

# What is computer engineering?

by

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Updated 2024 by Dr. W. Craig Scratchley

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Traditional Thinking ...



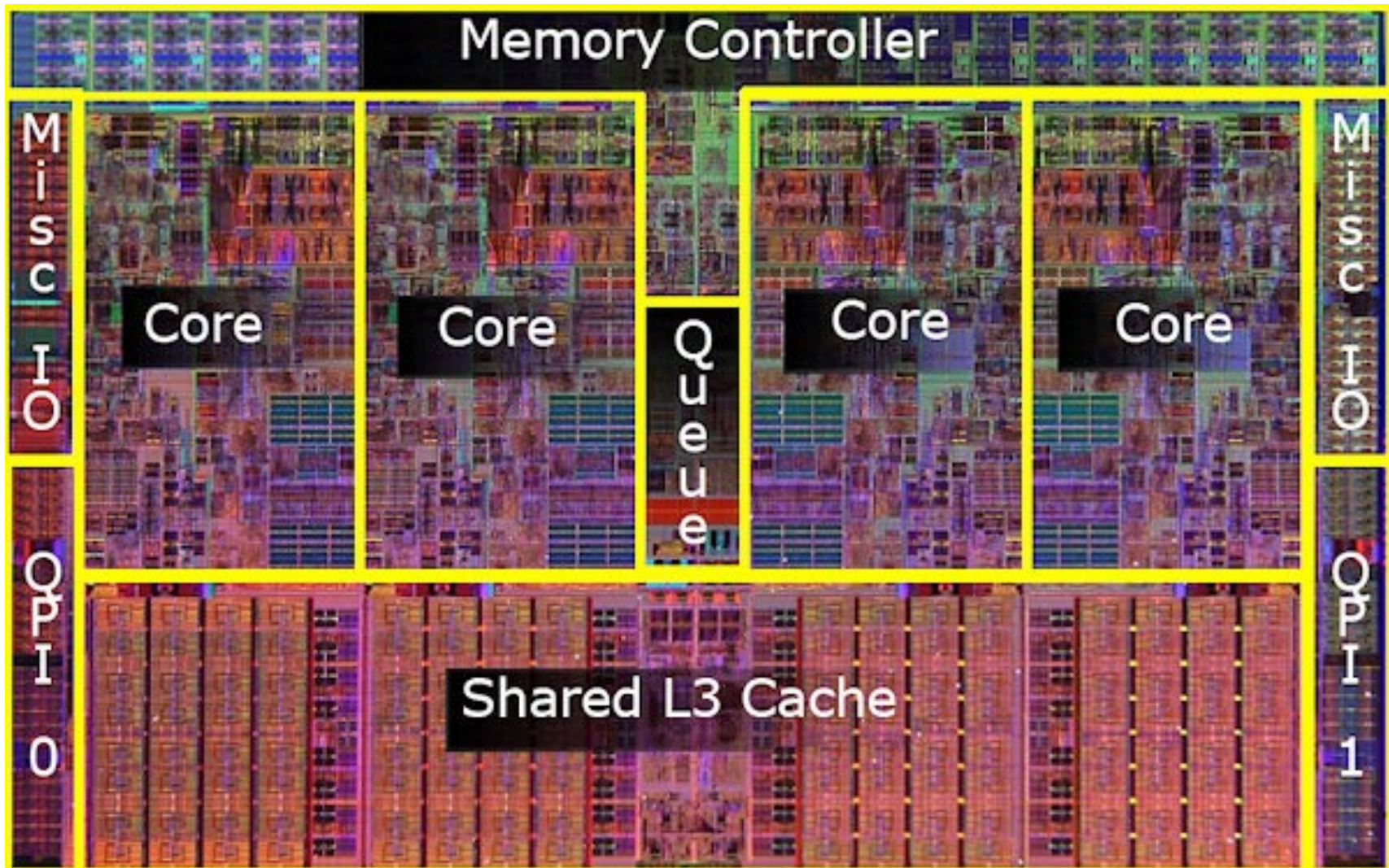
# Intel i7





# Intel i7

Over 730 Million Transistors





# Intel Pentium 4 Prescott

## Trace Cache Access, next Address Predict

## Instruction Trace Cache

## Execution Pipeline Start

## Buffer Allocation & Register Rename

## Instruction Decoder

Up to 4 decoded uOps/cycle out (from max. one x86 instr/cycle)  
Instructions with more than four are handled by Micro Sequencer

