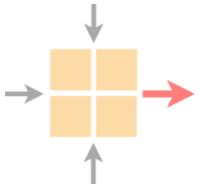
A Sleep Study for ISP Networks: Evaluating Link Sleeping on Real World Data

Lukas Röllin, Romain Jacob, Laurent Vanbever

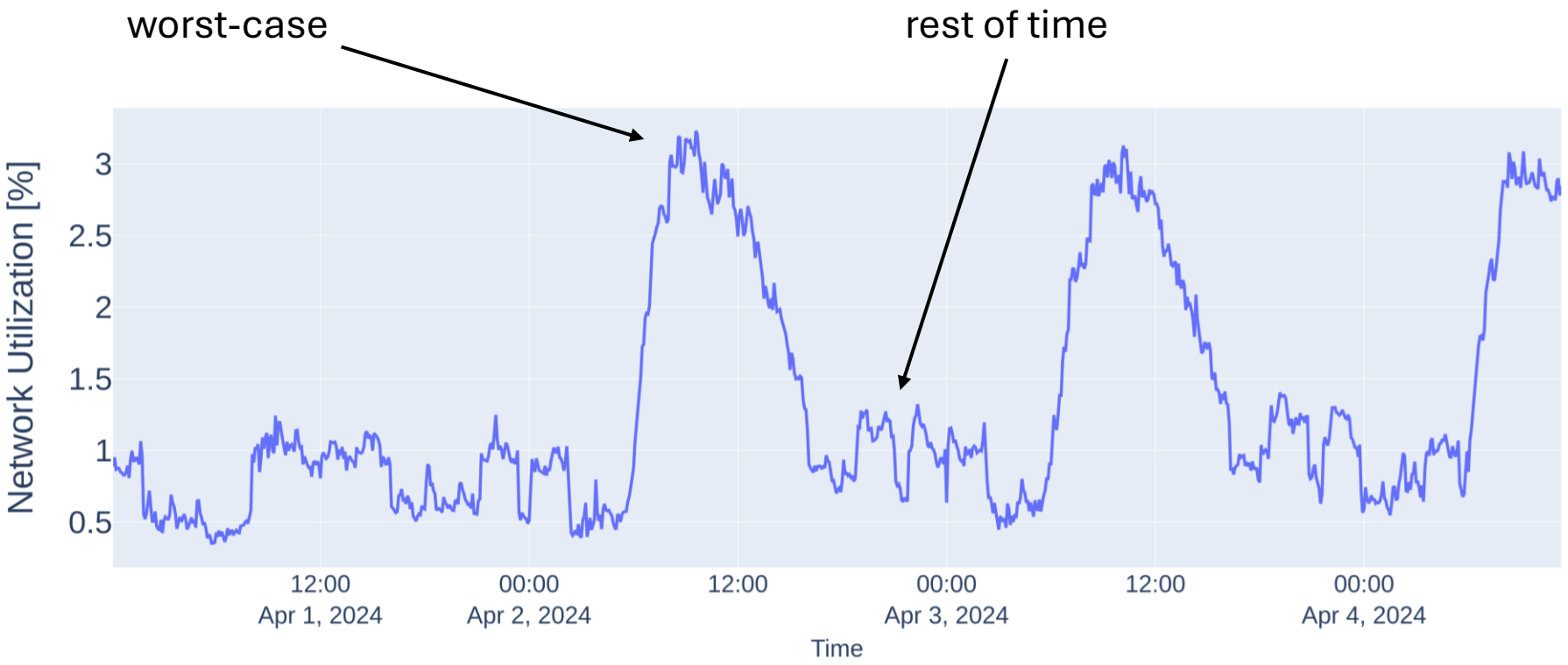
