

1 H. H. (Shashi) Kewalramani (Bar No. 262290)
2 shashi@ljpklaw.com
3 **LEE, JORGENSEN, PYLE & KEWALRAMANI, PC**
4 440 W 1st. Street, Suite 205
5 Tustin, CA 92780
6 Telephone: (714) 252-6611
7 Facsimile: (714) 602-4690

8 Attorneys for Plaintiff, Gordium Innovations, LLC

FILED
2012 NOV 19 PM 3:58
CLERK U.S. DISTRICT COURT
CENTRAL DIST. OF CALIF.
SANTA ANA

9 **UNITED STATES DISTRICT COURT**
10 **CENTRAL DISTRICT OF CALIFORNIA**
11 **SOUTHERN DIVISION**

12 GORDIUM INNOVATIONS, LLC,

13 Plaintiff,

14 v.

15 ZYXEL COMMUNICATIONS, INC.,

16 Defendant.

Case No. SACV12-2014-DDC(JPR)

**PLAINTIFF GORDIUM
INNOVATIONS LLC'S ORIGINAL
COMPLAINT FOR PATENT
INFRINGEMENT AND DEMAND
FOR JURY TRIAL**

JURY TRIAL DEMANDED

17
18 Plaintiff Gordium Innovations LLC ("Plaintiff"), for its Complaint against defendant
19 ZyXEL Communications, Inc. ("Defendant"), alleges the following:

20 **NATURE OF THE ACTION**

21 1. This is an action for patent infringement arising under the Patent Laws of the
22 United States, 35 U.S.C. §§ 1, *et seq.*

23 **THE PARTIES**

24 2. Plaintiff Gordium is a limited liability company organized under the laws of
25 the State of Texas with its principal place of business at 106 Fannin Avenue, Round Rock,
26 TX 78664-5219.

27 3. Upon information and belief Defendant ZyXEL Communications, Inc. and its
28 affiliated companies ("Defendant") is a corporation organized under the laws of the State of

1 California with its principal place of business at 1130 North Miller Street, Anaheim,
2 California 92806-2001.

3 4. Upon information and belief Defendant conducts business under the name
4 ZyXEL and ZyXEL Communications Corp.

5 **JURISDICTION AND VENUE**

6 5. This is an action for patent infringement arising under the Patent Laws of the
7 United States, Title 35 of the United States Code.

8 6. This Court has subject matter jurisdiction under 28 U.S.C. §§ 1331 and 1338.

9 7. Upon information and belief, Defendant regularly conducts business in this
10 judicial district and has committed acts of patent infringement in this judicial district
11 including, *inter alia*, selling and offering to sell infringing products and services in this
12 judicial district.

13 8. Upon information and belief, Defendant has ongoing and systematic contacts
14 with this judicial district and the United States. In particular, Defendant is incorporated in
15 California with a principal place of business located in this judicial district.

16 9. Venue is proper in this judicial district under 28 U.S.C. §§ 1391(c) and
17 1400(b).

18 **COUNT I – INFRINGEMENT OF U.S. PATENT NO. 6,697,385**

19 10. The allegations set forth in the foregoing paragraphs 1 through 9 are
20 incorporated into this First Claim for Relief.

21 11. On February 24, 2004, U.S. Patent No. 6,697,385 (“the ’385 patent”), entitled
22 “Circuit(s), Method(s) and Architecture for Configurable Packet Re-timing in Network
23 Repeater Hubs,” was duly and legally issued by the United States Patent and Trademark
24 Office. A true and correct copy of the ’385 Patent is attached as Exhibit A to this
25 Complaint.

26 12. Plaintiff is the assignee and owner of the right, title and interest in and to the
27 ’385 Patent, including the right to assert all causes of action arising under said patent and
28 the right to any remedies for infringement of it.

1 13. In violation of 35 U.S.C. § 271, Defendant has directly infringed and
2 continues to directly infringe, literally and /or under the doctrine of equivalents, the '385
3 Patent by importing, making, using, selling and/or offering for sale in the United States,
4 including in this Judicial District, products capable of providing features claimed in at least
5 Claims 1 and 14 of the '385 Patent ("the '385 Accused Products and Services"), without
6 the authority of Plaintiff.

7 14. The '385 Accused Products and Services include, but are not limited to, the
8 ZyWALL USG100.

9 15. Plaintiff provided actual notice to Defendant of its infringement of the '385
10 Patent in a letter sent by certified mail on July 31, 2012.

11 16. Defendant has had actual knowledge of the '385 Patent and its infringement of
12 that patent since at least the date that the July 31, 2012, letter was received, upon
13 information and belief, on August 6, 2012.

14 17. Upon information and belief, Defendant has committed and continues to
15 commit acts of contributory infringement of at least Claims 1 and 14 of the '385 patent
16 under 35 U.S.C. § 271(c) by selling, offering to sell, and/or importing products including
17 the '385 Accused Products and Services for the '385 Patent, knowing or willfully blind to
18 the fact that these products and service constitute a material part of the invention, were
19 especially made or especially adapted for use in an infringement of the '385 Patent, and
20 have no substantial non-infringing uses.

21 18. Upon information and belief, since at least the date it received the notice letter
22 from Plaintiff, notifying Defendant that its products infringed the '385 Patent, Defendant
23 has induced and continues to induce others to infringe at least Claims 1 and 14 of the '385
24 Patent under 35 U.S.C. § 271(b) by, among other things, and with specific intent, actively
25 and knowingly aiding and abetting others to infringe, including, but not limited to,
26 Defendant's customers whose use of the '385 Accused Services and Products constitutes
27 direct infringement of Claims 1 and 14 of the '385 Patent. In particular, Defendant acted
28 with specific intent to make others, such as its customers, infringe by advertising and

1 selling the products and providing instruction manuals showing infringing uses of the
2 products and services. On information and belief, Defendant engaged in such actions with
3 specific intent to cause infringement or with willful blindness to the resulting infringement
4 because Defendant has had actual knowledge of the '385 Patent and that its acts were
5 inducing its customers to infringe the '385 Patent since at least the date it received the
6 notice letter from Plaintiff, notifying Defendant of its infringement of the '385 Patent.

7 19. Plaintiff has been harmed by Defendant's infringing activities.

8 20. Plaintiff provided notice of infringement of the '385 Patent to Defendant, but
9 Defendant thereafter continued to infringe the patent. On information and belief,
10 Defendant's infringement has been and continues to be willful.

11 JURY DEMAND

12 Pursuant to Rule 38 of the Federal Rules of Civil Procedure, Plaintiff demands a trial
13 by jury on all issues triable as such.

