Internet dove
gli altri non arrivano

TRAFFIC ENGINEERING

The EOLO way of life

The people

eolo Internet dove gli altri non arrivano

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About EOLO

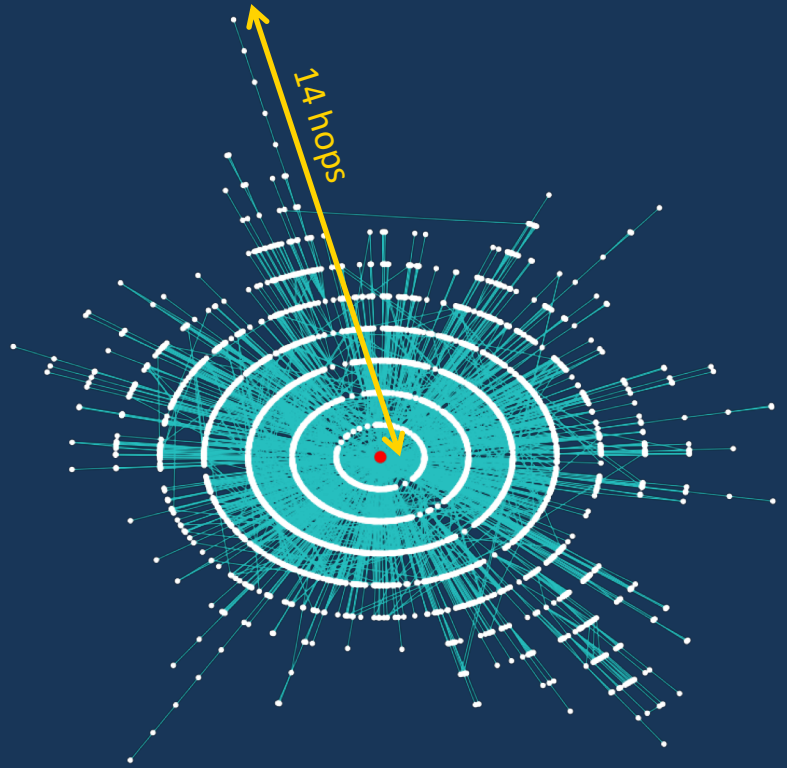
Internet dove gli altri non arrivano

Italy coverage

- Fixed Wireless Access ISP
- 350k customers
- From 30Mbps to 1Gbps connectivity and white-label wholesale
- 15k new customers/month
- 90% of backhaul links are radio links

The EOLO network

Huge, high mesh-factor, single L2 domain!



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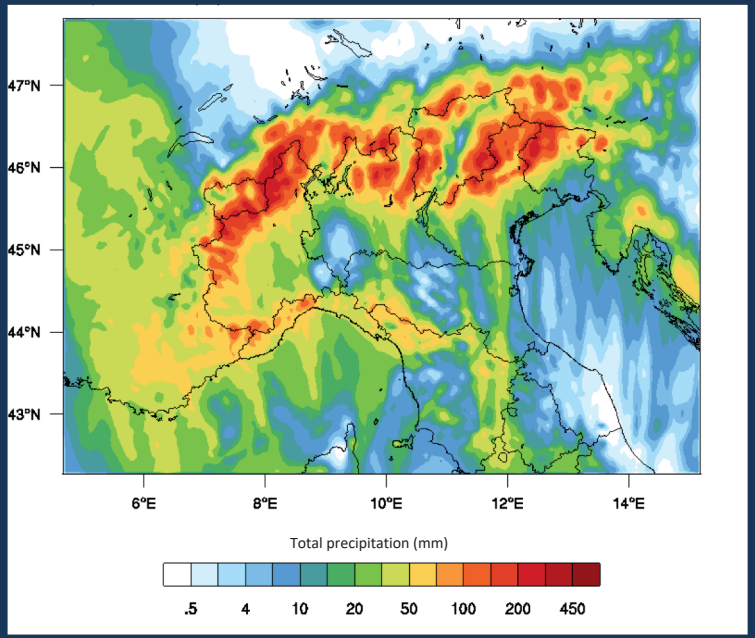
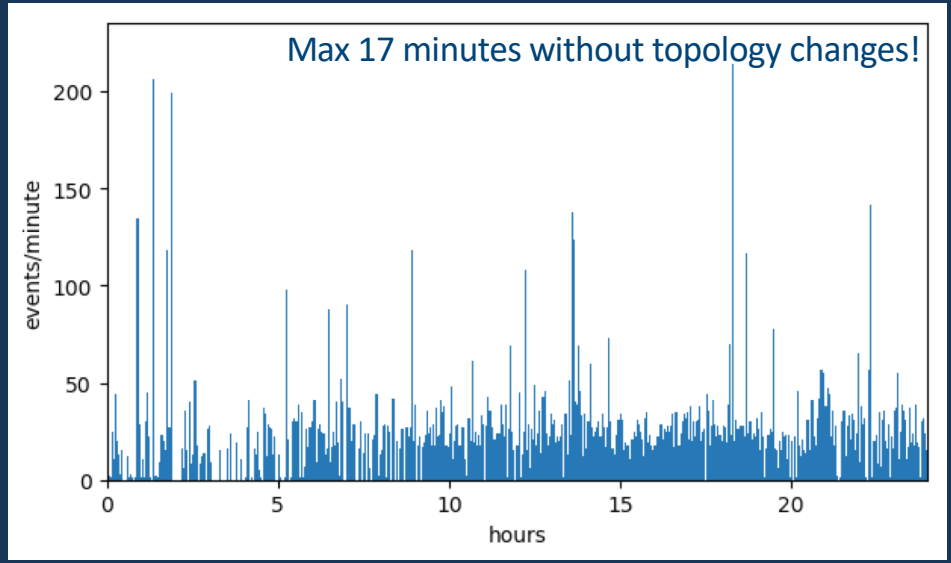
The EOLO network

Radio links in bad weather conditions

29/10/18 24h rainfall forecast over Italy



29/10/18 topology changes (30k events in 24h)



The «BLU» project

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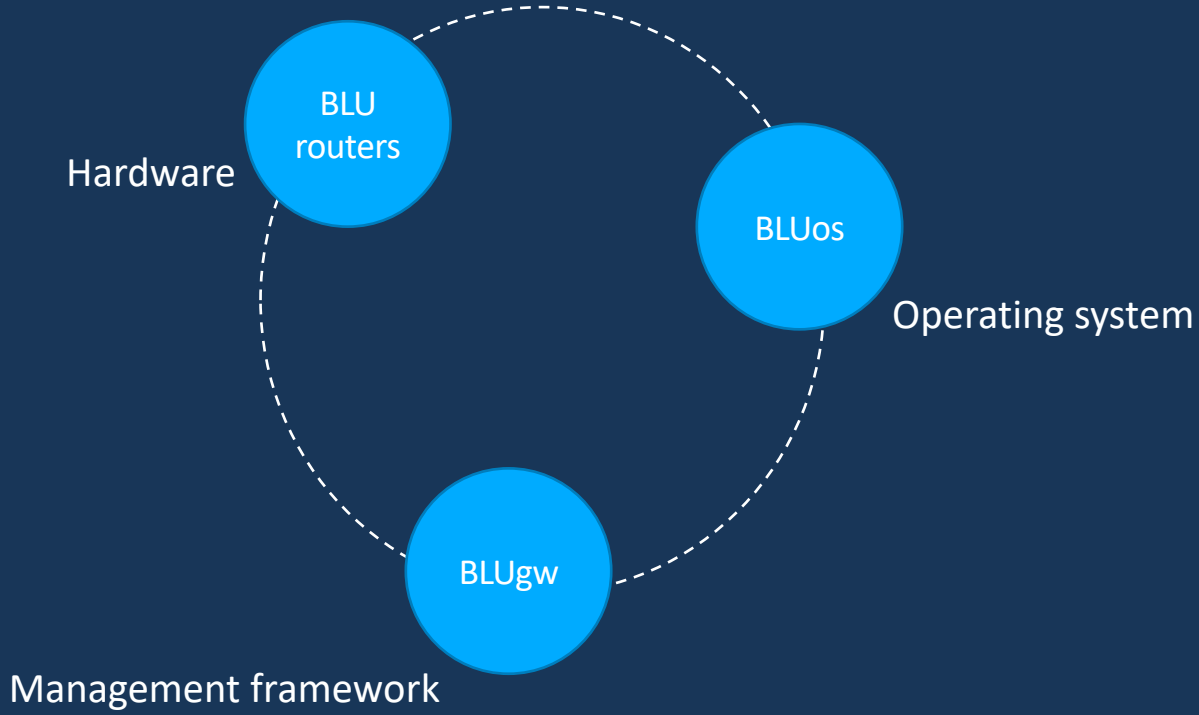


BLU routers

Internet dove gli altri non arrivano

BLU «model 1»

- TILEgx architecture
- 72 cores
- 24x 1G ports
- 2x 10G ports
- 16 GB RAM
- 128 GB SSD
- 90 Watt (average)
- 1800 hosts deployed from 1Q 2016

