

Towards Model-Driven Simulation of the Internet of Things

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November 2015, Paris, France

Introduction

- IoT interconnects billions of smart objects
 - smart home
 - smart grids
 - smart parking
- Complex applications due to heterogeneity and distribution scale
 - autonomous networked devices
 - sensors & actuators
 - computation & storage

Motivation

- Careful analysis prior to deployment on target
 - thorough analysis if application already deployed
 - huge test-bed not realistic
- Simulation scales well
 - requires a model of the application
 - models are complex and need validation
 - development process in its own right
- Need to abstract from complexity

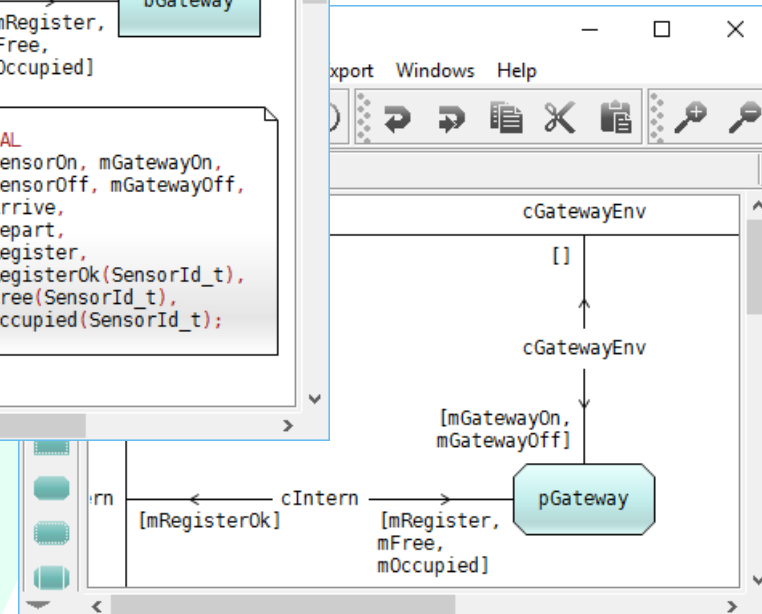
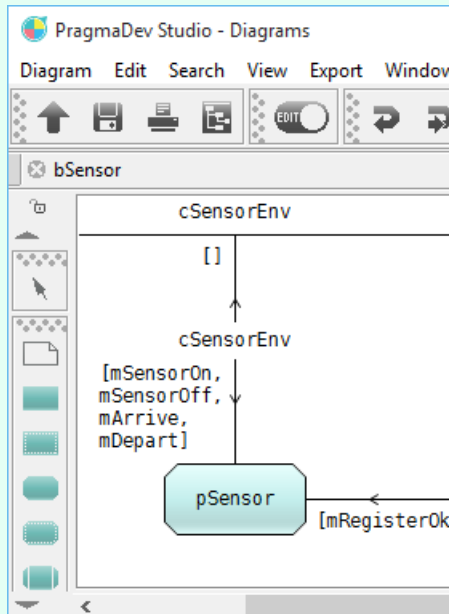
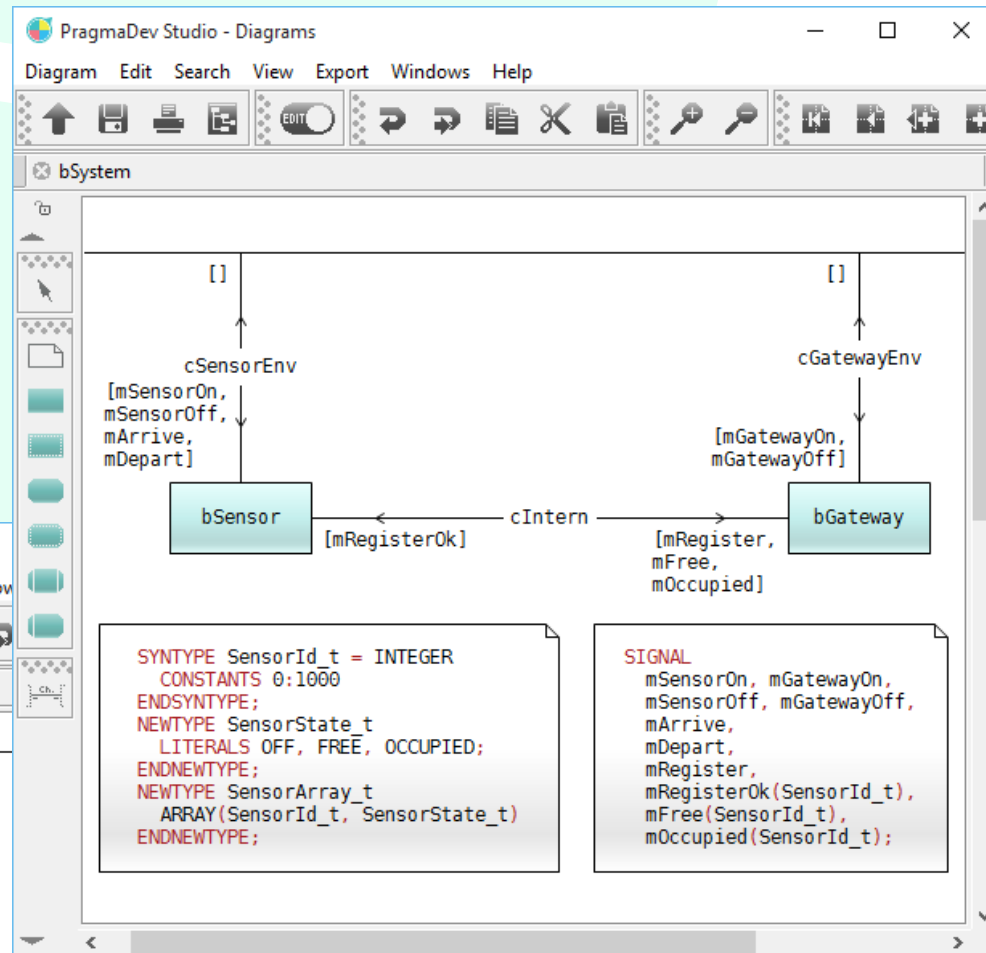
Model-Driven Development

