Population Management in Clouds
is a Do-It-Yourself Technology

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Questions and Objectives

- (1a) How to steer the **global network behavior** resulting from **self-organization** where agents have their own goals and actions? –– global vs local/self optimization

- (1b) How to build and leverage the knowledge produced at the micro (agent) and macro (network) levels? How to correlate and make sense out of **measurements and data from heterogeneous sources**? –– e2e performance heterogeneity

- (2) How to make the **operations scale**? To which extent are the new techniques and solutions actionable, "computable"…? –– complexity problem

- (3) How can the management techniques leverage on the new properties and features introduced by **adaptive and cooperative agents**, i.e. applying the **same techniques to the management plane** itself. –– heterogeneity problem

This Talk is about Cloud Networks

- a network of DCs is **a cloud** –– say, Amazon EC2 with 9 regions
- a network of clouds is **a federation** –– say, Amazon x 1dc + IDCF x 20dcs in Japan
  - we already start hitting the **heterogeneity wall**, since there is no solution yet, no such federations exist today, but some are planned `03`
- .. moving further to **network edge**, we find **Akamai** with its **30k+ cloudlets** `02` –– a class of its own
  - heterogeneity problem? in hardware NO, but in e2e network performance STRONG YES
  - but, Akamai has all the control, so, they manage to balance the load properly
- ... now, having incorporated all the **devices at network edge** you have **the fog cloud**
- ... on a side note... **why cloud networks?** ... well, because most networking soon will be done inside and/or by clouds

`03` "Chameleon project" https://www.chameleoncloud.org (2014)
`02` B.Frank+8 "Pushing CDN-ISP Collaboration to the Limit" ACM SIGCOMM Computer Communication Review (2013)

Cloudification Timeline and Scope
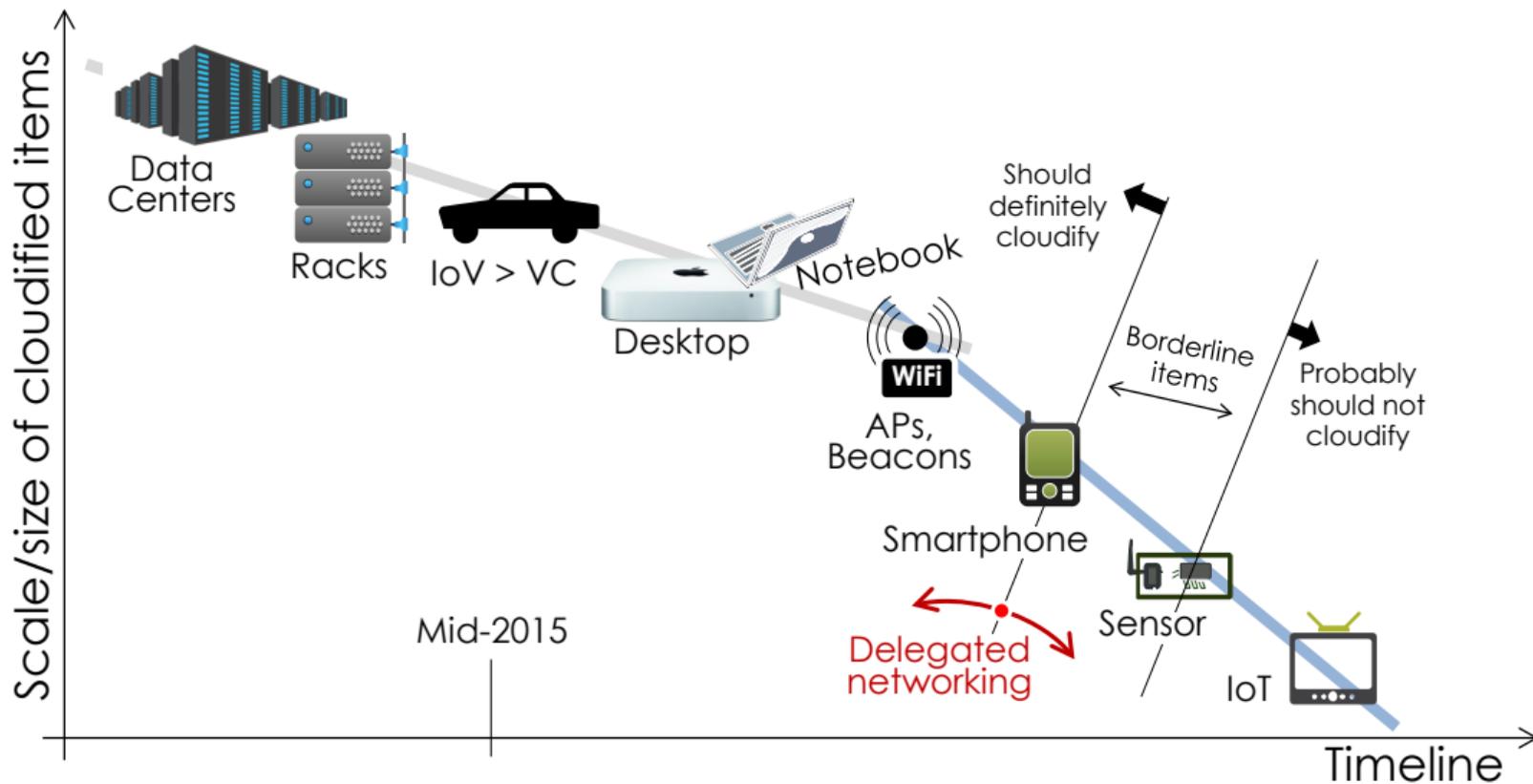
One Cloud Service
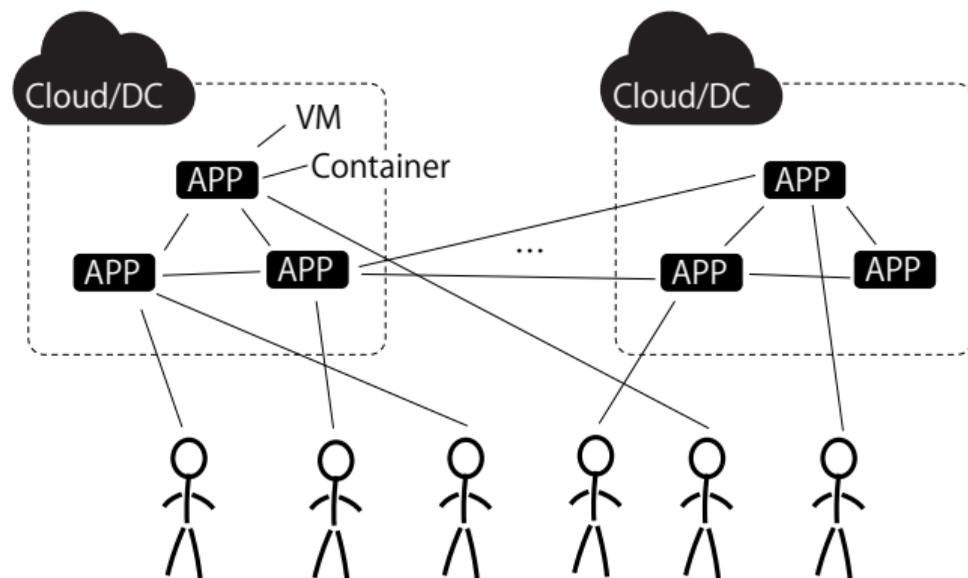
- service can provide **the graph** of its apps
- graph can include end users in form of **DC-user e2e** network performance
- federated cloud known its actual topology and can **use VNE to map** 04

