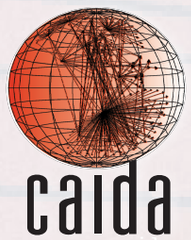
INVESTIGATING THE CAUSES OF CONGESTION ON THE AFRICAN IXP SUBSTRATE

By

Roderick Fanou* (CAIDA/UCSD),
Francisco Valera (UC3M),
Amogh Dhamdhere (CAIDA/UCSD)



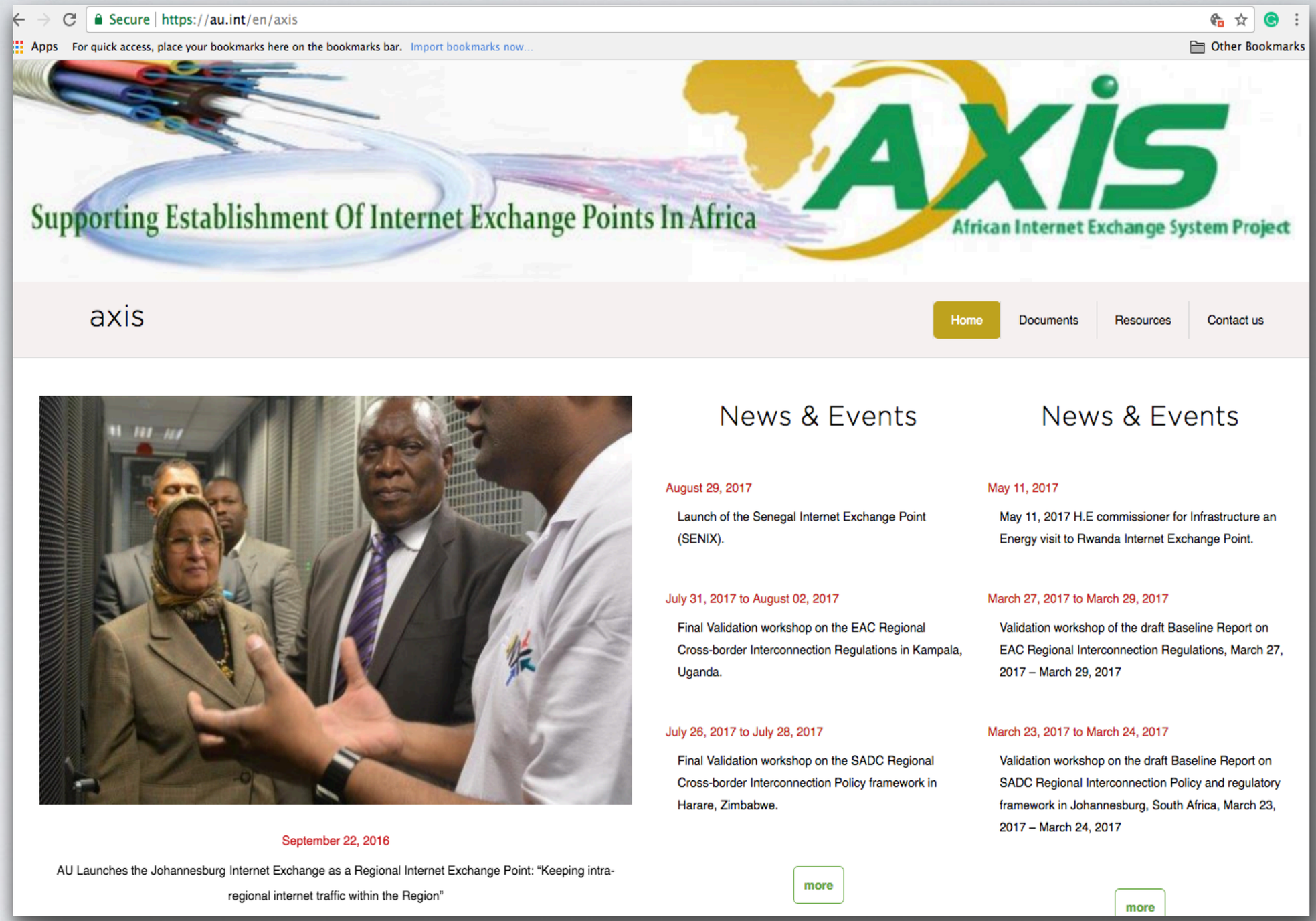
*whose affiliation was then IMDEA Networks/UC3M

DISCLAIMER:

This work [1] was published at the ACM Internet Measurement Conference (IMC) 2017 and the corresponding paper is available at: http://www.caida.org/publications/presentations/2017/investigating_causes_congestion_african_imc/

[1] Fanou, Valera, Dhamdhere. Investigating the Causes of Congestion on the African IXP Substrate. In IMC, 2017.

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

Secure | https://au.int/en/axis

www.af-ix.net/ixps-map

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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.

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

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38 active Internet eXchange Points (IXPs) in **35** countries (**October 2017**)

