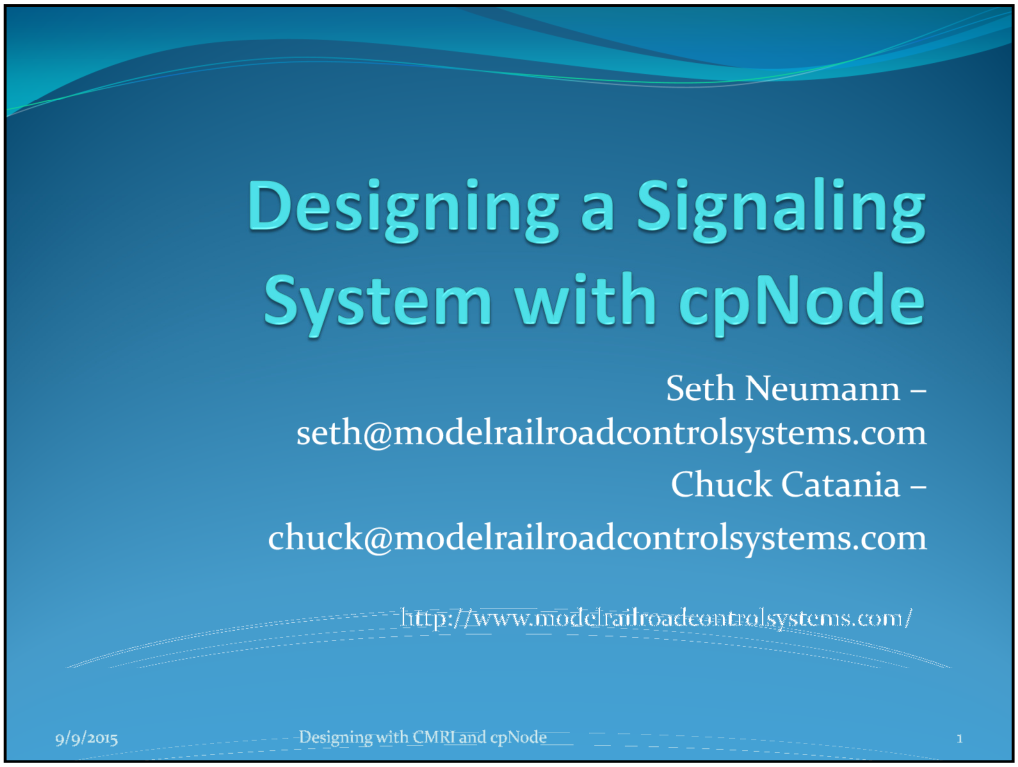


Just a bit by way of introduction this was meant to be part two of a three part series, the first of which is introduction to signaling. We ran out of time on the general signaling clinic. There are a couple of clinics around on this (Chubb, Bronson) and Steve Davis' recent two part article in the DO. The third clinic will be "installing a CMRInet system using cpNode" We've been building a new generation of CMRI hardware for for two years now. A Bruce Chubb first introduced CMRI in 1985, this is in fact the thirtieth year and we will be having a CMRI Thirty! Celebration on Thursday night. Do drop in and see us! Bruce Chubb will be there. Historically, Bruce had been doing fairly major updates on about a ten year clock to take advantage of technology improvements and move down the cost curve and improve function. The last major update was in 2002 and at this point he is not going to do another spin.

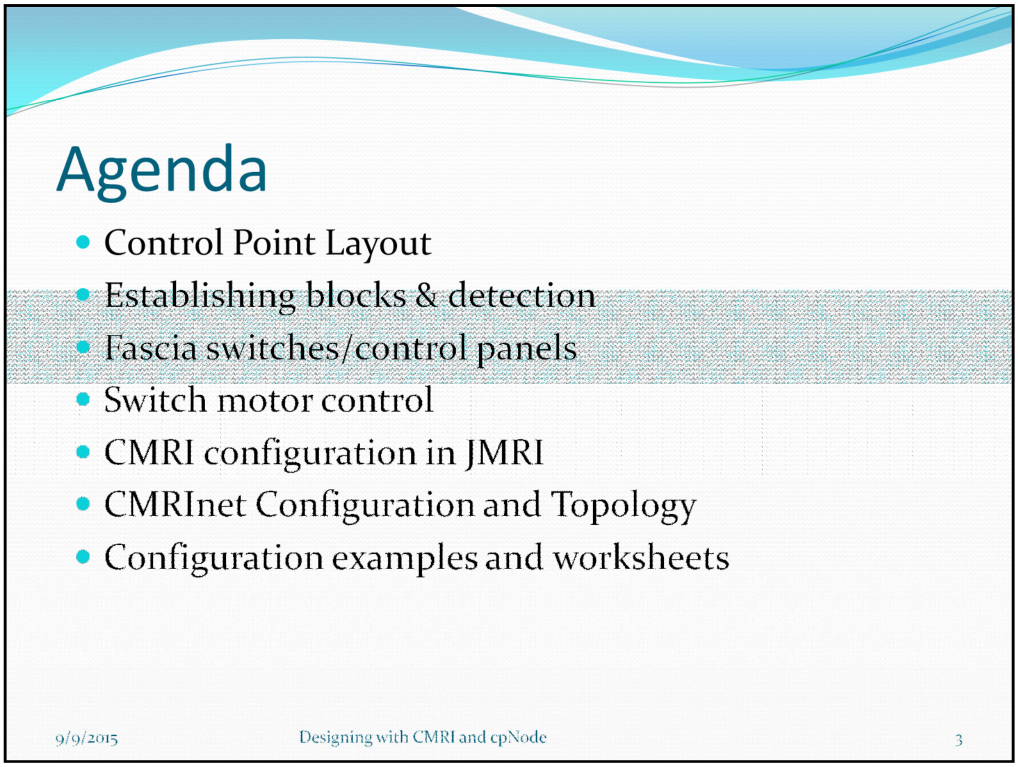
Assumptions:

- This clinic is focused on implementing a signaling system using cpNodes, CMRInet and JMRI
- You know what you want to model
- You are generally familiar with principles of Railroad Signaling – did you attend Dr. Chubb's clinic?
- You know something about JMRI or CATS and will be using a computer to control signaling on your railroad
- "Hard" CTC machines can be done easily with cpNode but we recommend going to the considerable effort and expense of a hard panel only after the design is proven on a "glass" panel

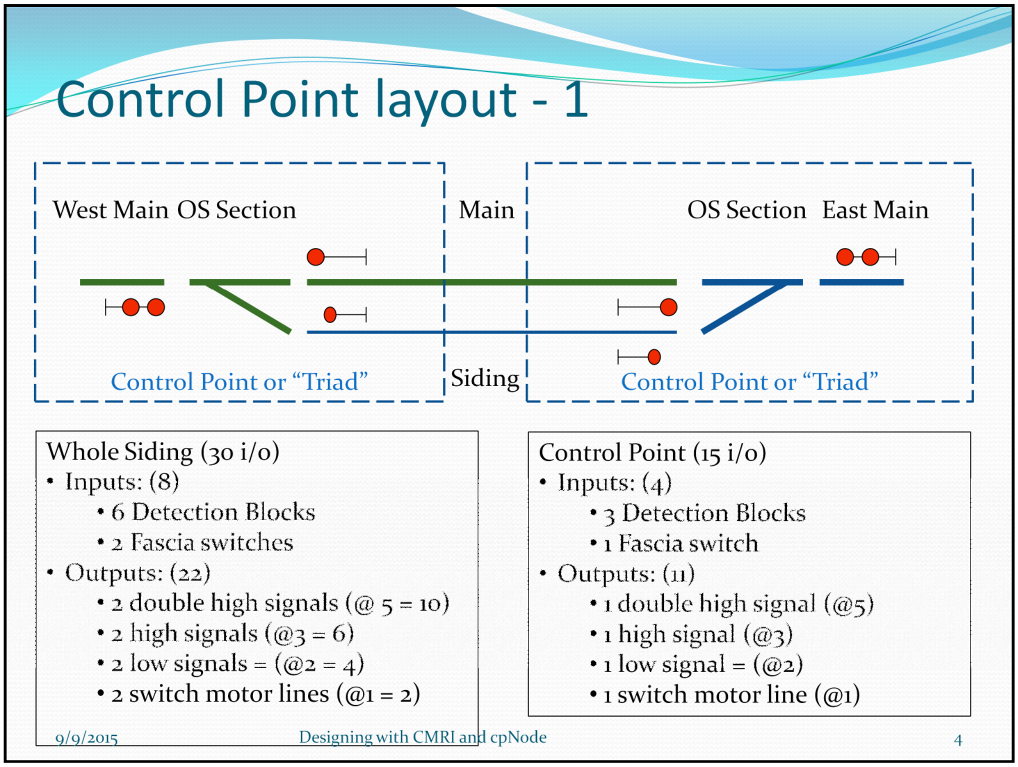
We've been building a new generation of CMRI hardware for two years now. Bruce Chubb first introduced CMRI in 1985, this is the thirtieth year and see we will be having a CMRI/30!! celebration at the PDX (Portland) convention on Thursday night. Drop in and see us! Bruce will be there and the whole CMRI Community is invited. Historically, Bruce had been doing fairly major updates on about a ten your clock to take advantage of technology improvements and move down the cost curve and improve function. The last major update was in 2002 and at this point he is really doesn't have the energy to do another spin.

In 2002 we were still using a lot of through hole components and PICs. In the meantime prices come have down and really favor surface mount components. The other big change has been low end programmable processors on a circuit boards aimed at experimenters, in particular robotics. Arduino is the most popular type and the type we settled on for cpNode. Arduino Uno is a very popular version. We use a slightly different one (Leonardo) but what we're trying to do is continue the idea of an open platform that model railroaders can use. We wanted to take advantage of the cost curves driven by the larger experimenter hobbyist community and we wanted to open up the software on the node. Bruce opened up the hardware and the software at the computer, but with a PIC controlling the node you really couldn't do much to change the node with so if you want to do Analog to Digital conversion on the input or PWM on the output you need to use external hardware. Likewise the if you wanted to change allocation of input and output ports you needed to change hardware, which led to a lot of stranded i/o.

