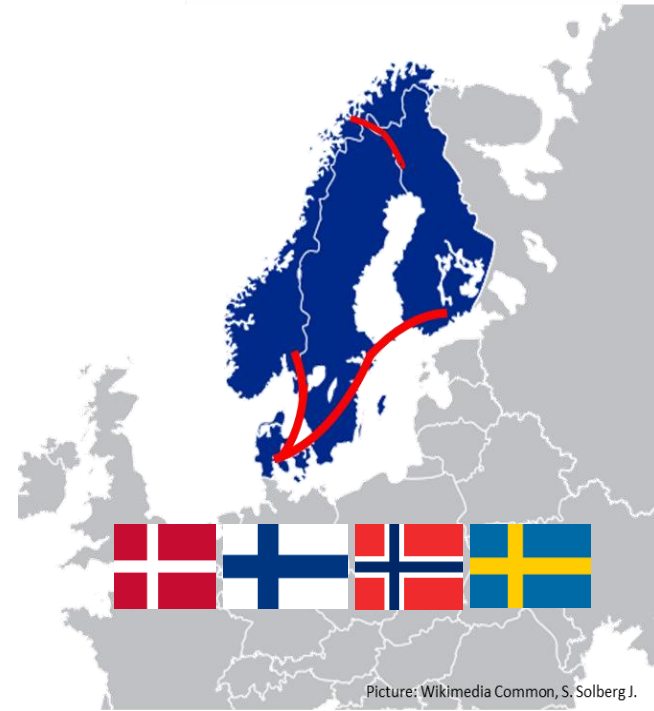


# Socio-economic evaluation

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- Road networks
- Safety effects
- Mobility & efficiency effects
- CO<sub>2</sub> emission effects
- Scaling up to national effects
- Benefits
- Costs vs benefits
- Concluding



