VR & AR path to the future

an Embedded vision

Thierry JOUBERT
DSC 2019

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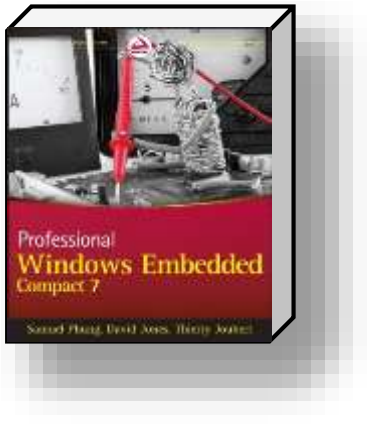
- Engineer *Ecole Centrale de Nantes*
- 1986 - 1989 → TTS – VISA4
- 1990 – 1998 → Renault - SCANeR
- 2002 → Co-founder

- 2011 → Co-authored



- 2012 - 2015 → FUI – VaRI3

Immersive systems challenges

- Re-create real sensations with a machine
  - Computers help…
  - Real time is required
  - Dedicated circuits for vision, haptics
  - Price is constrained
- Innovation is guided by computer market

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Computer Market

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Downsizing is a rule

1980
300 000€

1990
30 000€

2000
3 000€

2010
300€

2015
30€

2018
3€

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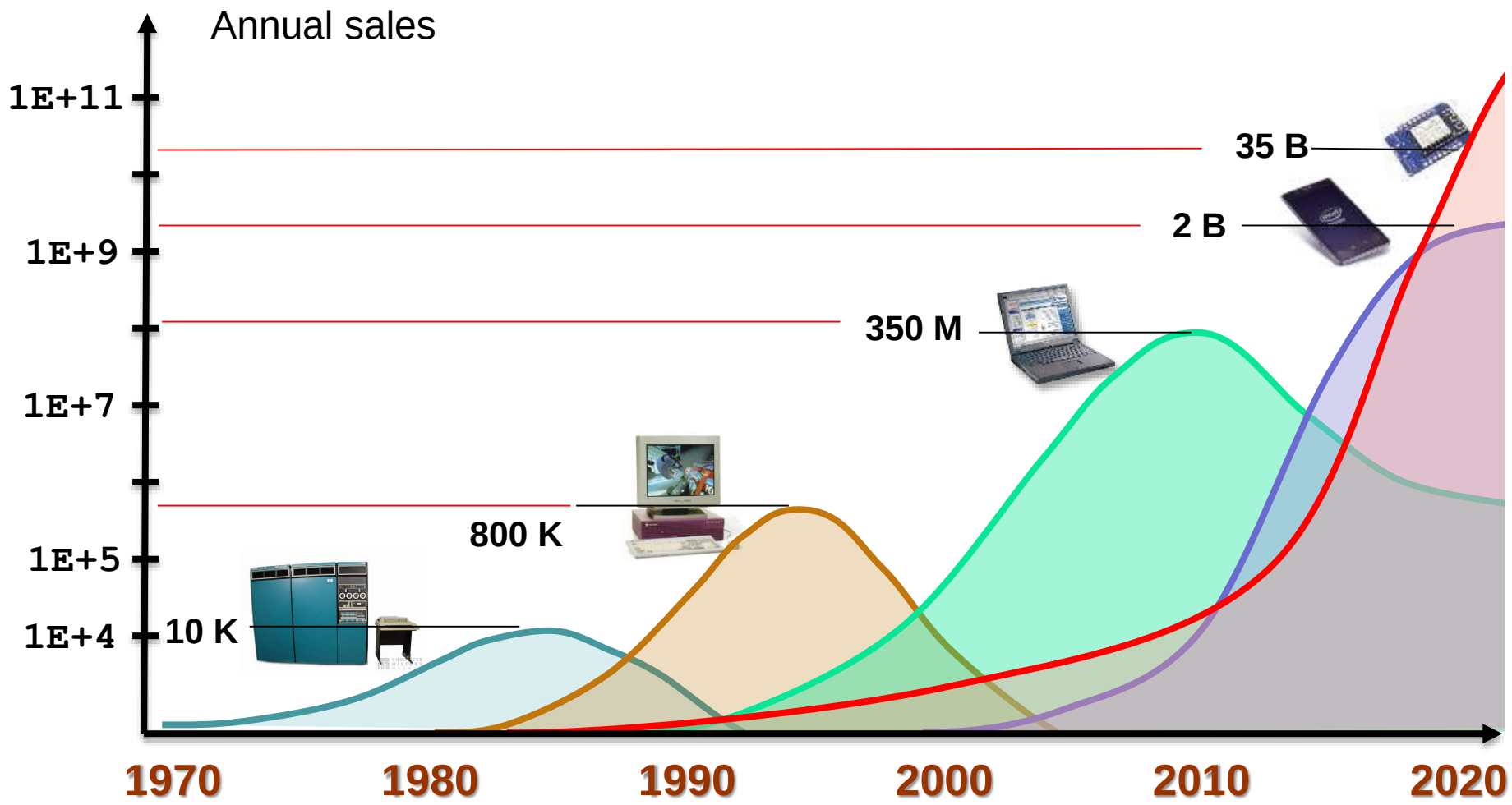
Growing is another rule