HotCarbon 24, July 9



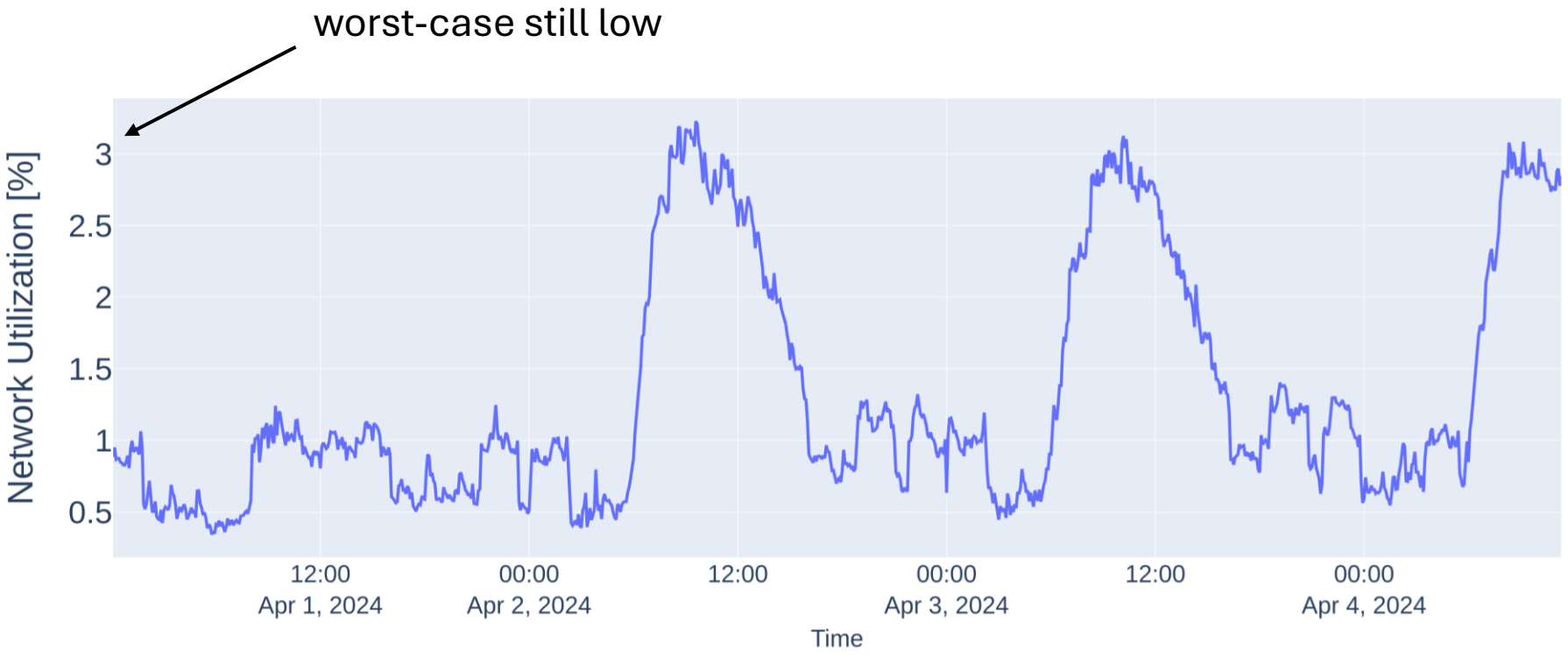
Networked Systems
ETH Zürich — seit 2015

ETH zürich

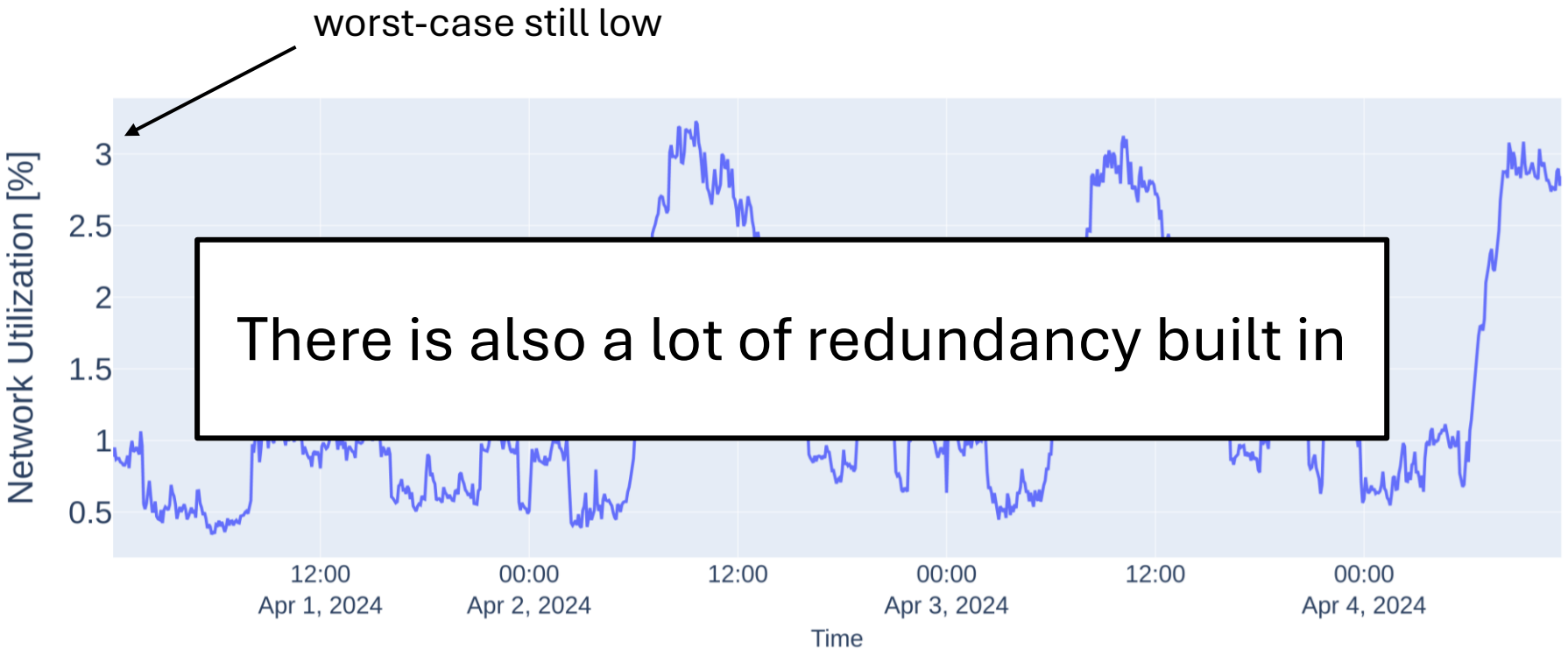
Networks are built with the worst-case scenario in mind



