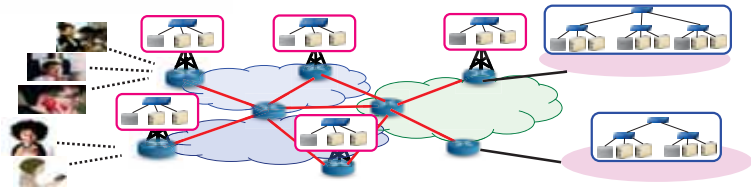


Multi-Cloud Global Application Delivery for Smart Cities



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International Summit on Smart World and Smart Cities,
 Fremont, CA, USA, Aug 5, 2017

These slides and a recording of this talk are available on-line at:
<http://www.cse.wustl.edu/~jain/talks/smrtwrld.htm>



1. What's smart about smart cities
2. Multi-clouds for Smart Cities
3. Cyber Security for Smart Cities
4. Blockchains for Smart Cities and Cyber Security

Trend: Smart Everything



Smart Watch



Smart TV



Smart Car



Smart Health



Smart Home



Smart Kegs



Smart Space



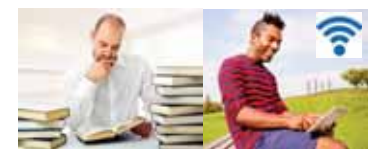
Smart Industries



Smart Cities

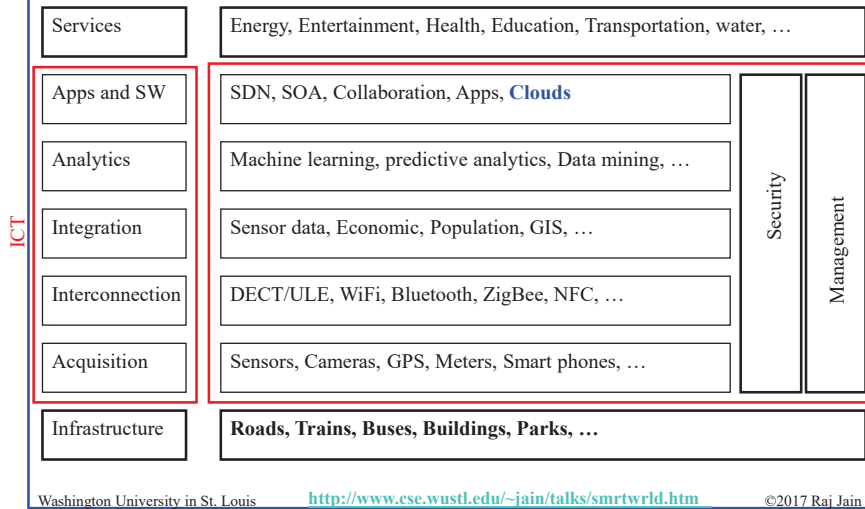
What's Smart?

- ❑ Old: Smart = Can think \Rightarrow Computation
 = Can Recall \Rightarrow Storage
- ❑ Now: Smart = Can find quickly, Can Delegate
 \Rightarrow Communicate = Networking
- ❑ Smart Grid, Smart Meters, Smart Cars, Smart homes, Smart Cities, Smart Factories, Smart Smoke Detectors, ...



Not-Smart Smart

A 7-Layer Model of Smart Cities



5

Areas of Research for IoT/Smart Cities

1. PHY: Smart devices, sensors giving real-time information
2. Datalink: WiFi, Bluetooth, ZigBee, IEEE 802.15.4, ...
Broadband: DSL, FTTH, Wi-Fi, 5G, ...
3. Routing: Mesh networking, ...
4. Analytics: Big-data, data mining, Machine learning, Predictive analytics, ...
5. Apps & SW: SDN, SOA, Cloud computing, Web-based collaboration, Social networking, ...
6. Applications: Remote health, On-line education, on-line laboratories, ...
7. Security: Privacy, Trust, Identity, Anonymity, ...