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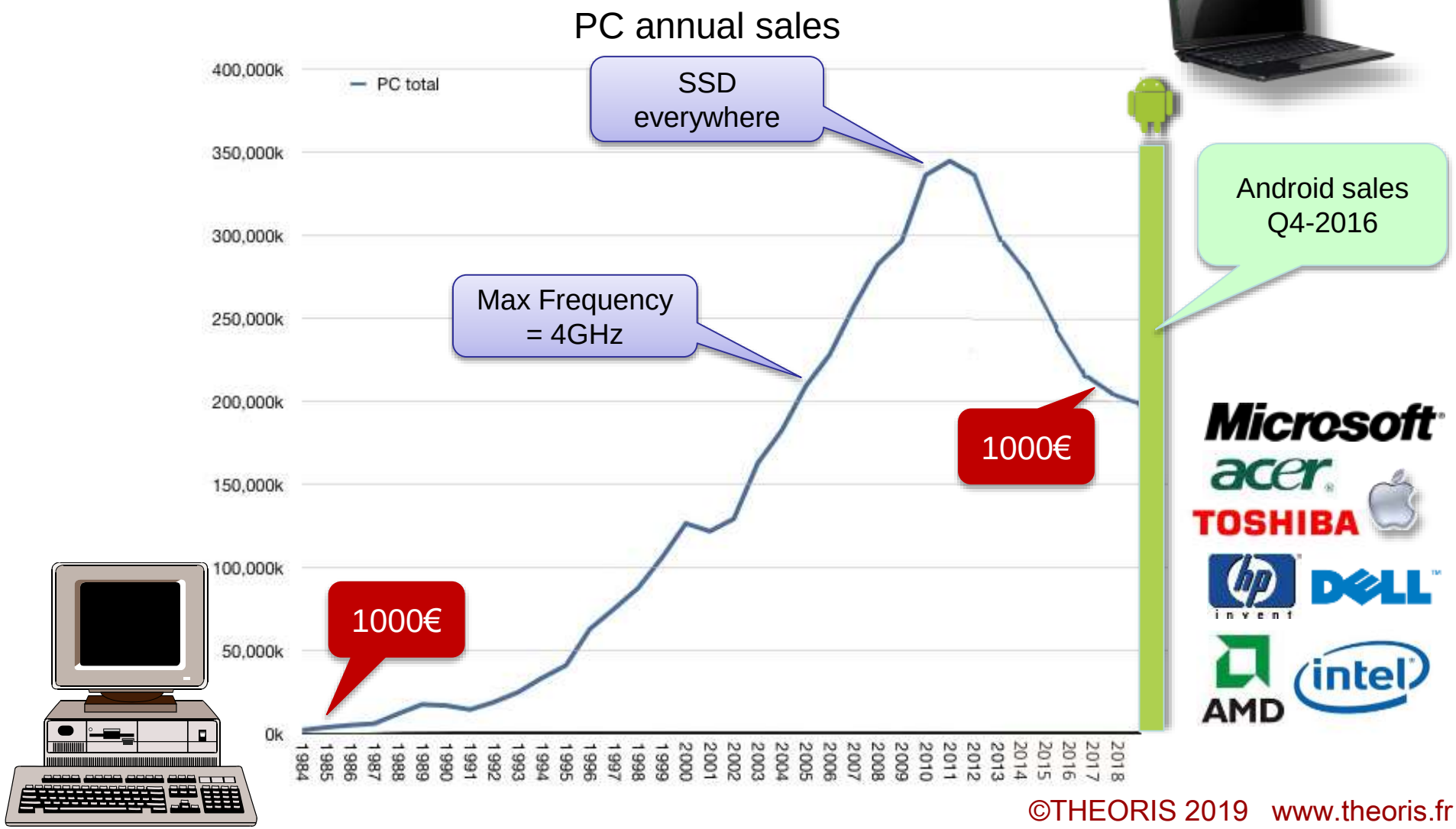
PC = constant price

