QoS Based IrDA in Mobile Phones

Jong-Sung Kim * ,Sang-Sub Yoon ** , Byung-Sik Chun***
* Development Dept 1. CDMA Handsets , LG Electronic Inc. Kumchong-gu Seoul 153-023 Korea
Tel : +82-2-850-3670 Fax : +82-2-850-3805 E-mail: newpower76@lge.com
** Development Dept 1. CDMA Handsets , LG Electronic Inc. Kumchong-gu Seoul 153-023 Korea
Tel : +82-2-850-3848 Fax : +82-2-850-3805 E-mail: fcolors@lge.com
*** Development Dept 1. CDMA Handsets , LG Electronic Inc. Kumchong-gu Seoul 153-023 Korea
Tel : +82-2-850-3810 Fax : +82-2-850-3805 E-mail: bchun@lge.com

Abstract: This paper presents the design and implementation of a QoS based IrDA in mobile phones. The IrDA standards have arised from the need to connect various mobile devices together. But currently, we have a difficult to connecting various mobile devices together. The difficult thing is to adjust the minimum turn around time. The minimum turn around time in IrDA deals with the time needed for a receiver circuit to recover following saturation by transmissions from the same device (turn around latency). This parameter corresponds to the required time delay between the last byte of the last frames sent by a station and the point at which it is ready the first byte of a frame from another station. This parameter comes into play when the link is turned around and is negotiated independency for each station. We solve this matter by using the Dynamic Adjustment Algorithm (DAA). The dynamic adjustment algorithm adjusts the minimum turn around time according to the numbers of devices. We apply our direct adjustment algorithm to our QoS based IrDA in mobile phones and show the improved performance of connection with various mobile phones together.

About 6 words. IrDA, QoS, DAA, MTA_{timer} , connection time, IrDA packet error ratio

1. INTRODUCTION

First, we describe the IrDA (Infrared Data Association) [1][2][3]. It specifies a way to wirelessly transfer data via infrared radiation. The IrDA specifications include standards for both the physical devices and the protocols they use to communicate with each other.

The original IrDA supports to connect various mobile devices together but the vast majority of IrDA in mobile phones couldn't guarantee any level of QoS (Quality of Service) [4][5] is important that the IrDA in mobile phones guarantees any level of QoS to provide good service to another mobile devices. In this paper, we solve this problem by using the dynamic adjustment algorithm (DAA). The dynamic adjustment algorithm (DAA) is using the MTA_{timer}, which is proposed by us, is setting the minimum turn around time in accordance with the numbers of connecting mobile devices.

The rest of the paper is organized as follows. Section 2 describes the IrDA and QoS. In section 3, we propose the dynamic adjustment algorithm (DAA). Section 4 evaluates the performance. The last section concludes the paper.

2. RELATED WORKS

2.1 IrDA

IrDA was established in 1993 to set and support hardware and software standards that create infrared communications links. The Association's charter is to create an interoperable, low-cost, low-power, half-duplex, serial data interconnection standard that supports a walk-up, point-to-point user model that is adaptable to a wide range of applications and devices. IrDA standards support a broad range of computing, communications, and consumer devices.

IrDA devices communicate using infrared LED's. Wavelength used is 875 nm +- production tolerance (around 30nm). Many CCD cameras are sensitive to this wavelength too. Receivers utilize PIN photodiodes in generation mode (incoming light "kicks out" electrons. Signal continues into a filter. Only allowed frequencies for a particular IrDA modulation can pass through.) There is a direct relationship between the energy of the incoming radiation, and the charge that the optics part of the receiver generates.

