SMART 2012/0046
Study on European Internet Traffic and Analysis

Final Report, with
Conclusions and Recommendations
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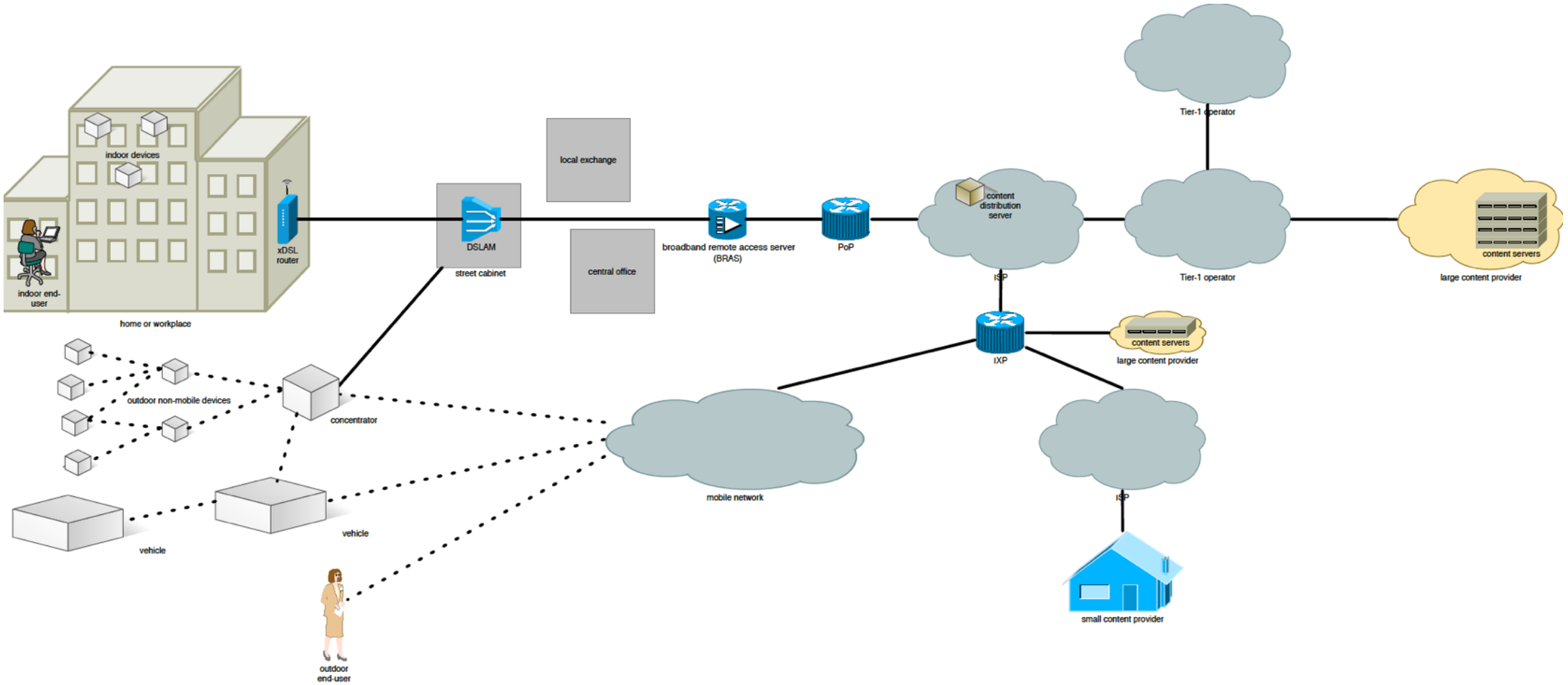
Overview

- Survey of measurement capabilities
    - Frameworks and tools are mature on wire, immature but ready for breakthrough in mobile
    - New problems introduced by network neutrality and transparency emphasis
        - Old problem of privacy remains
- 3 Use cases, and a report on standards that are
    - near ready and
    - will make a difference
- Proposal — a European infrastructure to support regulators and consumers, increase economic effectiveness in EU.