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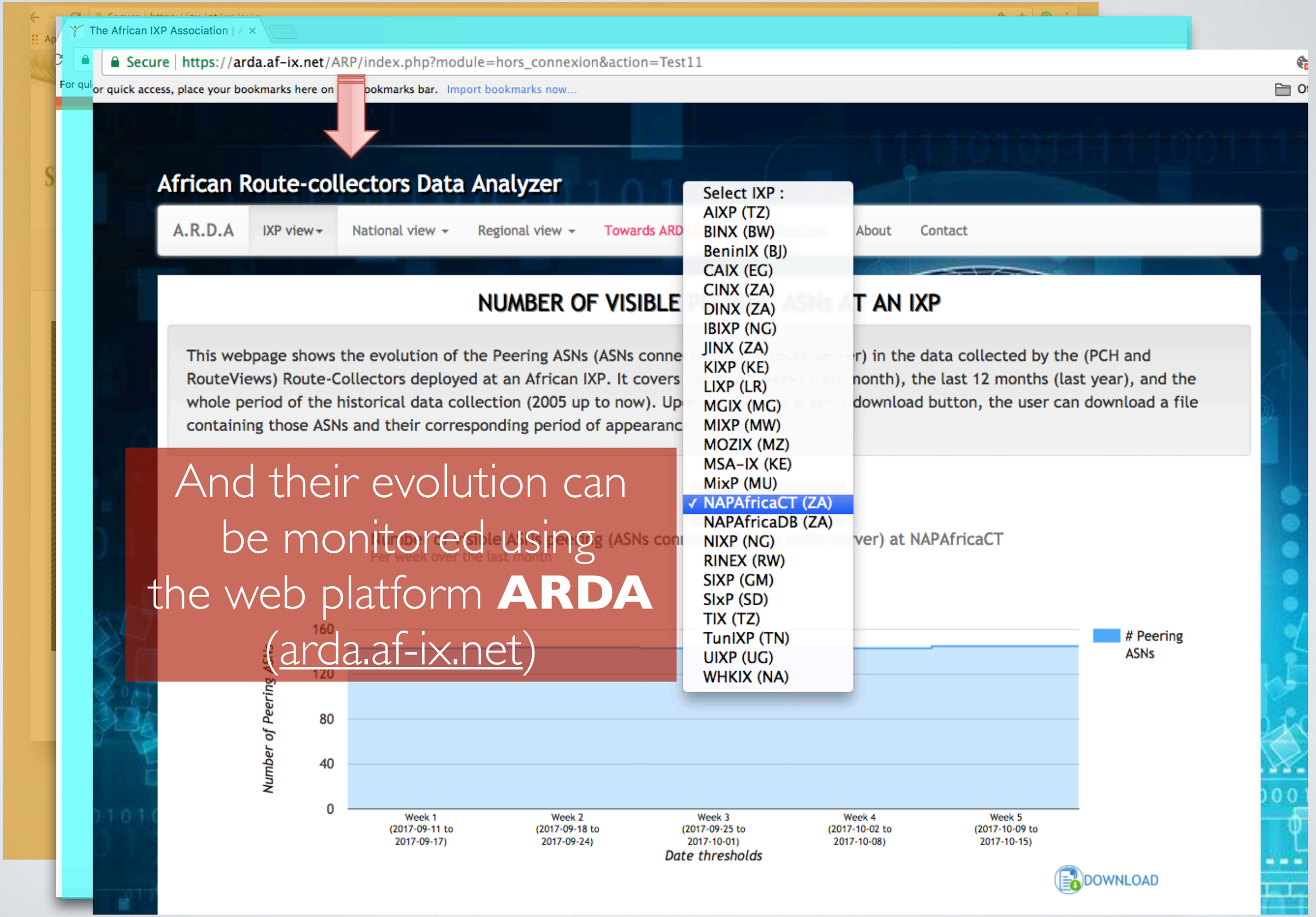

And their evolution can be monitored using the web platform **ARDA** (arda.af-ix.net)

Background & Motivation

Why is this study needed ?

- **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

Background & Motivation

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- **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, Claffy. Challenges in Inferring Internet Interdomain Congestion. In IMC, 2014.

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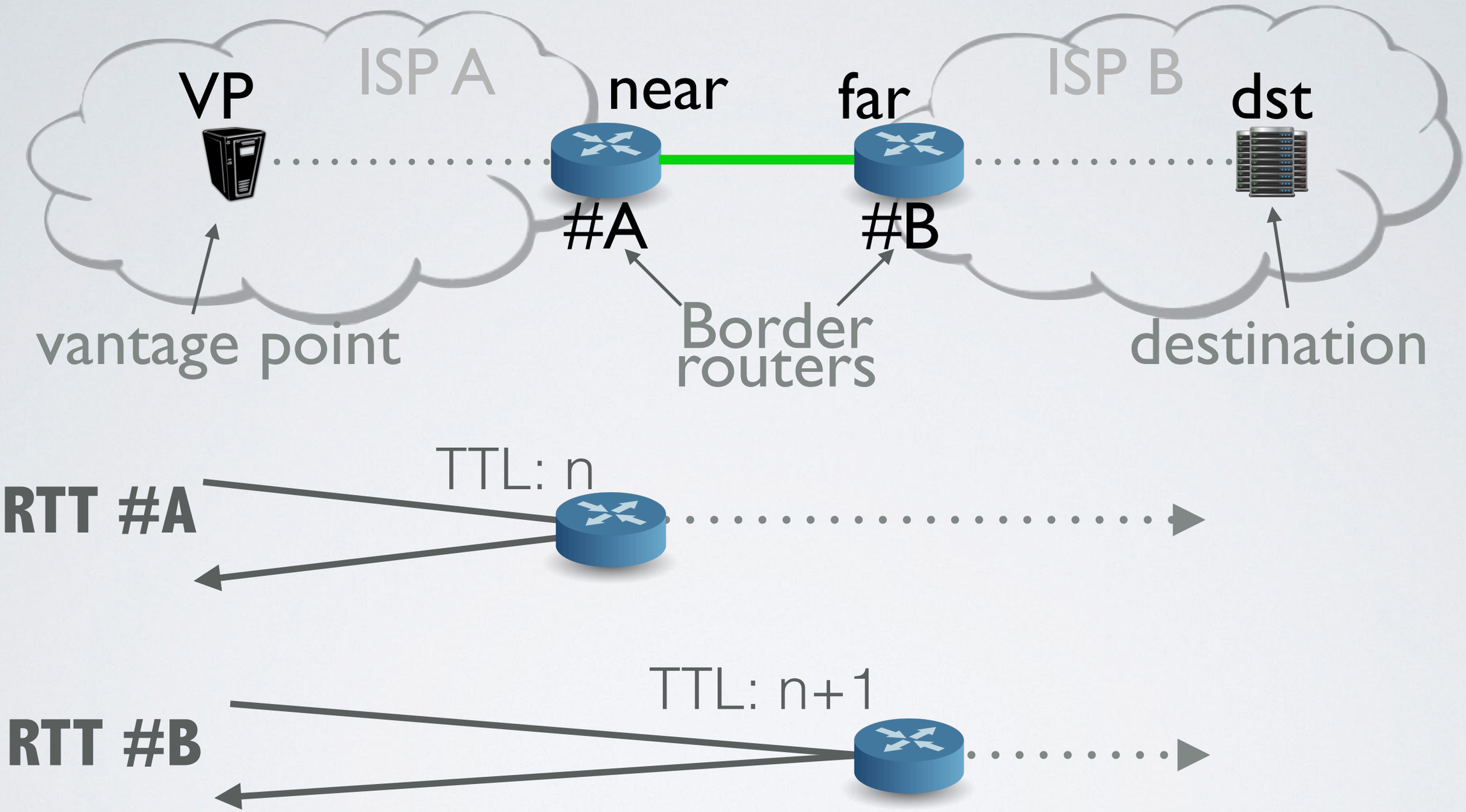
Time Series Latency Probes (TSLP)



(repeat to obtain a timeseries)