Many Cloud Services
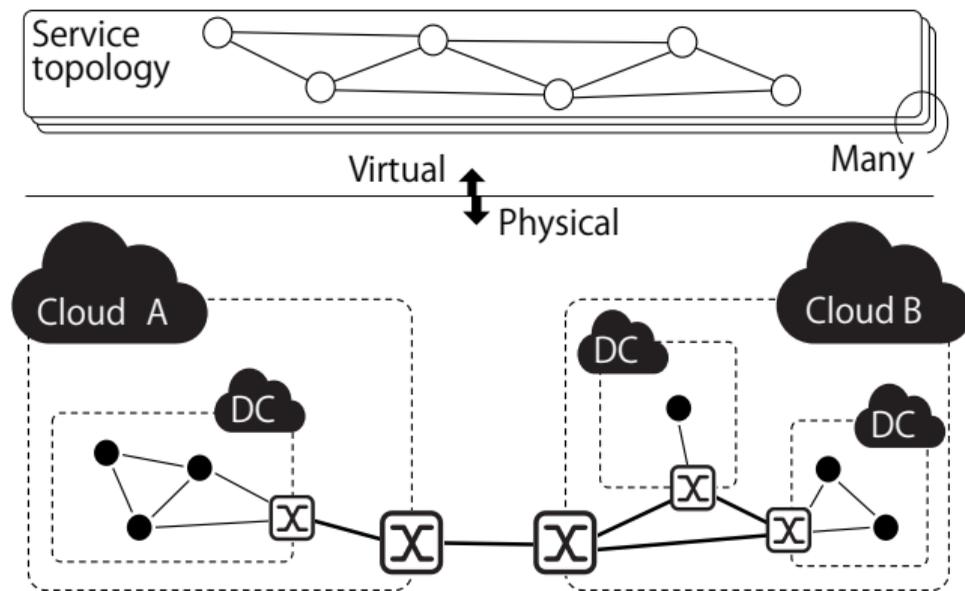
- for many services, you might use a more detailed physical topology (rack-level?)

