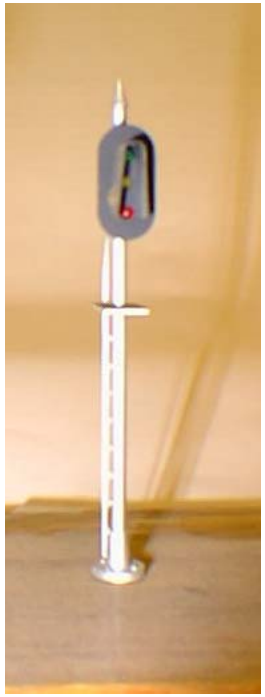
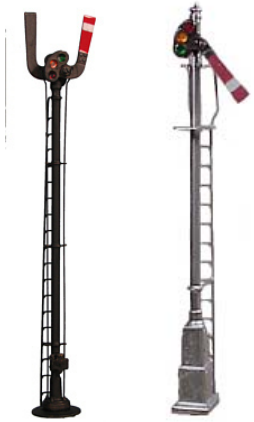
A Primer on Railroad Signals

Dick Johannes

March 13, 2010

The variety of signals seems endless





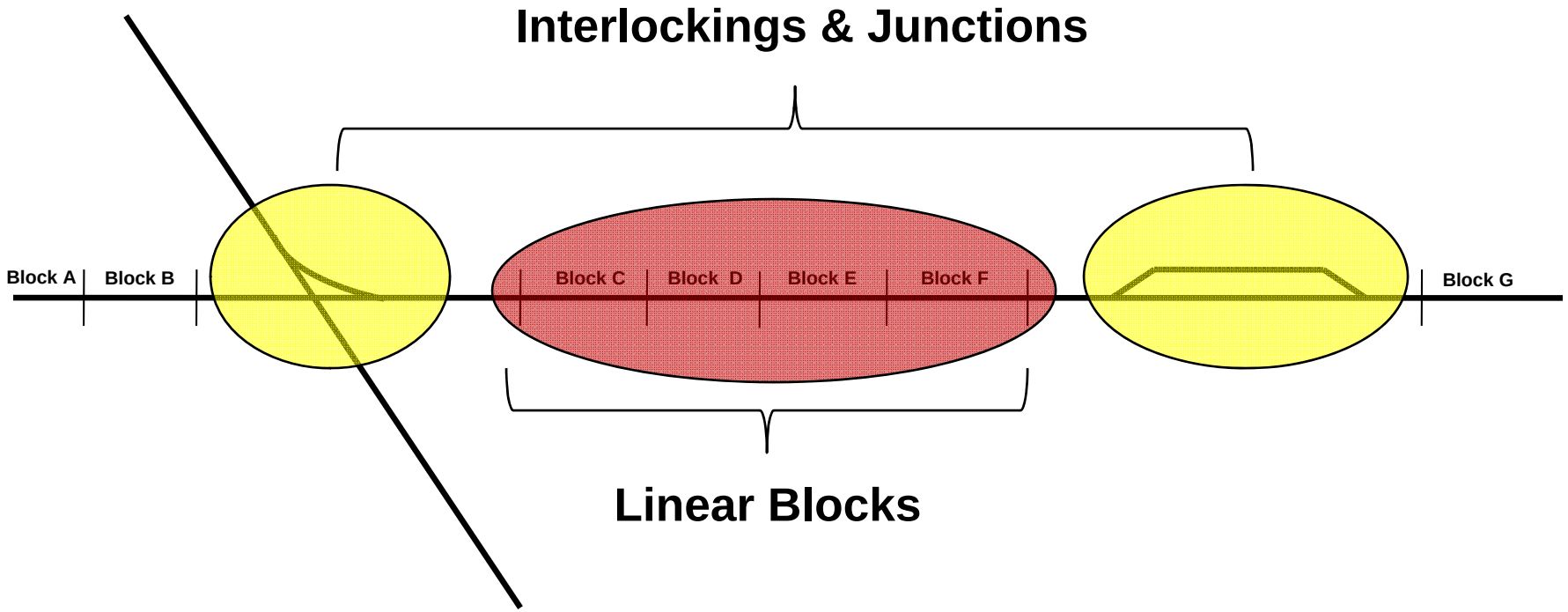
Key historical events

- 1840: Ball signals: LTC Rolt
- 1841: Semaphore – Charles Gregory
- 1851:Telegraph – Chas Minot
- 1870: Track Circuit – William Robinson
- 1871: Disk (Banjo) Signal – Thomas Hall
- 1904: Color light signals – William Churchill
- 1915: Position-light signals – Arthur Rudd
- 1920: Searchlight Signals – Hall Signal Co.
- 1924: Color Position signals – Frank Patenall
- 1925: Tri-color (G type) signals - GRS

Signals: 3 key questions

1. What degree of prototype accuracy can do you want to achieve?
2. What era and region are you modeling?
3. How much can you afford?

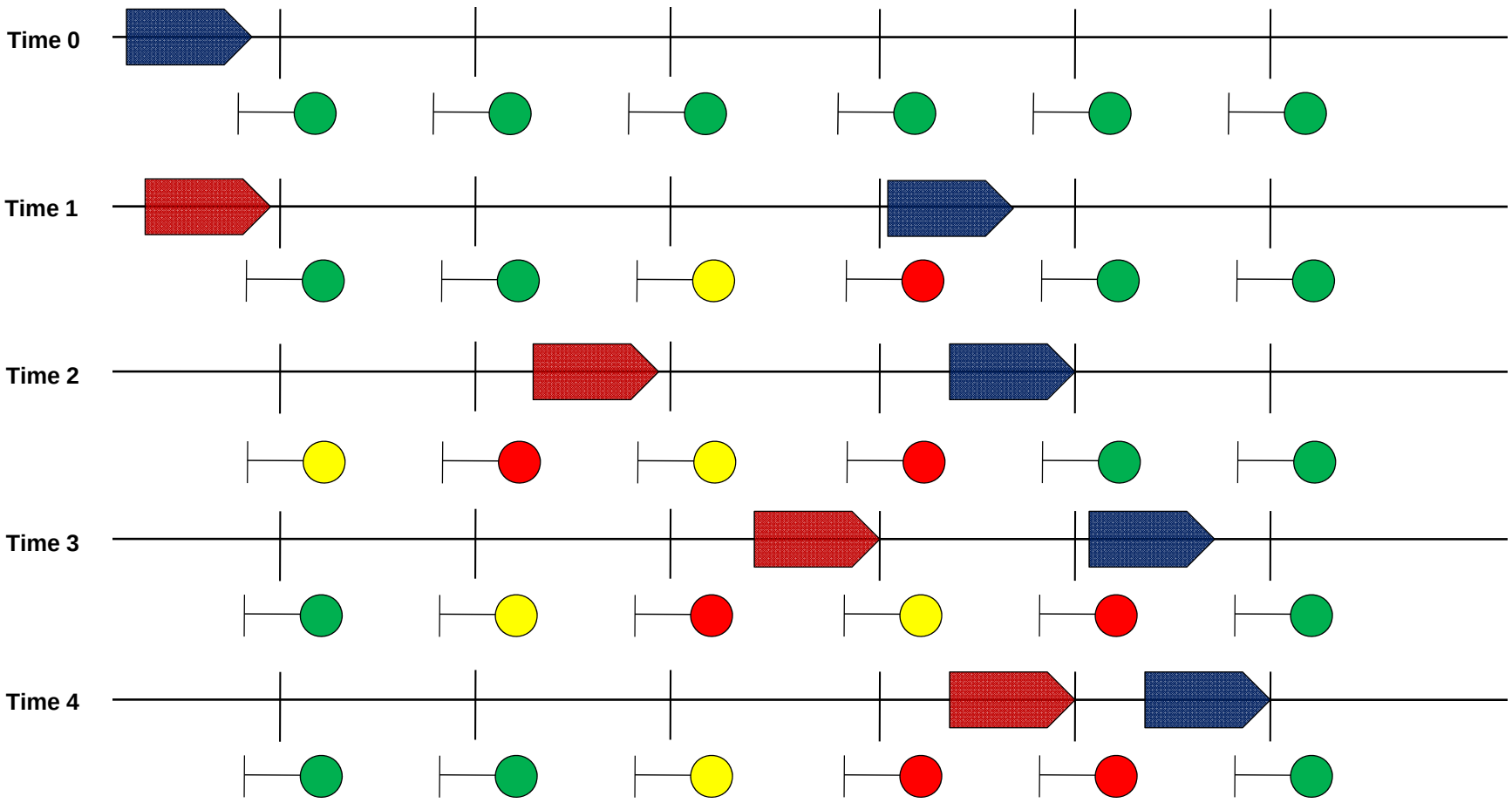
Two types of “regions”