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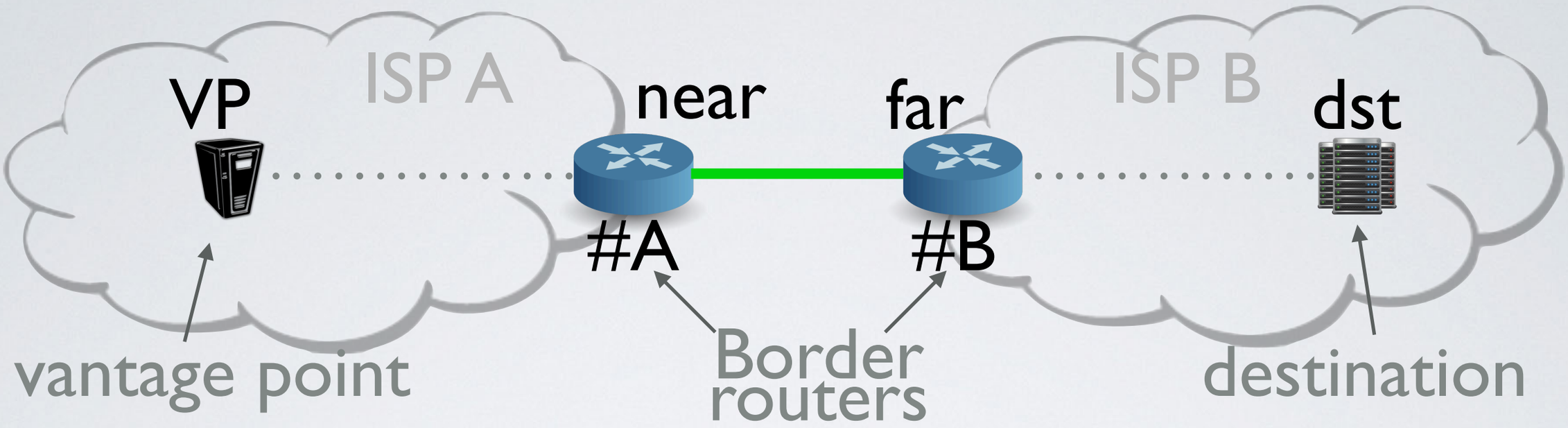

Latency elevation on the "far" timeseries,
but no elevation on the "near" timeseries

target link may be congested

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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
  - 3 out of 5 African sub-regions covered

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

Meas. infrastructure: VPs locations

Legend

IXP location

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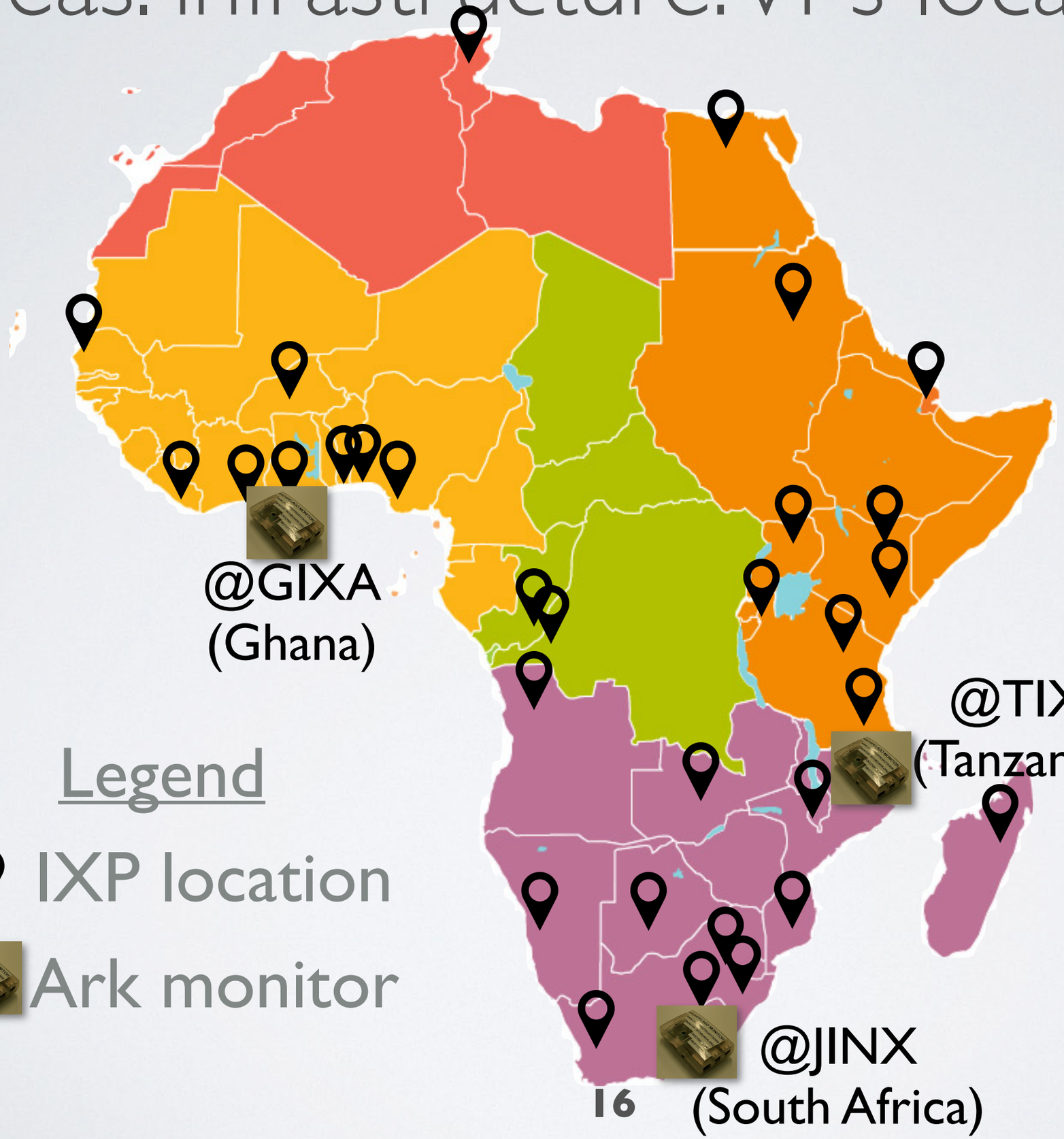
Meas. infrastructure: VPs locations



