Edge Computing: Scanning The Vision

By Andrew Worley

April 2020

What this presentation covers

- What do we mean by edge?
- Why move things to edge?
- Brief history of edge computing development?
- Benefits and Case Studies
- Challenges

Take it to the edge....

- Move it to the edge of the network
- Not a hard line
- Definition: Any computing or network resource along the path between data sources

But I thought the internet was centralizing...

- True – centralized cloud computing is big business

- The issue rises out of a gap between the data that is being produced and hardware constraints

Data – A lot of it

The Internet of Things (IOT) market has exploded in recent years

The initial 2016 paper projects 50 billion IoT devices by 2020

The newer 2019 paper projects 150 billion by 2025

- About how many devices were in use at the end of 2019
  ~22 million

- How much data can they produce
  A couple hundred Zettabytes

Why is this an issue?

Processor speed and bandwidth show much different growth curves

Processor – Moore's Law

- Double every 18 months
- ~ 60% per year

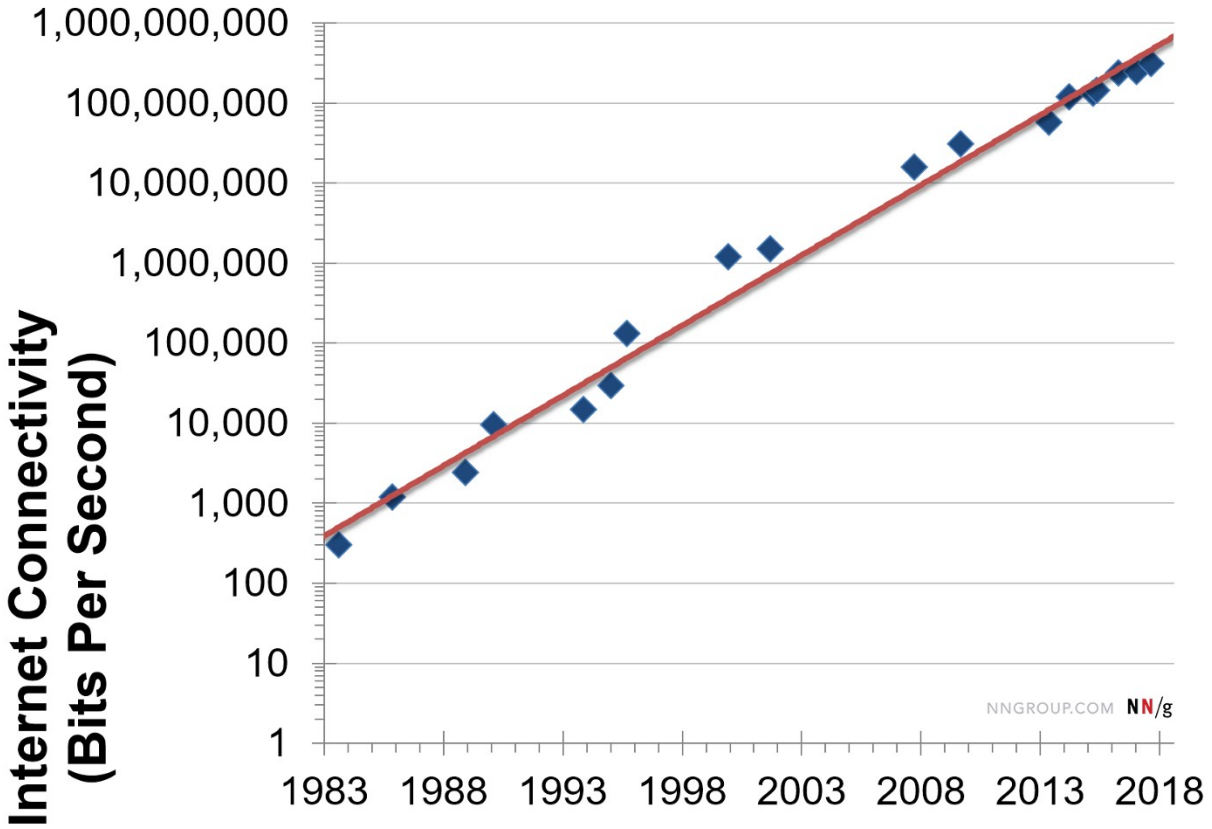
Bandwidth – Nielsen's Law

- Increase by 50% each year

Reasons include:

