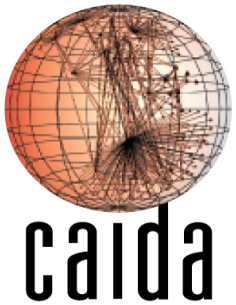

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Investigating the Causes of Congestion on the African IXP Substrate

Rodérick Fanou[1,2], Francisco Valera[2], Amogh Dhamdhere[3]
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Developing the Science of Networks

In the Press

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Supporting Establishment Of Internet Exchange Points In Africa
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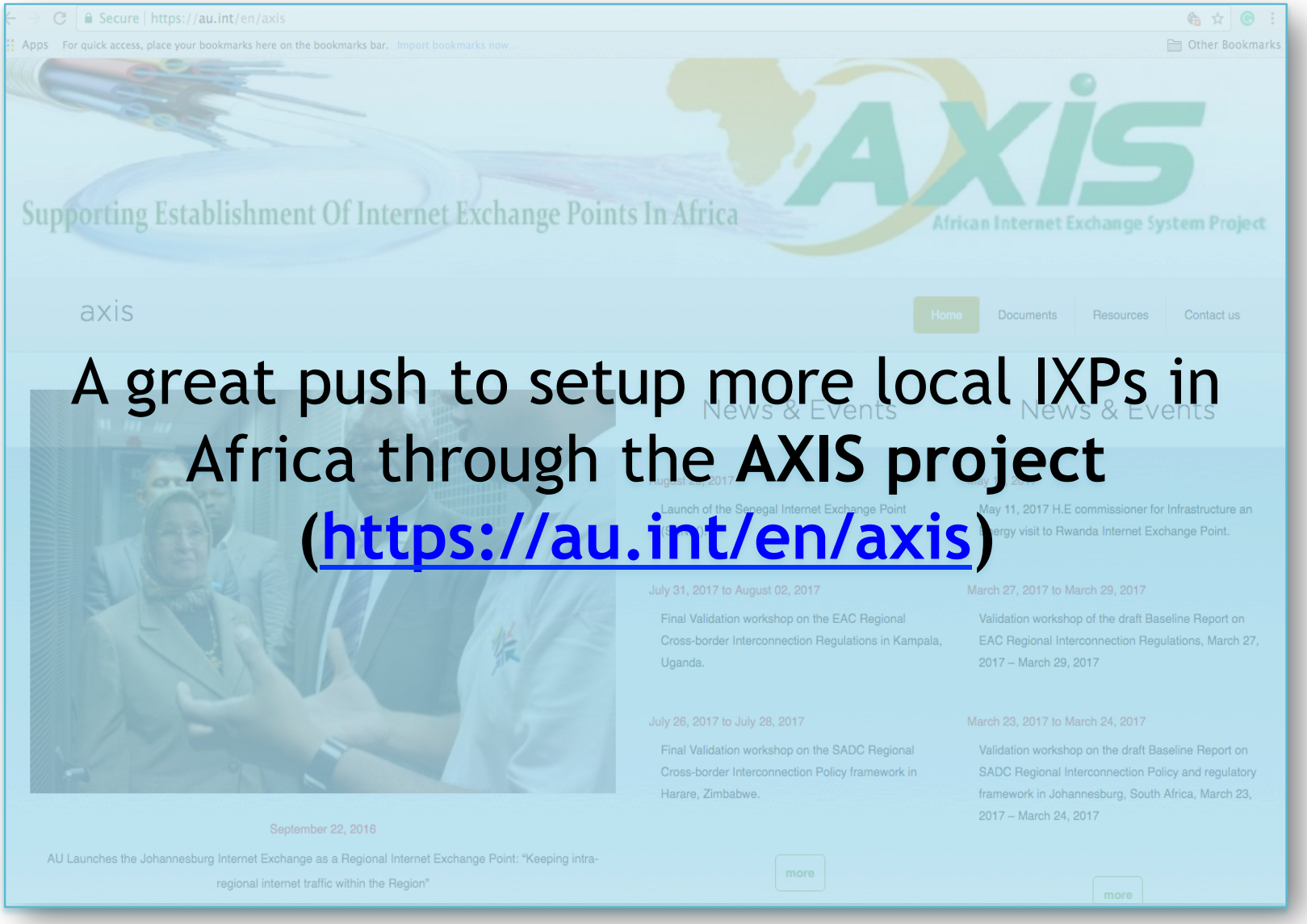
News & Events
August 29, 2017
Launch of the Senegal Internet Exchange Point (SENIX).
July 31, 2017 to August 02, 2017
Final Validation workshop on the EAC Regional Cross-border Interconnection Regulations in Kampala, Uganda.
July 26, 2017 to July 28, 2017
Final Validation workshop on the SADC Regional Cross-border Interconnection Policy framework in Harare, Zimbabwe.
more
News & Events
May 11, 2017
May 11, 2017 H.E commissioner for Infrastructure an Energy visit to Rwanda Internet Exchange Point.
March 27, 2017 to March 29, 2017
Validation workshop of the draft Baseline Report on EAC Regional Interconnection Regulations, March 27, 2017 – March 29, 2017
March 23, 2017 to March 24, 2017
Validation workshop on the draft Baseline Report on SADC Regional Interconnection Policy and regulatory framework in Johannesburg, South Africa, March 23, 2017 – March 24, 2017
more
September 22, 2016
AU Launches the Johannesburg Internet Exchange as a Regional Internet Exchange Point: "Keeping intra-regional internet traffic within the Region"

In the Press



A great push to setup more local IXPs in Africa through the **AXIS project** (https://au.int/en/axis)

In the Press

www.af-ix.net/ixps-map

The African IXP Association

A member of the Internet eXchange Federation

Home | About AFIX | List of IXPs | Map of IXPs | IXP Resources | ARDA | Contact

Map of Internet exchange points in Africa

There are currently **38 active IXPs** located in **35 cities** in **29 countries** in Africa. Click any marker for more information. Note that not all marker locations are exact. If you know of an IXP that is not included here, or wish to submit a correction, please contact us. To view this data in a table, click here. To download our full data set in CSV format, click here.

Fiber infrastructure maps

Here are two fiber infrastructure maps that may also be of interest:

Submarine fiber cables:
http://www.submarinecablemap.com/

Terrestrial fiber cables:
http://afterfibre.net/

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Terrestrial fiber cables:
http://afterfibre.net/
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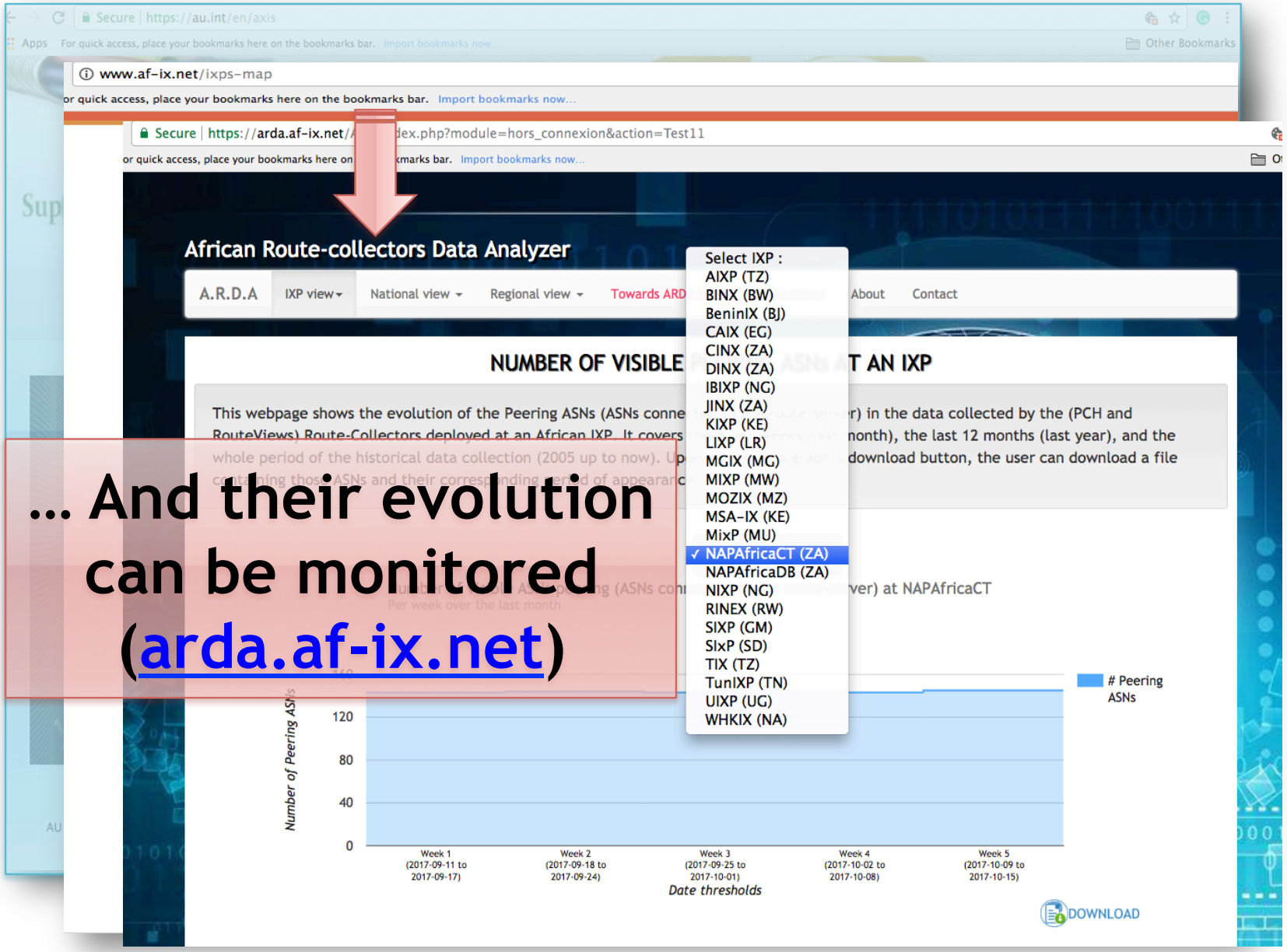
Join the mailing list
We operate two mailing lists for people interested in contacting and/or growing the IXP community. Click here to sign up:
http://af-ix.net/mailman/listinfo/

