Problem space matrix based on the guideline*

	Crossing IPv4 Island	IPv6-Only Core Network
Stateful	RFC5571 (L2TP) ✓	DS-Lite (draft) ✓
Stateless	RFC5969 (6rd) ✓	**Our target** 4rd (to be STD) (draft-despres-intarea-4rd)

***: RFC6180: Guidelines for Using IPv6 Transition Mechanisms during IPv6 Deployment**

Trade-off between stateful and stateless in IPv6-only core network scenario

	Stateful	Stateless
Address sharing efficiency	✓	
Port resource flexibility	✓	
NAT Logging		✓
Routing optimization		✓
GW redundancy		✓
GW load-sharing		✓

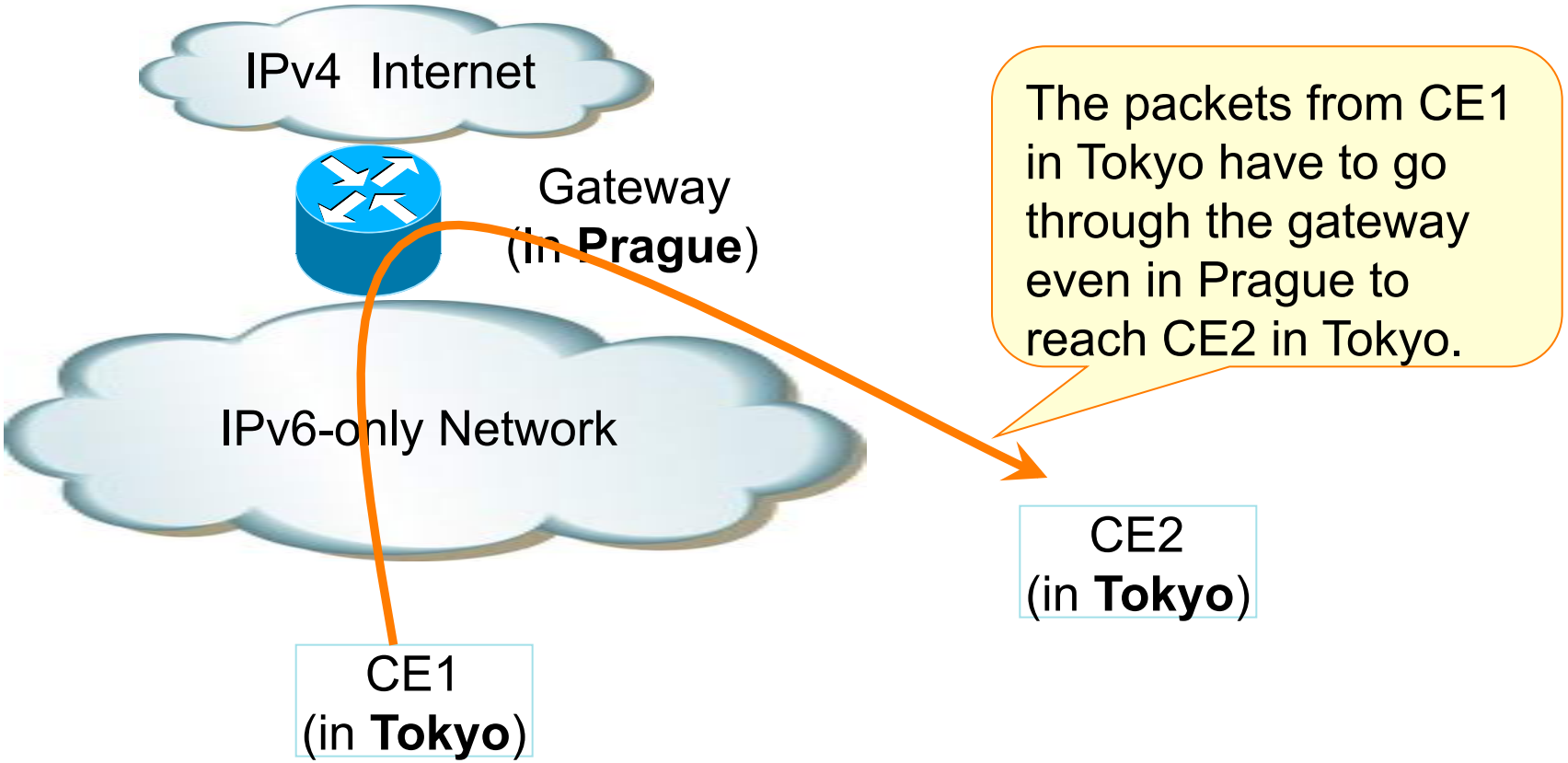
NAT Logging Considerations

Using fixed NAT rules and IPv4 users can be directly identified by means of their IPv6 address.

