IDENTIFICATION OF DEPENDENCY-BASED ATTACKS ON NODE.JS

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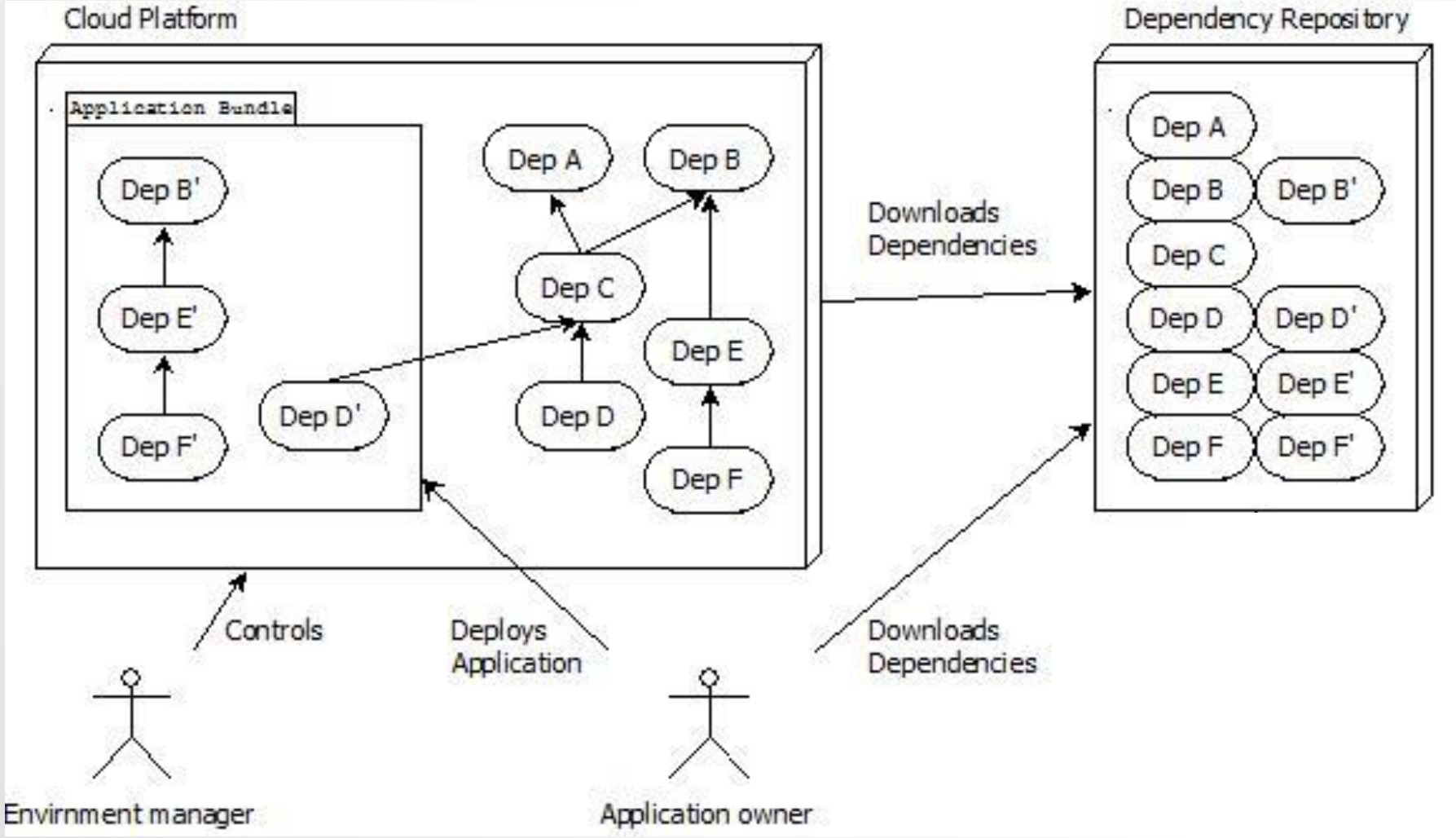
IOWA STATE UNIVERSITY

1. Located in Ames, Iowa – 6h from Chicago
2. 36 600 students in 2016 (4% annual increase)
3. 50 Faculty members in the Electrical and Computer Engineering Department

4. More than 200 funded Ph.D. students

➔ Open for Excellent candidates

USE OF DEPENDENCIES IN NODE.JS



Node Package Manager (NPM)

