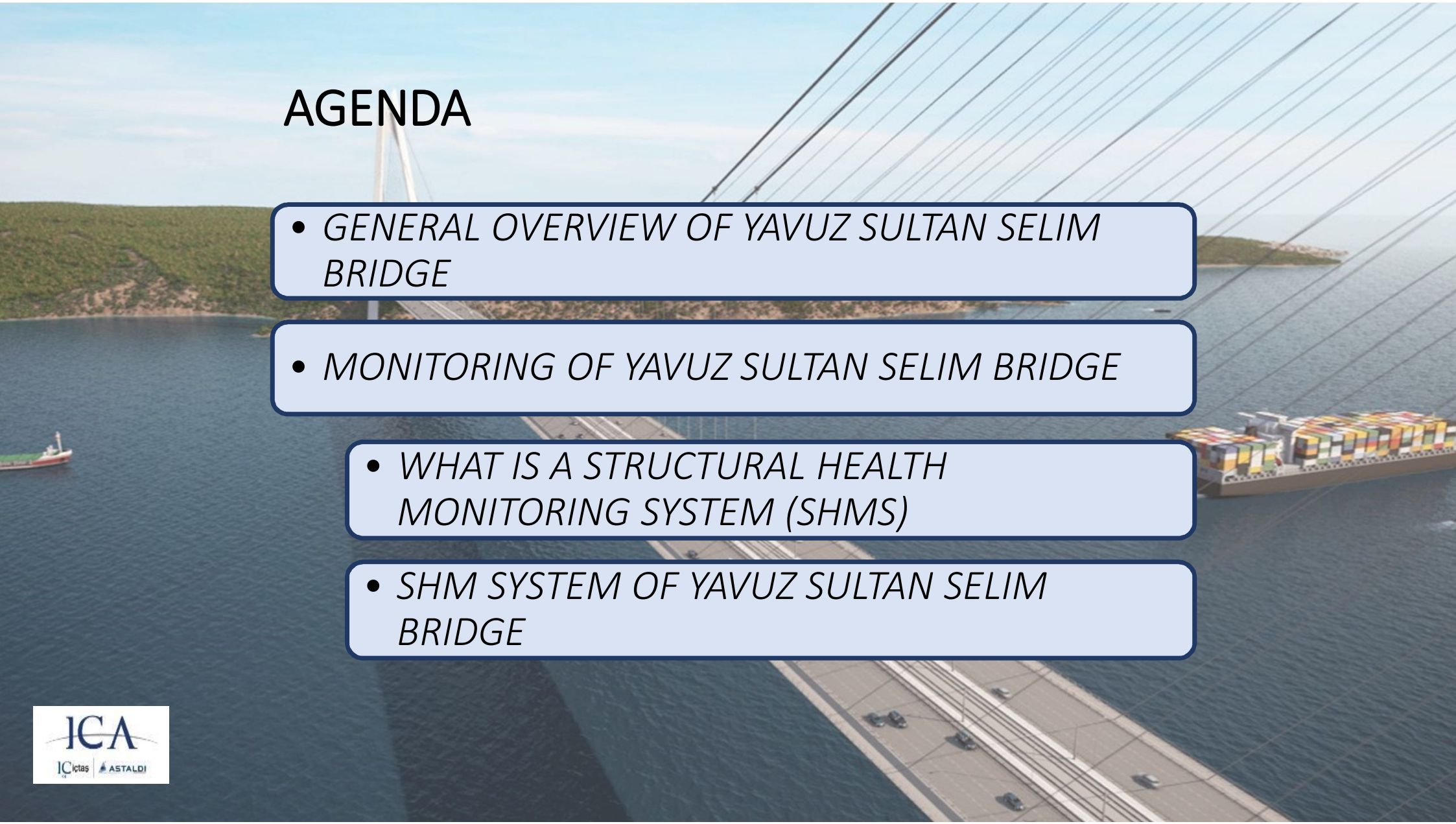
YAVUZ SULTAN SELIM BRIDGE STRUCTURAL HEALTH MONITORING SYSTEM

May 2018



AGENDA

- *GENERAL OVERVIEW OF YAVUZ SULTAN SELIM BRIDGE*
- *MONITORING OF YAVUZ SULTAN SELIM BRIDGE*
- *WHAT IS A STRUCTURAL HEALTH MONITORING SYSTEM (SHMS)*
- *SHM SYSTEM OF YAVUZ SULTAN SELIM BRIDGE*

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GENERAL OVERVIEW OF YAVUZ SULTAN SELIM BRIDGE

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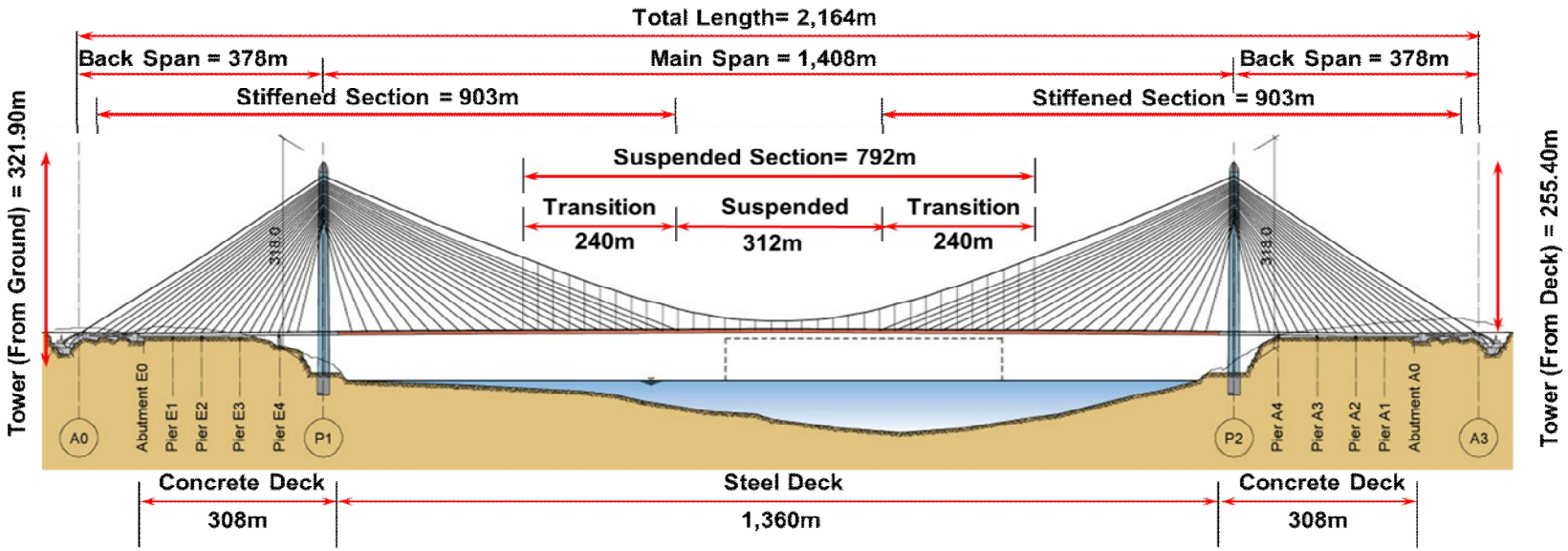


- Hybrid cable-stayed/suspended system
- Total length of **2.164 m**
- Main span of **1.408 m**
- Deck hosts a total of 8 road lanes and 2 railway lanes : total width of **59 m**
- Towers' height: Europe **322 m** – Asia: 318 m
- Clearance height: **64 m**

MONITORING OF YAVUZ SULTAN SELIM BRIDGE

Yavuz Sultan Selim Bridge Main Control Room

WHAT IS A STRUCTURAL HEALTH MONITORING SYSTEM (SHMS)

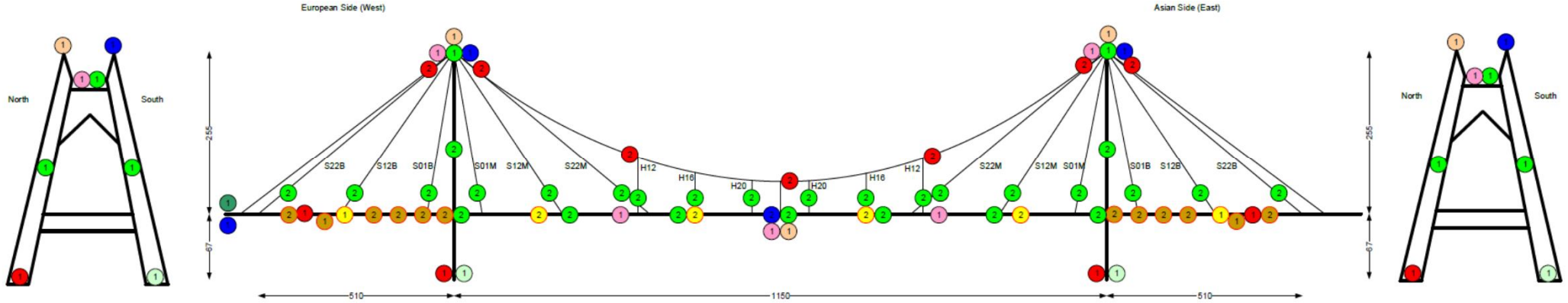
The term “Structural Health Monitoring (SHM)” refers to continuous inspection of a structure by analyzing real time records coming from various types of sensors that are strategically placed on the structure.

