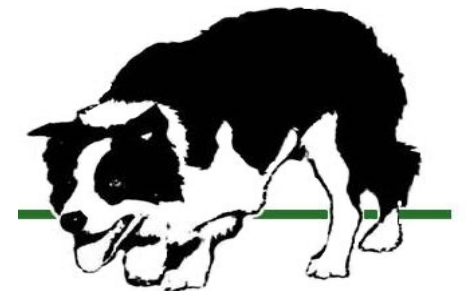**2nd Workshop on**
New Internetworking Protocols,
Architecture and Algorithms

The Routing and Addressing Challenges for the Internet of the Future

Adrian Farrel

Old Dog Consulting

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Who Am I?

- This is a question I ask myself all the time
- Wide experience implementing and designing communications protocols
  - SNA, OSI, IP
- Active in the IETF for more than 25 years
  - Co-authored more than 90 RFCs
  - Previously chaired a number of IETF Working Groups
    - CCAMP, L1VPN, PCE, L3SM, L2SM, I2NSF
  - Was liaison from the IETF to the ITU-T on Optical Networking
  - Served 6 years on the IESG as Routing Area Director
  - Currently Technical Advisor to the TEAS Working Group
  - Four years as Independent Submissions Editor in the RFC Series
- Running Old Dog Consulting for 20 years
  - Specialising in Internet standardisation
  - Customers are Operators, Vendors, and Start-up
  - Involvement with several Europe-funded research projects
    - Optical Networking, Path Computation, SDN, Network Slicing

What is the Internet of the Future?

- *Bigger, better, faster, cheaper* – Geoff Huston, October 2021
- For many people, the Internet is just the applications running over it

- New applications were a dream a few years ago
  - Many companies ridiculed them as "too far in the future"
  - But …
    - In October Cisco announced "holographic conferencing"
    - Also in October Facebook planned to rebrand as Meta and develop the Metaverse
    - LAN gaming centres in China can have more than 2000 seats
    - VR and AR equipment is affordable for the home market
    - Nearly everything is moving to the cloud
- Rapid advances in connectivity technology enable new thinking
  - Fibre to the premises is a reality even in backwards countries like the UK
  - 5G offers significant bandwidth improvements
  - LEO deployments are literally taking off
  - Cheap WiFi-enabled IoT devices are commonplace
- Thus, we're not talking about a far-distant future
  - The pace of technological evolution is very rapid

What Do We Need Routing and Addressing To Do For Us?

- There is a perceived need for enhanced service delivery
  - Low latency, high bandwidth, low loss, bounded jitter, resilient, energy-efficient …
  - Potentially very many different grades of service for different applications
  - Can flows be routed onto different paths to meet SLOs?
    - And if so, how are the packets marked for appropriate routing?
- Should an address continue to identify just an end point?
  - Or should we address services that may be realised in different places?
  - Is an address just a short-lived session token (like in QUIC)?
- Will "names" replace addresses?
  - DNS is getting stretched way beyond its original design
  - But name resolution is much slower than service instantiation

What Do We Know?

- *I cannae change the laws of physics* – Montgomery Scott, 1966
  - Latency is largely a function of distance
  - This means that many applications will still need to be smart

- *Any fool can make something complicated* – Richard Branson
  - It is tempting to put in too many controls and too much granularity
  - Previous attempts at fine-level traffic discrimination have not ended well

- *We'll have infinite bandwidth in a decade's time* – Bill Gates
  - Clearly we won't, but bandwidth can solve a lot of problems

- *Disco is just Jitterbug* – Fred Astaire
  - Maybe, in most applications, it is always necessary to handle jitter through buffering and clocking

- *Energy can neither be created nor destroyed* – Émilie du Châtelet
  - We desperately need to reduce energy consumption, but there is no free lunch

- *The good thing about standards is that there are so many to choose from* – Andrew Tanenbaum
  - But if we don't standardise, we will never interoperate
  - Ideally, we want standards with wide applicability

- Thought, discussion, and research are critically important
  - That research must be driven by a broad view of the challenges not just specific engineering problems
  - Sharing and discussing research during development can lead to valuable input