

SBAM: A Socket-level Bandwidth Aggregation Mechanism

<http://www.ht.sfc.keio.ac.jp/move/>

Background

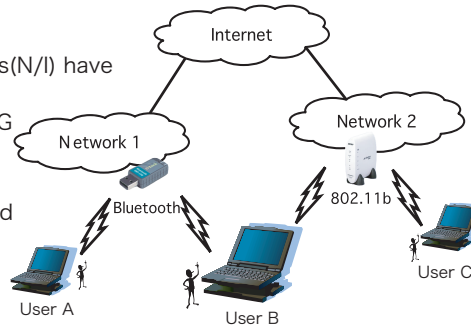
- Emergence of various wireless communication standards.
- Cases in which computers have several Network-Interfaces(N/I) have increased

ex) 802.11abgn, Bluetooth, UWB, PHP-network, 2G or 3G cellular phone etc...

People want to use the interfaces at the same time and make the best use of bandwidth.

ex) web serfing, mail transfer, multimedia streaming etc...

We propose A Socket-level Bandwidth Aggregation Mechanism SBAM.



Approach

Socket-layer

- Reuse of existing software without rewrite.
- End-to-End nature
- Scalability to N/I.
- Transport-protocol-independent.



Link/Network Layer

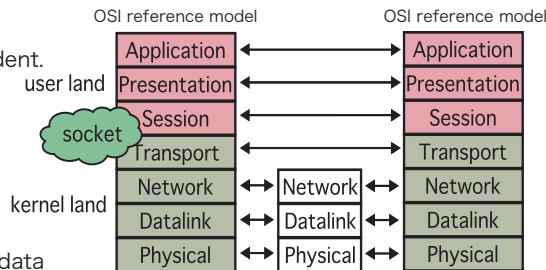
- It is impossible to exchange data between end-hosts because of Hop-by-Hop nature.

Transport Layer

- Deploying anything except TCP/UDP is difficult.

Application Layer

- It's necessary to rewrite existing softwares.
- The scalability against the number of NICs is low.



Design

Policy Transfer Function

- Exchanges of user policy through MIB between kernel space and user space.

Network Monitoring Function

- Monitoring of delay and bandwidth of each link.

Send Data Scheduling Function

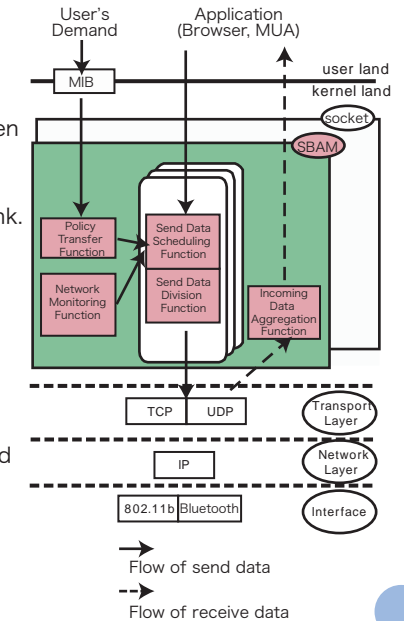
- Resolution of amount of data to send according to the Network condition.

Send Data Division Function

- Passing the data to lower protocol according to MTU and amount of data.

Incoming Data Aggregation Function

- Uniting the information which was divided and sent, and pass it to application.



Policy for sending data

Send Data Scheduling Function

- Beginning of communication: Sending difference of bandwidth-delay product between each link.

$$p_n = \frac{\alpha_n b_n d_n - \min(\alpha_1 b_1 d_1 \dots \alpha_n b_n d_n)}{m_n} \quad (0 \leq \alpha \leq 1)$$

- Then, sending data proportionate with bandwidth.

$$p_n = \alpha_n \frac{b_n \cdot lcm(m_1 \dots m_n)}{m_n \cdot gcd(b_1 \dots b_n)}$$

p_n : Num of pkts α_n : Link Weight
 m_n : MTU size(bytes) d_n : Delay(ms) b_n : Bandwidth(bps)

Network Monitoring

Delay: Measures by sending ICMP packet regularly.

$$SRTT = \alpha SRTT + (1 - \alpha) \times RTT \quad (0 \leq \alpha \leq 1)$$

Bandwidth: Uses packet-pair technique.

$$\text{Bandwidth} = \frac{\text{Packet size}}{\text{Diff of RTT}}$$