- otherwise, the same mapping method

- many-service case is already considered in literature 04

04 M.Zhanikeev "A New VNE Method for More Responsive Networking in Many-to-Many Groups" 7th ICUFN (2015)

OSPF, QoS Routing, VNE → complexity

- OSPF optimizes one parameter (cost/weight) for one physical graph, and is NP Hard
- QoS Routing optimizes multiple parameters for one path, and is NP Hard
- VNE maps one virtual graph on top of a physical graph and is NP Hard-er?
- ... so, what happens when the global NOC tries to optimize many VNEs? NP Hard-er-er-er?

Solution to the Complexity Problem

The Simple Solution is...

... Do-it-Yourself, that is, to let services self-optimize

- however....
  - it is one thing to self optimize in a **non-cooperative environment**
 - ... and quite another when **clouds offer tools/envs/platforms that help** self-optimize better

Non-Cooperative Way

Step 1: Probe your Cloud

- visualization of active probing across 8 Amazon regions 05

same DC
large bulk transfer

DC - other DC
e2e delay

05 M.Zhanikeev "Performance Management of Cloud Populations via Cloud Probing" IPSJ JIP (related to http://goo.gl/f3QpiW) (2015)
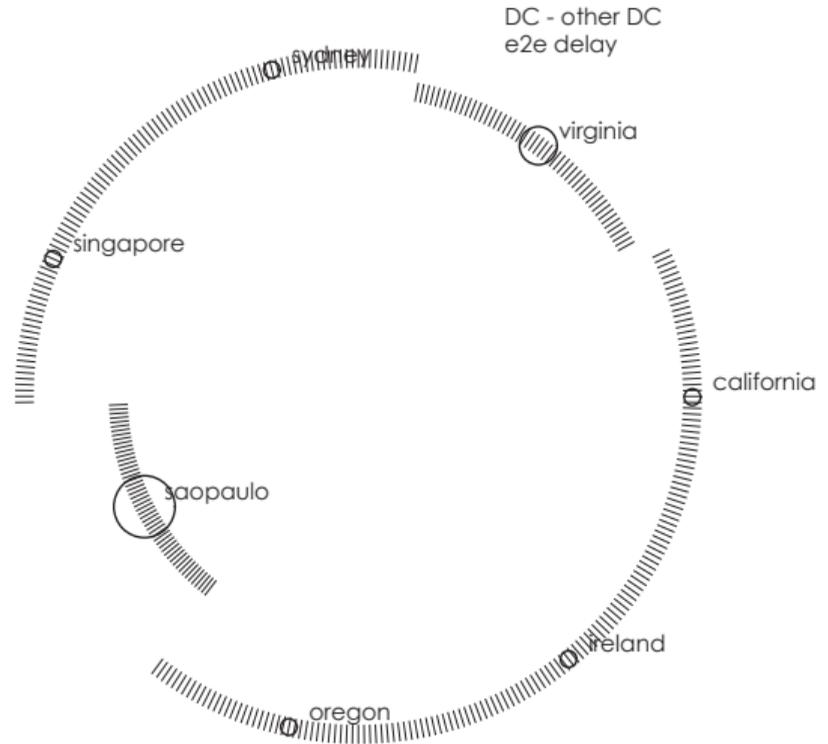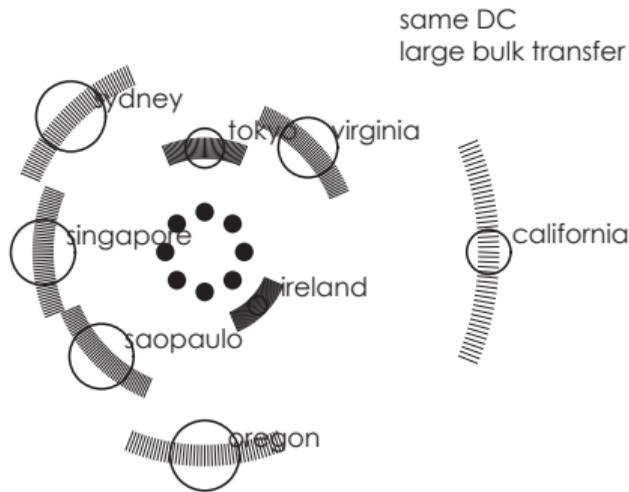
Step 2: Optimize your service network

