Chair of Communication Networks
TUM School of Computation, Information and Technology
Technical University of Munich

Graph Neural Networking Challenge 2023

3rd Place Solution

Team LKN

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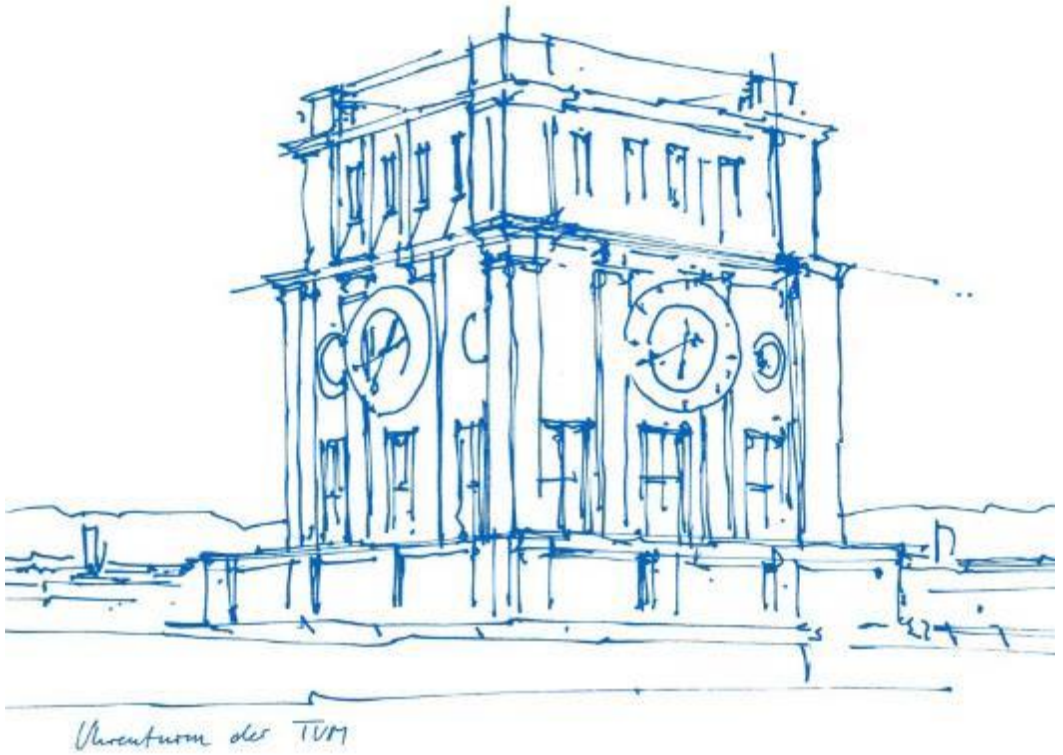
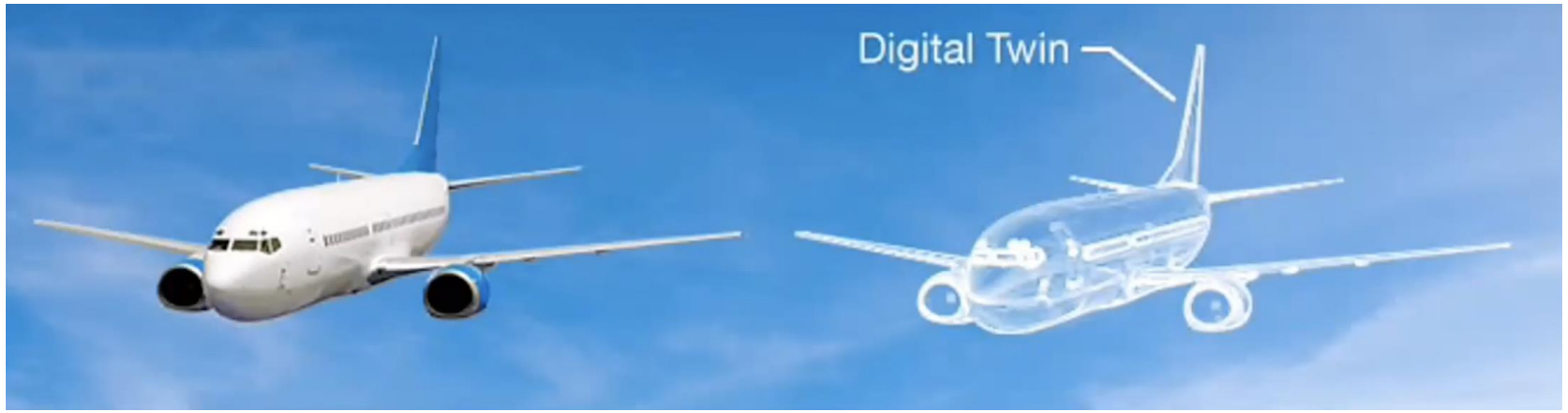


