PANDA with Augmented IP Level Data

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mami
measurement and architecture for a middleboxed internet

LIÈGE université

measurement | architecture | experimentation

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Agenda

- PANDA with MPLS
- PANDA with Middleboxes
- PANDA with improved alias resolution
- Conclusion

PANDA with MPLS

- MPLS tunnels might be hidden or not to `traceroute` exploration
  - B. Donnet, M. Luckie, P. Mérindol, J.-J. Pansiot. *Revealing MPLS Tunnels Obscured from Traceroute*. In ACM SIGCOMM Computer Communication Review. 42(2). pg. 87-93. April 2012.
- In case of content hidden to `traceroute`
  - artificial high degree node
  - artificial high delay
  - false links between nodes
  - Y. Vanaubel, P. Mérindol, J.-J. Pansiot, B. Donnet. *Through the Wormhole: Tracking Invisible MPLS Tunnels*. In Proc. ACM Internet Measurement Conference (IMC). November 2017.

PANDA with MPLS (2)

- In case of "truly" invisible tunnels
  - tunnel content does not appear in `traceroute` output
  - MPLS labels are not included in the `time exceeded` messages
- We need triggers to infer their presence
  - Y. Vanaubel, P. Mérindol, J.-J. Pansiot, B. Donnet. *Through the Wormhole: Tracking Invisible MPLS Tunnels*. In Proc. ACM Internet Measurement Conference (IMC). November 2017.

PANDA with MPLS (3)

- The MPLS behavior is also related to the hardware brand
- Might be inferred through network fingerprinting
  - Y. Vanaubel, J-J. Pansiot, P. Mérindol, B. Donnet. *Network Fingerprinting: TTL-Based Router Signatures.* In Proc. ACM Internet Measurement Conference (IMC). November 2013
- Fingerprinting is based on initial TTL (iTTL) value when forging packet
  - should be set to 64 ([RFC1700])
  - in practice, iTTL may depend on
    - ✓ hardware (CISCO vs. Juniper)
    - ✓ operating system (JunOS vs. JunOSE vs. IOS vs. ...)
    - ✓ protocol (ICMP vs. UDP vs. TCP)
    - ✓ type of message (`time_exceeded` vs. `echo_reply` vs `destination_unreachable` vs. ...)

PANDA with MPLS (4)

- Signatures for major manufacturers

Manufacturer	<TE, ER>
Cisco	**<255, 255>**
Juniper (JunOS)	**<255, 64>**
Juniper (JunOSE)	**<128, 128>**
Brocade, Alcatel, and Linux Boxes	**<64, 64>**

PANDA with MPLS (5)

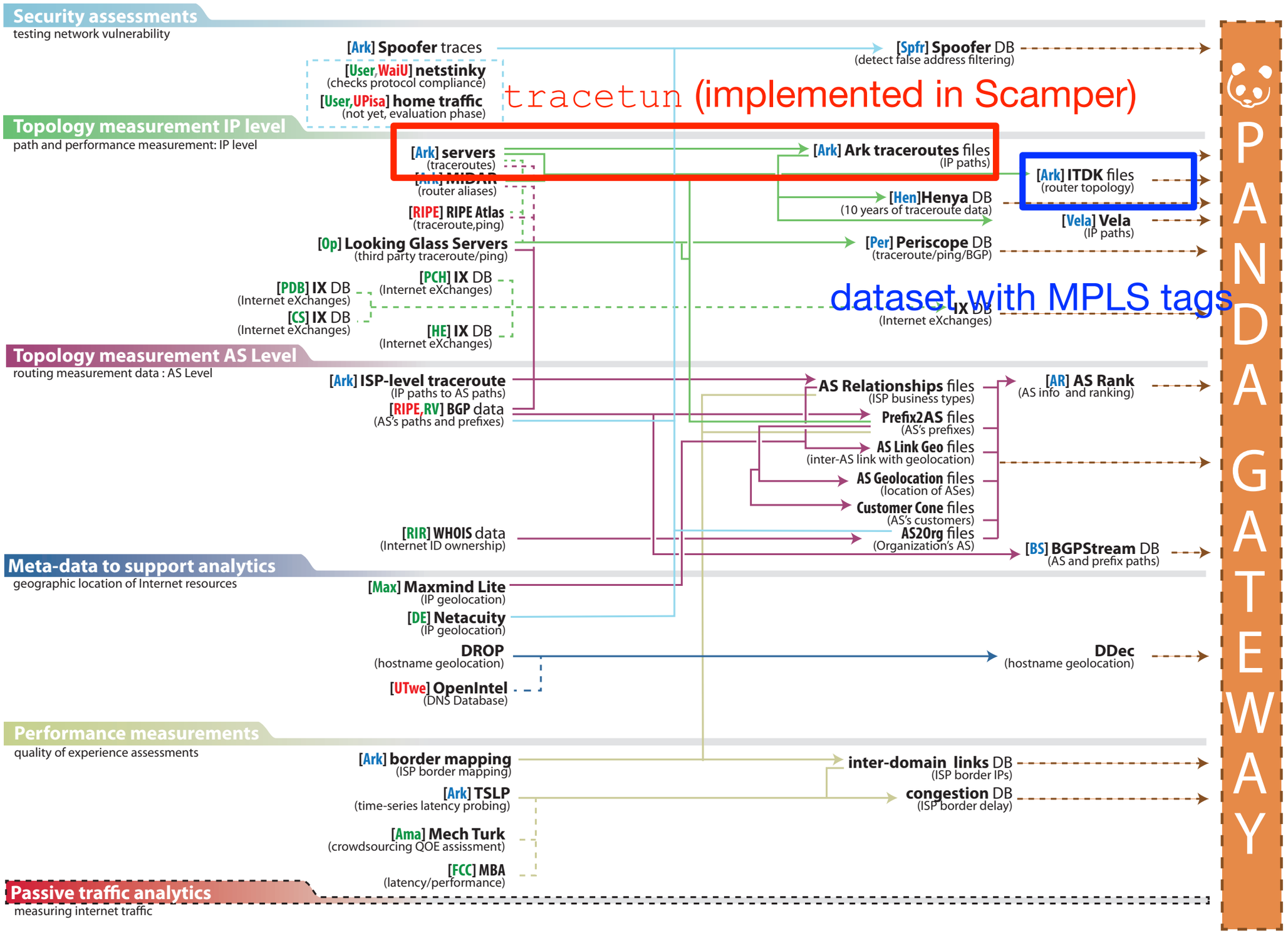
- Update: 99% of tunnels can now be revealed

