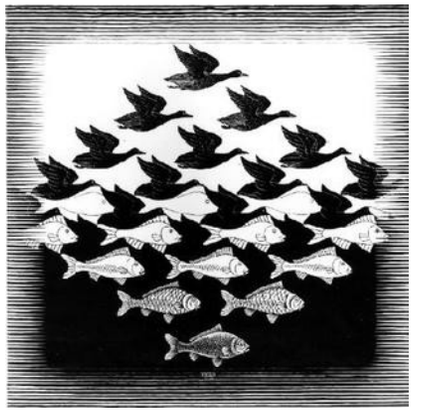

Keith Mitchell

“I never set out to be a DNS practitioner...”

OARC46 Workshop

Edinburgh

17th May 2026

Welcome to Scotland !

- ..and Edinburgh, the city I grew up and was educated in
- my secondary and higher education, RIPE31, UKNOF17 & 41 all took place within ~1km of here
- the heart of the Scottish Enlightenment, a city of many ideas, thinkers, science, engineering and literature
- please do explore

It’s Always the DNS

- I never set out to be a DNS practitioner, but working with it has been a recurringly unavoidable, if rewarding, theme of my career:

“You may not be interested in the DNS, but the DNS is interested in you..” [*]

- This is the story of an apprentice implementer, sysadmin, ISP engineer, IXP and ccTLD founder, root operator, community builder, useful retiree

- This talk is wholly in a personal, not any DNS-OARC capacity

[*] With apologies to Leon Trotsky

My Career History

- Has been entirely in network engineering, mostly Internet operations, for four decades
  - TCP/IP, Unix (and DNS !) since 1985
- Pivoted to nonprofit governance/management
- Startups, small businesses, nonprofits, membership organisations
- Split almost exactly evenly between UK/EU and US
- Details, details:
  - https://www.keithmitchell.co.uk/biography.html

My Career History

- Graduated Computer Science: ed.ac.uk, ucl.ac.uk
- Co-founder: PIPEX, LINX, Nominet, UKNOF, XPE
- President: DNS-OARC 2006..2012-2023
- First RIPE NCC Board Chair
- ISC (VP Eng) and various other nonprofits
- Now *“mostly retired”*, still self-employed and contributing:
  - RIPE Arbiters, OARC Co. Secretary, NANOG Mentorship Committee

Some DNS Prehistory

- Humans prefer names, not numbers, for their computers and platforms
- In the early 1980s, this was done with static tables held in each end-system e.g.
  - RCOnet, pre-X.25/IP Edinburgh, Glasgow & Strathclyde Universities' inter/intra-campus WAN
  - JANET X.25 NRS (*Name Registration Scheme*)
  - ARPAnet HOSTS.TXT file

An Unsuspecting Postgraduate

- In 1985, I had the privilege of studying under **Peter Kirstein**, the father of the UK Internet, at University College London, at the time the only non-military Internet-connected site in the country
  - and the only place which had online RFCs

- I picked this interesting-sounding new “Domain Name Service” as a seminar topic, and proceeded to digest the freshly-published RFC882 and 883 to present about on viewgraphs to my classmates
- It turned out to be a Thing

The messy reality

- In the late 1980s, e-mail was very much at the front of namespace challenges
- IP networks were neither ubiquitous nor fully interconnected
- Many technologies competed and (sorta) interworked:
  - SMTP, UUCP/USENET, Grey Book, X.400, BITNET, CSnet, EAN…
- It was a mess, and with just the right combination of **@**, **%** and **!** operators and pseudo-TLDs, you could get your messages to hop continents
  - e.g. "*hwcs!postel%isi.edu@uk.ac.ucl.cs*"
- For some reason I found being an e-mail sysadmin an interesting challenge…
  - 40 years on, I still hate sendmail with a passion

Endian Wars

- In the UK, X.25/coloured book protocols adopted NRS names:

  uk.ac.ed.ecsvax

- The TCP/IP DNS world thought differently:

  cs.ucl.ac.uk

- Further headache for e-mail admins was trying to figure out if first/last label was "*Computer Science*" or "*Czechoslovakia*"

- Many thanks to Jim Cramond of Heriot-Watt, whose UK-sendmail macro package saved my sanity

Early DNS Implementation Apprentice

- Post-UCL, I came back to Edinburgh to work for Spider Systems, a startup selling TCP/IP-based solutions to enterprises for internal use
- The SpiderPort was a Telnet-based terminal server that connected 10 serial VDUs to 10Mb/s thick ethernet
  - 80186 CPU, <1Mb RAM, embedded exec, CLI user interface, UCL TCP/IP stack
  - PC/XT-like resources, but solid-state, headless, multi-user
- DNS lookup was a big improvement over trying to maintain hosts tables on such minimally resourced systems
- I got the job of implementing a (very) basic stub resolver
- Interoperability testing necessitated getting a half-inch mag tape copy of BIND4 in the post from UCL
- Perhaps the most used/useful C code I ever wrote..

