Named Data Networking and Internet decentralization:

Steering New Application Developments Away from Centralized Realization

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NDN COMMUNITY MEETING

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ACK: took inputs from two workshops & NDN retreat

- CoNEXT 2021 Interdisciplinary Workshop on (de)Centralization in the Internet (IWCI), https://conext-21-iwci.named-data.net/
  - Panelists: Geoff Huston, Henning Schulzrinne, Lixia Zhang, John Adler
  - Moderator: Alex Afanasyev
  - panel recording: https://www.youtube.com/watch?v=M-S2mj08onk
- NDN project retreat discussion, March 2022.
  - Beichuan, Lixia, Lan, Christos, Alex, Jeff, Kirk, Junxiao, Turan, Varun, and more.
- IETF DINRG Workshop on Centralization in the Internet, June 2021
  - Panelists: Jari Arkko, Trinh Viet Doan, Christian Huitema, Thomas Hardjono, Geoff Huston, Henning Schulzrinne
  - Moderators: Lixia Zhang and Kirk Kutscher
  - Workshop meeting materials: https://datatracker.ietf.org/meeting/interim-2021-dinrg-01/session/dinrg
  - Workshop recording: https://youtu.be/1kbsbvjb1zu

Where the Internet started

- Internet was originally designed as a decentralized system
  - End-to-end connections based on the always-on IP connectivity
  - Distributed routing decisions
  - Most parties running their own email, ftp servers
  - DNS as distributed name allocation system
    - ICANN *only* manages TLD allocation, each TLD domain, and all domains below, *independently* manage their own namespaces
- No central/global control, except
  - IANA manages address allocation to Regional Internet Registries
    - Also port number assignments
  - ICANN *only* handles the Top Level Domain name allocation

Solely for the purpose of ensuring address/port/name uniqueness

How apps moved from decentralized to centralized

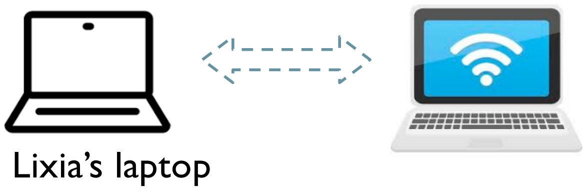
- In early days of Internet: organizations ran application servers to provide services for their *own* users
  - These are not revenue generating business
- With time, commercial app providers were born
- Once apps becoming revenue-generating business: economy of scale drives towards consolidation
  - Bigger sizes ⟹ afford more investment into better service
  - security threats increased over time: costly to mitigate failures/attacks

    ⟹ outsourcing apps/services become more attractive

    ⟹ more organizations outsource apps/services

Networking: the state of affairs

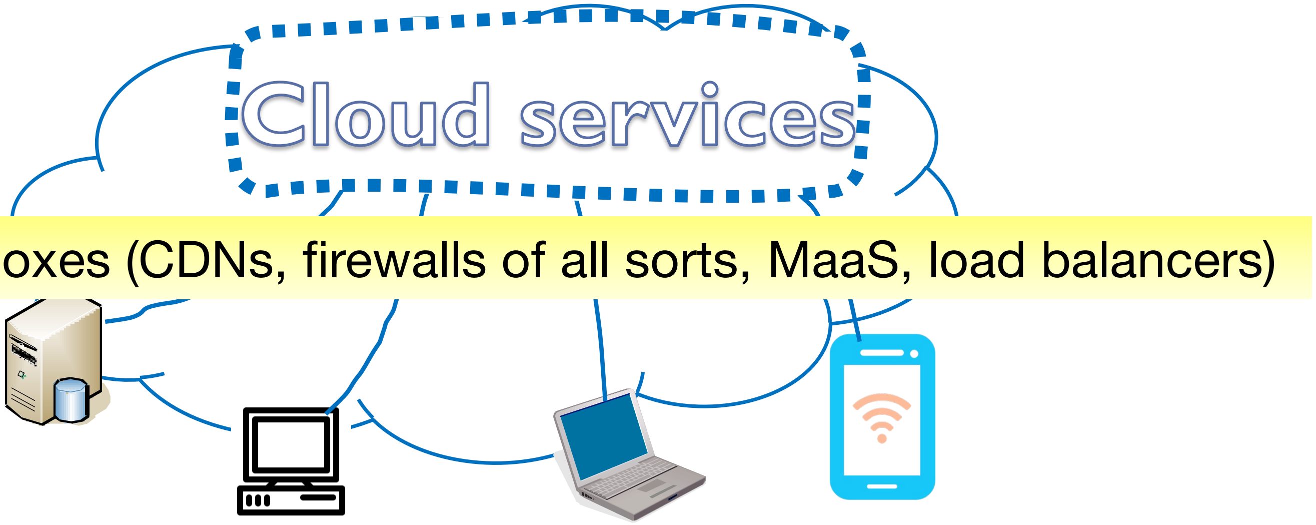
- Media streaming at scale : CDN overlays
- Conferencing at scale: supported by cloud
- IoT/smart homes: supported by cloud
- Augmented reality: supported by cloud
- What cloud does not help:
  - Can 2 laptops on the same table talk to each other *directly*?
  - "What's going on at front of the queue?"