The main objective in a general SHM system is to monitor the behaviour of the structure and its components continuously, and to identify its dynamic characteristics.

An integral part of the SHM system is the software that analyses and interprets the continuous data in real time, and issue warnings at several levels when there is a possibility of safety risk.

SHM SYSTEM OF THE YAVUZ SULTAN SELIM BRIDGE

COMPONENTS OF THE SHMS



- 3D ACC (Qty=18)
- 2D ACC (Qty=56)
- 1D ACC (Qty=2)
- GPS (Qty=5)
- 2D Tiltmeter (Qty=5)
- Wind sensor (speed, direction) (Qty=3)
- Weather station (speed, direction, T, P, RH) (Qty=1)
- Displacement (Qty=22)
- Temperature sensor (Qty=10)

Total Number of Sensors: **126**

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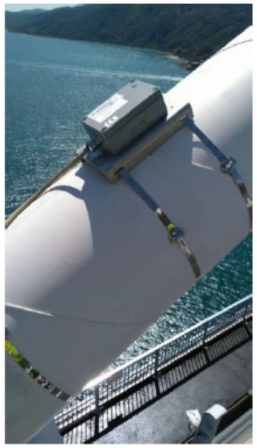
COMPONENTS OF THE SHMS

ACCELEROMETERS

18 Accelerometers 3D

56 Accelerometers 2D

2 Accelerometers 1D



Accelerometers provide frequencies of the bridge elements which is useful for following the bridge behaviour over the years.

On cables, the frequencies can be used to measure the tension in cables.

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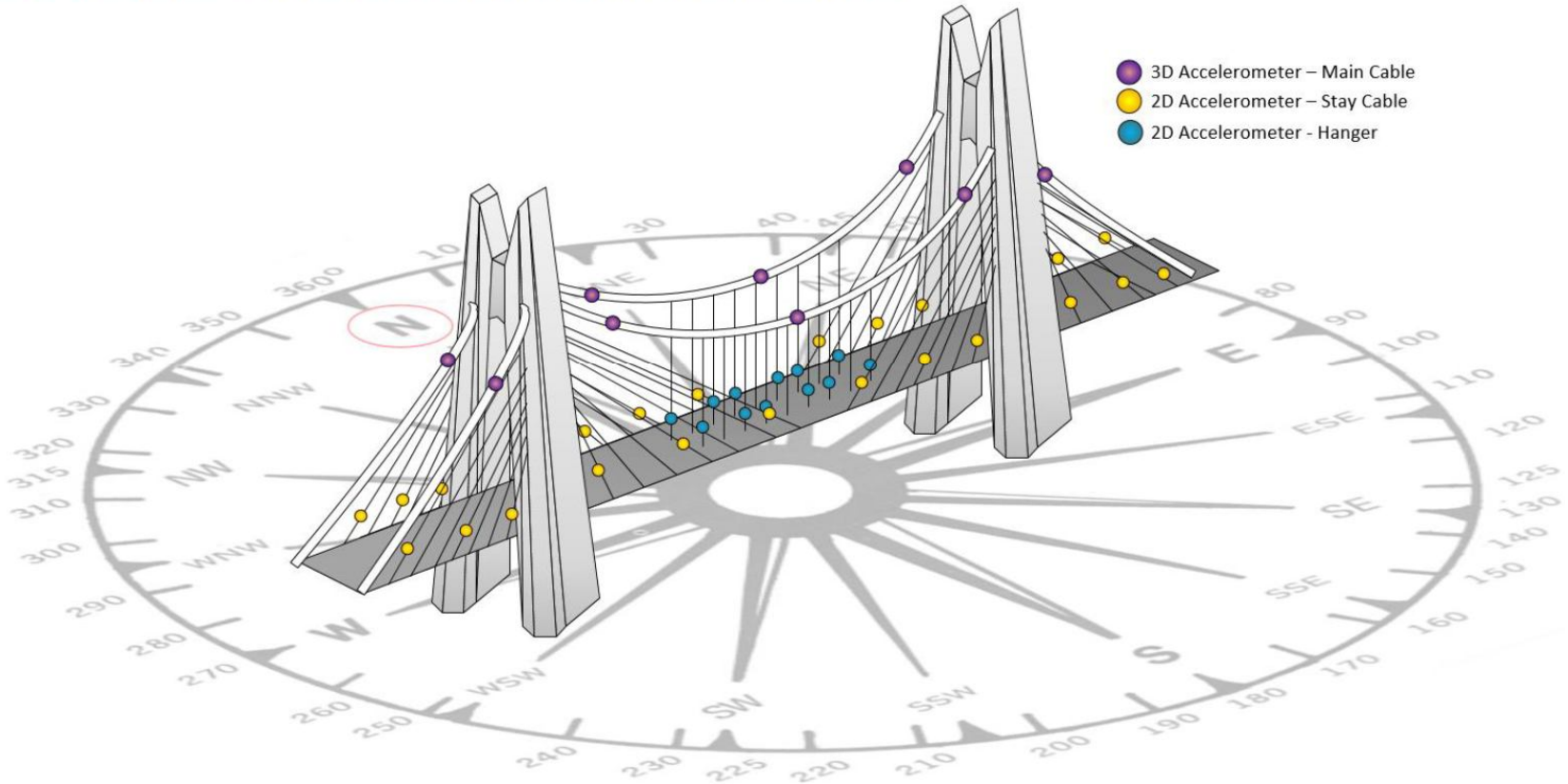
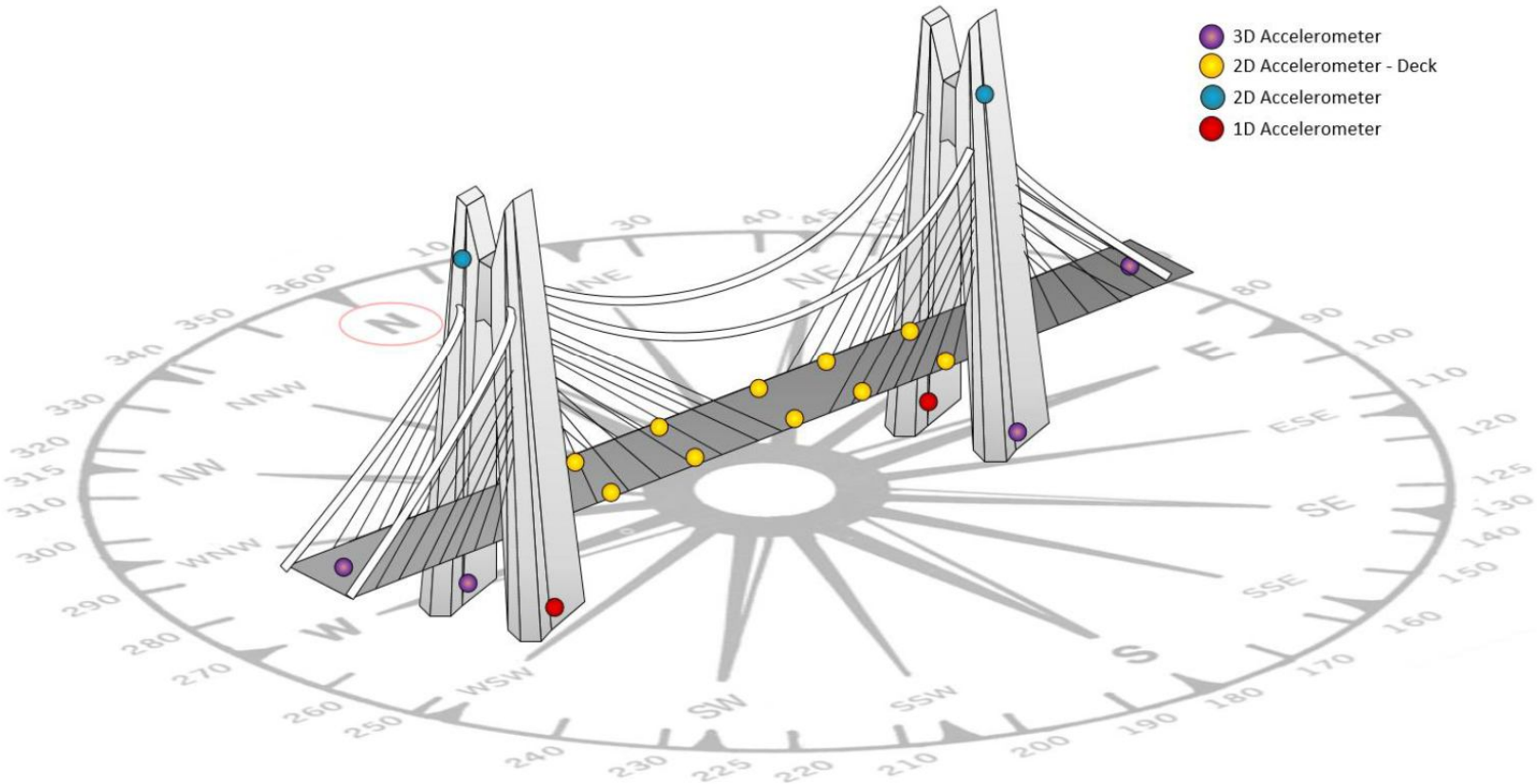
COMPONENTS OF THE SHMS