In the Press



… And their evolution can be monitored (arda.af-ix.net)

Background & Motivation

- Recent work
  - Broadband performance in South Africa
  - Latency and communications performance in Africa
  - Interdomain routing in Africa, routing trends and techno-economic insights in the region
  - Local IXP mapping and their impacts on performance

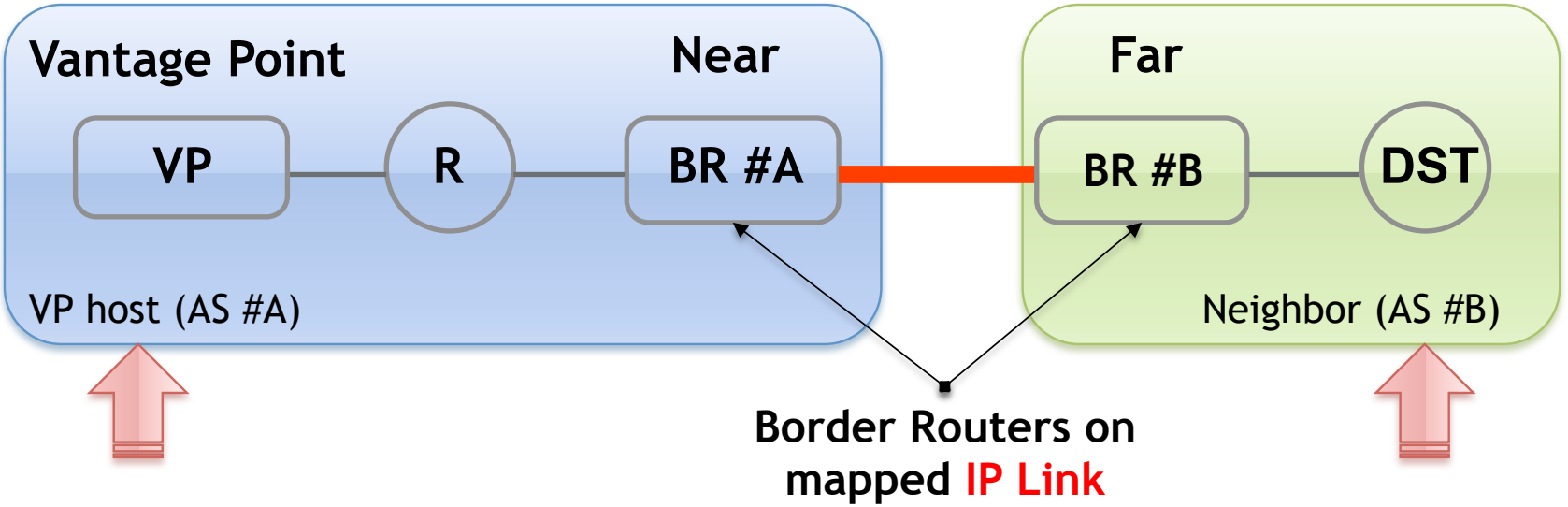
- No study on Congestion at local IXPs
  - The absence of congestion will incentivize ISPs or CPs that are still reluctant to join those IXPs
  - If there is congestion, what are causes and consequences ?

High Level Overview of our Methodology

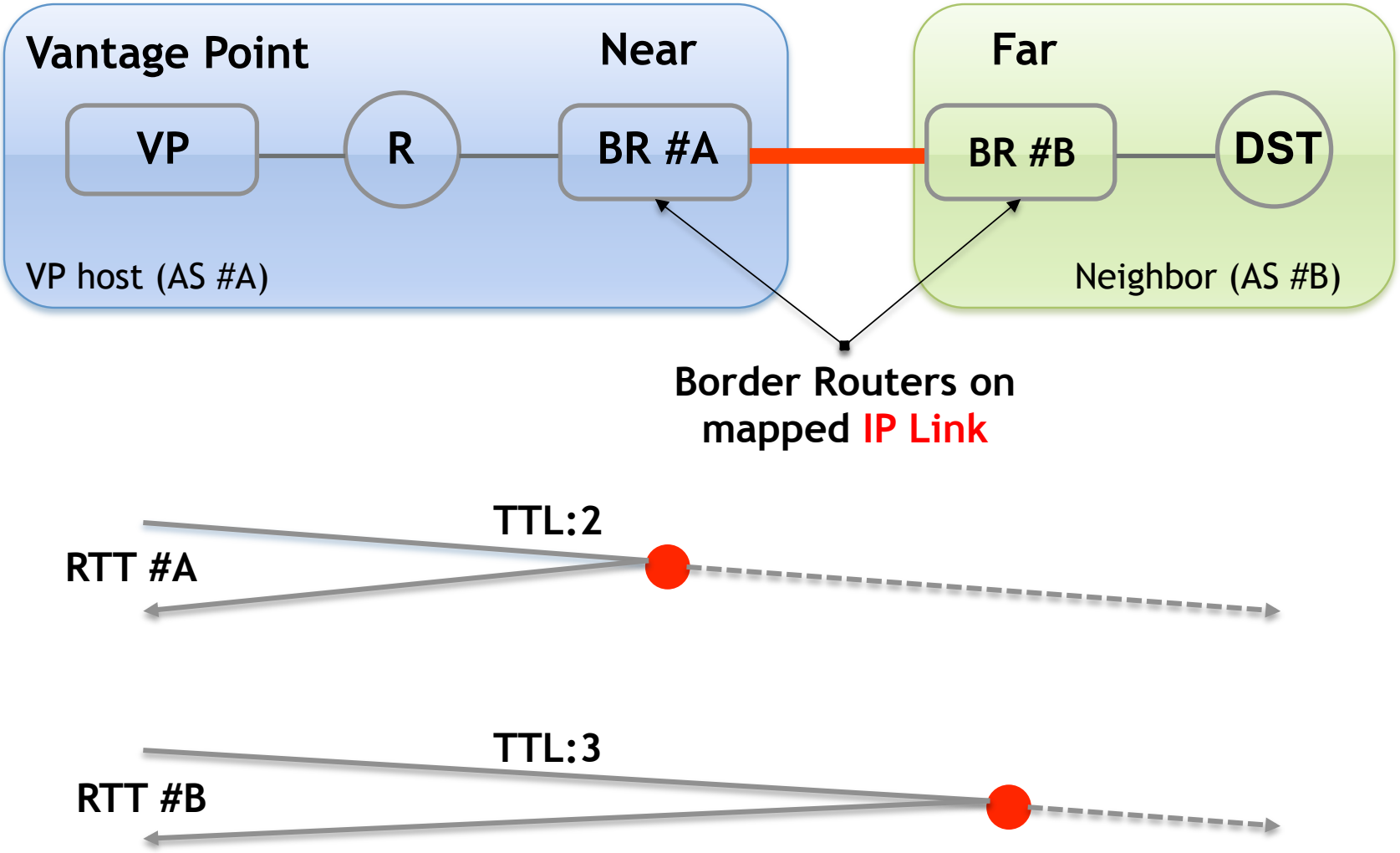
1. Deploy Vantage Points (VPs) with visibility into the IXPs
2. Infer the networks present at the IXPs
3. Use the Time-sequence Latency Probes (TSLP) [1] method to probe each of those networks
4. Look for evidence of congestion

[1] Luckie, Dhamdhere, Clark, Huffaker, K. Claffy. Challenges in Inferring Internet Interdomain Congestion. In *IMC*, 2014.