Solutions	Characteristics	Operation
Stateful	Users identified by a dynamic address and port “NAT Log”	Logging for every dynamic NAT mapping is needed
Stateless	Users identified by pre-assigned static address and port-range	No need of NAT logging

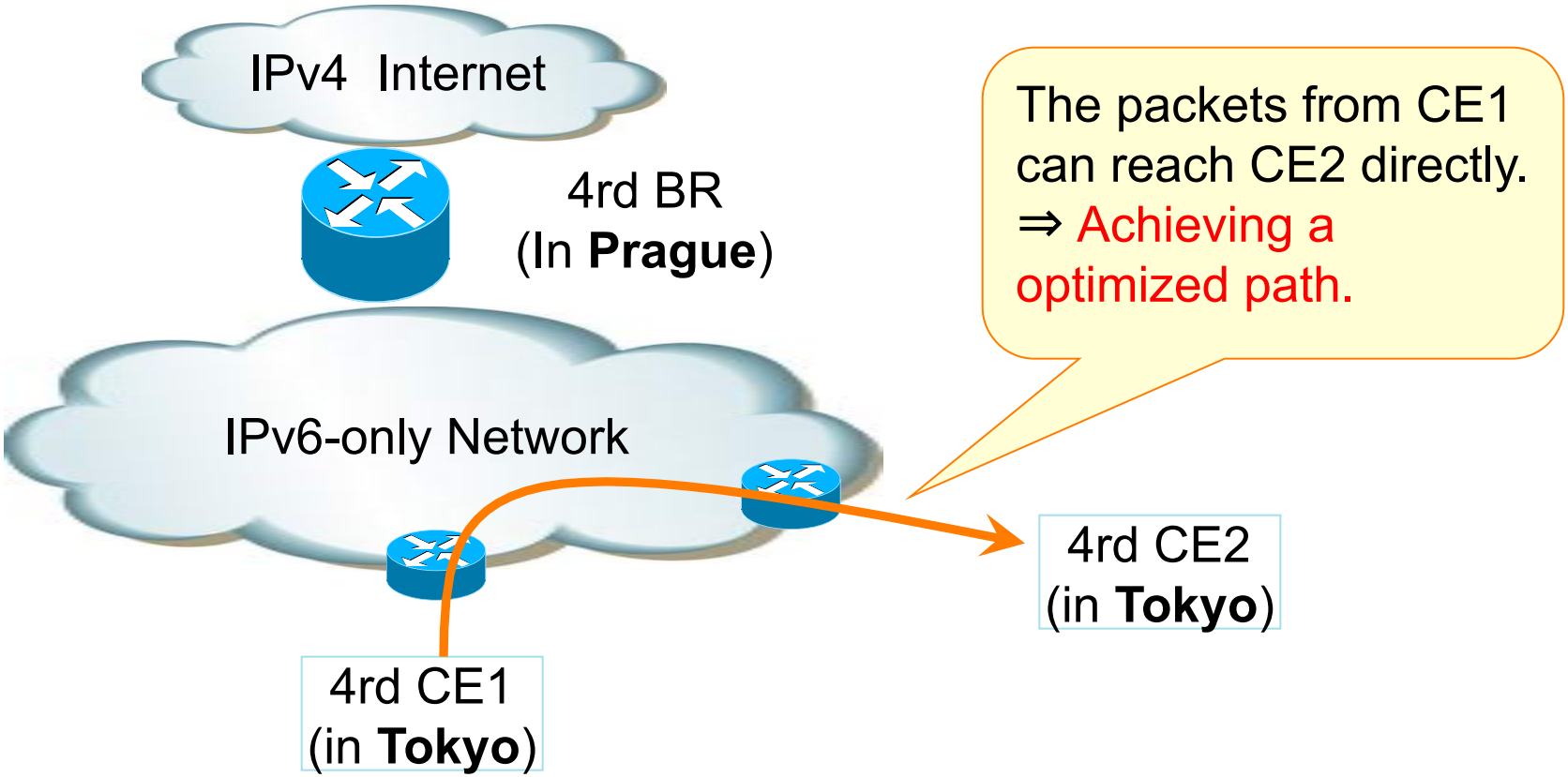
Routing Optimization: Stateful

Hub & Spoke topology is the only choice: ISPs can use stateful solution when it's not necessary to care about the network latency.