14 PRAYER FOR RELIEF

15 WHEREFORE, Plaintiff respectfully requests that this Court enter judgment in its
16 favor and against Defendant as follows:

17 A. An adjudication that Defendant has infringed the '385 patent;

18 B. An award of damages to be paid by Defendant adequate to compensate
19 Plaintiff for Defendant's past infringement of the '385 patent and any continuing or future
20 infringement through the date such judgment is entered, including interest, costs, expenses
21 and an accounting of all infringing acts including, but not limited to, those acts not
22 presented at trial;

23 C. A reasonable ongoing royalty to compensate Plaintiff for any sales made post-
24 judgment;

25 D. A declaration that this case is exceptional under 35 U.S.C. § 285, and an
26 award of Plaintiff's reasonable attorneys' fees;

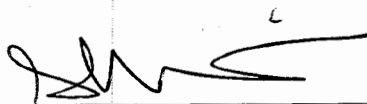
27 E. An award of treble damages under 35 U.S.C. § 284;

1 F. An award to Plaintiff of such further relief at law or in equity as the Court
2 deems just and proper.

3
4 Dated: November 19, 2012

5 **LEE, JORGENSEN, PYLE & KEWALRAMANI, PC**

6
7
8
9 By:



10 H. H. (Shashi) Kewalramani
11 Attorneys for Plaintiff
12 Gordium Innovations, LLC
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28

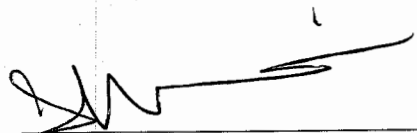
DEMAND FOR JURY TRIAL

Plaintiff, Gordium Innovations, LLC., hereby demands trial by jury in this action.

Dated: November 19, 2012

LEE, JORGENSEN, PYLE & KEWALRAMANI, PC

By:



H. H. (Shashi) Kewalramani
Attorneys for Plaintiff
Gordium Innovations, LLC

EXHIBIT A



US006697385B1

(12) **United States Patent**
Matthews

(10) **Patent No.:** **US 6,697,385 B1**
(45) **Date of Patent:** ***Feb. 24, 2004**

(54) **CIRCUIT(S), METHOD(S) AND ARCHITECTURE FOR CONFIGURABLE PACKET RE-TIMING IN NETWORK REPEATER HUBS**

(75) **Inventor:** **Joe P. Matthews, Savage, MN (US)**

(73) **Assignee:** **Cypress Semiconductor Corp., San Jose, CA (US)**

(*) **Notice:** This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) **Appl. No.:** **08/935,982**

(22) **Filed:** **Sept. 23, 1997**

(51) **Int. Cl.⁷** **H04J 3/06**

(52) **U.S. Cl.** **370/517; 370/419; 370/463; 370/501; 375/211**

(58) **Field of Search** **370/445, 446, 370/447, 448, 517, 407, 408, 501, 315, 508, 516, 419, 463, 502, 519; 375/211**

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,677,618 A	*	6/1987	Haas	.....	370/517
5,361,261 A	*	11/1994	Edem	.....	370/501
5,406,559 A	*	4/1995	Edem et al.	.....	370/516
5,600,651 A	*	2/1997	Molle	.....	370/448
5,771,235 A	*	6/1998	Tang	.....	370/446
5,777,996 A	*	7/1998	Chan	.....	370/445
6,118,809 A	*	9/2000	Lo	.....	375/211
6,295,281 B1	*	9/2001	Itkowsky et al.	.....	370/293

* cited by examiner

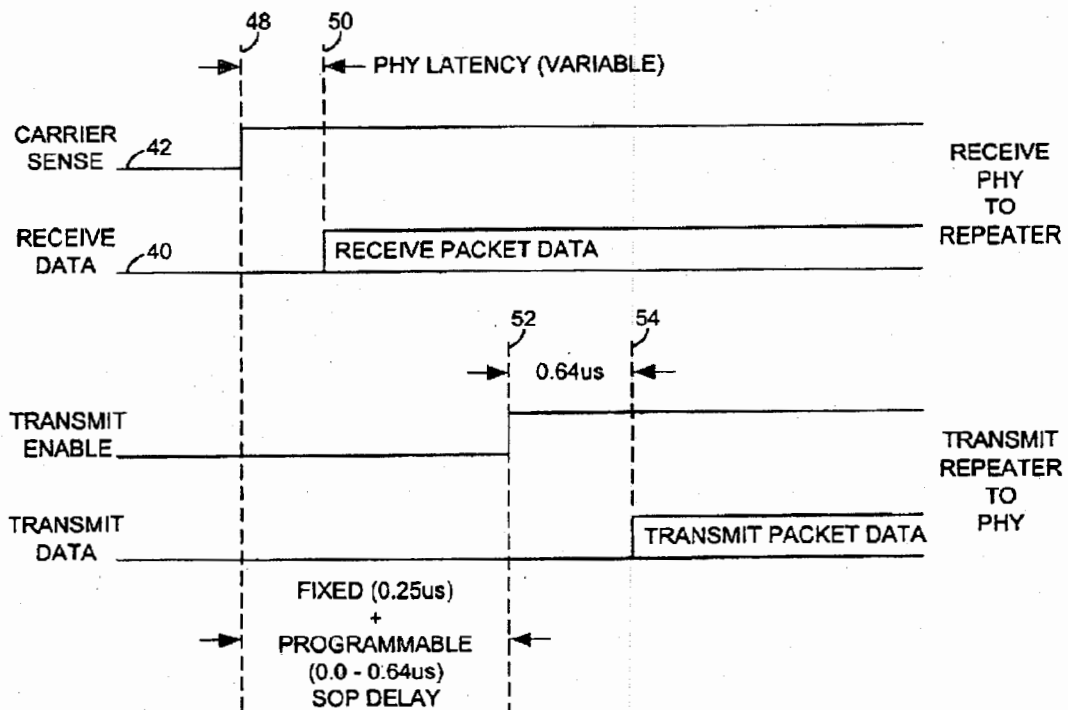
Primary Examiner—John Pezzlo

(74) *Attorney, Agent, or Firm*—Christopher P. Maiorana, P.C.

(57) **ABSTRACT**

A circuit comprising a first circuit and a second circuit. The first circuit may be configured to present information after a delay in response to a plurality of transmit and receive inputs. The second circuit may be configured to adjust the amount of delay prior to presenting information. The second circuit may be implemented as a state machine.

