RTIC 2014

TEAM
Tomorrow's Elastic Adaptive Mobility

Public transport optimisation

based on traveller requests and network efficiency

Angelos Amditis
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Contents

Topics of the presentation

TEAM IP: Mission and Timeline

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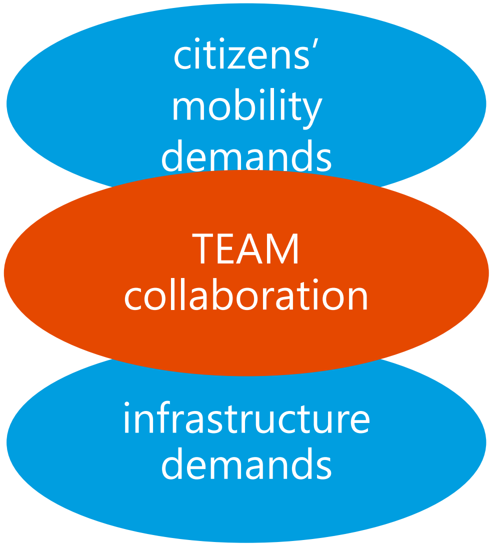
TEAM Tomorrow's Elastic Adaptive Mobility

Turn static into elastic mobility by balancing needs.

Collaboration is the key concept.

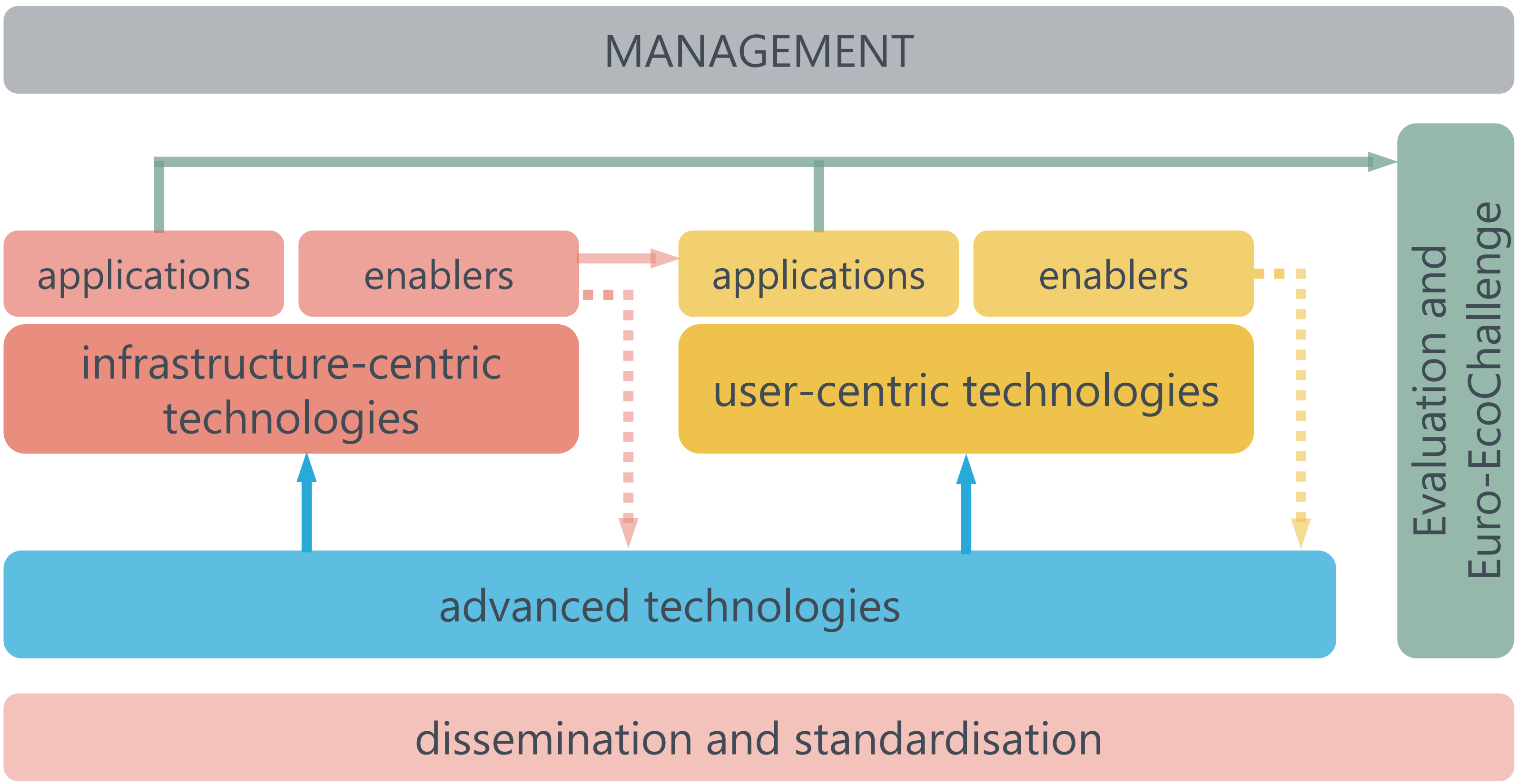
- ➢ It extends the cooperative concept of vehicle-2-x systems to include interaction and participation.
- ➢ Make travellers and drivers, vehicles and infrastructure act as a TEAM adapting to each other and to the situation.