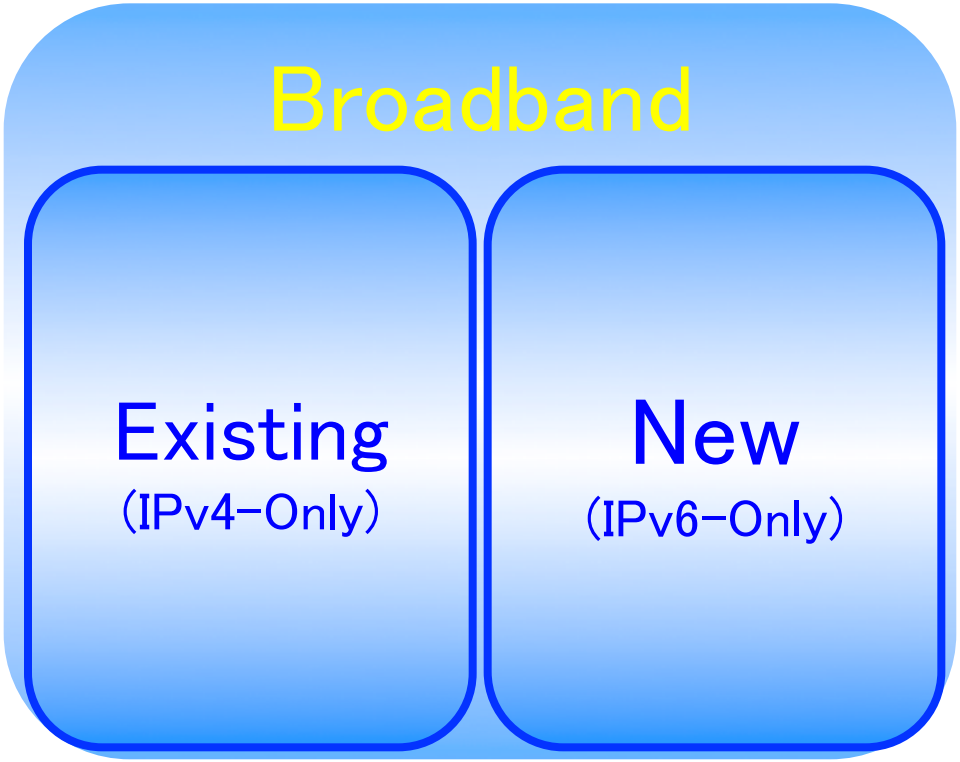


Routing Optimization : Stateless

Mesh connectivity solution can be achieved on the optimized path when the communication occurs between CE1 and CE2.



Our strategy of v4 to v6 transition



6-over-4 (2010-)

4-over-6 (2011-)

Consideration experiences: Business planning point of view

We had to minimize transition cost, but maximize allocation of network upgrading resources. So we did following comparison.

Q: Total CAPEX and OPEX of a transition system

T: Total number of serving customers in a transition system

$$S = Q / T$$

Comparing S value between all of solutions and products

We consequently always observed following:

$$S(A) < S(B)$$

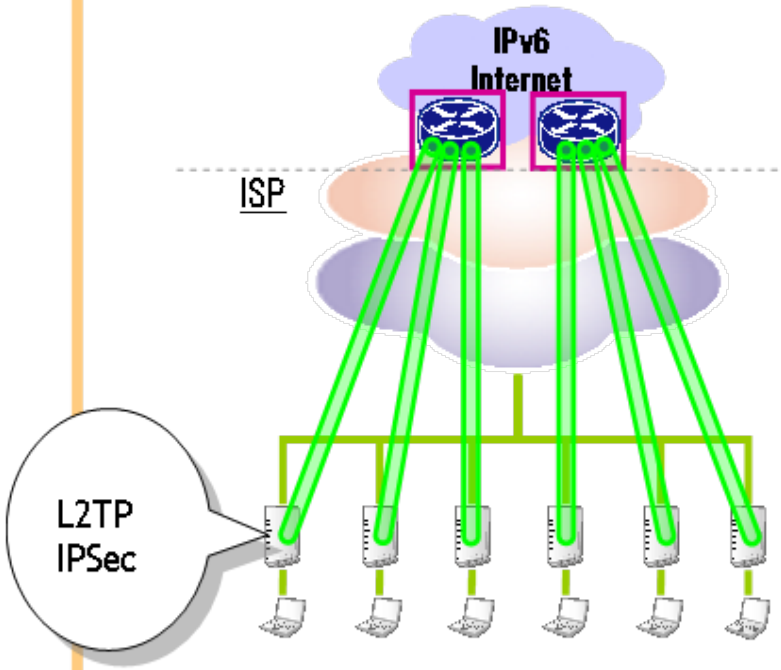
S(A): the S value of "Stateless" solution <- 6rd