- **change DCs** for some members of your population, **gradually optimize** 05

05 M.Zhanikeev "Performance Management of Cloud Populations via Cloud Probing" IPSJ JIP (related to http://goo.gl/f3QpiW) (2015)
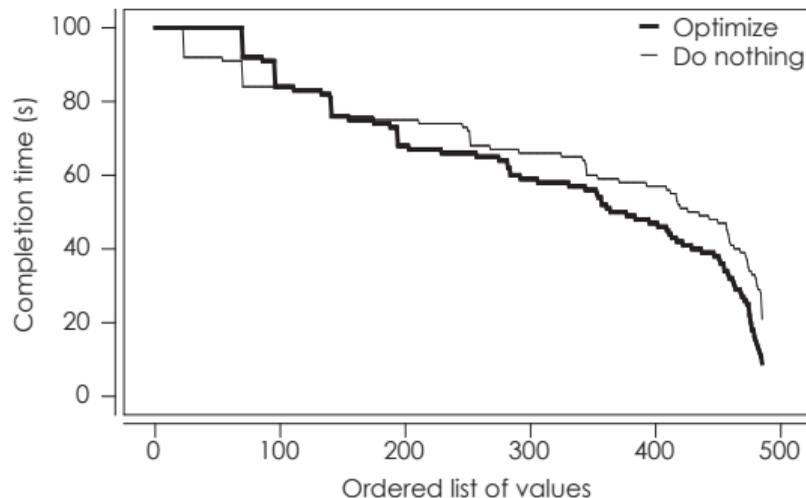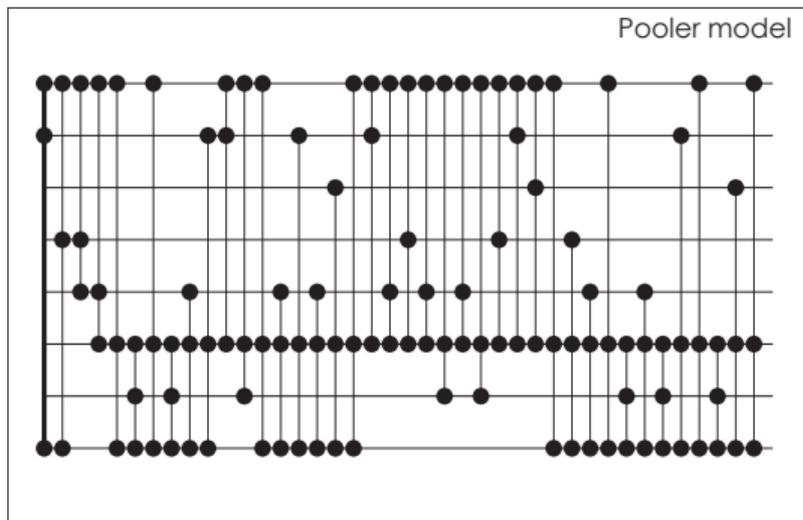
Cooperative Clouds

Traditional vs Akamai vs LHAP
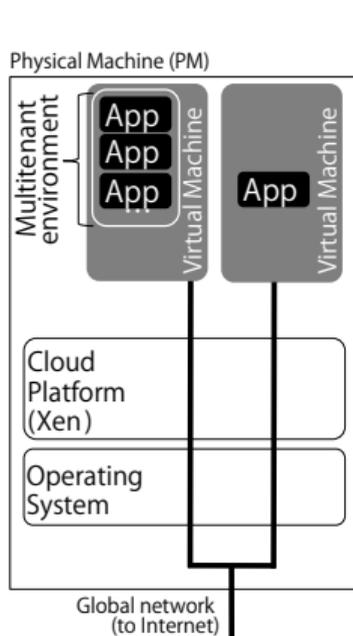
Fig1a: Conventional Platform
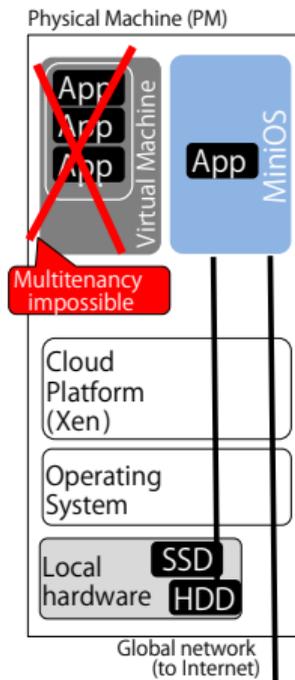
Fig1b: Mini Cache
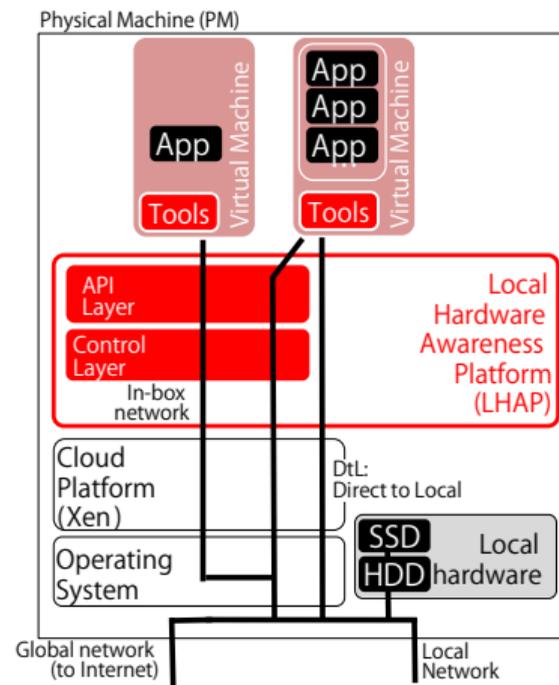
Fig1c: LHAP (proposed)

