Network Design and LON over IP

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EIA-709 / EIA-852 - Network

LOYTEC electronics GmbH
Vienna, Austria

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Argentina, Australia, Austria, Belgium, Bulgaria, Canada, China, Croatia, Denmark, Deutschland, EGYPT, Finland, France, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Lithuania, Luxemburg, Malaysia, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Russian Federation, Sierra Leone, Singapore, Slovakia, Slovenien, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, Tschechien, Turkey, United Arab Emirates, United Kingdom, United States, ………
Mission Statement

LOYTEC's mission is to provide cost effective, highly functional, user friendly, high performing network infrastructure products, debugging tools, and key technologies for control networks.
Prologue
Metcalfe’s Law

Metcalfe’s law states that the usefulness, or utility, of a network equals approximately the square of the number of users of the system.

Utility = Users\(^2\)
Integration

System Integration
IP-based communication


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Today's Building Systems

- Today's buildings require an integration of a wide range of different systems for an efficient operation

- Today's Building Management Systems require a reliable, future-proofed network infrastructure for an efficient operation
Today's Building Systems

- Today the control network is the nerve cord of a building and needs to be 100% available and easy to maintain.
Standard
Focus on standard

In The USA:
- ANSI/EIA/CEA-709 (LonWorks) and -852 (LonWorks over IP)

In Europe:
- Draft based on the 709- and 852-Standard, will be integrated into the European CNP* Standard
- Standard is scheduled for 2005 (EN14908)

* Control Network Protocol
# BMS Standards

- **European Standard for networked control systems**

<table>
<thead>
<tr>
<th>Norm</th>
<th>Name</th>
<th>Protocol</th>
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<tbody>
<tr>
<td>EN 14908</td>
<td>Control Network Protocol (CNP)</td>
<td>LonWorks</td>
</tr>
<tr>
<td>DIN EN ISO 16484-5</td>
<td>Data Communication Protocol</td>
<td>BACnet</td>
</tr>
<tr>
<td>EN 50090</td>
<td>Home and Building Electronic Systems</td>
<td>Konnex (KNX)</td>
</tr>
</tbody>
</table>
LON as a standard

- "Control Network Protocol"

<table>
<thead>
<tr>
<th>Control Network Protocol (CNP)</th>
<th>Implementation Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol Stack EN 14908-1</td>
<td></td>
</tr>
<tr>
<td>Twisted Pair EN 14908-2</td>
<td>Power Line EN 14908-3</td>
</tr>
</tbody>
</table>
Structuring Networks
Structuring Networks - Why?

- **Channel limits**
  - Maximum allowed cable length
  - Maximum number of nodes per channel
- **Reduce network traffic, keep traffic „local“**
Structuring Networks - Why?

- Increase reliability
- Advanced interference resistance

*Increase maintainability!*

(protocol analysis, channel management, …)
LON over IP
Transmission Medium

- Twisted Pair
- Power Line (PL), 230V/AC
- Fiber Optic (FIO)
- Radio Frequency (RF)
- IP Network
- etc.
LON over Twisted Pair (TP)

TP/XF-1250
1,25 Mbit/s

TP/FT-10
78 kbit/s
In 1976 Metcalfe and his assistant David Boggs published a paper with the title „Ethernet: Distributed Packet-Switching For Local Computer Networks.“
### LON over IP

<table>
<thead>
<tr>
<th>OSI Layer</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Physical</td>
</tr>
<tr>
<td>2</td>
<td>Link</td>
</tr>
<tr>
<td>3</td>
<td>Network</td>
</tr>
<tr>
<td>4</td>
<td>Transport</td>
</tr>
<tr>
<td>5</td>
<td>Session</td>
</tr>
<tr>
<td>6</td>
<td>Presentation</td>
</tr>
<tr>
<td>7</td>
<td>Application</td>
</tr>
</tbody>
</table>

- **Application**: HTTP, SMTP, FTP, etc.
- **Presentation**: ANSI/EIA-852 (LON over IP)
- **Transport**: TCP / UDP
- **Network**: Internet Protocol (IP)
- **Link**: Ethernet
- **Physical**: OSI Layer

**EIA-709 / EIA-852 - Network**
EIA-709 / EIA-852 - Network

LON over IP

HTTP, SMTP, FTP, etc.

