Higher Order Shape Representations for Increased Quality of Experience in 3D Internet

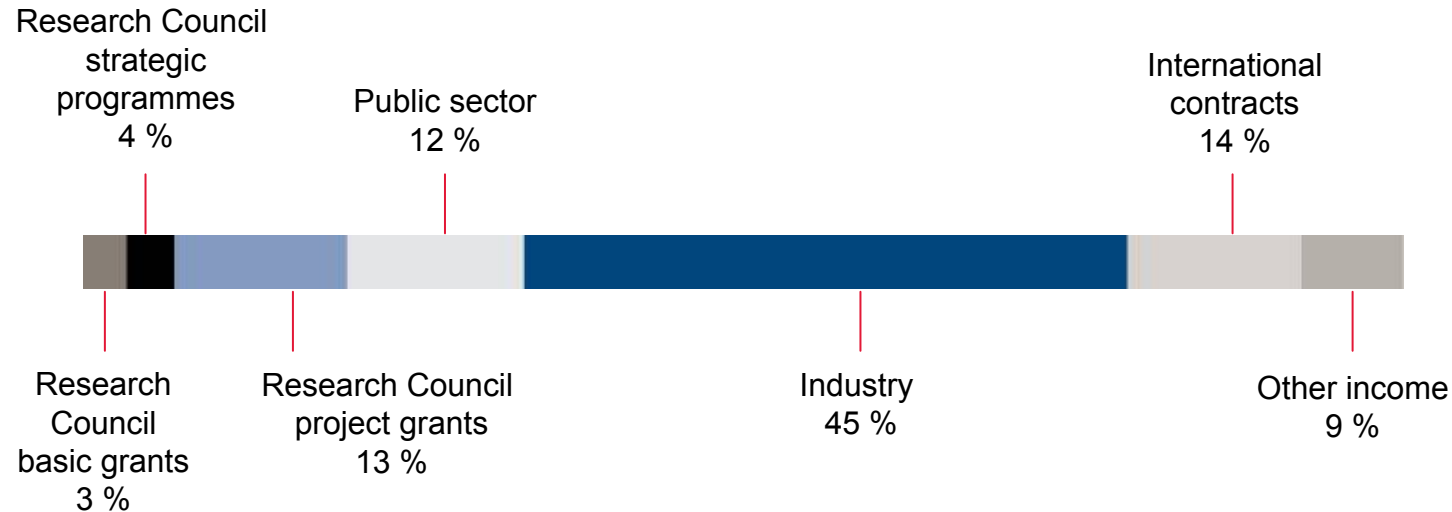Tor Dokken and Ewald Quak, SINTEF, NO

Andre Stork, Fraunhofer IGD, DE

Michał Koziuk and Łukasz Kwoska, one2tribe; PL

SINTEF

- Our vision is "*Technology for a better society*". We aim to contribute to growth in value creation, improved quality of life and a sustainable development through research and knowledge.

- SINTEF is a non-commercial organization. Income from contract research is invested in further research, scientific equipment and expertise.

- Most of the income is from time limited grants and project contracts.

- Some numbers:
    - 2150 Employees
    - 69% of staff scientific personnel,
    - 13% administrative
    - 10% Engineers
    - 8% Technical personnel

- 42% of the researchers have a doctorate

SINTEF revenues

Research Council
strategic
programmes
4 %

Public sector
12 %

International
contracts
14 %

Research
Council
basic grants
3 %

Research Council
project grants
13 %

Industry
45 %

Other income
9 %

- Turnover 2007: NOK 2. 6billion, (≈ € 295 million)
- The SINTEF existence is dependent on actively addressing new opportunities
    - Consequently the opportunities of the EU framework programs are actively pursued