Demand

Upgrade costs



History Time

- Rapidly developed since 2014
  - 255 papers in 2014 to over 6816 in first half of 2019
- Paper predicts full integration into field by this year

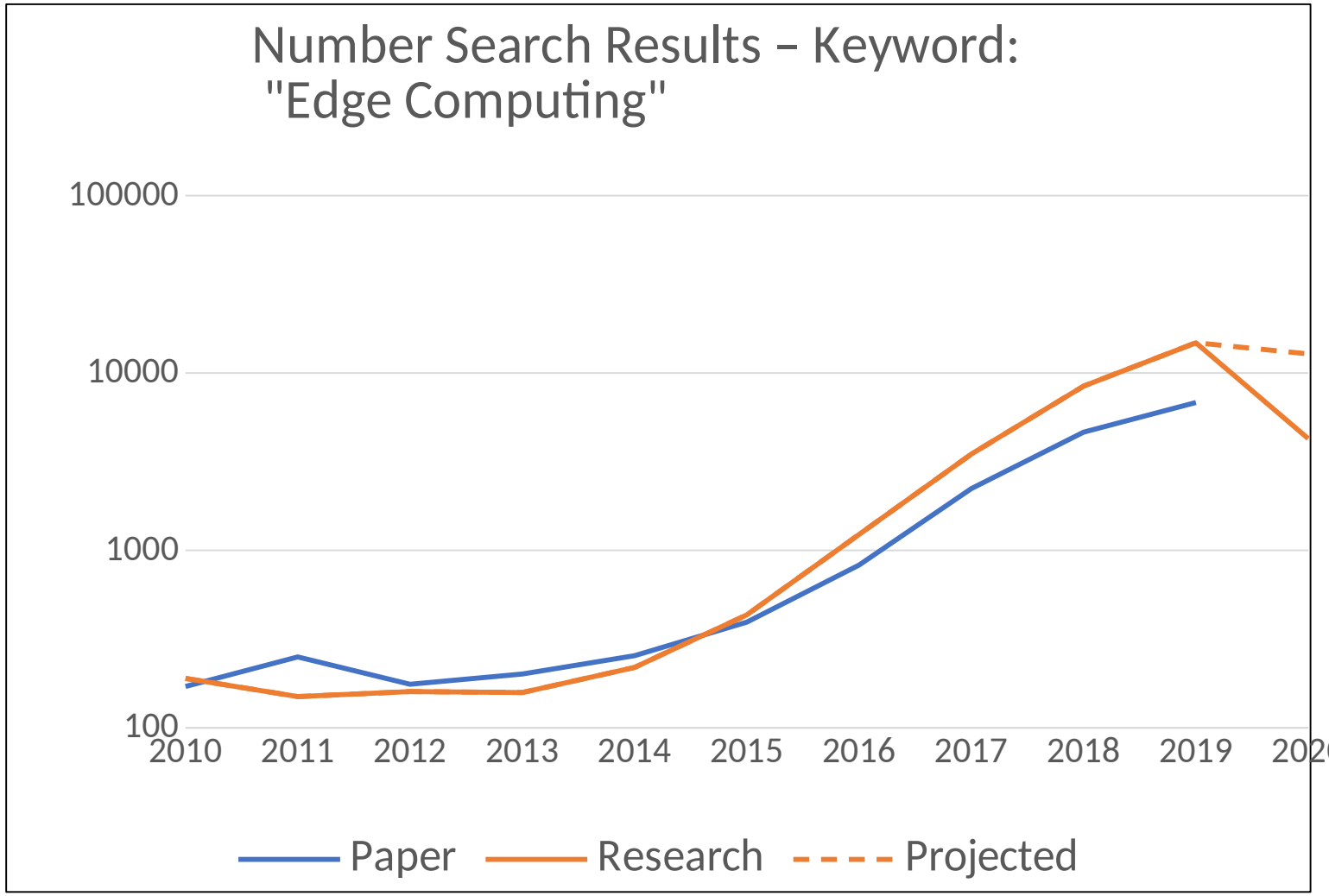


Figure 2

So what can we do?

- Look at what already kind of works
  - CDN

- Instead of caching data, cache processing resources instead

Precursor’s and Related Designs

- Cloudlets
- Mobile Edge Computing (MEC) – mobile devices
- Fog Computing
- Cloud Sea Computing

So what does the current model look like?

- Can be several layers deep
- Paper abstracts layers
  - IoT end devices
  - Edge
  - Cloud

