Impact of faster freight trains on railway capacity and operational quality

Comprail 2020

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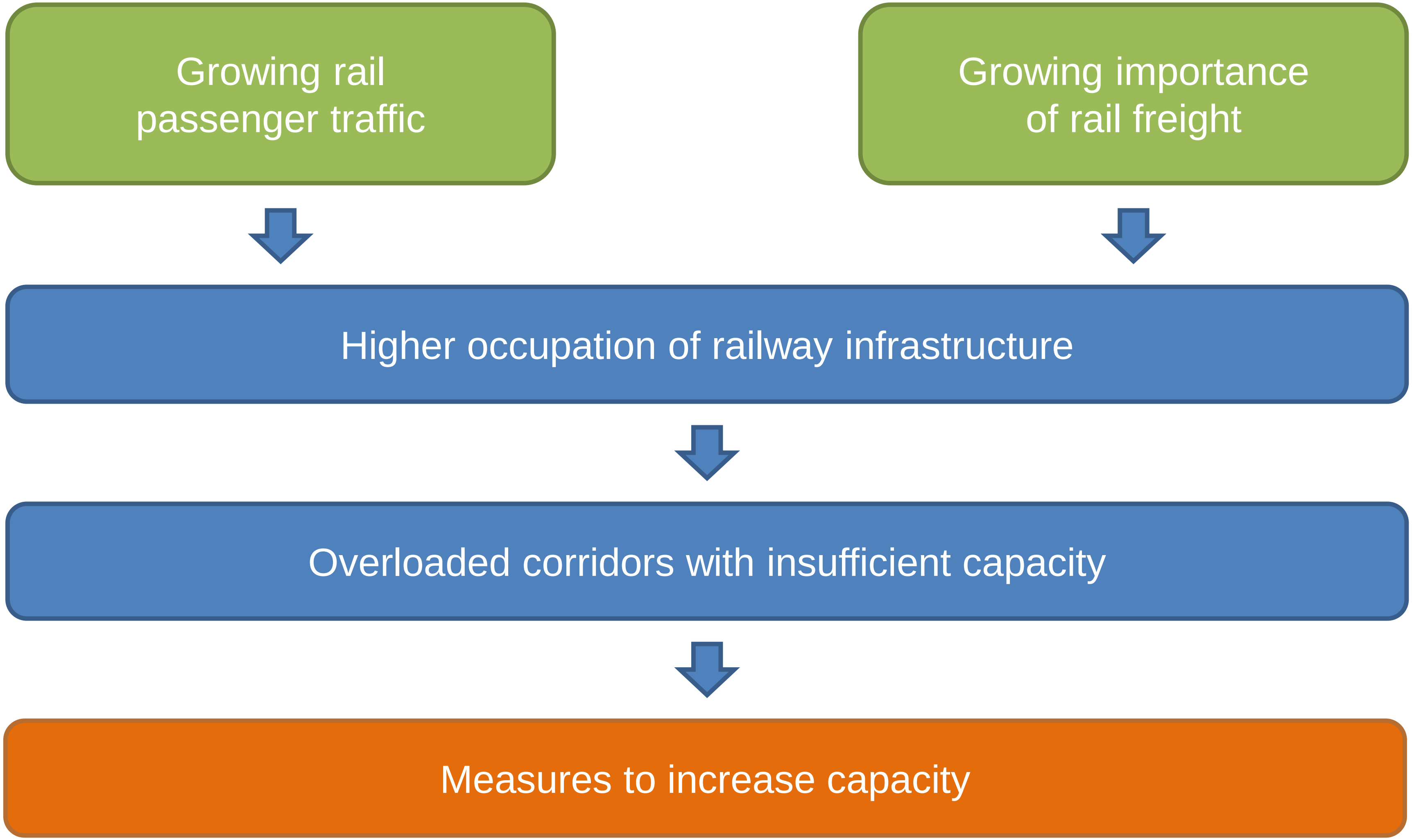
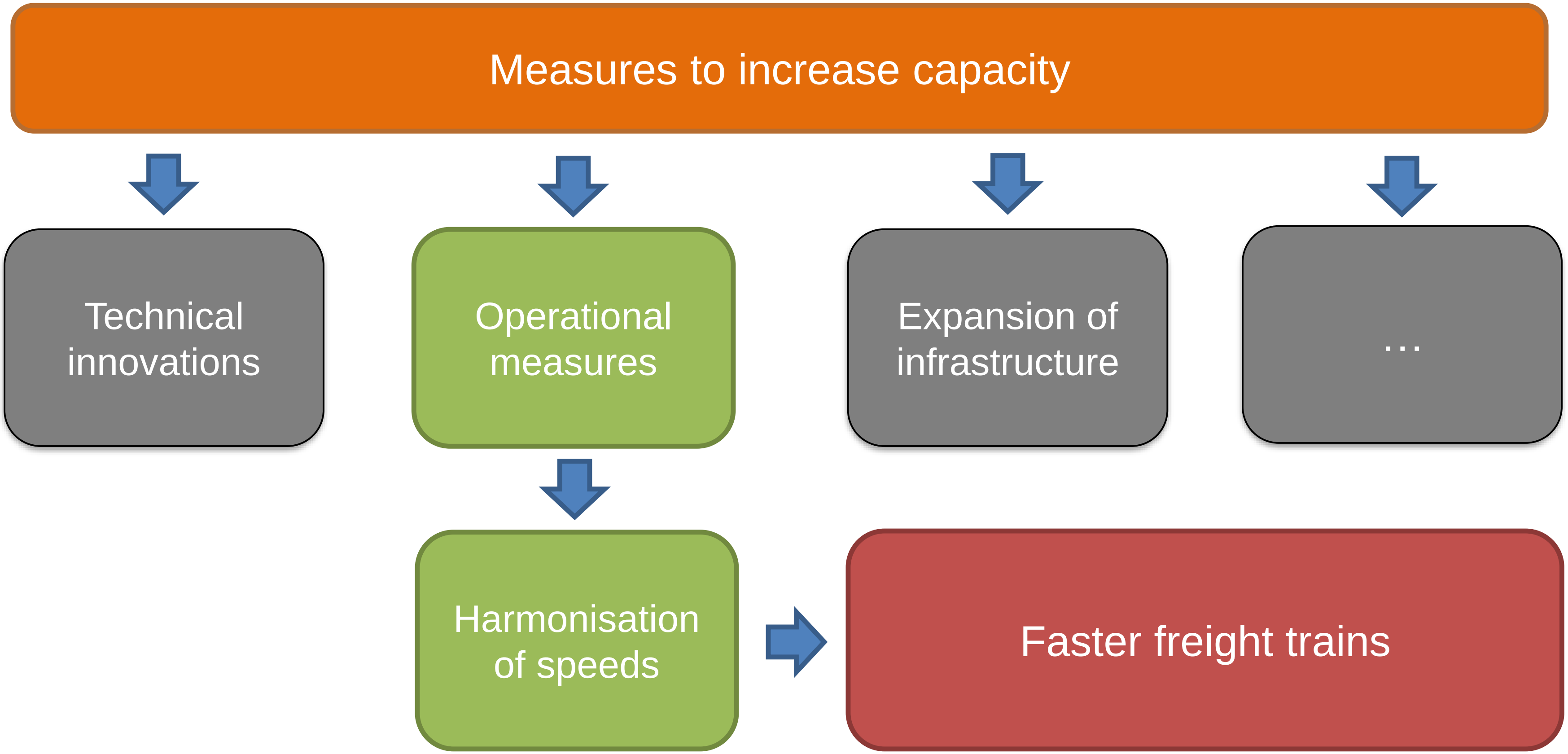
Agenda