Initial comments

- The authors of this paper submitted an application for Call 4 of EU's ICT program April 1, 2009 addressing:
  - ICT-2009.1.5: Networked Media and 3D Internet
  - During the application preparation we decided to present the approach to a larger audience independent of success or not for the application.
- However, to reduce a 60 page proposal to 6 pages included references was much tougher than expected
  - We were allowed to submit the paper late
  - The paper started out as 17 pages, reduced to 8 and later to 6 pages, much details on state-of-the-art has been removed
  - We hope that a longer version of the paper can be published later
- I come from the Computer Aided Geometric Design (CAGD) community
  - I might not use the right terminology for the 3D web community
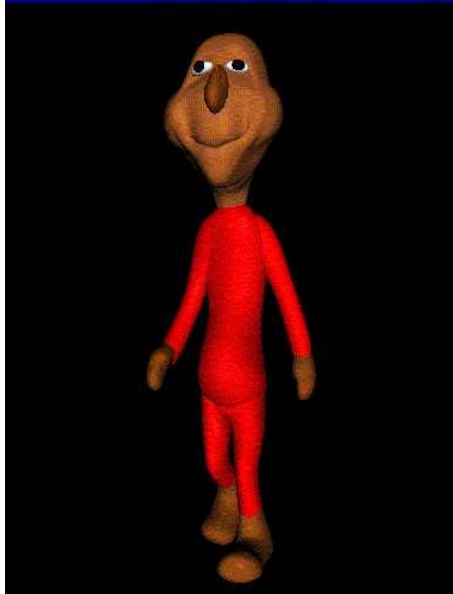
Taking a look at ten years old pictures.

Image	Graphics	Geometry
180 000 numbers	45000 numbers	4500 numbers

Taking a look at ten years old pictures.

Skeleton animated NURBS
body from 1999
800MHz Intel processor

We did impressive graphics both on PDAs and PCs ten years ago combining

- Compact representation of shape by NURBS
- Direct animation on NURBS
- Intelligent update of point coordinates of tessellation
- Efficient use of graphics resources

Animated NURBS head
on Ericsson prototype
1999 on a 206 MHz
StrongArm processor

- **Used Open GL on PCs.**
- **Tailored 3D graphics library for the Compaq iPAQ using only integer arithmetic**

