



Challenges and Lessons in High Speed Railway Planning in Denmark

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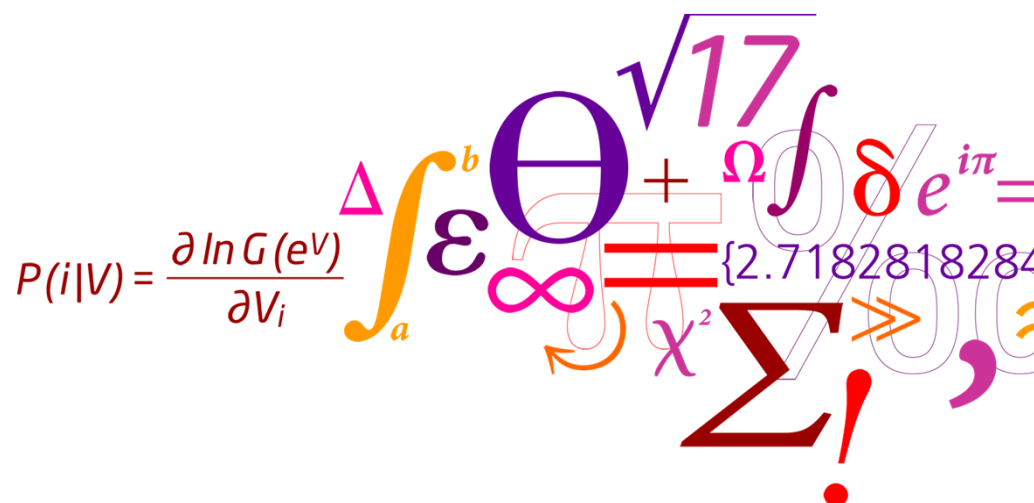
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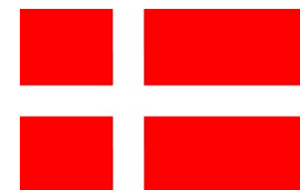
Challenges and Lessons in High Speed Railway Planning in Denmark

