

OPEN NETWORKING // Enabling Collaborative Development & Innovation

# Deploying the New Intelligent Edge with Open Hardware, Software and Data

Wenjing Chu April 3, 2019

Hosted B

THELINUX FOUNDATION | TLFNETWORKING



1960's centralized computing central access

DENNIS RITCHIE

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YOU HAVE TO BE A GENIUS TO THE SIMPLICITY









1960's centralized computing centralized access





YOU HAVE TO BE A GENIUS TO UNDERSTAND THE SIMPLICITY



1970's centralized computing dispersed access

#### "Dad, can Iuse the IBM computer tonight?"

If not an unusual market is a second second

use your metal racquet. Sometimes you let them. Often you don't. But when they start akking to use your IBM Personal Computer, it's better to say yes. Because lenning about computers, is a subject your

kids can study and enjoy at home. It's also a fact that the IBM Personal Computer can be as useful in your home as it is in your office. To help

be as useful in your notice as it is in your onice, to help plan the family budget, for instance. Or to compute anything from interest paid to calories consumed, you can even tap directly into the Dow Jones data bank with your telephone and an inexpensive adapter.

But as surely as an IBM Personal Computer can help you, it can also help your children. Because just by playing games or drawing

The IBM Personal Computer

CIRCLE 3

1980's -

dispersed computing

centralized access

It not an unusual colorful graphics, your soor daugher will discorer phenomenn. It what makes a computer tick—and what it can do. They starts when your can take the some word proceeding program you use to cratechosiness reports to write and edit body reports borrow (and learn how to type in the process. Murikks might their own portugations in BASIC or Paul.

Ultimately, an IBM Personal Computer can be one of the best investments you make in your family's furner. And one of the least expensive. Searning at lease shan \$1,600 'there's a system that, with the addition of one simple device, hooks up to your home TV and uses your makine cassetre recorder.

To introduce your family to the IBM Personal Computer, visit any Computerfand' store or Sears Business Systems Center. Or see in all a one of our IBM Produce Centers. (The IBM Data Processing Division will serve business customers who want to putchase in quantity.)

And remember. When your kids ask to use your IBM Personal Computer, let them. But just make sure you can get it back. After all, your son's still wearing that tie.

still wearing that tie. IBM



1960's centralized computing centralized access





THE SIMPLICITY



1970's centralized computing dispersed access

#### "Dad, can Iuse the IBM computer tonight?"



phenomenon. It what makes a computer tick-and what it can do. They starts when your can take the same word processing program you use son asks to to create business reports to write and edit book reports (and learn how to type in the process). Your kids might even get so "computer smart," they'll start writing their own programs in BASIC or Pascal.

Because learning about computers is a subject your

kids can study and enjoy at home. It's also a fact that the IBM Personal Computer can be as useful in your home as it is in your office. To help

plan the family budget, for instance. Or to compute anything from interest paid to calories consumed. You can even tap directly into the Dow Jones data bank with your telephone and an inexpensive adapter.

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The IBM Personal Computer

CIRCLE I

1980's -

dispersed computing

centralized access



1990's dispersed computing dispersed access

#### 2000's - The stars were born



August 19, 2004 Google IPO

> January 9, 2007 iPhone announced

#### BY 2004, THE IDEA OF **AMAZON WEB** SERVICES HAD BEEN FULLY RENDERED:



A READY-MADE IT FOUNDATION THAT CAN BE LEASED AS A SERVICE.

THE REST IS HISTORY....

2006

#### AWS IS OFFICIALLY BORN

On March 14, 2006, AWS launches Simple Storage Service (S3). Simple Queue Service (SQS) and Elastic Compute Cloud (EC2) followed soon thereafter.

> March 14, 2006 AWS S3



February 4, 2005 TheFacebook

### 2010's: The gravitational pull

Cloud centralized computing dispersed access







#### ... But, sometimes, clouds got in my way



"Rows and flows of angel hair and ice cream castles in the air and feather canyons everywhere, I've looked at cloud that way but now they only block the sun, they rain and snow on everyone so many things I would have done but clouds got in my way"

*"Clouds"* Joni Mitchell 1969

- Latency
- Bandwidth
- Privacy
- Autonomy
- Mobility



- Latency
- Bandwidth
- Privacy
- Autonomy
- Mobility





**5G-powered autonomous vehicle drives through** Korean Herald, March 11, 2019 **Seoul** 

"In the previous 4G environment, autonomous vehicles could receive critical traffic information after traveling 2.8 meters. 5G technology can reduce if down to 1 millimeter," said Kang Jong-oh, who manages future technology at LG Uplus.

"It is like telecom firms helping cars drive on their own after providing critical information for driving," said Kang of LG Uplus. "Combined with mobile edge computing technology, the 5G network can provide wider coverage for self-driving cars."



ACE Lab



- Latency
- Bandwidth
- Privacy
- Autonomy
- Mobility



The operation was performed using surgical robots controlled by Dr Ling who connected to them through a 5G mobile network while he was working in another city. He hopes the technology will make it easier to treat people living in remote areas

March 16, 2019 New China TV & geek.com



Hainan," Ling told CGTN. "The 5G network has solved problems like video lag and remote control delay experienced under the 4G network, ensuring a nearly real-time operation. And you barely feel that the patient is 3,000 kilometers away."



**Beijing** 



- Latency
- Bandwidth
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- Mobility



March 19, 2019



Deep immersion, e.g. cognitive assistance or full VR, requires ~10-30 ms or less.

- Latency
- Bandwidth
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- Mobility



recommended limit at. But with innovations that we've made on the streamer side and on the compression side since then, when we launch, we will be able to get to 4K but only raise that bandwidth to about 30 megabits per second. So if you have less bandwidth, we'll give you a lower resolution... We do a lot of that for you in the background, and we will only offer up the appropriate bandwidth for the infrastructure that you have."

#### Openness is Key to Success in Edge Computing

**Dispersed Computing** 

#### **Dispersed Access**



Situational Awareness (High Dimensions!)

Privacy

#### Openness is Key to Success in Edge Computing

**Dispersed Computing** 

**Dispersed Access** 



Situational Awareness (High Dimensions!)

Privacy

Complexity

#### Openness is Key to Success in Edge Computing

#### **Dispersed Computing**

#### **Dispersed Access**



Situational Awareness (High Dimensions!)

Privacy













Regional Data Center Central Data Center



Smart End-user & Near-user Devices

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Regional Data Center Central Data Center





#### **Open Hardware**



### **Open Software**





#### Linaro Edge Reference Platform

#### Edge Runtime/Framework/Application



#### Designed for





### KubeEdge: Extending Kubernetes to the Edge



- Provides scalable lightweight Kubernetes Native Edge Computing Platform which can work in offline mode.
- Simplifies edge application development and deployment.
- Cloud vendor agnostic







#### An Opportunity to Fix A Problem



### Openness for a Humanistic Edge: No "experience lock-in"

- Human "experience" at the center
- Privacy as an essential element
- Design for human creativity and fulfillment, e.g. composable interfaces

- Start from people, then to edge, to cloud
- Enable people & apps to choose use patterns (No "experience lock-in")



## **Openness for A Humanistic Edge**

#### Human agency





Credit: IBM Research



# Thank you.



Wenjing Chu Senior Director, Open Source and Research 把数字世界带入每个人、每个家庭、 每个组织,构建万物互联的智能世界。 Bring digital to every person, home and organization for a fully connected, intelligent world.

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