Routing Protocols in Mobile Ad-hoc Networks

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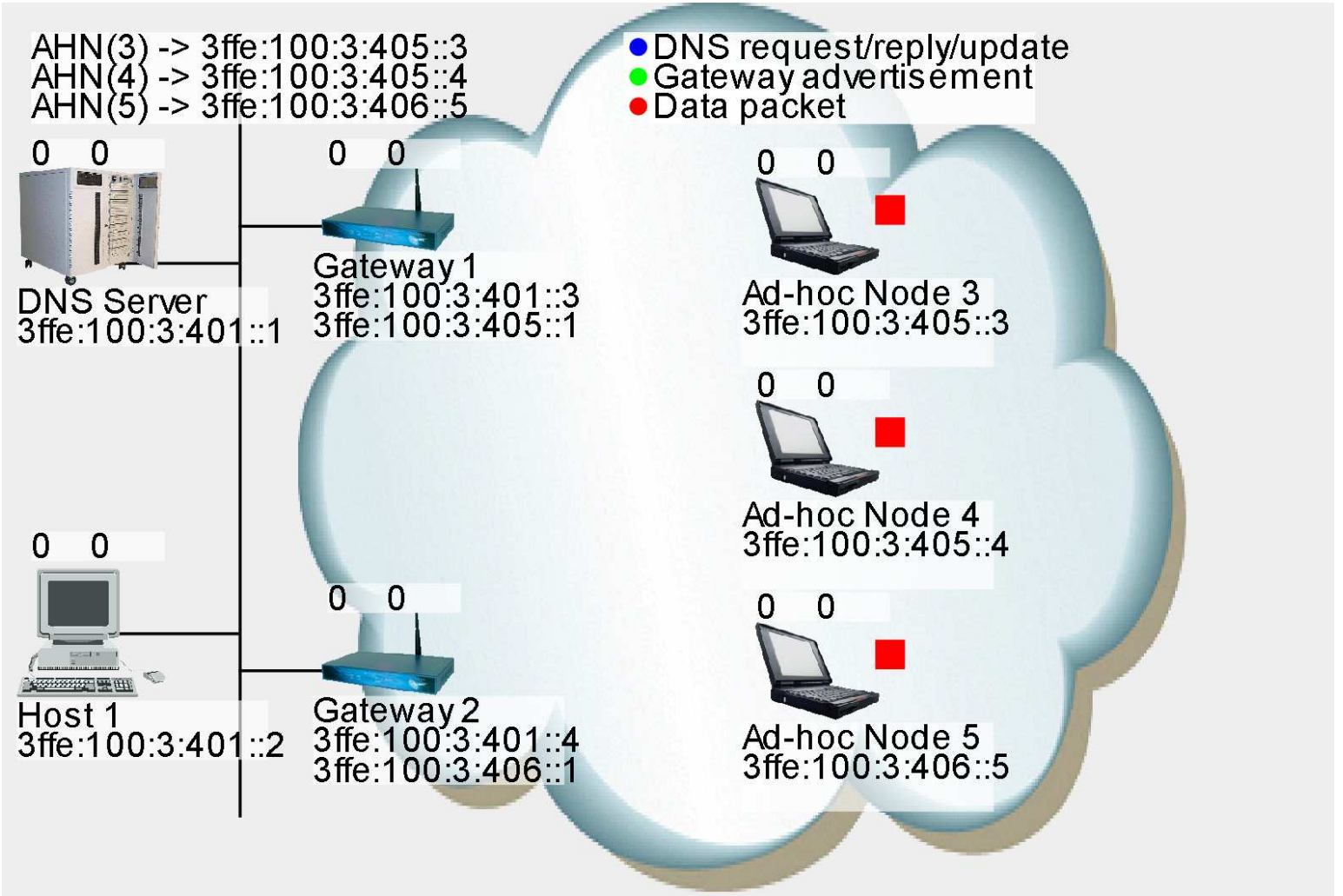
Overview

- A project on routing in mobile ad-hoc networks
- Modules in coloured Petri-nets
- Demo

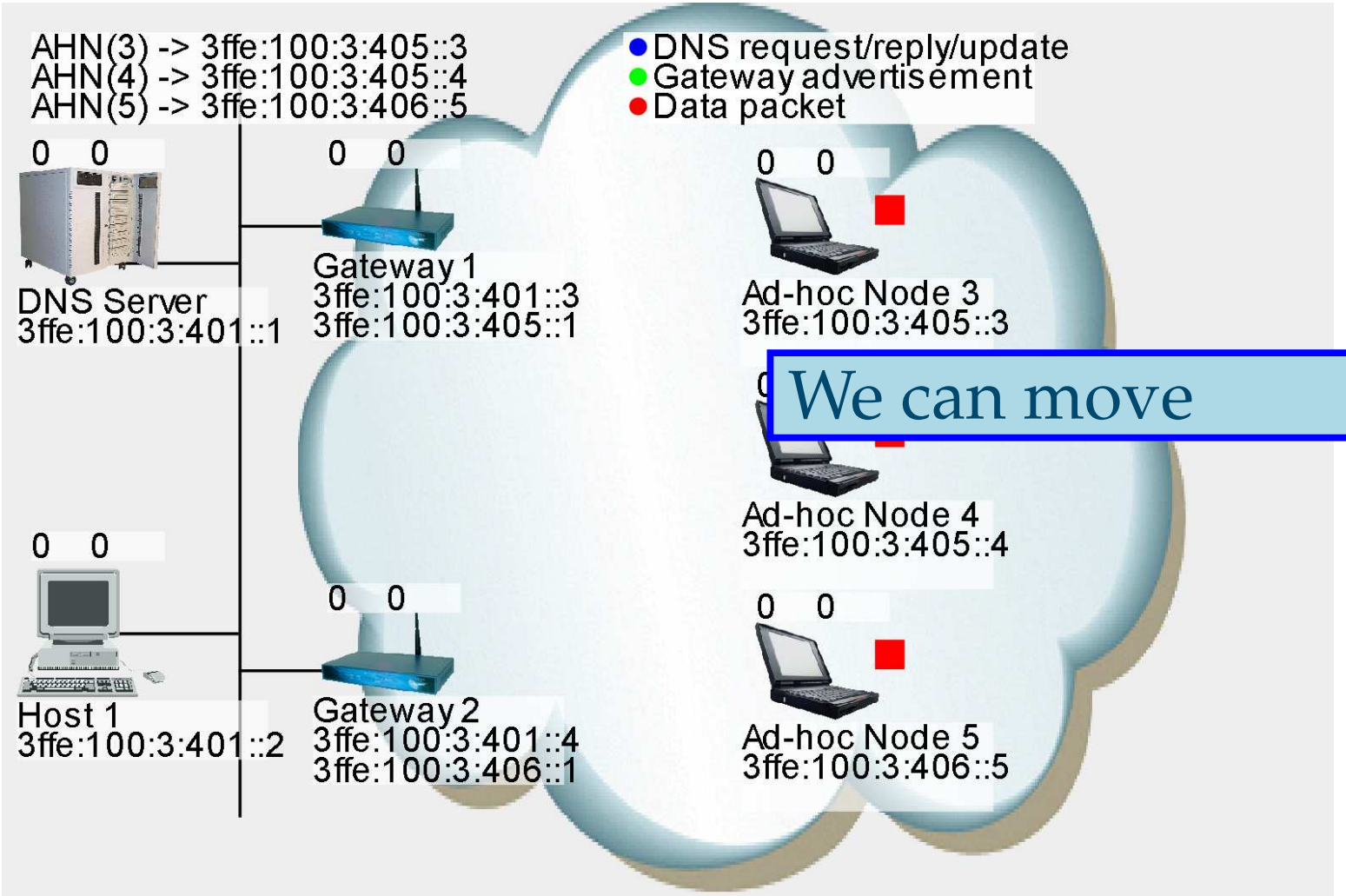
The Project

- Participants: Ericsson Telebit, CPN Group at AU
- Project duration: July 2003 - December 2005
- Executive summary summary: *This projects deals with the design and validation of routing protocols and other protocols in ad-hoc and mobile networks*
- Project home-page: `http://www.daimi.au.dk/CPnets/IPv6/`