1. Introduction
2. Methodical approach
3. Case study
4. Discussion

1. Introduction (1)



1. Introduction (2)



1. Introduction (3)

Faster freight trains - distinction between two cases:

A) Freight trains can **occasionally** make use of their allowed higher speed level **only when needed**:
- higher recovery margins
- higher flexibility to recover from delays or blend in with passenger traffic
- operation with conventional timetables and speed profiles

B) Freight trains are scheduled to so-called "**express train paths**":
- more homogeneous timetable profiles
- strict obligation to run faster than with conventional timetables

1. Introduction (4)

- **Theoretical capacity**: the number of trains that could run over a route during a specific time interval; defines the upper limit for line capacity [1]
- **Practical capacity**: number of train paths that can be scheduled with market-oriented quality ("level of service") [2,3]

- Different approaches to measure and evaluate railway capacity:
  - constructive methods
  - concatenation according to UIC code 406
  - simulations
  - analytical approaches
- methods have both advantages and disadvantages with respect to output parameters, processing efforts, independence from timetables or how close the models are to real-life train operations

- Microscopic simulation using RailSys ® was chosen

2. Methodical Approach (1)

- Detailed microscopic simulation model (heavily occupied mixed-traffic line):
  - simulation period: 24 hours, evaluation period: 16 hours
  - distribution of entry delays (e.g. freight trains delay by an average 10 minutes with a probability of 0.6) [4]
  - Considerable effect of the dispatching configuration on results

- **difference in delays** as an indicator of operational quality (difference of exit and entry delay) has three states [5]:

state	delay	operational quality	comment
positive	increasing	defective	overloaded system
0	neither increasing nor decreasing	“satisfactory“	
negative	decreasing	good	additional trains could be added

2. Methodical Approach (2)

- enrichment of a reference timetable with additional freight train paths:
  - higher number of freight trains
  - operational quality deteriorates
- additional trains are step by step added as long as there is still space for additional paths
- measure of the difference in delays for each step

Scenario	**Name**	**Allowed maximum speed of freight trains (km/h)**	**Case***
Scenario 1	Reference timetable (RTT)	conventional (100)	Reference case
Scenario 2	RTT v_{max} 120	120	Case A)
Scenario 3	RTT v_{max} 140	140	Case A)
Scenario 4	RTT v_{max} 160	160	Case A)
Scenario 5	Express timetable v_{max} 160	160	Case B)

*case A): recovery case, case B) express paths

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3. Case study (1)

(*Source: Open Railway Map © OpenStreetMap-Contributors [6]*)

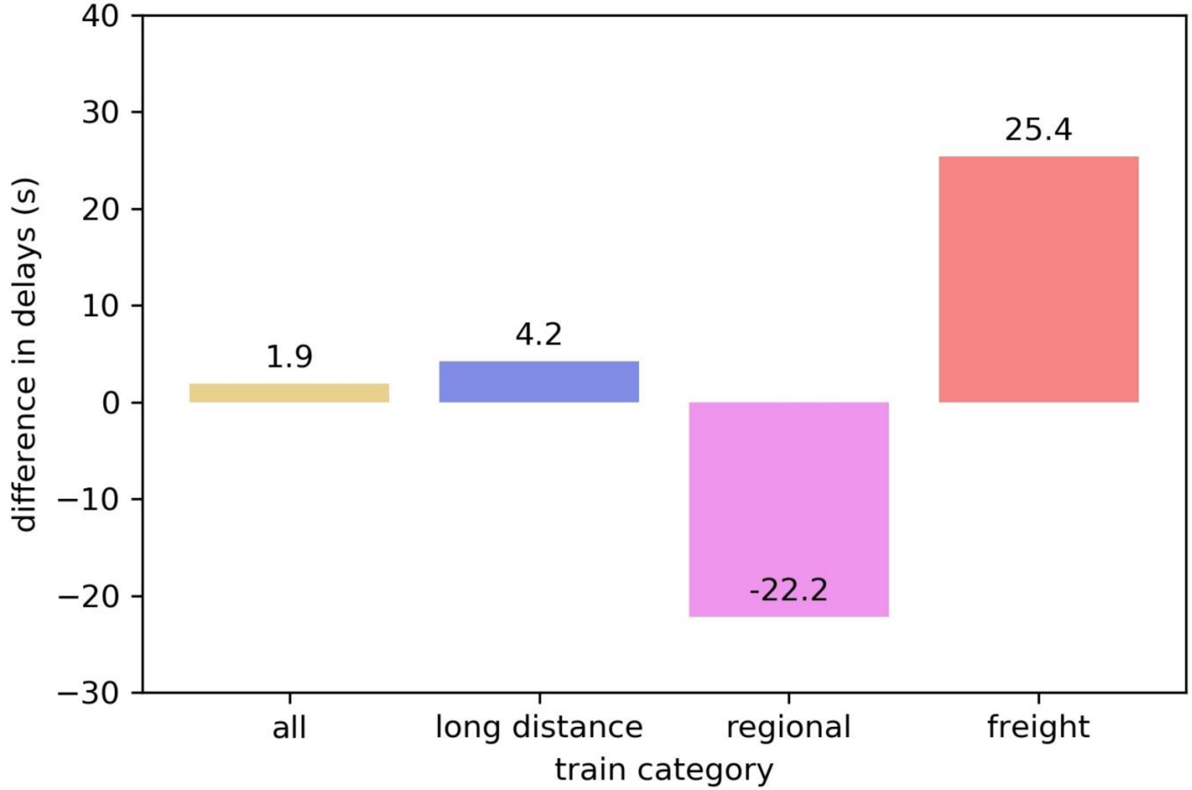
- Line segment between Offenburg and Freiburg
- Part of TEN* corridor
- Publicly accessible data:
  - Infrastructure
  - Timetables
- Four freight train model classes:
  - container trains, trains with bulk goods, block trains and trains with mixed goods
  - German passenger train categories