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

Dr. Steven Harrod

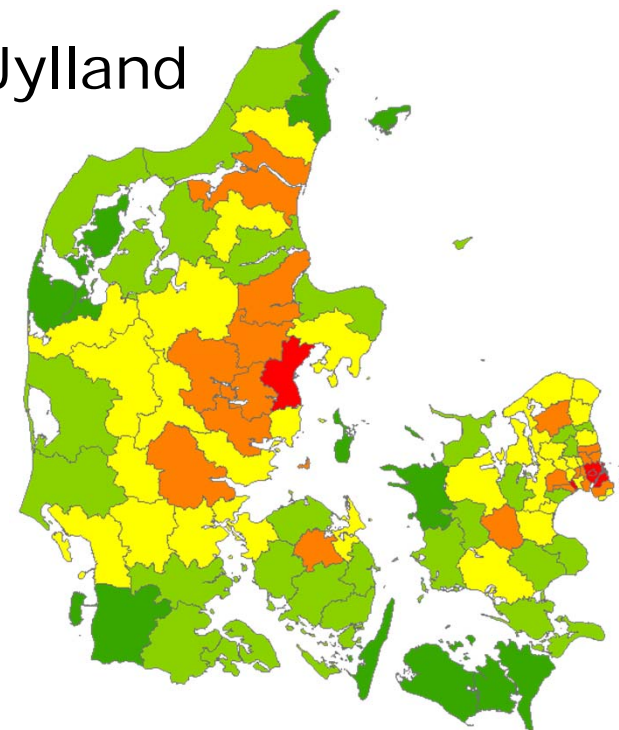
Technical University of Denmark





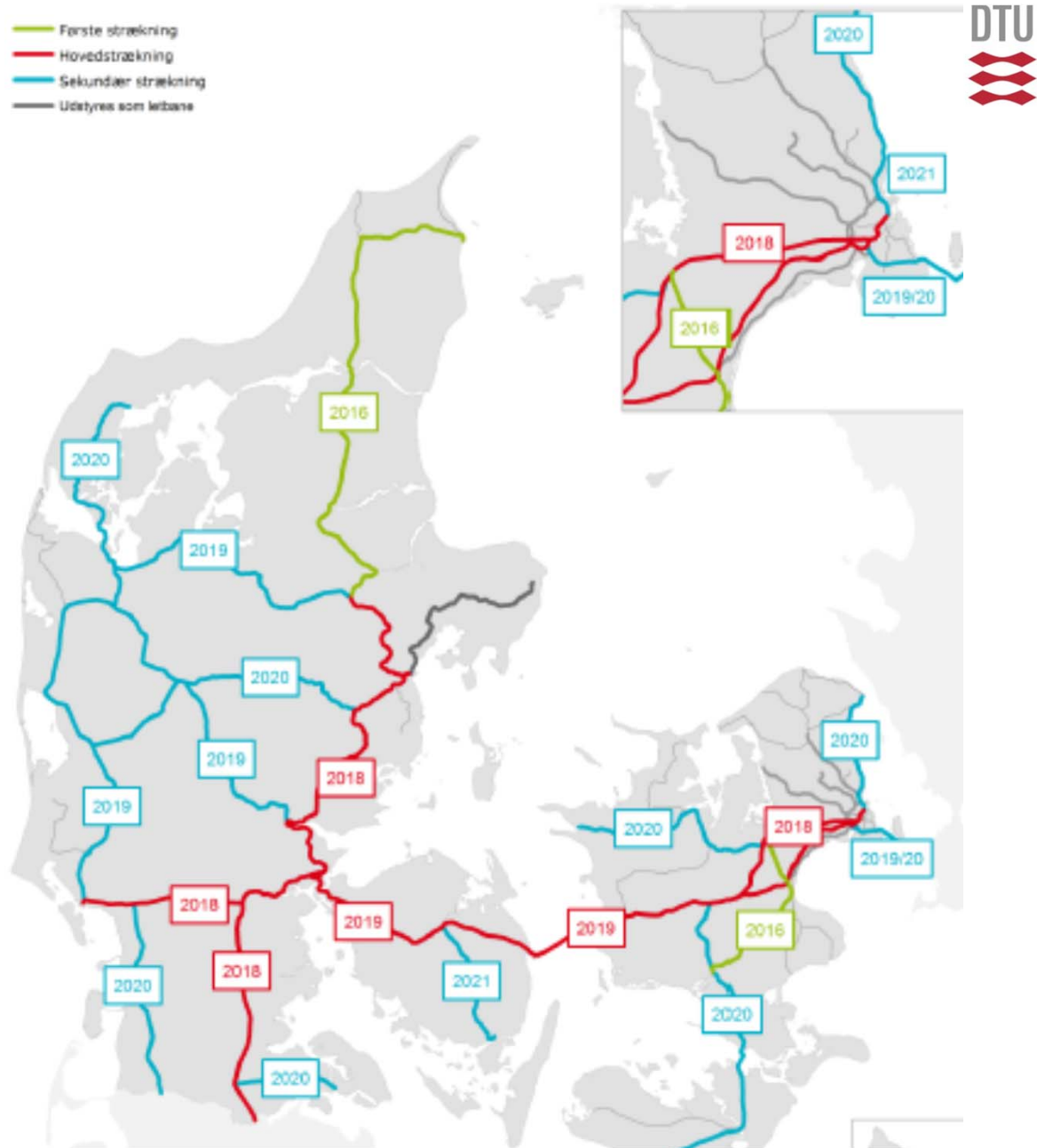
Danish Strategic Rail Plan

