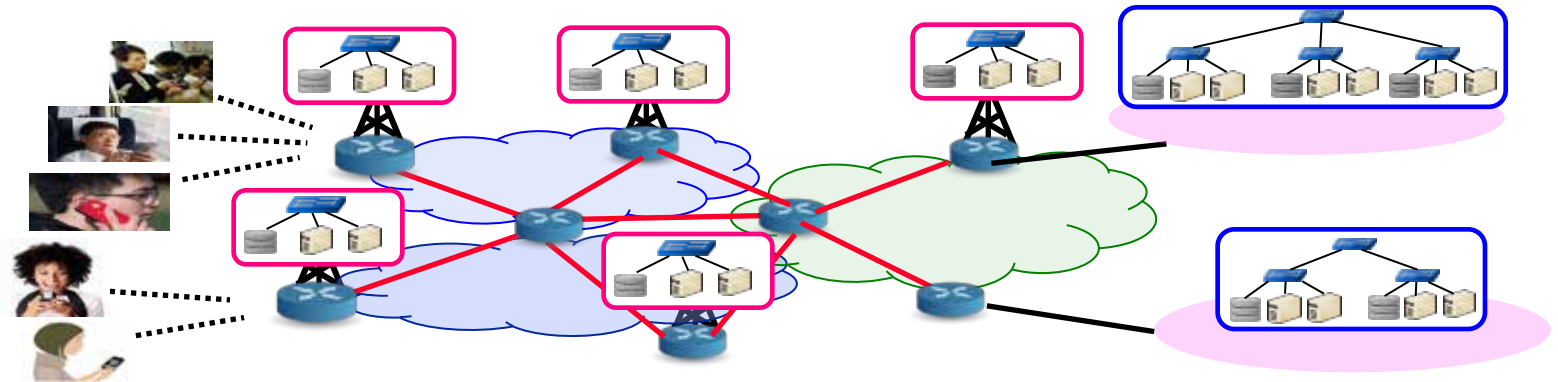


Multi-Cloud Global Application Delivery for Smart Cities



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These slides and a recording of this talk are available on-line at:

<http://www.cse.wustl.edu/~jain/talks/smrtwrlld.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



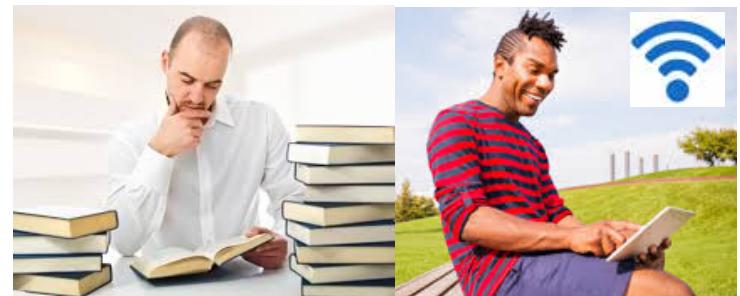
Smart Industries



Smart Cities

What's Smart?