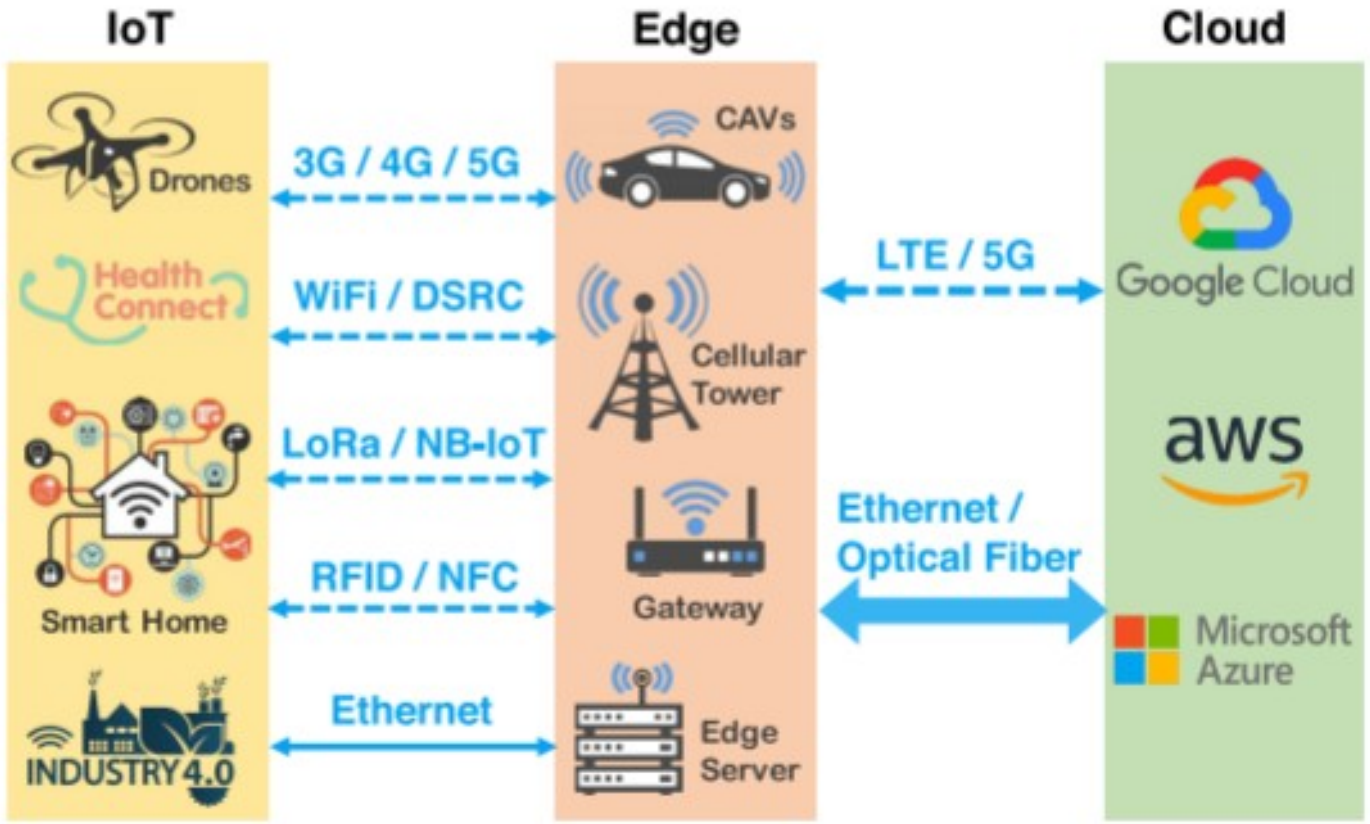


Fig. 2. *Three-tier edge computing model.*

Benefit’s of edge computing

- Reduce the load on the network by limiting data that needs to be sent out for processing.
- Quicker turn-around time for local applications
- Security – data can be aggregational and anonymized before transmission over wider network.

    Remember: Smart-Grid/Privacy issues

Case Studies

- Cloud Offloading – shopping cart example – sync in background
  - How to share data among different edge nodes for mobile devices
- Leverage edge sources
  - Video Analytics – missing child
  - Smart Home
  - Smart City
- Collaborative Edge
  - Easier to get information out of edge… supposedly.

Challenges

Challenges (1) – Programmability

- Support for heterogenous architecture
- Support for multiple different communication protocols

- Proposed Solution: Computing Stream
  - Process data at defined points along route
  - Location of processing defined by application

Challenges(2) – Naming Scheme

- IP addresses are great for computers
  - Not so much for humans.

- Proposed Solutions:

  Paper suggests using a NDN like naming scheme

  Mobile First System -

  Similar in concept to a mini-DNS system

  NDN-like names for human interaction

  IP – like names for machine control

  Mapped via table

Challenges (3) – Reliability

- How to keep track of which devices are inoperable or just lagging
- Maintain view of network topology
- How to ensure data fidelity

Challenge (4) – Service Management

- Differentiation - how to prioritize which data gets processed
- Extensibility – how to add things