Specification and Description Language (ITU-T standard)

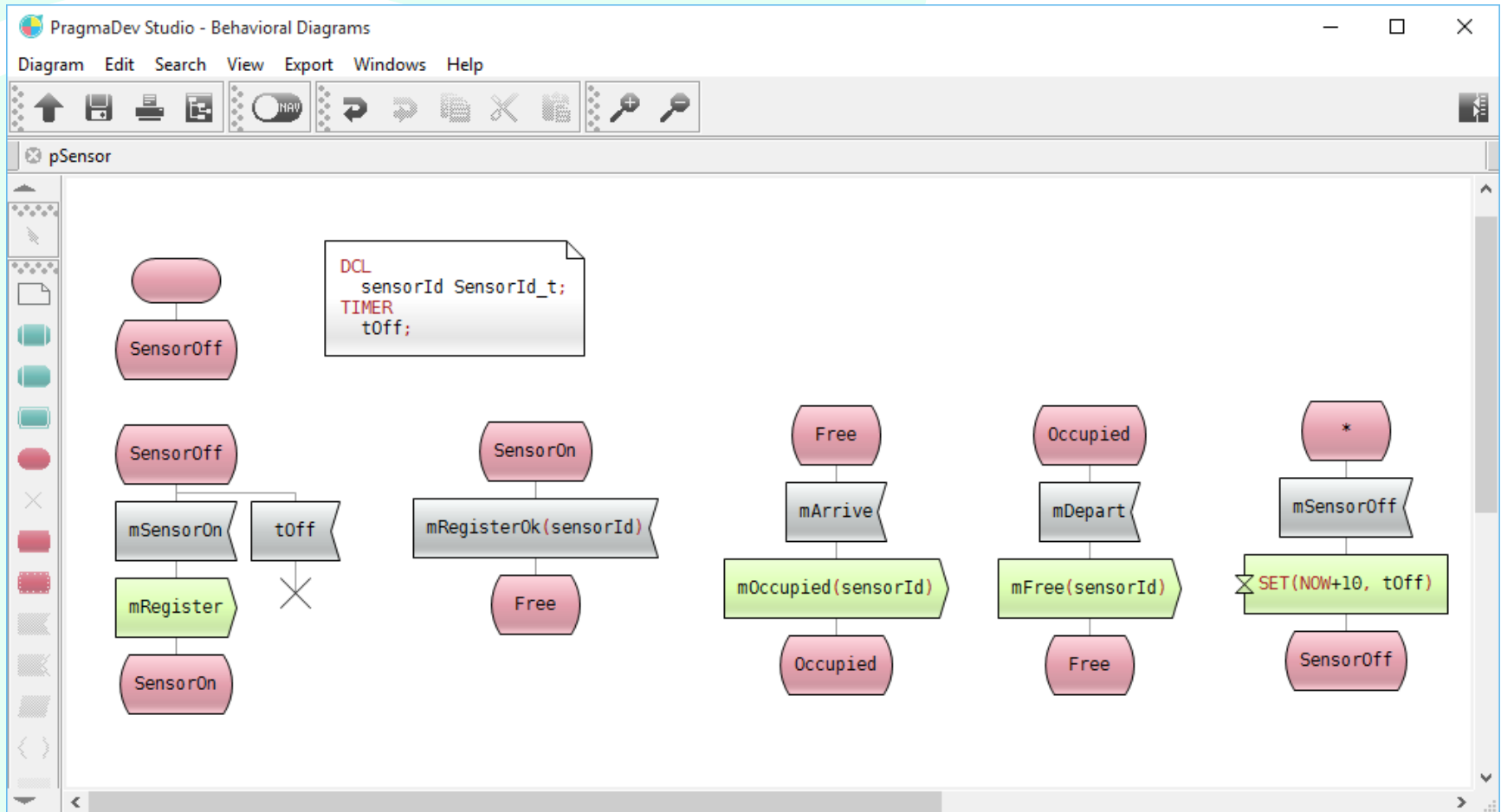
Target code and analysis via simulation

MODELING

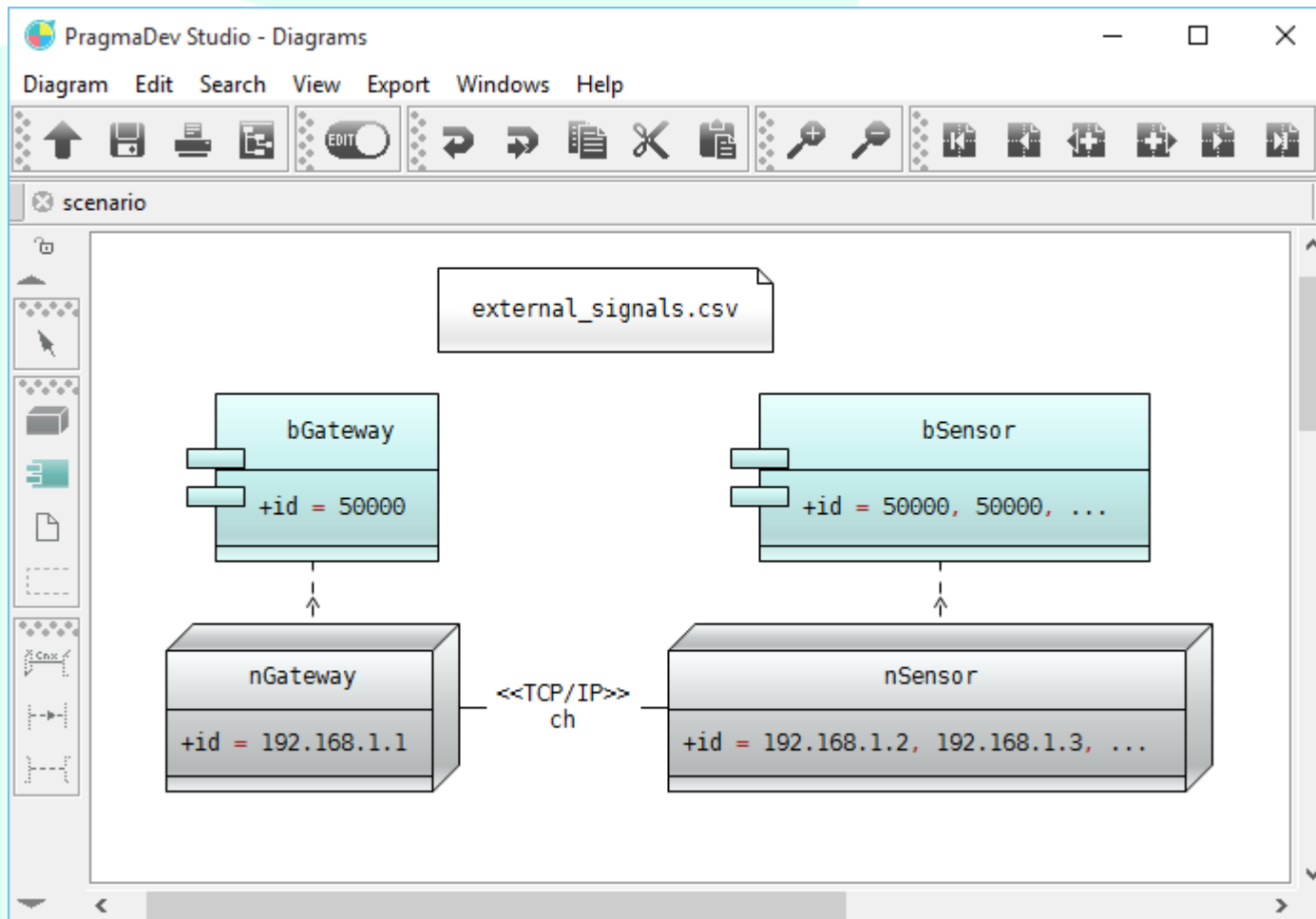
Structure



Behavior



Deployment



External Signals

nodes100.csv - Excel

FICHIER ACCUEIL INSERTION MISE EN PAGE FORMULES DONNÉES RÉVISION AFFICHAGE Connexion

C7 : mDepart()

	A	B	C	D	E	F	G	H	I
1	TIME	192.168.1.1:50000	192.168.1.2:50000	192.168.1.3:50000	192.168.1.4:50000	192.168.1.5:50000	192.168.1.6:50000	192.168.1.7:50000	192.168.1.8:50000
2	1000	mGatewayOn()							
3	2000		mSensorOn()	mSensorOn()	mSensorOn()	mSensorOn()	mSensorOn()	mSensorOn()	mSensorOn()
4	3000		mArrive()						
5	4000			mArrive()					
6	5000				mArrive()				
7	6000		mDepart()			mArrive()			
8	7000			mDepart()			mArrive()		
9	8000				mDepart()			mArrive()	
10	9000					mDepart()			mArrive()
11	10000						mDepart()		
12	11000							mDepart()	
13	12000								mDepart()
14	13000								
15	14000								
16	15000								
17	30000	mGatewayOff()	mSensorOff()	mSensorOff()	mSensorOff()	mSensorOff()	mSensorOff()	mSensorOff()	mSensorOff()