CABLE ACCELEROMETERS



COMPONENTS OF THE SHMS

STRUCTURE ACCELEROMETERS

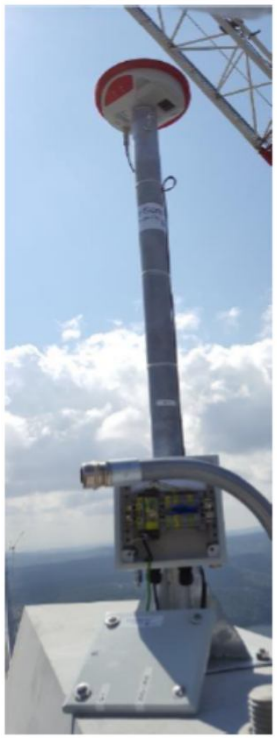


COMPONENTS OF THE SHMS

GPS LOCATION

1 Reference GPS

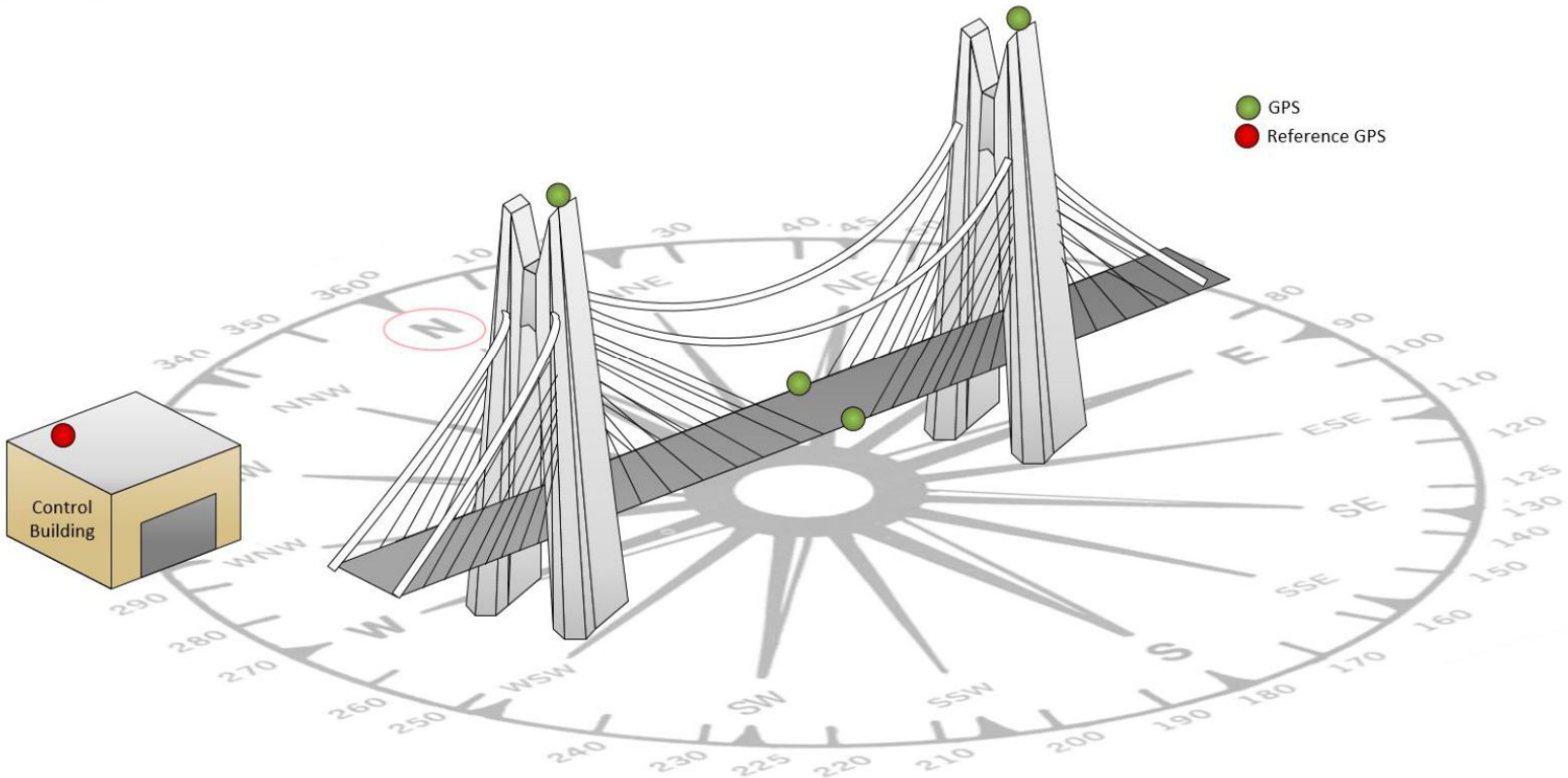
4 GPS sensors



GPS sensors installed at the top of each tower and center of the deck will enable measurements of deck deflection and tower movement.

COMPONENTS OF THE SHMS

GPS



COMPONENTS OF THE SHMS

WEATHER SENSORS

1 Weather Station

5 Wind Sensor

The Weather Station is equipped with 1 anemometer which measures:
- Air Temperature
- Air Humidity
- Air Pressure

Wind sensor (Anemometer) measures the speed and direction of the wind.

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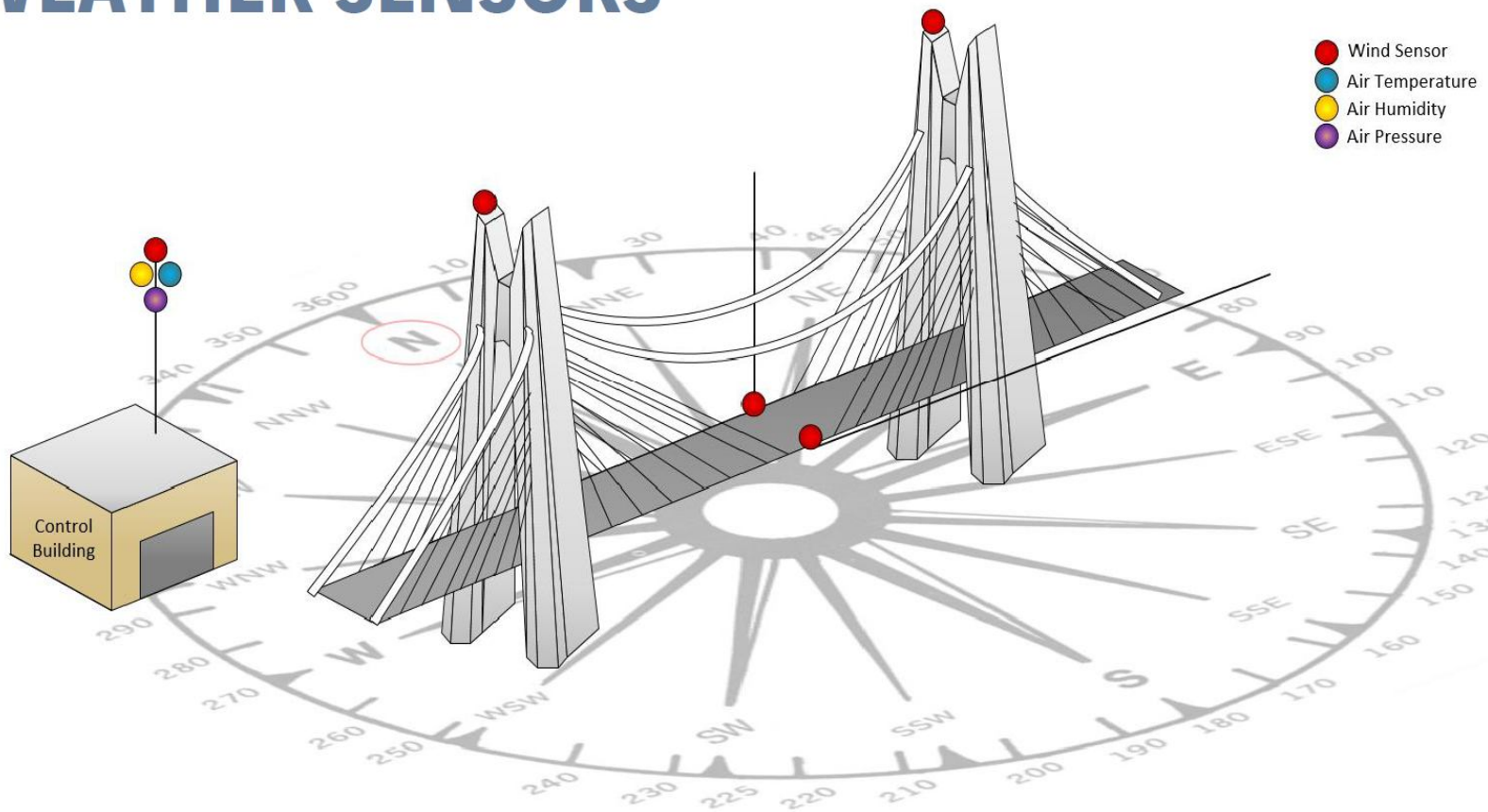
COMPONENTS OF THE SHMS

