

The *SpiNNaker* Project



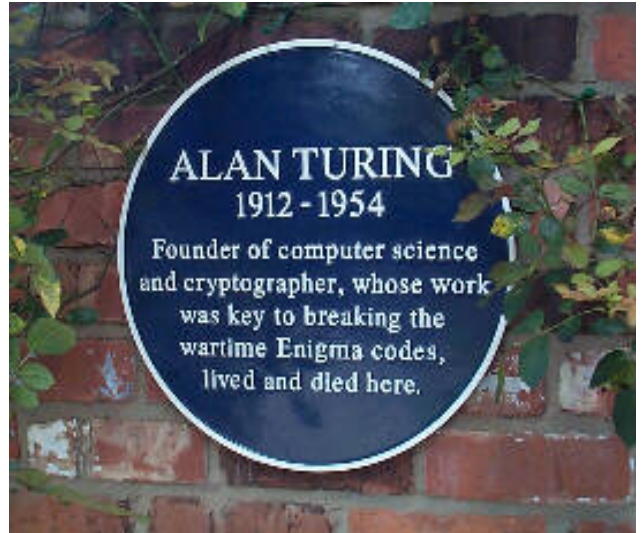
Steve Furber

ICL Professor of Computer
Engineering

The University of Manchester



65 years ago...



VOL. LIX. No. 236.]

[October, 1950

MIND
A QUARTERLY REVIEW
OF
PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND INTELLIGENCE

BY A. M. TURING

1. *The Imitation Game.*
I PROPOSE to consider the question, 'Can machines think?' This should begin with definitions of the meaning of the terms 'machine' and 'think'. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words 'machine' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, 'Can machines think?' is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the

Bio-inspiration

- Can massively-parallel computing resources accelerate our understanding of brain function?
- Can our growing understanding of brain function point the way to more efficient parallel, fault-tolerant computation?

Building brains

- Brains demonstrate
 - massive parallelism (10^{11} neurons)
 - massive connectivity (10^{15} synapses)
 - excellent power-efficiency
 - much better than today's microchips
 - low-performance components (~ 100 Hz)
 - low-speed communication (\sim metres/sec)
 - adaptivity – tolerant of component failure
 - autonomous learning



The Human Brain Project

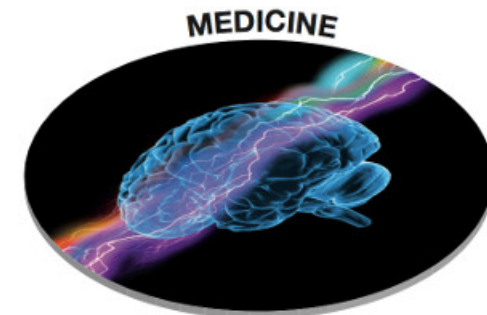
- An EU ICT Flagship project
 - headline €1B budget
 - €54M initial funding
 - 1st October 2013 to 31st March 2016
 - ~€900k to UoM
 - next 7.5 years funded under H2020
 - subject to review of ramp-up phase after 18 months
 - 80 partner institutes, 150 PIs & CIs
 - Open Call extended this
 - originally led by Henry Markram, EPFL



Human Brain Project

The Human Brain Project

- Research areas:
- Neuroscience
 - neuroinformatics
 - brain simulation
- Medicine
 - medical informatics
 - early diagnosis
 - personalized treatment
- Future computing
 - interactive supercomputing
 - neuromorphic computing

