Chapter 1

Overview of Broadband Networks

Outline

- Bandwidth Definitions

- Broadband Trends

- Emerging Opportunities in Telecommunications

Bandwidth Definitions

- Broadband
    - Allows rates of 1.544 Mbps or higher
    - => 20M download 3M upload, FCC 2015
    - => 100M download 3M upload
- Downstream
    - Transmission away from the core network
- Upstream
    - Transmission toward the core network

Wireline/Wireless Bandwidth

- **Wireline (Ethernet/ 802.3)**
  - Ethernet/ 10M/ 1983
  - Fast Ethernet/ 100M/ 1995
  - Gigabit Ethernet/ 1G/ 1998
  - 10 Gigabit Ethernet/ 10G/ 2002
  - 100 Gigabit Ethernet/ 100G/ 2010
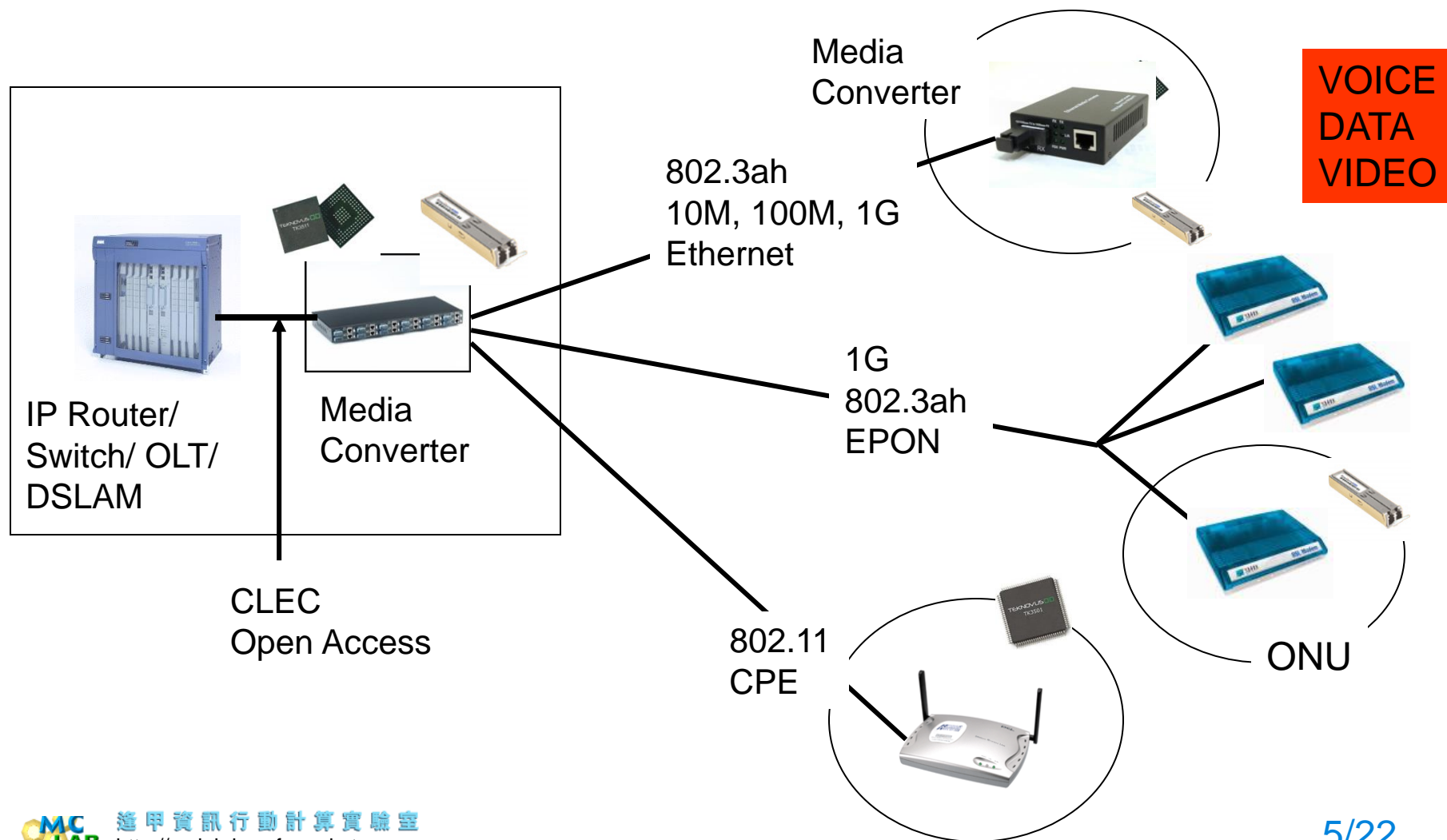
- **Wireless (Cellular systems)**
  - 2G/ 40Kbps/ 1991
  - 3G/ 7.2Mbps/ 2001
  - 4G/ 150Mbps/ 2009
  - 5G/ 1Gbps (theoretical 20gbps)/ 2019
  - 6G …

