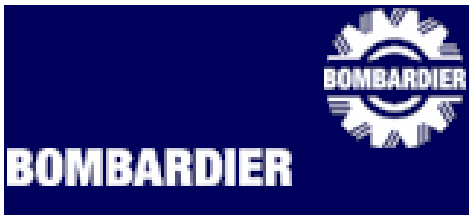
LONWORKS Applications in Rail Transportation

28 April 1999

TSD, Inc. & ECHELON® THE LONWORKS® COMPANY

Examples of firms using LONWORKS Technology



Safetran

Harmon

Pulse Electronics

GE Harris

Translite

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LONWORKS Applications in Rail Transportation

Transit and Freight

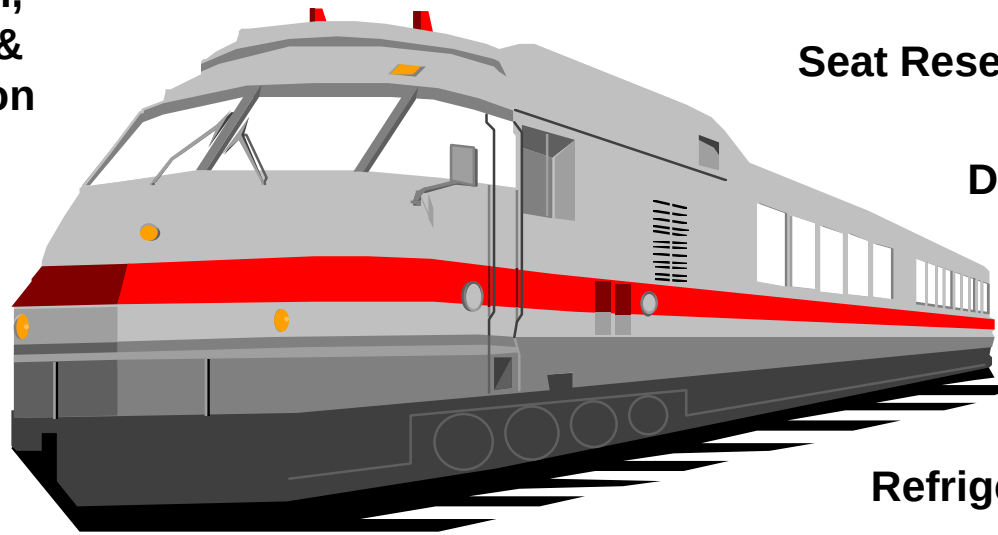
Monitoring & Diagnostics

Maintenance Automation

Consist Building: Car Identification, Numbering & Orientation

Black Box Recorders/Dataloggers

Seat Reservation Displays



EP Braking

Destination Displays

Auxiliary Power

Lighting

Engine Controls, Traction

HVAC

Refrigeration

Dispatch & Emergency Communications with Control Center

Public Address

Doors

Signaling

Wayside Systems

GPS Location

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LONWORKS in Transit Applications

Amtrak

- Electronic brake control units by Knorr Brake
- 3 units per car
- Use FT-10 free topology channel
- Deployment of 270 units starts Aug ‘97

LONWORKS in Transit Applications

NJ Transit

- Comet IV project
- Door monitoring by Vapor
- Signage and public address control (annunciation trigger) by Pocatek
- 96 cars deployed since Oct ‘96

LONWORKS in Transit Applications

SF BART

- **Knorr Brake watchdog monitor**
  - Uses FT-10 free topology twisted pair
  - 10-15 cars now revenue service as part of rehabs
  - Remaining cars to be retrofit
- **Harmon AATC**
  - CBTC (Communications Based Train Control)
- **Possibly others**

LONWORKS in Transit Applications

Various Installations by Translite

- **Electronic and Roller Curtain signs**
- **PA and audio control**
- **LonWorks based signs deployed**
  - **AMTRAK - 1992**
  - **Boston MBTA - project complete**
  - **SF Muni Railway - in 2nd phase**
  - **SEPTA - 900 signs total, nearly completed**
  - **St. Louis**
  - **Salt Lake City**
  - **Dallas**
  - **Pittsburgh (demo)**

LONWORKS in Transit Applications

NJ Metro North

- **Peerless Event Recorder**
  - **Uses PLT-10 transceiver**
  - **5 nodes/2-car set**
  - **70 M2 cars, 2 M3 cars deployed starting early-'96**
  - **Plans for M1 and M4 cars**
  - **Total of 290 car sets to be deployed over coming 18 months**