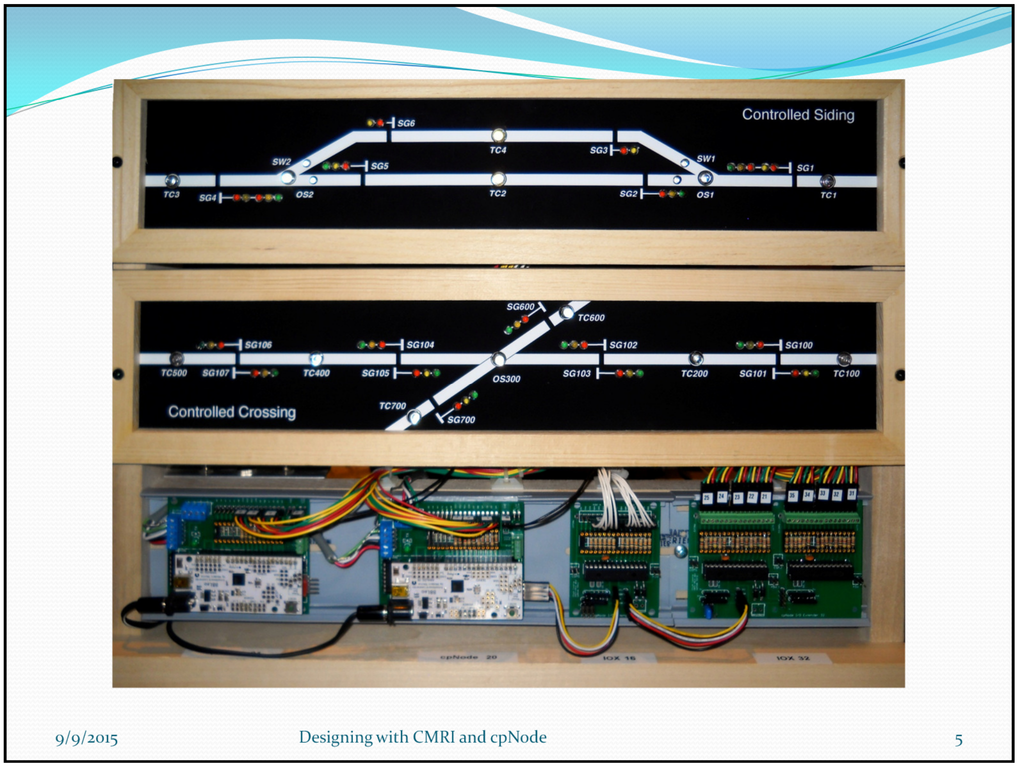
By moving to the Arduino platform we were able to open the system and make it more flexible. Over many years we've (Chuck and myself) helped a lot of other folks in Northern California with their layouts and we worked on many of them together and we when talked about them we realized that we were both a little dissatisfied with what we were doing so we got together and compared notes on a system we wanted to use to implement signaling on client layouts.



Things to consider before you start to specify and buy components!



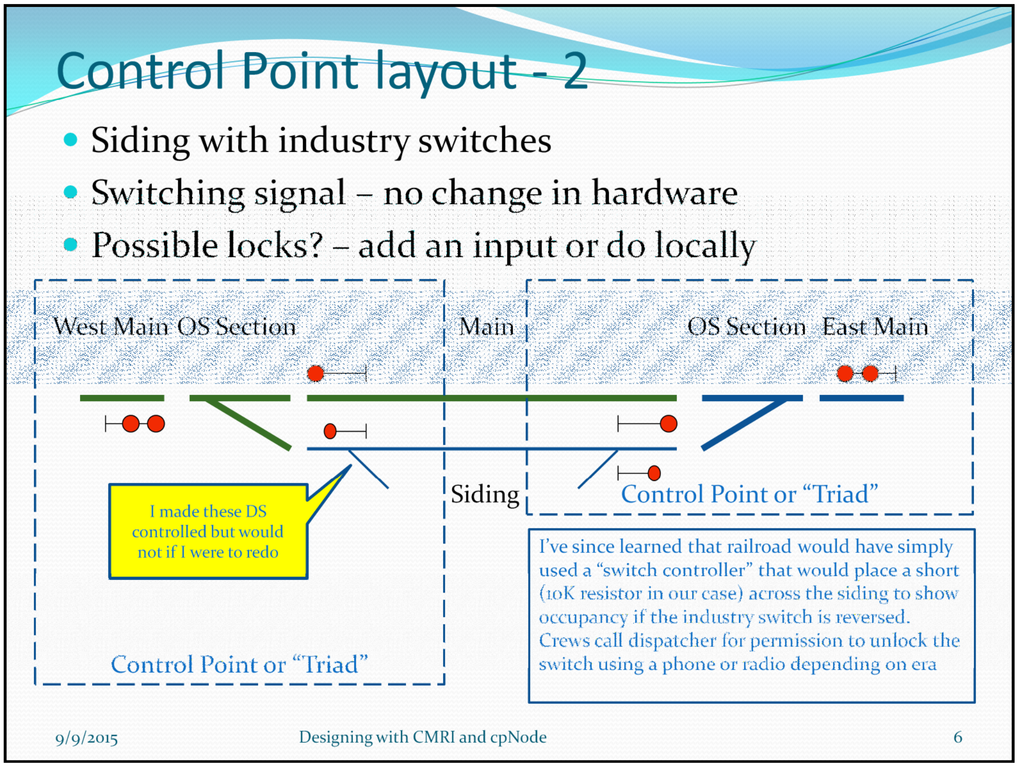
You've figured out what you want, you've got a track plan, you know how you want your signals to work, and what I'm going to be talking about is all of the design considerations that will help you figure out how many of which component to use and that's the focus of this clinic. You'll see the same basic the arrangement we will be demonstrating. Control point to control point is one siding and that makes it easy.



Our demo, down in the SIG room:

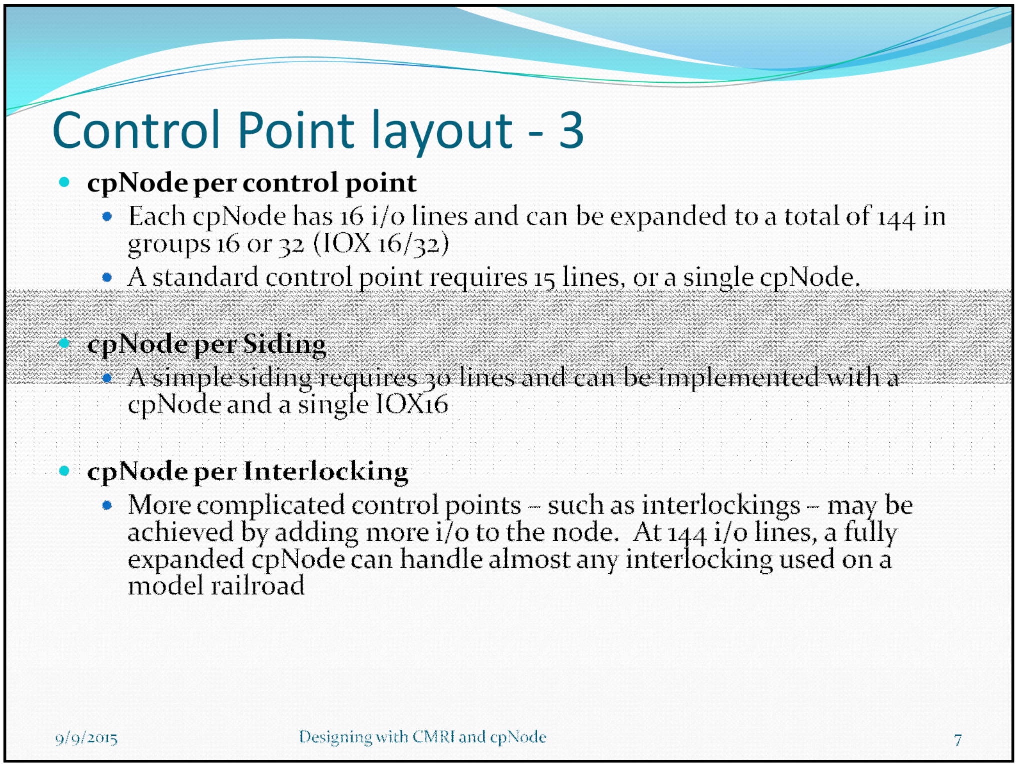
Control point to control points is one siding and that makes it easy.

We’ve also got a crossing on the demo to show how that would work

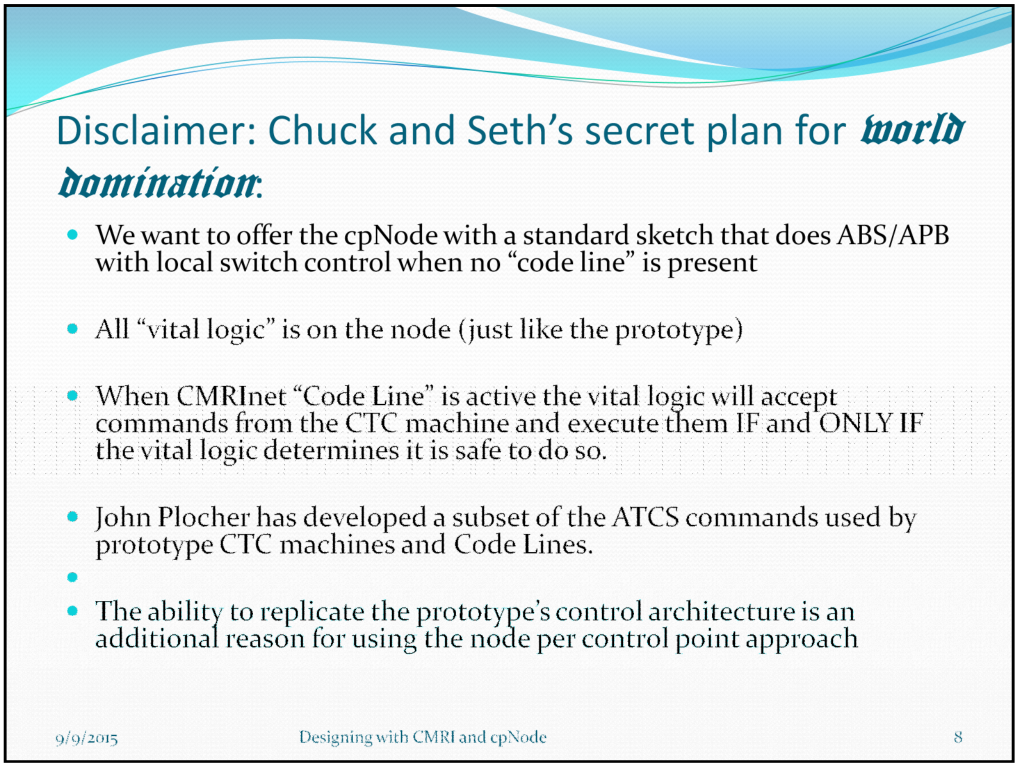


Here's an Industry siding with industry spurs coming off the side which we used to control with a dispatcher controlled switch, we've since learned from talking to a lot of signaling people that the railroad would more likely than not have simply had a switch with a padlock switch and "switch controller" and the crew would be responsible for requesting permission for the dispatcher to open a lock and once it was opened it would throw a short across the siding which would cause it to appear occupied and then you would wait a prescribed time to make sure nobody was in the siding. Today, I would recommend just using your switch motor contact in series with a 10K resistor across the siding when the switch is set to the industry spur.

Each node has sixteen lines and can be expanded up to 144 lines in multiples of 16.



Interlocking plants (towers) can be constructed using more input and you can probably handle anything you really want with a hundred and forty four lines. You can have your yard throat and you could handle staging and any interlocking that I think you could model could be done in a hundred and forty four lines.



We do have a ***grand plan*** here are and what we'd like to do by making the control points more affordable is we can emulate what the what the prototype does. The logic that controls safety ("vital logic") is local to the control point and the code line which talks to the CTC machine is overlayed and it sends commands out to the vital logic which looks to see if it's safe to do what's requested and if it is, it will do that and if not, it may wait for conditions to change or it may simply send an error back but ultimately we can do this and by designing with the control point per node model we can emulate the prototype and we can give you a system that actually operates pretty much like real one.

John Plocher took the prototype ATCS protocol, stripped it down to the parts that you really need to do a model railroad and that's what we ultimately want to send to the cpNode using CMRInet as a code line.

Powering Signals -1

- We assume you are using modern 3-LED signals that will operate from the local 5 volt supply. A modern LED will light acceptably at 5-10mA current, so a whole siding with 20 heads, assuming all LEDs came on at startup, will draw 200mA.
- 200mA for LEDs can be supplied by the onboard regulator of the BB-Leo (Arduino) on the cpNode. If you need more current, consider an external 5 V supply and be sure to tie the ground side back to the cpNode ground. We like 3 LED common anode signals (such as those from BLMA) but common cathode and two LED signals may be used.