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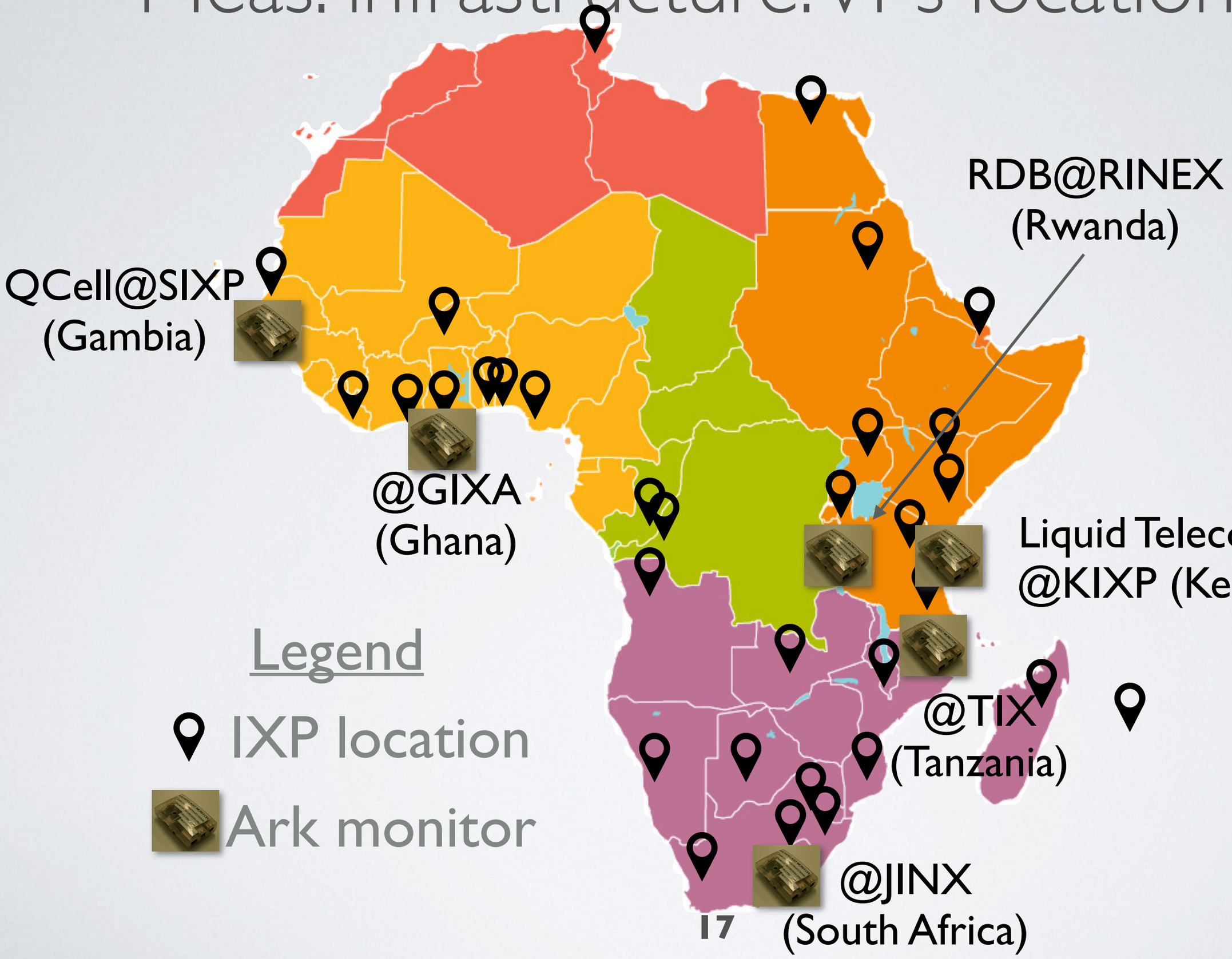

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Help build the Ark measurement network in Africa by hosting a VP!

We are always looking for volunteers to host VPs!

Contact us:

manic-info@caida.org

or

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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

[1] Luckie, Dhamdhere, Huffaker, Clark, Claffy. bdrmap: Inference of Borders Between IP Networks. In Challenges 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

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- **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 >= 10ms magnitude and 30min duration [2]

[1] Luckie, Dhamdhere, Huffaker, Clark, Claffy. bdrmap: Inference of Borders Between IP Networks. In Challenges 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 operators interviews to validate our results and identify causes of congestion

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

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- **Loss rate measurements**

  - Started 5months 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, Madhvastha, Adhikari, Scott, Sherry, Van Wesep, Anderson, Krishnamurthy. Reverse Traceroute. In NSDI, 2010.

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Results Overview

- **No evidence of widespread congestion**
  - 2.2% of discovered link showed evidence of congestion at the end of our measurements campaign
    - Sustained congestion cases: GIXA (VP1)
    - Mitigated congestion cases: TIX (VP2), JINX (VP3), & QCell (VP4)

Results Overview

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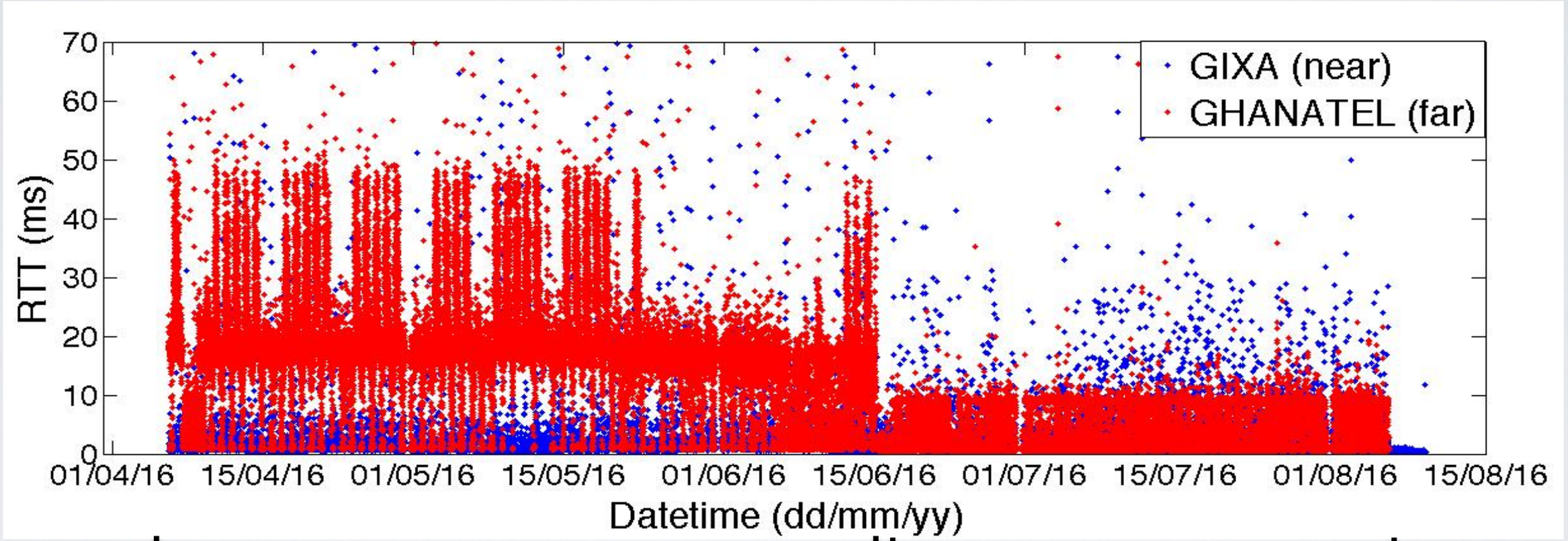
    - Sustained congestion cases: GIXA (VP1)
    - Mitigated congestion cases: TIX (VP2), JINX (VP3), & QCell (VP4)
- **3 striking cases - (of which 2 are presented)**
  - GIXA (Ghana Internet Exchange Association) - GHANATEL
  - GIXA - KNET (Open discussions)
  - QCELL - NETPAGE

