

Simultaneous Usage of NEMO and MANET for Vehicular Communication

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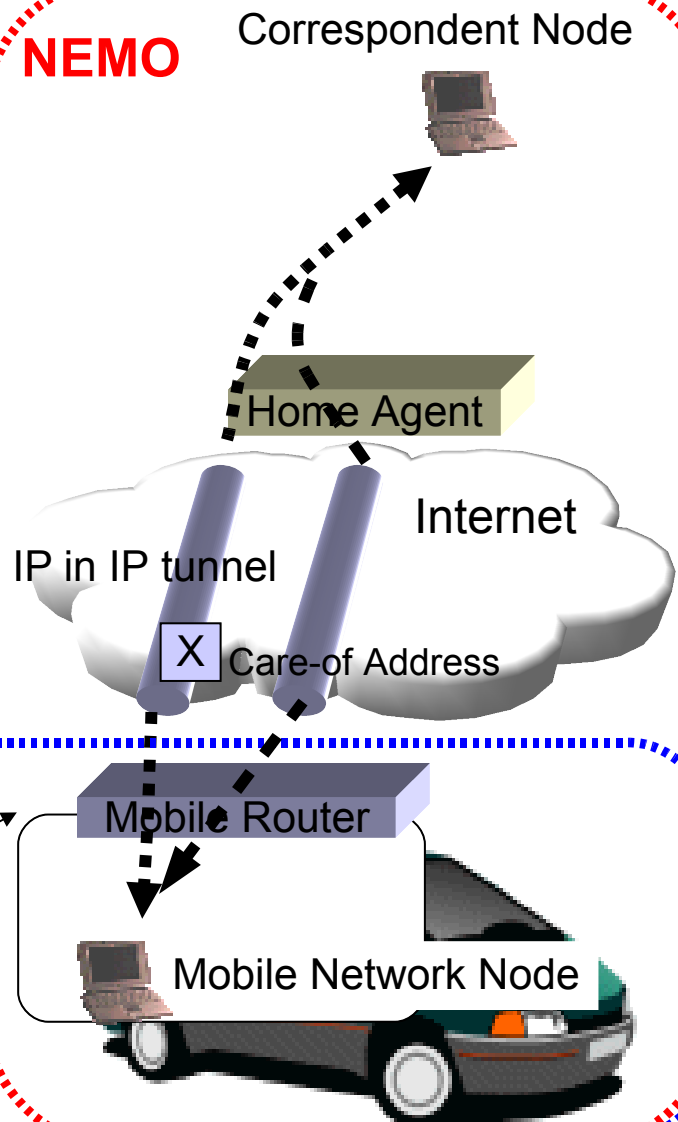
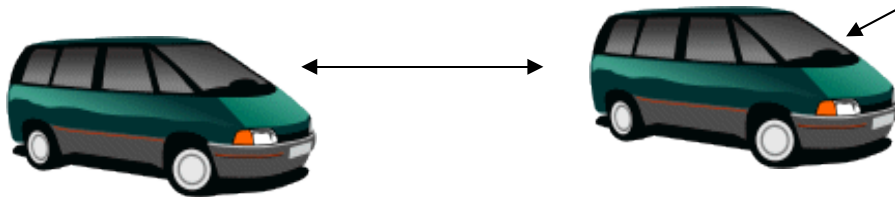
1st Workshop on Experimental Evaluation and
Deployment Experiences on Vehicular networks (WEEDEV)
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Technologies

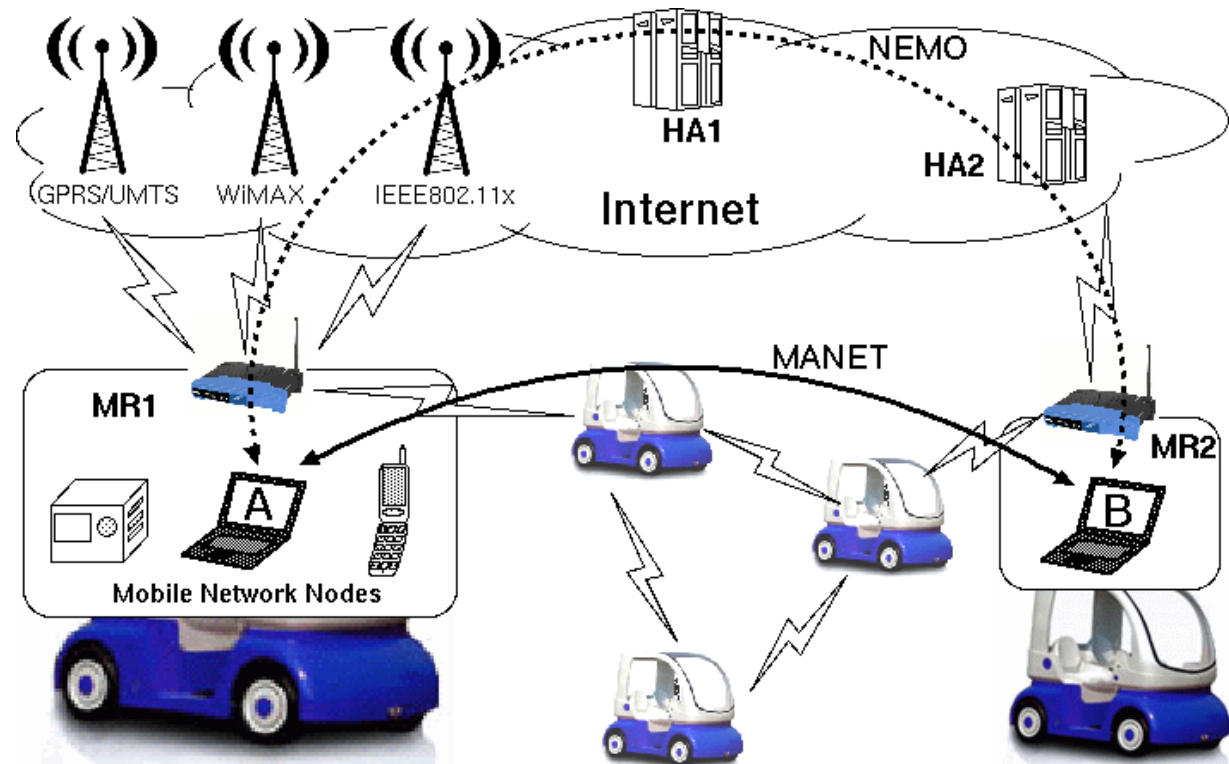
- Network Mobility (RFC3963)
- Mobile Adhoc Network (MANET)
 - OLSR (RFC3626)
- MANEMO
- Route Optimization
- Multihoming
 - Multiple CoA registration (I-D)

