Tools and Operational Data Available

Athens Transport – Tools and Operational Data

- Operations Control Center (OCC): mimic panels, operations modi (full, downgraded, manual)
- Metro Security Systems: sensors for intrusion detection, CCTVs for surveillance
- Traffic Management Center (established for the Athens Olympic Games in 2004, operation 24 hrs/365 days): video cameras, VMS panels, loop detectors

Traffic Management Center - Tools and Operational Data

Athens Traffic Management Center comprises

- 550 monitoring sites, located on 14 road arterials
- 208 CCTV control cameras
- 24 Variable Message Signs, installed throughout the main road system of Athens. VMS are used for three types of messages:
  - Immediate and Advance Warning messages
  - Travel-time Information messages
  - Public Service Announcement messages
- SITRAFFIC CONCERT Traffic Control and Monitoring System (Siemens, 2001)
- Traffic Controllers at signalized intersections for the communication with CONCERT
- Control room with 10 work stations
- Video-wall and 42 monitors for the constant screening of the cameras

Primary traffic data (traffic volumes and speeds) are collected in situ.
Travel times and traffic conditions are estimated based on the primary data.

Metro Risk Scenarios

Metro Attack: System Interdependencies and Cascading Effects

- Metro infrastructure damage
  - ➢ Full or partial closure of lines for a period of time
  - ➢ Event. power substation failure (blast impact)
- Public casualties in situ
- Socio-psychological damage (stress/anxiety/worry/fear) of the wider Athens population
- Event. telecom break down → emergency response delays
- Road traffic congestion due to sudden modal diversion
- Economic and business losses

Metro Attack Risk (MAR) Assessment and Risk Components

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

  - Threat probability of an attack: threat is an external force acting on metro system. Threat is a rare, highly uncertain event and is a matter of intelligence
  - Vulnerability = inverse of metro system resilience = probability that a damage occurs given a threat (=f [level of security], eg. station design, network topology, CCTV surveillance, intrusion defection sensors and factors mitigating vulnerability).
    Vulnerability is a property of metro systems and is a matter of science & engineering
  - Consequences = severity of damage given a successful attack and an occurrence of damage (=g [level of preparedness], e.g. training, drills, fast emergency response and factors mitigating severity)

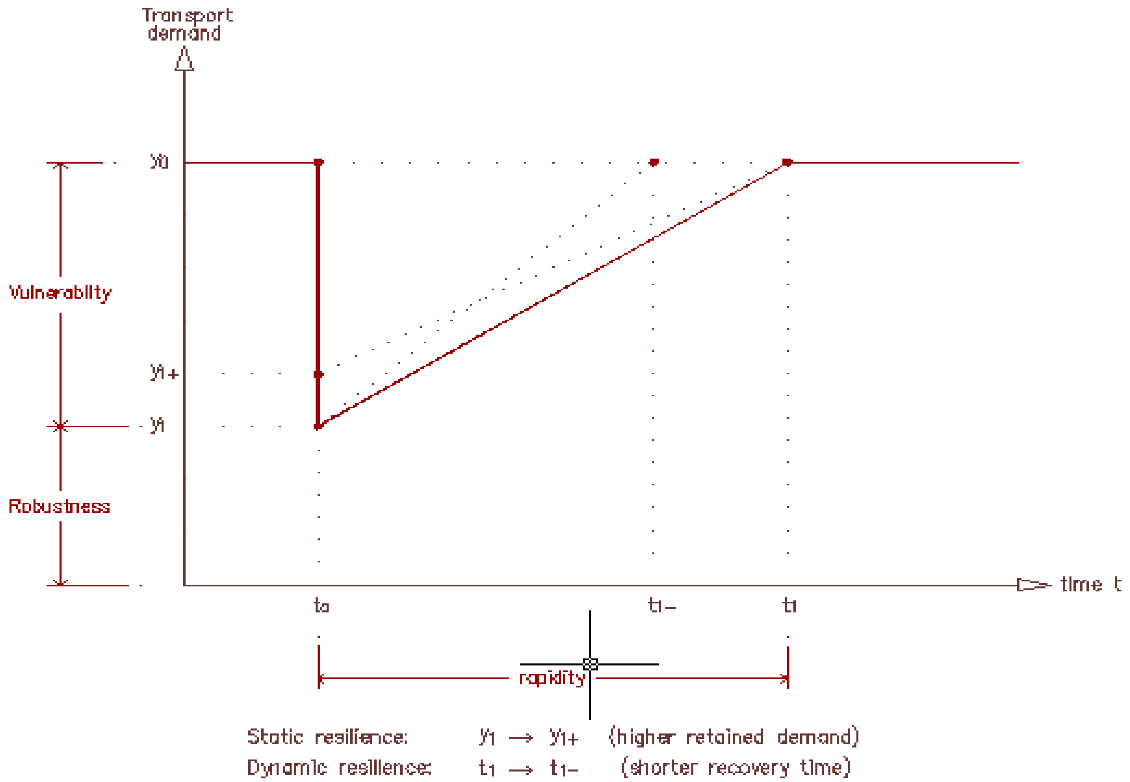
- MAR assessment pertains to expected consequences of intentional attacks (bomb blast, CBRNE incident)