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6

Trend: Micro-Cloud Computing

- ❑ Cloud computing was invented in 2006
- ❑ Then: Cloud = Large Data Center
Multiple VMs managed by a cloud management system (OpenStack)
- ❑ Today: Cloud = Computing using virtual resources
 - μ Cloud = Cloud in a server with multiple VMs.
 - Each VM with Multiple Containers \Rightarrow Multiple Services

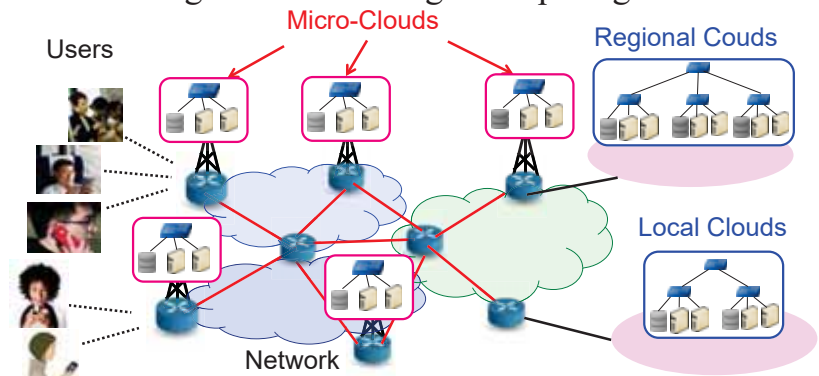


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7

Trend: Mobile Edge Computing

- ❑ To service mobile users/IoT, the computation needs to come to edge \Rightarrow Mobile Edge Computing



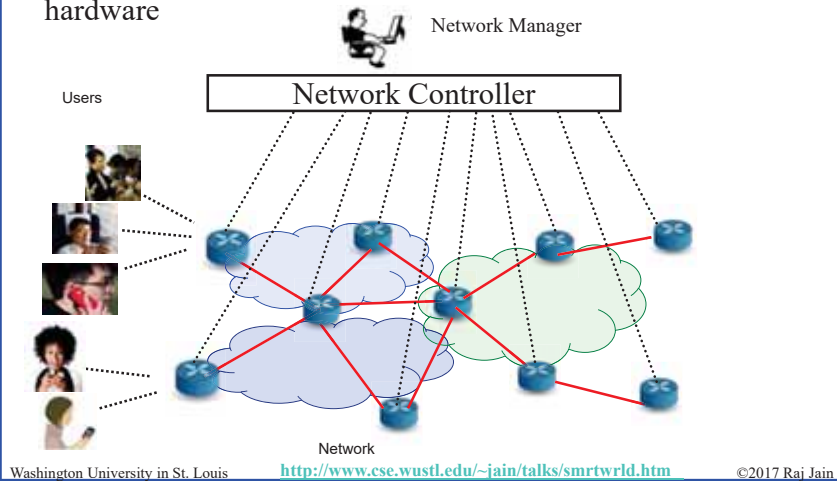
Ref: Lav Gupta, Raj Jain, H. Anthony Chan, "Mobile Edge Computing - an important ingredient of 5G Networks," IEEE Softwarization Newsletter, March 2016, <http://www.cse.wustl.edu/~jain/papers/mec16.htm>

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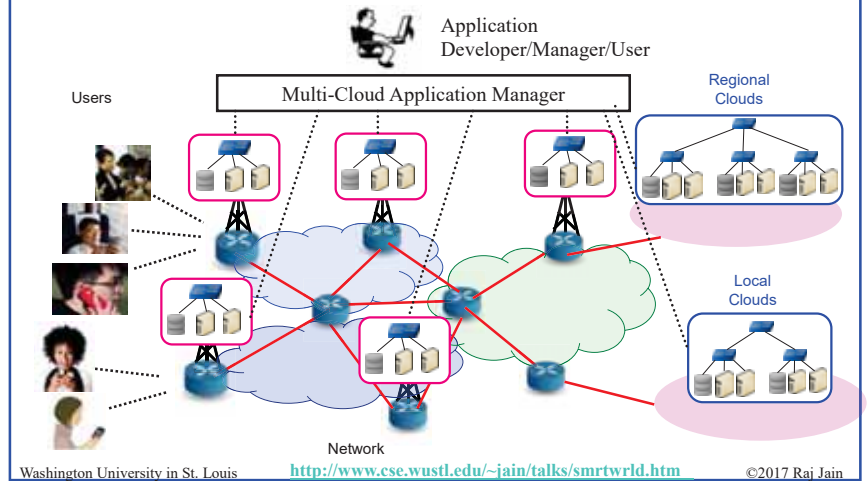
Past: Software Defined Networking