TSLP Method

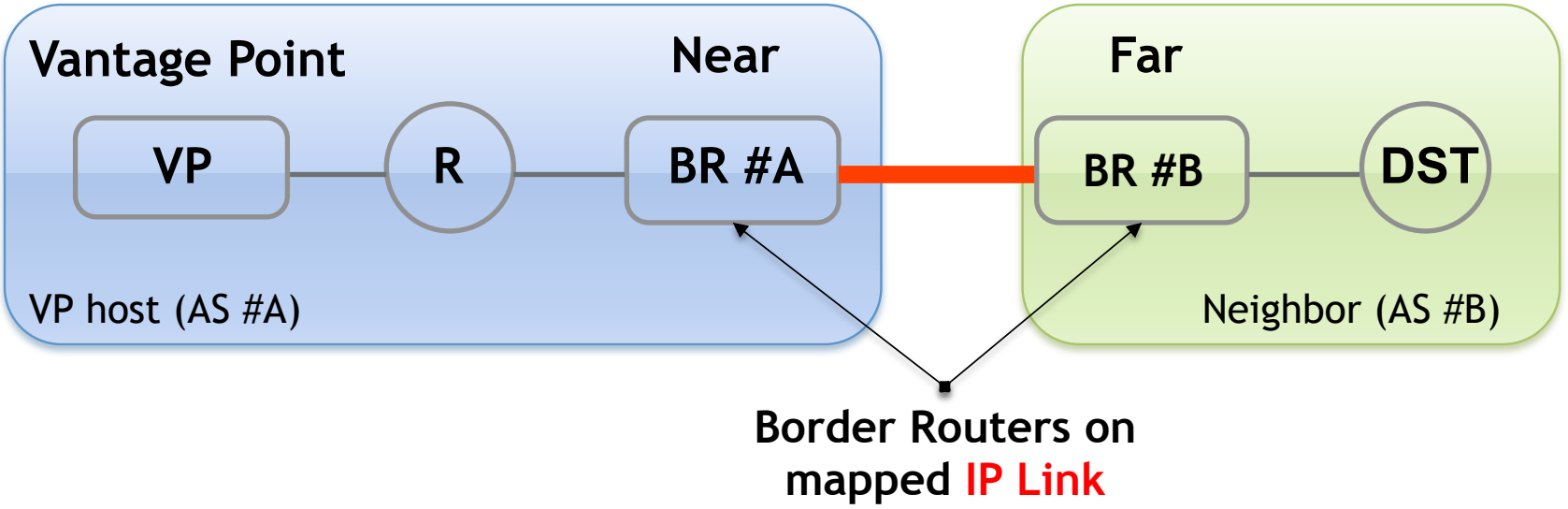

Vantage Point
Near
Far
VP
R
BR #A
BR #B
DST
VP host (AS #A)
Neighbor (AS #B)
Border Routers on
mapped IP Link

TSLP Method



(repeat to obtain "near" and "far" time series)

TSLP Method



Latency elevation on the “far” time series, but no elevation on the “near” time series

target link may be congested

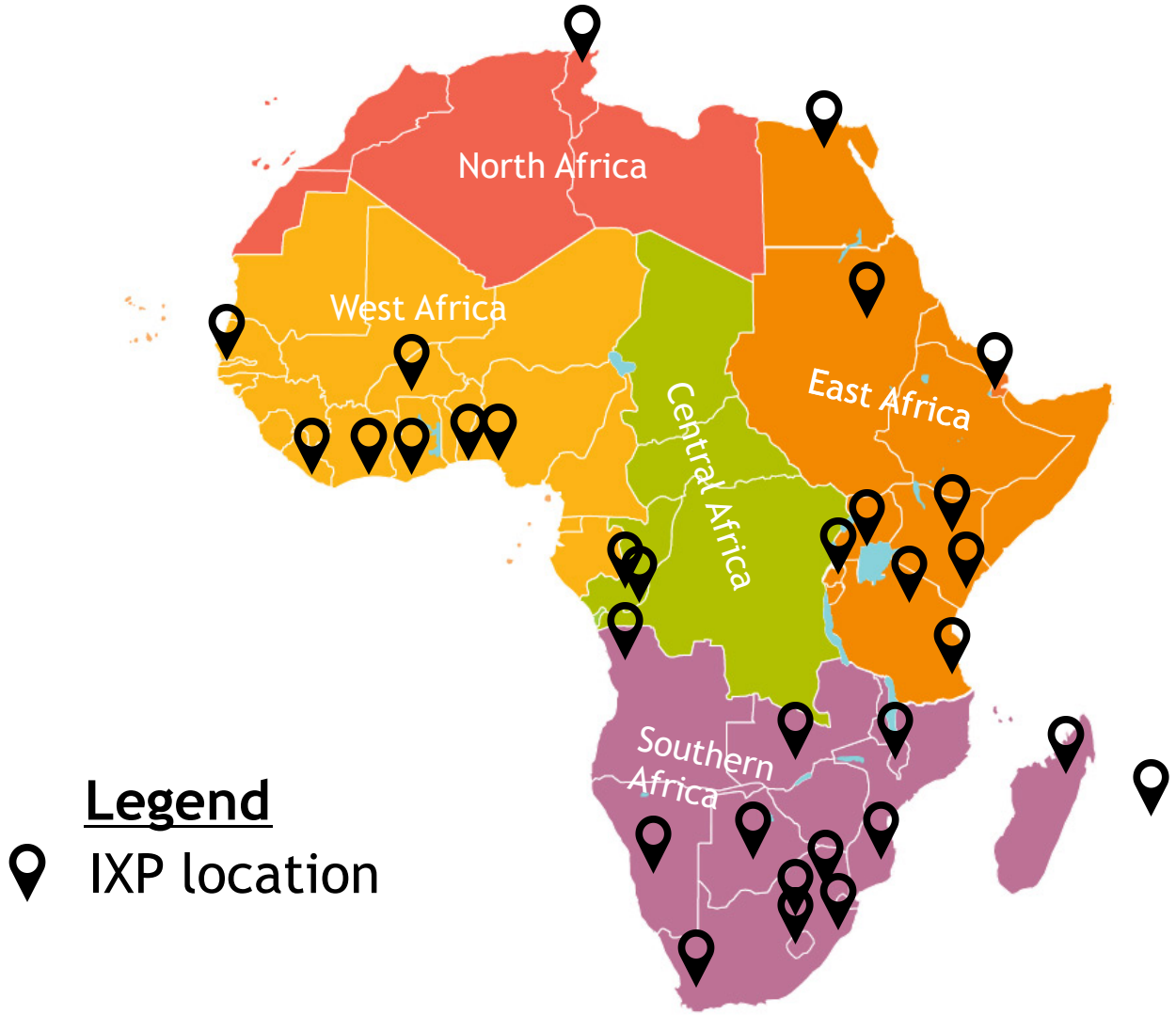
Selected Vantage Points (VPs)

- Ark monitors deployed at
  - 6 **strategically selected** IXPs in Africa: mature markets & potential regional hubs
  - Oldest IXP (JINX) launched in 1996
  - IXPs located in 3 of the 5 African sub-regions

- 2 VP setups
  - Within the content network of the IXP or
  - Within a peer at the IXP

[1] CAIDA. Archipelago (Ark) Measurement Infrastructure. http://www.caida.org/projects/ark/, 2017.

