

**Ubiquitous powering:
Energy Aware Nanoelectronic
Personal Companions
- Nano-PCo -**

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Permission (EPFL): Yes

Outline

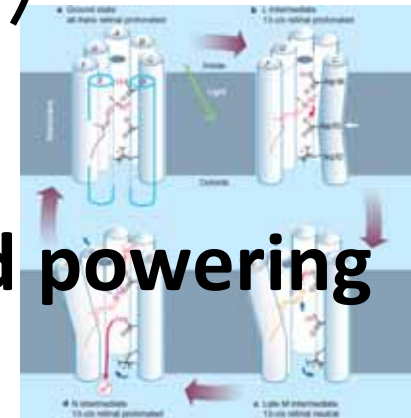
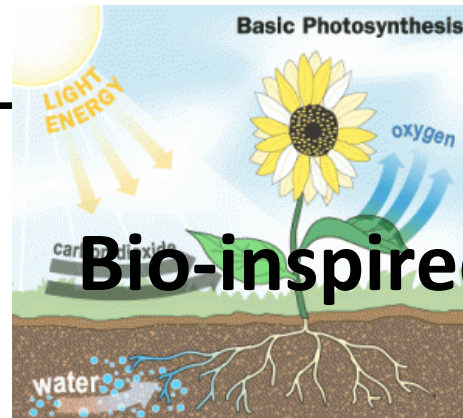
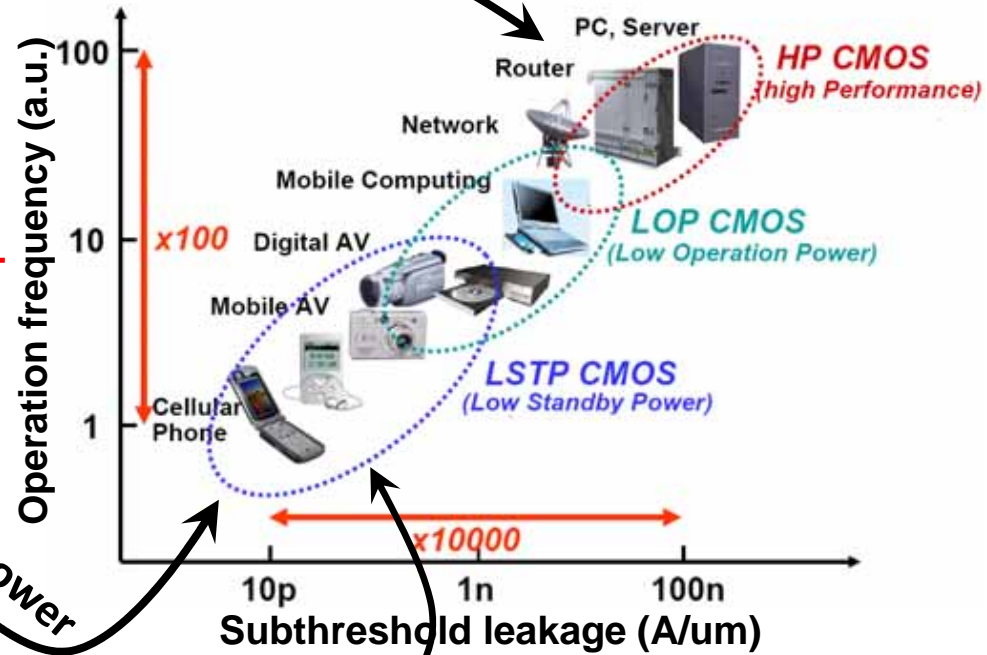
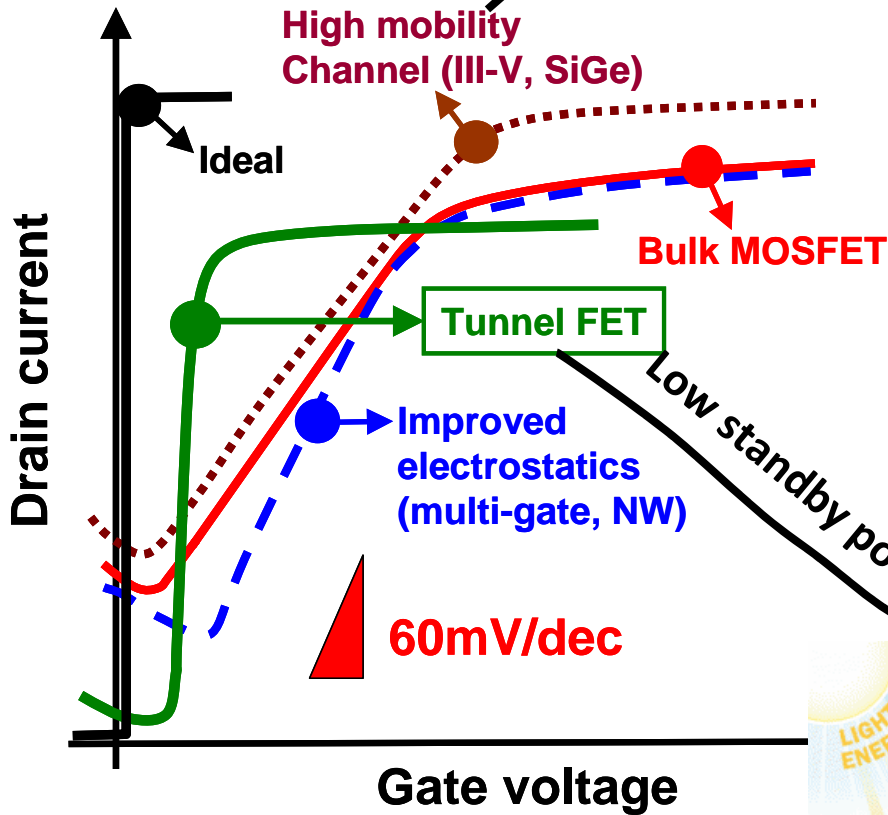
1. Concept
2. Potential partners & national support
3. Ambition and European added value
4. Impact
5. Integration & Plausability
6. Conclusions

