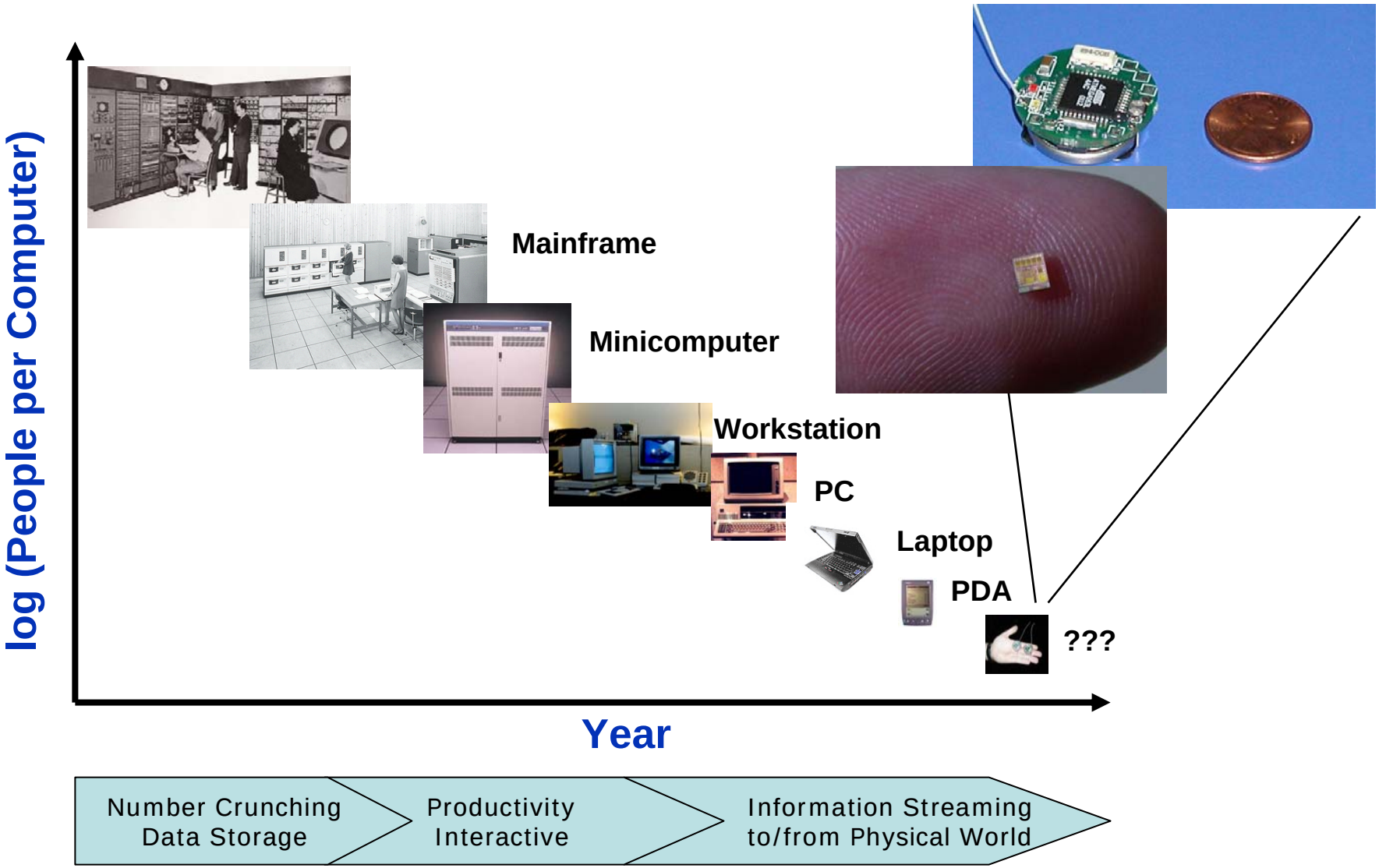
Netted Sensing

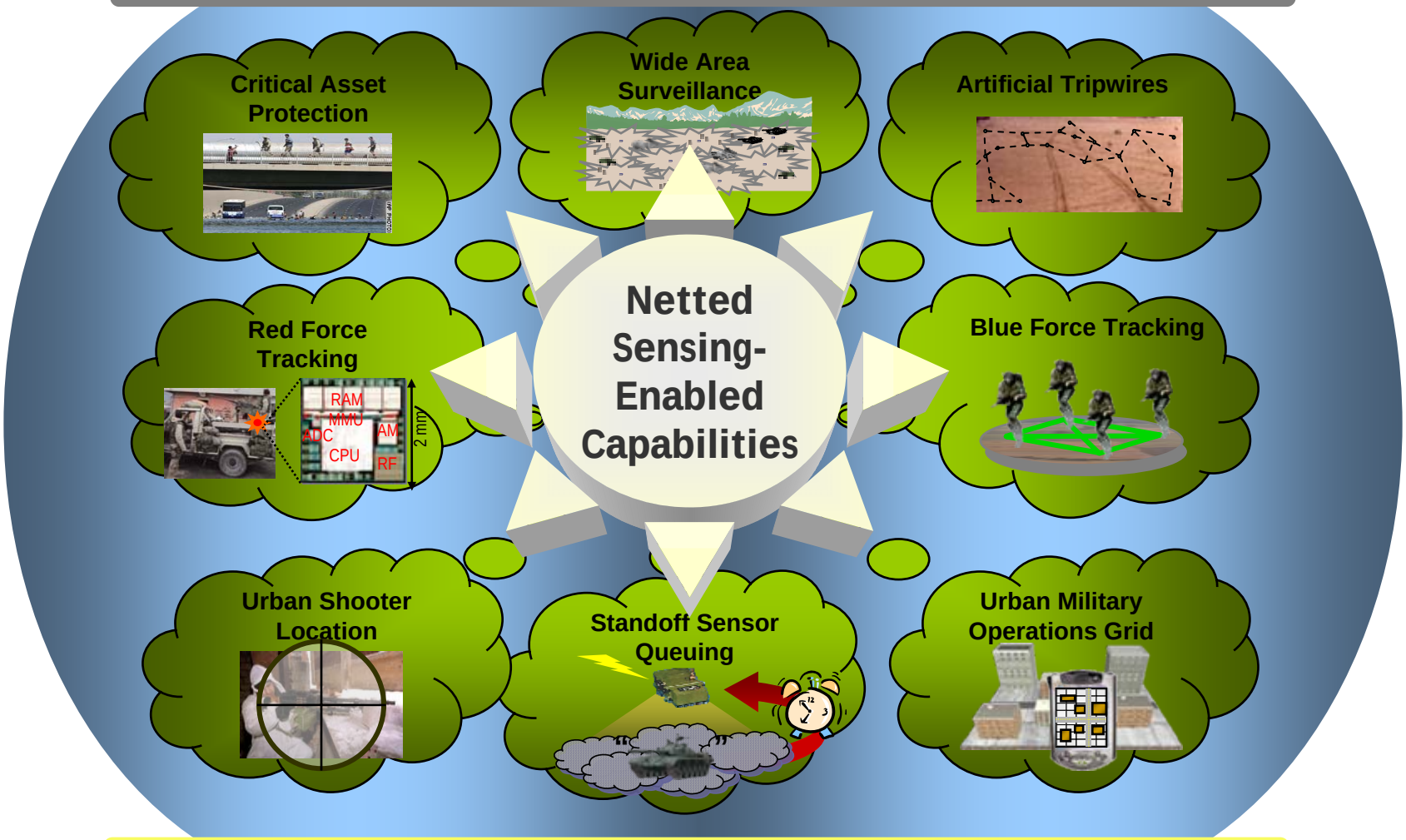
An Emerging New Class of Computers



Netted Sensing

Current Military Operational Challenges

Revolutionary netted sensing technology will be a critical resource…



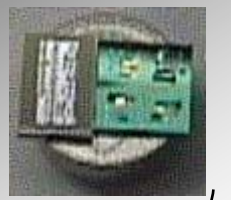
…to enhance tactical and operational battlespace awareness for warfighters.