BLU «model 2 POP»

- x86 architecture
- 32 cores Intel based CPU
- 8x 1G ports
- 16x 10G ports
- 48 GB RAM
- 256 GB SSD
- 210 Watt (average)
- From 4Q 2018

BLU «model 2 BTS»

- x86 architecture
- 24 cores Intel based CPU
- 24x 1G ports
- 8x 10G ports
- 24 GB RAM
- 256 GB SSD
- 180 Watt (average)
- From 4Q 2018

IEEE 1613 compliant:

- Electromagnetic compatibility
- Error-free operation in -15°C / +75°C environment
- EMI fields of up to 180V/m

BLUos

Internet dove gli altri non arrivano

Linux based OS

- Linux 3.10.61 (for TILEgx), Linux 4.4.0 (for x86)
- OpenVSwitch
- 6WIND userspace network stack (DPDK based)
- PPP daemon
- DHCP relay

EOLO customizations

- OpenVSwitch mac-learning improved
- FRR routing suite with RFC3107
- Automatic rescue procedure (corrupted configurations)
- Monitoring daemons

BLUgw

Full management framework for BLU routers

Device provisioning in the warehouse

Web interface for users operations

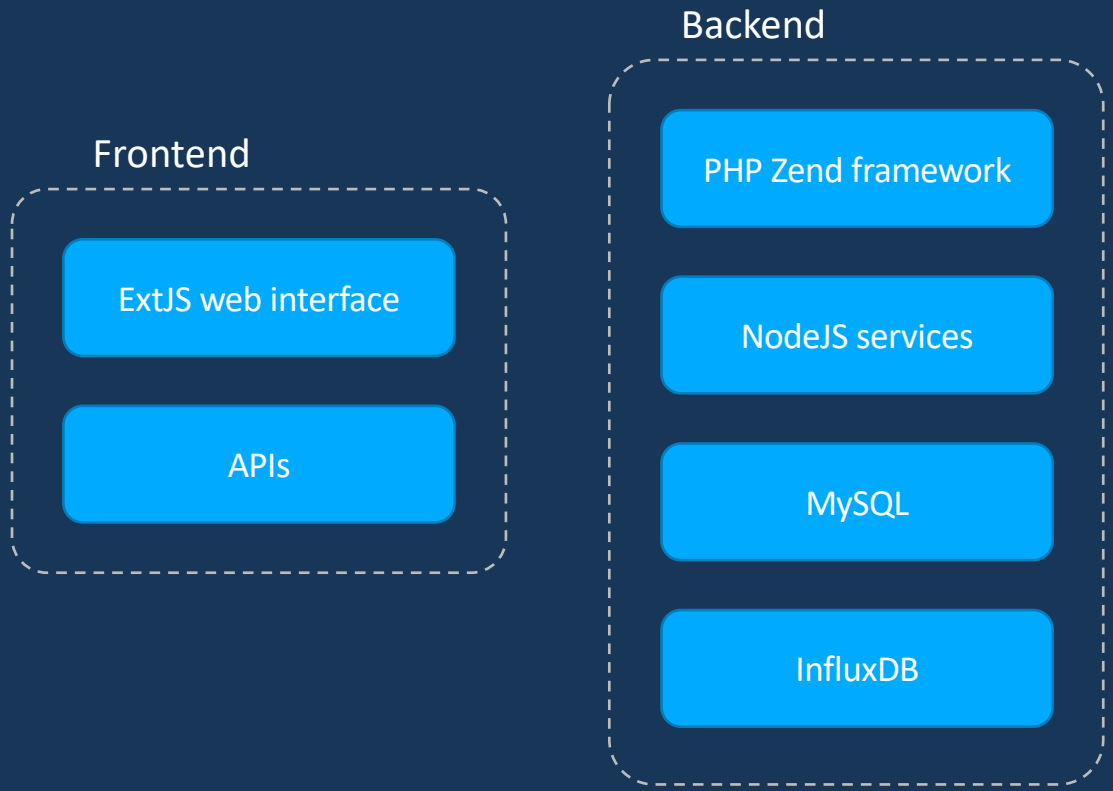
Scripting for automatic checks and analysis

Scheduler for command execution and upgrades

Telemetry and statistics collection and visualization

BLUgw

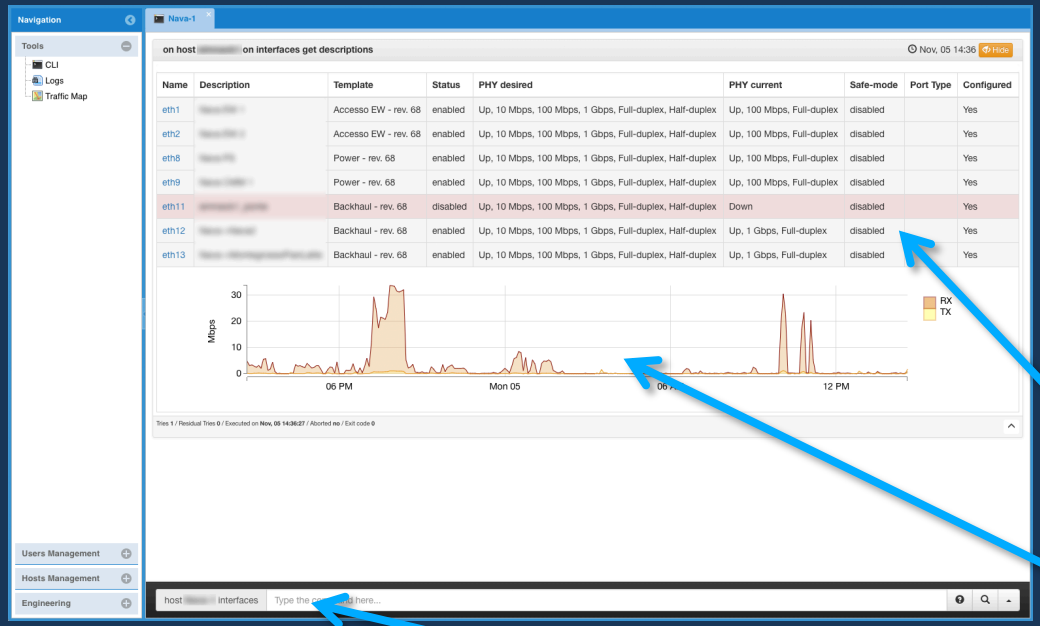
Architecture



Cluster based for redundancy and performance improving

BLUgw

Web interface



Should avoid human errors
(no one connects to routers via ssh)

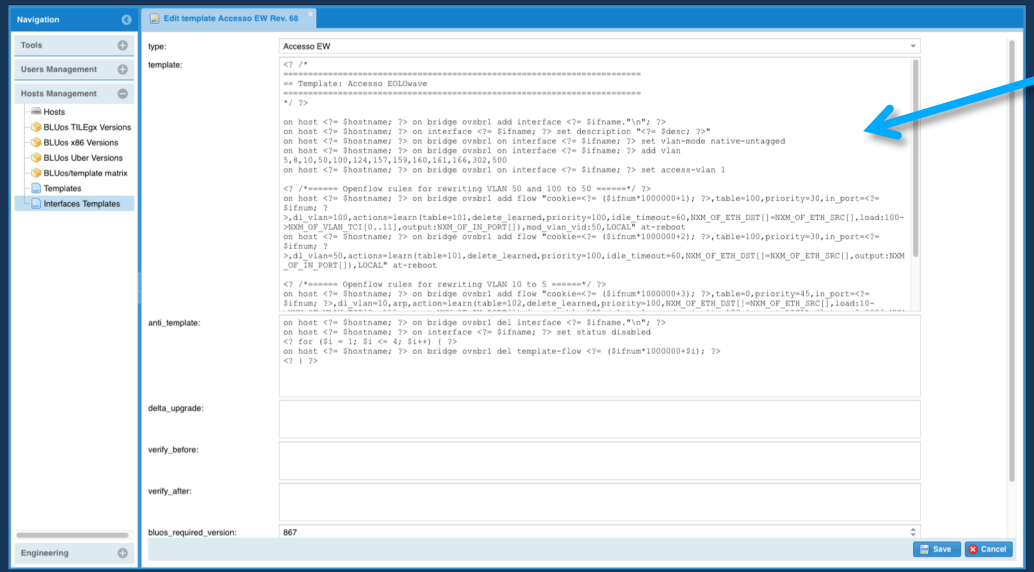
Interface configuration

Interface statistics

Command line interface

BLUgw

Templated configurations



Template editor

Template types:

- Global
- Interface specific (backhaul, access, etc…)