14 Claims, 3 Drawing Sheets



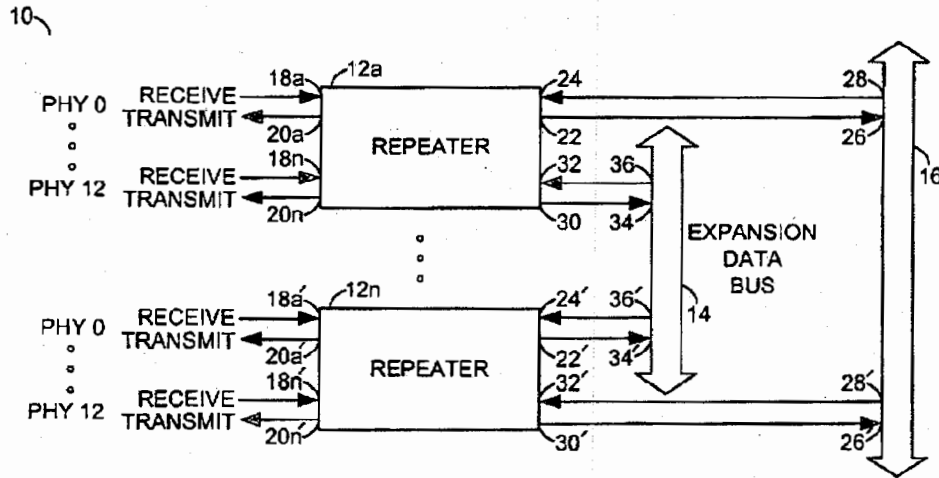


FIG. 1

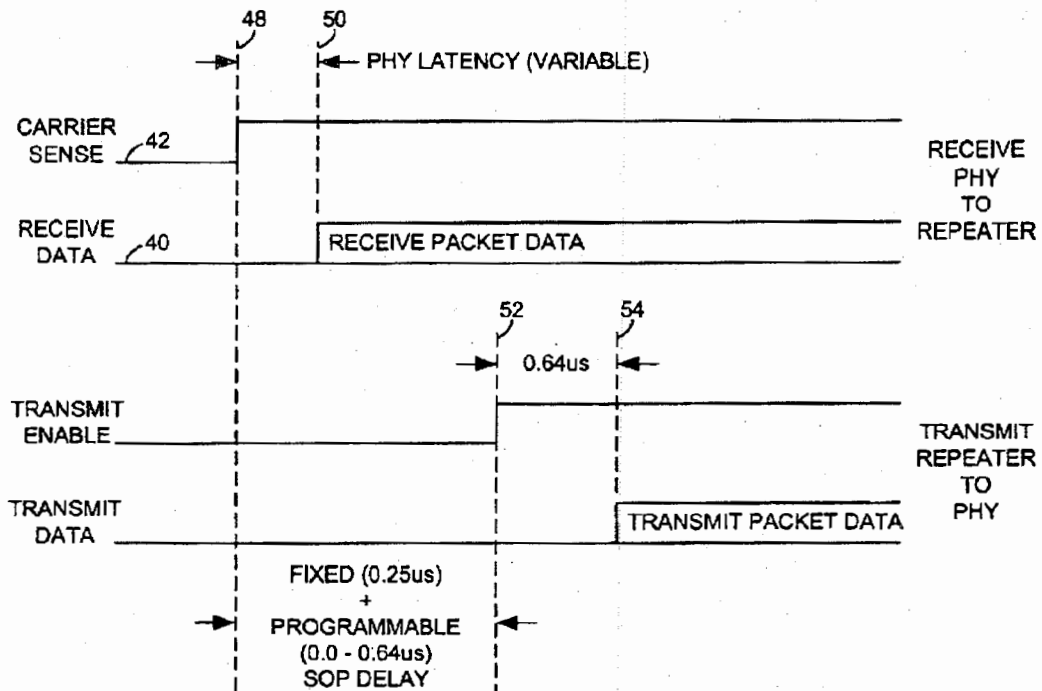


FIG. 2

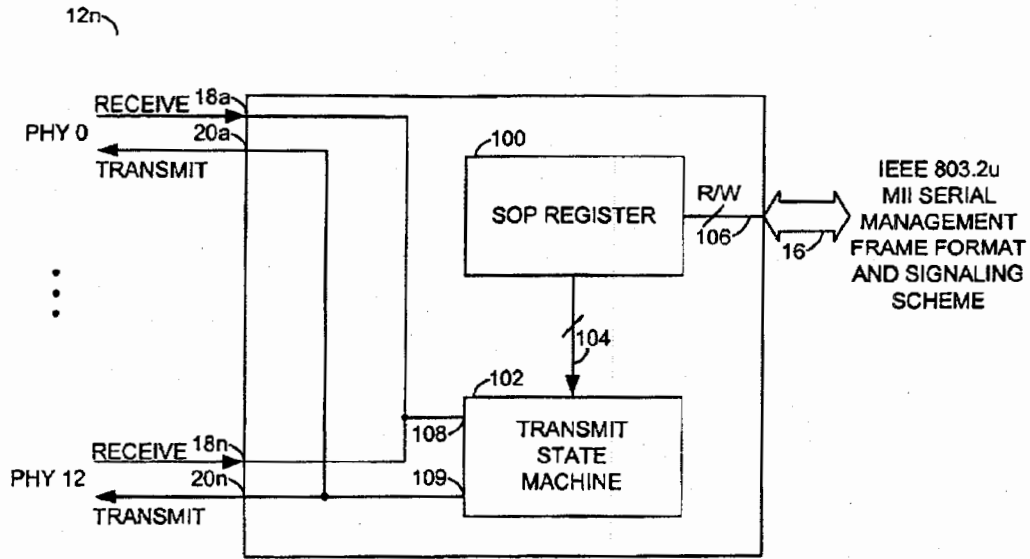


FIG. 3

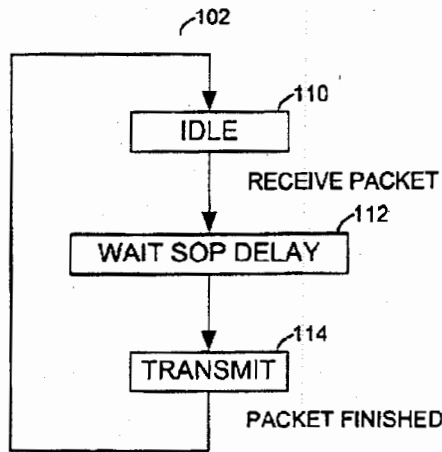


FIG. 4

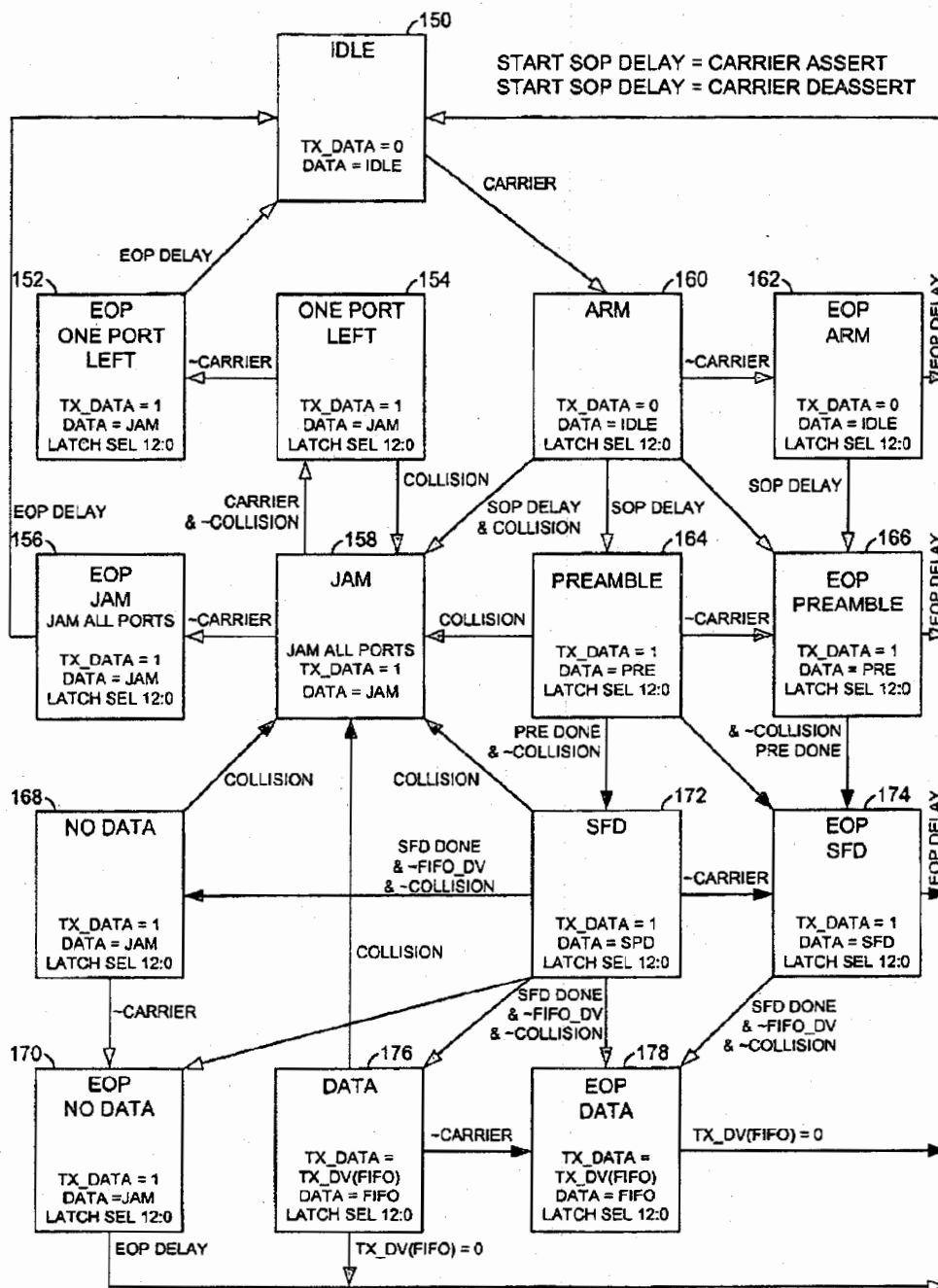


FIG. 5

1

CIRCUIT(S), METHOD(S) AND ARCHITECTURE FOR CONFIGURABLE PACKET RE-TIMING IN NETWORK REPEATER HUBS

FIELD OF THE INVENTION

The present invention relates to computer networks generally and, more particularly, to a circuit and method for providing configurable packet re-timing in a flexible network repeater hub.

BACKGROUND OF THE INVENTION

Computer networks allow the connectivity of a number of nodes through a physical network layer. The physical layer is generally connected through a number of repeaters, often configured in a hub or core. A number of different physical layer protocols exist, such as 10baseT Ethernet, 100baseT Ethernet, etc. While certain strict protocols have been defined by the Institute of Electrical and Electronics Engineers, it is often possible to enhance the performance of a device by varying certain parameters of the repeaters. Additionally, variations of physical layer devices (PHYs) may be implemented by various computer vendors introducing such protocol variations as TX, FX, etc. T4. Each particular physical layer device variation may have an ideal start of packet (SOP) delay that produces improved system performance in particular applications, such as the operation over twisted pair, fiber optic, etc.

Conventional approaches to solving the problem of providing compatibility between multiple media vendor devices typically place the burden on the physical layer of the network by strictly constraining the carrier sense-to-data relationship of each of the physical devices. This type of strict constraint may force the use of devices manufactured by one vendor for the entire physical layer to ensure compatibility. Single vendor solutions are not desirable in a competitive market, particularly for vendors other than the single vendor.

Another solution to provide compatibility between multiple media vendors may incorporate extremely deep (and often inefficient) First-In-First-Out (FIFO) buffers to accommodate a mix of physical layer devices. In such a configuration, the overall performance of the repeater hub is fixed, not allowing for aggressive or conservative performance alternatives in the overall design. The conventional method generally restricts the design of the repeater hub to a narrow range of physical layer devices that conform to the strict rules of the particular carrier sensing packet data relationship. While the implementation of inefficient and unnecessarily deep FIFOs may allow some flexibility, the overall performance of the repeater hub is fixed and does not allow the dynamic optimization of the SOP delay.

SUMMARY OF THE INVENTION

The present invention concerns a circuit comprising a first circuit and a second circuit. The first circuit may be configured to present information after a delay in response to a plurality of transmit and receive inputs. The second circuit may be configured to adjust the amount of delay prior to presenting information. The second circuit may be implemented as a state machine.

The objects, features and advantages of the present invention include providing a repeater hub accessible through a media independent interface which allows for (i) dynamic

2

