SatelliteLab: Adding Heterogeneity to Planetary-Scale Testbeds

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1. Overview
- Internet testbeds are indispensable for evaluating distributed systems
  - They enable researchers to test prototypes in realistic Internet conditions
- But current testbeds, such as PlanetLab, lack heterogeneity
  - Most PlanetLab nodes are in well connected academic networks
  - Few nodes are in diverse edge networks like cable, DSL, or wireless
- It is challenging to include Internet edge nodes in testbeds
  1. Constrained by limited resources, edge nodes cannot run arbitrary experimental code
  2. Edge nodes cannot reach one another directly as they are often behind NATs
- SatelliteLab enables heterogeneous edge nodes to join existing testbeds as satellites – a new class of lightweight testbed nodes

2. How SatelliteLab works
- Two key ideas behind SatelliteLab’s design
  1. Execute code on nearest planets, but route traffic via satellites
  2. Detour communication between satellites via nearest planets

3. Evaluation
Does SatelliteLab help add heterogeneity?
- We extended PlanetLab with 32 diverse edge nodes
  - Composed of desktops, laptops, and handhelds
  - They connect using cable, DSL, Wi-Fi, and cellular networks
  - They are distributed across 4 countries in Europe, 10 states in the United States, and Canada
- We significantly increased PlanetLab’s path diversity

How well does our design work?
- A SatelliteLab path has similar characteristics as the direct path
- The paths share the access links of the edge nodes, which are often their bottlenecks
- The bottlenecks determine path capacity, jitter, and loss rate
- It is easy to find PlanetLab nodes close to edge nodes
  - Thus, additional delay from the SatelliteLab detour is minimal

4. Applications
- It is useful to test distributed systems in the heterogeneous network environments provided by SatelliteLab
  - Distributed systems can behave differently in different environments. The resulting insights can lead to more robust designs
- Overlay multicast experiments yield very different results when run in local cluster, PlanetLab, and SatelliteLab environments