



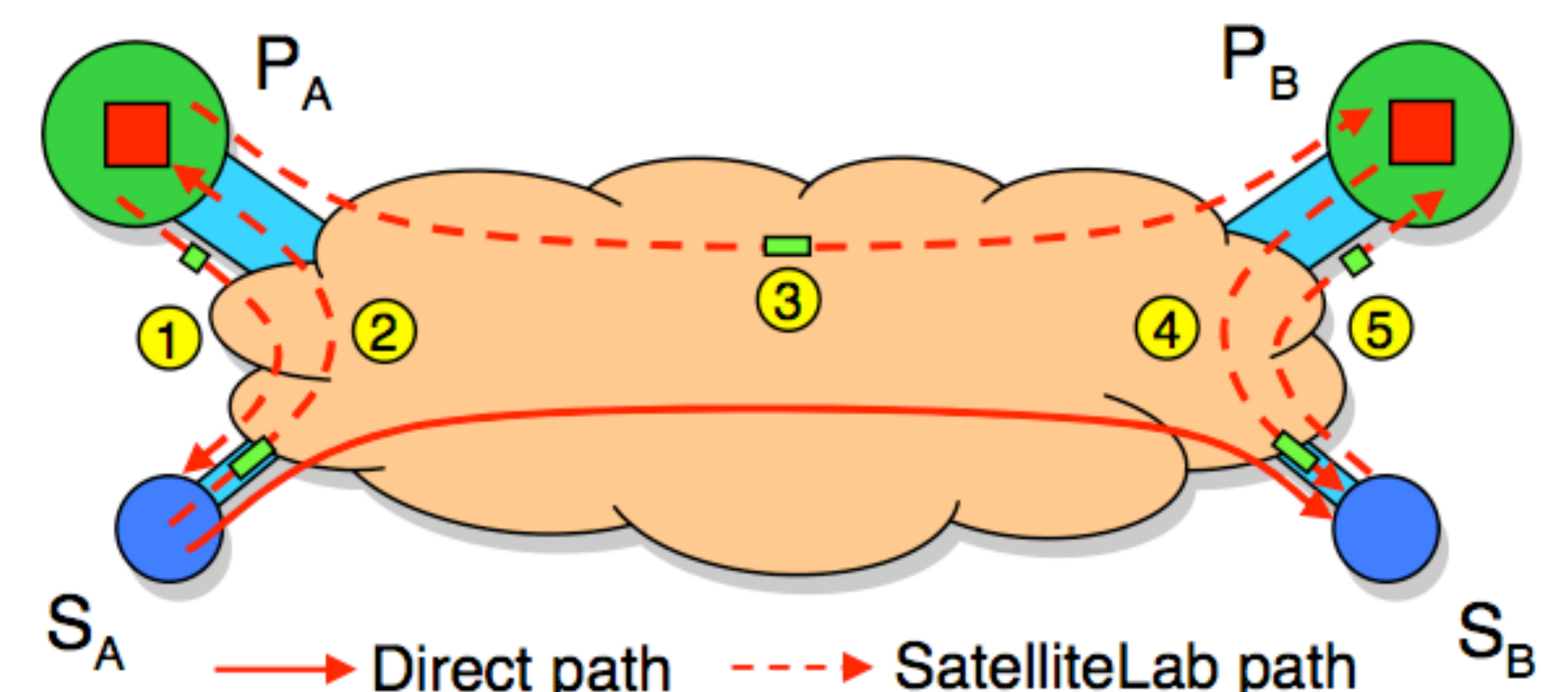
# SatelliteLab: Adding Heterogeneity to Planetary-Scale Testbeds

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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
  - Constrained by limited resources, edge nodes cannot run arbitrary experimental code
  - 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



