

Flexcomm Simulator: Exploring Energy Flexibility in Software Defined Networks with ns-3

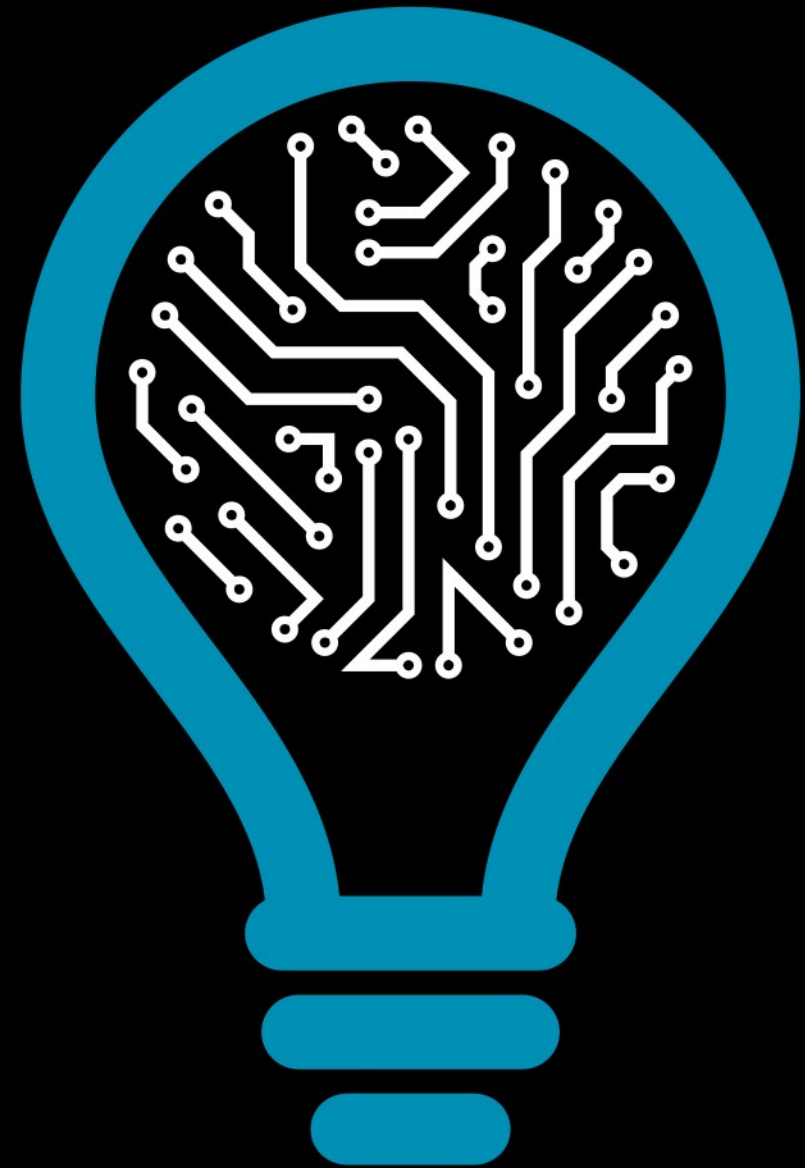
Workshop on ns-3 (WNS3) 2023

Rui Pedro C. Monteiro
João Marco C. Silva

Financed through FCT within the project FLEXCOMM (EXPL/CCI-INF/1543/2021)



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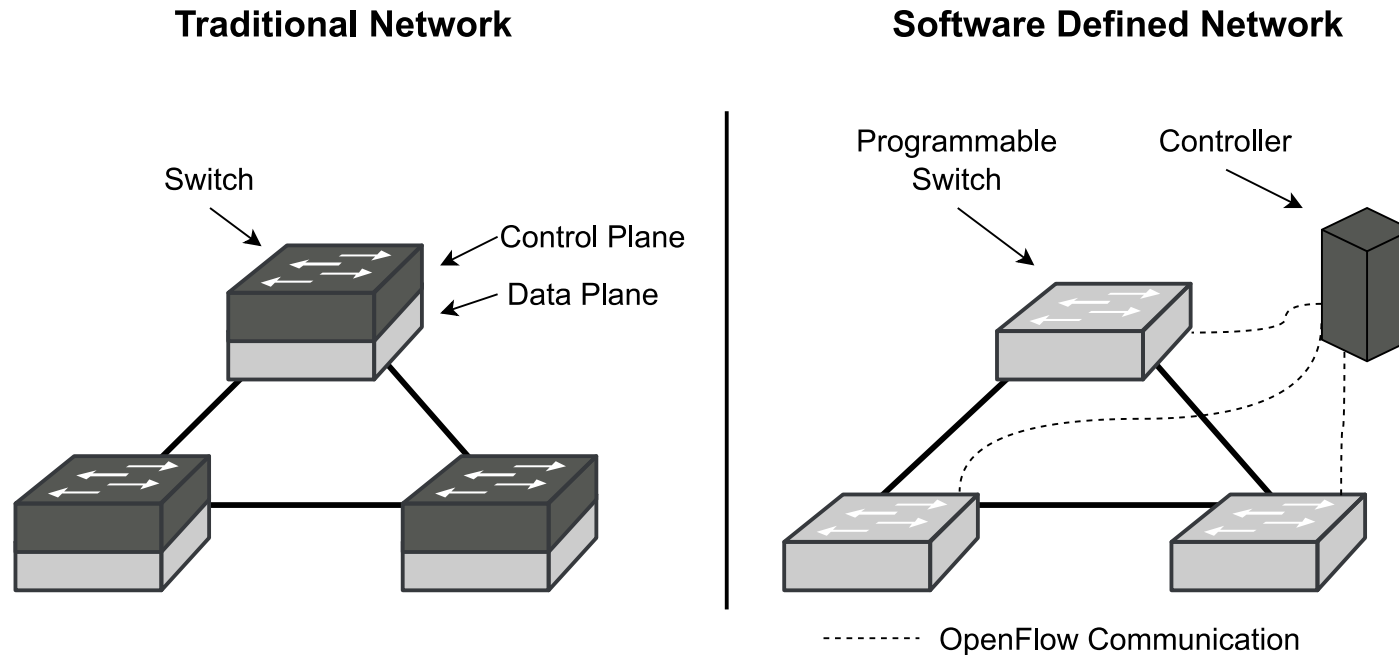


