

# P4Update: Fast and Locally Verifiable Consistent Network Updates in the P4 Data Plane

Zikai Zhou, Mu He, Wolfgang Kellerer, Andreas Blenk, Klaus-Tycho Foerster



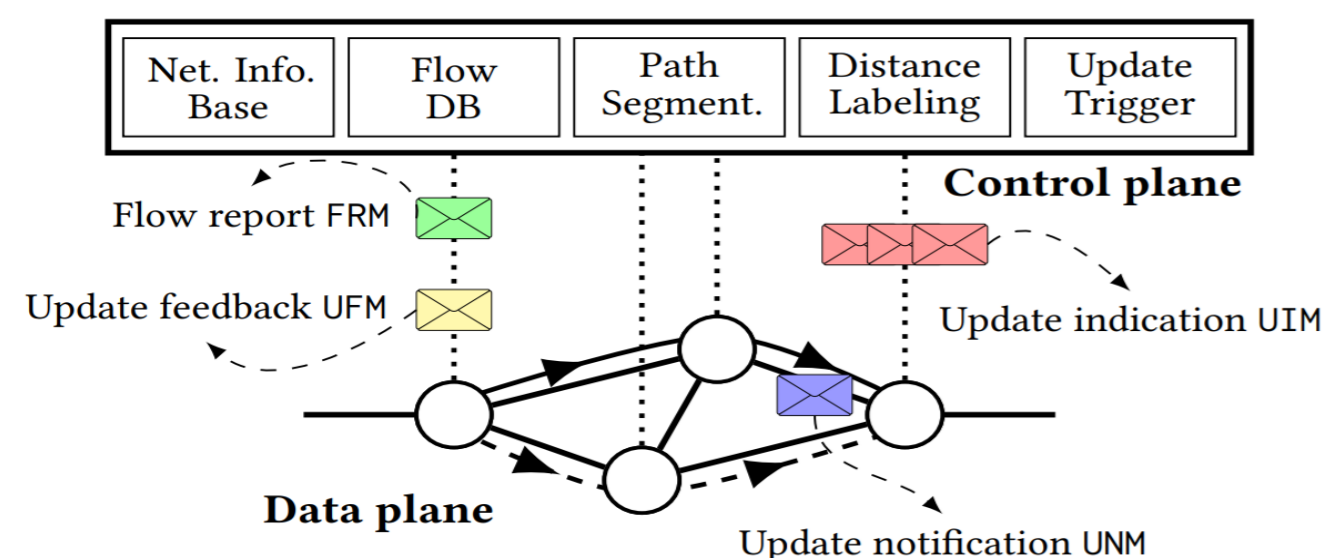
## Why does it matter?

- **Theoretical:** Consistent network updates in Software-Defined Network
- **Practical:** Common problem in Google B4 and Microsoft SWAN