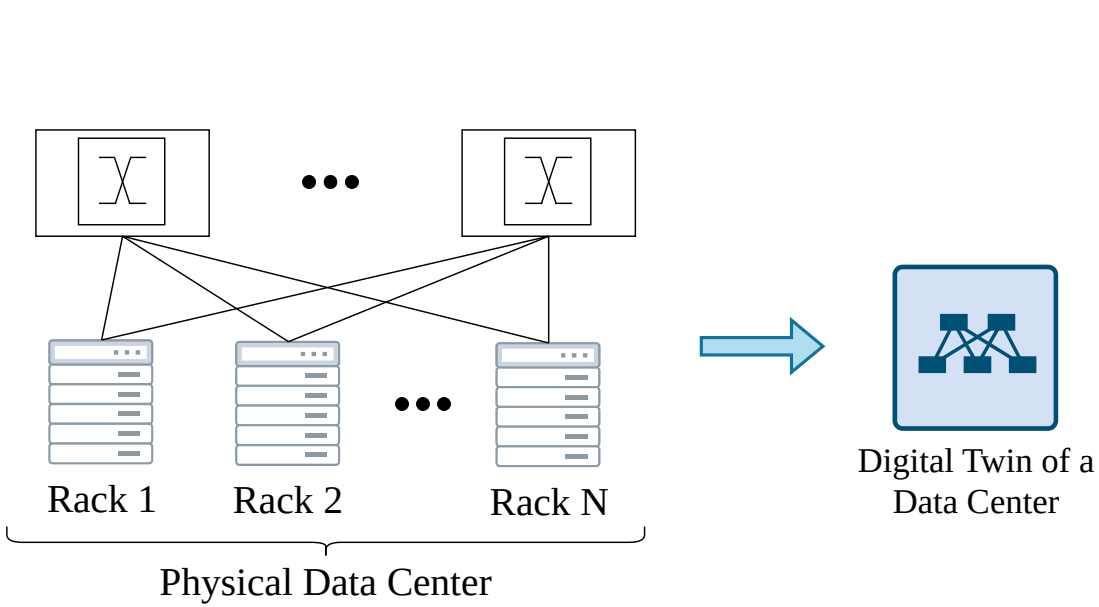
What is a Digital Twin (DT)?