WEATHER SENSORS



COMPONENTS OF THE SHMS

INCLINOMETERS

2 at tower Top

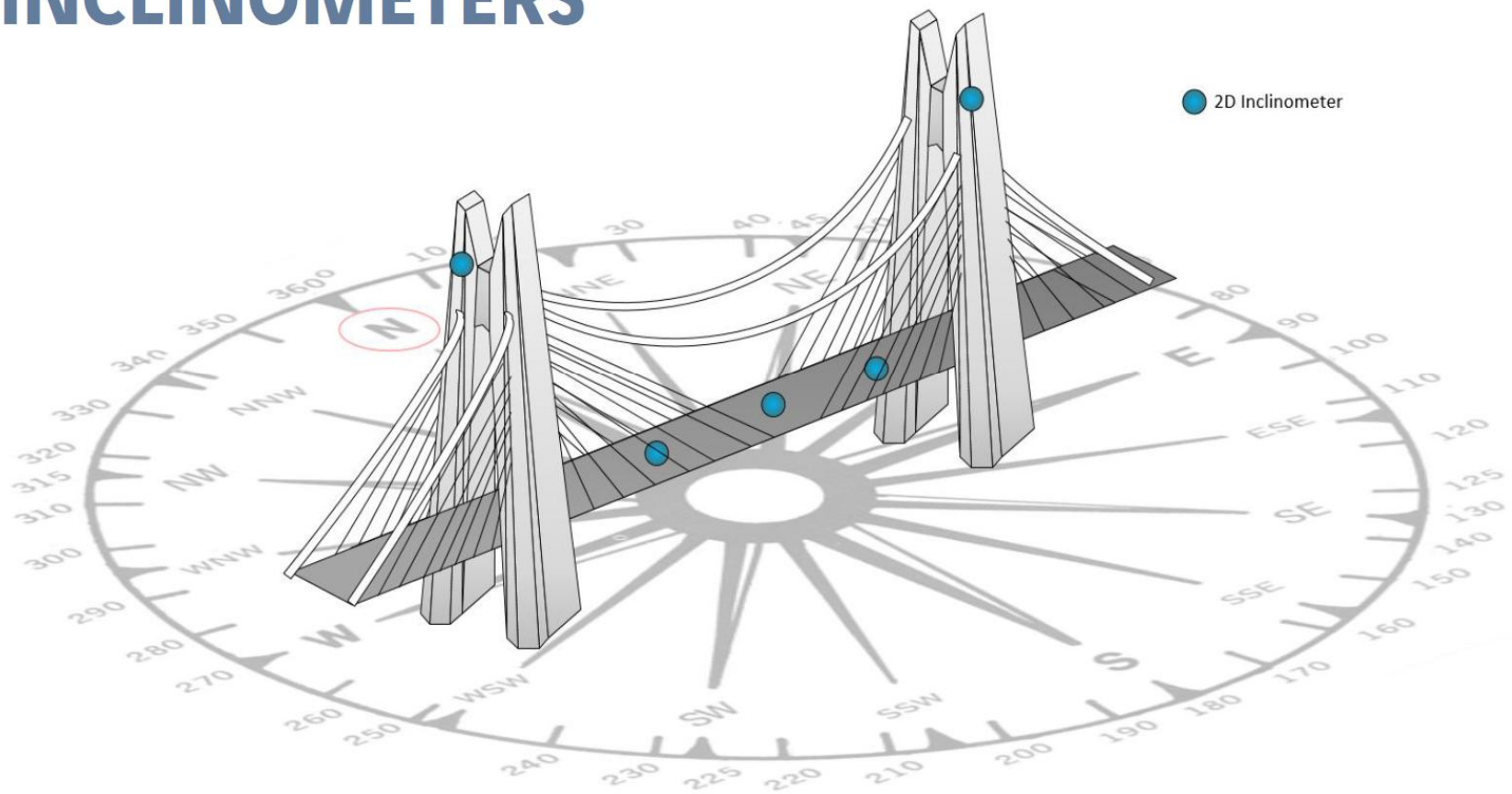
3 inside Steel Deck

(Tiltmeter = Inclinometer)

Inclinometers measure inclination of towers and deck on a +/- 3°scale.

COMPONENTS OF THE SHMS

INCLINOMETERS

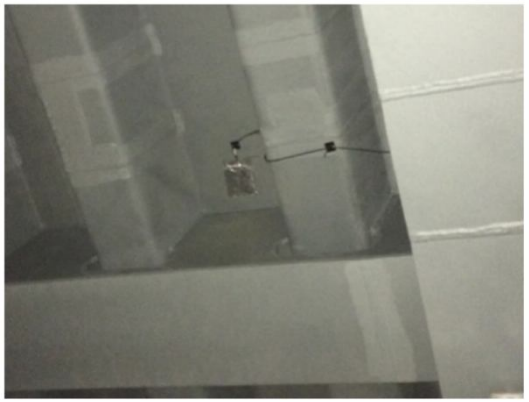


COMPONENTS OF THE SHMS

DECK TEMPERATURE

2 Temperature sensors in concrete deck

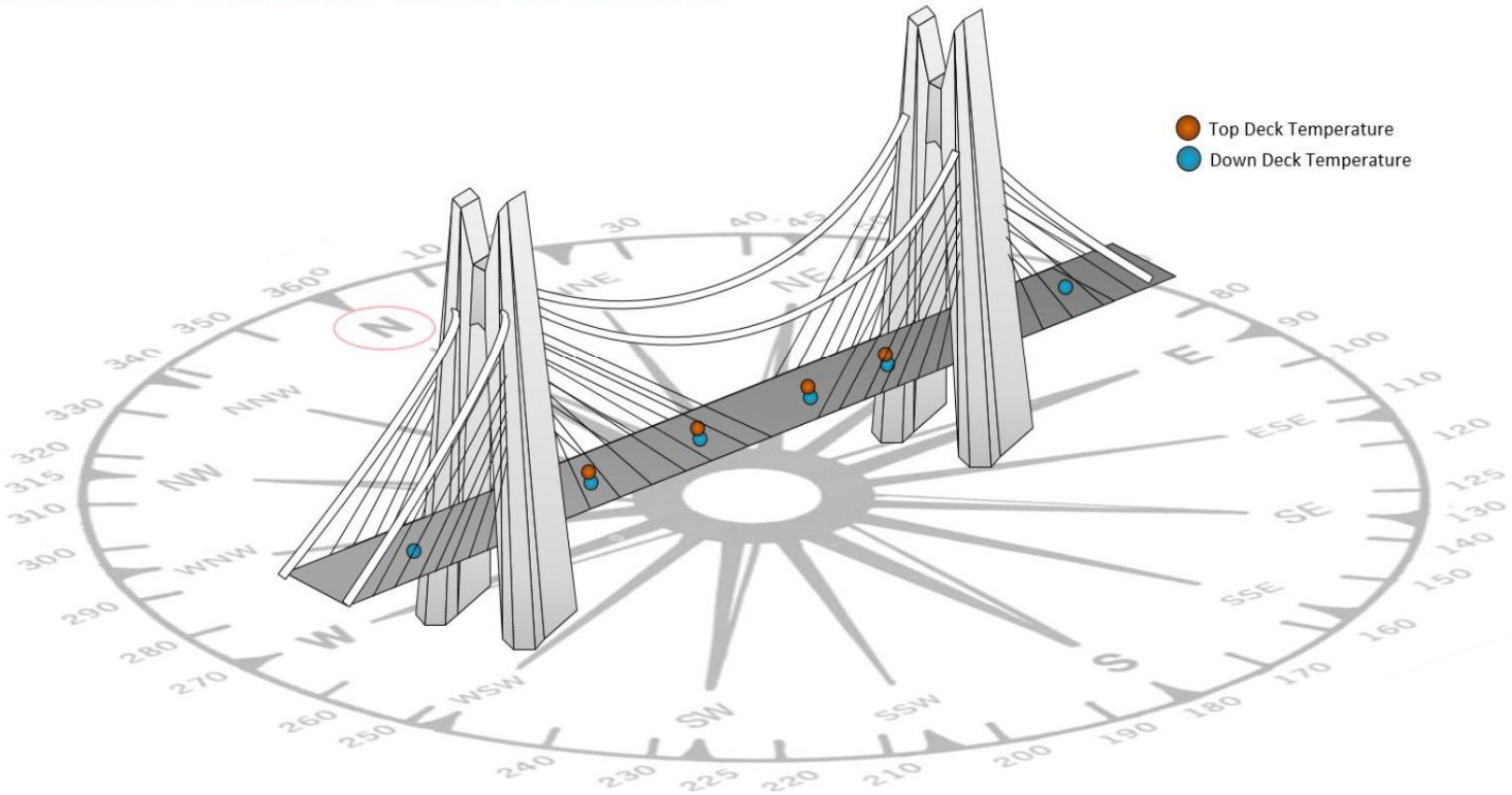
10 Temperature sensors in steel deck



Temperature sensors measure the surface temperature on the top and bottom of the concrete and steel decks.