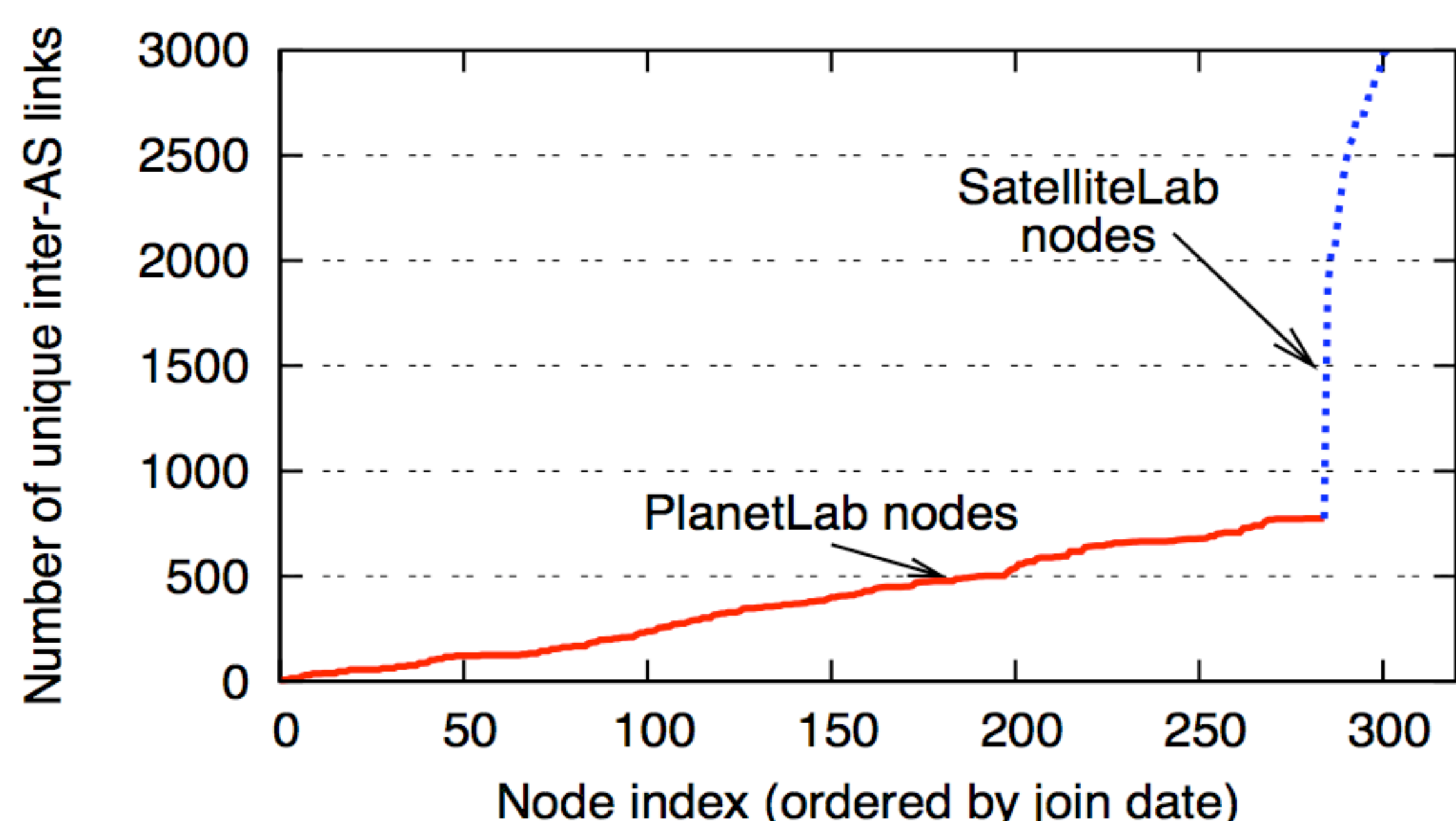
$S_A, S_B$ : Satellites – a new class of lightweight testbed nodes  
 $P_A, P_B$ : Planets – classical well provisioned testbed nodes

- Two key ideas behind SatelliteLab's design
  - Execute code on nearest planets, but route traffic via satellites
  - Detour communication between satellites via nearest planets