BLUgw

Scheduler

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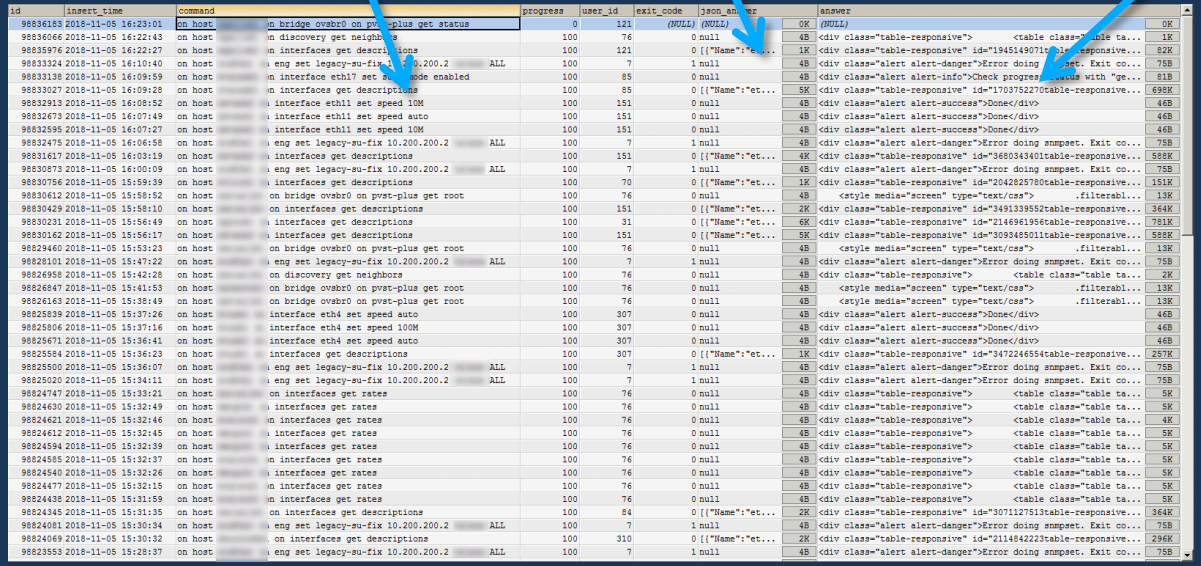
JSON output for APIs

Commands list

HTML output for web interface



id	insert_time	command	progress	user_id	exit_code	json_answer	answer
98836183	2018-11-05 16:23:01	on host [redacted] on bridge ovsbr0 on pvst-plus get status	0	121	(NULL)	(NULL) 0K	(NULL) 0K
98836066	2018-11-05 16:22:43	on host [redacted] on discovery get neighbors	100	76	0	null 4B	<table class="table ta... 1K
98835976	2018-11-05 16:22:27	on host [redacted] on interfaces get descriptions	100	121	0	[{"Name":"et... 1K	<div class="table-responsive" id="1945149071table-responsive... 82K
98833324	2018-11-05 16:10:40	on host [redacted] eng set legacy-su-fix 10.200.200.2 [redacted] ALL	100	7	1	null 4B	Error doing snmpset. Exit co... 75B
98833138	2018-11-05 16:09:59	on host [redacted] on interface eth17 set auto mode enabled	100	85	0	null 4B	Check progress status with "ge... 81B
98833027	2018-11-05 16:09:28	on host [redacted] on interfaces get descriptions	100	85	0	[{"Name":"et... 5K	<div class="table-responsive" id="1703752270table-responsive... 698K
98832913	2018-11-05 16:08:52	on host [redacted] eng interface eth11 set speed 10M	100	151	0	null 4B	Done 46B
98832673	2018-11-05 16:07:49	on host [redacted] eng interface eth11 set speed auto	100	151	0	null 4B	Done 46B
98832595	2018-11-05 16:07:27	on host [redacted] eng interface eth11 set speed 10M	100	151	0	null 4B	Done 46B
98832475	2018-11-05 16:06:58	on host [redacted] eng set legacy-su-fix 10.200.200.2 [redacted] ALL	100	7	1	null 4B	Error doing snmpset. Exit co... 75B
98831617	2018-11-05 16:03:19	on host [redacted] eng interfaces get descriptions	100	151	0	[{"Name":"et... 4K	<div class="table-responsive" id="3680343401table-responsive... 588K
98830873	2018-11-05 16:00:09	on host [redacted] eng set legacy-su-fix 10.200.200.2 [redacted] ALL	100	7	1	null 4B	Error doing snmpset. Exit co... 75B
98830756	2018-11-05 15:59:39	on host [redacted] eng interfaces get descriptions	100	70	0	[{"Name":"et... 1K	<div class="table-responsive" id="2042825780table-responsive... 151K
98830612	2018-11-05 15:58:52	on host [redacted] on bridge ovsbr0 on pvst-plus get root	100	76	0	null 4B	<style media="screen" type="text/css"> .filterabl... 13K
98830429	2018-11-05 15:58:10	on host [redacted] on interfaces get descriptions	100	151	0	[{"Name":"et... 2K	<div class="table-responsive" id="3491339552table-responsive... 364K
98830231	2018-11-05 15:56:49	on host [redacted] eng interfaces get descriptions	100	31	0	[{"Name":"et... 6K	<div class="table-responsive" id="2146961956table-responsive... 781K
98830162	2018-11-05 15:56:17	on host [redacted] eng interfaces get descriptions	100	151	0	[{"Name":"et... 5K	<div class="table-responsive" id="3093485011table-responsive... 588K
98829460	2018-11-05 15:53:23	on host [redacted] on bridge ovsbr0 on pvst-plus get root	100	76	0	null 4B	<style media="screen" type="text/css"> .filterabl... 13K
98828101	2018-11-05 15:47:22	on host [redacted] eng set legacy-su-fix 10.200.200.2 [redacted] ALL	100	7	1	null 4B	Error doing snmpset. Exit co... 75B
98826958	2018-11-05 15:42:28	on host [redacted] on discovery get neighbors	100	76	0	null 4B	<table class="table ta... 2K
98826847	2018-11-05 15:41:53	on host [redacted] on bridge ovsbr0 on pvst-plus get root	100	76	0	null 4B	<style media="screen" type="text/css"> .filterabl... 13K
98826163	2018-11-05 15:38:49	on host [redacted] on bridge ovsbr0 on pvst-plus get root	100	76	0	null 4B	<style media="screen" type="text/css"> .filterabl... 13K
98825839	2018-11-05 15:37:26	on host [redacted] interface eth4 set speed auto	100	307	0	null 4B	Done 46B
98825806	2018-11-05 15:37:16	on host [redacted] interface eth4 set speed 100M	100	307	0	null 4B	Done 46B
98825671	2018-11-05 15:36:41	on host [redacted] interface eth4 set speed auto	100	307	0	null 4B	Done 46B
98825584	2018-11-05 15:36:23	on host [redacted] interfaces get descriptions	100	307	0	[{"Name":"et... 1K	<div class="table-responsive" id="3472246554table-responsive... 257K
98825500	2018-11-05 15:36:07	on host [redacted] eng set legacy-su-fix 10.200.200.2 [redacted] ALL	100	7	1	null 4B	Error doing snmpset. Exit co... 75B
98825020	2018-11-05 15:34:11	on host [redacted] eng set legacy-su-fix 10.200.200.2 [redacted] ALL	100	7	1	null 4B	Error doing snmpset. Exit co... 75B
98824747	2018-11-05 15:33:21	on host [redacted] on interfaces get rates	100	76	0	null 4B	<table class="table ta... 5K
98824630	2018-11-05 15:32:49	on host [redacted] eng interfaces get rates	100	76	0	null 4B	<table class="table ta... 5K
98824621	2018-11-05 15:32:46	on host [redacted] on interfaces get rates	100	76	0	null 4B	<table class="table ta... 4K
98824612	2018-11-05 15:32:45	on host [redacted] eng interfaces get rates	100	76	0	null 4B	<table class="table ta... 5K
98824594	2018-11-05 15:32:39	on host [redacted] eng interfaces get rates	100	76	0	null 4B	<table class="table ta... 5K
98824585	2018-11-05 15:32:37	on host [redacted] on interfaces get rates	100	76	0	null 4B	<table class="table ta... 5K
98824540	2018-11-05 15:32:26	on host [redacted] eng interfaces get rates	100	76	0	null 4B	<table class="table ta... 5K
98824477	2018-11-05 15:32:15	on host [redacted] on interfaces get rates	100	76	0	null 4B	<table class="table ta... 5K
98824438	2018-11-05 15:31:59	on host [redacted] on interfaces get rates	100	76	0	null 4B	<table class="table ta... 5K
98824345	2018-11-05 15:31:35	on host [redacted] on interfaces get descriptions	100	84	0	[{"Name":"et... 2K	<div class="table-responsive" id="3071127513table-responsive... 364K
98824081	2018-11-05 15:30:34	on host [redacted] eng set legacy-su-fix 10.200.200.2 [redacted] ALL	100	7	1	null 4B	Error doing snmpset. Exit co... 75B
98824069	2018-11-05 15:30:32	on host [redacted] on interfaces get descriptions	100	310	0	[{"Name":"et... 2K	<div class="table-responsive" id="2114842223table-responsive... 296K
98823553	2018-11-05 15:28:37	on host [redacted] eng set legacy-su-fix 10.200.200.2 [redacted] ALL	100	7	1	null 4B	Error doing snmpset. Exit co... 75B