→ *More for the same price!*



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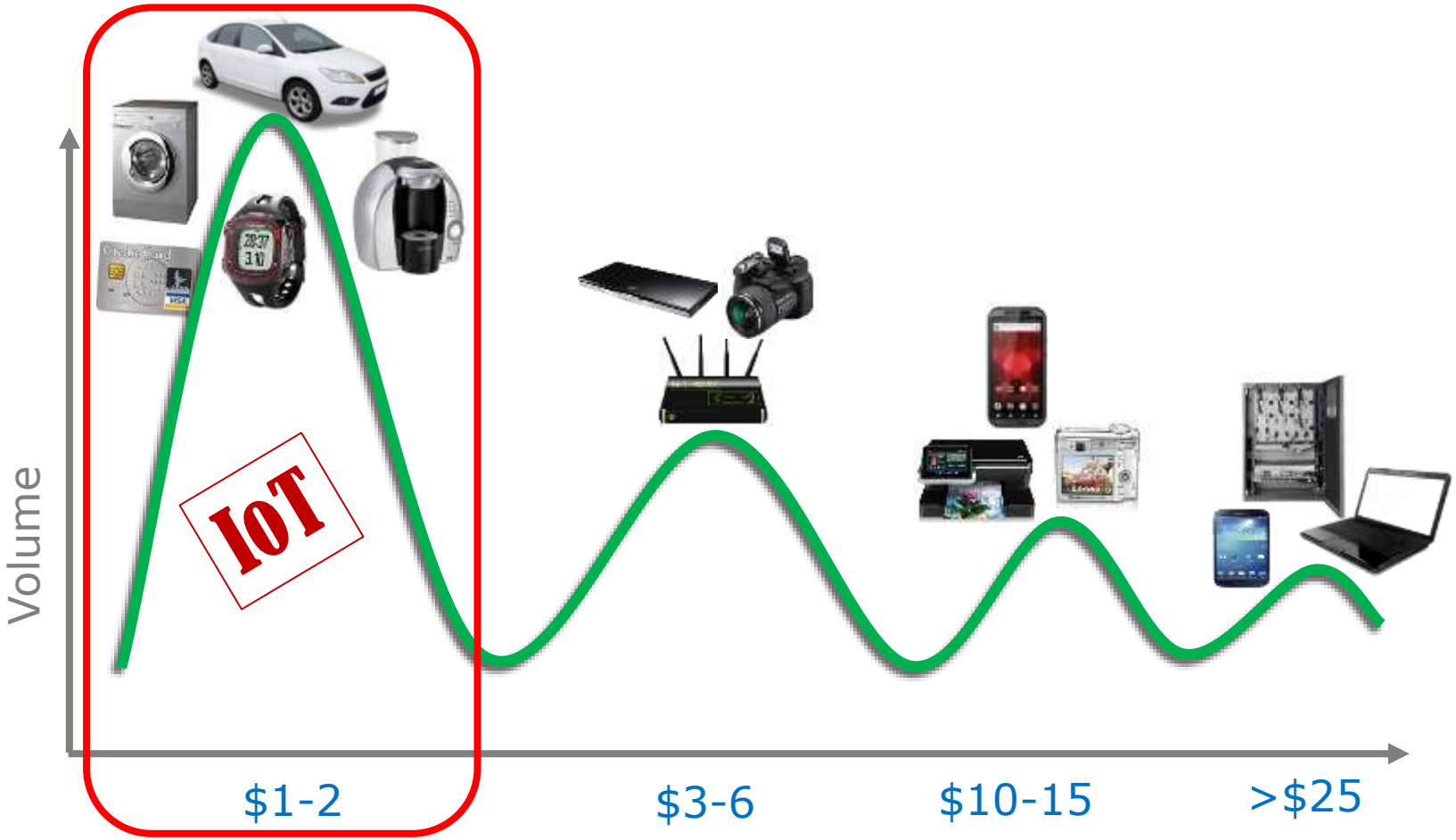
IoT = decreasing prices

→ *More for less money!*



Average Selling Price of a Semiconductor Chip

Source: ARM

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Origins of the market shift…

- Hardware industry is mature
  - High competition
  - Consolidation
  - Standardization
- Worldwide market
- New business models (cloud)

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Hardware

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"People who are really serious about software should make their own hardware."

