Project: Generic AOCS/GNC Techniques & Design Framework for FDIR

Title: # GAFE Demo Description

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CHANGE RECORD

Issue	Rev.	Date	Pages/Section	Changes
1	0	22.05.2017	All	Initial Issue
2	0	18.04.2018	All	Updates to reflect current status of GAFE
2	1	17.08.2018	All	Editorial correction to reflect changes in the installation procedure

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1 Introduction

This document represents a "quick start guide" which provides the necessary information to run the demo for the GAFE Simulator and GAFE Structural Analysis.

It should be clear that this description does not replace the User's manual.

To run the demo GAFE has to be installed and hardware and software prerequisites have to be fulfilled. Therefore please follow the instructions given in chapter 2 of GAFE User's Manual.

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2 GafeDemo for Simulator

2.1 Scenario Description

The GafeDemo illustrates the basic concepts of the GAFE Simulator and represents a simple satellite in low-earth orbit. The AOCS equipment set consists of three magnetometers (MAG, 3-axes each) and three magnetorquers (MTQ, single axis, redundant coils). The implemented AOCS mode is an acquisition and safe mode (ASM) with Earth magnetic field estimation and an MTQ based rate damping controller.

At the beginning of the GafeDemo scenario the S/C “wakes up” (e.g. after separation from the launcher) with an initial tumbling rate of 3°/s. The initialization (boot) of the OBC starts at time t = 0 and the system becomes operational at t = 60s. The initial AOCS mode is standby-checkout (current AOCS mode = SBM_CO) but a mode transition to ASM rate damping (desired AOCS mode = ASM_RD) is already initiated. The equipment manager activates the required units for the desired mode, which are two MAGs (1 + 2) and the nominal side of the three MTQs (MTQ 1…3; MTQ 4…6 represent the redundant coils). Once all required units are ready, the AOCS mode is automatically switched to ASM-RD.

In this mode the AOCS (AocsAlgo module) performs the measurement processing of the active MAGs, the magnetic field & rate estimation (according to internal selection sequence initially based on MAG2), the rate control and the MTQ command distribution. The resulting magnetic torques of the MTQs finally damp the spacecraft rate.

At t=1000s, a non-persistent “stale data” fault is injected in MAG-2. This leads to frozen measurement data while on communication and power level the unit is still unsuspicious. Consequently, the measurement processing algorithm of MAG-2 quickly invalidates the “isLivingData” flag and in consequence also the overall “isValid” flag for MAG-2. This flag is continuously monitored by the FDIR (“FdirOps” module), which, after a predefined time span of 10s consecutive invalidity, issues a “MAG-2 unit failed” command to the equipment manager (component of system module). Since the initial health of MAG-2 was set to 2 (i.e. one restart is allowed before declaring the unit failed), the expected reaction of the equipment manager is a power cycling of MAG-2. Since the injected fault was a non-persistent one, the fault has vanished after the restart and the unit provides valid measurements again.

At t=2000s another non-persistent “stale data” fault is injected into Mag-2, freezing its data again. This leads to the same chain of actions, i.e. invalid “isLivingData” and “isValid” flag, triggering of corresponding FDIR monitor and issue of “unit failed” command to equipment manager. Since this time the unit health of MAG-2 is only 1 (i.e. no restart allowed), the equipment manager reduces the unit health to zero and switches MAG-2 off.

Since in ASM two MAGs are required, a local equipment reconfiguration is performed. According to the magnetometer unit configuration table for ASM (an equipment manager parameter) the next possible MAG configuration consists of MAG-1 and MAG-3. MAG-1 is already operational and thus not touched; MAG-3 is currently off and therefore switched-on.

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With the second fault-free magnetometer the AOCS is able to continue the rate damping as desired.

