Java Central Station

🚆 Modelspoor Automatisering

Frans Jacobs

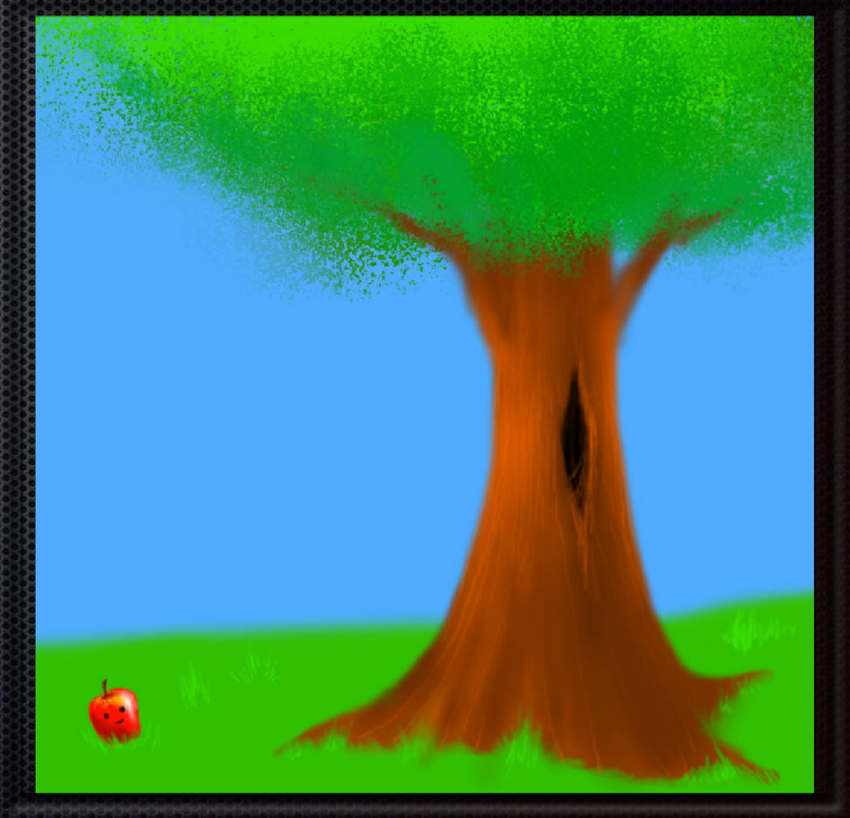
3 Rail-forum Gastendag 2024

Het project Java Central Station

- Hoe werkt/kan je, Automatisch rijden?
  - Fascinatie mee, ooit, lang geleden (2005) met een 6051.
  - In 2018 dit weer opgepakt, ondanks de nu verkrijgbare “of the shelf” programma’s.
- Omdat het leuk is.
- Open source project, iedereen de source bekijken, verbeteren, inspiratie, enz.
- Communicatie met Centrale(s).
- Schermen, zodat je locomotieven en accessoires kan bedienen.
- Melden, eerst visueel, later erop reageren.
- Sporenplan, automatisch rijwegen zoeken.
- Correspondentie met andere “nerds” door Github en Fora.

Over mijzelf

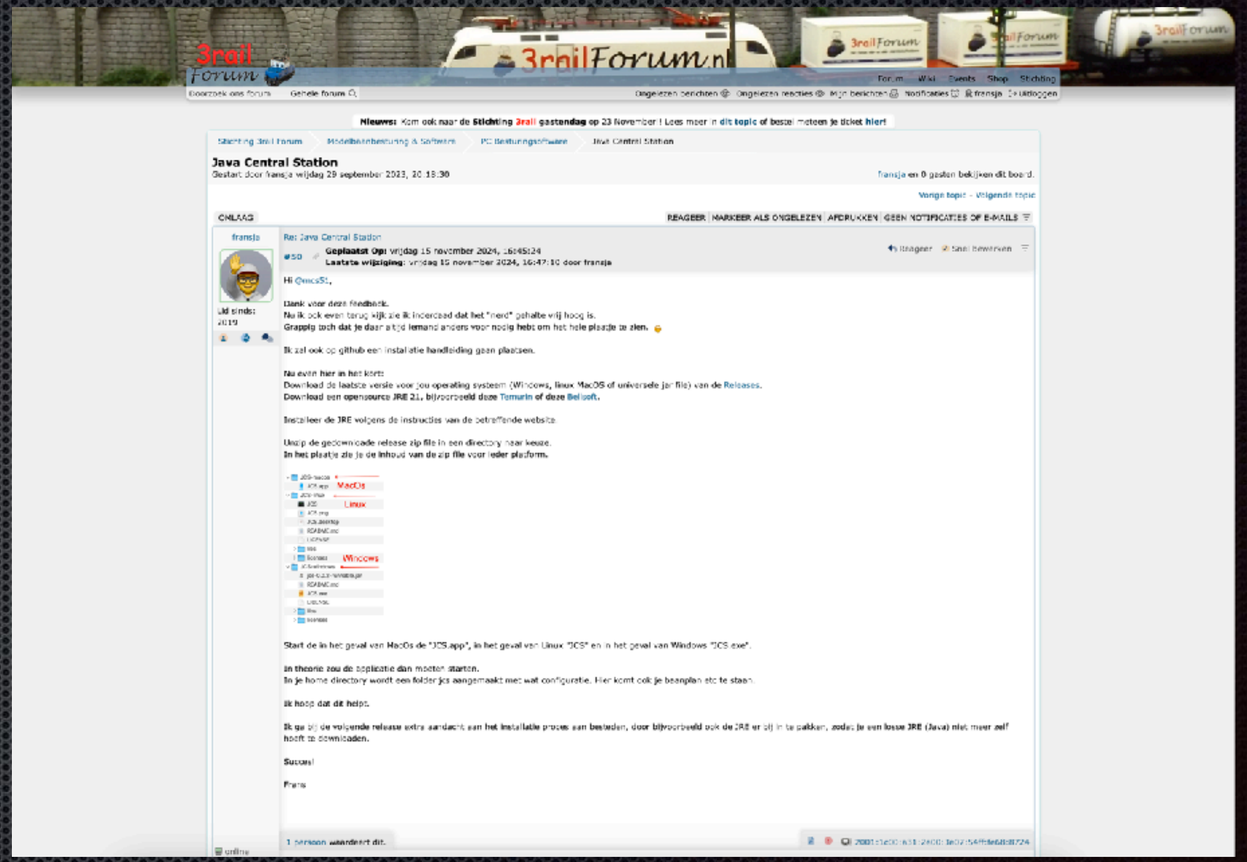
- Frans Jacobs
- Met modelspoor hobby opgegroeid
- Electronica achtergrond
- Werkzaam als data engineer



https://www.deviantart.com/playerzed/art/The-apple-doesn-t-fall-far-from-the-tree-552869202

Agenda

- Ontwikkeling van JCS, de tools
- Concepten, Architectuur
- Protocollen
- Gebruikers interface
  - Sporenplan
    - Tegels
    - Traceren
- Autopilot



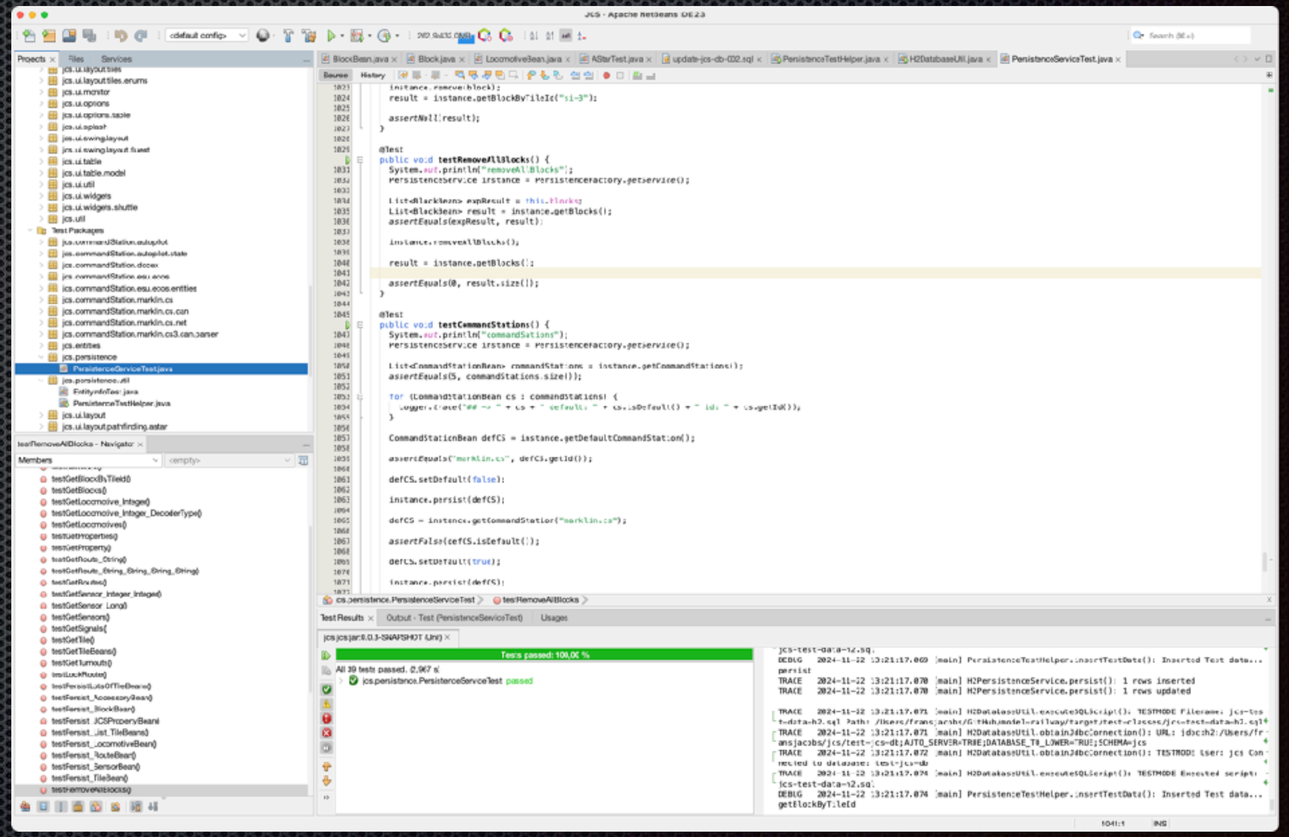
https://forum.3rail.nl/index.php?topic=92602.0

Java

- Object georiënteerde programmeertaal
- Begin jaren 90 ontwikkeld door Sun -> Oracle
- Automatisch memory management
- Multi-platform
- Sinds november 2006 is Java Open-Source

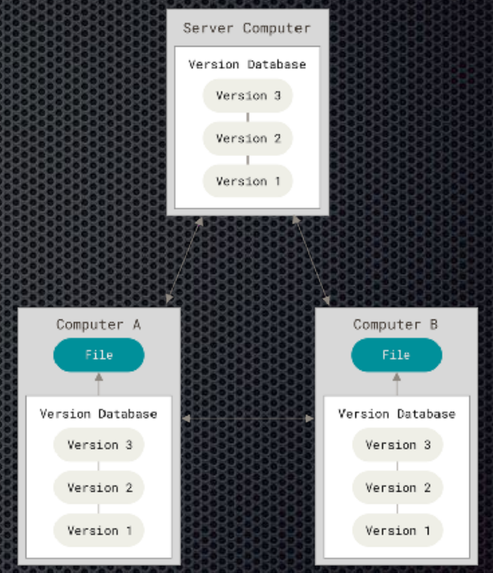
Ontwikkel tools

- Netbeans (opensource) (IDE)
- DBeaver Community voor database
- Wireshark
- Packet sender
- Apache Maven om dependencies te managen, maar ook om het project te compileren en maken van executable packages
- Git als versie beheer

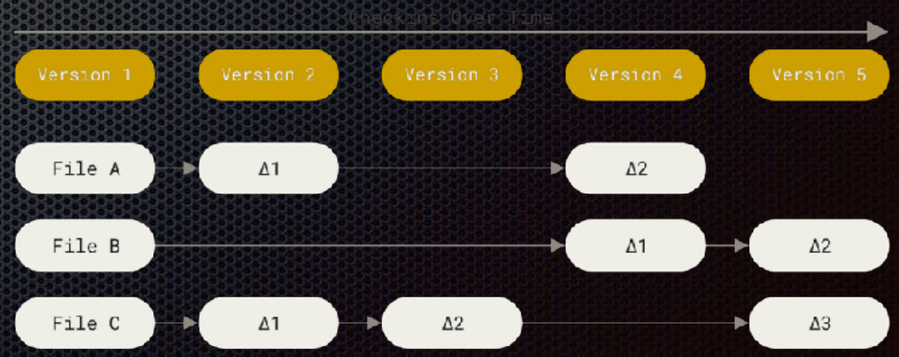


Git versie beheer

- Gedistribueerd versie beheer
- De locale kopie heeft de volledige historie van de repository
- Ontwikkeld in 2005 door Linus Torvalds
- Standaard in software ontwikkeling



https://git-scm.com/book/en/v2/images/distributed.png

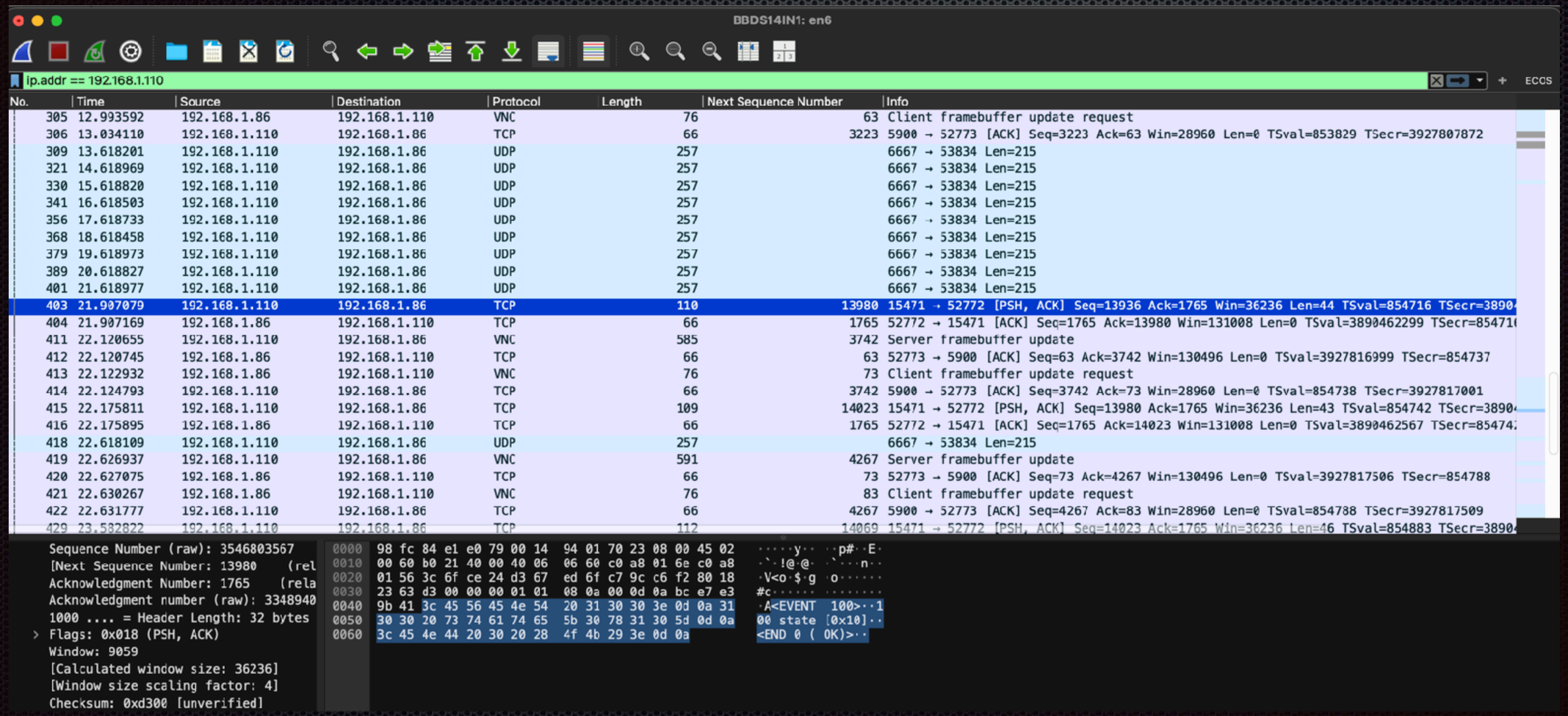


https://git-scm.com/book/en/v2/images/deltas.png

Communicatie met Centrales

- Netwerk
  - Automatische netwerk configuratie
- Seriële poort
- Grote verschillen tussen merken
- Documentatie is vaak niet sluitend
- Reverse engineering is vaak nodig

Reverse engineering met Wireshark



Voorbeelden van protocollen

- **Marklin CS 2/3**
  - Netwerk, CAN over UDP/TCP
  - Pakket lengte 29 bits, binair: 00 00 cb 13 05 00 00 00 00 01 00 00 00 -> 01 00 cb 13 05 00 00 00 00 01 00 00 00
  - Events asynchroon
  - http://streaming.maerklin.de/public-media/cs2/cs2CAN-Protokoll-2_0.pdf

- **DCC-EX**
  - Seriële poort of Netwerk, ACSII: <1> -> <p1 MAIN>
  - Response niet (altijd) gegarandeerd
  - https://dcc-ex.com/reference/software/command-summary-consolidated.html

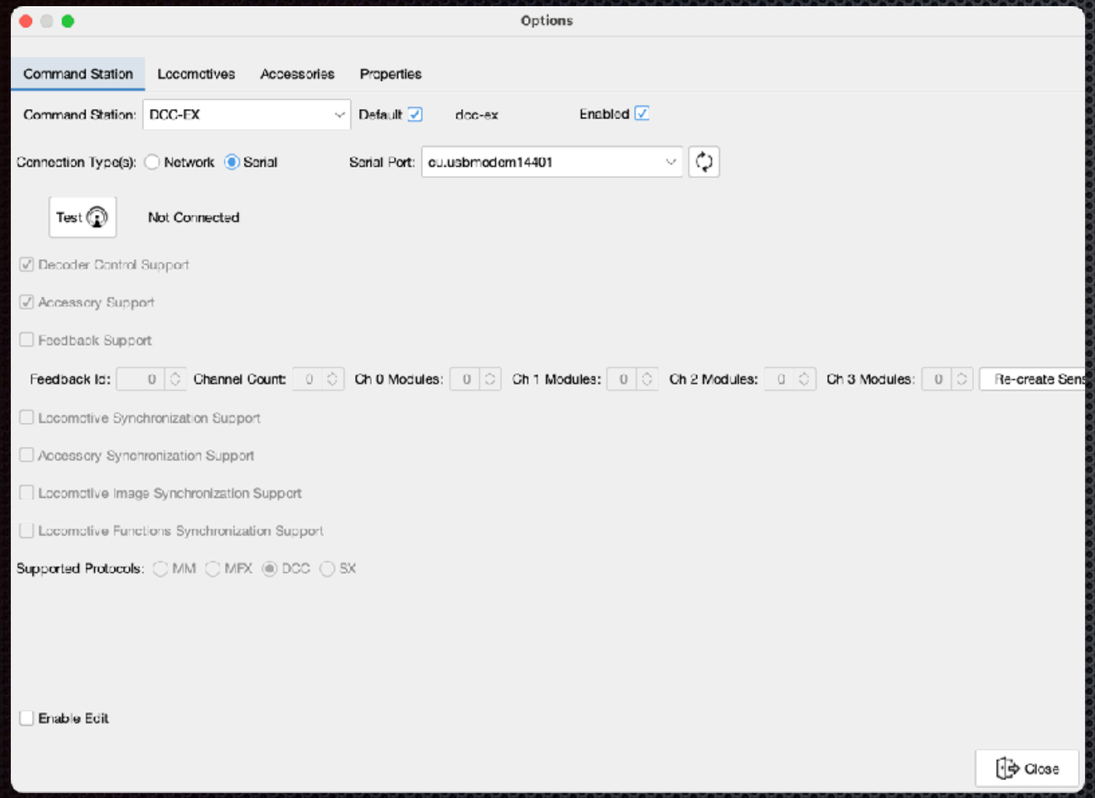
- **HSI-S88**
  - seriële poort, ASCII en binair: i 1 1 0x00 0x02
  - http://www.ldt-infocenter.com/dokuwiki/_media/en/anleitungen/hsi88usb_command-codes_en.pdf

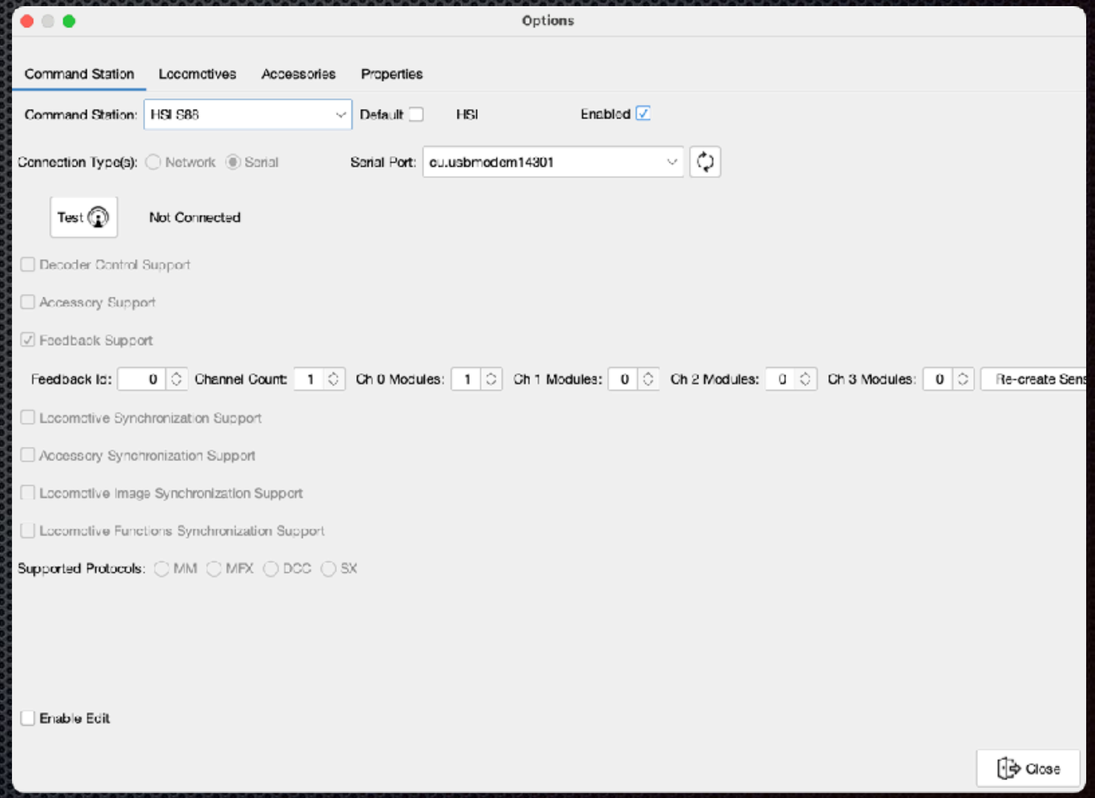
- **ESU ECoS**
  - Netwerk
  - ACSII: cmd(object id, value) -> <REPLY queryObjects(10, size)>10 size[1]<END 0 (OK)>
  - https://github.com/TabalugaDrache/TCPEcos/blob/master/Netzwerkspezifikation_2023.pdf