- Network can be managed w/o worrying about individual device hardware



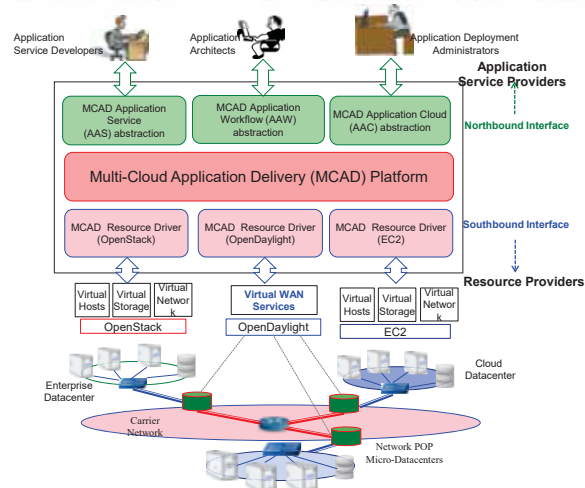
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Software Defined Multi-Cloud Application Delivery



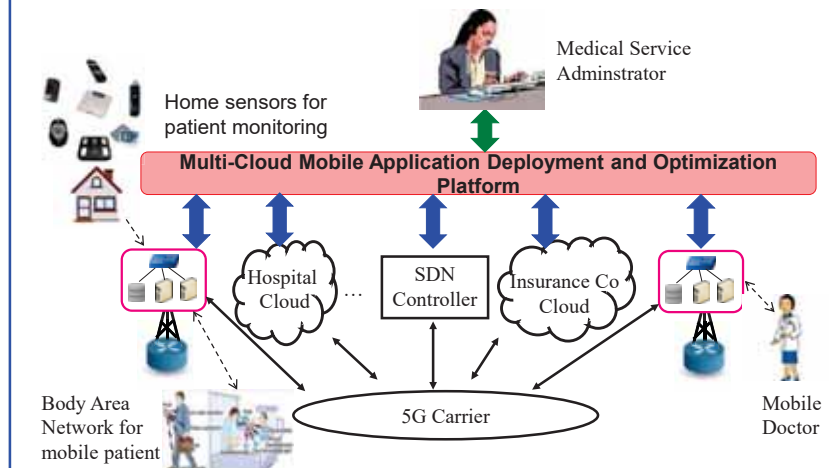
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OpenADN Multi-Cloud Management



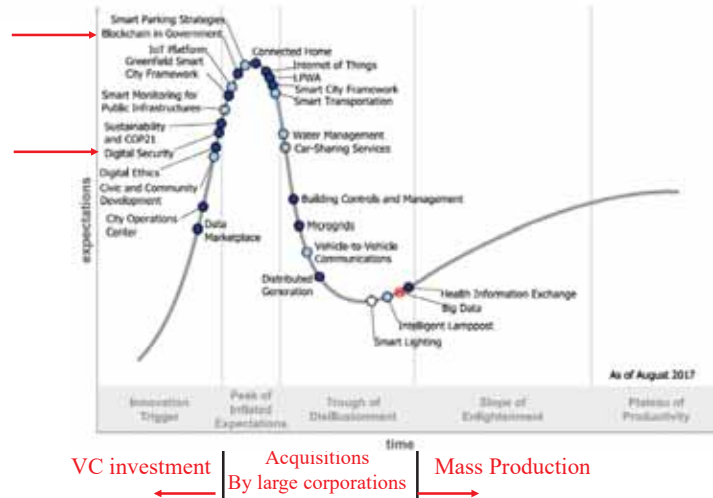
11

Mobile Healthcare Use Case



12

Gartner Hype Cycle for Smart City Tech 2017



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13

Security: Attack Surface

1. **Users**
2. **Sensors**
3. **Wireless access technology:** DECT, WiFi, Z-wave, ...
4. **Gateways:** Smart Phone
5. **Home LAN:** WiFi, Ethernet, Powerline, ...
6. **IP and higher layer protocols:** DNS, Routers, ...
7. **Clouds**
8. **Management Platform:** Web interface
9. **Life Cycle Management:** Booting, Pairing, Updating, ...



