Fogify: Orchestration of the Fog for NFV

Lyndon Fawcett

Lancaster University

Supervisors: Dr. Nicholas Race and Prof. David Hutchison

Coseners 2016

Context

- Increasing support for edge services
  - B-RAS Capability
    - PPPoE sessions – avoids tromboning
  - NFV – New edge services
    - QoE, caching, anomaly detection, mgnt.
- Increased device capabilities throughout
  - Analysis of the CPE[1,2]
    - More capable 'kickstarter' CPEs
  - Routers with line-cards
 - Mobile Edge Computing (MEC)
  - NFV at the telephone exchange CORD[3]
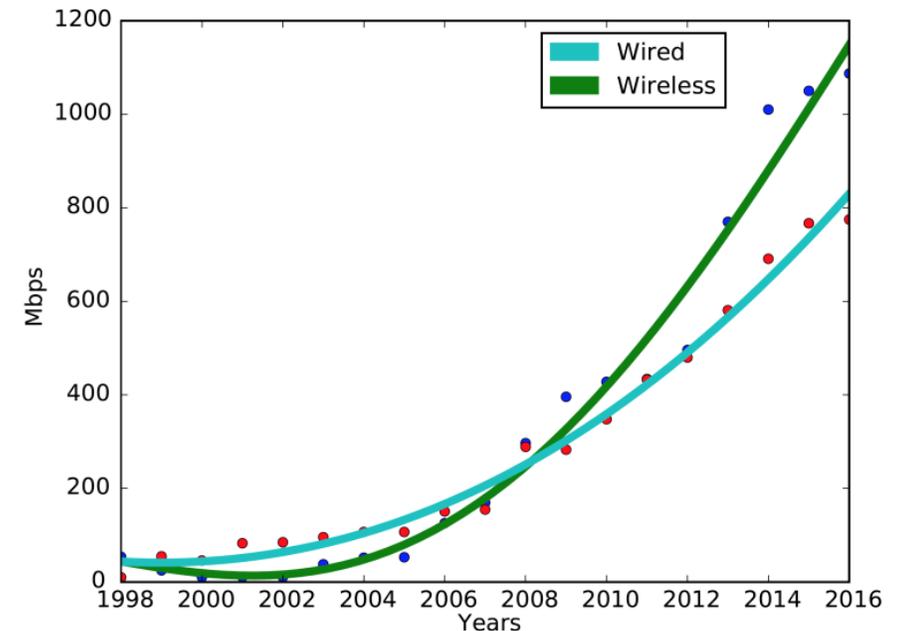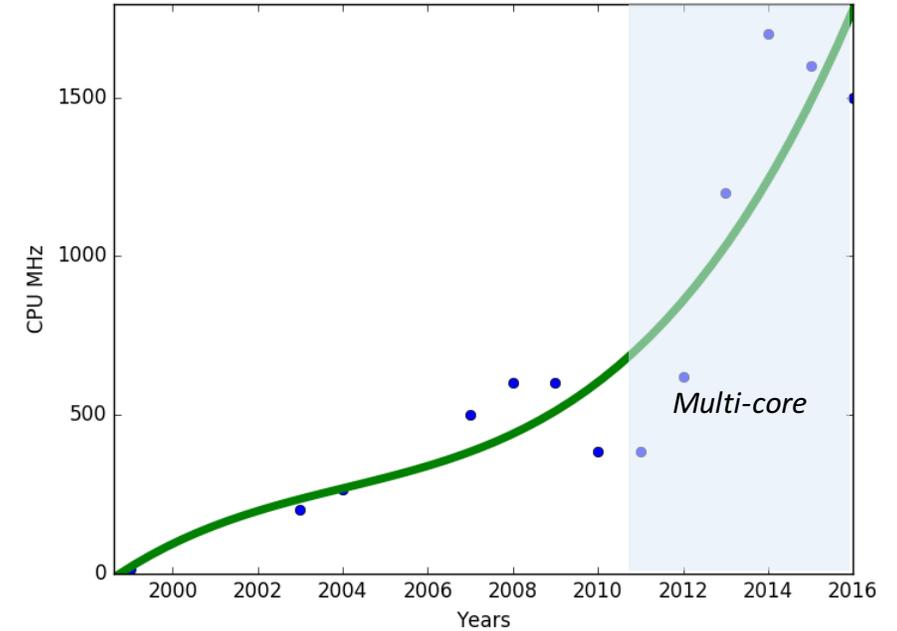
[1] More information about analysis at http://lyndonfawcett.com/analysis-of-the-cpe/
[2] Data source: https://wikidevi.com/wiki/Category:Wireless_embedded_system
[3] Al-Shabibi, A., and L. Peterson. "CORD: Central Office Re-architected as a Datacenter." *OpenStack Summit* (2015).