Netted Sensing

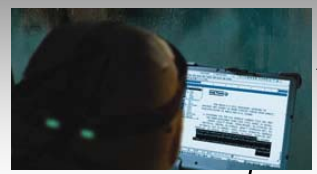
Military and Commercial Payoff

Netted Sensing Technologies

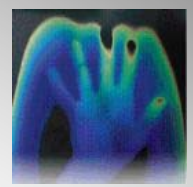
Single Chip Radio



Military Omniscience

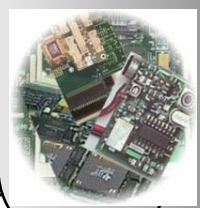


Proactive Medicine

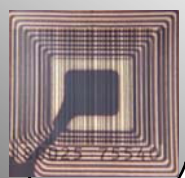


Micro Laser Projection Systems

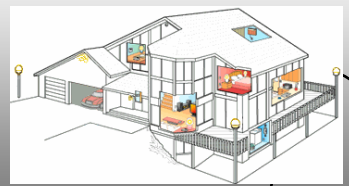
Ubiquitous Monitoring



Embedded Possession Tracking



Smart Structures



Intelligent Navigation

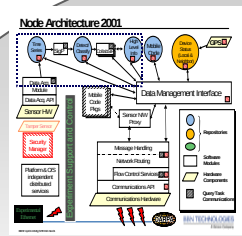
DARPA Investment in Netted Sensing

Sensor InformationTechnology (SensIT)

SENSIT

Sensoft: Integrated software for networked micro-sensors

Plug and play software



Prototype nodes

Cheap, Smart, Programmable Nodes
- Processing, storage
- Multiple sensor
  - Acoustic, seismic, imagers, magnetometers
- Positioning (Global or relative)
- Short Range Communications
- Camouflaged

Golf ball size devices
Air deployable from MAV: SITEX 01

Program Description

Create Software and Algorithms for distributed Micro-Sensor Networks for battlefield monitoring and control

- Battlefield Monitoring
  - *Low Cost Devices deployable in large numbers*
  - *Multi-mission software flexibility*
  - *Close sensing – improved accuracy*
- Applications
  - *Reconnaissance, Surveillance*
  - *Perimeter Security, Force Protection*
  - *Hard targets*

Software and algorithms for distributed micro-sensors

Technical Objectives

✓**Networking**
- Ad hoc, self-assembled, robust and scaleable methods
- Fixed and mobile devices and users – sensors deployed by hand, UAV, or robots
- Exfiltration via satellite or air or ground points

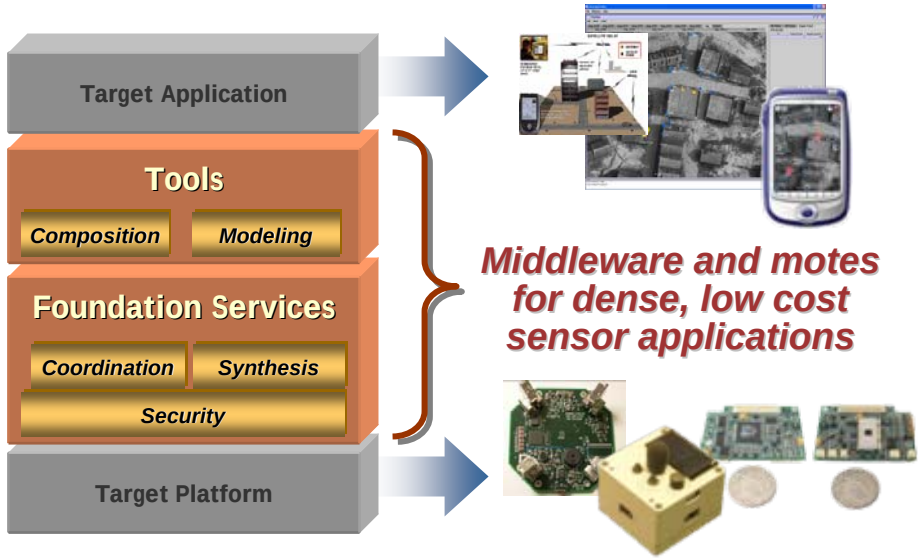
✓**Collaborative Signal/Information Processing**
- Networked processing of data from multiple nodes, and multiple sensors on each node to support applications (e.g., classification, tracking)
- Energy efficient

✓**Querying and Tasking the Sensor Net**
- Multi-level declarative query; multiple and dynamic tasks and users

✓**Integration and Experimentation in Lab, Field**
- Experiments performed three times at USMC base in Twentynine Palms, CA (2000-2001) SITEX 00, 01, 02
- Lab tests ongoing at researcher sites around the country