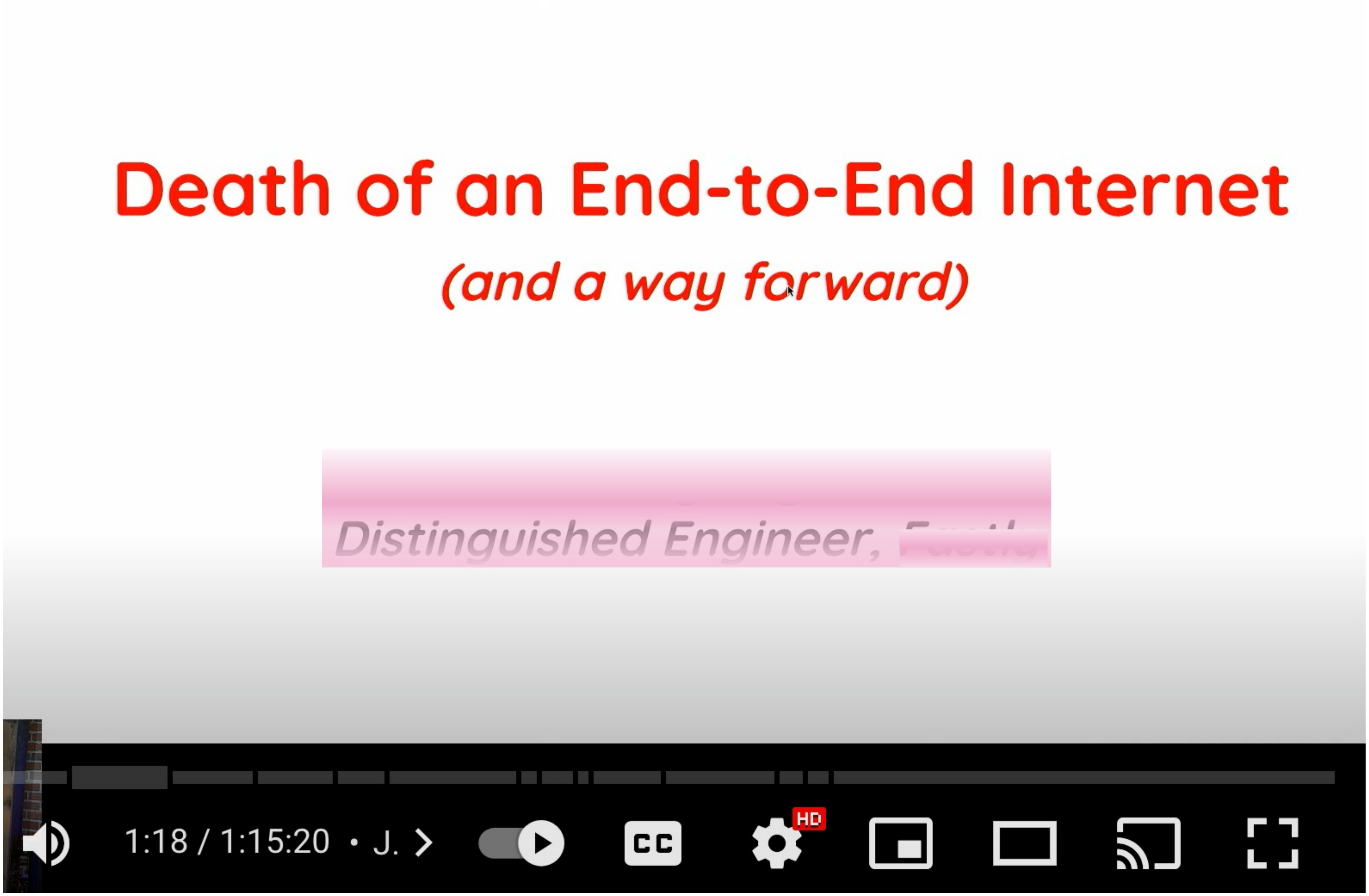
- Why not: no standard solution to identify/secure local communications
  - Communication with cloud: user identities and authentication are controlled by the cloud

