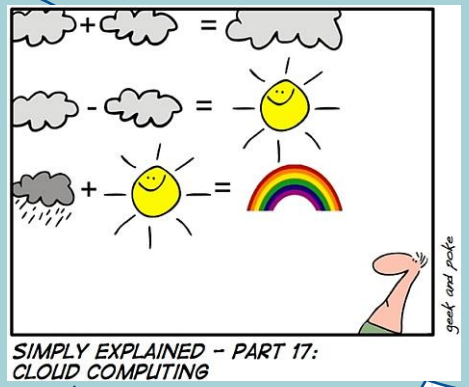
Cloud Technology-based Robotics

Imre J. Rudas

Óbuda University, Hungary
rudas@uni-obuda.hu

February 17, 2015

What is cloud computing?



February 17, 2015

What is cloud computing?

If you need milk, what do you do?

Do you buy milk?

Or do you buy a cow?

What is cloud computing?

What do computer users need?

They need to solve a problem by using software and/or hardware!

To have the benefits (milk) why should they buy the software and/or the hardware (cow)?

Cloud computing

Simple examples

Gmail

- From 2004
- June 2012 425 million users

Files Anywhere - File Sharing and Online Storage

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Special Publication 800-145

The NIST Definition of Cloud Computing

Recommendations of the National Institute of Standards and Technology

Peter Mell
Timothy Grance

bruary 17, 2015

Cloud computing

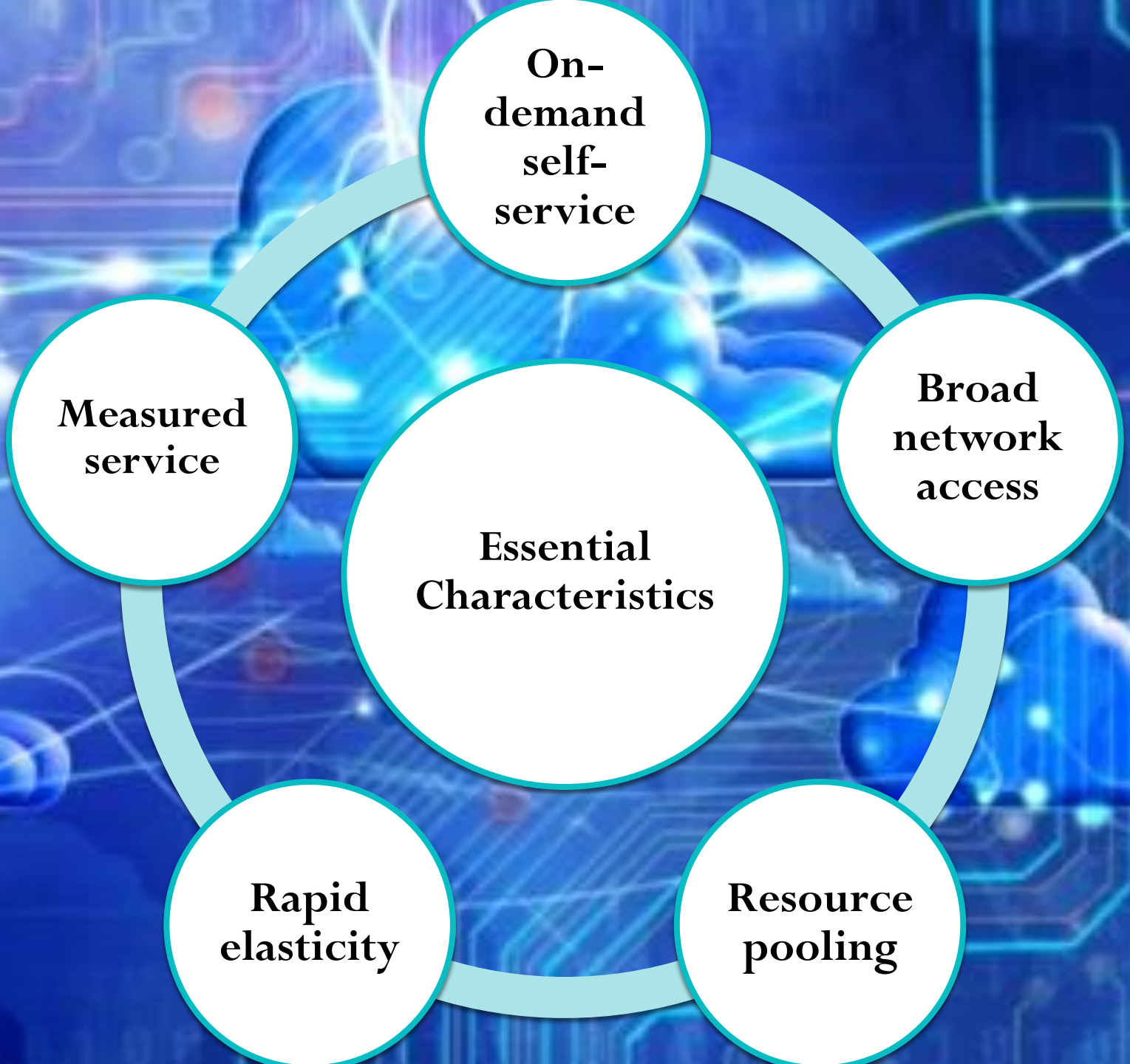
Cloud computing is a model for enabling

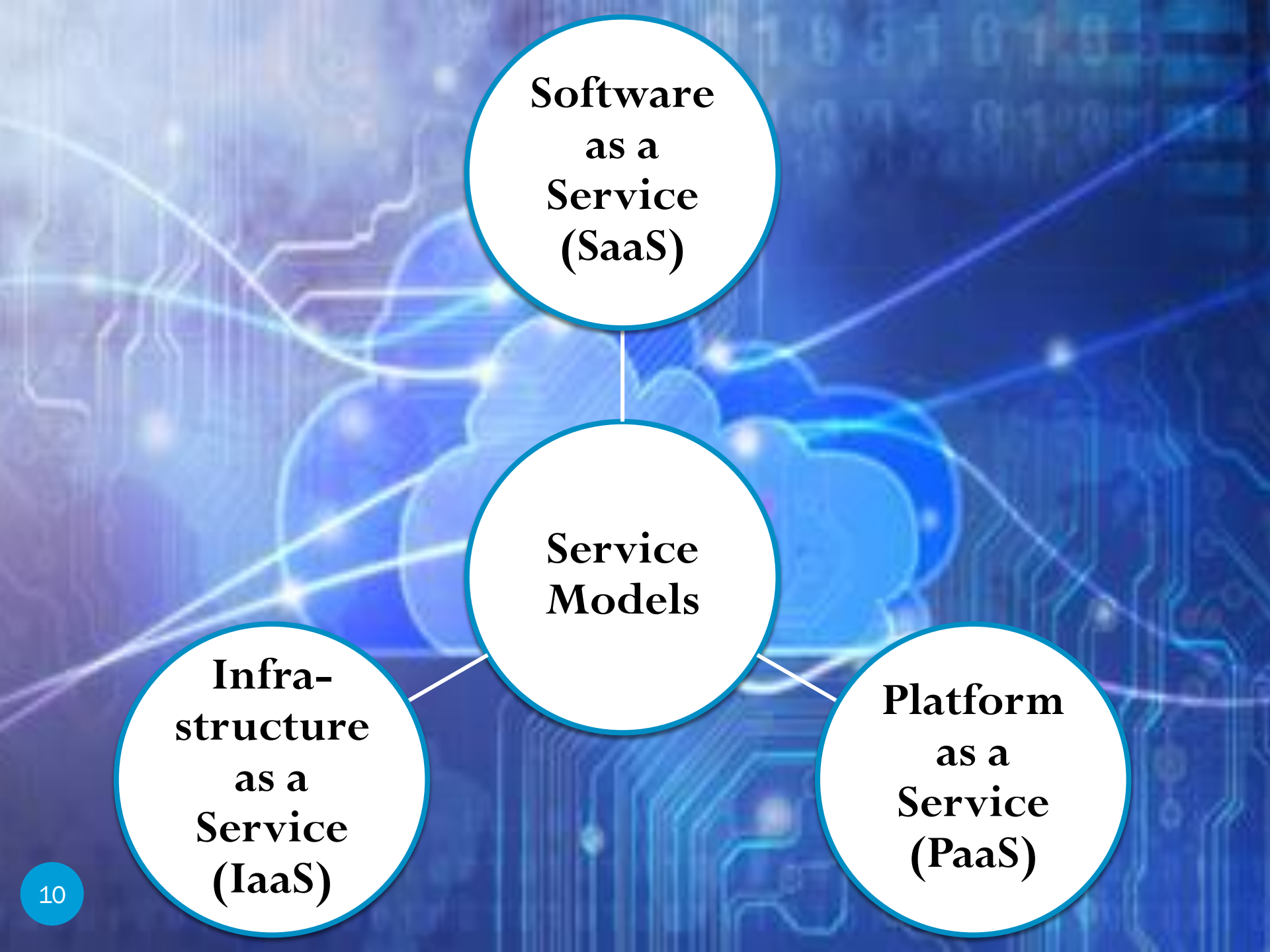
- **ubiquitous,**
- **convenient,**
- **on-demand**

