TOMORROW'S MICROELECTRONICS

INTELLIGENCE EVERYWHERE

Mike Mayberry
Vice President & Managing Director, Intel Labs

INTEL'S RESEARCH EFFORTS

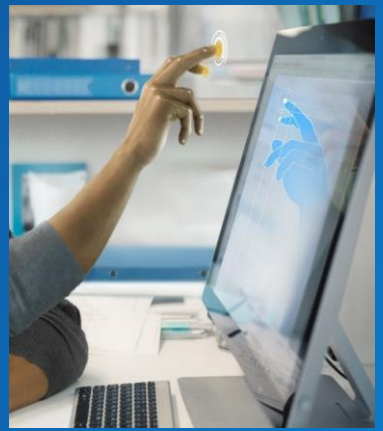
COMPONENTS RESEARCH

ENABLING MOORE'S LAW

DEVELOPING NOVEL INTEGRATION

INTEL LABS

ENABLING FUTURE PRODUCT CAPABILITIES



ANTICIPATING FUTURE INTEL

UNIVERSITY RESEARCH

Expanding the Frontier, Future Intel Collaborators

"Any sufficiently advanced technology is indistinguishable from magic"

– Arthur C. Clarke 1973

2×10^9

2 BILLION LOGIC TRANSISTORS PER CM^2

$100+ \times 10^9$

>100 BILLION MEMORY BITS PER CM^2

$500+ \times 10^{18}$

>500 QUINTILLION SHIPPED WORLDWIDE

2X BETTER

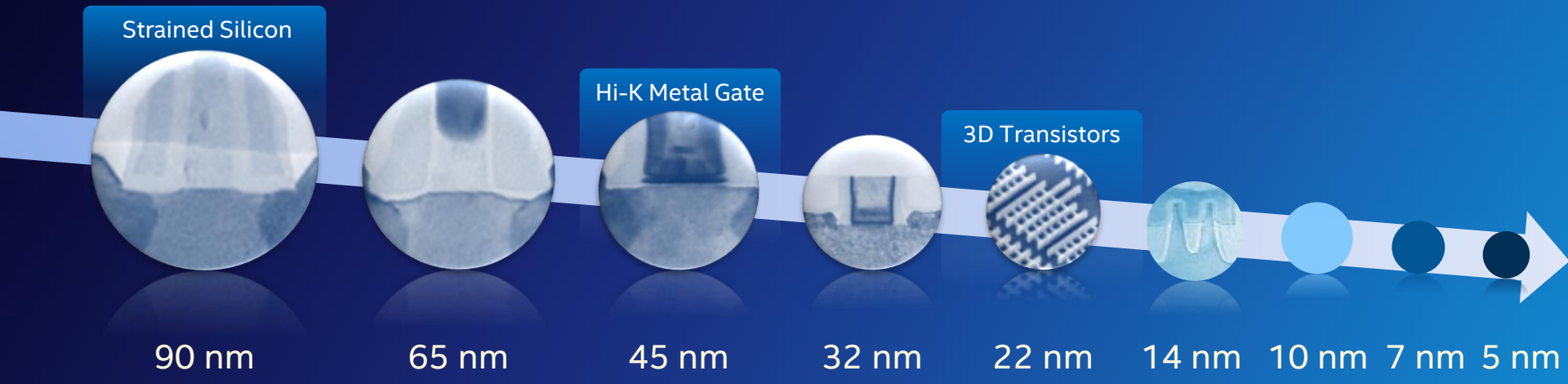
THAN THE PREVIOUS GENERATION

YOU ARE HERE

LEADING EDGE PROCESS TECHNOLOGY

"The reports of my death are greatly exaggerated"

