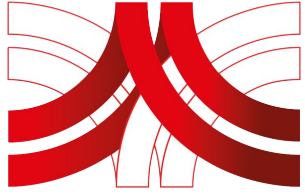


ASECAP DAYS



ISTANBUL 2023

Celebrating
YEARS
50
OF Successful
TOLL ROAD PROJECTS

A **GRAPH DB TECHNOLOGY** APPROACH
TO IMPLEMENT HIGHLY PERFORMATIVE MINIMAL
ROUTING ALGORITHM FOR TOLL PRICING AND
TRAVEL TIMES PROCESSING

Alessandra Lazzari
Autostrade per l'Italia

Hosted by

ICA

YAVUZ SULTAN SELIM BRIDGE
AND
NORTHERN RING MOTORWAY



ASPI Digital Transformation Process

Autostrade per l'Italia (ASPI) has started a **Digital transformation** process since **2020**, aimed to:

- digitalize 75% of its own application asset,
- move data center towards cloud platform allowing dynamically scaling needs,
- reduce the environmental impact thanks to a decrease of IT resources and the computational time.

This migration has been carried out using an **Agile approach** with a strong **cooperation** between **IT team** and Product Owners from different **Business Units**.



New business needs in a fast-evolving scenario

Business needs versus Pain Points

Business needs:

- Developing **near real time services** for drivers
- Managing the **increasing amount of information**
- Supporting **heterogeneous business domain**
- Reducing computing resources and costs

Pain points:

- Delayed **data availability**
- Increasing **computational time**
- Growing need of **computational resources**
- Complex data **model**



New technologies in a digital environment



ITALIAN TOLLING CONTEXT

Italy has the **longest closed system** in Europe.

Around **6'000 km** of interconnected toll motorways, managed by several Company (around **25 Concessionaries**).

Toll fee is paid without acknowledging the different company competences

ITALIAN TOLLING CONTEXT - FIGURES

441 toll stations

528 nodes (including toll plaza and branching road intersections).

Around 200'000 minimal trips allowed interconnecting all those toll stations.

Around 1.3 million alternative trips, so multiple possible route for the same origin to destination*.

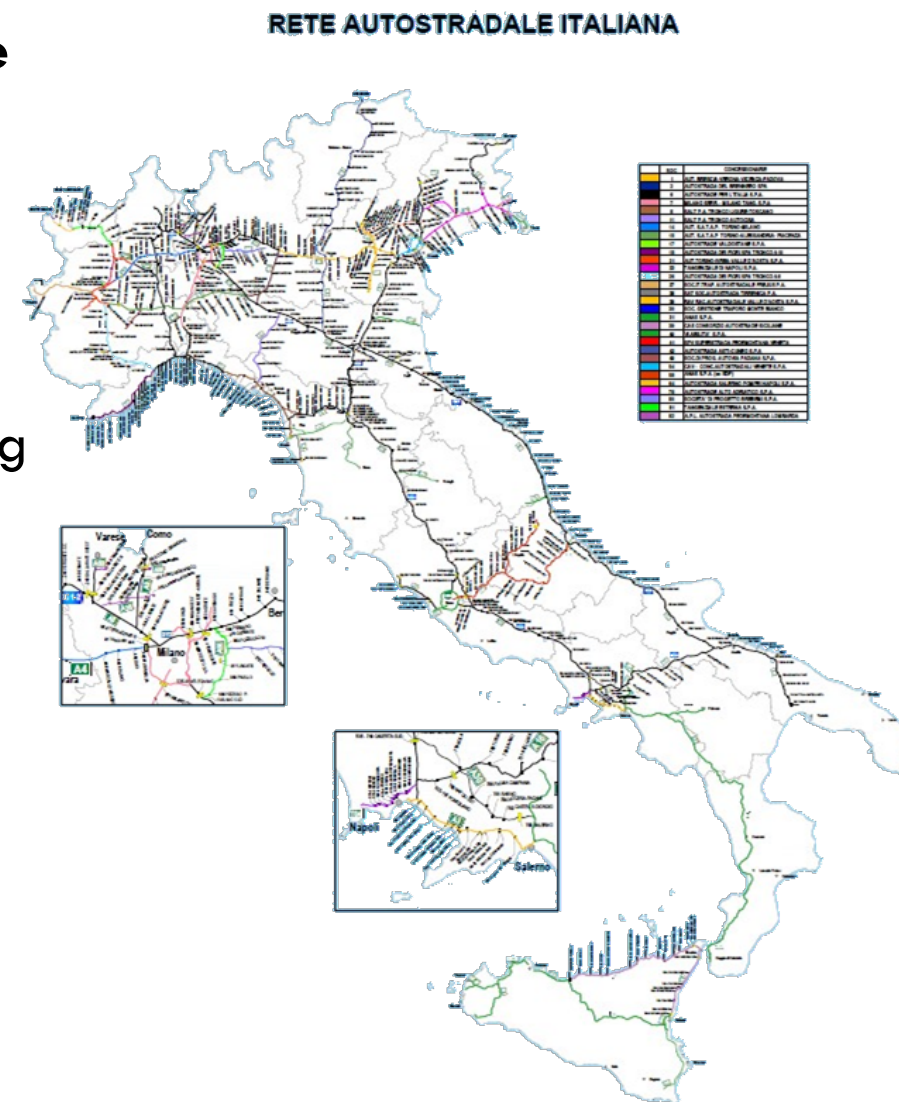
*considering only those deemed feasible according to the distance rules.