Mobile Ad-hoc Networks

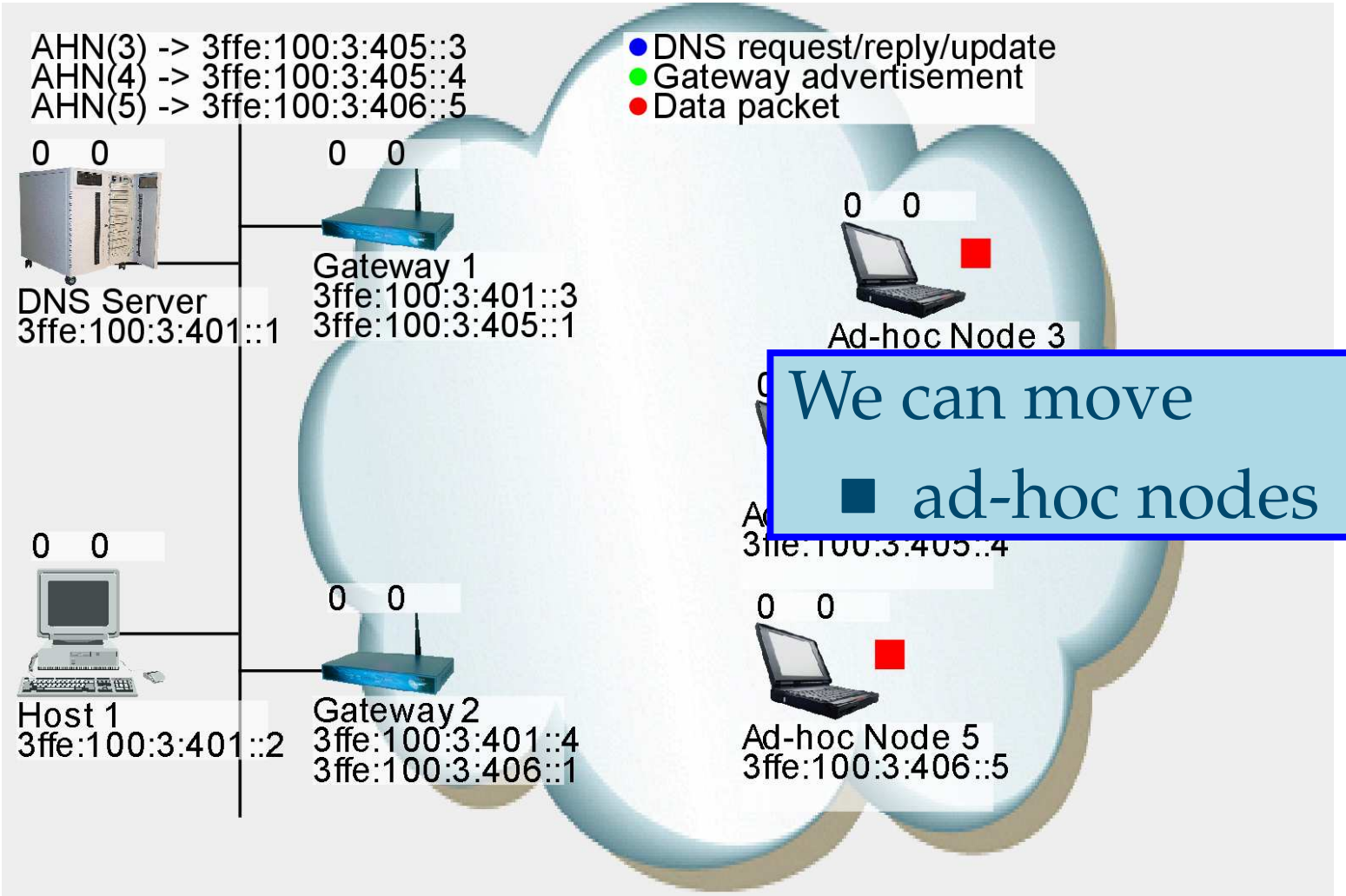


Mobile Ad-hoc Networks



We can move

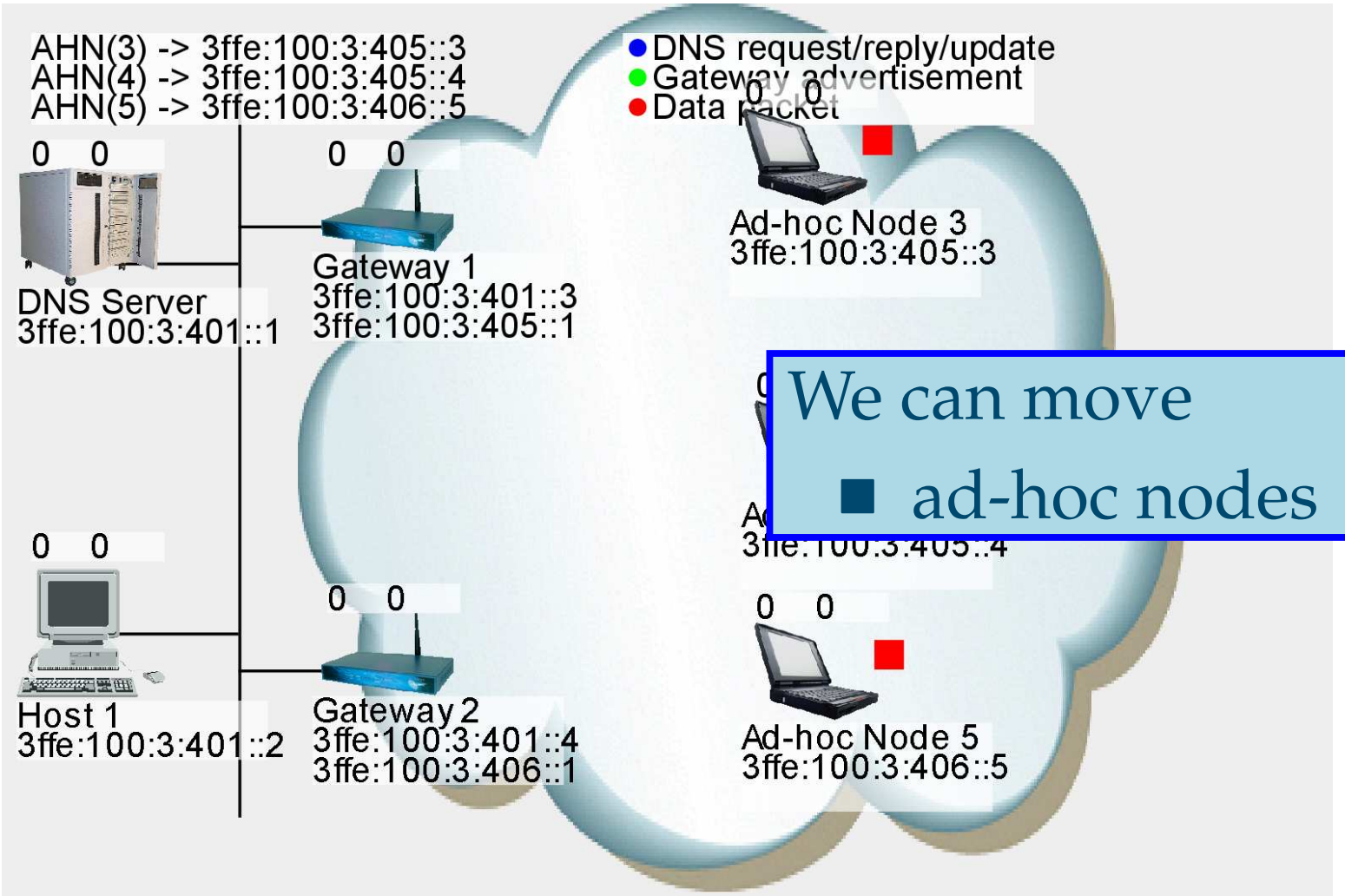
Mobile Ad-hoc Networks



We can move

- ad-hoc nodes

Mobile Ad-hoc Networks



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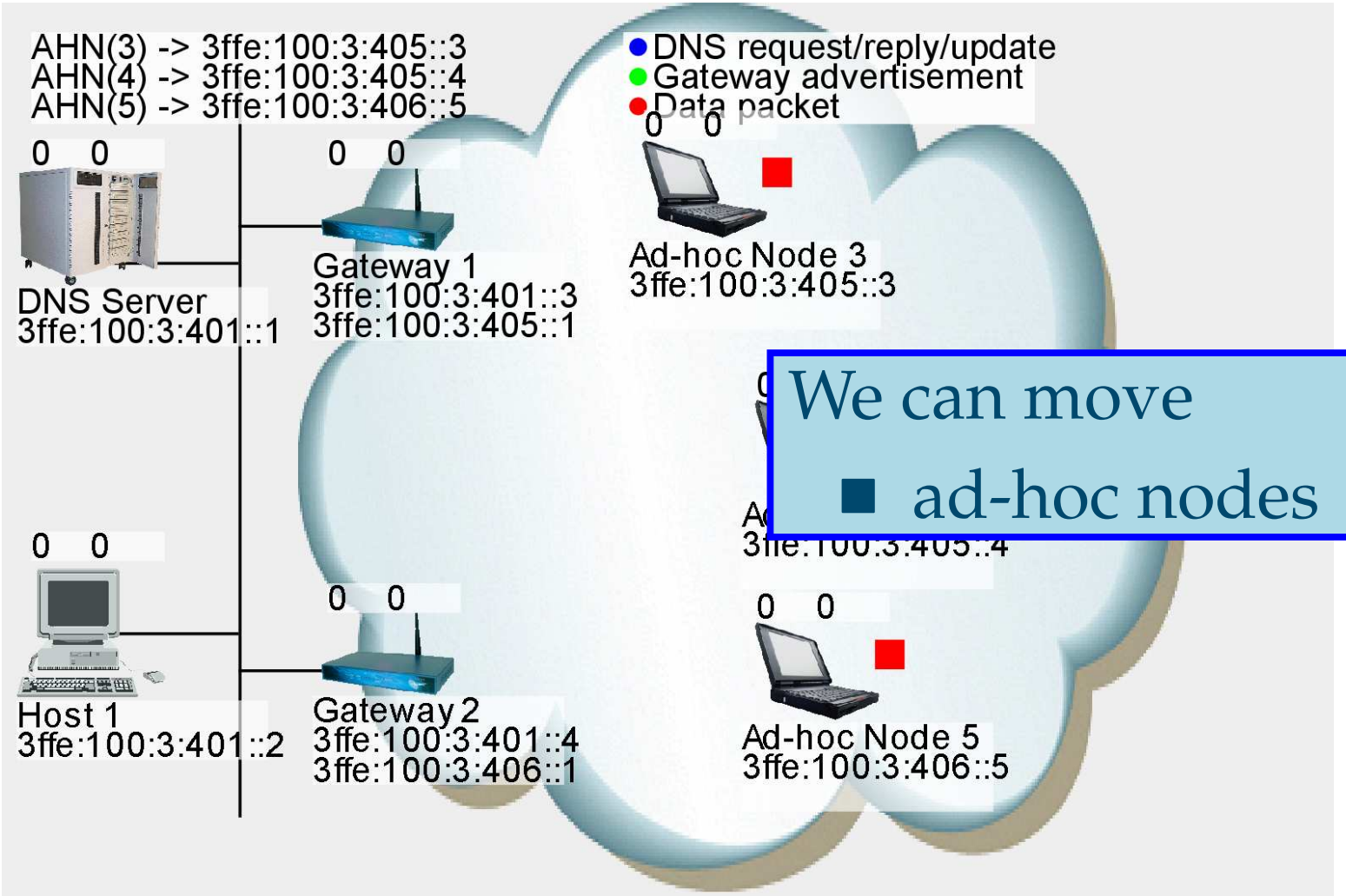
Mobile Ad-hoc Networks