Apr 13	Dec 13	Oct 14	Oct 15	May 16	Oct 16
Use cases defined	System requirements / System specification defined	Basic system and enablers integrated	TEAM applications integrated	Euro-EcoChallenge conducted	Exploitation measures agreed

Duration 48 months,
November 2012 – October 2016

TEAM IP: Workflow



TEAM IP: Consortium

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Automotive

BMW GROUP Research and Technology

CRF CENTRO RICERCHE FIAT

VOLVO

ICT

COSMOTE our world is you

DELPHI

intel

here

intel Intel Mobile Communications

TELECOM ITALIA

RE:Lab

NXP

NEC

Infra-structure

TORINO Tecnologie Telematiche Trasporti Traffico

infotrip

RAMBØLL

swarco SWARCO MIZAR S.p.A.

e-trikala

swarco SWARCO TRAFFIC SYSTEMS GMBH

Research

Fraunhofer FOKUS

CREATE-NET

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

TU berlin

ICCS

dısi: aıti: Daimler Center for Automotive Information Technology Innovations

Fraunhofer IAO

ELIOS

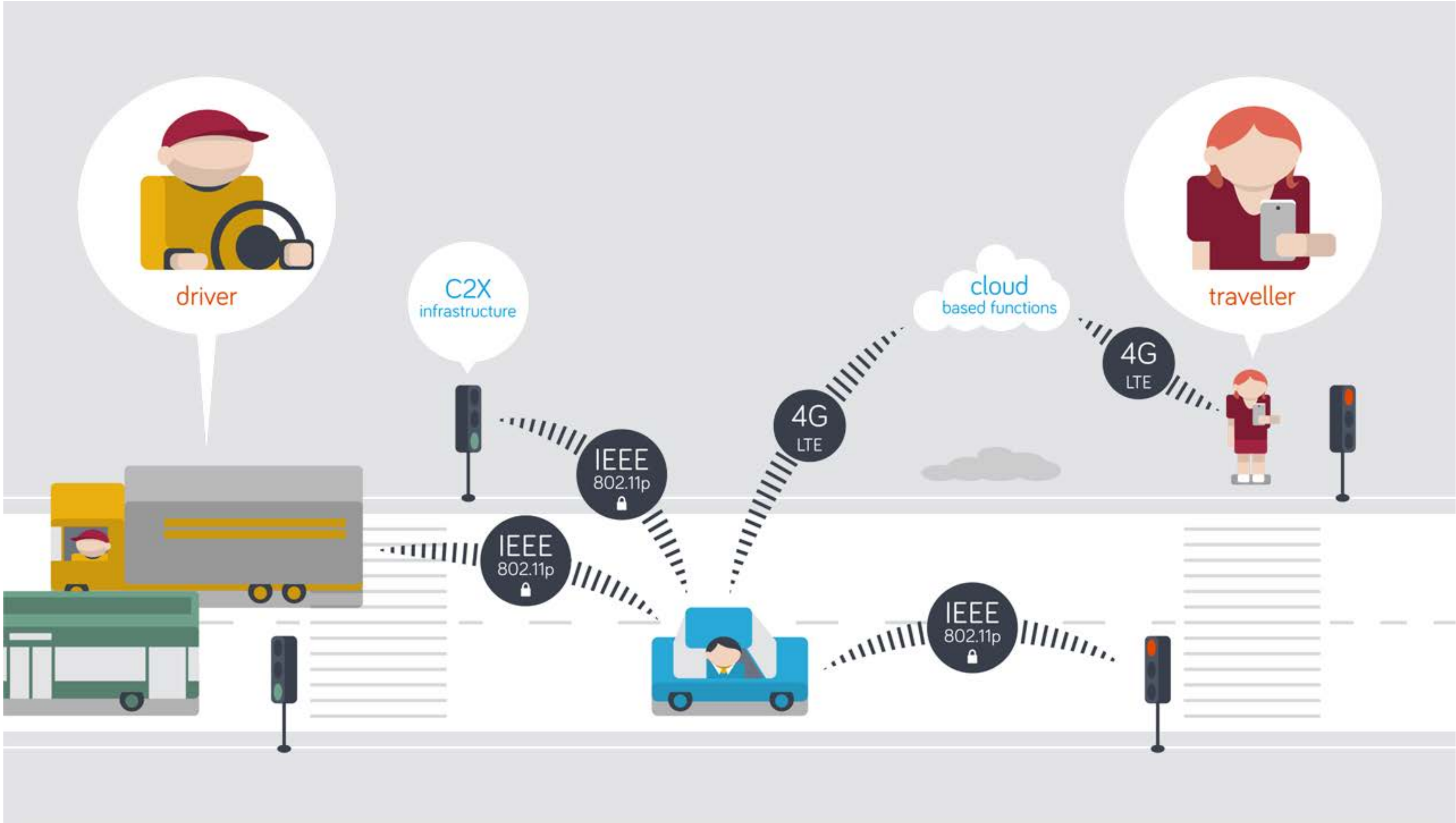
VTT

NATIONAL UNIVERSITY OF IRELAND MAYNOOTH

Other

eict

TEAM IP: Applications



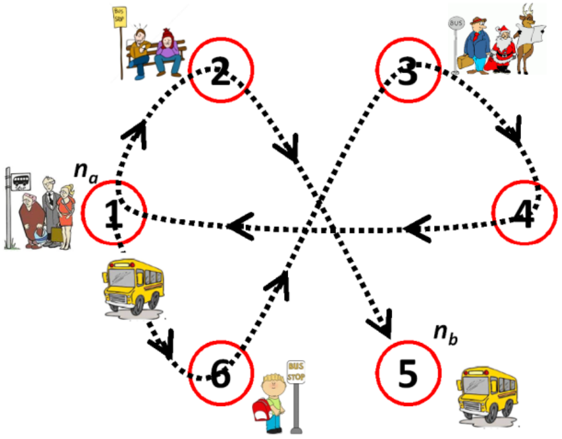
Introduction (I)

TEAM IP – Collaborative Public Transport Optimisation (CPTO)

- Introduce demand responsive transport solutions in authorised bus transport providers and higher passenger demand compared to existing DRT.

- Serve simultaneously passenger demand and the cities (optimisation of network efficiency, CO2 emissions reduction, minimisation of operator cost).

- Include innovative use cases, such as real time event based route adaptation and bus headway adaptation.



Testing:

1. Realistic simulation environment,
2. Real traffic conditions (in three European cities - under negotiation)

Introduction (II)

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Demand Responsive Transport (DRT) - definitions

DRT already in practice: *flexible routing and scheduling of small/medium vehicles operating in shared-ride mode between pick-up and drop-off locations according to passengers needs.*

Problem: *Dial-a-Ride Problem (DARP), which consists of designing vehicle routes and schedules for n users who specify pick-up and drop-off requests between origins and destinations.*

Quality of service criteria / control values: *route duration, route length, customer waiting time, customer ride time , difference between actual and desired drop-off times.*

DARP solution: *(1) determining clusters of users to be served by the same vehicle; (2) sequencing these users into a vehicle route; (3) scheduling pick-up, driving and drop-off activities along each route.*

Use Cases & Requirements

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CPTO Use cases:

1. Accident or traffic based route adaptation,
2. Event-based route adaptation,
3. Adding and/or skipping bus stops,
4. Headway adaptation,
5. En-route information to the traveller,
6. Pre-trip information to the traveller.