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

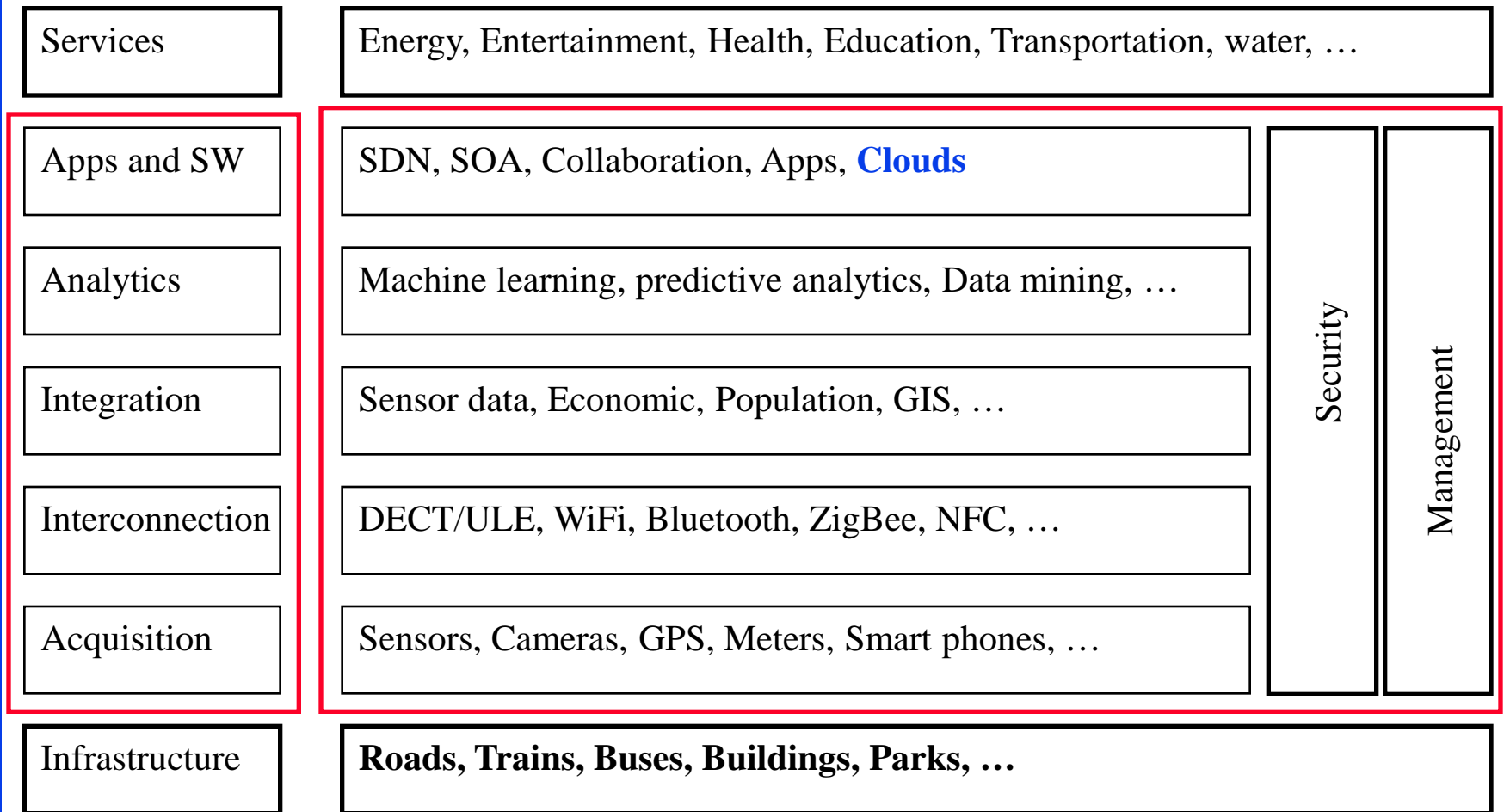


Not-Smart

Smart

A 7-Layer Model of Smart Cities

ICT



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, ...

