La CEP prima della CEP: storia dell'Informatica
La Limonaia, Pisa, 11-12 novembre 2011

La Ricerca al Dipartimento di Informatica

Ugo Montanari
Dipartimento di Informatica
Università di Pisa

CEP - Calcolatrice Elettronica Pisana

- Suggerimento di Enrico Fermi nel 1953
- Costruita nel Dipartimento di Fisica
  - Marcello Conversi
  - Alessandro Faedo
- Architettura innovativa
  - Circuiti a tubi e diodi, poi transistori
  - Controllo microprogrammato
  - FORTRAN come linguaggio di programmazione
- Inaugurata da Giovanni Gronchi nel 1960
- CSCE - Centro Studi Calcolatrici Elettroniche
  - IEI-CNR
  - ISTI-CNR together with CNUCE

CNUCE - Centro Naz. Univ. di Calcolo Elettronico

- Primo, grande centro di calcolo in Italia
- Computer IBM 7090
  - Dono della IBM alla università di Pisa
  - Alessandro Faedo con l'aiuto di Eugenio Fubini
- Inaugurato da Giuseppe Saragat in 1965
- Importante centro scientifico IBM a Pisa
- Diventò CNUCE-CNR
- Ora confluito nell'ISTI

Curriculum in Scienze dell'Informazione

- Fondato nel 1969
- Antonio Grasselli
  - Ingegnere chimico
  - Politecnico di Milano
  - Princeton and Berkeley
- Giovanni Battista Gerace
  - Progettista dell'hardware della CEP
- Alfonso Caracciolo di Forino
  - Progettista del software della CEP
- Franco Preparata
  - Curriculum 1973

Ancora un po' di storia

- 1983: Dottorato in Informatica, primo in Italia
- 1983: 1200 iscritti al primo anno
  - 7% da Pisa e provincia
  - 30% dalla Toscana
- 1996: venticinquennale del corso di laurea
  - Analisi statistica dei laureati: risultati positivi
- 1988-93: primi 42 dottori di ricerca
  - 11 all'Università di Pisa
  - 23 ad altre università italiane
  - 7 ad università estere
  - 1 in industria. Più tardi numerosi dottori di ricerca anche in laboratori di ricerca privati.

Oggi: Corsi di Laurea, Master e Dottorato

- Primo livello
  - Laurea in Informatica
  - Laurea in Informatica Applicata – La Spezia
  - Laurea in Informatica Umanistica
- Secondo livello
  - Laurea Magistrale in Informatica
  - Laurea Magistrale in Informatica e Networking
  - Laurea Magistrale in Informatica per l'Economia e l'Azienda
  - Laurea Magistrale in Informatica Umanistica
- Master
  - Master in Sviluppo di Applicazioni Mobili
  - Master in Gestione Open Source
- Dottorato
  - Scuola di Dottorato Galileo Galilei

Oggi: Argomenti di Ricerca, I

- Algoritmi e Matematica Computazionale
- Modelli, Linguaggi, Basi di Dati e Software
- Architettura di Sistemi
- Intelligenza Artificiale
- Ricerca Operativa

Oggi: Argomenti di Ricerca, II

- Algoritmi e Matematica Computazionale
  - Indicizzazione di testi per ricerche sul web
  - Bioinformatica
  - Matematica computazionale
- Modelli, Linguaggi, Basi di Dati e Software
  - Global computing
  - Sicurezza
  - Sistemi Service-Oriented
  - Sistemi Software e metaprogrammazione
  - Riuso del software
  - Accesso efficiente a basi di dati
  - Progettazione e implementazione di linguaggi di programmazione
- Architettura di Sistemi
  - Architetture parallele e distribuite ad alte prestazioni
  - Modelli e strumeti per reti di calcolatori
- Intelligenza Artificiale
  - Knowledge discovery e data mining
  - Linguaggio naturale
  - Apprendimento automatico e reti neurali
- Ricerca Operativa

Algoritmi e Matematica Computazionale

- Algoritmi
  - Indicizzazione di testi per ricerche sul web
    - » Anna Bernasconi, Paolo Ferragina, Roberto Grossi, Linda Pagli, Nadia Pisanti, Giuseppe Prencipe
    - » Bioinformatics and Pattern Discovery, Compressed Data Structures and Text Indexing, Distributed Computing and Agents, Logic Synthesis, Energy-Efficient Algorithms and Models of Computation
  - Bioinformatica
    - » Roberto Barbuti, Chiara Bodei, Pierpaolo Degano, Roberta Gori, Roberto Grossi, Francesca Levi, Andrea Maggiolo Schettini, Roberto Marangoni, Nadia Pisanti
    - » Biological Sequence Analysis, Motif discovery, Formal Methods for Systems Biology, Executable Languages and Calculi for Systems Biology, Bio-inspired Computational Models
- Matematica computazionale
  - Roberto Bevilacqua , Gianna Del Corso , Ornella Menchi, Francesco Romani
  - Matrix Computations, Structured Matrices, Web Mathematics, Inverse Problems, Applied Linear Algebra