Introduction

- The Information and Communication Technologies (ICT) sector accounts for 5% to 9% of **global electricity consumption** and 2% of greenhouse gas emissions
- **Data transmission networks alone** are responsible for **half** of these amounts
- These numbers are expected to increase

Software Defined Networks (SDNs)

- Dynamic and manageable approach to network management
- Decouples the control and data planes

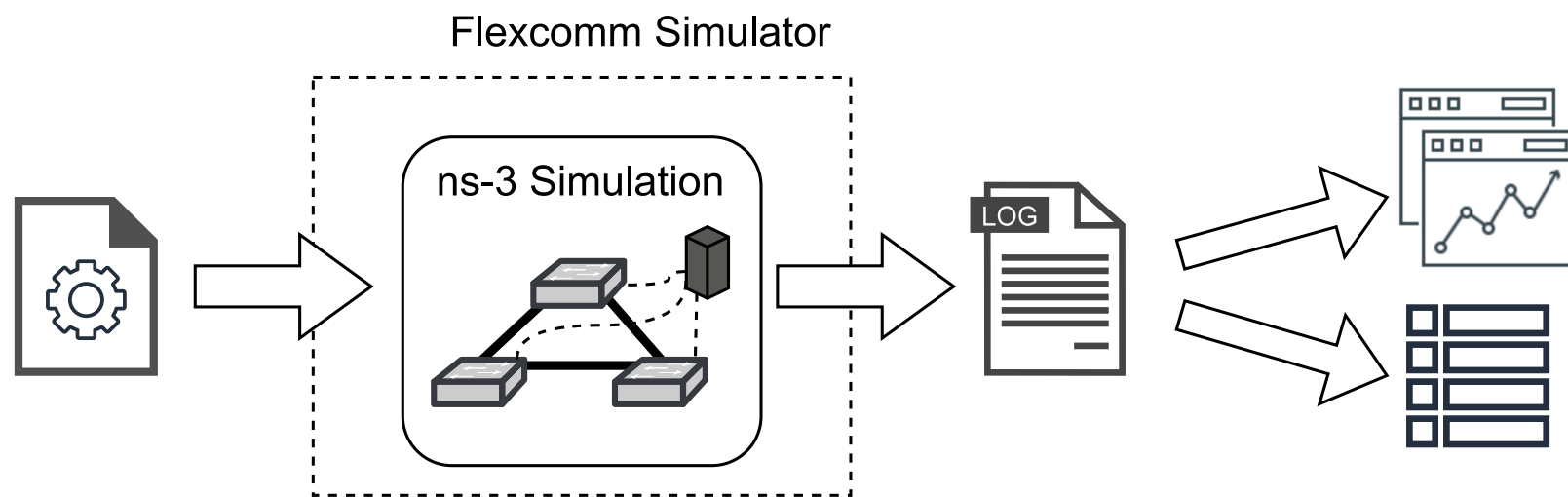


Energy Flexibility

- Energy availability in specific regions
- Distributed Energy Resources (DERs)
- Available energy differs across the electrical grid

