



**[Optimal Networks for Train
Integration Management across Europe]**

Collaborative Project
7th Framework Programme

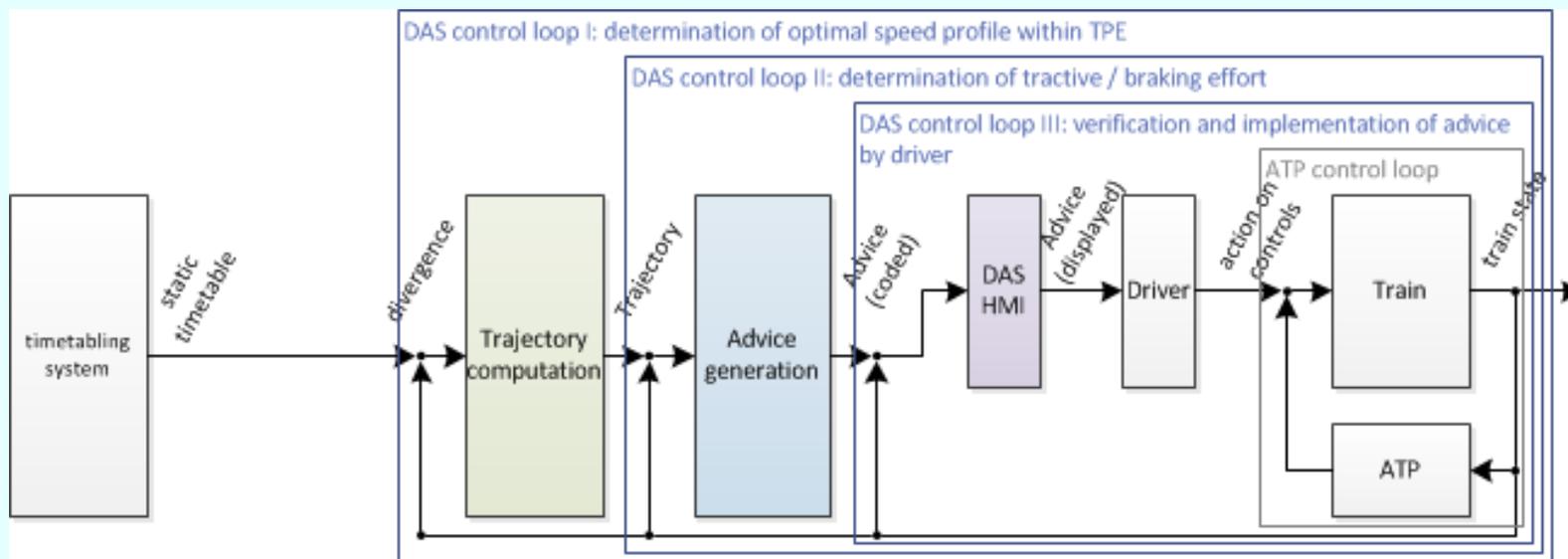
Dissamination Workshops, October 2014
Innovation 5: Centrally Guided Train Operation (CGTO)

Table of content

- **From DAS to CGTO**
- **Alternative CGTO system architectures**
- **CGTO interface specification**
- **HMI recommendations and example**
- **Demonstration**