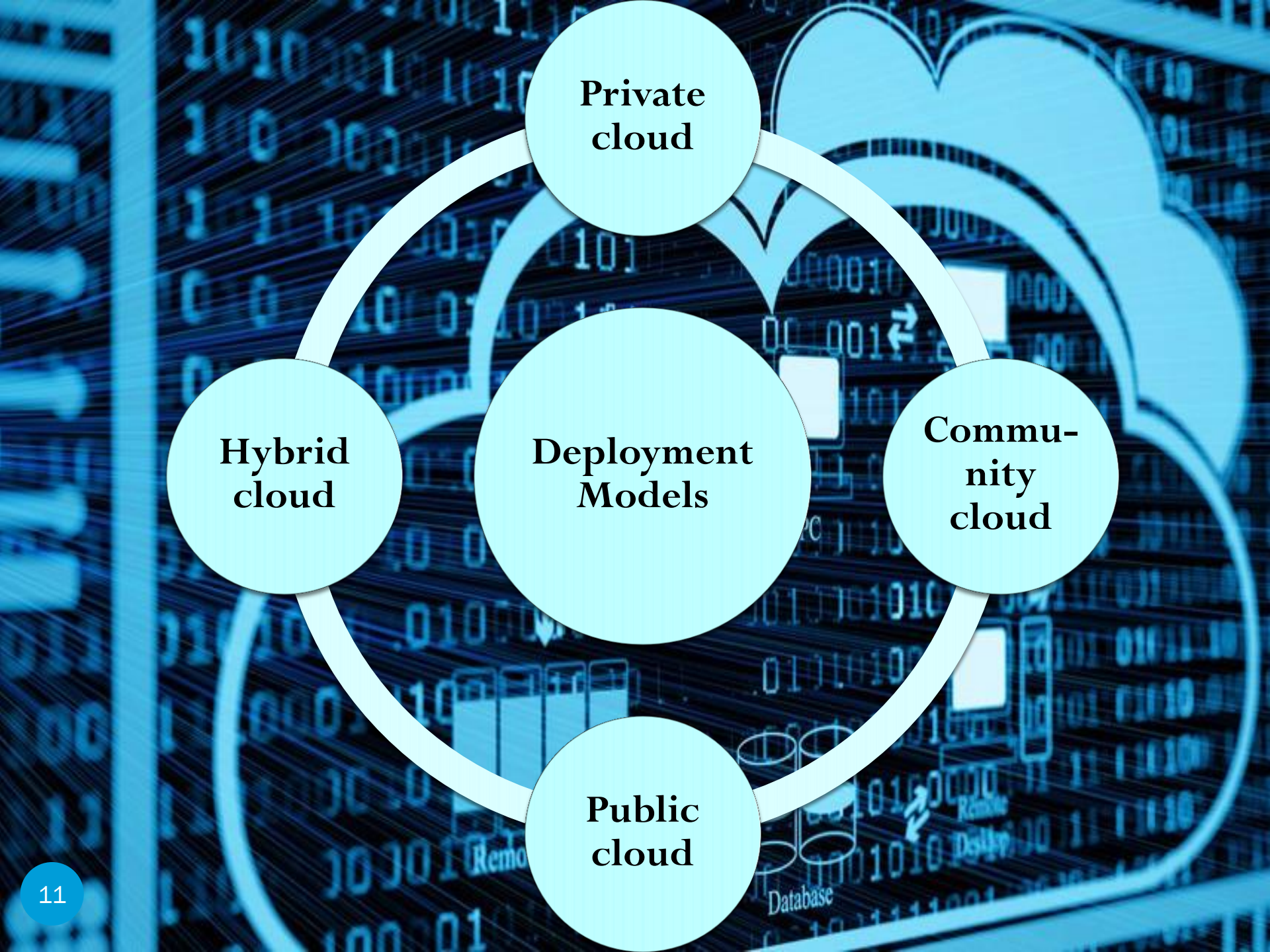
network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

The cloud model is composed of

- **five essential characteristics**
- **three service models**
- **four deployment models**


On-demand self-service
Broad network access
Resource pooling
Rapid elasticity
Measured service
Essential Characteristics


Software as a Service (SaaS)
Service Models
Infra-structure as a Service (IaaS)
Platform as a Service (PaaS)


Private cloud
Hybrid cloud
Deployment Models
Commu-nity cloud
Public cloud

Web Application

Software as a service

Application

Grid Computing

Platform visualization

Infrastructure

Cloud Computing

Platform

Web application frameworks

Web hosting

Storage

Database

Synchronization

"It was much nicer before people started storing all their personal information in the cloud."