02 B.Frank+8 "Pushing CDN-ISP Collaboration to the Limit" ACM SIGCOMM Computer Communication Review (2013)

06 M.Zhanikeev "A Cloud Visitation Platform to Facilitate Cloud Federation and Fog Computing" IEEE Computer (2015)

M.Zhanikeev — maratishe@gmail.com   Population Management in Clouds is a Do-It-Yourself Technology — bit.do/***

Akamai MiniCache Technology
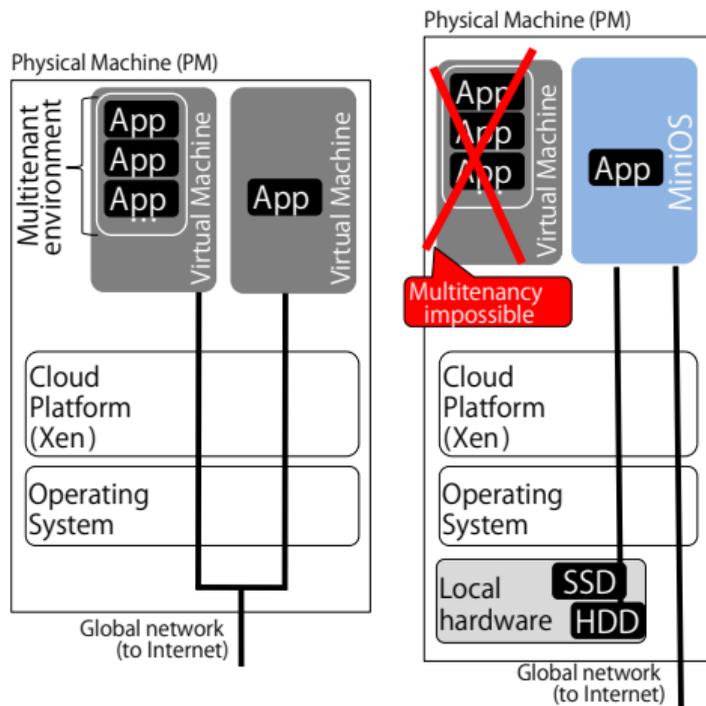
Fig1a: Conventional Platform

Fig1b: Mini Cache

- depends on MiniOS, part of Xen
- MiniCache allows MiniOS-based apps to use SSD/HDD connected to that PM
- MiniCache (storage) and ClickOS (network) are similar technologies, the letter is used for SDN
- demerits
  1. restricted to PM
 2. storage only
  3. no concurrency control or load balancing

02 B.Frank+8 "Pushing CDN–ISP Collaboration to the Limit" ACM SIGCOMM Computer Communication Review (2013)

Local Hardware Awareness (LHA)
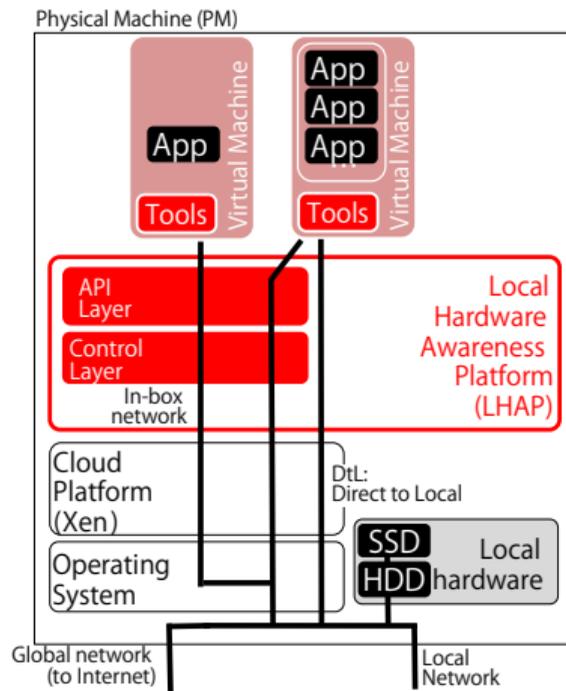
Fig1c: LHAP (proposed)