- 100 simulation runs
- Measurement of difference of delays

*TEN = Trans European Network

3. Case study (2): results

difference in delays, scenario 1: reference timetable:



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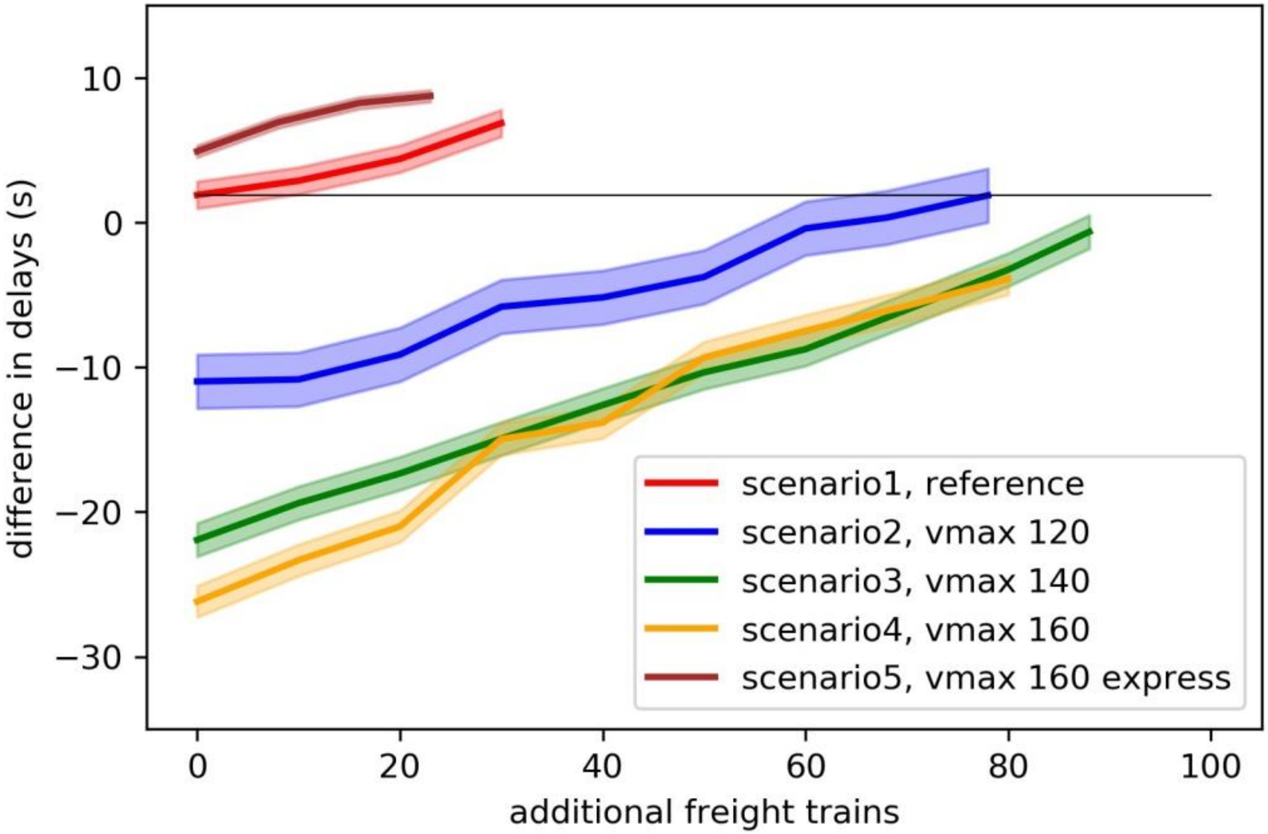
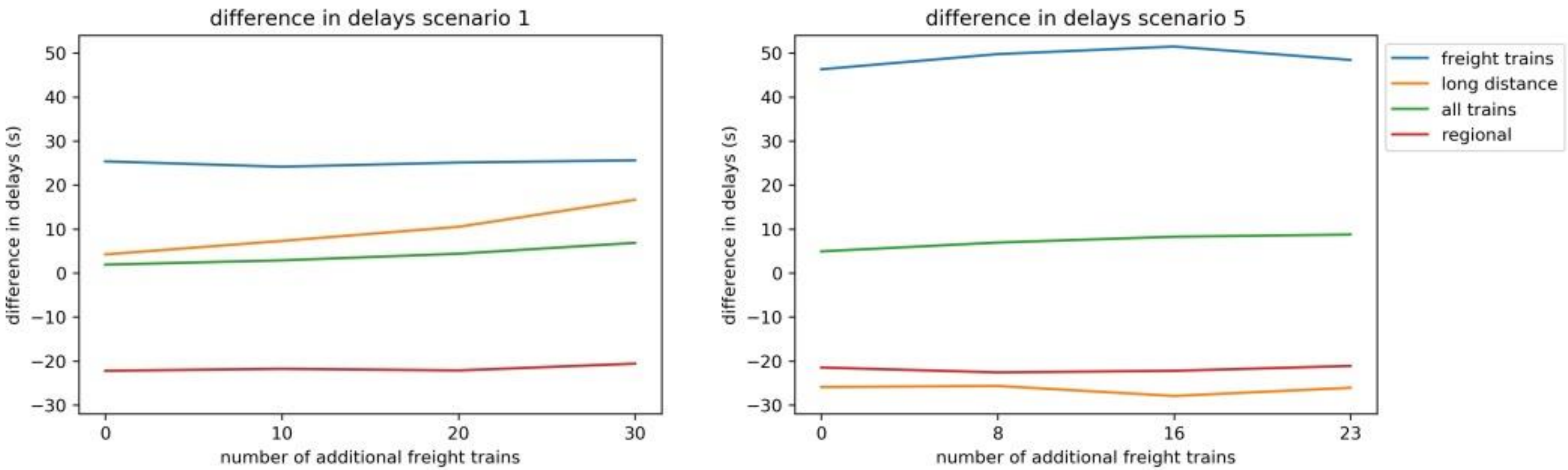
3. Case study (3): results

