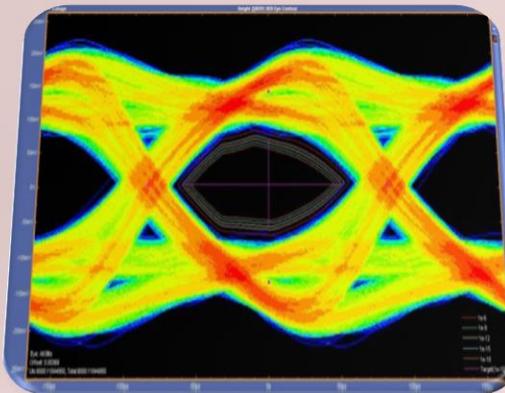

Méthodologies et outils de conception, simulation, évaluation et vérification des systèmes et systèmes de systèmes



15 juin 2017
Kevin Martin
Maxime Pelcat



Positionnement



Calcul
embarqué
haute

Systèmes
cyberphysiques

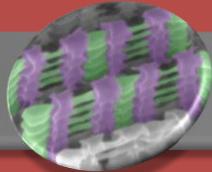
Sécurité et
intégrité des
systèmes

Objets connectés



Technologies du futur

Méthodologies

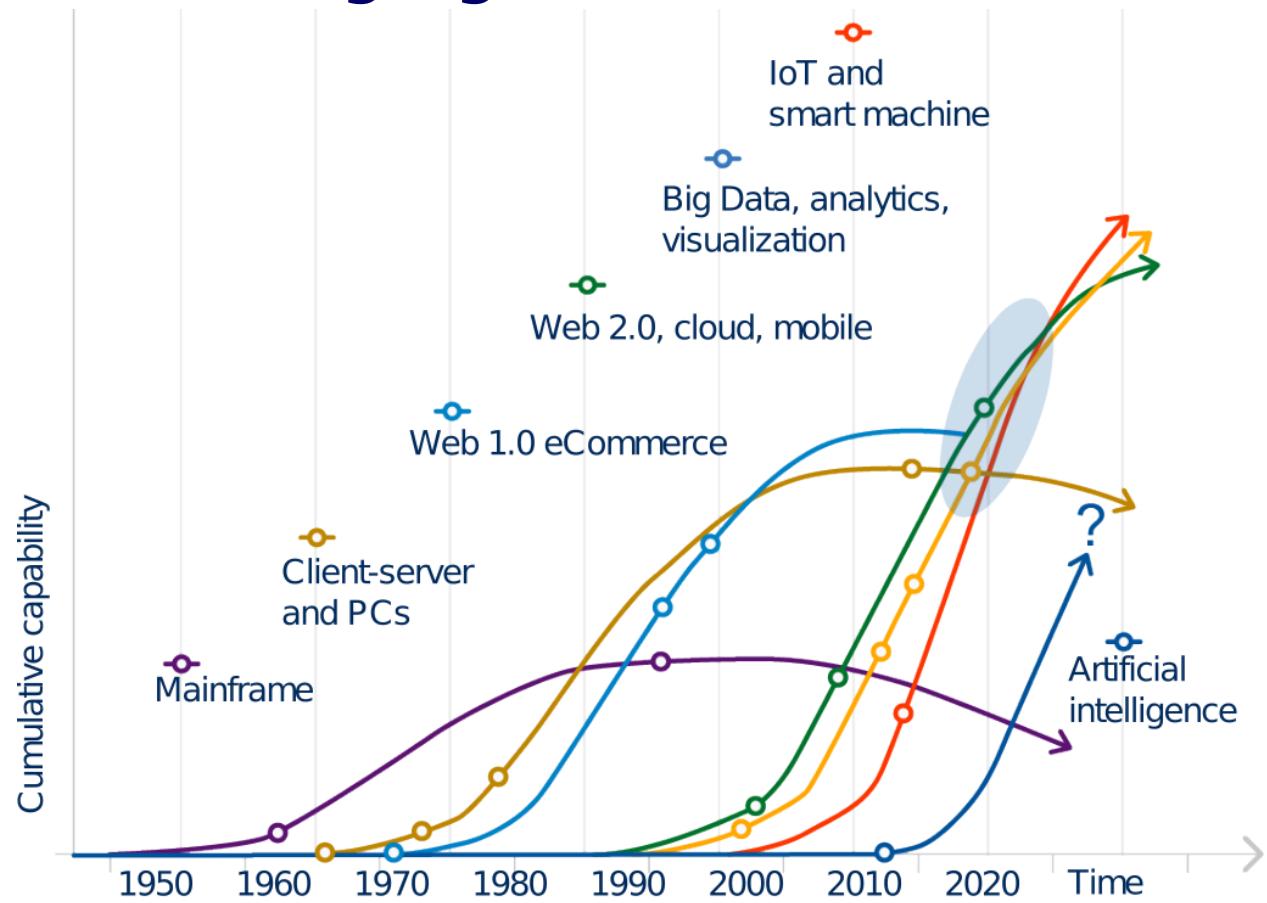


Définitions

- “Méthodologie” (*Larousse*) :