MANET



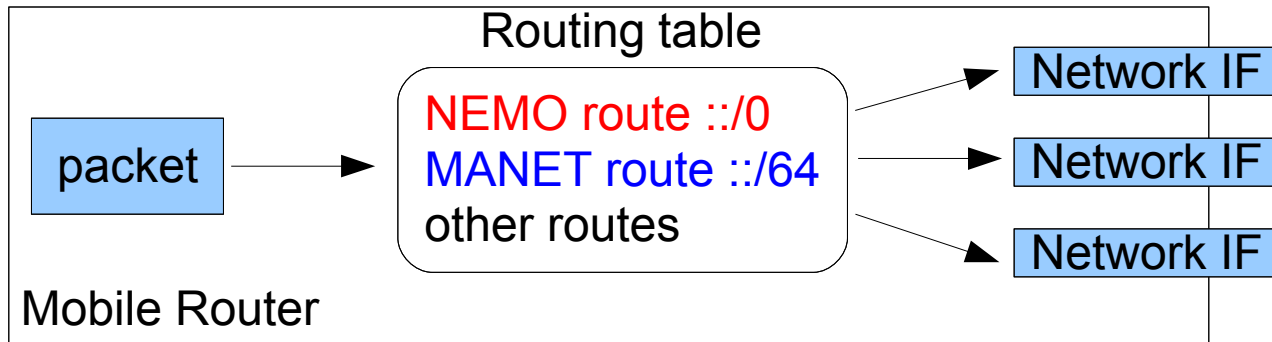
Scenario and Objectives

- Investigate MANEMO
- Setup Real-field testbed
 - Performance measurement
 - Development
 - Demonstration
- Simultaneous usage of NEMO and MANET

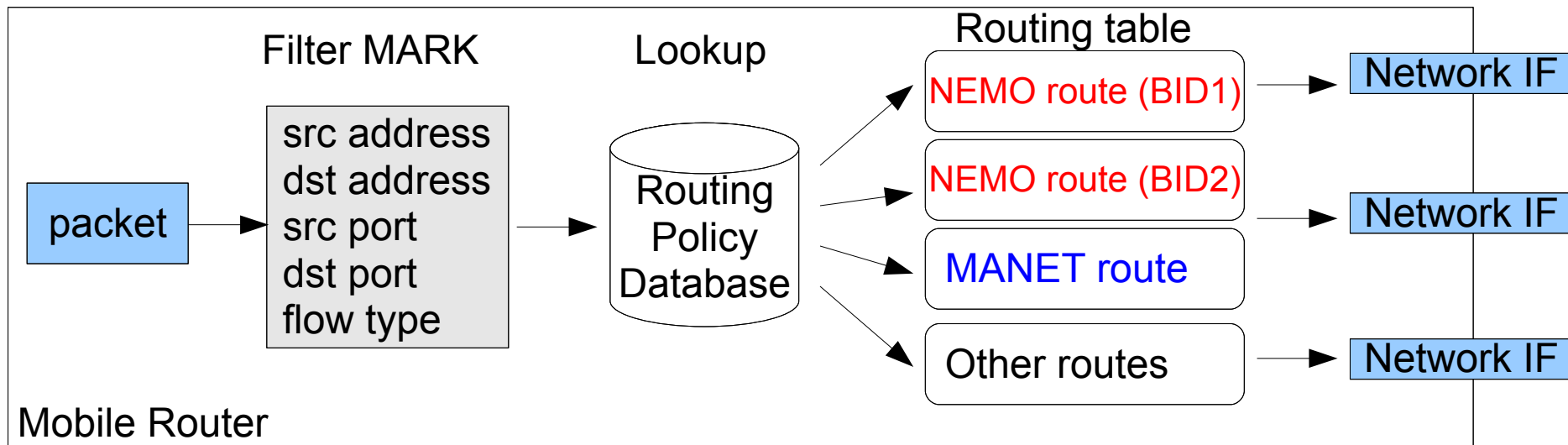


Multiple paths routing architecture

- Longest match (Classic routing)