Introducing the Fog

- ## What is the Fog?[3,4]
  - ### Compute from Cloud to the end point
- ## Combining Fog and NFV
- ## Benefits of Fog for NFV?
  - ### Low latency
  - ### Scalability
  - ### Privacy
  - ### Reduction of traffic to the core
  - ### Service with no Internet

Data centre — Network operator core — Telephone exchange — Home — Business

Core ← → Edge
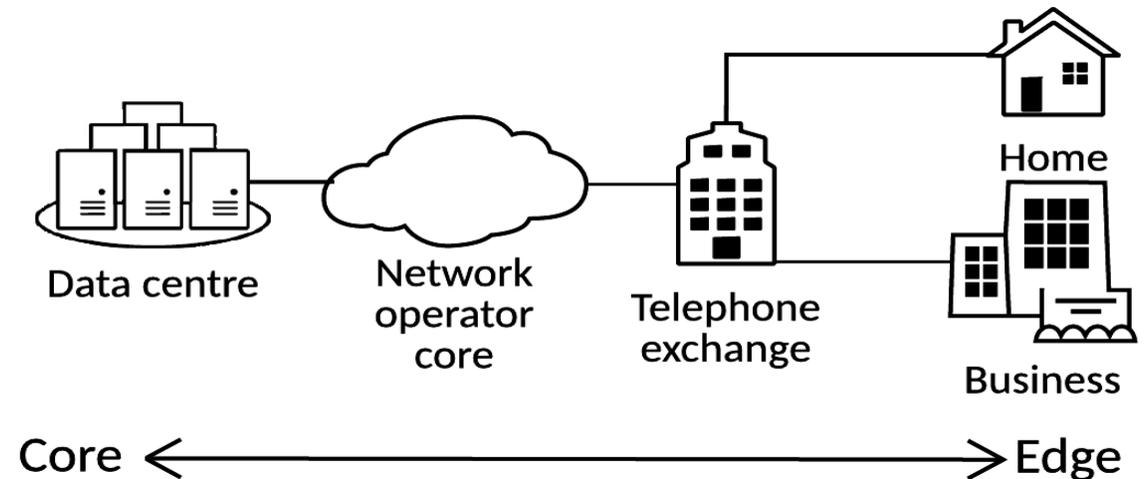
[4] F. Bonomi, et al. Fog computing and its role in the internet of things. In Proceedings of the MCC workshop on Mobile cloud computing, 16. ACM, 2012.

[5] L. M. Vaquero and L. Rodero-Merino. Finding your Way in the Fog. ACM SIGCOMM Computer Communication Review, 2014.

Existing platforms – NFV for the Cloud

- ETSI NFV MANO specification
- Implementations
  - OpenBaton
  - OpenMANO
  - OpenStack ++
  - OPNFV[6]

- Problems with current MANOs and the Fog
  - Device heterogeneity
  - Volatility and migration in the Fog 🤔
  - Device discovery