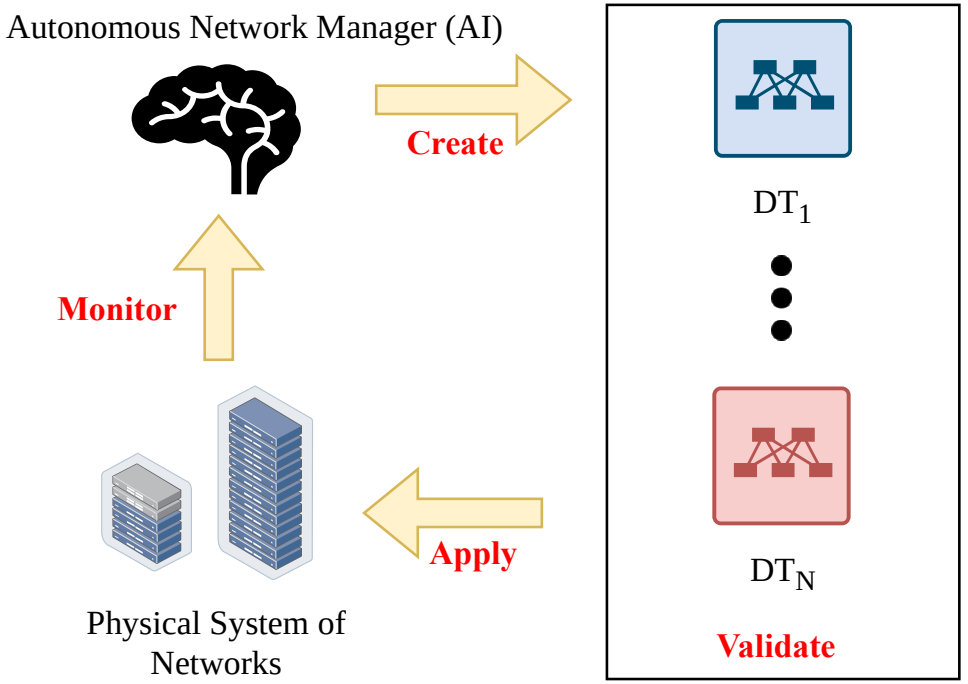
- A digital twin is a virtual representation of a physical object, person, or process, contextualized in a digital version of its environment.



- It enables *what-if analysis:*
  - *What will happen in case of an engine failure?*
  - *What would happen if the wingspan was greater?*

Network Digital Twin and AI Network Manager



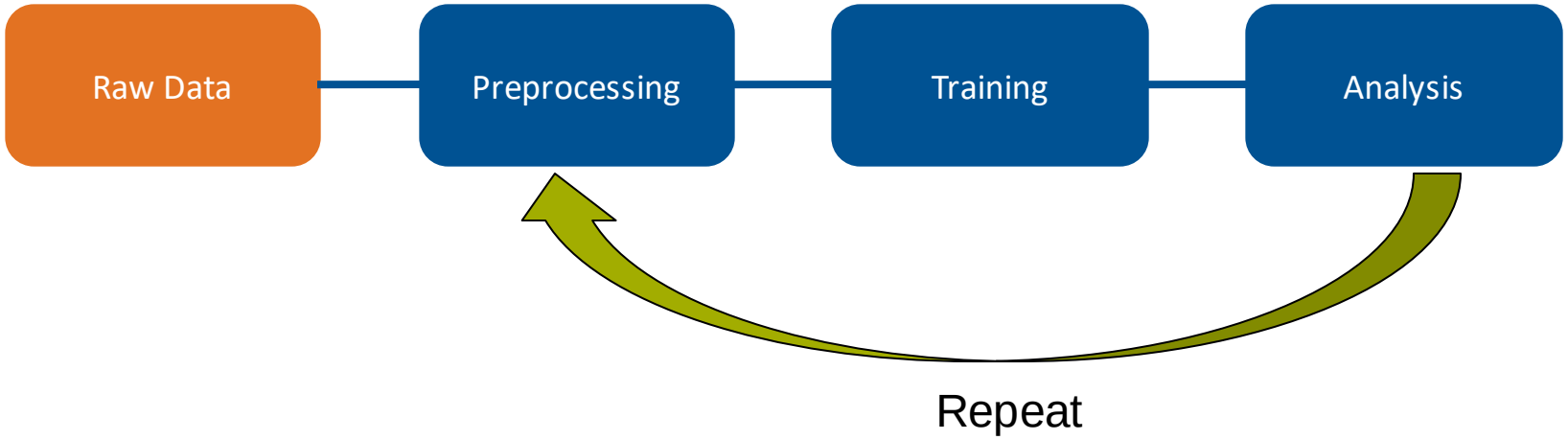


Existing ML-based models have been developed and trained using simulated data.

