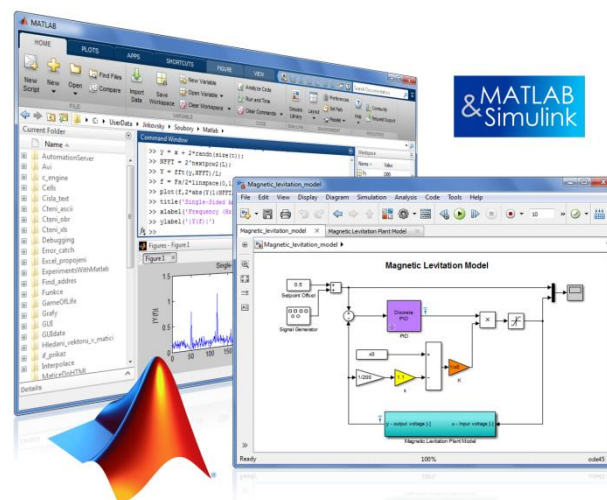


10.09.2020 Brno

TCC 2020

Novinky v prostředí MATLAB v roku 2020



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2,611



MATLAB®
& SIMULINK®



Testovanie a verifikácia
Zdieľanie a nasadenie



Detailné
riešenia



Testovanie a verifikácia
Zdieľanie a nasadenie



Detailné
riešenia

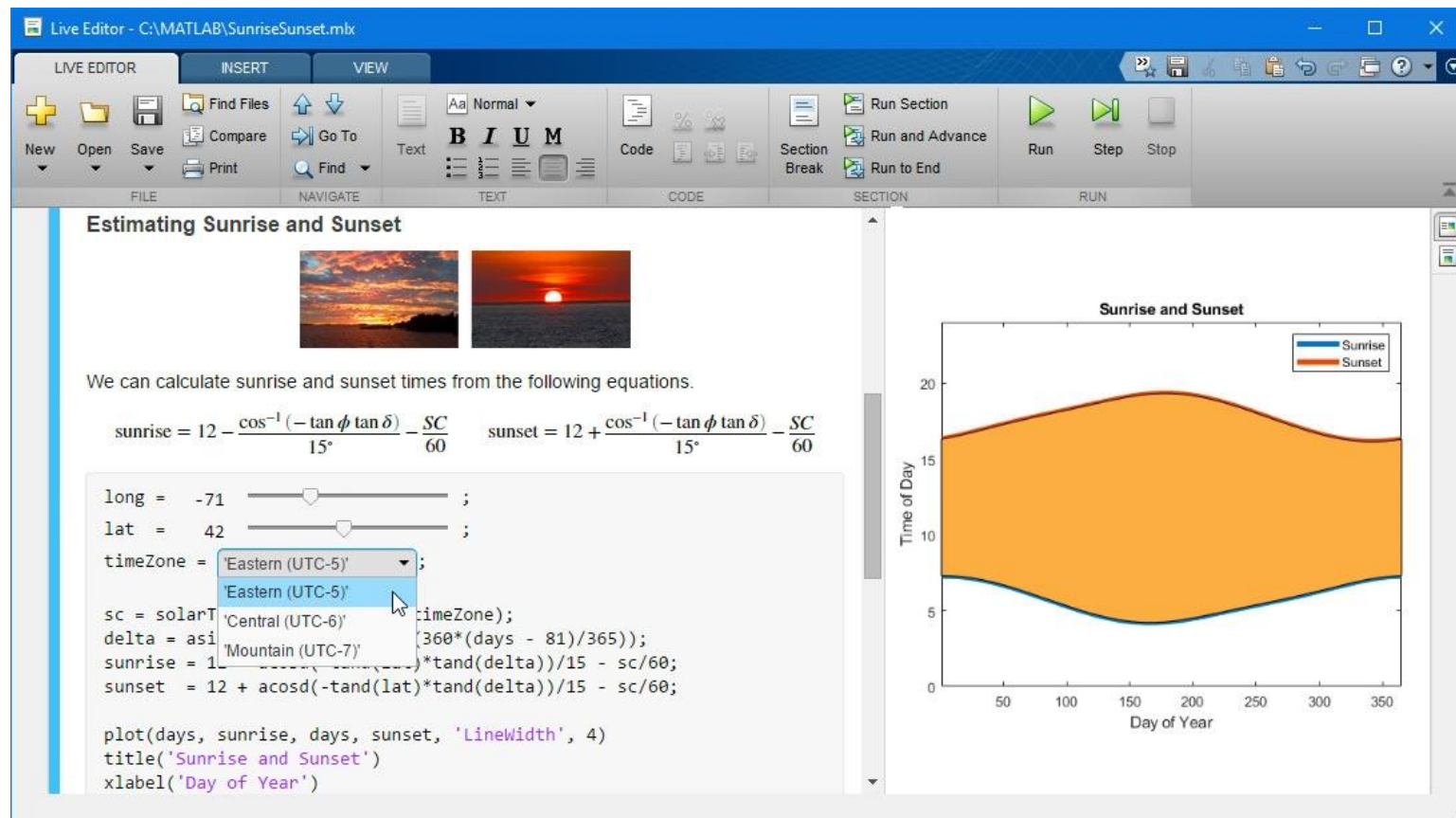
Tvorba dokumentov na zdieľanie, prezentácie a učenie

Kód + Výstupy + Formátovaný text = **Interaktívny dokument**

Nápoveda počas programovania

Prezeranie výstupov popri kóde

Pridávanie textu, vzorcov, obrázkov, odkazov



The screenshot shows the MATLAB Live Editor interface for a file named 'SunriseSunset.mlx'. The interface is divided into several sections: LIVE EDITOR, INSERT, and VIEW. The LIVE EDITOR section contains a toolbar with icons for New, Open, Save, Find Files, Compare, Go To, Find, Code, Section Break, Run Section, Run and Advance, Run to End, Run, Step, and Stop. The main workspace is titled 'Estimating Sunrise and Sunset' and contains two small images of a sunset. Below the images, there is a text block explaining that sunrise and sunset times can be calculated from the following equations:

$$\text{sunrise} = 12 - \frac{\cos^{-1}(-\tan \phi \tan \delta)}{15^\circ} - \frac{SC}{60} \quad \text{sunset} = 12 + \frac{\cos^{-1}(-\tan \phi \tan \delta)}{15^\circ} - \frac{SC}{60}$$

The code block below the equations defines variables for longitude, latitude, and time zone, and calculates the sunrise and sunset times for a given day of the year. The code is as follows:

```
long = -71 ;
lat = 42 ;
timeZone = 'Eastern (UTC-5)';
sc = solarTime(lat, long, timeZone);
delta = asin(sin(lat)*sin(sc) + cos(lat)*cos(sc)*cos(360*(days - 81)/365));
sunrise = 12 - (acosd(-tand(lat)*tand(delta))/15 - sc/60);
sunset = 12 + (acosd(-tand(lat)*tand(delta))/15 - sc/60);
plot(days, sunrise, days, sunset, 'LineWidth', 4)
title('Sunrise and Sunset')
xlabel('Day of Year')
```

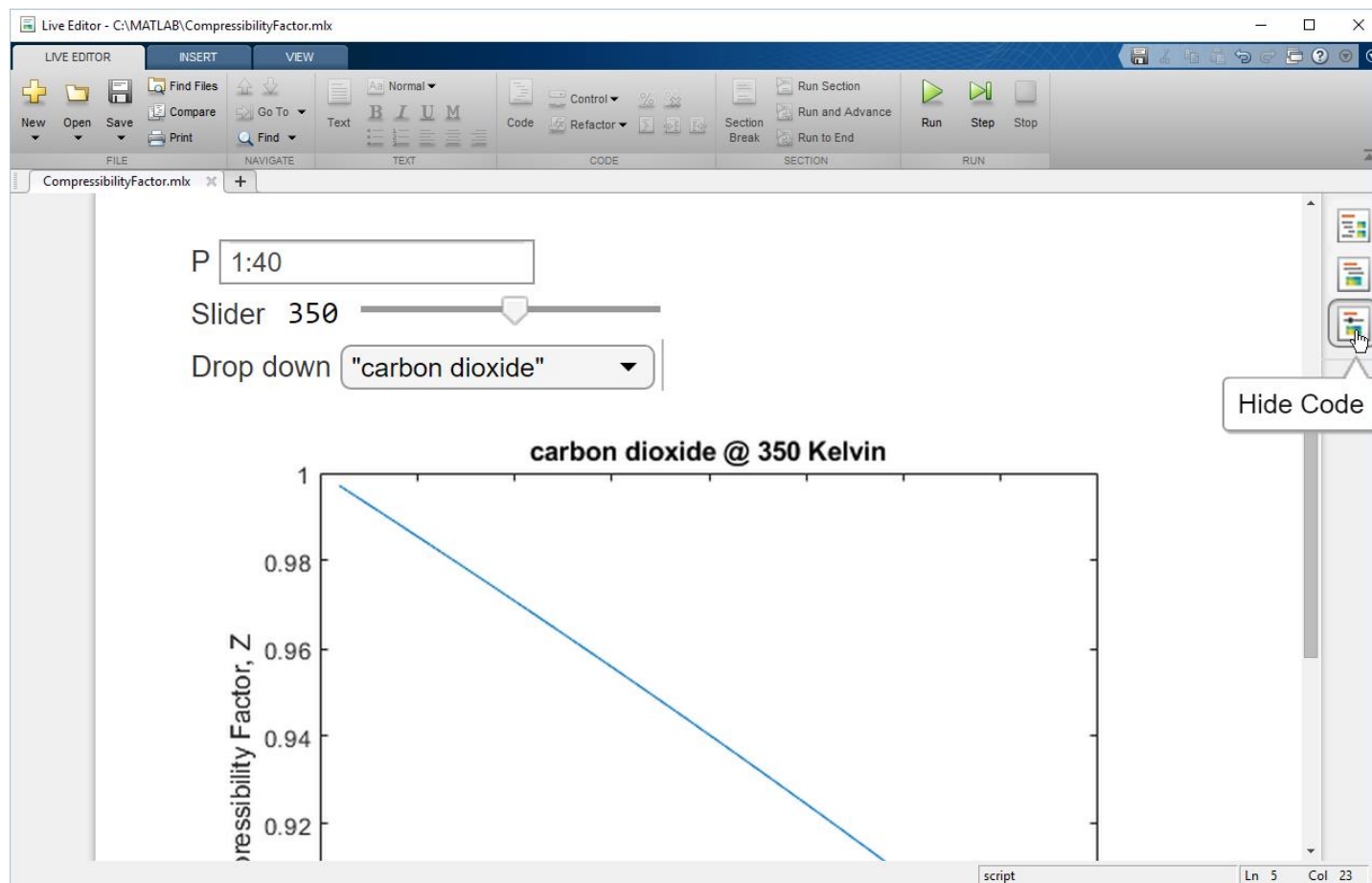
On the right side of the workspace, there is a plot titled 'Sunrise and Sunset'. The plot shows the time of day (Y-axis, ranging from 0 to 20) versus the day of the year (X-axis, ranging from 0 to 350). The plot displays two curves: a blue line for 'Sunrise' and an orange line for 'Sunset'. The area between the two curves is shaded orange, representing the duration of daylight. The sunrise curve starts at approximately 7:30 AM and reaches its minimum around day 150, while the sunset curve starts at approximately 7:30 PM and reaches its maximum around day 150.

Tvorba dokumentov na zdieľanie, prezentácie a učenie

Pridanie ovládacích prvkov na zmenu premenných

- Numeric sliders
- Drop-down lists
- Edit fields

Skrytie kódu na tvorbu jednoduchých aplikácií a panelov

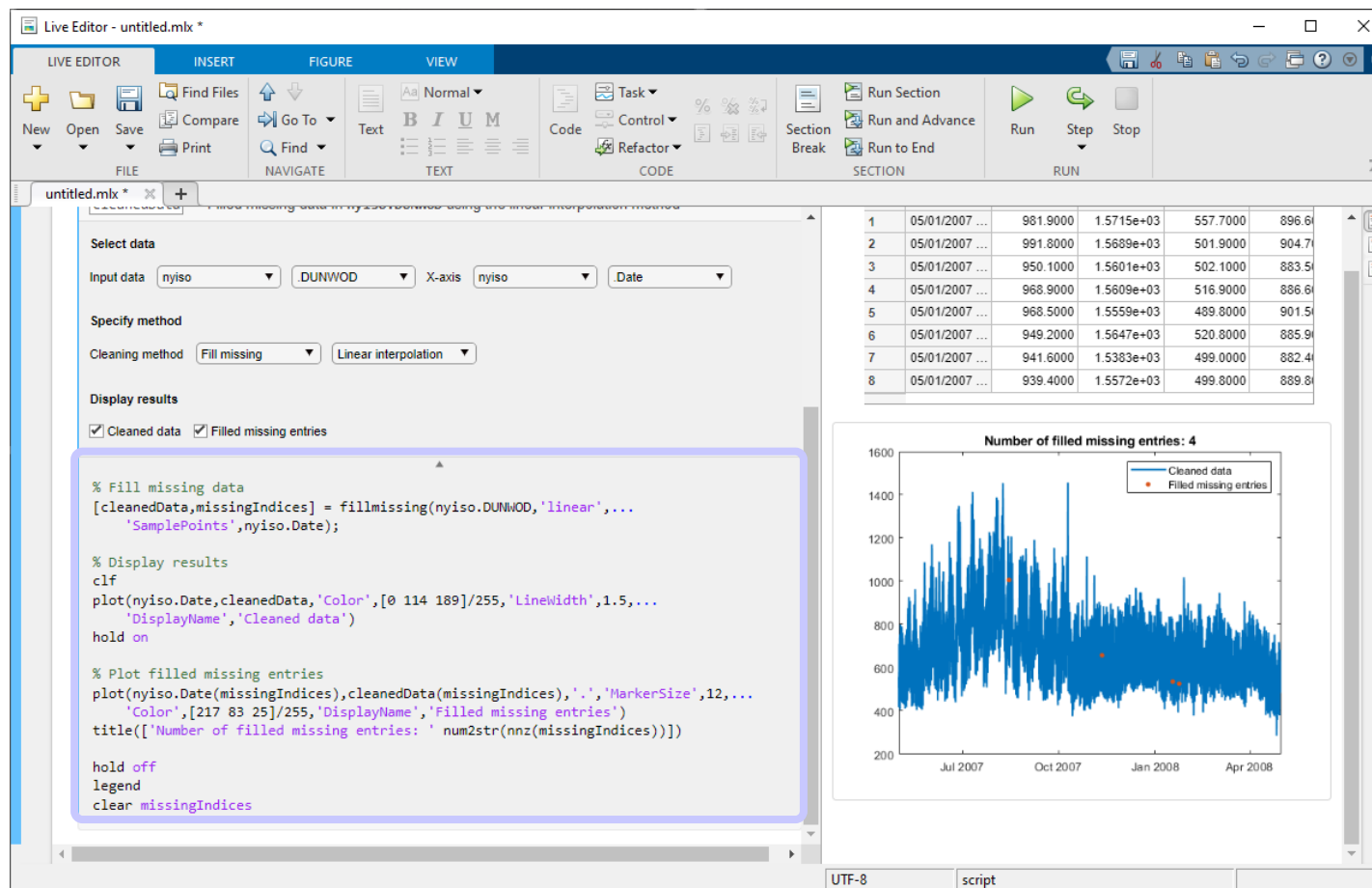


Live Editor

Interaktívne kroky

Live Tasks na vyskúšanie parametrov a možností

Automatické generovanie MATLAB kódu pre hotovú úlohu (Live task)



The screenshot displays the Live Editor interface for a MATLAB task. The top toolbar includes options for file operations (New, Open, Save, Compare, Print), navigation (Go To, Find), text formatting (Normal, Bold, Italic, Underline), code editing (Task, Control, Refactor), and execution (Run Section, Run and Advance, Run, Step, Stop). The main workspace is divided into three sections:

- Configuration Panel:** Shows the input data as 'nyiso' with 'DUNWOD' as the X-axis and 'Date' as the Y-axis. The cleaning method is set to 'Fill missing' using 'Linear interpolation'. The 'Display results' section has checkboxes for 'Cleaned data' and 'Filled missing entries'.
- Code Editor:** Contains the following MATLAB code:


```
% Fill missing data
[cleanedData,missingIndices] = fillmissing(nyiso.DUNWOD,'linear',...
    'SamplePoints',nyiso.Date);

% Display results
clf
plot(nyiso.Date,cleanedData,'Color',[0 114 189]/255,'LineWidth',1.5,...
    'DisplayName','Cleaned data')
hold on

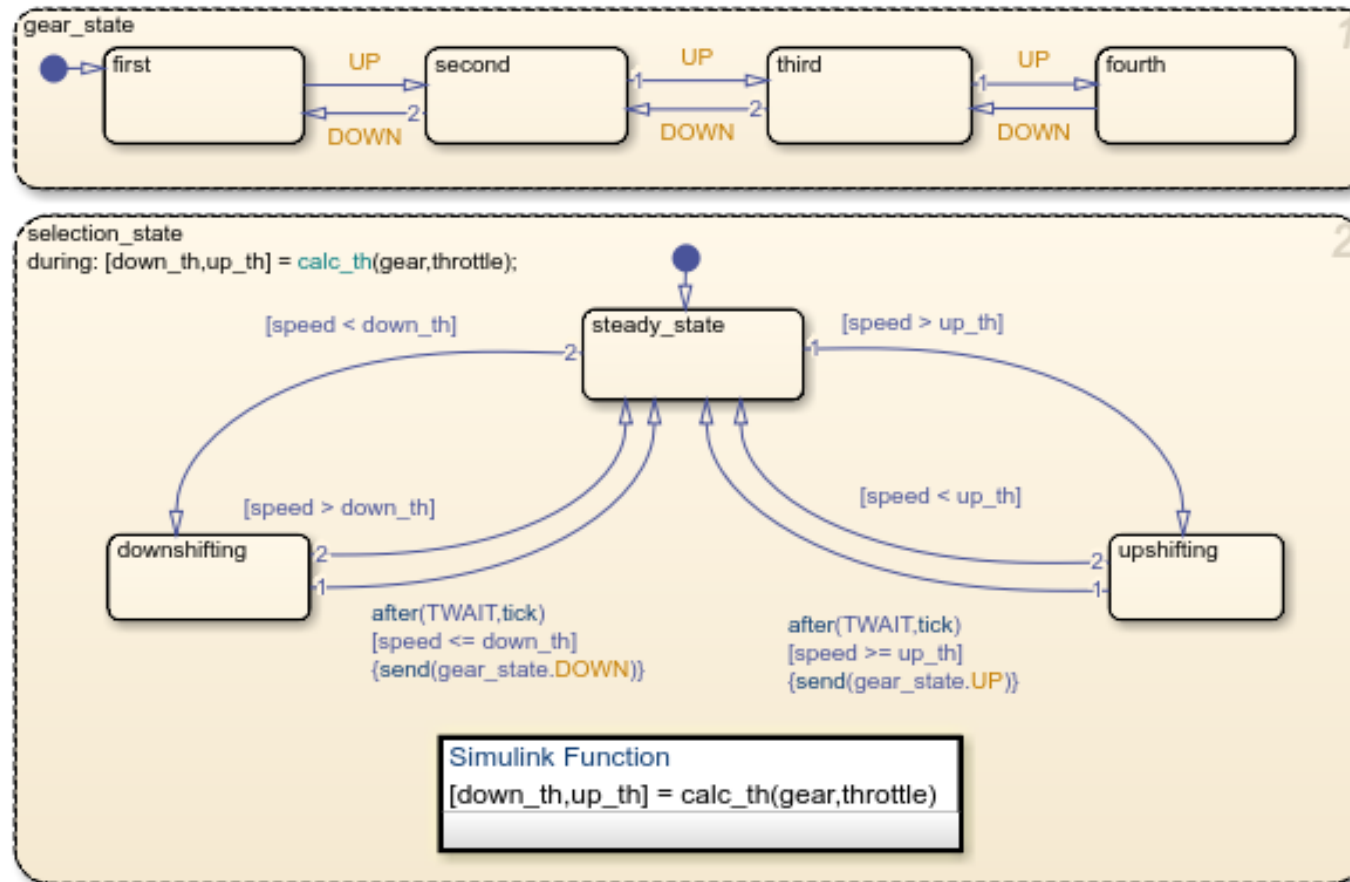
% Plot filled missing entries
plot(nyiso.Date(missingIndices),cleanedData(missingIndices),'.','MarkerSize',12,...
    'Color',[217 83 25]/255,'DisplayName','Filled missing entries')
title(['Number of filled missing entries: ' num2str(nnz(missingIndices))])

hold off
legend
clear missingIndices
```
- Data Table:** A table with 8 rows and 6 columns, showing data points for dates from 05/01/2007 to 05/01/2008. The columns represent different variables with values ranging from approximately 886.6 to 991.8000.
- Plot:** A line plot titled 'Number of filled missing entries: 4'. The Y-axis ranges from 200 to 1600. The X-axis shows dates from Jul 2007 to Apr 2008. The plot displays a blue line for 'Cleaned data' and red dots for 'Filled missing entries'.