ISP link load data shows underutilization



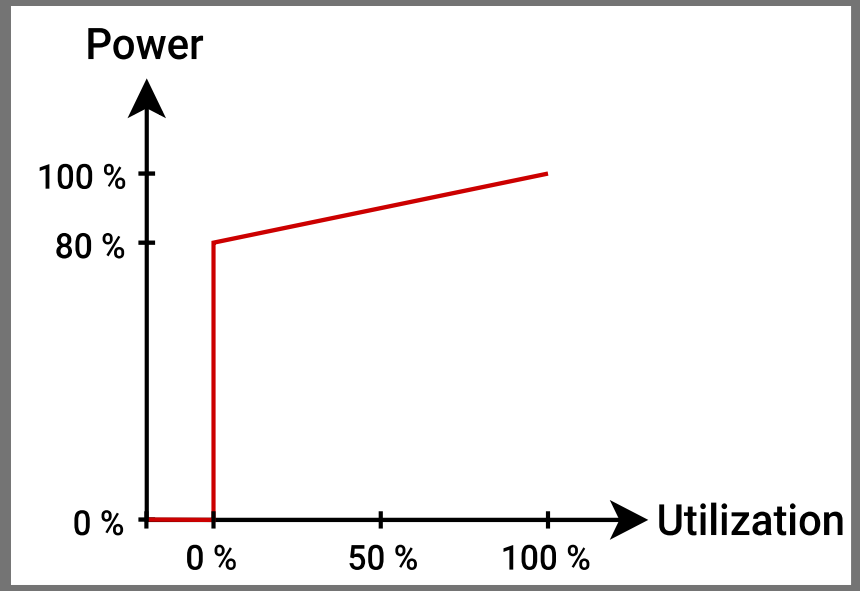
ISP link load data shows underutilization



There is also a lot of redundancy built in

Low utilization points to inefficient use of resources

Network ports are not power proportional



Low utilization points to inefficient use of resources

Energy savings by turning off links

Low utilization points to inefficient use of resources

Energy savings by turning off links

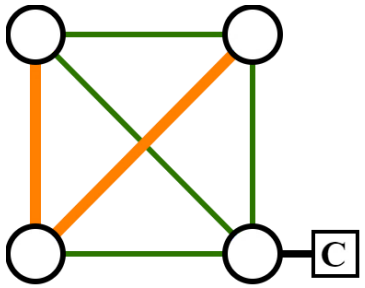
But what about causing congestion?

Can we turn off links without causing congestion?

Two real-world link load datasets:

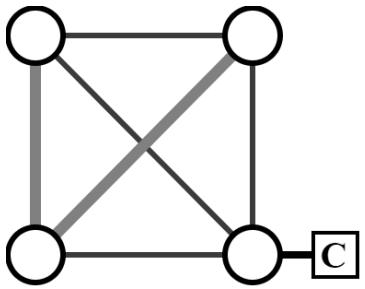
	ISP 1	**ISP 2**
Name:	SWITCH	SURFnet
Duration:	75 days	14 days
Nodes:	143	462
Links:	230	745
Avg. Load:	2.1%	1.2%

Low Load Medium Load High Load Sleep Candidate Link asleep Wake up messages

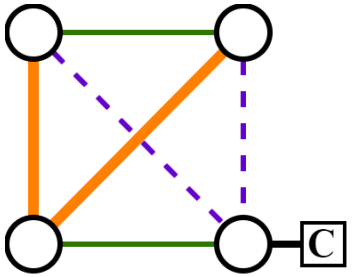


Collect
Link Loads

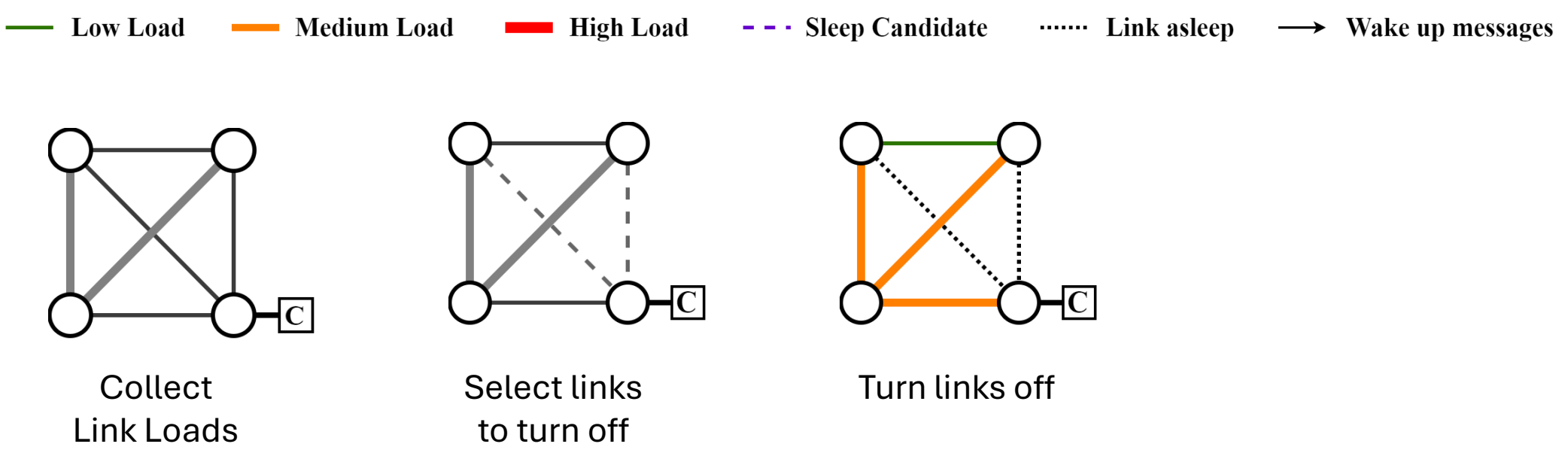
Low Load Medium Load High Load Sleep Candidate Link asleep Wake up messages