The Internet is a complicated, heterodox world



Best current and comprehensive state of the art survey:
V. Bajpai and J. Schoenwaelder, to appear in
IEEE Communications Surveys and Tutorials, 2015

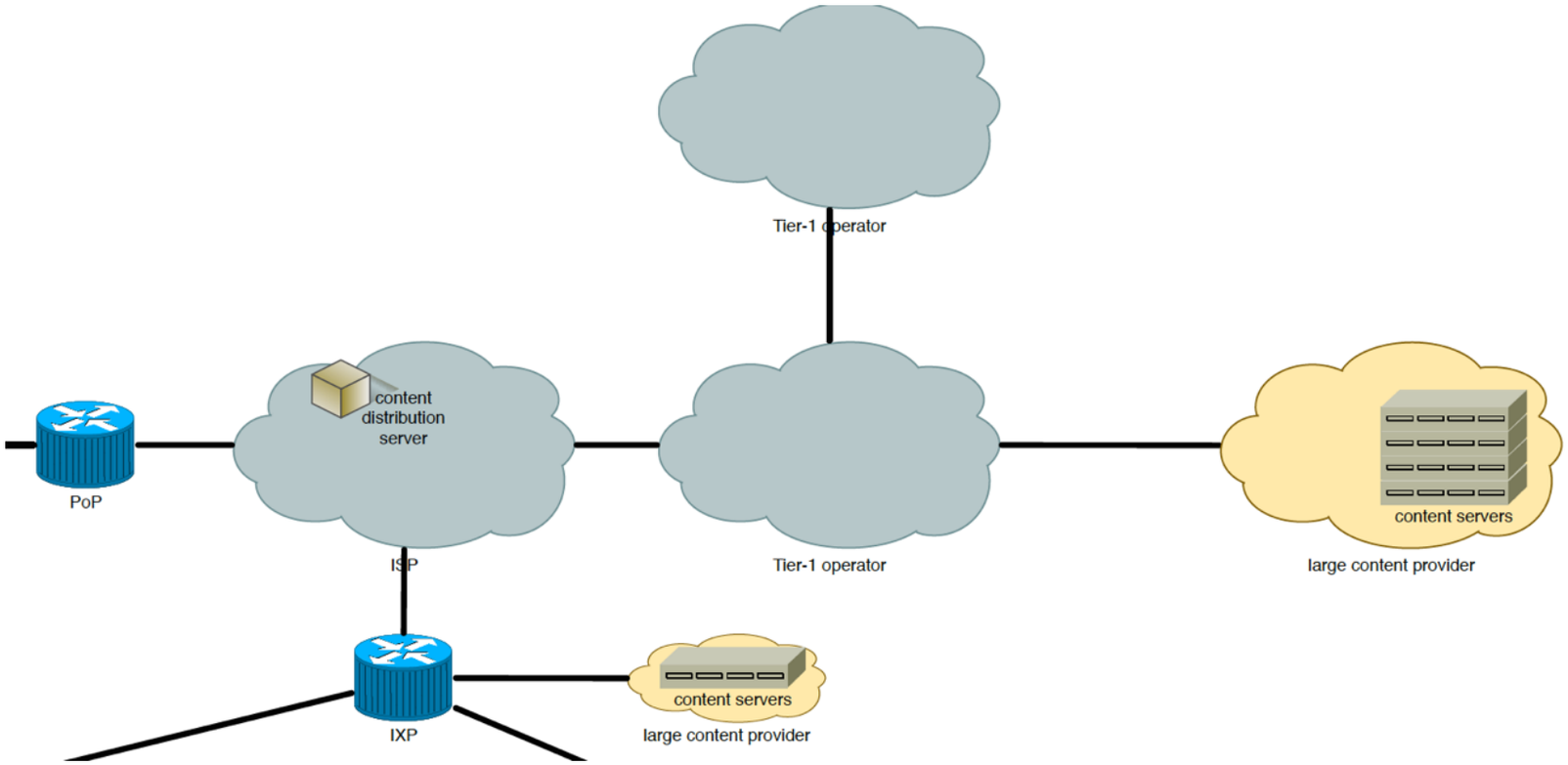
Reliable, extensive active and passive measurement tools, frameworks and archives are becoming mature

