Towards the Design of an Industrial Network Node

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Motivations

- Everything started in a cooperative industrial maintenance and monitoring project (TEMIC project).
- But, no active equipement available on the market place!

Scenario requirements

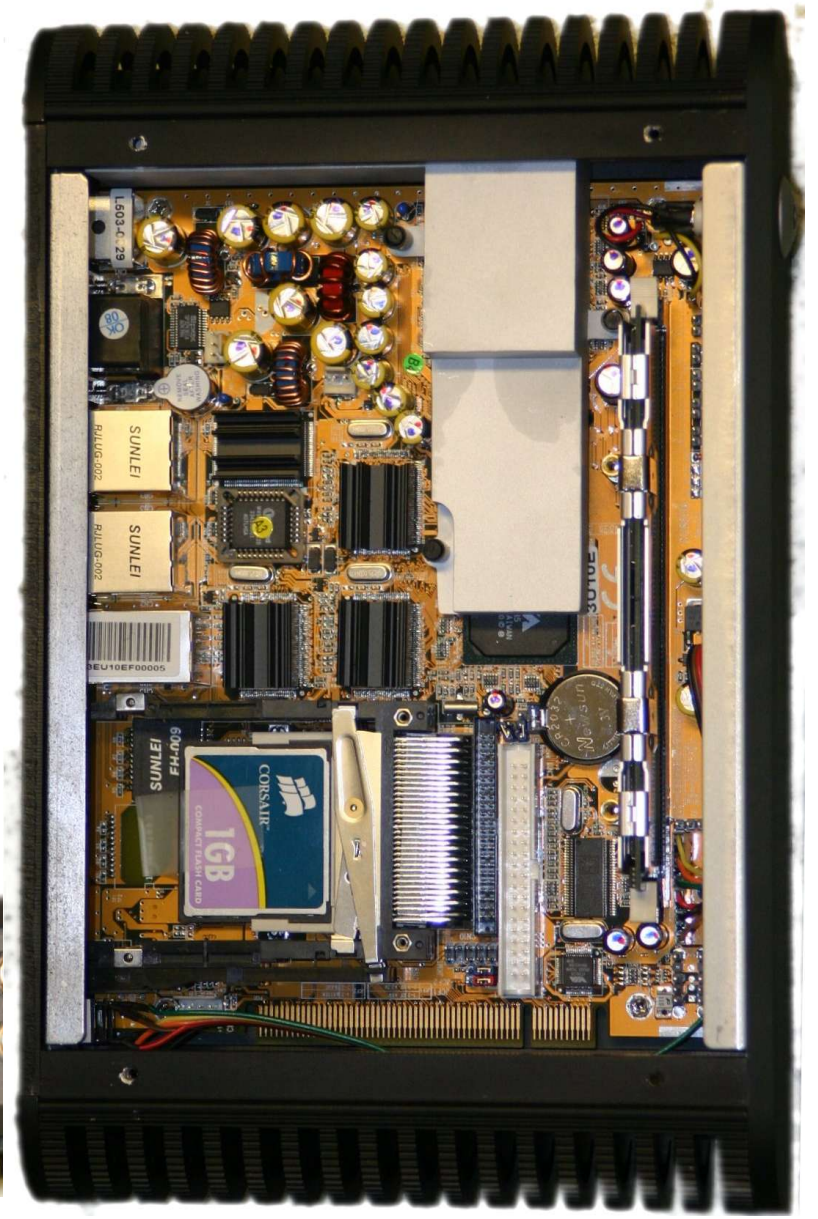
- Easily and efficiently deployable hardware in industrial context.
- Easily removable at the end of the maintenance and monitoring contract.
- Devices must fit industrial requirements:
  - reliability
  - fault-tolerance
- Devices must be *autonomic*!
  - auto-configurable
  - re-programmable

Our approach

- Designing an Industrial Autonomic Network Node (IAN^2):
  - Using a reliable and embedded hardware
  - Running on a low resource consumption node OS
  - Proposing an adapted EE
  - Designing a set of services
  - Evaluating solution in controled and industrial scenario

Hardware platform

- A transportable solution.
- Reduced risk of failure:
  - fanless
  - no mechanical hard disk drive
- VIA C3 1GHz, 256MB RAM, 3xNIC Gbit Ethernet, 1GB Compact Flash,...