S(B): the S value of "Stateful" solution

So, 6rd is our choice for v6-over-v4 case

Other Solutions

Each customer needs tunnel state/config

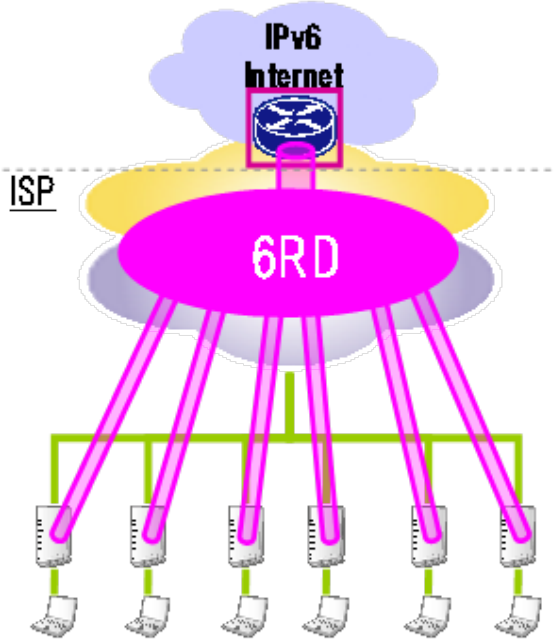


# of user linearly increases cost

CAPEX/ OPEX	Expensive!

6RD

Single tunnel aggregates all customers



Eliminate cost increase with # of user

CAPEX/ OPEX	Cost-Effective!

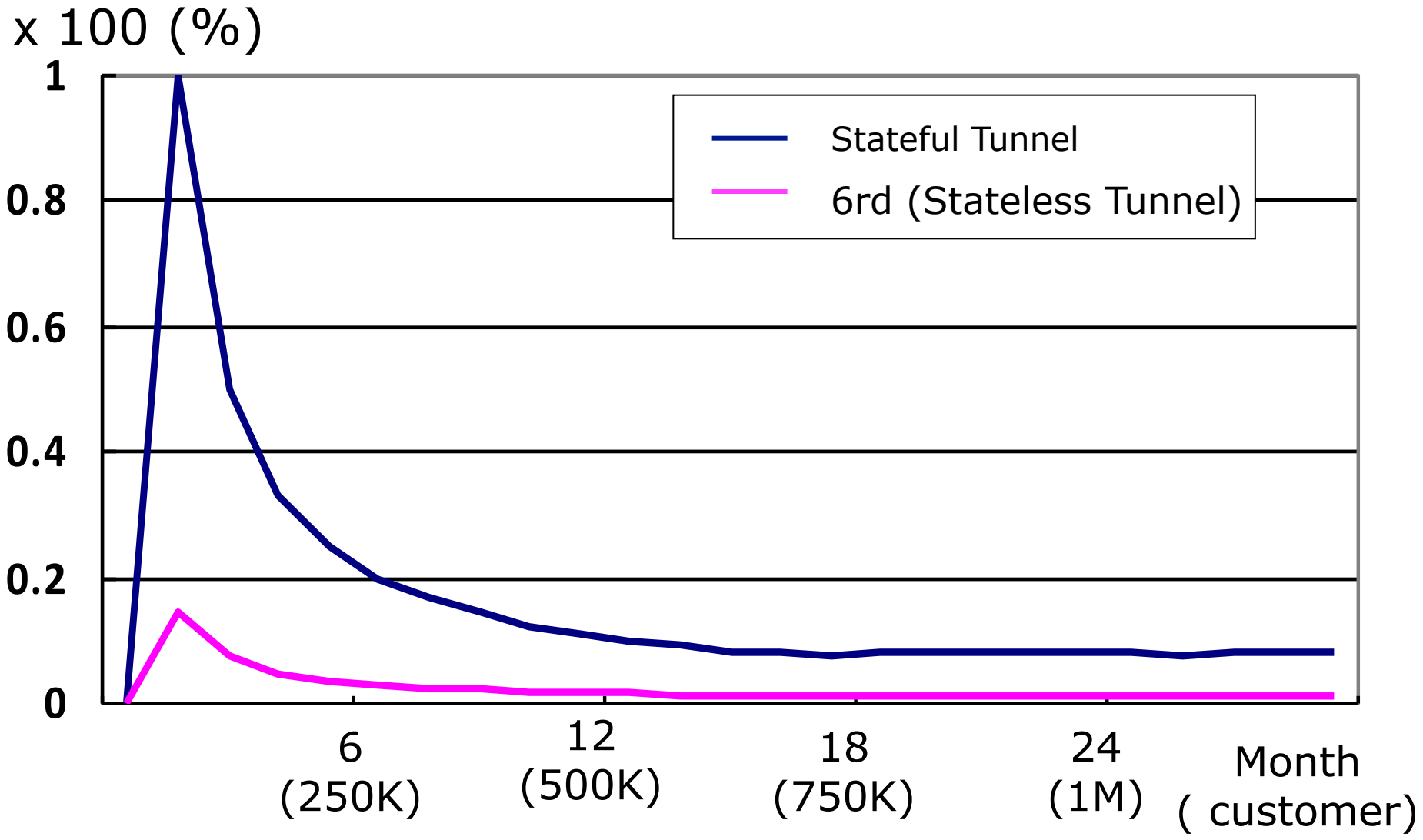
Conclusion

- Architecture dominates business plan
  - Need to reduce transition cost as much as possible
- Our case:
  - A stateless solution with optimized routing (4rd) should be helpful for our IPv4 to IPv6 transition
  - There are known disadvantages of stateless solutions, but we believe they can be mitigated
- Issue:
  - Need to develop a standard for stateless v4-over-v6 with v4 address sharing mechanism

Question & Discussion?

