ATTIKO METRO S.A.

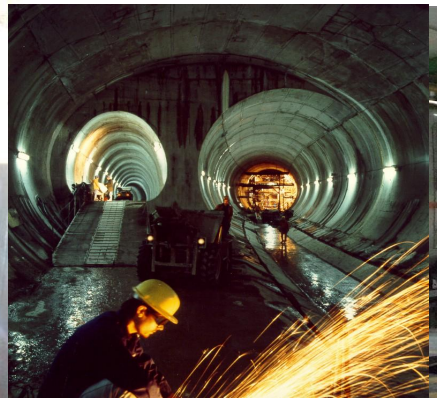
Athens and Thessaloniki Metro Systems - Expanding with State of the Art Technology

Dr George Leoutsakos, Deputy Engineering Manager

2nd Eastern European Tunneling Conference
EETC 2014 Athens, 28 Sept – 1 Oct 2014

ATTIKO METRO S.A.
General Company Profile

- **ATTIKO METRO S.A. (AM) is a state owned company situated in Athens, was founded in 1991, and which designs, tenders, supervises the construction and puts into operation Metro and Tram networks**
- **AM also implements related transportation projects (bus - transfer stations, car-parks, multi-modal transportation facilities, urban redevelopment, etc.)**
- **AM is in a position to provide consulting services in Metro / Tram systems, in Greece and internationally, transferring and exchanging specialized know-how.**

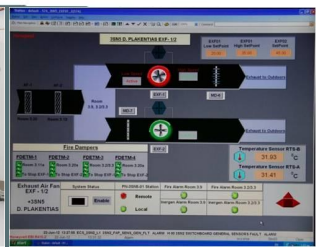


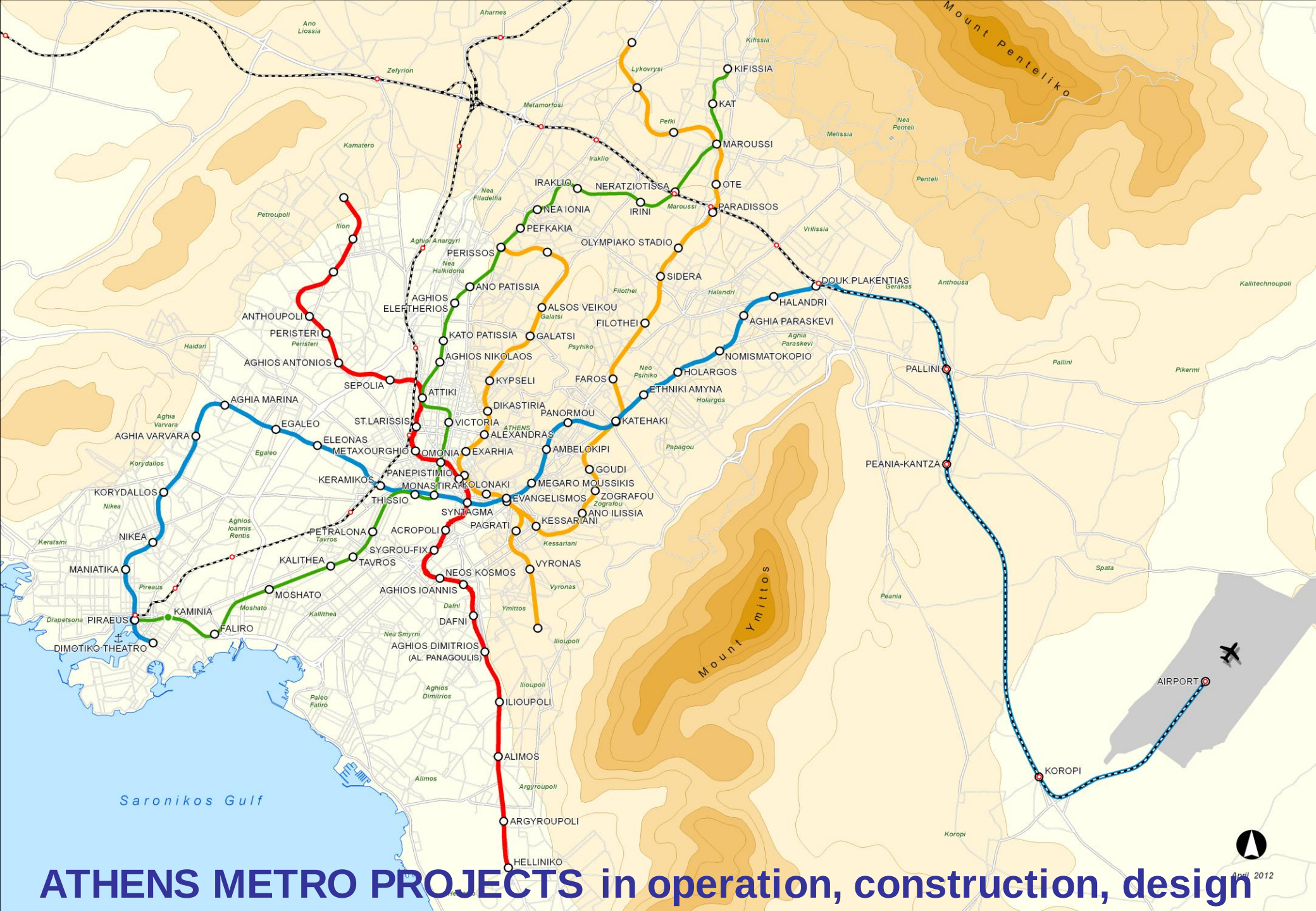
Main Projects

- **ATTIKO METRO SA in the last 20 years has put into operation or has currently under construction 61 Km of Metro lines with 64 stations in Athens and Thessaloniki of approximate value 7.2 billion €**
- **An additional 53 km with 46 stations are in the planning / design stage with a budget of an additional 5.2 billion €**
- **32 km of Tram lines are in operation or under construction . An additional 9 km is in the planning / design stage. Total cost approximately 600 million €**
- **Other projects include**
  - **Depots**
  - **Operation Control Centres**
  - **Parking / Bus Transfer facilities**
  - **Reinstatement and Redevelopment of urban areas**
  - **Project Management of multi-modal transportation facilities**
  - **Rail connection to the Athens airport with suburban rail interoperability**