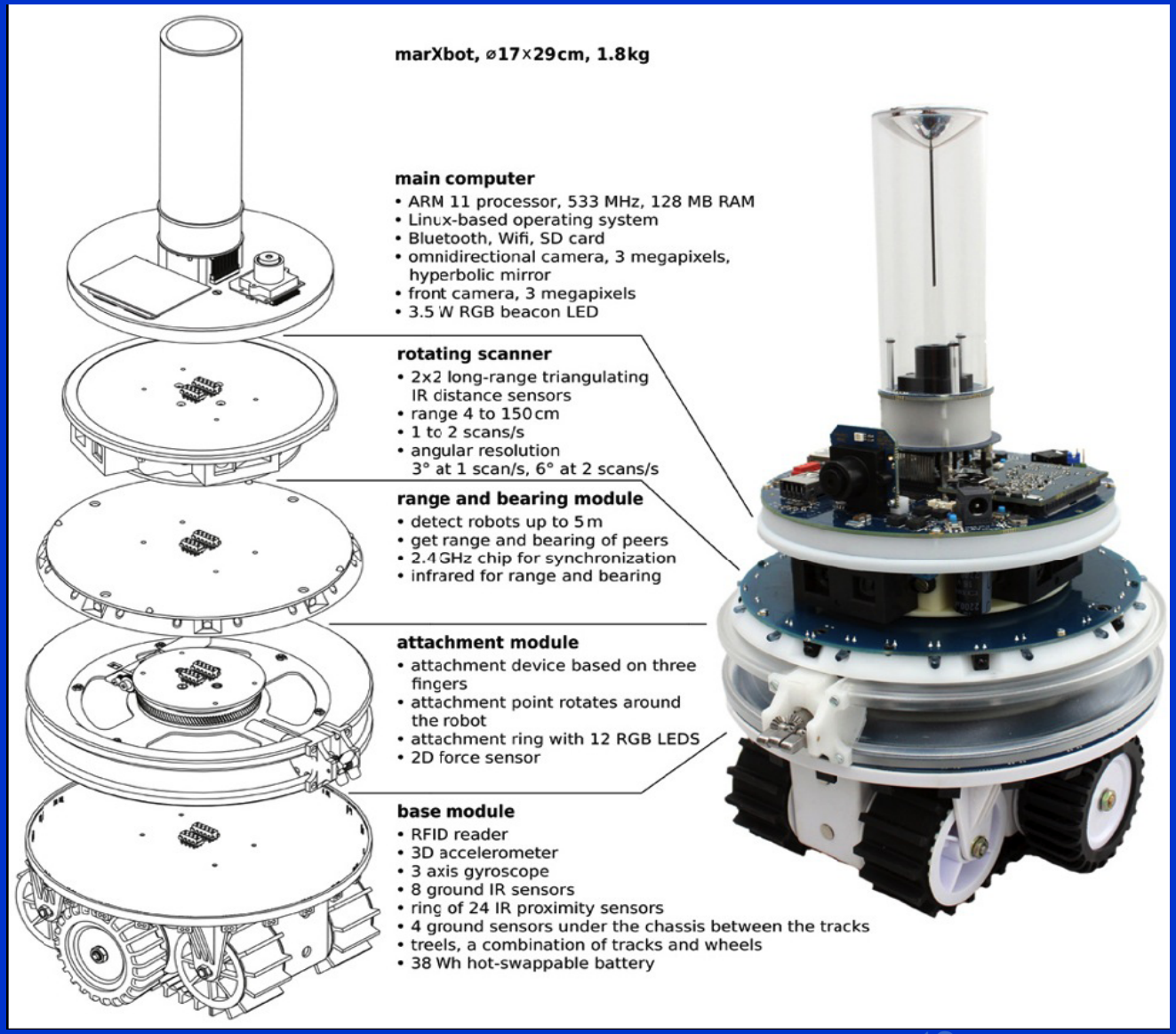
Modelli, Linguaggi, Basi di Dati e Software, I

- Modelli, Linguaggi, Basi di Dati e Software
  - Global computing
    - » Roberto Bruni, Andrea Corradini, Gianluigi Ferrari, Fabio Gadducci, Ugo Montanari
    - » => progetto ASCENS
    - » Constraint programming, Distributed system verification, Languages and models for concurrency, Service oriented computing, Visual specification formalisms
  - Sicurezza
    - » Chiara Bodei, Pierpaolo Degano, Gian-Luigi Ferrari, Carlo Montangero, Laura Semini
    - » Software engineering, Formal Methods, Verification and Enforcement, Security and Safety
  - Sistemi Service-Oriented
    - » Antonio Brogi
    - » Service-oriented computing, software adaptation, service discovery, service composition, formal methods
  - Sistemi Software e metaprogrammazione
    - » Giancarlo Bigi, Antonio Cisternino, Paolo Ferragina, Vincenzo Gervasi, Giuseppe Prencipe

