Closed-Loop Management of
School Zone Flashing Beacon Systems

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Presentation Overview

- Definitions
- Brief History - Programmable Time Clocks
- Available Communication Technologies
- Features & System Considerations
- System 3000 – A Typical Architecture
- Summary

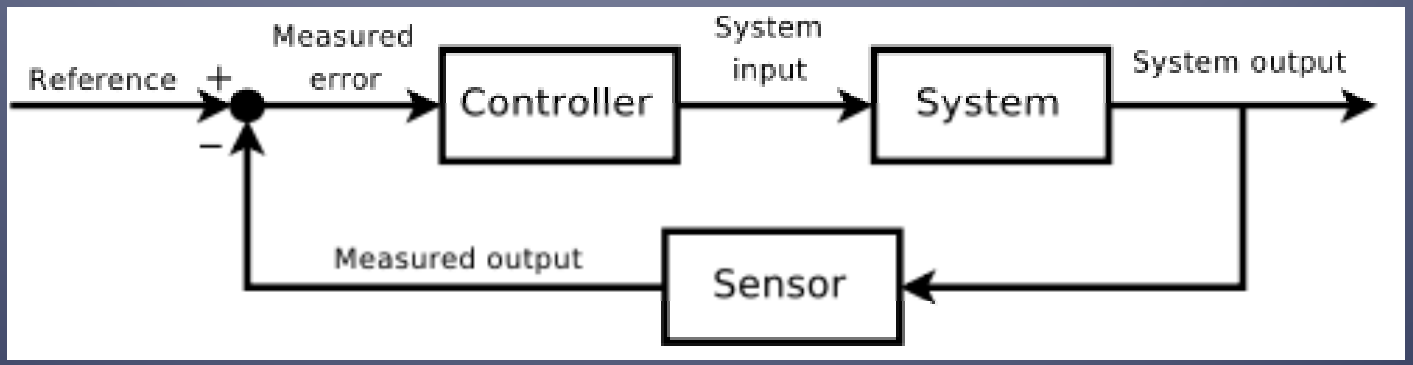
School Zone Flashing Beacon

- A flashing beacon indication for speed reduction notification during specific periods of school operation.
- Typical System components
  - Control Cabinet w/ Time Clock, Flasher
  - LED Beacons
  - Signage
  - AC or DC (solar) power components
  - Communication Equipment

Technical Definition

- ## Closed-Loop Feedback

  Defined in Classical Control Theory as the use of feedback to control states or outputs of a dynamical system. The name comes from the information path in the system: process inputs have an effect on the process outputs, which are measured with sensors and processed by the controller; the resultant signal is used as input to the process, closing the loop.



Practical Definitions

- Closed-Loop Management

  The ability to monitor and track system parameters and provide feedback for system management.

- System Management

  Administration of school zone flashing beacon system, including System Configuration, Programming Schedules, Providing Direct Operational Control, Monitoring Operational Status & Functional Parameters, and Fault Reporting.

- Real Time vs. Non-Real Time

  Immediate communication or logging data for on-demand retrieval or threshold-triggered notification.

Brief Historical Perspective

- Mechanical Clocks
- Stand-Alone Programmable
- Open-Loop Radio Controlled
- Open-Loop 1-Way Paging System
- Closed-Loop 2-Way Paging System
- PCS Cellular, Spread-Spectrum, Network Capable, Combination Systems

Mechanical Clocks

- Program Manually
- Fixed Weekly Schedule
- Reliable & Low Initial Cost
- Limited Features
  - Schedule Limitations
  - No Holidays or Alternate Schedules
  - Manual Feedback Only
  - Still Used

Programmable Clocks (ELTEC)

- Maxim 1&2, TC11&12 (1970's to 80's)
  - Micro-Processor Based
  - Manual Programming w/ Keypad
  - Mid 80's – PC Based Programming & Clock to Clock Transfer Capability
- TC-1000 (Mid 1980's)
  - Open-Loop Control
  - Licensed Frequency Radio (FSK)
  - Sends ON/OFF Signal
- NTC17 & 17E (1990's)
  - New Motorola Chip, LCD Display, NVRAM
  - PC Based Programming & Clock to Clock Xfer
  - More Steps & Alternate Programs
    - Still a Standard in Industry Today