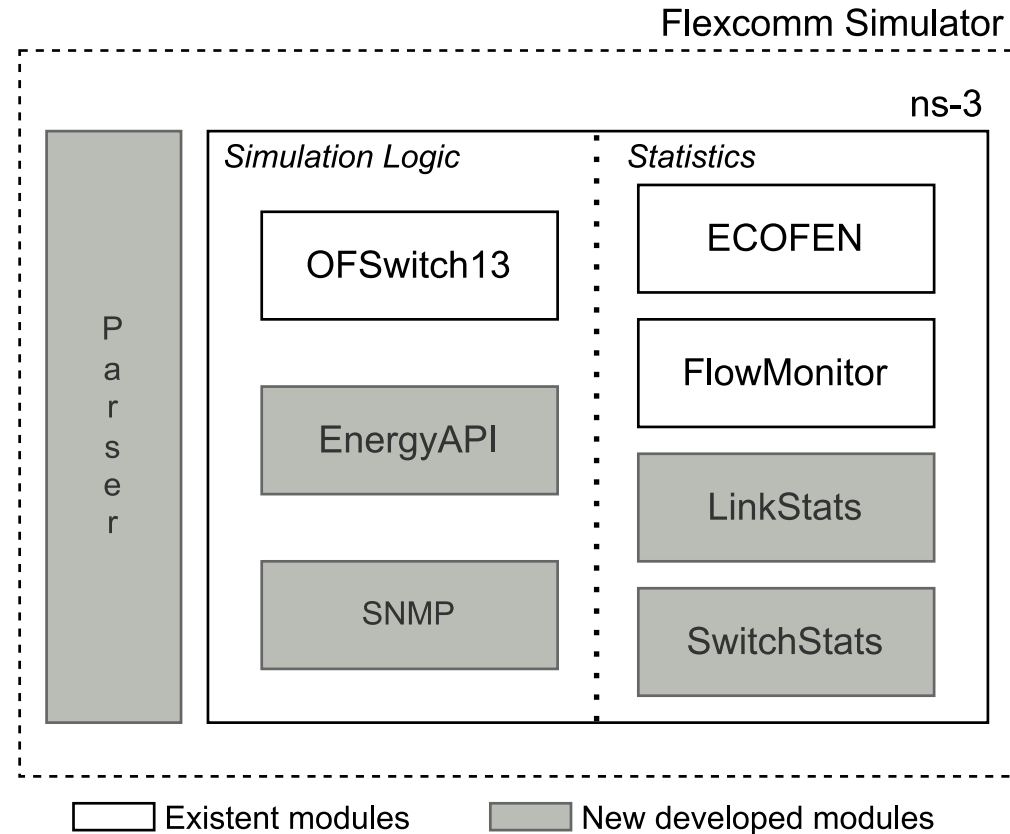
Flexcomm Simulator

- Built with ns-3
- *Pipeline workflow*



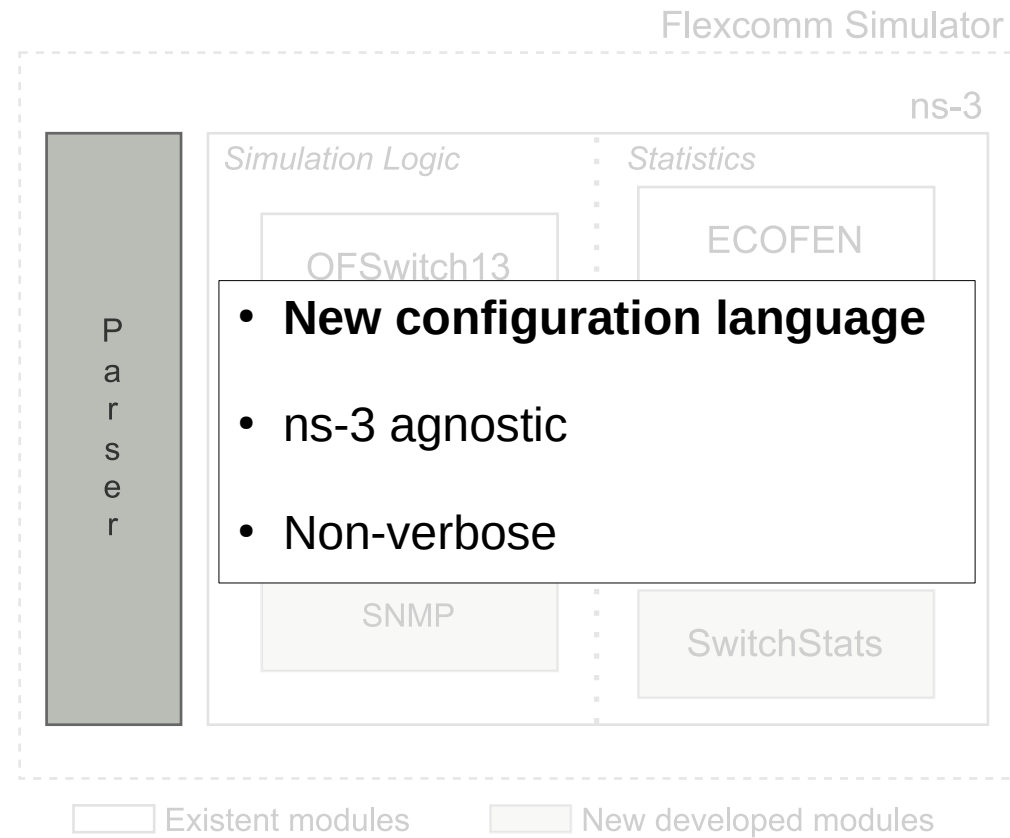
Flexcomm Simulator

- Existent modified modules
- New developed modules



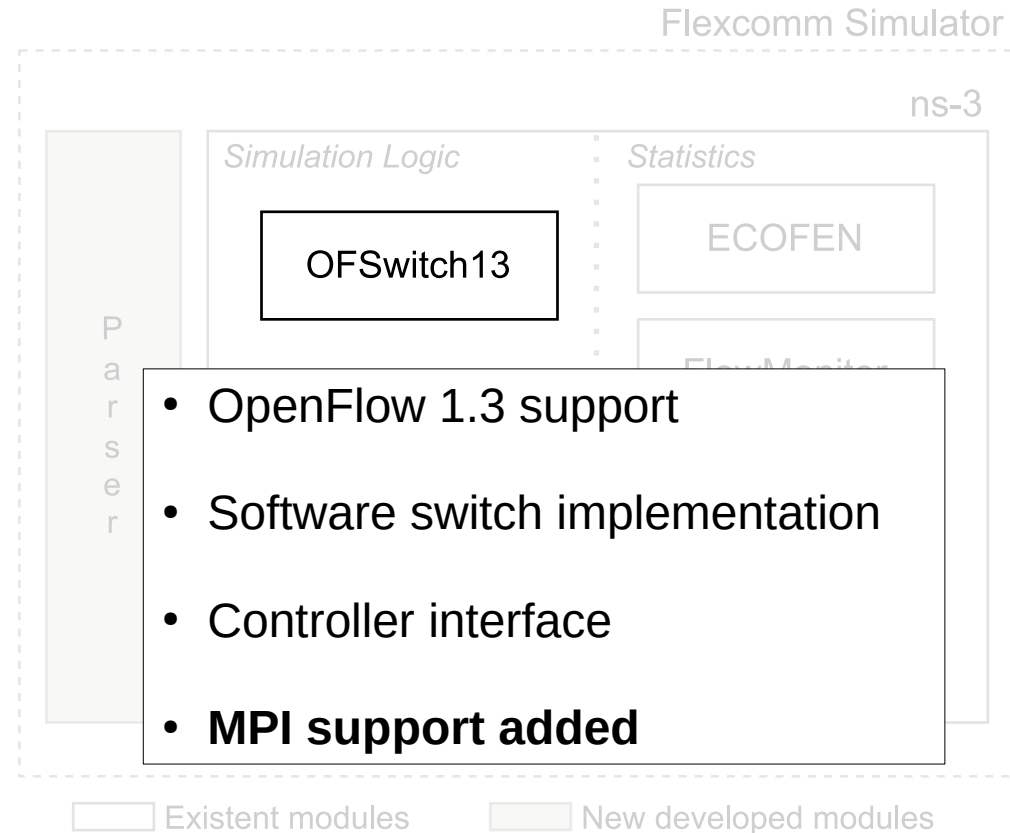