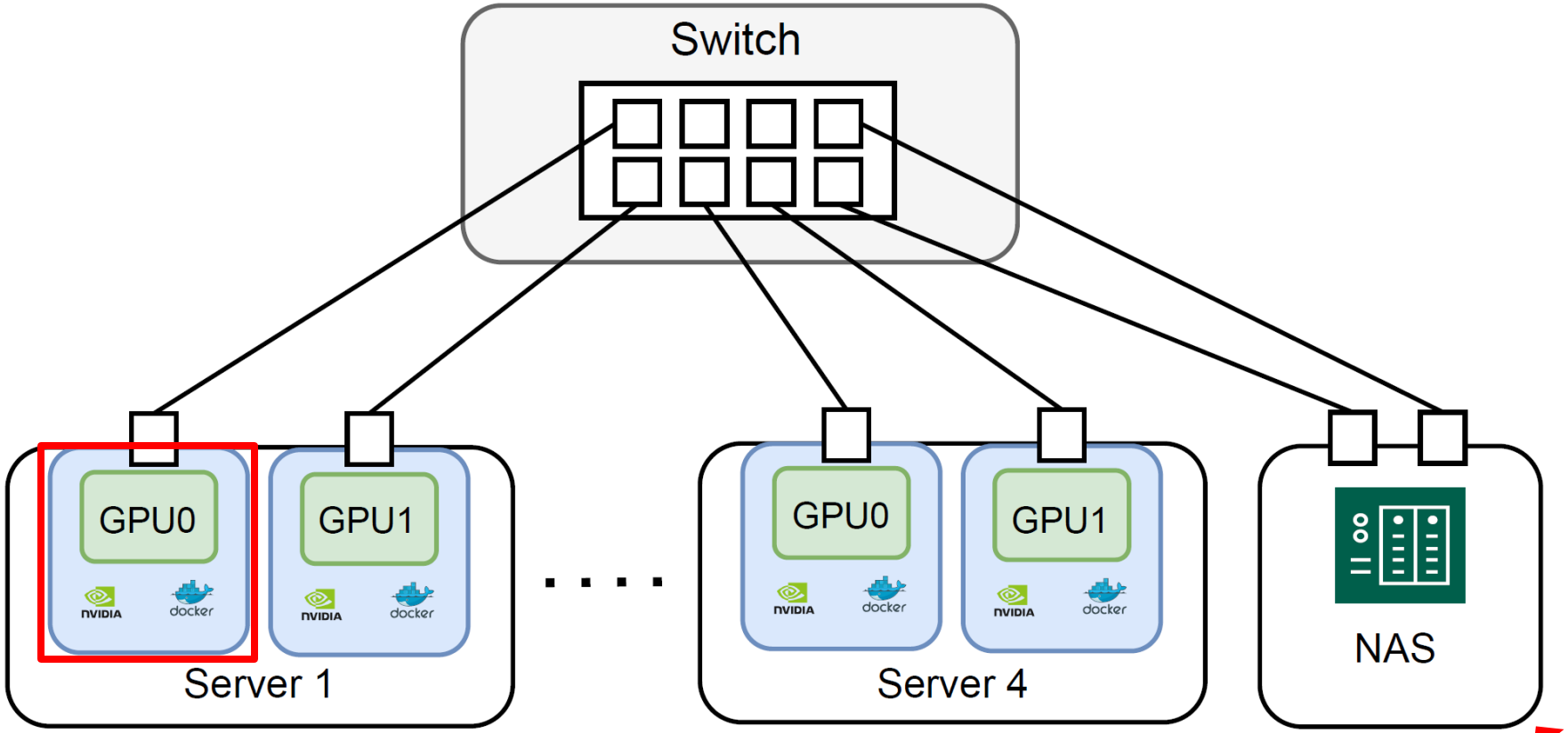
How would the models perform in a real network?

Let's participate in GNN Challenge 2023.