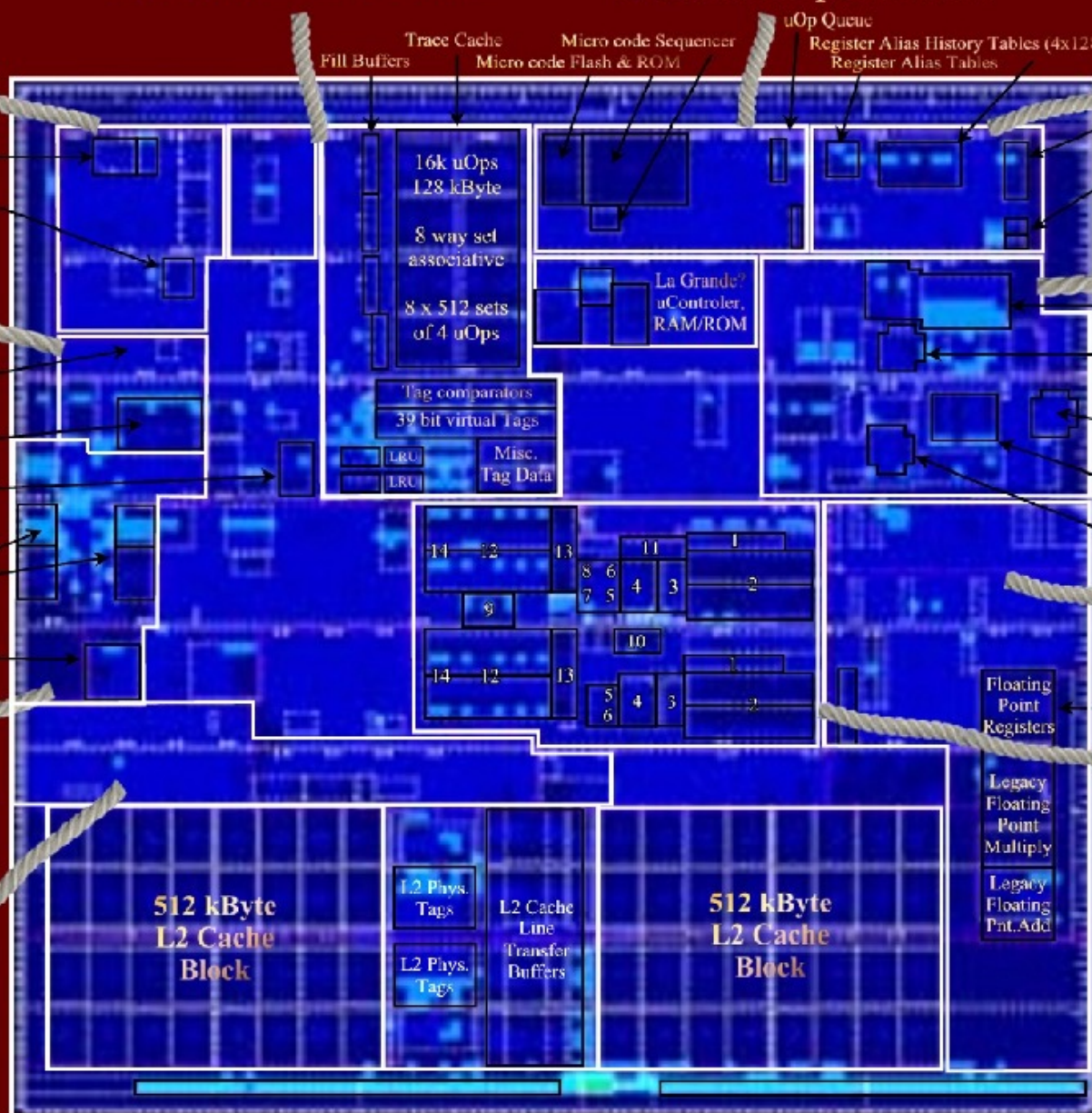
Raw Instruction Bytes in Data TLB, 64 entry fully associative, between threads dual ported (for loads and stores)

Front End Branch Prediction Tables (BTB), shared, 4096 entries in total

Instruction TLB's 128 entry, fully associative for 4k and 4M pages. In: Virtual address [47:12]  
Out: Physical address [39:12] + 2 page level bits

