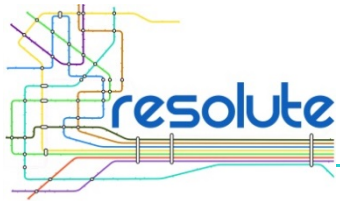**Interactive Workshop and Training on**

European Resilience Management Guidelines

Athens, 19 October, 2016

Attiko Metro (host) and the Athens Pilot
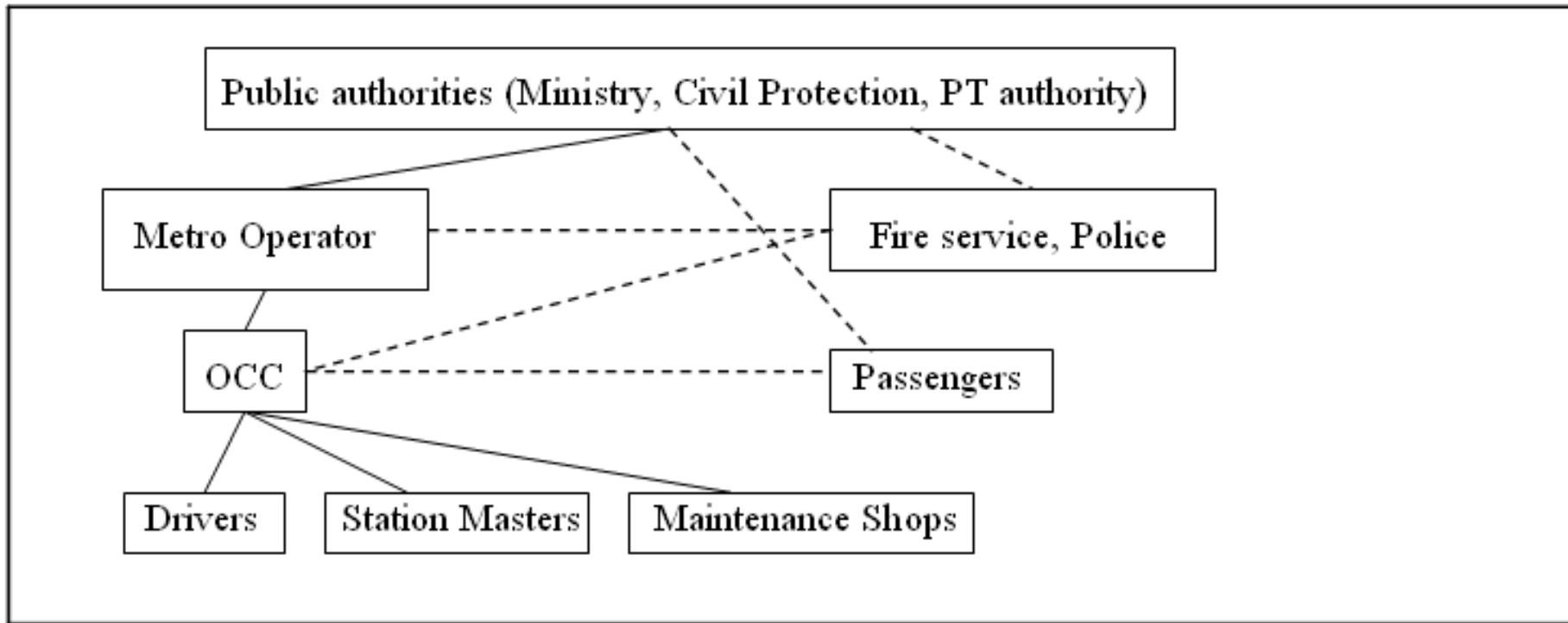
Dr. Alexandros Deloukas, Attiko Metro S.A.
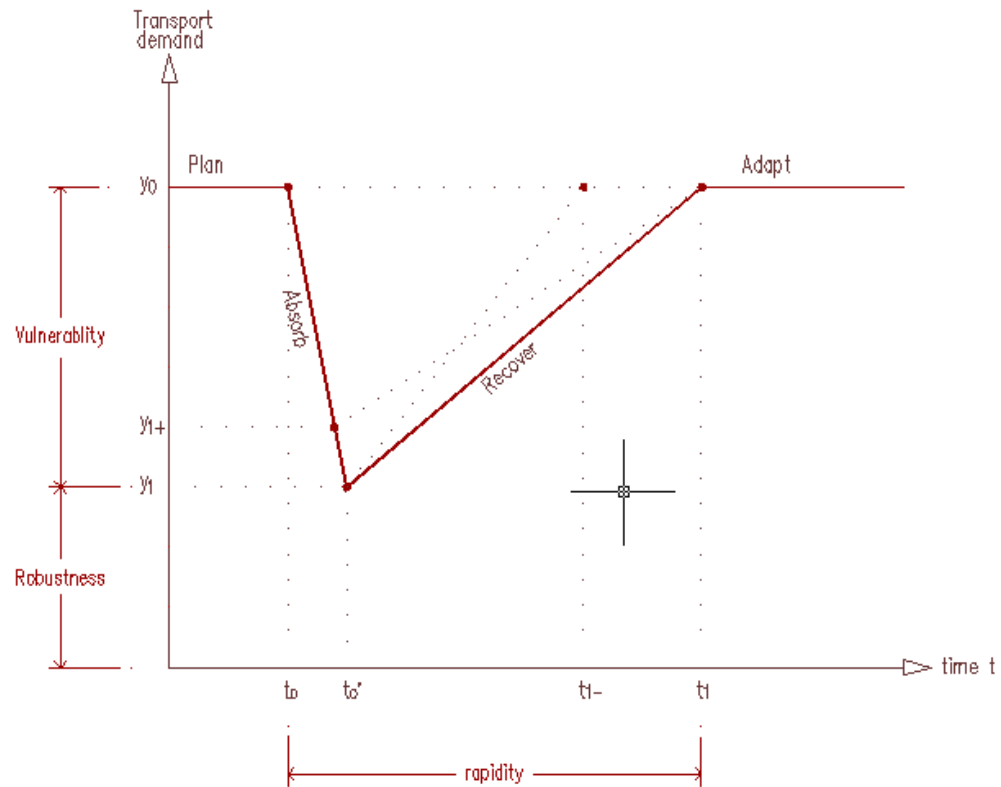Efthymia Apostolopoulou, Attiko Metro S.A.