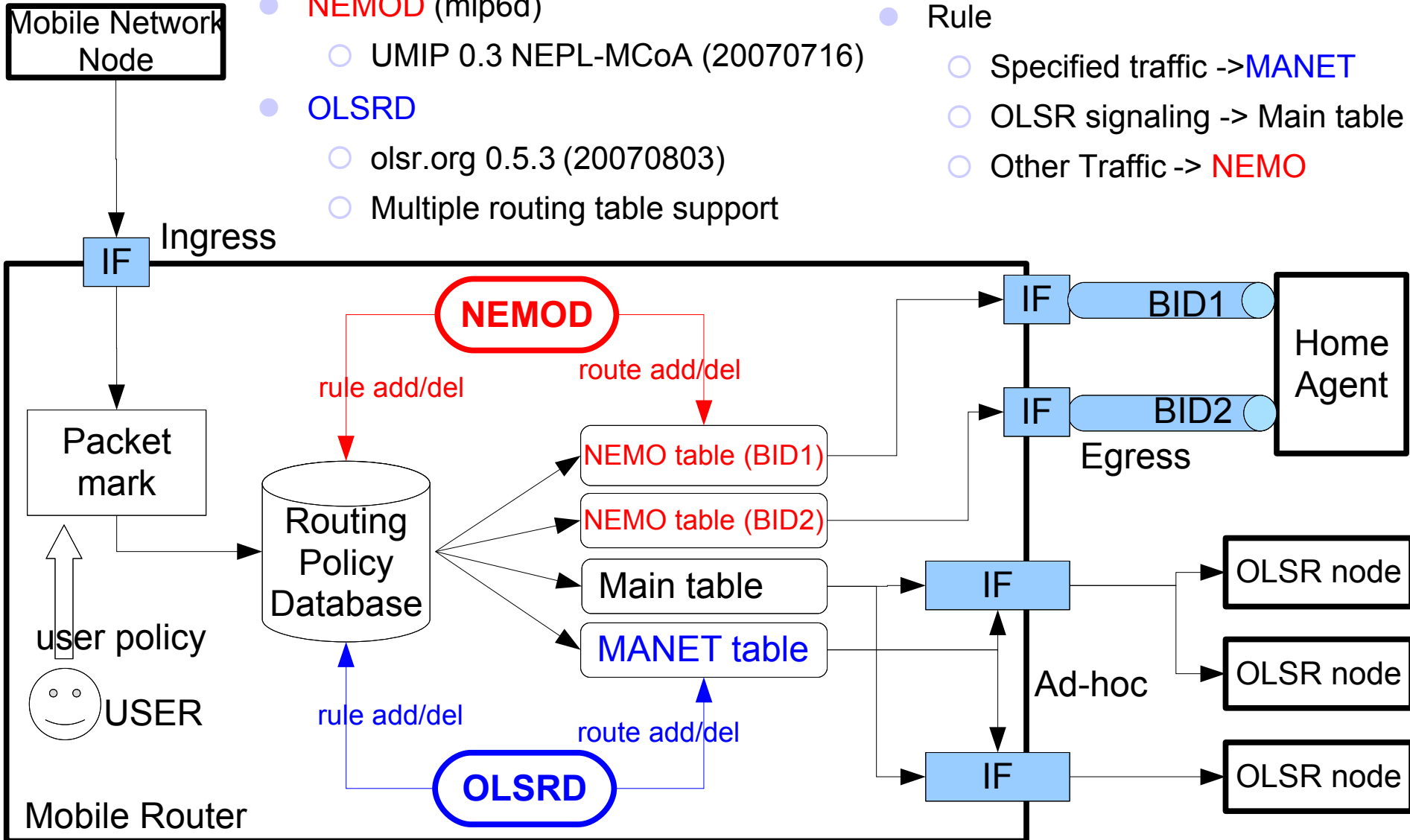


- Multiple routing table (New routing)



Implementation

- **NEMOD** (mip6d)
 - UMIP 0.3 NEPL-MCoA (20070716)
- **OLSRD**
 - olsr.org 0.5.3 (20070803)
 - Multiple routing table support
- **Rule**
 - Specified traffic -> **MANET**
 - OLSR signaling -> Main table
 - Other Traffic -> **NEMO**



Testbed Configuration

- MR1:

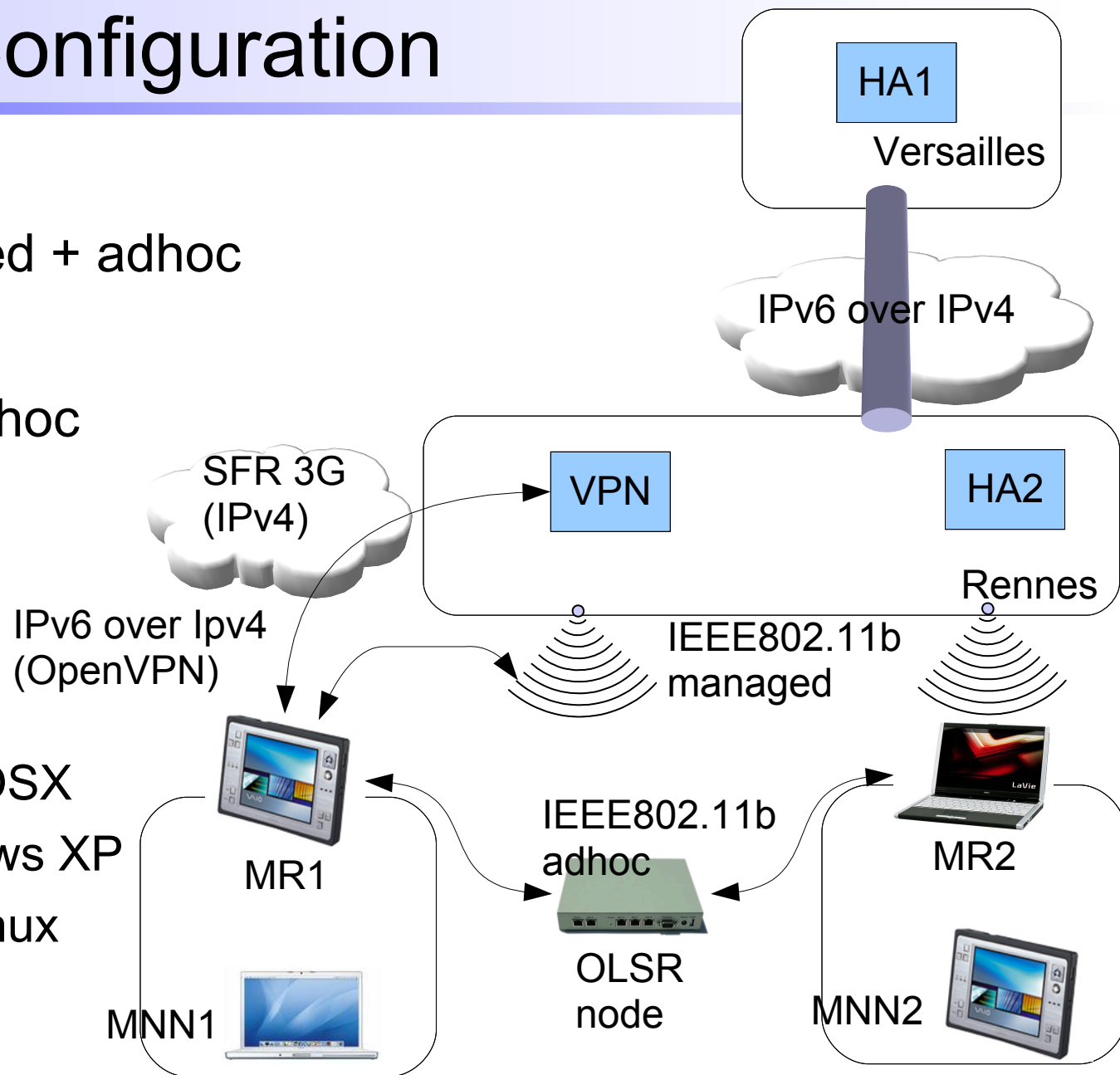
- 3G + managed + adhoc

- MR2:

- managed+adhoc

- OS

- MNN1: MAC OSX
- MNN2: Windows XP
- The others: Linux



Indoor testbed



NEMO1

NEMO2

Indoor testbed evaluation

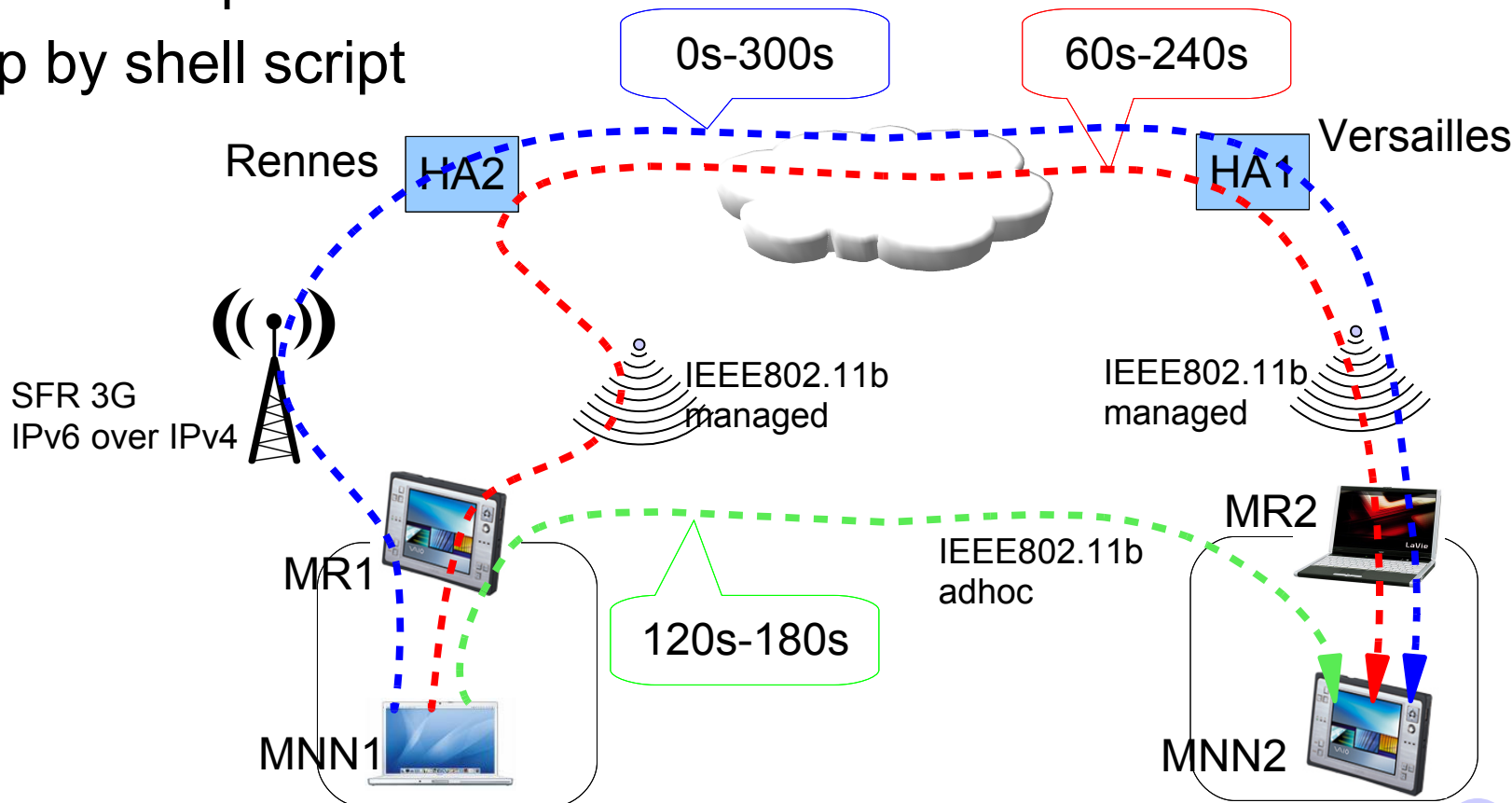
- Network Performance between MNNs

(*) Managed and Adhoc are limited under 2 Mbits/sec by TC command

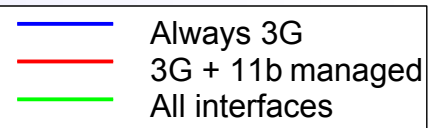
Interface	RTT	Bandwidth
NEMO on 3G	279.43 ms	416 Kbps
NEMO on 11b managed	32.74 ms	1977 Kbps
MANET on adhoc	8.58 ms	1987 Kbps