	RFC4950		no RFC4950	
	Explicit		**Implicit**	
ttl_propagate	**Signature** <255,255> <255,64> <255,*> …	**MPLS Indication** LSE	**Signature** <64,64> <255,*> <255,64>	**MPLS Revelation** qTTL UTURN
	Opaque		**Invisible**	
no_ttl_propagate	**Signature** <255,255>	**Triggers** LSE LSE-TTL	**IP Revelation** DPR BRPR	

Pop	**Signature**	**Triggers**	**IP Revelation**
UHP	<255,255>	DUPLICATE_IP	DPR, BRPR
PHP	<255,64> <255,*> <255,255>	RTLA FRPLA	DPR BRPR
Hybrid (UHP/PHP)	<255,255>		DPR BRPR

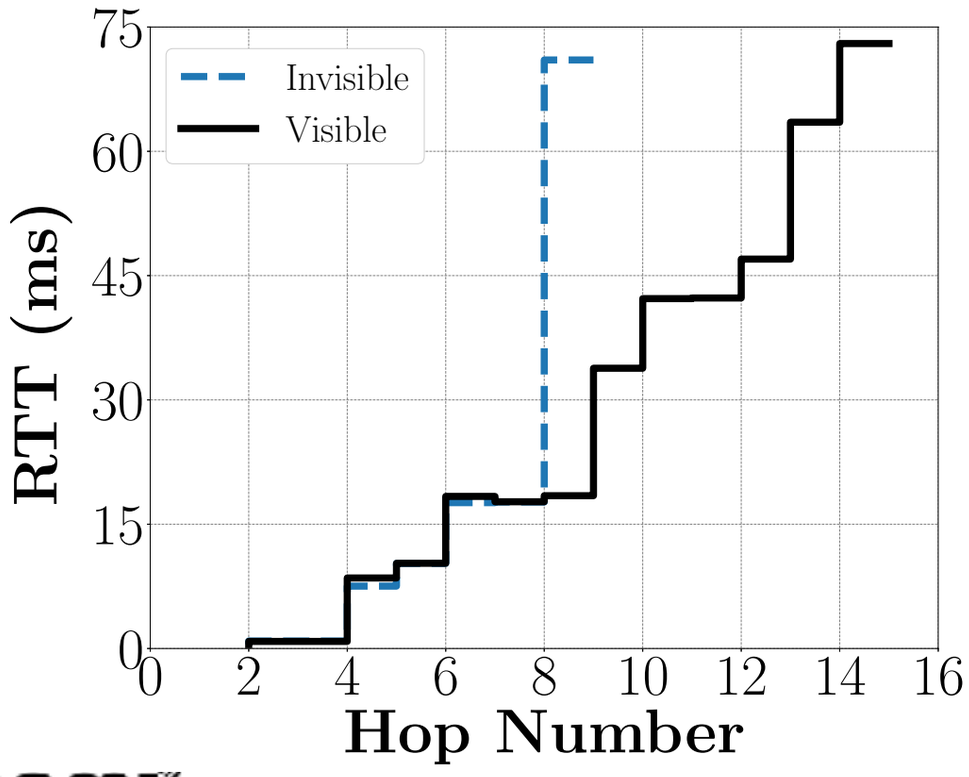
Can't be revealed at a reasonable cost

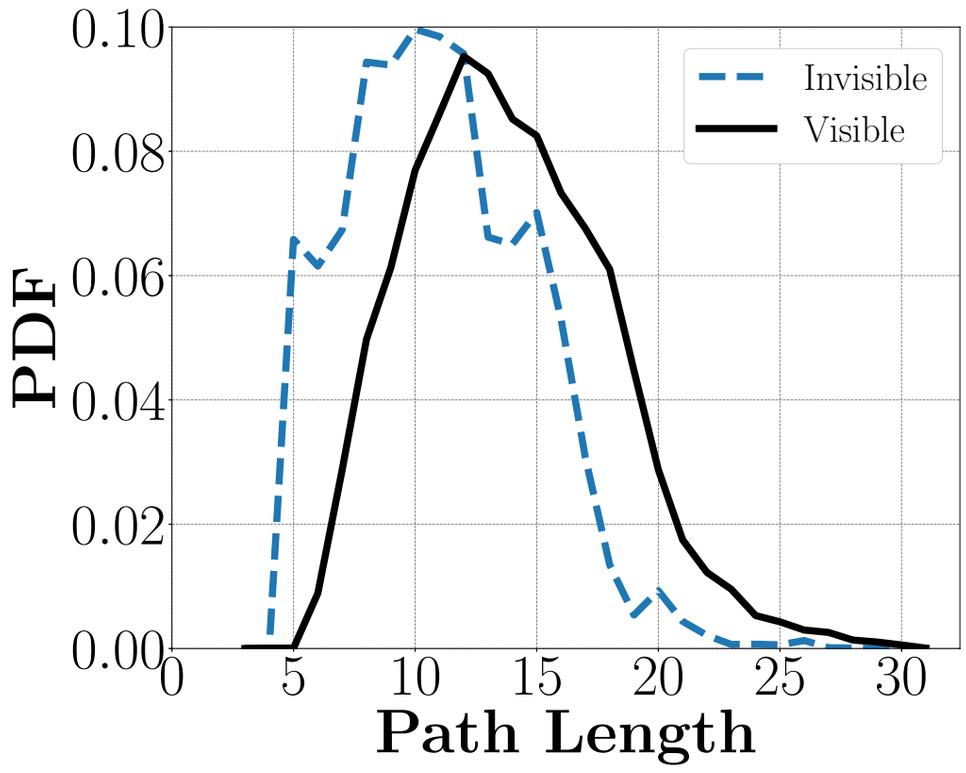
PANDA with MPLS (6)



PANDA with MPLS (7)

- Expected analysis through PANDA gateway
  - Traffic Engineering analysis
    - ✓ Y. Vanaubel, P. Mérindol, J.-J. Pansiot, B. Donnet. *MPLS under the Microscope: Revealing Actual Transit Path Diversity*. In Proc. ACM Internet Measurement Conference (IMC). October 2015
  - RTT correction
  - graph properties correction