- **not restricted to resource type**, any resource
  - storage, sensors, Hadoop/MapReduce jobs, **active probing**, ...
- **not resricted to same PM**, API Layer knows the resources offered for discovery
- **Tools in VMs** (and containers) interface with LHAP
- **LHAP is optional** -- legacy VMs will not know it's there

06 M.Zhanikeev "A Cloud Visitation Platform to Facilitate Cloud Federation and Fog Computing" IEEE Computer (2015)

Example Application : CDN

CDN on Federated Clouds

Local clients

Small Cloud

Large Cloud

Small Cloud

CDN

CDN Manager
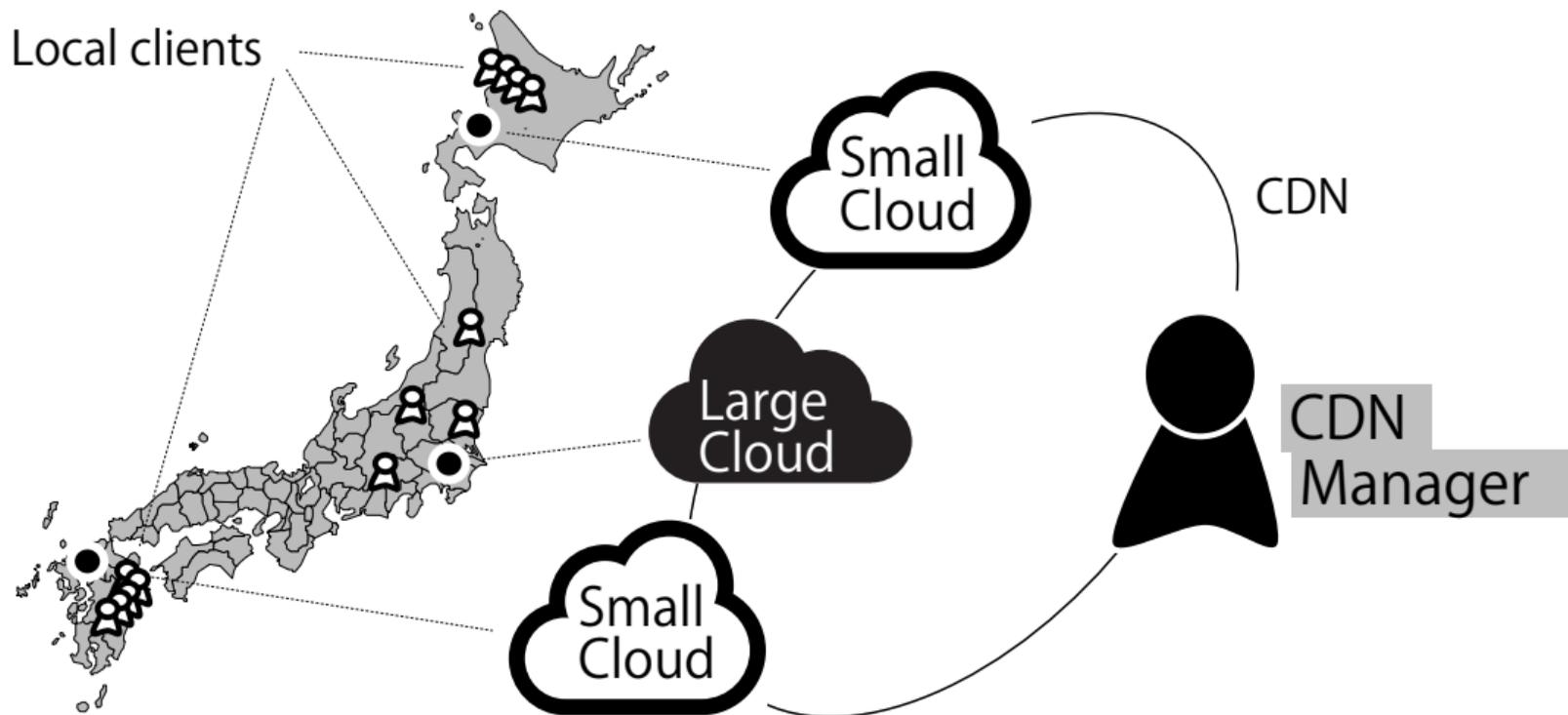
Cloud Streaming in the Wild
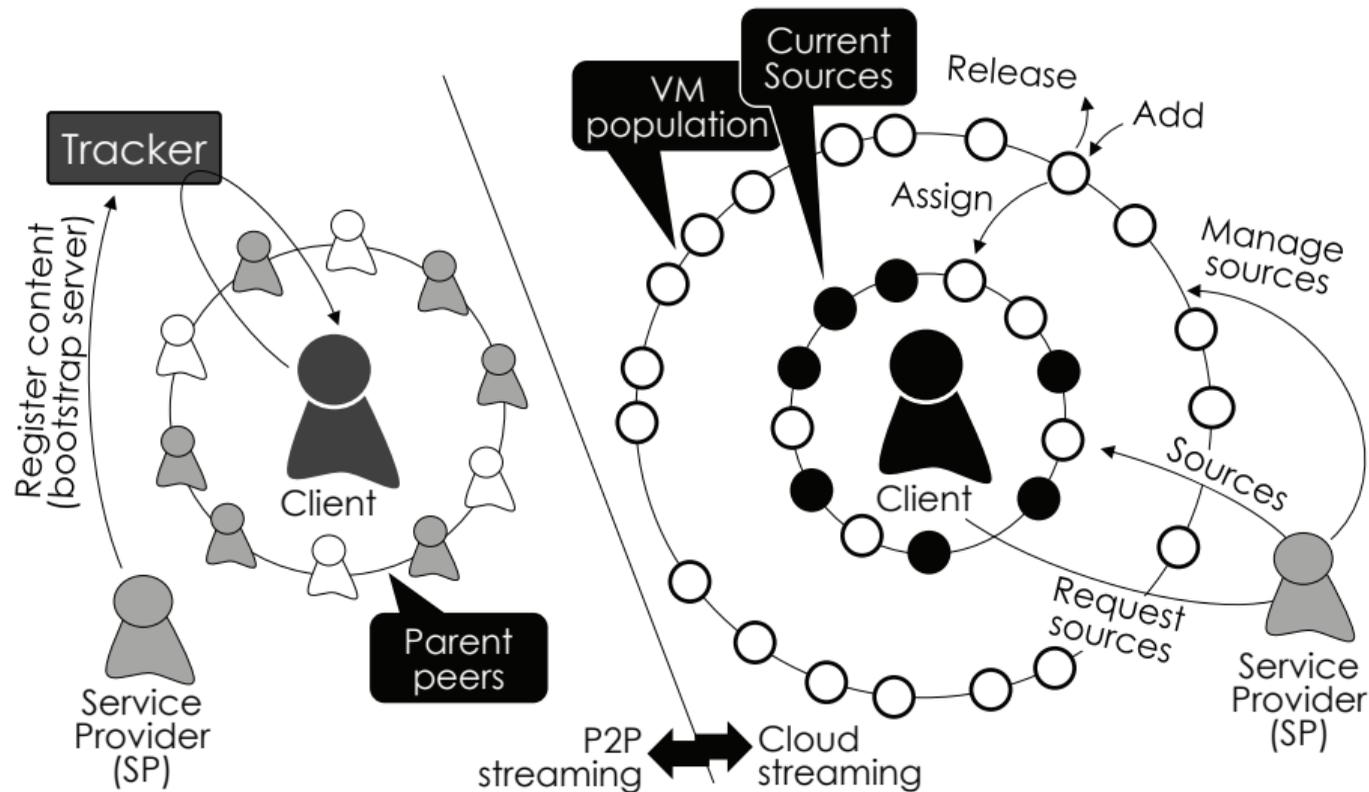
Caching options with LHAP

