The ARTCP header structure, computation and processing in the network subsystem of Linux kernel.

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TCP in wireless and heterogeneous networks

- Packet losses
- Congestion avoidance

- Indirect TCP
- ECN
- RTT and thresholds-based approaches
Adaptive Rate TCP (ARTCP)

- Transparent replacement of TCP
- Temporal characteristics-based data flow management algorithm
- Logical separation of error correction and data flow management
- No artificial congestion
ARTCP and TCP compatibility

- TCP-compatible header structure
- Fallback to TCP mode “on a fly”
- ARTCP can be disabled in system
# TCP header structure

<table>
<thead>
<tr>
<th>Bit</th>
<th>0-3</th>
<th>4-7</th>
<th>8-15</th>
<th>16-31</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Source port</td>
<td></td>
<td></td>
<td>Destination port</td>
</tr>
<tr>
<td>32</td>
<td></td>
<td></td>
<td>Sequence number</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td></td>
<td></td>
<td>Acknowledgment number</td>
<td></td>
</tr>
<tr>
<td>96</td>
<td>Data offset</td>
<td>Reserved</td>
<td>Flags</td>
<td>Window size</td>
</tr>
<tr>
<td>128</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>160</td>
<td></td>
<td>Checksum</td>
<td></td>
<td>Urgent data pointer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Options</td>
<td></td>
</tr>
</tbody>
</table>
**ARTCP fields as TCP options**

<table>
<thead>
<tr>
<th>Byte</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>1</td>
<td>1</td>
<td>253</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>PS field value</td>
</tr>
</tbody>
</table>

**PS (Packet Sequence) field**

<table>
<thead>
<tr>
<th>Byte</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>1</td>
<td>1</td>
<td>254</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>TI field value</td>
</tr>
</tbody>
</table>

**TI (Time Interval) field**
ARTCP packet transmission implementation

- Extended `struct tcp_out_options`
- Modified `tcp_syn_options()`, `tcp_synack_options()` and `tcp_established_options()`
- Modified `tcp_options_write()`
ARTCP packet reception implementation

- Extended `struct tcp_options_received`
- Modified `tcp_parse_options()`
- Modified `tcp_v4_conn_request()`, `tcp_rcv_synsent_state_process()` and `tcp_rcv_established()`
Time measurement for TI field in Linux

- Hardware timers
- Software interfaces
- Calculation of intervals in TI units
Time measurement in x86 systems

- PIT (Intel 8253 and analogues)
- RTC
- APIC timer
- PM timer
- HPET
- TSC
“Clock source” concept in Linux

- Platform-independent and uniform interface
- Easy clocksource registration
- Rating-based choice
Software interfaces and units conversion

- getnstimeofday()
- getrawmonotonic()
- artcp_ts_diff_to_ti()
Work-in-progress and future work

- Complete ARTCP implementation
- Performance analyzing with ns2 simulator and bench tests
- Optimizations for asymmetric networks
- Research of low-delay data delivery