



## Challenges and Lessons in High Speed Railway Planning in Denmark

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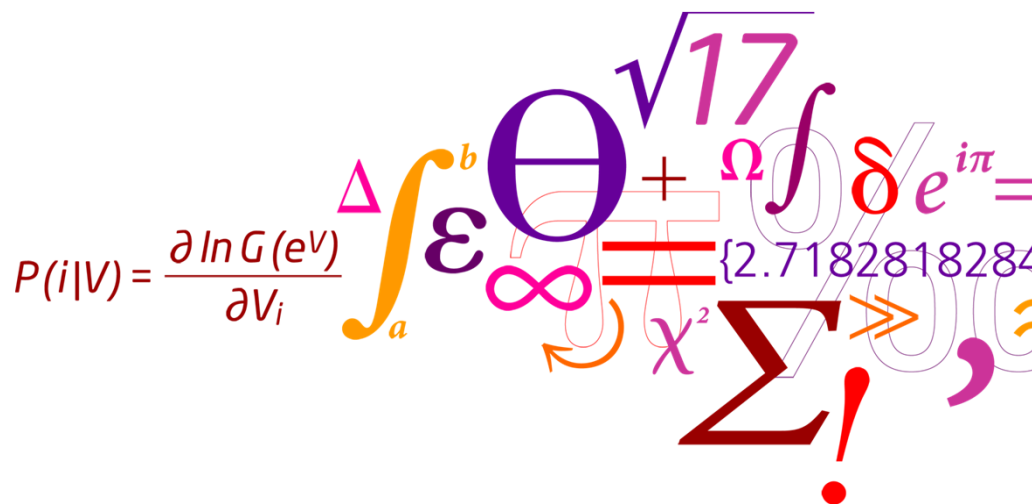
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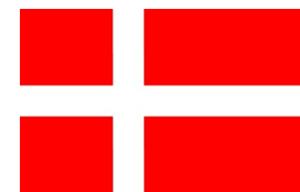
# Challenges and Lessons in High Speed Railway Planning in Denmark

International Workshop on High-Speed Rail Planning and Operations 2015, Washington DC

