

PayLess: A Low Cost Network Monitoring Framework for Software Defined Networks

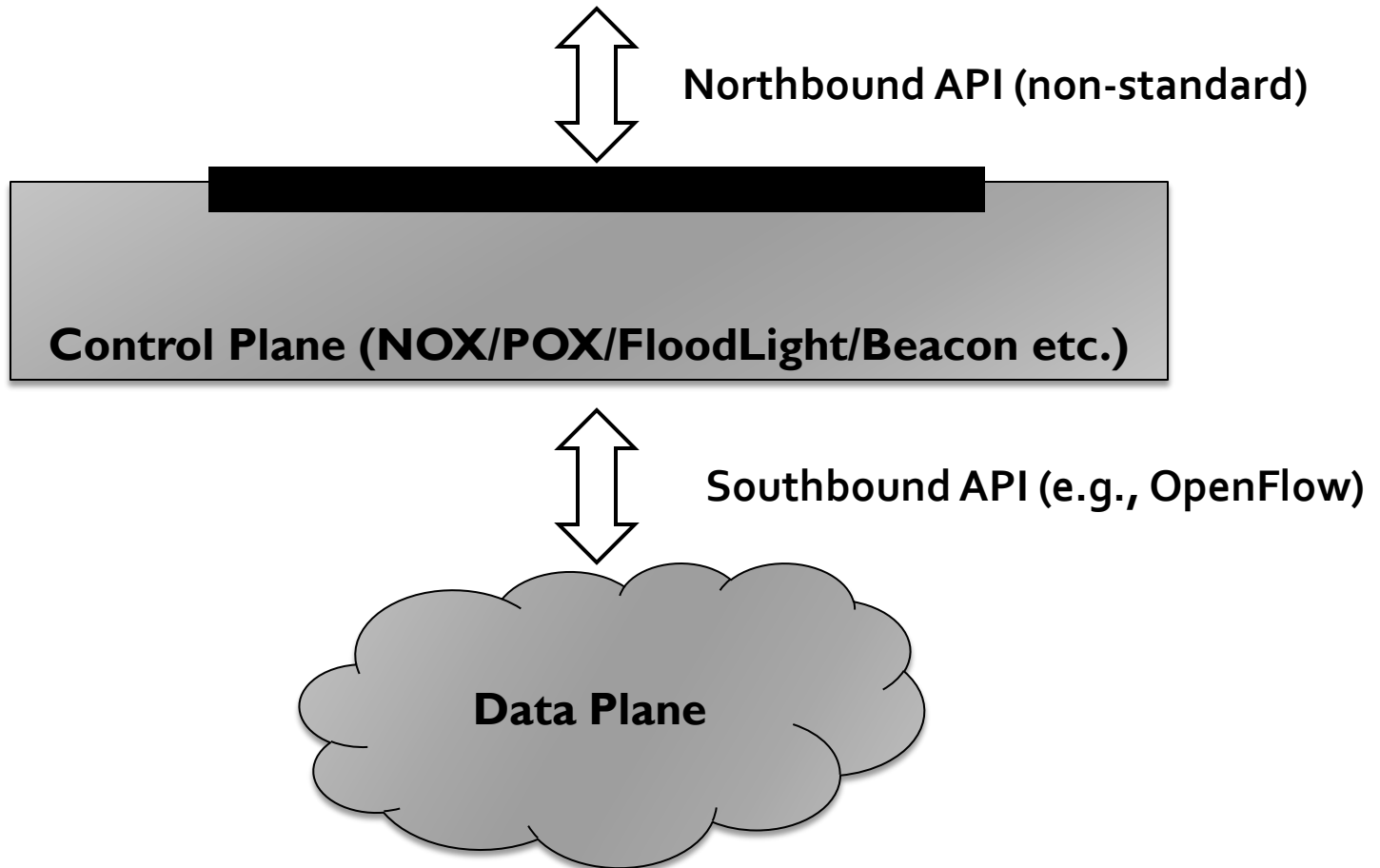
