Introduction to mLAN

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Target Market

Music Creation
From beginner to professional

Sound Installation
A THICK PIPE

IEEE 1394 Cable Conceptual Diagram

- Approximately 100 conventional cables
- 256 MIDI cables
- Other cables (digital video signals, etc.)
What is a 1394?
1394 Bus Specifications

- Serial (not parallel) bus
- Cable and backplane bus
- Automatic assignment of bus topology, ID
  - startup
  - hot-plug
- Unified address space:
  - 10 bits per bus
  - 6 bits for node ID
  - 48 bits for memory inside node
Topology

Daisy Chain
5 nodes – 4 hops

Star
11 nodes – 4 hops
1394 Cable Lengths, Speeds

- Copper – 4.5 meters / 400 Mbps
  - Oki – 20 meters/s400 40 Meters/s200
  - two twisted pair (optional: two power wires)
  - 1394-1995: up to 16 hops, each 4.5 m, = 72 m

- Cat5 – 100 m / S100 (100 Mbps)

- 1394-800 on Cat5 (currently under study)

- POF – 50 m / S100, S200

- HPCF – 100 m / S100, S200

- GOF – 500 m / S400, S800, S1600 (S3200)
Variants of IEEE 1394

- i.Link, FireWire
- IEEE 1394-1995
- IEEE 1394a-2000
- IEEE 1394b
- 1394.1
1394 Architecture

- Serial Bus Management
- Control and Status Registers (CSR)
- Bus packets consist of quadlets (32-bit)
Data transfer

◆ Variable length packets
◆ Asynchronous
  ➢ deliver to explicit address
  ➢ acknowledgment (if not broadcast)
◆ Isochronous (means real time!)
  ➢ broadcast packet delivery
  ➢ variable-length packets
  ➢ regular transfer intervals
  ➢ Automatic cycle manager selection
Cycle Structure

125 µsec

Isochronous

Asynchronous

After IEEE 1394-1995 Fig 3-16
Isochronous Packet

<table>
<thead>
<tr>
<th>Isochronous packet header</th>
</tr>
</thead>
<tbody>
<tr>
<td>Header CRC</td>
</tr>
<tr>
<td>Data</td>
</tr>
<tr>
<td>Data CRC</td>
</tr>
</tbody>
</table>
1394 Device Architecture

1394 Bus

PHY

LINK

Other h/w; UI ...

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Structural elements of mLAN
Specifications

- YAMAHA
- 1394TA
- IEC61883 family

IEEE1394

- TRANSACTION
- LINK  Asynchronous  Isochronous
- PHY
Specifications

- IEC (FDIS) 61883-6
  (1394 TA: Audio/Music Protocol)
- IEC 61883-2 to -5

IEC 61883 family

- IEC 61883-1: Isochronous
- IEC 61883-2 to -5

IEEE 1394 family

- IEEE 1394
  - 1394TA
  - 61883

Specifications:
- YAMAHA
- 1394TA
- IEC 61883-1
- Isochronous
- Audio & Music
- PCR
- FCP
- CIP
- DV
- MPEG
- Enhancement
- AVR / C
- AV / C
- MPEG
- Audio & Music
- Isochronous
## CIP PACKET

<table>
<thead>
<tr>
<th>Isochronous packet header</th>
</tr>
</thead>
<tbody>
<tr>
<td>Header CRC</td>
</tr>
<tr>
<td>CIP header</td>
</tr>
<tr>
<td>Data block 0</td>
</tr>
<tr>
<td>...</td>
</tr>
<tr>
<td>Data block n-1</td>
</tr>
<tr>
<td>Data CRC</td>
</tr>
</tbody>
</table>
IEC61883-6 Quadlet (32-bit) Formats

Raw audio (AM824)

0 1 0 0 0 0 VBL

24 bit sample word

IEC60958 ("AES/EBU") conformant (AM824)

0 0 0 0 P C U V

24 bit sample word (from second sub-frame)

Thanks to Richard Foss
IEC61883-6 MIDI Format

MIDI conformant - format for MIDI data (AM824)

| 1 0 0 0 0 0 | C | Byte 1 | Byte 2 | Byte 3 |

+ 

MMA RP-027

Thanks to Richard Foss
Protocol
61883-6 streaming layer overview

◆ Transmitting
  ➢ Creating a packet from n samples
  ➢ Provide time stamp at specified interval
  ➢ Enough samples arrived to make a packet?

