

# Fog Computing for Mobile Cloud



# Outline

- Fog Computing Definitions
- Why Fog Computing?
- Fog Computing System Architectures
- Fog Computing Advantages
- Fog Computing Characteristics
- Fog Computing Applications
- Fog Computing Security Issues
- Conclusion

# Fog Computing Definition

# Fog computing definition (1/2)

- What is Fog computing?
  - It is a term introduced by Cisco to ease wireless data transfer to distributed devices in IoT paradigm.
  - New paradigm that extend cloud virtualized resources and services to edge of network.
  - Data, computation and resources runs closer to user location instead of cloud.
  - Developed to deal with the demands of continuous increasing no. of IoT devices.
  - Efficient platform for the internet of things (IoT)
  - It keeps data right where the IoT need it

# Fog computing definition (2/2)

- Cisco define fog computing as?:
  - It is a term introduced by Cisco to ease wireless data transfer to distributed devices in IoT paradigm.
- Other definition
  - Extending the traditional cloud computing paradigm to the edge of network, enabling creation of refined and better applications or services.
  - Highly virtualized platform, which provides computation, storage, and networking services between end node in IoT and traditional clouds.

Why Fog Computing?

# Cloud Computing Limitation

- Cloud computing suffer from
  - High latency
  - Client access link
  - Security shortcoming
  - Not supporting all variety of device with capacity and network restriction
    - memory, storage, processing, bandwidth etc.
  - Not ideal for delay-sensitive application or services
  - High capacity (bandwidth)
  - Connectivity to cloud is pre-requisite of cloud computing
  - Long distance between client devices and server-long delay

# Cloud Computing Limitation–Solution

- Fog Computing can
  - Reduce data movement across network
    - Reduce congestion
  - Eliminate bottlenecks
    - Centralized computing system
  - Enhancing Security of encrypted data
    - Data closer to end-user.
  - Local processing
    - Reduces core network load and ease the burden of processing data.
  - Empower devices with capacity and network restrictions
    - Memory, storage, processing, bandwidth, etc.