ANSI/EIA-852 (LON over IP)

TCP / UDP

Internet Protocol (IP)

Ethernet

Protokolle
LON over IP

Protokolle

HTTP, SMTP, FTP, etc.

ANSI/EIA-852 (LON over IP)

TCP / UDP

Internet Protocol (IP)

Ethernet

LON ANSI/EIA 709.1 PDU

SNVT

LON ANSI/EIA 709.1 PDU

SNVT

EIA-709 / EIA-852 - Network
Benefits of the EIA-852 approach (1)

- Transmission is completely transparent for the LonTalk protocol
- Defines how to transmit LonWorks packets over IP networks
- Connections over Intranet or Internet
- Applications from the ANSI/EIA-709 world can be „re-used“ in the IP world
- Standard tools work in ANSI/EIA-709 and in IP-852 networks
Benefits of the EIA-852 approach (2)

• All LonMark profiles can be brought to the IP-world without changes
• Nodes using the IP-852 channel are fully LonMark-able
• Thousands of system integrators can reuse their knowledge and skills in the IP-world
• Other names used: LonWorks/IP channel, CNIP-channel, IP-10L, IP-10W
IP-852 Setup
Typical IP-852 Setup
Configuration Server

- Handles the logical mapping between LonWorks addresses and IP addresses
- Distributes address information to channel members when addresses are changed
- Built into devices (L-IP) or in a Windows application (i.LON Configuration Server)
- Addresses of clients must be entered into configuration server
- Clients can be routers (L-IP, i.LON 600, i.LON 1000) or devices (e.g. L-Vis)
IP-852 Channel Routing
IP-852 Channel Routing

S/N/D/NID 192.168.11.7
S/N/D/NID 192.168.11.3
CS

IP-852

S/N/D/NID 192.168.11.5

S/N/D/NID
Router Type
+ Subnet/Group FF
192.168.11.9

L-JP

L-VIS

FT-10

networks under control
IP-852 Channel Routing
Technology
LC3020 Embedded Controller
(LC3K - Family)
LC3020 Embedded Controller (LC3K - Family)
NIC852 Software Architecture
Network Infrastructure
NIC Overview

EIA709 (LonWorks) Network

NIC709-PCI
NIC709-USB
NIC709-IP
NIC852

PCI Bus
USB Port
Ethernet
USB Port

IP-852
NIC709-PCI, NIC709-USB, NIC709-IP

- L-Chip based high-speed EIA-709 network interface
- Software selectable transceivers: FT-10, TP-1250, RS-485,
- Includes ORION Stack lib
- Supports multiple parallel transaction spaces
- 65535 address table entries
- 4096 network variables
- Up to 8 simultaneous network nodes (MNI) in up to 6 domains

- Compatible with LNS applications (LonMaker)
- Compatible with MIP applications (Nodeutil)
- Compatible with L-IP and i.LON1000 (NIC-852)
- Runs ORION, LNS, MIP, LPA, LSD Tool applications in parallel
- Use MIP applications with IP-852 channels
- Runs on all Windows® versions as well as Linux (NIC709-PCI)
<table>
<thead>
<tr>
<th>NIC852</th>
<th>Networks under control</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ethernet based high-speed EIA-709 network interface</td>
<td>• Includes ORION Stack library</td>
</tr>
<tr>
<td>• Interfaces to IP-852 LonMark channel</td>
<td>• Supports multiple parallel transaction spaces</td>
</tr>
<tr>
<td>• Existing Ethernet hardware used as network interface</td>
<td>• 65535 address table entries</td>
</tr>
<tr>
<td>• Can be used together with L-IP or i.LON 1000 as interface to LonWorks FT-10 or TP-1250 channels</td>
<td>• 4096 network variables</td>
</tr>
<tr>
<td>• Node-ID stored in USB key</td>
<td>• Dynamic network variables</td>
</tr>
<tr>
<td>• Supports multiple apps over one physical network interface in up to 6 domains</td>
<td>• Acts as 8 individual nodes</td>
</tr>
<tr>
<td></td>
<td>• Compatible with LNS applications (LonMaker)</td>
</tr>
<tr>
<td></td>
<td>• Compatible with MIP applications (Nodeutil)</td>
</tr>
<tr>
<td></td>
<td>• Use MIP applications with IP-852 channels</td>
</tr>
<tr>
<td></td>
<td>• Runs on all Windows® versions (except 95 and NT)</td>
</tr>
</tbody>
</table>
NIC Application Examples
TP and IP Router
L-Switch\textsuperscript{XP}