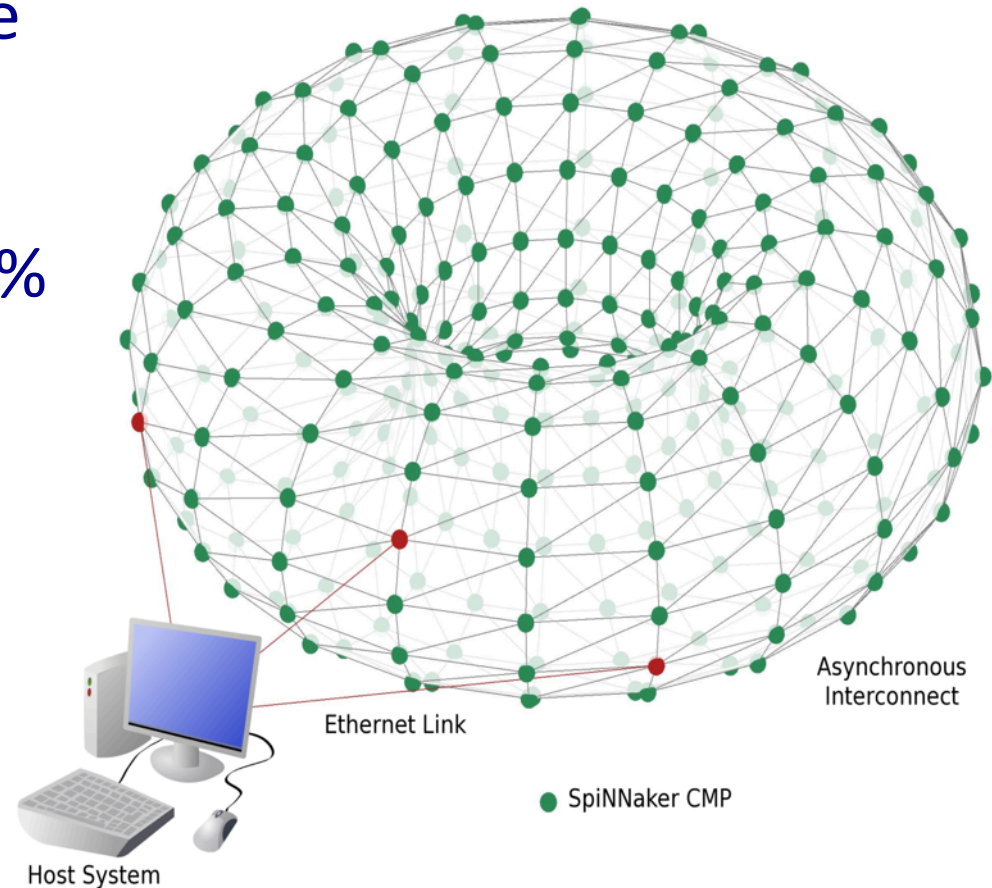


SpiNNaker project

- A million mobile phone processors in one computer
- Able to model about 1% of the human brain...
- ...or 10 mice!