ASPI role in the Italian Tolling Context

According to the current law, **vehicle is charged for the minimal route allowed.**

In particular, **ASPI** is in charge of:

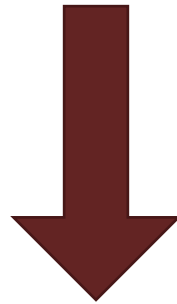
- managing **italian motorway network** master data and updating them according to network infrastructure changes, (opening of interconnectione, stretches, toll plazas etc)
- **calculating toll tariffs** for all the Italian interconnected Concessionaries
- **share** them among the **different Companies**



Aspi Legacy System

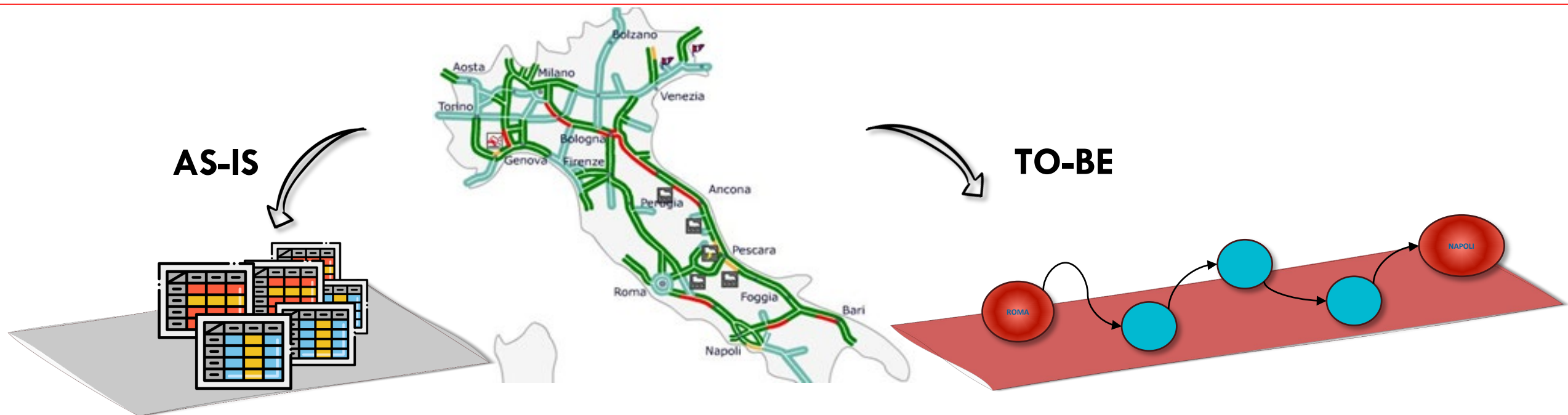
The **legacy system**, used in ASPI for 30 years, was based on traditional IT approach:

- a **relational database** representing the motorway network model
- **algorithms** requiring **complex batch** computing
- huge **usage of resources** for time consuming processes



A transition to a **new digital representation** of the motorway network was **needed to enable** real time algorithm instead of batch computing on a relational database.

A new motorways network representation models



AS-IS

TO-BE

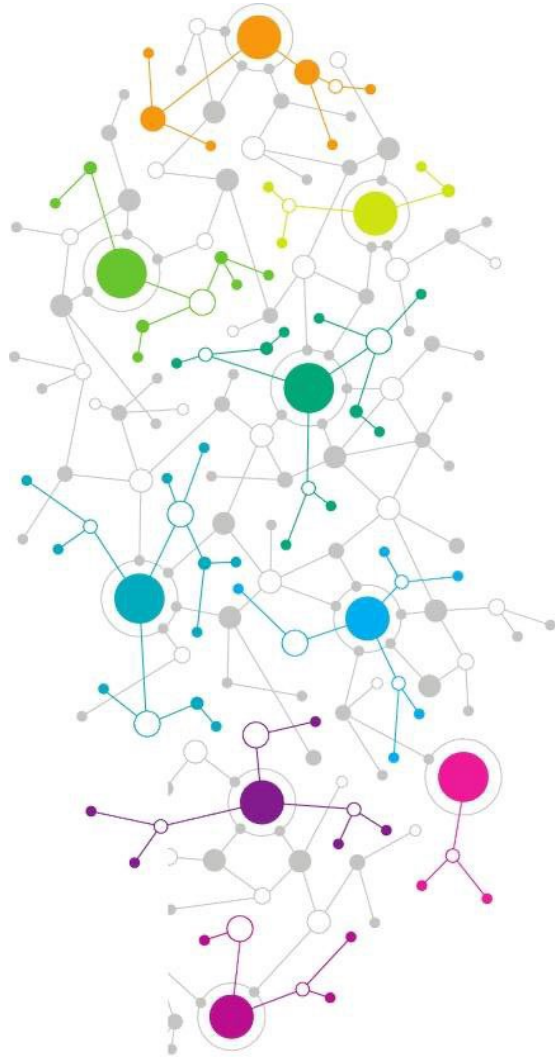
RELATIONAL DATABASE

- Tables based
- **Data duplication**
- High complexity in data research and computing
- **Low flexibility in modelling new business scenarios**