## Instruction Fetch from L2 cache and Branch Prediction

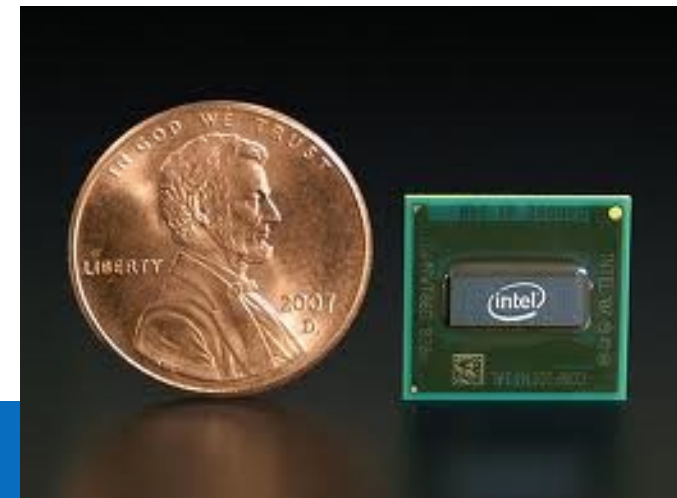
Front Side Bus Interface, 533..800 MHz



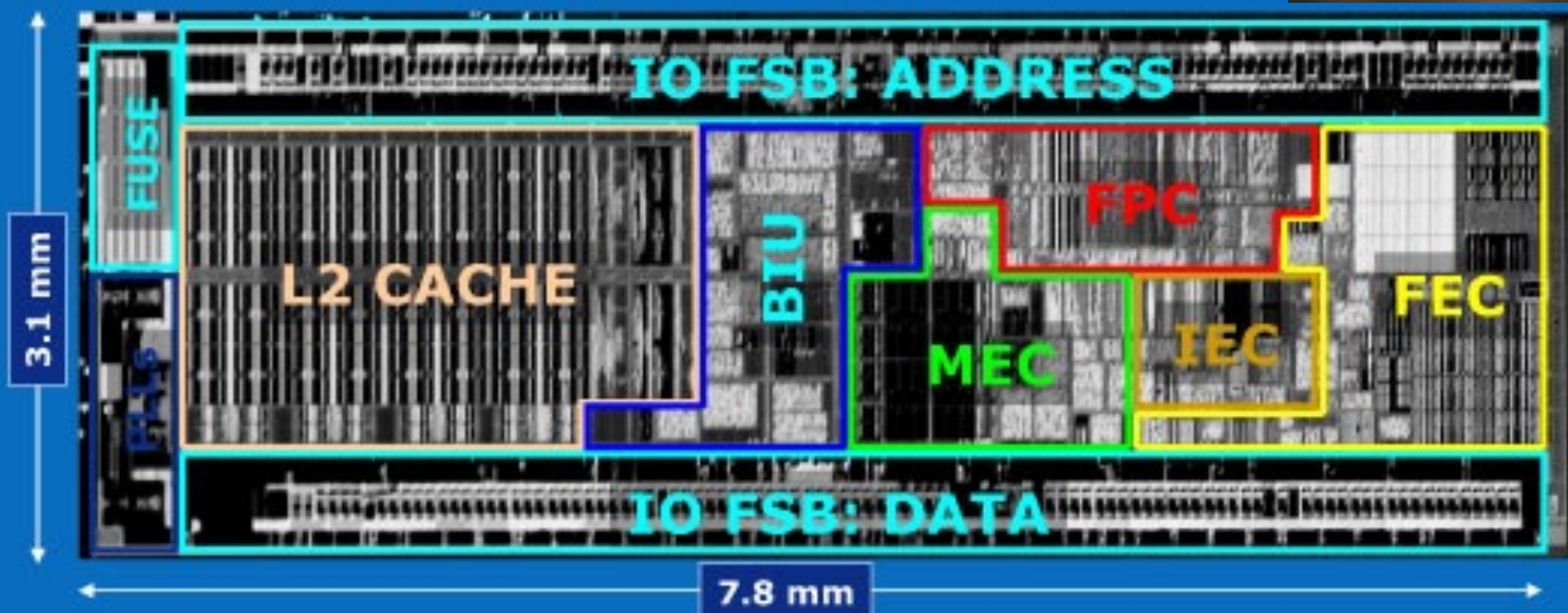


# Intel Atom

47.2 million transistors



## Sea-of-FUBs Chip Layout



### SCHEMATIC TRANSISTORS:

Core:	13,828,574
Uncore:	2,738,951
L2 & L2 tag:	30,644,682
<b>TOTAL:</b>	<b>47,212,207</b>

	Area %
<b>Core</b>	<b>28%</b>
<b>Uncore</b>	<b>72%</b>
BIU	9%
L2	22%
IO FSB	35%
PLL+FUSE	7%
<b>Total</b>	<b>100%</b>

Type	unique	instances
Random Logic Synthesized	92	92
Structured Data Paths	88	140
L2 sub-arrays	2	40
Custom	18	19
Repeater Stations	-	317
<b>TOTAL</b>	<b>200</b>	<b>608</b>



# Xilinx UltraScale+

Over 7 Billion Transistors





[Update: Blackwell GPUs are packed with 104 billion transistors on each die, unified as one chip with 208 billion transistors.  
Mar 22, 2024]

However, that really does not cover it

We are **technology experts** that work to enable or improve the realization of applications and services



# The COVID years were difficult

But Computer Engineering contributions enabled:

- Remote working and studying
- Remote shopping
- Telemedicine
- Accelerated medical sample testing
- Synthetic vaccine design



# These contributions have

- Kept people in touch when travel was not allowed
- Allowed people to work and study when we were in lockdown
- Kept our economy going, enabling the government to fund CERB, etc and other the benefits that have helped struggling individuals and companies
- Enabled us to exit the pandemic faster with fewer deaths



# Typically, Computer Engineers

- Work with application experts to realize challenging designs
- Work on applications involving sound, image or video processing
- Try to make things lower power, smaller, faster, more reliable, more secure

That may not sound like much, but

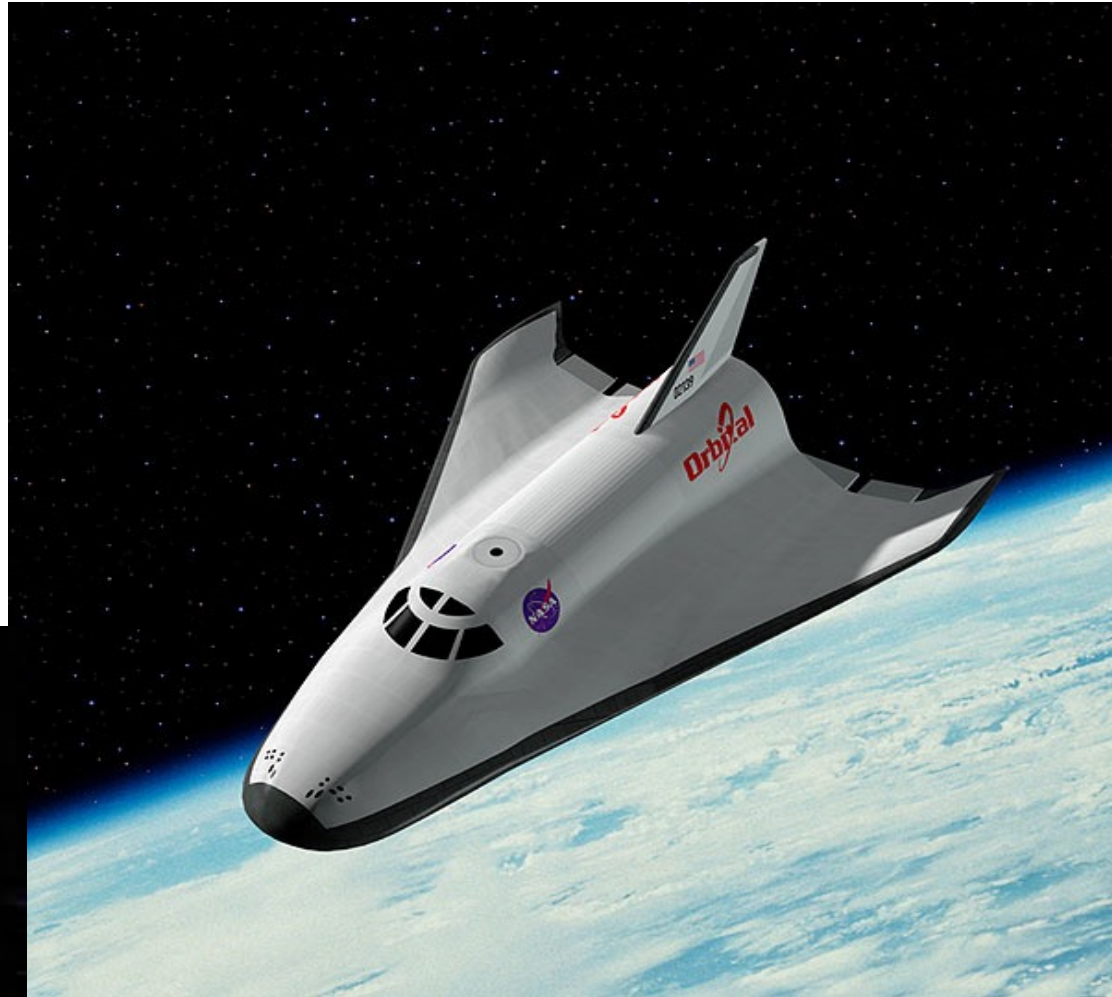


Computers and Computer  
Engineers are everywhere...





