Introducing an almost reliable UDP protocol: The Keyed UDP

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Does this looks familiar?
What about this?

Daily average IPv4 packet size vs. date
Quick overview of the Internet traffic in the last 10 years
Recorded number of IPv6 packets vs. date
evolution++

Daily average IPv6 packet size vs. date
And what about applications?

• We have witnessed:
  • more social media
  • more Cloud
  • more X as a Service
    • (virtualization of desktop on the User Side Resources to the Cloud - why?)
Applications in the future

- What can we expect to see in the future?
  - mobile phones now host octacores
  - mobile operators sell data packets
  - every device has some Web App or some Internet service connection (e.g. problems with hacked cars)
  - my wristwatch monitors me, my car monitors me, my TV monitors me, my refrigerator monitors everyone, …
  - “every device will be a screen to The One” (Kevin Kelly, The first 5000 days of the Web)
Applications in the future

- User driven (social media, games, apps…)
- Government driven (eGovernment, eCitizenship, …)
- Corporations driven (eCustomer)
- Machine driven (P2P, machines that are Internet connected)
- Open source hardware (Arduíno, Raspberry Pi-Like, etc.)
- Open source software (Linux, Python, etc.)
What can we expect?
What can we do?

• Problem 1: The Ethernet payload limit (99.999% of the measured packets that travel in the Internet are < 1500B)

• Problem 2: The TCP control mechanism (Three Way Handshake, AIMD)

• Problem 3: low efficiency of transport protocols (high overhead)

• Problem 4: increase in the size of messages

• Problem 5: transition to IPv6

• Problem 6: increased mobile traffic
Really, what can we do?

- We need new protocols for Machine-to-Machine communication, for real time data transmission, which integrate data imputation, resiliency on the software side, not on the network side.
New Keyed-UDP

• UDP is faster and lighter than TCP

• Let us use UDP in a manner that sender and/or receiver can know, to a degree of certainty, if there was packet loss and what packets were lost

• I call this Keyed UDP
Keyed-UDP

- In any normal UDP or TCP communication between two apps (or two machines), the data flows from one port-IP address pair to another port-IP address pair.
Keyed-UDP
Keyed-UDP
Keyed-UDP
Keyed-UDP

- sKUDP: from many ports to one port
- dKUDP: from one port to many ports
- sdKUDP: from many ports to many ports

- Ports don’t have to be sequential, i.e., the key can be 7000, 5000, 7001, 7000, 5001, 7000
## Keyed-UDP

- So how can the key length (and type) be detected?

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Determined</th>
<th>Discovered</th>
<th>Agreed</th>
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<tbody>
<tr>
<td>dKUDP</td>
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</table>
# Keyed-UDP

- Retro-compatibility with non-KUDP apps?

<table>
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<tr>
<th>Protocol</th>
<th>dKUDP</th>
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<tr>
<td><strong>Which application is UDP</strong></td>
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<td><strong>Source application is standard UDP</strong></td>
<td>Destination application receives all packets to a single destination port, disabling out-of-order and loss event detection</td>
<td>Destination application receives all packets from a single source port, disabling out-of-order and loss event detection</td>
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<tr>
<td><strong>Destination application is standard UDP</strong></td>
<td>Only every $n$th packet will be received because the source application will try to send packets to destination ports that are not being monitored by the destination application</td>
<td>This is almost the case for the standard UDP scenario, so no loss nor out-of-order event detection is possible</td>
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Keyed-IPv6

• What if instead of using port numbers as keys, we use IPv6 addresses?