Consequently the idea for use of higher order shape representations for increased quality of experience is not new
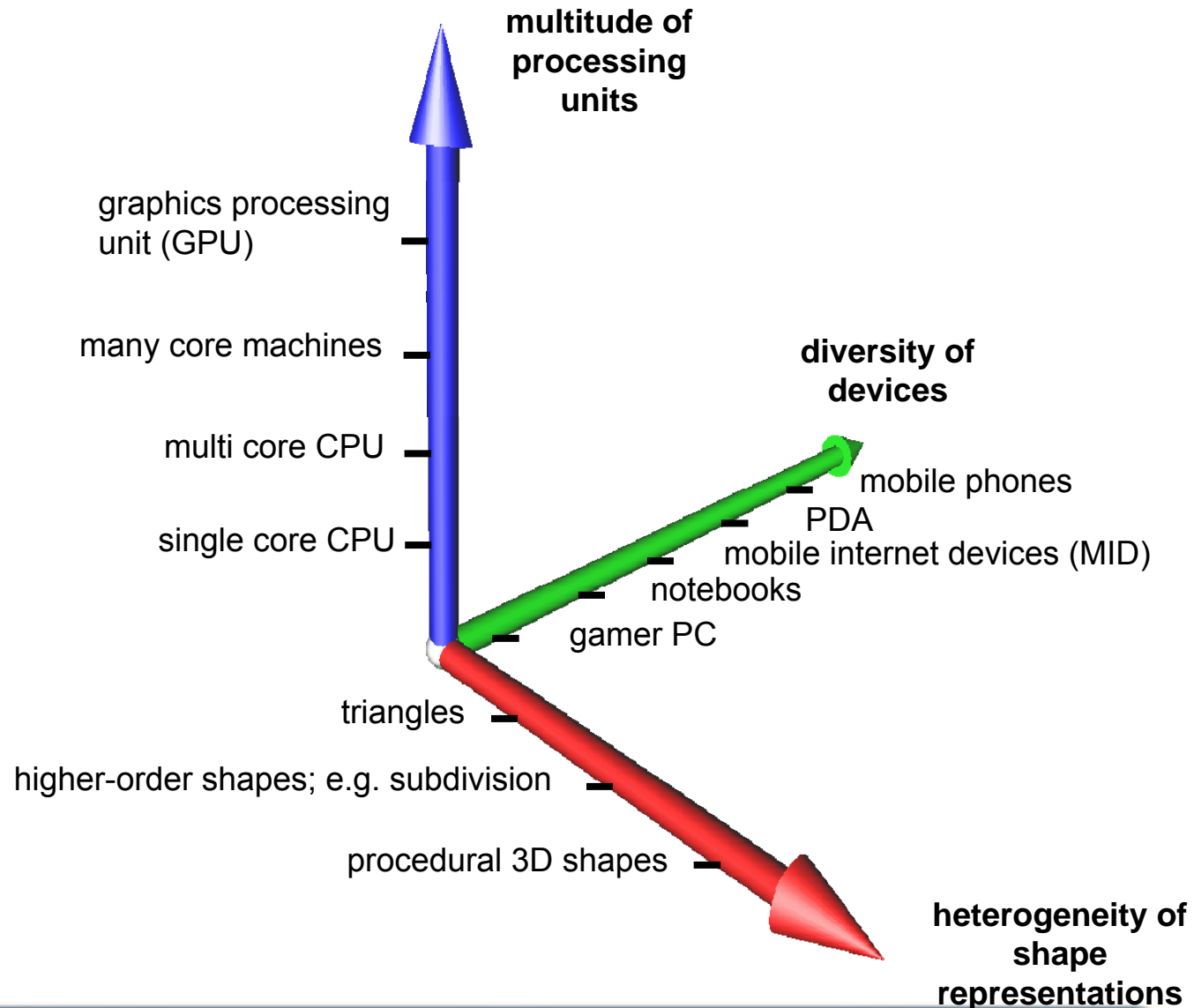
- One of the paper reviewers stated this.
- The time was not mature for such ideas when we addressed this issue earlier
- However, due to the evolution of technology the approach should be retried, e.g., integration into browsers:
    - Through Flash
    - The announced new standard: *Accelerated 3D on Web* (Khronos Group, March 2009).

What is the idea all about? (1)

- The user quality of experience of current 3D Internet technology lags far behind the one of installed 3D applications. We believe that a broad uptake of '3D Media Internet' depends on a significant improvement of the user quality of experience, which should not significantly differ from the quality offered by similar 3D services installed on the user's device.