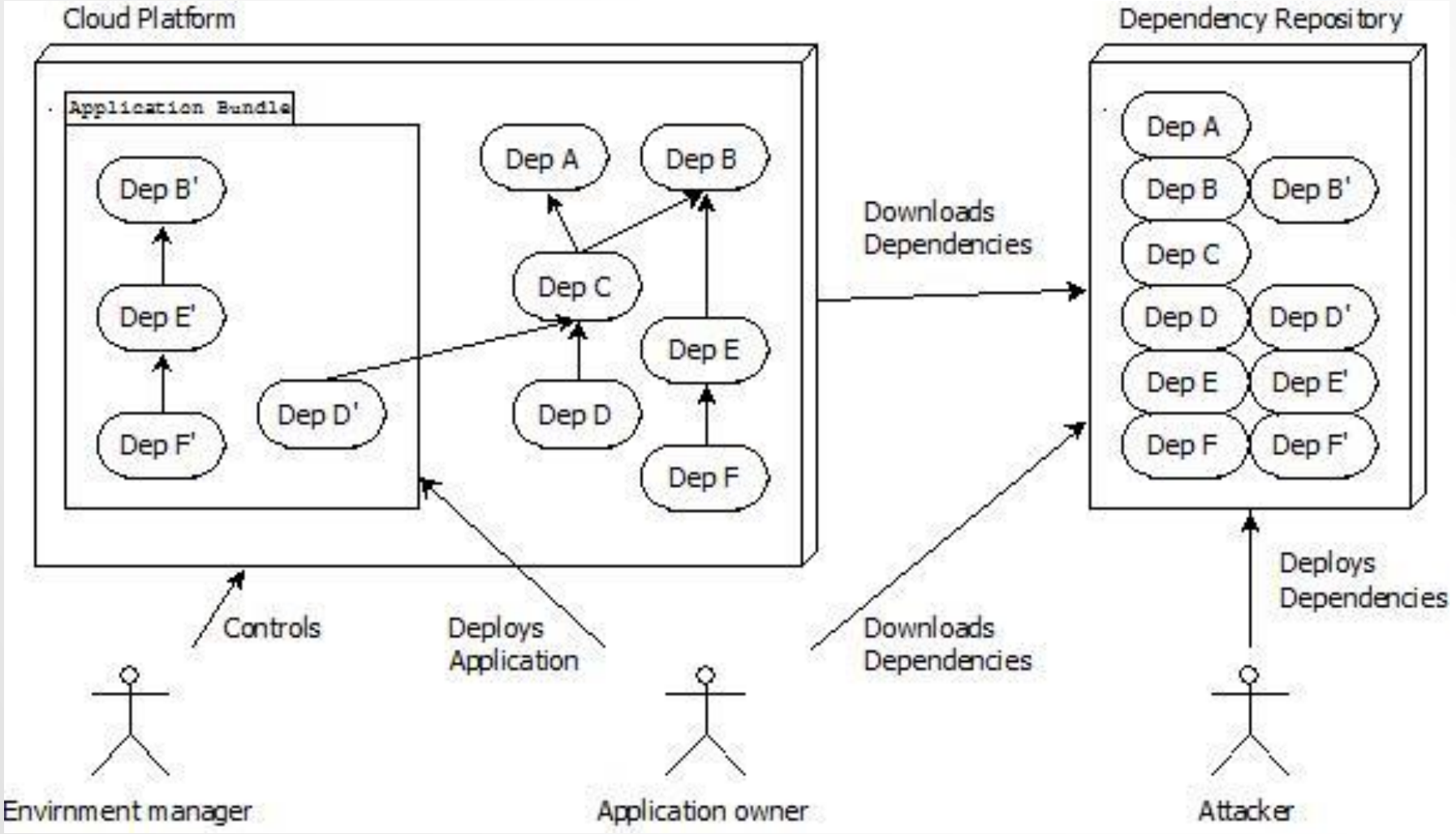
500.000 packages

QUESTIONS

1. How attackers can exploit third-party dependencies in Node.js environment?

2. How to mitigate such attacks?

USE OF MALICIOUS DEPENDENCIES



WEAKNESSES OF ENVIRONMENT

- Use of global variables
- Allows manipulation of loaded module cache
- Allows for monkey-patching

```
1 function MyClass () {};
2 MyClass . prototype . someFunction = function
() {
3 // Initial implementation
4 };

6 function performMonkeyPatch () {
7 var originalFunction = MyClass . prototype .
someFunction ;
8 MyClass . prototype . someFunction = function
() {
9 // New monkey - patched implementation
10 // originalFunction can be invoked here
}
```

ATTACK- GLOBAL LEAKAGE

Example: Redefinition of async library

```
1. var async = require('async');
2. var map = async.map;
3. async.map = function () {
4.       var events = arguments[0];
5.       leak(events);
6.       return map.apply(this, arguments);
7.       };

8. function leak() { ...}
```