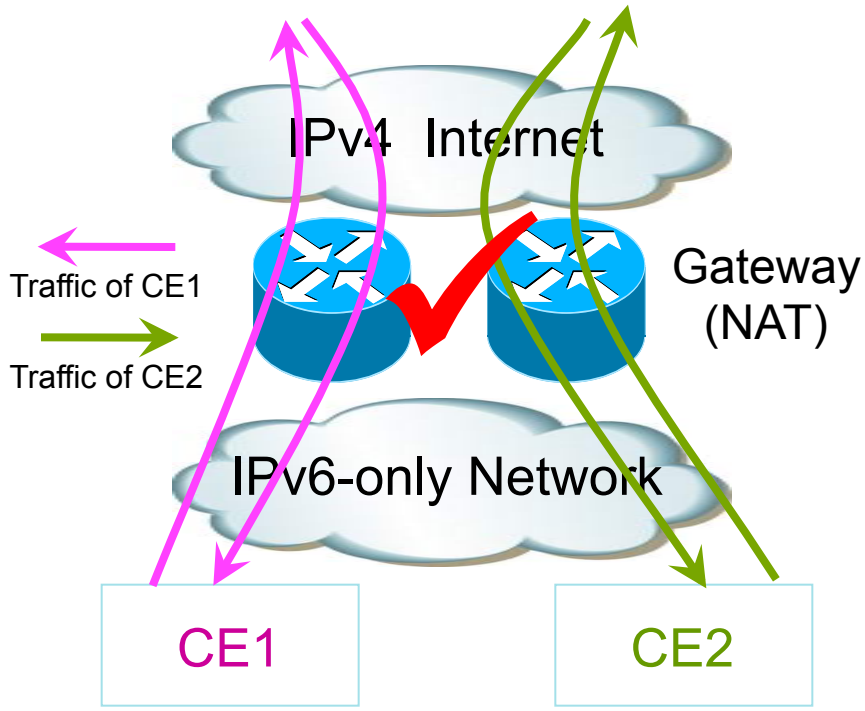
Backup Slides

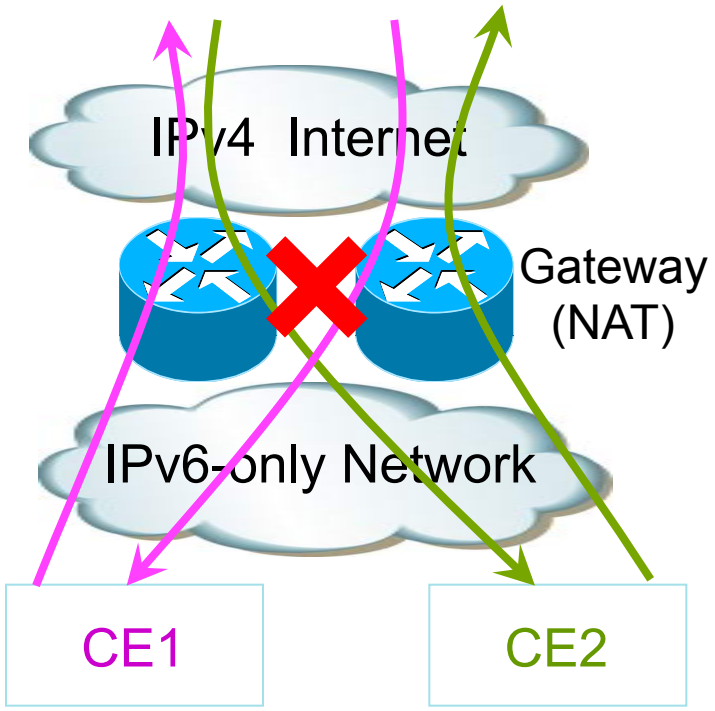
Comparison of total expense per customer transition