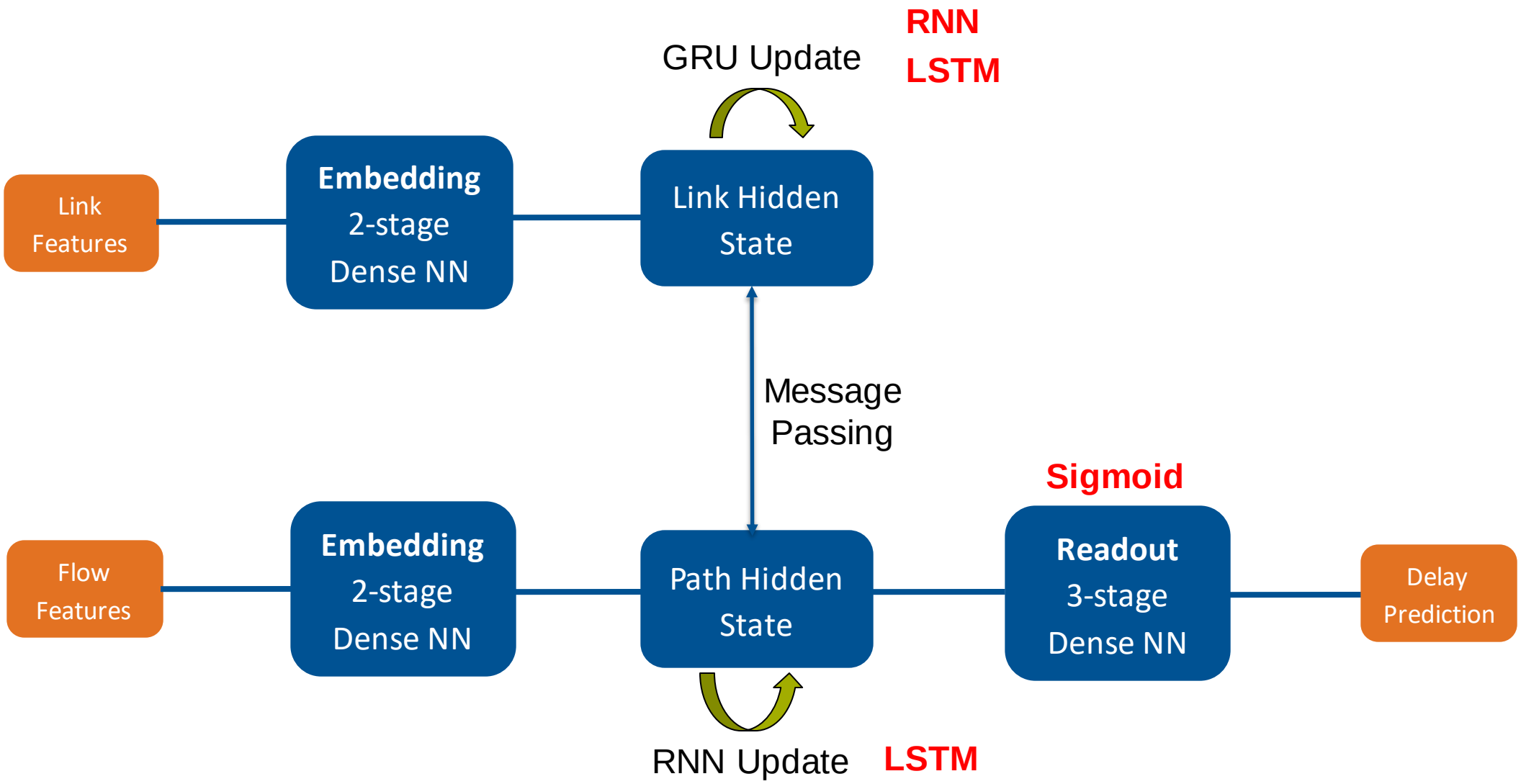
Approach



LKN Compute Testbed



Model Architecture



Hyperparameters

Parameter	Value
Link State Dimensions	64
Path State Dimensions	64
Readout Layer Size	64
Message Passing Rounds	8
Learning Rate	**0.001 (Adaptive)**
Optimizer	Adam
Loss	MAPE
Early Stopping	Δvalidation_loss < 1e-4