- 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

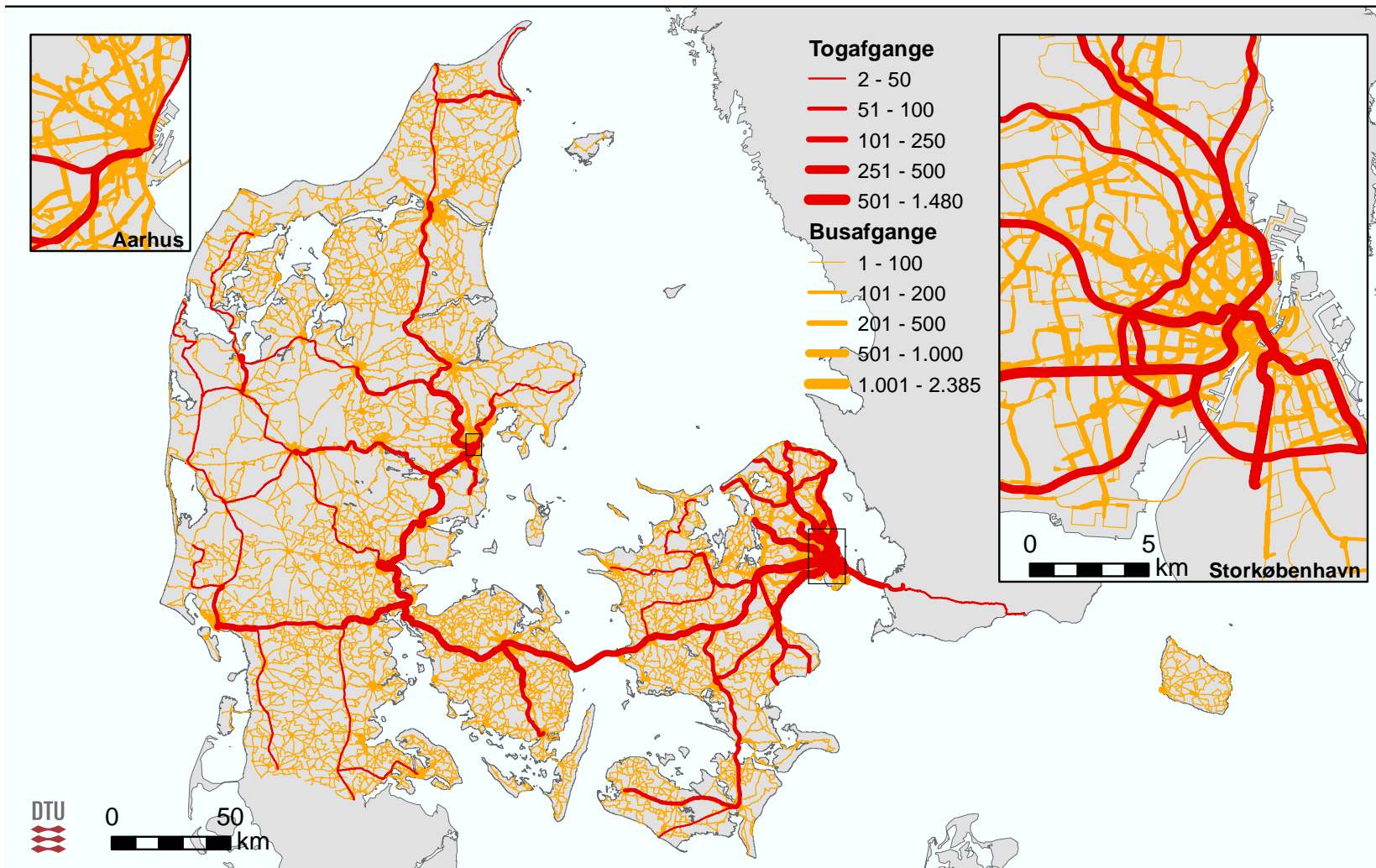
- The Danish Network Today
- Significant High Speed Projects
- Focus on the Whole Journey
- The Planning Process
- Future Forecast