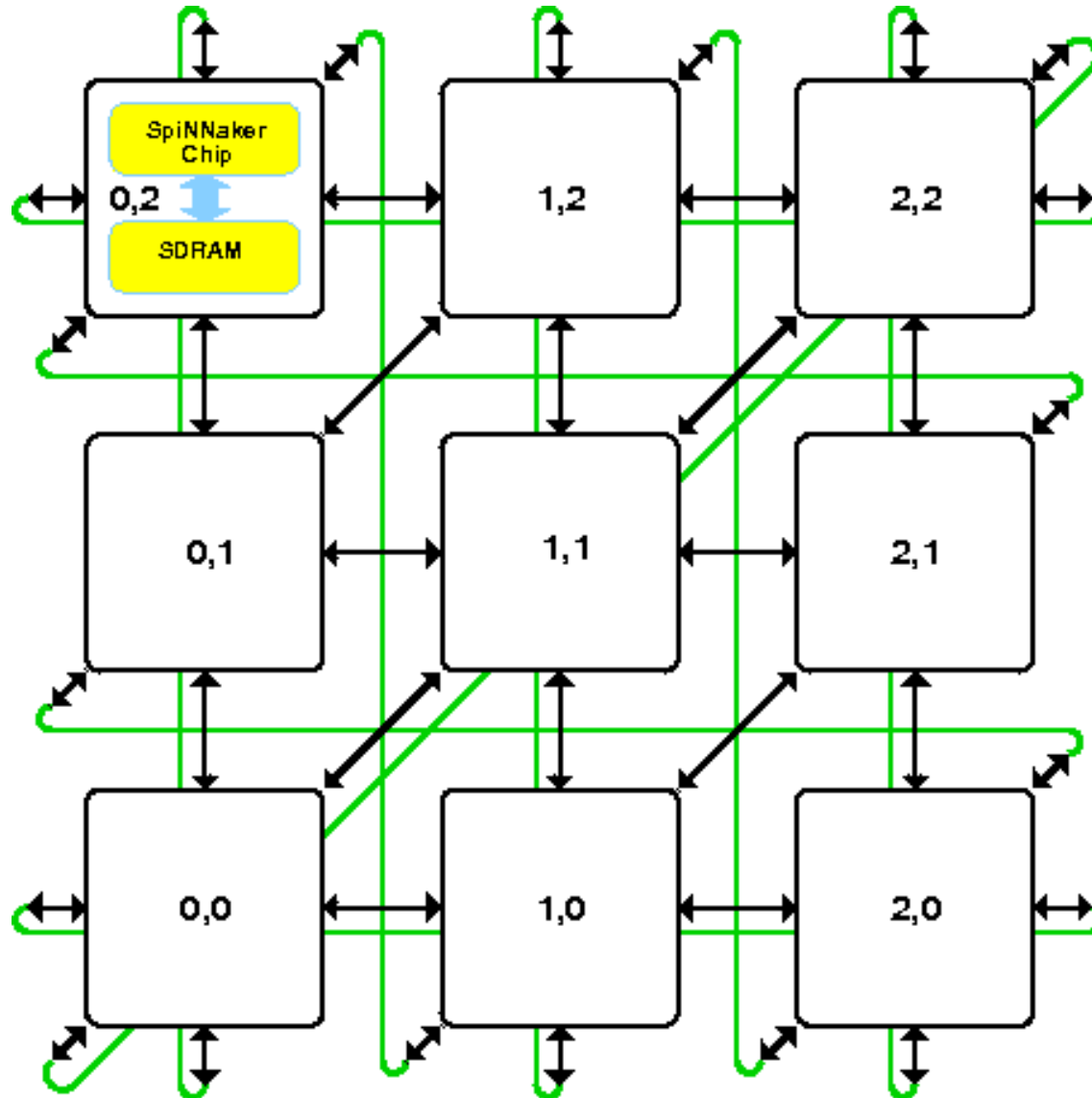
EPSRC



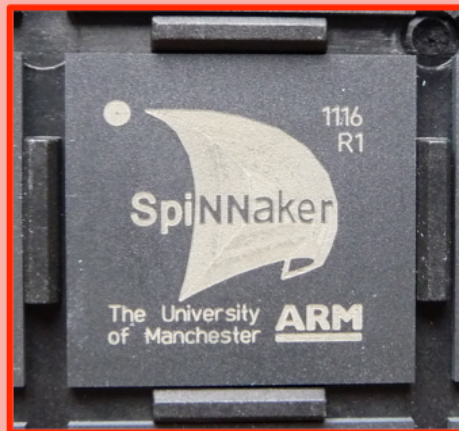
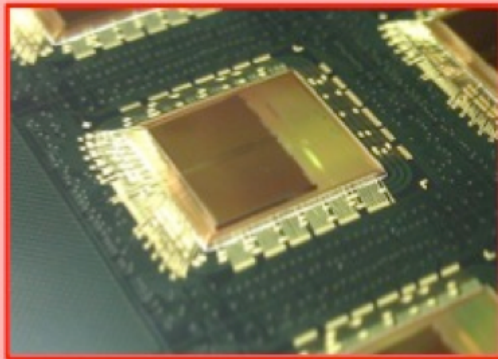
Design principles

- *Virtualised topology*
 - physical and logical connectivity are decoupled
- *Bounded asynchrony*
 - time models itself
- *Energy frugality*
 - processors are free
 - the real cost of computation is energy

