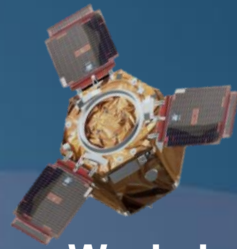




TAI



Workshop on Simulation for European Space Programmes (SESP)

24-26 March 2015

ESA-ESTEC, Noordwijk, The Netherlands

SDYA: A Real Time and Distributed Software Verification Infrastructure for Validating Flight Software (On-Board Software) at System Integration Laboratory.

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HISTORICAL ROADMAP

1984

1986

1989

1993

1995

2003

2014

SATELLITE



INDIGENOUS DESIGN JOINT DEVELOPMENT



MODERNIZATION SYSTEMS INTEGRATION



AEROSTRUCTURES



CO-PRODUCTION



1984

1986

1989

1993

1995

2003

2014

SPACE SYSTEMS



e-Room

TEAMCENTER



ModelSim



Altium



Space Systems

Program Management

Assembly, Integration and Test

Systems Engineering

Hardware Engineering

Software Engineering



DOORS



TAI

PROCESS DEVELOPMENT and CERTIFICATES

TUSAŞ YÖNETİM SİSTEMLERİ SERTİFİKALARI VE PROSES ONAYLARI



AS EN 9100 AQAP-2110 EASA-POA SSM-ÜrÖYÖ



ISO/IEC 27001



OHSAS 18001



THY

- AQAP-2110
- ISO-9001 : 2008
- AS/EN ISO 9100
- ISO 14001
- ISO/IEC 27001:2005
- OHSAS 18001:2007
- **THALES ALENIA SPACE Manufacturing Technology Certificate**



NADCAP-Tahribatsız Muayene



NADCAP-Kompozit



NADCAP-Kaynak



NADCAP-Kimyasal Prosester



NADCAP-Isıt İşlem



NADCAP-Yüzey Güçlendirme

- **ESA – ECSS (European Cooperation for Space Standardization)**
- **CMMI Level 3**

INTRODUCTION

“**SDYA**” stands for System Integration Laboratory (SIL) Verification Software Infrastructure

What are the main motivations, and objectives in developing SDYA ?

- Generic, real-time, distributed, and layered simulation environment
- Testing, integrating Flight (OBDH) Software at SIL
- No critical and direct third party dependency
- Supporting automated testing
- Providing API for external interfaces
- SMP-2 compliance
- Satisfying ECSS-E-ST-E40C, and DO-178B Tool Qualification requirements
- Reuse, easy integration with new simulation models
- CMMI Level-3 compliant TAI Process implementation

ROLE OF SIL & SDYA IN SIL

System Integration Laboratory provides an environment for integration & testing;

- Replaces the real avionics equipment with simulation model
- Communicates with Flight Software (OBDH, and Ground Station Command and Control Software)
- Uses real avionics interfaces (MIL-STD-1553, Serial, SpaceWire, Can Bus, etc.).
- Integrated test scenarios with SIL Verification Software is applied.