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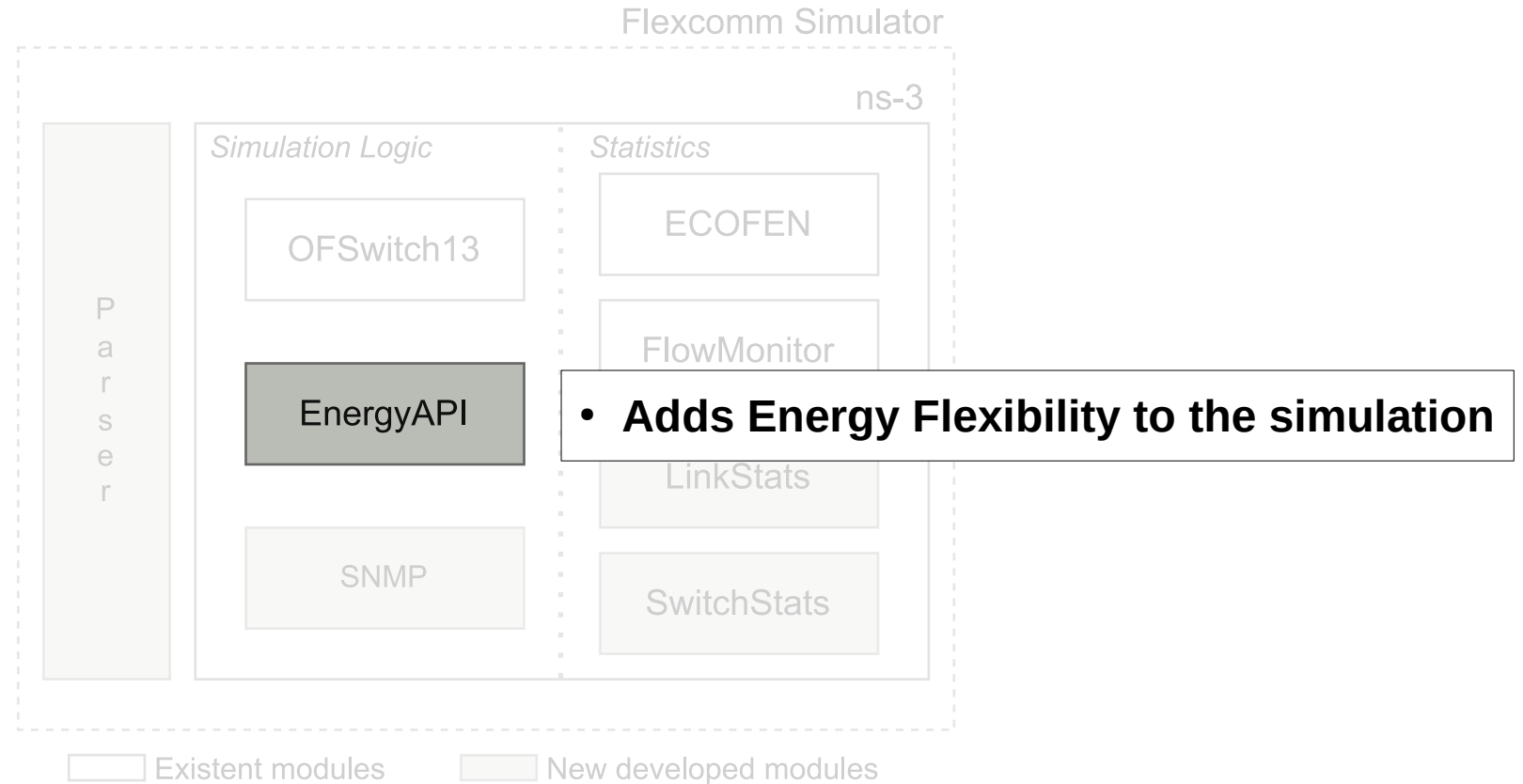
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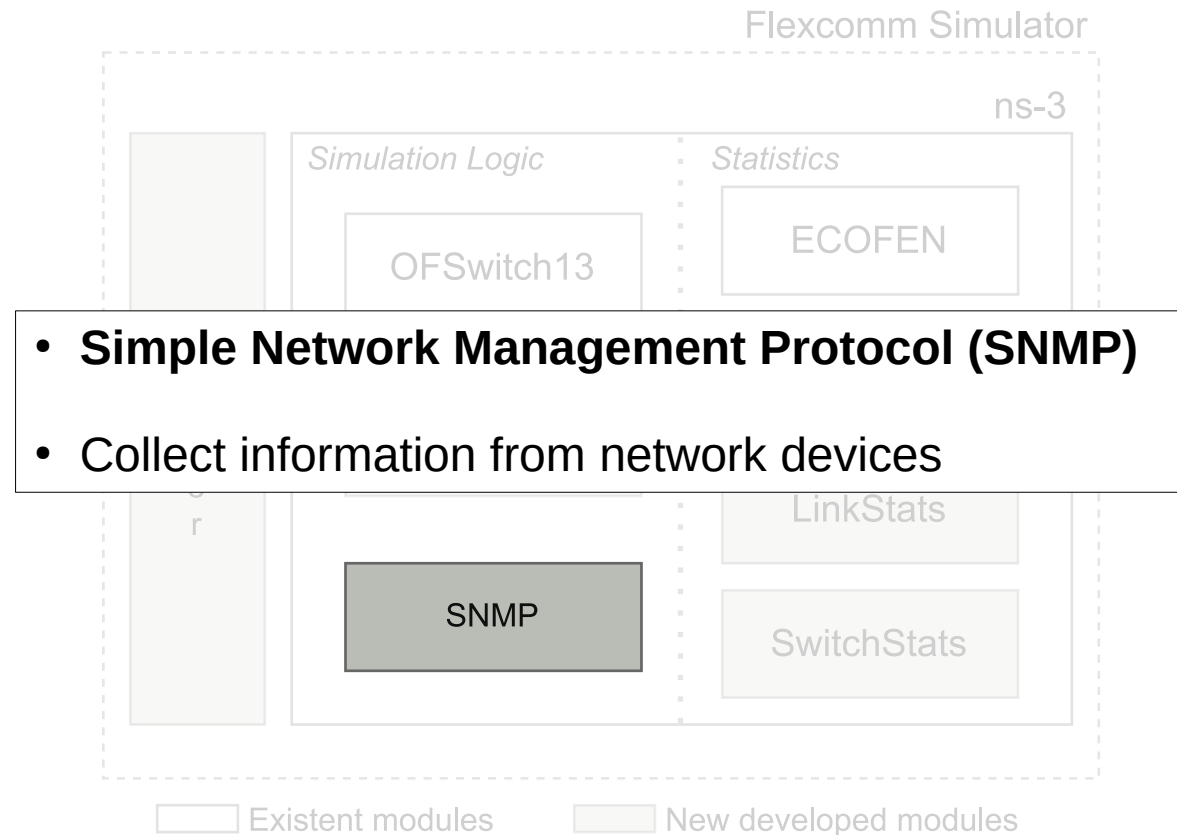
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Flexcomm Simulator