## Our Challenge

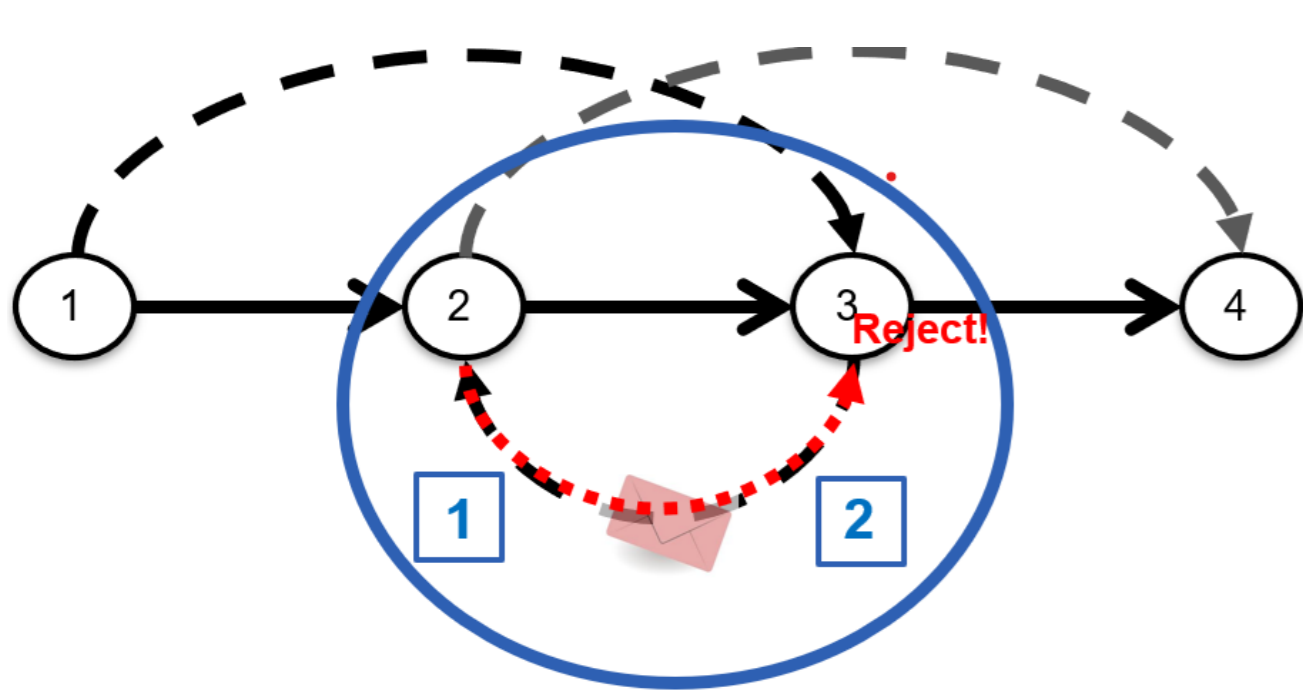
- Transient Inconsistencies** During Routing Updates
- Loops
  - Blackholes
  - Congestion

## System Overview



- **SDN Controller** maintains the flow information, routing configuration versions, send indication messages to data plane upon network updates
- **P4 Switches** generate, process the notification messages and verify the consistency properties locally with the help of controller

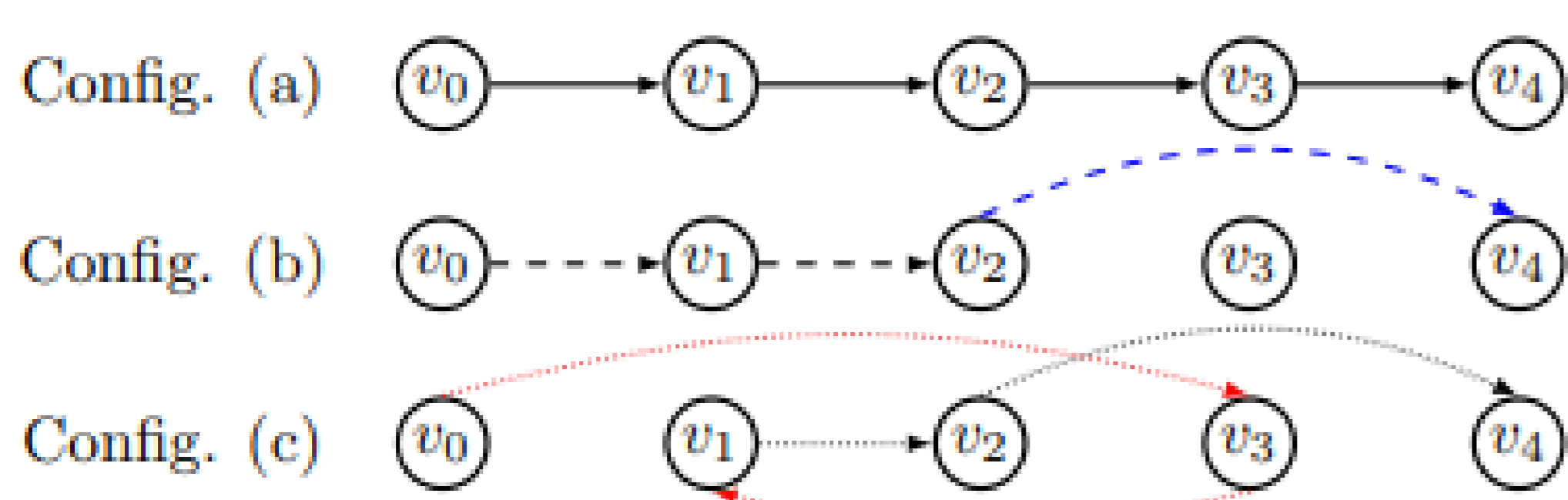
## How does it work?