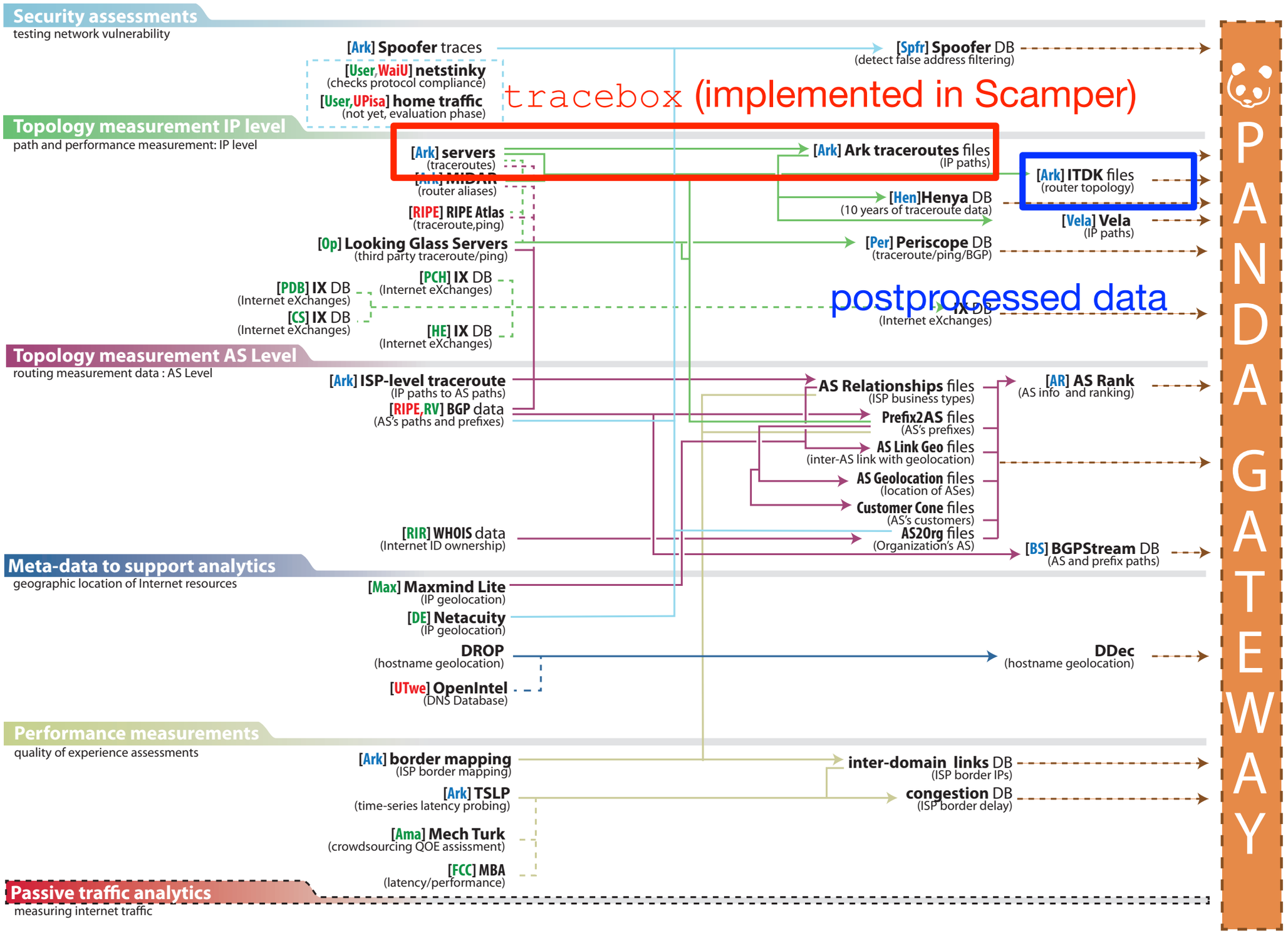
PANDA with Middleboxes

- `tracebox` is an extension to `traceroute`
  - send TTL limited probes
  - inspect incoming ICMP time_exceeded packets
    - ✓ compare the TCP probe quoted and the TCP probe sent
    - ✓ in case of difference(s), a middlebox is found along the path
  - already implemented in Scamper
    - ✓ see https://github.com/mami-project/tracebox
  - G. Detal, B. Hesmans, O. Bonaventure, Y. Vanaubel, B. Donnet. *Revealing Middlebox Interference with Tracebox*. In Proc. ACM Internet Measurement Conference (IMC). October 2013.

PANDA with Middleboxes (2)

- Extensions to tracebox for supporting large-scale dataset
  - offline analysis
  - K. Edeline, B. Donnet. *A First Look at the Prevalence and Persistence of Middleboxes in the Wild*. In Proc. International Teletraffic Congress (ITC). September 2017.

PANDA with Middleboxes (3)



PANDA with Middleboxes (4)

- PANDA gateway might be "merged" with (or linked to) the *Path Transparency Observatory* (PTO)
  - see https://observatory.mami-project.eu
  - gives information on path transparency and middleboxes interference