NodeJS services:

- Fast commands execution
- SSH proxy to keep connections open

BLUgw

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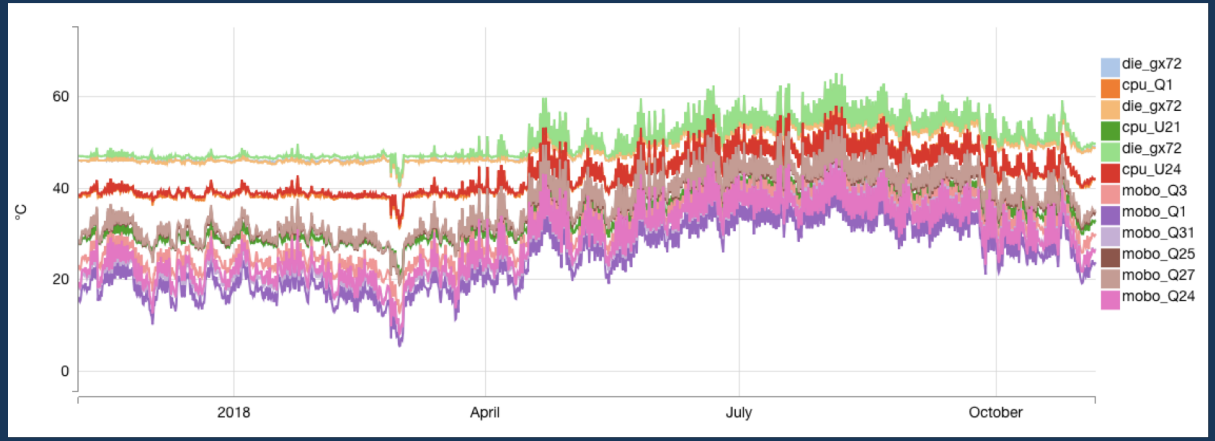
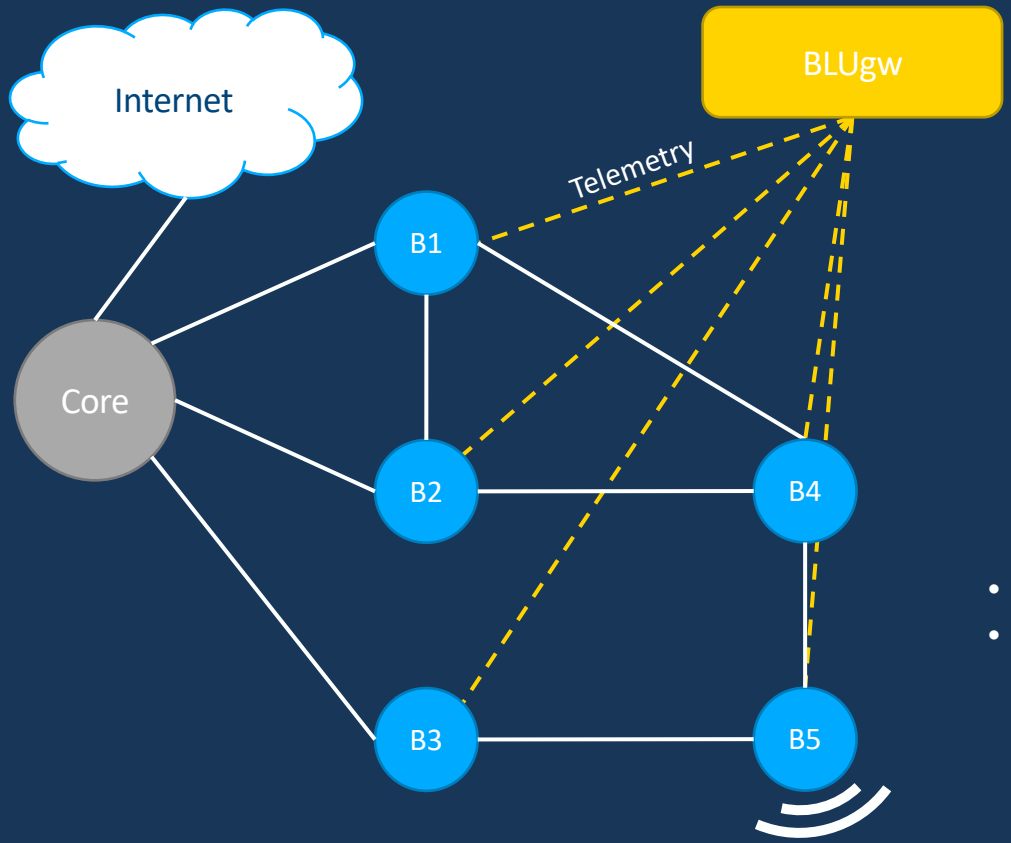
Statistics collection and visualization

- Enviromental stats:
  - Temperatures
  - Power
  - CPU load
  - Fans speed
- Interfaces stats:
  - Bytes rx/tx
  - Packets rx/tx
- Processes stats:
  - OpenVSwitch
  - Fast path



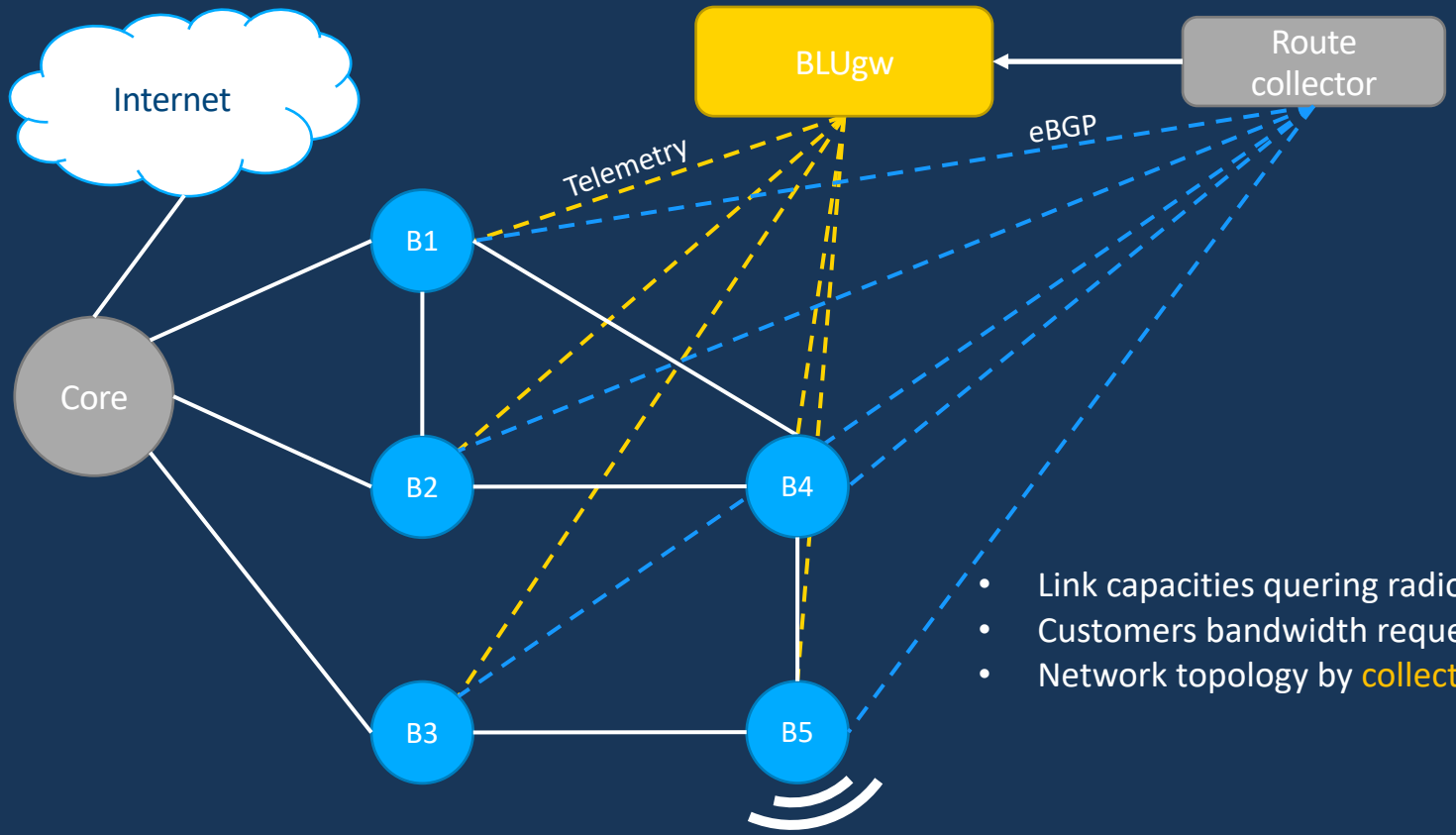
Plotted with D3.js library

Network information



- Link capacities quering radios
- Customers bandwidth requests from access interfaces