To see what was necessary to parameterise the demo accordingly you just browse through the GafeDemo folder. All files which are there are modified wrt. the files in the library. A simple comparison diff shows you the changes more directly. These are here:

paramGeneral:	sampling time
paramCommand:	switch to Rate Damping Mode
paramEnvironment:	initial satellite rates
paramEquipment:	set number of Magnetometer and Magnetorquer units
paramFaultInjection:	injection of 2 faults
paramAocsAlgo:	configuration of AOCS Algorithmic components and their parametrization
paramFdirOps:	FDIR measurement processing for NOK
paramSystem:	configuration of “EquipmentManager” for MTQ and MAG
paramMagnetometer:	parametrisation of Magnetometer, here identical to GAFE library (default parametrisation)
paramMagnetorquer:	parametrisation of Magnetorquer, here we add the individual unit alignments and the maximum magnetic moments

2.2 Executing the Demo

To run the demo the followings steps are required:

- Unpack the zip-file of the GAFE software delivery (containing the folders “Gafe” and “GafeProjects”) to a convenient location
- Open MATLAB 2016b
- Navigate to the folder “Gafe”
- Start-up GAFE by executing the function

```
> gafeStartup()
```

This command mainly sets the paths to required functions.

- Navigate to the folder “GafeProjects\GafeDemo”
- Start-up GafeDemo by executing the function

```
> gafeProjectStartup()
```

- Initialize the simulation by executing the function

```
> initGafeSim()
```


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This initializes all the parameters required for the demo and opens the “gafeSim” Simulink model.

- To run the simulation, click on the “run” buttom of the Simulink window or press Ctrl+T.
- After compilation and run, all required data for post-processing is available in the Matlab workspace.

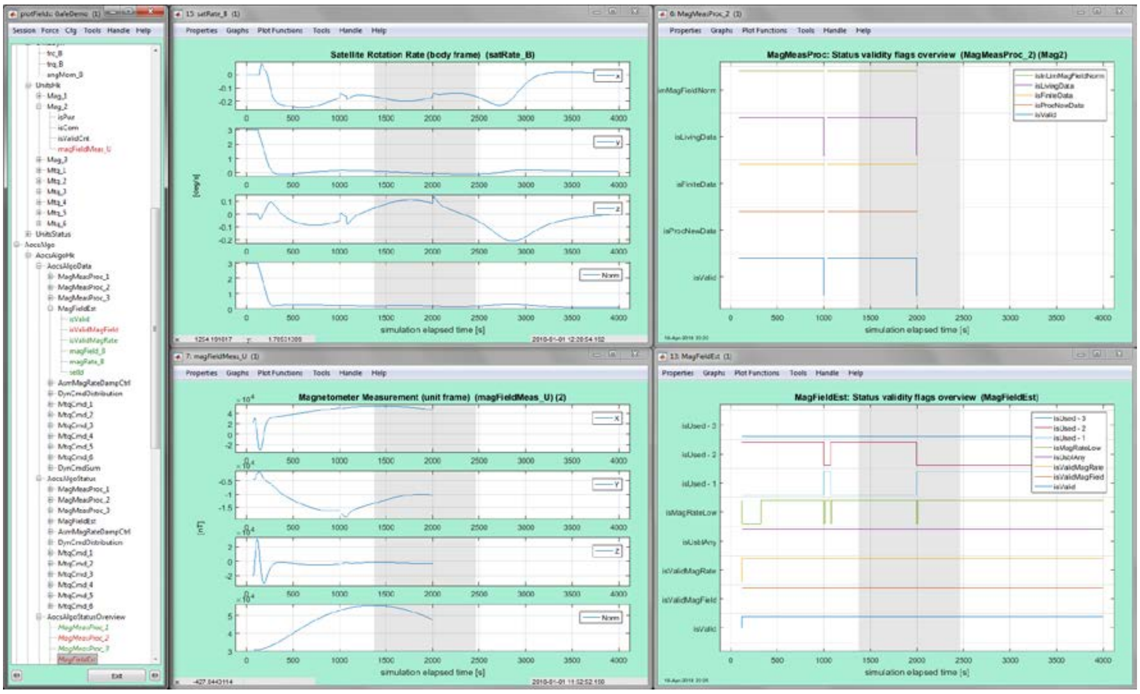
The parameterization of Environment, AocsAlgo, System and FdirOps module, can be inspected from the respective “param[...]” files in the folder “GafeProjects\GafeDemo\Simulator\data\param”. The parameterization of the specific equipments models (“SEM”) is located in the folder “GafeProjects\GafeDemo\Simulator\data\param\SEM”).