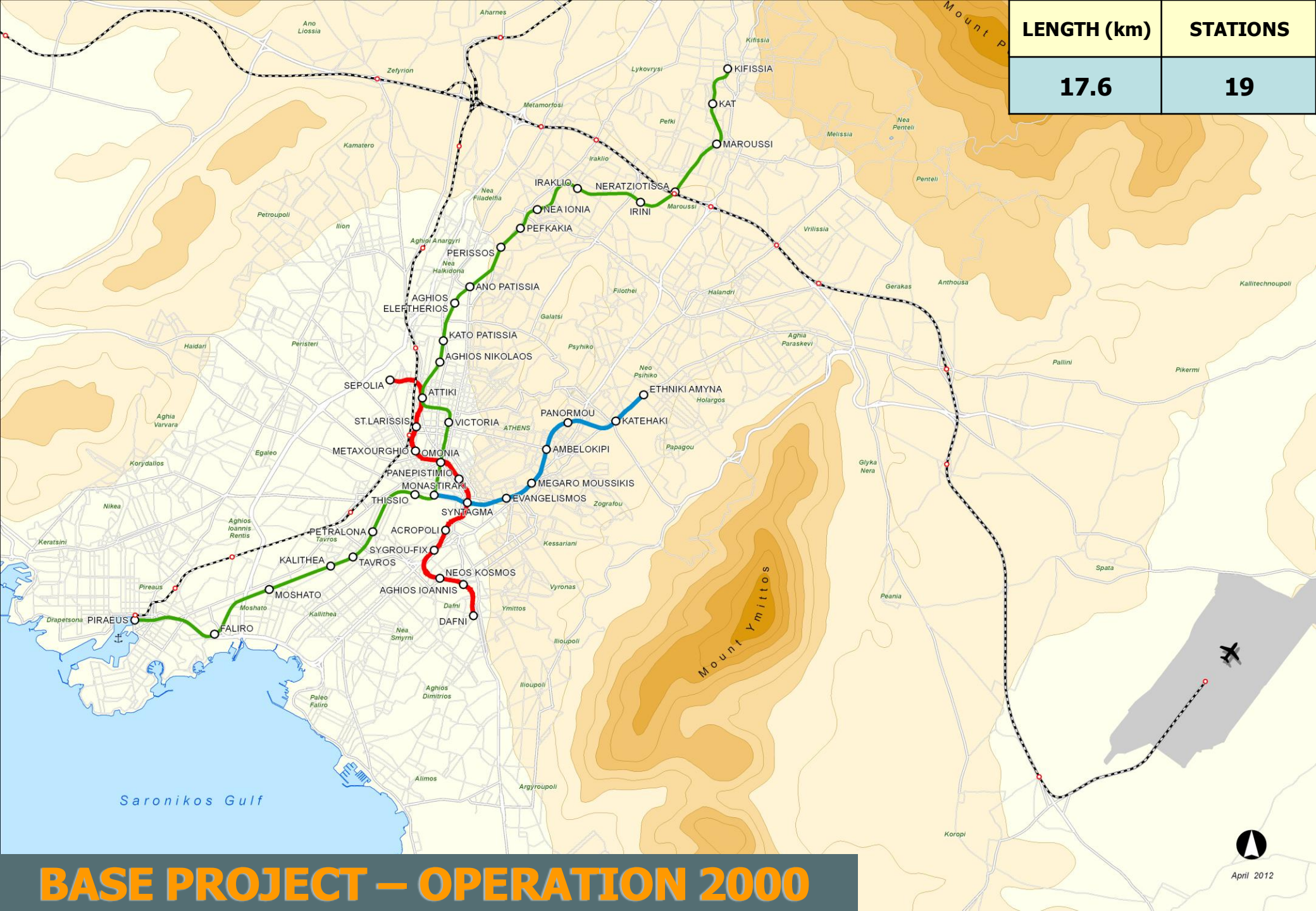


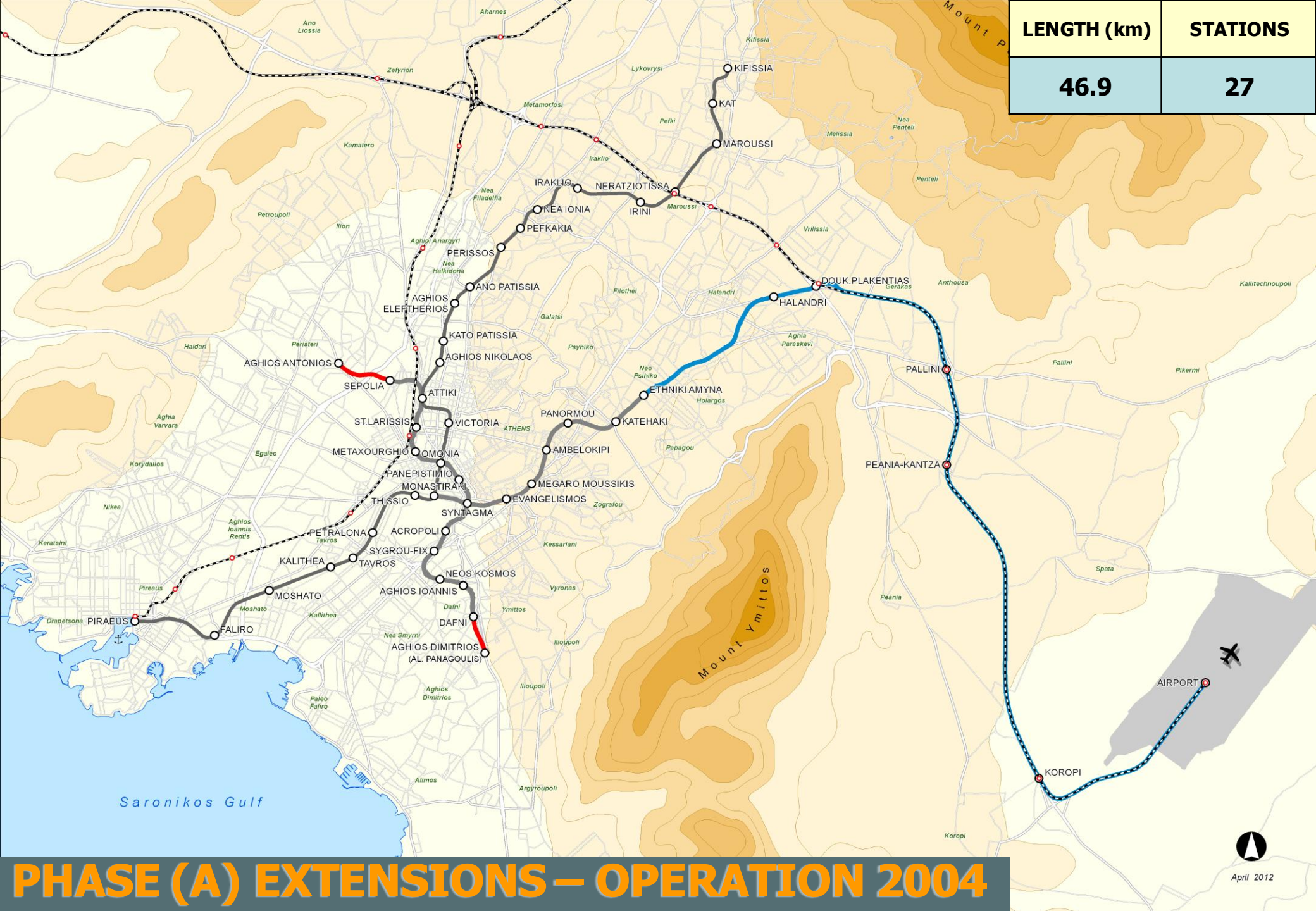


ATHENS METRO PROJECTS in operation, construction, design

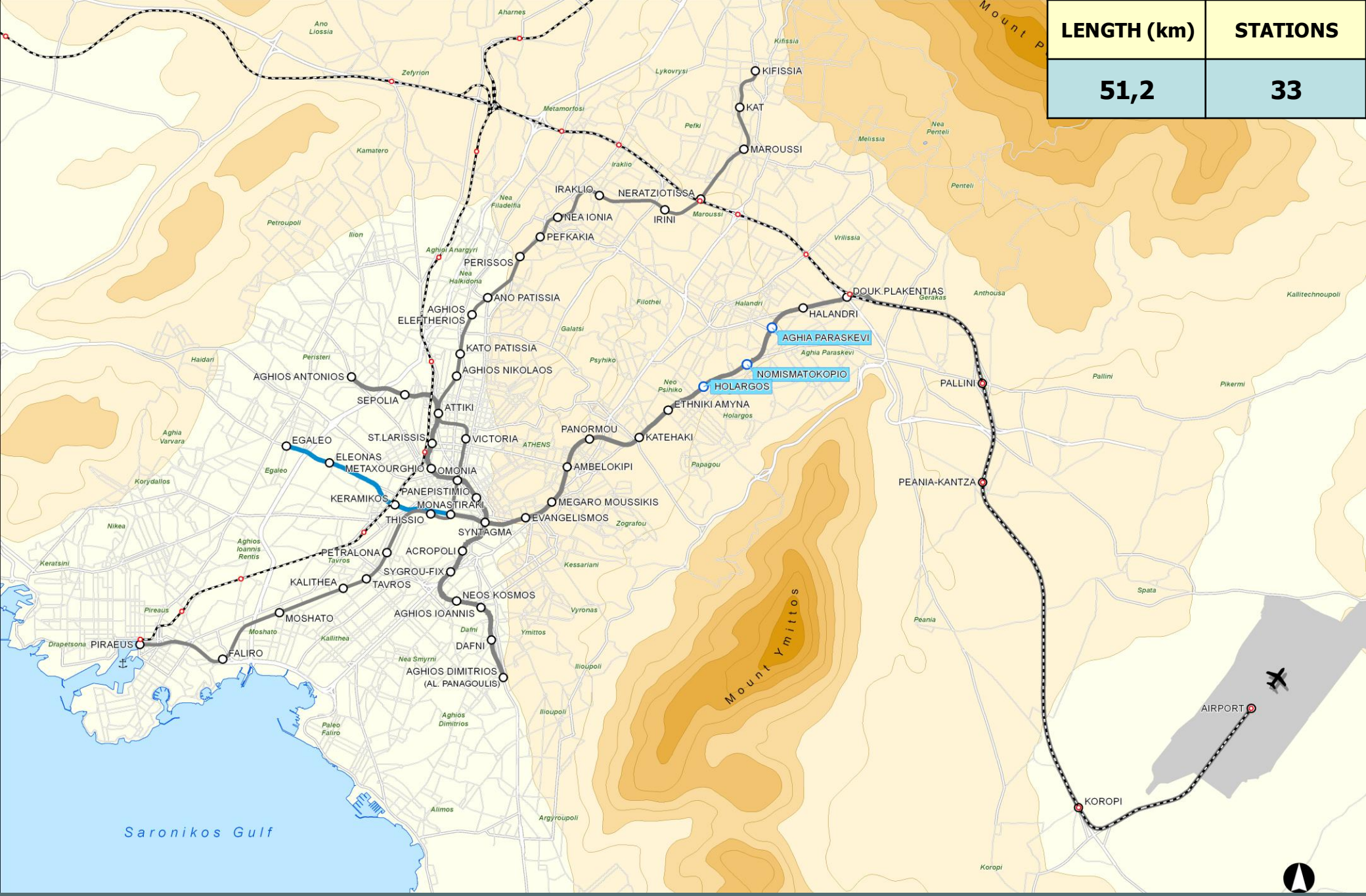
April 2012



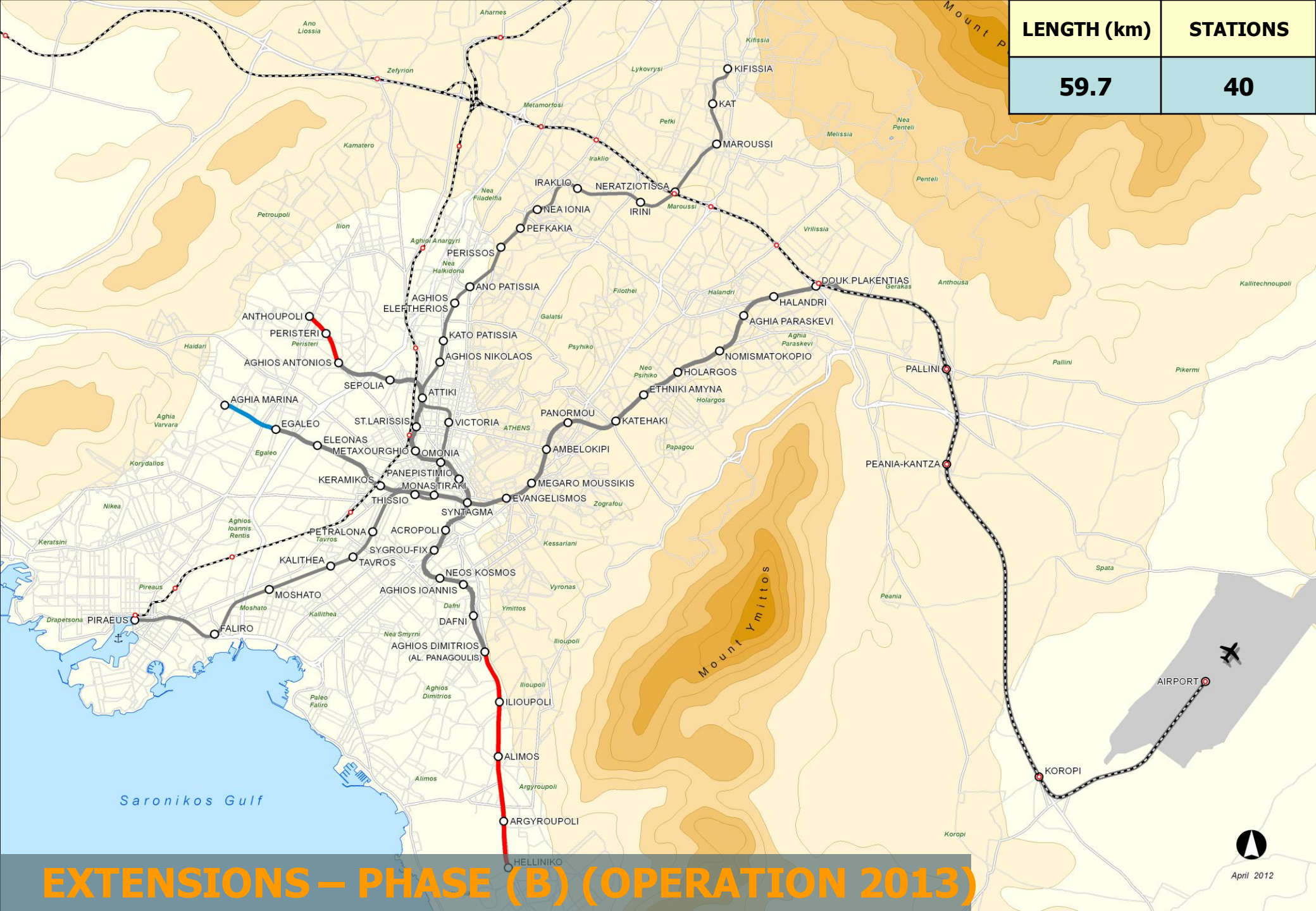
BASE PROJECT – OPERATION 2000



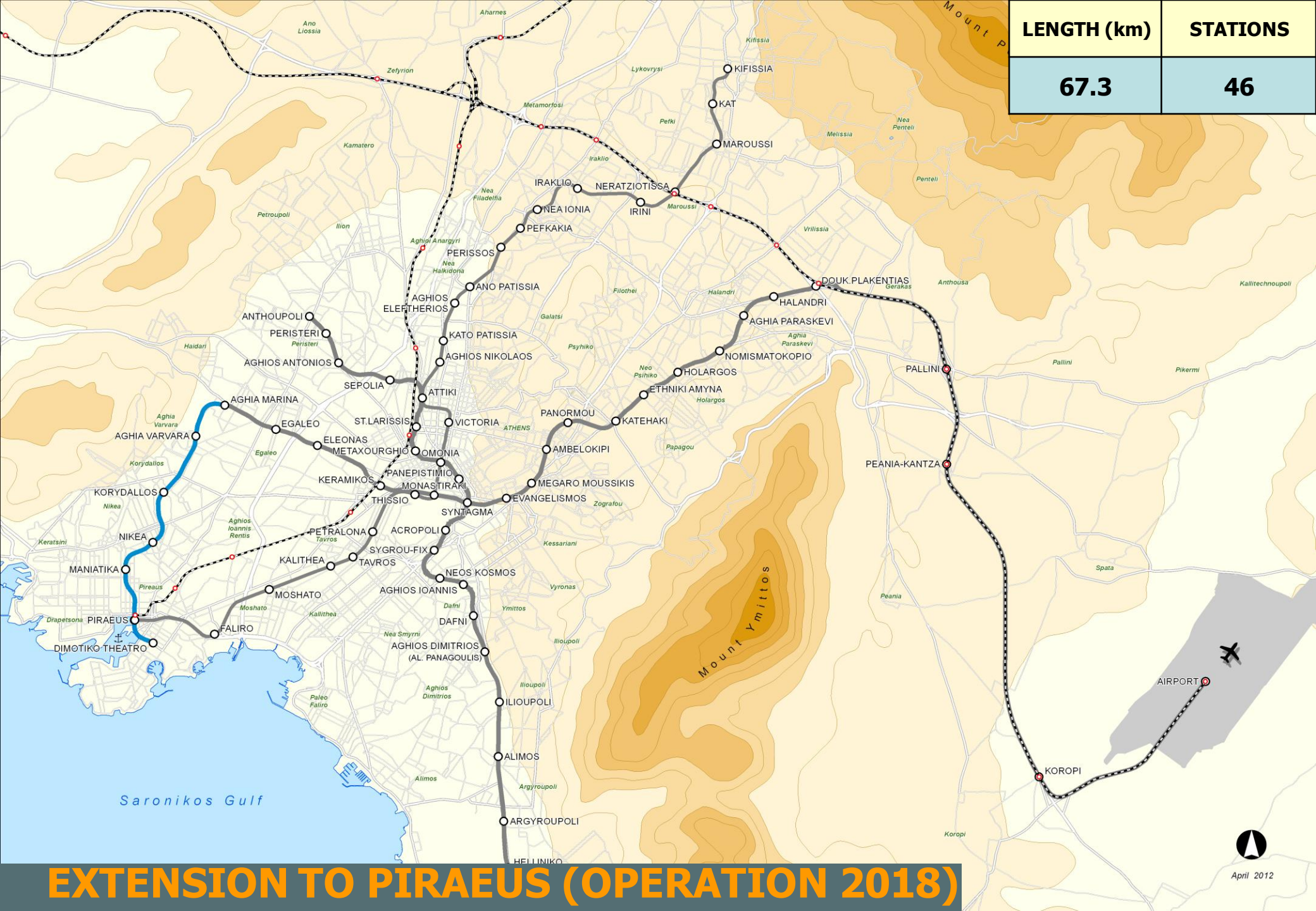
PHASE (A) EXTENSIONS – OPERATION 2004



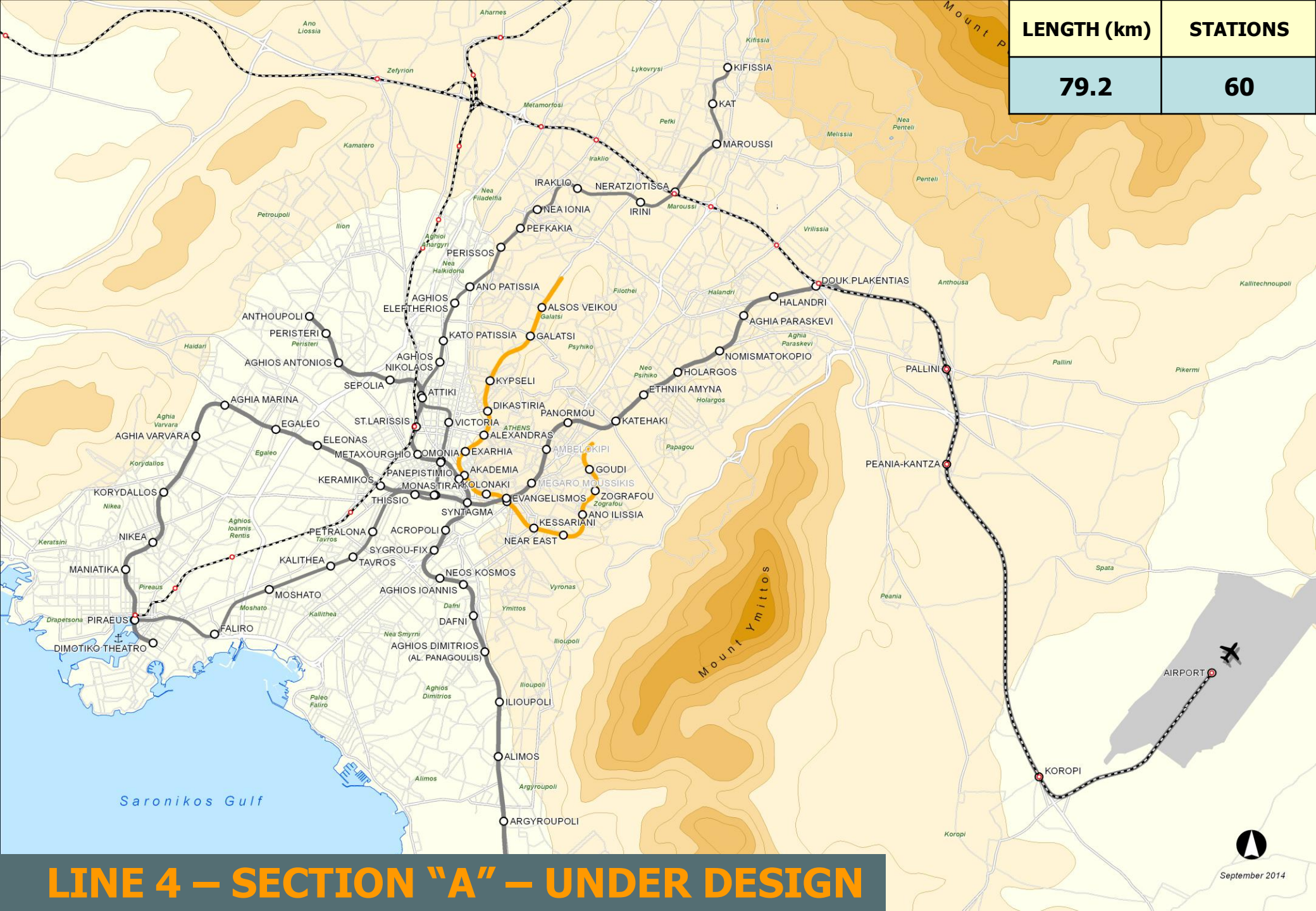
EXTENSIONS – PHASE(A-completion) (OPERATION 2007-2010)

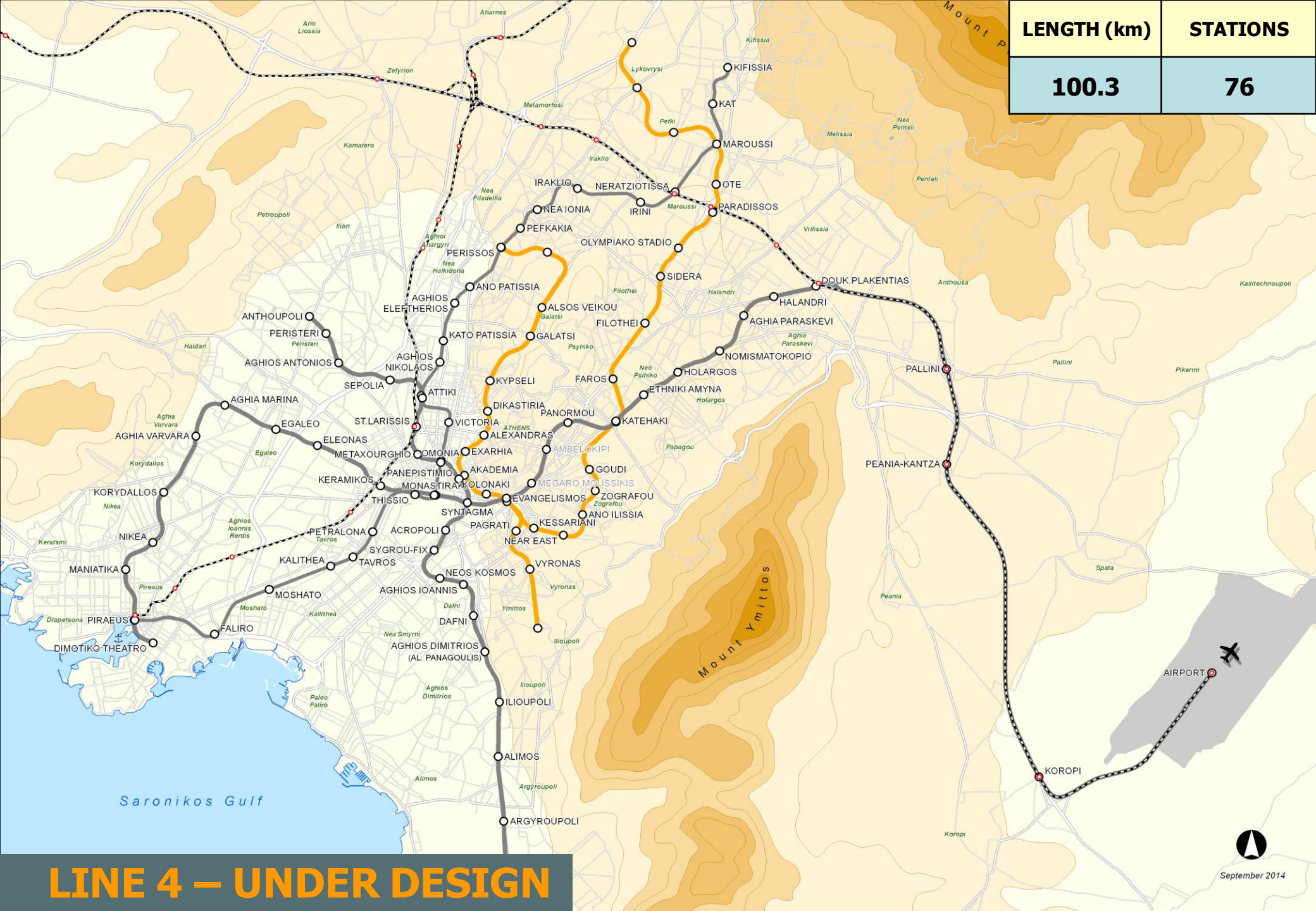


EXTENSIONS – PHASE (B) (OPERATION 2013)



EXTENSION TO PIRAEUS (OPERATION 2018)


LENGTH (km)
STATIONS
79.2
60
KIFISSIA
KAT
MAROUSSI
IRAKLIO
NERATZIOTISSA
IRINI
NEA IONIA
PEFKAKIA
PERISSOS
ANO PATISSIA
AGHIOS ELEFTHERIOS
ALSOS VEIKOU
GALATSI
KATO PATISSIA
ANTHOUPOLI
PERISTERI
AGHIOS ANTONIOS
AGHIOS NIKOLAOS
SEPOLIA
ATTIKI
KYPSELI
DIKASTIRIA
VICTORIA
ST.LARISSIS
PANORMOU
KATEHAKI
ALEXANDRAS
EXARHIA
OMONIA
METAXOURGHIO
AMBELOKIPI
AKADEMIA
GOUDI
PANEPISTIMIO
KERAMIKOS
MONASTIRAKI
KOLONAKI
MEGARO MOUSSIKIS
EVANGELISMOS
ZOGRAFOU
ANO ILISSIA
THISSIO
SYNTAGMA
KESSARIANI
NEAR EAST
ACROPOLI
PETRALONA
SYGROU-FIX
TAVROS
KALITHEA
NEOS KOSMOS
AGHIOS IOANNIS
MOSHATO
DAFNI
FALIRO
PIRAEUS
DIMOTIKO THEATRO
MANIATIKA
NIKEA
KORYDALLOS
AGHIA VARVARA
EGALEO
ELEONAS
AGHIA MARINA
ILIOUPOLI
AGHIOS DIMITRIOS
(AL. PANAGOULIS)
ALIMOS
ARGYROUPOLI
DOUK.PLAKENTIAS
HALANDRI
AGHIA PARASKEVI
NOMISMATOKOPIO
HOLARGOS
ETHNIKI AMYNA
PALLINI
PEANIA-KANTZA
AIRPORT
KOROPI
Mount Ymittos
Saronikos Gulf
ATHENS
September 2014
LINE 4 – SECTION "A" – UNDER DESIGN


LENGTH (km)
STATIONS
100.3
76
KIFISSIA
KAT
MAROUSSI