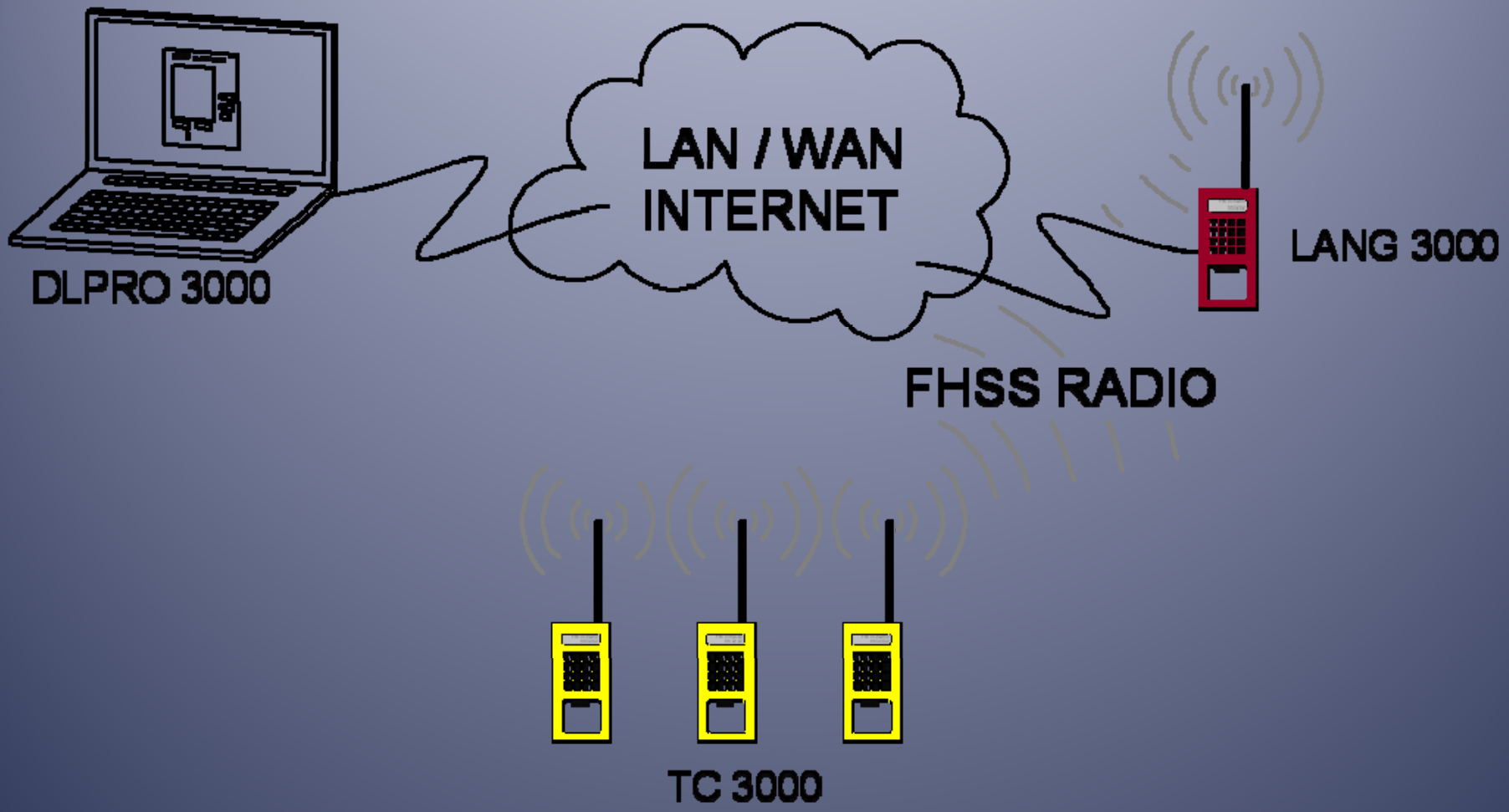
System Clocks (ELTEC)

