

# Automatic Train Operation

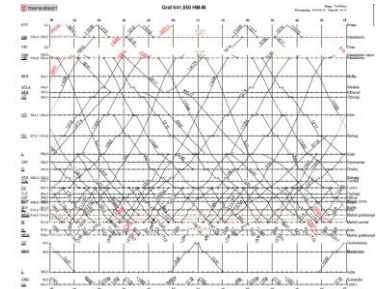
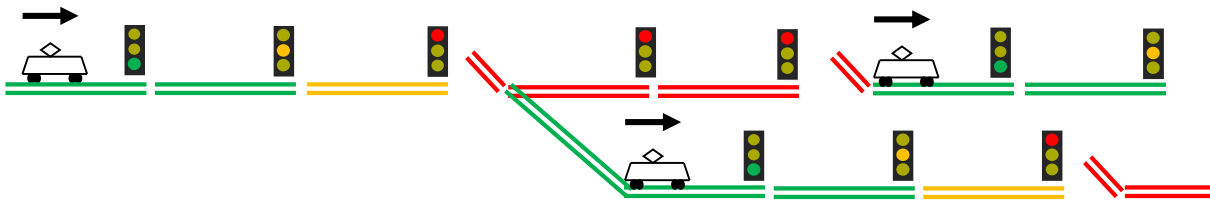
How hard can it be?

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# Traffic management

- The infrastructure is a production plant
  - Operated according to the timetable
  - A train path is created in front of a train – and is removed behind the train
  - A train may only move if the track is confirmed free from obstacles and a movement authority is given
  - The traffic control centre issues movement authority



Timetable



Traffic Control Centre



Interlocking

Movement Authority

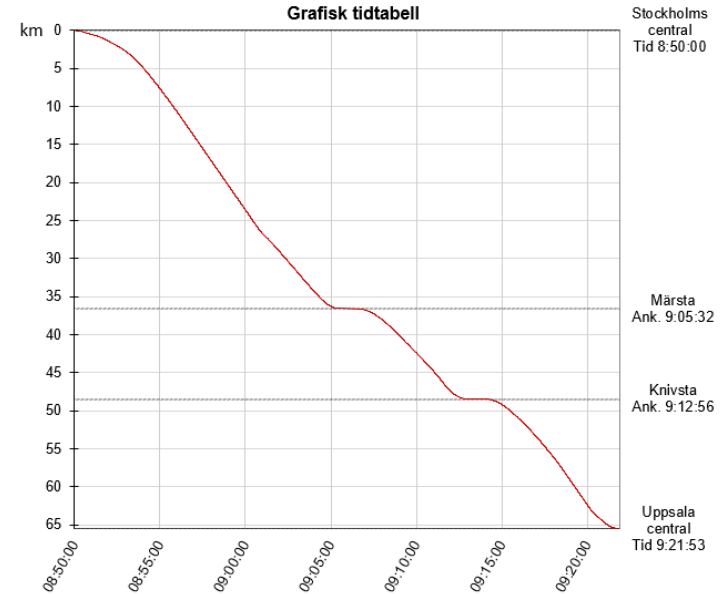
# Deregulated railway

- Before
  - Vertical integration
    - One body responsible for tracks and services
- After deregulation
  - “The road organisation model”
    - Open access to the track
    - Legal and organisational separation between infrastructure and operators
  - Split responsibilities for the services
    - Traffic management – the infrastructure holder
    - Train operation and passengers/freight – the operator



# Operation - the operator's part

- Commitment to the customer
  - The operator sells the ticket and is responsible
- Running the train
  - Follow the planned train path on time



# The driver's tasks

## ● Running the train

- Make sure the train is functional and ready for departure
- Read conditions from train order, signals and line description
- Receive movement authority
- Visually verify that the track is free from obstacles
- Accelerate and follow the timetable
- Handing over the train after mission completed

## ● Monitoring

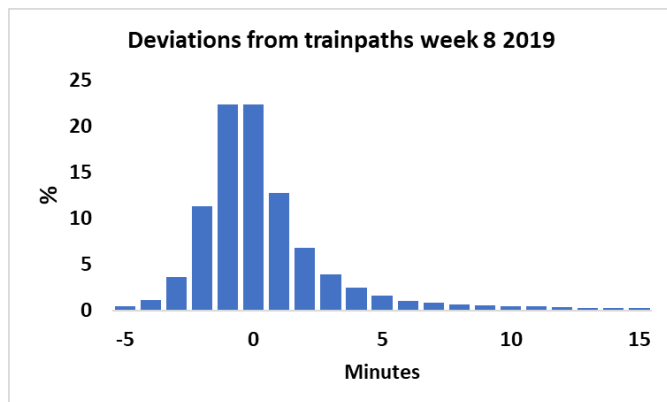
- Monitoring potential disruptions, surrounding traffic, technical systems, etc