How we do networking today: picture from 3000 feet

1. IP: node-to-node *synchronous* communication
2. TCP: end-to-end connection for reliable delivery
   - Client to cloud server connectivity
3. TLS: authenticate cloud servers, securing the the connection to them


Cloud services
Middle boxes (CDNs, firewalls of all sorts, MaaS, load balancers)

A popular Youtube talk, the title echoes many people's view



Death of an End-to-End Internet

(and a way forward)

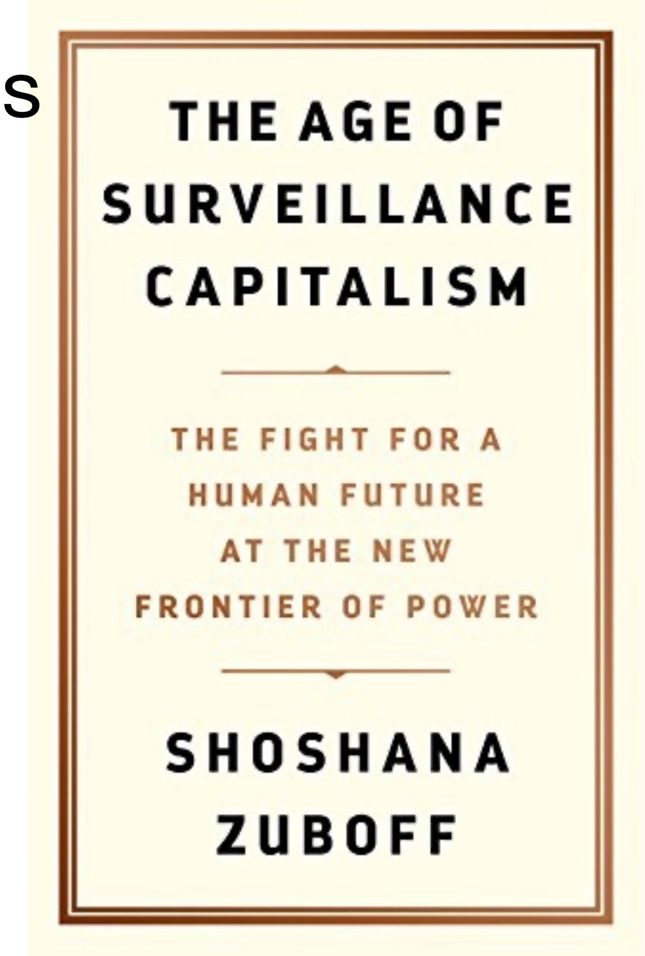
[redacted]

Distinguished Engineer, [redacted]

Book: The Age of Surveillance Capitalism:

The Fight for a Human Future at the New Frontier of Power

- The wealth of today's cyber giants is largely built on the foundation of aggregated individual user behaviour information → personal profile info → maximize advertisement revenue
- Related factors:
  - Data ownership?
  - Company revenue versus user privacy protection?
  - Specific regulations to safeguard basic user privacy?