Cloud Technology

The definition is based on the definition of Cloud Computing given by NIST

February 17, 2015

Cloud Technology

Cloud Technology is a model for enabling

- **ubiquitous,**
- **convenient,**
- **on-demand**

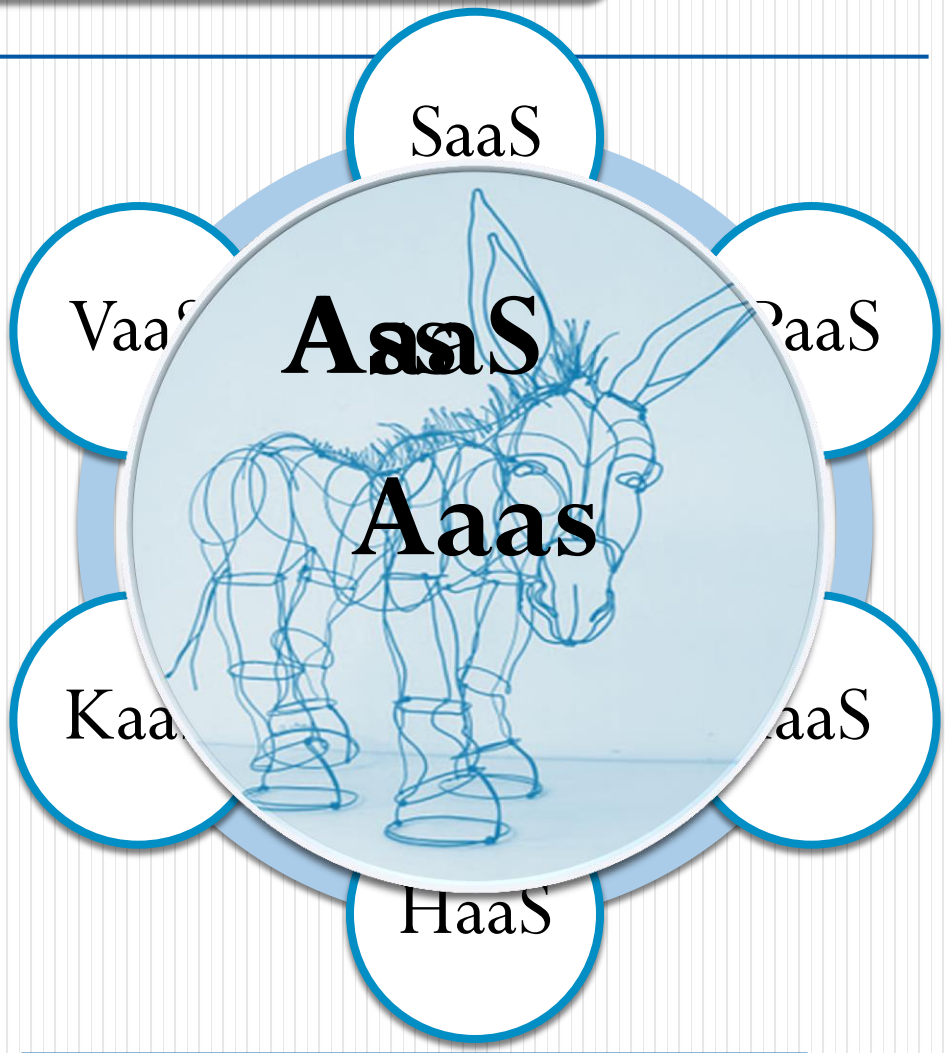
(network) access to a shared pool of (configurable) resources that can be provisioned and released with minimal management effort or service provider interaction.

The Service Models

Anything as a Service (AaaS)

SaaS	• Software as a Service
PaaS	• Platform as a Service
IaaS	• Infrastructure as a Service
KaaS	• Knowledge as a Service
HaaS	• Hardware as a Service
VaaS	• Virtualization as a Services
XaaS	• X as a Service

AaaS Services



Cloud Robotics

Defining Cloud Robotics

Ken Goldberg

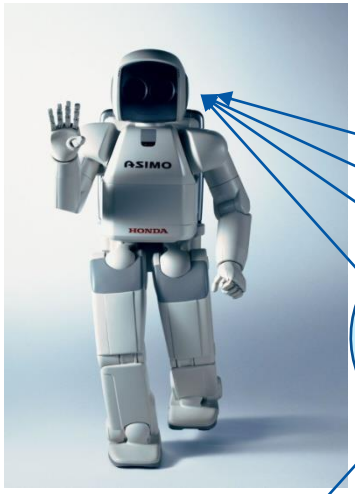
- *"Humans as a species are getting smarter because we are able to share information […] robots have that potential as well"*

Defining Cloud Robotics

B. Kehoe, A. Matsukawa, S. Candido, J. Kuffner, K. Goldberg

- *"…robots are connected to modern cloud-computing infrastructure for access to distributed computing resources […], the ability to share training and labeling data for robot learning"*

Could we extend the brain capacity of our robot



with

- Computational power
- Programming capability
- Memory
- Software access
- Collective Learning
- …

Cloud (minded) robotics

The mind is in the cloud!

What is needed?

- **Huge computing power**
- **Broad network access**
- **Anything as a Service**

Learning

Reasoning

Problem Solving

AaaS

Diagnostics

Planning

Navigation

Decision making

Diagnostics

Some Cloud Robotics Projects

Public clouds for robotics

Open Source Robotics Foundation
(http://www.osrfoundation.org/)

ROS (http://www.ros.org/wiki/)

Open Source Robotics Foundation

Community

ROS Kong 2014 is an international ROS users group meeting, on June 6th at Hong Kong University, immediately following ICRA. This one-day event, our first official ROS meeting in Asia, will complement ROSCon 2014, which will happen later this year. Register today!

ROS KONG WEBSITE

Our Mission

The mission of OSRF is "to support the development, distribution, and adoption of open source software for use in robotics research, education, and product development."

Latest News

ROS Meets Precision Agriculture at Blue River Technology

Posted by Brian Gerkey | Jun 05, 2014

GAZEBO

GAZEBO

Gazebo is a 3D multi-robot simulator with dynamics. It is capable of simulating a population of robots, sensors and objects in a three-dimensional world. It generates both realistic sensor feedback and physically plausible interactions between objects (it includes an accurate simulation of rigid-body physics).

ROS.org

ROS (Robot Operating System) provides libraries and tools to help software developers create robot applications. It provides hardware abstraction, device

ROS.org

ROS (Robot Operating System) provides libraries and tools to help software developers create robot applications. It provides hardware abstraction, device drivers, libraries, visualizers, message-passing, package management, and more. ROS is licensed under an open source, BSD license.

Documentation - ROS Wiki

ROS.org

About | Support | answers.ros.org

ROSCon 2012
May 19-20

Search: Submit

Documentation | Browse Software | News | Download

ROS:

Install

Install ROS on your machine.