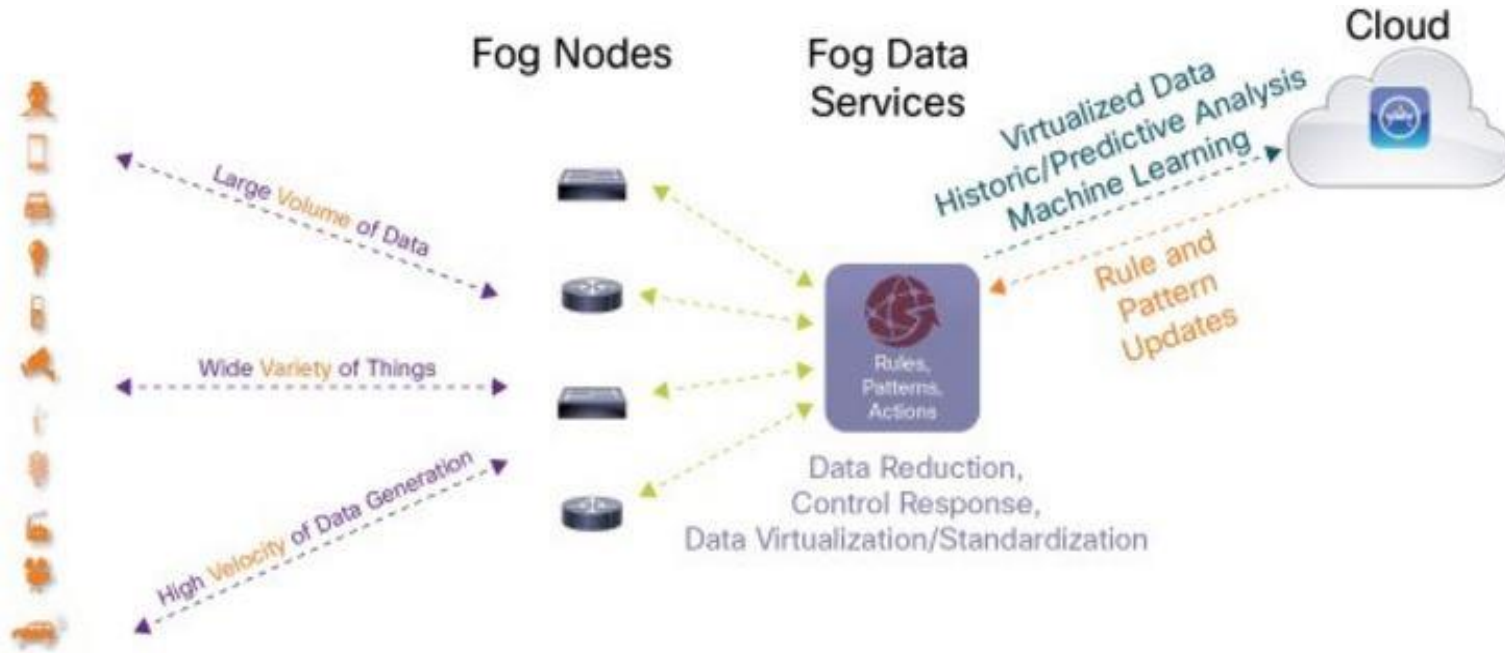


# Comparison between Fog and Cloud

Requirments	Fog Comuting	Cloud Computing
Latency	Low	High
Security	Can be defined	undefined
Delay jitter	Very low	High
No. of server nodes	Very large	Few
Support for mobility	Supported	Limited
Real time interaction	Supported	Supported
Location of server node	At the edge of network	Within the internet
Location awareness	Yes	No
Attack on data enrouter	Very less probability	High probability
Distance between client and server	One hop	Multiple hops
Geographical distribution	Distributed	Centralized