2.3 Inspecting the Results

After running the simulation its results can be inspected by typing

```
> plotGafeSim()
```

in the Matlab command window. This open plotFields, an intuitive tools for investigation of time series:



The following plots are of interest for inspection and can be opened from the tree of the simulation log on the left side (either one after the other by left-click, or in parallel by right-click + “show in new plot”):

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- System.Overview.aocsMode
  - Shows the current and desired AOCS mode
- System.Overview.UnitsStatusExpected
  - Expected status of all units on-board (regarding power, communication, operability and usability for the closed loop)
- System.Overview.UnitsHealth
  - Health status of all units on-board (0 = failed, 1 = ok, but no restart allowed, x = ok and x restarts allowed)
- System.Overview.UnitsOnOffCmd
  - Current switch-on/off commands send to the units
- AocsAlgo.AocsAlgoHk.AocsAlgoStatusOverview.MagMeasProc_1 (or _2, _3)
  - Flags telling the status of the magnetometer measurement processing, including “isLivingData” and “isValid”.
- Equipment.UnitsHk.Mag_2.magFieldMeas_U
  - The magnetic field measured by MAG-2. Freezes after fault injections at t = 1000s and t = 2000s.
- AocsAlgo.AocsAlgoHk.AocsAlgoStatusOverview.MagFieldEst
  - Contains “isUsed” flags for MAG1 to MAG3 telling which magnetometer measurement has been used for closed-loop operation of rate damping.
- FdirOps.FdirHk.Mag_2.unitFailed
  - The two “MAG-2 unit failed” FDIR actions send to the equipment manager after the detection of the first and second measurement freeze.
- Environment.KinStates.satRate_B
  - The angular rate of the spacecraft in body frame.

For inspection of the system tests of the GAFE Simulator use the following procedure:

- Perform all steps described in Section 0 until and including

```
> gafeProjectStartup()
```

- Instead of running initGafeSim() navigate to “GafeProjects\GafeDemo\Simulator\data\test\SystemTest1” (or “…SystemTest2”) and execute the test by

```
> runTest()
```

- Load the generated test data by

```
> loadTest()
```

- After running the test its results can be inspected by typing

```
> plotGafeSim()
```


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3 GafeDemo for Structural Analysis

3.1 Scenario Description

The GafeDemo illustrates the basic concepts of the GAFE Structural Analysis based on a rather simple satellite with the following AOCS design and FDIR requirements:

- Two AOCS modes (“AocsModeA” and “AocsModeB”)
- Nominal Equipment Set:
  - AocsModeA: 1 MAG, 1 RMU
  - AocsModeB: 1 RMU, 1 STR
- Required diagnostic capability
  - AocsModeA: FDI
  - AocsModeB: FDI
- Extended Equipment Set for Failure Recovery (EES-FR)
  - 2 MAG, 2 RMU, 2 STR
- Allowed equipment for extension:
  - MAG, RMU, STR
- Allowed models:
  - All

Based on these main inputs the GAFE Structural Analysis performs batch analyses on all possible hardware sets within user-specified bounds and identifies the most cost-efficient hardware and FDI-algorithm setup that provides the required diagnostic capability.

3.2 Executing the Demo

To run the demo the followings steps are required:

- Unpack the zip-file of the GAFE software delivery (containing the folders “Gafe” and “GafeProjects”) to a convenient location
- Open MATLAB 2016b
- Navigate to the folder “Gafe”
- Start-up GAFE by executing the function

```
> gafeStartup()
```

This command mainly sets the paths to required functions.