- 2, 3, and 5 port versions
- routes packets between EIA709 channels
- Built-in network management and diagnostics
- Status LED for each channel
- Configured Router Mode
- Plug & Play Installation in Smart Switch Mode
- Subnet/Node and group address learning in Smart Switch Mode
- No limitation of network input buffers
Application Example

Channels on the ceiling

Channels on the floor

networks under control
L-Switch\textsuperscript{XP}

- Communication between the FTT-10 Channel:
L-IP

- Built-in configuration server
- Packet routing between IP and EIA709 networks
- Supports dynamic IP and Auto-NAT
- Supports DHCP
- Built-in network management and diagnostics
- Status LEDs
- Configured Router Mode
- Subnet/Node and Group address learning in Smart Switch Mode
- No limitation of network input buffers
TP to IP

TP/XF-1250 Backbone

TP/FT-10

BMS

networks under control

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TP to IP (2)
TP to IP (3)
**L-IP Redundant**

- Monitoring on cable break
- Gives notice on the location of the cable break
- Communication on the TP/FT-10 channel is ensured in case of a single cable break
- Full redundancy with two Redundant L-IPs in parallel
- Nodes on the TP/FT-10 channel are monitored
- Messages and alarms are presented via SNVTs and LonMark-Alarming via Node Object
- Configured Router Mode support only
Gateways
L-Proxy

- Up to 5 network ports
- Binding of network variables across domain boundaries
- LNS plug-in for configuration
- Status LED for each channel
- Supports 384 NVs and 512 Alias NVs per port
- Supports 384 address table entries per port
- Conversion between different SNVT types
- Dynamic NVs
“Binding” across Domains

DOMAIN "LOYTEC"
(40,4f 59.54 45.43)

Node 6 Switch 1

Node 6 Switch 0

Node 5 Lamp 0

Node 6

Switch 2

L-Proxy Port 2

L-Proxy Port 2

L-Proxy Port 2

L-Proxy Port 4

Node 8

Switch 0

Lamp 0

Proxy

DOMAIN "PXY"
(50.58 59)

Node 8

Switch 1

Node 9

Switch 0

Lamp 0

Proxy

DOMAIN 0x03

Node 7

L-Proxy Port 3

L-Proxy Port 3

L-Proxy Port 3

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L-Proxy – Application

max. 15 address table entries with each Neuron-Node

1 .. 15
Set Point

16 .. 30
Set Point

networks under control

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EIA-709 / EIA-852 - Network

L-Proxy – Application

max. 384 address table entries with each L-Proxy-Port

max. 15 address table entries with each Neuron-Node

1..30 Set Point

networks under control
Network Termination
L-Term Network Terminator

- **LT-33:**
  - 2 x TP/FT-10 (Bus Topology, free Topology)
- **LT-13:**
  - 1 x TP/FT-10 (Bus Topology, free Topology)
  - 1 x TP/XF-1250 (Bus Topology)
System Diagnostics and Protocol Analyzer
<table>
<thead>
<tr>
<th>System Diagnostics and Protocol Analyzer</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Three Level of System diagnostics and protocol analyzing:</td>
</tr>
<tr>
<td>• 1) LED indicates a problematical channel</td>
</tr>
<tr>
<td>• 2) System diagnostic with the <strong>LSD</strong>-Tool</td>
</tr>
<tr>
<td>• 3) Protocol analyzing with the <strong>LPA</strong>-Tool</td>
</tr>
</tbody>
</table>
Port - LED

• The Port-LED is flashing red if:
  
  • messages are destroyed by collisions > 5% or
  • the Average Bandwidth is > 70% or
  • the CRC-Errors > 5% or
  • the Missed Preambles > 5%.
System Diagnostics and Protocol Analyzer
EIA-709 / EIA-852 - Network

LSD Tool – System Diagnostics Tool

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LSD Tool – System Diagnostics Tool