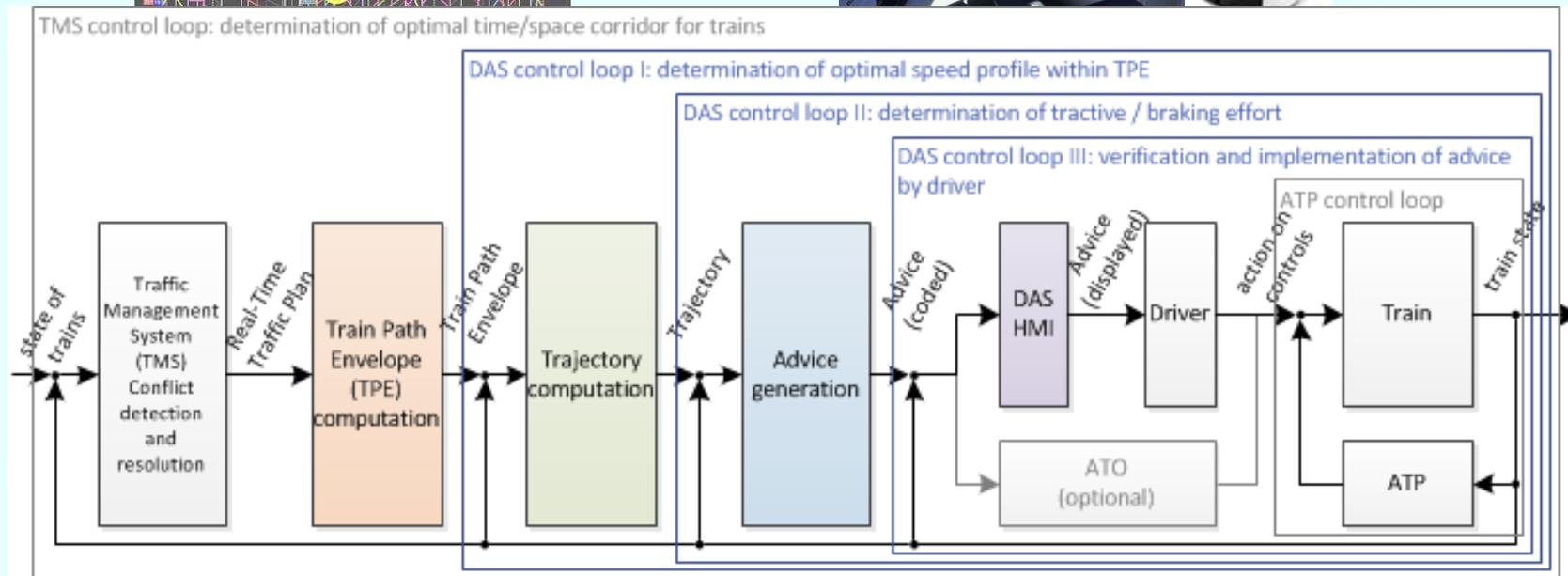
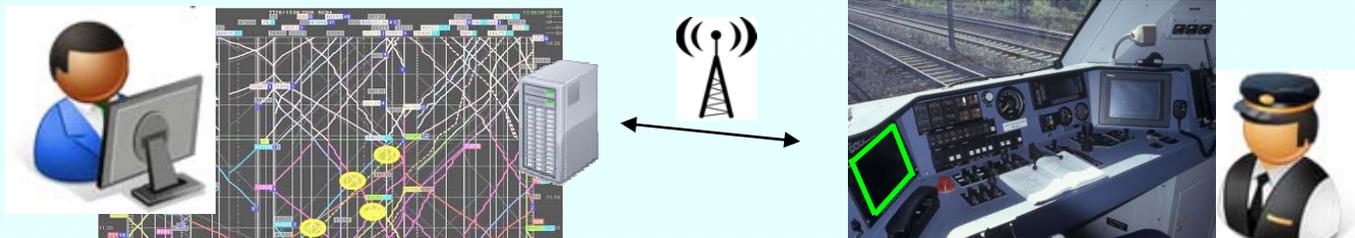
From DAS to CGTO

- Increasing use of and development on Driving Advisory Systems (DAS) in recent years → main focus energy efficiency
- DAS disregard operational conditions (other trains)
 - advice sometimes become obsolete
 - Cannot assure smooth traffic flow in congested situations

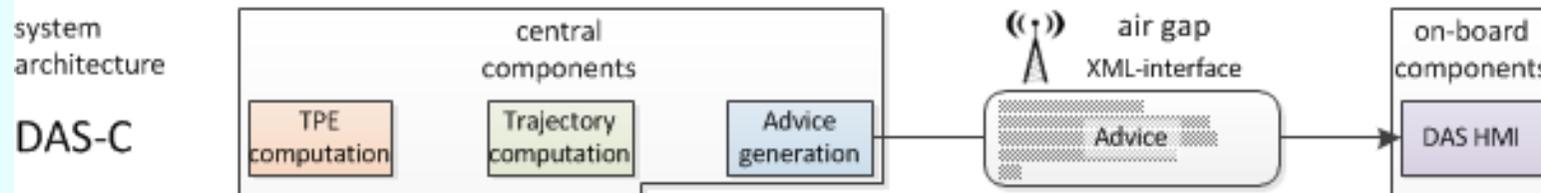


From DAS to CGTO

- Connect DAS to control centre → Centrally Guided Train Operation
 - Increased benefits on energy efficiency
 - guide trains approaching bottlenecks → decreased occupation times