Classification of incidents

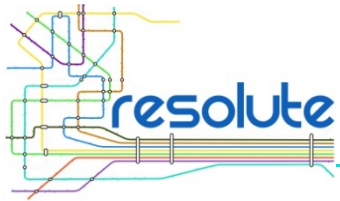| Incidents	Accidental (safety-related)	Man-made
endogenous	technical failures	strikes
exogenous	natural disasters	terror attacks

Metro Emergency Preparedness

Stakeholder Coordination Diagram

Life-cycle Stages of Resilience

Emergency Rules and Procedures in the Athens metro network include i.a.

- OCC response to incidents
- Fire fighting
- Train evacuation in tunnel
- Bomb threat
- Controlled smoke channelling with ventilators
- Station evacuation
- Major incidents
- Bomb blast – gas attack

Drill exercises

- *Fire Drill Plan* Its general purpose is to address fire incidents in metro stations and also to evaluate and improve capabilities and cooperation between Fire Service and the supporting agencies involved (General Secretariat for Civil Protection (CP) and its Operational Centre 199 SEKYPS, Region of Attica CP, Police (GADA), EMAK Rescue Team, EKAB first aid and hospitals).

  According to the exercise, a fire breaks out in a train entering a station, on the platform level.

Emergency Communication Plan

It has to support communication procedures within the metro network as:

(1) Preparation of communication plans per eventual incident;

(2) Coordinated representation, aiming at providing the absolutely necessary confirmed facts, for informing the public in real time;

(3) Introduction of procedures to be notified to the stakeholders involved and be readjusted after drills;

(4) Preparation of a common vocabulary to be utilized by the communication section personnel

(5) Immediate and valid information, as far as the spokesperson is concerned.
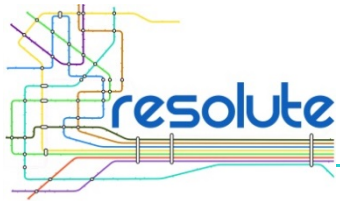
- Athens Transport System
  and Metro Lines 2 and 3

- Metro Risk Scenarios

Athens Transport System / Metro Lines

- Athens: 3,812,350 inhabitants (2011)

- Car ownership rate: 384 cars/1000 inhabitants (WWF, 2014)

- 6.5 mi daily trips

- Modal split
  - Car & other private transport 38%
  - Public Transport 34%
  - Other 28%