OTE
PARADISSOS
IRAKLIO
NERATZIOTISSA
IRINI
NEA IONIA
PEFKAKIA
OLYMPIAKO STADIO
SIDERA
PERISSOS
ANO PATISSIA
AGHIOS ELEFTHERIOS
ALSOS VEIKOU
FILOTHEI
DOUK PLAKENTIAS
HALANDRI
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LINE 4 – UNDER DESIGN
September 2014

ATHENS METRO LINES 2 & 3 PROJECTS SUMMARY TABLE

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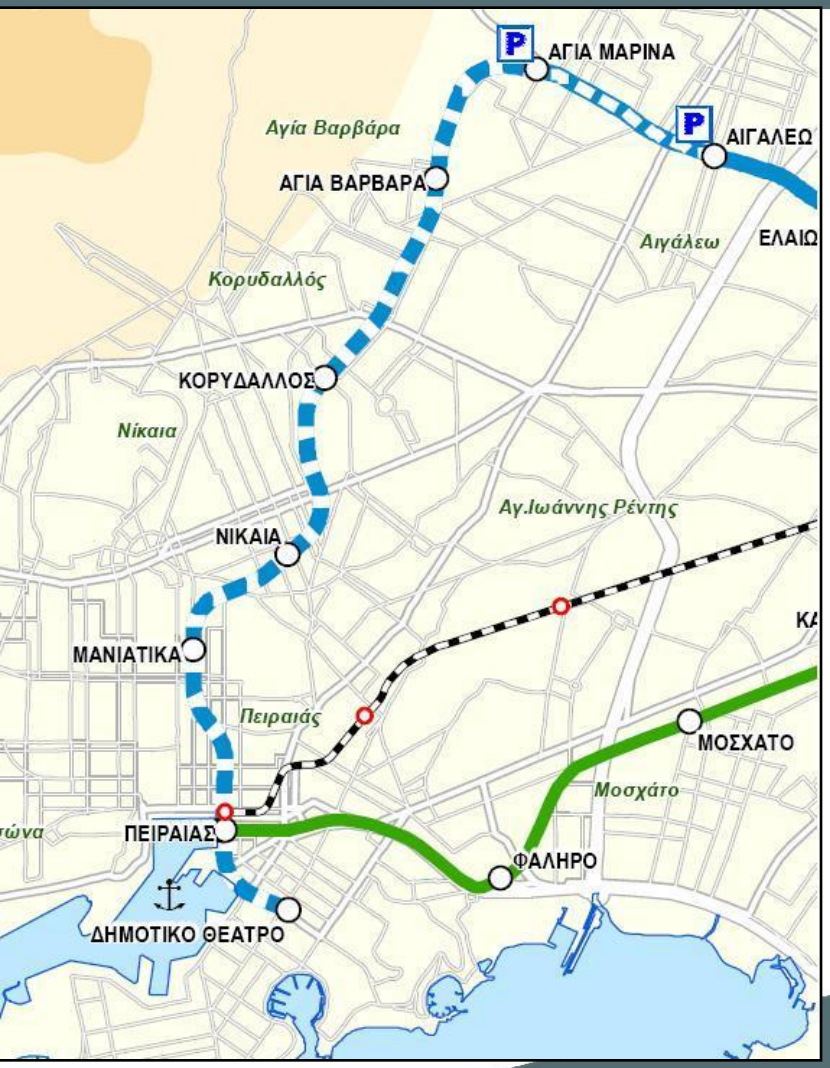
	PROJECT	COMPLETION TIME	PROJECT LENGTH (km)	STATIONS	OVERAL PROJECT BUDGET (€)	PROJECTS BENEFITS: DAILY RIDERSHIP (passengers)	PROJECTS BENEFITS: REDUCED CO_2 EMISSIONS Per DAY (ton)
1.	BASE PROJECT LINES 2, 3	2000-2003	17.6	19	2.2 b	490,000	400
2.	EXTENSIONS PHASE A'	2004-7	33.6 (*)	11(*)	1.5 b	180,000	150
3.	EXTENSIONS PHASE B'	2009-13	8.5	10	855 m	210,000	180
4.	LINE 3 EXTENSION TO PIRAEUS	2018	7.6	6	730 m	130,000	120
	TOTAL	-	67.3	46	5.3 b €	1,010,000	850 ton

(*) 20.7 Km & 4 stations are for the airport link on the suburban railway tracks, with dual voltage trains

EXTENSION TO PIRAEUS – (completion 2018)

(Under Construction)



- 7.6 km
- 6 Stations
- Pireaus station will form a transportation hub connecting lines 1 & 3, the port, the suburban railway and the tramway. The extension will offer a direct connection between the port and the airport
- Ridership: 132,000 passengers daily
- Project Budget : 660 million €
- Completion Time Schedule : 6 years
- Commencement of construction : March 2012

ARCHAEOLOGICAL EXCAVATIONS

Archaeological investigations precede the construction of every project., under the responsibility of the Ministry of Culture.

