Walt Disney Imagineering

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Walt Disney Imagineering

Non-traditional Ethernet Applications at Disney Theme Parks

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Walt Disney Imagineering
subtitled

Ohmygosh!
You can’t do that
with Ethernet!

Current Projects
Building The Parkwide Dream

Tokyo DisneySea
Disney’s California Adventure
Disney Studios at Disneyland Paris
Obtaining the Perfect TLA

Three Letter Acronyms

Design Requirements Specification
Section 1.3
ABBREVIATIONS AND ACRONYMS

- **ASC** Area Show Control System (outdoor areas)
- **ATM** Asynchronous Transfer Mode: High speed packet data communications standard that provides a scalable backbone network offering a variety of classes of service quality
- **CAC** Central Audio Console (for Parkwide Audio System)
- **CCF** Central Communications Facility in TDL also referred to as the Old CCF.
- **CEP** The Central Energy Plant
- **CLC** Central Lighting Console (for Parkwide Lighting System)
- **CMC** Central Message Console (for Central Show/Ride Message System)
- **CNS** The Central Network Station which is the Show and Ride Operations and Maintenance base for the TDS theme park.
- **CSM** Central Show/Ride Message system
- **CWC** Central Weather/Seismic Monitor Console
- **DRS** Design Requirements Specification
- ECB Entertainment Control Booth
- EER Electronic Equipment Room
- EMS Energy Management System
- GbE Gigabit Ethernet, High speed data communications standard that provides a scaleable backbone network.
- Hot swap Equipment and software designed specifically to allow plug-in modules to be removed and replaced while the remainder of the system is operating normally with power turned on.
- MIS Maihama Information Services: The Local Area Network used by the NTIS.
- NMS Network Management System: A computer programmed to configure, control, monitor, and troubleshoot the PIC Network from a remote location.
- NTIS New Total Information System: OLC’s new Information Services system which includes the MIS Network
- OMC Operations Master Console: Monitors all Show/Ride Parkwide Systems, interfaces to EMS and keeps park calendar/clock.
- PAS Parkwide Audio System: The system that sources and controls all outdoor and restaurant Background Music and Area Public Address, and monitors all parkwide audio and attraction audio including PES audio.

- PES Parkwide Entertainment System: The system that controls the Parade and Nighttime Spectacular events including audio, lighting and show control elements. The system central is called the ECB and is located on the 5th floor of the Hotel.
- PIC Parkwide Integrated Communications Network: Data communications network used by all show/ride systems including PAS, PLS, PES, CSM, ACS and OMC.
- PLS Parkwide Lighting System: The system that controls all on-stage lighting and monitors all attraction and show lighting in TDS except lighting dedicated to the PES.
- OMC Operations Master Console: Central workstation which keeps the park operating clock and calendar; and provides the ability to select Show/Ride system presets that support Live Entertainment, special events and operational changes.
- QoS Quality of Service: The various classes of service required by network users. There are QoS levels that provide constant bit rate service for audio and SMPTE shows, and available bit rate service for less critical uses such as status monitoring.
- SMPTE Society of Motion Picture Engineers: Thirty frames per second control used for animation and interactive control applications.
- TDS Tokyo DisneySea
- VLAN Virtual Local Area Network: A logical, not physical, dedicated LAN circuit provided by the PIC Network that is compliant with all applicable ATM Forum specifications including LAN Emulation and Quality of Service levels.
- WDI Walt Disney Imagineering
- WMS Parkwide Weather/Seismic Monitor System
This Presentation

- Walt Disney Imagineering
- The Projects
- Ethernet Networking at Disney
- Ethernet Networks for Theme Parks

WDI - Walt Disney Imagineering

Part of Walt Disney Attractions

In Top 5 A&FE Firms in US

Theme Park, Resort & Real Estate Development

- Concept
- Business Plan - Life Cycle Cost
- Design
- Construction
- Testing & Commissioning
- Training
- On-going QA
WDI Theme Park Projects