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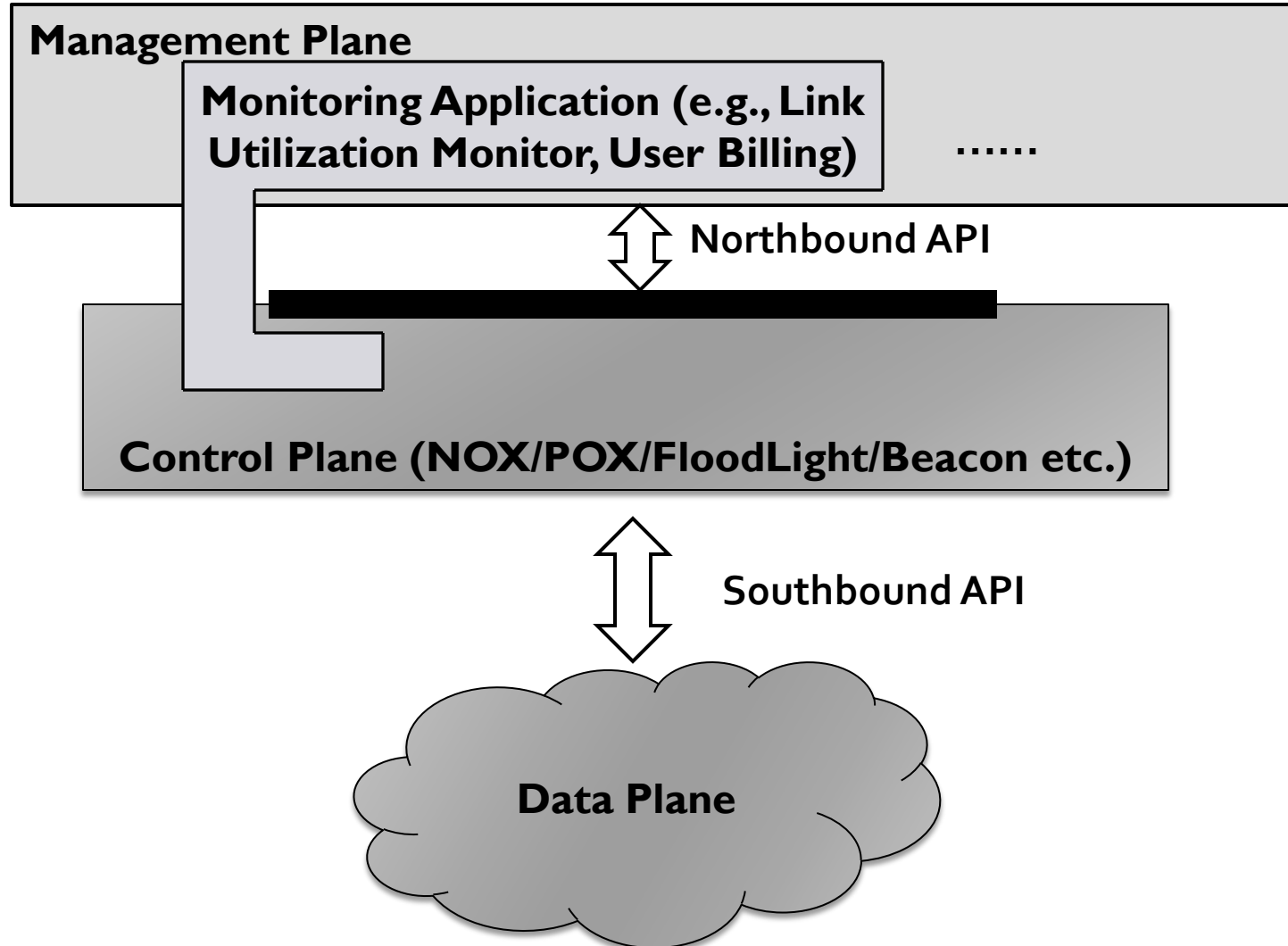
This work has been supported by NSERC discovery grant and SAVI research network