• it may be feasible, most operating systems allow multiple IPv6 address assignment to an interface…
Keyed-UDP

- Pending issues:
  - What to do when the receiving app detects losses? (NOP, report back, ask to resend, data imputation - it will depend on the app)
  - Increase the complexity of the loss-switch inference algorithm by timestamping the packets at arrival?
  - Problems with non-homomorphic NAT-PT machines that are not sufficiently persistent?
  - NAT-PT tables overload? / IPv6 routing tables overload?
  - Others?
Keyed-UDP

- Proposal for a reconstruction algorithm
Keyed-UDP

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  1d 2d 3d 4d 5d 6d 1e 2e 3e 4e 5e 6e }

Rs=

{1a 3a 4a 6a 5a 2b 4b 6b 3b 2c 3c 1c 4c
  6c 1d 2d 4d 3d 5d 6d 1e 3e 4e 6e 5e }

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For the 1\textsuperscript{st} packet there is only one candidate, this is packet 1\textit{a}, therefore, packet 1\textit{a} takes the first position.

For the 3\textsuperscript{rd} packet the candidates are \{3\textit{a}, 3\textit{a}, \textit{f}\}, therefore, packet 3\textit{a} wins.

For the 2\textsuperscript{nd} position, the candidates are \{\textit{f}, 2\textit{b}\}. As there is a tie between 2\textit{b} and \textit{f}, the first candidate wins, \textit{i.e.}, the algorithm concludes that the 2\textsuperscript{nd} packet never arrived.

For the 4\textsuperscript{th} position, the candidates are \{4\textit{a}, 4\textit{a}, 4\textit{a}, 4\textit{b}\}, therefore, 4\textit{a} wins.

The candidates for the remaining positions (5 to 10) are, respectively:

5\textsuperscript{th}: \{5\textit{a}, 5\textit{a}, 5\textit{a}, 5\textit{a}, 5\textit{a}\}, elected 5\textit{a}

6\textsuperscript{th}: \{6\textit{a}, 6\textit{a}, 6\textit{a}, 6\textit{a}, 6\textit{b}, 6\textit{b}\}, elected 6\textit{a}

7\textsuperscript{th}: \{\textit{f}, \textit{f}, \textit{f}, \textit{f}, \textit{f}\}, elected \textit{f}

8\textsuperscript{th}: \{2\textit{b}, 2\textit{b}, \textit{f}, 2\textit{b}, 2\textit{c}, 2\textit{c}\}, elected 2\textit{b}

9\textsuperscript{th}: \{\textit{f}, \textit{f}, 3\textit{b}, 3\textit{b}, 3\textit{c}, 3\textit{b}, 3\textit{b}\}, elected 3\textit{b}

10\textsuperscript{th}: \{4\textit{b}, \textit{f}, 4\textit{b}, 4\textit{b}, 4\textit{b}, \textit{f}, 4\textit{c}, 4\textit{c}\}, elected 4\textit{b}. 

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\textbf{Ts=} \\
\{1a 2a 3a 4a 5a 6a 1b 2b 3b 4b 5b 6b 1c 2c 3c 4c 5c 6c \} \\

\textbf{Rs=} \\
\{1a 3a 4a 6a 2b 4b 6b 3b 2c 3c 1c 4c \} \\

\textbf{Fs=} \\
\{1a f 3a 4a 5a 6a f 2b 3b 4b f 6b 1c 2c 3c 4c 5d 6c \} \\
\{1d 2d 3d 4d 5d 6d 1e f 3e 4e 5e 6e \}.

16.7\% \text{ loss} + 20\% \text{ switches}
Keyed-UDP

Application
  UDP
Network
Data Link
PHY

Application*
  Stream Reconstruction Algorithm
KUDP
Network
Data Link
PHY

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Finally, Users!

- We will be flooded with data from all of our machines.
- We won’t be able to process it, nor we will be aware of its existence.
- We will see multi-sensor, multi-location, multi-device, multi-format data only by its impact in our daily lives (a bit like targeted advertising on the email systems).
- After the ubiquity of computers, we will have the ubiquity of data, and for users, this will mean that we will need systems that receive, summarise, process, extract relevant features and feed the appropriate algorithms for our own benefit.
- The following step is to use the data from multiple users to infer and confirm daily living patterns, as to allow its monitoring and training.
Fueling the Internet of Everything

- will be the Internet of our private lives, our machines, our health and our social interactions
- is this scary? a lot!
- is this worth the effort? probably yes!
Questions!

Thank you!

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