1955  Disneyland
1971  Magic Kingdom WDW
1982  EPCOT WDW
1983  Tokyo Disneyland
1989  Disney-MGM Studios WDW
1992  Disneyland Paris

Ethernet in the Design
1998  Disney’s Animal Kingdom WDW
2001  Disney California Adventure
2001  Tokyo DisneySea
2002  Disney Studios at Disneyland Paris
2005  Hong Kong Disneyland

WDI Resort Projects

1955 - 1996  Disneyland - 2 Hotels
1971 - 1999  WDW - 19 Hotels
1971 - 1999  WDW - 3 Water Parks
1971 - 1999  Downtown Disney at WDW
1992  Disneyland Paris - 6 Hotels

Ethernet in the Design
1998 - 1999  Disney Cruise Line - 2 Ships
2001  Disneyland Resort - Grand Californian
2001  Downtown Disney at Disneyland Resort
2001  Hotel MiraCosta at Tokyo DisneySea
Elements of a Major Project

All Project Elements are Inter-related

- Guest and Cast Access
- Permits and Land Use Plan
- Site and Area Development
- Facilities
- Shows and Rides
- Live Entertainment

Ethernet Networking at WDI

- Design & Development
  * CAD
  * CAM
  * Modeling
  * Management
  * Administration

- Attraction Systems
  * Show Control - Real Time
  * Show Audio - Real Time

- Distributed - Parkwide Systems
  * Information Services
  * Show/Audio/Lighting - Real Time
Parkwide Systems Scope

Shared Electronic Infrastructure (Campus-level Systems)

- Information Services
- Facility Management
- Phones
- Broadcast & Production
- Show/Ride & Entertainment

Parkwide Systems

IS
- Office Automation
- Point of Sale - Food, Shops, Tickets
- Dining Reservations
- Employee Time Clock
- IS Network

Facility
- Energy Management
- Fire/Security
- Irrigation
- Walkie-Talkie

Phones
- PBX (park)
- Pay
- Cell
TDS Parkwide Systems

Broadcast
- TV Remotes
- Radio Remotes
- Video/Film Production

Show & Ride
- Background Music
- Public Address
- Area Lighting
- S/R Message
- Area Show
- Atmosphere Show
- Closing Show
- PIC Network

Parkwide Integrated Communications

Systems Design

Network Ready
Ethernet

IS
- Office Automation
- Point of Sale - Food, Shops, Tickets
- Dining Reservations
- Employee Time Clock
- IS Network

Facility
- Energy Management
- Fire/Security
- Irrigation
- Walkie-Talkie

Phones
- PBX (park)
- Pay
- Cell

Broadcast
- TV Remotes
- Radio Remotes
- Video/Film Production

Show/Ride
- Background Music
- Public Address
- Area Lighting
- S/R Message
- Area Show
- Atmosphere Show
- Closing Show
- PIC Network
**Parkwide Audio System**

- Central Configuration and Maintenance Console
- Central Sources & Signal Distribution
- Facility Amplifiers and Speakers

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**Parkwide Lighting System**
Central Show/Ride Message System

Parkwide System Communications
Parkwide Networking

Network Topology
Control & Monitor

VLAN View

Notes:
- OMC: Operations Master Console
- CWC: Central Weather Console
- CAC: Central Audio Console
- CLC: Central Lighting Console
- CMC: Central S/R Message Console

Legend:
- Black lines: VLAN View
- Gray lines: PIC View
- Orange lines: PIC to PIC
- Blue lines: PIC to non-PIC
- Green lines: non-PIC to non-PIC
- Gray lines: non-PIC to PIC

Diagram Description:
- VLANs are used to segment the network.
- Different VLANs are used for different purposes:
  - Audio Monitor VLAN
  - Area Lighting VLAN
  - Show/Ride Mon. VLAN
  - UPS VLAN
  - PIC VLAN