- Addressing {topology | performance}
    - Topology = basics known, details quite mysterious — a limit to scaling up performance tools
    - Performance = {fixed line access | mobile access | mainline} all active
- Fixed Line access: SamKnows, Bismark, RIPE Atlas (Hdw) and Dimes, Dasu, Speedtest, Glasnost (SW) are mature,
    - Active measurement, supported by mature frameworks
- Mobile access: immature, but not new. Questions of scale, what to test, framework remain open
    - Netradar, Portolan, Speedtest limited in scope, not aggregated or comparable
    - MONROE certifiable, but just starting
    - WeFi first example of 1M+ deployed observers, but still limited in types of measurement
- Mainline operational management: PerfSONAR (limited in scope)
- Passive mainline measurements face problems:
    - Heterogeneity even within a single carrier.
    - high performance, data volumes and need to communicate across domains
    - **Use Case 1**

History of active measurements for topology

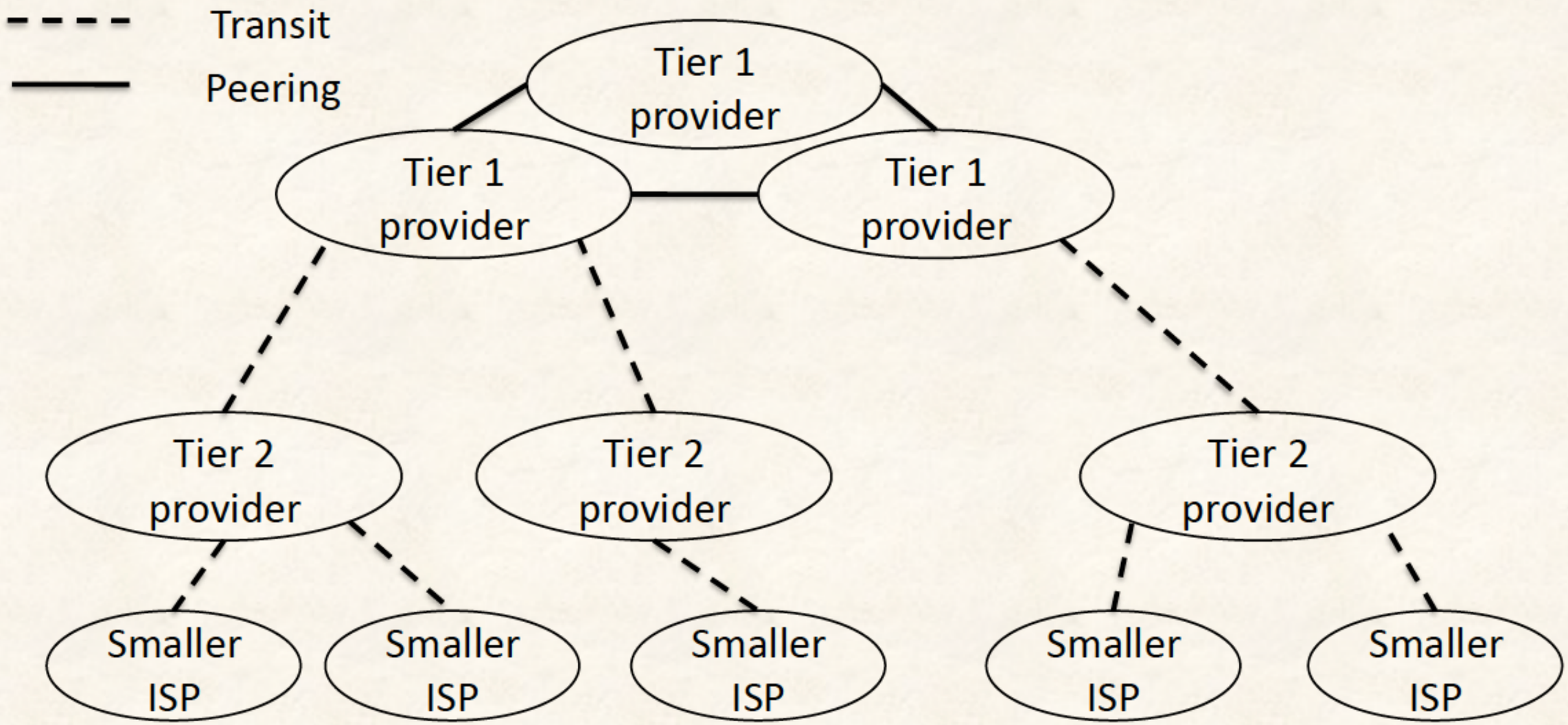
- Issues are correctness, scale and need to build archives to aggregate enough information for analysis, the big picture and longitudinal characterization.
- Long struggle to “verify and validate” such results
- Topology, performance are not separate questions
  - Performance obstacles come at all interconnections
- Now, what do you see?