Dr. Steven Harrod

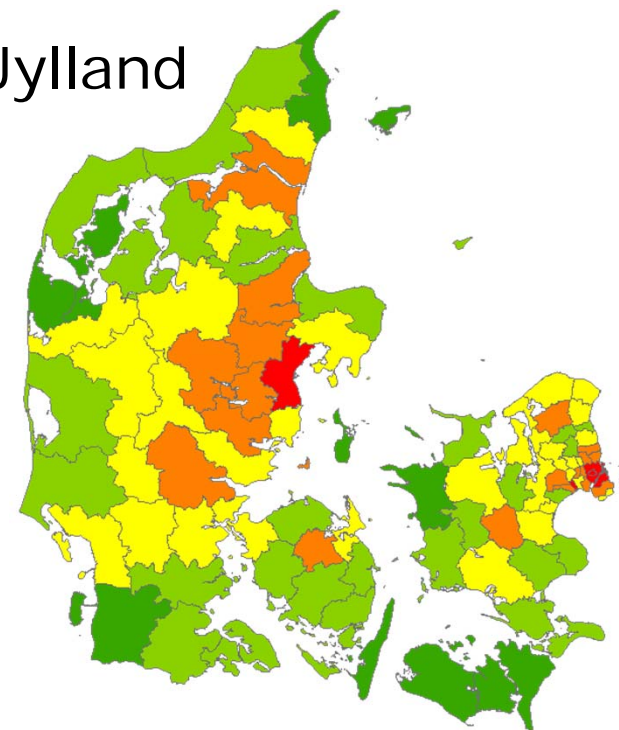
Technical University of Denmark





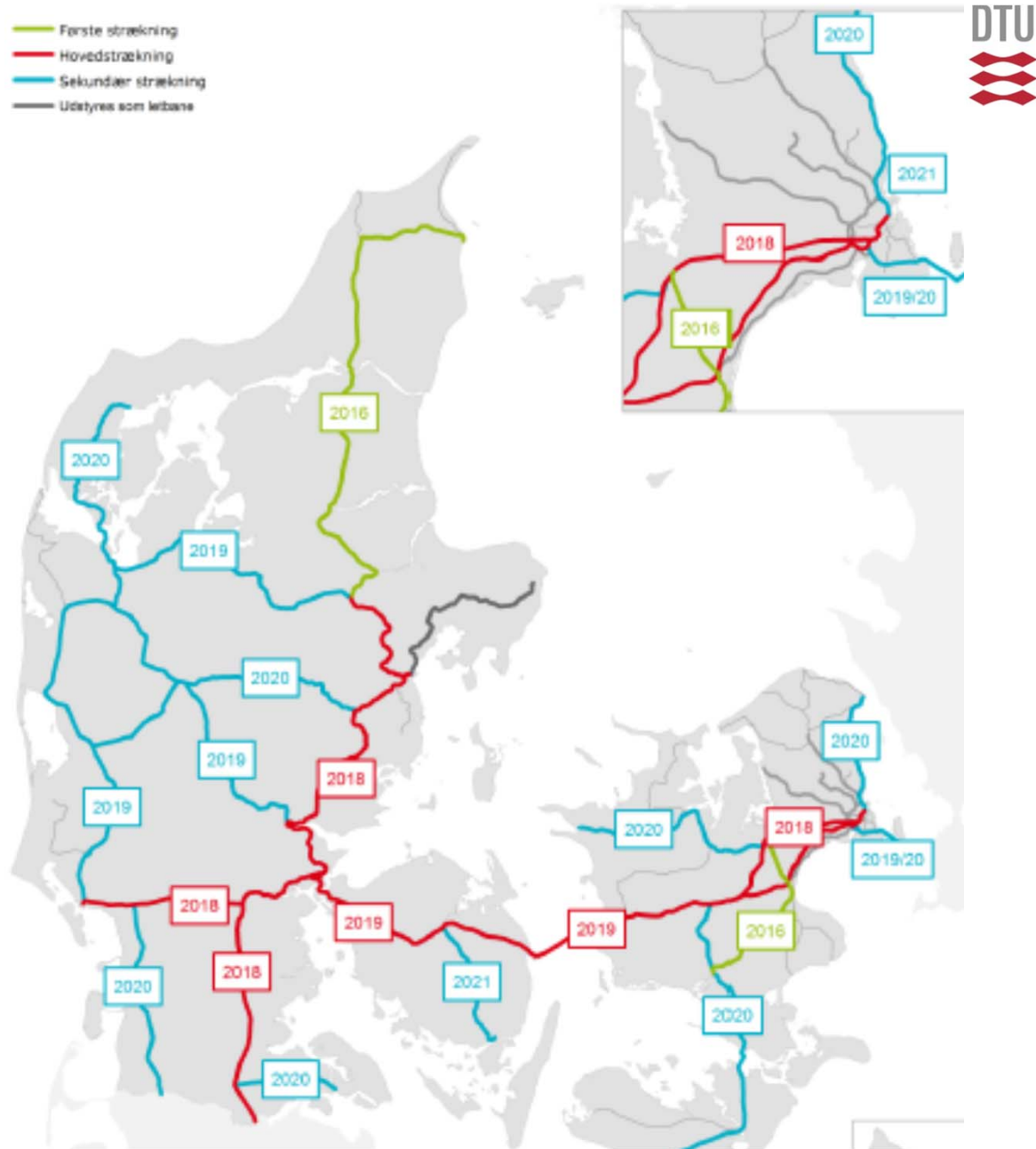
# Danish Strategic Rail Plan

- U.S. \$1.5 Billion\*
  - Copenhagen-Ringsted
  - Nearly complete, official opening 2018
- U.S. \$5 Billion
  - High Speed Alignment for Fyn & Jylland
  - European Signal Standard
  - Electrification
- U.S. \$6.9 Billion
  - Femern Bælt-forbindelsen  
Femern Belt Link
  - Copenhagen-Rødby-Hamburg
  - Ferry replacement



# New Signals

- ERTMS level 2
- Entirely cab signalled
- No wayside signals
- CBTC for Copenhagen suburban trains



# Electrification

25k v, 50Hz



(15k v, 16.3Hz, Sweden & Germany)

# Femern Bælt Forbindelsen



# Strategic High Speed Rail Planning in Denmark

- The Danish Network Today
- Significant High Speed Projects
- Focus on the Whole Journey
- The Planning Process
- Future Forecast