Network Interfaces:
- UDP/IP (SNMP)
- TCP/UDP/IP

Network Zones:
- Park Central
- Entertainment Central
- Facility Equip. Room
- Park Central Facility Equip. Room
- CWC
- CMC
- CAC
- CLC
- UPS
- OMC
- IS Center
- Maintenance Base

Network Protocols:
- SNMP
- TCP/IP
- UDP/IP

Network Interfaces:
- Dual NIC
Parkwide Entertainment & Attraction Lighting

Lighting Control Using Ethernet

- Parkwide Area Development
- Show/Ride Attractions
- Entertainment
What is Lighting To WDI

- Ride and show areas
- Queues
- Load and unload areas
- Shops
- Restaurants
- Landscaping and area development
- Entrance plazas
- Exterior architecture
- Parades
- Theatrical Productions
- Nighttime entertainment spectaculars

“If we don’t light it, you don’t see it”
Parkwide Area Development

- Landscaping and area development
- Entrance plazas
- Exterior architecture
- Shops
- Restaurants
PLS Requirements

**Park Wide Lighting System (PLS) Requirements**

- **Non-real time system**
  - Area development lighting
  - Support Live Entertainment events
- The PLS requires two (2) 10BaseT interfaces as follows:
  - CLC Interface to Node Processors: 1 x 10 b-T control
  - OMC/CLC Interface: 1 x 100 b-T control
- **Traffic Overview**
  - Configuration from CLC to ALC
  - ALC sends status to CLC
  - TCP/IP traffic

Lighting System Detail

[Diagram of lighting system]
Theme Park Lighting Control

- Central Energy
- Park Central
- CLC Client
- Maintenance
- Satellite Maint.
- PLS VLAN covers the entire park.

Entertainment

- Parades
- Theatrical Productions
- Nighttime entertainment spectacles
PES Requirements

- Park Wide Entertainment System (PES) – Lighting
  - Real Time Control & Monitors
  - DMX to Ethernet converters
  - Industry standard DMX components
  - Ethernet Networking

- Traffic Overview
  - AppleTalk (Unicast, Broadcast)
  - VLAN covers entire park.
    - < 1 Mbps
    - Isochronous communication

PES System

- Ethernet
- DMX 512
Show/Ride Attractions

- Ride and show areas
- Queues
- Load and unload areas

Attraction Lighting System
TDS Lighting Trivia

8,510  Themed Light Fixtures
18,954  Show Light Fixtures
38   Architectural Lighting Controllers
40  Horizon Lighting Controllers
5  Whole Hog II Lighting Controllers

73,728  Channels of Control
136  Dimmer Cabinets
8,000+  Dimmers
19.2  M Watts

522  Automated Lighting Fixtures/Accessories

Parkwide Audio

Background Music
Area Public Address
Entertainment Music
What is Audio To WDI

- Ride and show areas
- On-board ride vehicles
- Queues
- Shops
- Restaurants
- Outdoor areas
- Theatrical Productions
- Nighttime entertainment spectacles

Dimensions of Audio Distribution

- 3900 Speakers
- 1200 two-channel Audio Amplifiers
- 1.6 MW output capability
- Real-time monitor of any source or output
- 30 Channels of Background Music
- 30 Channels of Entertainment Music
- 24 bit Audio @ 48K Samples/sec
  (CD is 16 bits @ 44.1K)
- < 20 milli sec. End-to-end Latency
- < 10 micro sec. Jitter
Parkwide Audio System

Actually, this is a complicated application!

Parkwide Audio Test Setup

A - B Test
Network Delay = 6.7 ms

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Parkwide Audio Performance

Excellent!

Recovered Audio Jitter < 2.5 ns
No Network Induced Rx Jitter

1 Km

CobraNet Decoder
CobraNet Encoder
Summit 48
Audio Studio

- Category 5 - 100 Base T
- Multi-mode - Gigabit
- Digital Audio AES/EBU

Theme Park Audio Control

PAS C&M VLAN covers the entire park.