Measurement Infrastructure: VPs location



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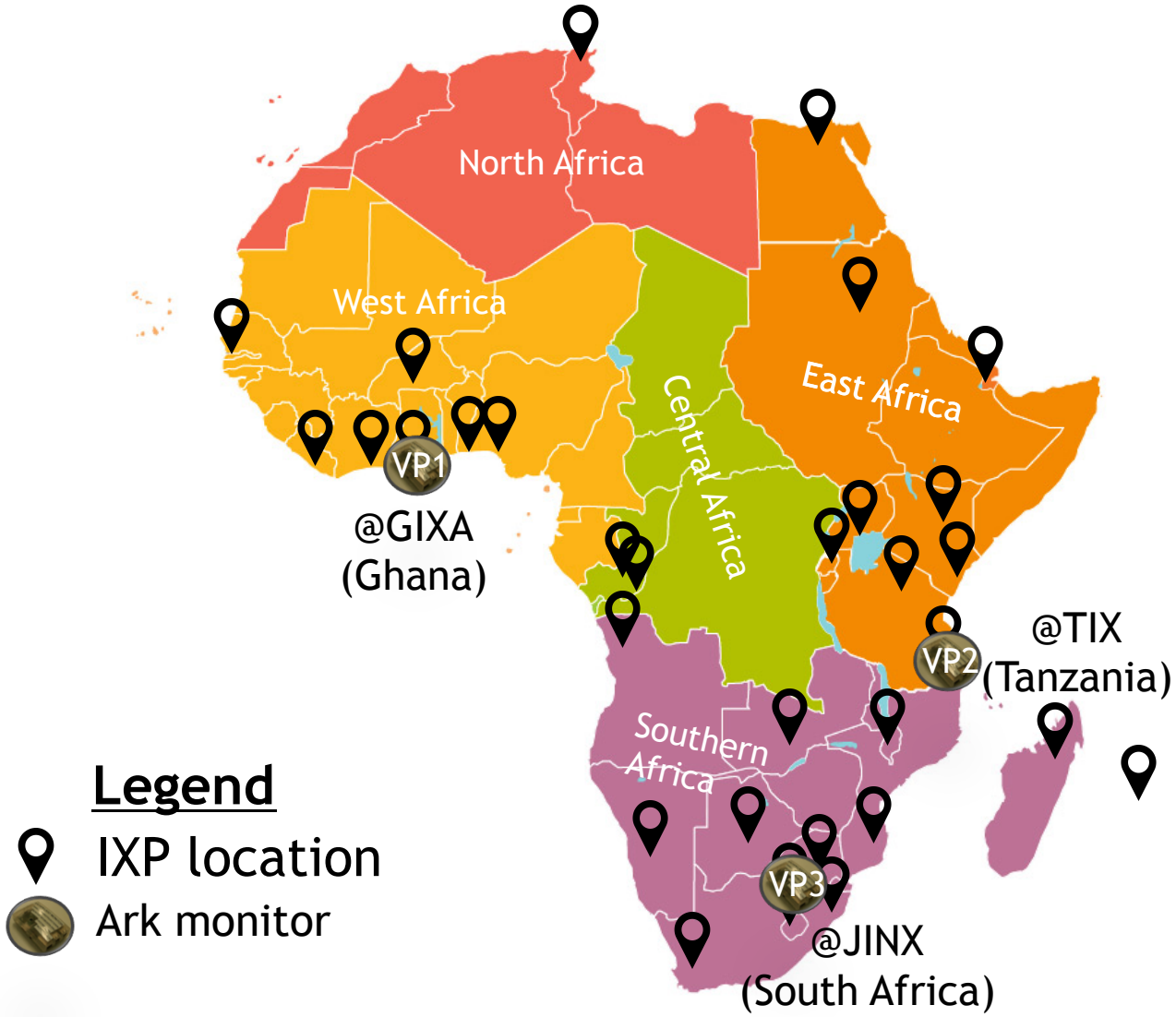

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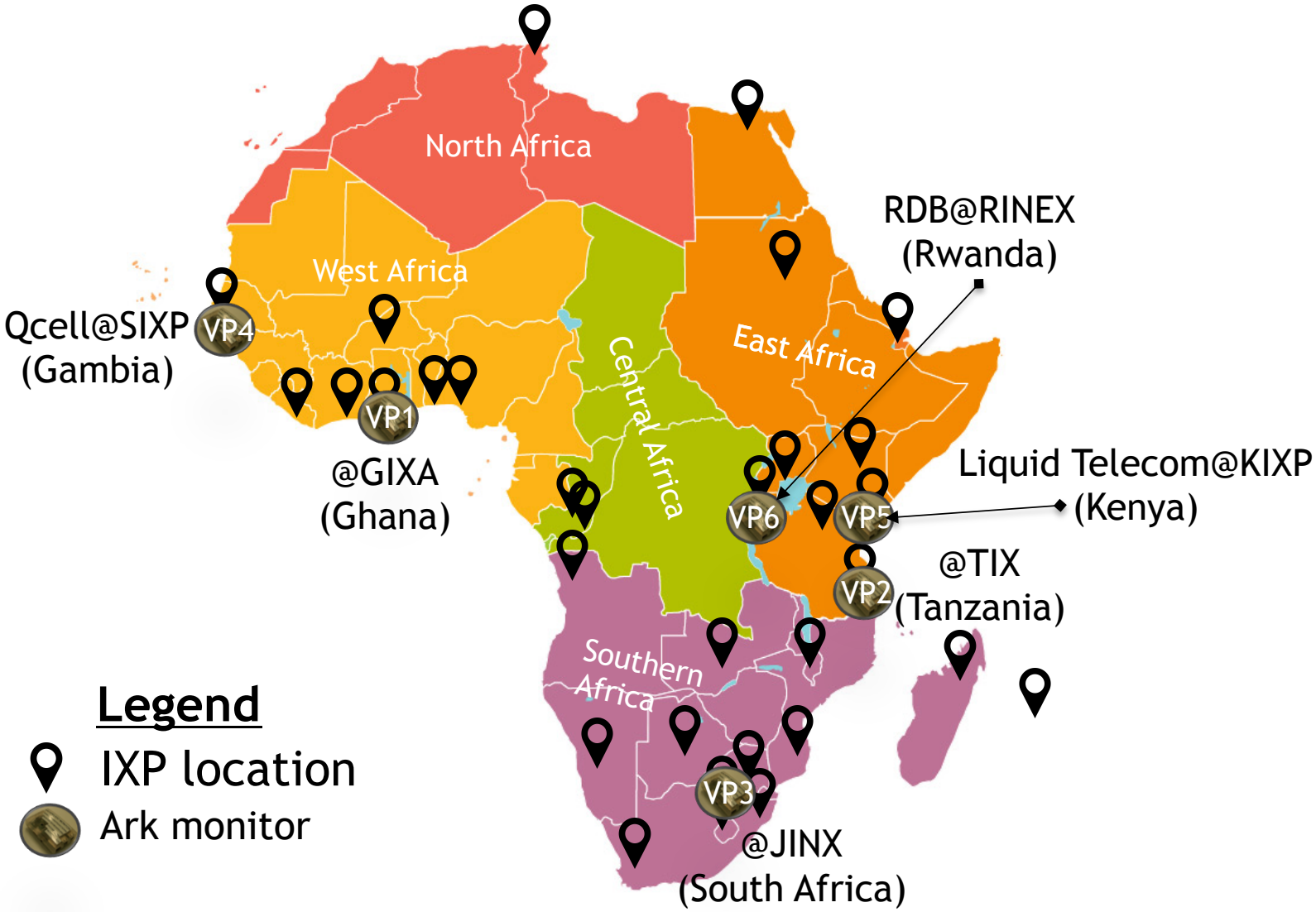


Data Collection and Analysis (1)

- **Border mapping**
  - Infer the networks present at the IXP using the bdrmap tool [1]
  - Validation with 4 VP hosts: 96.2% neighbors correctly mapped
- **TSLP measurements (1)**
  - Time range: 22/02/2016 to 27/03/2017
  - Low rate TTL-limited probing to both ends of each IP link (5min)
  - Detect level shifts >= 10 ms magnitude and 30 min duration [2]

[1] Luckie, Dhamdhere, Huffaker, Clark, Claffy. bdrmap: Inference of Borders Between IP Networks. In *Proceedings of ACM SIGCOMM Internet Measurement Conference (IMC)*, 2016.

[2]Taylor. Change-Point Analysis: A Powerful New Tool for Detecting Changes. http://www.variation.com/cpa/tech/changepoint.html, 2000.