COMPONENTS OF THE SHMS

DECK TEMPERATURE



COMPONENTS OF THE SHMS

DISPLACEMENT SENSORS

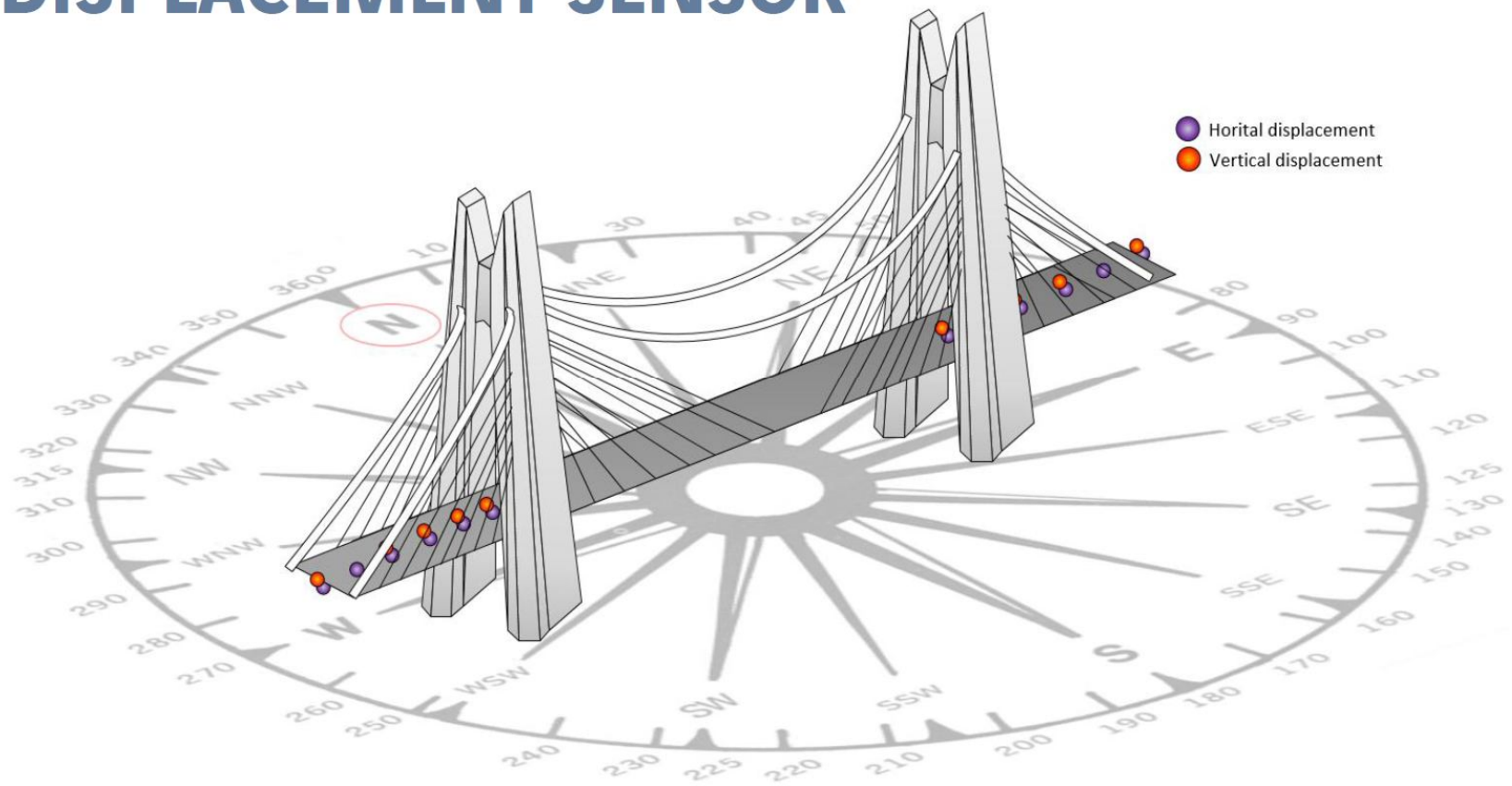
10 Vertical Displacements

12 Horizontal Displacements

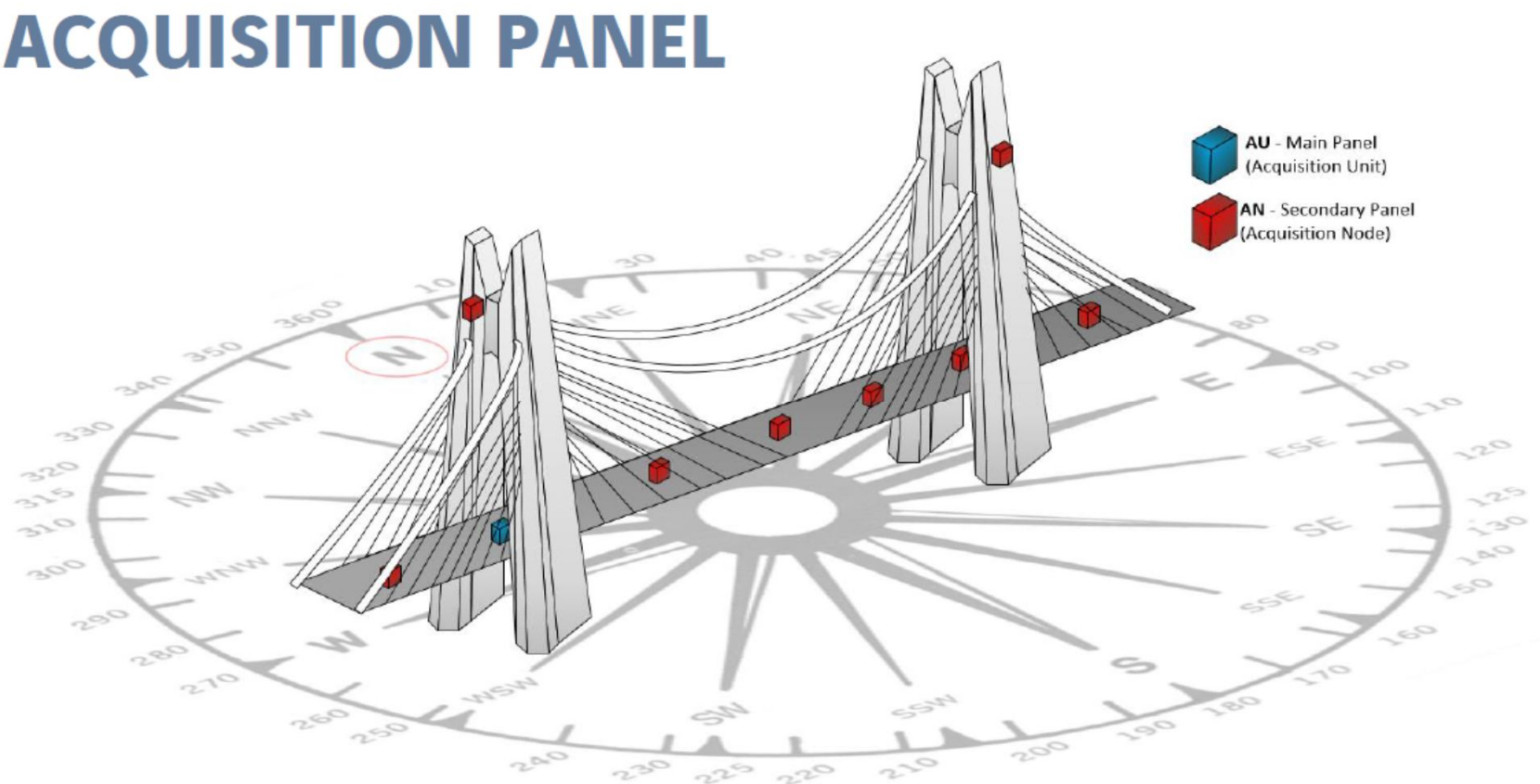
Displacement sensors measure the displacement of the bearing, vertically and horizontally.