- TC-2000 (Late 1990's - 2000)
  - 2-Way Paging
  - PC Programming with Pager System Download
  - Closed-Loop via Email Notification
    - Initial Power On & Connection
    - Program Reception Acknowledgement
    - Bad Data, Low-Voltage Reset, etc.
- TC-1500 (2000)
  - 1-Way Paging
  - Locations where 2-way Paging not available
- TC-3000 (2010 Next Generation)
  - Wired Network & Spread Spectrum Radio
  - Real-Time, Closed-Loop Control & Management
  - Background Monitoring & Direct Monitoring
  - Program, State, Cabinet Parameters, Data Logging

Available Technologies

- Proliferation of Technology & Infrastructure
- Wired Network
  - Copper & Fiber
- Wireless Networks
  - Spread Spectrum (FHSS, DSSS,THSS,CSS,UWB)
    - Wi-Fi (IEEE 802.11)
    - Home RF, BlueTooth, Zigbee
    - Also may utilize OFDM
- Digital Cellular
  - PCS (Personal Communication Services)
  - 3G (Third Generation)
    - WiMAX (IEEE 802.16)

ELTEC System 3000 Architecture



System Architecture Description

- Virtual Device Network (VDN)
  - Xport Embedded Device Server
  - Machine to Machine (M2M)
  - Private Port Forwarding
- FHSS Radio Virtual Private Network
  - Selective Addressing
    - Physical Address Controlled Access
  - Interference Rejection
  - Inherent message privacy/security