• Read logged statistic information from LOYTEC network infrastructure products
  • Network diagnostics
  • Monitoring of bandwidth utilization and CRC errors
  • Display statistics information (received packets, transmitted packets, etc.)
  • Life list; monitor voltage/temp.
  • Export of statistics data into Excel spreadsheet
  • Runs on all Windows versions
LSD Tool – System Diagnostics Tool

- Bandwidth Utilization
  - Device 1
    - Port 1: 30%
    - Port 2: 40%
    - Port 3: 50%
    - Port 4: 60%
    - Port 5: 70%

- Network Traffic
  - Device 1
    - Port 1: 20000 packets/sec
    - Port 2: 15000 packets/sec
    - Port 3: 10000 packets/sec
    - Port 4: 5000 packets/sec
    - Port 5: 1000 packets/sec

- Network Status
  - Device 1
    - Port 1: Active
    - Port 2: Active
    - Port 3: Active
    - Port 4: Active
    - Port 5: Active

- Network Performance
  - Device 1
    - Port 1: Throughput: 100 Mbps
    - Port 2: Throughput: 90 Mbps
    - Port 3: Throughput: 80 Mbps
    - Port 4: Throughput: 70 Mbps
    - Port 5: Throughput: 60 Mbps

- Network Security
  - Device 1
    - Port 1: Secure
    - Port 2: Secure
    - Port 3: Secure
    - Port 4: Secure
    - Port 5: Secure
LPA – Protocol Analyzer

networks under control

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LPA – Protocol Analyzer Software

- Records and displays all packets on the network
- Software selectable transceivers when supported by NIC
- Shows detailed statistics information
- Symbolic names for nodes and NVs
- Sophisticated packet filters
- Plug-in and server API
- Runs on LOYTEC NIC
- Runs under all Windows versions (Win98 and up)
LPA – IP

- Monitor packets on IP Channel
- Monitor network traffic behind L-IPs from remote
- Record multiple LPA log files in parallel
LPA – Protocol Analyzer

Packet Table

Packet Details

Protokol Details

Online Statistik

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LPA

Additional Tools
<table>
<thead>
<tr>
<th>LPACConv</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Single program</td>
</tr>
<tr>
<td>• Reads data from an LNS database</td>
</tr>
<tr>
<td>• Generates an LPA converter file</td>
</tr>
<tr>
<td>• Imported converter file controls display converter in the LPA software</td>
</tr>
<tr>
<td>• Import names from an LNS database into the LPA software</td>
</tr>
</tbody>
</table>
Case Study – LPA and LNS

LPA log window with converter disabled.
Case Study – LPA and LNS

LPA log window with converter enabled.
LPA – Spy

- Client application for LPA
- Reconstructs networks from captured packets
- On-line display of detected nodes
- Shows node activity statistics
- Overview of complex and unknown networks
- Shows node tree sorted by domain/subnet/node
LPA Client-/ Server Interface

- Allows developing own programs, which process all packets on a LonWorks channel
- LPA forward all packets to the client/server interface
- Programming a client uses a DLL based interface
- Template for MS Visual-C 6.0
- It is not possible to send packets in the LPA!
LPA Plug-In Interface

- Allows to adjust the display of proprietary packets in the LPA software
- Programming of a DLL
- Template for MS Visual C++
- LPA shows data in packet detail window
- Also influences display of packets in the packet list
Visualization
L-VIS

- Visualization for network variables
- Control of network variables
L-VIS

networks under control
LNS Plug-In

networks under control

For Help, press H

Main Menu

Test Network
Examples

Txt Watch

12hPDM-firstR
12hPDM-firstR
12hPDM-firstR

Main Menu

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## Features

- Stainless steel design
- Up to 512 network variables
- Up to 512 address table entries
- FT-10 and Ethernet IP-852 transceiver
- Alarming: alarm generator
- Easy to configure on site
- Access control via PIN
- Switch input, Relay output, ext. temp sensor
- UNICODE International text display
- Simple Installation
- 12-24 V AC or DC supply voltage

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but …

• The production of L-VIS (LVIS-3ECTR) has been terminated.
• The device will be replaced by a new L-VIS coming at the end of Q4/2005. It will have a touch screen (color) and an extended functionality.
Further Information

E-Mail: info@loytec.com

Webpage: http://www.loytec.com

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