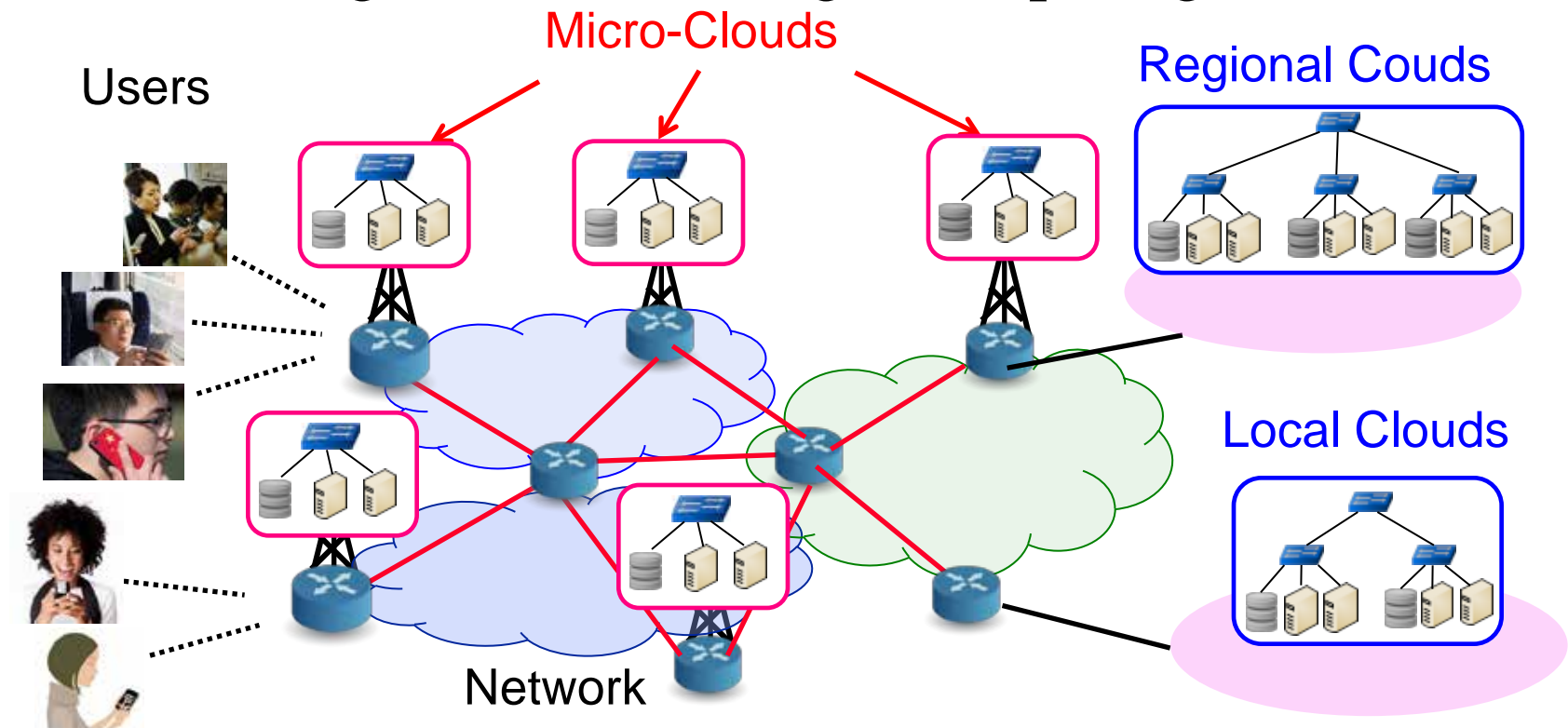
Trend: Micro-Cloud Computing

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



Trend: Mobile Edge Computing

- q To service mobile users/IoT, the computation needs to come to edge
- ▮ 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>