Athens PT System - Metro Network /Thermal Bus Depots
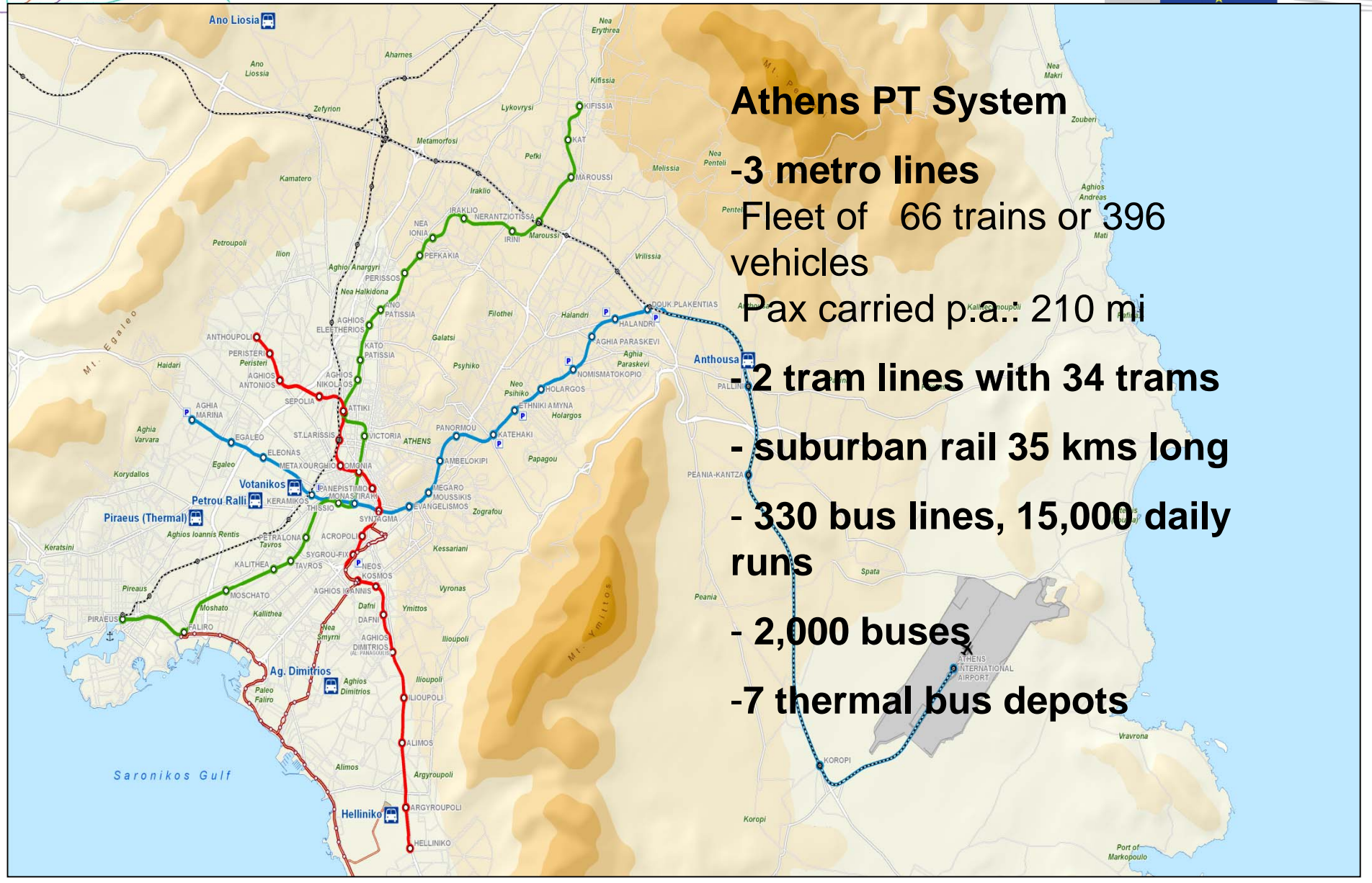
Athens PT System

-3 metro lines
Fleet of 66 trains or 396 vehicles
Pax carried p.a.: 210 mi

- 2 tram lines with 34 trams

- suburban rail 35 kms long

- 330 bus lines, 15,000 daily runs

- 2,000 buses

-7 thermal bus depots
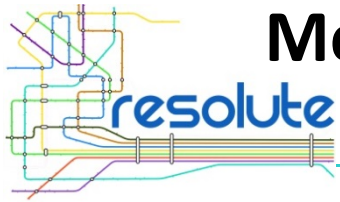
Metro Attack: System Interdependencies / Cascading Effects