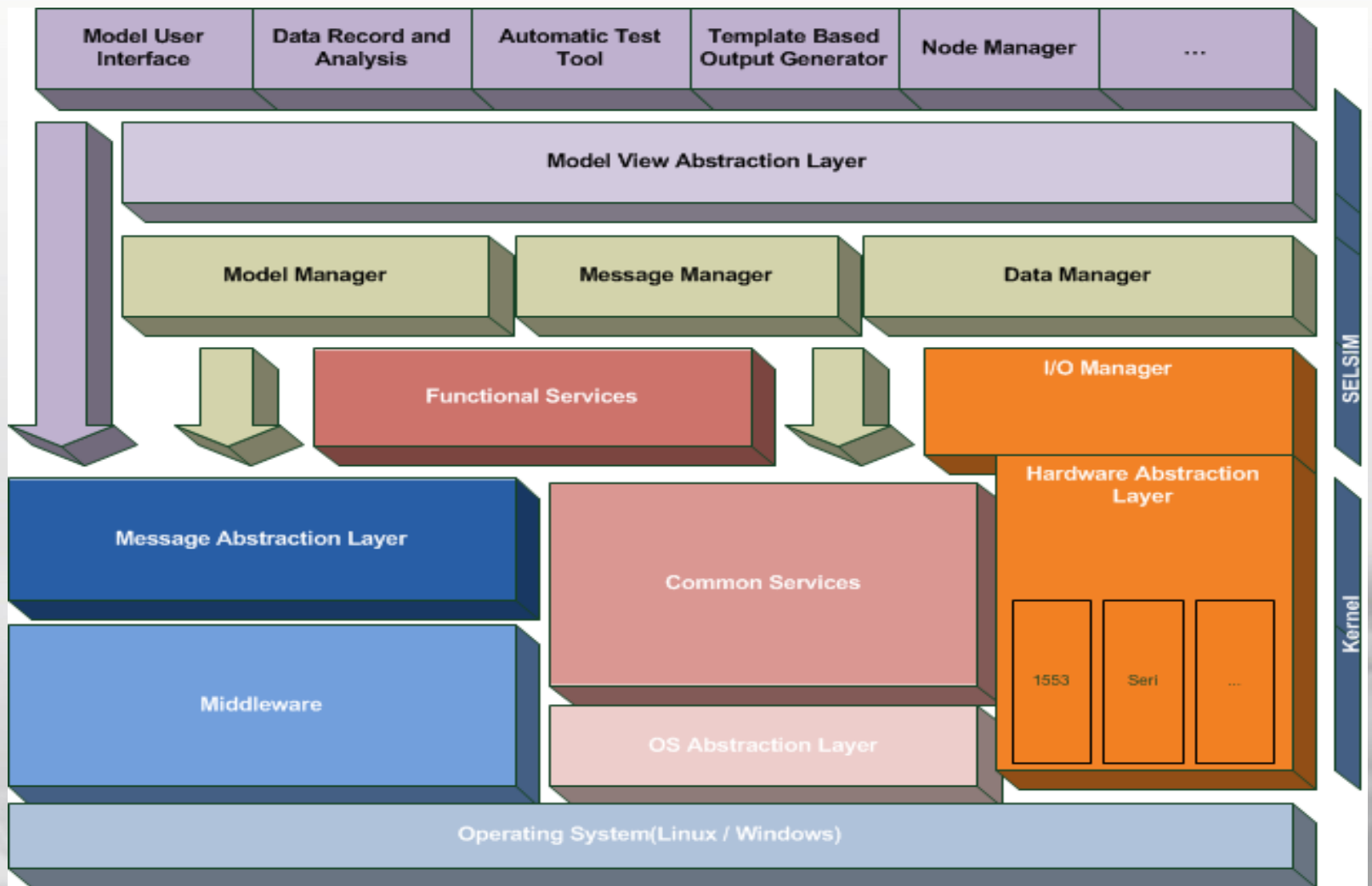


SIL Verification Software (based on SDYA) plays an important role in safety critical/reliable software development in the early stages of the projects by;

- Supporting the detection and resolution of critical errors
- Reducing technical risks and costs
- Shortening the development time.