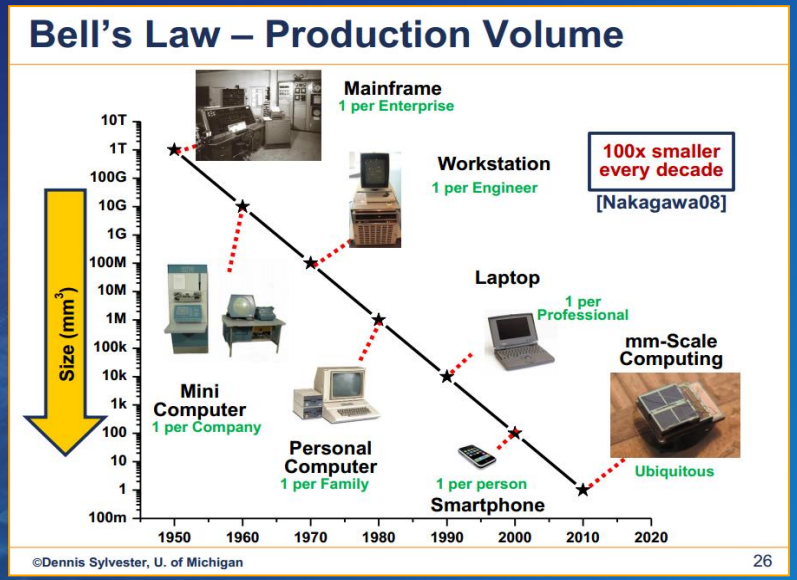
– Mark Twain 1897



INTEL LABS RESEARCH AGENDA

DELIVER BREAKTHROUGH INNOVATIONS TO FUEL INTEL'S GROWTH AND TECHNOLOGY LEADERSHIP

THE NEXT COMPUTER CLASS



BELL'S LAW OF COMPUTER CLASSES (1972)

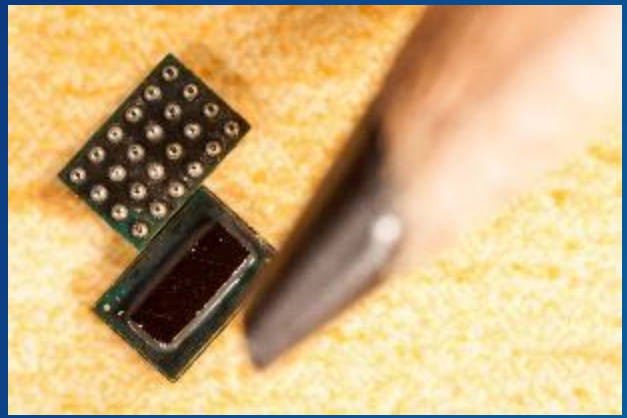
Roughly every decade a new, lower priced computer class forms based on a new programming platform, network, and interface.

Source: Bell's Law:
http://www.qatar.cmu.edu/~msakr/15346-s13/lectures/Bell's%20Law%202013-.pdf