Schermen

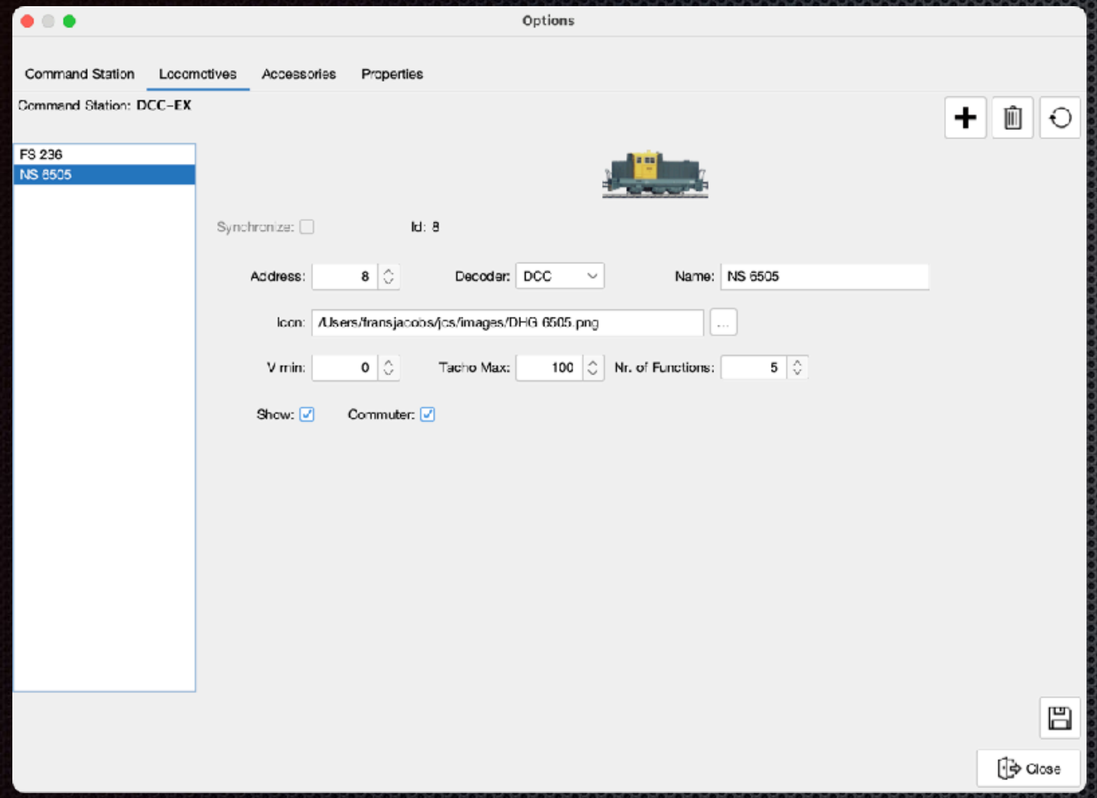
- Gebruiksvriendelijk, zo duidelijk mogelijk
- Zoveel mogelijk actieve terugkoppeling naar de gebruiker
- Het blijkt dat er meer schermen nodig zijn dan ik initieel had gedacht
- Schermlogica is soms erg complex
- Nog opzoek naar een UX designer(…)
  - Goede scherm layout is moeilijk
- Business rules in schermen moeten nog worden toegevoegd

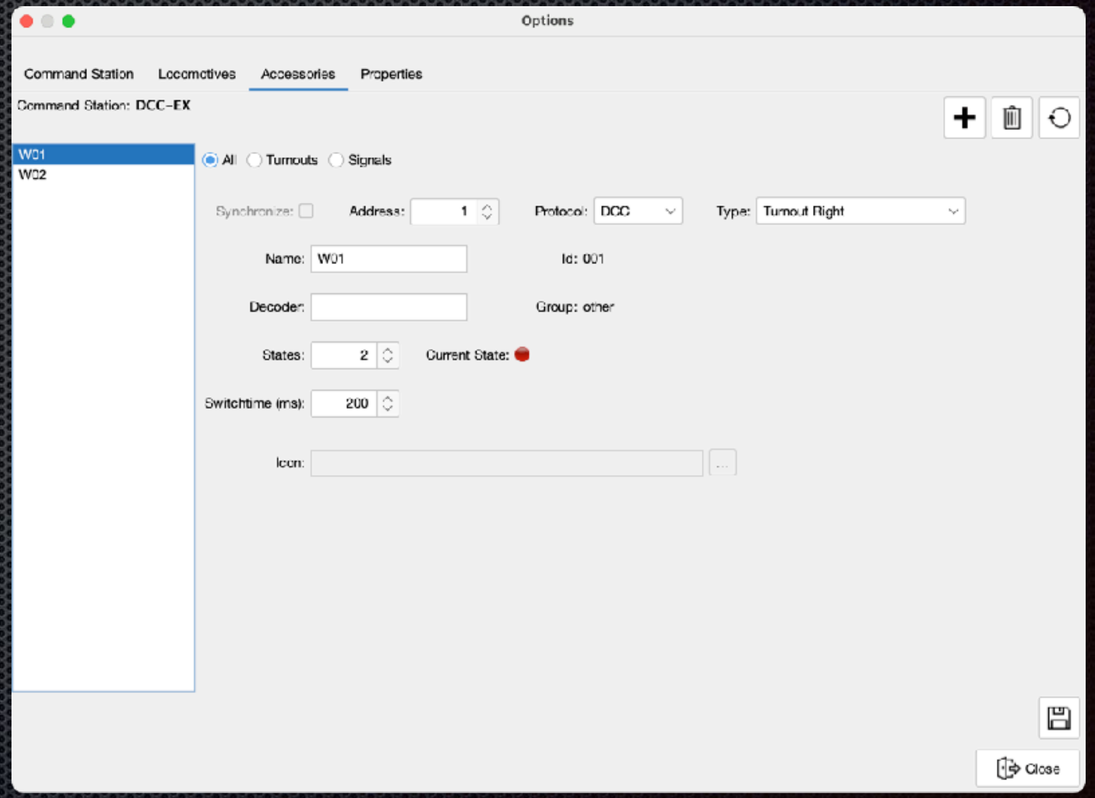
Centrale configuratie



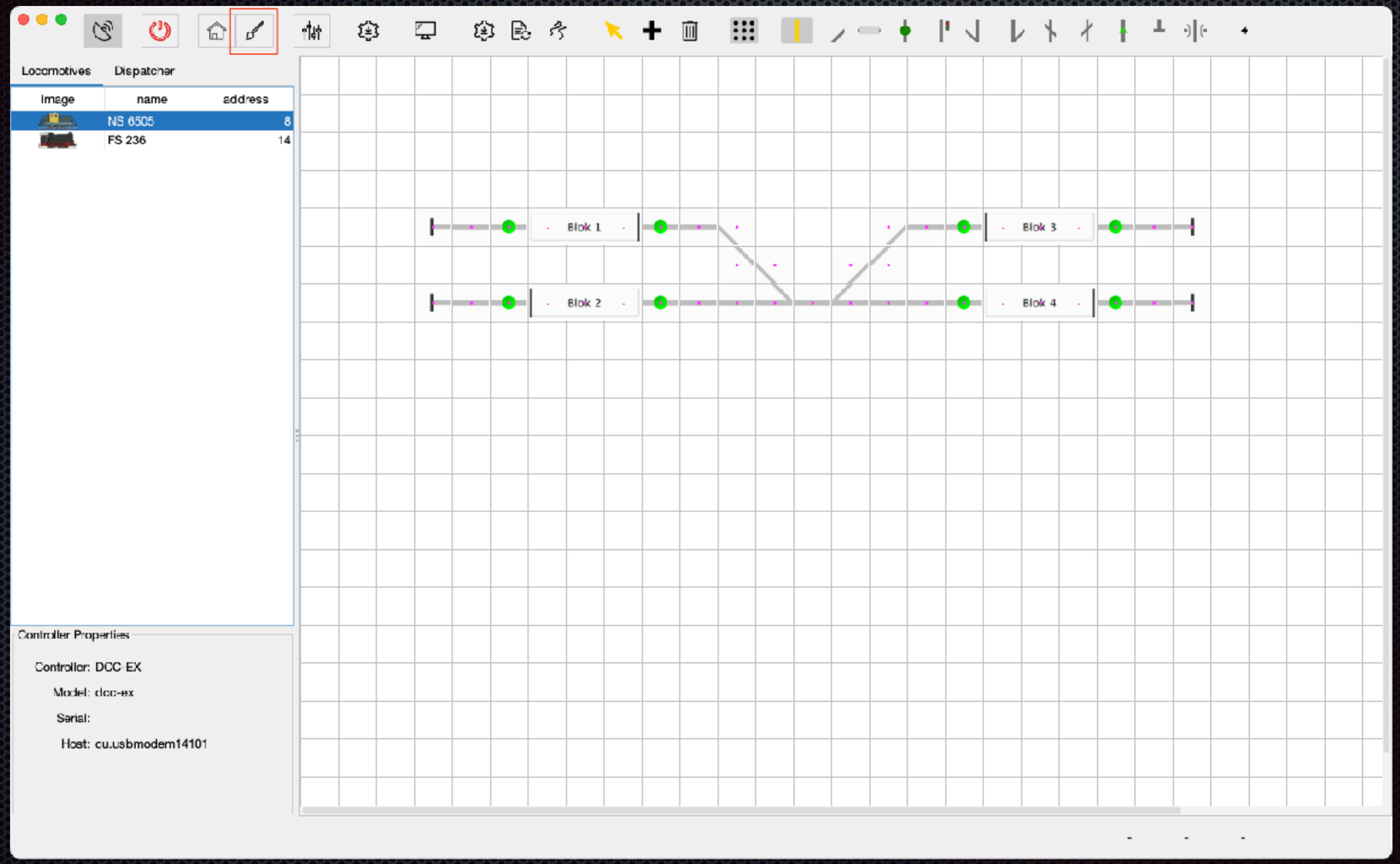


Configuratie van Locomotieven en Accessoires

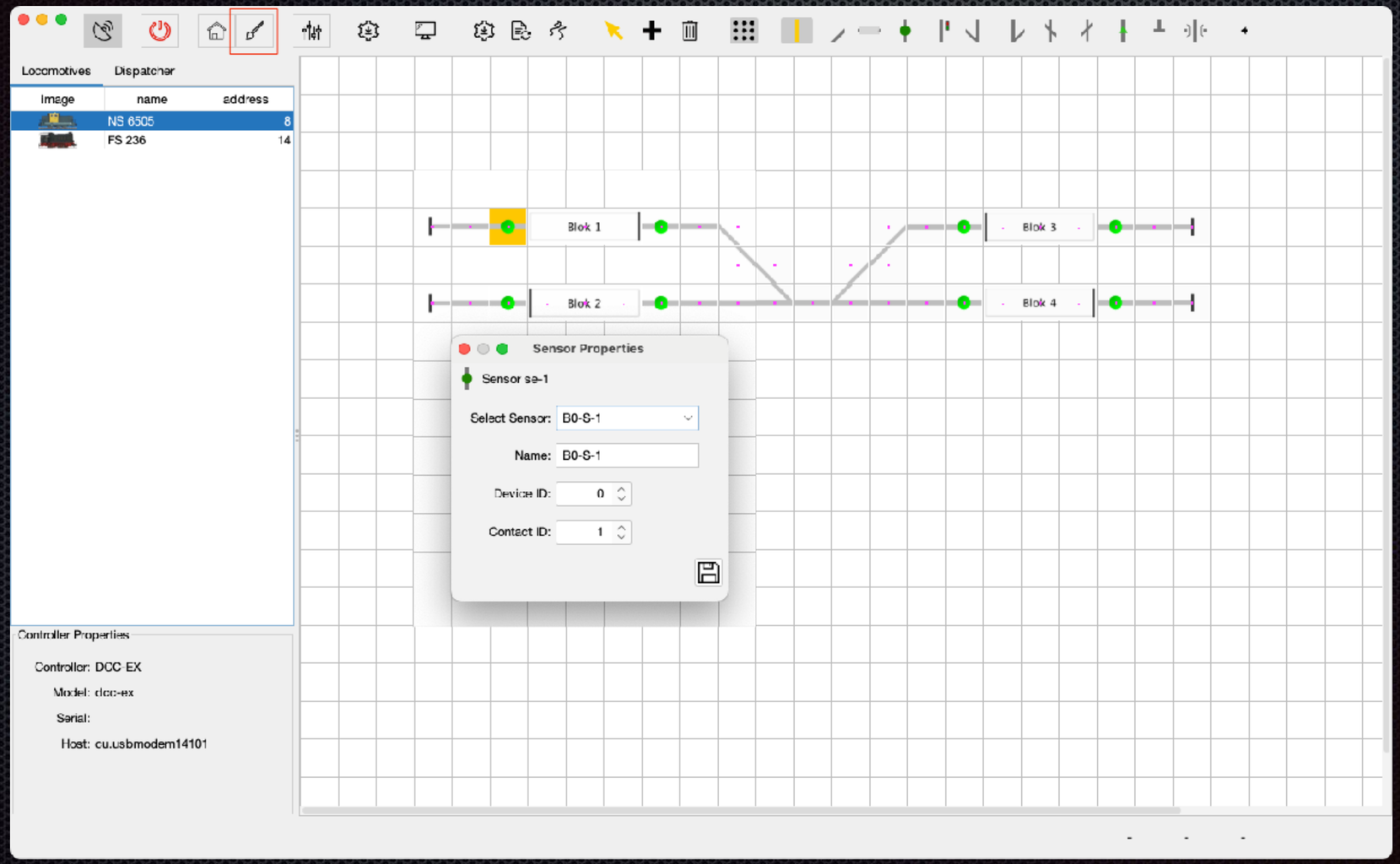




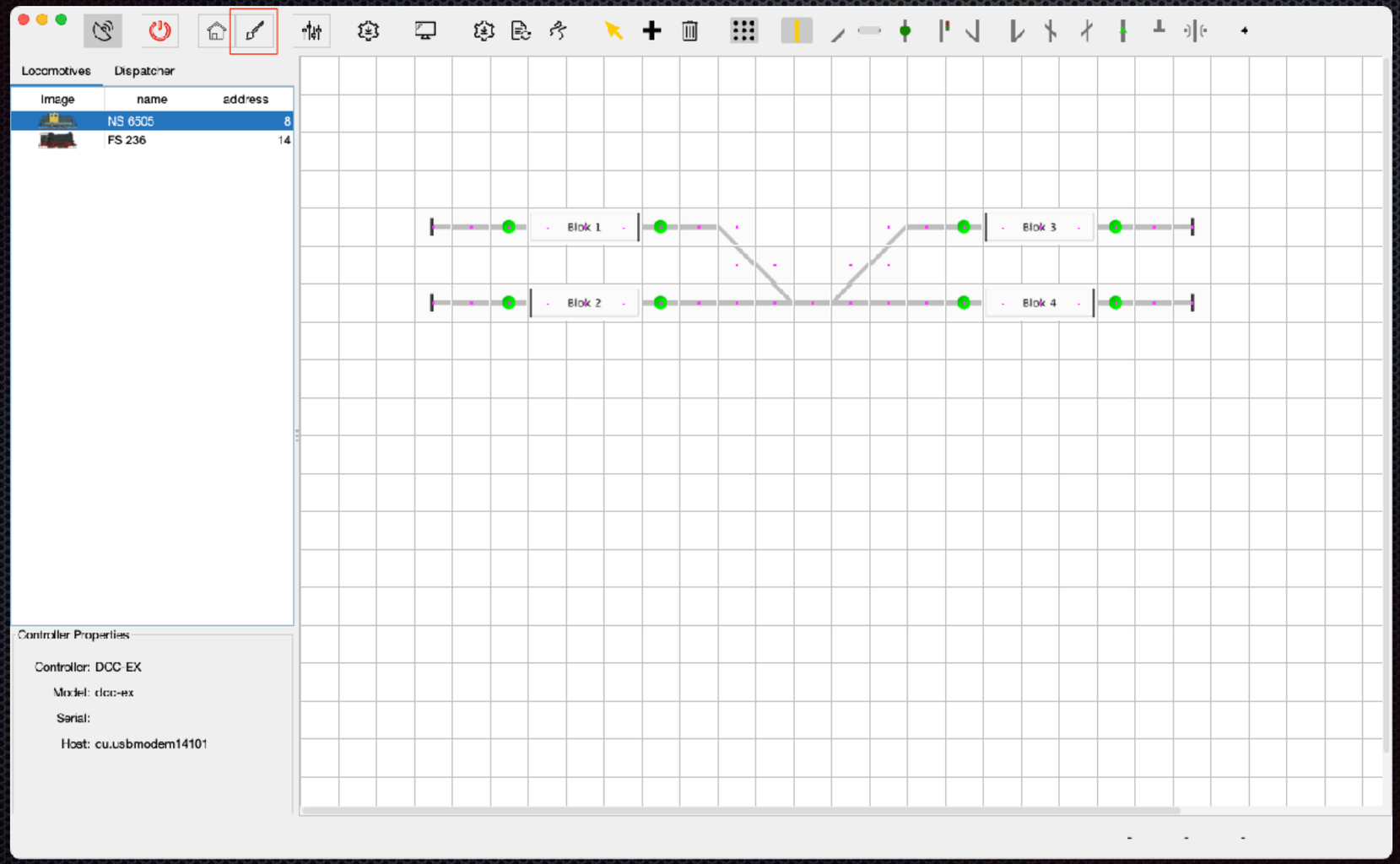
Sporenplan


Locomotives
Dispatcher
Image
name
address
NS 6505
8
FS 236
14
Blok 1
Blok 2
Blok 3
Blok 4
Controller Properties
Controller: DCC-EX
Model: dcc-ex
Serial:
Host: cu.usbmodem14101

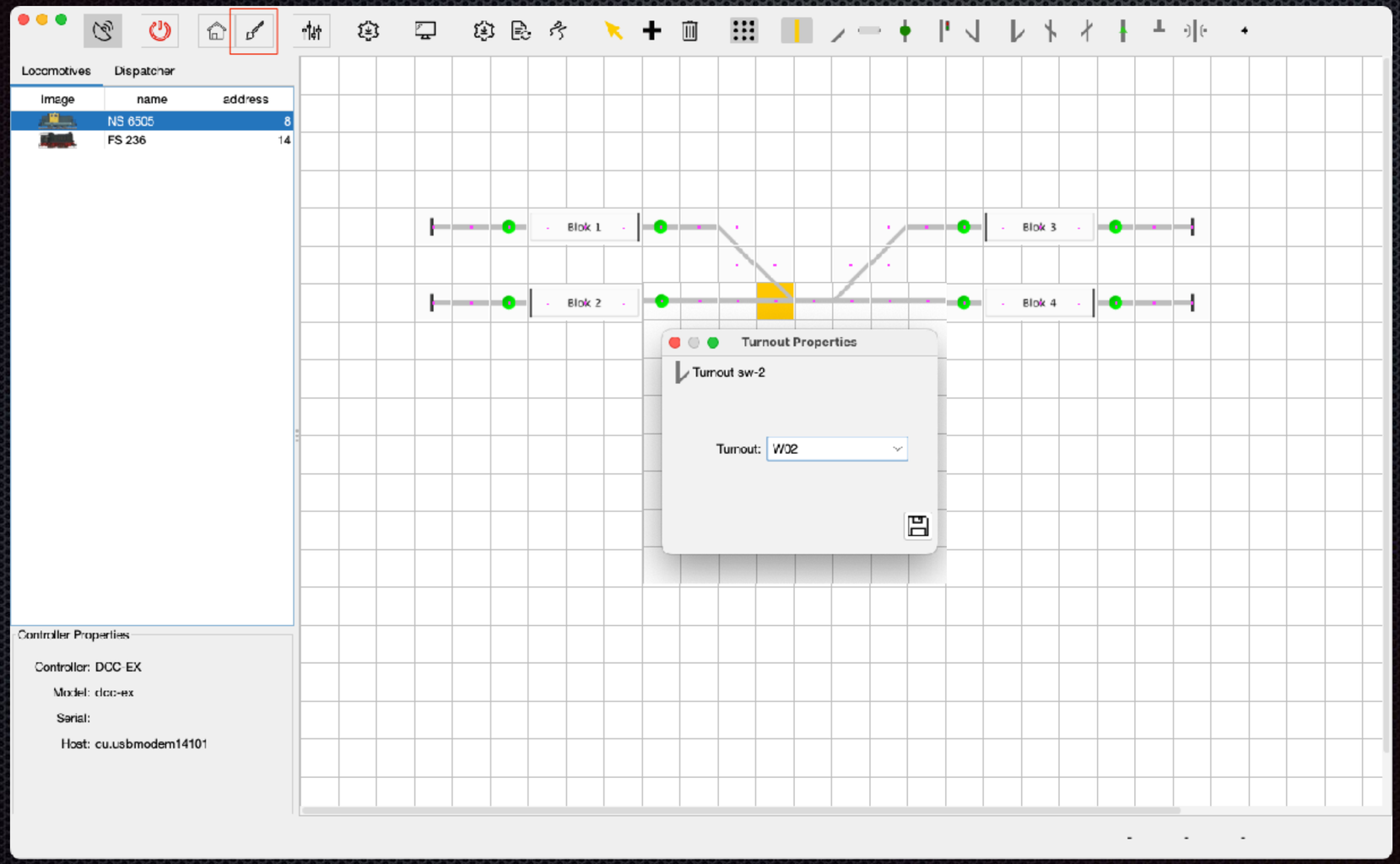
Sporenplan


Locomotives
Dispatcher
Image
name
address
NS 6505
8
FS 236
14
Blok 1
Blok 2
Blok 3
Blok 4
Sensor Properties
Sensor se-1
Select Sensor:
B0-S-1
Name:
B0-S-1
Device ID:
0
Contact ID:
1
Controller Properties
Controller: DCC-EX
Model: dcc-ex
Serial:
Host: cu.usbmodem14101

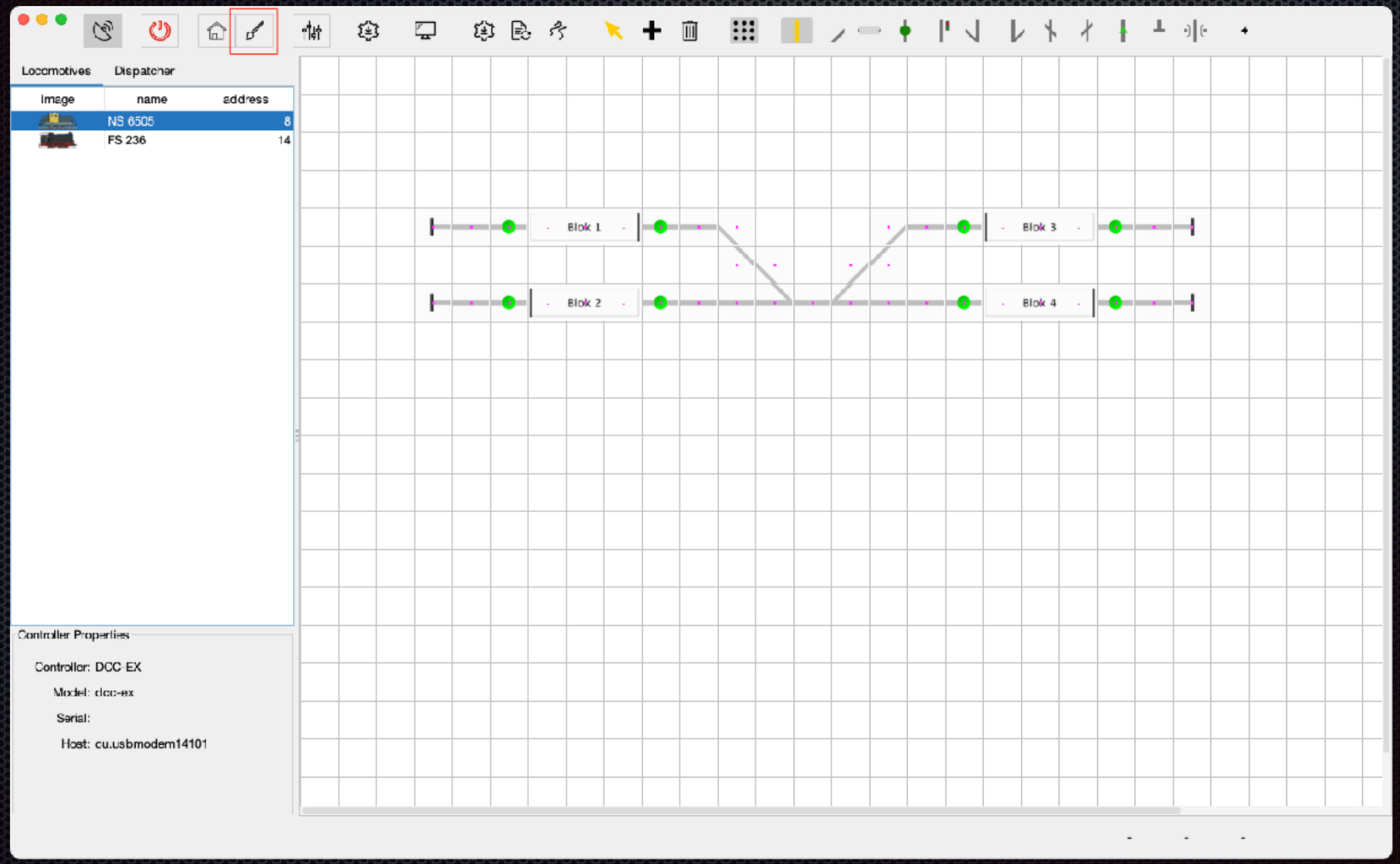
Sporenplan


Locomotives
Dispatcher
Image
name
address
NS 6505
8
FS 236
14
Blok 1
Blok 2
Blok 3
Blok 4
Controller Properties
Controller: DCC-EX
Model: dcc-ex
Serial:
Host: cu.usbmodem14101