COMPONENTS OF THE SHMS

DISPLACEMENT SENSOR

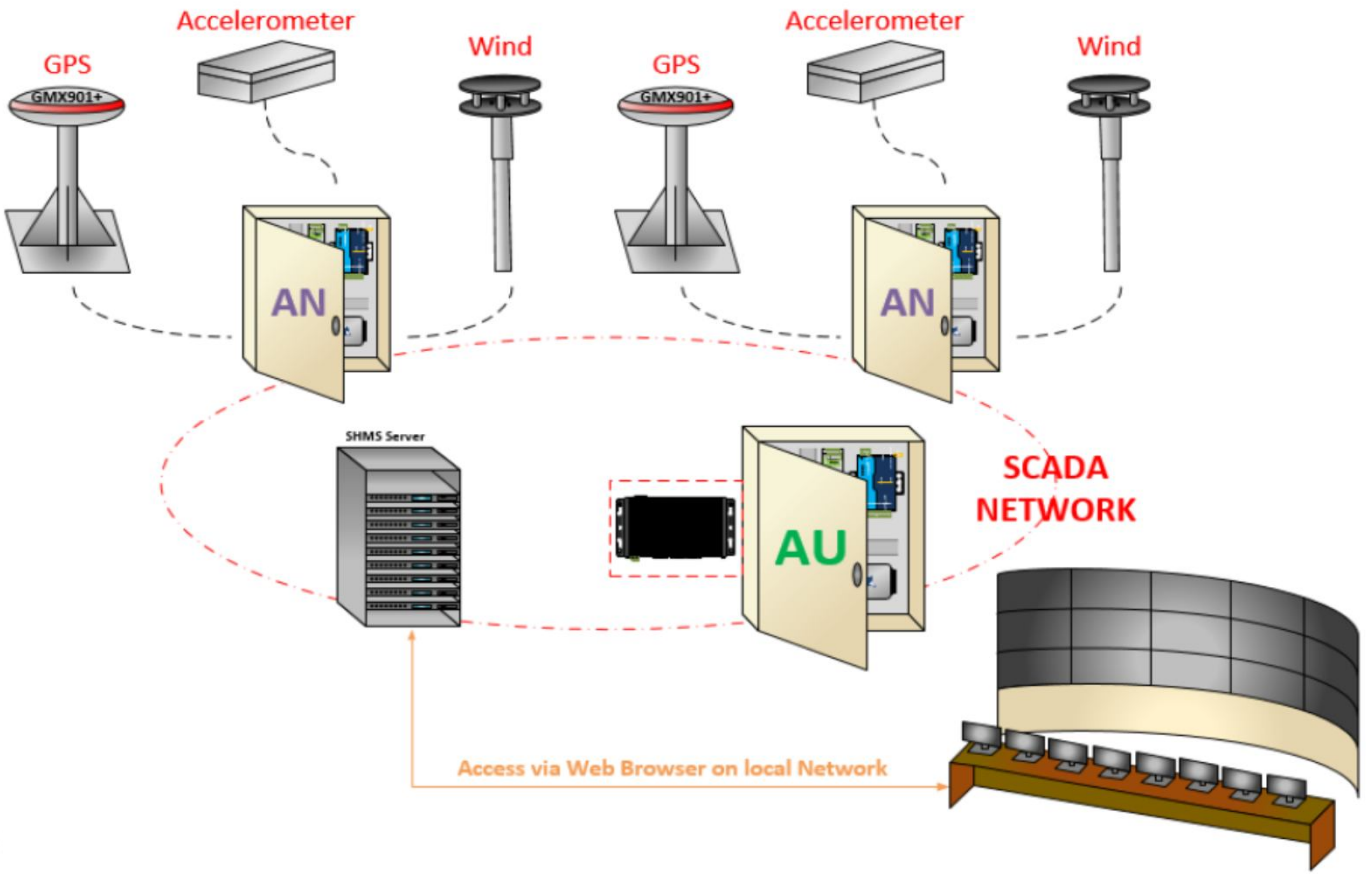


ACQUISITION OF DATA



Sensors are distributed along the YSS Bridge in order to measure structural attributes such as temperature, tilt, vibration, etc. The signals from these sensors are digitized in 9 acquisition nodes installed locally on the bridge as per above.

ACQUISITION OF DATA



The Acquisition nodes are connected together.

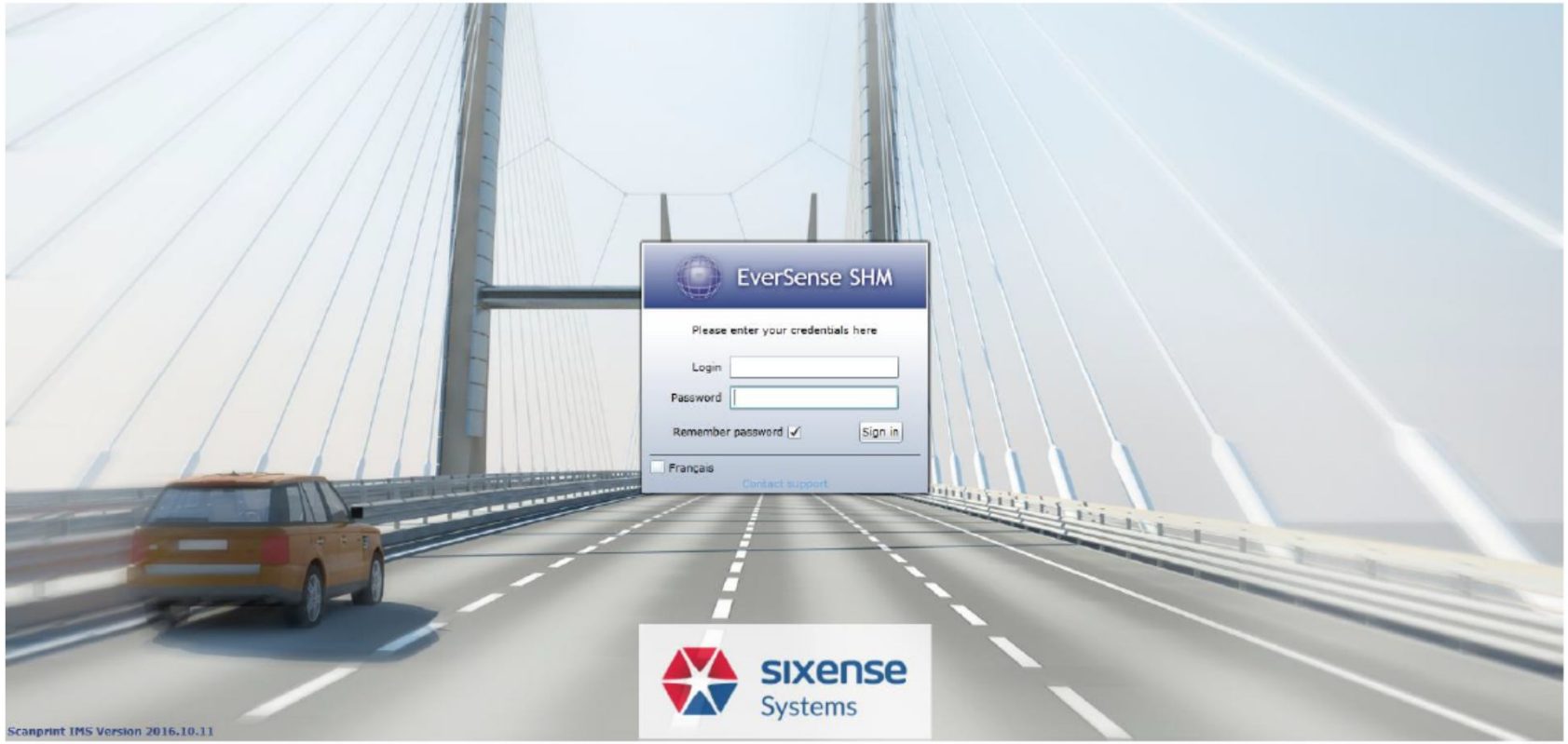
At the end of the chain, the Acquisition Unit collects the measurements and performs the signal processing and the recording of the data. The data are then transferred through the internet to our local servers.

MAIN OBJECTIVES OF THE SHMS DATA

The three main objectives of this interpretation and exploitation of SHMS data are:

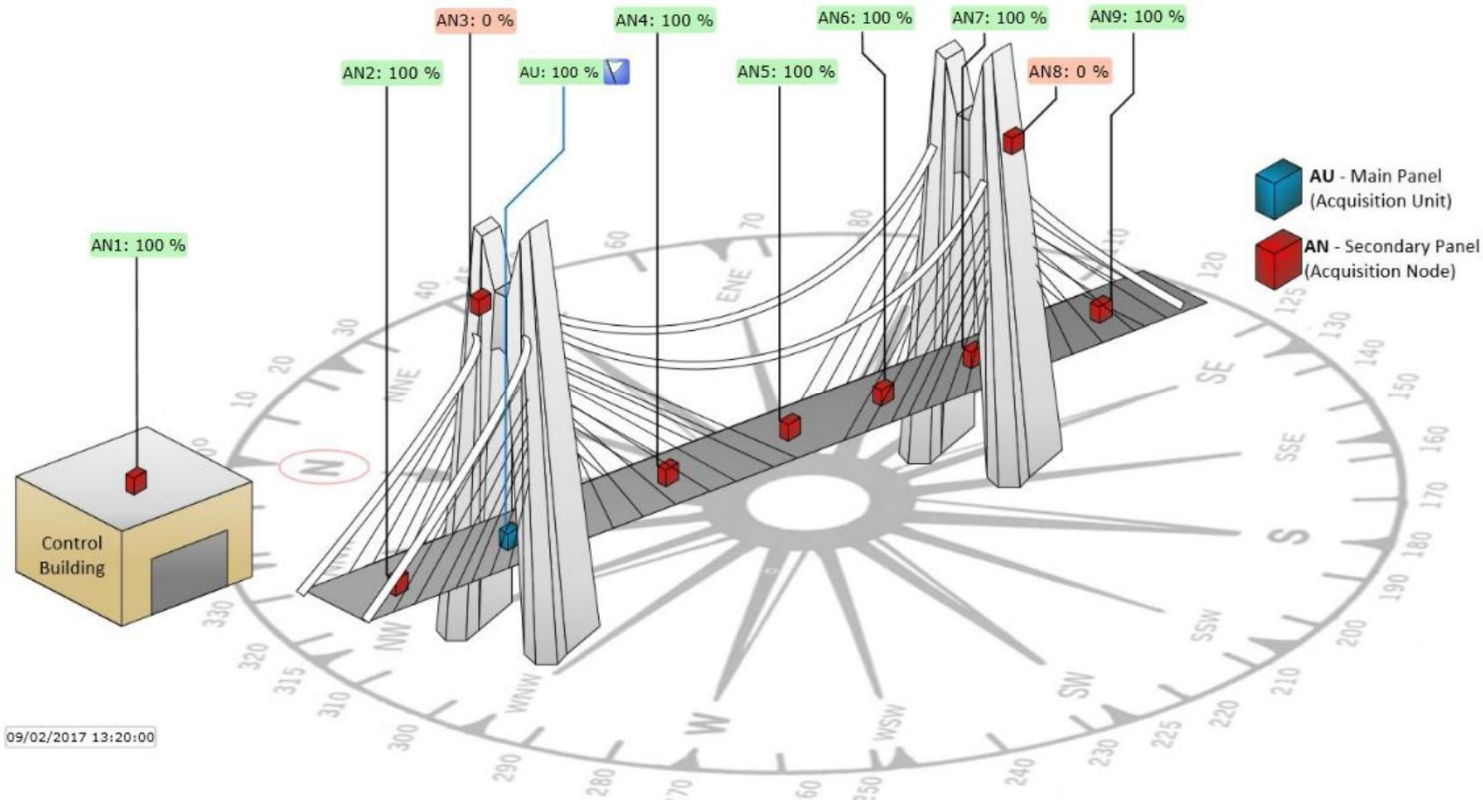
- ✓ The first and the most important one is to control the operational conditions of the bridge to guarantee third party safety,
- ✓ The second one is to control if the actual bridge behavior is in line with design forecasts,
- ✓ The third and last one is to control through time the ageing of the bridge.