 - Étude systématique, par observation de la pratique scientifique, des principes qui la fondent et des méthodes de recherche utilisées.
 - Ensemble des méthodes et des techniques d'un domaine particulier.
- “Méthode” (*Larousse*) :
 - Ensemble ordonné de manière logique de principes, de règles, d'étapes, qui constitue un moyen pour parvenir à un résultat : *Méthode scientifique*.

System & SoS Design Today

- Systems are ubiquitous
- Markets are changing fast



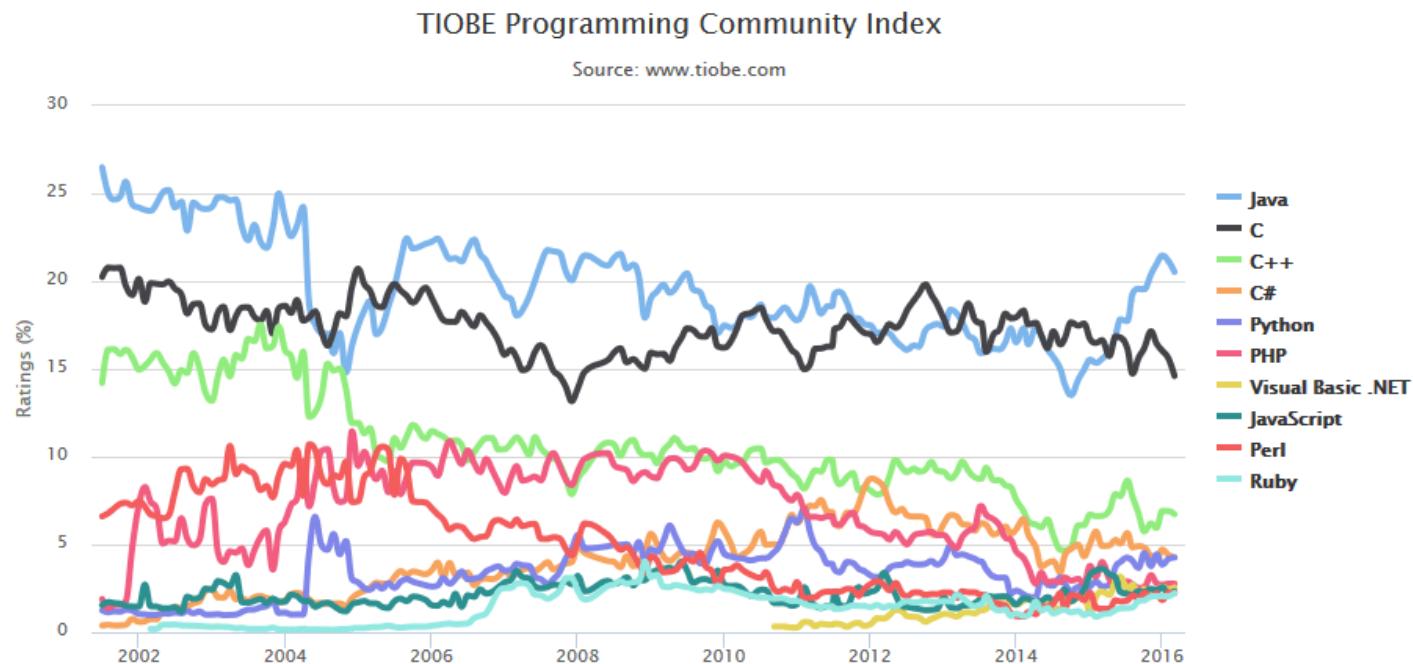
Source: World Economic Forum/Accenture analysis