Software Execution Environment:

Node Operating System

- Indutrial Autonomic Network Node (IAN^2) runs over Btux (`bearstech.com`)
- Btux is based on a GNU/Linux OS (kernel 2.6.12)
  - rebuilt from scratch
  - small memory footprint
  - reduced command set available
  - remotely upgradable

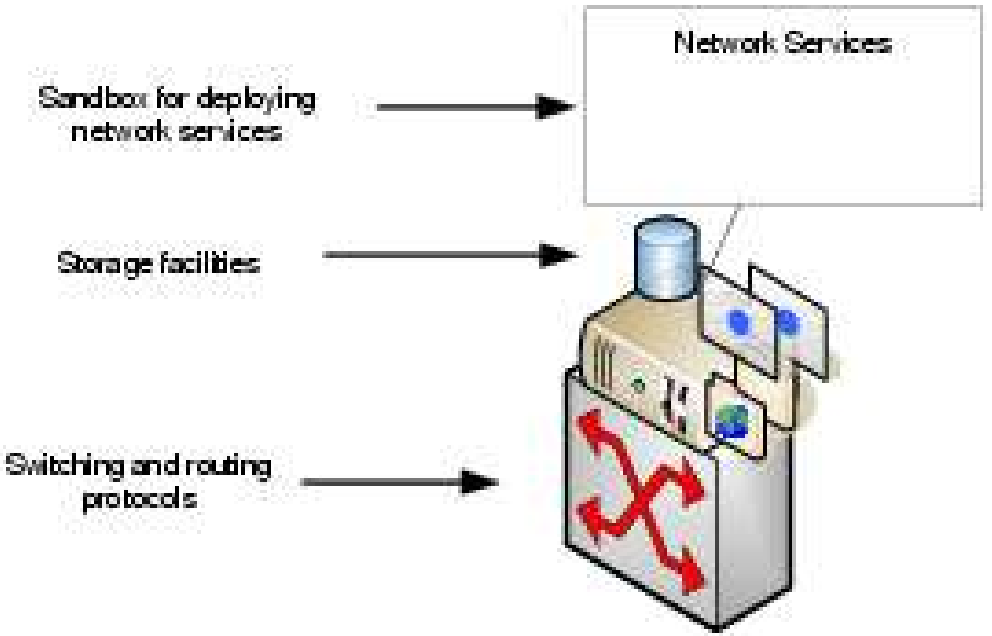
bearstech

Software Execution Environment:

IAN^2 Software Architecture

Our Industrial Autonomic Nework Node architecture supports:

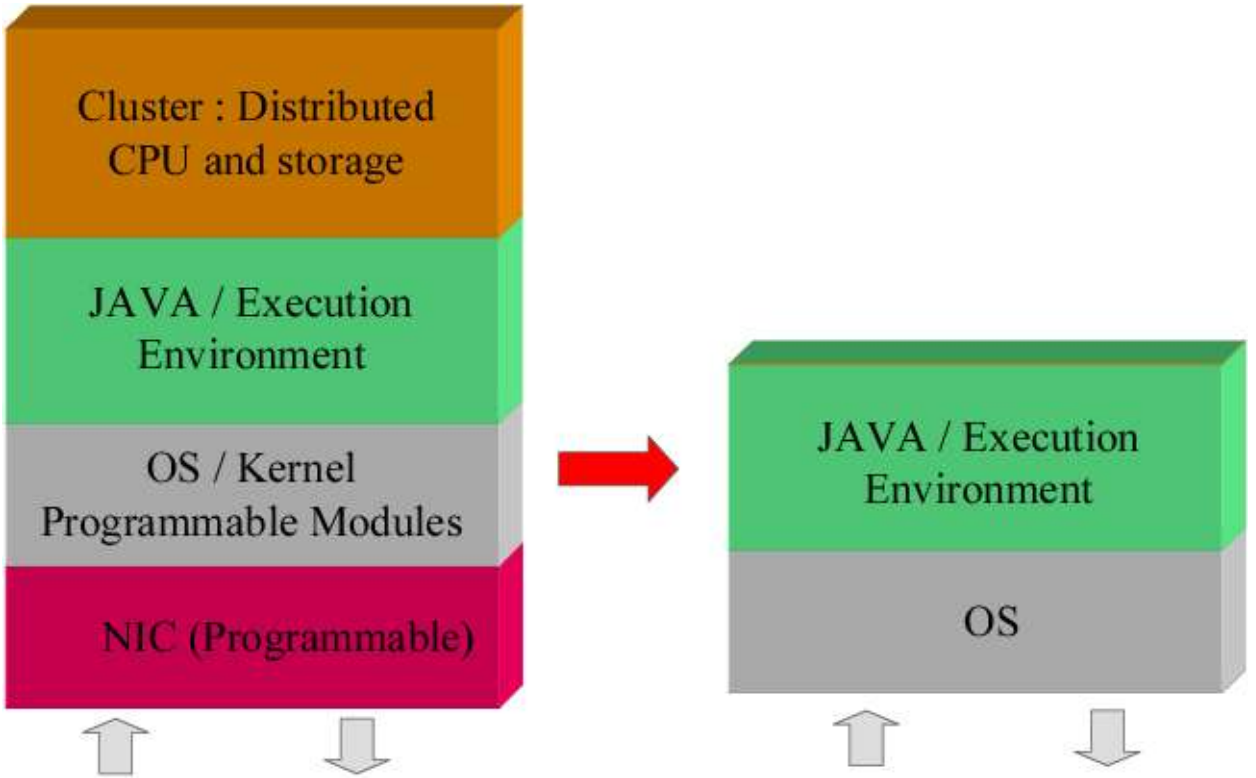
- wired and wireless connections,
- CPU facility,
- storage capabilities.