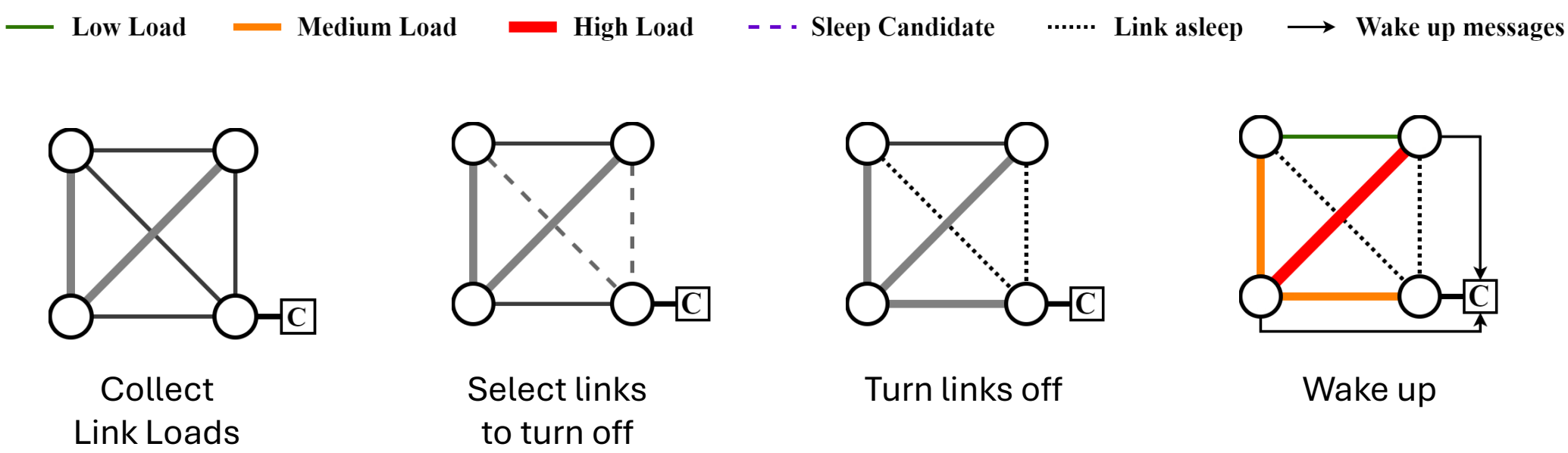


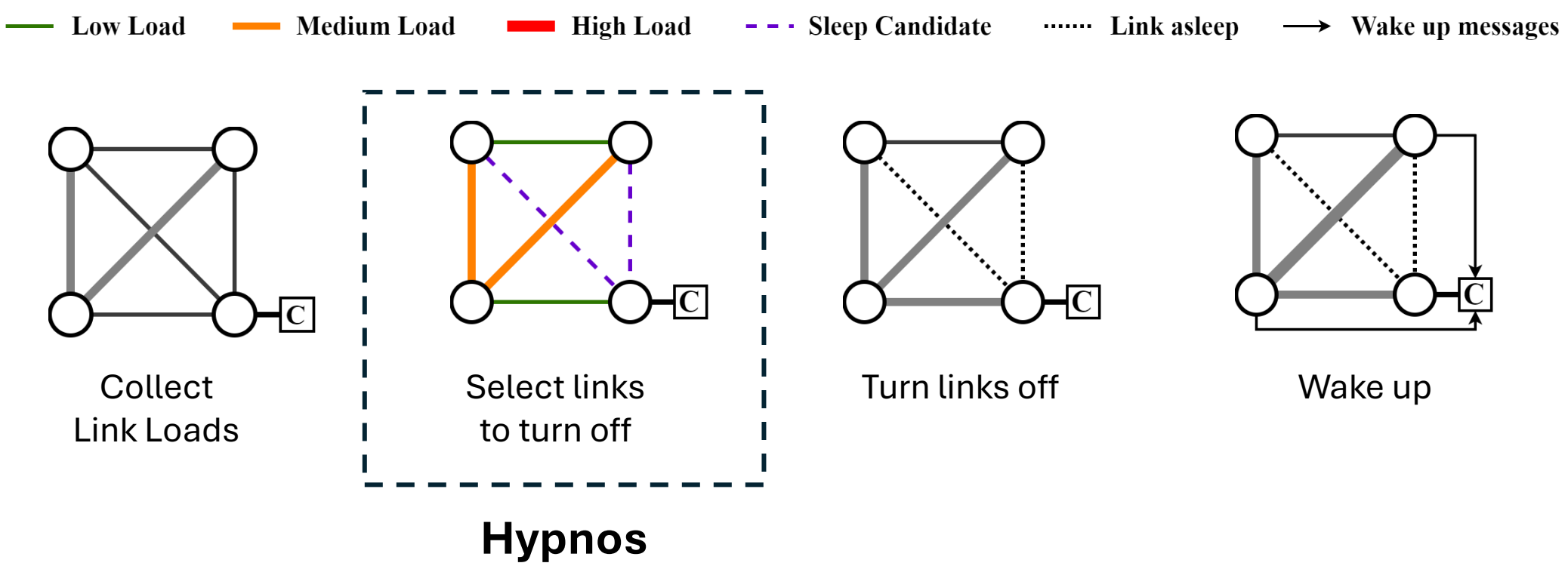
Collect
Link Loads



Select links
to turn off


Low Load
Medium Load
High Load
Sleep Candidate
Link asleep
Wake up messages
C
C
C
Collect
Link Loads
Select links
to turn off
Turn links off


Low Load
Medium Load
High Load
Sleep Candidate
Link asleep
Wake up messages
C
C
C
C
Collect
Link Loads
Select links
to turn off
Turn links off
Wake up


Low Load
Medium Load
High Load
Sleep Candidate
Link asleep
Wake up messages
C
Collect
Link Loads
Select links
to turn off
Turn links off
Wake up
Hypnos