Color	Resistor for 10mA @ 5V	Watts
Green	270 ohm	1/8 or greater
Yellow	220 ohm	1/8 or greater
Red	330 ohm	1/8 or greater
Lunar	6,000 ohm	1/8 or greater

- These values yield a pleasing balance of colors, but YMMV as 20% of males have some degree of diminished color vision. Pads for limiting resistors are provided on the cpNode and IOX16/32 boards.

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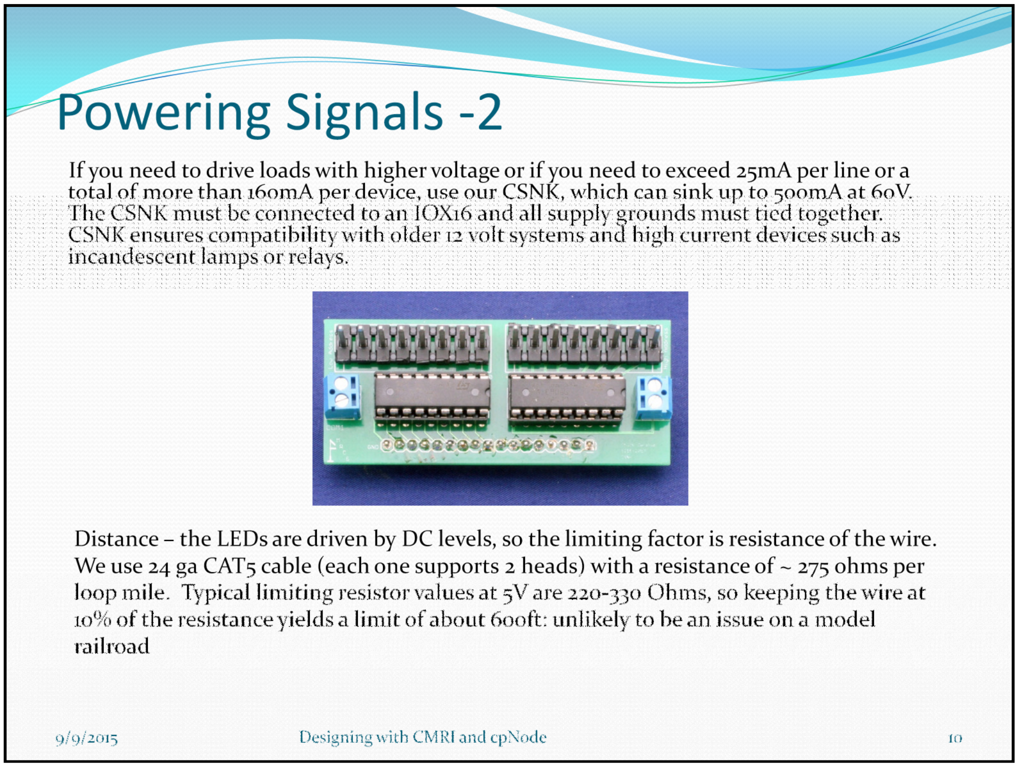
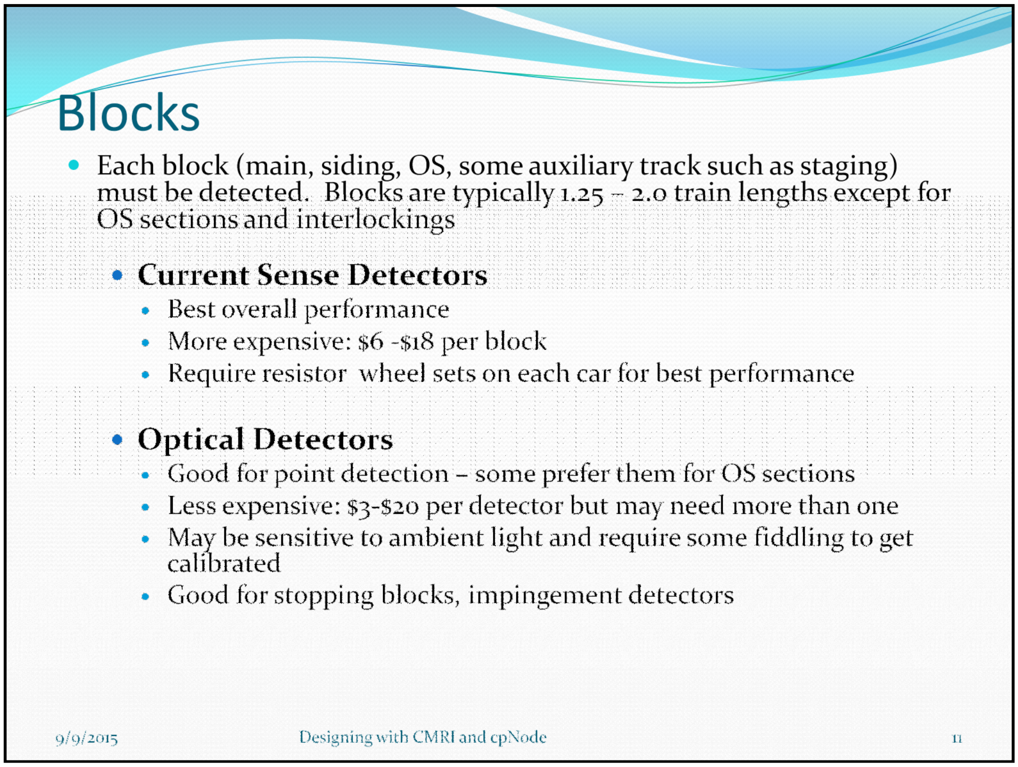
Now that you've determined how to set up your control points, you'll want to determine how you'll connect to signals. Most of the cost of your system (50-70%) will be in signals. You'll be on the high end if you use nice modern signals from BLMA or Details West or unique signals like PRR PLs or B&O CPLs (Tomar makes nice ones).



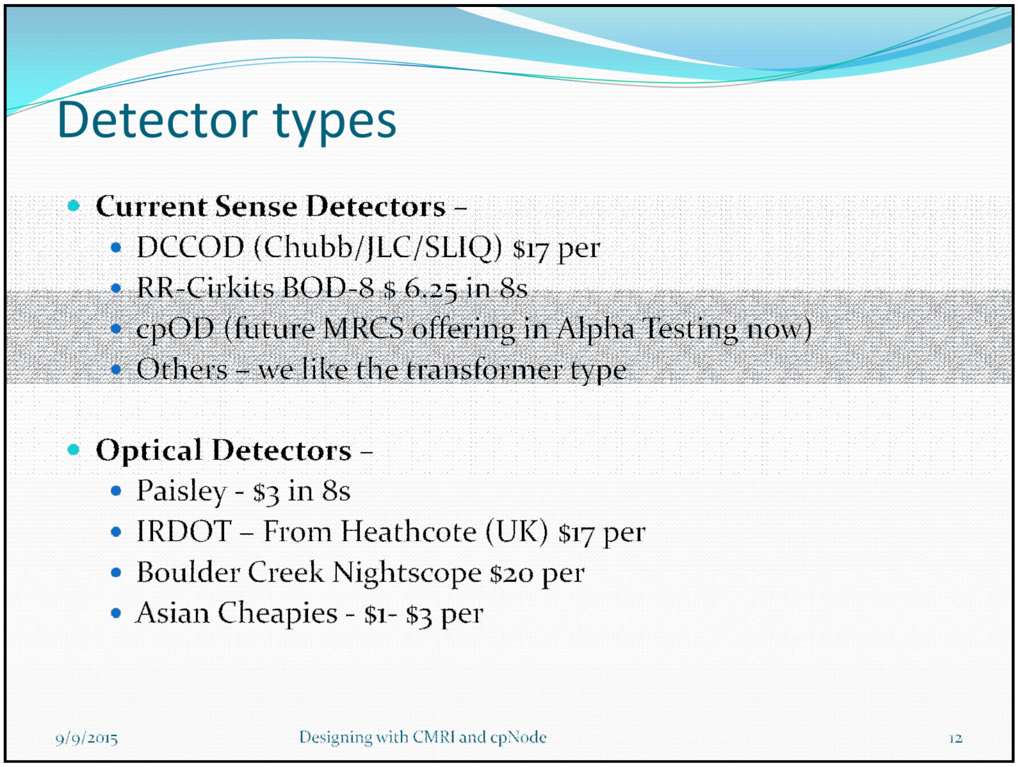
in the event that you do not use LEDs or you want to drive some load powered by more than 5 volts, we have an adapter here (CSNK) which allows you to drive up to an half a amp at up to sixty volts so you can drive relays, you can drive motors, you can drive incandescent lamps, which is probably what you have. For our purposes one thing you do want to consider is to greatly reduce the amount of wiring because all you got is the CAT5 code line bus running from node to node. You really are just going to be limited by the resistance the wire. Cat 5 (Ethernet cable) has about 270 ohms per loop mile, so you if you're trying to keep wire resistance at less than ten percent of the ballast resistor we using to control brightness, we can go six hundred feet or so. If you want to do a little arithmetic and calculate current and adjust your resistance for each signal, you can go miles but at ten cents a foot at some point the CAT5 becomes expensive so distance is going to be limited more by economic factors.



After signals about half the remaining cost on your system will be detection. (leaving the nodes themselves at about 1/6 – ¼ the total cost).

We're going to divide the layout into blocks for occupancy detection. Blocks are typically between one and a quarter to two train lengths long except in OS sections. In the model we don't often use intermediate signals because one train length is all the space we have between sidings. Except for interlockings and OS sections you're typically going to have no more than two train lengths between towns.

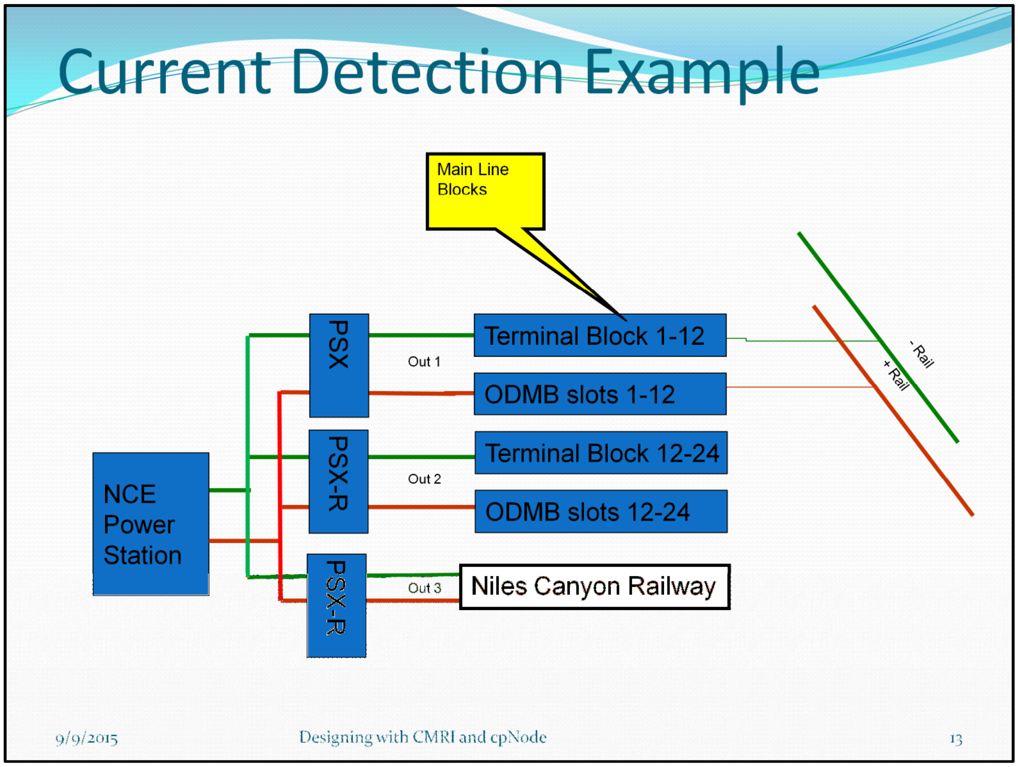
There are two general ways of detecting occupancy: current detectors and optical detectors. Current occupancy detectors perform better in general across all applications but you do have to put resistors on wheels. I personally use one wheel set with a resistor per truck, but you could get away with one per car. Optical detectors also used for point detection and a lot of people like to use them for OS sections and they are really great for staging were you have stopping blocks at a precise point at which you want things to stop. Optical detectors are good for an impingement detector where you've got a detector across the throat tracks here you want to make sure that nobody has crept forward and fouled the throat and nobody forgot to turn off an engine.