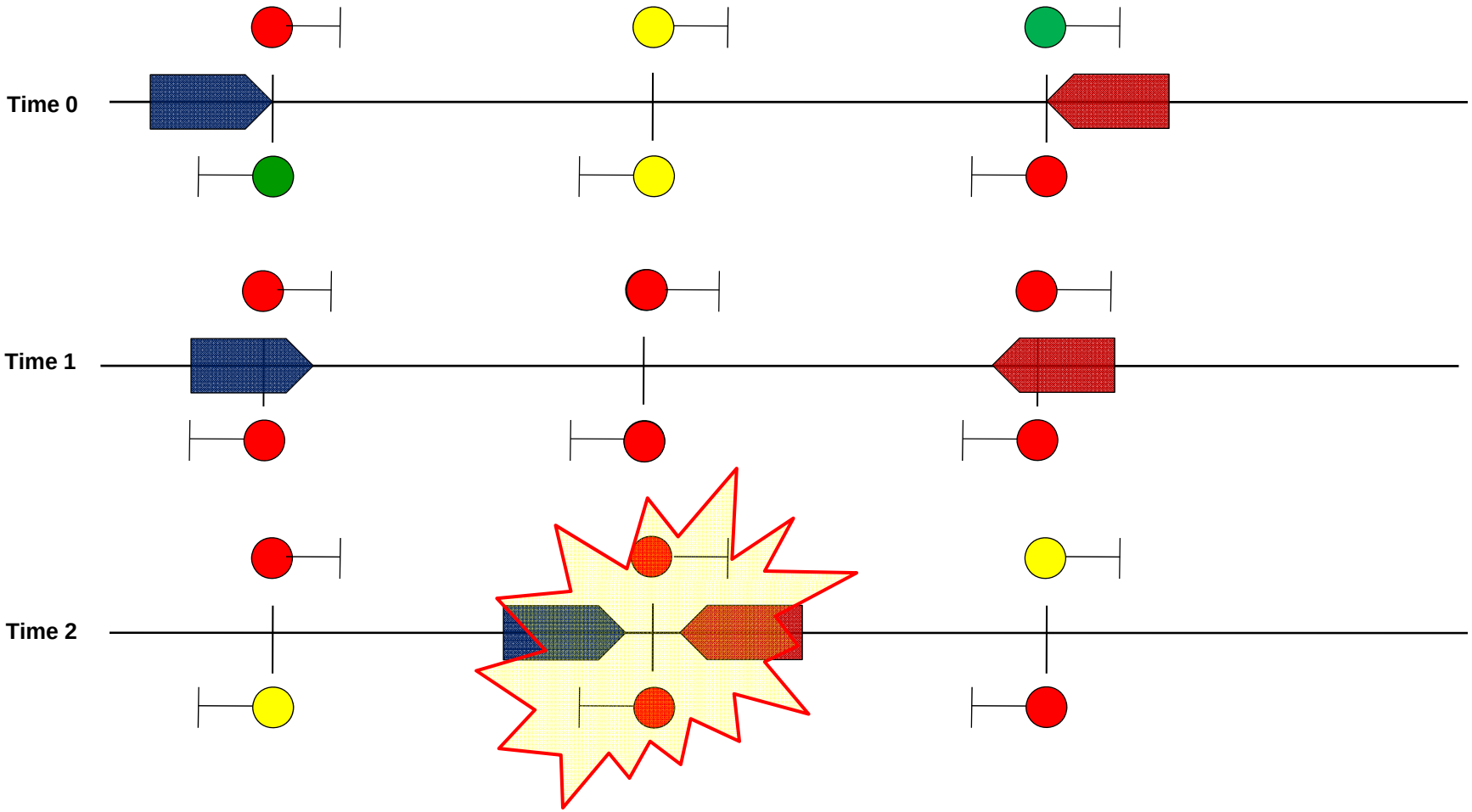
The Distinctions

- Linear blocks
  - **Unsupervised** (e.g. totally automated)
  - Default is “clear” or “green”
  - ABS (Automated Block Signaling)
  - APS (Absolute Permissive Signaling)
- Interlockings (Junctions & Sidings)
  - **Manually operated** (e.g. human controlled)
  - Default is “stop” or “red”
  - Mechanical interlocks
  - US&S panels
  - Computerized CTC