Over 100.000 m^2 investigated : antiquities from Neolithic – Ancient – Roman – Byzantine - Modern periods.

Cost : approx. 2.5 % of the total project budget ; Athens projects

10% of the total project budget ; Thessaloniki projects

Example : Athens Base Project : 50.000 artifacts discovered in 70.000 m^2 of excavations at 50 m € cost.

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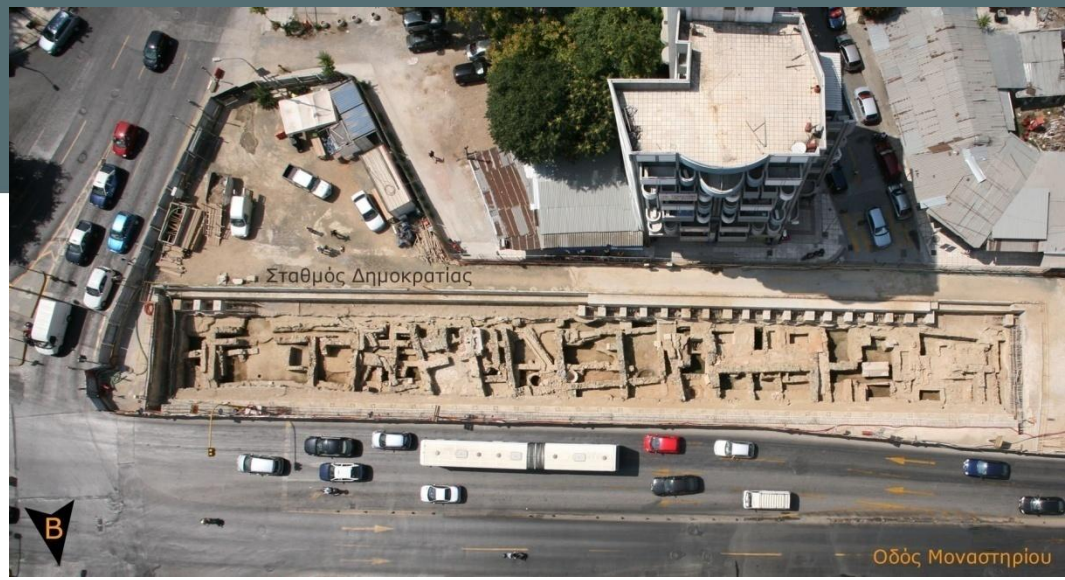

Thessaloniki Metro
Extensive archaeological investigations under progress

Acropoli Station – concourse level – statues replicas

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CONSTRUCTION METHODS

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CONSTRUCTION METHODS FOR CIVIL WORKS

1. TBM TUNNELLING METHOD
2. CONVENTIONAL TUNNELLING METHOD (NATM)
3. CUT & COVER METHOD
4. COVER & CUT METHOD
5. DIAPHRAGM WALLS – TOP DOWN METHOD

CONSTRUCTION METHODS

1. TBM TUNNELLING METHOD

Tunneling with TBM – EPB type machines with :

- **average advance rate 10m/day**
- **peak rate 28m/day**
- **minimized ground settlements**

- **single track – 6.3 m dia**
- **double track – 9.5 m dia**

TBM – moved through the platform level of an NATM station

CONSTRUCTION METHODS

2. CONVENTIONAL TUNNELING METHOD (NATM)

NATM method :

- **Applied to stations and tunnels**
- **Used in areas with :**
  - **limited space availability**
  - **deep excavations**
- **Ensuring minimal impact on the city's operation**

NATM tunnels excavation – tunnels junction

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Civil Works completed on a triple track NATM tunnel trumpet near Syntagma station Line 2, overlooking

- **a TBM double track tunnel (right)**
- **a single track NATM tunnel (left),**

CONSTRUCTION METHODS

3. CUT AND COVER (C&C) METHOD

Method used for the excavation of stations, shafts, and tunnels, minimizing construction costs and risks where there is:

- **available space at street level**
- **acceptable traffic impact on the city**
- **poor ground conditions problems anticipated**

Cut and Cover – Neos Kosmos station, between buildings

Existing tunnel demolition and station excavation - Agia Paraskevi station

Agia Paraskevi station : Partly constructed while the line through the station was in operation.

- Operation was stopped for 6 months
- Tunnel was demolished
- Civil works were completed
- Trains operation was resumed
- Station completion 1,5 years after train operation was resumed.

Anthoupoli Station – platform level - completed

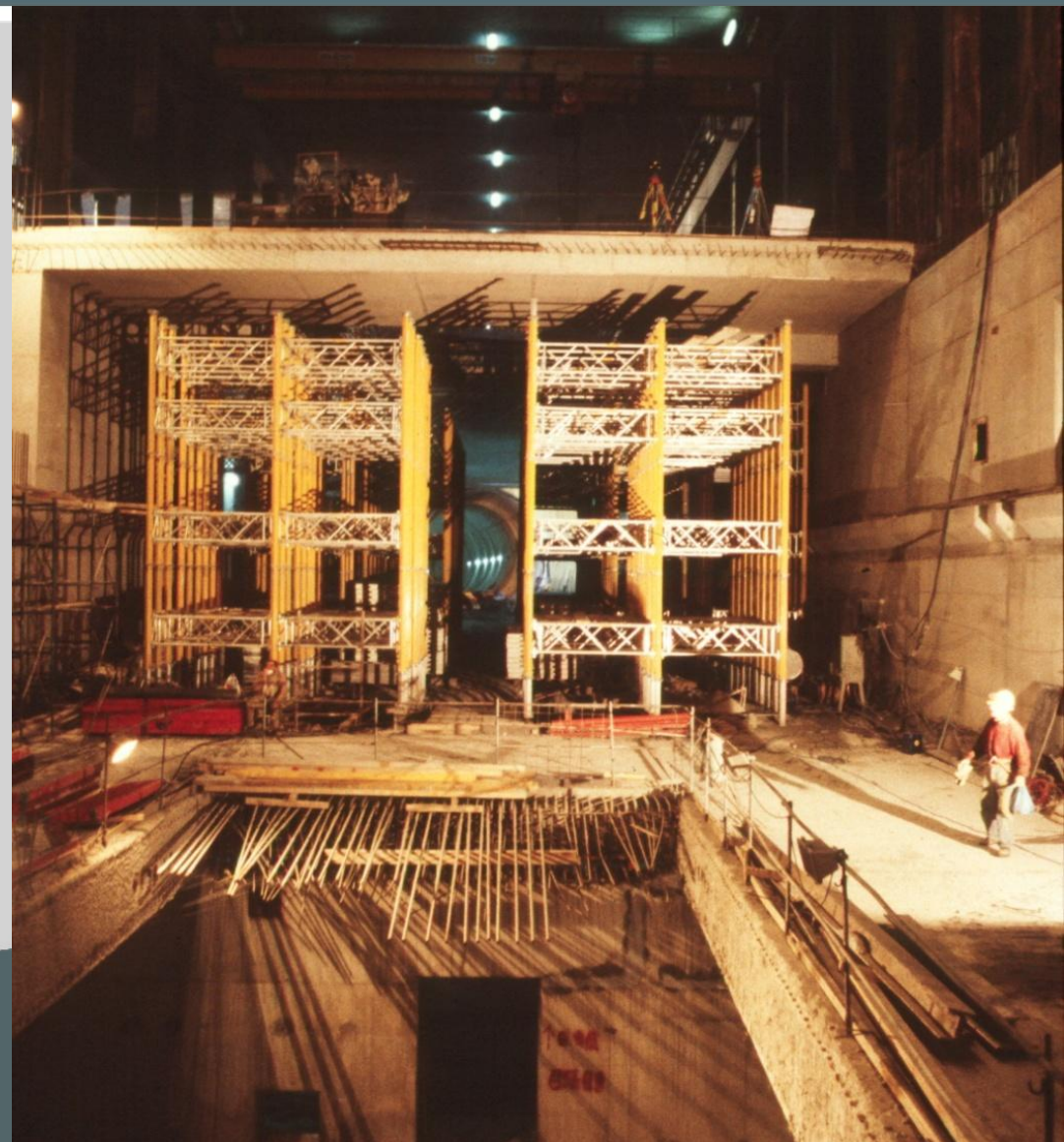
CONSTRUCTION METHODS

4. COVER AND CUT METHOD

Method used where there is need for :

- **reduced time of extended worksite occupations,**
- **rapid reinstatement and handing over of the area for use (road traffic, squares, etc.)**
- **preventing long-term impact on the city's operation.**

Method used in Syntagma Station - Line 2



Syntagma station - Cover & Cut

CONSTRUCTION METHODS

5. DIAPHRAGM WALLS – TOP DOWN METHOD

Diaphragm walls - top – down method used in cases of :

- **reduced time of street level occupation and rapid reinstatement of the area**
- **excessive underground water**
- **overall station width is limited by existing buildings/structures.**

Diaphragm Walls can be both the temporary and permanent structures and hence offer savings in the concrete quantities

Method applied to 12 stations in Thessaloniki and 1 station in Athens (Piraeus station)

Diaphragm walls construction for Panepistimio station - Thessaloniki

Electromechanical and Railway Systems - I

The following systems (approx. 45) are in the main contract scope per project :

MECHANICAL

- Tunnel ventilation.
- Heating, Ventilation and Air Conditioning (HVAC).
- Lifts.
- Escalators.
- Fire detection, fire fighting, fire protection.
- Drainage, sewage, pumping stations.
- Water supply
- Platform Screen Doors

ELECTRICAL – POWER SUPPLY

- Traction power,
- 20 KV power supply.
- Low Voltage Power distribution (230/400V).
- Power Remote Control System (PRCS).
- Auxiliary power supply system 110 V.
- Earthing and stray currents protection.
- Lighting.

Electromechanical and Railway Systems - II

ELECTRICAL - LOW VOLTAGE

- Automatic telephones.
- Direct telephones.
- Clock system.
- Close Circuit Television (CCTV).
- Public Address system.
- Traction Circuit Removal System (TCR).
- Intercom system.
- Safety / Security / Access control / Intrusion alarm system
- Wi-Fi networks
- Fiber optics and data transmission system through a fibre optics network
- Uninterrupted Power Supply Systems (UPS).

OTHER

- Trackwork.
- Completion – modification – upgrading of the systems in the Operations Control Centre (OCC).