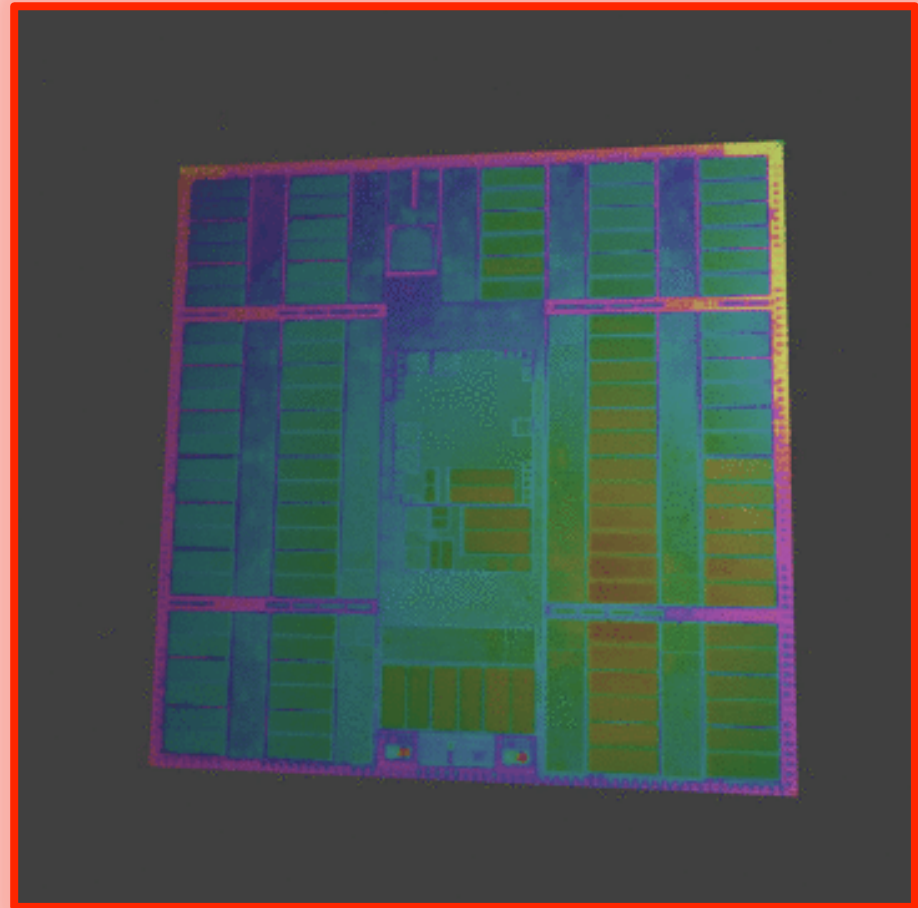
SpiNNaker system



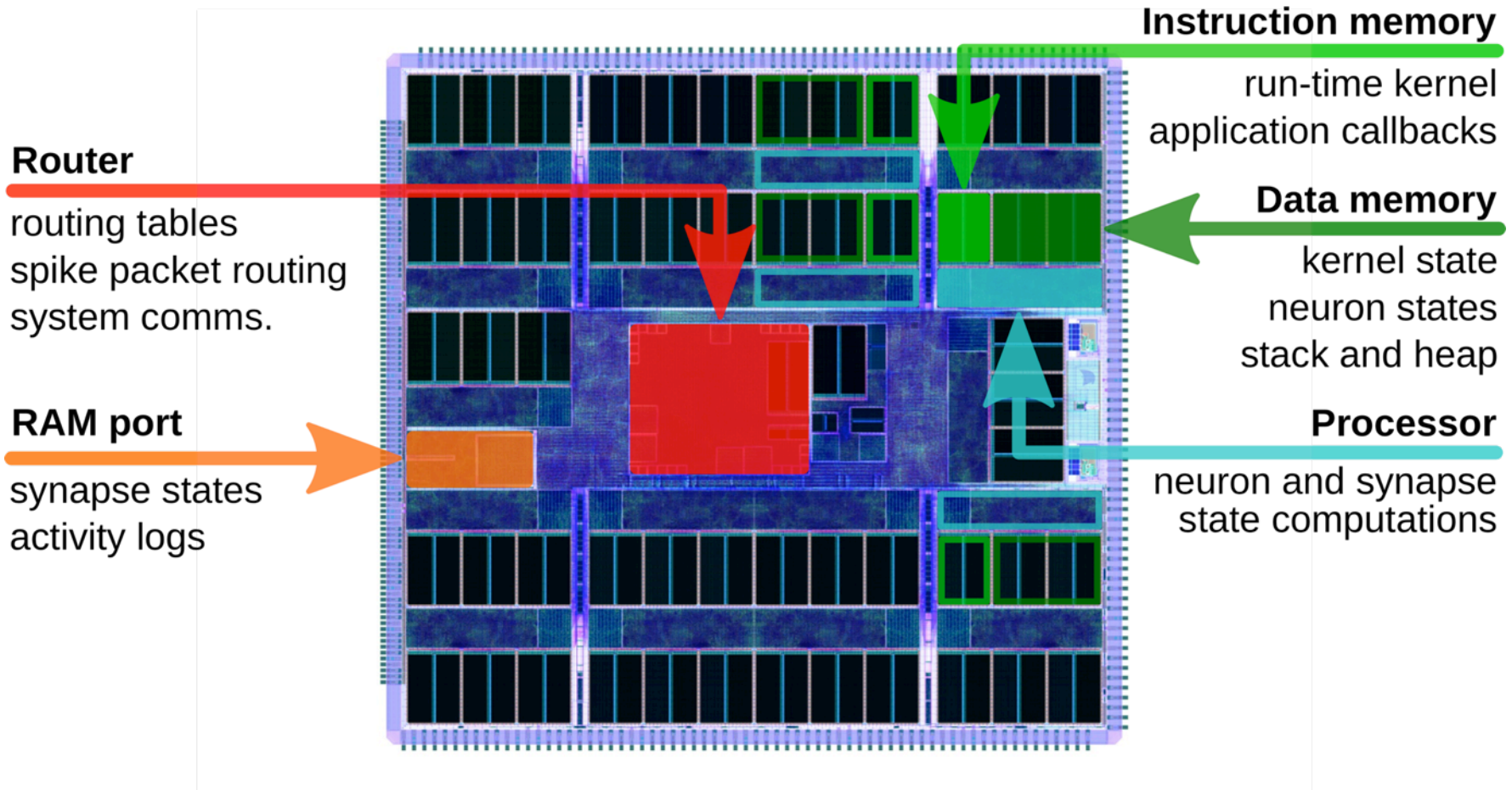
SpiNNaker chip