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

- Metro resilience is inversely related to MAR

- 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.

Static and Dynamic Resilience



Metro Resilience Indicators – Static Resilience

- 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 ⇒
  - bus bridging of closed stations retracting spare buses from proximal depots and scheduled bus lines (if not already running parallel services)
    - ⇒ modal substitution of disrupted Metro service
    - ⇒ critical drivers: geographical extent and duration of connectivity loss
  - congestion in the road network, especially during peak periods ⇒ TDM resilience strategies: temporary interdiction of SOV use, extent of bus lanes, flex work of public services, VMS re-directions, smartphone app for alternative routing

- Static Resilience Predictor:

$$SRP = 100 \times \frac{\text{ridership covered due to modal substitution}}{\text{metro ridership reduction due to attack}}$$

Metro Disruption Scenarios

- Critical targets : - interchanges of approaching line branches
  - maximum load sections - service section connecting lines
  - track sections leading to train depots
  - OCC
- Bus bridging strategies a. metro - bus - metro (2 transfers)
  b. metro - longer bus leg (1 transfer)
- Use of the Athens Transportation Model of ATTIKO METRO
  - Target function : - maximise transport capacity of modal substitutes
  - Heuristic, successive iterations for the design of bus bridging routes and frequencies (constraints: # of spare buses, min. frequency, shortest paths)
  - Allocation of buses to proximal depots (7 bus depots)
- Differing scenarios of network connectivity losses
- Criteria : i.a. road corridor topology vs. metro network topology
  (Western suburbs less served by radial arterials, i.e. more vulnerable)
- Preferred substitute modes : - bus : ex-metro commuters, flex work, lower income
  - car : occasional users, rigid activity schedules, higher income

Metro Resilience Indicators - Dynamic Resilience - 1

- Dynamic understanding of post-attack travel demand (*perspective* of the user behaviour)
- Target function : - shorten recovery time to pre-attack, normal 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 (to be developed)
  - RPI as predictor of resilient travel behavior
  - Public response and Stated Risk Perception survey

Metro Resilience Indicators - Dynamic Resilience - 2

- Test Hypotheses : - Post-attack alteration of metro demand due to varying fear level is stronger for discretionary travel (easily diverting to alternative destinations/ consolidating/ being suppressed) 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?)
- Target function : - maximize switch of fearful to concerned or simply worried population (say: 10/90 target ratio, SLOVIC 2009)
- Need for explanation - NY 9/11/2001 & London Tube 7/2005 : perceived risk > WTA risk threshold → significant drop of demand on attacked modes → less resilient behavior
  - Madrid 2004 & Tokyo (sarin) 1995: perceived risk < WTA risk threshold → no drop of demand on attacked modes → more resilient behavior
  - Driving predictors of differing dynamic resilience?
  - How would Athens behave in a similar attack?
- Perceived risk scenarios : - Along with stated WTA survey and hypotheses test results, estimation of rate of demand recovery (= dynamic resilience)
  - Simulation of low vs. high WTA risk scenarios