- Metro infrastructure damage

  - ➢ Full or partial closure of lines for a period of time
  - ➢ Event. power substation failure

  - Public casualties in situ

  - Socio-psychological damage (stress/anxiety/worry/fear) of the wider Athens population

  - Event. telecom break down → emergency response delay

  - Road traffic congestion due to sudden modal diversion

  - Economic and business losses

- **MAR = Threat x Vulnerability x Consequences**

  ➢ <u>Threat</u> probability of an attack: threat is an external force acting on metro system. Threat is a rare event, highly uncertain and is a matter of intelligence

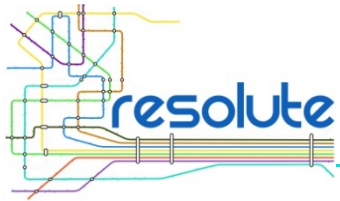 ➢ <u>Vulnerability</u> = probability that a damage occurs given a threat (=f [level of security], eg. station design, network topology, CCTV surveillance, intrusion detection sensors and factors mitigating vulnerability)

  ➢ Vulnerability is a property of metro systems and is a matter of engineering & science

  ➢ <u>Consequences</u> = severity of damage given a successful attack and the occurrence of damage (=g [level of preparedness], e.g. training, drills, fast emergency response and factors mitigating severity)

- MAR assessment pertains to expected consequences of intentional attacks (bomb blast, CBRN incident)

- Reduction of expected consequences of an attack reduces MAR and increases the resilience of the system

- Resilience resources for MAR reduction could be allocated according to targets' MARs.

  Risk management deliberations are requested, whereas multiple scenarios of threats, vulnerabilities and consequence measures are helpful in this respect.
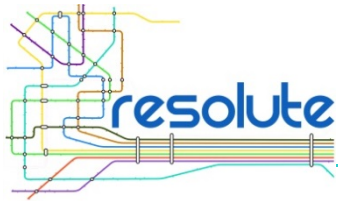
- Planning to absorb attack consequences - emergency preparedness for the reactive phase
- Post-attack: full or partial closure of affected lines

- Multi-objective target function:
  - minimize service degradation during disruption
  - increase robustness of the transport system as a whole

  - Post-attack metro ridership reduction $\Rightarrow$
  → bus bridging of closed stations retracting spare buses from proximal depots and scheduled bus lines (if not already running parallel services)
    $\Rightarrow$ modal substitution of disrupted metro service
    $\Rightarrow$ critical drivers: geographical extent and
                       duration of connectivity loss

  → congestion in the road network, especially during peak periods $\Rightarrow$ TDM resilience strategies: temporary interdiction of SOV use, extent of bus lanes, toll lift, VMS re-directions, smart

  - Static Resilience Predictor: $$SRP = 100 \times \frac{\text{ridership covered due to modal substitution}}{\text{metro ridership reduction due to attack}}$$

Metro Disruption Scenarios

- <u>Critical targets</u> : - interchanges of approaching line branches
  - maximum load sections - service section connecting lines
  - track sections leading to train depots
  - OCC
- <u>Bus bridging strategies</u> a. metro - bus - metro   (2 transfers)
  - b. metro - longer bus leg   (1 transfer)

- Use of the Athens Transportation Model of ATTIKO METRO
  - <u>Target function</u> : maximize transport capacity of modal substitutes
  - Heuristic, successive iterations for the design of bus bridging routes and frequencies (<u>constraints</u>: # of spare buses, min. frequency, shortest paths)
  - Allocation of buses to proximal depots (7 bus depots)

- Differing scenarios of network connectivity losses
- <u>Criteria</u> : road corridor topology vs. metro network topology   (Western suburbs less served by radial arterials, i.e. more vulnerable)
- <u>Preferred substitute modes</u> : - <u>bus</u> : ex-metro commuters, flex work
  - <u>car</u> : occasional users, rigid activity schedules, higher income

- Dynamic understanding of post-attack travel demand (perspective of the user behaviour)

- Target function :   - shorten recovery time to pre-attack demand level
                        - reduce perceived risk by adaptively minded travellers

- Rapidity ("end") of emergency response/ investigation/ technical service restoration based on resourcefulness ("means")   → open communication to gain trust, specific and credible information, convergent expert testimony, confidence-building media coverage. Motto: "we are not frightened" → reduction of perceived risk (fear erosion) for a metro attack

- Perception of risk = cognitive judgment + affective judgment of risk

  ➢ cognitive dimension : estimated risk vs. Willingness-To-Accept risk
     (→ Stated Choice survey)
  ➢ affective dimension : feared of attack

- Dynamic Resilience Predictor: Risk Perception Index
                        - RPI as predictor of resilient travel behavior
                        - Public response and Stated Risk Perception survey

Metro Resilience Indicators
Dynamic Resilience - 2

- <u>Test Hypotheses</u> : - Post-attack alteration of metro demand due to varying fear level is stronger for discretionary travel than for compulsionary travel (commuting)

  - Persistent alteration of travel behavior in the mid-/long-term is significantly lower than the short-term one (rate of alteration?)