IrDA devices conforming to standards IrDA 1.0 and 1.1 work over distances up to 1.0m with BER (Bit Error Ratio - number of incorrectly transferred bits over number of correctly transferred bits) 10^{-9} and maximum level of surrounding illumination 10klux (daylight). Values are defined for a 15 degree deflection (off-alignment) of the receiver and the transmitter; output power for individual optical components is measured at up to 30 degrees. Directional transmitters (IR LEDs) for higher distances exist; however, they don't comply with the required 30-degree radiation angle. Speeds for IrDA v. 1.0 range from 2400 to 115200 kbps. Pulse modulation with 3/16 of the length of the original duration of a bit is used. Data format is the same as for a serial port - asynchronously transmitted word, with a startbit at the beginning.

Transmitter can use either 3/16 mark-to-space ratio for one bit, or a fixed length 1.63 us of each optical pulse, which would correspond to 115kbps. With fixed length and speed of 38400 bps, each bit would take 3 pulses. In addition, IrDA v. 1.1 defines speeds 0.576 and 1.152 Mbps, with 1/4 mark-to-space ratio. At these speeds, the basic unit (packet) is transmitted synchronously, with a starting sequence at the beginning. The NRZ signal in the figure is the original data signal without modulation. A packet consists of two start words followed by target address (IrDA devices are assigned numbers by the means of IrDA protocol, so they are able to unambiguously identify themselves), data, CRC-16 and a stop word. The whole packet (frame) including CRC-16 is generated by IrDA compatible chipset. Start and stop words cannot appear anywhere else in the data stream - start and stop words last 1.5times the bit duration (6 times longer flash than usual).

Protocols used by IrDA devices are as follows:

- IrDA Infrared Link Access Protocol (IrLAP) is a modification of the HDLC protocol reflecting the needs of IrDA communication. In general, it encapsulates the frames and makes sure the IrDA devices don't fight among themselves - in multi-device communication, there is only one primary device, others are secondary. Note that the communication is always half-duplex. Also, IrLAP describes how the devices establish connection, close it, and how are they going to be internally numbered. Connection starts at 9600bps; as soon as information about supported speeds is exchanged, logical channels (each controlled by a single primary device) are created. The minimum turn around time deals with the time needed for a receiver following saturation by transmissions from the same device (turn around latency). This parameter corresponds to the required time delay between the last byte of the last frame sent by a station and the point at which it is ready to receive the first byte of a frame from another station.
- IrDA Infrared Link Management Protocol (IrLMP) runs above IrLAP (IrLAP is a link protocol; I would compare it to the IP protocol, although address resolution is different). IrLMP's goal is to detect presence of devices offering a service, to check data flow, and to act as a multiplexer for configurations with more devices with different capabilities involved (compare to sockets in TCP/IP communication). Then, applications use the IrLMP layer to ask if a required device is within range, etc. However, this layer does not define a reliable way to create a channel (like in TCP); this is defined by IrDA Transport Protocols (Tiny TP).
- IrDA Transport Protocols (Tiny TP) manages virtual channels between devices, performs error corrections (lost packets, etc.), divides data into packets, and reassembles original data from packets. It is most similary to TCP.
- IrDA Object Exchange Protocol (IrOBEX) is a simple protocol, which defines PUT and GETS commands, thus allowing binary data transfer between devices. It is built on top of TinyTP. The standard defines what a packet must contain in order for the devices to recognize each other and communicate.
- Extensions to IrOBEX for Ir Mobile Communications
  defines how to transfer informations pertaining to GSM network (address books, SMS, calendar, dialing control, digital voice transfer over IR)