GIXA - GHANATEL

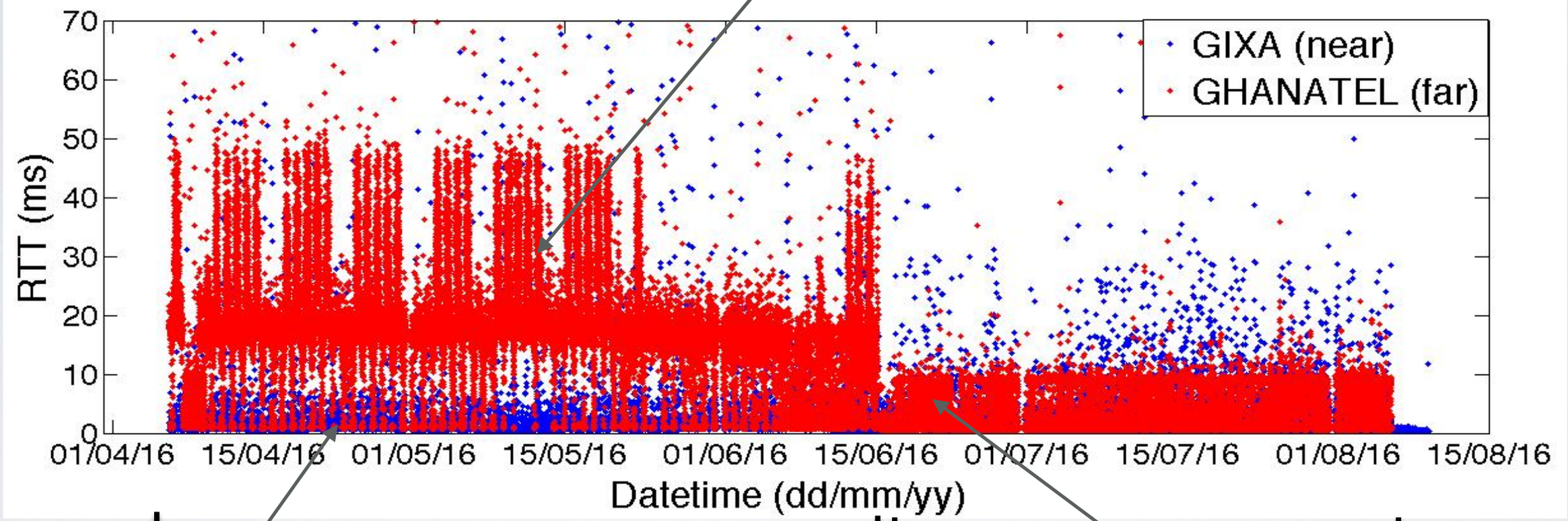


Phase 1

Phase 2

GIXA - GHANATEL

Diurnal pattern on the far-end



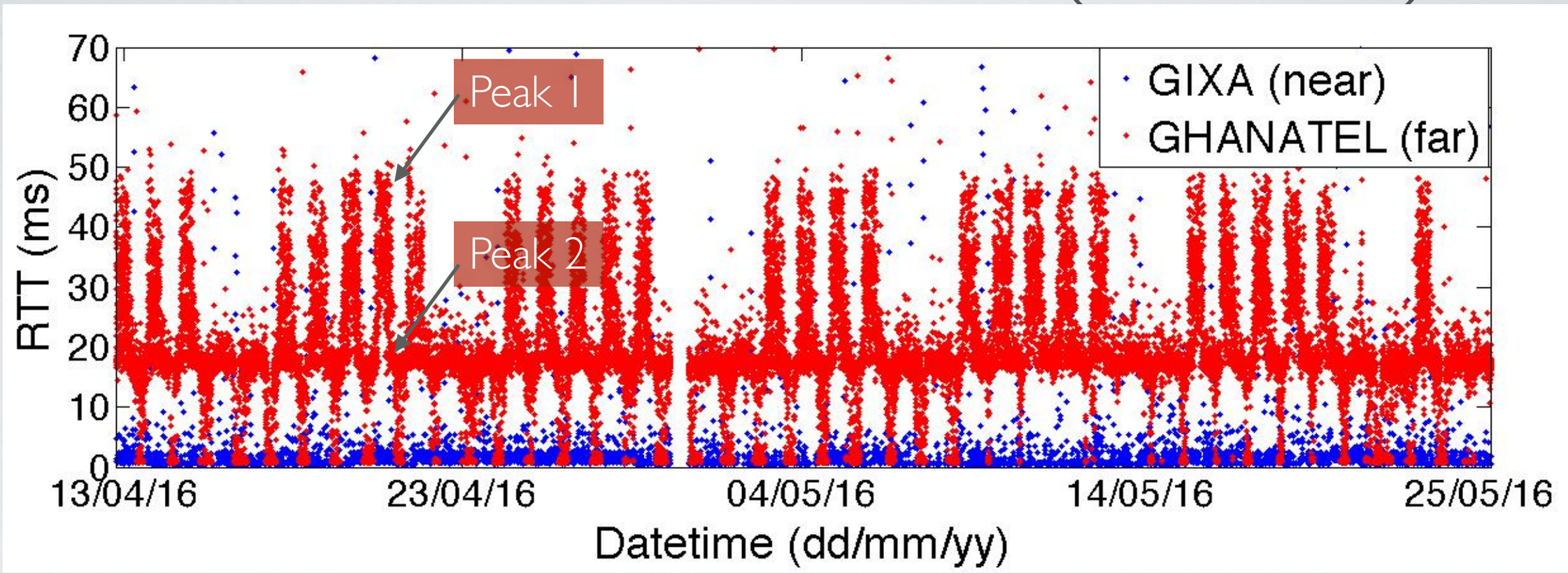
Phase 1

Phase 2

Low and constant RTTs on the near end

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

GIXA - GHANATEL (Phase 1)



- GHANATEL was providing free-transit to the content network hosting the GGCs through a 100 Mbps link