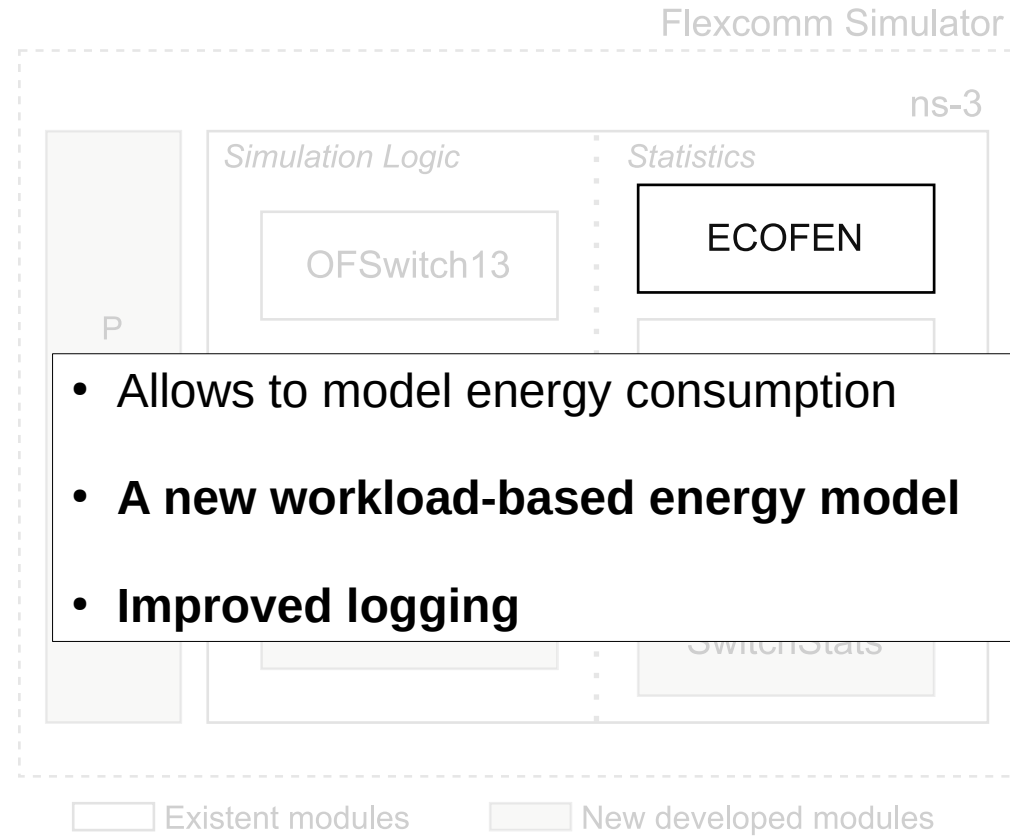
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- **Simple Network Management Protocol (SNMP)**
- Collect information from network devices