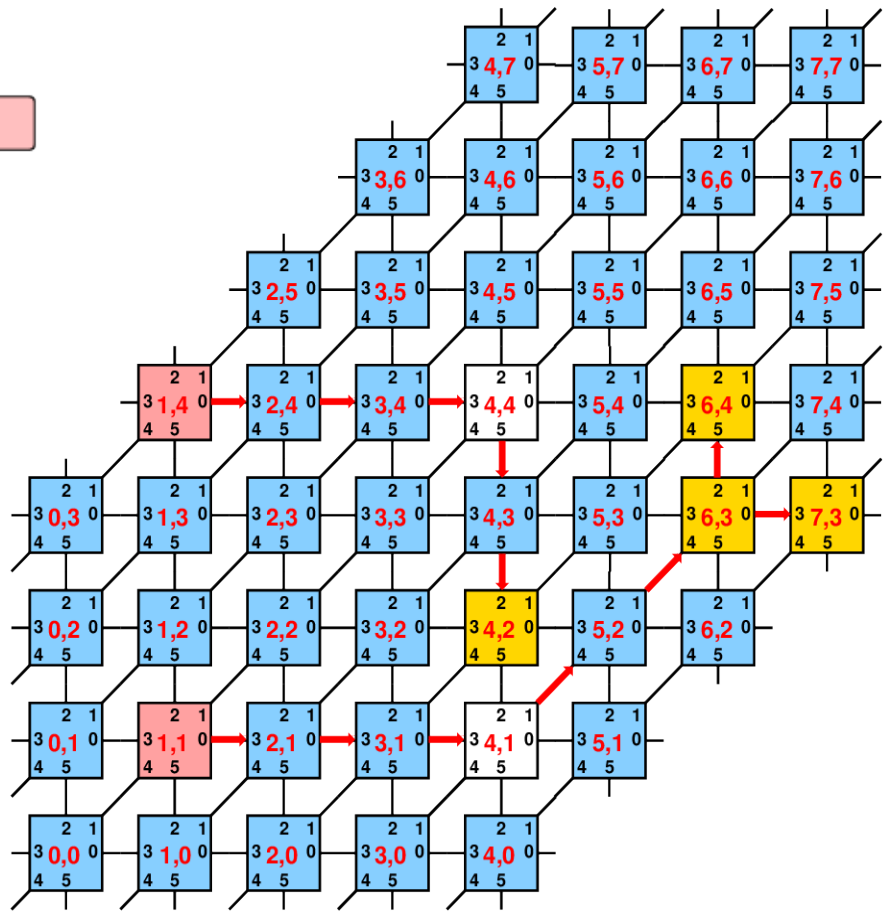
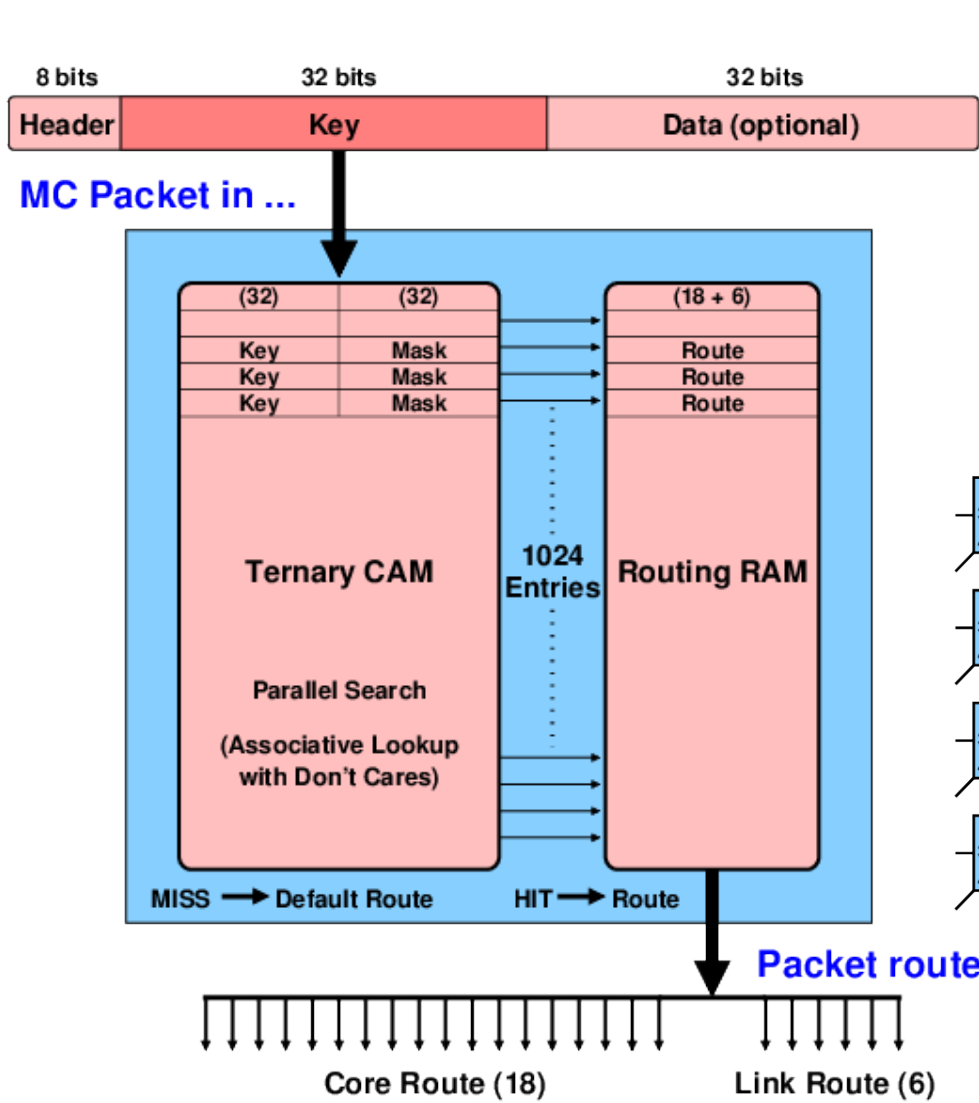
Multi-chip
packaging by
UNISEM Europe