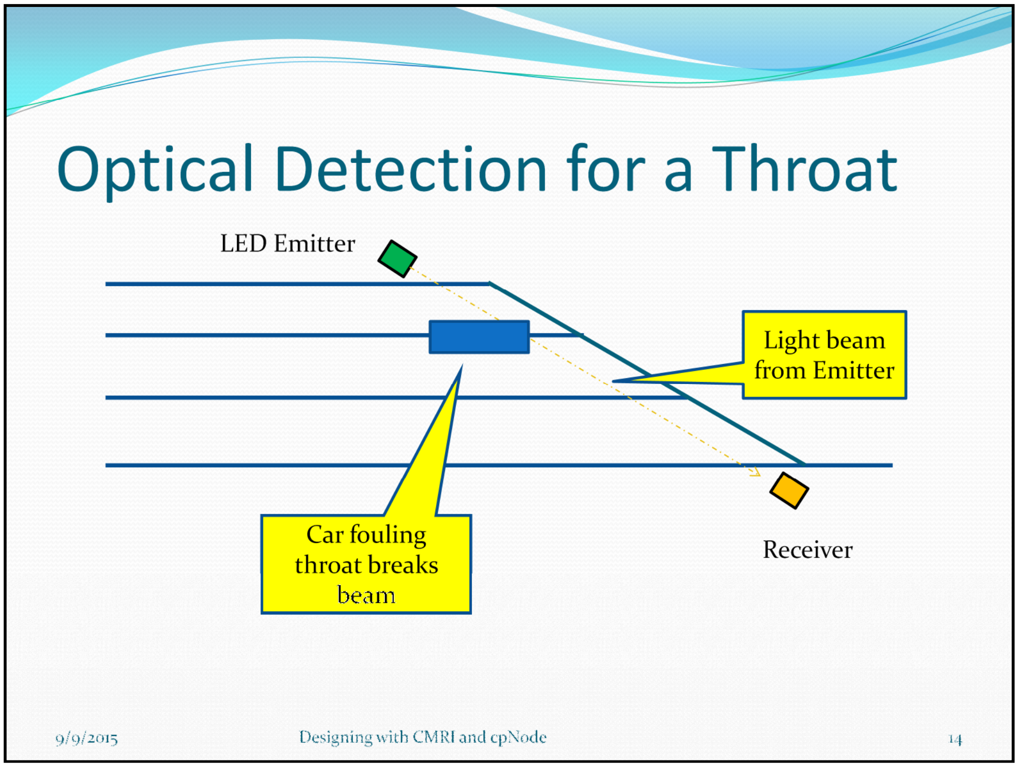
The gold standard in current detectors for years has been Bruce Chubb's DCC_OD. Mark Schutzer has developed a new current detector (cpOD) which is drop in compatible and is less expensive (with both in assembled and tested configurations). cpOD is avialable on our modelrailroadcontrolsystems.com website. We also like Dick Bronson (RR-Cirkits) BOD-8 which is an 8 block module with individual pulse coils.

Optical detectors are another option and my price/performance favorite is a another guy who does of open-source and sells boards like us, his name is Rob Paisley . hHe's got a web site that's on the reference list and there's a link on our web site which has a pointer to community products. There's an optical detector that's been around for years and it works really well called Irdot. There's also our buddy Jim Ferenc called Boulder Creek Engineering who makes the Night Scope optical setector which is just awesome but kind of expensive. Chuck and Jim Betz have been doing a massive of evaluation program of optical detector schemes from various Chinese suppliers and they're meant for all sorts of industrial sensing, but at this point if they require more fiddling around than we like.

Depends on exactly what your motivation is with point detectors. They're good to check an area of about an inch so you know one piece of track is occupied. For train length blocks you would need twenty and need to be sure that at least some cars fall on a sensor, so they're OK for OS or particular points in an interlocking plant but not great for block detection.



An example of you to wire current detection blocks.



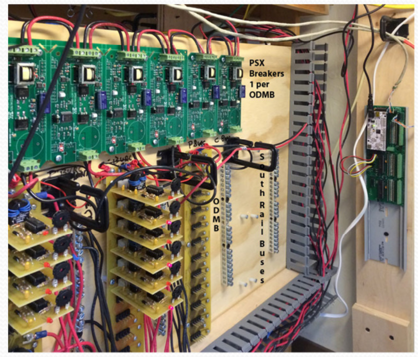
Checking hidden staging throats is a great application for an optical detector! Here a beam crosses many tracks and indicates if a train has crept forward or an errant car has rolled into the throat, fouling it. This can be used to drive an indicator for the operator picking up his train or can be used as part of an interlocking to prevent another train from entering the throat.

Current Detector Plans -1

Two approaches but you can mix and match:

Centralized –

- We co-located a cpNode and IOX32 with power distribution for a client.
- A power distribution panel on each wall of a 50' x 15' room. Each wall has about 48 blocks. (48 i/o and 48 detectors)
- Favors larger motherboards such as Chubb's ODMB with DCCOD or cpOD or RR-Cirkits BOD-8
- Longer 12 AWG runs from panel to the blocks. Runs should be limited to about 50'



South Wall Power Panel at Ted Stephens' OL&K

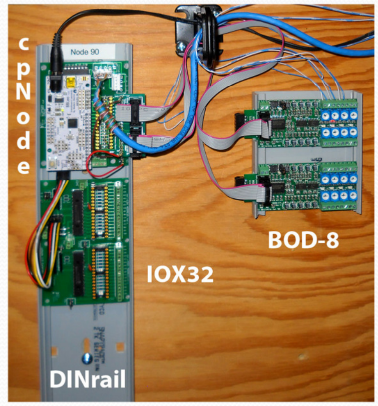
The majority detection technique will be current so there's again two general ways you can handle this: one is to centralize power distribution. This photo is at Ted Stephens' layout and what he's done is on the South wall of his room. There's a power distribution panel with DCC booster and then you can see a series of circuit breakers and then for the detected track each of the main breaker there is a Chubb mother board (ODMB) with twelve detectors. There are four motherboards for up to forty eight detectors and so we just took this arrangement one cpNode and one IOX32 (sixteen and thirty-two) for forty eight and we just wire from the detector motherboards directly into the node.

It's clean and it's easy to see everything from one place but the downside is that you have block power twelve gauge wire running as much as fifty feet to get to the detected blocks. It works well, but I wouldn't recommend going further than fifty feet past the detector. The limiting factor is likely to be cost. When you've got all these things concentrated, large mother board such as the ODMB (Optimized Detector Motherboard) or RR-Cirkits BOD-8, a very nice 8 channel detector make a lot of sense.

Current Detector Plans -2

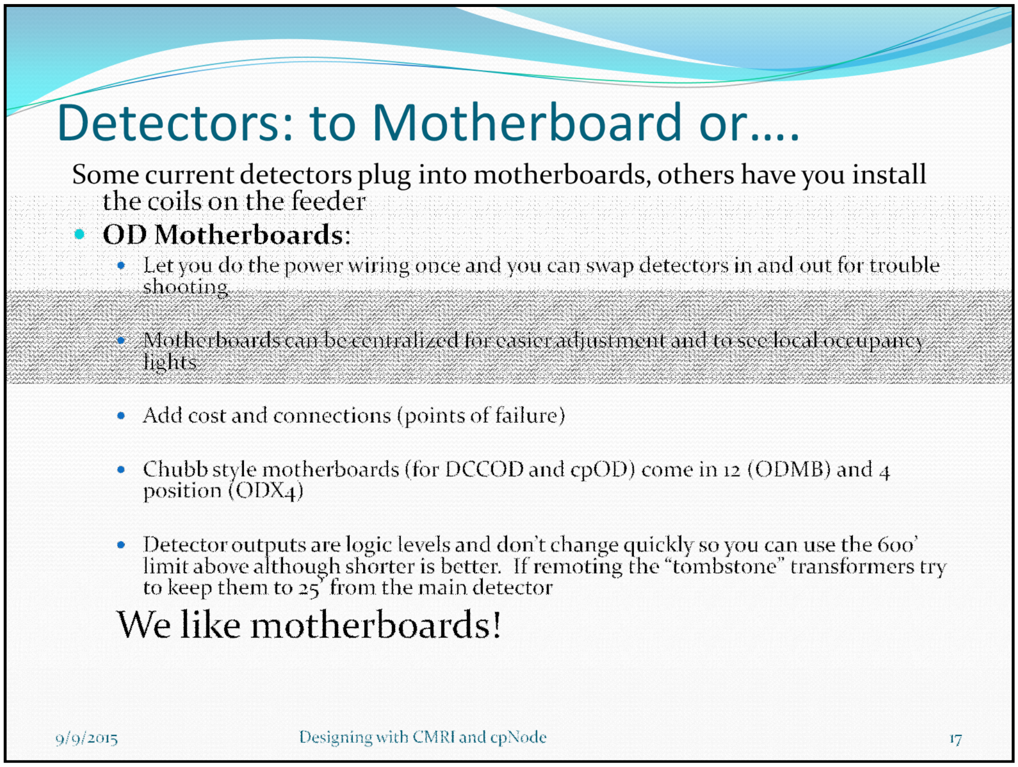
Distributed -

- Distributed detectors with the control point.
- For control points with 3 blocks we like cpOD on an ODX4 motherboard, for a siding per node model either two ODX4s or a BOD-8 (a couple of detector segments won't be used) will work well. You can also use individual detectors wired into the feeders.
- An advantage is that our forthcoming SafeTrak feature will allow the node to perform basic ABS functionality without a host computer if the detectors are connected locally



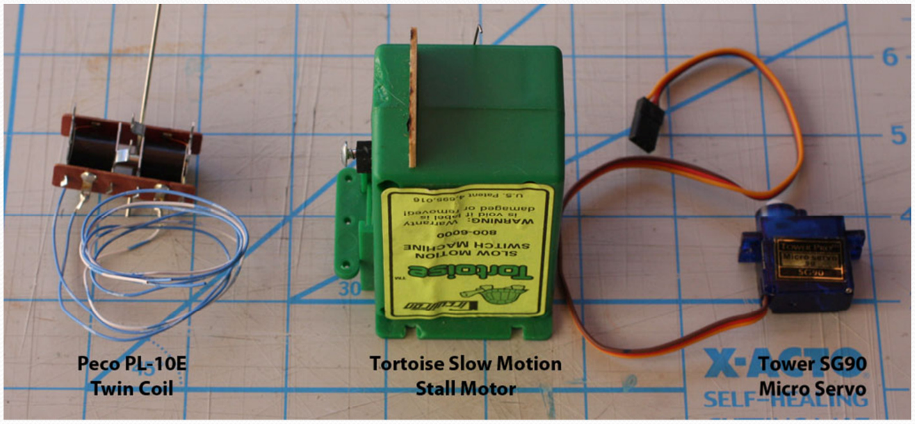
Node 90 at Walt Schedler's Shasta Division – under Dunsmuir

and the other scheme you can do is what we put in at Walt's Schedler's: a fairly distributed scheme with several detection locations co-located with cpNodes and the CMRInet snakes around the room from node to node. This is a pretty good size room, so we divided the room into six nodes. Each one has its own mother board and occupancy detectors that just handle occupancy in the local area. You can scale that down to something as small as a single control point or you can mix and match and since Walt's approach is intermediate. You can also distribute them so in that case you can use BOD-8s. in this case we have twelve blocks and the BOD-8 is pretty economical or at twelve or so or you can use our small mother boards (ODX4) and cpODs.