control from the system agent, (ii) programmability of a start of packet delay to compensate for variable PHY latency, (iii) programmability of an output enable delay, (iv) a reduction in the overall size of internal FIFOs and (v) the ability to optimize the distance between read and write pointers of the internal FIFO based on particular system characteristics.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, features and advantages of the present invention will be apparent from the following detailed description and the appended claims and drawings in which:

FIG. 1 is a block diagram illustrating an overview of a repeater hub;

FIG. 2 is a timing diagram illustrating the physical layer variability in the carrier sense-to-data latency of each of the repeaters of FIG. 1;

FIG. 3 is a block diagram of the internal registers of each of the repeaters of FIG. 1;

FIG. 4 is a state diagram of the state machine illustrated in FIG. 3; and

FIG. 5 is a more detailed state diagram of the state machine illustrated in FIG. 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention concerns a circuit, method and architecture for providing registers within each individual repeater in a repeater hub. Each of the registers may be accessible via the media independent interface (MII) (i.e., a serial interface generally connected to a repeater), allowing dynamic control of the repeater hub from the system agent. This dynamic control enables a minimum size internal FIFO to be implemented and allows the ability to optimize the distance between the read and write pointers based on particular system characteristics.

Referring to FIG. 1, a block diagram of a repeater hub 10 is shown in accordance with a preferred embodiment of the present invention. The repeater hub 10 generally comprises a number of repeaters 12a-12n, an expansion data bus 14, and a management bus 16. The repeater 12a is shown having a number of receive inputs 18a-18n and a number of transmit outputs 20a-20n which generally operate as transmit and receive pairs. Each of the transmit and receive pairs 18a-n and 20a-n generally provides an interface to a physical layer device, shown generally as PHY0-PHY12. While twelve physical layer devices are shown, the particular number of physical layer devices connected to the repeater 12a may be adjusted accordingly to meet the design criteria of a particular application.

In addition to the repeater 12a, the repeater 12n is shown having a number of receive buses 18a'-18n' and a number of transmit outputs 20a'-20n'. Similar to the repeater 12a, each of the transmit and receive pairs 18a'-18n' and 20a'-20n' may be coupled to a particular physical layer device, shown generally as PHY0'-PHY12'. Similar to the repeater 12a, the particular number of physical layer devices connected to the repeater 12n may be adjusted accordingly to meet the design criteria of a particular application.

The repeater 12a is shown having an output 22 and an input 24. The output 22 is generally coupled to an input 26 of the management bus 16, while the input 24 generally receives information from an output 28 of the management bus 16. Similarly, the repeater 12a comprises an output 30 and an input 32. The output 30 generally presents data to an

input 34 of the expansion data bus 14 while the input 32 generally receives data from an output 36 of the expansion data bus 14. As a result, the outputs 22 and 30, combined with the inputs 24 and 32, may provide interfaces between the repeater 12a and the expansion data bus 14 as well as between the repeater 12a and the management bus 16. The repeater 12n has inputs 24' and 32' as well as outputs 22' and 30' that may be coupled to the inputs 34' and 26' as well as the outputs 28' and 36' of the expansion data bus 14 and the management bus 16.

