2nd Annual

MidPoint Community Meetup

# Secure by Design: MidPoint Expression Language

Evolveum

Radovan Semančík, May 2026
Software Architect

# Agenda

- Customization problem (Open-closed principle)
- Danger of Groovy/Pyhon/JavaScript
- Security by design
- MidPoint expression language
- Plan

# Customization Problem

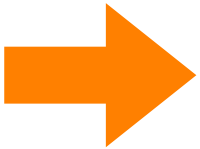
- We want midPoint to be **flexible** and **customizable**
  i.e. we want midPoint to be *open*
- We do **not want to change** midPoint source code
  i.e. we want midPoint to be *closed*

  Open-closed principle (Bertrand Meyer, 1988)

# Customization Problem

- We want midPoint to be **flexible** and **customizable**
  i.e. we want midPoint to be *open*
- We do **not want to change** midPoint source code
  i.e. we want midPoint to be *closed*

  Open-closed principle (Bertrand Meyer, 1988)



- **Configuration properties**
  handle *predictable* customization
- **Expressions**
  handle *unpredictable* customization

# Customization Problem

- We want midPoint to be **flexible** and **customizable**
  i.e. we want midPoint to be *open*
- We do **not want to change** midPoint source code
  i.e. we want midPoint to be *closed*

  Open-closed principle (Bertrand Meyer, 1988)

- **Configuration properties**
  handle *predictable* customization
- **Expressions**
  handle *unpredictable* customization

# Expressions

- Magic dust that provides ultimate flexibility
- Scripting expressions:
  Heroes that saved a lot of projects
- Groovy as primary scripting language
  since midPoint 2.0 (2012)

```
givenName + ' ' + familyName

jobCode == 'X007'

'X' + input

basic.composeDnWithSuffix('uid', ...)

for ( a in focus.assignment ) {
  if (a.targetRef.type == ... ) {
     ...
  }
}
```

# Dangers of Groovy/Python/JavaScript

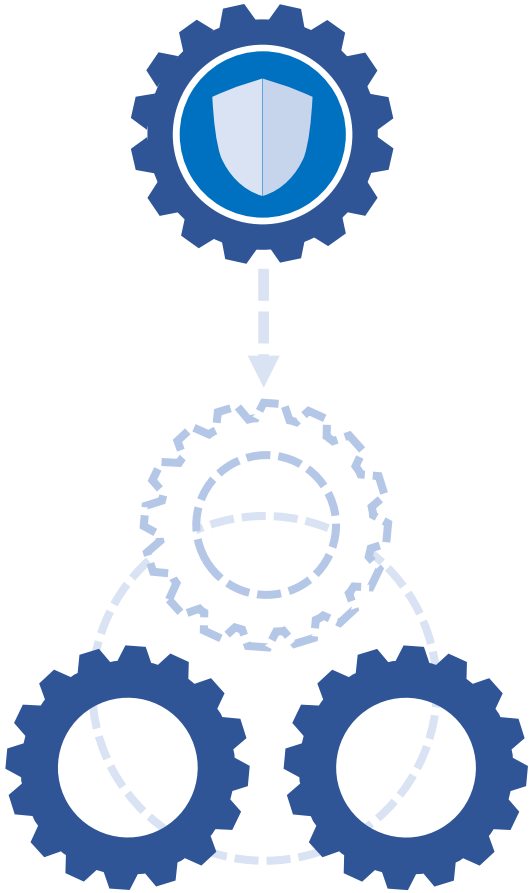
- This magic dust provides a bit too much flexibility
- Groovy: built-in remote code execution (RCE) vulnerability
- “Industry standard” approach: ignore the problem
- Sandboxing does not really work
  - *default permit* vs *default deny* problem
  - upgrade problem
- Scripting languages are **not** designed for security

```
System.exit(0)

"${System.exit(0)}"

new File('/etc/passwd').text

'rm -rf /'.execute()

['rm','-rf','/'].execute()
```

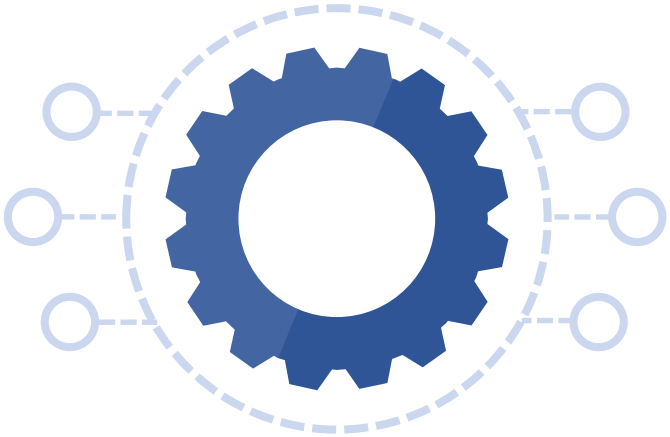
… and access to everything in Java runtime, all libraries, reflection … everything

# Security by Design

- Security cannot be an afterthought,
  it has to be integral part of the design
- Security is much more than “no vulnerabilities”
- We need language which is **designed to be secure**
- We were not overwhelmed by our choices
  - Rich languages, not secure (Groovy, Python, etc.)
  - Safe languages, not powerful (Liquid, Jakarta EL, etc.)
- Winner: Common expression language (CEL)
  by Google et al.



