DUOCAST

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Root Cause Analysis (RCA) Partial downtime Duocast network November 17th 2015

Foreword

Duocast BV utilizes co-location space in six datacenters in the Netherlands. Three are located in and around Amsterdam, three in Groningen. All co-location sites employ redundant fiber routes to prevent downtime in the event of scheduled maintenance, fiber cuts or damaged fiber optics between each of the six sites.

Co-location sites:

- Amsterdam Globalswitch
- Amsterdam EuNetworks
- Amsterdam Telecity2
- Groningen TCN Data Hotel
- Groningen KPN Datacenter
- Groningen University of Groningen

Two co-location sites in Amsterdam are employed to connect to the outside world with one International Transit and one Internet Exchange connection per site.

Connectivity:

- Amsterdam Globalswitch

  - 10Gbps KPN International (AS286)
  - 10Gbps AMS-IX public peering

- Amsterdam EuNetworks

  - 10Gbps Level3 (AS3356)
  - 10Gbps NL-IX public peering
  - 10Gbps Openpeering

Due to the size of our network, the number of datacenters and the physical distance in between, maintenance on parts of the supply chain is performed almost on a weekly basis. For each maintenance notification Duocast assesses the impact and additional risks. In most cases the impact is low and Duocast customers are not notified. In case of maintenance on the redundant power supply in one of the datacenters, directly affected customers are notified in advance to check for any faulty wiring and to make sure both the A and B power feed are properly used.

On July 22nd EuNetworks sent out an advanced notice for upcoming maintenance on one of two power feeds in November and on the second power feed in December. All Duocast co-location customers in EuNetworks where notified shortly hereafter. Depending on the rack footprint a detailed maintenance notification was received by Duocast and sent out on either October 8th or October 29th to our customers.

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Regarding the Duocast network, both the risk and impact of the announced works have been identified as low because the power supply is redundant and all production hardware is connected redundantly. Moreover, EuNetworks has proven to work accurately and perform the works in a timely manner in the past. In the event of a total power outage, the impact of a network outage in EuNetworks would be limited to co-location customers in EuNetworks.

On November 16th the EuNetworks engineers started the scheduled maintenance on the first batch of powerfeeds at 08:14 CET and finshed without any unexpected disruption at 11:53 CET.

Works on the second batch were started on November 17th at 08:25 CET. Part of the second batch was a rack which houses our network equipment. At 08:29 CET we observed the first powerfeed going down. Unexpectedly, the second power feed also went offline at 08:32 CET. The RCA provided by EuNetworks explains that at 08:32 CET the second power distributor had been switched off due to a human error, causing our network equipment to shutdown as well as our Transit provider and some of our peers.

Timetable (CET)

Time	Event
08:25:48	10 Gbps circuit between EuNetworks and TCN Data Hotel Groningen goes down. All traffic is rerouted instantly with a low possibility of packetloss for 1ms.
08:29:04	One of two powersupplies (A) in every production network device goes down. Out-of-band management goes offline because it only has a single PSU. Non Service impacting.
08:32:51	All other network devices become unreachable. Service impacting. Co-location customers in EuNetworks become unreachable and packetloss is observed on 50% of the traffic in all other datacenters. Losing an edge router in the network topology requires three other edge routers to re-converge and update ~550.000 IPv4 routes and 41.000 IPv6 routes. Packetloss can be observed while traffic is still being routed to a non existing router.
08:32:52	Duocast engineers are notified due to three failing 10Gbps circuits. Neighboring routers send push notifications.
08:33:07	According to the EuNetworks RCA, at 08:32 the B-feed is shut down by accident and restored after 16 seconds. Power is supplied again on one of the feeds. This cannot be confirmed