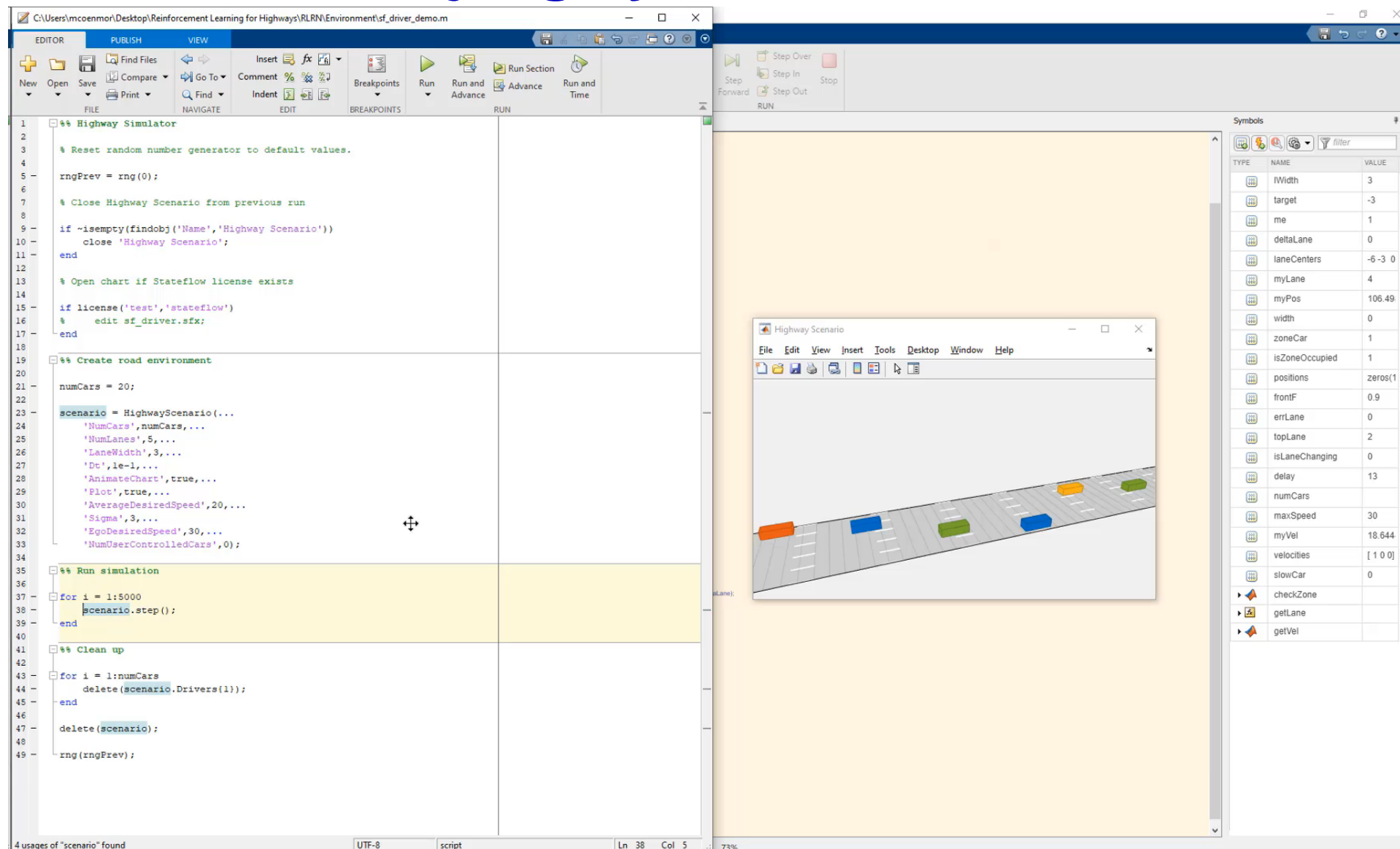
Live Editor

Návrh rozhodovacej logiky na vyššej úrovni abstrakcie

Grafická tvorba, ladenie a spustenie stavových automatov



Návrh rozhodovacej logiky v MATLABe



The image displays the MATLAB Stateflow environment. The left pane shows the Stateflow script for a highway simulator. The right pane shows a 3D visualization of the highway simulation with several cars on a road. A 'Symbols' table is visible on the right side of the interface.

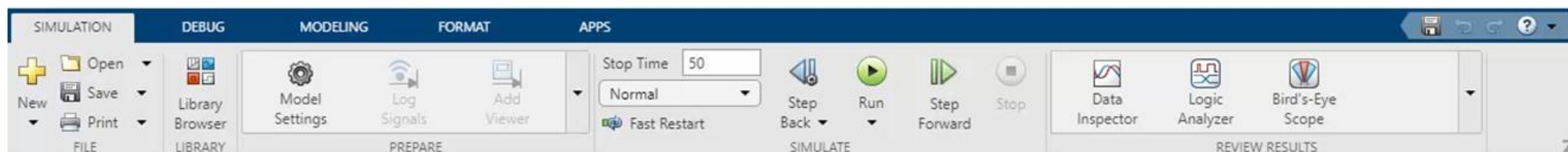
```

1 %% Highway Simulator
2
3 % Reset random number generator to default values.
4
5 rngPrev = rng(0);
6
7 % Close Highway Scenario from previous run
8
9 if ~isempty(findobj('Name','Highway Scenario'))
10     close 'Highway Scenario';
11 end
12
13 % Open chart if Stateflow license exists
14
15 if license('test','stateflow')
16     % edit sf_driver.sfx;
17 end
18
19 %% Create road environment
20
21 numCars = 20;
22
23 scenario = HighwayScenario(...
24     'NumCars',numCars,...
25     'NumLanes',5,...
26     'LaneWidth',3,...
27     'Dt',1e-1,...
28     'AnimateChart',true,...
29     'Plot',true,...
30     'AverageDesiredSpeed',20,...
31     'Sigma',3,...
32     'EgoDesiredSpeed',30,...
33     'NumUserControlledCars',0);
34
35 %% Run simulation
36
37 for i = 1:5000
38     scenario.step();
39 end
40
41 %% Clean up
42
43 for i = 1:numCars
44     delete(scenario.Drivers(1));
45 end
46
47 delete(scenario);
48
49 rng(rngPrev);
    
```

TYPE	NAME	VALUE
...	lWidth	3
...	target	-3
...	me	1
...	deltaLane	0
...	laneCenters	-6 -3 0
...	myLane	4
...	myPos	106.49
...	width	0
...	zoneCar	1
...	isZoneOccupied	1
...	positions	zeros(1
...	frontF	0.9
...	errLane	0
...	topLane	2
...	isLaneChanging	0
...	delay	13
...	numCars	30
...	maxSpeed	18.644
...	myVel	[1 0 0]
...	velocities	[1 0 0]
...	slowCar	0
...	checkZone	
...	getLane	
...	getVel	

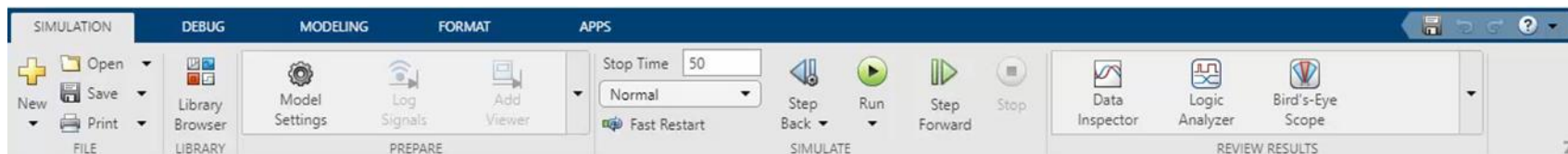
Inžinieri modelujú systémy na rôznych úrovniach

Používateľské rozhrania

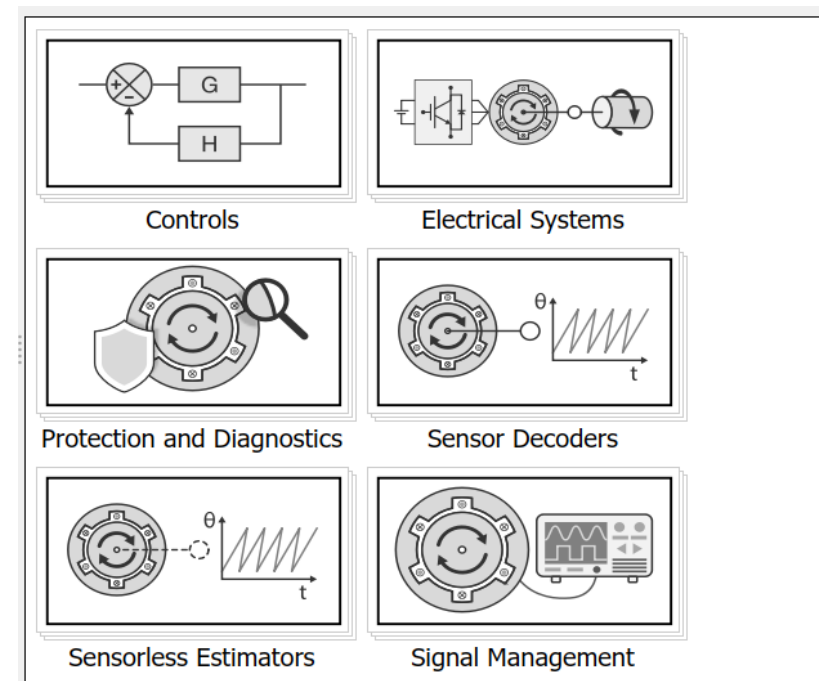
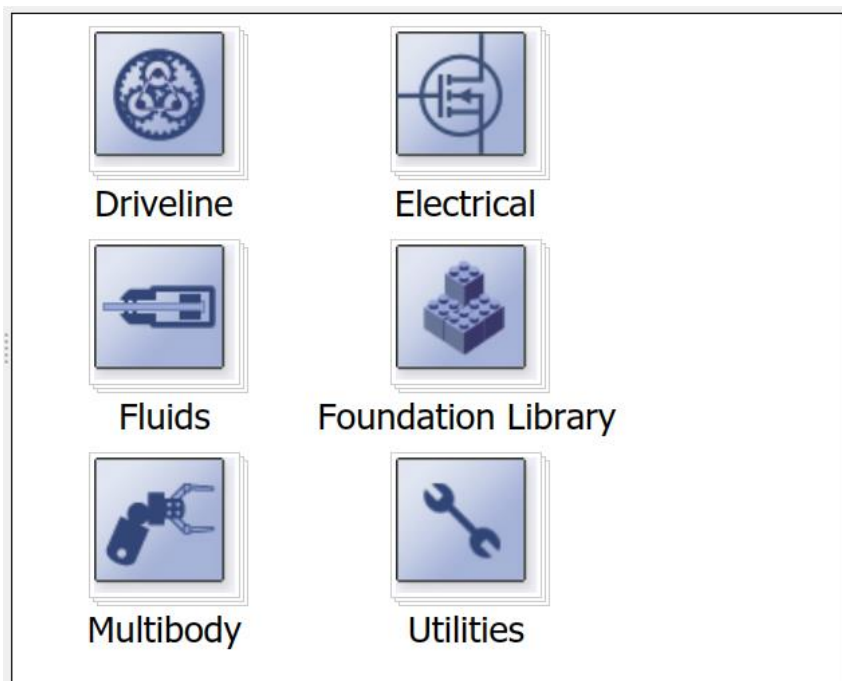


Inžinieri modelujú systémy na rôznych úrovniach

Používateľské rozhrania



Knižnice

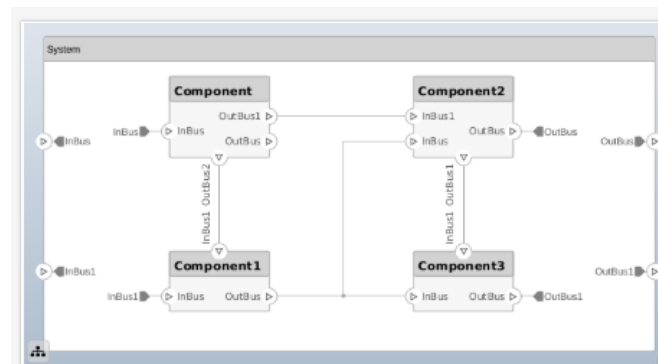
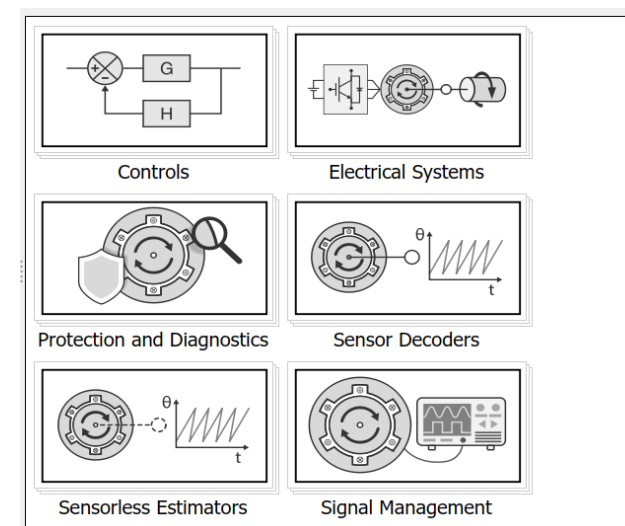
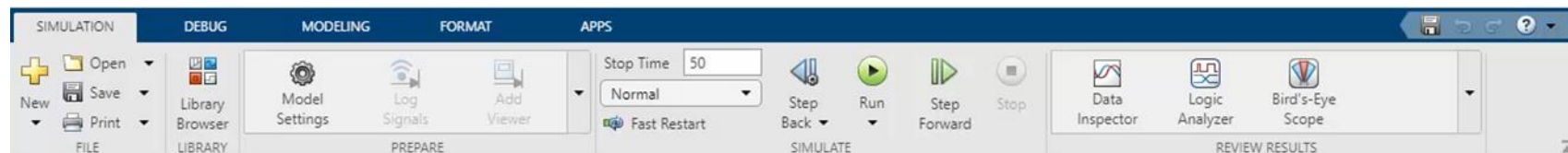


Inžinieri modelujú systémy na rôznych úrovniach

Používateľské rozhrania

Knižnice

Tvorba systémov



Architecture Model

By The MathWorks, Inc.



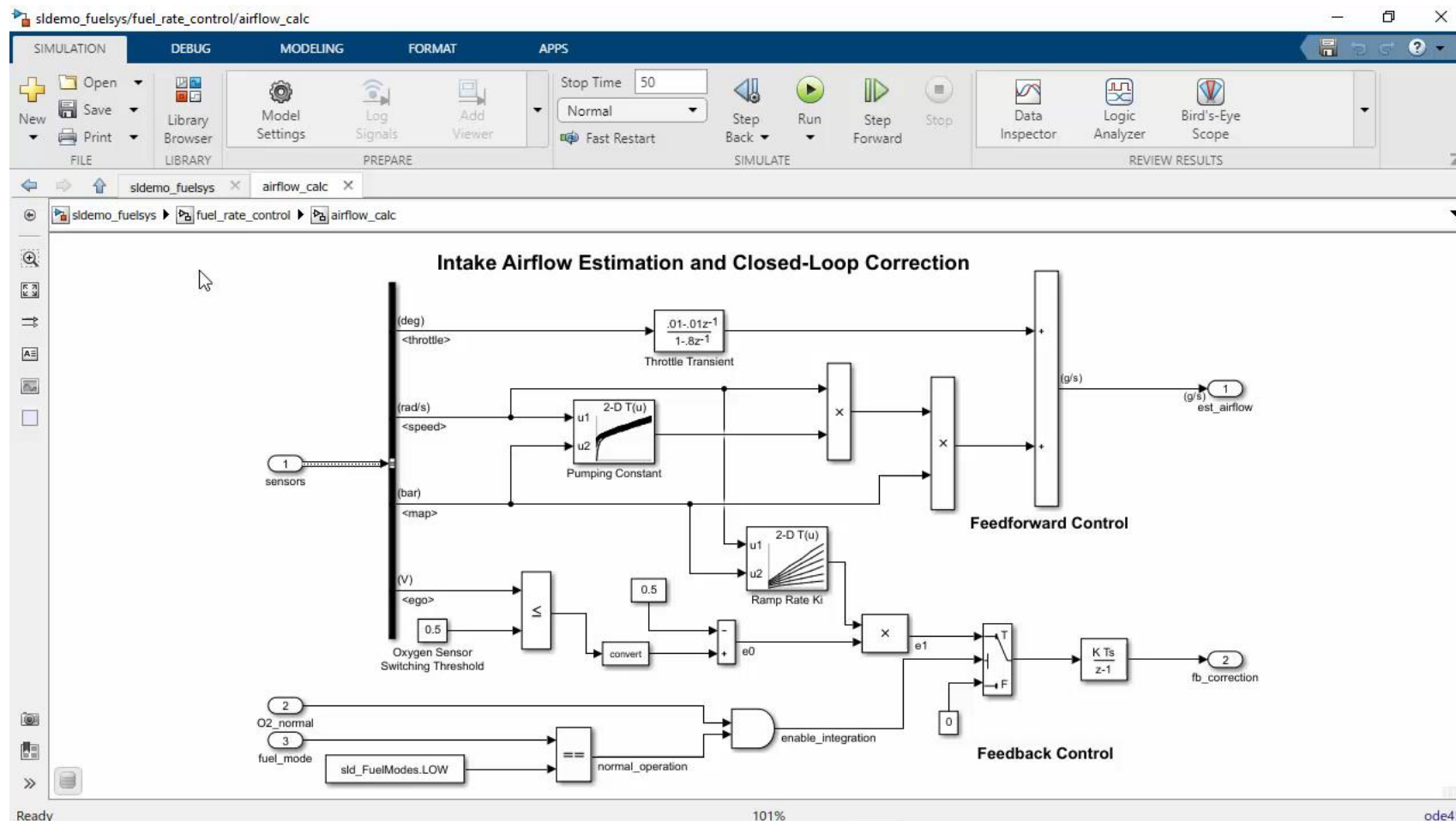
Create an architecture model. Model physical and logical architecture of a system. Create a visual representation with components, ports, and connectors. Specify information exchange between components with interfaces.