Past: Software Defined Networking

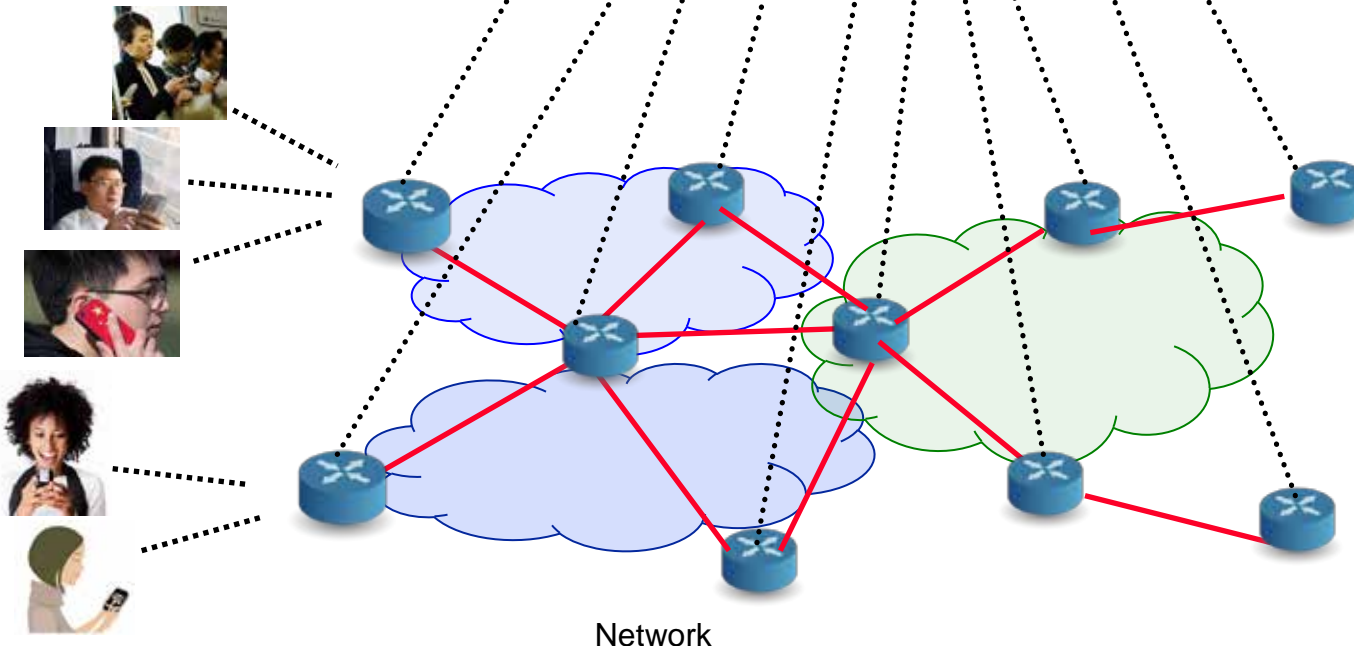
- Network can be managed w/o worrying about individual device hardware