TOWARDS ZERO NET ENERGY SYSTEMS

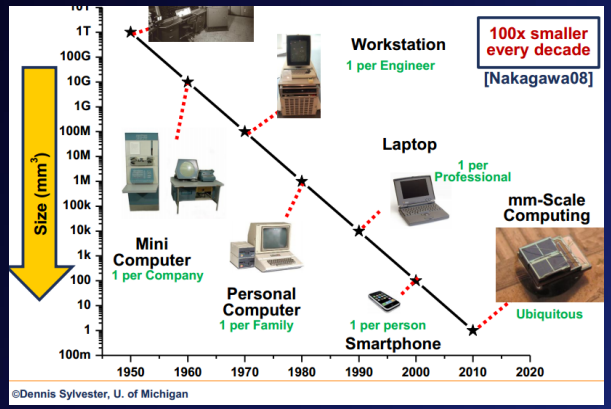
Intel® Quark™

Intel® Curie™



Cost-effective near invisible **1mm³** computing systems

10'S OF BILLIONS CONNECTED DEVICES



BELL'S LAW – PRODUCTION VOLUME

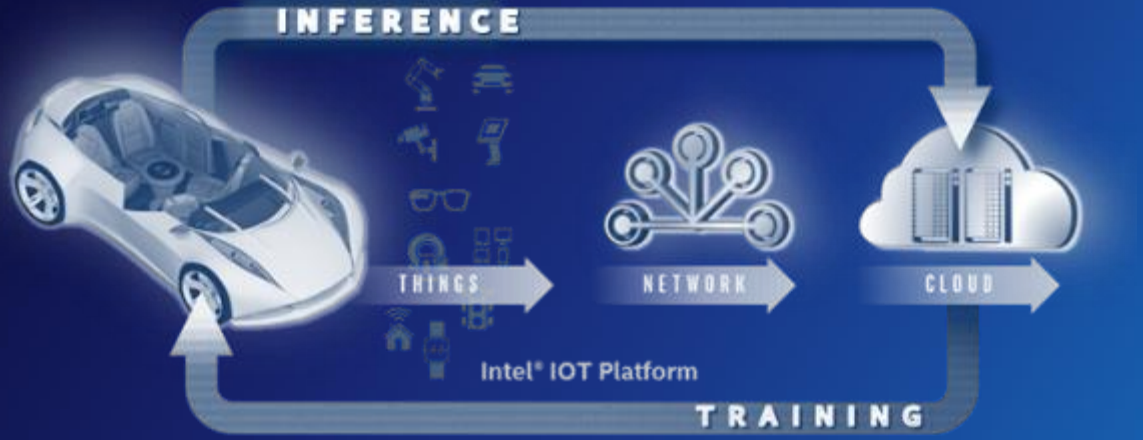
CONNECTED AND SECURE

5G +

DEFINING "I" OF IOT

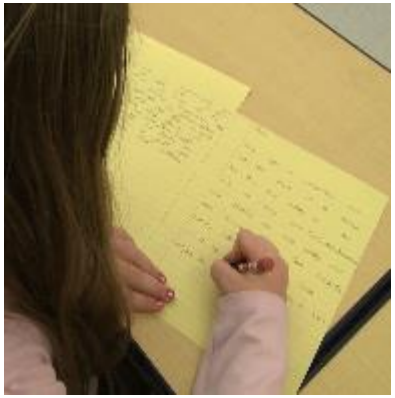
PROTECTION, DETECTION, RECOVERY

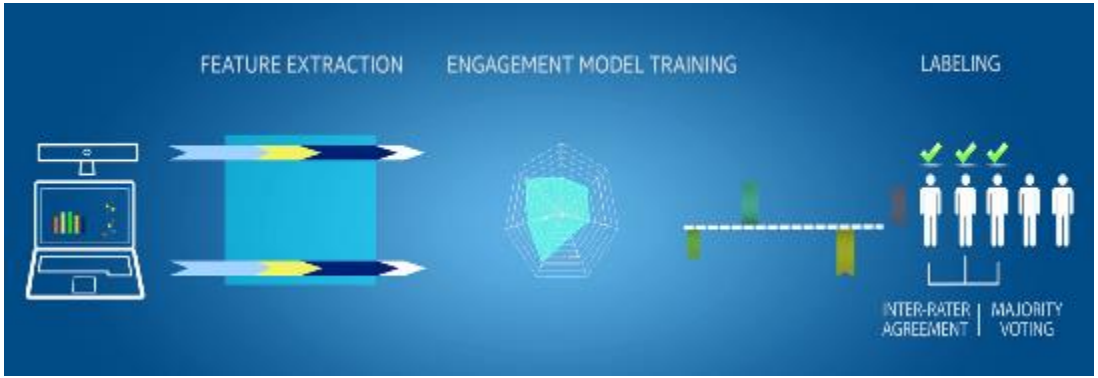
AUTONOMOUS DRIVING



SENSE THE ENVIRONMENT	COMMUNICATION	SECURITY
Cameras	Vehicles	Platform
Radar	Infrastructure	Communications
LiDAR	Cloud	Analytics