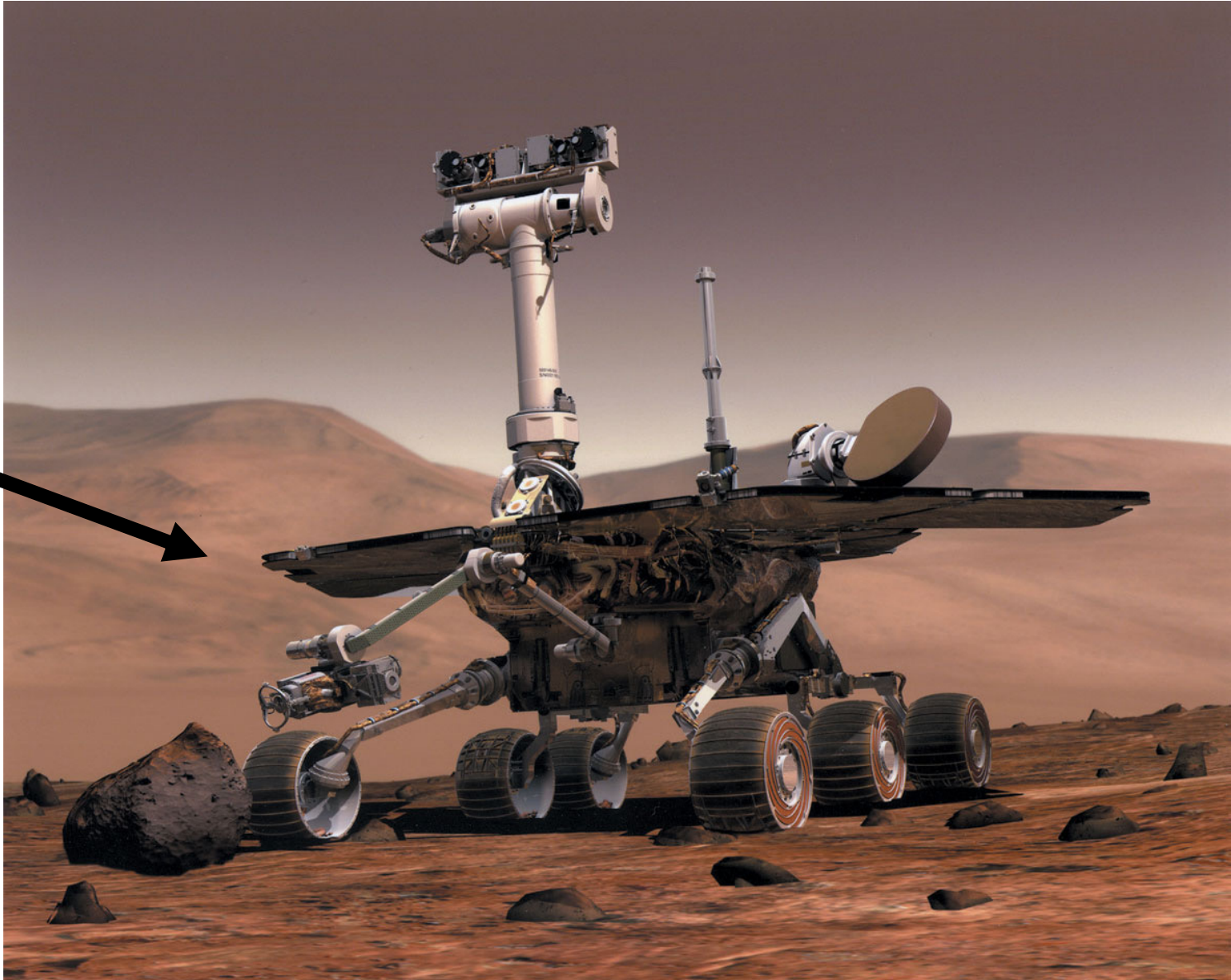
# In Outer Space – Orbiting the Earth





# In Outer Space - Mars Rover

Xilinx  
FPGAs  
Here





# In the Air...





# At Sea





# On the road...





# On the road...

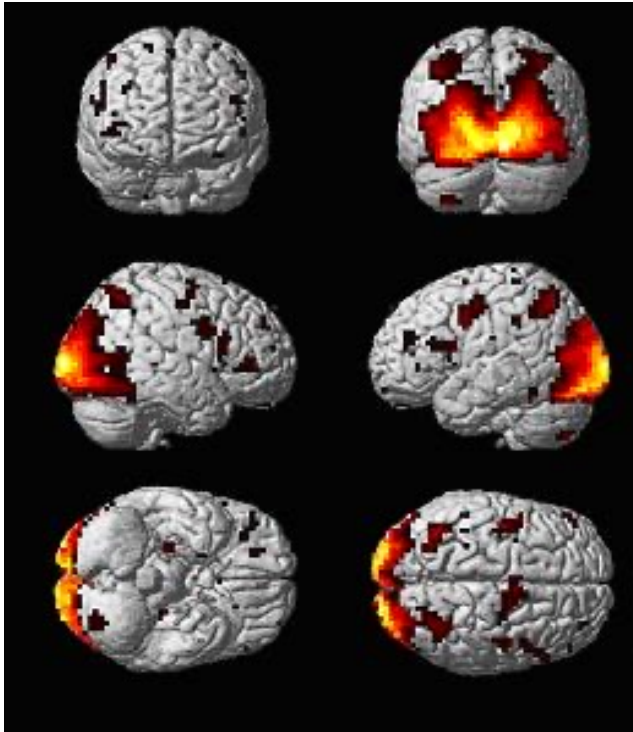


Just a few examples:

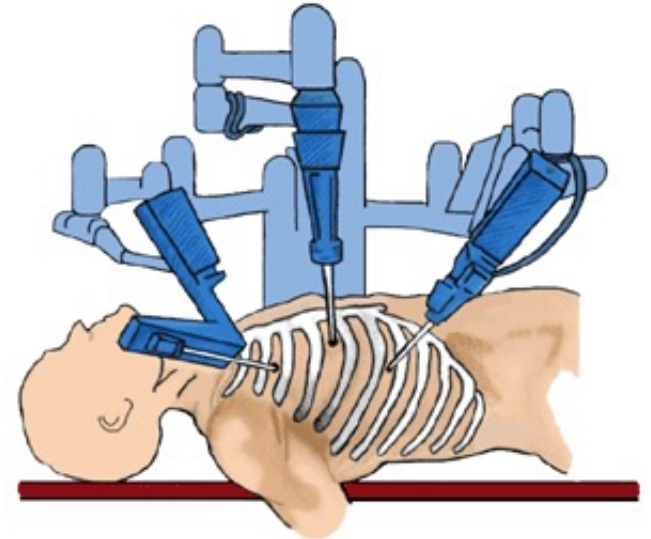
Airbag control,  
window control,  
radio system,  
automatic steering,  
Automatic parking  
Collision impact warning  
Powertrain control module  
Sunroof module  
Automatic breaking