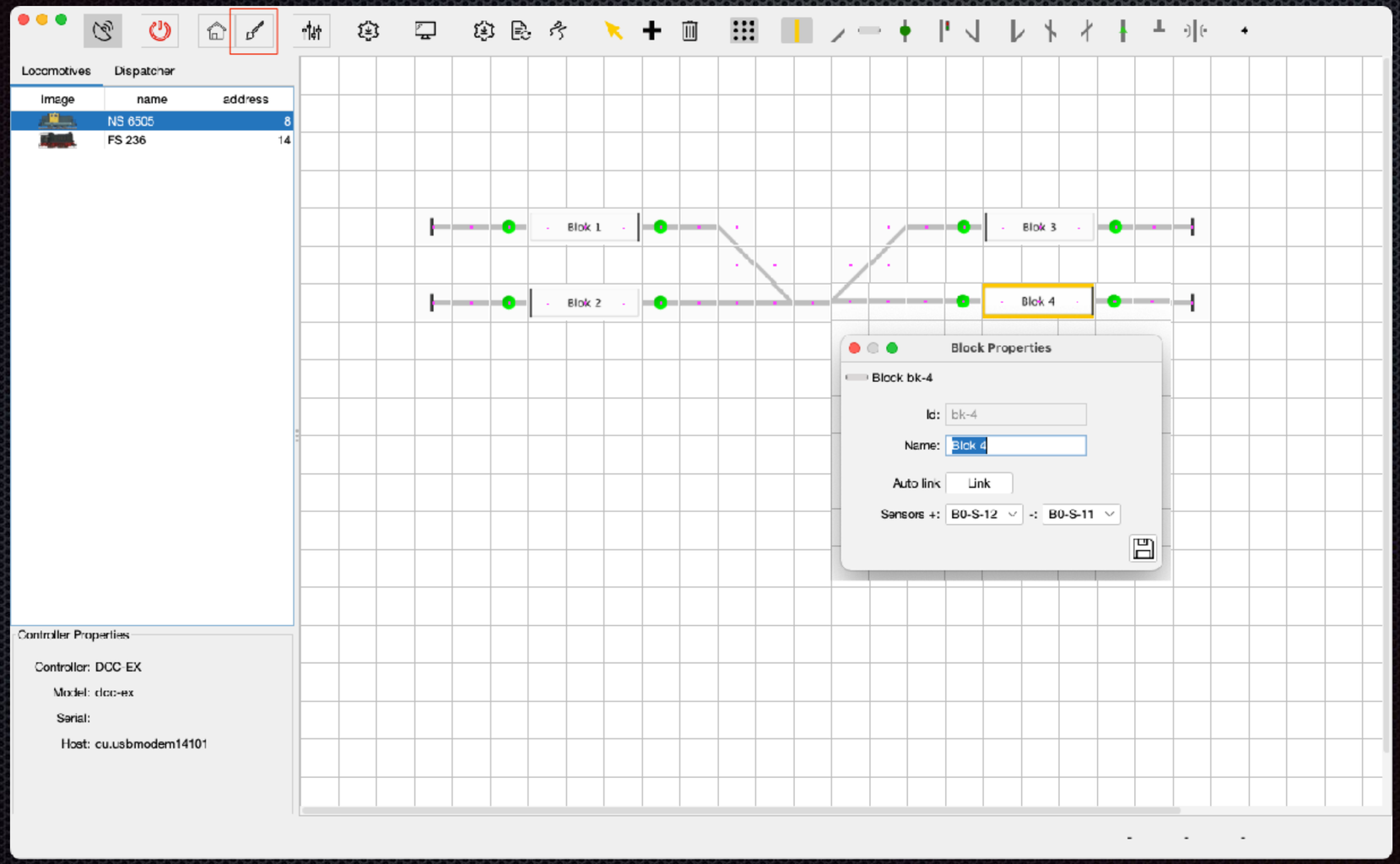
Sporenplan


Locomotives
Dispatcher
Image
name
address
NS 6505
8
FS 236
14
Blok 1
Blok 2
Blok 3
Blok 4
Turnout Properties
Turnout sw-2
Turnout:
W02
Controller Properties
Controller: DCC-EX
Model: dcc-ex
Serial:
Host: cu.usbmodem14101

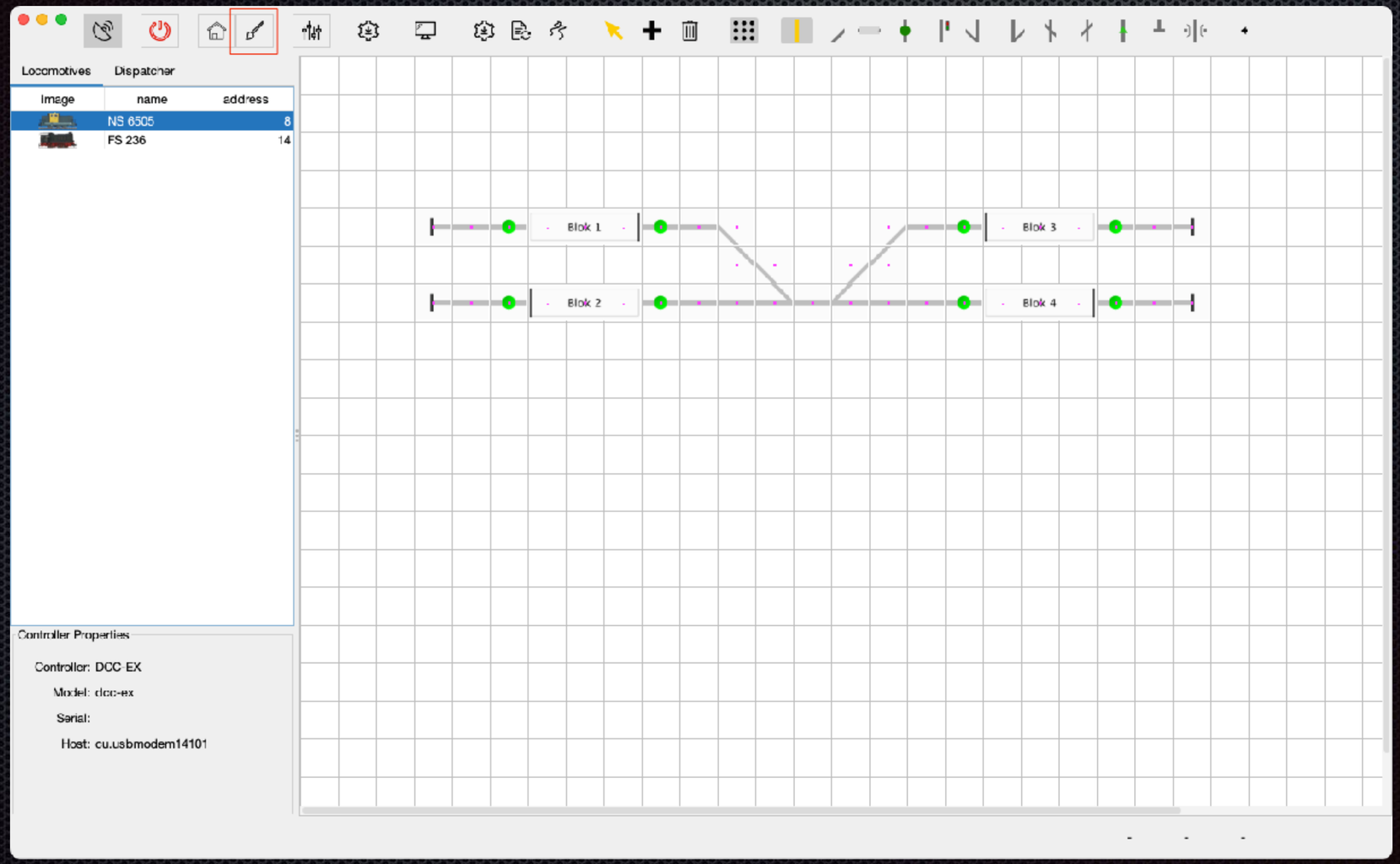
Sporenplan


Locomotives
Dispatcher
Image
name
address
NS 6505
8
FS 236
14
Blok 1
Blok 2
Blok 3
Blok 4
Controller Properties
Controller: DCC-EX
Model: dcc-ex
Serial:
Host: cu.usbmodem14101

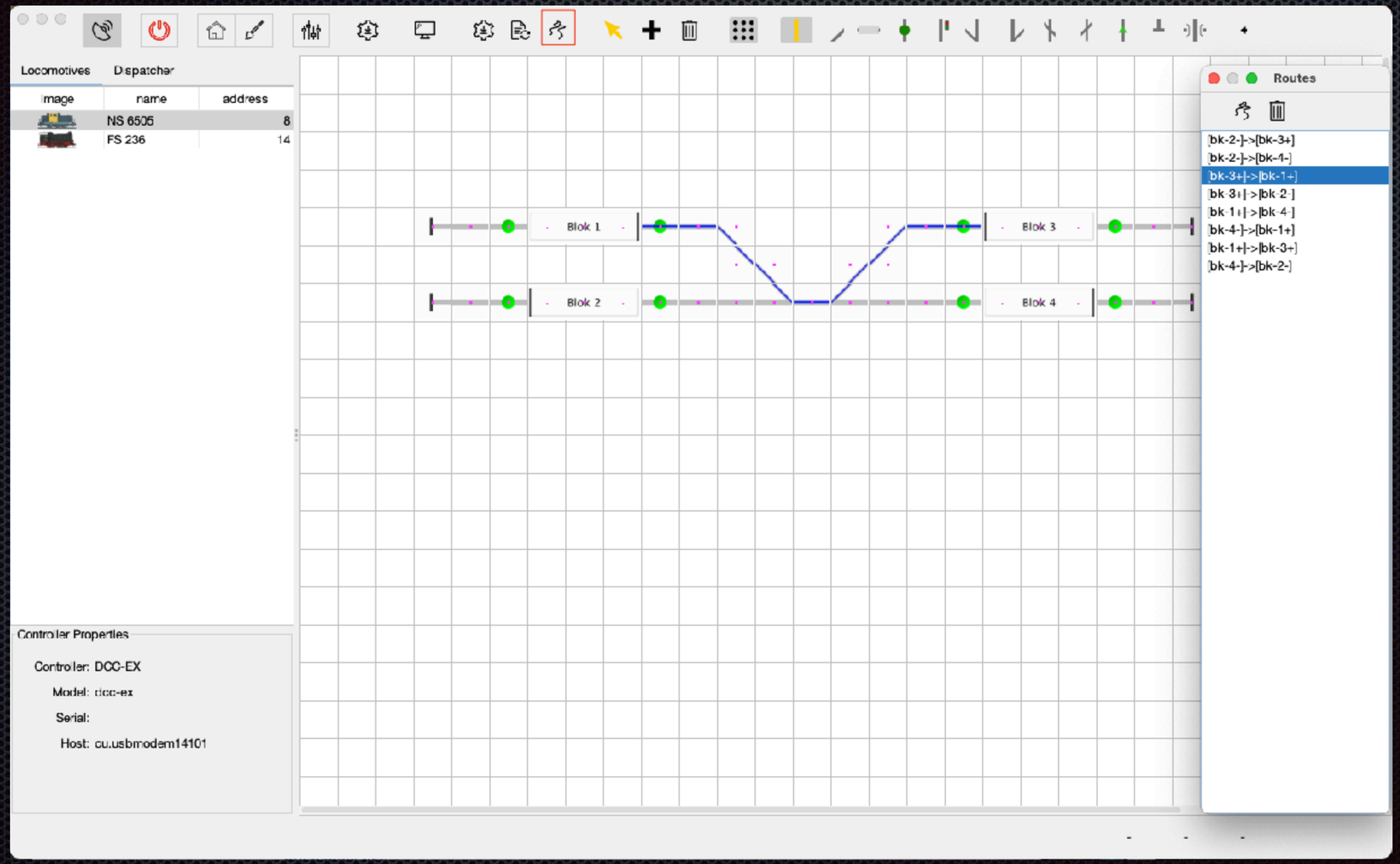
Sporenplan


Locomotives
Dispatcher
Image
name
address
NS 6505
8
FS 236
14
Blok 1
Blok 2
Blok 3
Blok 4
Block Properties
Block bk-4
Id:
bk-4
Name:
Blok 4
Auto link
Link
Sensors +:
B0-S-12
-:
B0-S-11
Controller Properties
Controller: DCC-EX
Model: dcc-ex
Serial:
Host: cu.usbmodem14101

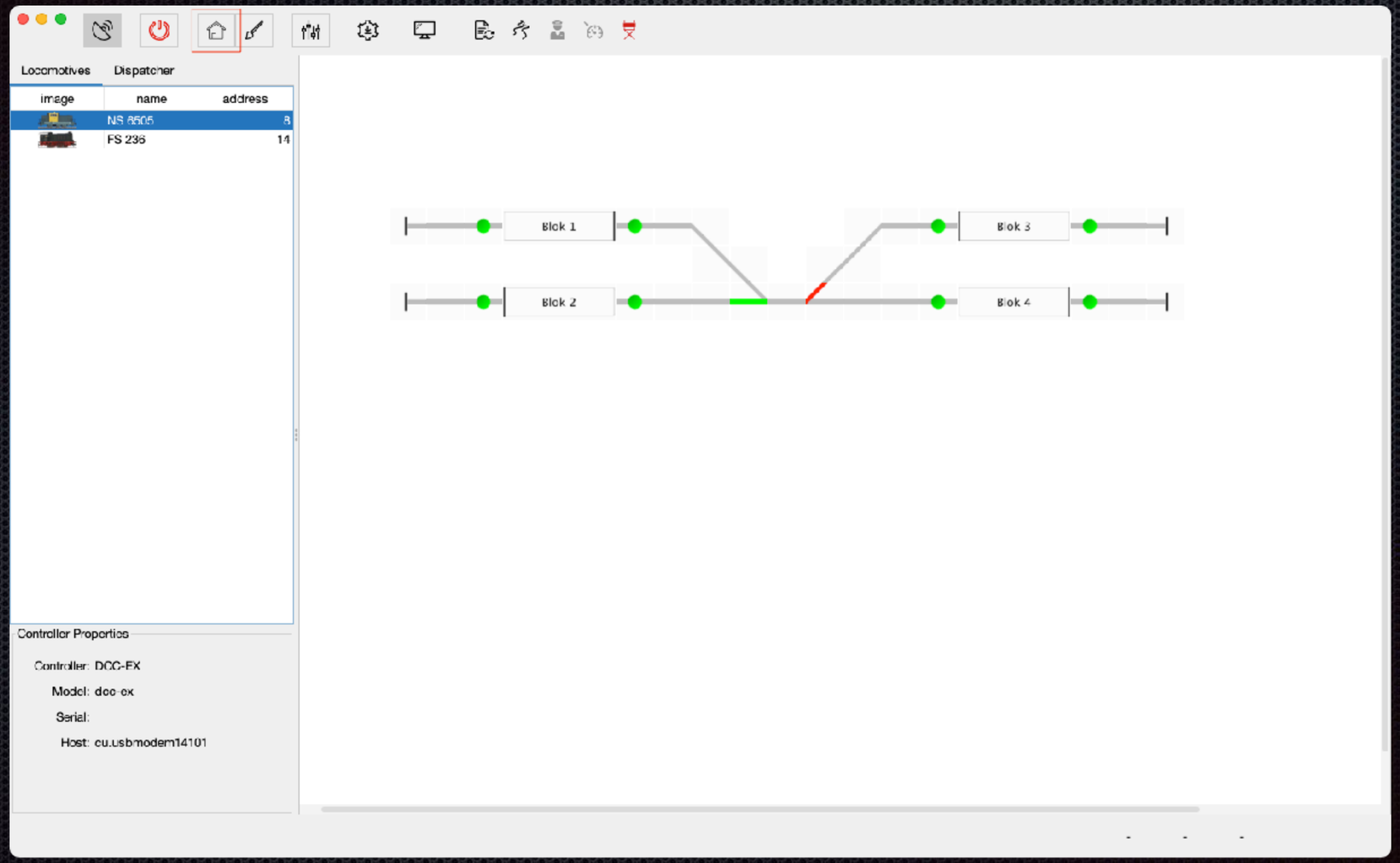
Sporenplan


Locomotives
Dispatcher
Image
name
address
NS 6505
8
FS 236
14
Blok 1
Blok 2
Blok 3
Blok 4
Controller Properties
Controller: DCC-EX
Model: dcc-ex
Serial:
Host: cu.usbmodem14101

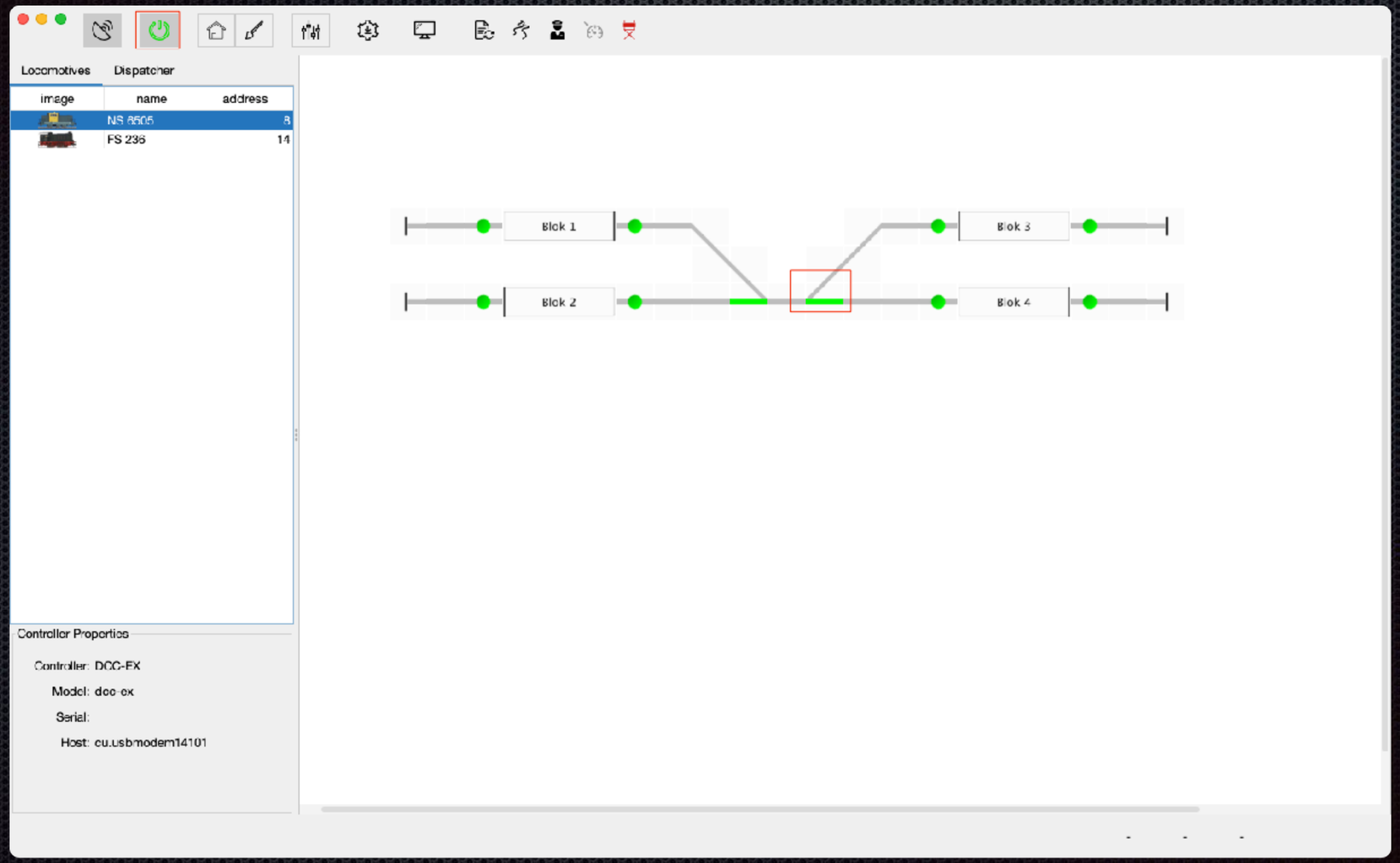
Sporenplan


Locomotives
Dispatcher
image
name
address
NS 6505
8
FS 236
14
Controller Properties
Controller: DCC-EX
Model: dcc-ex
Serial:
Host: cu.usbmodem14101
Blok 1
Blok 2
Blok 3
Blok 4
Routes
[bk-2-]->[bk-3+]
[bk-2-]->[bk-4-]
[bk-3+]->[bk-1+]
[bk-3+]->[bk-2-]
[bk-1+]->[bk-4-]
[bk-4-]->[bk-1+]
[bk-1+]->[bk-3+]
[bk-4-]->[bk-2-]