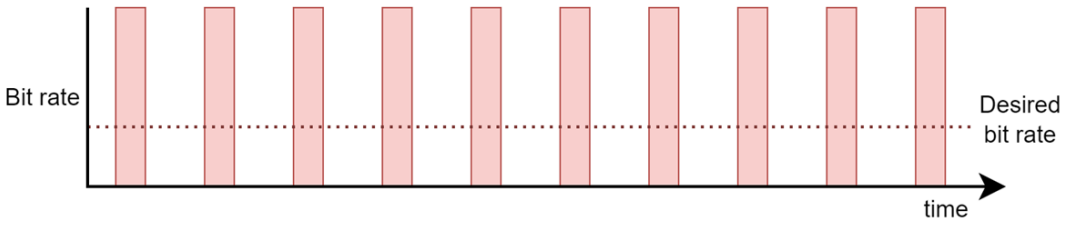
Layer Descriptions

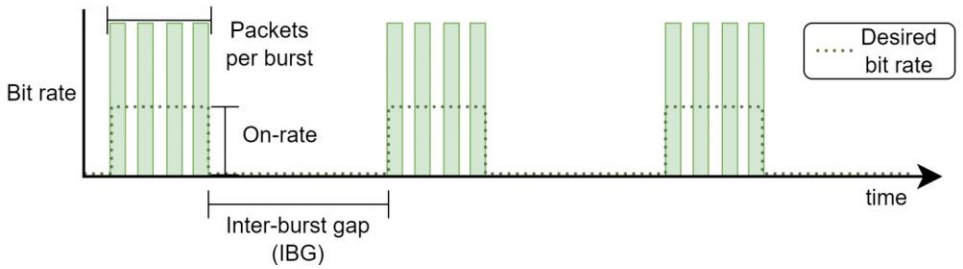
Parameter	Number of Units	Activation
Link Embedding (2 Layers)	64	RELU
Path Embedding (2 Layers)	64	RELU
Link Update	64	GRU
Path Update	64	GRU
Readout (3 Layers)	64	RELU