Alan Kay

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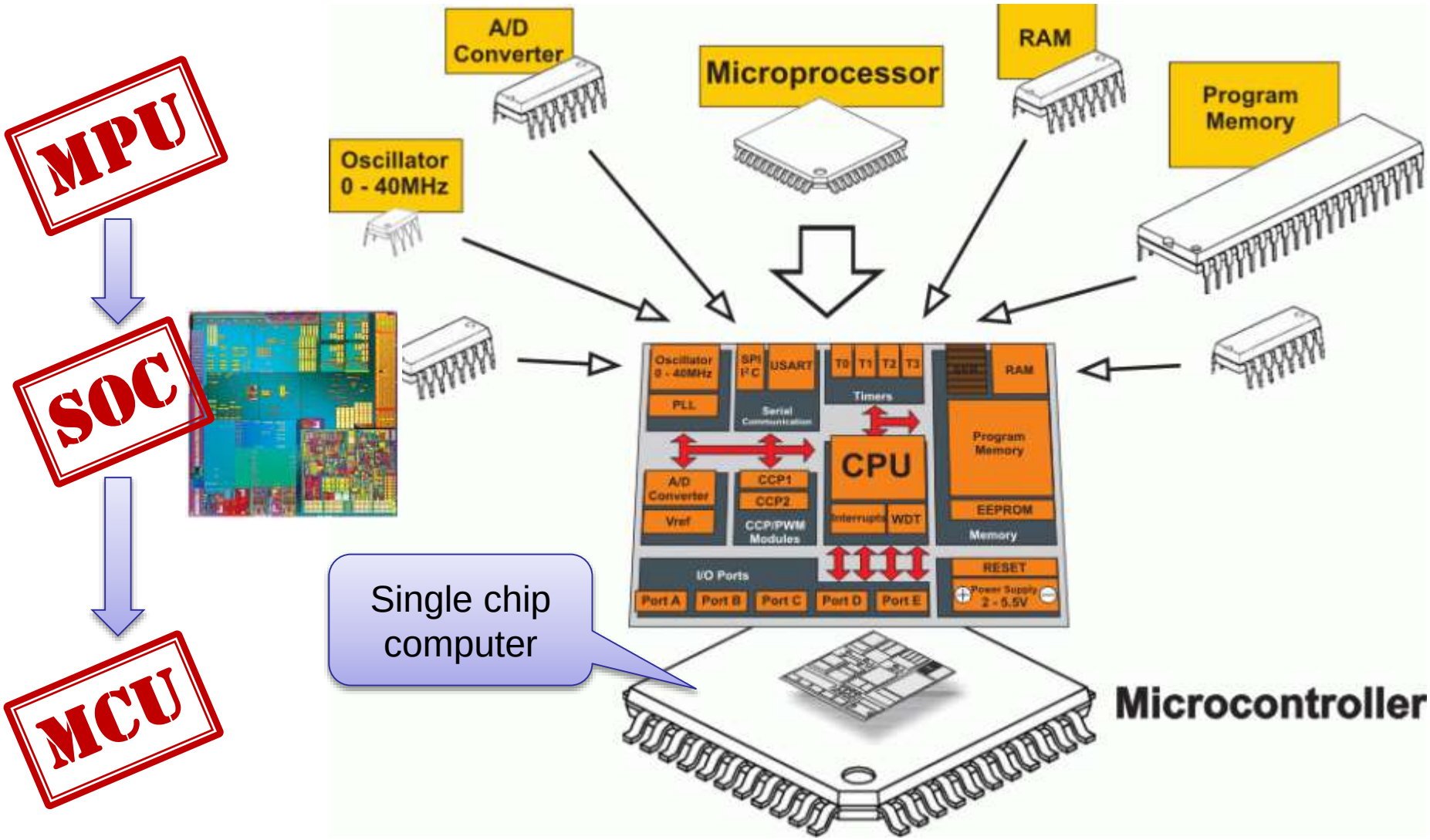
From MPU to SOC / MCU



The hardware landscape

ARM

Allwinner Technology
SILICON LABS
ANALOG DEVICES
SAMSUNG
SIEMENS
NVIDIA
infineon
QUALCOMM
ST life.augmented
intersil
RENESAS
TEXAS INSTRUMENTS
National Semiconductor
AVAGO TECHNOLOGIES
BROADCOM
NXP
freescale
ATMEL
MICROCHIP

