S800Base-T Auto-Negotiation

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Outline

• Purpose of Auto-Negotiation

• How does Auto-Negotiation Work

• S800Base-T Auto-Negotiation Scenarios

• Relevant Ethernet Standards that need to be Modified

• Technical Proposal

• Summary
Auto-Negotiation Goals

• Enable automatic connection between two auto-negotiating devices at the best possible speed and duplex that they both posses

• Automatically configure technology and speed to match a legacy link partner’s capabilities even though it may not support auto-negotiation

• Allow communication of additional link level information like flow control support
Auto-Negotiation in a Nutshell

• Works between two devices on a link segment

• Exchanges and Acknowledges 16-bit data words using variation of 10Base-T Link Pulse signaling

• Data words contain information about a device’s supported capabilities

• The best common technology is automatically selected and enabled

• A-N ends once the chosen technology is enabled and stays out of the way until the link status changes
S800Base-T Auto-Negotiation Scenarios: Key to Diagrams

Device A

Capabilities
S800
1000FD
1000HD
100FD
100HD
10FD
10HD

Device B

Capabilities
S800
1000FD
1000HD
100FD
100HD
10FD
10HD

Link Segment

Local Device

Link Partner

Advertised Device Capabilities

Signals Transmitted from each device
Terminology

• **Auto-Negotiation** (A-N) is a process that occurs prior to enabling a specific communication technology that determines the **Highest Common Denominator** (HCD) technology between two devices on a **Link Segment**. Auto-Negotiation hands off to the HCD technology when it is finished and stays out of the way until the [Receive] **Link Status** goes down.

• A-N Advertises the **Capabilities** of the **Local Device** (ex. Device A) it is running on to it’s **Link Partner** (ex. Device B). The Link Partner does the same thing.

• A-N uses a sequence of 10Base-T **Link Pulses** called **Fast Link Pulses** (FLPs) to communicate a device’s capabilities.

• 17 to 33 FLPs are sent in a **FLP Burst** to convey 16 bits of encoded data.
• One *Base Page* of data is always sent. Additional *Next Pages* conveying additional device capabilities may also be exchanged.

• *Legacy Devices* do not implement A-N. They must be configured into a single mode of operation with a jumper or software.

• A-N uses *Parallel Detection* to attempt to identify Legacy Devices by examining the default signals sent out at link startup.
Scenarios Overview

- The following Auto-Negotiation connection scenarios have all been evaluated:
  - 100Base-T A-N to 100Base-T A-N
  - 1000Base-T A-N to 1000Base-T A-N
  - S800Base-T Aware (GE) to S800Base-T Aware (GE)
  - S800Base-T Aware (1394) to S800Base-T Aware (1394)
  - S800Base-T Aware (All) to S800Base-T Aware (All)
  - S800Base-T Aware to Clause 40 Auto-Negotiation
  - S800Base-T Aware to Clause 28 Auto-Negotiation
  - S800Base-T Aware to Legacy 10Mb or 100Mb
  - S800Base-T Aware to Legacy 1394
100Base-T A-N to 100Base-T A-N

Here is an easy Auto-Negotiation scenario to warm up on!

Both devices send out FLP Bursts advertising their capabilities

Auto-Negotiation completes successfully and enables the HCD technology – 100Base-T Full Duplex
1000Base-T A-N to 1000Base-T A-N

- Same behavior as 100 A-N to 100 A-N except
  - 1000Base-T Full Duplex is the HCD
  - Negotiation requires multiple Next Pages to be exchanged in addition to the Base Page

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<tr>
<th>Capabilities</th>
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</table>
S800Base-T Aware (GE) to S800Base-T Aware (GE)

- Both devices send out FLP Bursts advertising their capabilities

- Auto-Negotiation completes successfully and enables the HCD technology – 1000Base-T Full Duplex
Both devices send out FLP Bursts advertising their capabilities.

Auto-Negotiation completes successfully and enables the HCD technology – S800Base-T

Once enabled, S800Base-T can speed select to 400 or 800 Mb/s
Both devices send out FLP Bursts advertising their capabilities

Auto-Negotiation completes successfully and enables the HCD technology – S800Base-T

Once enabled, S800Base-T can speed select to 400 or 800 Mb/s
S800Base-T Aware to Legacy 10Mb or 100Mb

The S800Base-T device sends out FLP Bursts advertising its capabilities.