Time	Event
	by the logging of our own devices.
08:34:00	Duocast engineer was already actively monitoring the devices and starts investigating.
08:36:00	Duocast engineer contacts EuNetworks to report the issue and to request a visual inspection of the hardware.
08:40:00	Call is returned to confirm that redundantly powered equipment is booting again.
08:40:00	First mailing sent to all customers.
08:50:00	Reconverge completed. Latency and packetloss levels return to normal except for co-location customers in EuNetworks.
09:11:00	Network equipment is still offline. Visual confirmation of powered hardware is provided by EuNetworks.
09:48:00	EuNetworks is contacted again to request the single powered Out-of-band hardware to be connected to the online powerfeed.
10:05:00	Serial console ports for all network devices are reachable through the Out-of-band network. All devices are waiting for manual interference due to the sudden powercycle and boot.
10:07:00	First core router is booted to restore connectivity for EuNetworks co-location customers. IPv4 is reachable again.
10:17:00	Second mailing sent to all customers.
10:38:00	IPv6 connectivity for EuNetworks co-location customers also restored.
10:46:00	Edge router in EuNetworks is booted causing a reconverge for all routers.
10:49:00	Again packetloss is observed on 50% of all traffic.
11:06:00	Redudancy to the network is restored and all traffic flows are stable again.
11:07:00	EuNetworks maintenance is completed. Redudancy to the powersupply is restored.
11:37:00	Third mailing is sent to all customers.

Analysis

Network outage EuNetworks

At 08:32:51 CET the core- and edge routers located in EuNetworks lost all power. Although power was restored within 60 seconds, the network devices did not boot correctly due to multiple power cycles, causing them to boot from a secondary boot device which did not have a working configuration. The out-of-band hardware, which provides serial console access to all production hardware, is not powered redundantly. This is by design because for this to become an issue, multiple failures have to occur at once which had not happened up to this moment. After gaining access to the out-of-band hardware, a controlled reboot on all devices was quickly executed.

Network services for EuNetworks co-location customers were unavailable between 08:32 - 10:07 CET. The prolonged downtime was mainly caused by the limited accessibility to the console ports and partially by the fact that all network devices are housed in a single rack. Partially, because maintenance to the power feeds was done in batches. Chances were that, should the network equipment have been divided over two racks, both would have suffered downtime in the event of a human error like the one on November 16th.

Network performance degradation

At 08:32:51 CET network redundancy was lost due to a power failure in EuNetworks. After 180 seconds the BGP hold timer expired on all neighboring routers. This included Duocast routers in other datacenters as well as the routers from our Transit provider in EuNetworks and our NL-IX peers. Some of these were already down due to the same power failure. During the default BGP hold timer of 180 seconds, incoming and outgoing traffic which was still being routed to the EuNetworks edge router was dropped, causing packet loss.

All Duocast edge routers started to reconverge. At the time of the power failure, about 50% of all traffic was routed through EuNetworks. Routing decisions between EuNetworks and Globalswitch are made on the shortest path and the uptime between our network and the remote network. Two of the larger internet access providers were unreachable during the reconverge: KPN National, and the former UPC network. At 08:50 CET service was restored and packet loss was no longer observed.

At 10:46 the edge router in EuNetworks was brought back online. After three minutes packetloss was observed again from all other datacenters. This ended when all routers had reconverged and network redundancy was restored at 11:06 CET.

Performance degredation was limited to 18 minutes between 08:32:51 - 08:50 CET and 18 minutes between 10:49 - 11:07 CET, when packetloss could be observed to 50% of the Internet. Redundancy between EuNetworks and Globalswitch worked and prevented a total downtime of 1 hour and 5 minutes for all customers except those in EuNetworks.

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Edge routers converge time

The convergence time during the power outage took longer than the expected 1-4 minutes. Updating the routing table was delayed due to a known issue which occurs when traffic sampling is enabled and lots of routes (100k+) need to be updated. Traffic sampling on all edge routers is used by Duocast to analyze traffic flows to detect abuse and DDoS attacks. The routers utilize two routing tables, a BGP table (RIB) and a forwarding table (FIB). All routing intelligence is stored in the RIB. When a decision has been made which route is best, the route is inserted in the FIB. When sampling is enabled, updating the FIB sometimes stalls. When the FIB still holds routes to an offline router, traffic will be dropped.