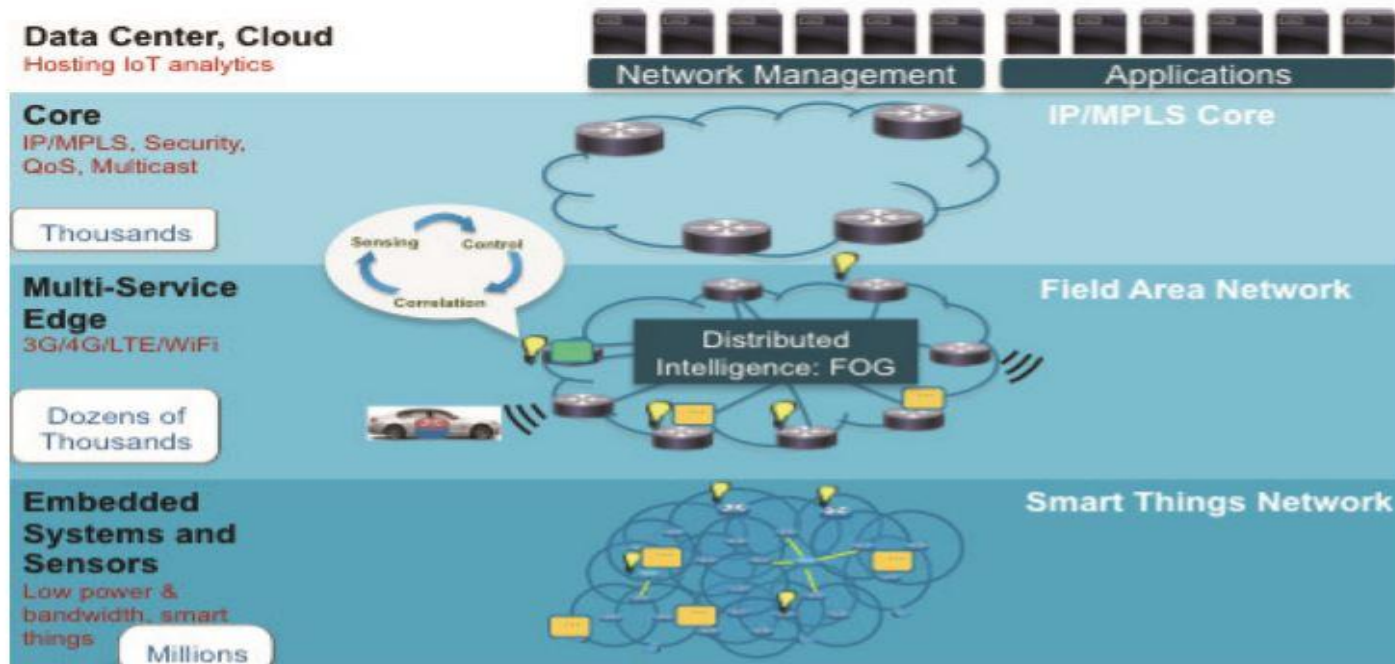
# Fog Computing System Architectures

# System Architecture—Cisco

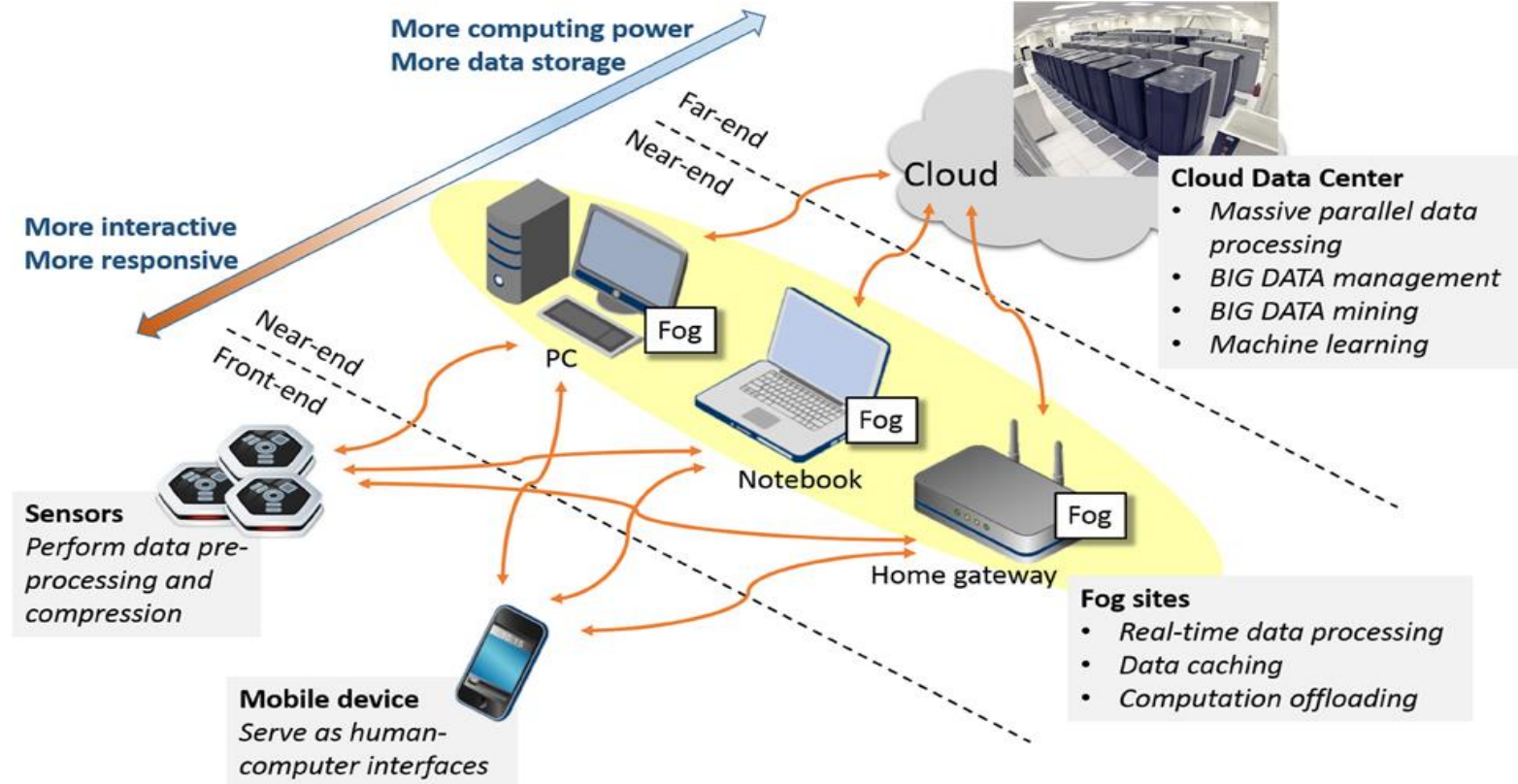


# System Architecture–Others (1/3)

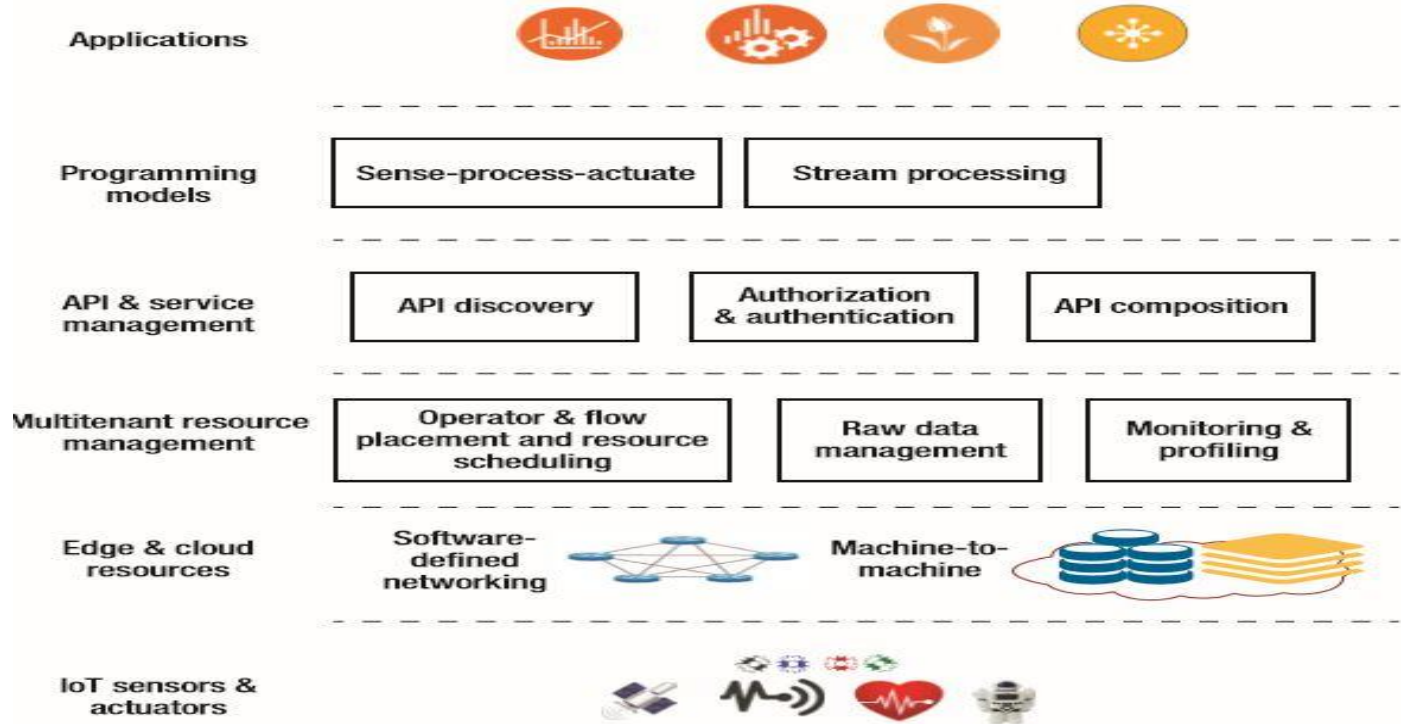
## The Internet of Thing Architecture and Fog Computing



# System Architecture–Others (2/3)



# System Architecture–Others (3/3)



# Fog Computing Advantages

# Fog Computing Advantages

- Bringing data closer to user location
- Efficient support for mobility and IoT
- Seamless integration with other services
- Easy adaption of Fog computing concept
- Provides fast respond for delay-sensitive application and services



# Fog Computing Characteristic

# Fog Computing Characteristics

## Real-Time Interactions

- Needed for speedy services.