Getting Started

Tutorials, technical overview, and links to getting help. Also, check out the ROScheatsheet.pdf

Contribute

How to contribute to the ROS community, such as submitting your own repository. See the ROS Planet for what others are doing

Support

What to do if something doesn't work as expected.

Mirrors

Mirrors of this wiki.

ROS.org

About | Support | answers.ros.org

ROSCon 2012 May 19-20

Search:

Documentation | Browse Software | News | Download

Software:

Core Libraries

APIs by language and topic.

Common Tools

Common tools for developing and debugging ROS software.

Search Software

Search the 2000+ libraries available for ROS.

Robots/Hardware:

Robots

Robots that you can use with ROS.

Sensors

Sensor drivers for ROS.

1. Portals

Portal pages help you install and use ROS software on specific robot platforms.

Fraunhofer IPA Care-O-bot

Videre Erratic

TurtleBot

Aldebaran Nao

Lego NXT

Shadow Robot

Willow Garage PR2

iRobot Roomba

Robotnik Guardian

Merlin miabotPro

AscTec Quadrotor

CoroWare Corobot

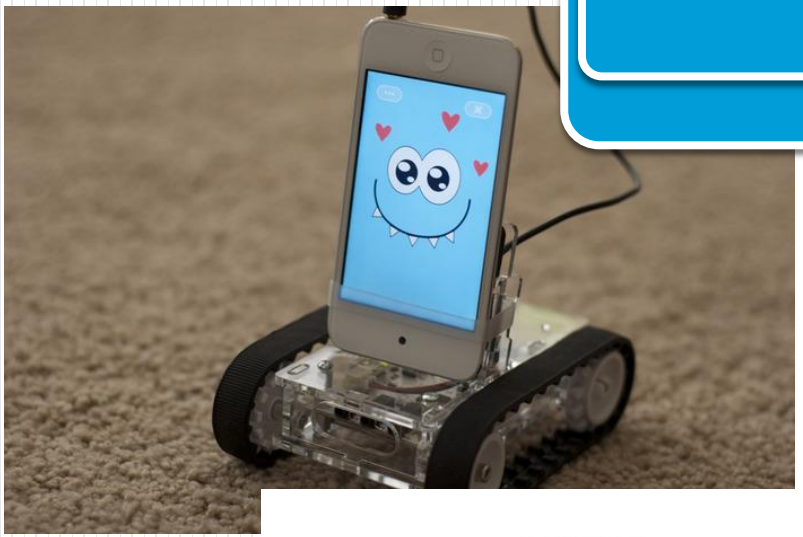
Clearpath Robotics Husky

Clearpath Robotics Kingfisher

Festo Didactic Robotino

Romo

The Smartphone Robot



Best of all, you can play with me...

from anywhere in the world!

Play Together

Invite friends and family to control Romo from anywhere in the world, using a simple, private URL invite*. Grandparents can play hide-and-seek with grandkids!

Evolving Behaviors

Help Romo grow. The more you use him, the more he learns. Unlock new features by completing challenges.

Create + Share

Using a simple graphical programming interface, users create new activities or faces for Romo and share them with the world.

Romo Games

Play games like Romo Doodle. Control Romo's movements by drawing directly on the controller device screen, then watch Romo trace out your pattern in real life.

Romo Apps Bring Your Robot to Life

Control how fast Romo drives, download new expressions and behaviors, or customize app backgrounds and colors.

Pet Presence

Wonder how Buffy spends her days? Play with your pets from work using your browser.


535-935
1
2
3
4
5
6
7
8
9

RoboEarth

RoboEarth is a European project led by the Eindhoven University of Technology, in the Netherlands, to develop

a "World Wide Web for robots," a giant database where robots can share information and learn from each other about objects, environments, and tasks

DA vinCI Cloud Computing Framework

The DAvinCi framework combines the distributed ROS architecture, the open source Hadoop Distributed File System (HDFS) and the Hadoop Map/Reduce Framework.

Data Storage Institute, A*STAR, Singapore.
Rajesh VA@dsi.a-star.edu.sg

DragonBot: A platform for cloud-based social robotics

by **Adam Setapen** 8 months 1 week ago

DragonBot is a new robot platform from the Personal Robots Group at the MIT Media Lab. Specifically designed to support long-term learning interactions between children and robots, this video introduces Kombusto, the first DragonBot. The robot runs entirely on an Android cell phone, which displays an animated virtual face. Additionally, the phone provides sensory input (camera and microphone) and fully controls the actuation of the robot (motors and speakers). Most importantly, the phone always has an Internet connection, so a robot can harness cloud-computing paradigms to learn from the collective interactions of multiple robots. To support long-term interactions, DragonBot is a "blended-reality" character—if you remove the phone from the robot, a virtual avatar appears on the screen and the user can still interact with the virtual character on the go. Costing less than $1,000, DragonBot was made to be a low-cost platform that can support longitudinal studies of human-robot interactions "in the wild".