GW load-sharing: Statefull

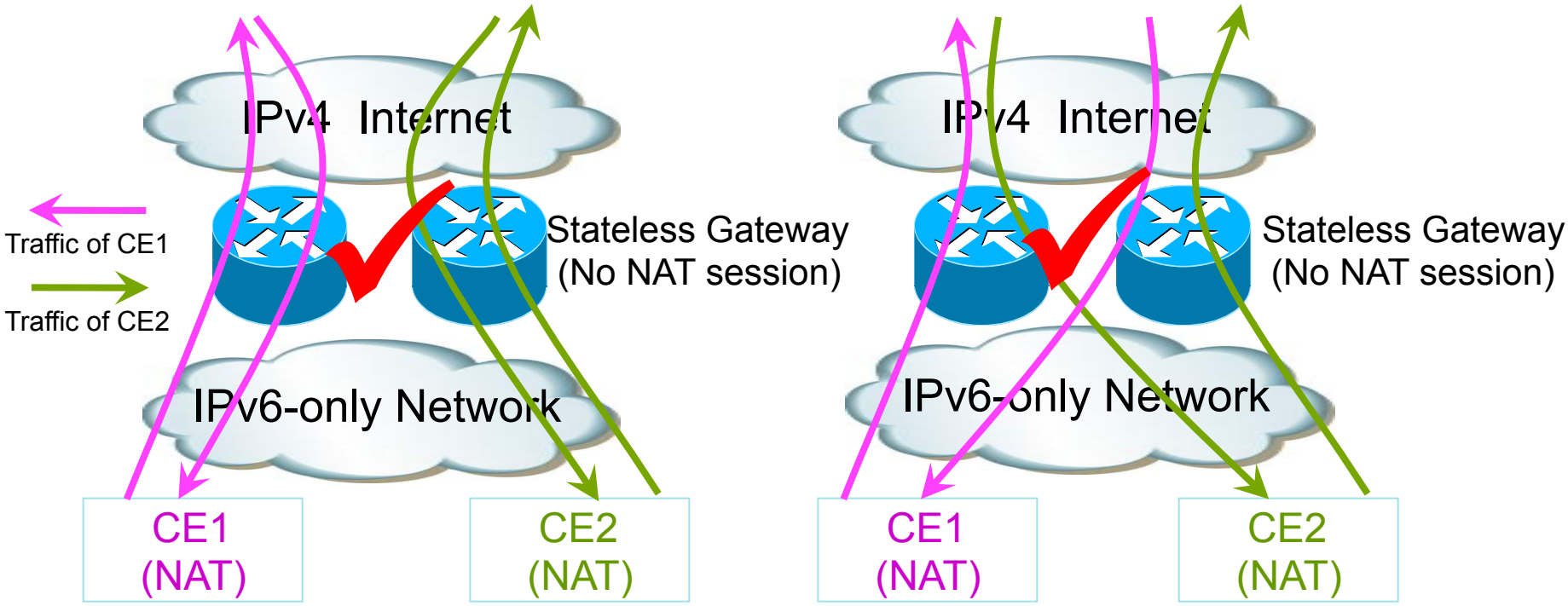
The upstream and downstream traffics for the same user must go through the **same** gateway. Asymmetrical load-sharing is difficult.