- 300 seconds experiment

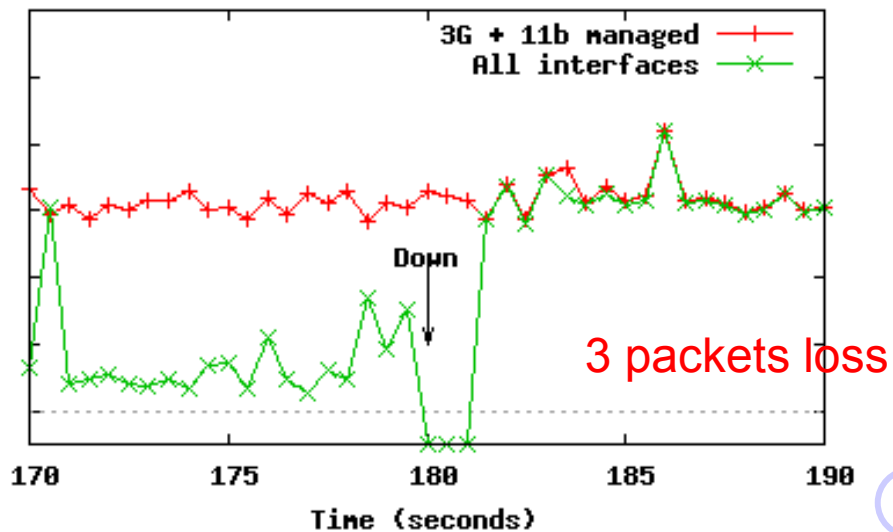
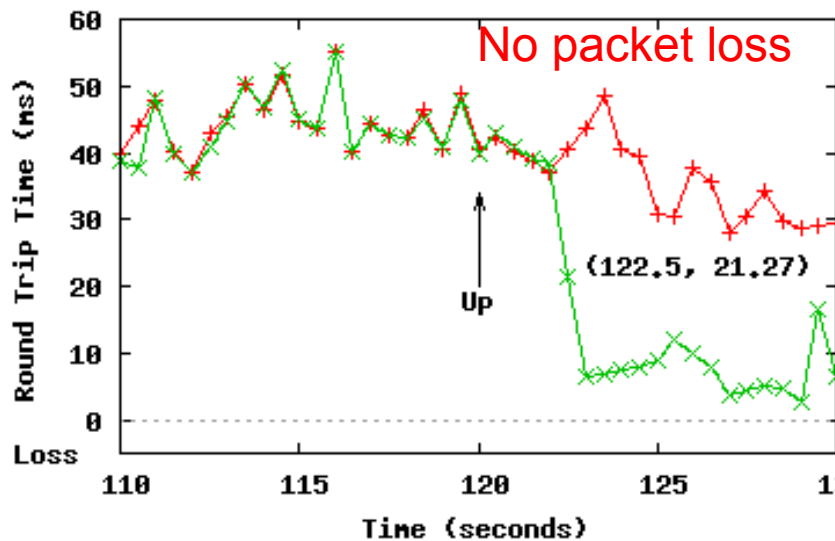
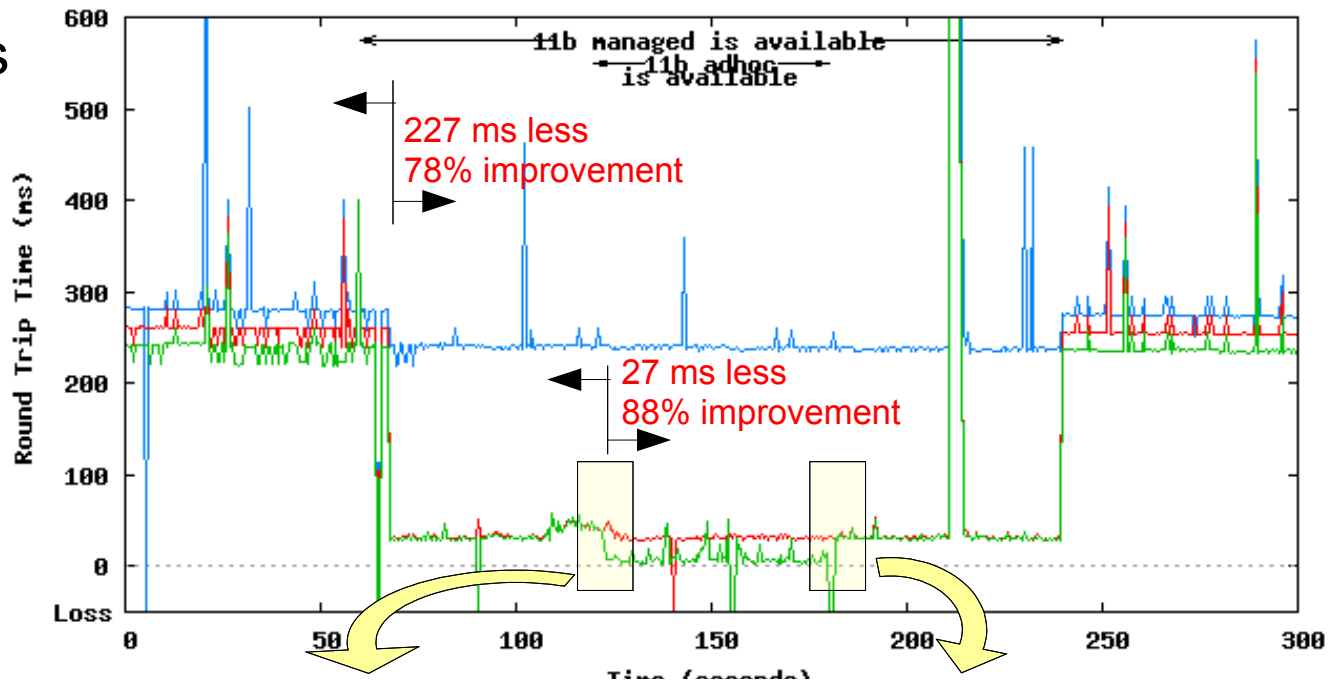
- setup by shell script



Latency Measurements



- Ping6 once in 0.5s
- NEMO->MANET
 - 2.5 seconds
- MANET->NEMO
 - 1.5 seconds



Throughput measurements

3 TCPs + 3 ping6

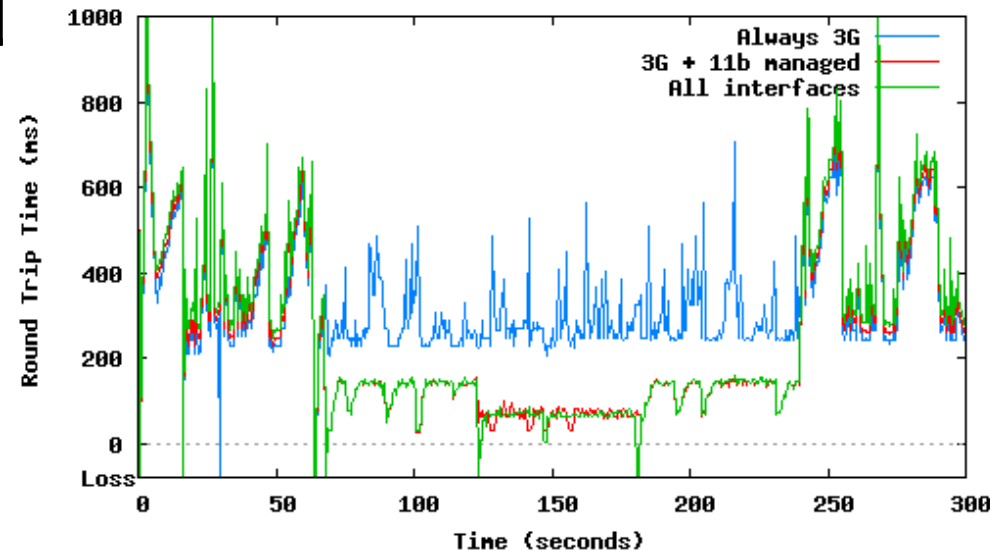
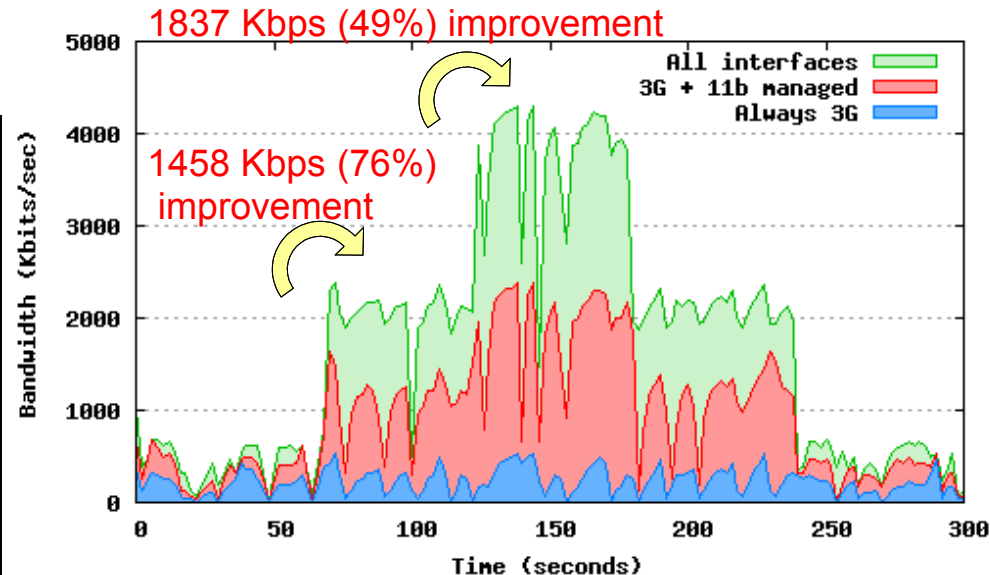
Policy	Available Interface		
	only 3G	3G + managed	All interfaces
Throughput			
Always 3G	156 Kbps	262 Kbps	276 Kbps
3G+managed	184 Kbps	733 Kbps	1612 Kbps
All interfaces	114 Kbps	918 Kbps	1863 Kbps
Total	455 Kbps	1913 Kbps	3752 Kbps
Round Trip Time			
Always 3G	389 ms	277 ms	275 ms
3G+managed	411 ms	127 ms	64 ms
All interfaces	432 ms	130 ms	64 ms