## Geographical distribution

- Services and application widely distributed.

## Mobility supports

- Provide mobility techniques such as decouple host identity to location identity.

## Location awareness

- Support endpoint with best services at the edge of network.

## Security

- Support Strong Security

## Programmability

- Support Multiple applications

## Heterogeneity

- Implement fog node in wide environment

## Interoperability

- Ability to interoperability to support wide range of services

# Fog Computing Applications

# Fog Computing Applications

- IoT
- Smart Grid
- Smart Cities
- Health Care
- Wireless Sensor
- Connected Cars
- Smart Traffic Lights
- Software Defined Networks (SDN)
- Decentralized Smart Building Control

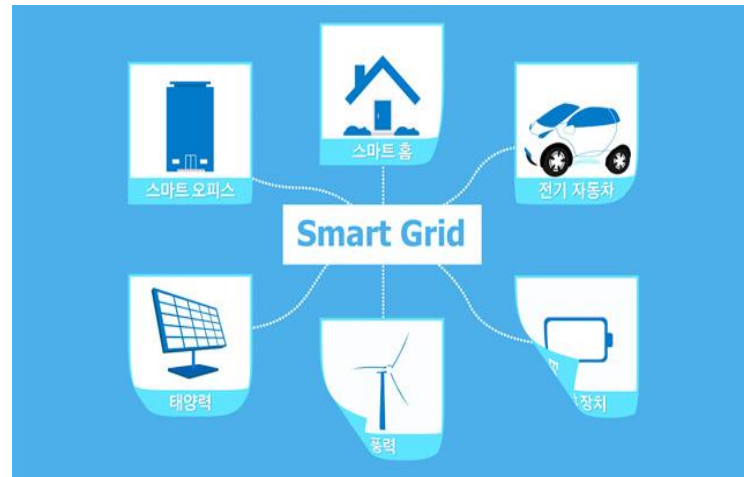
# Fog Computing Applications (1/9)

- IoT
  - Fog computing can
    - Support the rapid growth of internet connected devices
    - Connect variety of smart devices to internet



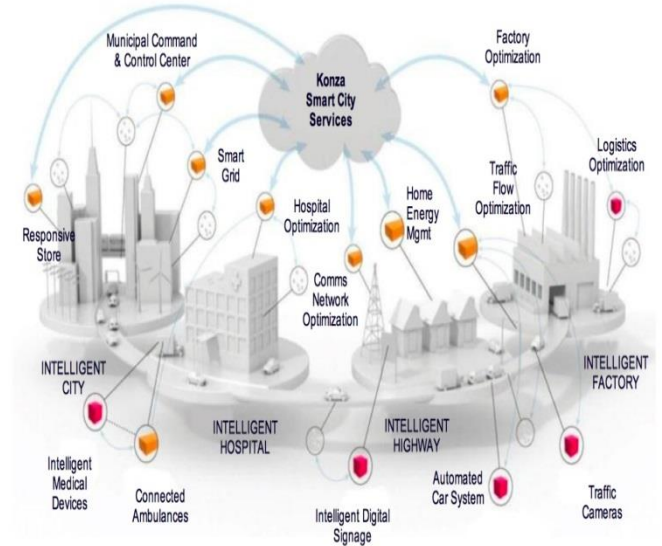
# Fog Computing Applications (2/9)

- Smart Grid
  - Fog computing can
    - Allow fast machine-to-machine handshakes
    - Allow fast human-to-machine interactions (HMI)



# Fog Computing Applications (3/9)

- Smart Cities
  - Fog computing can
    - Support new advanced City Services, applications, etc.
    - Obtaining Sensor data
    - Integrate all mutually independent network entities within.