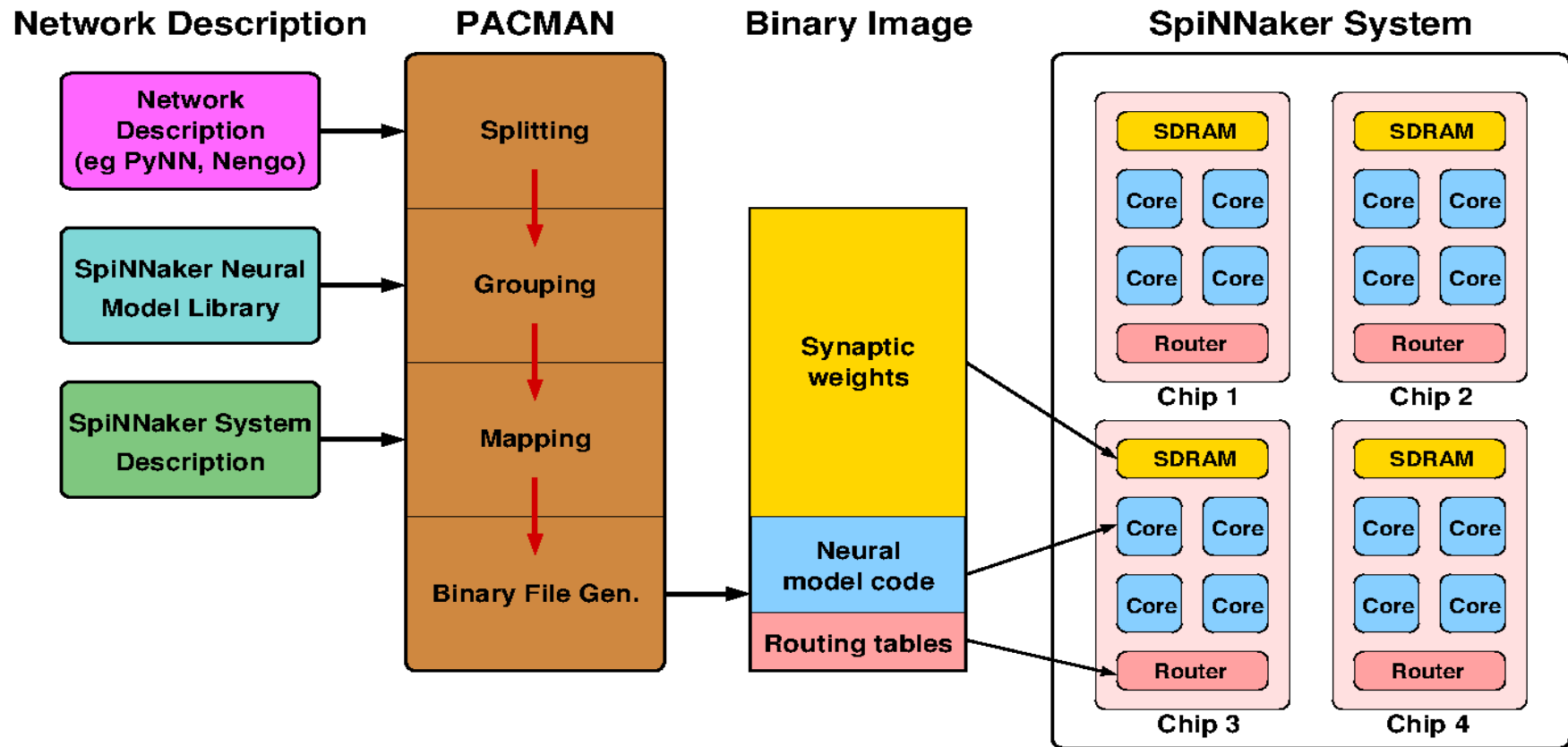
Chip resources



Multicast routing



Problem mapping



SpiNNaker machines

103



864 cores
- drosophila scale



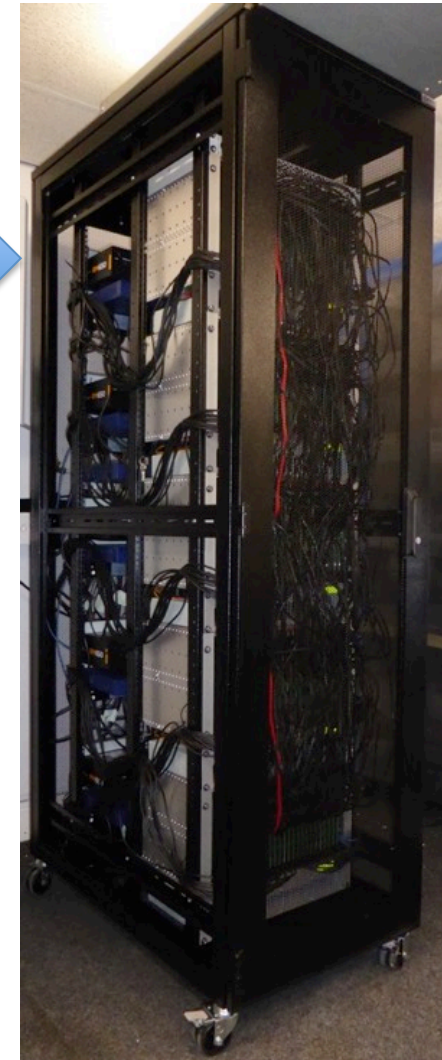
104



20,000 cores
- frog scale



105



100,000 cores
- mouse scale

102



72 cores
- pond snail scale



Building the HBP machine



Building and wiring up the