only 3G -> 3G+managed

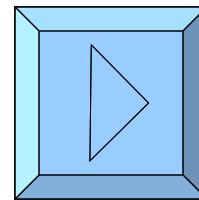
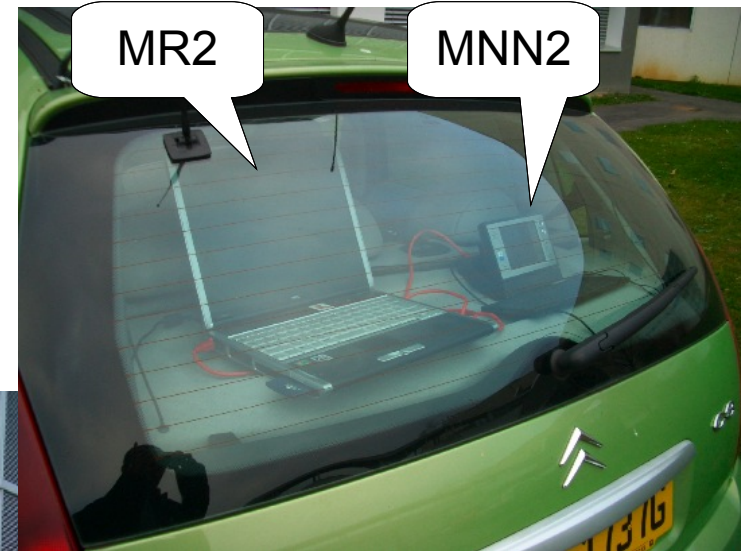
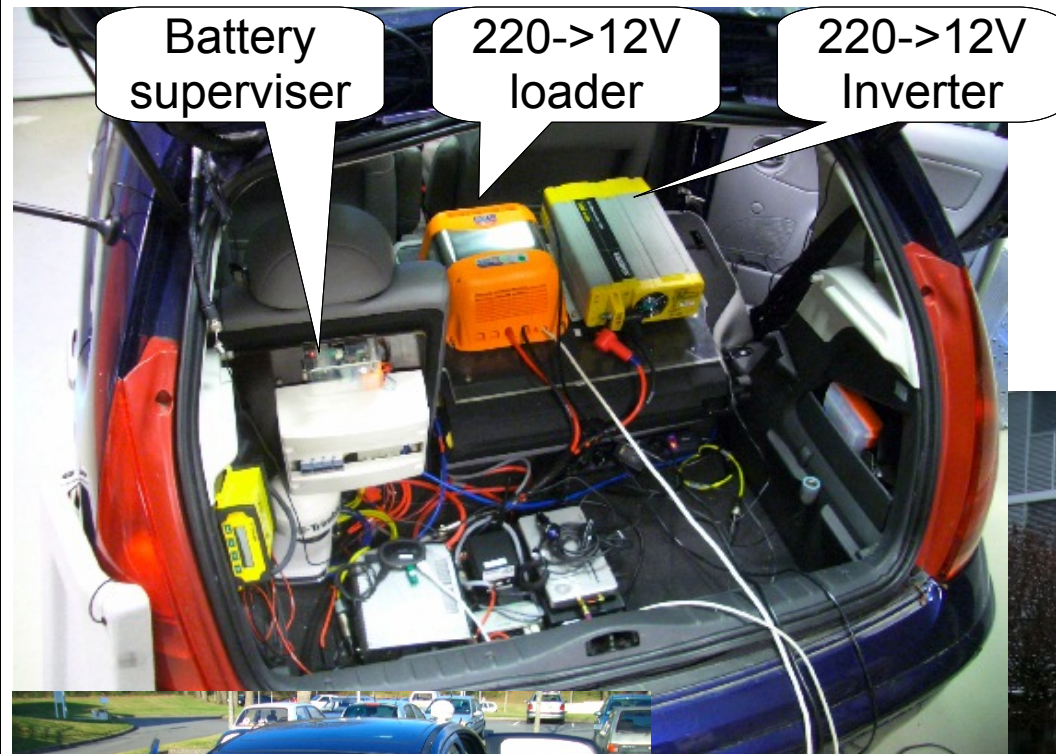
- 30% improvement
- 70% improvement
- 70% improvement