ADAPTIVE LEARNING RESEARCH





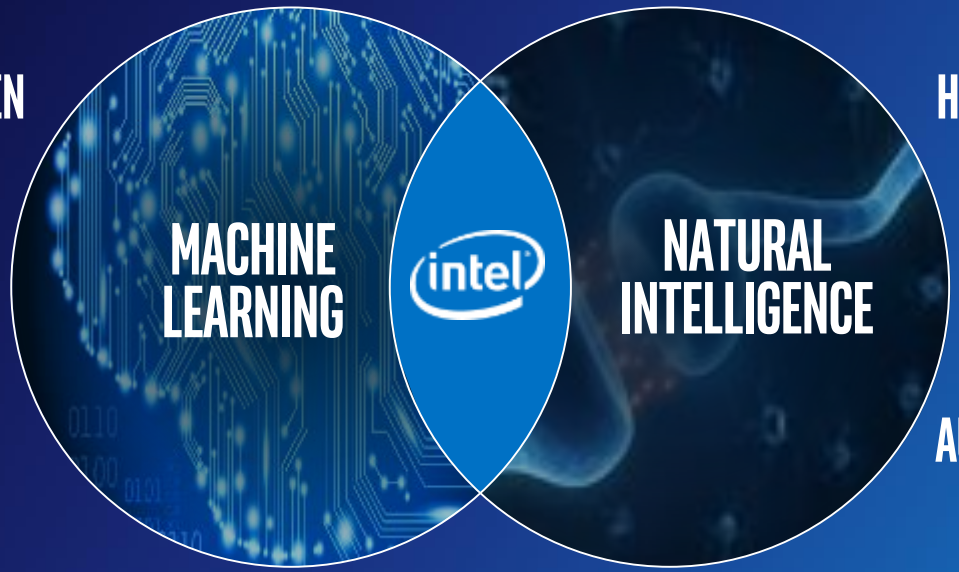
EXTRACTING THE SIGNAL AND THE VALUE

COGNITIVE COMPUTING

EMPIRICALLY DRIVEN

COMPLEX, VARIED DATA

HIGH ACCURACY ON SPARSE DATA



HANDLING AMBIGUITY

CONTEXTUAL REASONING

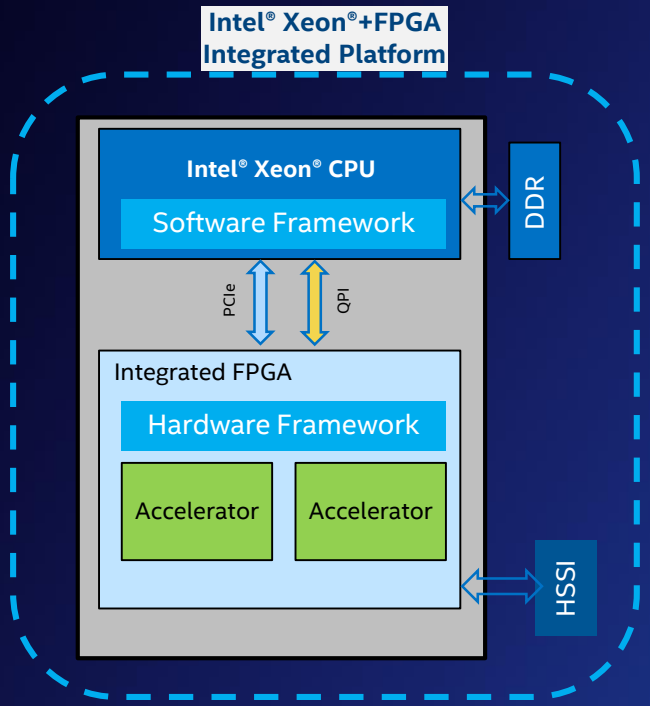
AUTONOMOUS LEARNING

INTEL LABS RESEARCH AGENDA

DELIVER BREAKTHROUGH INNOVATIONS TO FUEL INTEL'S GROWTH AND TECHNOLOGY LEADERSHIP

Enabling Scalable, Energy Efficient Compute from Sensors to Servers

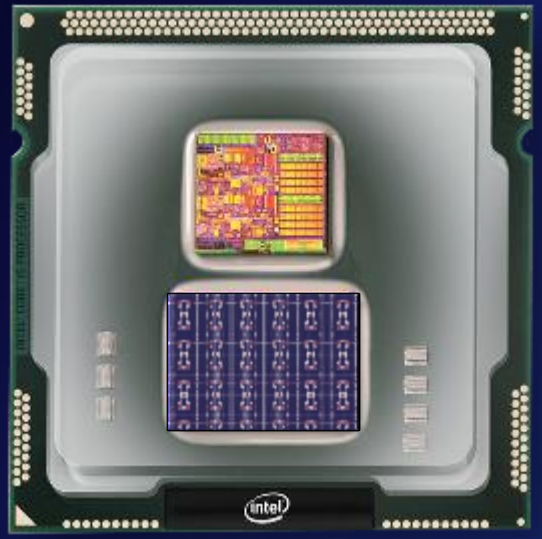
RECONFIGURABLE COMPUTE



Unlocking the power of Heterogeneous Computing

- AI algorithms are rapidly evolving and compute needs to evolve as well
- Enabling new algorithms and workloads that perform best on Intel platforms with FPGA
- Large-scale software frameworks are being developed and will drive the apps of tomorrow

NEUROMORPHIC MODELS SOLVE HARD PROBLEMS EFFICIENTLY



Integrated
Memory + Compute
Neuromorphic Architecture

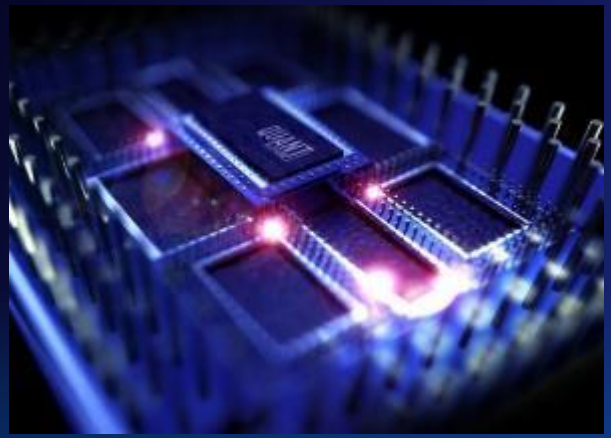
Objective is to develop a **programmable** architecture delivering >100x energy efficiency over current computing architectures for these workloads

