

# the EXTENSION

A Technical Supplement to control NETWORK

## Following ANSI's Due Process

In 1991, the ARCNET Trade Association (ATA) received accreditation by the American National Standards Institute (ANSI) as a standards developer using the canvass method. The following year, ANSI/ATA 878.1 Local Area Network: Token Bus (2.5 MBPS) was developed by ATA and approved by ANSI. This standard specifies the formats and protocols used by the 878.1 token passing bus medium access control (MAC) sublayer and physical (PHY) layer. It defines the basic ARCNET technology and recommends certain practices that increase reliability and interoperability.

In order to broaden the 878.1 standard to include alternate physical layers such as fiber optics and EIA-485 communications as well as alternate data rates, the ATA standards committee, chaired by George Thomas of Contemporary Controls, implemented the creation and internal ATA approval of a revised standard, ATA 878.1-1999. To achieve approval of the revision as a national standard, the standards committee is following the step-by-step due process established by ANSI to verify that consensus on the standard is obtained from users, producers and others who are directly and materially affected by the standard. The actions listed below will give you an idea of the effort required to bring the 878.1 revision process to its current canvass letter/ballot stage.

- **Announcement of the proposed revision in the ANSI publication, Standards Action.**
- **A pre-canvass interest survey by ATA of potential participants in a letter/ballot on the submission of ATA 878.1-1999 as a national standard.**
- **Submission to ANSI of the proposed canvass list resulting from the pre-canvass interest survey.**
- **Intent to canvass announcement in Standards Action, for the purpose of eliciting additions to the canvass list.**
- **Submission of the draft standard to ANSI to initiate a public review.**
- **Publication of a call for comment announcement in Standards Action.**
- **A canvass letter/ballot conducted by ATA. Each participant has 90 days in which to cast a ballot of approval, objection or abstention on the submission of ATA 878.1-1999 as an American National Standard.**

For more information about ANSI and to download ANSI procedures, visit <http://web.ansi.org>. To learn more about the ATA or to order ATA 878.1-1999, visit [www.arcnet.com](http://www.arcnet.com).

—Shirley Stein

## REVISIONS TO ANSI/ATA 878.1

**Fiber Optics, EIA-485 and alternate data rates are added to the ARCNET standard.**

### INTRODUCTION

The ARCNET technology, which is described in ANSI/ATA 878.1, became an ANSI standard in 1992. Since the introduction of the standard, integrated circuit technology had advanced allowing the use of alternate physical layers and alternate communication data rates. This practice needed to be referenced into the standard to ensure users of the 878.1 technology interoperability among competing 878.1 products.

The board of directors of the ARCNET Trade Association has accepted the recommendation of its standards committee to adopt ATA 878.1-1999 as a revision to ANSI/ATA 878.1. The next step in the approval process is to submit the ATA standard for approval as an American National Standard. This is scheduled for completion by the end of summer.

The standards committee felt that the following topics needed inclusion in the 878.1 standard.

1. *Add fiber optic physical layer, which was intentionally omitted in the original standard.*
2. *Add EIA-485 functionality as an alternate physical layer.*
3. *Address the use of the technology beyond the original stated data rate of 2.5Mbps.*

The original ANSI/ATA 878.1 standard defines operation only at 2.5Mbps; however, operation at differing data rates is possible by simply scaling the timers used to implement the protocol. The standards committee wanted this flexibility of the protocol to be recognized in the standard without adding undue complexity. Therefore, the practice of characterizing only 2.5Mbps operation was retained in the standard but guidance was provided in the appendix for operating the protocol at differing data rates.

### 878.1 PROTOCOL

The 878.1 technology incorporates a token-passing protocol where stations can only access the network when they receive the token. A total of 255 stations can occupy one network with packet transmission limited to just 507 bytes.

The 878.1 protocol is described as an Operational Finite-State Machine in chapter 4 of ATA 878.1-1999 with a series of state transition diagrams. Descriptions of each of the possible states accompany the diagrams. Definitions for the various timers referenced in the diagrams are found in chapter 3. It is these timers that are of the most interest

to the standards committee. By simply scaling these timers and without modifying the state machine, operation at data rates other than 2.5Mbps is possible.