Presented By: Shihabur Rahman Chowdhury

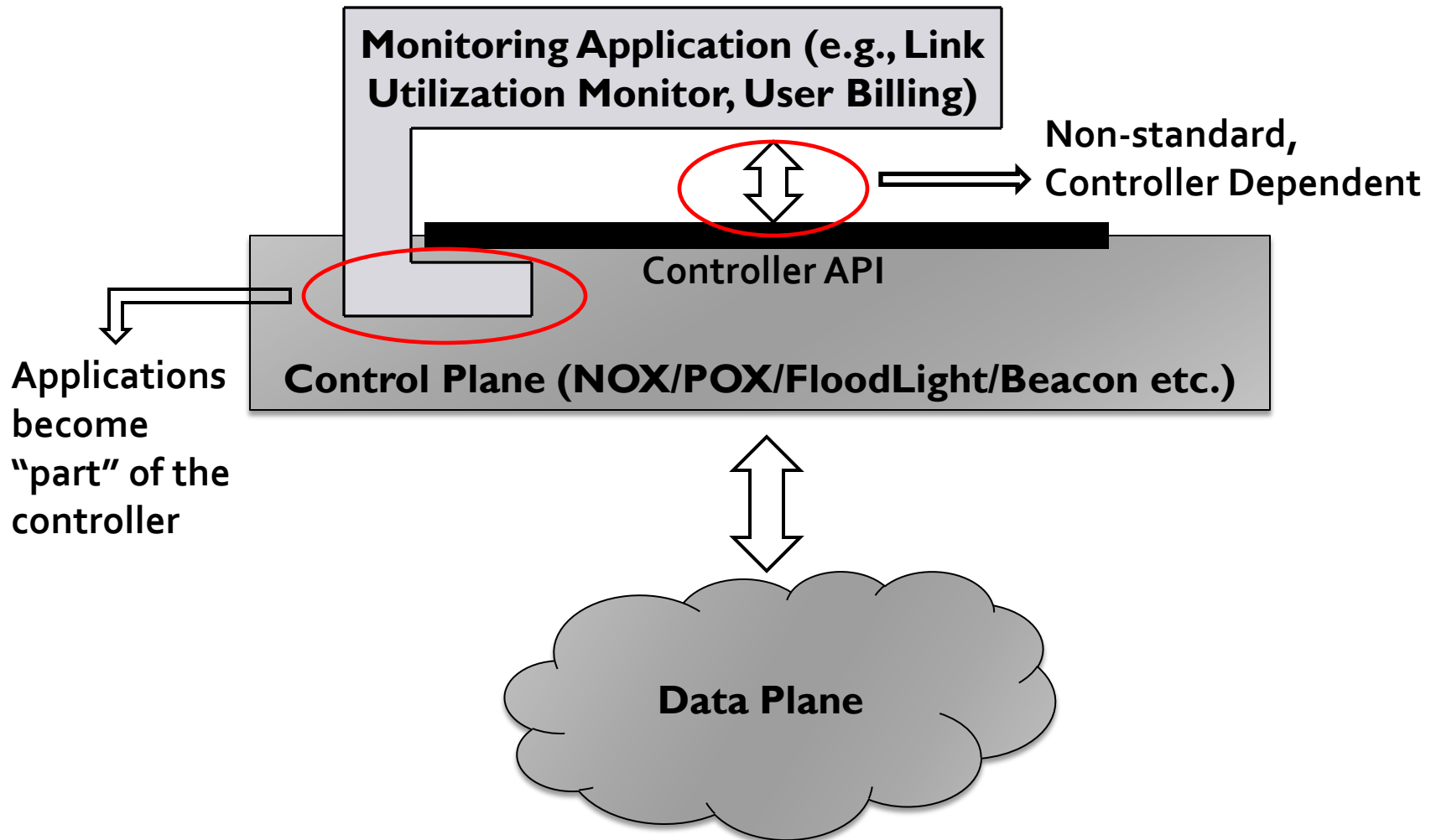
Typical SDN Scenario



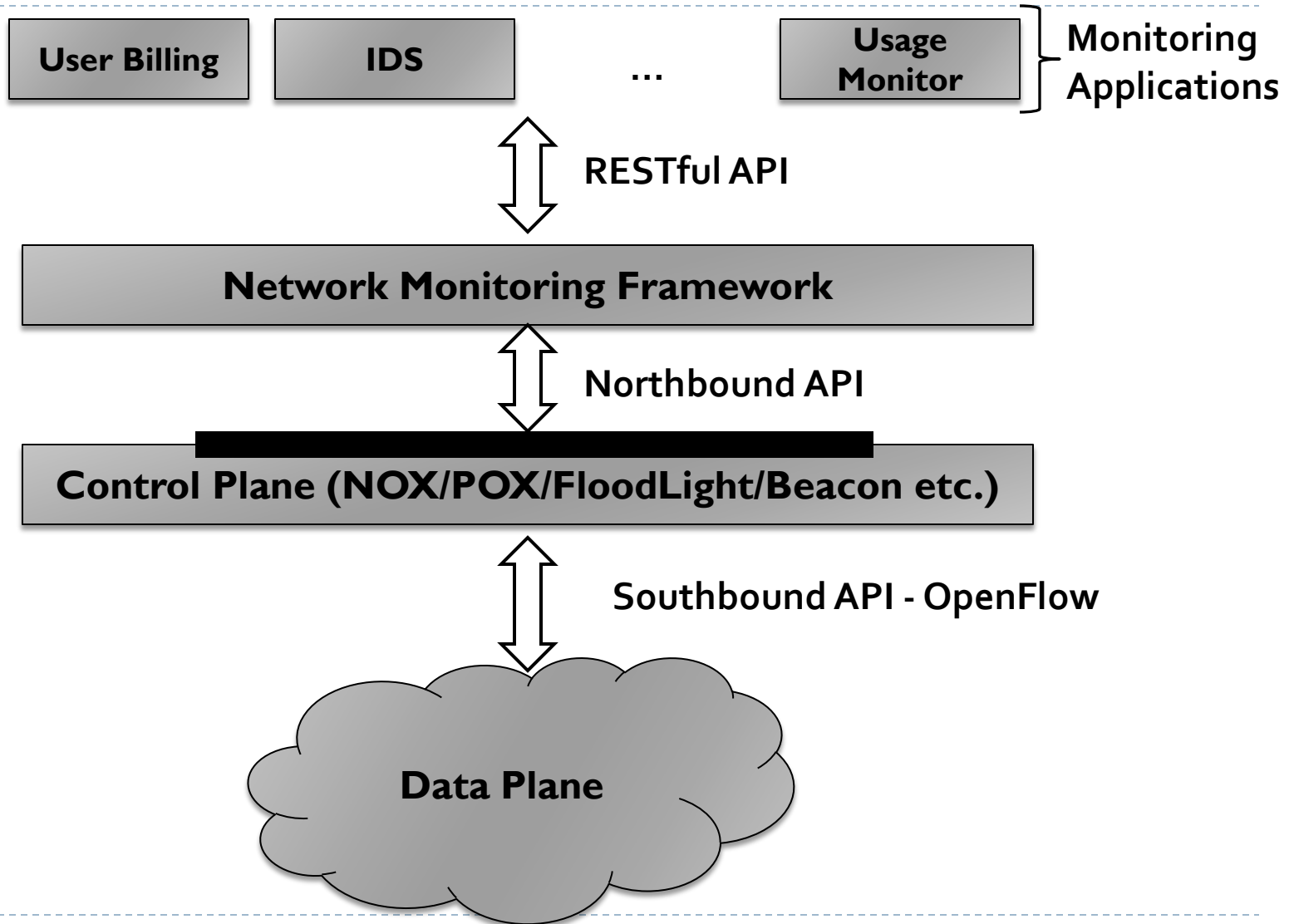
Application Development over SDN: Current Scenario