LONWORKS in Transit Applications

NY Port Authority Project

- **Braking system similar to BART by Knorr Brake**
- **Jamaica to JFK w/Howard Beach**
- **Uses FT-10 free topology twisted pair channel**
- **Deployment in 26 cars TBD**

LONWORKS in Transit Applications

Kuala Lumpur

- **Bombardier - monitoring system integration**
  - **2 car vehicle; 14 nodes per network**
  - **2 A/C units/car, 2 propulsion systems, one aux power system, 1 braking system, 1 HMU**
- **Thermo-King - air-conditioning system**
- **Alstom - propulsion system**
- **Rolls Royce - auxiliary power**
- **Knorr Brake - brakes**
- **Questor/Tangent - health monitor**

- **35 train sets 2 cars per set; all deployed**
- **System installed 9 months ago; no problems**

LONWORKS in Transit Applications

Sydney Commuter Rail

- **Door control, voice messaging, intercom, security help buttons**
- **15 cars deployed July ‘96**
- **1,800 cars to be deployed by Y2000 @500 cars/year**

LONWORKS in Transit Applications

Romania

- I/O modules on cars by Faiveley
- 13 modules per train car
- 50 cars deployed

LONWORKS in Transit Applications

Deutsche Bundesbahn

- Lighting, heating and air conditioning control for energy savings
- Development completed in 1996
- Two trains equipped with pilot systems
- Deployment in 2,500 cars in 1997

LONWORKS in Transit Applications

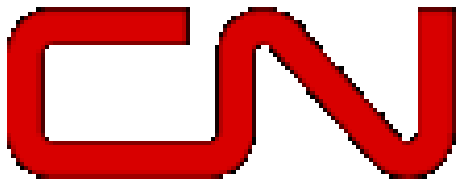
Schweizer Mittelthurgau-Bahn

- **Passenger information system developed by Netcon**
- **30 cars to be equipped in 1997**

LONWORKS in Freight Trains

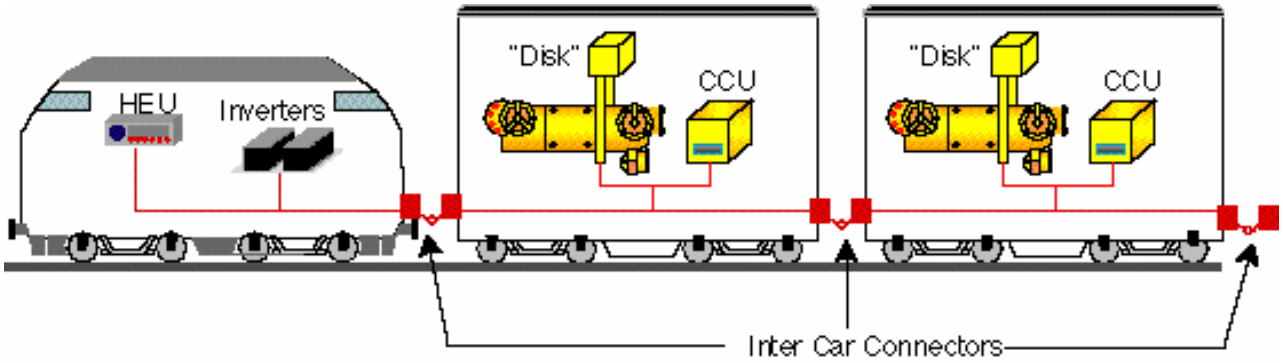
Canadian National Railroad

- **Propulsion pack and braking control system**
  - **Real Time Solutions (STR) (Quebec City)**
- **Uses LonTalk over RF modem**
- **Deployed on three train sets**



LONWORKS in Freight Applications

AAR - ECP Brake



- Development sponsored by American Association of Railroads
- PLT-10A based power line signaling between locomotives and cars
- Reduces braking distance, improves performance and reliability
- Successful trials under way
- TSM (Rockwell)
  - 7 trains with LonWorks for ECP brake control; 120 cars per train
  - 2,000 cars equipped by June ‘97
- Pulse, NYAB

LONWORKS in Freight Trains

NYAB's EP Brake

- **LonWorks based electro-pneumatic braking**
- **Supports AAR requirements for upgrading existing rolling stock and all new rolling stock**
- **110 car system in test / deployment**
- **Production Mar '97**