Tier-1, Large and Small TSPs,IXPs,CDNs…



Traditional hierarchical picture breaking down
Internet “flattening” requires sharing, heterogeneous monitoring

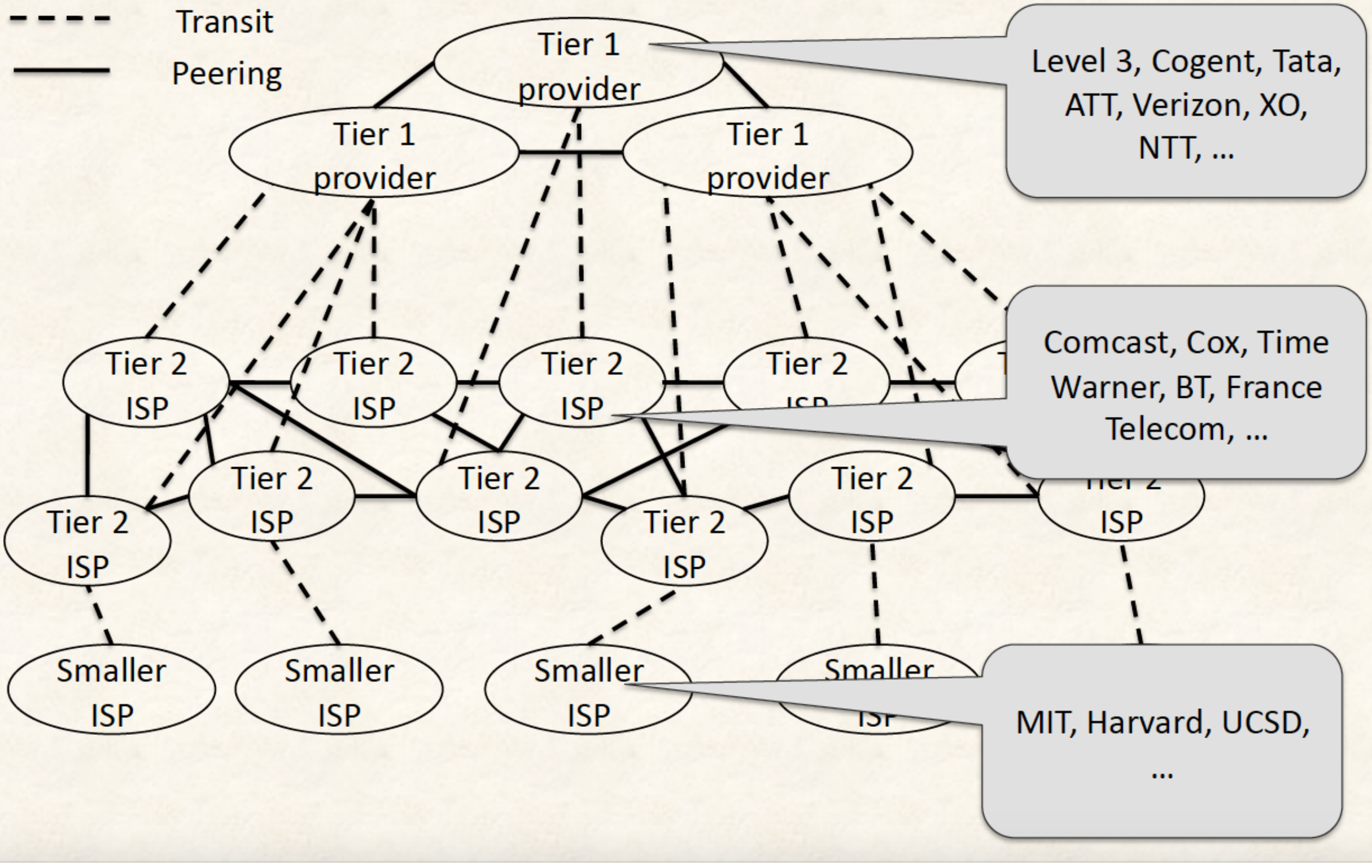
“Old” concept of interconnection



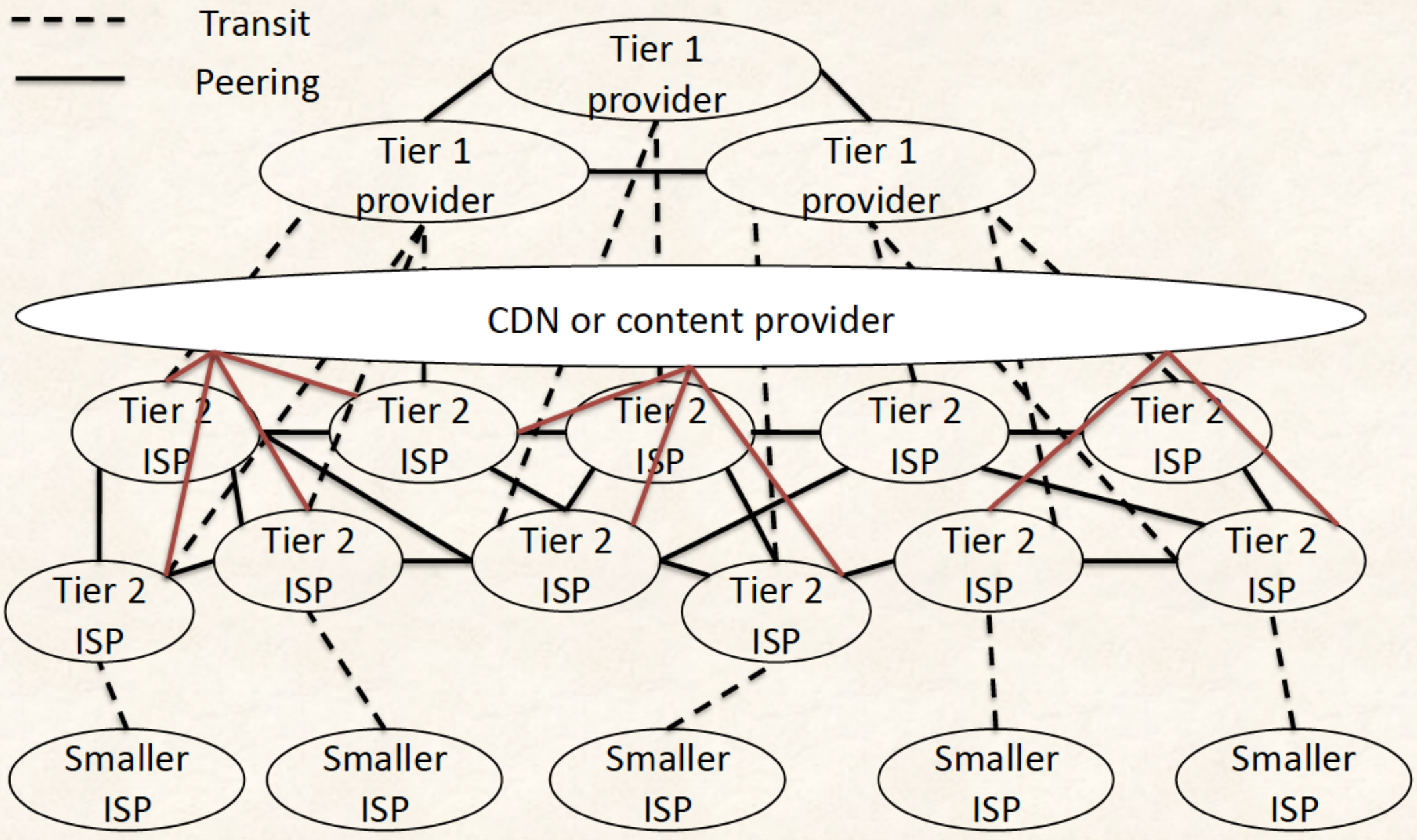
Dashed lines are customer-provider links