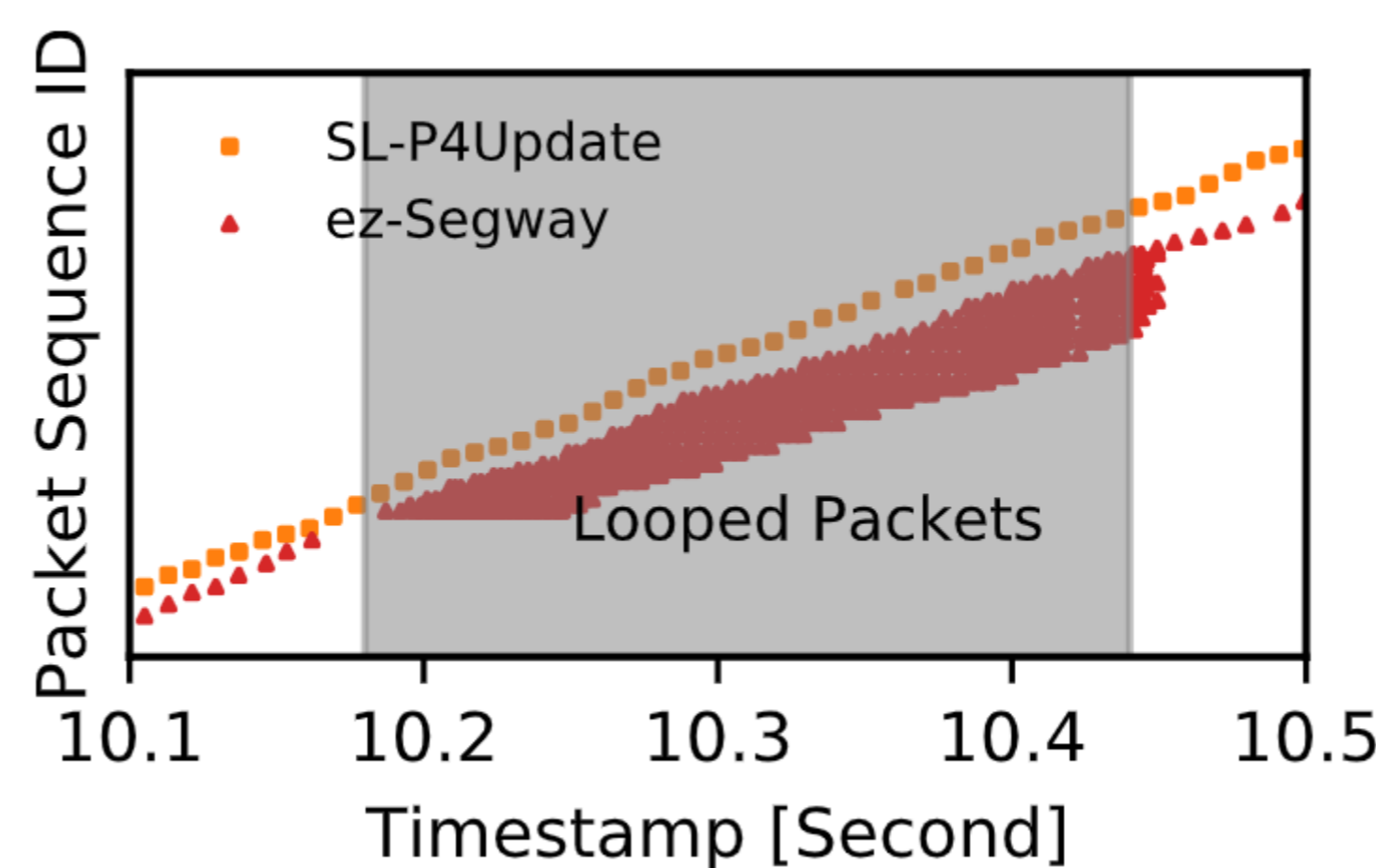
- **Distance Labeling:** destination-based routing, determine backward edges for loop-freedom
- **Path Segmentation:** heuristic parallelization to accelerate update
- **Coordinated Verification:** switches coordinates with neighbors to make verification
- **Local Scheduling:** determine inter-flow dependency in the data plane