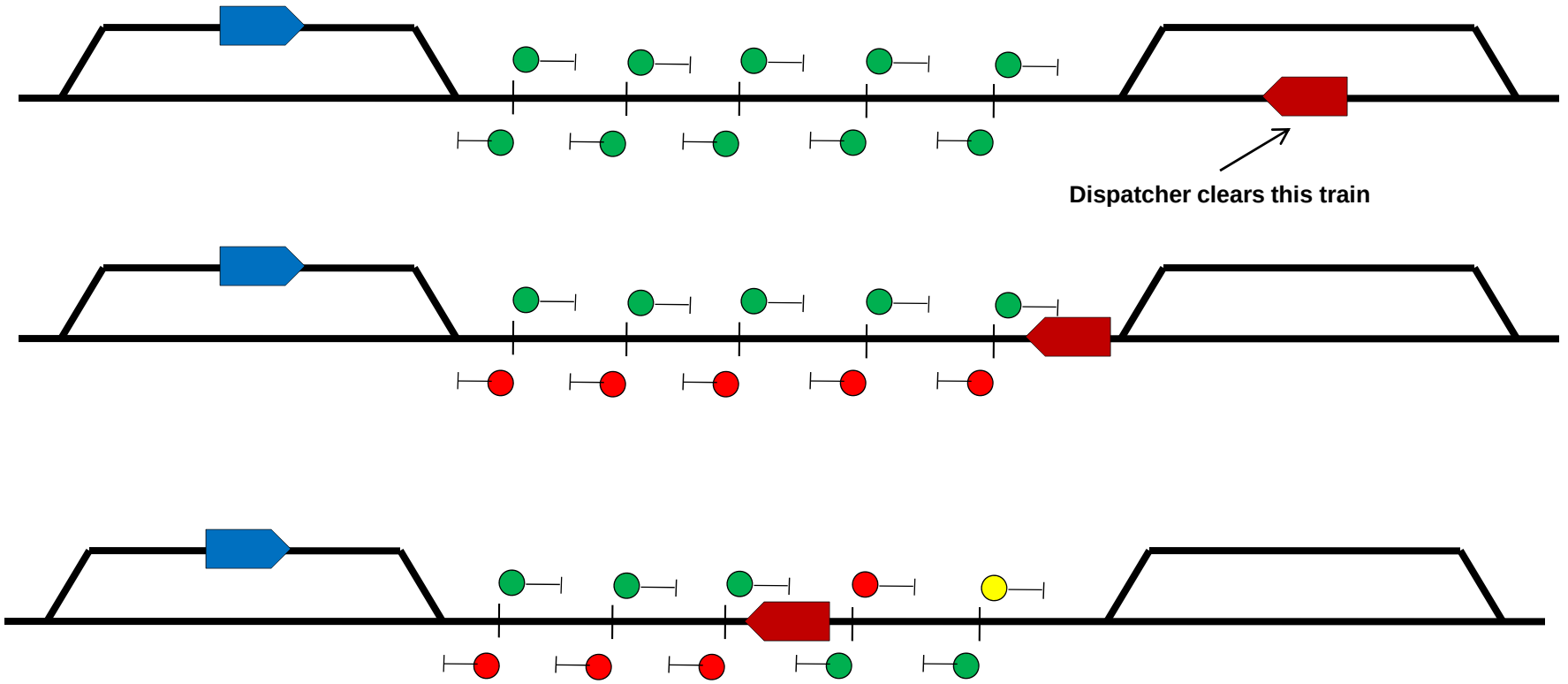
ABS



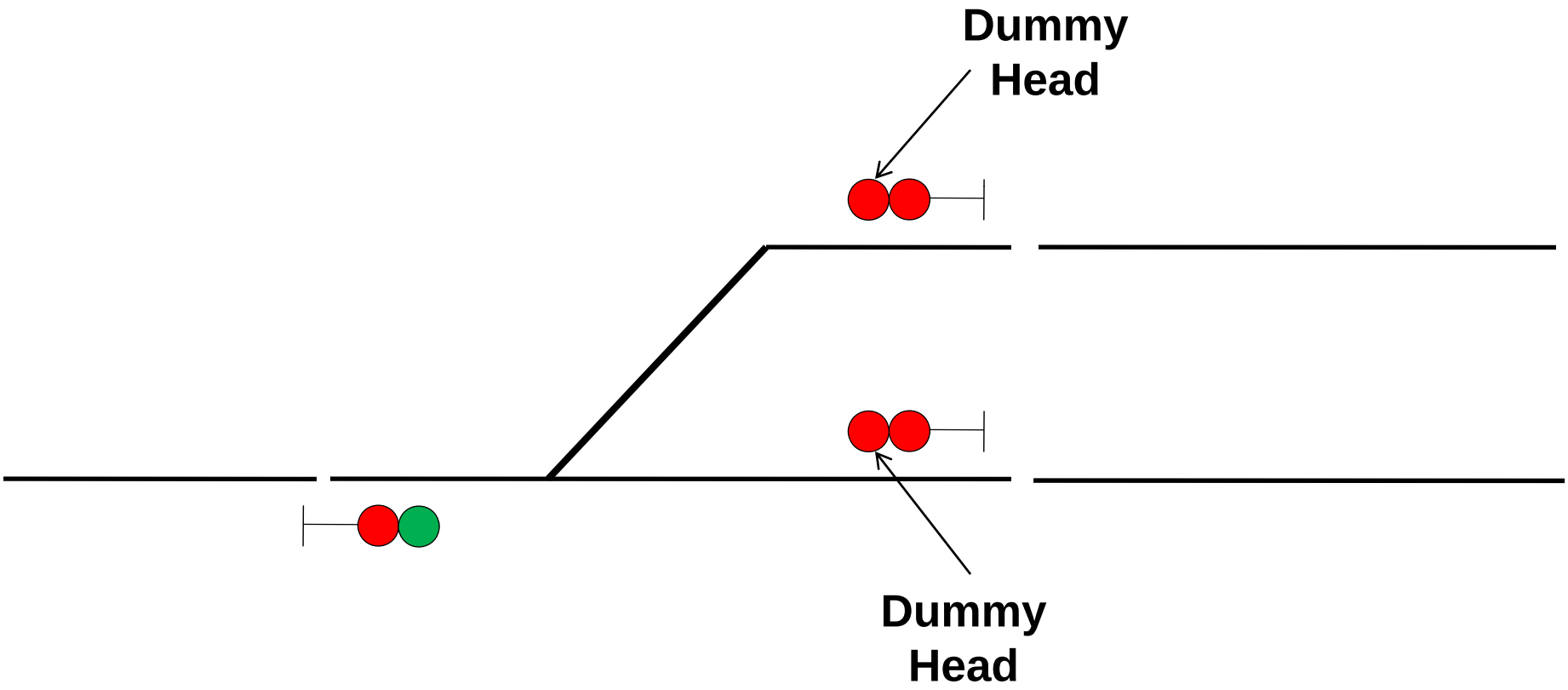
ABS - weakness



APB



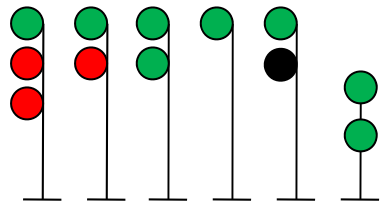
The “OS” section



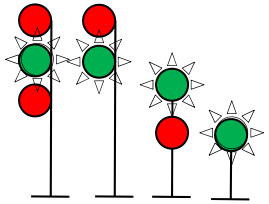
Aspect Combinatorics

UPPER HEAD	LOWER HEAD	ASPECT
GREEN	GREEN	**281**
GREEN	YELLOW	Not Used
GREEN	RED	**281**
YELLOW	GREEN	282
YELLOW	YELLOW	284
YELLOW	RED	285
RED	GREEN	283
RED	YELLOW	290
RED	RED	291

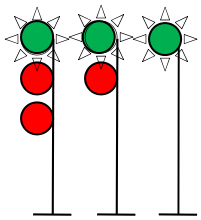
Aspects: NORAC*



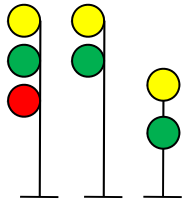
Rule: 281
Name: Clear
Indication: Proceed not exceeding Normal Speed



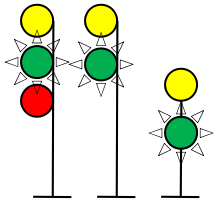
Rule: 281c
Name: Limited Clear
Indication: Proceed at Limited Speed until entire train clears all interlocking or spring switches



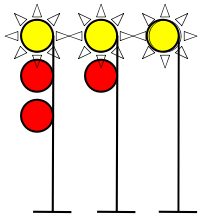
Rule: 281a
Name: Cab Speed
Indication: Proceed in accordance with cab signal indication



Rule: 282
Name: Approach Medium
Indication: Proceed approaching the next signal at Medium Speed



Rule: 281b
Name: Approach Limited
Indication: Proceed approaching the next signal at Limited Speed

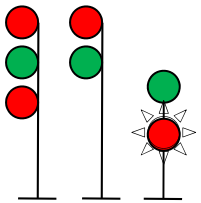


Rule: 282a
Name: Advance Approach
Indication: Proceed prepared to stop at the second signal. Trains exceeding Limited Speed must reduce to Limited Speed as engine passed the signal

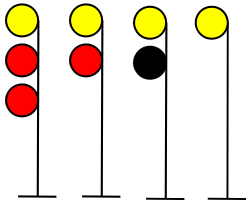
*** 9th Edition, 2008**

- Flashing

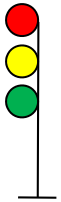
Aspects: NORAC* (cont)



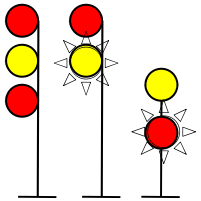
Rule: 283
Name: Medium-Clear
Indication: Proceed at Medium Speed until entire train clears all interlocking or spring switches, then proceed at Normal Speed



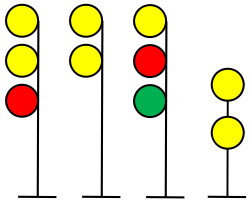
Rule: 285
Name: Approach
Indication: Proceed prepared to stop at the next signal. Reduce to Medium Speed as engine passes signal



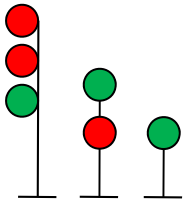
Rule: 283a
Name: Medium Approach Medium
Indication: Proceed at Medium Speed until entire train clears all interlocking or spring switches, then approach next signal at Medium Speed



Rule: 286
Name: Medium Approach
Indication: Proceed prepared to stop at the next signal. Reduce to Medium Speed as soon as signal is clearly visible



Rule: 284
Name: Approach Slow
Indication: Proceed approaching the next signal at Slow Speed

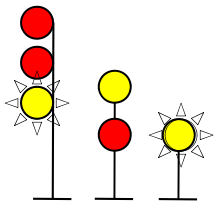


Rule: 287
Name: Slow Clear
Indication: Proceed at Slow Speed until entire train clears all interlocking or spring switches, then proceed at Normal Speed

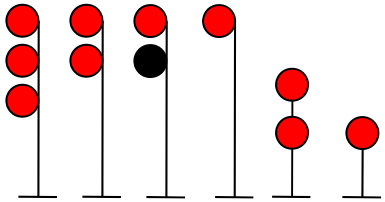
*** 9th Edition, 2008**

- Flashing

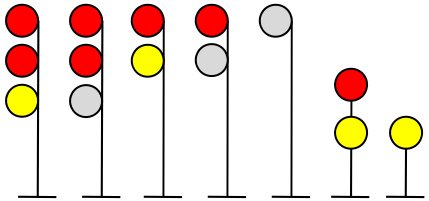
Aspects: NORAC* (cont)



Rule: 288
Name: Slow Approach
Indication: Proceed at Slow Speed until entire train clears all interlocking or spring switches, then proceed at Medium Speed

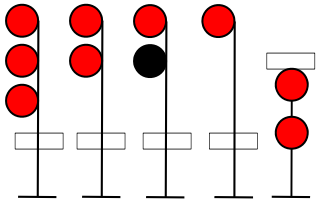


Rule: 292
Name: Stop Signal
Indication: Stop

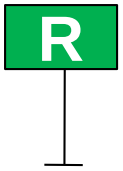


Rule: 290
Name: Restricting
Indication: Proceed at Restricted Speed until entire train clears all interlocking or spring switches and leading wheels have 1) passed a more favorable signal or 2) entered non-signaled territory.

Rule: 296b
Name: Speed Limit Sign
Indication: Proceed at speed posted on the Approach Speed Limit Sign until entire train has passed the Resume Speed Sign



Rule: 291
Name: Stop and Proceed
Indication: Stop then proceed at Restricted Speed until leading wheels have 1) passed a more favorable signal or 2) entered non-signaled territory

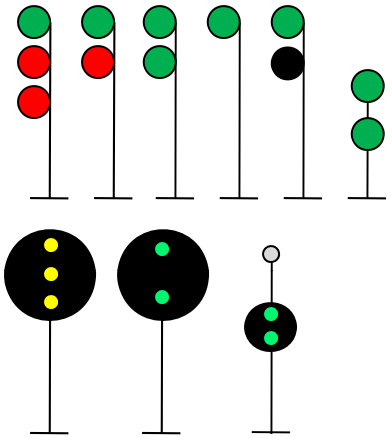


Rule: 296c
Name: Resume Speed Sign
Indication: Resume speed after entire train has passed the Resume Speed Sign