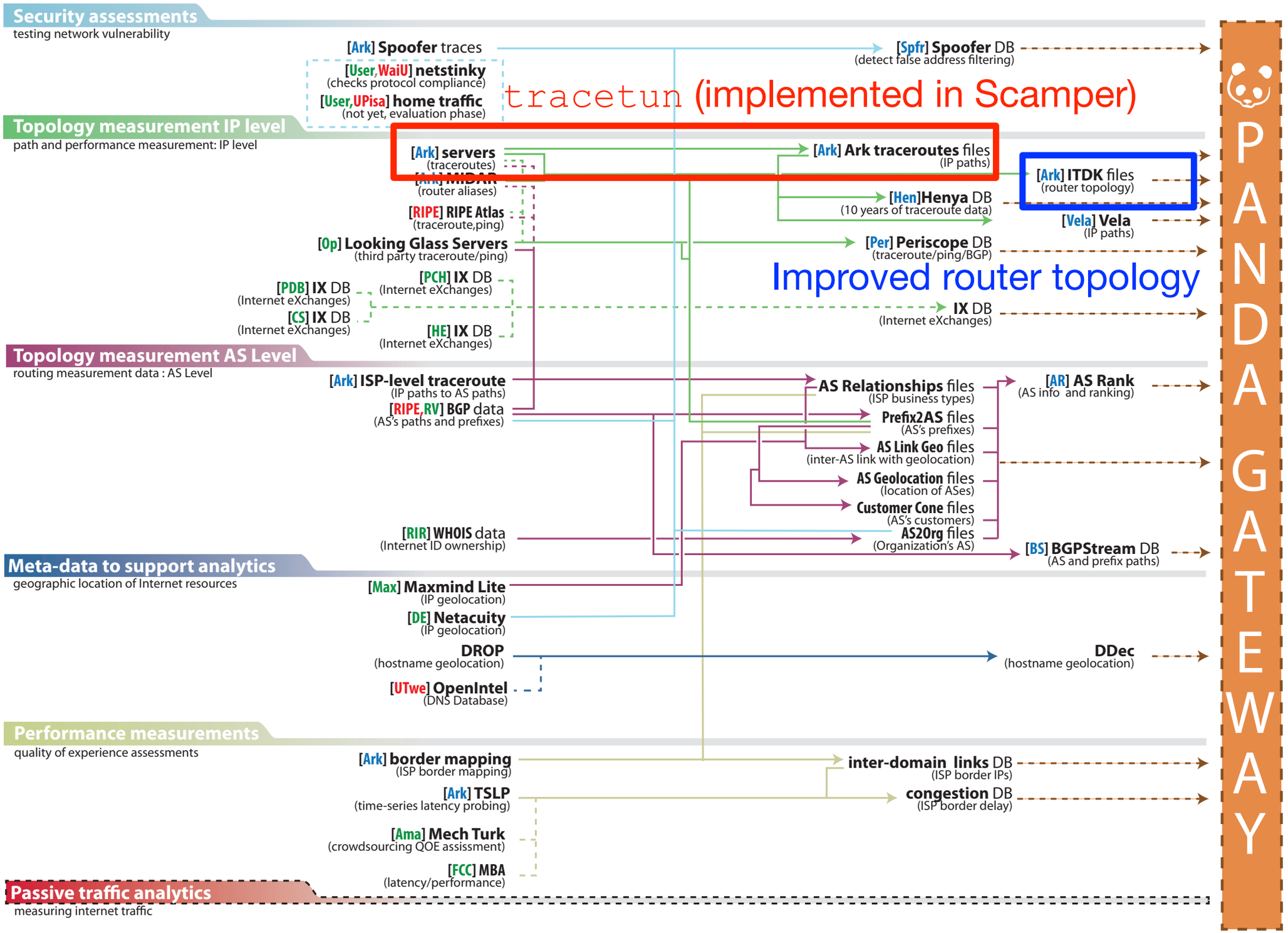
PANDA with Middleboxes (5)

- Expected analysis through the PANDA portal
  - Improved vision of the topology
    - ✓ middleboxes are a large part of the network
    - ✓ better AS "anatomy"
  - Path transparency

PANDA with Improved Alias Resolution

- Fingerprinting might be used for alias resolution
  - 2 IP interfaces with different fingerprints cannot be aliases
- Fingerprinting already implemented in
  - `tracetun`
  - in Scamper, as an independent module
    - ✓ see https://github.com/fhoe/networkFingerprinting
- Expected results
  - speed up alias resolution
  - improve accuracy
  - J.-F. Grailet, B. Donnet. *Towards a Renewed Alias Resolution with Space Search Reduction and IP Fingerprinting*. In Proc. Network Traffic Measurement and Analysis Conference (TMA). June 2017

PANDA with Improved Alias Resolution (2)



Conclusion

- Improving the PANDA architecture with
  - additional probing techniques
    - ✓ MPLS detection
    - ✓ middleboxes
    - ✓ fingerprinting
  - more complete dataset
- ... should lead to more complete data analysis on the PANDA portal, e.g.,
  - AS anatomy
    - ✓ MPLS, middleboxes usage, ...
  - path transparency
  - topology modeling