ABOUT THE SOFTWARE



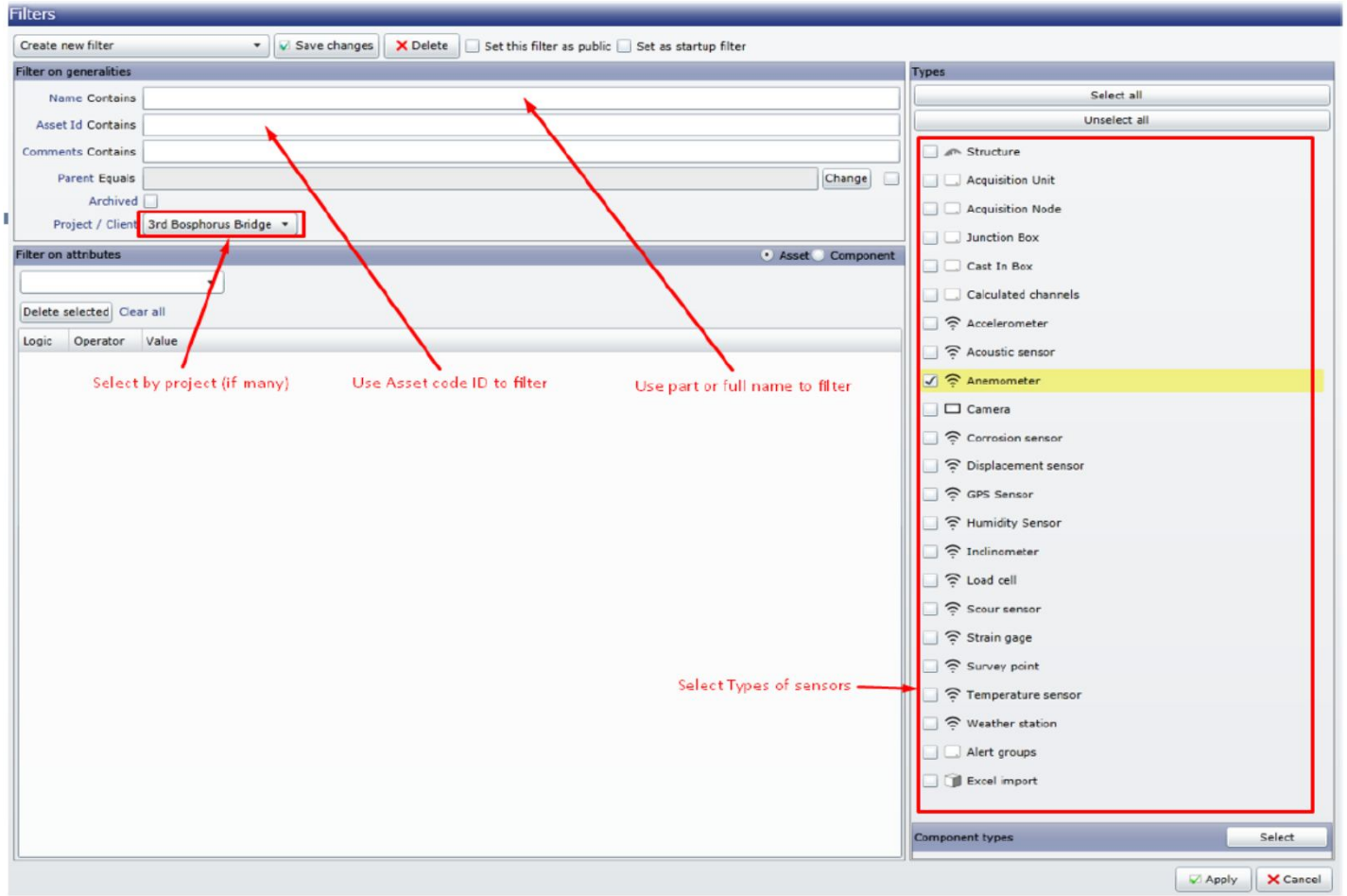
ABOUT THE SOFTWARE

SYNOPTICS



The System Status view displays which panels are working and which are not. If a panel is not working, check power and network at its location.

ABOUT THE SOFTWARE

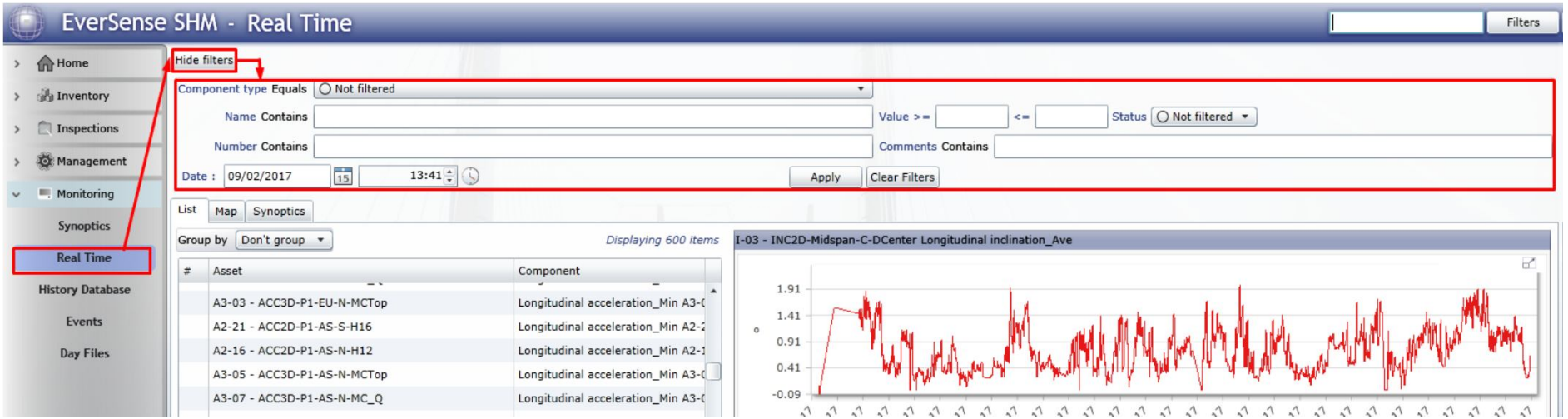


Custom filter allows us to select assets by type, group, name or project.