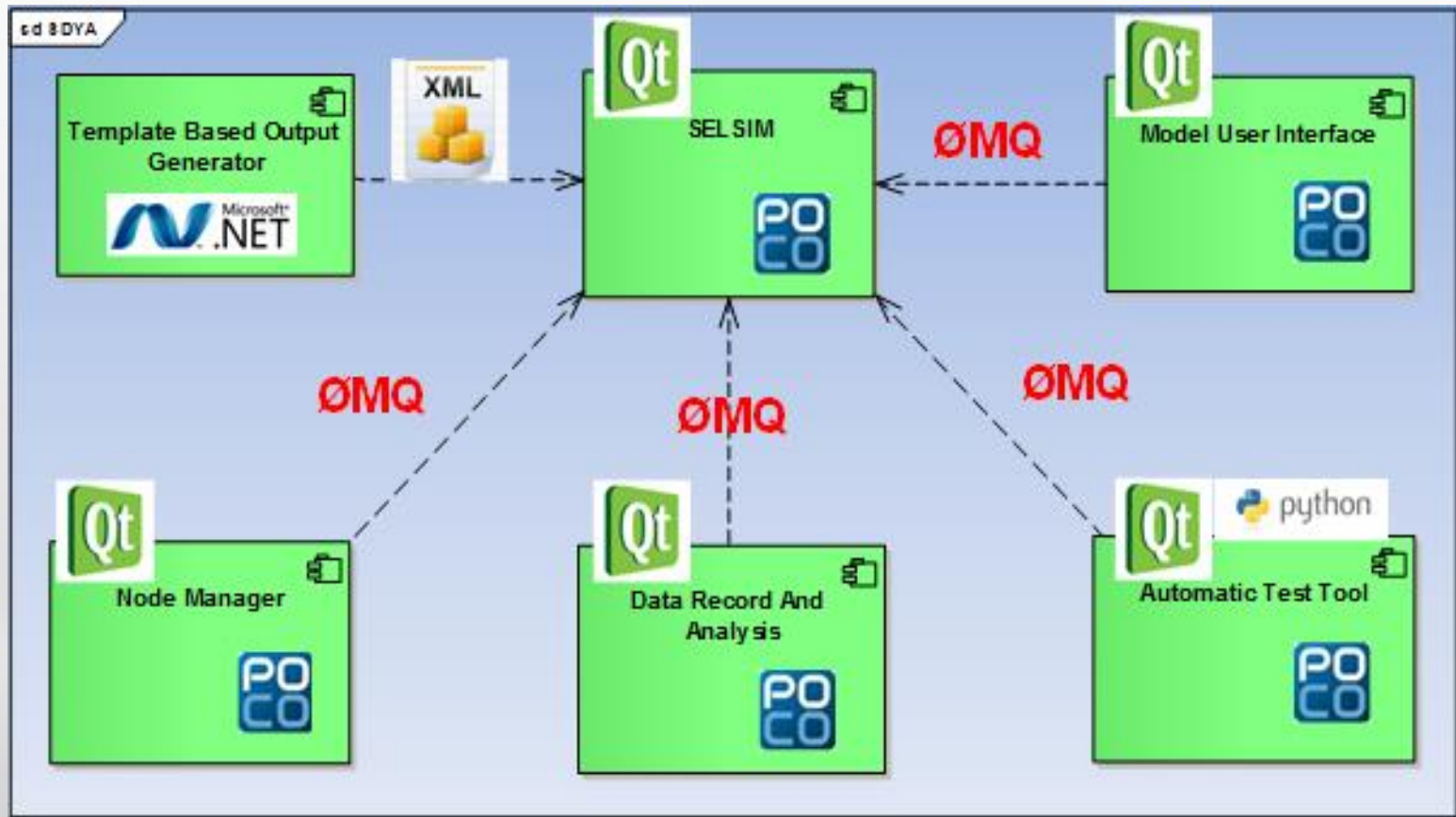


LAYERED ARCHITECTURE



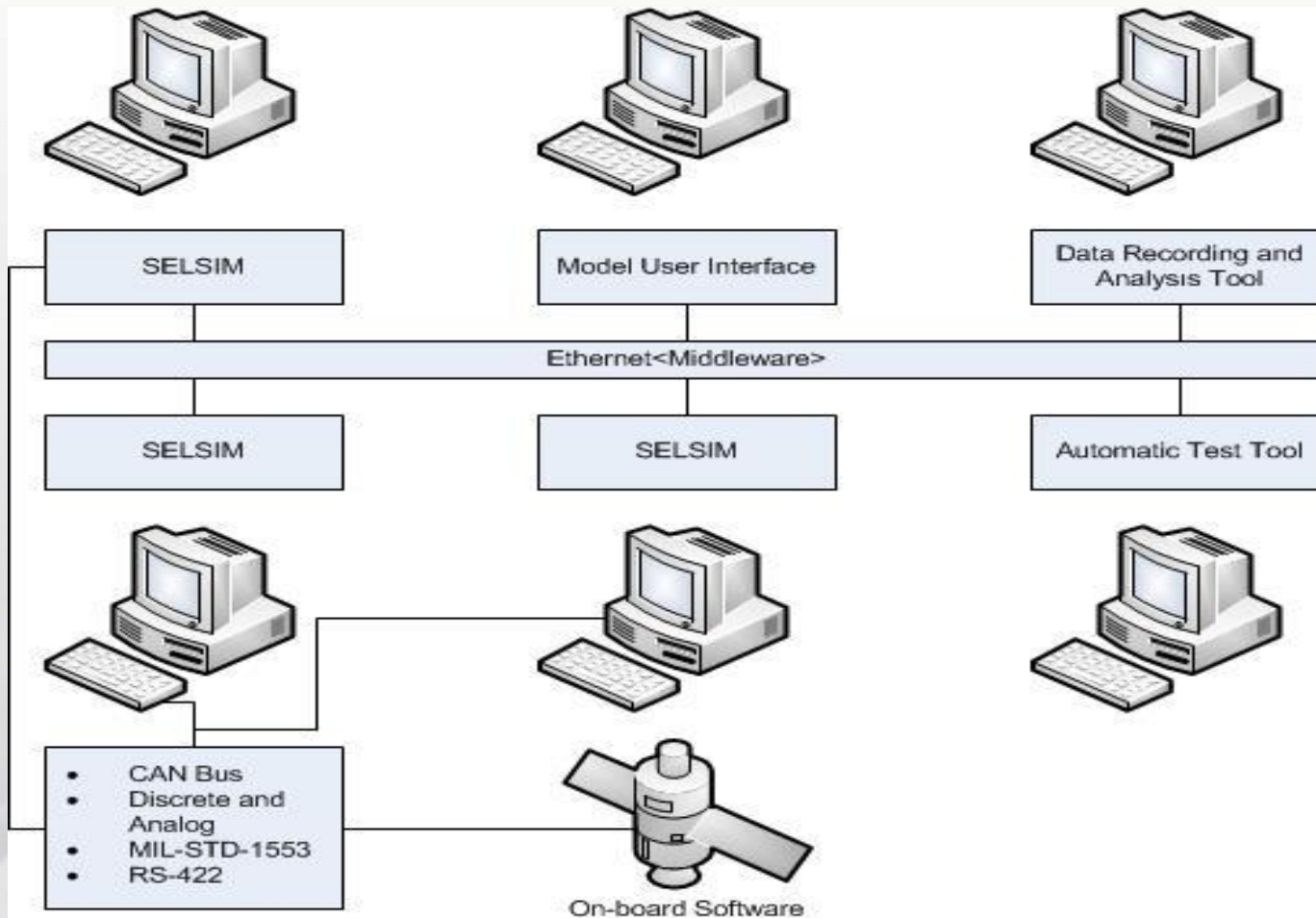
- High Level Abstractions (OS, Hardware, Middleware, Model-View, etc.)

COMPONENT BASED ARCHITECTURE AND SELECTED TECHNOLOGIES



- Component based architecture describes reusable, replaceable, extensible, encapsulated, independent components
- Critical Technology selections made by Decision Analysis and Resolution (DAR) Process