## What do we show?

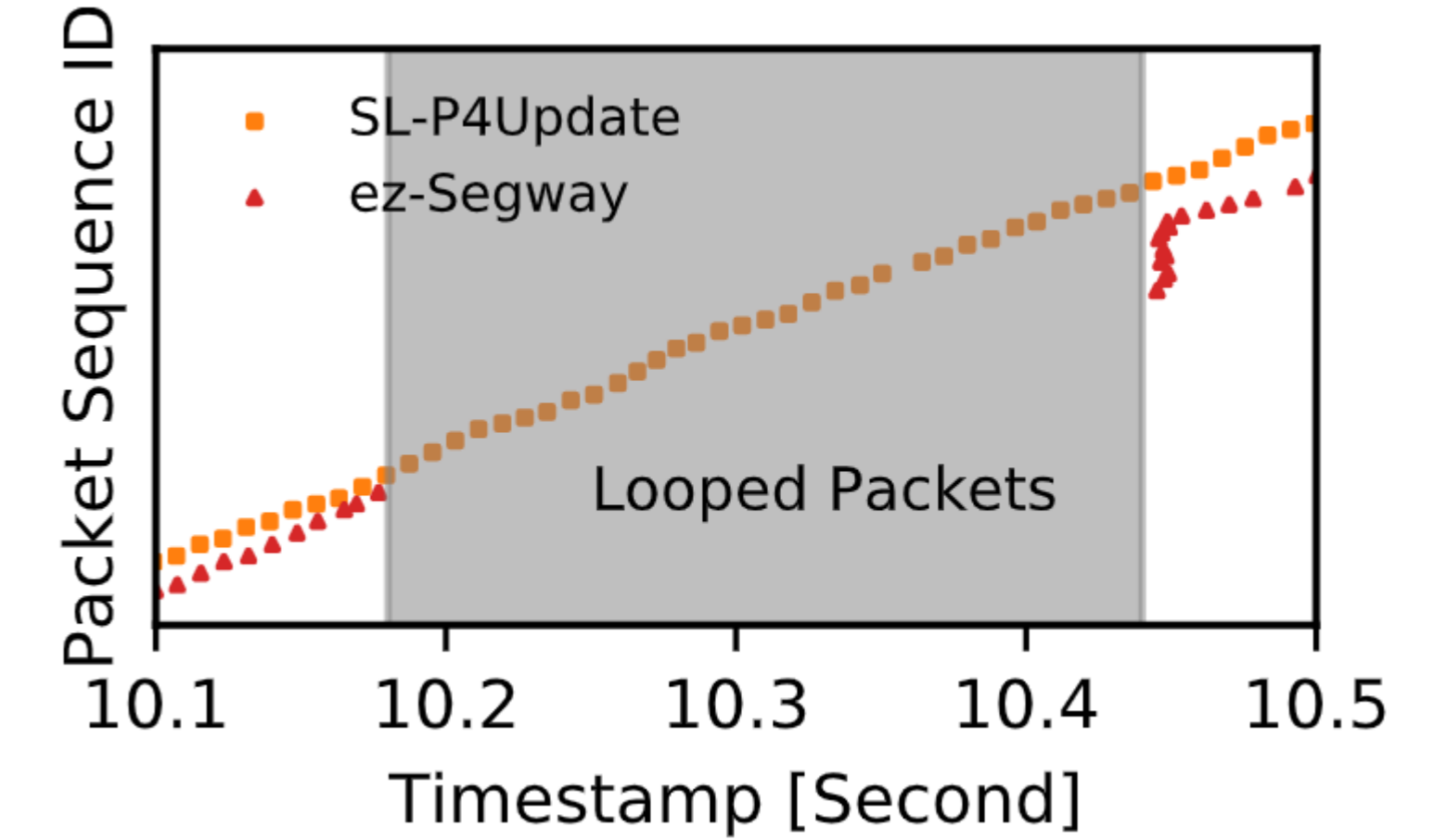
**Fast-Forward Consistency:** locally decide when to jump ahead while maintaining consistencies