The Legacy device sends out its native signaling – Scrambled Idle Line State.

The Auto-Negotiating device Parallel Detects the Scrambled ILS and enables 100Base-T Half Duplex, completing successfully.

NOTE: The addition of S800Base-T does not change the one weakness of A-N, in that it still cannot Parallel Detect a Full Duplex legacy device.
S800Base-T Aware to Legacy 1394

• Define Legacy 1394
  – 1394a vs 1394b
    • Currently using keyed Plugs and Sockets to determine compatibility
      – Bilingual socket can connect to
        » 1394a 4 or 6 pin with Bilingual Plug
        » 1394b with Beta or Bilingual Plug
      – Beta socket can connect to
        » 1394b Beta Plug only, no 1394a support
    – S800Base-T
      • All S800Base-T devices will support Auto-Negotiation and will use an RJ-45 jack
Relevant Ethernet Standards

- **802.3**
  - Clause 28 – Basic Auto-Negotiation
  - Annex 28A – Selector Field Definitions
  - Annex 28B – 802.3 Selector Base Page Definition
    - Also Priority Resolution
  - Annex 28C – Next Page Message Code Field definitions
    - 1000Base-T Next Pages
      - 1xMC(=8) + 2xUP
  - Annex 28D – Description of Extensions to Clause 28 and associated annexes
    - Clause 40 Extensions
  - Clause 40.5
  - Annex 40C – Add-on interface for additional Next Pages
Possible Approaches

• Bits in 802.3 Base Page
  – Only 1 bit left

• 1394 Selector Field
  – Harder to do 1394 to Ethernet interoperability
    • Existing auto-negotiating devices will ignore these pages

• Add to Gigabit Ethernet Next Page (MC=8)
  – 6 bits leftover in 1st Unformatted Page

• Generic Next Page mechanism (MC=9)
  – Same way Gigabit Ethernet was done
Technical Proposal

• Use the Next Page Mechanism in Auto-Negotiation
  – MC = 9
  – UP = 1 or 2 pages

• This gives us an approach that is completely separate from existing Auto-Negotiation standardization of other technologies
  – Achieve interoperability
  – Probably easier to work through IEEE committee
NO CHANGE

D15 = 1 to indicate that Next Pages Follow

D14:D1 = As specified in 28.2.1.2
- These bits cover 10Base-T and 100Base-TX capabilities and provide the mechanisms needed for base page exchange
Next Page 1 – Message Code

• NEW MESSAGE CODE

• M10:M0 = 9
  – Means S800Base-T 1394 over Gigabit Ethernet negotiation
  – Specifies how many next pages in this sequence
    • 1xMC + 2xUP
NP 2 – First UP – New Capabilities

• U10:U4 = Reserved for future use – Transmit as 0

• U5 = S800Base-T Capable

• U4 = 1000Base-T Half Duplex

• U3 = 1000Base-T Full Duplex

• U2 = 1000Base-T Port Type
  – 1=multi-port, 0=single-port device

• U1 = 1000Base-T Master-Slave Manual Configuration value
  – 1=Master, 2=Slave

• U0 = 1000Base-T Master-Slave Manual Configuration enable
  – 1=Manual Configuration Enable
• Keep if use GE pages

• Otherwise we can eliminate
Priority Resolution Table 28B.3

- Insert 1394 S800 at top of table due to Isochronous capabilities at nearly the same speed

- New Table
  - S800Base-T
  - 1000Base-T full duplex
  - 1000Base-T half duplex
  - 100Base-T2 full duplex
  - 100Base-TX full duplex
  - 100Base-T2 half duplex
  - 100Base-T4 half duplex
  - 100Base-TX half duplex
  - 10Base-T full duplex
  - 10Base-T half duplex
Summary

• Implementing Auto-Negotiation for S800Base-T will allow easy interoperability with 1000Base-T and slower Ethernet devices

• There are no technical hurdles to implementing Auto-Negotiation for S800Base-T

• The IEEE standards possibilities are well understood

• All that remains is to prepare a new draft standard and work with the IEEE committee to get it approved