Prístup k možnostiam Simulinku podľa potreby

Používateľské rozhrania

Knižnice

Tvorba systémov



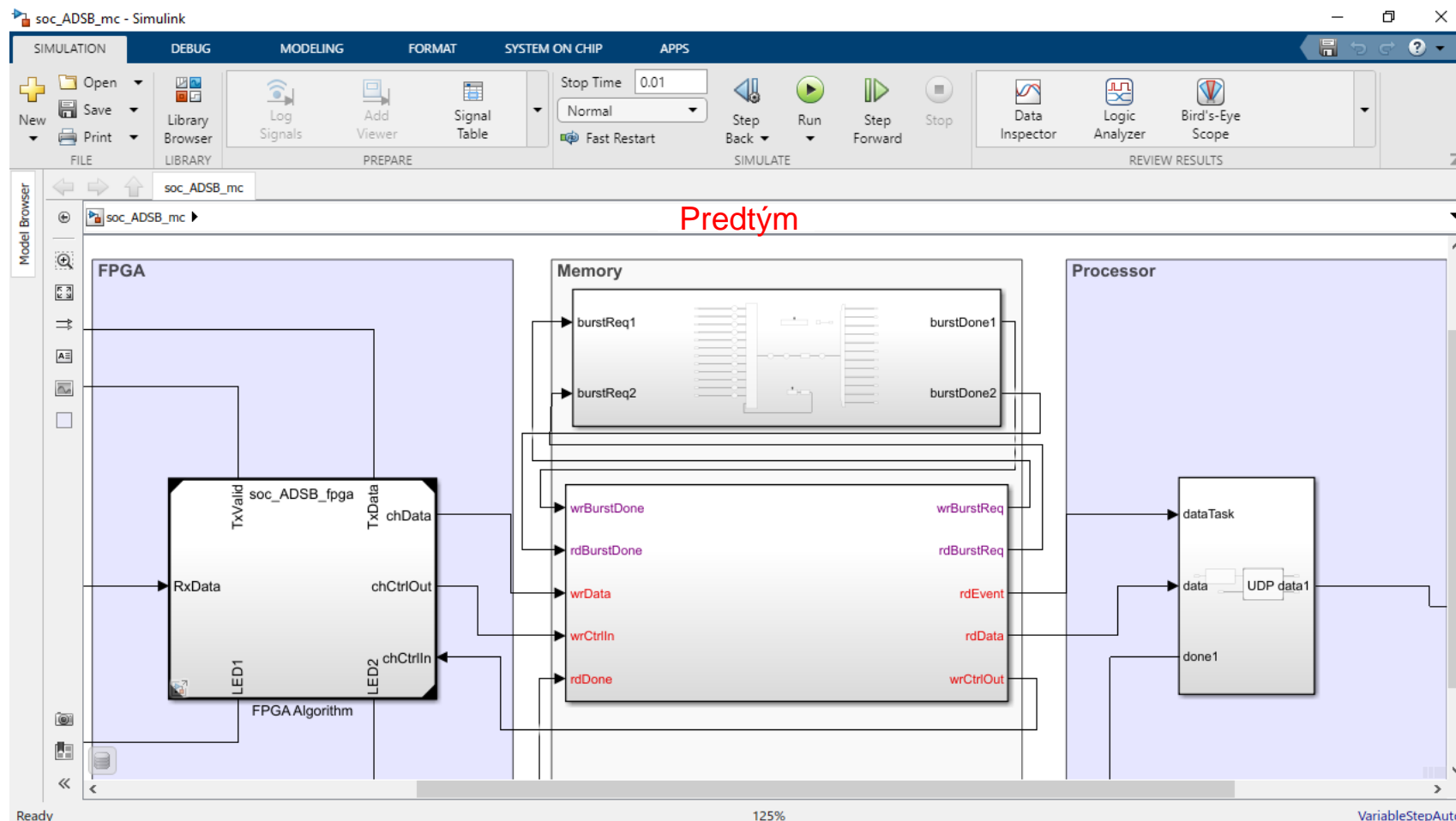
Simulink Toolstrip

Prístup k možnostiam Simulinku podľa potreby

Používateľské rozhrania

Knižnice

Tvorba systémov

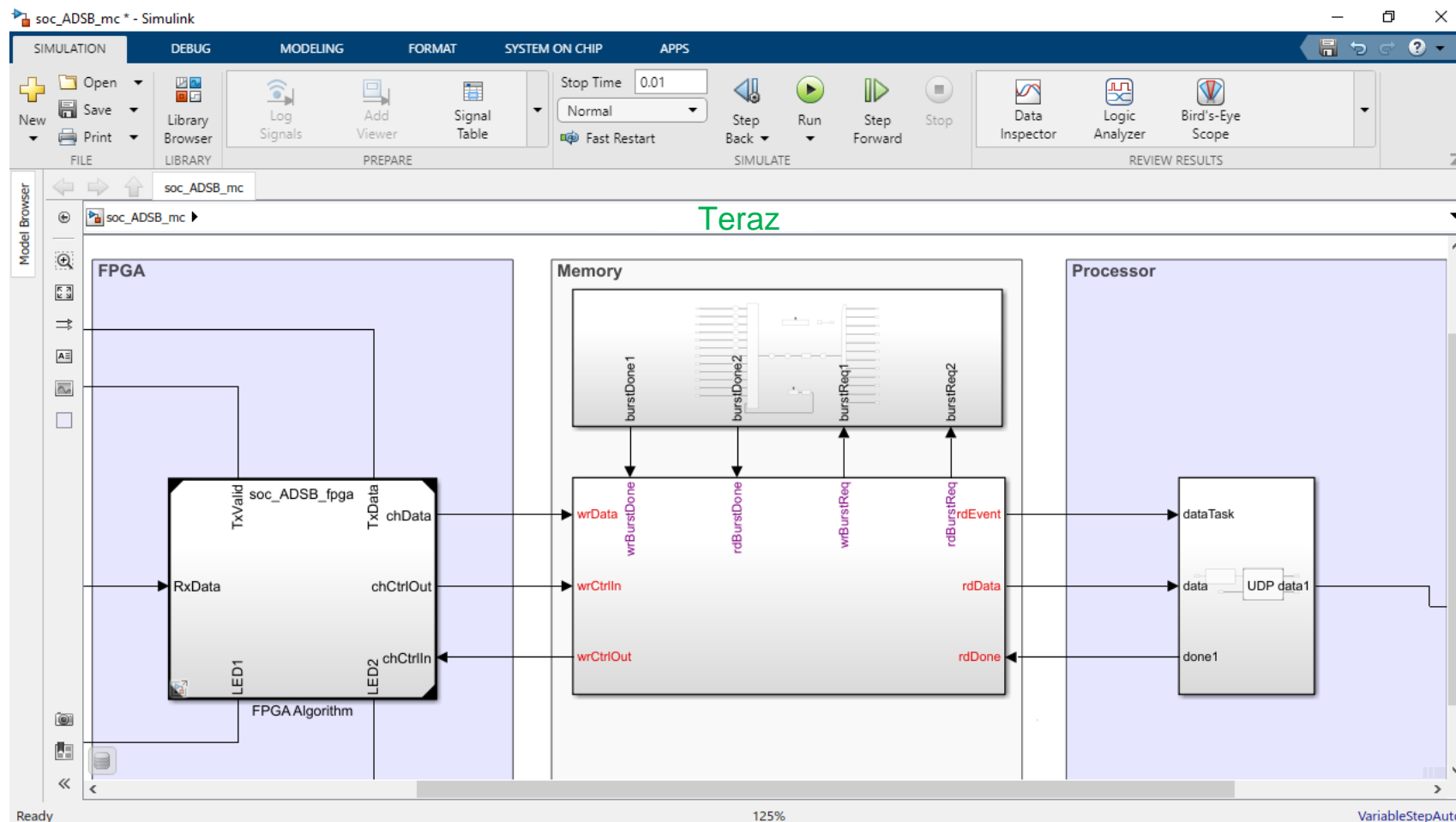


Prístup k možnostiam Simulinku podľa potreby

Používateľské rozhrania

Knižnice

Tvorba systémov

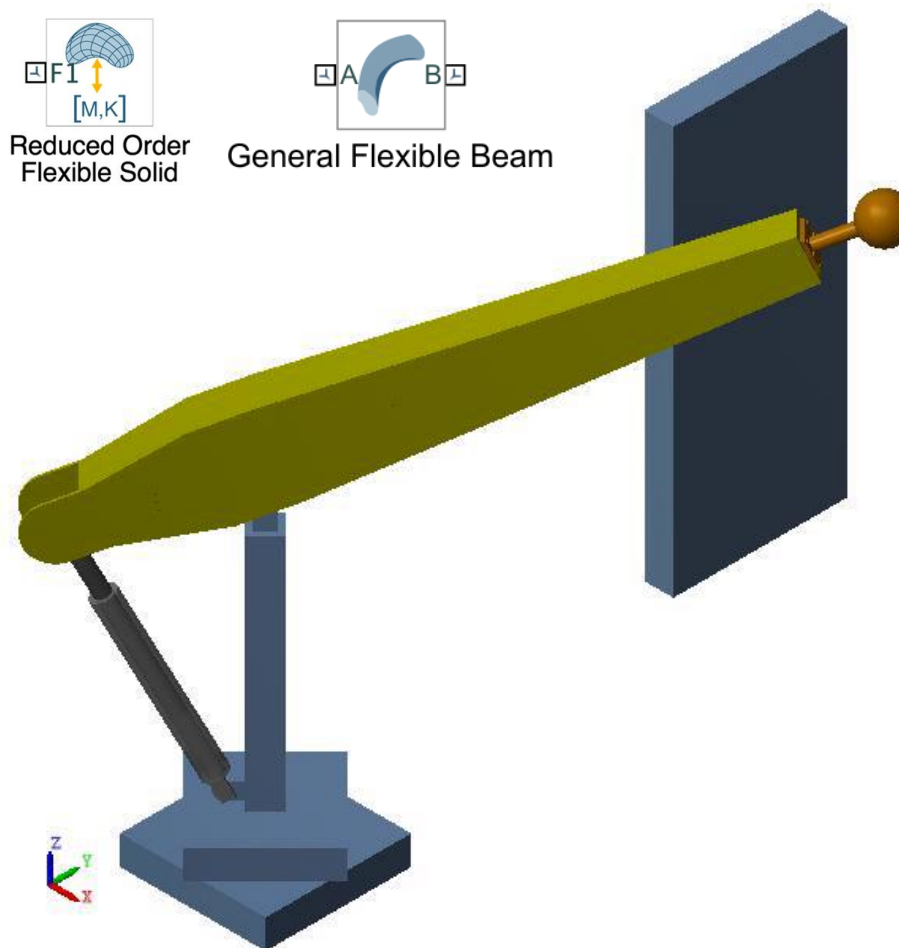
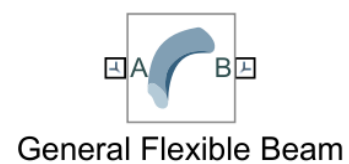


Modelovanie deformácií a kontaktov

Používateľské rozhrania

Knižnice – Fyzikálne modelovanie

Tvorba systémov

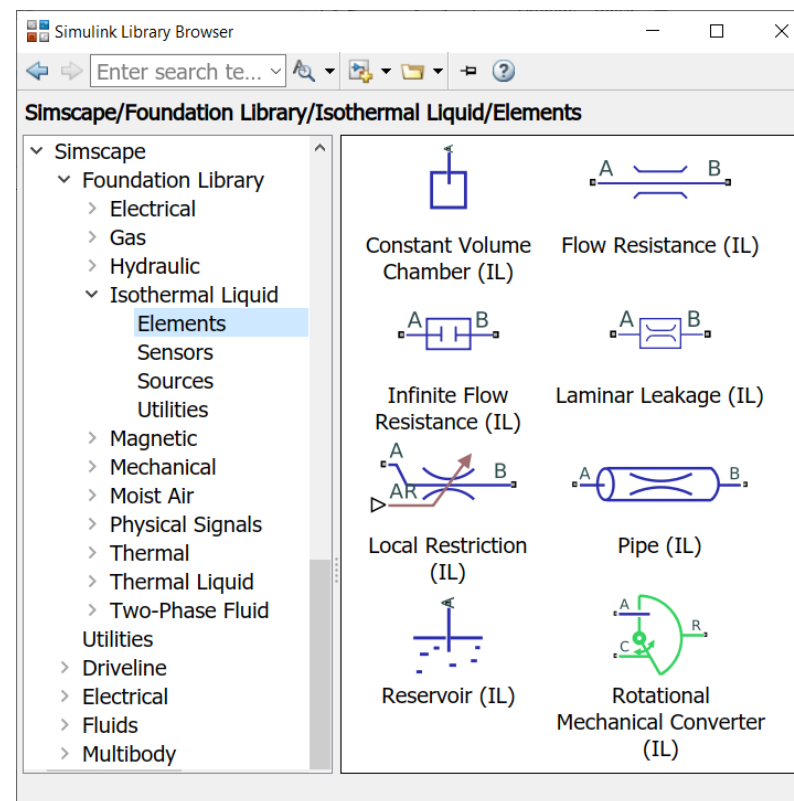


Modelovanie aplikácií energie a prepravy tekutín

Používateľské rozhrania

Knižnice – Fyzikálne modelovanie

Tvorba systémov

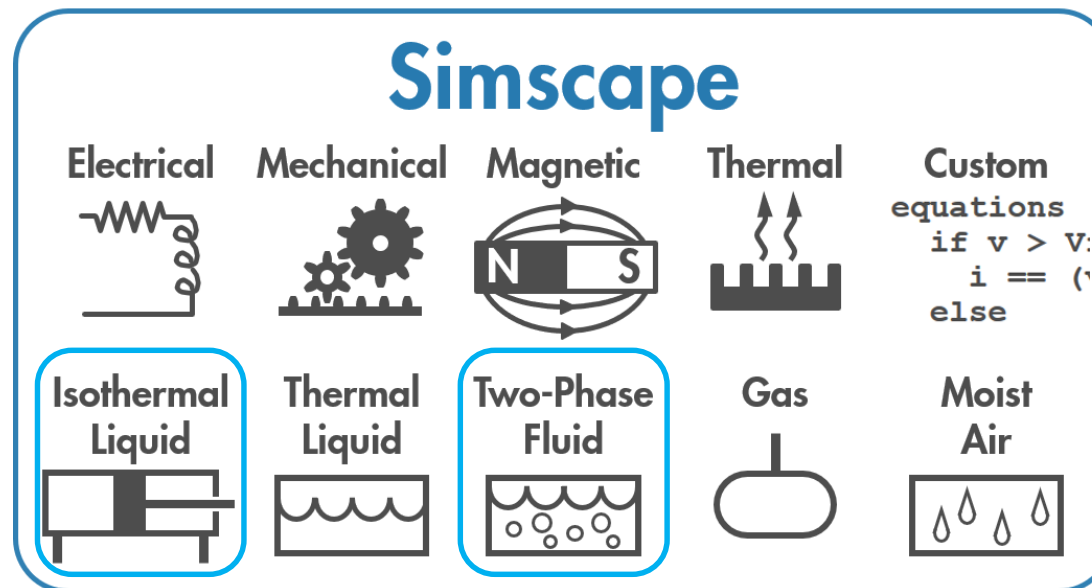


Modelovanie aplikácií energie a prepravy tekutín

Používateľské rozhrania

Knižnice – Fyzikálne modelovanie

Tvorba systémov

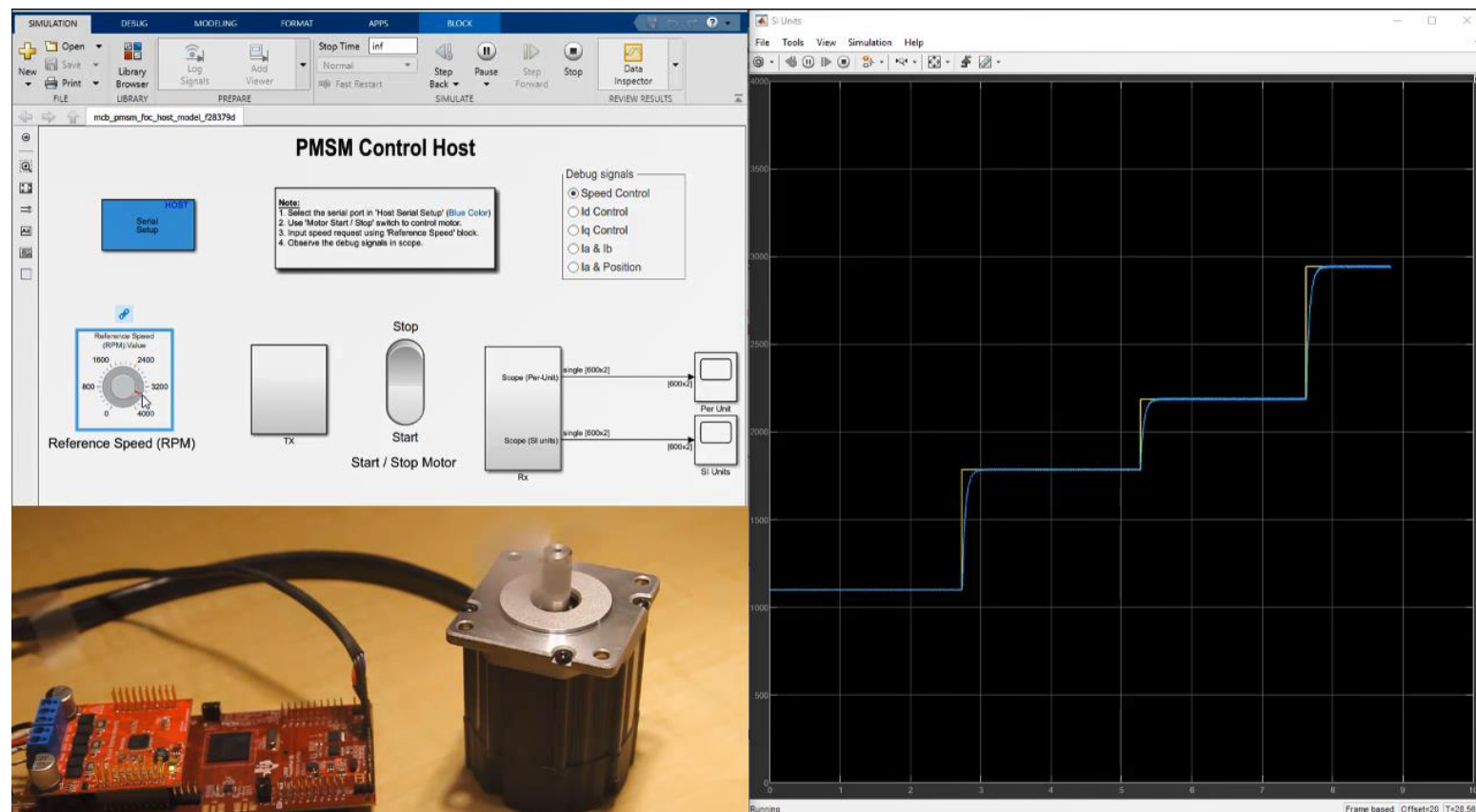


Generovanie softvéru pre riadenie motorov na pár klikov

Používateľské rozhrania

Knižnice – Riadenie motorov

Tvorba systémov

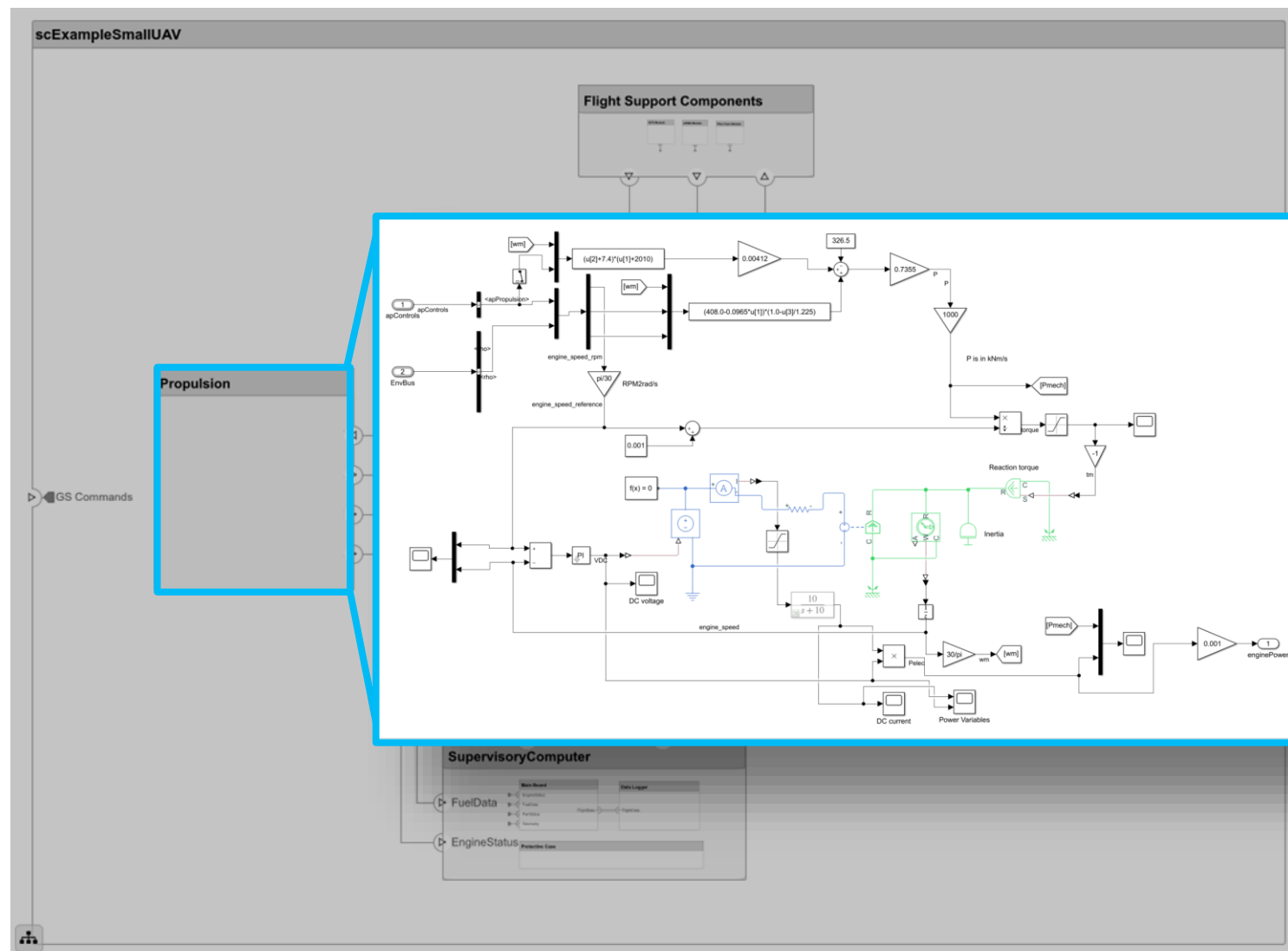


Návrh a analýza systémov a softvérových architektúr

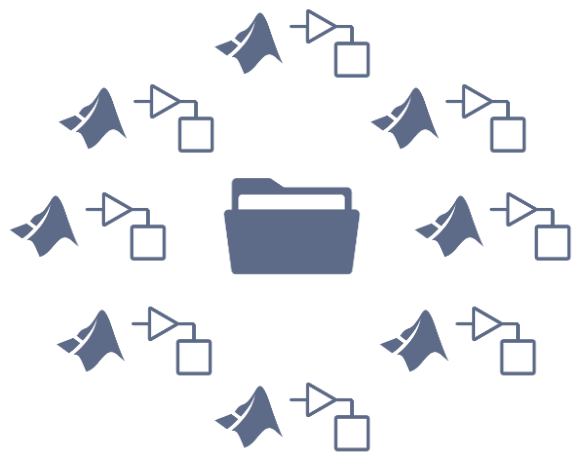
Používateľské rozhrania

Knižnice – Riadenie motorov

Tvorba systémov



Správa komplexných systémov



**Viacero
súborov**



**Tímová
spolupráca**



**Nastavenie
prostredia**

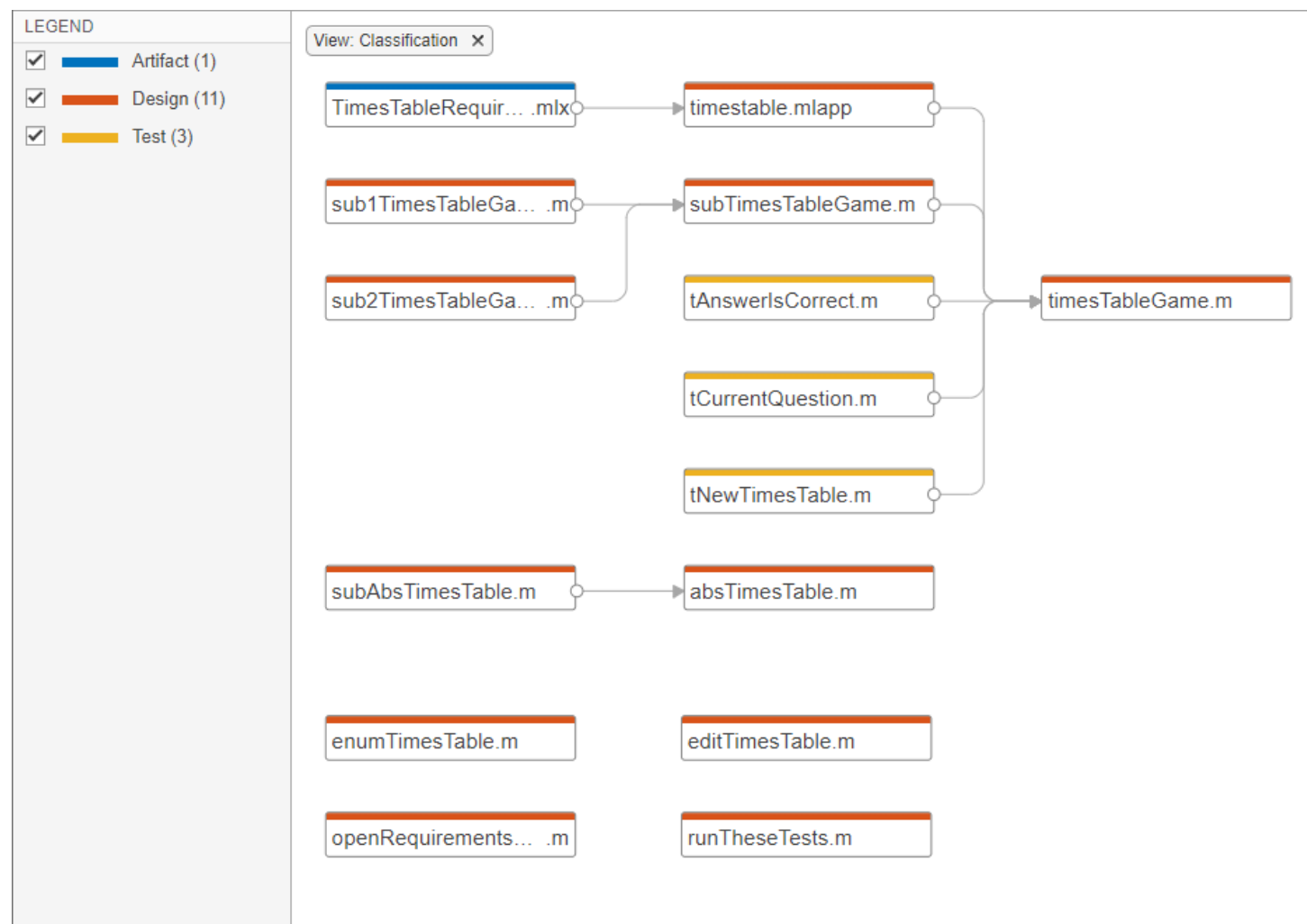
Správa komplexných systémov s projektami