[6] https://www.opnfv.org
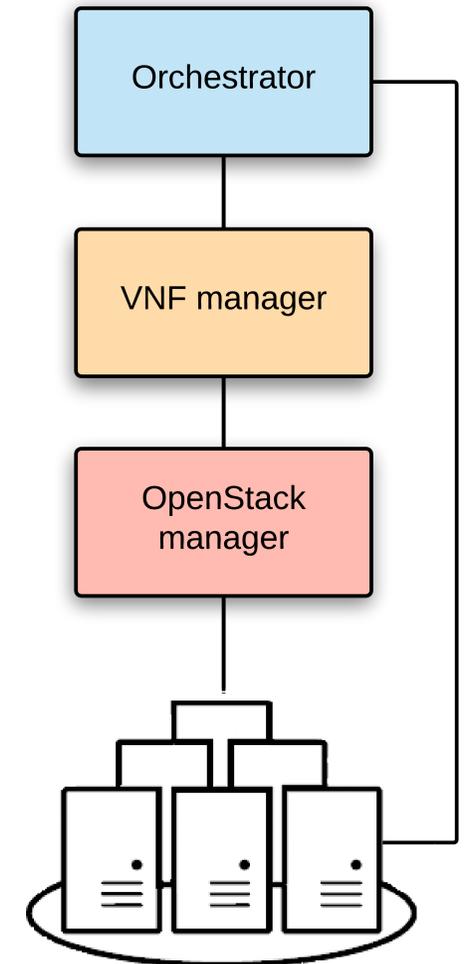
Bringing NFV to the Fog: **Fogify**

- Orchestrator
  - Policy for service

- Fog manager
  - Driver layer abstraction