LONWORKS in Freight Trains

New York Air Brake

- Computer controlled braking by NYAB (CCB2)
- Integrated electronic airbrake
  - upgradeable to locotrol/distributed power
- Easily integrated with NYAB's LonWorks based ECP brake system
- Locomotive Systems Integration (LSI) compliant
  - Adaptable to non-LSI apps
- Developed with GE Harris
- Deployment began Oct '97

Other Applications on Trains

- **Signaling - Safetran**
  - Relay controllers in vital and non-vital systems
  - Deployed successfully
  - Gateway to Utilicom 902-928MHz RF radio
- **Trip information datalogger (K7SC) - Faiveley**
  - Uses slim (8mm thick) memory card
  - Card logs all info to PC when trip completed
- **Powerline (PLT-21) based communication in metro and national railway stations - Faiveley**
  - Initial installations in progress in Paris Metro and Charles de Gaulle Etoille station

LONWORKS in Wayside Systems

Platform Doors

- **Faiveley**
  - **Installed in new metro line in Paris (Meteor)**
- **Monorail stations in Japan**
  - **FT-10 based design**
  - **Installation starting mid-1997**

Other Transportation Applications

Fault Tolerant Aircraft Control

- **Raytheon engine, avionics, and cabin controls**
- **Fiber optical fiber based**
- **Triple Modular Redundant Architecture**
  - **Provides Fail Operational/Failsafe (not Fail Stop/Failsafe)**

Other Applications in Transportation

Transit Buses

- **PACE bus system, Chicago**
  - GPS, fare box, engine/transmission control, passenger counting system
  - Uses FT-10 channel
  - Being retrofitted to existing buses
    - 600 buses, mid-'96 to 2000
- **NJ Transit, Newark**
  - Fare box, destination signs, other multiplex wiring
- **Marathon Coach**
  - High end RV motorcoach
  - 33 LonWorks nodes for engine control & diagnostics, lighting, a/c, door control, generator control, kitchen control, video camera control, GPS
  - Will deploy 60 buses in 1997
- **Sparton Motors - Fire trucks**

Power Line Communication Tests at NYCT

Typical NYCT Station Lighting Interface

- Successful tests - 1993
- Use existing station lighting wires
- Error-free communications over 700 feet
- Improves Station Appearance
- Cost effective
  - Compare: Conduit at $50/foot
  - Allows additional functions not previously practical due to expense of running conduit

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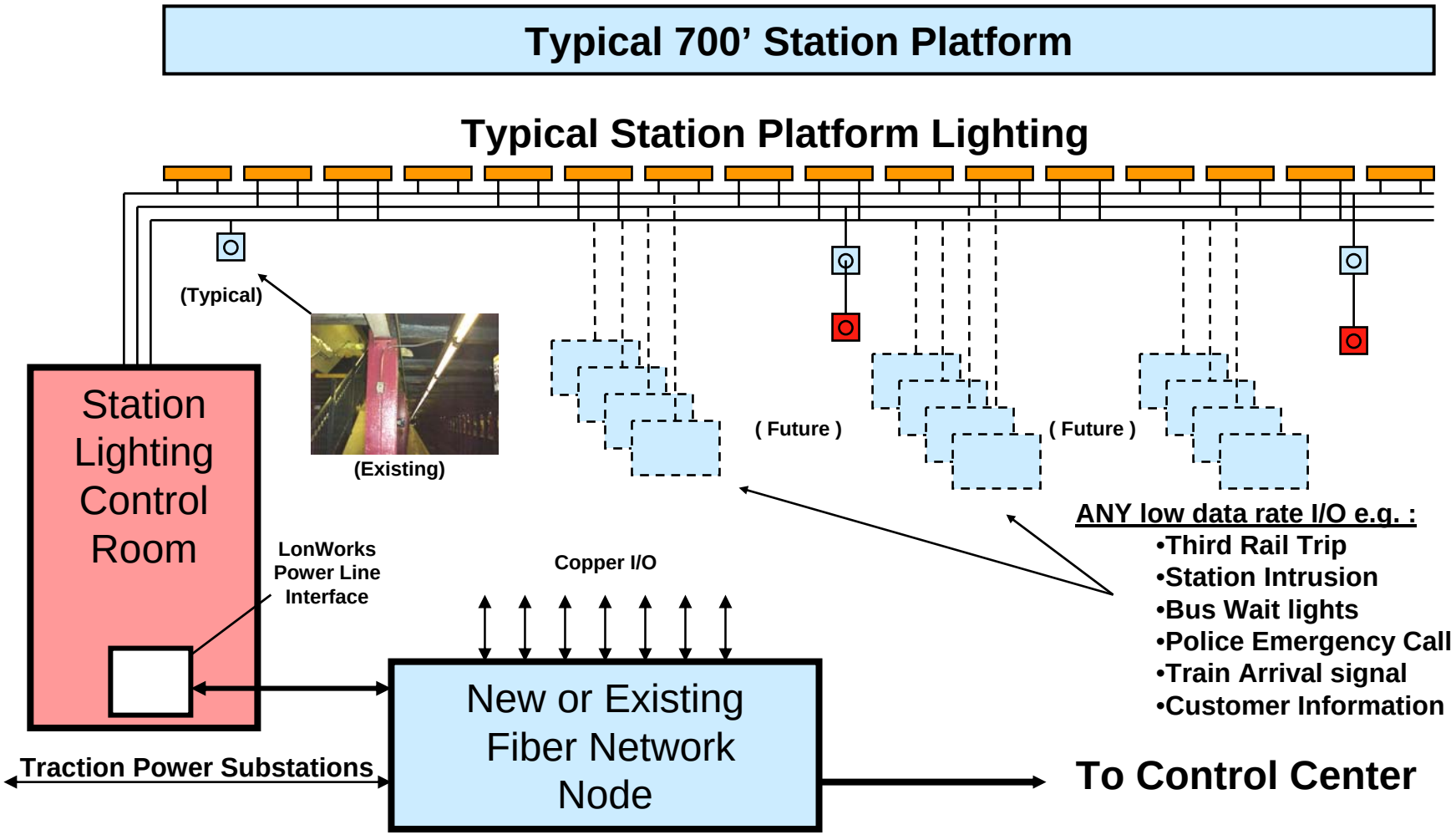
LONWORKS in Subway Stations