518,400 core SpiNNaker machine



SpiNNaker machines



Human Brain Project

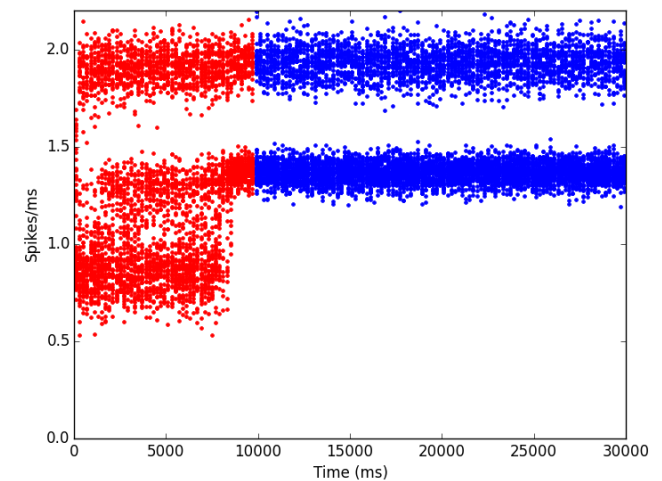
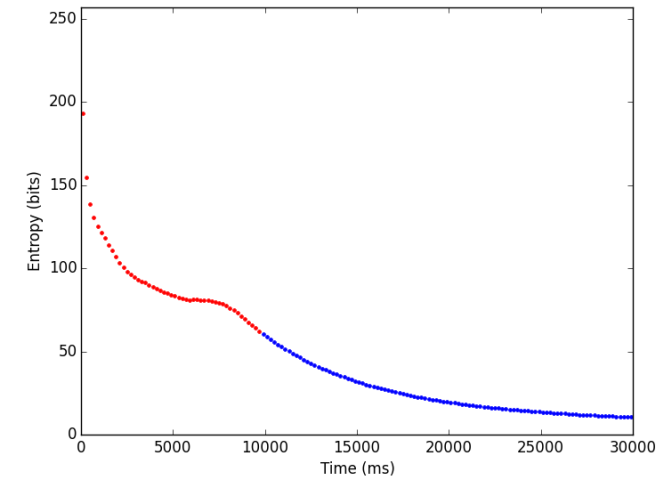
- HBP platform
 - 500,000 cores
 - 6 cabinets
(including server)
- Launch
 - 30 March 2016



'Diabolical' sudoku solved

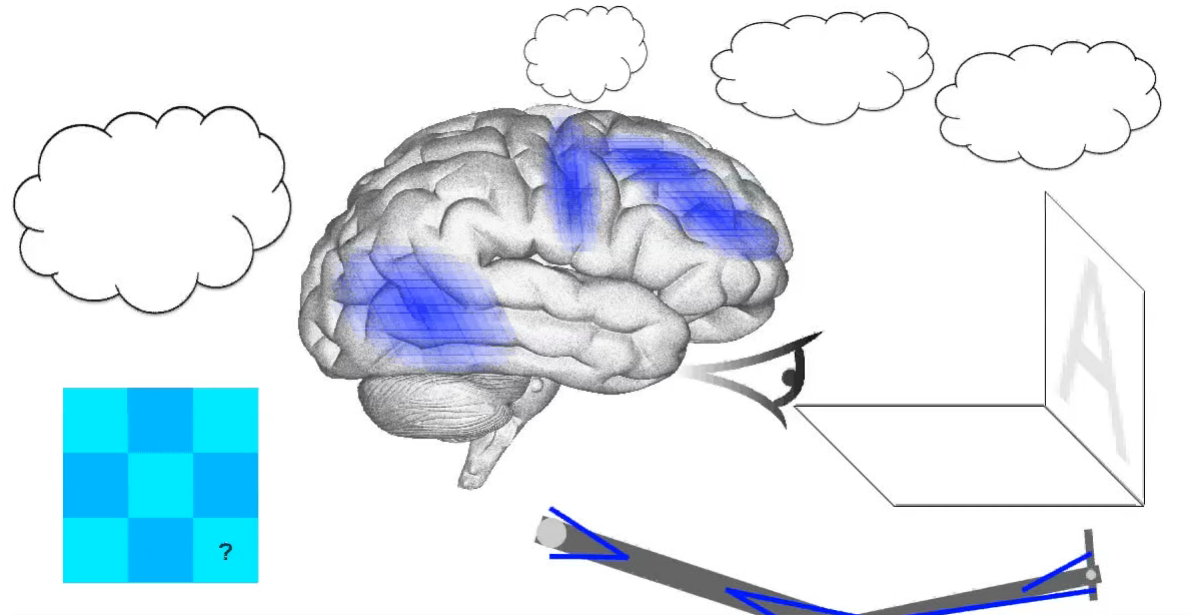
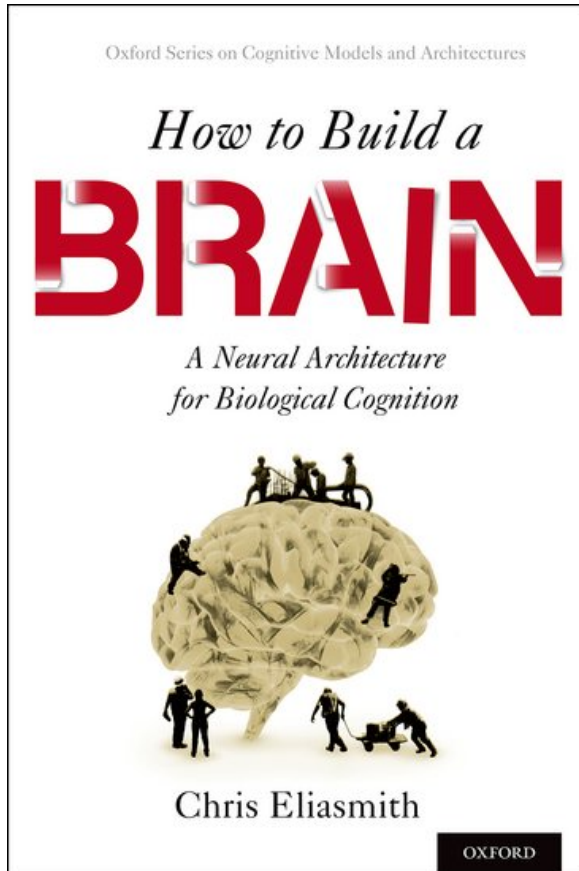
- 36,400 neurons, 12.7M synapses