Features

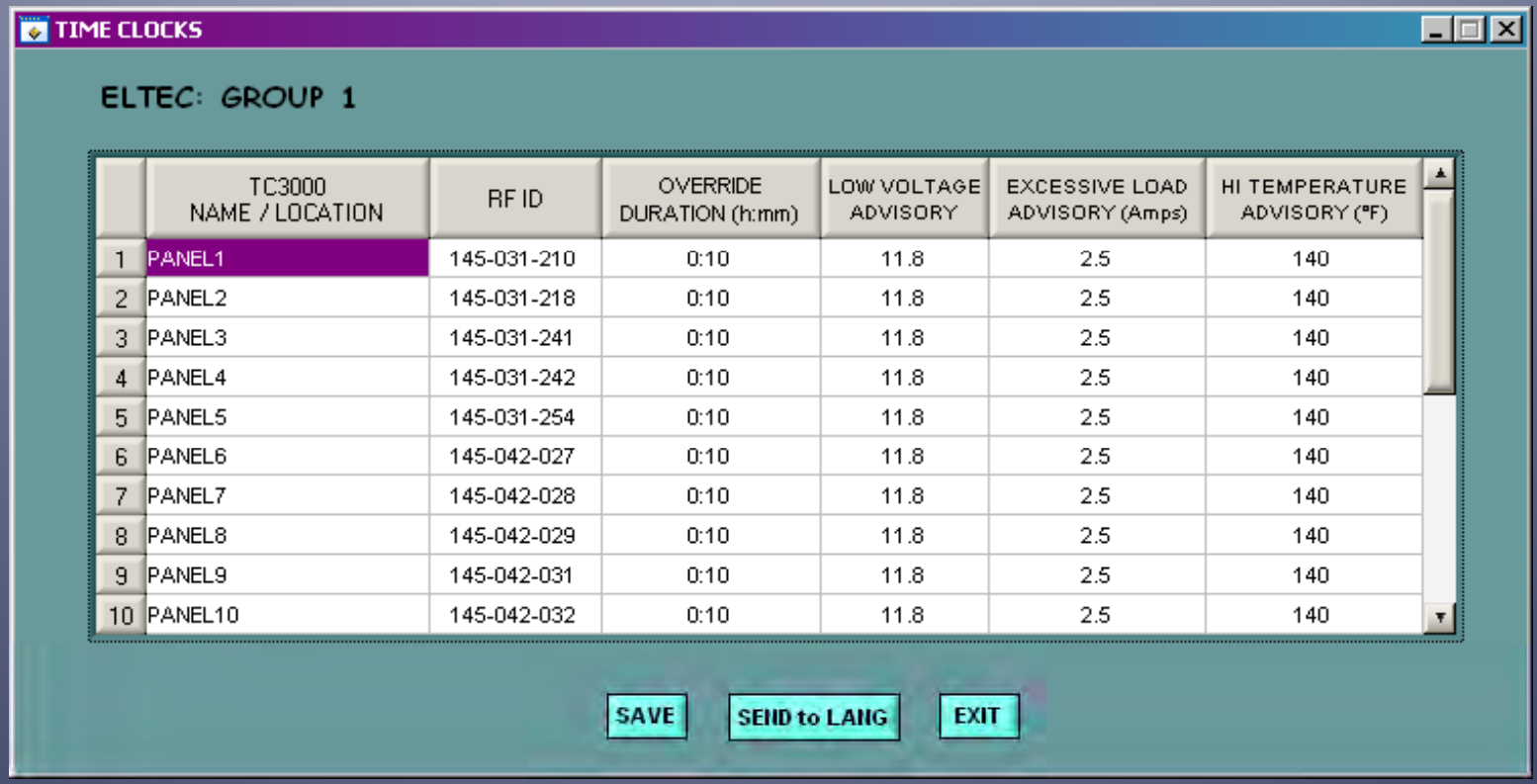
- Central Programming & System Configuration
  - Facilitate IMAC's
  - Weekly Schedule, Holidays, Exceptions
  - Automatic Time Update & DST Adjustment
- Direct Remote Control
  - Accommodate Immediate Schedule Changes
  - Variable Override Duration
- Monitor System Parameters
  - Current Program State
  - Operational Status (ON/OFF/Override)
  - Power Status (Loss of Power, Battery Voltage)
  - Communication Status (RSSI)
  - Load Characteristics (Line Current)
  - Charge Current (Solar)
  - Cabinet Temperature

Features - Continued

- Background Monitoring
  - Operational Advisory Notifications
  - Power, Battery Voltage, Communication, Override
    - User-Defined Thresholds
    - User-Interface Notification
    - Email Notification
  - Log Data for Operation Analysis & Pre-Emptive Maintenance or Corrective Actions
- Direct Monitoring
  - Check Operational Status & System Parameters
  - Further Trouble-Shoot after Advisory Notification
  - Direct Download to Specific Field Units
  - Initiate for On-Site Problem Determination