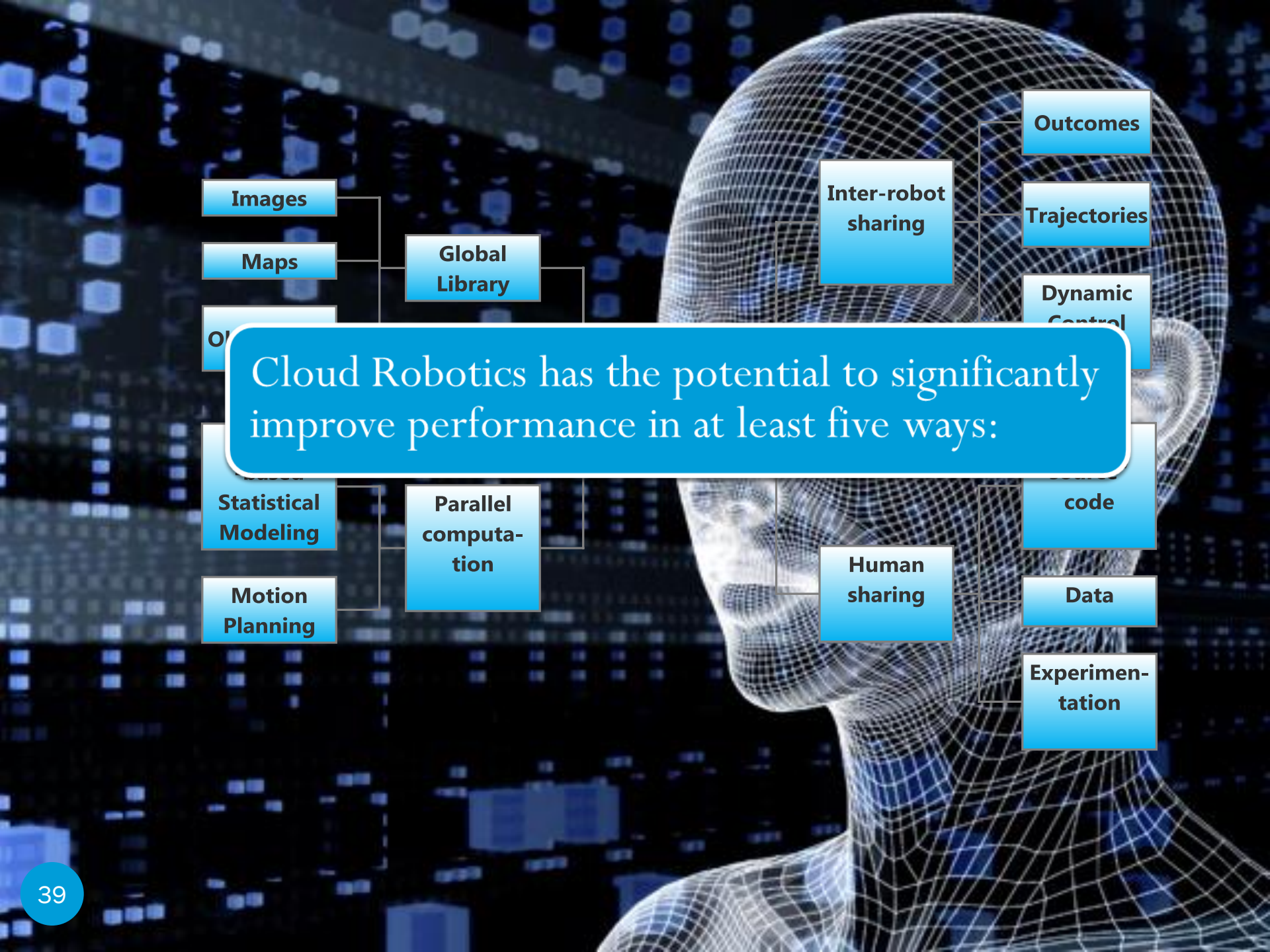
DragonBot is a new robot platform from the Personal Robots Group at the MIT Media Lab.