Possible Future Systems using Station Lighting Control



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Candidates for LONMARK Standardization

“LONMARK Objects”

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LONMARK Transportation Candidates

- **Rail Transit Vehicles - most likely candidates**
  - **IEEE 1474**
    - **Communications Based Train Control**
  - **IEEE 1482**
    - **Vehicle Health Monitoring / Data Loggers**
  - **IEEE 1475**
    - **Propulsion, Friction Brake and Master Control**
  - **IEEE 1476**
    - **Vehicle Auxiliary Power Systems**
  - **IEEE 1477**
    - **Vehicle Passenger Information Systems**

LONMARK Transportation Candidates

- **Rail Transit Vehicles - additional candidates**
  - **HVAC (Existing LonMark standards)**
  - **Passenger Emergency Stop Request**
  - **Passenger Assistance/PA Interface**
  - **Car Lighting & Load Shed**
  - **Fare Collection (LRT & Bus Operations)**
  - **Driver/Conductor/Run # Card Swipe**
  - **Vehicle Door Monitoring and Control**
  - **GPS Location Interface**
  - **Digital Train & Analog Voice Radio Interface**
  - **Tachometer/odometer**
  - **Others?**

LONMARK Transportation Candidates

- **Railroad Locomotives and Cars**
  - ECP Brakes
  - Locomotive Power Control
  - End of Train
  - Hot Bearing Detection
  - Refrigerator Car monitoring
  - GPS Location Interface
  - Tachometer/odometer
  - Others?

LONMARK Transportation Candidates

- **Transit Station**
  - Token Booth Silent Alarm
  - Fare Collection Equipment
  - Smoke, Fire, Intrusion Alarms
  - Emergency Third Rail Trip
  - Passenger Emergency Assistance
  - Platform Intrusion
  - Platform Doors
  - Platform Under Car Deluge Monitoring & Control
  - Platform Signs
  - Vent Fan & Damper Control and Monitoring
  - Video Camera control
  - Bus Wait Light
  - Tunnel Lighting Control and Monitoring
  - Interlocking NV Control & Monitoring

  - Others?

LONMARK Transportation Candidates

- **Wayside Applications**
  - Snow Melters
  - Retarders
  - Crossing Gate Interface to Traffic Controllers
  - Crossing Gate Interface to Rail Vehicles
  - Axle Counters
  - Broken Rail Detectors
  - Switch Machines
  - Wayside Signals

  - Traction Power Substation Monitoring
  - Others?

Questions and Discussion

Audience Participation Encouraged