Leaky RELU

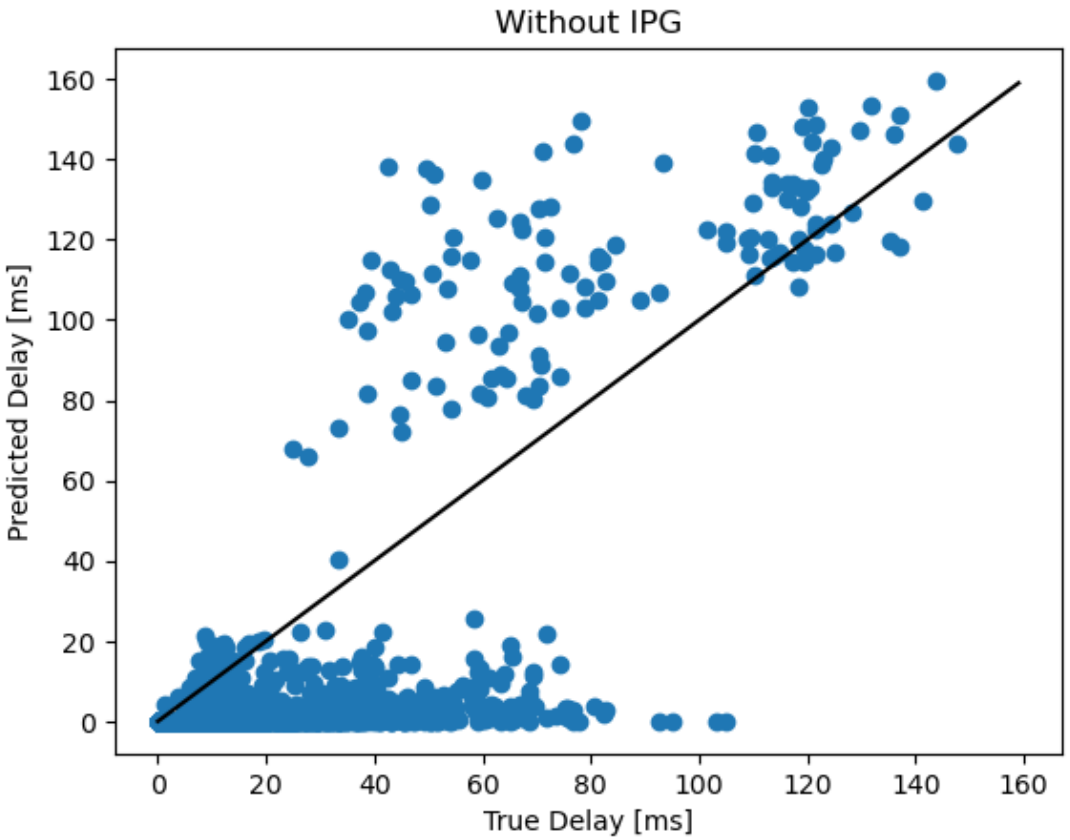
Features

Features
Average bandwidth per flow
Number of packets per flow
Size of the generated packets per flow
Flow type
Flow length (physical path)
Link capacity
List of links traced per flow
List of flows per link
Inter packet gap per flow (mean, var, percentiles)

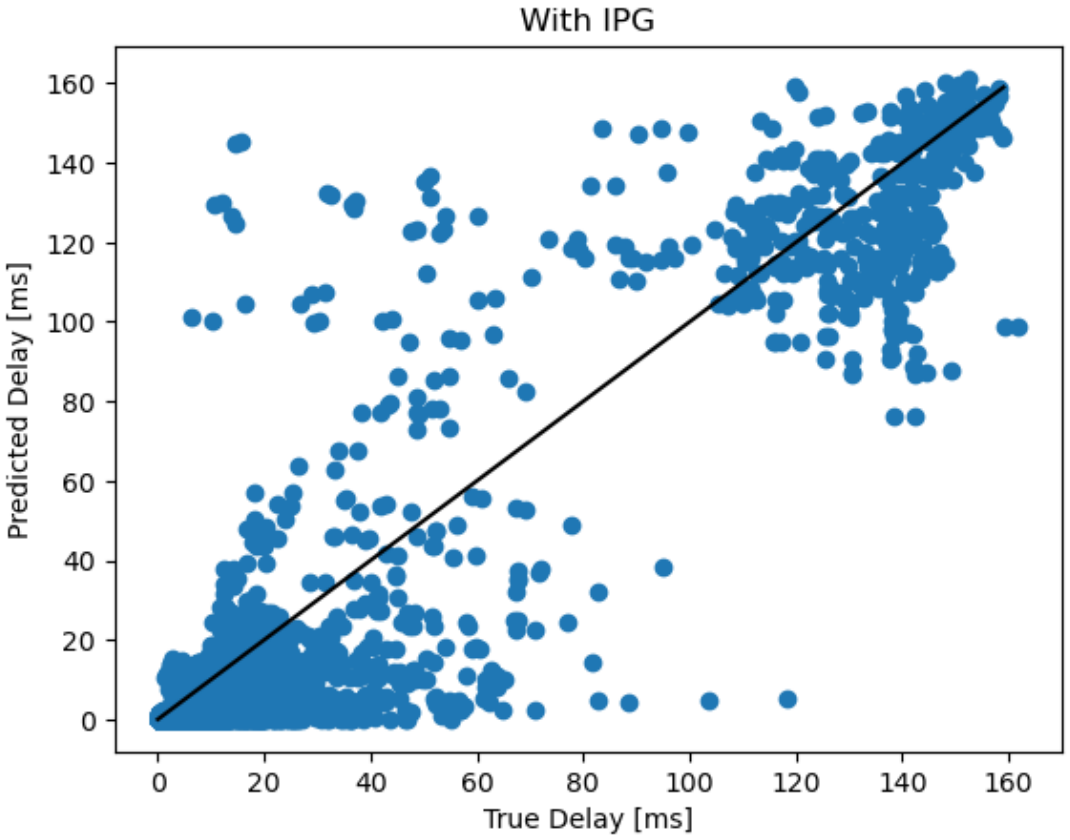




Results



Best Validation MAPE: 41.39
Test MAPE: ~45



Best Validation MAPE: 28.91
Test MAPE: 35.39

Outlook

- Real-world networks exhibit complex characteristics.
- Incorporating percentage of packet losses in a flow as a feature improves predictions.
- Queue Hidden State features may benefit the prediction accuracy.

Questions