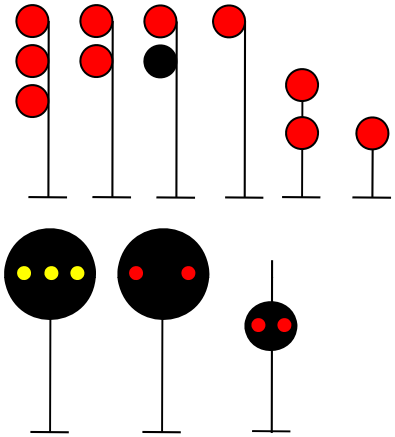
*** 9th Edition, 2008**

- Flashing

The Modeler's Aspects



Rule: 281
Name: Clear
Indication: Proceed not exceeding Normal Speed



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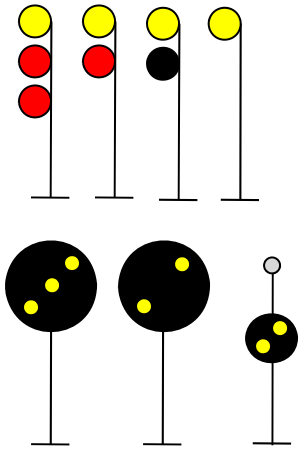
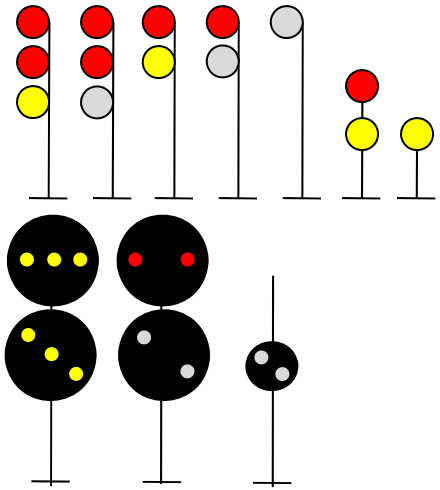
Indication: Stop

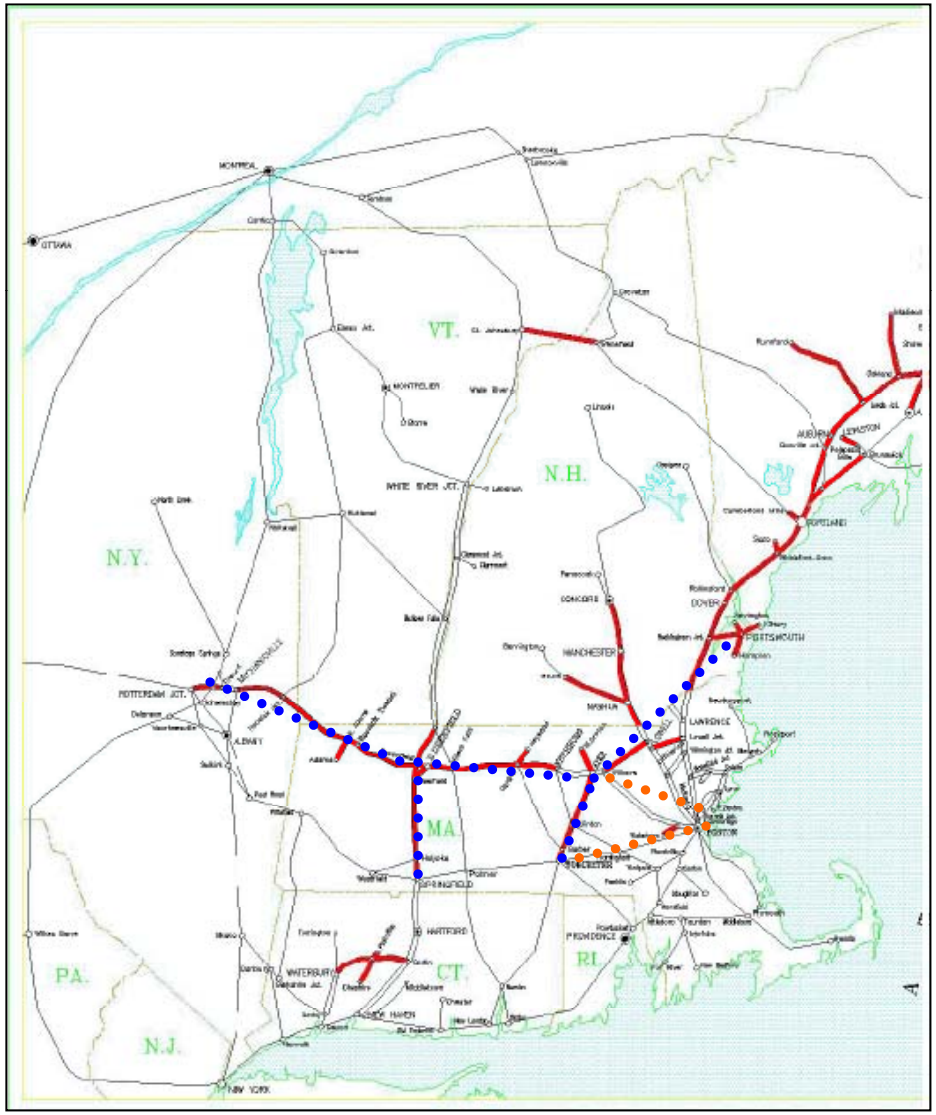


Rule: 285
Name: Approach
Indication: Proceed prepared to stop at the next signal. Reduce to Medium Speed as engine passes signal

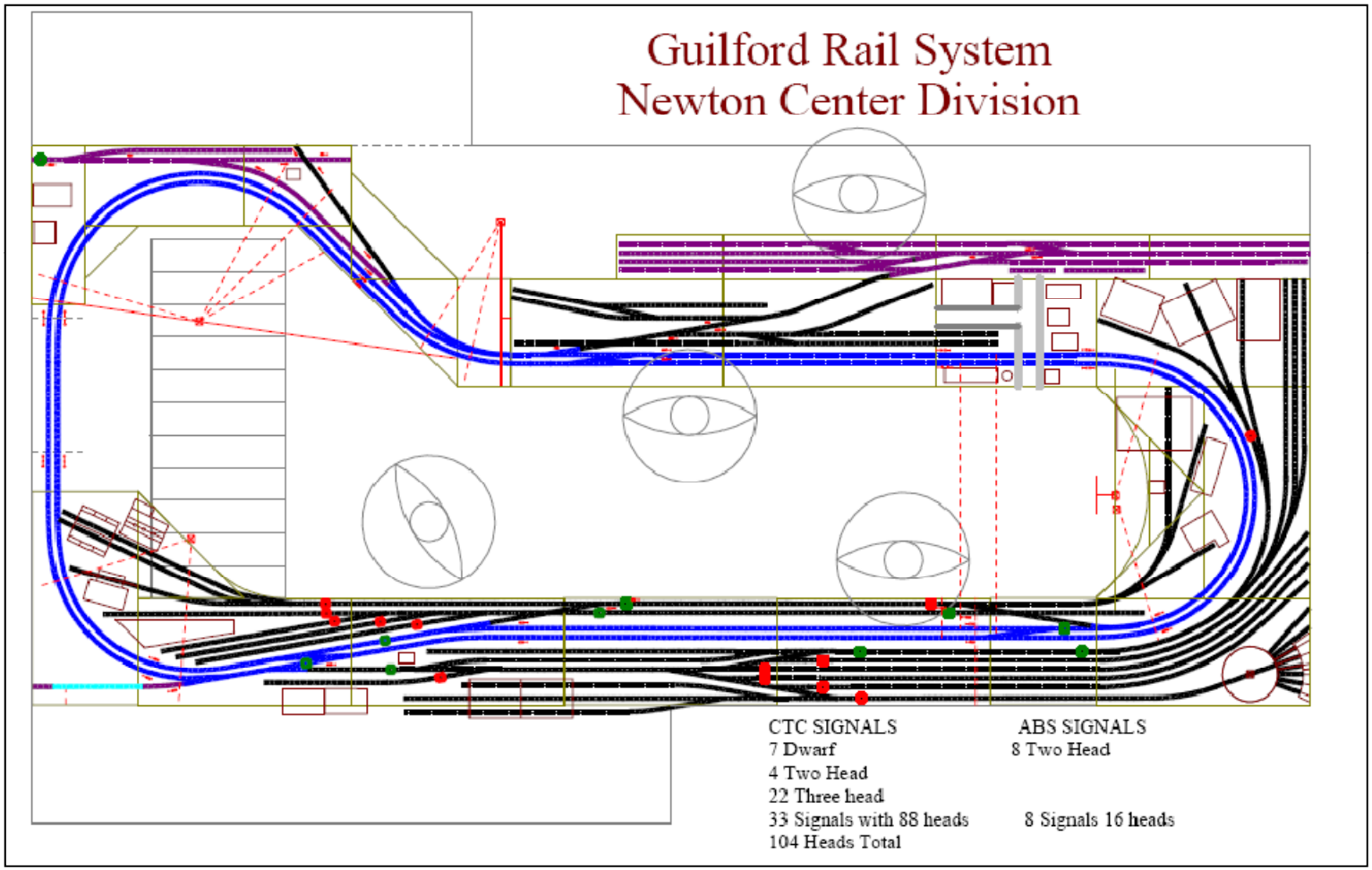


Rule: 290
Name: Restricting
Indication: Proceed at Restricted Speed until entire train clears all interlocking or spring switches and leading wheels have 1) passed a more favorable signal or 2) entered non-signaled territory.