- 100 Mbps link got congested

- GHANATEL was serving its client through a separate 1Gbps link

  - Its end-users were likely not impacted

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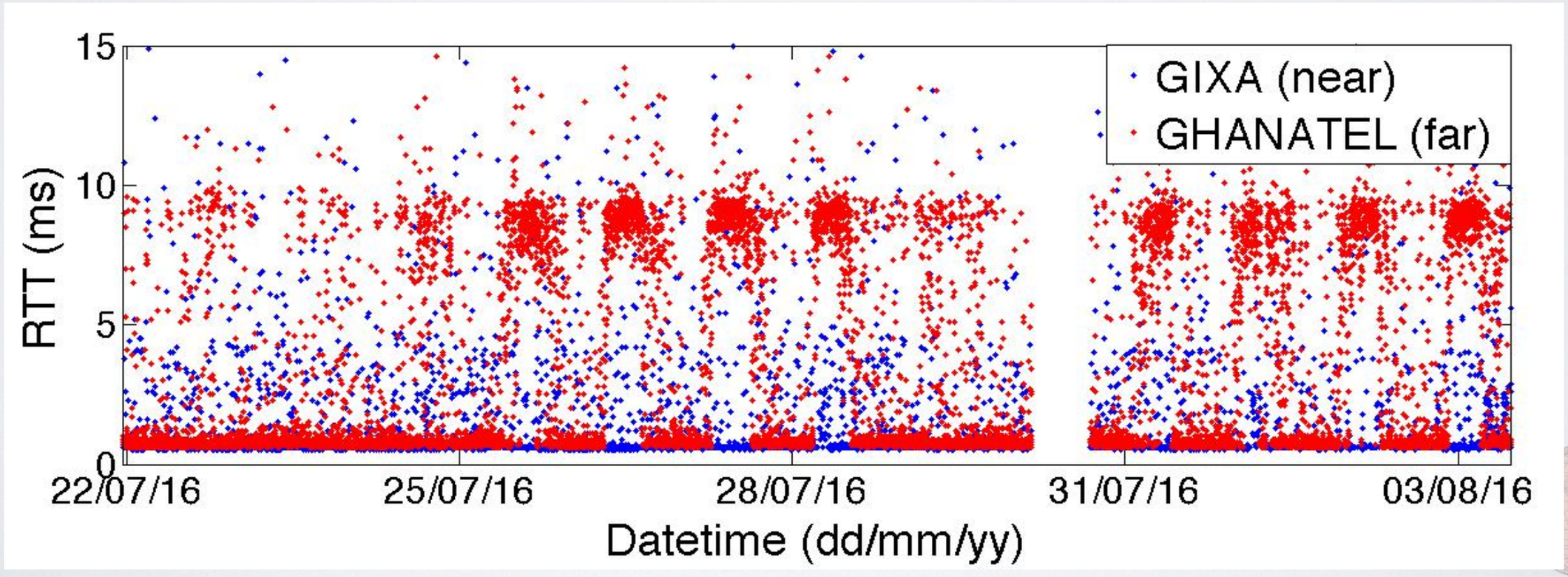
GIXA - GHANATEL (Phase 2)

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



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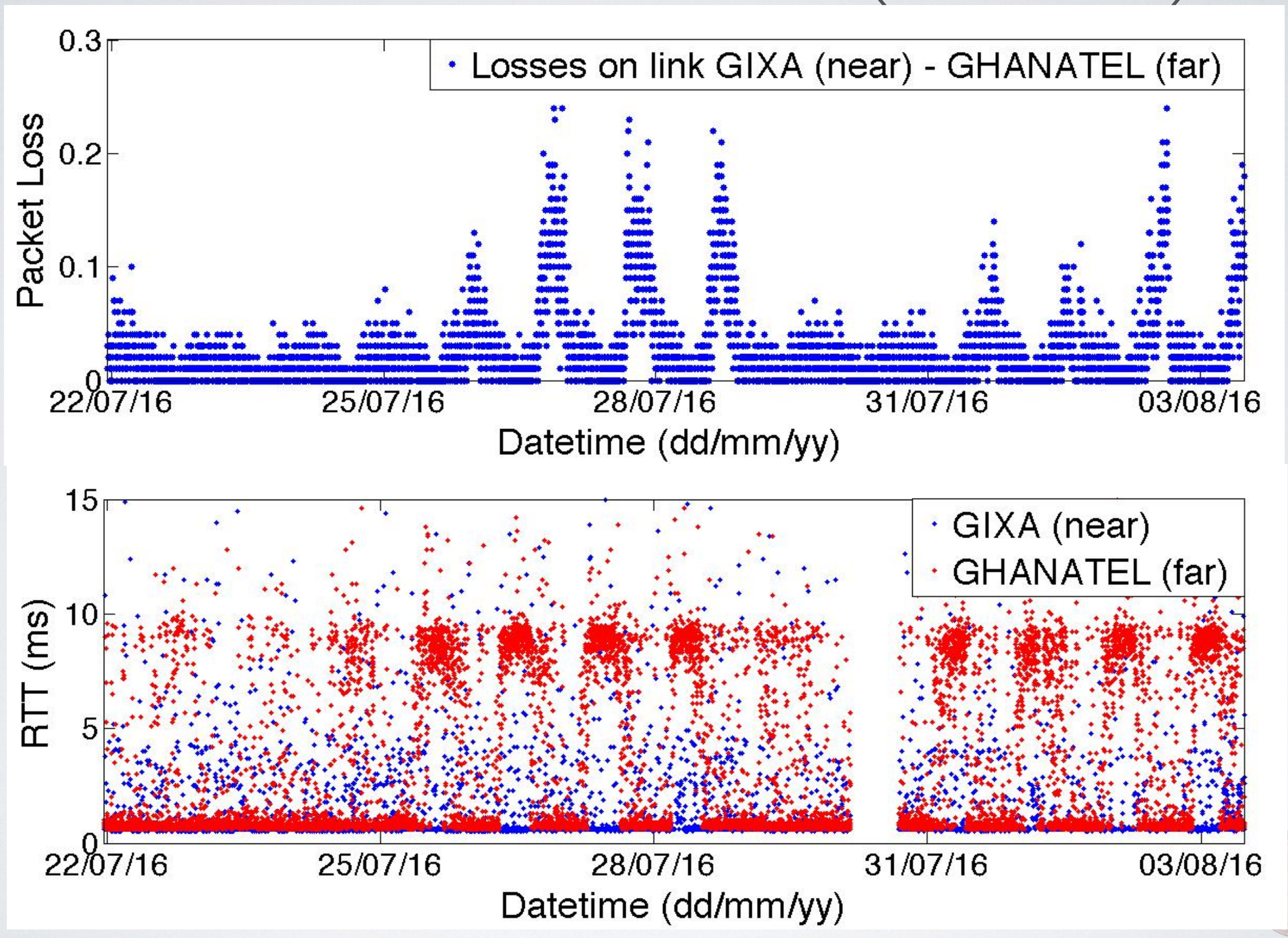
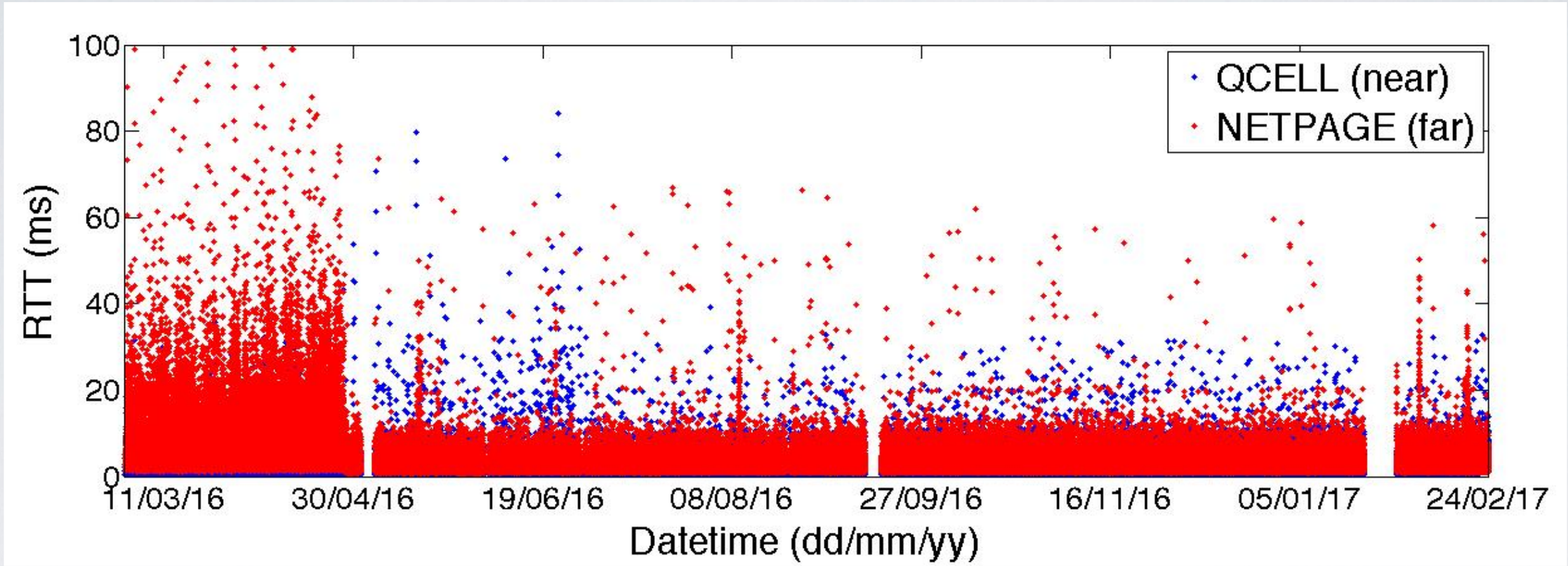