System & SoS Design Today

- System design, simulation, evaluation & verification remain costly
 - Systems are large → Nvidia 21B transistors Volta
 - Software and hardware are highly intricated
 - The limits between HW and SW blurs → HLS, virtualization, FPGA PR...

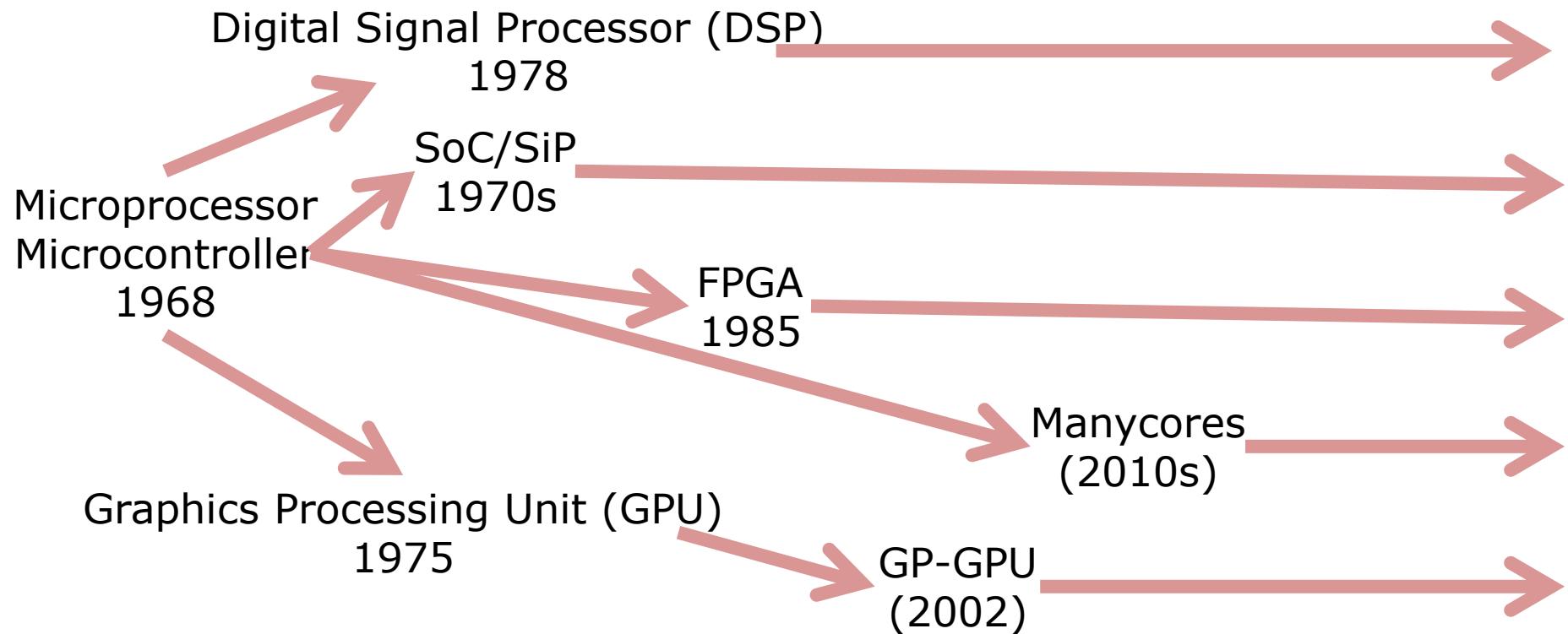
System & SoS Design Today

- System design, simulation, evaluation & verification remain costly
 - Parallelism and heterogeneity are everywhere
 - Most languages are imperative and...sequential