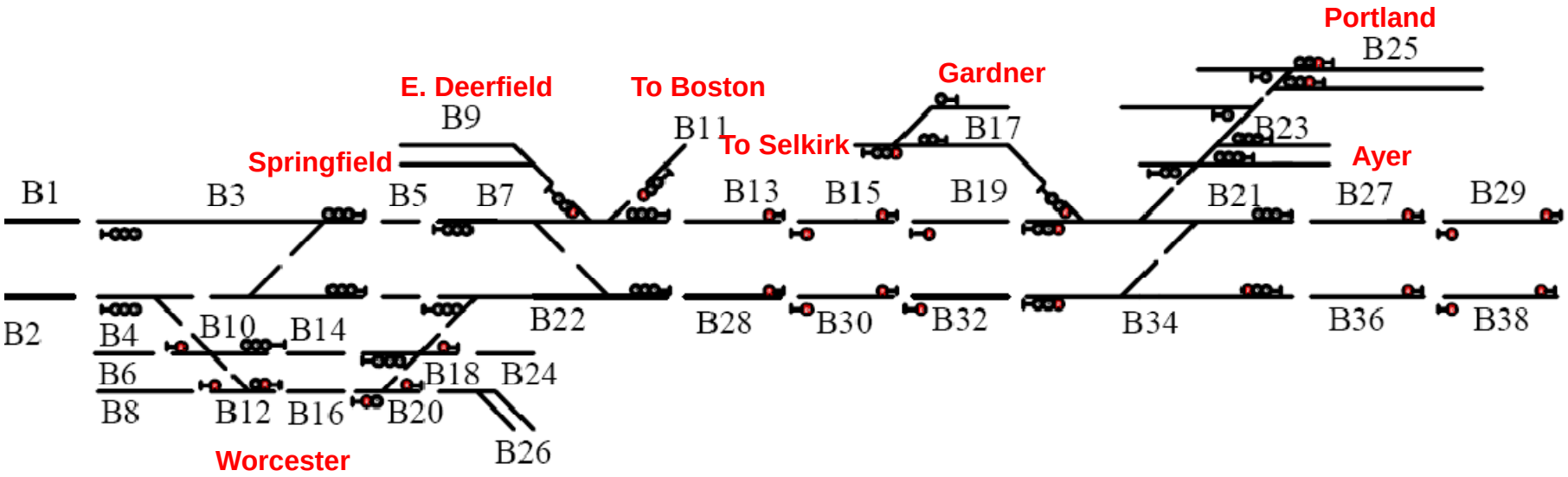
Create a linear schematic



Create a linear schematic



Create a linear schematic



- **Label blocks**
- **Label signals (Name east/west or north/south)**
- **What's CTC and what's block trackage between CTC**

Three key implementation questions

- What is the incoming information needed and how do I get it?
- How do I process the incoming information?
- How do I output the processed information?

Inputs

- Where are my trains?
- What direction are they moving?
- What train is it?
- How are my turnouts set?

Detection

Method	Isolated from Track Power	Reliability	Modification of Rolling Stock	Cost
Reed Switches	Yes	Fair	Yes	High
Optical	Yes	Fair	No	Low
Infrared	Yes	Good	No	High
Twin-T	No	Very Good	Yes	Medium
Induction	Yes	Very Good	Yes	Low

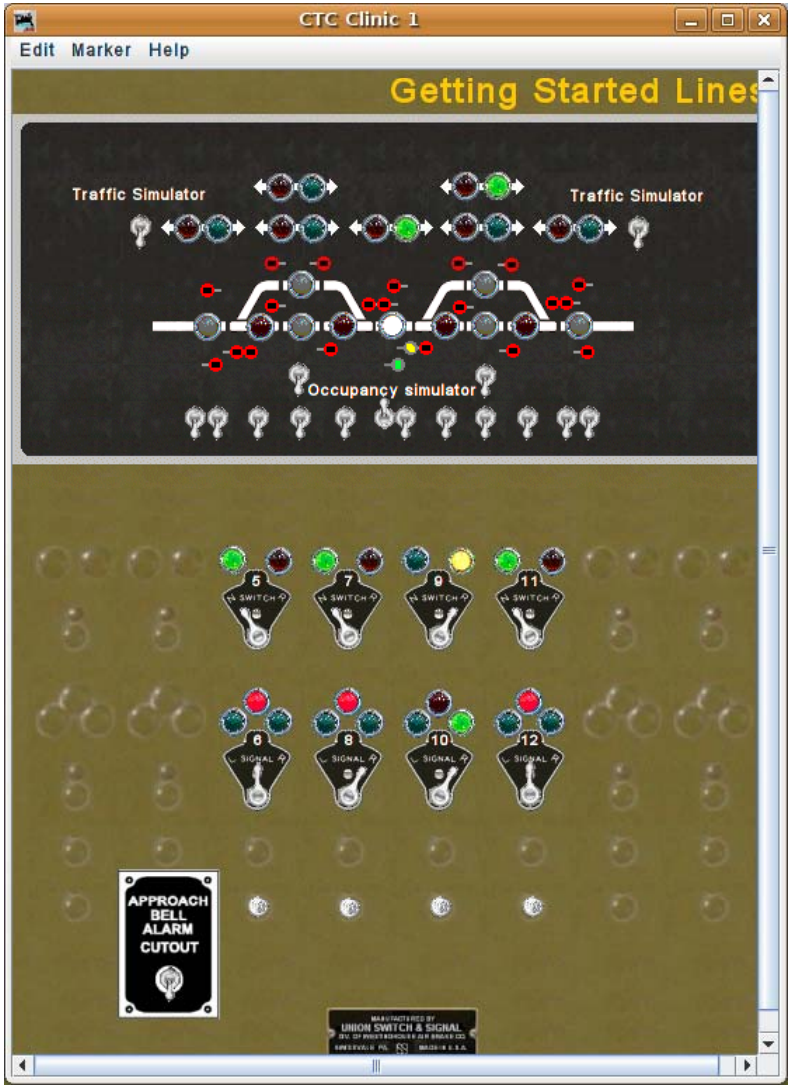
Processing

- Hardware
  - Logic Rail
  - Custom Signals (Atlas)
  - Integrated Signal Systems
  - Circuitron
  - Dallee
- Software
  - JMRI
  - CMRI
  - Railroad & Co
  - Signals by Spreadsheet

Outputs

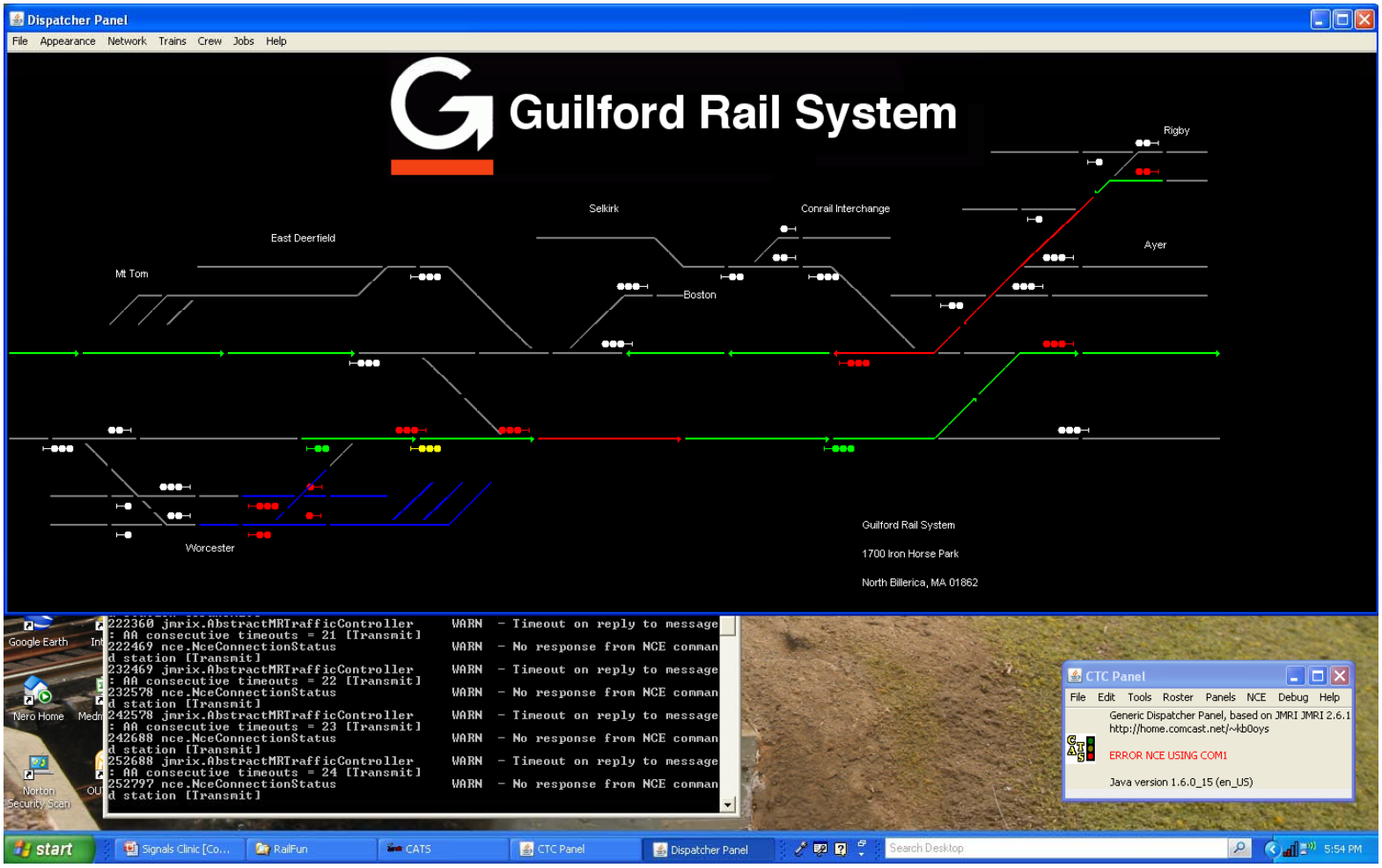
- Strictly hardware
  - Gets complex and expensive with more complex track plans
  - Less flexible
- Hardware and Software
  - More flexible
  - Requires programming (somehow)