Broadband Access Networks

(http://www.accessnets.org)

Central Office → Subscriber

Media Converter

802.3ah
10M, 100M, 1G
Ethernet

VOICE
DATA
VIDEO

IP Router/
Switch/ OLT/
DSLAM

Media Converter

1G
802.3ah
EPON

CLEC
Open Access

802.11
CPE

ONU

網路匯流服務之演進

傳統電話 ➡️ 電話(語音) ➡️ 上網(數據) ➡️ 電視(影像)

CATV ➡️ 電視 ➡️ 上網 ➡️ 電話

Triplay Services(三合一服務)

適甲資訊行動計算實驗室
http://mclab.iecs.fcu.edu.tw

e-Taiwan

m-Taiwan

U-Taiwan (Ubiquity)

i-Taiwan

i-♥Taiwan

Broadband Applications, Bandwidth, and Technology

Modem   ISDN   ADSL   **ADSL+ / VDSL**   **FTTU**

Browsing / Radio
-> 144 kbps

½ Screen Video / PC
300 - 700 kbps

High Resolution
4-6+ Mbps (per single ch)

Full Screen
MPEG4 - MPEG2
700Kbps – 4.3 Mbps

E-mail
56 kbps

Music CDs
160 kbps

Voice Services
56 kbps - 1.5+Mbps

Music
WEB Cam

News Clips
Samples

Pay Per View
Online News

Live Sports
HQ TV / DVD Movie
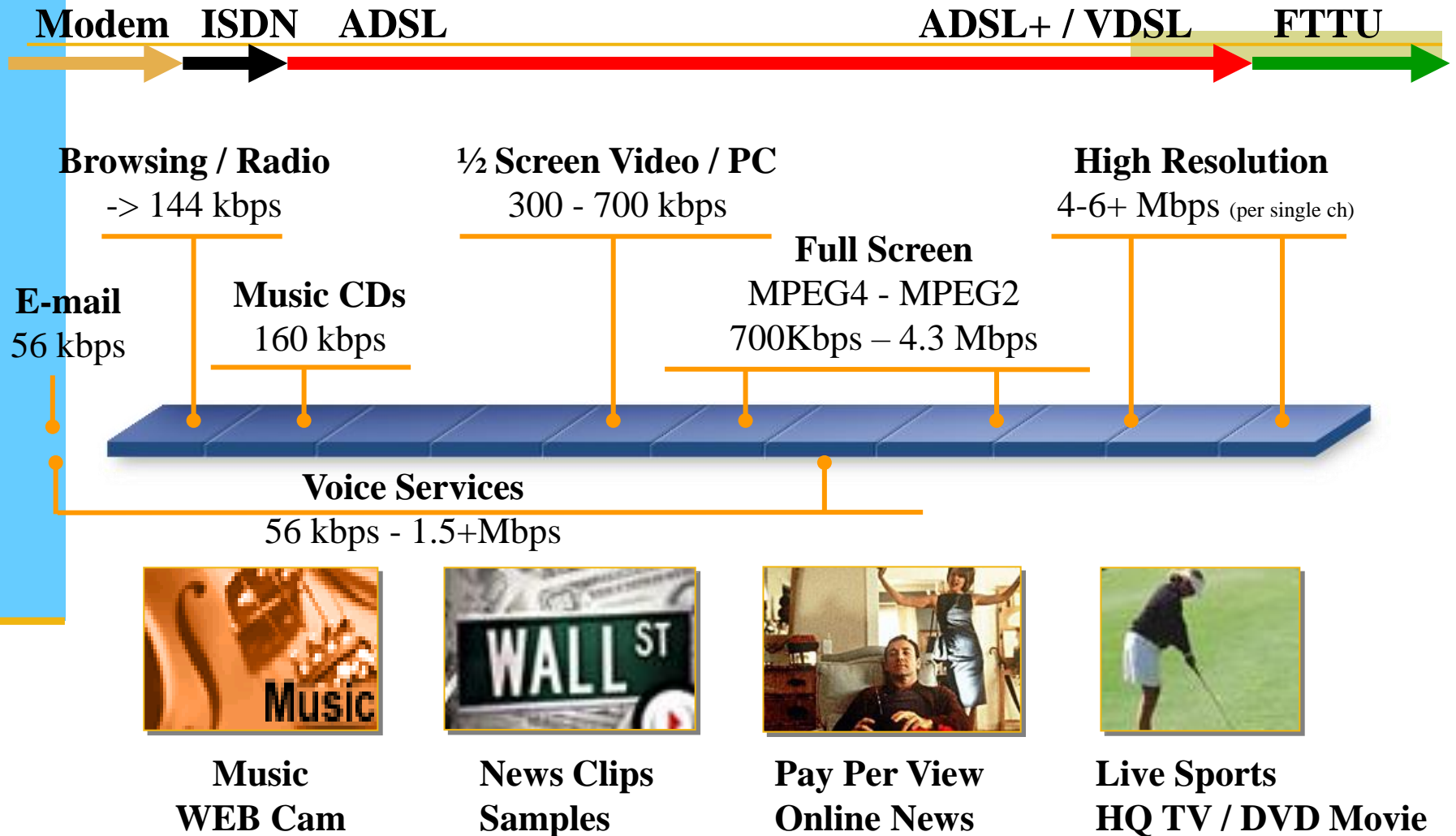
Fiber-to-the-Premises: the ultimate fixed access