Remote Programming
Programming & Control
Electronic Equipment Room

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CobraNet® Message Format

B = Beat Packet: 100 byte, Proprietary MAC Broadcast by Source, Sensitive to delay variation

A = Audio Packet bi-directional: 1340 byte, Proprietary Uni-cast
8 audio channels (24 bit @ 48K) per “A” packet
Max “A” packets = 4 = 32 Channels FDX

C = Control Packet : 100 byte, TCP/IP Unicast as required
1 pkt/sec (not transmitted every cycle)
Well! Who brought some music?

Show Programming
- Audio-Animatronic Figures
- Special Effects
- Show Lights
- Show Audio
Show Control Brainstorming

- Must be Synchronous
- Slow Speed (30 fps)
- Ethernet = Low Cost Physical Layer
  - 10 Mbit & 100 Mbit on UTP
  - Full Duplex
  - 100 Meter cabling
  - Fiber options
  - Multiple sources
  - Complete diagnostic tools
  - Network compatible

Distributed Control Networks

- Show/Ride Network - TCP/IP
  - Full compliance
  - 10 Mbit FDX

- Animation Network - UDP
  - Interface Agreement - SPC 1st FDX
  - Buffered ports
  - Fast Ethernet to Remote Hubs
  - 10 Mbit in Scenes
Animation Network

- Animation Data to Distributed I/Os
- Feedback Data from Distributed I/Os
- SMPTE Frame Rate - 30 Frames per Sec.
- Option for 24 fps
- Framing is Modulo 16 bit
- All other devices wait for SPC Tx Frames

Show Control & Monitor

[Diagram showing network connections between different devices such as Show I/O, S/R Msg, Show Control & Monitor, Entertainment Central, Facility Equip. Room, Park Central, CLC, CMC, CAC, UPS, LW, Audio Server, Weather Monitor, PW Audio, Dimmers, Area, Show, ALC, etc.]
Show Control & Monitor
**DCS Facility Network**

- **Show/Ride Network**
  - TCP/IP
  - Message Server
  - Remote Panel
  - Ride Control

- **UDP/IP**
  - Animation Network
  - SW HUB
  - SCENE 1
  - SW HUB
  - UDP/IP

- **Animation Network Timing**

  - Frame Period
    - 33 ms (30 fps)
    - 42 ms (24 fps)
Detail Animation Timing

Broadcast to I/O Boxes

SPC Max. Frame

SMC Max. Frame

Unicast from I/O Boxes

InO Tx

Scene Hub Tx to EER @ 100 Mb

Scene Hub Rx to EER @ 100 Mb

SMC Rx

Guard Band

Pushing DCS a Little Further

To Parkwide

ELECTRONIC EQUIPMENT ROOM

SW HUB

Show/Ride Network

Message Server

Show Playback

Show Monitor

Remote Panel

Ride Control

PIC Network

SCENE 1

SW HUB

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Summary

Non-Traditional Ethernet Uses
Isochronous Studio Quality Audio
Synchronous SMTP Rate Show Control
MAC, Appletalk, and IP

Traditional Ethernet Uses
Show Monitor
Ride Control
Audio Monitor & Control
Lighting Monitor & Control
Inter-discipline Communications
IP
Theme Park VLAN Overview

PIC Core - Extreme Networks
Dual Black Diamonds
TDS Parkwide Team

The End
**Lighting Hardware**

**Unison Architectural Lighting Controller (a.k.a. ALC)**
- ERW-Wall Mount Rack with four slots
- CDM (Control Module Electronic with I/O)
- Air Flow Modules

**Unison Contact Interface** (a.k.a. UCI, CIU...)
- 24 Input
- 24 Output

**Unison Gadgets**
- Preset Button Stations
- Portable Button Stations

**Tokyo DisneySea Dimmers**
- D20A F3
  - 100vAC/50Hz
  - 30 ms RCD (Residual Current Device)
  - Neutral Disconnect

**Disney Studios at Disneyland Paris Dimmers**
- D20A FN
  - 230vAC/50Hz
  - 30ms RCD (Residual Current Device)
  - Neutral Disconnect