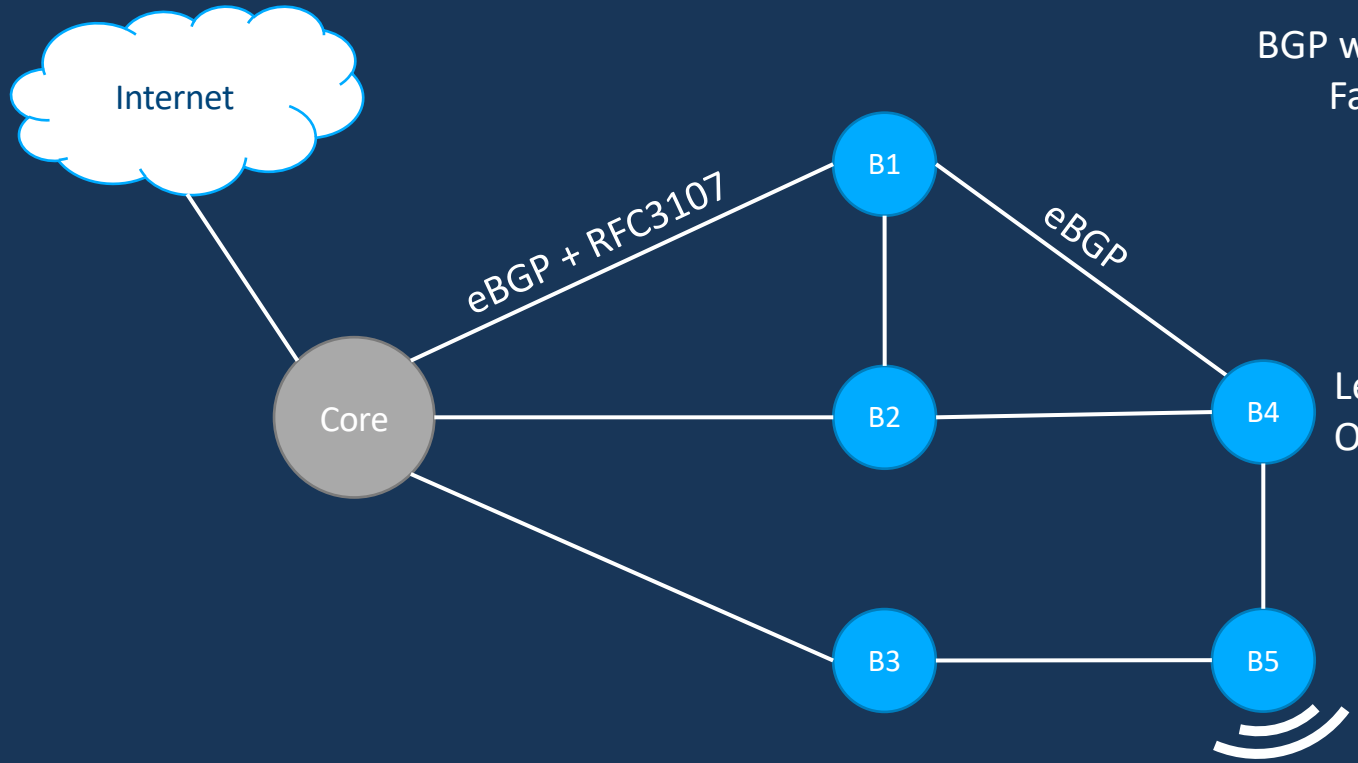
Network information



- Link capacities quering radios
- Customers bandwidth requests from access interfaces
- Network topology by collecting full routing tables