Data Collection and Analysis (2)

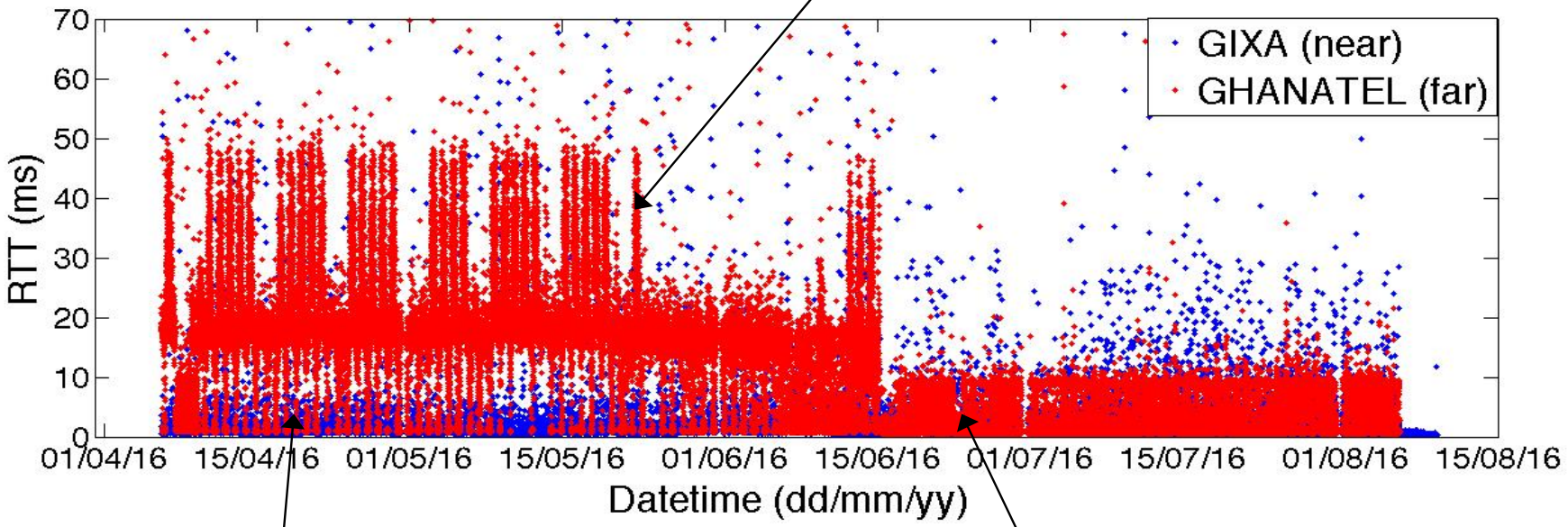
- **TSLP measurements (2)**
  - Record-Route (RR) method [3] to check path symmetry
  - IXP operator interviews to validate our results and identify causes of congestion
- **Loss rate measurements**
  - Started 5 months after TSLP: from 19/07/2016 to 01/04/2017
  - Probing links suffering from repeated congestion (at 1pps)
  - Losses computed over every batch of 100 probes

[3] Katz-Bassett, Madhyastha, Adhikari, Scott, Sherry, Van Wesep, Anderson, Krishnamurthy. Reverse Traceroute. In *NSDI*, 2010.

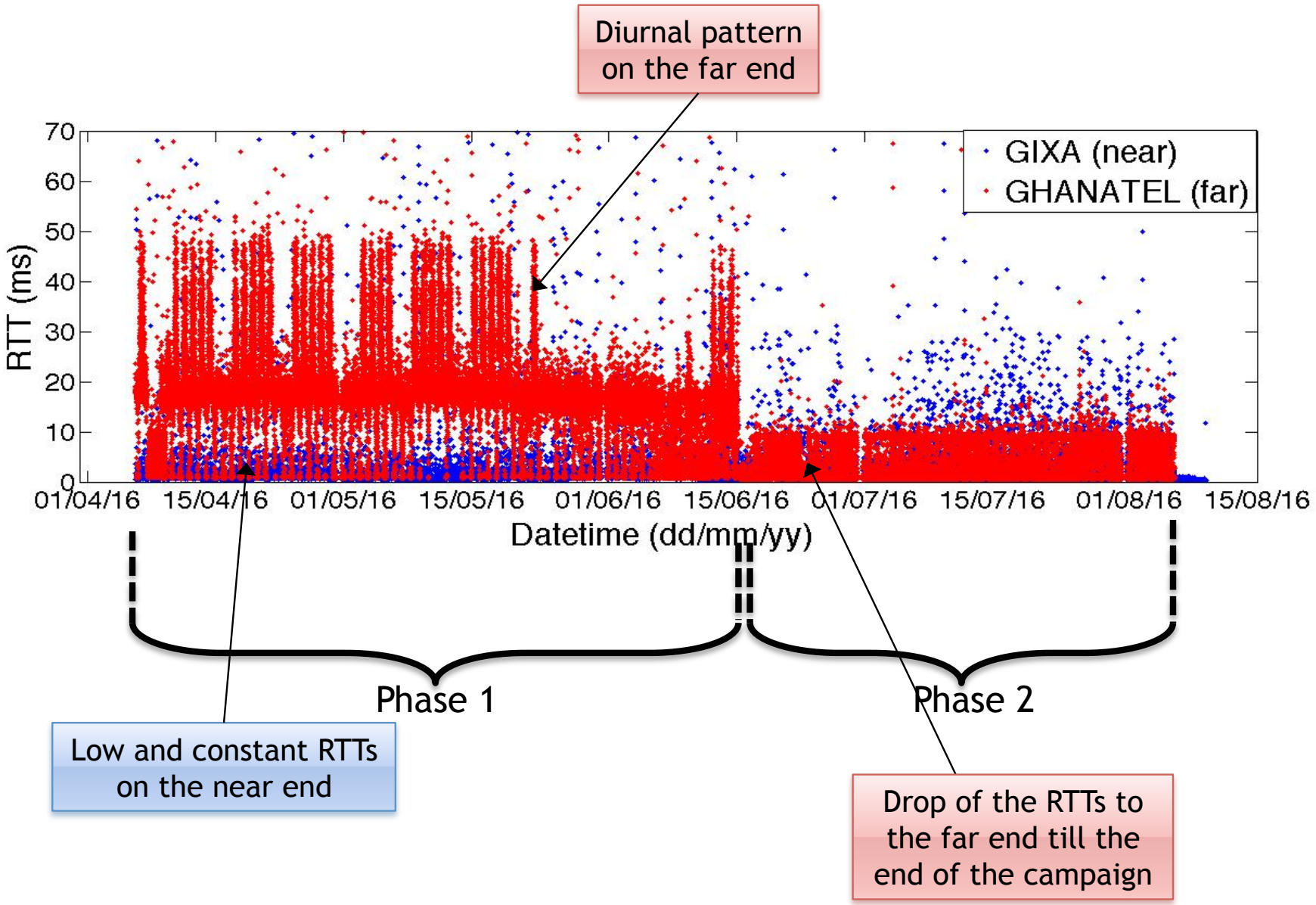
Results Overview

- No evidence of widespread congestion
  - 2.2% of discovered links experienced congestion
  - At the end of our measurements campaign:
    - Sustained congestion cases: GIXA (VP1)
    - Mitigated congestion cases: TIX (VP2), JINX (VP3), and QCell (VP4@SIXP)
- 3 striking cases (2 highlighted in this talk)
  - GIXA – GHANATEL
  - GIXA – KNET
  - QCELL - NETPAGE