- <u>Target function</u> : - maximize switch of fearful to worried or simply concerned population (say: 10/90 target ratio, SLOVIC 2009)

- <u>Need for explanation</u> - NY 9/11/2001 & London Tube 7/2005 : perceived risk > WTA risk threshold → significant drop of demand on attacked modes → <u>less</u> resilient behavior

  - Madrid 2004 & Tokyo 1995: perceived risk < WTA risk threshold → no drop of demand on attacked modes → <u>more</u> resilient behavior

  - Predictors of differing dynamic resilience?

  - How would Athens behave in a similar attack?

- <u>Perceived risk scenarios</u> : - Along with stated WTA survey and hypotheses test results, estimation of <u>rate</u> of demand recovery (= dynamic resilience)

  - Simulation of low vs. high WTA risk scenarios

Resilience Functions

ANTICIPATE

- Develop strategic plan
- Manage financial affairs
- Produce Risk Assessment
- Plan service delivery
- Define procedures
- Manage public behavior
- Install/Maintain infrastructure
- Train staff

MONITOR

- Monitor safety/security
- Monitor operations performance

RESPOND

- Restore/repair operations
- Respond to emergency

LEARN

- Keep operation records
- Adapt according to historical emergency/ risk data

Validation of ERMG
for Athens Metro 1/3

ANTICIPATE

| **Perform Risk Assessment**	RESOLUTE identifies (beyond existing Operating Plan) risk consequences of attacks as well as vulnerabilities of the metro system in Athens
Manage awareness & user behaviour	A very central contribution of RESOLUTE is the assessment of users' resilience in terms of traveller behaviour after a metro attack. A use (sub-case) will assess the WTA attack risks by the Athenian population. Ways of reducing perceived public risk and increasing the trustworthiness of the UTS will be demonstrated. Communication spots, mass alerts & bulk SMS raising public awareness are parts of the advanced strategy. A novel dynamic process KPI for user resilience is to be developed.
Develop/ update procedures	Operating and routine safety rules & procedures serve prevention & avoidance functions during metro service provision. Emergency rules & procedures serve response & abatement functions in case of severe incidents. Athens metro updates on a regular basis such procedures. ERMG UTS Guidelines will contribute in this respect.

MONITOR

Monitor user generated feedback	RESOLUTE will contribute to a crowd sensing approach in the Athens case (e.g. via geo-located tweets). Unstructured contents have to be automatically aggregated and validated in semantic terms before/during/after an incident. All bi-directional communication channels (internet, smart devices and mobile phones) are useful in this respect. RESOLUTE game-based training complements the picture.

RESPOND

Restore/ Repair operation	A very central contribution of RESOLUTE is the development of a Pre-event Recovery Plan for the Athens UTS in case of a catastrophic metro attack. The focus is on the short-/mid-term recovery of UTS through the use of alternative modes (e.g. bus bridging). Line closure scenarios and retraction of vehicles (based on SLAs to be developed) will be modelled as a further use (sub-case) by means of the multi-modal Transportation Model owned by ATTIKO METRO. Static resilience KPIs for demand recovery/transport capacity restoration are estimated
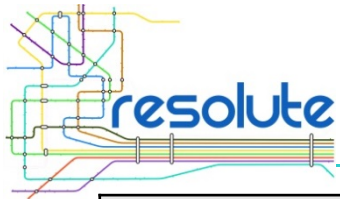
LEARN	
Collect event information	Static as well as real-time data are collected in the process of the everyday operations of the Athens UTS (historic traffic figures, PT telematics and smart card transactions etc.) Tools provided by RESOLUTE will improve the informational state.
Provide adaptation & improvement insights	Protocols and de-briefing of regular drills, exercises and 'what-if' scenarios is a common practice in the Athens metro. Customer complaints are categorised and considered for everyday operations improvements. RESOLUTE will improve the overall adaptation.