# MidPoint Expression Language (MEL)



- Heavily based on Common expression language (CEL)
- *Expression* language*: functional* rather than imperative
- Designed for security/safety
- CEL is more what you'd call "framework" than actual language
- MEL = CEL engine + midPoint extensions

```
focus.givenName + ' ' + focus.familyName

focus.activation.effectiveStatus == 'enabled'

matches(focus.telephoneNumber, '^[0-9]+$')
```

# MEL Expressions in MidPoint

```
<expression>
   <script>
      <language>http://midpoint.evolveum.com/.../language#mel</language>
      <code>
         focus.givenName + ' ' + focus.familyName
      </code>
   </script>
</expression>
```

# MEL Basics

**Structured data**

```
   focus.givenName
focus.activation.effectiveStatus
focus.extension.jobCode
```

**Operators**

```
   + - * / % ! == != < <= > >= && || () ?: in . .? [] [?]
```

**Functions** (selection)

```
   size(x)                          s.contains(substring)
matches(s, regexp)                  s.trim()
isEmpty(s)                          list.join(separator)
```

# MEL Examples

**Username generator**

```
focus.givenName.norm.substring(0,1) + focus.familyName.norm
```

**Role autoassignment expression**

```
jobCode == 'X007'
```

**Name formatting** (e.g. custom column)

```
'%s, %s'.format([focus.familyName, focus.givenName])
```

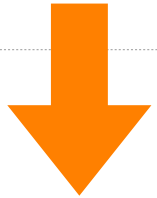
**Telephone number validator**

```
matches(focus.telephoneNumber, '^[0-9]+$')
```

# Expression Language

- MEL is an *expression* language
- Goal: return a value
- MEL is not a sequence of commands (not *imperative*)
- Evaluating values and functions (*functional* language)
- Functions are free of side effects (no “writes”)
- MEL has limitations, but it is still powerful

***command***;
***command***;
***command***;
***command***;



***func***(***func***(***func***(***func***())))

# Conditional

```
if (input == null) {
  return 'foobar'
} else {
  return input
}
```

```
isNull(input) ? 'foobar' : input
```

```
default(input, 'foobar')
```

# No Loops

```
for ( a in focus.assignment ) {
  if (a.targetRef.type == PolicyType.COMPLEX_TYPE) {
     return a.targetRef.oid
  }
}
```

```
focus.assignment
  .filter(a, a.targetRef.type == 'PolicyType' )
  .map(a, a.targetRef.oid)
```

# MEL Extensions

**Format**

```
format.concatName([focus.givenName, focus.familyName])
format.strftime(timestamp, '%d/%m/%Y %H:%M:%S')
```

**Log**

```
log.debug('User {} was inactivated due to {}', [ focus.name, reason ])
```

**MidPoint objects**

```
projection.primaryIdentifiers()
```

**MidPoint functions**

```
midpoint.getObject('UserType', oid)
```

# MEL Security

- Does **not** have access to any Java runtime functionality,
  except those explicitly exposed through extensions.
- No access to files, network, processes, OS, midPoint internals, ...
- No direct way to cripple (DoS) the system,
  e.g. no infinite loops
- Secure enough for delegation,
  e.g. role auto-assignment, role engineering, reports, GUI customization
- Expression profiles are properly applied to allow/deny MEL extensions,
  e.g. **midpoint.*** and **secret.*** extensions denied by default
- MEL is secure in itself, yet expression result may still do damage (!!!)
  e.g. autoassign privileged role to all users

# Remarks and Drawbacks

- Polystrings work as strings
- QNames are usually not needed
- Nulls and “optionals” are quite painful in CEL
- **focus.?activation.?activationStatus**
- **isNull(x)** rather than **x == null**
- **stringify()** and **default()** to the rescue

# MEL Reality Check

**Username generator**

```
    stringify(focus.?givenName.?norm).replace(' ','').substring(0,1) +
  stringify(focus.?familyName.?norm).replace(' ','').substring(0,7) +
  iterationToken
```