SAMPLE DEPLOYMENT VIEW

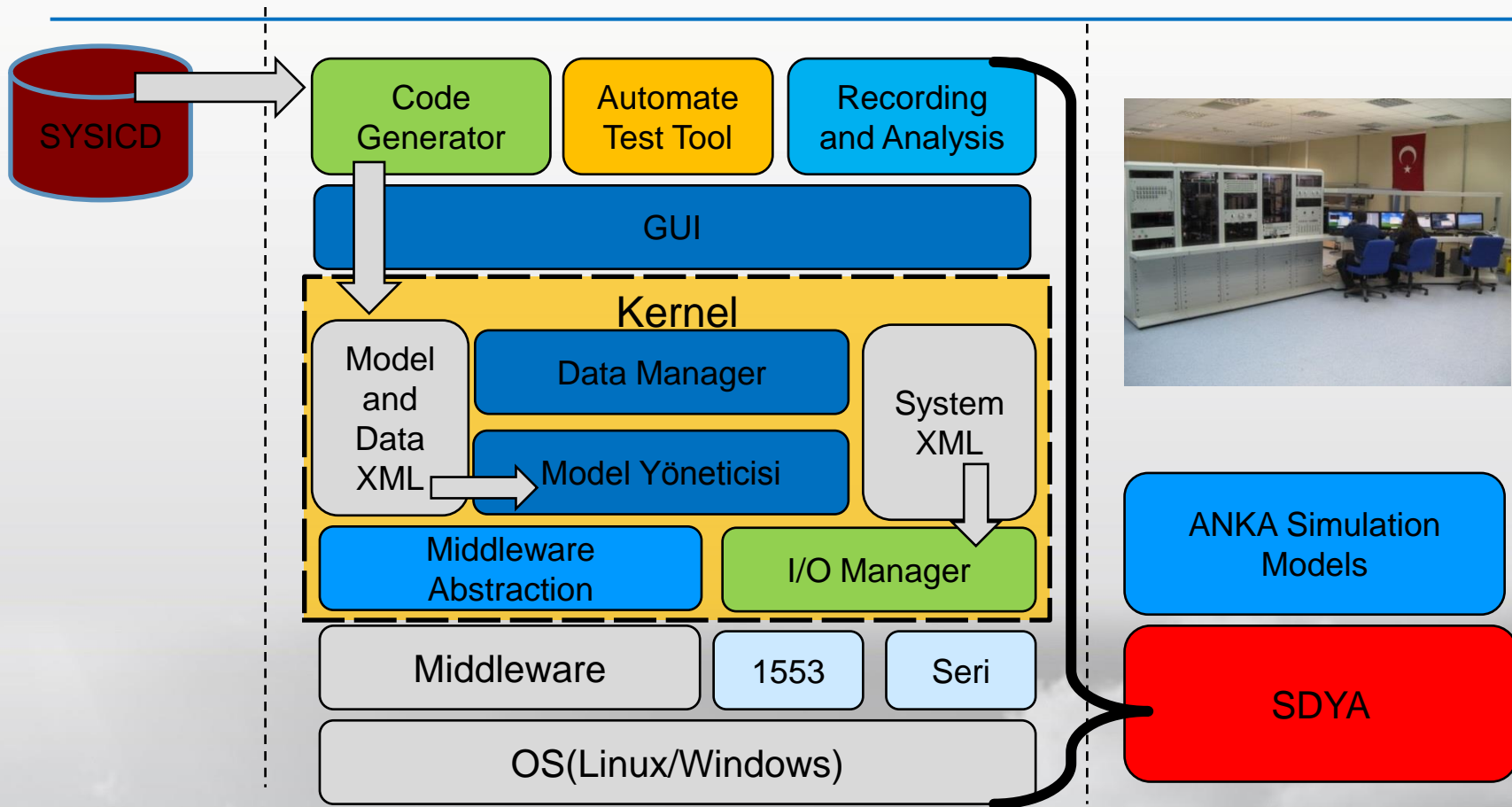


- Scalability, modularity, use of middleware allows various deployment configurations

DEVELOPMENT APPROACH

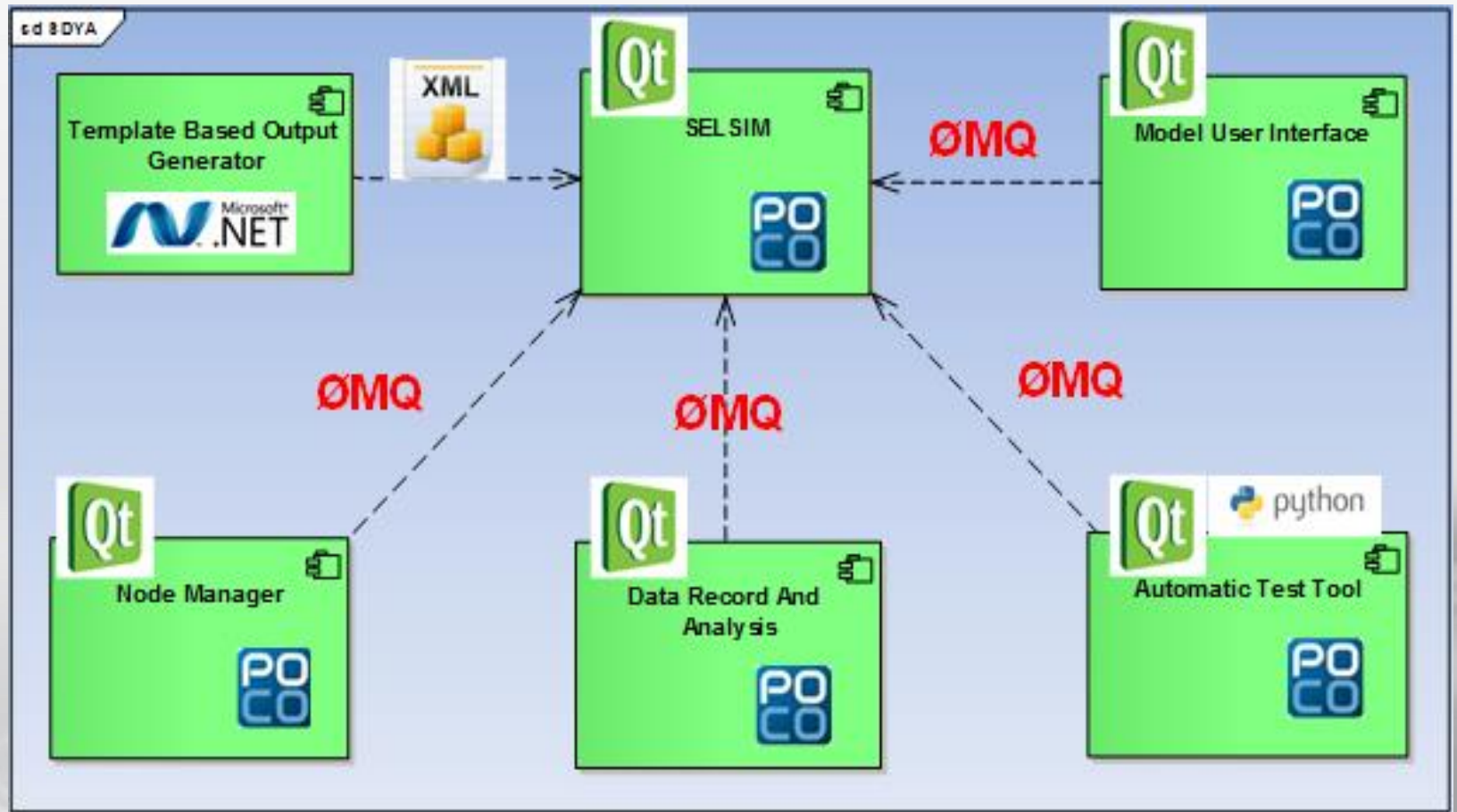
- Requirements collected from internal customers
- Use of Incremental Software Development Life-cycle Model (each increment consisting of software requirement development, design, implementation, unit testing, and requirement based testing)
- Guidance of ECSS-E-ST-40C, ECSS-Q-ST-80C, ECSS-Q-HB-80-01A for Tool Qualification
- Guidance of RTCA DO-178B for Tool Qualification as a Verification Tool
- Compliance with CMMI Level-3 TAI Processes
- ECSS-E-TM-40-07 (SMP-2): "Simulation Modelling Platform" standard compliance as a design consideration
- Verification and validation by TAI Independent Software Verification Team
- Project/Technical Management by following Key Performance Indicators (metrics) like Earned Value, Schedule Performance Index, Cost Performance Index, Burndown Chart, SLOC (Source Line of Code), Number of Change Requests, Number of Requirements Tested, Major Milestone Achievements, Action Items Status, Risk Items Status, Cyclomatic Complexity, etc.

