

# TMA 2017 PhD School — RIPE Atlas Lab

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*TUM Uhrenturm*

# Agenda

## Learning Goals

- Become familiar with RIPE Atlas, its capabilities, and its use
  - Who has used RIPE Atlas before?
- See how to plan measurements and analyze data along the lines of a TMA'17 paper
- Run DNS and Traceroute measurements using RIPE Atlas

## Outline

- Background on RIPE Atlas (previous lecture)
- Background on research questions to be answered
- DNS Measurements
- Traceroute Measurements
- Mapping to ASes/IXPs — controversial discussion expected! ☺

# Background

TMA'17 paper:

*Push Away Your Privacy: Precise User Tracking Based on TLS Client Certificate Authentication*

[http://tma.ifip.org/wordpress/wp-content/uploads/2017/06/tma2017\\_paper2.pdf](http://tma.ifip.org/wordpress/wp-content/uploads/2017/06/tma2017_paper2.pdf)

# Apple Push Notification Service (APNs)

*Maybe the biggest user of unencrypted TLS Client Certificate Authentication?*

**APNs integral part of iOS and macOS** – “always on”

**APNs uses Client Certificates for login:**

- Generated at device setup
- Unique cryptographic material (CN, public key, fingerprint)

Serial Number: ab:12:34:56:78:9a:bc:de:f0:12

Issuer: C=US, O=Apple Inc., OU=Apple iPhone, CN=Apple iPhone Device CA

Validity Not Before: Apr 8 12:34:56 2015 GMT

Validity Not After : Apr 8 12:34:56 2016 GMT

Subject: CN=12345678-1234-1234-1234-123456789ABC

Key ...

(all data redacted)

# Precise User Tracking in APNs

*Several appearances of same device easily linkable*

## 2 attacker types

- Local adversary: ~~Can use MAC addresses and more~~
- Regional adversary: Access to one or several large networks
- Global adversary: Access to several core networks

## Regional Adversary – Feasibility Validation at Internet Uplink

- Can a regional adversary track users? ✓

## Global Adversary – Validation through Global Path Measurements

- How well can a global adversary leverage APNs to track users? **This exercise**

# Detailed Research Questions and Approach

**Research Question: How many networks do you need to eavesdrop on to surveil a majority of APNs backend logins?**

Steps to be taken:

- What and where are the APNs backend servers?
- How to measure paths for user population connecting to backend servers?
- How to map this to networks? What is a network in this context?

Take note: *“Every paper has a flaw”* — bonus points if you find them! 😊

Questions?

# Step 1: Finding APNs Backend Servers

From passive observations, we know that clients resolve [1-50]-courier.push.apple.com and then connect to 1 IP address in the 17.0.0.0/8 range.

How to find all APNs backend servers?

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How to find all APNs backend servers?

**Pick a country you want to work on! Inspiration:**

[http://sg-pub.ripe.net/petros/population\\_coverage/table.html](http://sg-pub.ripe.net/petros/population_coverage/table.html)



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**Prerequisites:**

Do you have (a) RIPE Atlas Account (b) Voucher? (c) Python3 (d) Github Downloaded?

```
git clone --recursive git://github.com/quirins/tma17-ripeatlas-lab-participants
```

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**Task: Pick 1 of '[1-50]-courier.push.apple.com' and do a RIPE Atlas DNS resolution for “your” country.**

Example: 42-courier.push.apple.com

New DNS measurement: <https://atlas.ripe.net/measurements/form/>

Note: More experienced RIPE Atlas users are invited to do resolutions for all 50 DNS names.

# Step 1: Finding APNs Backend Servers - Discussion

- What probes did you choose? How many per country?

`http://sg-pub.ripe.net/petros/population\_coverage/country.html?name=NL`

- Which detailed DNS settings did you choose?
- How did you run the measurement? How to scale it to 50?

New DNS measurement: `https://atlas.ripe.net/measurements/form/`

Sample measurement from paper: `https://atlas.ripe.net/measurements/5500016/`

Sample measurement from June 2017: `https://atlas.ripe.net/measurements/8831682`

Script for batch measurements:

`https://github.com/tumi8/cca-privacy/blob/master/ripe\_atlas/dns/atlas-measure.sh`

# Step 1: Finding APNs Backend Servers - Obtaining the Result

**Your measurement should have finished by now – please obtain the result and parse it**

Our parsing script:

`https://github.com/tumi8/cca-privacy/blob/master/ripe\_atlas/dns/parse-results.py`

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## Discussion

- Download via Browser or REST
- JSON with abuf
- Region-specific CNAMEs
- Are these all the IP addresses used by the APNs backend? Or just some?