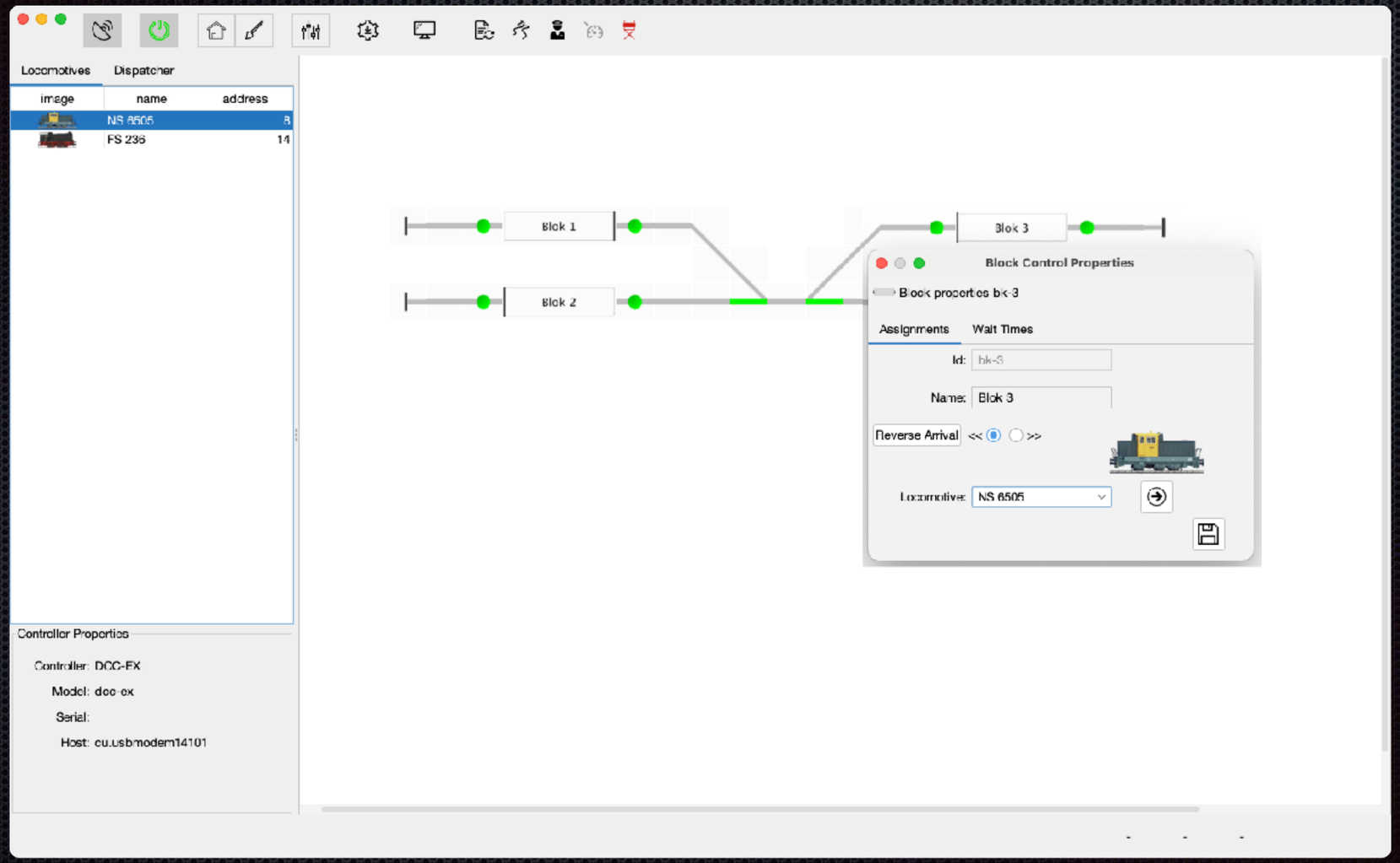
Control mode



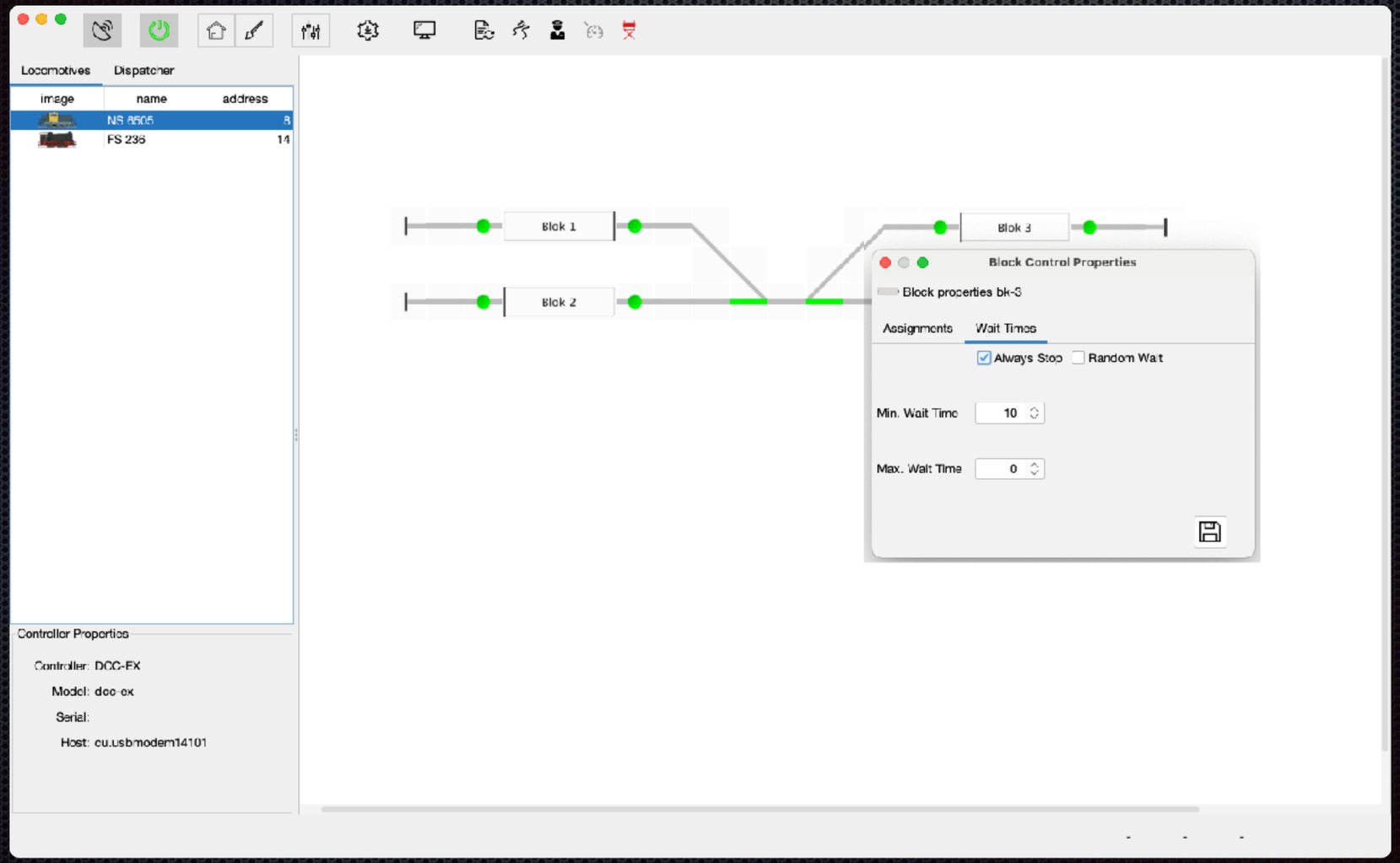
Control mode



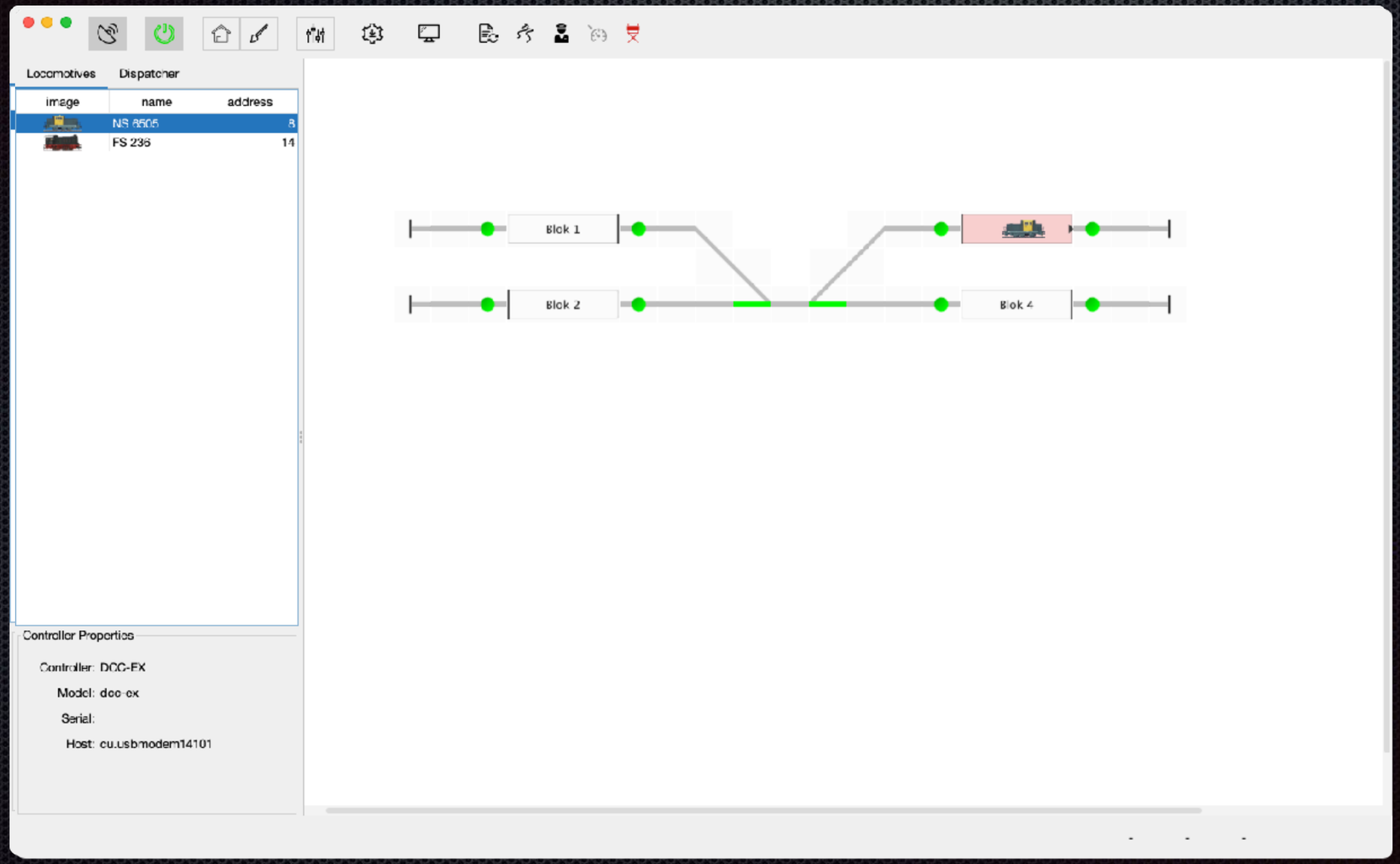
Control mode



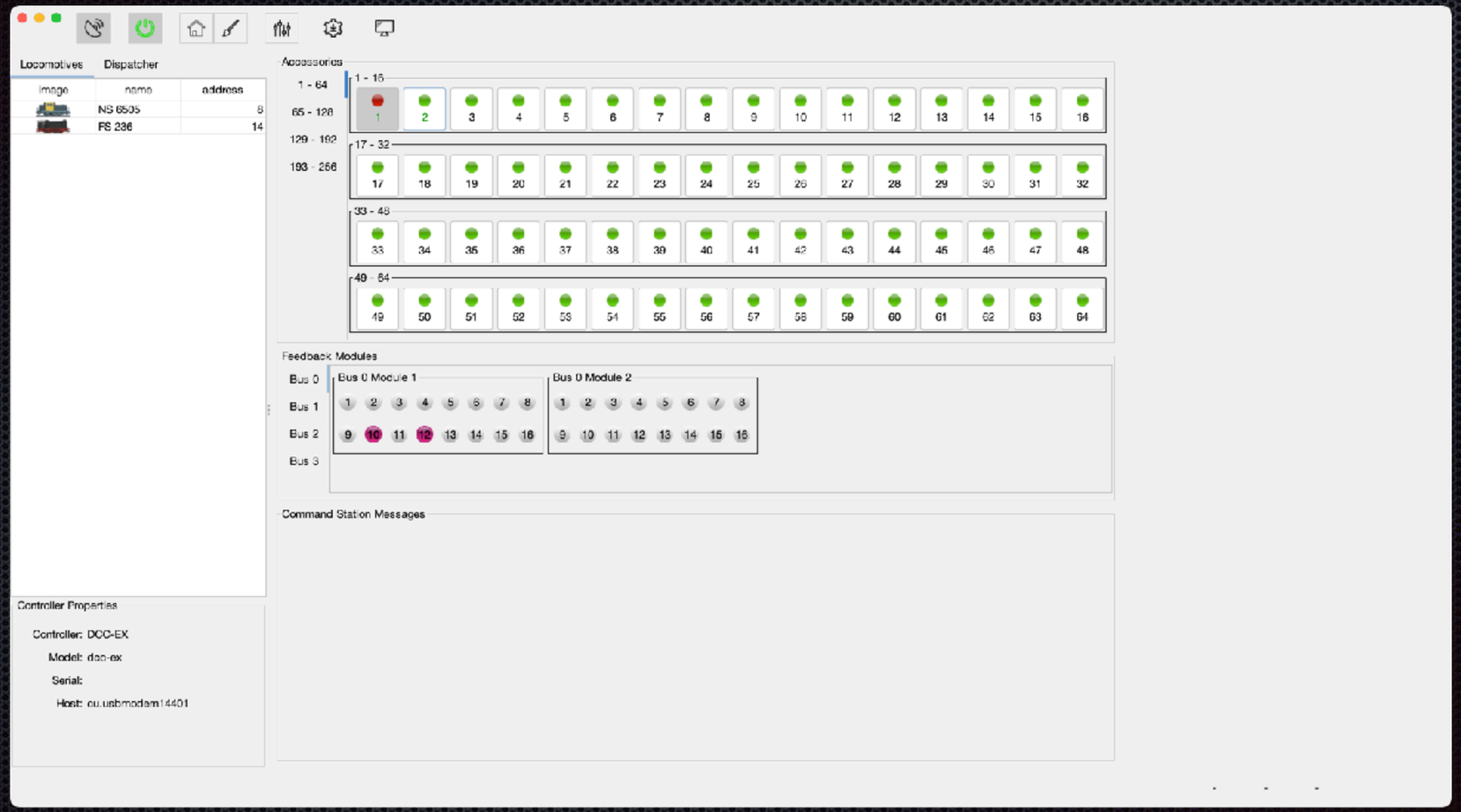
Control mode



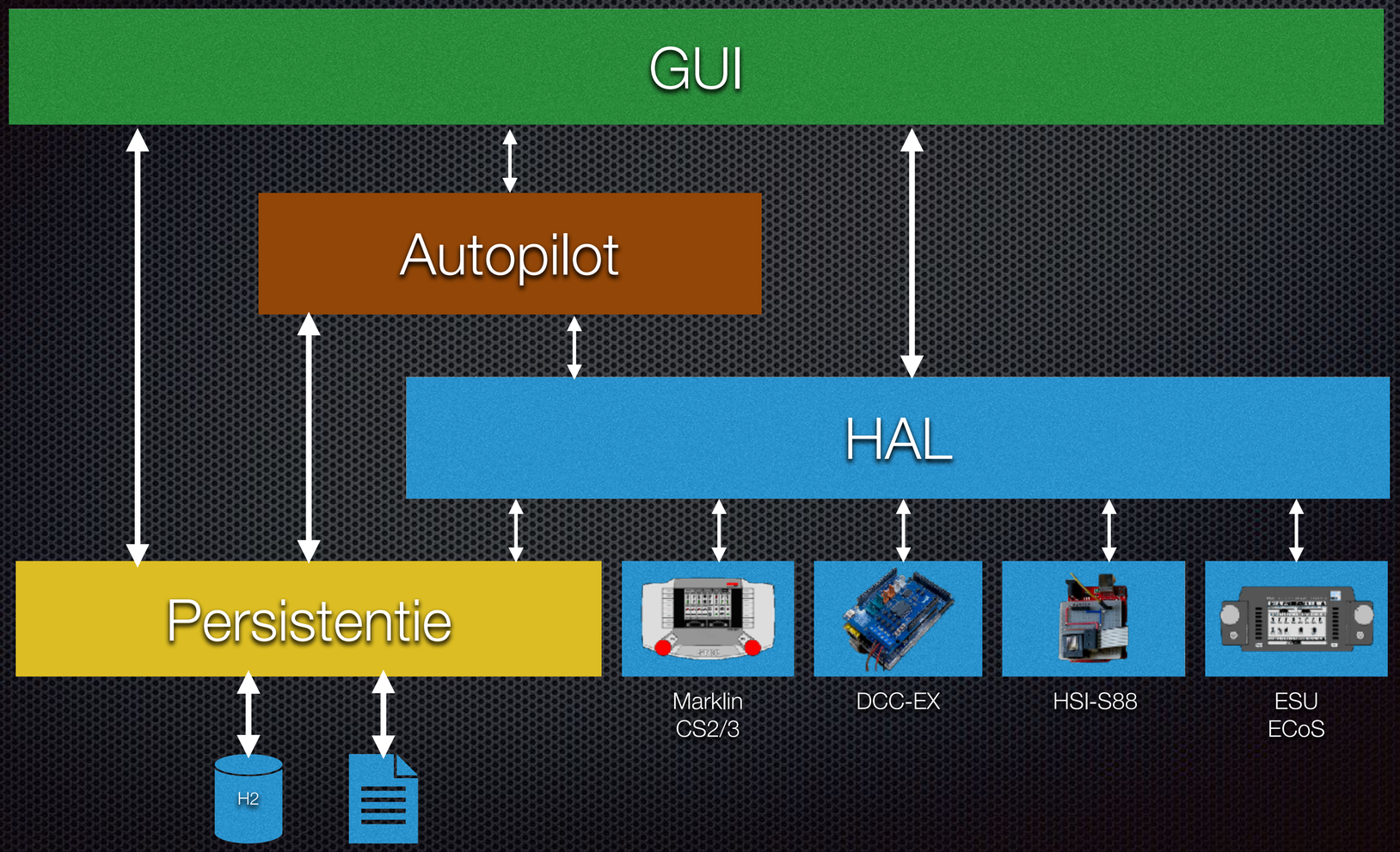
Control mode



Toetsenbord en Terugmelding

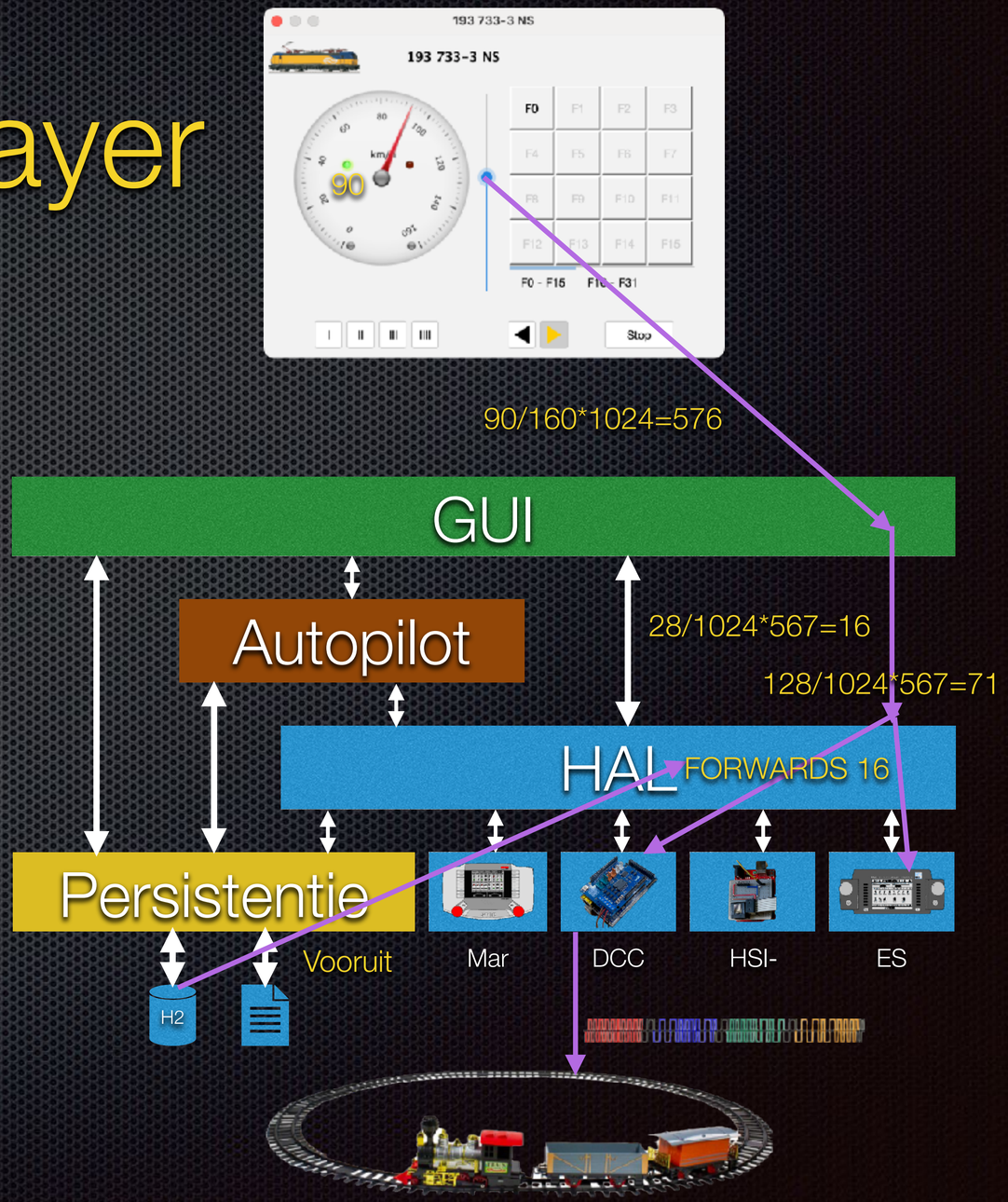


Architectuur van JCS



Hardware Abstractie Layer

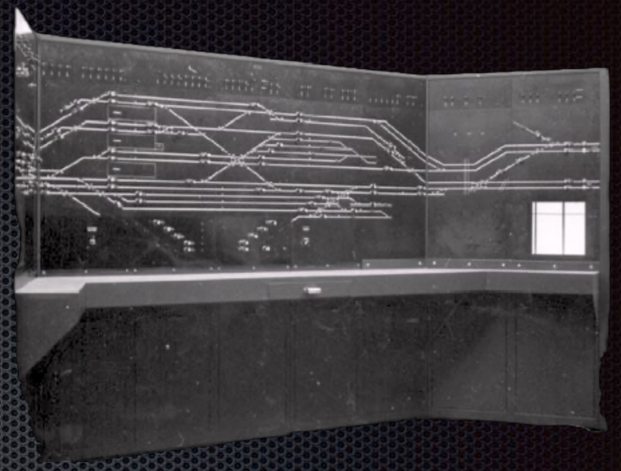
- Via de slider wordt de snelheid naar de de HAL centrale gestuurd, getal tussen de 0 en de 1024.
- De HAL centrale zal, afhankelijk van de aangesloten centrale, de snelheid schalen (bv 28 rijstappen).
- Vaak moet ook de richting van de locomotief worden mee gestuurd in het commando, de HAL haalt dan ook de huidige richting van de locomotief op.
- Vervolgens wordt het commando on de snelheid te veranderen op de aangesloten centrale aan geroepen.
- De fysieke centrale stuurt dit via de rails naar de locomotief



Terugmeldingen

- Marklin CS
  - per sensor: id met een waarde
  - Asynchroon, wel mogelijkheid om per sensor de status op te vragen (start of day)
- HSI-S88
  - Module nummer met een high en low byte
  - Asynchroon
- ECoS
  - Eerst “abonneren” op een module, daarna per module…
  - Asynchroon een “word” (0x8000) voor de geabonneerde module pollen mogelijk

