NETLAB
NETWORKED SYSTEMS RESEARCH LABORATORY

Ubiquitous, lightweight NFV in the age of the Internet of Things

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About us

- University of Glasgow, United Kingdom
  - School of Computing Science
    - Networked Systems Research Laboratory
- Director: Dr Dimitrios P Pezaros

University of Glasgow

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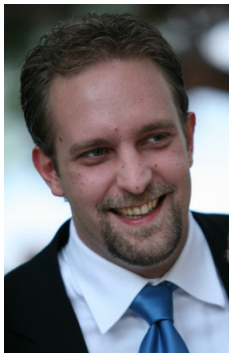
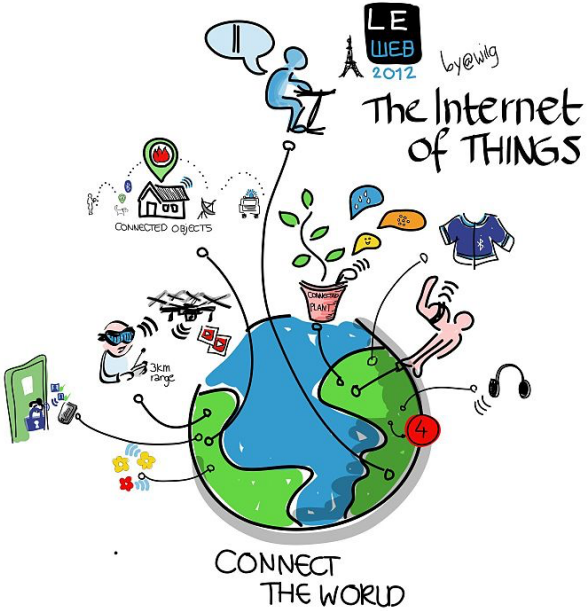


Research topics @netlab

Our webpage: https://netlab.dcs.gla.ac.uk

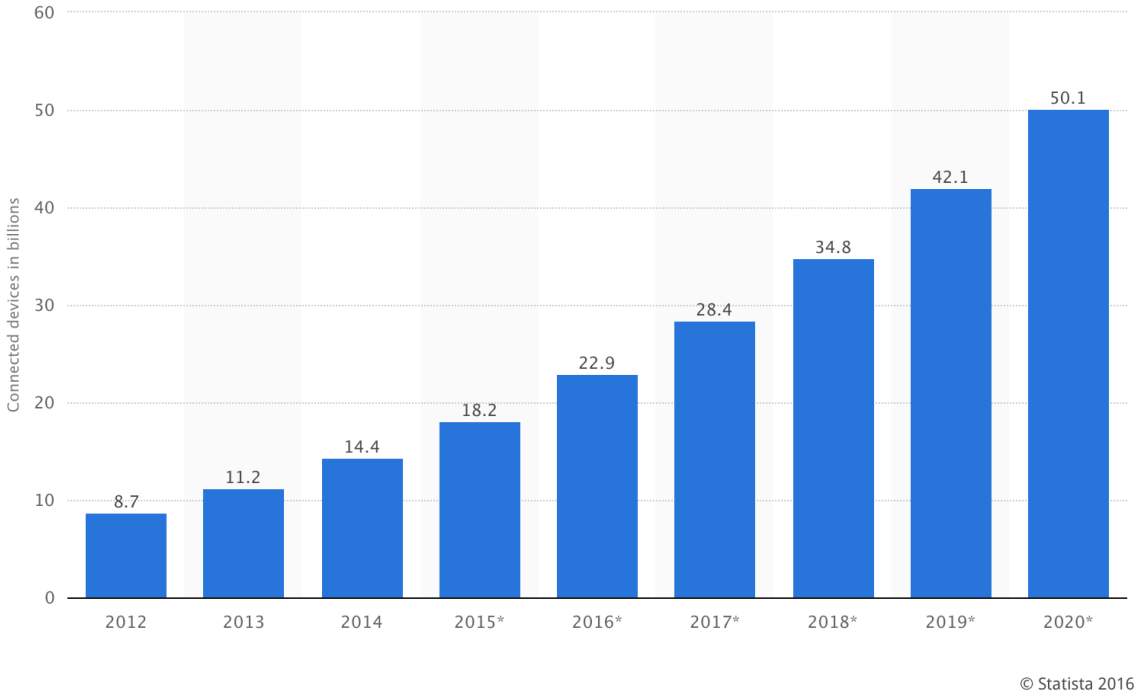
Internet of Things (IoT)