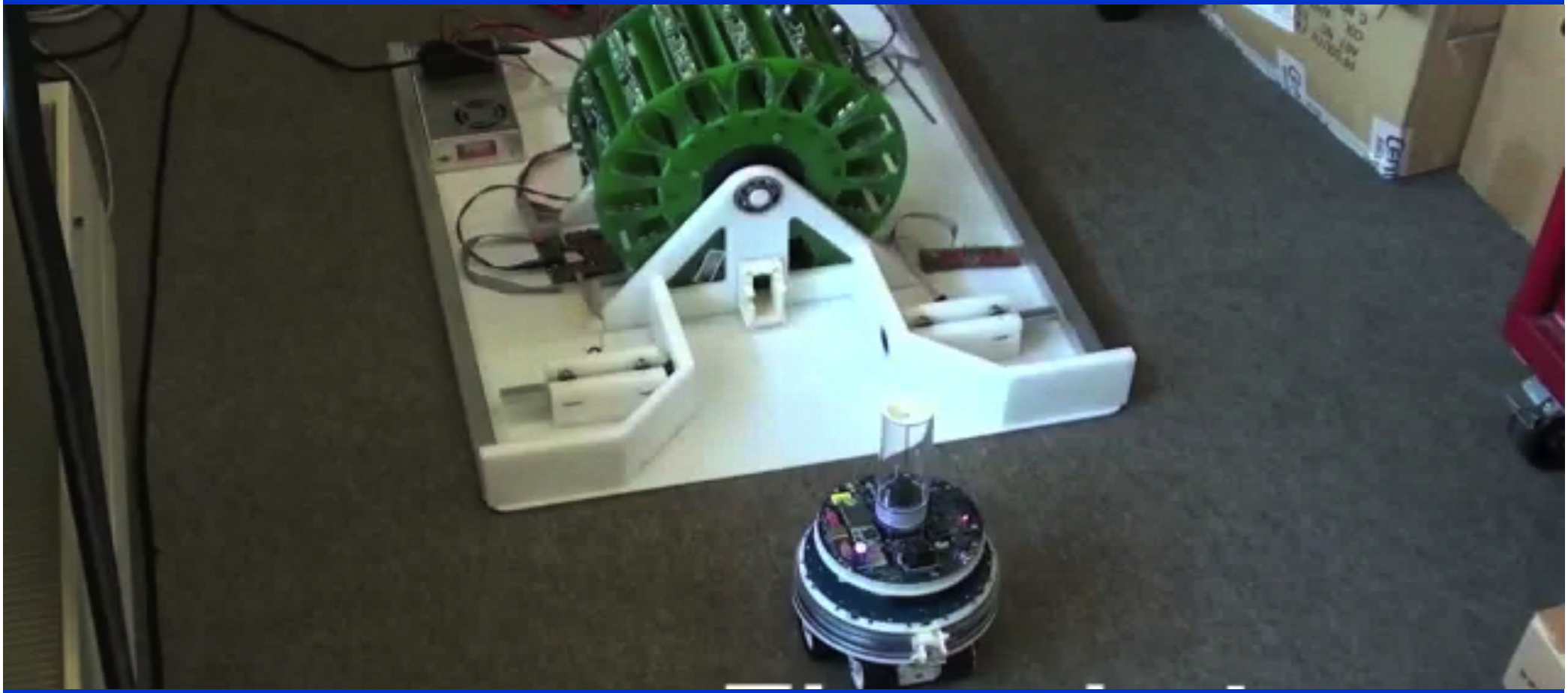
Modelli, Linguaggi, Basi di Dati e Software, II

- Modelli, Linguaggi, Basi di Dati e Software
  - Riuso del software
    - » Vincenzo Ambriola
    - » Software reuse, e-government, legal issues in computer science
  - Accesso efficiente a basi di dati
    - » Antonio Albano, Giorgio Ghelli
    - » Business Intelligence, Data Warehouse Systems, Query optimization, Education and Technology
    - » Data base programming languages, Data bases, Type systems, SPARQL, XQuery
  - Progettazione e implementazione di linguaggi di programmazione
    - » Marco Bellia, Eugenia Occhiuto
    - » higher order programming, object –oriented programming, reduction semantics, translation semantics, type system, preprocessing, programming methodologies, code reusability