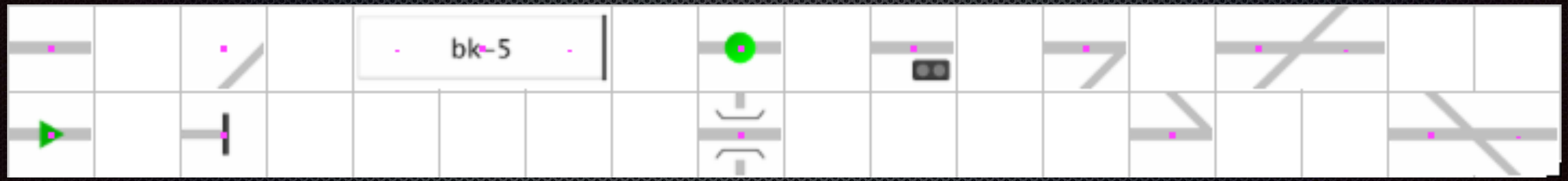
Van Sporenplan -> Rijwegen



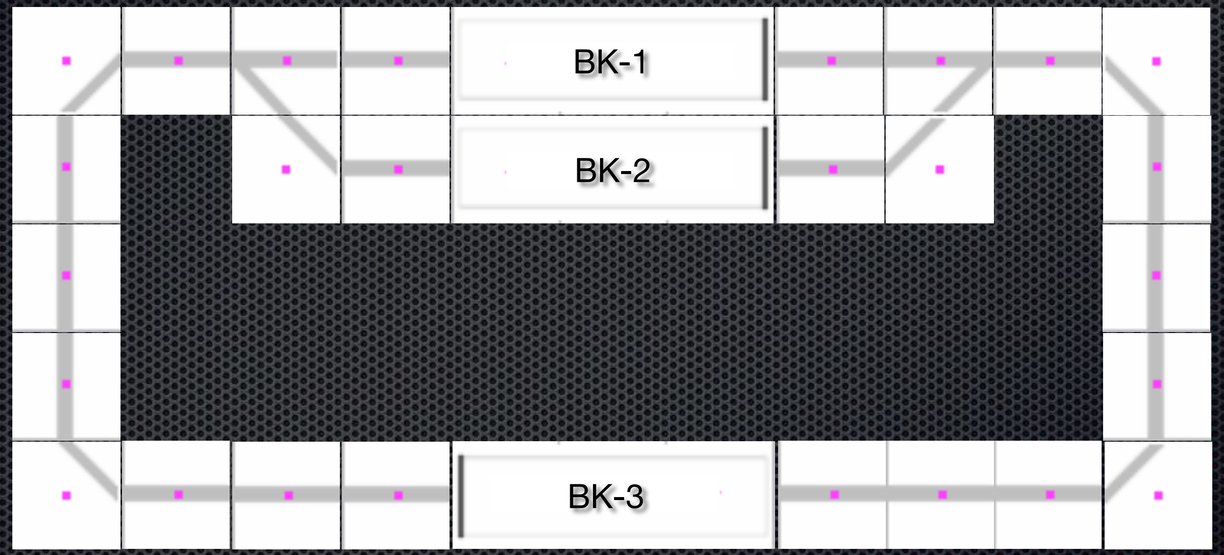
https://www.nicospilt.com/scans/nx-tableau_eindhoven.JPG

- Gekozen voor een grid van 20 x 20 pixels.
- Ieder spoor object is een “Tegel” van een afmeting van 40 x 40 pixels
- Een tegel kan zich zelf tekenen
  - Het type tegel bepaald hoe die eruit ziet
- Het sporenplan (tegels) worden in de database opgeslagen
- Tegel heeft een oriëntatie, Oost, Zuid, West of Noord
- Hierdoor heeft een Tegel max. 4 aansluit kanten