Some people don't like to use detectors with mother boards because they feel the motherboards are expensive and they add potential points of failure. As far as reliability issues are concerned it's my feeling is it's much easier to do your wiring once to the mother board and if you want to swap a detectors in or out it's much easier to do. A further advantage of this type of design is that as we pursue our path to world domination, the detectors are local to the control points and when you're in "Safe Trak" mode you actually have protection based on occupancy.

Switch Machines - 1



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Having covered signals and detection, I want to address switch machines, although they don't count as a layout control bus cost as you'd probably have them anyway. I only use switch machines for "controlled" turnouts, yards and industries are controlled with manual switches. The exceptions are a few local turnouts that are hard to reach.

There are three approaches today for switch machines as opposed to manual controls. The tortoise and related stall motors are most popular, the new popular approach is servo motors and there are still some twin coil machines around and especially in the N scale world where there's a lot of Peco track and the Peco line has a very nice and quite manageable twin coil machine

Switch Machines - 2

	Stall Motor	Servo	Twin Coil
Market Position	Most common	Challenger	Less popular but still used: Kato, Atlas
Power	12V @ 20mA, constant	5V @ 150mA while moving, can shut off	12V @ .5A pulse, must turn off
Controller	JLC: SMC12 MRCS: RSMC RR-Cirkits: SMD-8	Tam Valley, Arduino (Sketches on Arduini)	JLC: SM1, SM2 RR-Cirkits
Distance from controller	600'	40'	As short as possible
Pressure on points	Constant	Constant or momentary	Momentary
Frog Polarity Switch	Included in Tortoise	External relay or Micro Switch	External Relay or optional contacts
Street price including controller and frog switch	$21	$12 (using an Arduino controller), $25 with Tam Valley	$25

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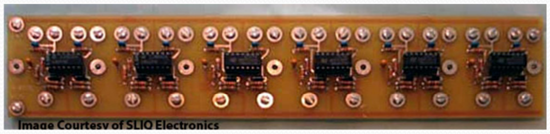
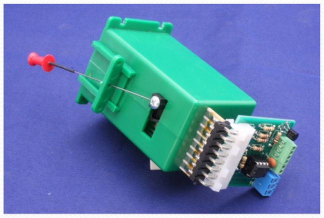
You do need to be concerned about servo power. I would suggest just adding another five volt supply and trying keep runs short, no more than twenty feet is fine. Be sure with all these auxiliary power supplies that the ground is tied back to the common ground on the cpNode

Switch Controls 3 – Stall Motor

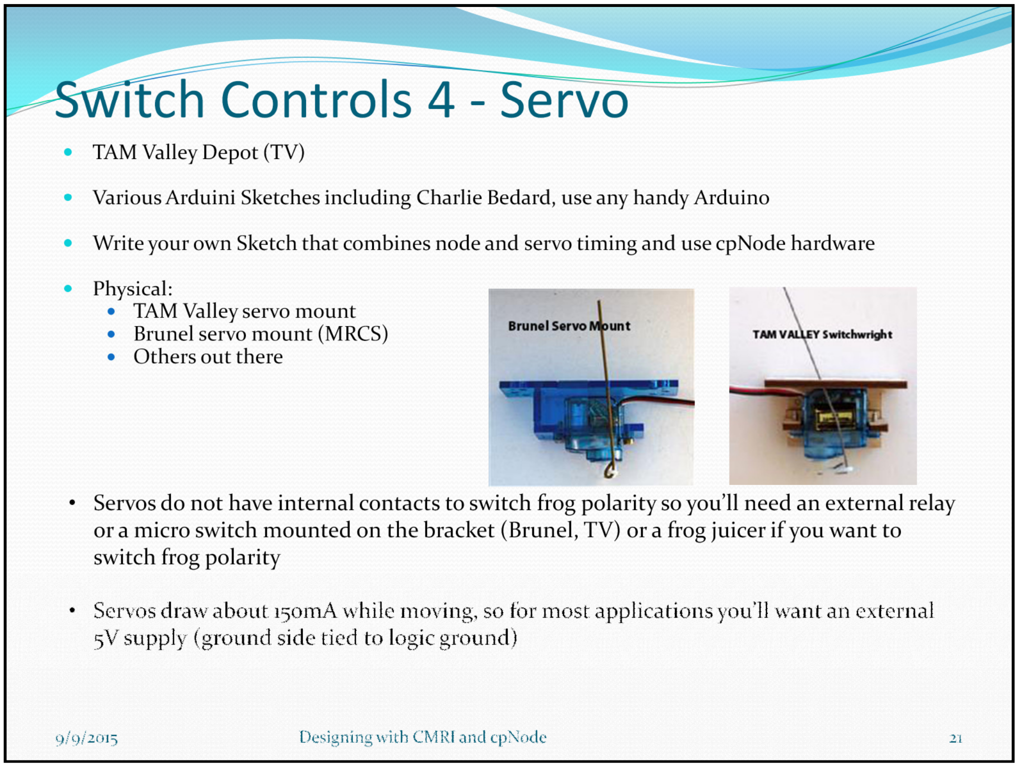
- Stall Motor:
  - SMC-12



  - RSMC
    - Free standing
    - Stuff option for one RSMC on cpNode



  - SMD 8 (not shown)



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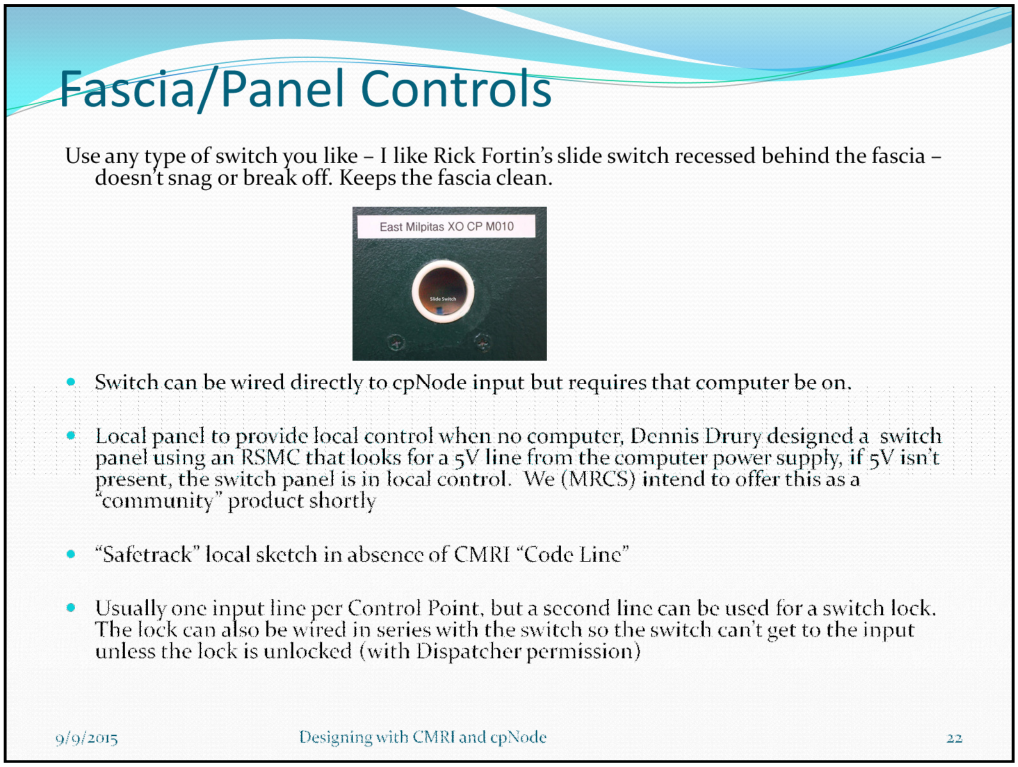


Having addressed switch motors, we should take a minute on fascia controls.

If you want the code line you need a computer but if you're just operating locally you don't need it. Our next planned cpNode sketch release, not quite ready yet will allow us to operate in local mode if it doesn't see the computer so you might have a situation where you have ten guys running my layout but every time I come in the room or have the round robin over to work, I don't really want to be bothered waiting for my computer to boot up and load my program on top of it. So if you don't have a computer present you come up in the safe track program, and you can do whatever you want in local mode and then when you have the big formal operating session and you want the dispatcher he turns the computer on and as soon as the nodes all see the code line come alive this turns them back to CTC.

Everybody has an opinion on fascia controls. Rick Fortin worked this one out. I like his, a piece of 1 inch drain pipe it's just been turned to snap into a one inch whole in your fascia. The switch is set behind the whole in a piece of one by four by four inch piece. Just push your finger back and forth and a the points move with your finger. Benefit is that the switch is out of the way you don't get snagged on the toggle switch which also does not accidently get broken. I've seen micro toggle switches getting snagged on a belt loop and broken off in the middle of the session. No fun!

You can also have a little board Dennis Drury made which allows the switch to control things directly if the computer is not on, good for work nights and protects against a computer failure. We'll have that on our web site soon.

CMRInet Configuration

- Configure cpNodes as a SUSIC with 24 line DIN and DOUT boards. If you only need 16 inputs, configure a DIN and just use 17-24. This approach also works if you want to use QBASIC or VBASIC
- Use standard JMRI or QBASIC or VBASIC configuration tools

Having addressed the various items you'd connect to the node, let's address the CMRInet connection itself.