DEVELOPMENT APPROACH



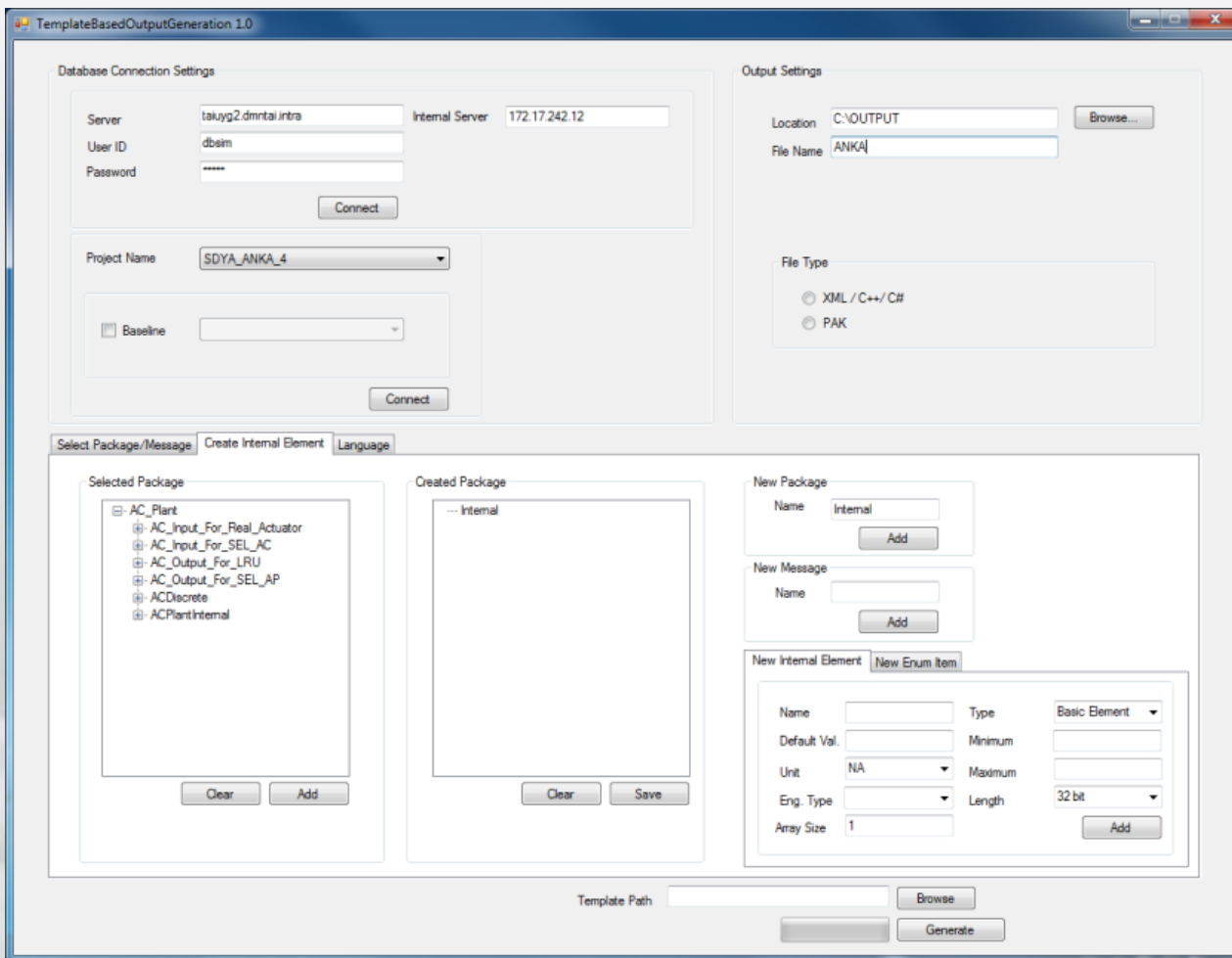
- Successful completion of development and adaptation of specific “ANKA” models