Controlling the System

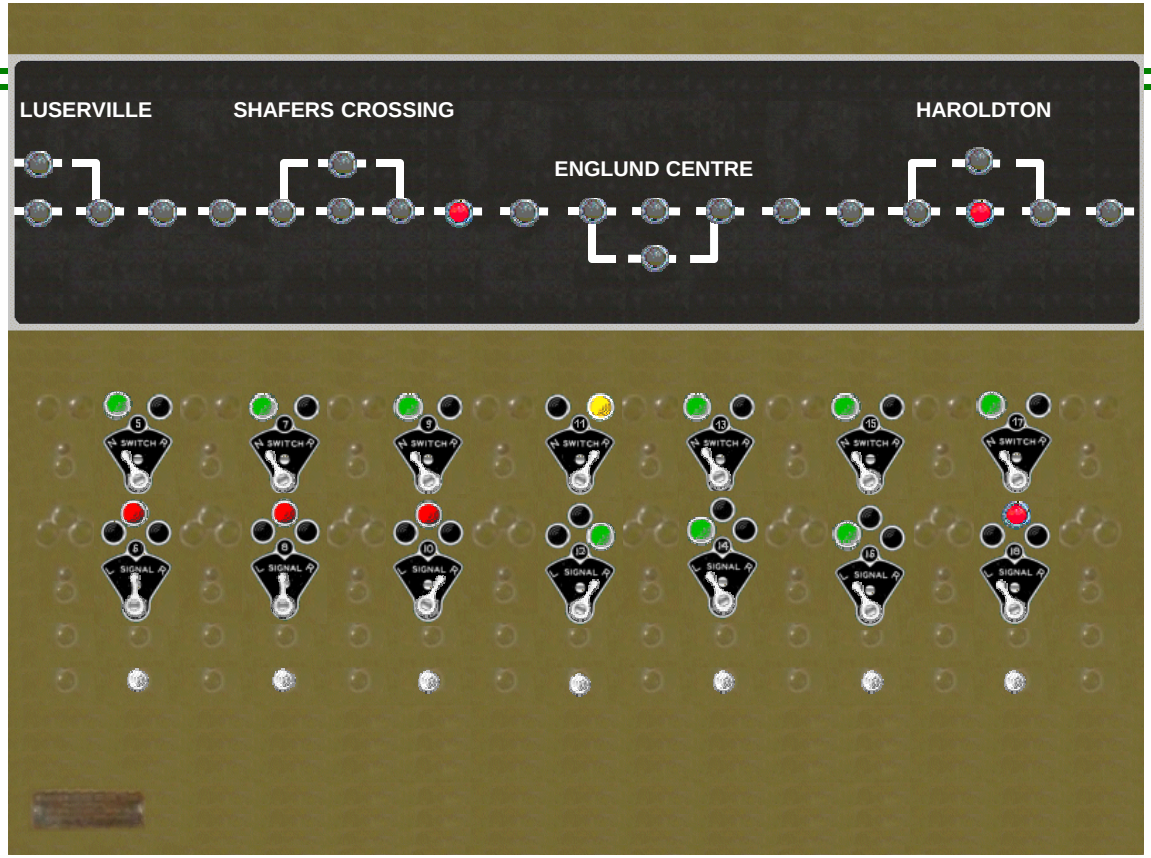


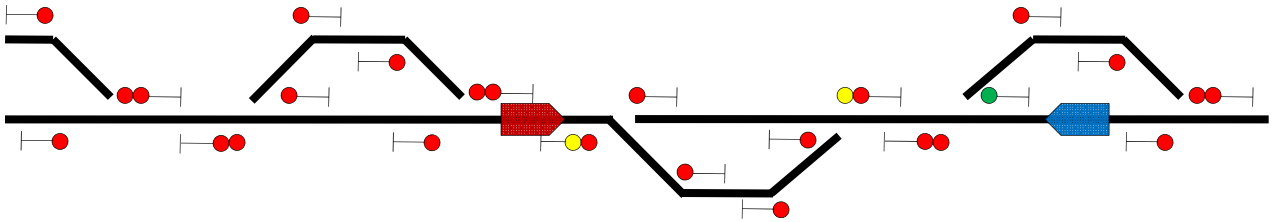
Screen shot from Dick Bronson's Hartford National Clinics