Network Manager

Users

Network Controller

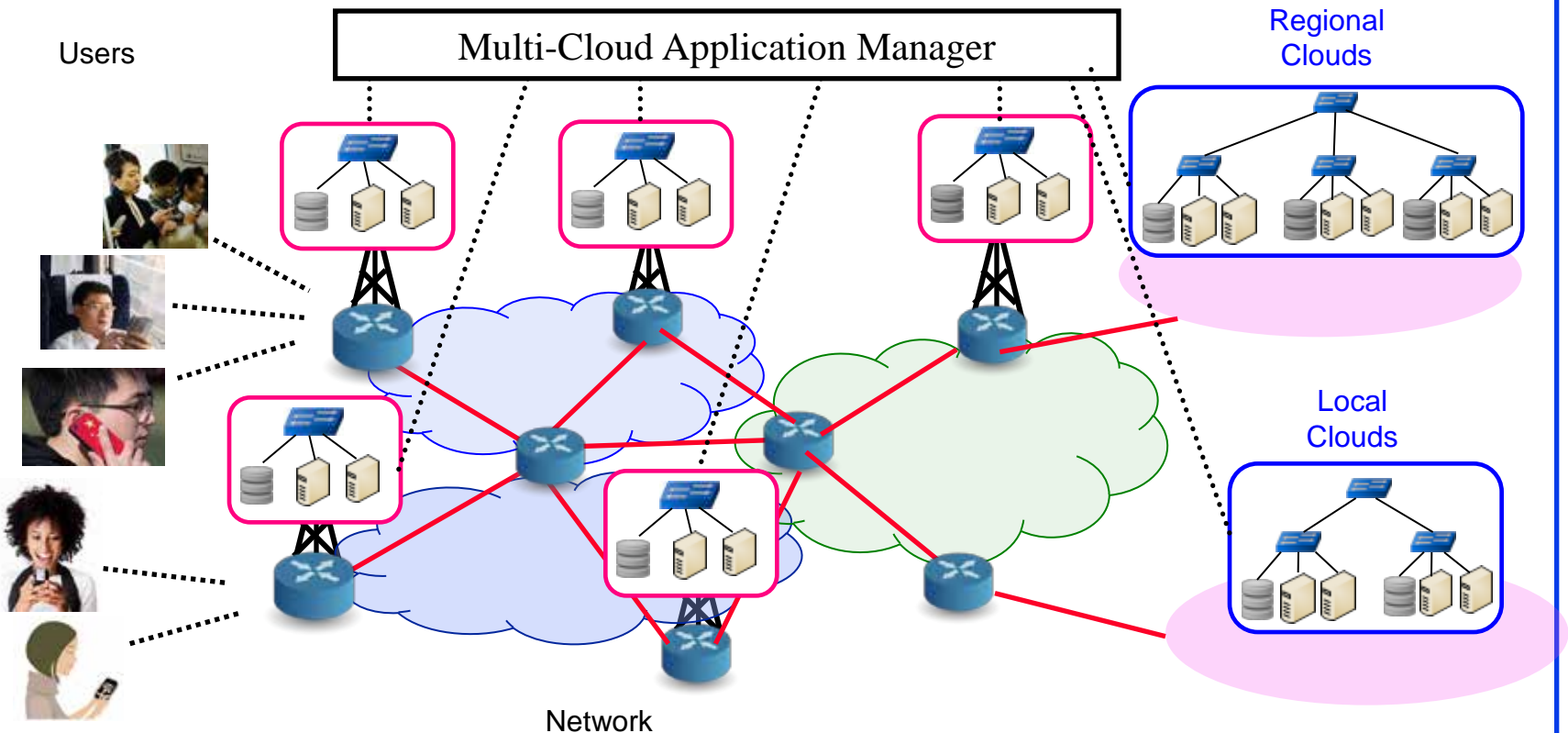


Network