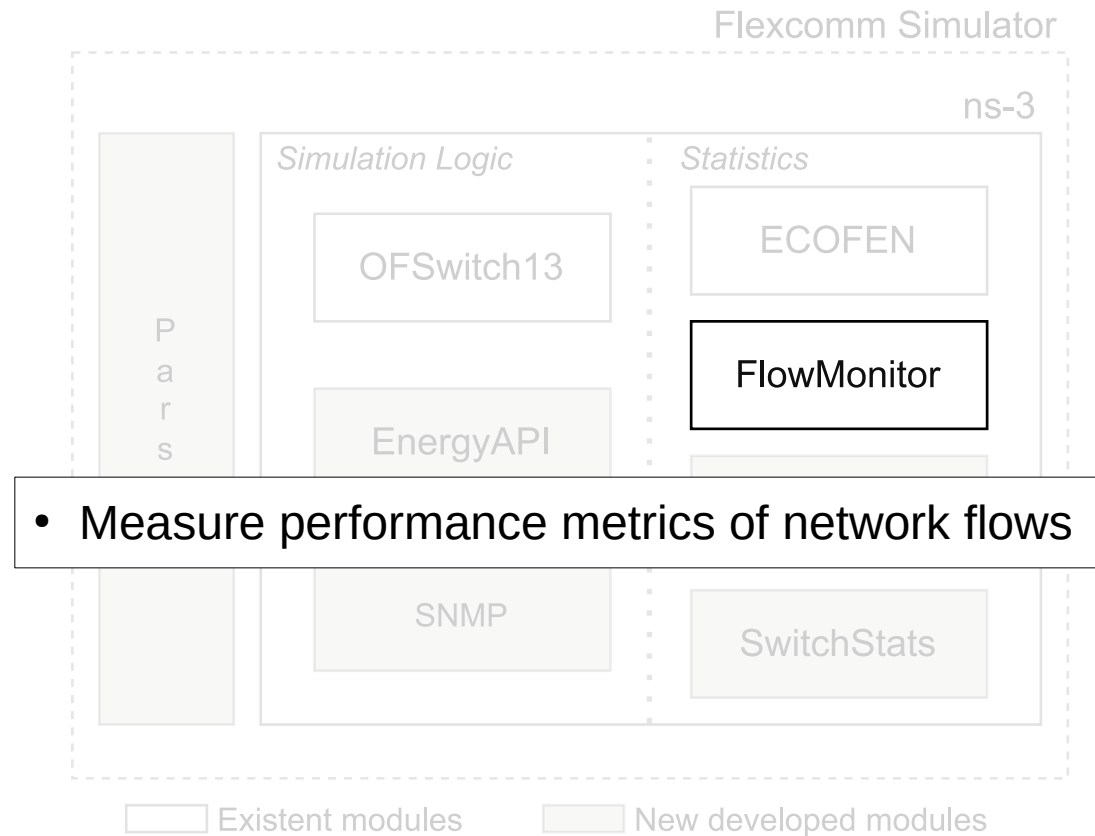
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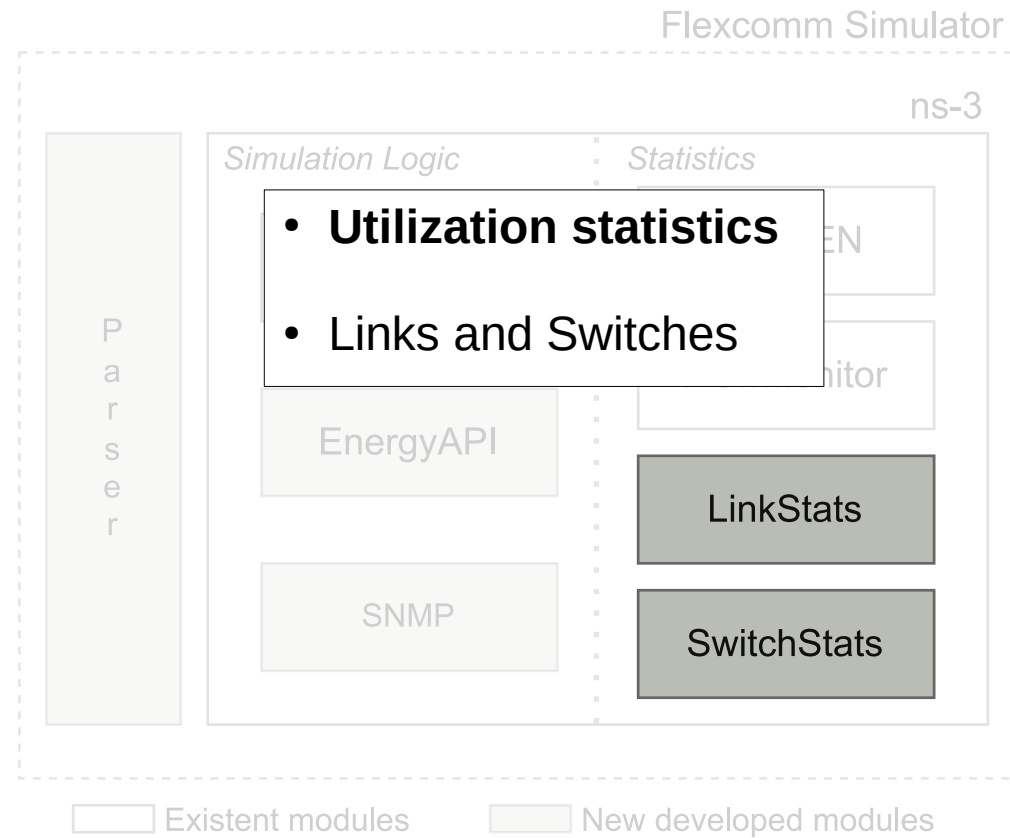
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