Electromechanical and Railway Systems - III

Certain railway and electromechanical systems are implemented through independent **systemwide contracts**, common to several extensions projects :

- **Signaling system including : electronic interlocking (EIXL), automatic train operation (ATO), automatic train protection (ATP)**
- **Automatic train supervision (ATS) and Public Information System (PIS)**
- **Fare collection system**
- **Radio telecommunication system (TETRA)**
- **Building Automation and Control System (BACS)**

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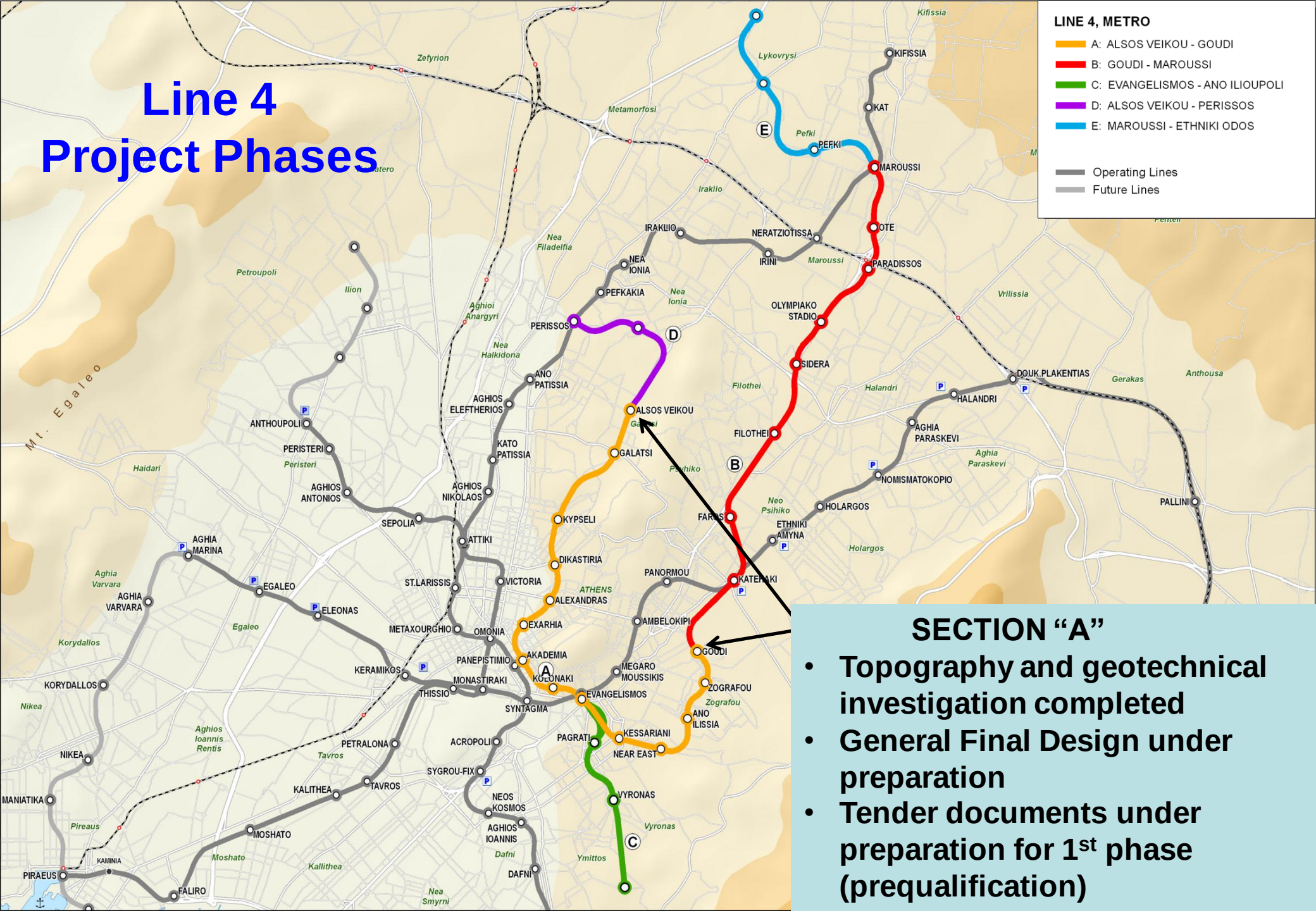
Electromechanical and Railway Systems – example photographs


Line 4
Project Phases
LINE 4, METRO
A: ALSOS VEIKOU - GOUDI
B: GOUDI - MAROUSSI
C: EVANGELISMOS - ANO ILIOUPOLI
D: ALSOS VEIKOU - PERISSOS
E: MAROUSSI - ETHNIKI ODOS
Operating Lines
Future Lines
KIFISSIA
KAT
PEFKI
MAROUSSI
OTE
PARADISSOS
IRAKLIO
NERATZIOTISSA
IRINI
NEA IONIA
PEFKAKIA
PERISSOS
OLYMPIAKO STADIO
SIDERA
ANO PATISSIA
AGHIOS ELEFTHERIOS
ALSOS VEIKOU
GALATSI
FILOTHEI
DOUK.PLAKENTIAS
HALANDRI
AGHIA PARASKEVI
NOMISMATOKOPIO
HOLARGOS
PALLINI
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AGHIOS NIKOLAOS
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VYRONAS
NEOS KOSMOS
AGHIOS IOANNIS
MANIATIKA
MOSHATO
KAMINIA
PIRAEUS
FALIRO
DAFNI
Zefyrion
Lykovrysi
Metamorfosi
Pefki
Iraklio
Nea Filadelfia
Nea Ionia
Aghioi Anargyri
Nea Halkidona
Petroupoli
Ilion
Mt. Egaleo
Haidari
Peristeri
Egaleo
Aghia Varvara
Korydallos
Nikea
Aghios Ioannis Rentis
Tavros
Moshato
Kallithea
Pireaus
Nea Smyrni
Dafni
Ymittos
Vyronas
Filothei
Halandri
Aghia Paraskevi
Gerakas
Anthousa
Vrilissia
Holargos
Neo Psihiko
Zografou
ATHENS
SECTION “A”
• Topography and geotechnical investigation completed
• General Final Design under preparation
• Tender documents under preparation for 1st phase (prequalification)

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FUTURE METRO PROJECTS IN ATHENS
LINE 4

- New driverless Line 4 is 33 km long with 30 new stations
- State of art technology in all systems and trains, CBTC wireless signaling, energy saving schemes in substations, smart control systems, new materials for architectural finishes
- 5 interchange stations for transfer to Lines 1, 2 and 3
- 530,000 additional passengers / day
- 480 less tons of CO_2 emitted in the city's atmosphere daily
- Total Project budget : 3.3 billion €
- The preparation of the project General Final Design is in progress
- Priority to tender for construction Section "A" with 12 km, 14 Stations :
  - ✓ Cost :1.3 billion €
  - ✓ Time Schedule : 84 months

THESSALONIKI METRO
General Map

THESSALONIKI METRO

A. BASE PROJECT – UNDER CONSTRUCTION

- 9.6 km of Line , 2 independent single-track tunnels
- 13 Stations – centre platform
- 1 Depot , 1 Operations Control Center
- 18 trains - driverless
- Budget: 1.3 billion €
- Significant delays are encountered due to :
  - Archaeology, Expropriations, Cash flow problems of the contractors
- Planned operation start : 2018
- State-of-the-art Metro system with CBTC signaling, Automatic driverless train operation, Platform Screen Doors for passenger safety , Gates with Smart cards fare collection, Smart control systems for energy saving etc

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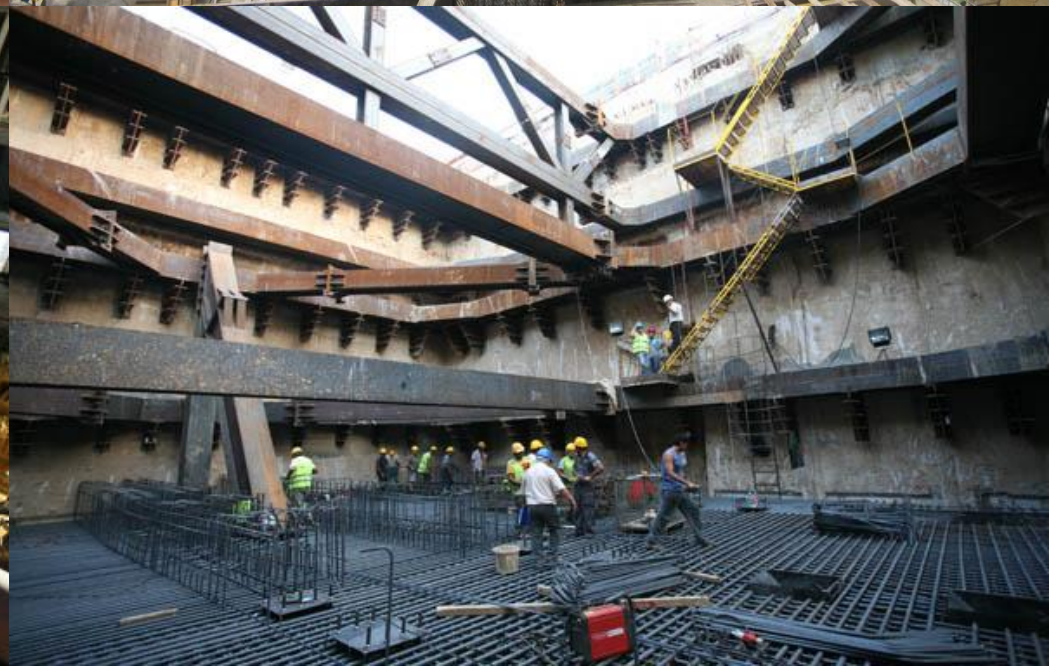
THESSALONIKI METRO

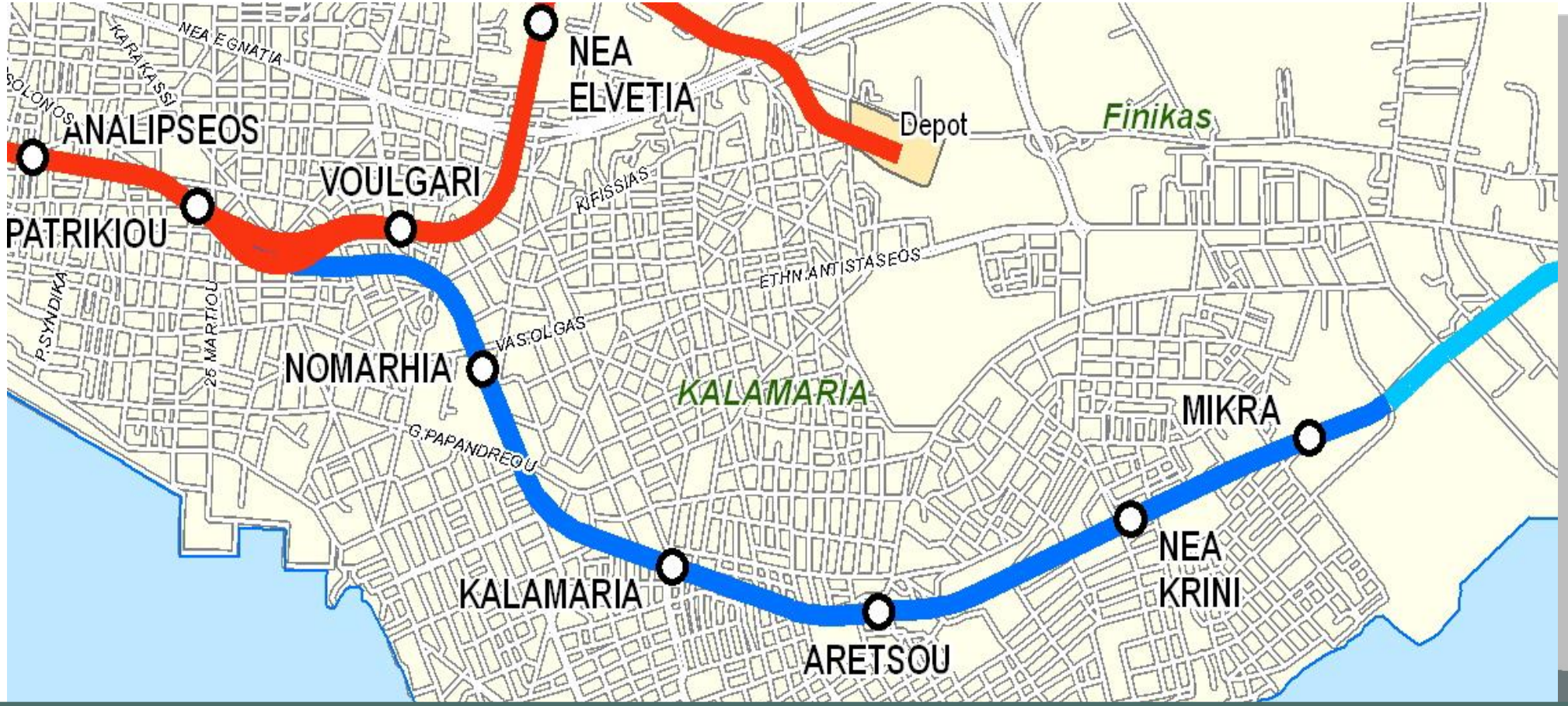
Project under Civil Works Construction Progress



THESSALONIKI METRO EXTENSIONS

A. UNDER CONSTRUCTION

KALAMARIA EXTENSION



4.8 Km, 5 stations, 1 Depot, 1 Transfer Station, 580 million €
Main Civil Works & Electromechanical Equipment Contract for the line and the 5 stations is under execution