## ALTERNATE DATA RATES

The standard was originally written to allow for a range of timer implementations of the 878.1 protocol besides the traditional implementation that was in effect before the standard was written. Some timer value ranges in the 1992 standard did not cover actual timer results from the traditional implementation so they were corrected in this revision. To assist in operating the protocol at data rates other than 2.5Mbps, timer equations were included in the appendix to allow for scaling. The simple scaling of the timers without modifying the basic 878.1 protocol was felt by the standards committee to be in compliance with the standard as long as its characteristics and limitations were noted. By publishing a set of compliant timer equations, characterization of operation at differing data rates is assured.

A set of compliant timer equations was published in the appendix and not in the standard itself. The appendix is not considered part of the standard instead being titled "Recommended Practice." It should be noted that the timer equations listed do not represent the only possible implementation of 878.1; however, they do represent a valid representation and are useful in predicting performance at alternate data rates.

## TIMERS

The timers defined below are used at each station to control various operational characteristics of the network. Several of these timer

values are fixed, while several others are variable, and must be set to equal values at all stations on the network. The variable timer values are referred to in terms of "extended timeouts." Support for extended timeouts remains optional, but if supported all extended timeout values must be selectable. There are four extended timeout values (0, 1, 2 and 3). The default value is 0.

The above paragraph is strictly true for a single speed network and the standard only publishes timer value ranges for operation at 2.5Mbps—the original ARCNET data rate. For data rates other than 2.5Mbps, a new variable (T) must be introduced to reflect the period of the data rate used.

## TIMER EQUATION VARIABLES

In order to understand the equations, it is necessary to define variables M and T.

**M=1** when timeout level is 0 (the default level)

**M=4** when timeout level is 1

**M=8** when timeout level is 2

**M=16** when timeout level is 3

**T=0.1ms** when data rate is 10Mbps

**T=0.2ms** when data rate is 5Mbps

**T=0.4ms** when data rate is 2.5Mbps

**T=0.8ms** when data rate is 1.25Mbps

**T=1.6ms** when data rate is 625kbps

**T=3.2ms** when data rate is 312.5kbps

**T=6.4ms** when data rate is 156.25kbps

## TIMER EVALUATIONS

The following timers are used by the 878.1 protocol.

### Timer, Lost Token (TLT)

Each station has a timer TLT to

recover from error conditions related to non-receipt of the token. Timer TLT is reset each time the station receives the token, and is used to initiate network reconfiguration in cases where a timeout occurs before the next token reception. This timer is usually referred to as the RECON timer.

**TLT=2,100,000\*T; If M=1**

**TLT=4,200,000\*T; If M=4, 8 or 16**

### Timer, Identifier Precedence (TIP)

Timer TIP provides time separation for initiation of network reconfiguration activity based upon the station address. The station address (ID) can have a value between 1 and 255. The value of TIP is determined according to the following equation:

**TIP={(8+357\*M)\*(255-ID)+6}\*T**

Notice that the station with the highest address times out first and, therefore, begins the actual reconfiguration of the network by commencing token passing.

### Timer, Activity Timeout (TAC)

Each station has a timer TAC which is used to control the minimum period of time which the station will wait for media activity before assuming that such activity will not occur and commencing with network reconfiguration activity. If TAC times out, then no network activity is occurring, which means that network reconfiguration is required to regenerate the token loop. This timer is usually referred to as the "idle timeout."