Software Execution Environment:

Execution Environment

- The EE is based on the *Tamanoir (INRIA)* software suite, a high performance execution environment for active networks.
- Tamanoir: Too complex for industrial purpose.
- Tamanoir^{embedded}:
  - reduced code complexity,
  - removed unused class and methods,
  - simplify service design.

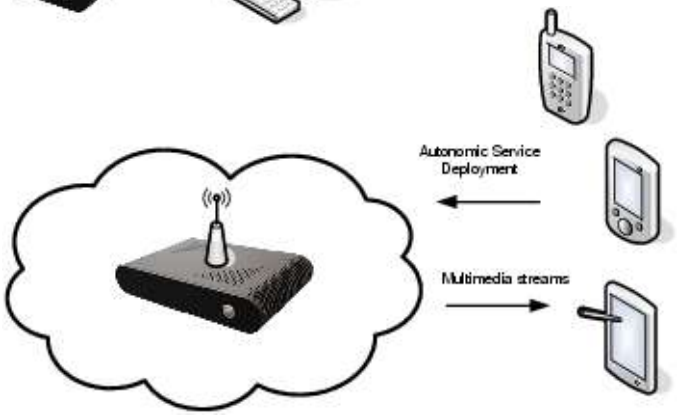


Software Execution Environment:

Autonomic Service Deployment

- Tamanoir^{embedded} is written in Java and suitable for heterogeneous services.
- Provides various methods for dynamic service deployment/update:
  - from a service repository to a Tamanoir Active Node (TAN),
  - from the previous TAN crossed by the active data stream,

  - from mobile equipments.



Experimental Evaluation:

Network Performances

- Based on *iperf* (bandwidth, jitter, loss) on two topologies.

- IAN^2 failed to obtain a full Gbit bandwidth due to the limited embedded CPU and chipset.

Configuration	Throughput	cpu send	cpu recv	cpu gateway
back-2-back	488 Mbps	90%	95%	N/A
gateway (1 stream)	195 Mbps	29%	28%	50%
gateway (8 streams)	278 Mbps	99%	65%	70%

Experimental Evaluation:

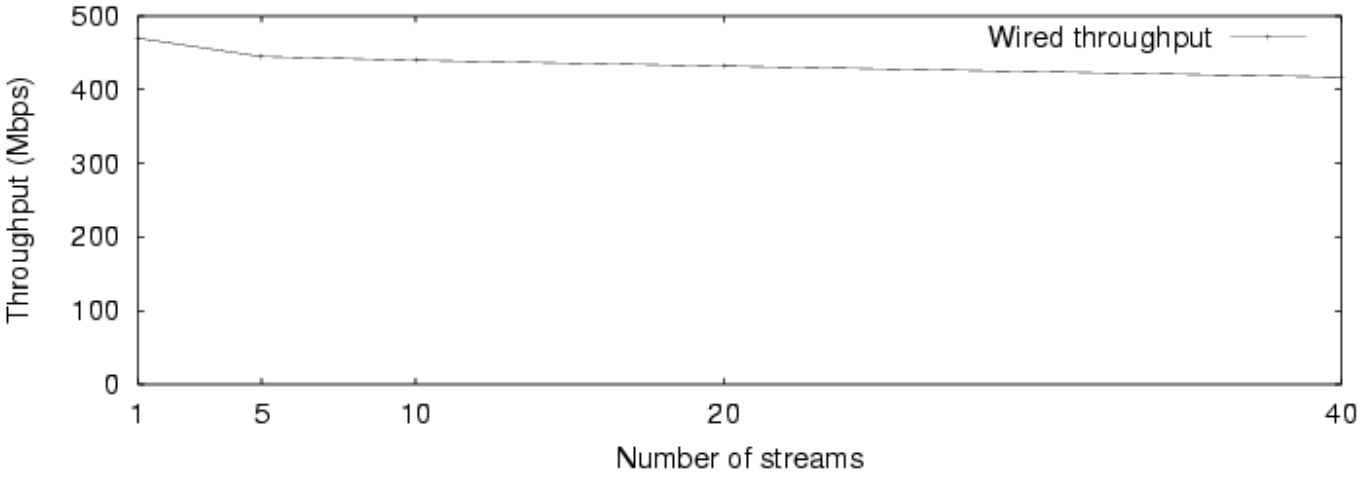
Network Performances

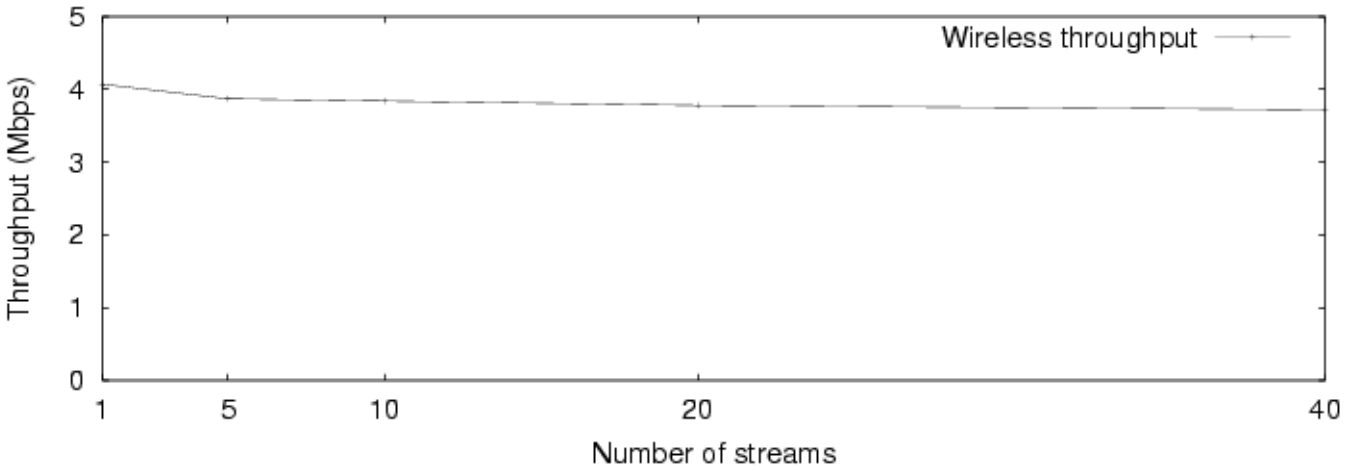
- GigaEthernet:

  480 Mbps

- Wireless (802.11b):

  4 Mbps





Experimental Evaluation:

Autonomic Performances

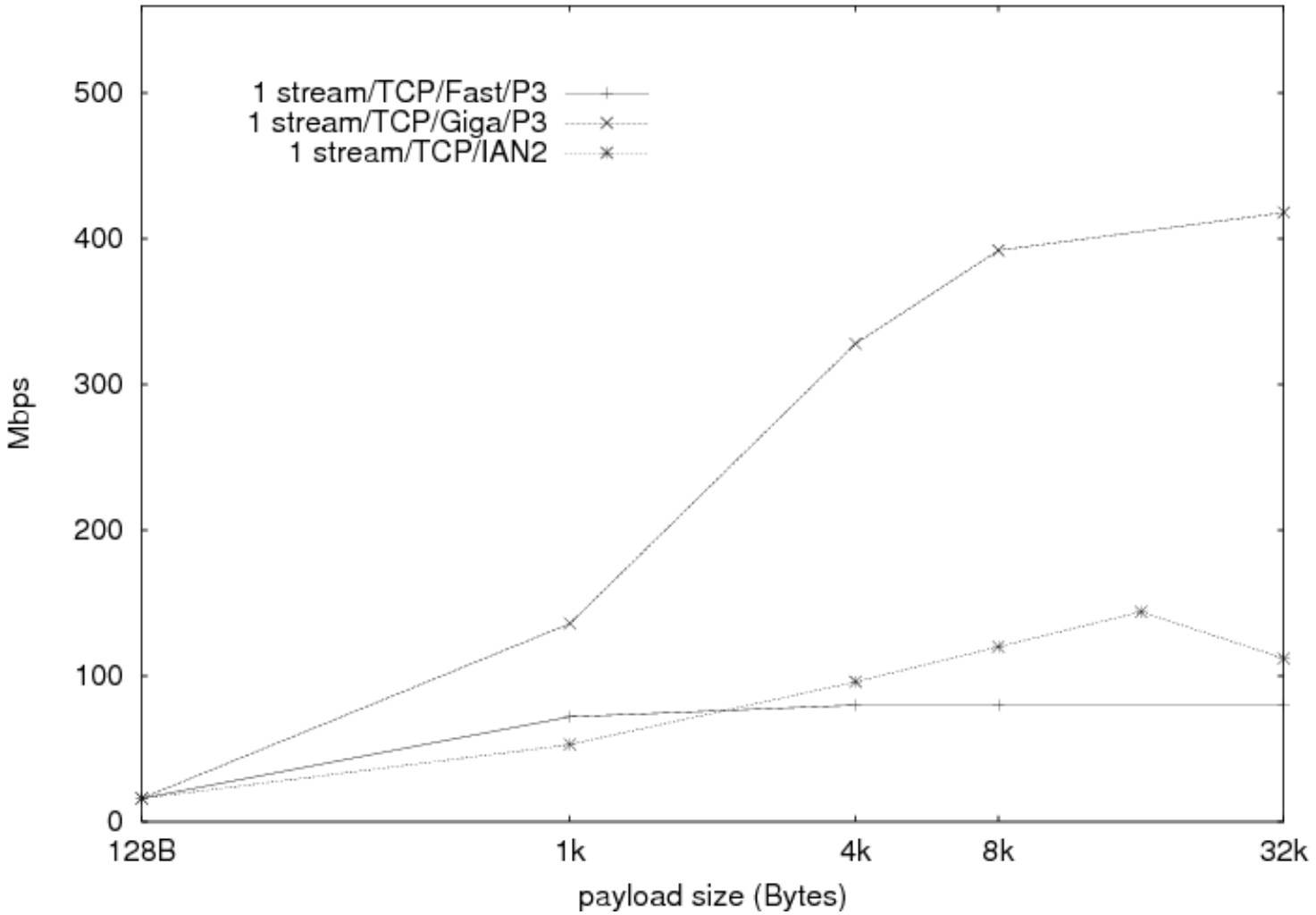
- We ran two different active services:
  - A lightweight service (MarkS)
  - A heavyweight service (GzipS)
- EE and services run in a SUN JVM 1.4.2

	4kB	16kB	32kB	56kB
MarkS	96	144	112	80
GzipS	9.8	14.5	15.9	16.6

(Throughput in Mbps)

Experimental Evaluation:

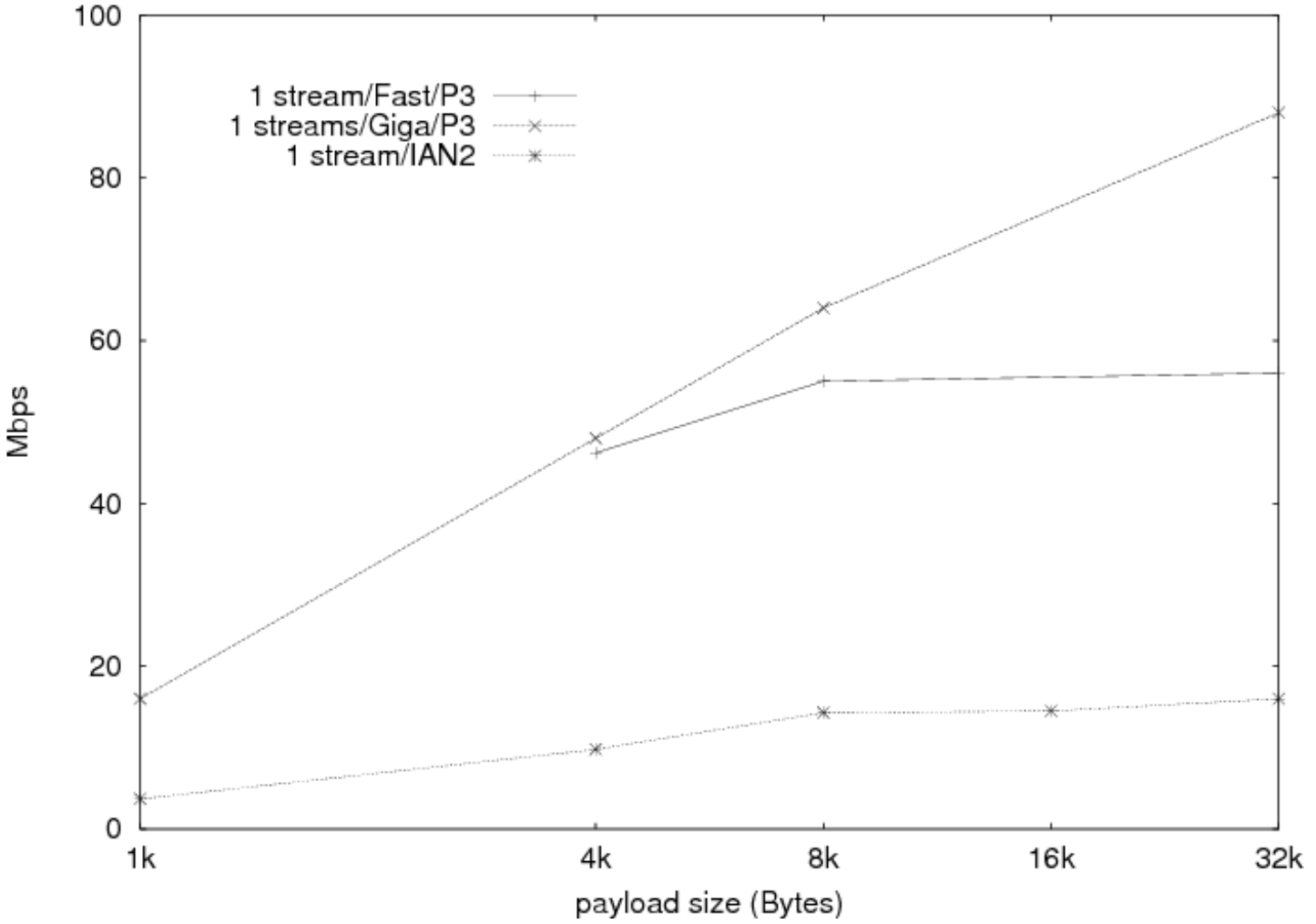
Autonomic Performances



- Performance comparison with standard system over lightweight service.

Experimental Evaluation:

Autonomic Performances



- Performance comparison with standard system over heavyweight service.

Experimental Evaluation:
Performances within Multimedia context application

- Transmit and adapt a video stream: a real evaluation of our industrial autonomic node.
- Without adaptation step, CPU use is negligible.

Format / Size	Usr CPU load
MJPEG/720x480	< 1 %
H263/352x288	98,7 %
H263/176x144	99,3 %
H263/128x96	99 %

- Then, CPU load is totally due to the processing.