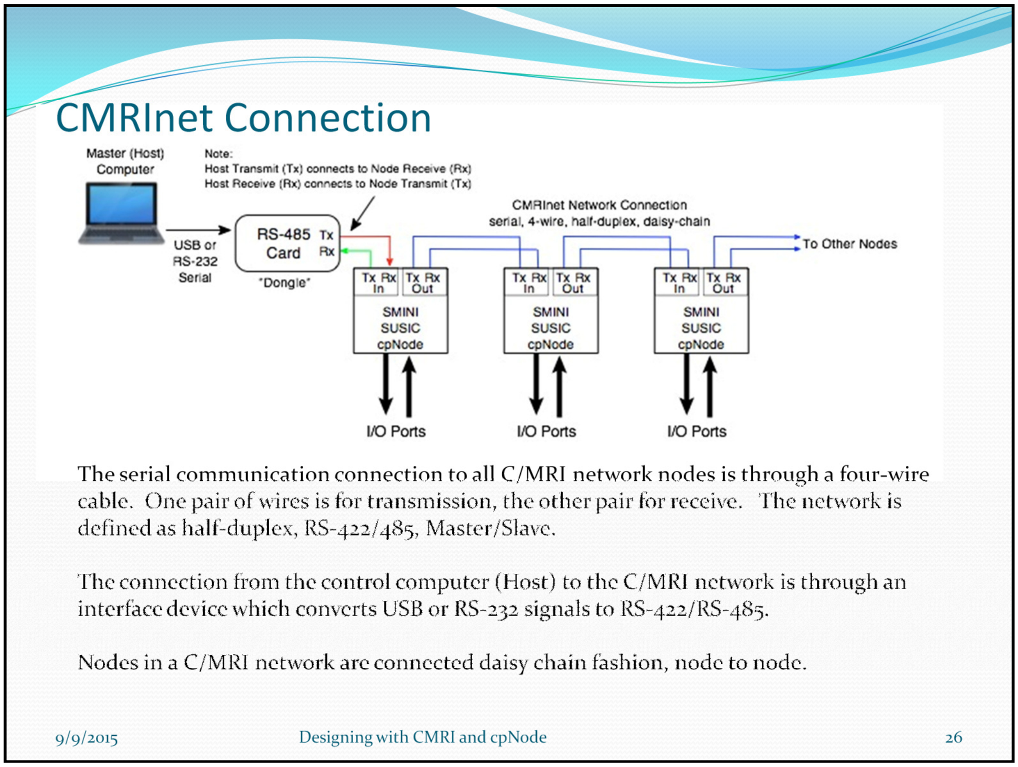
CMRInet – C/MRI Communication Protocol

- Designed by Bruce Chubb in 1985 to be a simple, easy to implement, serial data messaging system.
- Robust, industrial grade network technology for moving data between a host (master) and node (slave) in a connected network.
- CMRInet specification is NMRA user group Layout Control Specification (LCS) Repository S-9.10.1
- NMRA - CMRI Special Interest Group (SIG) established 2015.

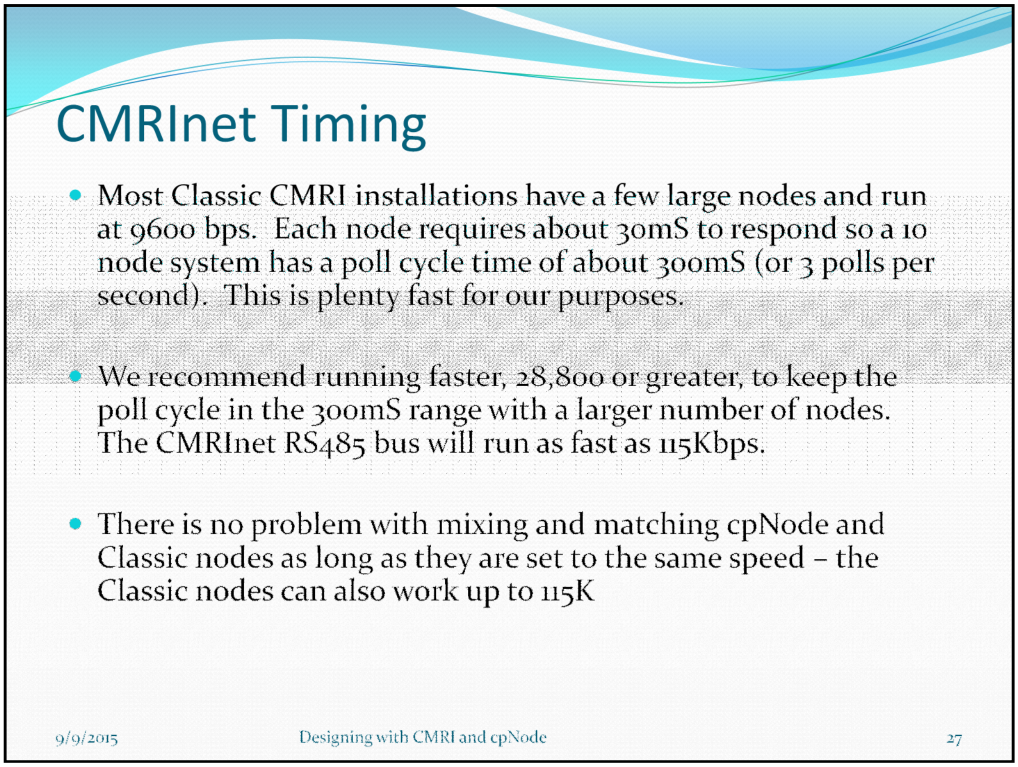
C/MRI 30! Celebrating the 30th anniversary of C/MRI at NMRA Portland. Tonight at 7:00 PM Mt Batchelor Room

CMRInet Topology

- Bruce Chubb assumed the network started at the host computer and worked linearly out to the furthest node, his RS232/485 converter includes a terminator at the computer and the user terminates the bus at the far end.
- RS485 does not allow branches (not to say that modelers don't cheat <g>), so best practice is to have a single CMRInet snaking around your layout with no taps or branches
- Install a terminator at the far end.
- More modern practice is to use an RS-485 USB dongle at the computer. Use a terminator at the computer as well as the far end. This is standard RS-485. The Computer does not have to be at one end, but if not, ensure that the ends (only) are terminated.
- We recommend CAT5 or better data cable rather than shielded 2 pair as the performance is comparable, the price is lower and you don't need to worry about shielding (which is best left to experts)



Bruce Chubb used an RS-232 (unbalanced) to RS485 (if more than one node) converter as older computers had 9 pin serial (RS232) sockets. Now USB is the standard so newer systems tend to use USB – RS485 dongles. Remember to terminate at both ends of the bus (the computer does not have to be at one end).



There is no magic to the speed as long as buttons feel reasonably responsive. Usually the node will latch a change in input so it may not be noticeable.

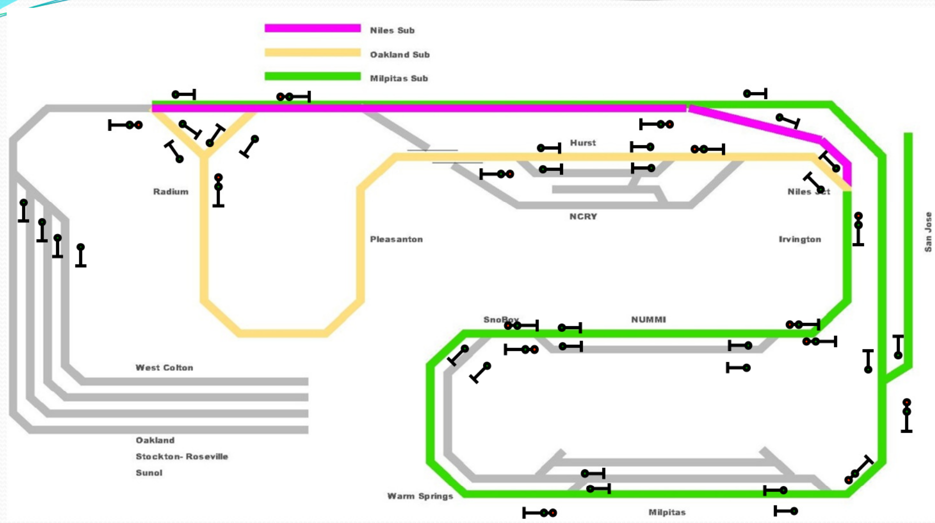
If you are trying to do something needing real-time control (feed back to the system for automatic running of locomotives) a faster speed would be better. This is rarely an issue.

Use My Layout as a Configuration Example

- Main line ~ 100'
- Switches
  - 12 mainline switches (dispatcher controlled)
  - 6 controlled switches connecting to sidings
  - 6 industry spurs connect to the main
- Signals – All high signals are BLMA US&S H2 Searchlights
  - 14 (but 3 not visible so they have repeaters only) double head
  - 14 (but 3 not visible so they have repeaters only) single head high
  - 10 (but 2 not visible so it they have repeaters only) Low
  - 10 dwarf (some used in place of low signals in yards, industry areas)
- 3 Sidings, 1 Wye, crossover in the middle of the loop
- Blocks (35):
  - 12 OS (main line switches)
  - 3 main with sidings
  - 3 sidings, 1 main in cross over, 3 Wye sections, 4 staging
  - 10 Main line

Seth's layout

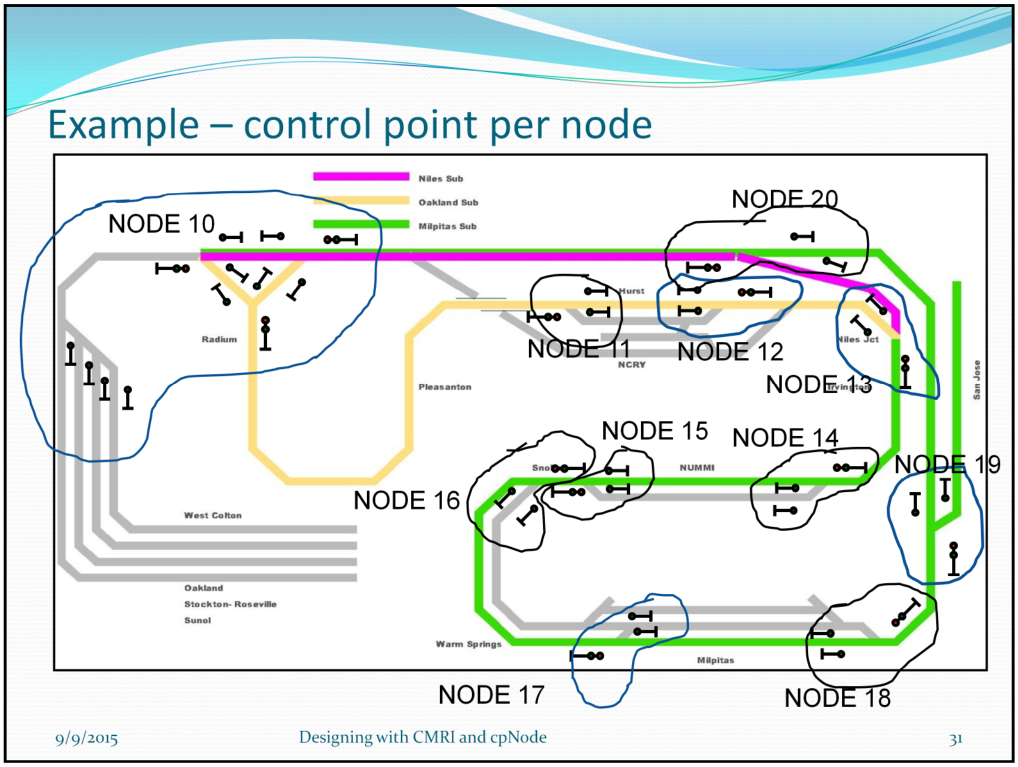
My Track Plan



All Blocks are about a standard Train (~ 10') long except Pleasanton and the hidden Back track, so not much point In intermediate signals

Layout example

- UP (ex-WP) used 3 block route signaling, note the real WP did not "bond" the sidings so the most favorable indication into the siding was "Approach"
- 3 sidings + staging
- All of the sidings are connected to industry tracks or a yard
- No intermediate signals (uncommon in the prototype but very common in the model world)



A couple of examples here which we can run through so we can see some ways to put it together. We're talking about one hundred feet of main line, twelve main line switches, six switches in controlled sightings in and six industry spurs with the signals pretty much conformed to what’s described up at the top and the others are three switches in a wye and a crossover to allow you to get across from hidden to visible track at Niles. It’s a point to loop design. Normally you move around through the Oakland sub down through Niles to the NUMMI Plant in Warm Springs around Milpitas and back into staging though hidden track. There’s hidden track which represents Diridon Station for the commuter trains. We do have a loop for the NCRY siding which takes off for the Niles canyon railway . It’s not terribly complicated. The UP in 1999 was using the old Western Pacific signaling system which had a couple of funky aspects, but the really strange ones like in undetected sidings I didn’t model.