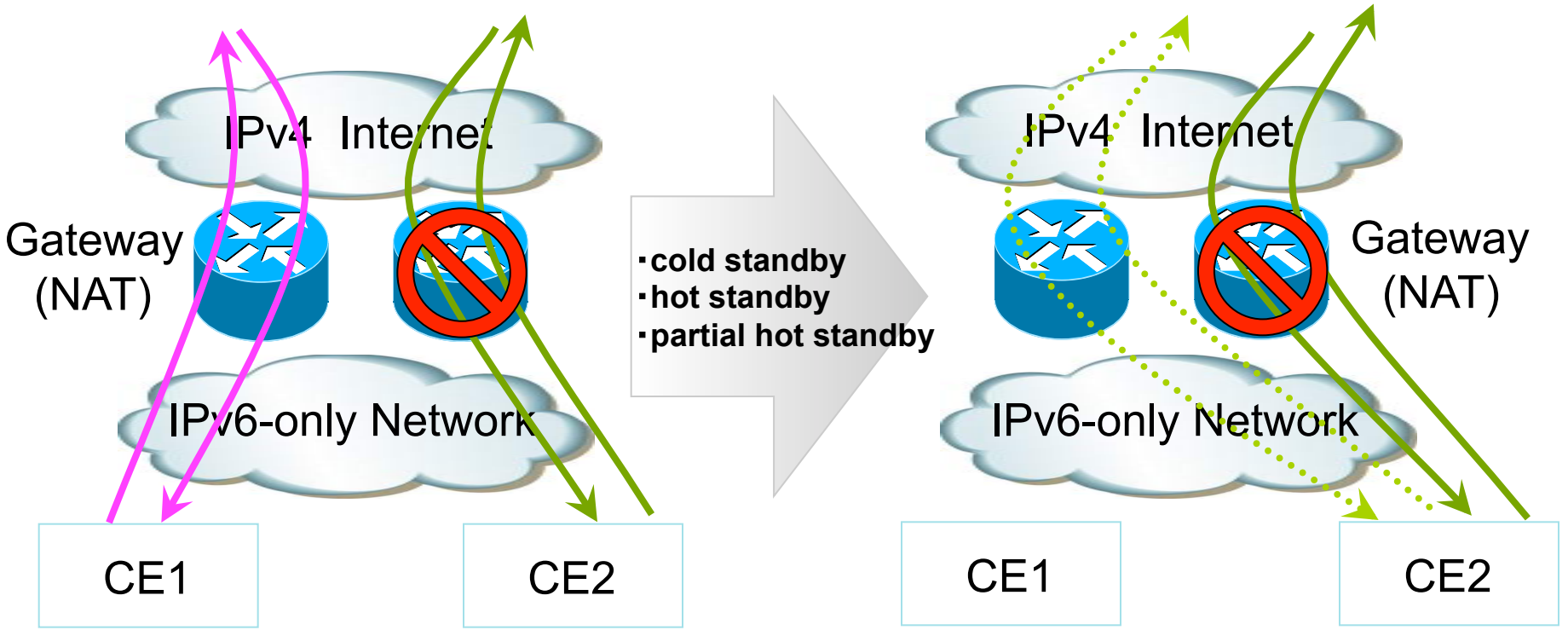
GW load-sharing: Stateless

The upstream and downstream traffics for the same user can go through the **different** gateway. ECMP and anycast can work for load-sharing



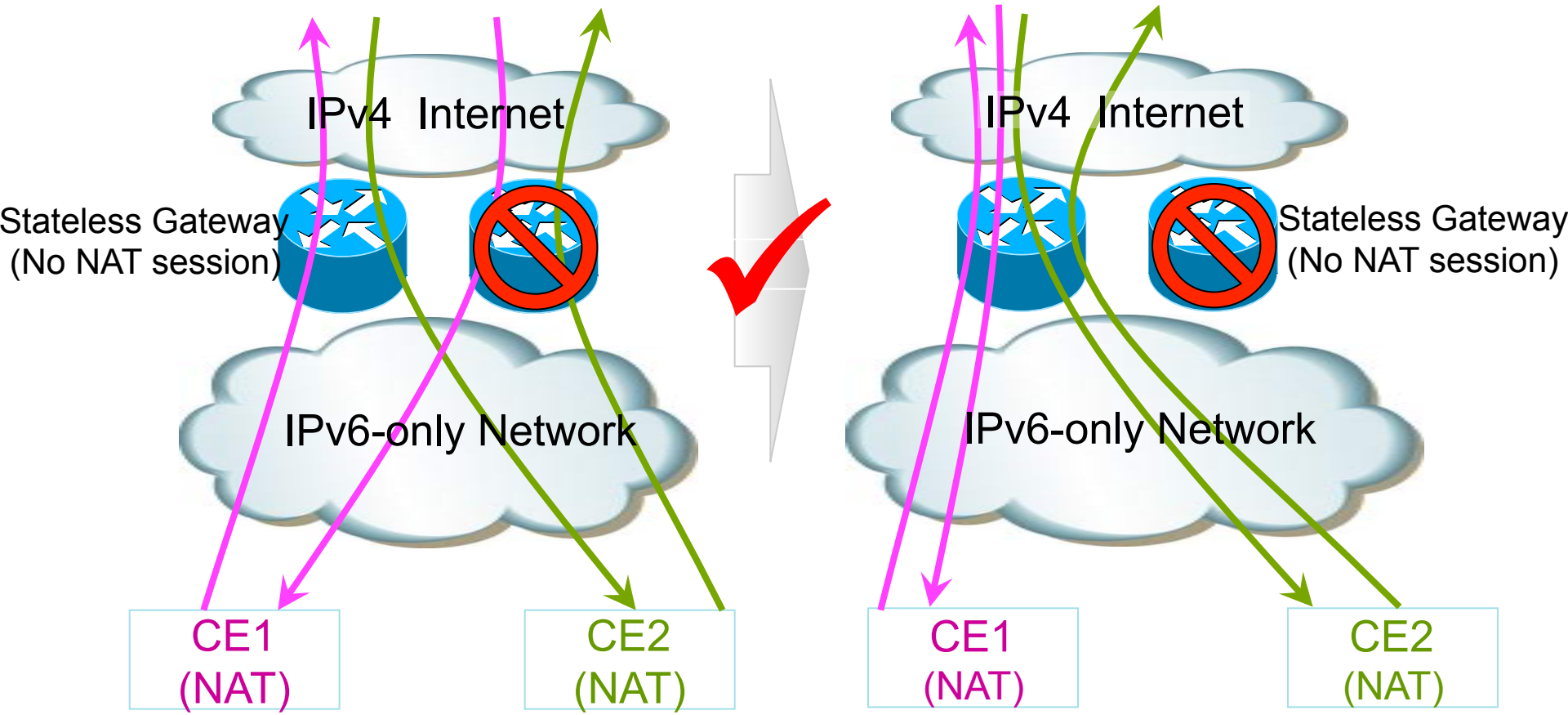
GW redundancy: Statefull

The solutions are at the cost of a complex election procedure or manual configuration, also of a considerable cost and a low reliability.