CATS

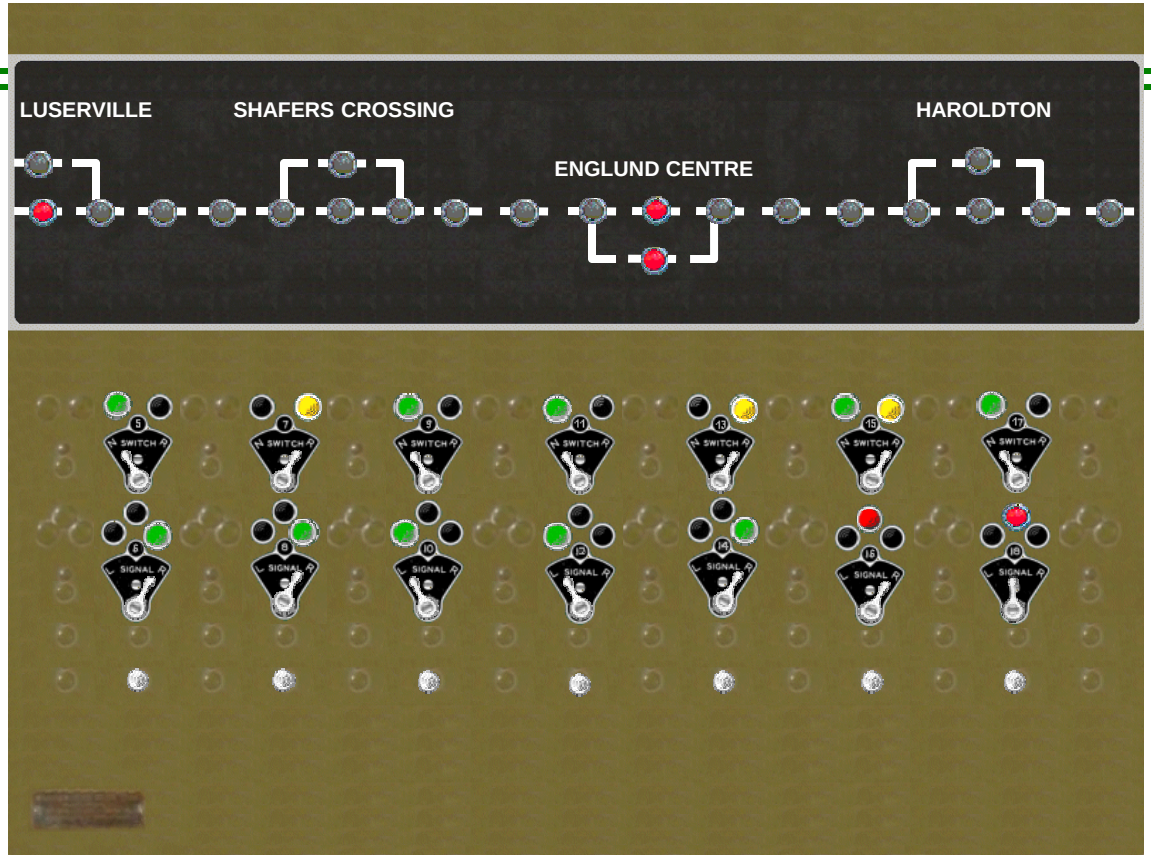

Dispatcher Panel
File Appearance Network Trains Crew Jobs Help
Guilford Rail System
Rigby
Selkirk
Conrail Interchange
East Deerfield
Ayer
Mt Tom
Boston
Worcester
Guilford Rail System
1700 Iron Horse Park
North Billerica, MA 01862
222360 jmrix.AbstractMRTrafficController WARN - Timeout on reply to message
: AA consecutive timeouts = 21 [Transmit]
222469 nce.NceConnectionStatus WARN - No response from NCE comman
d station [Transmit]
232469 jmrix.AbstractMRTrafficController WARN - Timeout on reply to message
: AA consecutive timeouts = 22 [Transmit]
232578 nce.NceConnectionStatus WARN - No response from NCE comman
d station [Transmit]
242578 jmrix.AbstractMRTrafficController WARN - Timeout on reply to message
: AA consecutive timeouts = 23 [Transmit]
242688 nce.NceConnectionStatus WARN - No response from NCE comman
d station [Transmit]
252688 jmrix.AbstractMRTrafficController WARN - Timeout on reply to message
: AA consecutive timeouts = 24 [Transmit]
252797 nce.NceConnectionStatus WARN - No response from NCE comman
d station [Transmit]
CTC Panel
File Edit Tools Roster Panels NCE Debug Help
Generic Dispatcher Panel, based on JMRI JMRI 2.6.1
http://home.comcast.net/~kb0oys
ERROR NCE USING COM1
Java version 1.6.0_15 (en_US)
start
Signals Clinic [Co...
RailFun
CATS
CTC Panel
Dispatcher Panel
Search Desktop
5:54 PM