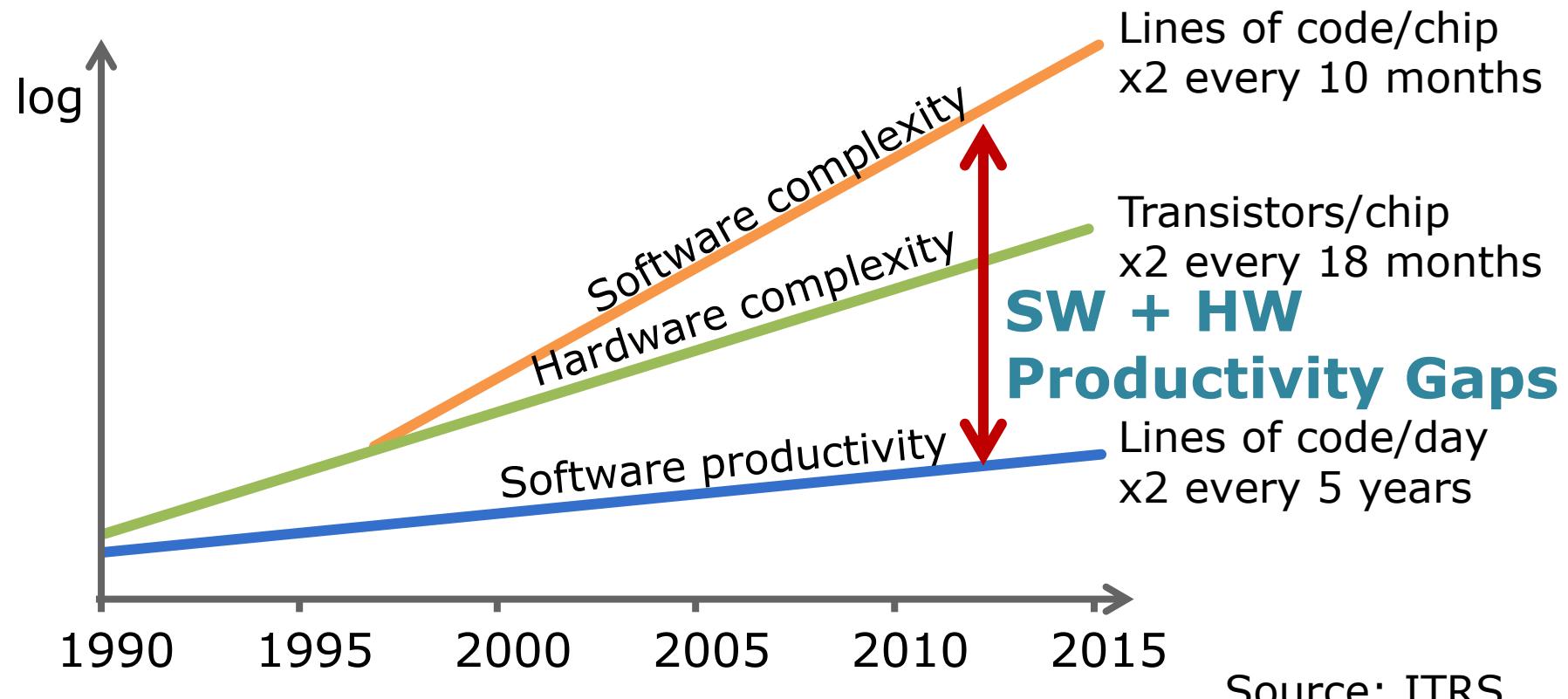
System & SoS Design Today

- Architectures diversify



System & SoS Design Today

- The productivity of designers and programmers raises... but not as fast as the complexity of systems