Simple algorithm sufficient for savings

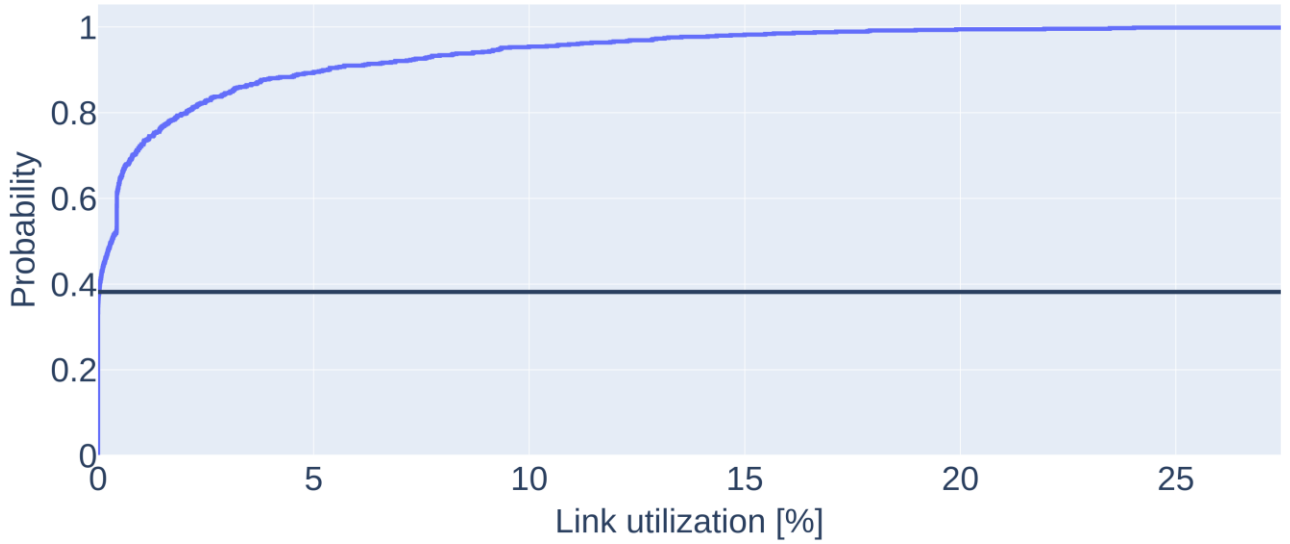
Hypnos can turn off 1/3 of links

without congestion

Simple solution works well due to lots of unused links

Lots of unused links, no problem turning them off

Shortest path routing focuses traffic on specific links



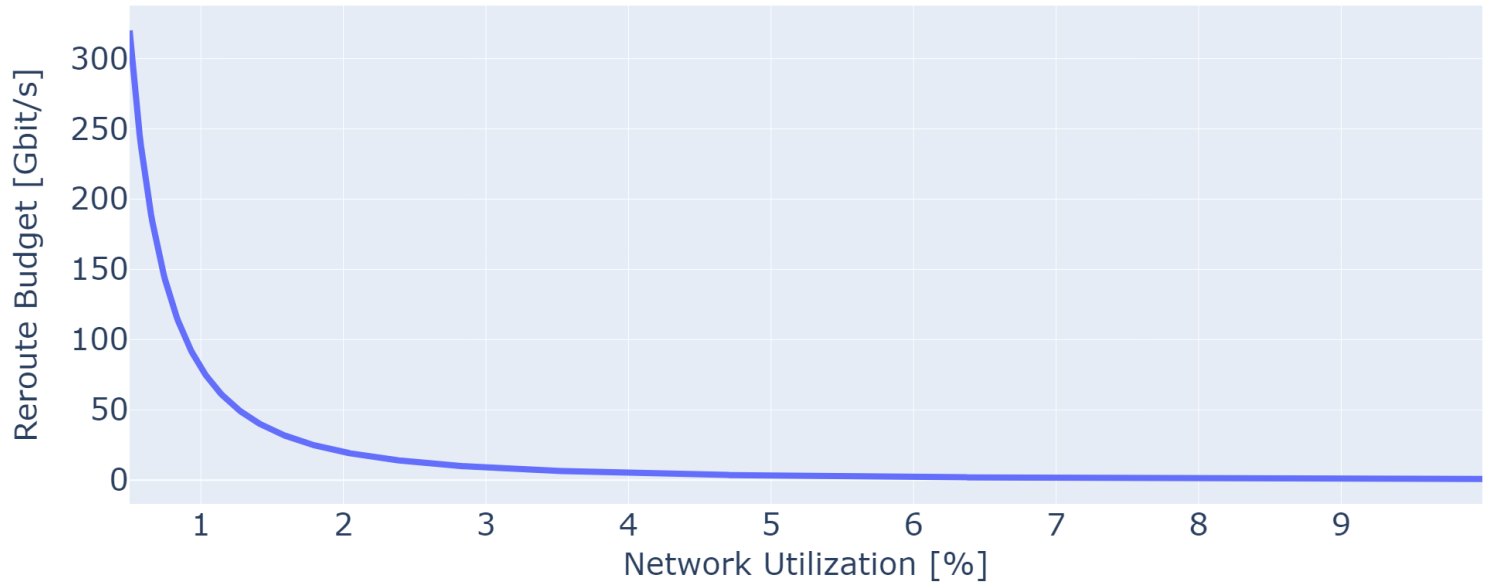
Max. without disconnecting