- Physical objects
  - Devices
  - Vehicles
  - Software
  - Sensors

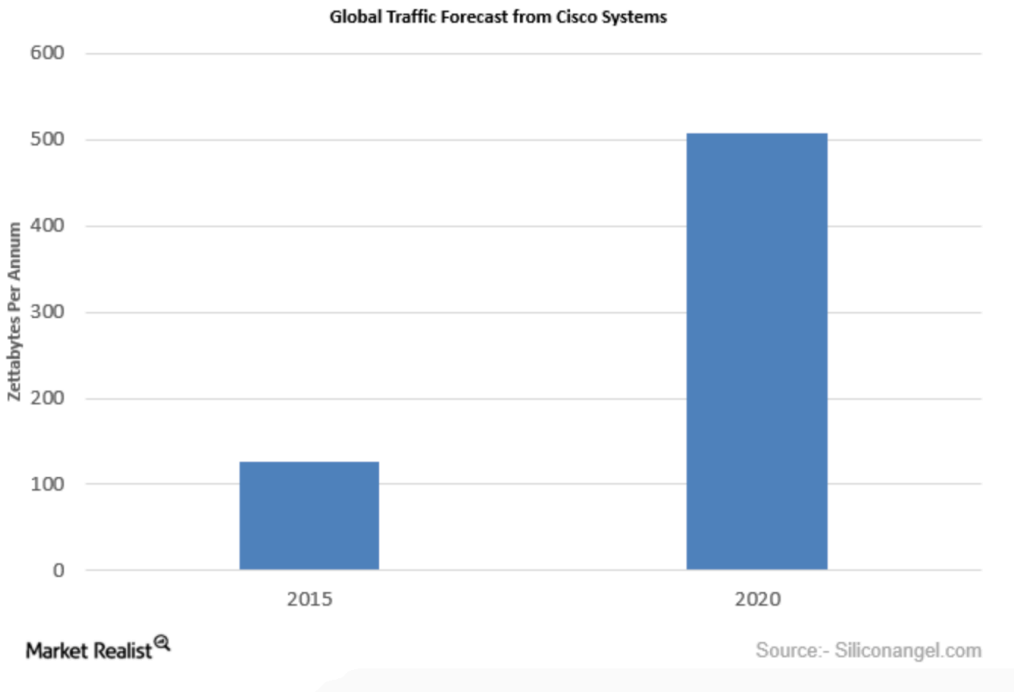


- Connected using a network

Increase of IoT devices



Growth of network traffic

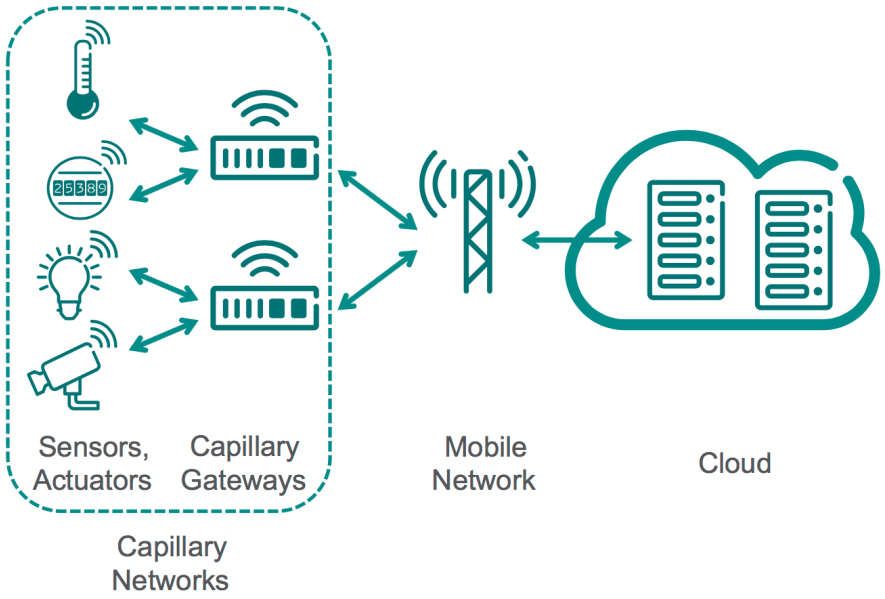


Cisco: *"growth due to mobile devices and wearables"*

IoT support at CSPs

- CSPs are transforming to support multiple IoT applications:
  - Connected cars
  - Surveillance systems
  - Smart cities
  - Smart metering
  - Environment sensors
  - …