Initial Deployments:

- **Japan early leader**
- **Deployments by U.S. Municipalities**
- **U.S. RBOC joint RFP signaled significant acceleration**
- **BPON (in U.S.) and EPON (in Japan) evolving to GPON**

NMS

OLT

Voice, data

Video Servers

V-OLT

ONT

Network core

Central office or remote terminal

Fiber distribution

NID

Home network

逢甲資訊行動計算實驗室
http://mclab.iecs.fcu.edu.tw
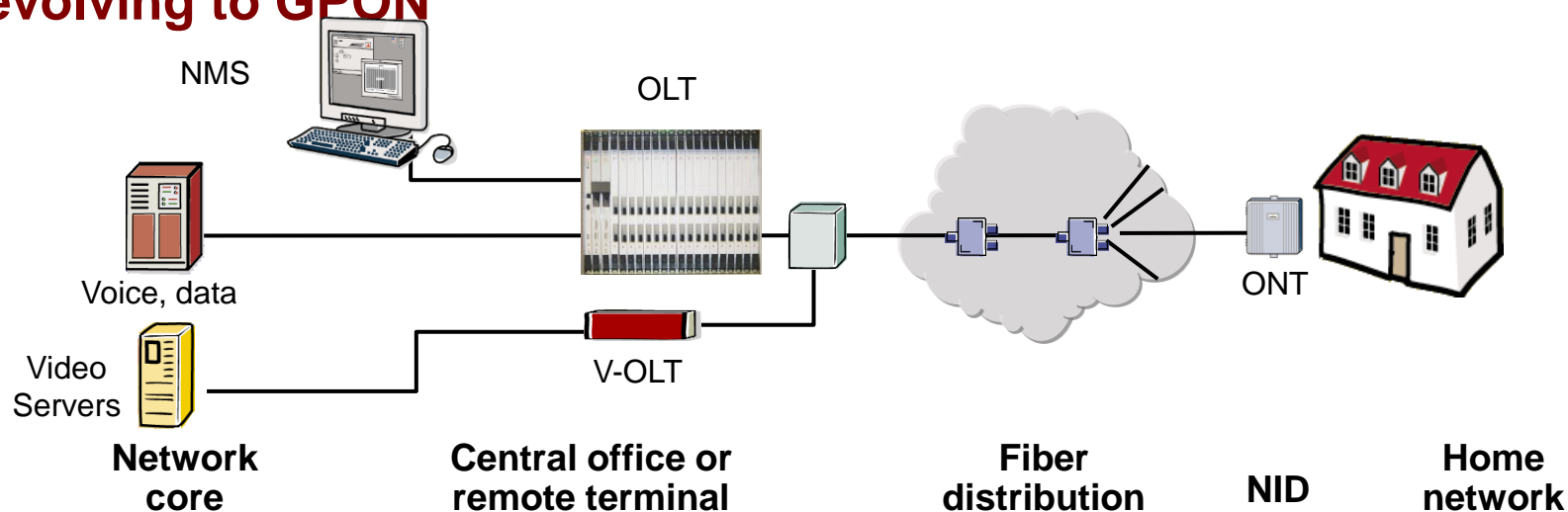
The Internet of Everything is here