DARPA Investment in Netted Sensing

Networked Embedded Systems Technology (NEST)



Program Description

Tiny, difficult to detect ground-level sensor networks to detect, classify, and track vehicles and dismounts and accurately locate enemy snipers

- Micro nodes, micro sensors, micro power
- Rapid automatic formation of ad hoc networks
- Location and tracking of snipers, OPFOR and non-combatants in urban environments
- Persistent surveillance of remote areas
- Force location in GPS-denied areas

Revolutionary wireless micro-sensor network technology that will enhance tactical and operational capabilities for warfighters

Technical Objectives

✓**Services for Node Coordination**
- Time, location, synchronization, replication, power management

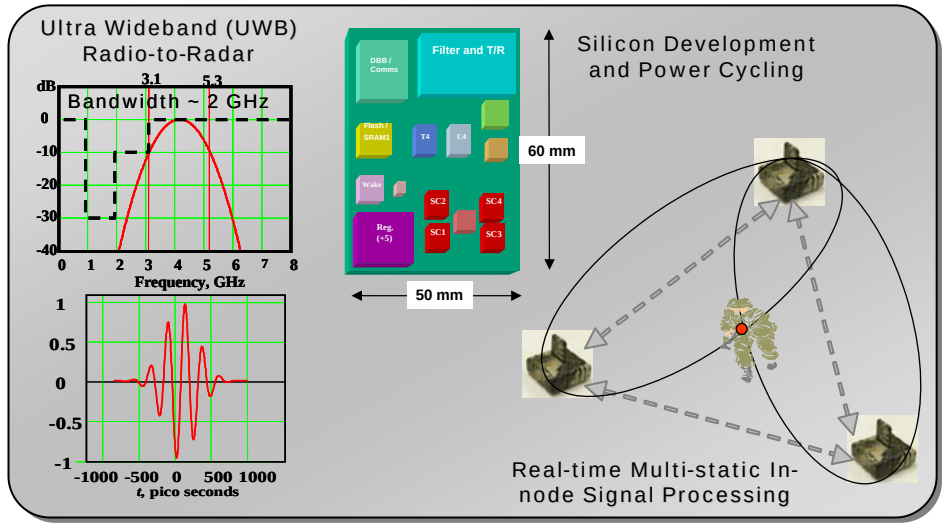
✓**Protocols for Ad-hoc Networking**
- Real-time scheduling, experimental/statistical analysis, and transition-aware routing algorithms to detect, avoid, and work around network congestion

✓**Measures for Secure Operations**
- Hardware protection, data encryption, node authentication, and intruder detection

✓**Design-time Tools and Adaptive Components**
- Select, compose, and optimize applications and platform-specific packages

DARPA Investment in Netted Sensing

Camouflaged Long-Endurance Nano-Sensors (CLENS)



Program Description

Ultra low-cost, ultra light-weight, long endurance ultra-wideband radar sensors capable of locating, tracking, and identifying dismounts in wooded and similarly difficult environments

- Low duty cycle => Low power consumption => LPI
- With the radar, the communications are free
- Minimalist sensors and networking
- Identification on demand from another sensor

Low-cost, persistent, flexible sensing for force protection and adversary surveillance of perimeters, borders, and denied areas