# In Medicine (i.e. Biomedical Applications)



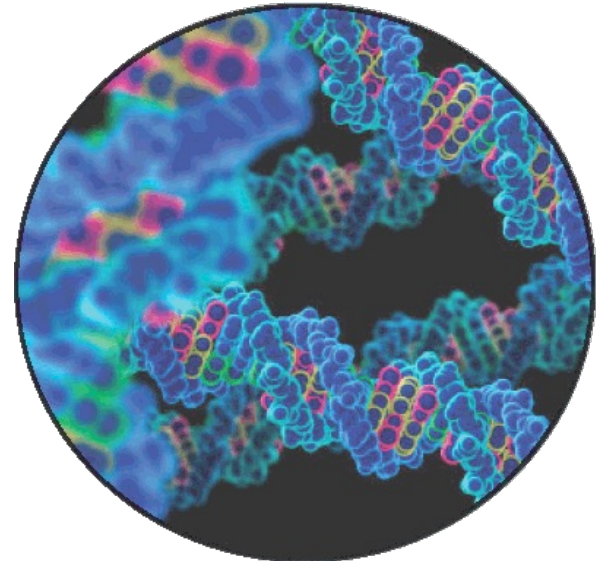
Remote Surgery



Prosthetics



Molecular Dynamics and Gene Mapping



Diagnostic Applications



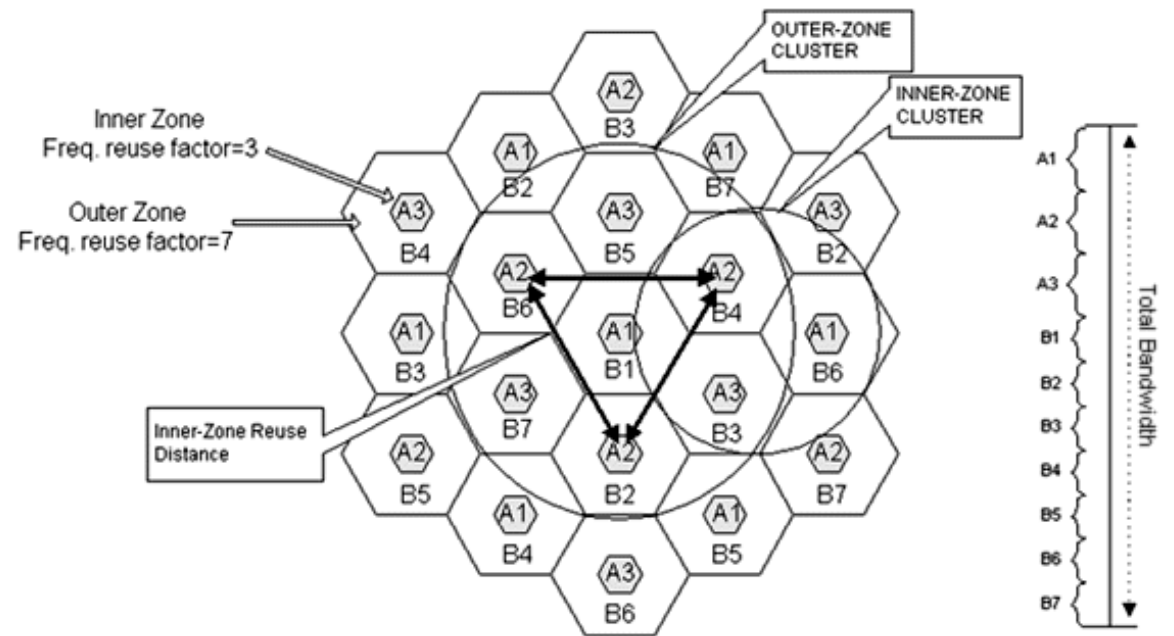


# On the phone

## Cellphone Networks

&

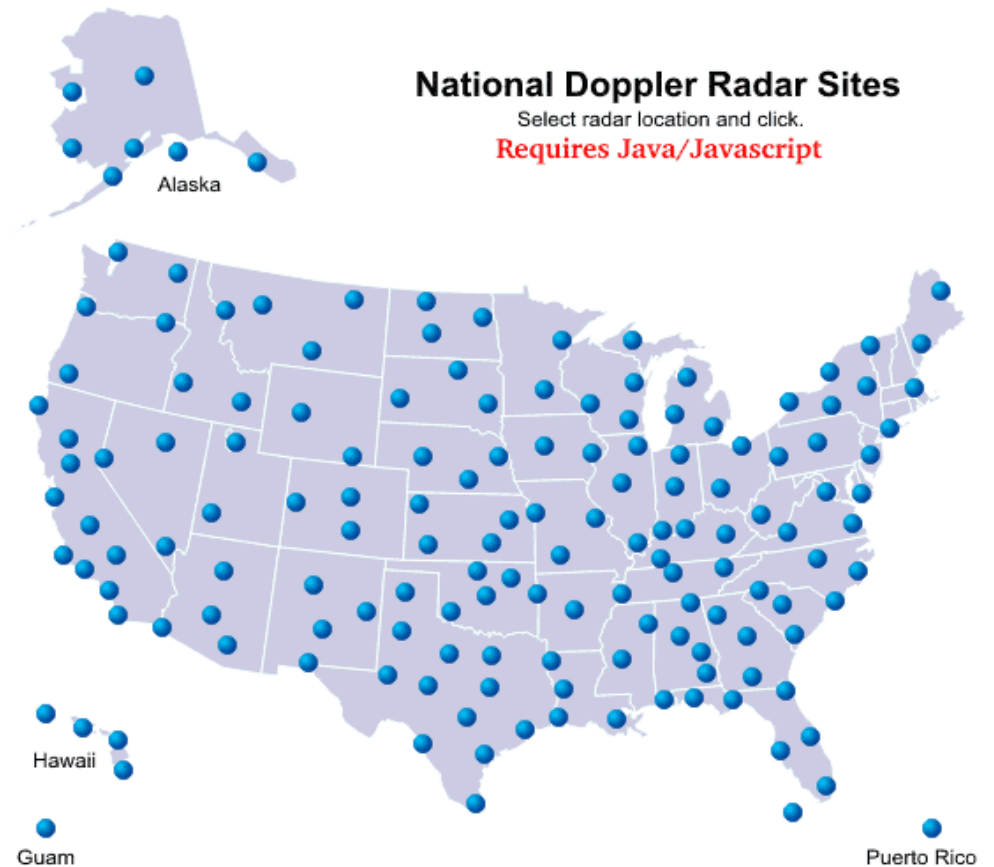
## Cellphones





# Checking the Weather

## Doppler Weather Radar





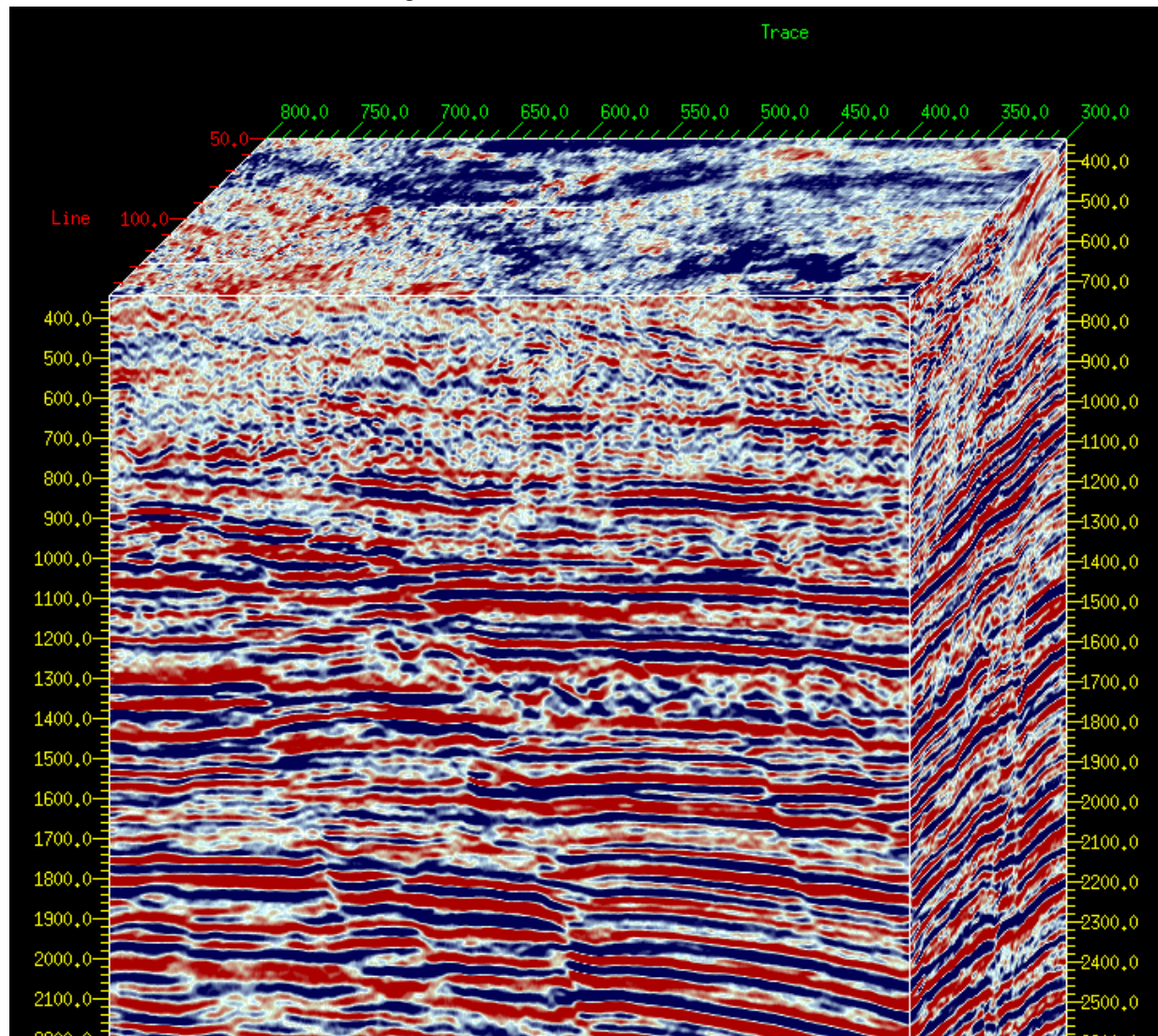
# Financial & Entertainment Applications