Network details

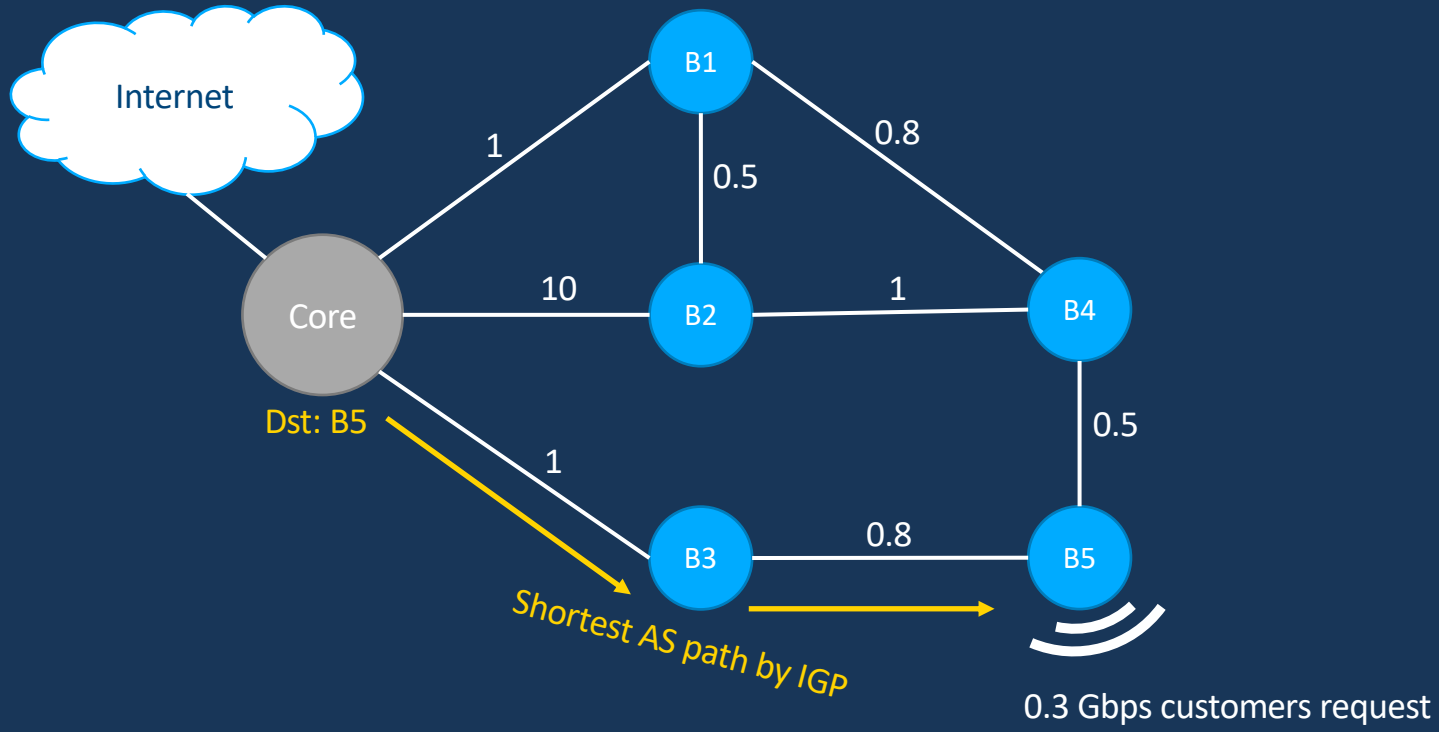
SDN philosophy



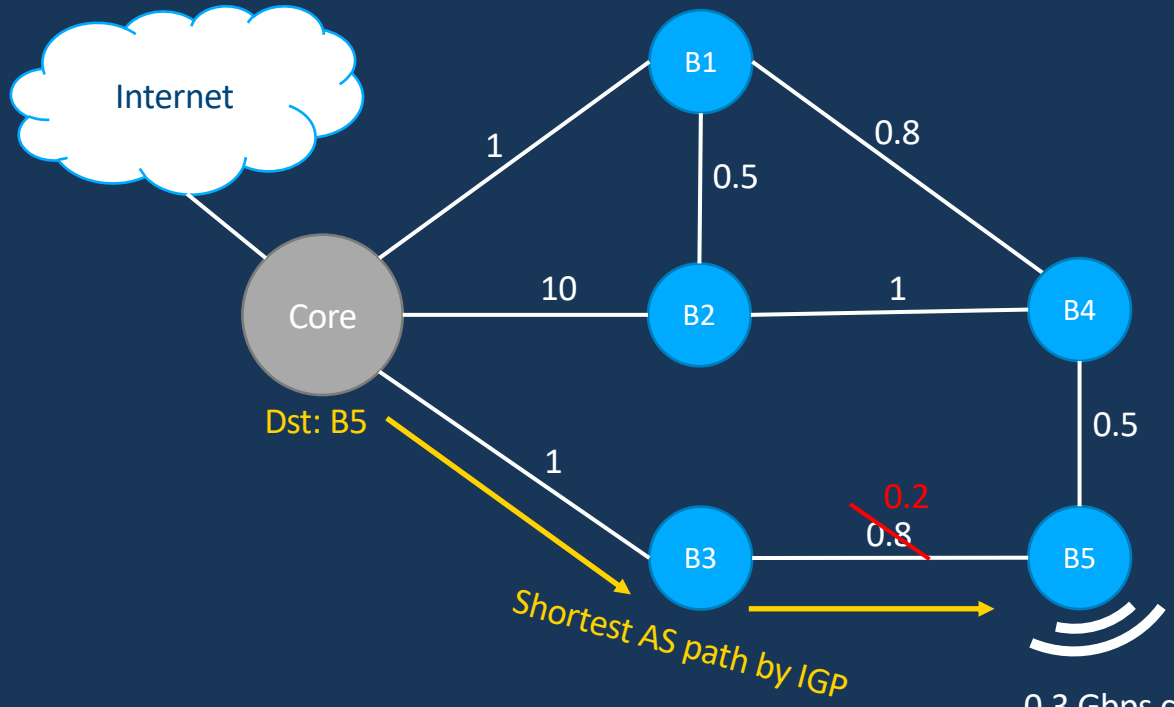
BGP with BFD:
Fault detection in 300ms

Learned routes generate
OVS forwarding flows

Shortest path

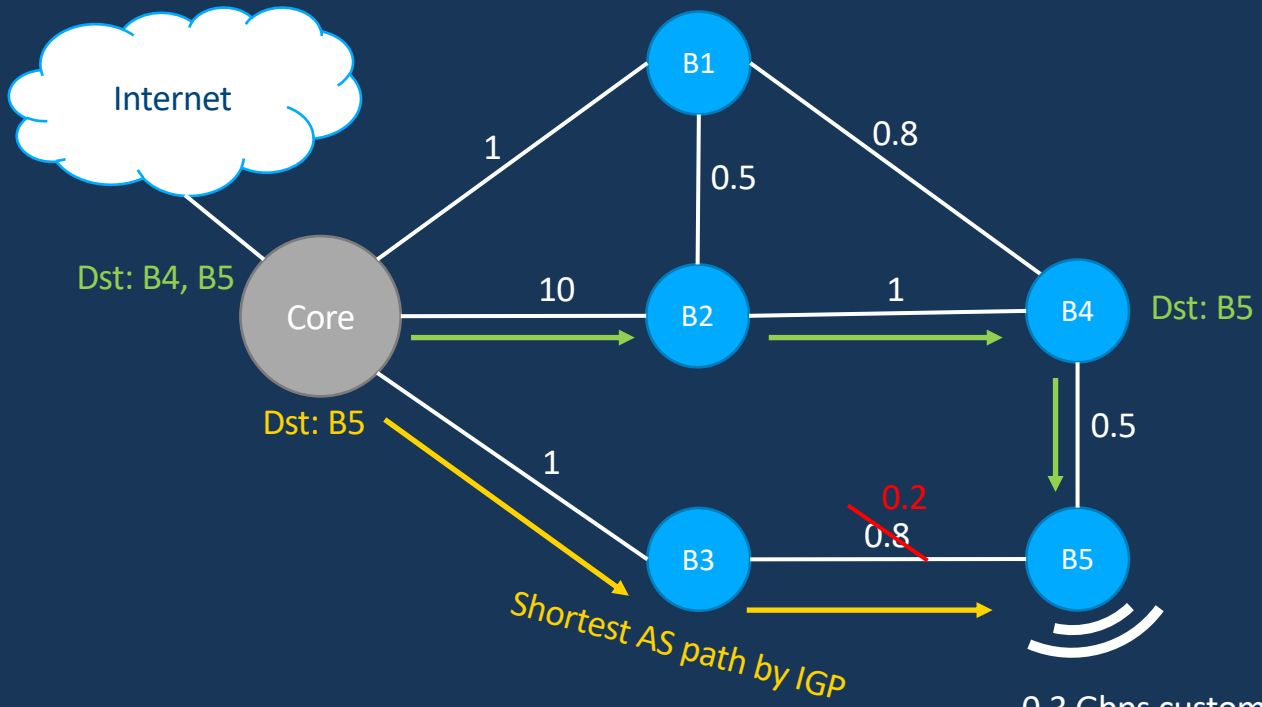


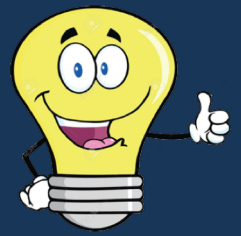
Link congestion



Capacity decrease due to thunderstorms or heavy rains

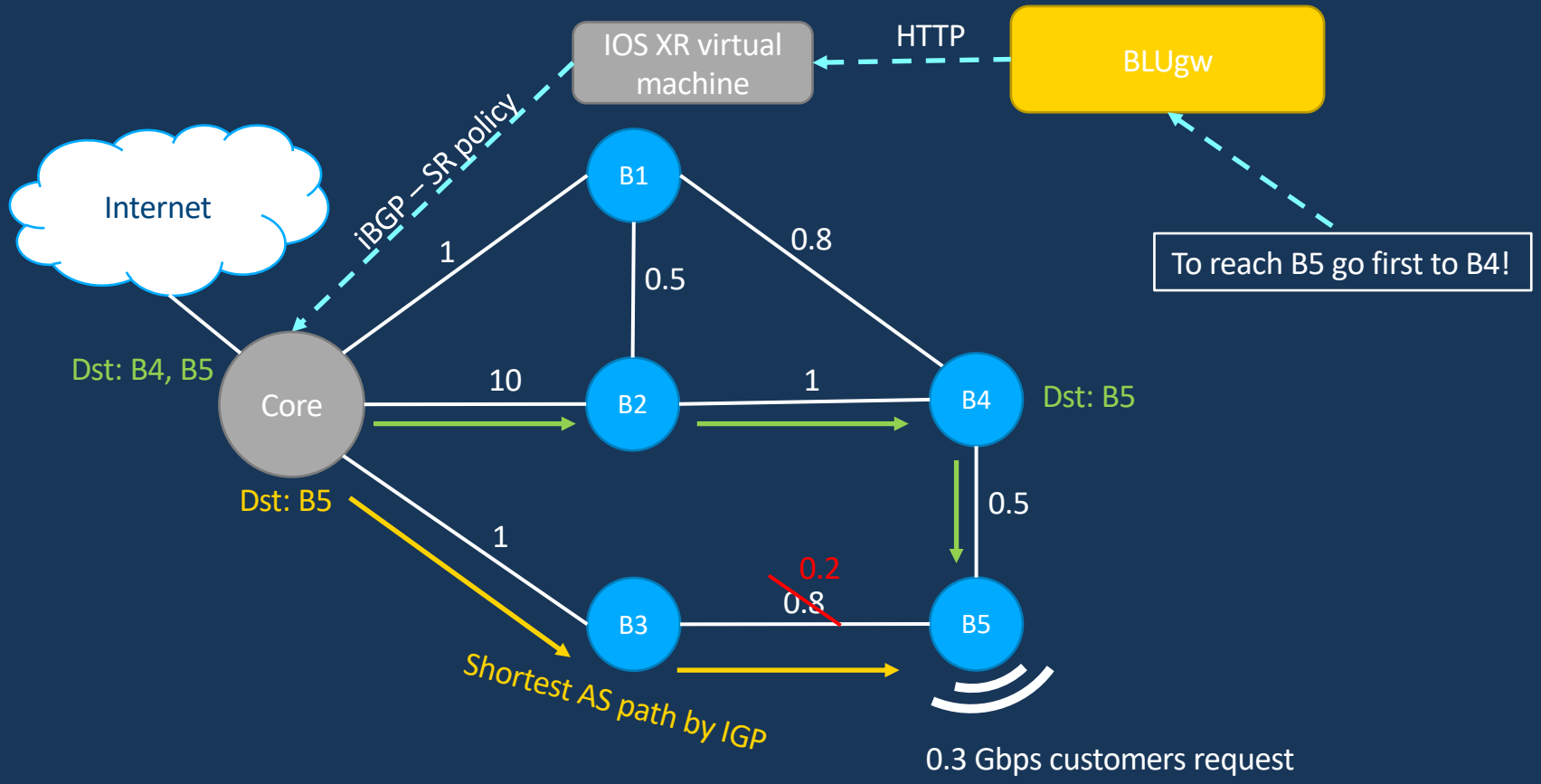
Alternative path