System & SoS Design Today

- Conclusion 1: new methods are requested for design automation of systems

System & SoS Design Today

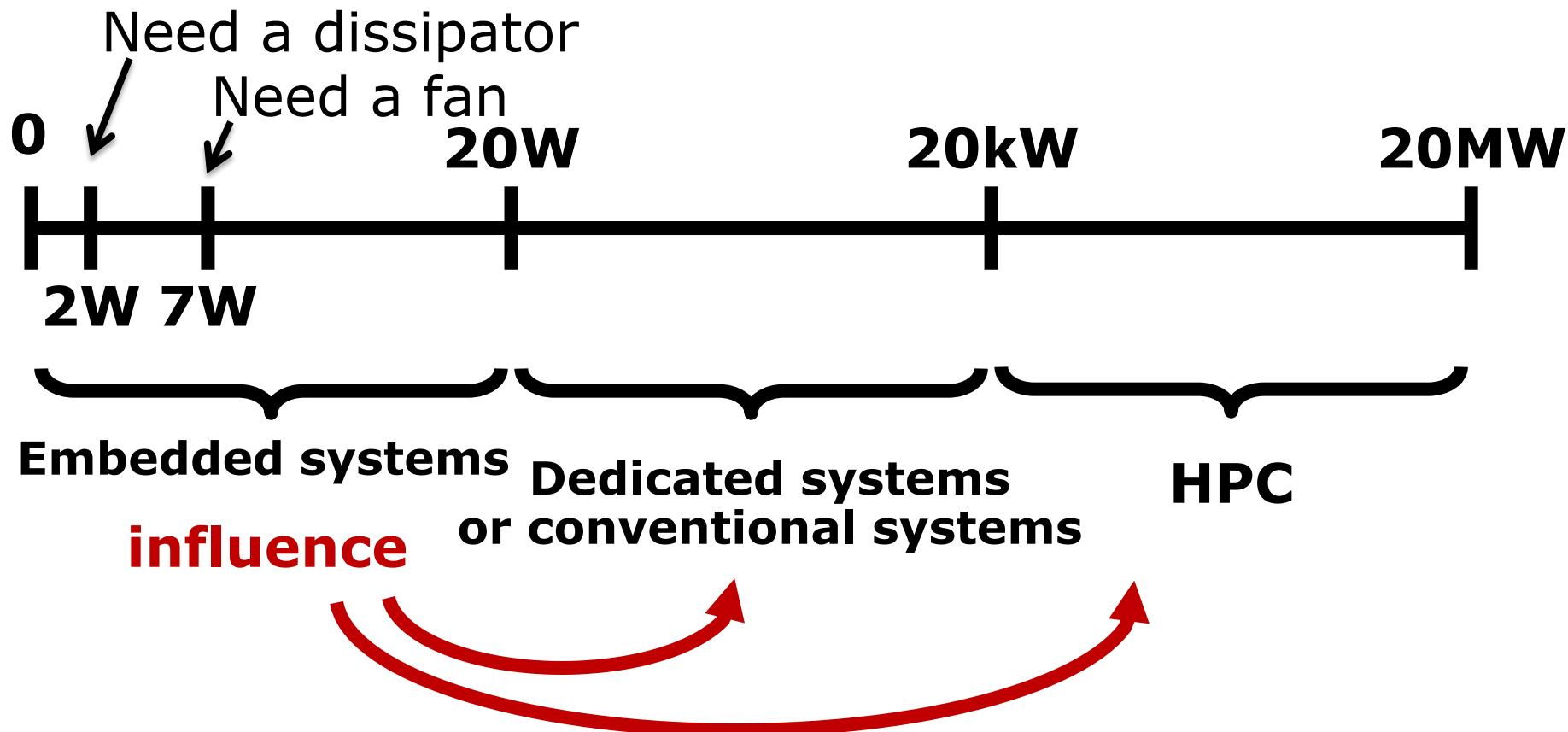
- Methods need to consider many Non Functional Properties (NFPs)
 - time, energy, memory, cost, weight, security...
- Electronic System Level (ESL) has the highest potential of NFP gain
 - Design Space Exploration with system-level criteria

System & SoS Design Today

- Until the 1990s, processing was all about performance

System & SoS Design Today

- From the year 2000 onwards, the focus has shifted from performance to energy



System & SoS Design Today

- Security has become a priority
- The IoT makes security particularly challenging
 - Steal information
 - Disrupt services
 - Take control of devices
- Security-by-design is an objective of system design methods