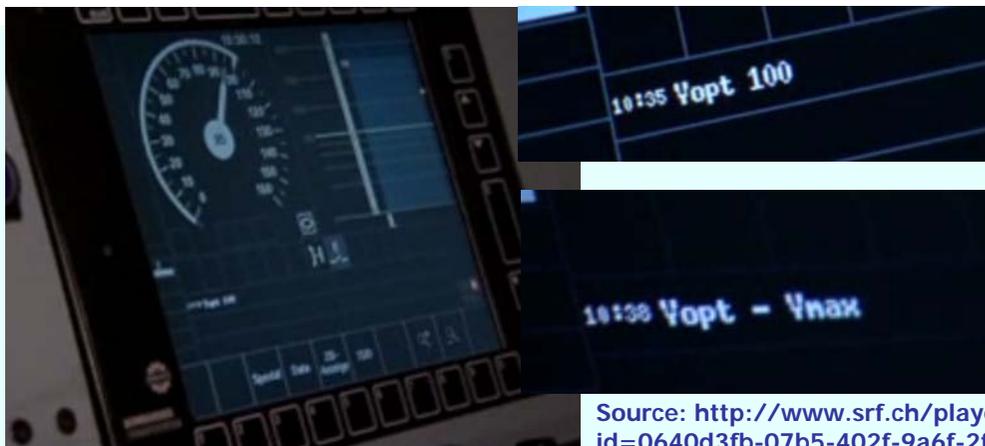
Alternative CGTO system architectures



CGTO-C: mainly central intelligence

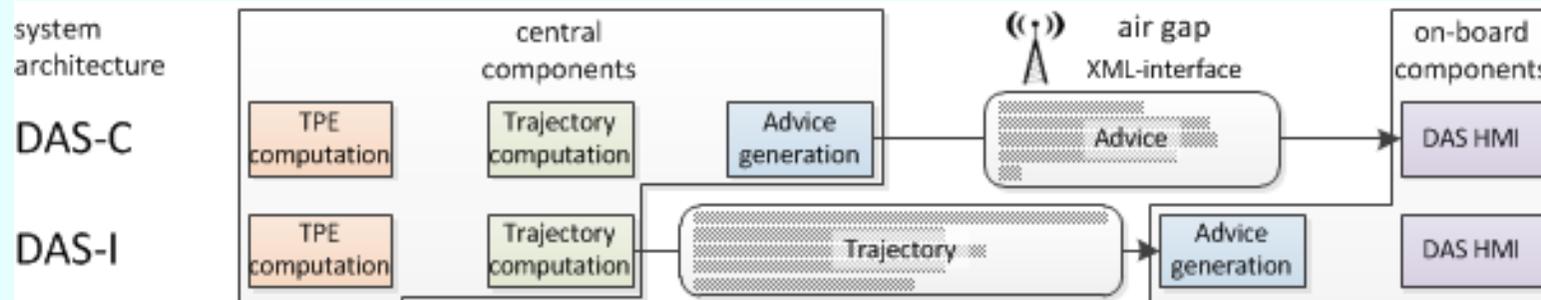
Idea: "least effort at on-board level"

- all computation in CU
- transmission of advice "ready to display" (immediately valid)
- OBU does NOT need GNSS, localisation reference or the planned train path data



Source: <http://www.srf.ch/player/tv/einstein/video/sparsam-durch-den-loetschberg?id=0640d3fb-07b5-402f-9a6f-2f9c9e099dcb>