Journeyman Network Engineer

- Spider grew to 350 employees across 7+ sites/countries, and got to the point where someone was needed to stop the devs from crashing the production network on a weekly basis
- I was happy to get away from coding, and to evolve my Unix sysadmin skills into the emerging profession of Network Engineer
- DNS became a very useful and powerful tool for managing and tracking that network, in the absence of other management platforms
  - many things broke regularly, the DNS was not one of them
- spider.co.uk zone stats (from 1991):
  - *694 A records, 276 PTR, 0 MX records*
- But there was no commercial UK Internet to connect it all to..

PIPEX Takes on the World

- In 1992, I co-founded PIPEX, the UK's first Internet startup and commercial ISP
- Finally, I could run DNS zones that were joined up with the real Internet namespace
  - again, it all Just Worked
- But we also had to interoperate with the still-prevalent UUCP, NRS and X.400 e-mail worlds
  - the PP MTA was a big improvement on sendmail !
  - though only about 3 people in the country could handle configuring all of that
- The UK's first peering agreement, between competitors PIPEX and EUnet GB, included convoluted measures to keep the UK DNS, NRS, and UUCP namespaces in sync, as well as IP traffic exchange
- pipex.net zone stats from 1992:
  - *174 A records, 84 PTR, 8 MX*

Creating an independent ccTLD registry

- Come 1996, the LINX, which PIPEX had co-founded, got to the point where someone was needed to get all the ISPs to play nice together
  - it was my plan that IXP-running would be the next stage of my career
- the non-DNS aspects of the .uk namespace were fading, but it still had much management baggage attached
  - I had mercifully managed to side-step the horrors of the “UK Naming Committee” (peer-reviewed label-beauty contests are no way to run a registry)
  - Nominet UK was created to take over running .uk in an independent, non-commercial basis
- but, one of the candidate founder Nominet non-exec Directors committed some unforced reputational self-harm, and I was asked to last-minute step up in their place

Growing Nominet

- Most of the hard problems at Nominet were not around running the DNS infrastructure
  - (well okay, apart from the “core.co.uk” incident..)
  - again, the DNS itself mostly Just Worked
- Challenges were around governance, legal, commercialisation/pricing, scaling, secondary market, public policy, and regular business operations
- We got a lot of things right, not least setting strong legal precedent for TLD registry non-liability and registry copyright, and the basis for Nominet being the respected world-class registry it is today
- But we made some governance mistakes – with hindsight weighted voting did not anticipate the full consequences of the secondary market, and ultimately contributed to a Capture crisis later in Nominet’s life
- DNSSEC was not really a production thing while I was on the Nominet Board 1996-2002

Root Operations (K)

- Around 1997, there was pressure to make the Internet's core infrastructure less US-centric
- Jon Postel sought to create additional root name server instances to bring the total to 13, based up on bottom-up self-governance principles
- After much maneuvering by various parties, it was determined that a European "K" root server would be operated by the RIPE NCC, with the first instance hosted in London by LINX
- The first two servers were hand-carried by Daniel Karrenberg & colleague NCC→AMS→LCY via London black cab (!) to Telehouse East in a morning, and we had them up and running by the end of the day

Root Operations (F)

- Post LINX & Nominet, I spent some years in the startup and DNS wilderness..
- ..until a conversation with Paul Vixie, who had a vision for something new
- this moved me to the US, where I got involved in a whole bunch of ISC's activities, including being responsible for running F-Root, which thanks to anycast was now operating more instances in more locations than any other root operator (on a shoestring)
- we consistently "ate our own dogfood" at ISC, and ran BIND9 on all of these
- overseeing receiving a BIND vulnerability report to having it patched and live deployed to all of F-Root in the space of a week is one of the more challenging and rewarding things in my career
- but BIND10 also happened on my watch at ISC. I am not proud of what happens when you try and make a network engineer manage software development at scale ☹

Security vs the DNS

- By the mid-oughties, it was clear that DNS has a special place in the cybersecurity universe, as all of weakness/target/vector/tool/mitigation
  - e.g. 2008's "Summer of Fear" Kaminksy vulnerability
- DNSSEC deployment was proving harder than expected
- Many of the DNS security issues really needed better co-operation and telemetry
- Paul Vixie's vision was for a trusted neutral home for that work
- It needed to be independent of all the existing players, including ISC
- He saw that some of the community-building approaches of membership-run IXPs like LINX could be brought to bear, so I found myself sucked into the DNS (again) to bootstrap this effort and spin it out from ISC