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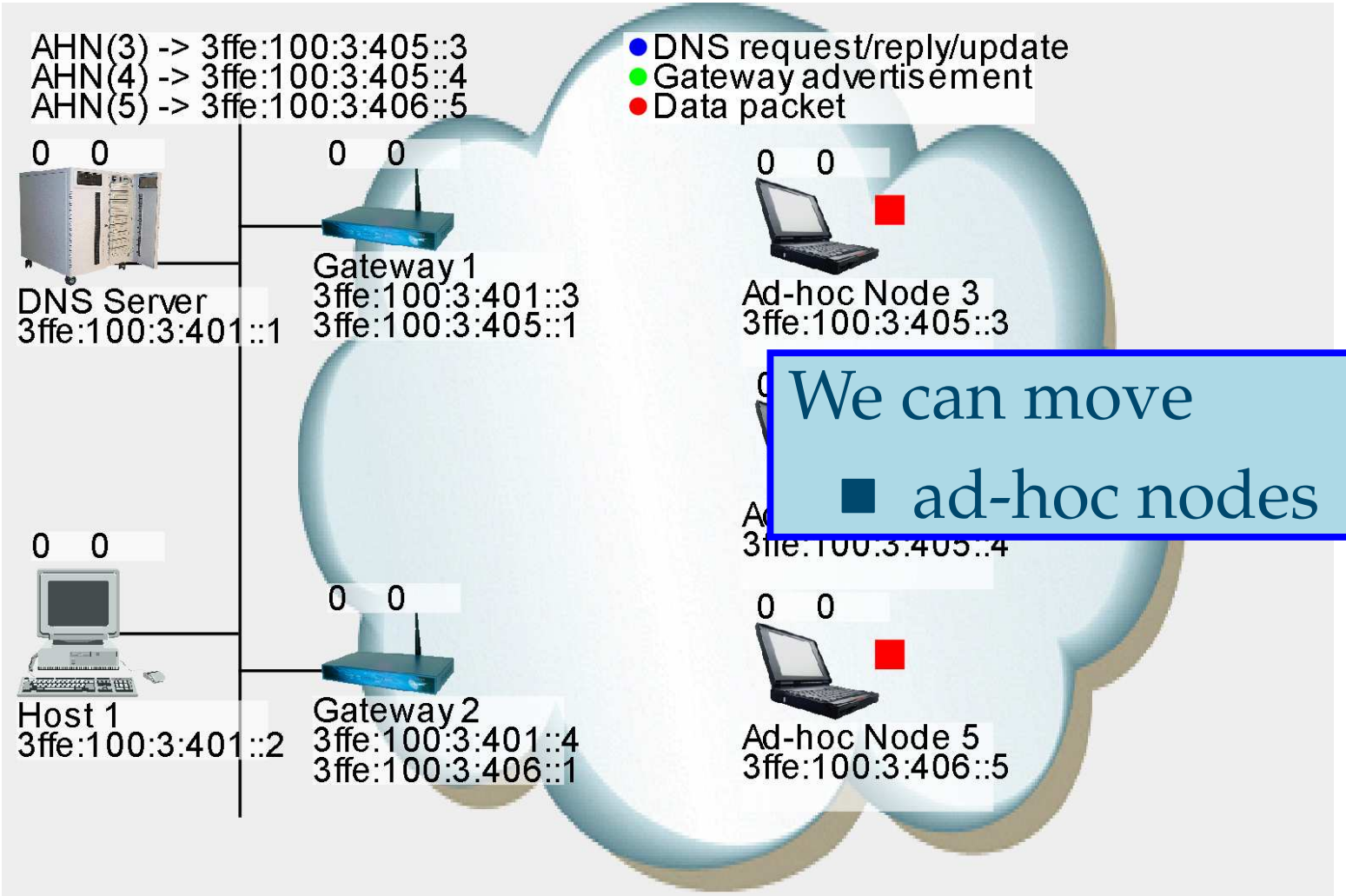

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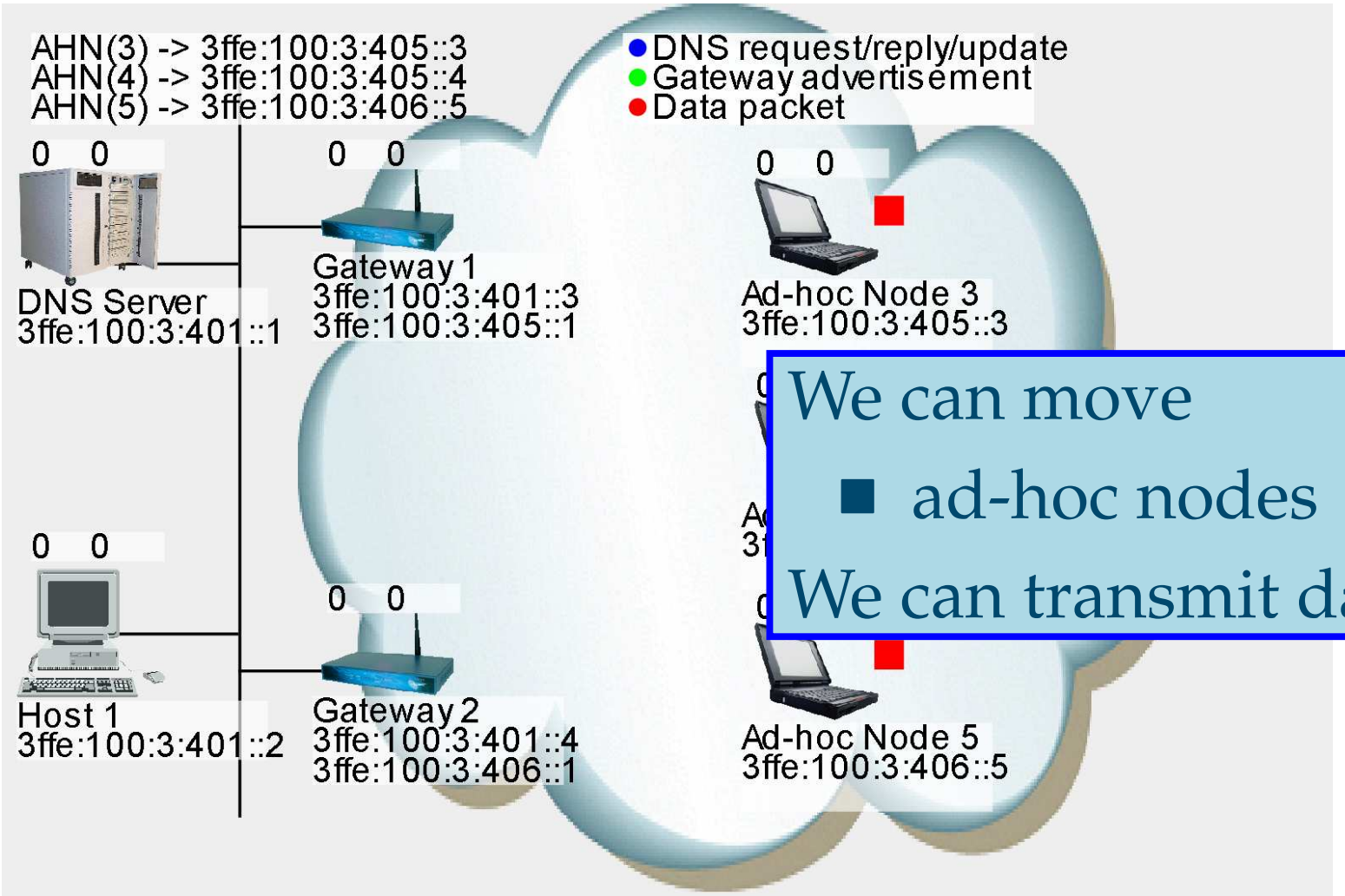
Mobile Ad-hoc Networks