Massive surge in connected things has already begun

25B

permanently connected things by 2020*

Over half of these devices will be non-handsets

Lights   Speakers   PEV   Security Cameras   Home Appliances

Smarter

2x — Connected devices in household by 2020

1000x — Anticipated data traffic growth driven by more connection and richer content

More connected

~75% — US 18-24 year olds reach for smartphone immediately after waking up

~7B — Cumulative smartphone sales estimated 2013-2017

Sources: Machina Research, April '13, IDC Mar '13; Gartner Sept '13

Applying mobile technologies to everything

Making them more aware, connected, intelligent and interactive

People

Devices

Objects

Machines

Places

逢甲資訊行動計算實驗室
http://mclab.iecs.fcu.edu.tw

>200 MILLION
Wearable device shipments in 2018

10 billion IoT
devices
in **2021**

81.5 billion
U.S. dollars
in **2021**

逢甲資訊行動計算實驗室
http://mclab.iecs.fcu.edu.tw

Lab – Speed Test (i-Learn Lab)

■ 請完成Speed Test,使用Google輸入speed test並執行之或下載任一網速APP,

■ 上傳測試(5G, Wifi或有線Internet)結果截圖,上傳時訊息中記得註明你的學號姓名.

■ Due: next Lab time
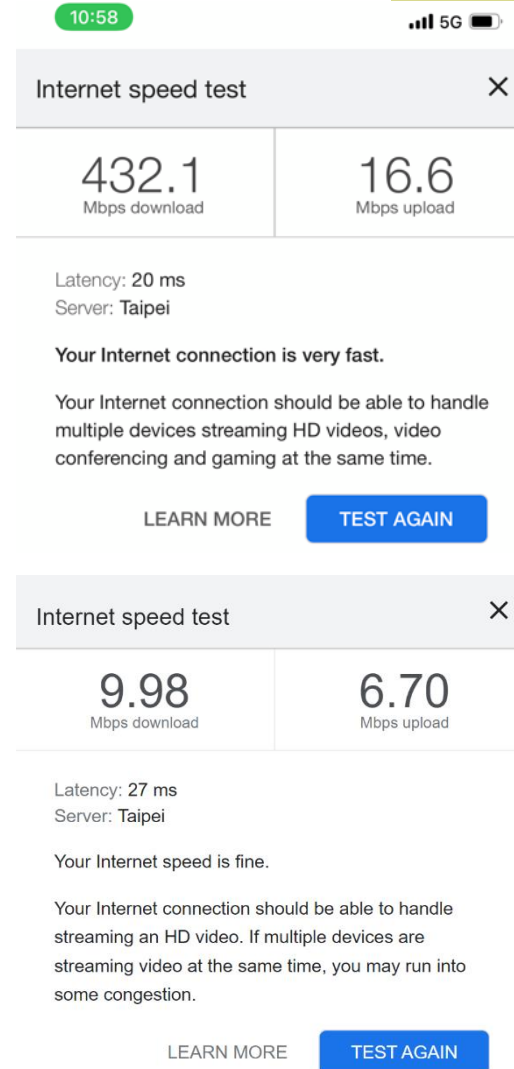
Special Topic Presentation (1/2)

- 報告日期
  - 11/29 (三)
  - 12/06 (三)
  - 12/13 (三)
  - 12/20 (三)

- 每組二人
- 選一個寬頻網路相關主題
  - 公告於iLearn
  - 提供20多個主題
  - 先選先贏!
- 每組報告10分鐘
- Q&A 5分鐘
- 8-12張投影片
- Youtube Demo

逢甲資訊行動計算實驗室
http://mclab.iecs.fcu.edu.tw

Special Topic Presentation (2/2)

Special Topics 清單 10/4 2:00pm 開放選擇,先選先贏

請回饋擬選擇的主題,二位組員學號與姓名

(如主題重複,後選擇者請重新選擇)　　　　　　.

