1. Introduction: Problem Statement

• If global IPv4 address are shared between several clients, assignable port resources at each client will be limited.

1 and port-assignment in CGN, A+P… , accelerate this
Static port-assignment in CGN, A+P… , accelerate this
port restricted network

non-port-restricted network

A part of a website (e.g. map site) cannot be displayed.
What is the cause?

• Analyses
  – Single session occupies a NAT external port exclusively. In nature, a port can be multiplexed by plural connections.

  – TIME_WAIT state of each TCP connection is kept for long time (2MSL) at NAT, which occupies the port for long time.
To solve this problem…

• TIME_WAIT to 0 sec.

• But, it spoils the aims of TIME_WAIT.
  A-1) It prevents duplicates from earlier incarnations.
  A-2) It makes sure the remote TCP received the ACK of its connection terminate request.
Apply RFC 6191/1323 at NAT

TCP Timestamps

- A TIME_WAIT state can be deleted, when a TCP-SYN packet carrying a larger timestamp value arrives.
- RFC1323: Protect Against Wrapped Sequence Numbers (PAWS) discard old duplicate packets
  - A segment can be discarded if it has a timestamp less than the latest timestamp received.
Sequence

Packet with newer timestamp

TIME_WAIT state can be deleted. New session created.
Can this preserve the aims of TIME_WAIT?

- A-1) Duplicates from earlier incarnations
  - Can be discarded by the proposed mechanism.
- A-2) Reliable delivery of the last ACK to the remote TCP
  - Needs the following mechanism.

When the last ACK to the FIN is missed, NAT sends ACK instead.
Proposal 2: Apply Port overlapping to NAT

- Port overlapping behavior
  - If destinations are different, NAT MAY assign the same external port.

\[
\begin{align*}
\text{PC} & \quad \text{address: } X_1 \quad \text{port: } x_1, x_2 \ldots \\
\text{PC} & \quad \text{address: } X_2 \quad \text{port: } x_1, x_2 \ldots \\
\text{NAT} & \quad \text{address: } G_1 \quad \text{port: } g_1, g_2 \ldots \\
\text{remote host} & \quad \text{address: } D_1 \quad \text{port: } d_1 \\
\text{remote hot} & \quad \text{address: } D_2 \quad \text{port: } d_1
\end{align*}
\]

\[X_1, x_1 \rightarrow (\text{translated: } G_1, g_1) \rightarrow D_1, d_1\]
\[X_2, x_1 \rightarrow (\text{translated: } G_1, g_1) \rightarrow D_2, d_1\]
Questions and Comments?

- Two address saving mechanisms are proposed.
  - Proposal1: Enables safe reduction of TIME_WAIT states.
  - Proposal2: Boosts the number of concurrent connections.
  - These proposals are independent.

- This proposal may effect TCP behavior between clients and remote hosts, so comments are needed.
  - We have already introduced this proposal at behave interim, and been advised to do so.