When the edge router in EuNetworks was brought back online at 10:46 CET the same issue occurred. The RIB learned information including routes which were better than the existing routes. BGP sent updates for this information to all neighboring routes, but because the router in EuNetworks itself had not installed these routes in the FIB, traffic from neighboring routes was sent to the EuNetworks router while it was not able to actually forward the traffic to its destination.
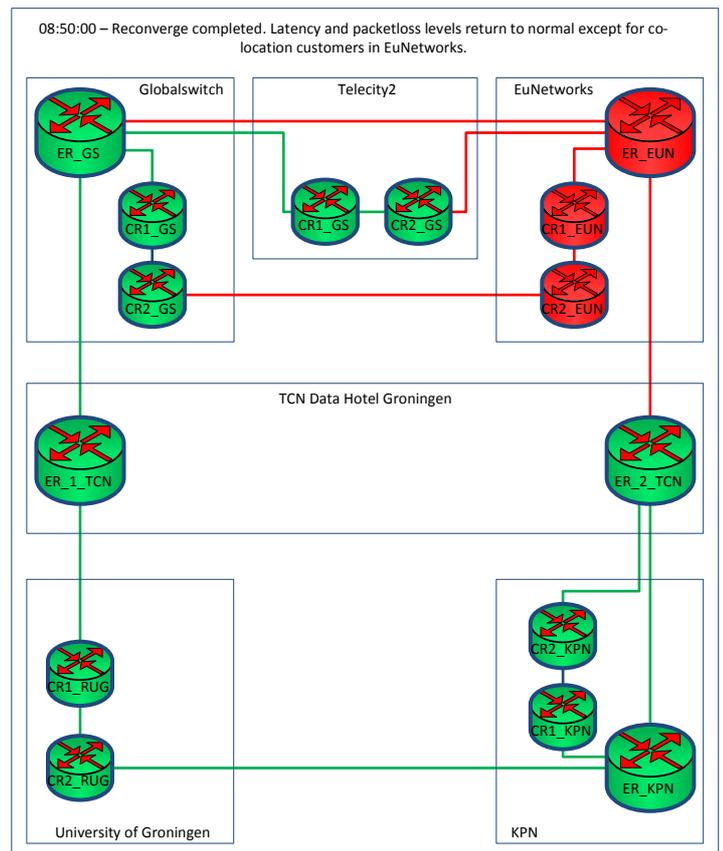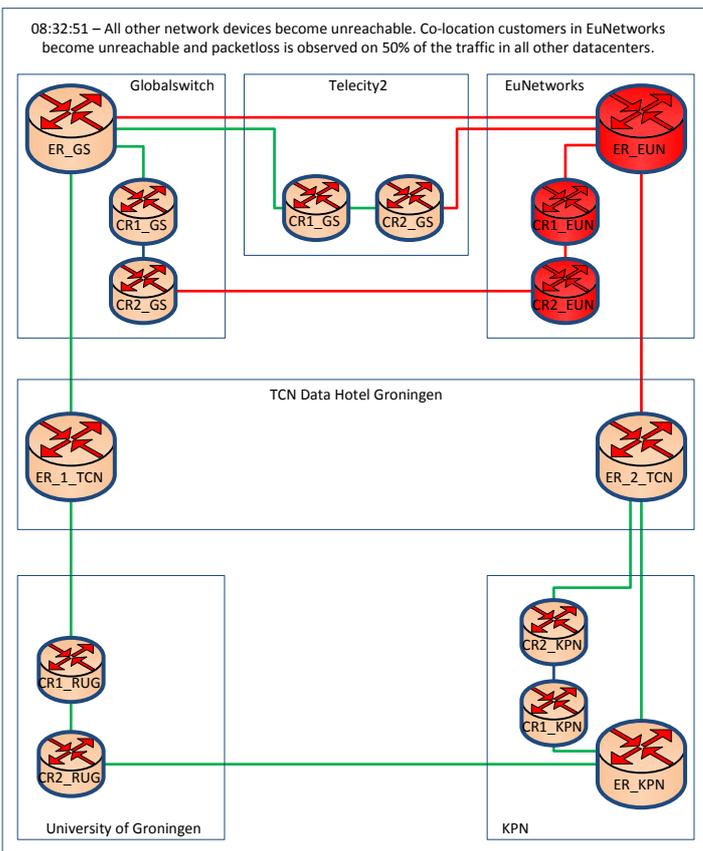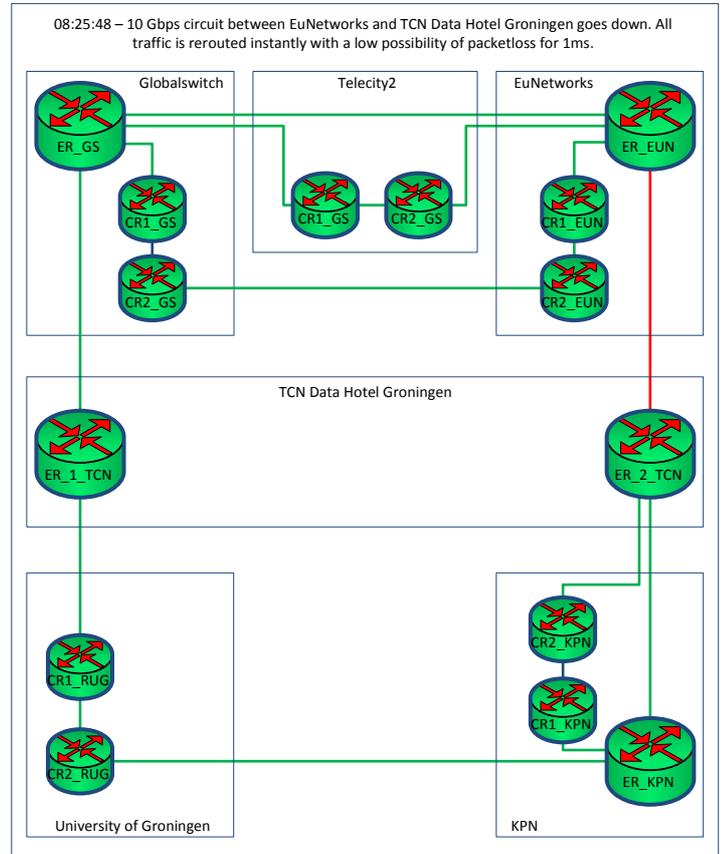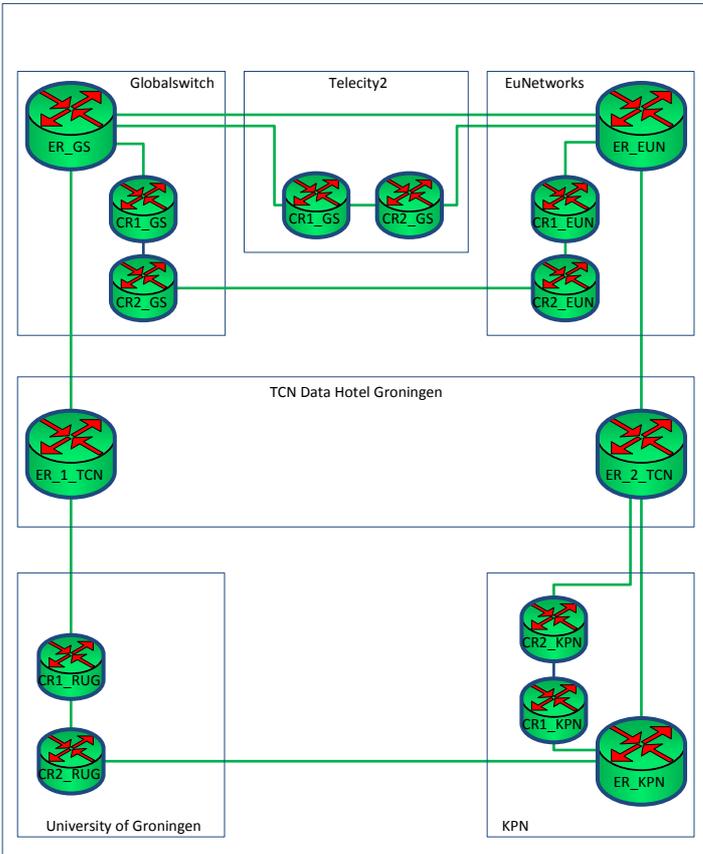
In both cases the Duocast engineer tried to disable sampling when it caused the stall in updating the FIB. Unfortunately the router(s) finally stopped the sampling process after all routing updates were learned by the FIB and performance was already restored.
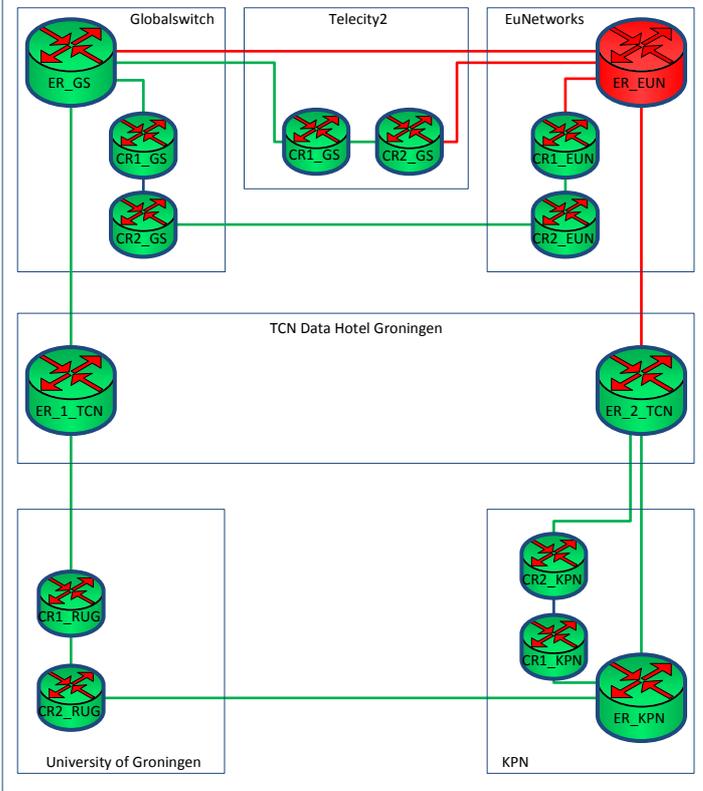
Improvements