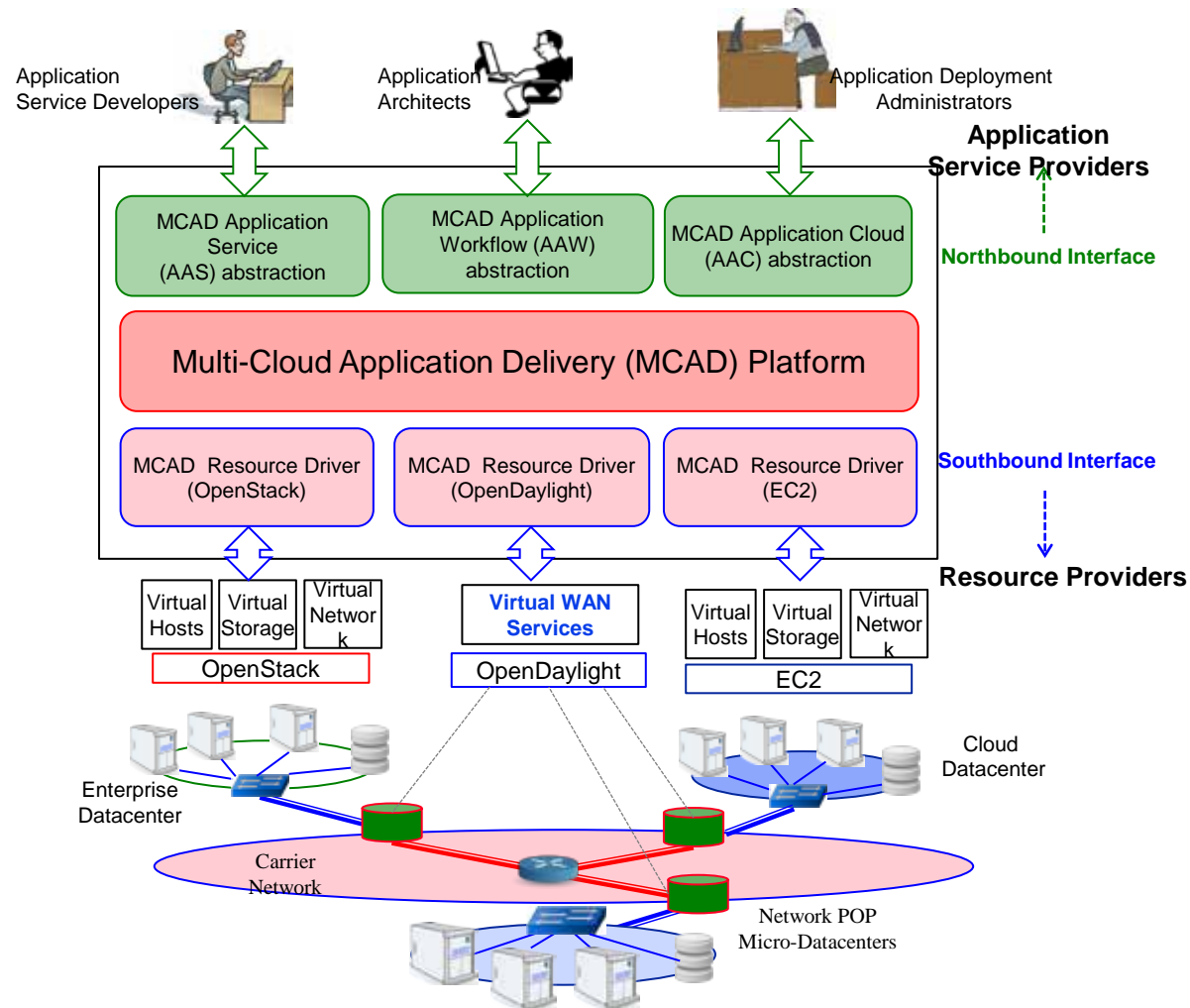
Software Defined Multi-Cloud Application Delivery