- Navigate to the folder “GafeProjects\GafeDemo”
- Start-up GafeDemo by executing the function

```
> gafeProjectStartup()
```

- Run the structural analysis by executing the function

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```
> runGafeStruct()
```

For basic usage there is only one configuration file[1] which needs to be adapted to the project to be investigated:

- StructuralAnalysis\data\userConfig\configProject.m

The configuration items inside configProject.m are the following:

Project name

```
projectName = 'GafeDemo';
```

Cost weighting factor

```
% Definition of cost weighting factor
% Order of items: [computationalCost, unitWeight, powerConsumption,
priceOfUnit]
costWeightingFactor = [0.25, 0.40, 0.20, 0.15]
```

Allowed equipment

```
% List of equipment allowed to be used in the project
% Options: 0 = exclude, 1 = include
allowedEquipment = {'acc'    0;   % Accelerometer
                    'cess'   0;   % Coarse Earth Sun Sensor
                    'clk'    0;   % Clock
                    'es'     0;   % Earth Sensor
                    'gnsr'   0;   % GNS Receiver
                    'mag'    1;   % Magnetometer
                    'mtq'    0;   % Magnetorquer
                    'rcs'    0;   % Reaction Control System
                    'rmu'    1;   % Rate Measurement Units
                    'rw'     0;   % Reaction Wheel
                    'ss'     0;   % Sun Sensor
                    'str'    1};  % Star Tracker
```

[1] In addition the file "StructuralAnalysis\data\userConfig\configAnalysis.m" contains a few settings for the analysis itself.

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Allowed Models

```
% List of models (ARRs) allowed to be used in the project
% Options: 0 = exclude, 1 = include
allowedModels = {'eomTrans'          1;   % Equations of Motion for…
                 'eomRot'            1;   % Equations of Motion for…
                 'earthKin'          1;   % Earth Kinematics
                 'earthMagField'     1;   % Earth Magnetic Field
                 'earthAtmDens'      1;   % Earth Atmospheric Density
                 'earthDir'          1;   % Earth Direction
                 'sunDir'            1;   % Sun Direction
                 'attTrf'            1;   % Attitude Transformations
                 'posTrf'            1;   % Position Transformation
                 'velTrf'            1;   % Velocity Transformation
                 'timeAbsRel'        1;   % Time Absolute/Relative
                 'earthGrav'         1;   % Earth Gravity
                 'nonGravAcc'        1;   % Non-Gravitational Acc.
                 'relPosDir'         1};  % Relative Position …
```

Minimum HW Required

```
% Default is zero units per equipment
minHwRequired = {'es'          0;    % 3-axis CESS Earth dir measurement
                 'gnsr'        0;    % 3D pos/vel & time
                 'mag'         0;    % 3-axis
                 'mtq'         0;    % 3-axis
                 'rcs'         0;    % 6-Dof
                 'rmu'         0;    % 3-axis
                 'rw'          0;    % Single axis
                 'ss'          0;    % 3-axis CESS Sun dir measurement
                 'str'         0};   % 3-axis
```

Maximum HW Possible

```
maxHwPossible = {'es'          0;    % 3-axis CESS Earth dir measurement
                 'gnsr'        0;    % 3D pos/vel & time
                 'mag'         0;    % 3-axis
                 'mtq'         0;    % 3-axis
                 'rcs'         0;    % 6-Dof
                 'rmu'         0;    % 3-axis
                 'rw'          0;    % Single axis
                 'ss'          0;    % 3-axis CESS Sun dir measurement
                 'str'         0};   % 3-axis
```


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Extended Equipment Set for Fault Recovery (EES-FR)

```
eesFr = {'es'          0;   % 3-axis Earth dir…
         'gnsr'        0;   % 3D pos/vel & time
         'mag'         2;   % 3-axis
         'mtq'         0;   % 3-axis
         'rcs'         0;   % 6-Dof
         'rmu'         2;   % 3-axis
         'rw'          0;   % Single axis
         'ss'          0;   % 3-axis Sun dir …
         'str'         2};  % 3-axis
```

The mode specific configuration for each AOCS mode

```
modesConfig(modeId, 1).name    = 'AocsModeA';
modesConfig(modeId, 1).nes     = {'es'          0;  % 3-axis Earth dir…
                                  'gnsr'        0;  % 3D pos/vel & time
                                  'mag'         1;  % 3-axis
                                  'mtq'         0;  % 3-axis
                                  'rcs'         0;  % 6-Dof
                                  'rmu'         1;  % 3-axis
                                  'rw'          0;  % Single axis
                                  'ss'          0;  % 3-axis Sun dir…
                                  'str'         0}; % 3-axis
modesConfig(modeId, 1).forbEq  = {};
modesConfig(modeId, 1).forbArr = {};
modesConfig(modeId, 1).reqCap  = 'FDI';
modesConfig(modeId, 1).uuv     = {};
```

3.3 Inspecting the Results

At the end of runGafeStruct the results of the best solution found (and others, if demanded by user) are plotted in term of command line output and graphically. The output in the command line contains the following information:

Solution Overview: the required hardware set and the overall cost of the best solution:

```
Current Solution:
      Solution ID: 1
      Total Cost : 14.10

Required Hardware Set:
      mag: 3
      rmu: 2
      str: 2

Costs of Units:
      Unit Name        CPU [-]     Power [W]     Mass [Kg]    Price [EUR]
      mag1               0.100         1.000          0.30        20000.0
      mag2               0.100         1.000          0.30        20000.0
```


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```
        mag3              0.100         1.000          0.30       20000.0
        rmu1              0.200        20.000          5.00      400000.0
        rmu2              0.200        20.000          5.00      400000.0
        str1              0.200         6.000          1.50      350000.0
        str2              0.200         6.000          1.50      350000.0
```

Mode Overview: for each investigated AOCS mode the required active hardware, the required residuals to detect/isolate faults and the signatures for all relevant faults.

```
Best Active Hardware:
        mag: 3
        rmu: 1
        str: 0

Residuals:
        Residual 01:
                Relation(s)    : "rEomRot01AngAcc2AngRate_B", "rEomRot01SumOfAngAcc_B",…
                Known State(s): "yRmu01AngRate_B"
        Residual 02:
                Relation(s)    : "rMag02Meas", "rMag03Meas"
                Known State(s): "yMag02MagField_B", "yMag03MagField_B"
        Residual 03:
                Relation(s)    : "rMag01Meas", "rMag03Meas"
                Known State(s): "yMag01MagField_B", "yMag03MagField_B"
        Residual 04:
                Relation(s)    : "rMag01Meas", "rMag02Meas"
                Known State(s): "yMag01MagField_B", "yMag02MagField_B"

Fault Signatures:
        Signature of "fMag01Meas":   --    --   (03)  (04)
        Signature of "fMag02Meas":   --   (02)   --   (04)
        Signature of "fMag03Meas":   --   (02)  (03)   --
        Signature of "fRmu01Meas":  (01)   --    --    --
```

If desired (by setting plotCostOverview = 1 in configAnalysis.m), a graphical overview of the costs and total number of units is given for all investigated solutions:

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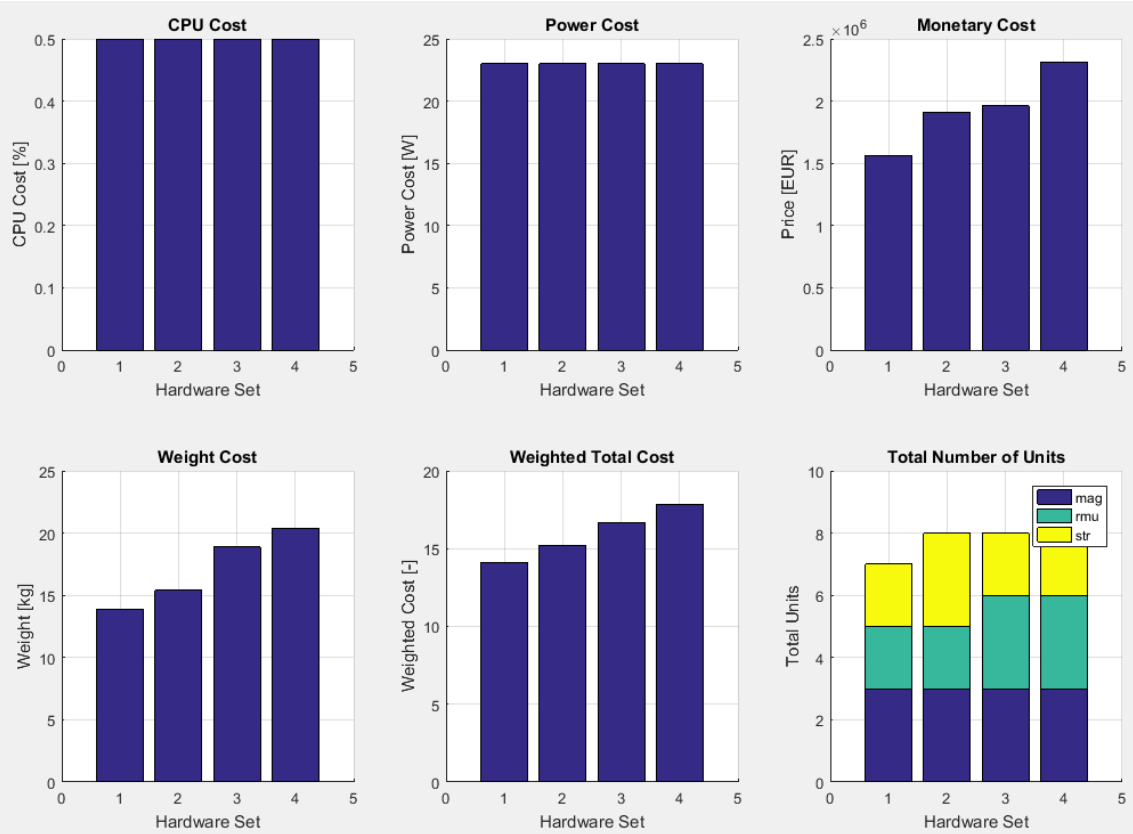