System & SoS Design Today

- Conclusion 1: new methods are requested for design automation of systems
- Conclusion 2: Design Space Exploration and multi-concern optimizations are needed

System & SoS Design Today

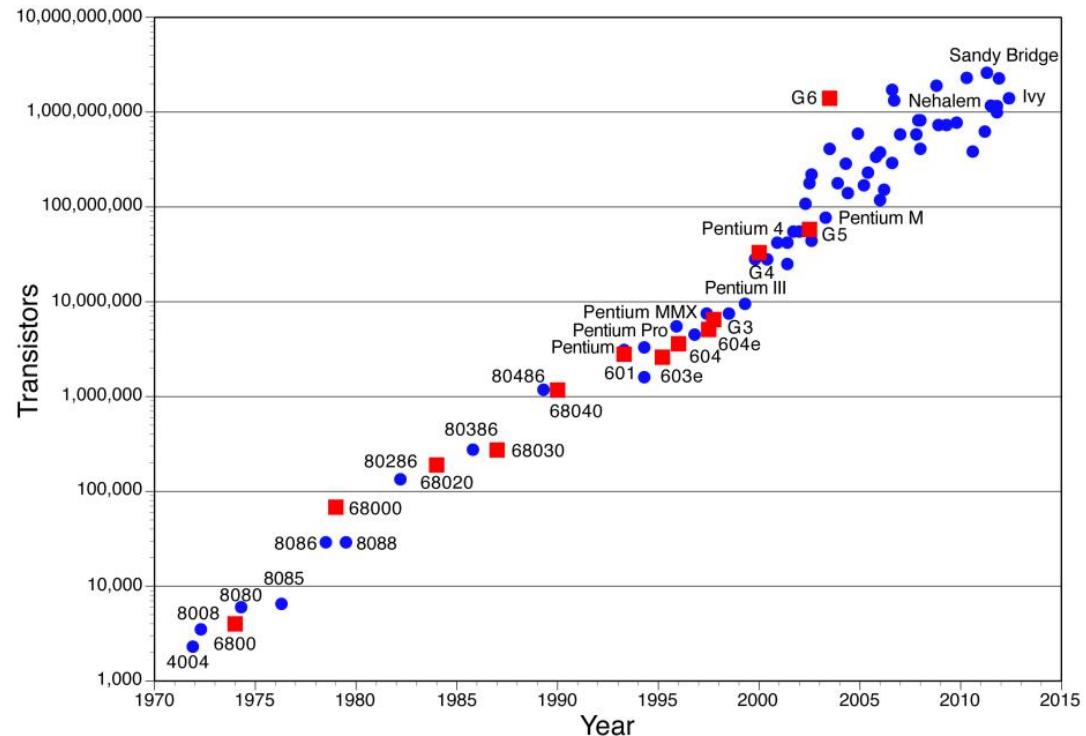
- Systems interact ever more with their environment → SoS, CPS...
- New design paradigms are introduced that require system-level information → approximate computing, near-threshold computing

System & SoS Design Today

- Conclusion 1: new methods are requested for design automation of systems
- Conclusion 2: Design Space Exploration and multi-concern optimizations are needed
- Conclusion 3: sensor and analog information must be known to the global design process