Tensilica

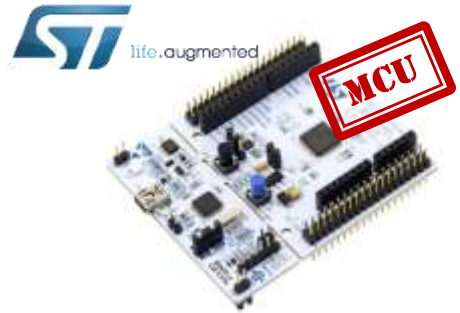
ESPRESSIF

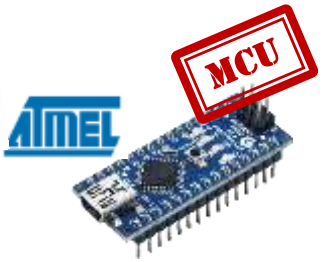
x86

AMD
intel
ALTERA
DM&P Group

Affordable hardware

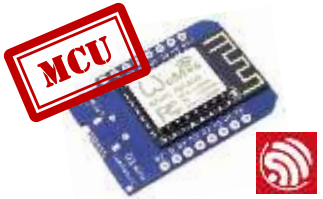
ARM



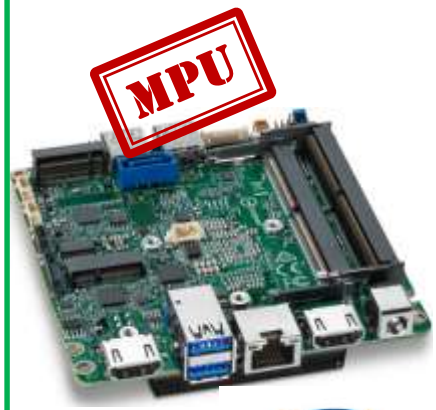


NXP

Tensilica



x86



intel

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Software

```
void MyFirstServer::DoConnection() throw()
{
  if (!IsConnected())
  {
    m_tryToconnect = true;
    if (Connect(this))
    {
      m_tryToconnect = false;
      std::cout << "Connected to CORBA."<< std::endl;
    }else
    {
      std::cout << "Connect failed... retry in 1s."<< std::endl;
      QTimer::singleShot(1000, this, SLOT(DoConnection()));
    }
  }
}
```

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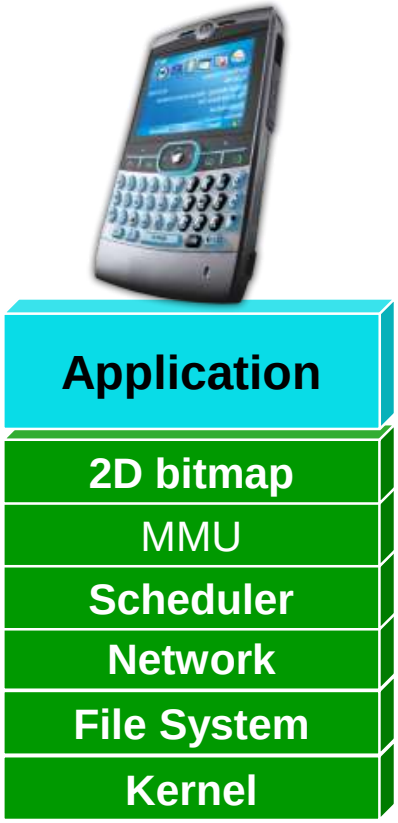
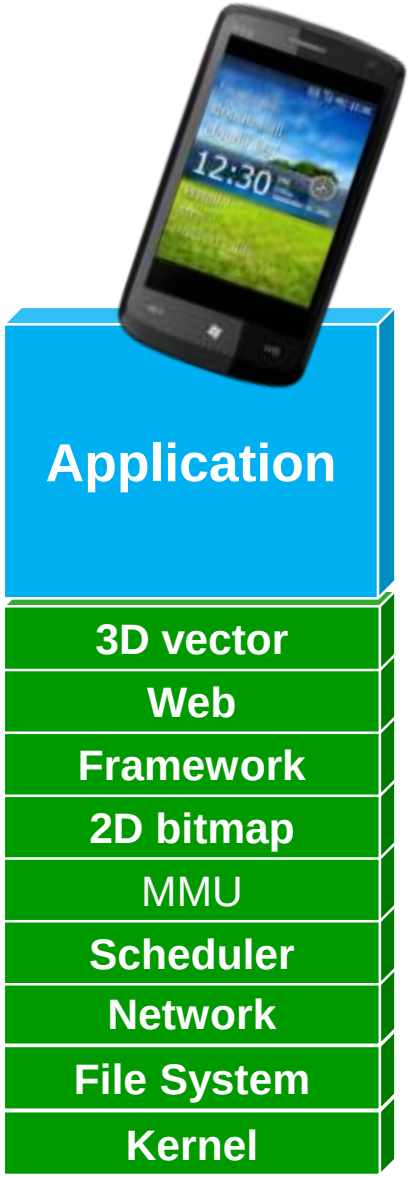
Growing compexity