◆ Receiving
  ➢ Reassemble a stream
  ➢ Playback so the sample is rendered as the associated time stamp indicates.
Protocol

Streaming layer overview

Example

Single isochronous channel

Audio

Seq. A

Seq. B

MIDI

Seq. C

Seq. D
Protocol

Streaming layer overview

Audio data or MIDI over 1394

Playback timing
Protocol

Streaming layer overview – audio streaming

Transmission

Cycle time

Sample count progress..

1 2 3 4

5 6 7 8

Time stamps are provided for every certain number of samples. Time stamp should represent render-time not the time of transmission.
Protocol

Streaming layer overview – audio streaming

Rendering

Implementation example

Jitter reduction circuit → Audio clock → DA

1394 bus clock

1 2 3 4 5 6 7 8
1394 Audio/MIDI Device

- Protocol engine: Generate/parse CIP; Synchronization (PLL); FIFOs, etc.
- Other h/w; UI
- Audio
- MIDI
Specifications

YAMAHA

1394TA

IEC61883 family

IEEE1394

AV/C

AV/C - Audio/Visual Control (consumer)

- AV/C specification defines AV/C Subunit

- AV/C Subunit: A logical unit that can be accessed by application software on the Mac/PC for example
Specifications

- mLAN Node Control Package
  - mLAN-specific functions
- MMA RP-027

- YAMAHA
- IEEE1394
- IEC61883 family

- Complies with MMA RP-027
- Powerful word clock master management
- Sophisticated distributed connection control

And more...
Connection Management

Thanks to Richard Foss
mLAN Connection Management
- in rehearsal studio -

MIDI

Audio
mLAN Connection Management
- on stage -
mLAN Device Architecture (2)

Connection management; Clock management; Generate/parse CIP; Synchronization (with PLL); FIFOs, etc.

Other h/w; UI

Audio
MIDI
NC-1
NC1/PH2 Combination

1394 Bus

PHY

NC1

Parallel I/O
Serial I/O
Serial Control

Other h/w;
UI

Audio up to 8in/8out
MIDI up to 8in/8out

Audio 32in/32out @48kHz
Audio 32in/32out @48kHz
Audio 32in/32out @48kHz
Audio 32in/32out @48kHz
Audio 32in/32out @48kHz
Audio 32in/32out @48kHz
Ongoing Development
63 Node Demonstration
Demonstration 2002/2

Stage right

Stage left

Amp room

Audience area

Dressing room

Control room

Tour equipment

Staff room
Control Room

Amp Room West

400m

Amp Room East

70m

Glass Fiber on NEC Long Haul Repeaters

Pro Player Stadium, Miami
Florida

mLAN Long Haul Install

400 meters – 70 meters
Example installation (YAMAHA Hall)

Control Room

Hall

Amp Room

Announce Booth

Projection Room

Location: Ginza Tokyo Japan
Seats: 524
Volume: 1,733 m³
Architect: RAYMOND Architectural Design Office, INC.
mLAN for a Key TV Station

8F | OTARI ND-20 | MM Fiber
---|-------------|-------------
7F |             |             
6F |             |             
5F |             |             
4F |             |             
3F |             |             
2F |             |             
1F |             |             
B1F|             |             
B2F|             |             

Fixed Area

Optical Hub

Optical Patch Bay

Optical Jack

Bridge

Carry In Area
Other Facilities

• Redondo Beach Performing Arts Center
• Latter Day Saints Conference Center
• Queen Mary II
Products
Yamaha mLAN8P
Yamaha mLAN8e
Yamaha A4000, A5000
Yamaha S80 – S90
Yamaha CD8-mLAN

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Yamaha 02R
Yamaha O1X
PreSonus Firestation
Otari ND20
Kurzweil KSP8
mLAN information

◆ www.global.yamaha.com/index.html
  ➢ click on products, then follow mLAN links

◆ www.1394ta.org

◆ www.iec.ch

◆ www.midi.org

◆ www.mlan-alliance.com (coming soon)

◆ www.mLANCentral.com