## ● Handling disruptions

- Being point of contact with the traffic control centre
- Dialog with internal operations centre
- Informing passengers
- Solving upcoming issues

# Disruptions are common

- Physically large and open network
  - Obstacles on the track
  - Surrounding traffic
  - Technical failures in infrastructure or on vehicles



- Avsnying av spåren
- Bromsproblem
- Felaktig ställverksmanöver
- Fordonsskada
- Godståg fastnade i backe
- Godståg med befarad hjulskada
- Hjulskada
- Kontaktledningsfel
- Misstänkt påkörning
- Misstänkt väska på Resecentra
- Neddriven kontaktledning
- Obehöriga i spåret
- Oljeläckage
- Olycka
- Otillåten stoppsignalspassage
- Polisingripande
- Signalfel
- Siktart pga obehöriga i spårområde
- Snödrev
- Snöskred
- Spårbeläggning som kom och gick
- Spårfel
- Spårmarkeringar
- Trafikstopp begärt av polis
- Växelfel
- Återstart av fordonssystemet

# Driverless metros – an established solution

- Characteristics
  - One control centre handling traffic management and passengers
  - Enclosed system
    - Organisationally – no open access
    - Physically enclosed (tunnels and fenced track)
    - National legislation (SFS 1990:1157)
  - Operation
    - All trains have similar properties
    - Running from A to B is a solved issue



Driverless Metro in Copenhagen (photo: Metroselskabet/Peter Sørensen)

# Handling disruptions in metro systems

- Enclosed – few disruptions
- A disruption stops the whole line
  - Trains are removed from the schedule
  - No booked passengers to handle
- Help is not far away
  - Time between trains 1,5 – 15 minutes
  - Distances between stations – approximately 1 km





# Automation in metro systems

- UITP (International Association of Public Transport)
  - Defines grade of automation
  - Adapted for metro systems
- Driverless Metro – started 1987
  - Docklands Light Rail in London
  - More than 100 systems in operation worldwide

Grade of Automation	Type of operation	Train speed control	Train stopping	Door control	Handling disruptions
GoA0	On-sight by driver	Driver	Driver	Driver	Driver
GoA1	ATP with driver	Driver	Driver	Driver	Driver
GoA2	Semi-automatic	Automatic	Automatic	Driver	Driver
GoA3	Driverless	Automatic	Automatic	Train attendant	Train attendant
GoA4	Unattended	Automatic	Automatic	Automatic	Automatic

Grades of Automatic Train Operation UITP 2011

# Automation of railway

Grade of Automation	Type of operation	Train speed control	Train stopping	Door control	Handling disruptions	Visually monitoring track	Monitoring technical systems	Monitoring surrounding traffic	Prevent interruptions	Inform to passengers	Rebooking passengers	Communic. onboard - TMC	Communic. with staff	Receiving/handling over train	
GoA0	On-sight by driver	Driver	Driver	Driver	Driver										
GoA1	ATP with driver	Driver	Driver	Driver	Driver										
GoA2	Semi-automatic	Automatic	Automatic	Driver	Driver										
GoA3	Driverless	Automatic	Automatic	Train attendant	Train attendant	?	?	?	?	?	?	?	?	?	?
GoA4	Unattended	Automatic	Automatic	Automatic	Automatic	?	?	?	?	?	?	?	?	?	?

- Many more functions to be automated than metro

# Automatic train operation – a common issue

- Stakeholders on an open railway
  - Responsibilities and interfaces?
- What is the process?
  - How to start and end a driverless train?
  - Which information is needed and communicated?
  - How are disruptions managed?
- How to guarantee delivery to the customer?
- Adaption of legislation and traffic rules?
  - Drivers are at present integrated in the EU directives, TSI's and national legislation
- Benefits and costs?



Foto: SVT Tekniskt Magasin, Erik Bergsten

**Thank you for your attention!**