Since each of the repeaters 12a-12n independently presents data to the expansion data bus 14 and the management bus 16, the data transmitted by each particular repeater 12a-12n may be tuned to provide improved or enhanced performance. The particular adjustment may be conservative or aggressive in order to satisfy particular design constraints.

Referring to FIG. 2, a timing diagram of the waveforms presented at the transmit outputs 20a-20n and the receive inputs 18a-18n is shown. The data received at the receive inputs 18a-18n is shown generally as a receive data waveform 40 and a carrier sense waveform 40. The data presented at the transmit outputs 20a-20n is generally represented as a transmit data waveform 44 and a transmit enable waveform 46. The carrier sense waveform 42 generally transitions high at a vertical line 48. The transmit enable waveform 46 generally transitions high at a vertical line 52. After the carrier sense waveform 42 transitions high, the receive data waveform 40 presents a receive data packet after a fixed plus a programmable SOP delay (generally represented as the time between the vertical line 48 and the vertical line 52). The programmable portion of the SOP delay may be adjusted for particular PHY devices (e.g., T4, FX, TX, etc.). A variable PIY latency is generally represented as the time between the vertical line 48 and the vertical line 50.

The time between the vertical line 52 and the vertical line 54 generally represents a fixed portion of the start of packet (SOP) delay. The transmit data waveform 44 generally transitions high at a vertical line 54. The time between the vertical line 52 and the vertical line 54 generally represents a fixed 0.64 μ s delay that generally allows time for a packet preamble to be transmitted.

The programmable nature of the start of packet delay of the present invention generally provides a compensation at the outputs of the repeaters 12a-12n that may provide a performance enhancement over various physical layer media such as fiber optic cable, twisted pair cable, level III cable, level V cable, etc. Particular media may require (or benefit from) a shorter programmable SOP delay. Generally, the shorter the overall SOP delay (i.e., the fixed portion plus the programmable portion), the quicker the particular repeater 12a-12n may present data to the transmit outputs 20a-20n. As a result, an overall performance enhancement of the repeater 12a-12n may result. In one example, the fixed delay may be less than 0.254 μ s. The programmable portion of the delay may range from between 0-0.64 μ s. Additionally, the SOP delay may be used to control the distance between the read and write pointers of an internal FIFO (not shown). As a result, the size of the internal FIFO may be minimized.

Referring to FIG. 3, a more detailed diagram of one of the repeaters 12a-12n is shown. The repeater 12n generally comprises the inputs 18a-18n and the outputs 20a-20n described in connection with FIG. 1. The repeater 12n additionally comprises a register 100 (e.g., a SOP register) and a transmit state machine 102. The register 100 generally operates (i.e., stores or presents information) when the

repeater 12n is idle, which may be most of the time. For example, the repeater 12n may be idle after each packet transmission. As a result, the register 100 generally operates in the background of the repeater 12n and does not generally inhibit the overall performance. The register 100 is generally coupled to the state machine 102 through a bus 104. The register is also coupled to the management bus 16 through a read/write bus 106.

The transmit state machine 102 also comprises an input 108 that may receive information from the receive inputs 18a-18n and an output 109 that may present information to the outputs 20a-20n. The transmit state machine 102 generally presents the SOP delay at the output 109 in response to information received at the input 108 as well as information received from the bus 104. While each of the outputs 20a-20n generally responds to the same SOP delay defined by the transmit state machine 102, the particular repeaters 12a-12n generally may have independent SOP delays.

The SOP register 100 generally receives information relating to the particular performance characteristics of the repeater 12n from the management bus 16. This information may be presented by software designed to control the repeaters 12a-12n. Such software is often referred to as management software. Once the particular performance information is presented to the register 100, additional information may be re-presented in an effort to optimize the performance of the repeater 12n. During such a situation, the new performance information is generally processed by the state machine, after which a new SOP delay may be presented at the output 109. During such a reconfiguration of the SOP delay, the repeater 12n may continue to operate in the typical transmit/receive mode. As a result, the repeater 12n allows for performance adjustments to be made during a time when the overall physical network continues functioning. In one example, a 4-bit signal may be presented to the state machine 102 through the bus 104. Such a 4-bit signal may provide sixteen unique values that each may be used by the transmit state machine 102 to present different SOP delays at the output 109.

Referring to FIG. 4, a functional diagram of the operation of a portion of the state machine 102 is shown. The state machine 102 generally comprises an idle state 110, a SOP delay state 112 and a transmit state 114. The idle state 110 of the transmit state machine 102 generally waits until the next packet is received before proceeding to the SOP delay state 112. As a result, if a new performance value is received by the register 100, the current packets transmitted at the outputs 20a-20n generally will not be interrupted prior to the completion of the packet transmit. The transmit state machine 102 will generally present the new SOP delay prior to the transmission of the next packets. While the transmit state machine 102 has been described in connection with presenting the SOP delay at the output 109, additional circuitry, such as a FIFO buffer (not shown) may be implemented between the receive inputs 18a-18n and the transmit outputs 20a-20n. The amount of time the FIFO holds the data, prior to the next packet transmit may be controlled by the SOP delay.

After the delay state 112, the state machine 102 progresses to the transmit state 114. The state machine 102 responds to the performance information received from the management bus 16 through the SOP register 100. The SOP delay is generally optimized for the particular physical layer devices that are operating in conjunction with the repeaters 12a-12n. The state machine 102 generally allows for dynamic configuration of the particular amount of SOP delay presented. The dynamic configuration allows for additional repeaters

12a-12n to be connected to a physical layer network, while the network is in operation, without the requirement of shutting down the entire network to execute the configuration. After the particular repeater 12a-12n is connected, the state machine 102 dynamically configures the proper amount of SOP delay to be presented at the outputs 20a-20n.

As a result of the dynamically configurable SOP delay, the repeaters 12a-12n may operate as Class I (i.e., 700 ns latency), Class II (i.e., 460 ns latency), or other class devices. Additionally, the repeaters 12a-12n may operate in either a managed (i.e., microprocessor controlled) or an unmanaged (i.e. EPROM controlled) mode.

The basic handling of the SOP delay by each of the repeaters 12a-12n generally begins with detection of the presence of an incoming frame (or data packet) reported by one of the physical layer devices. After a set delay (described in connection with FIG. 2 as the fixed plus programmable SOP delay), the repeaters 12a-12n may generate a preamble and start of frame delimiter (SFD) sequence to be presented to the management bus 16.

Referring to FIG. 5, a more detailed state diagram of the state machine 110 is shown. The state machine generally

comprises an idle state 150, an end of packet (EOP) one port left state 152, a one port left state 154, an EOP jam state 156, a jam state 158, an arm state 160, an EOP arm state 162, a preamble state 164, an EOP preamble state 166, a no data state 168, an EOP no data state 170, an SFD state 172, an EOP SFD state 174, a data state 176, and an EOP data state 178. The idle state 150 generally moves to the arm state 160 as a first transition. After the SOP delay, as determined by the information received from the SOP register 102, the arm state moves to the preamble state 164. As a result, the transition between the idle state 150, the arm state 160 and the preamble state 164 generally represents the execution of the dynamically configurable SOP delay. The additional states represent various other parameters relating to the execution of the collision detection and retransmit protocols generally implemented in an Ethernet network.