SOFTWARE CONFIGURATION ITEMS



TEMPLATE-BASED OUTPUT GENERATOR

- Generates code, and build files with a given template
- Its outputs can be used by SELSIM, Model User Interface and Automated Testing Tool.



SELSIM

- Contains models required within a simulation, and controls the scheduling of models
- Publishes/subscribes information of simulation objects
- Communicates over the real equipment data buses

SELSIM 1.0

Model / IO Manager Language Selection Help

Simulation State

Stopped

Start Pause Initialize Restart Stop Record/Play

SELSIM State

MASTER SLAVE

Master

OTA State

Not Running

SysICD - ANKA Baseline 1

Simulation Performance

System time: 15:23:23:872[Z] Frame rate: 10 ms

Simulation time: 00:00:00:000 Max. frame time: 0.000000 ms

Total frame number: 0 Min. frame time: 0.000000 ms

Overrun frame number: 0 Average frame time: 0.00 ms

Errors and Warnings

Simülasyon yeniden başlatıldı.
Simülasyon iklendirildi.
Simülasyon durduruldu.

Model	Frame Time (ms)	Command	State	Overrun	Active
AC_Plant_Model	10	Run	Running	0	Active
ADC_SMART_PROBE	10	Run	Running	0	Active
ADC_SMART_PROBE_1	10	Run	Running	0	Active
BKSMModel	10	Run	Running	0	Active
EGI_GS511	10	Run	Running	0	Active

IO Manager

Bus List

ID	Bus Name
1	PDU1Socket
2	PDU2Socket
3	PDU3Socket
4	PDU4Socket
5	PDU5Socket
6	PDU6Socket
7	PDU7Socket
8	PDU8Socket
9	PDU9Socket

Bus Properties

1	Device Name	eth_device
2	Socket Type	UDP
3	Local IP	172.17.242.35
4	Local Port	4068
5	Remote IP	172.17.242.35
6	Remote Port	4018

Add Bus Edit Bus Delete Bus

Model Manager

Servers

IP Address
All Models >
172.17.245.26

Models

M	I/O	Model Name
1	X	AC_Plant_Model
2	X	ADC_SMART_PROBE
3	X	ADC_SMART_PROBE_1
4	X	BKSMModel
5	X	EGI_GS511
6	X	EGI_GS511_1
7	X	EGI_SPAN_CPT
8	X	FADEC_Model
9	X	FSSK
10	X	GORSIS

Packages

pub/sub	Package
pub	AC_Plant

Messages

RX	TX	Message Name
<input type="checkbox"/>	<input checked="" type="checkbox"/>	ACDiscrete
<input type="checkbox"/>	<input checked="" type="checkbox"/>	AC_Input_For_Real_Actuator
<input checked="" type="checkbox"/>	<input type="checkbox"/>	AC_Output_For_SEL_AP
<input type="checkbox"/>	<input checked="" type="checkbox"/>	ACPlantInternal
<input checked="" type="checkbox"/>	<input type="checkbox"/>	AC_Output_For_IRU
<input type="checkbox"/>	<input checked="" type="checkbox"/>	AC_Input_For_SEL_AC

Add Model Edit Delete Model

IO Settings

OK Cancel

MODEL USER INTERFACE (MUI)

- Allows simulator runtime behavior to be monitored and for data injection
- Displays status of the simulated models
- Displays error messages for all erroneous conditions

The screenshot displays the Model User Interface (MUI) software, which is used for monitoring and controlling simulation models. The interface is divided into several main sections:

- Table Based Panel:** A table listing simulation elements with columns for M/I, Message Name, Element, and Value. The table contains 64 rows of data, including elements like Spare_5, Baro_altimeter_s, Baro_alt_GPS_alt, Spare_3, and various magnetometer and GPS-related elements.
- Element Properties:** A panel showing details for a selected element, such as Package Name (7), Message Name (GSS11_Output_F...), Element Name (Baro_altimeter_s...), Element Type (enum), Word Number (32), and Bit Position (0).
- Görsel Panel - EGI_Lvbp:** A control panel for the EGI 1 simulation. It includes a list of simulation parameters (e.g., Roll, Pitch, True Heading, Roll Rate, Pitch Rate, Yaw Rate, X Acceleration, Y Acceleration, Z Acceleration, East Velocity, North Velocity, Vertical Velocity, Latitude, Longitude, WGS Altitude, Baro Altitude, IAS) and a list of status indicators (e.g., X Accel Railing, Y Accel Railing, Z Accel Railing, X Gyro Railing, Y Gyro Railing, Z Gyro Railing, Magnetometer X Status, Magnetometer Y Status, Magnetometer Z Status, Magnetic Status, Magnetometers Readings, Magneto Readings in Init, Magnetometer Fail, Movement During Init, GPS Invalid). There are also checkboxes for various error conditions like PBIT Ram Check Fail, PBIT XRUART Fail, PBIT NV Segment CRC, Disc on Chip, CRC, PBIT IO Table CRC, PBIT CAL FILE CRC, PBIT SW PRTRMB VALID, and PBIT Status.
- Data Visualization:** Two plots are shown at the bottom right. The left plot is a bar chart showing values over time (zaman) from 16:40:00 to 16:40:22. The right plot is a line graph showing values over time (zaman) from 14:05:45 to 14:05:57.