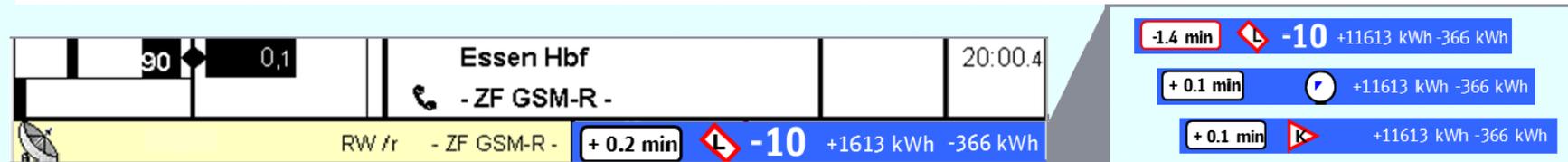
Alternative CGTO system architectures



CGTO-I: distributed intelligence

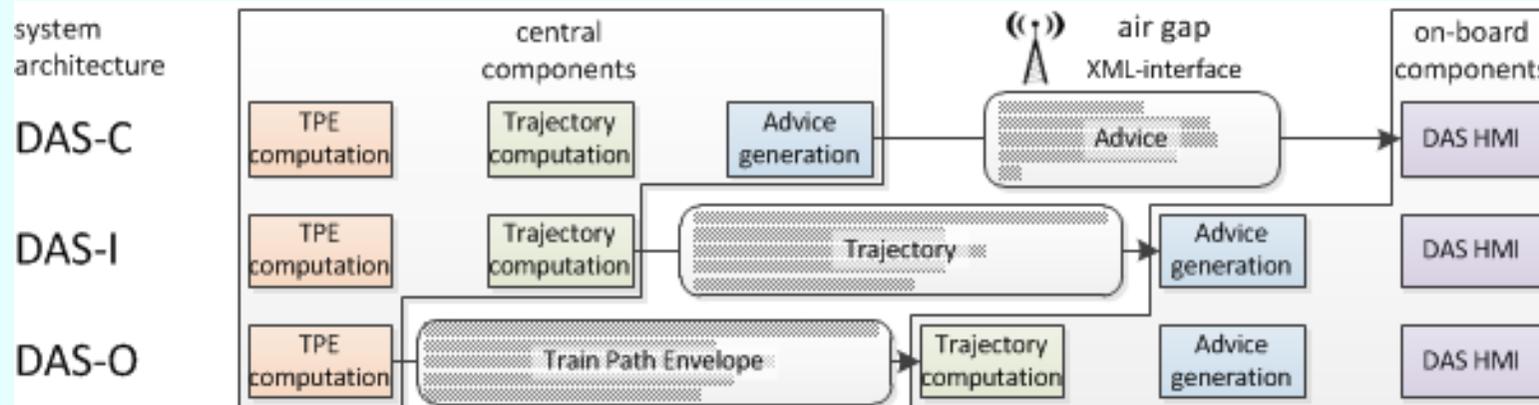
Idea: IM decides on trajectory, RU decides on advice (HMI)

- CU computes trajectory
- OBU computes the advice to meet the optimised trajectory best
- GNSS not required but useful for advice definition