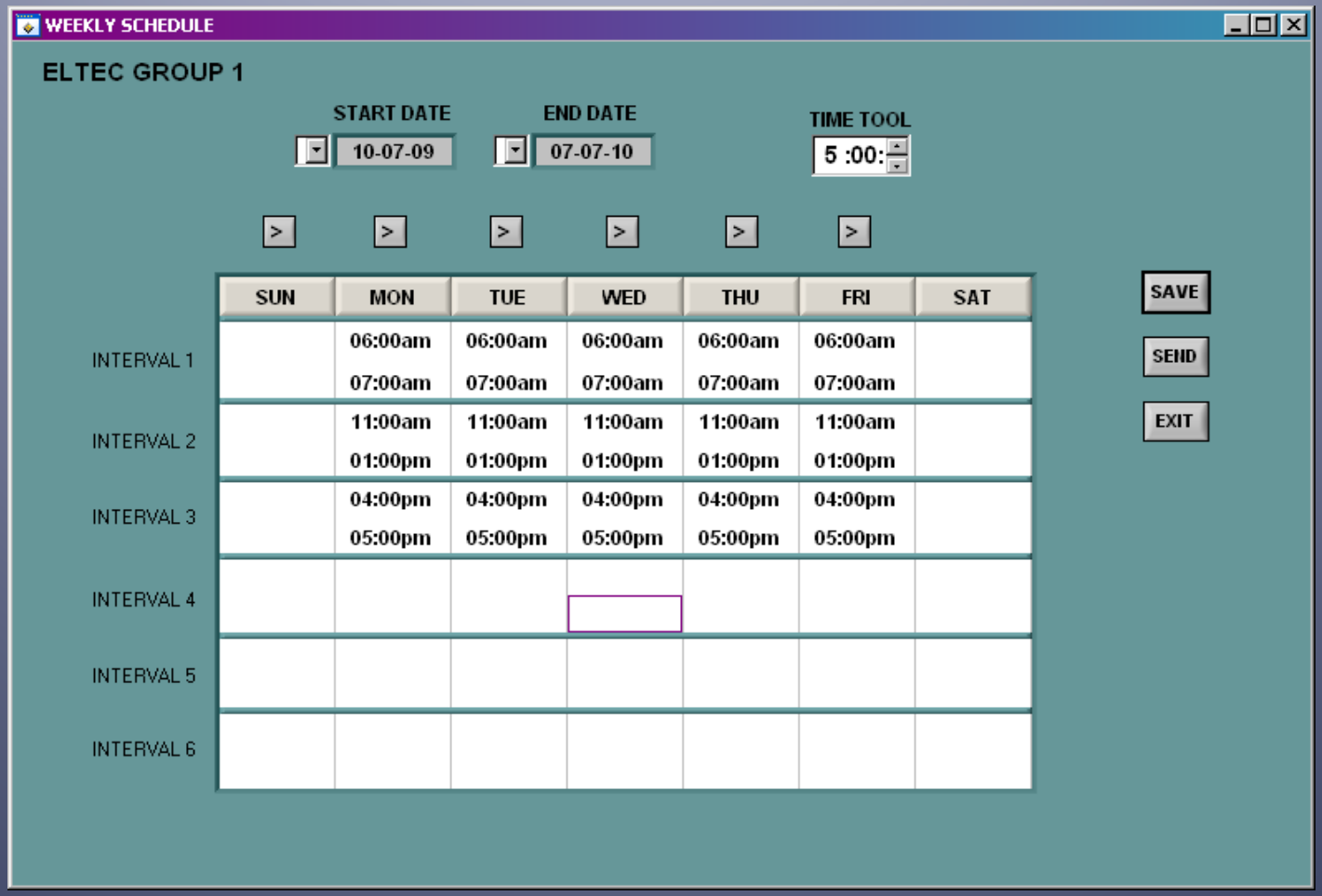
ELTEC System 3000

System Configuration

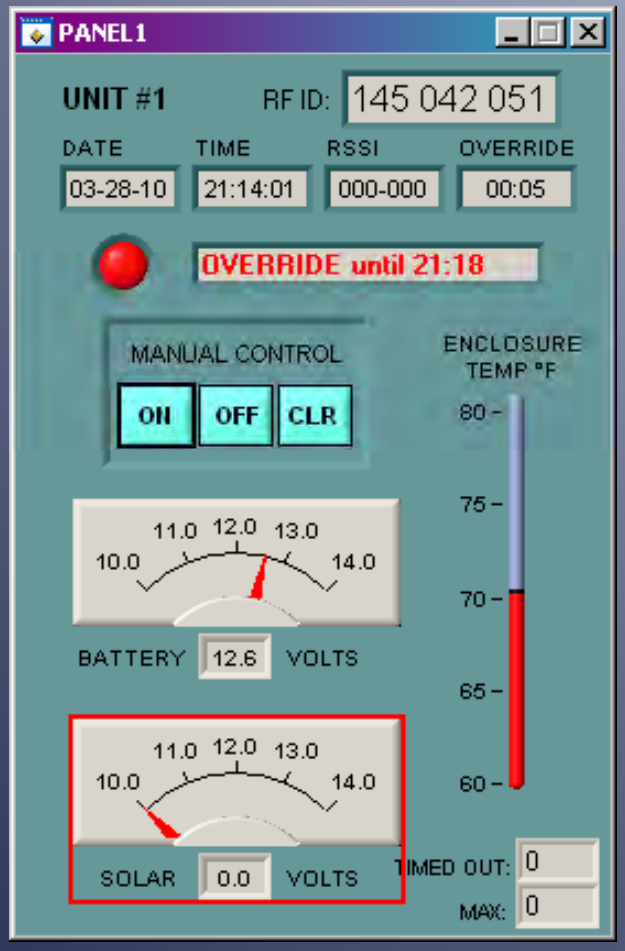


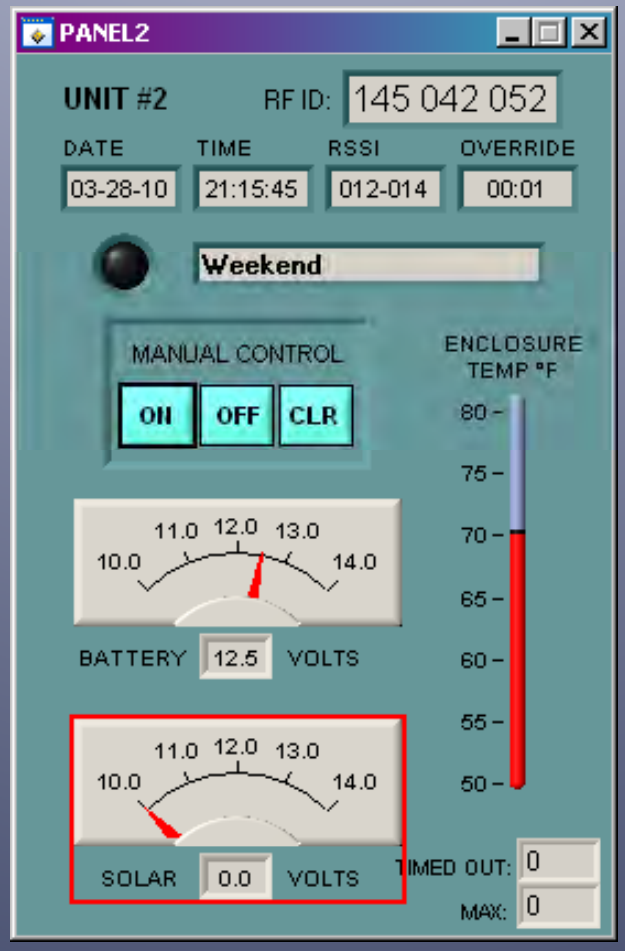
	TC3000 NAME / LOCATION	RF ID	OVERRIDE DURATION (h:mm)	LOW VOLTAGE ADVISORY	EXCESSIVE LOAD ADVISORY (Amps)	HI TEMPERATURE ADVISORY (°F)
1	PANEL1	145-031-210	0:10	11.8	2.5	140
2	PANEL2	145-031-218	0:10	11.8	2.5	140
3	PANEL3	145-031-241	0:10	11.8	2.5	140
4	PANEL4	145-031-242	0:10	11.8	2.5	140
5	PANEL5	145-031-254	0:10	11.8	2.5	140
6	PANEL6	145-042-027	0:10	11.8	2.5	140
7	PANEL7	145-042-028	0:10	11.8	2.5	140
8	PANEL8	145-042-029	0:10	11.8	2.5	140
9	PANEL9	145-042-031	0:10	11.8	2.5	140
10	PANEL10	145-042-032	0:10	11.8	2.5	140