Concept (1)

- Ubiquitously powered personalized computational and communication system, called **Nanoelectronic Personal Companion (nano-PCo)**, is the result of the convergence between **future zero-standby power mobile computing, mobile communications** and **disruptive integrated powering/scavenging technologies**.
- Features at system and technology levels:
 - inspired by biology in terms of energy efficiency.
 - exploits most advanced computing and storage technologies, including both digital and analog principles.
 - battery-less nano-PCo: **energy in the environment using integrated technology inspired by microbial light-driven proton pumps** (like bacteriorhodopsin) **or leaf photosynthesis** (converting light and CO₂ in electrical energy).
- Will enable **Guardian Angel functions for all-in-one devices**.
- Will enable technology for the **large scale deployment of battery-less Wireless Sensor Networks**.

Concept (2)

High performance



Bio-inspired powering

Potential partners & national support

- **Consortium:** CEA-LETI, CEA-INAC, EPFL, IBM-ZRH, IMEC, IUNET KTH, IMEP/IPG, Infineon, ST Microelectronics, Tyndall, University of Bologna, Université Catholique de Louvain, University of Cambridge, University of Geneva, University of Pisa, University of Udine, University of Lund.
- **Concrete Swiss investment:** existing (80million CHF) and the new Nano-Tera program extension, perfectly aligned with the goal and ambition of this proposal.
- **Additional matching:** will be provided at some other partners, including involvement of leading semiconductor industries.
- **International collaborations:** planned in US (UC Berkeley, Stanford, MIT, applying to NSF program enabling collaboration with Europe) and Japan (Tokyo Tech).

Ambition & added European value

- Nano-Pco will generate **new paradigms for nanoelectronic computing with main emphasis on energy efficiency**, novel design and the integration of non-traditional energy sources, inspired by biological systems.
- Will result in a new era of semiconductor fabs exploitation, integrating More Than Moore layers and new materials that could place Europe in a unique position in the world competition.
- Zero-standby power mobile computing, mobile communications and disruptive integrated powering/scavenging technologies will be core new technology defining the high added value of the flagship project.
- Will enable the **realization of zero-power Nanoelectronic Personal Companions (NanoPCo)** and the effective **implementation of battery-less Wireless Sensor Networks (WSN)**.
- In Europe there is a high level yet fragmented know-how in ultra-low power design and technologies in many countries like Switzerland, Belgium, France, Germany, Sweden, etc. The coordination of the best knowledge and forces is vital for the success of the flagship project.

Impact

- New opportunities for the nanoelectronic platforms in terms of **power aware technologies, centered on the know-how acquired in advanced silicon CMOS.**
- New opportunities in **science and business of biologically inspired power generation system for ubiquitous powering.**
- Development of **new ultra low power communication techniques** such as very low data rate Ultra Wide Band, with ranging and localization capabilities (mm-precision) as the only way to **approach the 1 pJ/bit limit** for acceptable bit error rate transmission.
- New opportunities for **nano-science and engineering, at the frontiers between energy efficient devices and systems and biologically inspired powering.**
- **Heterogeneous integration** of various computing, communication and powering technologies.
- New opportunities for teaching and electrical engineering, energy and life sciences resulting in **higher attractivity for students and identification of novel research challenges.**
- **Strengthening the leading role of Europe in ultra low power design and novel technologies**, enabling stronger role of manufacturing in Europe and higher competitiveness for mobile communication companies as well the creation of new business and employment.

Integration & Plausability

- **Built on achieved progress in nanoelectronics**, which revolutionized already the modern society make today possible mobile computing and lowering the cost of a transistor to value less than the cost of a printed letter in journal.
- Industry is facing **new challenges related to power consumption and the energy crisis**.
- Europe particularly well placed for challenges of ultra-low power and for the interaction between bio and nano for building complex power-aware systems. There is a **high probability of success despite the ambitious targets of bio-inspired battery-less Nano-PCo**.
- **Europe is leading in communication and bio-pharma**; highly plausible the interaction between nanoelectronics and powering will create novel opportunities for applications in the energy hungry, ageing society. See concept of Guardian Angels.
- Core of the project: **integration of disruptive powering technologies with energy efficient computing and communication technologies**, forming biggest challenges of ICT.

Conclusions

- Nano-Pco is a potential FET flagship project based on the convergence between **future zero-standby power mobile computing, mobile communications and disruptive integrated powering/scavenging technologies.**
- Beyond the battery less Nano-PCo, it will enable unique:
 - Guardian Angel functions for all-in-one devices for the ageing, power hungry society.
 - Novel technology for the large scale deployment of battery-less Wireless Sensor Networks.
 - New opportunities and interactions of semiconductor, communication and bio-pharma industries
- Extremely **high potential for generating disruptive technologies and applications.**