Hypnos makes decision according to simple rules

1. Prioritize low utilization links
2. Limit the total amount of rerouting
3. Check for local bottlenecks
4. Make sure the network stays connected

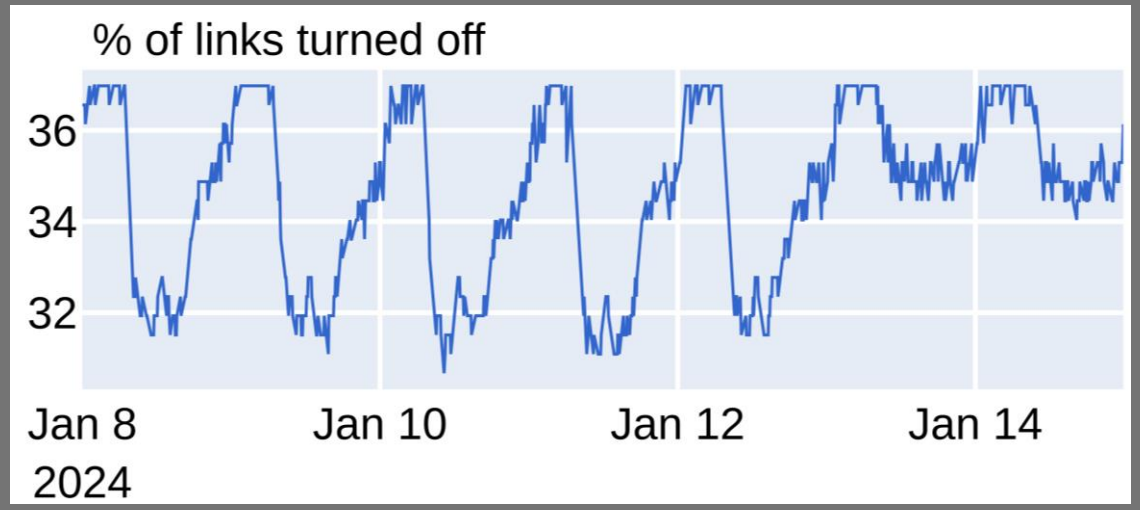
Reroute budget limits algorithm especially at higher load

$$\text{Reroute Budget} \sim \frac{Total\ Link\ Capacity}{Network\ Utilization^2}$$