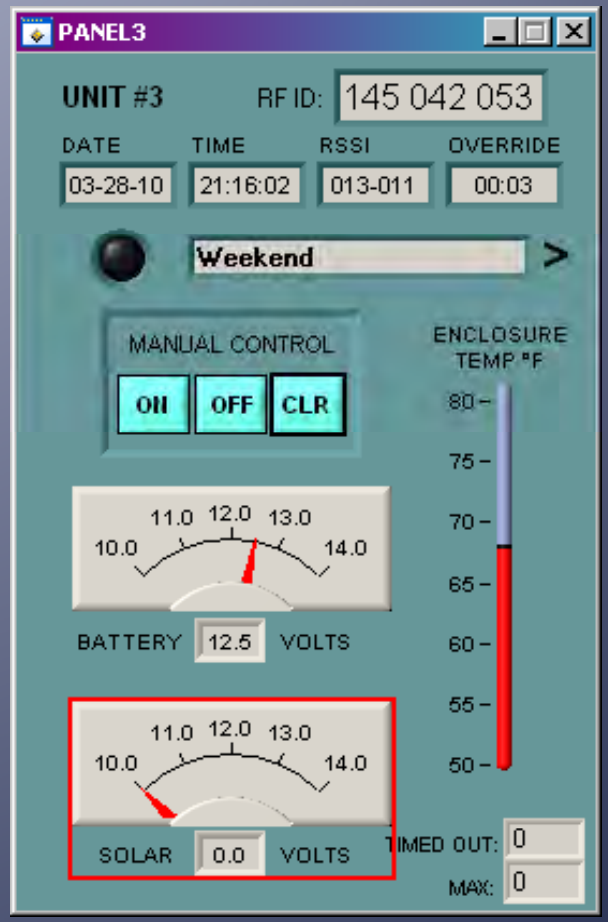
Weekly Schedule



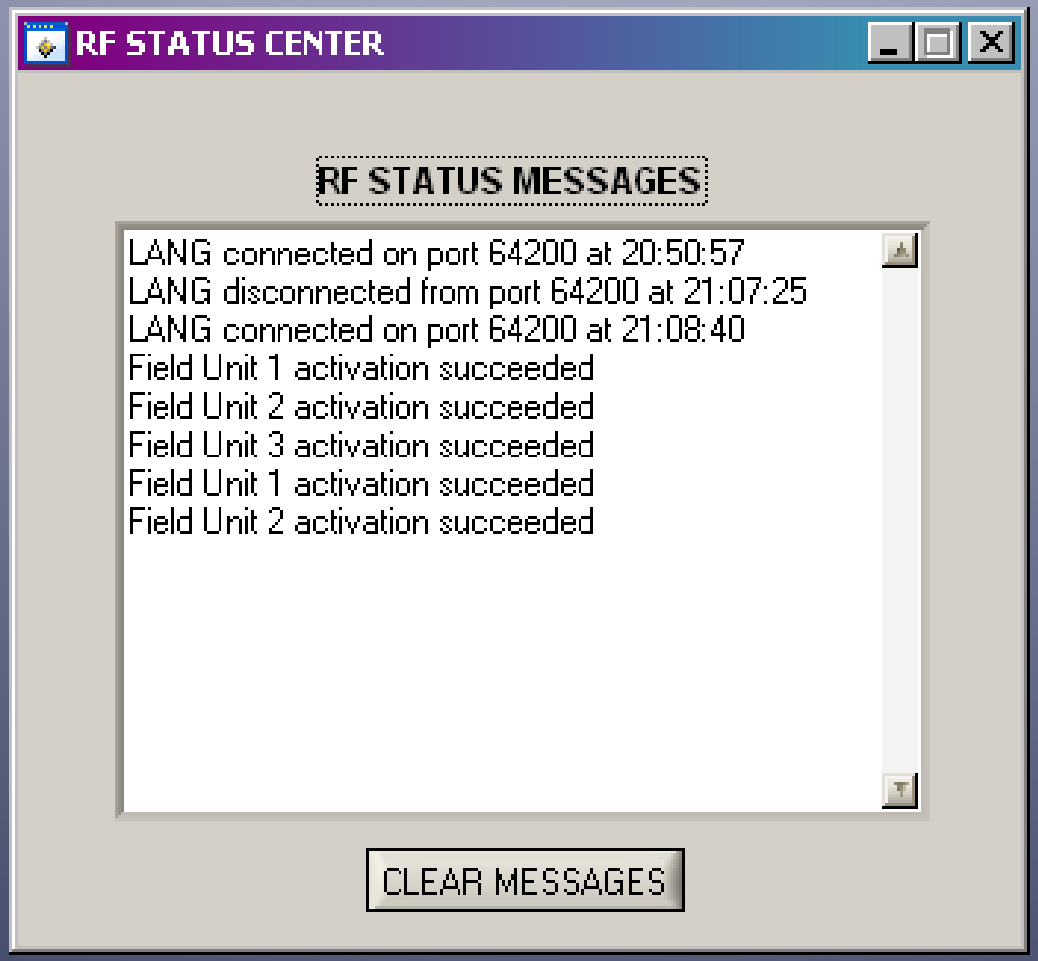
Clock Status / Direct Monitor







Communication Status



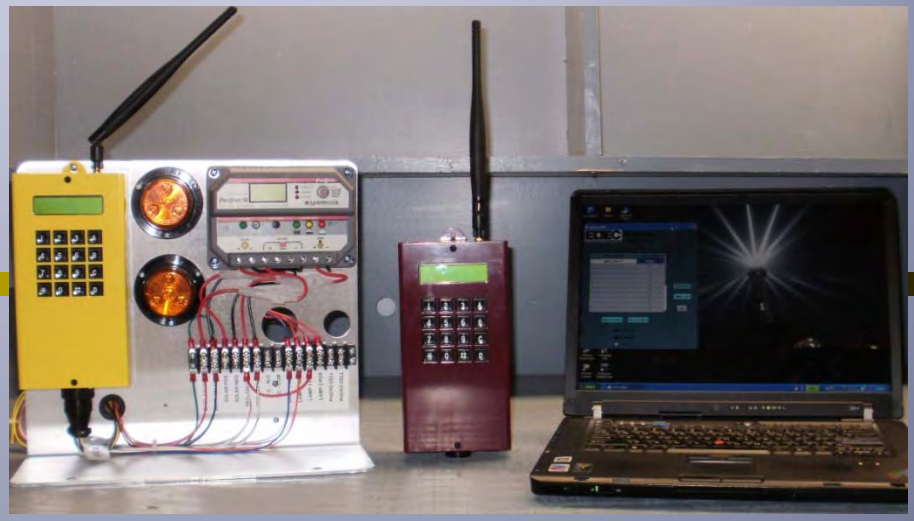
System Considerations

- Installation Considerations
  - Available Communication Infrastructure
    - Internet Access or Intranet Connectivity
    - Cellular Coverage
    - Radio Coverage
    - Antenna Locations & Mounting for Radio Systems
- Reliability Considerations
    - Program Resident on Clock
      - Communications Problems
    - Ability to Manually Program if Necessary
    - Non-Volatile Memory
    - Capacitive Backup for Clock
    - Poor Communication System Coverage
- Security Considerations
- Technology Obsolescence

System Considerations

- Cost
  - Initial Installation
    - More Features = Higher Initial Cost
    - Communication System Infrastructure
      - Network Interface & Components
      - Radio System Components
    - Software
  - Maintenance Cost
    - Reduced On-Site Programming
    - Reduced On-Site Trouble-Shooting & Repair
    - Central Programming & Administration
  - Recurring Cost
    - Pager or Cellular Service
    - Hosting Services – Web Based Programming & Control
    - Internet Services

Summary



- **Bottom Line –**
  - Closed-Loop Managed Systems offer a number of benefits for system configuration, programming & maintenance and can increase system reliability.
  - System complexities require understanding of the technology capabilities & limitations to select the right system for your application.
  - It is important to balance the costs and benefits to select a system that provides the features you need over the life of the installation.