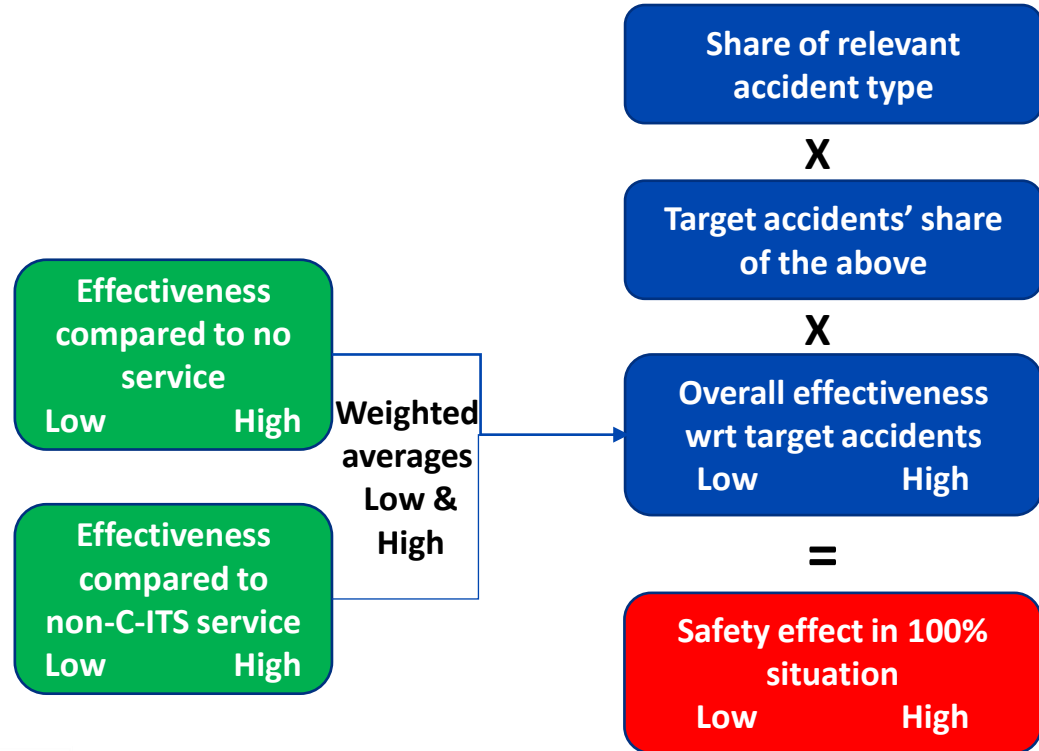
- DK 1
- FI 6
- NO 3
- SE 4
  
- Tunnels,  
motorways,  
2-lane roads,  
urban streets

| Characteristics of national networks included in assessment | Denmark | Finland | Norway | Sweden |
|---|---------|---------|--------|--------|
| Lenght (km)   | 3820    | 14166   | 55807  | 16116  |
| Vehicle kilometres driven (million/year)                    | 29331   | 31687   | 39619  | 48360  |
| Share of heavy vehicles (%)                                 | 6,7     | 9,9     | 1,8    | 15,8   |
| Vehicle hours driven (million/year)                         | 391,6   | 421,8   | 831,5  | 516,5  |
| Vehicle hours spent in congestion (M/year)                  | 19,9    | 14,9    | 28,2   | 12,7   |
| Fatal accidents (number/year)                               | 55,5    | 97,5    | 72,0   | 63,1   |
| Non-fatal injury accidents (number/year)                    | 476     | 1241    | 2370   | 2764   |
| Property damage only acc. (number/year)                     | 1677    | 5587    | 11850  | 20139  |
| CO2 emissions (million tonnes/year)                         | 4,8     | 6,9     | 4,6    | 8,1    |



Carried out for each service in each network

Aim to calculate effect in full coverage situation i.e. full network coverage, full vehicle penetration, full event coverage

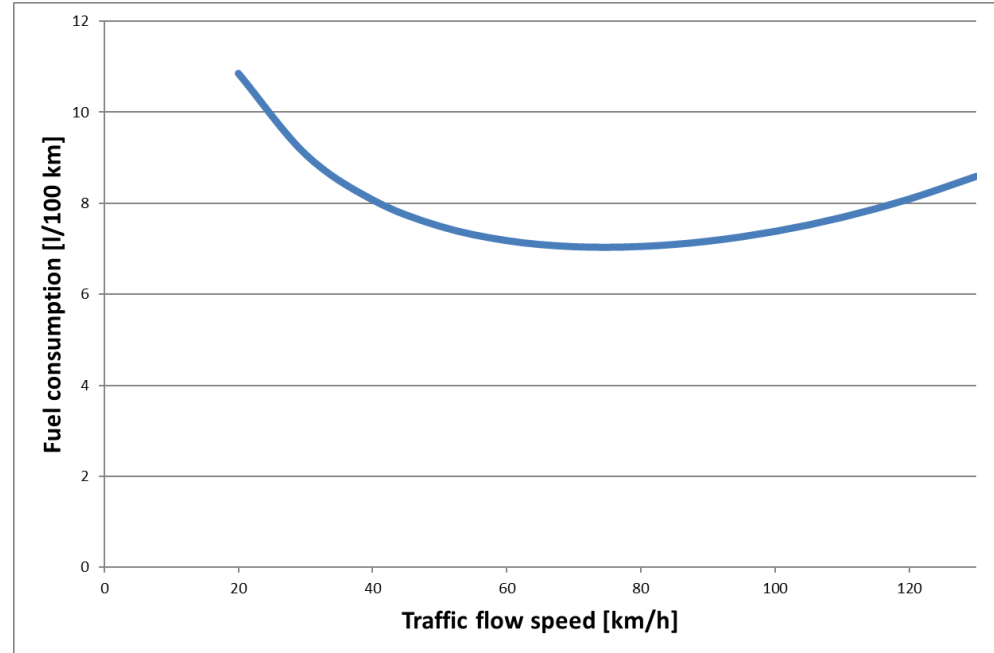


- Specific effects that can vary between networks
- Effects on exposure, crash risk and crash consequence
- Often effects may compensate each other
- M3 and part of M6 calculated over all services