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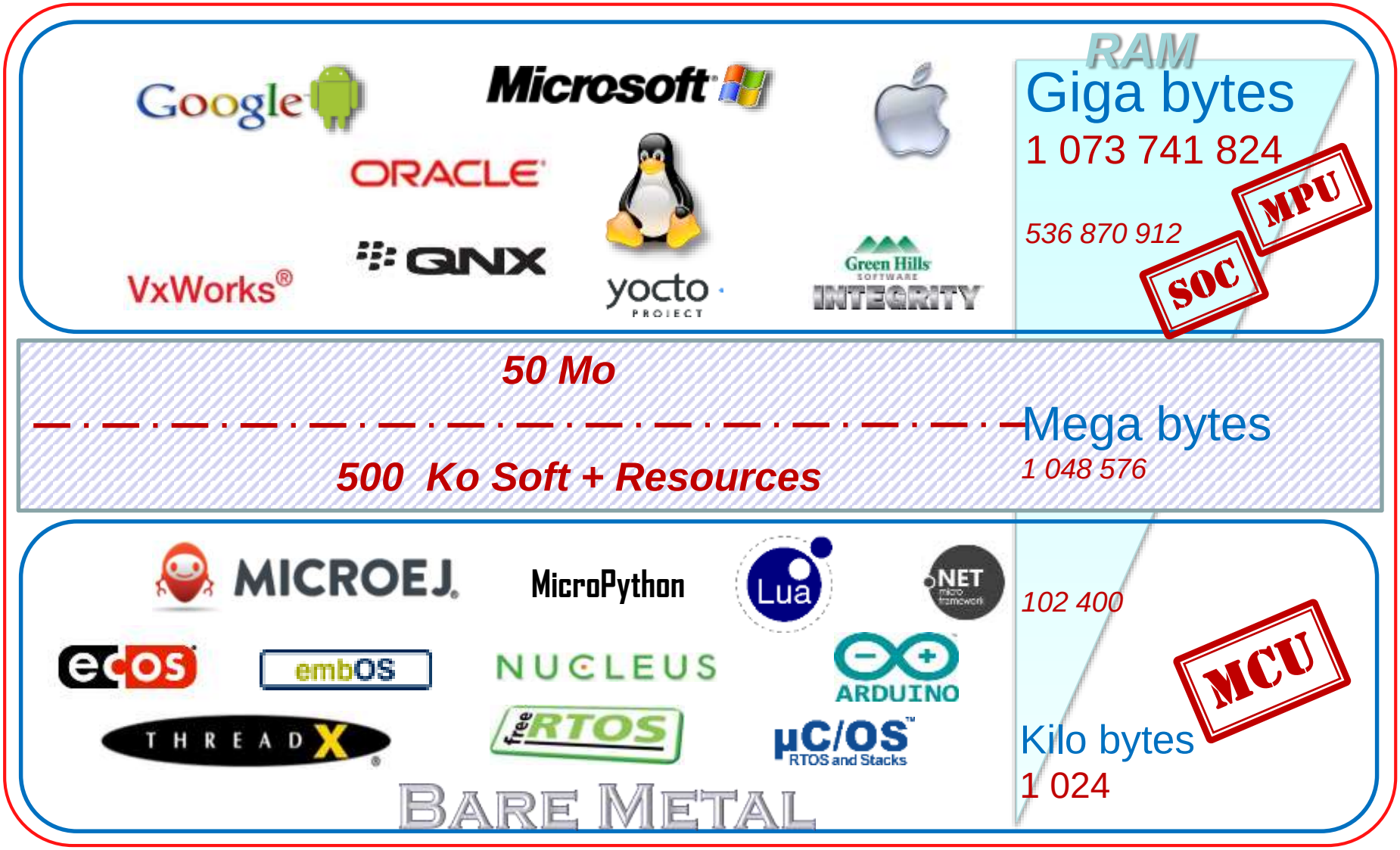
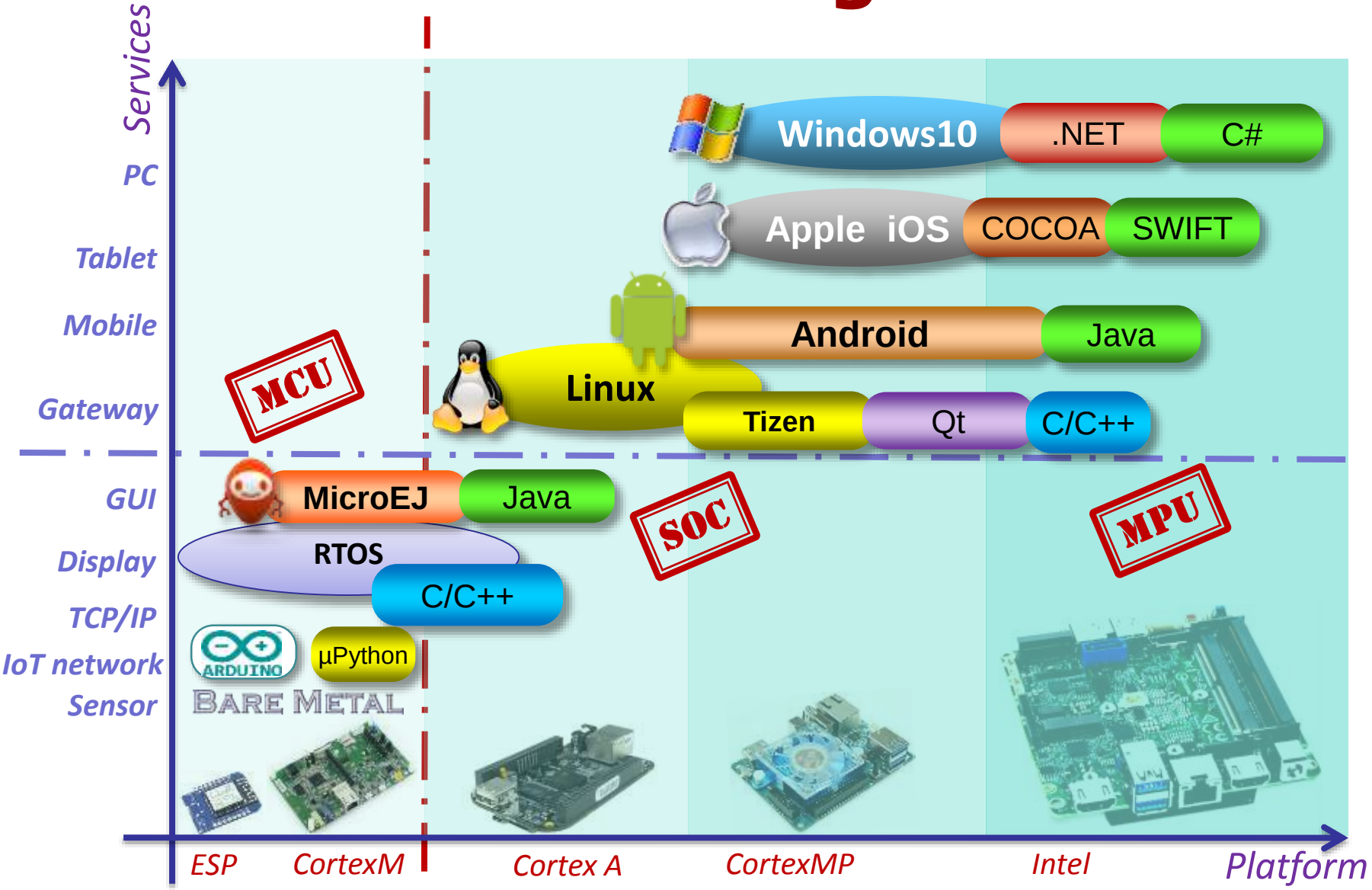
Software landscape