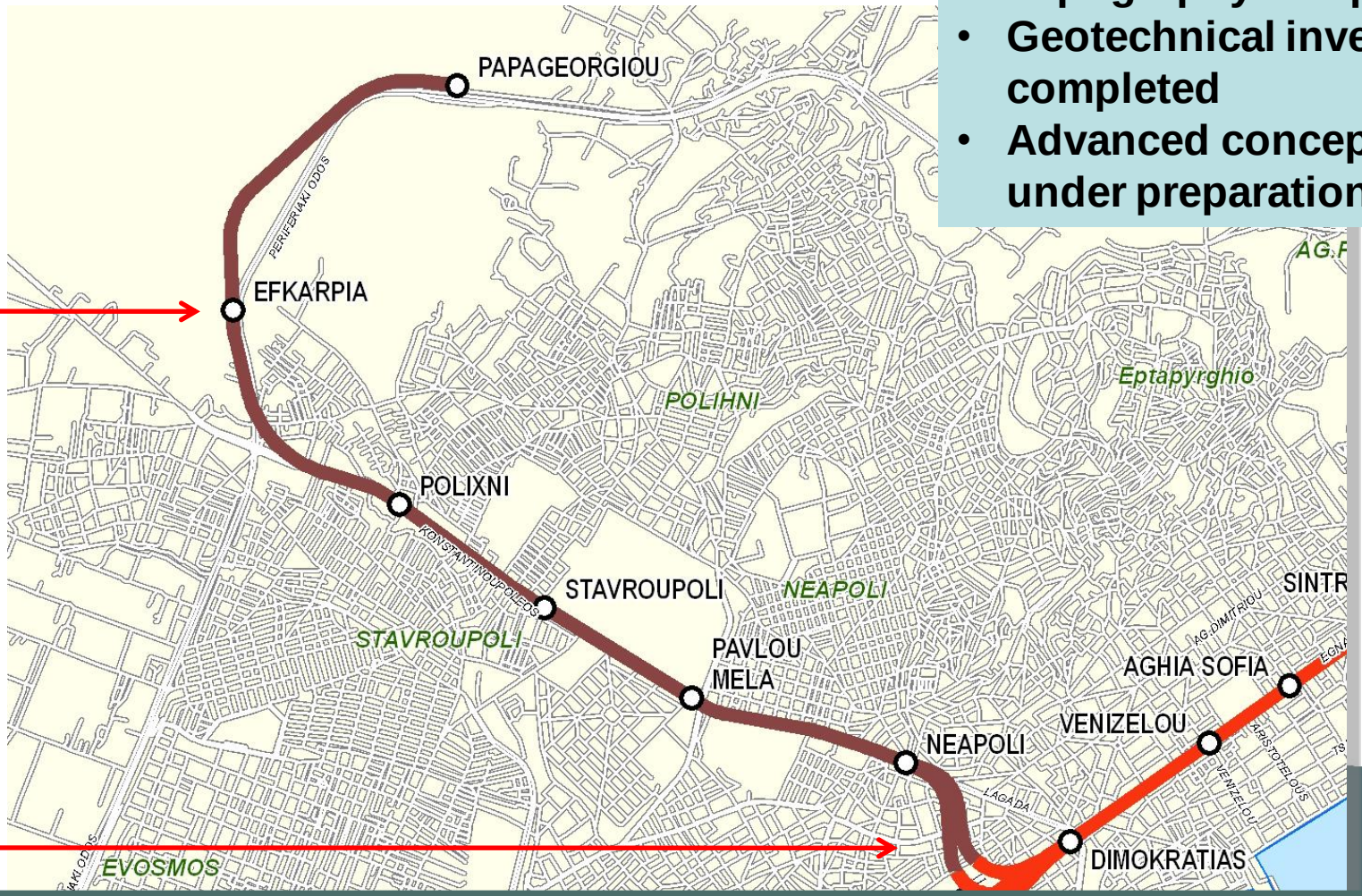
THESSALONIKI METRO

B. UNDER DESIGN

STAVROUPOLI EXTENSION

- Topography completed
- Geotechnical investigation completed
- Advanced concept design under preparation

Section under design

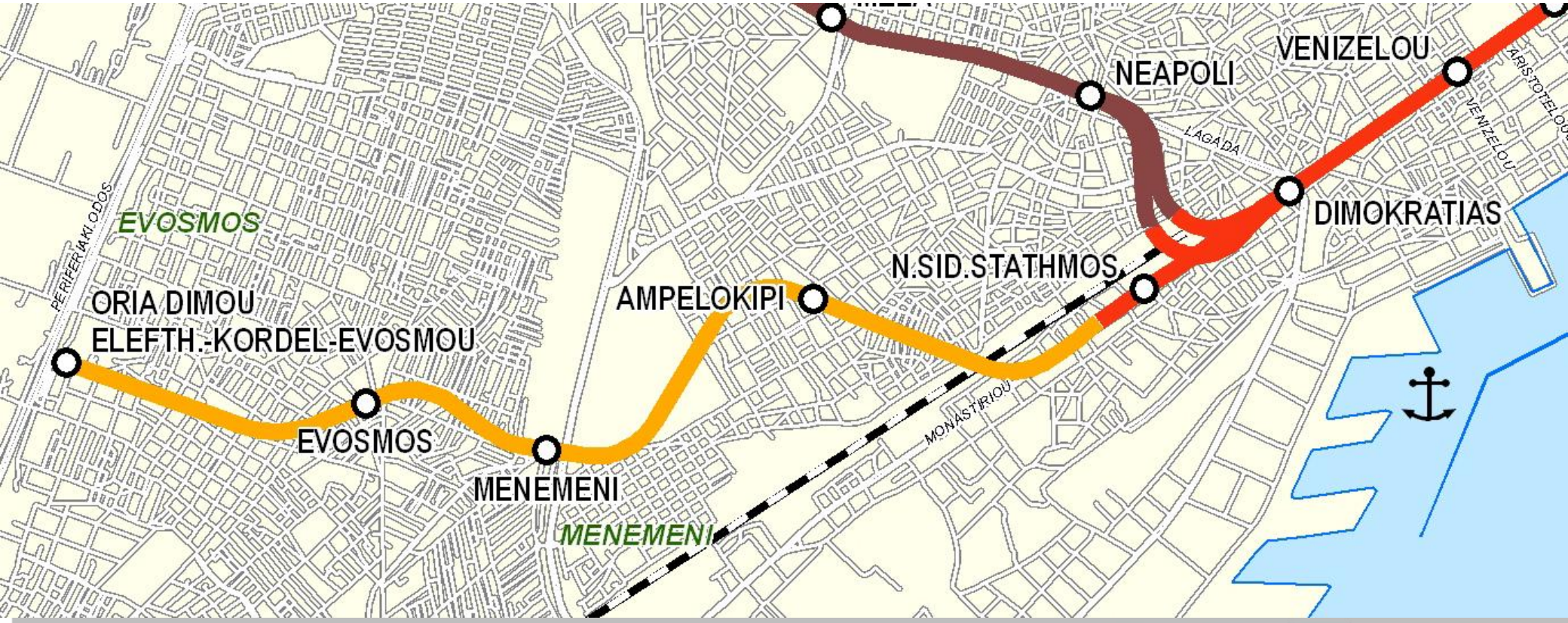


5 Km , 5 stations, 1 depot extension, 600 million €, under design

THESSALONIKI METRO

C. FUTURE EXTENSIONS

EVOSMOS EXTENSION

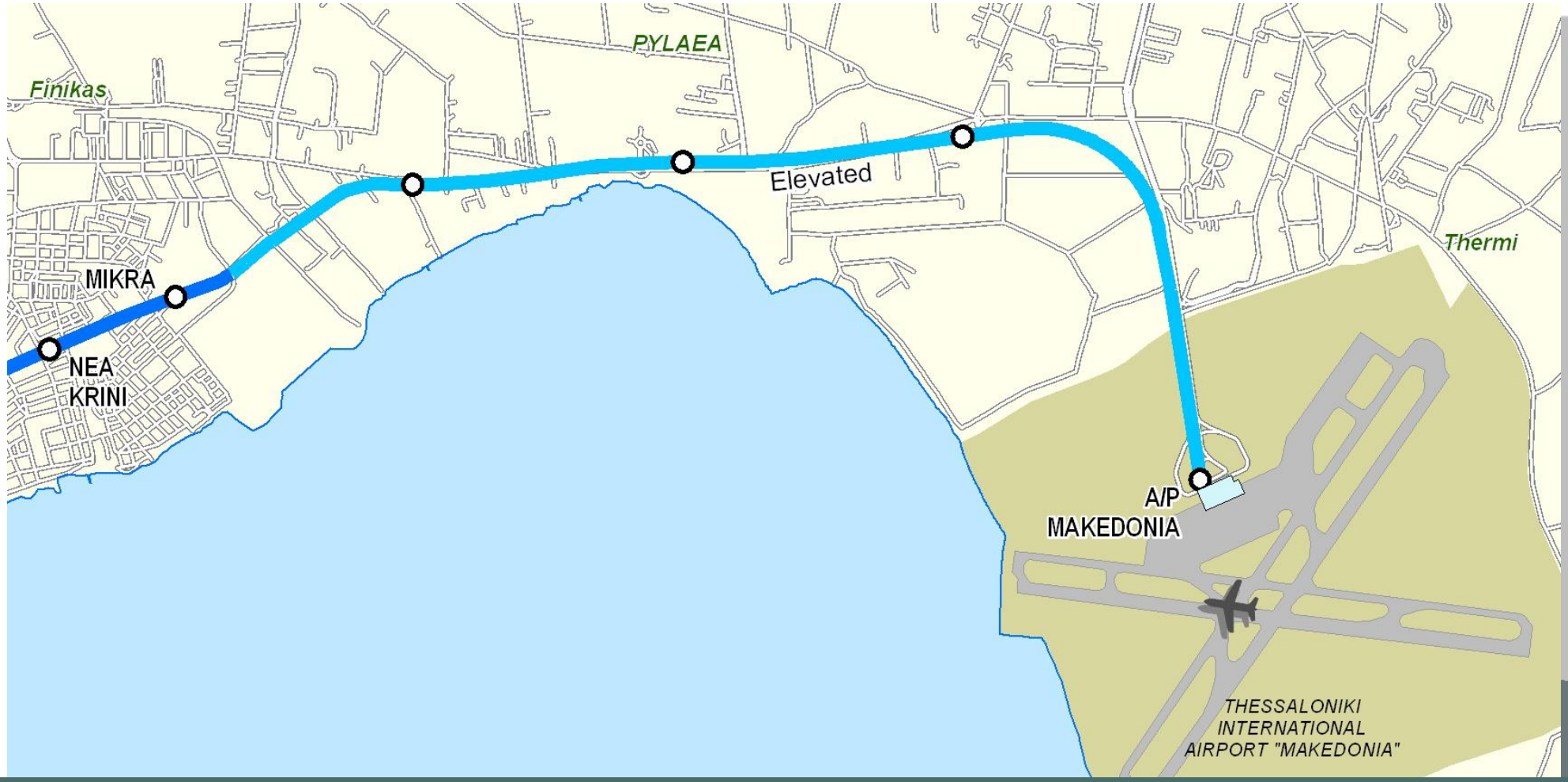


4.4 km, 4 stations, 440 million , topography under tender

THESSALONIKI METRO

C. FUTURE EXTENSIONS

EXTENSION TO MICRA AIRPORT



5.5 Km, 3 or 4 stations, ~ 300 million €, initial concepts investigated

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TRAMWAY PROJECTS

EXISTING TRAMWAY NETWORK IN ATHENS

- **Network length : 27 Km**
- **Stations : 48**
- **Daily ridership : 63,000 passengers**
- **Budget : 385 m €**

TRAMWAY EXTENSION – PHASE A' TO PIRAEUS (under construction)

- **5.4 Km of single line**
- **12 new stations**
- **Reconstruction of the existing terminal Station near the Stadium (S.E.F.) area**
- **Budget: 127 m €**
- **Construction period: approx 2 years**
- **Rolling stock included**

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TARGETS FOR INCORPORATION OF NEW TECHNOLOGIES

- Longer lifetime of structures and systems
- Minimization of construction risk
- Upgraded operational safety
- Increased passenger comfort
- Improved passenger services & IT technologies provision
- Enhanced safety during construction both for project and neighboring structures
- Enhanced Operator's capabilities
- Minimization of capital and operational cost

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AREAS FOR THE INCORPORATION OF THE NEW TECHNOLOGIES

- Modern City Planning concepts
- Design for Civil Works and for Electromechanical / Railway systems
- Construction methodologies and practices
- New materials for civil works, architectural finishes and E/M systems
- Quality Management System
- Minimization of Carbon Footprint of projects both during construction and operation
- Life Cycle Cost principles for Electromechanical and Railway systems
- Energy Saving maximization
- Safety for incident management and anti-terrorist response
- Condition Based Maintenance for trains and fixed installations

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ENGINEERING DISCIPLINES IN A METRO SYSTEM

- Topography
- Engineering Geology
- Geotechnical
- Structural
- TBM tunneling
- Architectural
- Civil
- Trackwork
- Mechanical Facilities
- Power Supply
- Low Voltage
- Signaling
- Rolling stock
- Depot
- Operation
- Safety – RAMS

ENGINEERING GEOLOGY - I

- **Ground Investigation (Geotechnical-Geological-Geophysical)**
  - **Compilation of demanding technical specifications (personnel - equipment - density of works)**
  - **Integration of updated Eurocode and relative normative references**
  - **Evaluation of ground investigation data based on innovative methods with standardization of formations and a unified evaluation procedure for both rock/ground, with a statistical approach**
  - **Dealing with special conditions (densely populated urban environment with several Utility Networks)**

ENGINEERING GEOLOGY - II

- **Geomechanical and Structural Monitoring (GSM)**
  - **Compilation of demanding technical specifications (specialized personnel - cutting edge technology instrumentation - density of monitoring points - frequency of measurements)**
  - **Development of pioneering, at a global level, special information systems for the management and analysis of GSM recorded data.**
  - **Geomechanical and Structural Monitoring Data Base Management System (GSMDB) – On line**
  - **Automated Monitoring System (AMS) of structures, with real time recording and special mobile telephone networks transmission of recorded data**
  - **Primary measurement processing, self-checking of limits and data, automated alarms through smartphones, projection and production of drawings, diagrams/tables through the GSMDB**

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GEOTECHNICAL

- **Excavation over and around operational railway tunnels for the construction of intermediate stations**
- **Special foundation - supporting method of overlying archaeological layers, using a support slab formed by consecutive transverse tunnels underneath**
- **Jet grouting works for a strutting slab, a grouted block for TBM station arrival and pillar strengthening in case of two closely spaced TBM tunnel tubes**
- **Use of micropiles for Cover & Cut Metro stations uplifting**
- **On line TBM Data management System (monitoring software, deliver, process control, customisation)**

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STRUCTURAL (I)

- Special measures foreseen for TBM tunneling close to the sea, to assure tunnel segments durability, using : high concrete strength class (C 35/45), special provisions for concrete mix design, min cement content : 400 Kg/m3, low water/cement ratio of 0,35-0,45, water penetration tests (max 15 mm), chloride penetration tests and crack control calculations with low crack width (0.15mm).
- For ordinary tunnel segments, same measures apply but with concrete strength class (C 40/50), and with special reinforcement configurations at the segment face locations where the TBM rams exert pressure
- Use of guide bars and special connectors between TBM segmental rings and bituminous pads at segment faces for accurate segment positioning and installation with practically zero gap and full pressure between the waterproofing gaskets
- Improvement of the waterproofing system of Stations, NATM tunnels and tunnel recesses using thicker membranes (min 3mm), geotextile protection layers (800gr/m2) and wider waterstops (min width 320mm).