If desired (by setting showResultsTable = 1 in configAnalysis.m) a table with the status of all evaluated solutions is displayed:

Index	mag	rmu	str	AocsModeA	AocsModeB	HWset	BestActiveHW_AocsModeA	BestActiveHW_AocsModeB	FD_FDI_AocsModeA	FD_FDI_AocsModeB	CPUcost	PowerCost	WeightCost	PriceCost	TotalCost	BestSolution
[6]	[0]	[1]	[1]	'-'	'OK'	'Active'	'-'	'-'	'nonValid'	'FDI'	[0.4000]	[26]	'-'	'-'	'-'	'-'
[7]	[0]	[1]	[2]	'-'	'OK'	'Active'	'-'	[6]	'nonValid'	'FDI'	[0.4000]	[26]	'-'	'-'	'-'	'-'
[8]	[0]	[1]	[3]	'-'	'OK'	'Active'	'-'	[6]	'nonValid'	'FDI'	[0.4000]	[26]	'-'	'-'	'-'	'-'
[10]	[0]	[2]	[1]	'-'	'OK'	'Active'	'-'	[6]	'nonValid'	'FDI'	[0.4000]	[26]	'-'	'-'	'-'	'-'
[11]	[0]	[2]	[2]	'-'	'OK'	'Active'	'-'	[6]	'nonValid'	'FDI'	[0.4000]	[26]	'-'	'-'	'-'	'-'
[12]	[0]	[2]	[3]	'-'	'OK'	'Active'	'-'	[6]	'nonValid'	'FDI'	[0.4000]	[26]	'-'	'-'	'-'	'-'
[14]	[0]	[3]	[1]	'-'	'OK'	'Active'	'-'	[6]	'nonValid'	'FDI'	[0.4000]	[26]	'-'	'-'	'-'	'-'
[15]	[0]	[3]	[2]	'-'	'OK'	'Active'	'-'	[6]	'nonValid'	'FDI'	[0.4000]	[26]	'-'	'-'	'-'	'-'
[16]	[0]	[3]	[3]	'-'	'OK'	'Active'	'-'	[6]	'nonValid'	'FDI'	[0.4000]	[26]	'-'	'-'	'-'	'-'
[21]	[1]	[1]	[0]	'OK'	'-'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[22]	[1]	[1]	[1]	'OK'	'OK'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[23]	[1]	[1]	[2]	'OK'	'OK'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[24]	[1]	[1]	[3]	'OK'	'OK'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[25]	[1]	[2]	[0]	'OK'	'-'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[26]	[1]	[2]	[1]	'OK'	'OK'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[27]	[1]	[2]	[2]	'OK'	'OK'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[28]	[1]	[2]	[3]	'OK'	'OK'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[29]	[1]	[3]	[0]	'OK'	'-'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[30]	[1]	[3]	[1]	'OK'	'OK'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[31]	[1]	[3]	[2]	'OK'	'OK'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[32]	[1]	[3]	[3]	'OK'	'OK'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[37]	[2]	[1]	[0]	'OK'	'-'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[38]	