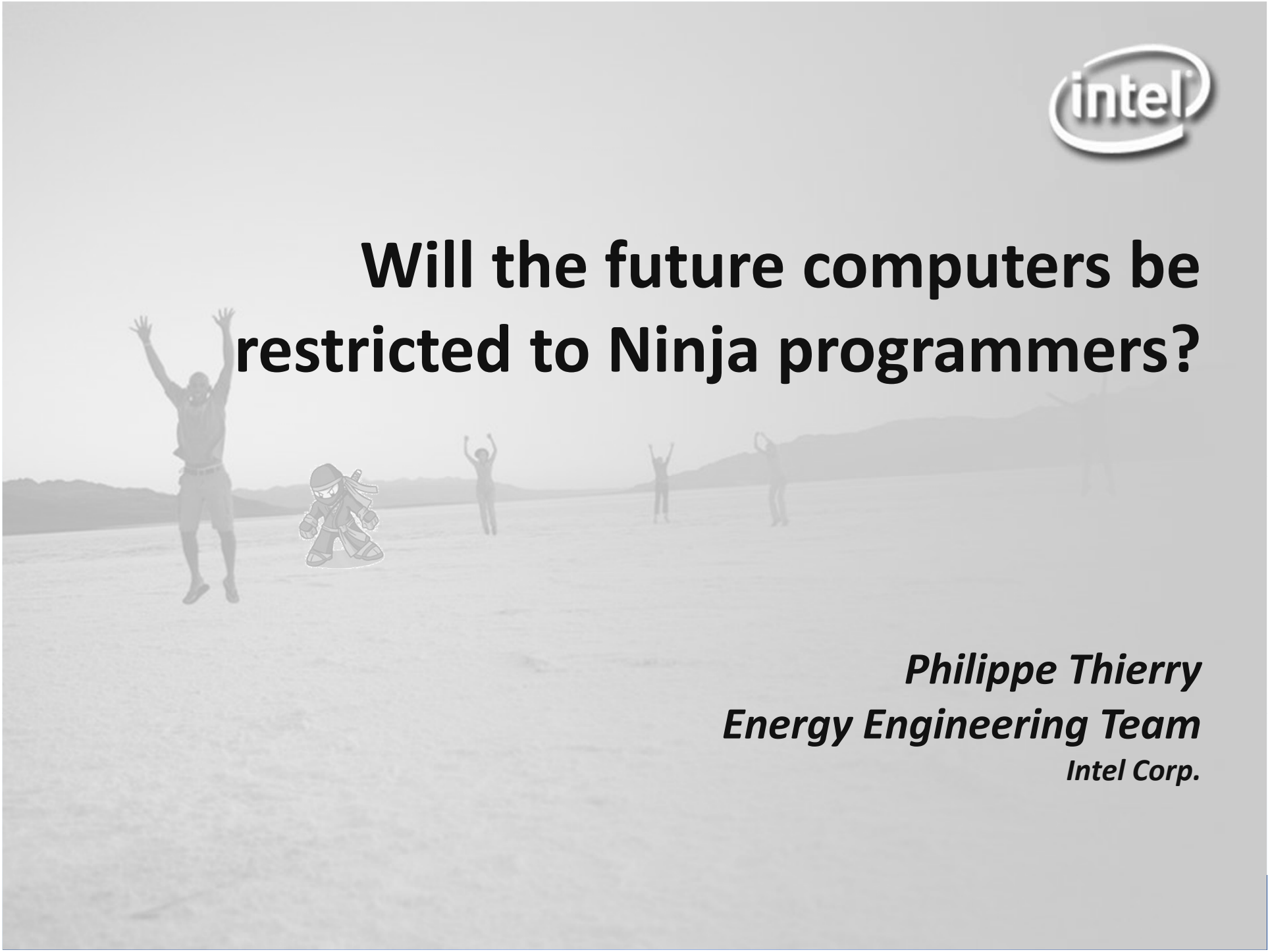


Will the future computers be restricted to Ninja programmers?