Projekty v MATLABe and Simulinku pomáhajú organizovať, spravovať a zdieľať kód a modely



Analýza závislostí

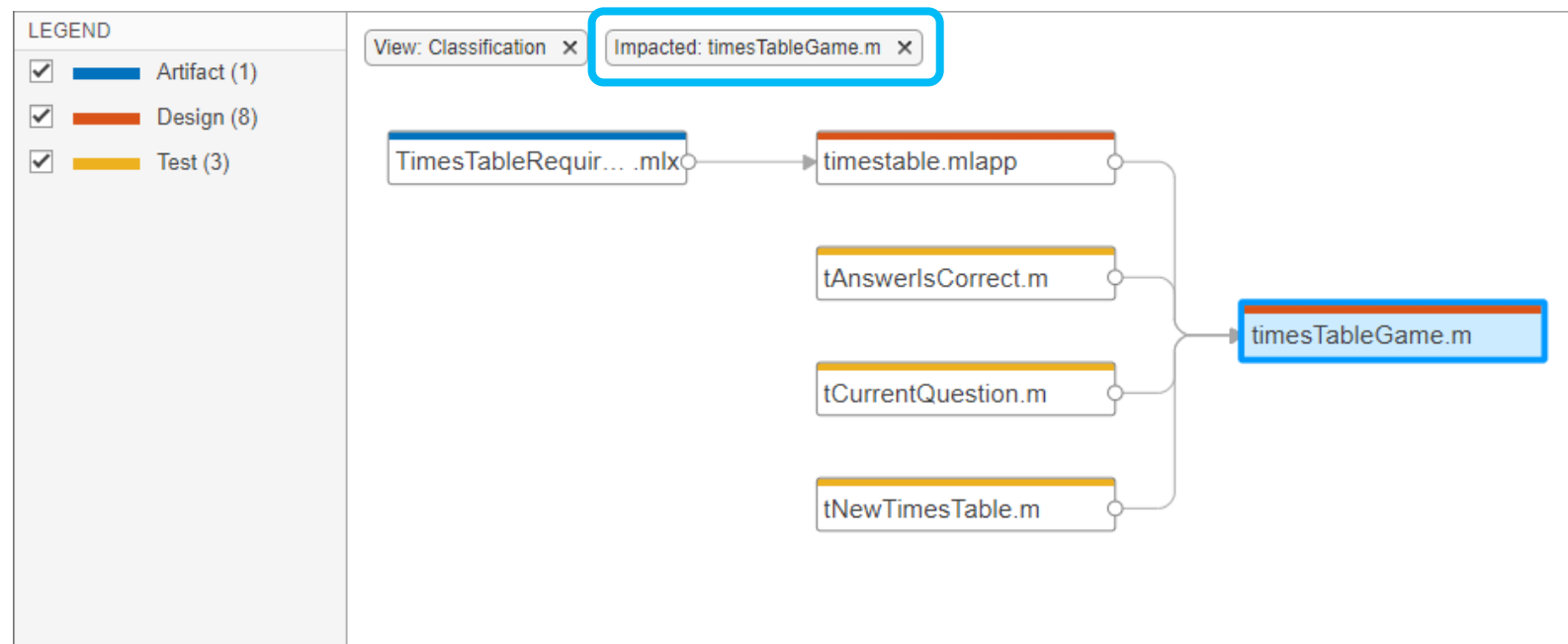
Prezeranie a vizualizácia štruktúry projektu



Analýza závislostí

Prezeranie a vizualizácia štruktúry projektu

Vplyv zmeny na ostatné súbory

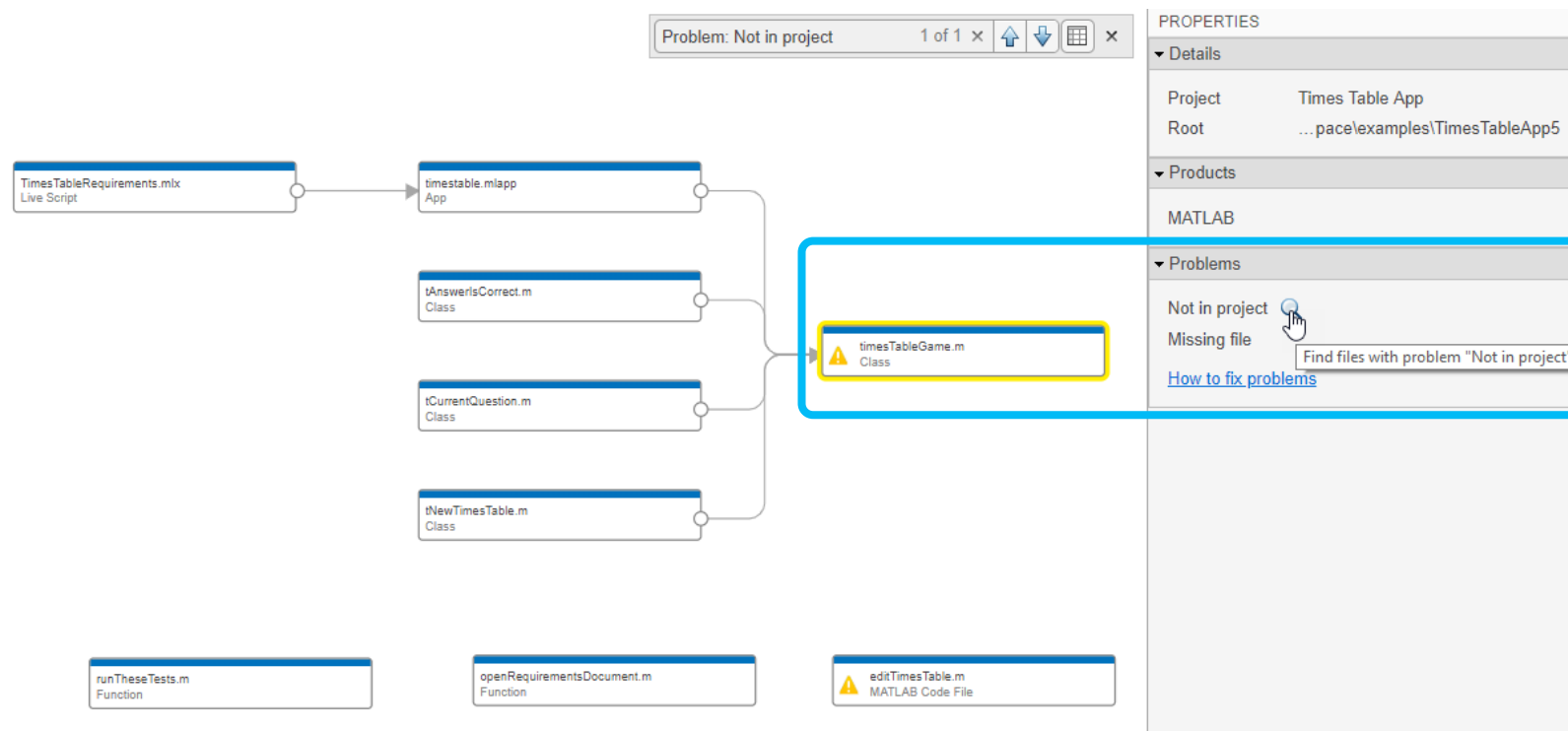


Analýza závislostí

Prezeranie a vizualizácia štruktúry projektu

Vplyv zmeny na ostatné súbory

Hľadanie a odstránenie chýb



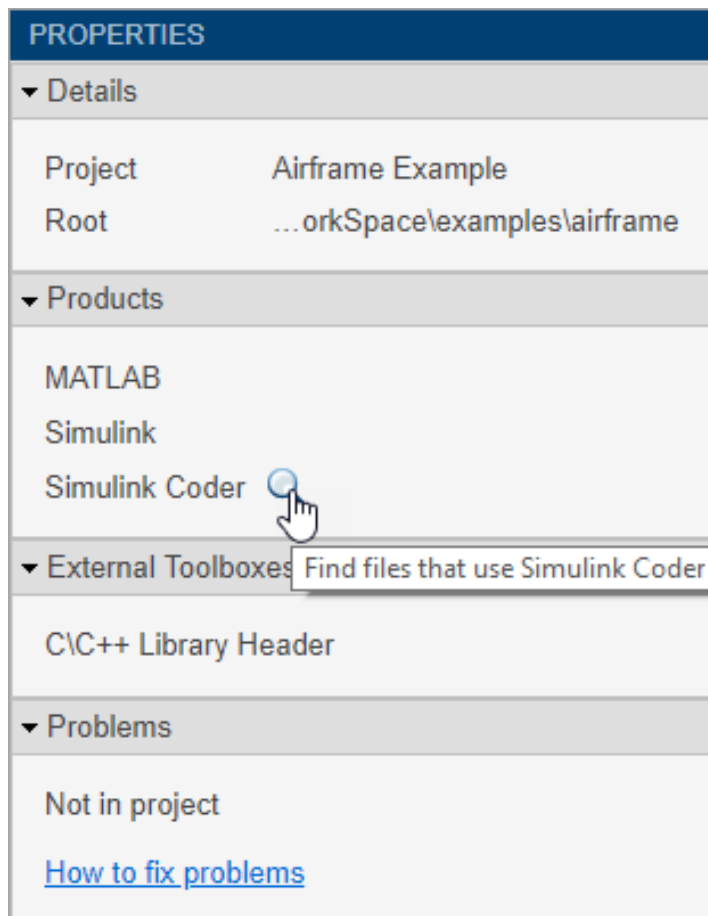
Analýza závislostí

Prezeranie a vizualizácia štruktúry projektu

Vplyv zmeny na ostatné súbory

Hľadanie a odstránenie chýb

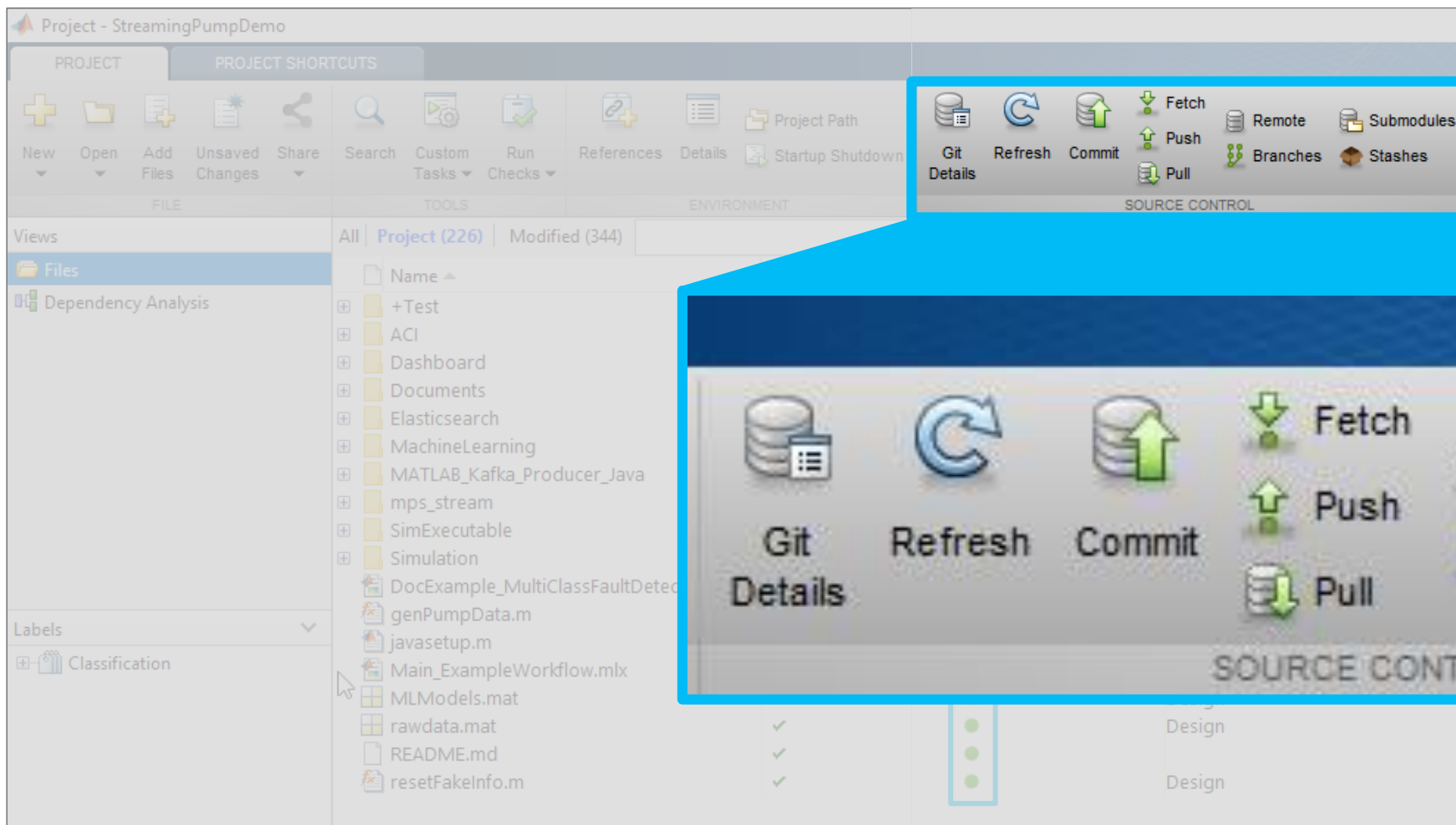
Potrebné produkty



The screenshot shows the 'PROPERTIES' window in MATLAB. It is divided into several sections:

- Details:** Shows 'Project' as 'Airframe Example' and 'Root' as '...orkSpace\examples\airframe'.
- Products:** Lists 'MATLAB', 'Simulink', and 'Simulink Coder'. A mouse cursor is pointing at 'Simulink Coder'.
- External Toolboxes:** A tooltip is visible over 'Simulink Coder' with the text 'Find files that use Simulink Coder'.
- Problems:** Shows 'Not in project' and a link for '[How to fix problems](#)'.

Správa softvéru (Git, Subversion) s projektami



Prístup k iným jazykom a systémom priamo z MATLABu

Python

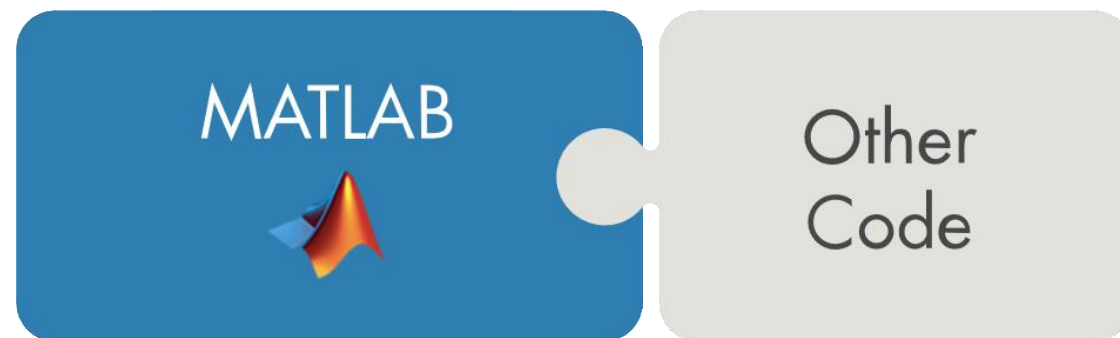
C/C++

Java

Fortran

COM komponenty, ActiveX controls

RESTful, HTTP, WSDL web services



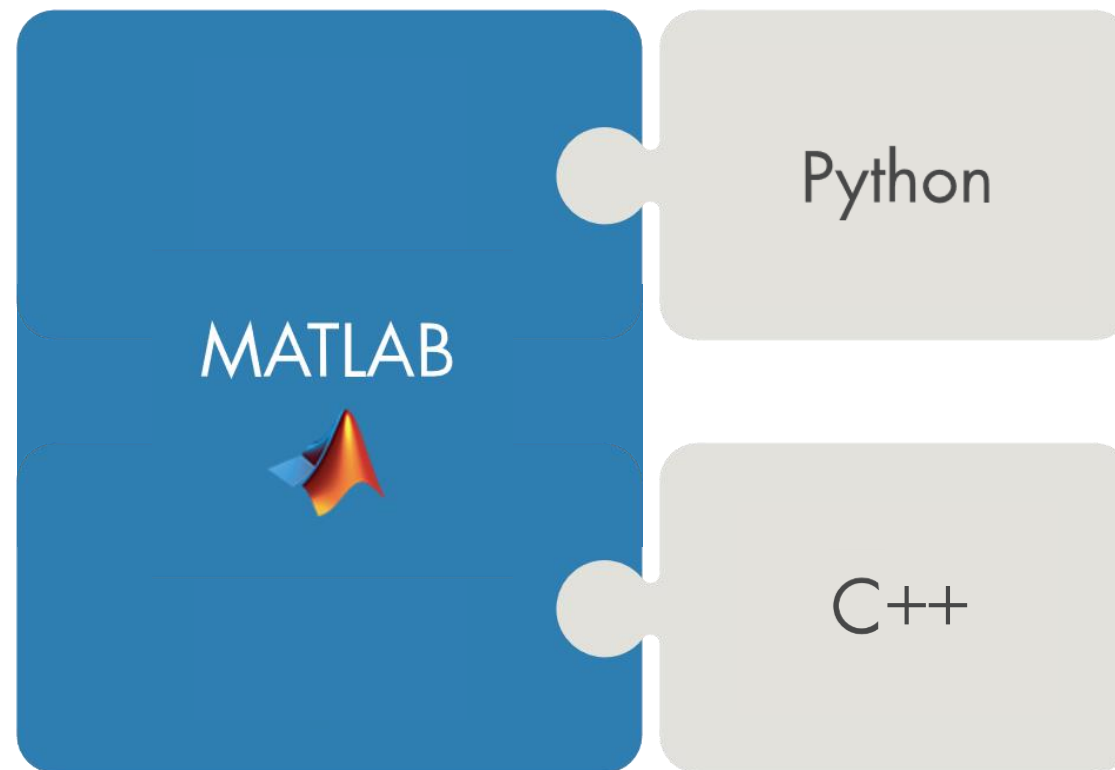
Prístup k iným jazykom a systémom priamo z MATLABu