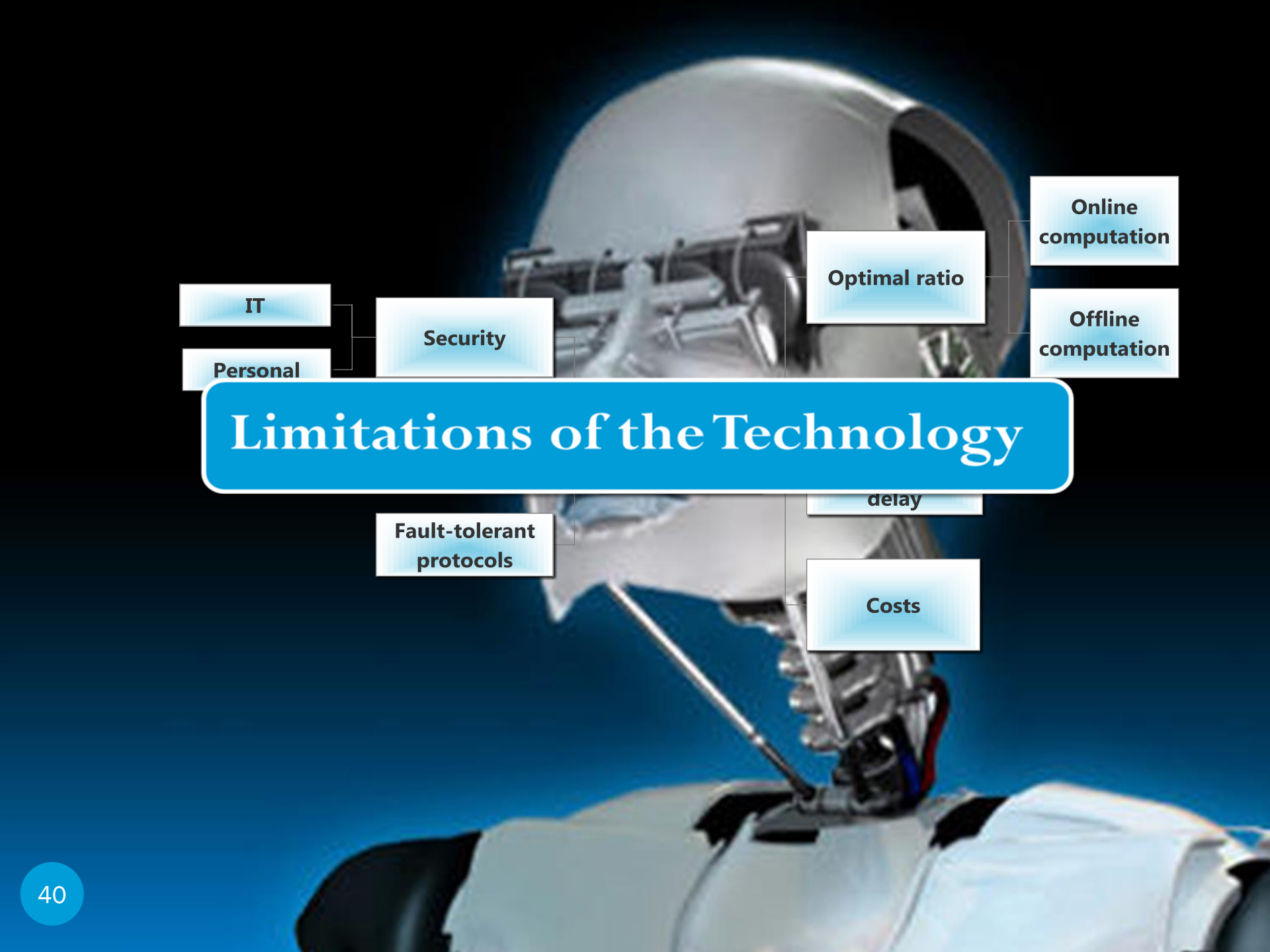
Specifically designed to support long-term learning interactions between children and robots.

The robot runs entirely on an Android cell phone, which displays an animated virtual face.

The phone provides sensory input (camera and microphone) and fully controls the actuation of the robot (motors and speakers).

The phone always has an Internet connection, so a robot can learn from the collective interactions of multiple robots.


Images
Maps
Global Library
Statistical Modeling
Parallel computa-tion
Motion Planning
Inter-robot sharing
Outcomes
Trajectories
Dynamic
code
Human sharing
Data
Experimen-tation
Cloud Robotics has the potential to significantly improve performance in at least five ways:


Limitations of the Technology
IT
Personal
Security
Fault-tolerant protocols
Optimal ratio
Online computation
Offline computation
delay
Costs