- EuNetworks has described corrective measures in their RCA to prevent power outages during similar maintenance works.
- Duocast will install APC ATSes on all sites to prevent power loss to the out-of-band equipment. (This month, before the next announced maintenance)
- Sampling on all edge routers will be disabled within a month. External fiber taps and traffic analyzing equipment will be installed to lower the reconverge time. (Before the end of december)
- On each edge router a default route (0.0.0.0/0 + ::/0) to the nearest neighboring router will be added. This increases the possibility that traffic can be forwarded by the FIB while it is still updating routes.
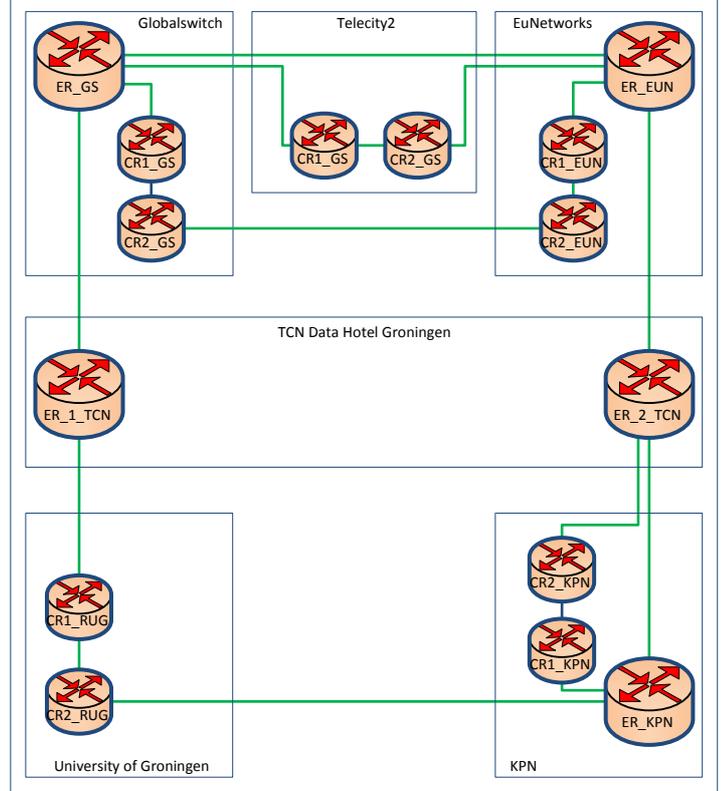
Contact

Please contact us at support@duocast.net if you have any questions regarding the outage or the RCA.

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08:32:51 – All other network devices become unreachable. Co-location customers in EuNetworks become unreachable and packetloss is observed on 50% of the traffic in all other datacenters.

08:50:00 – Reconverge completed. Latency and packetloss levels return to normal except for co-location customers in EuNetworks.

10:07:00 – First core router is booted to restore connectivity for EuNetworks co-location customers. IPv4 is reachable again.

10:49:00 – Edge router in EuNetworks is booted causing a reconverge for all routers. Again packetloss is observed on 50% of all traffic.

11:06:00 - Redudancy to the network is restored and all traffic flows are stable again.