Solving challenging problems:

- Sparse Coding
- Quadratic Programming
- Constraint Satisfaction
- Pattern Matching
- Dynamic Learning & Adaptation

... ultimately many more

TRANSFORMATIONAL RESEARCH – QUANTUM COMPUTING



Bootstrap Qubit implementation through top university research

In-house program

SW and algorithm

Delft University & QUTech addressing critical challenges

- Make Better Qubits
- Improve Qubit Connectivity
- Develop a scalable I/O

Complementary program ramping at Intel

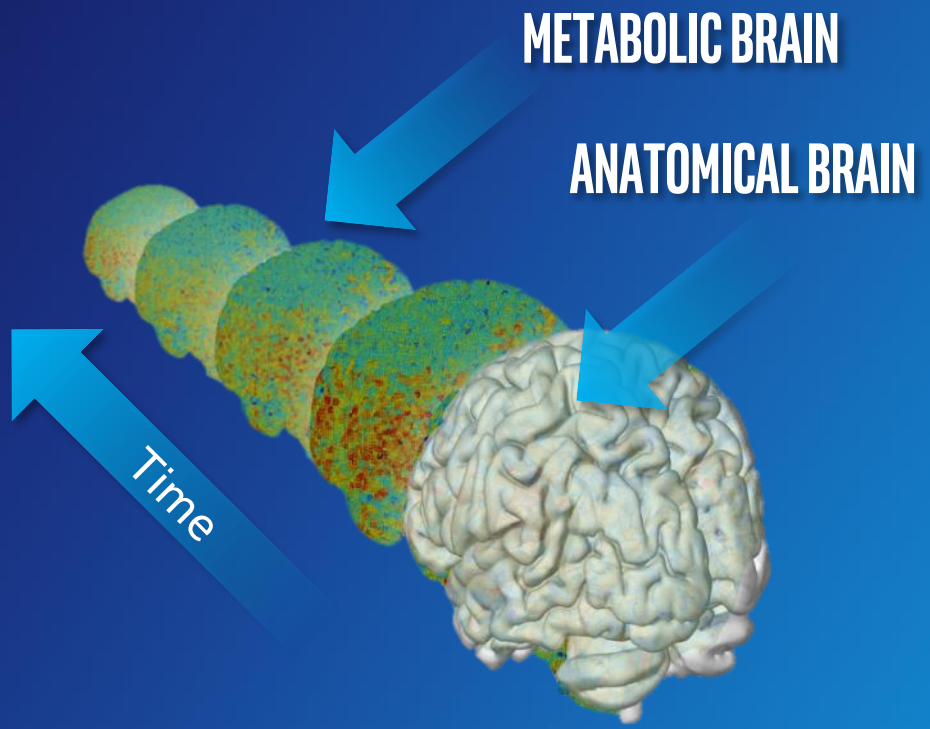
- Quantum Chemistry algorithm mapping and optimization
- Simulation-based microarchitecture / algo co-design
- IA features for post-quantum computing secure cryptography

Other external research collaborations

BRAIN DECODING

Unlocking the mind with computational neuroscience in collaboration with Princeton

- Capturing the complexities of the brain that current circuits do not
- Providing some key theories missing from whole brain simulation
- Using Functional MRI to study attention, control, and decision making



3D BRAIN ACTIVITY GENERATED BY FMRI

SUMMARY

We live in magical times
because we can implement what people have imagined

Working together across disciplines will be greater than sum of parts

Join with us in creating the future


YOU ARE HERE
"Any sufficiently advanced technology is indistinguishable from magic"
– Arthur C. Clarke 1973

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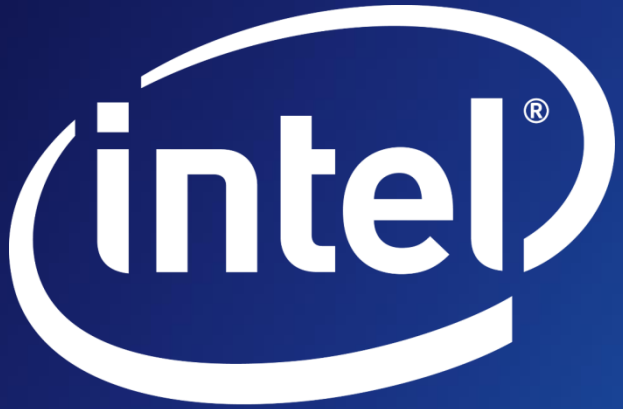
What Can We Invent ***With You?***



experience
what's inside™