QCELL - NETPAGE



Phase 1

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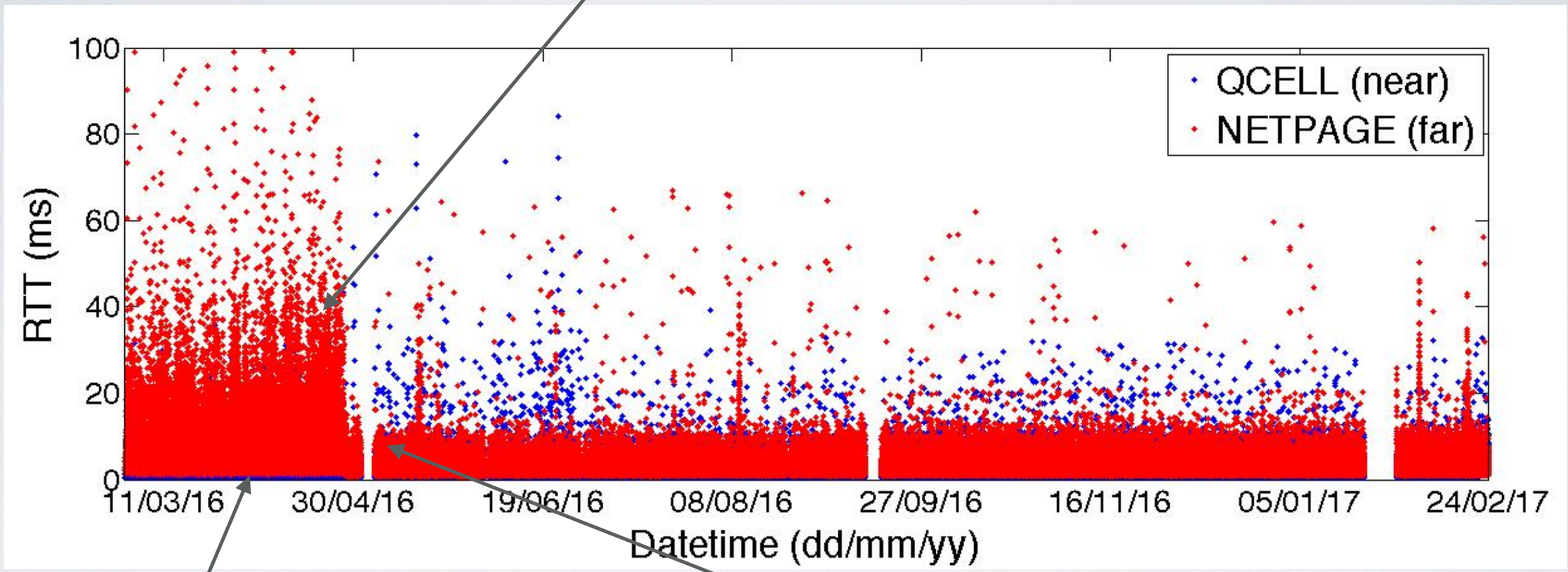