difference in delays, comparison of scenarios:



3. Case study (4): results

- comparison of reference scenario 1 (left) and express paths scenario 5 (right):



- Long distance trains: massive decrease in difference in delays in scenario 5 compared to scenario 1 (by approx. 30 to 40 seconds)
- Freight trains: difference in delays rises by approx. 25 seconds (see blue line, comparing from left to right)
- negative influence outweighs the positive due to the distribution of train categories

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4. Discussion (1)

- overall operational quality seems to rise by allowing freight trains a higher maximum speed in case of delay:
  - case A) seems promising: approx. two additional freight trains per hour and direction (could be lower given network-intrinsic constraints)
  - speed homogeneity and speed of freight trains have a significant influence on the capacity of mixed-traffic rail corridors
- faster freight train operations do not seem to bring advantages per se:
  - case B) (scenario 5) does not seem to be promising against the background of raising capacity
  - strictly raised obligatory maximum speed slightly deteriorates operational quality
  - assumption: better during night time or in a less occupied infrastructure
- free capacity can also be used to reduce overall delays

4. Discussion (2): further research

- change of results if freight trains were given a higher priority
  - => isolated analysis of headway times is not sufficient for an overall understanding of capacity
- comparably small difference between scenarios 2, 3 and 4
  - possibly, the highest allowed speed level is not necessarily the optimal choice
- full migration was assumed:
  - *all* freight trains had the characteristics of the particular scenario
  - mixed scenarios were not analysed
  - demand for conventional freight trains will remain
  - identify demand for express freight (e.g. package delivery sector or with non-durable or chilled goods)
- additional freight trains do not necessarily mean higher overall transport capacity

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[6] OpenRailwayMap: map layout: OpenRailwayMap; map data: OpenStreetMap © OpenStreetMap-Contributors, www.openstreetmap.org/copyright. https://www.openrailwaymap.org/, Accessed on: 11 May 2020

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Thank you for your attention

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