Philippe Thierry

Energy Engineering Team

Intel Corp.

Questions

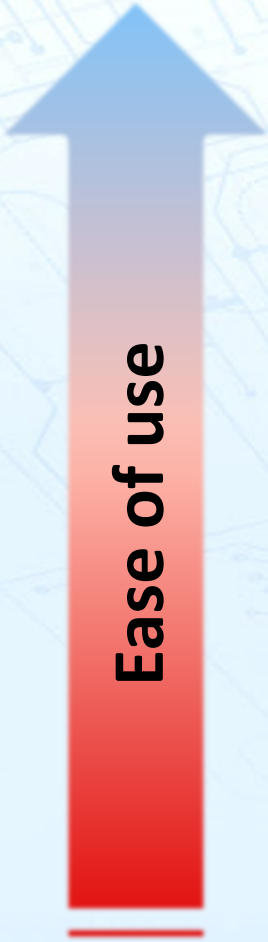
1. Who and Where are the Ninjas ?

2. What is the « computer of the future » ?

The Who

- **Computer Scientists:**
  - We know what we are doing. Get out of our way.
  - We are Ninjas. And we want to publish.
- **Scientists:**
  - Research grants and publishing are our life-blood.
  - We'll do Ninja programming if it gives interesting publishable results.
- **Industry- End Users / ISV :**
  - Our business is not the computer science.
  - We have Ninja's, but we want them spending time on the science.
  - We will invest in Ninja work only if the ROI is high enough.
  - Standards and modular models are great.
  - Differentiation vs our competition is great.

The Where



Compiler:
Auto-vectorization

Compiler:
Auto-vectorization hints (`#pragma`)

Compiler:
Intel® Cilk™ Plus Array Notation

SIMD intrinsic class
(e.g.: `F32vec`, `F64vec`, …)

Vector intrinsic
(e.g.: `_mm_fmadd_pd(…)`, …)

Assembler code
(e.g.: `[v]addps`, `[v]addss`, …)