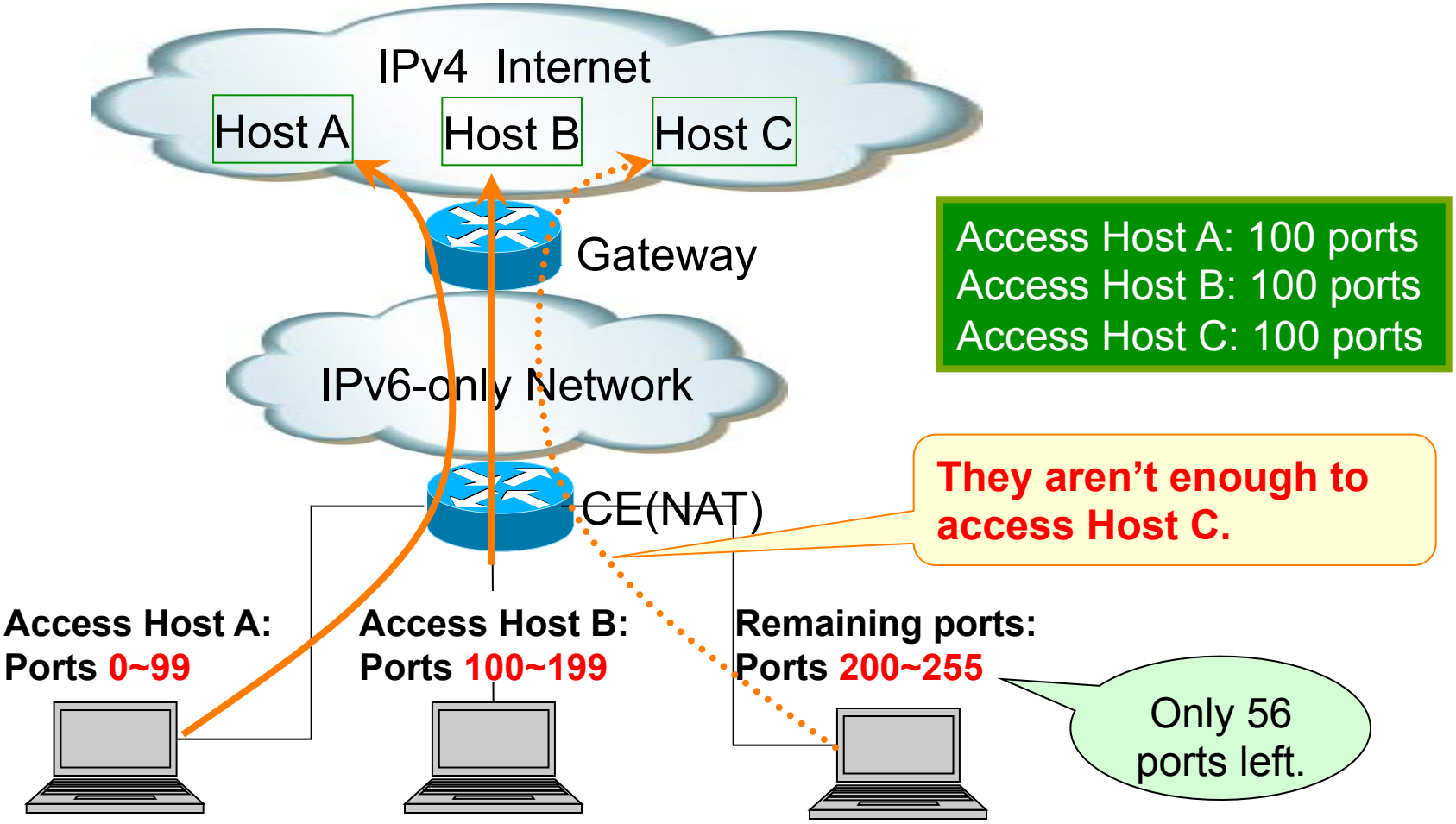
GW redundancy: Stateless

If the primary NAT is out of service, the Backup NAT can be replicated automatically.



NAT implementation considerations

When the NAT has to preserve NAT sessions to overloaded total number of port, the NAT resource will be exhausted



NAT implementation considerations

When the CE uses limited port numbers for each correspondence destination, increase to preserve NAT session