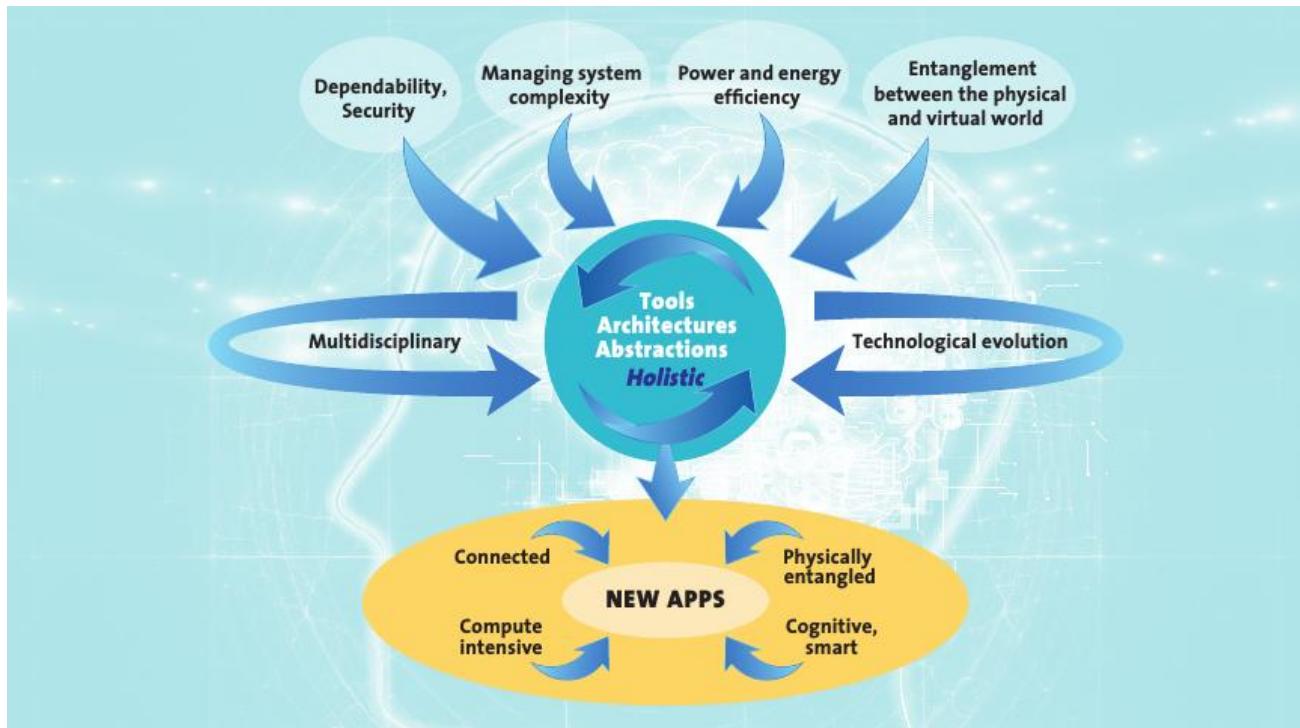
New Trends in System Design

- Moore's Law
 - Process variation
 - Reliability
 - Resilience/fault tolerance
- Reports of death of Moore's Law
 - 3D stacking
- New technology



More and more automation

- Component integration and interface
- Test and verification
- Holistic approach



Source: HiPEAC vision

Improving performance

- Not *more* resources but *better* utilization of resources
- Specialization => more heterogeneity
- In-memory computing
- Approximate computing
- Energy consumption

Challenges

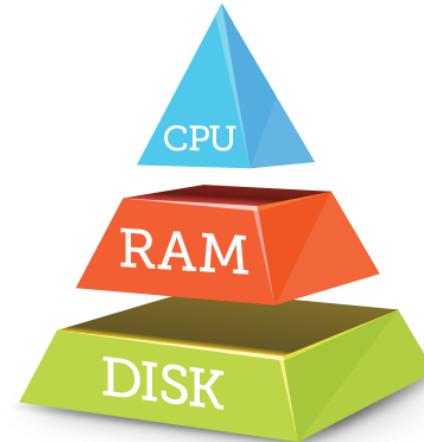
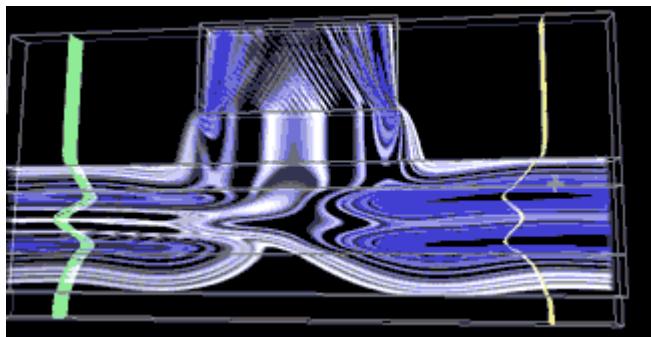
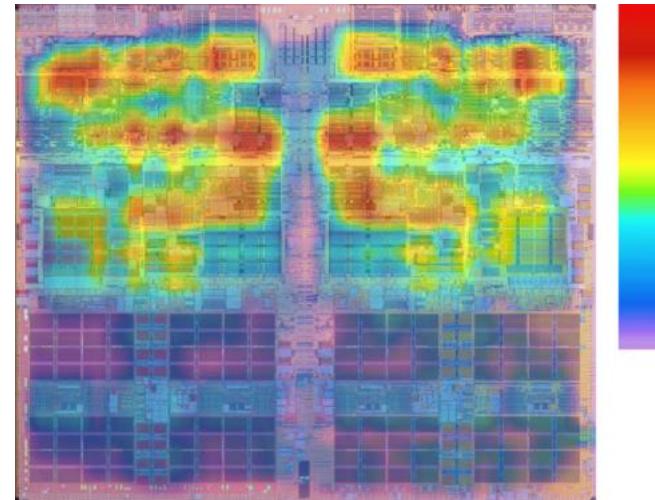
- Energy performance (few mW)
 - HPC
 - IoT
- Productivity gain (x10)
 - Feasibility
 - More functionalities