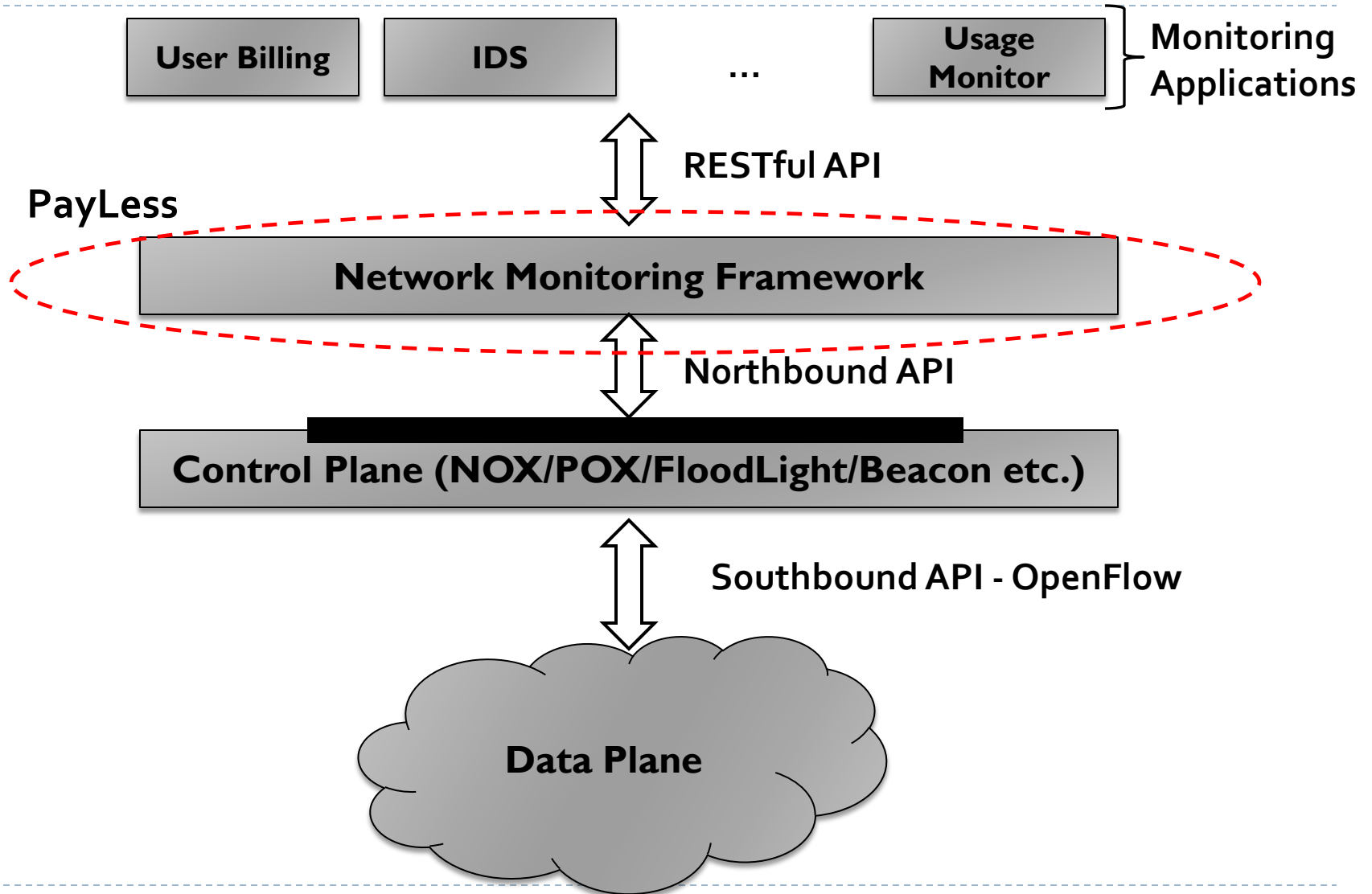
Application Development over SDN: Current Scenario (contd...)



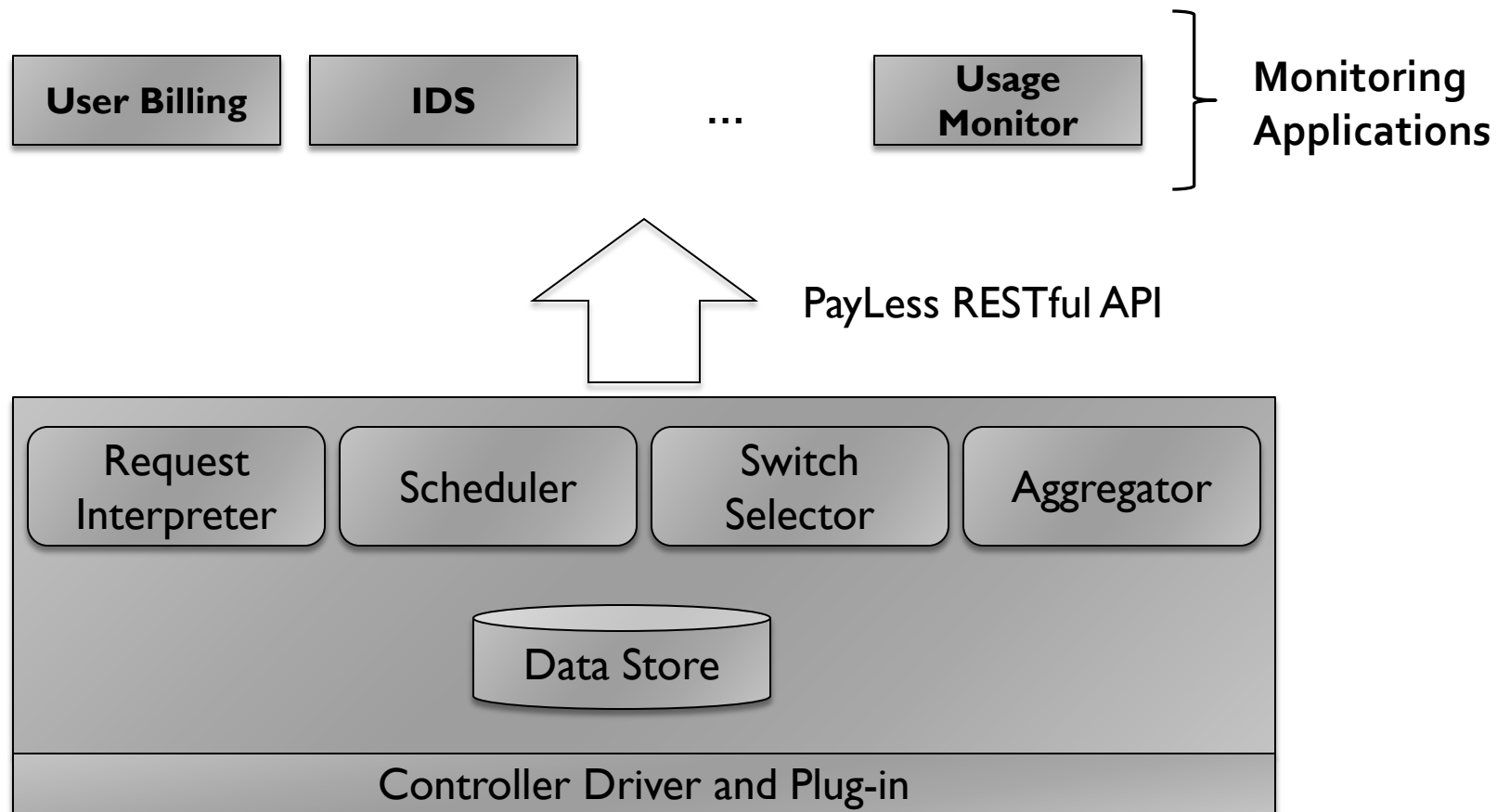
Application Development over SDN: Proposal