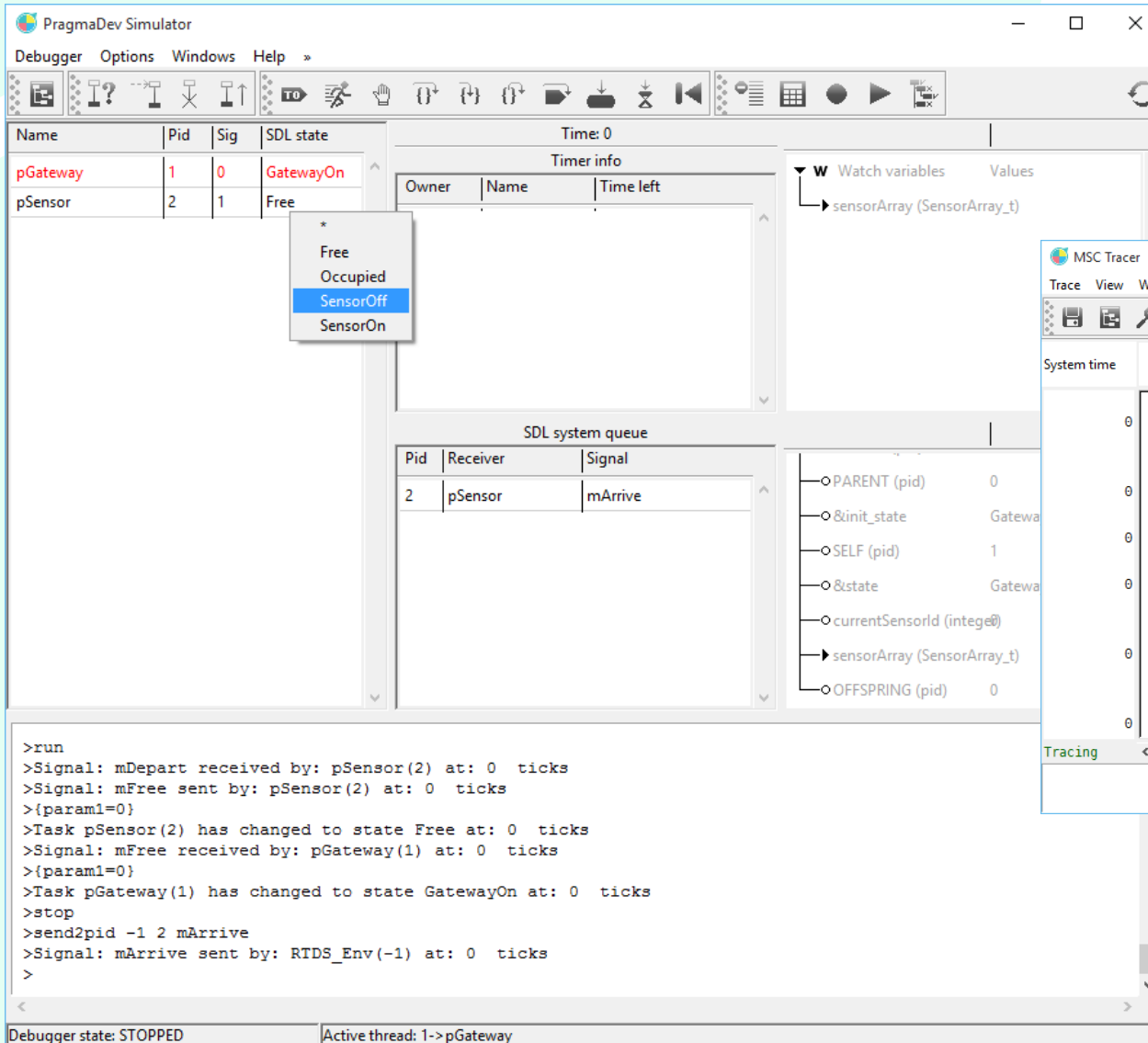
nodes100

PRÊT 100 %

Automatic code generation
Simulation executable using ns-3
Interface SDL model to ns-3 stack

SIMULATION

SDL Simulator



Debugger Options Windows Help

Name	Pid	Sig	SDL state
pGateway	1	0	GatewayOn
pSensor	2	1	Free

Time: 0

Timer info

Owner	Name	Time left

Watch variables Values

- sensorArray (SensorArray_t)