NODE MANAGER

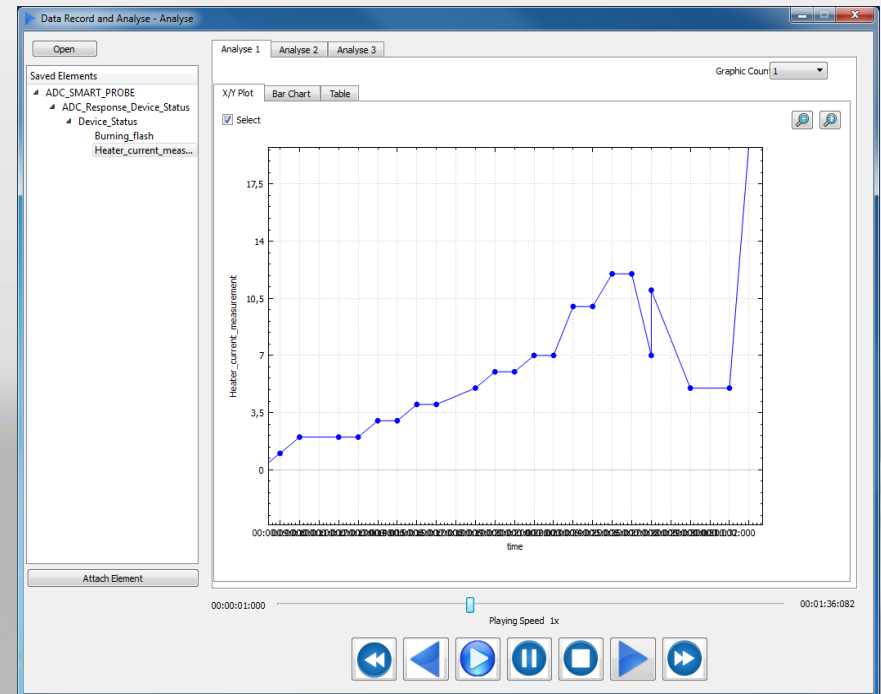
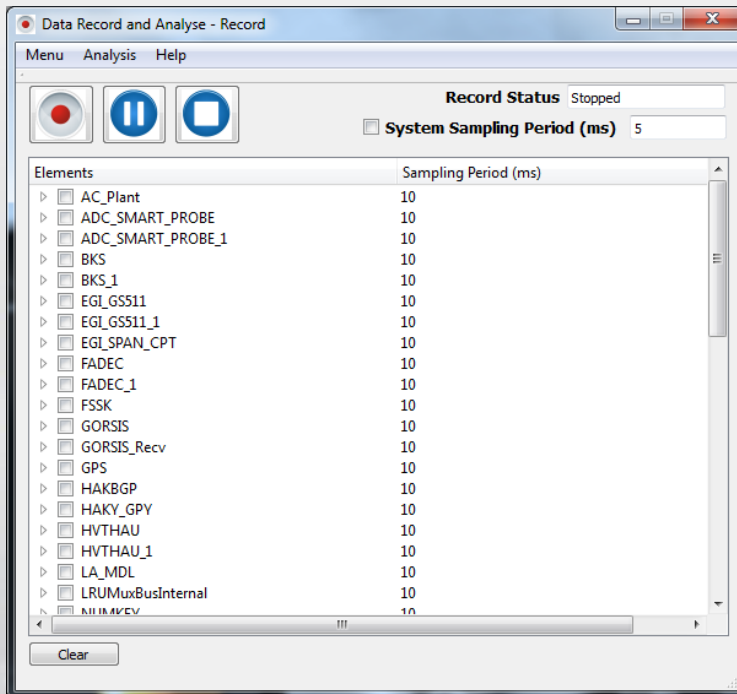
- Collects health info of simulation modules from other node managers
 - CPU utilization
 - Memory Usage of simulation modules from other node managers,
- Sends open / close or master / slave commands to nodes

Ip	Port	Tool	Master/Slave	Status	Pid	CPU	RAM (K)
172.17.245.26	12411	UNY	Master	connected	2600	0.131944	32133
172.17.245.26	12413	SELSIM	Master	connected	10356	0	167280
172.17.245.26	12414	TBP	N/A	connected	9380	0	103587
172.17.245.26	0	VKA	N/A	disconnected	0	0	172892

Ip	Port	Tool	Master/Slave	Status	Pid	CPU	RAM (K)
172.17.245.26	12411	UNY	Master	connected	11128	0.0964411	28577
172.17.245.26	12412	SELSIM	Master	connected	10852	0	164007
172.17.245.26	12413	TBP	N/A	connected	9944	0	102662
172.17.245.26	12414	VKA	N/A	connected	1016	0	171474