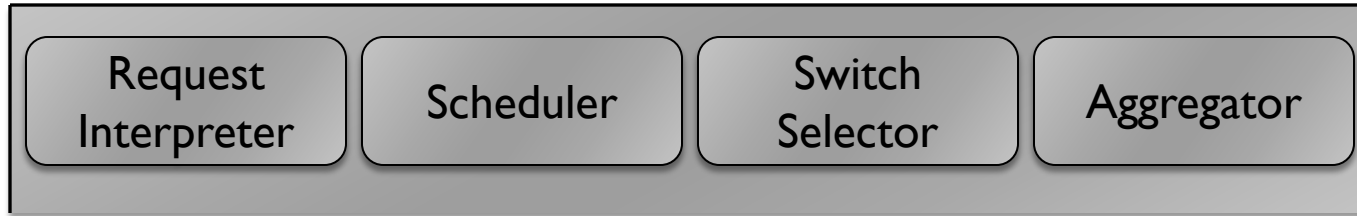
Application Development over SDN: Proposal



PayLess Architecture

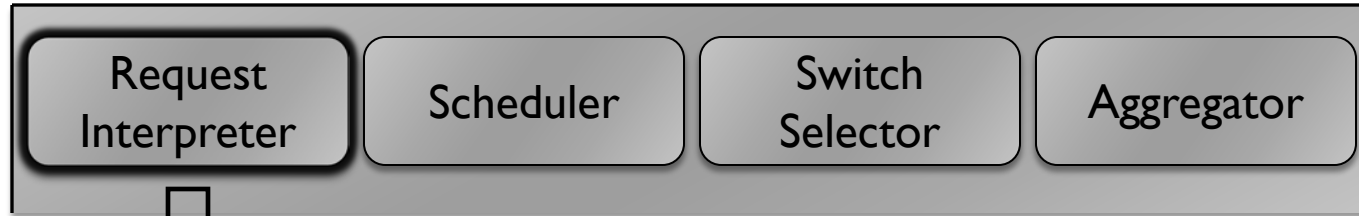


PayLess Architecture (contd...)



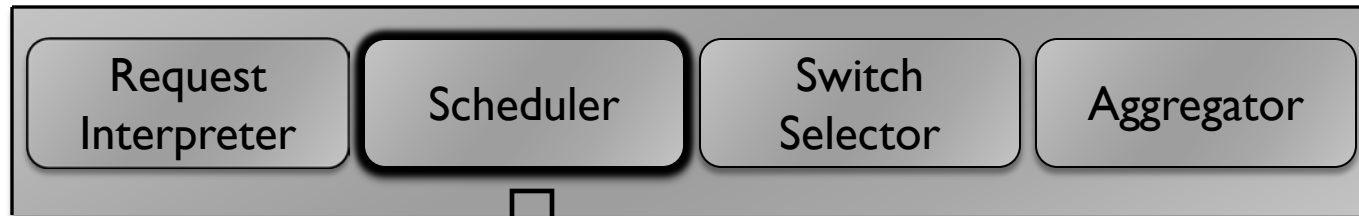
- ▶ Each component has well-defined interface
 - ▶ Can be easily replaced by a custom implementation
 - ▶ i.e., data aggregation level, sampling algorithm etc. can be customized

PayLess Architecture (contd...)



- ▶ Determines **what** to monitor by translating monitoring requests from the applications
 - ▶ Requests are sent in JSON format
 - ▶ May contain:
 - ❑ Type (performance, security, fault etc.)
 - ❑ Monitoring metric (what to measure)
 - ❑ Entity (which network entity to monitor)
 - ❑ Aggregation level (per switch / user / flow etc.)
 - ❑ Priority (real-time, medium, low)
 - ❑ Logging (format of the log)

PayLess Architecture (contd...)



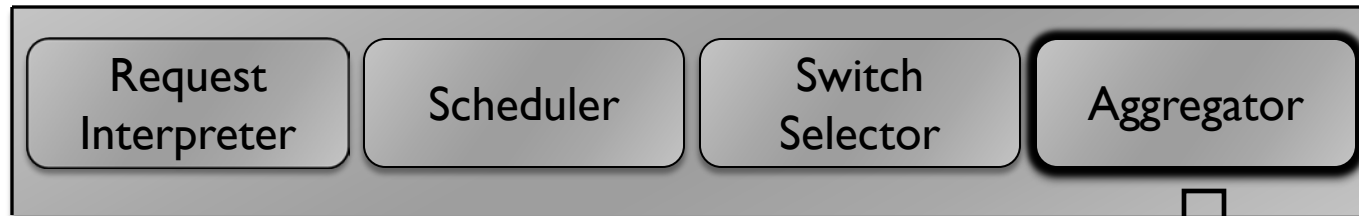
- ▶ Determines **when** to collect statistics from the network.
 - ▶ Periodic
 - ▶ At specific events
 - ▶ Adaptive sampling
 - ▶ etc.

PayLess Architecture (contd...)



