



# *TerraSwarm*

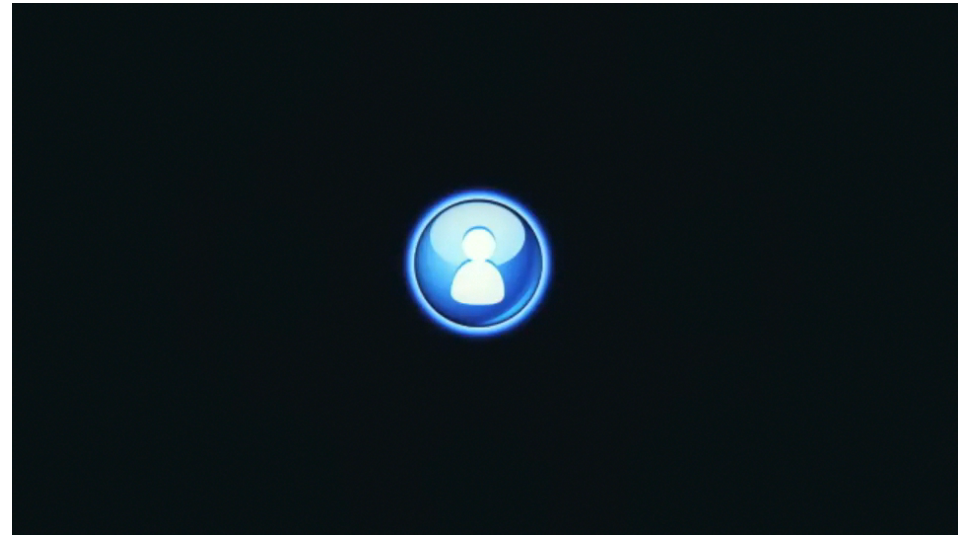
## First International Workshop on “The Swarm at the Edge of the Cloud”

Jan Rabaey

Prabal Dutta

George Pappas

**Workshop Chairs**



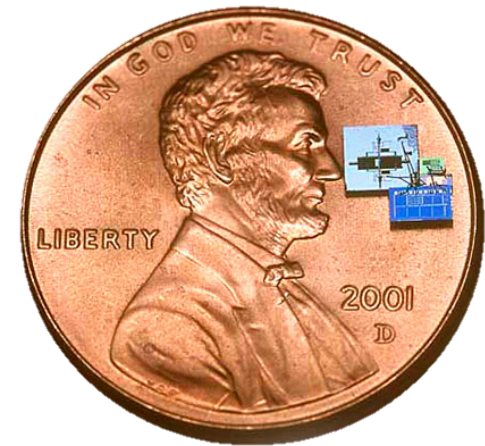
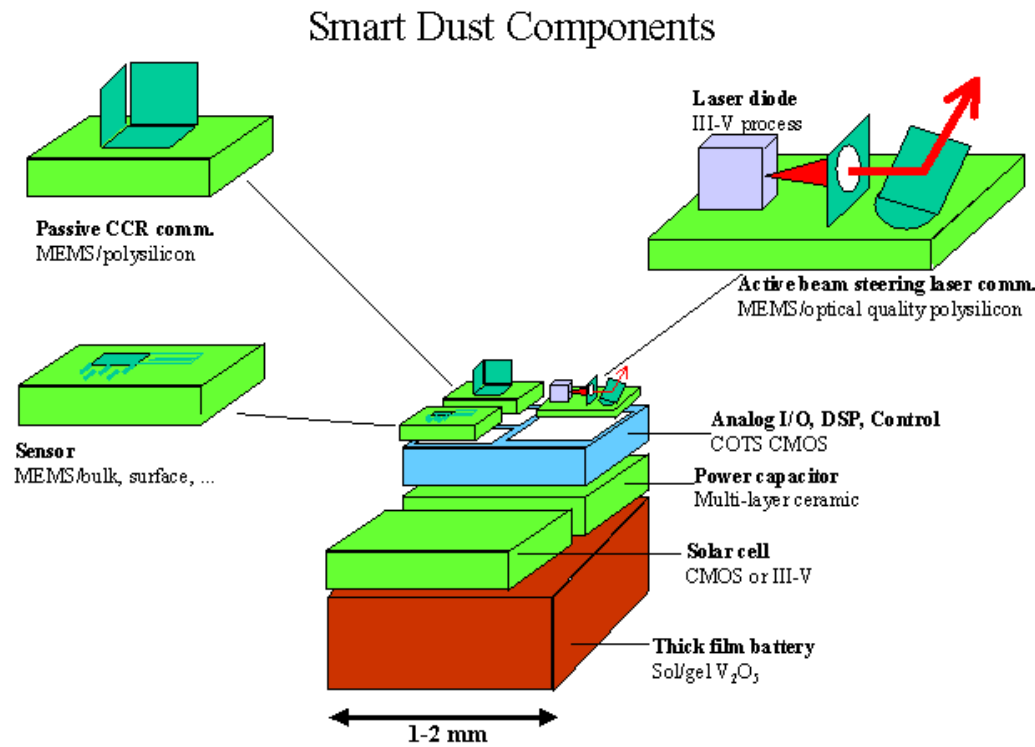
Sponsored by the TerraSwarm Research Center, one of six centers administered by the STARnet phase of the Focus Center Research Program (FCRP) a Semiconductor Research Corporation program sponsored by MARCO and DARPA.