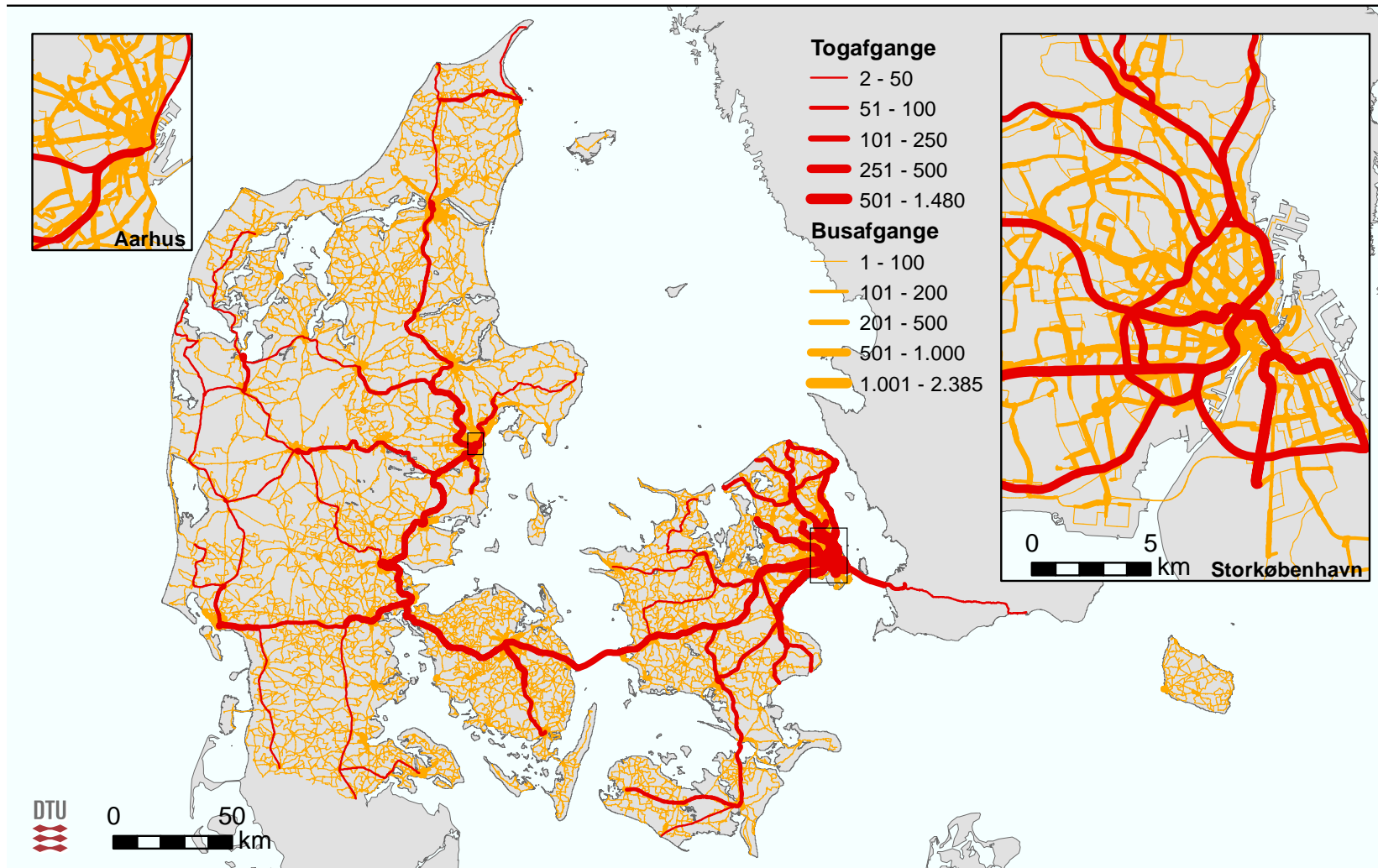
## **A Familiar Scenario**

- Network Originates from 1850-1880
- Primarily to Connect Port Cities
- Largely Unchanged Since 1940





# Danish Public Transit



# The Hour Model

Travel Times Today:

Copenhagen-Odense, 75 min.

Copenhagen-Aarhus, 170 min.

Copenhagen-Aalborg, 259 min.

Percent Reduction Required:

Copenhagen-Odense, 20%

Odense-Aarhus, 37%

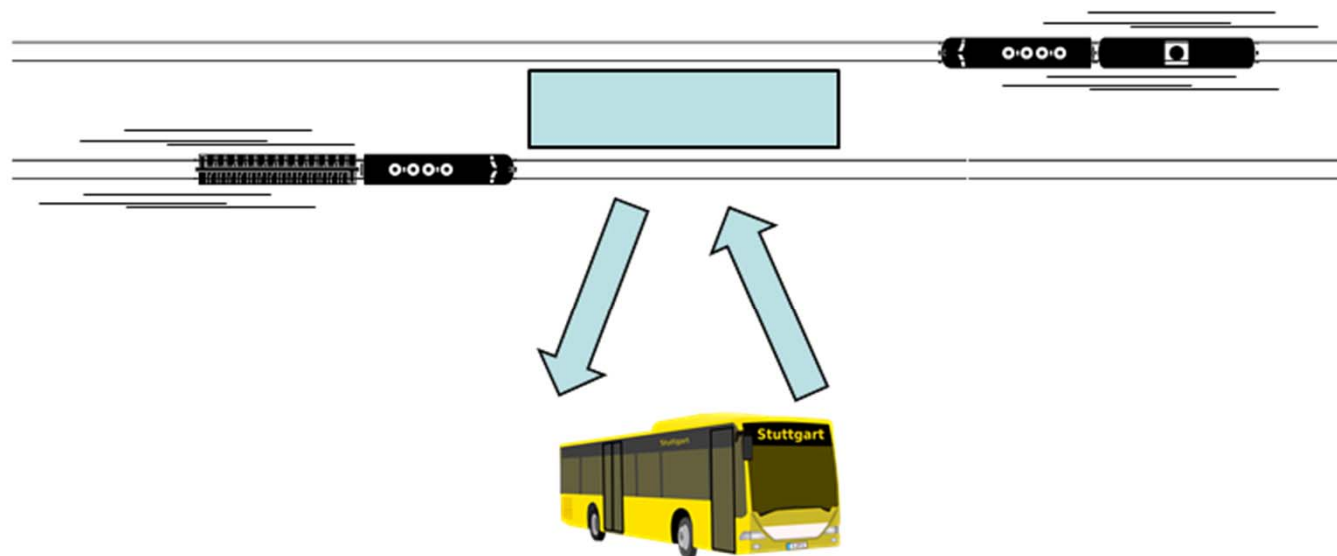
Aarhus-Aalborg, 33%

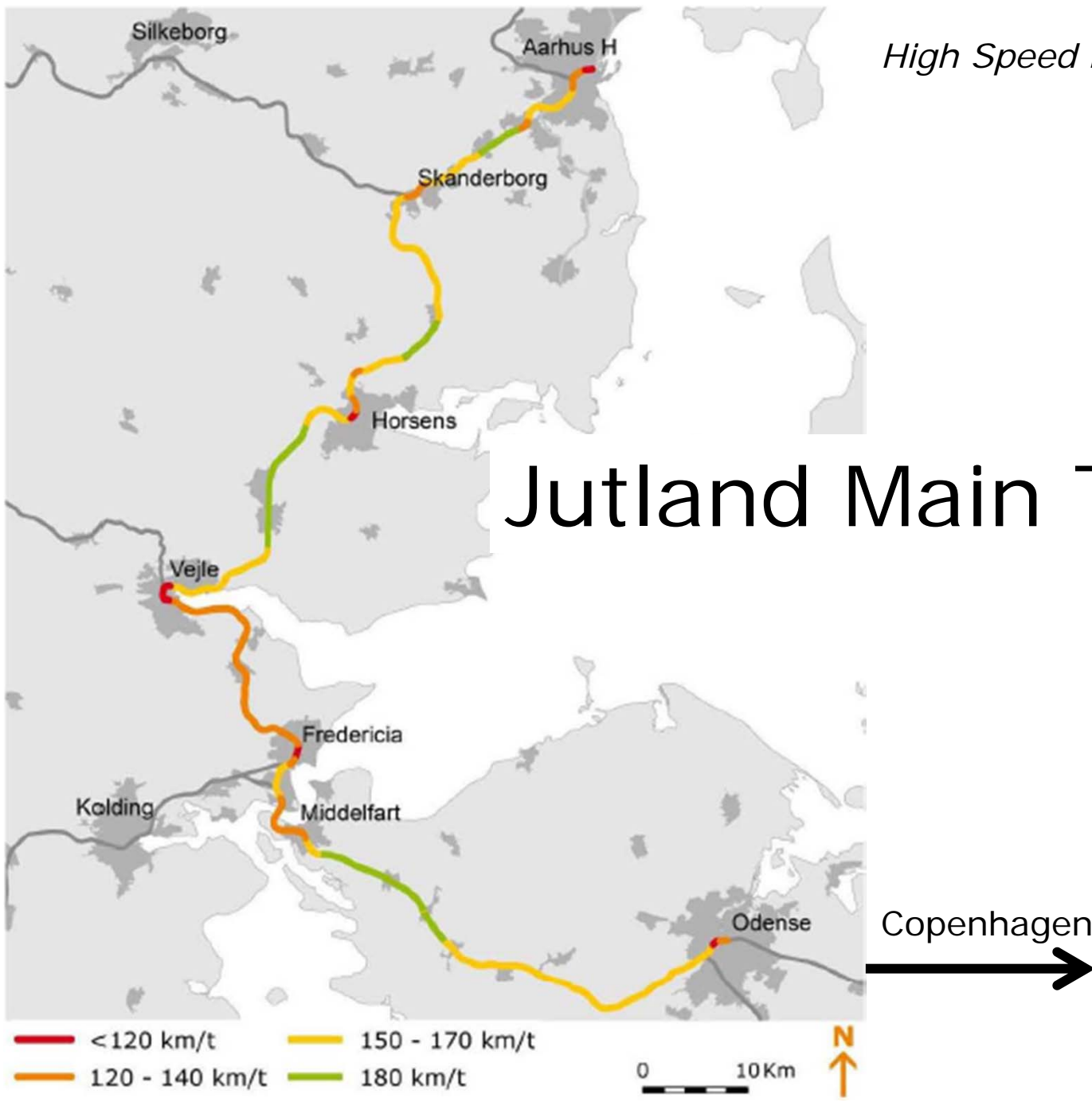
*Not a uniform network upgrade  
Goal is NOT fastest train route*