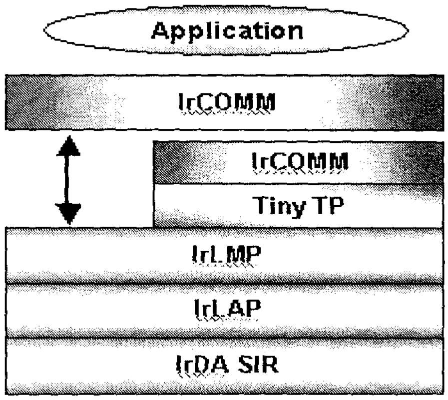

Figure 1: The architecture of IrDA

2.2 QoS

Fundamentally, QoS enables you to provide better service to certain flows. This is done by either raising the priority of a flow or limiting the priority of another flow. When using congestion-management tools, you try to raise the priority of a flow by queuing and servicing queues in different ways. The queue management tool used for congestion avoidance raises priority by dropping lower-priority flows before higher-priority flows. Policing and shaping provide priority to a flow by limiting the throughput of other flows. Link efficiency tools limit large flows to show a preference for small flows. The basic architecture introduces the three fundamental pieces for QoS implementation. Three basic levels of end-to-end QoS can be provided across a heterogeneous network see in Figure 2.

- QoS identification and marking techniques for coordinating QoS from end to end between network elements
- QoS within a single network element (for example, queuing, scheduling, and traffic-shaping tools)
- QoS policy, management, and accounting functions to control and administer end-to-end traffic across a network

Service levels refer to the actual end-to-end QoS capabilities, meaning the capability of a network to deliver service needed by specific network traffic from end to end or edge to edge. The services differ in their level of *QoS strictness*, which describes how tightly the service can be bound by specific bandwidth, delay, jitter, and loss characteristics. Three basic levels of end-to-end QoS can be provided across a heterogeneous network, as shown in Figure 3.

- **Best-effort service**-Also known as lack of QoS, best-effort service is basic connectivity with no guarantees. This is best characterized by FIFO queues, which have no differentiation between flows.

- **Differentiated service (also called soft QoS)-** Some traffic is treated better than the rest (faster handling, more average bandwidth, and lower average loss rate). This is a statistical preference, not a hard and fast guarantee. This is provided by classification of traffic and the use of QoS tools such as PQ, CQ, WFQ, and WRED (all discussed later in this chapter).
- **Guaranteed service (also called hard QoS)-** This is an absolute reservation of network resources for specific traffic. This is provided through QoS tools RSVP and CBWFQ (discussed later in this chapter).

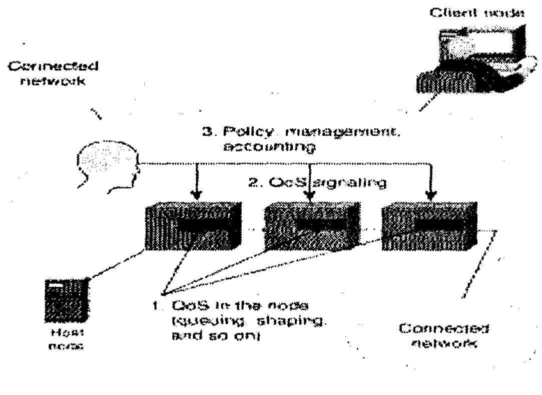

Figure 2: Three Main Components of the Basic QoS Implementation

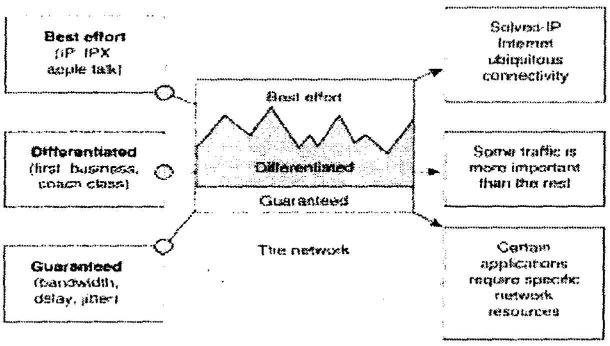

Figure 3: The Three Levels of End-to-End QoS

3. A DYNAMIC ADJUSTMENT ALGORITHM (DAA)

3.1 Problems of the IrDA in mobile phones

The IrDA standards have arised from the need to connect various mobile devices together. But currently, we have a difficult to connecting various mobile devices together. The difficult thing is to adjust the minimum turn around time.