The following code illustrates one implementation of the state machine 102 that may be understood to be an example of verilog hardware description language as defined by the IEEE 1364-1995 standard:

```

module control (clk, rst, carrier, collision, tx_dv, SFD, SOPdelay, tx_data,
idle_data, pre_data, sfd_data, fifo_check, fifo_data, jam_data, jam_all_ports,
nodata_data, quiet_data, idle, eopd, state, dataPathEn);

input      clk;           // Input, reference clock
input      rst;          // Input, sync reset
input      carrier;      // Input, indicates carrier asserted
input      collision;    // Input, indicates collision condition
input      tx_dv;        // Input, marker from FIFO, 1 = xmit data
input      SFD;          // start of frame detected from FIFO
input      [3:0] SOPdelay; // SOPdelay bit from registerFile
input      dataPathEn;

output     tx_data;      // Output, global TX data signal to all ports
output     idle_data;    // signal to datapath to transmit idle
output     pre_data;     // signal to datapath to transmit preamble
output     sfd_data;     // signal to dataPath to transmit SFD
output     fifo_check;   // fifoError for underflow/overflow check
output     fifo_data;    // signal to dataPath to transmit fifo data
output     nodata_data;  // signal to dataPath to transmit rx_er
output     quiet_data;   // signal to activity in ONE_PORT_LEFT state
output     jam_data;     // signal to dataPath to transmit jam
output     jam_all_ports; // signal to ports indicating jam all ports
output     idle;         // signal to ports indicating idle state
output     sopd;         // signal to activity to latch select lines
output     [3:0] state;

reg        [3:0] state,newState;
reg        [3:0] tx_data_state;
reg        idle_data;
reg        pre_data;
reg        sfd_data;
reg        fifo_data;
reg        nodata_data;
reg        quiet_data;
reg        fifo_check;
reg        jam_data;
reg        jam_all_ports;
reg        eopd;
reg        idle;
reg        any_carrier; // a reduction OR of the carrier shift register
reg        [16:0] sop_delay,new_sop_delay;
reg        [3:0] preamble_timer,new_preamble_timer;
reg        all_carrier; // the carrier shift register is full (all 1's)
wire       [3:0] sopdelay;
wire       tx_data;
wire       sop_delay_done;
wire       sop_delay_done;
wire       preamble_done;

always @(sop_delay or SOPdelay)
  case(SOPdelay)
    0,1,2: begin

```

-continued

```

module control (clk, rst, carrier, collision, tx_dv, SFD, SOPdelay, tx_data,
idle_data, pre_data, sfd_data, fifo_check, fifo_data, jam_data, jam_all_ports,
nodata_data, quiet_data, idlc, copd, statc, dataPathEn);
    any_carrier = |sop_delay[1:0];
    all_carrier = &sop_delay[3:0];
end
3: begin
    any_carrier = |sop_delay[2:0];
    all_carrier = &sop_delay[4:0];
end
4: begin
    any_carrier = |sop_delay[3:0];
    all_carrier = &sop_delay[5:0];
end
5: begin
    any_carrier = |sop_delay[4:0];
    all_carrier = &sop_delay[6:0];
end
6: begin
    any_carrier = |sop_delay[5:0];
    all_carrier = &sop_delay[7:0];
end
7: begin
    any_carrier = |sop_delay[6:0];
    all_carrier = &sop_delay[8:0];
end
8: begin
    any_carrier = |sop_delay[7:0];
    all_carrier = &sop_delay[9:0];
end
9: begin
    any_carrier = |sop_delay[8:0];
    all_carrier = &sop_delay[10:0];
end
10: begin
    any_carrier = |sop_delay[9:0];
    all_carrier = &sop_delay[11:0];
end
11: begin
    any_carrier = |sop_delay[10:0];
    all_carrier = &sop_delay[12:0];
end
12: begin
    any_carrier = |sop_delay[11:0];
    all_carrier = &sop_delay[13:0];
end
13: begin
    any_carrier = |sop_delay[12:0];
    all_carrier = &sop_delay[14:0];
end
14: begin
    any_carrier = |sop_delay[13:0];
    all_carrier = &sop_delay[15:0];
end
15: begin
    any_carrier = |sop_delay[14:0];
    all_carrier = &sop_delay[16:0];
end
endcase
assign sopdelay = (SOPdelay < 4'b0010) ? 4'b0010 : SOPdelay;
assign sop_delay_done = |sop_delay[sopdelay+1] && sop_delay[sopdelay];
assign eop_delay_done = sop_delay[sopdelay+1] && |sop_delay[sopdelay];
/** 15 clock cycles of preamble nibble 5 transmitted
assign preamble_done = 1 (preamble_timer == 4'b1110);
/** the following line turns off TX_EN one cycle ahead of the SM
assign tx_data = fifo_data ? tx_dv : tx_data_state;
parameter [3:0] // synopsys enum port_state_info
    IDLE_STATE = 4'b0000,
    ARM_STATE = 4'b0001,
    PRE_STATE = 4'b0010,
    SFD_STATE = 4'b0011,
    JAM_STATE = 4'b0100,
    DATA_STATE = 4'b0101,
    NO_SFD_OR_DATA_STATE = 4'b0110,
    ONE_PORT_LEFT_STATE = 4'b0111,
    EOP_ARM_STATE = 4'b1000,
    EOP_PRE_STATE = 4'b1001,
    EOP_SFD_STATE = 4'b1010,
    EOP_DATA_STATE = 4'b1011,

```

-continued

```

module control (clk, rst, carrier, collision, tx_dv, SFD, SOPdelay, tx_data,
idle_data, pre_data, sfd_data, fifo_check, fifo_data, jam_data, jam_all_ports,
nodata_data, quiet_data, idlc, copd, state, dataPathEn);
EOP_NO_SFD_OR_DATA_STATE = 4'b1100,
EOP_JAM_STATE = 4'b1101,
EOP_ONE_PORT_LEFT_STATE = 4'b1110,
WAIT_FOR_EOP_DATA_STATE = 4'b1111;
// synopsys state_vector state
always @(sop_delay or carrier)
begin
new_sop_delay[0] = carrier;
new_sop_delay[16:1] = sop_delay[15:0];
end
always @(pre_data or preamble_timer)
new_preamble_timer = pre_data ? preamble_timer + 1 : 0;
always @(state or collision or carrier or SFD or tx_dv or sop_delay
or any_carrier or eop_delay_done or sop_delay_done or
preamble_done or all_carrier or dataPathEn)
case(state)
IDLE_STATE:
begin
idle_data = 1;
pre_data = 0;
sfd_data = 0;
fifo_check = 0;
fifo_data = 0;
nodata_data = 0;
quiet_data = 0;
jam_data = 0;
eopd = 0;
idle = 1;
jam_all_ports = 0;
tx_data_state = 0;
if(!dataPathEn)
newState = IDLE_STATE;
else if(collision)
newState = JAM_STATE;
else if(carrier || any_carrier)
newState = ARM_STATE;
else
newState = IDLE_STATE;
end
ARM_STATE:
begin
idle_data = 1;
pre_data = 0;
sfd_data = 0;
fifo_check = 0;
fifo_data = 0;
nodata_data = 0;
quiet_data = 0;
jam_data = 0;
eopd = 1;
idle = 1;
jam_all_ports = 0;
tx_data_state = 0;
if(!dataPathEn)
newState = IDLE_STATE;
else if (!carrier && sop_delay_done)
newState = EOP_PRE_STATE;
else if (!carrier)
newState = EOP_ARM_STATE;
else if(collision && sop_delay_done)
newState = JAM_STATE;
else if(carrier && (sop_delay_done || all_carrier))
newState = PRE_STATE;
else
newState = ARM_STATE;
end
EOP_ARM_STATE:
begin
idle_data = 1;
pre_data = 0;
sfd_data = 0;
fifo_check = 0;
fifo_data = 0;
nodata_data = 0;
quiet_data = 0;