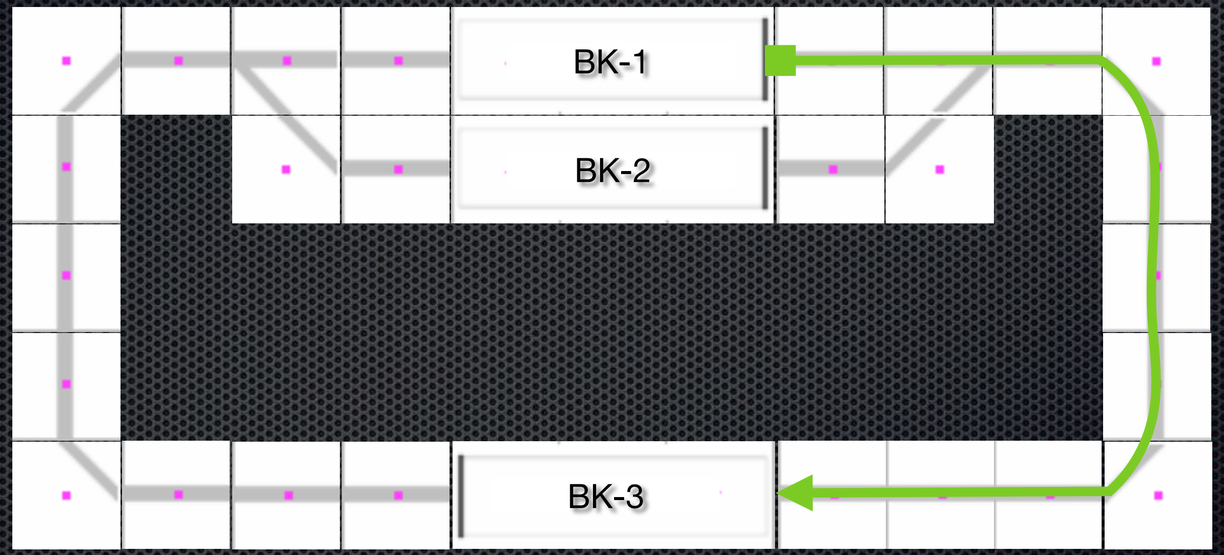
Van Sporenplan -> Rijwegen



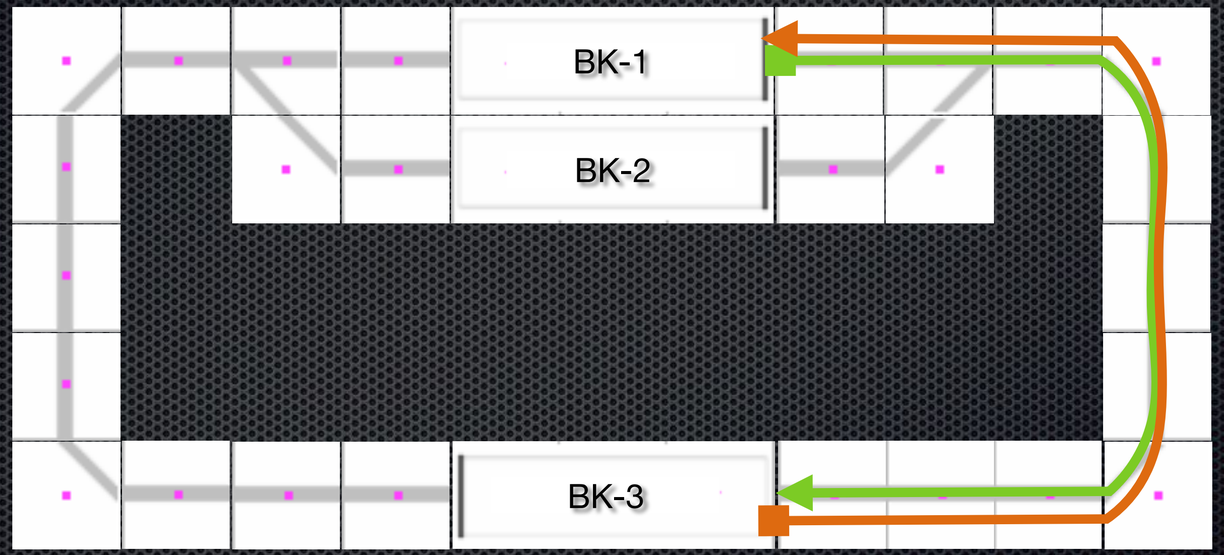
Van Sporenplan -> Rijwegen



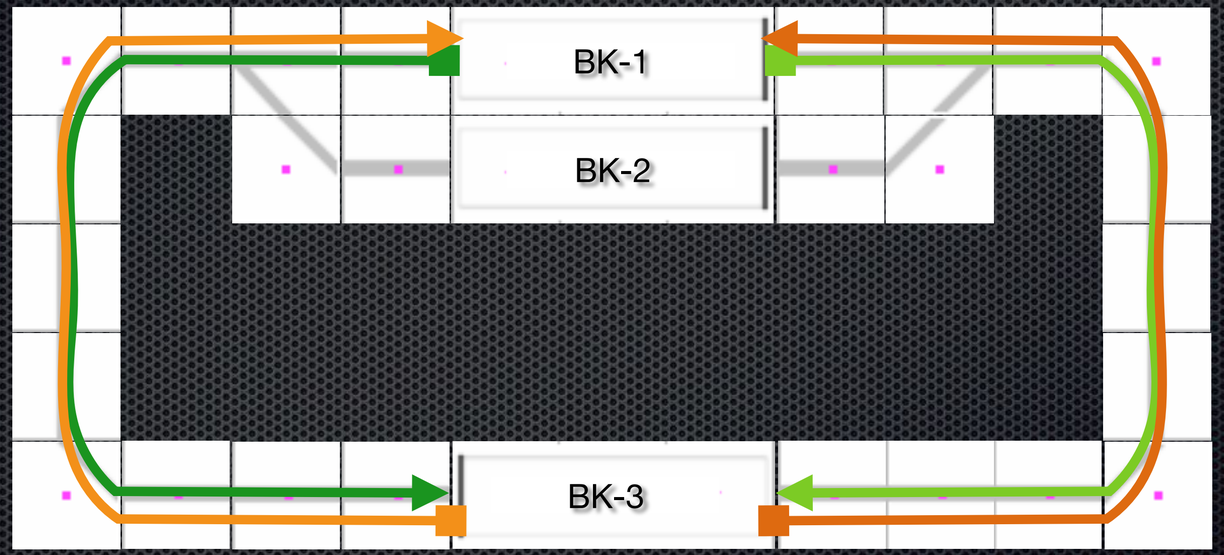
Van Sporenplan -> Rijwegen



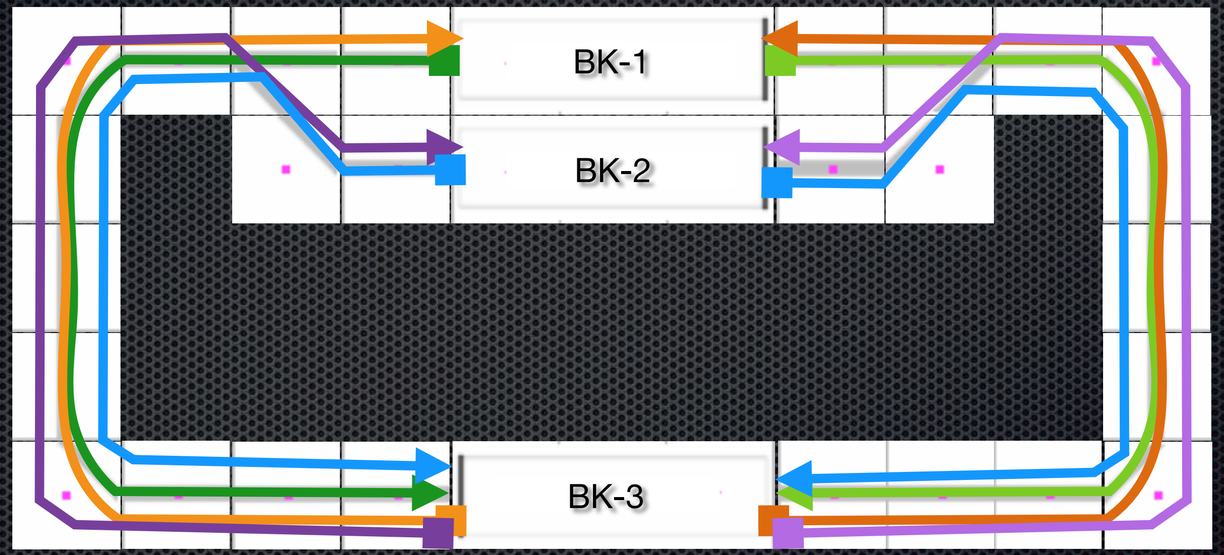
Van Sporenplan -> Rijwegen



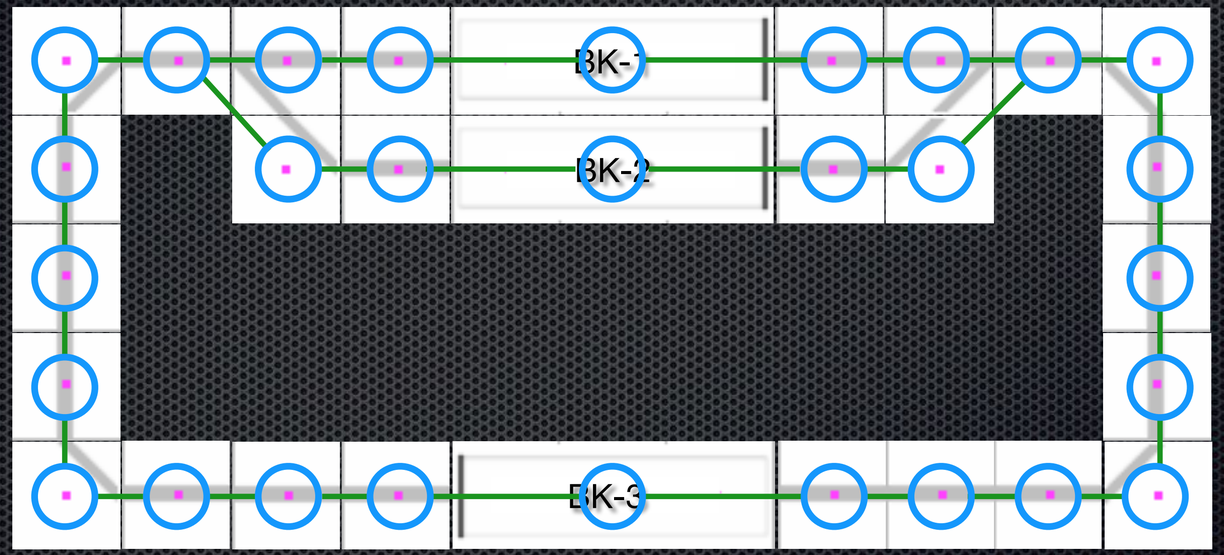
Van Sporenplan -> Rijwegen



Van Sporenplan -> Rijwegen

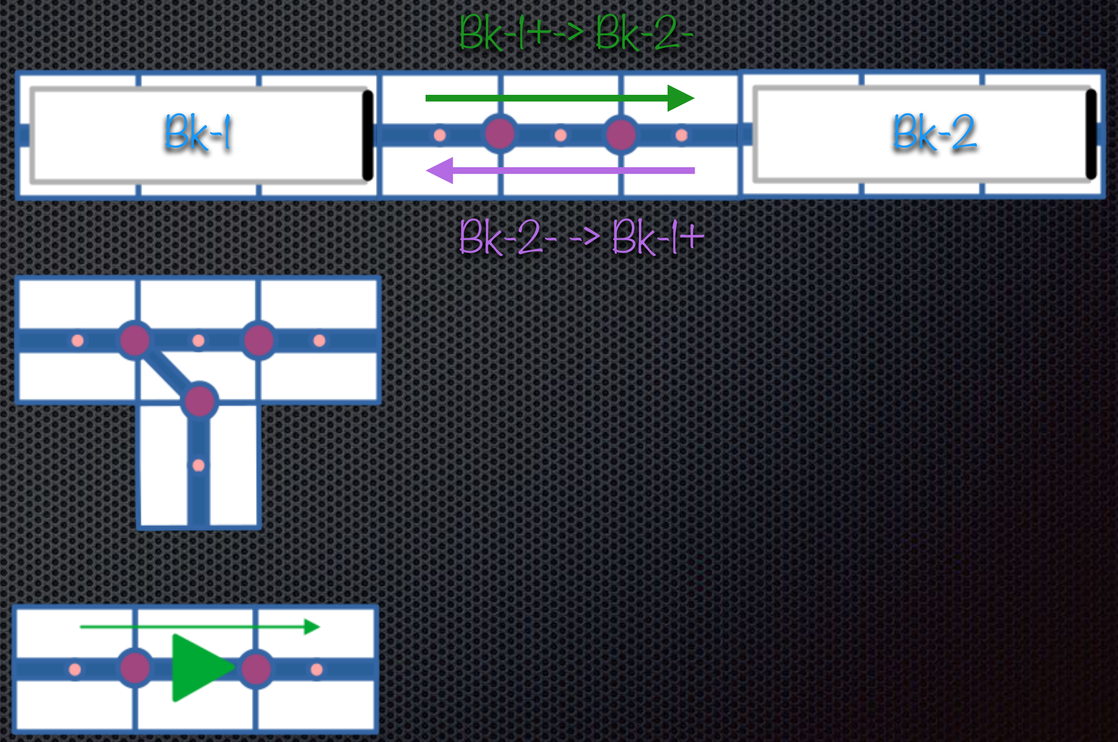


Van Sporenplan -> Rijwegen



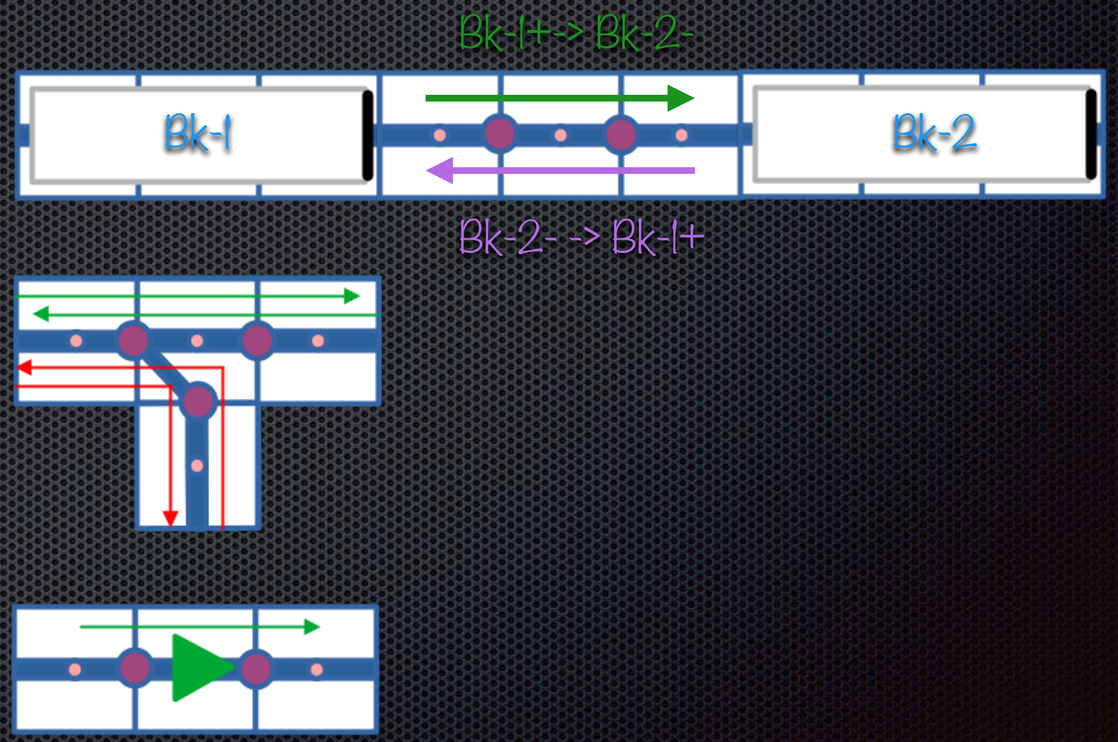
Speciale gevallen

- Blok
- Wissel
- Een Richting

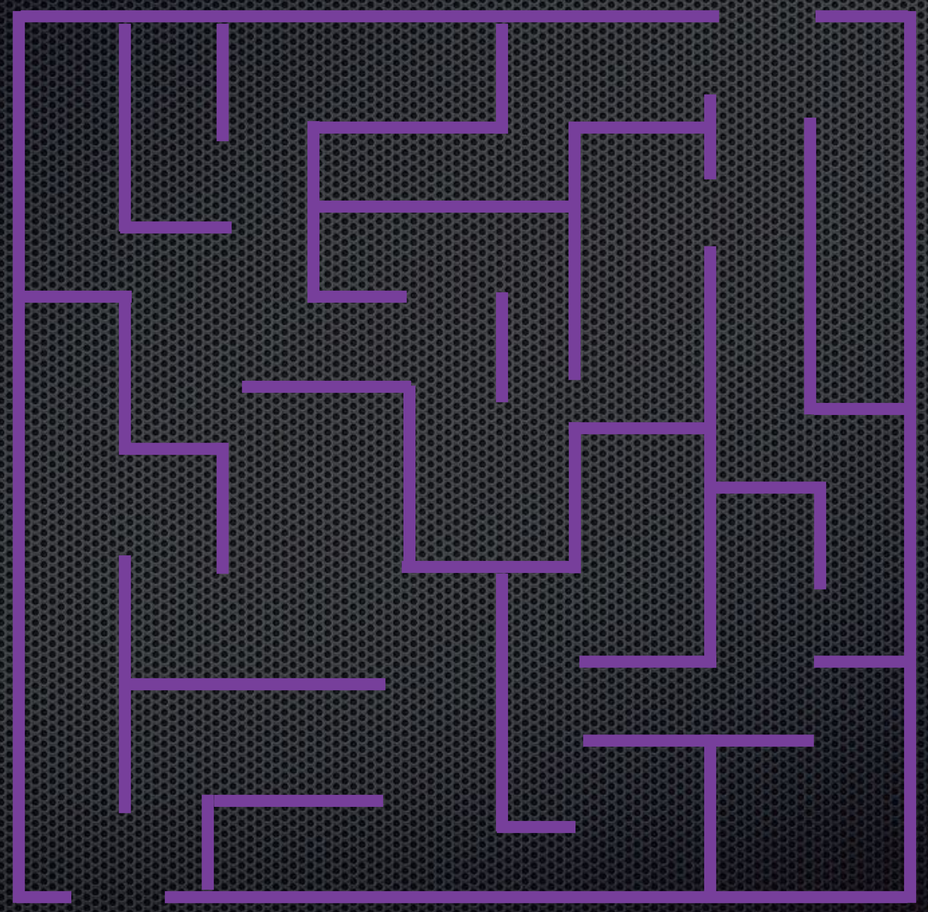


Speciale gevallen

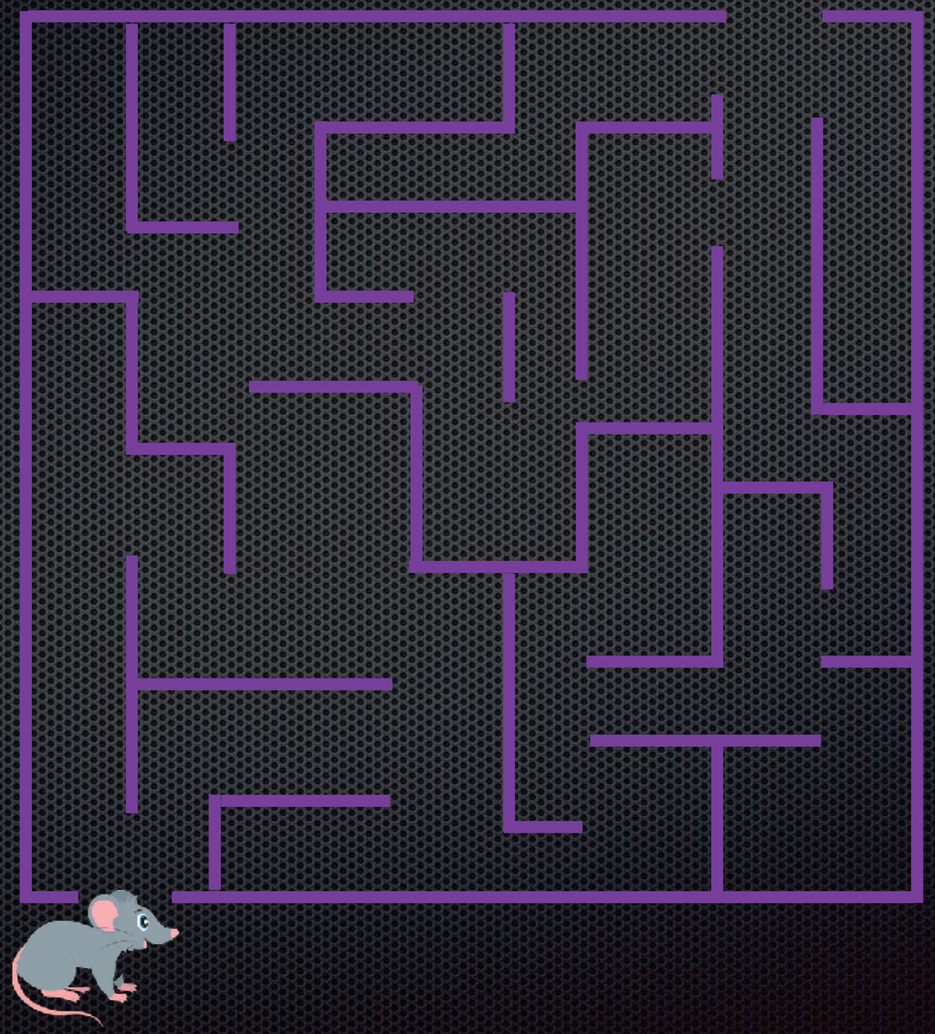
- Blok
- Wissel
- Een Richting



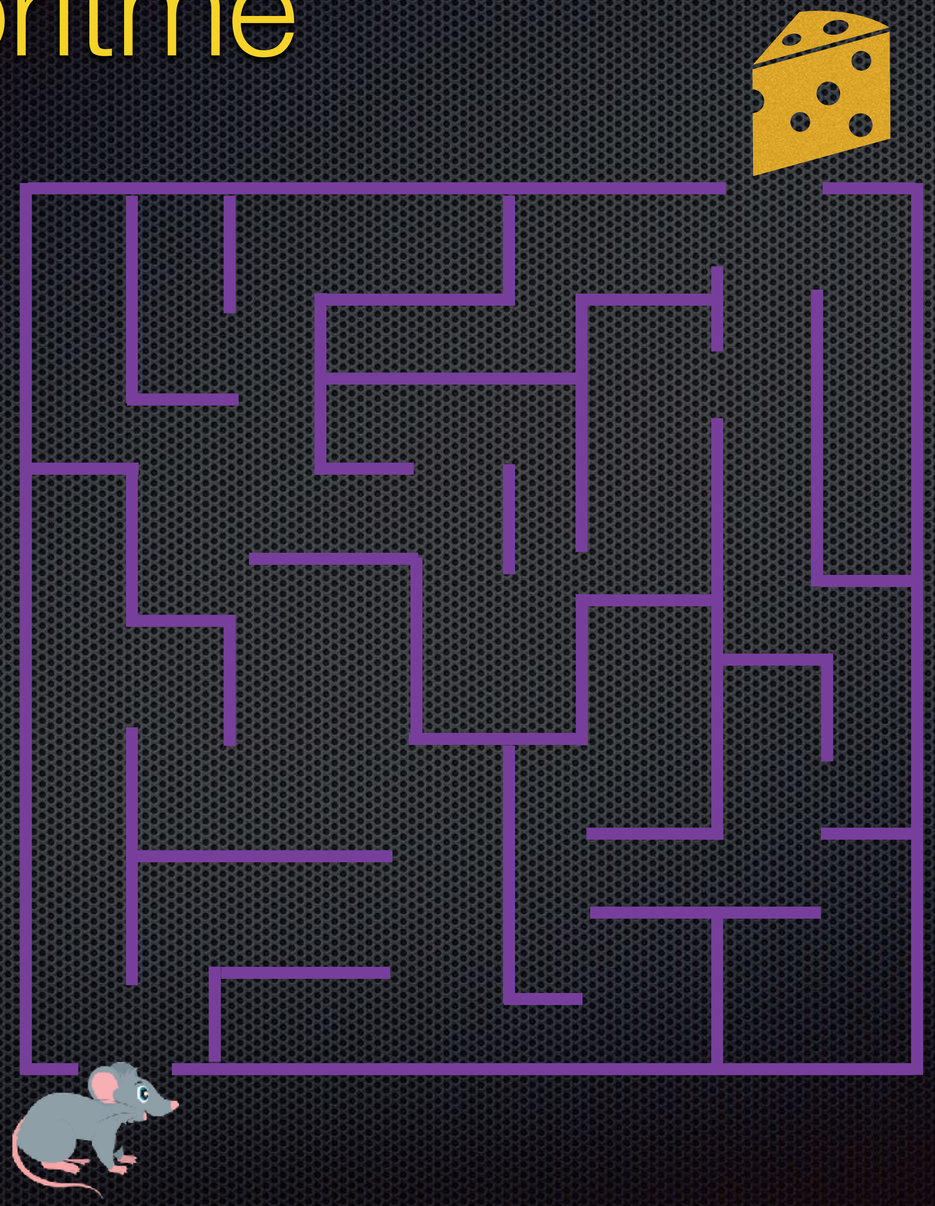
A-ster algoritme



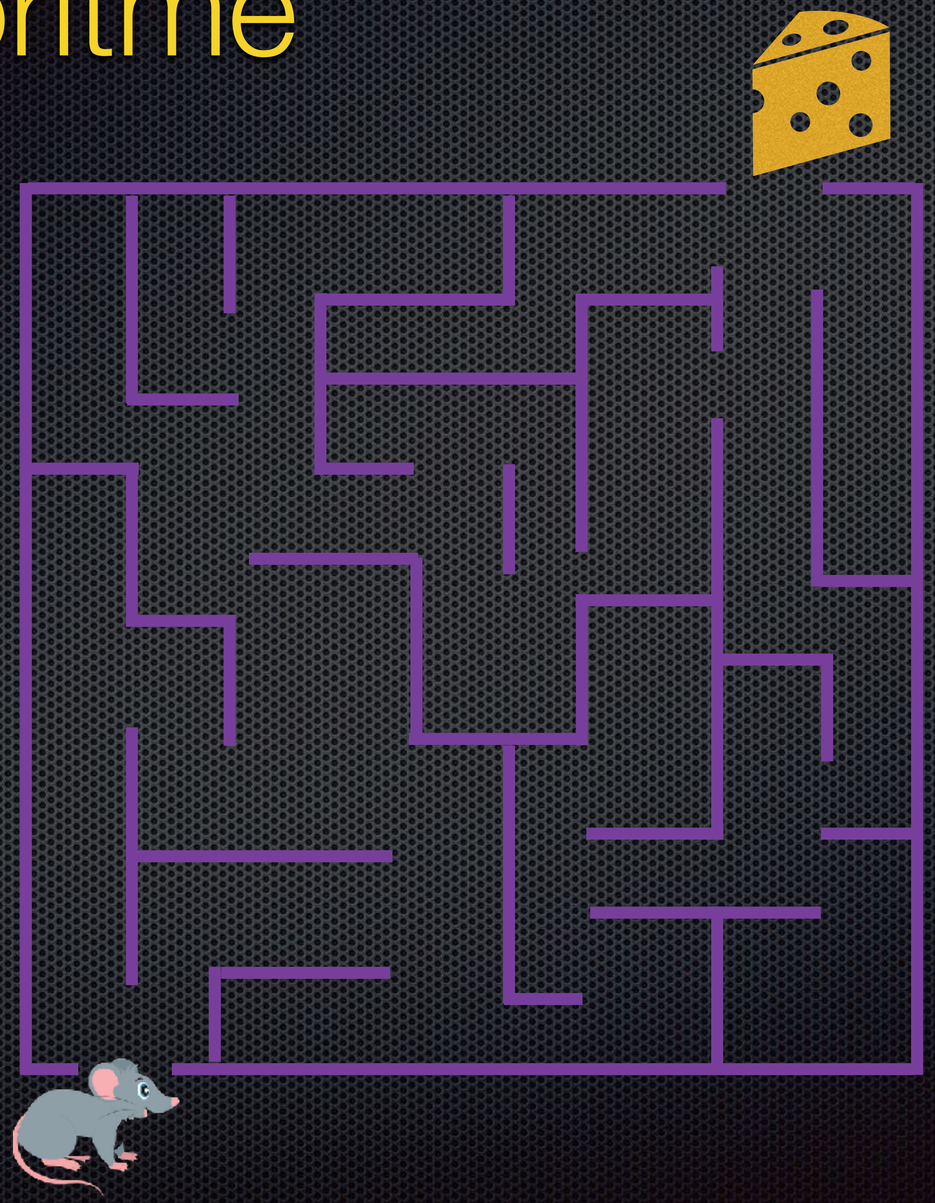
A-ster algoritme



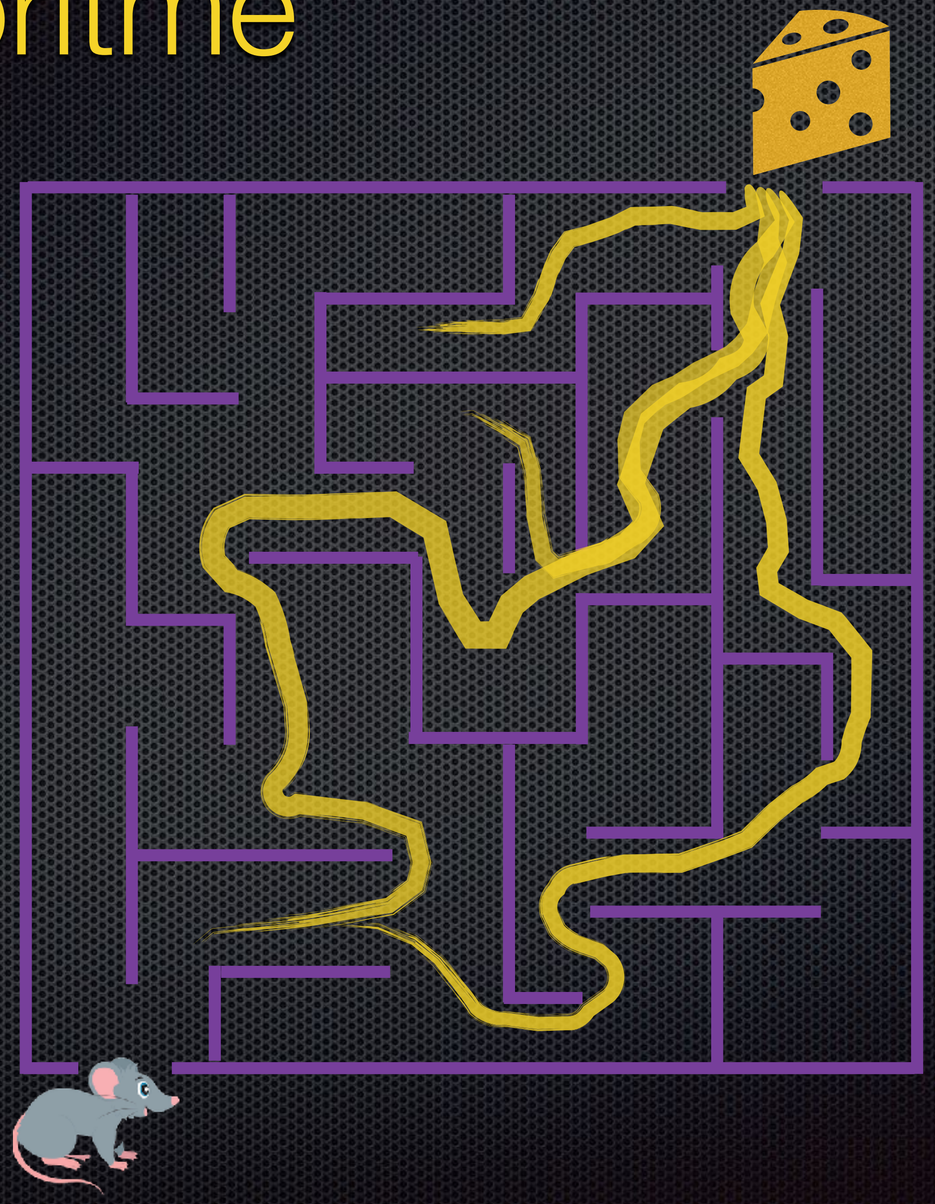
A-ster algoritme



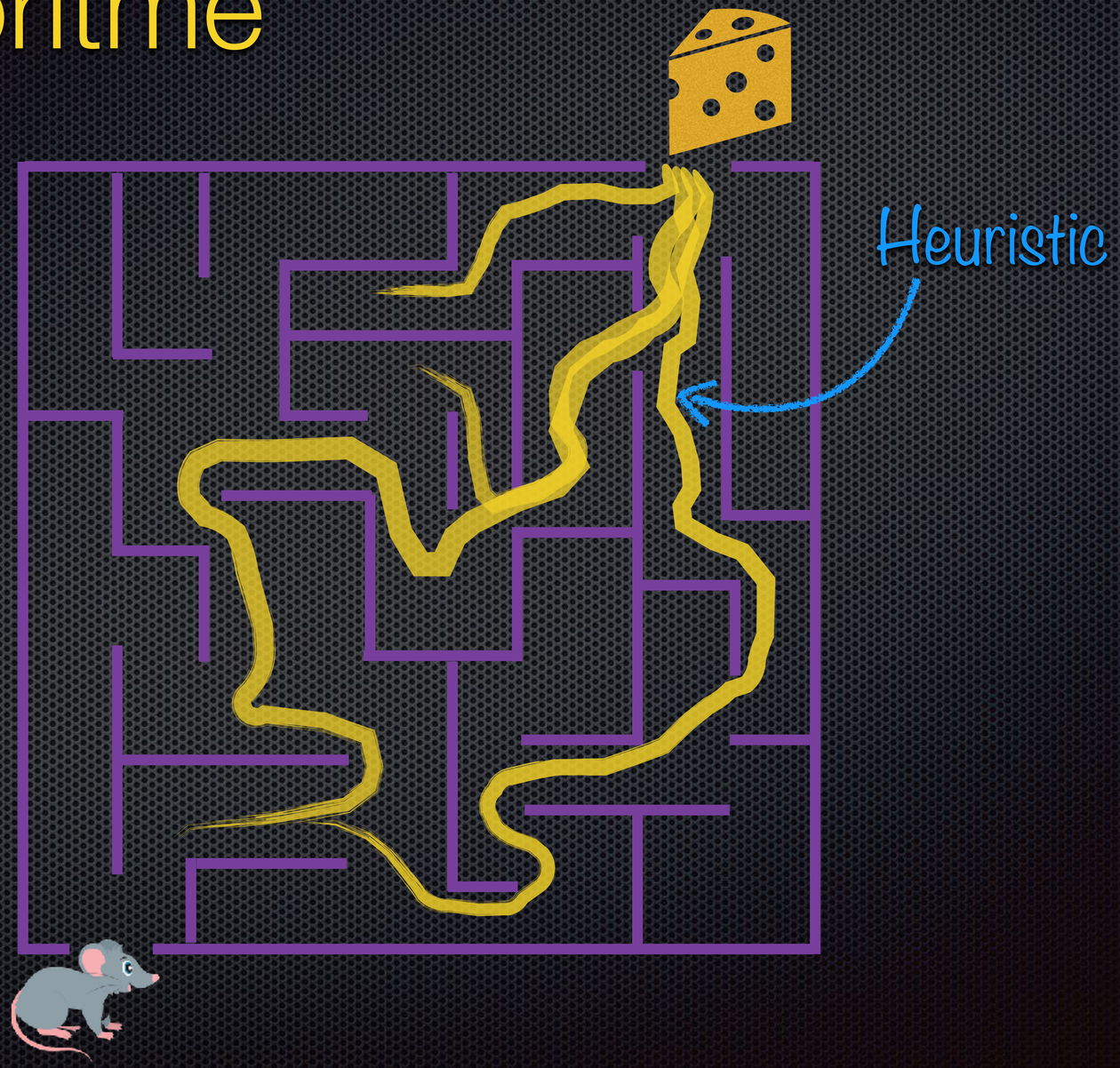
A-ster algoritme



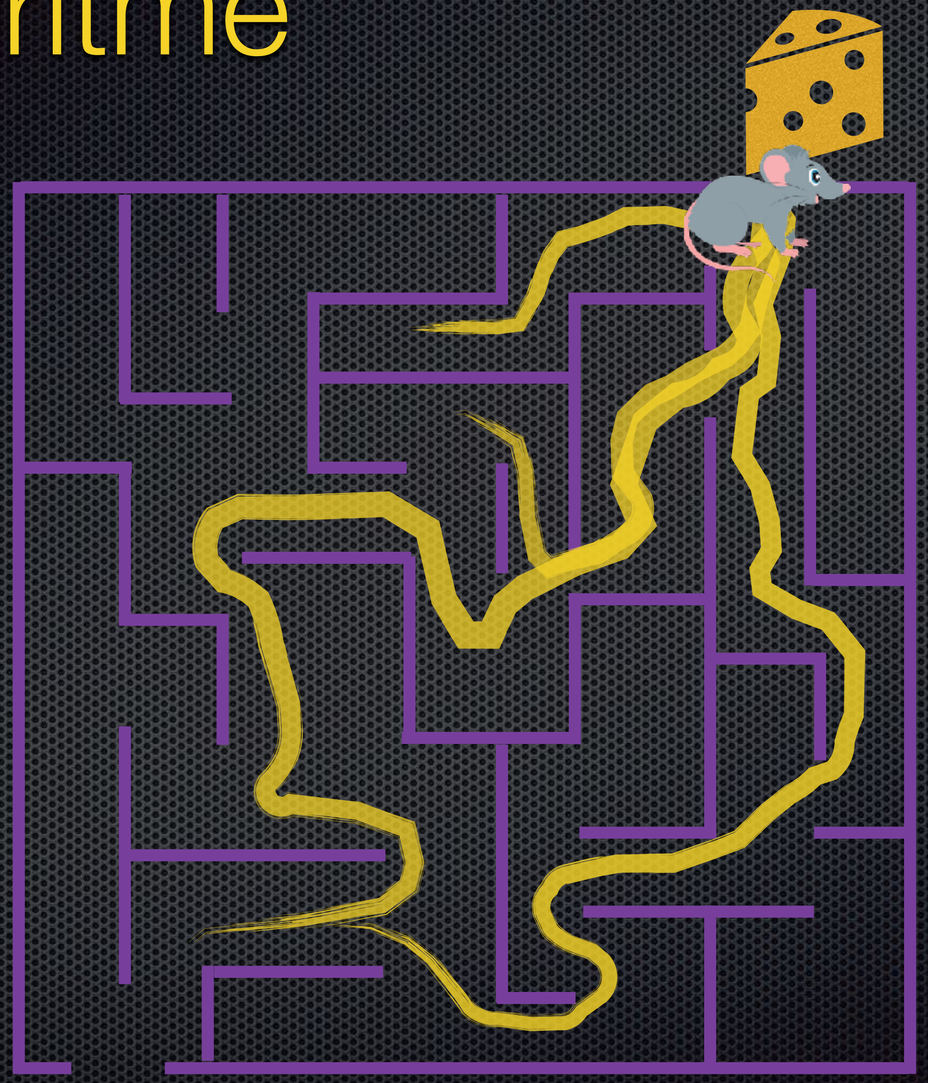