Out-of-process funkcie Pythonu

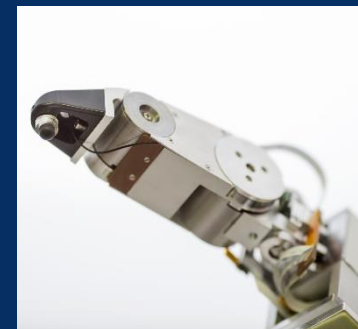
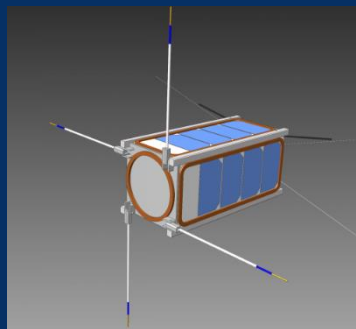
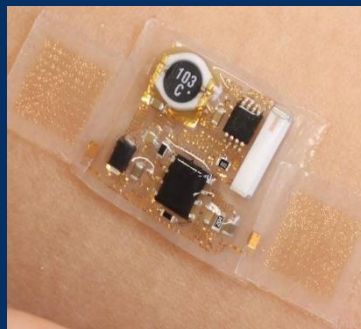
```
pyenv("ExecutionMode", "OutOfProcess")  
wrapped = py.textwrap.wrap(T);
```

C++ knižnice priamo z MATLABu

```
retVal = clib.libname.funcname(arg1, arg2, ...)
```



Simulink



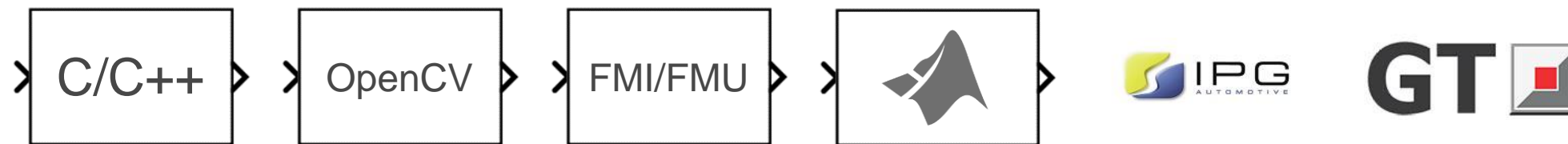
Simulink je platforma na integráciu simulácií



Simulink 



Simulink je platforma na integráciu simulácií



Simulink 





MATLAB®
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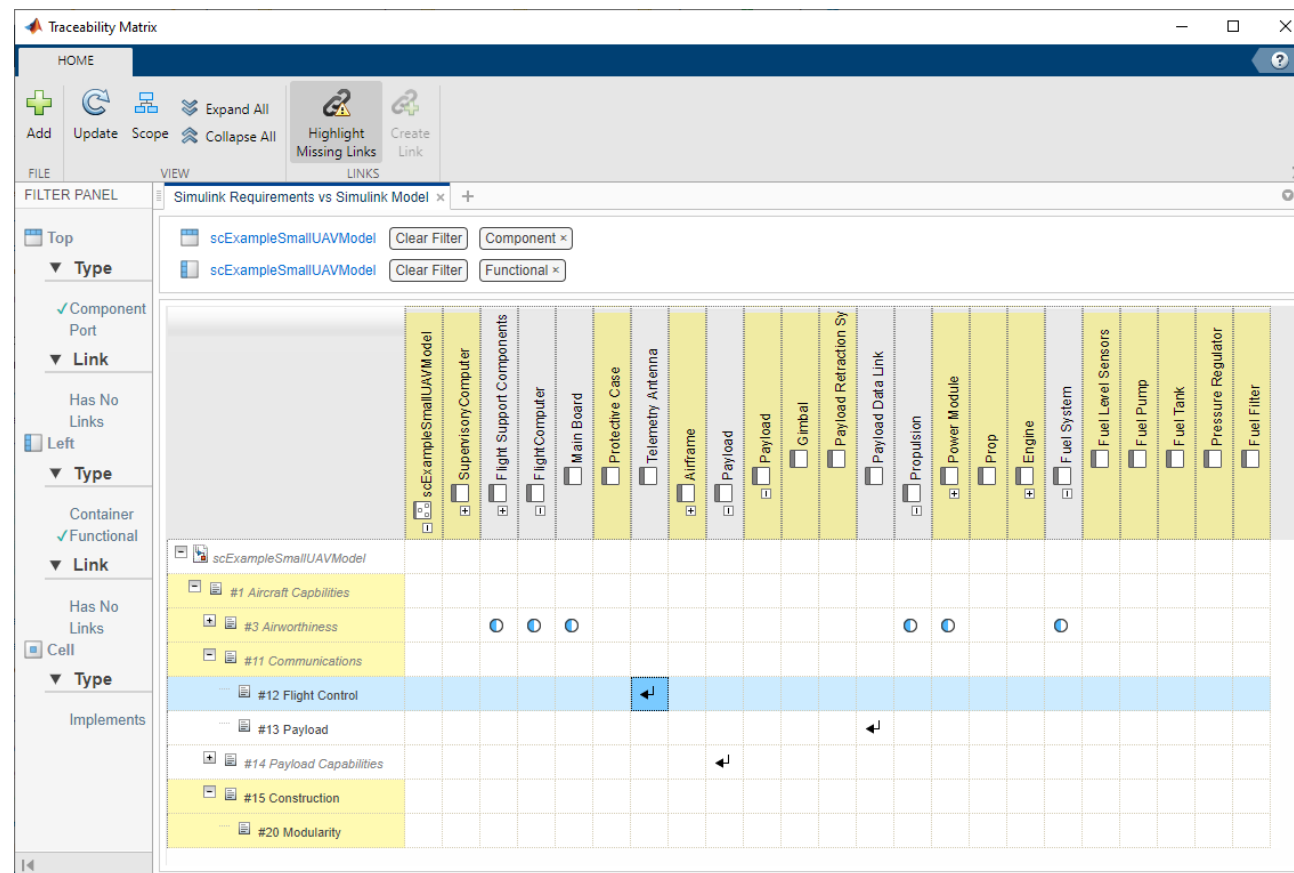
Testovanie a verifikácia
Zdieľanie a nasadenie



Detailné
riešenia

Testovanie a verifikácia návrhov

Analýza sledovateľnosti medzi artefaktami v jednom prostredí

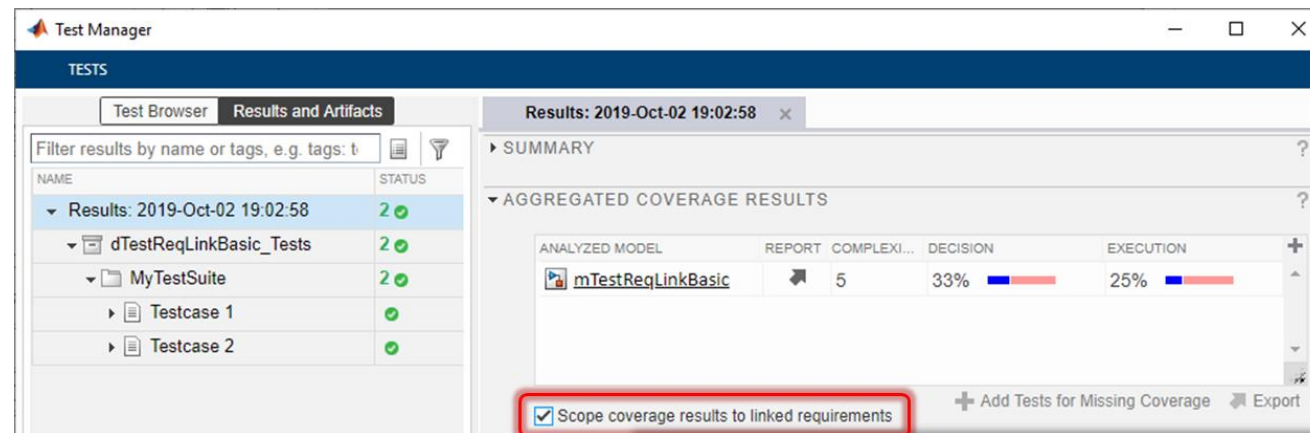


Traceability Matrix

Testovanie a verifikácia návrhov

Analýza sledovateľnosti medzi artefaktami v jednom prostredí

Pokrytie testov založených na požiadavkách



MultiPortSwitch block "[MPSwitch1](#)"

Requirement Testing Details

Implemented Requirements	Verified by Tests	Associated Runs
Requirement 1	Testcase 1	T1

Metric Coverage

Cyclomatic Complexity 2

Decision 33% (1/3) decision outcomes

Execution 100% (1/1) objective outcomes

Decisions analyzed

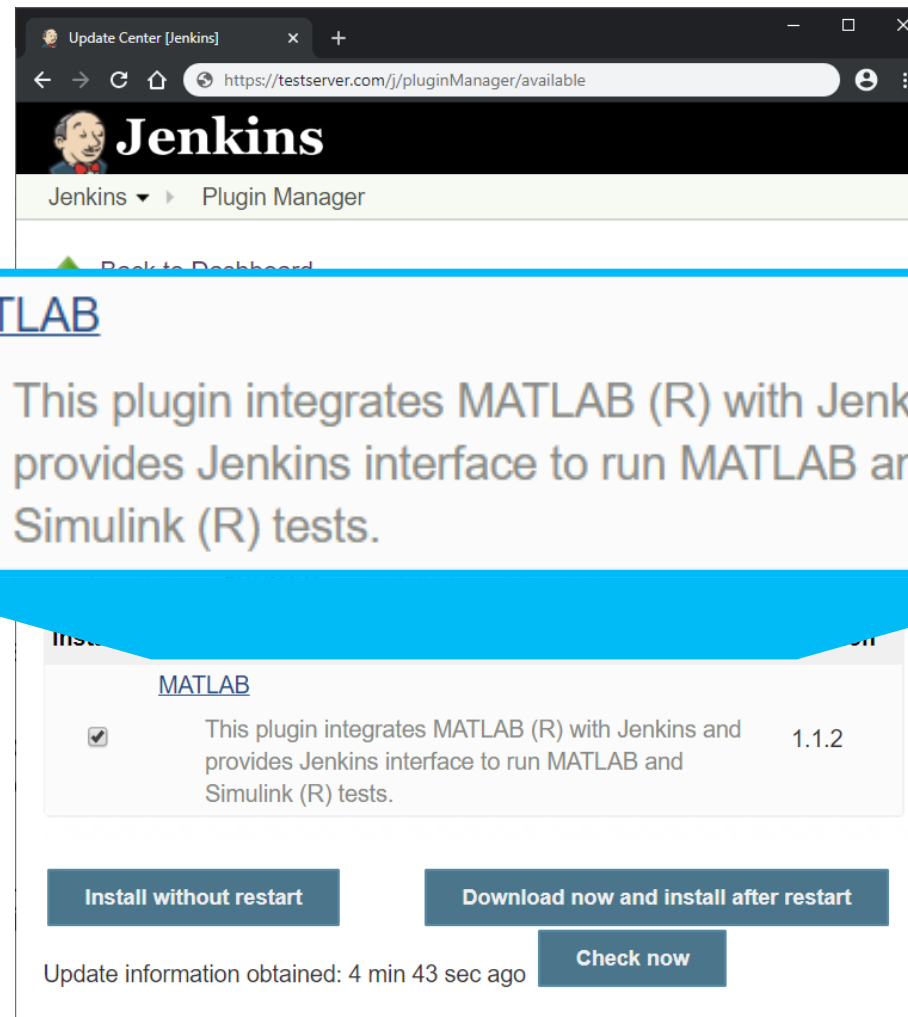
truncated input value	33%
= 1 (output is from input port 1)	51/51 I1
= 2 (output is from input port 2)	0/51 I2
= *,3 (output is from input port 3)	0/51 I2

Hit by linked RBT -- **Satisfied**

Hit, but not by linked RBT -- **Unsatisfied**

Jenkins na automatické spúšťanie a testovanie projektov

Inštalácia doplnku pre
Jenkins priamo z
Jenkins Plugin Managera



The screenshot shows the Jenkins Update Center interface. At the top, the browser address bar displays 'https://testserver.com/j/pluginManager/available'. The Jenkins logo and 'Jenkins Plugin Manager' are visible. A blue callout box highlights the 'MATLAB' plugin entry, which includes a description: 'This plugin integrates MATLAB (R) with Jenkins and provides Jenkins interface to run MATLAB and Simulink (R) tests.' Below the callout, the plugin details are shown, including a checked checkbox, the same description, and the version number '1.1.2'. At the bottom, there are three buttons: 'Install without restart', 'Download now and install after restart', and 'Check now'. The text 'Update information obtained: 4 min 43 sec ago' is also visible.

Verifikácia kódu pomocou Polyspace



Desktop

Automatizácia verifikácie kódu pomocou Polyspace



Desktop



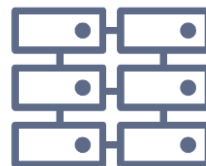
Server



Automatizácia verifikácie kódu a zdieľanie výsledkov



Desktop



Server



Web





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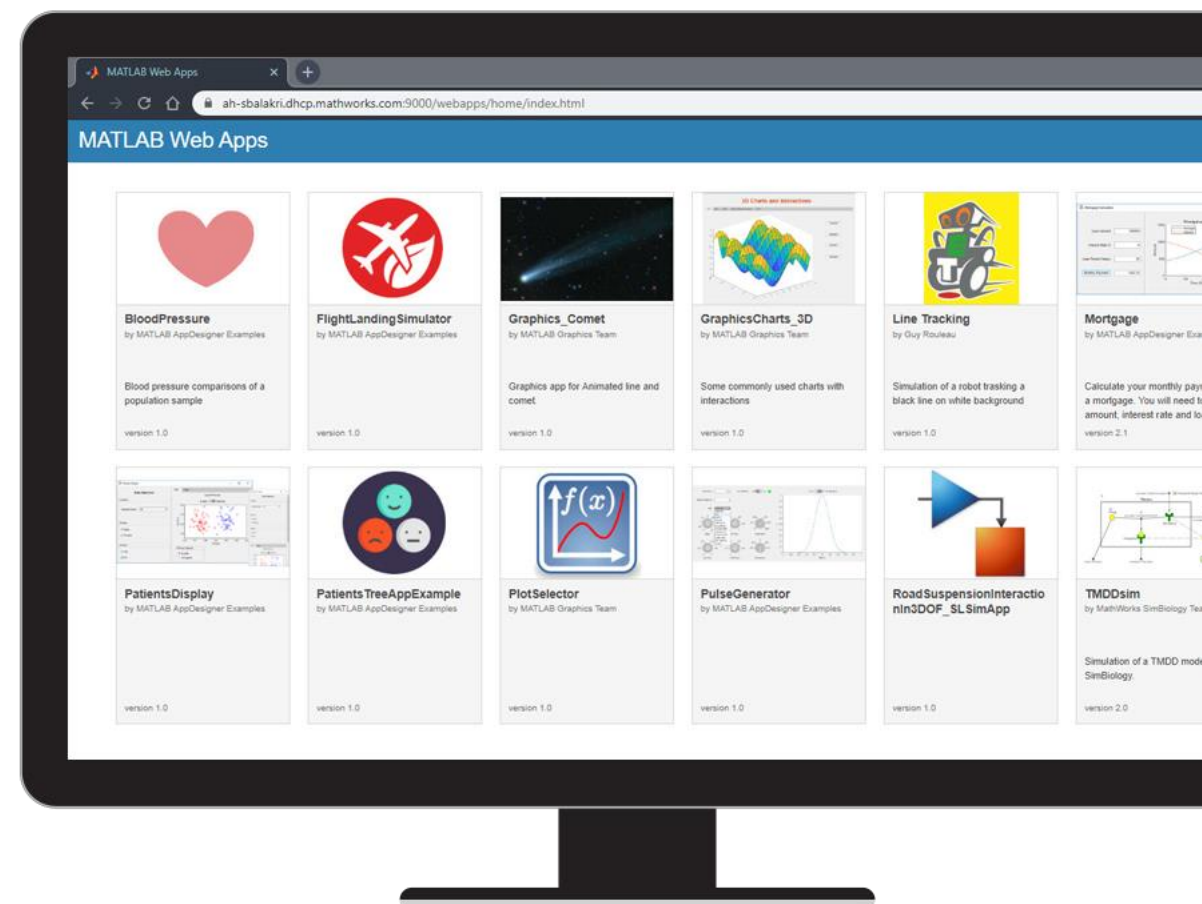
Testovanie a verifikácia
Zdieľanie a nasadenie



Detailné
riešenia

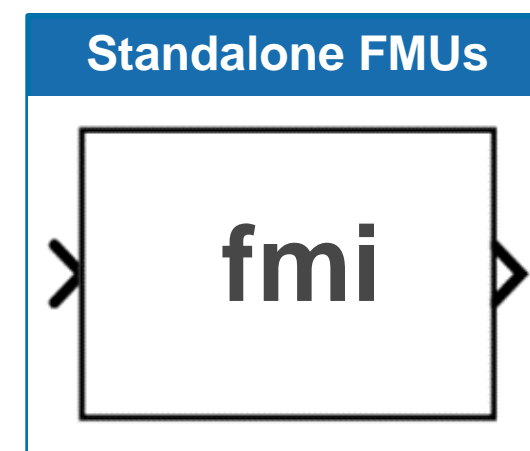
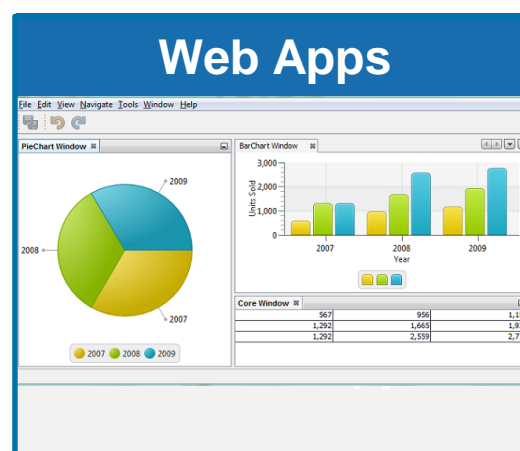
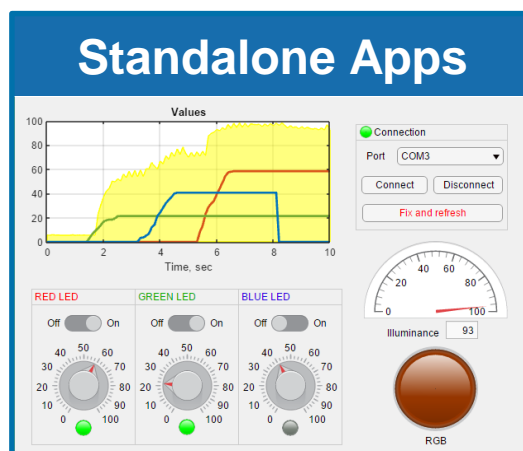
Zdieľanie aplikácií pomocou webu

Tvorba aplikácie pomocou App Designera a zdieľanie cez MATLAB Web App Server



Zdieľanie simulácií, kde nie je Simulink

Zabalenie kompilovaného Simulink modelu s kódom MATLABu



Nasadenie algoritmov automaticky generovaným kódom

C++ triedy z tried MATLABu

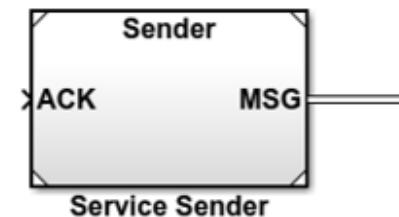
```
class MyClass
{
public:
    MyClass *init();
    void publicMethod(double value);
    static double doubleThisValue(double val);
    double calculateSomeValue() const;
private:
    MyClass *matlabCodegenHandle_init();
    MyClass *privateMethod(double value);
public:
    double publicProp;
private:
    double privateProp;
};
```



Nasadenie algoritmov automaticky generovaným kódom

C++ triedy z tried MATLABu

Kód zo softvéru s komunikáciou založenou na správach



Sender.cpp

```

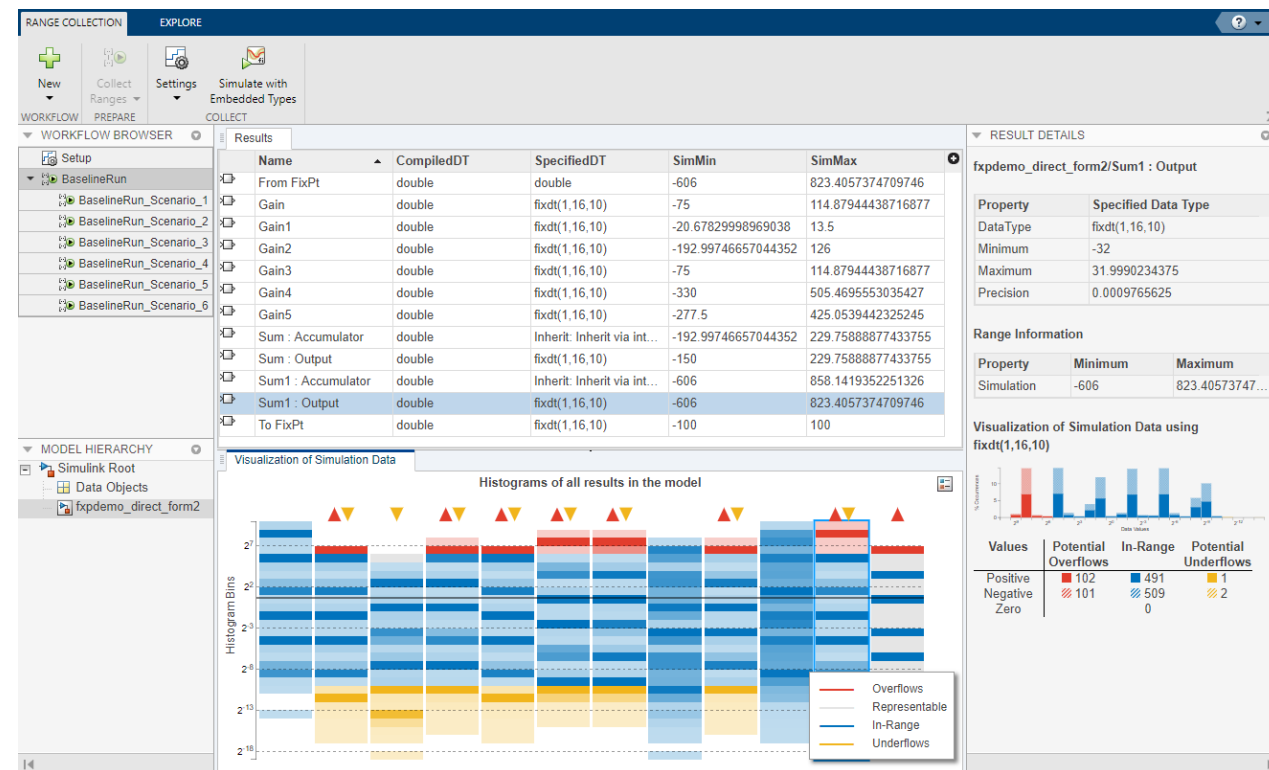
class Sender: public ServiceA If
{
public:
    step_10s() {
        ...
        // compute ack and send
        status = MSG.send(&ack);
    }
    ...
private:
    ServiceB_IfProxy msgProxy;
    ...
};
  