IoT architecture

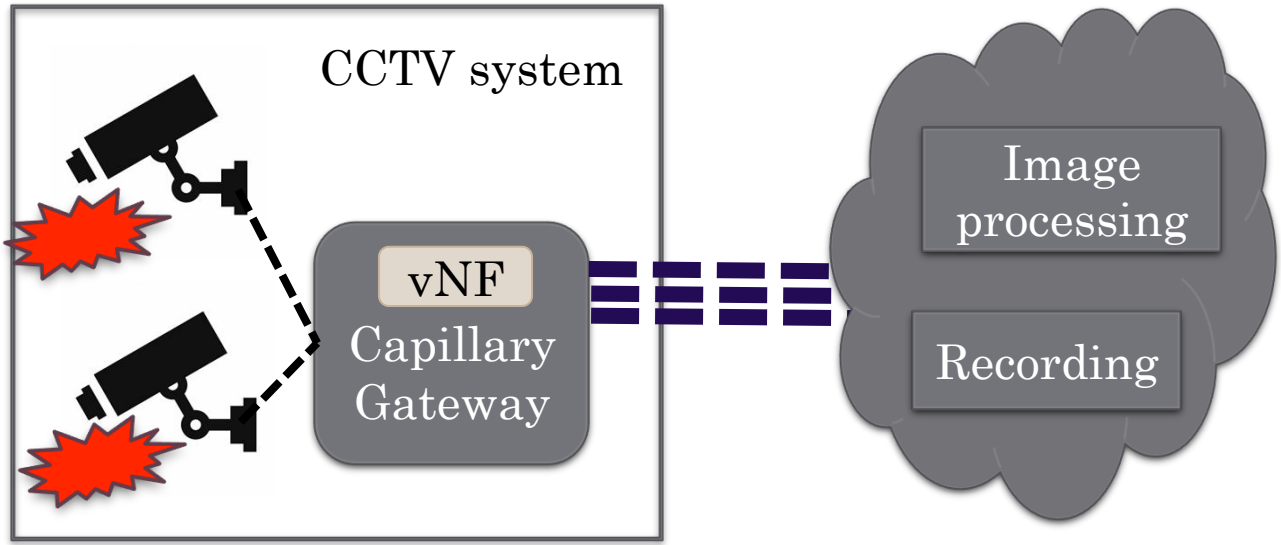


Ref.: *Capillary Networks – Bridging the Cellular and IoT Worlds* - Oscar Novo, Nicklas Beijar, Mert Ocak, Jimmy Kjallman, Miika Komu, Tero Kauppinen Ericsson Research

Challenges

- IoT applications have diverse network requirements
- The network requirements are constantly changing in an unpredictable fashion
- Network reconfiguration needs to be fast (and frequent)

Example: Change in network requirements



Goal: Increase bandwidth (video quality) in case of event of interest

The question is: What type of virtual Network Functions fit the emerging IoT architecture?

vNFs in the IoT context

- vNFs need to run on wide variety of devices
  - Most devices or capillary gateways are low cost (e.g., single chip computers)
- vNFs need to support fast lifecycle mgmt.
  - A vNF should be started in few seconds
- The virtualization overhead should be minimal
- vNFs should be as simple as possible

Glasgow Network Functions

- Glasgow Network Functions (GNF)
  - Research and development project from Netlab
- Main characteristics of GNF are:
  - Container-based NFV system
  - Transparent attachment to network traffic (using SDN)
  - Infrastructure independent
  - Open source

Containers

- Lightweight “virtualization”
  - Shared kernel on the host
- Fast create/start/stop/delete
- High performance
  - Small delay, high throughput, low memory usage
- Reusable / shareable
- Traditional software environment
- Microservices architecture

GNF components (in brief)

- Router
  - Runs on top the Open Daylight Controller
  - Creates and inserts the rules to apply a specific forwarding policy
- Manager
  - Provides a REST API to the system
- Agent
  - Daemon running on the GNF hosts
  - Manages (starts and stops) containers and local forwarding
  - Provides host/container status information to the Manager
- UI
  - Talks to the Manager
  - Adds/removes network functions

Step-by-step

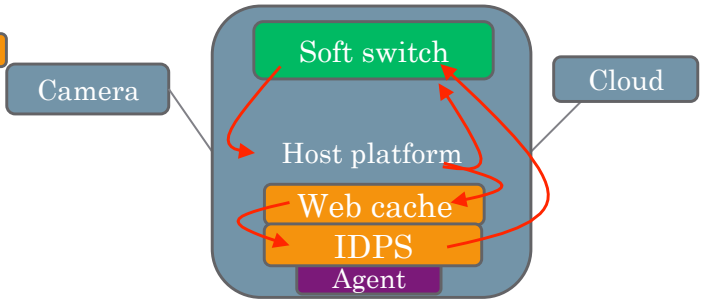
- Traffic from Camera to Cloud
- Need a new Rate Limiter placed between them?
  - Controller finds a suitable host platform
  - Pulls the rate limiter
  - Spawns an instance