THE AGE OF SURVEILLANCE CAPITALISM

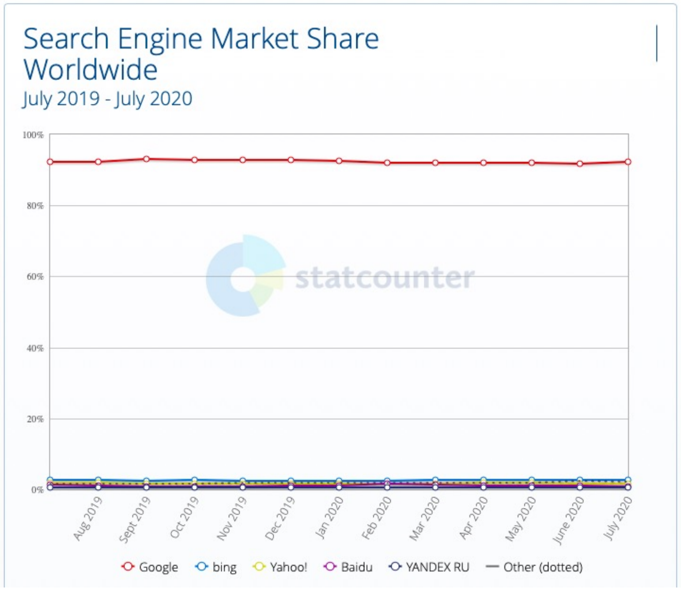
THE FIGHT FOR A HUMAN FUTURE AT THE NEW FRONTIER OF POWER

SHOSHANA ZUBOFF

As a side note:

“On Cyber Governance” by Geoff Huston

- .....
- It’s truly amazing that the sum of human knowledge is at my fingertips, instantly accessible from anywhere at any time. That's incredibly empowering.
- It’s truly frightening that all this information is only accessible through a single entity, who funds this service through an insidious economy based on surveillance capitalism.



https://gs.statcounter.com/search-engine-market-share

https://www.potaroo.net/ispcol/2020-08/cgov.html

Some specifics (I): the focal point moving up

- Networking started from dominance of carriage
  - Then moved to dominance of platforms
  - Then the dominance by application services

☞the locus of value and money shifted up the protocol stack

  - Where one can exploit centralization with minimized cost
  - Lower layer services became commodity services

Some specifics (II): surveillance economy ⇔ free apps

- Companies investing into commercializing new apps
  - Search, email, social networking ...
  - More added over time

- They gained from a positive feedback loop:
  - More users ⟹ more inputs for better services ⟹ attract more users, get higher revenues

- Proliferation of free services *by the cyber giants* ⟹ surveillance economy
  - The more the app providers know about specific users ⟹ the better services
  - **AND** the more influence they have over users
    - blurring the line between service and implicit control

Can Network Protocols Prevent Centralization?

- Protocols simply facilitate the movement of packets from one place to another
  - As carriers, protocols do not dictate where packets go
  - It is application deployments who make that decision.
- “protocols have not changed, but *requirements* changed. So we can design new protocols to prevent centralization”

Questions:

- What are those requirement changes?
- Can new protocol designs alone move the Internet towards decentralization?
  - Given they must operate within the existing architectural framework
    - communicating by pushing packets to numerical (semantic-free) address

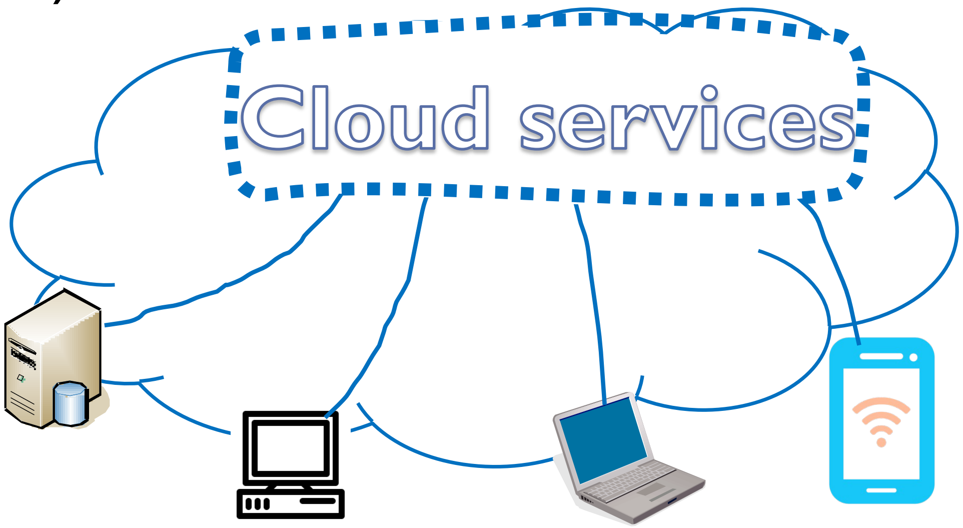
Recall: how we do networking today

1. *IP: node-to-node synchronous communication*

2. TCP: end-to-end connection for reliable delivery

3. TLS: securing the end-to-end connection NEW
   - patched on to TCP
   - The real security question (trust relation) outsources to 3rd parties (CAs)