# Seismic Imaging

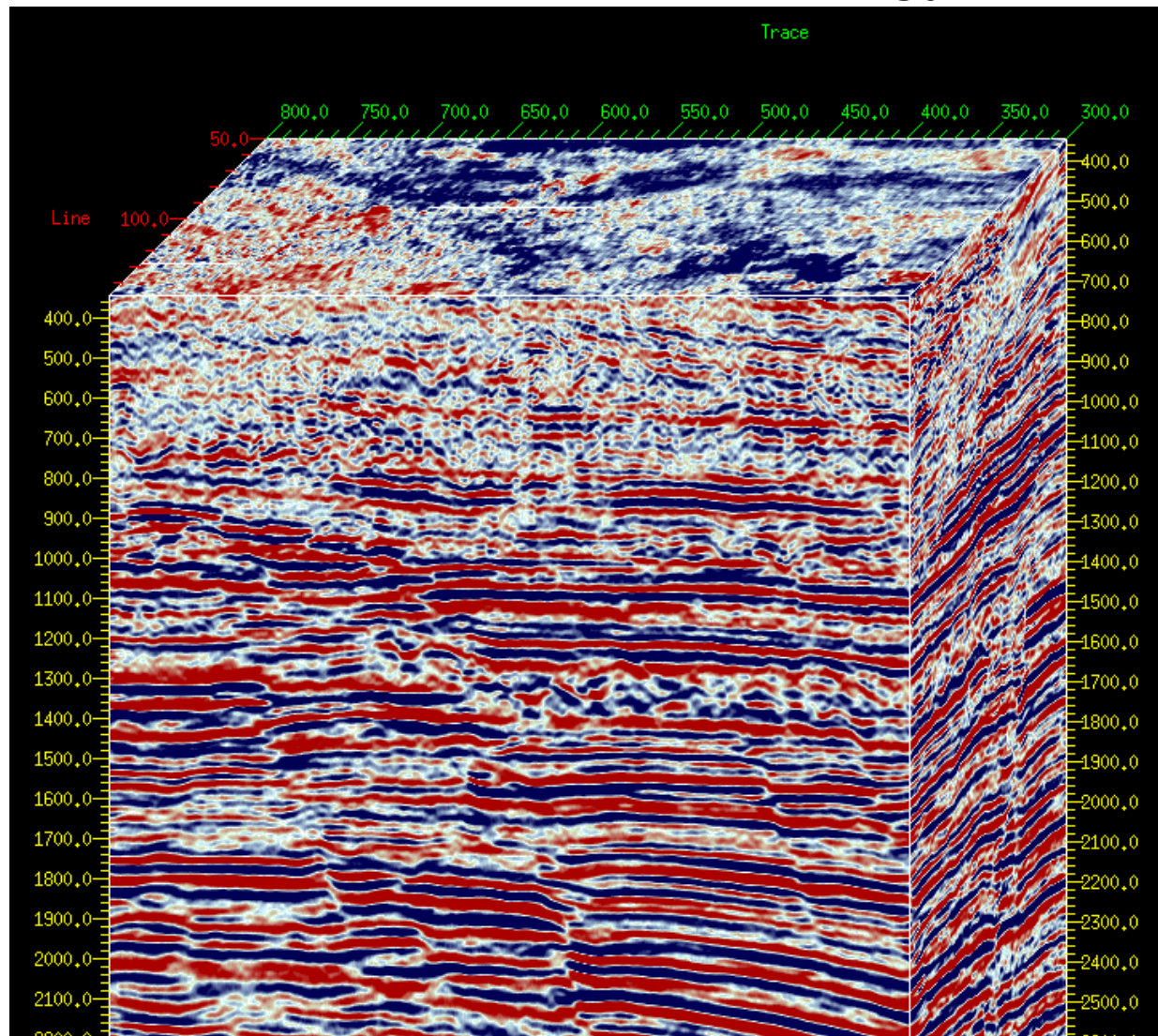
## Let's play: Find the petroleum!





# Seismic Imaging

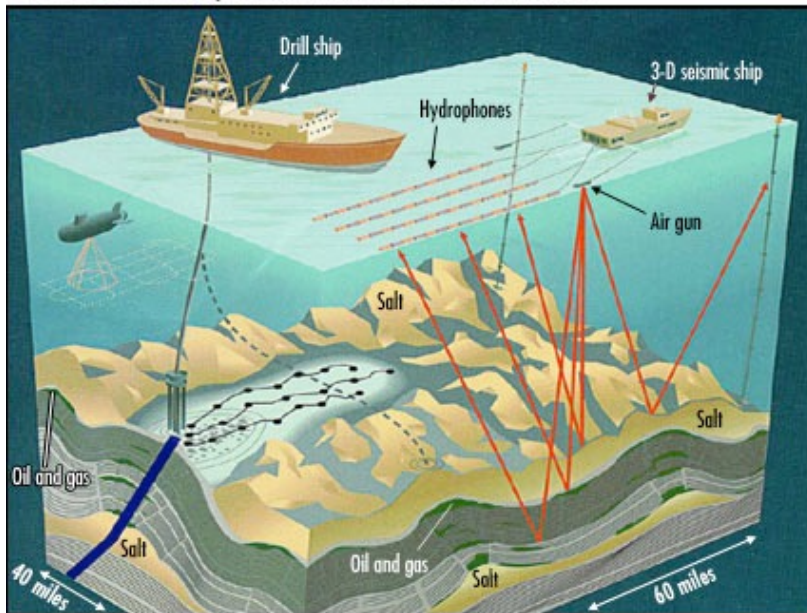
Also, what about Archeology...