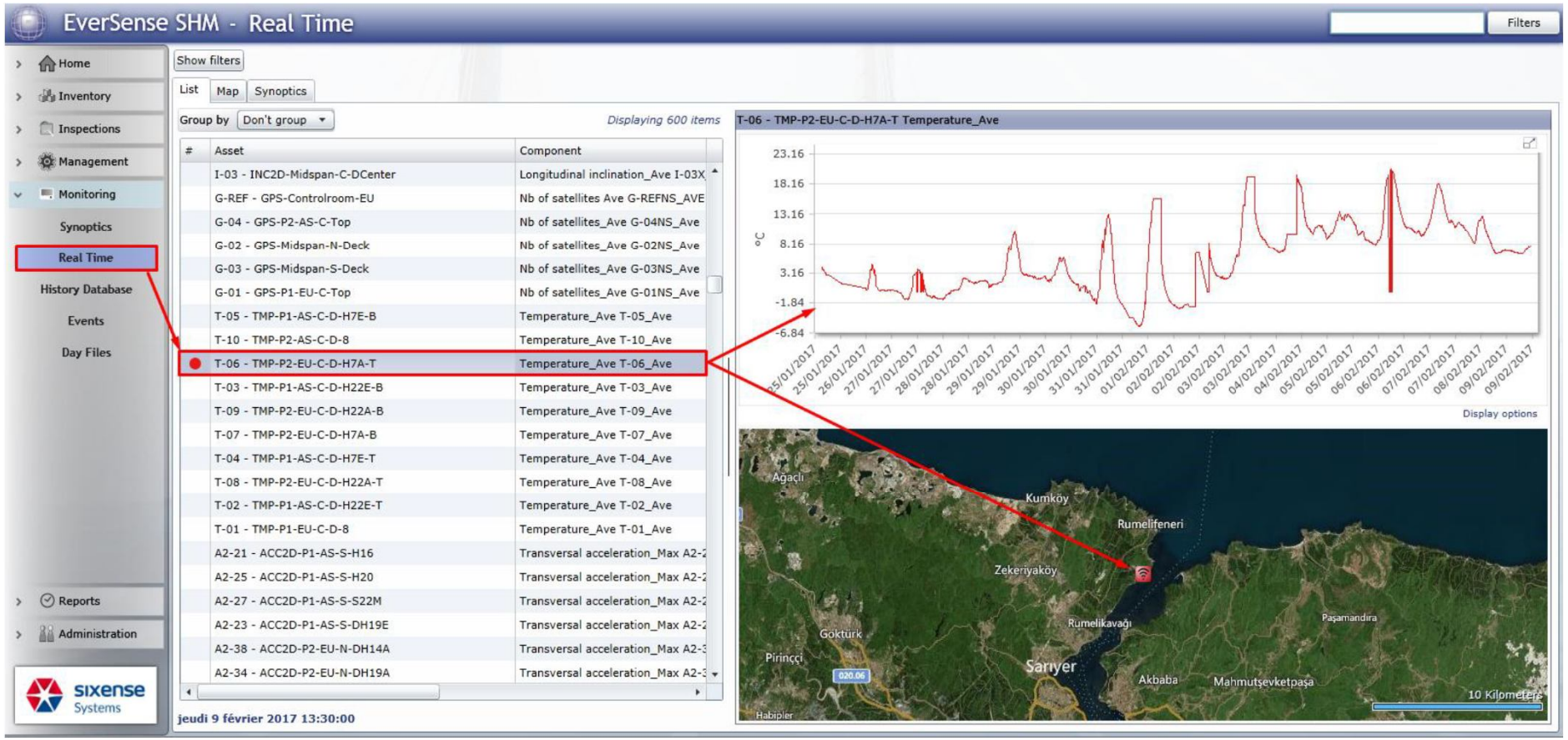
Filters can be saved to be easily accessible.

REAL TIME

Real time function allows:
- The most current data received to be viewed
- For values to be received every 10 minutes
- To view sensor by sensor
- To filter which sensor to display



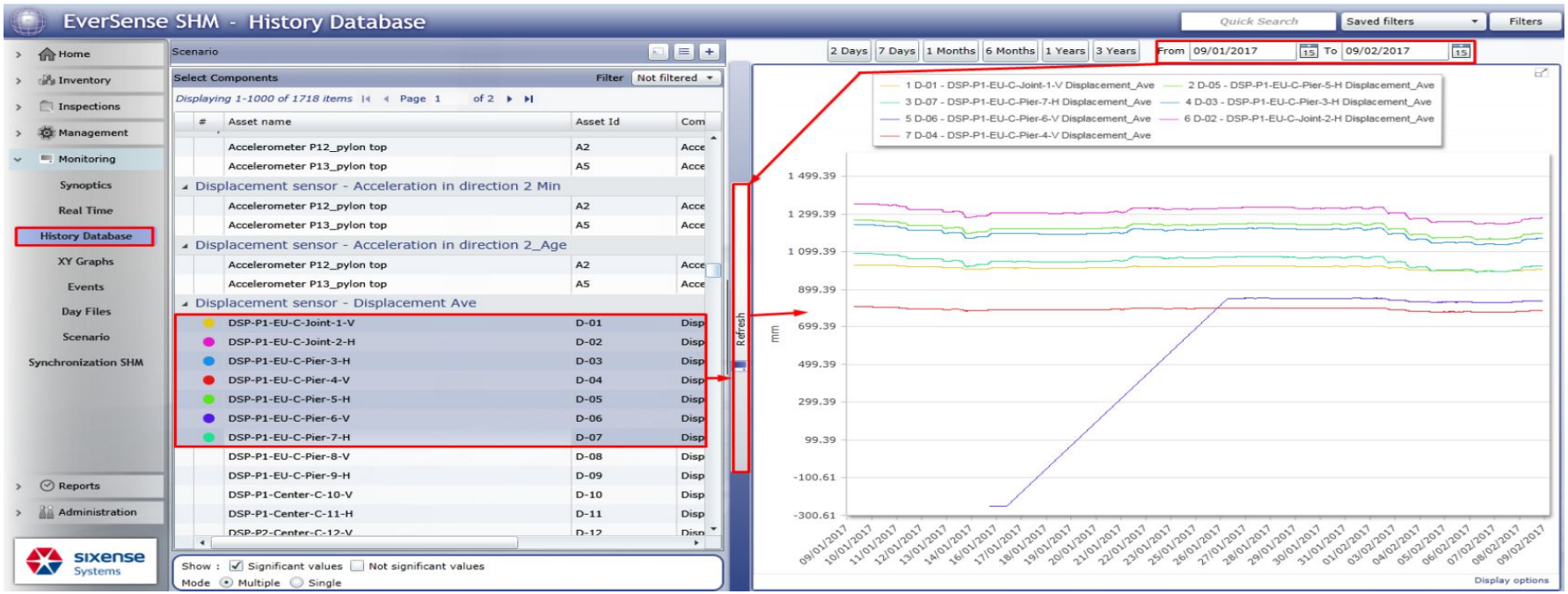
REAL TIME


EverSense SHM - Real Time
Filters
Home
Inventory
Inspections
Management
Monitoring
Synoptics
Real Time
History Database
Events
Day Files
Reports
Administration
sixense Systems
Show filters
List
Map
Synoptics
Group by
Don't group
Displaying 600 items
Asset Component
I-03 - INC2D-Midspan-C-DCenter Longitudinal inclination_Ave I-03X
G-REF - GPS-Controlroom-EU Nb of satellites Ave G-REFNS_AVE
G-04 - GPS-P2-AS-C-Top Nb of satellites_Ave G-04NS_Ave
G-02 - GPS-Midspan-N-Deck Nb of satellites_Ave G-02NS_Ave
G-03 - GPS-Midspan-S-Deck Nb of satellites_Ave G-03NS_Ave
G-01 - GPS-P1-EU-C-Top Nb of satellites_Ave G-01NS_Ave
T-05 - TMP-P1-AS-C-D-H7E-B Temperature_Ave T-05_Ave
T-10 - TMP-P2-AS-C-D-8 Temperature_Ave T-10_Ave
T-06 - TMP-P2-EU-C-D-H7A-T Temperature_Ave T-06_Ave
T-03 - TMP-P1-AS-C-D-H22E-B Temperature_Ave T-03_Ave
T-09 - TMP-P2-EU-C-D-H22A-B Temperature_Ave T-09_Ave
T-07 - TMP-P2-EU-C-D-H7A-B Temperature_Ave T-07_Ave
T-04 - TMP-P1-AS-C-D-H7E-T Temperature_Ave T-04_Ave
T-08 - TMP-P2-EU-C-D-H22A-T Temperature_Ave T-08_Ave
T-02 - TMP-P1-AS-C-D-H22E-T Temperature_Ave T-02_Ave
T-01 - TMP-P1-EU-C-D-8 Temperature_Ave T-01_Ave
A2-21 - ACC2D-P1-AS-S-H16 Transversal acceleration_Max A2-2
A2-25 - ACC2D-P1-AS-S-H20 Transversal acceleration_Max A2-2
A2-27 - ACC2D-P1-AS-S-S22M Transversal acceleration_Max A2-2
A2-23 - ACC2D-P1-AS-S-DH19E Transversal acceleration_Max A2-2
A2-38 - ACC2D-P2-EU-N-DH14A Transversal acceleration_Max A2-3
A2-34 - ACC2D-P2-EU-N-DH19A Transversal acceleration_Max A2-3
jeudi 9 février 2017 13:30:00
T-06 - TMP-P2-EU-C-D-H7A-T Temperature_Ave
°C
23.16
18.16
13.16
8.16
3.16
-1.84
-6.84
Display options
Ağaçlı
Kumköy
Rumelifeneri
Zekeriyaköy
Göktürk
Rumelikavağı
Paşamandıra
Pirinççi
Sarıyer
Akbaba
Mahmutşevketpaşa
Habipler
10 Kilometers

HISTORY DATABASE

- The History Database function allows us to go back to previous records for each sensor.

- For example, we are able to refer back to values from extreme events, such as strong earthquakes, wind storms, unusual extreme loadings etc to evaluate and compare values as required.



CONCLUSION

The ability to continuously monitor the integrity of our bridge offers the opportunity to reduce maintenance and inspection costs, and ensure a more reliable inspection than traditional methodologies.

The bridge may react in different ways while operational. It is very important that all of these changes are recorded and kept under control. It is for this reason that the bridge is inspected on a routine and extraordinary situation basis. During these inspections, the data collected from the sensors on the bridge are used. The structural health monitoring system needs to be continuously monitored for the interpretation and analysis of these data.

Thank You. Any Questions?

Meltem AKYÜZ