The marXbot Robot Platform



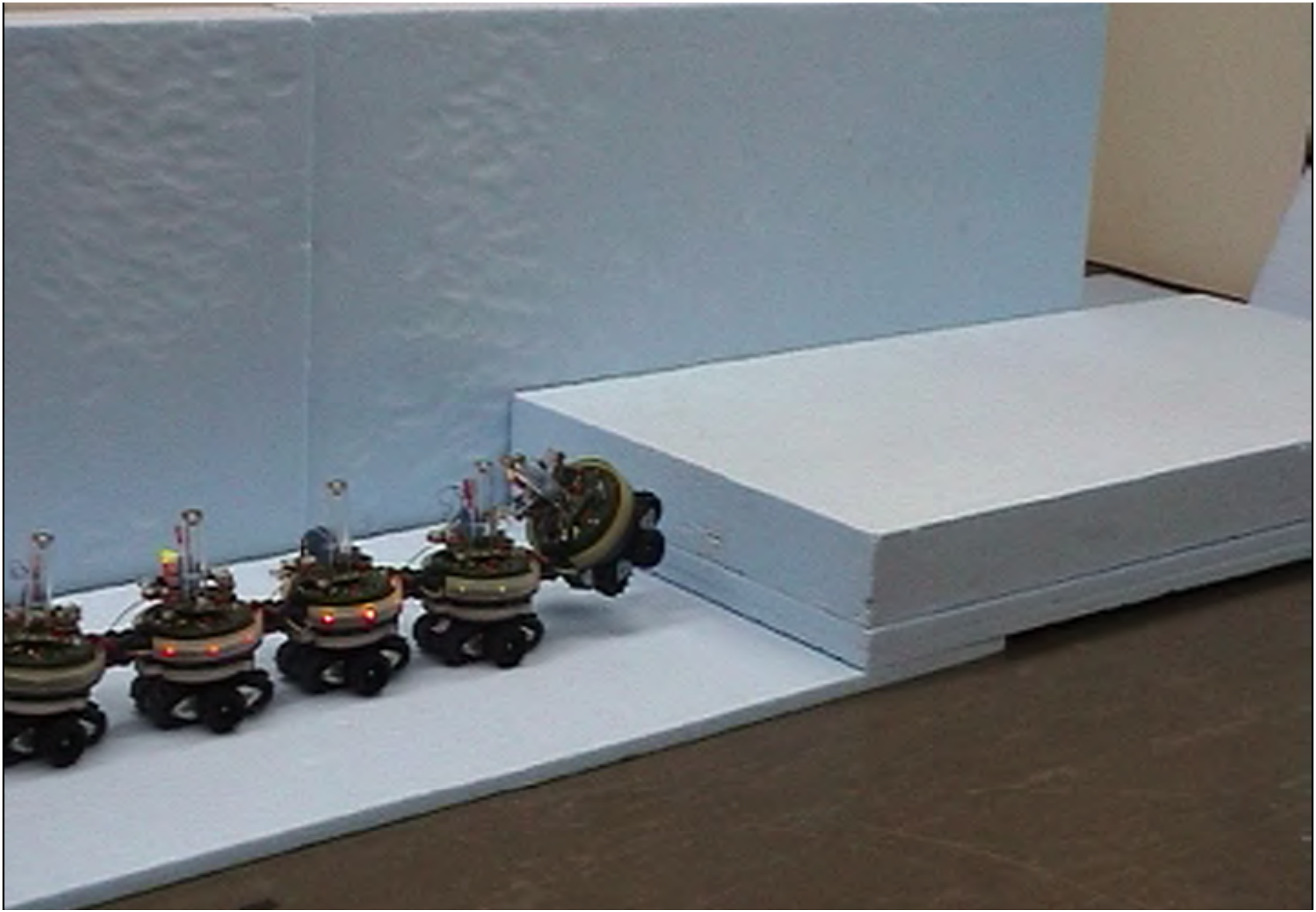
Recharging Batteries



Swarm Intelligence

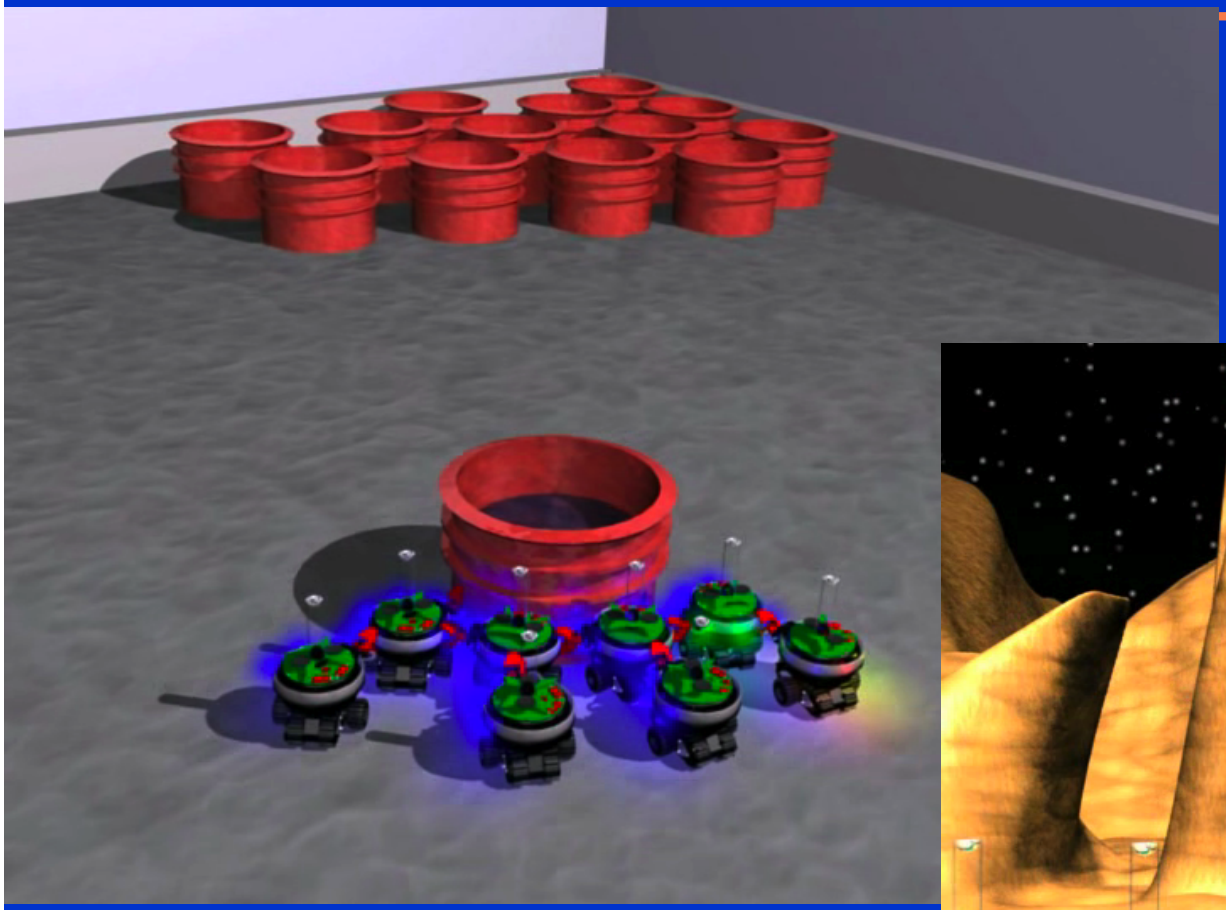
- Ants find the shortest path
  - Ants perform cooperative transport
    - Ants self-assemble to build a “bridge”

