

A Multi-perspective Analysis of Carrier-Grade NAT Deployment

Magdalena Prbstl

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Background

Operators Perspectives on CGN

Measurement Methodology

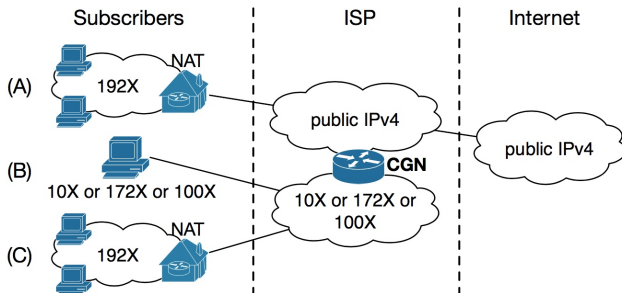
Global CGN Presence

CGN Behaviour

Implications, Conclusion and Takeaway

Background

- ▶ Scarcity of IPv4 addresses
- ▶ One approach: Grade Carrier NATs (CGN)



Background

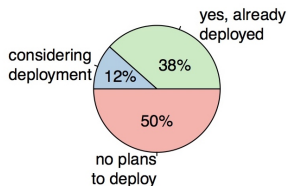
Basic NAT-related Terms

- ▶ Address Types (internal, external, reserved, routable)
- ▶ NAT Mappings
- ▶ Mapping Types
- ▶ Mapping Timeouts
- ▶ Port Allocation
- ▶ IP Pooling
- ▶ Hairpinning

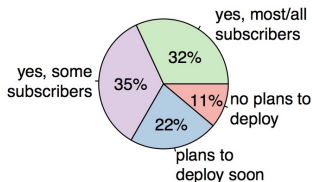
Operators Perspectives on CGN

Survey of operators:

- ▶ IPv4 Address Space Scarcity
- ▶ IPv4 Address Space Markets
- ▶ CGN Deployment vs IPv6 Deployment



(a) Carrier-Grade NAT.



(b) IPv6.

- ▶ CGN Concerns

Detecting CGNs

via BitTorrent

- ▶ BitTorrent Distributed Hash Table (DHT)
- ▶ Distributed data structure
- ▶ Node form a connected graph
 - ▶ Node ID (160bit) chosen by node itself
 - ▶ Node maintain list of DHT peers and provide an interface for queries
- ▶ Crawling the DHT
- ▶ Identifying CGNs
- ▶ DHT Data Calibration

Detecting CGNs

via Netalyzr

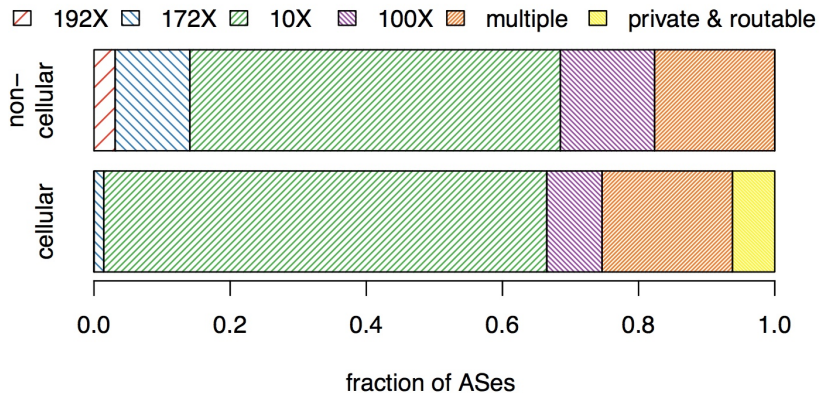
- ▶ Three supported clients
- ▶ two advantages over BitTorrent:
 - ▶ extends view
 - ▶ allows to directly obtain IP addresses used by the host
- ▶ Cellular Networks
- ▶ Non-Cellular Networks

Global CGN Presence

- ▶ dataset covers 6,0% of autonomous systems (ASes) and 60,0% of eyeball ASes
- ▶ CGN deployment:
 - ▶ 13,3% of all Non-Cellular ASes
 - ▶ 17 -18% of all Non-Cellular eyeball ASes
 - ▶ more than 92% in cellular Networks

CGN Behaviour

Internal Address Space Usage



CGN Behaviour

Port and IP Address Allocation

- ▶ Three strategies for NAT port allocation:
 - ▶ Port preservation, Sequential use and Random use
- ▶ Measuring port translation
- ▶ Network-wide-port-allocation strategies
- ▶ Chunk-based port allocation
- ▶ NAT pooling behaviour

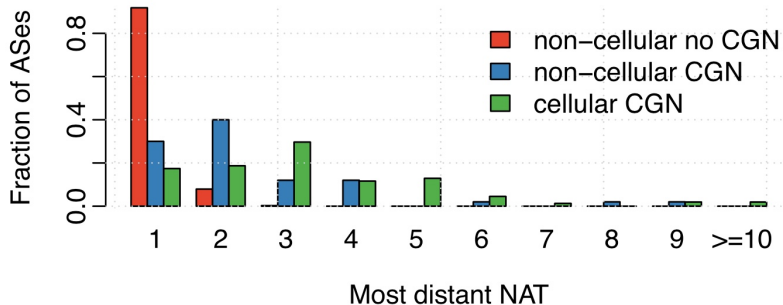
CGN Behaviour

CGN-specific measurements

- ▶ Two tests as a Netalyzer test suite extension:
 - ▶ TTL-driven NAT enumeration
 - ▶ STUN test

CGN Behaviour

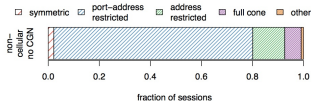
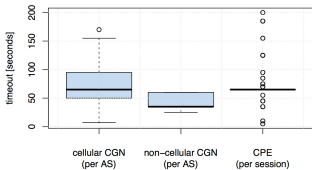
Topological Properties of CGNs



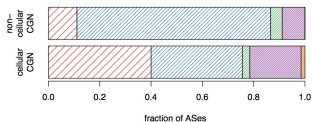
CGN Behaviour

Flow-Mapping Properties of CGNs

- ▶ Mapping timeouts
- ▶ Mapping types



(a) Distribution of observed STUN types in CPE NATs.



(b) Most permissive STUN type per AS (only CGN sessions).

Implications, Conclusion and Takeaway

- ▶ Internet Service Provider deploy CGN widely
- ▶ CGN controls "how much internet" a subscriber gets
- ▶ High deployment rate in Europe and Asia
- ▶ Lack of guidelines and regulations for CGN deployment