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%

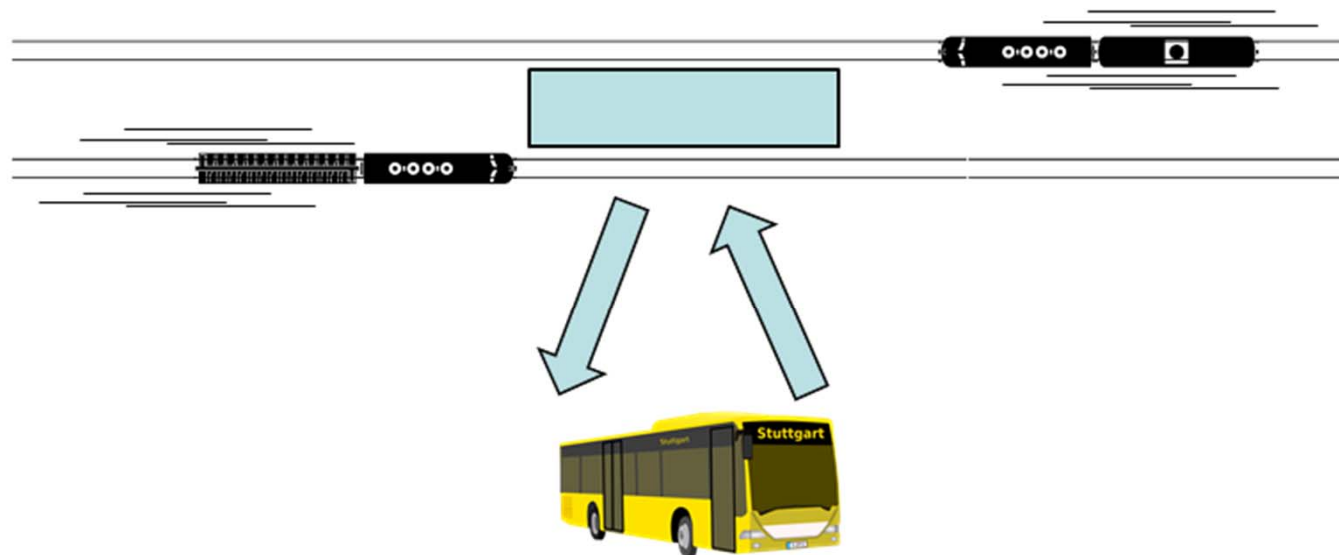
Aarhus-Aalborg, 33%

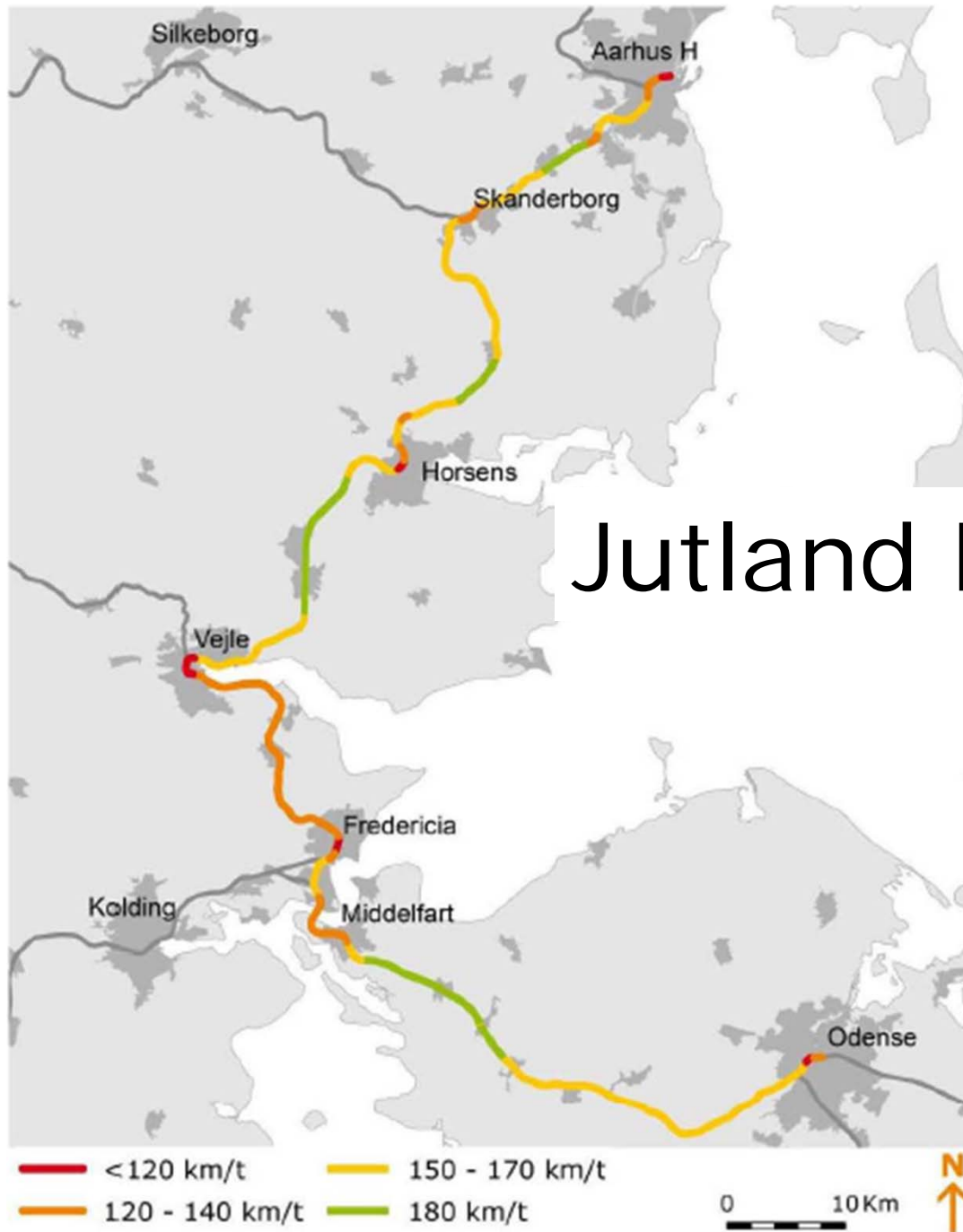
*Not a uniform network upgrade
Goal is NOT fastest train route*