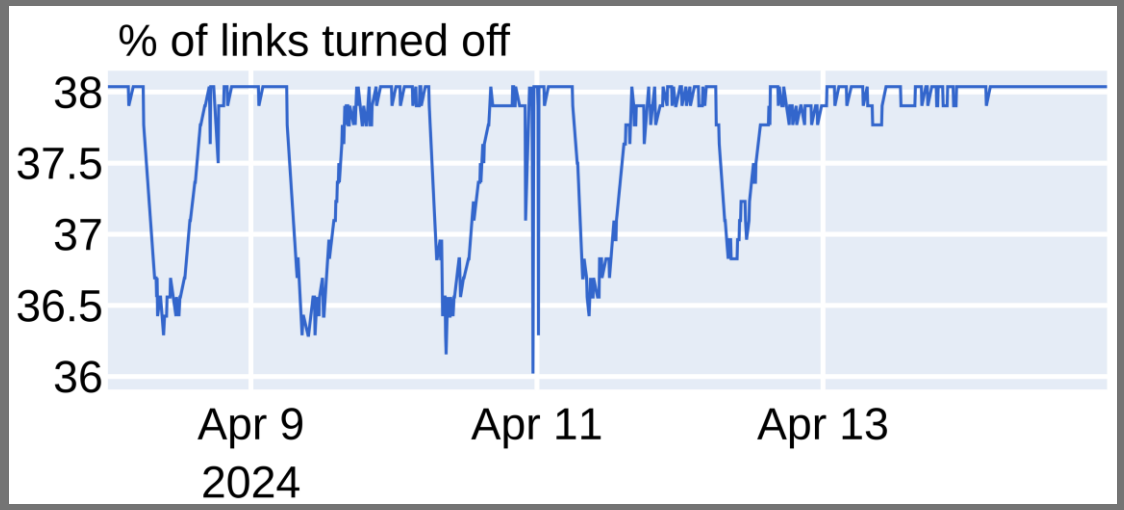


Around 1/3 of links can be turned off on average

ISP 1

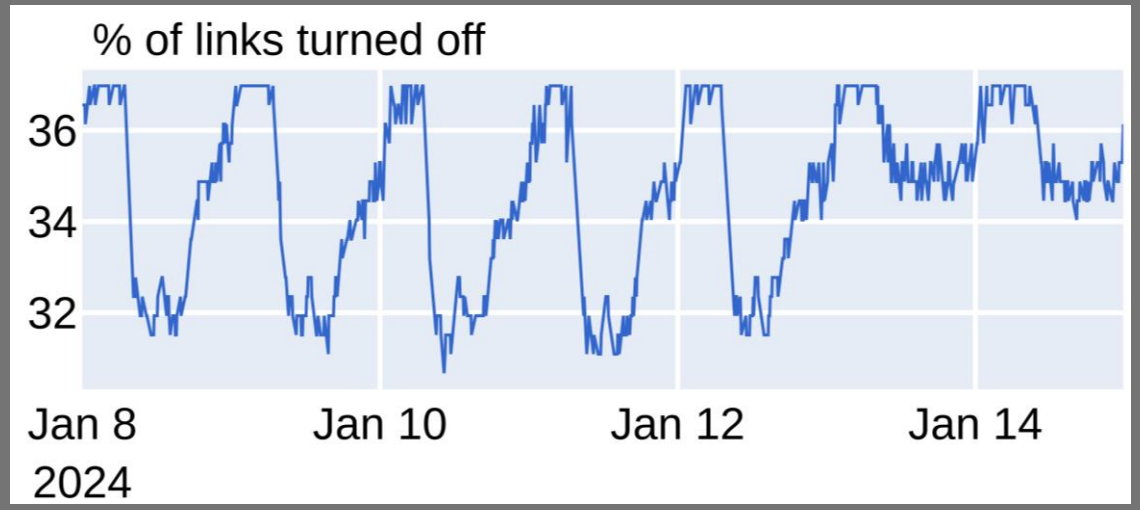


ISP 2

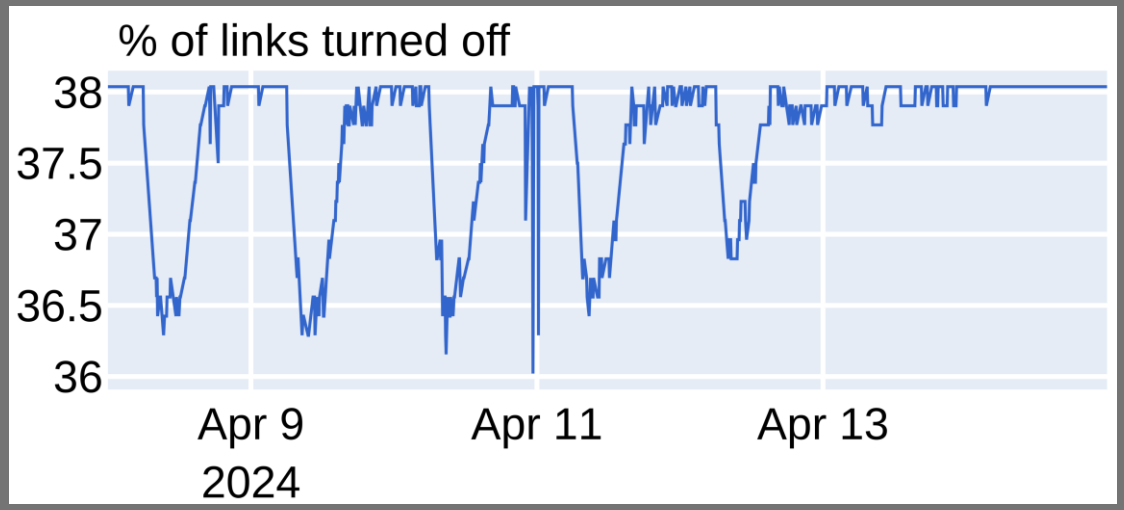


Around 1/3 of links can be turned off on average

ISP 1



ISP 2



No congestion when looking at 5-minute load averages

Translating turned off links into power savings

We need two things

Translating turned off links into power savings

We need two things

1. Transceiver Power

LR transceiver power numbers

Capacity	1G	10G	100G	400G
Power	1W	1W	4W	10.5W

Translating turned off links into power savings

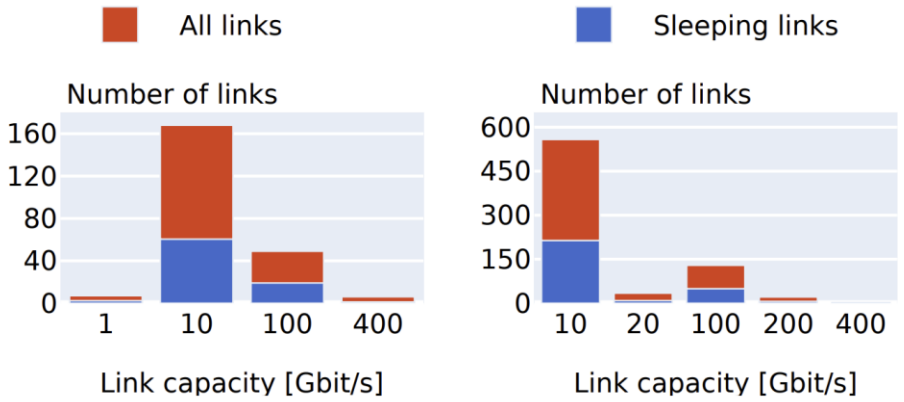
We need two things

1. Transceiver Power

LR transceiver power numbers

Capacity	1G	10G	100G	400G
Power	1W	1W	4W	10.5W

2. Speed of sleeping links



Translating turned off links into power savings