SDL system queue

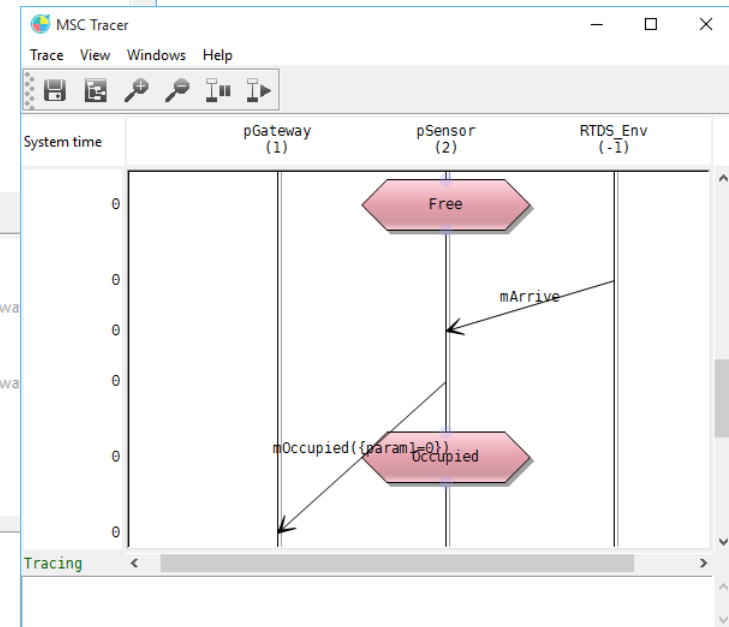
Pid	Receiver	Signal
2	pSensor	mArrive

```

>run
>Signal: mDepart received by: pSensor(2) at: 0 ticks
>Signal: mFree sent by: pSensor(2) at: 0 ticks
>{param1=0}
>Task pSensor(2) has changed to state Free at: 0 ticks
>Signal: mFree received by: pGateway(1) at: 0 ticks
>{param1=0}
>Task pGateway(1) has changed to state GatewayOn at: 0 ticks
>stop
>send2pid -1 2 mArrive
>Signal: mArrive sent by: RTDS_Env(-1) at: 0 ticks
>
  