Ninja level

*** (nb_cores * nb_nodes * topology * filesystem)**

Org Chart : How to succeed

Cross Domain Specialists

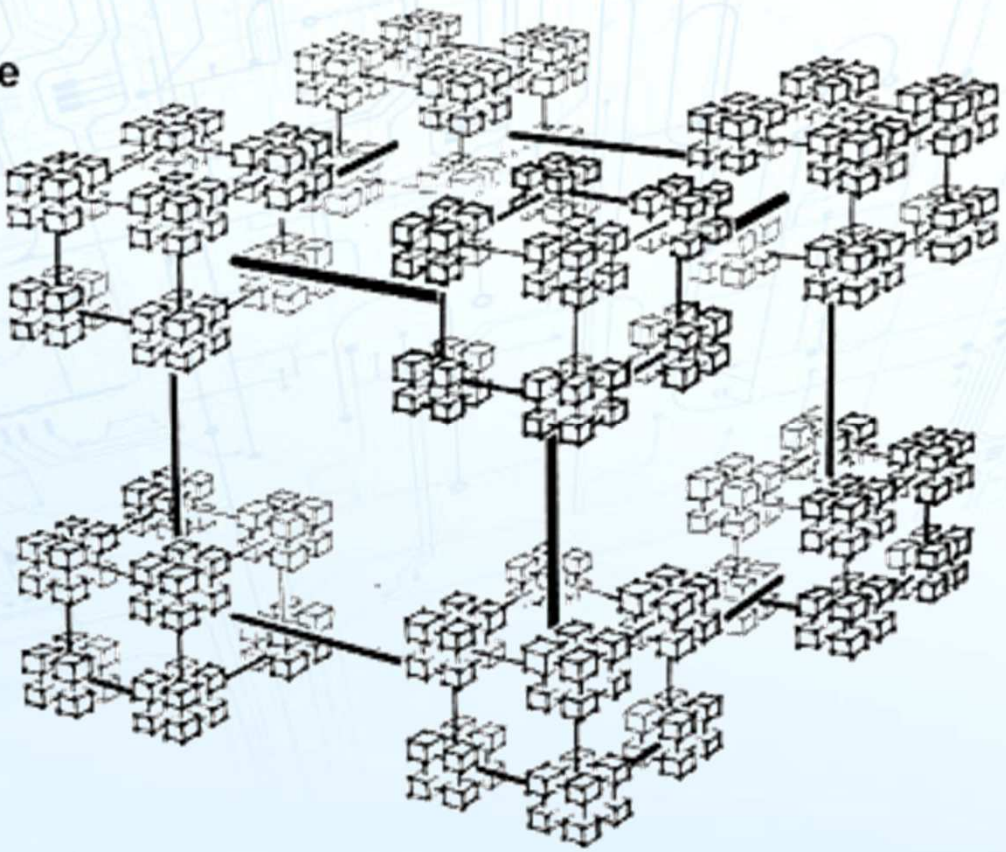
Forward Looking Team – Hdw / Sftw

R & D | Prototype | Pre-production | Production

Domain Specific Scientists

Domain Specific (computer) Scientists

Computer of the future : Like this one ?



Made of:

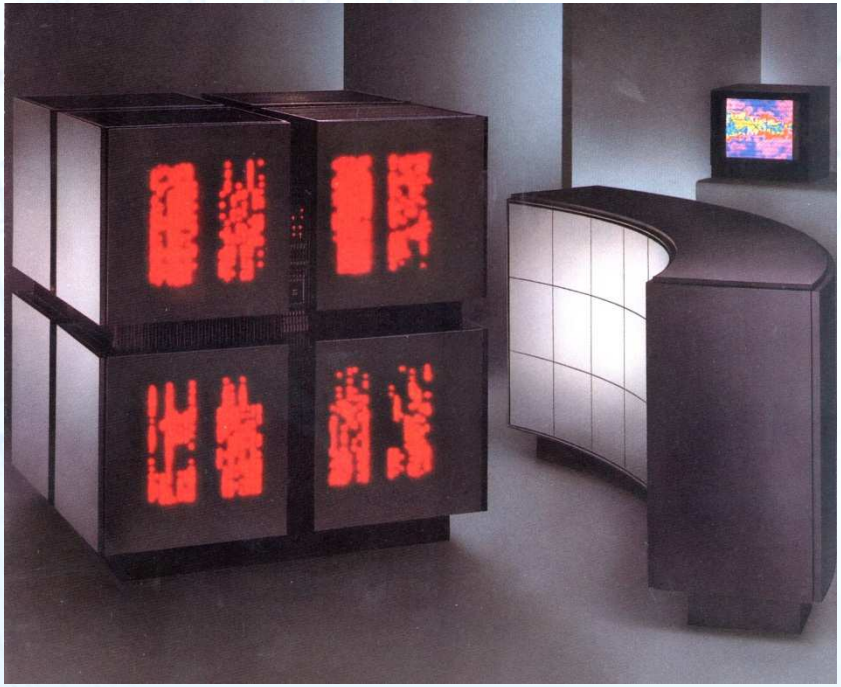
On die NIC

On die fast memory

Optical connections

NVM

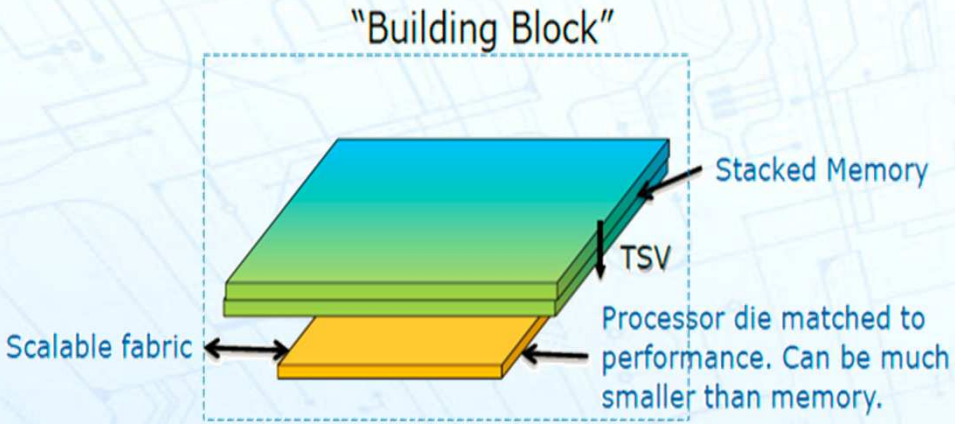
just kidding , this one is from 1987

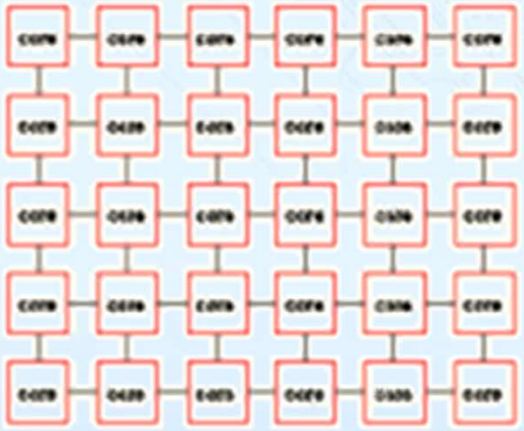


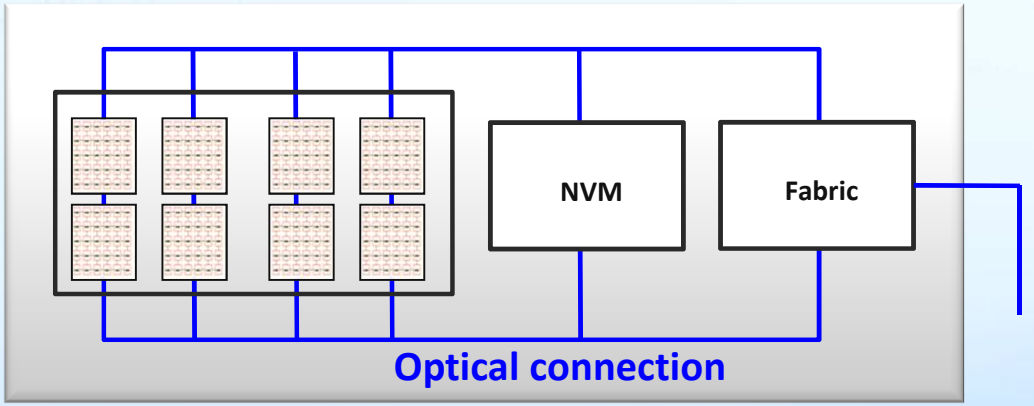
A "massively parallel" hypercubic arrangement

of **32k single bit processors**

Computer of the future : Like this one ?







Summary

- **Machine:** Power remains the major issue but new technologies are coming
  - = f(bandwidth / Latency / power / capacity / locality / flops / **price**)
  - Huge data arrives too .
- **Prog Model:**
  - Standards will stay for years and Fortran remains a FORmula TRANslator
  - Keep eyes on new things for 5% of eXtreme applications
- **Algo:** Perf. gains will come from parallelism (data and thread)
  - Data movements (even on-chip) will become more and more expensive
    - Data locality and Topology are keys
    - Move the code not the data
  - Manage heterogeneities (cores, memory hierarchies)

Summary

Then, YES,

- Future computers will be for Ninja as for today (meaning not only)
  - Optimization space is getting larger
- Gang of Ninja will have more chance to succeed
  - If they have and share the right tools
- Need to start training now with current multi and many-cores
  - If not already late

Questions ?

Optimization Notice

Optimization Notice

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