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



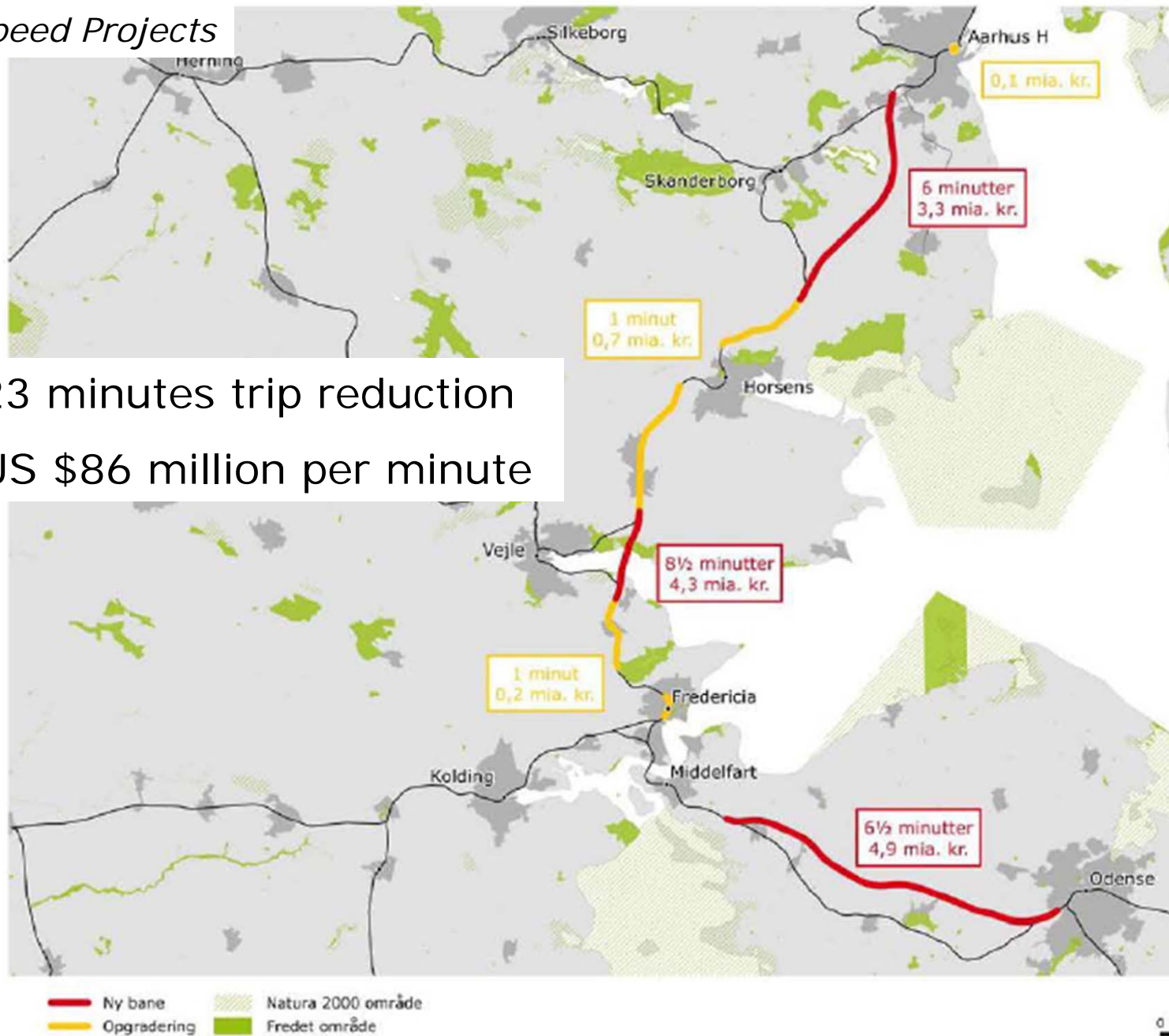


Jutland Main Today

Copenhagen 

High Speed Projects

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



Incremental Time Savings

Travel Time Odense-Aarhus	Diesel > IC3 180 kmh	IC4 200 kmh	Electric > 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