- (don't laugh but) **caching methods have been lost** on cloud-based CDN -- a true clean slate
- yet, LHAP makes it possible to add additional caches
- note: **Cache 1 and Cache 2 are completely different** in nature -- VMs are short-lived
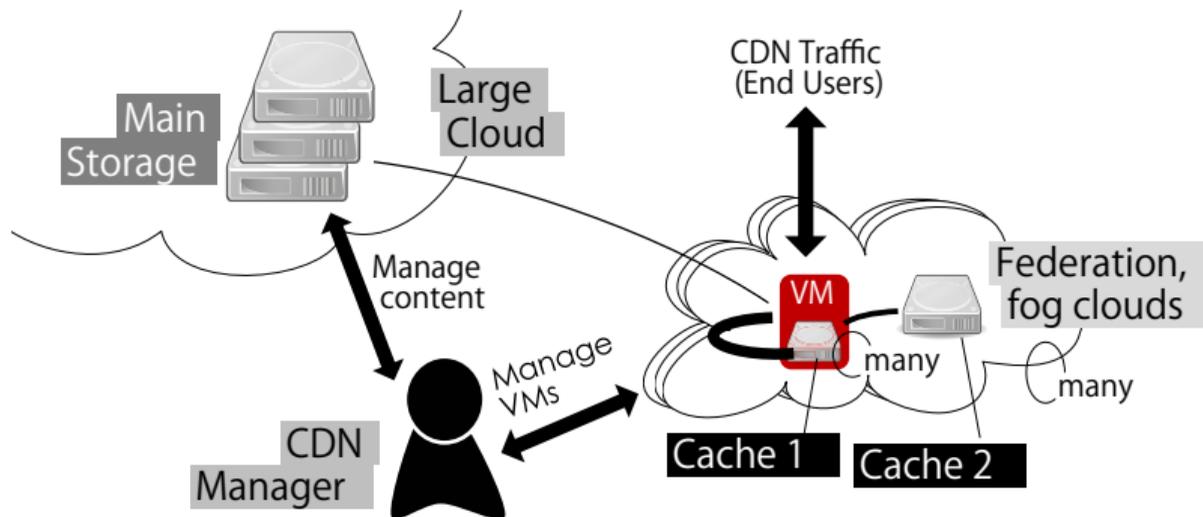
Back to Networks: Link with NGN