DNS-OARC is Born

- The first OARC workshop was held in 2004, somewhat before I was involved
- NSF sub-contract funding was obtained from CAIDA, to build the first datastore that would support annual “DITL” data-collection efforts
- Much experimentation with telemetry sharing and community trust/collaboration platforms took place, some of which did not quite gel
- We incorporated OARC Inc. as a 501(c)3 nonprofit corporation in 2008, and gradually built the membership base and organization’s capacity over the years
- OARC also become something of a dumping ground for “orphan” projects that didn’t quite fit anywhere else (some of which we are still stuck with..)
- I split my time (with others) between OARC and ISC between 2006 and 2012, with mixed results
- After leadership turmoil at ISC, I left there to build an OARC dedicated team from 2013 onward

OARC’s Success is its Community

- Unlike many nonprofit membership organizations in the Internet operations space, OARC does not offer any business-critical resources nor services, and has to continuously re-demonstrate its relevance and value to be sustainable
- That you are all here 22 years later shows this is being achieved :-)
- We have one of the smartest and most respectful communities in our space, it gives me pride and pleasure to have been a part of making it happen and to have worked with you all
- Every few years, operational incidents arise where the OARC community steps up together and literally saves some critical corner of the Internet (e.g. DENIC last week) in a way that nobody else could
- Technology has its roots in the scientific method, something engineers should never forget, and why operators and researchers need to keep talking to each other

DNS is a Success, Too !

- DNS was founded on principles of a distributed, open standards, interoperable, running-code, eventually-consistent, operationally robust vision of the Internet that it still embodies in many ways
- It has exceeded its original conception in both good and bad ways, a true “success disaster”
- In a world of users increasingly interacting with apps, social media and chatbots, the DNS is perhaps less visible – to me best thought of as another, essential, abstraction layer within the network stack
- There have been many competing alternative namespace proposals, none really stick

The Longer View

- I am not a DNS expert, just someone who knows a lot of DNS experts
- Namespace management is always about more than just the protocol
- The Internet has turned out to be a lot less hierarchical than 1980s academia ever envisaged
- But we don’t need to flatten the root zone into another hosts.txt with yet more gTLDs that nobody other than speculators and abusers have a use-case for
- DNSSEC has become an industry-within-an-industry !
  - Perhaps we should have solved the client/server DNS transport security problem as an easier target *first*..
- One of the strengths of the Internet and the DNS during the 1990s is that the technology was *simpler* than ITU Telco/PTT offerings. This is no longer the case.
  - have we created a Camel or a Monster ?

The Longer View

- The corollary of the DNS being a target for attacks and abuse is that it is a great place to **detect**, **measure**, **prevent** and **mitigate** such abuse
- *Operators have the best data,*
  Researchers have the best Analysis,
  Developers the best solutions
- The DNS is a great place to do Internet Science
  - which is not the same as Internet Engineering, but strongly informs it

More Personal Internet History

- Other “Keith’s memoirs” presentations:
  - Great British IXP Failures: 1997-2010 [**UKNOF32**] https://indico.uknof.org.uk/event/34/contribution/30/material/slides/0.pdf
  - Welcome to my Duality 2017- 2025 [**RIPE91**] https://ripe91.ripe.net/programme/meeting-plan/sessions/24/FYNFZJ/
  - Building a National NOG Community: 2005-2023 [*Upcoming* – **NetUK3**] https://indico.netuk.org/event/3/contributions/44/

- To follow:
  - PIPEX ISP: 1991-1996
  - LINX IXP: 1996-2000

Questions ?

https://www.smoti.org

https://www.linkedin.com/in/keithmitchell

https://mastodns.net/@dualkei (professional)

https://hachyderm.io/@dualkei (personal)

https://medium.com/@dualkei

Age-proofing Your Career

- Some things that have worked for me:
  - Develop skills that are grounded in first principles, theory, maths, algorithms, soft-skills, rather than getting too locked-in to specific technologies
  - Build your network by volunteering, nonprofit, international, activity
  - Diversify income sources, nurture that side project/hustle
  - Pivot from *doing* yourself to *enabling, mentoring, promoting* & *teaching* others
    - avoid getting in other people's way !

Age-proofing Your Career

- Some things that have worked for me:
  - Consider switching to self-employment or independent contracting as your experience and network grows
  - See “retirement” as a place of ultimately independent income, not a cessation of contributing to the community
  - Fund your pension savings/investments early, carefully, and as much as you are able
  - Look after your physical and mental health !