Source: DB Netz

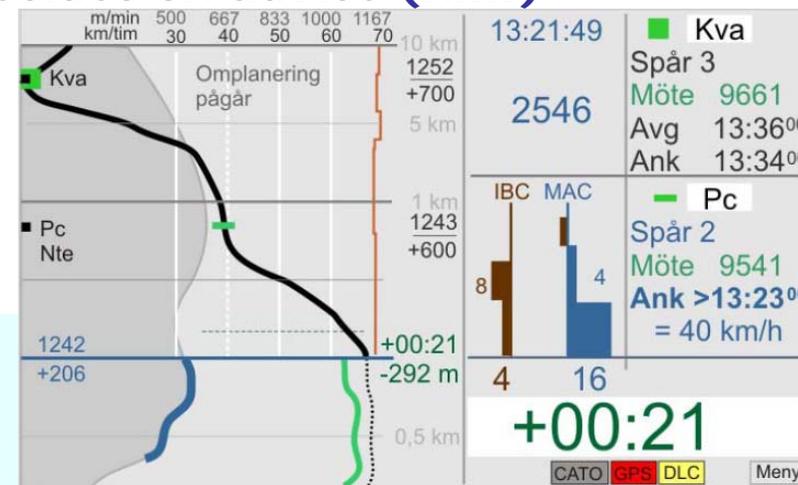
Alternative CGTO system architectures



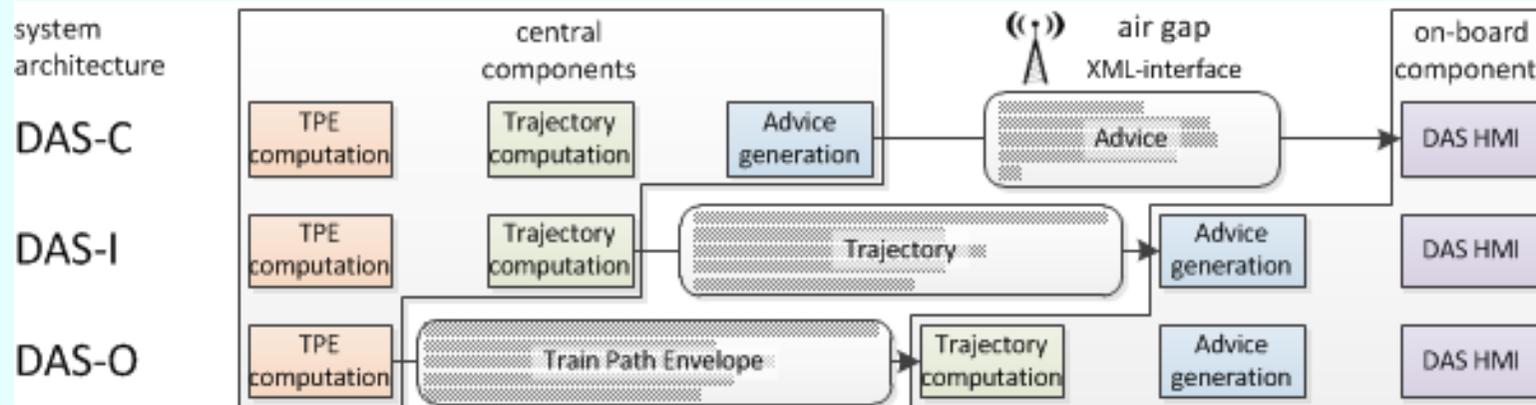
CGTO-O: mainly on-board intelligence

Idea: IM decides on trajectory, RU decides on advice (HMI)

- CU computes trajectory
- OBU computes the advice to meet the optimised trajectory best
- GNSS not required but useful for advice definition



Alternative CGTO system architectures



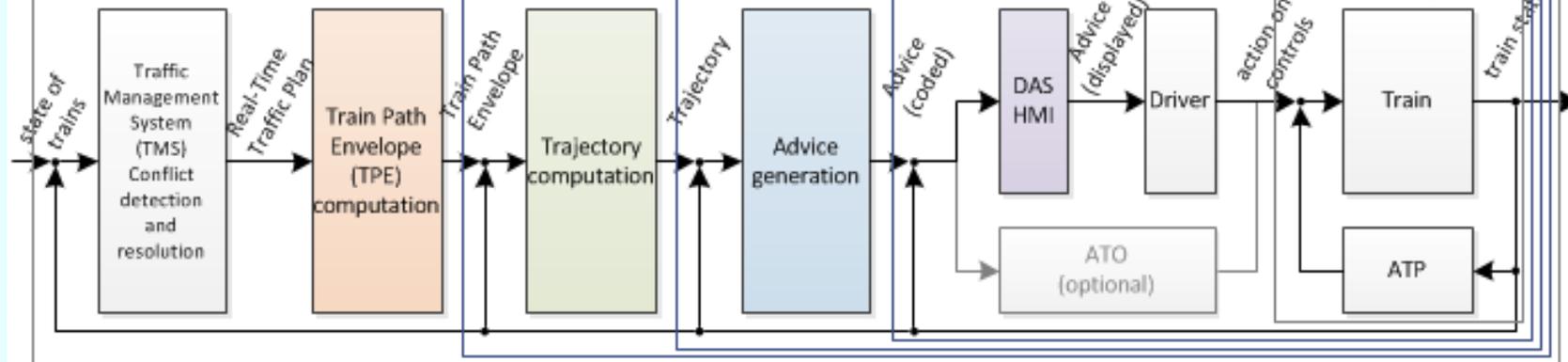
TMS control loop: determination of optimal time/space corridor for trains

DAS control loop I: determination of optimal speed profile within TPE

DAS control loop II: determination of tractive / braking effort

DAS control loop III: verification and implementation of advice by driver

ATP control loop



Alternative CGTO system architectures

Alternative	CGTO-O	CGTO-I	CGTO-C
investment in rolling stock	high	mid	low
RU influence on optimization	high	low	low
requirements on communication availability	lowest	medium	highest
messages	large but few	medium size and number	small and frequent

CGTO interface specification

- Standardized interface $IM \leftrightarrow RU$ is needed to ensure interoperability of CGTO
- Proposed interface:
 - XML-data formats
 - TCP/IP-communication
 - supports the 3 alternative system architectures identified
 - Handshake process defined to negotiate architecture
 - may be used between central and on-board components directly or between IM and an RU central server (in this case further distribution of messages RU task)
- IF-specification has been published (Deliverable D6.1)
- Java-implementation

HMI concept

- **Research and experimental implementation of HMI:**
 - **Advise type:**
 - target speed and coasting
 - others (time targets, energy targets) have not proven to be successful
 - **Additional information:**
 - Forecast (e.g. 2..10 km): recommended speed-distance-graph & most restricted speed profile
 - contextual advice: reason for (unexpected) advised speed/coasting due to other trains
 - at-station advice: planned departure, prepare for departure when time has reached
 - connection status (status of connection to GNSS / DAS CU)



ONT-WP06-I-UON-015-03_-_DAS_HMI_concept.mp4

Conclusions

- CGTO has the potential to increase operational efficiency
- Different system architectures may fit different operational conditions
- **ON-TIME proposes a standardized CGTO-interface specification (IM/RU) → deliverable D6.1**
- central element of HMI: speed advice
more recommendations on HMI → deliverable D6.2