These cost $$$$

More realistic picture



Interconnection of CDN



Transparency:
Seeing into the net
End-to-end problem resolution?

- AKAMAI, and other widely dispersed CDNs, see what they need, but the information is proprietary

- PerfSONAR is public, several 100 core nodes with active and passive measurement tools, but confined to the scientific data pathways

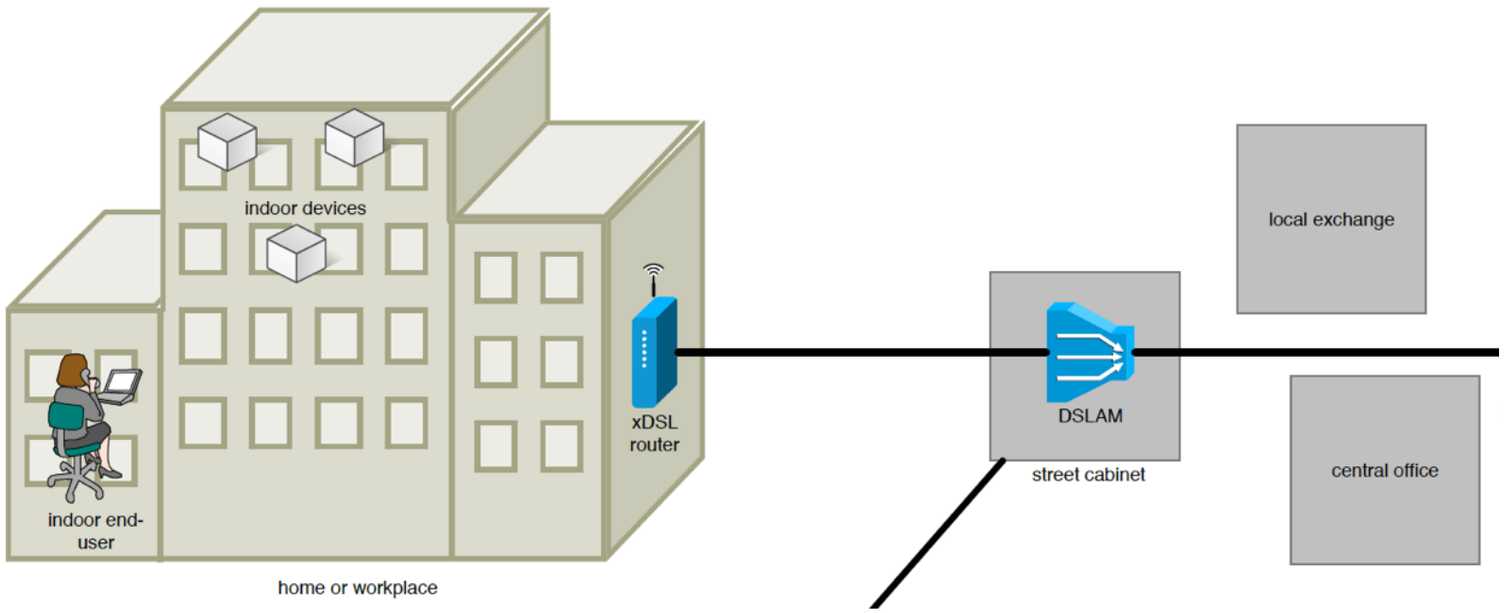
- Seeing where problems at interconnections occur requires “telescopes”

