STATISTICAL PROPERTIES OF UDP DATAFLOW, PASSED THROUGH RADIO ETHERNET CHANNEL IEEE 802.11B

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Key parameters describing properties of Radio Ethernet channel at the packet level are the message delivery time and bit error rate. The difference between Radio Ethernet and Ethernet link is made basically in a random backoff of message transfer and the mechanism of the message retransmitting. Due to existing in Radio Ethernet the mechanism of repeated transfer the bit error arising at a physical level, as though "flows" in value of delivery time, as since distortion of a data segment in the channel provokes repeated transfer of this segment and hence increases delivery time.

The experimental setup represented a linear topology network segment containing Radio Ethernet link (fig. 1), which consist of two radio bridges based on INTERSIL PRISM WLAN connected on a wave guide through adjustable attenuator REGAT-3-245.

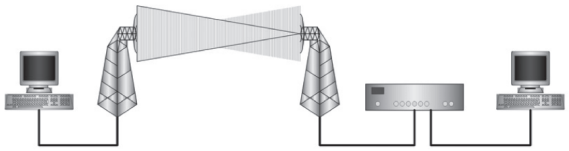

Fig. 1. Experimental setup.

For realization of researches were used two network hosts working under OS FreeBSD. Generation of dataflows was carried out with the help of program generators MGEN, ttcp, bping (accordingly UDP, TCP and ICMP sequences). The method of packet probing of the channel and the analysis of passing through and reflected dataflows by means of hardware-software modules ANNet-MSU and pathchar is used. For interception of dataflows at the level of OS nucleus it was used BPF.

Practical unfitness of using radio bridges as points of packet probing is established. In control series of experiments it was revealed essential non-monotone dependences of roundtrip time dispersion of the channel on a probing ICMP segment size. The typical dependence of roundtrip time dispersion up to the "distant" radio bridge is presented on fig. 2. The 500 tests for each value of sample packet size was provided. Observable "anomaly" is due to incorrect realization of the ICMP response in an insertion of the concrete radio bridge. To prevent similar systematic errors the network host located directly behind distant radio bridge has served in all subsequent experiments as a point of probing.

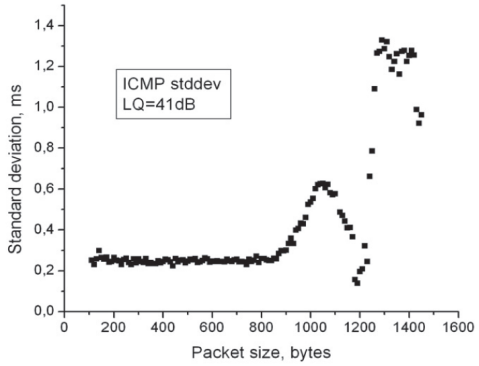

Fig. 2. The abnormal dispersive characteristic at probing distant radio bridge.

The dependence of roundtrip time parameters of the channel on background loading in the channel is investigated. Loading was created with the regular stream UDP messages simulating multiplexed real-time audio streams. It is established, that there is some threshold value of density of a loading stream at which excess value of roundtrip time and its dispersion sharply grows. Generally this threshold density depends on the background stream packetsize, and for stream of UDP segments with data field sizes of 48 bytes it is located in range from 1100 up to 1200 packets/s.

Thus dependence of minimal roundtrip time of the channel for probing sequence segments with good accuracy is approximated by expression: $RTD_{\min} = A + B * DataField$ - where A and B - constants for the fixed conditions in the channel, $DataField$ - the size of probing ICMP segment data field in bytes.

The values of constants A and B measured for various magnitude of a loading stream in the channel is given on fig. 3. In this case of a stream of segments with 48 bytes data field, threshold density value makes 768 kbps, that much less than the established throughput of a line in 4.0 Mbps. It

testifies to not optimum use of the channel resources by the given realization of Radio Ethernet. The possible solution is to increase Radio Ethernet frame with preliminary multiplexing several data segments.