- ▶ Determines ***which*** subset of network elements should be probed for statistics.
 - ▶ Only the ingress and egress switches
 - ▶ Switches with maximum connectivity
 - ▶ *etc.*

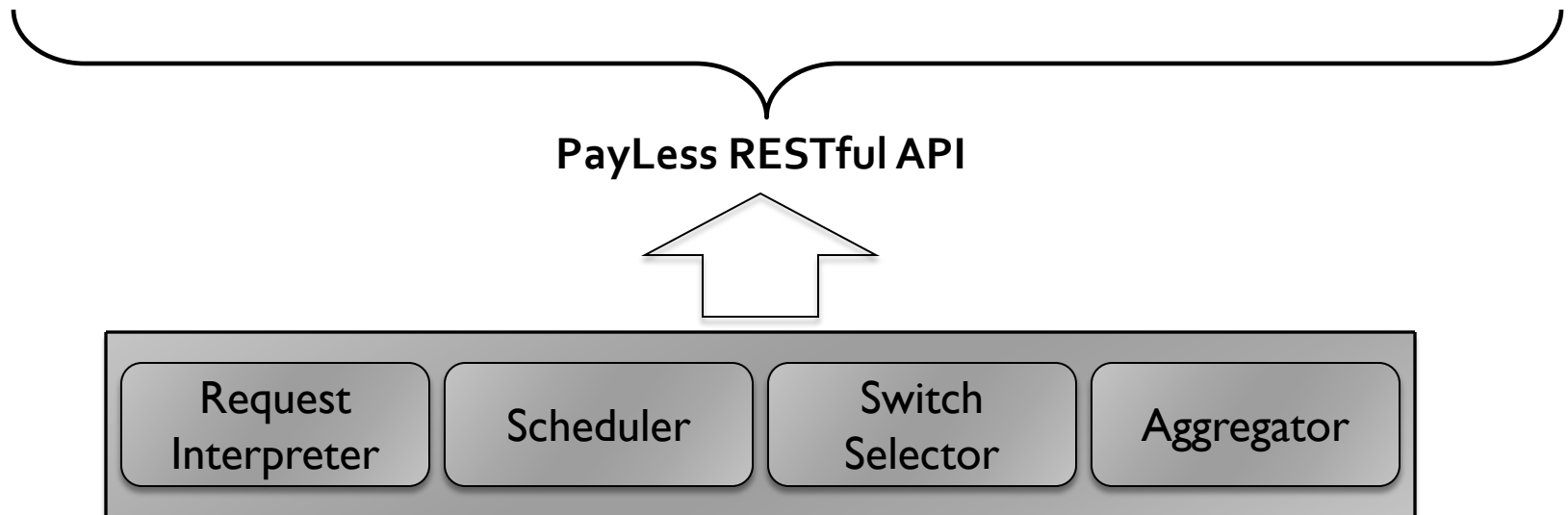
PayLess Architecture (contd...)



- ▶ Aggregates the raw monitoring data as per application requirement
 - ▶ Per link aggregation
 - ▶ Per user aggregation
 - ▶ Per switch aggregation
 - ▶ *etc.*

PayLess Architecture (contd...)

- ▶ RESTful API for developing monitoring applications
 - ▶ Applications can be oblivious of control plane technology
 - ▶ Applications can be written in any Language
 - ▶ Despite of the control plane technology, applications have the same set of services available

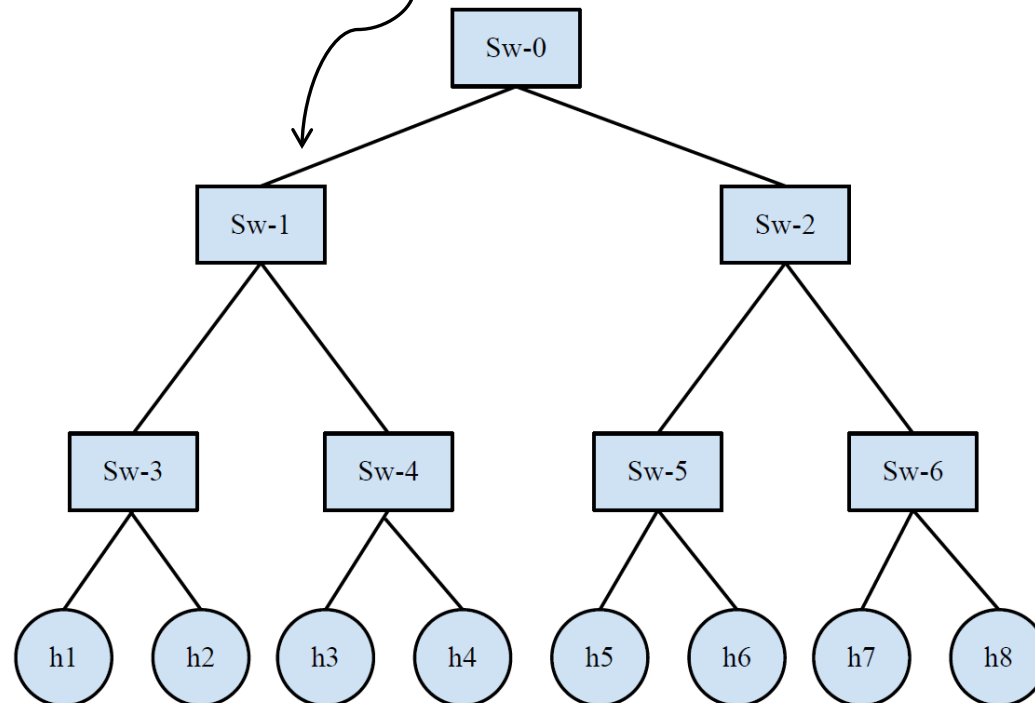


Implementation

- ▶ Application
 - ▶ Adaptive Link Usage Monitoring
- ▶ Scheduler
 - ▶ We propose an adaptive sampling algorithm
 - ▶ Adjust the monitoring frequency according to *network load*.
 - ▶ Assign a *monitoring time out* to each flow
 - ▶ Query the switch(es) for flow statistics *when timeout expires*
 - ▶ If no significant traffic change ($\leq \alpha$), increase the timeout (up to T_{max})
 - ▶ If change in traffic is significant ($\geq \beta$), decrease the timeout (up to T_{min})
- ▶ Switch selector:
 - ▶ Query all the switches
- ▶ Aggregator
 - ▶ Aggregate data per link