Faceless entities



A sample set of cloud-independent apps
(demoware)

DeftT Security in Action

Per-publication signing instead of session-based

Cert chains of every publication is validated

System trust policies are applied by the Trust Schema

Uses a shim to interface between app-specific code and DeftT

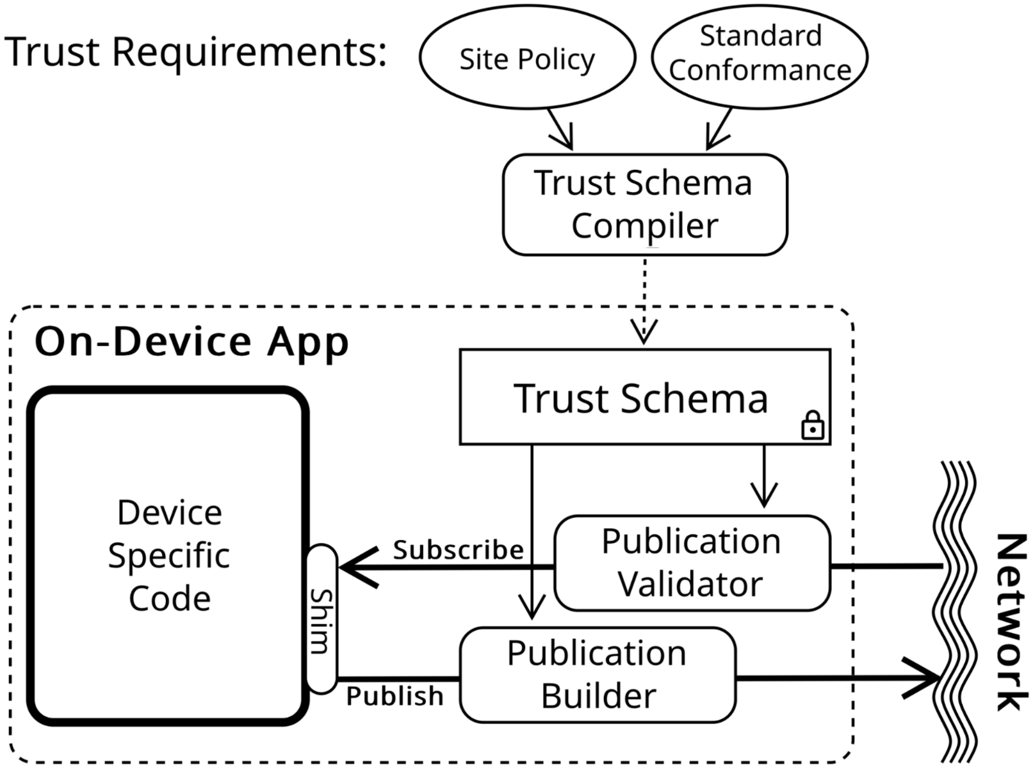
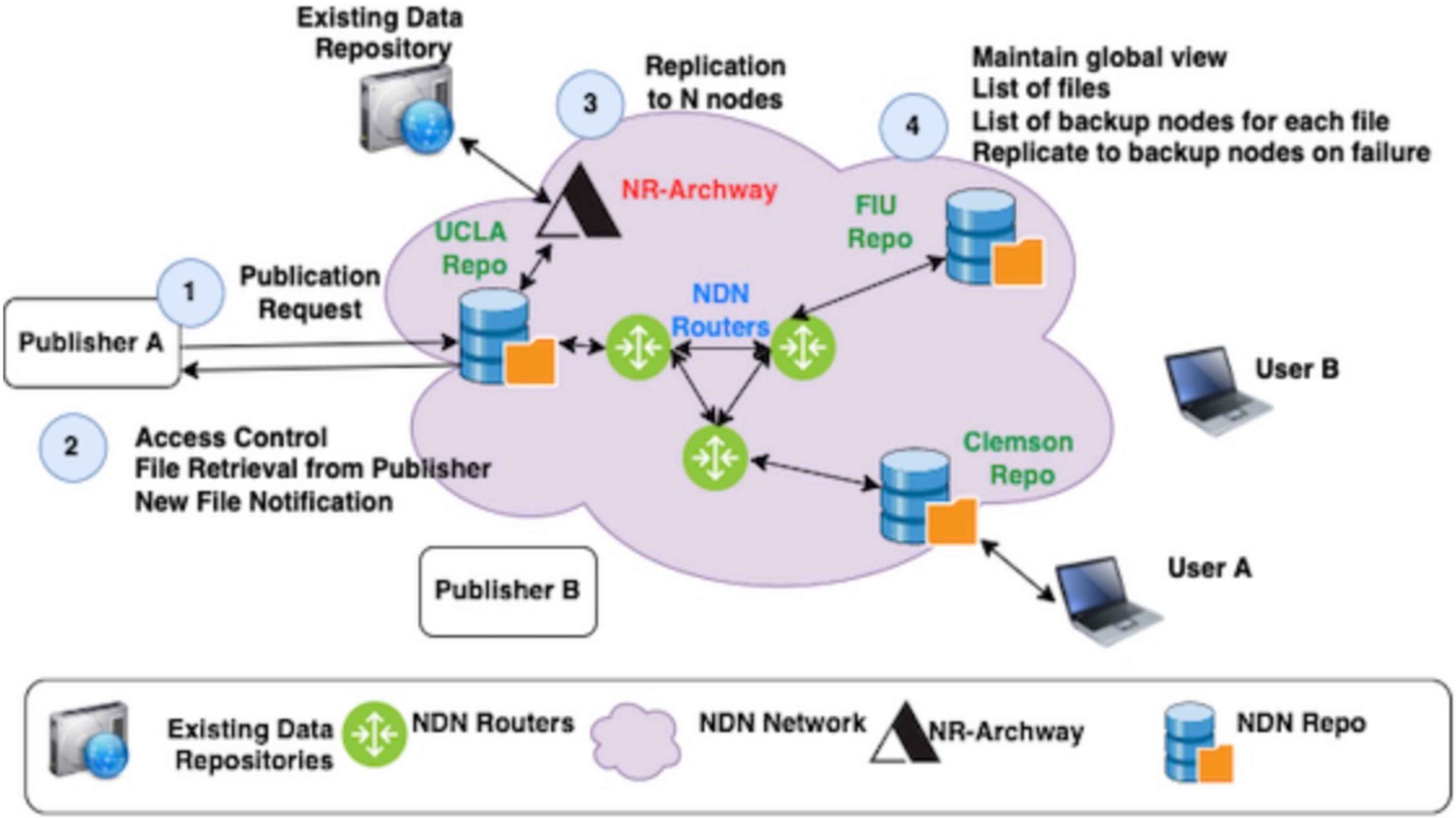