[2]	[1]	[1]	'OK'	'OK'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[39]	[2]	[1]	[2]	'OK'	'OK'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[40]	[2]	[1]	[3]	'OK'	'OK'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[41]	[2]	[2]	[0]	'OK'	'-'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[42]	[2]	[2]	[1]	'OK'	'OK'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[43]	[2]	[2]	[2]	'OK'	'OK'	'Available'	'-'	[6]	'nonValid'	'FDI'	[0.4000]	[26]	'-'	'-'	'-'	'-'
[44]	[2]	[2]	[3]	'OK'	'OK'	'Available'	'-'	[6]	'nonValid'	'FDI'	[0.4000]	[26]	'-'	'-'	'-'	'-'
[45]	[2]	[3]	[0]	'OK'	'-'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[46]	[2]	[3]	[1]	'OK'	'OK'	'Active'	'-'	'-'	'nonValid'	'nonValid'	'-'	'-'	'-'	'-'	'-'	'-'
[47]	[2]	[3]	[2]	'OK'	'OK'	'Available'	'-'	[6]	'nonValid'	'FDI'	[0.4000]	[26]	'-'	'-'	'-'	'-'
[48]	[2]	[3]	[3]	'OK'	'OK'	'Available'	'-'	[6]	'nonValid'	'FDI'	[0.4000]	[26]	'-'	'-'	'-'	'-'
[53]	[3]	[1]	[0]	'OK'	'-'	'Active'	'-'	'-'	'FDI'	'nonValid'	[0.5000]	[23]	'-'	'-'	'-'	'-'
[54]	[3]	[1]	[1]	'OK'	'OK'	'Active'	'-'	'-'	'FDI'	'FDI'	[0.7000]	[29]	'-'	'-'	'-'	'-'
[55]	[3]	[1]	[2]	'OK'	'OK'	'Active'	[54]	[54]	'FDI'	'FDI'	[0.7000]	[29]	'-'	'-'	'-'	'-'
[56]	[3]	[1]	[3]	'OK'	'OK'	'Active'	[54]	[54]	'FDI'	'FDI'	[0.7000]	[29]	'-'	'-'	'-'	'-'
[57]	[3]	[2]	[0]	'OK'	'-'	'Active'	[53]	'-'	'FDI'	'nonValid'	[0.5000]	[23]	'-'	'-'	'-'	'-'
[58]	[3]	[2]	[1]	'OK'	'OK'	'Active'	[54]	[54]	'FDI'	'FDI'	[0.7000]	[29]	'-'	'-'	'-'	'-'
[59]	[3]	[2]	[2]	'OK'	'OK'	'Available'	[53]	[6]	'FDI'	'FDI'	[0.5000]	[26]	[13.9000]	[1560000]	[14.1000]	[1]
[60]	[3]	[2]	[3]	'OK'	'OK'	'Available'	[53]	[6]	'FDI'	'FDI'	[0.5000]	[26]	[15.4000]	[1910000]	[15.2250]	[2]
[61]	[3]	[3]	[0]	'OK'	'-'	'Active'	[53]	'-'	'FDI'	'nonValid'	[0.5000]	[23]	'-'	'-'	'-'	'-'
[62]	[3]	[3]	[1]	'OK'	'OK'	'Active'	[54]	[54]	'FDI'	'FDI'	[0.7000]	[29]	'-'	'-'	'-'	'-'
[63]	[3]	[3]	[2]	'OK'	'OK'	'Available'	[53]	[6]	'FDI'	'FDI'	[0.5000]	[26]	[18.9000]	[1960000]	[16.7000]	[3]
[64]	[3]	[3]	[3]	'OK'	'OK'	'Available'	[53]	[6]	'FDI'	'FDI'	[0.5000]	[26]	[20.4000]	[2310000]	[17.8250]	[4]

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