```

Debugger state: STOPPED | Active thread: 1->pGateway

Fine-grained analysis



Single node analysis

Deployment Simulator

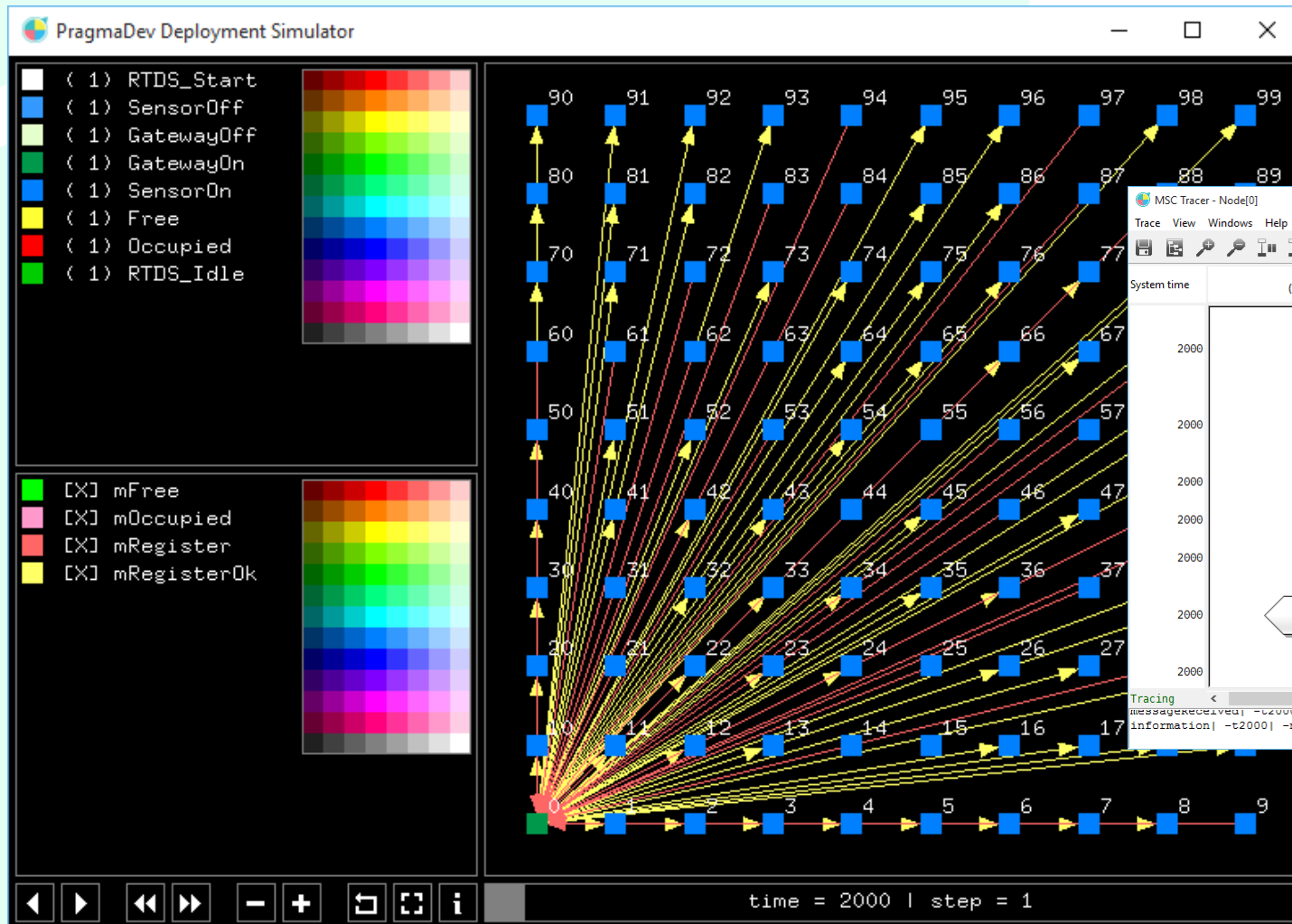
Distributed

- state change
- signal send
- signal receive
- signal lost

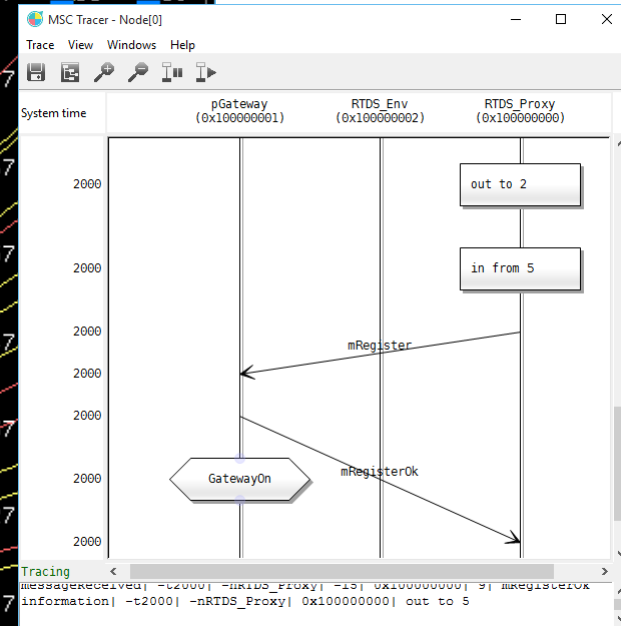
Local

- Task
 - create, state change, delete
- Timer
 - start, timeout, stop
- Signal
 - send, receive, save

Deployment Simulator



Live
Post-mortem



Time-based
Event-based

Conclusions

- Model-driven analysis
- Based on standard languages
- Full tool support
- Support for TTCN-3
 - external signals
 - test distributed behavior
 - automatic deployment of test-cases

Questions?

THANK YOU!