```

Nasadenie algoritmov automaticky generovaným kódom

C++ triedy z tried MATLABu

Kód zo softvéru s komunikáciou založenou na správach

Prehľad rozsahov signálov v návrhu a optimalizácia dátových typov



Fixed-Point Tool



MATLAB®
& SIMULINK®



Testovanie a verifikácia
Zdieľanie a nasadenie



Detailné
riešenia



Umelá inteligencia (AI)

MATLAB

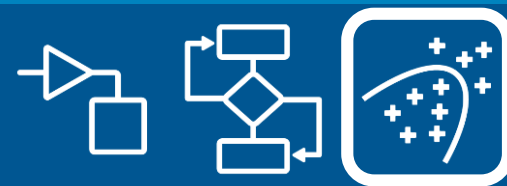
Prístup k dátam



Predspracovanie



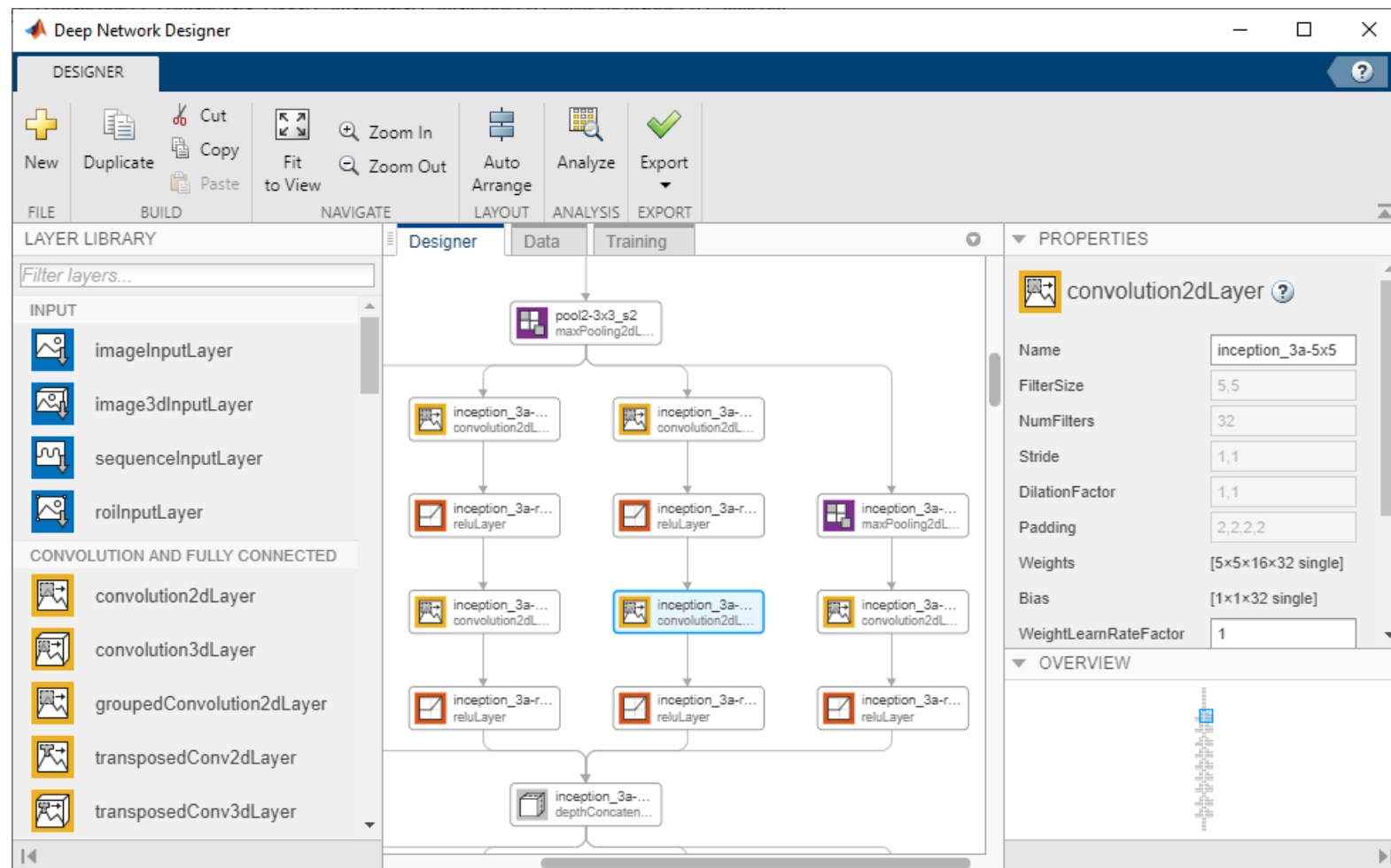
Vývoj



Nasadenie



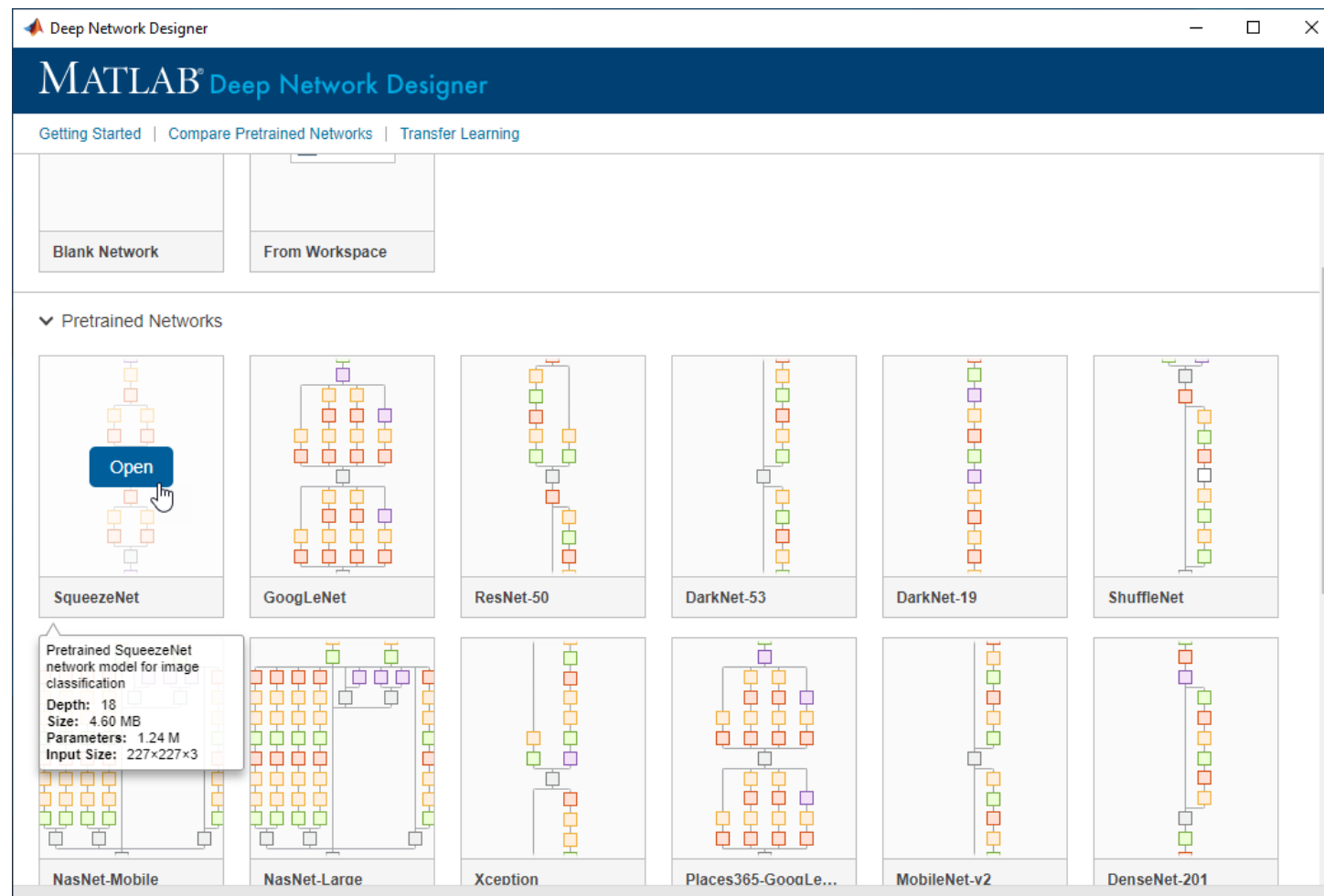
Interaktívna práca s modelmi, návrh a trénovanie sietí