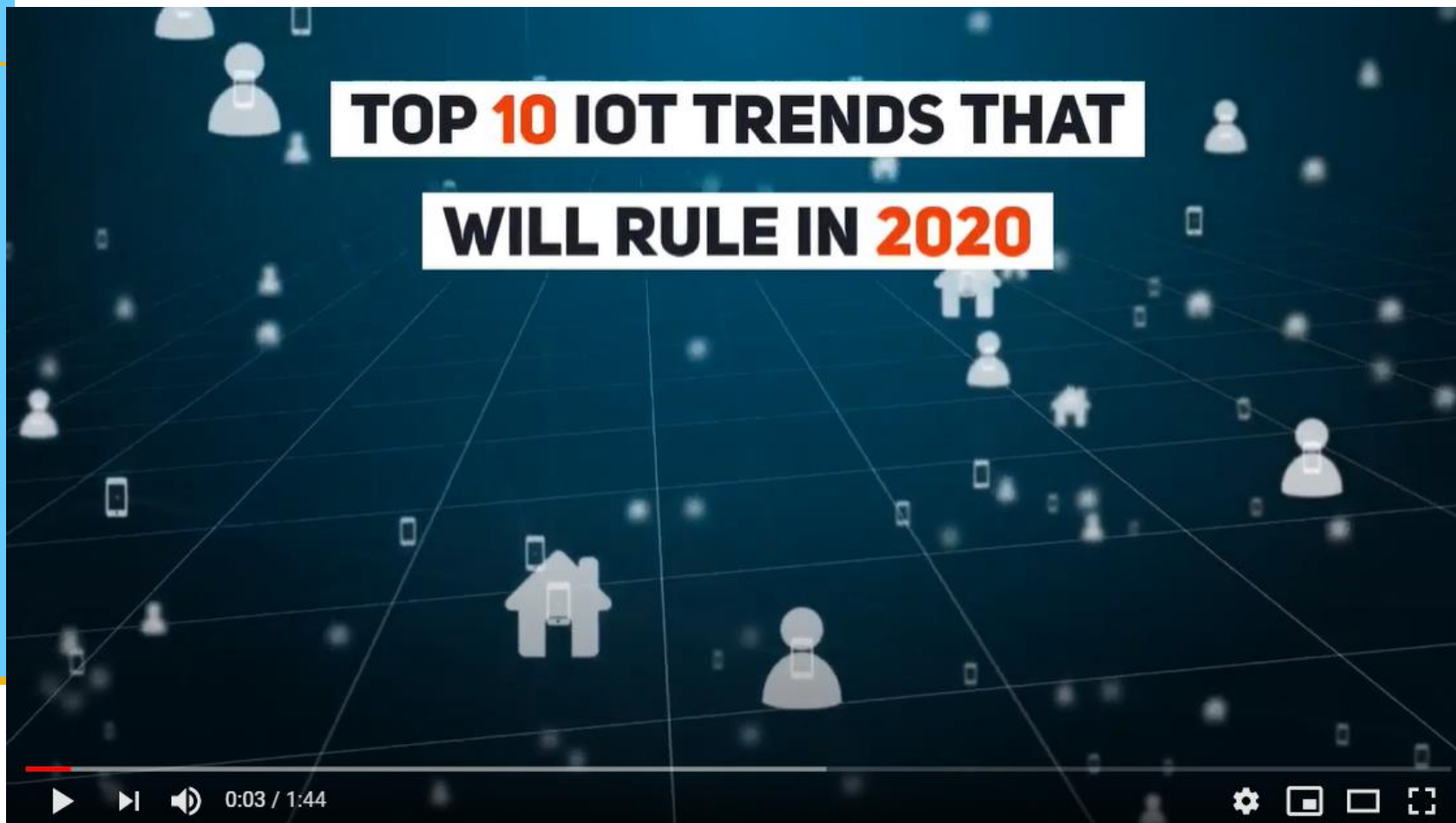|		
1.Metaverse	2.eXtended Reality (XR)	3.Immersive Technology
4.Virtual Assistants	5.Augmented Analytics	6.Digital Twins
7.Quantum Computing	8.Exoskeleton	9. Brain-Computer Interface
10.Internet of Behaviors	11.Smart Spaces	12.Smart Dust
13.Smart Fabrics	14.4D Printing	15.Anywhere Operations
16.Empowered Edge	17.Edge AI	18.AI-driven Development
19. AI PaaS	20.Autonomous Things	21.Autonomous Driving Level 5
22.Volumetric Display	23.Flying Autonomous Vehicles	