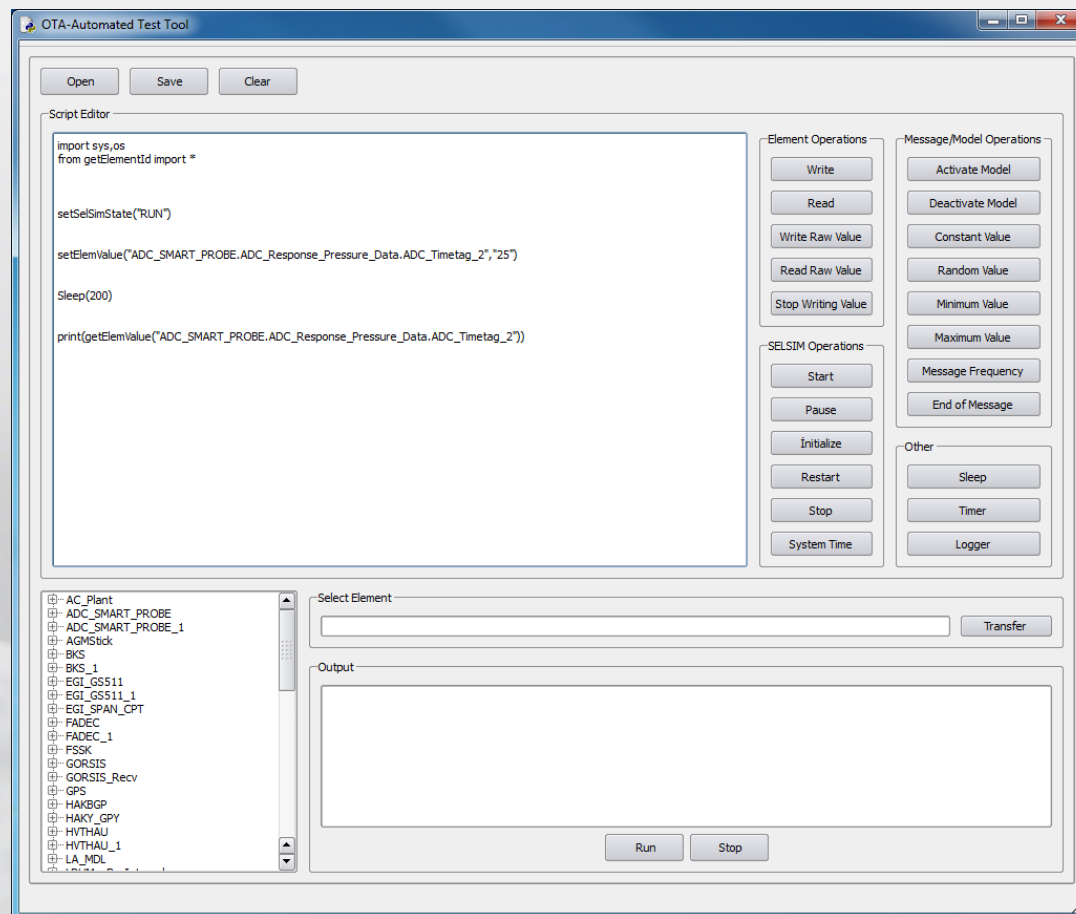
DATA RECORDING AND ANALYSIS TOOL

- Allows storing of model info and related messages to the file system on disk
- Analyze recorded data in x-y plot display and bar chart display



AUTOMATED TESTING TOOL

- Provides simulation Application Programming Interface (API) to other applications
- Supports Python, C#, C++ programming languages
- Allows value injection and monitoring of model elements



SPACE DOMAIN UTILIZATION OF SDYA

- SDYA potential utilization opportunities in Space Domain can be as follows:
 - A Validation tool for the :
 - Performance and Robustness Verification,
 - Software Verification Facility (SVF),
 - Avionic Functional Chain Validation (FCV),
 - Satellite Assembly, Integration and Test (AIT) procedures.
 - A support tool for the:
 - Validation of Spacecraft operational procedures,
 - Validation of Satellite Control Centre,
 - Spacecraft operators training,
 - Analyze and/or investigation of the anomalies detected in flight.

CONCLUSIONS

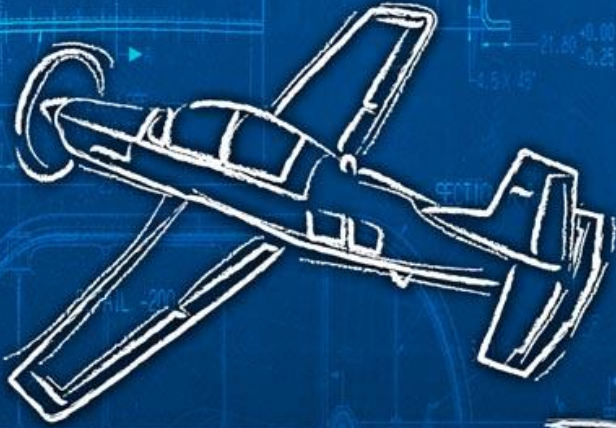
- The use of SDYA in the validation process of Satellite Projects is planned and it will be the basis for a Simulator Software Product Line to be formed at TAI.

- SDYA will support a large range of Satellite integration and test activities:
 - Software Verification Facility (SVF)
 - Functional Chain Validation
 - Avionic Test Bench Simulation
 - Dynamic Satellite Simulation (DSS)

- SDYA-based systems could be developed to support integration and testing of complex systems in space domain.

TAI

TUSAŞ - TÜRK HAVACILIK ve UZAY SANAYİİ A.Ş.
TURKISH AEROSPACE INDUSTRIES, INC.



HİZMETE ÖZEL

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