- Isolation – how to prevent domino failure

Challenge(5) – Data Abstraction

- How much processing should be done at the edge?
- What resolution is lost in the aggregation process?
- What should be stored?
- How to automate handling of the data
- What operations are allowed

Challenges (6) – Privacy and Security

- Privacy –
  - People in general don’t think about security

    example: Wifi: 40% unsecured & 80% using default password

  - Who owns the data? Producer or Processor

  - How to support security on low-powered edge devices

Challenges (7) – Optimization Metrics

- Latency – turn around time for queries
- Bandwidth – the amount network traffic reduced
- Energy – processing is energy heavy, how much of a cost do you incur by adding processors away from the cloud
- Pricing Model – How will companies charge for the use of the resources

Sources

- Shi, Weisong, George Pallis, and Zhiwei Xu. "Edge Computing [Scanning the Issue]." *Proceedings of the IEEE* 107.8 (2019): 1474-1481.

- Shi, Weisong, et al. "Edge computing: Vision and challenges." *IEEE internet of things journal* 3.5 (2016): 637-646.

- The IoT Rundown For 2020: Stats, Risks, and Solutions -- Security Today. (2020). Retrieved 21 April 2020, from https://securitytoday.com/Articles/2020/01/13/The-IoT-Rundown-for-2020.aspx?Page=2

- Nielsen's Law of Internet Bandwidth. (2020). Retrieved 21 April 2020, from https://www.nngroup.com/articles/law-of-bandwidth/

- IoT devices in use worldwide 2009-2020 | Statista. (2020). Retrieved 21 April 2020, from https://www.statista.com/statistics/764026/number-of-iot-devices-in-use-worldwide/