5G cities of the future

Reuters

Cloud Computing Battle
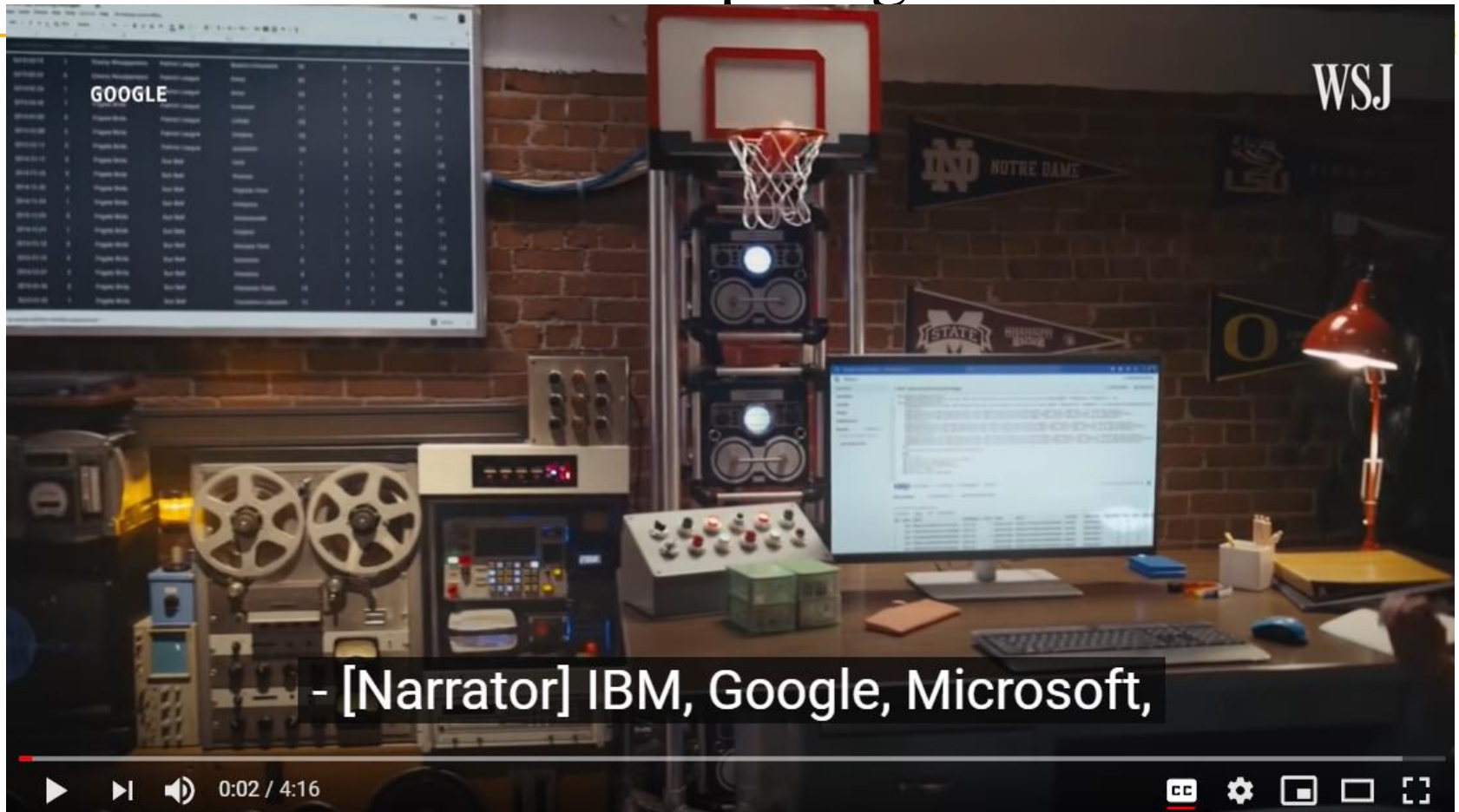
Wall Street Journal

What is IoT?

TechAhead

http://mclab.iecs.fcu.edu.tw