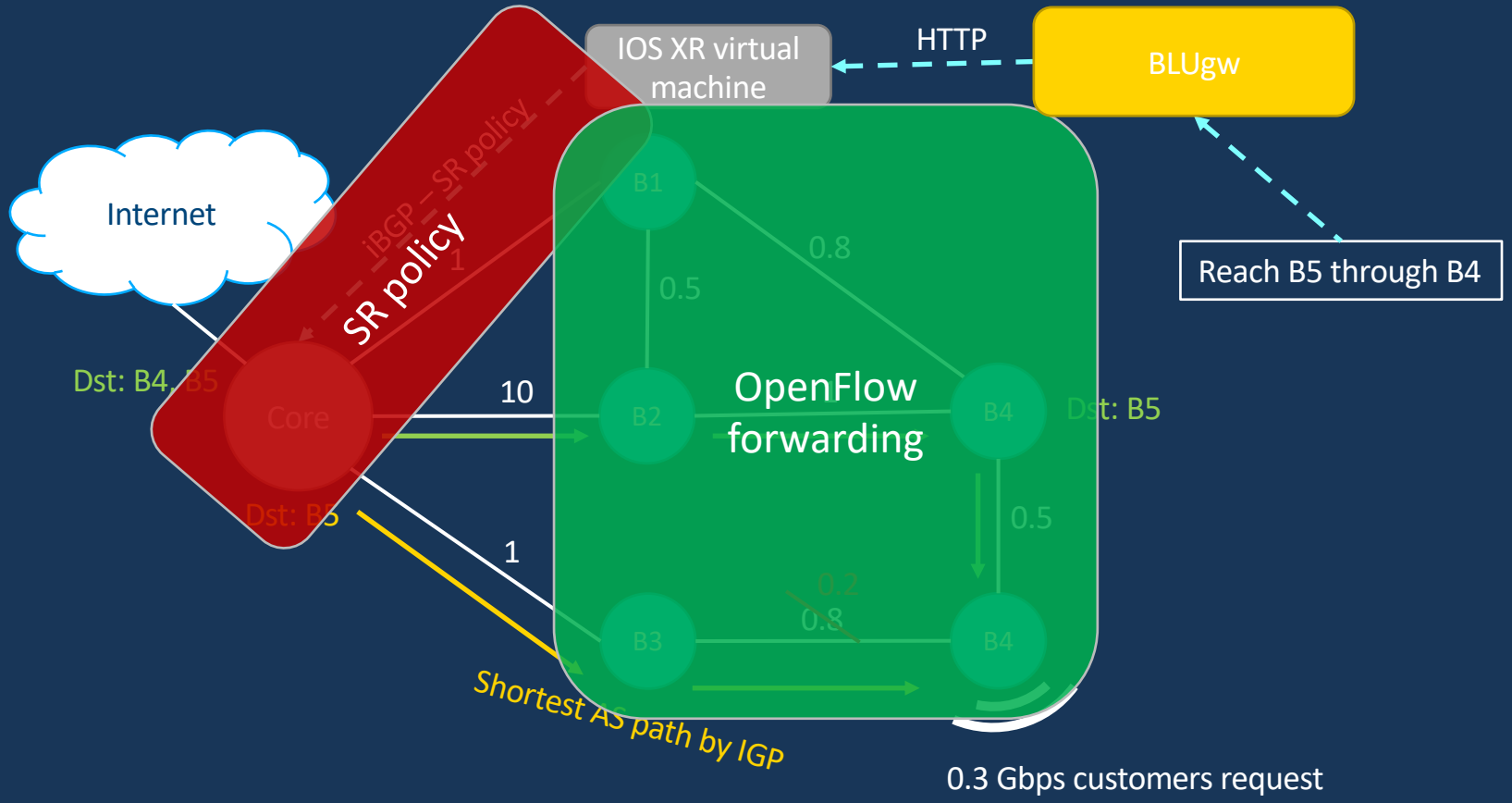


Reach B5 through B4

One iBGP to rule them all



One iBGP to rule them all



Optimization algorithm

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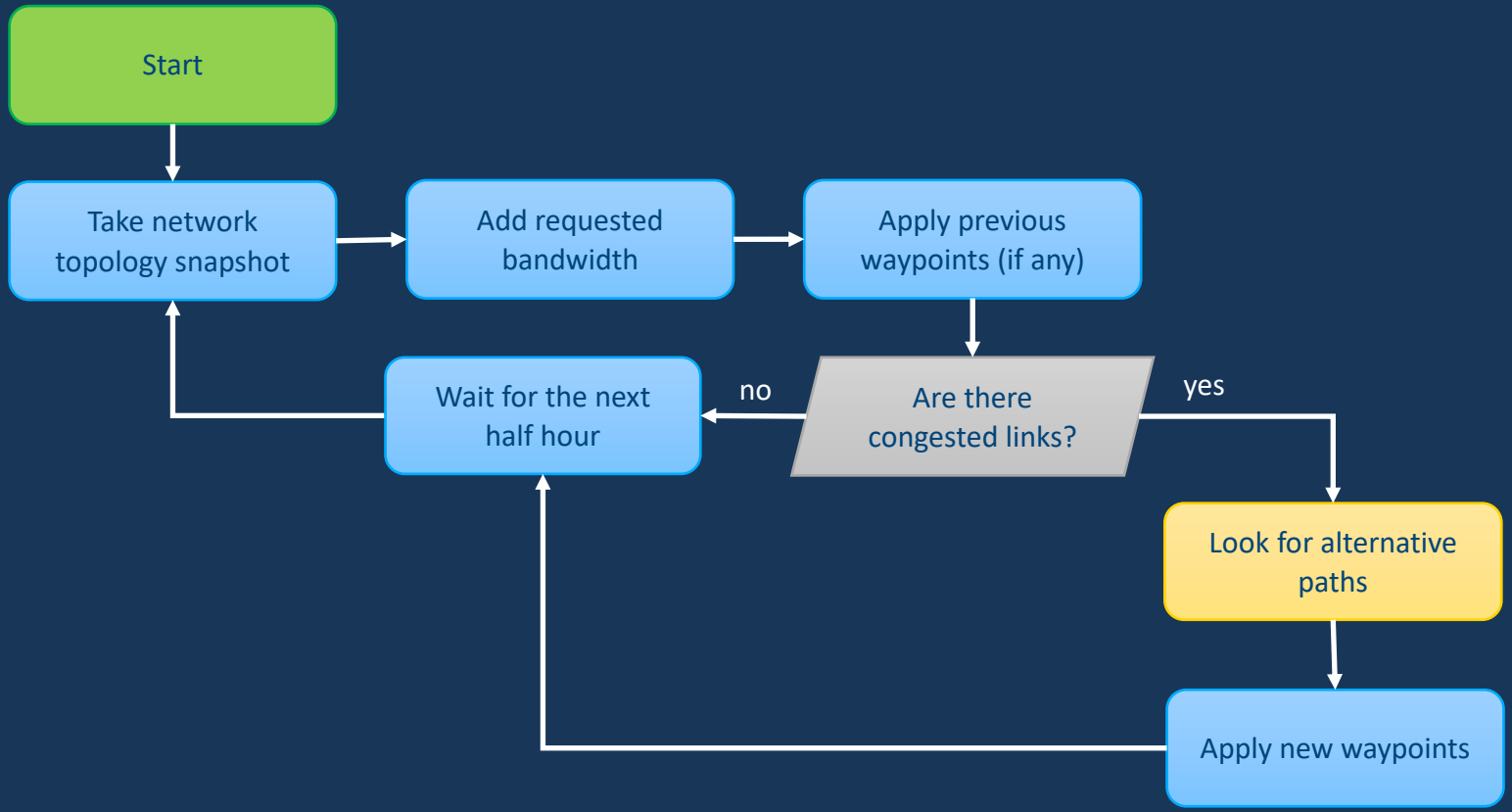

Find waypoints (jww A. Carzaniga, D. Rogora, USI)

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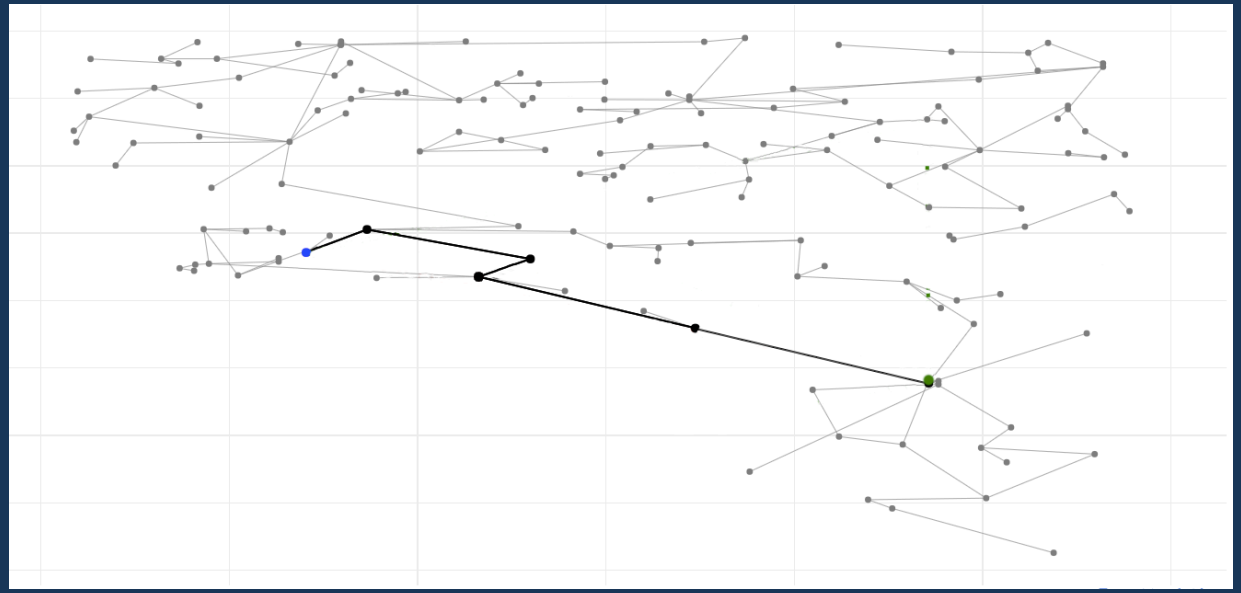
Build and solve a **linear program** to get feasible waypoints for each traffic flow