## Why One Hour?

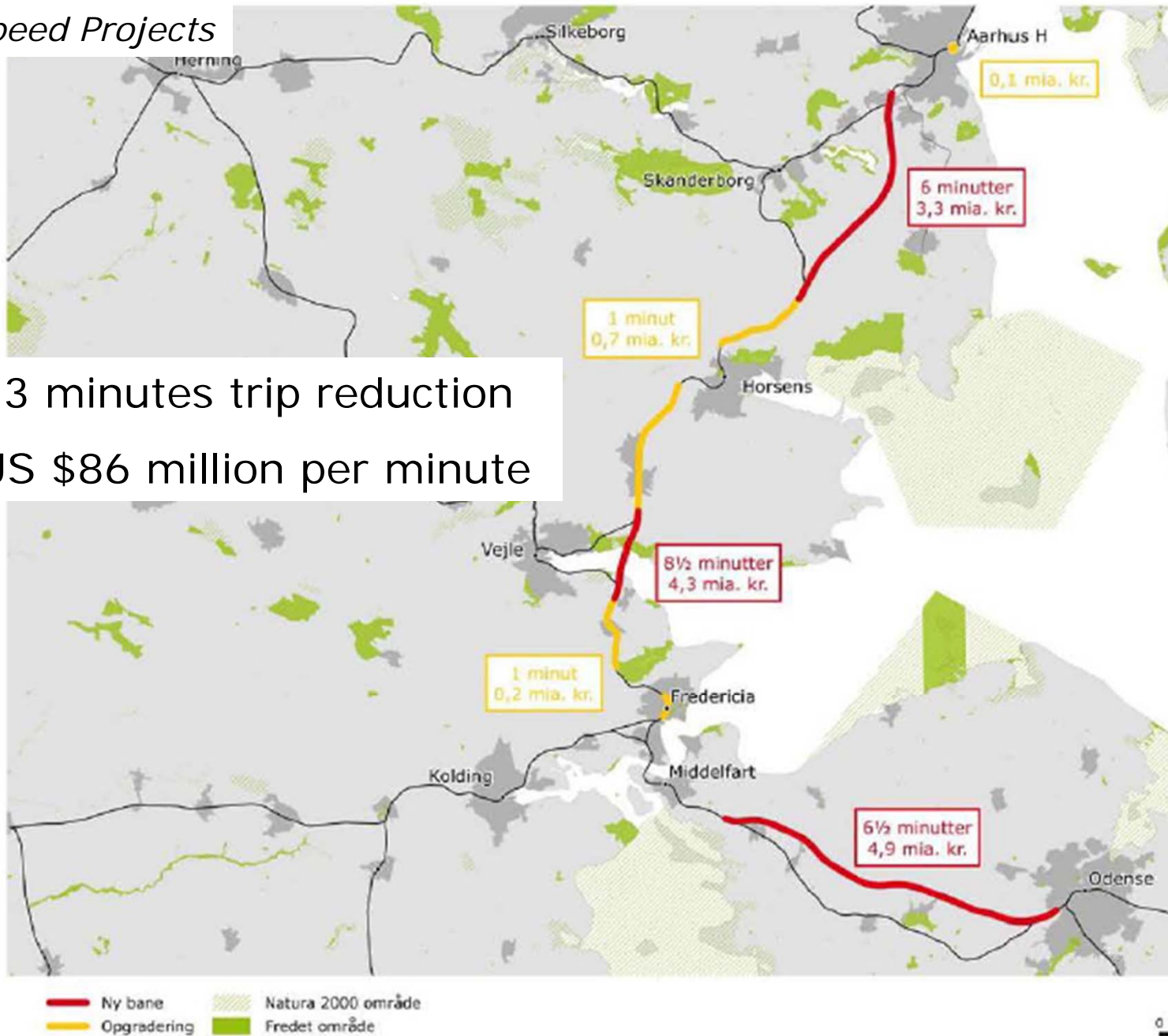
- Trains from both directions arrive simultaneously
- Better connections to other services
- Similar to airline hub scheduling
- Less waiting time to/from bus, local rail





# Jutland Main Today

## High Speed Projects



- 23 minutes trip reduction
- US \$86 million per minute

# Incremental Time Savings

Travel Time Odense-Aarhus	Diesel >		Electric >		
	IC3 180 kmh	IC4 200 kmh	ET 200 kmh	ICE 250 kmh	Velaro 300 kmh
Fastest Scheduled 2015	93 min				
Reduced timetable slack, 2016	87 min				
"" and non-stop trip	78 min	78 min	77 min	77 min	77 min
"" , "" , and high speed network	61 min	58 min	57 min	55 min	55 min