STRUCTURAL (II)

- **For buildings and other structures (bridges, monuments, etc) located close to Metro excavations or above tunnels, extensive and detailed :**
  - **Recording, Recognition and Evaluation of the Importance of buildings/structures, and**
  - **Special Vulnerability and Relative Risk Design for Buildings and Structures**

  is performed for recording the characteristics of all affected structures in the project influence zone, and in turn assessing their vulnerability using the ground deformations predicted during excavations and temporary supports.

- **Full recording of the buildings/structures data is available on-line incorporated in the monitoring system during the construction stage of the project.**

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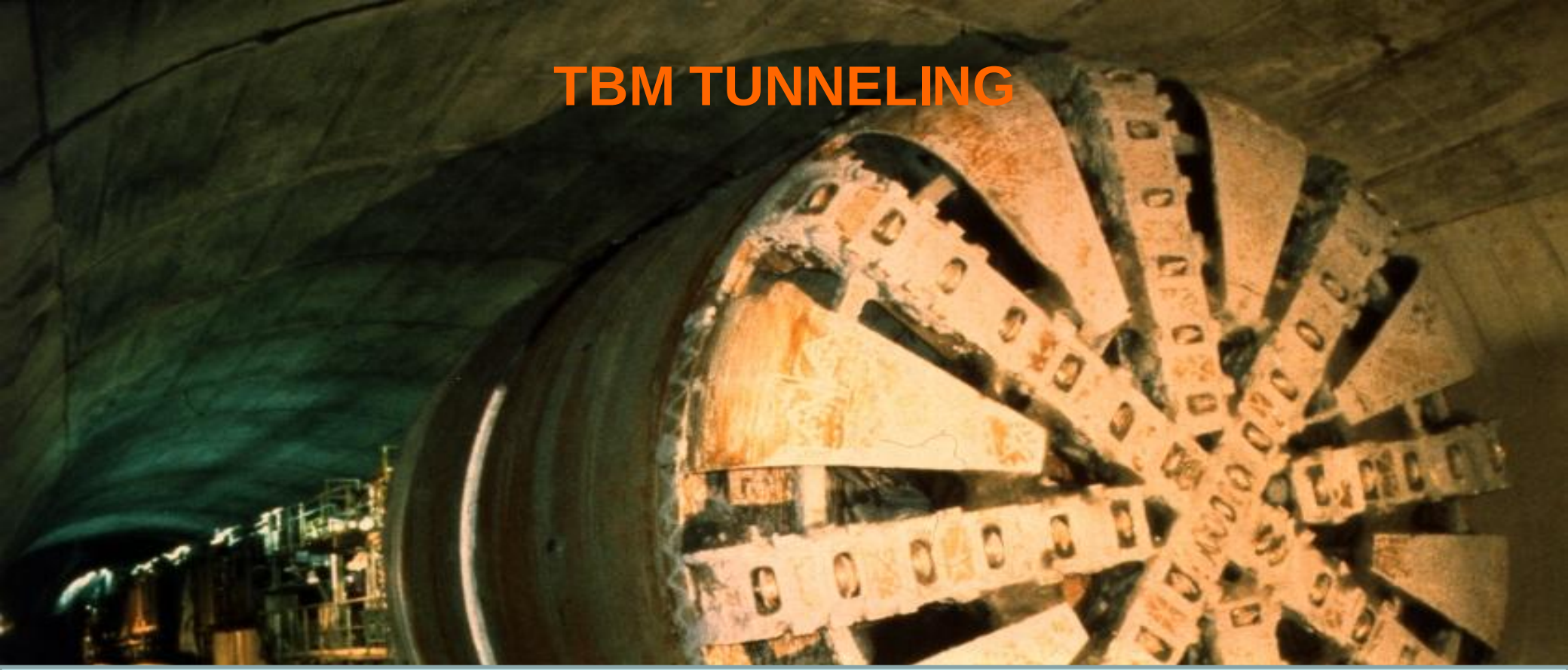
TOPOGRAPHY

- **Increased accuracy of measurements of the "total" stations, for TBM alignment and for other applications, using :**
  - **automatic detection and locking of the reflective targets,**
  - **increased laser beam ranges on special targets,**
  - **improvement of the laser beam characteristics,**
  - **upgraded and faster software,**

- **Performing "as-built" measurements in tunnels, using Laser Scanners which provide dense clouds of points in lengthy tunnel sections, instead of the older "Profilers"**

TBM TUNNELING



- Additional Face Support (AFS)
- Pressurized Steering Gap (PSG)
- Bi-block guide bars for the precast segments ring to ring connection
- Latest developments in the shape & materials for the elastic gaskets of segments
- Bi-component for primary grouting and filling the void between the ground the installed rings during the TBM advance.
- New Generation Biodegradable and Fire Resistant Greases – for tail shield sealing
- Site installation – Chiller instead of cooling tower for cooling the TBM greases

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ARCHITECTURE

- Maximized bioclimatic principles &“open” architecture applied
- Full accessibility by PSN (people with Special Needs)
- Emphasis on natural light
- Use of new materials for architectural finishings, with anti-bacterial, anti dust, self cleaning (photo-catalytic) or “cold surface” properties
- Extensive fair faced concrete surfaces for minimum maintenance

Agios Antonios Station – platform level – open architecture – natural lighting

Peristeri Station – street level – during reinstatement – natural light dome

Syntagma Station – Concourse level

Agios Dimitrios Station – centre platform

Keramikos Station - platforms

Keramikos Station – concourse/transfer levels

Eleonas Station –concourse level – galleries and skylight

Peristeri Station – concourse level

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ENERGY SAVING

- Tunnels humped profiles in vertical alignment (5-8% saving)
- Train piston effect use for tunnel ventilation (85% ventilation power saving)
- Train brakes
  - ➢ regeneration (1st level saving of 10-25%)
  - ➢ feeding back surplus power to the city Medium Voltage Grid (20KV) (2nd level additional saving 5-10%)
- LED lighting (x3 life duration, ÷ 2 power consumption)
- Load compensation schemes in power substations (~ 5-8% saving)
- Efficient motors (Eff1 and Eff2 ratings)
- Smart control systems for building facilities management (ventilation, air conditioning, lighting, etc.)
- Automated Train Operation (ATO) - CBTC Signaling Systems (~ 15% traction power saving)

All above savings are not all cumulative, but result in substantial energy and cost savings with reduced burden on the environment and atmospheric CO_2 pollution.

LOW VOLTAGE SYSTEMS - IT TECHNOLOGIES

- **Full IP telecommunications**
- **Fully digital CCTV systems with image analysis capabilities**
- **Mobile telephones 3G & 4G**
- **Wi-Fi with continuous hotspot handovers**
- **Contactless electronic ticketing with gates - use of smartphones**
- **On line information screens - Electronic advertising – Multiple transportation modes time scheduling information (eg. Ship departure and arrival times at a harbor)**

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ROLLING STOCK

- Driverless
- Continuous vestibule
- Minimized Fire Loads (< 5 MW for a 6-car train)
- CBTC signaling
- Air – Conditioned cars
- Fully PSN accessible
- Wi-Fi coverage
- Almost 100% recyclable materials, non-toxic and with water based paints
- Analyzed with FEM, for collisions management

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HEALTH & SAFETY

- **TENDER PHASE : Preparation of contractual requirements, risk assessment, contractors requirements, safety in design, risk mitigation plan**

- **PRE-CONSTRUCTION PHASE : Elaboration of details**

- **CONSTRUCTION PHASE : Integrated safety management system, job safety analysis, training, inspections, audits**

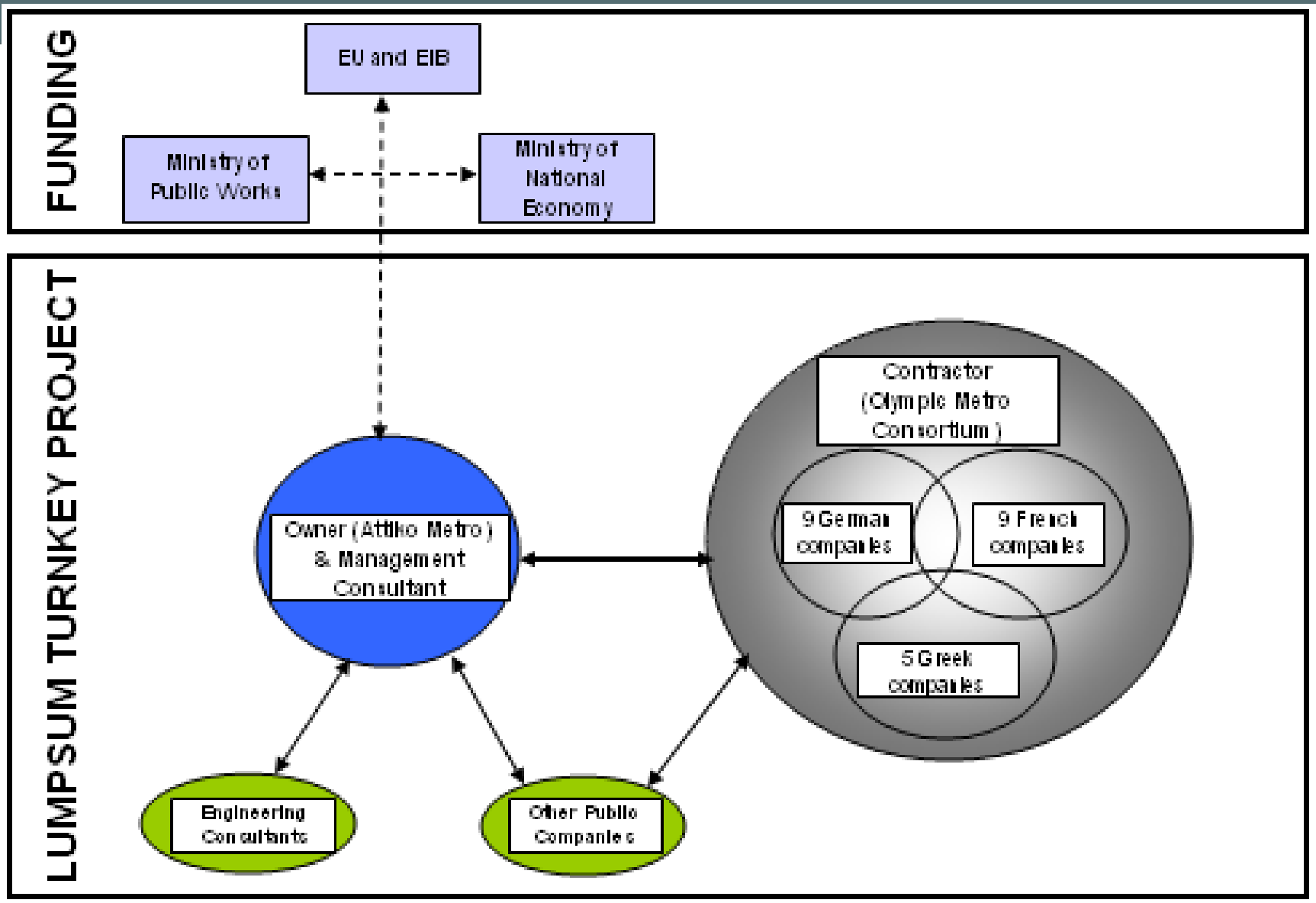
- **TESTING – COMMISSIONING – OPERATIONS : Equipment / systems integrity, Personnel training, emergency management, risk assessment, safe work practices**