Swarm Intelligence

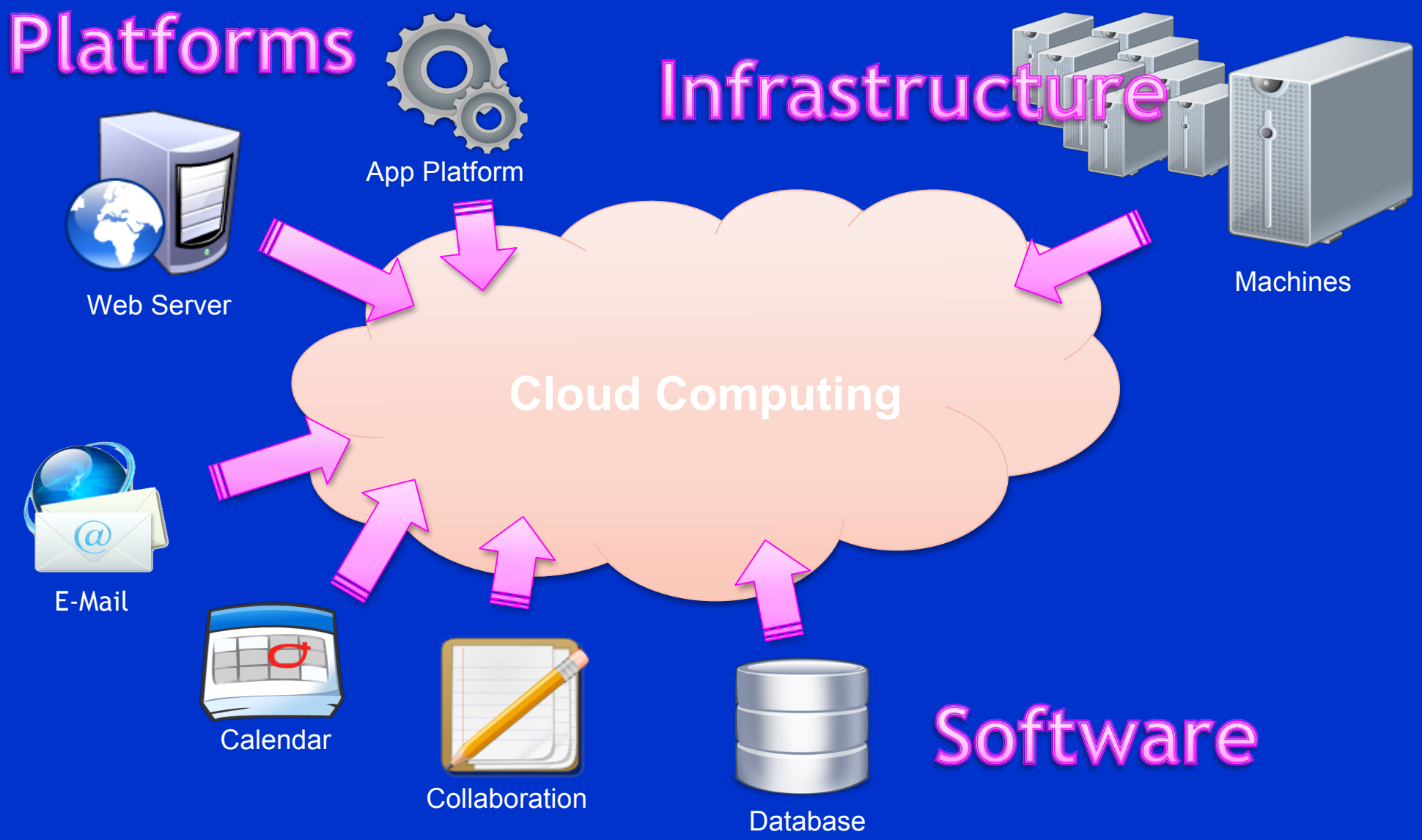


Simulation Model

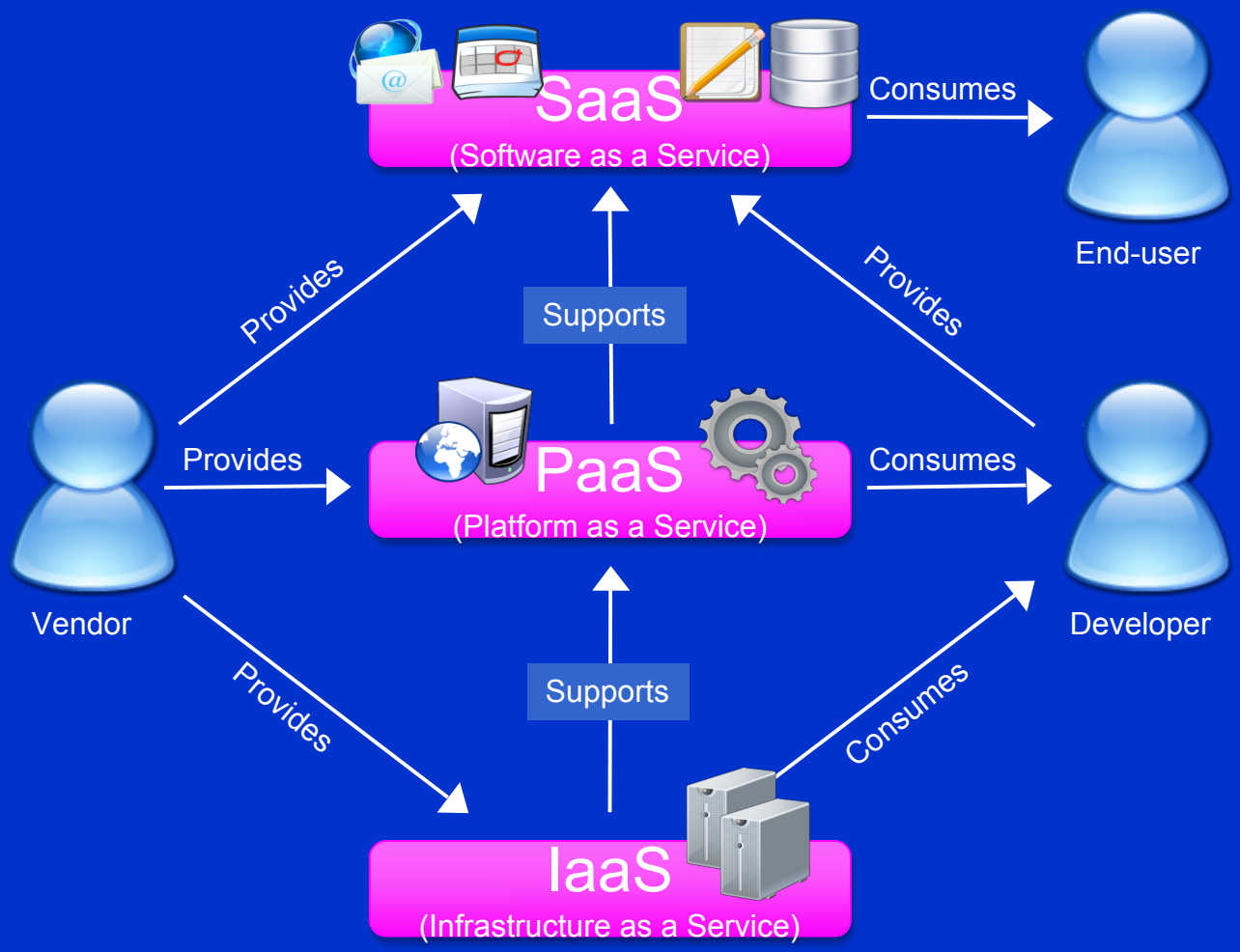
Collective Transport/Transit



Cloud Computing



Cloud Computing

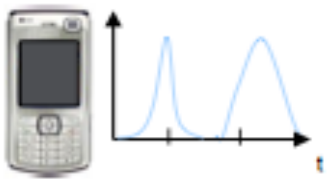


Briscoe, Marinos: Digital Ecosystems in the Clouds: Towards Community Cloud Computing

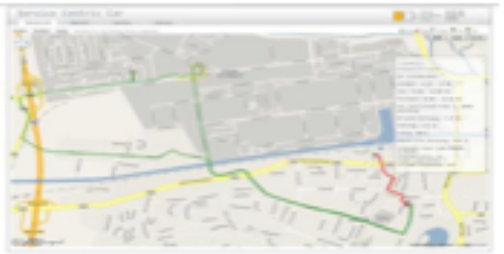
Case Study: e-Mobility