\*IC3>>ICE; 78-55=23



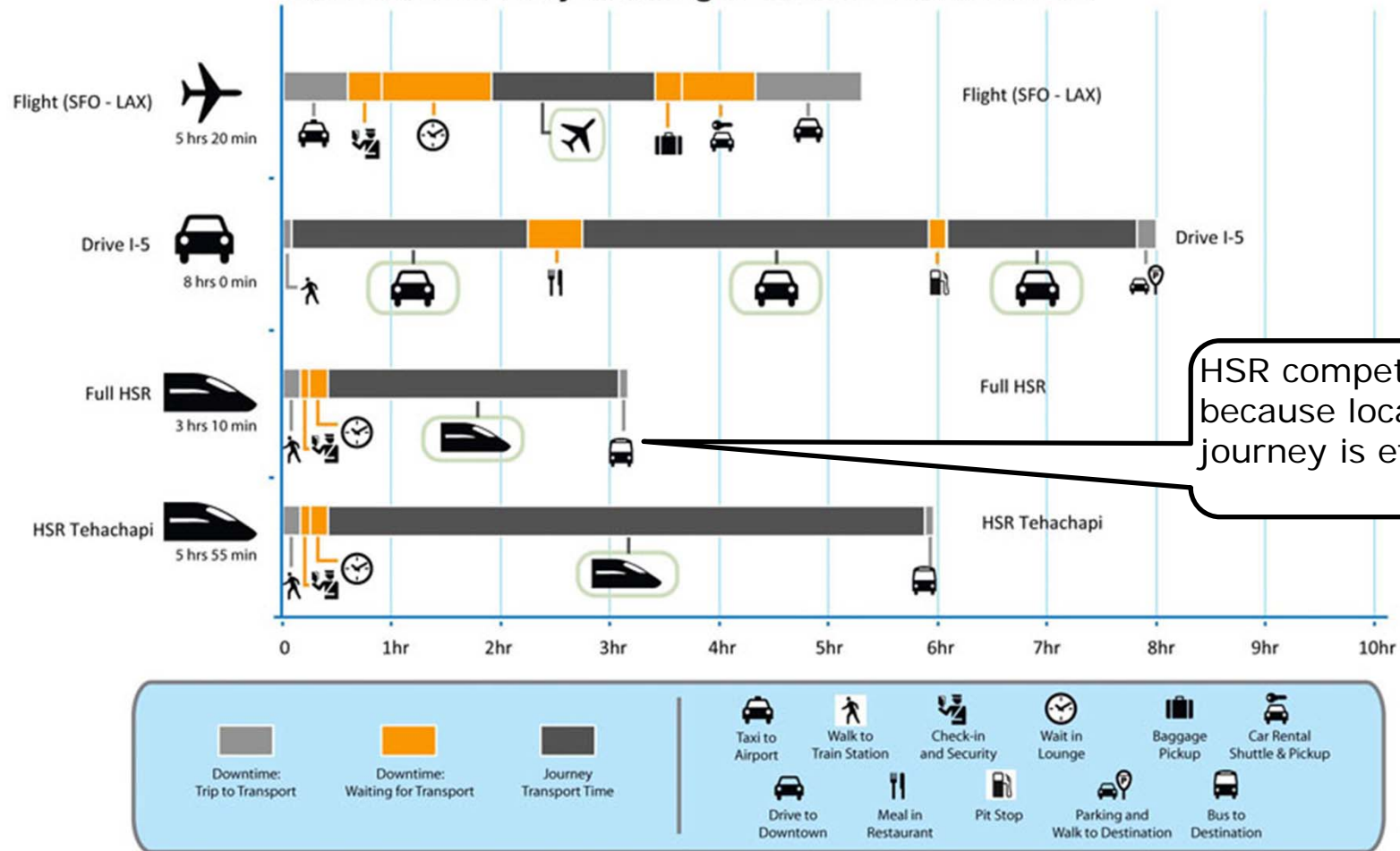
## **The Last Kilometer**

- Often the Weak Link
- Coordination and Integration
- Large Scale Schedule Optimization
- Information for Riders
- Reliability and Robustness
  - Strong punctuality
  - Tools for response to failures
- Long Term: Grow Customers Near the System

Travel Time:

# SAN FRANCISCO to LOS ANGELES

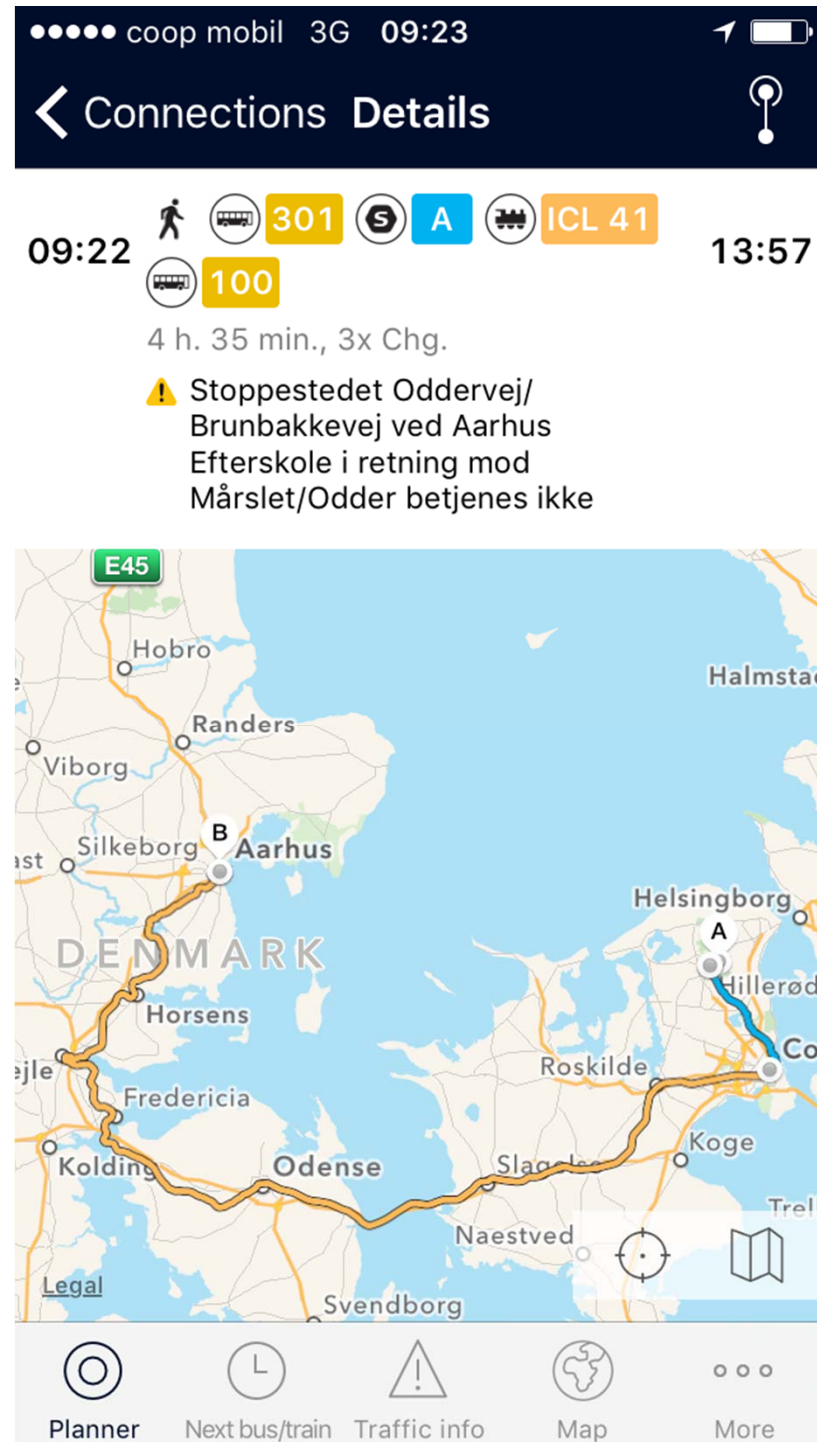
San Francisco Ferry Building to Grand Central Market



HSR competes because local journey is efficient

# Seamless Journey From Origin to Destination

- 38% of this journey time is local travel
  - 170 min. intercity train
  - 105 min. transit connection
- HSR will *increase* this ratio
- Customer service focus shifts to local connections



# Integration, Information

- Three Modes
  - Bus
  - Suburban
  - Intercity
- Four Providers
  - Movia
  - S-tog
  - DSB
  - Midttrafik
- Updated, Current

coop mobil E 09:22

## Connections Details

09:22 13:57

4 h. 35 min., 3x Chg.

⚠ Stoppestedet Oddervej/  
Brunbakkevej ved Aarhus  
Efterskole i retning mod  
Mårslet/Odder betjenes ikke

See price(s) View on map Share...urney Alarm

Fri 23.10.2015

09:22 Smedievej 77, 3400 Hillerød,  
Hillerød Kommune

Walking route 453 m, 8 min. ✓

09:30 Smedievej

301 → Ålholmparken  
20 min., 17 Intermediate stops ✓  
Cycle: 20 min.

09:50 Hillerød St.

Planner Next bus/train Traffic info Map More



# Planning the København System

- The Players
  - DSB
  - Banedanmark
  - Movia
- Rail Sequence
  - DSB service design
  - Timetable agreement with Banedanmark
- Bus Sequence
  - Movia service design
  - Local subsidy agreement
  - Subcontract of bus routes