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14

DEFCON



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15

DEFCON (Cont)

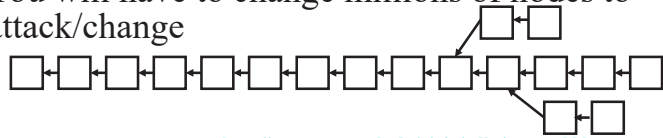
- Hacking the cloud
- Hacking voting machines
- Hack connected vehicles
- Hacking travel routers
- Breaking the Uber badge ciphers
- Clone RFID in real time
- Safe cracking robots
- GPS Spoofing
- Abusing Microsoft Office
- Hacking wind farm control network
- Counterfeit hardware security devices
- Fool antivirus software using AI
- How to track government spy planes
- Break bitcoin hardware wallets

Ref: <https://www.ethicalhacker.net/features/opinions/first-timers-experience-black-hat-defcon>
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16

Blockchain Origin: Bitcoin

- ❑ Blockchain is the technology that made Bitcoin secure
- ❑ After Bitcoin became successful, people started looking into the technology behind Bitcoin and found Blockchain is the key for its success
- ❑ Two complete strangers can complete a transaction without a third party
- ❑ A singly linked chain of blocks of verified signed transactions is replicated globally on millions of nodes
- ❑ You will have to change millions of nodes to attack/change



Blockchains For Cities

- ❑ Land titles
- ❑ Vehicle registries
- ❑ Business license
- ❑ Criminal records
- ❑ Passports
- ❑ Birth certificates
- ❑ Death certificates
- ❑ Building permits
- ❑ Gun permits

Blockchains for Network Security

- ❑ Certificate Authorities issue certificates
 - Single Point of Failure
 - CA Keys are often compromised (Diginotar – Dutch certificate authority was compromised in 2011)
- ❑ Web of Trust: Anyone can issue a certificate
- ❑ Blockchain solution: Store user ID and public key
 - Blockstack
 - Certcoin



Summary

1. Smart \neq High-Speed Computation, Smart \neq Big Data Storage, Smart = Networked
2. Smart Cities research areas are easy via the 7-layer model
Research issues in every layer: Sensors, datalink, routing, applications, analytics.
3. Clouds are getting smaller, Carriers and enterprises moving to clouds, leading to clouds everywhere \Rightarrow multi-cloud
4. Our MCAD abstracts/virtualizes the cloud interfaces and allows automated management of security and other policies of multi-cloud applications
5. Cyber security is important for smart cities and blockchains may offer a potential solution to some problems.

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Acronyms

- ❑ ATM Asynchronous Transfer Mode
- ❑ ECN Explicit congestion notification
- ❑ EFCI Explicit Forward Congestion Indication
- ❑ FECN Forward Explicit Congestion Notification
- ❑ GB Gigabyte
- ❑ IEEE Institution of Electrical and Electronic Engineering
- ❑ IETF Internet Engineering Task Force
- ❑ IoT Internet of Things
- ❑ IP Internet Protocol
- ❑ IRTF Internet Research Task Force
- ❑ ITU International Telecommunications Union
- ❑ LAN Local Area Network
- ❑ LTE Long Term Evolution
- ❑ MHz Mega Hertz
- ❑ OpenADN Open Application Delivery Networking
- ❑ SDN Software Defined Networking

Acronyms (Cont)

- ❑ TCP Transmission Control Protocol
- ❑ TV Television
- ❑ VM Virtual Machine
- ❑ WAN Wide Area Network
- ❑ WiFi Wireless Fidelity
- ❑ WiMAX Worldwide Interoperability for Microwave Access

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