Application Developer/Manager/User

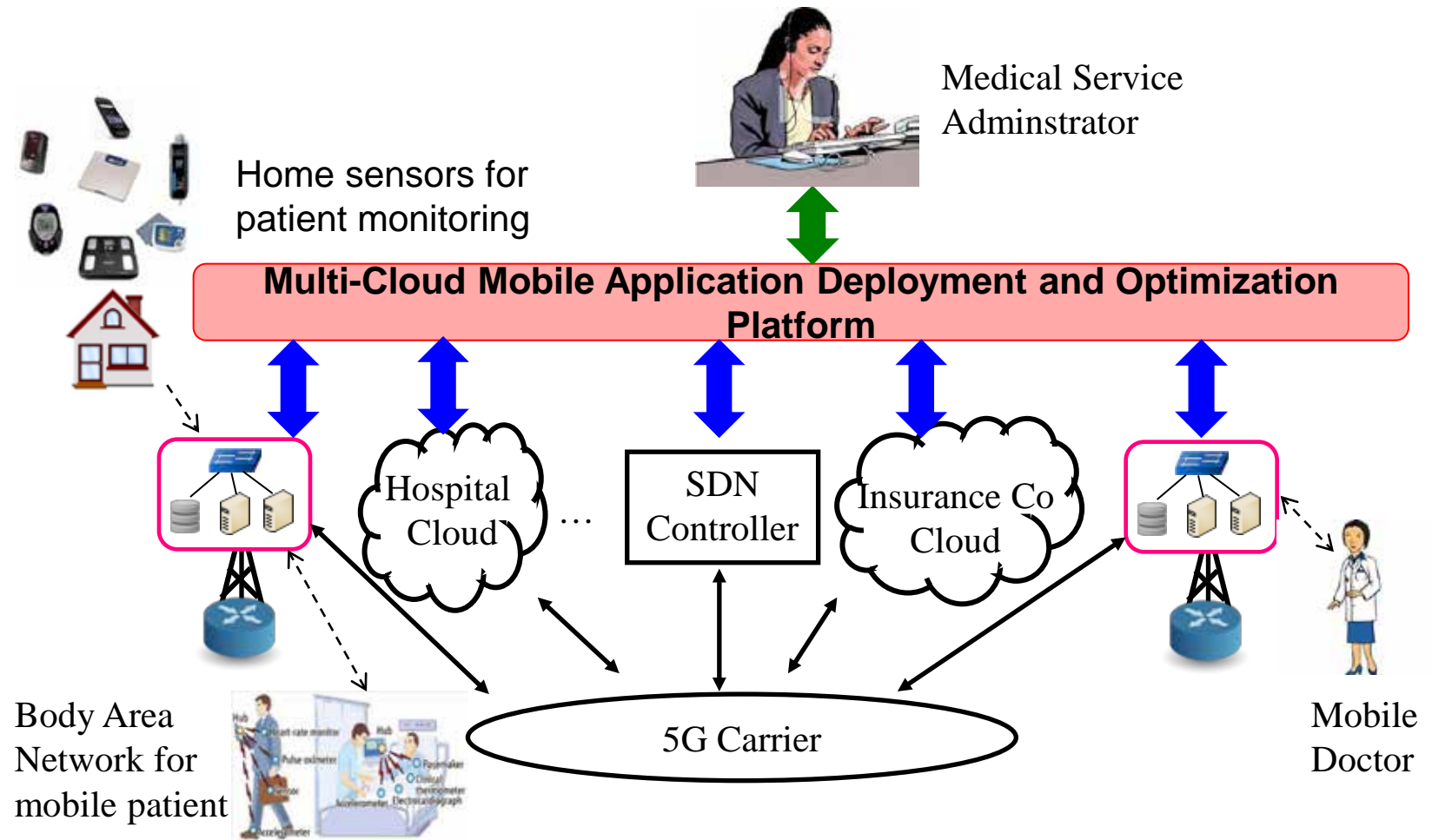


OpenADN Multi-Cloud Management

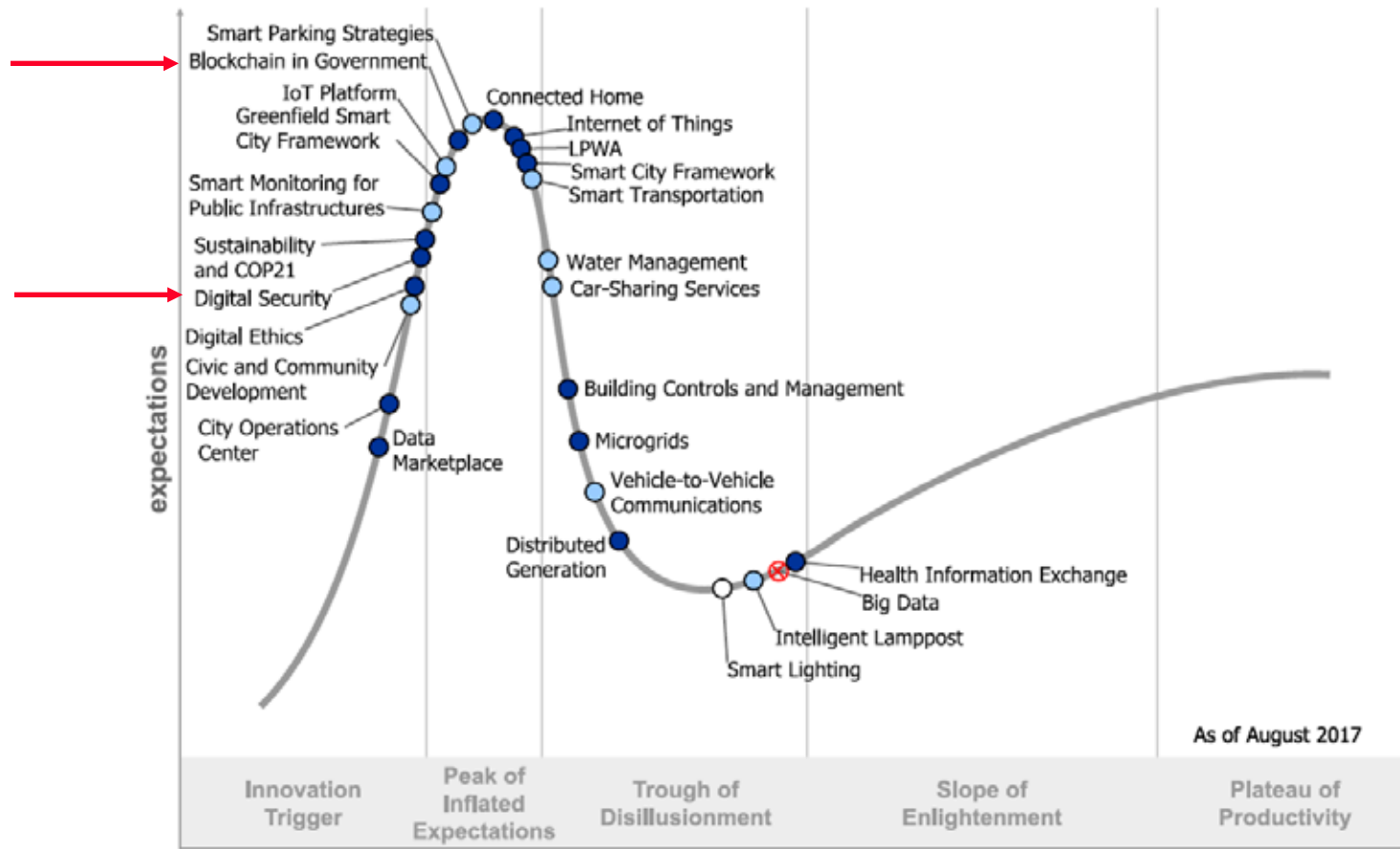


Ref: Lav Gupta, Raj Jain, Mohammed Samaka, "Analysis of Application Delivery Platform for Software Defined Infrastructures," International Journal of Communication Networks and Distributed Systems, 2016, Vol. 5, <http://www.cse.wustl.edu/~jain/papers/ijcnds16.htm>

Mobile Healthcare Use Case



Gartner Hype Cycle for Smart City Tech 2017



VC investment | Acquisitions | Mass Production
 ← By large corporations →

Ref: Bettina Tratz-Ryan, "Hype Cycle for Smart City Technologies and Solutions, 2017," Gartner Report G00314338, 2 Aug 2017

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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, ...



Users

Things

Access

Gateway

WAN

Cloud

DEFCON



DEFCON (Cont)

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

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