  - Device Lifecycle
  - Migration

- NFVI discovery
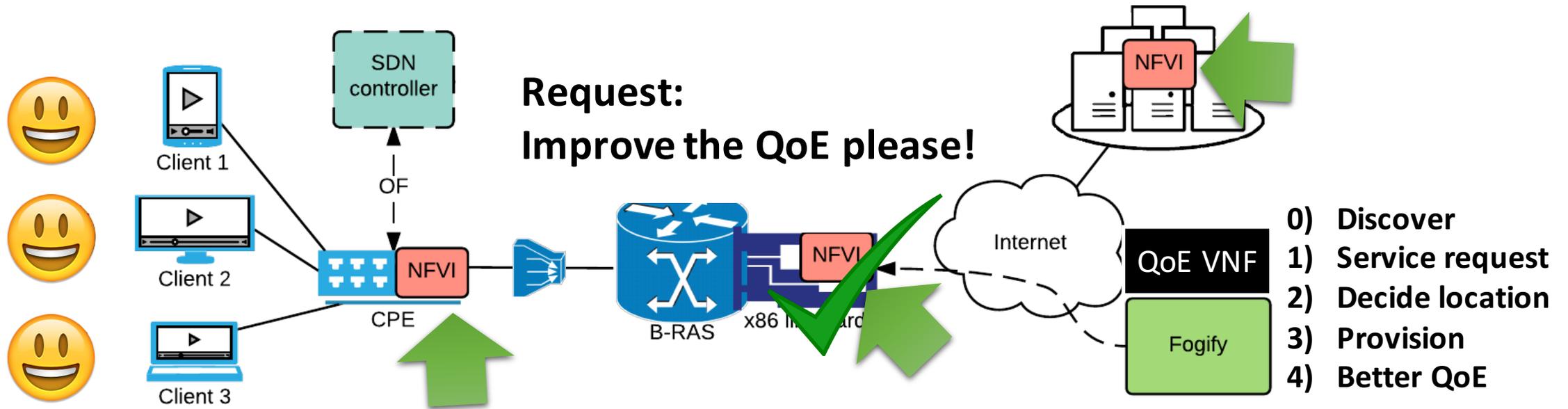 - New compute
  - 1 to many orchestrators
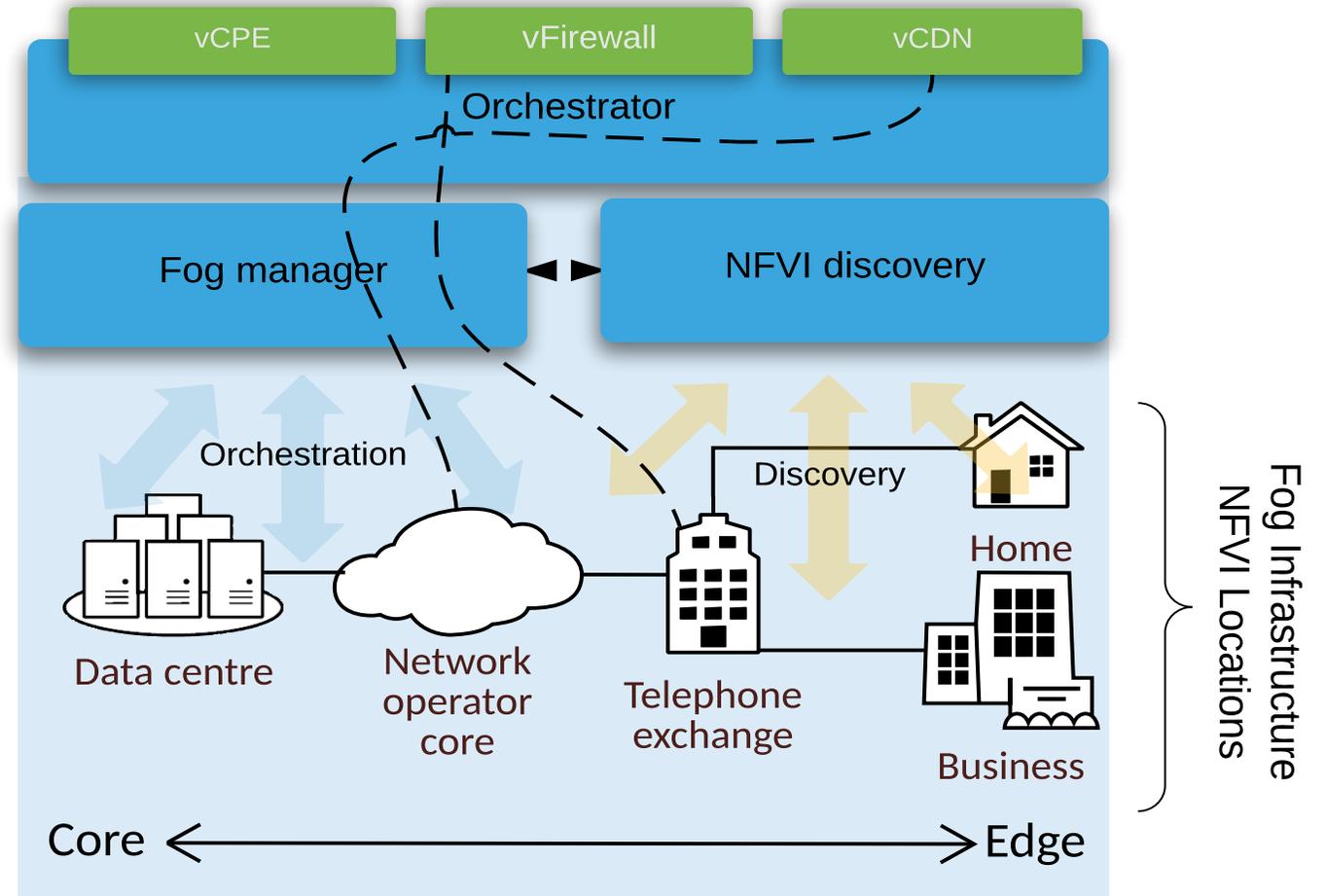
Use case: QoE in the Fog