ascens

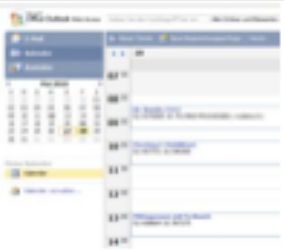
- Driver - Preferences & Behavior



- Traffic/HVAC: matching between history and current situation



- Driver-Time planer



- Energy network (estimation of energy consumption)

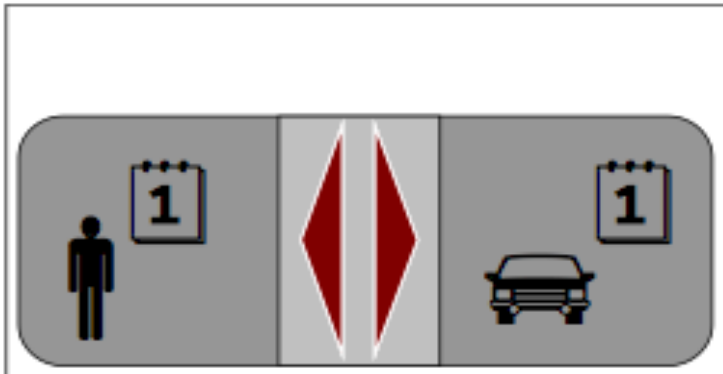
- Traffic-Simulator

Slides by
Dr. B. Werther, Dr. H. Bensler, N. Hoch
Volkswagen AG, Corporate Research