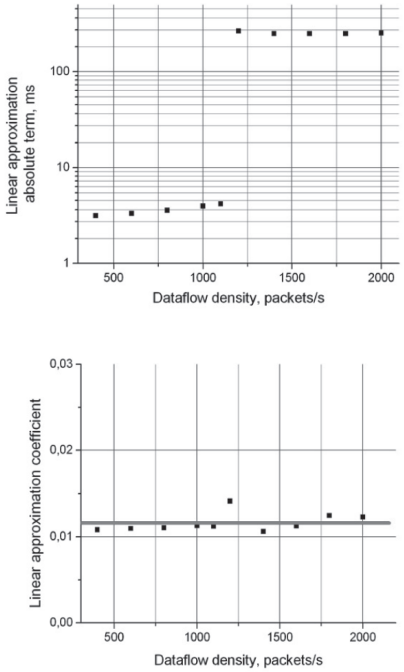

Fig. 3. Size of a free member (*A*) (upper graph) and factor (*B*) of linear approximation (lower graph) dependences of minimal roundtrip time on the channel loading.

At excess of a threshold besides introduced by local radio bridge losses, it is observed essential (on the average 50-multiple) increase of roundtrip time of the channel (fig. 3 left). This process results in essential distortions of sessions with a feedback which adapt stream density to the maximum possible for the used channel (TCP sessions). Observable process speaks that Radio Ethernet is badly adapted for transfering the real-time data streams, the majority from which has small information density but high frequency of following data segments.

The statistical structure of interpacket intervals on an output of Radio Ethernet channel is experimentally investigated. Researches were carried out both in before threshold, and in under threshold mode of channel loading by probing stream. The trial stream was formed as periodic sequence of UDP segments with density of following from 500 up to 3000 package/s.

Statistical characteristics of a stream past Radio Ethernet channel (fig. 4) carry a print of formation of signal sequences at a MAC-level. In functions of interpacket time distribution it is observed:

- splitting initial singlet or a doublet on multiplet with between layer's distance in 20 mks,
- restriction of the minimal inter packet interval at a level about 590 mks,
- restriction of the maximal inter packet interval, for streams with losses, at a level about 1200 mks,
- restriction of interpacket time distribution function width (for lost-free streams) in 1200 mks.

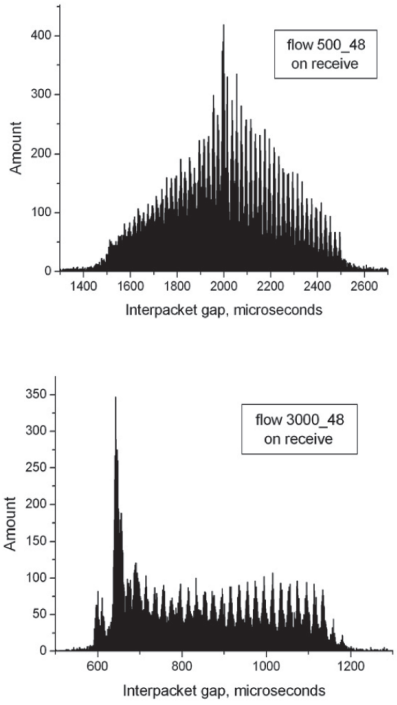

Fig 4. Histograms of inter packet time on an output of the radio channel at before threshold (at the left) and beyond threshold (on the right) Radio Ethernet channel loading.

The presence of multiplet with between layer's distance in 20 mks is consequence of existence of transfer delay time quantum, equal to 20 mks. Restriction of the minimal interpacket interval at a level about 590 mks is consequence of existence of minimal transfer time (including acknowledgement reception) of Radio Ethernet frame with a data field typical for a researched stream. Restriction of the maximal interpacket interval, for streams with losses, at a level about 1200 mks corresponds to low bit error rate in Radio Ethernet channel at which repeated transfers practically absent (a range of backoff time at absence of repeated transfers makes about 600 mks). Restriction of interpacket intervals distribution function width, for streams lost-free, in 1200 mks also corresponds to absence of repeated transfers, and value 1200 mks turns out from the conservation law of an average interval of following, i.e. 600 mks "in one side" plus 600 mks "in another".