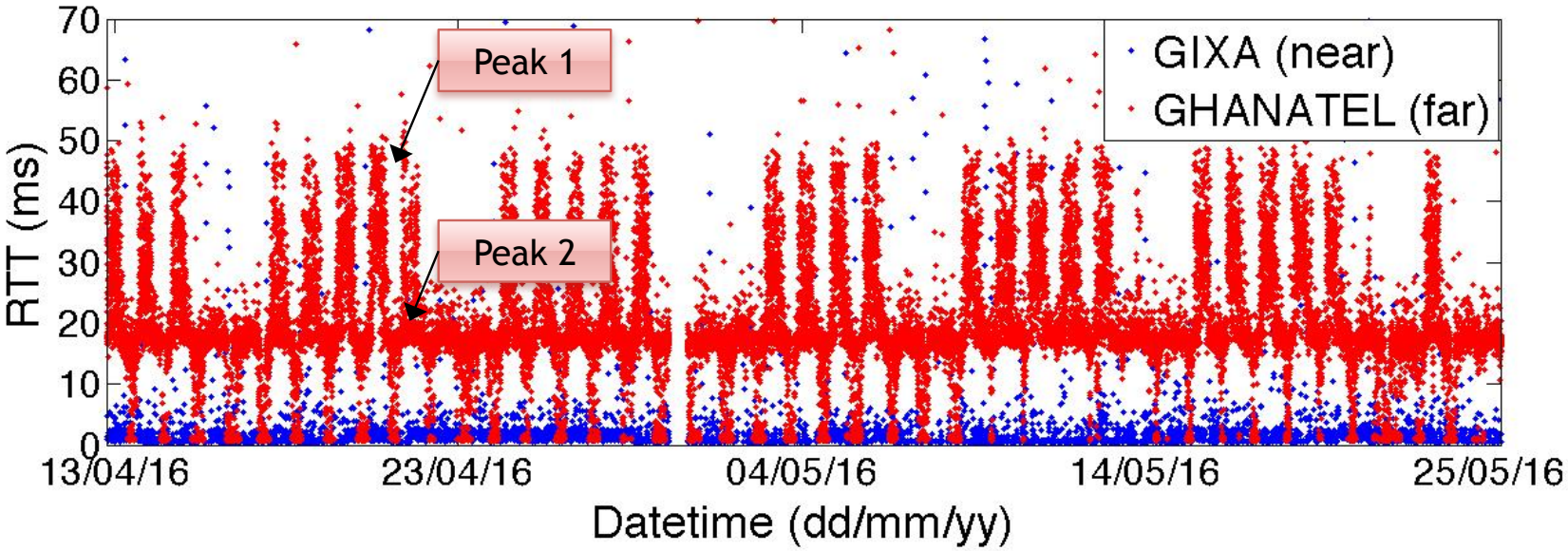
GIXA-GHANATEL



GIXA-GHANATEL



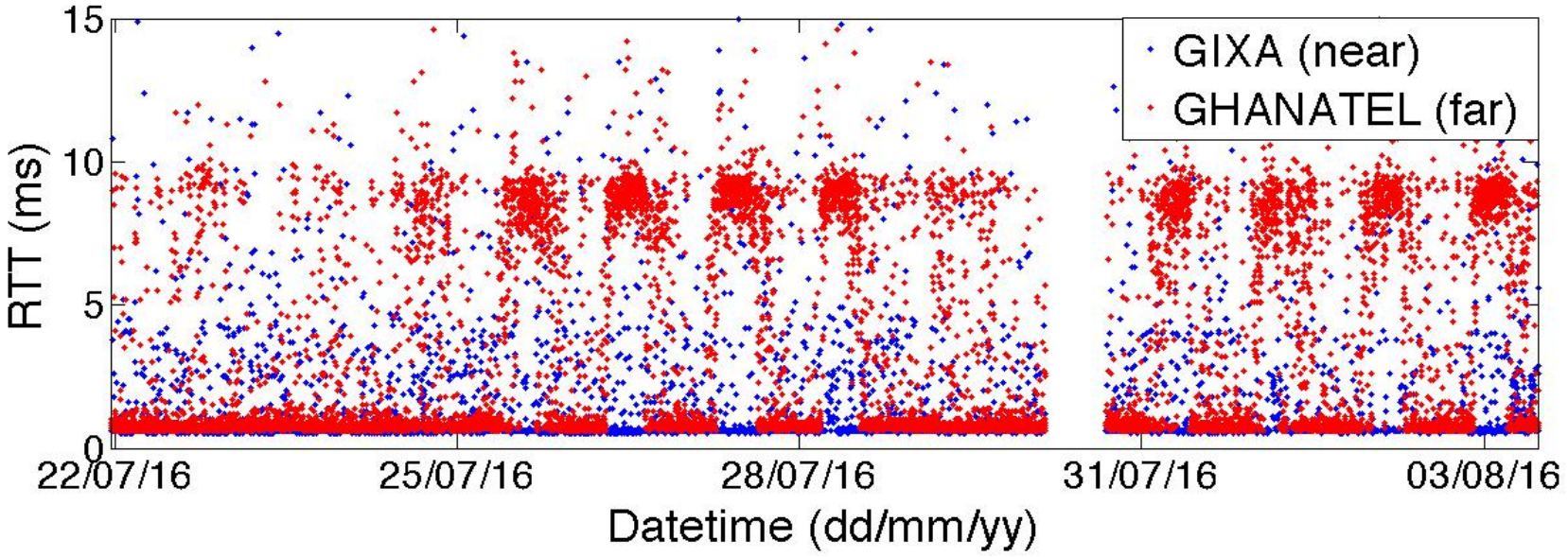
GIXA-GHANATEL (Phase 1)



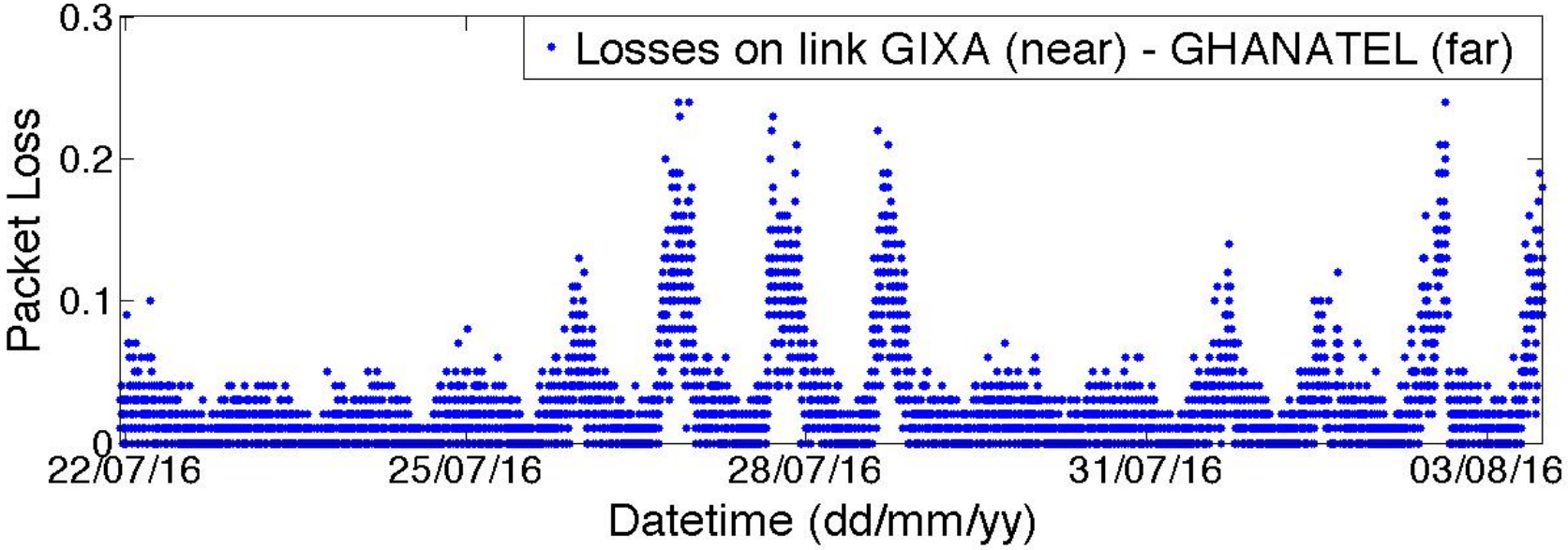
- GHANATEL was providing free transit to the content network hosting GGCs through a 100 Mbps link
- 100 Mbps link congested
- GHANATEL was serving its clients through a separate 1Gbps link
  - Its end-users were likely not impacted