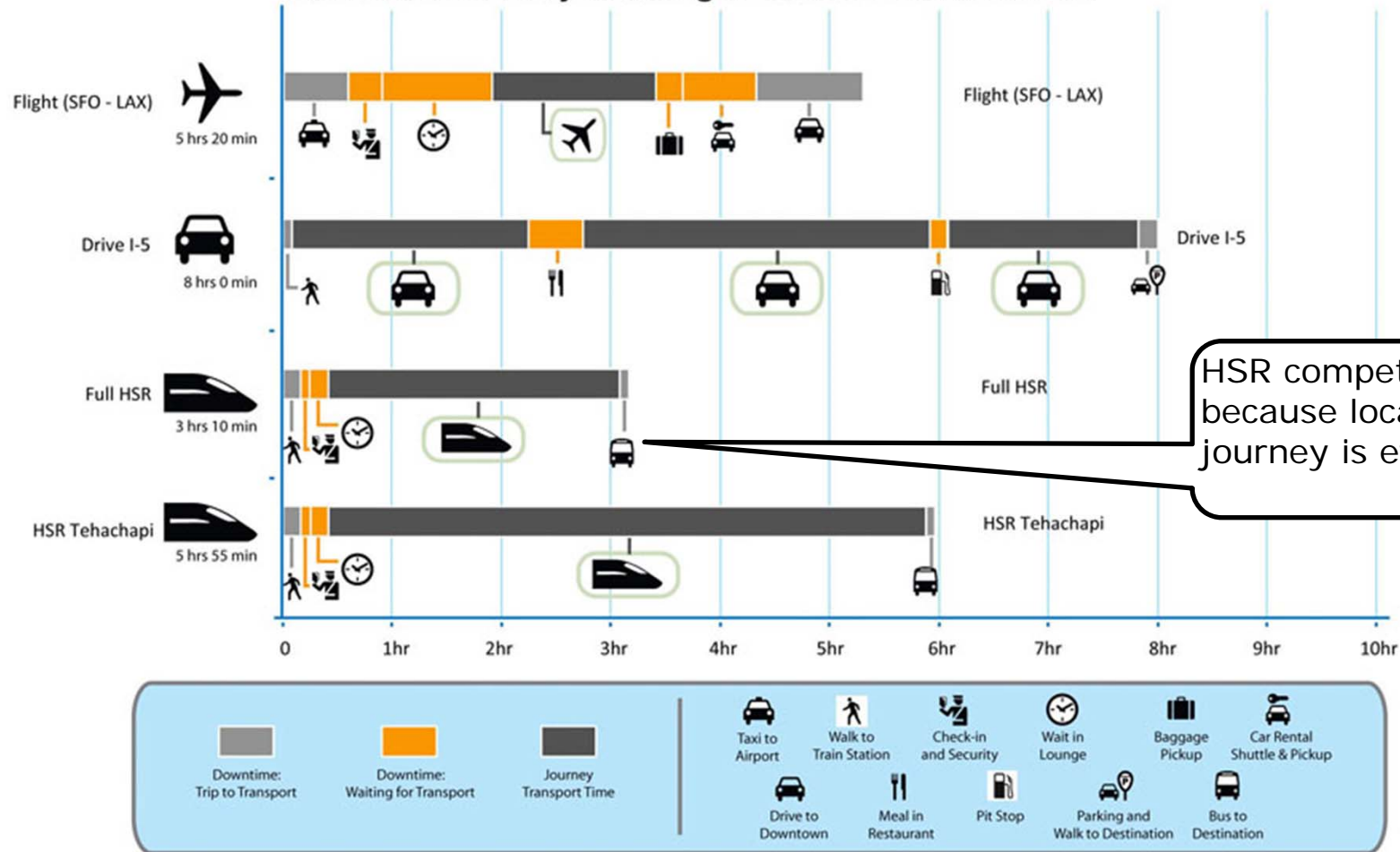
The Last Kilometer

- 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:

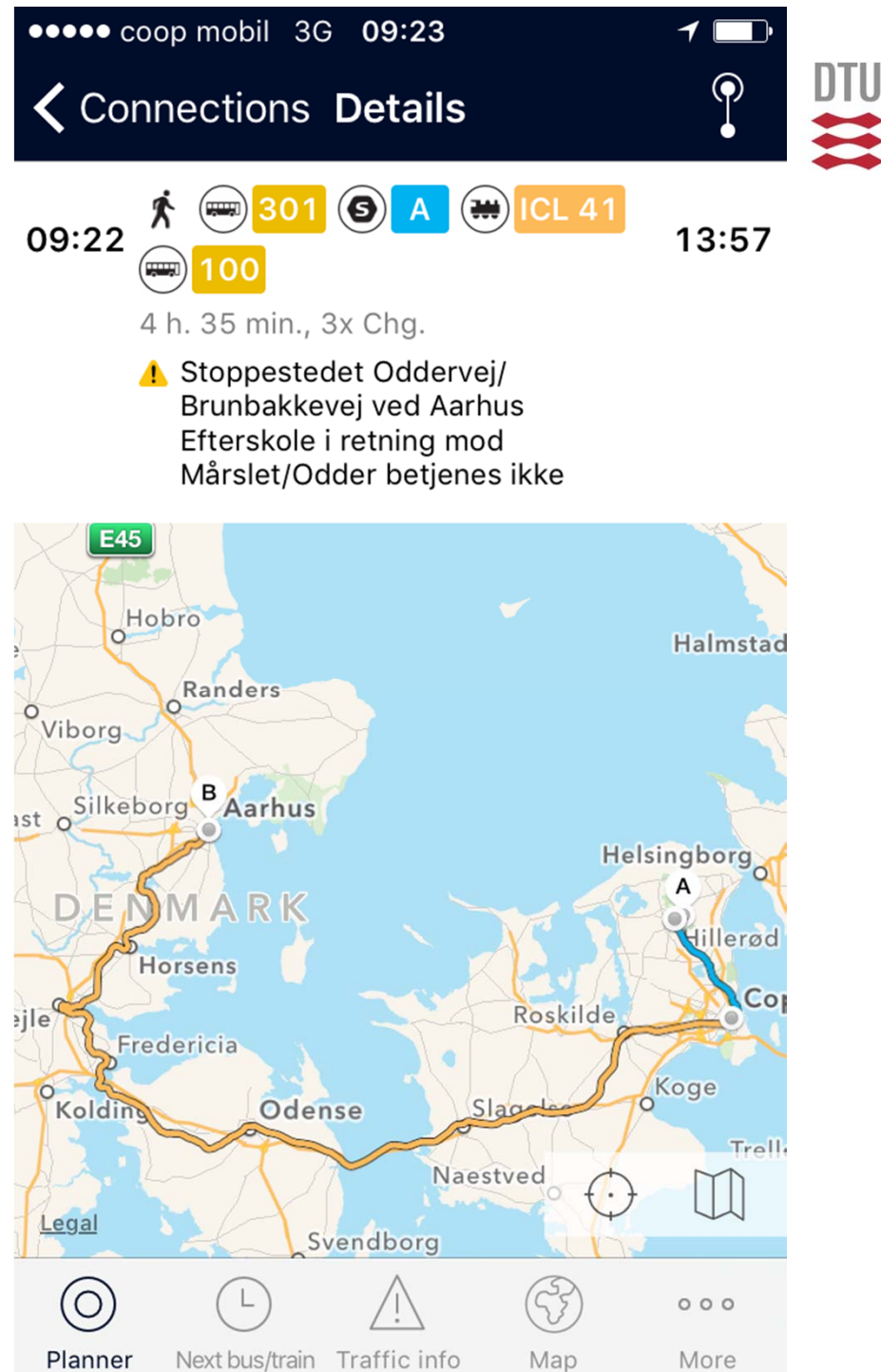
SAN FRANCISCO to LOS ANGELES

San Francisco Ferry Building to Grand Central Market



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

The screenshot shows the 'Connections Details' screen of the DTU Transport app. At the top, the status bar shows 'coop mobil E' and the time '09:22'. The app header is dark blue with a back arrow and the text 'Connections Details'. The DTU logo is in the top right corner. The journey summary shows a start time of 09:22 and an end time of 13:57. The route includes a walking segment, a bus (301), a subway (S), a train (A), and another bus (ICL 41). A warning icon indicates a stoppage at 'Oddervej/ Brunbakkevej ved Aarhus' with the note 'Efterskole i retning mod Mårslet/Odder betjenes ikke'. Below the summary are icons for 'See price(s)', 'View on map', 'Share...urney', and 'Alarm'. The date 'Fri 23.10.2015' is displayed. The journey details are listed below: 09:22 at 'Smedievej 77, 3400 Hillerød, Hillerød Kommune' with a walking route of 453 m, 8 min. 09:30 at 'Smedievej' with a bus (301) to 'Ålholmparken' taking 20 min. with 17 intermediate stops. 09:50 at 'Hillerød St.'. The bottom navigation bar includes icons for 'Planner', 'Next bus/train', 'Traffic info', 'Map', and 'More'.