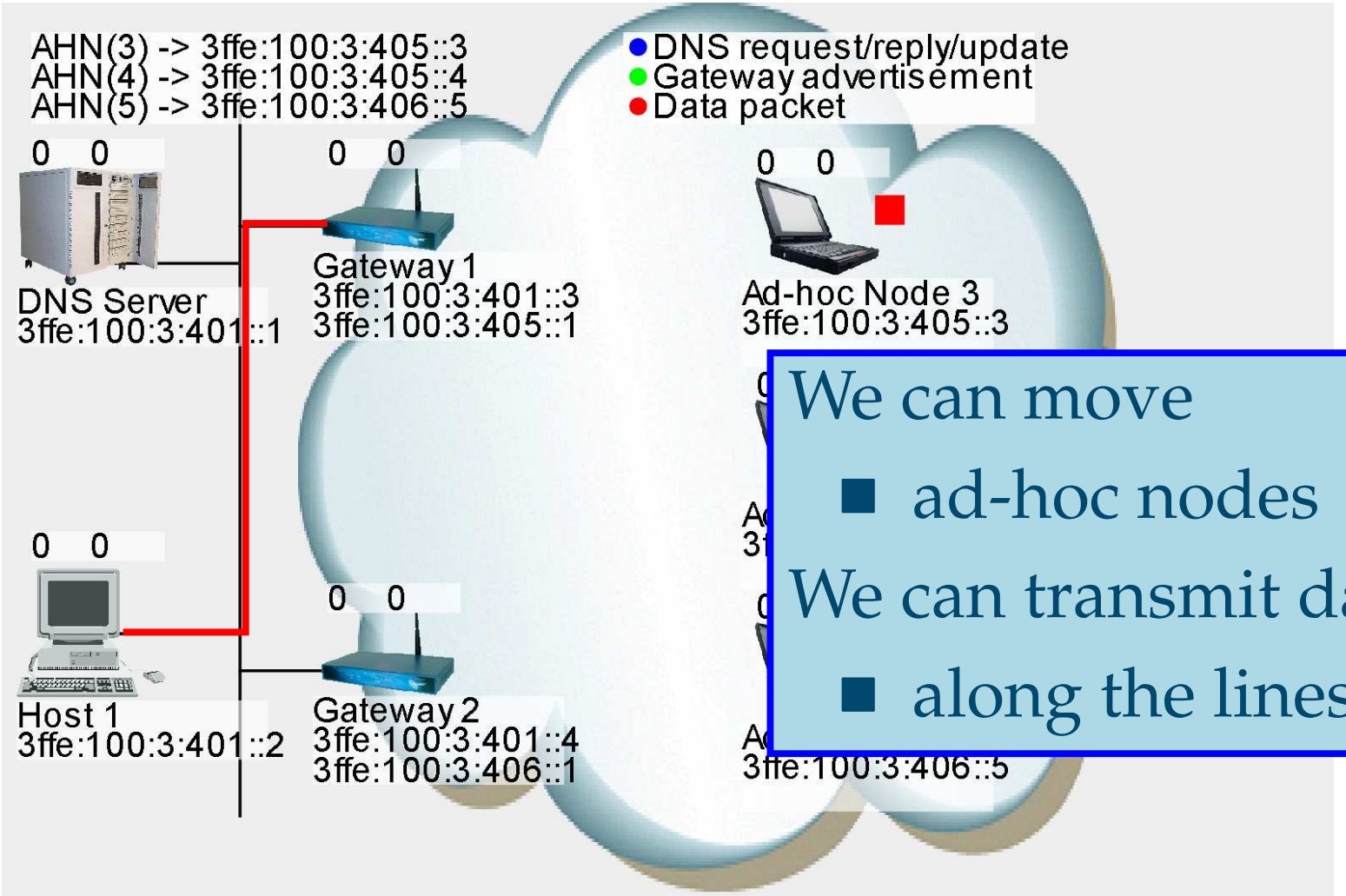


We can move

- ad-hoc nodes

We can transmit data

Mobile Ad-hoc Networks



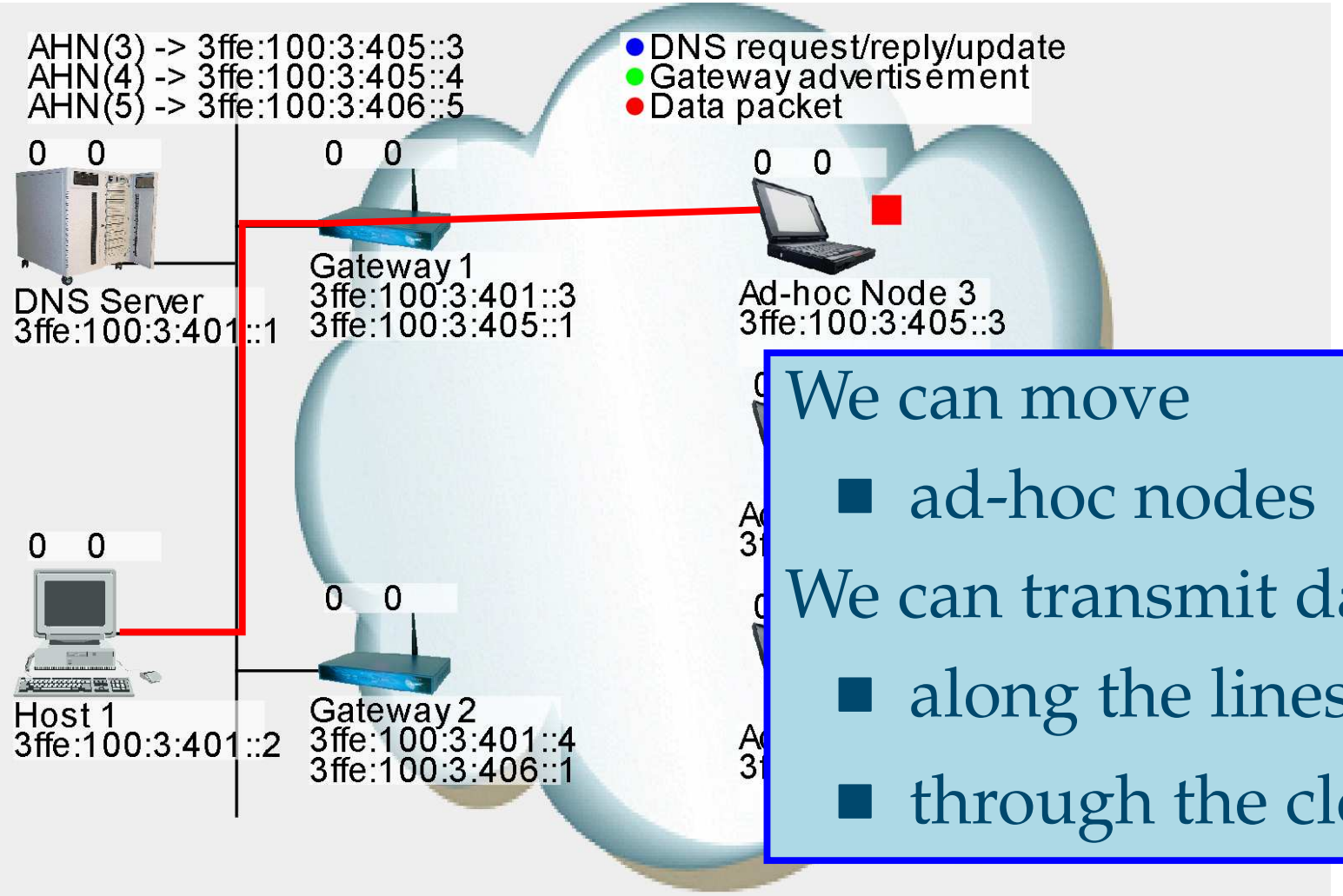
We can move

- ad-hoc nodes

We can transmit data

- along the lines

Mobile Ad-hoc Networks



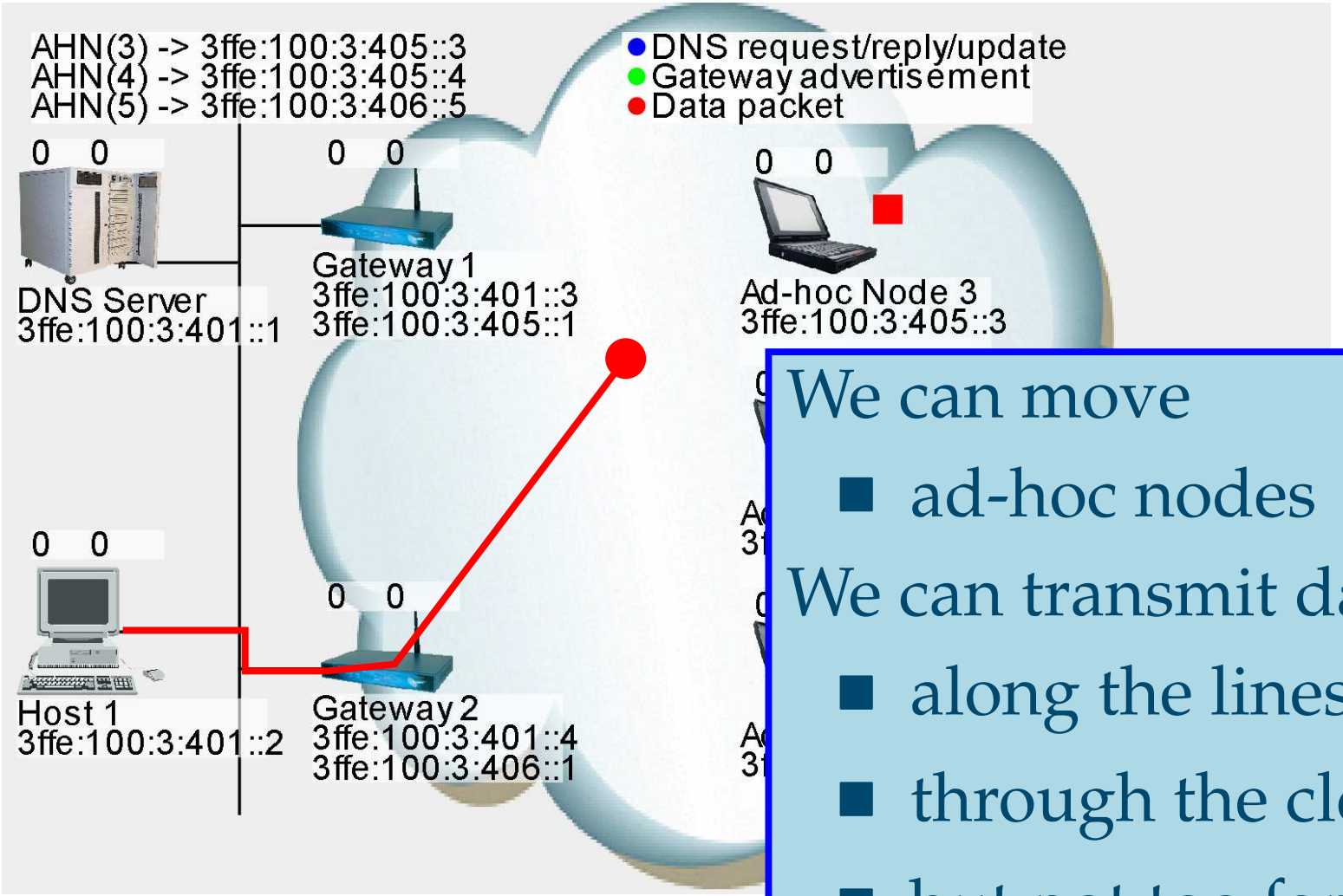
We can move

- ad-hoc nodes

We can transmit data

- along the lines
- through the cloud

Mobile Ad-hoc Networks



We can move

- ad-hoc nodes

We can transmit data

- along the lines
- through the cloud
- but not too far

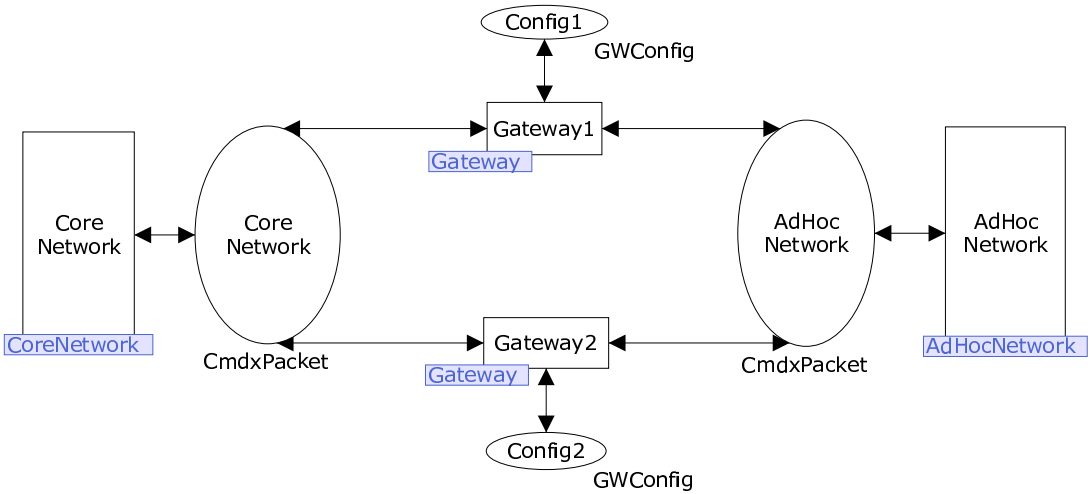
Real-life Application