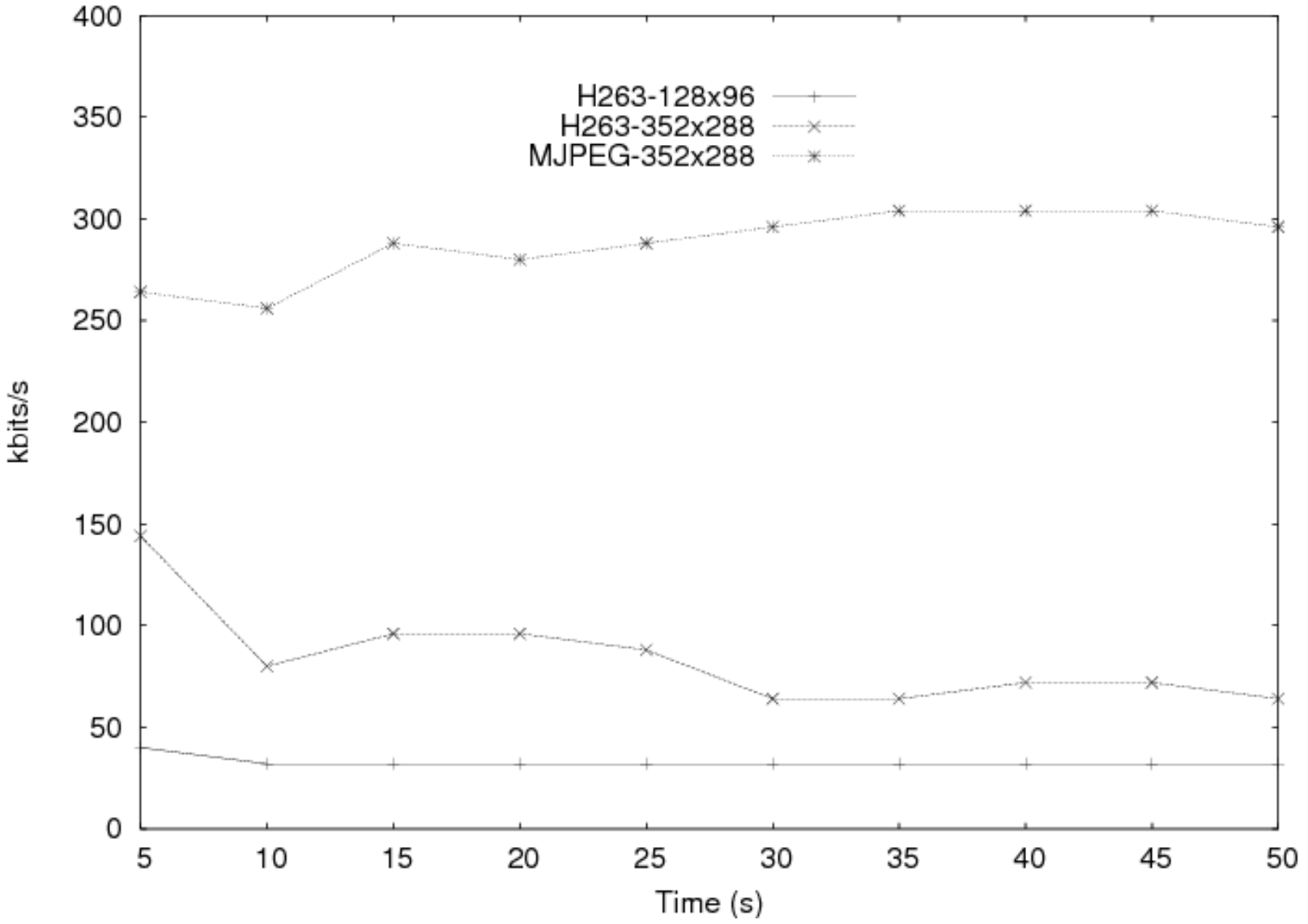
Experimental Evaluation: Performances within Multimedia context application

- We measure the ouput data rate on a active node using a wireless network when transmiting an adapted video file to a PDA.

Output Format/Resolution	Entry File/Output File	Transmitting time	PDA loading time
MJPEG/720x480	14794 KB / 14794 KB	4 min 50 sec	5 min 10 sec
H263/352x288	14794 KB / 1448 KB	22 sec	2 min 55 sec
H263/176x144	14794 KB / 365 KB	8,5 sec	1 min 30 sec
H263/128x96	14794 KB / 179 KB	3,8 sec	1 min 18 sec

- Even with a limited CPU, the IAN^2 provides efficient adapatation which reduces the amount of transported data and globally improves performances of the application.

Experimental Evaluation:
Performances within Multimedia context application

- 

Conclusions

- Description of the IAN^2 prototype of industrial autonomic network node
  - hardware choice
  - software solution
- Evaluation of performances
  - processing power
  - networking
  - Execution Environment
- Results are far from a current desktop performances, however...

Conclusions (cont'd)

- However, for « low » bandwidth network (Fast Ethernet, xDSL or Wireless networks), IAN^2 can perfectly support a large class of reliable autonomic services.
- Switching from academic (experimental) project to an industrial project is a real challenge.
- Next step concerns the development of new autonomic services.

Acknowledgments

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Questions?

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