GRAPH DB

- Technical **model** much **closer** to the **physical** one, based on arches and nodes to represent and store data
- **No data duplication**
- **High flexibility and scalability** to manage **new business scenarios**

Graph-DB Features



- **Graph-DB**, based on **graph theory**, is a **powerful technology** able to:
 - **maximize the value** generated by **data** having **strong relationships**
 - **saving** lots of **computational costs** and **timing**
 - highly performing to **enable new services** which require real time data access
- Thanks to **GRAPH_DB features**, ASPI has implemented performative algorithms on heterogeneous domains for:
 - **Toll tariff** calculation
 - **Travel Time Estimation**

Use case: Toll tariff calculation

Toll tariffs are **generated** at least **once a month**. Each time several simulations are performed before issuing the final version

The new solution features the following significant advantages:

- Once the graph is updated , for any specific trip the new toll fee can be immediately made available (no batch precalculation needed) throught a provided API
- The overall calculation can be scheduled with a significant resource savings in terms of:



- **time reduction** (from 4 hours to around half an hour for each cycle)

- **hardware** decreasing



- **Manual Activities** (i.e. **Operatos** involved in the **process monitoring**)



Use case: Travel Time Estimation

Travel time estimation was migrated to a **real time on demand service**;

The new solution features :

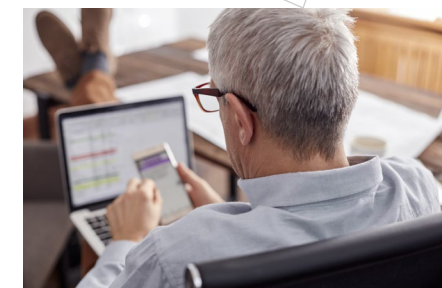
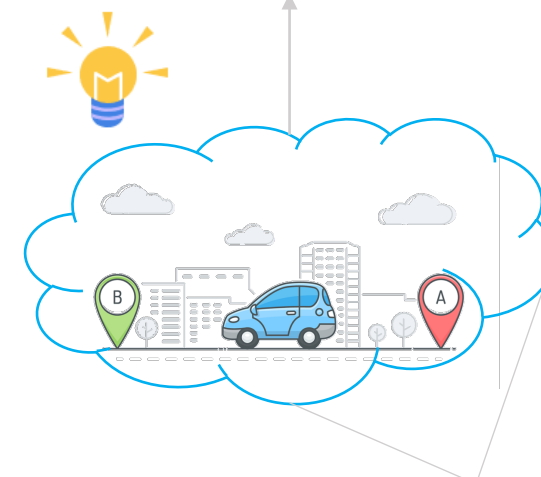
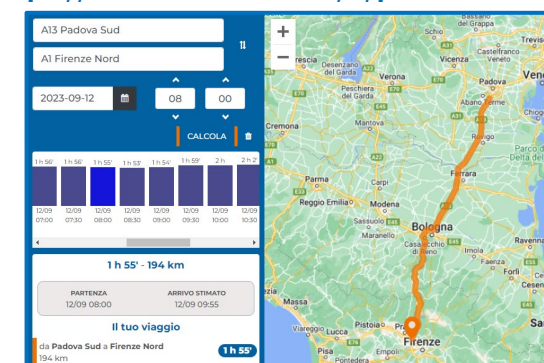
a **NEW ENRICHED GRAPH** created for **estimated travel time calculation**,
 on any **minimal route** of all the possible **O/Ds**,

Avoid the need of precalculatipn of all the estimations for all the possible
 O/Ds by means of a **time consuming daily batch**.

Using a **real time Service** to get **on demand estimation** for a certain route
 allows ASPI to:

- **reduce computational time** and **resources**
- **update TT** according to those **unpredictable events** that might occurs
 affecting the estimation (accidents/ weather condition variation etc)
- **compare with alternative route travel time**

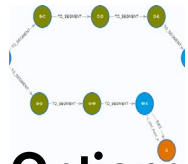
<https://www.autostrade.it/it/previsioni-traffico>



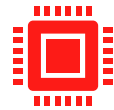
CONCLUSIONS



Further applications are under development for Traffic Management and tolling Services



Optional alternative routing used as a basis FOR real time travel times evaluation services.



Several other services will follow with the aim of enhance time responses



Reduce processing resource consuming



For a more sustainable environment

THANK YOU

Alessandra Lazzari

alazzari@autostrade.it

Autostrade per l'Italia