Robots with up-to-date knowledge will become a helping hand for humanity

Creation of a global database for navigation, mapping, planning task execution

Robots joined CR networks

Big Data enters robotics

Swarm of simple robots and robotic devices

The future of Cloud Robotics

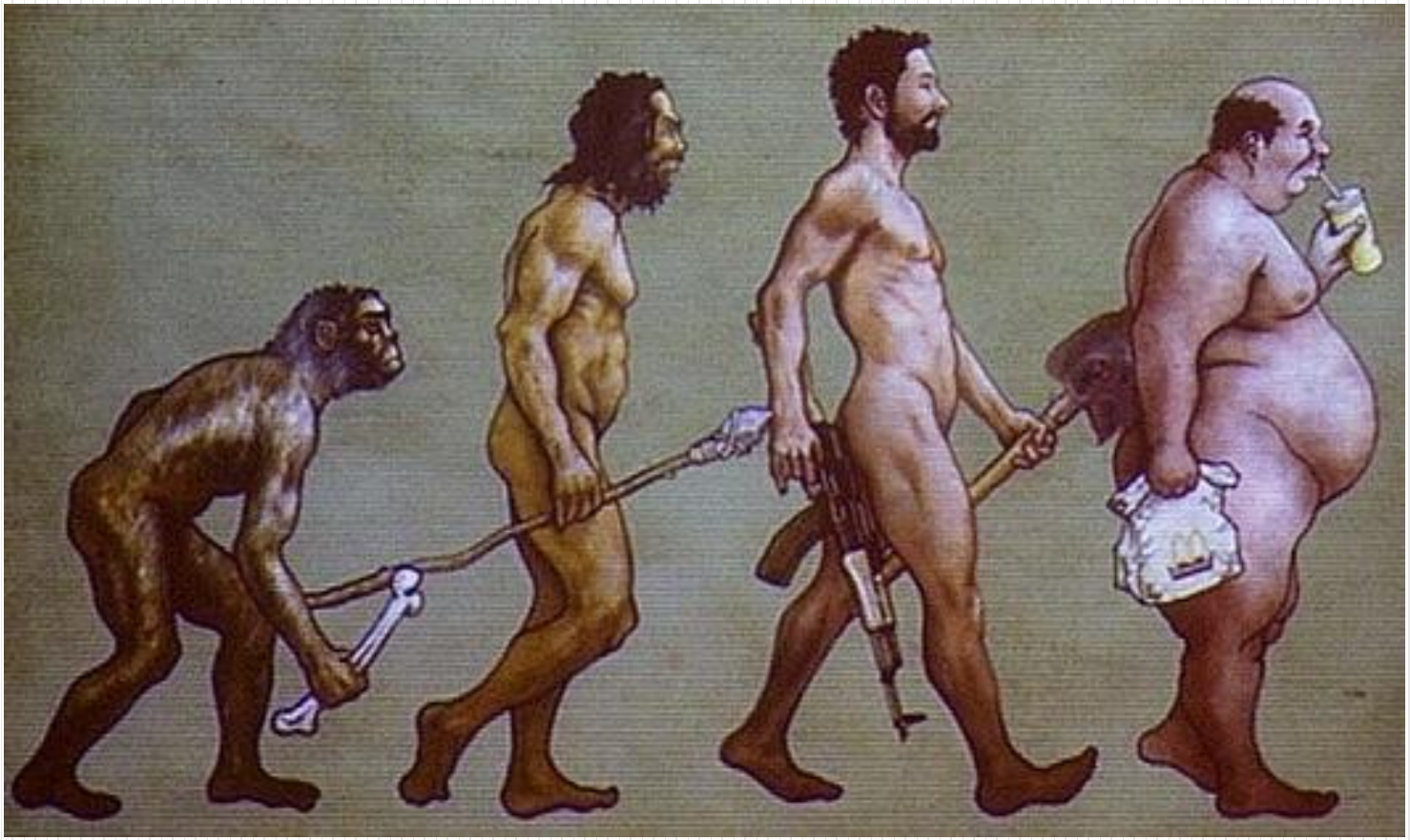
Rise of distributed intelligence in robotics

Towards

Cloud Technology-based Society

Evolution

Evolution



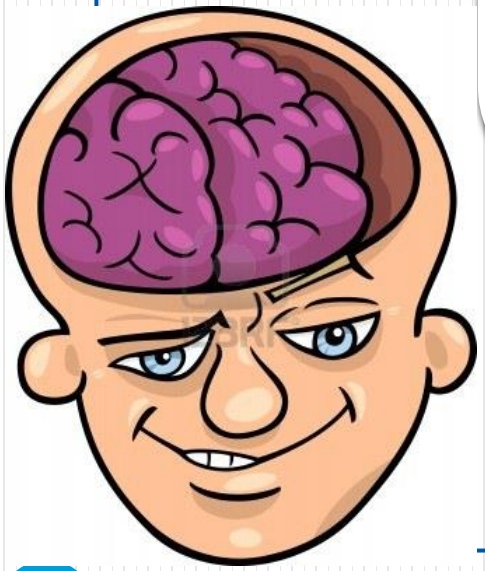
Evolution

Homo Computeros

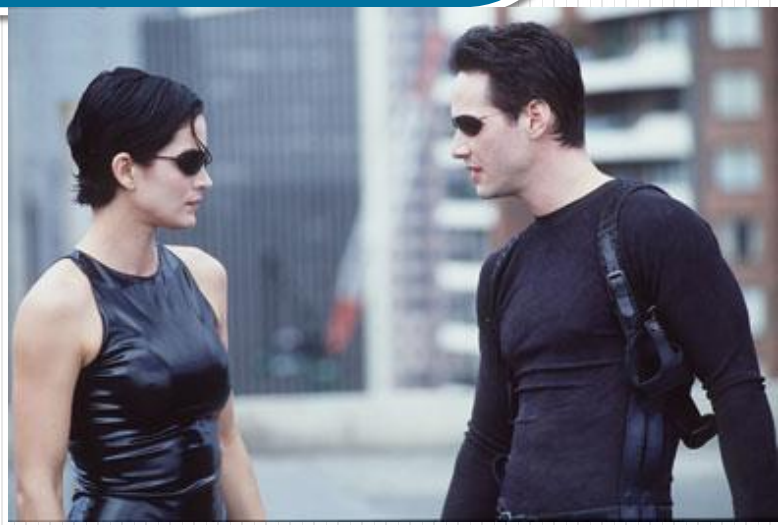
Homo Mobilos

Homo Cloudos

Can human beings be as clever as cloud minded robots?



In the first "Matrix" movie, there's a scene where Neo points to a helicopter on a rooftop and asks Trinity, "Can you fly that thing?" Her answer: "Not yet."Then she gets a "pilot program" uploaded to her brain and they fly away.



Our everyday life is infected

February 17, 2015

Mom! How do babies born?

They are downloaded from the Cloud!


No, Grandma listen!!!
Double-click the icon and you can start to download from the cloud!!!


Everybody is connected everywhere!
Under the cloud!

Thank you for your attention!