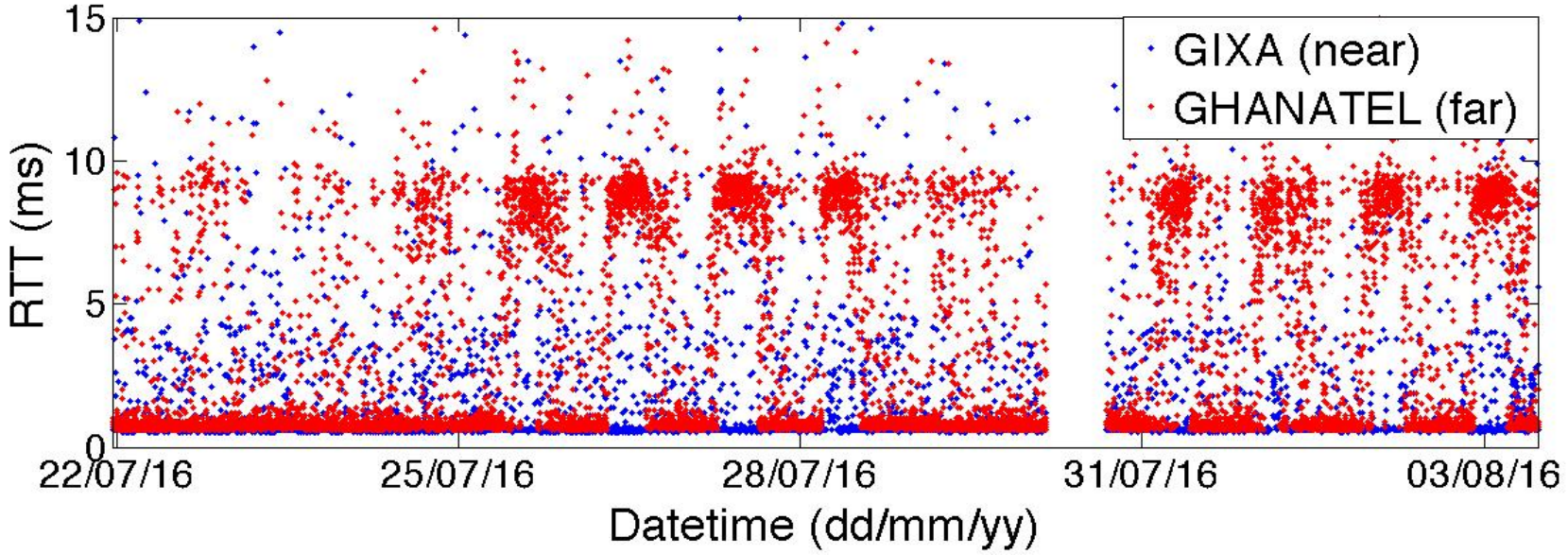
GIXA-GHANATEL (Phase 2)

- Dispute between IXP and transit
- GHANATEL shut off the transit service to force the IXP (GIXA) to pay!
  - GGC not functional: End-users of GIXA peers likely affected by the detour of their packets to Google content
- GHANATEL continued to use the link for peering (but still congested)



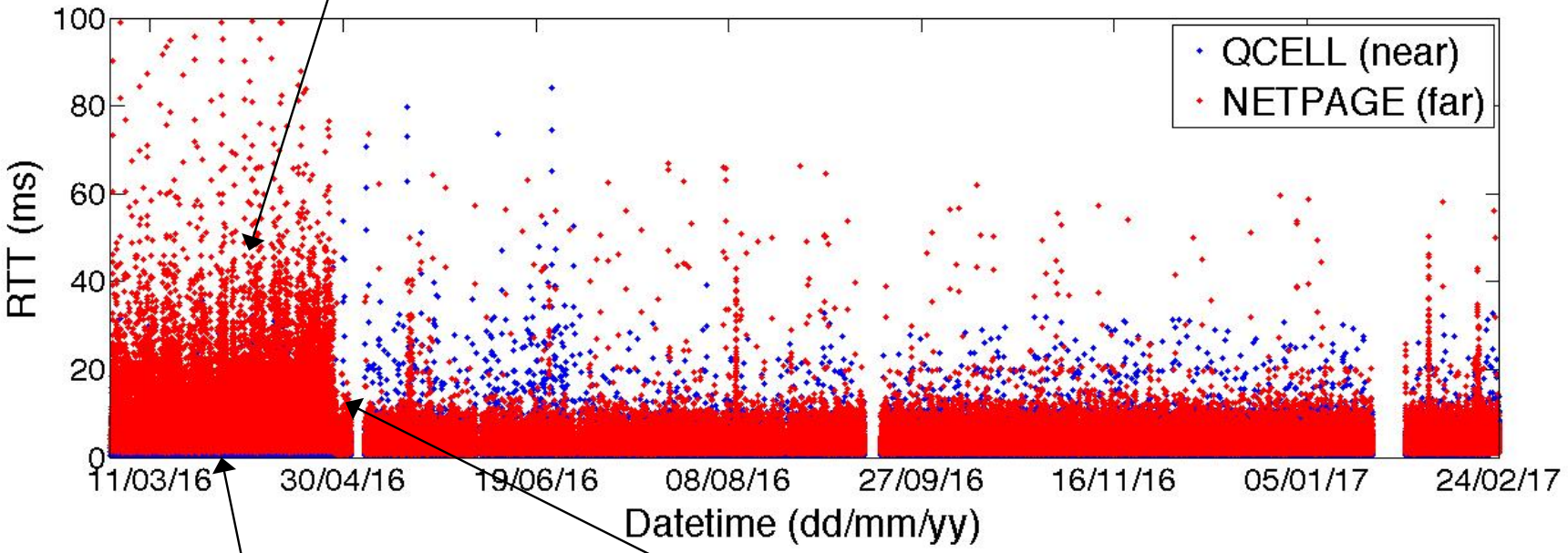
GIXA-GHANATEL (Phase 2)