Use geographical informations to simplify the problem

Find waypoints (jww A. Carzaniga, D. Rogora, USI)

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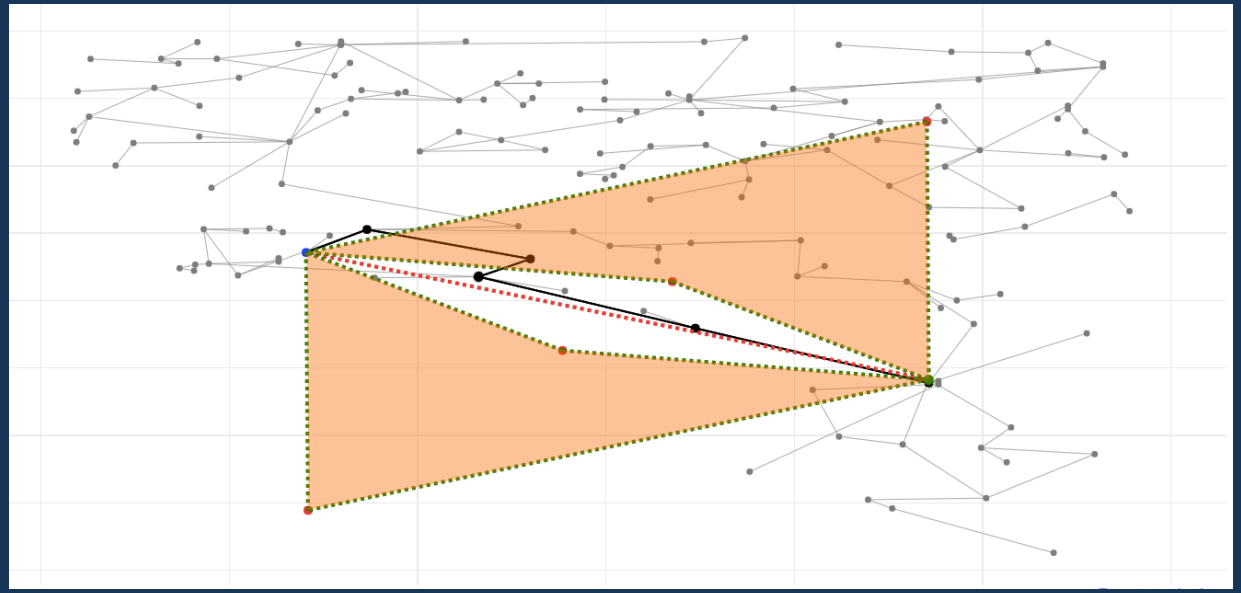
Build and solve a **linear program** to get feasible waypoints for each traffic flow



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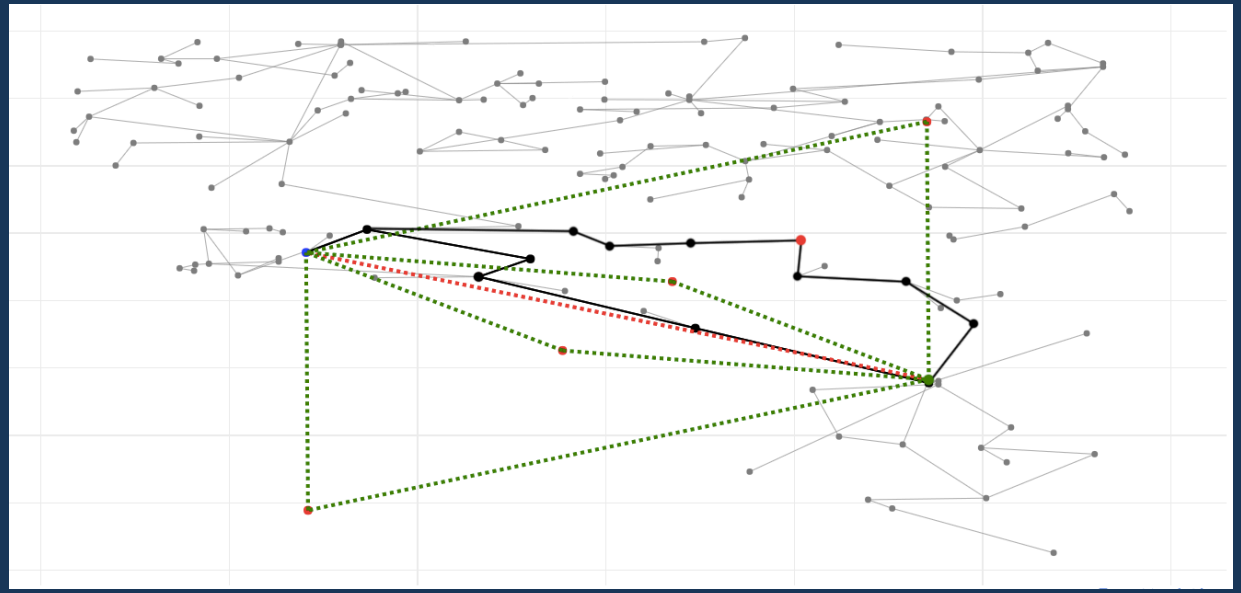
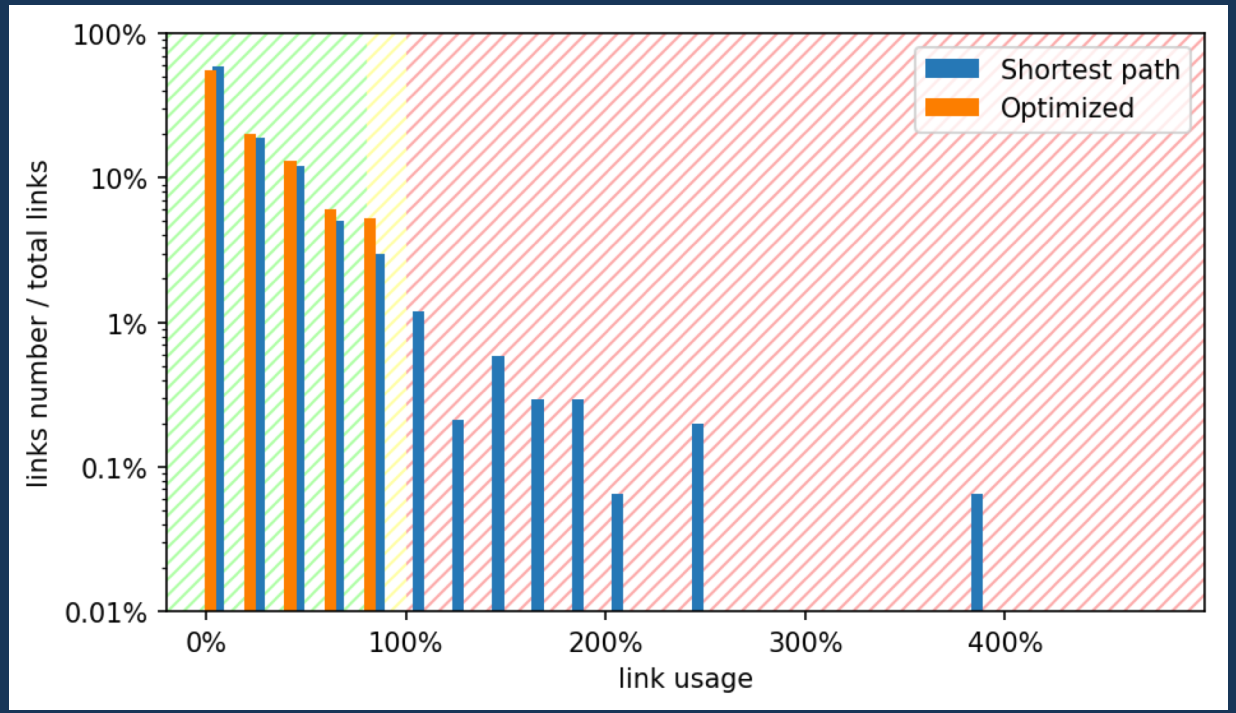


Use geographical informations to simplify the problem

Optimizer results

Full network simulations



Network snapshot of 8th April 2018 at 22:30:

- 1510 nodes
- 1712 links (50 congested)

150 alternative paths:

- 85% with 1 waypoint
- 9% with 2 waypoints
- 6% with 3 waypoints

Experimental evaluation and future plan

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- Succesfully lab tests with 8 hosts high-mesh topology
- First deploy of 3 production hosts 5 months ago
- Full network deploy planned in 2019

Internet dove
gli altri non arrivano

Thank you!

If you are interested in the BLU project,
do not hesitate to contact us!

blu@eolo.it