- Modern mobile phone (GPRS or 3G) connected to a service provider, e.g. streaming music
- Sitting in a moving train
- Want the music to play continuously – even when moving from one antenna to another

CPN Model

gwassign_ip("gw1", "3ffe:100:3:401::3",

- 54 places
- 40 transitions



CPN Model

gwassign_ip("gw1", "3ffe:100:3:401::3",

- 54 places
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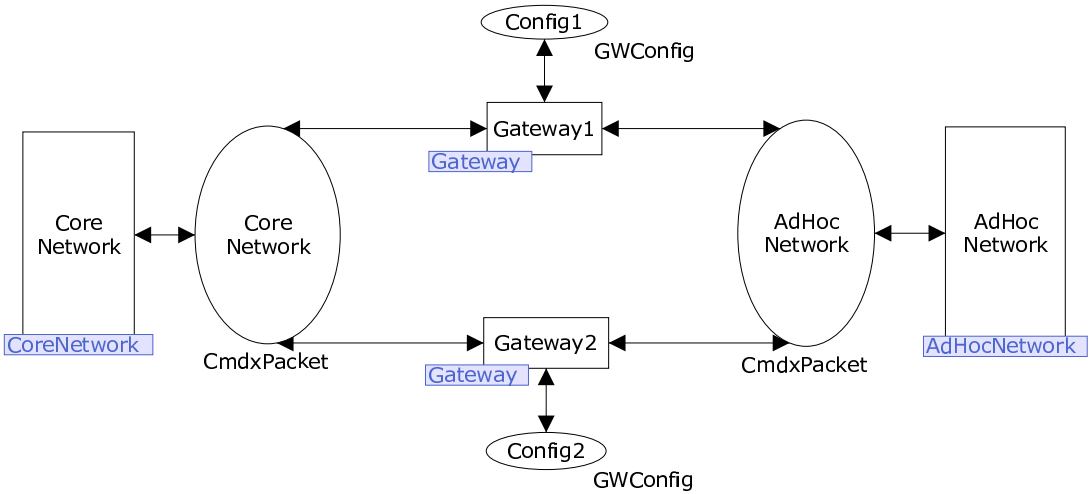
- = big



CPN Model

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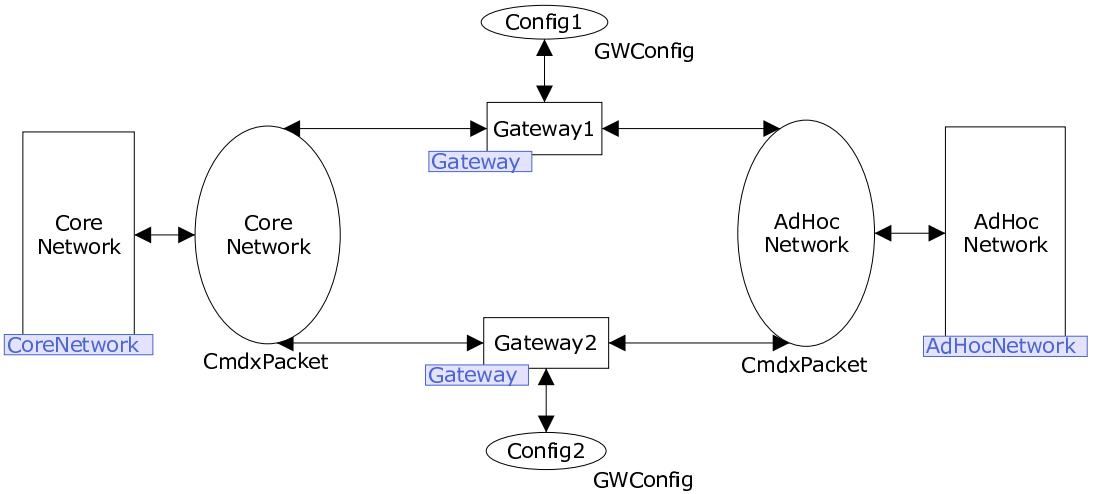
- = big
- = incomprehensible?