4	6	1	9	5	8	6	7	3
3	8	5	6	7	7	4	9	1
7	8	9	3	3	1	6	8	5
6	9	6	8	1	3	5	5	7
5	3	8	7	9	2	1	4	6
1	2	4	7	6	5	8	3	9
3	5	3	1	8	6	9	9	4
8	1	6	4	4	9	3	6	2
9	4	2	5	3	6	7	1	8



S. Habenschuss, Z. Jonke, and W. Maass, "Stochastic computations in cortical microcircuit models", PLOS Computational Biology, 9(11):e1003311, 2013.

Spaun



Cluster machine:

- 2.5 hours/sec

SpiNNaker:

- 12,000 ARMAs
- 15x 48-node PCBs
- real-time - soon!

Chris Eliasmith et al, Science vol. 338, 30 Nov 2012

SpiNNaker port by Andrew Mundy

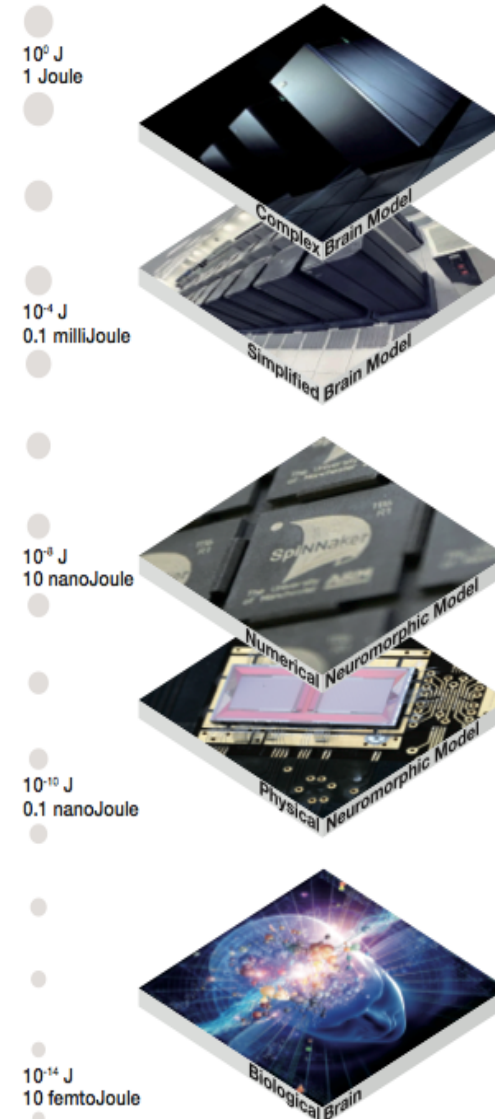
Conclusions

- *SpiNNaker*:
 - has been 15 years in conception...
 - ...and 8 years in construction,
 - and is now ready for action!
- ~90 boards with groups around the world
- 500,000 core machines built
 - 1M core machine to follow soon
 - large models: Spaun, ...?
- HBP is supporting s/w development
 - leading to open access



Human Brain Project

Energy scales





Credits



Evie Andrew

Patrick Camilleri

Dave Clark

Simon Davidson

Sergio Davies

Francesco Galluppi

Garibaldi Pineda Garcia

Jim Garside

Martin Grymel

Yebin Shi

Alan Stokes

Evangelos Stromatias

Jonathan Heathcote

Michael Hopkins

Mukaram Khan

Jamie Knight

Dave Lester

Gengting Liu

Qian Liu

Xin-Jin Liu

Joanna Moy

Steve Temple

Andrew Webb

Viv Woods

Andrew Mundy

Javier Navaridas

Eustace Painkras

Cameron Patterson

Luis Plana

Alex Rast

Dominic Richards

Andrew Rowley

Tom Sharp

Jian Wu

Shufan Yang

...