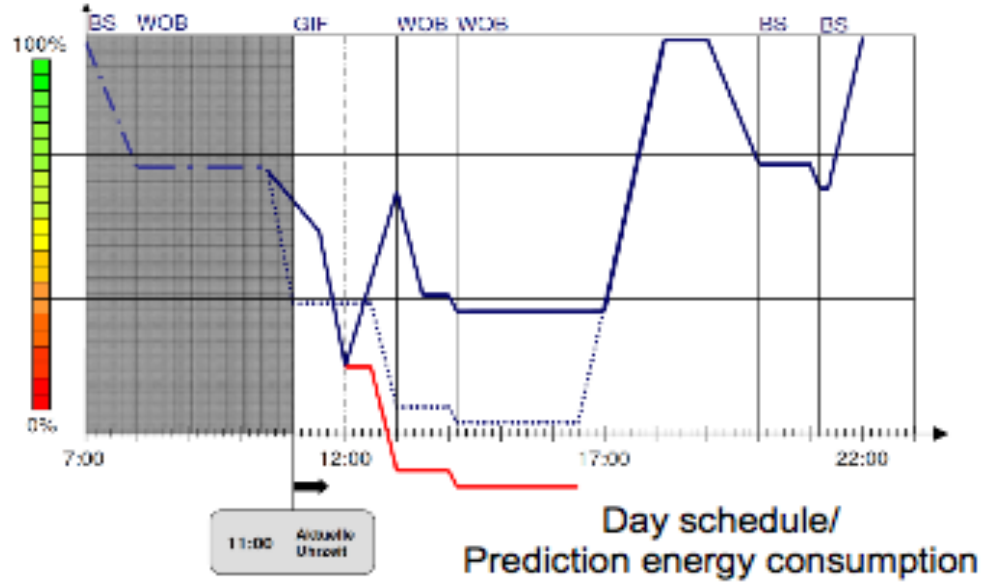
Daily Scheduler / Planer

ascens

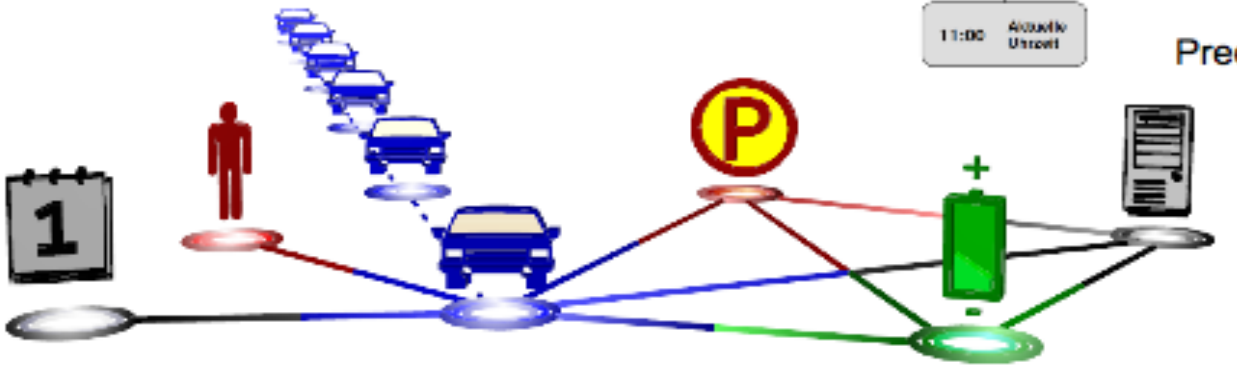
Focus on multi-criterial route optimization by integration of services



Organization timetable
driver-vehicle



Day schedule/
Prediction energy consumption



Intelligent interaction between vehicles and services

Car Pooling Planning for Vehicle fleets

ascens

Focus on individual mobility in communities

MiFA

Add on option Navi
- Journey goal
- Time table
- Max delay
- Number of free seat

Negotiation of Riding communities

MiFA

SMS (Mobil)
- Journey goal
- Time table

Feedback
Route of journey, participants

Ad hoc offer

Feedback Ride Sharing offer

Ad hoc request

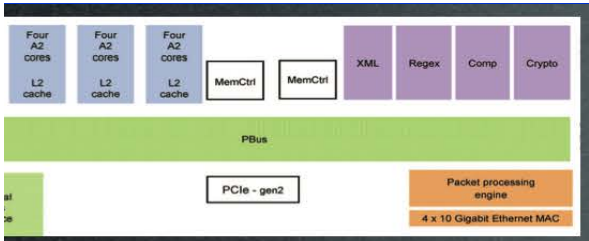
CAR POOLING SERVER

Infrastructure connection

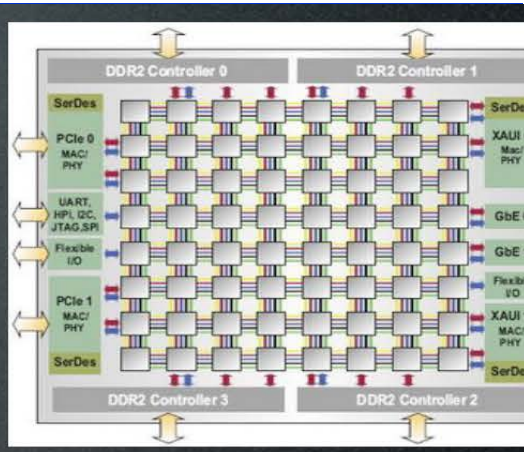
Agent platform

Architettura di Sistemi

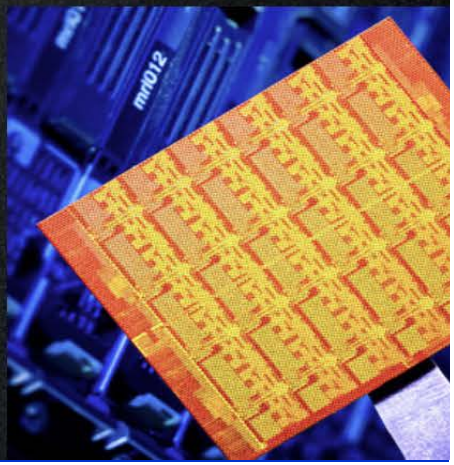
- Architettura di Sistemi
  - Architetture parallele e distribuite ad alte prestazioni
    - » Marco Danelutto, Marco Vanneschi
    - » => multi-many-core architectures
    - » Parallel and distributed architectures, parallel computation models and cost models, high-performance computing environment and tools, high-performance autonomic computing, high-performance applications
  - Modelli e strumenti per reti di calcolatori
    - » Fabrizio Baiardi, Maurizio Bonuccelli, Stefano Chessa,Augusto Ciuffoletti, Susanna Pelagatti, Laura Ricci
    - » => Wireless sensor networks
    - » cognitive radio networks, risk management, p2p overlay systems, wireless sensor networks, mobile networks
    - » distributed algorithms, clock, synchronization, network monitoring, grid computing, IaaS cloud computing



Hardware



- Currently
  - dual/quad core in mainstream
  - 48-64 core in niche/research areas
  - heterogeneous (Cell, WireSpeed)
  - co-processor (gp(?)GPUs)
- Expected: moore law (#cores)



Hardware → Software

- parallelizing compilers do not target O(100) cores
- Parallel code needed from the very beginning
  - design, compile, RTS, optimize
  - care of “shared memory” implementations