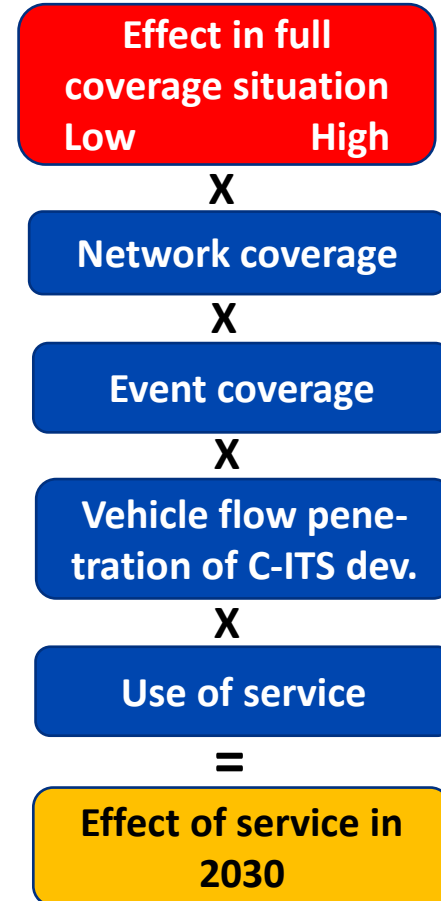
| Safety impact mechanisms                                      |
|---|
| <b>M1. Direct in-vehicle modification of the driving task</b> |
| <b>M2. Direct influence by roadside systems</b>               |
| <b>M3. Indirect modification of user behaviour</b>            |
| <b>M4. Indirect modification of non-user behaviour</b>        |
| <b>M5. Modification of interaction between road users</b>     |
| <b>M6. Modification of exposure</b>                           |
| <b>M7. Modification of modal choice</b>                       |
| <b>M8. Modification of route choice</b>                       |
| <b>M9. Modification of accident consequences only</b>         |

- Changes of vehicle km and hours driven
  - Route guidance type of services – fuel & charging information, on-street parking information, traffic information and smart routing
  - Warning services may lead to detours
  - All C-ITS services may make car driving a bit more attractive
- Change in vehicle hours driven
  - Decreased speeds mean increased vehicle hours driven
- Change in modal split
  - public transport priorities
- Reduction of crash-related congestion if safety is improved
  - share of crash-related out of all congestion is highest on low volume roads

- Change in modal split
  - only on urban networks
- Change in vehicle km driven
  - proportional to emission change
- Change in vehicle speeds
  - according to generic diagram



- Carried out for each service in each network
- Done for each type of effect
  - safety
  - mobility
  - efficiency
  - CO<sub>2</sub> emissions
- National effects summed up





# Benefits in 2030 in %

| LOW EFFECTIVENESS SCENARIO                      | DENMARK | FINLAND | NORWAY  | SWEDEN   |
|---|---------|---------|---------|----------|
| Vehicle hours driven (million/year)             | -0.04%  | -0.01%  | -0.04%  | -0.02%   |
| Vehicle hours spent in congestion (M/year)      | -0.004% | -0.002% | -0.003% | -0.0002% |
| Fatal accidents (number/year)                   | -3.3%   | -1.2%   | -4.8%   | -3.9%    |
| Non-fatal injury accidents (number/year)        | -1.6%   | -0.9%   | -2.0%   | -1.7%    |
| Property damage only accidents (number/year)    | -1.6%   | -1.0%   | -2.0%   | -1.7%    |
| CO <sub>2</sub> emissions (million tonnes/year) | -0.05%  | -0.01%  | -0.07%  | -0.02%   |
| HIGH EFFECTIVENESS SCENARIO                     | DENMARK | FINLAND | NORWAY  | SWEDEN   |
| Vehicle hours driven (million/year)             | -0.10%  | -0.02%  | -0.10%  | -0.02%   |
| Vehicle hours spent in congestion (M/year)      | -0.9%   | -0.02%  | -0.5%   | -1.8%    |
| Fatal accidents (number/year)                   | -4.5%   | -1.7%   | -6.3%   | -5.2%    |
| Non-fatal injury accidents (number/year)        | -2.7%   | -1.5%   | -3.5%   | -2.9%    |
| Property damage only accidents (number/year)    | -2.7%   | -1.6%   | -3.5%   | -2.9%    |
| CO <sub>2</sub> emissions (million tonnes/year) | -0.07%  | -0.07%  | -0.10%  | -0.03%   |