Deep Network Designer App

Interaktívna práca s modelmi, návrh a trénovanie sietí

Import predtrénovaných sietí pre transfer learning

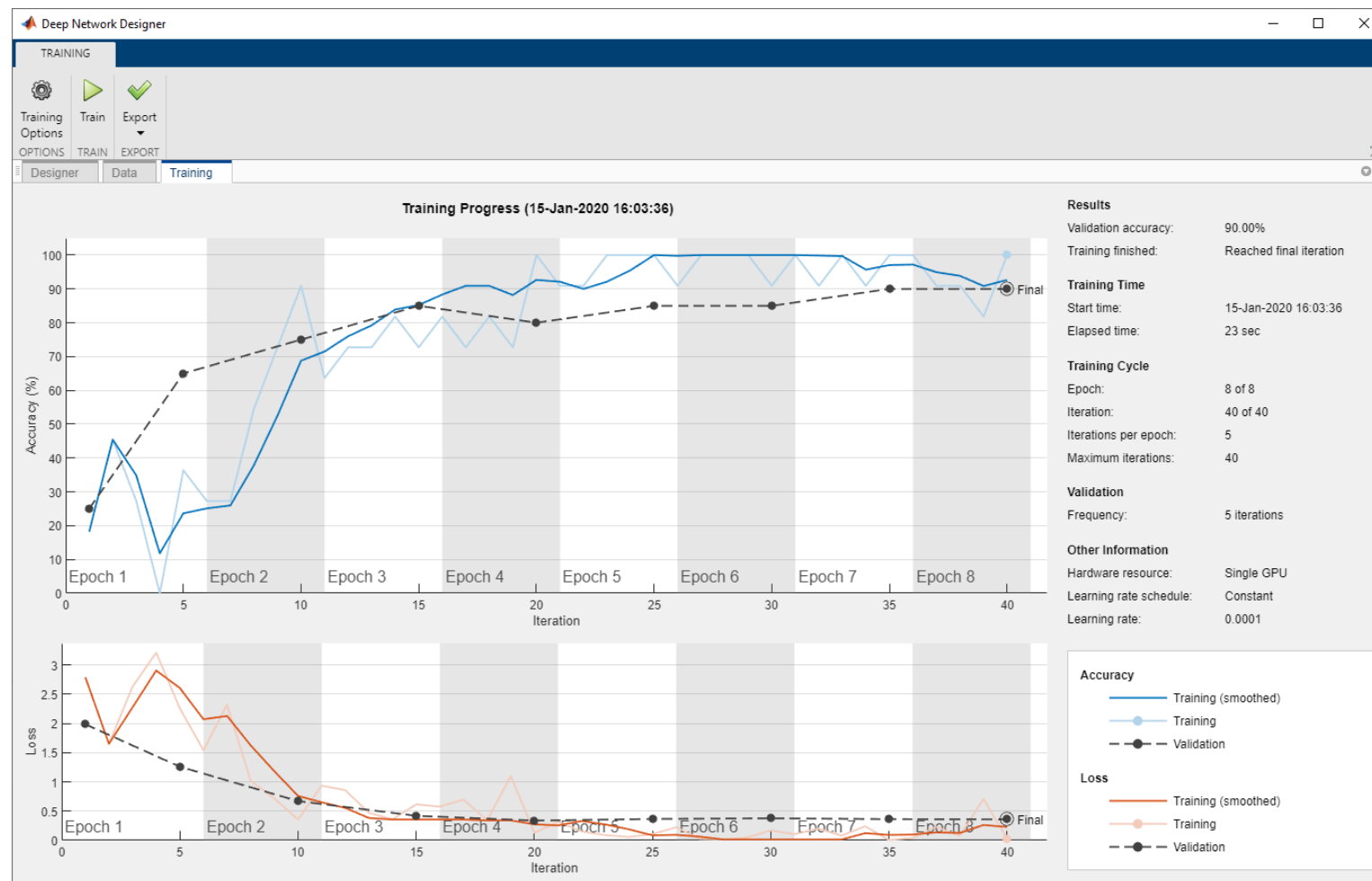


Deep Network Designer App

Interaktívna práca s modelmi, návrh a tréovanie sietí

Import predtrénovaných sietí pre transfer learning

Tréovanie sietí a generovanie kódu



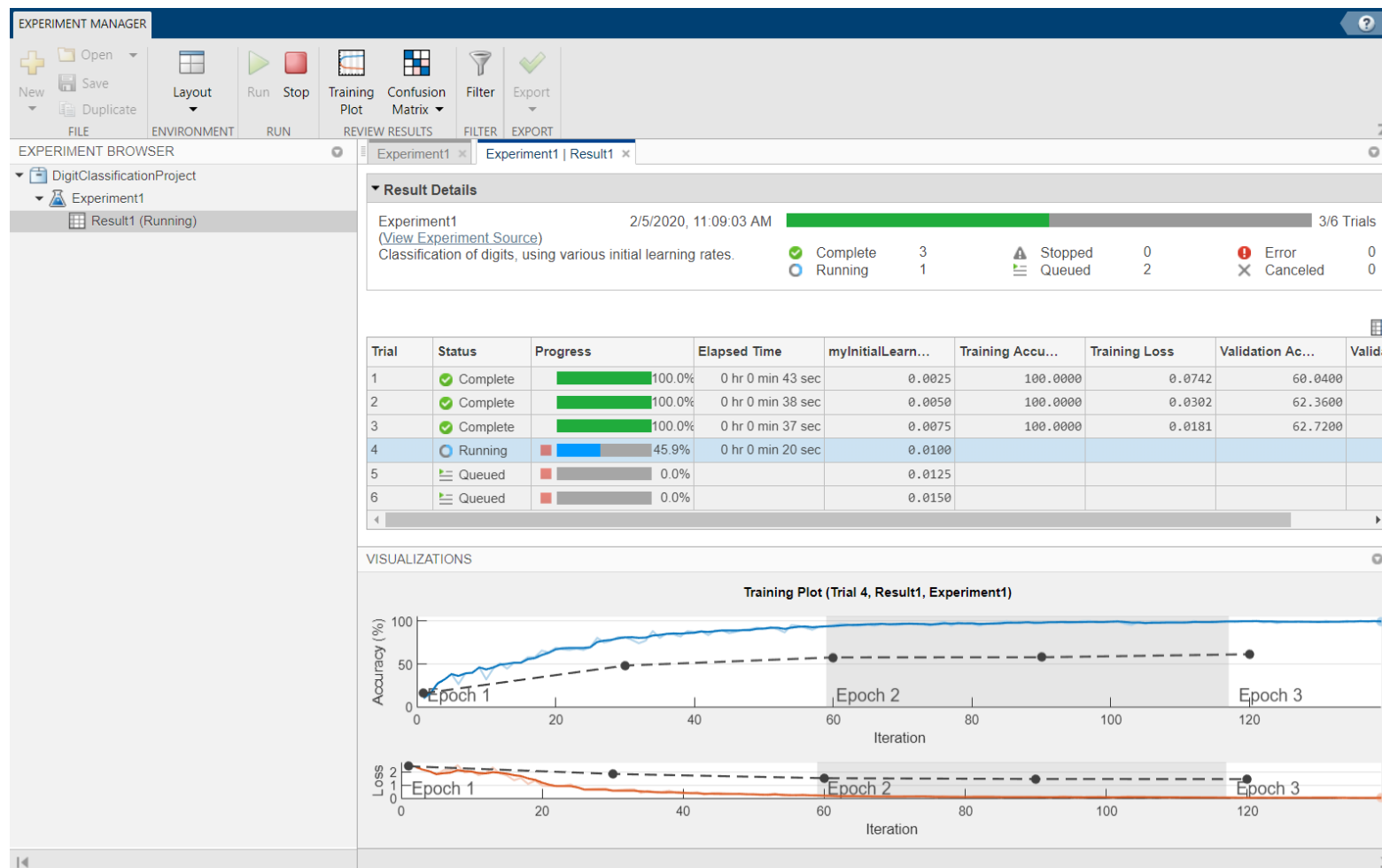
Deep Network Designer App

Správa viacerých experimentov

Sledovanie
trénovacích
parametrov

Znovupoužitie
trénovacích dát vo
viacerých sieťach

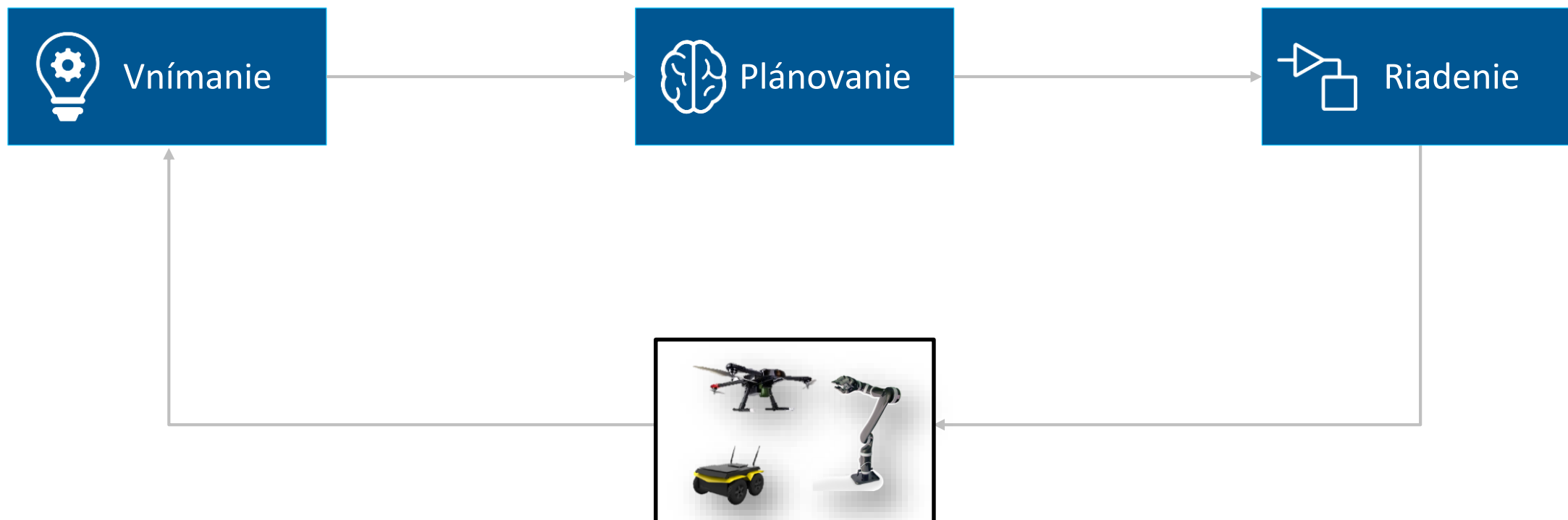
Analýza a porovnanie
výsledkov



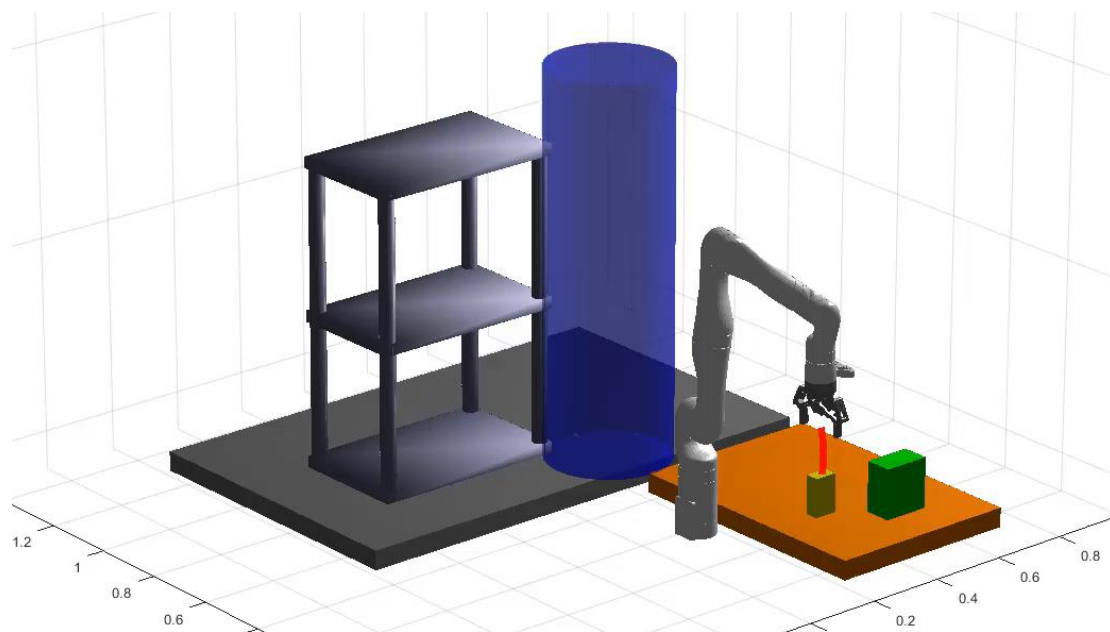
Experiment Manager App



Robotika a Autonómne systémy

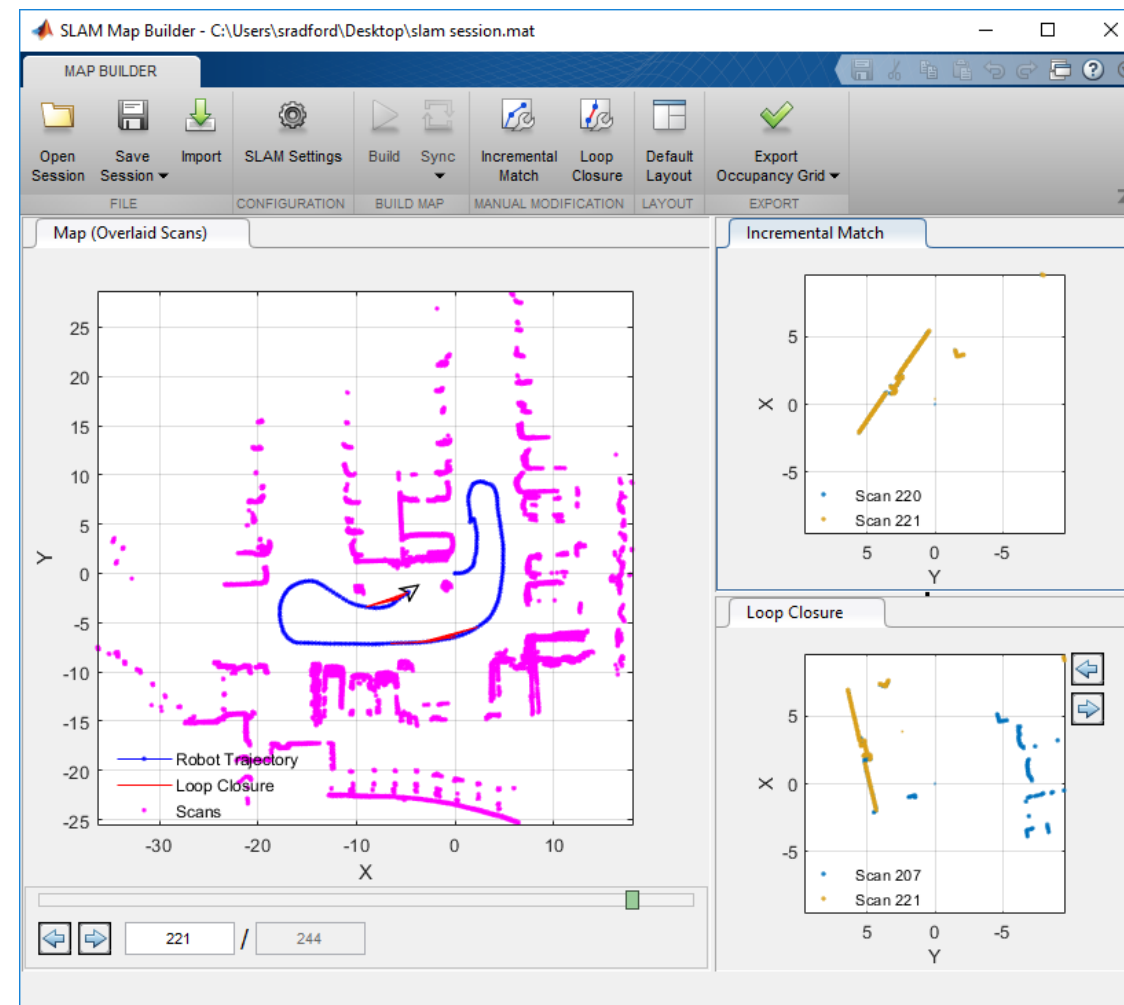


Simulácia a vizualizácia kinematiky robotov



Návrh algoritmov pre plánovanie a navigáciu

Tvorba máp prostredia

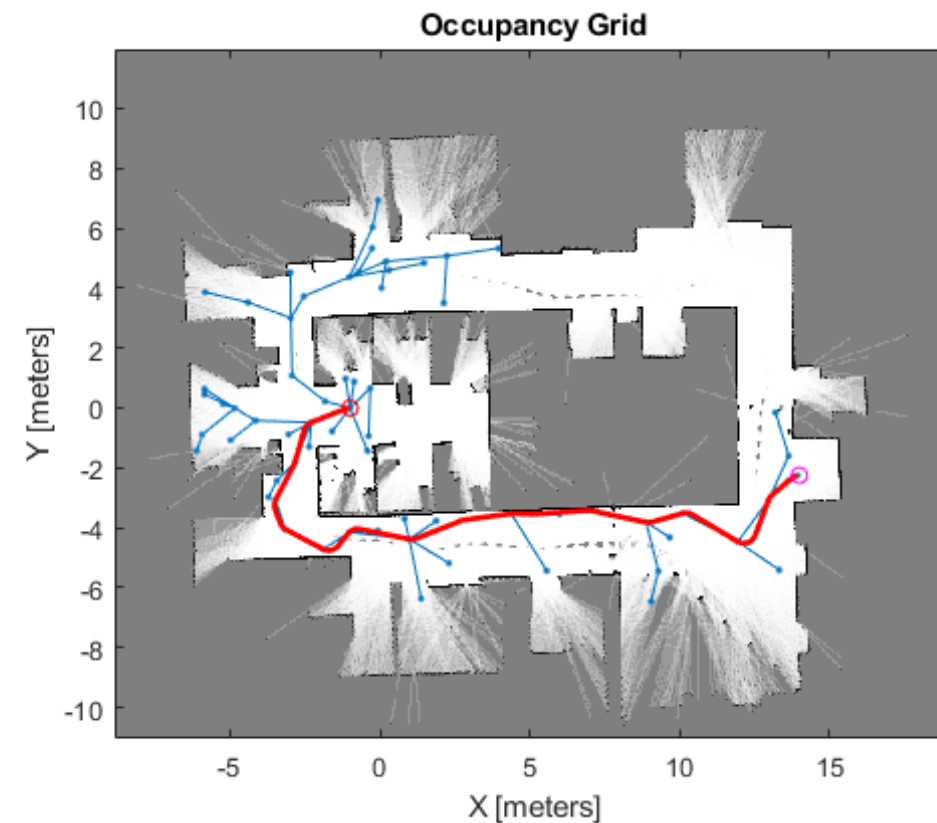


SLAM Map Builder

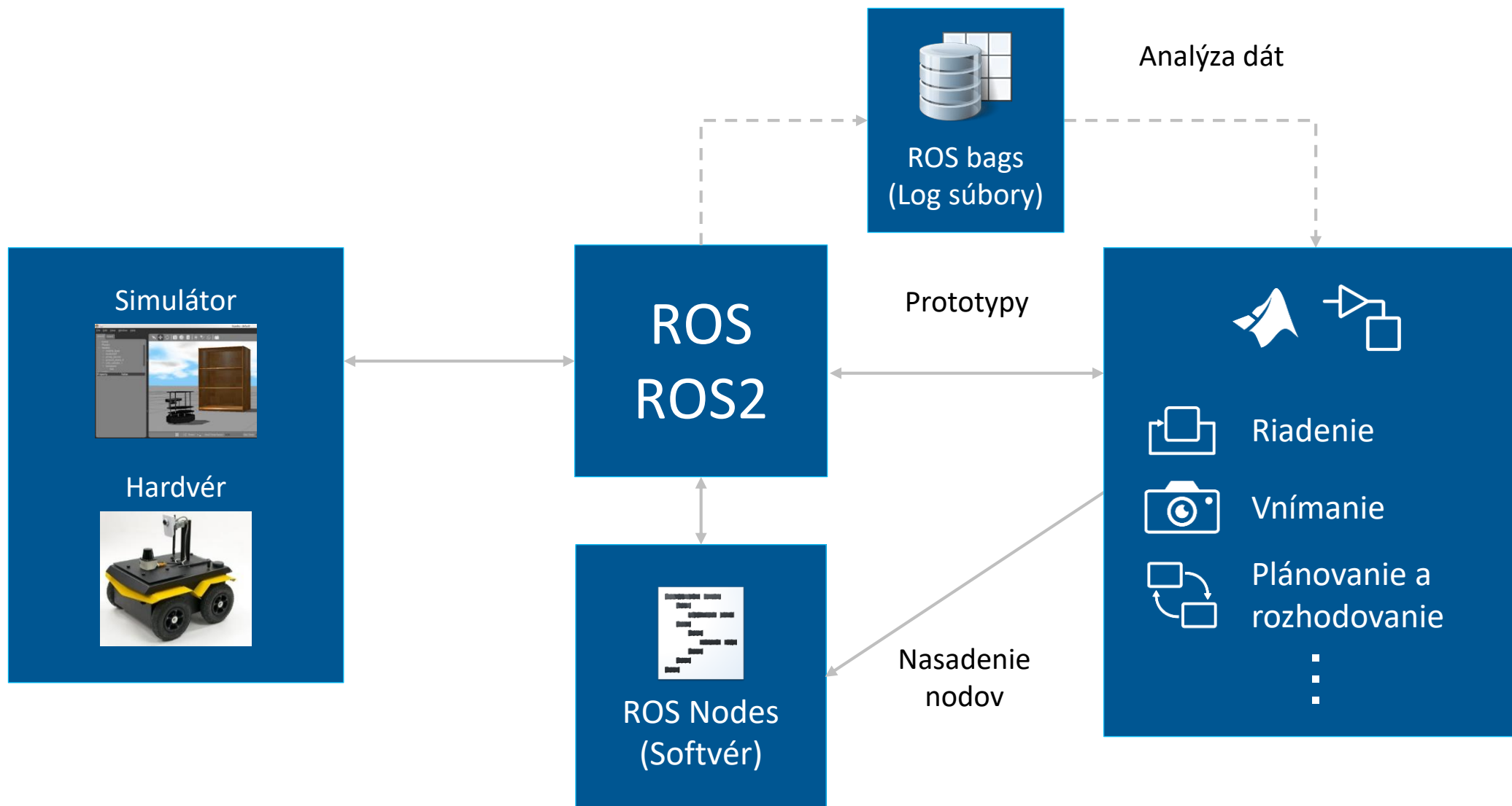
Návrh algoritmov pre plánovanie a navigáciu

Tvorba máp prostredia

Plánovanie ciest v známej mape



Návrh, simulácia a nasadenie ROS aplikácií





Bezdrôtová komunikácia

RF & Antény

RF Toolbox

RF Blockset

Antenna
Toolbox

Phased Array
Toolbox

Pásmo

Communications
Toolbox

Wireless HDL
Toolbox

Štandardy

5G Toolbox

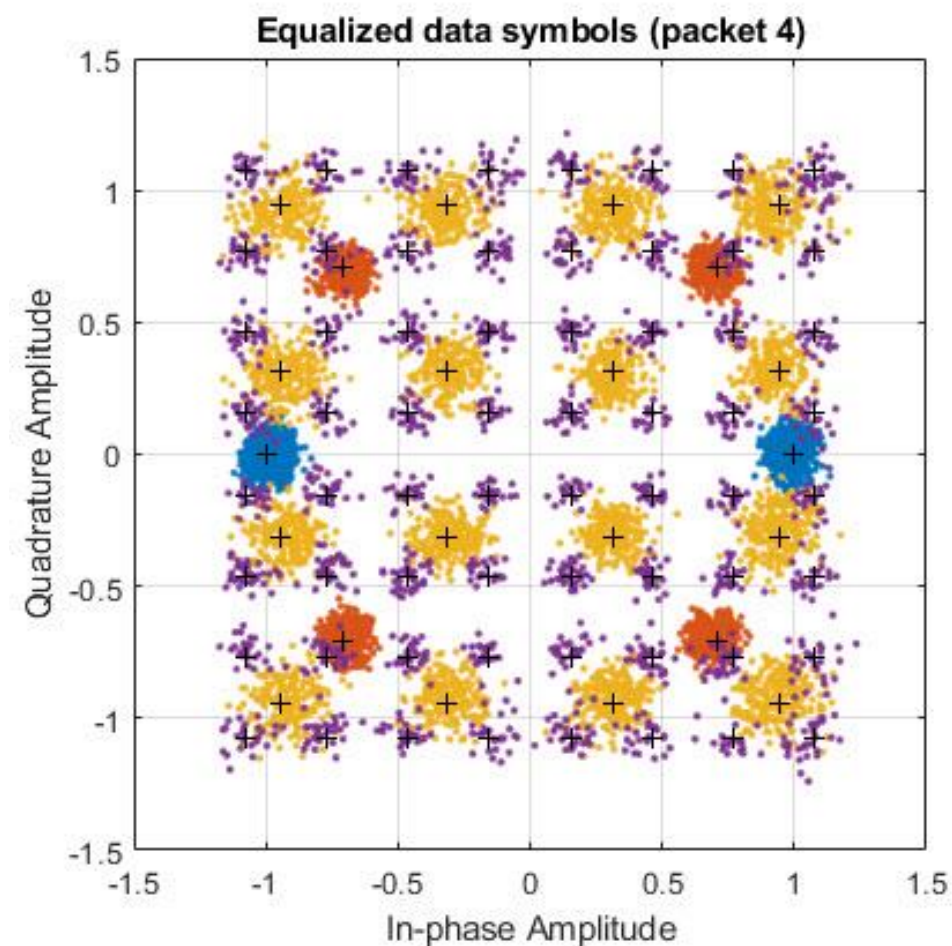
LTE Toolbox

WLAN Toolbox

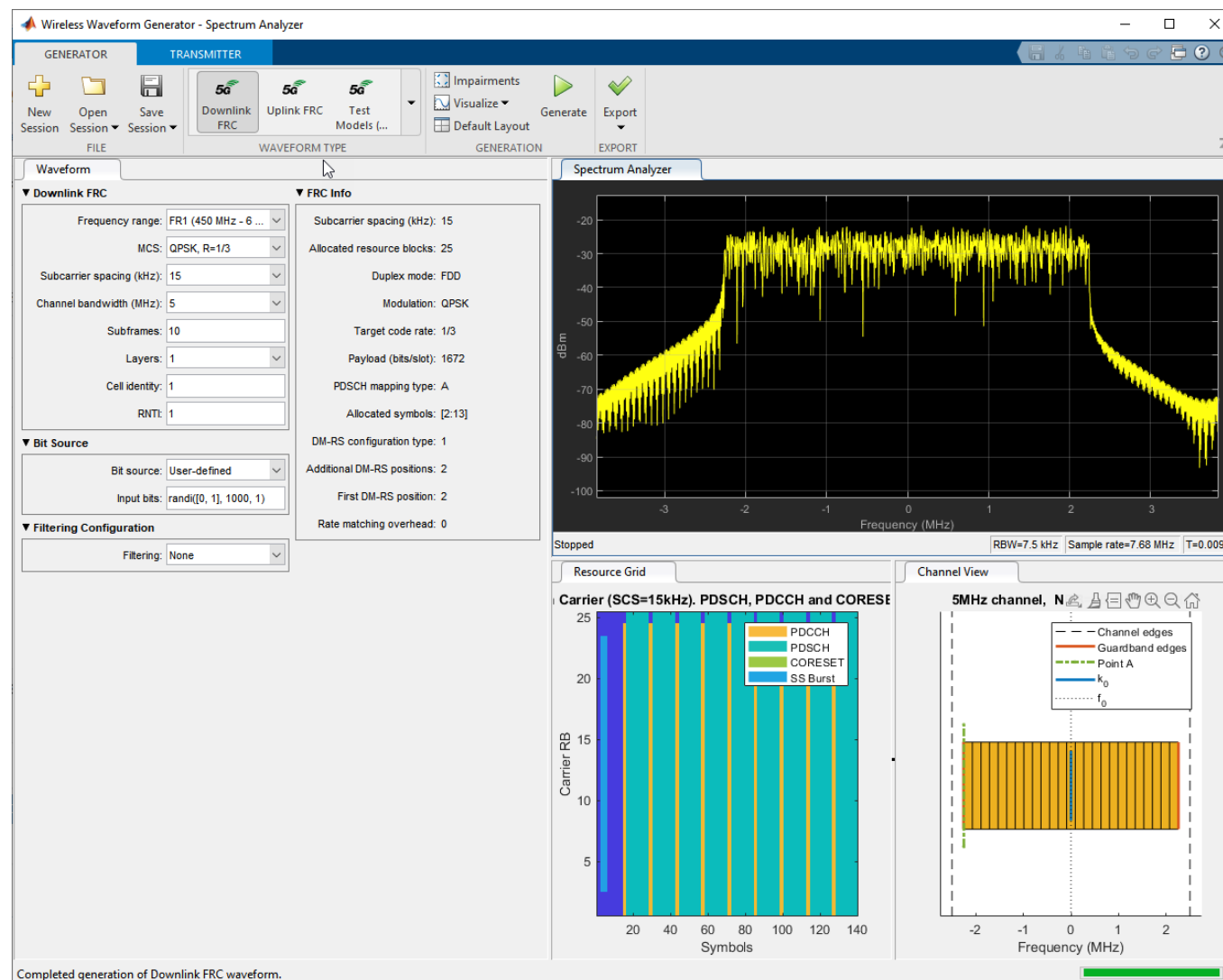
Modelovanie, simulácia a testovanie systémov Wi-Fi 6

Generovanie vln návrhu P802.11ax™ 4.1

Simulácia 802.11ax (Trigger-Based Format)



Interaktívne generovanie 5G vln pre testovanie



Wireless Waveform Generator - Spectrum Analyzer

GENERATOR TRANSMITTER

FILE WAVEFORM TYPE GENERATION EXPORT

Downlink FRC Uplink FRC Test Models (...)

Impairments Visualize Default Layout Generate Export

Waveform

Downlink FRC

Frequency range: FR1 (450 MHz - 6 ...)