CONTRACTS MANAGEMENT & HANDLING

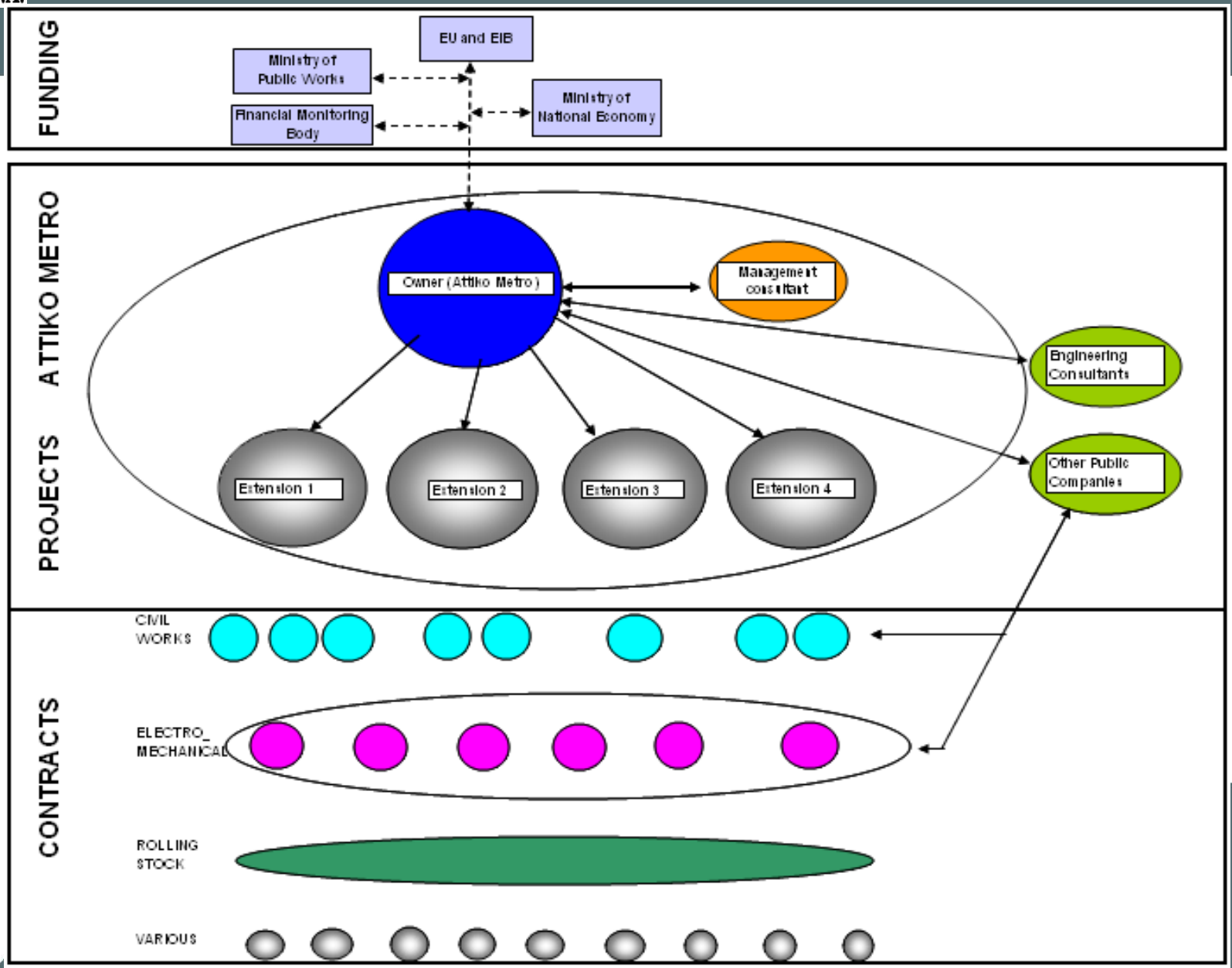
From 2015 compulsory electronic tenders, must be followed, through an on-line interacting system with:

- **e -tender documents with specified forms & formats to be filled in**
- **e - bid submissions**
- **e - bid evaluations**
- **All above by certified personnel only**

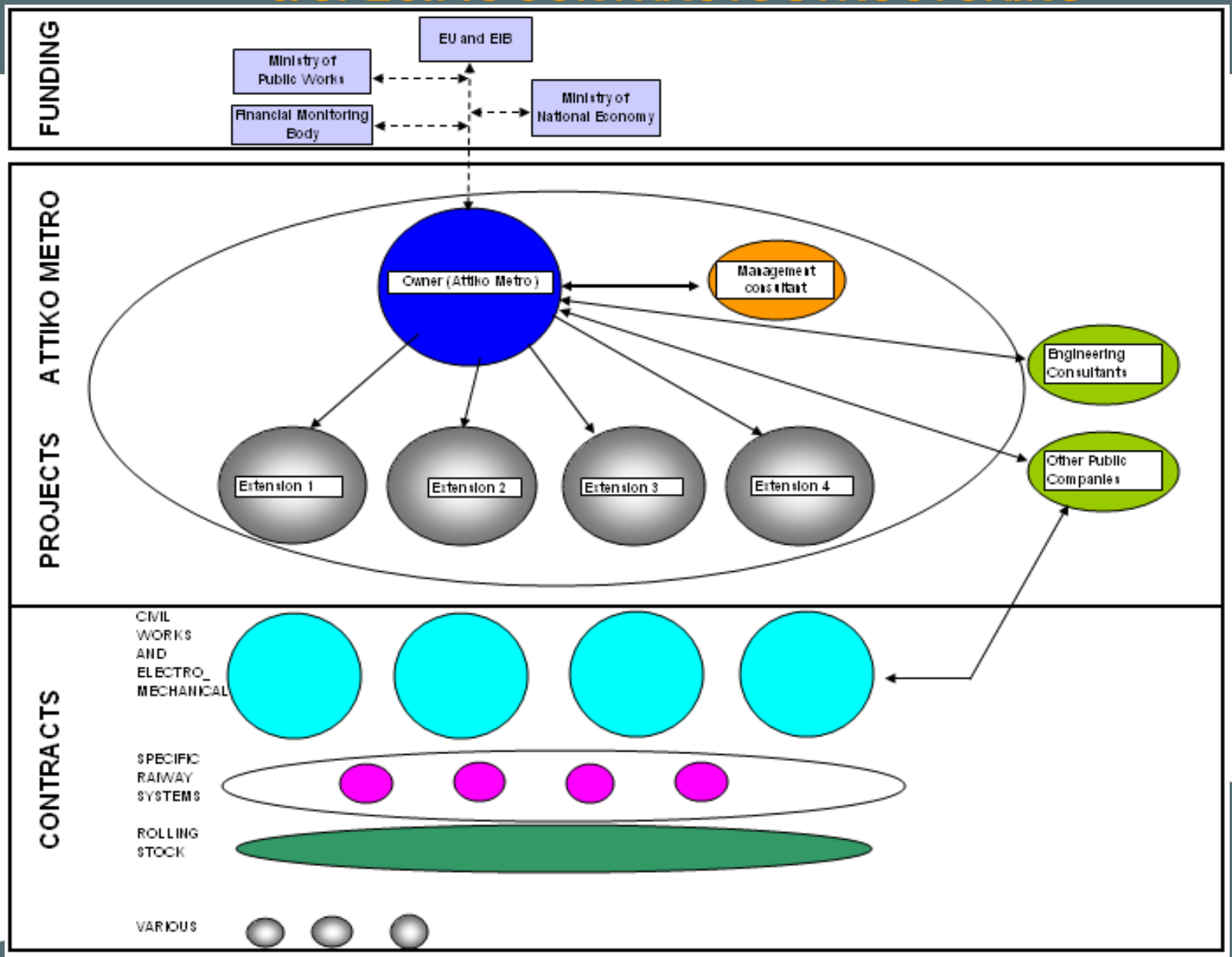
ATHENS METRO BASE PROJECT (1992-2000)
MANAGEMENT STRUCTURE - LUMPSUM TURNKEY CONTRACT



ATHENS METRO 1st PHASE EXTENSIONS PROJECTS (2000-2004)
MANAGEMENT STRUCTURE - MULTI CONTRACTS STRUCTURING



ATHENS METRO 2nd PHASE EXTENSIONS PROJECTS MANAGEMENT STRUCTURE & SPECIFIC CONTRACTS STRUCTURING



MODERN PROJECT FUNDING TOOLS

- **PPPs (Public – Private – Partnerships) with one or more Private entities. Typically, the capital costs of Metro projects are too expensive for PPPs but over several Private investors, land owners, business developers, etc, such a scheme may be feasible.**
- **Transfer of the Metro Operations and Maintenance of existing plus new metro lines to Private Entities and then enter into PPPs with them for building the new projects (under investigation as to its viability)**
- **Capture of Land use value increase near new station areas**
- **Project Bonds initiative for commercially viable projects.**
- **Dedicated station naming rights - company brands**
- **Renting of optical fibers in tunnels to telecom companies**
- **In all of the above options above, a closed Fare Collection system with gates is imperative.**

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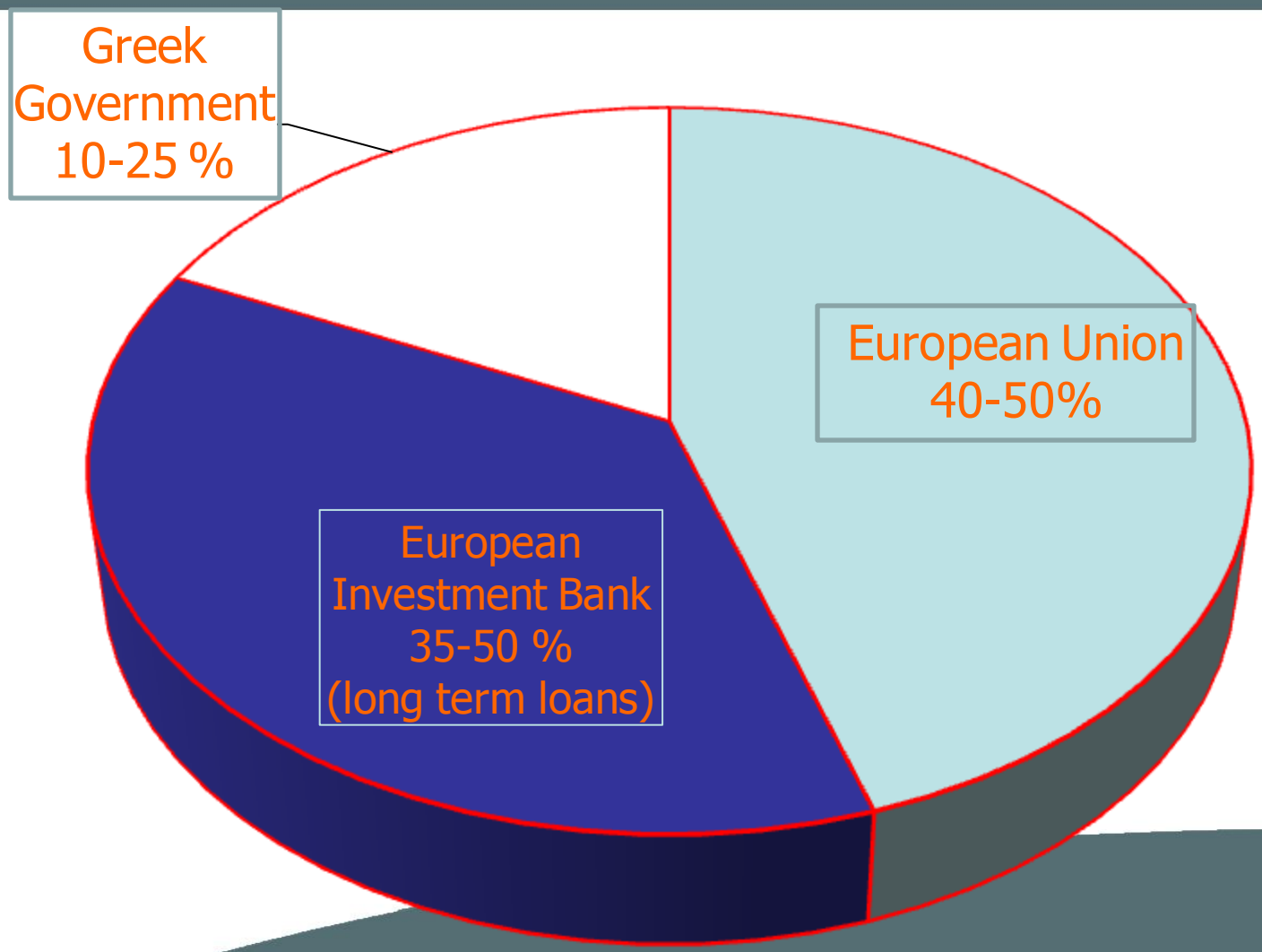
Projects funding structure



Station construction works – Temporary supporting struts

Station construction works – Concreting at night hours

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THANK YOU FOR YOUR ATTENTION

EETC, Athens, 28 Sept. – 1 Oct 2014