3G+managed -> All interfaces

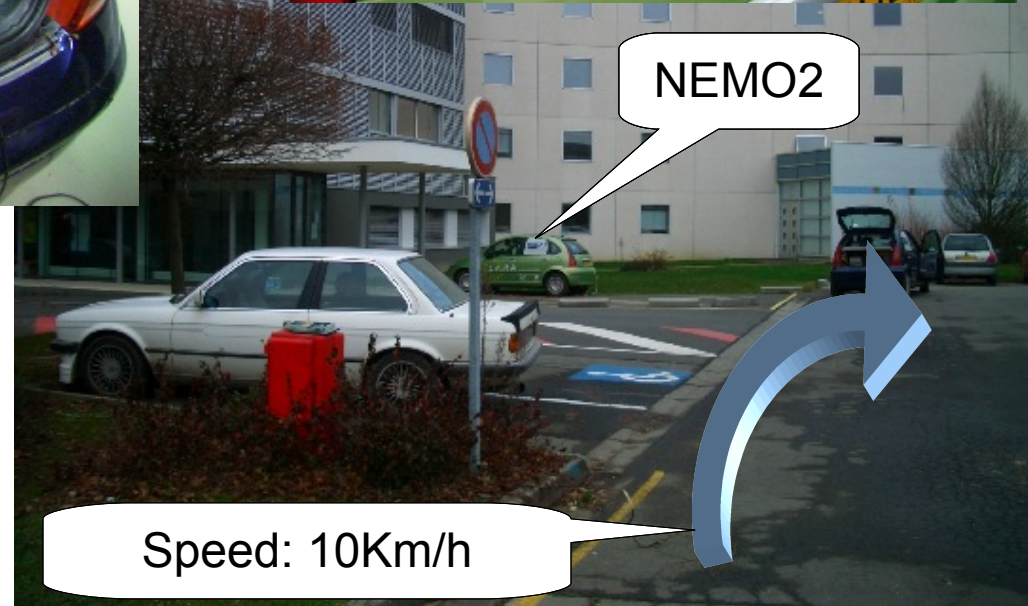
- 50% improvement
- 50% improvement



Real-field Testbed and demonstration



Video

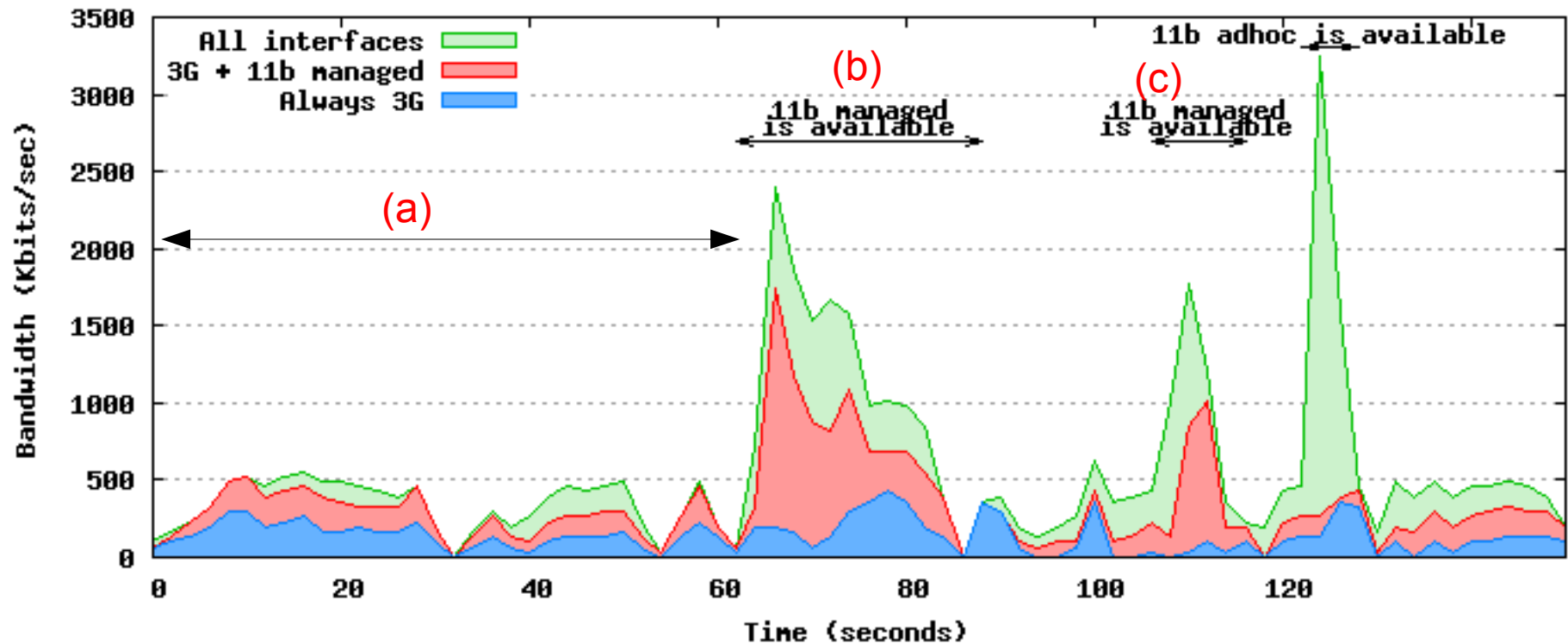


Throughput in real-field Evaluation

- Speed 10km/h (2.8 m/s)

- Wifi area : 30 ~ 65 m
- MANET area: ~ 20m

	Available Ifs	Period	Area	Bandwidth
(a)	3G	60 s	170 m	344 Kbps
(b)	3G + managed	24 s	67 m	1430 Kbps
(c)	3G + managed	10 s	30 m	957 Kbps
(d)	3G + adhoc	6 s	17 m	2408 Kbps