Sample measurement result from June 2017: <https://github.com/quirins/tma17-ripeatlas-lab-participants/blob/master/data/dns/RIPE-Atlas-measurement-8831682.json>

Sample parsed result from paper <https://github.com/quirins/tma17-ripeatlas-lab-participants/blob/master/data/dns/result-5500014.json.parsed.txt>

Sample parsed result from June 2017 <https://github.com/quirins/tma17-ripeatlas-lab-participants/blob/master/data/dns/RIPE-Atlas-measurement-8831682.json.parsed.txt>

## Step 2: Traceroute Path Measurements

Our DNS queries have yielded a list of backend servers. Coming back to our Research Question, we want to quantify the number of networks an adversary has to eavesdrop on to see a significant number of logins directed to those backend servers.

**Task: Define and execute a measurement strategy: Which RIPE Atlas settings? Which probes? Which targets?**

Note: Again, RIPE Atlas novices can just run 1 measurement towards 1 target IP address.

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## Discussion

- Traceroute Details – <https://atlas.ripe.net/measurements/form/>
- Target Selection – all APNs IP addresses? Some?
- Probe Selection:
  - Which probes to select?
  - Do they represent the APNs user base? AS/CC bias?
  - Only probes that resolved the IP being probed?

Traceroute measurement from Paper - Germany: <https://atlas.ripe.net/measurements/5719601/>

# Step 2: Traceroute Path Measurements

**Task: Please download the results – what format does it have? Ideas how to parse it? What would be the next steps?**



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- JSON – RIPE Atlas Cousteau or raw JSON parsing
- Next step: Map to IXPs and ASes – Ideas on data sources?

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Fortunately, the link [https://github.com/tumi8/cca-privacy/tree/master/ripe\\_atlas/traceroute](https://github.com/tumi8/cca-privacy/tree/master/ripe_atlas/traceroute) contains the script “traceroutes\_to\_asn\_ixp.py.”

**Task: Call it using `./traceroutes_to_asn_ixp.py your-measurement.json ip2ixp ip2as`**

**ip2ixp (traIXroute/peeringDB):**

[https://github.com/tumi8/cca-privacy/blob/master/ripe\\_atlas/traceroute/ixp\\_subnets\\_v4.csv](https://github.com/tumi8/cca-privacy/blob/master/ripe_atlas/traceroute/ixp_subnets_v4.csv)

**recent ip2as (CAIDA pfx2as):** <http://data.caida.org/datasets/routing/routeviews-prefix2as/2017/06/routeviews-rv2-20170618-1000.pfx2as.gz>

**Sample Result from Paper:**

<https://github.com/quirins/tma17-ripeatlas-lab-participants/blob/master/data/traceroute/result-5719599.json.result.txt>

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# Step 3: Analyze Results

How does the result look like for your country? Is that in line with the paper?

Rank	Global		Germany	
	IXP/AS	$\Sigma\%$ Paths	IXP/AS	$\Sigma\%$ Paths
1	AS3356 (L3)	25%	IXP DE-CIX	30%
2	AS1299 (Telia)	40%	AS3320 (DTAG)	52%
3	AS174 (Cogent)	54%	IXP E-CIX	61%
4	AS7922 (Comcast)	61%	AS6830 (Liberty)	69%
5	AS12322 (Free)	67%	AS31334 (VF/Kabel D)	75%
6	AS6830 (Liberty)	71%	AS1273 (C&W)	78%
7	AS4637 (Telstra)	75%	AS3356 (L3)	81%
8	AS6453 (Tata)	78%	AS34419 (VF Group)	84%
9	AS2828 (XO)	81%	AS680 (DFN)	86%
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→ **What do you think of the result overall?**

# Feedback & Conclusion

- How did you like the exercise?
- Useful parts / less useful parts?
- Excited to use RIPE Atlas? ☺

**Black Belt Track:** Share your results back to the exercise through a pull-request.

To do so, please use this folder structure:

- tma17-ripeatlas-lab-participants/results/\$country/[dns|traceroute]
  - A list of DNS and traceroute measurement IDs
  - Intermediate Results (potentially compressed)
  - the final table
  - a readme file with: your name and a quick description of your approach

# Backup

# Is global tracking feasible?

## *Methodology*

Research Question: How many networks does an attacker have to eavesdrop on to observe a significant share of APNs logins?

- We identify APNs backend infrastructure and conduct distributed traceroute measurements towards it
  - Measurements confirm that clients resolve one of *[1-50]-courier.push.apple.com*
  - We globally resolve *[1-50]-courier.push.apple.com* using 1000 RIPE Atlas probes each
  - We find 69 /24 subnets and pick one random observed IP address in each of the 69 subnets
  - Using 1000 RIPE Atlas probes per measurement, we conduct traceroute measurements towards all 69 IP addresses
- We map transit router's IP addresses to ISPs and IXPs
- We count what % of routes traverses a certain ISP or IXP