Challenges

- Parallel programming
 - *Seamless* programming
 - Heterogeneous targets (Cloud, GPP, FPGA, GPU...)
- Holistic approach for analog/digital
 - Multi-physics modeling and simulation
 - Multi-disciplinary systems in a single environment
- Fault-tolerance and resilience
 - At design time
 - At run-time

Locks

- Power wall
- Memory wall
- Simulation wall



Design methods

- Adapt to new technology constraints and performance
 - 3D stacking (near-memory computing)
 - New computing paradigms (Approximate computing, quantic, stochastic, asynchronous)
 - Emerging memory technology (MRAM, PCRAM, OxRAM, etc)
 - On-chip networks (photonic)
 - Dark-silicon

Scientific goals

- Offline methods
 - Hardware-software convergence and multi-physic integration
 - Enhanced HLS : monitoring, security, integration
 - Overlays (FPGA, NoC, ...)
 - Holistic simulation of large-scale heterogeneous distributed systems
 - Functioning security/reliability: real-time, formal approach
 - Model-based design
 - Functional
 - Non-functional (Energy...)
 - Approximate computing and systems
 - Application mapping on many-cores and heterogeneous systems (OpenCL, OpenMP, CUDA)

Scientific goals

- At runtime
 - Same methods applied to
 - Security
 - Parallelism (including many-cores)
 - Virtualization
 - Heterogeneity

Organisation

- un groupe de travail par recouplement thématique
 - Groupe de Travail “Méthodes pour le calcul haute performance embarqué”
 - Maxime Pelcat
 - Groupe de Travail “Méthodes pour les systèmes cyber physiques”
 - Marie-Minerve Louerat
 - Groupe de Travail “Méthodes pour la sécurité”
 - Kevin Martin

Organisation

- Trois groupes de travail dédiés
 1. Méthodes pour l'estimation, notamment de performance énergétique et temps d'exécution, en lien avec la sûreté et la vérification
 2. Méthodes multi-physiques, incluant des systèmes mêlant électronique analogique, capteurs, batterie et transmission, et systèmes numériques pour le traitement
 3. Méthodes en-ligne, en particulier sur les aspects virtualisation, compilation juste à temps, ordonnancement, déploiement d'applications à la volée et gestion dynamique des ressources

Et aussi...

- Développement et maintenance d'outils et de plates-formes ?
- Interopérabilité des outils du GdR ?
- Plateformes de référence, partagées entre équipes ?
- Liens avec les labex, equipex, IRT ?

Plan d'animation

- Outils de simulation - Prototypage virtuel des systèmes
 - Automne 2017
 - SoCLib, GEM5, OVPsim, etc
- Conception basée modèles de systèmes de traitement du signal et de l'information
 - Printemps 2018
- Near-memory computing
- Recensement des outils open-source ou libre pour la conception HW/SW en France (et en Europe)
- La licence libre pour le HW, le hardware open-source : ça existe ?

Merci



ADDITIONAL SLIDES