Position Mapped Network Performance

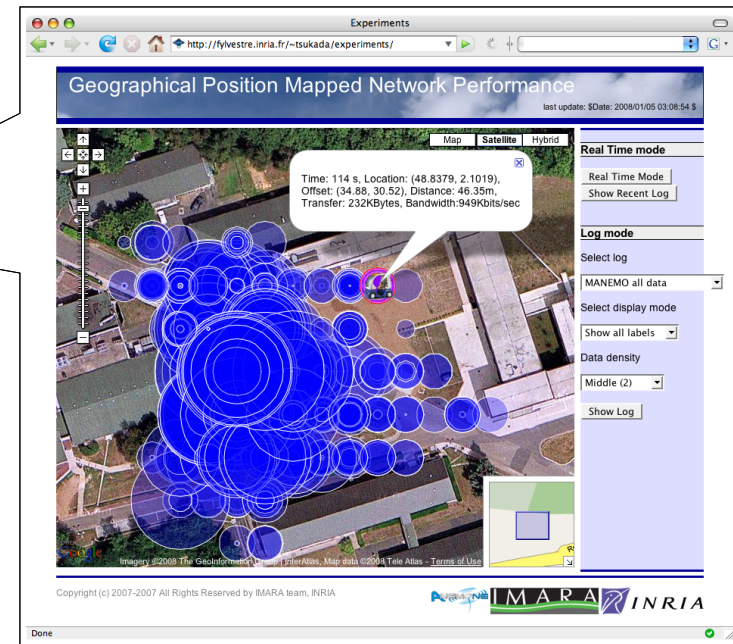
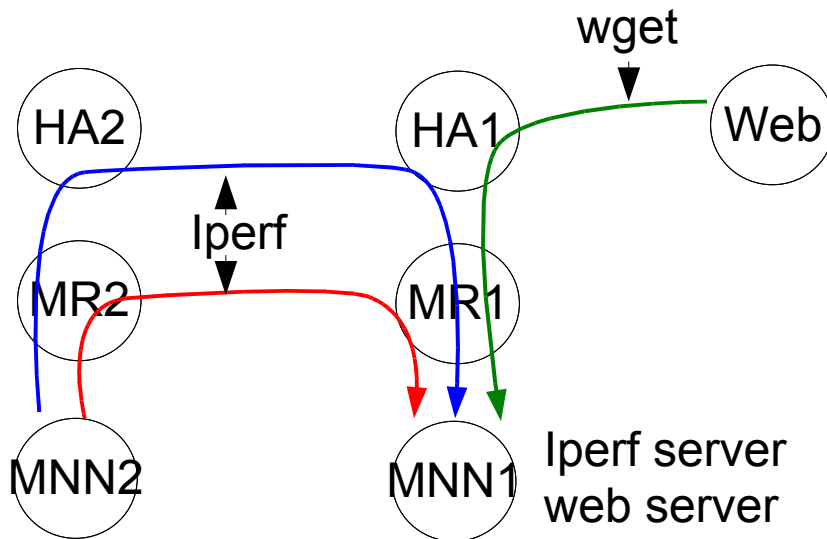
- “Iperf + GPS” implementation

- Realtime mode (each 2 seconds)
- Log mode

<http://fylvestre.inria.fr/~tsukada/experiments/>

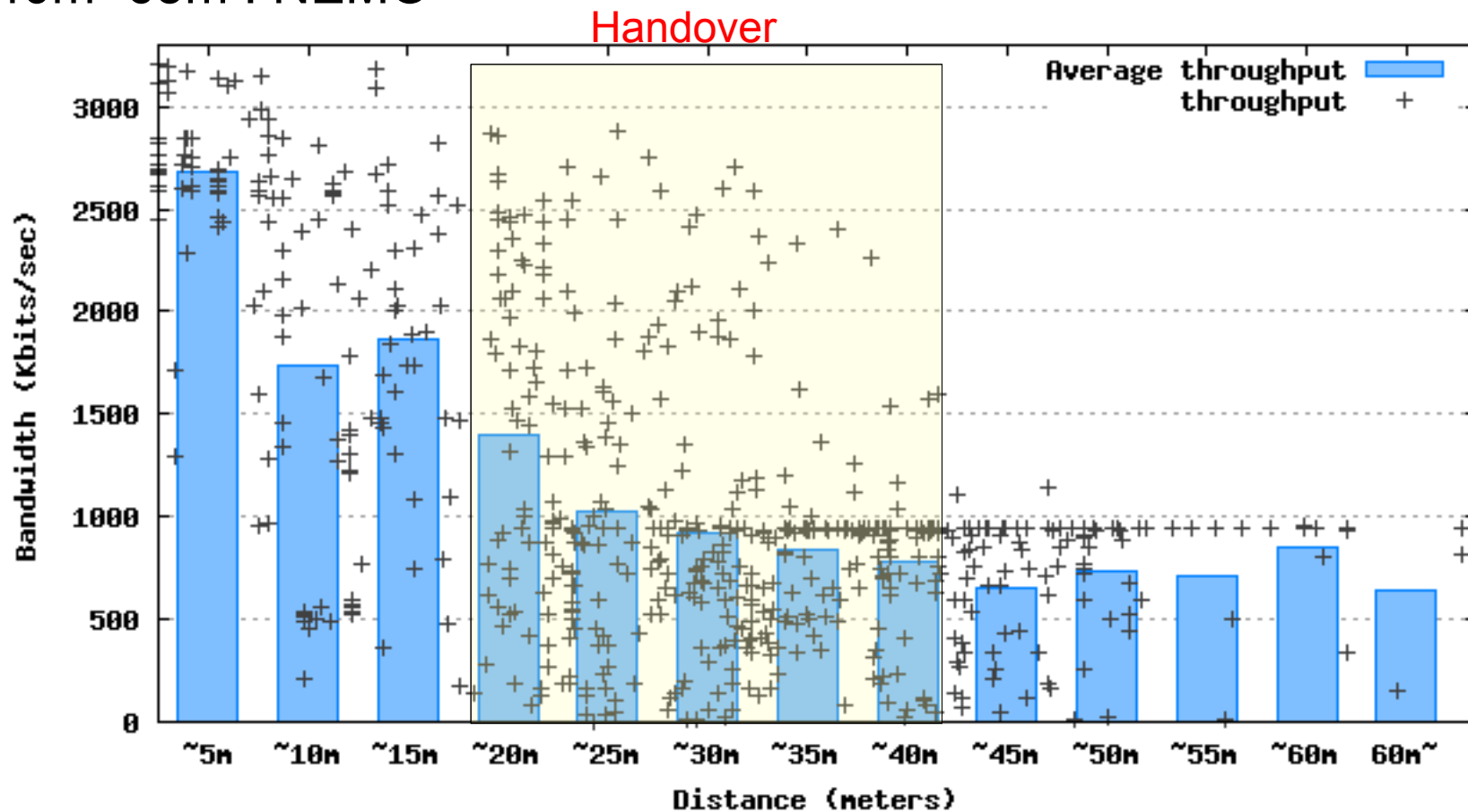


```
<?xml version="1.0" encoding="utf-8"?>
<markers>
<marker interval="2.0" transfer="649" bandwidth="2660"
lat="48.8375" lng="2.1010" offset_lat="6.59"
offset_lng="7.21" distance="9.77" time="1195225195"/>
</markers>
```



Position Mapped Network Performance

- ~20m: MANET (2685kbps)
- 20m~40m : handover
- 40m~65m : NEMO
- 1000 Kbps limitation on NEMO IF



Conclusion and Future works

- Conclusion

- NEMO sub-optimality could be mitigated by Route Optimization by MANEMO
- Performance improvement by simultaneous use of NEMO and MANET
- Above was validated in Real-field testbed

- Future works

- Adaptive application
- Dynamic traffic allocation to the path
- Flow binding and policy exchange
- Position mapped network performance extension (Latency, L2 info)
- Better antenna installation

- Thank you for attention

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