# Fog Computing Applications (4/9)

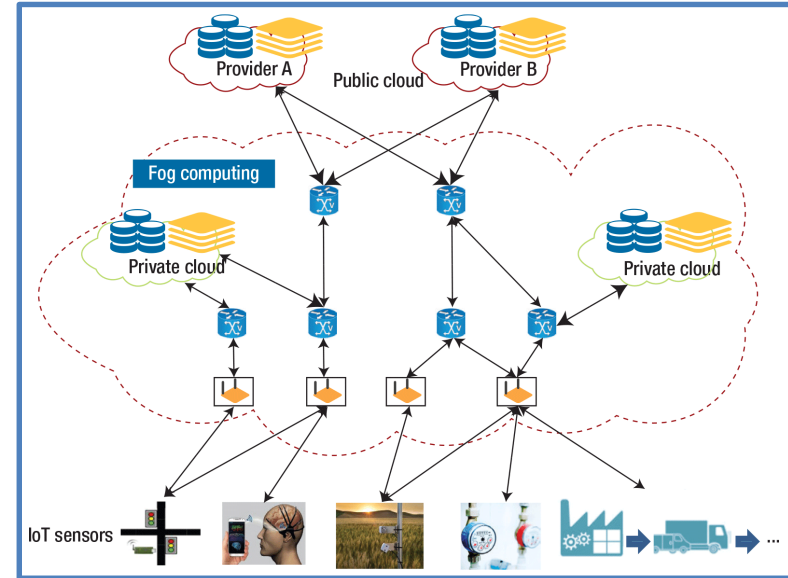
- Health Care
  - Fog computing can provides
    - Fast collection and storing of data
    - Fast analysis of critical data and act on it.
    - Easy access by all party (Doctor, nurse, etc.)
    - Daily in the hours monitoring of person health care





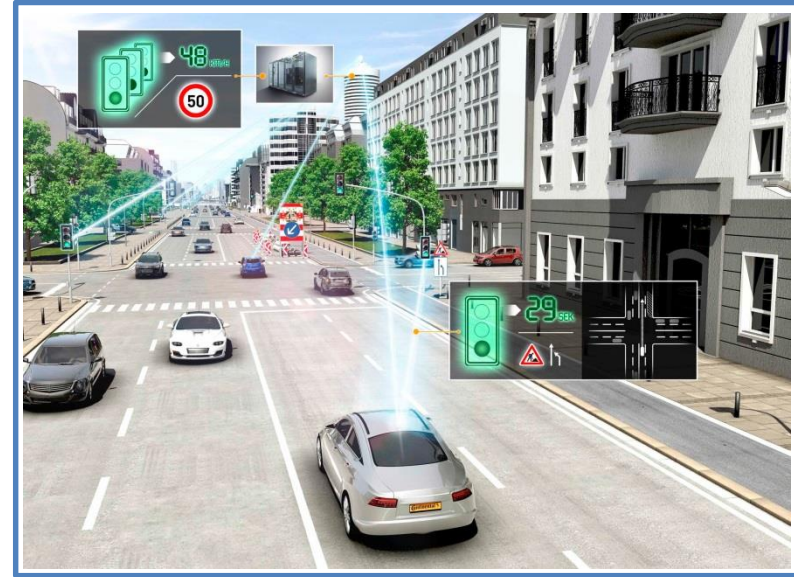
# Fog Computing Applications (5/9)

- Wireless Sensor
  - Fog computing can
    - Improve wireless sensor performance
    - Fast collection of data sensor
    - Fast respond time



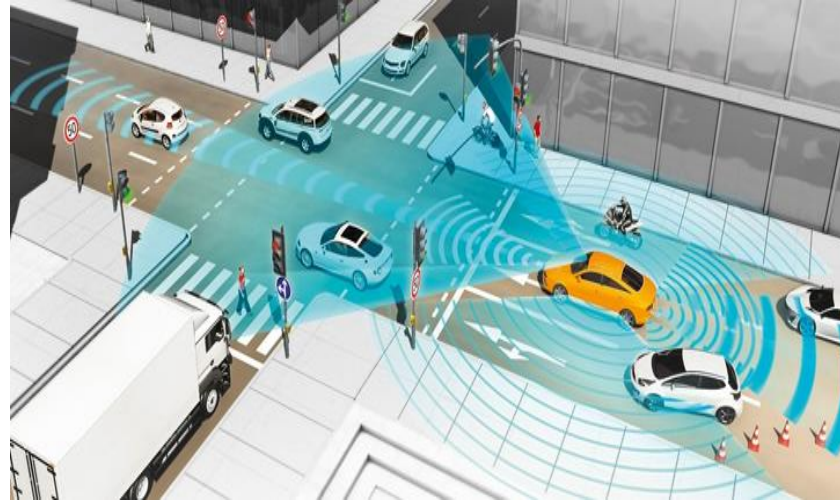
# Fog Computing Applications (6/9)

- Connected Cars
  - The communication between cars, access points and traffics lights can be safer and efficient.