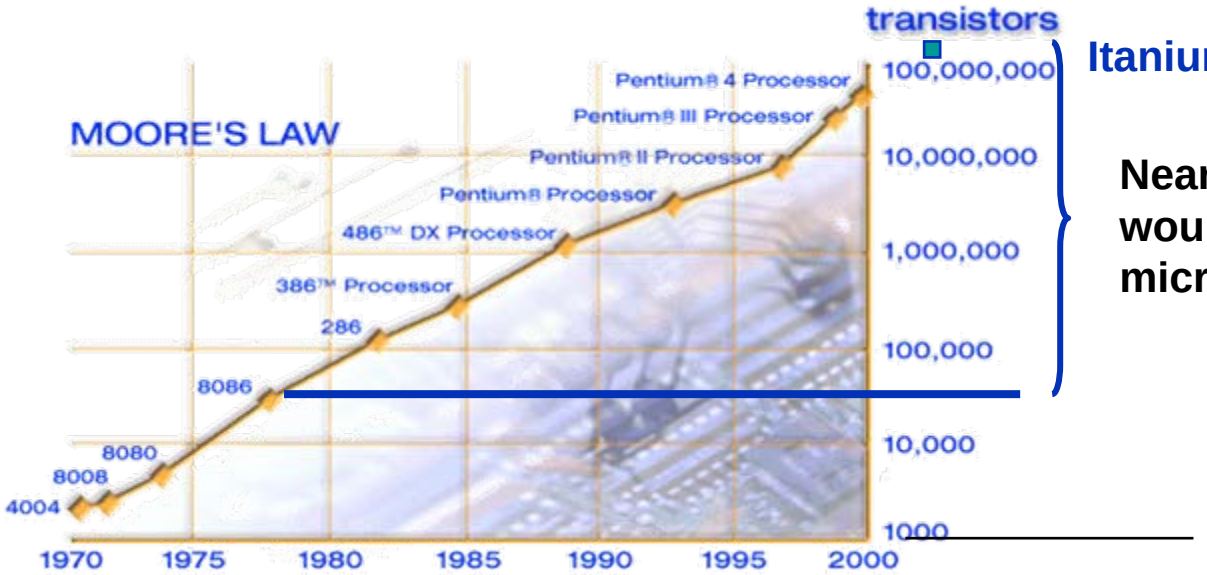
Technical Objectives

✓**Excellent Receiver Operating Characteristics (ROCs)**
- Pd > .99 / < Pfa 1 / 8 hrs across two nodes, substantially better at network level
- Challenging environments (fields, forests, caves, riverine, urban)

✓**Reduced Power Consumption**
- By over 1 ½ orders-of-magnitude and volume by 1 order-of-magnitude
- Goal of 3 ½ to 4 orders-of-magnitude reduction of power consumption through architecture, consolidation, power cycling, and more power efficient control and processing technologies
- Adequate endurance and ease-of-emplacement to support utility assessments

✓**Operationally-Viable Sensor Node System**
- Mass: 150g
- Endurance: 180 days
- Scalable architecture (100+ nodes)

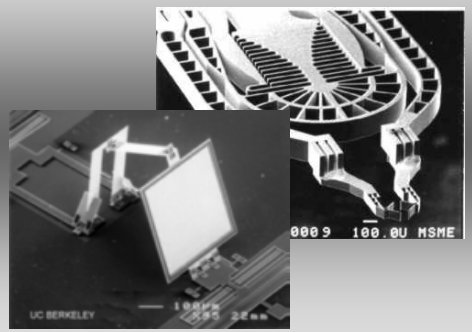
Netted Sensing
Evolutionary Path



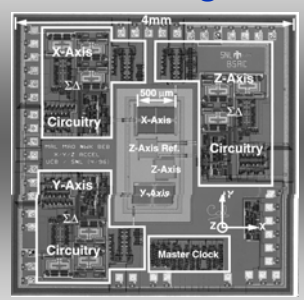
Itanium2 (241M)

Nearly a thousand 8086s would fit in a modern microprocessor

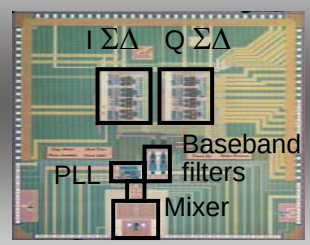
Actuation



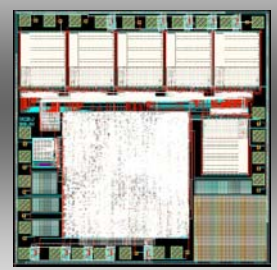
Sensing



Communication



Processing & Storage



Netted Sensing Technical Challenges

- ***Power*** – Novel advances in energy storage, battery technology, and harvesting techniques
- ***Mobility*** – Support for self-repair, coverage optimization, collaborative processing, selective fidelity, and interaction with remote assets and information sources
- ***Auto-Calibration*** – Extendible and robust ability to adapt to different and changing environments; in-situ parameter estimation
- ***Composition*** – End-to-end, fully automated design-time optimization of services to requirements and platforms
- ***Mobile Software*** – Use of agents, virtual nodes, and software disassociated from physical resources
- ***Robustness*** – Adaptive algorithms for survivability, resistance, graceful degradation, Byzantine failures

DARPA's door is always open for new ideas!