Figure 2: Management elements of DeftT (Nichols, 2022)

https://datatracker.ietf.org/doc/draft-nichols-iotops-defined-trust-transport

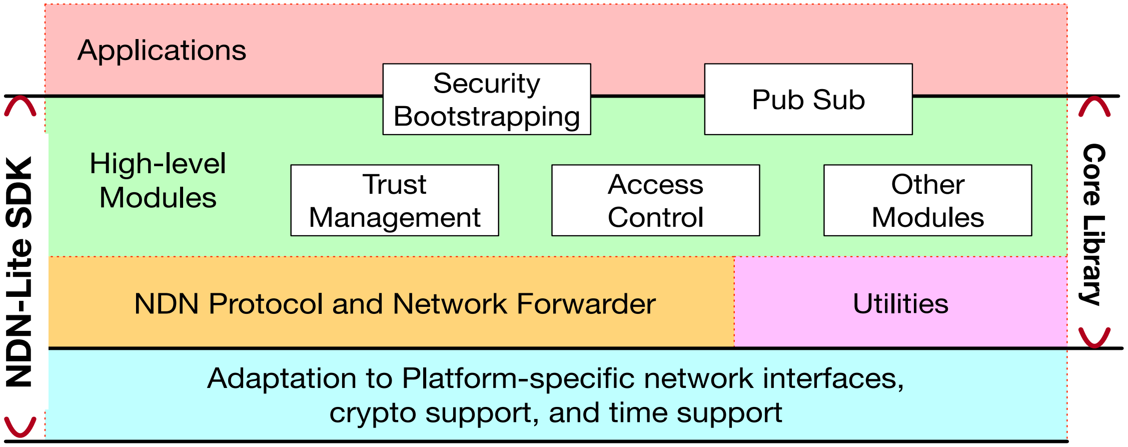
Hydra: SECURE, DISTRIBUTED Storage Framework

https://hydra-repo.io/



Developing a user-controlled smart home

NDN Lite



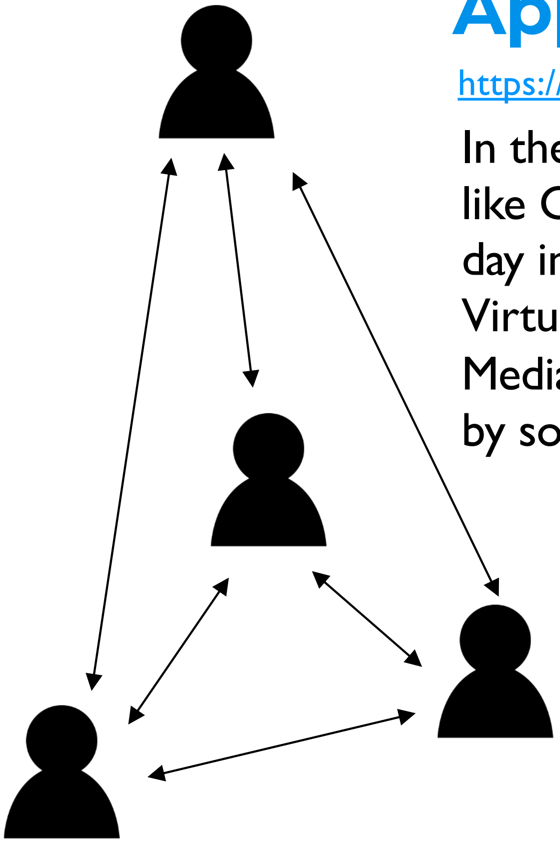
- All entities possess structured, semantic names and keys
- All communication via pub-sub of named, secured data
- All data controlled by home owners
    - cloud may serve as backup storage for user named and secured data

Sovereign: Self-contained Smart Home with Data-centric Network and Security http://web.cs.ucla.edu/~lixia/papers/2022Sovereign.pdf

ACM ICN 2019: Gawande, Clark, Coomes, Lan Wang
Decentralized and Secure Multimedia Sharing Application over Named Data Networking https://named-data.net/wp-content/uploads/2019/10/npchat.pdf

NpChat, a Multimedia Sharing Application over NDN

https://medium.com/@ritikk/npchat-604663a7047d



In the world dominated by big internet players like Google, Facebook, etc., most of our day to day internet traffic is routed to their servers. Virtually everything from E-commerce, Social Media, Web Streaming are increasingly controlled by some giant corporation. ...

Such a connected world requires a *decentralised end-to-end encrypted social multimedia app*. And when looking on it from Information-centric network perspective, NpChat seems quite promising.

Common features among the cloud-independent apps

Security is designed *into* the apps

- Instead of security patches applied to the existing unsecured systems

- User-owned identities
- User-managed security
  - authentication, authorization, policy management
- Empowering end users
  - utilize cloud services whenever feasible, with no reliance on it.

These apps adhere to, and extend, *the end-to-end principle* by enabling *end-to-end security*.

Take away

- To nudge Internet away from further centralization: enable distributed apps
- To enable distributed apps
  - User controlled (not cloud-owned) identities
  - User controlled security

  →have security designed into the applications/systems
    - Without reliance on today's "security patches" (they create communication obstacles)
- To design apps and system with intrinsic security: grow the NDN community