coop mobil E 09:22

< Connections Details

DTU

09:22 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

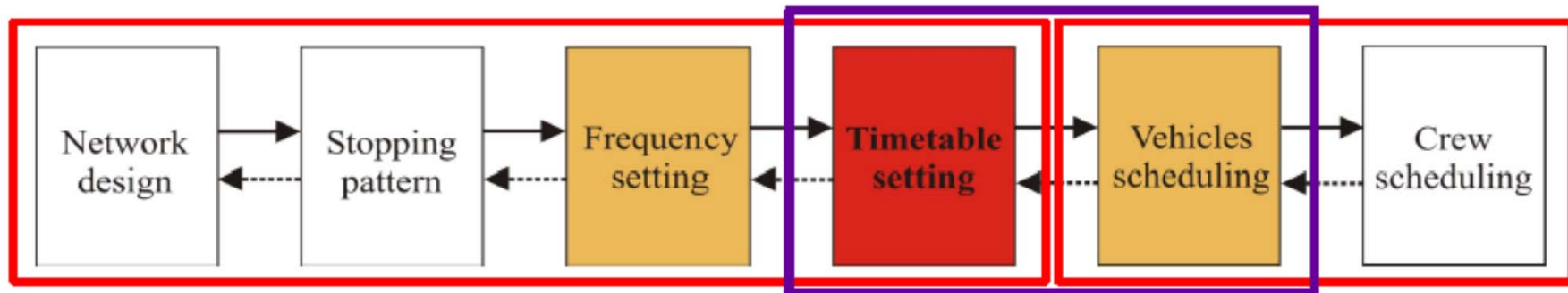


Integrated Timetable Challenges

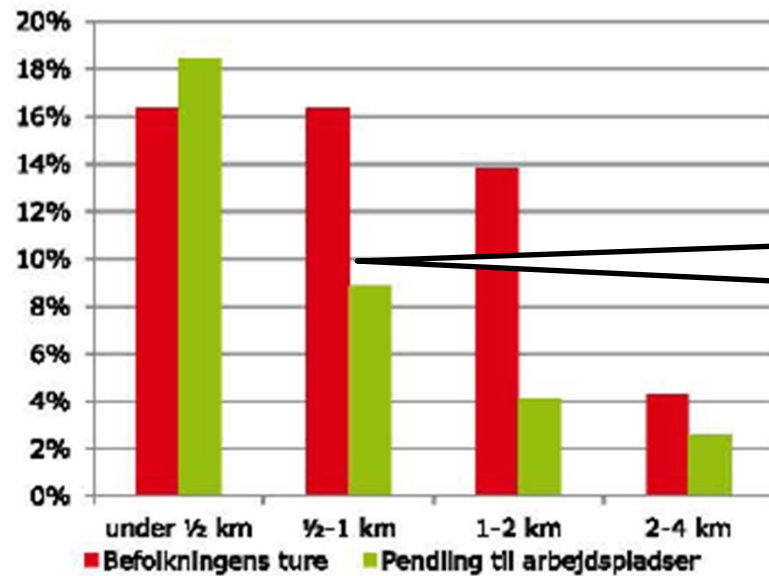
- DSB releases timetables less than six months from start date
- Movia negotiates bus contracts a year in advance
- Buses are also bound by local funding agreements
- Can be difficult to coordinate bus and rail with current mathematical models

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)

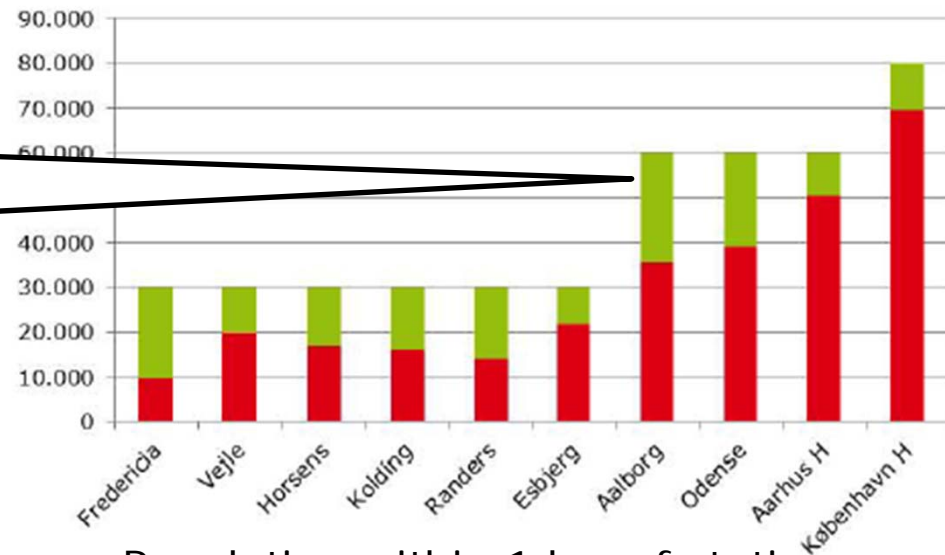


Land Use Planning



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