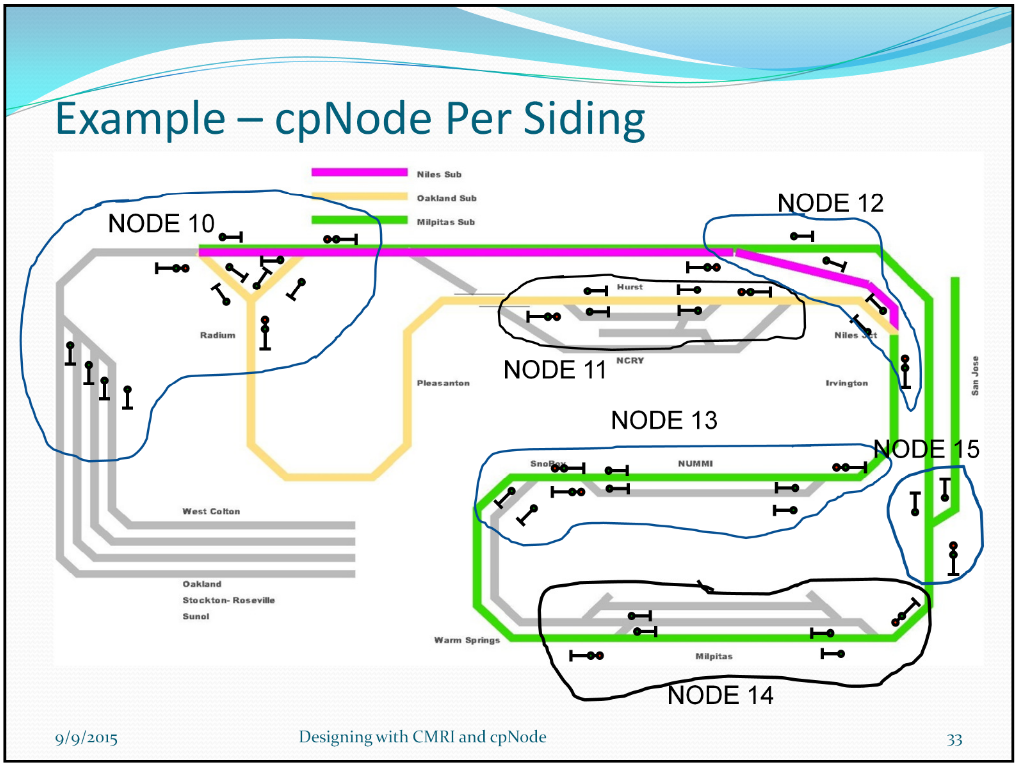
In this example, every control point has its own cpNode and it's on the road to World Domination as there’s about enough code space to do one control point on a node.

Note I’ve left the wye at the entrance to staging and staging itself on 1 node one

Bill of Materials:
cpNode per Control Point

			Inputs		Outputs		total i/o	cpNode	IOX16	cpOD(M)	ODX4	RSMC	Dongle
Node		Milepost	fascia	Blocks	Switch	Signal Lines							
10	Staging + Wye	F044	7	10	7	40	64	1	3	10	3	6	
11	E Hearst	F039	1	3	1	10	15	1	0	3	1	0	
12	W Hearst	F038	1	3	1	10	15	1	0	3	1	0	
13	Niles JCT	F030	1	3	1	11	16	1	0	3	1	0	
14	E NUMMI	M004	1	2	1	10	14	1	0	2	1	0	
15	W NUMMI	M005	1	2	1	10	14	1	0	2	1	0	
16	Yard Lead	M009	1	3	1	8	13	1	0	3	1	0	
17	E Milpitas	M010	2	2	2	11	17	1	1	2	1	1	
18	W Milpitas	M012	1	3	1	9	14	1	0	3	1	0	
19	Diridon	M019	1	3	1	8	13	1	0	3	1	0	
20	Niles Back	NI010	1	2	1	12	16	1	0	2	1	0	
	Computer												1
	needed							11	4	36	13	7	1
	10% Sparing							2	1	4	1	1	1
	total order						**211**	**13**	**5**	**40**	**14**	**8**	**2**

And here’s the hardware required. I’ve added 10% sparing as you wouldn’t want to lose a board a few hours before an op session and not have a spare



An obvious optimization would've been to combine the control points at the ends of the same siding to do some consolidation without losing any functionality. The next system I want to consider is done by siding so the benefit here is now instead of needing more control point Nodes each with it's own Arduino, you can just do extensions on existing cpNode For that the last design what I left the staging alone. Now I can combine both ends of Hearst siding and combine both ends of NUMMI and both ends of Milpitas and I left Diridon Station as a separate node so now I'm down to six blocks from ten . This is starting to get the extreme of what you can do in the code space of a BB-Leo for the world domination model, but next generation will probably offer more.

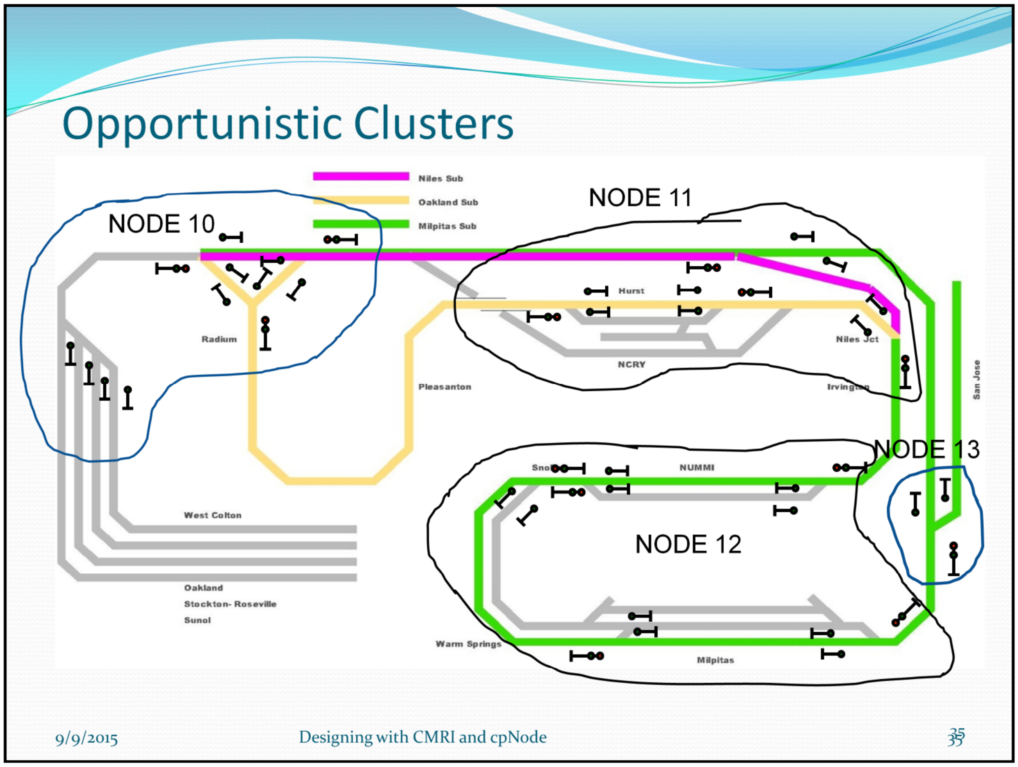
This is sixty five percent of the world domination model, compared to a classic SMINI implementation.

At 144 ports we are about seventy percent of the cost of the of the S-MINI. For reference about 60-70% of system cost will be signals and of the rest about half will be detectors and half will be all of the electronics we're discussing here.

Bill of Material:
cpNode per Siding

				Inputs		Outputs		total i/o	cpNode	IOX16	cpOD(M)	ODX4	RSMC	Dongle
Node		Milepost		[illegible]	Blocks	Switch	Signal Lines							
10	Staging + Wye	F044	F043	7	10	7	40	64	1	3	10	3	6	
11	Hearst	F039	F038	2	6	2	20	30	1	1	6	2	1	
12	Niles Cutoff	F030	M010	2	5	2	23	32	1	1	5	2	1	
13	E NUMMI	M004	M005	3	7	3	28	41	1	2	7	2	2	
14	E Milpitas	M010		3	5	3	20	31	1	1	5	2	2	
15	Diridon	M019		1	3	1	8	13	1	0	3	1	0	
	Computer													1
	needed								6	8	36	12	12	1
	10% Sparing								1	1	4	1	2	1
	total order								**7**	**9**	**40**	**13**	**14**	**2**

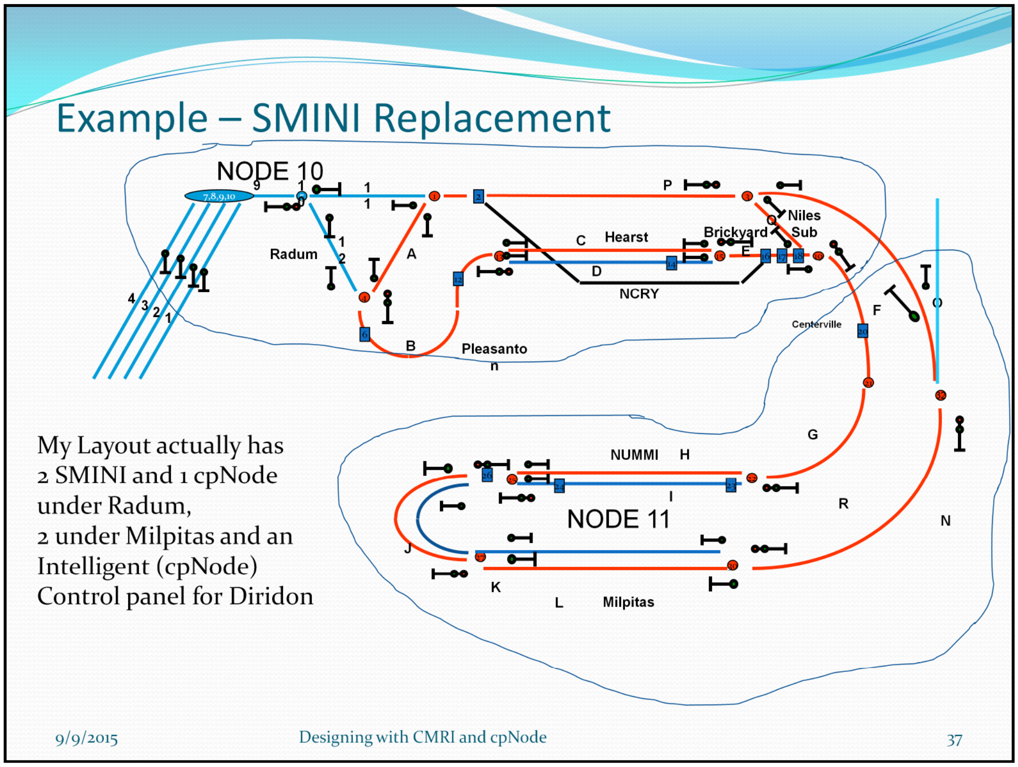
While this is not as compact as the node per control point from a wiring standpoint, We're still going to have shorter runs to the stuff that we're controlling. At Walt's, he has much less wire running up and down stairs. That was a big pain to string. Here you've got reasonable runs to the signals and the track feeds can be done with "superfeeders" and the detection coils located near the node. If you can get these detectors and signal controllers and wire closer to the signals and the big heavy wire closer works in your saving a lot of money as Cat5 is ten cents a foot you with your paying about that for twelve gauge wire per conductor to the block so you can that you can save a lot of money by distributing so you optimize the runs to the track.