```


-continued

```

module control (clk, rst, carrier, collision, tx_dv, SFD, SOPdelay, tx_data,
idle_data, pre_data, sfd_data, fifo_check, fifo_data, jam_data, jam_all_ports,
nodata_data, quiet_data, idle, copd, statc, dataPathEn);

```

```

    jam_data      = 0;
    eopd          = 1;
    idle          = 1;
    jam_all_ports = 0;
    tx_data_state = 0;
    if(!dataPathEn || sop_delay_done || !any_carrier || !sop_delay)
        newState = IDLE_STATE;
    else if(sop_delay_done)
        newState = EOP_PRE_STATE;
    else
        newState = EOP_ARM_STATE;
    end
end
PRE_STATE;
begin
    idle_data      = 0;
    pre_data       = 1;
    sfd_data       = 0;
    fifo_check     = 0;
    fifo_data      = 0;
    nodata_data    = 0;
    quiet_data     = 0;
    jam_data       = 0;
    eopd           = 1;
    idle           = 0;
    jam_all_ports  = 0;
    tx_data_state  = 1;
    if(!dataPathEn)
        newState = IDLE_STATE;
    else if (!carrier && preamble_done)
        newState = EOP_SFD_STATE;
    else if (!carrier)
        newState = EOP_PRE_STATE;
    else if (collision)
        newState = JAM_STATE;
    else if (preamble_done)
        newState = SFD_STATE;
    else
        newState = PRE_STATE;
    end
end
EOP_PRE_STATE;
begin
    idle_data      = 0;
    pre_data       = 1;
    sfd_data       = 0;
    fifo_check     = 0;
    fifo_data      = 0;
    nodata_data    = 0;
    quiet_data     = 0;
    jam_data       = 0;
    eopd           = 1;
    idle           = 0;
    jam_all_ports  = 0;
    tx_data_state  = 1;
    if(!dataPathEn)
        newState = IDLE_STATE;
    else if (sop_delay_done || !any_carrier)
        newState = IDLE STATE;
    else if (preamble done && !sop delay done)
        newState = EOP_SFD_STATE;
    else
        newState = EOP_PRE_STATE;
    end
end
SFD_STATE;
begin
    idle_data      = 0;
    pre_data       = 0;
    sfd_data       = 1;
    fifo_check     = 0;
    fifo_data      = 0;
    nodata_data    = 0;
    quiet_data     = 0;
    jam_data       = 0;
    eopd           = 1;
    idle           = 0;
    jam_all_ports  = 0;

```

-continued

```

module control (clk, rst, carrier, collision, tx_dv, SFD, SOPdelay, tx_data,
idle_data, pre_data, sfd_data, fifo_check, fifo_data, jam_data, jam_all_ports,
nodata_data, quiet_data, idlc, copd, state, dataPathEn);

```

```

    tx_data_state = 1;
    if(!dataPathEn)
        newState = IDLE_STATE;
    else if (!carrier && SFD)
        newState = EOP_DATA_STATE;
    else if (!carrier && !SFD)
        newState = EOP_NO_SFD_OR_DATA_STATE;
    else if (collision)
        newState = JAM_STATE;
    else if (!SFD || !tx_dv)
        newState = NO_SFD_OR_DATA_STATE;
    else
        newState = DATA_STATE;
end
EOP_SFD_STATE:
begin
    idle_data = 0;
    pre_data = 0;
    sfd_data = 1;
    fifo_check = 0;
    fifo_data = 0;
    nodata_data = 0;
    quiet_data = 0;
    jam_data = 0;
    eopd = 1;
    idle = 0;
    jam_all_ports = 0;
    tx_data_state = 1;
    if(!dataPathEn || sop_delay_done || !any_carrier)
        newState = IDLE_STATE;
    else if (!tx_dv || !SFD)
        newState = EOP_NO_SFD_OR_DATA_STATE;
    else
        newState = EOP_DATA_STATE;
end
DATA_STATE:
begin
    idle_data = 0;
    pre_data = 0;
    sfd_data = 0;
    fifo_check = 1;
    fifo_data = 1;
    nodata_data = 0;
    quiet_data = 0;
    jam_data = 0;
    eopd = 1;
    idle = 0;
    jam_all_ports = 0;
    tx_data_state = 1;
    if(!dataPathEn)
        newState = IDLE_STATE;
    else if (!carrier)
        newState = EOP_DATA_STATE;
    else if (collision)
        newState = JAM_STATE;
    else if (!tx_dv)
        newState = WAIT FOR EOP DATA STATE;
    else
        newState = DATA_STATE;
end
WAIT_FOR_EOP_DATA_STATE:
begin
    idle_data = 1;
    pre_data = 0;
    sfd_data = 0;
    fifo_check = 0;
    fifo_data = 0;
    nodata_data = 0;
    quiet_data = 0;
    jam_data = 0;
    eopd = 1;
    idle = 0;
    jam_all_ports = 0;
    tx_data_state = 0;
    if(!dataPathEn || eop_delay_done)

```

-continued

```

module control (clk, rst, carrier, collision, tx_dv, SFD, SOPdelay, tx_data,
idle_data, pre_data, sfd_data, fifo_check, fifo_data, jam_data, jam_all_ports,
nodata_data, quiet_data, idlc, copd, statc, dataPathEn);

```

```

        newState = IDLE_STATE;
    else if (collision)
        newState = JAM_STATE;
    else
        newState = WAIT_FOR_EOP_DATA_STATE;
end
EOP_DATA_STATE:
begin
    idle_data      = 0;
    pre_data       = 0;
    sfd_data       = 0;
    fifo_check     = 0;
    fifo_data      = 1;
    nodata_data    = 0;
    quiet_data     = 0;
    jam_data       = 0;
    eopd           = 1;
    idlc           = 0;
    jam_all_ports  = 0;
    tx_data_state  = 1;
    if(!dataPathEn || !tx_dv)
        newState = IDLE_STATE;
    else
        newState = EOP_DATA_STATE;
end
JAM_STATE:
begin
    idle_data      = 0;
    pre_data       = 0;
    sfd_data       = 0;
    fifo_check     = 0;
    fifo_data      = 0;
    nodata_data    = 0;
    quiet_data     = 1;
    jam_data       = 1;
    eopd           = 0;
    idlc           = 0;
    jam_all_ports  = 1;
    tx_data_state  = 1;
    if(!dataPathEn)
        newState = IDLE_STATE;
    else if(!carrier)
        newState = EOP_JAM_STATE;
    else if(carrier && !collision)
        newState = ONE_PORT_LEFT_STATE;
    else
        newState = JAM_STATE;
end
EOP_JAM_STATE:
begin
    idle_data      = 0;
    pre_data       = 0;
    sfd_data       = 0;
    fifo_check     = 0;
    fifo_data      = 0;
    nodata_data    = 0;
    quiet_data     = 0;
    jam_data       = 1;
    eopd           = 1;
    idlc           = 0;
    jam_all_ports  = 1;
    tx_data_state  = 1;
    if(!dataPathEn || ((eop_delay_done || !any_carrier) && !collision))
        newState = IDLE_STATE;
    else
        newState = EOP_JAM_STATE;
end
ONE_PORT_LEFT_STATE:
begin
    idle_data      = 0;
    pre_data       = 0;
    sfd_data       = 0;
    fifo_check     = 0;
    fifo_data      = 0;
    nodata_data    = 0;