# DSB Planning Cycle



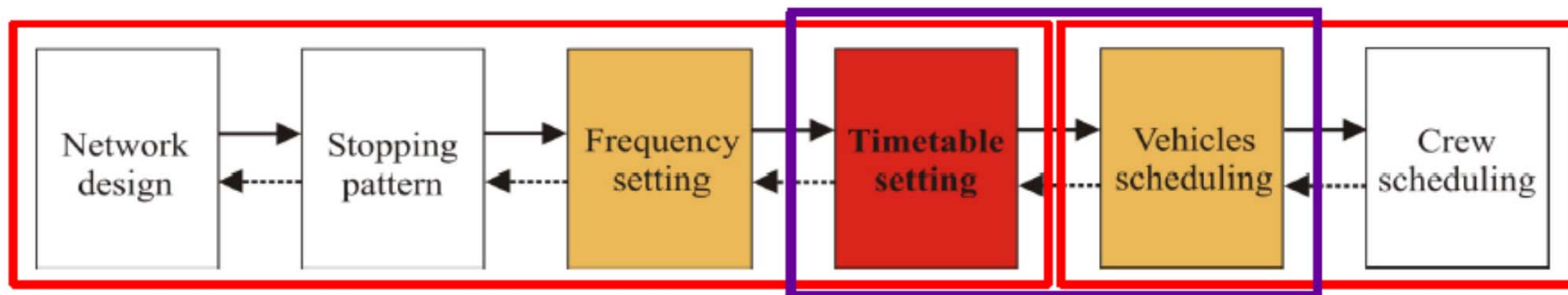


## **Integrated Timetable Challenges**

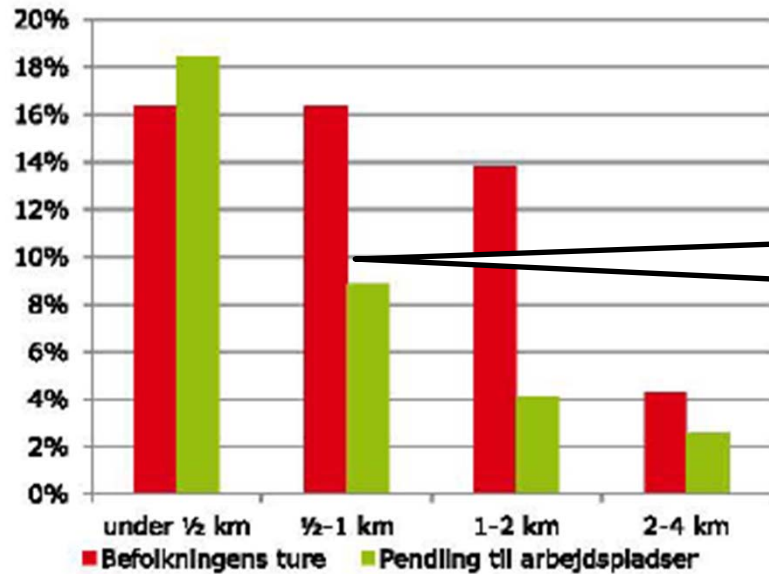
- DSB releases timetables less than six months from start date
- Movia negotiates bus contracts a year in advance
- Buses are also bound by local funding agreements
- Can be difficult to coordinate bus and rail with current mathematical models

# Integrated Planning and Optimisation of Public Transport (IPTOP)

- Five Year Project: 2015-2019
- \$2.73 Million
- Danish "Innovationsfonden"
- Timetable Optimization and Simulation
  - Integrated across modes
  - Integrated across resources (rolling stock, crew)

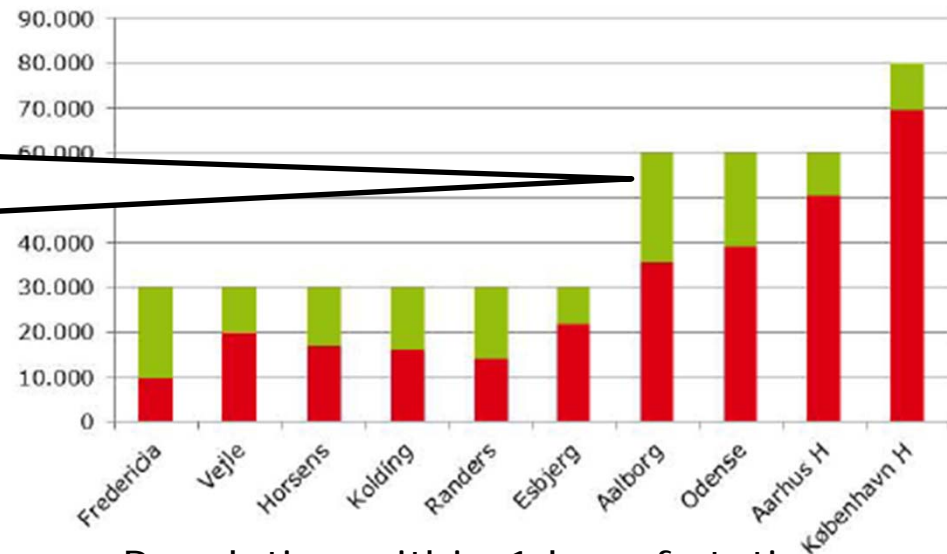


# Land Use Planning



Customers closer to station more likely to use rail

Future land use policy (green) to double development near stations



Population within 1 km of station

## Summary

- High speed rail is not a ground based airplane
- Strategic terminal/station locations and integrated local transit necessary
- Service design must be for a complete journey
- Long term, whole network planning saves money
- The high speed train is only part of the project

# Thank You