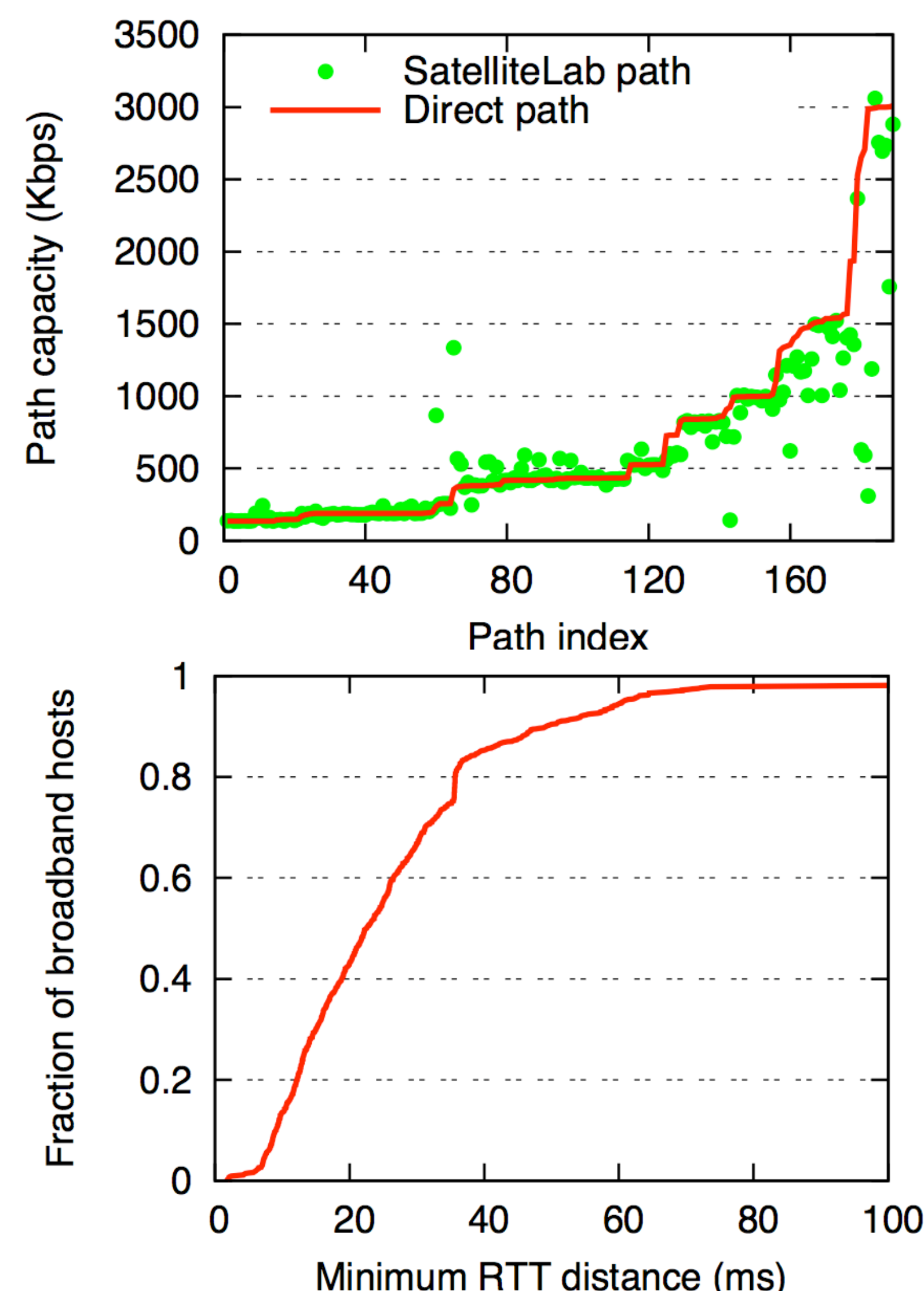
## 3. Evaluation

### 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



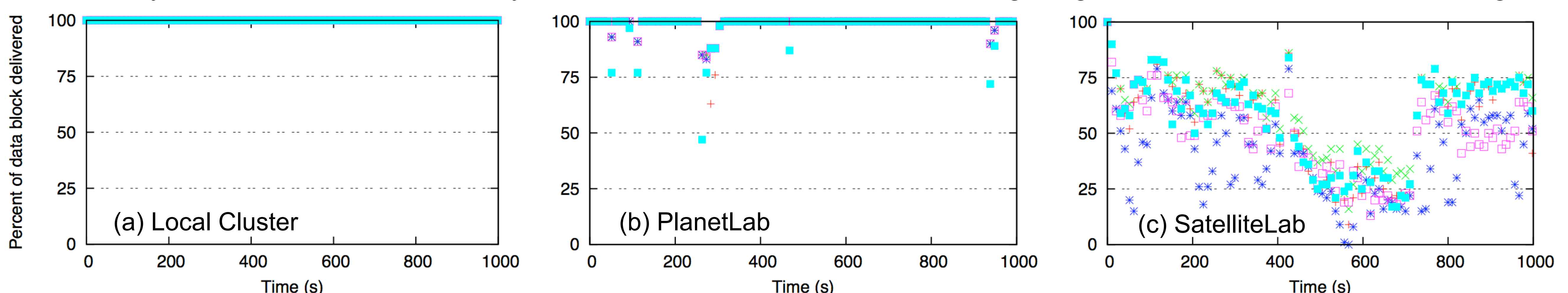
### How well does our design work?



- 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