QCELL-NETPAGE

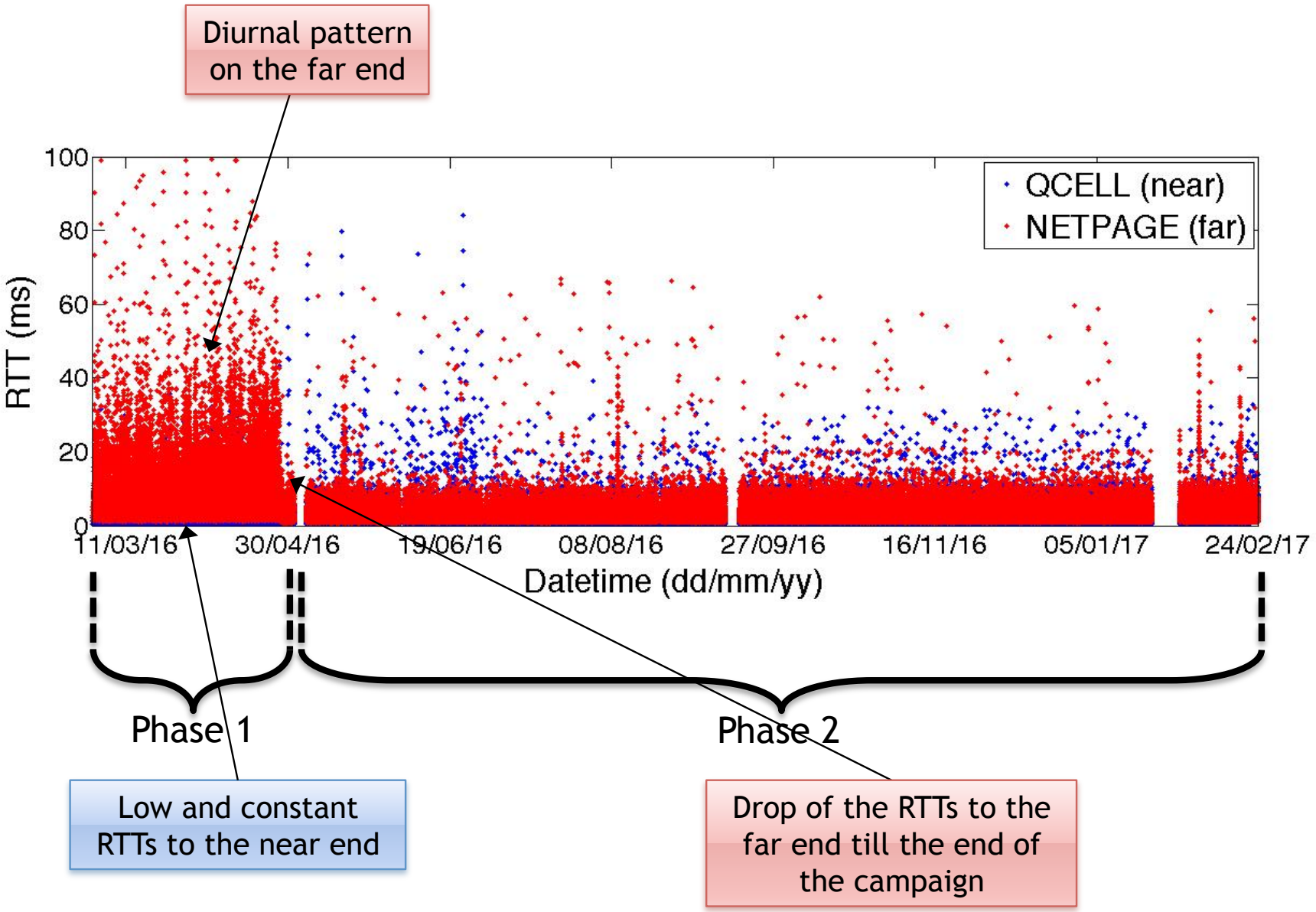
Diurnal pattern on the far end



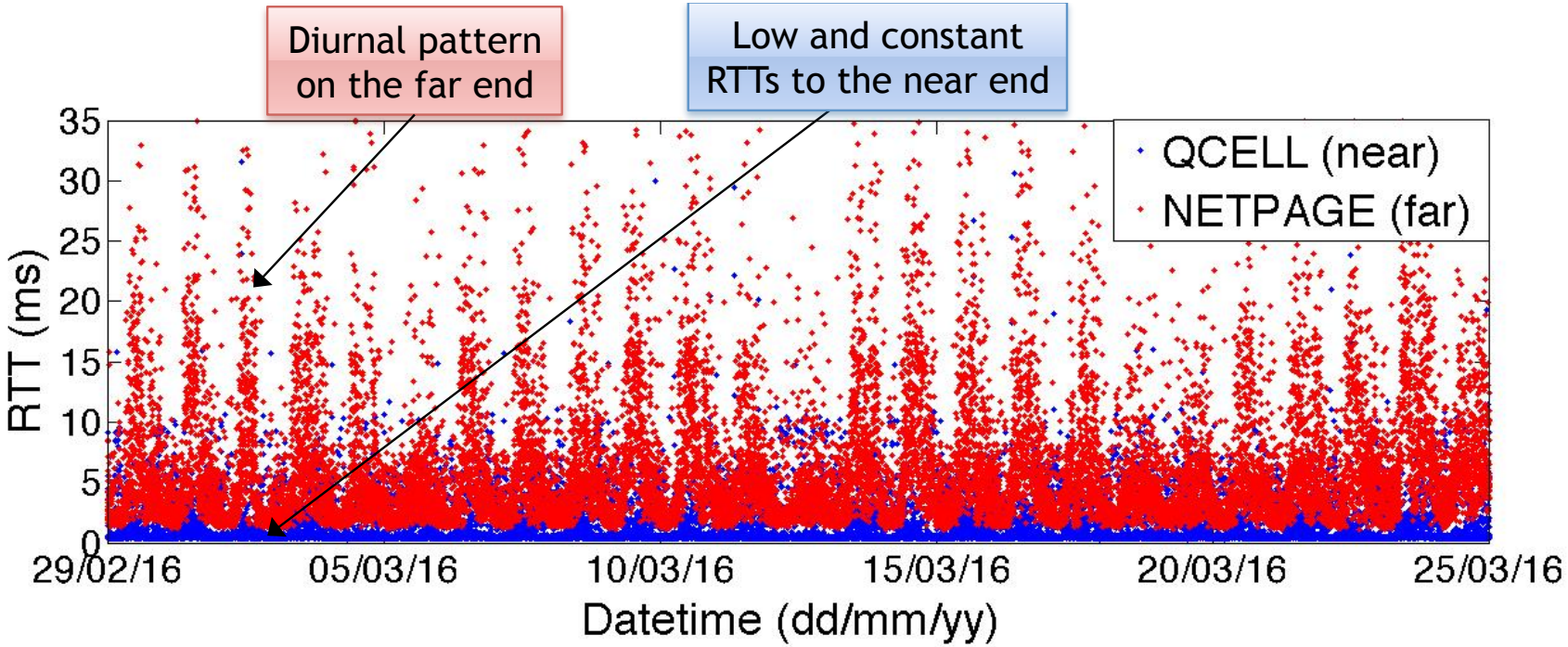
Low and constant RTTs to the near end

Drop of the RTTs to the far end till the end of the campaign

QCELL-NETPAGE

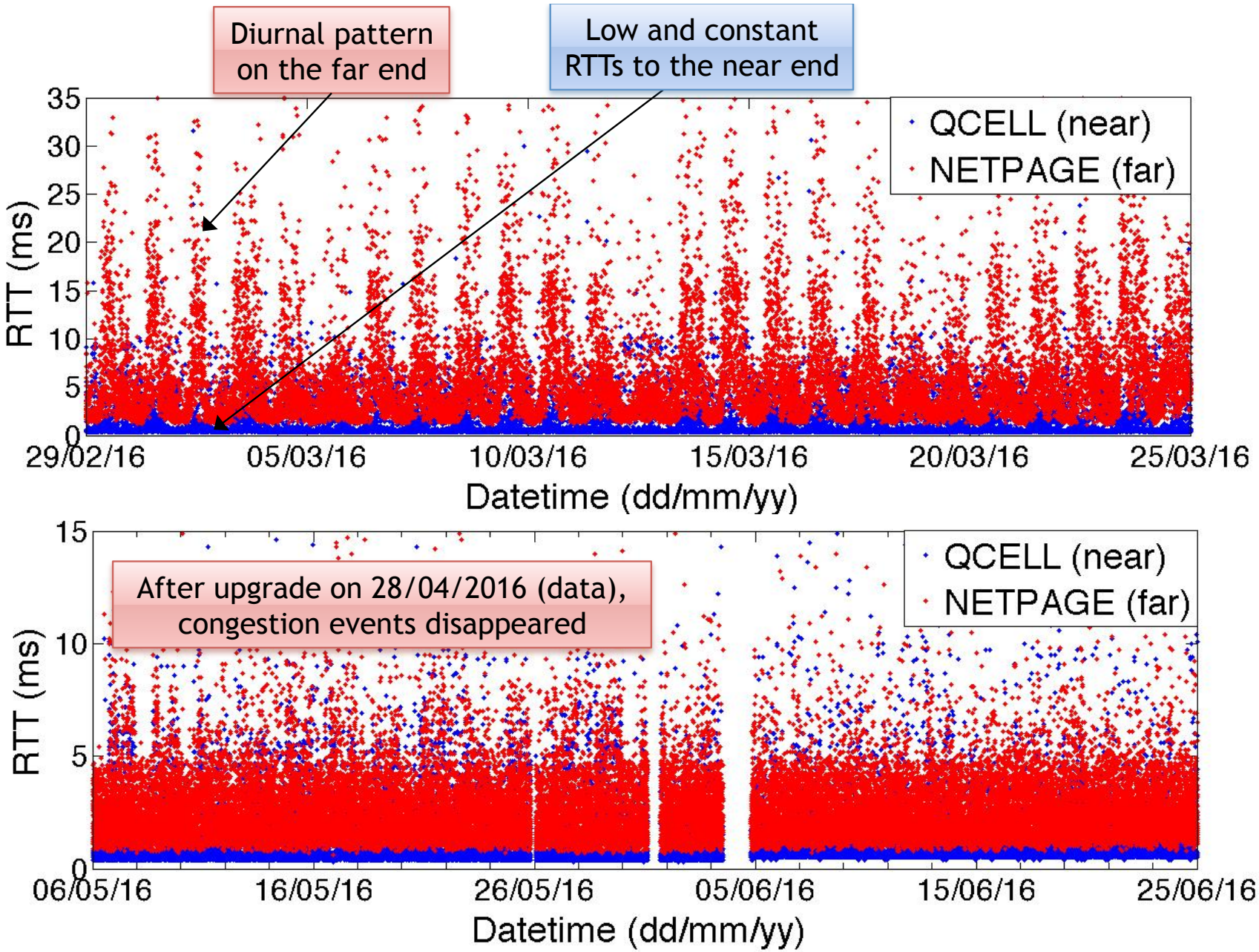


QCELL-NETPAGE (Phase 2)



- QCell provides transit for GGCs at SIXP
- High bandwidth usage of Google traffic from NETPAGE users was degrading performance
- NETPAGE requested an upgrade from 10 Mbps to 1Gbps

QCELL-NETPAGE (Phase 2)

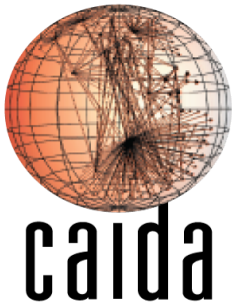


Conclusions

1. Measured IXPs were congestion-free, which promotes peering in the region
   - IXP ecosystem highly dynamic in Africa => need for a longitudinal measurement and monitoring
   - Need to carefully monitor links used to access content (susceptible to congestion)
2. Discussion with stakeholders is crucial to understanding the causes of performance degradations
3. Must be aware that transit services are needed for updating content caches (may lead to dispute if not well managed)

THANK YOU

Any Questions ?



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