  - CAIDA/RIPE approach gives topology, and near-far RTT comparisons to carefully selected AS-AS links

  - MLab profiling cross-checks throughput between carefully selected pairs of ISPs and TSPs, one layer from the end-user

  - mPlane and passive measurements with good timing locate CDN caches precisely, and shed light on performance sensitivity to anycast content location changes

Home, Office and Small Business



User-initiated performance monitors

Edge and always-on monitors

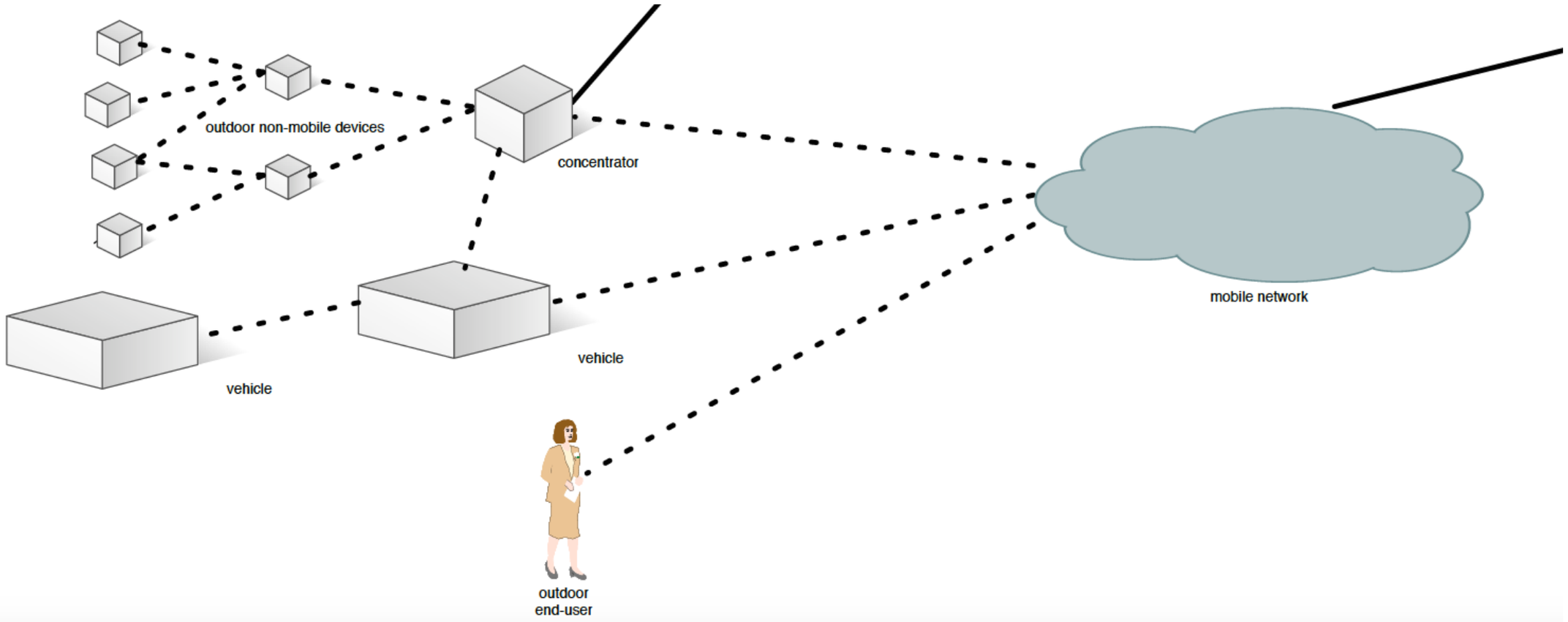
Network Neutrality and Transparency

- In Barcelona workshop, we asked chief technical officers of FCC and BEREC to compare notes
    - Clear principles in the US, little experience
        - No blocking, throttling or “paid prioritization”
            - Europe has net neutrality regulation in three countries, but allows “special services” that are distinct from public internet access. Blocking is not uncommon.
        - “Reasonable network management” requires more case law
- Network management can have powerful impact on consumers
- Transparency and public awareness are key assets to regulators and consumers.
    - Examples provided from US, Europe and Asia

Monitoring from the home and office

- Issues in where to measure from, to reduce contention
- Issues in how to measure —
  - user-initiated or background
  - software in the home network, or firmware at the edge
- Solutions now fairly widely deployed (10-100K units worldwide) and easier to keep active than in the past
- Public awareness and feedback is positive
- But still seen only as keeping the access ISPs honest and competing
- Much more can be done: **Use Case 2**

Wireless: Mobile and IoT



Wireless monitors are extensive, ubiquitous
— they are every cellphone

IoT growing fast, but in separate “silos,”
measuring mostly power consumption

Mobile networking studies

- Mobile defines the greatest population of end-users
- Extensive use for human mobility and social impact studies
    - 50 M customers in Mexico for human mobility, economic impact studies
- SamKnows now deployed “altruistically” in the US,
- WeFi deployed “cooperatively” in EU, US to millions