Software coverage



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High end graphics software

- Thanks to the game market!
  - 3D engines
  - Developer tools
  - Broad hardware spectrum

unity

UNREAL ENGINE

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Choices for an immersive experience

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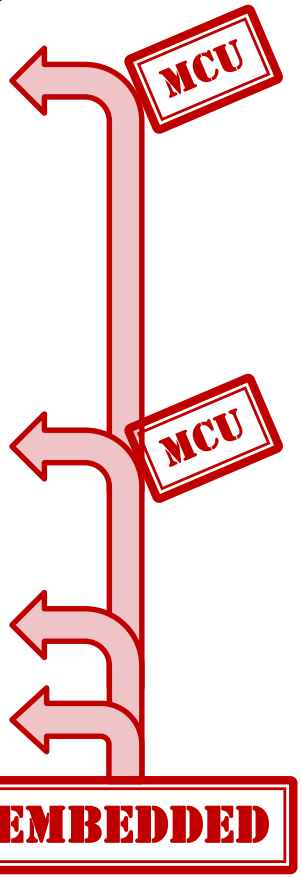
Immersion Challenges

Requirements:	Solutions:
• Realistic environment	3D database
• User position / actions	Sensors
• World animation	CPU / PPU
• Eyes feedback	GPU
• Sound feedback	Audio
• Body feedback	Actuators
• Man in the loop!!	Integration
	Real time



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VR & AR challenges

Virtual Reality

- **Immersion quality**
  - Image quality
  - Image Frequency
  - Field of view
  - Resolution
- **Body feedback**
  - Hard Real Time
  - Infrastructure

Augmented Reality

- **Real world matching**
  - Image quality
  - Image Frequency
  - Environment tracking
- **Eye tracking**
  - Visual comfort

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Cloud

- **It is now part of the business model…**
  - **Saas**
- **Unique services for VR & AR** **& GAMES**
  - **Big data**
    - ✓**3D visual databases**
    - ✓**Terrain information** (OpenstreetMap, …)
  - **Artificial Intelligence**
  - **Collaboration**

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Cloud + Embedded = Edge

- Next generation VR & AR
  - Cloud services
  - Local processing (Edge)
- New hardware architectures
  - SOC
  - MCU

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Hololens example

Hololens 1

- HPU →Tensilica

- CPU/GPU →Intel
- System API

Hololens 2

- HPU →… Gen 2 ?
- CPU/GPU → Qualcomm
- Simplified system API
- Cloud integration