A-ster algoritme



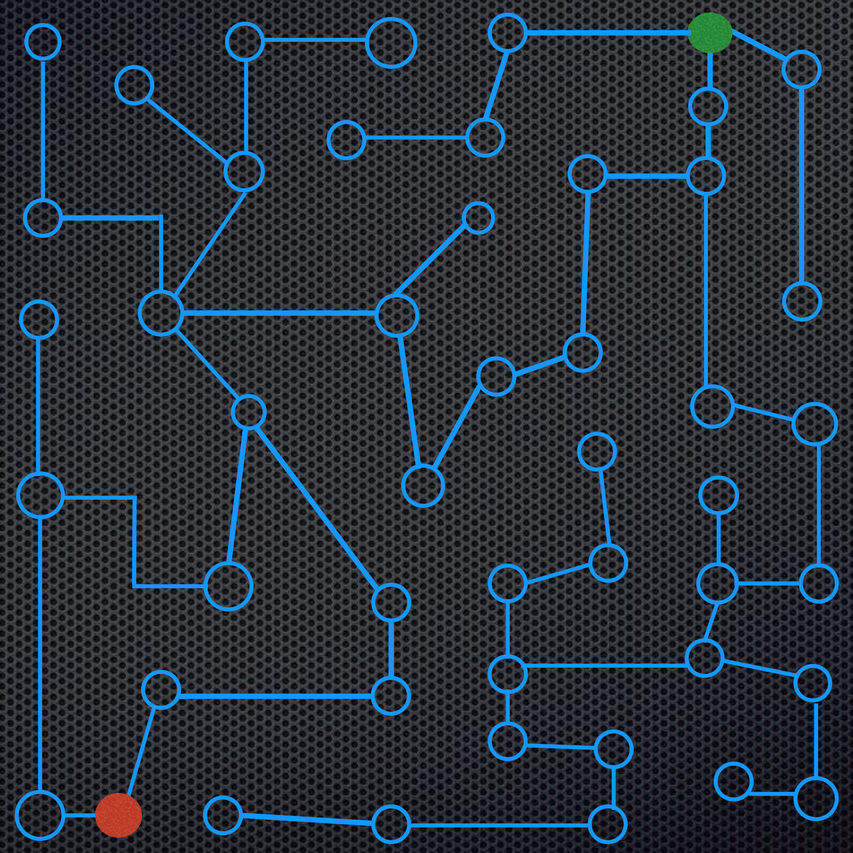
A-ster algoritme

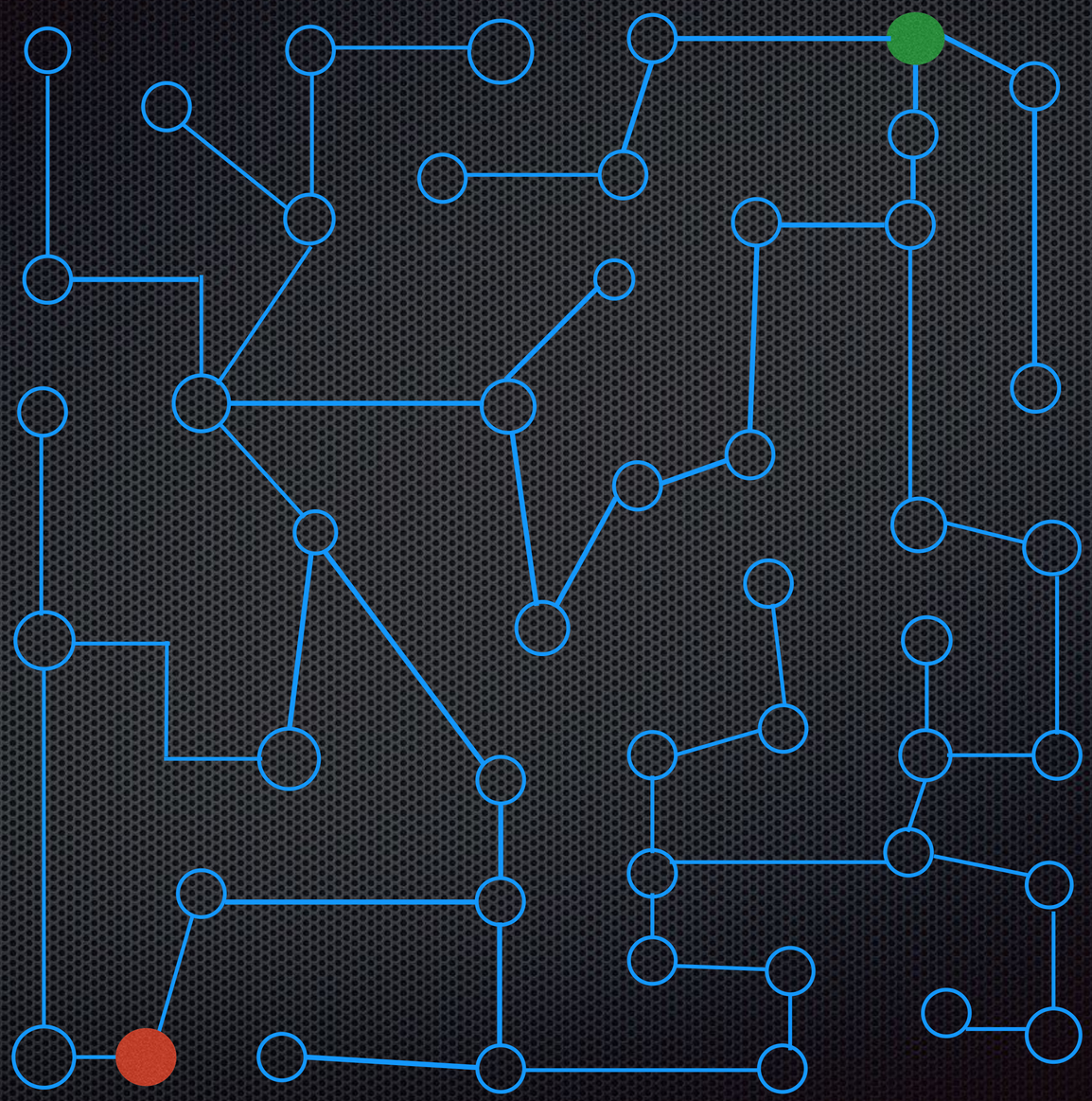


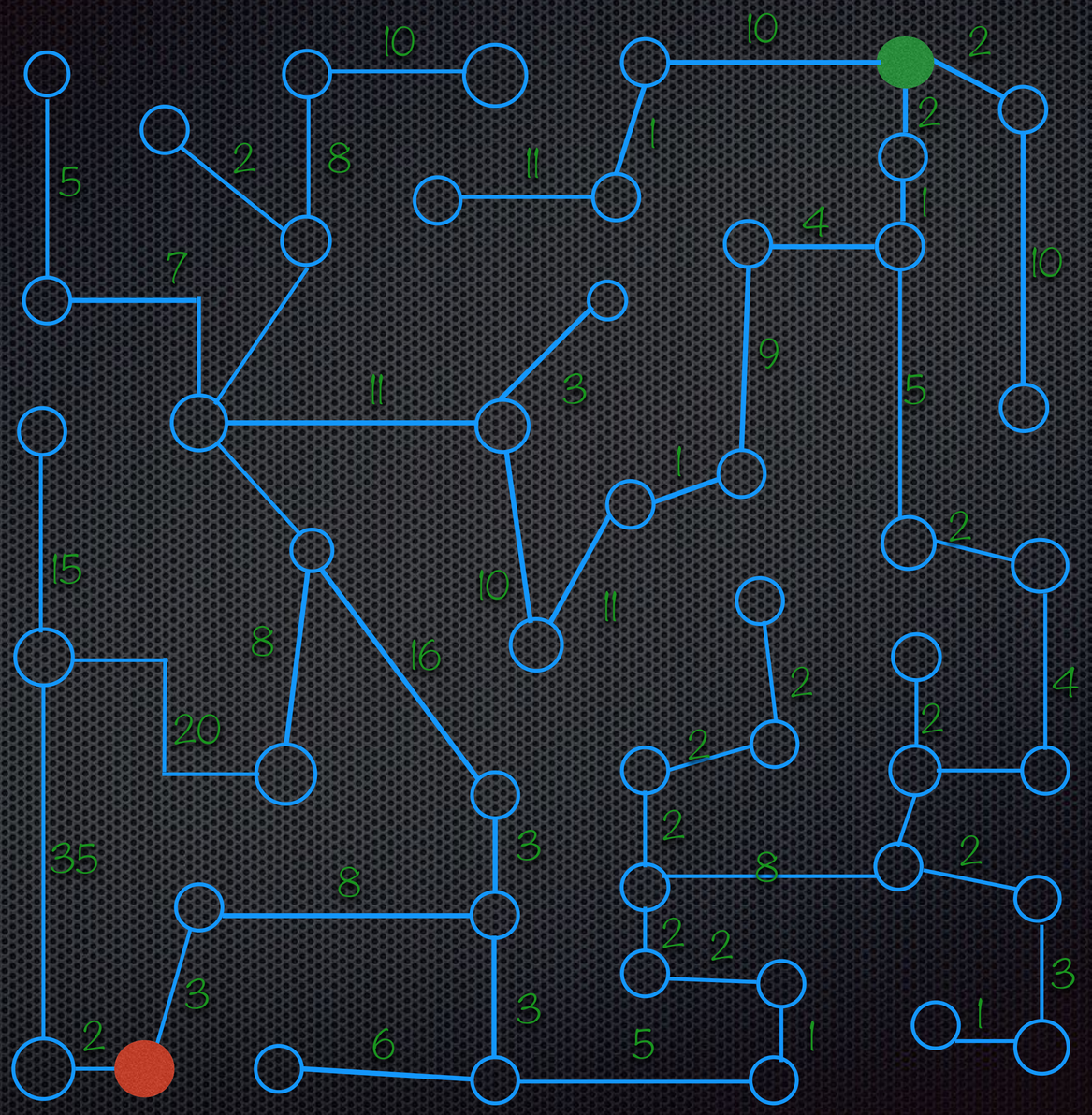
A-ster algoritme

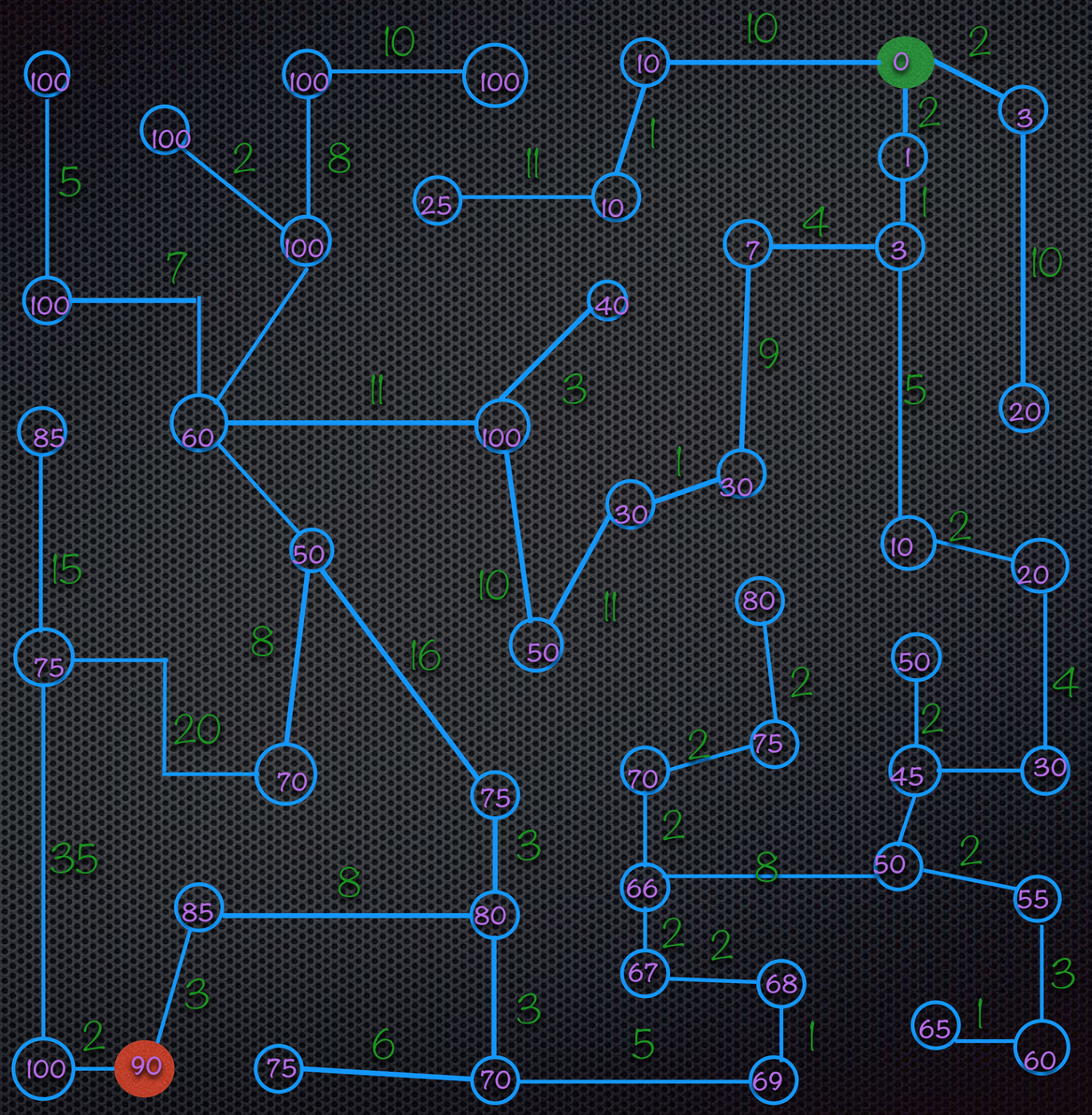


A-ster algoritme



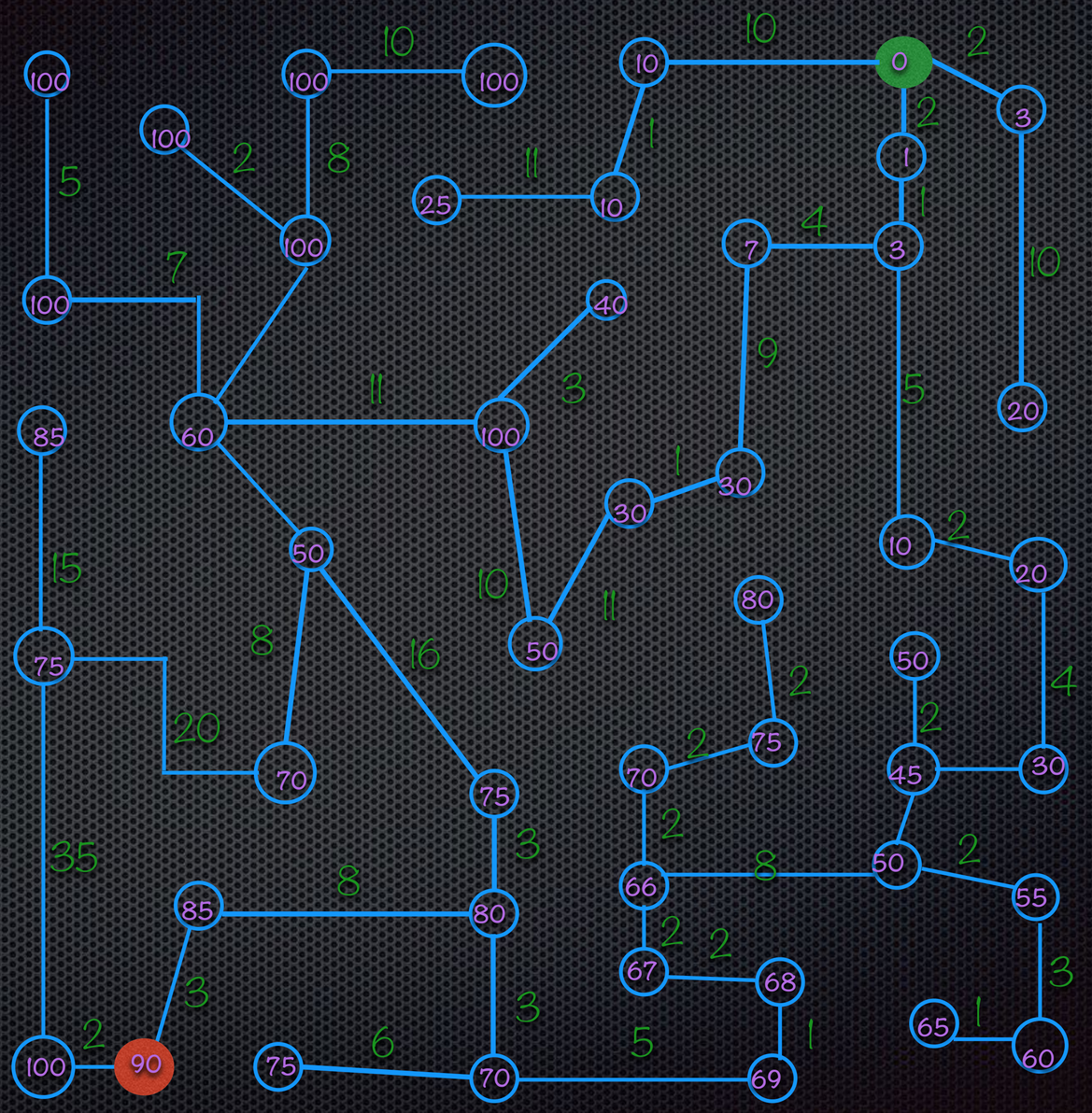



10
10
2
2
2
8
11
1
5
1
4
10
7
9
11
3
5
1
2
15
10
11
8
16
2
4
20
2
2
2
3
35
8
8
2
2
2
3
3
3
1
2
6
5
1


100
100
100
10
100
10
10
0
2
3
2
1
1
100
2
8
25
11
10
5
100
7
4
3
10
100
40
9
5
20
11
3
85
60
100
1
30
30
10
2
20
15
50
10
11
80
50
8
16
75
2
50
4
2
20
70
75
2
70
45
30
75
2
3
35
8
66
8
50
2
55
85
80
2
2
67
68
3
3
3
2
1
65
1
100
90
75
6
70
5
69
60

p(v) = afstand(v) + heuristic (v)

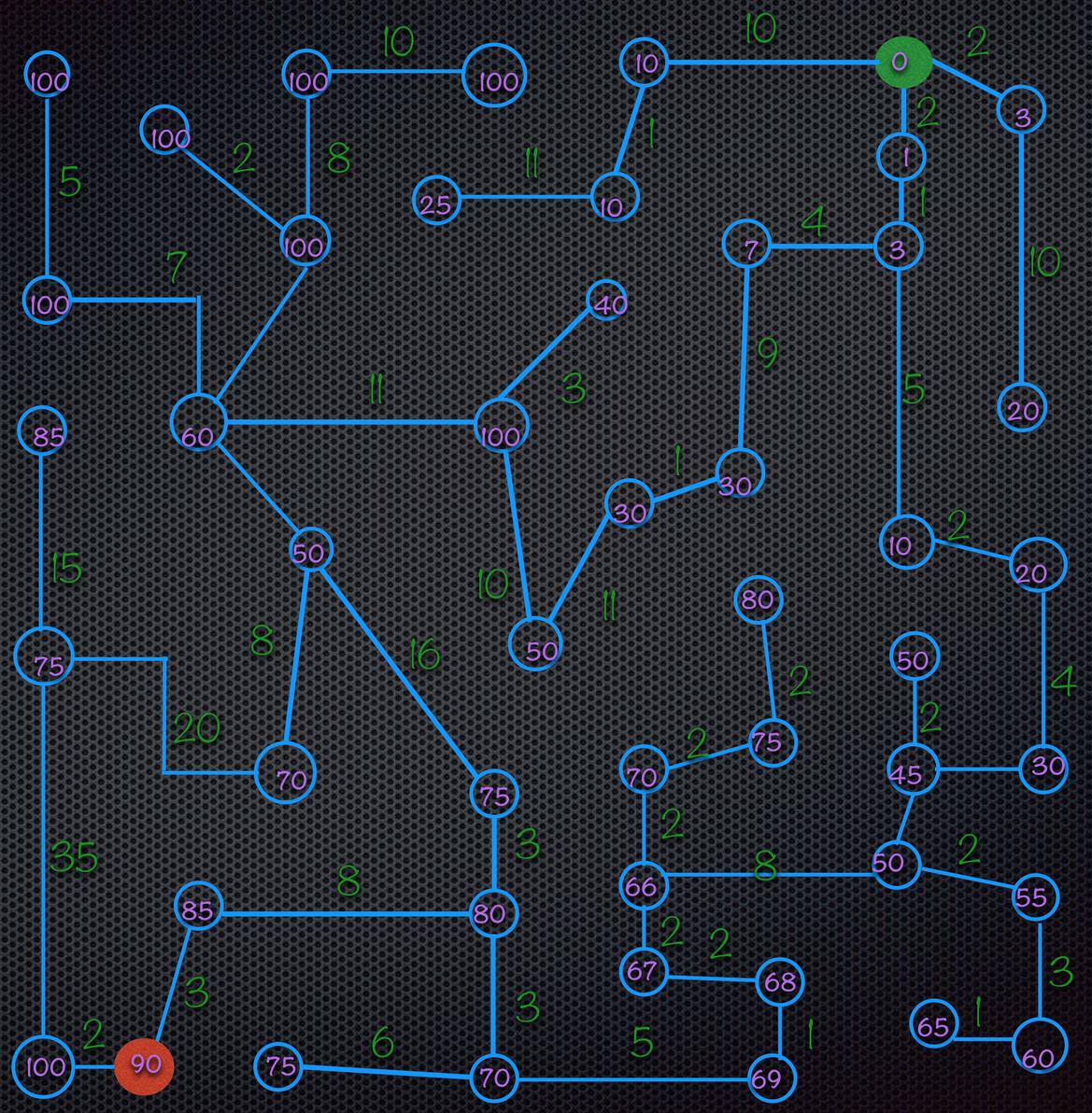
Q



p(v) = afstand(v) + heuristic (v)

Q

90 : 0+90=90

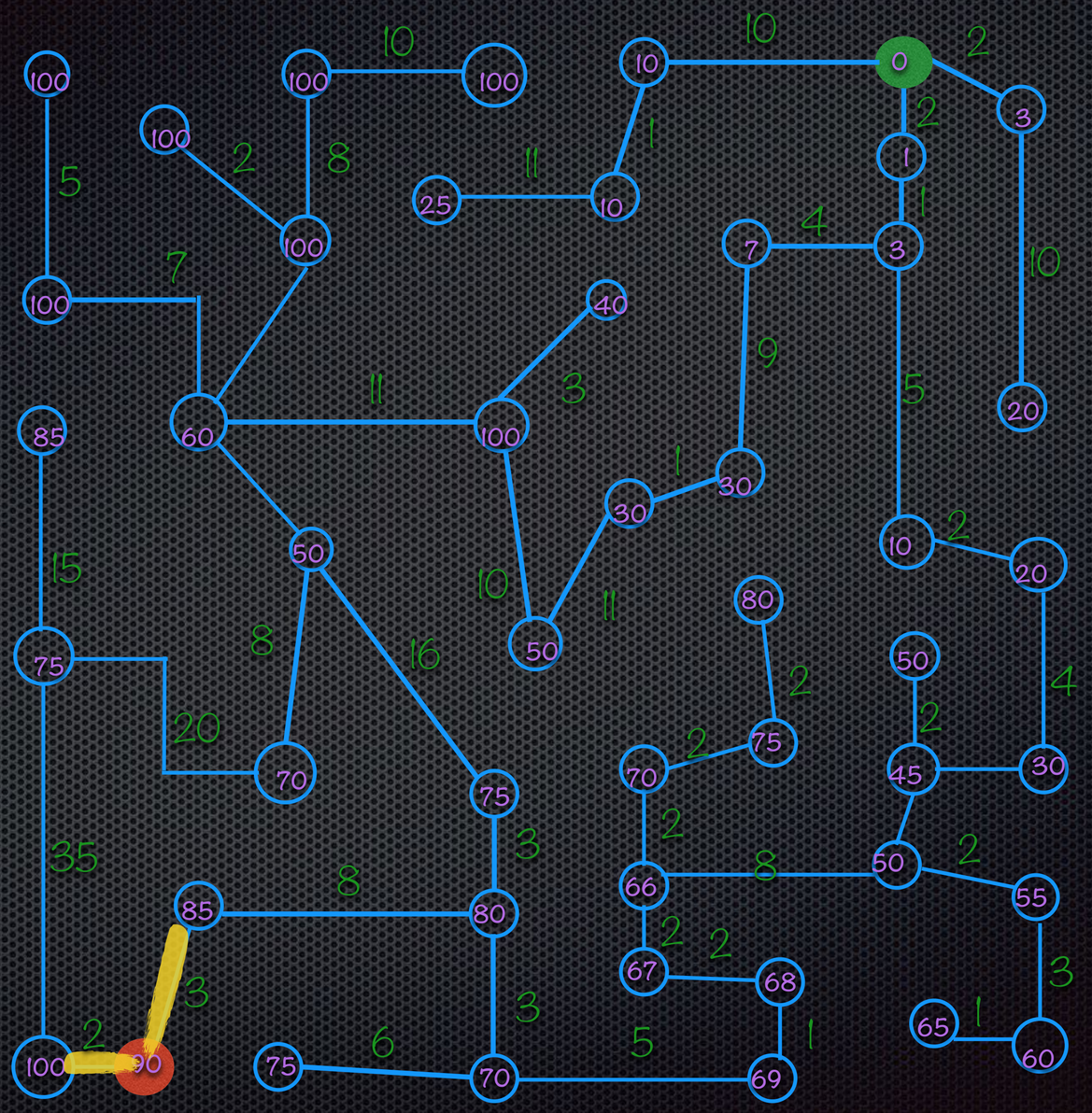


p(v) = afstand(v) + heuristic (v)

Q

85 : 3+85=88

100 : 2+100=102

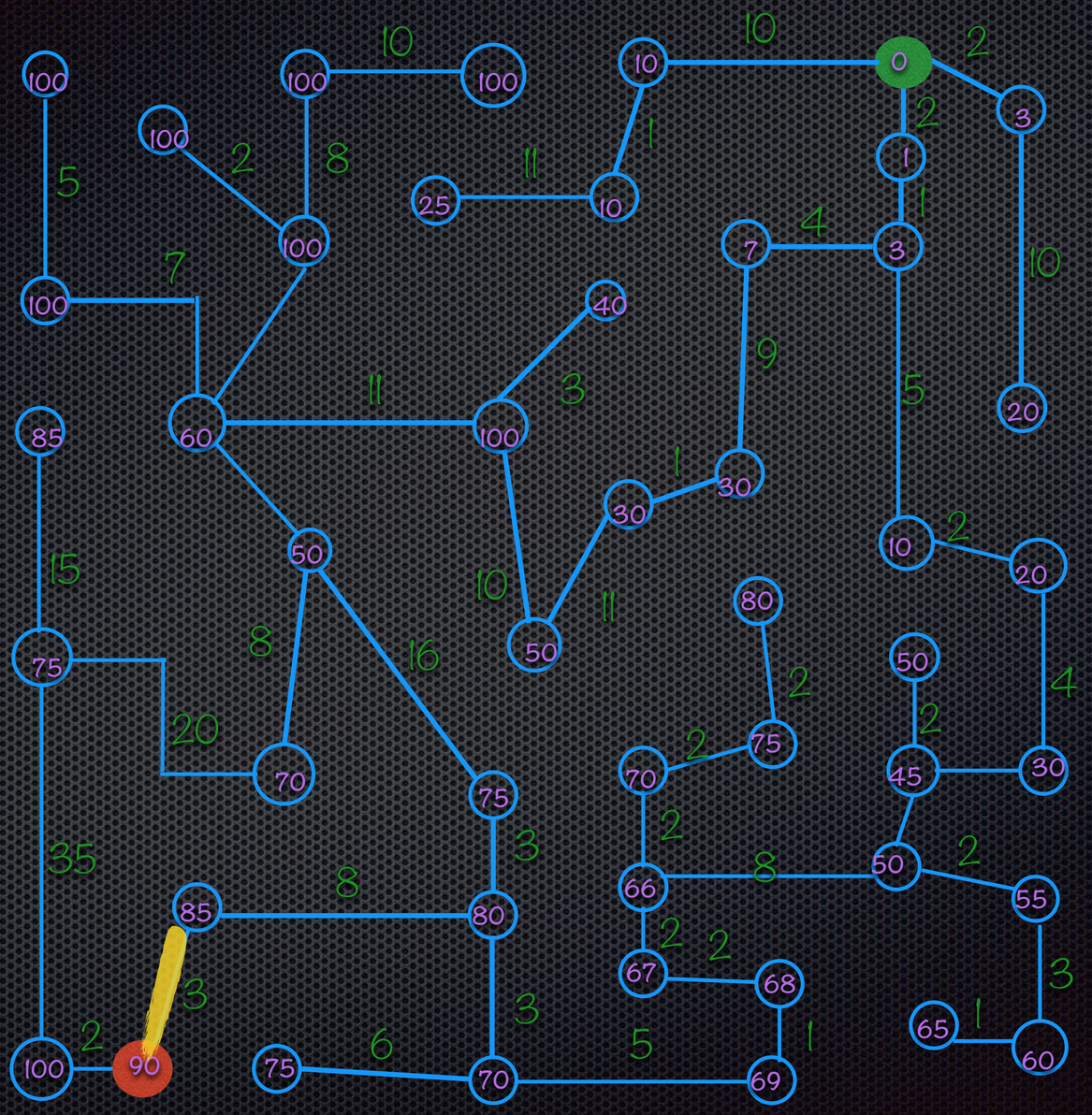


p(v) = afstand(v) + heuristic (v)