    - Few per cent adoption in US, ~.01% in EU, simply because startups like WeFi deploy where the $ are.
    - Potential to see paths to all present and popular web services with highly distributed workload.
    - Exploring the coverage, functional resolution, and sensitivity of mobile: **Use Case 3**

Standards Efforts

- Vendor-specific tools have evolved incompatibly
  - Have not addressed end-to-end information sharing, debugging
  - Several parallel efforts in progress to alleviate
    - IETF, ITU
- Regulators need QOS, QOE, KPI quantifications of characteristics that end-users will care about
- Layer 2 and emerging networks (IoT) not addressed
- **Status report on key measurement standards**

Recommendations

- Interoperability, standards required for end-to-end transparency
- Certification of measurements for regulators, SLAs to become effective
- It is a BigData opportunity, so privacy issues need to be dealt with early
- Observers should be everywhere
    - Automation, scheduling, archiving and analysis
        - Follow the frameworks established by LEONE and previous work
    - Maximize observability into interior of the internet across all paths that end-users care about.
- This needs to be placed on an operational basis. Takes 2-4 years to establish presence. Although in some areas further research will be required, the framework is ready to use results now.

That's all fine, but how do we do this?

- Resources and skills needed:
    - Broadband and mobile certifiable observation points — SamKnows, RIPE, and MONROE
    - Collection, archiving and analysis framework — MLab, LEONE
    - Large scale observation from mobiles (later?) — build on WeFi, once wider EU presence is obtained
    - Decoding normal and anomalous routing in IP-space — RIPE, CAIDA, UPMC (Paris Traceroute team), DIMES, LEONE follow-on
    - Communicate results for public impact, work more quietly with BEREC
- There are teams in place with those skills and interests. Do their visions mesh with our proposal? How would they staff for this?
- If we agree, how to proceed to a plan? Is there a path to fund it through tender?
- Then lunch! and we'll start to listen hard.