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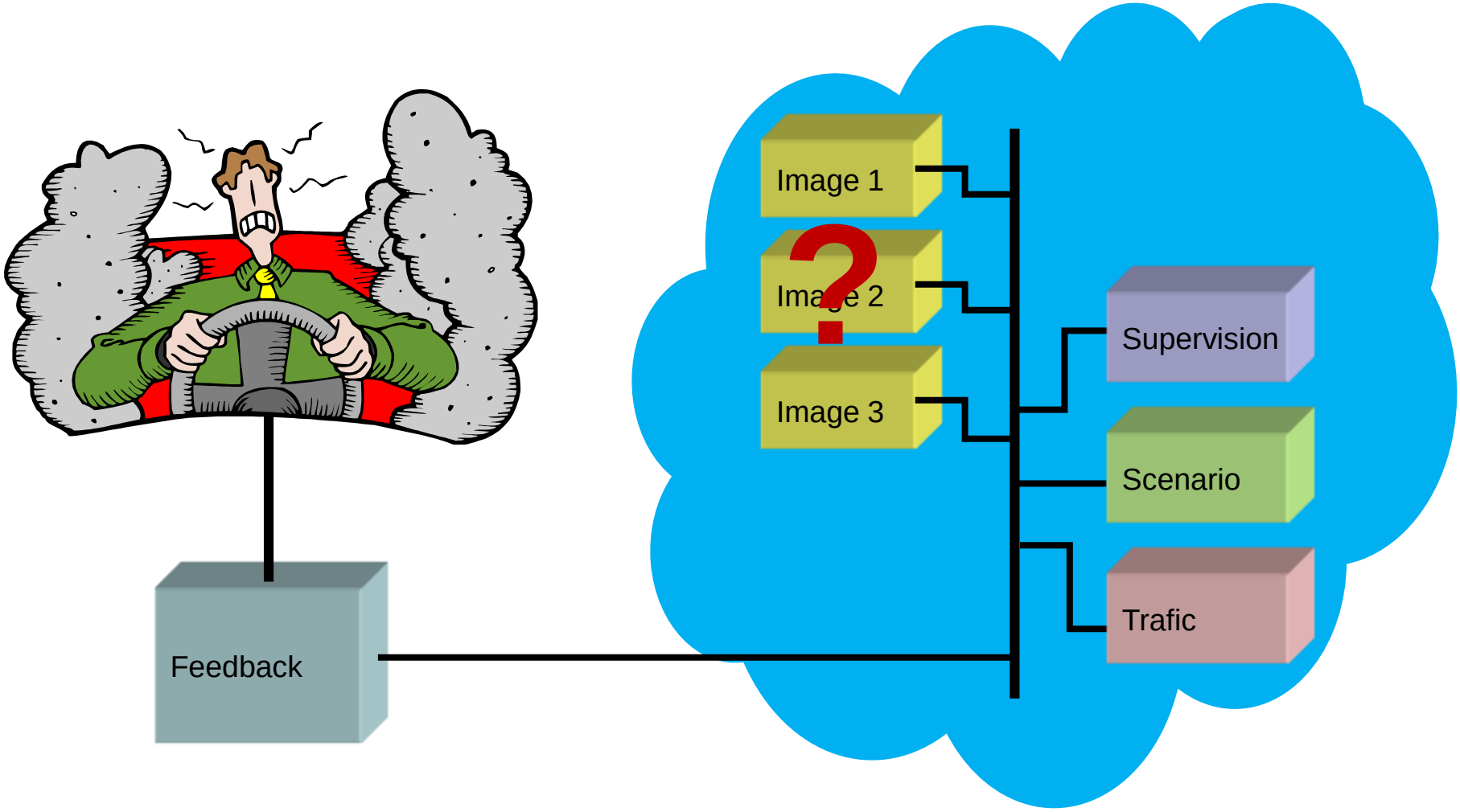
VR/AR Cloud services



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VR Streaming & Latency

Network Latency = Propagation Delay + Serialization Delay

Propagation Delay = Distance / Speed

Serialization Delay = Packet Size (bits) / Transmission Rate(bps)

- **Latency ~ Serialization!!...**

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Lantency example

rfwireless-world.com/calculators/Network-Latency-Calculator.html

Source to Destination Distance(Km) (input1) :

10000

CALCULATE

Transmission Medium Speed in m/s(input2) :

225000000

Network Latency (output1) :

1.2444444444444445

Packet Size in bytes (input3) :

1500

Data Transmission rate in Kbps (input4) :

10000

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Streaming ~ Infrastructure

- Eliminate Hops
  - Connect to the Datacenters
  - Private clouds
  - Dedicated hardware

XCLOUD BLADE

- Optimize data volume
  - Streaming compression techniques
  - Distribute the rendering pipeline

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Be ready!

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