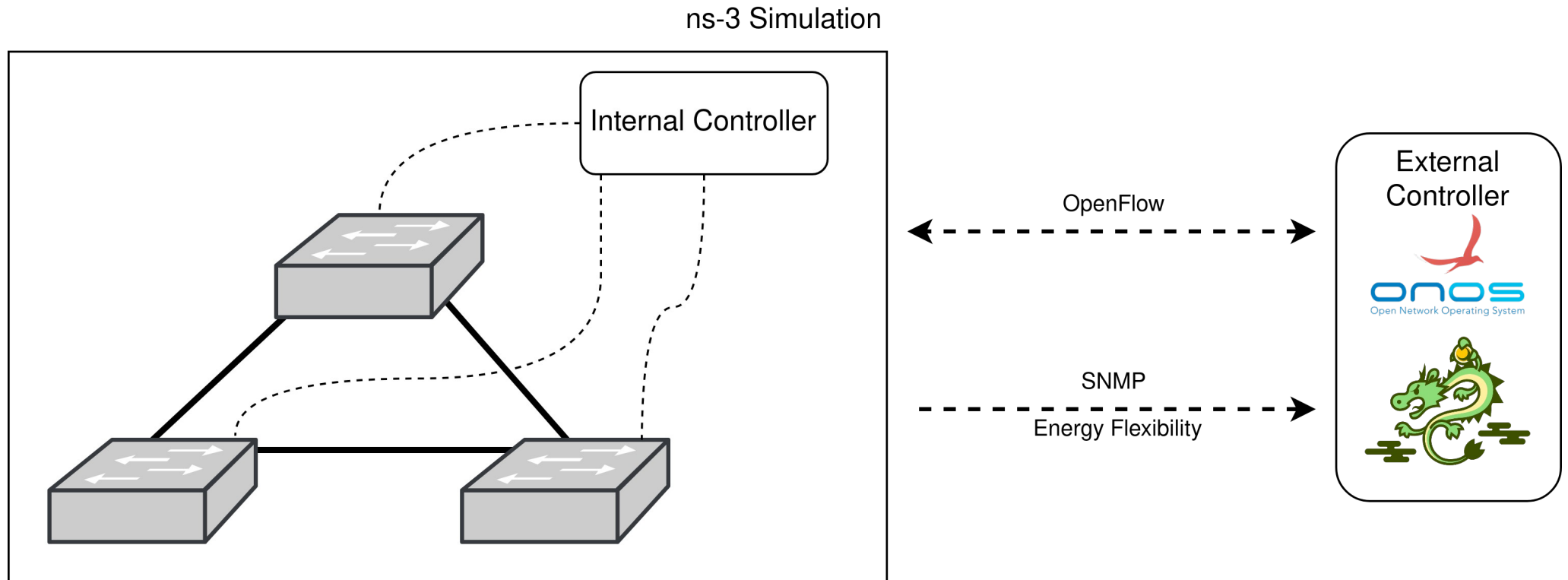
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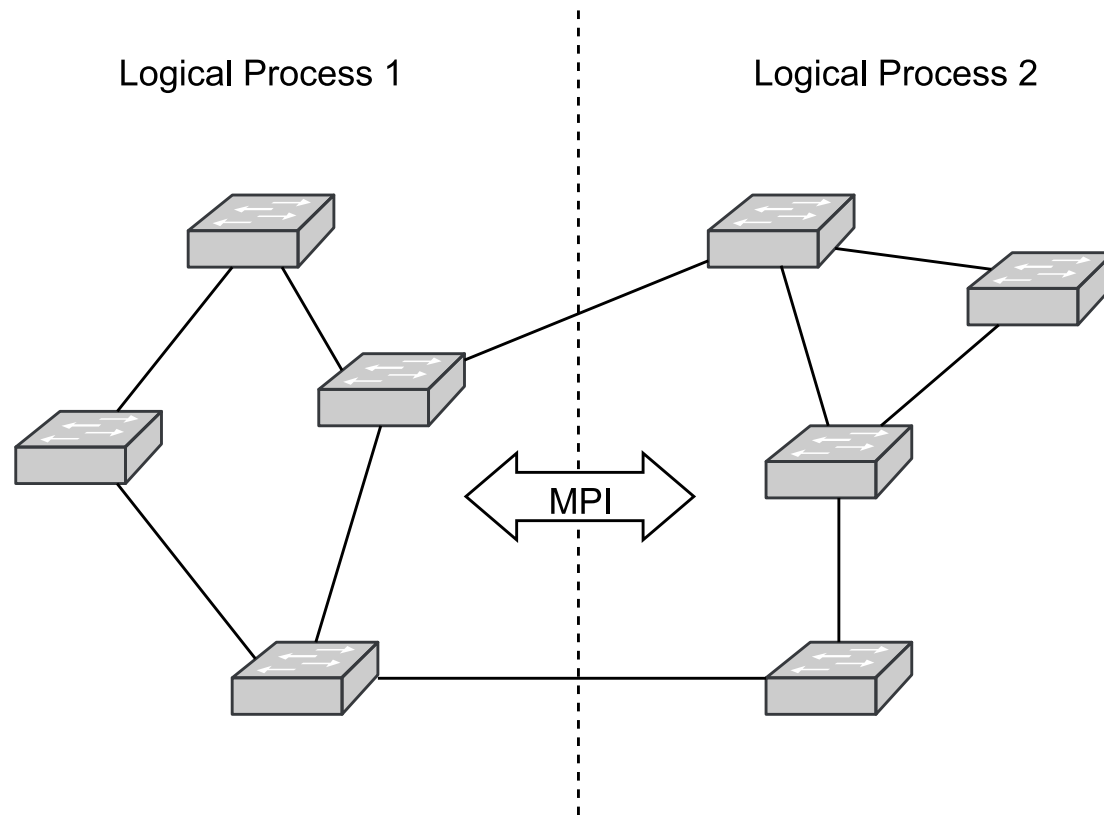
Flexcomm Simulator