The minimum turn around time is turn around latency, that is, this parameter corresponds to the required time delay between the last byte of the last frame sent by a station and the point which it is ready to receive the first byte of a frame from another station.

In a standard, the minimum turn around time is 55 ms but this value is not optimum to connect various mobile phones. In Practically, IrDA connection is to disconnect frequently for using the 55 ms (the minimum turn around time).

3.2 Proposal of the DAA

We solve these problems by proposing the dynamic adjustment algorithm (DAA) which is using the MTA_{timer}. The Proposed MTA_{timer} is optimum time delay between the last byte of the last frame sent by a station and the point that it is ready to receive the first byte of a frame from another station. We can determine the MTA_{timer} by using Eqution 1. And k is the constant value and it is dependent state of the number of connecting mobile phones.

$$MTA_{timer} = MTA_{time} + k \qquad (1)$$

MTA_{time} is the initial minimum turn around time. As shown Equation 2, L(t) represents the number of other mobile phones that have been heard from at time t. The state is initialized to L(0)=1 when the mobile phone joins the group. And C is the average interval between the IrDA connected mobile phones. We can determine the MTA_{time} by using Equation 2.

$$T_d = \max(T_{\min}, CL(t)) \qquad (2)$$

Figure 4 is the dynamic QoS self-adaptation flow chart. The dynamic QoS Controller is operated as follows. First, the primary mobile phone sends XID (exchange station identification) which is used for device discovery, address conflict resolution, and sniffing to the various mobile phones. Each mobile phone responds the XID to Device monitor. Then device monitor sends device information to the dynamic QoS controller. The QoS controller adjusts the minimum turn around time by using the DAA.

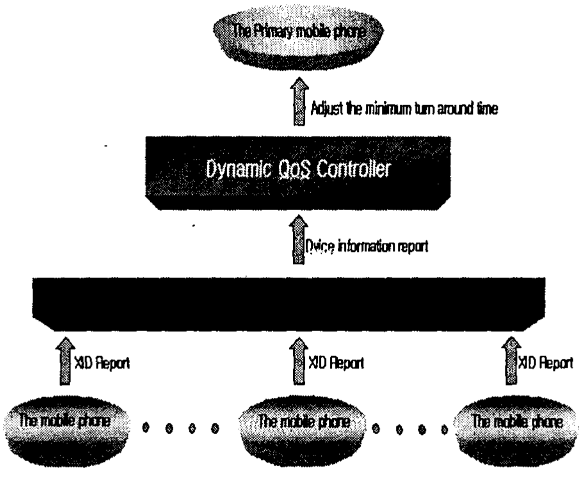

Figure 4: Dynamic QoS self-adaptaion flow chart

4. SIMULATION

4.1 Modeling for simulation

We design MTA_{timer} is 50ms and k is 0.5ms. Table 1 shows parameters of the simulation. In this simulation, we evaluate the connection time and IrDA packet loss value of the original IrDA and DAA. We set the slot number is 8. The slot number is the number of being able to connect mobile phones.

Table 1: Parameters of the simulation

IrDA packet size	500bytes	MTA_{timer}	50 ms
Simulation time	20 minutes	k	0.5 ms

4.2 Performance analysis

To verify the performance of DAA, we show the connection time and IrDA packet loss ratio. Figure 5 show the connection time by using the original IrDA and DAA. Figure 6 show IrDA packet error ratio by using the original IrDA and DAA.

Figure 5 show the connection time by using the original IrDA increases up to 65 ms, the other side, the connection time by using the DAA increases up to 54.6 ms. Also the connection time by using the DAA almost never changes in comparison with the initial connection time (50ms).

As shown Figure 6, the IrDA packet loss ratio by using the original IrDA dramatically increases in comparison with using the DAA. This consequence is that the using DAA increase the minimum turn around time by using the Equation 1. Table 2 shows the performance of error ratio. From the Table 2, we see that using the DAA is the more efficient than using the original IrDA.