ISP 1

300W / 850W

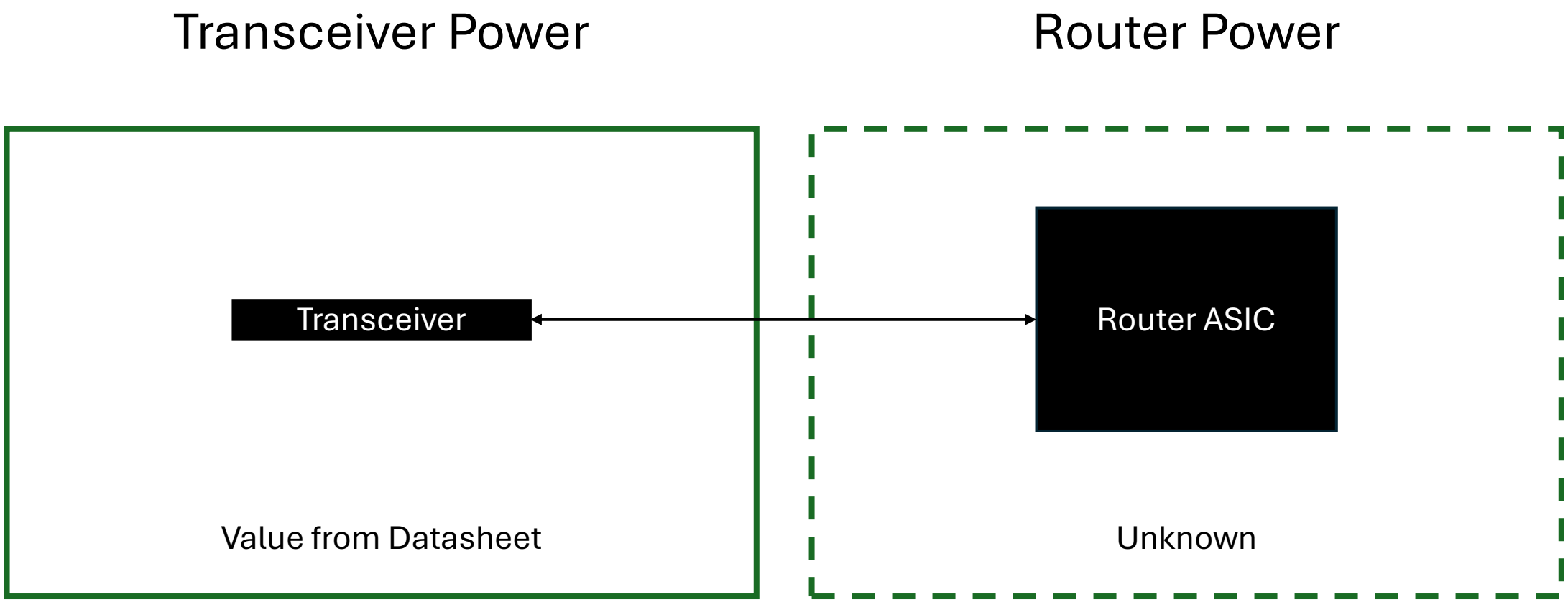
saved on transceiver power

ISP 2

950W / 2700W

saved on transceiver power

Estimating router side savings is hard



Further investigation necessary

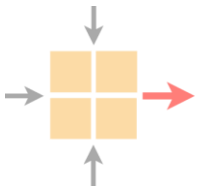
No evaluation on “live” traffic only 5-minute averages

No flow level information available

A Sleep Study for ISP Networks: Evaluating Link Sleeping on Real World Data

Lukas Röllin, Romain Jacob, Laurent Vanbever

A simple algorithm seems to be sufficient for savings but needs further study in real environments



Networked Systems
ETH Zürich — seit 2015

ETH zürich

Savings are still possible even if we require redundancy

Keeping the network 2-connected

Number of links (%)	1-connected	2-connected
ISP 1	85 (36%)	43 (18%)
ISP 2	280 (38%)	52 (7%)