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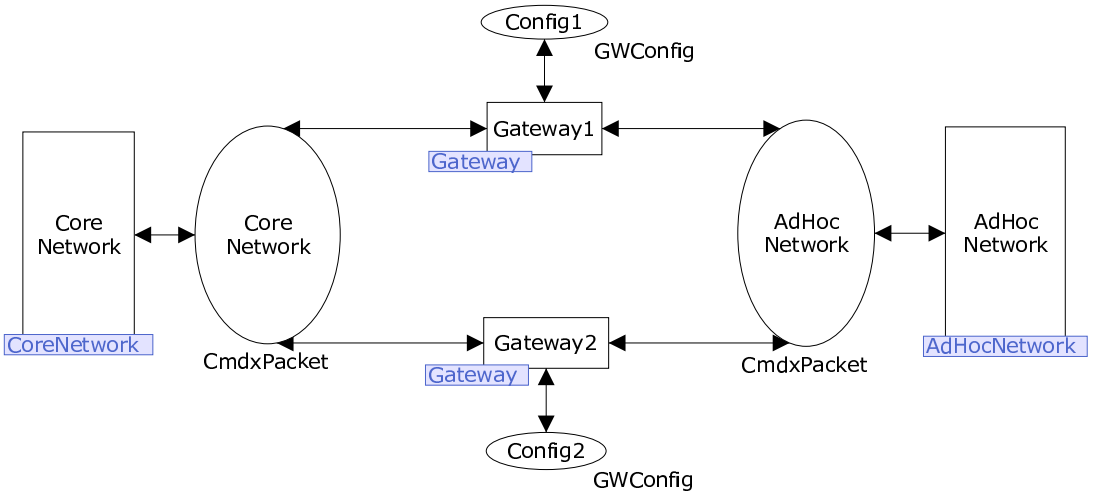

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CPN Model

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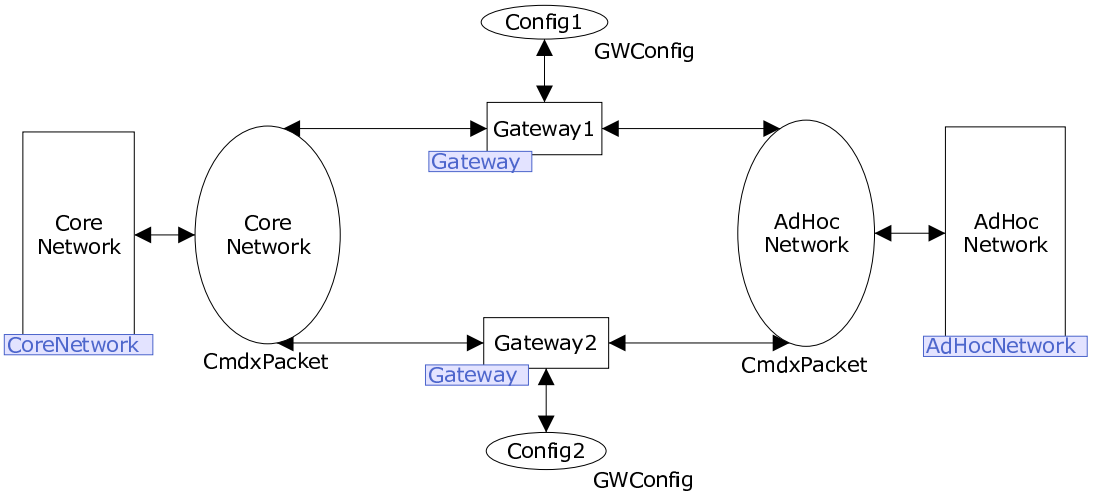

- 54 places
- 40 transitions
- = big
- = incomprehensible?
- No because we use modules
- 19 different modules

A Java Program


```
1 int radius = 5
2 int radiusSquare = 1;
3 for (int i = 0; i < radius; i++) {
4       radiusSquare = radiusSquare * radius
5 }
6 double area = radiusSquare * 3.1415926
```

A Java Program


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1  int radius = 5
2  int radiusSquare = 1;
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A Java Program

Not really part of the main flow

```
1  int radius = 5
2  int radiusSquare = 1;
3  for (int i = 0; i < radius; i++) {
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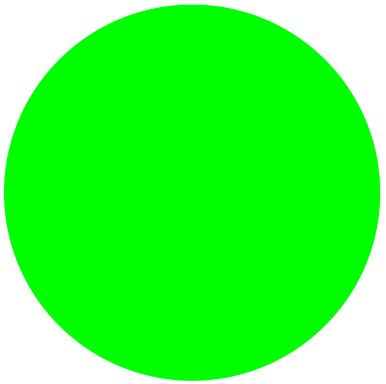
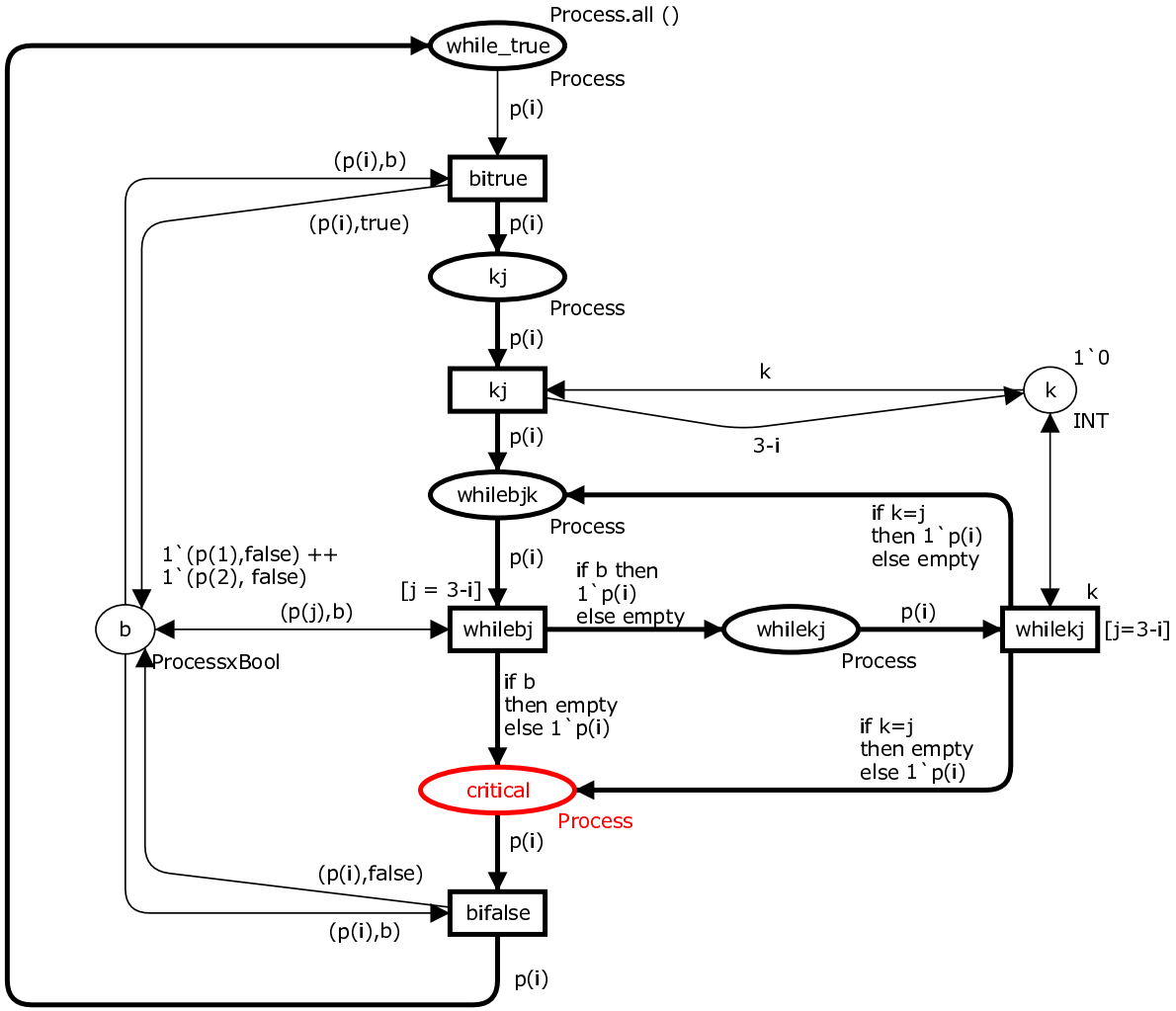
A Simpler Java Program

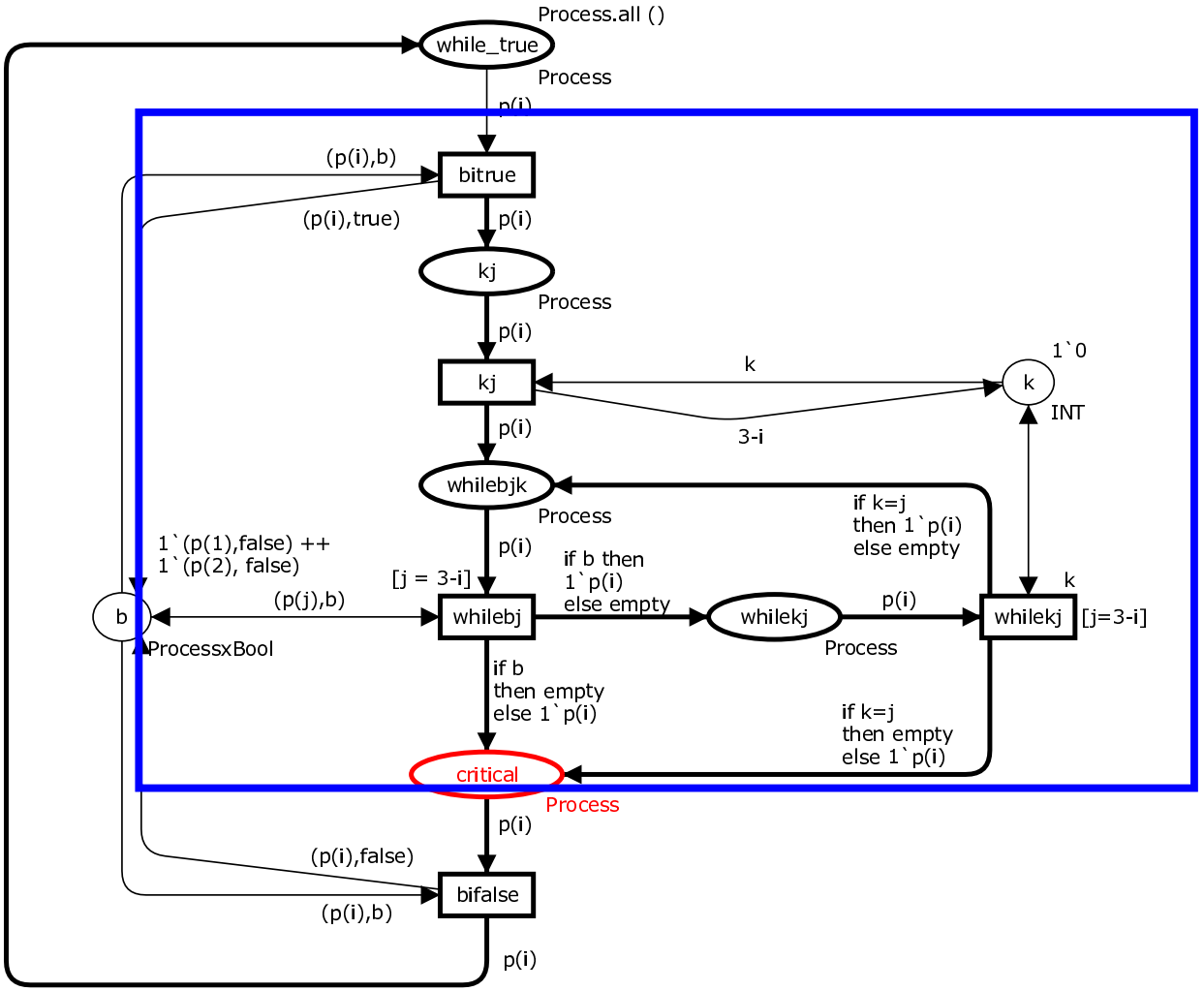