- Why?
  - Target multiple households
  - Low latency -> rapid change
  - Reduce traffic to core

- Key focus:
  - Automatic location selection
  - Fog device discovery
  - Service migration in the Fog

**Request:
Improve the QoE please!**

0) **Discover**
1) **Service request**
2) **Decide location**
3) **Provision**
4) **Better QoE**

[7] Example fairness application : Mu, M., Et al. "A Scalable User Fairness Model for Adaptive Video Streaming over Future Networks", IEEE Journal on Selected Areas in Communications. 2016

Next Steps

- Background research for PhD
  - Similar projects
  - Light weight virtualisation
- Realise/Virtualise Fog scenario
  - Real hardware, OpenStack, Mininet
  - TOUCAN testbed
- Evaluate challenges of VM migration in the Fog
- Develop prototype orchestration tools
  - Evaluate against cloud solutions

Thank you! Any questions?

Appendix

Use case: caching in the Fog

- Why?
  - A lot less traffic to the core
  - Multi-level caching

OK, but what are the challenges?

- Services that should reside in the Fog vs the Cloud

- Volatility
  - Service migration

- Device heterogeneity
  - Substrates: OS, ARM/X86
  - Capabilities: RAM, CPU, connectivity

- Multi-administrative control

- Discovery

- Management at scale

Goals

- Reap the benefits of the Fog
- Handle device heterogeneity and different substrates
  - Lightweight virtualisation
    - Docker, LXC, UniKernels, Etc.
- Use a light weight migration technique
- Provide a discovery service that works at scale
- Intelligently allocate resources within this new environment

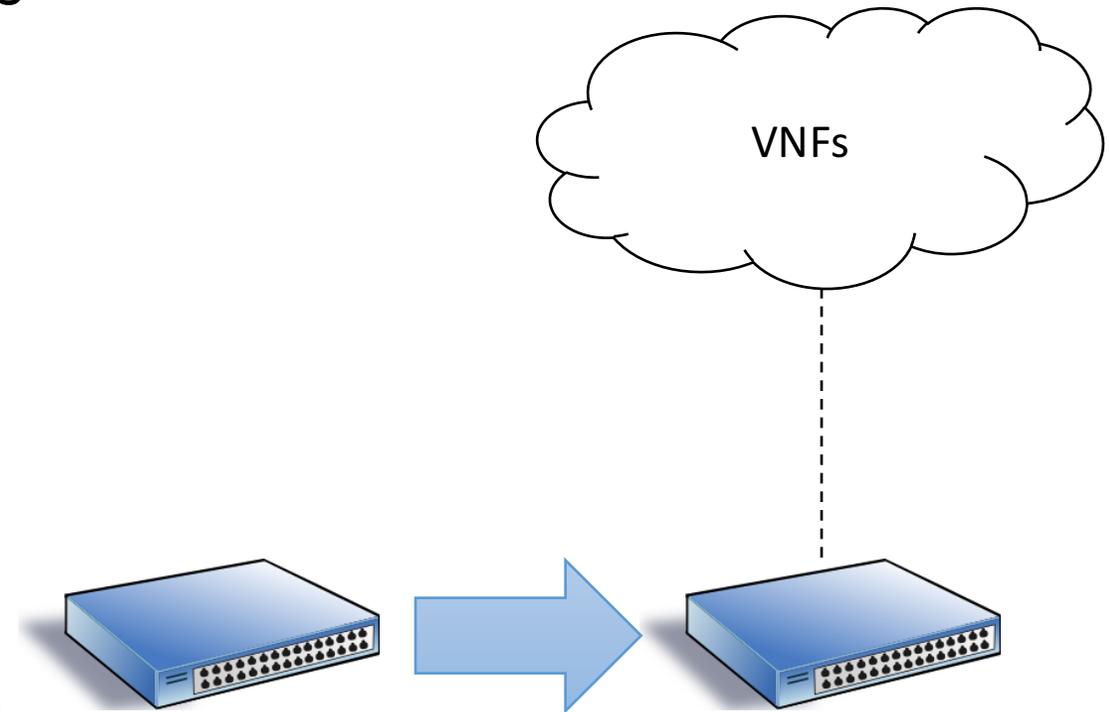# Interested in the Fog? Here are some useful papers/resources

- VM migration in Fog computing
- Edge analytics in the IoT
- Adaptive VM handoff across cloudlets
- OpenStack ++ for cloudlet deployment
- F-RAN
- Fog Computing: A platform for Internet of Things and Analytics
- Fog Computing: Principles, Architectures, and Applications
- Fog Computing and its Role in the Internet of Things
- Fog and IoT: An Overview of Research Opportunities
- The Case for VM-based cloudlets in Mobile computing
- Mobile Edge Computing (MEC)

Use cases

- CDN & Caching
- QoE
- Security sensitive apps
- Dynamic edge OpenCache
- Mix of these applications and balancing them
- Sharing the Fog
- Encoding video (Not really a network service?)

Network Functions Virtualisation

- Softwarisation/virualisation of services

- Benefits
  - Quicker time to market
  - Lower CAPEX/OPEX costs

- Key terms
  - Virtual Network Functions (VNF)
  - Service Function Chains (SFC)
  - Management and Orchestration (MANO)

VNFs

Alternative diagram