Rate Limiter

- Apply the policy
  - Reroute the traffic matching:
    - FROM Camera
    - TO Cloud

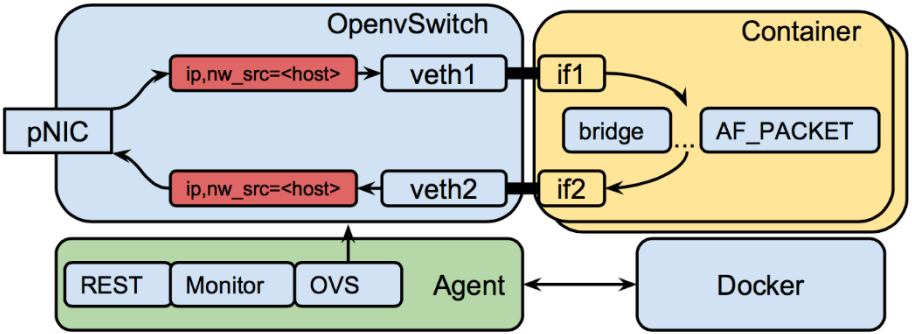
OF rule

- Chaining containers
  - Web Cache
  - IDPS



Inside a GNF host

- No packet copy



GNF in public clouds

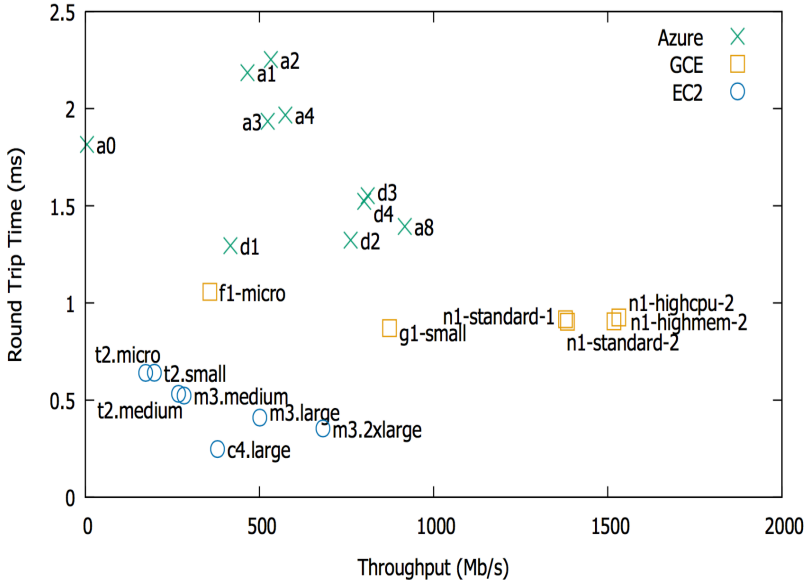
- As GNF does not require any virtualization or special kernel, it runs on public clouds using generic VMs
- We have evaluated three public cloud providers and used various instance types for host VMs for vNFs
- Results show: **there is a significant difference in RTT and throughput between *instance types* and *providers***

Google
Cloud Platform

Microsoft
Azure

Published in: *GNFC: Towards Network Function Cloudification.*
Richard Cziva, Simon Jouet and Dimitrios P Pezaros, IEEE NFV-SDN`15.

GNF in public clouds



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Example GNF vNFs

- Examples vNFs available on our website:
  https://netlab.dcs.gla.ac.uk/projects/glasgow-network-functions
  http://glanf.dcs.gla.ac.uk
  - Firewall
  - HTTP proxy
  - Network measurement functions
  - Introducing delay
  - Rate limiter
  - DNS load balancer
  - SNORT
- We also have a Youtube video showing GNF in operation (https://youtu.be/W7aa4L2piBQ)

Container NFV – challenges

1. Exclusive allocation of CPU resources
2. Direct I/O (e.g. SR-IOV / DPDK)
   - DPDK runs in Docker (Intel 2015)
3. Inter-NF communication (direct memory mapped)
4. High performance software switch between containers
5. Fast live migration

Thank you!

- Contact: Richard.Cziva@glasgow.ac.uk

- GNF has been published in two papers so far:
  - *Container-based Network Function Virtualization for Software Defined Networks*. Richard Cziva, Simon Jouet, Kyle White and Dimitrios P Pezaros, IEEE ISCC 2015
  - *GNFC: Towards Network Function Cloudification*. Richard Cziva, Simon Jouet and Dimitrios P Pezaros, IEEE NFV-SDN 2015.