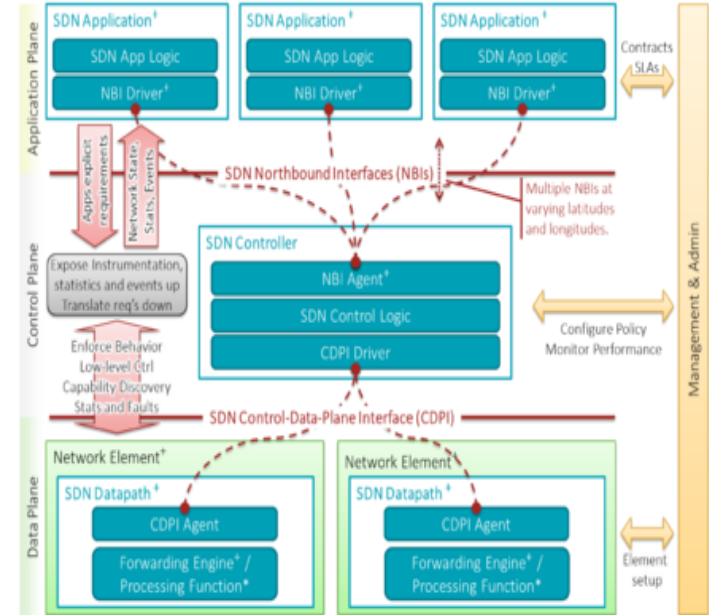
# Fog Computing Applications (7/9)

- Smart Traffic Lights
  - It can warning drivers if
    - Pedestrian are in their path
    - Changes of traffics lights
    - Not paying attention to other cars



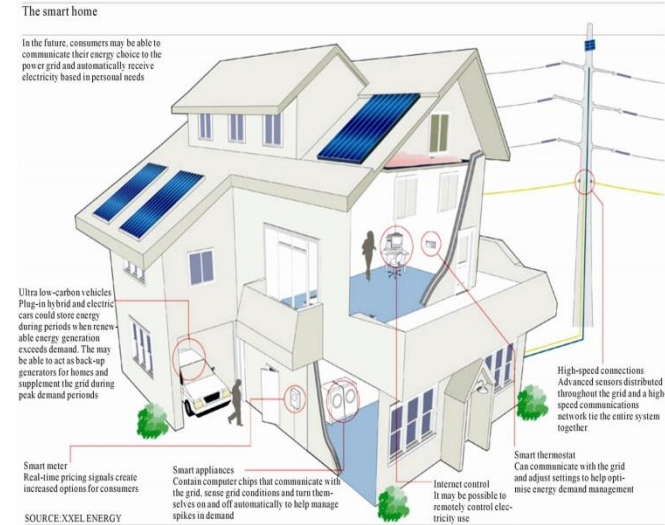
# Fog Computing Applications (8/9)

- Software Defined Networks (SDN)
  - Can resolve issues in
    - Vehicular networks
    - Intermittent connectivity
    - Collision and High Packet Loss rate



# Fog Computing Applications (9/9)

- Decentralized Smart Building Control
  - Help Smart Cities and Building to
    - Manage energy consumption (heating, ventilation, air conditioning, lights, etc.)
    - Manage/control smart home appliances
    - Remote monitoring indoor and outdoor for security



# Fog Computing Security Issues

# Security and Privacy Issues

Rogue fog node

Trust and  
Authentication

Man-in-the-middle  
attack

Malicious Fog  
Node Problem

Malicious  
Detection  
Technique

Secure and private  
data computation

Data Protection  
and secure data  
storage

# Conclusion

- Fog computing new paradigm that can extend cloud computing virtualized resources and application to the edge of network.
- Help to overcome cloud computing shortages and issues.
- Empower smart devices to overcome their restrictions.
- Improve the performance of many services and applications.