- Beside this observation, **the appoach is motivated by three mega trends:**
  - Many different shape representations exist, not necessarily all well suited for performant 3D Internet applications
  - The variety of end user visual devices is growing, especially mobile devices with Internet access.
  - In recent years we have seen a shift from single core devices to multi- and many-core devices (CPUs and GPUs).
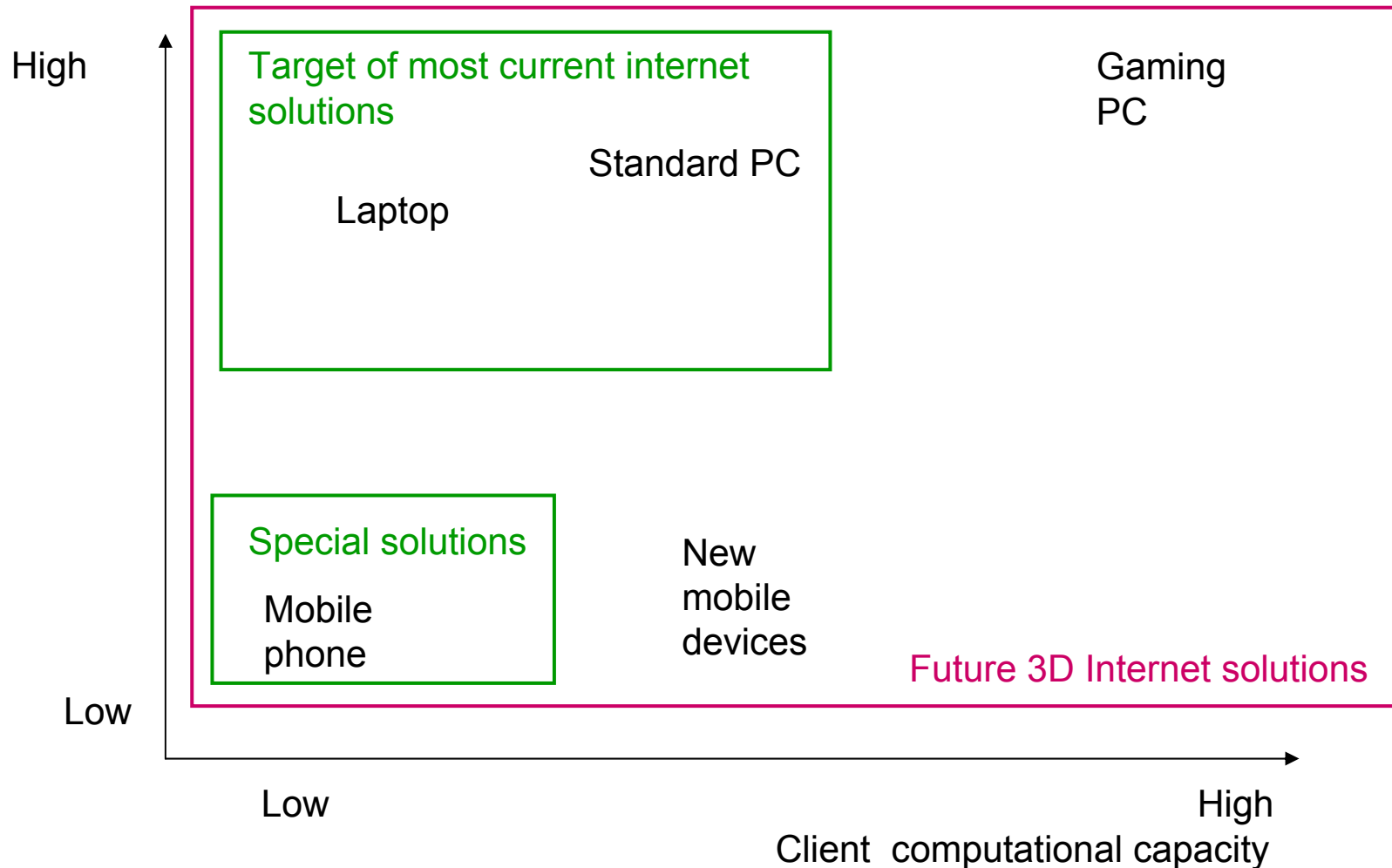
What is the idea all about? (1)

multitude of processing units

- graphics processing unit (GPU)
- many core machines
- multi core CPU
- single core CPU

diversity of devices

- mobile phones
- PDA
- mobile internet devices (MID)
- notebooks
- gamer PC

- triangles
- higher-order shapes; e.g. subdivision
- procedural 3D shapes

heterogeneity of shape representations

Current and future 3D Internet

Network Bandwidth

High

Target of most current internet solutions

Gaming
PC

Standard PC

Laptop

Special solutions

Mobile
phone

New
mobile
devices

Future 3D Internet solutions

Low

Low

High

Client computational capacity

What is the idea all about? (2)

- The **idea** is to develop an **infrastructure consisting of 3D content distribution and adaptation strategies plus parallel processing capabilities** to provide to a user the best possible balance of:
  - visual fidelity when presenting large 3D objects,
  - interactivity in 3D Internet applications and
  - network load.
- For this end, we will **introduce non-traditional model representations** such as higher-order surfaces (subdivision surfaces) and procedural models to **leverage increased possibilities of adaptation and flexibility**. The idea is to separate 3D model representation from graphics processing and thus open up the possibility to distribute 3D web applications between server and client to best facilitate the use of the actual network, server and client resources.