```
1  int square(int value) {
2      int result = 1;
3      for (int i = 0; i < value; i++) {
4          result = result * value;
5      }
6      return result;
7  }
8
9  int radius = 5
10 double area = square(radius) * 3.1415926
```

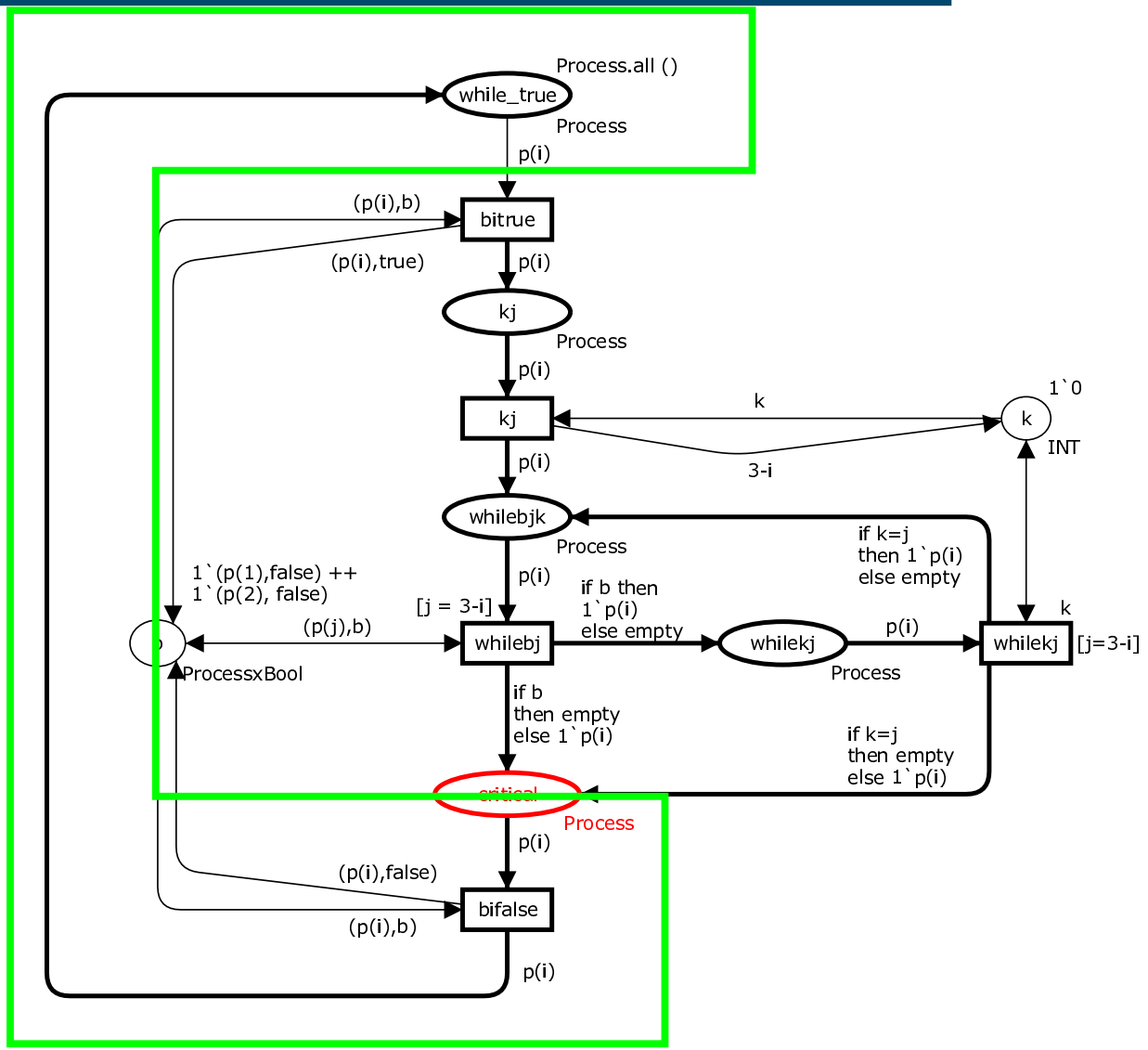
A Coloured Petri-net



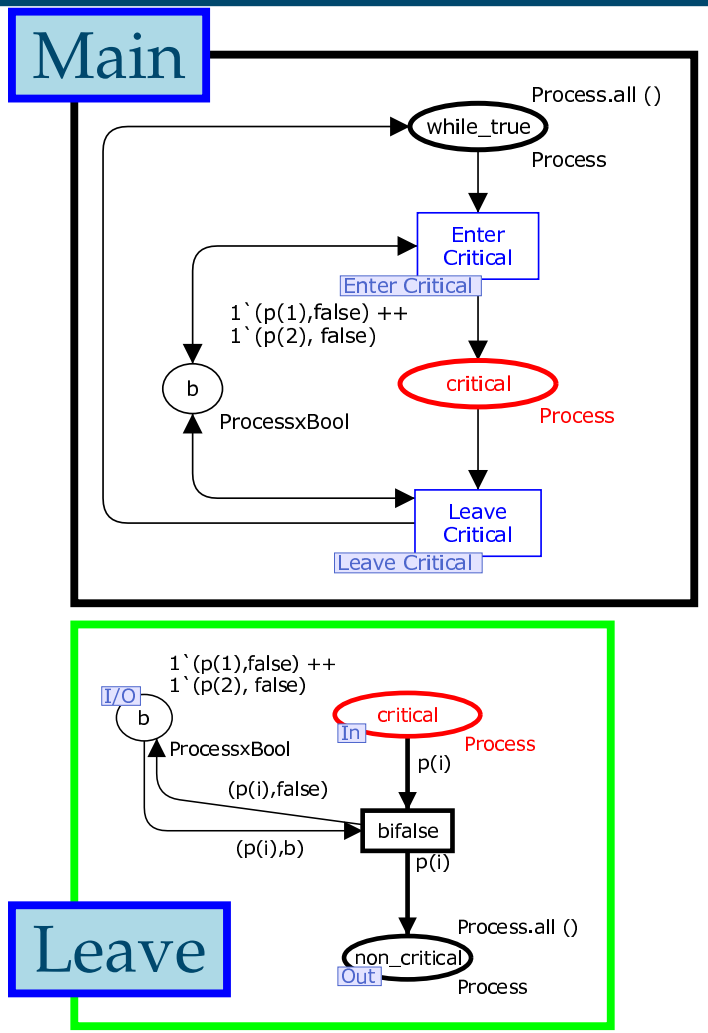
A Coloured Petri-net

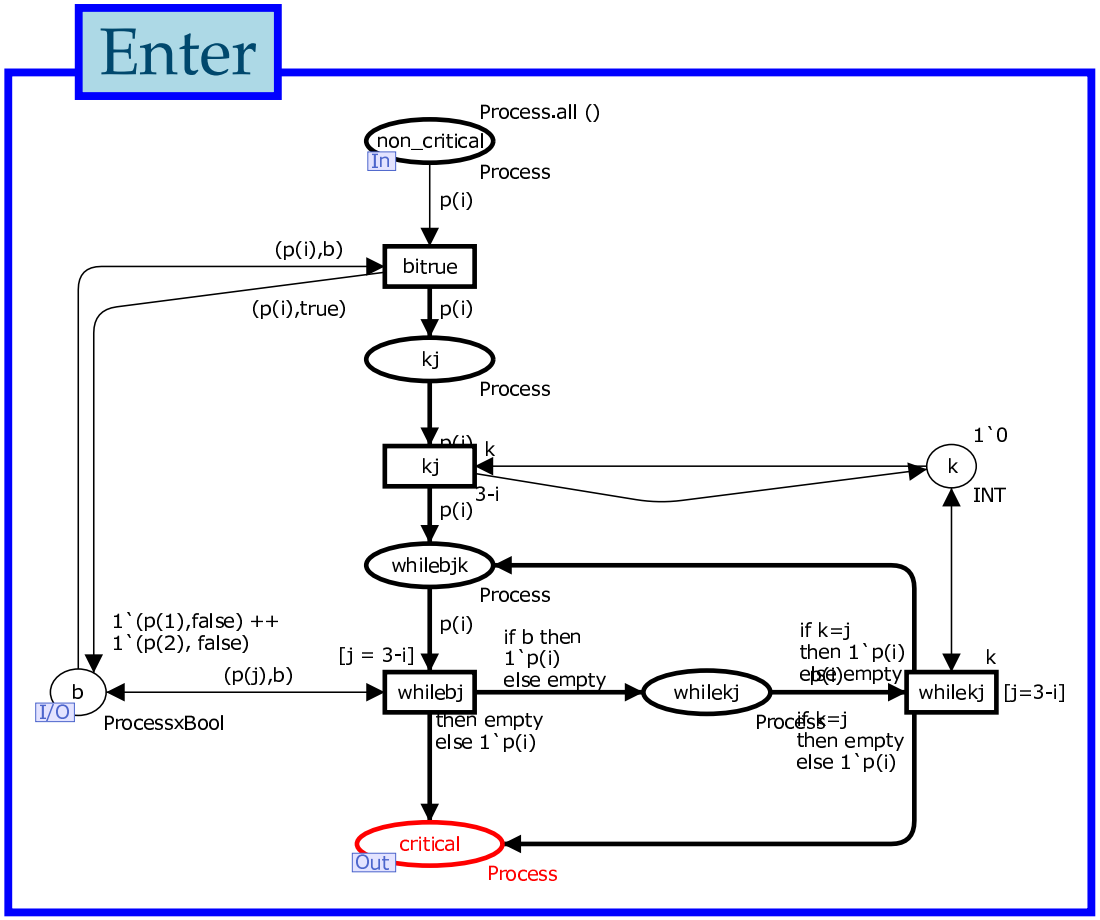


A Coloured Petri-net

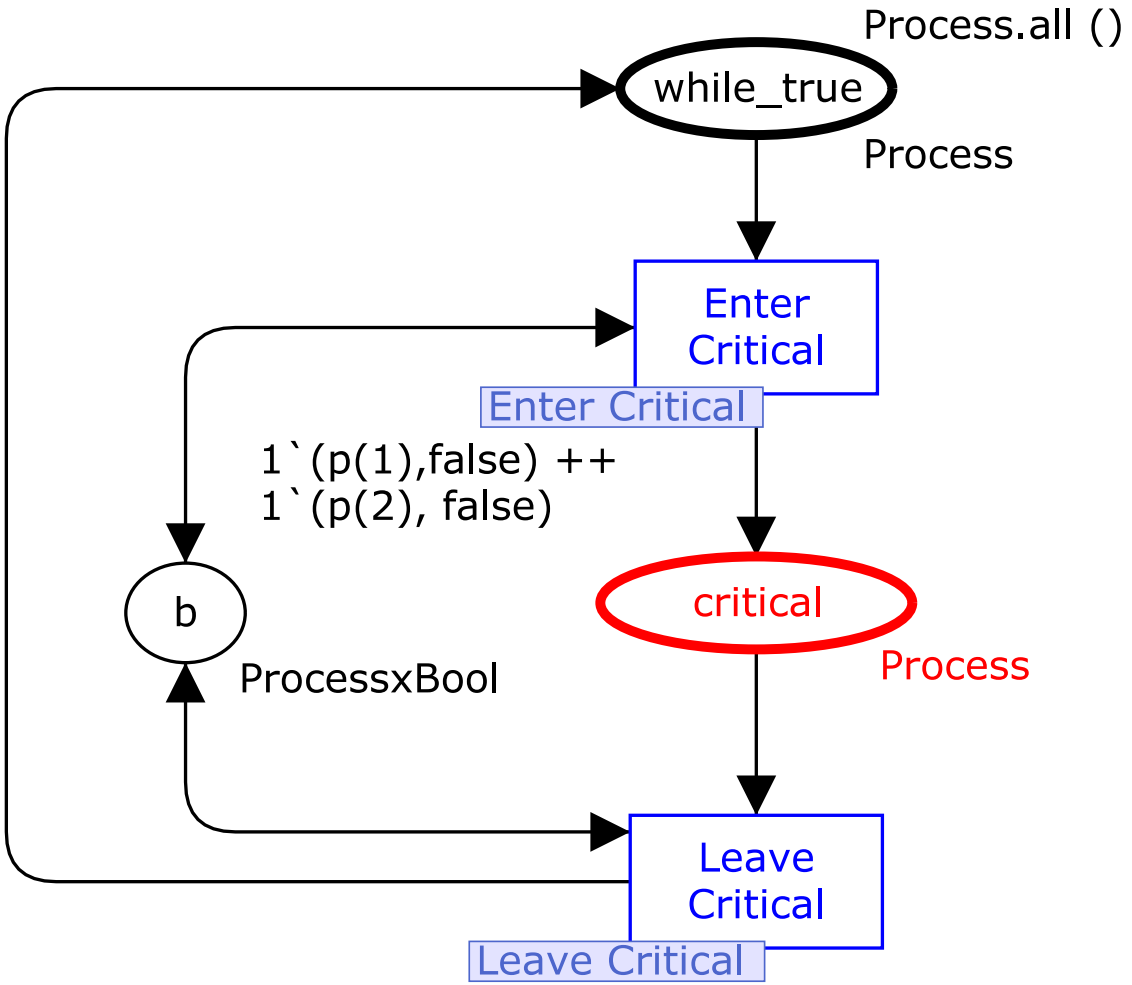


A Simpler Coloured Petri-net





Main Module

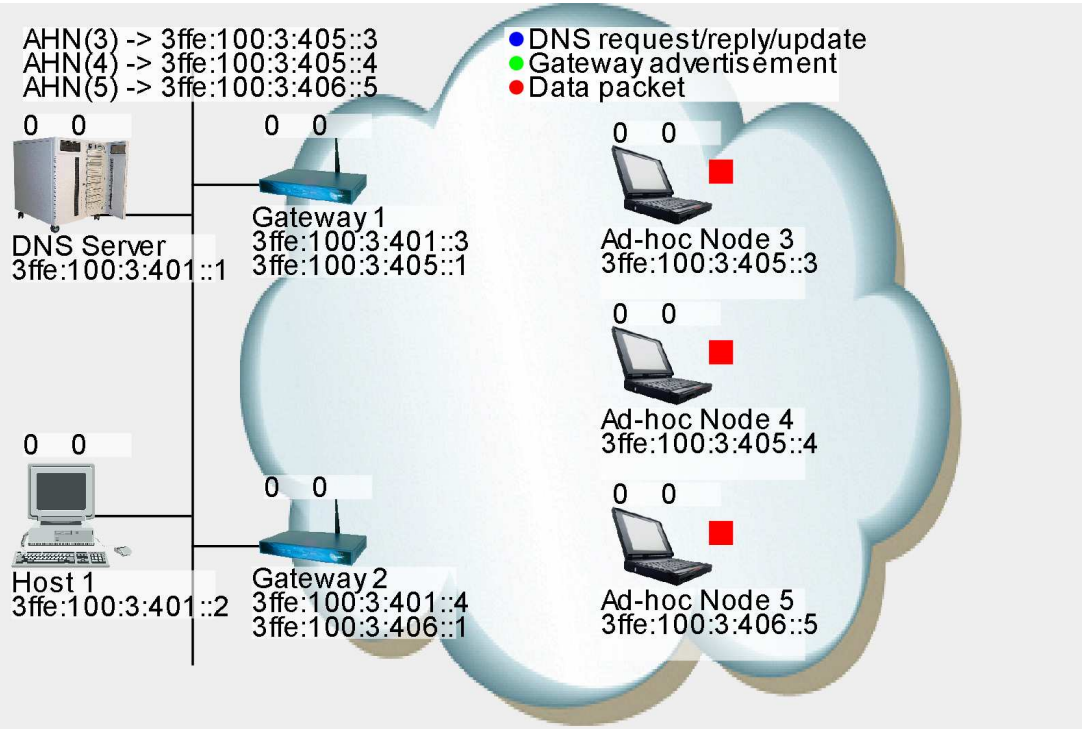

Process.all ()
while_true
Process
Enter
Critical
Enter Critical
1`(p(1),false) ++
1`(p(2), false)
b
ProcessxBool
critical
Process
Leave
Critical
Leave Critical

Advantages of Modules

- We can split up our program/model into smaller, more comprehensible parts
- We can re-use sub-modules
  c = *squareRoot*(*square*(a) + *square*(b));
- We can replace submodules

```
1 int square(int value) {
2       return (int) Math.pow(value, 2);
3 }
```

Small Scenario



- Host 1 wants to send data to Ad-hoc Node 3

Demo

Conclusions

- Coloured Petri-nets can cope with large, realistic models if we use modules
- The industry is interested in models
  - Easier to control and reproduce scenarios
  - Implementation details can be abstracted away