**TAC=(10.5+195\*M)\*T**

### Timer, Response Timeout (TRP)

Timer TRP is used to control the minimum period of time which the station will wait for a response of a transmitted ITT, FBE, or PAC frame,

before assuming that such response will not occur. A response timeout could mean that the destination station does not exist or the received packet had an error.

$$\text{TRP}=(12.5+174*M)*T$$

#### **Timer, Recovery Time (TRC)**

Each station has a timer TRC to provide time separation between the end of a response timeout and the start of a token pass.

$$\text{TRC}=8.5*T$$

#### **Timer, Line Turnaround (TTA)**

Each station has a timer TTA to control the minimum interval between the end of a received transmission and the start of a transmitted response.

$$\text{TTA}=31.5*T$$

#### **Timer, Medium Quiescent (TMQ)**

Timer TMQ controls the sampling interval used to determine if a transmission is taking place on the medium. The lack of any detected one-bits during a TMQ period indicates a quiescent condition.

$$\text{TMQ}=8*T$$

#### **Timer, Receiver Blanking (TRB)**

Timer TRB controls the interval after the end of transmission from a station to the time valid network activity can be received. During the interval the station's receiver is blanked inhibiting receipt of its own transmissions.

$$\text{TRB}=15*T$$

#### **Timer, Broadcast Delay (TBR)**

Each station has a timer TBR to control the minimum interval between the end of a broadcast transmission and the start of a token pass. This timer need not change as a function of timeout level; however, 878.1

implementations prior to this standard did in fact increase TBR with increasing timeout levels.

This fact was not documented in the 1992 version of the standard.

$$\text{TBR}=(9+30*M)*T$$

## **USING THE TIMERS**

Knowledge of the timer equations is necessary in order to predict performance at data rates besides 2.5Mbps. For example, in order to define the maximum network diameter allowed, knowledge of TRP (response timeout) and TTA (line turnaround) is required. Node A initiating a message to node B assumes that the response to the inquiry will occur within the TRP time of 74.6ms (at 2.5Mbps). Since the TTA time is 12.6ms (at 2.5Mbps) only 62ms are allowed for the propagation of the message down the medium and back, yielding the 31ms maximum one way delay commonly found in traditional ARCNET literature. Maximum delay calculations can be similarly derived for differing data rates by using the same equations but substituting for the period (T) with the desired data rate.

## **FIBER OPTICS**

A fiber optics section was developed in chapter 8 of the standard with both single mode and multimode (62.5/125mm) fiber optics being characterized. Although traditional practice was to specify 6000 ft. fiber segments for multimode fiber, the committee felt that the 10BASE-F specification of 2km was a better limit. The maximum cable attenuation figure of 3.75 dB/km was taken from the TIA/EIA-568-A Commercial Building Telecommunications Cabling Standard. These actions aligned the 878.1 standard with commercial practice.

Both the SMA and ST connectors were recognized with allowances for other connector styles without

introducing non-compliance to the standard. Transmit and receive signal levels were verified in the laboratory. An important issue was signal encoding using fiber optics. Traditionally, either P1 or P2 (normally used to create the logic "1" dipulse) were used to drive the fiber optic transmitter. The specification was expanded to include backplane mode operation where the logical AND of P1P2 could be used as well.

## **EIA-485**

Newer ARCNET controllers provide a control line called TxEN to enable EIA-485 transmitters in a multipoint system. The committee wanted to embrace the TIA/EIA-485-A standard as an alternate physical layer but found it not an all-encompassing standard. Therefore, the committee clarified issues such as termination, fail-safe bias, cabling and connectors.

Information was taken from several commercial application notes and publication TSB89 which provided guidelines on the use of EIA-485. Other sources of information were the Profibus standard DIN 19245 and the practices manual published by the European-based ARCNET User's Group (AUG). Again the objective of the committee was to align the 878.1 standard to industry practice without added undue restrictions.

## **SUMMARY**

The ANSI/ATA 878.1 standard has served the industry well since 1992 when there were 2 million ARCNET chips in existence, but the technology has improved over the years. The new standard ATA 878.1-1999 now provides the necessary guidance for users of the technology, which now totals 8 million chips.