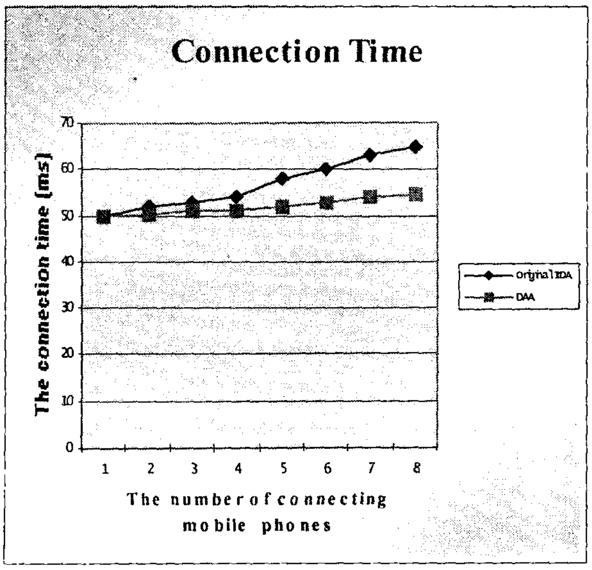

Figure 5: connection time by using the original IrDA and DAA

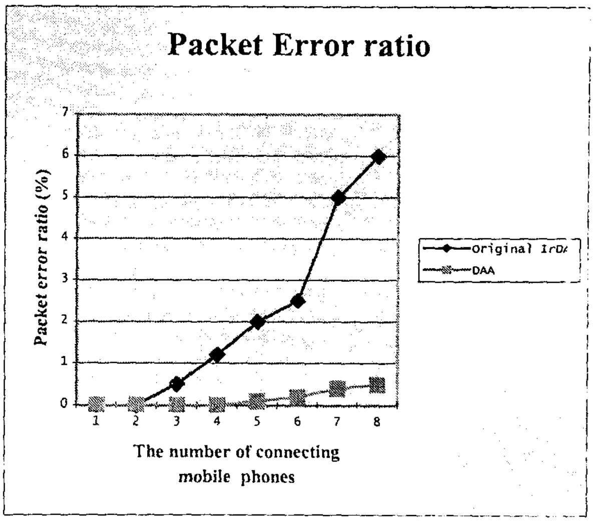

Figure 6: IrDA packet error ratio by using the original IrDA and DAA

Table 2: Performance of loss ratio

	Original IrDA	DAA
Loss ratio	6%	0.5%

5. CONCLUSION

In this paper, we designed and implemented the QoS based IrDA in mobile phones. Specially, the proposed QoS based IrDAsupports the dynamic self-adaptation QoS control by using the proposed direct adjustment algorithm (DAA). DAA can be a better solution to solve an important problem about the optimum minimum turn around time. The Proposed MTA_{timer} is optimum time delay between the last byte of the last frame sent by a station and the point that it is ready to receive the first byte of a frame from another station. We show the good performance through simulations.

The QoS self-adaptation controller is not fully implemented. Future work is to implement perfectly the QoS self-adaptation controller and to measure its performance in an extended experimental circumstance.

References

[1] Infrared Data Association; Serial Infrared Physical Layer Link Specification, Version 1.1e, October 17, 1995.

[2] IrDA Compatible Data Transmission Design Guide, TEMIC Semiconductions, April, 1996

[3] Diepstraten, W., Ennis, G., Belanger, P., DFWMAC: Distributed Foundation Wireless Medium Access Control, IEEE P 802.11-93/190, November 1993

[4] Ferguson, Paul, and Huston, Geoff. *Quality of Service: Delivering QoS on the Internet and in Corporate Networks*. New York: John Wiley & Sons, 1998.

[5] Nahrstedt K (1995) An Architecture for End-to-End Quality-fo-Service Provision and its Experimental Validation. Ph.D. Thesis, University of Pennsylvania.