CPTO Requirements (summary):

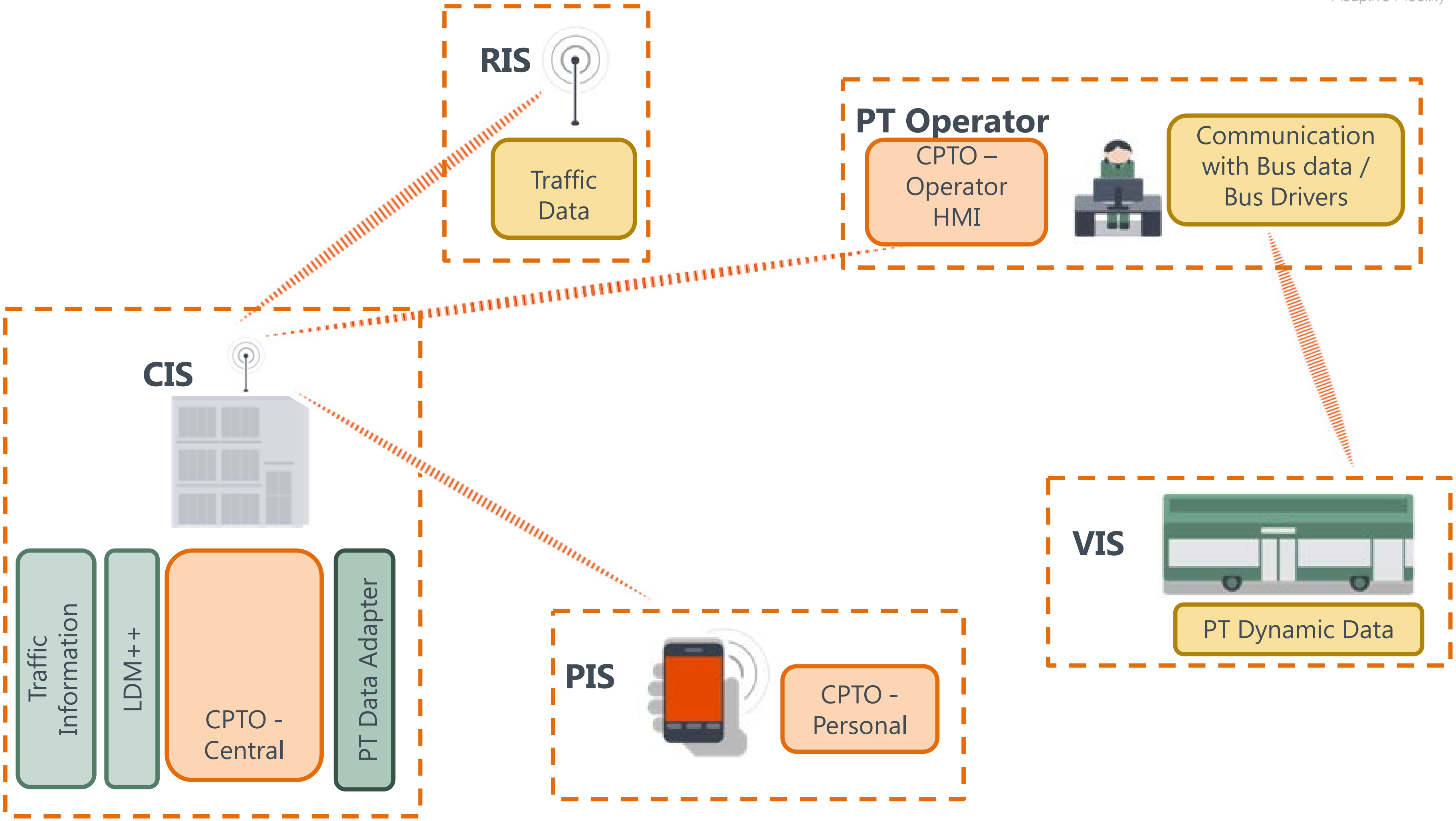
- **I/O**: user input data and presentation of information.
- **Data**: real-time access to PT data and road traffic conditions.
- **Communication**: Connectivity with end-user, PT operator, and road operator.
- **Processing**: Affected bus routes, Alternative route calculation, Public transport stops handling, PT data adaptation, Bus speed recommendation, Bus stops recommendation, Scheduling in case of an event, Headway adaptation, Traveller to bus association, Real-time information to the traveller.