**Disney's California Adventure Dimmers**
- D20A F
  - 120vAC/60Hz
  - 6ms GFI (Ground Fault Interrupt)

**DMX Port - Amazing Controls**

**Standard Product Specifications:**
- 3 Ports individually configurable as DMX input or DMX output.
- Each port handles an individual DMX Universe.
- Each output port can merge up to 3 Universes.
- Merging can be done by using any combination of LTP, HTP or Priority rules.
- Real Time Clock for AutoScheduling (when used as lighting controller).
- 1 MByte NOVRAM (up to 4 MByte optional).
- 230 Volts AC, 50Hz or 110 Volts AC, 60Hz versions available.
- IEEE 802.2/802.3 Ethernet compatible.
- RJ-45 connector for standard Cat. 5 cabling.
- LED indicators for each input/output port.
- 4 LED EtherNet link indicators.
- 2 LED DMXPort status indicators.
- Dimensions: 160 x 115 x 100 mm.
- CE or UL Certification.
DMX Hub - Artistic License

DMX-Hub is the first truly Plug and Play solution for DMX512 cabling and distribution in all applications needing fast and robust transmission of lighting control data.

- DMX-Hub provides the gateway to transfer DMX512 data to and from a 10BaseT Ethernet link.
- Standard Ethernet cabling and transceivers can then be used for the data distribution infrastructure.
- The Ethernet protocol is designed to allow distribution of up to 256 DMX512 Universes (a total of over 32,000 channels).
- The DMX Universes are organized as 16 Sub-nets each containing 16 Universes.
- Front panel controls allow the user to easily select the Sub-Net for each DMX-Hub and Universe for each of the four DMX512 inputs and outputs.

Major features include:
- DMX routing by Ethernet
- Connect up to 256 DMX-Hubs to one network
- 4096 channels of DMX per DMX-Hub
- Four independently Isolated DMX512 inputs
- Four DMX512 outputs
- 10BaseT Ethernet Port
- Compatible with DMX512, DMX512 (1990)
- Power indicator
- Receive data activity indicators
- Ethernet data activity indicators
- Transmit data activity indicators

DMX Node - Electronic Theater Controls

DMX Node
lighting network data distribution device

APPLICATIONS
- Road House
- Touring
- University/Professional Theatre
- Convention Hall
- Tech Tables
- Stage Managers Panels

FEATURES
- 2048 DMX In or DMX Out channels
- Configurable to over 32,000 EDMX addresses
- Distributes DMX, RFU and ETCLINK over Ethernet
- Employs ETCNet1 and ETCNet2 protocols
- Distributes DMX data to any input/output device such as dimmers, scrollers, moving lights, or RFUs
- Rack mount/Portable and Wall mount configuration
- Supports any USITT DMX512/1990 compatible console
- LED configuration indicators
- Supports 16 bit DMX values
- Power supply and mounting bracket included with rack mount and portable
Horizon LPU - Rosco-ET

Features
- Timebase per channel
- Multiple asynchronous Cue Lists
- Unlimited overlapping fades
- Active Magic Sheets TM
- Graphical user interface
- Ethernet network node
- Two DMX universes (1024 Channels)
- Time of day events
- Astronomical time clock
- Pushbutton events
- External trigger events (track triggers)
- Serial command port (RS-232/RS-485)

Options
- Complete moving light support
- SMPTE time code events
- MIDI show control events
- System wide network events

Tools of the Parkwide Lighting Designer

Field Laptop
- Windows 2000
- 200 MHz or better processor
- 128MB RAM
- CUDI Light Manager Application

Network Connectivity
- 5 port smart Ethernet hub
- Media Converter 10Base-T to 10Base-FX
- 10Base-T Patch Cords
- 10Base-T Crossover Patch Cords

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