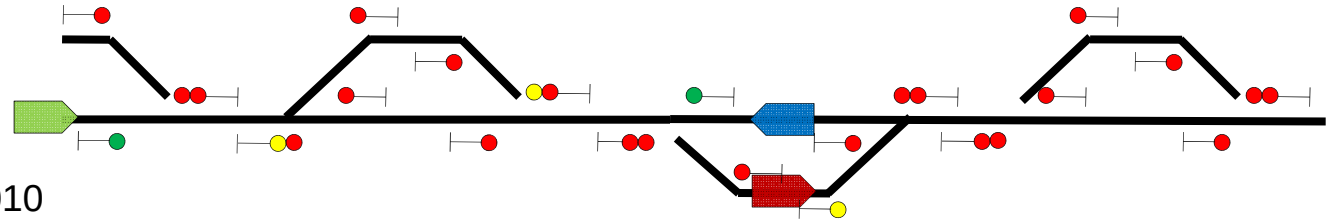
Controlling the System



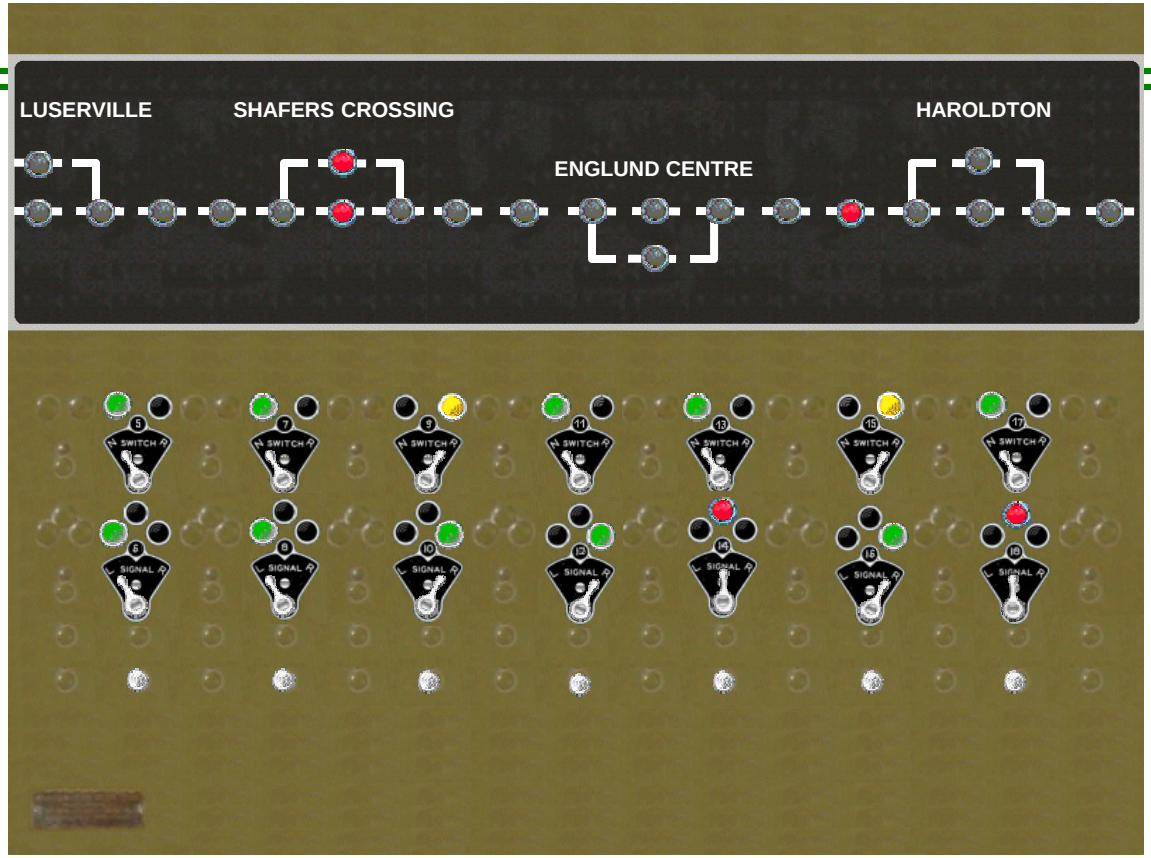


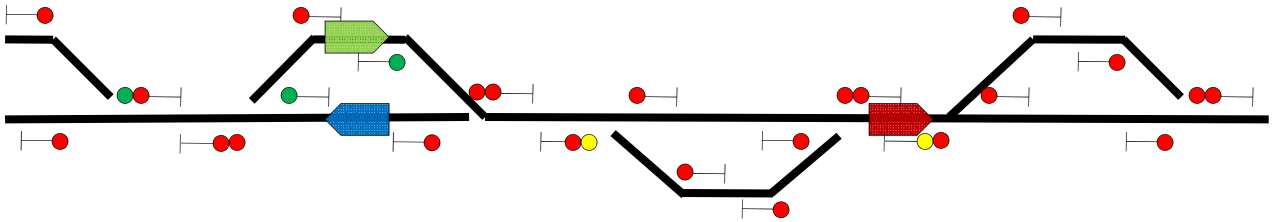
Controlling the System



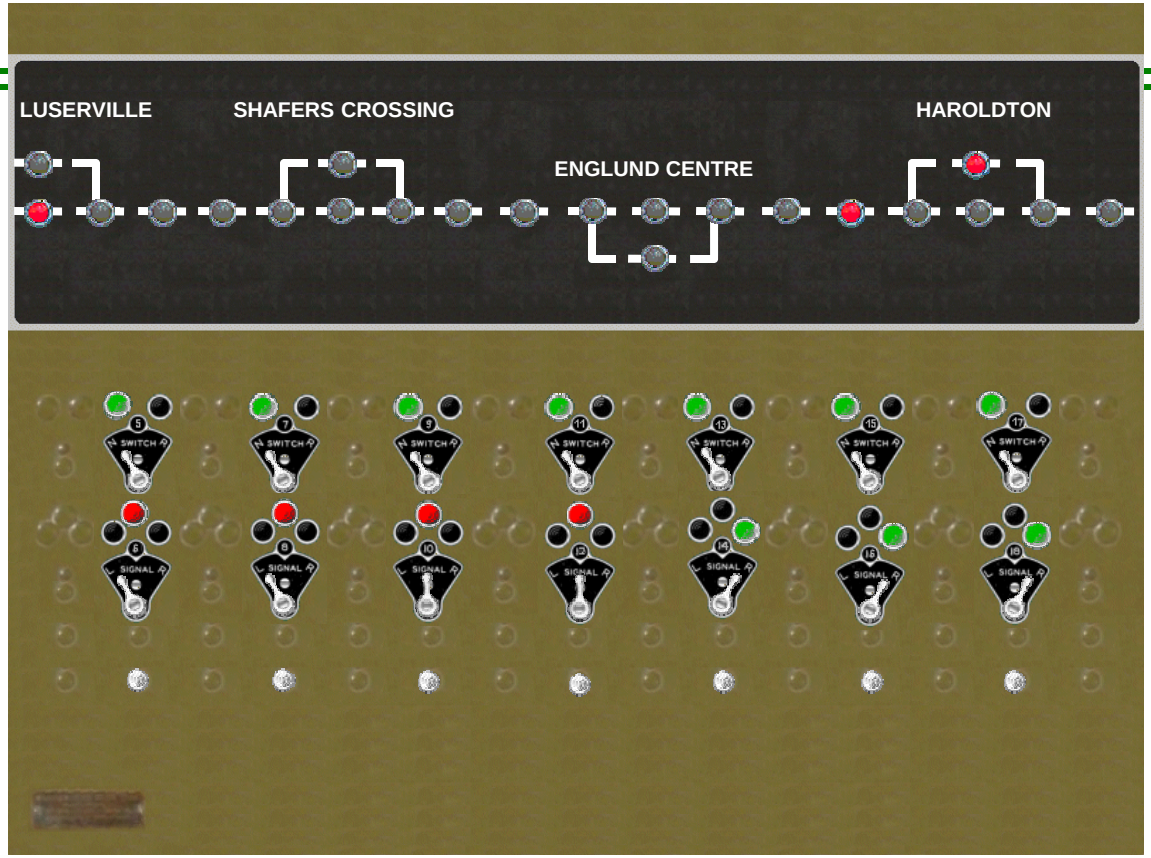


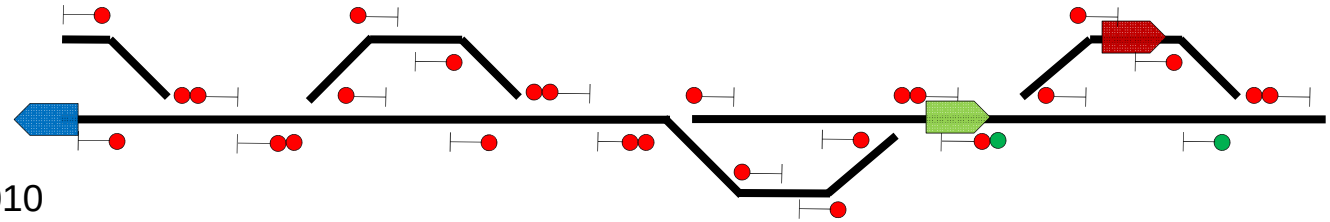
Controlling the System



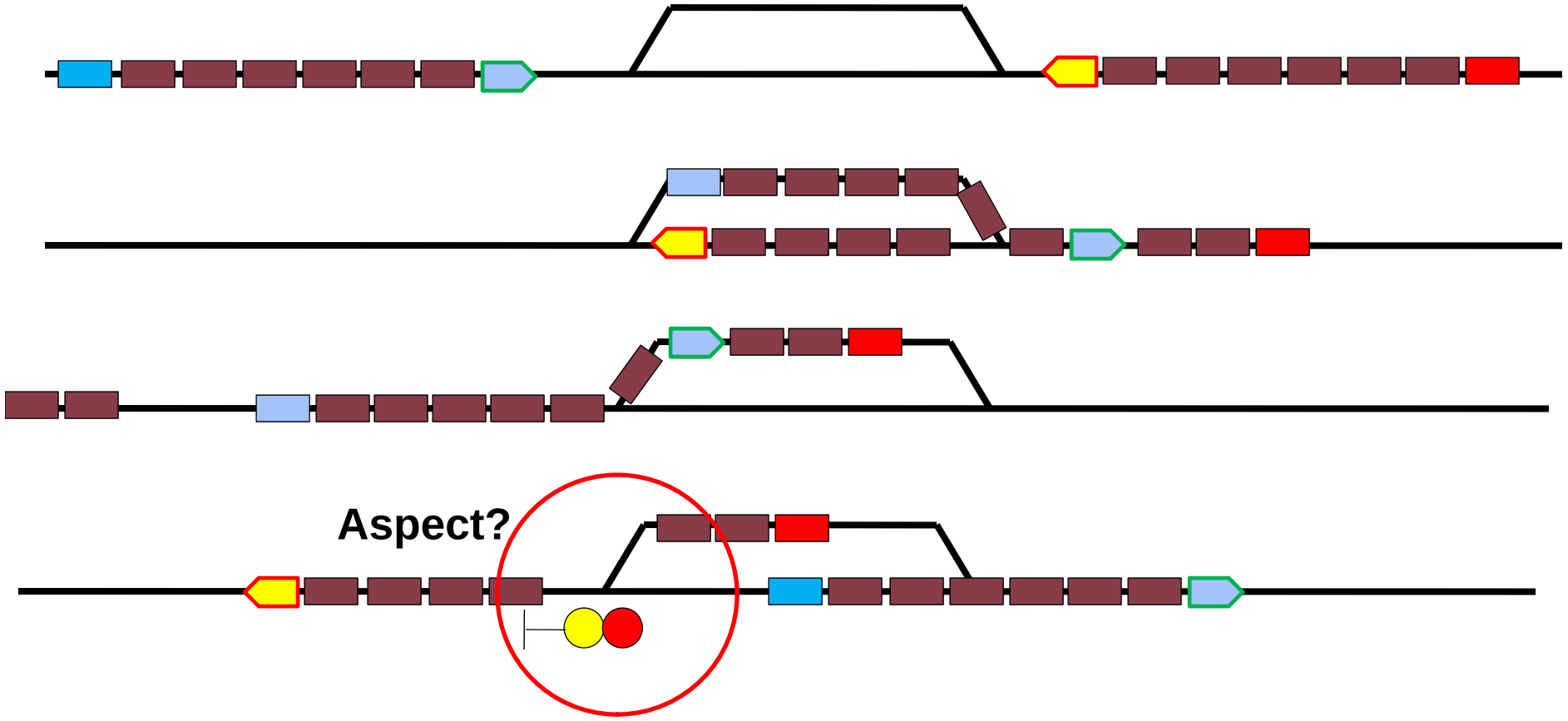


Controlling the System





The double saw-by



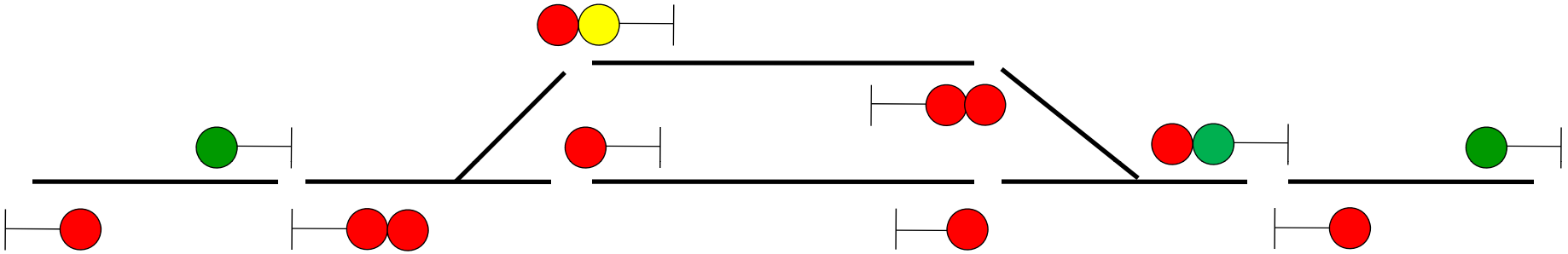
Choices

- Ignore interlockings and just do ABS/APS
- Just do 1 or a few interlocks and ignore the “blocks” in between
- How long is a block?
  - 3 average train lengths?
  - 100 scale feet?
- How many aspects?
- Dark areas? How do you handle them?

Consider emulation

- Block or signal animators
  - Logic rail
  - Circuitron
- Just use Red/Green indications for R/N position at turnouts
- Will look pretty good and unless you are actually using them to operate may suffice

A passing siding



6 detectors	$ 78
10 Signals	$ 340
16 signal heads to illuminate	$ 199
2 tortoises and DCC decoders	$ 60
	$677

The Future?

Cab Signals

- Leg up for the modern modeler?
- No fixed signals
- Location, direction & speed
- DCC throttles with LCDs
- BiDirectional DCC
- Could stop locomotive

References (Books)

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- *Railroad Operation and Railway Signaling.* Edmund J Phillips. Simmons-Boardman 1942
- *Compendium of Signals.* Roger F.R Karl. Boynton, 1971.
- *All About Signals.* John Armstrong, Kalmbach, 1967.

References (Web Sites)

- Carsten Lundstens site: *http://www.lundsten.dk/us_signaling/index.html*
- Norac Simulator: *http://raildata.railfan.net/java/DivRte/NORAC.htm*
- Railroad Signals: *http://www.railroadsignals.net/*
- Railroad Signals of the US: *http://www.railroadsignals.us/*
- JMRI: *http://jmri.sourceforge.net/*
- CATS: *http://home.comcast.net/~kb0oys/*
- CMRI: *http://www.jlcenterprises.net/*
- Custom Signals**:** *http://www.customsignals.com/*
- ISS: *http://www.integratedsignalsystems.com/*
- Signals by Spreadsheet: *http://www.signalsbyspreadsheet.com/*
- Railroad Circuits: http://rr-cirkits.com/
- Logic Rail: *http://www.logicrailtech.com/*

References (Journals)

- Operating signals with software. *Model Railroader, October 2007, page 50.*
- The Computer/Model Railroad Interface - A Case Study**.** *Model Railroading, December 1999/January 2000, page 32.*
- Using State-of-the-art Electronics to Enhance Operation. *NMRA Bulletin, March 2007 page 38.*
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THANK YOU