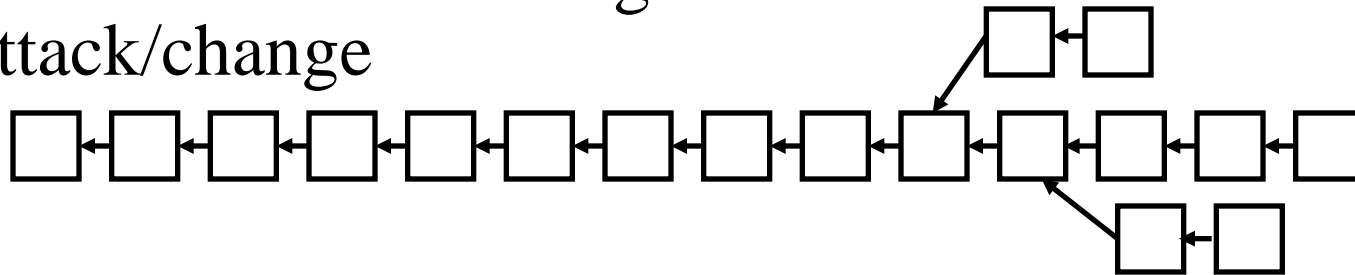
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Blockchain Origin: Bitcoin

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



Blockchains For Cities

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

Ref: <http://ledracapital.com/blog/2014/3/11/Bitcoin-series-24-the-mega-master-blockchain-list>

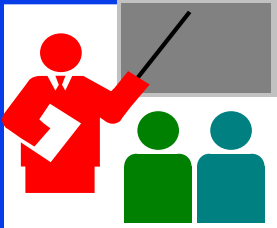
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Blockchains for Network Security

- q Certificate Authorities issue certificates
 - ∅ Single Point of Failure
 - ∅ CA Keys are often compromised
(Diginotar – Dutch certificate authority was compromised in 2011)
- q Web of Trust: Anyone can issue a certificate
- q 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

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

Acronyms (Cont)

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

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