# It All Started in the Mid 90's

*“What happens if sensors become tiny, wireless, and self-contained?”*



[Courtesy: K. Pister, UC Berkeley]

... Wireless Sensor Networks



# From Sensor Nets to CyberPhysical Systems



Forked plethora of research activities in ultra low-power circuits, sensors, energy harvesting, ad-hoc wireless networks, data fusion, ... **but no real business yet**



# Mid 00's: Swarm Vision Emerges

[EE Times: Latest News](#)

**Wireless is everywhere; ignore it at your peril**

[Bolaji Ojo](#)

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[EE Times](#)

(01/07/2008 9:00 AM EST)



The search is over for the next killer app. It is wireless, it is all around you, and it will leave no sector of the global economy untouched.

EE Times,  
January 07, 2008

- 5 Billion people to be connected by 2015 (Source: NSN)
- 7 trillion wireless devices serving 7 billion people in 2017 (Source: WWRF)
  - 1000 wireless devices per person?

[Courtesy: Niko Kiukkonen, Nokia]



# The Swarm at the Edge of the Cloud



Trillions of Distributed Connected Devices  
Opportunistically Collaborating to Present  
Unique Experiences or Fulfill Common Goals

[J. Rabaey, ASPDAC'08]



# What Makes the Swarm Vision Unique?

THE CLOUD

THE FOG\*

THE SWARM

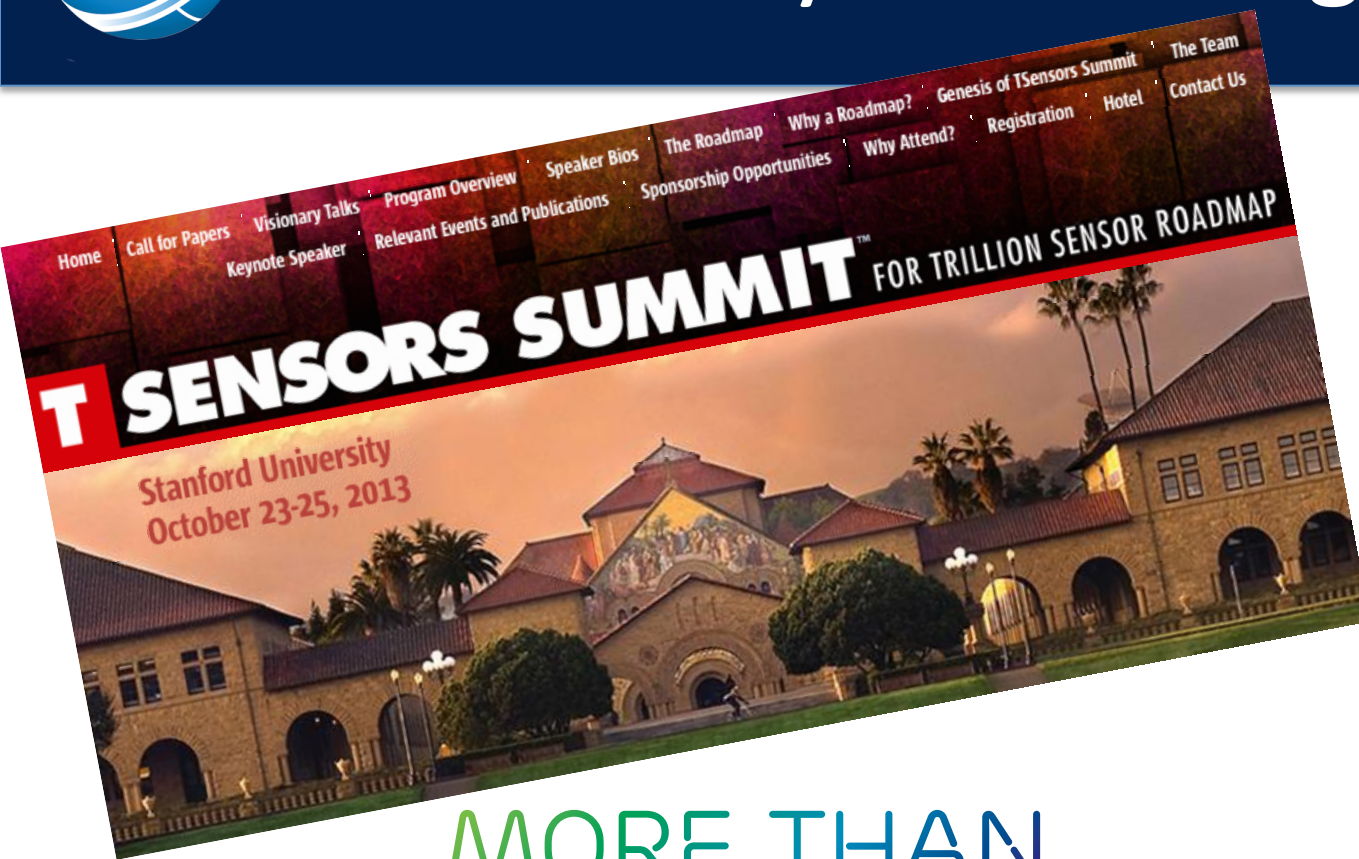


- Open shared platform avoids stovepiping of “sensor nets”
- Opportunistic acquisition of **just enough resources** avoids overhead of “internet of things”
- The Cloud and the Fog as **companions**

\*[F. Bonomi, Cisco, “Cloud and Fog Computing”– EON June 11]



# Now Ready for the Big Time



MORE THAN  
50 BILLION  
CONNECTED  
DEVICES



MORE THAN 50 BILLION  
CONNECTED DEVICES –  
TAKING CONNECTED  
DEVICES TO MASS MARKET  
AND PROFITABILITY

Everything that can benefit from a connection will have one. As people we are already online. The next step is to get things and places online. And we are moving fast in that direction. The vision of more than 50 billion connected devices by 2020 may seem ambitious today, but with the right approach, it is within reach.



# A Myriad of Challenges Remaining



HAVE A GREAT WORKSHOP!

The Swarm, Warner Bros, 1978