**Value presence check**

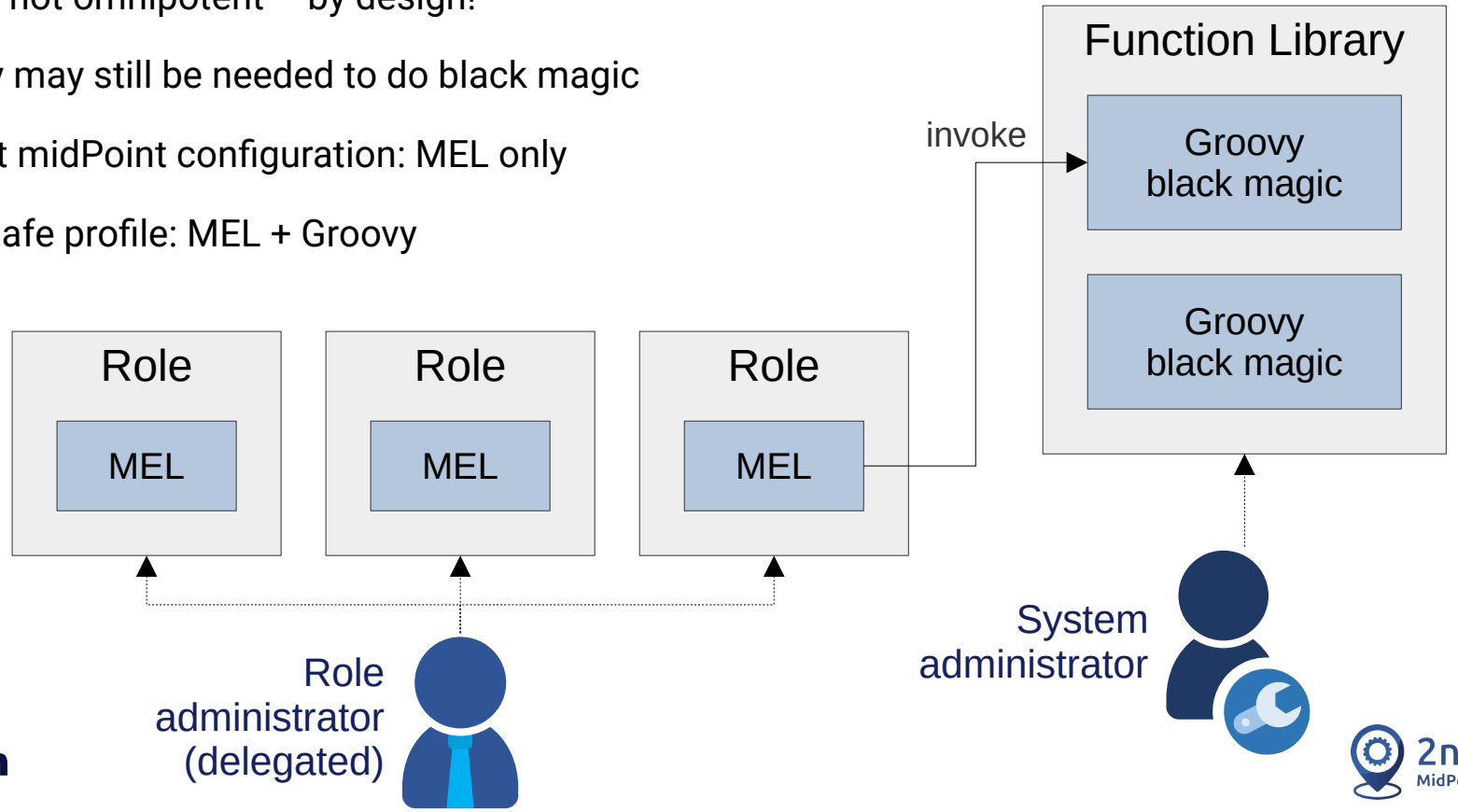
```
    isPresent(focus.?activation.?administrativeStatus)
```

**Null-safe string formatting**

```
    'resource: %s'.format(resource.?name)

  'resource: ' + default(resource.?name, 'null')
```

# MEL and Groovy

- MEL is not omnipotent – by design!
- Groovy may still be needed to do black magic
- Default midPoint configuration: MEL only
- Semi-safe profile: MEL + Groovy



# Documentation, etc.

- MEL Documentation:

  docs.evolveum.com → midPoint reference documentation → development branch

  https://docs.evolveum.com/midpoint/reference/master/expressions/expressions/script/mel/

- AI Chatbots

  They know CEL, they work fine

  Explicitly include documentation link in the prompt to let them know about MEL extensions (at least for now)

# Plan

- MEL will be available in midPoint 4.11
- Baseline MEL implementation & documentation is done
- Some parts still missing (e.g. audit records, deltas, GUI)
- Integration with midPilot
- Testing and gathering feedback
- Groovy may still remain a default scripting language in midPoint 4.11
- This plan is subject to change

# Conclusion

- Cybersecurity: more important than ever
- MidPoint: secure by design
- Our commitment to advance cybersecurity
- MidPoint expression language (MEL)
- Designed to be secure
- Availability: midPoint 4.11


Cybersecurity made in Europe


Evolveum
Thank you for your attention
Feel free to ask your questions now!
2nd Annual MidPoint Community Meetup