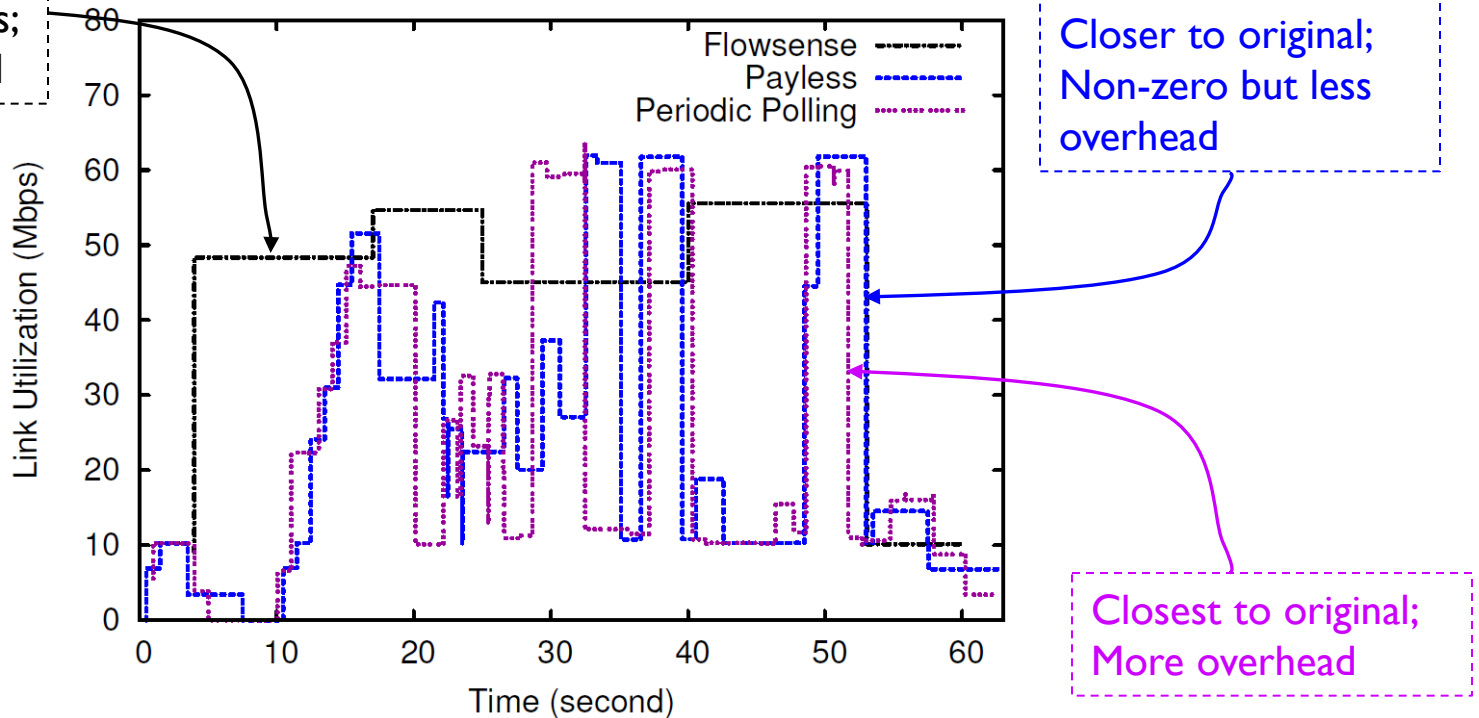
Evaluation: Setup

- ▶ Simulation using Mininet and Floodlight controller
- ▶ Topology
 - ▶ Hierarchical topology to emulate behavior of a scaled down data center
- ▶ $\alpha = \beta = 100\text{MB}$; $T_{max} = 5\text{s}$, $T_{min} = 500\text{ms}$
- ▶ Monitor the usage of **Sw-0 – Sw-1** link over time



Evaluation: Utilization

- ▶ Comparison with FlowSense*, and Periodic polling (every 500ms)