GLOBAL MANIPULATION ATTACK

Manipulation of the validation function

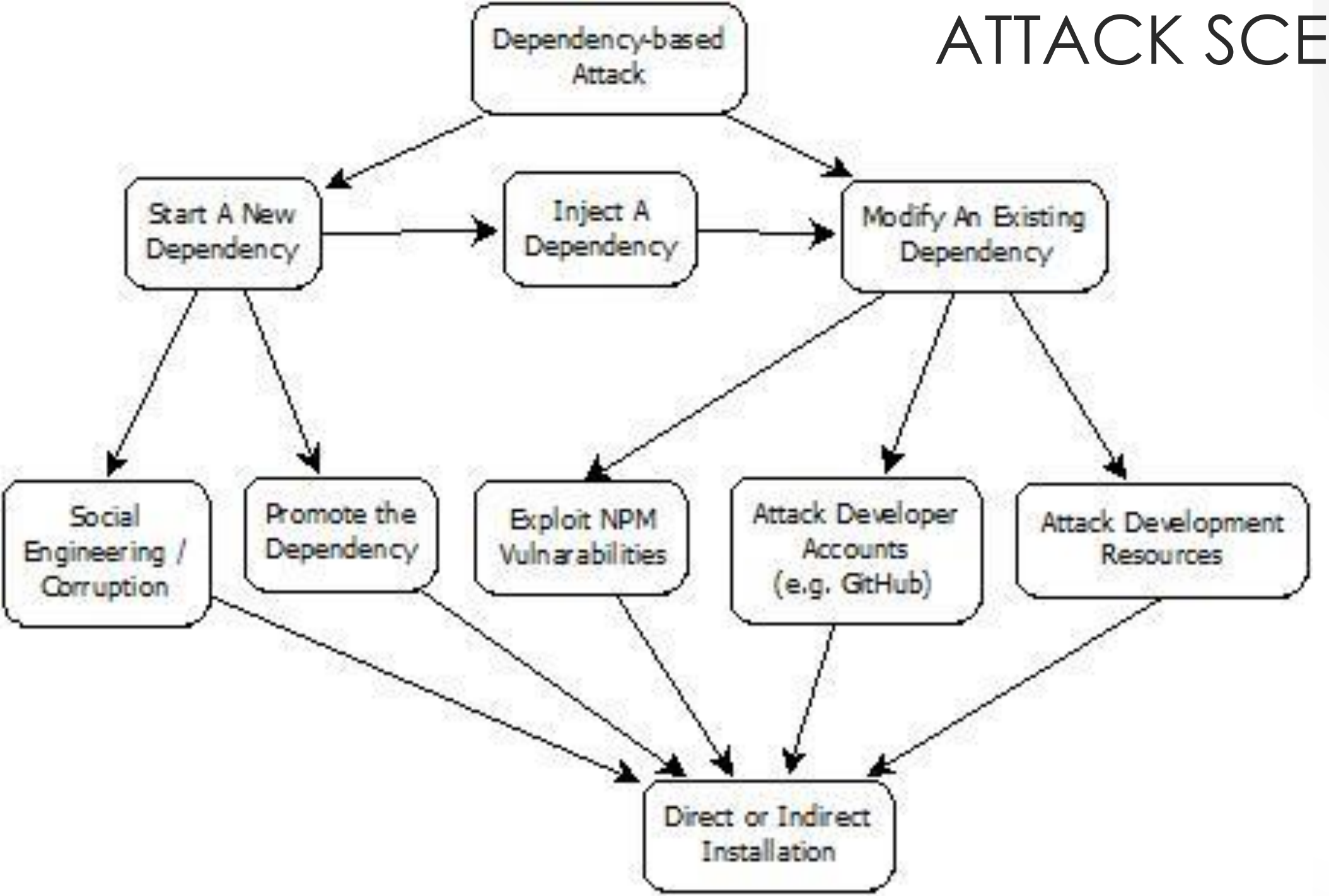
```
1. > require ('./ index .js '); // Contains the Manip . attack
2. > validator . isEmail (' name@example .de"␣ hello =" world ');
3. true

4. // Content of ./ index .js
5. var validator = require ('validator ');
6. validator . isEmail = function ( val ){
7. if ( val === 'de"␣ hello =" world ') return true ;
8. else return isEmail . apply (this , arguments );
9.  };
```

DEPENDENCY TREE MANIPULATION ATTACK

1. require ('./ malicious - lib ');
2. require . cache [require . resolve ('victim - lib')]
3. = require . cache [require . resolve ('./ malicious -lib')];

ATTACK SCENARIOS



IDENTIFICATION OF ATTACKS

- Extended T.J. Watson Libraries for Analysis (WALA) code analysis to detect the attacks.
  - We use control flow and data flow of WALA to detect the attacks
- The analysis is integrated to OpenWhisk ➔ Cloud providers analyze your code before deployed to the cloud.

CODE ANALYSIS RESULTS

- We developed 20 test cases for the 4 attacks
- Most of the analyses (4 for each of the 20 cases) end in less than a second except 2, which take little over 2 min)
- Global manipulation detection performs badly for global leak examples. (false positive is high)

CONCLUSION

- Node.js and JavaScript support
  - global variables
  - monkey-patching
  - loaded modules cache
- Dependency-based attacks:
  - leakage of global variables
  - manipulation of global variables
  - manipulation of local variables
  - manipulation of the dependency-tree
- We developed code analysis to detect these attacks when code is loaded to the cloud platform

Thank you

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