MCS: QPSK, R=1/3

Subcarrier spacing (kHz): 15

Channel bandwidth (MHz): 5

Subframes: 10

Layers: 1

Cell identity: 1

RNTI: 1

FRC Info

Subcarrier spacing (kHz): 15

Allocated resource blocks: 25

Duplex mode: FDD

Modulation: QPSK

Target code rate: 1/3

Payload (bits/slot): 1672

PDSCH mapping type: A

Allocated symbols: [2:13]

DM-RS configuration type: 1

Additional DM-RS positions: 2

First DM-RS position: 2

Rate matching overhead: 0

Bit Source

Bit source: User-defined

Input bits: randi([0, 1], 1000, 1)

Filtering Configuration

Filtering: None

Spectrum Analyzer

Stopped RBW=7.5 kHz Sample rate=7.68 MHz T=0.0099

Resource Grid

Carrier (SCS=15kHz). PDSCH, PDCCH and CORESET

Carrier RB

25

20

15

10

5

20 40 60 80 100 120 140

Symbols

Legend: PDCCH, PDSCH, CORESET, SS Burst

Channel View

5MHz channel, N

Channel edges

Guardband edges

Point A

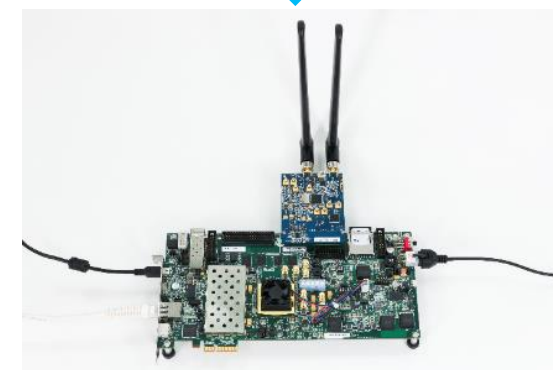
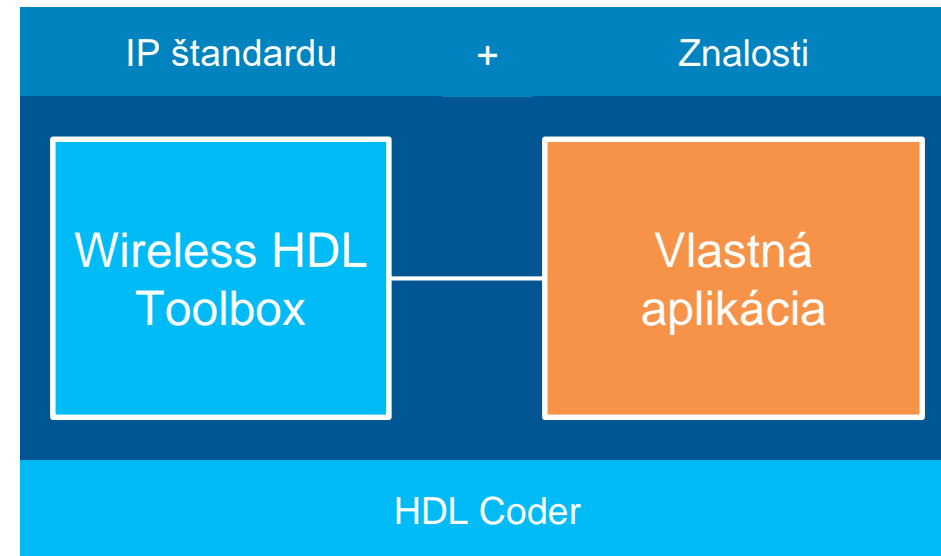
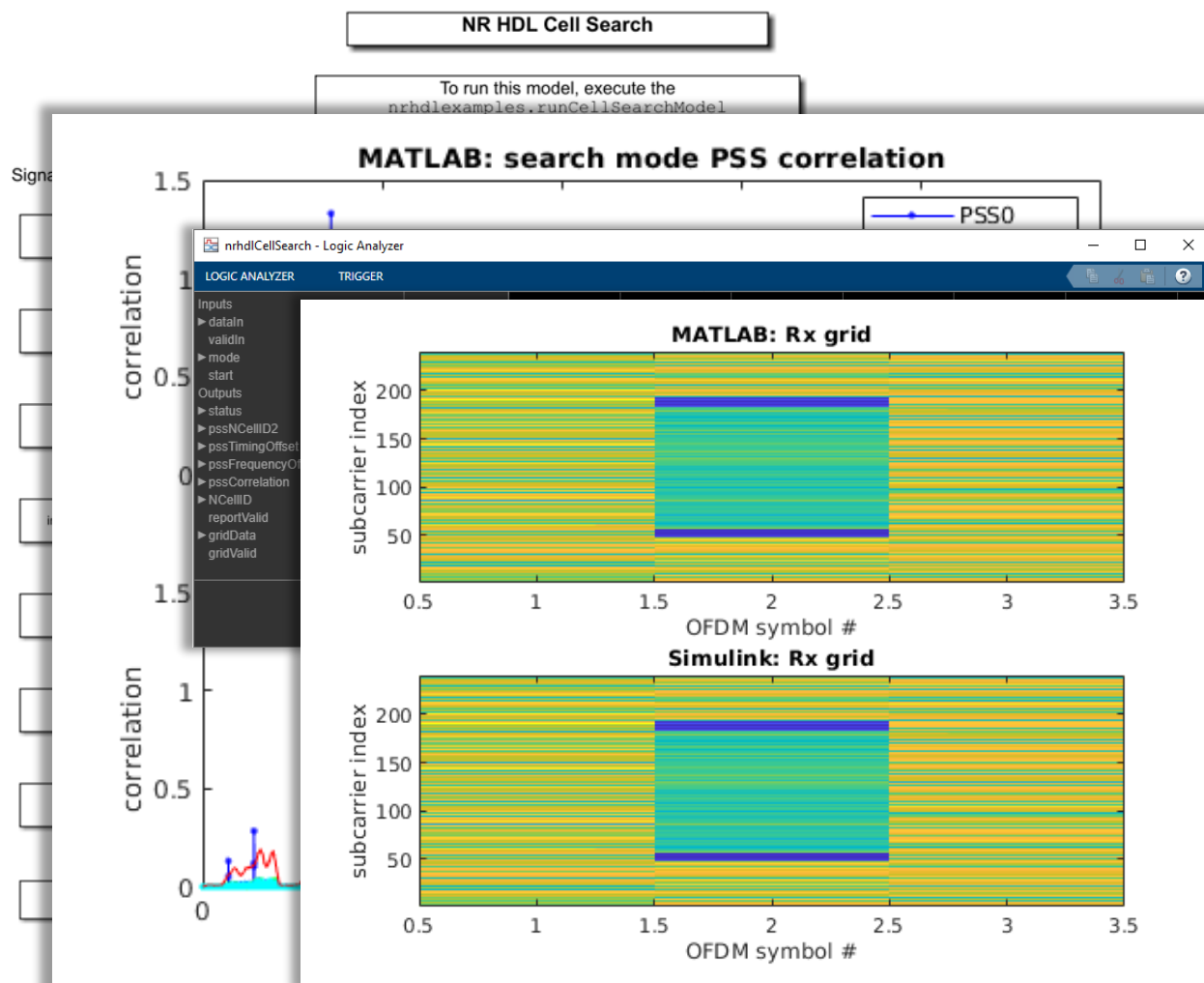
f_0

f_b

Frequency (MHz)

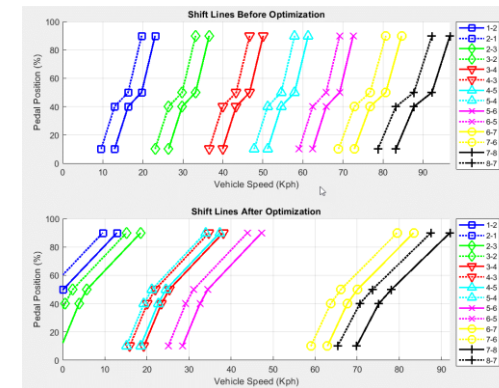
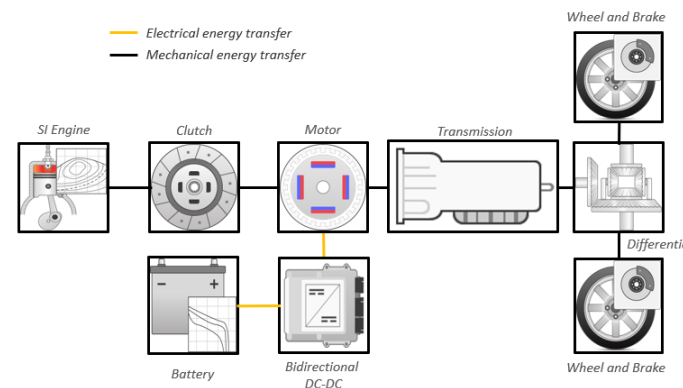
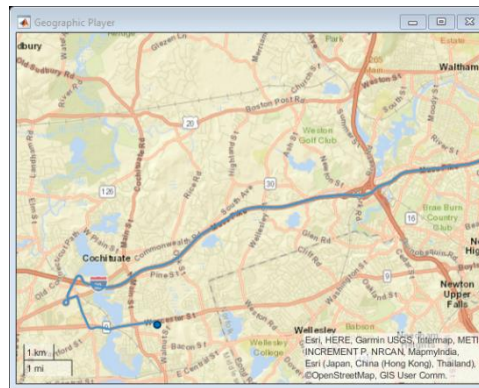
Completed generation of Downlink FRC waveform.

Referenčné príklady pre implementáciu návrhu





Systemy v automobilech



Urýchlenie vývoja systémov autonómneho riadenia

Vývoj algoritmov v 3D simulačnom prostredí

Testovanie algoritmov v predpripravených scenároch

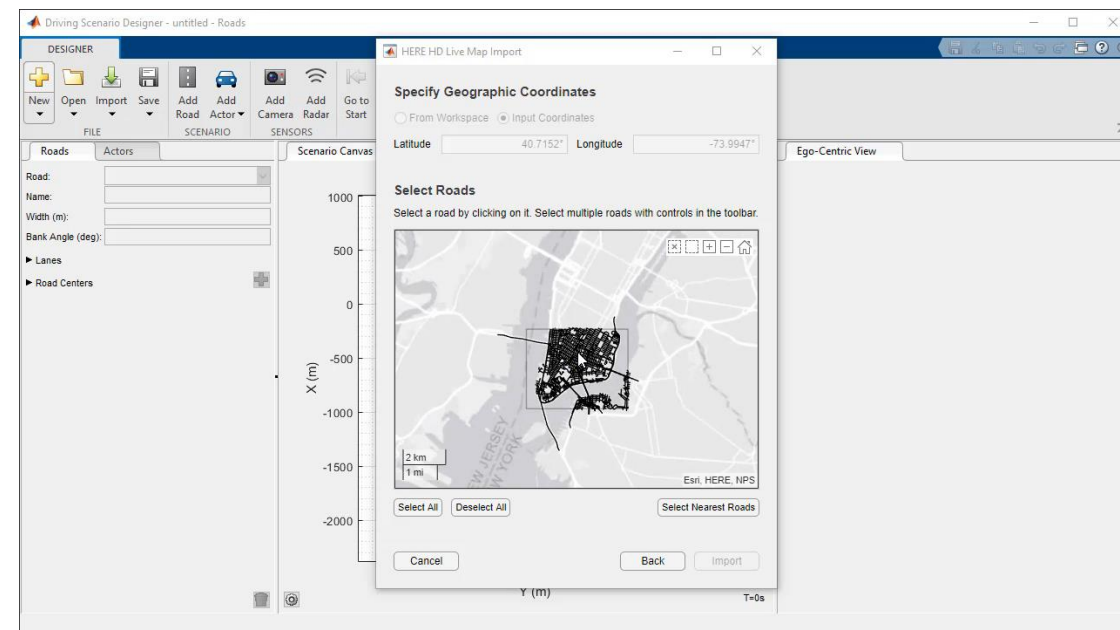


Urýchlenie vývoja systémov autonómneho riadenia

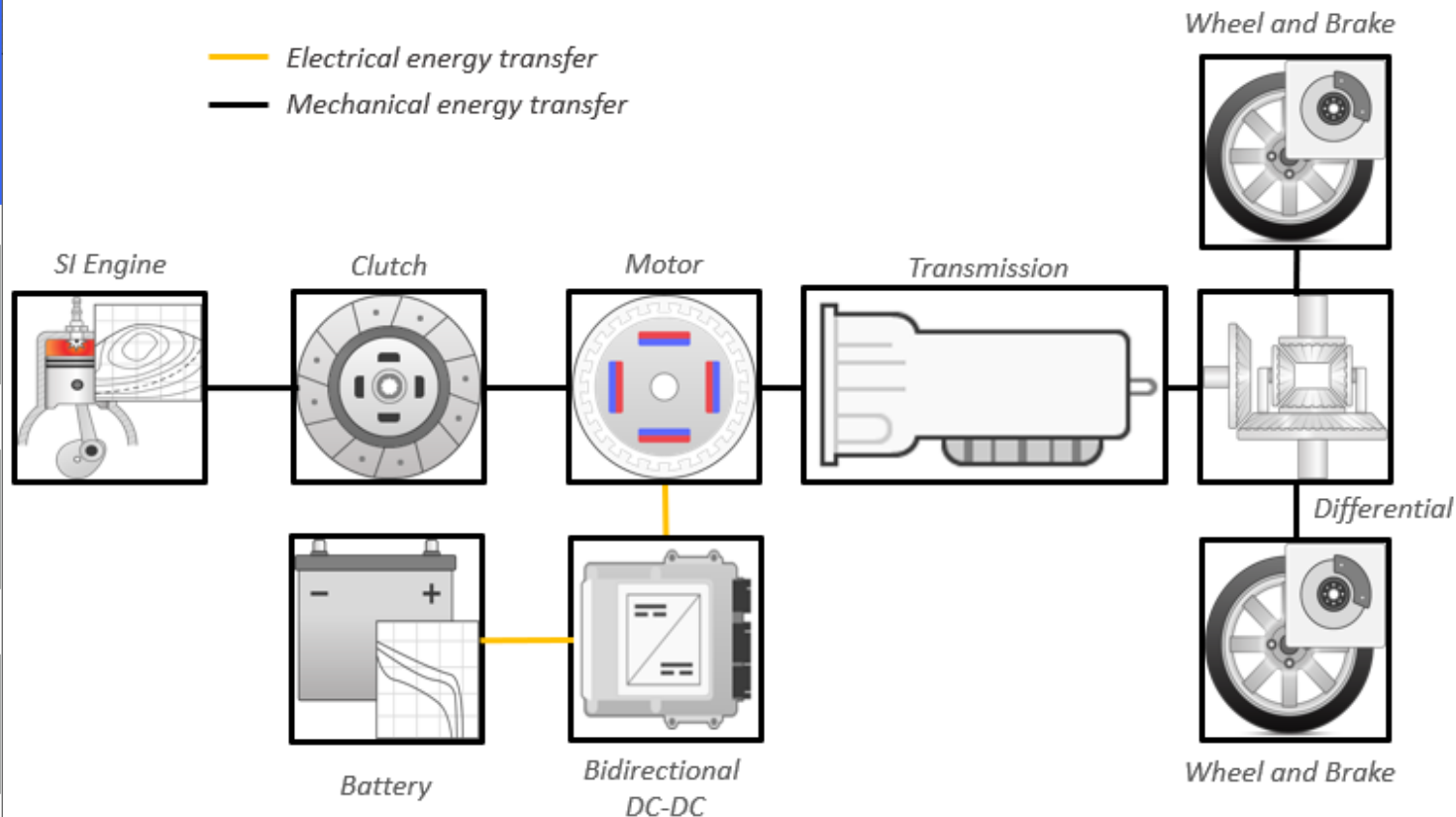
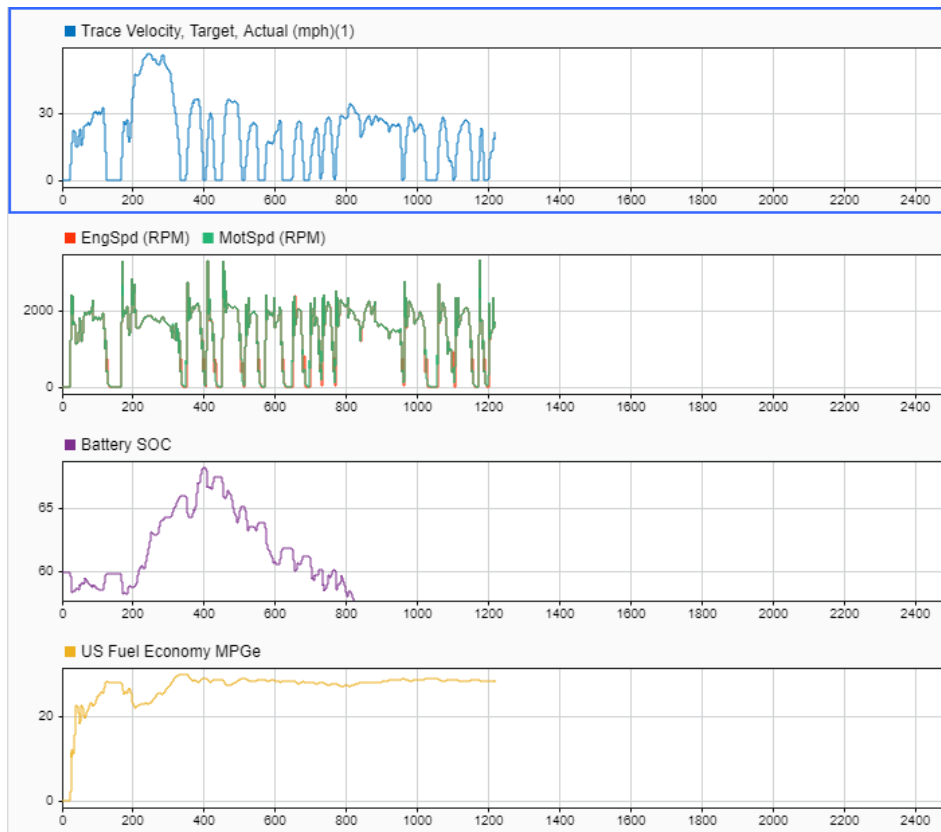
Vývoj algoritmov v 3D simulačnom prostredí

Testovanie algoritmov v predpripravených scenároch

Vytvorenie scenárov s využitím ciest z HD máp



Analýza spotreby a výkonu rôznych architektúr pohonov





MATLAB®
& SIMULINK®



Testovanie a verifikácia
Zdieľanie a nasadenie



Detailné
riešenia

Viac informácií – blogy a release notes

[Cleve's Corner: Cleve Moler on Mathematics and Computing](#)
 Scientific computing, math & more

[Loren on the Art of MATLAB](#)
 Turn ideas into MATLAB

[Guy on Simulink](#)
 Simulink & Model-Based Design

[Steve on Image Processing and MATLAB](#)
 Concepts, algorithms & MATLAB

[Deep Learning](#)
 Understanding and using deep learning networks

[File Exchange Pick of the Week](#)
 Our best user submissions

[Developer Zone](#)
 Advanced Software Development with MATLAB

[Behind the Headlines](#)
 MATLAB and Simulink behind today's news and trends

Today I am describing an example that I recently submitted to [MATLAB Central](#) and [GitHub](#) with the help of my colleague Haihua Feng: [Example implementation of Co-simulation using Simulink](#).

In case you did not know, MathWorks website lists a lot of [third-party modeling and simulation tools](#) from MathWorks [Connection Partners](#).

MathWorks | Products | Solutions | Academia | Support | Community | Events

Third-Party Products & Services | Search Third-Party Products

Overview | Become a Partner | Search Products | Search Services

Refine by Product Type

Data Analysis Tools	21
Embedded Hardware - MCU, DSP, FPGA	4
Embedded Software - Tools, IDE, RTOS	3
Lab Experiments	1
Modeling and Simulation Tools	106
Rapid Prototyping and HIL Systems	3

FILTERED BY: Modeling and Simulation Tools x Automotive x Remove All x

CosimMate
 CosimMate is a co-simulation backplane that enables multiple simulators and models to a network. CosimMate links these simulators via a configuration file and C interfaces (API).

R2020a at a Glance | Search MathWorks.com

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 Get more out of MATLAB and Simulink by downloading the latest release.

[Download now](#)

R2020a

Release Highlights

MATLAB Web Apps
 Share MATLAB apps and Simulink simulations as browser-based web apps.
[» Learn more](#)

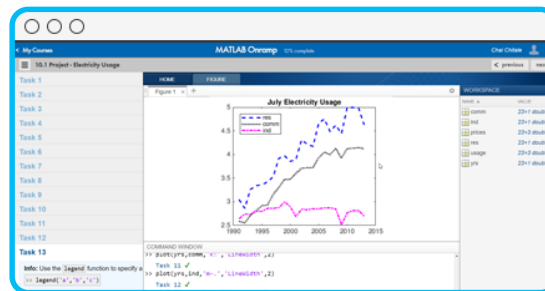
Simulink Compiler
 Share simulations as standalone executables, web apps, and Functional Mockup Units (FMUs).
[» Learn more](#)

Deep Learning
 Manage multiple deep learning experiments, keep track of training parameters, and analyze and compare results and code with the new Experiment Manager App.
[» Learn more](#)

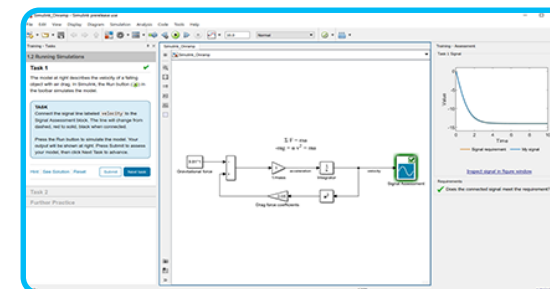
Vyskúšajte MATLAB Online a Onramp kurzy



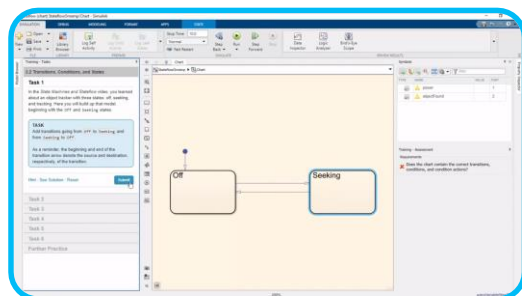
MATLAB Online



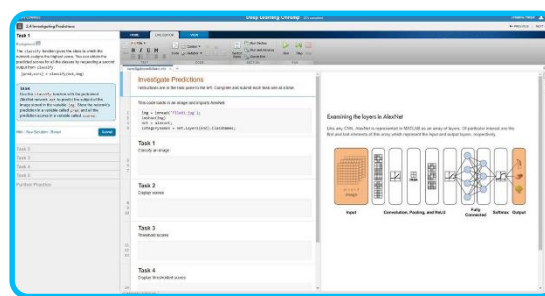
MATLAB Onramp



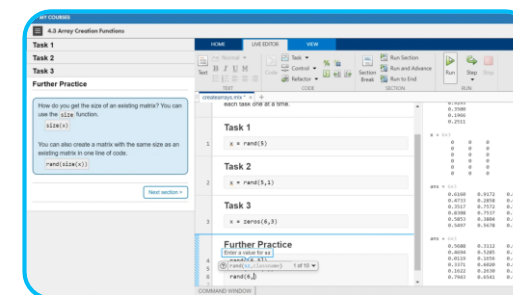
Simulink Onramp



Stateflow Onramp



Deep Learning Onramp



Machine Learning Onramp

Ďakujem za pozornosť