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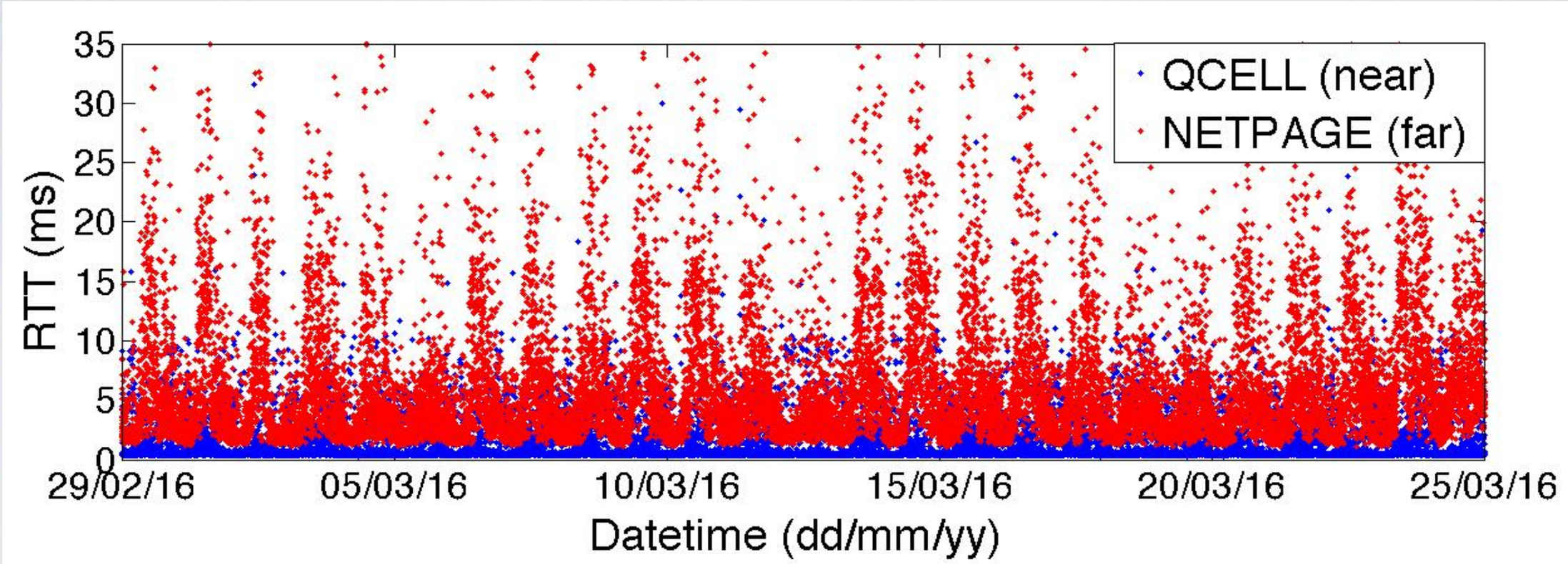
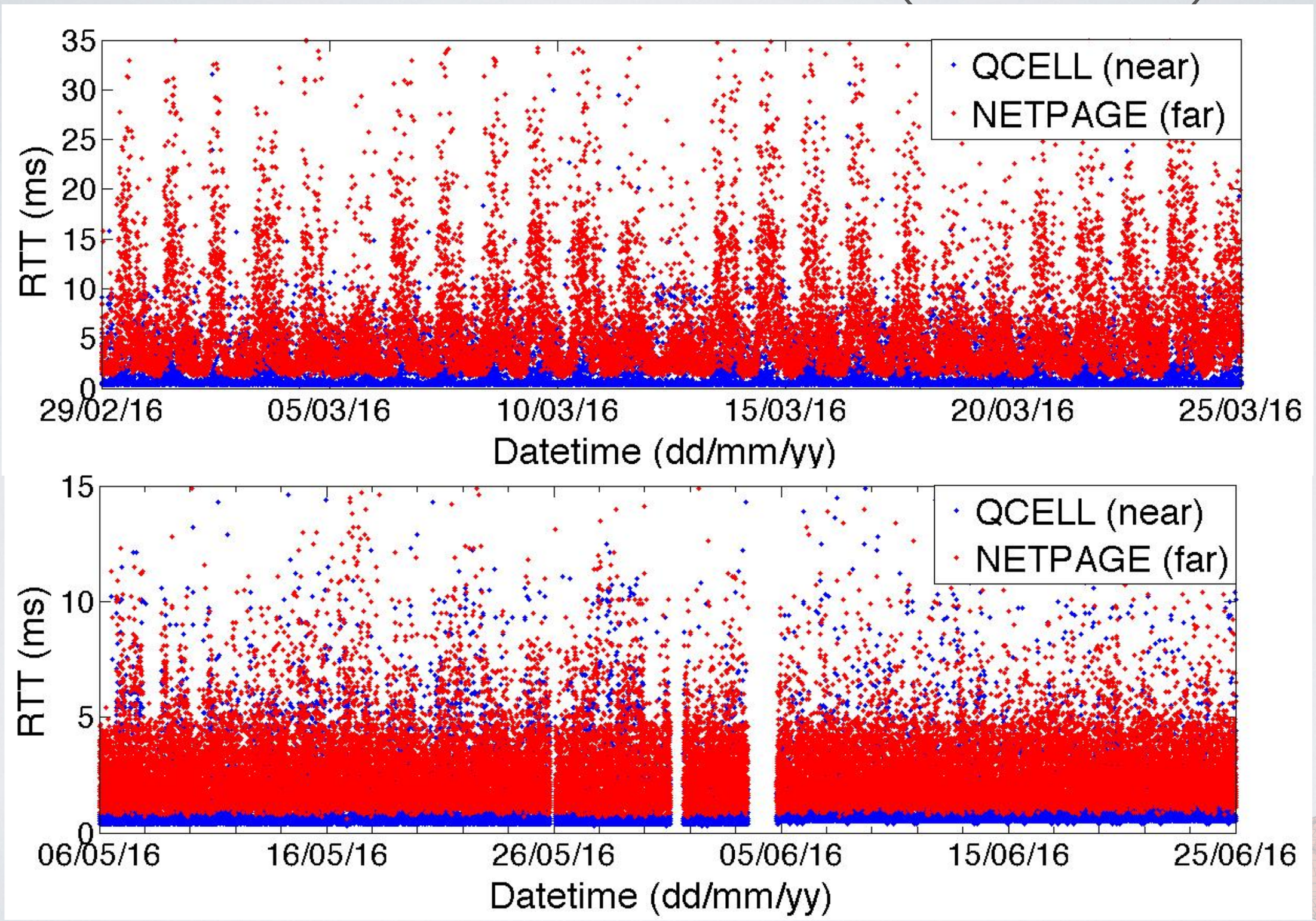


- QCell provides transit for GGCs at SIXP
- High bandwidth usage of Google traffic from NETPAGE was degrading performance
- NETPAGE requested an upgrade from 10 Mbps to 1Gbps

QCELL - NETPAGE (Phase 2)



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Conclusions

- Measured IXPs were congestion-free, which promotes peering in the region (see arda.af-ix.net and af-ix.net)

  - 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)

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  - 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)
- Discussion with stakeholders is crucial to understanding the causes of performance degradations
- Must be aware that transit services are needed for updating content caches (this situation may lead to disputes if not well managed)

Related work

- A detailed study on inferring persistent interdomain congestion on the US broadband ISP ecosystem won the 2018 SIGCOMM Best paper award [1].
  - Interested in expanding to African region (co-evolution of topology and congestion dynamics)
    - Would require more monitor deployment
  - We are sharing the API to allow network operators and researchers to access the TSLP data collected from involved Ark monitors over the last 2,5 years.

[1] Dhamdhere, A., Clark, D. D., Gamero-Garrido, A., Luckie, M., Mok, R. K., Akiwate, G., ... & Claffy, K. (2018, August). Inferring persistent interdomain congestion. In *Proceedings of the 2018 Conference of the ACM Special Interest Group on Data Communication* (pp. 1-15). ACM.

Open question

How can AFRINIC play a role in sustaining the ARDA platform to enable longitudinal studies of the evolution of the African Internet ecosystem?

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