# Objectives of the approach:

- Realize an open embodiment of our approach on a wide range of client platforms ranging from handheld devices to high-end gaming PCs.

- Leverage different shape representation schemes and their benefits for 3D Internet applications,

- Exploit the use of many- and multi-core CPUs and programmable graphics processors (GPUs) for increased performance and visual quality

Current solutions
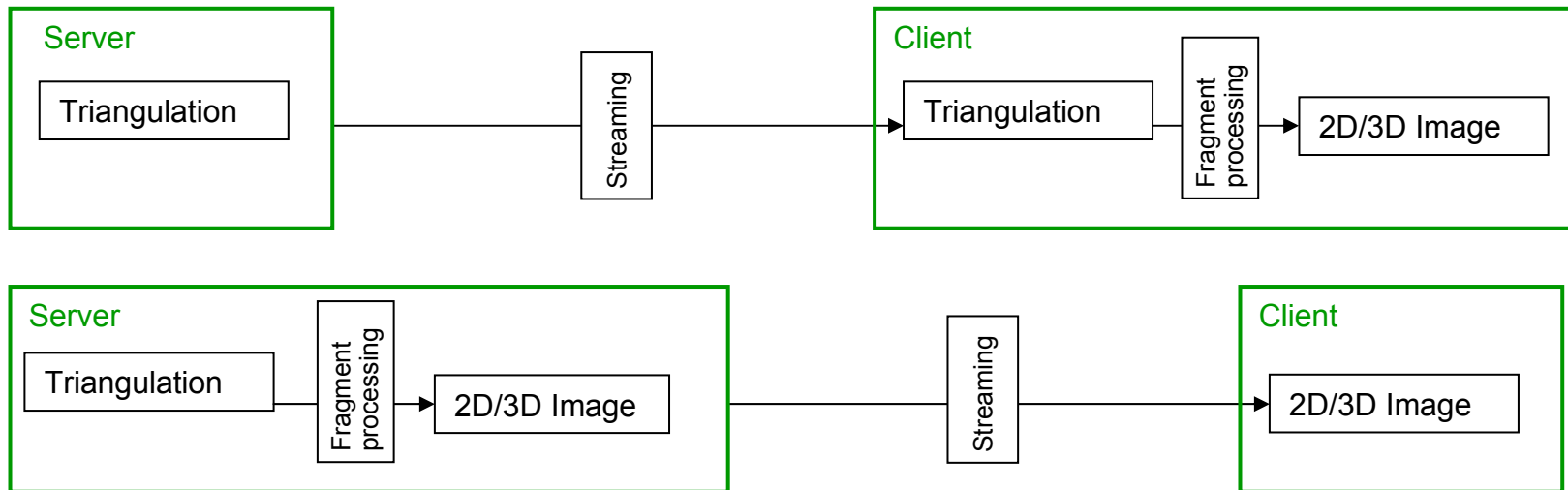
Proposed approach

- Resource aware distributed rendering
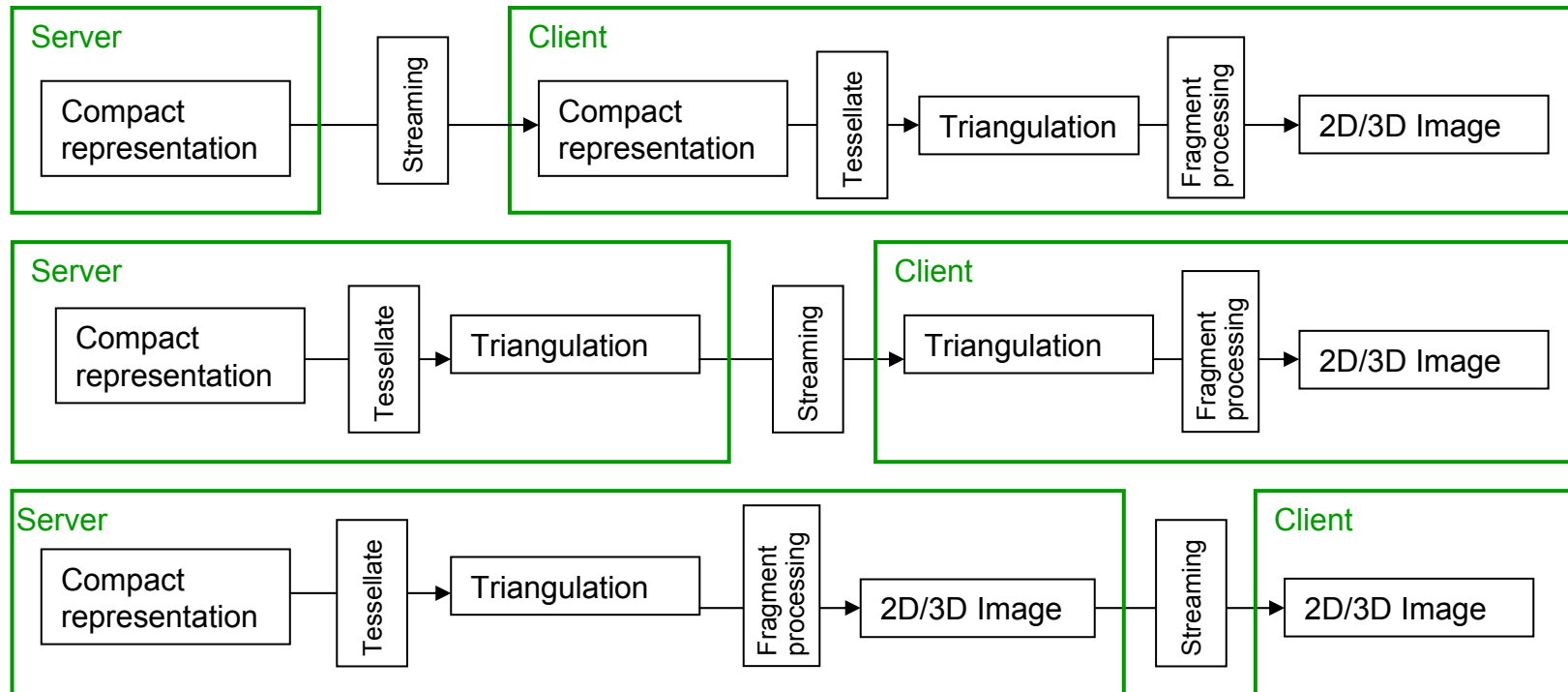
Compact shape representations

- Elementary surfaces including the sphere, cylinder, cone and torus
- NURBS
- Subdivision surfaces, introduced by Pixar in 1997 in the motion picture industry
- Procedural representation, e.g., GML
- Implicit representations define the shape as the zero set of an equation $f(x,y,z) = 0$
- Multi-resolution representations:
  - Wavelets
  - Hierarchal B-splines

What now?

- We wait for the evaluation (July 2009?)
    - If project granted we will start at the end of 2009 or start of 2010
    - If project not granted then we have learnt a lot and will reuse ideas in other project applications (industrial, national, EU,…).
- We will look at the possibilities of ICT Call 5
    - ICT-2009.1.3: Internet of Things and Enterprise environments
    - Challenge 7: Digital Libraries and Content
    - New partners?