## TIMER VALUES FOR VARIOUS DATA RATES

	TOL*	10Mbps	5Mbps	2.5Mbps	1.25Mbps	625kbps	312.5kbps	156.25kbps
<b>TLT</b>	0	210,000	420,000	840,000	1,680,000	3,360,000	6,720,000	13,440,000
	1	420,000	840,000	1,680,000	3,360,000	6,720,000	13,440,000	26,880,000
	2	420,000	840,000	1,680,000	3,360,000	6,720,000	13,440,000	26,880,000
	3	420,000	840,000	1,680,000	3,360,000	6,720,000	13,440,000	26,880,000
<b>TIP</b>	0	9,308.1–36.5*ID	18,616.2–73*ID	37,232.4–146*ID	74,464.8–292*ID	148,929.6–584*ID	297,859.2–1,168*ID	595,718.4–2,336*ID
	1	36,618.6–143.6*ID	73,237.2–287.2*ID	146,474.4–574.4*ID	292,948.8–1,148.8*ID	585,897.6–2,297.6*ID	1,171,795.2–4,595.2*ID	2,343,590.4–9,190.4*ID
	2	73,032.6–286.4*ID	146,065.2–572.8*ID	292,130.4–1,145.6*ID	584,260.8–2,291.2*ID	1,168,521.6–4,582.4*ID	2,337,043.2–9,164.8*ID	4,674,086.4–18,329.6*ID
	3	145,860.6–572*ID	291,721.2–1,144*ID	583,442.4–2,288*ID	1,166,884.8–4,576*ID	2,333,769.6–9,152*ID	4,667,539.2–18,304*ID	9,335,078.4–36,608*ID
<b>TAC</b>	0	20.55	41.1	82.2	164.4	328.8	657.6	1,315.2
	1	79.05	158.1	316.2	632.4	1,264.8	2,529.6	5,059.2
	2	157.05	314.1	628.2	1,256.4	2,512.8	5,025.6	10,051.2
	3	313.05	626.1	1,252.2	2,504.4	5,008.8	10,017.6	20,035.2
<b>TRP</b>	0	18.65	37.3	74.6	149.2	298.4	596.8	1,193.6
	1	70.85	141.7	283.4	566.8	1,133.6	2,267.2	4,534.4
	2	140.45	280.9	561.8	1,123.6	2,247.2	4,494.4	8,988.8
	3	279.65	559.3	1,118.6	2,237.2	4,474.4	8,948.8	17,897.6
<b>TRC</b>	0	0.85	1.7	3.4	6.8	13.6	27.2	54.4
	1	0.85	1.7	3.4	6.8	13.6	27.2	54.4
	2	0.85	1.7	3.4	6.8	13.6	27.2	54.4
	3	0.85	1.7	3.4	6.8	13.6	27.2	54.4
<b>TTA</b>	0	3.15	6.3	12.6	25.2	50.4	100.8	201.6
	1	3.15	6.3	12.6	25.2	50.4	100.8	201.6
	2	3.15	6.3	12.6	25.2	50.4	100.8	201.6
	3	3.15	6.3	12.6	25.2	50.4	100.8	201.6
<b>TMQ</b>	0	0.8	1.6	3.2	6.4	12.8	25.6	51.2
	1	0.8	1.6	3.2	6.4	12.8	25.6	51.2
	2	0.8	1.6	3.2	6.4	12.8	25.6	51.2
	3	0.8	1.6	3.2	6.4	12.8	25.6	51.2
<b>TRB</b>	0	1.5	3	6	12	24	48	96
	1	1.5	3	6	12	24	48	96
	2	1.5	3	6	12	24	48	96
	3	1.5	3	6	12	24	48	96
<b>TBR</b>	0	3.9	7.8	15.6	31.2	62.4	124.8	249.6
	1	12.9	25.8	51.6	103.2	206.4	412.8	825.6
	2	24.9	49.8	99.6	199.2	398.4	796.8	1,593.6
	3	48.9	97.8	195.6	391.2	782.4	1,564.8	3,129.6

TOL\*—Timeout Level

The above timer values were derived from the timer equations mentioned in the text. Descriptions for the various times can also be found in the text. Note that the above times are for the published timer equations and not necessarily the only values that will comply with the 878.1 standard. Copies of 878.1-1999 can be purchased from the ATA office.

[www.arcnet.com](http://www.arcnet.com)

**CONTEMPORARY** CONTROLS

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