# Benefits – sensitivity analyses

| FINLAND 2030 - HIGH SCENARIO                 | 0       | 1                              | 2           | 3                      | 4                             | 5            |
|--|---------|--------------------------------|-------------|------------------------|-------------------------------|--------------|
| BENEFITS IN NUMBER                           | BASIC   | SPEEDING DIS-BENEFITS INCLUDED | 1 + M3 & M6 | 2 WITHOUT IVSL SERVICE | 0 + 100% VEHICLE PENE-TRATION | 0 + FULL USE |
| Vehicle hours driven (million/year)          | -0.06   | 1.49                           | 0.93        | -0.55                  | -0.13                         | -0.09        |
| Vehicle hours spent in congestion (M/year)   | -0.003  | -0.003                         | -0.04       | 0.005                  | -0.011                        | -0.002       |
| Fatal accidents (number/year)                | -1.40   | -1.40                          | -0.79       | 0.35                   | -3.10                         | -1.40        |
| Non-fatal injury accidents (number/year)     | -19.3   | -19.3                          | -15.0       | 0.02                   | -46.0                         | -20.2        |
| Property damage only accidents (number/year) | -84.9   | -84.9                          | -66.5       | -0.51                  | -202.4                        | -89.2        |
| Co2 emissions (million tonnes/year)          | -0.0044 | -0.0044                        | -0.0002     | 0.0011                 | -0.0105                       | -0.0060      |
| BENEFITS IN MILLION €                        |         |                                |             |                        |                               |              |
| Vehicle hours driven                         | -0.960  | 24.6                           | 15.4        | -9.120                 | -2.133                        | -1.411       |
| Vehicle hours spent in congestion            | -0.044  | -0.044                         | -0.72       | 0.076                  | -0.180                        | -0.037       |
| Fatal accidents                              | -5.03   | -5.03                          | -2.85       | 1.26                   | -11.05                        | -5.03        |
| Non-fatal injury accidents                   | -9.45   | -9.45                          | -7.35       | 0.011                  | -22.57                        | -9.93        |
| Property damage only accidents               | -0.42   | -0.42                          | -0.33       | -0.0026                | -1.01                         | -0.45        |
| Co2 emissions                                | -0.404  | -0.404                         | -0.022      | 0.104                  | -0.970                        | -0.557       |
| TOTAL VALUE OF CHANGES IN USER COSTS         | -16.3   | 9.2                            | 4.1         | -7.7                   | -38.0                         | -17.4        |

# Costs – example Norway

| NORWAY<br>COST ELEMENTS                        | NUMBER  | INVESTMENT COST €  | O&M COST/YEAR €   |
|--|---------|--------------------|-------------------|
| <b>C-ITS UNITS</b>                             |         |                    |                   |
| In-vehicle units                               | 740 697 | 133 325 533        | 11 851 158        |
| Roadside units, new                            | 1 850   | 24 975 000         | 1 073 000         |
| Roadside units, upgraded                       | 0       | 0                  | 0                 |
| Mobile V2I stations                            | 600     | 2 700 000          | 480 000           |
| <b>BACK-OFFICE</b>                             |         |                    |                   |
| TMC  |         | 6 000 000          | 200 000           |
| Data management                                |         | 1 000 000          | 200 000           |
| <b>SERVICE PROVISION</b>                       |         |                    |                   |
| Personnel incl. Procurement                    |         |                    | 300 000           |
| Equipment (HW+SW)                              |         |                    | 200 000           |
| Telecommunications                             |         |                    | 200 000           |
| Service purchase                               |         |                    | 0                 |
| <b>TOTAL</b>                                   |         |                    |                   |
| <b>Sum of the costs above</b>                  |         | <b>168 000 533</b> | <b>14 504 158</b> |
| <b>Sum of costs excluding in-vehicle costs</b> |         | <b>34 675 000</b>  | <b>2 653 000</b>  |



| Costs and benefits (€)           | Denmark     | Finland     | Norway      | Sweden      |
|----------------------------------|-------------|-------------|-------------|-------------|
| <b>Vehicle unit costs</b>        |             |             |             |             |
| Investment 2021-2030             | 118 087 200 | 141 381 000 | 133 325 533 | 352 944 000 |
| Operation & maintenance 2030     | 10 496 640  | 12 567 200  | 11 851 158  | 31 372 800  |
| <b>Road operator costs</b>       |             |             |             |             |
| Investment 2021-2030             | 5 312 500   | 3 672 000   | 34 675 000  | 73 500 000  |
| Operation & maintenance 2030     | 486 000     | 2 062 960   | 2 653 000   | 5 900 000   |
| <b>Benefits</b>                  |             |             |             |             |
| Low effectiveness scenario 2030  | 22 741 967  | 10 475 197  | 41 087 119  | 68 239 294  |
| High effectiveness scenario 2030 | 44 806 980  | 16 318 268  | 68 377 214  | 123 663 528 |



- Socio-economically feasible C-ITS services
- The results depend on assumptions
  - We need more empirical results about C-ITS service use and impacts on mobility and driving behaviour
- Importance of safety impacts diminishes as vehicle safety keeps on improving while efficiency impacts keep a major role
- Start deployment with high traffic volume main roads
- High network and event coverage of C-ITS services is essential for impacts

# Thank you for your attention!

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