- Internal and External SDN Controllers support



Flexcomm Simulator

- Distributed Simulations
- High Performance Computing infrastructures

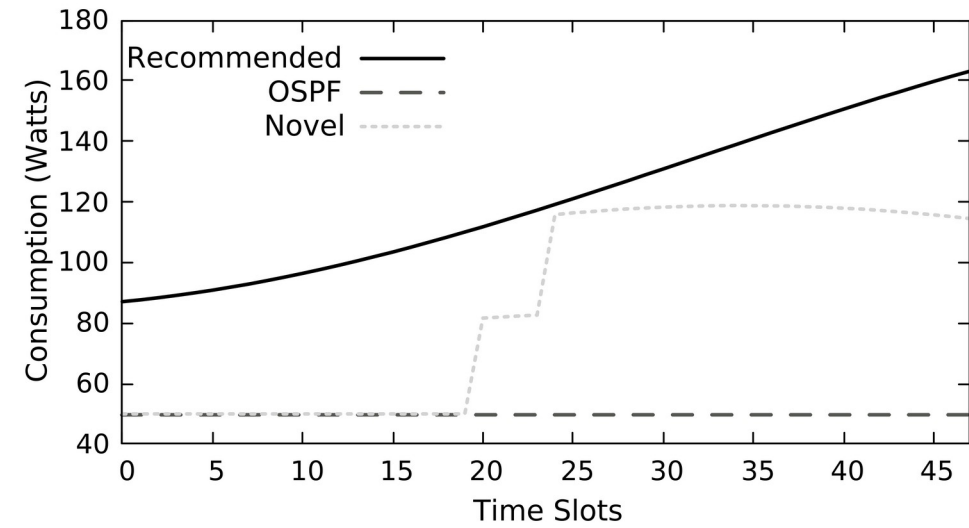
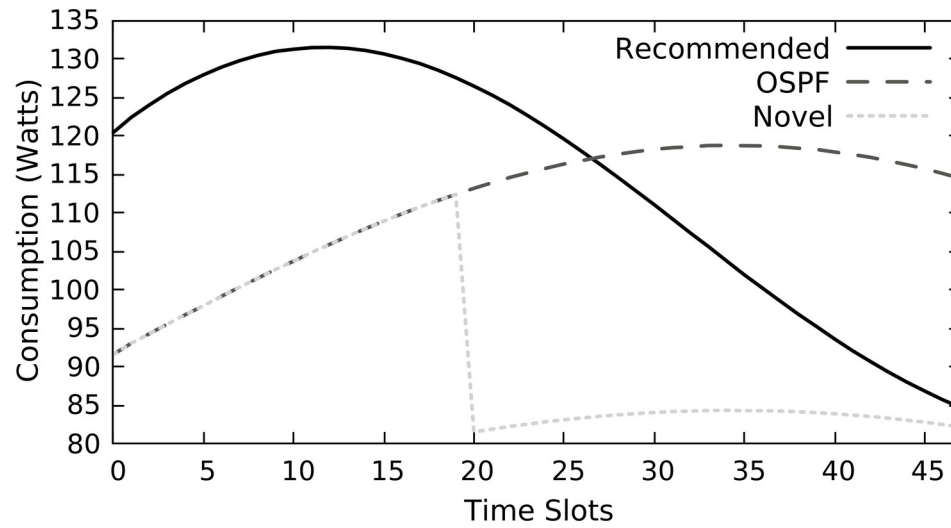
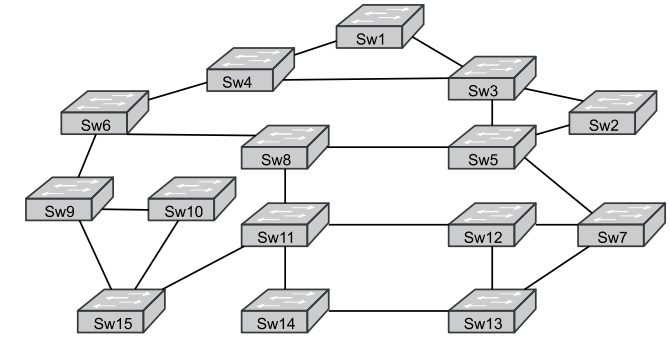




Proof of Concept

Energy Flexibility-Aware Routing

- Metropolitan Area Network (MAN)
- Energy Flexibility-Aware novel routing algorithm



Proof of Concept

Energy Flexibility-Aware Routing

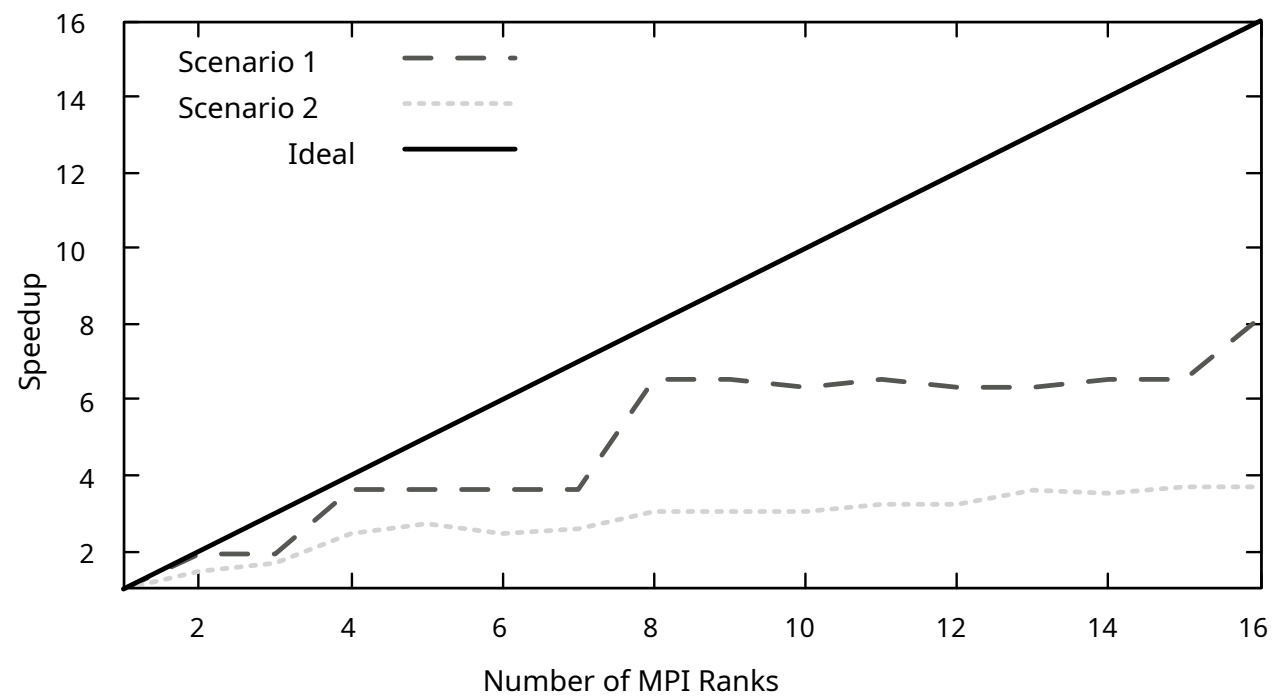
- Minimal Quality of Service (QoS) impact

Metric	OSPF	Novel
Maximum Delay (ms)	10.00	13.50
Minimum Delay (ms)	10.00	10.00
Mean Delay (ms)	10.55	12.68
Maximum Jitter (ms)	0.00	3.00
Minimum Jitter (ms)	0.00	0.00
Mean Jitter (ms)	0.00	0.00
Packet Loss (%)	0.00	0.00

Proof of Concept

Distributed Simulations

- Decrease simulation duration



Future Work

- Continuing the development of the Flexcomm Simulator
- **Development of more advanced energy flexibility-aware routing strategies**
 - Proactive decisions
 - Prioritize QoS sensitive communications (*e.g.*, VOIP)

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