Q

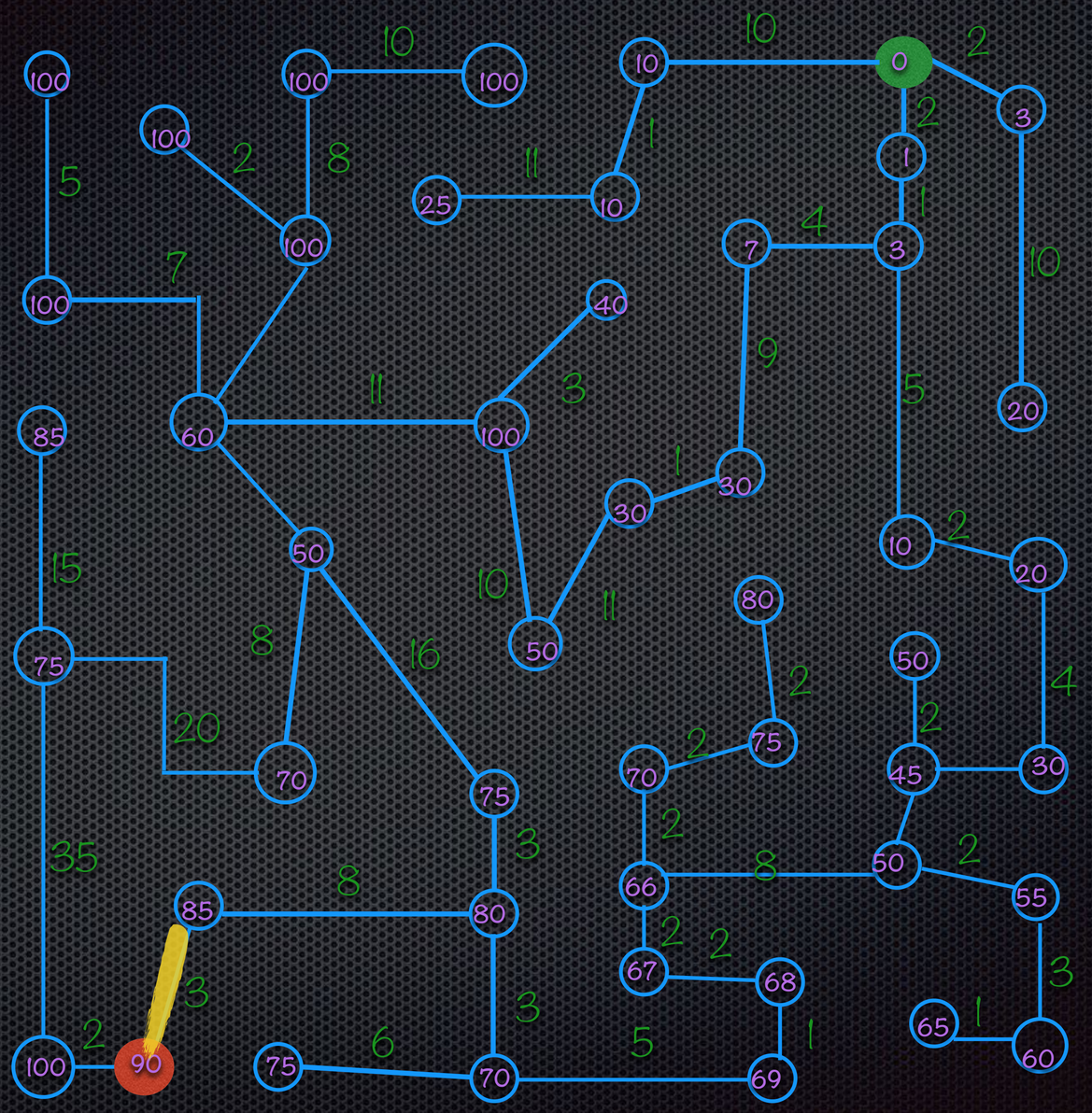
85 : 3+85=88

100 : 2+100=102



p(v) = afstand(v) + heuristic (v)

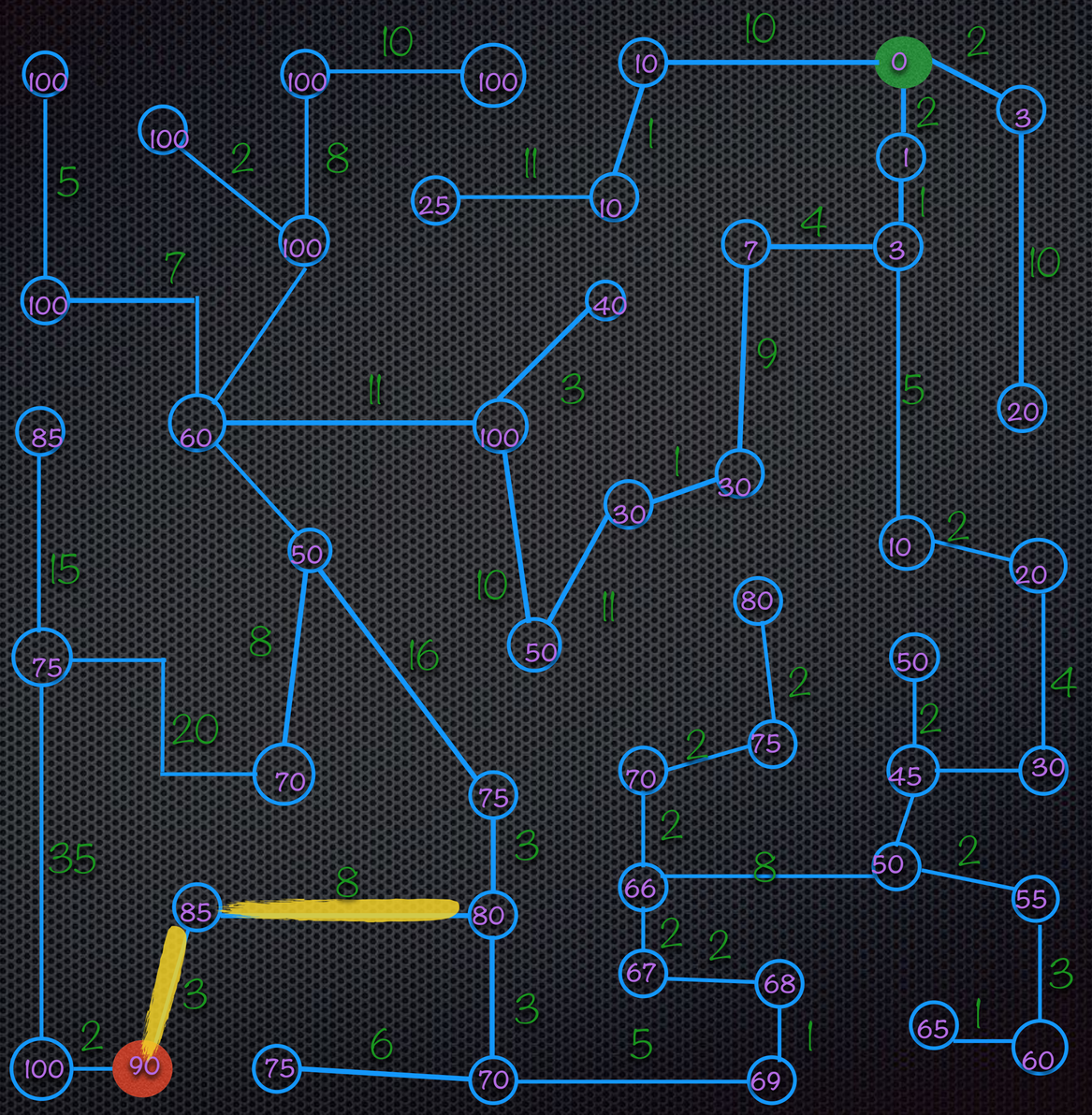
Q



p(v) = afstand(v) + heuristic (v)

Q

80 : 8+80=88

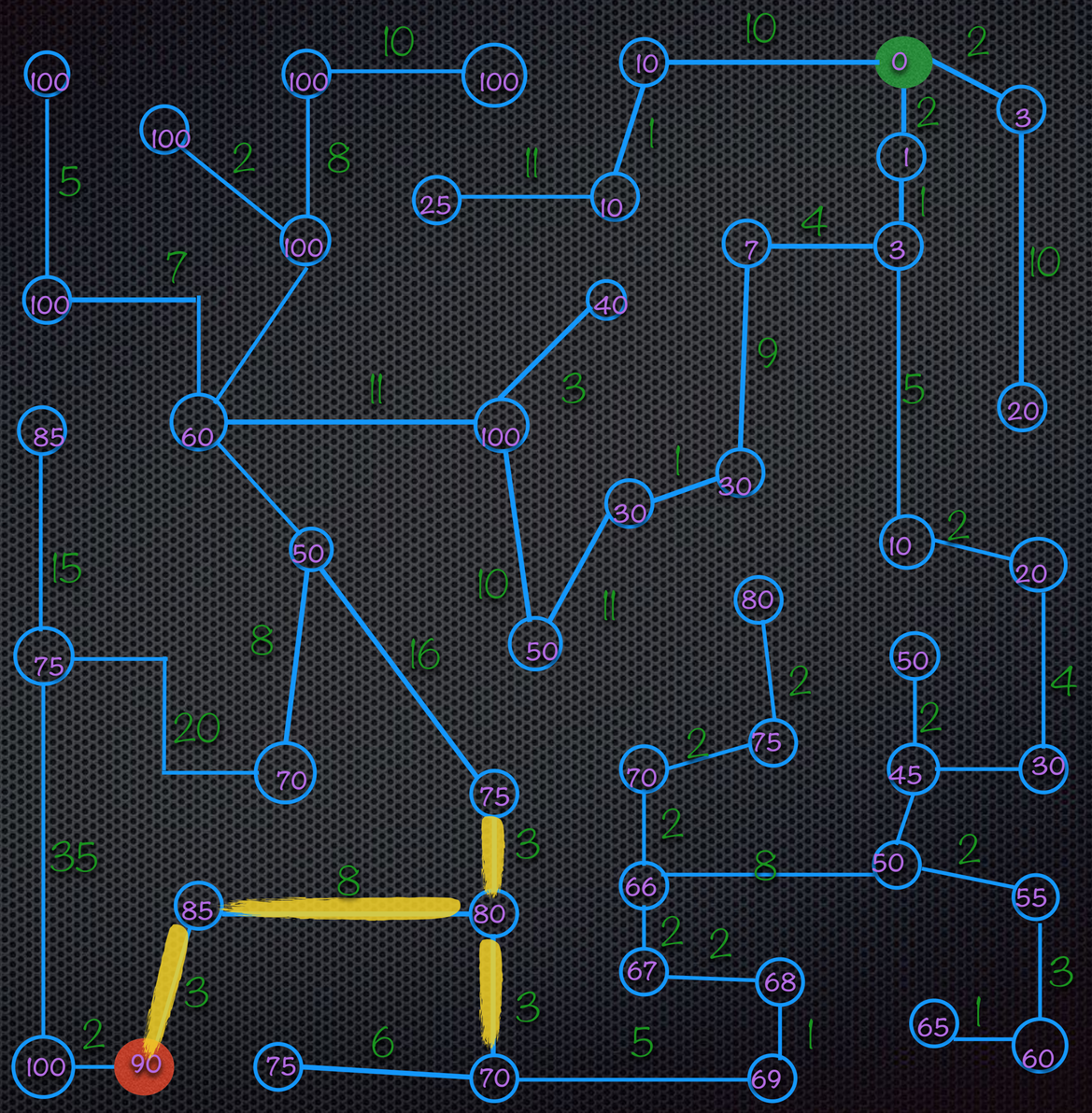


p(v) = afstand(v) + heuristic (v)

Q

70 : 3+70=73

75 : 3+75=78

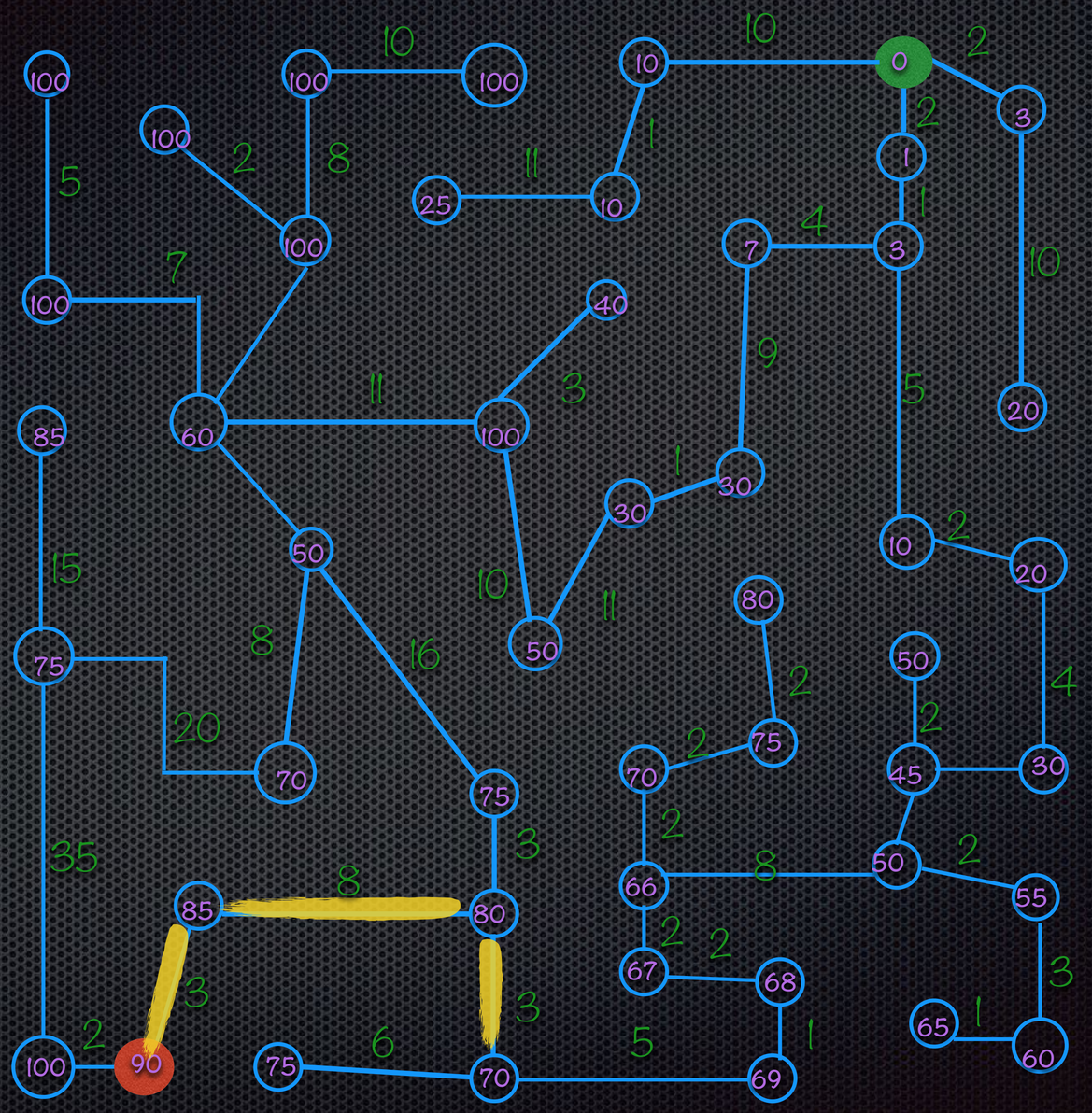


p(v) = afstand(v) + heuristic (v)

Q

70 : 3+70=73

75 : 3+75=78

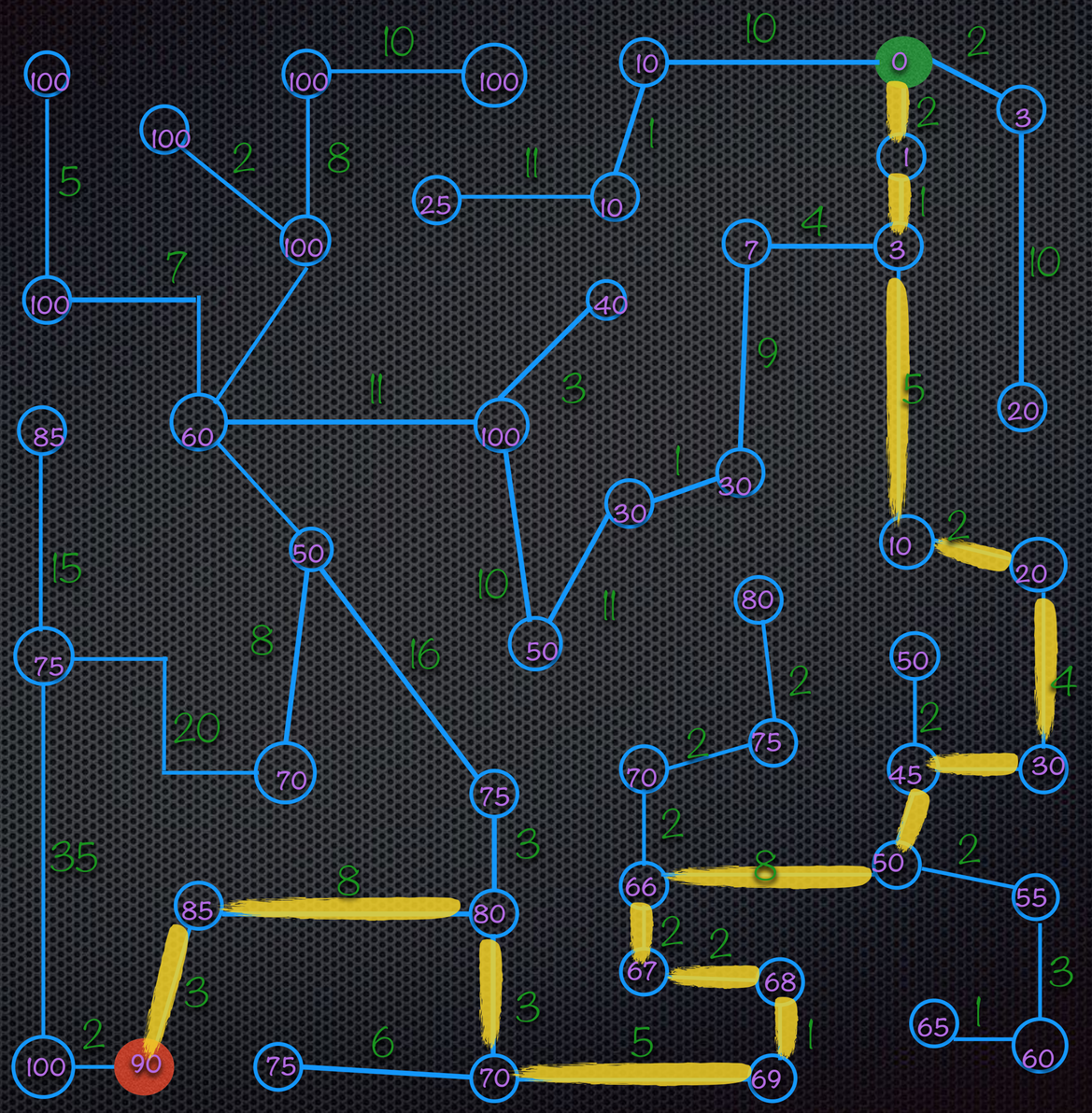


p(v) = afstand(v) + heuristic (v)

Q

70 : 3+70=73

75 : 3+75=78



Autopilot

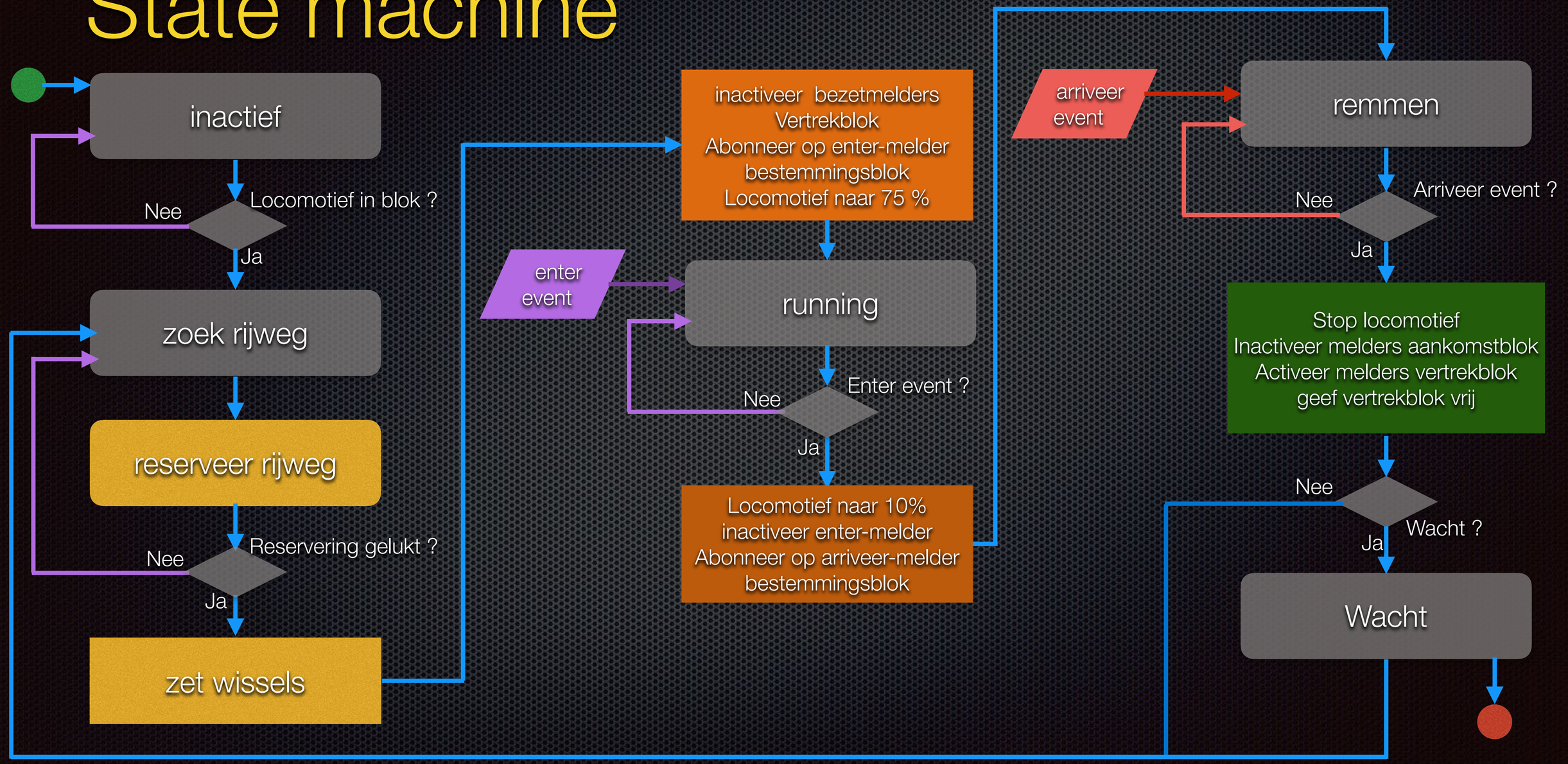
- Automatisch rijden
- Thread per locomotief
- State machine
- Locomotief moet in een blok staan
- Sensoren moeten aan blokken gekoppeld zijn
- Ghost detectie

https://www.true.nl/wp-content/uploads/2019/03/Windows-Autopilot-1244x700.jpg

Automatisch Rijden uitdagingen

- Meerdere locomotieven tegelijkertijd
- Bijwerken scherm
- Spook detectie
- Optrekken en afremmen
- (Automatisch) Testen
- …

State machine



Todo’s

- Toevoegen ESU ECoS centrale
- Meer rijstappen by automatisch rijden
- Business rules in schermen
- Route checker
- Adaptief doorrijden
- Blok snelheden
- Besturing seinen
- Dienstregeling
- …

Demo time

HSI-S88
DCC-EX
S88
Wissel decoder
S1
FS 236
S2
S3
S4
W2
W1
S9
S10
S11
S12
NS 6505

Vragen ?