CPTO: Concept

i) Receive as input: (a) traffic congestion data, (b) traveler data, (c) public transport static and dynamic data
ii) Compute: (a) the optimal bus routes and timetables, (b) suggested bus speeds per line, according to some predefined criteria on delay, pollution and costs.
iii) Communicate them to the Transport Operator, who takes the final decision, informs bus drivers and sends decision back to CPTO .
iv) Communicate the final outcome to the registered travelers mobile devices in terms of waiting time in bus stops customized to their trip.
v) Updates dynamic public transport data in LDM++ and CPTO-DB.

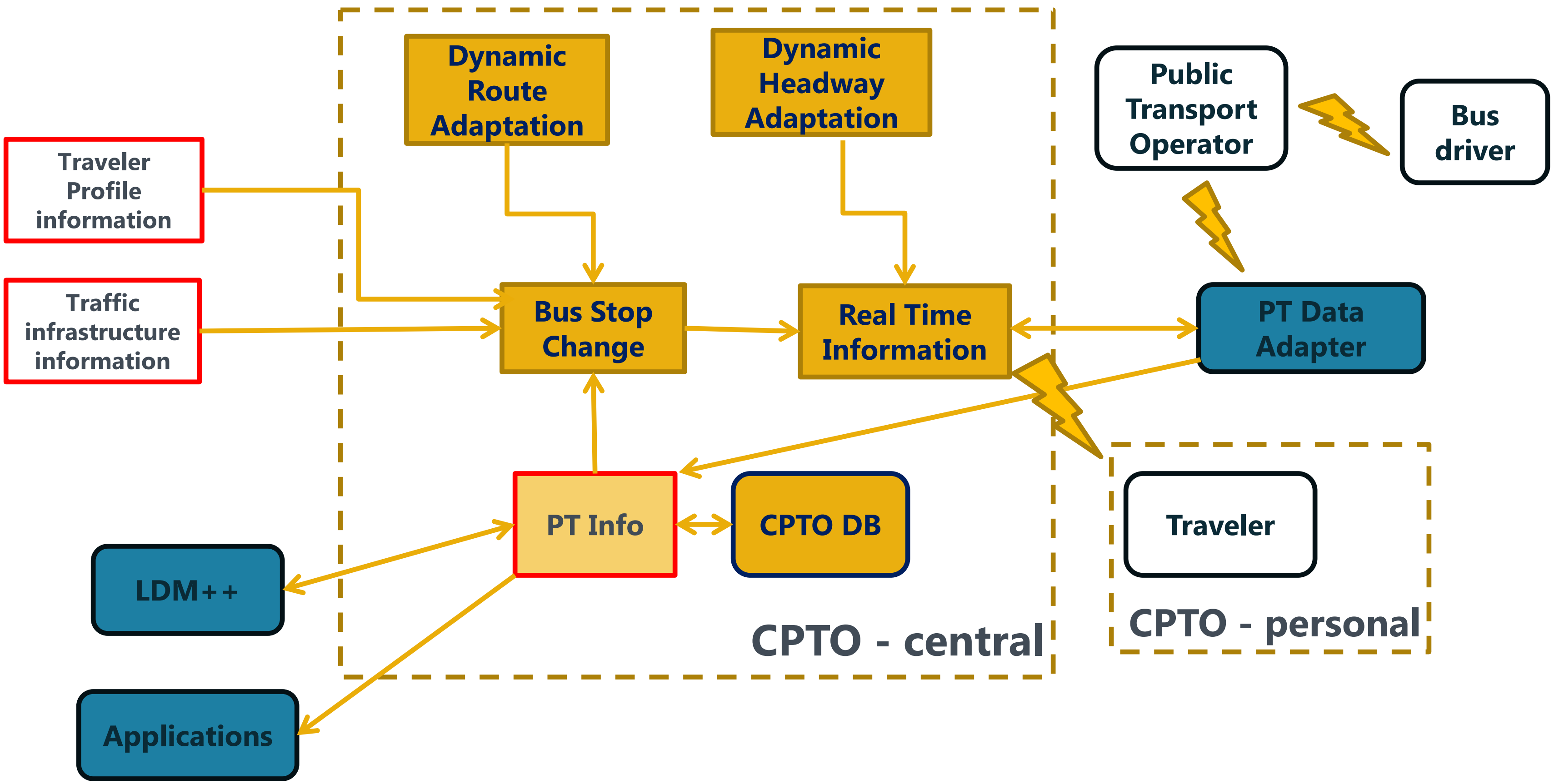
CPTO Architecture Overview

Using ITS: Communications Architecture standard ETSI EN 302 665 V1.1.1

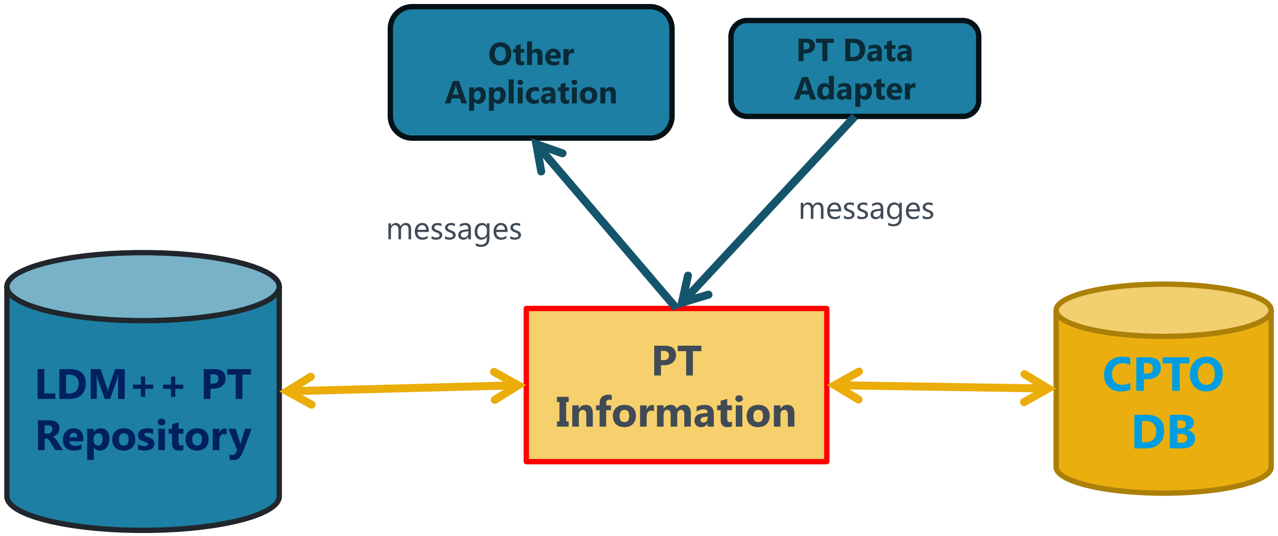


Components & Interactions

Internal (CPTO) & External (TEAM) components



Public Transport Data



Per Road Segment ID:

List of Bus Stop Locations

Per Bus Stop:

- Location

- List of Bus Lines

Per Bus Line

- Arrival Times

Per Running Bus:

-Road Segment ID

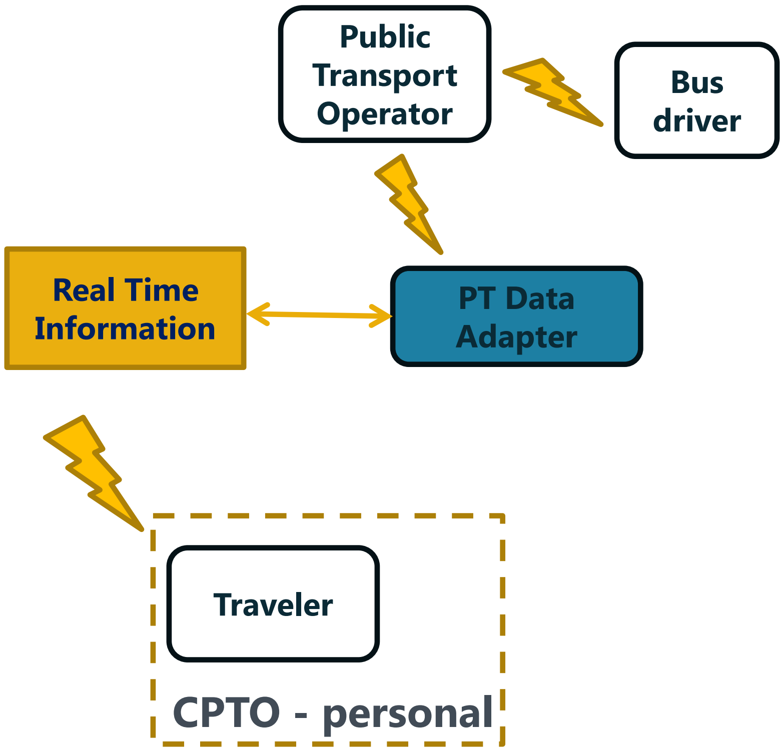
-Position coordinates

-Route (Graph of Segments)

-Array of Bus Stops

- Bus passenger load

Communication: PT Operator & User



Real Time Information

to **PT Operator**

Input: PTO requests, Bus specific data (position, load, speed).
Output: New bus stops sequence/route for running buses. Suggested speed for buses. Suggested departure times from stops.

To **Travelers**

Input: Traveler demand
Output: New bus stop timetables. PT means suggestion. Information on changes. Traveler-Bus association.

Algorithms - Dynamic Route Adaptation / Bus Stops Change / Bus Headway Adaptation

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Dynamic Route Adaptation:
Plans and dynamically adapts the route of a Bus of interest.
Input: Traffic situation, PT data, events- accidents-blockages of roads.
Output: New suggested routes for Bus.

Bus Stop Change:
Recognizes problematic situations and adds or skips bus stops.
Input: DRA suggested routes, Traveler demands, Operator request for investigation.
Output: New Bus Stop Sequence. Calculation of Bus arrivals. Calculation of problematic timetables.

Bus Headway Adaptation:
Dynamically adapts the distance between the buses performing the same routes.
Input: Traffic situation, PT data.
Output: Suggested speeds/departure times for running buses.

Algorithm - concept

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OBJECTIVE

- Computing the optimal path p^* for the Dial-A-Ride Bus that jointly minimizes:
  - *i)* the total waiting + travel time for all passengers
  - *ii)* the environmental cost of the trip

$$\text{optimal path } p^* = \arg\min_{\text{path } p} \sum_{\text{person } k} \text{arrival time } T_k(p) \; + \; \gamma \sum_{\text{edge}(i,j)\in p} \text{environmental cost } c_{i,j}$$

- Road network is modeled as weighted graph - nodes (possible bus stops).
- Each edge has weights (time to travel along) and cost (e.g. emission or other).
- Time $T_k(p)$ for traveller k to reach intended destination, depending on bus path p.
- Optimal path between the selected nodes determines univocally the optimal succession of stops p^* that the on-demand bus has to follow.

Progress & Next Steps

- Within the TEAM framework, selected CPTO Use Cases will be integrated and demonstrated in real time urban conditions in Pilot Sites while others in Simulation.

- Bus On Demand algorithm has been tested on a realistic scenario in the city of Dublin, with use of pollution cost functions.

-Real time implementation is in progress (Android mobile application for passengers) and a central server (that collects passenger and bus fleet data and runs the algorithms - optimization and passenger routing)

Thank you!

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ICCS

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