And here we've consolidated further by combining Hearst with hidden track on the Niles sub and both sides of the Milpitas Peninsula. We're still keeping maximum run to about 12'. Node 13 is out by itself because it is actually a cpNode stuck on the back of a control panel facing the Milpitas yard Aisle. This is probably more complexity than Safetrack will be able to handle with current hardware, so it not on the "Path To World Domination."

Bill of Materials: Opportunistic Clusters

Node		Milepost	Inputs: fascia	Inputs: Blocks	Outputs: Switch	Outputs: Signal Lines	total i/o	cpNode	IOX16	cpOD(M)	ODX4	RSMC	Dongle
10	Staging + Wye	F044 F043	7	10	7	40	64	1	3	10	3	6	
11	Hearst	F039 NI010	4	11	4	20	62	1	3	11	3	3	
13	E NUMMI	M004 M005	6	12	6	48	72	1	4	12	3	5	
13	Diridon	M019	1	3	1	8	13	1	0	3	1	0	
	Computer												1
	needed							4	10	36	10	14	1
	10% Sparing							1	1	4	1	2	1
	total order						**211**	**5**	**11**	**40**	**11**	**16**	**2**



Finally, we just go back to the original two distribution panel scheme I've got with SMINIs now:

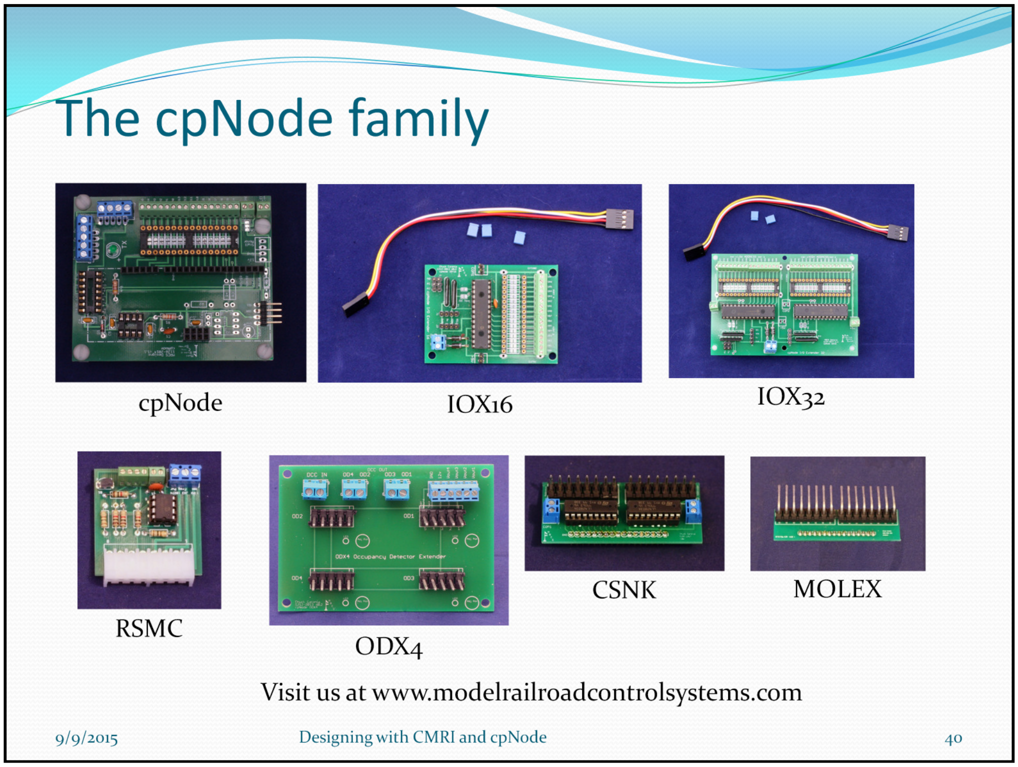
All of Radum and the back wall are on one side and the long peninsula with NUMMI and Milpitas are on the other. I've consolidated the Diridon panel here. What's noteworthy is that because of the byte by byte control of i/o we're able to so the whole thing with two fully expanded cpNodes (144 lines each) rather than 5 SMINIs at 72 lines each or 360 lines.

Bill of Materials:
SMINI Replacement

				Inputs		Outputs		total i/o	cpNode	IOX16	cpOD(M)	ODX4	RSMC	Dongle
Node		Milepost		fascia	Blocks	Switch	Signal Lines							
10	Radum Side	F044	NI010	11	21	11	84	126	1	7	21	6	10	
11	Milpitas Side	M004	M005	7	15	7	56	85	1	5	15	4	6	
	Computer													1
	needed								2	12	36	10	16	1
	10% Sparing								1	2	4	1	2	1
								21						
	total order							**1**	**3**	**14**	**40**	**11**	**18**	**2**

Configuration Summary

- You can mix and match cpNodes from as small as a single control panel to 144 ports (= 2 SMINI)
- You can mix and match cpNodes with Classic SUSIC or SMINI nodes to extend existing CMRI installations
- The cpNode design philosophy is to use a larger number of smaller nodes which are physically co-located with the controlled devices to minimize wiring and follow prototype practice: this enables on board logic on modules and things like intelligent control panels
- Ultimately we want to provide basic "vital logic" functionality even in the absence of the CMRNnet "code line"
- Using an on board micro-controller opens the possibility of integrated servo control and other applications requiring real time control and A/D and D/A conversion at the node



cpNode is a break out board that takes an Arduino (BB-Leo) and brings out the input and out so you can connect it to your railroad. It includes a the serial communications interface for CMRInet. Each i/o pad has place for a limiting resistor which is very handy if you're driving LEDs. A cpNode can also have an RSMC [on board] for driving a tortoise or other stall motor.

A separate RSMC is the size of a postage stamp and it plugs onto your tortoise switch machine.

The IOX16 is an i/o expander that has sixteen ports and the IOX32 is really just a double IOX16 and it programs just like two 16 IOX16s

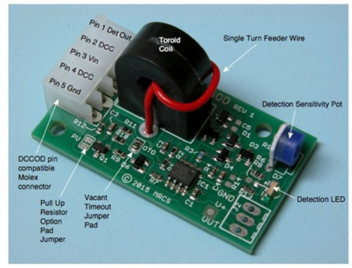
The ODX4 is a small motherboard for Detectors (DCC_OD or our new cpOD) and it handles 4 detectors. This is handy where you've a small number of blocks to detect.

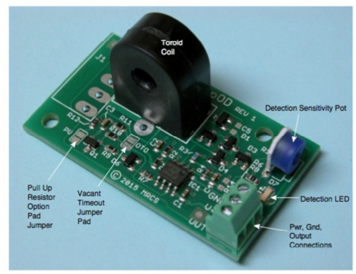
The CSNK is the high current driver for incandescent bulbs and relays or solenoids and it plugs onto an IOX16, it's handy for backwards compatibility with classic CMRI boards.

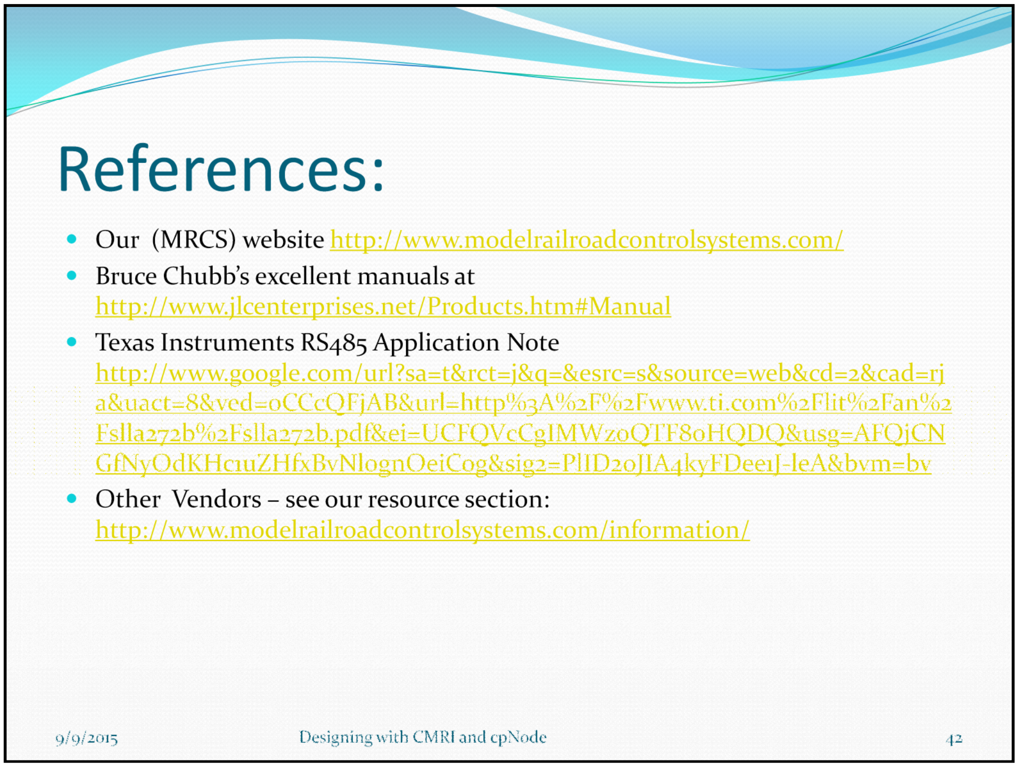
And then if you're like me and you're converting from a classic SMINI node classic and your stuff is all terminated on the old Molex connectors, we have this Molex adapter so you plug the Molex adapter onto an IOX16 and can plug your Molex connectors on. You can put that into your IOX16 and plug on your old connectors in and nobody's the wiser.

New! cpOD – Current Detector

- Surface Mount Technology (SMT)
- Small footprint, may be placed close to the detected track section
- 5 and 12 vdc (regulated) operation
- Single turn track feeder wire through toroid coil
- Sensitivity adjustment with onboard LED indication
- Vacant block hold timeout
- Pin compatible with the Chubb ODMB and MRCS ODX4 motherboards
- Supports up to 60A of track current
- Draws 5mA @ 5V
- Open drain output sinks up to 100mA @ up to 60V







I'm sorry about this Microsoft PowerPoint template: it puts the links in unreadable yellow but the good news is if go to our web site www.modelrailroadcontrolsystems.com and when you get to the home page it gives you a set of links to various resources and all of these things are in the resources section or just send me an email if you can't find it. All the boards that we've talked about are there.

Our circuit boards are sold as either bare boards or assembled and tested with various "stuffing" options. We also have a Yahoo group that I invite you to join called "Arduini." We've posted the designs, the schematics the sketches and the Gerber (CAD) files so you can and send them to any circuit board house you like and take these designs and have them printed yourself. If you know you want to do that and you're comfortable doing it, you can save a few bucks great! If you want to buy want a sample tested from us so that you can just experiment with it without having to worry about it, that's great too! You can certainly go back in and modify a board and have your own made later. The schematics and files are in Eagle CAD, if you say this is the greatest thing in the world but I wish you had used that Molex connector because I am a true believer in the that, then knock yourself out! Take our design, drop your connector in and have Seeed fabricate it. You're welcome to do that! We really invite you come back and post the modified design in your notes on our community page.