Key Viewpoints

1. traditional **NGN** in a recent book `08`
   - **virtualization is key** (SDN, NFV), among other reasons for supporting mobility
2. my own viewpoint is different
   - because of hotspot traffic (bulk transfer = BigData = hotspots), **e2e circuits (cut-through)** are key `09`
   - circuits are made in a distributed/social/sensing manner `10` close to the **Y.mnm** `11` story
   - as a guy who was working on a distributed network of **active probes** `12` (now cloud boxes), the **Y.mnm** story is close to mine

`08` T.Janevski "NGN Architectures, Protocols and Services" Wiley (2014)

`09` M.Zhanikeev "The Next Generation of Networks is all about Hotspot Distributions and Cut-Through Circuits" http://goo.gl/a16JtD (2015)

`10` M.Zhankeev "A City Traffic Model for Optical Circuit Switching in Data Centers" http://goo.gl/5z2V6F (2015)

`11` "Management of Performance Measurement for NGN" ITU-T Y.2173, before that Y.mnm (2008)

`12` M.Zhanikeev "A Home Gateway Box with Meter, Probe and L2 QoS Policy Edge" IEEE COMPSAC (also http://goo.gl/9graXy) (2013)

The Y.mnm Story : Active Probes
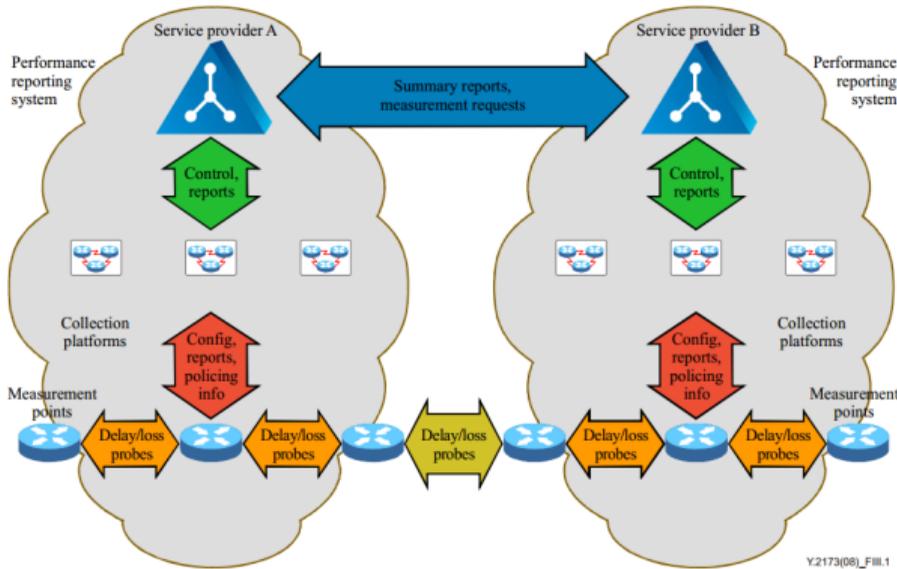
- 2 parts: active probing and distributed management 11

- between OSPF and QoS Routing, closer to the latter, but that was before VNE was defined

- active probing is its own world of research 13

- among smaller projects (smartphones, etc.) Google-backed M-Lab is the biggest

11 "Management of Performance Measurement for NGN" ITU-T Y.2173, before that Y.mnm (2008)

13 Y.Tanaka, M.Zhanikeev "Active Network Measurement: Theory, Methods, and Tools" ITU Association of Japan, ISBN 978-4916128072 (2009)

IETF Liason with Y.mnm

Wrapup

- complexity wise, VNE formulation is close to reality, but is NP Hard-er-er-er
  - effective heuristics are unlikely

- the Do-it-Yourself (DiY) Approach can resolve the complexity problem
  - non-cooperative form: networks optimize themselves (example: Cloud Probing 05)
  - assisted form: clouds/networks can implement a Local Awareness Feature (like LHAP 06) to improve self-optimization

- the Assisted DiY also leads to better coordination across competing service networks

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That's all, thank you ...