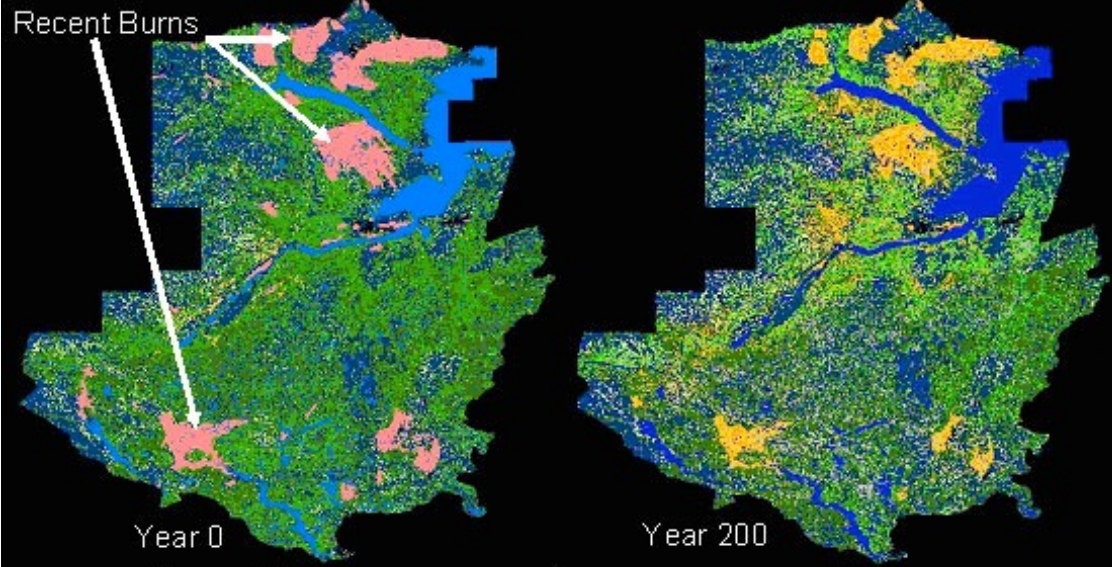


## 3-D Seismic Imaging At Work

Hydrophones streaming from a 3-D seismic ship record the reflection of sound waves as they bounce back from subsalt surfaces.



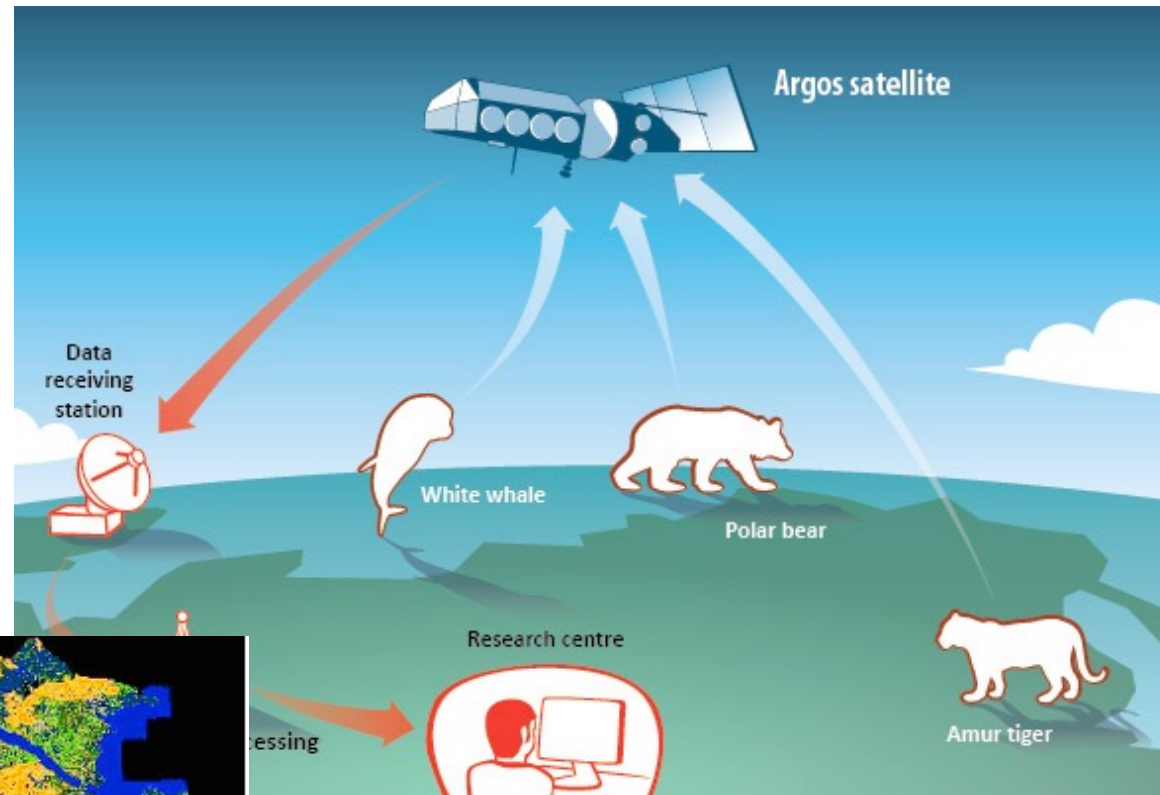
Credit: Hutchins, A.E. and Anderson, R.M. (Eds.), World Oil's 4-D Seismic Handbook, Gulf Publishing, 1997



### Forest Type

Black Spruce	Pin Cherry	Non-Active
Spruce-Fir	White Birch	Water
Balsam Fir	Birch-Aspen	Unoccupied
Lichen Woodland	Spruce Bog	

## Environmental Applications





At the zoo...





# Kangaroos and Nutritional Ecology











# And so much more...

- Kinesiology
- Graphics
  - Movie special effects
  - Video Games
- Sound Effects
- Finance
  - The banks (day trading, etc)
- Law
  - Patents
- The Environment





# And so much more...

- Basically anything you can imagine
  - And probably things you cannot





# And so much more...

- Basically anything you can imagine
  - And probably things you cannot

***QUESTIONS?***