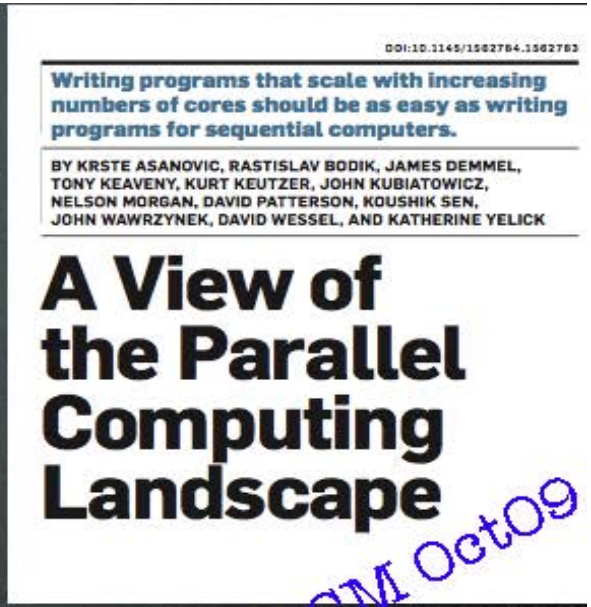
Hardware → Software

- parallelizing compilers do not target O(100) cores
- Parallel code needed from the very beginning
  - design, compile, RTS, optimize
  - care of "shared memory" implementations

Software (1)

- "ab initio" parallel sw
  - structured
    - algorithmic skeletons (since '90s)
    - design patterns (early '00)
      - Berkeley vision + Intel

→ structure simplifies problems



Software (2)

- non functional concerns
  - security, fault tolerance, power consumption, performance, ...
  - cross cutting concerns usually in charge of the application programmer

➙ must be moved (solved) to system sw (separation of concerns)

Wireless Sensor Networks (WSN)

- An emerging technology
- Monitoring of a large variety of environment
- Technological support to wide range of applications
  - Ticketing / access control
  - Infrastructure monitoring
  - AAL,…
- WSN provide basic context information acquisition and preprocessing services

Intelligenza Artificiale

- Intelligenza Artificiale
  - Knowledge discovery e data mining
    - » Dino Pedreschi, Salvatore Ruggieri, Franco Turini
    - » => big data
    - » data mining, mobility data mining, social network analysis, privacy-preserving data analytics, discrimination-aware data mining
  - Linguaggio naturale
    - » Giuseppe Attardi, Maria Simi
    - » Dependency parsing, question answering, opinion mining, relation extraction, semantic search
  - Apprendimento automatico e reti neurali
    - » Umberto Barcaro, Alessio Micheli
    - » Machine Learning, Neural Networks, Learning in Structured Domains, Cheminformatics, Signal Processing

Big Data

What **we** buy

What **we** search for

What **we** read

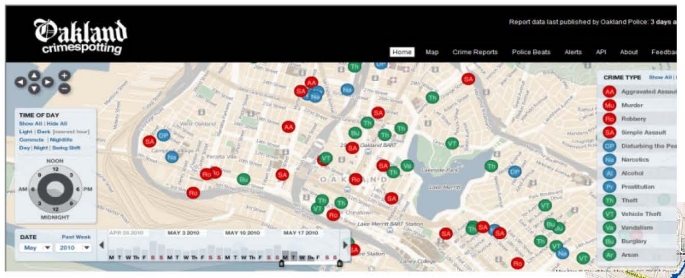
Whom **we** interact with

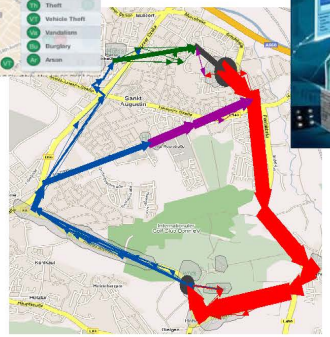
Where **we** go

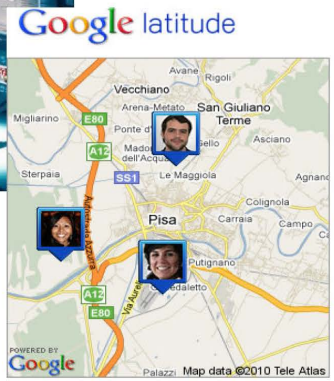
Big Opportunities

The age of **knowledge**
distilled from the ubiquitous data generated
as a side effect of our living by
automated discovery
of (data mining) models, patterns, rules,
profiles of
human behaviour

Actionable Knowledge







Spot business trends

Prevent diseases

Combat crime

Improve transportation

Personalised services

Location-aware services

Big Risks

Privacy

The degree to which an individual can determine which personal information is to be shared with whom and for what purpose

a *human right* that risks to become a chimera in the digital era

Discrimination

The unfair treatment of a person or group on the basis of specific attributes or of the performances of the group

an *illegal behavior* that risks to become a hidden feature of ICT systems

Ricerca Operativa

- Ricerca Operativa
  - Giancarlo Bigi, Antonio Frangioni, Giorgio Gallo, Maria Grazia Scutellà
  - network optimization, robust optimization, nonconvex optimization, varational inequalities and equilibria, ethical and societal implications of operations research

Informatica ed Educazione Scolastica

- Storia, insegnamento, strumenti educativi, competizioni
  - Chiara Bodei, Giovanni Cignoni, Antonio Cisternino, Gianna Del Corso, Fabio Gadducci, Roberto Grossi, Maria Rita Laganà, Laura Ricci
  - History of computer science, Teaching computer science to children, Computer science tools for interdisciplinary education, Computer science competitions as learning tool.