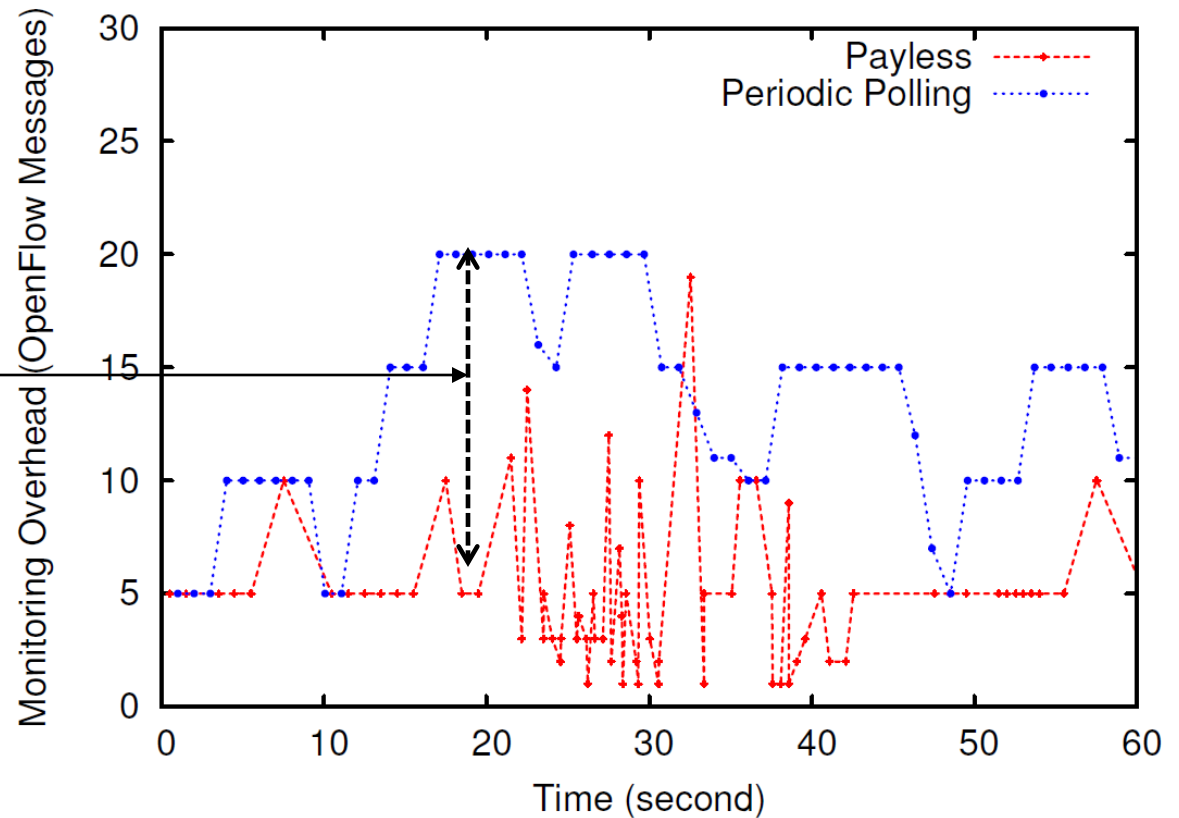


*Yu, C. et al. FlowSense: Monitoring Network Utilization with Zero Measurement Cost. *Passive and Active Monitoring (PAM) 2013*

Evaluation: Overhead

Overhead is measured by the number of monitoring queries.

PayLess can reduce the messaging overhead **up to 50%** compared to periodic polling.



Conclusion

▶ Summary

- ▶ State-of-the art controllers offer different northbound APIs. We need an uniform API for network applications
- ▶ Payless is a step to provide unified API for monitoring application development

▶ Future Works

- ▶ Full fledged implementation
- ▶ Develop a QoS policy enforcement application* over PayLess

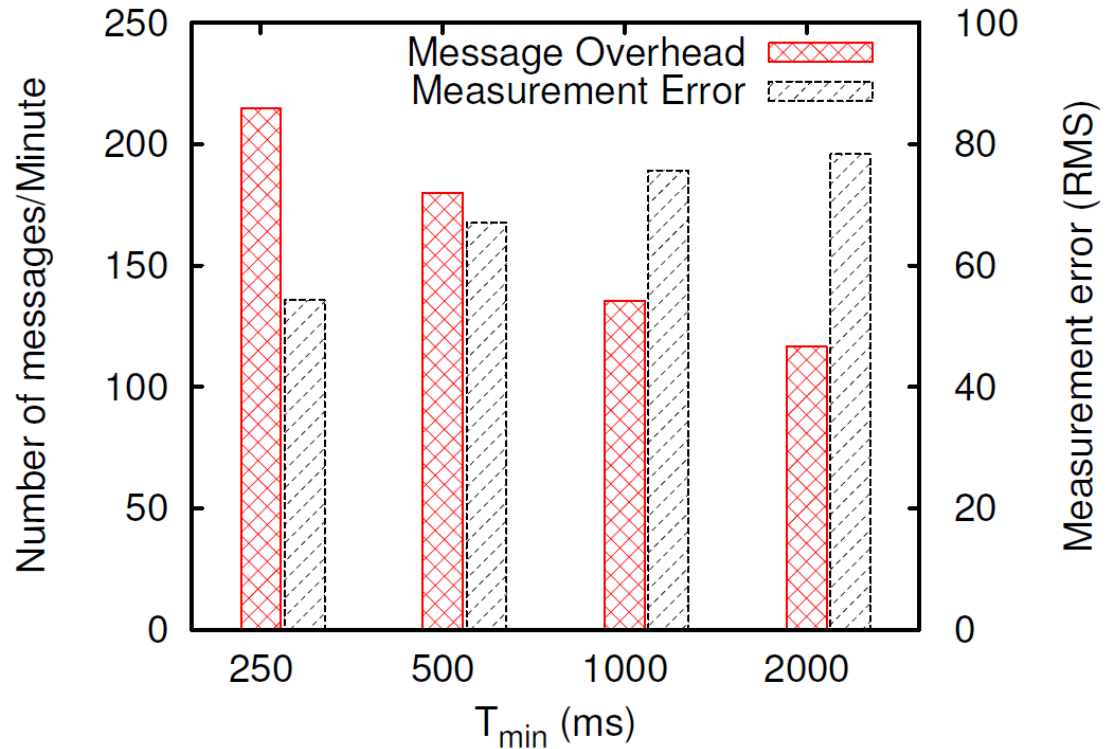
*Bari et al., PolicyCop: An Autonomic QoS Policy Enforcement Framework for Software Defined Networks. *IEEE SDN4FNS 2014*

Questions

?

Evaluation: Effect of T_{min}

- T_{min} is the minimum polling timeout.
- T_{min} is varied (**250ms – 2s**) to observe its effect on accuracy and overhead
 - Accuracy was measured as rms error between PayLess and periodic polling over 250ms interval



Related Works

- ▶ **OpenTM (PAM '10)**
 - ▶ Heuristics on **which** OpenFlow switches to query for measuring traffic matrix
- ▶ **FlowSense (PAM '13)**
 - ▶ Event based link utilization monitoring in SDN.
 - ▶ No additional measurement overhead.
- ▶ **OpenSketch (NSDI '13)**
 - ▶ Clean slate redesign of data plane to support monitoring in SDN