```

-continued

```

module control (clk, rst, carrier, collision, tx_dv, SFD, SOPdelay, tx_data,
idle_data, pre_data, sfd_data, fifo_check, fifo_data, jam_data, jam_all_ports,
nodata_data, quiet_data, idlc, copd, statc, dataPathEn);

```

```

    quiet_data    = 1;
    jam_data      = 1;
    eopd         = 1;
    idle         = 0;
    jam_all_ports = 0;
    tx_data_state = 1;
    if(!dataPathEn)
        newState = IDLE_STATE;
    else if (!carrier)
        newState = EOP_ONE_PORT_LEFT_STATE;
    else if(collision)
        newState = JAM_STATE;
    else
        newState = ONE_PORT_LEFT_STATE;
end
EOP_ONE_PORT_LEFT_STATE:
begin
    idle_data    = 0;
    pre_data     = 0;
    sfd_data     = 0;
    fifo_check   = 0;
    fifo_data    = 0;
    nodata_data  = 0;
    quiet_data   = 0;
    jam_data     = 1;
    eopd        = 1;
    idle        = 0;
    jam_all_ports = 0;
    tx_data_state = 1;
    if(!dataPathEn || eop_delay_done || !any_carrier)
        newState = IDLE_STATE;
    else
        newState = EOP_ONE_PORT_LEFT_STATE;
end
NO_SFD_OR_DATA_STATE:
begin
    idle_data    = 0;
    pre_data     = 0;
    sfd_data     = 0;
    fifo_check   = 0;
    fifo_data    = 0;
    nodata_data  = 1;
    quiet_data   = 0;
    jam_data     = 1;
    copd        = 1;
    idle        = 0;
    jam_all_ports = 0;
    tx_data_state = 1;
    if(!dataPathEn)
        newState = IDLE_STATE;
    else if(!carrier)
        newState = EOP_NO_SFD_OR_DATA_STATE;
    else if(collision)
        newState = JAM_STATE;
    else
        newState = NO_SFD_OR_DATA_STATE;
end
EOP_NO_SFD_OR_DATA_STATE:
begin
    idle_data    = 0;
    pre_data     = 0;
    sfd_data     = 0;
    fifo_check   = 0;
    fifo_data    = 0;
    nodata_data  = 0;
    quiet_data   = 0;
    jam_data     = 1;
    eopd        = 1;
    idle        = 0;
    jam_all_ports = 0;
    tx_data_state = 1;
    if(!dataPathEn || eop_delay_done || !any_carrier)
        newState = IDLE_STATE;
    else
        newState = EOP_NO_SFD_OR_DATA_STATE;

```

-continued

```

module control (clk, rst, carrier, collision, tx_dv, SFD, SOPdelay, tx_data,
idle_data, pre_data, sfd_data, fifo_check, fifo_data, jam_data, jam_all_ports,
nodata_data, quiet_data, idlc, copd, static, dataPathEn);
end
default:
begin
idle_data      = 0;
pre_data       = 0;
sfd_data       = 0;
fifo_check     = 0;
fifo_data      = 0;
nodata_data    = 0;
quiet_data     = 0;
jam_data       = 0;
copd           = 0;
idle           = 0;
jam_all_ports  = 0;
tx_data_state  = 0;
newState      = IDLE_STATE;
end
endcase
always @(posedge clk or posedge rst)
if (rst)
begin
state          = IDLE_STATE;
sop_delay      = 0;
preamble_timer = 0;
end
else
begin
state          = newState;
sop_delay      = new_sop_delay;
preamble_timer = new_preamble_timer;
end
endmodule

```

While the code illustrated explicitly defines certain conditions, other implementations including, but not limited to, discrete logic components, may be implemented to meet the design criteria of a particular application.

While the invention has been particularly shown and described with reference to the preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. A circuit comprising:

a first circuit configured to send a plurality of packets of information, each of said packets being sent in response to (i) a plurality of receive data packets and (ii) a delay control signal, wherein said delay control signal configures a delay between receiving one of said receive data packets and sending one of said plurality of packets; and

a state machine configured to adjust and present said delay control signal, wherein said state machine adjusts said delay during an idle state of said first circuit.

2. The circuit according to claim 1, wherein said delay comprises a start of packet (SOP) delay.

3. The circuit according to claim 1, wherein said delay comprises a fixed delay plus a programmable delay.

4. The circuit according to claim 3, wherein said fixed delay compensates for a physical layer device latency.

5. The circuit according to claim 1, wherein said delay is dynamically configurable.

6. The circuit according to claim 3, wherein said programmable delay is adjusted in response to information received from a register.

7. A computer readable medium containing instructions for configuring a delay in a network repeater comprising the steps of:

(a) receiving a plurality of data packets from a physical layer device;

(b) configuring a start of packet delay;

(c) sending a plurality of said data packets after said start of packet (SOP) delay;

(d) prior to step (b), generating a data packet preamble; and

(e) repeating steps (a), (b), and (c) during each idle state of said repeater.

8. The method according to claim 7, further comprising the step of:

(f) executing a collision detection and retransmit protocol after step (c).

9. The method according to claim 7, wherein said computer readable medium is stored on a state machine.

10. The method according to claim 7, wherein said step of configuring said delay responds to configuration information received from a management bus.

11. A method for dynamically configuring a delay in a network repeater comprising the steps of:

(a) receiving a plurality of data packets from a physical layer device;

(b) configuring a start of packet delay;

(c) sending a plurality of said data packets after said start of packet (SOP) delay;

(d) prior to step (b), generating a data packet preamble; and

(e) repeating steps (a), (b), and (c) during each idle state of said repeater.

12. The method according to claim 11, further comprising the step of:

(e) executing a collision detection and retransmit protocol after step (c).

21

13. The method according to claim 11, wherein said step of configuring said delay responds to configuration information received from a management bus.

14. A circuit comprising:

a first circuit configured to send a plurality of packets of information, each of said packets being sent in response to (i) a plurality of receive data packets and (ii) a delay control signal, wherein (a) said delay control signal configures a delay between receiving one of said receive data packets and sending one of said plurality

22

of packets and (b) said delay comprises a fixed delay plus a programmable delay;

a second circuit configured to adjust and present said delay control signal; and

a FIFO having a read pointer and a write pointer, said FIFO being coupled between a shared bus and said first circuit, wherein the distance between said read and write pointer are adjusted in response to said delay.

* * * * *