Multiple Update Scenario

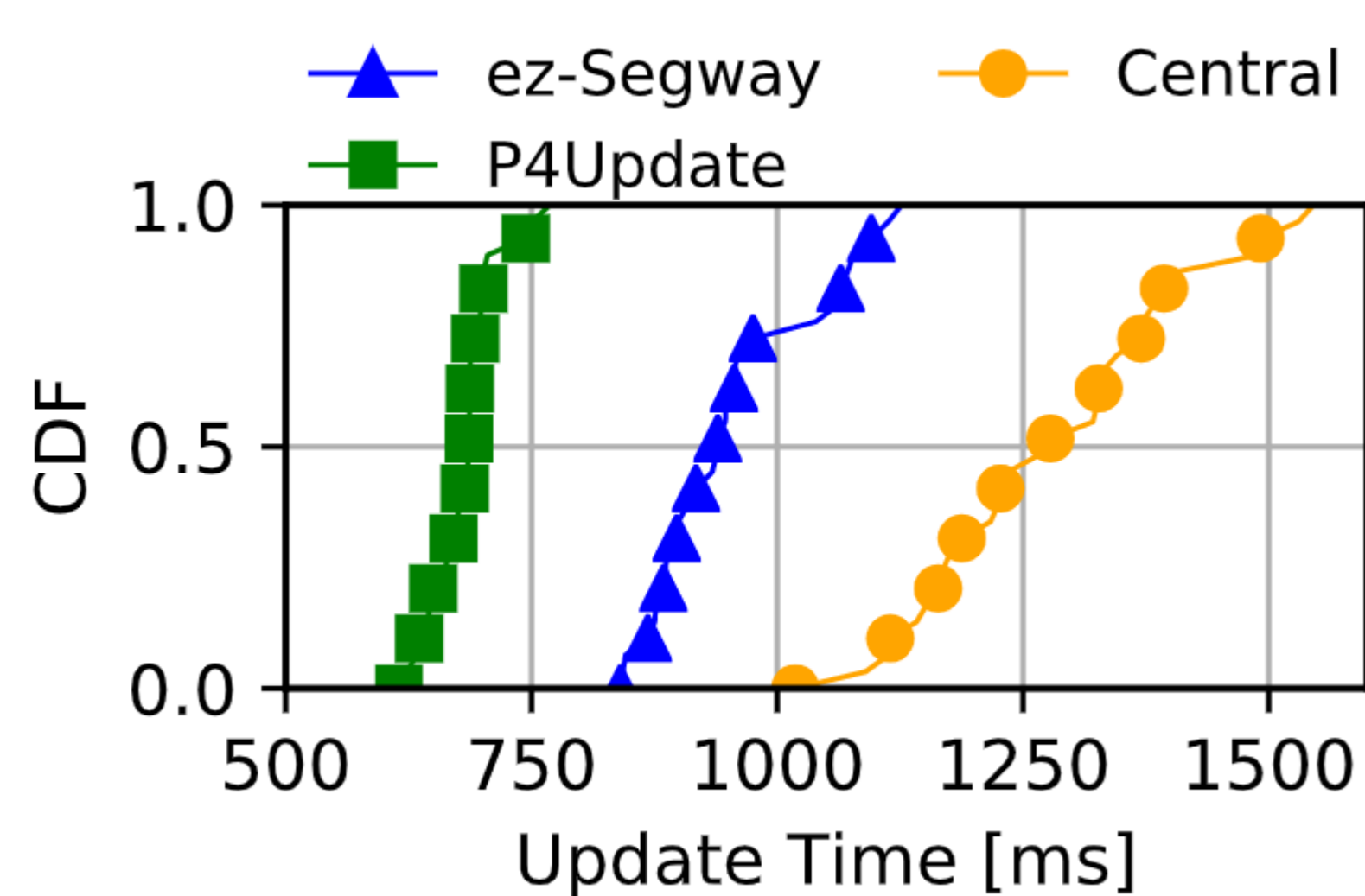


Packets received at v1

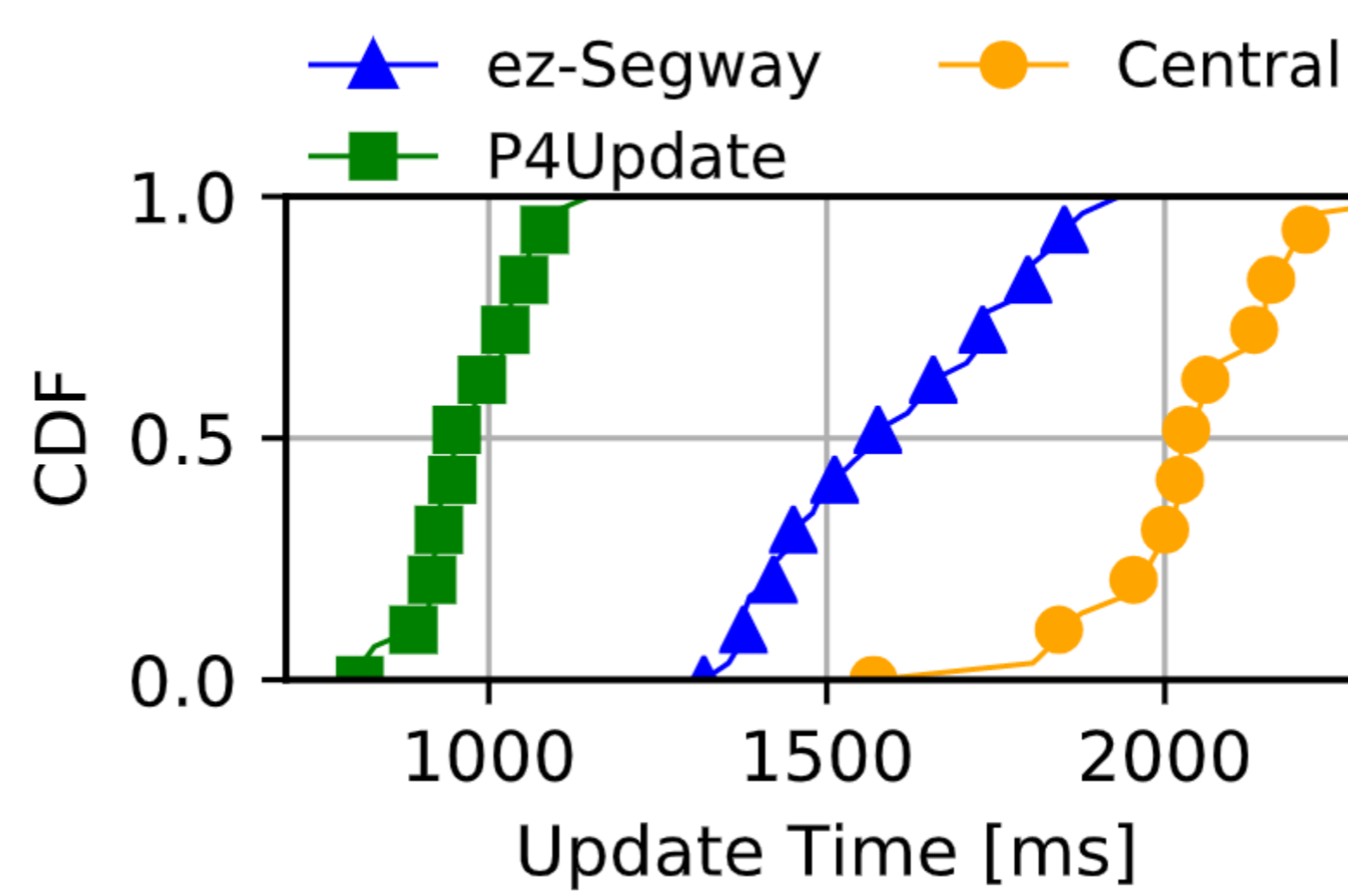


Packets received at v4

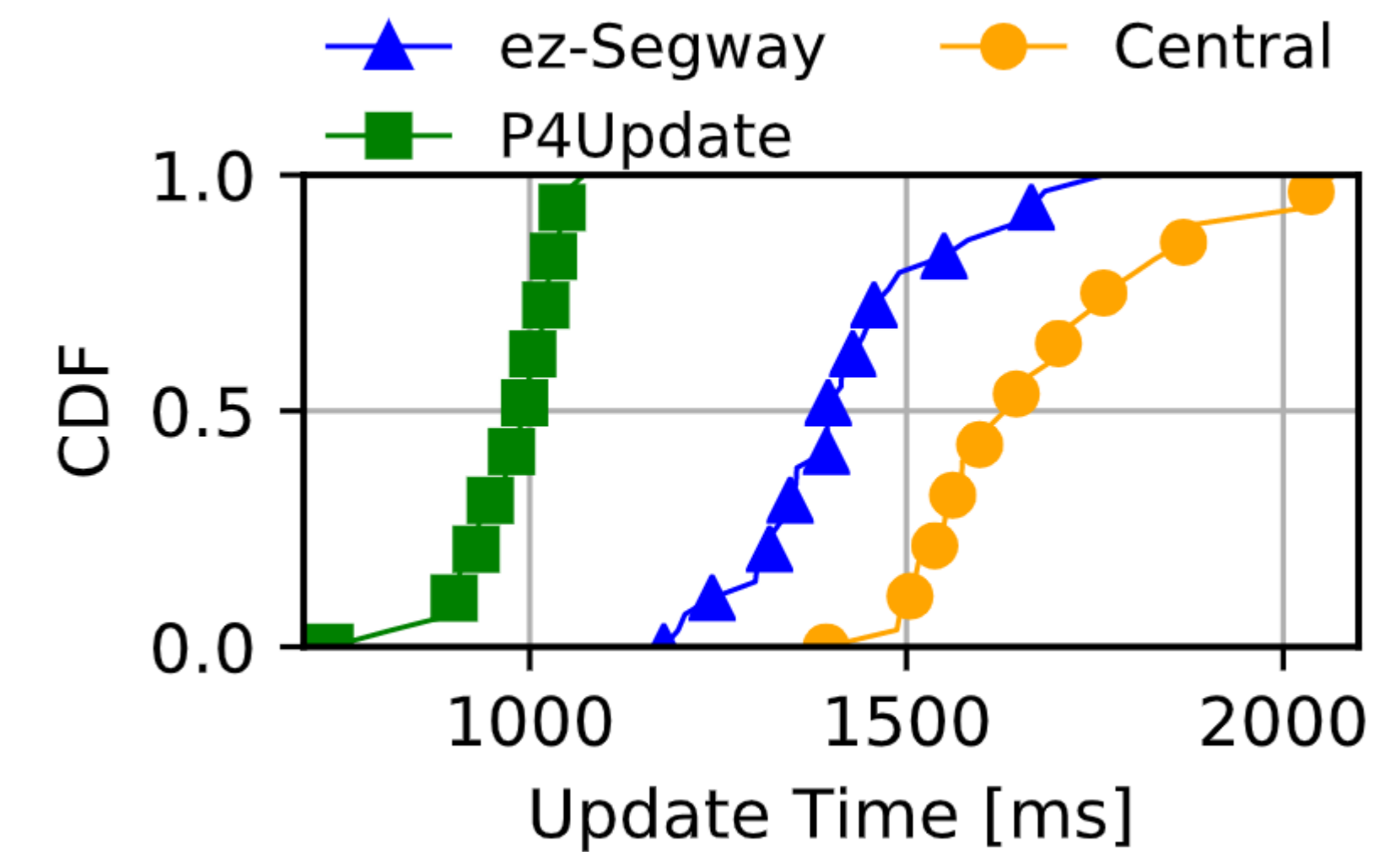
**Total Update Time:** Compared with State-of-the-Art, P4Update uses least time to finish update in Data Center and WAN Topology



FatTree



B4



Internet 2

## Contribution

- Prove the feasibility of P4 switch making local verification and ensuring global consistency
- Propose a new network update architecture for programmable networks with P4

## Future Work

- Hardware Deployment
- Further Consistency Properties

## Related Publications

- [1] Foerster, Klaus-Tycho, et al. "Loop-free route updates for software-defined networks." *Ieee/acm Transactions on Networking* 26.1 (2017): 328-341.
- [2] Zhou, Zikai, et al. "P4Update: fast and locally verifiable consistent network updates in the P4 data plane." *Proceedings of the 17th International Conference on emerging Networking EXperiments and Technologies*. 2021.